

CAEN SyS 2017 Product Catalog

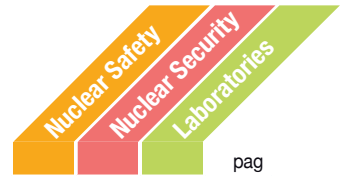


Systems and Spectroscopy Solutions



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MISSION

Develop radiation detection instruments and solutions with added value and operational benefit for our customers, enhancing safety through nuclear measurements

WHO WE ARE

CAEN SyS has a strong knowledge on nuclear measurement, developing Radiation Measurements Systems and Spectroscopy Solutions applied to operations within Nuclear Fuel Facilities, Nuclear Power Plant, Measurements Laboratories and Security premises.



CAEN has traditionally demonstrated by collaborating with very large international research projects (LHC@CERN, ALMA@ESO, DEAP@SNOLAB, ICARUS@LNGS, XMASS@Kamioka....) the ability to well understand customers' needs and translate their expectations in cost-effective and very reliable solutions.

CAEN SyS is focused on providing its nuclear measurement expertise and technical support, offering radiation detection products and systems that help operators to minimize their Operational Expenses with on-time delivery and with a high degree of quality, safety and security.

WHAT WE DO

CAEN SyS nuclear measurement products and systems covering, among many others:

- Health Physics , Spectroscopy and Radiation Measurements Systems
- Custom Nuclear Measurement Systems: Plant, Waste, Safeguards, Security
- Nuclear Waste characterization products and solutions
- Spectroscopic survey of large surfaces with real-time mapping information
- Detection of gamma and neutron sources ; RPM Radiation Portal Monitor
- Identification of gamma radionuclides and SNM detection
- Networking of Radiation detectors and Robotics solutions
- Safeguards and Security products for non-proliferation and threats
- Fuel Cycle process monitoring and Fuel characterization;
- Fresh & Spent Fuel Burn-up solutions/measurements
- Nuclear Emergency Preparedness : Training, Products and Systems
- Site Remediation studies; products and solutions for mitigation plans

PARTNERSHIP

To further increase its capacity and knowledge in nuclear applications, CAEN Group has already structured privileged partnerships and collaboration agreements for research and technology cooperations with INFN (Italian National Institute of Nuclear Physics) and the Universities of Padova and Ferrara. CAEN is also expanding its collaboration network worldwide (US, ASIA and EU) with Industries, National Laboratories and Academics entities.

CAEN SyS established a privileged industrial strategic partnership with:





Believe in Digitization... Developing a Solution

We believe that Nuclear Operations could be improved through the implementation of novel and enabling technologies such as smart sensors, virtual reality, wireless transmission, data fusion and data mining integration.

Such Digitization could be seamlessly implemented in many operations such as Plant and Facilities Maintenance activities as well as Process Control and Data Review Management.

CAEN SyS is mastering such technologies and is implementing custom-specific Business-Case integrated solutions ready to be used and easy to be handled by customer specific data management systems (typically owned and controlled by Nuclear Operators)

Innovative solutions... customers' tailored systems

CAEN SyS is fully mastering the whole product development chain: Modeling, Detectors, Processing Digital Electronics, Applied Software, Data Base, Network Management, Data Mining & Digitization of Processes (D&D and Waste, Maintenance, etc.).

Starting from this basis and through the collaboration with CAEN the FlexiSpec platform has been developed.

FlexiSpec is a Flexible gamma Spectrometry data acquisition and signal management platform that uses Multi-Parametric Digital Pulse Processing (DPP) for Spectroscopy applications.

It is an adaptable, multi-purpose complete platform (HW & SW) which can be easily

tailored for matching customer needs and readapted for different measurement conditions. FlexiSpec platform has been successfully used in disparate fields and applications, among them the innovative solutions realized by CAEN here mentioned:

- VeryFuel for IAEA: a fast neutron counting system for safeguards and non proliferation activities
- Multi-detect DAQ for DHRUVA project @ BARC: a data acquisition system for gamma ray spectroscopy of fission fragment nuclei
- Single Photon Emission Computed Tomography (SPECT): a Compton camera for medical imaging
- Relocatable Tagged Neutron Inspection System (C-BORD): a TOF detection system for Homeland Security
- Tap Water Monitoring (TAWARA): a water radioactive contamination monitoring system
- FlexiSpec for Dismantling and Decommissioning: a system for characterization of waste from nuclear power plants

Technology Innovation... a plus when is fully mastered

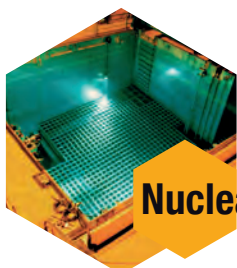


Details are of great value and CAEN SyS care about customer satisfaction when Innovation is implemented

CAEN SyS is continuously developing with CAEN new detection solutions for the frontier of the worldwide physics experiments, so CAEN SyS is exposed normally many years before the technology will become mature for other markets such as the nuclear Industry, and when is going to be implemented is already fully mastered by CAEN SyS experts.

AREAS

CAEN SyS is operating in three main areas:



Nuclear Safety



Nuclear Security



Laboratories

NUCLEAR SAFETY

CAEN SyS offers innovative nuclear measurement solutions to improve the safety of personnel and maintain the assets of a nuclear facility as well as to guarantee the safeguard of the public and the environment both inside and outside a nuclear site. An effective monitoring of the environment in all nuclear facilities is needed in order to ensure the safest good operation and an early warning/detection and identification of a potential accidental radiation release.

By providing innovative instruments and solutions, CAEN SyS helps to safely protect facilities assets, operators and the public.

- Health Physics Radiation Monitors and Systems
- Gamma Spectroscopy Systems : Portable & Laboratories
- Post accident remediation approaches
- Customized Nuclear Measurements Systems
- Mobile Laboratories for Environmental & Nuclear Emergencies
- Nuclear Fuel quality controls and characterizations
- Aerial radiological surveys; Radiological mapping of sites and large areas
- Radioprotection Solutions to support ALARA improvements; solutions for Nuclear Fast Response and Emergency Teams
- ISO CONTAINERS Laboratories : ISO Health Physics-module, ISO WBC-module, ISO Spectroscopy & Counting Lab module, ISO Clean access, ISO Hub module
- Technology solutions for contamination assessment, pre-Dismantling, Decommissioning and Radioactive Waste operations
- Measurement solutions to support SNM Transportation and temporary and long term storage integrity analysis
- Radioactive Waste digitization and spectroscopic processing monitoring (liquid and solid)



NUCLEAR SECURITY

With the recent increase of terrorist attack threats, CAEN SyS, strong of CAEN experience and know-how in designing multi-input electronics for all kind of radiation detectors, is capable of providing innovative systems to detect and identify Special Nuclear Material (SNM). Being CAEN constantly working with the most important agencies in the past years, all this experience is finally completed by CAEN SyS that brings these innovative solutions to the market.

- Radioactive sources and SNM Search identification and mapping
- Nuclear Industry Infrastructure access monitoring
- Security access and clearance areas
- Public access and infrastructure early warning detection
- Public and goods transportations
- RPM – Radiation Portal Monitor (Gamma-Neutron) for Vehicle, Pedestrian and Cargo radiation detection with SNM Identification



LABORATORIES

Thanks to CAEN experience in Nuclear Physics electronics, CAEN SyS is bringing a comprehensive set of instruments and experiences for laboratory applications. From Educational activities to specialized employees training, top performance nuclear radiation measurements are paramount to CAEN SyS that is becoming the new leader in laboratory solutions.

- Environmental sample analysis and Very High sensitivity measurements
- Multi detector experiments and measurements
- Mobile laboratories and Whole Body Counters (WBC)
- Educational, Training and Expertise development programs
- Gamma Spectroscopy systems (HpGe, NaI, LaBr, CdZnTe..)
- Active Coincidence and Anti-Compton Spectroscopic Systems



CAEN SyS
Systems and Spectroscopy Solutions

Waste, Decommissioning and Dismantling

FREE RELEASE WASTE ASSAY COUNTER

AURAS3000

MAIN FEATURES

- Free Release Assay of large waste containers up to 3 m³
- On-line weighing to 3000 kg and 1 kg resolution
- Full Quantitative Assay of all detectable gamma emitters, with non-gamma emitter estimates by correlated scaling factors
- Four large area HPGe detectors
- Individual and averaged activity and MDA reporting
- Automated computer control
- Extensive Safety Protection

DESCRIPTION

AURAS 3000 is A highly automated system for measuring a variety of sample sizes and forms (bags, boxes, barrels, B25 containers, etc...), with densities approximately in the range 100 kg/m³ to 2000 kg/m³. The system uses four mechanically cooled HPGe spectrometers.

The main parts of **AURAS 3000** are:

- Main rail with moving platform for materials to be monitored
- Cross rail with two detectors towers (2 HPGe each); the towers can be positioned to best fit the measurement geometry, and each detector can be independently moved along the vertical
- Remote PC control station and local PLC interface

Analysis of spectra is performed with a gamma spectrometry waste assay software operating under the control of a user interface developed with National Instruments LabVIEW.

AURAS 3000 is designed for heavy work and long life.



AURAS 3000

A sample container is first positioned by crane or forklift onto the heavy duty scanning platform. The operator starts the scan through the LabVIEW user interface, and chooses the container type to be scanned from a set table. This results in an adjustment of the detector position under computer control as required by the counting geometry. "Bookkeeping" data such as container

description is entered at this stage.

The scan commences and the heavy duty conveyor moves the container through the center of the four detectors, stopping to count at predetermined positions for predetermined count times along the range of travel. The container is weighed automatically by the online weighing system to a resolution of 1 kg.

The spectra from each detector/position combination are saved and analyzed individually using the gamma spectrometry waste assay software. An individual assay value for the container is calculated, based on each detector/position individually, and an averaged value is also calculated. If one or more values are in large disagreement with the averaged value, this is an indication of non-uniformity in the contents of the box. Individual and averaged MDA values are also calculated. Detection limits better than 0.01 Bq/g are generally achievable in a 40 minute count for low density materials.

TECHNICAL SPECIFICATIONS

Mechanical structure

- Max dimensions: 8,8 x 5,5 x 2,5 m³ (L x W x H)
- Total weight: 5000 kg

Linear actuators characteristics

- Max speed: 6 mm/s (50 Hz)
- Power supply: tri-phase
- Max force: 600 kg

Platform motor characteristics

- Max speed: 40 mm/s
- Rpm: 1400 (50 Hz)
- Power supply: tri-phase (0,55 kW)
- Max force (chain): 700 kg

Safety devices

- Thermal magnetic circuit breakers
- Electro-mechanical end-stop safety devices
- Perimetral barrier
- Emergency push buttons

Weighting device

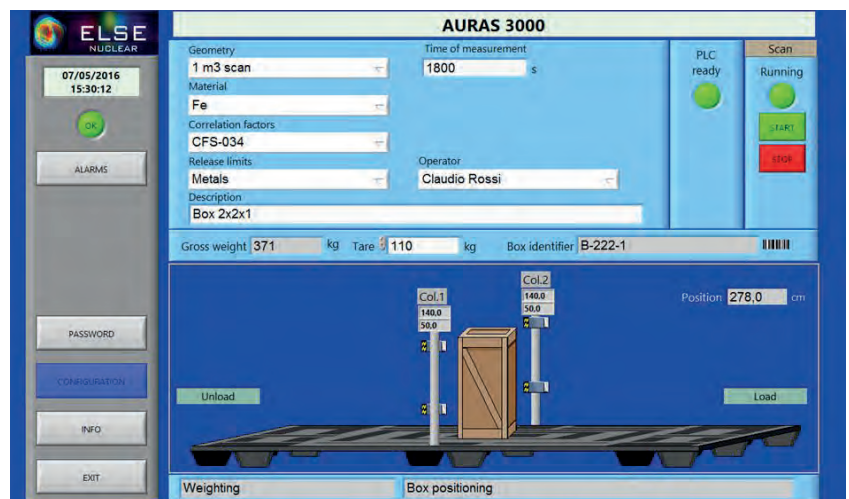
- Resolution: 1 kg

Management software

- Semi-automatic measurement procedure
- Detectors self-adjustment to the measurement geometry
- Post-processing of gamma spectrometry data
- Release report
- Correlation factors determination

OPTIONS

Please note that **AURAS 3000** stations can be adapted to specific requirements through a customization of the basic configuration here described. The customization can be applied to the mechanical layout of the rails (length) and/or to the measurement equipment.



AURAS 3000 software main panel



AUTOMATED DRUM MONITORING SYSTEM

ADAMOS series

MAIN FEATURES

- Detector: HPGe
- Energy range: 40 keV – 10 MeV
- Automatic drum centering and weighting function
- Drums size: up to 500 l and 2500 kg
- High precision density measurement device
- Local and remote operator interfaces
- Layers measurement of the drum's volume
- Analysis software for activity concentration measurements

DESCRIPTION

ADAMOS is a series of automated Segmented Gamma Scanner stations, designed to measure drums containing solid radioactive waste materials. Drum's radioactive content is measured in vertical layers by means of a collimated high efficiency HPGe detector: the drums are rotated by the support platform while the measurement is being performed, and the detector is moved to different heights to scan each layer (sub-section of the total volume).



The figure shows ADAMOS – SCINT/L model

The system also features an automatic centering function, an horizontally movable detector frame and a set of collimators; the correct measurement setup is automatically selected by the software based on the needed measurement type and the radioactivity level.

Multiple drums can be loaded on an input conveyor, then they are moved to the measuring position; after measurement they are expelled to an output conveyor for unloading. Drum sizes up to 500 l and 2500 kg are supported, with a density up to 2 g/cm³. Up to 8 drums can be measured in a fully automatic way (batch mode).

A highly reliable PLC manages all mechanical moving parts and machine security devices. Macro operations are executed by the PLC on the remote management software request. The operator can interact with the system through a local touch-screen panel PC (installed on the electronics main box) and a remote management PC. The whole machine status is constantly monitored by the software in order to catch failures or anomalous conditions.

A main feature of **ADAMOS** stations is that the density of the drum content can be determined for each vertical layer by means of a medium activity radioactive

source (as low as 10 mCi). This can be extremely useful in case of inhomogeneous materials.

A spectrometric analysis software is used for the determination of the activity concentrations. The system efficiency is pre-calculated by means of **MONTECARLO** simulations based on the measurement geometry and the density of the drum content. The measurement report may include information about correlated isotopes concentrations and possible hot-spot locations. Typical minimum detectable concentrations are of a fraction of Bq/g for 1 h measurement.

ADAMOS stations are equipped with several safety devices, to prevent any harm to operators and to the mechanical parts of the system:

- Main power supply switch located on the front of the electronics box
- Perimetral gridded fences with sliding and interlockable doors
- Emergency stop push-buttons located on the front of the electronics box and on the remote control keyboard
- Key switch for manual operation and area lock activation
- Emergency switch at the end of the unloading conveyor

TECHNICAL SPECIFICATIONS

Measurement features

- Energy range: 40 keV – 10 MeV
- Resolution (FWHM) for ^{60}Co (1332.5 keV): ≤ 2 keV
- Resolution (FWHM) for ^{57}Co (122 keV): ≤ 1.1 keV

Detector

- Type: HPGe
- Weight: 27,2 kg
- Power supply: 230 V
- Working temperature: $-10\text{ }^{\circ}\text{C} \div +50\text{ }^{\circ}\text{C}$
- Humidity: up to 100%
- Cooling time: < 5 hours

Electrical specifications

- Power supply type: AC, three-phase +N+G
- Power supply voltage: 400 V
- Absorbed current: 60 A
- Frequency: 50 Hz
- Protection grade: IP 55

Mechanical specifications

- Maximum dimensions:
W x H x D = 11800 x 2714 x 4205 mm
- Loading conveyors (each section): 300 kg

- Unloading conveyors (each section): 300 kg
- Central conveyor: 1125 kg
- Central structure: 1150 kg
- Electric axes (each): 230 kg
- Electronics box: 220 kg
- Weighting station:
 - max = 2500 kg
 - precision = $\pm 2,5$ kg

Counting and signaling electronics

- Digital MCA (16 k-channels)

Density measurement source

- Radionuclide: ^{22}Na
- Activity: 10 mCi
- Pb shielding thickness: 10 cm

Control console

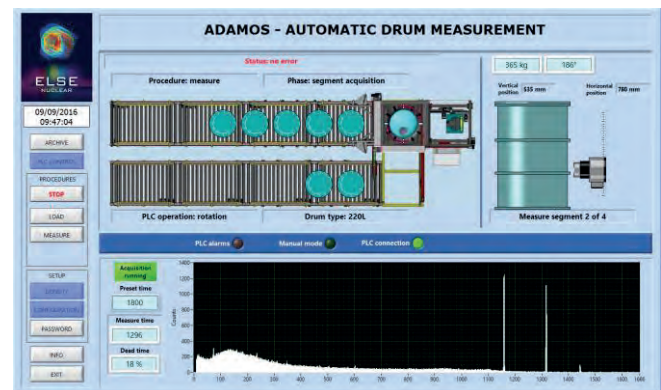
- Industrial touch-screen panel PC: LCD TFT 8.4"
- Remote management PC: desktop PC, with Ethernet/LAN board 100 Mbps (or better) and Color laser printer

Management software

- Graphic software for data analysis, visualization and storage
- Alarm and malfunctioning statuses management

OPTIONS

Please note that **ADAMOS** stations can be adapted to specific requirements through a customization of the basic configuration here described. The customization can be applied to the mechanical layout of the conveyors and/or to the measurement equipment. The particular system here described is ADAMOS HPGe/LD, one of the more complex developed until the present date



Software screenshot of ADAMOS – HPGe-U model



SPECTROMETRIC STATION WITH SCINTILLATORS FOR FREE RELEASE OF DECOMMISSIONING MATERIALS

FREE-AND 16

MAIN FEATURES

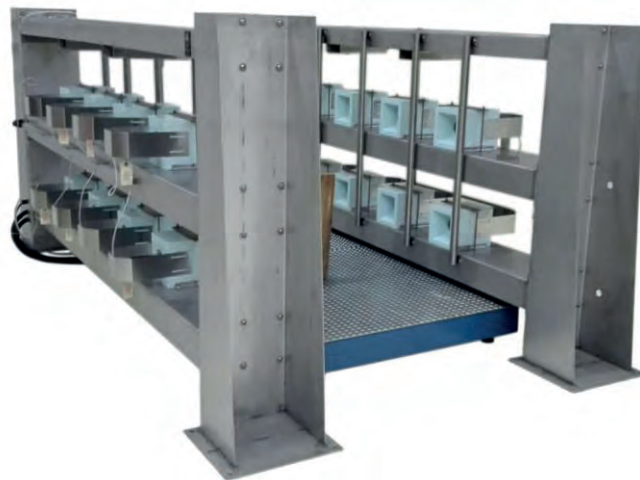
- Robust mechanical structure with weighting platform
- Detectors: 16 3"x3" scintillators with multichannel electronics
- Lead shielding/collimator for each detector
- Max container dimensions: 100 x 105 x 210 cm³
- Control PC with user-friendly software
- Geometries database and release limits calculation
- Data archive and production of exportable and shareable reports
- Self-diagnosis function and electrical protections

DESCRIPTION

The **FREE-AND 16** spectrometric station is a robust and handy system designed to perform the weighting and spectrometric analysis of materials, coming from nuclear power plants decommissioning activities. The performed measurements are typically used to determine the mass activity concentration.

The main components are:

- Two series of 3"x3" scintillator detectors (16 in total), one at each side of the weighting platform, equipped with multichannel electronics
- Mechanical support structure for detectors
- Weighting platform where the containers are placed
- Junction boxes mounted on the lateral supports, and control PC with user-friendly software



FREE-AND-16

The detectors are distributed in linear arrays of 4 units, two for each side. Each detector is mounted inside a lead shielding structure, which acts at the same time as a collimator: this way each scintillator "sees" a defined portion of the container volume.

The minimum achievable sensitivity that the system can reach is 0,04 Bq/g (15 minutes measurement, 300 kg of material, 1 g/cm³ density).

The mechanical support structure is made of AISI 304 stainless steel, which can well resist to the weight of the equipment and to accidental bumps that could happen while handling the containers in everyday use.

The weighting platform has a maximum limit of 6000 kg and a minimum sensitivity of 1 kg. Thanks to its dimensions, containers of different type and dimensions can be placed on the platform, up to a maximum of 100x105x210 cm³ (WxHxD).

The operator interacts with **FREE-AND 16** through a sophisticated yet easy-to-use software. To perform the measurement, the operator shall select the proper geometry from a previously defined database, then set the measure time; at this point the procedure automatically starts when the container is placed upon the weighting platform.

At the end of the process, and according to previously defined limits tables, the system calculates the release level of the material and it produces a complete report that can also be exported as a file. These files are automatically archived by the system.

To complete the software equipment, a user definable backup plan is available, as well as applications for the efficiency calculation, self-diagnosis functions, and the possibility to connect the system in an existing data network.

*NOTE: thanks to the geometry and the configuration of the spectrometric station, **FREE-AND 16** can be also used in other applications besides decommissioning, and it can be adjusted to the requirements as for dimensions and detectors number.*

TECHNICAL SPECIFICATIONS

Maximum dimensions

- WxHxD = 202x150x360 cm³

Detectors

- Type: 3"x3" scintillator crystal
- Number of units: 16 in total, 8 for each side, distributed on two lines of 4 units each
- Energy resolution: < 7,5 % for ¹³⁷Cs (FWHM at 662 keV)
- Multichannel photomultiplier base

Shielding/collimator of the detectors

- Dimensions: 20 x 20 x 25 cm³; 9,5 cm central hole

- Truncated-pyramid-shaped front, 40° aperture angle
- Thickness: 5 cm

Weighting system

- Maximum limit: 6000 kg
- Resolution: 1 kg
- Platform dimensions: 150 x 250 cm²
- Steel platform and framework

Power supply

- Voltage: 400V ± 10% - 48-50,5 Hz
- Distribution: TNS- triphase and neutral
- Automatic magneto-thermic switch

Control consolle

- Type: PC with printer
- Data communication: Ethernet LAN 100 Mbps

Management software

- Representation of detector – collimator – container
- Efficiency curves calculation
- Spectra elaboration to determine the mass activity (Bq/g)
- Geometry and radiological identification database management
- Customizable isotope release concentration limit table
- Customizable analysis reports and printing options
- Peaks marking with prompt fit display
- Calculation of the activities of non gamma-emitters using tabulated scaling factors
- Good functioning verification
- Results processing, printing and archive



FREE-AND-16 software main panel



AUTOMATIC RADIOLOGICAL MONITORING SYSTEM FOR PIPES

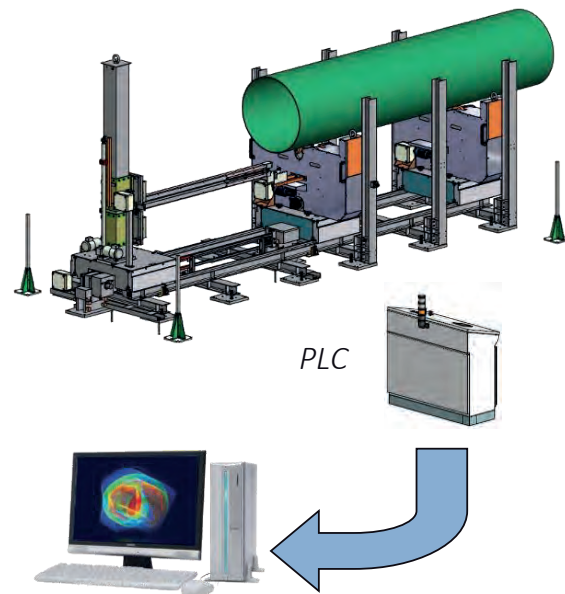
PIPE SCANNER

MAIN FEATURES

- Detectors: two pairs of plastic scintillators (250x45x20) mm³
- Detectors installed in two horizontal poles, scanning the internal and external surfaces of the pipe
- Pole support movable along the vertical direction
- Poles support truck movable along the railway toward the pipe and back to load position
- Movable support stations: pipe lodging and rotation devices
- Optical devices: determination of diameter and length of the pipe, as well as surface roughness check
- Control panel: interaction between operator and system, parameters setting, automatic measurement cycle management
- Safety devices preventing collisions between the movable parts of the system or damages to the structure and to the operators when the measurement cycle is activated

DESCRIPTION

The **PIPE SCANNER** system is designed to perform a complete and accurate radiometric scan of the internal and external surfaces of a pipe, tube, or similar conduit, e.g. coming from decommissioning of Nuclear Power Plants. The measurement cycle is totally automatic, carried out by the PLC sequences, which are managed by the software installed on the host PC. The user interface of the management software allows the operator to set the input parameters, the measurement settings, and to start the automatic cycle by a simple command on the touch-screen display. The system status is shown both on the display and on the alarm beacon.



Host PC for remote control

After loading the pipe the system runs a series of preliminary tests through optical devices: actual diameter and length measurement, and roughness check. When all the preliminary checks are carried out, the measurement cycle starts: the pipe is automatically divided in portions to be scanned by the detectors, according to its length, and for each section the system acquires the radiometric data. The system can also detect “hot spots” of contamination. At the end of the scanning a report is produced, with the reading of the surface contamination. Safety devices and a perimeter infrared barrier prevent any dangerous man/machine interaction.

The mechanical structure is composed by a rail line, on which are mounted two lodging stations for the pipes and the detection station.

The lodging stations are two robust support structures, manually movable on the railway; through the manual brakes installed on them, they can be fastened in a proper position along the railway, depending on the length of the pipe they have to sustain. In each support stations there is a pair of compass rollers: when the work cycle is started, they close and lift up the pipe and put it in rotation around its axis, at a proper speed depending on its diameter. The plastic scintillators are installed by pairs in the tip of two poles, mounted on a support vertical column. The detectors in the two poles face each other, in order to "see" both the pipe's surfaces, internal and external; depending on the diameter, the poles are positioned at the upper or the lower side of the cylinder. Moving the support station along the railway through PLC commands, the poles are inserted in the pipe allowing the scanning of each section of the surfaces.

TECHNICAL SPECIFICATIONS

Hardware:

- Detector poles:
 - Max speed: 6 mm/s (50 Hz)
 - Movement resolution: $\pm 1,5$ mm
 - Power supply: 3P (0,08 kW)
 - Max force: 600 kg
- Detector truck:
 - Max speed: 40 mm/s
 - Movement resolution: ± 2 mm
 - Rpm: 1400 (50 Hz)
 - Power supply: 3P (0,55 kW)
 - Gear ratio: 1:200
 - Max chain stress: 1000 N
- Compass roller:
 - Max speed: 4 mm/s (50 Hz)
 - Movement resolution: ± 3 mm
 - Power supply: 3P (0,08 kW)
 - Max force: 600 kg
- Rollers:
 - Max speed: 2,5 cm/s
 - Rpm: 2,5 (50 Hz)
 - Power supply: 3P (0,09 kW)
 - Gear ratio: 1:540
- Dimensions: $6 \times 2 \times 3$ m³
- Total weight: 4000 kg

Detectors:

- Two pairs of plastic scintillators (250x45x20) mm³
- MDA in a 60 s static measurement:

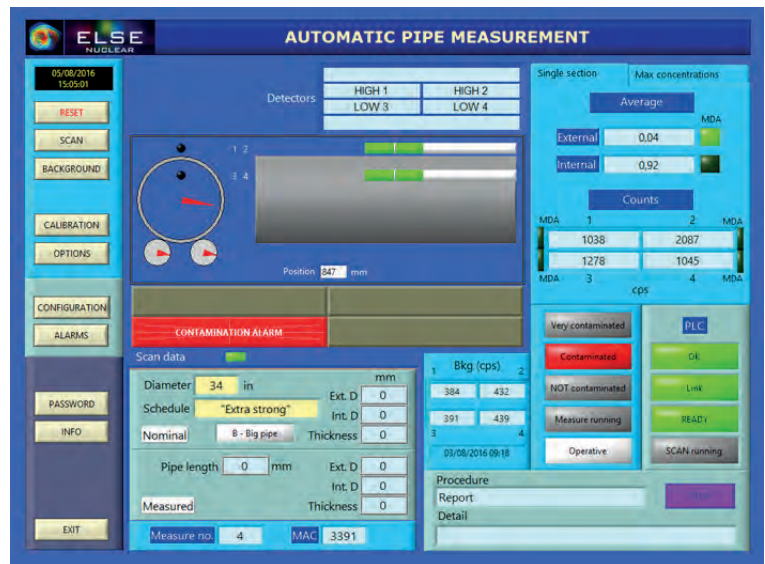
- 60 Bq (⁶⁰Co source, 25x4 cm wide, 2 cm far from detector)
- MDA in a 60 s dynamic measurement:
 - 0.14 Bq/cm² (homogeneous contamination of ⁶⁰Co, 2 cm far from detector)

Electrical requirements:

- Power supply: 400V (3P+T) 50Hz
- Max power: 8000 VA
- Max start power: 20000 VA
- Nominal power: 4500 VA
- Detectors actuator inverter output: max power 0,40 kW
- Truck motor inverter output: max power 0,75 kW
- Compass inverter output: max power 0,40 kW
- Rollers inverter output: max power 0,40 kW

Management software main functions:

- Parameters settings
- System calibration
- PLC commands activation
- Preliminary centering operations
- Measurement management
- Safety controls



PIPE SCANNER software main panel



RADIATION MONITORING SYSTEM OF WASTE MATERIALS FROM DECOMMISSIONING OF POWER NUCLEAR PLANTS

ARCHIMEDES II 9102 WiFi

MAIN FEATURES

- Detectors: 2 large plastic scintillators
- Fast measurement of the gamma activity of bags containing up to 150 Kg of waste materials
- Mobile system mounted on wheels
- Removable detectors for use in remote mode
- Measurements up to 200 Bq of ^{60}Co in 10 seconds
- Luminous and acoustic signal when the alarm threshold is exceeded
- Beacon column indicating the functioning status of the system
- Host PC for data processing and storage
Analysis Software and data base of measurements
- Optionals: barcode reader, scale, label printers
- MDA (^{60}Co): down to 200 Bq (10 min)

DESCRIPTION

The **ARCHIMEDES II 9102 WiFi** is designed to perform fast measurements of the gamma activity of bags, containing waste materials coming from the Nuclear Power Plants Decommissioning or from plants where high neutron flows were used.

It is a mobile system, mounted on wheels, hence it's easy to handle and versatile in all the different types of applications and of locations where its deployment is requested. The system is composed of a base structure with an installed control console, and two vertical detection units facing the measurement area where the bags are loaded. The system elements are protected by 3 mm of stainless steel.



ARCHIMEDES II 9102 WiFi

The detectors position on the base can be adjusted to best fit the size of the material and maximize the counting efficiency. Thanks to these two particular features, the system can comply to a wide range of waste storage requirements. The detectors are fully removable from the support base, allowing remote-mode measurements when needed; the acquired data are sent to the host PC through the WLAN connection, and a central unit performs data acquisition and processing.

When the detectors are used in remote mode, the power supply is provided by rechargeable batteries installed in each module. When the detectors are connected to the support base (normal mode) the batteries are recharged and the power supply is provided by the mains.

The system is equipped also with an alarm beacon, and the analysis and management software.

The **ARCHIMEDES II 9102 WiFi** allows measurements down to 200 Bq of ⁶⁰Co in 10 minutes (within a 95% confidence level, 10x10 cm source at 5 cm from the detector).

The system **ARCHIMEDES II 9102 WiFi** calculates the gamma activity of the material being monitored and compares it with the operative clearance limits; then it issues an acoustic and visual signal to confirm the good functioning and the measurement result.

Before starting the actual measurement phase, it is possible to run a test to verify the proper functioning of the system itself. The System Software allows the setting of the operative parameters, as well as the analysis and the archiving of the data coming from the electronics associated with the detectors.

Optionally, the following accessories are available on request: a barcode reader, a scale to measure the weight of the materials to be measured, and a set of printers for labels (typically written in green or red depending on the measurement results).

TECHNICAL SPECIFICATIONS

Detection unit

- n.2 large plastic scintillator detectors
- 2" low noise photomultipliers
- Removable detectors powered by batteries (when used in remote mode)
- Detector dimensions: 500 x 500 x 50 mm
- Lead shield thickness: 1 cm on the external sides of each detector's module
- Steel window thickness: 1 mm on the side facing the measurement area
- Distance between the detectors mounted on the structure's base: selectable from 2 up to 50 cm
- Detectors: anti-vibration structure

Acquisition unit

- Low noise Power Supply and Signal Processing electronics
- Threshold Discriminators for each Detection Unit
- Wlan Ethernet Interface to PC

Alarm beacon

- White light: ready
- Green light: uncontaminated
- Yellow light: measurement in progress
- Red light and siren: contaminated (alarm)

Host-PC

- Industrial panel PC, LCD touch-screen display
- Display: LCD TFT 8.4"
- RAM: 256 MB

Processing software

- Analysis and Data Archiving Software for the management of the measurement system
- Radioactive measured level visualization, Bq, Bq/cm² or Bq/g unit

Weight and dimensions:

- Max dimensions (excluding alarm column): 160x95x110 cm³ (WxLxH); Total weight: 350 kg

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Scale to measure the weight of the materials to be measured
 - Max weight: 150 kg; resolution: 20 g
- Set of printers for labels (typically written in green or red depending on the measurement results)
- Barcode reader
 - Reading distance up to 30 cm; reading resolution 5 mm; code distinction up to 10 cm



ARCHIMEDES II 9102 WiFi software main panel



PORTAL RADIATION MONITOR FOR EXCAVATION MATERIALS

ARCHIMEDES III 9103

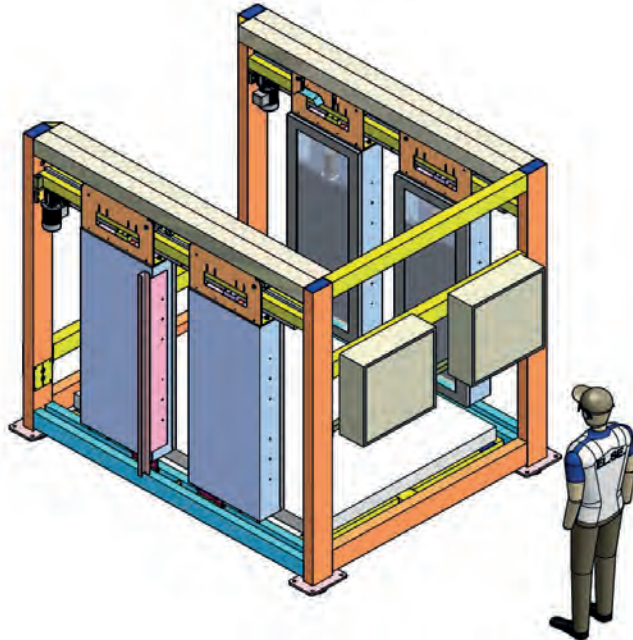
MAIN FEATURES

- Portal-shaped structure equipped with platform scale
- Detectors: high-sensitivity plastic scintillators
- Dimensions of each detector (WxHxD): 500x1000x50mm³
- Detector's shielding: lead panels
- Energy range: 50 keV ÷ 2 MeV
- Scale's max measurable weight: 5000 kg
- Scale's resolution: 1kg
- Control PC connected via LAN
- Activation PLC commanded by the management software installed on the PC
- Data archive, shareable in local network
- Acoustic and luminous signals for system's status and alarms indication

DESCRIPTION

The portal monitor **ARCHIMEDES III 9103** is designed to measure the radioactivity level in excavation materials of various nature, to define their proper destination as far as their release in the environment is concerned. The portal is composed, in its standard configuration, of two couples of large surface detectors (5000 cm²), each mounted on one of the two lateral sides of the portal structure.

