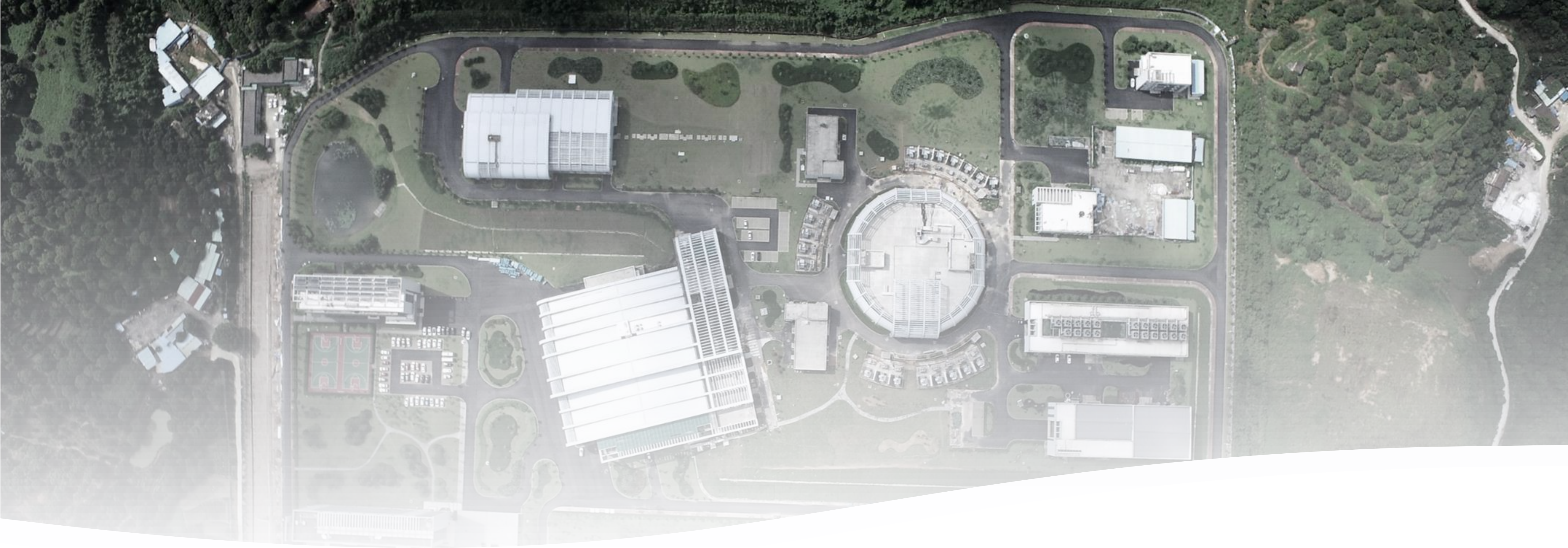


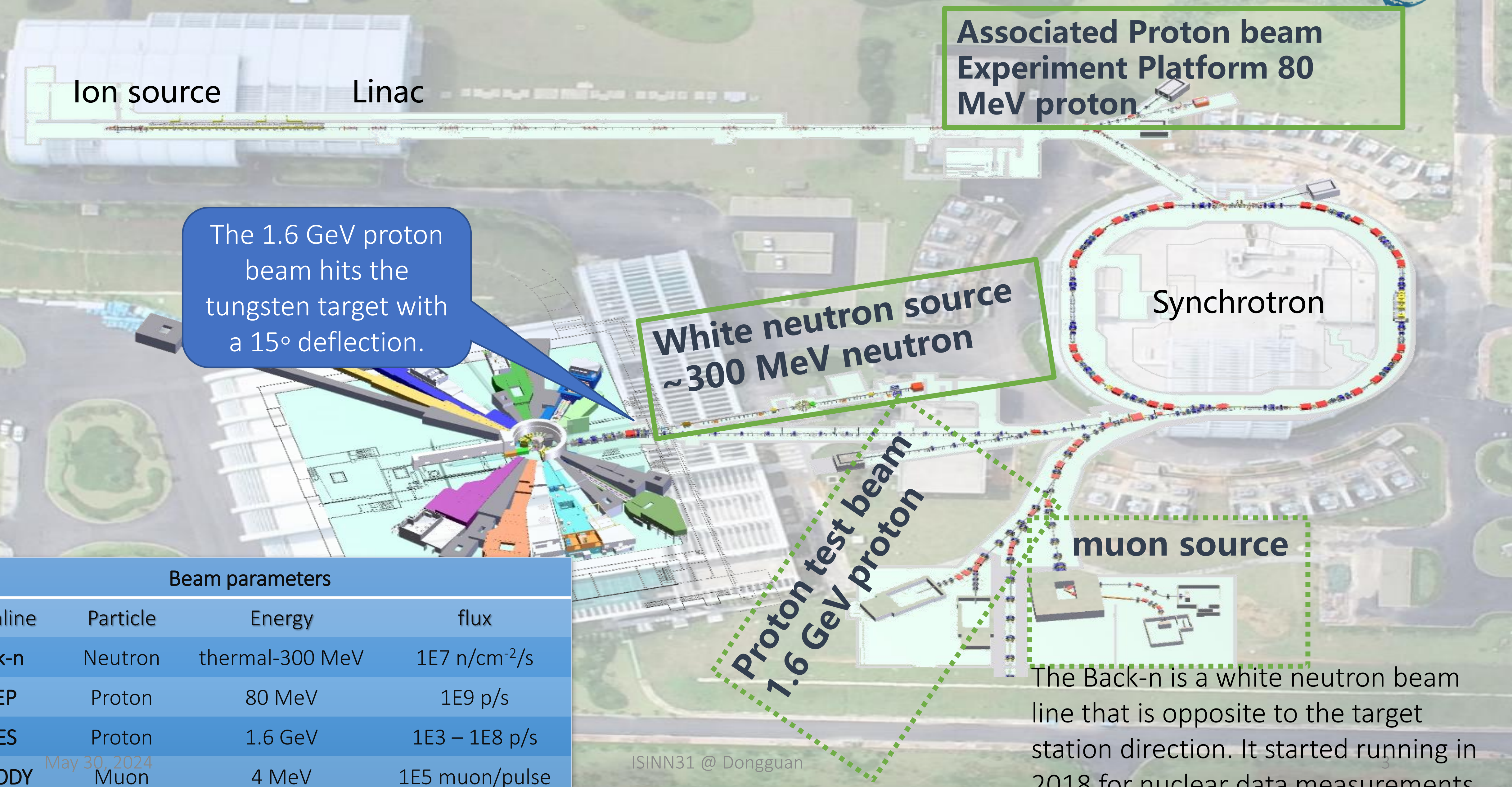
Current Status and Experiments of the Back-n White Neutron Facility

Ruirui Fan on behalf of Back-n team

白光中子实验装置

Back-n

CSNS Beam Expansions Application

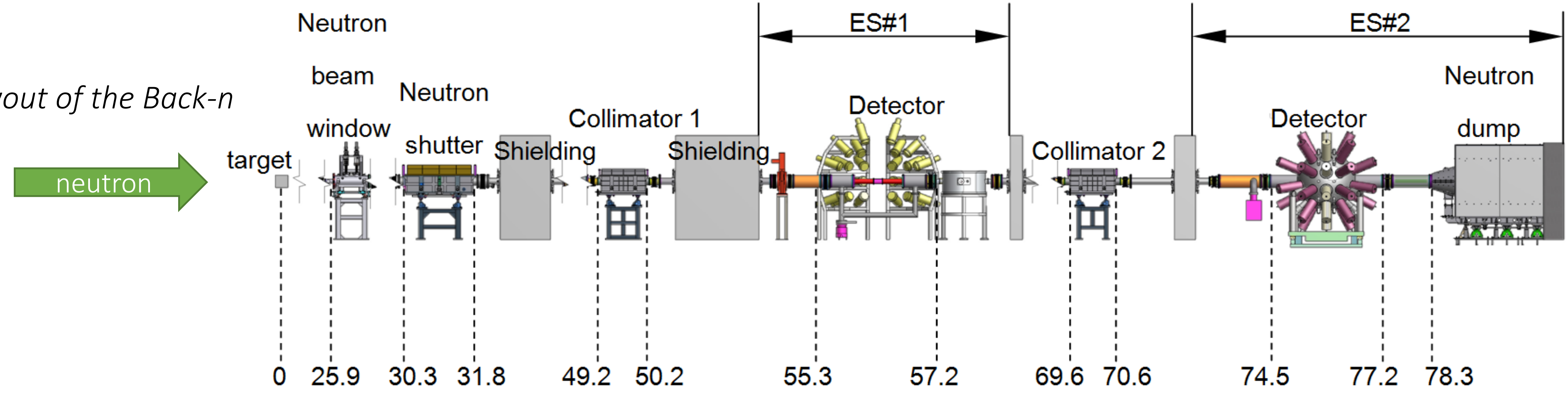


Beam parameters			
Beamline	Particle	Energy	flux
Back-n	Neutron	thermal-300 MeV	1E7 n/cm^{-2}/s
APEP	Proton	80 MeV	1E9 p/s
HPES	Proton	1.6 GeV	1E3 – 1E8 p/s
MELODY	Muon	4 MeV	1E5 muon/pulse

The Back-n is a white neutron beam line that is opposite to the target station direction. It started running in 2018 for nuclear data measurements.

