Development of the SCONE detector

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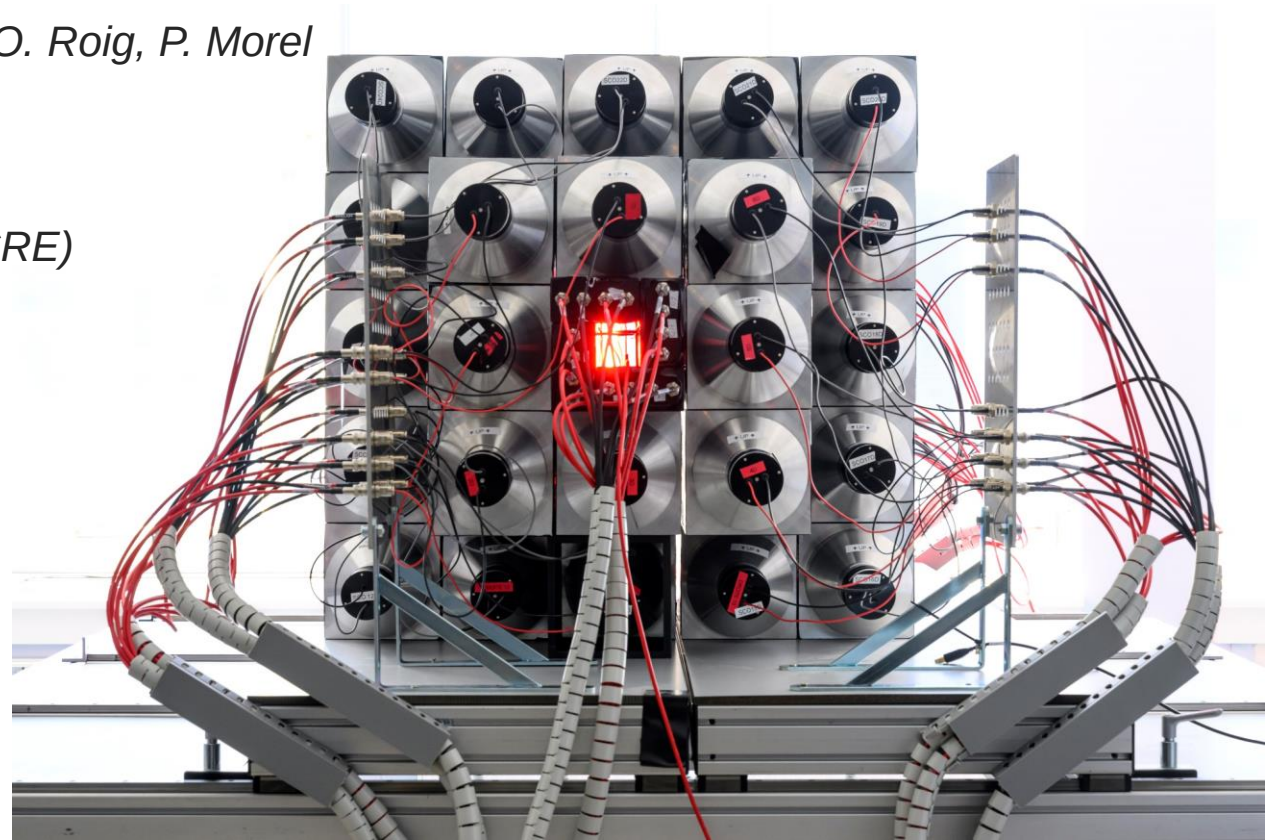


