Practical information on RAON
-Towards the BUP or LOI-

Byungsik Hong
(Korea University)

FAZIA Days

25-27 June 2025

USER beams in 2024

Call for proposal

2024 Call for Proposals of Low-Energy Beam at RAON

December 12, 2023 to January 19, 2024
Institute for Rare Isotope Science
Asia/Seoul timezone

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- IRIS Homepage
- RAON Users Association Homepage

User Support Office
user_support@ibs.re.kr
+42 878 8746

CALL FOR PROPOSALS

The Institute for Rare Isotope Science (IRIS) invites proposals for beam times extended to domestic users in Korea. The primary beams to be provided in 2024 will be Ne-20 and Ar-40 accelerated by the superconducting linac SCL3 at the energies of ~20 MeV/u or less with a maximum current of ~40 μA. Proton beams of 40 and 70 MeV can be provided by a cyclotron up to 10 kW or less.

The beam times will be provided for non-proprietary experiments based on the scientific merits through the review of proposals by the PAC members. There will be no beam time charge for non-proprietary experiments as long as the results are expected to be published.

The experimental systems such as KoBRA, MMS, and CLS can be used for experiments. Details of the experimental conditions can be discussed with the contact person of each experimental system.

The proposals need to be submitted by January 19, 2024 to allow for scientific and technical reviews of the proposals prior to the PAC meeting, which will take place in early March, 2024.

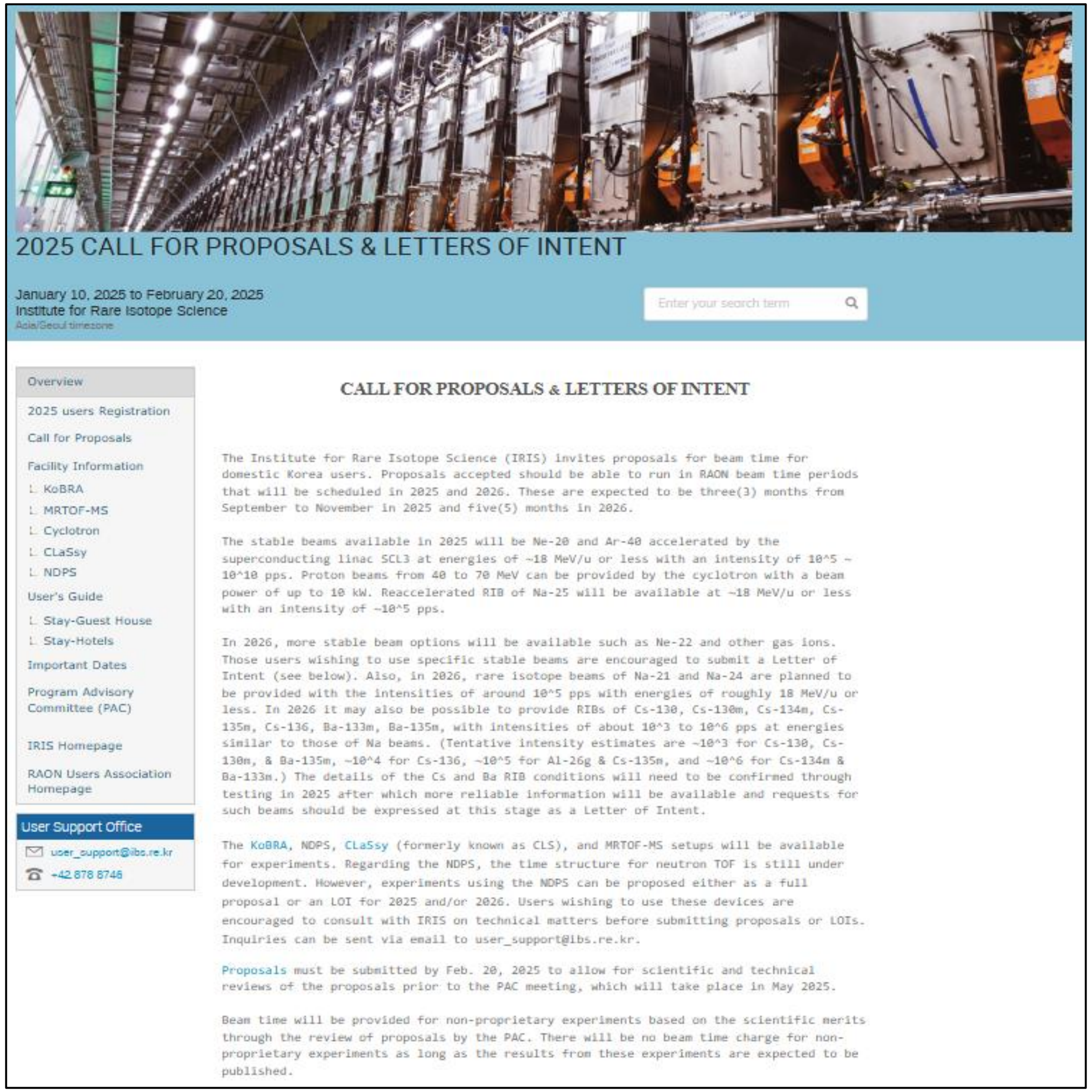
Important dates

- 12 December, 2023: Call for proposals
- 19 January, 2024: Deadline for submission of proposals
- Early March, 2024: First PAC Meeting
- Middle of March, 2024: Notification of approved experiments
- May ~ June, 2024: Ne-20 and Ar-40 beams provided from the SCL3
- Beam times for proton beams/ISOL can be discussed and fixed individually

- https://indico.ibs.re.kr/event/630
- Proposal call in Dec. 2023 - Jan. 2024
- Only for domestic users
- 30 proposals were submitted.
- The experiments were performed from June to August in 2024, including commissioning of KoBRA.

USER beams in 2025

Call for proposal


2025 CALL FOR PROPOSALS & LETTERS OF INTENT

January 10, 2025 to February 20, 2025
Institute for Rare Isotope Science
Asia/Seoul timezone

Enter your search term

- Overview
- 2025 users Registration
- Call for Proposals
- Facility Information
  - KoBRA
  - MRTOF-MS
  - Cyclotron
  - CLaSsy
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- User's Guide
  - Stay-Guest House
  - Stay-Hotels
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CALL FOR PROPOSALS & LETTERS OF INTENT

The Institute for Rare Isotope Science (IRIS) invites proposals for beam time for domestic Korea users. Proposals accepted should be able to run in RAON beam time periods that will be scheduled in 2025 and 2026. These are expected to be three(3) months from September to November in 2025 and five(5) months in 2026.

The stable beams available in 2025 will be Ne-20 and Ar-40 accelerated by the superconducting linac SCL3 at energies of ~18 MeV/u or less with an intensity of 10^5 ~ 10^10 pps. Proton beams from 40 to 70 MeV can be provided by the cyclotron with a beam power of up to 10 kW. Reaccelerated RIB of Na-25 will be available at ~18 MeV/u or less with an intensity of ~10^5 pps.

In 2026, more stable beam options will be available such as Ne-22 and other gas ions. Those users wishing to use specific stable beams are encouraged to submit a Letter of Intent (see below). Also, in 2026, rare isotope beams of Na-21 and Na-24 are planned to be provided with the intensities of around 10^5 pps with energies of roughly 18 MeV/u or less. In 2026 it may also be possible to provide RIBs of Cs-130, Cs-130m, Cs-134m, Cs-135m, Cs-136, Ba-133m, Ba-135m, with intensities of about 10^3 to 10^6 pps at energies similar to those of Na beams. (Tentative intensity estimates are ~10^3 for Cs-130, Cs-130m, & Ba-135m, ~10^4 for Cs-136, ~10^5 for Al-26g & Cs-135m, and ~10^6 for Cs-134m & Ba-133m.) The details of the Cs and Ba RIB conditions will need to be confirmed through testing in 2025 after which more reliable information will be available and requests for such beams should be expressed at this stage as a Letter of Intent.

The KoBRA, NDPS, CLaSsy (formerly known as CLS), and MRTOF-MS setups will be available for experiments. Regarding the NDPS, the time structure for neutron TOF is still under development. However, experiments using the NDPS can be proposed either as a full proposal or an LOI for 2025 and/or 2026. Users wishing to use these devices are encouraged to consult with IRIS on technical matters before submitting proposals or LOIs. Inquiries can be sent via email to user_support@ibs.re.kr.

Proposals must be submitted by Feb. 20, 2025 to allow for scientific and technical reviews of the proposals prior to the PAC meeting, which will take place in May 2025.

Beam time will be provided for non-proprietary experiments based on the scientific merits through the review of proposals by the PAC. There will be no beam time charge for non-proprietary experiments as long as the results from these experiments are expected to be published.

- https://indico.ibs.re.kr/event/870/
- Proposal call in January- February 2025
- Only for domestic users again
- 22 proposals & 8 LoIs

Year	Isotope	SIB/RIB	Energy	Expected Intensity
2025 - 2026	Ne-20	SIB	Up to 18 MeV/u	10^5 to 10^{10} pps
	Ar-40	SIB		
	Proton (from Cyclotron and only in ISOL vault)	SIB	40 MeV or 70 MeV	Up to 10 kW (beam power)
	Na-25	RIB	Up to 18 MeV/u	Up to 10^5 pps
2026 (To be confirmed in 2025)	Na-21	RIB		
	Na-24	RIB		
	Cs-130	RIB		Up to 10^3 pps
	Cs-130m	RIB		
	Cs-134m	RIB		Up to 10^6 pps
	Cs-135m	RIB		Up to 10^5 pps
	Cs-136	RIB		Up to 10^4 pps
	Ba-133m	RIB		Up to 10^6 pps
	Ba-135m	RIB		Up to 10^3 pps

Other information

- ISOL beam commissioning in 2024
  - Cyclotron: protons @ 70 MeV, 11 μA
  - RIB: $^{25}Na^{5+}$ @ 10 keV
  - SCL3: 16.5 MeV/u with $\sim 10^4$ at KoBRA

    (IRIS plans to measure the precise beam intensity in 2025.)
- Development of the beam structure
  - SCL3
    - 2023: 100 μs, pulse repetition rate of 1 Hz
    - 2024: 5 ms, 20 Hz, total beam power < 3.7 W
    - 2025: 5 ms, 20 Hz, total beam power < 370 W (expectation)
  - ISOL
    - 2024: 40 μs, pulse repetition rate of 1 Hz
    - 2025: $\sim$400 μs, pulse repetition rate 10 Hz (expectation)

