

# Summary: Instrumentation

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Gøran J. Nilsen  
ISIS Neutron and Muon Source

- 6 sessions:
  - Scattering Instruments: Inelastic and SANS (Tuesday 15:20) Monika Hartl
  - Scattering Instruments: Various Instrumentation Concepts (Wednesday 9:10) Tianjiao Liang
  - Neutron Instruments: Non-scattering Applications (Wednesday 11:00) Matthew Frost
  - Scattering Instruments: Detectors (Thursday 11:00) Gøran Nilsen
  - Scattering Instruments: Engineering (Thursday 14:50) Melvin Borrego
  - Scattering Instruments: Diffraction (Thursday 16:00) Masatoshi Arai

# Statistics

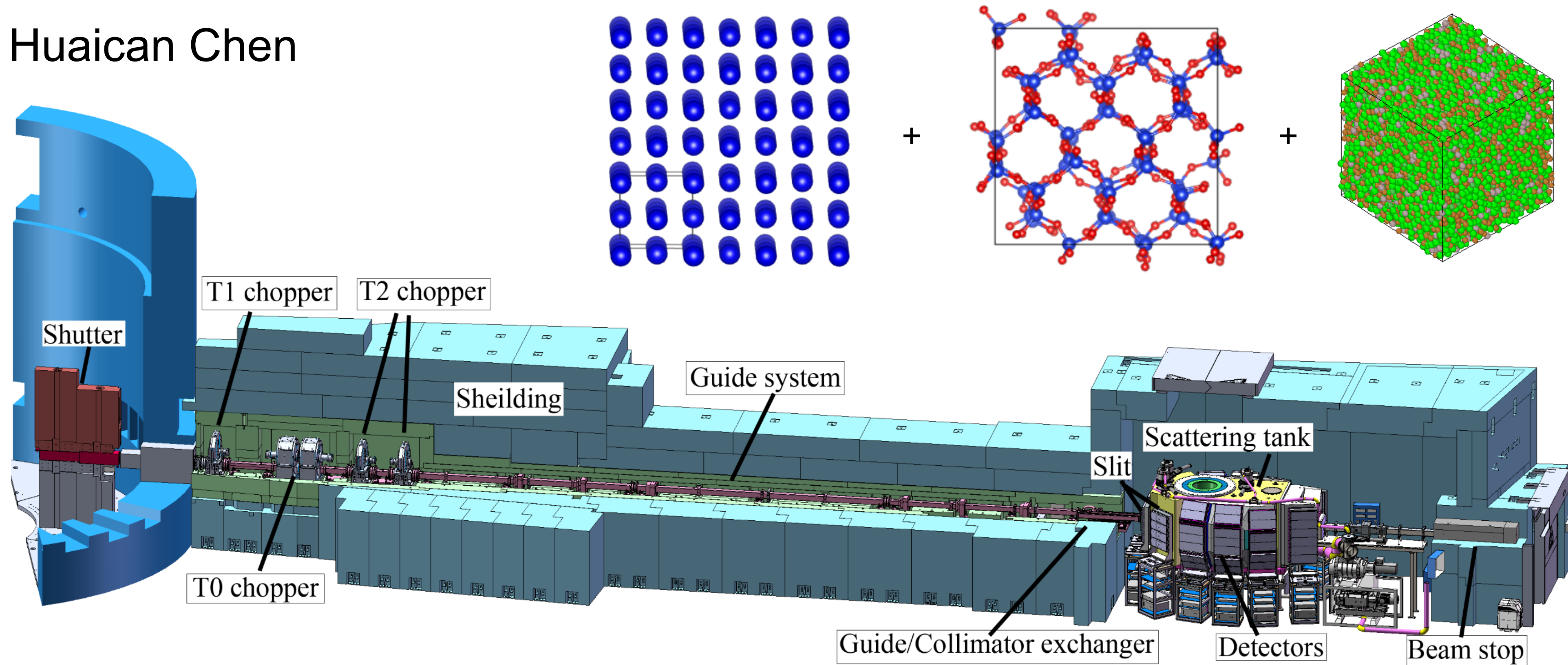
- ▶ 6 sessions:
  - ▶ 20 talks from 8 countries
    - ▶ **China: 8**
    - ▶ US: 4
    - ▶ Sweden: 3
- ▶ Also >5 posters...
- ▶ Young people well represented among speakers!

# Elastic scattering and imaging

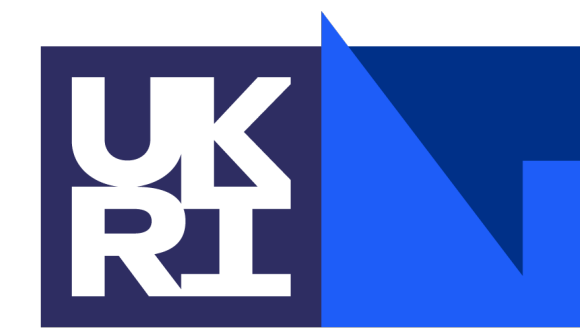


- ▶ MPI - total scattering diffractometer at CSNS

Huaican Chen



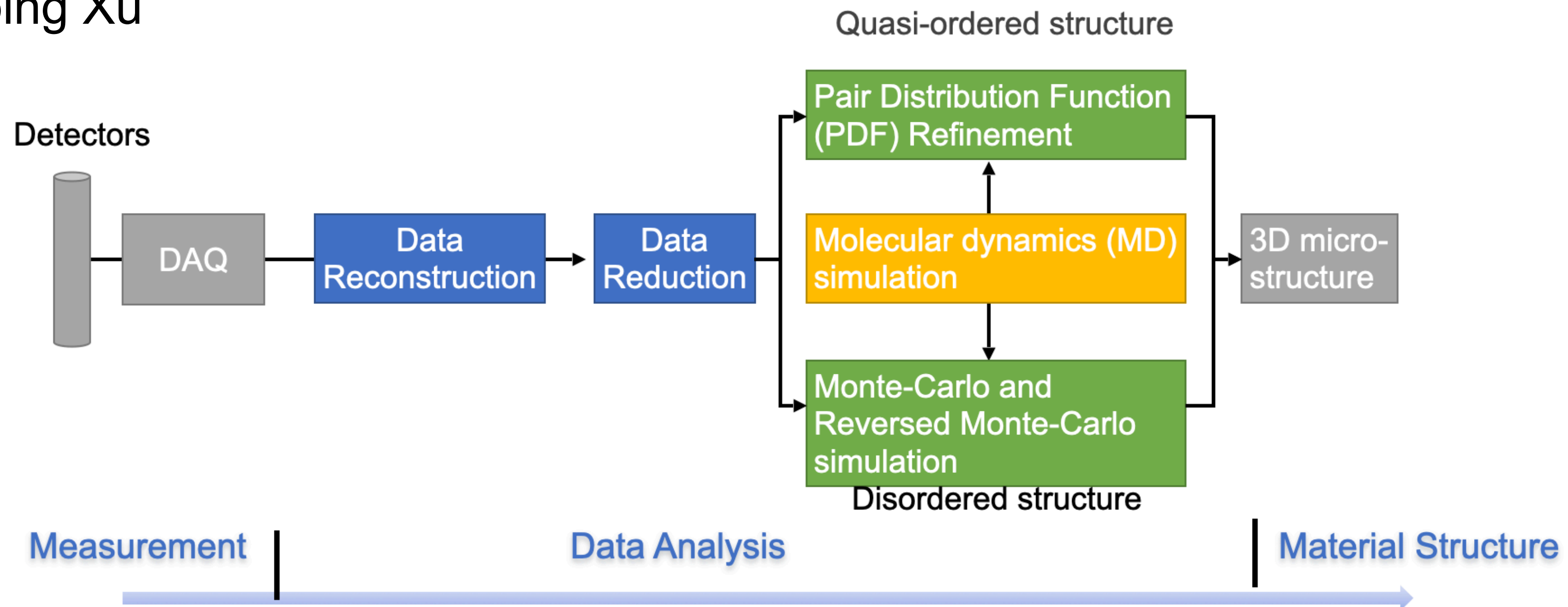
# Elastic scattering and imaging



- Well integrated software workflow can help to get the most out of experimental data:

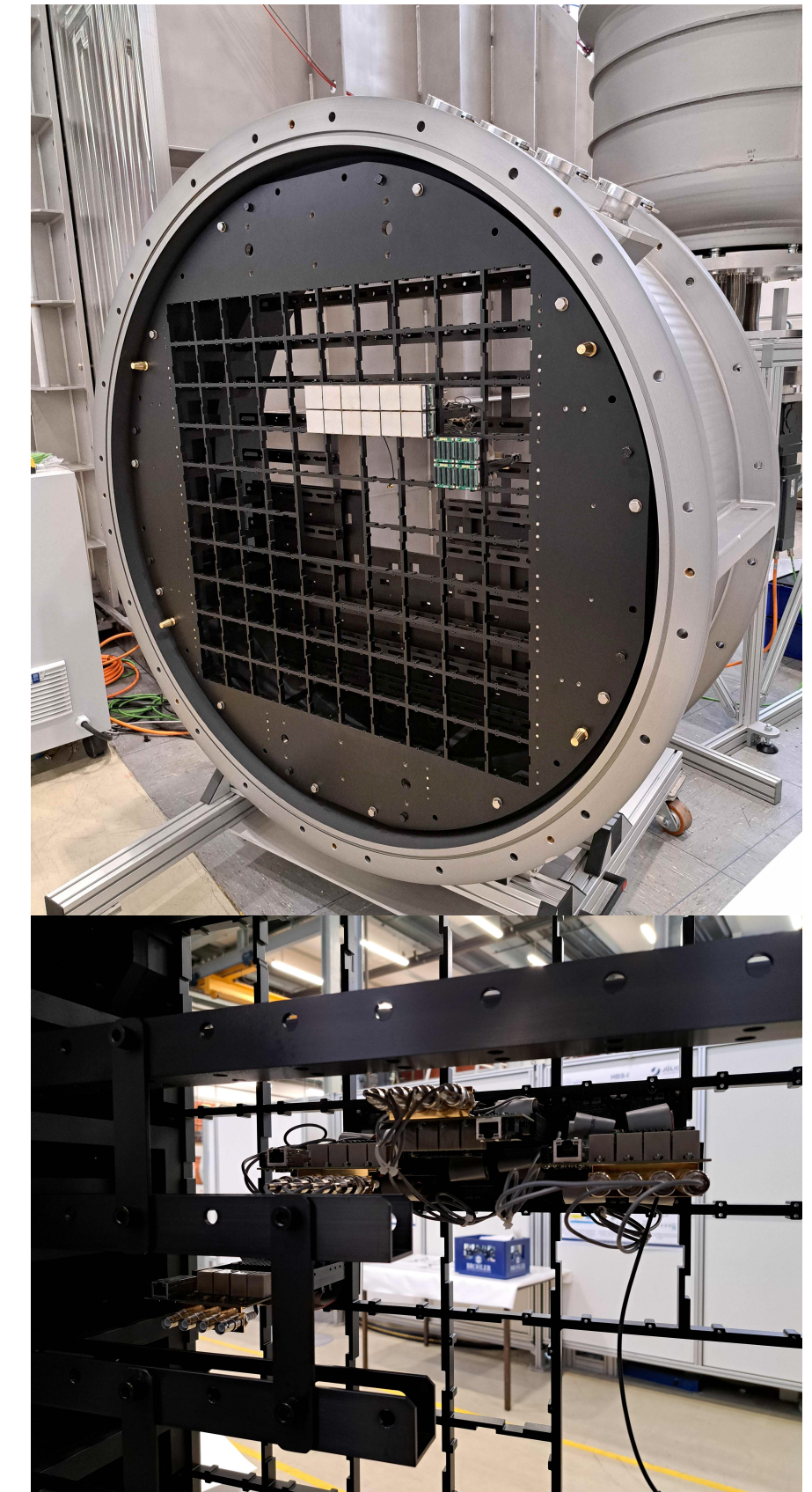
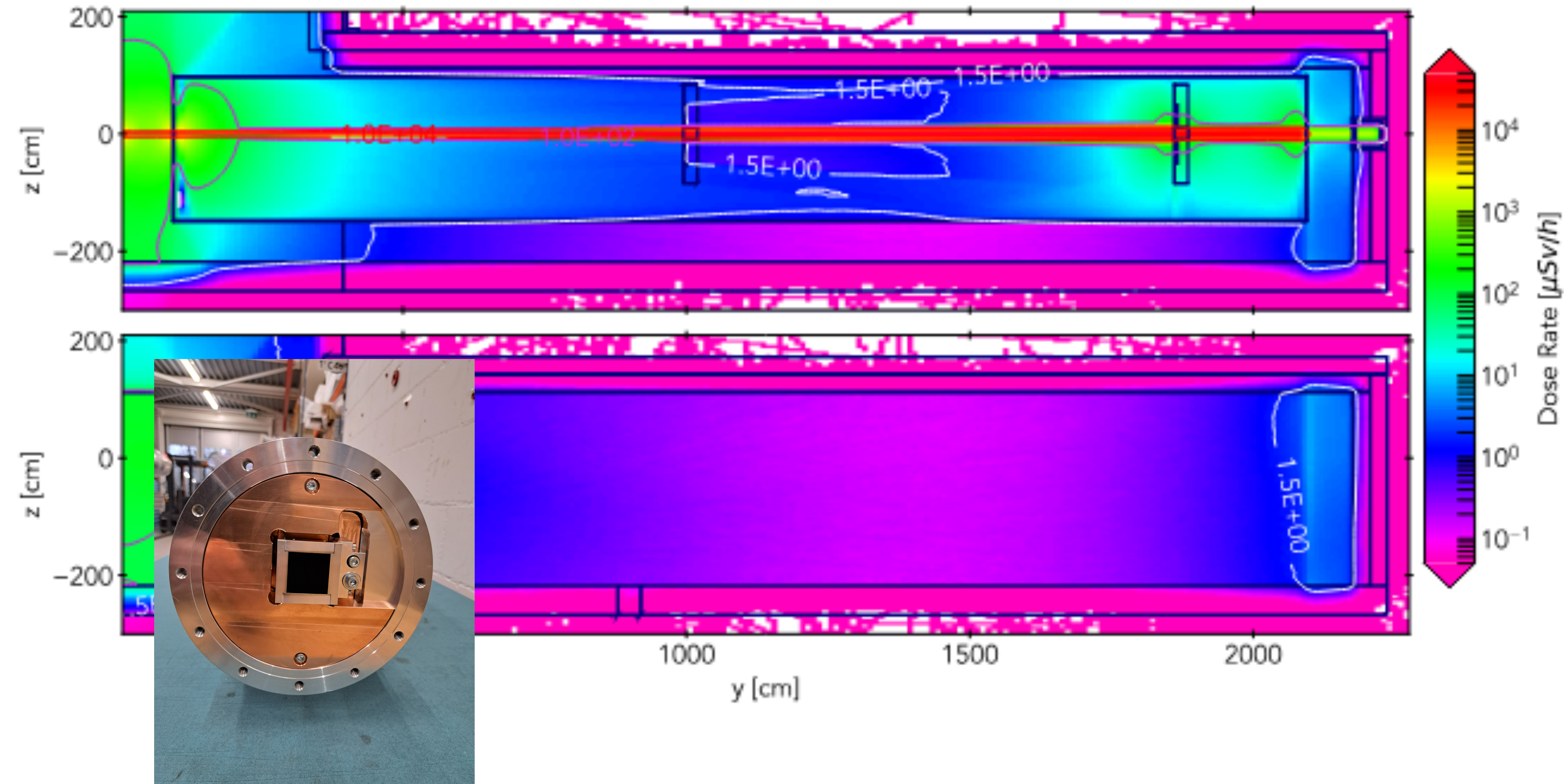
Huaican Chen  
Juping Xu

