SoNDe Project
Status Update

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Solid-State Neutron Detector

1. Introduction
2. SoNDe?
3. Demonstrator Development
4. Upscaling and Next Steps

Introduction

Codin Gheorghe from IDEAS

Integrated Detector Electronics AS (IDEAS)

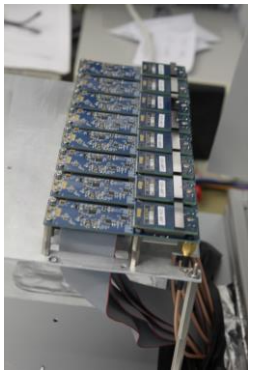
IDEAS is a privately owned Norwegian company.

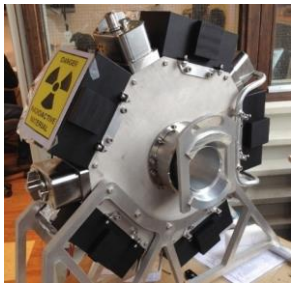
History: Founded in 1992 as a spin-off from Norway's high-energy physics activities at CERN (Geneva, Switzerland)

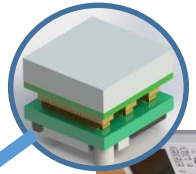
IDEAS purpose: To develop **integrated circuits for image sensors** (x-rays, gamma rays, charged particles, IR, thermal).

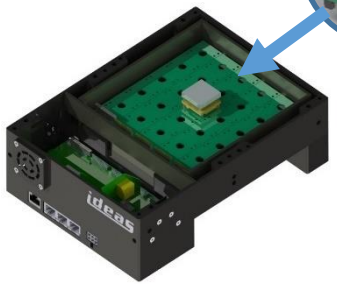
IDEAS products are used in industrial and scientific applications including space missions.

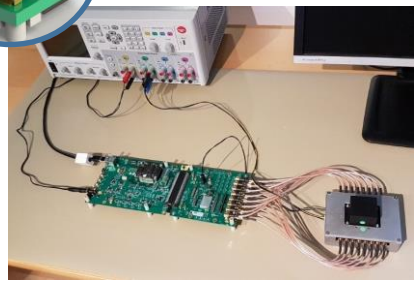
~~ASIC and~~ System Projects at IDEAS

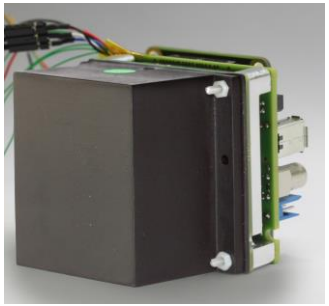


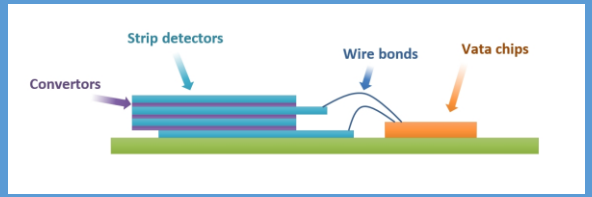




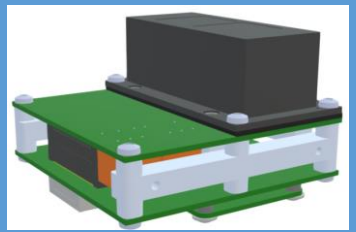








ADBANG
Neutron detector based on silicon sensors with etched structures



NGSduo
Novel Non-3He based dual neutron gamma sensor

SoNDe

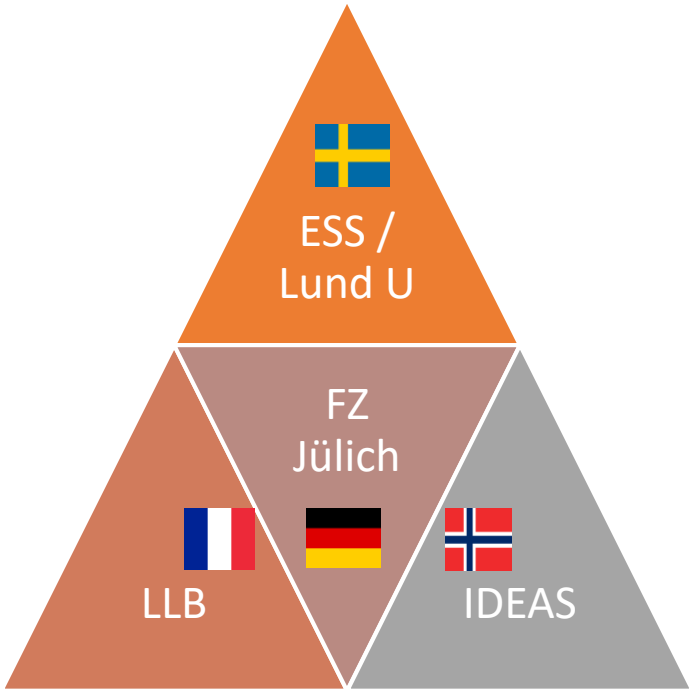
Who is SoNDe?