Other information

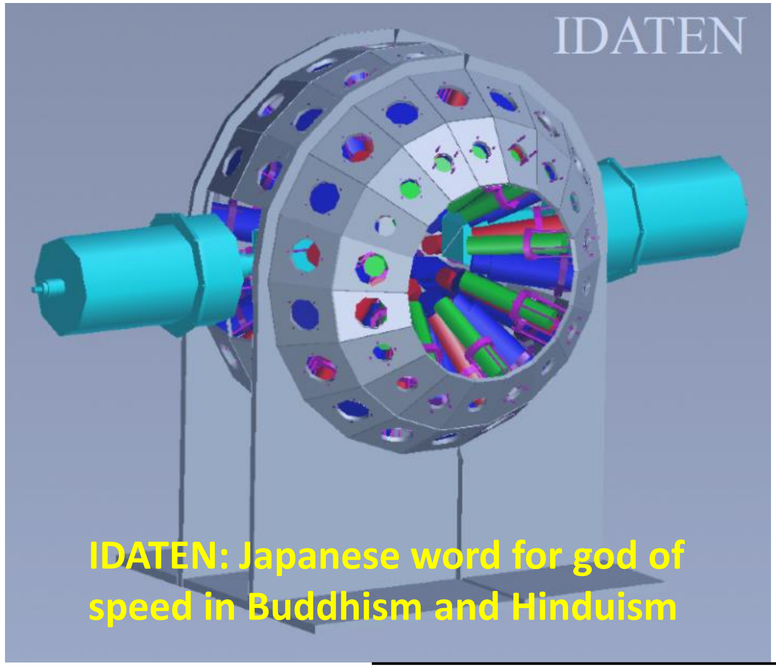
- Expected user beamtimes in 2025 & beyond
  - > 300 hours in Sep.-Nov., 2025
  - ~500 hours in Mar.-Jul., 2026
  - ~500 hours in Jul.-Nov., 2027
  - > 1,800 hours in Sep.-Dec. 2028
- Additional comments from IRIS
  - ISOL plans to use UCx or ThC target with 1 kW proton beams from 2026. The RI beams from those targets are expected from 2027, including post-acceleration.
    - (2025) SiC target
    - (2026~) TiC target
    - (2027~) UCx or ThC target
  - *If FAZIA collaboration plans to conduct the beam experiment at RAON in the future, please consider to write LOIs after making some discussion with IRIS staffs in advance.*

Available detectors for low-energy experiments at RAON

KHALA

Fast-timing gamma detection system

International Detector Assembly for fast-Timing measurements of Exotic Nuclei



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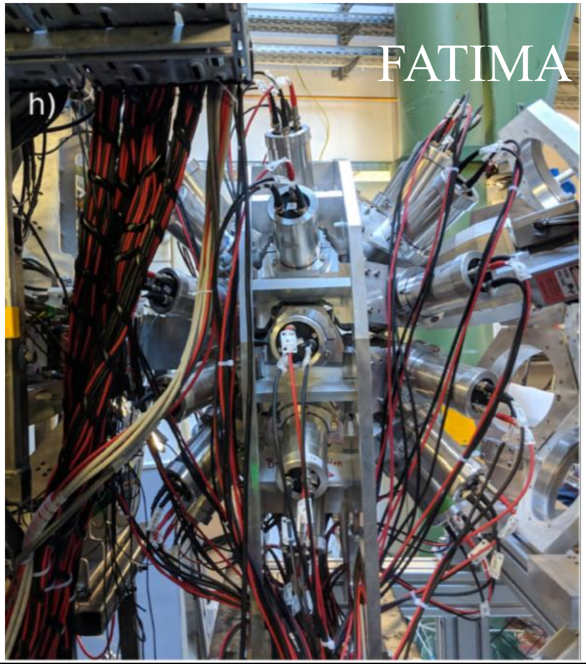
Korea High-resolution Array of $LaBr_3$
NIMB 541, 253 (2023)

+

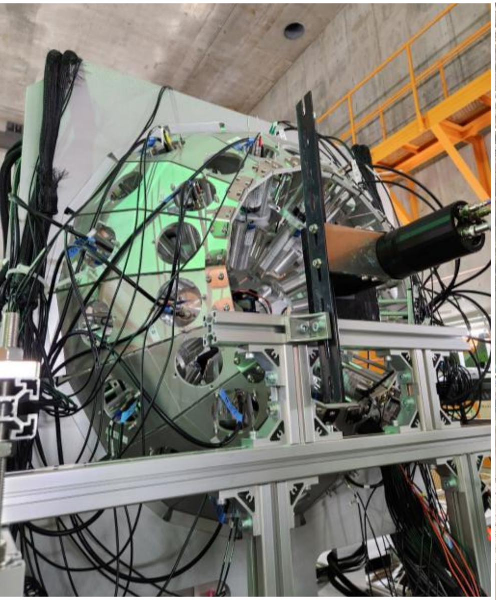
FAst TIMing Array for DESPEC at FAIR
NIMA 969, 163967 (2020)

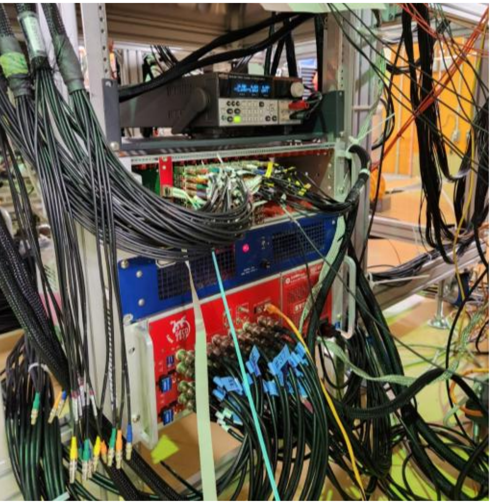


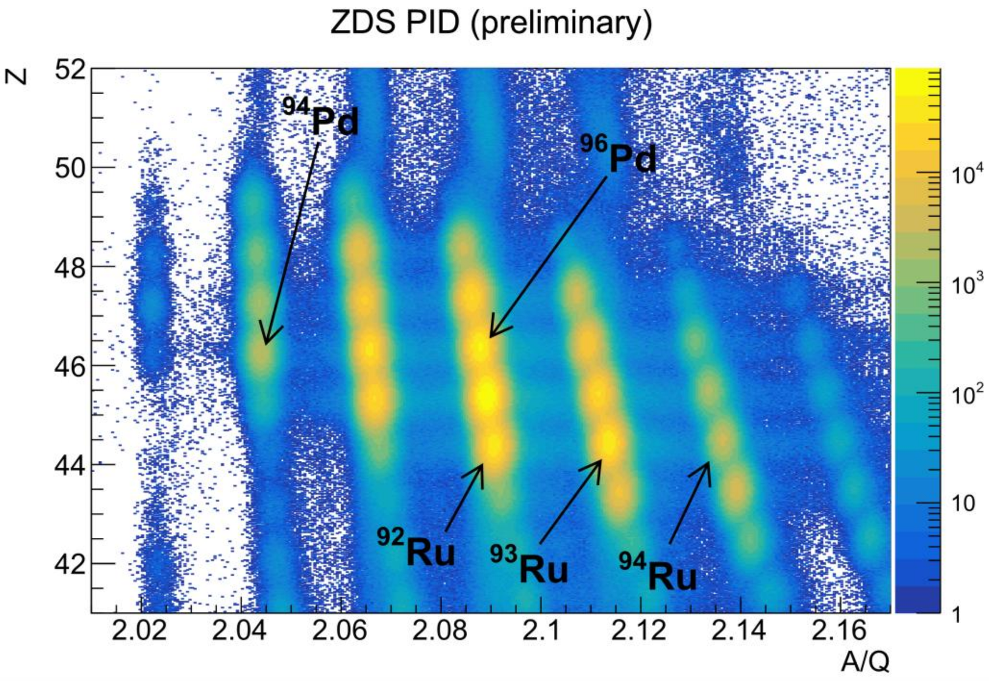
	KHALA	FATIMA
Number of detectors	**46**	**36**
$LaBr_3$(Ce) crystal size	**1.5″(ϕ) × 1.5″(L)**	**1.5″(ϕ) × 2″(L)**
Energy resolution	**3.31% @ ~650 keV**	**3.4% @ ~800 keV**
Timing resolution ($\Delta T_{\gamma\gamma}$)	**335(1) ps with ^{22}Na (511-511 keV)**	**~320 ps with ^{60}Co (1332-1173 keV)**
Passive Pb shield	**None**	**Optional**
Owners	**Korea U. (36) & SNU (10)**	**U. of Surrey & U. Brighton**

KHALA

- **Commissioning experiment at RIBF in June 2024**
  - Only KHALA detectors were used for this RUN.





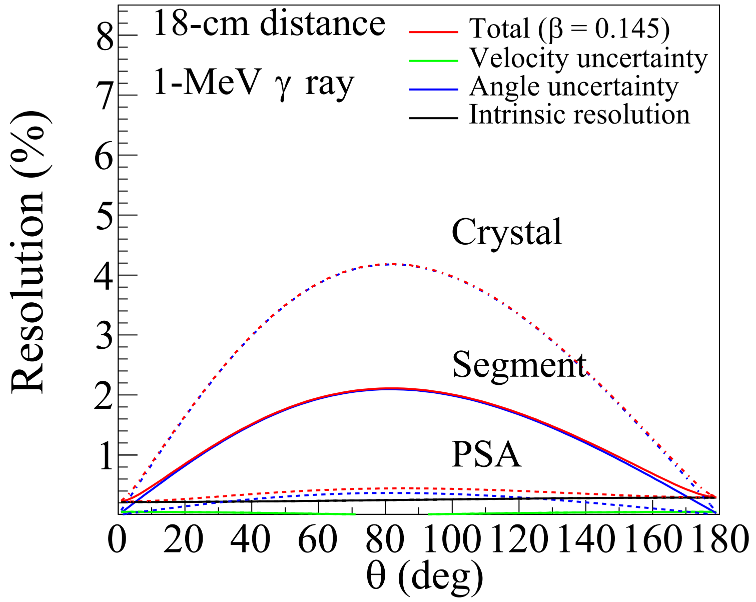


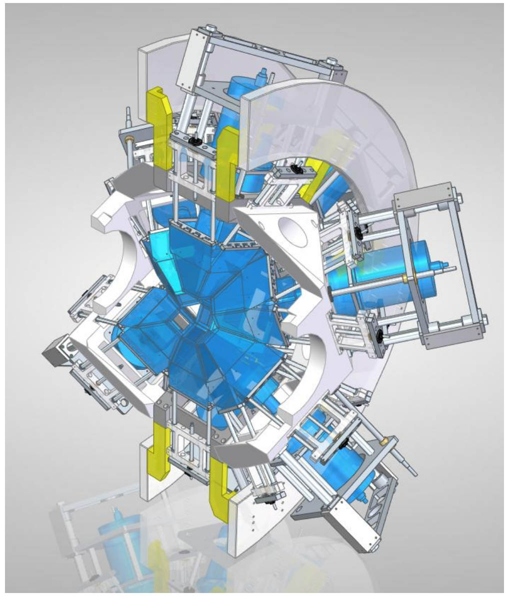
- Some of isotopes, e.g., ^{94}Pd, ^{96}Pd, ^{94}Ru, have not been studied yet.
- Two students (J. Lee & Y. Jang) from Korea University are analyzing the data for their theses.

