

On-target neutron flux monitoring with Self Powered Detectors at n_TOF

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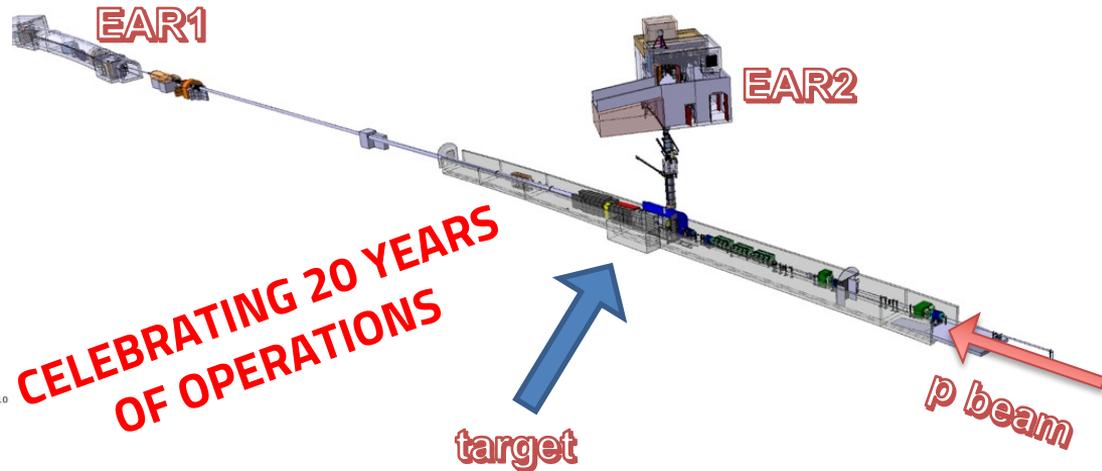
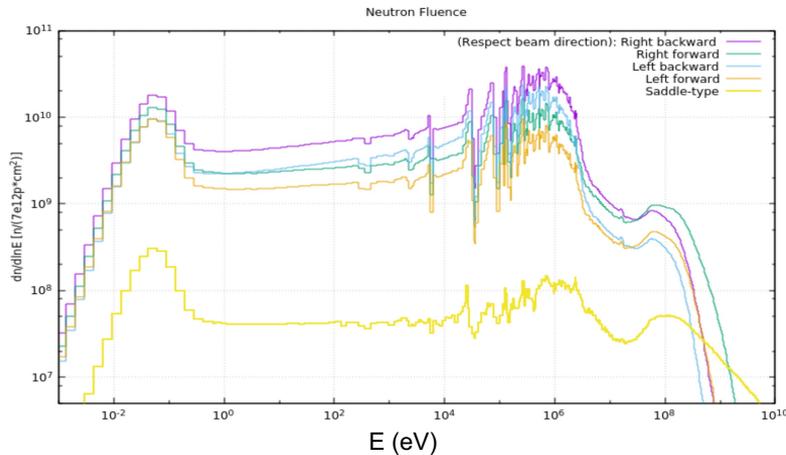
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The CERN n_TOF experiment for nuclear (astro)physics

The **nTOF experiment at CERN** exploits the 20 GeV PS proton beam interaction with a **lead target**, to produce neutrons by **spallation**.

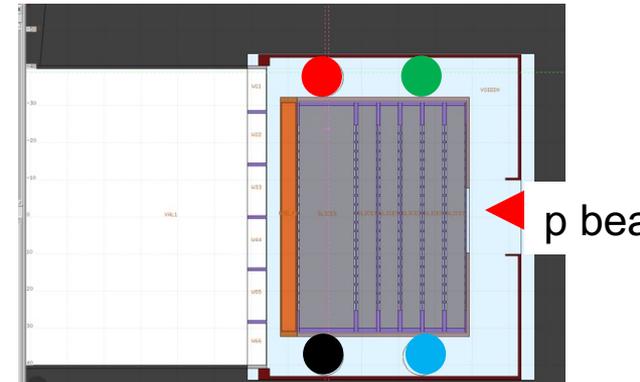
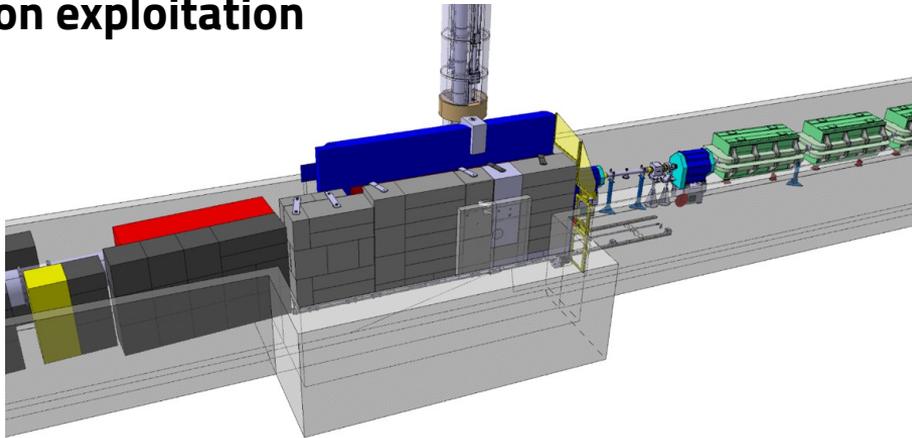
Neutron spectrum close to the target has a wide **energy spectrum up to hundred MeV** and a long tail down to thermal neutrons



nTOF new spallation Target#3

Beam started on July 19th. Up to 10^{13} protons per pulse on target, energy range up to GeV, mainly eV-100 MeV
integral flux 10^{11} n/cm²s

Online flux measurement necessary for target performance monitoring and on-target irradiation station exploitation