The SoNDe Project

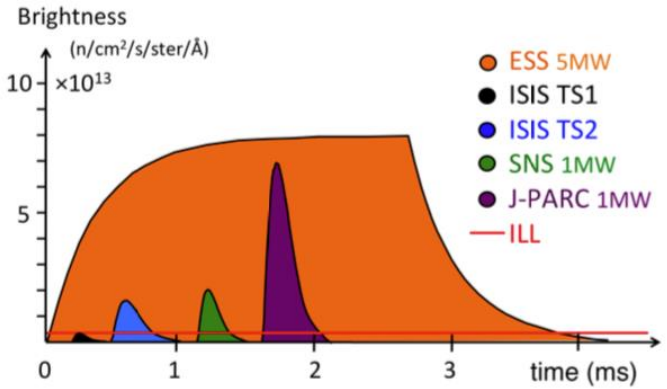
Solid-State Neutron Detector

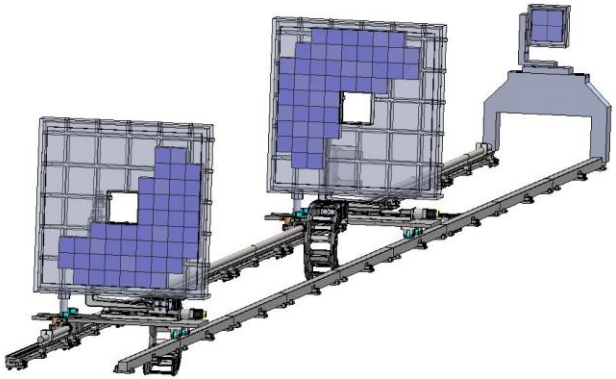
Supported by the European Union within the H2020 framework programme

SoNDe shall develop the detector for the SKADI instrument at ESS.



Why SoNDe?





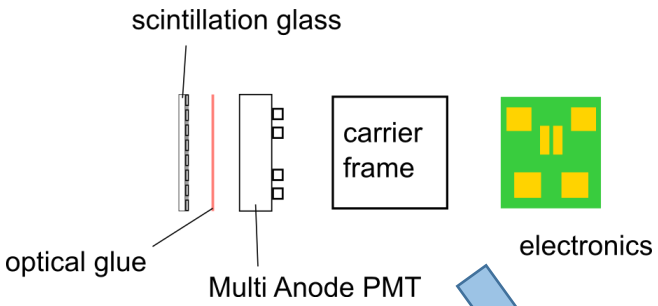
- **<u>High (local) flux</u>**
- Modern pulsed MW neutron sources create unprecedented peak fluxes on neutron detection systems
- Long-term perspective in case of **<u>^{3}He shortage</u>** as a detector material
- New instruments may require a **<u>new placing pattern</u>** of active area
- Monolithic design requires long shutdowns as complete detector needs to undergo repairs

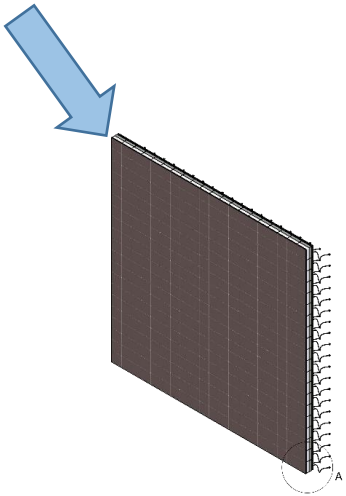
Goals

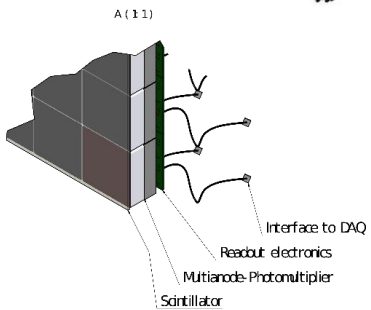
Solid-State Neutron Detector

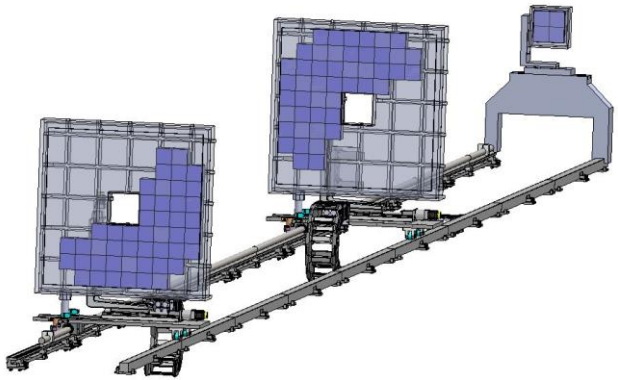
1. High-flux capability, capable of handling the peak-flux of future world-leading spallation sources (gain factor of 20 over current detectors)
2. High-resolution of 3 mm by single-pixel technique, better by interpolation
3. High detection efficiency of 80 % or more
4. No beam stop necessary, thus enabling investigations with direct beam intensity (using an adapted attenuator)
5. Strategic independence of ^{3}He
6. Time-of-flight (TOF) capability, necessary to exploit maximum flux, with a time resolution in the µs regime
7. Modularity, improving maintenance characteristics of today's neutron detectors

