

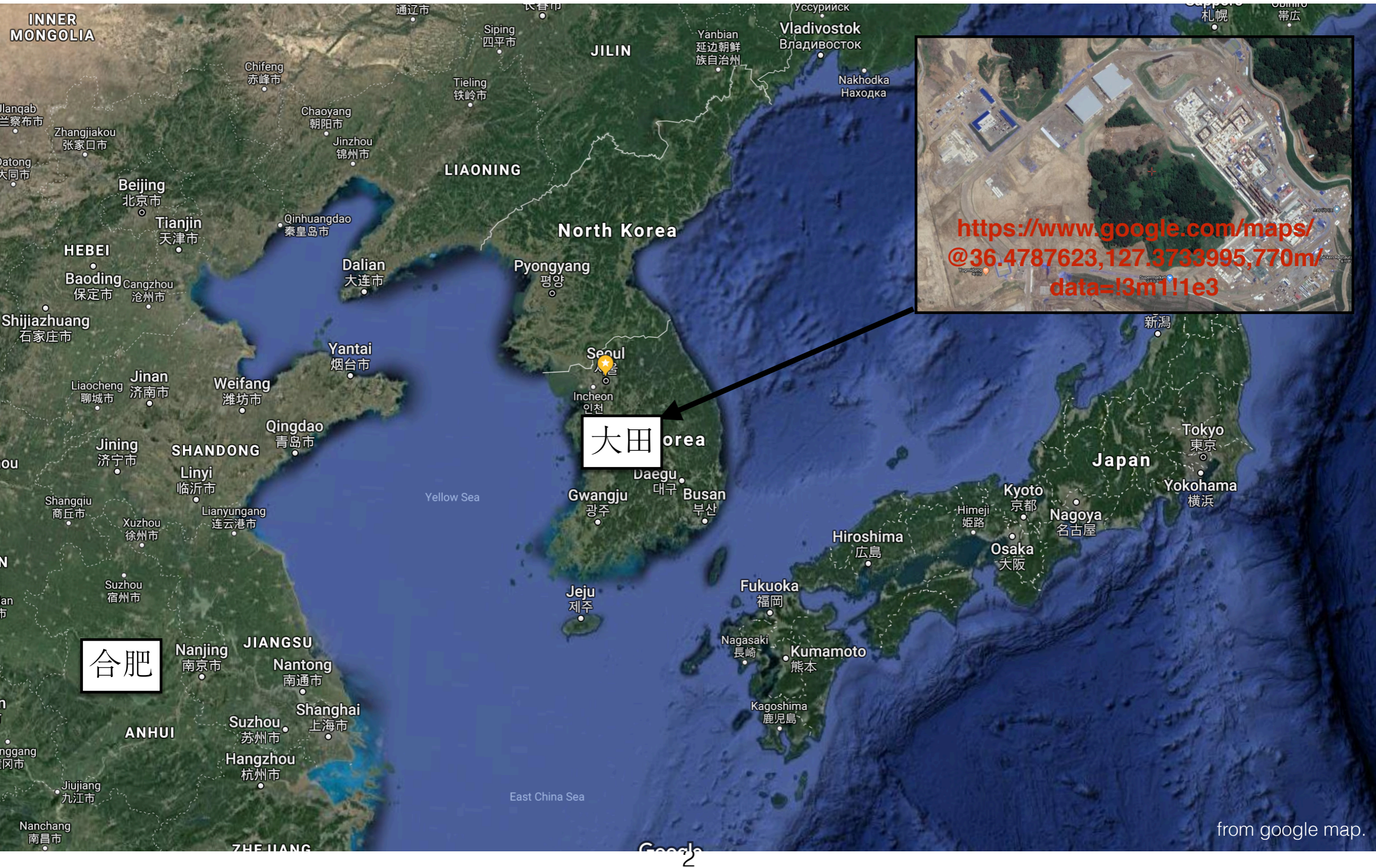
LAMPS at RAON

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Rare isotope Accelerator complex for ON-line experiment

RAON



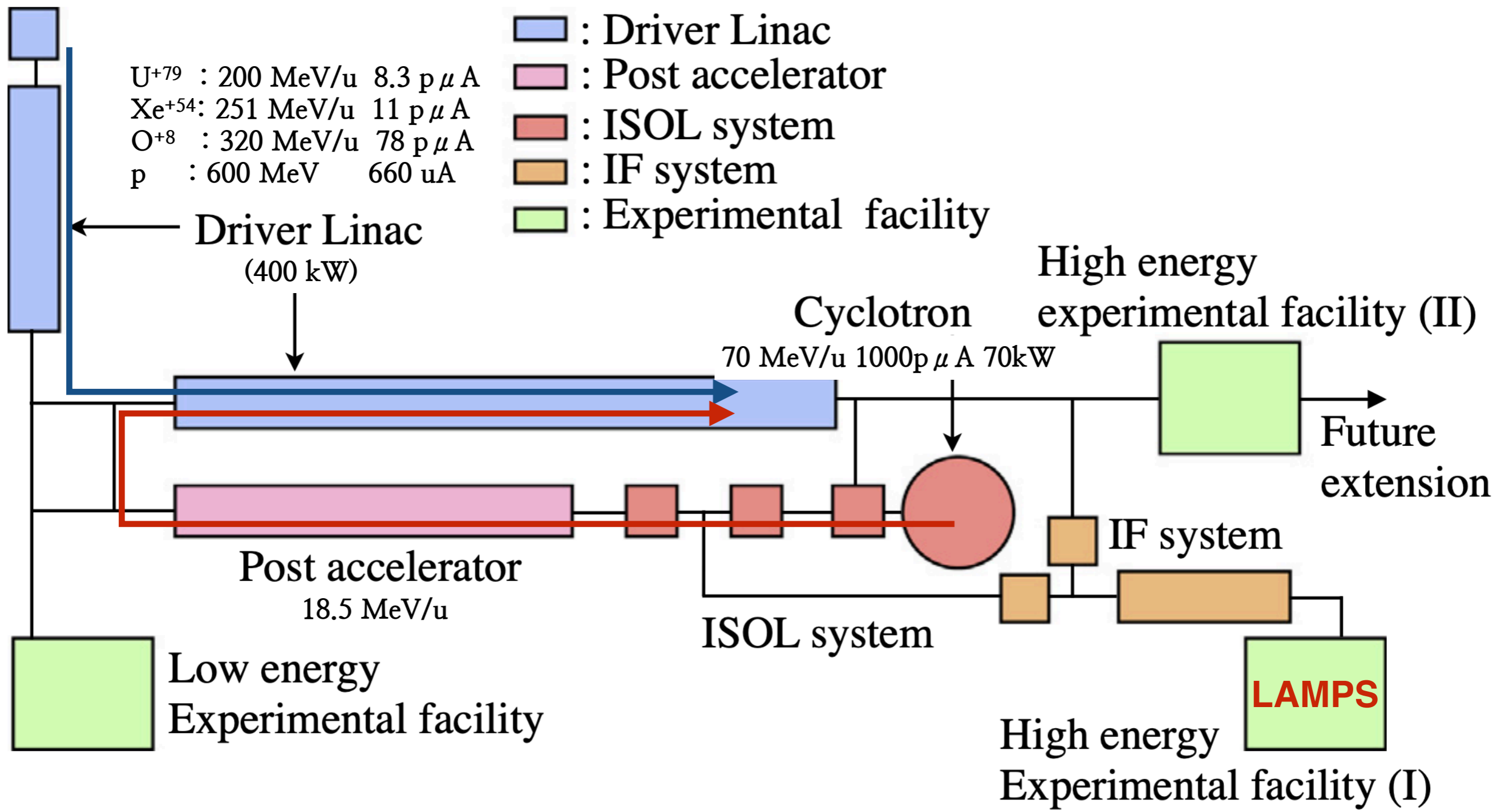
Facility

- High intensity RI beams by ISOL & IF
 - ISOL : direct fission of ^{238}U by 70 MeV proton by 200 MeV/u, $8.3\text{ p}\mu\text{A}$ ^{238}U
 - IF : Select RI in the beam
- High quality neutron-rich RI beams
- Exotic RI beams by ISOL + IF

ECR-IS

U^{+79} : 200 MeV/u 8.3 p μA
 Xe^{+54} : 251 MeV/u 11 p μA
 O^{+8} : 320 MeV/u 78 p μA
 p : 600 MeV 660 uA

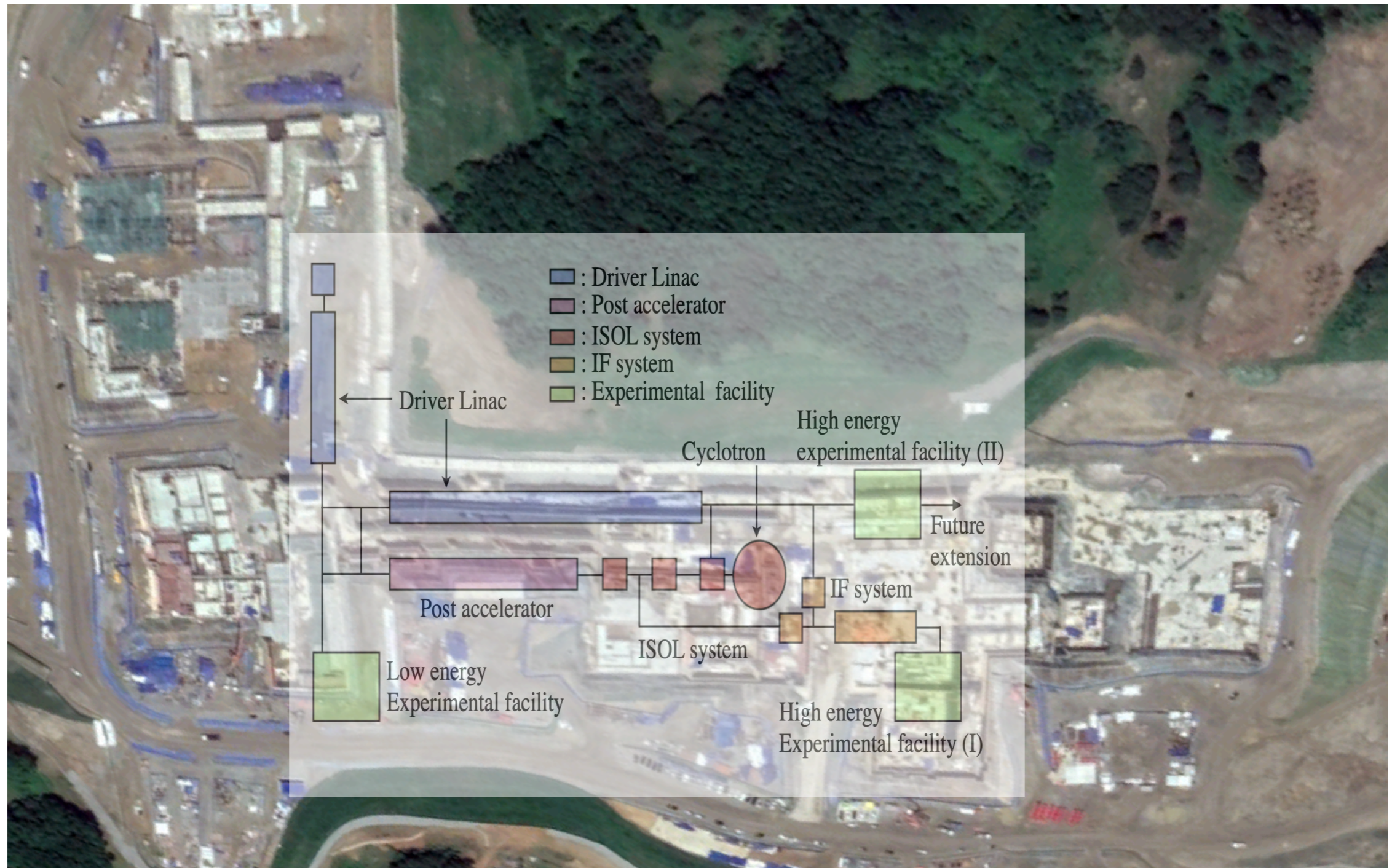
- : Driver Linac
- : Post accelerator
- : ISOL system
- : IF system
- : Experimental facility