Back-n

Layout of the Back-n

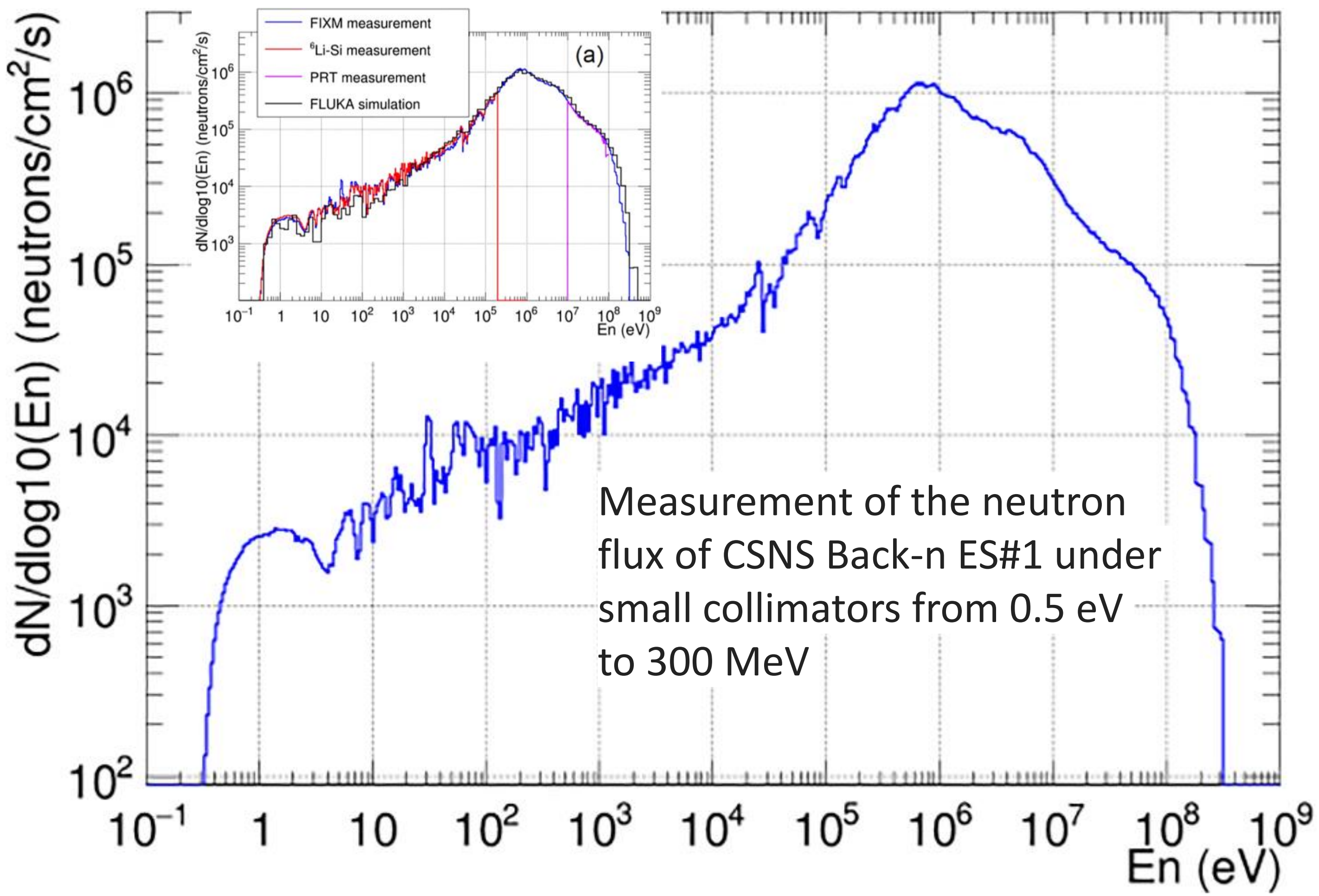


Shutter (mm)	Coll#1 (mm)	Coll#2 (mm)	ES#1 spot (mm)	ES#1 flux ($n/cm^2/s$)	ES#2 spot (mm)	ES#2 flux ($n/cm^2/s$)
Φ3	Φ15	Φ40	Φ15	1.27E5	Φ20	4.58E4
Φ12	Φ15	Φ40	Φ20	2.20E6	Φ30	7.81E5
Φ50	Φ50	Φ58	Φ50	4.33E7	Φ60	1.36E7
78×62	76×76	90×90	75×50	5.98E7	90×90	2.18E7

The back-streaming neutrons are leading to the Back-n tunnel, which has a long flight distance for the neutron time-of-flight method. Two end stations ES#1 and ES#2 are constructed for different nuclear data measurements. The ES#1 has a distance of about 55 m, and ES#2 is about 70 m from the target. Different sets of beam spots, collimator apertures and neutron fluxes at Back-n at 100 kW in proton beam power can be found in table.

1. 2017 JINST 12 P07022
2. Eur. Phys. J. A (2019) 55: 115

Back-n neutron energy spectrum measurement



Energy range	flux (neutrons/cm^2/s)
0.1-1 eV	4.08×10^3
1-10 eV	1.79×10^4
10-100 eV	3.01×10^4
0.1-1 keV	5.01×10^4
1-10 keV	1.23×10^5
10-100 keV	4.30×10^5
0.1-1 MeV	2.98×10^6
1-10 MeV	2.77×10^6
10-200 MeV	6.21×10^5
Total	7.03×10^6

We used different reference cross-sections to measure the energy spectrum, including: (n, p), ^{6}Li(n, t), ^{235}U(n, f), ^{238}U(n, f)

Eur. Phys. J. A (2019) 55: 115
Chen, Y., Qiu, Y., Li, Q. *et al. Eur. Phys. J. A* **60**, 63 (2024).

The white neutron energy range

The Back-n has a wide neutron energy range from **cold neutron (0.4 meV) to 300 MeV (Fig 1)**. To avoid the frame overlap, a Cadmium filter is employed at the upstream end of the beamline (window).

- Thermal neutrons or epithermal neutrons are the reference for lots of experiments, and some important parameters such as neutron polarization need to be calibrated using thermal neutrons.

Changing the beam filter 1 mm Cadmium → 1.7 mm boron nitride (BN), can get a lower cutoff energy(**300->20 meV**).

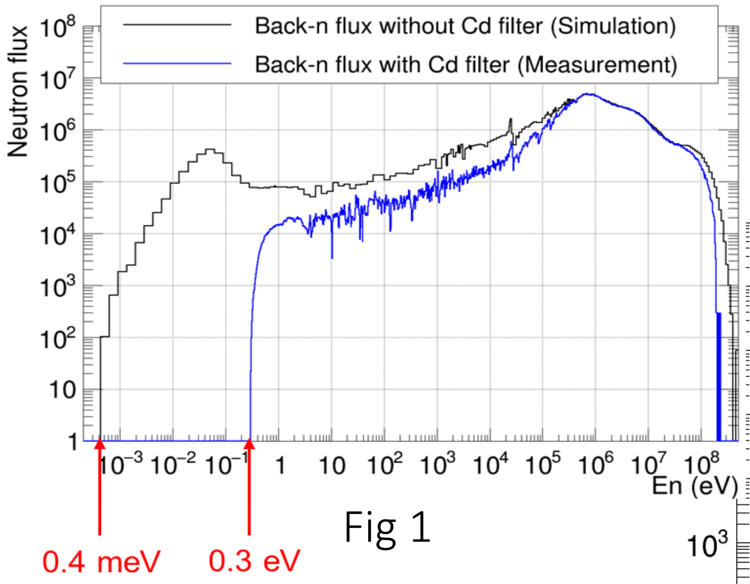


Fig 1

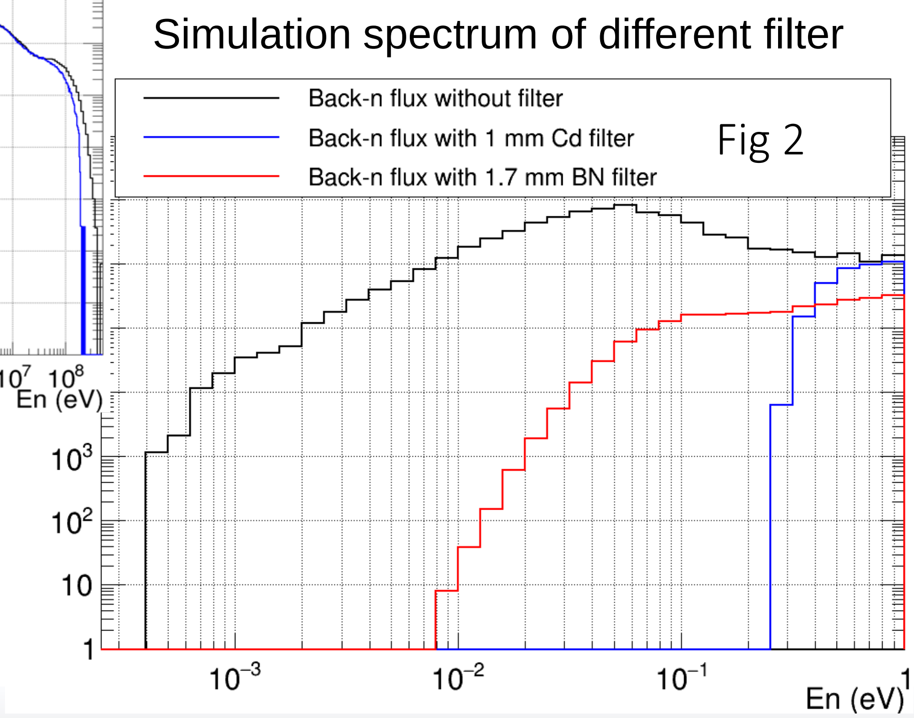
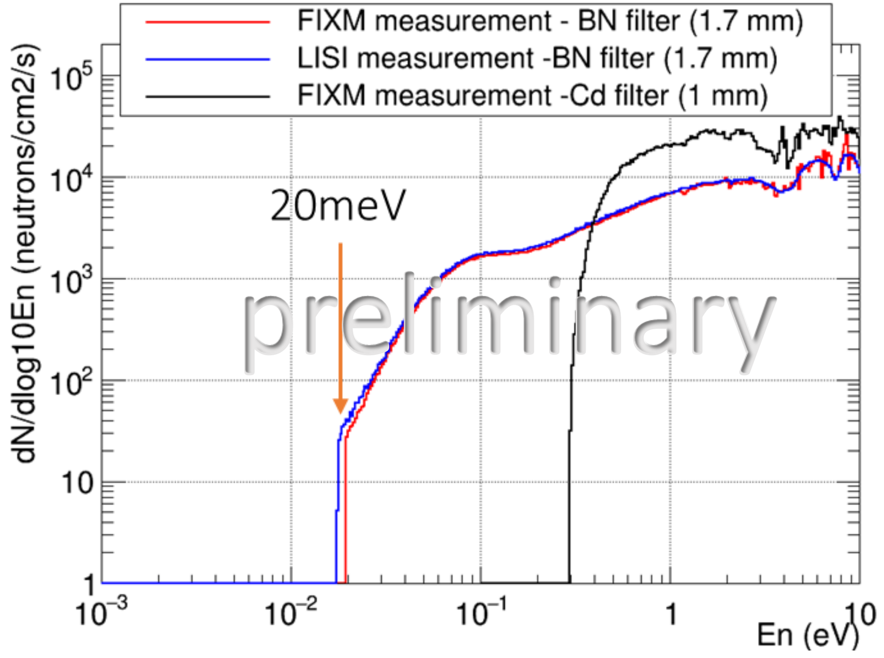


