Development and Experimental Performance Evaluation of a Dose-Rate meter for Pulsed Beam.

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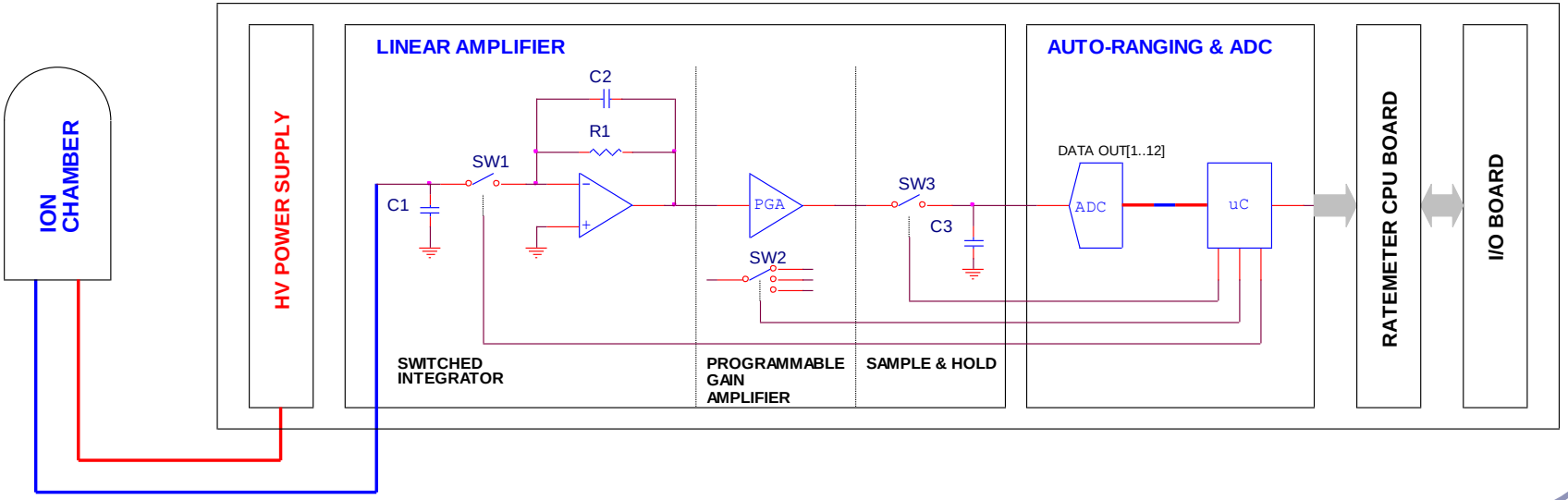
Environmental Gamma Radiation Monitoring System

Silena Gamma Radiation Monitor:

- ***High pressure Ion Chamber Detector mod. Centronic IGC5/A6.4 N9.6***
- ***High voltage power supply***
- ***6 decades linear amplifier***
- ***Auto-ranging & A/D Converter***
- ***Digital Rate-meter & Relay I/O Boards***



Performance of the Silena Gamma Radiation Monitor

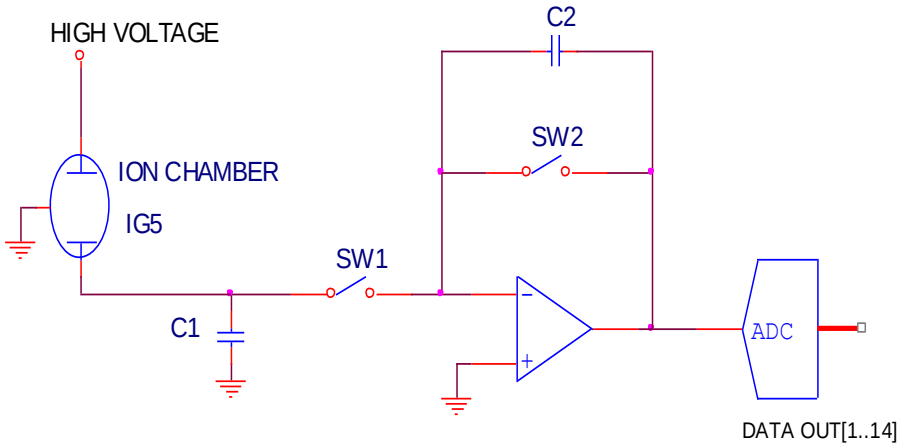
- **…. stable radiation levels or continuous pulsed radiation field**
  - ***Good accuracy and linearity***
  - ***Excellent long term stability at natural background radiation levels***

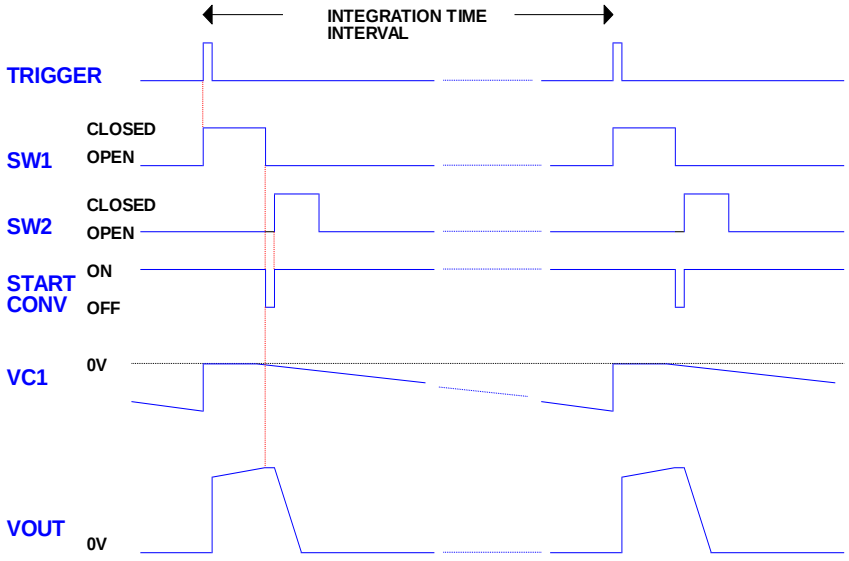
- **…. fast and wide fluctuations of the radiation levels or short time, intermittent high intensity pulsed radiation field**
  - ***Good accuracy and linearity within the first 3 decades (max dose value of 250nGy for 1s fixed integration time)***
  - ***First stage saturation and wrong selection of gain amplifier***
    - ***over the 3rd decade***
    - ***when full scale change is required, because of different dose values***

An experimental acquisition system was design ….