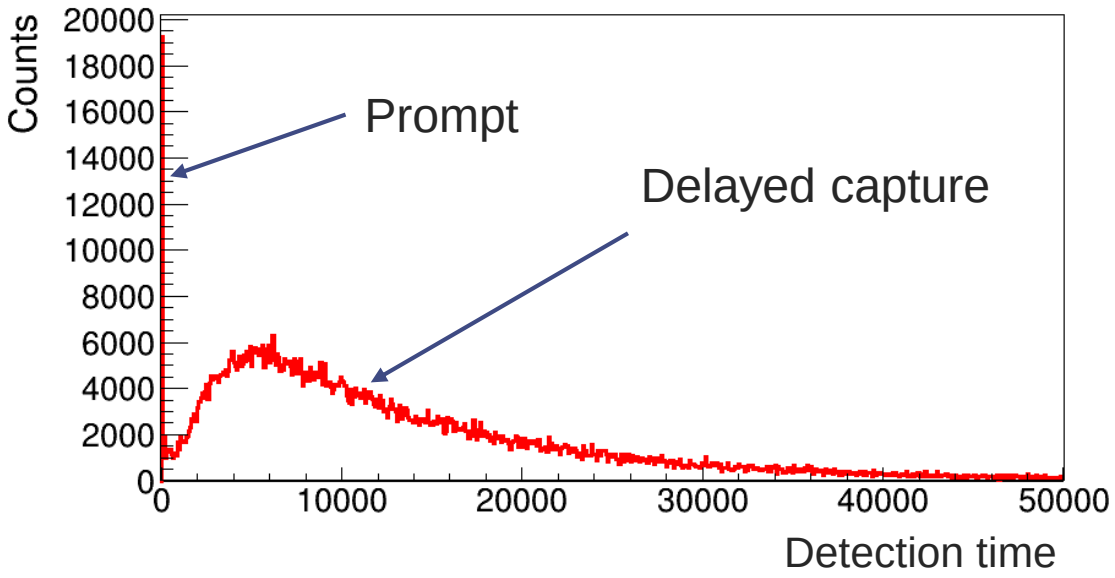
Experimental program at NFS

1. **Measurement of (n,xn) reaction cross-sections : one test experiment. Not enough beam time to demonstrate the feasibility**
2. **Study of prompt neutron and γ-ray emission in neutron induced fission**
   - ✓ **Complete neutron distributions**
   - ✓ **Total γ-ray energy**
   - ✓ **Averaged γ-ray multiplicity**
   - ✓ **Neutrons-γ correlations**
   - ✓ **Complete γ-ray multiplicity distributions**

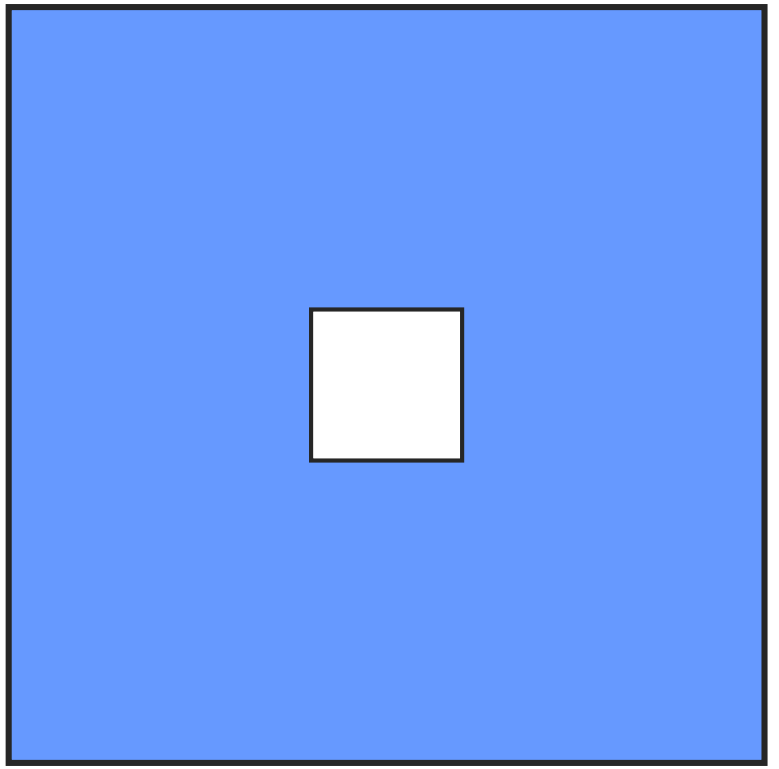
Neutron and γ-ray detection principle

- Neutrons:
  - ✓ Scattering on H → almost all the energy deposited in less than 30 ns → **"prompt signal"**
  - ✓ Radiative capture mainly on Gd (~90 %) after thermalization → **delayed signal** (1 – 50 µs). **Neutron multiplicity** through delayed capture events statistics.
- γ-rays: multiple Compton scattering → on average 55 % of energy deposited in less than 3 ns. **"prompt signal"**