Technology and Integration (SKADI)

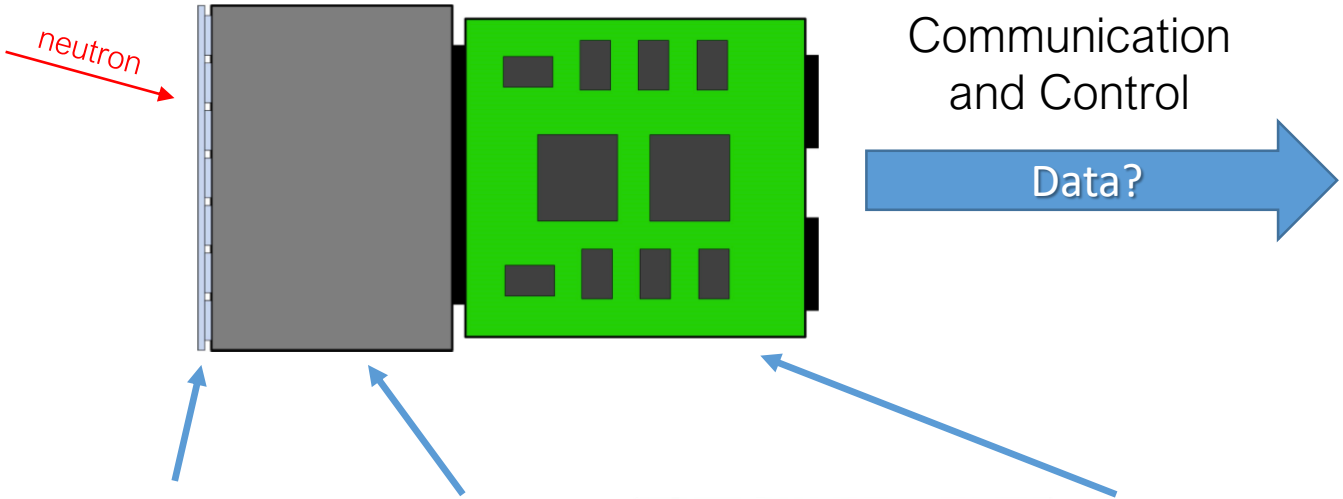








Detection Concept



Demonstrator Development

Electronics Design & Validation

Evaluation of MaPMT Tubes

Evaluation of the Demonstrator and Scintillator Characterisation

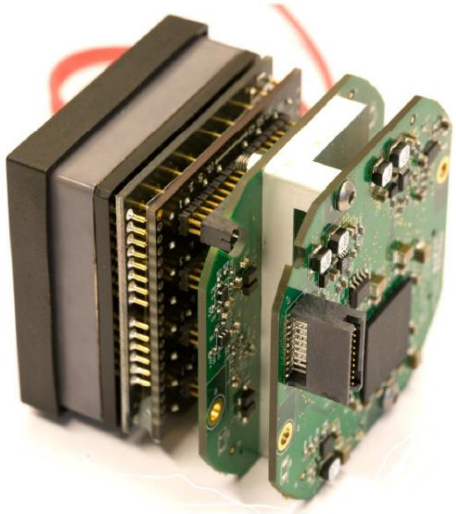
Detailed Specifications (Electronics)

Item	Specifications
Interface	64 channels of the Hamamatsu H8500c Tube
DNR	up to -80pC
Power	ca. 2W per module
Dimensions	The module should have the same size as the H8500c Tube (52mm x 52mm)
Gain compensation	Compensate for MaPMT gain variations.
Timing accuracy per event	< 100ns
Extend the Field of View	Modular architecture
Communication	Ethernet
TOF Mode Performance	up to 100 kcps per channel
Spectroscopy Mode Performance	14bit at 50 kcps per module

Two Modes! TOF and Spectroscopy!

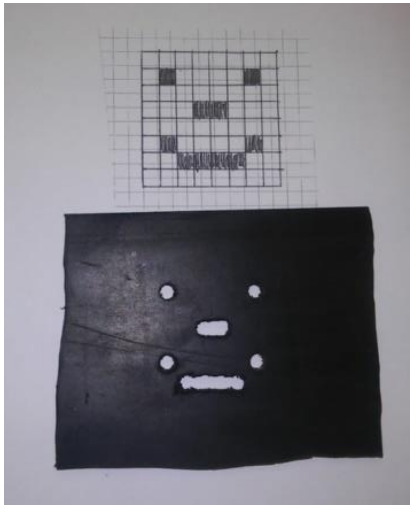
First Tests with Neutrons

The prototype system with 8x8 pixel matrix has been set up using the IDEAS ROSMAP system. A neutron source and a moderator has been used to illuminate a pattern on the prototype detector.