Status of RAON

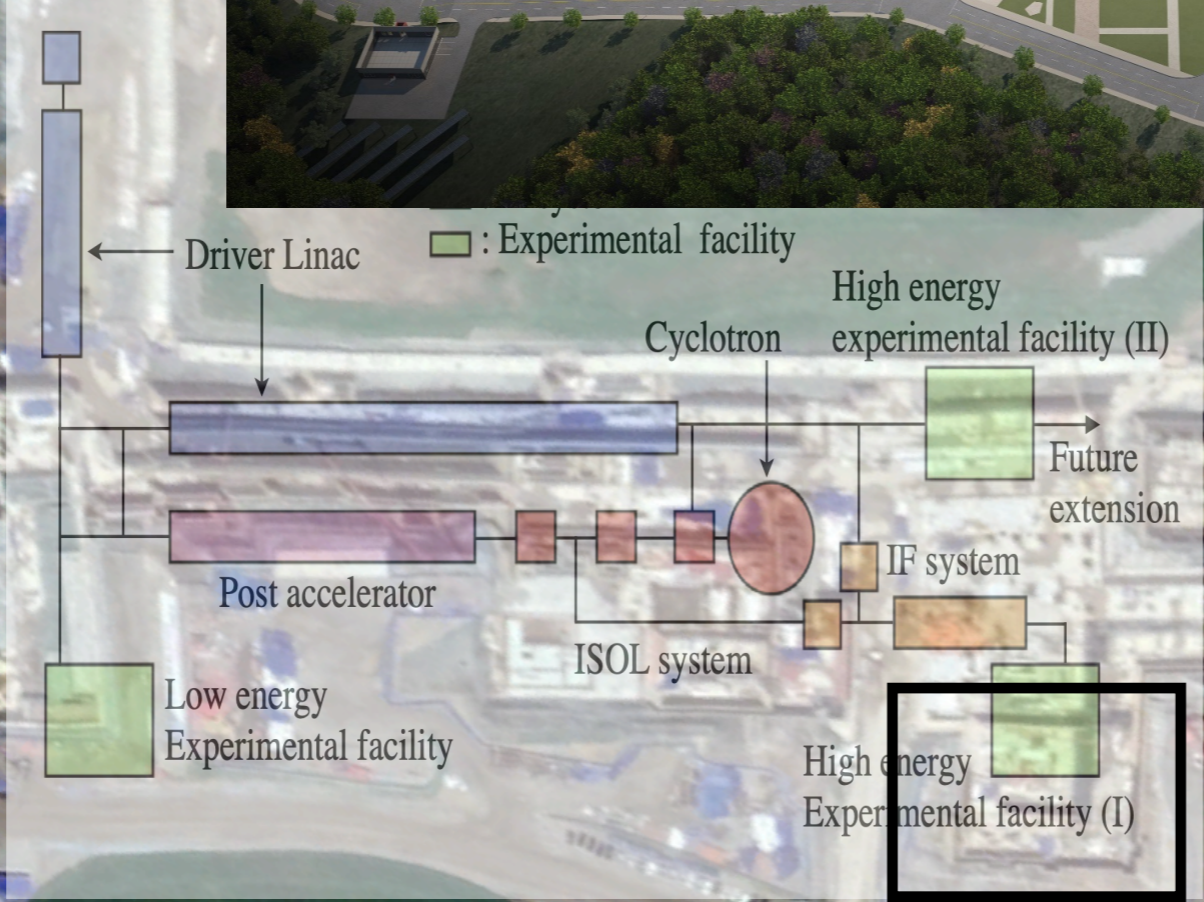
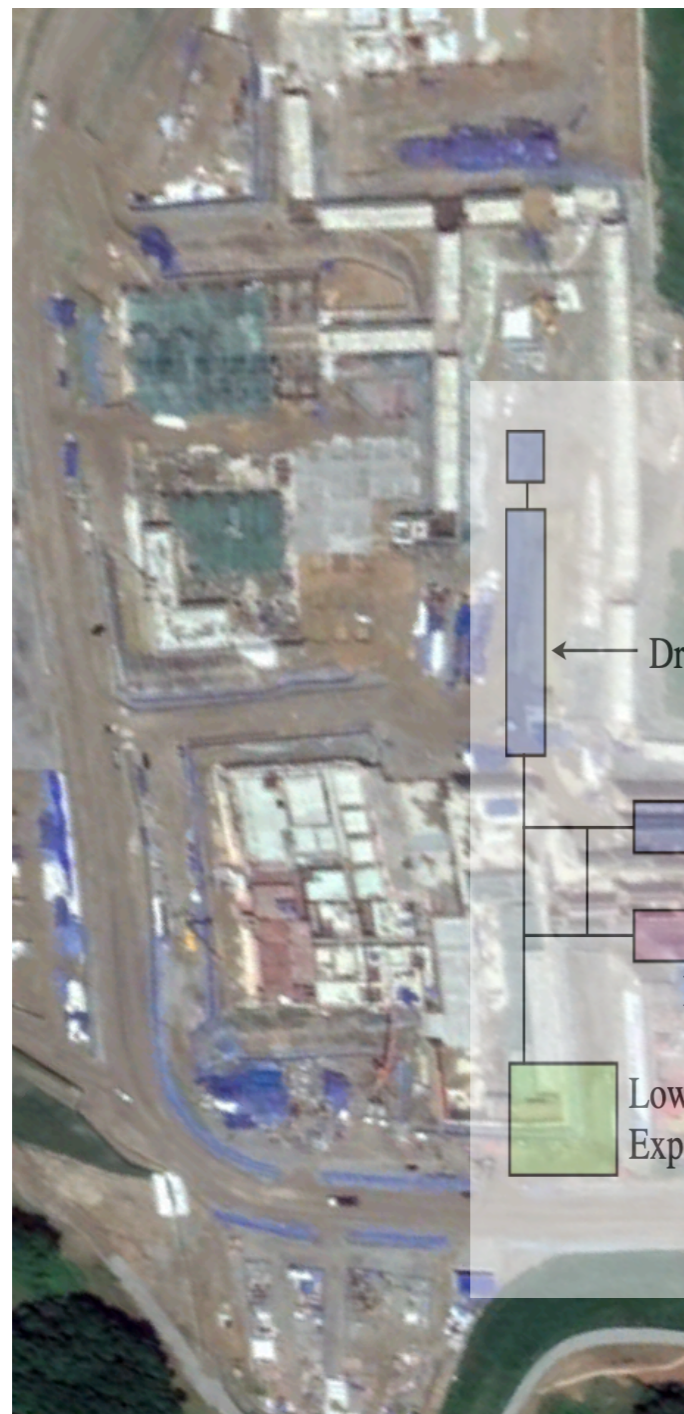
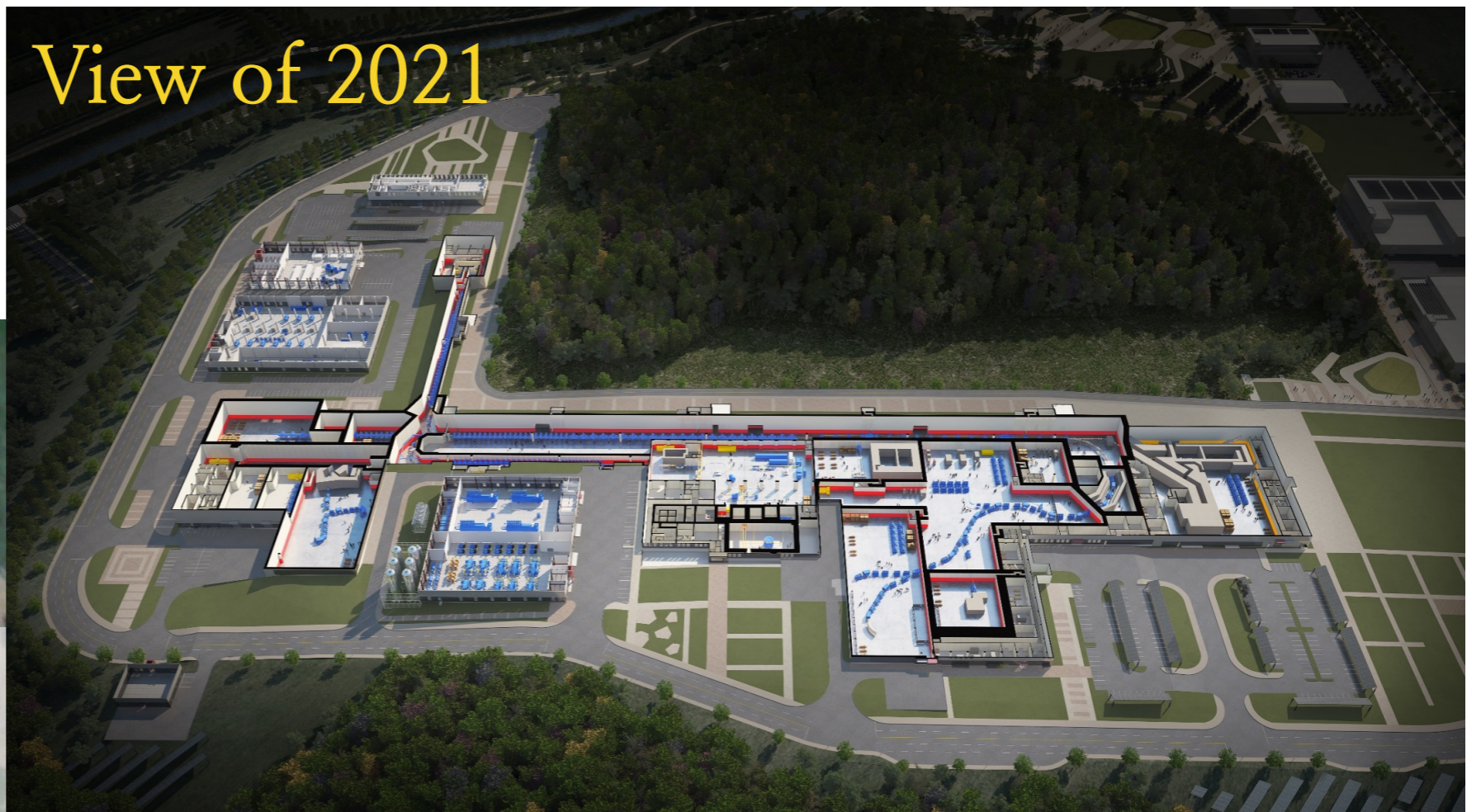


