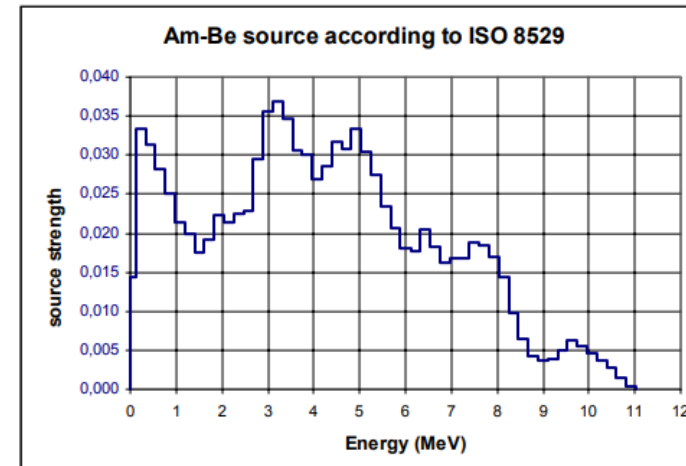
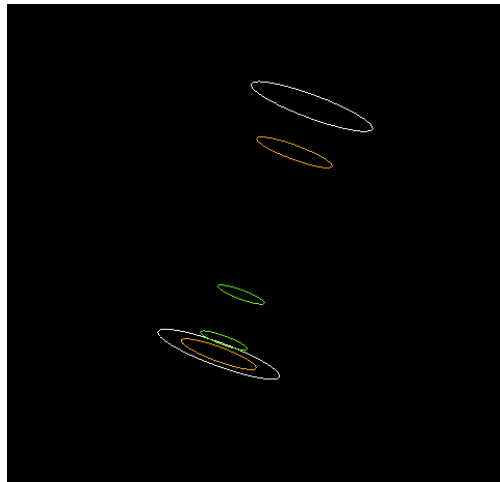
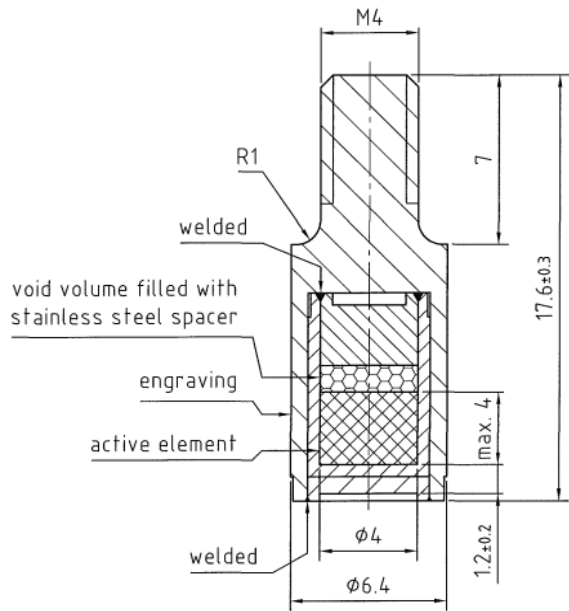