  → **Averaged total γ-ray energy**



Usual Gd-loaded liquid organic scintillator



Particularity of the SCONE setup

- Neutrons:
  - ✓ Scattering on H → almost all the energy deposited in less than 30 ns → **"prompt signal"**
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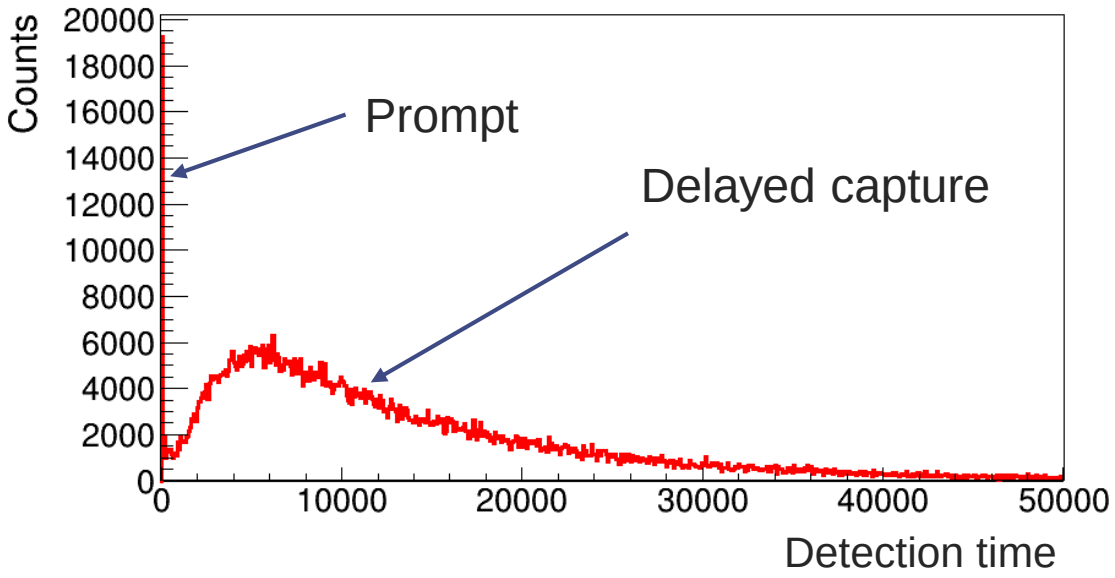
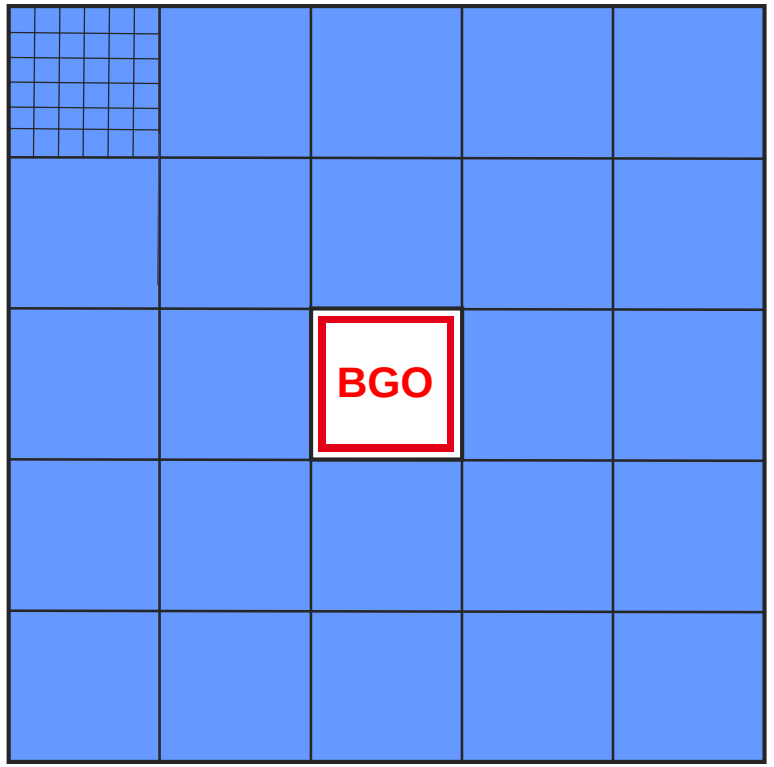
- γ-rays: multiple Compton scattering → on average 55 % of energy deposited in less than 3 ns. **"prompt signal"**

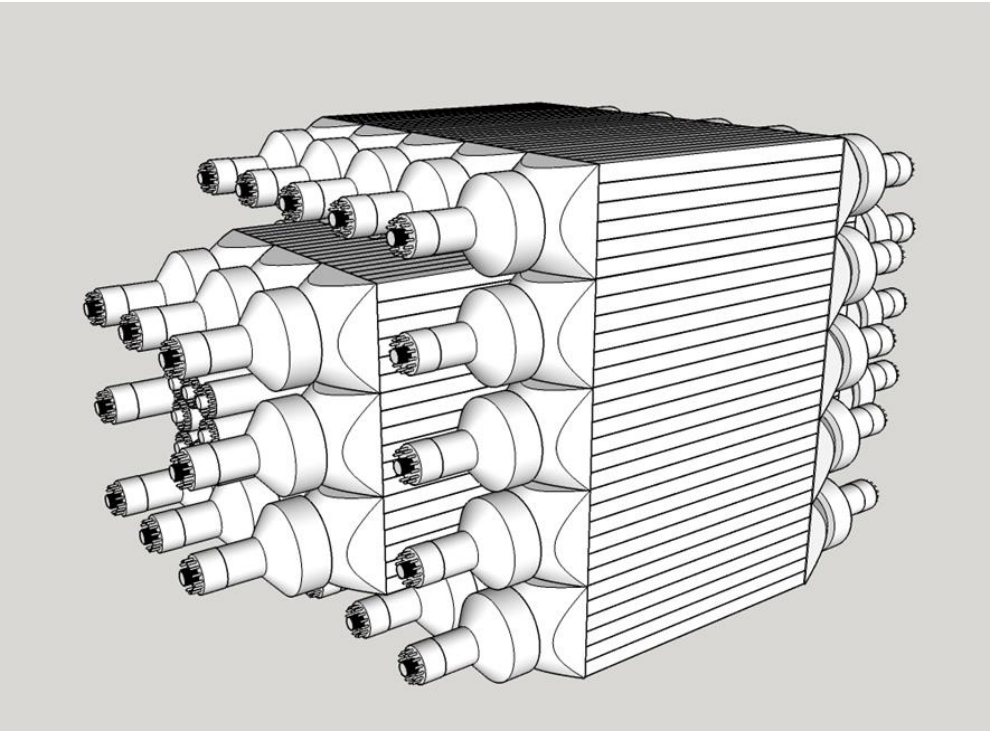
→ **Averaged total γ-ray energy** + **Multiplicity**