Experimental front-end electronics

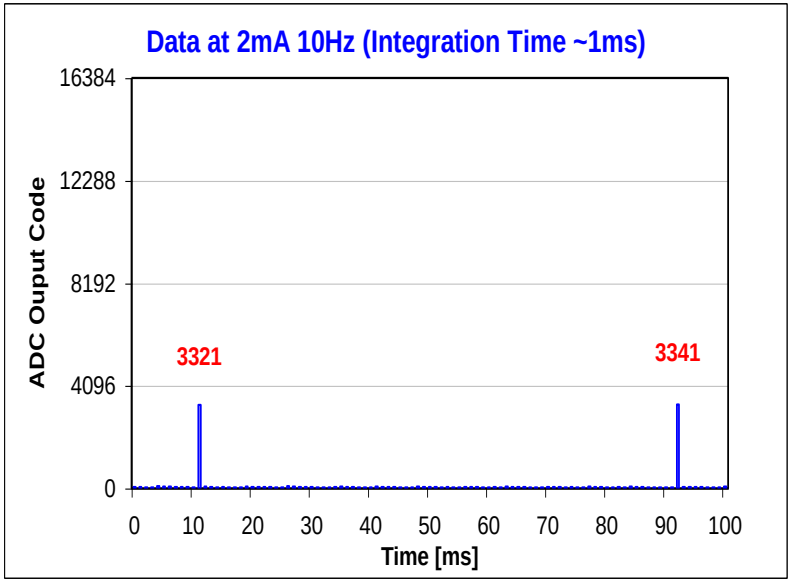
- **Main features**
  - ***Output voltage signal of the amplifier proportional to the charge accumulated within the integration time.***
  - ***Remote control of the integration time.***
    Options available: 100μsec, 1ms, 10ms, 100ms, 1s.
  - ***No loss of the charges generated by the detector and continuous integration of the input signal.***

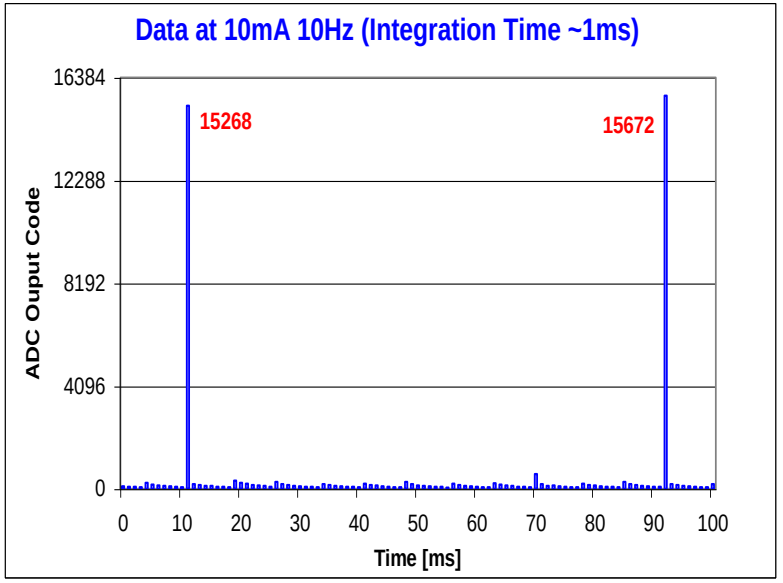




Preliminary test in high energy pulsed radiation field

- **Objectives**
  - ***Study the response of the front-end experimental acquisition system***
  - ***Define the requirements for the new front-end electronics***





Linac beam operating at 900 MeV with 70 nsec pulse duration

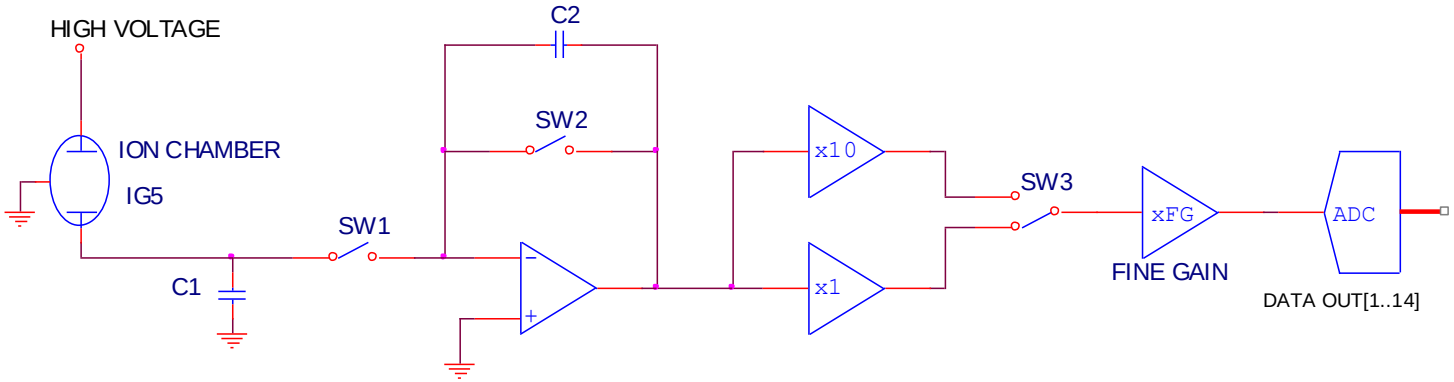
Different electronic set-up of the experimental acquisition system was evaluated ...

New front-end electronics development

- **Main Requirements**
  - ***Good accuracy and long term stability with very low input current (10^{-14}A) at natural background radiation level***
  - ***Capability to process high number of charges within a very short time interval (up to100nC in 1ms)***
  - ***Fast time response (<2ms)***
  - ***Good linearity within 7 decades dynamic range up to 10^{-7}A (high radiation dose rate)***
  - ***Hardware & Software compatible with existing Silena Gamma Monitor (modular electronic board level)***