## Data analysis process for MPI

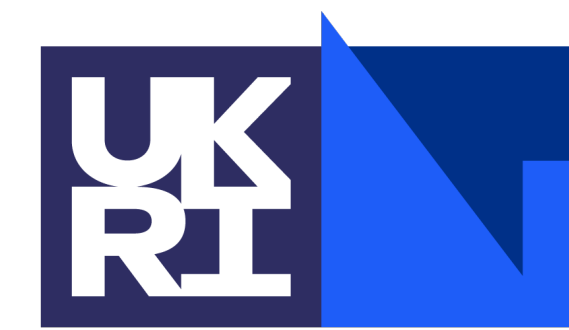


# Elastic scattering and imaging

- SKADI - ESS (S. Jaksch) - background reduction and detector:

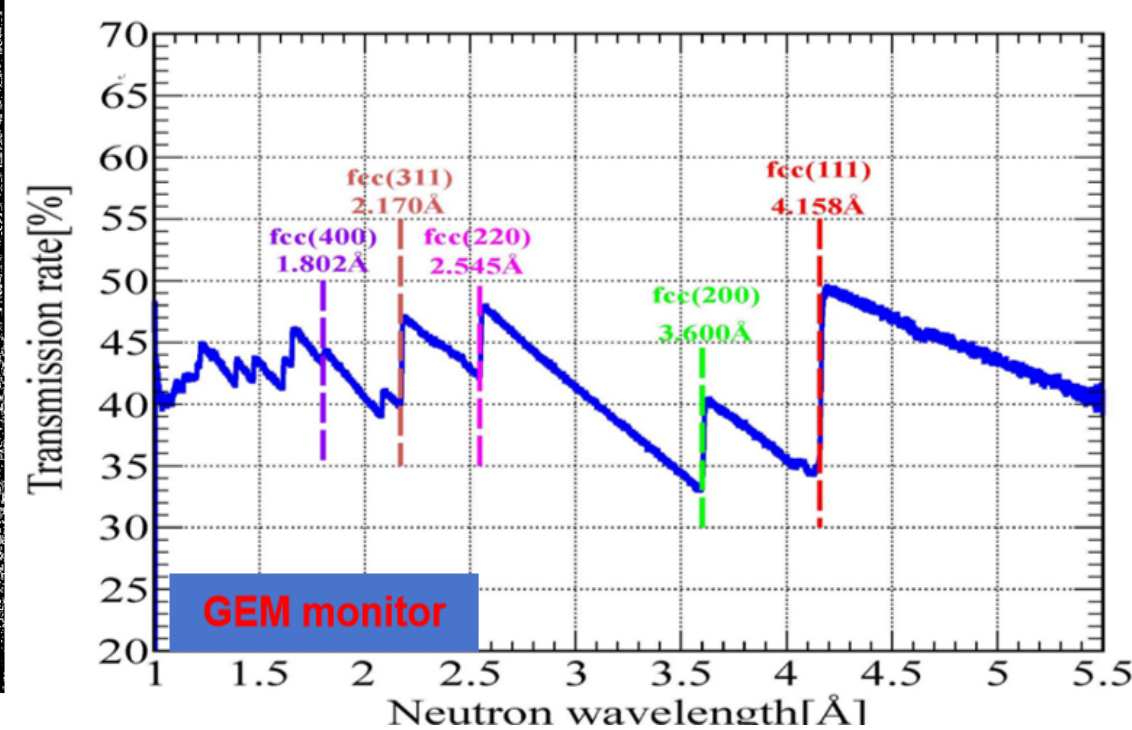
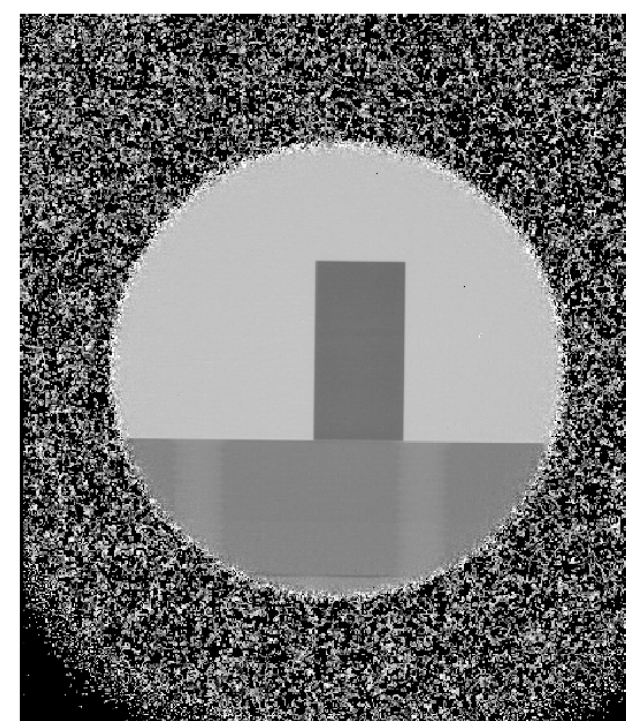
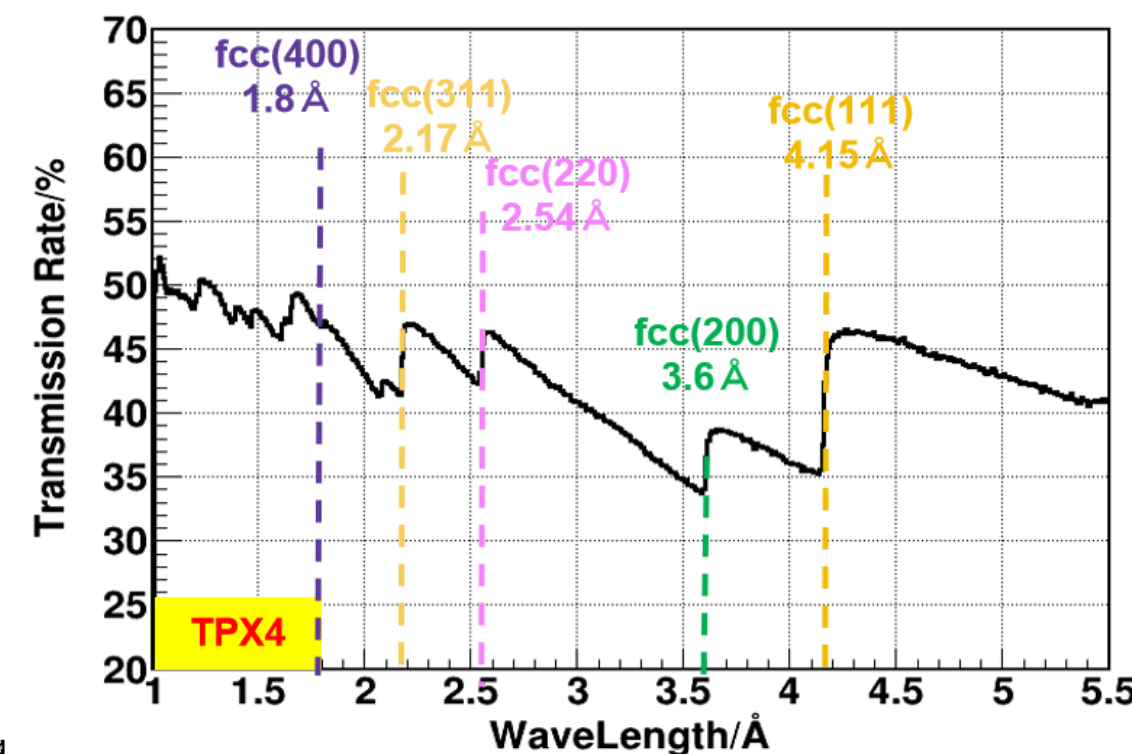


