Application of energy resolved neutron imaging at n_TOF EAR2

Letter of Intent to the INTC

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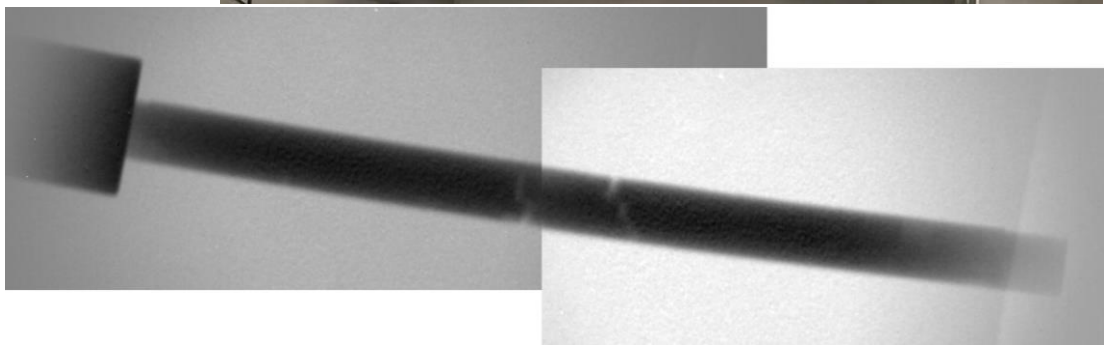
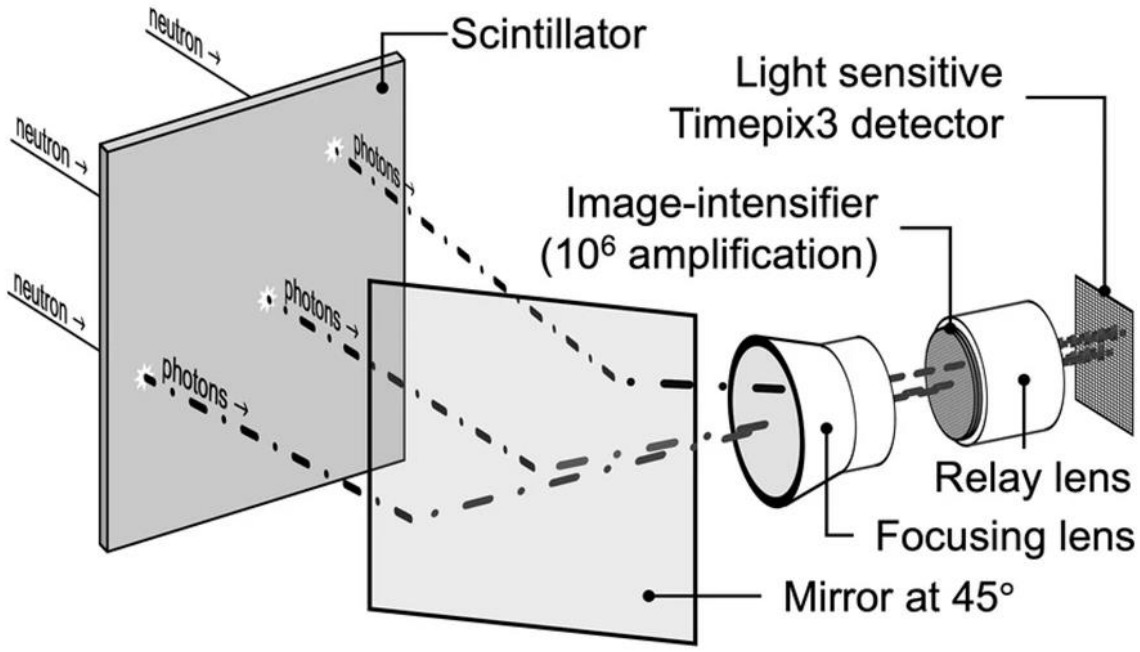
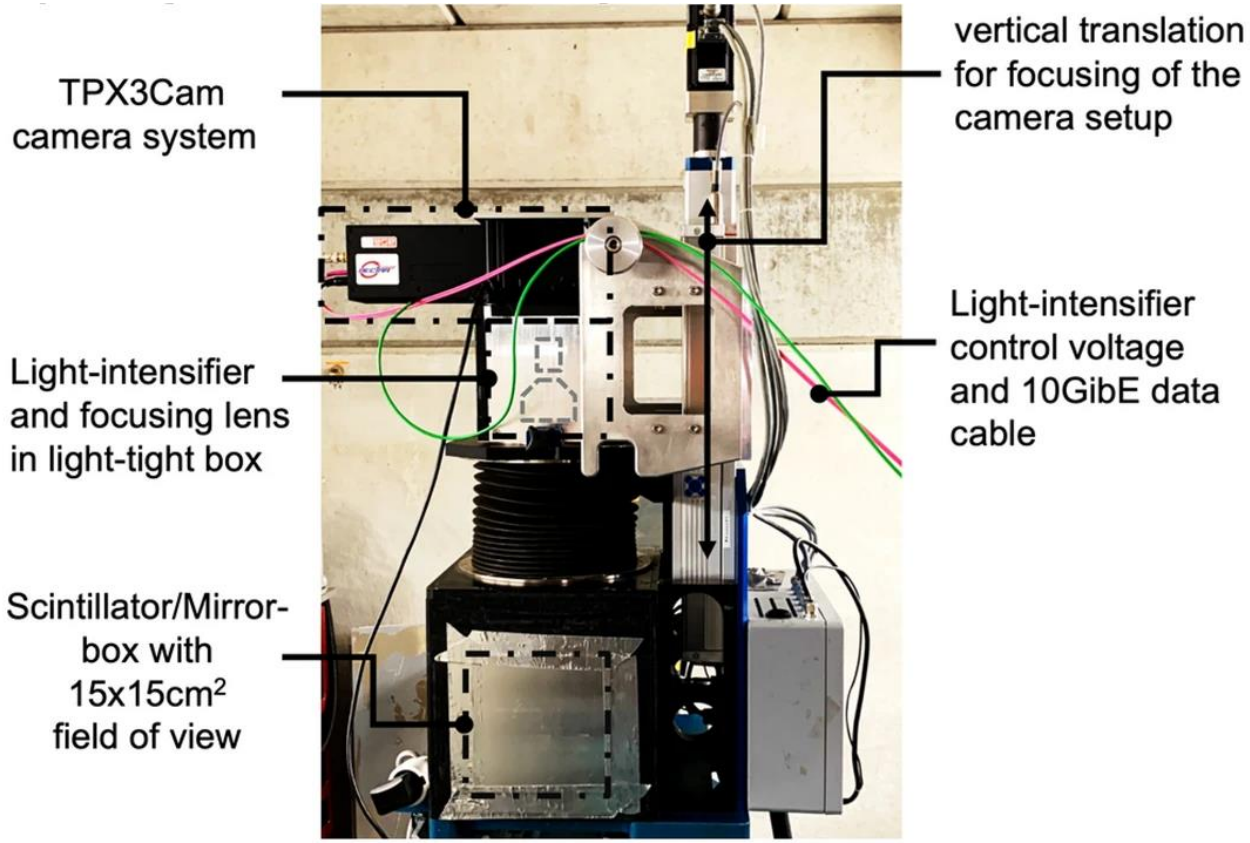