Status of RAON



Status of RAON

View of 2021



Area for LAMPS

Large Acceptance Multi-Purpose Spectrometer (LAMPS)

Physics of LAMPS

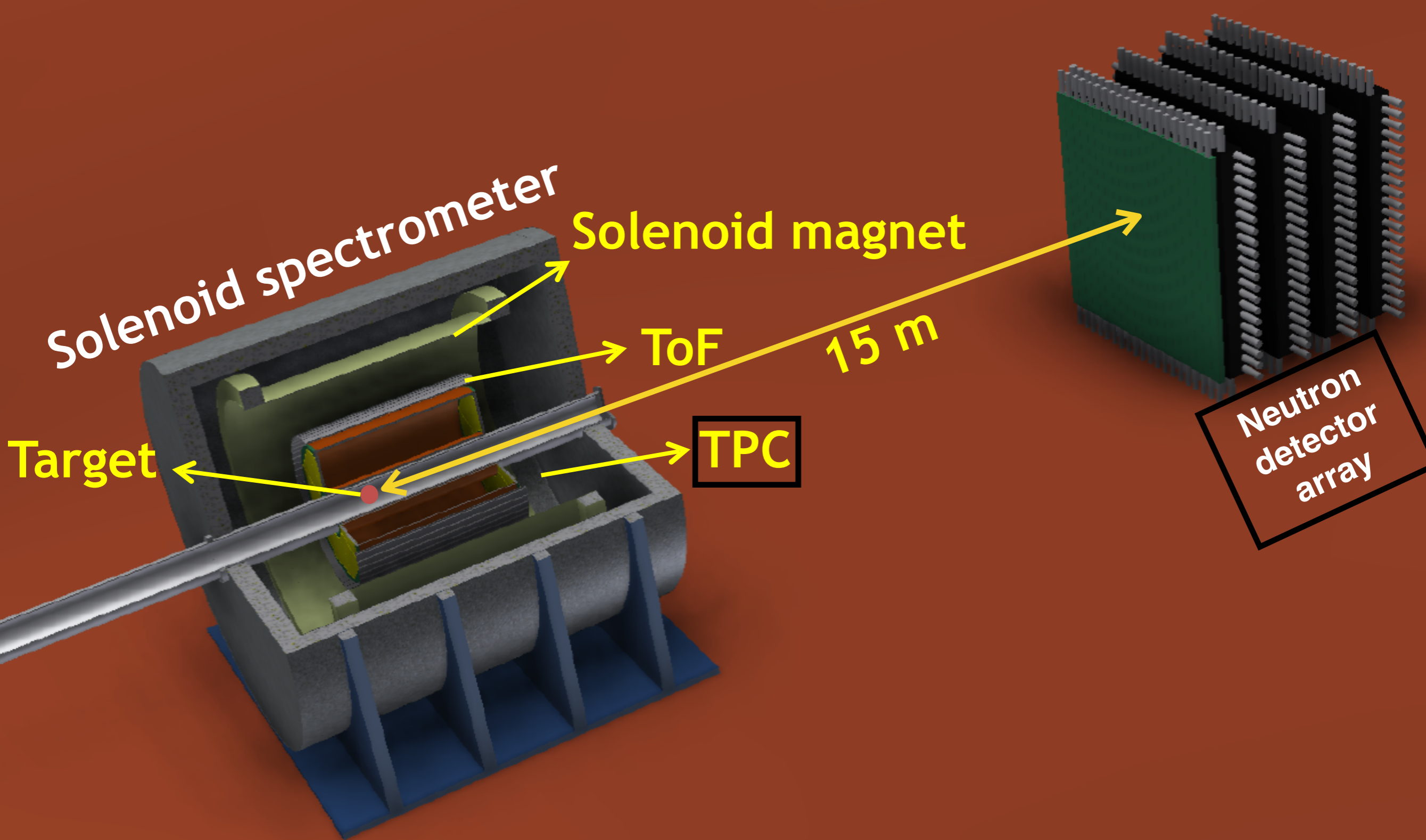
Physics of LAMPS

- Nuclear symmetry energy at supra-saturation density via heavy-ion collision experiment
 - Using rare isotope beam
 - Various beam energy
 - Various collision system
- Ratio of mirror nuclei & π^-/π^+
- Isospin diffusion parameter
- Collective flow
- Dipole emission
- Energy range
 $18.5 \text{ MeV/u} < E_{\text{beam}} < 250 \text{ MeV/u}$
- Example of reactions
 $^{50,54}\text{Ca} + ^{40}\text{Ca}, ^{68,70,72}\text{Ni} + ^{58}\text{Ni}, ^{106,112,124,130,132}\text{Sn} + ^{112,118,124}\text{Sn} \dots$

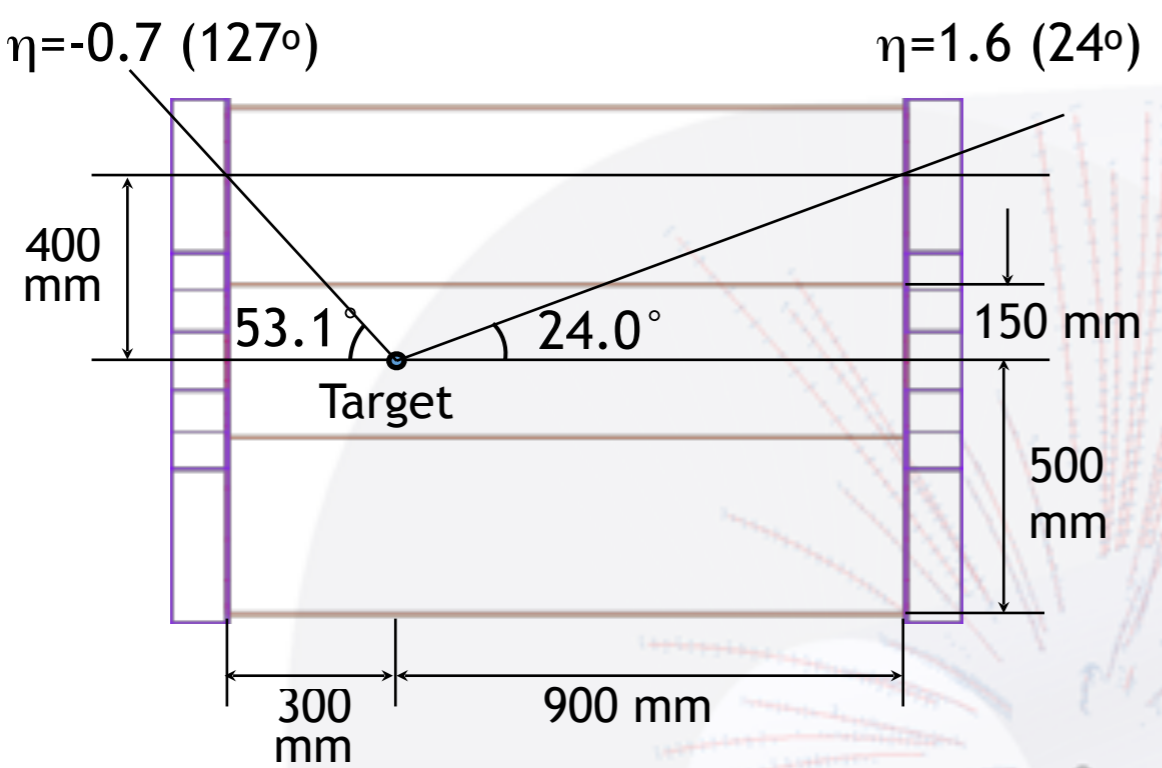
Measureable parameters

- Particle ratios: n/p , $^3\text{H}/^3\text{He}$, etc.
- Pion ratio (π^-/π^+)
- Collective flow
- Electric dipole emission