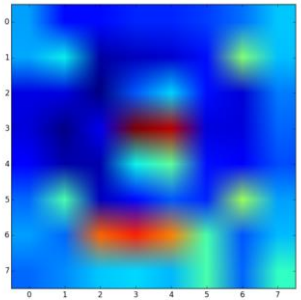


ROSMAP system provided by IDEAS.

Neutron detection through a “smiley” shaped moderator:

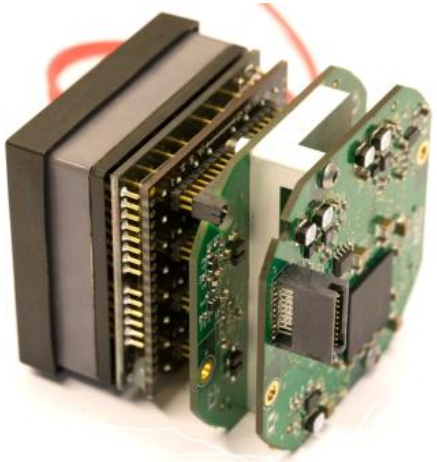


Prepared moderator which generates a distinct pattern on the prototype system.

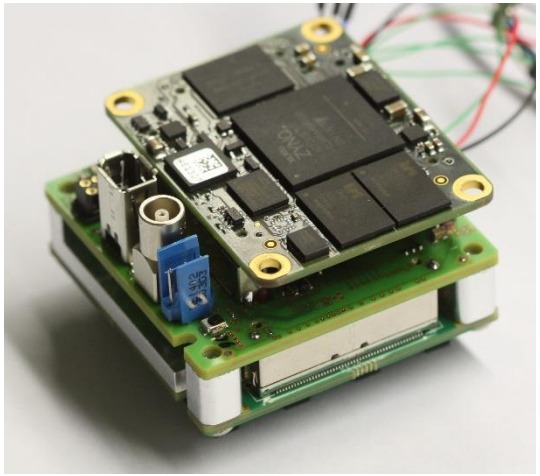


Resulting pattern during illumination of the system with neutrons and read-out of the 8x8 pixel matrix.