# Elastic scattering and imaging



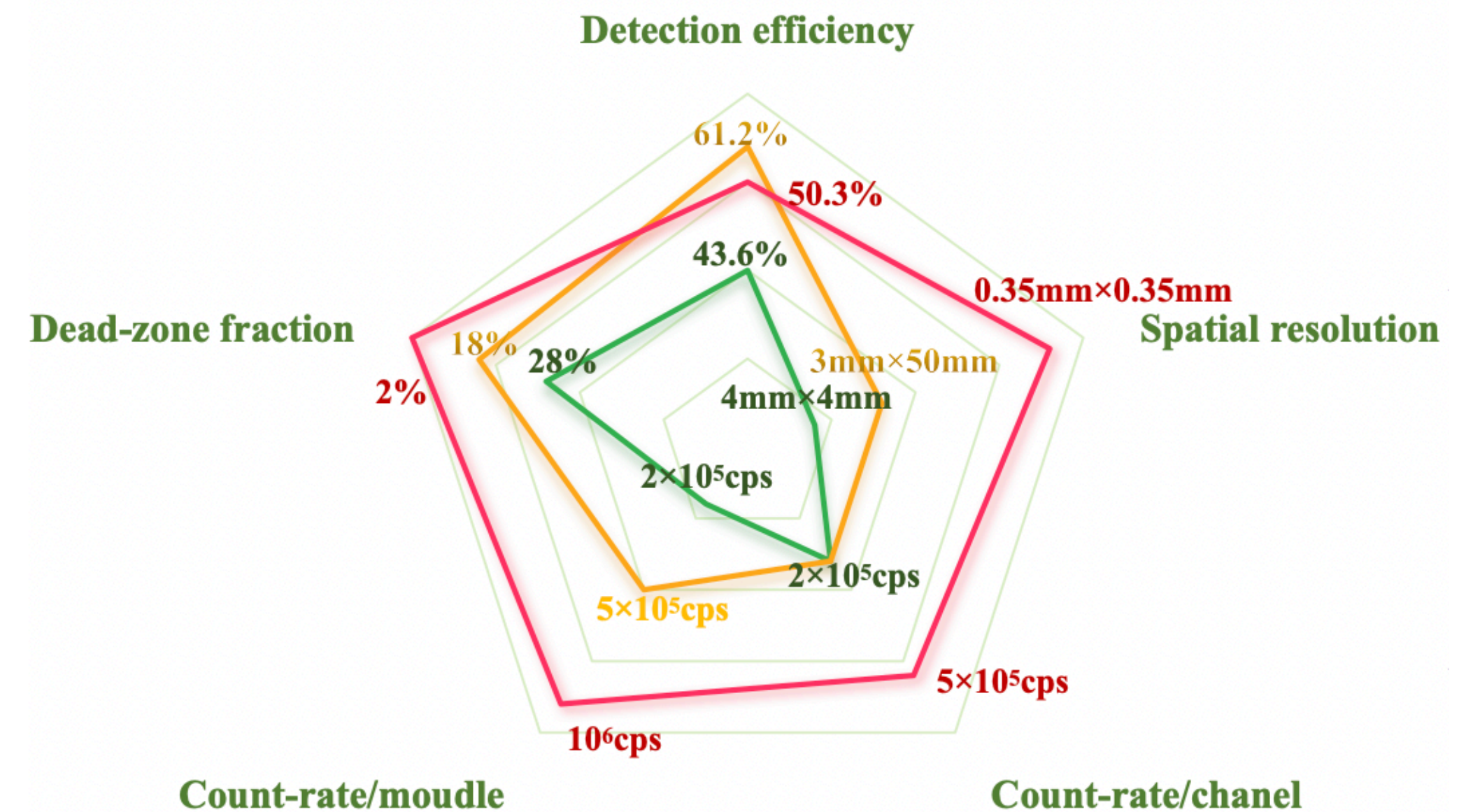
- ▶ New detectors are pushing spatial resolution, count-rate, efficiency, and cost, opening up for new applications:

Zhong Sun

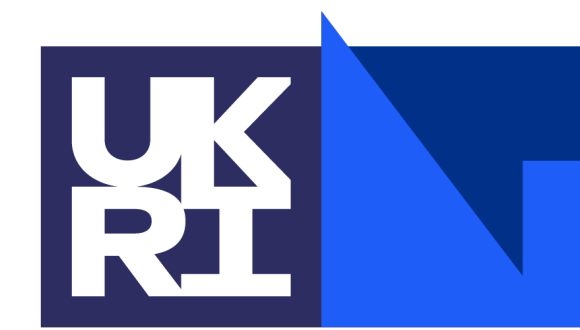


Bin Tang

## Scintillator detector family performance

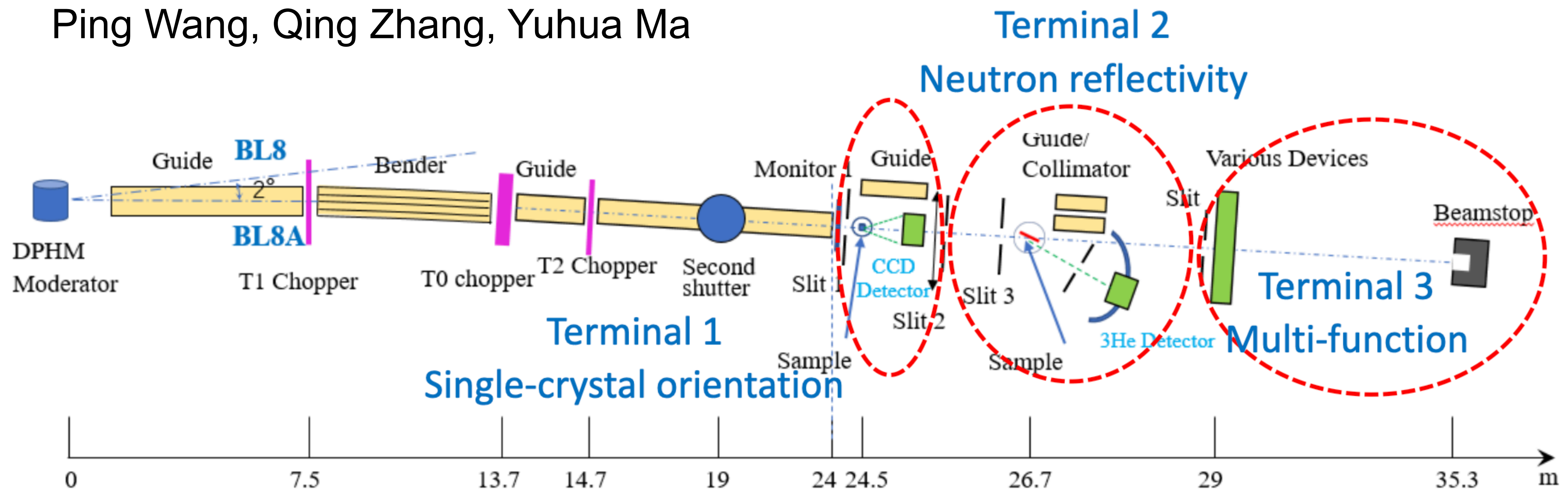


# Elastic scattering and imaging



- ▶ New detectors are pushing spatial resolution, count-rate, efficiency, and cost, opening up for new applications:

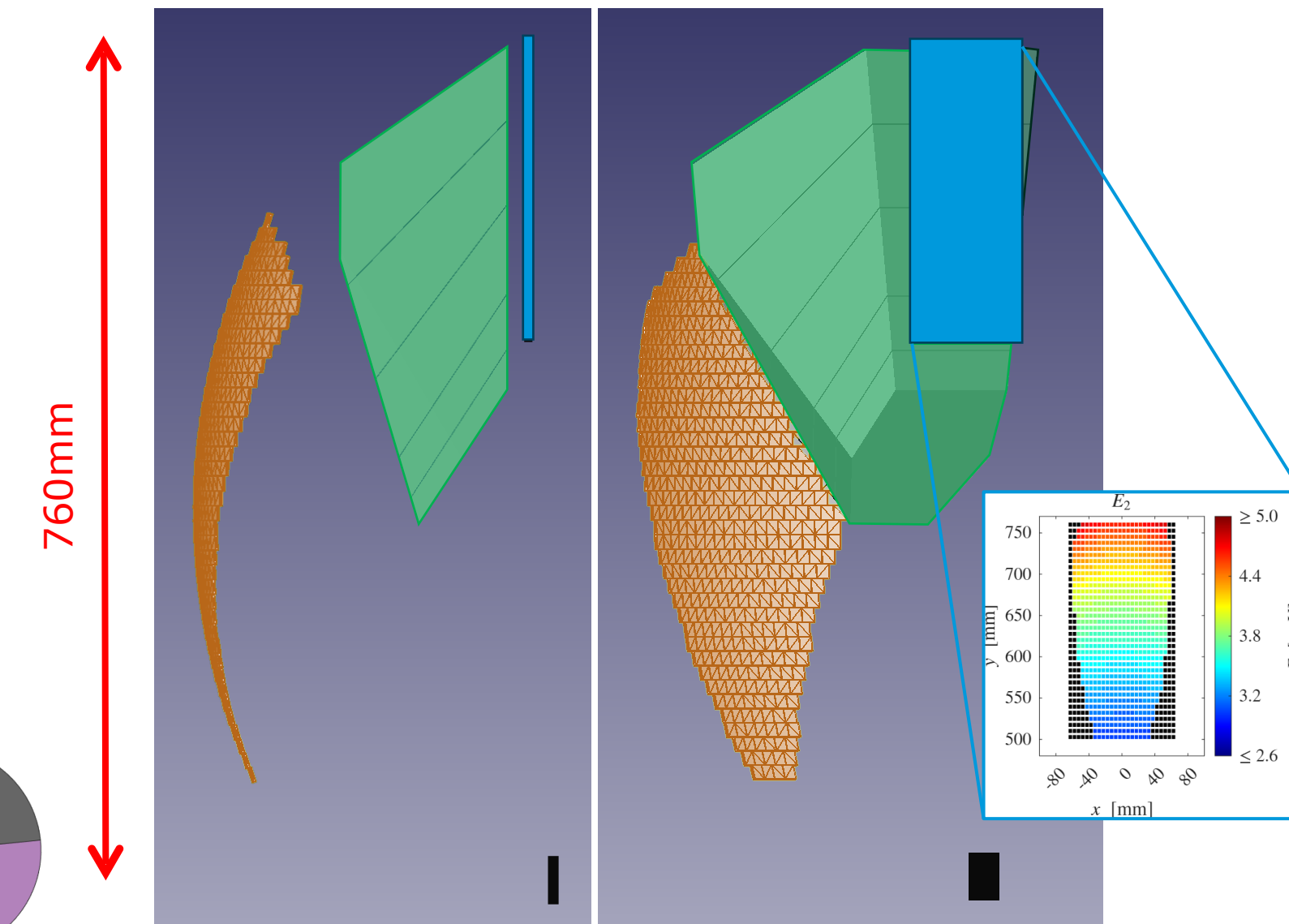
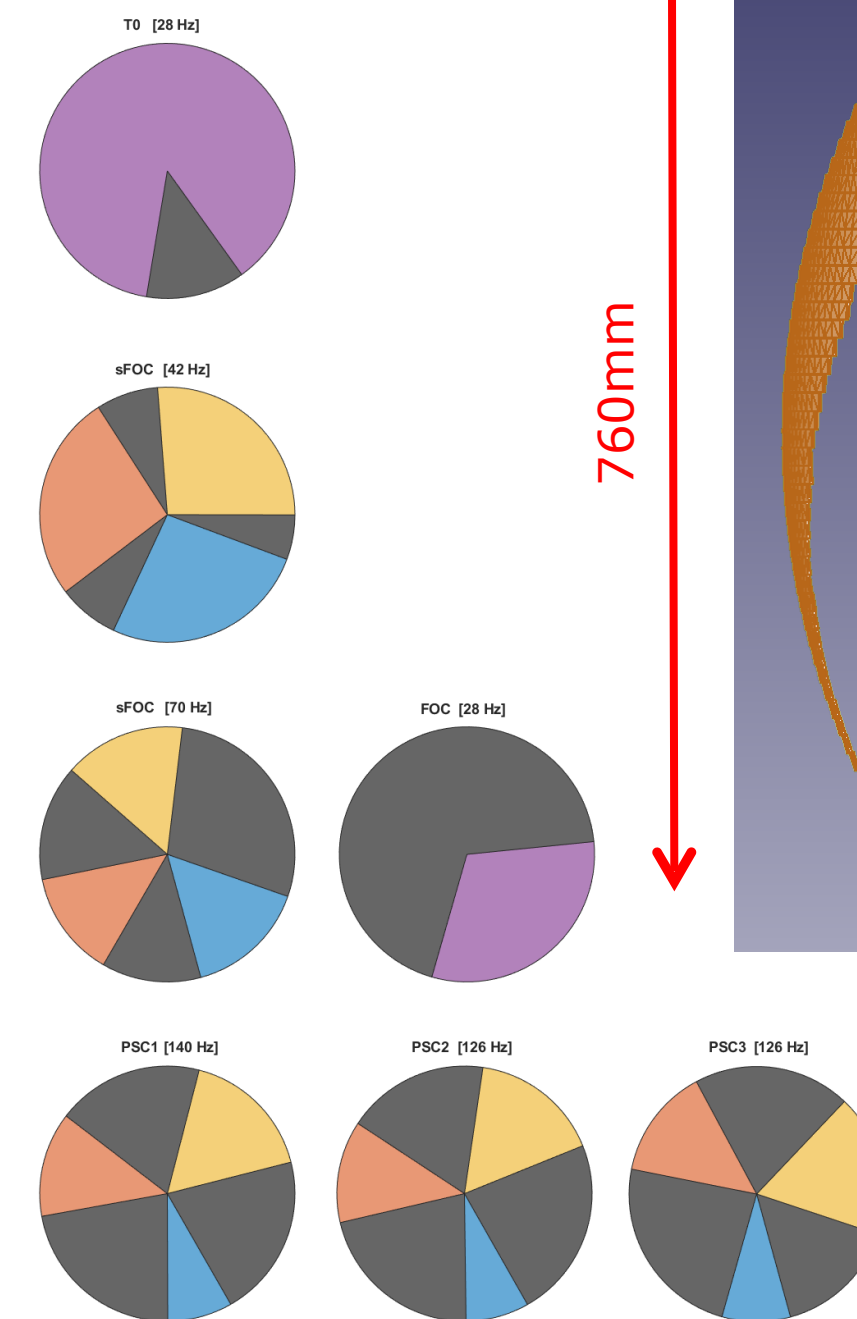
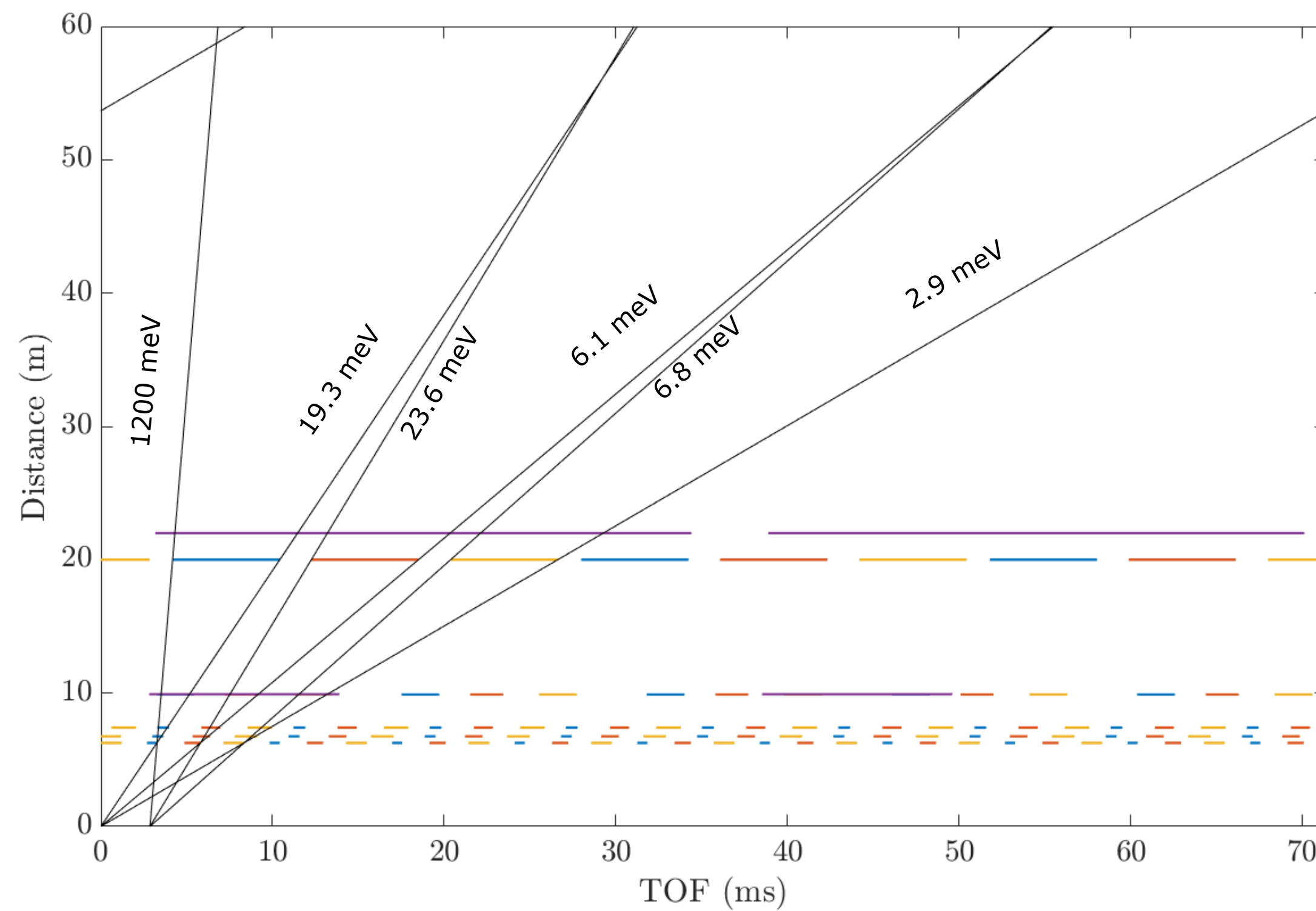
Ping Wang, Qing Zhang, Yuhua Ma



