university of groningen

energy ESRIG sustainability

^{206,208}Pb (n,n) & (n,n`γ) cross section measurements with the ELISA neutron spectrometer @GELINA

Jisk Knijpstra

Talys Workshop @ICTP
October 2023

Groningen

KVI building

Nuclear energy research group

- Hadron, hypernuclear, heavy ion physics *@GSI FAIR*
- Nuclear cross section measurements *@JRC-Geel GELINA*

The need for nuclear cross section data

Gen. IV reactors

- Fast reactors
- ^{232}Th / ^{233}U fuel cycle
- Cross section uncertainties are propagated in reactor models

⇒ Improve nuclear data libraries

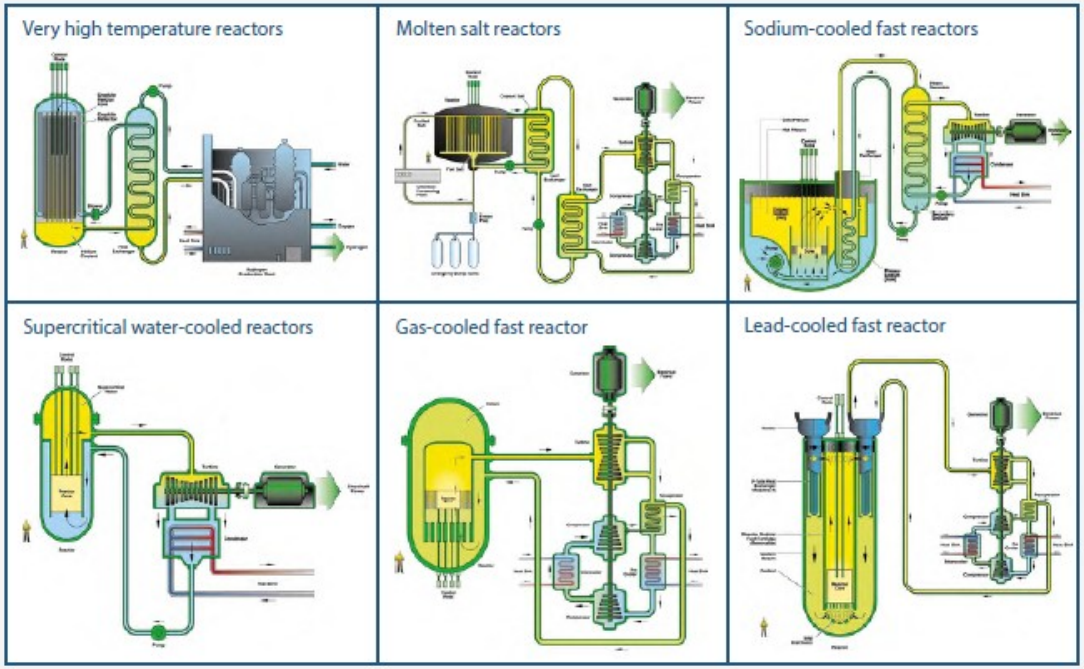

Figure 1: Generation IV International Forum [gen-4.org]

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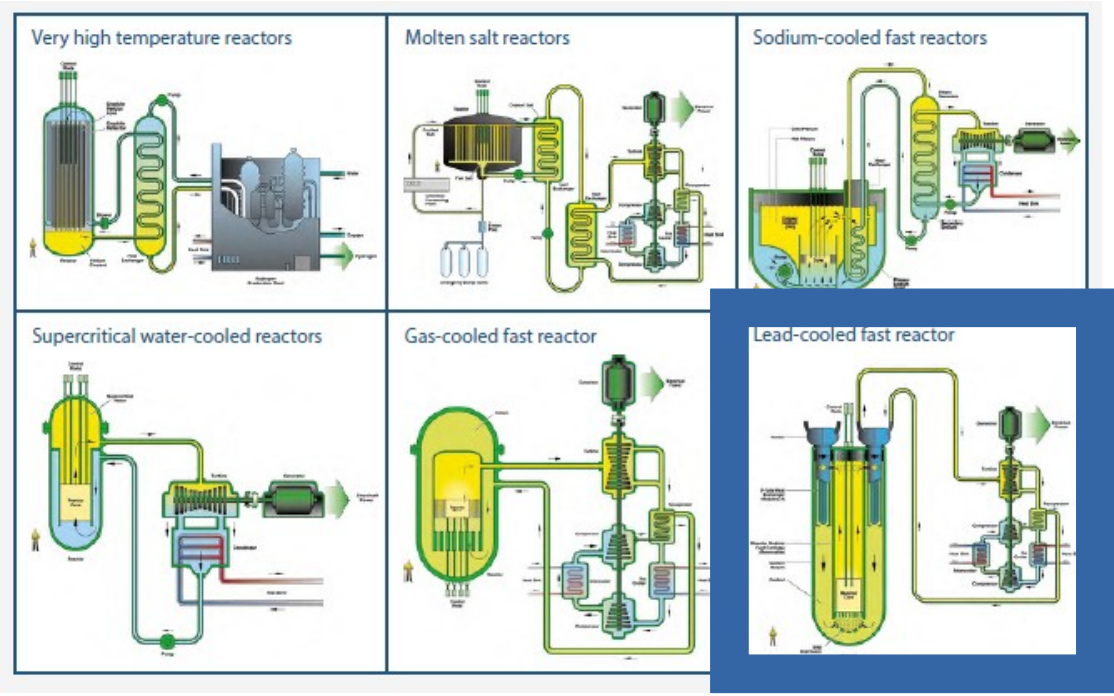