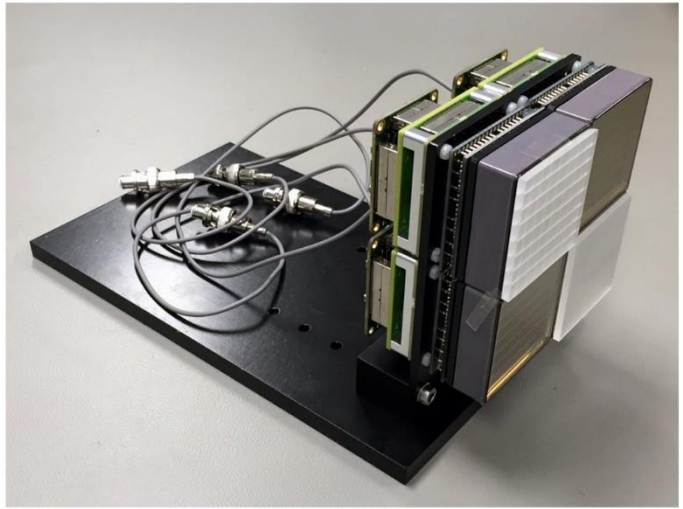
Demonstrator Development



ROSMAP-SP

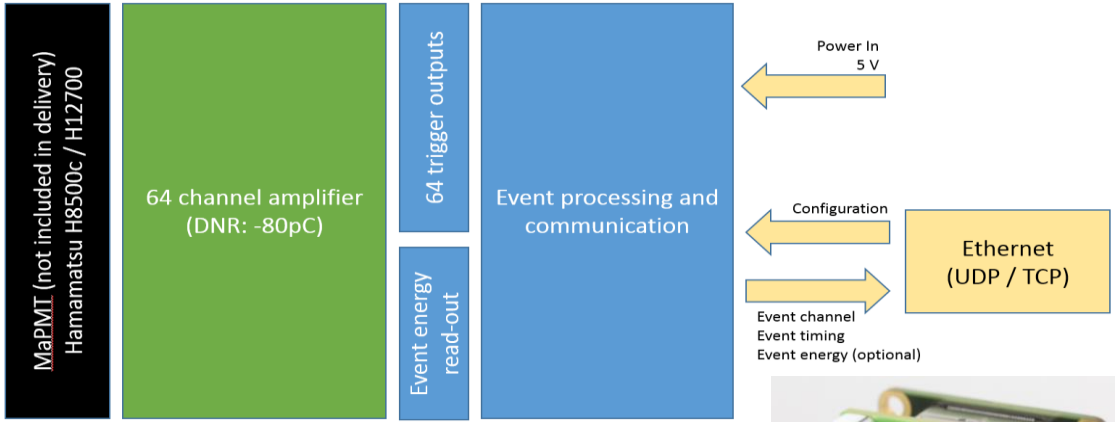


SoNDe
Data Acquisition Module

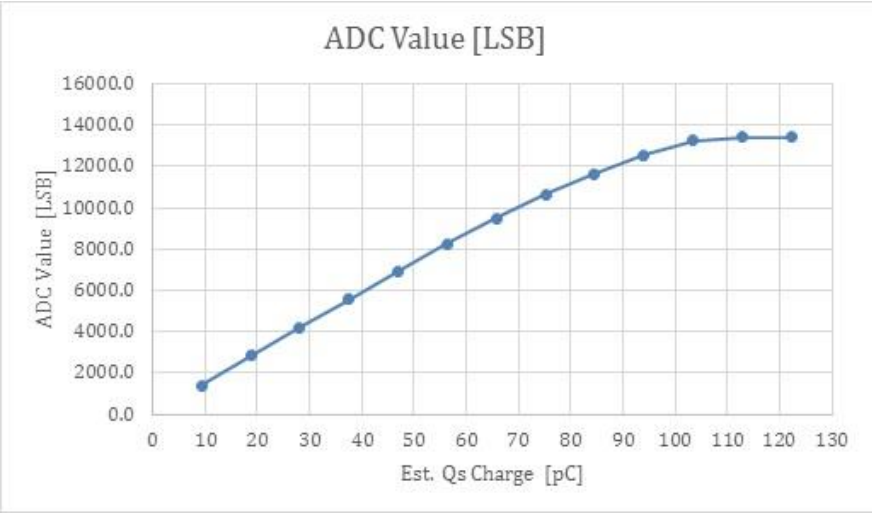


SoNDe 2x2 Demonstrator

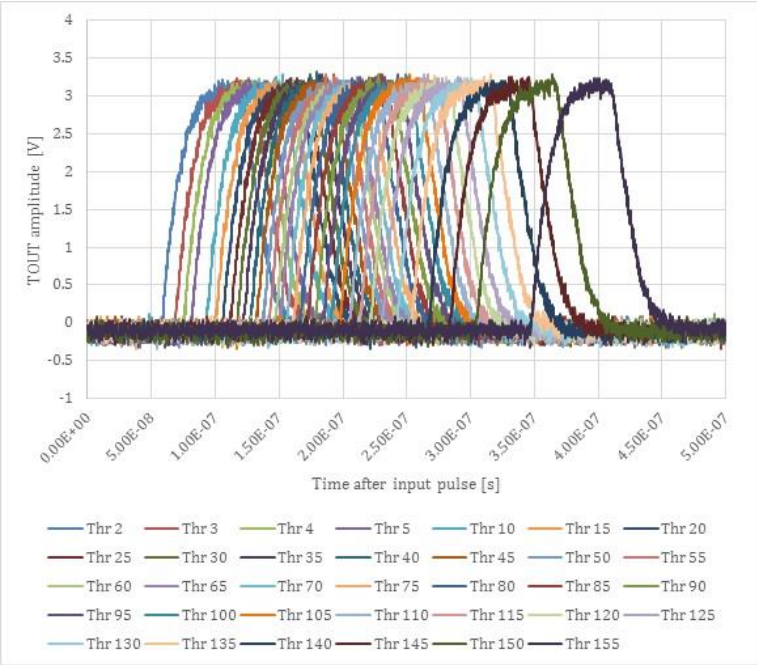
Module Setup



Performance

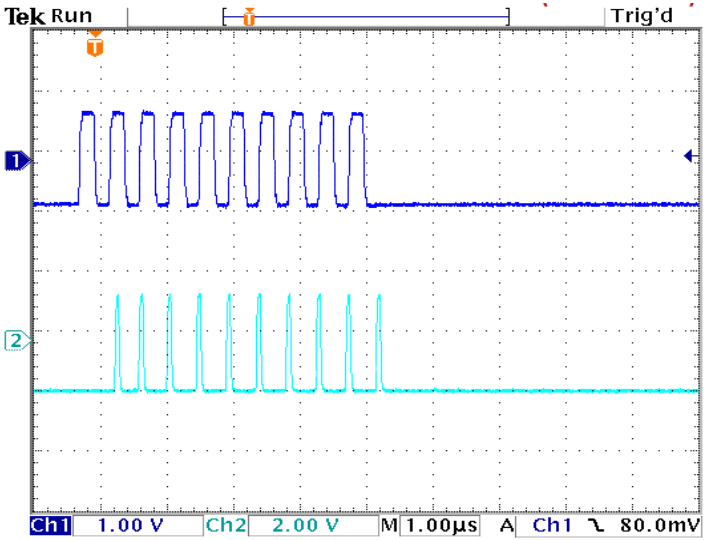


Gain and DNR measured in the lab.
80pC DNR achieved!