# Inelastic scattering instruments

- Several indirect geometry instruments with novel secondary spectrometers:

e.g. VESPA (Monika Hartl, Adrien Perrichon)

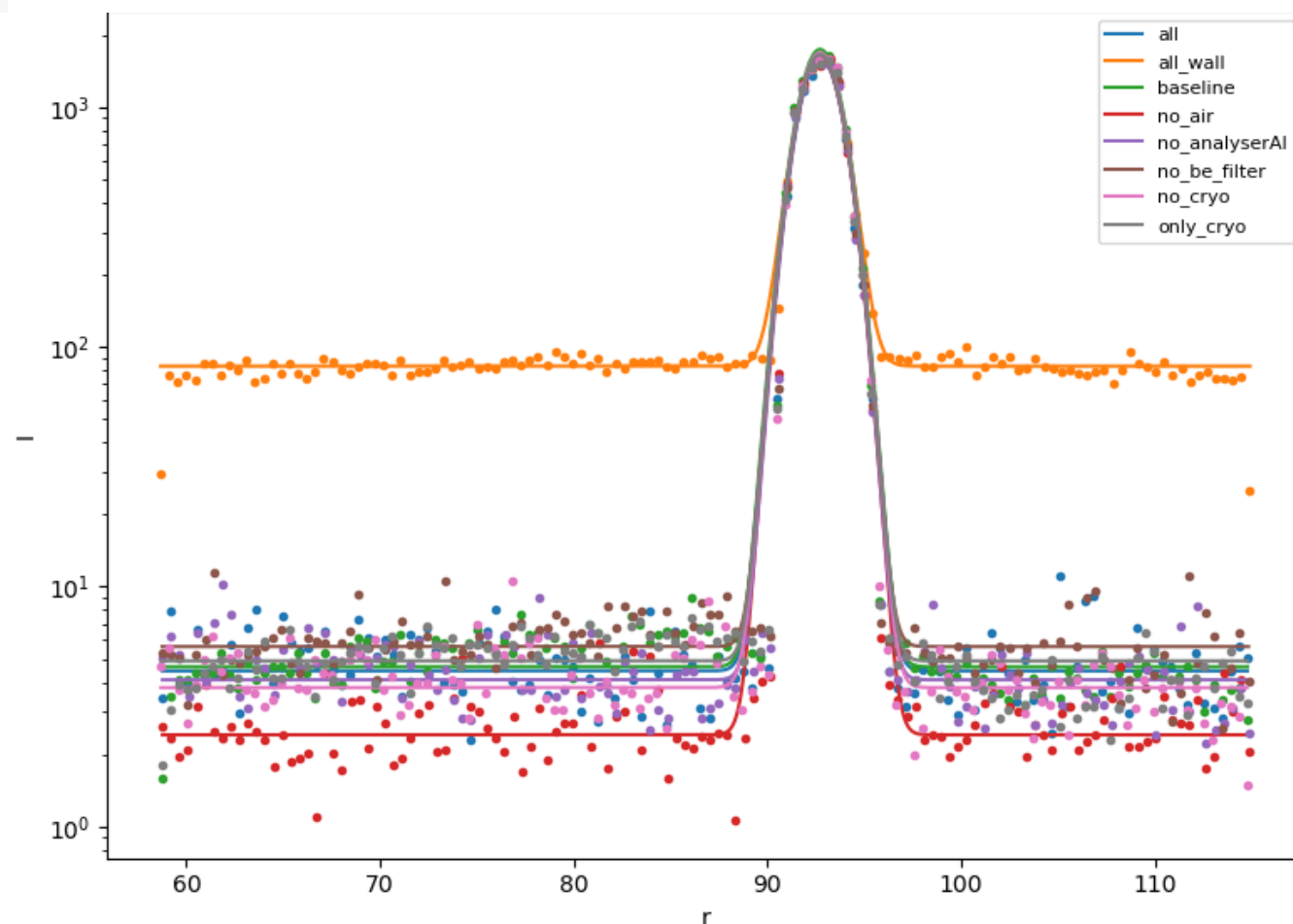
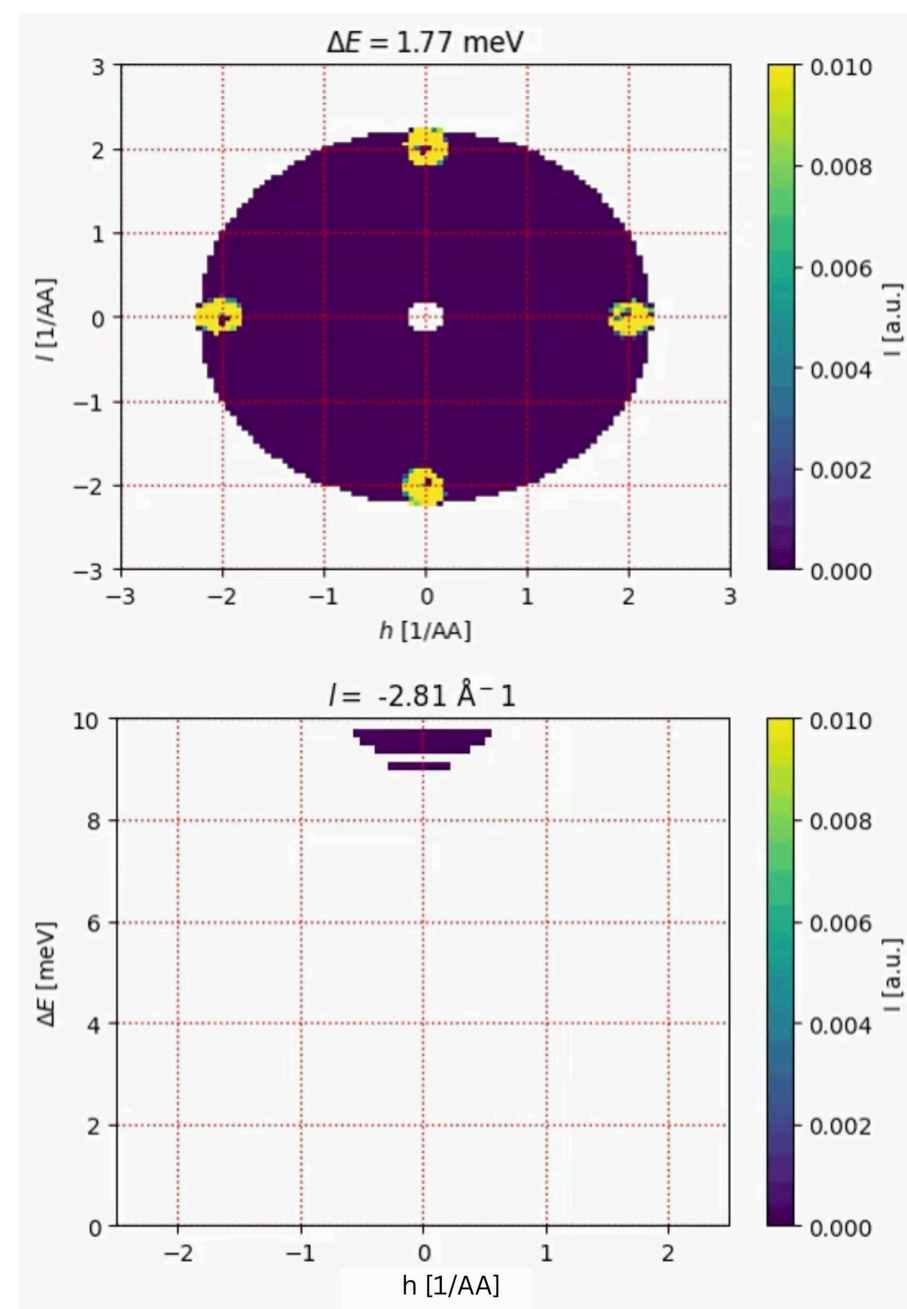