Fig 2



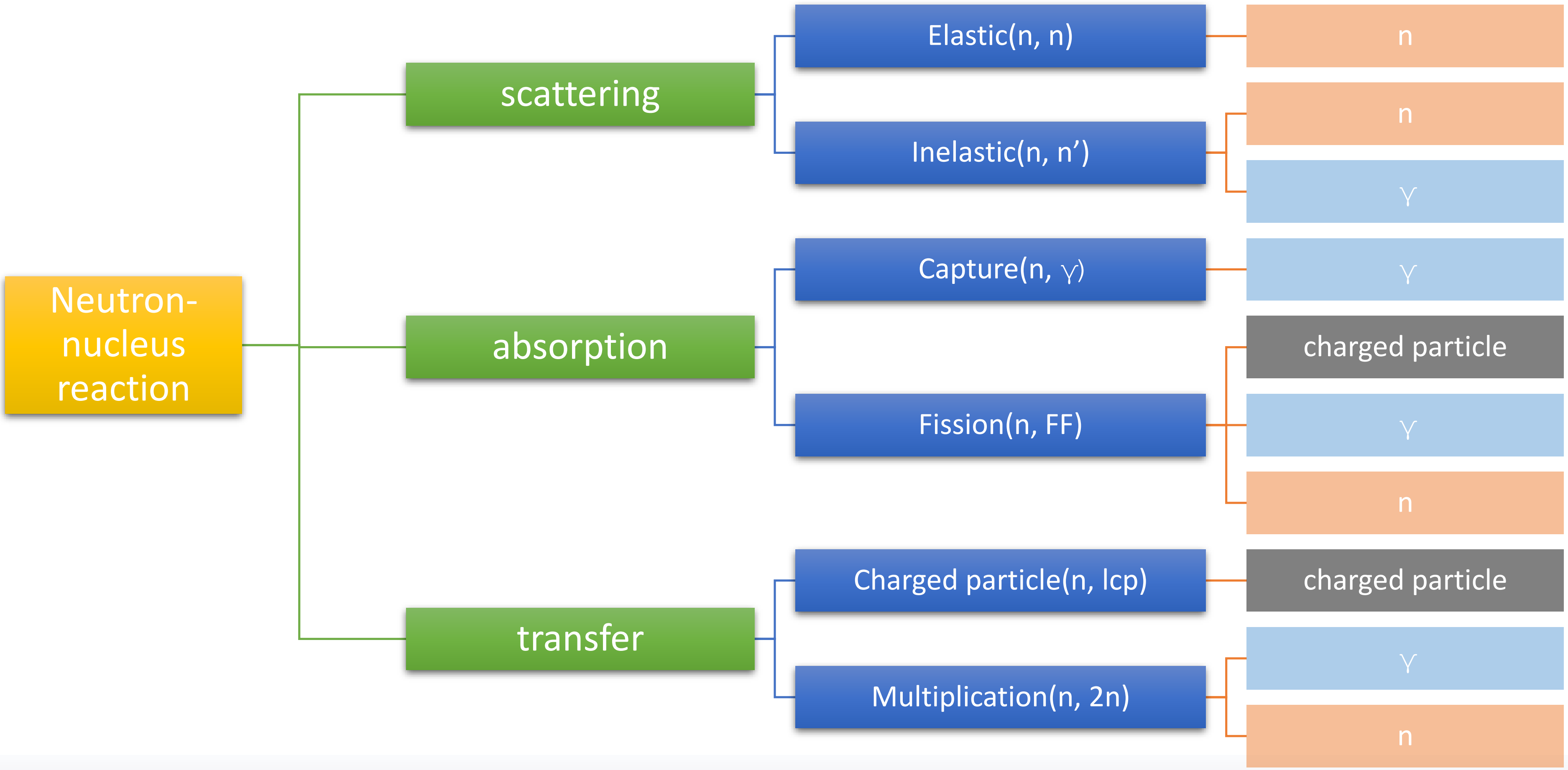
Experimental spectrum Fig 3

核数据测量实验

Nuclear data measurement

Classification of Neutron and Nucleus Reactions

Neutron and nucleus reactions can be divided into three main categories based on the nuclear reaction process: scattering reactions, absorption reactions, and transfer reactions.



C_6D_6(Benzene-d6) scintillator detector

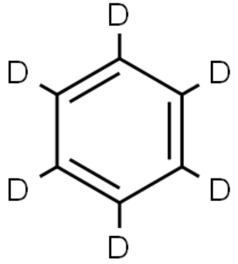


Photo of the C6D6 detector system

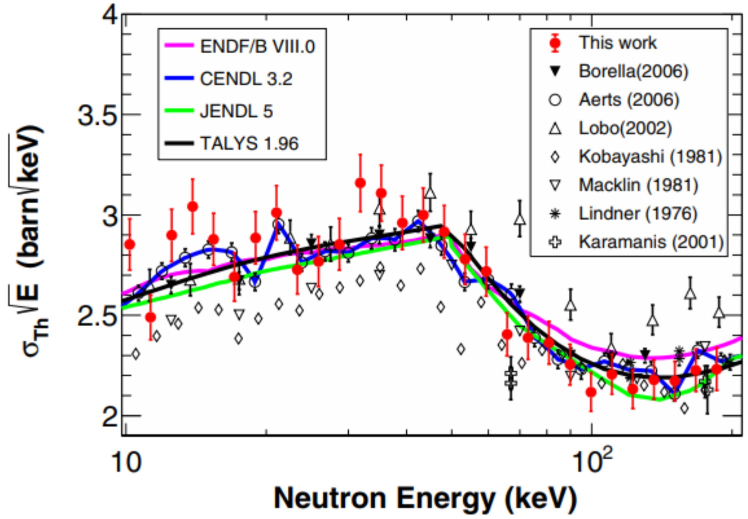


Fig. 10 The capture cross sections of ^{232}Th multiplied by the square root of the neutron energy. The uncertainty of some data sets is omitted to maintain the readability of the figure

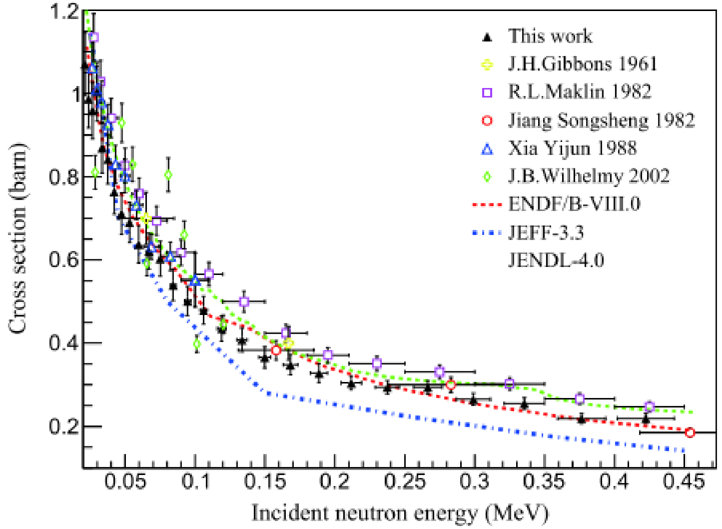


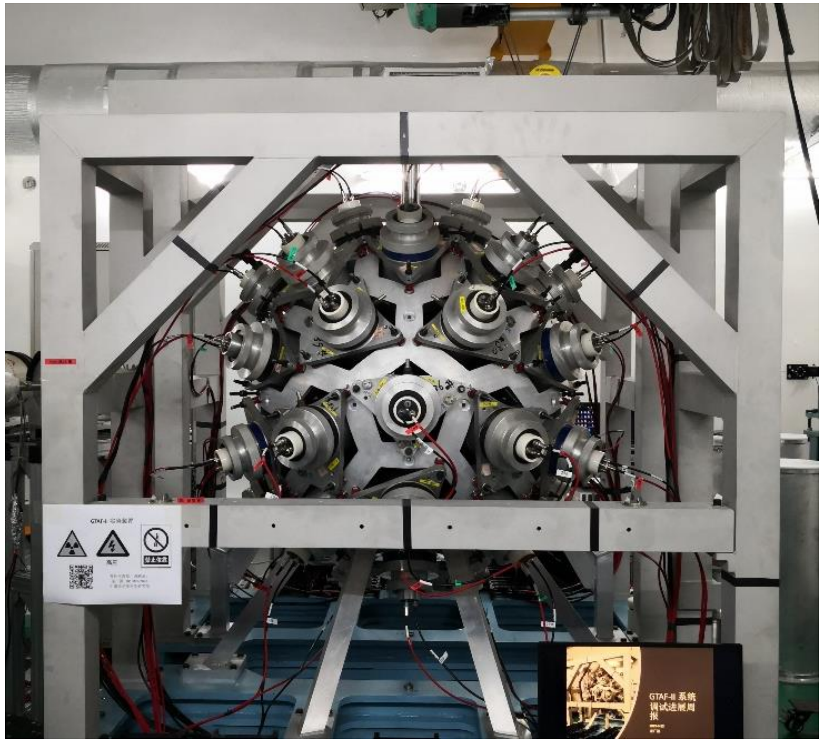
Fig. 15. (color online) The capture cross sections of ^{169}Tm obtained by the relative measurement of ^{197}Au(n,γ).

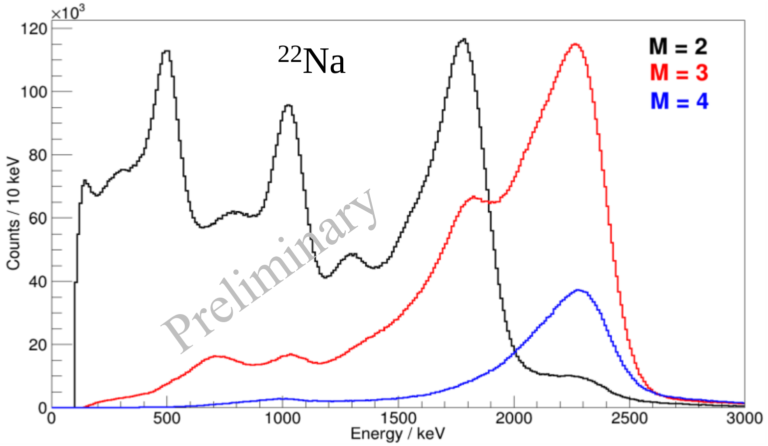
The C_6D_6 liquid scintillator is EJ315, which is produced by ELJEN Technology Corporation. The shell of the scintillator is made of aluminum and the size is 130mm in diameter and 76.2mm in length. The C_6D_6 detectors are placed upstream of the sample relative to the neutron beam, and the detector axis is at an angle of 125 degrees from the neutron beam.