Detectors

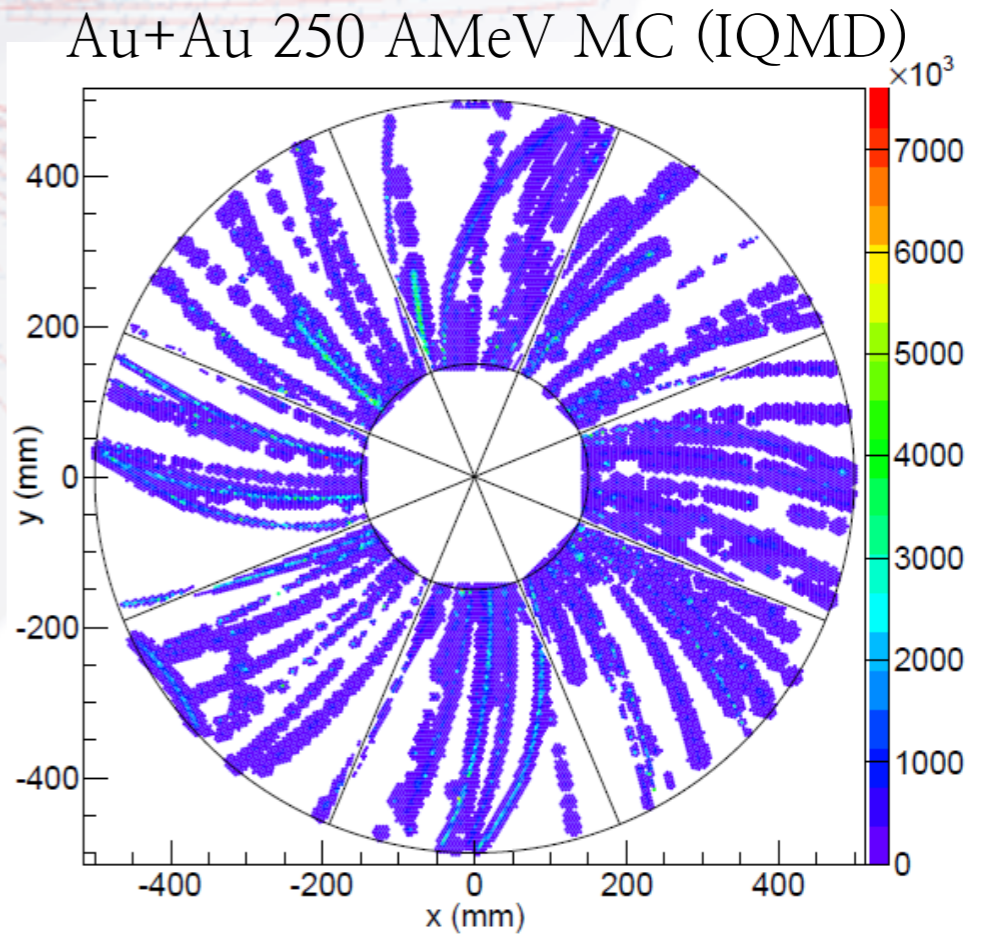
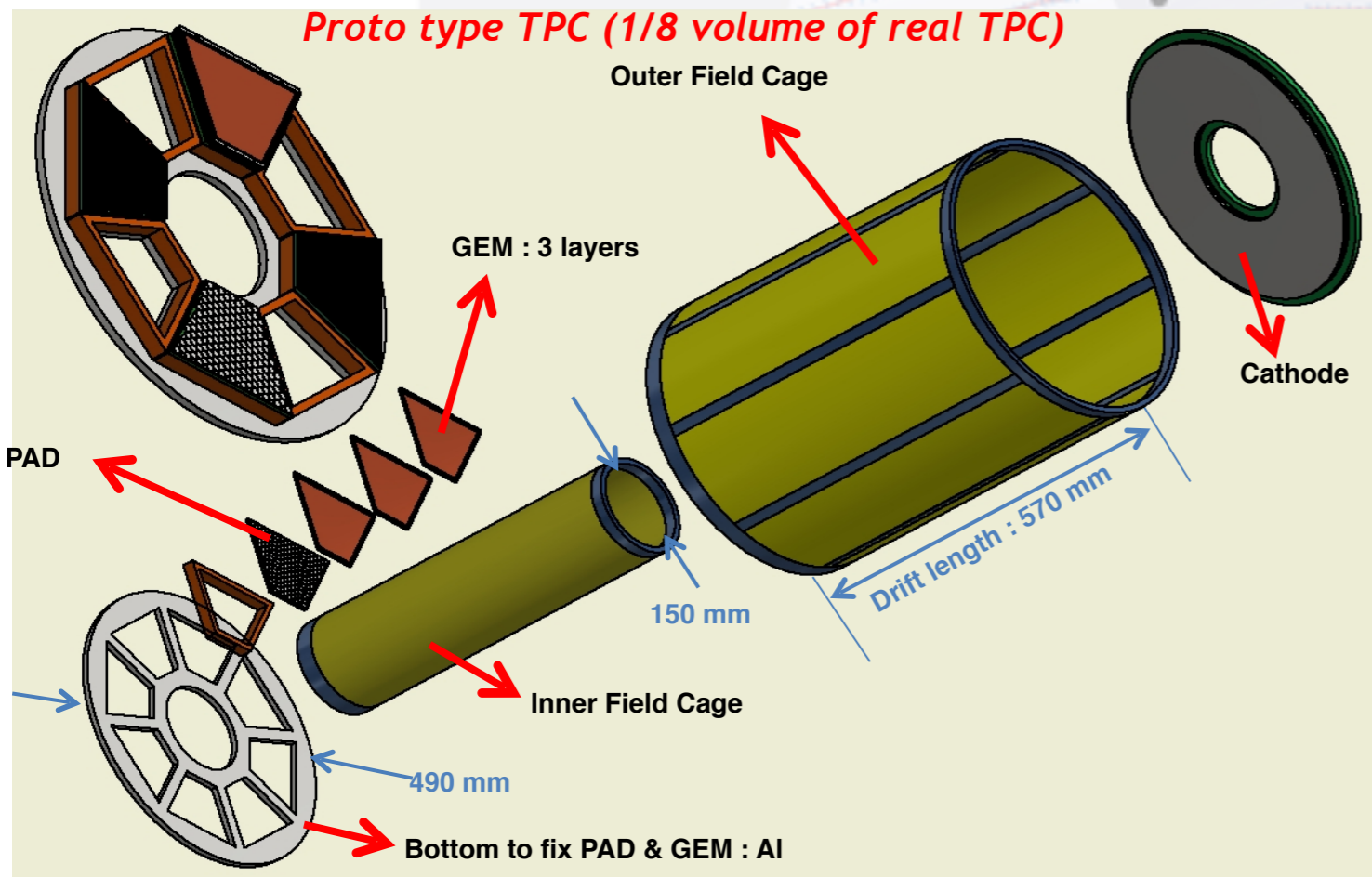


Time Projection Chamber (TPC)

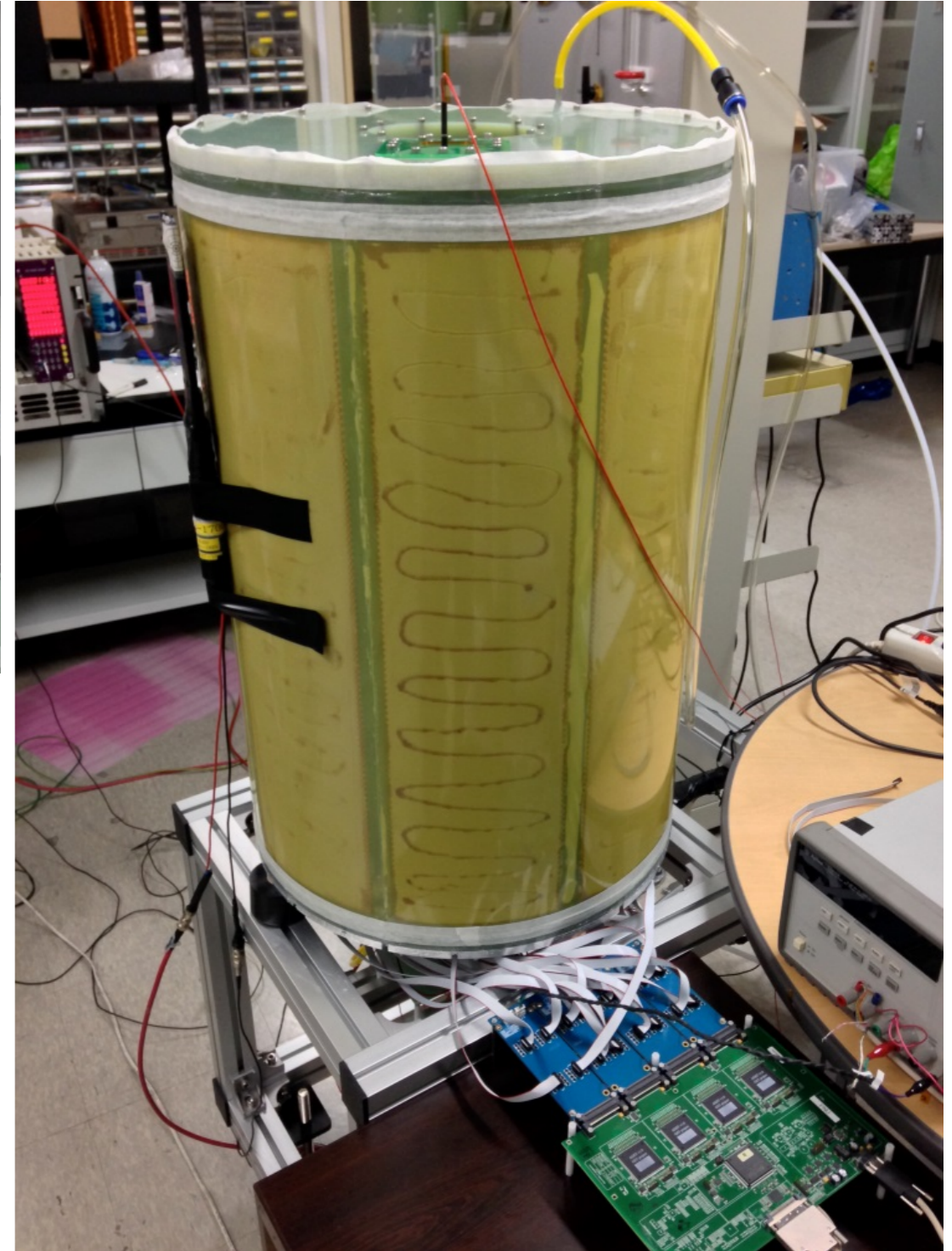
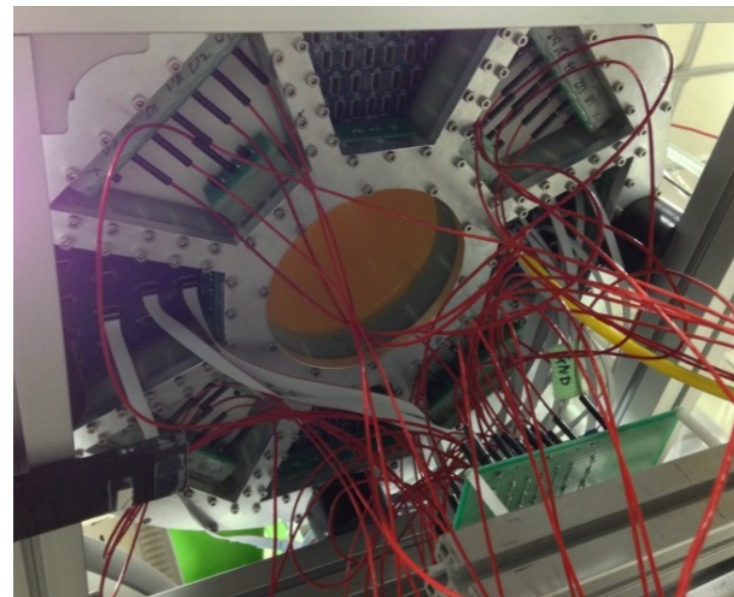
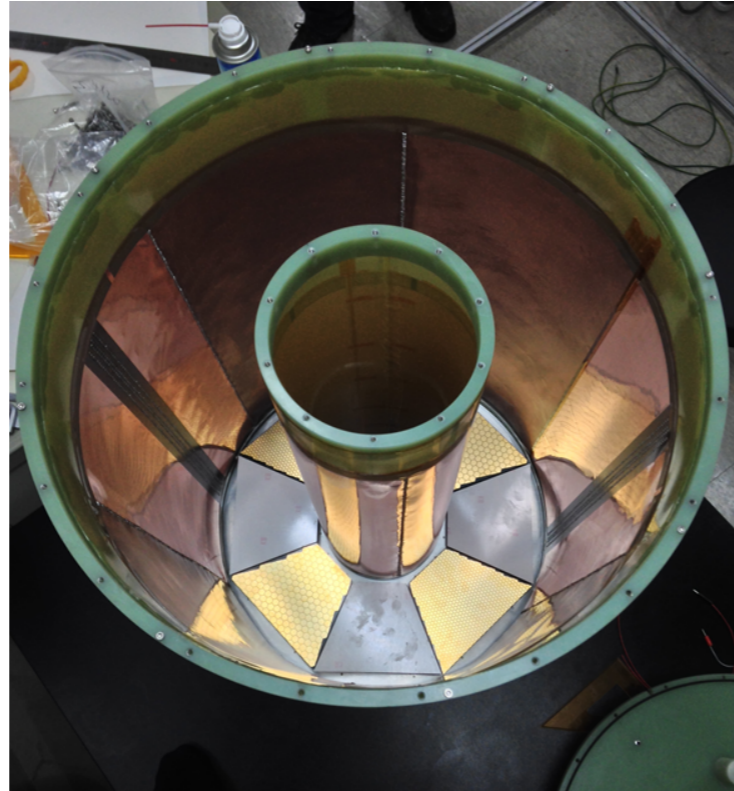
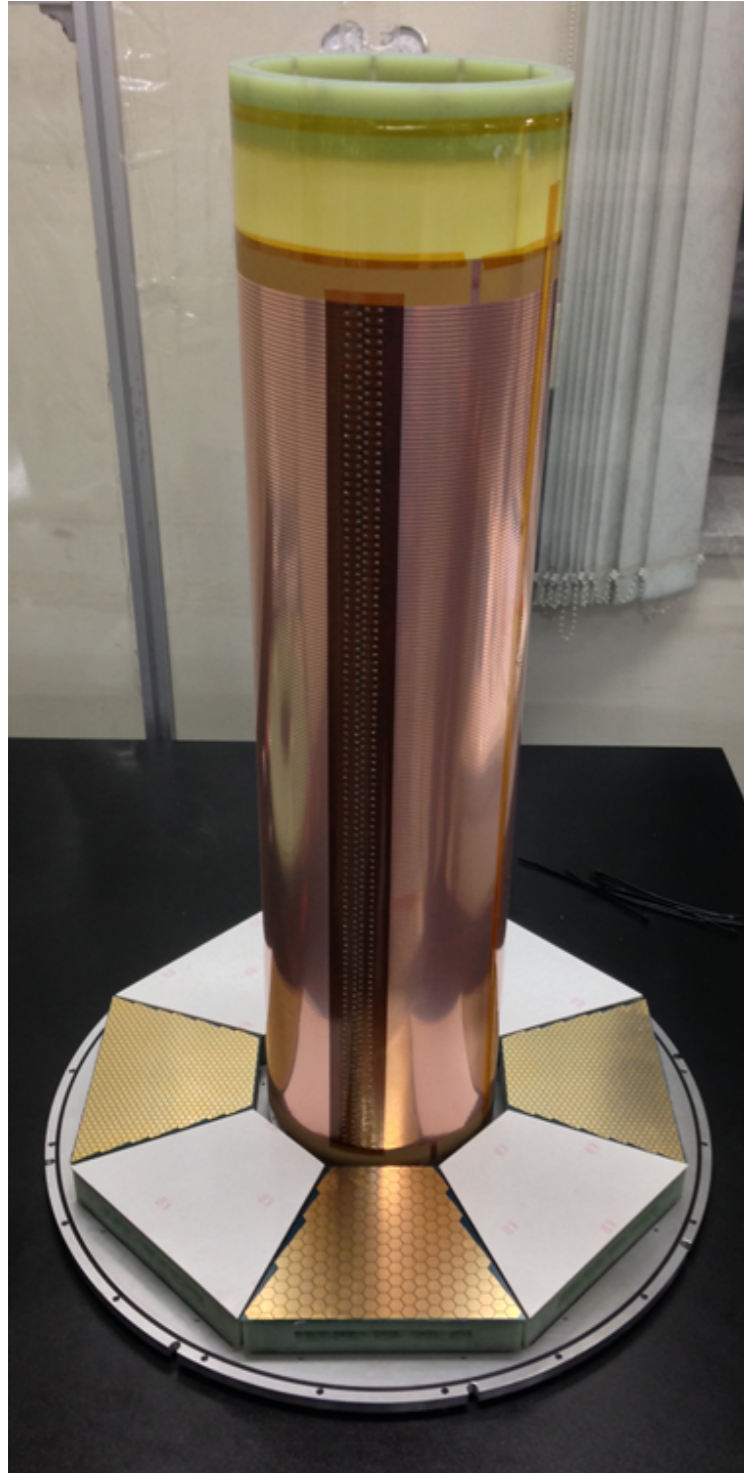