# Inelastic scattering instruments

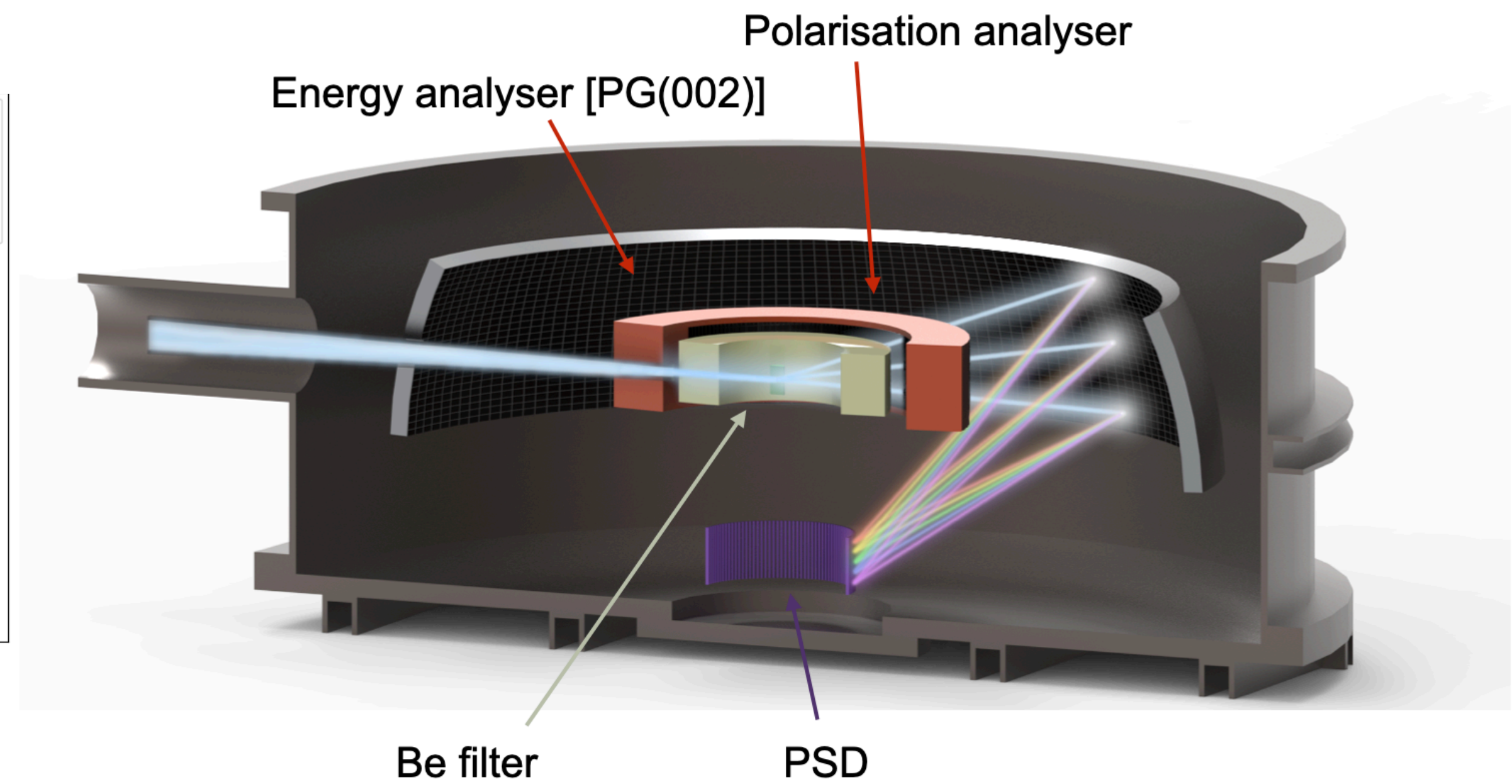


- ▶ Several indirect geometry instruments with novel secondary spectrometers:

*e.g.* FANTASTIC (K. Karyos)



*e.g.* SHERPA (G. Nilsen)



200x IRIS

# Inelastic scattering instruments



- ▶ New functionalities and concepts in the poster session:

## ICANS XXV Polarization Commissioning at POLANO

T. R. Yokoo<sup>1,2,3,4</sup>, S. Itoh<sup>1,2,3</sup>, K. Ikeuchi<sup>1,2,3</sup>, D. Ueta<sup>1,2,3</sup>, T. Ino<sup>1,2,3</sup>, S. Yamauchi<sup>1,2</sup>, H. Ohshita<sup>1,2</sup>, G. J. Nilsen<sup>5</sup>, K. Nemkovskiy<sup>6</sup>, N. de Souza<sup>6</sup>, A. Manning<sup>6</sup>, S. Yano<sup>7</sup>, H. Hayashida<sup>8</sup>

1 J-PARC Center, 2 IMSS High Energy Accelerator Research Organization (KEK), 3 Degree Programs in Pure and Applied Sciences, Graduate School of Science and Technology, University of Tsukuba, 4 Materials Structure Science, Department of Advanced Studies, The Graduate University for Advanced Studies, SOKENDAI, 5 ISIS Neutron and Muon Source, Rutherford Appleton Laboratory, 6 ACNS, Australia's Nuclear Science and Technology Organization, 7 National Synchrotron Radiation Research Center, 8 CROSS

April 13-17 2026 @ Malmö, Sweden

### POLANO Project

Time evolution of POLANO project  
Brand new inelastic spectrometer is now planned to be installed in J-PARC MLF. POLANO is a Polarization Analysis Neutron Spectrometer (POLANO) targeting the application of polarized neutron technique to inelastic scattering spectroscopy can reveal the role of each component within material science of multi degrees of freedom.

POLANO is based on the joint project between KEK (High Energy Accelerator Research Organization) and Tohoku University in the framework of S-type project.

### POLANO Specifications

decoupled moderator (BL23)  
moderator view: 10 cm x 10 cm  
L1 x 17.5 m, L2 x 2.0 m, L3 x 1.85 m  
scattering angle: 3°-25°, <math>\langle 2\theta \rangle</math>=21°, <math>\langle 2\theta \rangle</math>=25°  
Maximum Sample Size: 2 cm x 2 cm  
1 meV<math>\times</math>E<math>\times</math>Q  
AE/E = 4% (E<math>\times</math>Q)  
AQ/Q = 1-2%

(1) wide Q-E area:  
E=100 meV & C=10 Å<sup>2</sup> coverage  
(2) correlation methods:  
gain for high intensity polarization experiments  
(3) SEOP/Super-mirror:  
polarization analysis capability up to E<math>\times</math>Q=40 meV  
(4) high accessibility:  
compact design, large space at polarizer section (logn L3)

### POLANO specifications

L1=17.5 m, L2=2.0 m, L3=1.85 m

| Stage               | Polarizer/Analyzer                         | Target Range                                       |
|---------------------|--|--|
| 1st Phase 2023-2023 | SEOP polarizer                             | E<math>\times</math>Q=30 meV (42 meV)              |
| 2nd Phase 2023-2024 | Fan-type supermirror analyzer              | E<math>\times</math>Q=100 meV                      |
| 3rd Phase 2045      | DNP High P <sub>z</sub> SEOP/MEOP Analyzer | E<math>\times</math>Q=100 meV, P <sub>z</sub> =95% |

### Scientific cases @ POLANO

POLANO opened for general user programs in late 2019 with unpolarized neutron experiments. Parallel operation of both 1) target general and project use, and 2) commissioning for neutron polarization and R&D of devices. Here some of scientific cases are presented as examples of unpolar results.

Exotic quantum excitation in 1D spin chains  
NIZBANDS is known as a quantum spin chain system, that shows many exotic (unknown and complicated) spin dynamics due to quantum spin fluctuations in Haldane chains.

High energy hydrogen dynamics in ZrH2  
For a three dimensional harmonic oscillator, hydrogen oscillation in ZrH2 was measured up to 500 meV of incident neutron energy.

### Polarization tuning & commissioning

30 atm cm X & Rb hybrid cell  
QE 80 cell: 80 (100) mm, L=60 (100) mm  
D=6 (2.5) atm  
long life time  
appropriate R/R ratio  
small X detector

POLANO enables polarization analysis of inelastic scattering in the dynamics of multiple degrees of freedom.

Research Objectives:  
Dynamics of spin, orbital, charge, and lattice in magnetic superconducting materials and functional materials

Features:  
POLANO is a direct geometry spectrometer with middle energy and spatial resolution. Combination of SEOP He gas spin filter and 3.5 Qc bending mirror analyzer makes it possible high energy polarization experiment.

SEOP polarizer:  
This is the first SEOP polarizer and the first one to be installed in the MLF. It is designed to be compatible with the existing SEOP polarizer and the SEOP analyzer.

Analyzer:  
This is the first analyzer with a large scattering angle and a large Q range. It is designed to be compatible with the existing analyzer and the SEOP polarizer.

## Concept of the Collaborative Chopper Spectrometer TUKUYOMI for J-PARC

Kenji Nakajima  
J-PARC Center, Tokai, Ibaraki 319-1195, Japan  
Corresponding author: kenji.nakajima@j-parc.jp

### Introduction

Here we show an initial and brief concept of our idea of TUKUYOMI, a collaborative chopper spectrometer (CCS) for AMATERAS. A CCS is a concept of a chopper spectrometer designed to collaborate with existing full-scale spectrometers to enhance scientific output by lower-cost in construction and operation by compromising on functionality and performance. CCS-TUKUYOMI is a complementary chopper spectrometer operating together with AMATERAS, a chopper spectrometer at Materials & Life Science Experimental Facility (MLF), J-PARC. TUKUYOMI will be a smaller and simplified version of AMATERAS. TUKUYOMI is expected to calm down overheated users' demands (excessive competition) and to enhance scientific output by small investment.

### Concept of Collaborative Chopper Spectrometer (CCS)

The idea is inspired by a modern military concept, Collaborative Combat Aircraft (CCA). CCA is the concept of an AI-assisted unmanned combat aircraft operating in collaboration with a manned combat aircraft as a combat buddy (wingman). A Collaborative Chopper Spectrometer (CCS) is a complementary spectrometer designed to be used in conjunction with a full-scale chopper spectrometer (FCS). Like manned-unmanned teaming considered in the CCA concept, a CCS is used together with a FCS.

A FCS (in the most of cases) has the highest performance at the facility to lead the science at there. However, construction cost of a FCS usually high. Employing well-trained operating staff also some time can be challenge to the facility. If your facility can have unlimited resources, you can construct number of FCSs as much as you want. But, if not, a CCS may help your facility.

### Collaborative Chopper Spectrometer (CCS)

- As a fundamental premise, CCS collaborates with its FCS. Highly edged and difficult experiments are carried out at its FCS. Its CCS deals with other experiments to reduce the load of its FCS.
- The first priority of CCS is achieving less financial cost and less human resource cost in construction and operation.
- The performance and the choice of measurements of CCS should be limited.
- CCS should equips ability of automated and autonomous operation.
- CCS should be considered as a part of its FCS. Under the manned-unmanned teaming concept, the user program of CCS should be considered as a part of that of its FCS. All proposals should be submitted to its FCS. The instrumental scientist of the FCS should consider and decide which proposals are carried out on her/his CCS.