Plastic scintillator + Gd foils



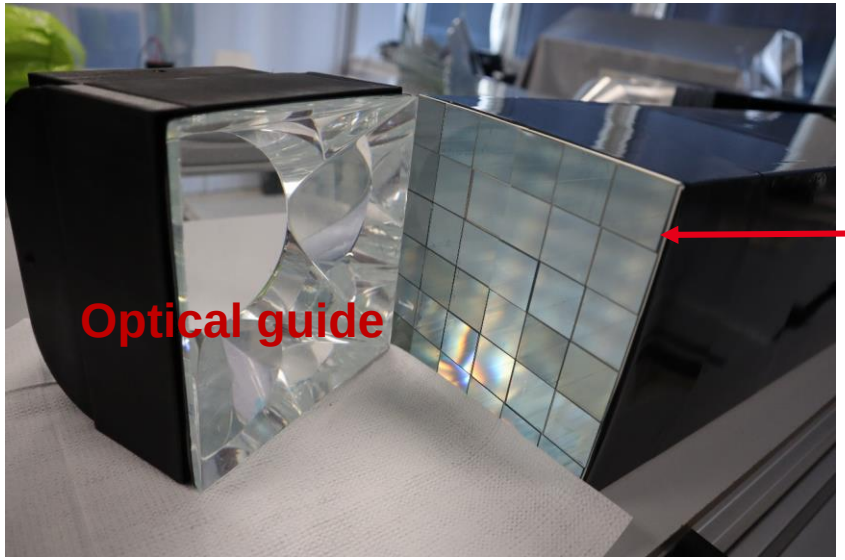
High segmentation + internal BGO array



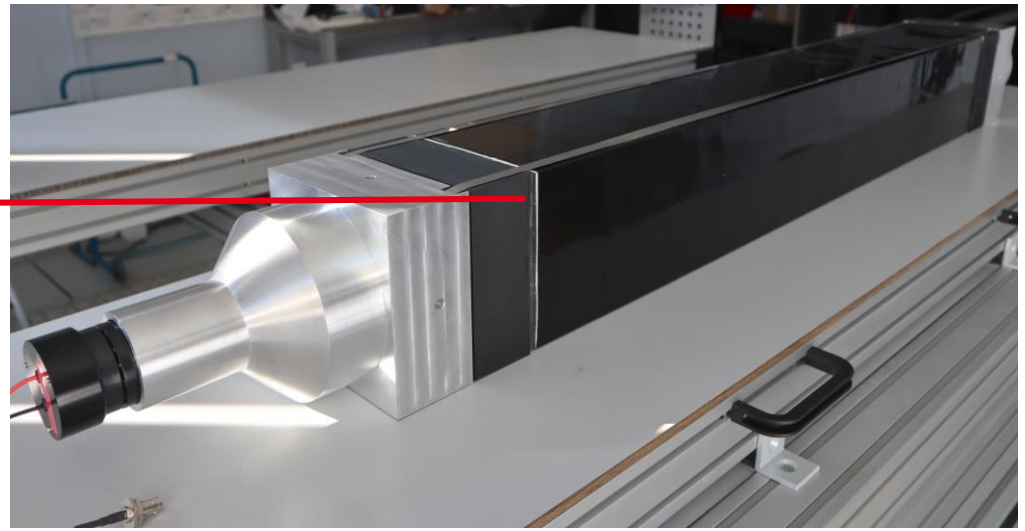
SCONE in few numbers

- **992 plastic scintillator bars (25x25 mm wide)**
- **1984 internal sheets: mirror foils + Gd loaded paint**

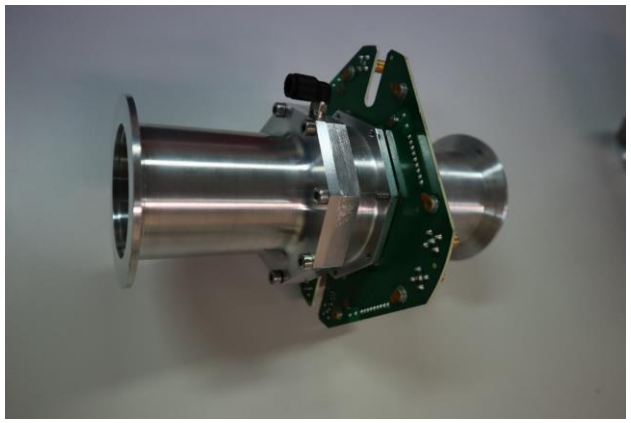
Eight 1 m assemblies (36 bars)
Sixteen 50 cm assemblies (36 bars)
Eight 40 cm assemblies (8 bars)