Simulation of AmBe measurements with LIME @LNGS

CYGNO Simulation Meeting – 27 February 2023

F. Di Giambattista

AmBe neutron source



<https://rifj.ifj.edu.pl/handle/item/217>

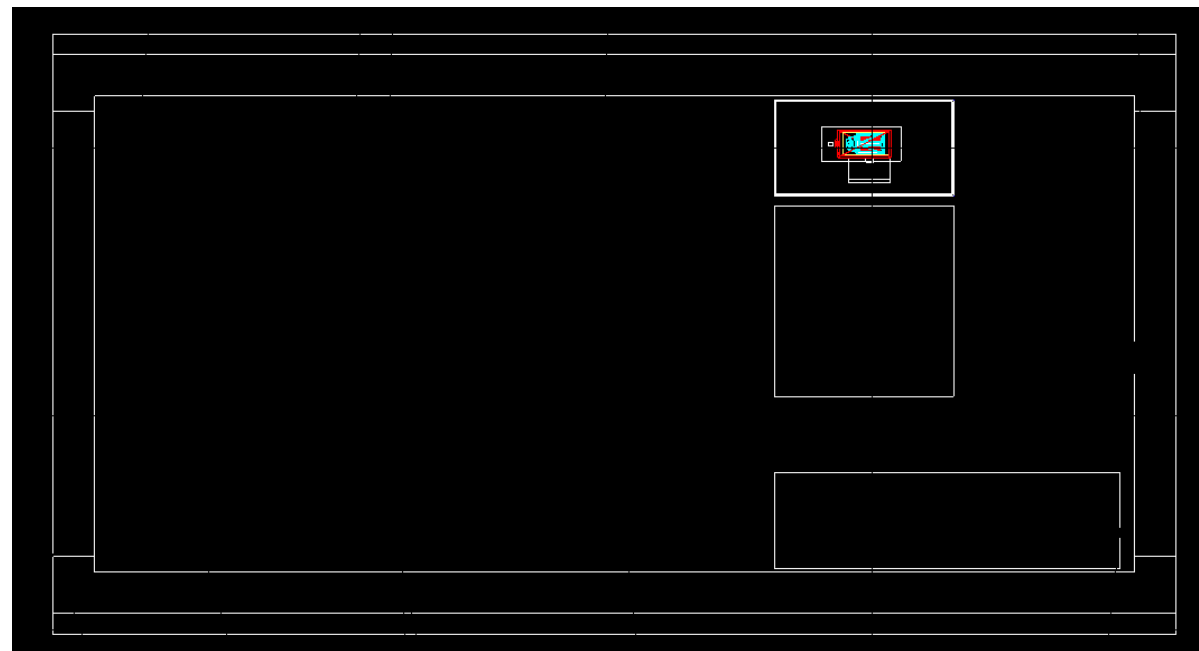
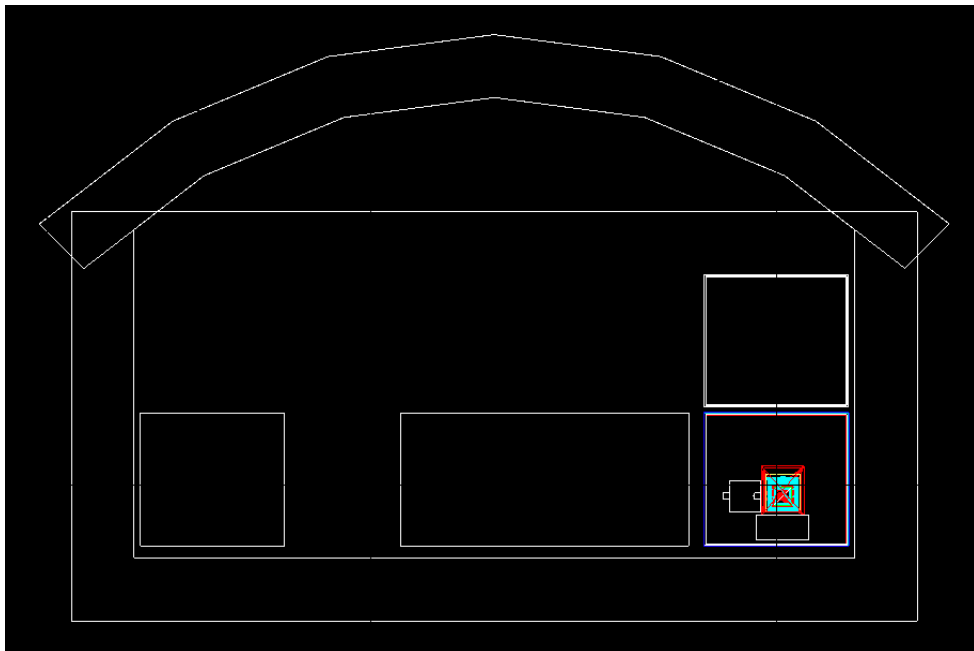
- Simplified geometry in GEANT4:
 - Capsule: stainless steel cylinder with 6.4mm diameter, 17.6mm height
 - AmBe source: cylinder made of homogeneous mix of AmO₂ and Be, 4mm diameter, 4mm height