### CCS-TUKUYOMI & FCS-AMATERAS

Collaborative Chopper Spectrometer TUKUYOMI

Full-scale Chopper Spectrometer (FCS) AMATERAS

### Why do we need CCS-TUKUYOMI, CCS of AMATERAS?

All of inelastic instruments at J-PARC is highly demanded and contributing to rich and fruitful outcomes from MLF, J-PARC. AMATERAS is not an exception. Only small number of proposals are approved at AMATERAS and many others are sent to the waiting list. If we can carry all "Reserved" proposals, the productivity of AMATERAS can be increased 3 times more, which should be done by CCS-TUKUYOMI.

### Why to realize CCS-TUKUYOMI?

#### How to reduce the construction cost?

- Make smaller.** Relaxing energy resolution from 1% to 3-4% or more, flight paths can be shorter 2/3 of AMATERAS, which cause reduction of cost of 50% in shielding and 30% in beam transport. We also can reduce number of detectors. In reality, there is a high demand at AMATERAS for experiments with slightly loose resolution and high intensity.
- Omitting choppers.** May be, we can remove a pulse-shaping chopper, which AMATERAS equipped, with 5-10% reduction of cost.
- Others.** If the 2nd target station of MLF will be a lower repetition rate source, we may be able to omit counter measures against TQ background.

#### How to reduce the operating human resources?

One of the solution is introducing ability of automated and autonomous operation to CCS. MLF, J-PARC now launched the project of AI-Platform, which can be adapted to TUKUYOMI. Since 85% AMATERAS proposals plans simple rotation scan, things may be easy.

### Concluding comment

Continuously improving the productivity of research output is one of the important challenges in facility management. If resources were unlimited, this would be an easy task. However, in reality, budgets and human resources are always limited. Therefore, maximizing results by making the most of the resources given is the arts of facility management. In this respect, the concept of balancing high and low costs in instruments selection is important. CCS can be one solution. Therefore, for the future plan of MLF, J-PARC, we would like to propose TUKUYOMI as a candidate instrument in order to improve the productivity of the facility and enable more users to access MLF in a sustainable manner.

## Symbiotic Spectrometers Njord & Remora

E. Fogh<sup>1</sup>, N. L. Amin<sup>2</sup>, G. S. Tucker<sup>2</sup>, M. Aouane<sup>2</sup>, R. Georgii<sup>1,3</sup>, J. Voigt<sup>4</sup>, R. Toft-Petersen<sup>2,5</sup>

<sup>1</sup>TUM, <sup>2</sup>ESS, <sup>3</sup>MLZ, <sup>4</sup>FZJ, <sup>5</sup>DTU

### Concept

Njord and Remora are a paired instrument concept proposed for the European Spallation Source. Njord is an indirect-geometry spectrometer pushing flux into a tightly focused beam for sub-mm samples; Remora is a symbiotic direct-geometry spectrometer on the same beamport, increasing user capacity via otherwise unused neutrons. Together they expand the reach of cold neutron spectroscopy and boost ESS throughput.

### Njord secondary spectrometer

The MUSHROOM analyser provides continuous in-plane coverage with large out-of-plane acceptance for 4D (Q, E) volumes (Bewley, 2021).

### Symbiotic spectrometer

Remora is a direct-geometry ToF spectrometer positioned upstream of Njord on the same beamport, extracting neutrons via an HOPG monochromator that is mostly transparent off the Bragg condition.

#### Key specifications

| Monochromator   | HOPG (002, 004), (006)                 |
|-----------------|--|
| Fundamental A   | 4.8 Å                                  |
| Flux @ 4.8 Å    | $3 \times 10^{16}$ n/s/cm <sup>2</sup> |
| Flux @ 2.4 Å    | $9 \times 10^{16}$ n/s/cm <sup>2</sup> |
| Sample-detector | 2.5 m                                  |
| Dynamic range   | 0.1 meV to 50 meV                      |
| Elastic ΔE      | 150 μeV                                |

Multiple HOPG harmonics are separated in time by the ESS pulse structure, enabling simultaneous recording of spectra at different incident energies (repetition rate multiplication). A Fermi chopper controls sample illumination time and energy resolution.

### Extreme flux on tiny samples

Njord is an indirect-geometry ToF spectrometer designed for extreme flux on sub-mm<sup>3</sup> samples in complex sample environments.

#### Key specifications

|                       |  |
|-----------------------|--|
| Beam spot             | 3 mm x 3 mm                              |
| Flux (PSC parked)     | $2.5 \times 10^{16}$ n/s/cm <sup>2</sup> |
| Divergence            | 22°                                      |
| Bandwidth             | 1.7 Å                                    |
| E coverage            | 3.4 meV to 5 meV                         |
| Out-of-plane          | 15° to 25°                               |
| In-plane              | ±5° to ±140°                             |
| Analysers solid angle | 1.4 sr                                   |

A MUSHROOM-type crystal-analyser array accepts a very large solid angle of scattered neutrons, covering the full scattering-angle range in a single setting. Energy resolution spans from 42 μeV (elastic, PSC Δt = 0.5ms) to 0.9 meV (ΔE = 10meV, PSC parked).

### Nested Mirror Optics (NMO)

Njord achieves its extreme focusing through Nested Mirror Optics: compact, elliptically shaped, nested supermirrors that accept large divergence and refocus onto the sample with 72x brilliance transfer.

- Precisely defined illumination without close-optics
- Supports polarising supermirror coating upgrades
- Minimal background from sample environment

### Science enabled by Njord

Njord targets materials limited by sample size, weak signals, or extreme sample environments.

- Metal-organic framework phonon dynamics
- Superconductor excitation spectra under pressure
- m-m scale quantum spin liquid, supersolid crystals
- Ice & clathrates GPa scale phonon dispersions
- Barocaloric operando vibrational studies

### Two instruments, one beamport

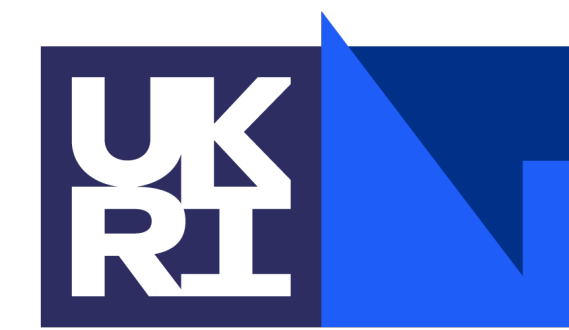
The long ESS pulse enables Njord and Remora to share a single beamport without significant mutual interference.

- Graphite transmits >85% of A < 4.8 Å to Njord
- Remora extracts the complementary spectral window
- Independent pulse-shaping for Njord does not reduce Remora flux
- Njord pushes the frontier for small-sample and extreme-conditions spectroscopy. Remora adds competitive user capacity comparable to LET and INS.
- Together, they maximise use of the ESS brightness.

### Want to know more?

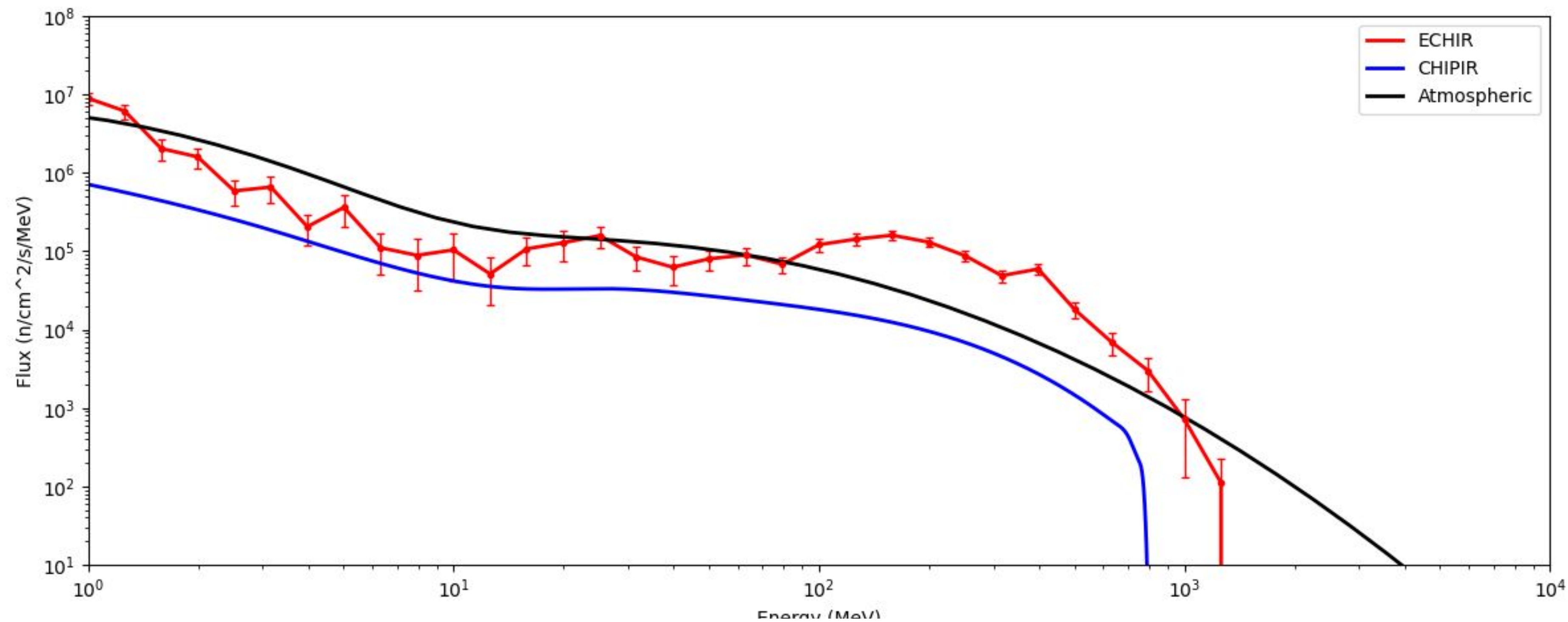
References are available in the proposal  
arXiv:2404.11543  
Get the proposal and add your endorsement at njordremora.org!

# Other instruments



- ▶ A large fraction of the instrumentation talks were about non-scattering instruments:

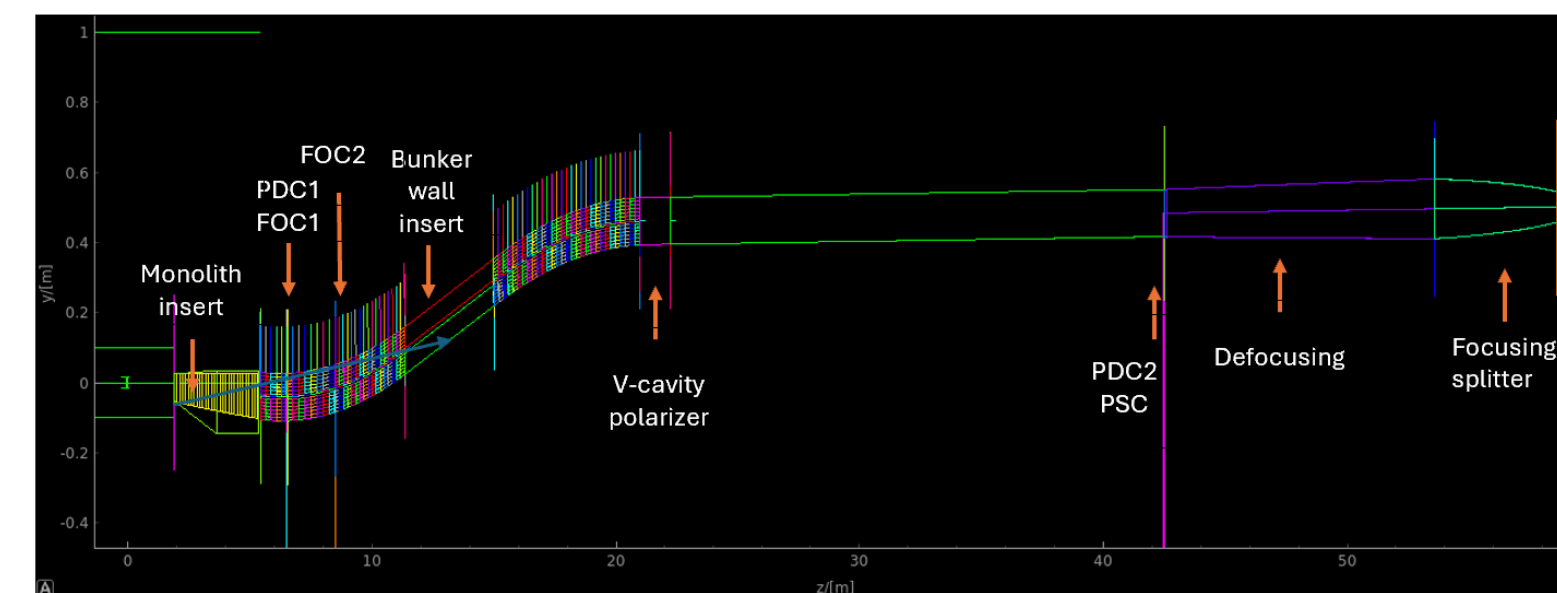
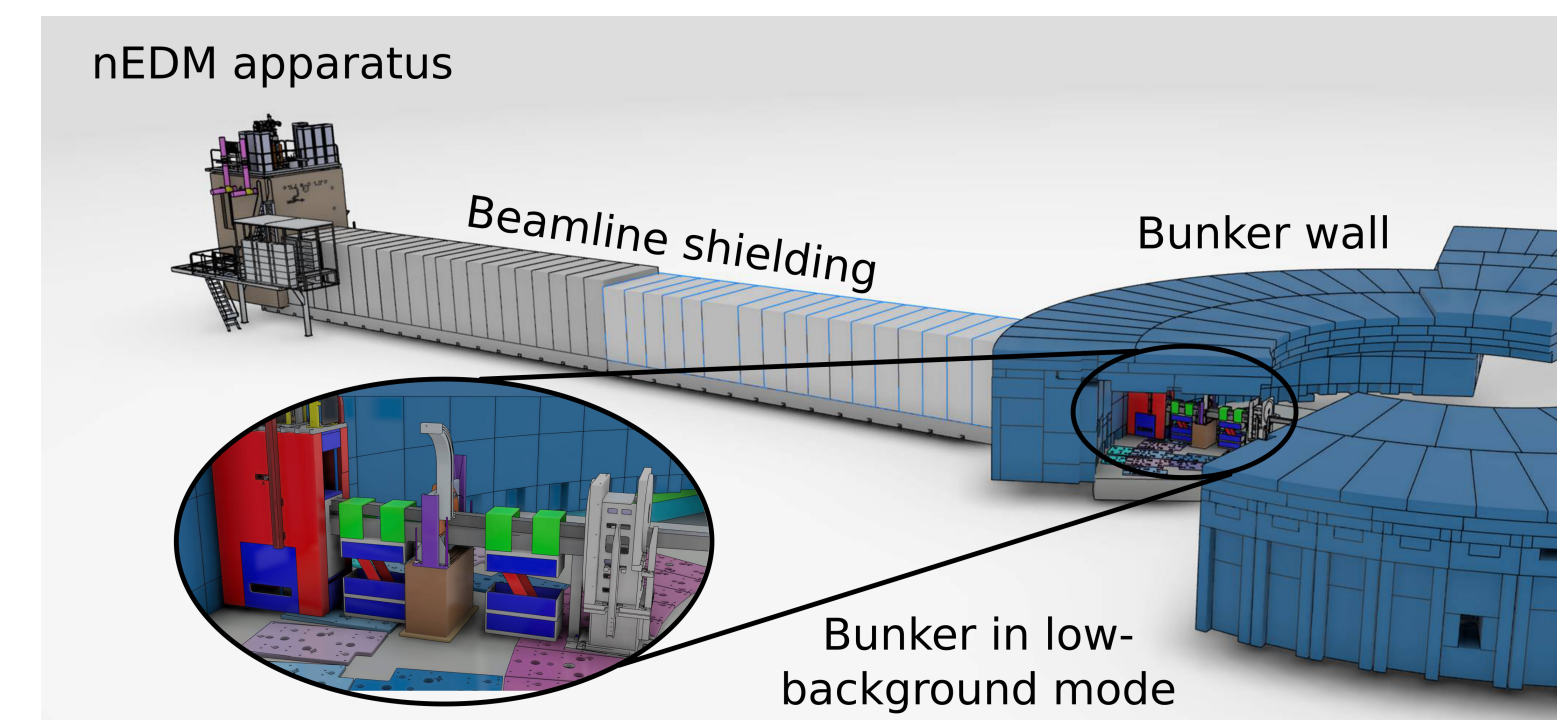
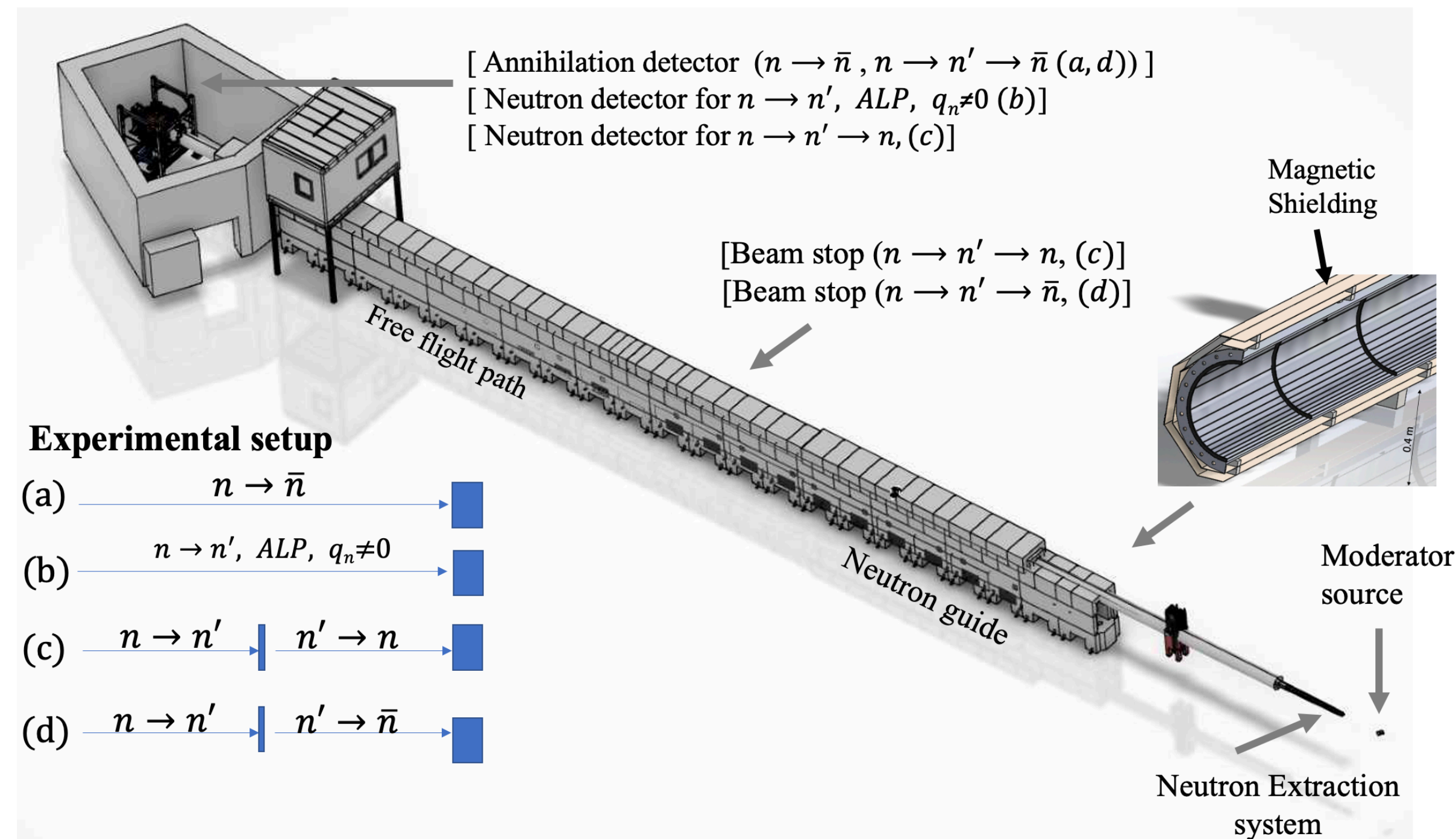
## ECHIR - Mila Myllymäki



# Other instruments

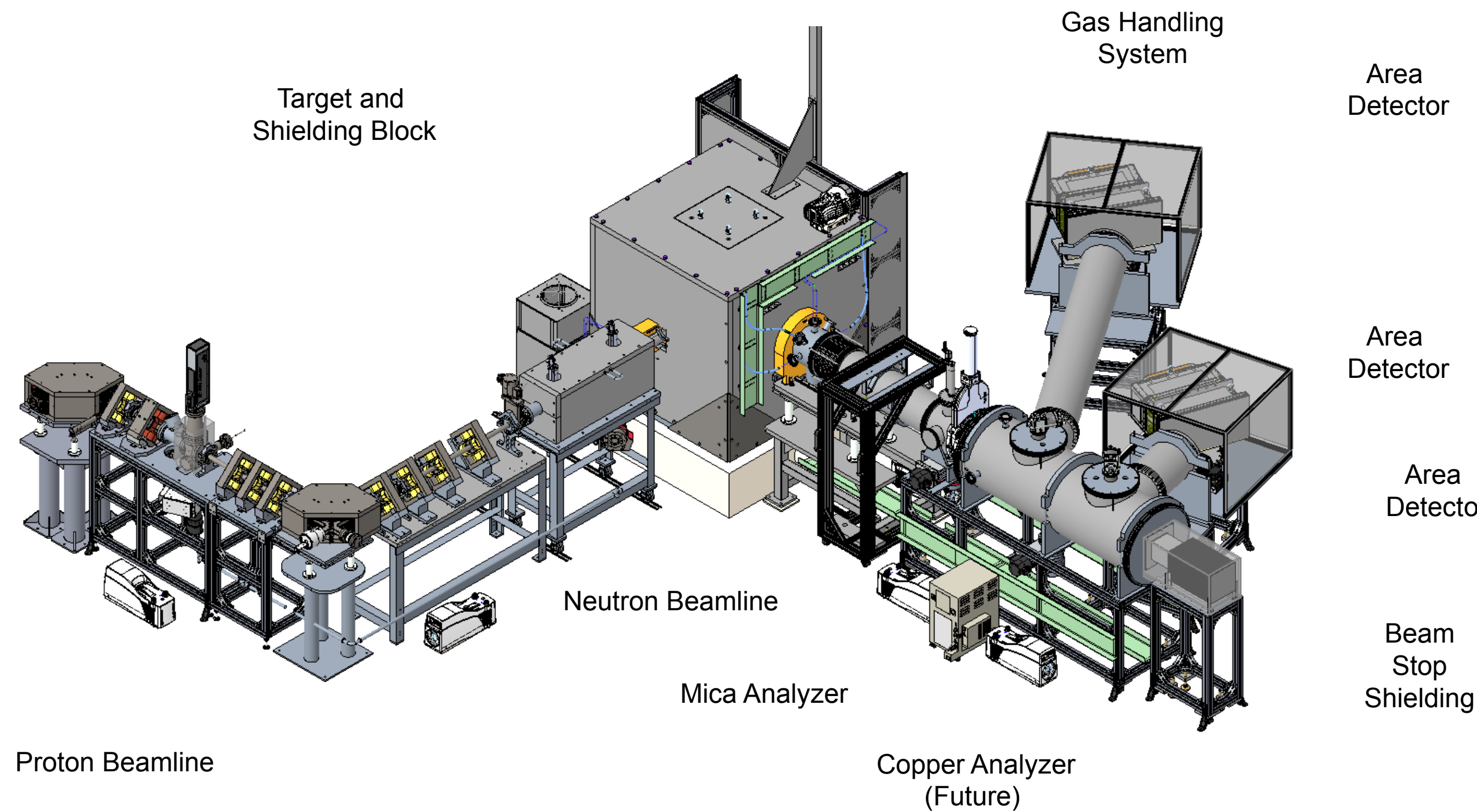
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## FINESSE/NNBAR Valentina Santoro