The portal configuration provides a broad measurement area and at the same time it guarantees the best sensitivity. The monitor has an open top; this allows to easily place the containers and boxes to be monitored on the platform.



ARCHIMEDES III 9103

In the measurement area, delimited as we said by the portal structure, are placed the boxes containing excavation material. The boxes have specific and defined standard dimensions, which can be inserted in the system's database so that they can be recalled during the measurements. Actually, the relative position of the detectors is adjustable through a PLC, to maximize the measurement's efficiency according to the different geometries.

The portal is equipped with a platform scale to measure the weight of the boxes; the scale is installed at the base of the measurement area.

The whole **ARCHIMEDES III 9103** system is managed by the user-friendly software installed on the control PC.

The software performs the following main functions:

- Commands the PLC for the detector's movement and adjustment
- Receives as an input the measurement parameters (box dimensions)
- Detects the weight of the box
- Acquires and processes the data
- Receives as an input new measurement geometries, if needed
- Manages the alarm and malfunctioning statuses
- Saves the measurements in dedicated archives that can be recalled anytime

The environment background is automatically and continuously measured, and it is automatically subtracted from the measurements.

The monitoring operation is activated via software, by selecting the box type and then pressing the dedicated virtual button, clearly visible on the main panel of the user interface.

TECHNICAL SPECIFICATIONS

Measurement performances

- Energy range: 50 keV ÷ 2 MeV
- MDA: <5 Bq/g
- The reported MDA is referred to the following measurement conditions:
 - Box dimensions: 1300 x 1200 x 900 mm³ (conservative hypothesis)
 - Box material: Iron, 3 mm thickness, flat surfaces
 - Monitored material: 1.8 g/cm³ density
 - Contaminant isotope: ¹³⁷Cs
 - Contaminant geometry: point source
 - Contaminant position: at the box's centre, 75 cm from detectors
 - Confidence level: 95%
 - Measurement time: 600 s

Detection units

- Detectors type: plastic scintillator
- Number of units: 4 rectangular surface detectors
- Detectors dimensions: W x H x D = 500 x 1000 x 50 mm³
- Photomultiplier: 2" diameter, bialkali photocathode
- Photomultiplier connector: 14 pin M

Weighting system

- Max weight: 5000 kg
- Resolution: 1 kg

Detectors housing

- Pb shielding: proper thickness which guarantees 0.1 µGy/h in every point of the detectors

Power supply

- Low noise power supply: 220 VAC – 50 Hz

Control console

- Type: Tower or Rack PC
- Data communication: Ethernet LAN 100 Mbps

Acoustic-luminous alarm beacon

- Type: LED with siren
- Height: 230 mm
- Diameter: 40 mm
- Green light: not contaminated
- Yellow light: measurement in progress
- Red light/siren: contaminated (alarm)
- Acoustic level: 85 dB at 1 m

Management software

- Software for data analysis, visualization and archive on HDD
- Archives shareable via LAN
- Data acquisition from detectors and platform scale
- PLC interface
- Alarm and malfunctioning statuses management



ARCHIMEDES III 9103 software main panel



CONVEYOR BELT GAMMA MONITOR FOR SMALL OBJECTS

CARONTE 9400

MAIN FEATURES

- Detectors: 4 shielded plastic scintillators
- Upper detector: adjustable position along the vertical
- Wheel-mounted structure
- PLC controlled conveyor belt
- Software remote management
- Automatic, photocell-surveyed monitoring cycle
- Parameter setting: measuring time, alarm thresholds, calibration factor
- Measurement unit selection: cps, Bq, Bq/g
- Automatic background subtraction
- Monitoring of detector status
- Measurement data storage and display
- Push-buttons for manual controls and emergency stop
- Ethernet connection to remote PC unit

DESCRIPTION

The portable **CARONTE 9400** gamma monitor is designed to easily measure the radioactivity level of small objects such as boxes, tools or other similar equipments. The materials to be monitored are placed by the operator on one side of the conveyor belt, which is activated by PLC commands. The mechanical cycle and the measurement procedure are entirely controlled by the remote software, in automatic or manual mode. In automatic mode the conveyor belt is constantly moving, and a set of three photocells allows the software to know the object position and properly manage the conveyor motion.

A background acquisition is needed before **CARONTE 9400** can start the measurement procedure; the management software will automatically subtract the background value from the measurements.

If the alarm thresholds are exceeded, a proper visual and acoustic indication will be activated.



CARONTE 9400

The automatic cycle consists in the following three stages:

- First the length is determined by means of the first photocell, placed before the detectors, then the materials are positioned at the centre of the measurement area.

- The radioactivity level is determined: the software performs the data acquisition for a preset time. If the object is longer than the measurement area, consecutive steps are performed until the entire length of the object is scanned by the detectors.
- Finally, after the measurement, the materials are carried at the end of the conveyor belt, which automatically stops; now the operator can remove the monitored object and place a new one on the other side of the conveyor. The cycle is automatically resumed.

The 4 detectors are mounted in a tunnel-shape configuration: two at the sides of the passageway, one under the conveyor (inside a drawer), and one at the top of the measurement area. The upper detector can be vertically moved to adapt to materials dimensions, improving the overall measurement sensitivity. The detectors are shielded with lead sheets on the external sides, to minimize the environmental background contribution to the measurement.

CARONTE 9400 is mounted on 4 blocking wheels, so it can be easily positioned and moved according to the customer needs. On the mechanical structure there are push-buttons to manually activate the conveyor belt and the upper detector positioning, if needed; there is also an emergency button which immediately and completely stops **CARONTE 9400**.

TECHNICAL SPECIFICATIONS

Conveyor belt:

- Speed: 13 cm/s
- Chassis on wheels
- Belt cover resistant to cuts and chemical corrosion

Measurement tunnel:

- Plastic scintillators: 4
- Detector dimensions: 400 x 400 x 50 mm³
- Pb shielding: 10 mm thick
- Min distance between upper and lower detector rows: 80 mm
- Max distance between upper and lower detector rows: 800 mm

Detection limits:

- MDA per detector: <200 Bq
- Reference source: ⁶⁰Co 100 mm x 100 mm

- Distance from detector: 50 mm
- Measuring time: 10 seconds
- Environmental background: 0.2 μSv/h

Acquisition and control unit:

- PC based
- Power supply of the system electronic modules
- Acquisition of data from the detectors
- Data processing and measurements display
- Automatic management of the machine operative steps
- Measurements archiving on non-volatile memory

Plc & inverter:

- Management of conveyor belt motion
- Interfaced with Acquisition and control unit in automatic mode
- Manual control available
- Warning for failure status
- Safety management

Management software:

- Comparison of the measured background value with the preset threshold
- Management of the measurements steps
- Acquisition and display of detector count rates
- Calculation of activity in Bq, Bq/g or in Bq/cm²
- Comparison with the alarm thresholds
- Management of the acoustic and visual signaling



CARONTE 9400 software main panel



RADIATION MONITOR FOR LAUNDRY AND SMALL OBJECTS

BOX COUNTER

MAIN FEATURES

- Detectors: up to 5 large plastic scintillators
- Lead shielding on the external sides of the detectors
- Decontaminable internal and external surfaces
- Measuring chamber:
700 x 835 x 700 mm³
- 4 side doors: 700 x 835 mm²
- External dimensions:
1059 x 1391 x 971 mm³
- 4 pivoting and lockable wheels
- Visual and acoustic alarm indication
- Power supply: 220 VAC – 50 Hz
- Control console with touch-screen PC
- Ethernet connection available

DESCRIPTION

The **BOX COUNTER** system is designed to perform a fast gamma radiation monitoring of laundry, waste bags, tools and other small objects. The system measures the radioactive contamination of the items placed inside the measuring chamber, and compares the result with the release limits. System statuses such as alarm events and malfunctions are displayed on the PC of the control console and signaled by the visual/acoustic alarm unit installed on the top of the monitor.

The **BOX COUNTER** system can be easily moved and positioned by the operator thanks to 4 pivoting and lockable wheels. The enclosure is entirely made of stainless steel, all internal and external surfaces are specifically designed to be easily cleaned and decontaminated.



BOX COUNTER

The core of the system is the measuring chamber, which is designed to provide a large active volume as well as a high sensitivity.

The (WxDxH) 700x700x835 mm³ chamber is accessible through 4 side doors.

Five detectors are installed, 4 in the doors and 1 in the top side, facing the chamber through a thin stainless steel panel.

The detectors are based on large plastic scintillators, properly dimensioned to achieve an excellent sensitivity throughout a wide gamma energy range.

The associated PMT base provides HV supply and analogical signal processing.

The external sides of the detectors are shielded with lead sheets, in order to minimize the environmental radiation background and improve the system sensitivity. Each detectors of the **BOX COUNTER** can detect a 4 kBq ¹³⁷Cs source in 10 seconds (MDA, 95% confidence, for a point source at 50 cm).

The control console, consisting in the touch-screen PC and the graphic management software, is installed on the top of the monitor in an easily accessible position.

The software allows to operate and manage the system, i.e. activate the measurements; analyze, display and save the data coming from the counting electronics; set the operational parameters, such as alarm thresholds, detector enabling and calibration factors; activate, mute and reset the alarm and malfunction statuses through relay switches. A quality check can be performed before the measurement starts, to verify the proper functioning of the system.

TECHNICAL SPECIFICATIONS

Measurement features

- Energy range: 35 keV ÷ 2 MeV
- Minimum detectable dose (1 detector): 1 nGy/h (95% confidence, 10 s integration)
- Maximum dose: 1 mGy/h
- Environmental conditions:
environmental background < 0.2 µSv/h
functioning temperature between -20 and 50 °C
air humidity < 80%

Detectors

- Type: PVT plastic scintillators
- Number of units: From 2 up to 5
- Surface: 2500 cm²
- Thickness: 50 mm
- Photomultiplier: 2" diameter
- Shielding: Pb 10 mm
- PMT base connection: 14 pin M

PMT base

- PMT connection: 14 pin F
- Built-in modules: HV, pre-amplification, discriminator

- Available settings: HV 0÷ 1000 V, low level discriminator 'THR' 0÷4500 mV, high level 'WIN' 0÷4.5 V
- Counting electronics connection: DB-9 –power supply IN 24 VDC, digital counts output (TTL/optoisolated)
- Dimensions: Diameter 58 mm, height 86 mm

Housing

- Maximum dimensions:
(W x H x D) = 1059 x 1391 x 971 mm³
- Measurement compartment dimensions:
(W x H x D) = 700 x 835 x 700 mm³
- Side doors dimensions: (W x H) = 700 x 835 mm²
- Material: Stainless steel AISI 304
- Protection: IP55
- Handling: 4 pivoting and lockable wheels

Counting and signaling electronics

- Low noise power supply: IN 220 VAC – 50 Hz / OUT 24 VDC
- Signals acquisition: From 2 to 6 inputs counter/frequencymeter 32 bit
- Status management: 4 relays NO/NC
- PC interface: RS485/232

Control console

- Industrial touch-screen panel Pc
- Display: LCD TFT 8.4"

Management software

- Graphic software for data analysis, visualization and storage
- Alarm and malfunctioning statuses management

Acoustic-luminous alarm beacon

- Type: LED and sirena
- Height: 230 mm
- Diameter: 40 mm
- Green light: Not contaminated
- Yellow light: Ongoing measurement
- Red light/siren: Contaminated (alarm)
- Acoustic level: 85 dB at 1 m





CAEN SyS
Systems and Spectroscopy Solutions

Radiation Monitoring Systems & Health Physics

Environmental Monitoring Probes

HIGH PRESSURE IONIZATION CHAMBER FOR GAMMA MONITORING

ICP / ICP-PF Series

MAIN FEATURES

ICP

- Energy range: 80 keV ÷ 10 MeV
- Volume: 5.2 liters
- Measurement range:
 - 10 nSv/h ÷ 10 Sv/h (environmental)
 - 10 nSv/h ÷ 0,1 Sv/h (pulsed fields)
- Energy response:
 - ± 20% from 80 keV to 120 keV
 - ± 5% from 120 keV to 2 MeV
 Dimensions: Ø 186 mm, W_{max}= 256 mm, D_{max}= 327 mm, H_{max}= 560 mm

ICP-T

- Energy range: 35 keV ÷ 10 MeV
- Volume: 5.2 liters
- Measurement range:
 - 10 nSv/h ÷ 10 Sv/h (environmental)
 - 10 nSv/h ÷ 0,1 Sv/h (pulsed fields)
- Energy response:
 - ± 20% from 40 keV to 120 keV
 - ± 5% from 120 keV to 2 MeV
 Dimensions: Ø 186 mm, W_{max}= 256 mm, D_{max}= 327 mm, H_{max}= 560 mm

DESCRIPTION

High pressure ionization chambers **ICP** and **ICP-T** are designed for environmental area monitoring of the gamma dose rate; the enclosure of ICP-T is suited for the detection of low-energy gammas (>35 keV). All models are supplied together with state-of-the-art HV and electrometer boards, providing power supply, signal acquisition and processing. A special electrometer model (details below) is available for measuring very high-level pulsed radiation fields, such as those generated by synchrotrons and other accelerators.



ICP detector

ELECTROMETER

Two versions of the electrometer are available:

- ICP and ICP-T versions, with electrometer for environmental area monitoring:
 - 9 decades with autoranging (from 10 nSv/h to 10 Sv/h)

- ICP-PF and ICP-T-PF versions, with electrometer for pulsed fields (pulse duration 70 ns, repetition frequency 10 Hz, number of pulses: 1, 2, 10 with Linac currents 1, 2, 5, 10 and 15 mA):
 - 7 decades with autoranging (from 10 nSv/h to 0,1 Sv/h)

- Single pulse detection tested up to 3,5 nC/pulse
~ 4,3 µGy/pulse

TECHNICAL SPECIFICATIONS

Common to all versions:

- Accuracy: $\pm 5\%$ at environmental background level
- Temperature range: $-25 \div +50$ °C
- Relative humidity: $\leq 95\%$ non condensing



HIGH-PRECISION DIRECTIONAL ION CHAMBER

PIC

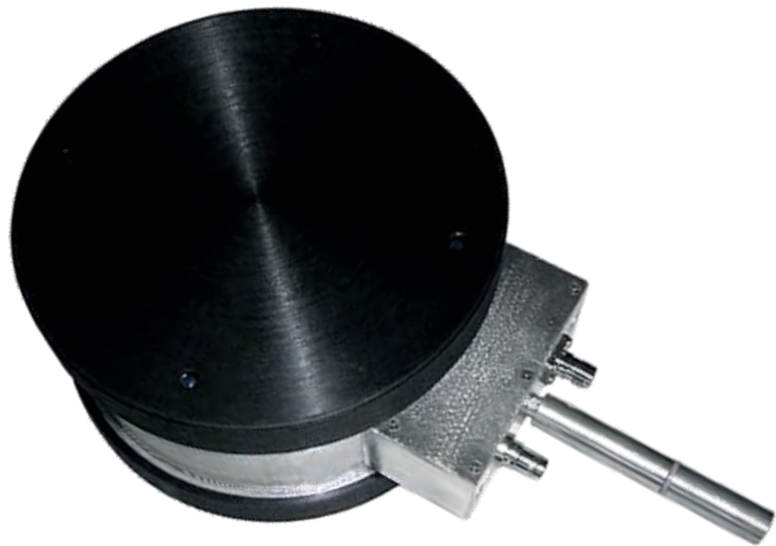
MAIN FEATURES

- High sensitivity free-air ion chamber
- Specifically designed for collimated beams' measurements
- Large active diameter
- Big active volume
- Extra-thin Mylar window for X-ray monitoring
- Tripod mount
- Coupled to ultra-sensitive electrometer (SATURN series)

DESCRIPTION

PIC is a high-precision directional free-air ion chamber, capable of measuring the intensity of a collimated particle beam passing through its entrance and exit windows.

Light and compact, **PIC** is provided with a special thread compatible with tripods used for standard cameras. It is a very robust device, designed to detect essentially every kind of charged and non-charged particles, ranging from gamma and X-rays to high-energy protons and heavy ions.



PIC chamber

PIC collects the charge generated in its active volume by the collimated beam of particles passing through it, thanks to the polarization provided by a high voltage supplier.

The large active diameter and the big volume guarantee a high sensitivity even to low beam intensities. The connection to the special ultra-sensitive electrometer allows the **PIC** to work over a very wide dynamic range, up to 9 decades.

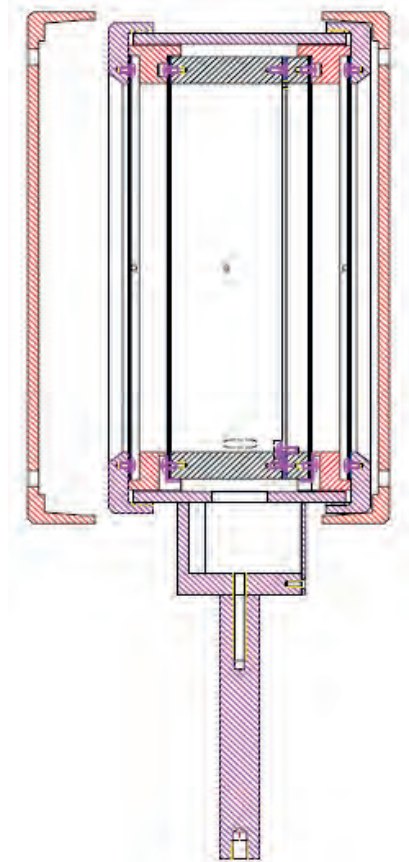
The acquired data are sent on-line via a fast Ethernet connection to a PC, where the user friendly software allows an instantaneous visualization of the differential and integrated data, including their safe storage and management in a database.

TECHNICAL SPECIFICATIONS

- 40 mm active length
- 140 mm active diameter
- Typical output current: 100 fA – 100 nA
- TNC and SHV connectors
- 12 μm Mylar windows metallized with aluminum
- 4 Mylar windows: 2 active + 2 for safety
- Guard ring
- Protective caps for safe storage

APPLICATIONS

- Beam monitor for particle accelerators (linacs, cyclotrons, synchrotrons)
- Reference chamber in metrology/calibration laboratories using collimated sources of ionising radiation
- Reference ion chamber for X-ray generators
- 1.75 keV at 1.33 MeV



PIC schematic drawing

WIDE RANGE GAMMA PROBE

MERCURY GMP WR / WR-L

MAIN FEATURES

- Measurement range:
0.1 $\mu\text{Sv/h} \div 1 \text{ Sv/h}$
(MERCURY WR),
10 nSv/h $\div 10 \text{ Sv/h}$
(MERCURY WR-L)
- Detectors: 2 energy-compensated Geiger-Müller tubes
- Energy range: 40 keV $\div 1300 \text{ keV}$
- Automatic switching between GM tubes, based on acquired counts level
- Integrated power supply electronics
- Microprocessor-based processing unit, anti-saturation and input selection circuits
- Wall mounting accessory
- Suitable for outdoor installation
- Connectable to the PC via the CAENSYS ratemeter of the SATURN series
- Communication interfaces: RS232/422/485, Wireless ZIGBEE (upon request), Ethernet (upon request)

DESCRIPTION

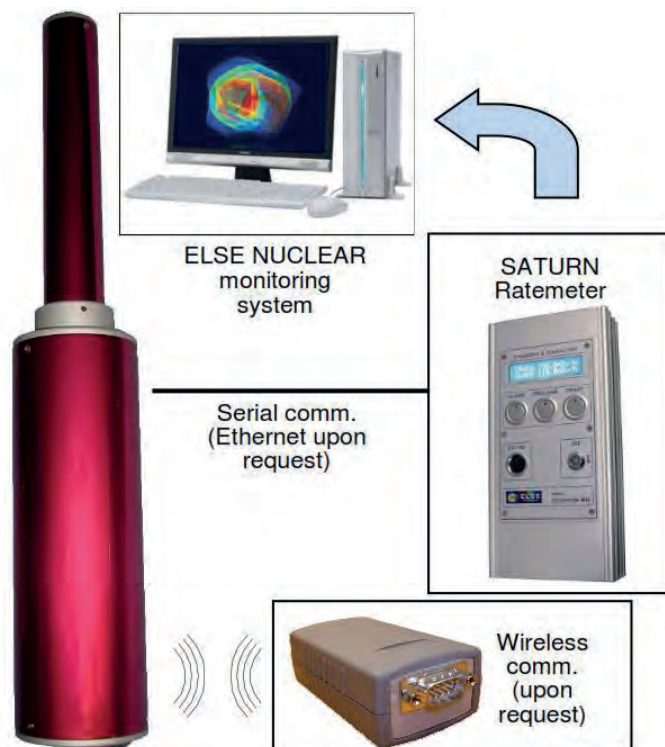
The wide range probe **MERCURY GMP WR** is composed by 2 energy-compensated Geiger-Müller detectors for wide-range gamma fields measurements, housed in a high-protection cylindrical aluminum case together with the HV and processing electronics.

The measurement range can be further extended from 10 nSv/h to 10 Sv/h in the **MERCURY GMP WR-L** version.

The switching between the 2 GM tubes is automatically controlled by the internal electronics, which continuously surveys the counts level (anti-saturation and input selection).

The aluminum case has a protection grade IP65, which makes possible to install the probe outdoor granting its safety and functioning.

It is also provided with the wall mounting accessory.



MERCURY GMP WR schematic connection

MERCURY GMP WR is connected to the CAENSYS ratemeter of the SATURN series, through a serial communication.

The ratemeter receives and processes the data from the detector, performs the analysis and comparison with the thresholds, displays the results and the status through proper signals.

Also, it allows to set the operative parameters via its keyboard.

Several MERCURY probes, each connected to a SATURN ratemeter, can be inter-connected to form a multi-point measurement network (monitoring system).

MERCURY GMP WR is a low energy consumption probe, so it has a long operating time if power supply is provided by an external battery.

PS-ZB module can be provided upon request: it provides local power supply to the connected MERCURY probe as well as ZIGBEE Wireless communication. A receiver (**ZB-TC**) will be positioned in a place without any barriers such as walls, columns, or machines, so that it can receive a clear signal coming from the probe. The receiver is then connected to the ratemeter to acquire the radiological data.

Upon request, a GPS can be installed in the PS-ZB too.

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Ethernet connection
- PS-ZB: power supply station (batteries) with wireless communication
 - GPS (as part of PS-ZB module)
- ZB-TC: ZIGBEE transceiver associated to the PS-ZB

TECHNICAL SPECIFICATIONS

Mechanical structure

- Input selection circuit
- Anti-saturation circuit
- Dead time correction
- Fail-limit management (counts per time unit)
- Subtraction of intrinsic background
- Overflow management
- Moving average algorithm for instantaneous dose-rate
- Dose rate transmission every second
- Communication protocol management compatible with CAEN SYS digital probes
- Parameter management and storage
- Communication interfaces:
 - RS232/422/485
 - Wireless ZIGBEE (upon request)
 - Ethernet (upon request)

- Detector type: two energy-compensated Geiger-Müller tubes
- Dose rate range:
 - MERCURY GMP WR: 100 nSv/h ÷ 1 Sv/h
 - MERCURY GMP WR-L: 10 nSv/h ÷ 10 Sv/h
- Total dimensions:
 - MERCURY GMP WR: $\varnothing = 7$ cm; L = 42 cm
 - MERCURY GMP WR-L: $\varnothing = 7$ cm; L = 62 cm
- Energy range: 40 keV ÷ 1300 keV
- Energy response (^{137}Cs): +30 / -20%
from 50 to 1300 keV
- Angular Dependence (^{137}Cs): <15% at $\pm 45^\circ$ from the indicated axes
- Linearity: <10% from 100 nSv/h to 100 mSv/h
- Temperature Range: $-10^\circ\text{C} \div +50^\circ\text{C}$
- Relative humidity: up to 95% (not condensed)
- Power: 24 VDC
- GMP WR absorption: 65 mA
- PS-ZB absorption: 4 A
- ZB-TC absorption: 12 mA
- Holder material: Aluminum
- Protection grade: IP 65
- Mounting: wall mounting



PS-ZB and ZB-TC modules



GEIGER-MÜLLER GAMMA RADIATION PROBE

GM-1

MAIN FEATURES

- Measurement range: $0.1 \mu\text{Sv/h} \div 1 \text{ mSv/h}$
- Low voltage power supply 5 VDC
- Built-in HV module
- Energy range: from 40 keV to 1.3 MeV
- Traceable calibration on demand
- Wall mounting accessories available
- Connectable to stand alone rate-meters or monitoring systems
- Aluminum housing

DESCRIPTION

The **GM-1** detectors are lodged in aluminum cylinders, together with a built-in HV board, providing power supply to the Geiger-Müller tube, and signal processing electronics.

The data are transmitted to a rate-meter or to a monitoring system, through the circular multi-pole connector available at the bottom of the housing. The maximum distance from the readout unit to the **GM-1** probes is 50 meters. Detectors can be supplied together with the wall mounting bracket, if needed. The environmental work conditions of the **GM-1** are the following:

- Temperature: $0 \div 45^\circ \text{C}$
- Maximum relative humidity: 95%



GM-1 detector

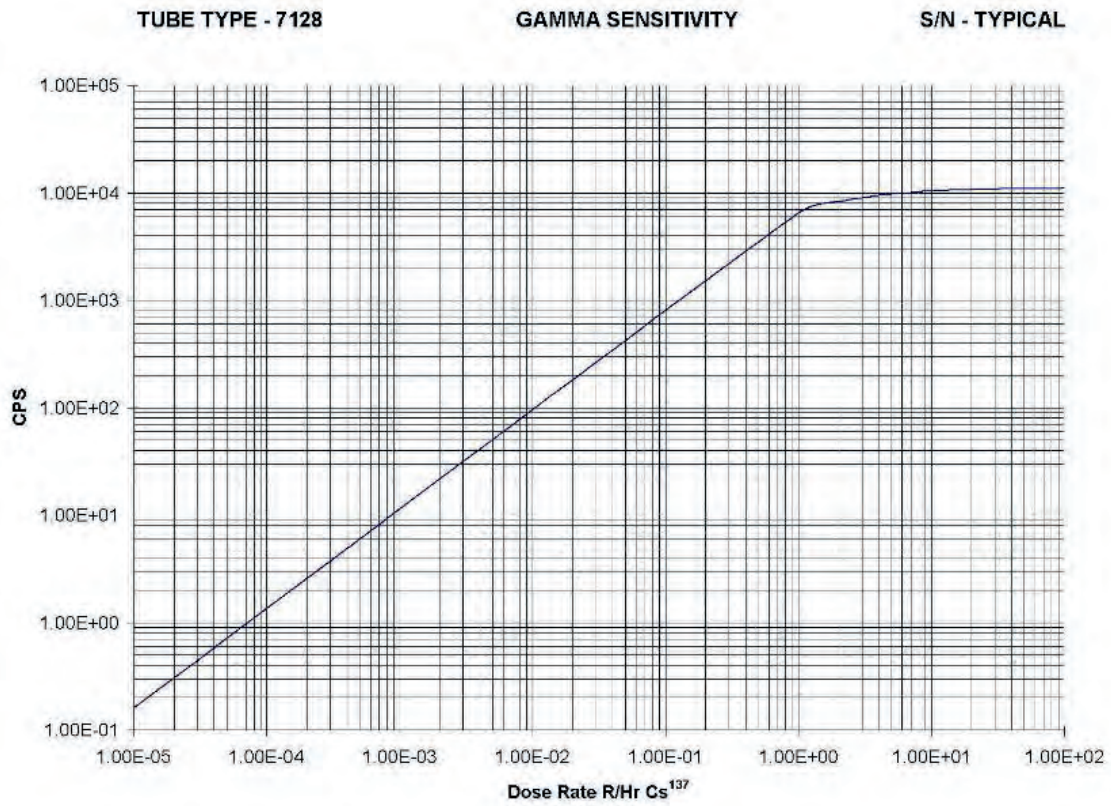
OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Airtight PMMA holder for duct mounting: GM-ATH

TECHNICAL SPECIFICATIONS

- Mechanical dimensions:
 - Only housing: L = 187 mm ; \varnothing = 40 mm
 - Total (circular connector included): L = 196 mm ; \varnothing = 40 mm
- Measurement range: 0.1 μ Sv/h \div 1 mSv/h
- Typical sensitivity (60Co): 18 cps/ μ Sv/h



ENVIRONMENTAL DETECTION UNIT FOR GAMMA RADIATION WITH NaI(Tl) SCINTILLATOR

PNAI series

MAIN FEATURES

- High sensitivity gamma detector
- Connectable to stand alone rate-meters or monitoring systems
- Specifically designed for real time or sampled stack monitoring
- Compact dimensions
- Built-in signal processing electronics

DESCRIPTION

The **PNAI** detection unit is based on a NaI(Tl) scintillator probe, designed for high sensitivity gamma radiation measurements; these probes best apply to the detection of small activity concentrations in air and in gas exhausted from controlled zones.

The series comes with two detectors versions: **PNAI** with 2" x 2" crystal dimensions; **PNAI/3** with 3" x 3" crystal dimensions.

The NaI(Tl) scintillator includes a 2" 14 pins photomultiplier, connected to the photomultiplier base model PAD; the PAD provides power supply, preamplification, output signal discrimination and digital conversion, allowing to connect a reading unit and manage the acquired data.



PNAI detector

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Aluminum airtight holders with mounting flange for duct mounting: models PNAI/ATH and PNAI/3/ATH
- In order to reach the maximum of sensibility required in air monitoring (1 Bq/g), the high sensibility air monitoring system option with SDU-1M is available for the 2" x 2" PNAI detector, with 10 cm lead shielding, Marinelli 3 l beaker, and 16 m³/h air pump
- PNAI can also be connected to a multichannel electronics module, to be used in MISTRAL XM air/stack monitoring systems: this option is called PNAI-MC.

TECHNICAL SPECIFICATIONS

Detector

- Type: NaI(Tl) scintillator
- Energy range: 30 keV ÷ 2 MeV
- Crystal dimensions: 2"×2" or 3"×3"
- Temperature range: 0 ÷ 40 °C
- Housing material: aluminum
- Photomultiplier: diameter 2"

PAD photomultiplier base

- Available settings: HV 0 ÷ 1000 V
 - Low Level Discriminator 0 ÷ 4500 mV
 - Upper Level Discriminator 0 ÷ 4.5 V
- Test points: High Voltage, Threshold, Window, Output Pulse, Ground (2 points)

Dimensions and weight

- PNAI
 - Total weight: 1.05 kg
 - Dimensions: Ø=58 mm, H=271 mm
- PNAI/3
 - Total weight: 1.95 kg
 - Dimensions: Ø=82 mm, H=311 mm

SDU-1M mounting set

- Measurement geometry: Marinelli Beaker
- Pump flow: 16 m³/h
- Volume: 3 liters
- Pump flow monitoring: 2% accuracy
- Shield: 100 mm thick lead
- Total weight: 600 kg



HAND-HELD RADIATION SURVEY METER FOR GAMMA RADIATION

B-RAD

MAIN FEATURES

- Hand-held photon dose rate meter
- Specifically designed for use in extremely intense magnetic fields, up to 3 T
- Double display
- Light and compact, ideal for radiation surveys
- Built-in signal processing electronics
- Equipped with a Hall probe
- Technology originally developed at CERN, licensed to ELSE NUCLEAR
- Optional telescopic rod (2.5 m)

DESCRIPTION

B-RAD is a portable, hand-held radiation survey meter, capable of measuring the photon dose rate in presence of strong electromagnetic fields. It has been tested to work properly in magnetic fields up to 3 T. For comparison, conventional devices fail to operate at intensities as low as 0.1 T. Light and compact, equipped with an extensible telescopic rod, up to 2.5 m, **B-RAD** is ideal for radiation surveys and for local measurements of contamination or residual radioactivity in hot spots. It also includes a Hall probe connected to an indicator for a rough measurement of the magnetic field in which it is operating.



B-RAD employs a high sensitivity $\text{LaBr}_3(\text{Ce}^{3+})$ crystal directly coupled to a Silicon photomultiplier (SiPM) matrix. The excellent scintillation properties and the high photon resolution of the scintillator (4% FWHM at 662 keV) make the device capable of operating over a wide energy range with a very fast response, i.e. reducing at minimum dead time-related issues.

This technology has been originally developed at CERN (*), and has become the standard for radiation surveys in the Large Hadron Collider (LHC) experiments. It is commercialized under an official license granted by CERN, with the "CERN Technology" label.



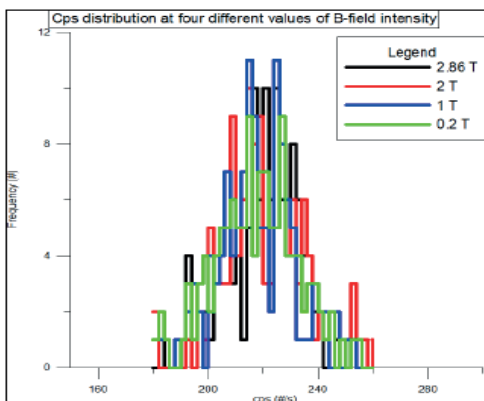
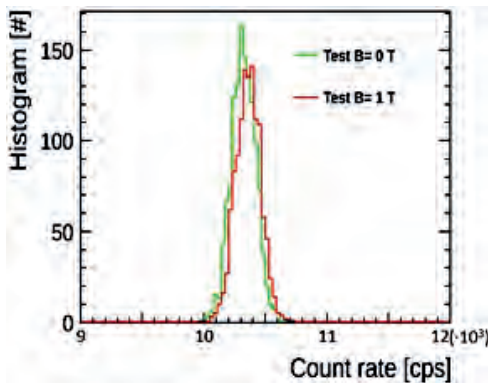
technology

(*) Patent resulting from patent application number EP 14170108.6 "Portable Radiation Detection Device for Operation in Intense Magnetic Fields".

TECHNICAL SPECIFICATIONS

- Crystal:
 - Type: LaBr₃:Ce³⁺ (8%)
 - Dimensions: 0.6"×0.6" or 1"×1"
- Housing material: aluminum
- Dose rate range: 100 nSv/h – 10 mSv/h
- Sensitivity:
 - 150 cps/μSv/h (0.6" crystal)
 - 650 cps/μSv/h (1" crystal)
- Energy range: 30 keV ÷ 2 MeV
- Temperature range: 0 ÷ 40 °C
- SiPM matrix: 0.6" or 1"
- Battery life up to 12 hours
- Detector dimensions:
 - Main unit: 24 cm x 12 cm x 9 cm (h)
 - Probe: 18 cm x 5 cm (diameter)

Tests were performed with the **B-RAD** by measuring the radioactivity emitted by a ¹³⁷Cs source in magnetic fields. The intensity of the magnetic field was steadily increased from 0 up to 3 T by first introducing in the magnetic field only the probe, and then introducing both probe and main unit. No detectable changes in the mean value or spread of the cps distributions have been noted for different values of the magnetic field, as it can be seen from the plots below, thus confirming the complete insensitivity of the device to magnetic field effects.

