# Commissioning of a mobile neutron detector for LNGS

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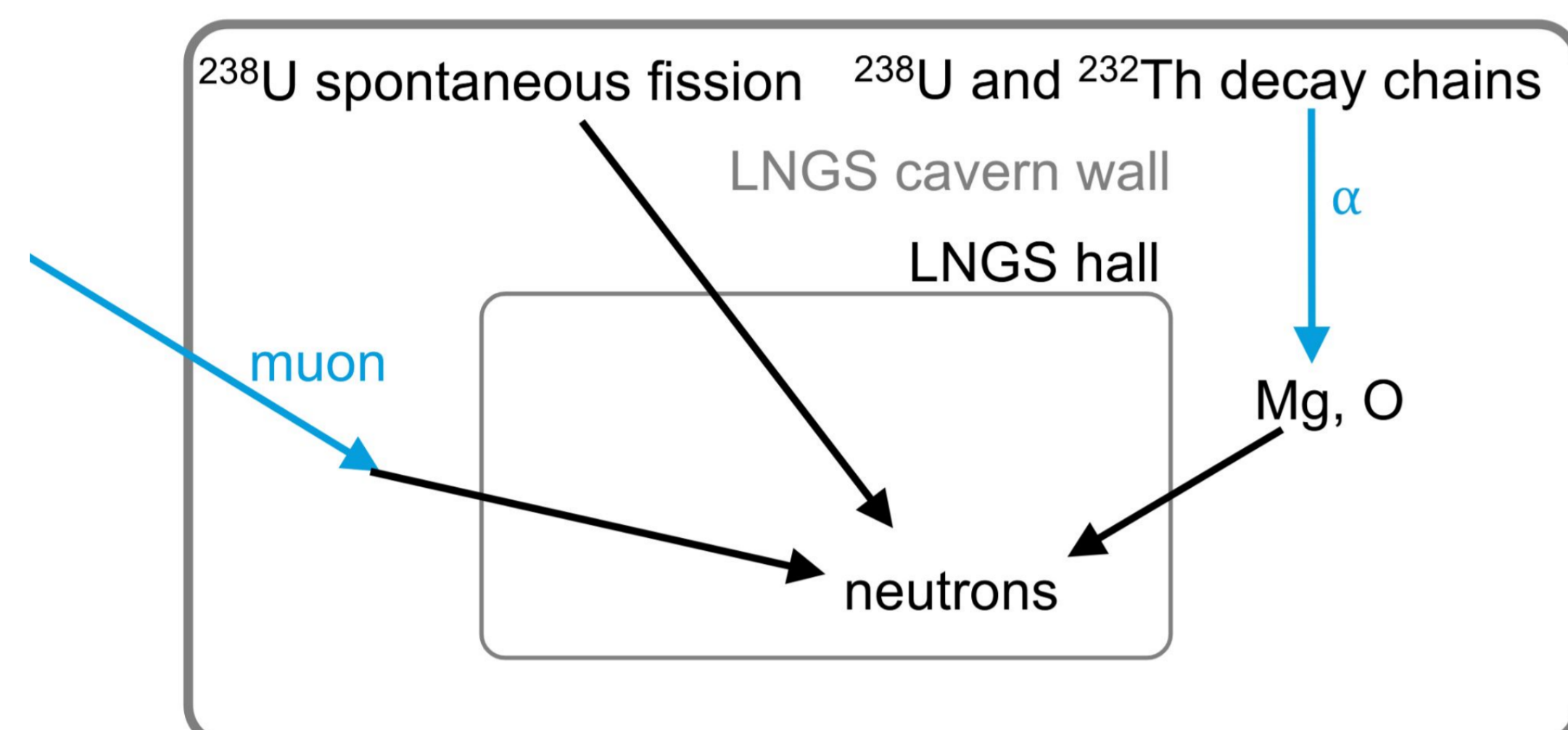
UNIVERSITÀ DEGLI STUDI DELL'AQUILA — INFN LNGS — KIT Karlsruher Institut für Technologie

## LNGS neutron background

- Time and location dependent
- Complex direct comparison of previous measurements
- ALMOND (**A**n **L**NGS **Mo**bile **N**eutron **D**etector) is designed to overcome these challenges