Measurement Technique

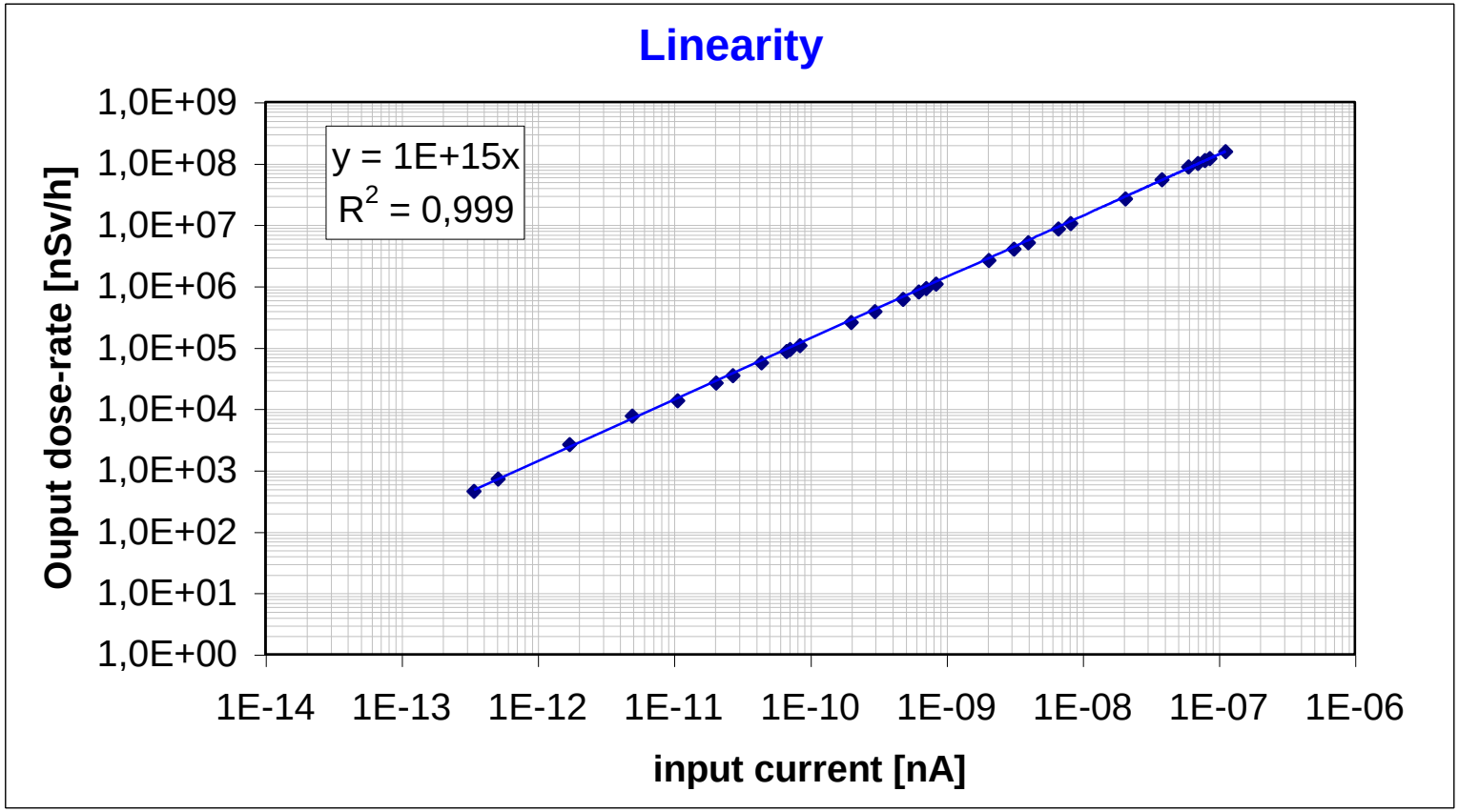
- **Operation mode**
  - ***Charge transferred to capacitor C2 every 1ms by SW1 (integration time)***
  - ***Charge in C2 reset every 1ms or hold by SW2, depending on output voltage level***
  - ***X1 and X10 output signal cyclically sampled by the ADC***
  - ***Dose rate, as the sum of 1000 individual integrated values, calculated every 1 s by the u-controller, taking into account the conversion factor***



- **Important features:**
  - ***Switch charge injections neutralization***
  - ***Offset error correction***
  - ***Thermal drift compensation***