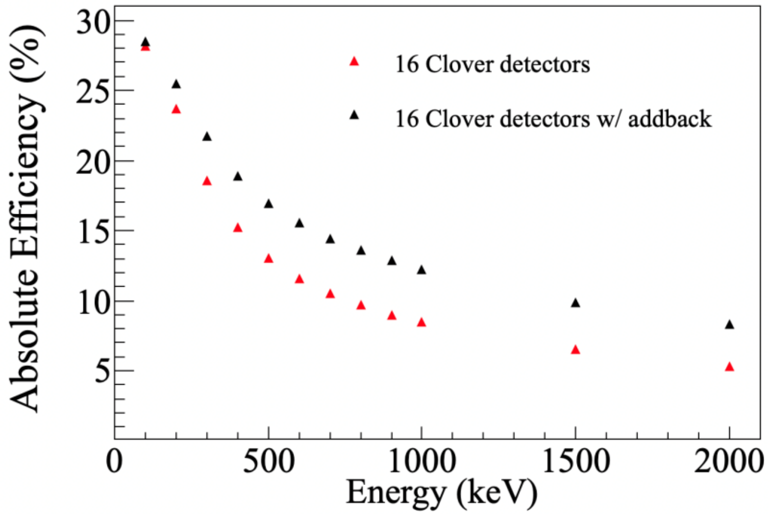
ASGARD

CENS/IBS

- ASGARD: Array of Super clover GAmma-Ray Detectors
- One clover consists of 4 Ge crystals with 8 segmented electrodes
  - Improve the energy resolution by correcting the Doppler broadening effect, which is benefitial in angular distribution measurement
- Multi-purpose capability for either low-energy in-beam or delayed γ-ray spectroscopy

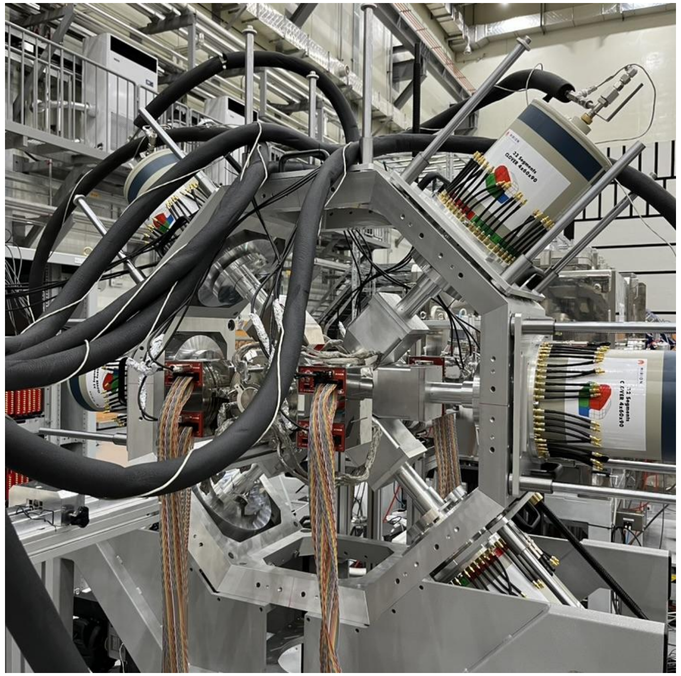




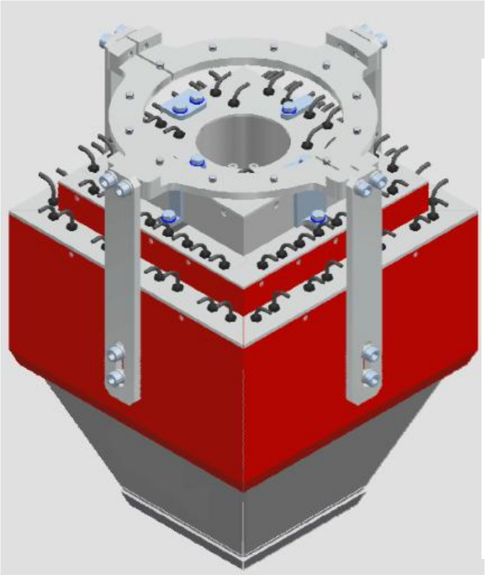


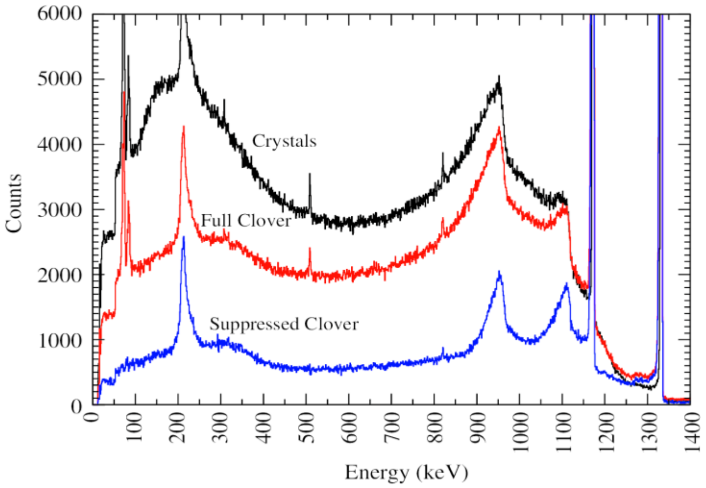
ASGARD

- **Status**
  - Total 10 clover detectors are procured at **CENS/IBS** now.
  - A total 12 clover detectors will be ready by Dec. 2025.
  - 6 clover detectors were installed in Jun.-Sep. 2024 in the decay station frame.
  - The ASGARD supporting frame is waiting for installation.
  - The DAQ system (FADC-based digitizers) has been developed in collaboration with NOTICE (the local industry).



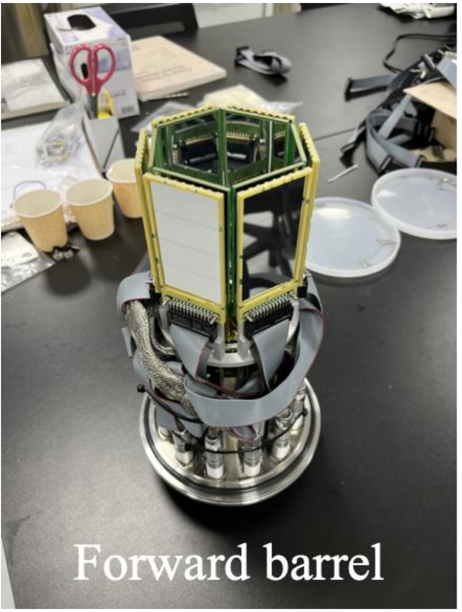
- **The upgrade with anti-Compton suppressor** will dramatically improve the sensitivity of the detector.
  - A maximized detection sensitivity is essential for new discovery.
- New anti-Compton suppressor with easier (compared to TIRGRESS) mounting & dismounting scheme was designed and manufactured.

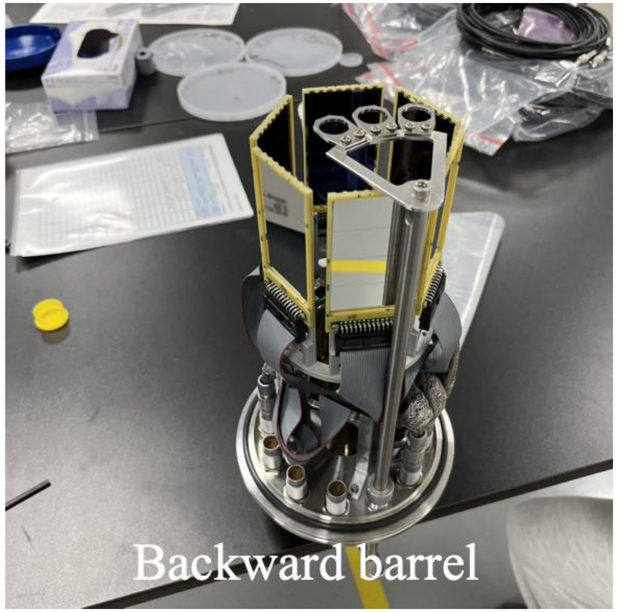


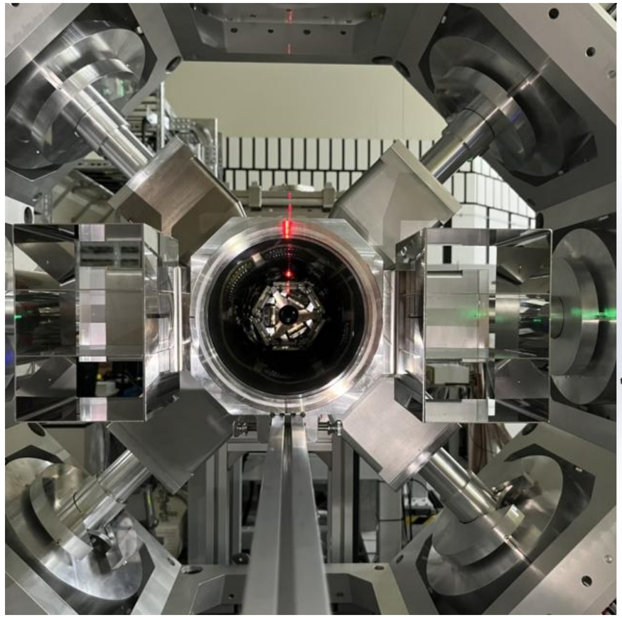


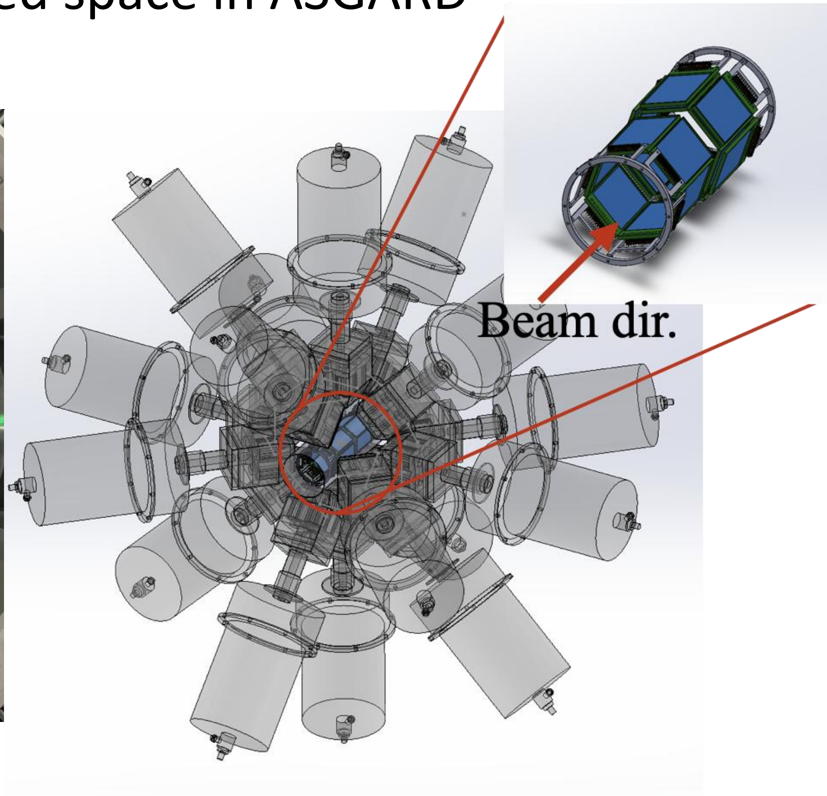
STARK Jr.