- Neutrons generated from AmBe disk with standard ISO spectrum
- 59 keV gammas from ²⁴¹Am decay to ²³⁷Np (~10⁵ gammas per neutron)
- 4.38 MeV gammas from α + ⁹Be → ¹²C* + n (~58%)

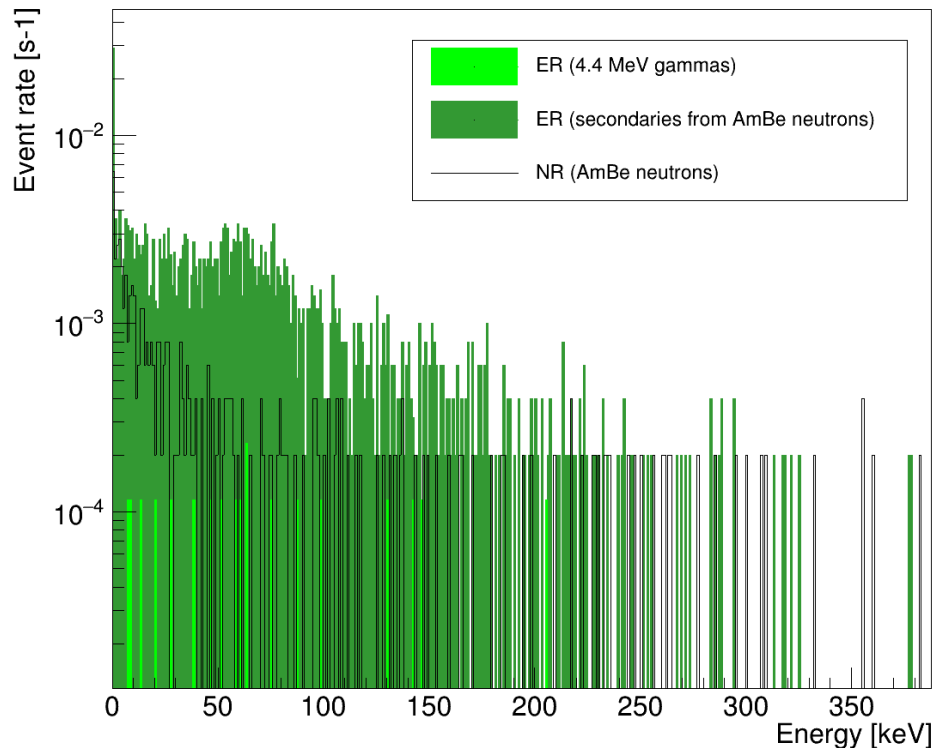
<https://www.sciencedirect.com/science/article/abs/pii/S0969804307001200>

GEANT4 geometry setup

- Copper shielding, 4 cm thickness on all sides
- 100x50x50 cm³ polyethylene box, 2 lead blocks 20x10x5 cm³ , PE blocks below LIME
- Container made of concentric boxes: 1cm PC + 1mm Al + 5cm PU foam + 1mm Al (inner to outer layer)
- Hall made of rock (1m thickness), 25x6.5x11.5 m³
- Virtual surfaces for DAMA, the gallery and the control room, through which the fluxes are computed