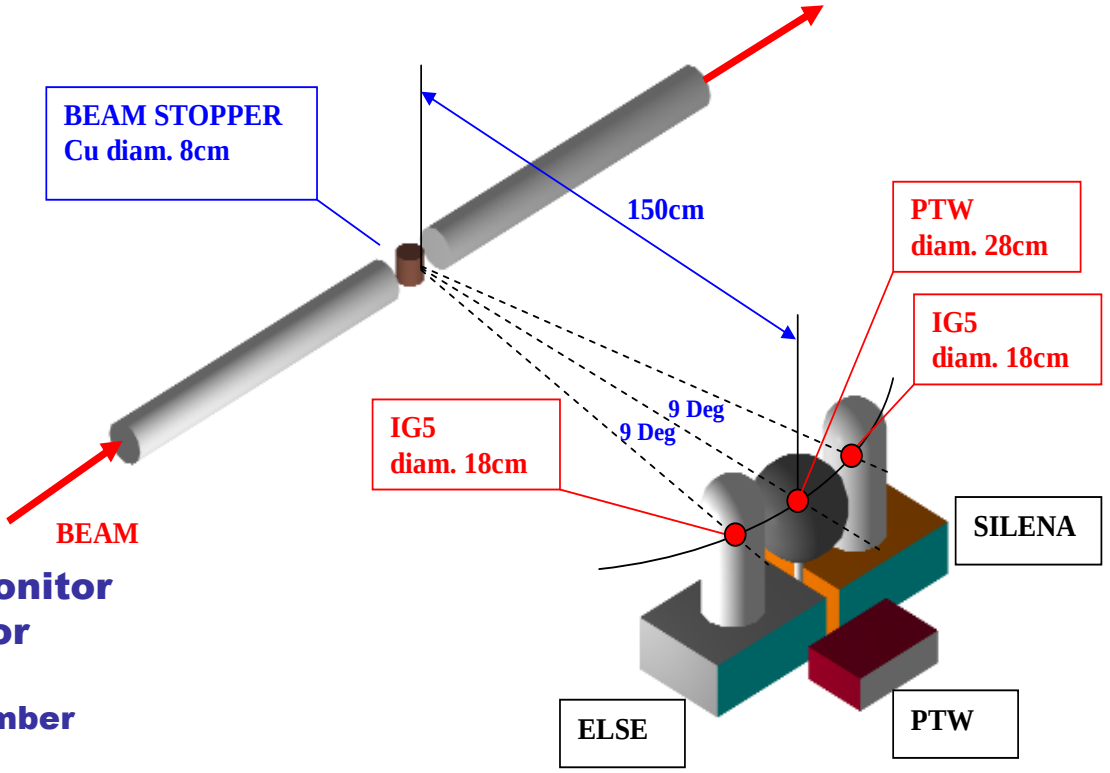
Linearity

Measurements with current generator



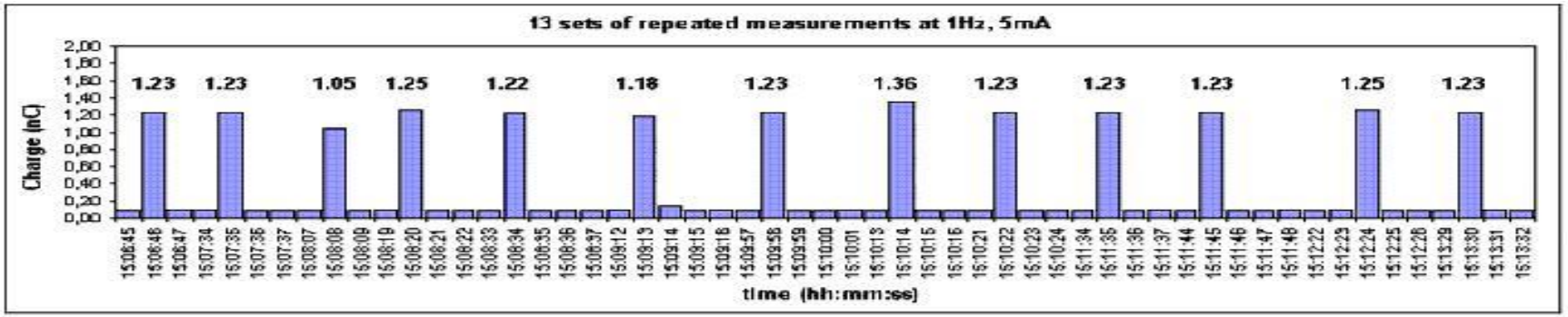
Test Conditions & Layout

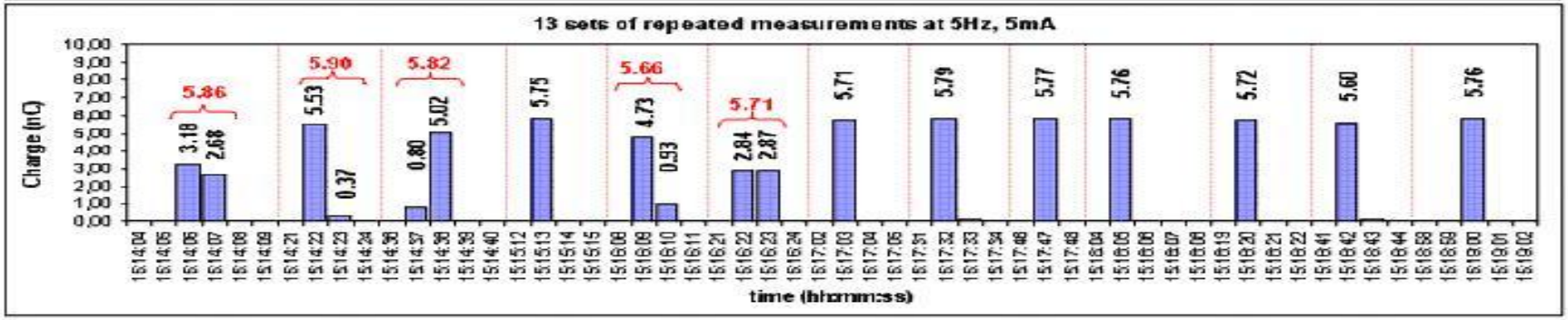
- **Experimental conditions**
  - ***Linac beam operating at 900 MeV with 70 nsec pulse duration***
  - ***Repetition rate 10Hz***
  - ***Number of pulses 1, 5 and 10 with linac currents of 1mA, 2mA, 5mA, 10mA, 15mA***

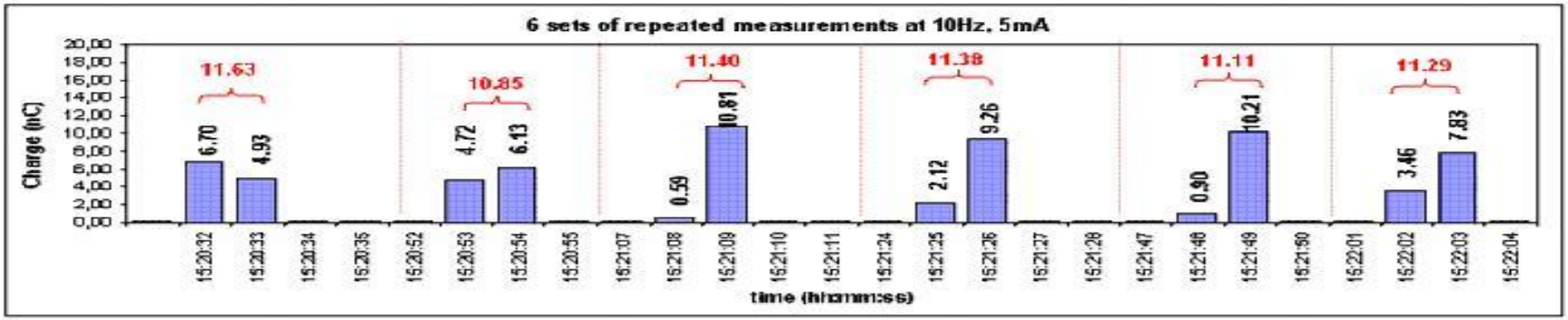


1) ELSE New Gamma Monitor
2) Silena Gamma Monitor
3) Reference system:
- **32003-PTW Ion Chamber**
- **Keithley mod. 6517**