Figure 1: Generation IV International Forum [gen-4.org]

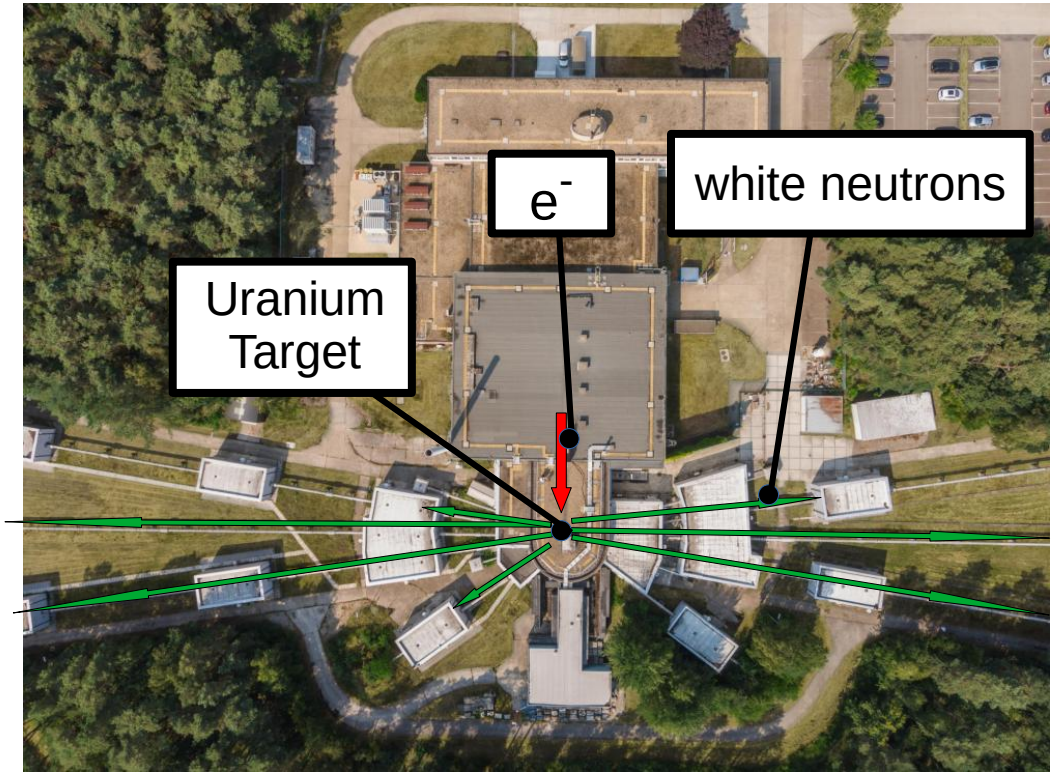
^{206,208}Pb cross sections for **ALFRED**

(Advanced Lead-cooled Fast Reactor European Demonstrator, Romania, 300 MW)

GELINA facility

LINAC-driven pulsed white neutron source
- 800 Hz repetition rate
- few eV to 20 MeV neutrons
- ~1 ns spread (FWHM)