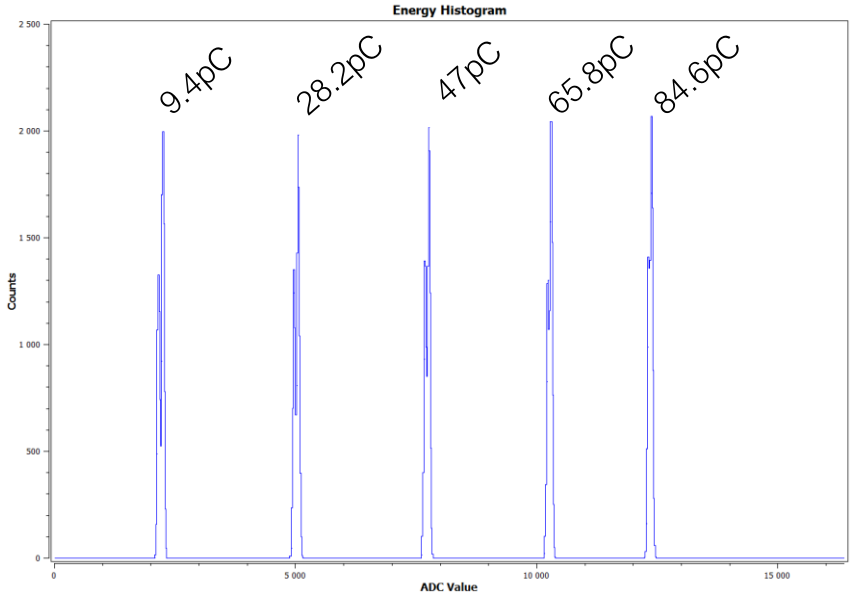


Time-stamp accuracy measured in the lab.
± 100ns achievable

Performance



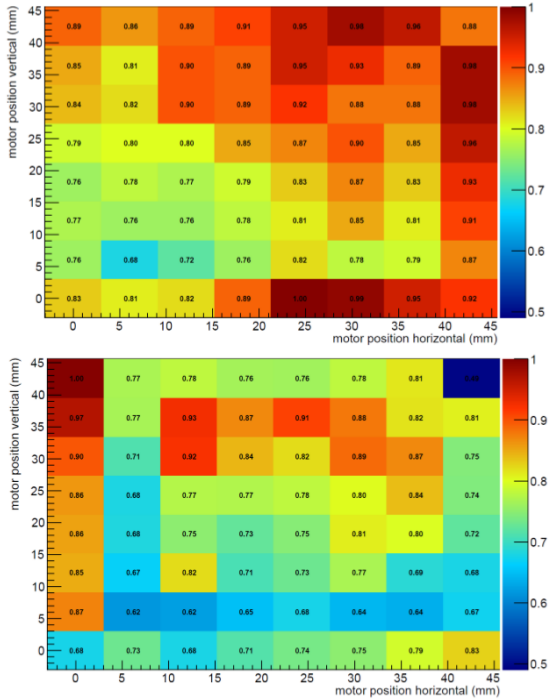
Detection rate measured in the lab.
Over 2M samples per second detected and transferred (best case).
Below 1M samples per second is more realistic.



Pulse height accuracy estimated in the lab.

MaPMT Gain Variations

Tests performed by Lund University.



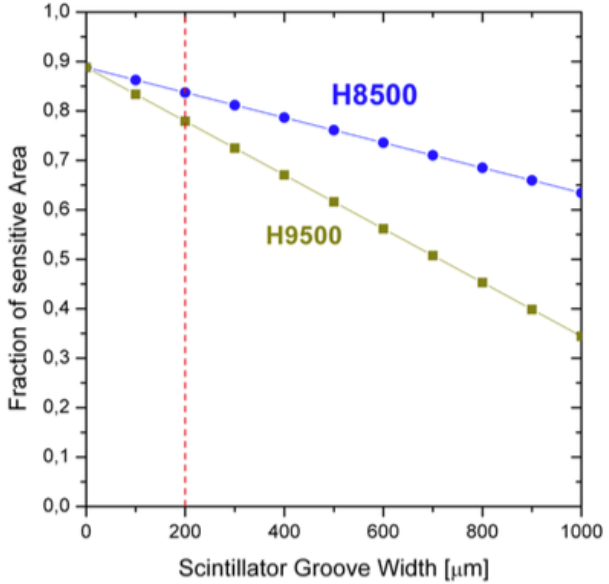
Channel relative gain as provided by manufacturer (top) and as measured by the team at LU (bottom

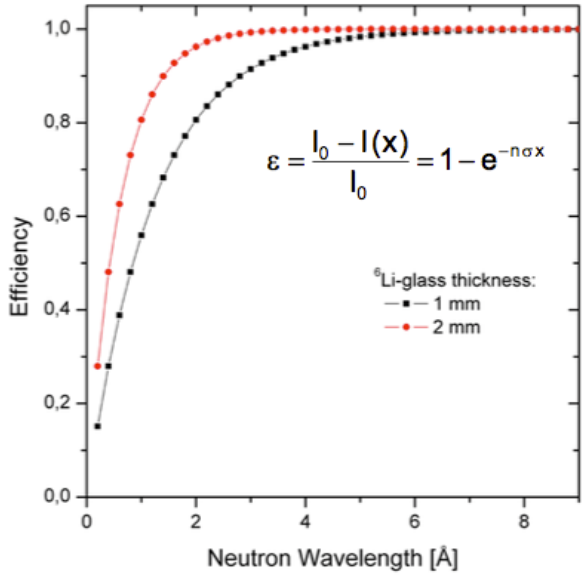
Conclusions

- Each used MaPMT has to be characterized
- Lund University is establishing a characetization procedure.