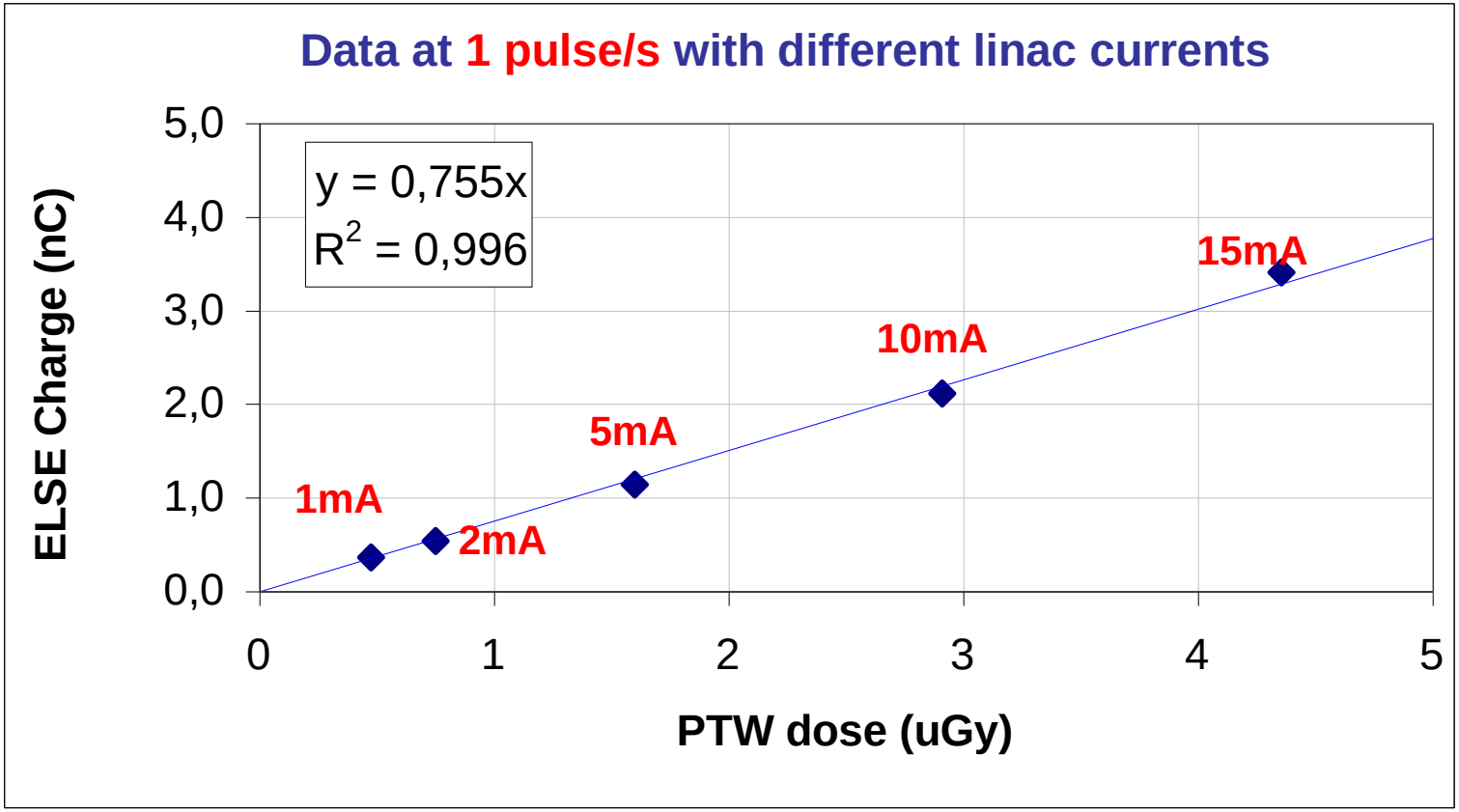
Pulsed Beam Response



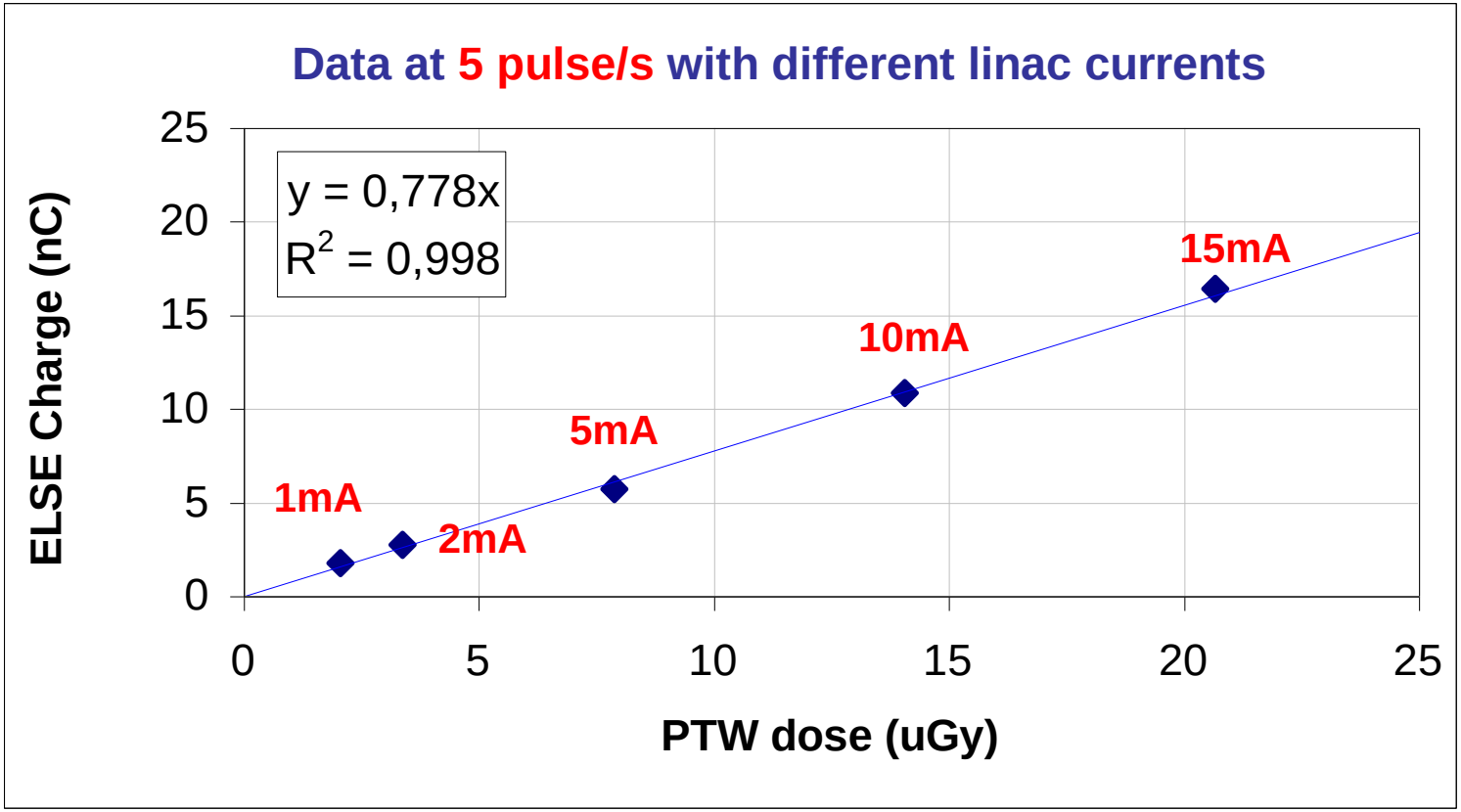




Comparison with reference system



Comparison with reference system