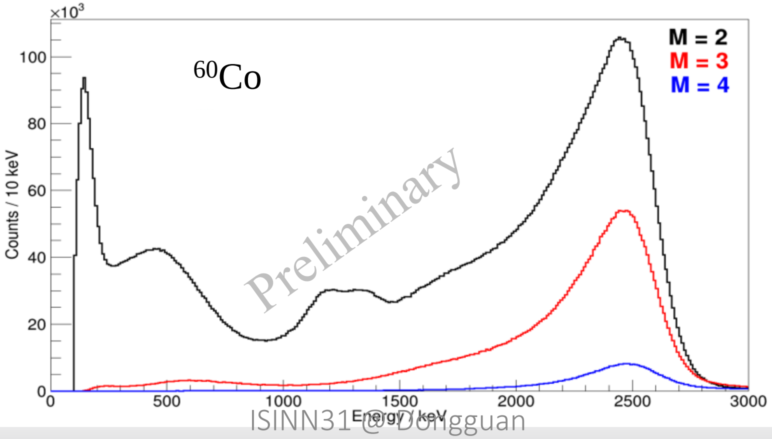
Radiation Detection Technology and Methods, 3(3): 52
Chinese Physics C, 46(4): 044002
Chinese Physics B, 31(6): 060101

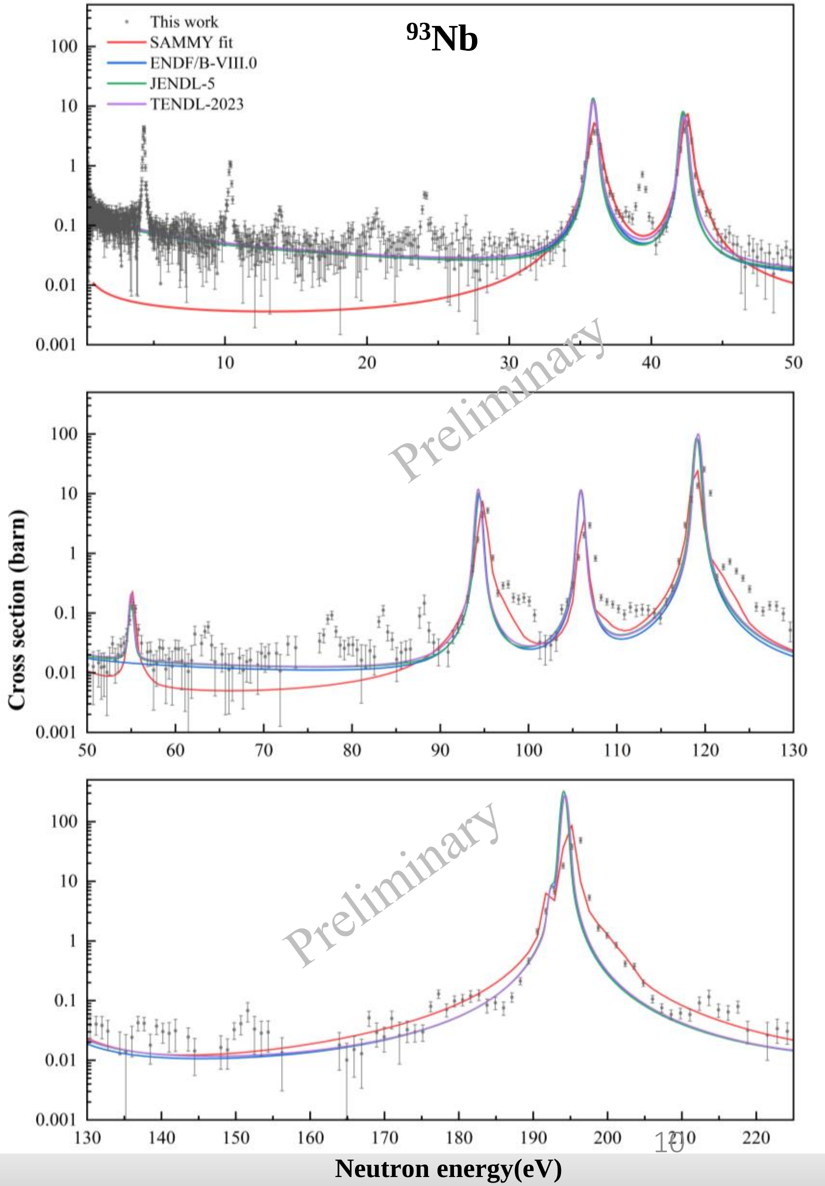
Gamma Total Absorption Facility（GTAF）

- ✓ Precise measurements of (n, γ) cross-section
- ✓ Suitable for micro-samples and low cross-section samples
- ✓ Spin&parity identification



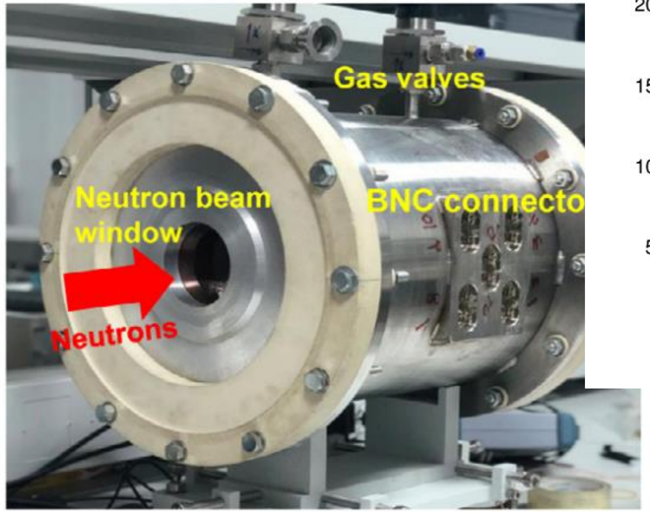


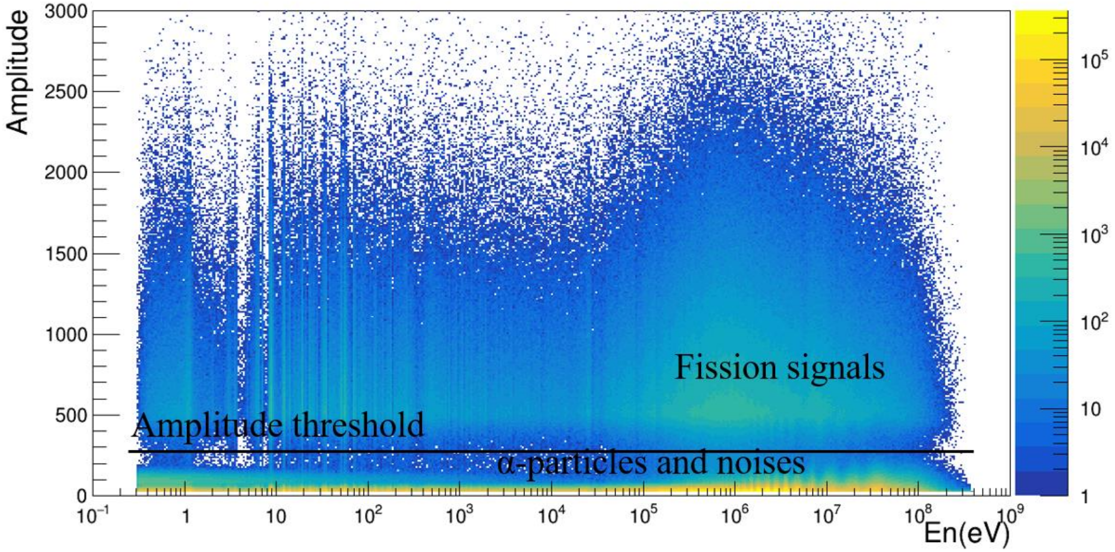




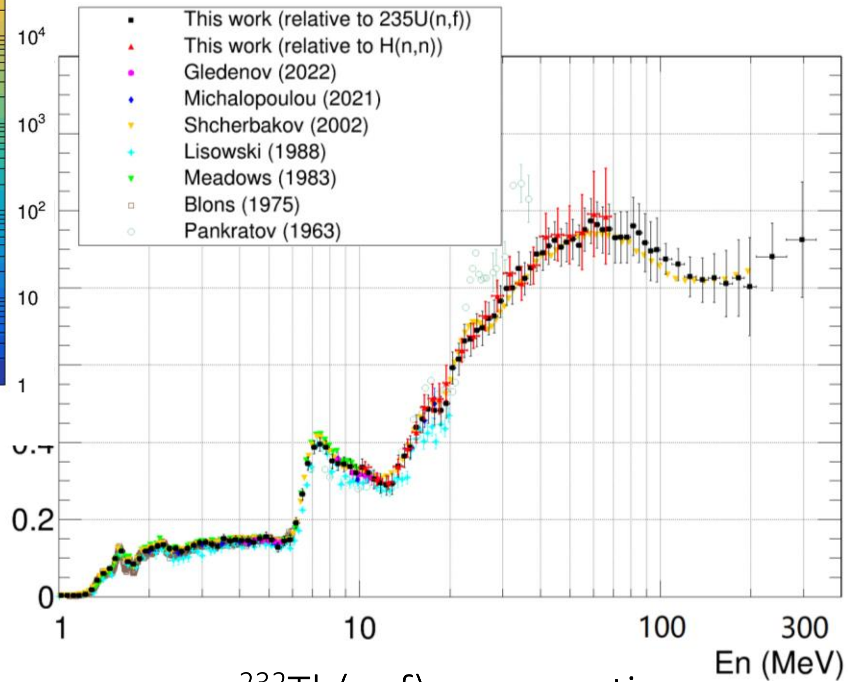
Connect：
LUAN Guangyuan（lgyciae@hotmail.com）
JIANG Wei（jiangwei@ihep.ac.cn）

The fission chamber





The 2D spectra of neutron energy-amplitude measured



^{232}Th(n, f) cross section

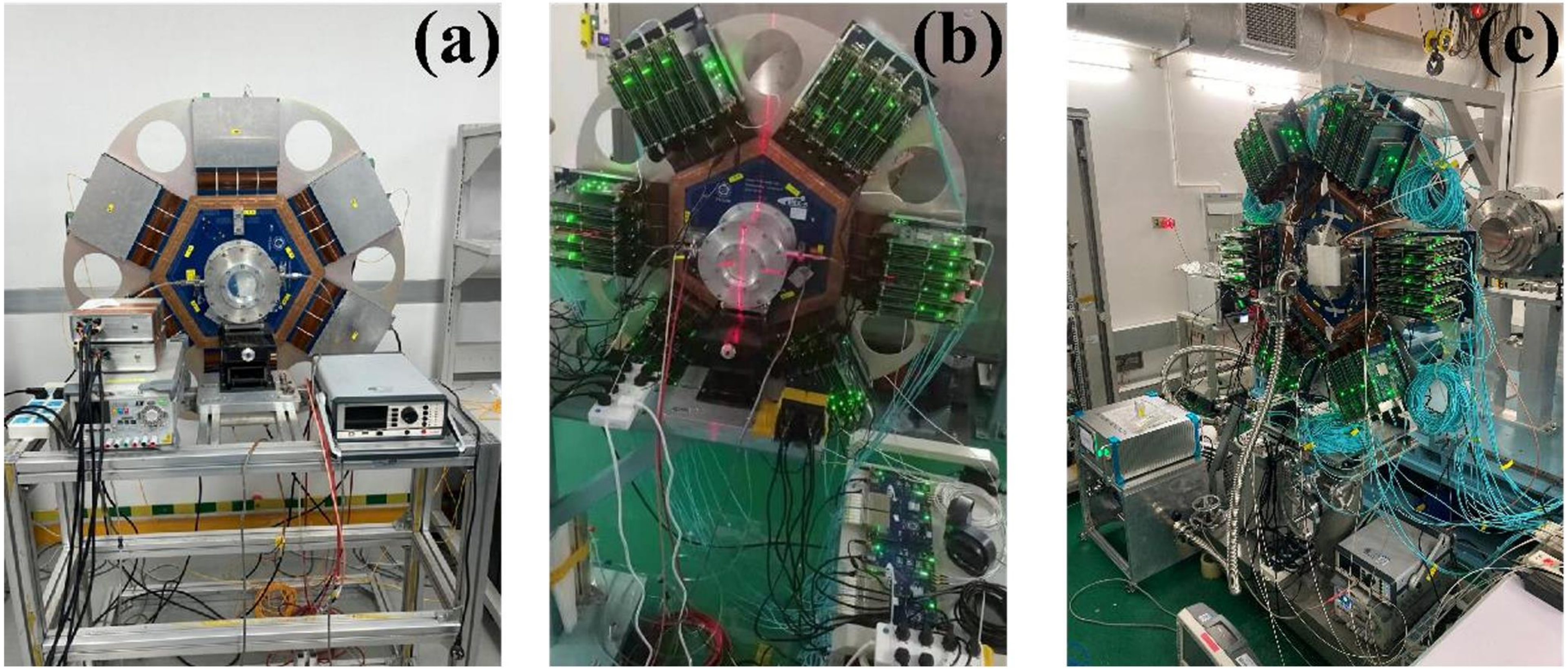
The fission ionization chamber detector measures the fission fragments generated through the reaction between the fission material (^{235}U, ^{238}U) and neutrons, and records the energy of the neutrons by measuring their flight time.