Efficiency

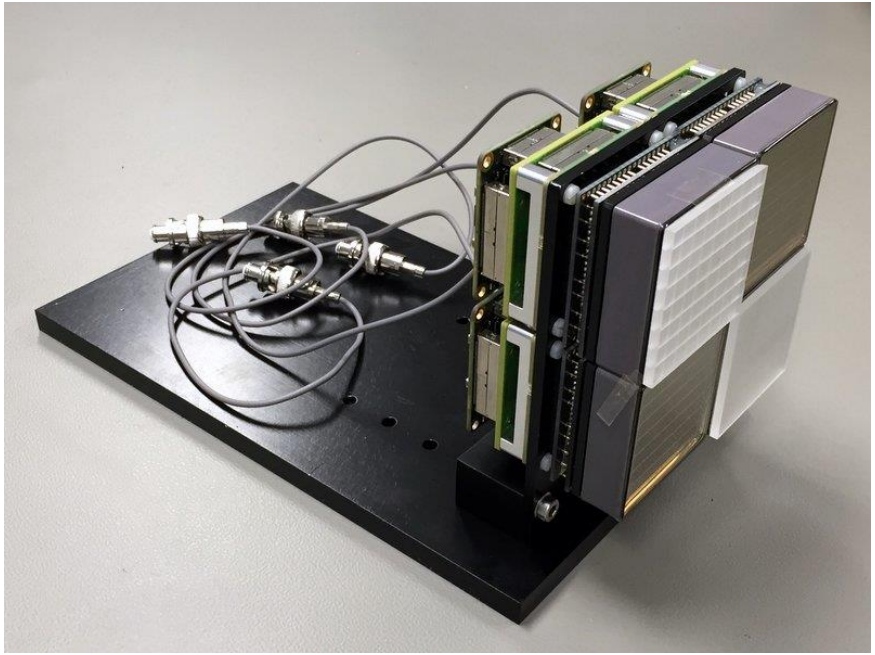
Estimated by Forschungszentrum Jülich.

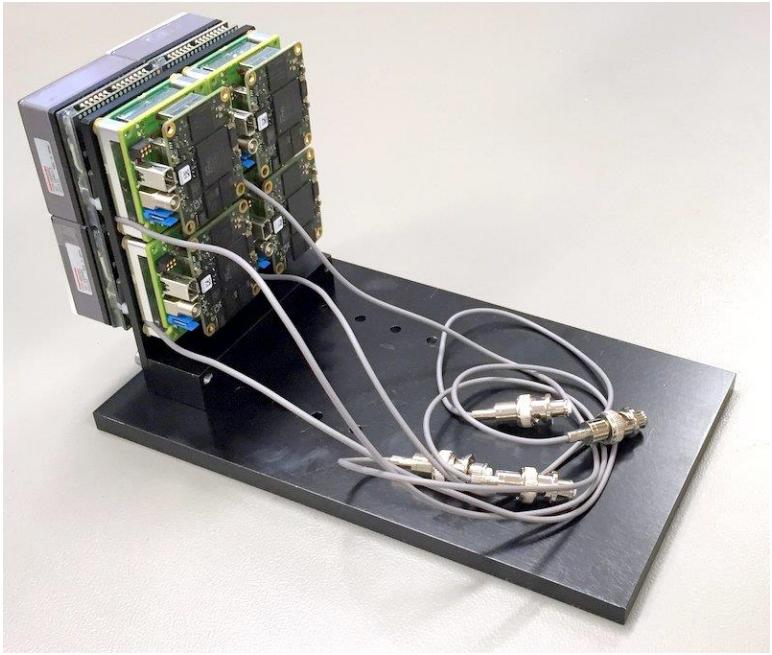




Measurements and analysis are still ongoing.