$^{238}$U spontaneous fission   $^{238}$U and $^{232}$Th decay chains
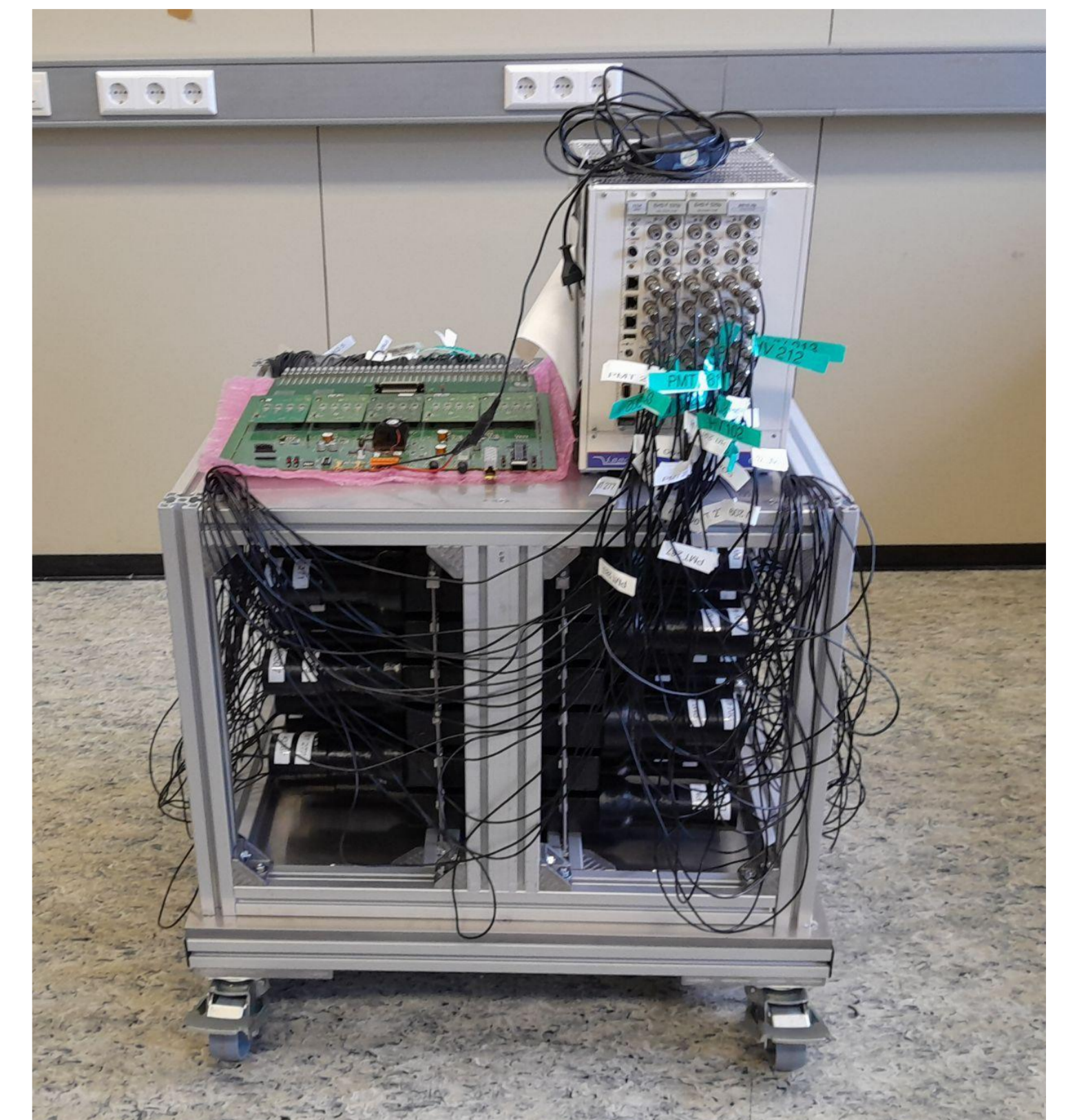
LNGS cavern wall