Specification

- Complete information of charged particles
 - momentum & PID of charged particles
- Readout electronics
 - GET electronics
- Inside solenoid magnet
 - Magnetic field strength : upto 1 T
- Dimension
 - Diameter : 1000 mm
 - Length : 1200 mm
 - 23k channels
- Acceptance
 - 3π sr

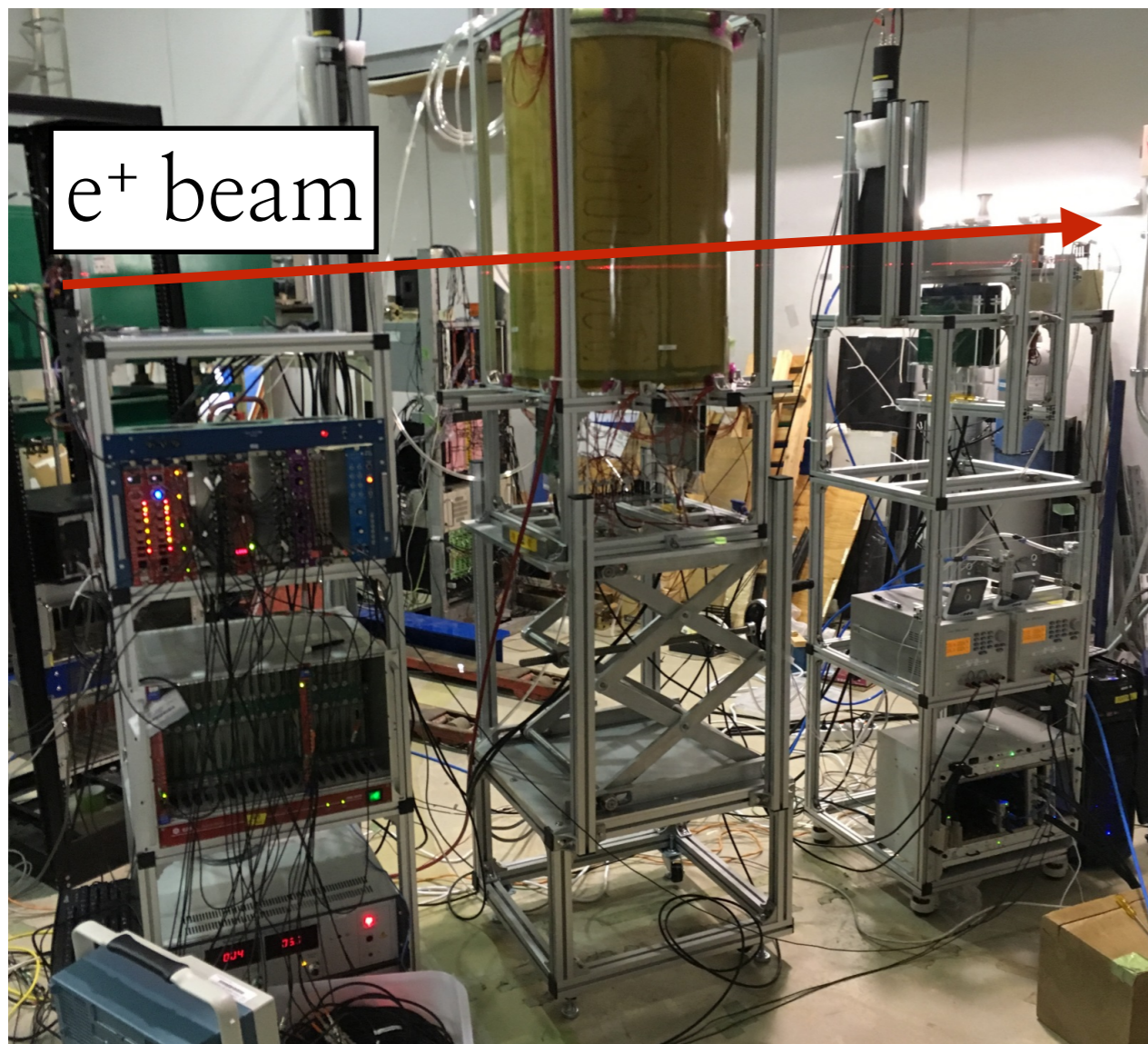


Prototype TPC

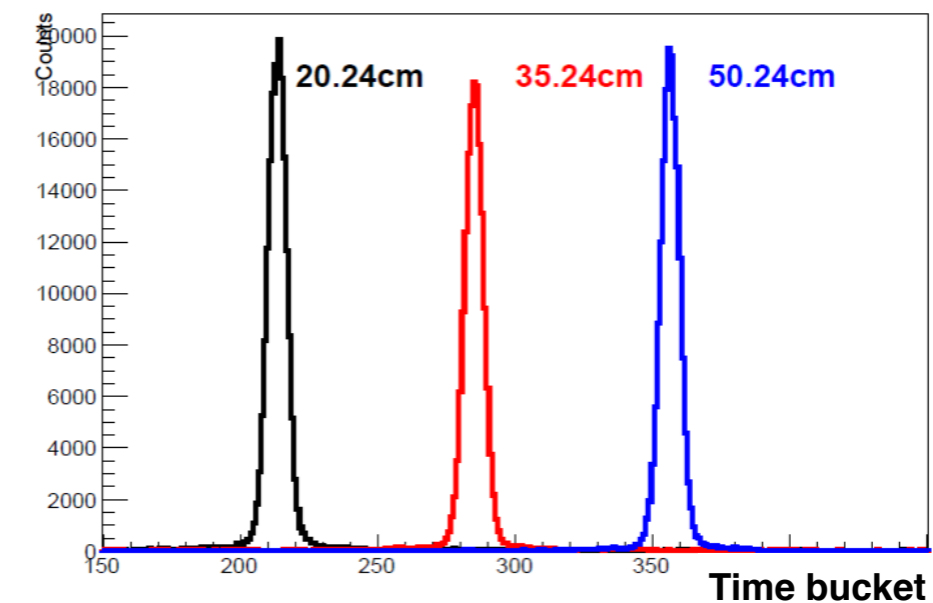


1/8 size in volume of real-size LAMPS TPC (2016)
GEM test for Real-size LAMPS TPC is underway