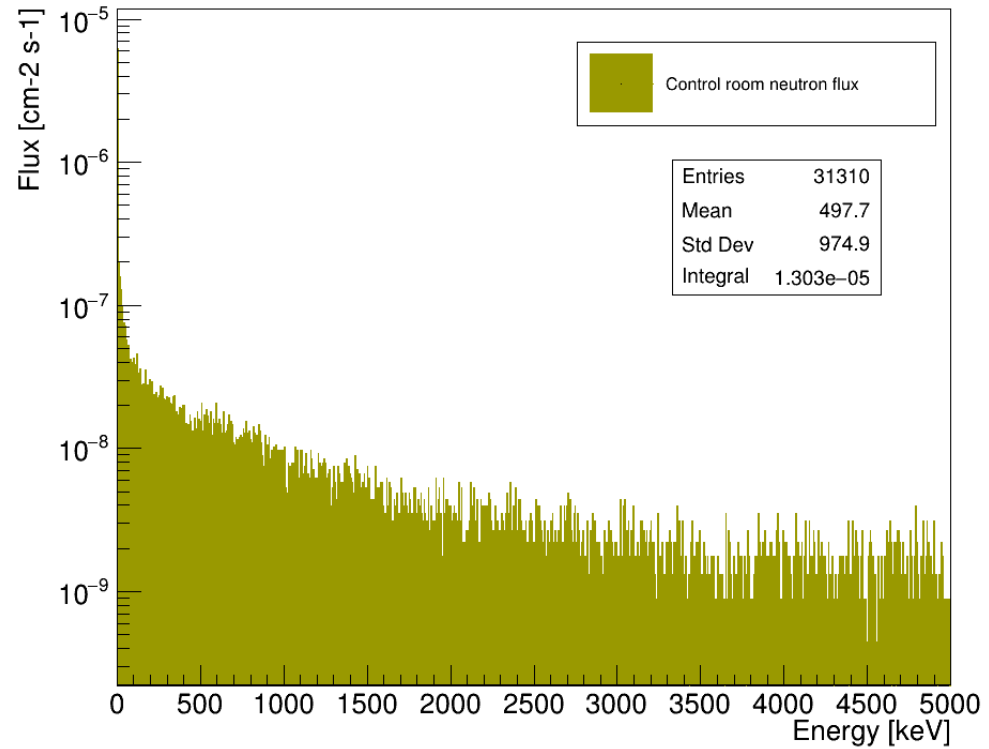
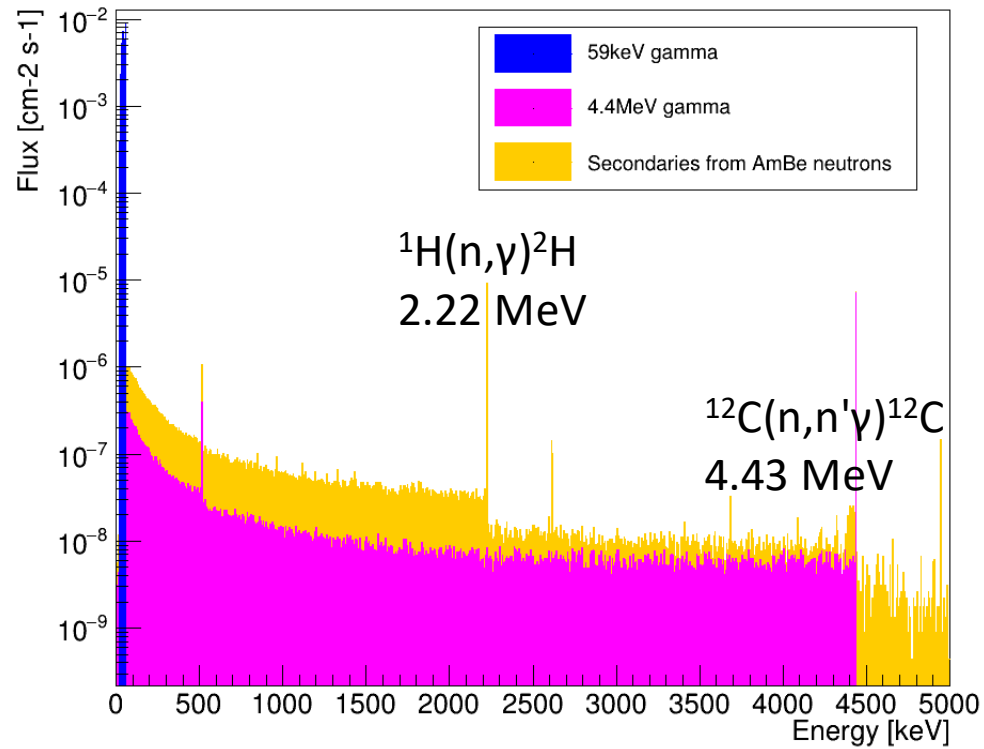