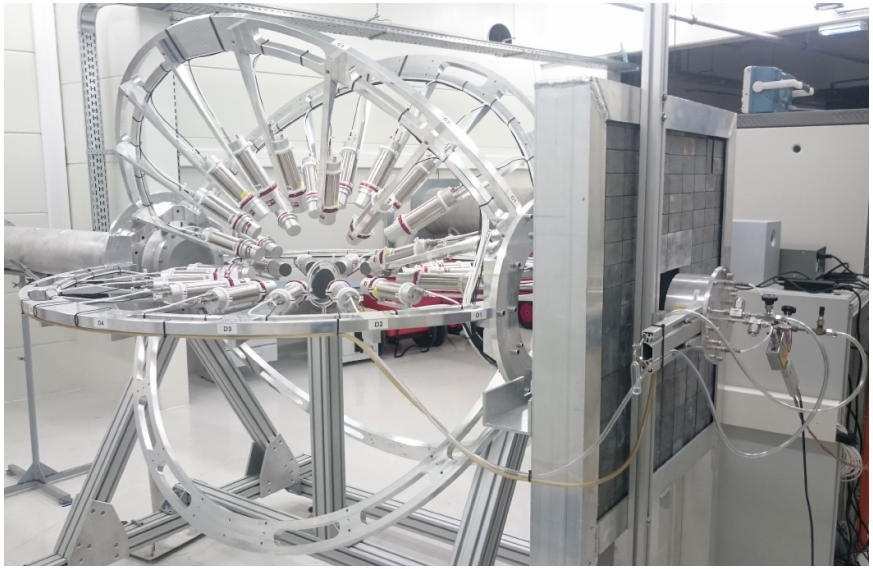
2 HPGe arrays: GAINS & GRAPhEME (n,xnγ)
1 liquid organic scintillator array: **ELISA** **(n,n) & (n,n`γ)**



ELISA neutron spectrometer

- 27 m flight path
  ➔ t.o.f. ⇔ neutron energy

- 32 liquid organic scintillators:
  16 EJ301 + 16 EJ315



E. Pirovano, PhD thesis

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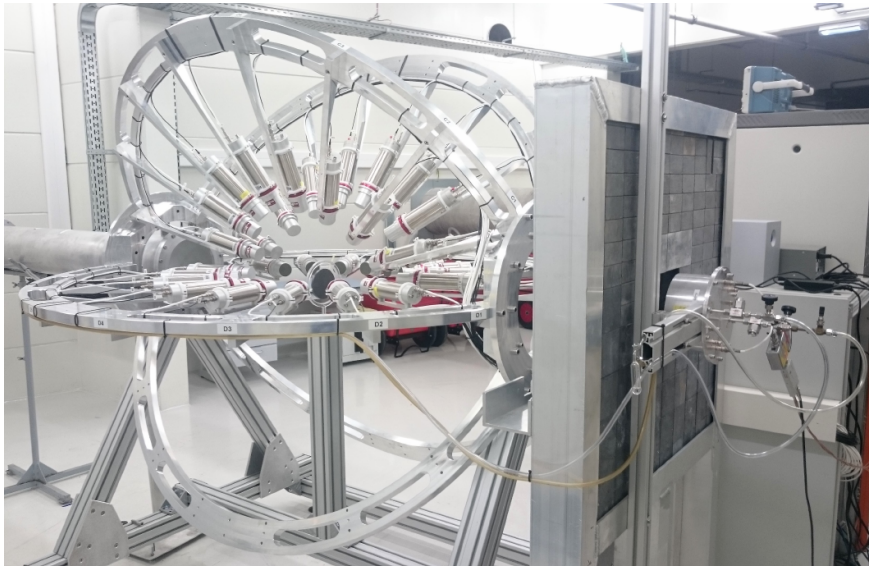