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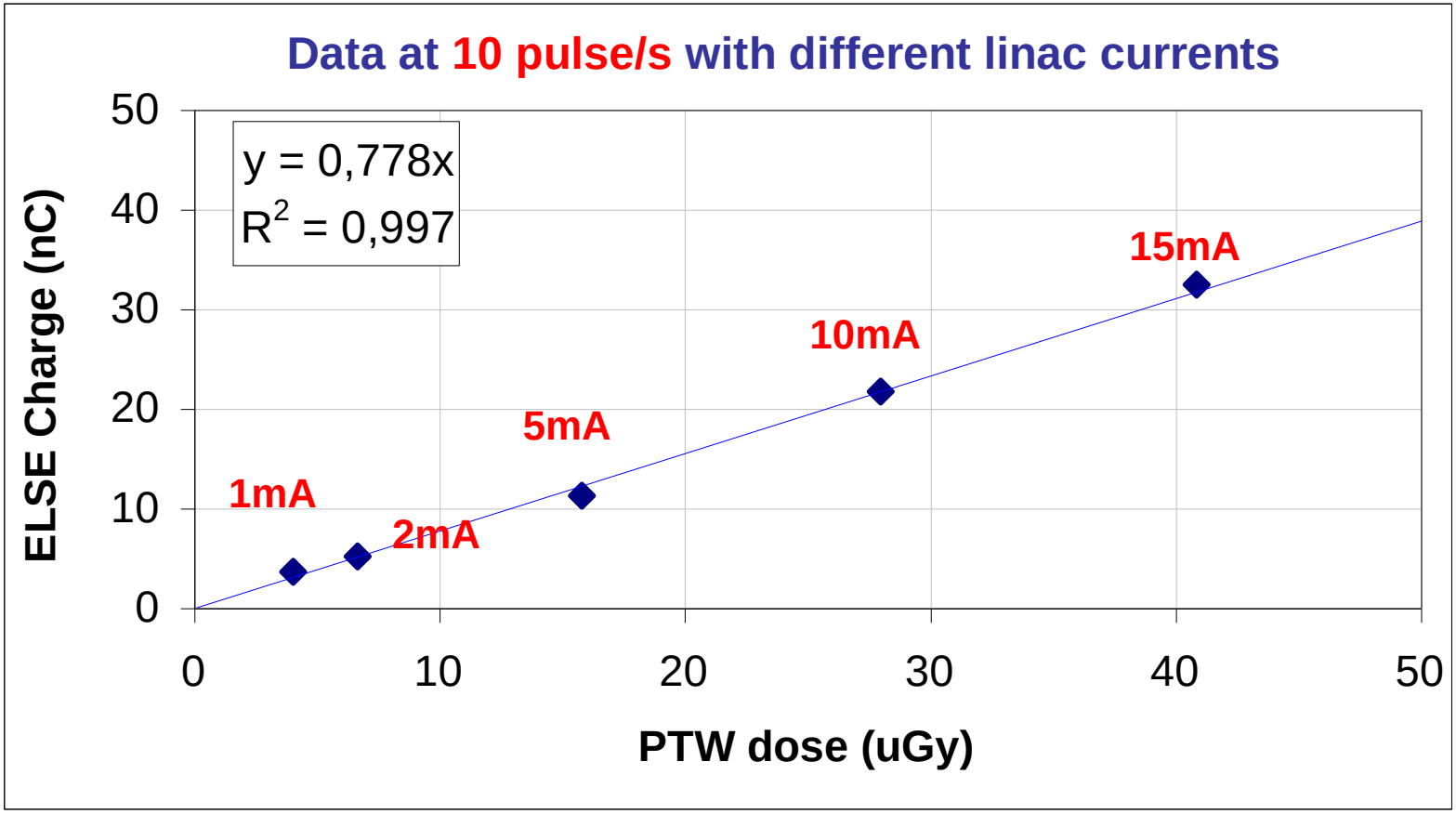
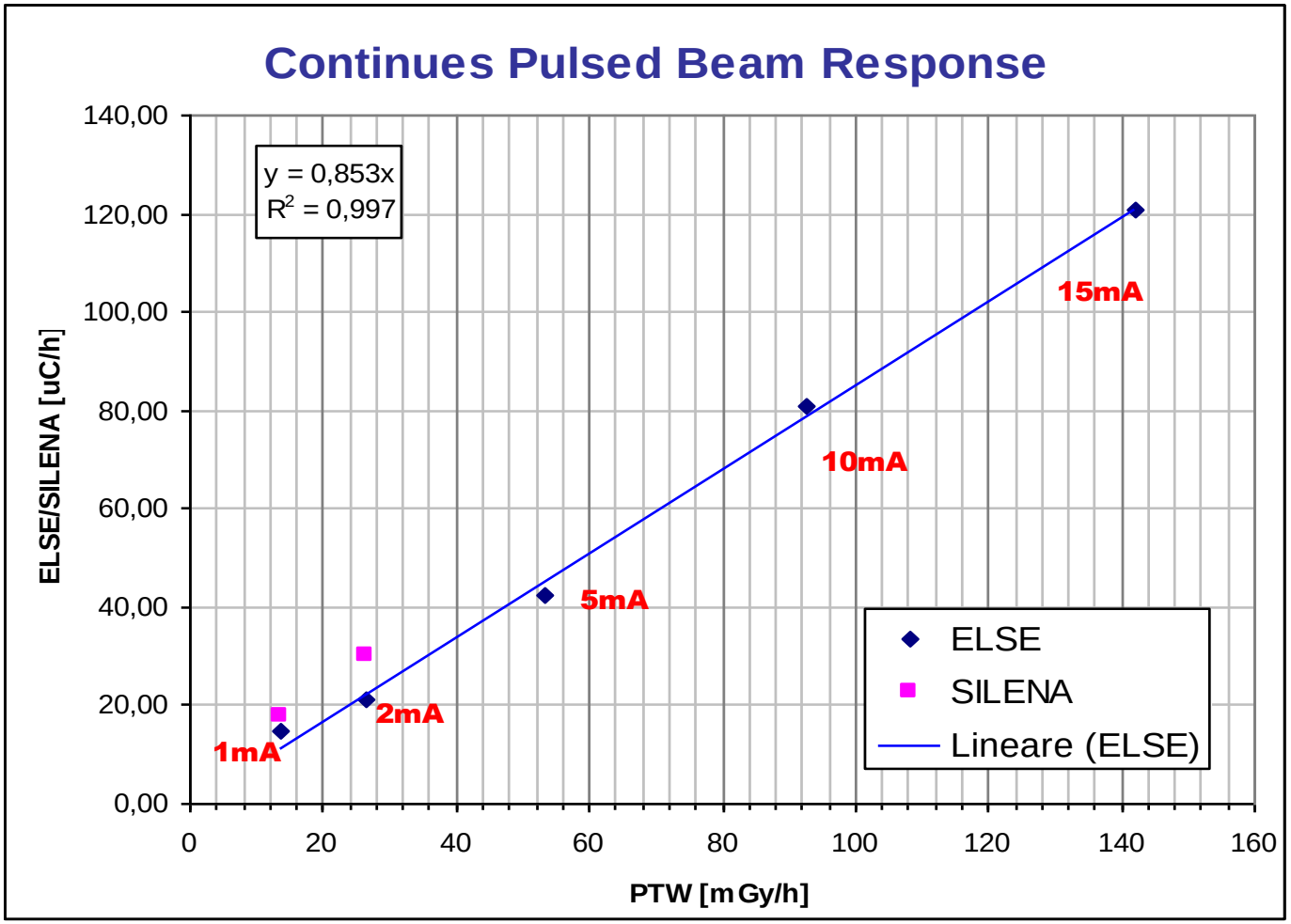
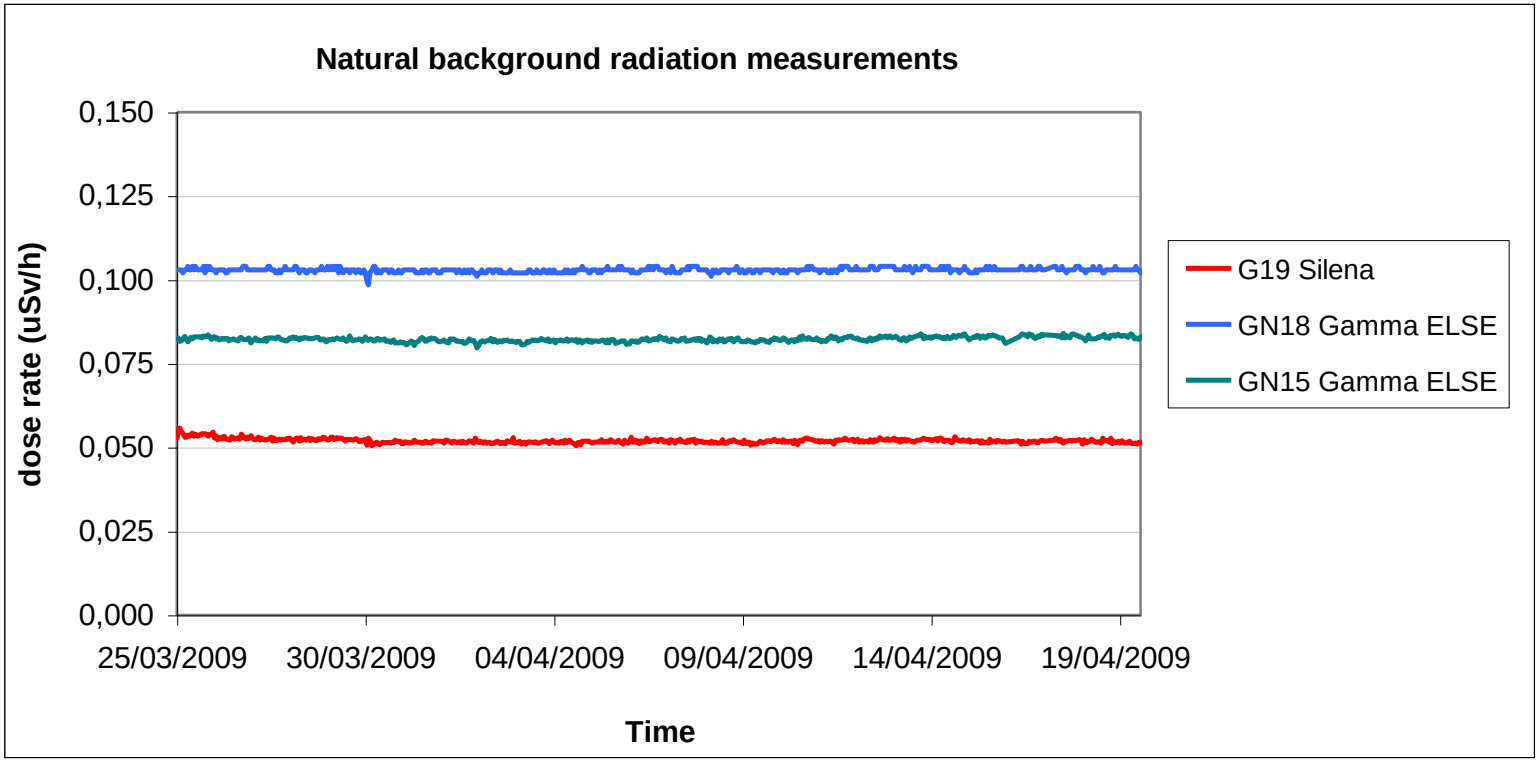