1 m long assemby

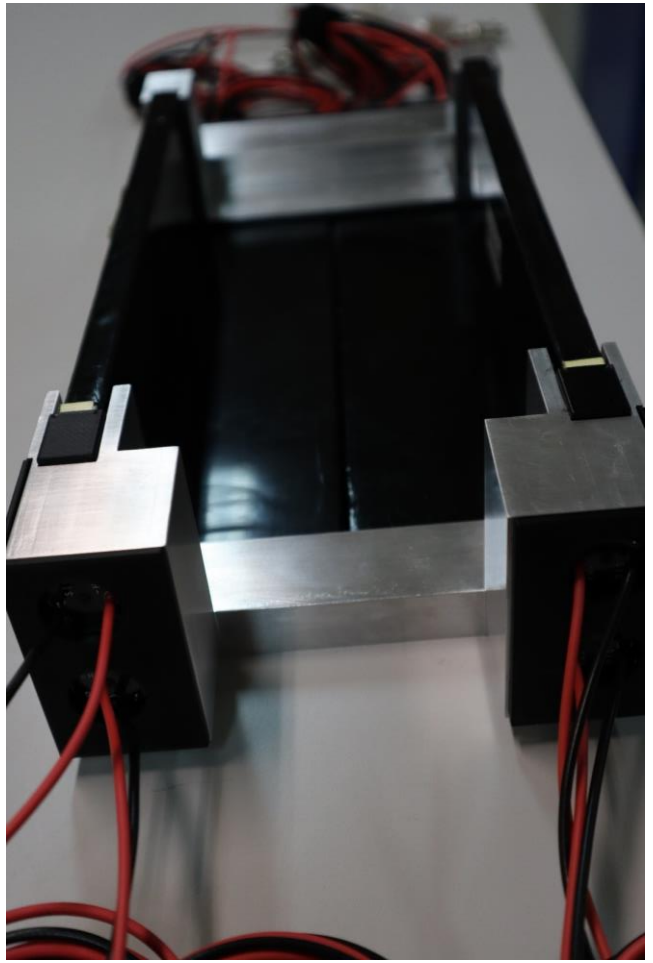


FIC

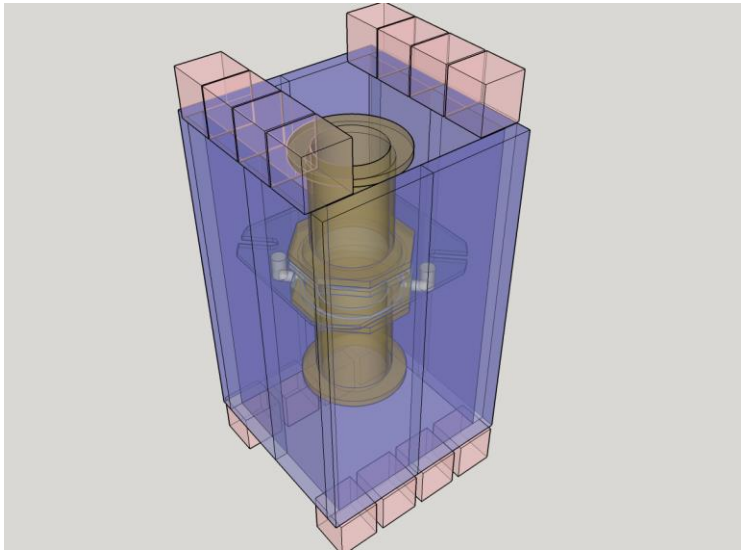


^{238}U deposit from JRC-Geel

Half of the BGO array



1. Setup

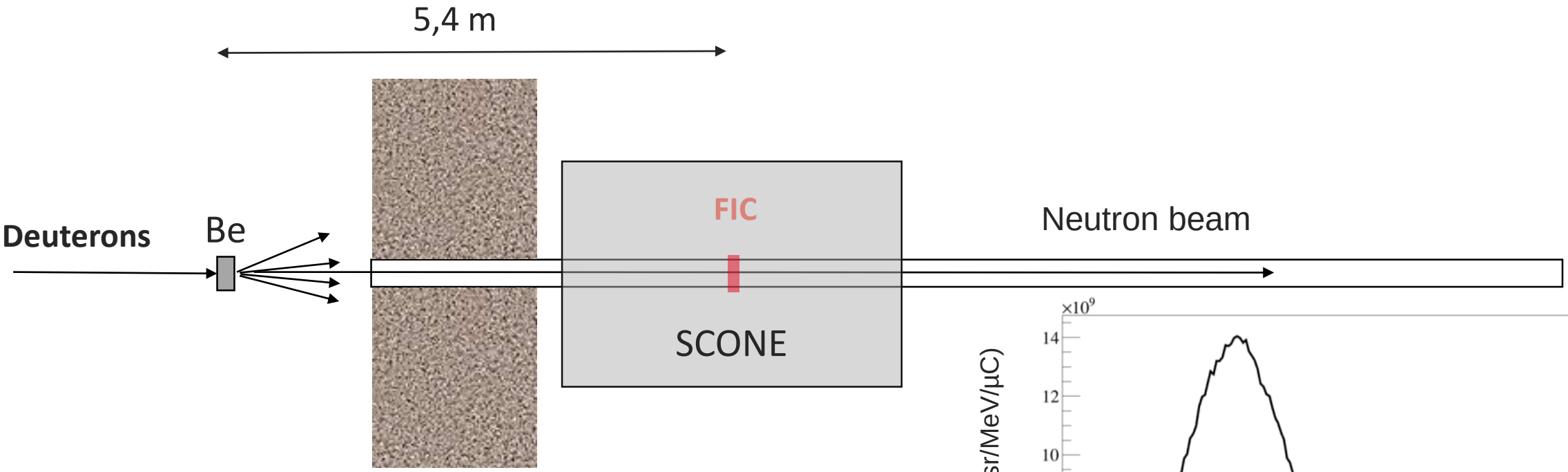


FIC + BGO array

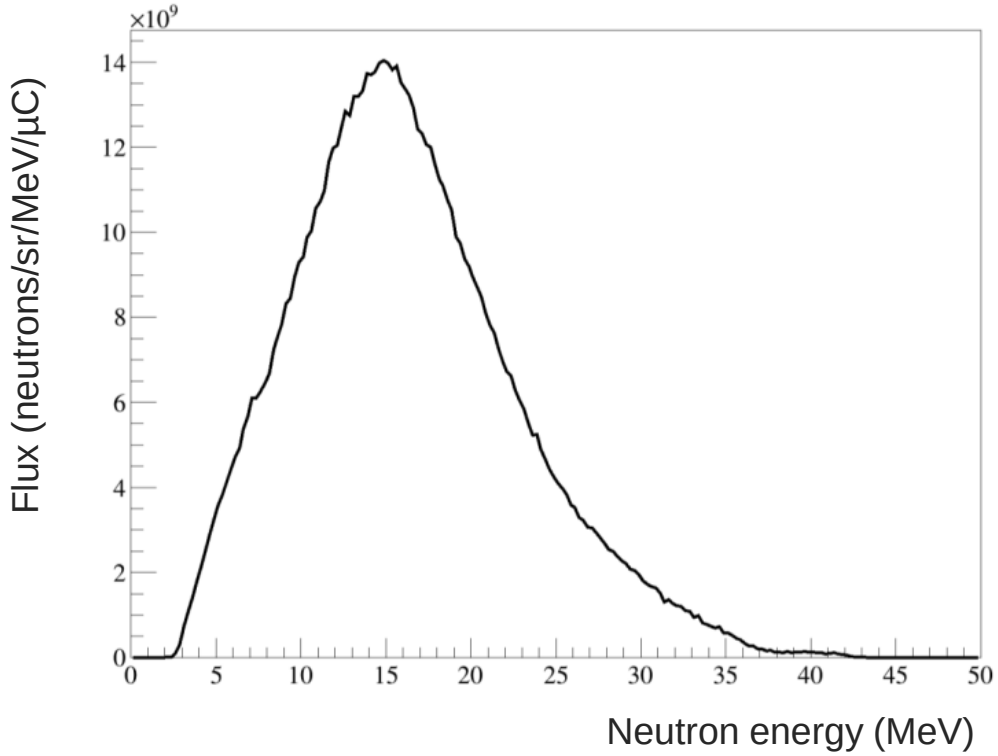
- Compact fission chamber (FIC)
- Internal BGO array → lower the γ-ray energy threshold (~120 keV)
- SCONE detector