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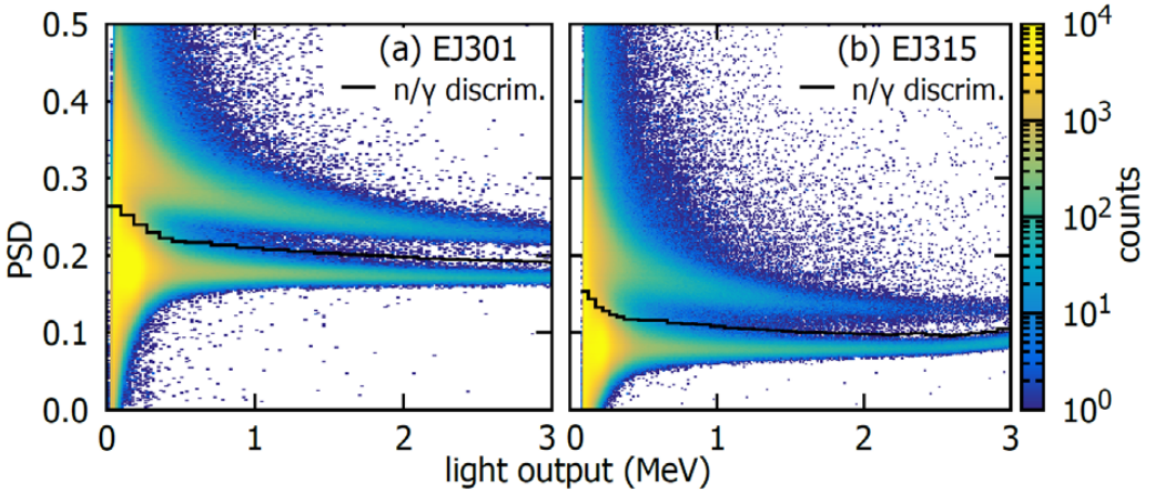

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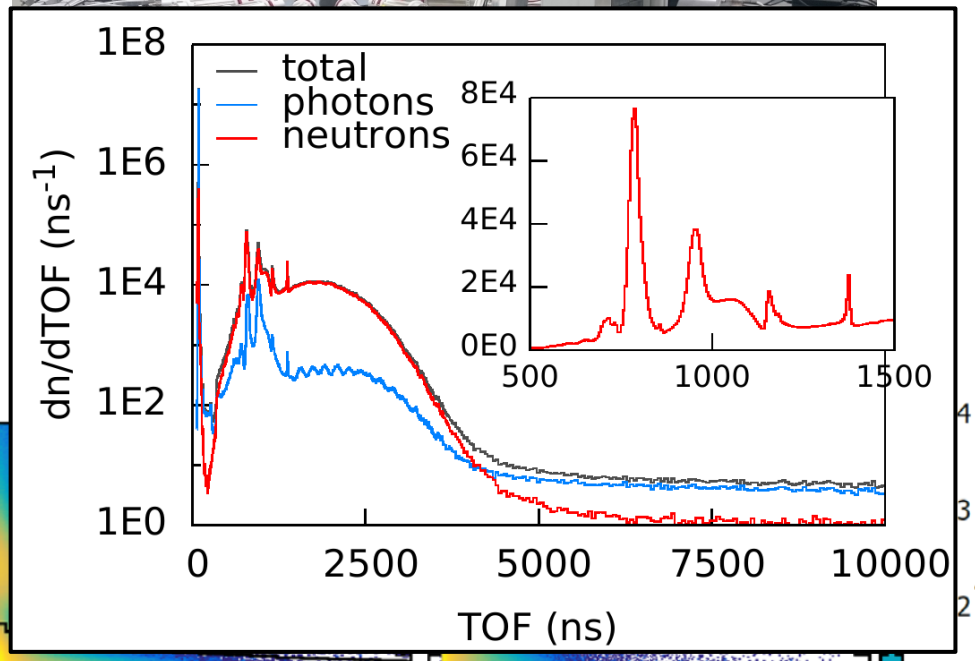