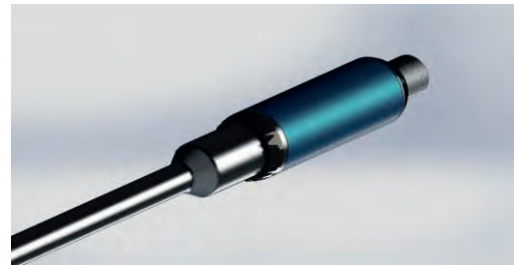


APPLICATIONS

- Radiation surveys at particle accelerators
- Medical accelerators (electron linacs including Image Guided Radiation Therapy (IGRT) with MRI imaging, cyclotrons for radionuclide production and radiotherapy)
- Radiation measurements at medical PET/MRI scanners
- Radiation measurements in industrial applications, metal recycling and for fire brigade services
- Current and future technologies involving the need of measuring radioactivity in the potential presence of perturbing magnetic fields

OPTIONS AVAILABLE UPON REQUEST

- Display and recording of the spectrometric information of the gamma field (4% FWHM at 662 keV)
- Extension of the temperature operating range to industrial grade
- Custom size of the LaBr₃:Ce³⁺ (8%), up to 3" x 3"
- Telescopic rod up to 2.5 m



Probe mounted on rod (above) or handle (under)



NEUTRON REM COUNTER FOR PULSED FIELDS

LUPIN 5401 He³-NP / BF₃-NP

MAIN FEATURES

- Proportional counter: He³ (spherical moderator) or BF₃ (cylindrical moderator)
- Energy Range: from thermal up to 20 MeV
- Optional Pb shield for energy range extension up to 5 GeV
- H*(10) rate: from 10 nSv/h to 100 mSv/h
- Unaffected by signal pile-up and so particularly suited for pulsed neutron field
- Maximum H*(10) per burst in pulsed fields: 200 nSv (³He), 2 μSv (BF₃)
- Connectable to Saturn series rate-meters
- Available interfaces for communication with the Saturn series rate-meter: serial RS232 or RS485/422 for long distance, Ethernet (optional), Wireless ZigBee up to 1 km (optional)
- Remote management, acquisition and display software (optional)
- Excellent gamma rejection (< 0.5 μSv/h at 50 mSv/h, 662 keV)

DESCRIPTION

The environmental monitoring unit **LUPIN 5401** is a modular system for neutron H*(10) measurements, with excellent performance for detection in pulsed neutron fields.

The instrument is composed by the following parts:

- Neutron Proportional Counter: ³He or BF₃;
- Spherical or cylindrical polyethylene moderator (with optional Pb layer)
- Built-in Power Supply, Signal Acquisition and Processing, and Control Electronics.

The built-in electronics processes the signal coming from the detection unit, and elaborates the instantaneous H*(10) rate value every second.

The data are sent to the connected Saturn rate-meter, which locally displays the instantaneous H*(10) rate and the integrated values, and compares them to the pre-set alarm thresholds.



LUPIN 5401 HE³-NP



LUPIN 5401 BF₃-NP

The Saturn rate-meter provides also the light indications and the acoustic signal to alert the operator when an Alarm or Pre-alarm status occurs.

The Alarm signal can be instantaneous or delayed by setting a delay time. The Good Functioning of the unit is always checked by the built-in CPU board.

The Alarm, the Pre-alarm thresholds and the operating parameters are stored

on a non-volatile memory and they can be set by the operator on the keyboard or remotely via the Remote Management Software (optional).

The connection to the Host PC can be made by using direct link or multi-drop depending on the communication type (RS232/Ethernet or RS485).

The **LUPIN 5401** monitoring unit is available with different configurations:

- Stand-alone (with LCD display)
- Wall mounted
- On trolley with fixed or mobile detector

TECHNICAL SPECIFICATIONS

He³ Detector

- Model: Centronic SP9, 2 atm filling gas pressure
- Type: ³He Spherical Proportional Counter
- Energy range: from 0.025 eV to 20 MeV, optional extension up to 5 GeV
- H*(10) rate range: from 10 nSv/h to 100 mSv/h
- Neutron sensitivity: 1 cps/μSv/h
- Gamma sensitivity: < 0.5 μSv/h at 50 mSv/h, 662 keV
- Angular dependence: < 5%
- Temperature Range: 0° ÷ 40 °C
- Total weight with optional Pb layer: 14 kg
- Maximum H*(10) per burst in pulsed fields with underestimation ≤ 10%: 200 nSv

BF₃ Detector

- Model: Centronic BF3-15EB20/25-SHV
- Type: BF₃ Cylindrical Proportional Counter
- Energy Range: from 0.025 eV to 20 MeV , optional extension up to 5 GeV
- H*(10) rate range: from 10 nSv/h to 100 mSv/h
- Neutron sensitivity: 0.6 cps/μSv/h
- Gamma sensitivity: < 0.5 μSv/h at 50 mSv/h, 662 keV
- Angular dependence: < 20%
- Temperature Range: 0° ÷ 40 °C
- Total weight with optional Pb layer: 18 kg
- Maximum H*(10) per burst in pulsed fields with underestimation ≤ 10%: 2 μSv

Built-in Electronics

- Processing circuit: Current Amplifier
- Integrated HV module: Operative voltage up to 2100 V
- Analog to Digital Converter: 12 bits at 10 Msps
- Digital Pulse Processing: Cyclone III FPGA device
- Watchdog: Good Functioning circuit control

- Available Communications: serial RS232, serial for long distance RS485/422 half duplex/full duplex, Ethernet 10-100Mbit/s (optional), Wireless ZigBee up to 1 km (optional)
- Memory: not volatile for parameters storage
- Temperature Range: 0° ÷ 40 °C
- Optional hardware configuration: the Acquisition and control unit is detached from the Neutron probe and hosted in a separate housing (maximum distance 15 m)

Electrical characteristics

- Power requirements: 24 VDC; max 2,5 W (max consumption)

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Local alarm
- Gamma probe
- Ultra-fast response (Alarm signal in 50 ms) for dual use as neutron rem counter – beam loss monitor

Different hardware and Software configurations are quoted on demand. The company ELSE NUCLEAR offers the own experience to develop special products and systems to satisfy the customers' needs.

Papers published in international scientific journals:

- ❖ *M. Caresana, M. Ferrarini, G.P. Manessi, M. Silari and V. Varoli, LUPIN, a new instrument for pulsed neutron fields, Nuclear Instruments and Methods in Physics Research Section A 712 (2013) 15-26.*
- ❖ *M. Caresana, C. Cassell, M. Ferrarini, E. Hohmann, G.P. Manessi, S. Mayer, M. Silari and V. Varoli, A new version of the LUPIN detector: improvements and latest experimental verification, Review of Scientific Instruments 85 (2014) 065102.*



Radiation Monitoring Systems & Health Physics

Environmental Monitoring Stations and Systems

AIR CONTAMINATION MONITORING SYSTEM

MISTRAL XM

MAIN FEATURES

- Lead shield for 3 liters Marinelli geometry with NaI(Tl) detector, or optional LaBr₃(Ce³⁺)
- Associated electronic for MCA
- Minimum detectable activity: <1 Bq/l of ¹⁸F with T_M ≥ 5 min
- Energy Range: ≥ 25 keV
- Pump to sample and expel the air
- Flow switch for pump good functioning control
- Interception electrovalves for the multiplexed automatic sampling of up to 8 rooms in the facility
- Acquisition, processing and display of the energy spectra
- LCD color monitor
- Data acquisition and processing software
- Relays for remote devices control
- Flow rate meter installed into the Stack (optional)

DESCRIPTION

The **MISTRAL XM** monitoring system is designed to sample and monitor the activity concentration in the air, in Marinelli geometry. The **MISTRAL XM Rooms** version can sample and monitor the air coming from up to 8 rooms; the **MISTRAL XM Stack** version is used to monitor the air expelled from a chimney or Stack. In both cases, **MISTRAL XM** is composed of two main parts:

- Sampling and detection unit: SDU-XM (the "X" stands for the number of sampling points, from 1 to 8)
- Acquisition and processing unit: APU



Acquisition
and
Processing Unit



Sampling
and
Detection Unit

The SDU-XM sampling and detection unit consists in a NaI(Tl) detector with MCA electronics (PNAI-MC), a lead shielding, a pump to sample the air, a flow switch to control the pump functioning, and an array of electro-valves which automatically sample the air from the rooms to be monitored. If required, the system can also manage the expulsion of the monitored air, for example into the Stack. As an option of the **Stack** version, a flow rate meter (STACK-DFM) can be installed into the Stack, allowing the system to calculate the activity referred to the expelled air's volume. The flow rate meter and the mounting flanges are

specifically dimensioned over the specifications of the Stack (air speed and stack geometry/diameters). STACK-DFM is mounted in a box together with a data acquisition module, necessary to communicate with the control PC. The APU acquisition and processing unit consists in the data processing/display elements (PC + software), the management/power supply electronics, and the 19" rack which the components are installed in. The system performs a spectrometric analysis of the detected radiation, thanks to multichannel electronics and a software specifically designed for this task. The **MISTRAL XM** can be included in an environmental monitoring system (i.e. PITAGORA 5700), thanks an Ethernet connection with the central acquisition unit of the system.

TECHNICAL SPECIFICATIONS

Detection unit

- Detector: 2"x2" NaI(Tl)
- Min detect. activity: <1 Bq/l of ¹⁸F with T_M ≥ 5 min
- Energy range: ≥ 25 keV
- Background rate at 511 keV: 0.02 cps
- Temperature range: 0 - 40 °C
- Max temperature gradient: 5 °C/h

Measurement chamber

- Geometry: Marinelli Beaker
- Capacity 3 liters
- Shielding: Lead, 100 mm thick
- External dimensions (∅xH) = 60 x 100 cm
- Weight: 600 kg

Air sampling pump (typical)

- Flow rate: 16 m³/h
- Max RPM: 1420 RPM
- Protection grade: IP 54
- Power supply: 380 V (220 V available)
- Max current: 2.2 A
- Power: 0.55 kW
- cos φ: 0.76

Flow switch

- Air capacity: 1.8 ÷ 431 l/h
- Accuracy: 2%
- Max pressure: 34 bar
- Temperature range: 1-121 °C
- Output: low flow signal
- Power supply: 24 V DC

Interception electro-valve

- Power supply: 24 V DC
- Pipe diameter: 1/4"

Power supply unit (in the cabinet)

- Input voltage: 220 V AC
- Max power: 250 W
- Output voltage: 24 V DC

Acquisition unit

- Holder: Cabinet - 19" Rack
- Processor: Intel Pentium Dual Core 2,60GHz E5300
- RAM memory: 2 GB
- LCD monitor 17"
- Cabinet dimensions (WxHxD) = 58x188x61 cm
- Total weight = 80 kg approx.

Sampling unit

- Total dimensions (WxHxD) = 100x150x60 cm
- Total weight = 700 kg approx.

I/O management board

- Type of relay outputs: N.C. / N.O
- Outputs number: 16
- Insulating resistance: 100 MΩ
- Relay ON/OFF time: 5 ms (typical value)
- Insulated inputs number: 16

Acquisition, processing and display software

- Data acquisition every second
- Data archiving
- Operative and calibration parameters set-up
- Correct functioning, alarm and acoustic signals management
- Data display in alphanumeric and graphic form
- Display of the gamma spectrum

Signal processing unit

- Signal shaping: Semi-Gaussian
- Output signal: unipolar, from 0V to 8V
- ADC inputs range: ± 0.05 a 10 V
- A/D resolution: 12 bit
- DNL: 1 LSB
- Max Sample rate: 200 KS/s
- Trigger: digital
- Counters: two, 24 bit
- High voltage supply: from 0 to 1000V

OPTION AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Stack flow rate meter for released activity calculation: STACK-DFM
- Expulsion of the monitored air
- LaBr₃(Ce³⁺) scintillator detector instead of NaI(Tl)



ENVIRONMENTAL AERIAL BETA MONITOR UNIT WITH ION CHAMBERS

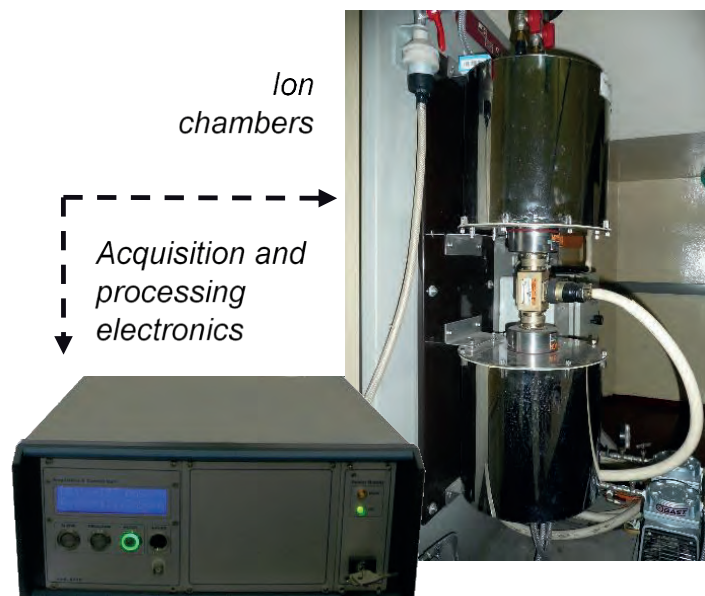
NAUSICAA 5303 2IC

MAIN FEATURES

- Detectors: double pressurized ion chamber
- Active volume of each chamber: 10 l
- Material: AISI 316 stainless steel
- Measurement range: 3.7×10^4 Bq/m³ - 3.7×10^9 Bq/m³
- Local visualization of the acquired data and alarm statuses
- Connectable to a Host PC (available on request) through serial (RS485/422 available for long distances), Ethernet or wireless (on request) connection
- Remote management and data visualization software available on request

DESCRIPTION

The aerial Beta monitor **NAUSICAA 5303 2IC** is a system designed to measure Beta activity in the air, compensating for the Gamma background. The main components are two identical ion chambers built in stainless steel, and the acquisition/processing electronics featuring a display and a functional operator interface.



The two ion chambers are cylindrical and typically aligned between them. The air to be monitored flows in just one of the two chambers, while in the second there is a reference gas (which can be air itself). The HV power supply value is the same for both cameras, but with opposite polarity. The electrodes of the cameras are connected on a single impedance, so the resulting current is actually the difference between the two single currents coming from each camera. This configuration allows to compensate for the environmental Gamma radioactivity, improving the measurement performance. Furthermore, before passing through the active volume of the chambers, the air flows in a de-ionizing space where electric charges are eventually absorbed; this process further limits possible spurious signals.

Given its configuration and its compensation ability, the monitoring unit can measure the gas (air) activity as follows:

- Differential measurements with reference: a reference gas is put in one chamber, while the gas to be monitored flows in the other chamber

- Continuous differential measurements: the gas to be monitored flows in one chamber, while the other chamber is kept closed

The electronics of the **NAUSICAA 5303 2IC** performs the acquisition, the processing and the visualization of the data coming from the measurement unit. Thanks to the display it is possible to locally read the activity concentration value, and the built-in acoustic and luminous signaling devices alert the operator of any alarm, pre-alarm or malfunctioning event. The alarm and pre-alarm thresholds levels, as well as the others operative parameters, are saved in the internal non-volatile memory, and they can be entered by the operator using the provided keyboard or remotely via the management software (accessory). The standard configuration of **NAUSICAA 5303 2IC** monitor, suitable for indoors applications, is composed by the measurement unit (wall- or panel-mounted) and a 3U 63HP desk rack which the electronics modules are installed in. It's possible to connect the acquisition unit to a host PC through RS232 serial connection, for distances up to 10 meters; for longer distances (up to 1 km) a RS485/422 connection is available. Also, an Ethernet or wireless connection are available on request. On the host PC is installed the archives transferring software, that allows to save the monitoring data and visualize them on the PC. Alternatively, the 5700 SMON software can be installed on request: 5700 SMON allows the complete remote management of the monitoring unit.

TECHNICAL SPECIFICATIONS

Detector unit

- Type: double pressurized ion chamber
- Material: AISI 316 stainless steel
- Measurement unit dimensions ($\varnothing \times H$) = 30 x 85 cm
- Total measurement unit weight: 21 kg
- Active volume (each camera): 10 l
- Maximum supported flux: 3 m³/h
- Maximum pressure: 220 millibar
- Gas input/output tubes diameter: \varnothing 18 – 20
- Insulation resistance: 10¹⁴ Ω
- Power supply voltage: from ± 150 V to ± 1000 V

Note: with a 600 V value each camera can generate currents up to 10⁻⁸ A, with a saturation error lower than 20%.

Measurement performances

- Measurement range: from 3.7 x 10⁴ Bq/m³ to 3.7 x 10⁹ Bq/m³
- Saturation: 9.25 x 10⁹ Bq/m³
- Sensitivity:
 - Alfa emitting gas: 4.86 x 10⁻²¹ A/Bq/m³ per keV
 - Beta emitting gas (3.7 x 10⁴ Bq activity)
 - Tritium: 1 x 10⁻¹⁴ A
 - C-14: 8.8 x 10⁻¹⁴ A
 - Kr-85: 7.6 x 10⁻¹⁴ A
 - Xe-133: 1.3 x 10⁻¹³ A
 - Gamma emitting gas: 10⁻⁷ A/Sv/h
- Beta resolution: 5.45 x 10² Bq

Acquisition and control unit

- Dose rate measurements: instantaneous (μ Sv/h), 1 minute average and 1 minute maximum
- Integrated dose: referred to 1 hour, 24 hours and total
- LCD display 2x16 characters with LED and siren for alarm, pre-alarm and good functioning
- Real time clock circuit
- Watchdog circuit for functioning control
- Interfaces: RS232; RS485/422 for long distances; Ethernet 10/100; wireless (upon request)
- Memory: E2PROM for parameters, DataFlash for measurements

Electrical characteristics

- Power supply: 230 Vac 50 Hz; consumption: 12 W (typical value)
- Temperature range: 0 ÷ 40 °C

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Wireless communication with the Host PC
- 5700 SMON complete remote management software with synoptic screen (connection cables included)
- CPC data concentrator PC
- ALU alarm unit for status remote signaling



ENVIRONMENTAL GAMMA RADIATION MONITORING UNIT

NAUSICAA 5301 IC series

MAIN FEATURES

- Detector: pressurized ion chamber
- Measurement range: 10 nSv/h ÷ 100 mSv/h (pulsed field version) or 10 nSv/h ÷ 10 Sv/h (environmental measurement version)
- Energy range: 80 keV ÷ 10 MeV, extendable to 35 keV ÷ 10 MeV (with ICP-T detector)
- Local display of acquired data and alarm status
- Connectable to a Host PC (optional) through serial cable (even RS485/422 for long distances), Ethernet, or wireless (upon request)
- Software for archives storage available on the host PC
- Software for remote management and data visualization available upon request

DESCRIPTION

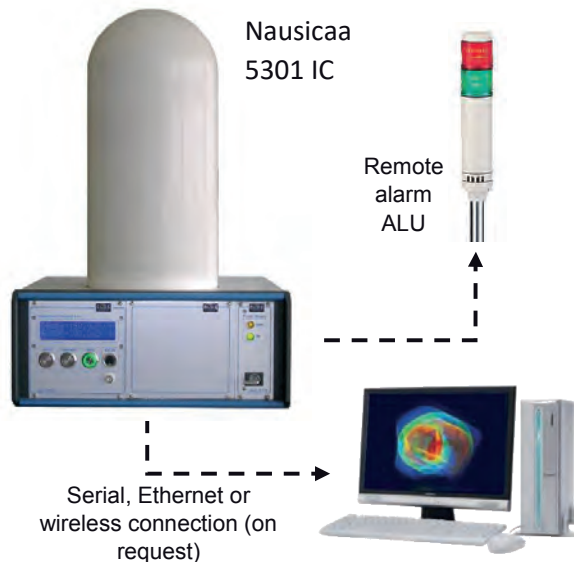
The **NAUSICAA 5301 IC** environmental monitoring unit is a modular system for gamma dose measurements, and it comes in two versions: with an electrometer for pulsed field measurements (7 decades, **NAUSICAA 5301 IC - PF**) or with an electrometer for environmental measurements (9 decades, **NAUSICAA 5301 IC**, default version).

The detector is a 16-atm ion chamber of the ICP series, which allows to extend the detection energy range down to the low energies (35 keV), by choosing the proper model.

The instrument is composed by the following main parts:

- Ion chamber detector;
- Power supply and signal processing electronics
- Acquisition and control unit

The acquisition and control unit elaborates and visualizes the data coming from the detection group, composed by the ion chamber and the connected electronics.



The unit allows to visualize locally the dose rate or the integrated dose values and eventually indicates alarm, pre-alarm or bad functioning statuses through acoustic and luminous signals.

The threshold values for alarm and pre-alarm statuses, and the operational parameters, which are saved in the internal memory, can be set by the operator through the external keyboard or through the remote management software (optional). The standard configuration of **NAUSICAA 5301 IC** monitoring unit, suitable for indoor use, is composed by a table box 3U 63HP, which hosts the electronics modules, and the ion chamber directly installed on top of it.

Wall mounting accessories are also available, as well as a high-protection IP65 container for outdoor use. It is possible to connect the acquisition unit to a host PC through a serial communication, up to a 10 m distance, or RS485/422 interface, for longer connections (up to 1 km). An Ethernet connection is also available, and upon request a wireless communication module can be provided. The optional host PC includes the software for archive storage, which allows to save in the memory the monitoring data and to visualize them on the PC. Alternatively, the 5700 SMON software can be installed, which allows a complete remote management of the monitoring unit.

TECHNICAL SPECIFICATIONS

- Temperature range: 0 ÷ 40 °C
- Weight: 20 kg with ICP; 17 kg with ICP-T
- Dimensions (WxDxH): 365x390x560 mm

Measurement features

- Measurement range:
 - 10 nSv/h ÷ 10 Sv/h (environmental measurement version)
 - 10 nSv/h ÷ 100 mSv/h (pulsed field version)
- Energy range:
 - 80 keV ÷ 10 MeV (Mod. ICP); 35 keV ÷ 10 MeV (Mod. ICP-T)
- Energy response: ± 20% from 80 keV to 120 keV; ± 5% from 120 keV to 2 MeV
- Accuracy: ± 5% at environmental background radiation levels

Detection unit

- High pressure ion chamber, filling gas: Argon 6.4 atm + Nitrogen 9.6 atm (12 atm + 3 atm in ICP-T)

Power supply and processing electronics

Two alternative electrometers, one for pulsed fields and one for environmental measurements:

- Pulsed field electrometer (tested in Trieste at the ELETTRA synchrotron under the following conditions: 70 ns pulse length, 10 Hz repetition frequency, number of pulses: 1, 2, 10 with Linac

currents 1, 2, 5, 10 and 15 mA, see “Development and experimental performance evaluation of a dose-rate meter for pulsed beam, in Proceedings of the RADSYNCH 2009, 65-70”):

- 7 decades with automatic scale change
- Single pulse detection up to 3.5 nC/pulse ~ 4.3 µGy/pulse
- Environmental measurements electrometer:
 - 9 decades with automatic scale change
- Digital setting of calibration parameters
- Low-noise HV circuit: 0 ÷ 1.3 kV digital control

Acquisition and control unit

- Dose rate measurements: instantaneous (µSv/h), 1 minute average and 1 minute maximum
- Integrated dose: referred to 1 hour, 24 hours and total
- LCD display 2x16 characters with LED and siren for alarm, pre-alarm and good functioning
- Real time clock circuit
- Watchdog circuit for functioning control
- Interfaces: RS232; RS485/422 for long distances; Ethernet 10/100; wireless (upon request)
- Memory: E2PROM for parameters, DataFlash for measurements

Electrical characteristics

- Power supply: 230 Vac 50 Hz; 60 W (typical value)

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Wireless communication with the Host PC
- UTAS software utility for archive storage (connection cables included)
- 5700 SMON complete remote management software with synoptic screen (connection cables included)
- CPC data concentrator PC
- ALU alarm unit for status remote signaling
- Trolley kit: bare/unwired trolley for wheeled transport
- Rechargeable 12VDC battery power supply

ORDER GUIDE

		ELECTROMETER CHOICE	
		Environmental conditions	Pulsed radiation fields
DETECTOR CHOICE	Conventional energy range	NAUSICAA 5301 IC	NAUSICAA 5301 IC -PF
	Extended energy range	NAUSICAA 5301 IC -T	NAUSICAA 5301 IC -T-PF



ENVIRONMENTAL GAMMA RADIATION MONITORING UNIT

DISCOVERY 5302 IC

MAIN FEATURES

- Detector: pressurized ion chamber (ICP series)
- Measurement range: 10 nSv/h ÷ 100 mSv/h (pulsed field version) or 10 nSv/h ÷ 10 Sv/h (environmental measurement version)
- Energy range: 80 keV ÷ 10 MeV (with ICP detector) extendable to 40 keV ÷ 10 MeV (with ICP-T detector)
- Local display of acquired data and alarm status
- Data storage in non-volatile circular memory buffer
- Host PC communication: RS485/422 for long distances and 10/100 Mbit/s Ethernet or, alternatively, Wireless LAN (option)
- Wireless communication 802.15.4/Multipoint Network Topologies (XBee) or, alternatively, GSM modem (option)
- GPS locator available
- Remote management software available, for data display and storage

DESCRIPTION

The **DISCOVERY 5302 IC** monitoring unit is a modular system for gamma dose measurements, assembled in a highly protected insulated PVC housing. The detector is a pressurized ICP ion chamber; alternatively, the model ICP-T is available, which allows to extend the lower energy range down to 40 keV, if needed.

DISCOVERY 5302 IC comes in two standard versions: with an electrometer for pulsed field measurements (7 decades) or with an electrometer for environmental measurements (9 decades).

The Acquisition and control unit processes and locally displays the data coming from the detection unit (i.e. the dose rate or the integrated dose value) and eventually indicates the alarm or malfunctioning conditions, through acoustic and luminous signals. The measurements are automatically saved in a non-volatile circular memory buffer.



DISCOVERY 5302 IC

DISCOVERY 5302 IC can be used outdoor, and it can be easily mounted on a telescopic tripod with adjustable legs, to be positioned where needed. On the front side of the housing are installed the water proof LCD display and the function buttons panel; the connections to the power set, as well as the Ethernet or RS485 connection to the remote station and to other eventual external devices (i.e. alarm repetition), are on the back side of the housing.

The processed measurements can be shown by the local display or the remote Host PC, which can be connected to the unit through serial or Wireless communication. The alarm thresholds and the operative parameters are saved in the non-volatile memory, and can be set by the operator either locally or through the remote management software (option).

The low voltage power supply can be provided by the built-in rechargeable batteries, which have an autonomy of 4 hours, in case of remote measurements or should a power outage occur.

The XBee Pro wireless communication complies to standard 802.15.4/Multipoint Network Topologies, and allows communication up to 1 km in open space or 100 m indoor. A simple XBee compatible USB adaptor is needed on the PC. As an alternative to the XBee interface, a GSM modem can be used. In the monitoring unit is also installed a satellite GPS locator, which associates the acquired measurements with the position. The Ethernet interface is also available in the IEEE 802.11b version (Wireless LAN).

TECHNICAL SPECIFICATIONS

- Temperature range: $-10 \div 40$ °C
- Protection: IP65
- Weight: 25 kg
- Dimensions: $\varnothing = 40$ cm, H = 67 cm
- Power supply: 12 VDC
- Power absorption: 15 W; maximum absorption: depending on the options and accessories

Measurement features

- Energy range:
 - 80 keV \div 10 MeV (with ICP); 40 keV \div 10 MeV (with ICP-T)
- Energy response: $\pm 20\%$ from 80 keV to 120 keV; $\pm 5\%$ from 120 keV to 2 MeV
- Accuracy: $\pm 5\%$ at environmental background radiation levels

Detection unit

- Type: pressurized ion chamber (16 bar)
- Gas: Argon + Nitrogen

Power supply and processing electronics

Two alternative electrometers, one for pulsed fields (7 decades) and one for environmental measurements (9 decades):

- Pulsed field electrometer:
 - 7 decades with automatic scale change (10 nSv/h \div 100 mSv/h)

- Single pulse detection (i.e. storage ring beam dump) up to 3,5 nC/pulse \sim 4,3 μ Gy/pulse (*)
 - Environmental measurements electrometer:
 - 9 decades with automatic scale change (10 nSv/h \div 10 Sv/h)
 - Digital setting of calibration parameters
 - Low-noise HV circuit: 0 \div 1,3 kV digital control (*)
- Test carried out at Elettra – Trieste Synchrotron “Development and Experimental Performance Evaluation of a Dose-Rate meter for Pulsed Beam” - RadSynch 2009

Acquisition and control unit

- Watchdog circuit for functioning control
- Interfaces: RS485/RS422, Ethernet 10/100 Mbit/s, XBee wireless communication
- LCD display 2x16 characters with LED and horn for alarm, pre-alarm and good functioning
- Dose rate measurement: instantaneous (μ Sv/h), average referred to 1 minute and maximum referred to 1 minute
- Integrated dose: referred to 1 hour, 24 hours and total
- 3 outputs for remote alarm repetition

Alternative communication interfaces

- Wireless LAN communication interface as an alternative to Ethernet 10/100 Mbit/s
- GSM modem as an alternative to XBee wireless communication interface

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- 5700 SMON complete remote management software with synoptic screen (connection cables included)
- ALU alarm unit for status remote signaling
- GPS locator
- Photovoltaic panel
- Surge Arrester and line protections



ENVIRONMENTAL MONITORING SYSTEM

PITAGORA 5700

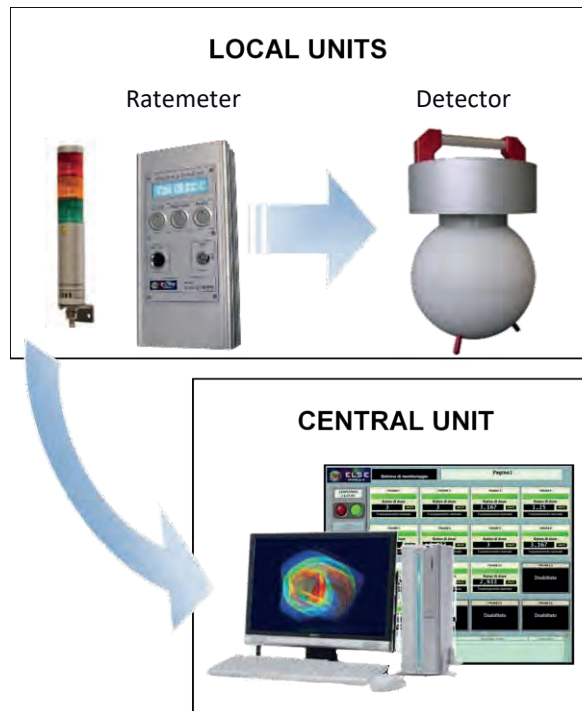
MAIN FEATURES

- PC based Central control station
- User friendly remote management software, with easy access to the archives
- Connection of up to 45 monitors via Ethernet (for distances < 100 m) or RS485 (for distances > 100 m)
- One connection cable required for each local unit (data transmission)
- Monitors can be up to 1 km far
- Supports all available detectors
- Local visualization of measuring data of all local units
- Remote management of all local units (setup of parameters and alarm thresholds)
- Continuous control and real-time display visualization of equipment's status
- Storage every minute on daily files of instantaneous, average, maximum dose rate, and integrated dose
- Graphical display of stored data with calculation tools

DESCRIPTION

The **PITAGORA 5700** environmental monitoring system is a modular and flexible system, consisting of wall mountable equipment, specifically designed to detect area and air radioactivity. The system allows both dose-rate monitoring of gamma/neutron fields (Area monitoring) and activity measurements of air contamination (Air and/or Stack monitoring).

The basic structure of the **PITAGORA 5700** is composed of up to 45 local units (detector + SATURN ratemeter) and a central unit (CPC computer + 5700 sMON software + Junction Box).



Pitagora 5700 schematic architecture

The recommended distance between detectors and the connected ratemeter is about 15-30 m. Each local unit can be provided with an alarm column, composed by red, yellow and green lamps and siren, indicating alarm and pre-alarm status, probe's malfunction and good operation. The system supports also the NAUSICAA 5301 IC series, the gamma-neutron monitoring station SATURN 5702, and ELSE NUCLEAR Pulsed Field monitoring equipment. The system's central unit collects the data of all the local units of the **PITAGORA 5700**. The connected units may be the local ratemeters (area and stack monitoring) and the APU control unit of the MISTRAL XM air monitor.

TECHNICAL SPECIFICATIONS

Power supply and Ethernet/RS485 network unit (Junction Box)

- Allowed inputs: up to 45
- Low-noise power supply: IN 220 VAC – 50 Hz / OUT 24 VDC
- Network: Ethernet or RS485
- Ethernet connection to local units: 1 Eth. data cable (+1 for power supply if required)
- RS485 connection to local units: 1 cable for 24 VDC power and RS485 data
- Dimensions: (WxDxH) 460x380x180 mm (typical)

CPC – Data concentrator PC

- Type: Tower PC
- Connectability: Ethernet LAN 100 Mbps

ALU – Alarm unit

- Type: LED with siren
- Height: 230 mm
- Diameter: 40 mm
- Green light: Good functioning
- Yellow light: Prealarm
- Red light/siren: Alarm
- Acoustic level: 85 dB at 1 m

For technical specifications of the other components, please refer to the specific product data-sheet

ORDER GUIDE

Central processing unit	Options		Control unit (up to 45)	Detector (1x unit)	Options
PITAGORA CENTRAL UNIT (CPC + Junction Box)	PRINTER	Area dose monitor	SATURN series	GM-1 PCP GMP-WR ICP LUPIN 5401	ALU SSD Calibration
			NAUSICAA 5301 IC series and SATURN 5702 (no external ratemeter needed)		
		Stack monitor On-line	SATURN series	PNAI	ALU STACK-DFM
		Stack monitor Off-line	SATURN series	PNAI + SDU-1M	ALU STACK-DFM
		Air/Stack monitor MISTRAL XM	APU	PNAI-MC + SDU-XM	ALU STACK-DFM



GAMMA AND NEUTRON ENVIRONMENTAL MONITORING MOBILE STATION

SATURN 5702

MAIN FEATURES

- Trolley-mounted gamma and neutron monitoring station
- Gamma detector: high pressure ionization chamber ICP series
- Neutron detector: extended-range rem counter LUPIN 5401 BF₃-NP
- Removable detectors for remote measurements (up to 20 m)
- Local dedicated displays for data visualisation
- Alarm column for status visualisation
- Independent relays available for interlock operations: good functioning, pre-alarm and alarm outputs
- Networkable in a radiation monitoring system
- Modular electronic boards that can be employed for different probes

DESCRIPTION

SATURN 5702 is a mobile station equipped with two detectors for gamma and neutron ambient dose equivalent, H*(10), rate monitoring.

The detectors are standard stand-alone instruments:

- Ion chamber-based gamma detector: ICP series (ICP, ICP-T, ICP-PF or ICP-T-PF)
- BF₃-based neutron detector: LUPIN 5401 BF₃-NP

The detectors and the electronics are housed in a specifically designed trolley-mounted mechanical structure. If necessary, each detector can be removed from the support structure to be employed remotely, up to 20 meters.

An alarm column is mounted on the top of the mobile station, providing luminous and acoustic warning signals related to the status of the monitoring station: Green (good functioning), Yellow (pre-alarm), Red and Horn (alarm). These statuses can be replicated on external devices through 4 relay contacts available for Green, Yellow and Red statuses.



SATURN 5702

ICP series

High-pressure ionization chambers of the ICP series are designed for gamma dose rate environmental area monitoring. All models are equipped with state-of-the-art high voltage supplier and electrometer boards, for polarization,

power supply, signal acquisition and processing. A special electrometer model (details in the next page) is available for measuring very intense pulsed radiation fields, such as those generated by synchrotrons and other pulsed accelerators (-PF versions).

LUPIN 5401 BF₃-NP

The environmental monitoring unit LUPIN 5401 BF₃-NP is an extended-range rem counter designed for neutron dose rate environmental area monitoring, with excellent performance for detection in pulsed neutron fields, as the detector is not affected by dead time effects common of all commercial detectors. The detector is composed of a BF₃ neutron proportional counter, a polyethylene moderator loaded with high-Z material, and built-in electronics for power supply, signal acquisition and processing.

SATURN I 5700 RTM

The detectors are connected via external cables to a local acquisition and control unit, which is composed by a standard 19" electronics rack equipped with two dedicated SATURN I 5700 RTM rate meter units. Each rate meter is equipped with a display, 3 function keys with status LEDs, and a plug for external keyboard.