Event rate in detector

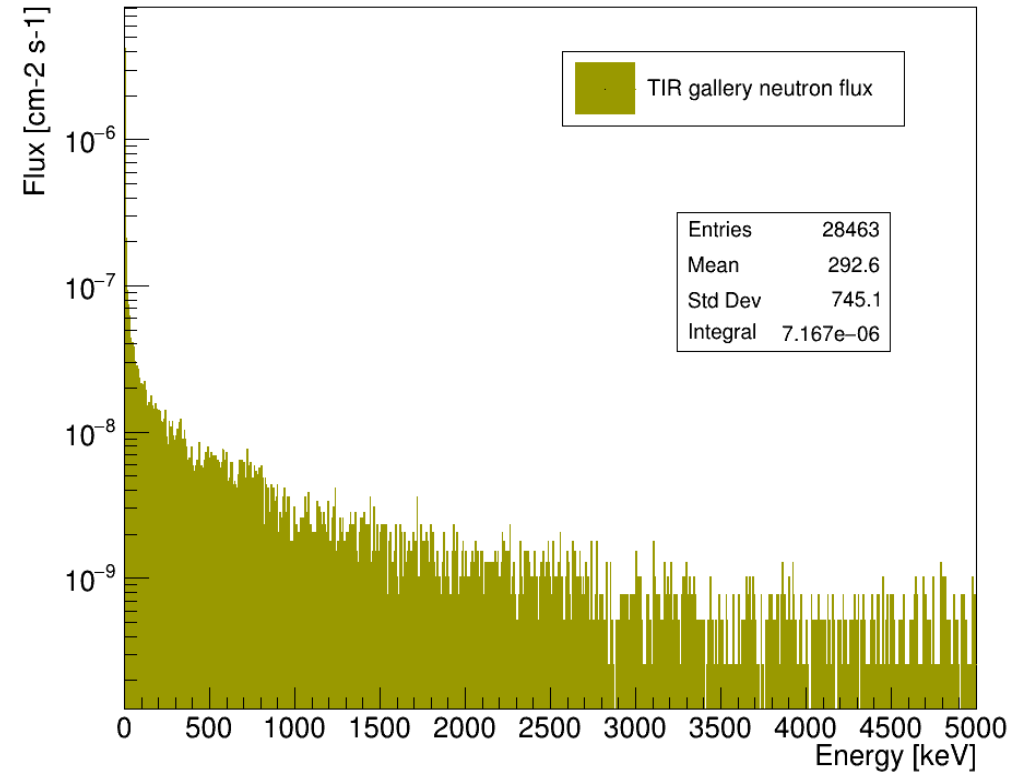
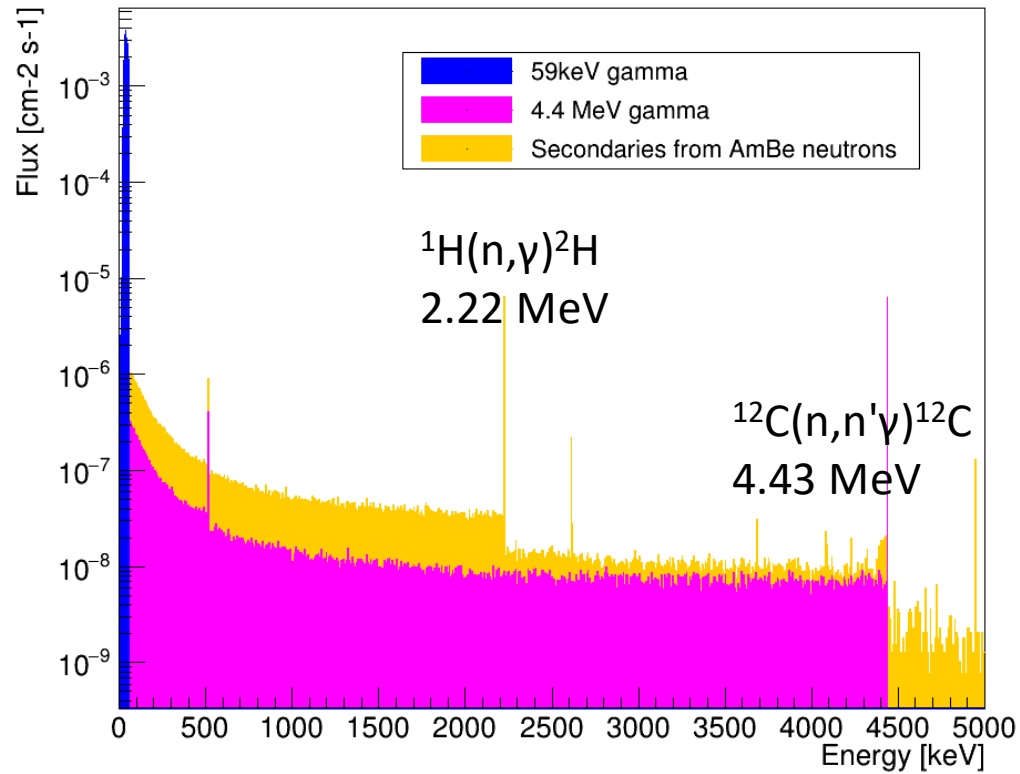