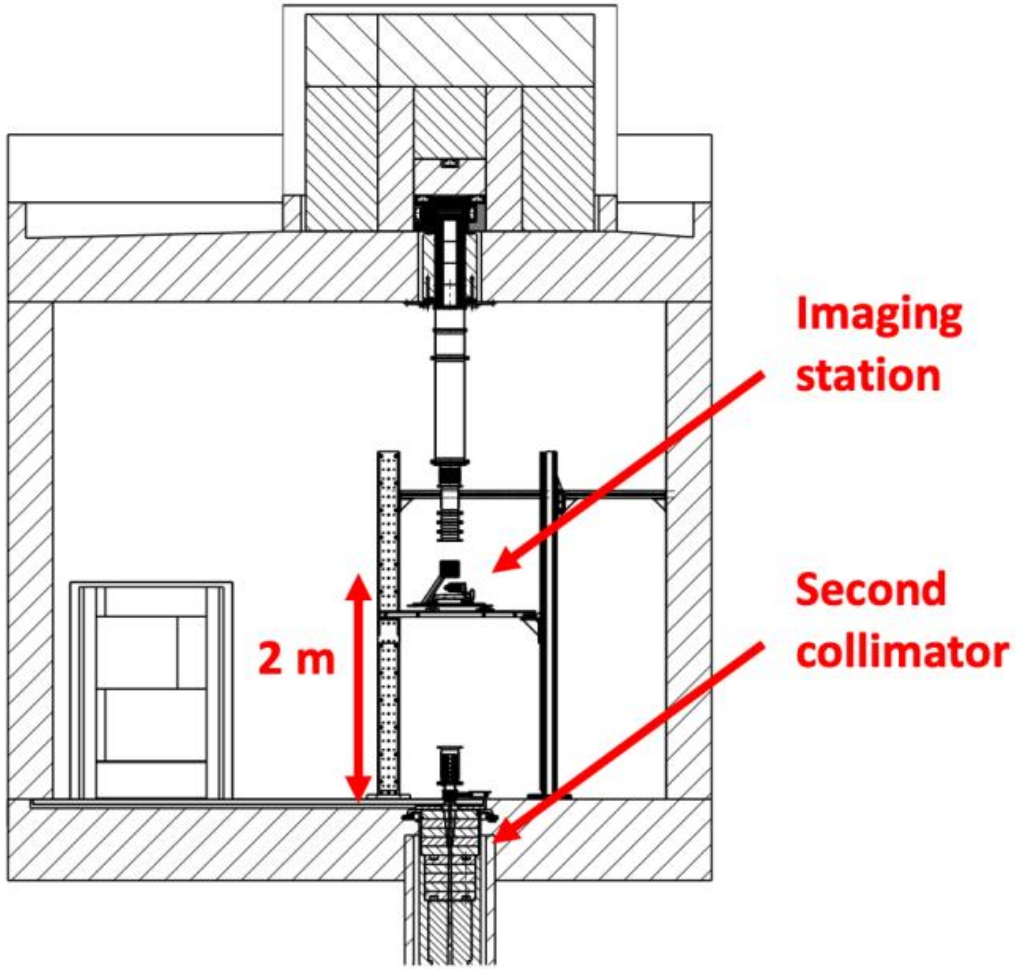
Neutron Imaging in a nutshell

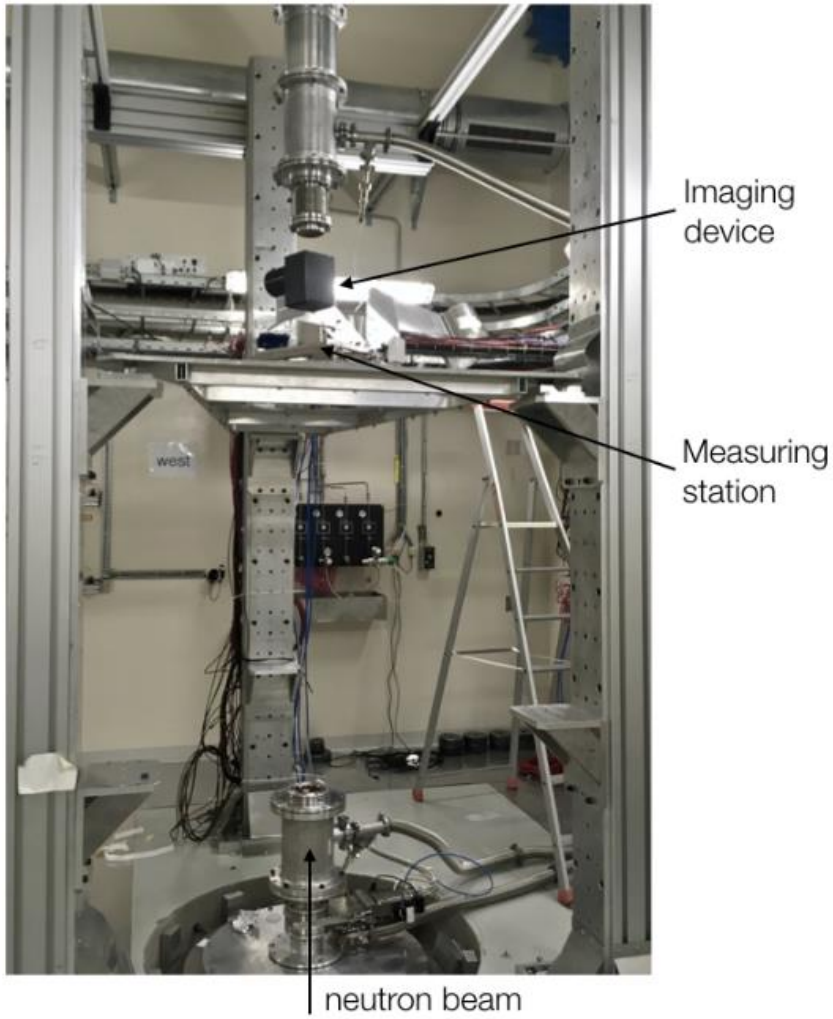




A. S. Losko et al., Sci Rep. 11, 21360 (2021): TOF imaging setup @ BOA (PSI)