- STARK Jr.: Silicon Telescope Array for inverse Kinematics studies Jr.
- Silicon barrel array is being built by **CENS/IBS** for the charged particle measurement.
- New design of X6, using 8 resistive strips
- Precise energy measurement by 4 standard strips
- Hexagonal shape, viewing from the beam directipn, in the limited space in ASGARD





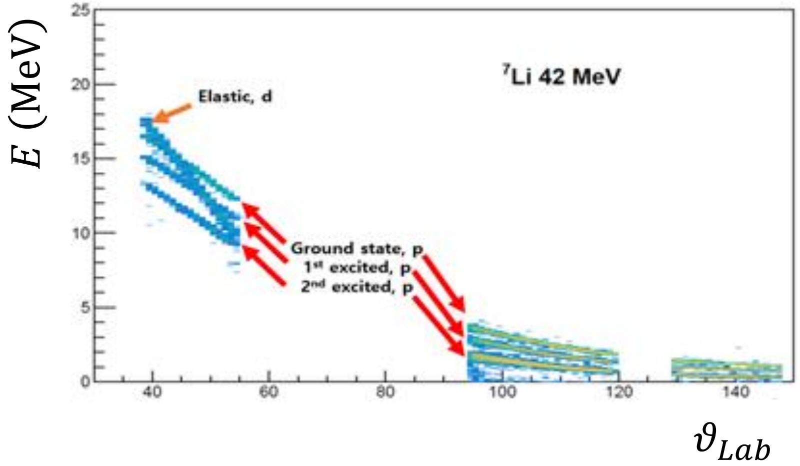


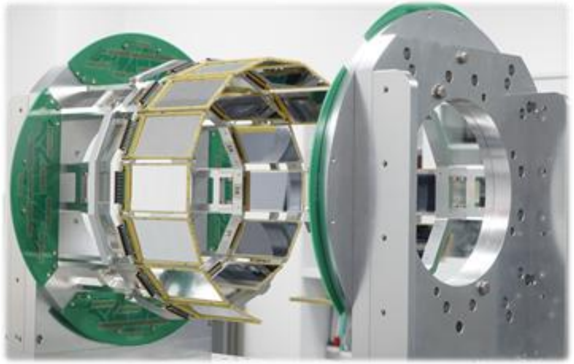


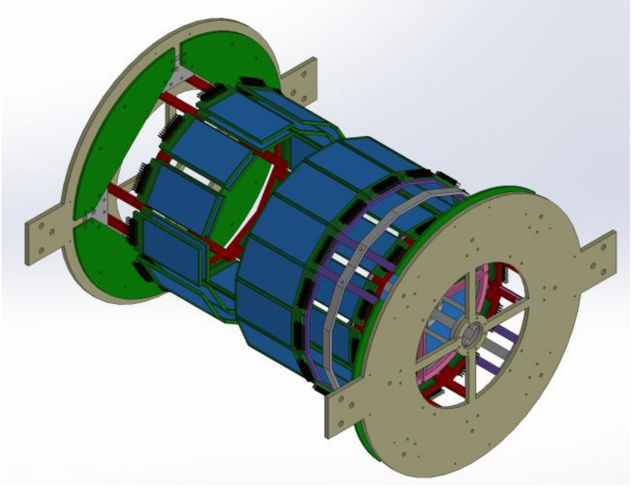
STARK

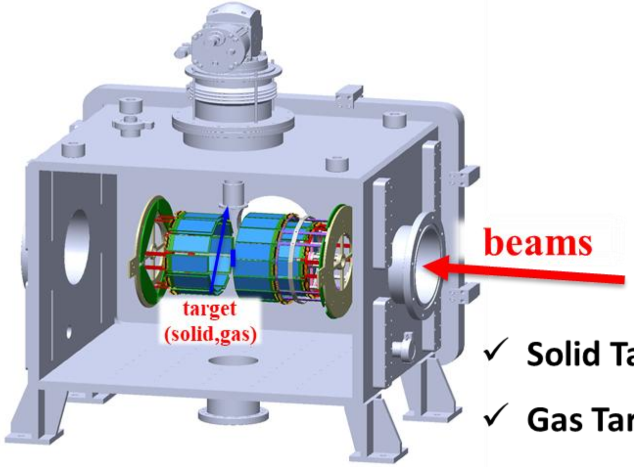
- Three rings with 12-16-12 polygons; 96-116-107 mm from centre of the target
- Scattering chamber: 580(X) x 400(Y) x 600(Z) mm^3
- CryoSTAR (low temperature gas-cell target) compatible
- The efficiency measurement with alpha source and beams
  - (α,p) *reactions, transfer reactions, optical model potential studies*

^{7}Li(d,p)^{8}Li reaction simulation with
^{7}Li beams @ 42 MeV





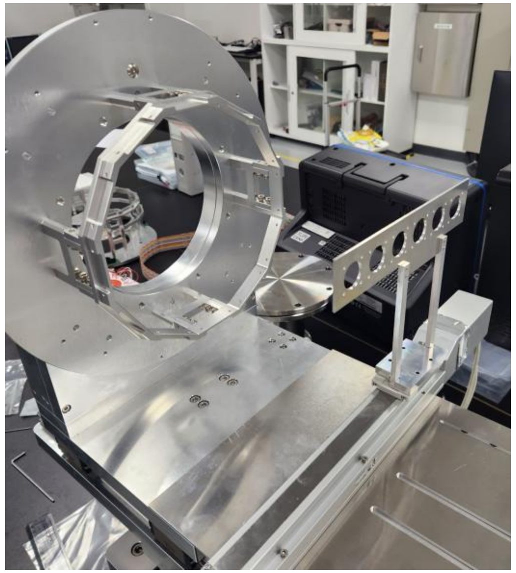


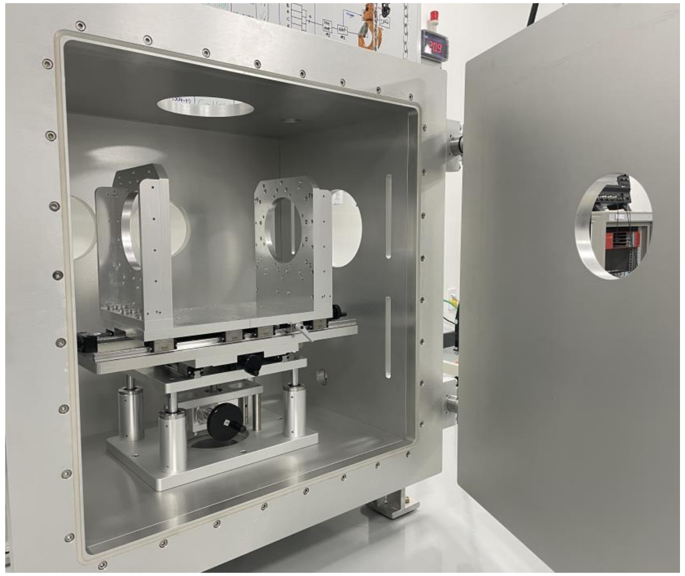


✓ **Solid Targets: CH_2, CD_2**

✓ **Gas Targets: H_2, D_2, ^4He, ^3He, N_2**

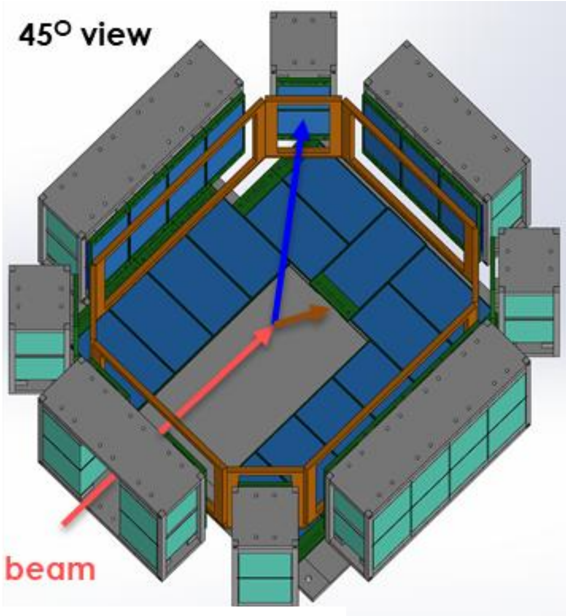
CENS/IBS



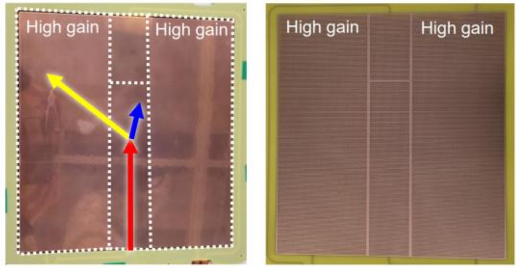


ATOM-X

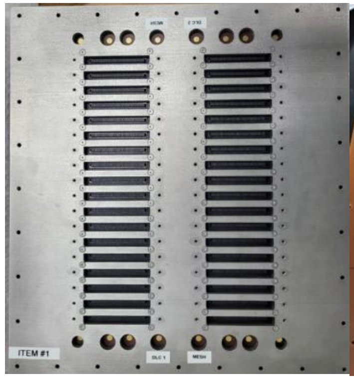
- AToM-X: Active-target TPC for Multiple nuclear eXperiment
- Dimensions of an active area: 256(x) x 180(y) x 288(z) mm^3
- Scattering chamber: Portable similar to the TexAT chamber
- Octagonal shape field cage, larger active area than the TexAT micromegas
- New micromegas with a position resolution of 0.5 mm (w/ 4 x 4 mm^2 pixels)
- Total 5,658 channels (4,608 from micromegas plate and 1,050 from aux detectors)
- GET electronics for signal processing: New AsAd board production
- Online data analysis cluster system: 48 CPUs, 96 GB Memory, and 11 TB SSDs



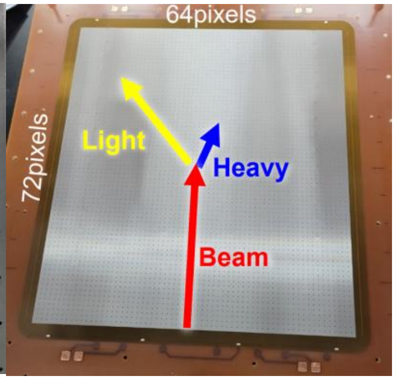
GEM (thickness 256 μm and 1 mm)