- 59 keV gammas are expected to induce less than 2 ER/s with 4cm of copper
- Secondary events produced by neutrons and 4.4MeV gammas induce 0.3 ER/s
 - <8280 ER/hr (<4320 ER/hr above 20 keV)
- Neutrons from AmBe source induce 0.065 NR/s = 234 NR/hr (122 NR/hr above 20 keV)
- Possible contribution of lead radioactivity: 1.0×10^{-6} events/s per Bq (2.3×10^{-3} events/s if 100Bq/kg)

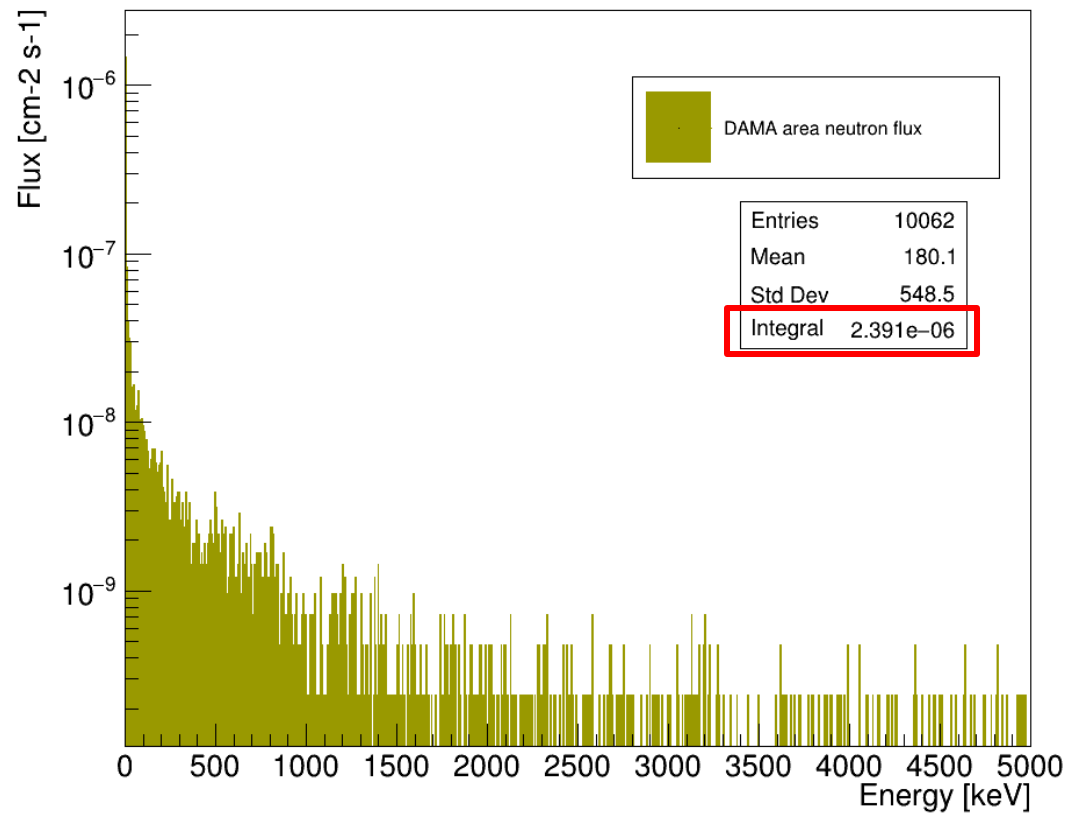
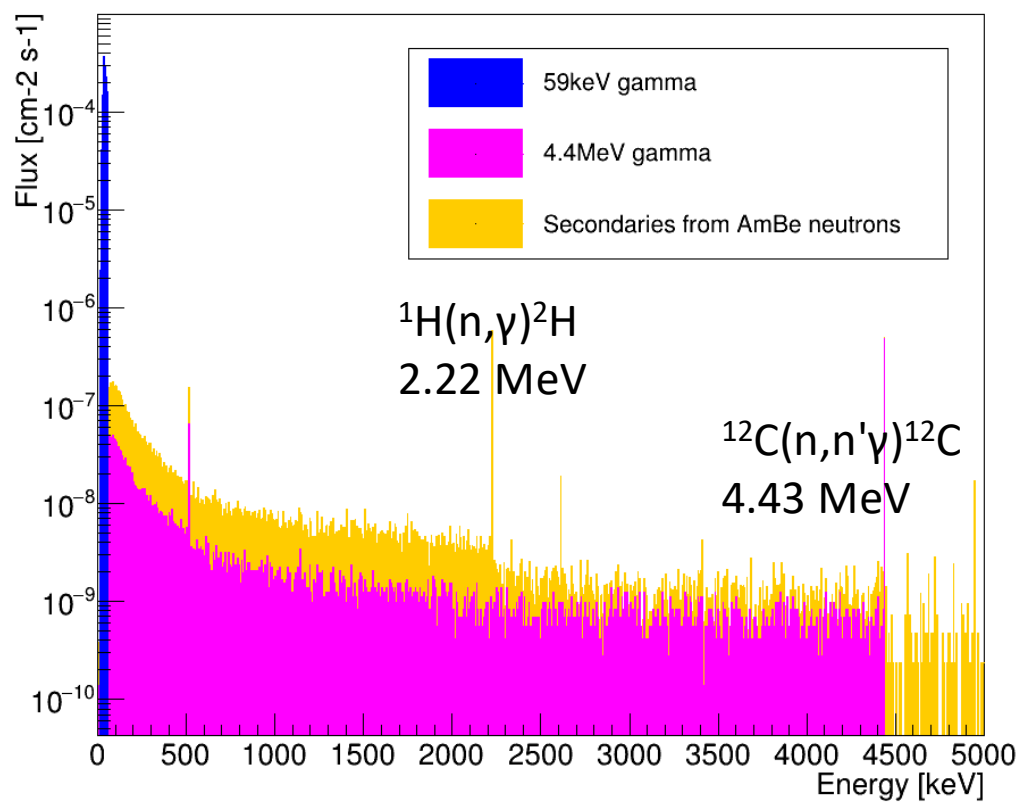
Control room



TIR gallery



DAMA area



Flux summary

- Control room:
 - 0.043 gammas/cm²/s (8% wrt environmental flux)
 - 1.303x10⁻⁵ neutrons/cm²/s (5 times environmental flux)
- Tunnel:
 - 0.019 gammas/cm²/s (3% wrt environmental flux)
 - 7.17x10⁻⁶ neutrons/cm²/s (2.6 times environmental flux)
- DAMA:
 - 0.0016 gammas/cm²/s (0.3% wrt environmental flux)
 - 2.39x10⁻⁶ neutrons/cm²/s (1.07x10⁻⁶ below 100 eV) - 86% of environmental flux
 - **Can we add more polyethylene?**
 - Simplest case: 100x60x60 cm³ PE shield, the flux in the DAMA area becomes 1.91x10⁻⁶ n/cm²/s (9.16x10⁻⁷ below 100 eV) - 69% of environmental flux