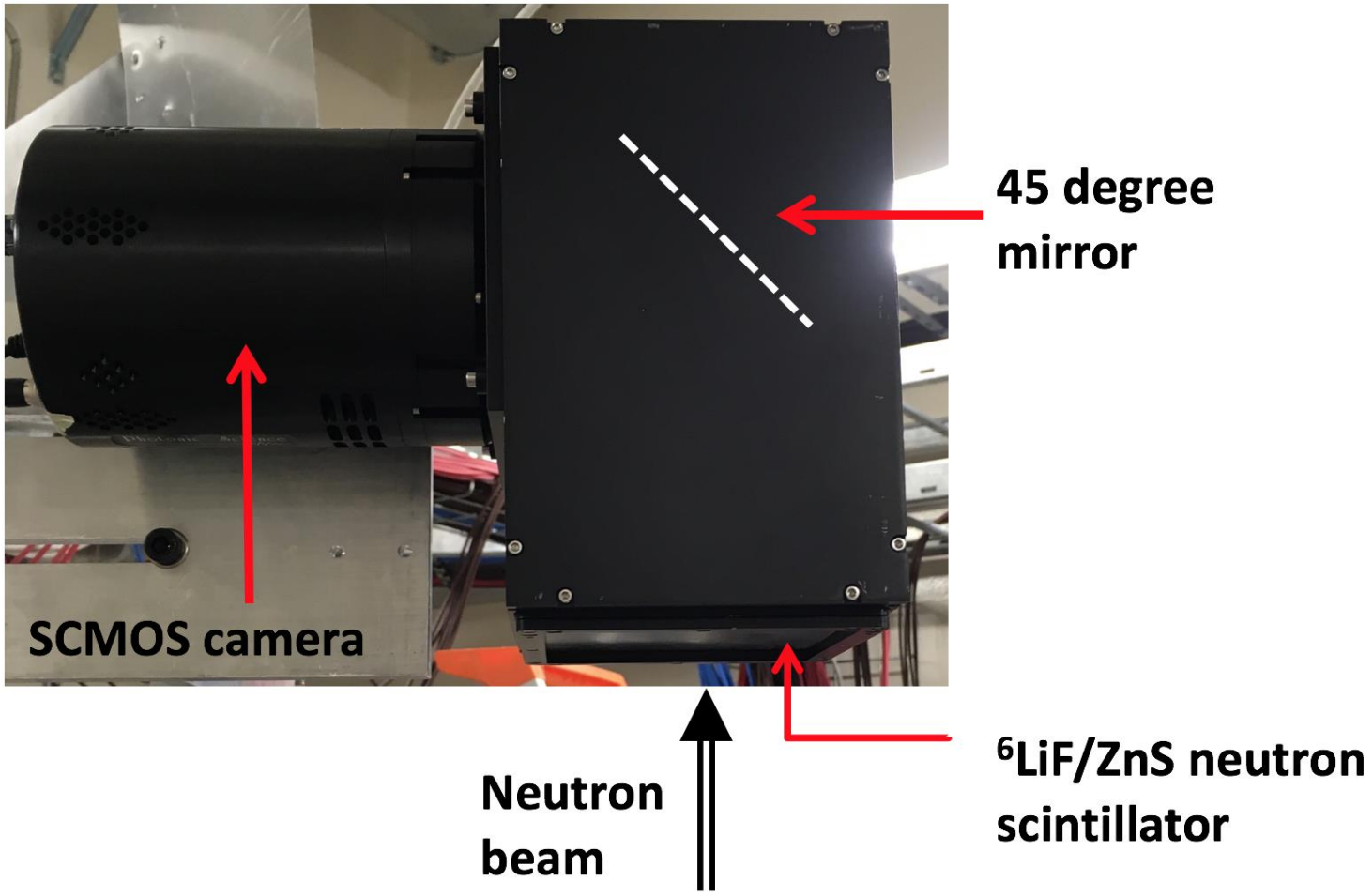
Imaging @ n_TOF (2015-2018) – setup





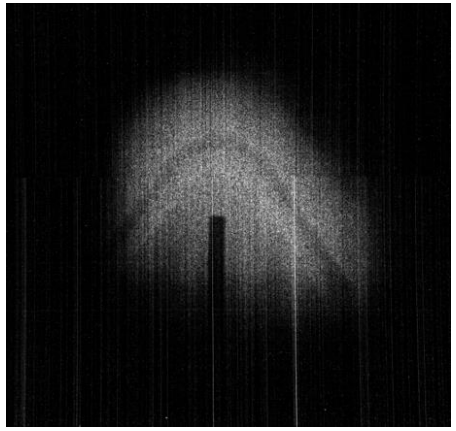
Imaging @ n_TOF (2015-2018) – setup (zoom)

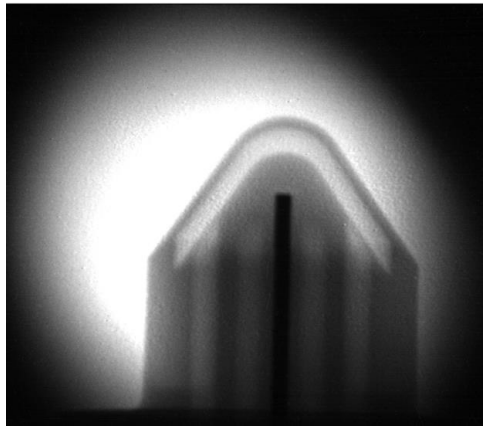
- **Detection system from Photonic Science:**
  - ZnS/6LiF based neutron scintillator (100×100 mm^2, 100 μm)
  - Air-cooled SCMOS camera 2k×2k @ ½ inch × ½ inch
- **Auto mode or triggered by PS**