48 independent γ-ray detectors → multiplicities

First experiment at GANIL/NFS on ^{238}U

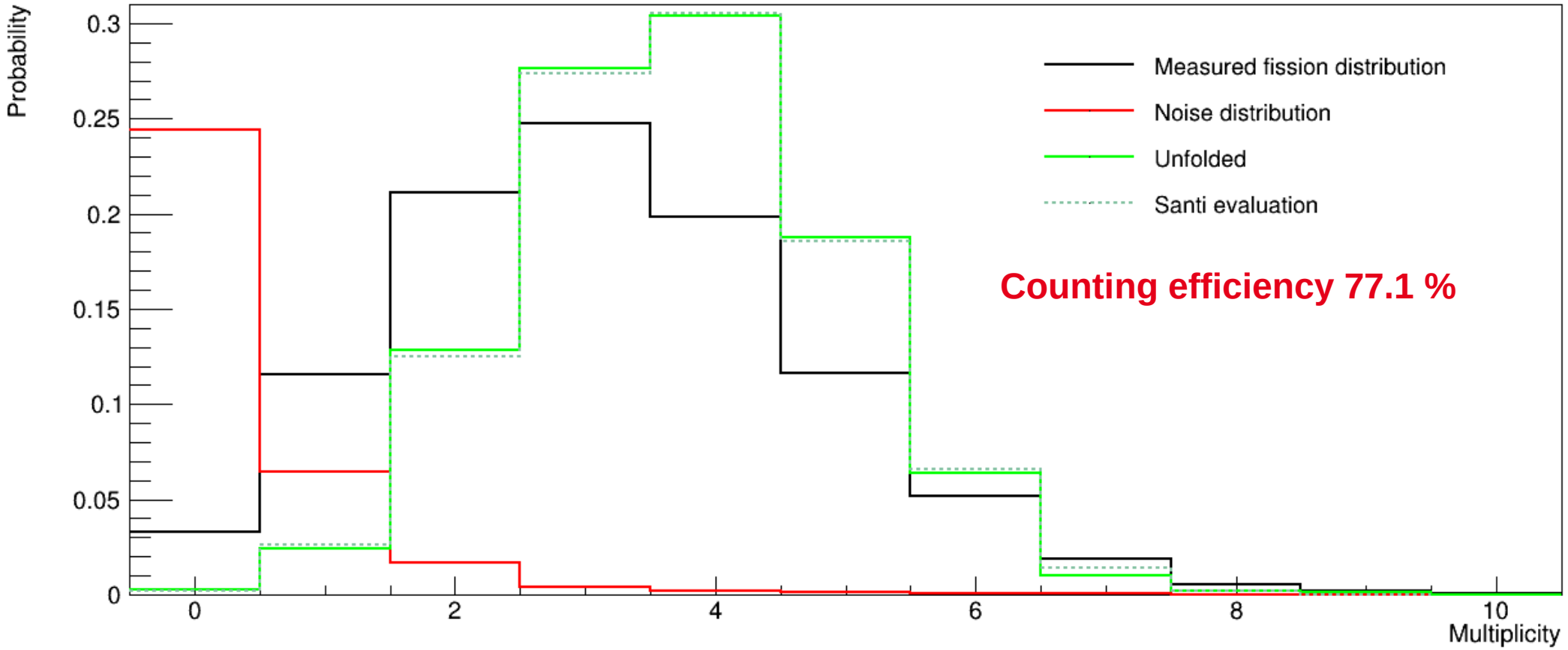


- **Average energy ~15 MeV**
- **10^5 n/s on target at 120 nAe**
- **3 samples 13 mg total**