LNGS hall

α

muon

Mg, O

neutrons

## A capture-gated mobile spectrometer

- EJ-200 Scintillator
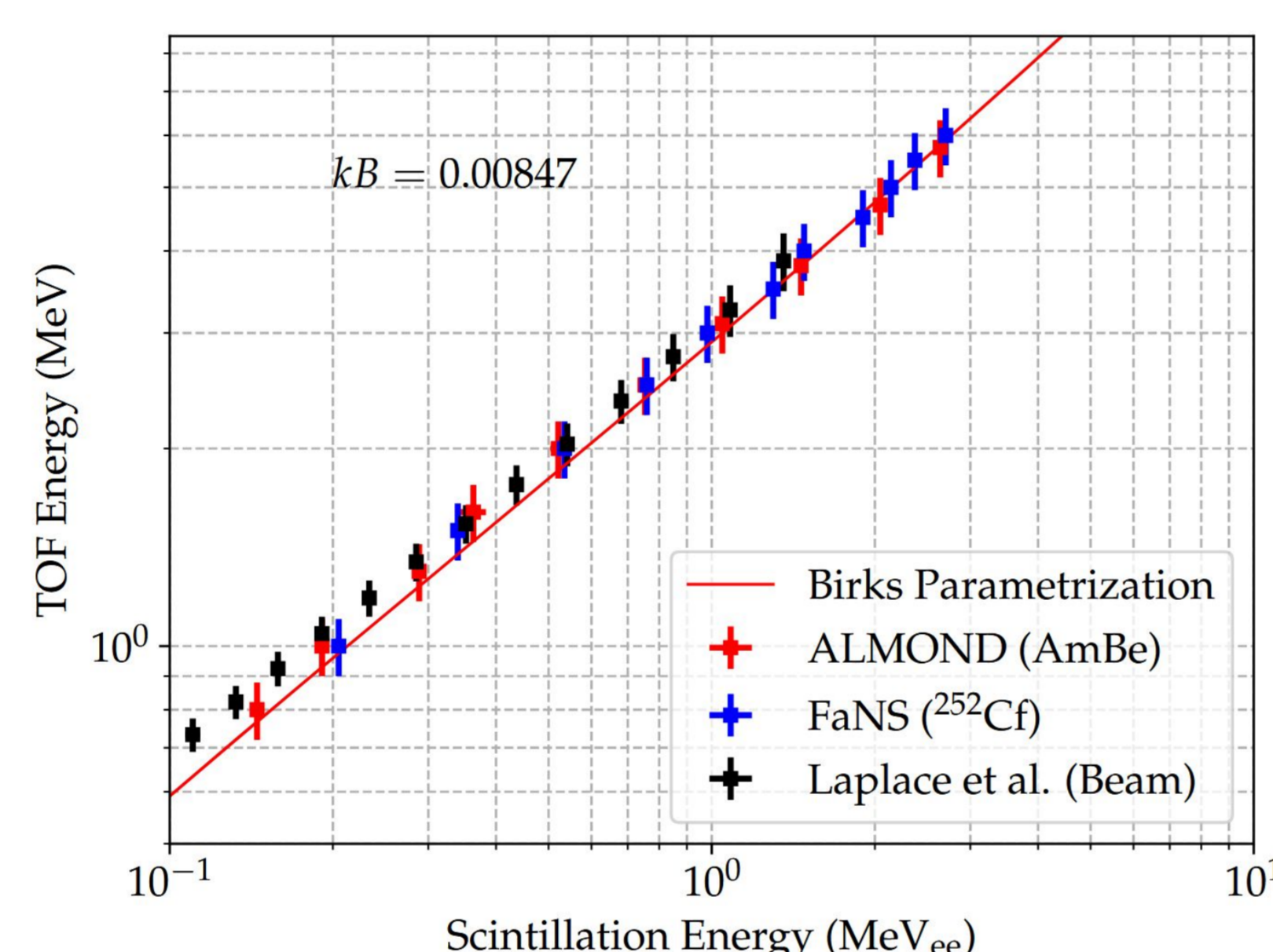- Reflector foil
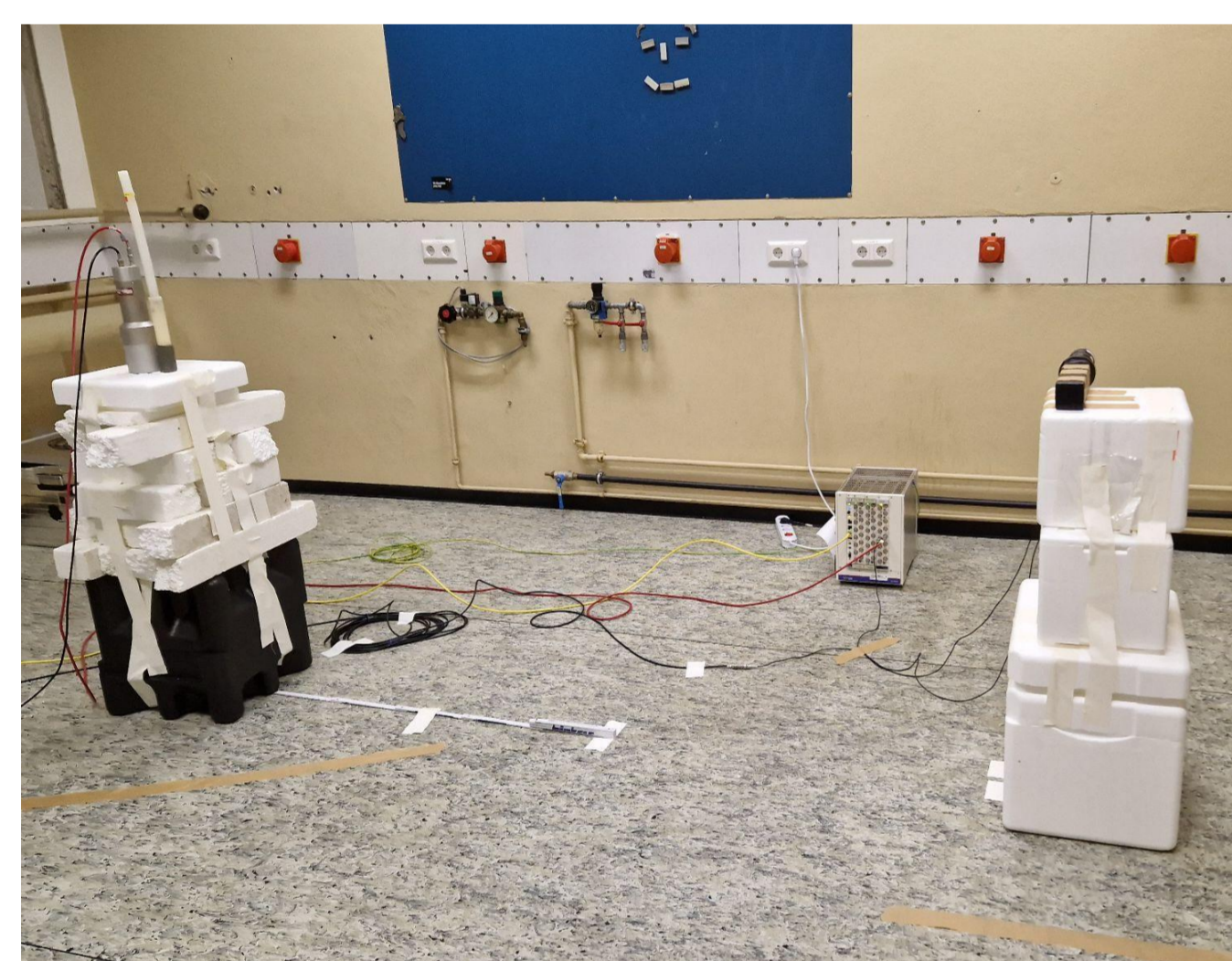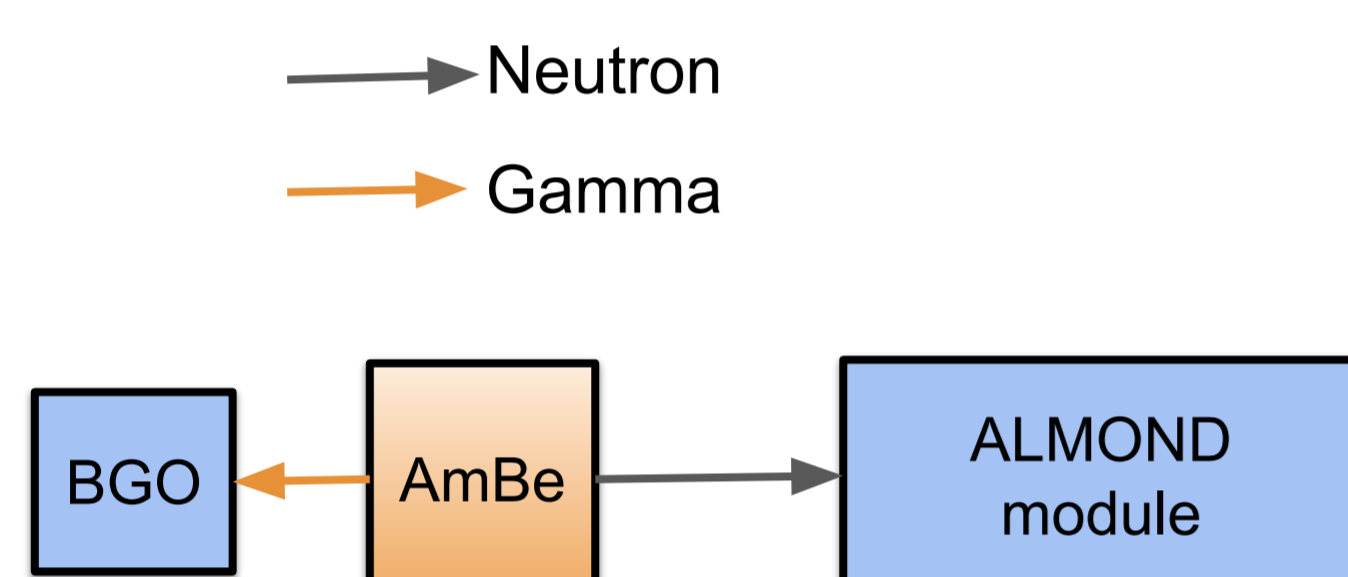- 