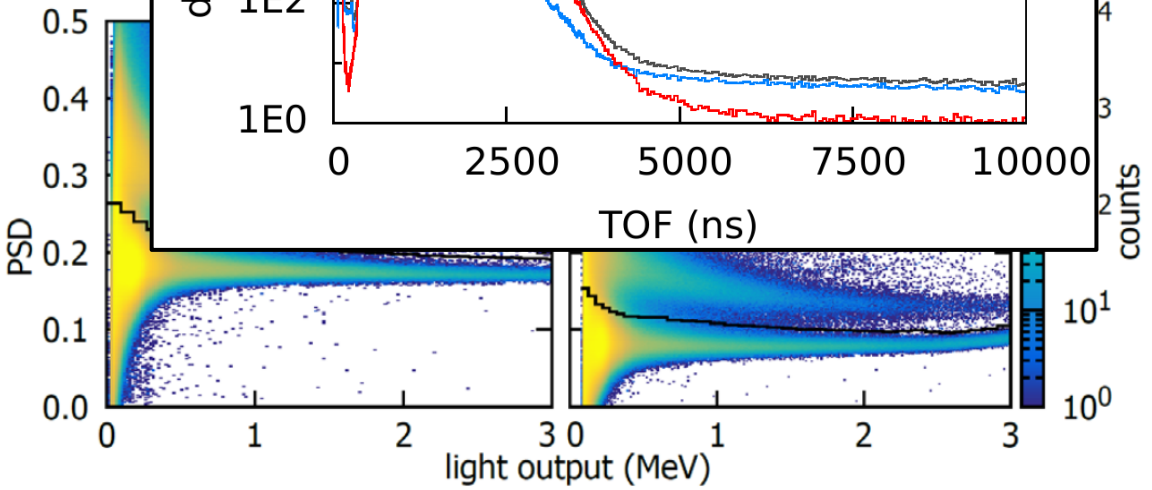

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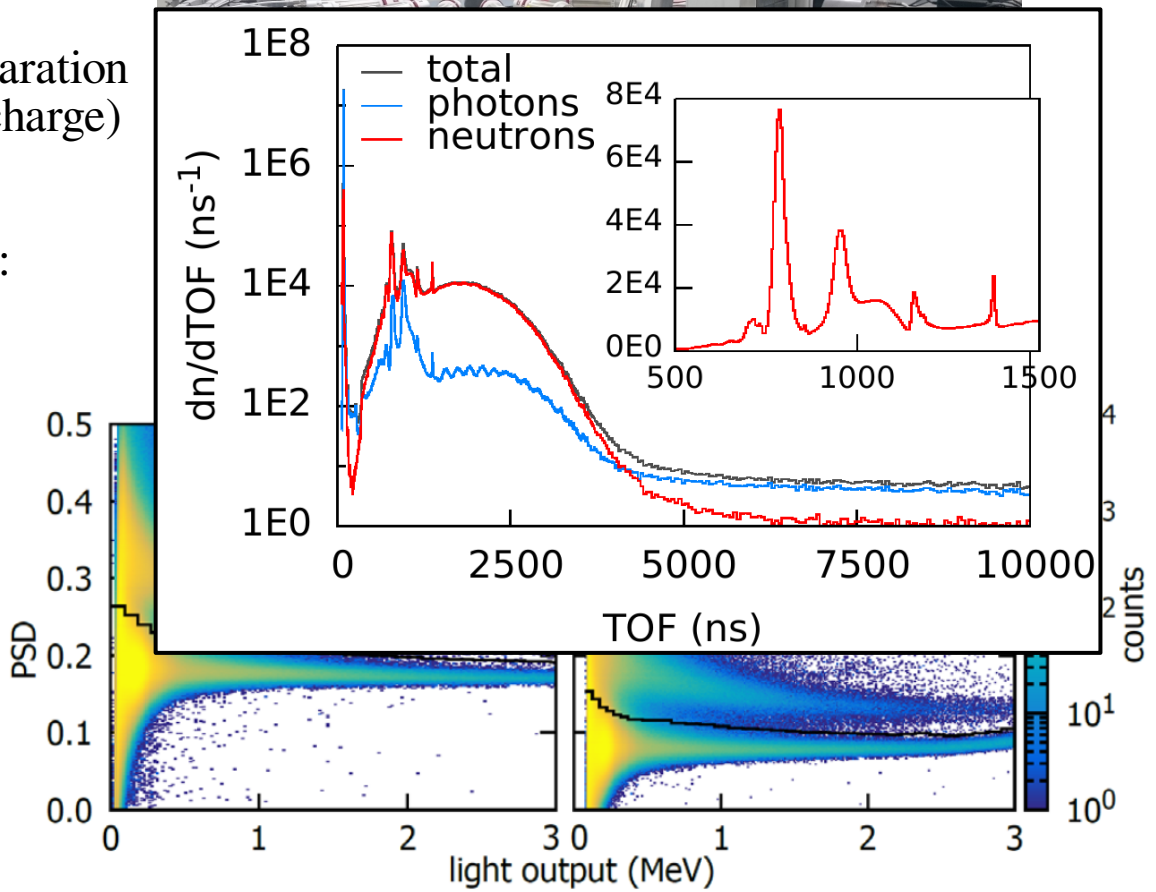