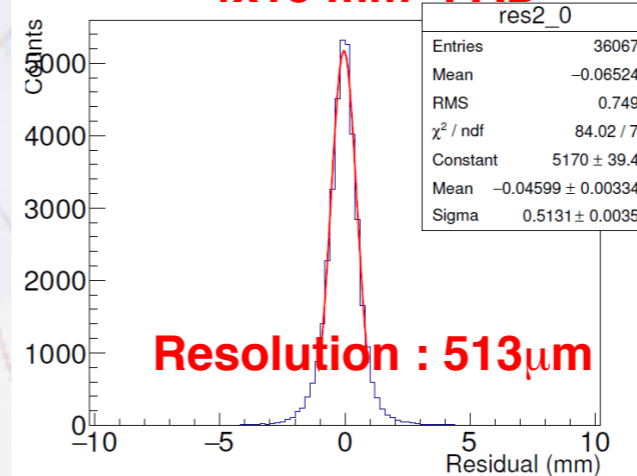
TPC ELPH beam test and result



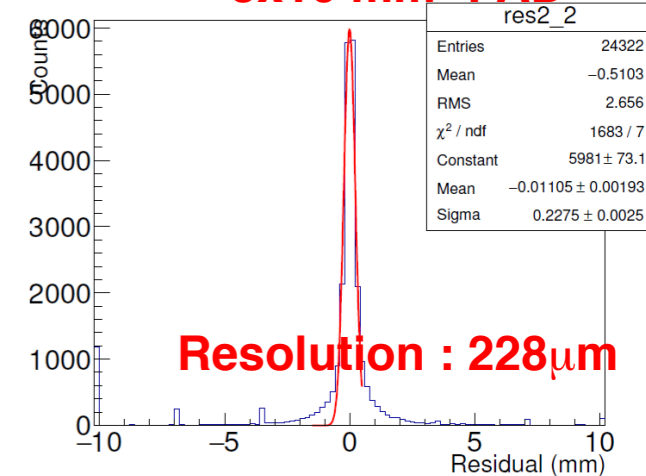
Drift Time distribution as beam height @ ELPH test



4x15 mm² PAD



3x10 mm² PAD



Test summary

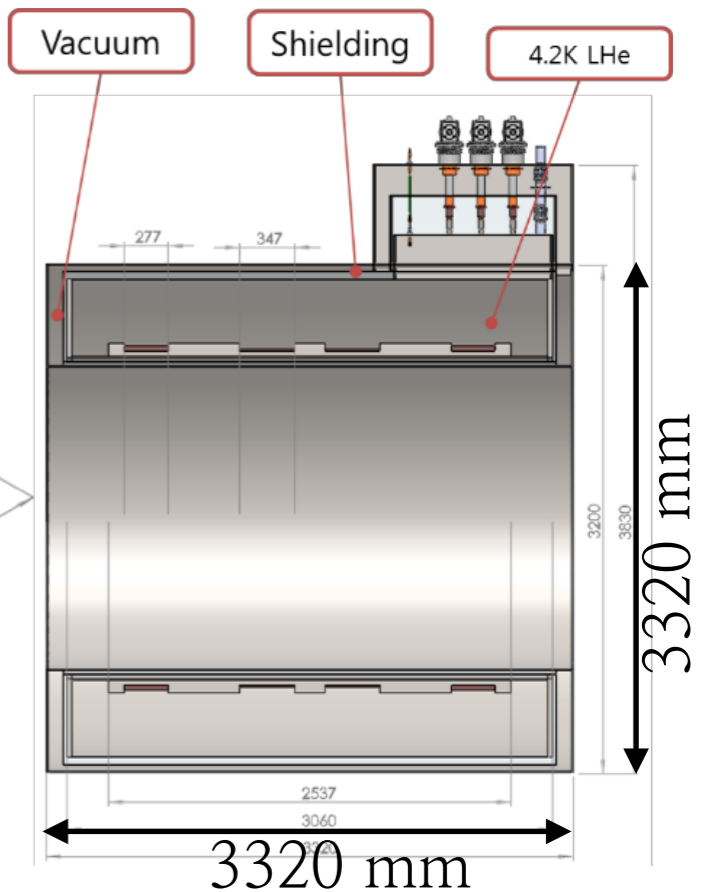
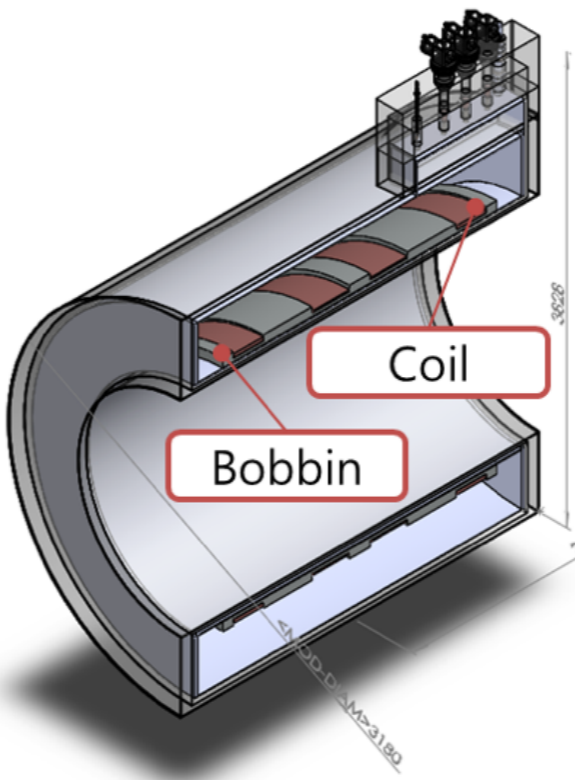
- beam time : 2days (12h+12h)
- positron beam
- beam height @ TPC
: 20.24cm, 35.24cm, 50.24cm
- test gas : Ar-CH₄(90:10), Ar-CO₂(90:10)
- Electric field of FieldCage
: 115, 125, 135, 145, 155V/cm - P10
170V/cm - ArCO₂
- Operating HV @ GEM : 345V

Result summary

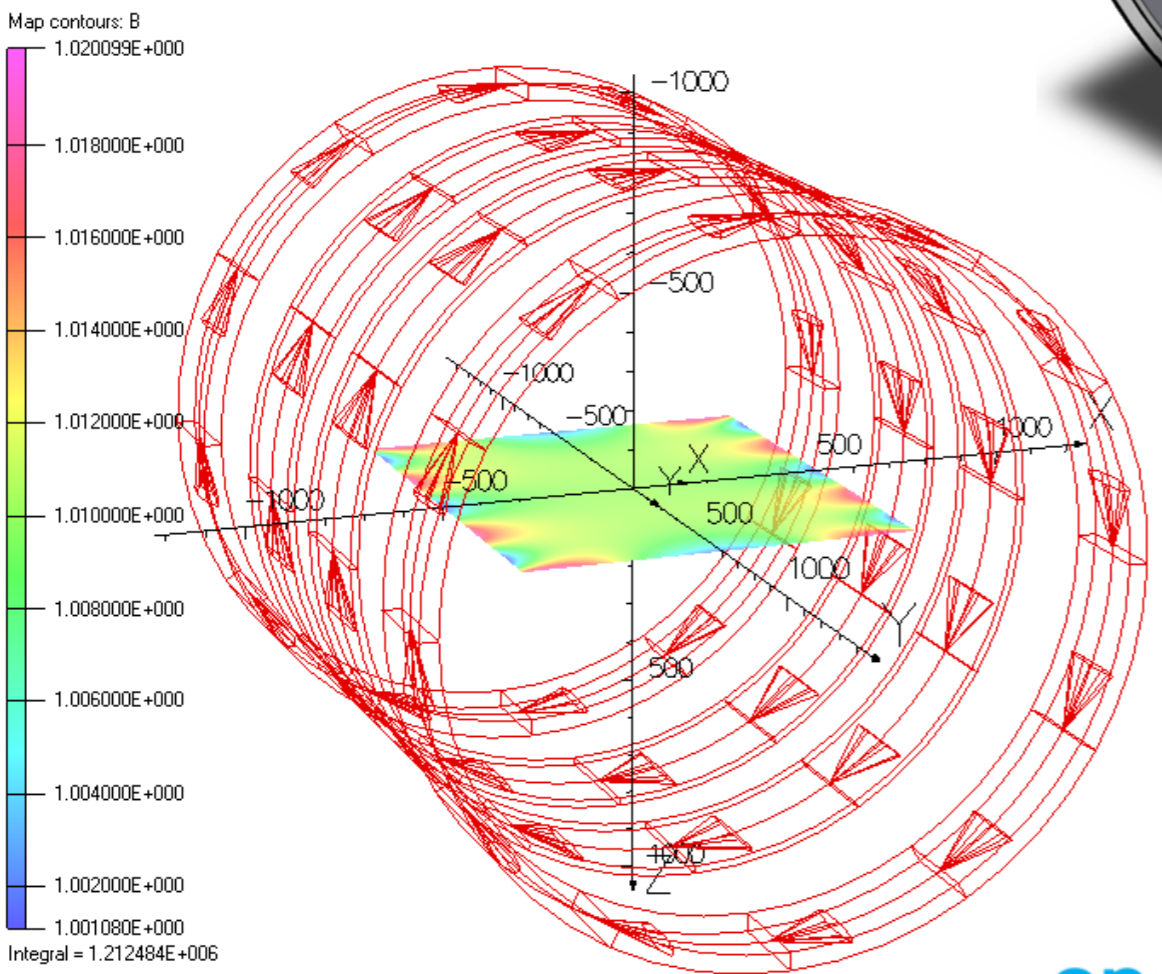
- Drift velocity
 - P10: 5.25 cm/ μ s @ E=155 V/cm
 - P20: 6.77 cm/ μ s @ E=205 V/cm
 - ArCO₂: 1.06 cm/us @ E=170 V/cm
- Diffusion
 - P10 : 414 μ m @ E=155 V/cm
- Position resolution
 - 3x10 mm² Pad : 228 μ m
 - 4x15 mm² Pad : 513 μ m

Superconducting Solenoid magnet

- Requirements
- Field uniformity : $\Delta B/B < \pm 1\%$
 - Field Intensity : upto 1T
 - Inner radius : 1600 mm
- Achieved
- Field uniformity : 1.8%
 - Bmin : 1.005T



