INTENSE *Meeting - 4/April/2022*

DAQ software for radioactive waste monitoring

Matías ***Simonetto***

Radioactive waste

- Radioactive waste o ***radwaste***: wastes, solid or liquid, containing radioactive material.
- Usually produced in **nuclear fission reactors**, but they can also be produced by different **industrial processes** and **medical applications**.
- In particular, the **Dismantling & Decommissioning** of nuclear plants is becoming an important source of nuclear waste.
- Radioactive **danger decreases with time**. Unfortunately, the time scale can vary from a few hours to years for medical and industrial waste, and up to tens of thousands of years for nuclear fission reactor waste and nuclear weapon decommissioning.
- **Composition can be very different** from case to case.
- In general is classified according to the level of radioactivity. This project is focused mainly on **very low** and **low level** wastes.

Monitoring

- The main approach currently used to manage radioactive waste of low and intermediate level are the **segregation** and **storage**, with disposal at surface or close to the surface.
- The practice so far has been to store the radwaste drums following their initial characterization, the only monitoring consisting in an overall **set of few ambient detectors** and **periodic manual checks** done by operators.
- Instead, this project proposes a **granular real-time online monitoring system**, consisting of a series of numerous radiation sensors to be **placed around the waste drums**. This keeps a better track of the history of the radwastes, and also improves the ability to detect localized leaks.
- The radiations considered relevant are:
  - Neutron radiation
  - Gamma Radiation
  - (Alpha and Beta radiation are also important, but they are stopped by the container.)

Detectors

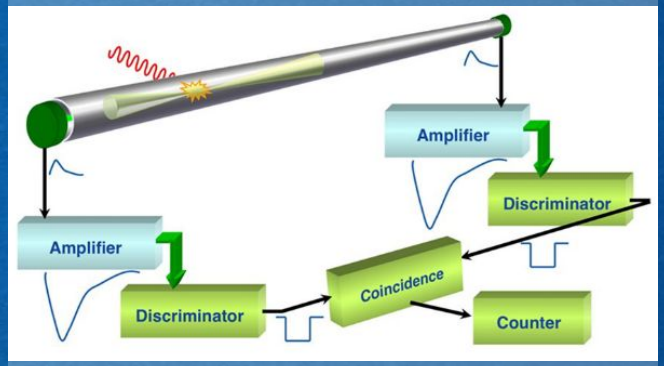
- For the proposed monitoring system, the **detectors must be: reasonably cheap, robust and reliable**.
- Under this project, in the **Laboratori Nazionali del Sud of the INFN Catania** have been specially developed and optimized two types of sensors:
  - **SciFi**, for **gamma-ray** detection.
  - **SiLiF**, for **neutron** detection.

Cosentino, L., Ducasse, Q., Giuffrida, M., Meo, S. Lo, Longhitano, F., Marchetta, C., Massara, A., Pappalardo, A., Passaro, G., Russo, S., & Finocchiaro, P. (2021). Silif neutron counters to monitor nuclear materials in the micado project. Sensors, 21(8). https://doi.org/10.3390/s21082630

M. Giuffrida. (2020). I rivelatori del progetto MICADO per il monitoraggio dei rifiuti radioattivi. [Unpublished degree thesis]. Università degli Studi di Catania.

Gamma detectors: SciFi

- Plastic **scintillating fibre** + **two SiPM's** (silicon photomultipliers).
- Several sources of spurious events: both SiPM's operate in **coincidence**.

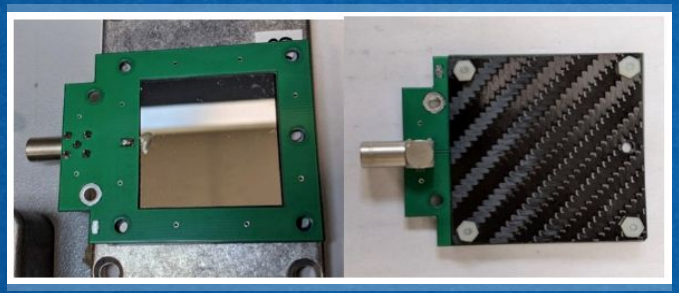


Cosentino, L., Ducasse, Q., Giuffrida, M., Meo, S. Lo, Longhitano, F., Marchetta, C., Massara, A., Pappalardo, A., Passaro, G., Russo, S., & Finocchiaro, P. (2021). Silif neutron counters to monitor nuclear materials in the micado project. Sensors, 21(8). https://doi.org/10.3390/s21082630

M. Giuffrida. (2020). I rivelatori del progetto MICADO per il monitoraggio dei rifiuti radioattivi. [Unpublished degree thesis]. Università degli Studi di Catania.