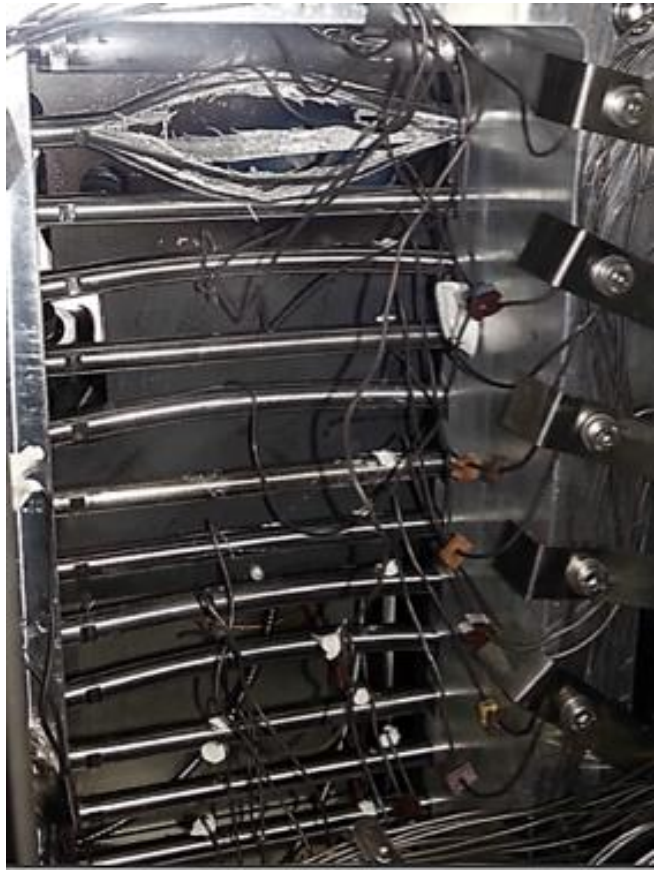


Imaging @ n_TOF (2015-2018) – results

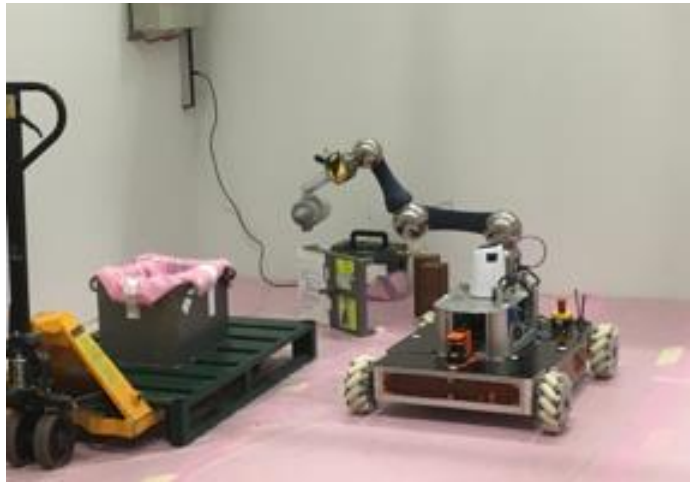
- **Feasibility study:**
  - 2015 – small collimator
  - 2016 – big collimator

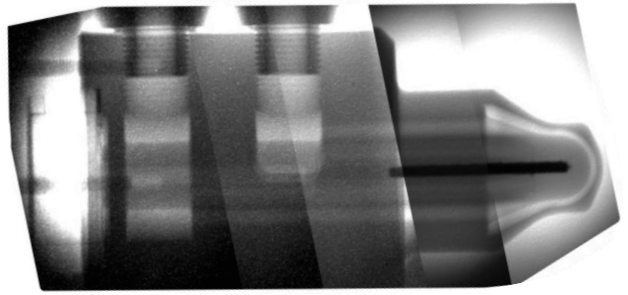




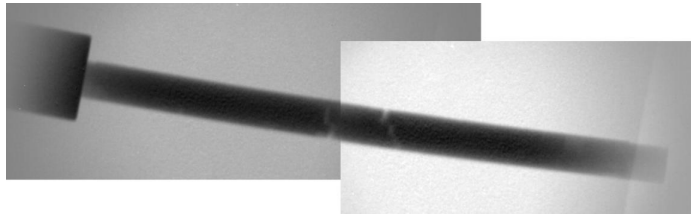


- **Measurement in 2017:**
  - AD target
  - HRMT-27 rods





F. Mingrone et al.,F. Mingrone et al., Instruments 2019, 3(2), 32

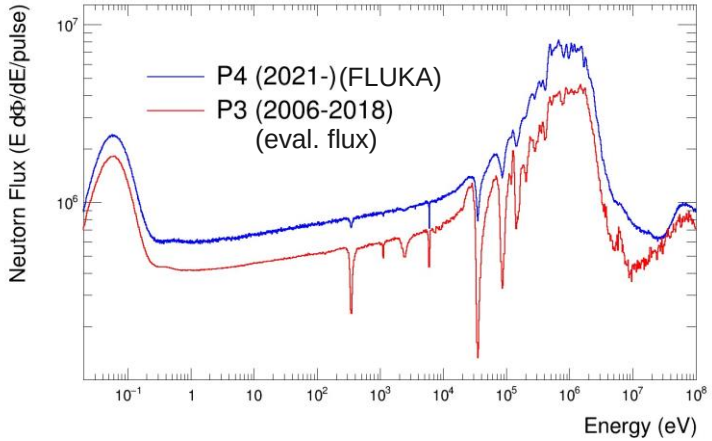


Conclusions in 2018

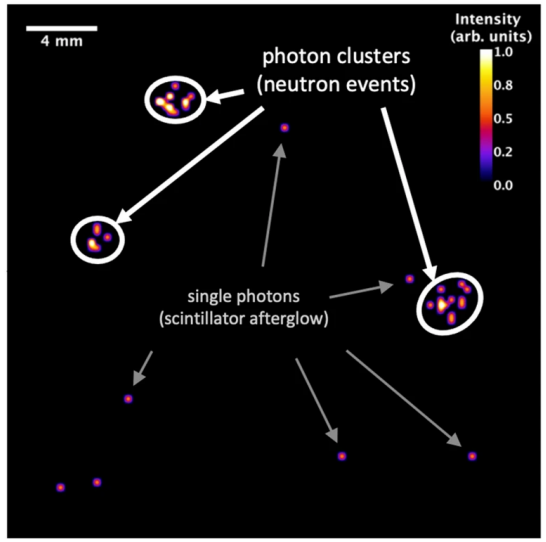
- **Neutron Imaging (NI) possible @ EAR2**
- **Definitely not competitive with dedicated facilities (PSI, FRM-II, ILL, …):**
  - EAR2 flux ~ 10^6 n/cm^2/pulse ~ 10^5 n/cm^2/s
    (~ 10^7 n/cm^2/s @ PSI ICON/NEUTRA cold/thermal)
  - Spatial resolution (has not been fully characterized)
  - Full characterization of EAR2 wrt NI is missing
- **But n_TOF has 2 features:**
  - Wide neutron energy spectrum (1 meV – 100 MeV)
    - imaging with „cold“ - fast neutrons via time gating
    - „All in one“ imaging
  - (Only) vertical beam line world wide