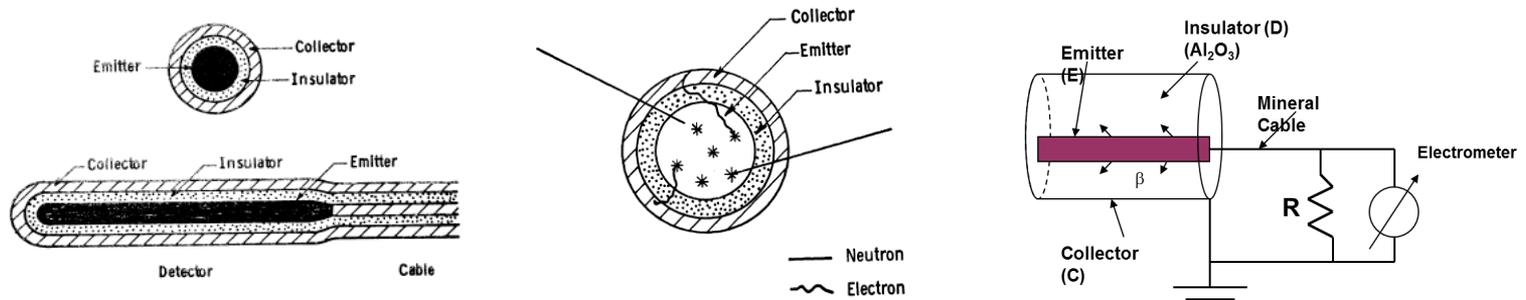


Self Powered Neutron Detectors for Fast Neutrons

Self Powered (Neutron) Detectors (SPNDs) are **rugged miniature** devices used for **fixed in-core reactor monitoring** both for safety purposes and neutron and gamma flux mapping.

operate **without any bias voltage**

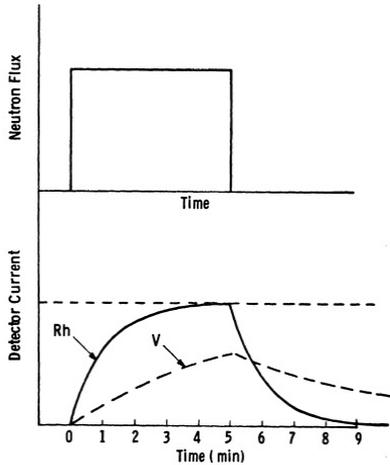
usually constructed in a **coaxial configuration** with a **central emitter characteristic of each device** type. The other electrode or metallic sheath is called collector and the two are separated by a coaxial insulator. Typical **diameter is 3mm**



V, Co, Rh are common elements used as emitter in the thermal neutron SPNDs. Their sensitivity for fast neutron is rather low due to limited cross section of these elements. Alternative materials should be used to cover fast neutron energy range.

Contributions to signal formation

Different reactions can take place in the electrodes and the insulator, inducing a current through the emission of electrons



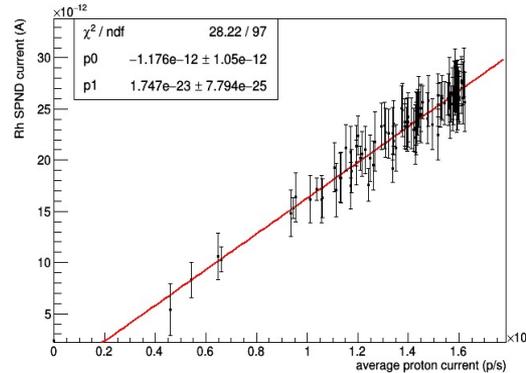
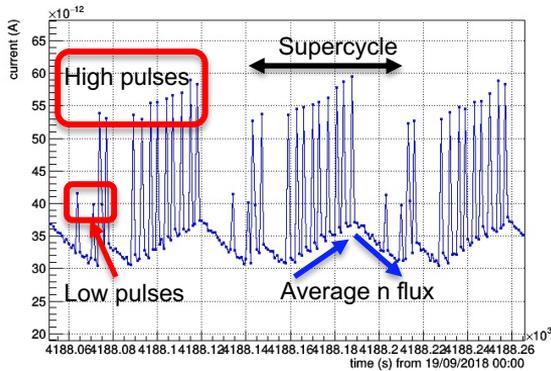
- (β decay): the nuclei of the emitter are activated by a neutron capture and decay with β electron emission
→ **delayed response**
- (n,γ): photons from a radiative capture interact through Compton and photoelectric effect
→ **prompt response**
- (γ,e^-): external photons interact through Compton and photoelectric effect
→ **prompt response**

→ The **net current is the algebraic sum of all the contributions**

n_TOF: high flux of fast neutrons monitoring with SPND

Previous experiment on n_TOF Target#2 with SPNDs demonstrated:

- ✓ **SPND response under several operation conditions w/gamma and charged background**
- ✓ **Delayed signal proportional to neutron flux, prompt signal proportional to proton bunch charge, low noise** considering detectors position and cable length



- This led to the **installation of SPNDs in the new nTOF Target#3 assembly to monitor the neutron yield** independently from PS accelerator data.

PhD theses: possible activities

Within this project **several activities** could be argument for a **PhD thesis**:

- **Commissioning** of the new set of SPNDs on **n_TOF Target#3 at CERN**
- Development of **novel integrated radiation transport and electromagnetic model** for SPND signal formation
- **Design of new SPNDs for n_TOF NEAR** high neutron flux experimental station: dimensions and active materials

Experimental activities will be performed **within the n_TOF collaboration**: possibility to **participate in data taking at CERN** for **short and long term stays**, inclusion in the list of authors for **publications**.

For info or a (zoom) meeting : salvatore.fiore@roma1.infn.it

Thank you



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