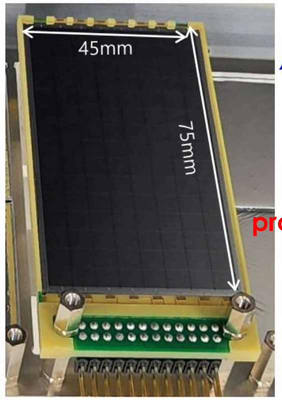


Top View of Micromegas

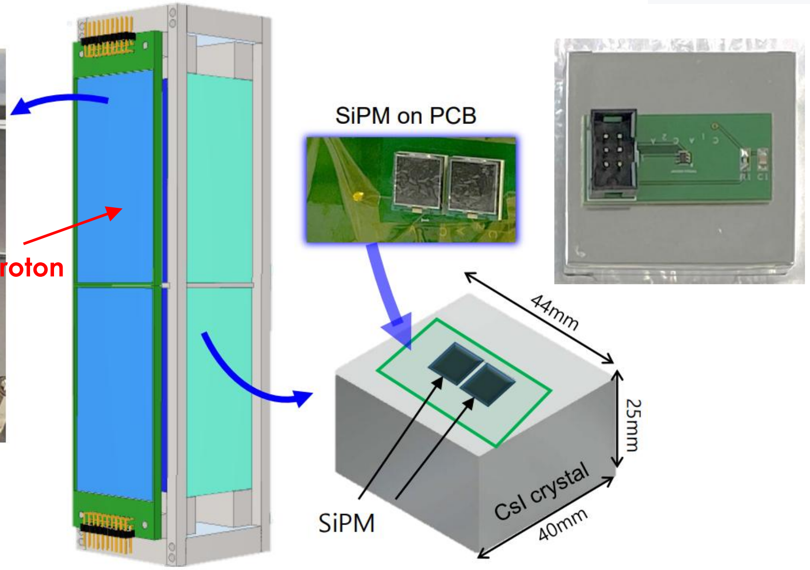


Bottom View of Micromegas





X6 Si. Det.
X. Pereira-Lopez *et al.*, NIMB (2023)

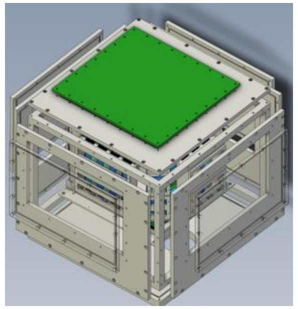


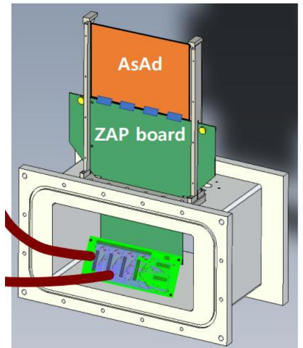
S. Bae *et al.*, NIMB (2023)

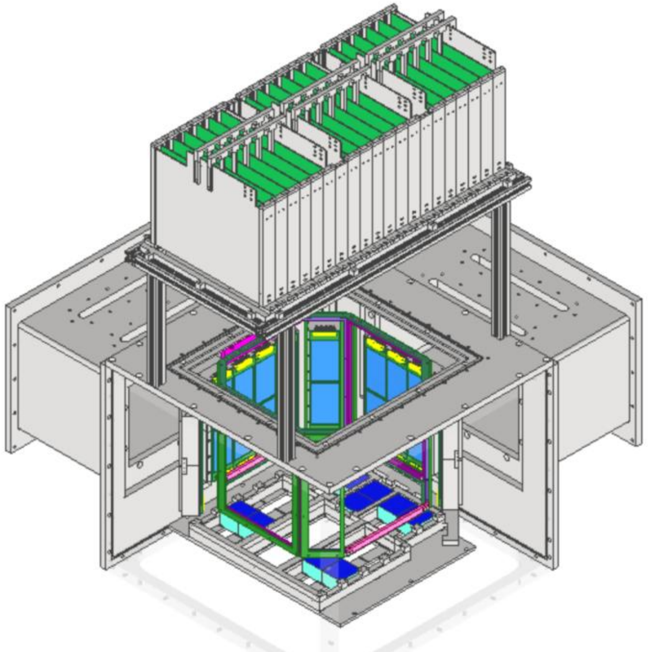
CENS/IBS

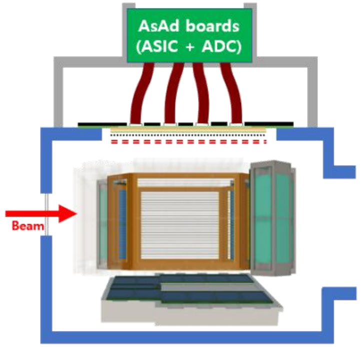
ATOM-X

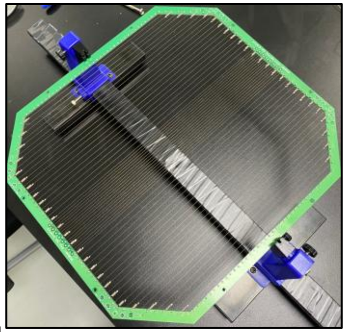
- **Chamber and electronics**
  - Assembly chamber with 1/2”-thick Al
  - Signal merging PCB & ZAP board (bias and signal processing)
  - Micromegas instead of top flange
  - Analysis software package : LILAK (Low and Intermediate energy nucLear experiment Analysis toolKit) is a task-based analysis toolkit and contains general classes for MC simulation and reconstruction (pulse shape analysis, Hough transform, RANSAC, etc.).
  - Status: Under commissioning with α source

