Karlsruhe Institute of Technology

UNIVERSITÀ DEGLI STUDI DELL'AQUILA

INFN LNGS

JOHANNES GUTENBERG UNIVERSITÄT MAINZ

A mobile neutron spectrometer for the Laboratori Nazionali del Gran Sasso (LNGS)

M. Solmaz et al.,
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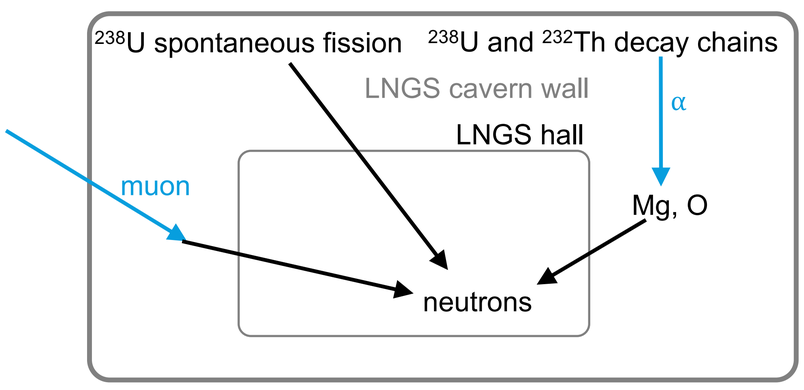
F. Pompa (University of L'Aquila & INFN LNGS), U. Pirling, F. Buchleither (Karlsruhe Institute of Technology)

Gadolinium foil

Neutron background at LNGS

Most of ambient neutron background comes from **radioactive isotopes** on the walls, but concentrations of **U and Th** vary considerably with location.
Aim: reducing systematic uncertainties with a **mobile detector**.

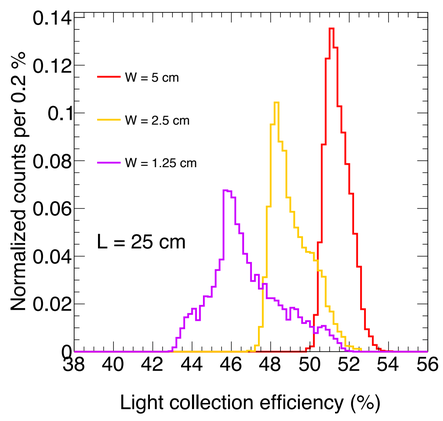


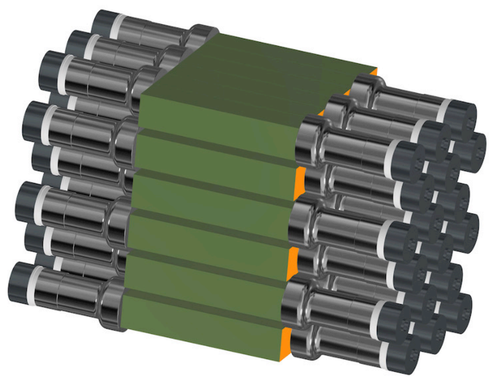
Design choice

36 plastic scintillator modules of (25 x 5 x 5) cm for optimal **uniform** light collection, surrounded with reflector- and **gadolinium foils** for neutron capture. Readout with PMTs.

$$^{157}\mathrm{Gd} + n \rightarrow {}^{158}\mathrm{Gd} + \gamma s \ (7.95\,\mathrm{MeV})$$
$$^{155}\mathrm{Gd} + n \rightarrow {}^{156}\mathrm{Gd} + \gamma s \ (8.53\,\mathrm{MeV})$$

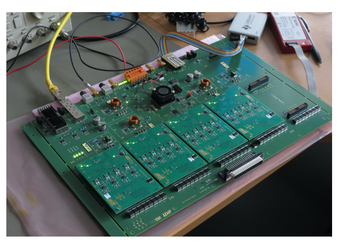
gamma



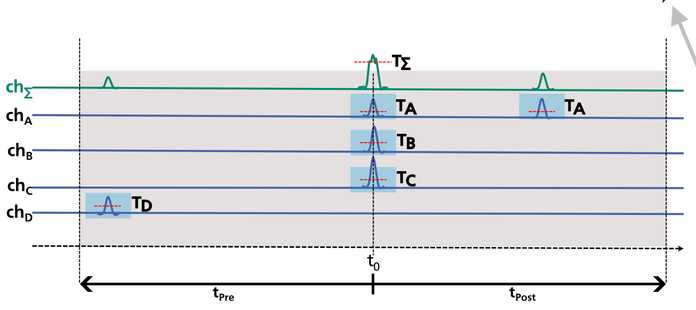


DAQ

Based on a FPGA-Board developed for the TRISTAN experiment: 40 input-channels, sampling rate 62.5MHz.
Pulses identified with a **boxcar** filter. Trigger on **sum channel** starts transmission of pulse-snippets within +/- 100 µs.