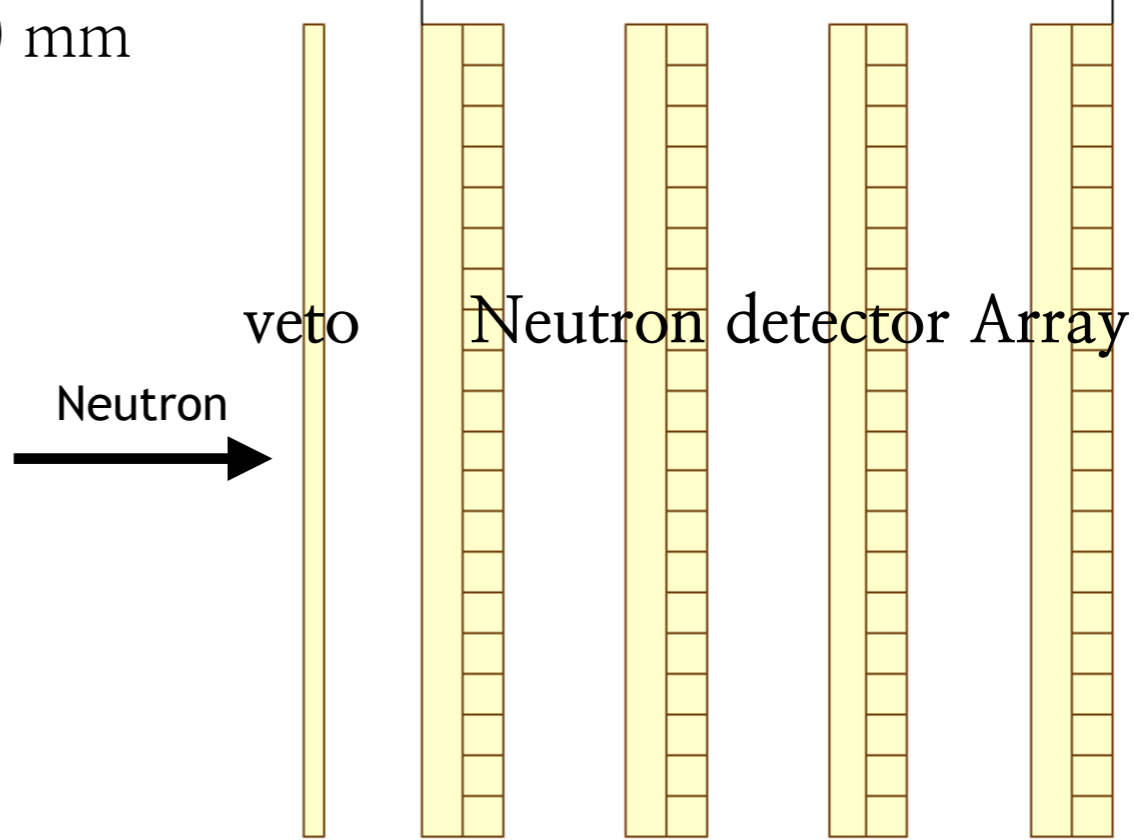
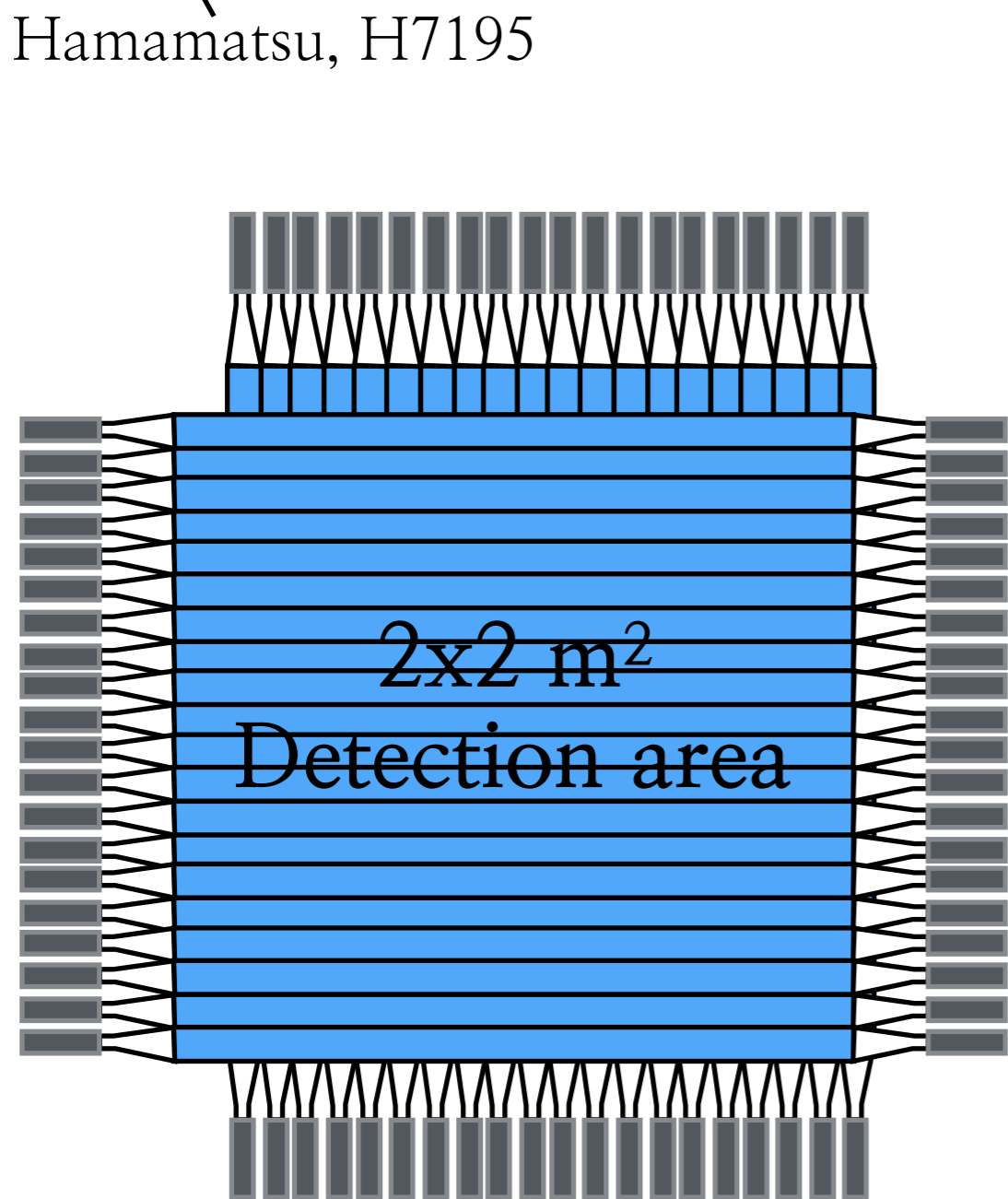
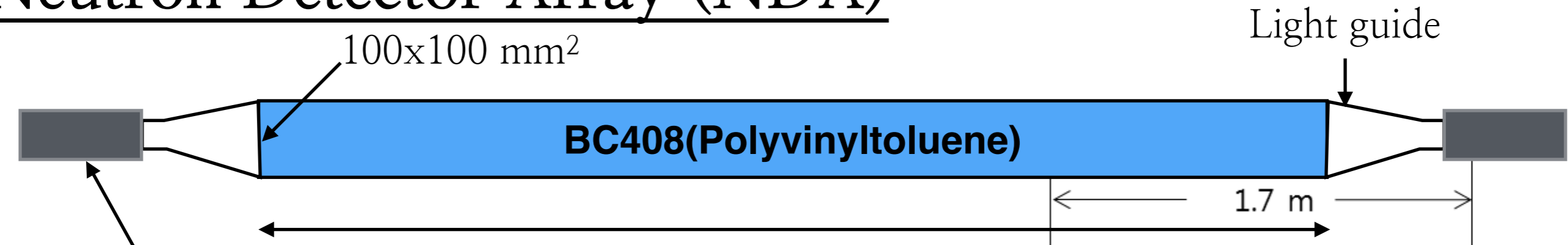
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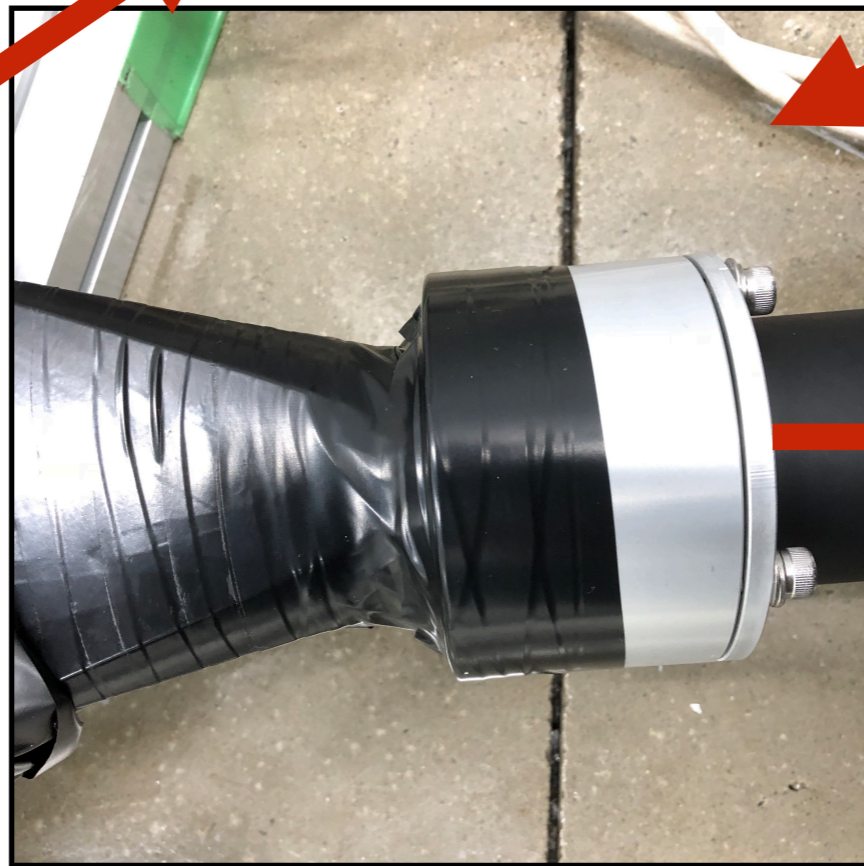
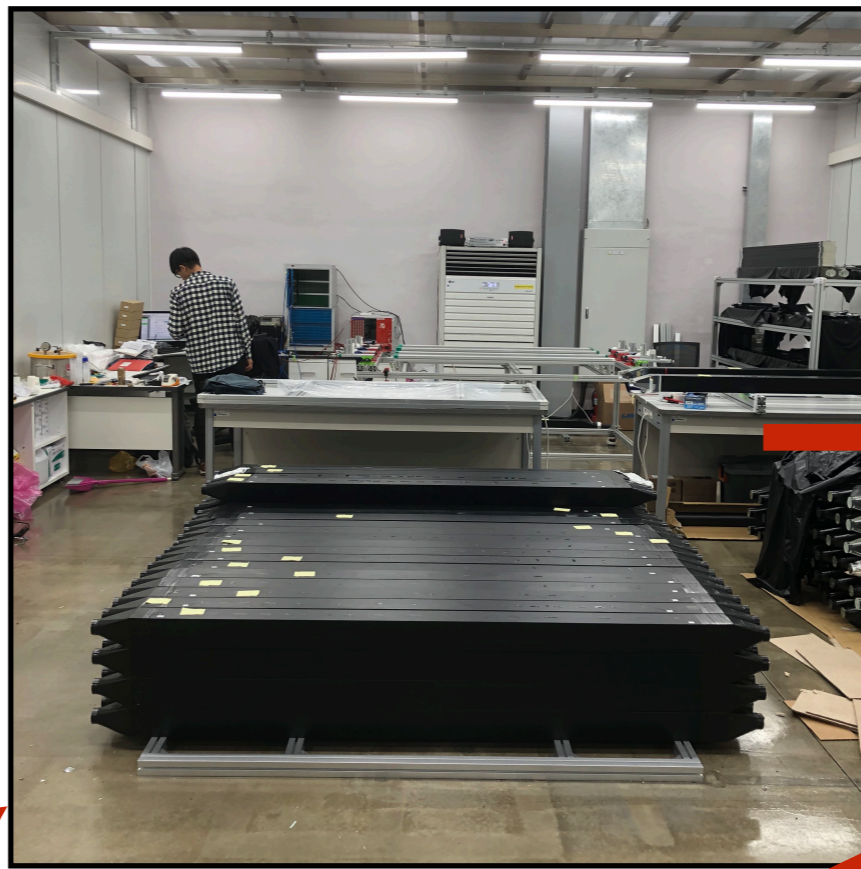
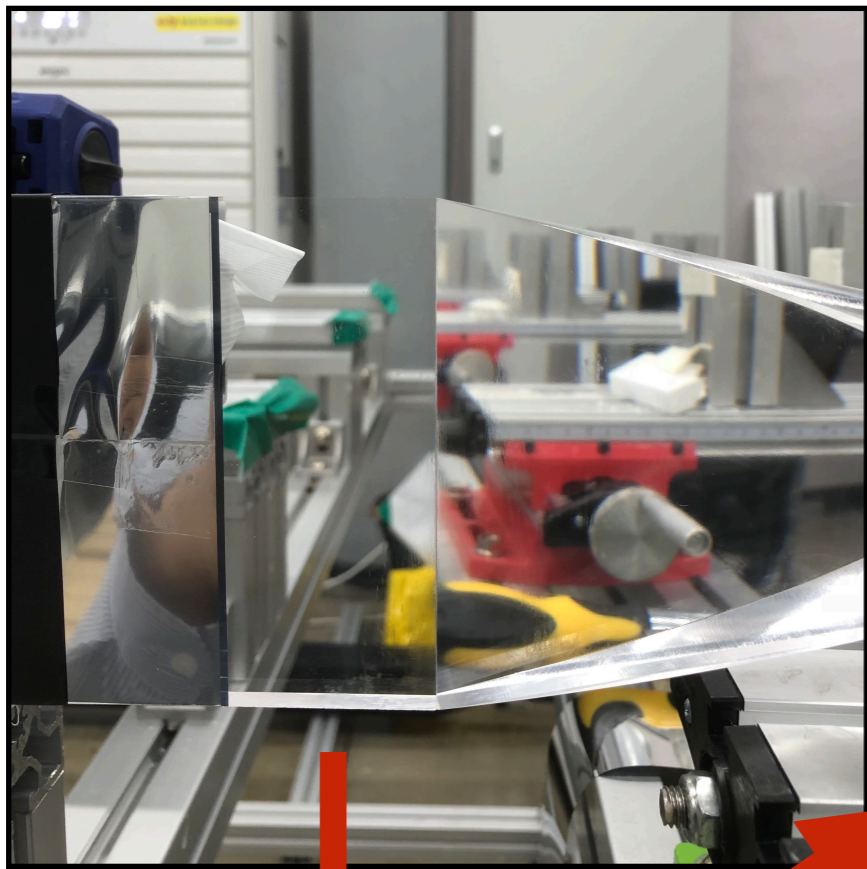
- Progress & schedule
- Purchasing : 2018
 - Production : 2019~2020
 - Commissioning : 2021