Nuclear Inst. and Methods in Physics Research, A 940 (2019) 486–491
Physics Letters B, 839: 137832
EPJ Web of Conferences, 284: 01013
Annals of Nuclear Energy, 140: 107301

Back-n multipurpose TPC

1. NIMA 1039 (2022) 167157
2. Z. Chen et al 2022 JINST 17 P05032
3. NIMA1058(2024)168912
4. NIMA 1060 (2024) 169045

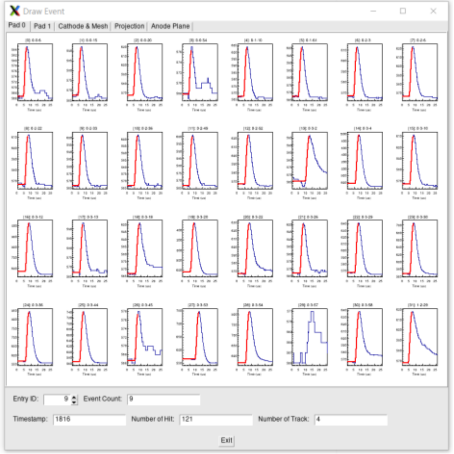
Hardware Update

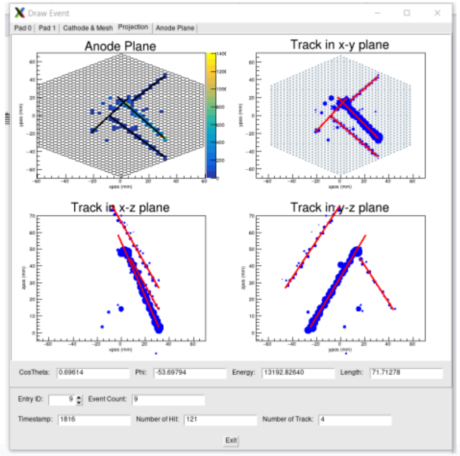


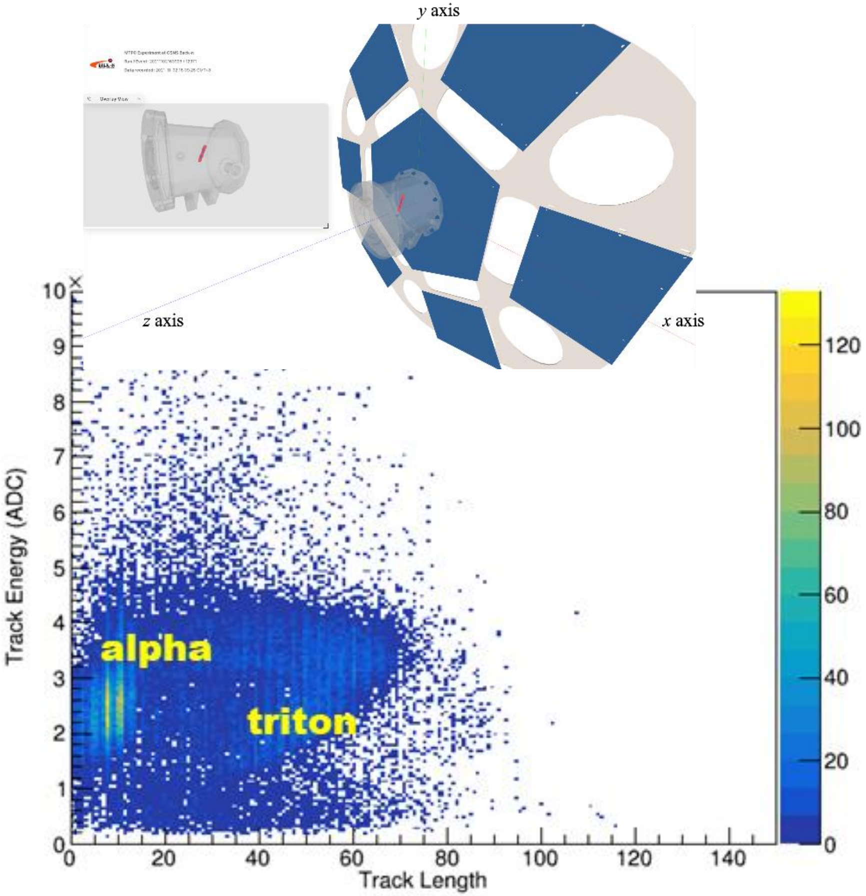
2019 2021 2023

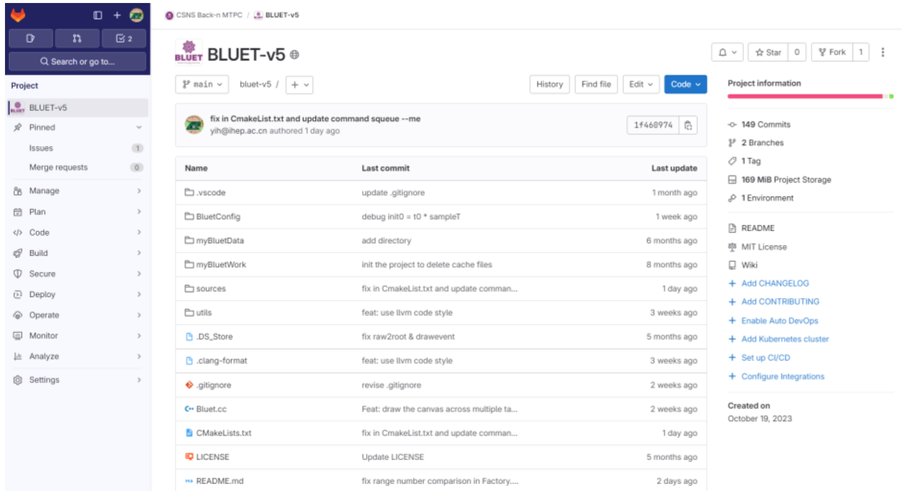
BLUET framework

- UI interface, Simulation, Waveform analysis, Event reconstruction…
- BLUET code has been upgraded to version v5, developed based on Gitlab open to everyone.