The operator can visualise the dose rate measurement on the displays. Interaction with the system occurs through the function keys on the front panels (basic functions) and an external keyboard (advanced functions, such as operational parameters setting).

Optionally, **SATURN 5702** can be connected to a remote host PC with a data management software (5700 sMON) through RS485/422 or ETH connection.

TECHNICAL SPECIFICATIONS

Should any further technical detail be required, please refer to the specific product data sheet.

SATURN 5702:

- Weight: about 130 kg
- Dimensions: 60x68x160 cm (typical)
- Temperature Range: -20 ÷ +50°C
(LCD only: 0 ÷ 40 °C)
- Power supply: 230/110 VAC; 50/60 Hz

ICP series (ICP or ICP-T)

- Energy range: 80 keV ÷ 10 MeV
(35 keV ÷ 10 MeV with ICP-T)
- Measurement range: 10 nSv/h ÷ 10 Sv/h
(÷ 0.1 Sv/h with ICP-PF and ICP-T-PF)
- Sensitivity: ~10⁻⁶ A/Sv/h (¹³⁷Cs)

- Electrometer characteristics:
 - 9 decades with auto-ranging (ICP and ICP-T, for environmental area monitoring)
 - 7 decades with auto-ranging (ICP-PF and ICP-T-PF, for pulsed fields monitoring)
 - Single pulse detection up to 3.5 nC/pulse ~ 4.3 µGy/pulse

LUPIN 5401 BF₃-NP

- Energy range: thermal (0.025 eV) ÷ 5 GeV
- Measurement range: 10 nSv/h ÷ 100 mSv/h
- Neutron sensitivity: 0.6 cps/µSv/h
- Gamma sensitivity: < 0.5 µSv/h at 50 mSv/h (¹³⁷Cs)
- Typical performances with pulsed beams
 - Sensitivity: 0.5 counts/nSv
 - Maximum Dose Intensity per Burst: 1.5 µSv/burst
 - Repetition rate: up to 500 Hz

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- ³He proportional counter instead of BF₃

Different configurations are quoted on demand. The company ELSE NUCLEAR offers the own experience to develop special products and systems to satisfy the customer needs.



NETWORK OF ENVIRONMENTAL MONITORING CABIN STATIONS

CPMON 5303

MAIN FEATURES

- Monitoring cabin installed on a platform
- Wireless communication between the cabins and the base station (host PC)
- Radiation detector: environmental continuous gamma monitor based on ionization chamber
- Power supply provided by solar panels and rechargeable batteries
- Filtered sampling system with digital flowmeter
- Base station: host PC connected to the monitoring stations through radio transceiver
- Data management software with graphical user interface

DESCRIPTION

The **CPMON 5303** monitoring system is composed by a network of cabin stations communicating with a central visualization/management station (host PC) through a radio connection.

In each cabin are installed a gamma monitor NAUSICAA 5301 IC and a filtered sampling device, as well as the electronics and the power supply batteries, linked to the solar panels installed on the top of the cabin.

The cabins are sized to accommodate the equipment required, and are provided with proper insulation and ventilation necessary to ensure the best thermal conditions, as well as protection from rain. The access structures such as doors and stairs are designed to ensure high security. The support pylon and its base are designed to support the weight of the cabins, the platform, the photovoltaic panels and the operators, also in strong wind.



Example of mast-assembled system

Photovoltaic modules are connected to the instruments through a charge controller. In daytime the solar panels charge the batteries and provide the power supply, while at night it is provided by the batteries.

The monitors include a pressurized ionization chamber detector. The detector is connected and fully managed by the acquisition and control unit, which locally performs the functions of reading, processing and displaying data. The acquisition and control unit manages the status of alarm, pre-alarm and malfunction, which are indicated by three LEDs (red, yellow, green) and by the internal buzzer; it can be also connected to an alarm beacon. The filtered

sampling device is small and requires low power supply, to adapt to outdoor installation, and to reduce the size of photovoltaic panels.

The central monitoring station consists of a host-PC which receives data from the cabins. The connection is established via WiFi directional antenna mounted on the cabins, and omni-directional antenna for reception / transmission from the central station. The graphical software installed on the host-PC enables the management overview of the whole monitoring system, displaying in real time the values of dose rate, the flows of the aspirations and the status of monitors. The user can remotely control the main functions that can be accessed locally from the NAUSICAA monitors. The data are stored in history files on a daily basis and saved to disk, and can be viewed and printed at any time. The central unit interrogates every minute the local units, which respond by sending the data. If it finds an alarm, the local unit transmits the data immediately, updated every second, without waiting for the query.

TECHNICAL SPECIFICATIONS

Detector module NAUSICAA 5301 IC:

- Type: High Pressure Ionization Chamber
- Volume: 5.2 liters
- Gas filling: Argon + Nitrogen
- Energy Range: from 80 keV up to 10 MeV
- Dose Rate Range: from 10 nSv/h up to 10 Sv/h
- Calibration Factor: 0.71×10^{-6} A/Sv/h (^{137}Cs)
- Temperature Range: -25° / $+50^{\circ}$ °C
- Low electronic noise HV Circuit: 0/1.3 kV digitally driven

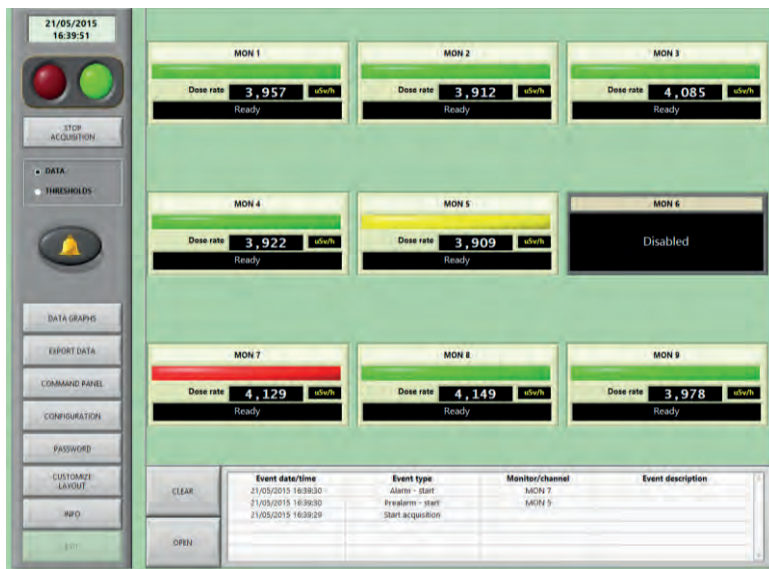
- Electrometer: 9 decades with autorange or 7 decades for pulsed fields (high dose in short time)
- Power: 220 Vac 50 Hz; max 60 W absorbed

Sampling device F&J model df-75l-ac:

- Power supply: 12 VDC or 220 VAC 50 Hz
- Dimensions: 20×23×30 cm
- Peso: 5 kg
- Max flux: 65 to 75 lpm (typical)
- LED display
- Automatic flux control
- Filter diameter: 55 mm
- Work temperature: $-18 \div +50$ °C

Host pc:

- Ethernet 10/100 Mbit – connection RJ45
- Wi-Fi connection
- Software:
 - User friendly remote management software
 - Easy access to the archives
 - Real time visualization of monitoring status: good operation (green), pre-alarm (yellow), alarm (red)
 - Hard Disk check
 - Acquisition minute by minute and storage on daily file of dose average and the maximum rate
 - Daily report with minute, hour, day, month and year of storage data
 - Visualization and storage of integrated data on 10 minute, 1 hour or 1 day
 - Possibility of processing portions of data, saving the results on text file
 - Printable archives compatibles with spreadsheet (e.g. Microsoft Excel)
 - Up to 8 visible and printable historical graphics
 - Management of operative parameters for single monitoring point
 - Shared archives on LAN network by Ethernet connection
 - Password access



Software main panel



ENVIRONMENTAL MONITORING RACK UNIT

SATURN I 5700 RTM

MAIN FEATURES

- Data and alarm statuses visualization on alphanumeric LCD display
- Continuous detector data management
- Storage of acquired data in internal non-volatile memory
- Supports several probe types
- Rack mounting
- Luminous and acoustic signalling of good operation, alarm and prealarm conditions
- Interfaces available for data communications: serial RS232, RS485 (or 422) for long distances (max 1 km), Ethernet
- External keyboard for parameter settings
- Luminous and acoustic beacon available for remote alarm repetition
- Concentrator PC and software available for remote management

DESCRIPTION

The **SATURN I 5700 RTM** environmental monitoring unit is a compact and modular ratemeter, each designed to receive, process and visualize the dose measurement provided by one of the several probe available.

The **SATURN I 5700 RTM** is designed to be mounted in RACK; several ratemeter units can be installed at once, and each of them manages the data provided by the connected probe. The CPU board of each RTM unit continuously receives and processes the data, comparing the results to the memorized thresholds, and saving the data in its internal non-volatile memory. The alarm and pre-alarm threshold values, as well as every operational parameter are also saved in the memory, and can be locally set by the operator through an external keyboard, or remotely through the remote management software (optional). In both cases, a password is needed to access and modify the parameters; the external keyboard allows the operator to insert the password.



SATURN I 5700 RTM display panel

Events such alarms, pre-alarms or bad functioning are signaled by acoustic and luminous indicators, and optionally by a remote alarm beacon.

The measurement unit is able to receive data from several types of detectors, each one with different features and application; this feature provides a high adaptive potential. For the list of main compatible ELSE NUCLEAR detectors, see next page.

By default, the unit locally visualize the dose rate and average dose values; the operator can eventually select others available measurements, setting the proper parameters.

The acquisition units can be connected to a concentrator host PC via RS232, for distances up to 10 meters; for longer connection up to 1 km a RS485/422 connection is available, as well as an Ethernet connection, an interlock relay, and (upon demand) a wireless module.

The 5700 sMON software installed on the PC allows to completely and remotely manage the units in real time. Alternatively, an archive transferring software can be installed, which allows to save the monitoring data and to visualize them on the PC.

TECHNICAL SPECIFICATIONS

- Temperature range: 0 ÷ 40 °C
- Power supply: 230 Vac 50 Hz

Power supply and processing electronics (only for ICP series probes)

Two alternative electrometers, one for pulsed fields (7 decades) and one for environmental measurements (9 decades):

- Pulsed field electrometer (70 ns pulse length, 10 Hz repetition frequency, number of pulses: 1, 2, 10 with Linac currents 1, 2, 5, 10 and 15 mA):
 - 7 decades with automatic scale change
 - Single pulse detection up to 3.5 nC/pulse ~ 4.3 mGy/pulse (*)
- Environmental measurements electrometer:
 - 9 decades with automatic scale change
- Digital setting of calibration parameters
- Low-noise HV circuit: 0 – 1.3 kV digital control

(*) test carried out at Elettra – Trieste Synchrotron “Development and Experimental Performance Evaluation of a Dose-Rate meter for Pulsed Beam”- RadSynch 2009

Acquisition and control unit

- Dose rate measurements: instantaneous, 1 minute average and 1 minute maximum
- Integrated dose: referred to 10 minutes, 1 hour, 24 hours and total
- LCD display 2x16 characters with LED and siren for alarm, pre-alarm and good functioning
- Real time clock circuit
- Watchdog circuit for functioning control
- Interfaces: RS232; RS485/422 for long distances; Ethernet 10/100; wireless (upon request)
- Memory: E2PROM for parameters, DataFlash for measurements

Main parameters list

- Date and time
- Detector type
- Calibration factor
- Measurement unit
- Alarm and prealarm thresholds
- Minimum duration for prealarm/alarm conditions
- Local acoustic alarm muting option
- Manual reset of alarms/failures/doses/all
- Alarm autoreset option
- Fail-limit levels
- Background value
- Moving average settings
- Serial port communication speed
- Test mode with an external source for quality control purposes

Supported detectors¹

The monitor SATURN I 5700 RTM supports any of the following detectors:

- Geiger-Müller counter series GM
- Proportional counter: model PCP
- Double Geiger detector: model GMP WR
- Ionisation chamber series ICP, including electrometer board and HV
- Scintillation detector series PNAI: PNAI NaI(Tl) 2"x2", PNAI/3 NaI(Tl) 3"x3"
- Neutron probes: NP series probes and LUPIN 5401 pulsed rem counter

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Wireless communication with concentrator host PC
- Software utility for data archive download: model UTAS (connection cables included)
- Data concentrator PC model CPC, with software application for complete remote management of the monitor, featuring a synoptic diagram: model 5700 sMON (connection cables on request)
- Additional alarm unit for remote signalling: model ALU

¹ For more information and technical specifications concerning the detectors, see the relevant data sheets



WALL MOUNTING DIGITAL RATEMETER

SATURN I 5700 RTM-WM

MAIN FEATURES

- Data display on alphanumeric LCD screen
- Continuous detector data management
- Maintains internally stored archives of acquired data
- Supports several probe types
- Luminous and acoustic signalling of good operation, alarm and prealarm conditions
- Interfaces available for data communications: serial RS232, RS485 (or 422) for long distances (max 1 km), Ethernet
- External keyboard for parameter settings
- Wall mounting
- Luminous and acoustic beacon available for remote alarm repetition

DESCRIPTION

The acquisition and control unit **SATURN I 5700 RTM-WM** is a compact ratemeter, designed for managing and processing signals from the connected area monitoring detector. **SATURN I 5700 RTM-WM** is designed to be wall mounted, by means of its supporting lugs. The unit continuously acquires data coming from the detector, processes them and compares results with user defined internally stored threshold parameters.

Possible failure, alarm or prealarm conditions are signalled by means of acoustic, luminous devices and relays. Two user selected measurements can be displayed at the same time on the ratemeter screen, including: instantaneous or average countrate, doserate, activity concentration; counts, dose or activity integrated values.

Measurements, alarm/prealarm thresholds and operating parameters are stored into an internal, non-volatile memory. Thresholds and parameters can be set up by the user by entering a security password that protects the setting menu. Security codes and parameter values can be entered by means of an external keyboard, connectable to the unit when needed. Hereafter we list the main parameters you can set:

- | | |
|--|--|
| • Date and time | • Serial port communication speed |
| • Detector type | • Alarm autoreset option |
| • Calibration factor | • Fail-limit levels |
| • Measurement unit | • Background value |
| • Alarm and prealarm thresholds | • Moving average settings |
| • Minimum duration for prealarm/alarm conditions | • Manual reset of alarms/failures/doses/all |
| • Local acoustic alarm muting option | • Test mode with an external source for quality control purposes |

The monitor can be controlled by a host PC through an Ethernet network (or RS485 for long distances). 5700/SMON, the PC control software, is a remote management Windows application with a synoptic diagram that displays in real time the data processed by the monitor and its operating condition and stores all information to disk archives. Some system parameters and alarm/prealarm thresholds can be changed remotely upon password authorization. Alternatively to 5700 SMON, a utility application is available to allow downloading of the **SATURN I 5700 RTM-WM** internal data archives to the computer.

TECHNICAL SPECIFICATIONS

- Power supply: 220VAC/24VDC – 50 Hz; max absorption: 60 W
- Dimensions (WxHxD) = 109 x 225 x 46 mm; Weight: 995 g; Case material: aluminum
- Temperature range: 0 ÷ 40 °C

- 4 relays with both NC and NO changeover contacts for remote signalling of monitor status
- 1 contact NO/NC for interlock purposes; TTL level for beam-on status input

Display Unit

- 2x16 Alphanumeric LCD back-lit display with contrast regulation
- Monitor status LED: green=good operation; yellow=prealarm; red=alarm
- Resettable acoustic-luminous alarm annunciator
- 3 Function Keys for data/parameters visualization
- External keyboard with multi-pin circular connector for parameter setting

Acquisition and control unit

- Dose rate measurements: instantaneous, 1 minute average and 1 minute maximum
- Integrated dose: referred to 10 minutes, 1 hour, 24 hours and total
- Real time clock circuit
- Watchdog circuit for functioning control
- Interfaces: RS232; RS485/422 for long distances; Ethernet 10/100; wireless (upon request)
- Memory: E2PROM for parameters, DataFlash for measurements

Supported detectors¹

The monitor SATURN I 5700 RTM-WM supports any of the following detectors:

- Geiger-Müller counter series GM
- Proportional counter: model PCP
- Double Geiger detector: MERCURY GMP WR
- Ionisation chamber series ICP, including electrometer board and HV
- Scintillation detector series PNAI: PNAI NaI(Tl) 2"x2", PNAI/3 NaI(Tl) 3"x3"
- Neutron probes: LUPIN 5401 pulsed rem counter

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Additional alarm unit for remote signalling: model ALU
- Software utility for data archive download: model UTAS (connection cables included)
- Software application for complete remote management of the monitor, featuring a synoptic diagram: model 5700 SMON (connection cables on request)
- Data concentrator PC: model CPC



SATURN I 5700 RTM-WM

¹ For more information and technical specifications concerning the detectors, see the relevant data sheets

ORDER GUIDE

Version	Supported detectors
SATURN I 5700 RTM-WM	GM series PCP MERCURY GMP WR ICP series PNAI series LUPIN 5401

Options
ALU UTAS 5700 SMON CPC



WALL MOUNTING MONITORING UNIT

SATURN II

MAIN FEATURES

- Data display on alphanumeric LCD screen
- Continuous detector data management
- Maintains internally stored archives of acquired data
- Supports several probe types
- Luminous and acoustic signalling of good operation, alarm and prealarm conditions
- Interfaces available for data communications: serial RS232, RS485 (or 422) for long distances (max 1 km), Ethernet
- External keyboard for parameter settings
- Wall mounting
- Luminous and acoustic beacon available for remote alarm repetition

DESCRIPTION

The **SATURN II** monitoring unit's main component is a compact ratemeter designed for managing and processing signals from the connected area monitoring detector.

SATURN II is a modular unit designed to be wall mounted, by means of its supporting lugs, and its layout has been studied to deliver functionality and quality design. Depending on installation needs, the detector can be installed in the same mechanical module of the ratemeter, or alternatively in a separate one; an alarm module can be added to either of the previously mentioned configurations.



SATURN II

The unit continuously acquires data coming from the detector, processes them and compares results with user defined internally stored threshold parameters. Possible failure, alarm or prealarm conditions are signalled by means of acoustic, luminous devices and relays. Two user selected measurements can be displayed at the same time on the ratemeter screen, including: instantaneous or average countrate, dose rate, activity concentration; counts, dose or activity integrated values.

Measurements, alarm/prealarm thresholds and operating parameters are stored into an internal, non-volatile memory. Thresholds and parameters can be set up by the user by entering a security password that protects the setting menu. Security codes and parameter values can be entered by means of an external keyboard, connectable to the unit when needed. Hereafter we list the main parameters you can set:

- Date and time

- Detector type
- Calibration factor
- Measurement unit
- Alarm and prealarm thresholds
- Minimum duration for prealarm/alarm conditions
- Local acoustic alarm muting option
- Manual reset of alarm/failures/doses/all
- Alarm autoreset option
- Fail-limit levels
- Background value
- Moving average settings
- Serial port communication speed
- Test mode with an external source for quality control purposes

connectable to the unit when needed. Hereafter we list the main parameters you can set:

The monitor, or a system of monitors, can be controlled by a host PC through an Ethernet network (or RS485 for long distances). 5700 sMON, the PC control software, is a remote management Windows application with a synoptic diagram that displays in real time the data processed by the monitor and its operating condition and stores all information to disk archives. Some system parameters and alarm/prealarm thresholds can be changed remotely upon password authorization. Alternatively to 5700 sMON, a utility application is available to allow downloading of the **SATURN II** internal data archives to the computer.

TECHNICAL SPECIFICATIONS

- Power supply: 220VAC/24VDC – 50 Hz; max absorption: 60 W
- Temperature range: 0 ÷ 40 °C
- 4 relays with both NC and NO changeover contacts for remote signalling of monitor status
- 1 contact NO/NC for interlock purposes; TTL level for beam-on status input

Display Unit

- 2x16 Alphanumeric LCD back-lit display with contrast regulation
- Monitor status LED: green=good operation; yellow=prealarm; red=alarm

- Resettable acoustic-luminous alarm annunciator
- 3 Function Keys for data/parameters visualization
- External keyboard with multi-pin circular connector for parameter setting

Acquisition and control unit

- Dose rate measurements: instantaneous (mSv/h), 1 minute average and 1 minute maximum
- Integrated dose: referred to 10 minutes, 1 hour, 24 hours and total
- Real time clock circuit
- Watchdog circuit for functioning control
- Interfaces: RS232; RS485/422 for long distances; Ethernet 10/100; wireless (upon request)
- Memory: E2PROM for parameters, DataFlash for measurements

Supported detectors¹

The monitor SATURN II supports any of the following detectors:

- Geiger-Müller counter series
- Proportional counters
- Double Geiger detector: MERCURY GMP WR
- Ionisation chamber series ICP, including electrometer board and HV
- Scintillation detector series PNAI: PNAI NaI(Tl) 2"x2", PNAI/3 NaI(Tl) 3"x3"
- Neutron probes: LUPIN 5401 pulsed rem counter

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Additional alarm unit for remote signalling: model ALU
- Software utility for data archive download: model UTAS (connection cables included)
- Software application for complete remote management of the monitor, featuring a synoptic diagram: model 5700 sMON (connection cables on request)
- Data concentrator PC: model DCPC

¹ For more information and technical specifications concerning the detectors, see the relevant data sheets

ORDER GUIDE

Version	Supported detectors	Options
SATURN II	Geiger-Müller Proportional counters MERCURY GMP WR ICP series PNAI LUPIN 5401	ALU UTAS 5700 sMON CPC



ZIGBEE/BLUETOOTH TRANSCIVER

ZB-TC

MAIN FEATURES

- Different variations available
- “On-chip” or external adjustable antenna
- Modular and flexible
- Communication distance up to 1 km with PRO version of XBee module
- Different communication protocols available
- Two units can be mounted in a single box, i.e. for double probe devices (optional ZB-TC II)
- Bluetooth version available

DESCRIPTION

The **ZB-TC** module is a ZigBee (WiFi) transceiver that can be used (in a pair) to communicate data from a probe to its reading unit. Different versions are available, depending on the used components and the scope of the device. For example, a ZB-TC allows the communication with a MERCURY GMP probe + PS-ZB accessory or in general with a probe, installing a module at each end of the wireless bridge. Optionally, it is possible to mount two modules in a single box (**ZB-TC II**), typically with trolley-mounted double probe devices (as an alternative to using a single module for each probe).



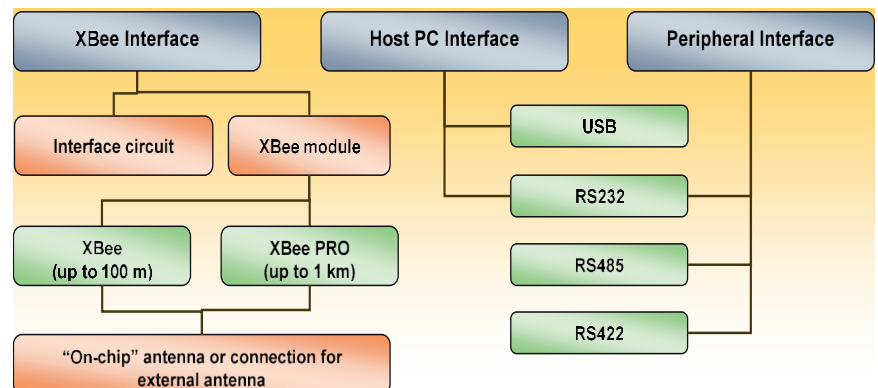
ZB-TC I USB with external antenna

The **ZB-TC** module is composed of the main parts here listed:

- XBee Interface: wireless communication circuit where the XBee module is installed
- Host PC Interface: interface with the device (reading unit/probe) fitted for RS232 and USB
- Peripheral Interface: interface with the device (reading unit/probe) alternative to the previous one, fitted for RS485, RS 422 and RS232

AVAILABLE VERSIONS AND SINGLE MODULE COMPOSITION

	Single or double module (optional)	Interface type
ZB-TC	I	USB, RS 232, RS 485, RS 422
	II	



SCHEMATIC EXAMPLES

Here are reported some examples that can help to better visualize what has been described. The examples represent the more frequent cases, using images of specific instruments; the ZB-TC module can be used with: NAUSICAA series, ICP series, MERCURY GMP-WR, LUPIN series.

ZB-TC I: single module for wireless communication between PC and detector

With NAUSICAA and SATURN+probe, a direct connection with the PC is possible.



ZB-TC I: single module for wireless communication between ratemeter and detector

The SATURN ratemeter can be connected to all the probes listed before.



ZB-TC II: double module for wireless communication between double probe trolley and detectors

Double version for double probe trolleys with remote detectors.



VISUALIZATION AND PROCESSING SOFTWARE FOR MONITORING NETWORKS

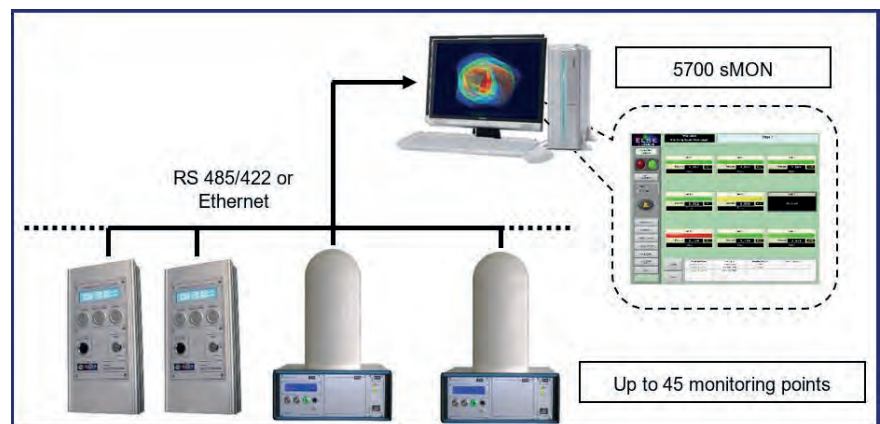
5700 sMON

MAIN FEATURES

- User friendly remote management software, with easy access to the archives
- Contemporary display of up to 45 monitors
- Continuous control and real time visualization of monitoring status: good operation (green), pre-alarm (yellow), alarm (red)
- Acquisition and storage minute by minute on daily file of dose average and maximum rates
- Daily report with minute, hour, day, month and year of storage data
- Visualization and storage of integrated data on 10 minute, 1 hour or 1 day
- Possibility of elaboration of portions of data, saving the results on text file
- Printable archives compatibles with spreadsheet (i.e. Microsoft Excel)
- Contemporary display of up to 4 printable historical graphics
- Management of operative parameters for each local monitoring point
- Shared archives on LAN network through Ethernet connection
- Password protection

DESCRIPTION

The software **5700 sMON** is a complete, windows compatible, remote software package for real time control, display and management of an entire monitoring network, utilising serial (RS485 or RS422) or Ethernet connections. The graphic interface presents four management windows: Main, Parameters, Command and Graphics. Everyone of these has virtual keys and selectors available for user friendly access to the functions.



5700 sMON schematic architecture

TECHNICAL SPECIFICATIONS

The 5700 sMON software displays and processes the data coming from the monitoring units connected to the system, and allows to control in real time the whole network from a central remote unit, through a serial/Ethernet connection.

Up to 45 detectors are connectable to the network managed by the software; further expansions are possible.

The software archives every minute the dose rate and maximum instantaneous rate data, providing a daily archive file. Every 10 minutes, every hour and every day, the medium rates are saved and stored too. The archives can be shared on a local LAN network through an Ethernet connection. The Client version of the software allows to visualize both the real time data and the archives.

With 5700 sMON software package it is possible to operate with the following menu:

- MAIN PANEL

A synoptic panel which displays measurement data and monitoring status of all the detectors of the system (up to 45) using a color code: good operation (green), pre-alarm (yellow), alarm (red). From the Main panel the operator can access the other operational sub-menus: Parameters panel, Command panel, and Graphics panel.

- PARAMETERS PANEL

Allows the configuration of the connected detectors and their ID; it is protected by a password.

- COMMAND PANEL

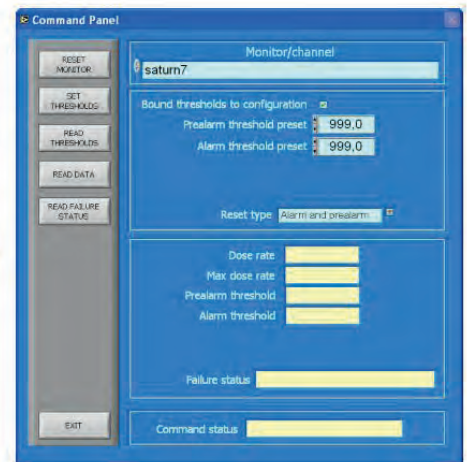
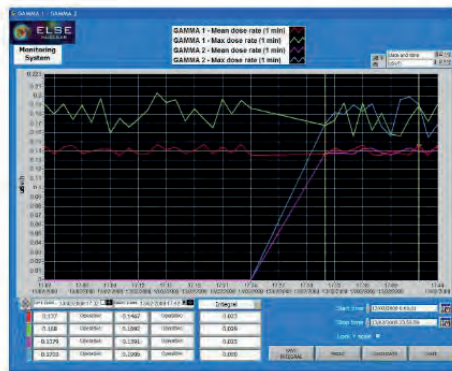
Allows the configuration of alarm thresholds and manages the alarm and fault event reset; it is protected by a password.

- GRAPHICS PANEL

Allows the visualization of up to 4 data graphics. It is possible to elaborate chosen data from several graphics and save the result on a text file



HOST PC



NEUTRON SPECTROMETER

BONNER SPHERE

MAIN FEATURES

- Detectors: ^3He proportional counters
- Moderators: HD polyethylene, spherical, from $\varnothing 3''$ to $\varnothing 12''$
- Ethernet connection between central box and PC
- User-friendly operational software
- Settable measuring parameters
- Data storage and graphic/numeric display
- Exportable archived data (ASCII files)
- Energy range extension up to 5 GeV (optional)
- Special electronics for use in pulsed fields (optional)

DESCRIPTION

The **Bonner sphere spectrometer** consists in an array of thermal neutron detectors (^3He proportional counters), each housed in a spherical polyethylene moderator of different dimensions. Through the comparison between the neutrons detected by each sphere, it is possible to determine the incident neutron energies. These data are processed by an unfolding code, which provides the neutron spectrum.

A special set is available upon request to extend the energy range up to 5 GeV. Each sphere is connected to a specifically designed pre-amplification and adjustment module (PREAMP-N-HV) that provides a TTL pulse output completely compatible with the connected digital counting system. The central acquisition box is based on 8-CH TTL hi speed DIO modules, a real-time processor and a reconfigurable field-programmable gate array. The central box is connected to a PC through an Ethernet cable, and is programmed to continuously acquire the counts coming from the detectors, also when the acquisition PC is off.



Bonner Sphere set

A user-friendly dedicated acquisition software is installed on the PC; it allows to start and stop the measurements as defined by the set parameters, and to store them in tabulated text files. The software allows also to modify the parameters and to visualize the saved data.

The status indicator displayed in the main panel shows the following main information for each channel (sphere):

- Detector name (adjustable as a parameter)
- Activation (selectable as a parameter), i.e.: green → activated
- Counts: shows the integral counts value during the measurement, updated every second
- Average CPS: shows the average cps during the measurement, updated every second

The data are stored in the main folder of the archives, which includes a sub-folder for every year.

TECHNICAL SPECIFICATIONS

Detectors

- Spherical proportional counter
- Filling gas: ^3He
- Body material: Stainless Steel
- Electrode: 17.5 μm Tungsten
- Insulation: Alumina
- Diameter: 33 mm
- Length: 134 mm
- Filling pressure: 200 kPa
- PET137 connector for counter
- Typical sensitivity: 0.25 cps/ $\mu\text{Sv/h}$ (when housed in the 8" sphere)
- Housing: HD polyethylene cylindrical inserts for fitting of SP9 detectors in the spheres

Bonner spheres

- The set includes the following moderators for the proportional counters:
- HD polyethylene moderator: \varnothing 3", \varnothing 4", \varnothing 5", \varnothing 6", \varnothing 7", \varnothing 8", \varnothing 9", \varnothing 9.5", \varnothing 10", \varnothing 12"

Analyzer

- PREAMP-N-HV modules, one for each sphere, containing Pre-Amplifier and discriminators boards
- EHT supply adjustable via external trimmer up to 2000V
- 220 VAC/24 VDC power supply adapter
- Multi-input acquisition system connected via Ethernet to the PC

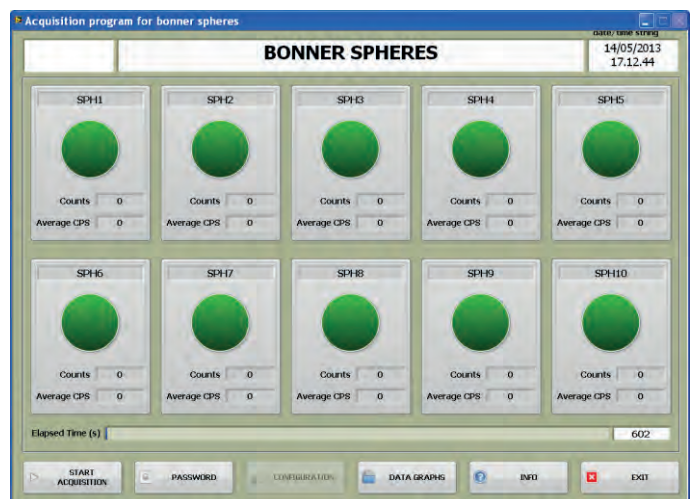
Operational acquisition & display software

- Independent data acquisition from each PREAMP-N-HV module
- Numeric representation of each detector counts and status, real-time updating (every second)
- Either manual or automatic Start/Stop with user-settable integration time
- Synchronized start and stop commands for all the acquisition inputs
- Graphical display of acquired/archived data
- Data export and storage in ASCII format files

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Bonner sphere set for extension to 5 GeV
 - \varnothing 3" HD polyethylene inner moderator, 1" lead shell, \varnothing 7" HD polyethylene outer moderator
 - \varnothing 4" HD polyethylene inner moderator, 1" lead shell, \varnothing 8" HD polyethylene outer moderator
 - \varnothing 4" HD polyethylene inner moderator, 0.5" lead shell, \varnothing 7" HD polyethylene outer moderator
 - \varnothing 4" HD polyethylene inner moderator, 0.5" copper shell, \varnothing 7" HD polyethylene outer moderator
- Special electronics (with no dead time) for use in pulsed fields



Moderators (above) and software panel (under)





CAEN SyS
Systems and Spectroscopy Solutions

Radiation Monitoring Systems & Health Physics

Wastewater Monitoring Systems

MONITORING AND DISPOSAL SYSTEM FOR RADIOACTIVE WASTEWATERS

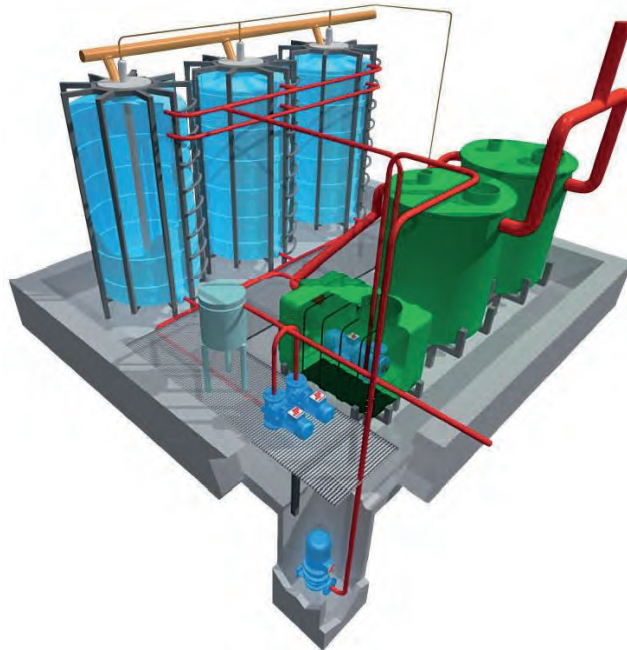
WDMS NT-VK

MAIN FEATURES

- Automatic system managed by remote PC
- Imhoff purification tanks
- Decay tanks
- Washing and sampling circuit
- Detector: 2"x2" NaI(Tl), multichannel electronics
- Measurement geometry: Marinelli beaker in a lead shielding well
- Release pumps
- Safety devices against flooding
- Safety flooding well
- Power supply switchboard with PLC and local emergency push-button
- Remote management software with virtual emergency button

DESCRIPTION

The diagnostic and therapeutic procedures involving radioactive substances, and their partial elimination through the patient's metabolism, require the mandatory use of controlled toilets (said "hot") before the patients are dismissed or during their hospitalization. This is necessary to hold the radioactive wastewaters in proper tanks for the required time before releasing them in the public sewers. The **WDMS NT-VK** system is designed to collect and monitor radioactive wastewaters, which can obtain the free release only after their radioactivity drops under the values allowed by the laws in force.