100 µm gadolinium foil
- Low background ET9302B PMT
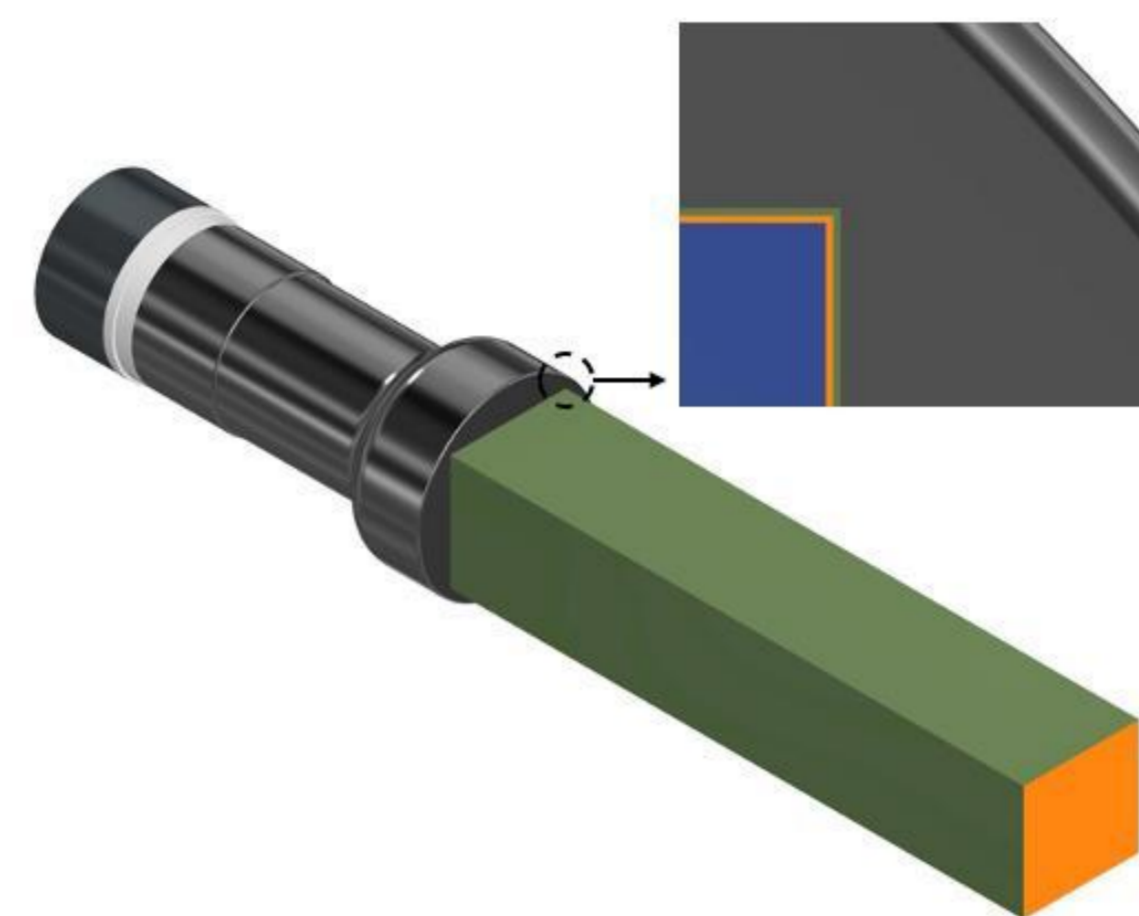