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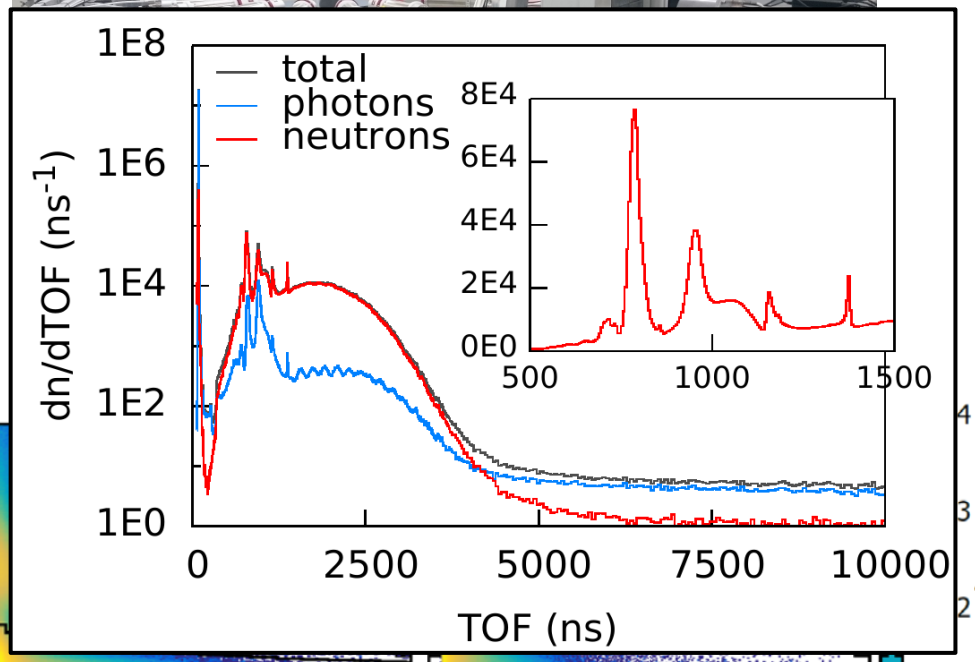
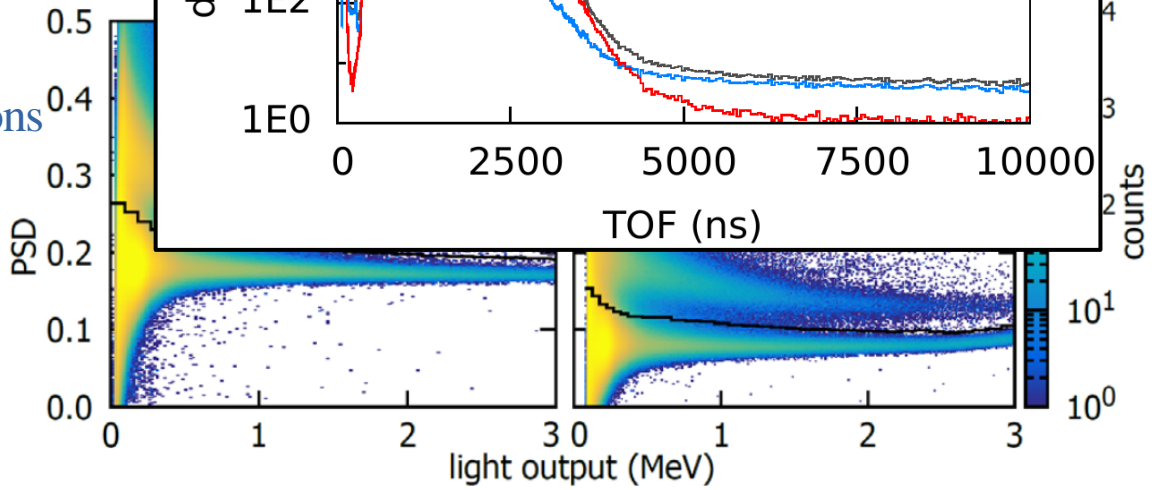
Background due to:

- time-independent room-return neutrons
  - ➔ averaging t.o.f. > 9000 ns bins





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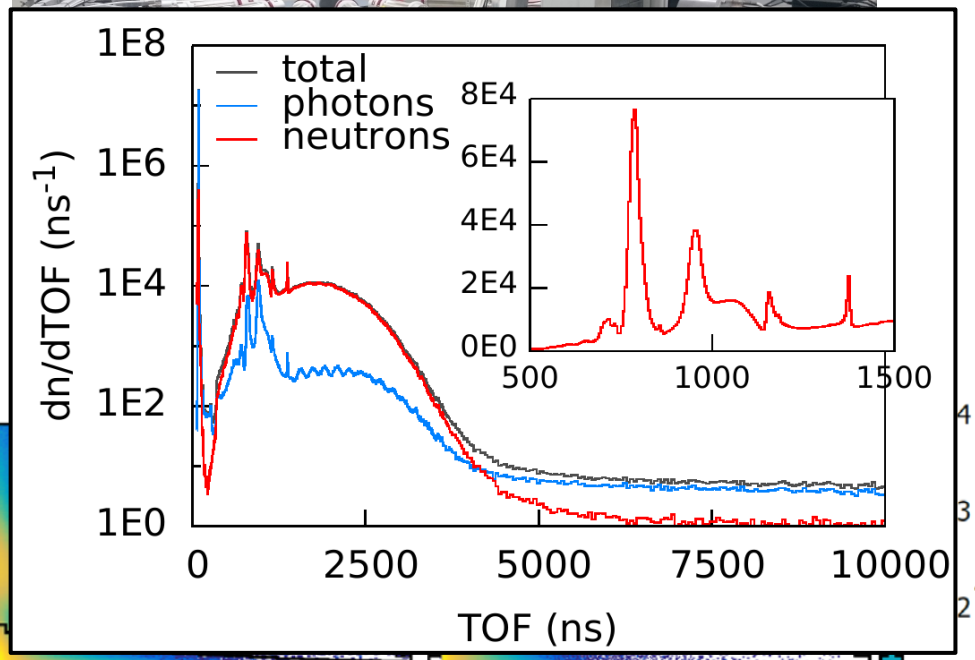
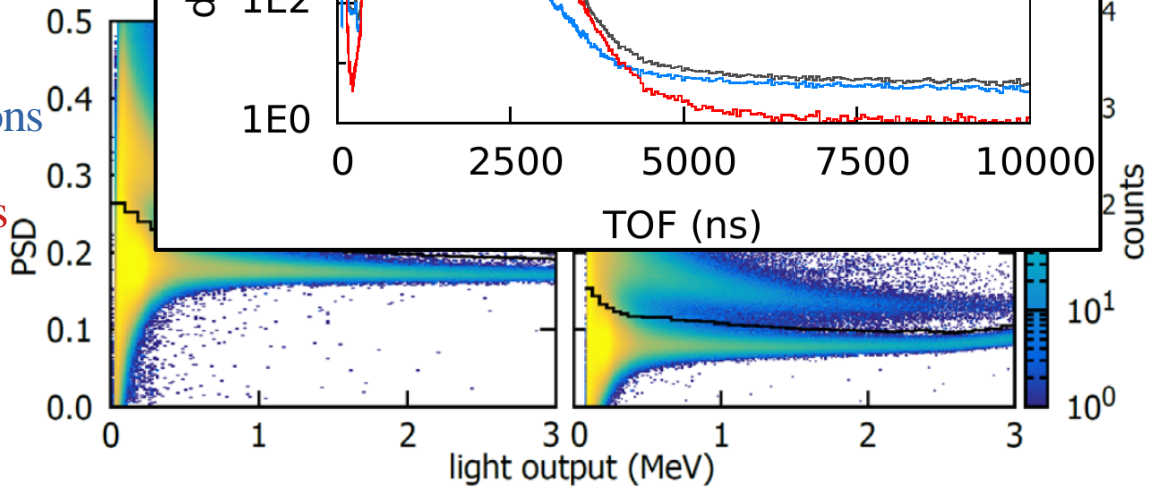
- time-dependent air scattered neutrons