Neutron detectors: SiLiF

- Film di ^{6}LiF (neutron reactive) + silicon detector.
- Detector sensitive to gamma-rays: energy based gamma/neutron discrimination.

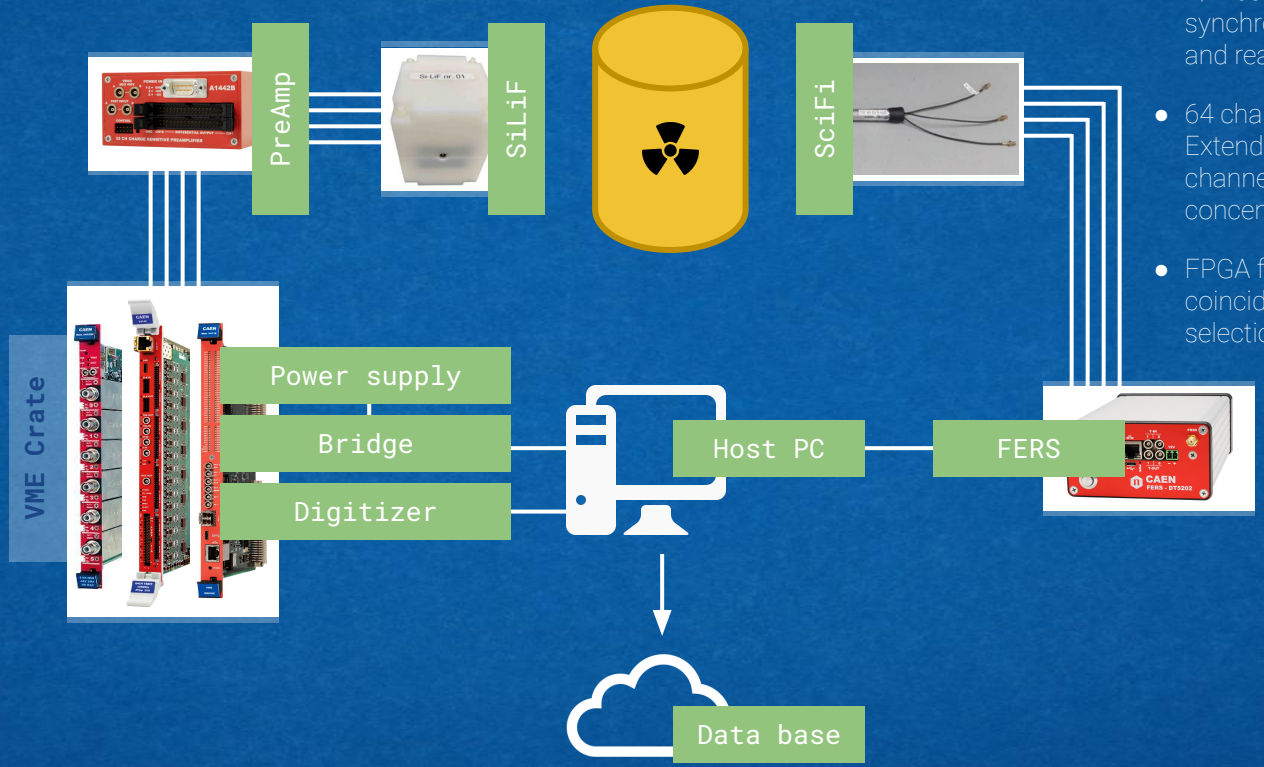


Cosentino, L., Ducasse, Q., Giuffrida, M., Meo, S. Lo, Longhitano, F., Marchetta, C., Massara, A., Pappalardo, A., Passaro, G., Russo, S., & Finocchiaro, P. (2021). Silif neutron counters to monitor nuclear materials in the micado project. Sensors, 21(8). https://doi.org/10.3390/s21082630

M. Giuffrida. (2020). I rivelatori del progetto MICADO per il monitoraggio dei rifiuti radioattivi. [Unpublished degree thesis]. Università degli Studi di Catania.