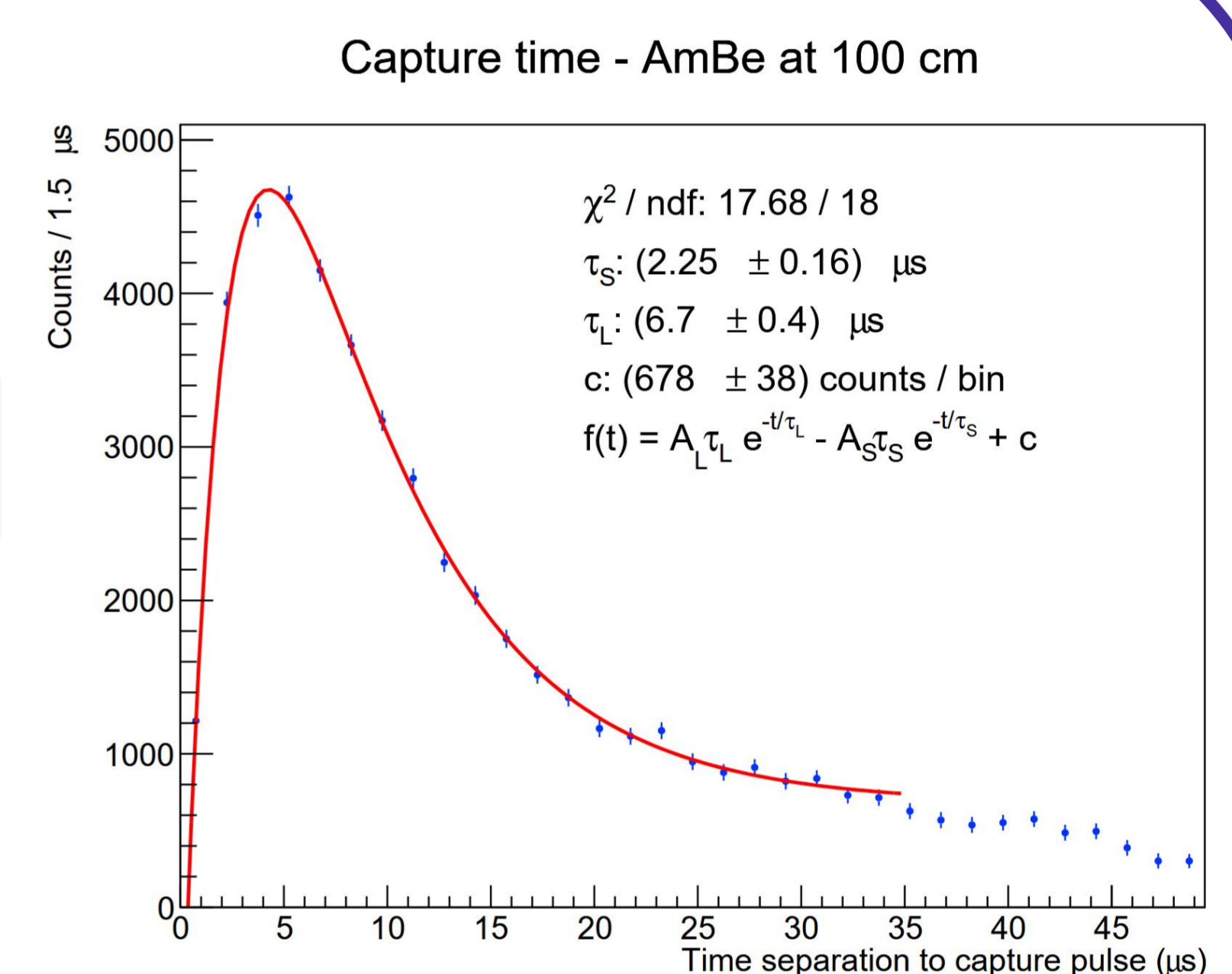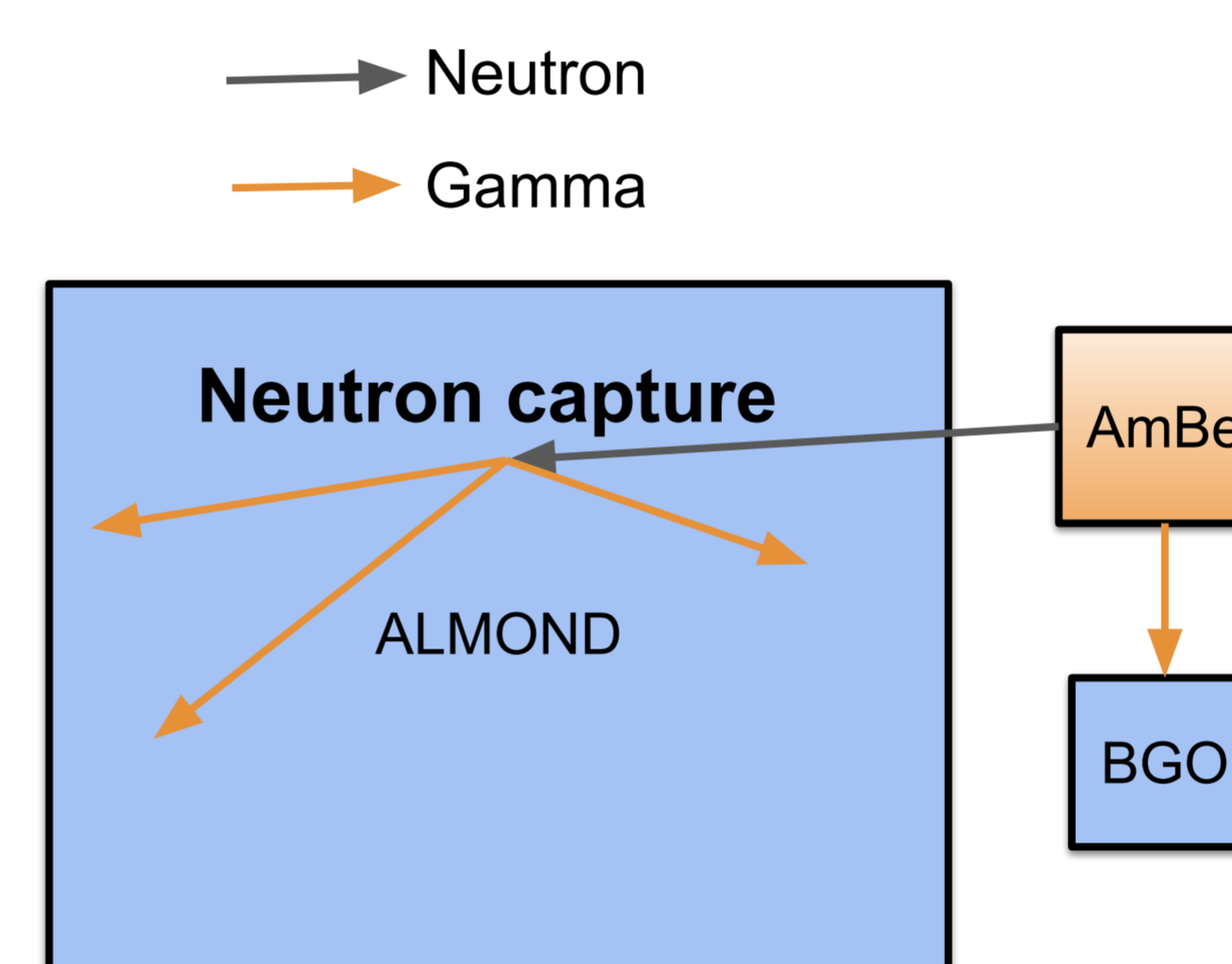Scheme of a single 5 × 5 × 25 cm module.