WDMS NT-VK schematic representation

The monitoring system's main components are described in the following:

- Purification group: Imhoff tanks designed to collect the wastewaters coming from the wards and to separate liquid wastes from solid
- Sorting group: pumps and conduits system designed to pour the wastewaters in the decay tanks
- Decay group: tanks array to hold and stock the wastewaters until their radioactive levels reach allowed values for the free release
- Sampling system: valves and pumps system that performs the washing procedures of the sampling circuit and the stocked wastewaters sampling itself, allowing the measurement in Marinelli geometry
- Release group: depending on the monitoring results, the wastewaters contained in the sampled tank can be released in the sewers

- Safety groups and devices: they mainly consist in guard levels - installed in all the system's critical stages - which stop the wastewaters flow in case of detected anomaly, and a safety flooding well which can eventually collect and stock wastewaters overflowing from any on the system's group

The entire system is locally managed by a PLC, the action of which are commanded by a remote management software installed on a PC.

Through the interactive synoptic interface of the software the operator can activate the system automatic cycles, set the measurement parameters, visualize the alarms and release archives, and monitor the system's status (filling levels, pumps stages, measurements, alarms). Depending on the measurement results, and as defined by the procedures in force, the operator can also activate the monitored wastewaters release in the public sewers. An emergency virtual button is located on the main panel of the software, as well as the PLC switchboard

TECHNICAL SPECIFICATIONS

System's layout:

Some components of the system, mainly the number and the type of the decay tanks, can change according to specific installation requirements; however, the groups of the systems, as described in this document, as well as the functioning logic, are essentially the same.

Radiological monitoring specification:

- Detector: 2"x2" NaI(Tl)
- PMT base
 - Signal digital processing ADC
 - Built-in memory, pre-amplification and HV
 - PC connection through Ethernet port
 - Advanced MCA software
- 1 liter Marinelli beaker complete of connections to the system
- Lead well 50mm thickness Mod. POZ 50.50
 - Support framework with adjustable base and nylon collar for the detector

SAFETY DEVICES

Redundant critical elements:

The elements of the hydraulic system that manage the flow of the wastewaters (pumps, purification tanks, etc.) are

designed to minimize the risks of overflowing due to any malfunctioning, and to guarantee the operational functioning of the system also during maintenance procedures.

In particular, the critical elements are installed in couples: this way, if for example the first Imhoff tank gets clogged, or if it needs maintenance, the second Imhoff tank allows to continue the normal operations without risks or interruptions. This redundancy is applied also to the sorting pumps, which by the way works alternatively even in normal functioning, to minimize their wear.

Containment group:

It consists in a perimetral waterproof containment barrier built on the floor, able to contain eventual wastewaters flooding from any system's stage and to convoy them to a safety flooding well; from here, under the operator's command, the wastewaters can be poured back in the sorting group through a dedicated pump.

Level signal systems:

These devices indicate to the operator the progressive filling of the decay tanks, the sorting group and the safety flooding well; if a first "maximum" level should be exceeded and if the system doesn't respond accordingly, the safety device alert the operator when a second "too full" threshold is reached.

Emergency "Stop" switches:

Push-button on the PLC switchboard and virtual buttons on the software's panels. The activation of one of these switches stops any ongoing action of the system. When the emergency status is switched off, the systems waits an operator's explicit command before resuming its functioning.

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Single-channel acquisition electronics, as an alternative to the DIGIBASE module



LIQUID EFFLUENT MONITORING SYSTEM

LEM

MAIN FEATURES

- Measurement geometry: 3 liters Marinelli Beaker
- Detector type: 2"x2" NaI(Tl) scintillator
- Shielding: lead well, 10 cm thickness
- Panel PC and PLC for sampling circuit command and alarm output
- Management software
- Ethernet interface available
- Efficiency calibration function for reference radionuclide
- Fault and alarm statuses indication
- Alarm events saving and archive
- Efficiency in measurement geometry: >1.5% (¹³⁷Cs)
- Energy range: 50 keV – 2 MeV
- Measurement range: 3.7 10³ (MDA 5 min) – 3.7 10⁸ Bq/m³
- Optional sources for quality control and calibration

DESCRIPTION

The **LEM** system allows to sample the liquid effluents and to perform a gross gamma measurement of the samples in Marinelli geometry. The system is designed to survey the activity released through liquid effluents, performing the calculation of volumetric activity of the samples. The system is studied to be a fixed equipment and it can be installed in several environments. **LEM** is a user-friendly, reliable, long-lasting and sturdy system.



LEM monitoring system

LEM system is composed of the following main parts:

- Mechanical structure: stainless steel stand
- Electrical and command board with panel PC and PLC: integrated in the stand and equipped with safety switch
- Measurement system: NaI(Tl) detector, single channel analyzer PAD, 3 l Marinelli, 10 cm lead shielding well
- Sampling circuit and self-priming pump
- Software for system management, data acquisition and processing, failures and alarms indication

From the PLC based control unit it is possible to command the sampling circuit. The system is equipped with a touch-screen operator panel. The PLC automatically manages all the cycle steps, and it constantly checks the proper functioning of the system, eventually communicating to the management software the error messages. From the software it is possible to visualize in real time the measurement, to control the system's status, to set the operative parameters, to manage the measurement steps, and to interact with the PLC to program the cycle (i.e. once a day at a defined hour) or to manually activate it.

Alarm, prealarm and failure conditions (low flow, pump malfunctioning, detector fail) are indicated by the management software through the screen. The system visualizes the volumetric activity and the total activity, or the count rate and integrated counts. The operator can set and save on non-volatile internal memory the threshold values and the operative parameters through a keyboard; to access all these functions, a safety password is required. The LEM system saves and archives all the alarm events. The software is equipped with a routine for quality control, to be used with the test source optionally provided with the system.

TECHNICAL SPECIFICATIONS

Power supply, weight and dimensions

- Single phase 220 V, 50 Hz
- Stainless steel stand
 - WxDxH = 80x100x200 cm
 - max weight = 700 kg
- Lead well
 - \varnothing x H = 60 x 100 cm
 - max weight = 600 kg

Main specifications

- Detector type: 2"x2" NaI(Tl) scintillator
- Cylindrical lead well, 10 cm thickness, built in 29 elements for an easy assembling and installation
- Plexiglass Marinelli beacker, 3 liters, connections included, can be completely disassembled for cleaning and decontamination activities
- Single channel photomultiplier base PAD
- Ethernet interface available
- Electric safety, isolation and waterproofing
- Protection grade of underwater parts: IP67
- Protection grade of non-underwater parts: IP44

Measurement specifications

- Measurement unit: volumetric activity (Bq/m³) or count rate (cps or cpm)
- SCA (Single Channel Analyzer) monitor, gross gamma type functioning
- Calibration can be performed with standard source provided with calibration certificate, to guarantee traceability as determined by international laws
- Efficiency in measurement geometry: >1.5% (¹³⁷Cs)
- Response in measurement geometry: >12 cps/kBq (¹³⁷Cs)
- Bkg value in measurement geometry: <0.2 cps
- Energy range: 50 keV – 2 MeV
- Measurement range: 3.7 10³ (MDA in 5 minutes) – 3.7 10⁸ Bq/m³
- Indications for "Fault" (zero counts in the preset time interval), readings under MDA and over range
- Relative intrinsic error: ≤10% over the measurement range

- "Fail safe": alarm and interlock activation in case of power supply interruption
- Detector easily disassembled for maintenance activities

Sampling circuit

- Flow range: 100 – 500 l/min
- Flow sensor for malfunctioning detection
- Working pressure of sampling system: 10 bar
- Self-priming pump:
 - Allowed liquid temperature: from 0 °C to +35 °C
 - Max operating temperature: 40 °C
 - Sound pressure: ≤ 70 dB (A)

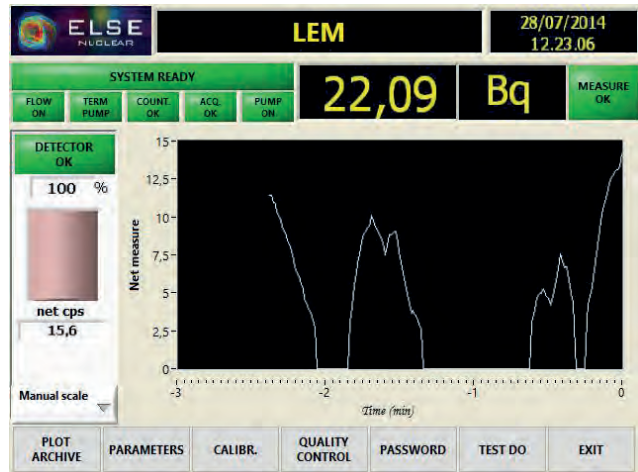
Sampling and measurement cycle

- Pump activation
- If needed, washing of Marinelli beacker with clean water from the circuit
- Sampling of water contained in the pool
- Flowing of the liquid to the Marinelli beacker
- Measurement of the liquid
- Pump shut off

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- ¹³⁷Cs source for calibration, activity < 40 kBq, composed of a gel matrix inserted in a Marinelli identical to the measurement chamber
- ¹³⁷Cs point source, activity < 10 kBq, for periodical quality controls



LEM software main panel





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Health Physics

HAND-FOOT-CLOTHES GAMMA MONITOR

VITRUVIUS 8220

MAIN FEATURES

- Four plastic scintillator detectors for high sensitivity measurements of gamma contamination
- Pre-recorded voice messages
- Detachable probe for clothes monitoring
- MDA: 0.3 Bq/cm² for ⁶⁰Co in 10 s; 0.4 Bq/cm² for ¹³⁷Cs in 10 s
- Stainless steel structure for easy decontamination
- Management and visualization software
- Automatic background subtraction with background follower
- User defined alarm thresholds
- Audible and visual alarm annunciation
- Colour LCD graphic display 7"
- External keyboard for system set-up
- Ethernet interface

DESCRIPTION

The hand-foot-clothes monitor **VITRUVIUS 8220** is an instrument specifically designed for checking gamma contamination on the body of workers operating in areas where it's possible to come into contact with radioactive material. In particular, **VITRUVIUS 8220** monitor performs the measurement of gamma contamination of hands, feet and clothes of the operator.



VITRUVIUS 8220

The contamination is measured by means of plastic scintillator detectors, located at hands/feet positions and coupled to photomultipliers and related amplification electronics for signal conditioning. The detector at the right hand position can be detached from the structure in order to measure clothes in a close counting geometry. A possible contamination is indicated both visually and acoustically by the software application that manages the monitor.

A pre-recorded voice guides the operator through all the measurement procedure, giving also warning messages should an anomaly or an alarm occur.
The operator interacts with the monitor through control/management panels and virtual self-explaining buttons.

TECHNICAL SPECIFICATIONS

Detectors

- Detector type: Plastic Scintillator PVT
- 2 Hand detectors, dimensions:
(WxHxD) 25x15x2 cm³, 375 cm² (each)
- 2 Foot detectors, dimensions:
(WxHxD) 35x15x2 cm³, 525 cm² (each)
- Clothes detector (right hand):
weight = 3 kg, cable length = 220 cm

Processing electronics

- Low ripple HV circuit
- Low electronic noise preamplifier
- Discriminator circuit with adjustable thresholds

Mechanical structure

- Stainless steel

Acquisition and control unit

- CPU unit for data processing and storage
- Windows operating system
- Ethernet interface
- Colour LCD graphic display 7"

Management software

- Automatic background subtraction
- Alarm threshold adjustable for each detector

- Separate parameter set (thresholds, calibration factor, etc.) for each
- detector and user defined isotope
- Measurement display in cps or Bq/cm²
- Visual and audible indication when the alarm threshold is crossed
- Pre-recorded voice messages management

Performance(*)

- Efficiency ISO 7503-1 hands/clothes detectors:
 - 32% for ⁶⁰Co
 - 18% for ¹³⁷Cs
- MDA hands/clothes detectors:
 - 0.3 Bq/cm² of ⁶⁰Co
 - 0.4 Bq/cm² of ¹³⁷Cs
- Efficiency ISO 7503-1 feet detectors:
 - 23% for ⁶⁰Co
 - 7% for ¹³⁷Cs
- MDA feet detectors:
 - 0.2 Bq/cm² of ⁶⁰Co
 - 0.7 Bq/cm² of ¹³⁷Cs

Power supply, weight and dimensions

- Power supply: 220 V, 50 Hz AC
- Dimensions: (WxHxD) 62x128x80 cm³
- Weight: 60 kg

(*) Source surface 150 cm² and 10 seconds measurement time.



BORATED POLYMER FOR THERMAL NEUTRON SHIELDING

BONES

MAIN FEATURES

- Ideal material for neutron shielding applications with excellent attenuation factor
- Easily cuttable and adaptable to surfaces
- Lightweight and resistant to high temperature
- Variable thickness and dimensions
- Boron concentrations variable on request, up to 25% in weight
- Surface finish: smooth plain or nylon impression
- Resistant to external deterioration agents

DESCRIPTION

BONES is a flexible, lightweight, easy to manipulate and heat resistant polymer, containing a variable concentration of natural Boron, up to 25% in weight. Boron (in particular the Boron-10 isotope, whose natural abundance is 20%) has a high capture cross-section for thermal neutrons (3835 barn), which means that **BONES** has an excellent attenuation factor for thermal neutrons, up to 300. Thanks to these features, **BONES** is a shielding material highly suitable for applications where the stray radiation fields are characterized by a non-negligible neutron component. The shielding power of **BONES** is maximized when it is directly coupled to concrete walls: the impinging neutrons are first thermalized by the concrete walls and then captured by the boron atoms contained in **BONES**. The attenuation factor is clearly proportional to both the **BONES** thickness and its Boron concentration.



BONES

The main applications are:

- Shielding for bunkers and access mazes of radiotherapy vaults, to minimize radiation leaks, to contain the secondary neutron dose absorbed by the patients, and to reduce the neutron activation of the components of the linear accelerator and the bunker itself
- Shielding for particle accelerators, for both industrial and research applications
- Shielding for electronic devices that must be protected from potential radiation induced failures caused by cosmic rays

BONES takes the form of sheets of variable dimensions and thickness, according to the customer's specific needs.

BONES can be easily manipulated and installed by non-specialized personnel; it can also be easily cut and shaped with common scissors.

The sheets are ready to be installed on concrete, metal or other material surfaces, using standard mounting techniques.

TECHNICAL SPECIFICATIONS

- Attenuation factor for thermal neutrons: 300 (data for 4 mm thickness, 25% boron enrichment)
- Boron atomic density per cm³: up to 1.6×10^{22}
- Density: 1.16 ± 0.05 g/cm³
- Temperature range: resistant up to 150° C
- Available dimensions:
 - Width 50 cm x Length 50, 100 or 200 cm
 - Width 100 cm x Length 100 or 200 cm
- Available thickness: from 3 mm to 25 mm
- Bent radius: 12.7 mm
- Appearance and odor:
 - State: rubbery solid
 - Color: grayish black
 - Odor: mild rubbery odor
- Solubility in water: negligible
- Resistant to: oxidation, sunlight aging, heat



COMPACT AND ADVANCED SCANNER FOR THIN LAYER RADIO-CHROMATOGRAPHY (TLC)

bSCAN

MAIN FEATURES

- Performs both radiochemical and radionuclidic purity analysis using a single instrument
- Implements radio-TLC and energy spectrum acquisition and analysis
- Compact instrument with a size of (WxHxD) 38 x 35 x 25 cm³
- Uses a NaI(Tl) detector properly shielded against background radiation with two sets of changeable collimators. A plastic detector can be used as well for PET radiopharmaceuticals
- Variable and automatic scanning speeds
- Modern and intuitive software for performing both analysis and setting or checking the status of the instrument
- Automatic saving of the spectrum for convenient latter review
- Automatic energy spectrum analysis with nuclide identification
- Software settings can be changed to satisfy user preferences
- Colourful and customizable measurement reports

DESCRIPTION

bSCAN is a compact and advanced instrument designed to perform Thin Layer Radio-Chromatography (TLC). Radio-Chromatography is an analytical technique that allows the identification and quantization of different compounds in a radioactive mixture. Particularly, Radio TLC is a well-established method in Nuclear Medicine laboratories for fast and accurate assessments in quality control (QC) of the radioactive pharmaceuticals used in nuclear medicine procedures. The technique is also widely used by the labeling laboratories and radiopharmaceutical producers.



The in vivo behaviour of the radiopharmaceuticals is dependent upon their quality, which today demands high standards of “radionuclidic”, “radiochemical” and “chemical purity” or particle sizing of the suspensions in the labelled compound. Radiopharmaceuticals must comply with both radiation and pharmaceutical standards to ensure their efficacious use and the imaging quality while minimizing the radiation hazard to the patients. By using this single instrument, laboratories can test for two parameters of the QA/QC process, namely the radiochemical and radionuclidic purity.

The bSCAN comes with an advanced, intuitive and modern software. The software guides the user to perform both analyses in an easy and natural way.

The bSCAN instrument is compact in size and contains state of the art components, such as a fully digital multichannel-analyzer (MCA) and a precise and well-shielded NaI(Tl) detector that provides superior energy resolution and therefore better radionuclide identification. The instrument uses a standard USB connection to communicate with the PC.

The bSCAN instrument is composed by the following components:

- The scanner instrument, which integrates:
 - A fully programmable displacement unit scanner.
 - A NaI(Tl) scintillator detector, typical 1 x 1 inch crystal size. The detector is placed inside a properly shielded scanning head with a changeable set of collimators.
 - A compact and digital multichannel analyzer (MCA).
- The bSCAN software.
- A controlling PC (optional).

TECHNICAL SPECIFICATIONS

TLC Scanner :

- Model: bSCAN-TLC201
- Dimensions (W x H x D): 38 x 35 x 25 cm³ (15 x 13.7 x 9.8 in.)
- Weight: 8.5 kg (19 lbs)
- Power supply: 24 Volts, an external AC/DC power converter for 100-240 Volts is supplied.
- Fuses: 2 Amps, user-changeable.
- Scan area: Strips of max 50 x 210 mm (2.0 x 8.3 in.)
- Scan speed:
 - Automatic, from 0.1 to 2 cm/sec.
 - Fixed to ~ 0.5 cm/s (0.2 in/s) when using Manual scan mode
- Scanner control: via USB connection. USB-B port connector on the back of the instrument.
- Strip carrier: standard supplied with two plastic strip carries.
- Front switches and indicators:
 - On-Off switch with LED power-on indicator
 - Manual scan push-button
 - Reset push-button for scan reset operation.
 - Blue LED signaling BUSY state
 - Red LED signaling detector High Voltage is On.

- Rear connectors:
 - 24V DC socket.
 - USB-type B connector
- Shielding: Detector head providing minimum 10 mm of lead (Pb) around the detector

Detector :

- Type: NaI(Tl) scintillator detector with integrated photomultiplier
- Detectable radiation: Photons: Gammas and X-rays
- Detector crystal dimensions: Typically 1x1 inches. Other sizes can be delivered upon request.
- Typical energy resolution: 7% to 8 % at 662 keV
- Collimation: Set of two (2) of 20 mm-thick (0.8 in.) lead (Pb) with apertures of 1 mm (0.08 in) and 3 mm (0.12 in.)

Spectrometer :

- Mca type: BrightSpec Topaz-Pico digital MCA, inside the instrument enclosure
- Acquisition modes:
 - PHA (from 256 up to 4098 chan-nels)
 - MCS (from 256 up to 4098 chan-nels).
- Dwell times— From 0.1 s to 24 hrs with 0.1 s resolution
- Data communication: USB (2.0)

Software :

- bSCAN version 1.0 or higher, compatible with MS Windows OS: Windows XP and Windows 7, for 32 and 64-bits processors.
- Software supplied with the bSCAN instrument on a CD-ROM with User's Manual

Standard package contents:

- bSCAN scanner
- Two sets of collimators: 1 mm and 3 mm aperture
- Two plastic Strip holders
- One standard EU three-point power cord
- Standard 100-240 Volts AC/DC power converter
- 2 meters long standard USB cable
- One NaI(Tl) scintillator detector with photomultiplier. Typical crystal sizes of 1 x 1 in.
- Other crystal sizes and/or detector types (e.g. plastic for PET analysis) can be supplied upon request.
- bSCAN software on a CD-ROM
- User's Manual



CAEN SyS
Systems and Spectroscopy Solutions

Gamma Spectroscopy

Single Channel Analyzers, Multi Channel Analyzers and Tube Bases

DUAL INDEPENDENT 32K DIGITAL MCA WITH HV AND PREAMPLIFIER POWER SUPPLY

Hexagon

MAIN FEATURES

- Dual 32k Digital MCA and Pulse Processor
- Provides pulse height analysis (PHA), time-stamped list mode and multichannel scaler
- Suited for high resolution spectroscopy with HPGe, Silicon and scintillation detectors as NaI and LaBr₃
- Operate with Resistive Feedback and Transistor Reset preamplifier
- Open access to embedded CPU for custom developments
- 2 HV power supply channels (up to ± 5 kV) with HV inhibit, programmable ramp
- 2 DB9 connectors for preamplifier power supply (± 12 V, ± 24 V), HV inhibit and Detector Temperature read
- 2 BNC inputs for TRP inhibit or ADC gate
- Front panel OLED Display
- Ethernet and USB readout interfaces
- Link for synchronizing multiple MCAs
- 24 Programmable digital I/Os (e.g. ICR, SCA, MCS start/stop, MCS advance and sweep, etc.)
- MC² Analyzer software to manage the acquisition and to perform basic spectrum analysis
- Signal Inspector by both BNC Analog Output and Software visualization

DESCRIPTION

Hexagon is a compact, stand-alone dual digital 32k MCA, available in desktop form factor.

It is designed for high energy resolution semiconductor detectors, like HPGe and silicon drift detectors, connected to charge sensitive preamplifiers.

Hexagon integrates advanced firmware algorithms operating digital pulse processing for Pulse Height Analysis (PHA).

The embedded CPU runs an OS able to execute custom routines for automated operations.

The processing algorithms can be easily adapted to different detectors and application ensuring effective data analysis even at high count rates.

It provides advanced tools for configuring baseline restoration and pile-up rejection.



Moreover the module features on-board spectrum recording, acquisition settings logging and autonomous data acquisition when unconnected from external devices.

Thanks to the two input simultaneous acquisition, the module is able to manage coincidence and anti-coincidence logic between detectors, allowing the user, for example, to easily take advantage of background rejection or anti-compton techniques.

Hexagon embeds I/O connectors for SCA, MCS and Coincidence/Anticoincidence functions, it integrates High Voltage Inhibit and TRP Inhibit. Clock and Synchronization connectors are provided, which allow the time stamp of multiple modules to be aligned with high accuracy.

The module embeds an LCD screen to monitor real time the data acquisition results, e.g. ICR, OCR and dead time.

Hexagon may provide at the same time energy, time stamp and the digitized pulse in a configurable time window (e.g. Including the rising edge region) in order to perform further offline analysis.

Acquisition settings and mathematical analysis are performed through the **MC²Analyzer** software, providing energy spectra with up to 32k channels, which can be exported and imported in ASCII or N42.42 compliant files. CAEN further provides drivers for the supported communication interfaces; configuration software tools, C and LabVIEW libraries. demo applications and utilities.

TECHNICAL SPECIFICATIONS

Dimensions :

- 237 x 51 x 164 mm³ (W x H x L) (without connectors)
- 154 x 50 x 195 mm³ (W x H x L) (including connectors)

OPTIONS

The two high voltage supply channels can be ordered in three different polarity configurations:

- both channel positive: 2 HVPS +5kV/300μA, 2 LVPS ±12V/100mA, ±24V/50mA
- both channel negative: 2 HVPS -5kV/300μA, 2 LVPS ±12V/100mA, ±24V/50mA
- mixed polarity configuration: 1 HVPS +5kV/300μA, 1 HVPS -5kV/300μA, 2 LVPS ±12V/100mA, ±24V/50mA

COMPACT, STAND-ALONE DIGITAL MULTI-CHANNEL ANALYZER WITH PULSE HEIGHT ANALYSIS

TOPAZ-Pico

MAIN FEATURES

- Fully digital Multi-Channel Analyzer (MCA), suitable for medium-energy resolution detectors.
- PCB available for OEMs
- Full Pulse-Height Analysis (PHA) and Multi-Channel Scaling (MCS) modes of data acquisition
- Up to 4096 channels for PHA and MCS acquisition
- Advanced electronic noise reduction algorithms
- Compact MCA with size of 80 mm x 60 mm (PCB) and 107x72x19 mm³ in the aluminium case, weight < 150 grams (with case)
- USB 2.0 for data communication and device control
- Miniature design combining low power consumption with low noise
- Basic spectrum acquisition and device control software included
- Available programming libraries for Windows and Linux Operating System (upon request)
- Optional TTL counter input, suitable for connection of a counter, e.g. neutron counter

DESCRIPTION

TOPAZ-Pico is a compact, stand-alone digital Multi-Channel Analyzer (MCA), which can perform Pulse Height Analysis (PHA) of the signal produced by a standard scintillation detectors.

The device is therefore useful for obtaining the energy spectrum from the photon radiation detected by the scintillator, and can be easily interfaced to a typical PC or notebook via a standard USB port for further data transfer and analysis. The MCA is provided with a basic software package that allows to control the device, and to acquire and visualize the energy spectrum.



TOPAZ-Pico BNC

The bMCA software incorporates an advanced and easy-to-use “discovery” function that can be used to detect automatically the MCAs of the bMCA series and **TOPAZ** series connected to the PC.

A set of programming libraries is also offered, which makes the incorporation of the **TOPAZ-Pico** into existing radiation systems or setups very easy.

The programming libraries are available for both MS Windows and Linux operating systems. The device is available either in a rugged, pocket-size aluminium box with input and output connectors or as separate Printed-Circuit Board (PCB) for OEM distribution.

OPTIONS AVAILABLE

TOPAZ-Pico is provided with several scintillation detector assemblies. Our catalogue includes NaI(Tl), CsI(Tl), BGO and CeBr₃ detectors. Standard configurations with

- NaI(Tl), CsI(Tl) and BGO, with cylindrical volume 2”x2” or 3”x3”
- CeBr₃ with cylindrical volume 1.5”x1.5”

Other scintillator types and volumes can be provided on request.

In addition to standard supply, the following options are available upon request:

- Topaz-Pico
- Topaz-Pico/BNC has BNC connector for signal and separate SHV connector for HV output
- Topaz-Pico OEM board

TECHNICAL SPECIFICATIONS

PHA Acquisition Mode

- Spectral memory size of 256, 512, 1024, 2048 and 4096 channels
- Coarse gain with amplification factors of 1, 2, 4 and 8. Fine gain from 1 to 2 in steps of 1/4096
- Upper and Lower Level Discriminator settings given in channels

MCS Acquisition Mode

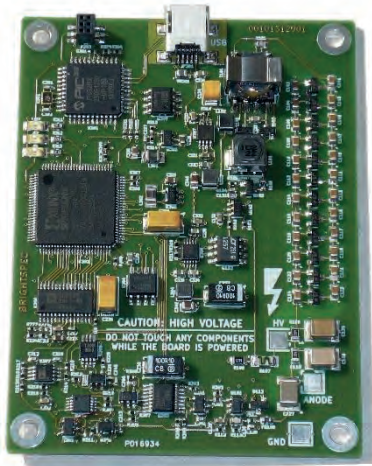
- Spectral memory size of 256, 512, 1024, 2048 and 4096 channels
- Dwell time from 0.1 sec to “count-forever”
- Easy to setup from ROIs or nuclide information.

Digital Settings

- Rise Time: from 0.1 to 12 μ sec in steps of 0.2 μ sec
- Flat Top: from 0.1 to 8.0 μ sec in steps of 0.1 μ sec
- Threshold: 1 to 255
- Digital Base Line Restorer (BLR)
- Pile-Up Rejector (PUR)

High Voltage Power Supply

- Miniature HV power supply embedded into the MCA assembly
- Voltage: (positive) 0 to 1500 Volts in 4096 steps



TOPAZ-Pico OEM

Data Communication

- USB 2.0, cable included

Physical

- Sizes:
 - MCA box: 107 x 72 x 19 mm³ (HxWxD)
 - PCB only: 80 mm x 60 mm
- Weight: less than 150 grams (including box)
- Connectors :
 - USB type mini B (to computer)
 - Lemo connector. Type ERA 0S 403 CLL (for both detector HV Bias and Signal)
- Indicators:
 - Red LED for detector high voltage
 - Yellow LED for incoming count rate (ICR)
 - Green color LED for power and communication status

Other

- The device is supplied with a basic software to control operation, data acquisition and visualization.
- (upon request) necessary programming libraries for Microsoft Windows and Linux

Optional

- The MCA can be supplied with extra input connector for TTL signal counting



TOPAZ-Pico

COMPACT DIGITAL MCA FOR ED XRF

TOPAZ-X

MAIN FEATURES

- Fully digital, ultra-compact MultiChannel Analyzer (MCA) suitable for high energy resolution, Peltier cooled detectors
- PCB available for OEMs
- Fast flash 14 bit ADC (50 Hz) with a 100 MHz DSP and a 32 bit CPU at 200 MHz
- Advanced spectroscopy acquisition modes: PHA, MCS, LIST and TLIST. TLIST with 40 ns resolution
- Hi speed data transfer rate (480 Mbit/sec)
- Up to 16K channels for PHA and MCS acquisition
- Analog shaping parameters automatically adjusted to match digital shaping
- Advanced electronic noise reduction algorithms
- Compact MCA with size of 68 mm x 46 mm (PCB) and 86x70x18 mm in the aluminum case, weight < 150 grams (with case)
- Powered over USB or external low noise power AC/DC module
- Miniature design combining low power consumption with low noise
- Available programming libraries for Windows and Linux Operating System (upon request)
- Incorporated into full featured and powerful X ray spectrometry software bAxil

DESCRIPTION

The Topaz-X is an advanced, fully digital, compact Multi Channel Analyzer. This device is used to process the electronic pulses produced by a high resolution, electrically cooled silicon detector such as Silicon drift detector (SDD) or Silicon PIN diode (Si-PIN). The MCA implements several advanced modes of data acquisition, such as: Pulse Height Analysis (PHA), Multi-channel scaling (MCS), LIST and Time LIST mode (TLIST). For the latter, each recorded pulse will be stored not only with the pulse height information (energy), but with the arrival time stamp as well.

In TLIST mode the event time resolution is up to 40 nano seconds.

The Topaz-X design incorporates the latest advances in digital electronics.

The core of the MCA is its 14-bit high quality fast flash ADC running at 50 MHz, a 100 MHz DSP processor and a 200 MHz CPU.



The MCA FPGA design implements powerful digital processing techniques and algorithms to better separate the useful signal from noise and to maximize performance under high count rate conditions.

The device has a spectral memory size of up to 16 384 (16K) channels available for any acquisition mode (PHA, MCS, LIST or TLIST modes).

The Topaz-X transfers acquired data via an ultra fast USB connection to the PC with data transfer rates of 480 Mbit/sec.

The device can be powered via the USB connection or using an external low noise AC/DC power supply, which is included in the delivered package.

The device can be controlled via our basic acquisition software (bMCA software), which can be freely downloaded from our WEB site.

Alternatively, the MCA control is incorporated into our fully featured X ray spectrometry analysis software bAxil.

An attractive package price can be obtained when ordering the MCA together with bAxil software.

The MCA is cased into a rugged aluminum box of pocket sizes with one input connector (detector preamp signal), two input/output programmable connections and an interface connector (USB mini type B) to the PC.

The device can be requested with mini lemo or standard BNC connectors.

This device is also available as a separate PCB only, which makes it attractive to the OEM market. The programming libraries for Windows and Linux OS are available as well.

TECHNICAL SPECIFICATIONS

Device

- 14 bit high quality flash ADC running at 50MHz
- 100MHz DSP processor in high performance FPGA
- 200 MHz 32 bit CPU

Data acquisition

- Spectral memory size up to 16 384 (16K) channels
- Acquisition modes : PHA, MCS, LIST mode and TLIST mode
 - LIST and TLIST modes with 40 nsec event time resolution
- Analog gain from x1 to x256
- Coarse gain with amplification factors of 1, 2, 4, 8, 16, 32, 64 and 128. Fine gain from 1 to 2 in steps of 1/16384 (~ 0.000061)
- Upper and Lower Level Discriminator settings given in channels
- Adjustable and/or automatic Inhibit signal reset

Digital Settings

- Analog shaper parameters are automatically adjusted to match the digital shaping settings
- Trapezoidal filter
- Rise Time: from 0.1 to 20 μ sec in steps of 0.2 μ sec
- Flat Top: from 0.1 to 8.0 μ sec in steps of 0.1 μ sec
- Threshold: 1 to 255
- Digital Base Line Restorer (BLR)

- Pile-Up Rejector (PUR)

Power Supply

- Device power via USB connection or external low-noise AC/DC power adaptor (supplied)

Data communication

- USB 2.0, cable included (standardly 3 meters long).

Physical

- Sizes:
 - MCA box: length 86 mm, width 70 mm, height 18 mm
 - PCB only: 68 mm x 46 mm
 - Weight: less than 100 grams (including box)
- Connectors :
 - USB type mini B (to computer)
 - Input signal: PreAmplifier detector signal
 - Two general purposes programmable input/output ports
 - The device can be supplied either with Lemo or standard BNC connectors (to be speci-fied at the order)

- Indicators:

- Red LED for detector high voltage
- Yellow LED for incoming count rate (ICR)
- Green color LED for power and communication status

Other

- The device is supplied with a basic software to control operation, data acquisition and visualization.
- (upon request) necessary programming libraries for Microsoft Windows and Linux

Optional

- The MCA can be supplied with full-featured X-ray spectrometry software bAxil, at package cost.