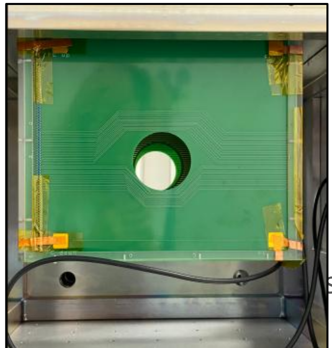


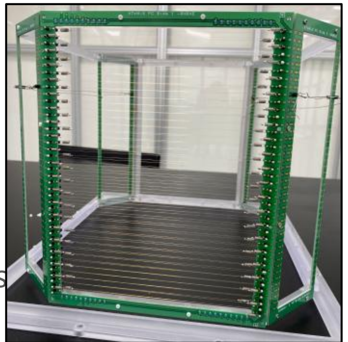


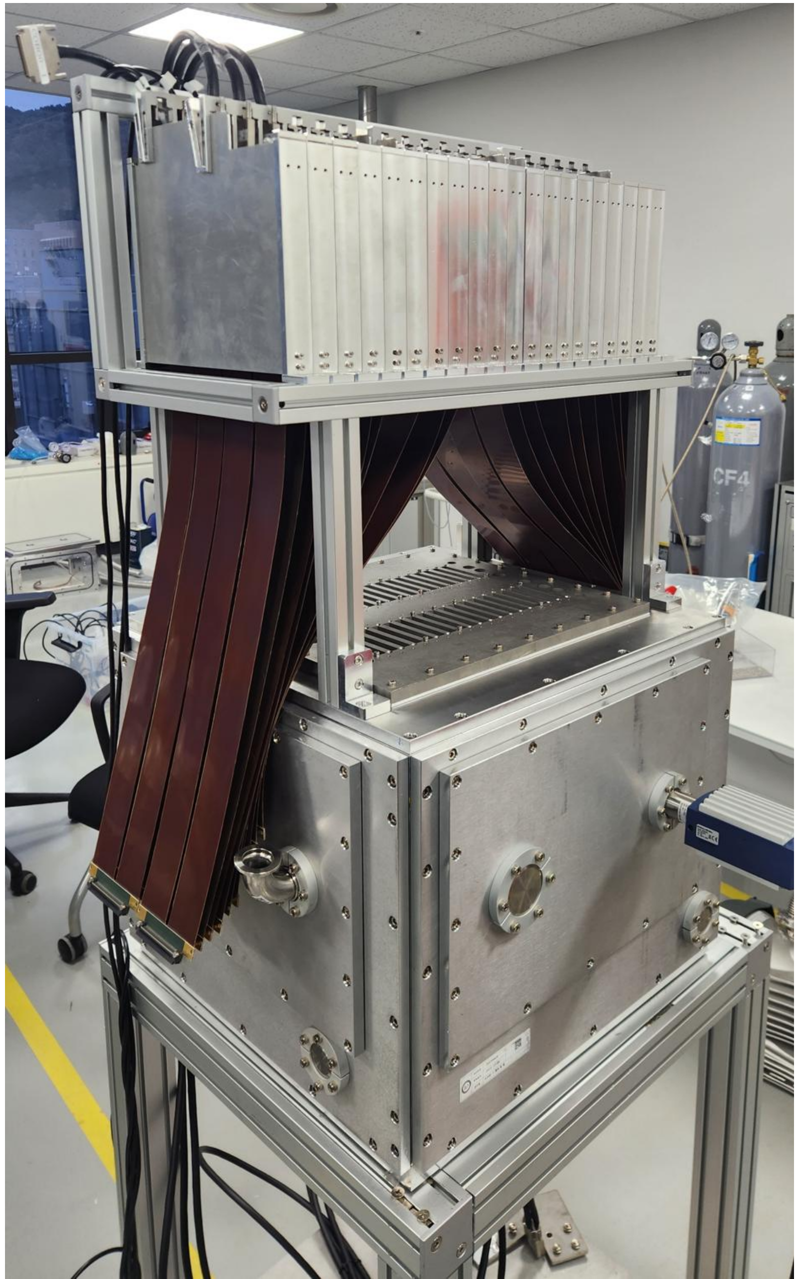








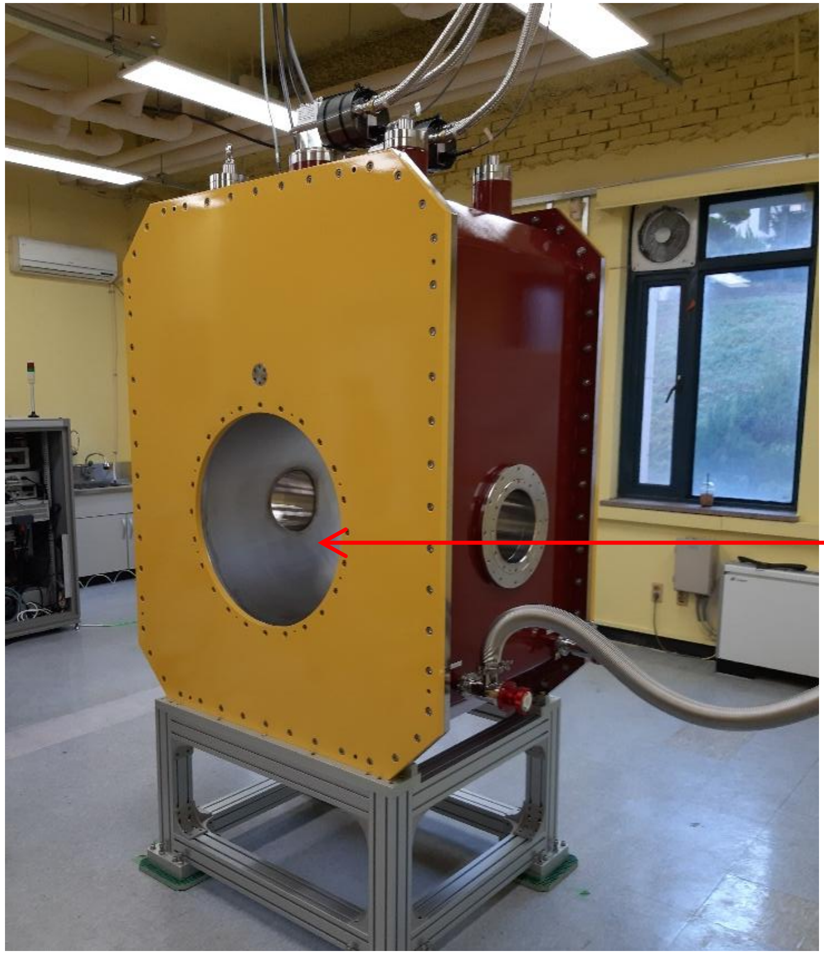


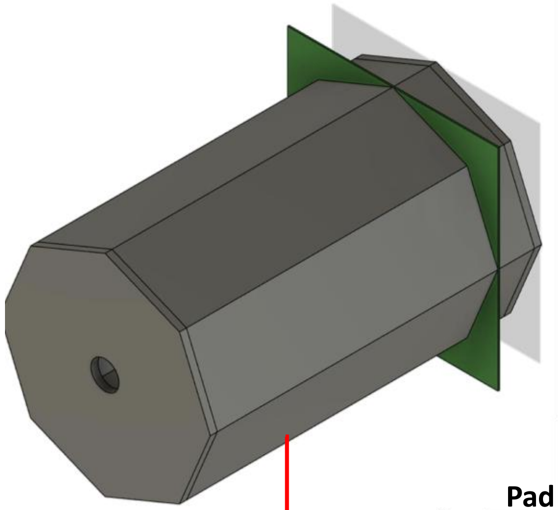


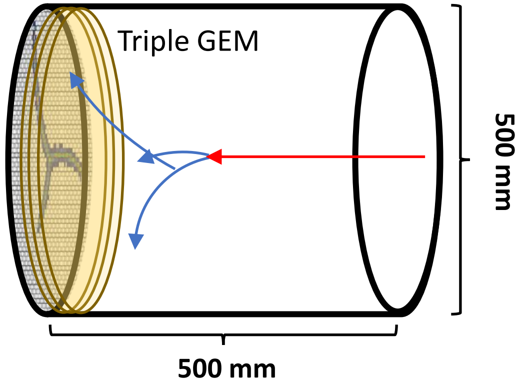
SC magnet & CENuM AT-TPC

- Superconducting solenoid magnet
  - B_{max} = 1.5 T
  - Diameter & length of the detector installation space = 60 cm each
  - Commissioning successfully done in 2019

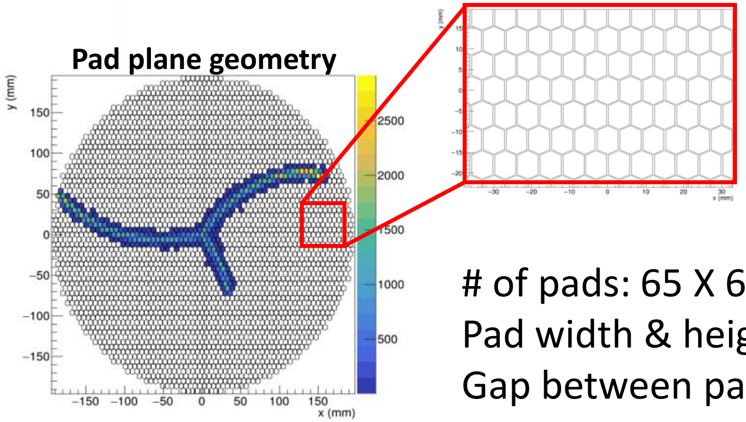
- Design of AT-TPC
  - Number of channels: > 3,000
  - $\phi \simeq$ 40 cm
  - Cylindrical shape similar to the LAMPS TPC







Korea U./ Sejong U.



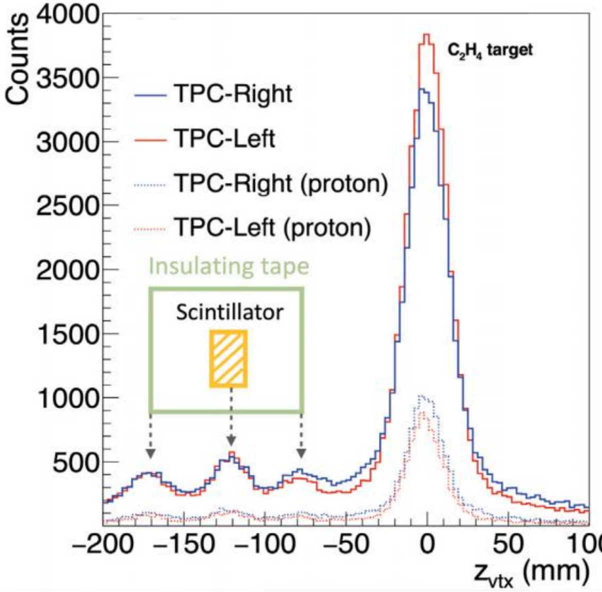
# of pads: 65 X 65 = 3,300
Pad width & height: 6 mm each
Gap between pads: 0.5 mm

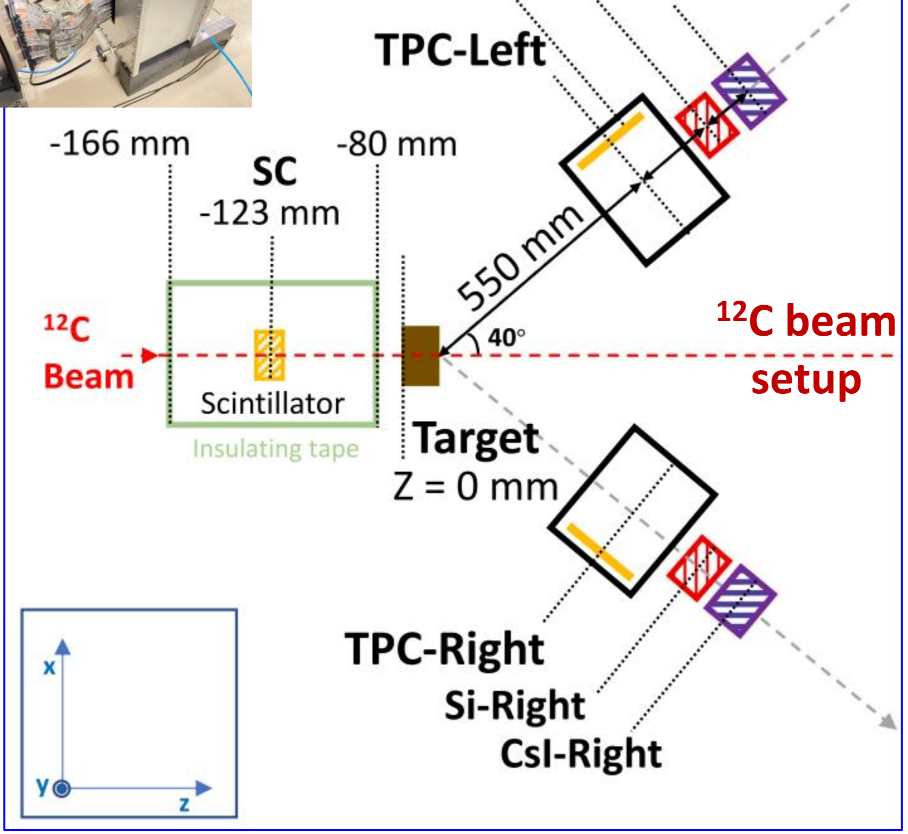
CENuM AT-TPC

- Beam test of two prototypes at HIMAC in Japan in Feb. 2023
  - Beams: p @ 100 MeV, ^{12}C @ 200 MeV/u, 10^6 ppp
  - Performance test for the LAMPS detector elements including CENuM AT-TPC [Y. Cheon et al., NIMA 1066, 169610 (2024)]
  - Plan to analyze $^{12}C(p,2p)$ Quasi-Free Scattering (QFS) events