ALMOND in its calibration setup: a Bosch profile structure houses an array of 6 × 6 modules, DAQ board and HV supply on top, Pb sheets on side walls dismounted.

## Americium-Beryllium calibrations

→ Neutron
→ Gamma

BGO — AmBe — ALMOND module

$kB = 0.00847$

TOF Energy (MeV) vs Scintillation Energy (MeVee)

— Birks Parametrization
— ALMOND (AmBe)
— FaNS ($^{252}$Cf)
— Laplace et al. (Beam)

Neutron **time-of-flight** calibration with a single module

→ Neutron
→ Gamma

**Neutron capture**

ALMOND

AmBe

BGO

### Capture time - AmBe at 100 cm

$\chi^2$ / ndf: 17.68 / 18
$\tau_S$: (2.25 ± 0.16) µs
$\tau_L$: (6.7 ± 0.4) µs
c: (678 ± 38) counts / bin
$f(t) = A_L \tau_L \, e^{-t/\tau_L} - A_S \tau_S \, e^{-t/\tau_S} + c$

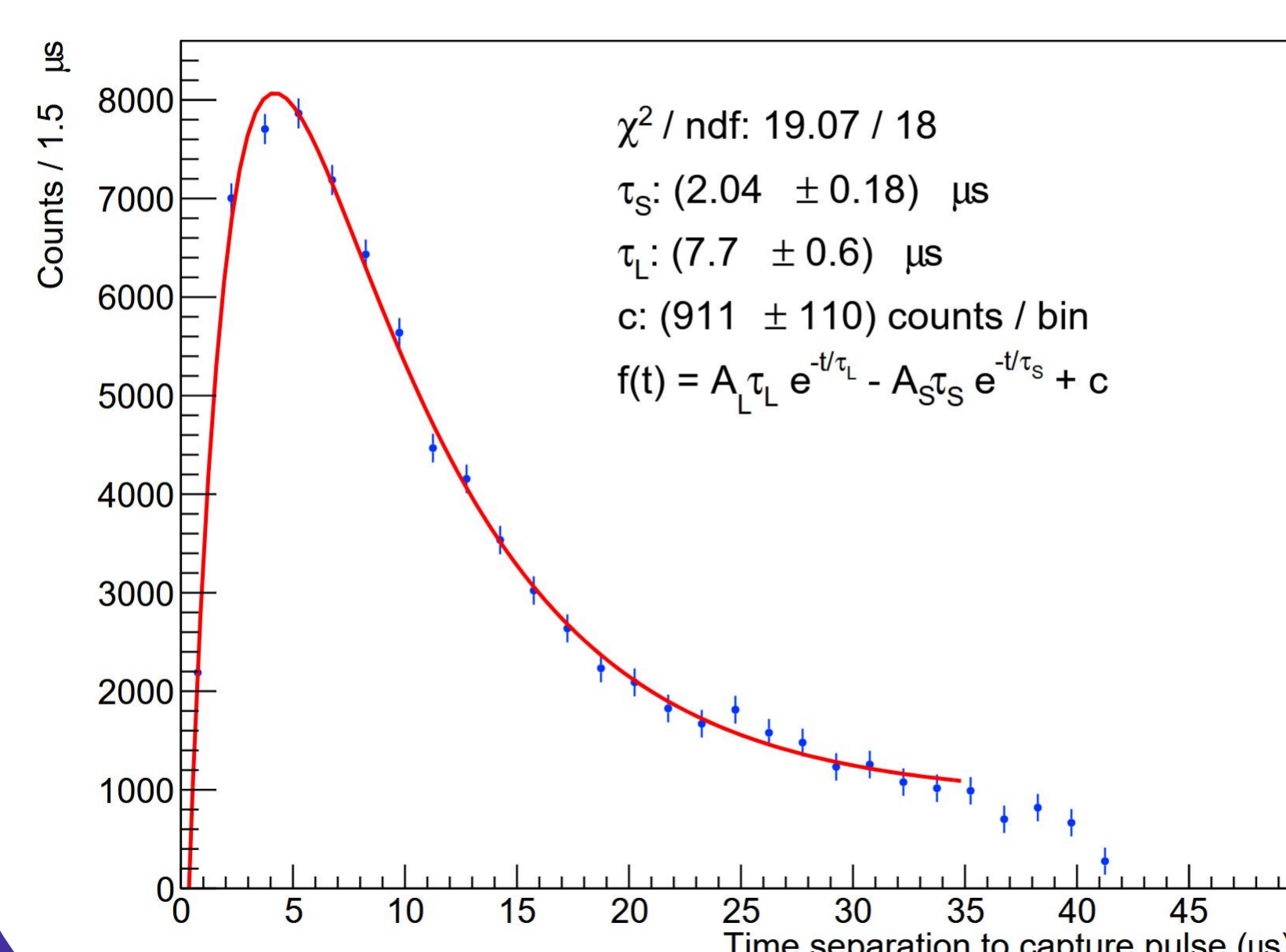Counts / 1.5 µs vs Time separation to capture pulse (µs)