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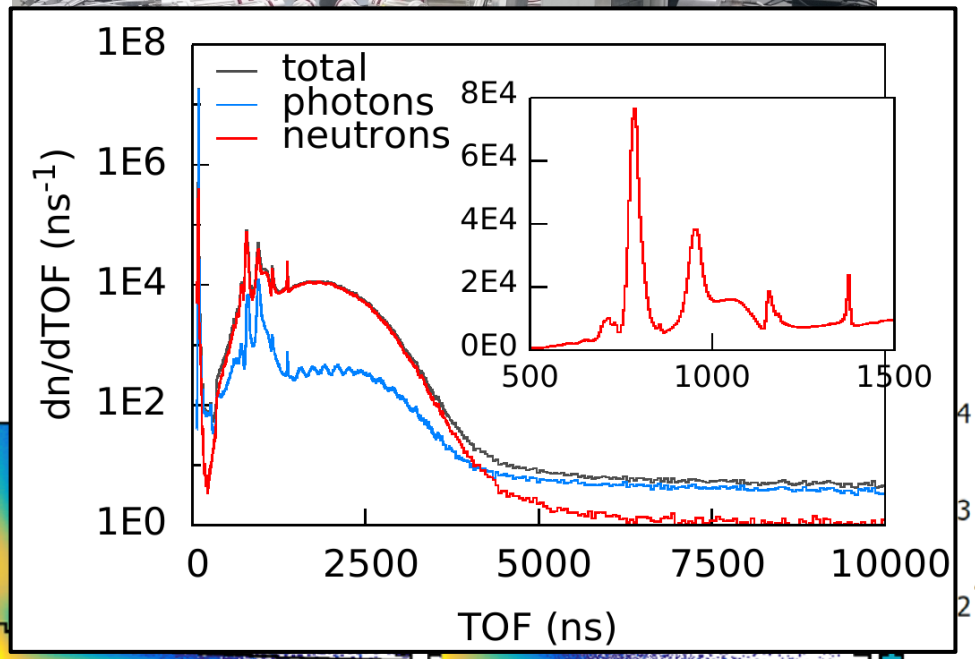
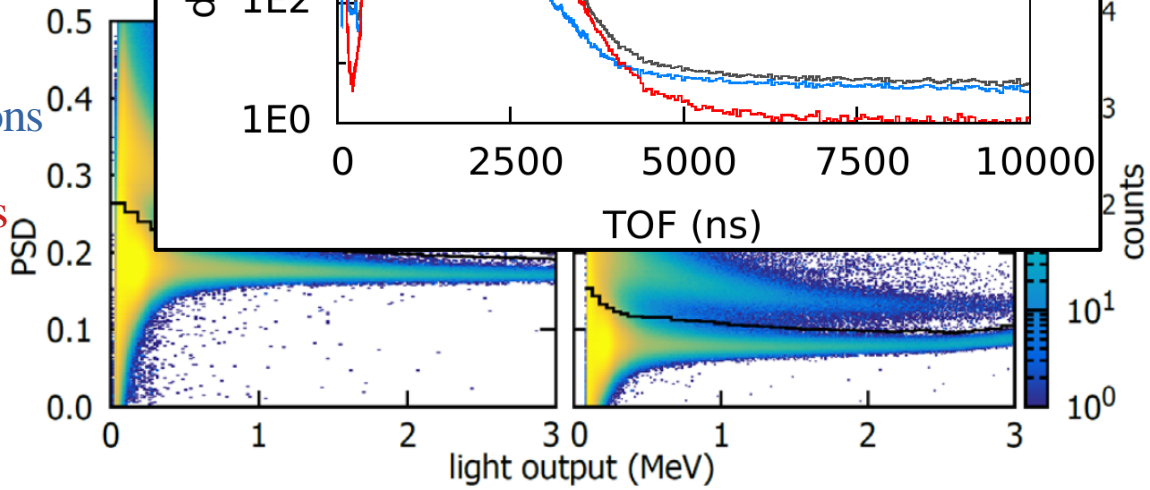




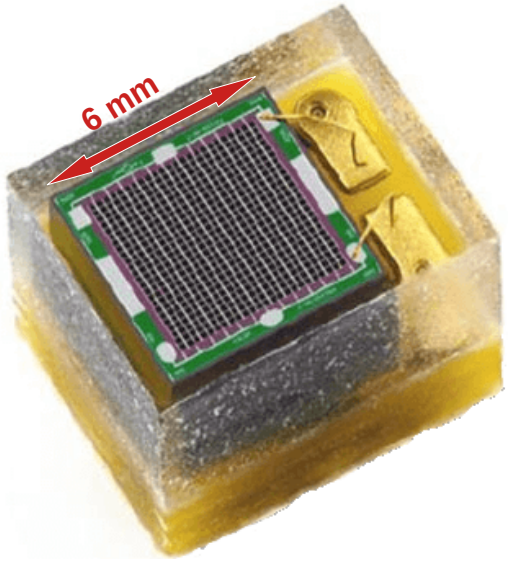
Background due to:

- time-independent room-return neutrons
  - ➔ averaging t.o.f. > 9000 ns bins
- time-dependent air scattered neutrons
  - ➔ sample out measurements
    - OR -
  - ➔ place setup in vacuum

ELISA upgrade plans

PMTs produce heat – problematic in vacuum
- ➔ replace with SiPM readout (MPPC)

Extend setup with 4 NaI(Tl) detectors
- ➔ detect n,γ coincidences
- ➔ improve inelastic cross section precision



SiPM/MPPC: pixel sensors based on single-photon avalanche diodes