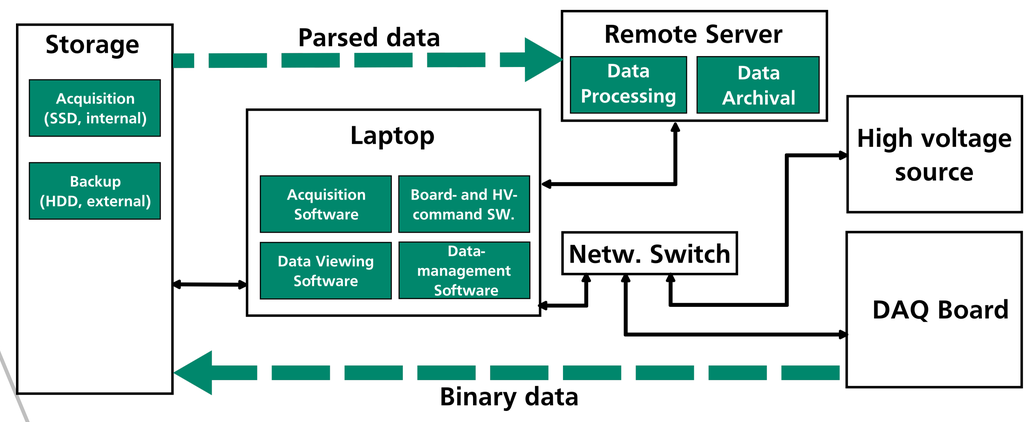
Picture: S. Wüstling



Software

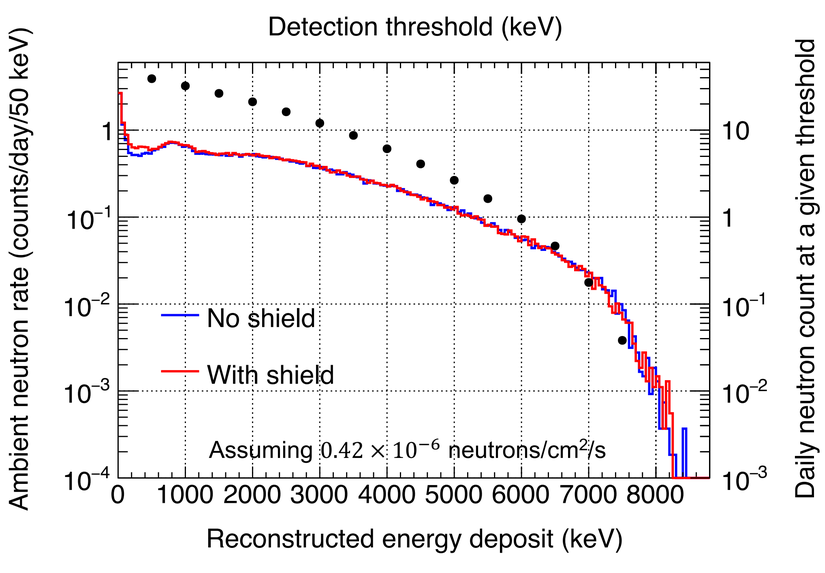
Waveform data sent to a Laptop via UDP for **offline analysis**. The Software (python 3.10) includes:

- interactive CLI to set/read registers from the board
- interactive CLI to manage data reception and target files
- library of analysis and data conversion methods



Simulated detector response

The **pile-up** due to gamma background can lead to false coincidences → detector is equipped with a **lead shield**.
Expected signal: **12 neutrons/day**.

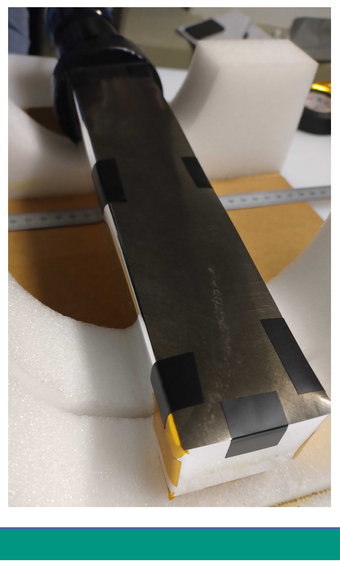


Detector assembly

proton recoil

neutron

PMTs are characterized, first modules are assembled. Scintillators **glued** to PMTs and **wrapped** with reflector and Gd foils. Data taking is planned for 2024.



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