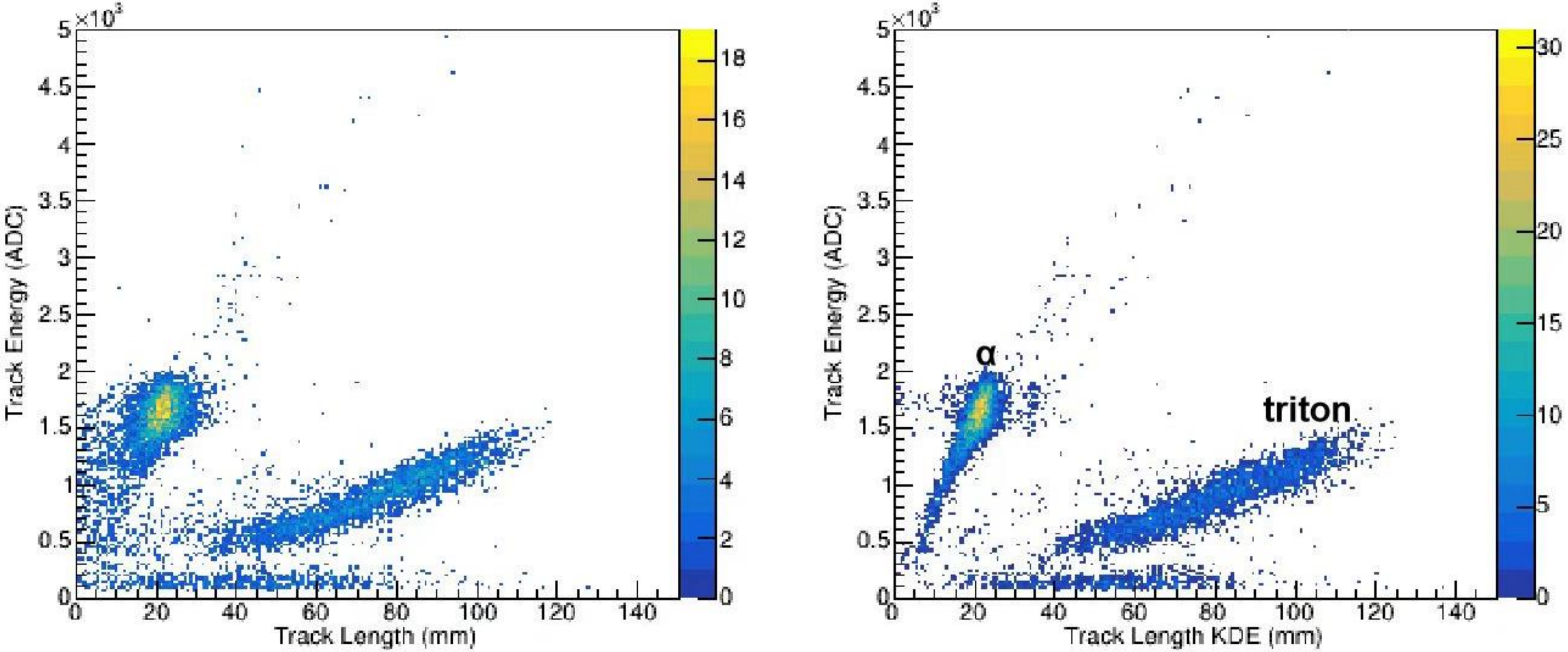






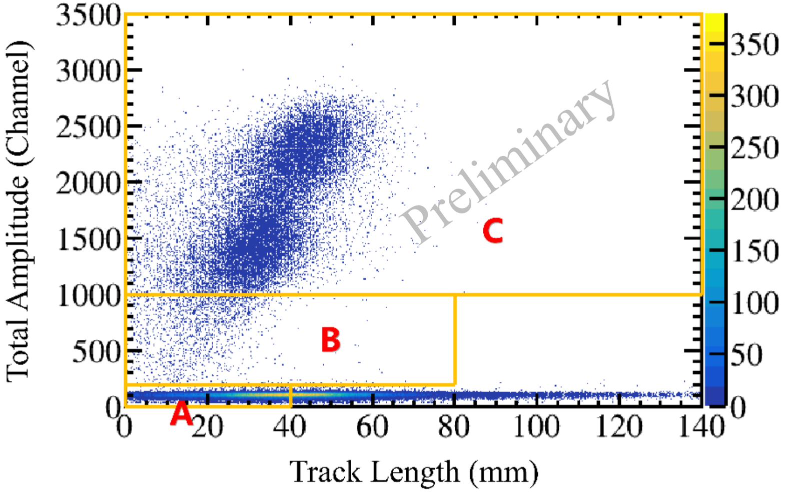


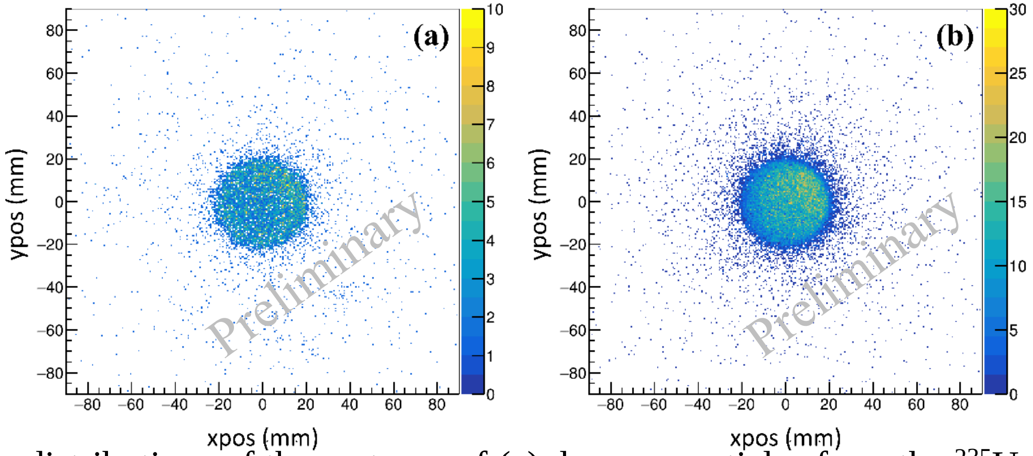
Software update



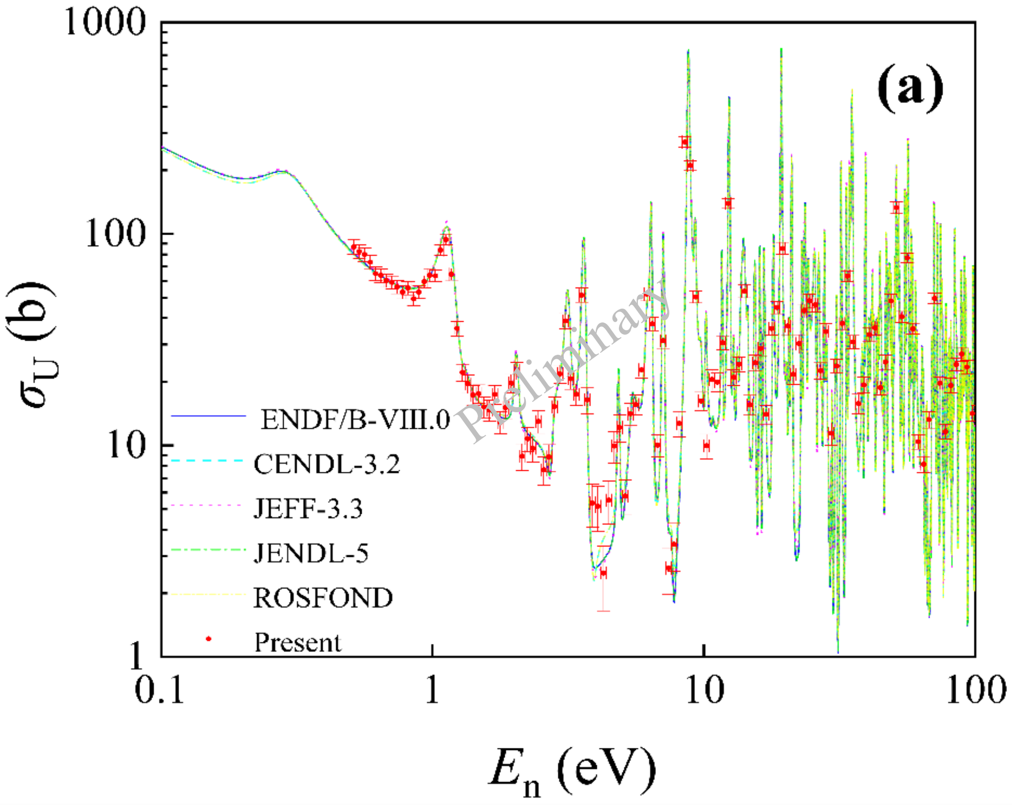
The improved particle resolution achieved through the trajectory fitting algorithm

^{235}U(n, f) cross section measurement





The distributions of the vertexes of (a) decay α particles from the ^{235}U sample. (b) fission fragments from the ^{235}U(n, f) reaction.



Courtesy: Haofan Bai(PKU)

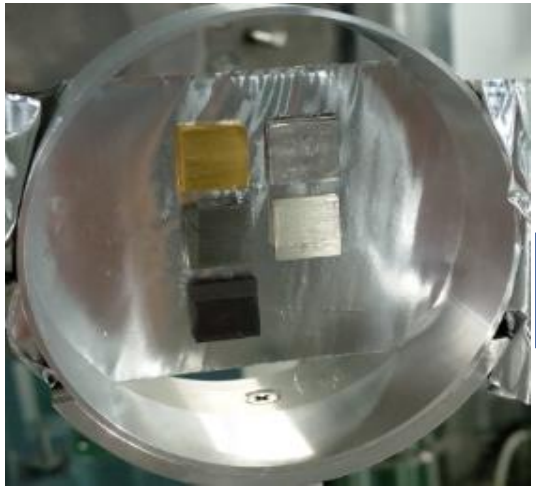
白光中子应用和基础物理

Application and Fundamental Physics

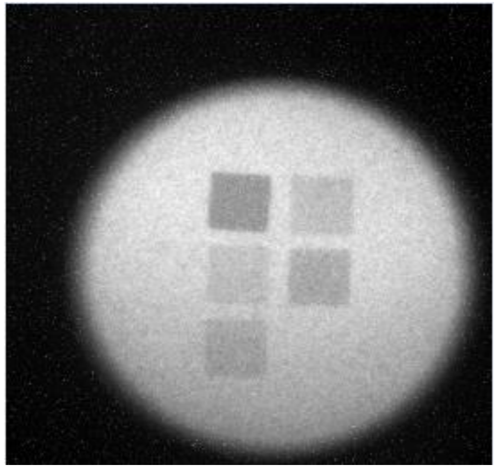
Neutron Resonance Transmission Imaging(NRTI)

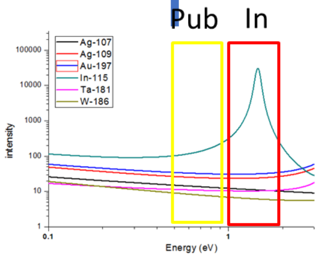
sample：

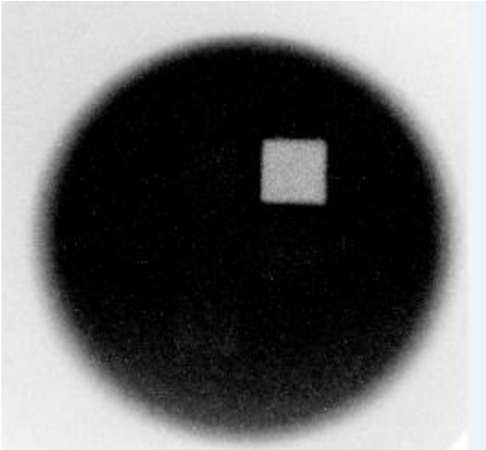
Au、Ag、W、Ta、In



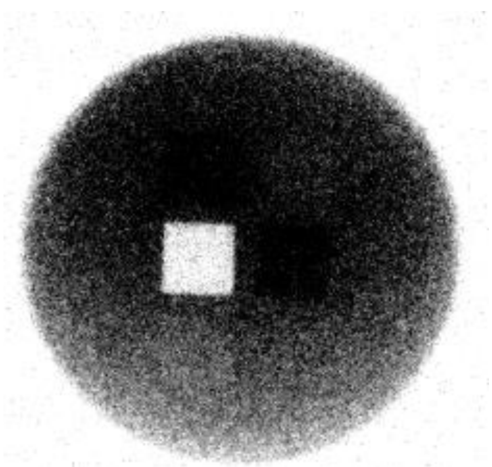
Transmission image







Indium



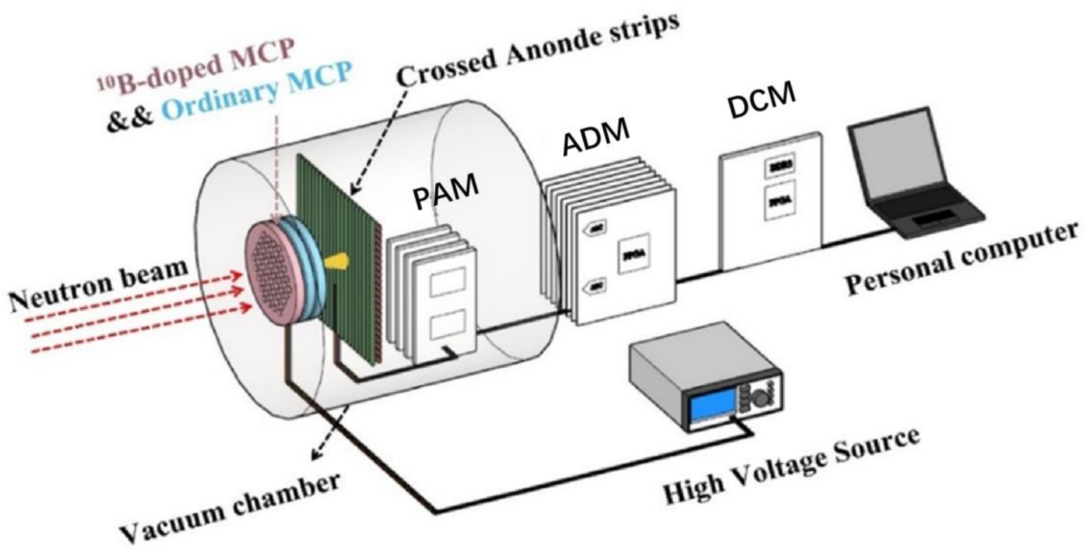
Tungsten

For the inspected sample containing nuclides that exhibit sharp cross-section resonances, the nuclides' distributions can be identified by analyzing the time-resolved transmission images of the neutrons through the sample. *