Continues Pulsed Beam Response



Long Term Stability

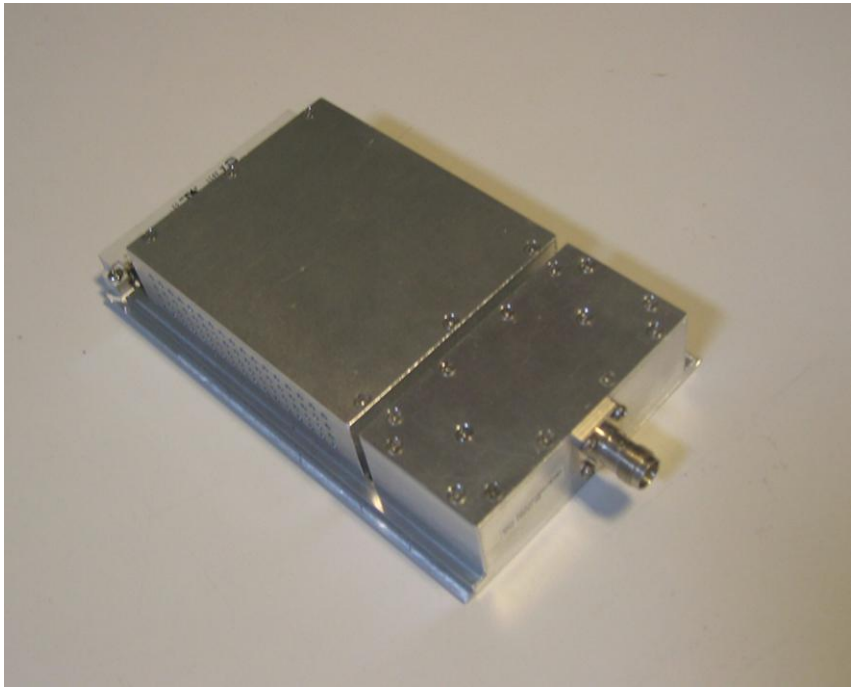


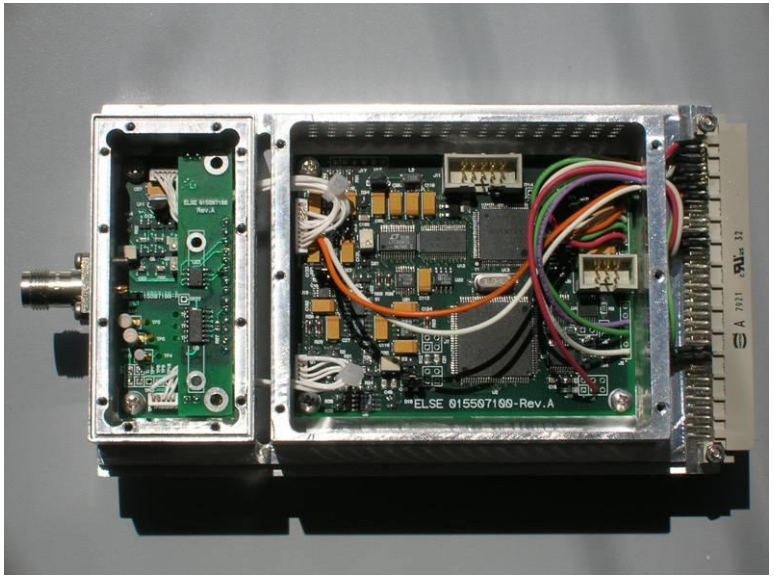
	G19 Silena	GN18 Gamma ELSE	GN15 Gamma ELSE
Minimum	50,4 nSv/h	98,4 nSv/h	79,7 nSv/h
Maximum	55,7 nSv/h	104,0 nSv/h	84,0 nSv/h
Average	51,9 nSv/h	102,9 nSv/h	82,3 nSv/h
Stand.Dev.%	1,26%	0,65%	0,82%