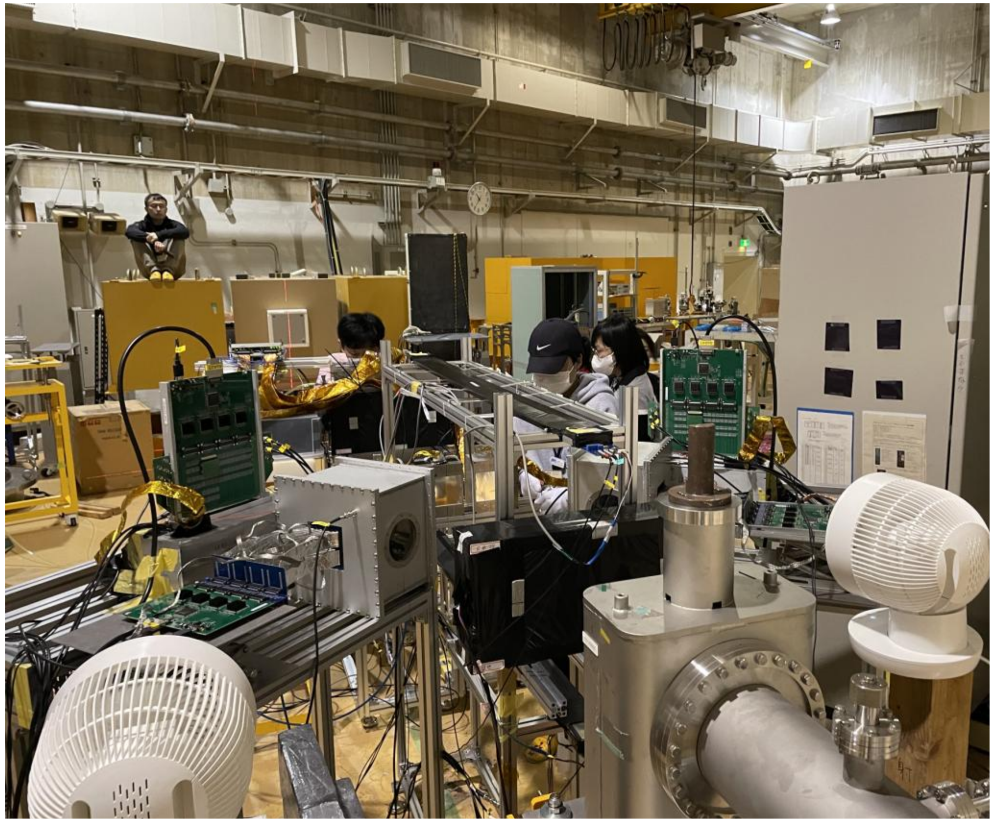
Prototype AT-TPC →

↓ Reconstructed vertex distribution by AT-TPC

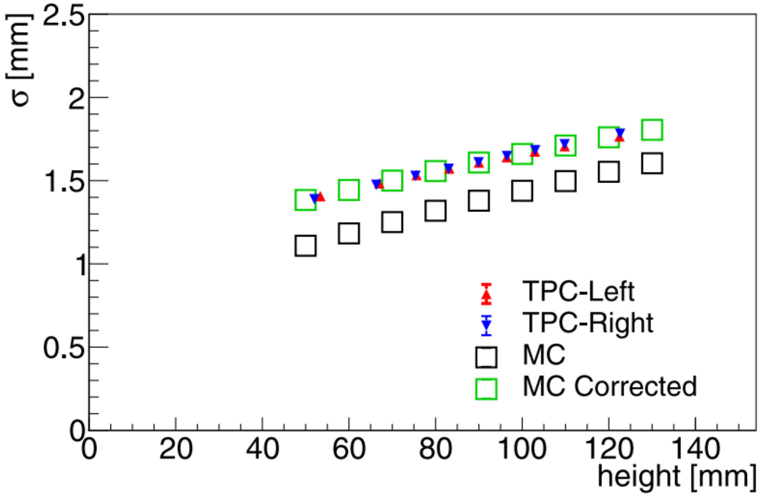


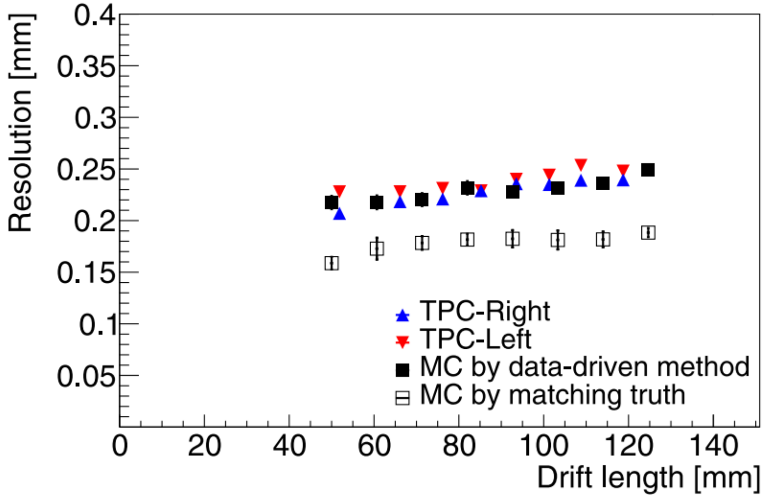


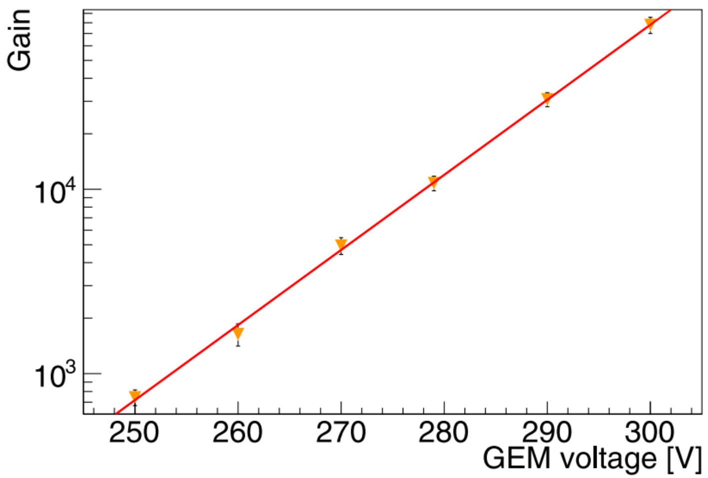
^{12}C beam setup

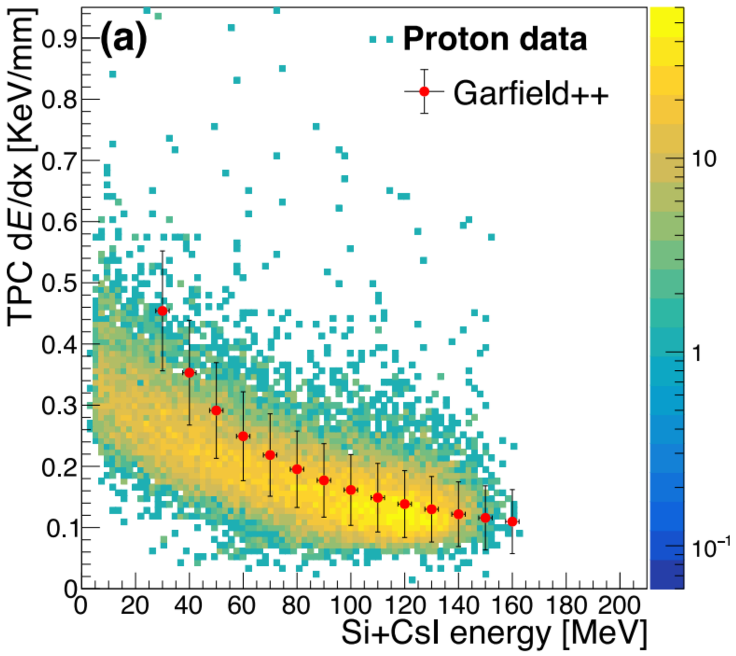


CENuM AT-TPC









- **Characteristics of CENuM AT-TPC**

↖ Transverse diffusion of electrons vs. drift length

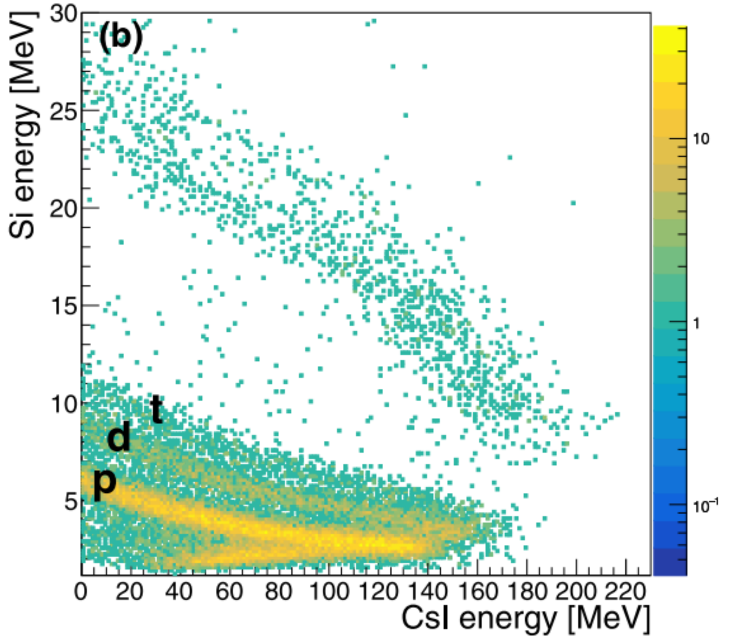
↑ Spatial resolution vs. drift length

↗ Gain vs. GEM bias voltage

→ ΔE vs. E for Si+CsI (PID)

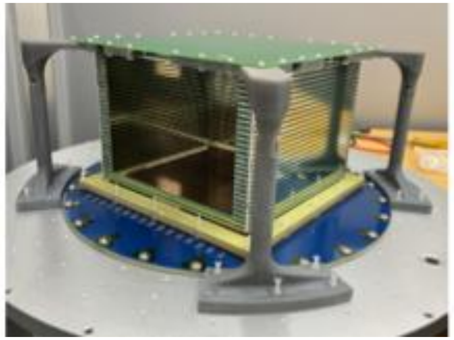
← Correlation of dE/dx(TPC) vs. $\Delta E + E$(Si+CsI) for protons

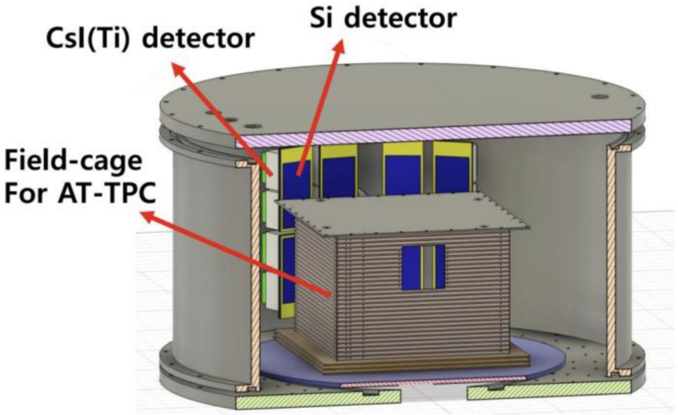
[NIMA 1066, 169610 (2024)]



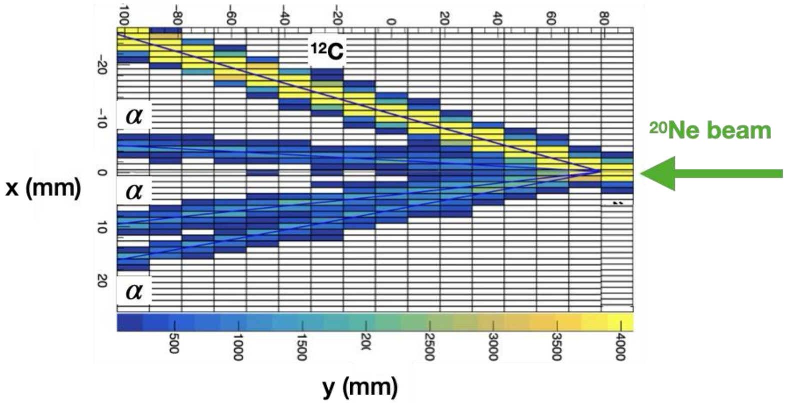
TPC-Drum: yet another AT-TPC

Sejong U./Korea Univ.