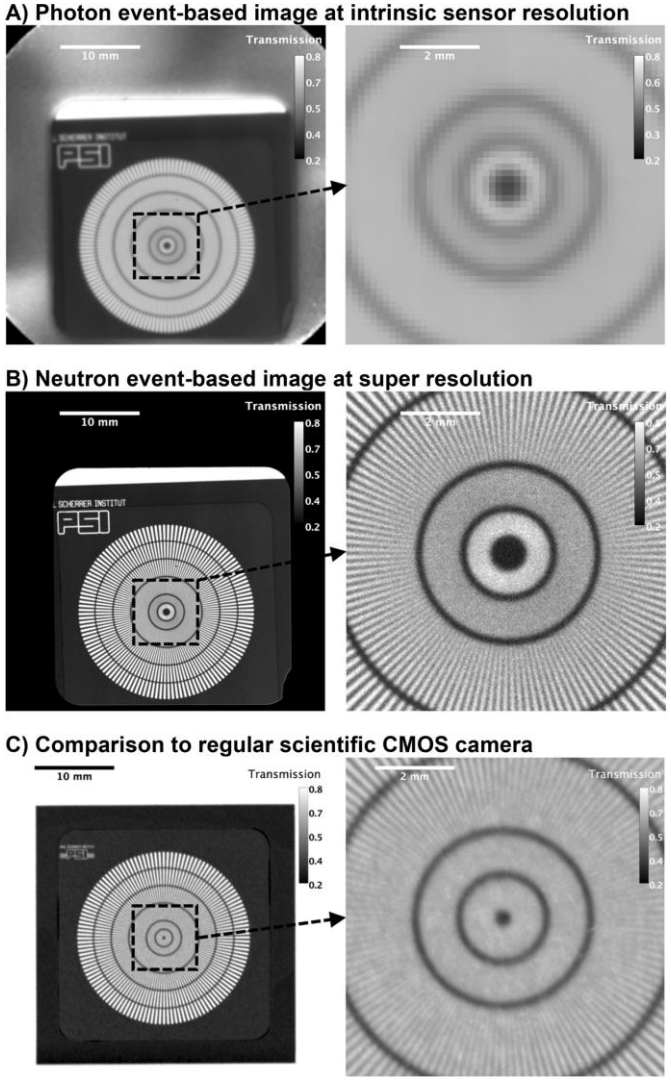
Restarting & extending NI activities: Potential

- **New spallation target → higher neutron flux**



- **Developements in the imaging community:**
  - Almost standardized and commercially available TOF cameras, i.e. TPX3CAM from Amsterdam Scientific instruments based on TimePix3 technology (1.6 ns time resolution, 500 MHz frame rate) → enables n/γ-discrimination
  - Novel fast neutron scintillators (multilayer and ZnS:Cu)