Conclusions

- ***Good accuracy and long term stability with very low input current (10^{-14}A) at natural background radiation level***
- ***Good linearity within 7 decades dynamic range up to 10^{-7}A (high radiation dose rate)***
- ***Capability to process high number of charges within a very short time interval (up to 100nC in 1ms)***
- ***Fast time response (<2ms)***
- ***Capability to detect single shot radiation (e.g. storage ring beam dump) tested up to 3.5 nC/pulse (corresponding to ~4.3 uGy/pulse)***
- ***Simple calibration of the electrometer through digital offset and gain.***

ELSE Electrometer





Radiation monitors inside Elettra Service Area

WE WORK WITH ENERGY IN RADIATION TECHNOLOGY

- **Founded in 1990 …… design and manufacture analog and digital instrumentations for nuclear radiation application fields**
  - ***Industrial and research nuclear applications***
  - ***Radiation Protection Instrumentation***
  - ***Environmental Nuclear Radiation Monitoring Systems for PET-Cyclotron facilities & Nuclear Medicine***
- **Services**
  - ***Hardware & Software development***
  - ***State-of Art Custom design solutions***
  - ***System application***

El.Se. Srl pays careful attention to the "customer satisfaction" and works in synergy with their customers, committed to excellence.

Product & Market

- **Product lines**
  - ***Environmental Gamma & Neutron Radiation Monitoring Systems***
  - ***Alpha/Beta particulate Monitoring Systems***
  - ***Air Monitoring Systems***
  - ***Counting Systems & Contamination Monitors***
  - ***Pedestrian & Portal Systems for SNM***
  - ***Special System for decommissioning***
- **Main Customers**
  - ***Hospitals, Environmental Agencies, Universities and Research Institutes***
  - ***Particle Accelerators***
  - ***Radiology/Radiotherapy Centers & Nuclear Medicine Laboratories***
  - ***Nuclear Power Plant & Industrial Companies***

Gamma & Neutron Monitoring Systems

SATURN I Gamma/Neutron Monitors with fixed or removable probes

Nausicaa Gamma Monitor

Mercury Dual GM Probe Gamma Area Monitor

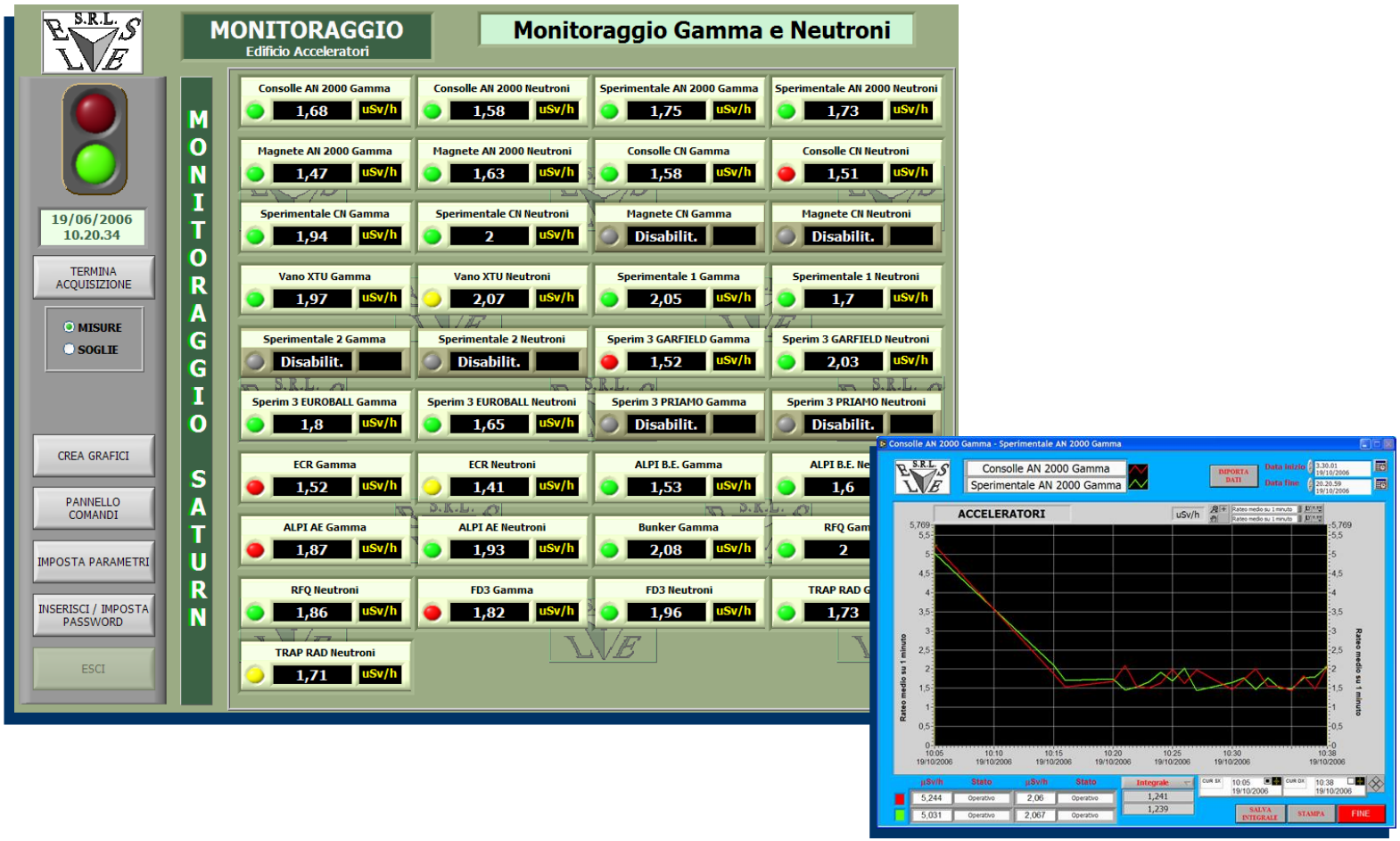
Alpha/Beta and Air Monitoring Systems

Alpha/Beta Particulate Monitors

Low Background Alpha/Beta Counting System

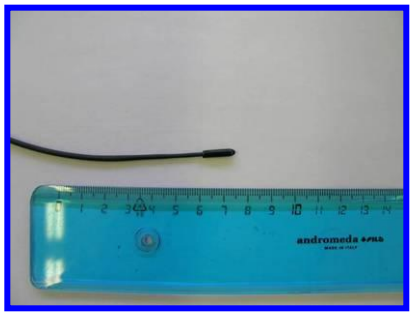
Air/Gas monitoring system

Monitoring Management Software



Research & Development

NSG Project - New Scintillanting Glass
(UNIMIB-El.Se.-IEO-Starlite-Fraen-ODL)



Special System for Decommissioning

Acknowledgements

ELETTRA, Trieste