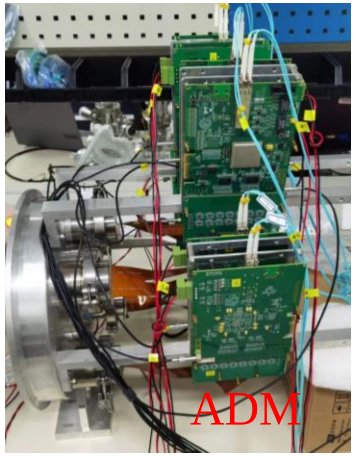
*NIMA 1048, 2023, 167892

NRTI based on ^{10}B-doped MCP

Detection system

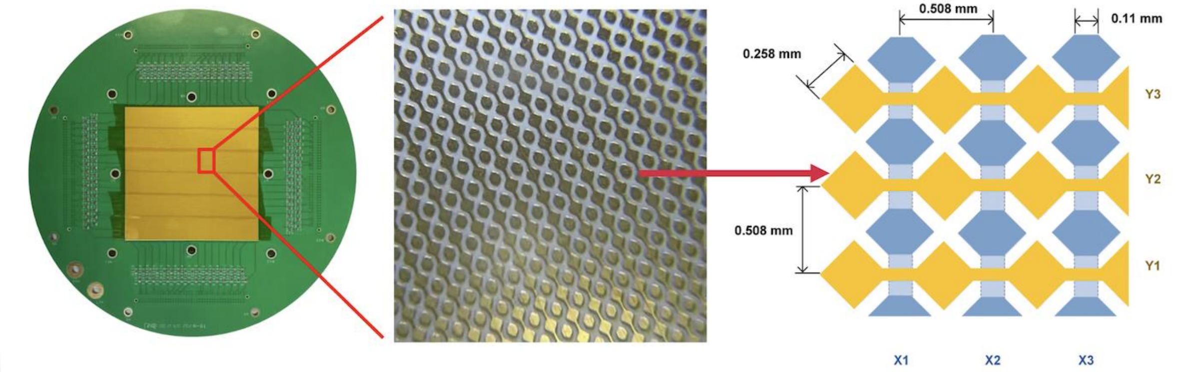


Schematic diagram MCP detection system

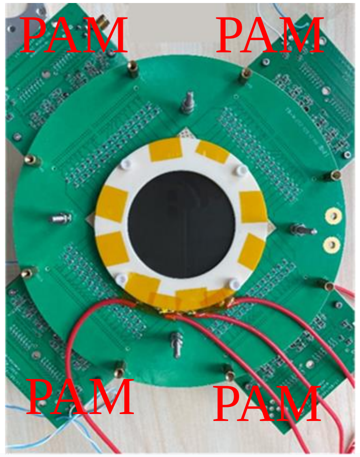


Sample rate : 80 MSPS
Sampling resolution:12 bit

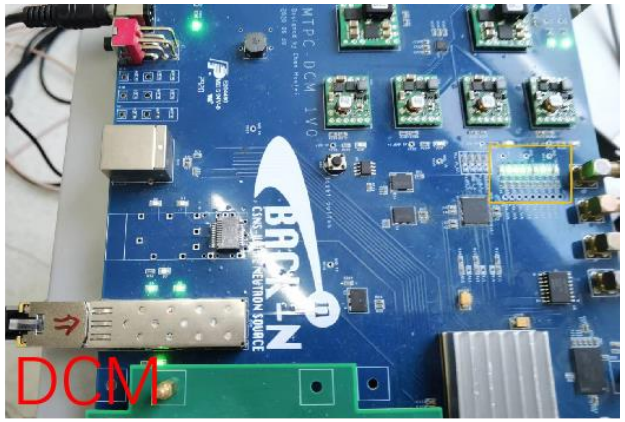
Analog-to-Digital Module



Crossed Anonde Strip 128x128

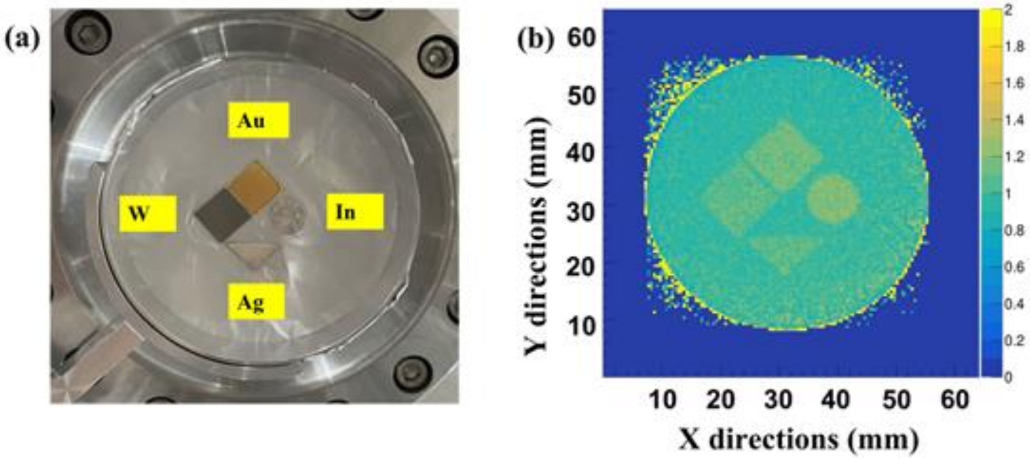


Pre-Amplifier Module

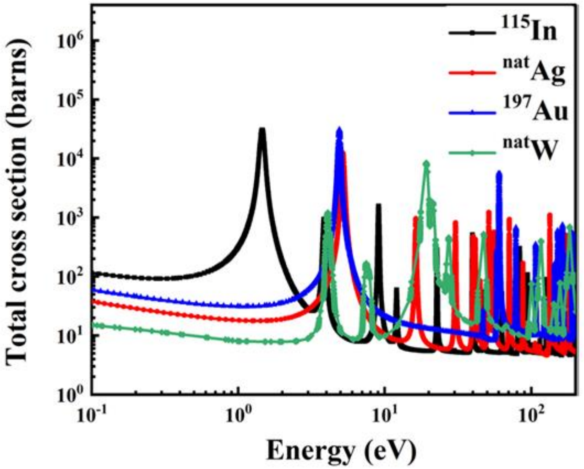


Data Concentrator Module

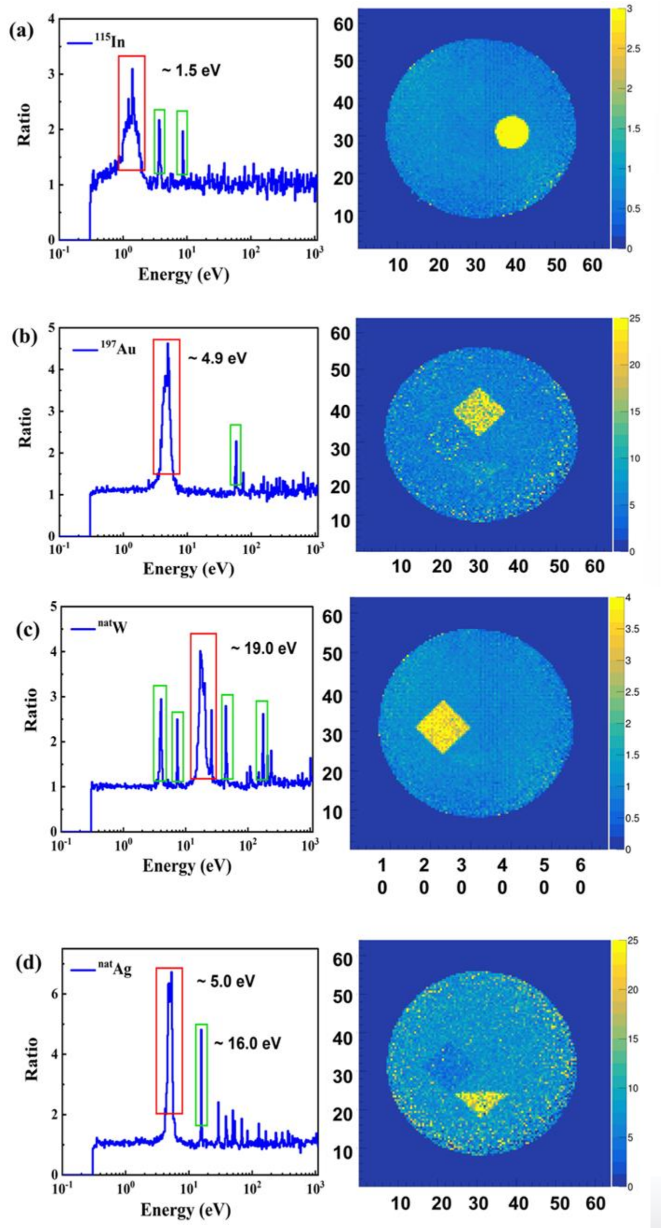
NRTI based on ^{10}B-doped MCP



Sample objects and the neutron transmission image over the full-energy region

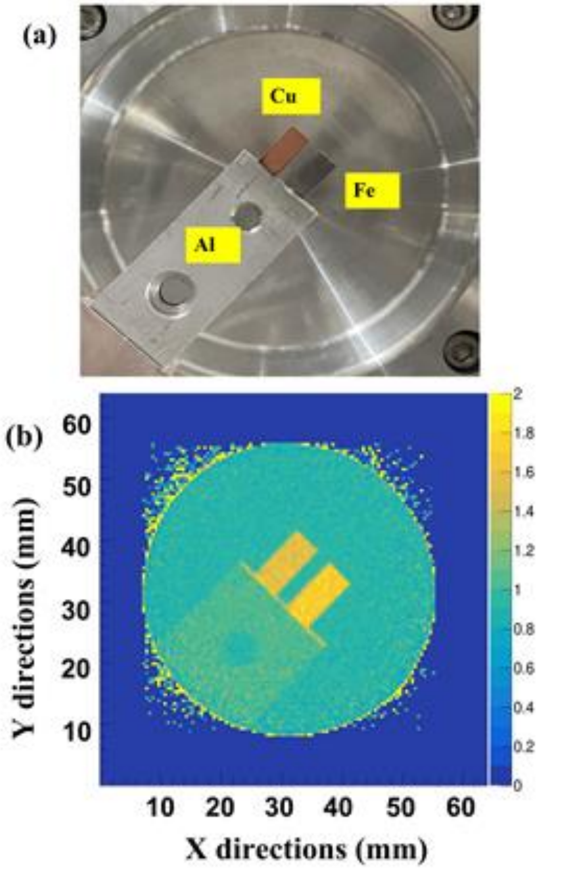


Cross sections of ^{115}In, ^{nat}W, ^{197}Au, and ^{nat}Ag within the energy region of **1–200 eV**