ACTIVE, STAND-ALONE, FULLY FEATURED MCA TUBE BASE FOR SCINTILLATION SPECTROSCOPY

γ STREAM

MAIN FEATURES

- Fully stand-alone MCA including high voltage power supply, preamplifier, battery and data-storage on SSD
- Compatible with scintillation detectors as NaI(Tl), LaBr₃(Ce), and CeBr₃, using standard 14-pin and 10-8
- stages PMTs
- Different acquisition modes available: signal inspector, time stamped list mode, PHA, SCA (coming soon), MCS (coming soon)
- Open access to embedded CPU for custom developments
- Available with embedded GPS for data geo-localization
- Gain stabilizer based on natural or calibration radioactivity
- Wire and wireless connectivity through USB, Ethernet, Bluetooth and Wi-Fi
- Front panel cover against dust and rain for outdoor operation
- Front panel auxiliary digital I/O connectors for synchronization, external trigger, coincidence/anticoincidence modes, veto, MCS, SCA
- Supported by CAEN **MC²Analyzer** software GUI, and **GammaTOUCH** application for smartphones and tablets with Android OS

DESCRIPTION

γ stream is a compact and portable system for gamma ray spectroscopy with scintillation detectors, which provides an active Multi-Channel Analyzer (MCA) integrated in a 14-pin photo-multiplier tube (PMT) base. **γ stream** fully integrates in a stand-alone device the high voltage to bias the PMT, the preamplifier to shape the signal from detector, and the MCA for a complete Pulse Height Analysis online.

γ stream makes easy the measurements with scintillation detectors, such as NaI(Tl), LaBr₃(Ce) and CeBr₃, with no need of additional cables.

Its socket and voltage divider can supply standard 14-pin and 10-stage (S2580 and S2580G models) or 8-stage (S2580LB and S2580LBG models) PMTs.



γ stream has been designed to work stand-alone, with no need of additional devices, cables, nor human assistance. **γ stream** features internal rechargeable Li-Ion battery providing long-term duration for unattended on-field acquisitions.

Once **γ stream** is programmed via computer or mobile phone, it then acquires and logs data in an internal SSD memory. An embedded CPU, running Linux OS, controls the acquisition and data recording, as well as the supported communication interfaces.

Multi-interface communication capability by Ethernet, USB 2.0, Bluetooth or Wi-Fi, makes possible the remote control via computer or smartphone.

It may acquire and record data in different modes: PHA, time stamped list mode and signal inspector.

γstream can also operate outdoor thanks to a front panel cover protecting from water and dust.

γstream is suited for a variety of environment thanks also to the software suites **GammaTOUCH** and **MC²Analyzer**, both provided with user-friendly GUIs. **GammaTOUCH** can run on smartphones or tablets with Android OSs, providing an immediate and easy data acquisition control. It provides georeferenced and time-stamped histograms logging the location of the integrated GPS system or the one embedded in the mobile device. On the other side **MC²Analyzer** can be run on recent Windows Os, providing the user with histogram analysis tools.

Considering that scintillation detectors are usually sensitive to temperature changes, and advanced algorithm for gain stabilization is available. The user can select a specific range where the algorithm recognizes a peak and adjust its position according to peak and adjust its position according to the temperature variations.

γstream is provided with several scintillation detector assemblies. Our catalogue includes NaI(Tl), CsI(Tl), BGO and CeBr₃ detectors. Standard configurations with:

- NaI(Tl), CsI(Tl) and BGO, with cylindrical volume 2"x2" or 3"x3"
- CeBr₃ with cylindrical volume 1.5"x1.5"

Other scintillator types and volumes can be provided on request.

TECHNICAL SPECIFICATIONS

Mechanical structure

- Dimensions: 71,2 x 66,4 x 163,8 mm³ (W x H x L) (including connectors)
- Weight: 700 g

Detectors & PMT

- Scintillation detectors
- 14-pin 10-stage PMTs (S2580)
- 14-pin 8-stage (S2580LB)

Data signal processing:

- 12-bit and 62.5 MHz ADC
- Software selectable coarse gain: x1, x2, x4, x8
- Trapezoidal filter for the energy calculation with software adjustable rise time in the range 0÷16 μs and flat top in the range 0÷16 μs
- Trigger threshold software adjustment
- Software fine tuning of the Pole-Zero cancellation
- Digital fine gain
- Automatic gain stabilization

- Pile-up rejection and Live Time correction
- Baseline restorer with programmable averaging
- Time stamp: 16 ns resolution
- High frequency noise filter

Operating modes

- PHA (Pulse Height Analysis): pulse height histogram over 1k-2k channels
- List mode: pulse height and time stamp for each event
- Signal Inspector: input and internal filters waveforms

Communication interfaces:

- Ethernet
- USB
- Bluetooth
- Wi-Fi
- GPS (S2580G and S2580LBG only)

OPTIONS

In addition to standard supply, the following options are available upon request:

- **γstream**
- **γstream-GPS** includes the GPS receiver and the antenna for data georeferencing
- **γstream-LaBr** is dedicated for 8-dynode 14-pin PMT used with LaBr(Ce) detectors
- **γstream-LaBr-GPS** is dedicated for 8-dynode 14-pin PMT used with LaBr(Ce) detectors and includes the GPS receiver and the antenna for data georeferencing.



COMPACT, DIGITAL MCA

bMCA

MAIN FEATURES

- Fully digital Multi Channel Analyzer (MCA) built into a compact 14-pin photomultiplier tube base
- Full Pulse-Height Analysis (PHA) and Multi-Channel Scaling (MCS) modes of data acquisition
- Up to 4096 channels for PHA and MCS acquisition
- Advanced electronic noise reduction algorithms
- Compact MCA with sizes of (H) 75 mm x (Ø) 55 mm
- USB 2.0 or Ethernet data communication. Ethernet with device IP address set via DHCP or fixed
- Extremely fast data communication rates with 1K PHA spectrum being to the PC sent in 30 microseconds
- Miniature design combining low power consumption with low noise
- Basic spectrum acquisition and device control software included
- Available programming libraries for Windows and Linux Operating System (upon request).
- LED indicators for communications and device power, HV power and incoming count rate (ICR)

DESCRIPTION

bMCA is an advanced, fully digital, compact Multi-Channel Analyzer (MCA), which can perform Pulse Height Analysis (PHA) and Multi-Channel Scaling (MCS) of the signal produced by a standard 14-pin standard photomultiplier coupled to a scintillation detector. PHA mode is regularly used in nuclear spectrometry and radiometry, while MCS is a very useful feature for following photon detections in a particular specific energy regions in function of time. MCS acquisition mode is useful to both laboratory and industrial applications that make use of radioactive sources or seek for radioactive materials.



The device is therefore useful for obtaining the energy spectrum from the photon radiation detected by the scintillator, and can be easily interfaced to a typical PC or notebook via a standard USB or Ethernet ports for further data transfer and analysis. When the Ethernet port is present the device is powered via Power-over-Ethernet (PoE) technology. On the data communications side, this device features lightning-fast transfer rates, with a 1024-channel spectrum being transmitted typically in less than 30 microseconds.

bMCA is provided with a basic software package that allows to control the device, and to acquire and visualize the energy spectrum. The software

incorporates an advanced and easy-to-use “discovery” function that can be used to detect automatically all the **bmCA**s (USB or Ethernet) connected to the available PC. A set of programming libraries are also offered, which makes the incorporation of the **bmCA** into existing radiation systems or setups very easy. The programming libraries are available for both MS Windows and Linux operating systems.

bmCA can be provided with several scintillation detector assemblies. Our catalogue includes NaI(Tl), CsI(Tl), BGO and CeBr₃ detectors.

OPTIONS AVAILABLE

Standard configurations with:

- NaI(Tl), CsI(Tl) and BGO, with cylindrical volume 2”x2” or 3”x3”
- CeBr₃ with cylindrical volume 1.5”x1.5”

Other scintillators types and volumes can be provided on request.

In addition to standard supply, the following options are available upon request:

- bmCA-USB
- bmCA-Ethernet



TECHNICAL SPECIFICATIONS

PHA acquisition mode:

- Spectral memory size of 256, 512, 1024, 2048 and 4096 channels
- Coarse gain with amplification factors of 1, 2, 4 and 8. Fine gain from 1 to 2 in steps of 1/4096
- Upper and Lower Level Discriminator settings given in channels

MCS acquisition mode:

- Spectral memory size of 256, 512, 1024, 2048 and 4096 channels
- Dwell time from 0.1 sec to “count-forever”
- Easy to setup from ROIs or nuclide information.

Digital Settings:

- Rise Time: from 0.1 to 12 µsec in steps of 0.2 µsec
- Flat Top: from 0.1 to 8.0 in steps of 0.1 µsec
- Threshold: 1 to 255
- Digital Base Line Restorer (BLR)
- Pile-Up Rejector (PUR)

High Voltage Power Supply:

- Miniature HV power supply embedded into the MCA assembly
- Voltage: 0 to 1500 Volts in 4096 steps

Data communication:

- Ethernet, IP address fixed or set via DHCP
- Fast transfer rates: 30 µs typical for a 1024-channel energy spectrum.
- Set of cables and PoE injector

Physical:

- Size: height 75 mm, diameter 55 mm
- Weight: approximately 200 g
- Connectors: Ethernet RJ45
- Indicators:
 - Red LED for detector high voltage
 - Yellow LED for incoming count rate (ICR)
 - Green color LED for power and communication status

Other:

- The device is supplied with a basic software to control operation, data acquisition and visualization.

COMPACT MICROCONTROLLER-BASED SCA

bPAD

MAIN FEATURES

- Compact Single Channel Analyzer with microprocessor control on a 14-pin photomultiplier tube base
- Integrates Preamplifier-Amplifier-Discriminator and HV power supply
- TTL output
- Optional analog output signal range of 0 to 2V, 50 Ω impedance
- Optional analog voltage rate level range from 0 to 2.5V, 50 Ω impedance, variable sensitivity
- USB communications
- Device can be powered from USB and/or an external supply of 6 to 36 Volts via a pluggable terminal block
- Compact size of 56mm (\varnothing) x 71mm (H)
- Very low power consumption: 1 watt maximum
- Miniature and efficient high voltage power supply
- Configuration software for easy setup and visualization of device operation, also implements a “pseudo-PHA” mode of operation
- LED indicators for communication status and device power, HV power and incoming count rate (ICR)

DESCRIPTION

bPAD is a compact microcontroller-based Single Channel Analyzer. The device contains a charge sensitive preamplifier, a variable-gain amplifier and a window discriminator; all in a 14-pin photomultiplier tube base, which are commonly used with scintillator-type radiation detectors. This electronic device outputs a TTL pulse per photo-event, making it compatible with most industrial, environmental and laboratory counting system.



The **bPAD** also includes its own miniature, programmable and efficient high voltage power.

The device is therefore useful as a compact system to monitor the count rate in an energy region of interest. In contrast with traditional SCAs the **bPAD** is fully controlled by a microprocessor, providing easy setup and “smart” modes of operations.

bPAD parameters can be conveniently set via USB with a PC and the provided configuration software.

The PC software also comes with a “pseudo-PHA” acquisition mode.

In this mode, the software slides the single-channel window over the whole input range, constructing in such a way an energy spectrum.

By using this spectrum, the user can visually identify the energy range of interest and immediately set the boundaries of the **bPAD** discriminator window.

This represents a large improvement over the traditional “blind” method used with most other SCAs.

bPAD has two modes of operation:

- Integral, where counts are output for signals above a single energy threshold level
- Differential, where counts are output for signals within a defined energy window (SCA)

TECHNICAL SPECIFICATIONS

Device And Digital Settings:

- Acquisition modes: Integral and differential.
- Coarse gain: x1, x2, x4, x8 (optionally also x16, x32, x64, x128)
- Fine gain: x1...x2 in 4096 steps
- Upper and Lower Level discriminator resolution: 2048 steps
- Output: 5 Volts TTL signals of 2.5 μ sec duration.



High Voltage Power Supply:

- Miniature HV power supply embedded into the device assembly
- Voltage: 0 to 1500 Volts in 4096 steps

Data Communication:

- USB 2.0, cable included.
- TTL output via SMA connector, cable included.

Physical:

- USB connector: type mini B, used for PC communications or powering.
- Power connector: pluggable terminal block, 6 to 36 Volts, plug included.
- Power consumption: 1 watt maximum
- Size: Height 71 mm, Diameter 56 mm
- Weight: Approximately 80 grams

Indicators:

- Red LED for detector high voltage
- Yellow LED for incoming count rate (ICR)
- Green LED for power and communication status

Other:

- The device is supplied with Windows™ PC software for setup and pseudo-PHA, the software can also display the CPS value for the defined SCA region

Gamma Spectroscopy

Spectroscopy Software

γ STREAM CONTROL SOFTWARE FOR ANDROID

GammaTOUCH

MAIN FEATURES

- Runs on mobile phones and tablets with Android™ release from 4.1 Jelly Bean
- Fully compatible with CAEN Gamma stream device
- HV and Acquisition control
- Programmable run cycles
- Gamma stream Battery monitoring
- Gain Stabilization setting
- Histogram view
- GPS data management



DESCRIPTION

GammaTOUCH is a software application for Android™ running on personal devices like smartphones or tablets, fully compatible with **CAEN Gamma stream** device. It is designed as an easy-to-use assistant for outdoor operations and provides an immediate control of Gamma stream. Energy spectra can be displayed, and statistics can be monitored runtime. Through the **GammaTOUCH** it is possible to integrate the GPS coordinates and time of the mobile device with the time-stamped event list.

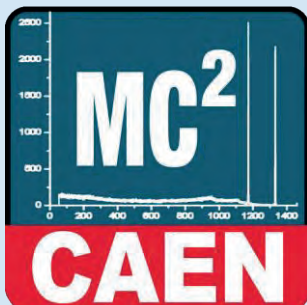


DIGITAL MCA DATA ACQUISITION AND ANALYSIS SOFTWARE

MC² Analyzer

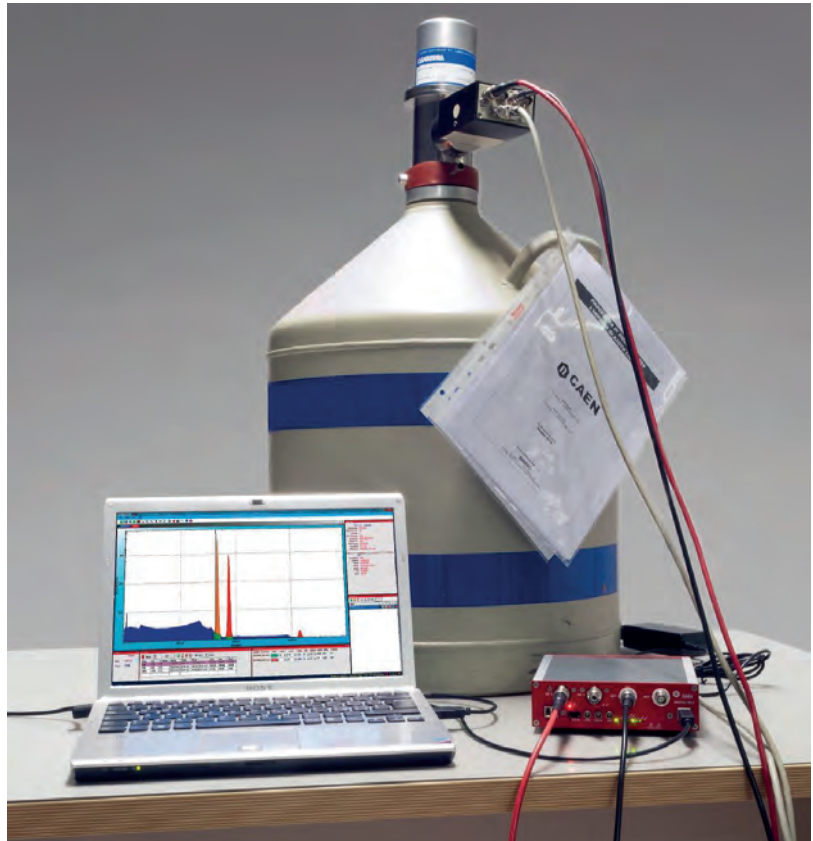
MAIN FEATURES

- Designed for:
 - 724, 725 and 730 Digitizer families
 - 770/780/781 Digital MCA families and gamma stream
- Trapezoidal filter replacing shaping amplifier and peak sensing ADC
- Online baseline restoration and ballistic effect correction
- Online pile-up correction for live-time measurement
- PHA and time-stamped list mode available
- Full setting of all the relevant DPP-PHA parameters and power supplies for DT5780 and gamma stream controlled by the **MC²Analyzer** software
- Complete simultaneous control of different boards
- Advanced mathematical analysis on collected spectra (peak search, background subtraction, peak fitting, etc.)
- Provides Energy, Time Stamp lists and histograms



DESCRIPTION

MC² Analyzer is a software specifically designed to manage CAEN Digital MCA (780/781 family, DT5770, and gamma stream) as well as CAEN digitizers running DPP-PHA (Digital Pulse Processing for the Pulse Height Analysis) firmware, like 724, 725 and 730 families and **Gamma Stream** Digital MCA Tube Base. The DPP-PHA firmware implements a digital trapezoidal filter on the input pulse, which replaces the traditional analog chain of shaping amplifier and peak sensing ADC.



The MCA is therefore directly connected to the charge sensitive preamplifier, with no need of additional devices.

The PHA algorithm is able to perform online baseline restoration, ballistic effect corrections, and manage the pile-up for the live time information. PHA and time-stamped list acquisition modes are available.

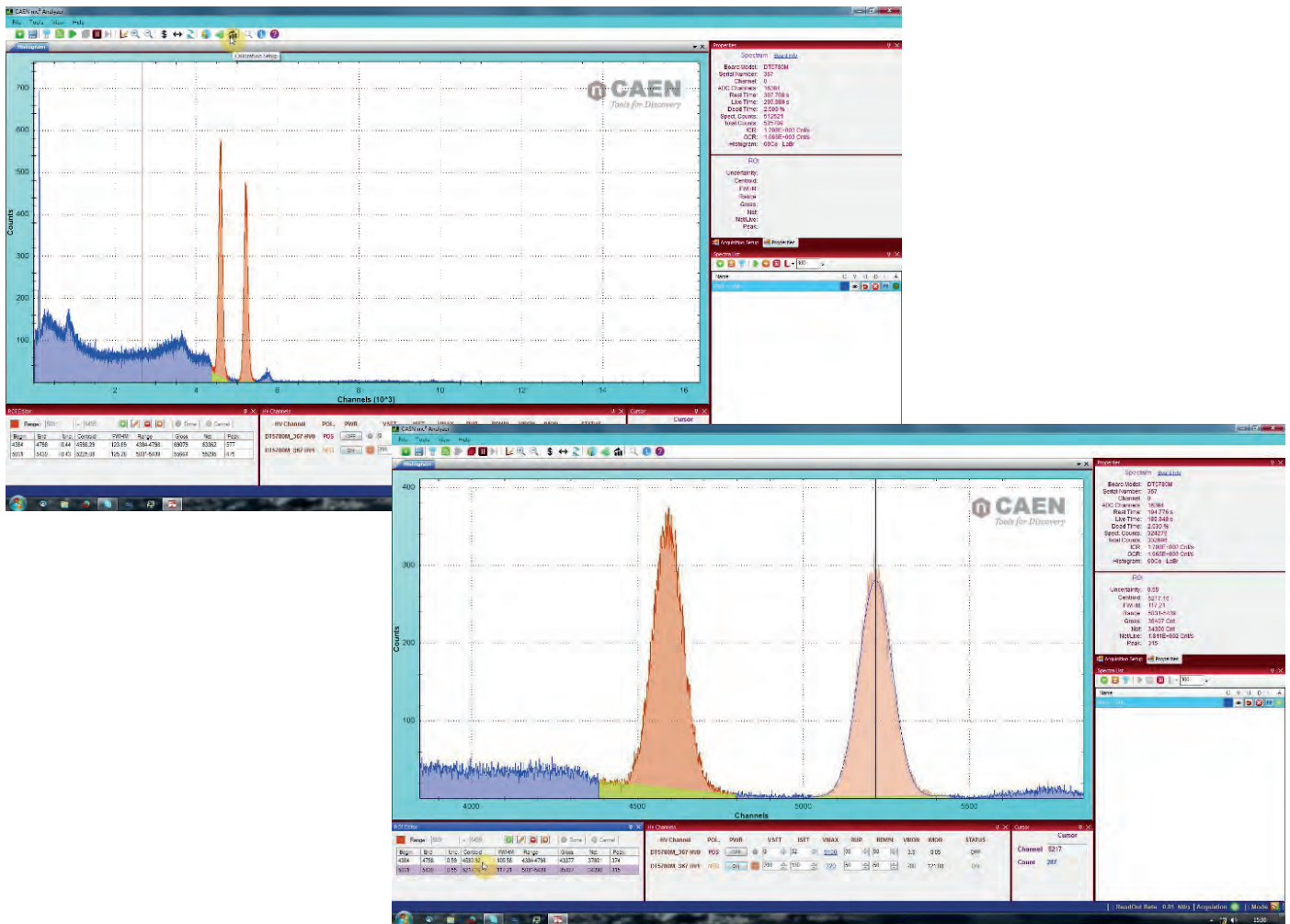
MC² Analyzer software allows the user to set all the relevant DPP-PHA parameters for each acquisition channel (like trigger threshold, shaping parameters, etc.), handle the communication with the connected boards, run the data acquisition and plot both waveforms for on-line monitoring of the acquisition and histograms. It can also control the HV power supplies provided in DT5780 and **Gamma Stream**.

Moreover, it is able to perform advanced mathematical analysis on both the ongoing histograms and collected spectra: peak search, background subtraction, peak fitting, energy calibration, ROI selection, dead time compensation, histogram rebin and other features available.

The software is designed with multi-channel and multi-board capabilities: it can handle several boards and manage the data acquisition from each of them at the same time.

MC² Analyzer is also able to manage hardware coincidences from different channels to the same board and to handle different digitizers.

MC² Analyzer can provide as output both the energy - time stamp lists from each enabled channel for off-line analysis and spectra as 1-column ASCII or ANSI N42.42 compliant files, including all the useful information for the commercial or user defined software for quantitative analysis.



ADVANCED SOFTWARE FOR THE XRF SPECTRUM ANALYSIS

bAXIL

MAIN FEATURES

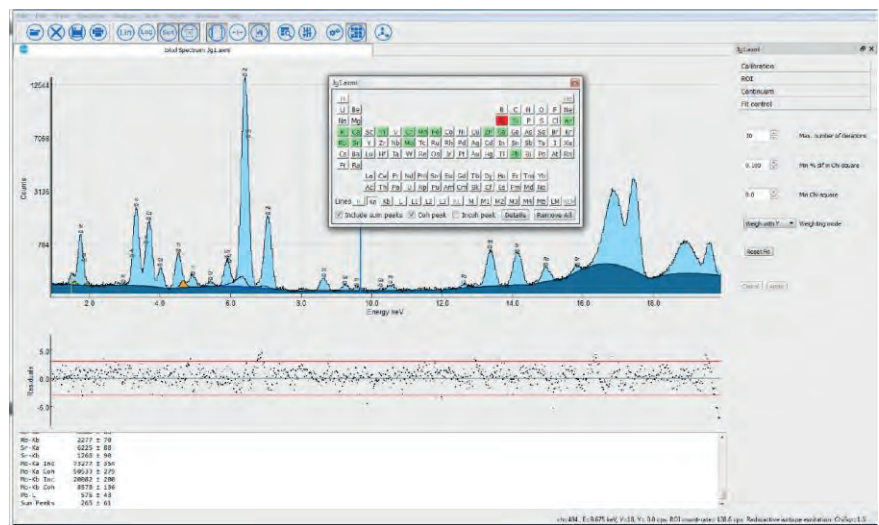
- two types of peak shapes: “Gaussian” and “Voight profile”
- additional peak shape components as tail and step fraction functions
- fit coherent and incoherent excitation peaks
- fit non-fluorescence peaks (E.g. Gamma-rays, diffraction peaks, etc.)
- Visual distinction and marking of sum and escape peaks
- Advanced graphical user interface (GUI) that can be set to user’s preferences
- saving in XML-formatted files (*.axml)
- Customizable analysis reports
- Quantification via different methods:
 - Linear regression using calibration standards
 - Standard-based Fundamental Parameter Method
 - Standard-less Fundamental Parameter Method
- Additional module for file batch analysis in unattended mode of operations
- Special option for macro-XRF image scan analysis, with ultra fast hybrid fitting algorithm and image data compression
- Additional tool program for creating compressed image scan data using intelligent and spectroscopy-aware algorithms
- multi-platform (Windows, MAC OS or Linux)

DESCRIPTION

The analysis of the energy spectra resulting from a x-ray fluorescence process (ED XRF) is still the most critical step in ED XRF analytical technique due to its complexity.

Furthermore, the advances of today’s measurement and detection technologies imposes new challenges to the XRF spectrum analysis.

bAxil is a new software for the XRF spectrum analysis. Although it is based on the internationally well known AXIL spectrum analysis methods, it incorporates recent developments and research in spectrum analysis and peak de-convolution.



bAxil has been developed using the most recent and powerful software development and programming techniques.

The software takes advantage of higher computer power (such as 64-bit processors), modern operating systems (**bAxil** is a multiplatform software), and new data structures (XML-based files).

bAxil software incorporates a special module and new algorithms for fast XRF image scanning analysis and data compression.

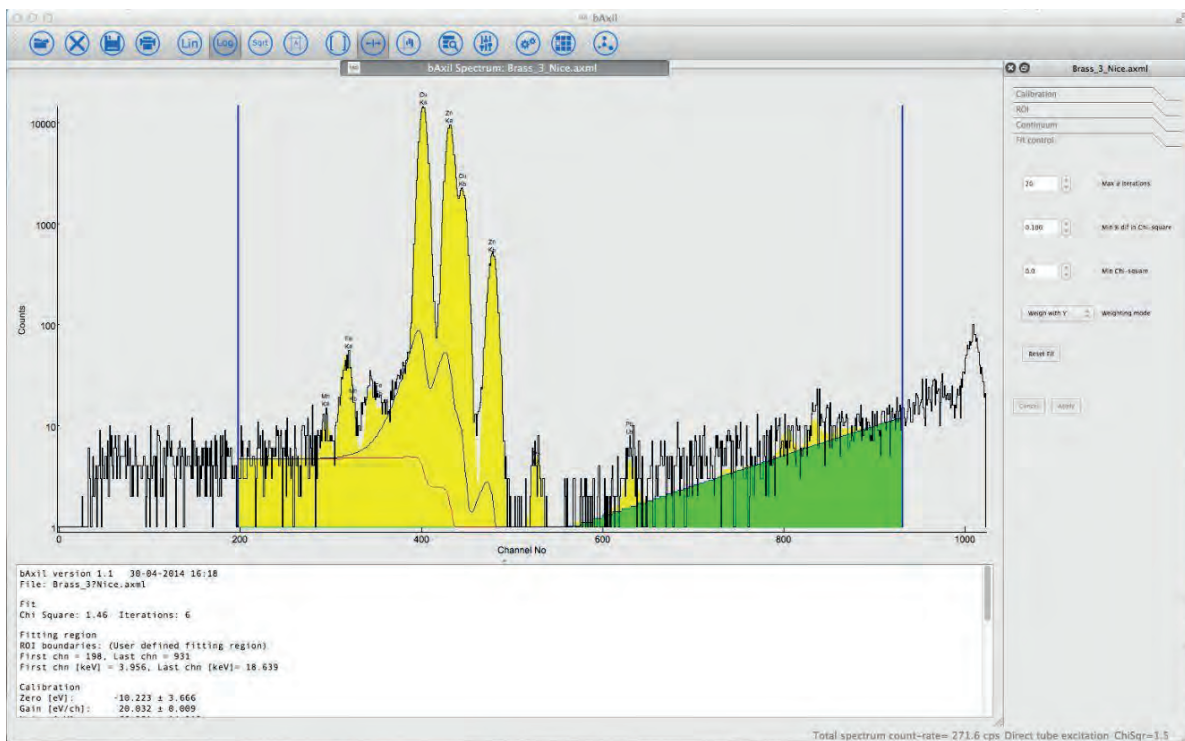
Additionally, the **bAxil** product line includes “**bAxil** Programming Libraries” which (as separate product) allows the user to take advantage of the powerful spectrum analysis engines and include them in their own development.

TECHNICAL SPECIFICATIONS

bAxil application software package is composed by the following components:

- Spectrum analysis, which includes major features, such as:
 - Two different peak-shape functions for spectrum de-convolutions: Gaussian or Voight profile
 - Addition of extra peak-shape components to fitting functions, like “Step” and “Tail” fractions
 - Possibility to fit peaks that do not results from XRF emissions (e.g. gamma-ray, etc.)
 - Capability to fit coherent and incoherent excitation peaks

- Quantitative analysis via different calculation methods:
 - Using calibrations obtained by “Linear Regression” derived from measured standards
 - Standard-less “Fundamental Parameter” calculation method
 - Standard-based “Fundamental Parameter” method
- A Batch mode of operation for the analysis of large amount of XRF spectral files in an unattended way



Gamma Spectroscopy

Spectroscopy Systems

PACKAGE FOR HIGH RESOLUTION X-RAY SPECTROMETRY

XR-Spec package

MAIN FEATURES

- Complete package for X-ray spectrometry
- Detector with active sensor areas from 10 to 170 mm²
- Excellent peak to background performance achieved over a wide range of x-ray acceptance angles by means of 'on chip' internal collimators
- High energy resolutions (<130 eV with SDD of 20 mm²)
- Compact DSP-based MCA with up to 16K MCA memory, 32-bit depth. Fast flash 14-bit ADC
- PHA, MCS, LIST and TLIST data acquisition modes (TLIST with <40 ns time resolution)
- Two programmable I/O ports
- USB connection to the PC or stand-alone with power adaptor
- Programming libraries for easy interface (Linux, MS Windows)
- Full bAxil software package
- Advanced spectrum analysis with several peak shape functions and continuum models
- Hybrid (linear and non-linear) spectrum fitting for ultra fast spectrum process for large image scan analysis
- Quantitative analysis using several methods
- Batch unattended file spectrum analysis
- MCA control embedded into bAxil

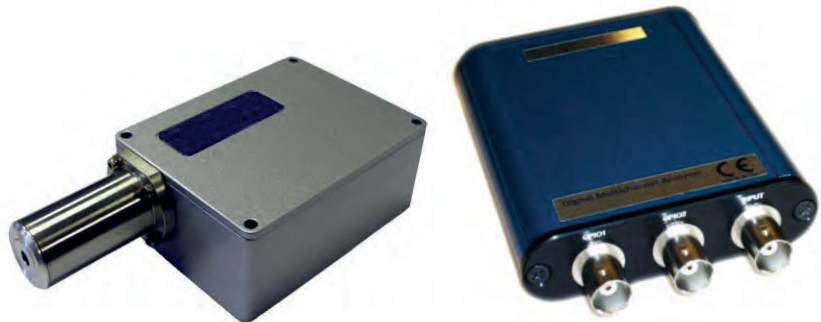
DESCRIPTION

The **XR-Spec** is a complete package designed for high resolution X-ray spectrometry.

The package is composed by the following main parts:

- Silicon Drift Detector (SDD)
- Multi Channel Analyzer (MCA)
- Analysis software

The XR-SPEC exploits the best features of each component gathering them in a complete package perfect for high-resolution X-ray spectrometry.



SILICON DRIFT DETECTOR (SDD)

SDD utilize sensors that are hermetically sealed and cooled by thermoelectric devices, with temperature control circuits which maintain the guaranteed energy resolution over a +10°C to +40°C ambient temperature range. Excellent peak to background performance is achieved over a wide range of x-ray acceptance angles by means of 'on-chip' internal collimators. For all types of X-Ray Fluorescence applications, SDD detectors offer high spectral quality, excellent resolution, and high peak to background ratios over a wide energy range.

MULTI CHANNEL ANALYZER (MCA)

Topaz-X is an advanced, fully digital, compact Multi Channel Analyzer used to process the electronic pulses produced by a high resolution, electrically cooled silicon detector such as Silicon drift detector (SDD) or Silicon PIN diode (Si-PIN). The MCA implements several advanced modes of data acquisition, such as: Pulse Height Analysis (PHA), Multi-channel scaling (MCS), LIST and Time LIST mode (TLIST). For the latter, each recorded pulse will be stored not only with the pulse height information (energy), but with the arrival time stamp as well. In TLIST mode the event time resolution is up to 40 ns.

ANALYSIS SOFTWARE

bAxil is a new software for the XRF spectrum analysis. Although it is based on the internationally well know AXIL spectrum analysis methods, it incorporates recent developments and research in spectrum analysis and peak deconvolution.

bAxil has been developed using the most recent and powerful software development and programming techniques.

It takes advantage of higher computer power (such as 64-bit processors), modern operating systems (bAxil is a multiplatform software), and new data structures (XML-based files).

TECHNICAL SPECIFICATIONS

SILICON DRIFT DETECTOR

Features

- Sensor active areas from 10mm² to 170mm²
- Sensor collimated areas from 7mm² to 150mm²
- Sensor thickness 0.45 mm
- Multi-Z (low fluorescence) on chip collimation
- Active temperature control
- Dedicated low voltage and bias power supply

Performance

- Typical Resolution:
 - <130 eV with SDD of 20 mm²
 - <140 eV with large SDD (e.g. 170 mm²)
- exceptional peak to background >15000:1

Physical size

- Compact body:
 - 77 x 58 x 30mm excluding probe and connectors
 - 4 mounting holes for heat sinking
- Detector body:
 - 130 x 90 x 130mm excluding probe and connectors
 - Tube length: Standard tube lengths from 50 to 300mm
- Tube length: standard tube lengths from 50 to 300mm

TOPAZ-X MCA¹

Device

- 14 bit high quality flash ADC running at 50MHz
- 100MHz DSP processor in high performance FPGA
- 200 MHz 32 bit CPU

Data acquisition

- Spectral memory size up to 16 384 (16K) channels
- Acquisition modes : PHA, MCS, LIST mode and TLIST mode (TLIST mode with <40 ns time resolution)

Data communication

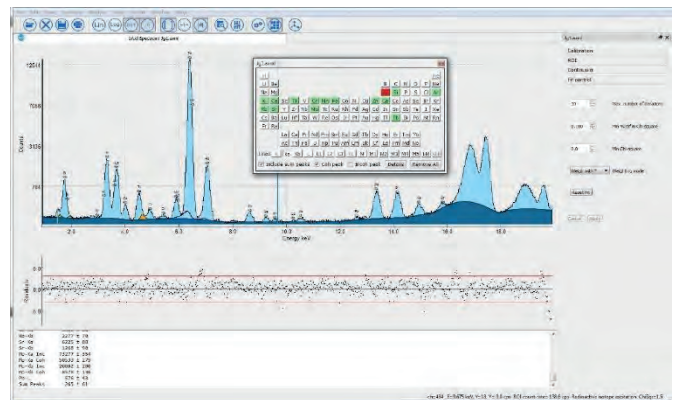
- USB 2.0, cable included

Physical Sizes:

- MCA box: length 86 mm, width 70 mm, height 18 mm
- Weight: less than 100 grams (including box)

B-AXIL ANALYSIS SOFTWARE¹

- Spectrum analysis, which includes major features, such as:
 - Two different peak-shape functions for spectrum de-convolutions: Gaussian or Voight profile
 - Addition of extra peak-shape components to fitting functions, like "Step" and "Tail" fractions
 - Possibility to fit peaks that do not results from XRF emissions (e.g. gamma-ray, etc.)
 - Capability to fit coherent and incoherent excitation peaks
- Quantitative analysis via different calculation methods:
 - Using calibrations obtained by "Linear Regression" derived from measured standards
 - Standard-less "Fundamental Parameter" calculation method
 - Standard-based "Fundamental Parameter" method
- A Batch mode of operation for the analysis of large amount of XRF spectral files in an unattended way



¹ For more information and technical specifications, see the relevant data sheets

AUTOMATED SPECTROMETER FOR RADIONUCLIDE ANALYSIS

RADARM

MAIN FEATURES

- Gamma-ray detector based on HPGe detector in U-style cryostat with remote preamplifier (PA) and 30l Dewar vessel
- Lead shield
- Multichannel analyzer
- Software for spectra processing, identification of radionuclides and calculation of their activities SpectraLineGP
- Spectra analysis software Nuclide Master Plus
- Software for efficiency calibration of arbitrary shaped objects EffMaker
- Automatic sample changer based on robot arm with compact controller
- Table with sample holders and safe cabinet
- Barcode reader together with barcode printer
- Control software for robotic arm
- Master controller with process managing software
- Liquid nitrogen sensor and monitor
- Cable set of 3m length

DESCRIPTION

The **RADARM** is an automated low-background gamma-ray spectrometry system based on high-purity germanium detector.