- Energy calibration and capture time measurement with a tagged AmBe source at KIT
- Detection based on **neutron capture** in gadolinium foils and BGO tagging
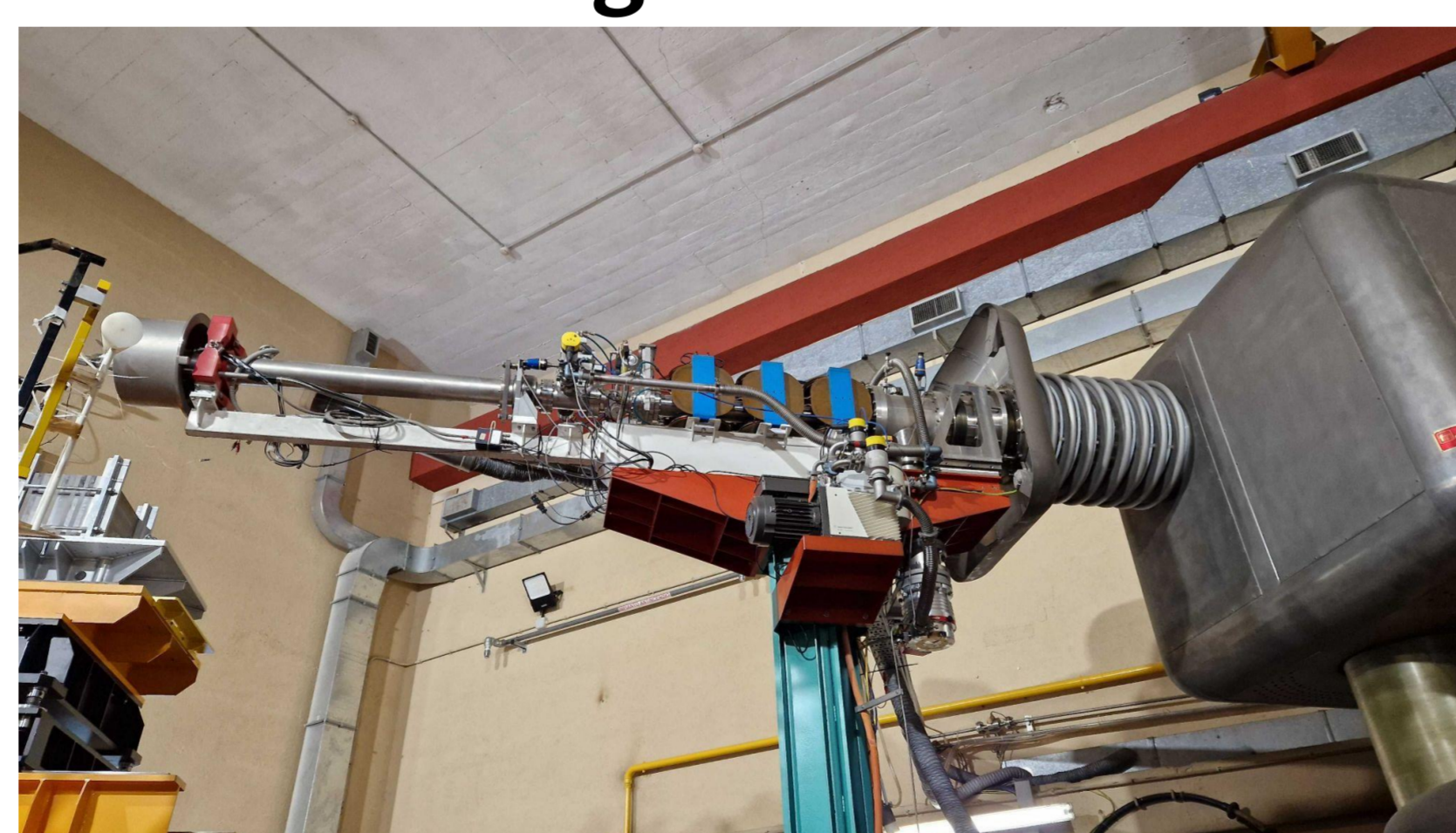
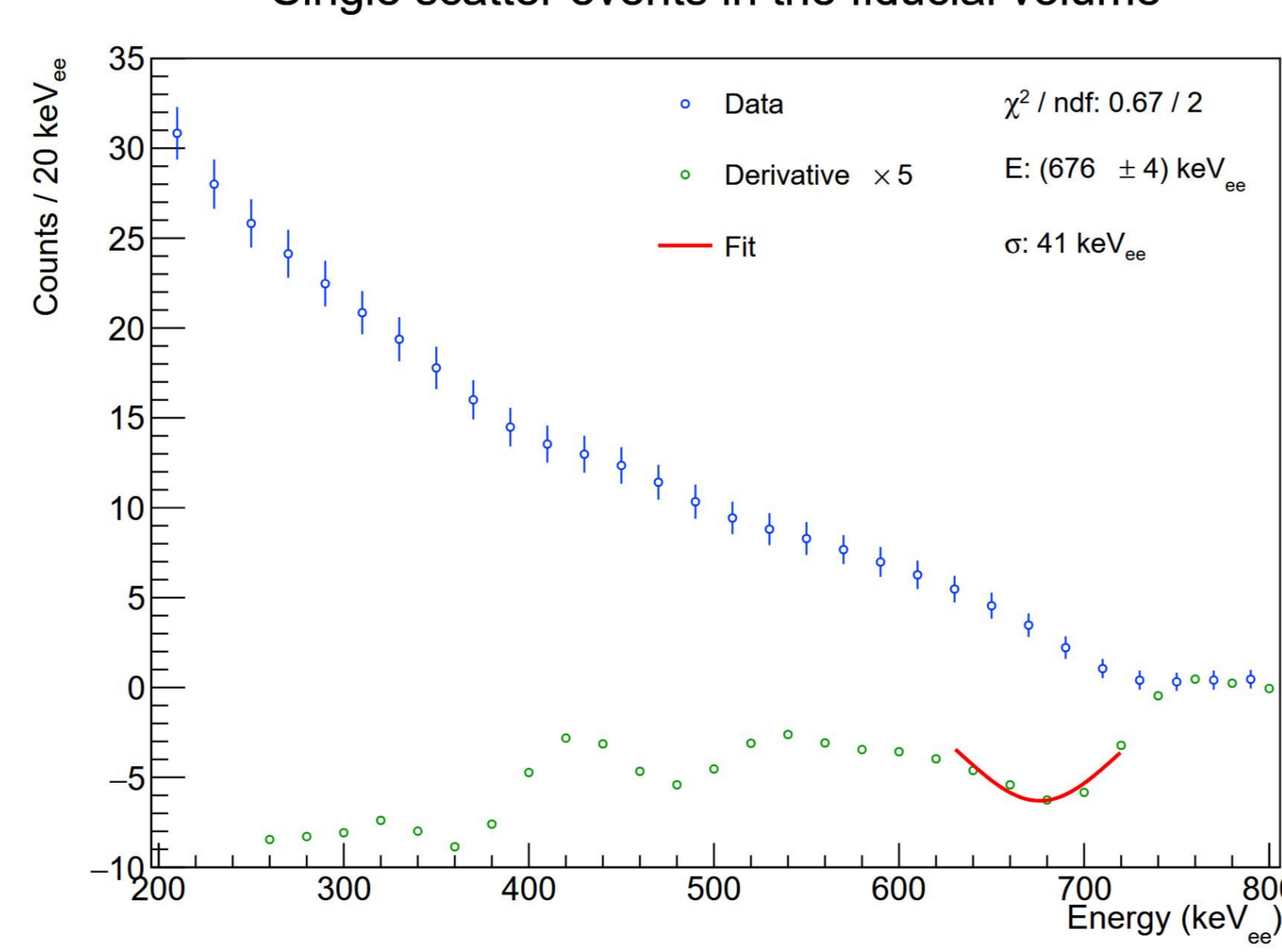## Calibrations at ENEA Frascati

### Americium-Boron source

### DD generator

#### Capture time - AmB at 140 cm

$\chi^2$ / ndf: 19.07 / 18
$\tau_S$: (2.04 ± 0.18) µs
$\tau_L$: (7.7 ± 0.6) µs
c: (911 ± 110) counts / bin
$f(t) = A_L \tau_L \, e^{-t/\tau_L} - A_S \tau_S \, e^{-t/\tau_S} + c$

Counts / 1.5 µs vs Time separation to capture pulse (µs)

#### Single scatter events in the fiducial volume

- Data
- Derivative ×5
- Fit

$\chi^2$ / ndf: 0.67 / 2
E: (676 ± 4) keVee
σ: 41 keVee

Counts / 20 keVee vs Energy (keVee)

## Commissioning at LNGS

CUPID

- Currently taking data in Hall A
- Planned measurements in other areas of LNGS

Preliminary

- Neutron candidates
- Accidental coincidences

Events vs Day