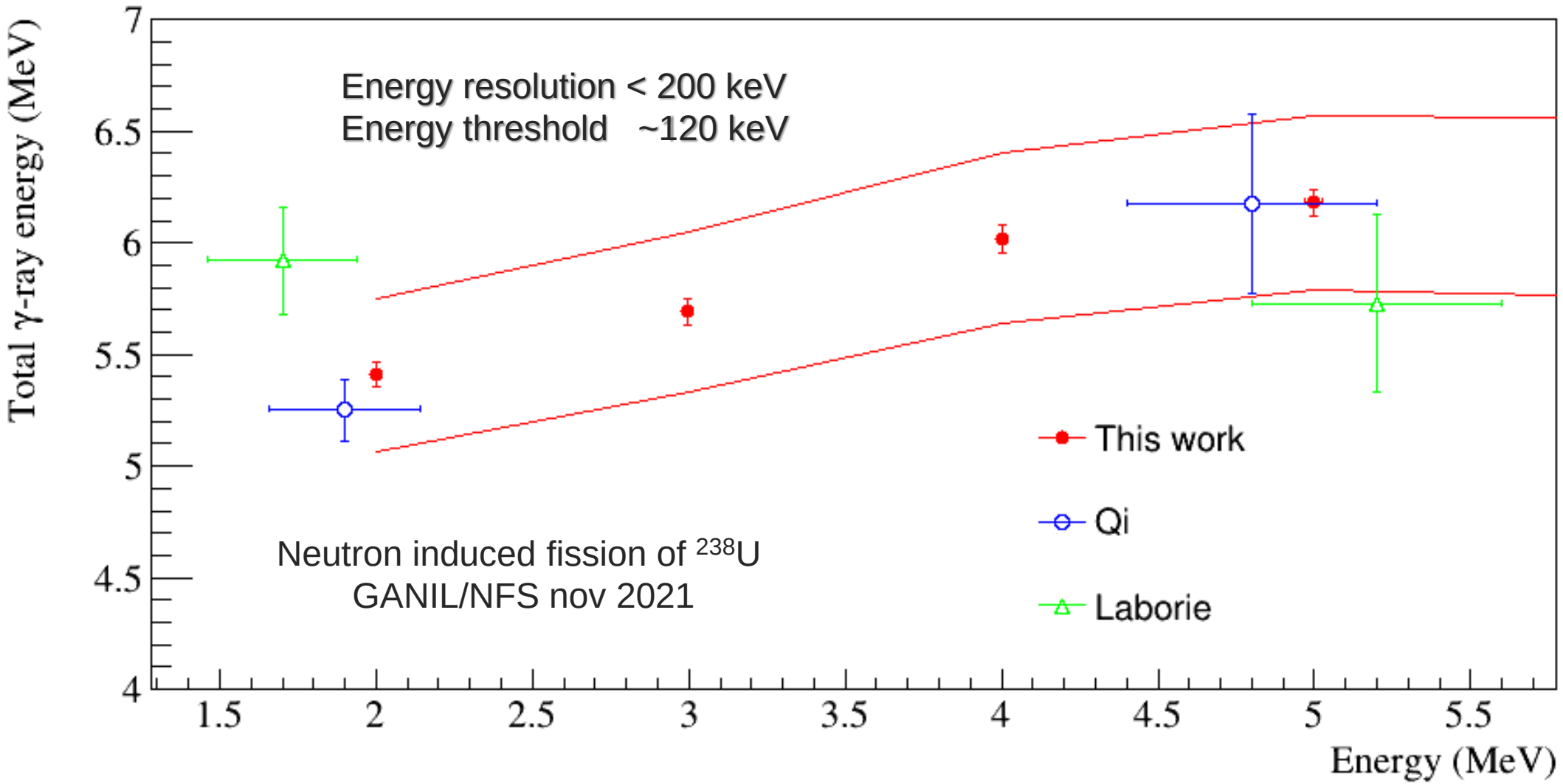


Neutron multiplicities

^{252}Cf spontaneous fission



Prompt fission γ-ray calorimetry



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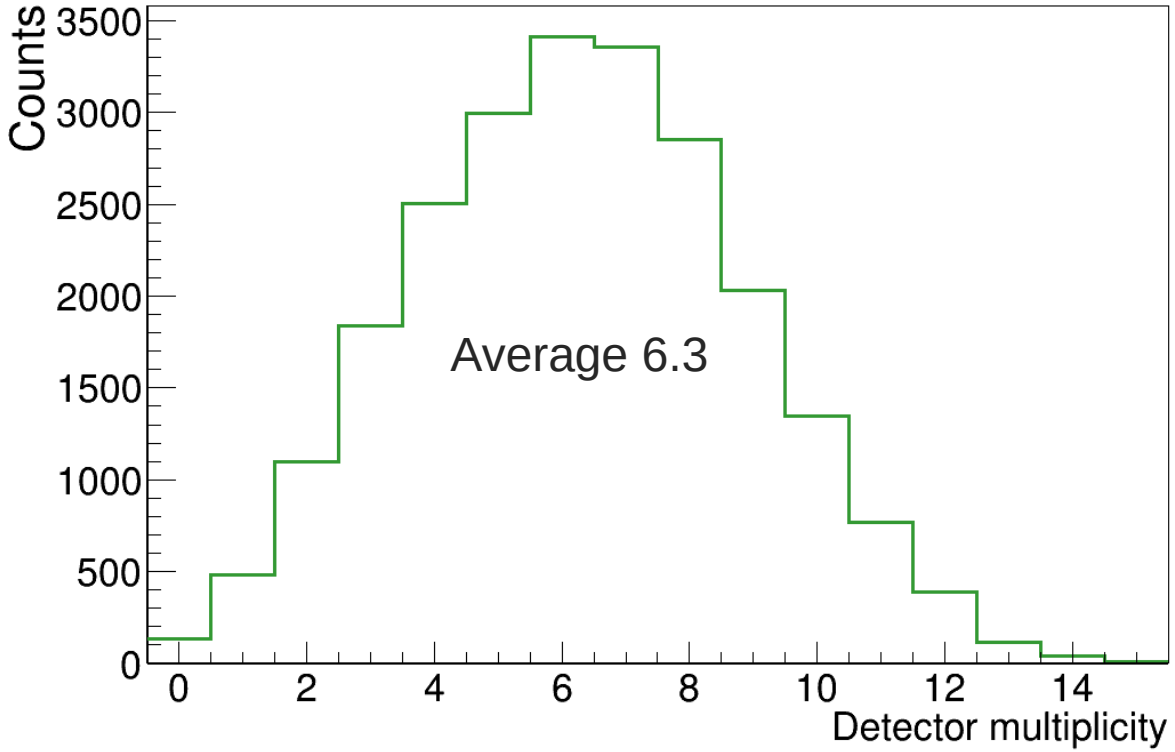

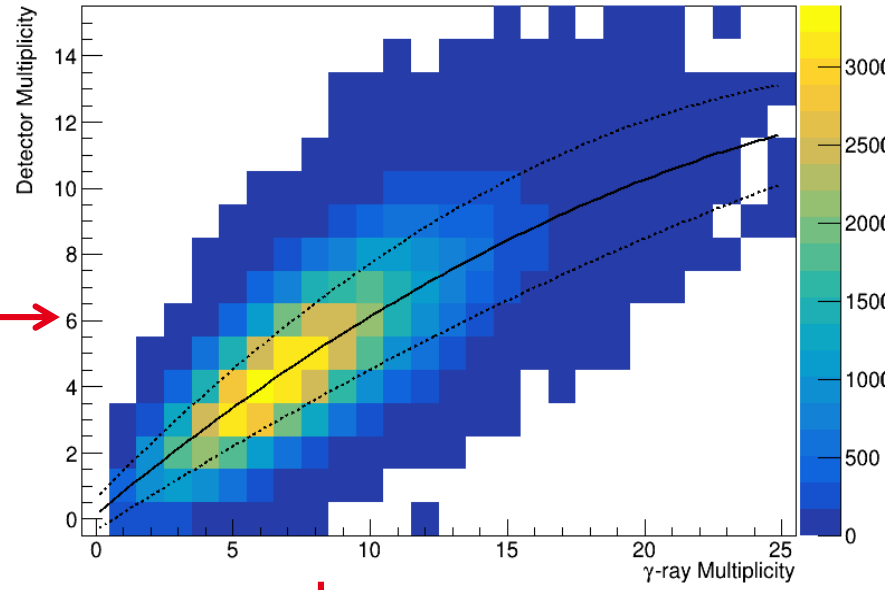

8.5±0.4 for E_γ > 120 keV

Conclusion

- Cross-section measurement for (n,xn) reactions to be demonstrated
- First complete neutron multiplicity obtained for high averaged multiplicities:

  original method for P_ν unfolding (B. Fraïsse et al. PRC 108, 014610)
- Prompt fission γ-ray calorimetry
- First large volume detector able to measure averaged γ-ray multiplicities
- Complete $P\gamma$ distributions can be obtained