The **RADARM** is intended for the detection and analysis of radio nuclides from various types of environmental objects such as rocks, minerals, sludge, slag soil, plant, sediment and particulate matter in air and water.

The spectrometric system is able to determine the composition of a sample based on the photon energy and the activity based on the photon flux.



The low-background lead shielding together with the highly pure germanium (HPGe) p-type detector gives precise results even for low activity materials. The fully automated sample changer enables the user to measure up to 40 samples, without having to interact with the Automated Spectrometer.

This reliable robotic sample changer increases the productivity and reduces the possibility of health risks for the operator.

Automatic Sample Changer

The six-axis robot handles a payload of up to 3kg and with a reach of 580 mm, the robot is able to carry out a series of operations using flexible rather than hard automated solutions. In addition to a horizontal reach of 580 mm, the robot has the ability to reach 112 mm below its base. Furthermore, the robot has a very compact turning radius, which is enabled by the robots symmetric architecture, without offset on axis 2. This ensures the robot can be mounted close to other equipment

TECHNICAL SPECIFICATIONS

Measurement features

- Detection limit for ^{137}Cs radionuclide specific activity, measurement time 1 hour: 0.5 Bq/kg
- Absolute sensitivity to gamma flux for 30%* efficient detector: 4.5×10^{-3} pulse/quantum
- Instrumental background intensity for energy range from 40 KeV to 3 MeV: 5×10^{-4}
- ^{137}Cs radionuclide specific activity measurement error for measurement time 1 hour: 20 %
- Shield thickness:
 - Lead wall: 100 mm
 - Copper wall: 10 mm
- AC power supply:
 - Voltage: 230 V
 - Frequency: 50 Hz



Lead shield

- Thickness of lead walls: 100 mm
- Internal dimensions: $\varnothing 202 \times 332$
- Liners
 - Tin, thickness 1 mm
 - Copper, thickness 9 mm
- Outer jacket: 1.5 mm low carbon steel

Automatic sample changer

- Six-axis manipulator
- Payload: 3 kg
- Reach: 580 mm
- Fastest 6-axis robot
- Accuracy: ± 0.01 mm
- Footprint: 180 mm squared
- Weight: 25 kg
- IP30 protected
- All motors and cabling enclosed
- Compact controller
- Sample holder tool for vessels with diameter in range 40 – 110 mm.

Barcode reader and writer

To assure the correct processing of all data during the measurement and analysis process, the samples are marked by using a barcode printer that is connected to the workstation. Here all necessary information about the sample is stored in a database. Using the bar code reader, the information stored in the database is retrieved for each sample before the measurement process is started. This fully automated process delivers all necessary information for the measurement and analysis process. Counting and signaling electronics

Samples

Measurement geometries are:

- Bottle 500 ml
- Bottle 250 ml
- Denta 60 ml
- Denta 30 ml

Given numbers are applicable to a specific model but it is not a limitation. The system is flexible enough to be adjusted in accordance to specific requirements.



CAEN SyS
Systems and Spectroscopy Solutions

Detectors

INORGANIC SCINTILLATOR DETECTOR ASSEMBLIES FOR MULTIPLE APPLICATION

Inorganic Scintillator Detectors

MAIN FEATURES

- PMTs surrounded by solid Mu-Metal Shield
- Compact assembly
- Superior energy resolution
- Optional voltage divider
- Optional fastening tread and holder for γ stream based assemblies
- NaI(Tl):
 - Very high light output
 - good energy resolution
- CsI(Tl):
 - Non-hygroscopic
 - Rugged
 - Long wavelength emission
- BGO:
 - High density and Z
- CeBr:
 - Fast timing
 - high light output
 - Ultra-Low background Scintillation Crystal

DESCRIPTION

Inorganic scintillators are composed by certain materials, which have the properties to emit light when ionizing radiation interact in it. The detection of ionizing radiation through scintillation light is one of the oldest techniques documented.

Efficient detection of Gamma rays requires the material of the scintillator to be with high density and high atomic number. Inorganic scintillation crystals meet the requirements of stopping power and optical transparency, their densities ranging from roughly 3 to 9 g/cm³ makes them very suitable to absorb penetrating radiation (Gamma rays). Materials with high Z-values are used for Gamma ray spectroscopy at high energies (>1 MeV).



Since photoelectron statistics plays a key role in the accurate determination of the energy of the radiation, so the use of scintillation materials with a high light output is preferred for all spectroscopic applications. On the other side, fast light emission (through fluorescence process), improves the measurement of the ionizing radiation interaction time.

The **Inorganic scintillator assemblies** are composed by the following components:

- the crystal (e.g. NaI(Tl), CsI(Na))
- A 14-pin 10 stages PMT

This can be matched with MCA PMT base **yStream**, **bPAD** and **bmCA**.

The assembly can be also provided with a voltage divider, to be matched with **TOPAZ-Pico** MCA.

ACCESSORIES

In addition to standard supply, the following accessories are available upon request:

- **yStream** active digital Multi-Channel Analyzer integrated in a 14-pin PMT base
- **bPAD** compact microcontroller-based Single Channel Analyzer
- **bmCA** digital Multi-Channel Analyzer integrated in a 14-pin PMT base
- **TOPAZ-Pico** compact, stand-alone digital Multi-Channel Analyzer

APPLICATION

Each scintillation crystal has its own specific application. For high resolution Gamma ray spectroscopy, NaI(Tl), or CsI(Na) (high light output) are normally used. CeBr₃ has exceptional light emission and fast light deexcitation time.

For high energy physics applications, the use of bismuth germanate Bi₄Ge₃O₁₂ (BGO) crystals (high density and Z) improves the Gamma ray energy confinement.

NaI(Tl):

- General scintillation counting
- health physics
- environmental monitoring
- high temperature use

CsI(Tl):

- Particle and high energy physics
- general radiation detection
- photodiode readout
- phoswiches

BGO:

- Particle physics
- geophysical research
- PET
- anti-Compton spectrometers

CeBr₃:

- High resolution spectroscopy
- fast timing
- particle and high energy physics
- ultra-low background

OPTIONS AVAILABLE

Model	Material	Dimension	Decay Constant	Voltage Divider	Resolution for ¹³⁷ Cs
51B51/2M	NaI(Tl)	2" Ø x 2" h	0.23 ms	no	< 7,5 %
51B51/2M-E1	NaI(Tl)	2" Ø x 2" h	0.23 ms	yes	< 7,5 %
76B76/3M	NaI(Tl)	3" Ø x 3" h	0.23 ms	no	< 7,5 %
76B76/3M-E1	NaI(Tl)	3" Ø x 3" h	0.23 ms	yes	< 7,5 %
51B51/2M-Cs	CsI(Tl)	2" Ø x 2" h	0.6/3.4 ms	no	< 8 %
51B51/2M-E1-Cs	CsI(Tl)	2" Ø x 2" h	0.6/3.4 ms	yes	< 8 %
76B76/3M-CS	CsI(Tl)	3" Ø x 3" h	0.6/3.4 ms	no	< 8 %
76B76/3M-E1-CS	CsI(Tl)	3" Ø x 3" h	0.6/3.4 ms	yes	< 8 %
51B51/2M-BGO	BGO	2" Ø x 2" h	0.3 ms	no	< 13 %
51B51/2M-E1-BGO	BGO	2" Ø x 2" h	0.3 ms	yes	< 13 %
76B76/3M-BGO	BGO	3" Ø x 3" h	0.3 ms	no	< 13 %
76B76/3M-E1-BGO	BGO	3" Ø x 3" h	0.3 ms	yes	< 13 %
38B38/2M-CEBR-LB-X	CeBr	1.5" Ø x 1.5" h	19 ns	no	< 4,2 %
38B38/2M-E1-CEBR-LB-X	CeBr	1.5" Ø x 1.5" h	19 ns	yes	< 4,2 %

LIQUID NITROGEN COOLED DETECTORS FOR GAMMA AND X-RAYS SPECTROSCOPY

HPGe Planar Detectors

MAIN FEATURES

- Built-in or Remote Preamplifier types are available depending on application
- Option to choose a preamplifier type with a resistive or opto-electronic feedback high energy rate up to 15000 MeV/sec
- Ability to increase energy rate to 20000 Mev/s radiation detection in any spatial orientation made possible by modifications to the portable cryostat during manufacturing
- Energy range from 3 keV to 1500 keV
- Input window materials: Aluminium, Beryllium or Carbon-fiber
- Excellent peak symmetry and high resolution
- HV supply protection if detector is warm
- High count rate indicator
- Variable cryostat design modifications
- Can be transported and stored without cooling

DESCRIPTION

Gamma and X-ray **HPGe Spectrometer** is intended for the conversion of gamma and X-ray quantum energy to signals proportional to their energy level. This is accomplished using amplitude electric signals and their amplification for further registration with a nuclear physics apparatus.



It is also intended for use as the gamma and X-ray detection component of radiological monitoring equipment for environmental objects in nuclear energetics, industrial production, agriculture, medicine, etc.

The **HPGe Planar Detectors** complete set is composed by the following components:

- HPGe planar detector
- Preamplifier with cooled input stage
- Dewar vessel
- Cable set
- Documentation

ACCESSORIES

In addition to standard supply, the following accessories are available upon request:

- Hexagon_Multichannel Analyzer
- Analytical Software packages:
 - quantitative and qualitative analysis
 - Gamma spectra modeling and efficiency registration calculation for complex geometry objects
 - extended radionuclide library
- Liquid nitrogen storage and filling system
- Liquid nitrogen sensor and monitor
- Cable set extension



Model	Diameter, mm	Detector Sensitive Area, Area [mm ²]	Detector Sensitive Area, Thickness [mm]	Energy Resolution at 5.9 keV [eV]	Energy Resolution at 122 keV [eV]
GPD – 05 145	5	20	6	145	465
GPD – 08 155	8	50	6	155	485
GPD – 12 165	12	100	7	165	490
GPD – 12 160	12	100	10	160	490
GPD – 16 180	16	200	11	180	495
GPD – 25 300	25	500	13	300	545
GPD – 36 360	36	1000	13	360	585
GPD – 36 300	36	1000	15	300	560
GPD – 45 400	45	1590	14	400	600
GPD – 50 400	50	2000	15	400	600
GPD – 50 600	50	2000	20	600	750
GPD – 50 460	50	2000	35	460	680
GPD – 60 500	60	2800	25	400/500	700
GPD – 70 560	70	3800	25	560	750
GPD – 70 600	70	3800	30	600	780
GPD – 80 620	80	5000	30	620	800
GPD – 80 720	80	5000	30	480	720
GPD – 90 500	90	6500	30	500 ± 30	750

* Plenty of cryostat geometries are available

LIQUID NITROGEN COOLED DETECTORS FOR HIGH RESOLUTION GAMMA SPECTROSCOPY

P-type HPGe Coaxial Detectors

MAIN FEATURES

- 10% – 160% efficiency HPGe p-type coaxial detectors are available
- Energy range from 40 keV to 10 MeV for GCD model
- Energy range from 3 keV to 10 MeV for GCDX model
- Input window materials: Aluminium, Beryllium or Carbon-fiber
- Built-in or Remote Preamplifier types are available depending on application
- High efficiency of radiation detection
- High energy rate up to 200000 MeV/sec
- Excellent peak symmetry and high resolution
- Detection of radiation in any spatial orientation depending on cryostat modification
- Manufacture in a portable cryostat is possible
- High count rate indicator
- HV supply protection if detector is warm
- Low instrument background and Ultra – low background materials are available

DESCRIPTION

Germanium detectors are semiconductor diodes having a p-i-n structure in which the intrinsic (I) region is sensitive to ionizing radiation, particularly X rays and gamma rays.

When photons interact with the material within the depleted volume of a detector, charge carriers (holes and electrons) are produced and are swept by the electric field to the P and N electrodes. This charge, which is in proportion to the energy deposited in the detector by the incoming photon, is converted into a voltage pulse by an integral charge sensitive preamplifier.



Because germanium has relatively low band gap, these detectors must be cooled with Liquid nitrogen (temperature of 77 °K).

P-type HPGe Coaxial Detector is also intended for Detection of Gamma rays in nuclear energetics and environmental control, in industry and scientific research, in medicine and other applications.

The **P-type HPGe Coaxial Detector** complete set is composed by the following components:

- HPGe coaxial detector
- Preamplifier with cooled input stage
- Dewar vessel

- Cable set
- Documentation

ACCESSORIES

In addition to standard supply, the following accessories are available upon request:

- Hexagon_Multichannel Analyzer
- Analytical Software packages:
 - quantitative and qualitative analysis
 - Gamma spectra modeling and efficiency registration calculation for complex geometry objects
 - extended radionuclide library
- Liquid nitrogen storage and filling system
- Liquid nitrogen sensor and monitor
- Cable set extension



Model	Efficiency,%	Energy resolution at 122 keV (eV)	Energy resolution at 1.33 MeV (keV)	Peak / Compton ratio	Peak Shape FW.1M / FWHM	Peak Shape FW.02M / FWHM
GCD-10175	10	825	1.75	41:1	1.90	2.65
GCD-15180	15	825	1.80	46:1	1.90	2.65
GCD-20180	20	850	1.80	51:1	1.90	2.65
GCD-25185	25	850	1.85	55:1	1.90	2.65
GCD-30185	30	875	1.85	58:1	1.90	2.65
GCD-35190	35	875	1.90	60:1	1.90	2.65
GCD-40190	40	895	1.90	62:1	1.90	2.65
GCD-50190	50	895	1.90	64:1	1.90	2.65
GCD-60200	60	1000	2.00	68:1	2.00	3.00
GCD-70200	70	1000	2.00	73:1	2.00	3.00
GCD-80210	80	1200	2.10	77:1	2.00	3.00
GCD-100220	100	1200	2.20	81:1	2.00	3.00
GCD-120220	120	1200	2.20	83:1	2.00	3.00
GCD-140220	140	1200	2.20	86:1	2.00	3.00
GCD-160230	160	1250	2.30	88:1	2.00	3.00

* Plenty of cryostat geometries are available

LIQUID NITROGEN COOLED DETECTORS FOR GAMMA AND X-RAYS SPECTROSCOPY

Portable HPGe Detectors

MAIN FEATURES

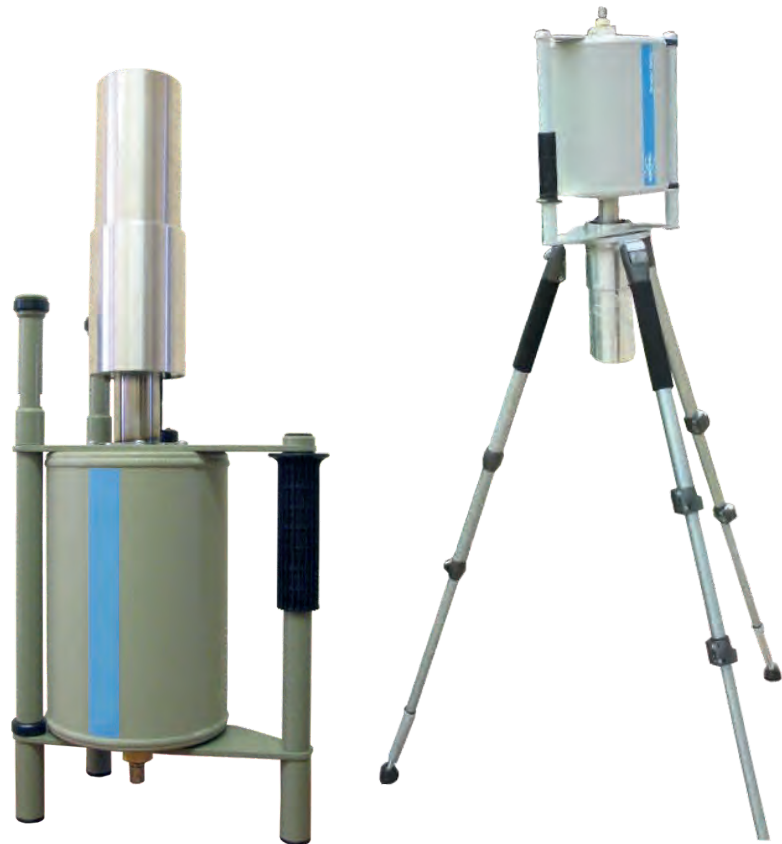
- Ultra-light cryostat fabrication for minimum gamma absorption
- Light weight aluminium construction
- Detection of radiation in any spatial orientation
- Compact low consuming electronics
- Available with HPGe coaxial or planar detector
- Transportation and storage without cooling
- Input window materials: Aluminium, Beryllium or Carbon-fiber
- Dewar vessels available with different volumes from 1l to 7l

DESCRIPTION

Germanium detectors are semiconductor diodes having a p-i-n structure in which the intrinsic (I) region is sensitive to ionizing radiation, particularly x rays and gamma rays.

When photons interact with the material within the depleted volume of a detector, charge carriers (holes and electrons) are produced and are swept by the electric field to the P and N electrodes.

This charge, which is in proportion to the energy deposited in the detector by the incoming photon, is converted into a voltage pulse by an integral charge sensitive preamplifier.



Because germanium has relatively low band gap, these detectors must be cooled with Liquid nitrogen (temperature of 77 °K).

Portable HPGe Detector is designed for detection, accumulation and processing of gamma spectra in field and industry conditions where small dimensions and weight of spectrometer are important.

The **Portable HPGe Detectors** complete set is composed by the following components:

- HPGe coaxial detector
- Preamplifier with cooled input stage
- Dewar vessel
- Cable set
- Documentation

ACCESSORIES

In addition to standard supply, the following accessories are available upon request:

- Hexagon_Multichannel Analyzer
- Analytical Software packages:
 - quantitative and qualitative analysis
 - Gamma spectra modeling and efficiency registration calculation for complex geometry objects
 - extended radionuclide library
- Hand-cart for Multichannel Analyzer, battery, transformer, etc.
- Additional batteries
- Recharger
- Collimators
- Transport case

- Tripod
- Liquid nitrogen storage and filling system
- Liquid nitrogen sensor and monitor
- Cable set extension

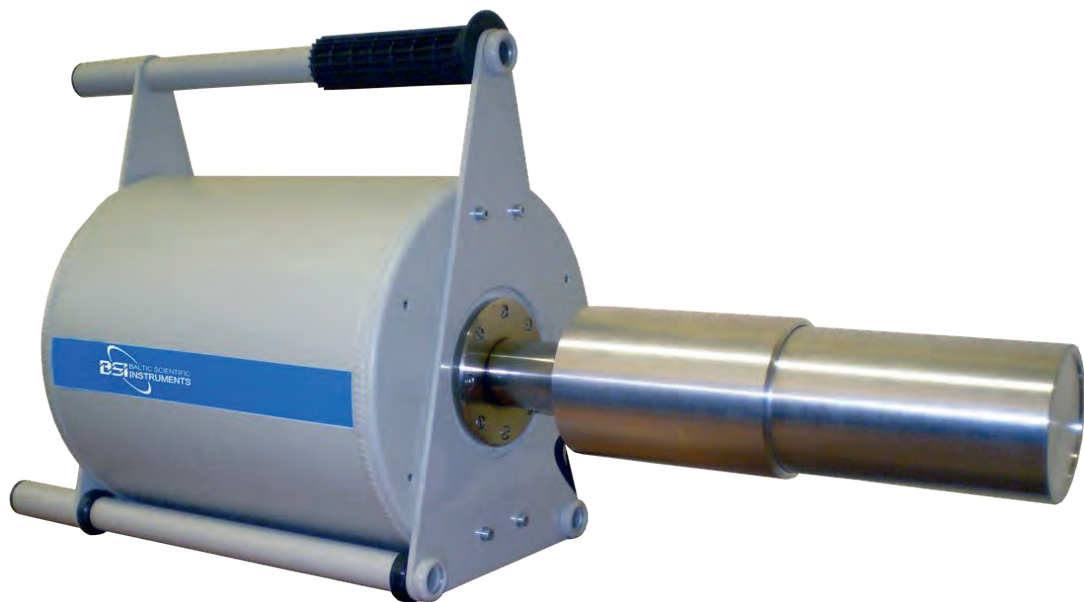
TECHNICAL SPECIFICATIONS

Detectors

- Energy range: 40 – 10000 keV
- Energy range extended: 3 – 10000 keV
- HPGe detector efficiency: 30 % *
- Energy resolution for 30% efficiency detector:
 - 0.875 keV at 122 keV
 - 1.85 keV at 1.33 MeV
- Time of cooling after refilling: 4 h **
- Time of continuous operation (depending on Dewar vessel volume): 1d, 2d, 5d
- Al end cup thickness: 0.7 mm
- Weight of detector with filled Dewar vessel:
 - 1,5 l - 7 kg
 - 3,0 l - 11 kg
 - 5,0 l - 15 kg

* HPGe Detectors are available with efficiency from 10% to 100%

** Depending on Dewar vessel volume and/or detector efficiency



HPGe HAND HELD SPECTROMETER

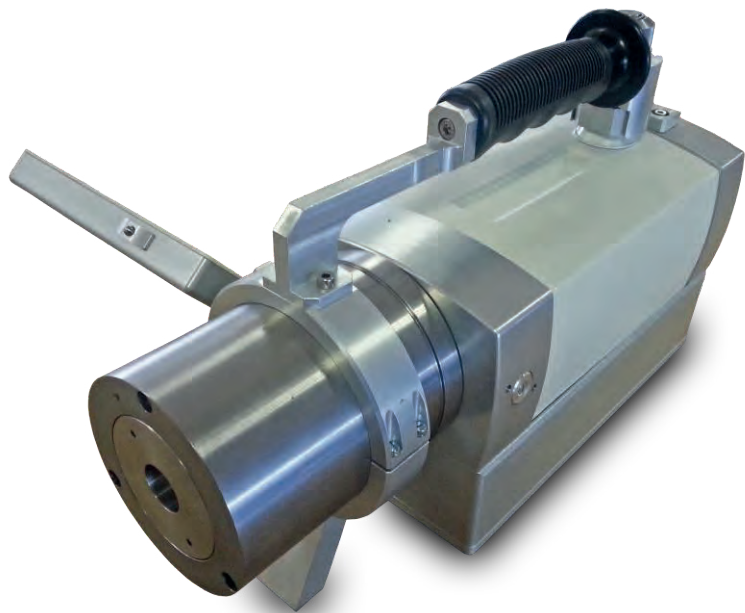
NitroSPEC

MAIN FEATURES

- Minimal weight and size
- Ready for operation in about 1 hour
- Energy range 40-3000 keV
- Autonomous operating time up to 20 hours
- Simple with low cost maintenance and service
- No additional vibrations
- Completely integrated solution
- Minimal time to reach the operating temperature
- Highly competitive price

DESCRIPTION

The **NitroSPEC** is the world's smallest liquid nitrogen cooled Spectrometer which is based on High Purity Germanium (HPGe) semiconductor detectors. The **NitroSPEC** is providing the complete range of functions and features which are offered by regular laboratory spectrometer based on HPGe detectors but in a really miniature composition of all major components. During the development of the **NitroSPEC**, R&D specialists were aimed at HPGe detector, Dewar vessel for liquid nitrogen, MCA with software package and visualization monitor integration in only one miniature monounit to provide easy and comfortable use. Due to the fact that during the measurement no cables are needed, the operator is unrestricted in his mobility. power supply is no longer an issue as everything is integrated.



The **NitroSPEC** can be equipped with a wide range of HPGe detectors depending on the application:

- HPGe planar GPD detectors are available for analysis of Gamma and X-rays.
- HPGe coaxial GCD detectors are available with relative efficiencies up to 20%. Standard or with extended energy range (X series).

The **NitroSPEC** includes preamplifier, digital MCA with 16K channels, High and Low Voltage power supply and a set of batteries to provide maximal flexibility. In field mode the **NitroSPEC** is used as identifier simultaneously acquiring and

saving data for performance of quantitative and qualitative analysis in laboratory conditions. Communication between working station and the **NitroSPEC** is possible via USB or wireless connection.

The **NitroSPEC** complete set is composed by the following components:

- HPGe detector (coaxial or planar)
- Digital multi-channel analyzer
- Analytical software package
- Touch screen display
- Dewar vessel
- Communication interface (USB, wireless)
- Adaptor

ACCESSORIES

- Lead Shielding with collimators
- Hand-cart
- Hard-sided transport case
- Funnel for LN₂ filling
- Car charger
- Spare battery

TECHNICAL SPECIFICATIONS

Detectors

- Relative efficiencies available: 10%, 15%, 20%
- Energy range: 40 - 3000* keV
- Energy resolution for 10% efficient coaxial detector:
 - 825 eV at 122 keV,
 - 1.75 keV at 1.33 MeV

Cooling system

- Dewar vessel volume: 0.6 l
- Time for reaching of operating temperature after liquid nitrogen filling: <1.5 h
- Detector holding time: >20 h

Power supply

- Power consumption: < 3.5 W
- Voltage: 12 V
- Li-Ion Battery operation time: >8 h

Data acquisition

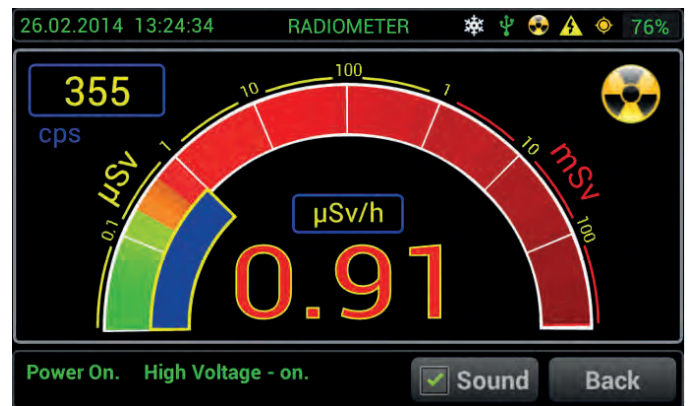
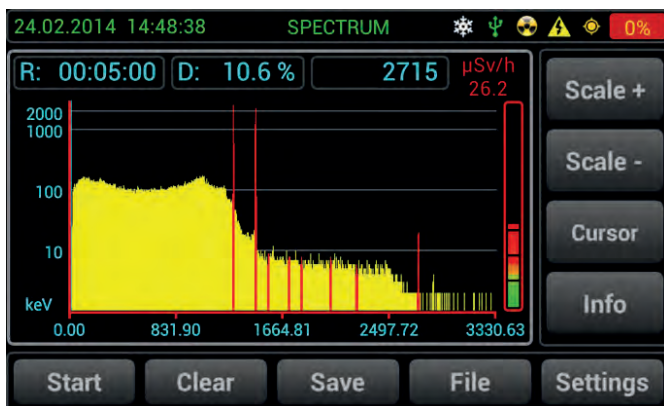
- Maximum number of quantization levels of ADC: 16K
- Channel capacity: 2³²
- Integral nonlinearity: <0.04 %
- Differential nonlinearity: <1 %
- Temperature instability: <0.01 %/°C

Physical size

- Dimensions: 154x324x217 mm
- Weight: 4.95 kg

Others

- Navigation system: GPS
- Operational temperature range: 0/+40 °C
- Ingress Protection: IP65



* Available with extended energy range (X series)

Nuclear Fuel, Safeguard and Security

FAST NEUTRON DETECTION SYSTEM FOR FRESH FUEL CHARACTERIZATION

VeryFuel

MAIN FEATURES

- Fits the profile of the fuel assemblies for PWR and WWER1000 reactors.
- Detector assembly and DAQ system with modular digital electronics, embedded PC and data processing software included
- 12 cells of EJ-309 liquid scintillator arranged on three detection panels
- biased by individual HV channels and read out by individual flash ADC
- Collects neutron coincidences from induced nuclear reactions at much higher rate compared to presently available systems detecting thermal neutrons
- Statistical uncertainty on the ^{235}U enrichment in 17×17 PWR lower than 1% with 15 min acquisition time
- Immune to burnable poisons
- Easy set-up of the instrument in-field with minimal cabling and connection complexity
- Collect, transfer and store raw data comprising waveforms, cell number/address and time stamps to allow data integrity evaluation and give the possibility for an independent re-processing of stored data on site or at the Head Quarters.
- Provide an easy configuration mode for in-field use comprising a real-time data analysis, with display of the main result in the form of ^{235}U linear mass and related uncertainty for item verification.

DESCRIPTION

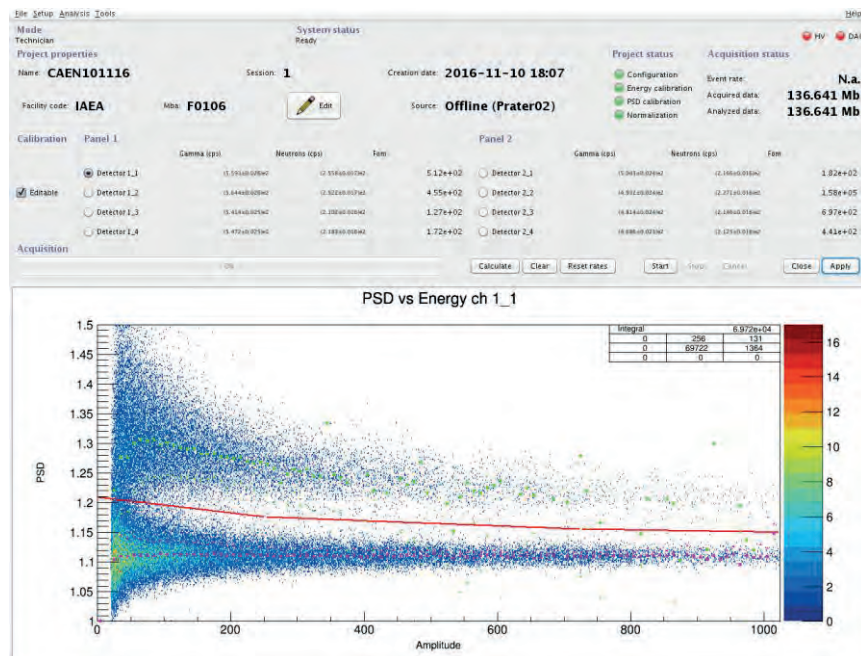
The **VeryFuel** is an Non Destructive Assay (NDA) tool for verification of modern fresh fuel assemblies. The **VeryFuel** has the capability to measure the ^{235}U content with unprecedented speed and much lower systematic uncertainty in presence of burnable poisons. The **VeryFuel** is a liquid scintillator-based instrument detecting fast neutrons from induced nuclear fissions. The standard geometric configuration fits the profile of the fuel assemblies for PWR and WWER1000 reactors.



CAEN developed the **VeryFuel** for the International Atomic Energy Agency (IAEA) and its user requirements have been defined in the safeguards operational divisions.

The **VeryFuel** comprises a detector assembly and a DAQ system with modular digital electronics, embedded PC and data processing software. The detector assembly is composed by 12 cells of EJ-309 liquid scintillator, arranged on three detection panels. The fourth panel of the assembly, composed by high density polyethylene, has the housings for two Americium-Lithium sources (AmLi). Each liquid scintillator cell is biased by individual High Voltage channels and read out by individual flash Analog-to-Digital Converters. The detectors and data analysis was developed by the IAEA and Member States Support Programs.

The software allows the user to configure the data acquisition through an intuitive graphical user interface and shows the result of the real time data processing. When the data acquisition is started, the events are read from the digitizer modules, encoded in binary files, analysed and filtered by a series of configurable selection criteria.



PEDESTRIAN PORTAL MONITOR

PPM 9300

MAIN FEATURES

- Two gamma detectors based on plastic scintillators, PMT and PMT base with digital output
- Integrated motion sensor for measurement start
- Alarm events logging
- Local alarm beacon with remote repetition possibility
- PC based management, user friendly software mod. 9300-SW-RM, Windows compatible
- Modular and compact electronics with counters, relays, power supply and HV
- Easy to use and maintain
- Strengthened structure, can be fastened to the floor
- Connectable to interlock devices
- Available version with network camera for motion detection, measurement start and picture snapshots of alarm events
- Neutron detection sub-system available

DESCRIPTION

The **PPM 9300** monitor has been designed and realized to monitor unauthorized radioactive sources transportation or possible contaminations on persons passing through the device. The system features a portal mechanical structure, with two columns on the sides of the measuring zone, each containing one plastic scintillator detector with a large sensitive area. Both detectors are shielded on the external side by means of lead plates, in order to reduce the contribution from the environmental background radiation. The measurement starts when the sensor detects the passage of a person through the portal. The monitor measures the radioactivity level, subtracts the background contribution and compares the net result with an alarm threshold. All measured data and information about alarm and failure statuses are displayed by the software.



PPM 9300

The background level is automatically determined by the monitor when no passage through the portal is occurring.

The acoustic-luminous beacon installed on the top of the portal informs about the running measurement, the good operation and the alarm status (red lamp and siren). An output connector is available on the top of the portal to control external interlock devices, for example to forbid the passage in case of alarms.

Moreover, it is available on request an additional alarm unit for remote signaling.

All alarm events are archived to the PC hard disk, including the event date/time, the measured activity level and the current alarm threshold setting. Similarly, all failure events are logged. If the optional camera is present, the pictures of the alarmed passage are also stored to disk. All data and pictures can be later reviewed at any time.

TECHNICAL SPECIFICATIONS

Measurement features

- False alarm rate: <1/10'000 (alarm threshold at 5 σ)
- Energy range: 35 keV \div 2 MeV
- Efficiency referred to ^{137}Cs : 50 kcps/ $\mu\text{Gy/h}$ (per detector, source at the center of the passage)
- Minimum Detectable Activities (5 σ confidence level):
 - ^{137}Cs : 20 kBq
 - ^{239}Pu : 10 mg
 - Enriched-U, 93% in ^{235}U : 300 mg
 - Natural-U: 30 g

Detection unit

- Detection: 2 plastic scintillators, with integrated PMT
- Detector dimensions (WxDxH): 28x4x198 cm
- Lead shielding thickness: 10 mm
- Photomultiplier base Mod. PAD, complete with:
 - High voltage / Pre-amplifier
 - Discriminator window with threshold

Acquisition and power supply module

- Signal acquisition: two 32 bit counter/frequency inputs
- Status management:
 - 4 relays NO/NC for the local alarm annunciator
 - 4 relays NO/NC for interlock purposes (in parallel with the above outputs)
 - 4 relays NO/NC for the remote alarm annunciator (on request)

Software 9300-SW-RM

- Operating system: WINDOWS
- Connection interface: Ethernet
- Detector signal sampling rate: 1 second
- User interface:
 - Main screen
 - Parameter setting dialog
 - Alarm archive display dialog
 - Network camera settings (if present)

Control Console

- Type: Tower PC
- Data communication: Ethernet LAN 100 Mbps

Power supply, weight and dimensions

- Power supply: 220 VAC 50 Hz
- Portal dimensions (WxDxH): 104x40x225 cm

- Weight: 360 kg

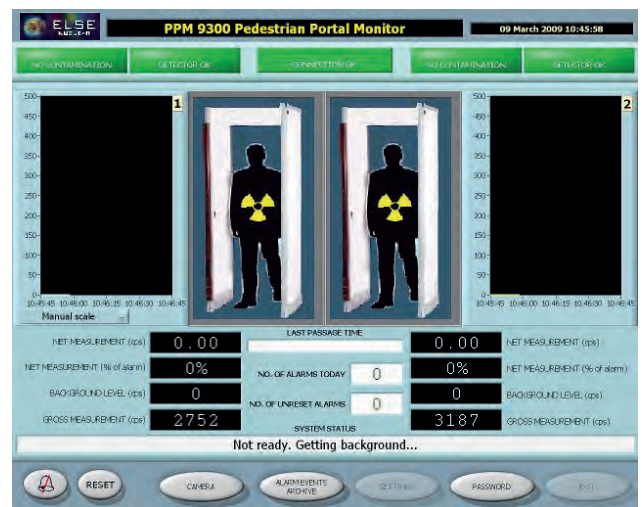
Available motion/passage sensor

- The following sensors are available by customer choice:
 - Infrared
 - Microwave
 - Combined infrared/microwave
 - Network camera with embedded PIR and firmware motion sensing

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Additional alarm unit for remote signaling mod. ALU
- Passage interlock device
- Neutron detection unit: moderator- and shielding-free ^4He -filled tubes loaded with lithium converter for fast and thermal neutron detection



Software panels



PORTAL RADIATION MONITORING SYSTEM FOR VEHICLES

GALILEO 9900 series

MAIN FEATURES

- High sensitivity measurements of gamma radiations
- Adjustable configuration for best compliance to layout and vehicles specifications
- Large plastic scintillators
- False alarm rate: 1:10'000
- Continuous monitoring and automatic environmental background subtraction
- Pass-through speed control
- Alarm and bad functioning events management, with local display and remote (upon request) indications
- Ethernet communication for remote monitoring (upon request) and teleservice (upon request)
- Designed to resist to maximum wind loads
- Connectable to vehicle identification devices (plate readers)
- Available relays for safety devices connection (interlock, alarm indicators...)