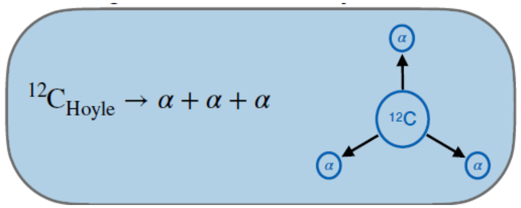


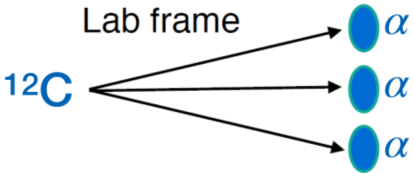


Simulation for $^{20}Ne + ^{4}He \rightarrow C_{Hoyle} + ^{12}C_{gs}$

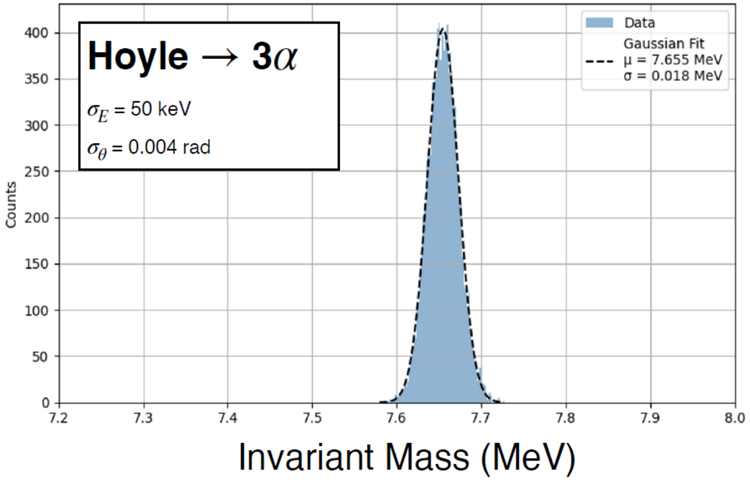


- Number of channels = 768
- He (90%) + CO_2 (10%) at 650 or 760 Torr
- Array of 8 Si-CsI modules (Si: 1-mm thick)
- Triple GEM amplification, A = 20 x 20 cm^2
- GET electronics (4 AsAd + CoBo)
- Energy measured using Si (resolution: 40 - 50 keV)
- Momentum determined by TPC
  - Cluster's spatial resolution ~150 μm
  - Track's angular resolution ~ 4 mrad
  - Excellent resolution in invariant mass measurement
- PID, for example, using E by Si and dE by TPC





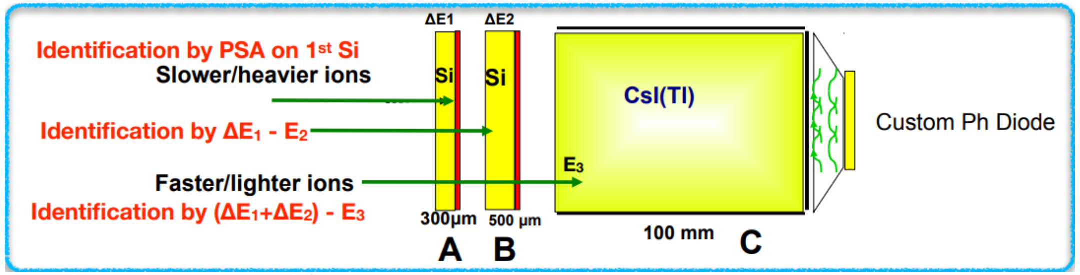
Toy MC simulation of TPC-Drum

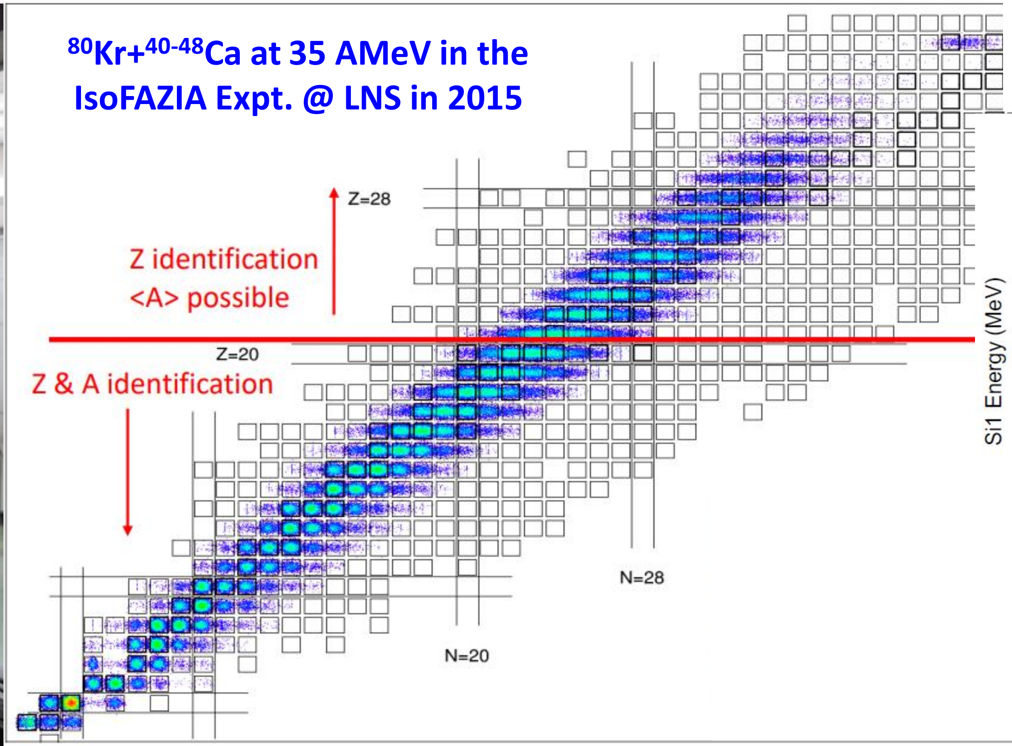


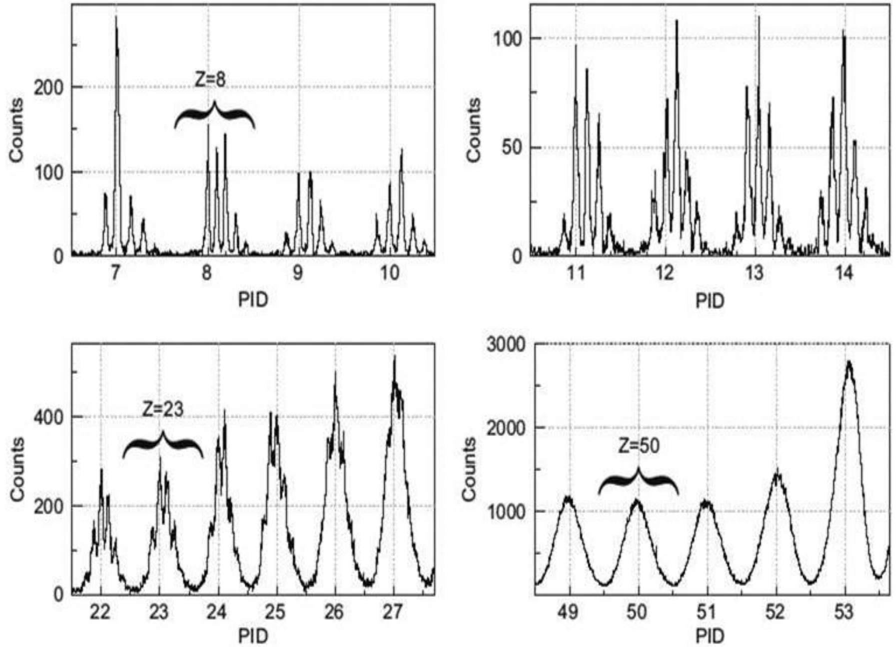
FAZIA

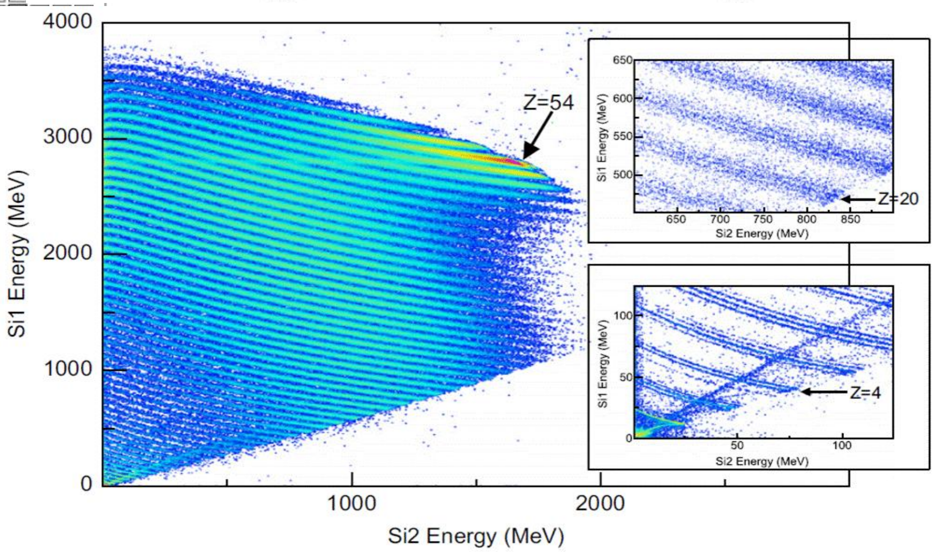
Korea U./Inha U.

- One FAZIA block consists of 16 Si_1+Si_2+CsI telescopes with a cross-section of 2×2 cm^2.
  - – New Si chips and new FEB electronics are being developed in Korea.







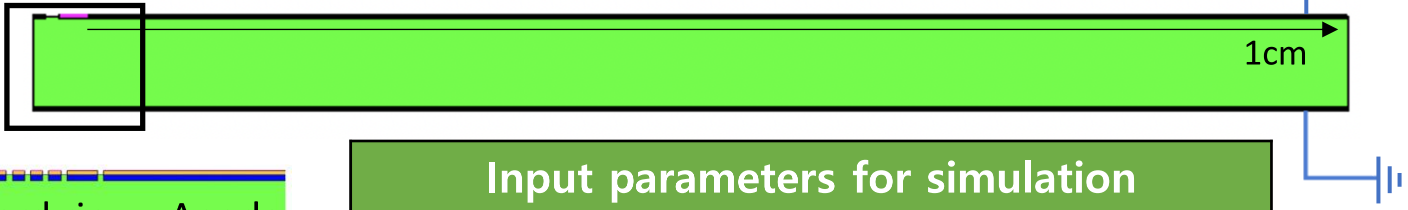


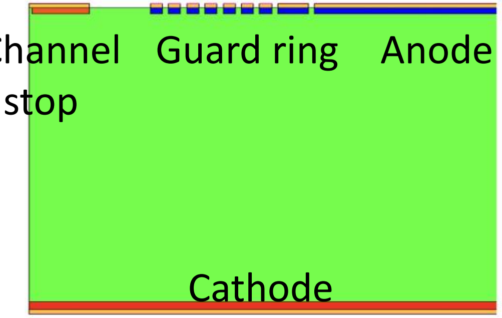
FAZIA

- Design of PiN sensor using TCAD: Simulation setup

Half of cross section of 2 x 2 cm^2 chip

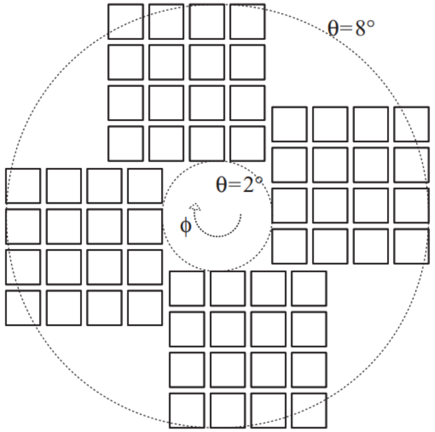
Thickness: 720 μm





Edge of silicon sensor

Input parameters for simulation				
T (K)	300		Doping density	
V_0 (V)	0 ~ - 700		(blue)	P^+ Boron
Carrier lifetime	Electron	$1x10^{-4}$ s^{-1}	(green)	N^- Phosphorus
	Hole	$3x10^{-4}$ s^{-1}	(red)	N^+ Phosphorus



→ Results

- Breakdown voltage point is close to -600 V
- Enough to reach full depleted voltage (400 V)

— We are also developing 150 μm-thick chips.

← We plan to build 4 FAZIA blocks by the end of 2025 for the experiments at RAON.

Extended view