System scheme

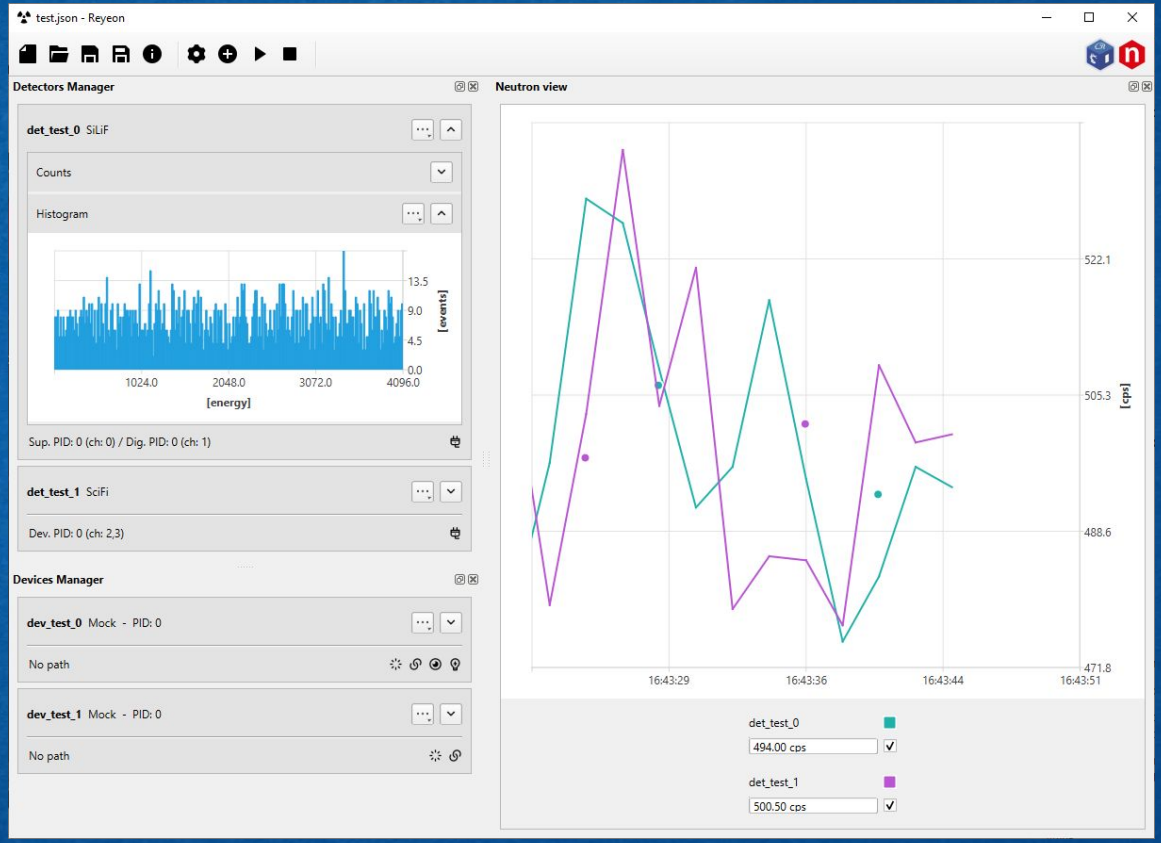
- 32 channels (32 detectors) by PreAmp. Easily extendable.
- Digitizer FPGA firmware with PHA (Pulse Height Analysis) for energy-based event selection.



- Front-End Readout System.
- Includes Front End electronics, A/D converters, trigger logic, synchronization, local memory and readout interface.
- 64 channels (32 detectors). Extendable system: up to 8192 channels with a single concentrator board.
- FPGA firmware with coincidence-based event selection.

Monitoring software

- Modular design: detectors and devices of different type can be easily added/removed.
- Device management:
  - Devices can be setted up from within the monitoring software. No need of additional programs.
  - Configurations are saved. Device setup is done only once time and not every time the program is launched.
- Detector management:
  - Simple and clear identification of the detectors and their relations with the devices and the radwastes.
  - Straightforward visualization and saving of count-rates.
- Alarms:
  - Device malfunction.
  - Radiation levels.
- Communication with cloud database.



END

Thanks!