The SoNDe Module and 2x2 Demonstrator

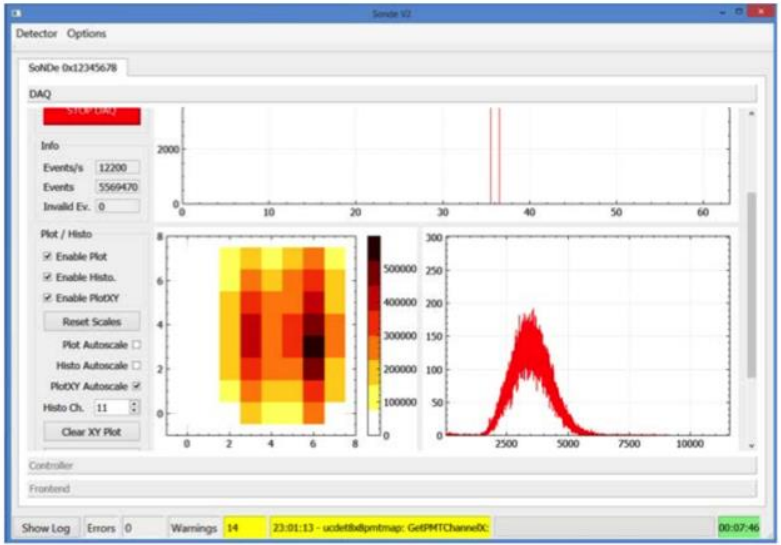




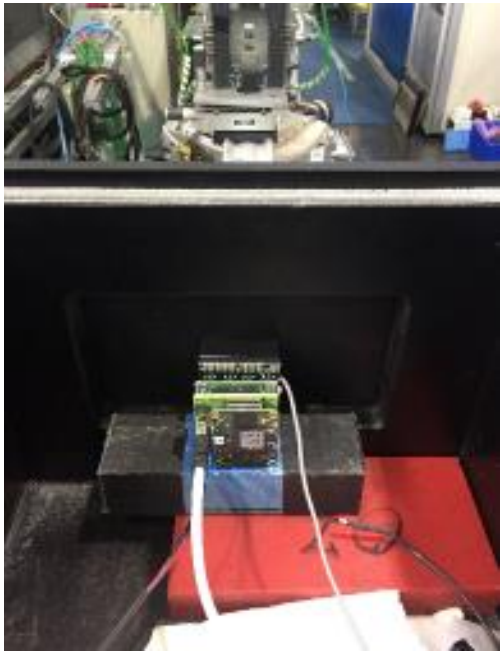
First Results with Neutrons

Solid-State Neutron Detector

Tests performed by Forschungszentrum Jülich. Goal is to characterize the Li glass scintillator. Tests are performed with different versions of the scintillator glass (grooved, un-grooved).



First measurements using a neutron beam in Munich.



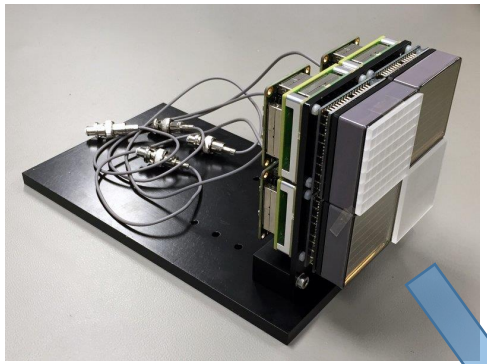
Next Steps (Upscaling)

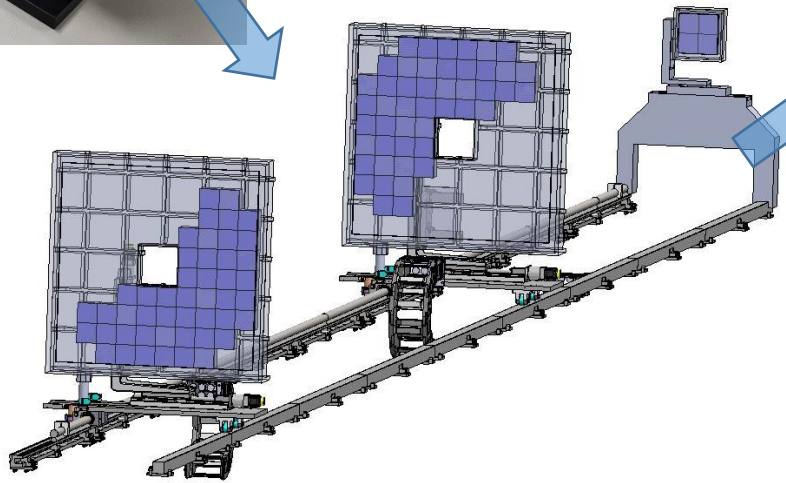
Manufacture and Test a Large Scale Detector

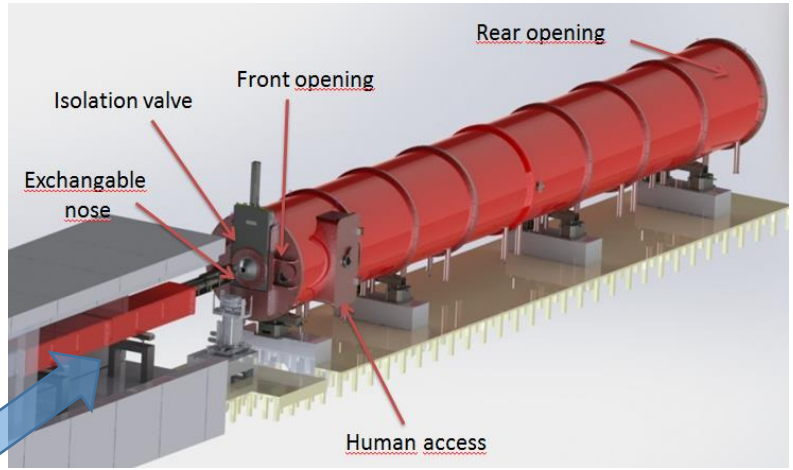
Last Details

- Conclusion on dynamic range (Li-glass scintillator tests)
- Power requirements (depends on mechanical and environmental design of SKADI)
- Final performance tests (ongoing by FZJ in Munich)
- Last details on scintillator design
- Adapt communucation link into ESS

Next (big) Milestone (Construction)







Thanks to all Contributors and Listeners!

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