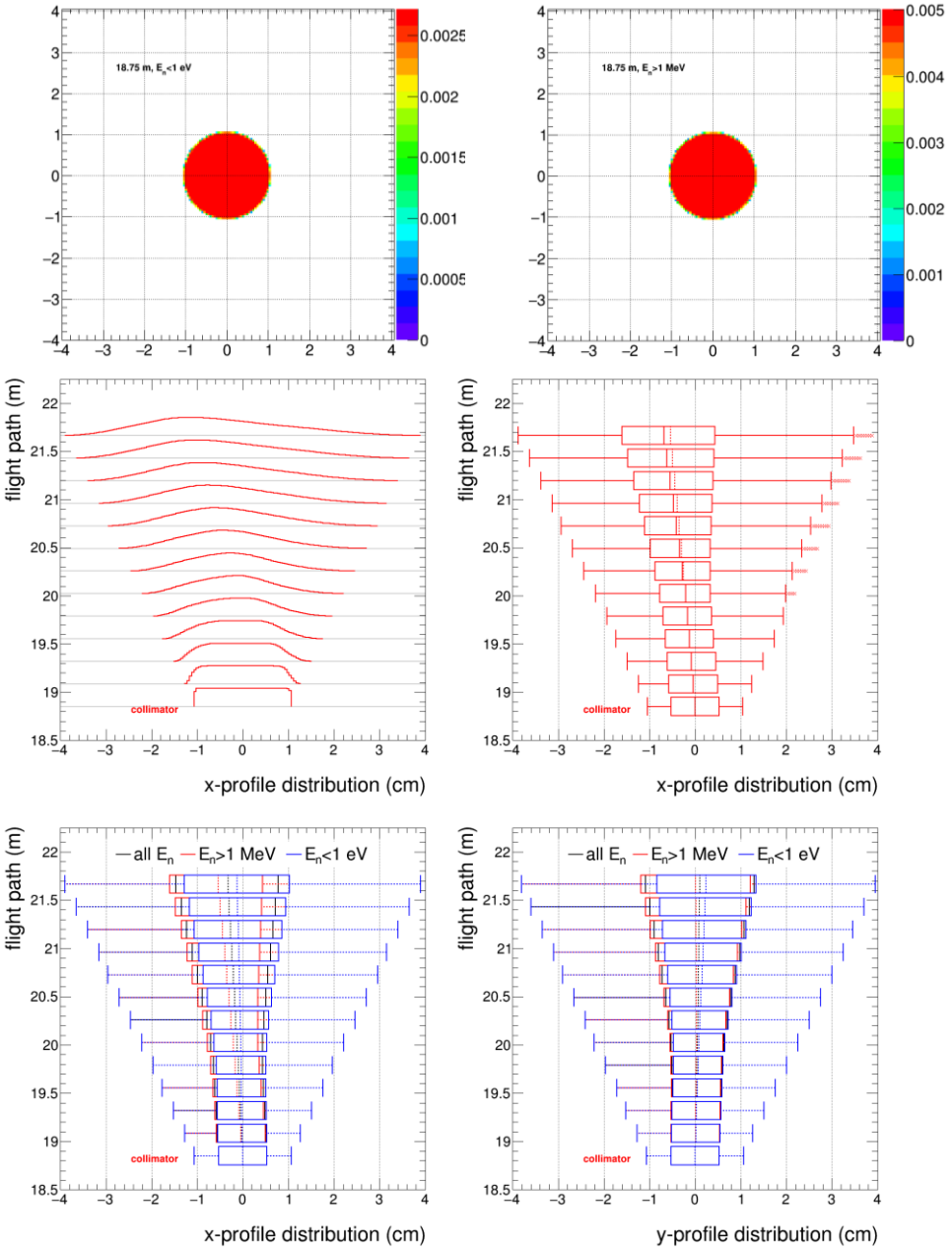




A. S. Losko et al., Sci Rep. 11, 21360 (2021)

Aims with a TOF setup

- **Finalize the characterization of n_TOF EAR2:**
  - Flux & Profile: full field of view & different flight paths
  - Spatial resolution (Siemens stars, step wedges) over TOF
- **Beam profile at different flight paths**
  - Slow and fast neutrons follow a slightly different path (energy dependent BIF (& position dependent RF?))
- **Scintillator characterization**
  - Fast scintillators so far only at reactors
  - Characterizations of efficiency and light yield over the whole E_n range
- **Application to CERN equipment:**
  - Irradiated AD target (swap 16-17th May) and Pb sample irradiated at HiRadMat



Conclusions & proton request

- **Full Characterization and extension of the EAR2 neutron imaging potential with TOF imaging**

- **Aiming to provide:**
  - Information for n_TOF (energy resolved, full beam profile measurements)
  - Characterization of fast & slow neutron and γ–ray scintillators over a wide energy range (rather unique at n_TOF)
  - Application to samples relevant to CERN

- **7×10^{17} protons are requested to perform these experiments at n_TOF EAR2**

- **Suggestions, remarks, propositions, help & interested people are always welcome!**

Thanks!

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