DESCRIPTION

The **GALILEO 9900 SERIES** system is designed to automatically monitor the load of vehicles passing through its structure, and to detect any radioactive contamination due to the presence of gamma emitting radionuclide.



Example of GALILEO 9900: 2UV version (above) and 4UV version (under)

Through proper data processing, tested and validated in the installation sites, the counts acquired by the detectors are continuously compared to the set alarm thresholds; if a threshold is exceeded, the system immediately gives a warning to the operator through acoustic and luminous indications. The system has a portal configuration, with the holding structures for the detectors placed at the sides of the passageway; the number of detection units changes according to the required sensitivity and to the expected vehicle type; in

particular, a detection unit can be installed horizontally on the top of the passageway. Each detection unit is composed of a high-efficiency plastic scintillator faced towards the passageway, together with a photomultiplier and the electronics for HV and signal processing.

The detector sides which are not faced towards the measurement area (the passageway) are properly shielded, to lower the environmental background value and to improve the system sensitivity. Two position detectors, at the entrance and at the exit of the passageway, detect the vehicle's transit and calculate its speed.

The power supply and acquisition module provides power supply to the detection units and the position detectors, acquires the counts coming from the detectors, and indicates the system status through relays. It can be installed up to a 1 km distance from the detection units; it is connected to the control console, which allows to completely manage the system through the very simple and user-friendly visual software.

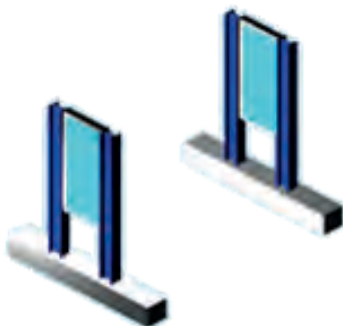
The software processes the measurements with proper calculation algorithms, capable of distinguish the alarm events and to hedge the false alarms. The continuous background monitoring, and its subtraction from the measurements, are automatically carried out. The alarm events are stored in the memory and they can be recalled through the software for consultation; the archives can be shared via LAN and exported, for example with USB memories. Upon request, the monitoring activity can be remotely controlled, using the Ethernet-LAN door of the control console, and the operator can contact CAEN SyS service center for on-line service.

CONFIGURATION

To be compliant with specific logistic and radioprotection requirements, GALILEO 9900 SERIES system has several different versions each with a different set of principal components. Please note that this data sheet will refer to th version.

All technical data are in common with the others versions; if necessary, a note will be provided to better c

- **Detector housing** for Detection unit and position detectors. It is specifically built for outdoor installations, with high IP protection grade hinges, junctions and clamps. Thanks to its design, maintenance operations of the internal elements can be easily carried out. Design and materials are made to ensure proper shielding of the external sides of the detector, and a high gamma efficiency on the detector's measurement face. The housing is available in a vertical or horizontal configuration. The height of the support column and the position detectors orientation can be adjusted according to the installation requirements.
- **Detection units** PVT large-surface scintillators for gamma radioactivity measurements, installed at the sides of the portal passageway. The unit number, the distance between them, the height from the ground and the orientation are adjustable according to the installation site, the performance specifications and the type of vehicles (trucks of several dimensions, wagons, etc). Higher sensitivity can be achieved with a "bridge" configuration, with an additional detection unit located on top of the passageway. It is possible to monitor vehicles moving in or out the installation site, or eventually in both ways.
- **Power supply and acquisition module** wall mounted or in a rack configuration. The module contains the power supplies, the acquisition and counting electronics, the relays for status signaling and the control Console connection interface. The distance for the connection to the control console can be up to 1 km. Upon request, an alarm beacon with siren can be installed near the module or at a distance. Additional relays are available to command security devices in interlock mode, e.g. passage-blocking devices.
- **Control console** composed of a PC, rack or tower configuration, with processing and management software GALILEO 9900 SERIES. It allows the operators to control the system.
- **Typical configurations:**



2 vertical units configuration GALILEO 9900 2UV



GALILEO 9900 4UH (4 horizontal units)



GALILEO 9900 3UH (bridge configuration)



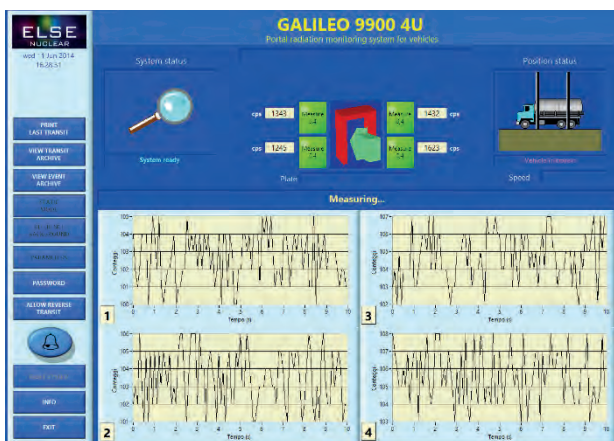
GALILEO 9900 5UH

GALILEO 9900 SOFTWARE

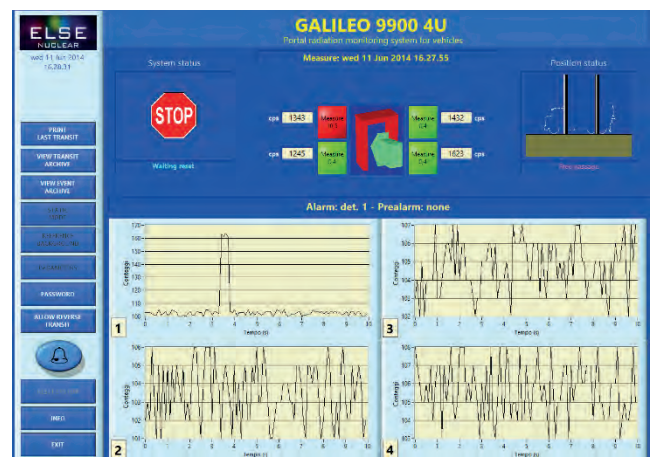
The system measures, as a function of time, the quantity of radiations coming from the vehicle passing through the portal. At the end, when the measurement area returns free, the software establishes whether the load is contaminated. If so, it gives an optical and acoustic signal. The contamination can be just suspected (pre-alarm) or firmly verified (alarm). The pre-alarm and alarm thresholds are indicated in sigma units (number of standard deviations) over the background value.

The counts temporal trend, and the spike's position which determined the alarm, allow to identify the position of the source in the vehicle.

During the passage, on the main panel is showed the temporal trend of the counts



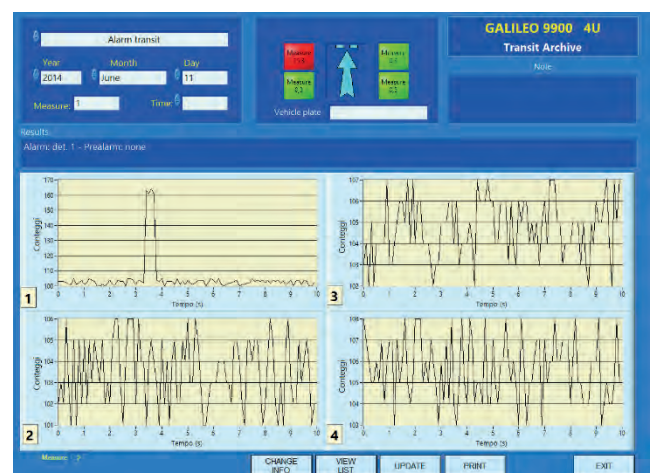
At the end of the transit, the measurement result is showed



The parameters are set from the parameter panel; it is possible to disable all the detectors but one



The archive panel allows to scroll the alarm events, sorted by data and hour



The software controls the trend of environmental background every few seconds. The readings of the detectors are considered background until the measurement area is free, and values too high or too low are considered as bad functioning. While the vehicle is passing through, the program stops the background acquisition and uses the last stored value to subtract it from the

The algorithm is able to adapt itself to differences in type of load, speed and dimensions of the vehicles passing through; furthermore it applies proper filters for spurious events, in order to prevent false alarms and to achieve the best sensitivity. Finally, the software warns the operator if the position detectors are abnormally engaged.

TECHNICAL SPECIFICATIONS

Measurement features

- False alarms rate: $<1/10'000$ (5σ alarm threshold)
- Efficiency referred to Cs-137: 150 kcps/ μ Sv/h (per detector, source at 2 m)
- Energy range: 35 keV \div 2 MeV
- Minimum detectable dose: 5nGy/h (95% confidence, 0.4 s integration)
- Maximum transit speed: User set, up to 10 km/h

Detection unit

- Detector type: Plastic PVT scintillator
- Number of units: From 2 to 5
- Volume of each unit: 25 l
- Surface of each unit: 5000 cm²
- Depth: 5 cm
- Position sensors: 2, at the start/end sides of the portal area (3 in 4UV version)

Photomultiplier base

- Type: CAEN NUCLEAR PAD
- Built-in modules: HV, pre-amplification, discrimination
- Dimensions: \varnothing 58 mm, height 86 mm

Detector lodging

- Maximum dimensions (WxHxD): 734 x 1483 x 222 mm³
- Material: Stainless steel AISI 304 S.B., with plexiglass windows
- Protection grade: IP65
- Measurement side: PMMA 5 mm
- Shielding on external sides: Pb 10 mm
- Total weight (of each unit): 171 kg
- Maximum wind speed: 150 km/h
- Dynamic equivalent pressure: 2.25 kN/m²
- Minimum terrain capacity: 0.6 MPa

Support column

- Weight and dimensions: variable among versions; example: H = 140 cm \rightarrow weight = 52 kg

Power supply and acquisition module

- Low-noise power supply: IN 220 VAC – 50 Hz / OUT 24 VDC

- Signals acquisition: from 2 to 6 counter inputs/frequency-meter 32 bit
- Statuses management: 4 relays NO/NC

Control console

- Type: Tower or rack PC
- Data communication: LAN Ethernet 100 Mbps

OPTIONS available upon request

In addition to standard supply, the following options are available upon request:

- CDRB12810 - Calibrated ¹³⁷Cs source for quality controls
- GALI-HOLD - Source holder for test and quality controls procedures
- GALI-PLATE - Plate detection and memorization kit: infrared illuminated camera for plate digital reading and archive
- GALI-CAM - Vehicle identification kit: camera and software to associate alarm events with images of the vehicle passing through
- GALI-SERV - Remote service via internet delivered by CAEN personnel
- ALU - Additional alarm unit with siren for remote signaling



PLASTIC SCINTILLATOR FOR RADIATION MONITORING ON CONVEYORS

CM 9700

MAIN FEATURES

- Continuous high-sensitivity gamma monitoring
- Detector: 7.5 liters plastic scintillator
- Dynamic environmental background subtraction
- Historic data archive and display
- Parameters: measurement setup, alarm thresholds, calibration
- Continuous good functioning check
- Acoustic-luminous signals for alarm and malfunctioning events
- Relay available for external safety devices connection (interlock, alarm signaling, etc.)
- More than one detector can be installed to be used as independent measurement channels
- Great configuration flexibility

DESCRIPTION

CM 9700 is a radiation monitoring device designed to automatically control the gamma radioactivity levels in materials being transported on conveyors systems, whatever the nature of materials and the type of conveyor may be.



Monitoring of the material carried by a conveyor

CM 9700 is composed of the following main parts:

- detector (PVT plastic scintillator)
- stainless steel housing for the detector
- built-in electronics for signal forming, amplification and discrimination (PAD)
- unit for data processing/management and communication to the PC (ratemeter of the SATURN series)
- remote control unit (PC) connected via Ethernet, with management software and alarm column

The plastic detector can have different dimensions depending on the specific needs. Typically, a 7,5 liters detector is used (100x15x5 cm), because it represents the best performance vs weight/price ratio.

As an alternative, and upon specific request, bigger or smaller detectors can be used, thanks to the high flexibility in the production of such elements.

The detector and electronics housing can be installed directly over or under the conveyor, meaning at a significantly small distance from the materials to be monitored.

This allows to obtain high sensitivity measurements without using big and heavy detectors, getting rid at the same time of any mechanical and electrical interferences that may be caused by a direct contact with the conveyor structure. The mechanical structure of the housing has an IP65 protection grade.

The processing and management electronics can be installed both inside the housing or near the PC, depending on the distances involved. An interlock relay is also available, for example to block the conveyor in case of an alarm detection.

The management software installed on the PC allows the operator to completely control the monitoring system, and to interact with it as in signaling management, parameters setting, data display and exportation.

The management software is able to manage several detectors connected to the central unit, even if different in dimensions. Therefore, if needed, several **CM 9700** can be installed and managed as a network of independent measurement channels. For example: two units can be installed at the sides of the conveyor; two or more detectors can be horizontally installed side by side; if there is more than one conveyor, a detector can be installed on each of them. Possibilities are virtually unlimited, thanks to the high flexibility features and modular structure of this technology.

Whereas static monitoring devices perform measurements in repeated conditions under the full control of the operator, an instrument such as the **CM 9700** must be able to automatically adapt to extremely variable situations. The fundamental measurement parameters are subject to unforeseeable changes, which determine the measurement results:

- the radioactive background can be affected by external environmental conditions
- the geometrical efficiency can change with the distance from detector to material
- the gamma energy may not be univocally determined

Under these critical conditions, the key feature of **CM 9700** is its high measurement sensitivity coupled with a high grade of reliability in alarm detection. The final result is a single value for each connected unit, displayed on the PC monitor, which is compared with the alarm thresholds set as parameters. If the thresholds are exceeded, the system issues the relative alarm warnings. Environmental background is subtracted by the system in two different ways: a dynamic determination can be carried out (default mode), or a fixed value can be inserted to be subtracted from each detector measurement.

TECHNICAL SPECIFICATIONS

Detection units

- Detector type: PVT plastic scintillator
- Number of units: 1 (or more, up to 40)
- Active volume for each unit: 7.5 l (adjustable upon request)
- Dimensions: 100x15x5 cm³ (adjustable upon request)

Detector housing

- Dimensions (WxHxD): 36x149x22 cm³ (adjustable upon the detector)
- Weight: 92 kg (adjustable upon the detector)
- Material: Steel
- Protection grade: IP65
- External sides shielding: Lead, 1 cm

Central acquisition unit

- Hardware: PC (rack or desktop)
- Data communication: Ethernet 10/100 Mb/s
- Interlock: Available NO/NC contact piloted by alarm
- Power supply: 220 VAC – 50 Hz low electronic noise

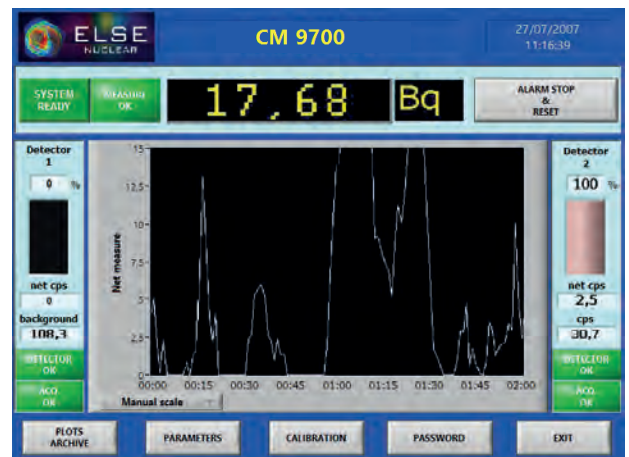
Alarm column

- Type: Column with LED lights and siren
- Dimensions: Ø x H = 40 x 195 mm
- Luminous signals: Green = good functioning; Red = alarm
- Acoustic level: 85 dB at 1 m

OPTIONS AVAILABLE UPON REQUEST

In addition to standard supply, the following options are available upon request:

- Remote service: assistance via internet by our engineers
- Custom configuration (number, dimension and positioning of the detectors)



Software main panel





CAEN SyS
Systems and Spectroscopy Solutions

Airborne Gamma Ray Spectrometry

AIRBORNE GAMMA RAY SPECTROMETRIC ULTRACOMPACT MAPPING SYSTEM

GammaFLY

MAIN FEATURES

- Rugged and compact design makes the system portable and mountable by a single operator on most common helicopters (e.g. Robinson's R44 Raven and Eurocopter Ecureuil AS 350 B3)
- GammaFLY can operate with no human assistance
- Detector assembly is composed of 4 modular units for a total of 16.8 Liters of NaI(Tl) crystals
- Data acquisition and power supply are integrated in a single board controlled by the on-board computer
- Battery makes the system autonomous from external power
- 16 channel digital Multi-Channel Analyzer (CAEN SD7740) able to integrate the input charge of each NaI(Tl) detector and build the energy histogram
- Able to work in stand-alone modality with a built-in computer unit
- Flexible and selectable data recording to deliver both list-mode data for radiometric mapping and full-energy gamma spectra for real-time monitoring

DESCRIPTION

The airborne gamma ray spectrometer system GammaFLY consists of 16 sodium iodide NaI(Tl) crystals with a total volume of 1024 cubic inches (16.78 liters).

The NaI(Tl) crystals are coupled to the fully integrated 16 channels multi-channel analyzer CAEN SD7740 with special digital pulse processing firmware.

CAEN SD7740 also provides 16 channels of 4 kV High Voltage to bias the NaI(Tl) Detectors.

Data logging is available in both data list with time stamp and energy of the single event, and energy spectrum up to 4096 channels with user selectable full range from 20 keV to 10 MeV.



The method of Full Spectrum Analysis with Non-Negative Least Square is used to precisely analyze the contribution of different natural and man-made isotopes, as ^{40}K , ^{137}Cs , and daughter products of ^{238}U and ^{232}Th .



TECHNICAL SPECIFICATIONS

Physical parameters :

- Weight: 130 kg (total)
- 72 x 61 x 60 cm³ (L x W x H)

Gamma-ray spectrometer :

- Detectors: 16 NaI(Tl) - cubic shaped (1lt. each)
- Energy range: 20 keV to 10 MeV
- Energy resolution: < 7% for ¹³⁷Cs
- Spectrum channels: 256/512/1024/2048/4096 user selectable
- Number of DAQ channels: 16
- Sampling rate: 62.5 MS/sec per ch.
- Digital Pulse Processing: on-line Charge Integration
- On-line gain stabilization
- Dead time: negligible
- HV: 16 Channels, 4 kV , 3 mA
- I/O: USB 2.0

Inputs :

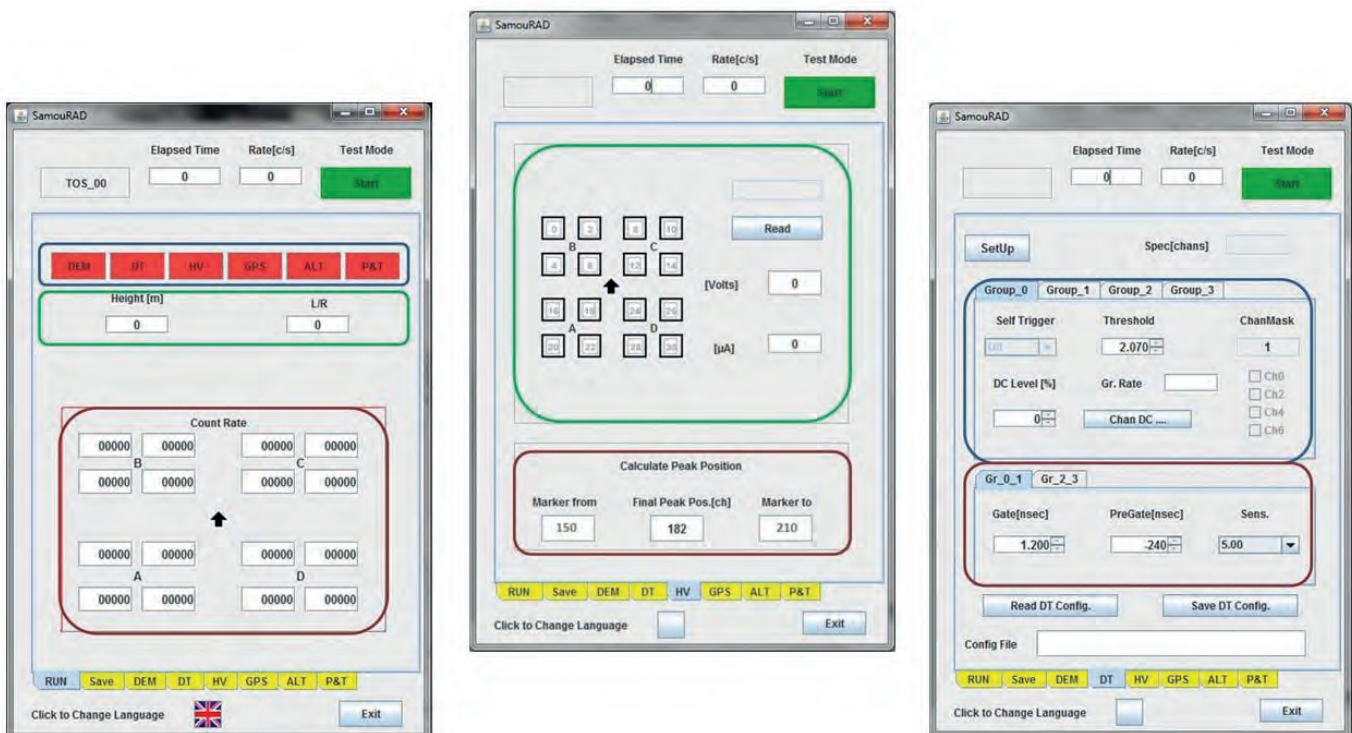
- Detector configuration
- Navigation plan
- Calibration data

Outputs :

- List mode events (Energy and Time)
- Individual spectra
- Navigation parameters
- Operation state-of-health
- Flight position
- Flight altitude
- Density of the air

Power supply and consumption :

- Battery power: 13.2V DC / 60Ah
- Total power consumption: less than 100W
- Battery life: 8 hrs+



Industry Services, Expertise and Collaboration

Industry Services and Expertise

SAFETY EVALUATIONS

- Safety evaluations of nuclear facilities, laboratories, premises
- Case study development for safety evaluations
- Development of Scenarios for Safety Improvements
- Study of innovative nuclear instruments and solutions for safety enhancement

CUSTOMIZED SOLUTIONS

- Concept & Design of customized Nuclear Measurement Systems :
 - Safety evaluation and Safety Plan
 - Concept Study and Development
 - Modeling (MCNP, GEANT4 etc..) and geometric study
 - Detector and Electronic Design
 - Mechanical Design & assembly (Robotics)
 - Safety Qualification
 - Deployment & Training

RADIOLOGICAL STUDIES & EMERGENCIES

- Safety Analysis and Safety Assessments
- Radon Measurement and Mitigation Services
- Radiological Release & Dose Evaluation
- Data Management & Statistical Analysis
- Nuclear Emergency Planning
- Post Accident Intervention
- Site Remediation Approach & Method

Collaboration



NINE Nuclear and Industrial Engineering is managed and operated by nuclear and aerospace engineers sharing extensive background and experience in all key areas of Nuclear Reactor Safety technology that can be used to support both NPP Operators and Safety Authorities.

NINE experiences take benefit from the past developed projects related with both the preparation and review of Safety Analysis

Reports and associated supporting documents following USNRC and

IAEA standards and involving all the steps of safety analysis from cross sections generations to core physics, fuel performance, thermalhydraulics, containment, fission products transportation and to the dose evaluation.

NINE can provide services also to Embarking Countries to set up nuclear infrastructures following International Standards.

- Safety Assessment by Deterministic & Probabilistic Analysis (PSA levels 1, 2 and 3)
- Licensing & Regulatory Support
- Operational Support
- Spent Fuel & Radioactive Waste Management
- Radiation Protection and Shielding Design
- V & V of Computational Tools
- Qualification of Evaluation Models
- Design and Conduction of Thermal Fluid Dynamics Experiments
- Training and Knowledge Transfer

Selected services

RADIOACTIVE WASTE MANAGEMENT

NINE can provide or support the design of Rad-Waste Management facilities following the identification of best strategies and the design of customized processes for treatment, conditioning and final disposal of contaminated materials, taking all related safety aspects into account.

SAFETY ASSESSMENT AND LICENSING

NINE can perform full-range probabilistic and deterministic safety assessment of nuclear installations, support related licensing processes, and provide independent review of safety analyses. Best Estimate approach, advanced computational tools and rigorous qualification procedures are systematically applied. Reference is made to widely accepted regulations and standards.

OPERATIONAL SUPPORT

NINE can provide operational support regarding in-core fuel management and fuel cycle optimization. Full core analyses are inherently three-dimensional and take fuel depletion into account. Both stationary and time-dependent neutron-physical phenomena can be predicted by means of combined deterministic and statistical methods.

- Design of Treatment and Conditioning Processes
- Design of Containers and of Radiation Shielding
- Evaluation of Dose to Personnel and Population
- Multi-physics and Multi-scale Coupling
- Uncertainty Quantification
- Containment and Severe Accident
- Full 3-D core simulation
- Fuel cycle optimization
- Thermal-Hydraulics, Reactor Physics and Fuel Performance codes





Tools for Discovery

Costruzioni Apparecchiature Elettroniche Nucleari (C.A.E.N.) is one of the most important spin-offs of the Italian Institute of Nuclear Physics (INFN).

Founded in 1979 by a group of senior engineers from the INFN, is today world wide recognized as one of the leading companies in the electronics instrumentation field.

CAEN Network Companies is a micro-cluster of companies with excellence know how.

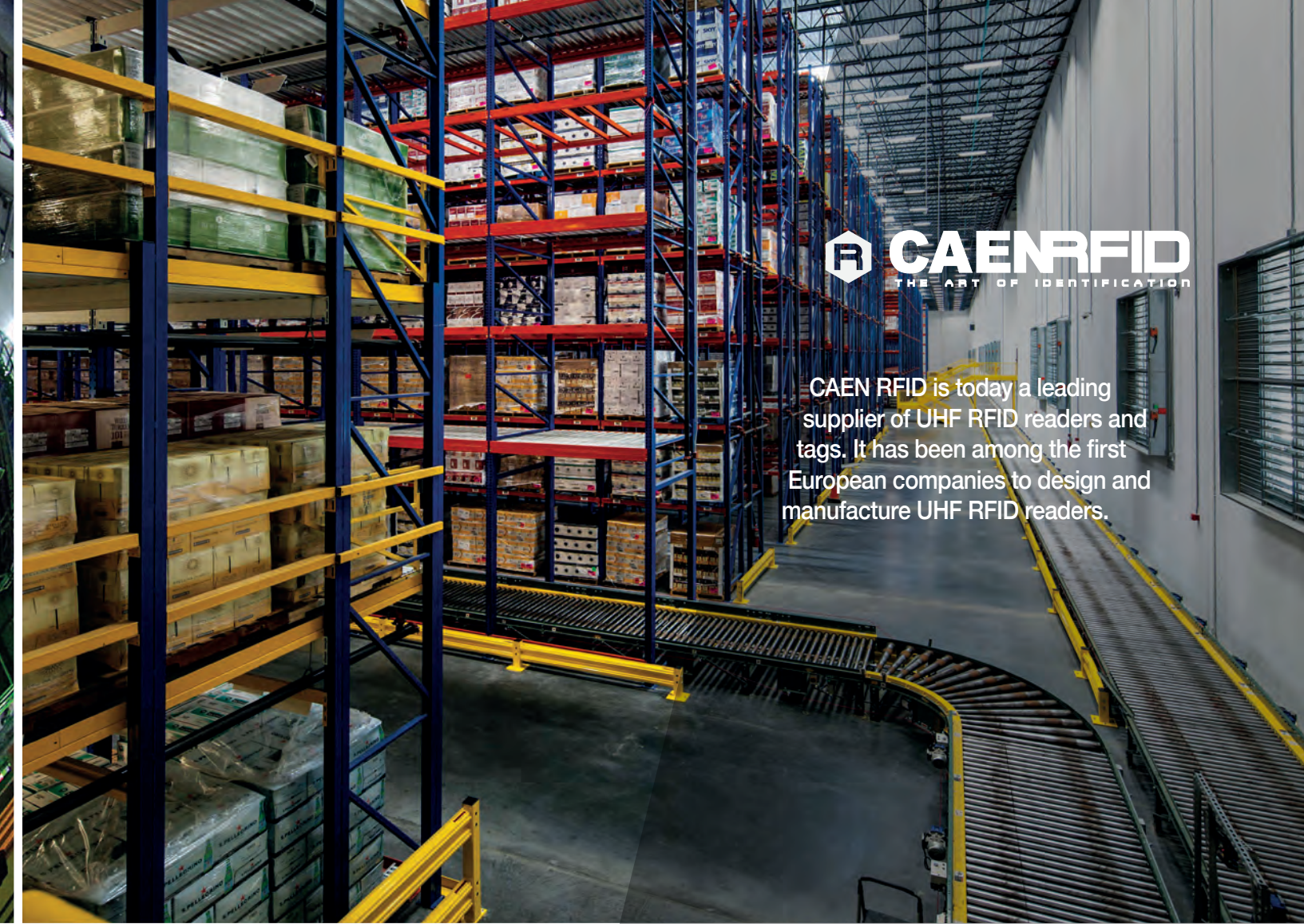
CAEN

GROUP COMPANY

CAENSyS is part of CAEN Group Company, which is a micro-cluster of companies with excellence know how.

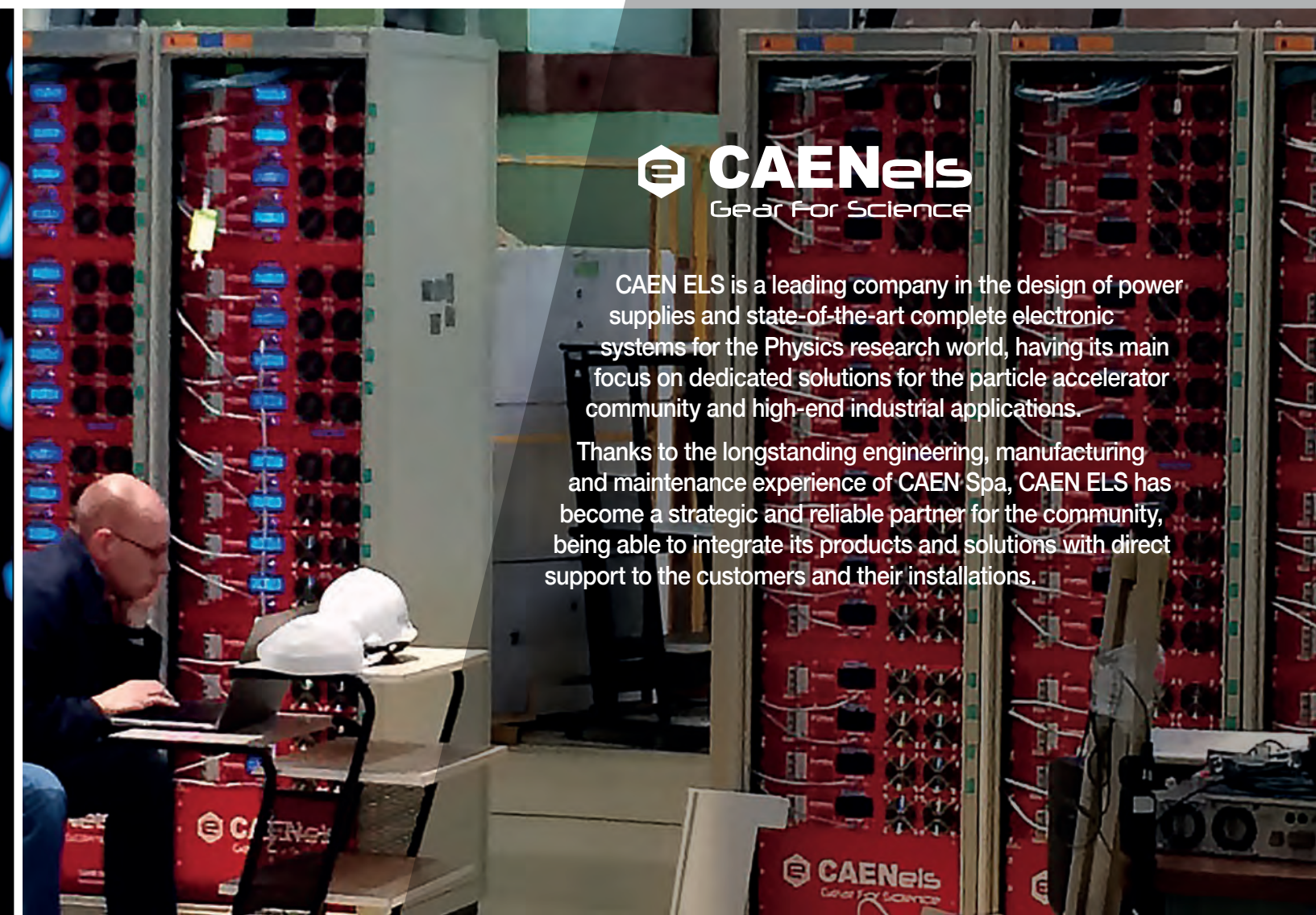


CAEN qS designs, organizes and implements "state of the art" solutions for Information Security and assists organizations in managing and controlling the critical infrastructures for protection at the highest possible standard.



 **CAENRFID**
THE ART OF IDENTIFICATION

CAEN RFID is today a leading supplier of UHF RFID readers and tags. It has been among the first European companies to design and manufacture UHF RFID readers.



 **CAENels**
Gear For Science

CAEN ELS is a leading company in the design of power supplies and state-of-the-art complete electronic systems for the Physics research world, having its main focus on dedicated solutions for the particle accelerator community and high-end industrial applications.

Thanks to the longstanding engineering, manufacturing and maintenance experience of CAEN Spa, CAEN ELS has become a strategic and reliable partner for the community, being able to integrate its products and solutions with direct support to the customers and their installations.

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CAEN SyS s.r.l.

Via Vetraia 11

55049 - Viareggio

Italy

Phone +39.0584.388.398

Fax +39.0584.388.959

info@caensys.com

www.caensys.com