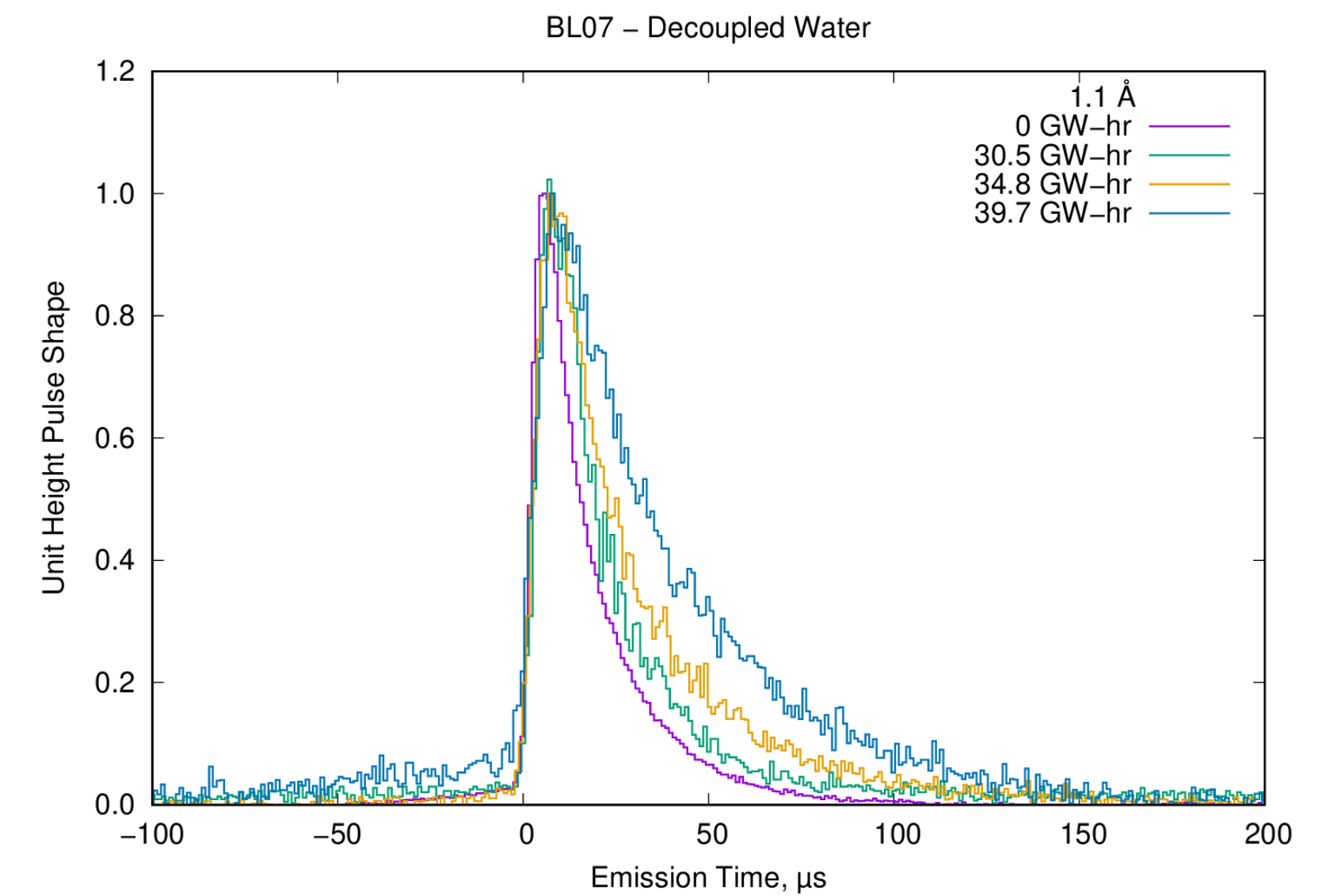


# Moderators

- ▶ Brighter and more efficient moderators can provide large gains
- ▶ Continuous monitoring of performance critical

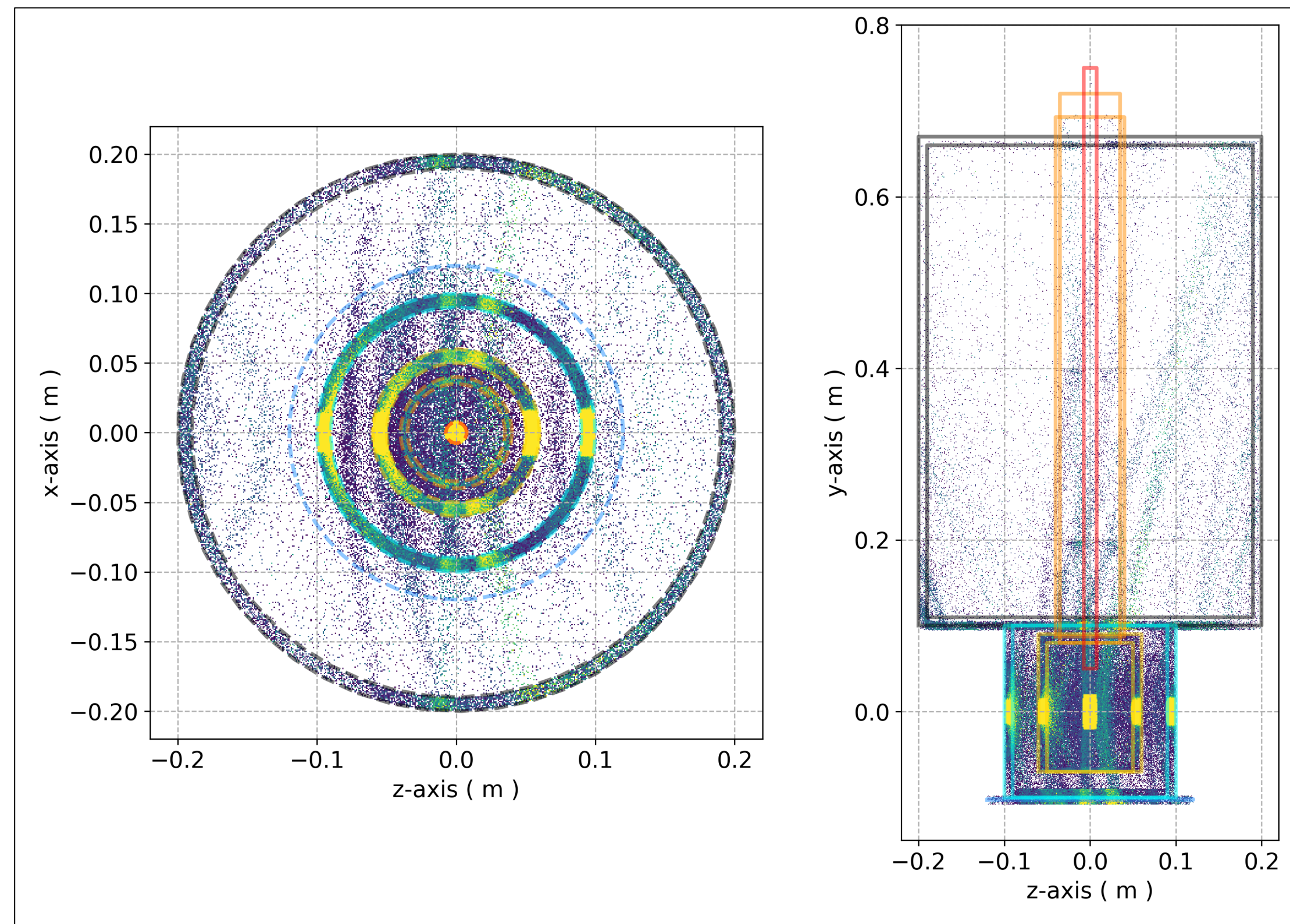


## E. Iverson

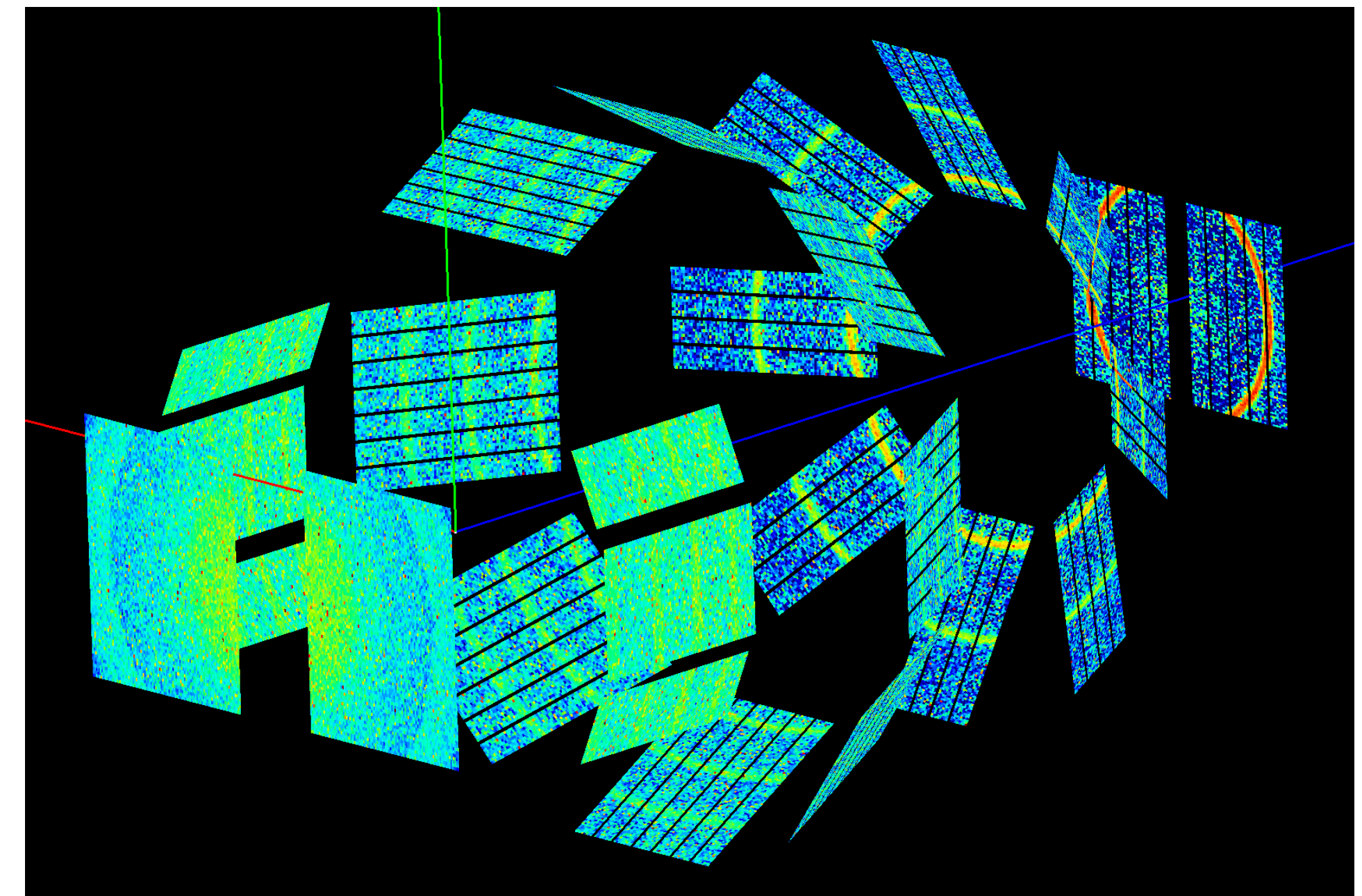


# Simulations

- Developments in mean that instruments can be simulated in more detail than even, including multiple scattering background from sample environment:



G. Sala



BL21 NOVA

# A few takeaways...



- There are still plenty of new instrumentation ideas, particularly for spectrometers
- Even on smaller sources, optimized instrument designs can be useful/competitive
- These developments are driven by advancements in software and technology, particularly:
  - Simulations (McStas, Vitess, NCrystal, OpenMC, MCNP etc.)
  - Virtual experiments
  - Realistic background calculations
- Optimized moderators and neutron delivery systems
- Detectors (Timepix, wavelength shifting fibres etc.)

# Acknowledgements

- ▶ Thanks to all the presenters and to the session chairs:
  - ▶ Monika Hartl
  - ▶ Tianjiao Liang
  - ▶ Mel Borrego
  - ▶ Matt Frost
  - ▶ Masatoshi Arai
  - ▶ Mads Bertelsen