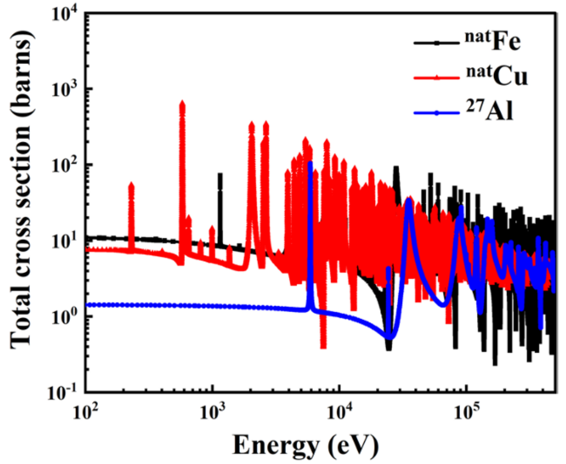


Identification imaging with neutron energy selected

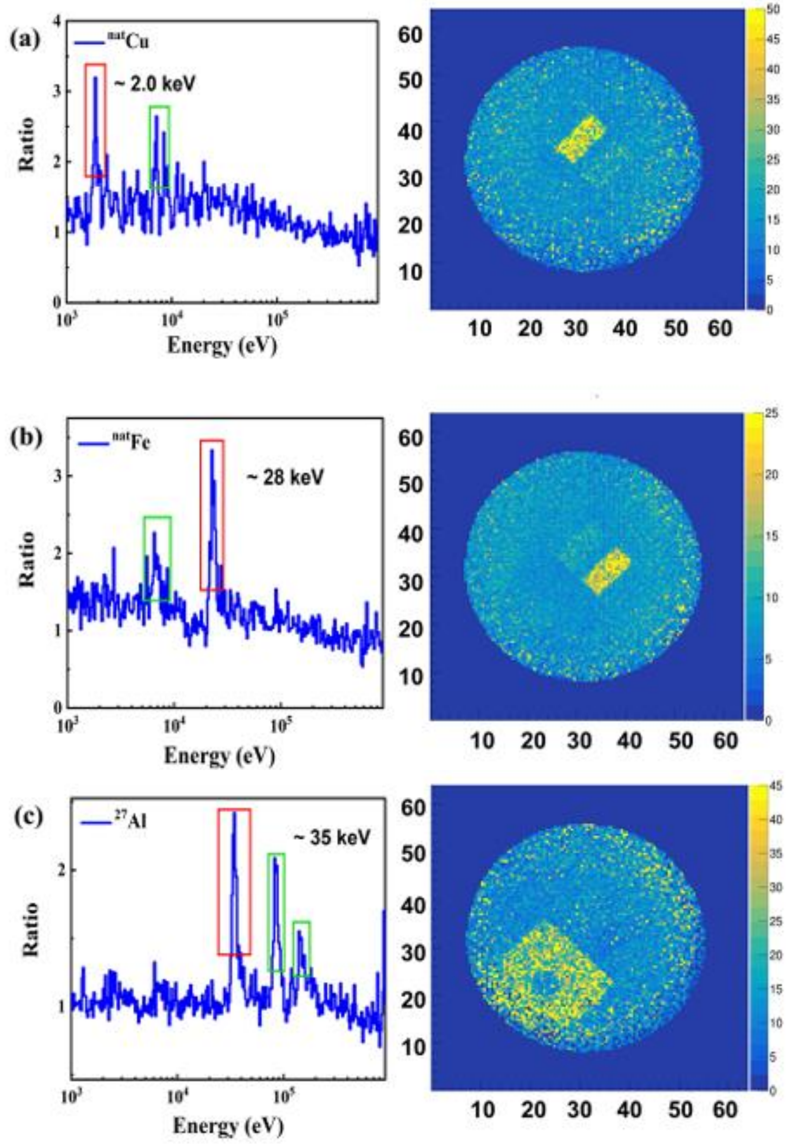
NRTI based on ^{10}B-doped MCP



Sample objects and the neutron transmission image over the full-energy region

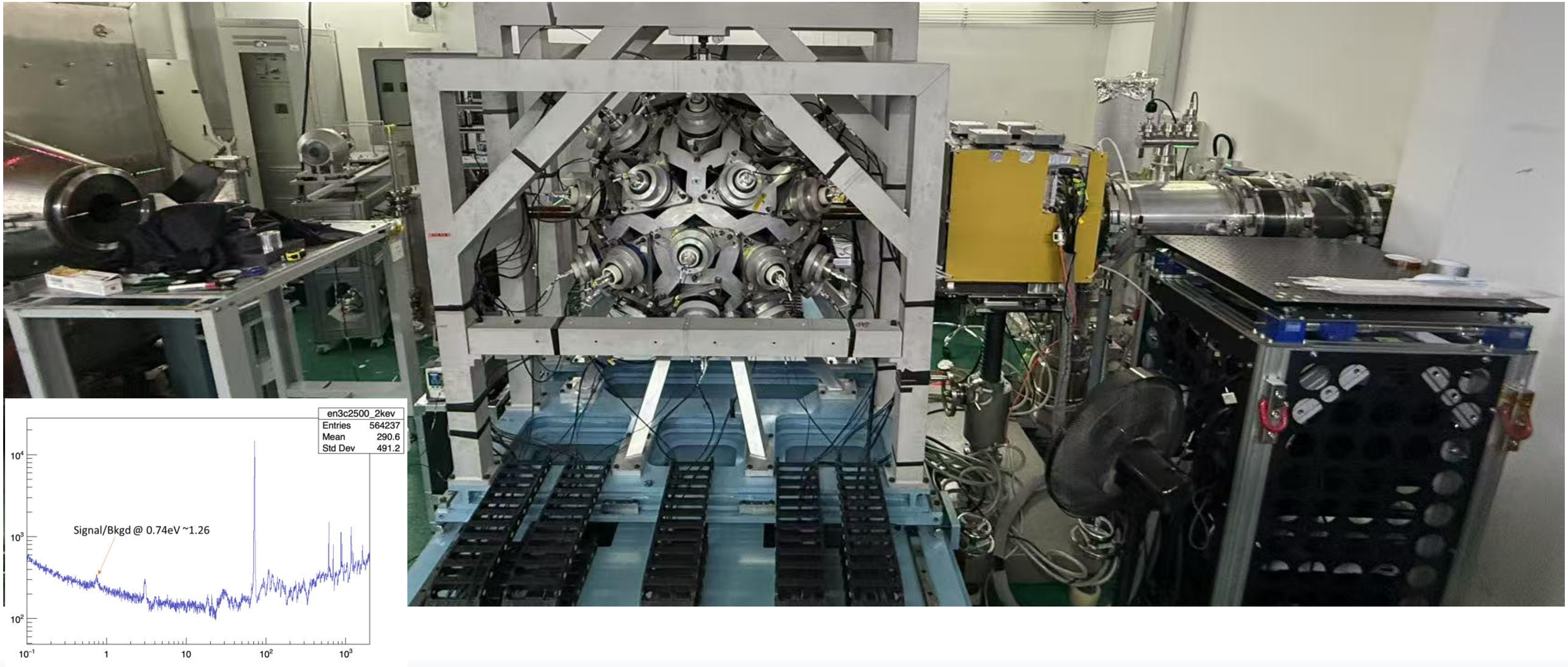


Cross sections of ^{nat}Cu, ^{nat}Fe, and ^{27}Al in the energy region of **100 eV–500 keV**

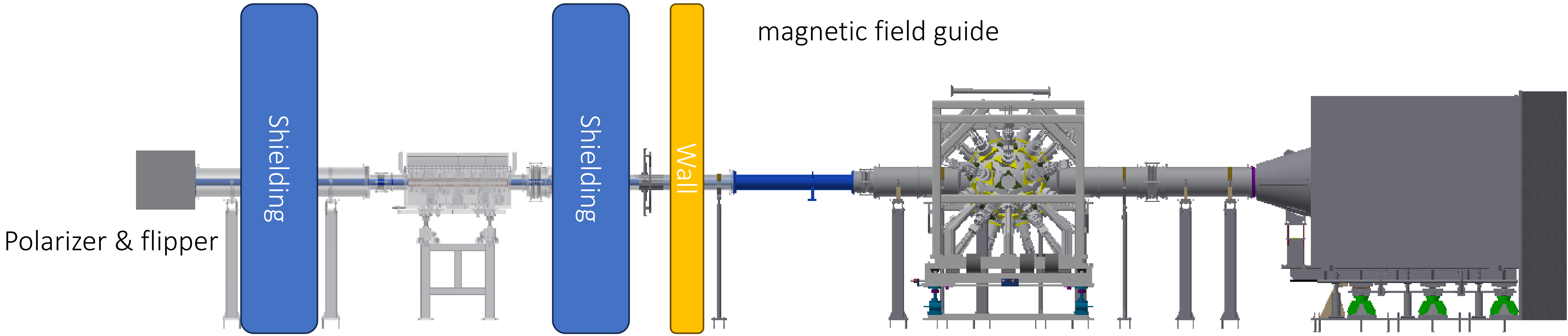


Identification imaging with neutron energy selected

NOPTREX at Back-n



Optimization of NOPTREX



The testing is scheduled to take place during the NOPTREX beam time in July of this year.

会议和朋友

ISINN and friends

ISINN


31st International Seminar on Interaction of Neutrons with Nuclei
Dongguan, China
26 May 2025


HUAWEI


ISINN-31
Professor Huanqiao Zhang
Academician of the Chinese Academy of Sciences


International Seminar on Interaction
with Nuclei

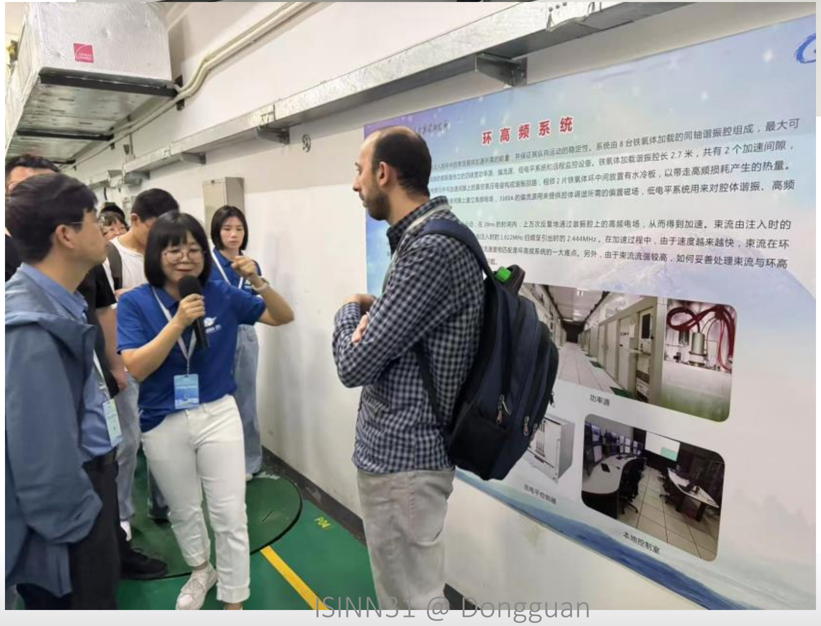

ISINN-31
Professor Sheng Wang
Director of the Spallation Neutron Source Science Center


CSNS-II New Buildings

splendid moment

Written by Professor Amir: 'I owe the Chinese people a debt of gratitude.'


学科技术体系
高能所概述


环高频系统


散裂文创
CSNS Gifts


健身房管理规定
SNS
T2828
DHS

再见，朋友

See you, my friends