Neutron Detector Array (NDA)



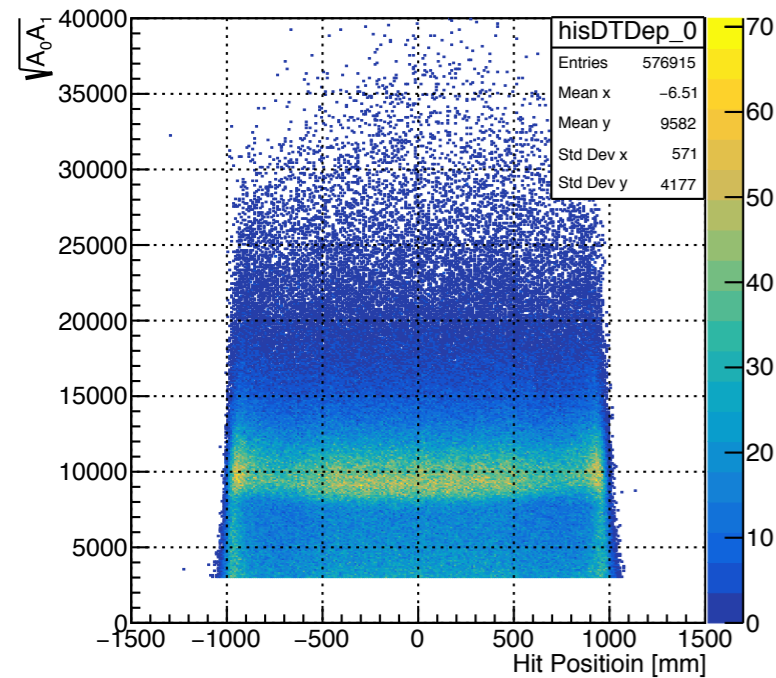
- Specification
- Complete information of neutron
 - Energy & Momentum from TOF and hit position
 - Readout electronics
 - 500 MHz FADC (Notice)
 - Dimension
 - 2 x 2 m² detection area (~0.0014 sr)
 - Thickness : 20 cm / stage, 4 stage in total
 - 180 modules / 360 channels



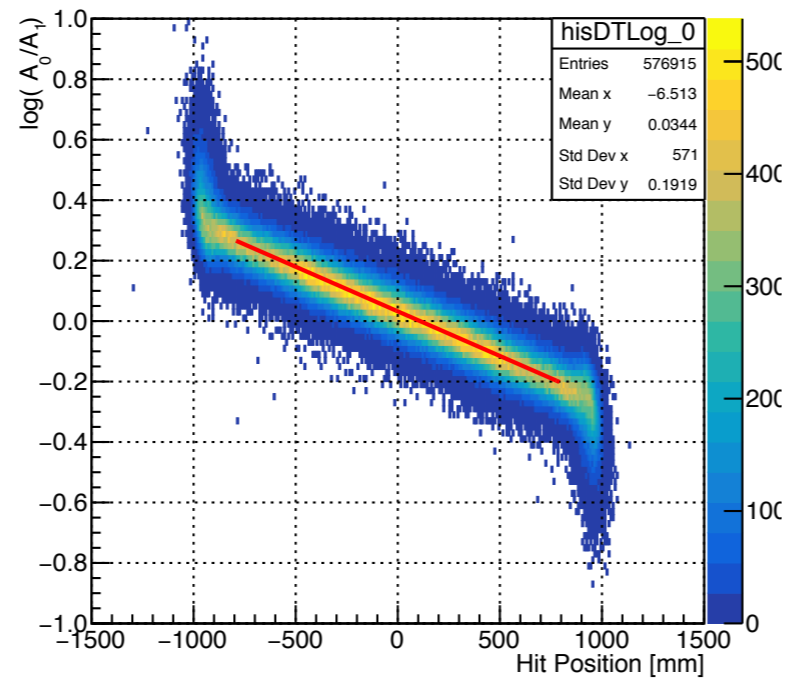
We will end production & construction in this month(2018/11).

Basic Performance of NDA

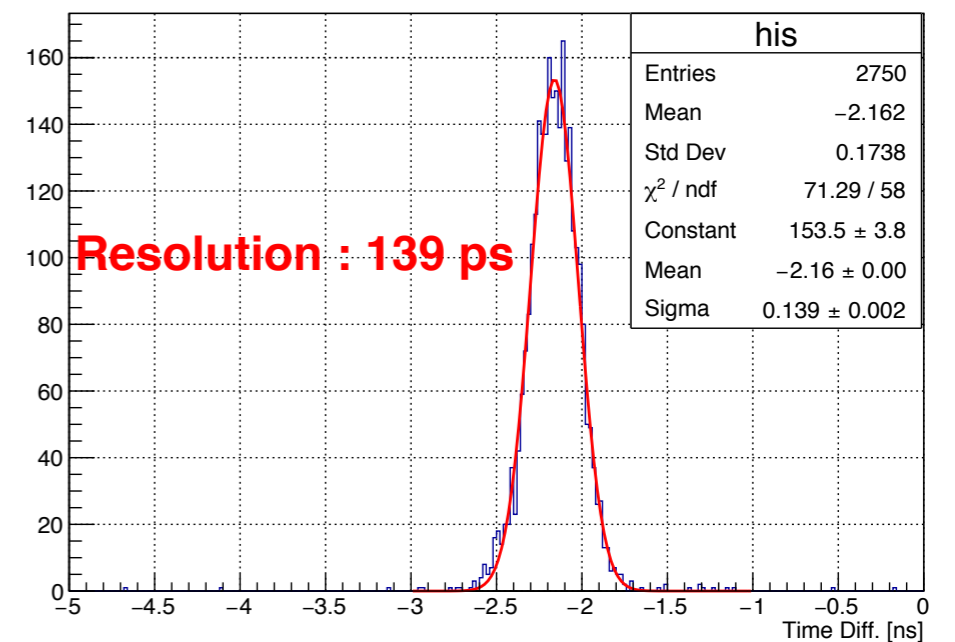
Cosmic ray hit dist.



Attenuation



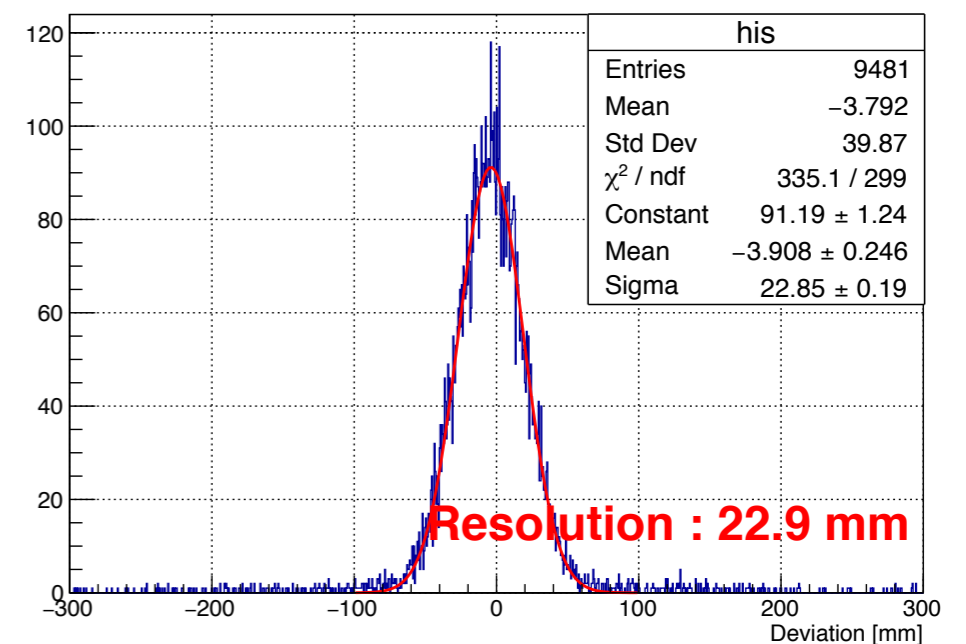
Timing resolution



Performance summary

- MIP peak
 - 9k ~ 10 k count (Changes ~ 10% by position)
- Attenuation Length
 - 3389 ± 22 mm (50% for 2m)
- Position / timing resolution
 - 22.9 mm / 139 ps
- Speed of light in the scintillator
 - 154~158 mm / ns

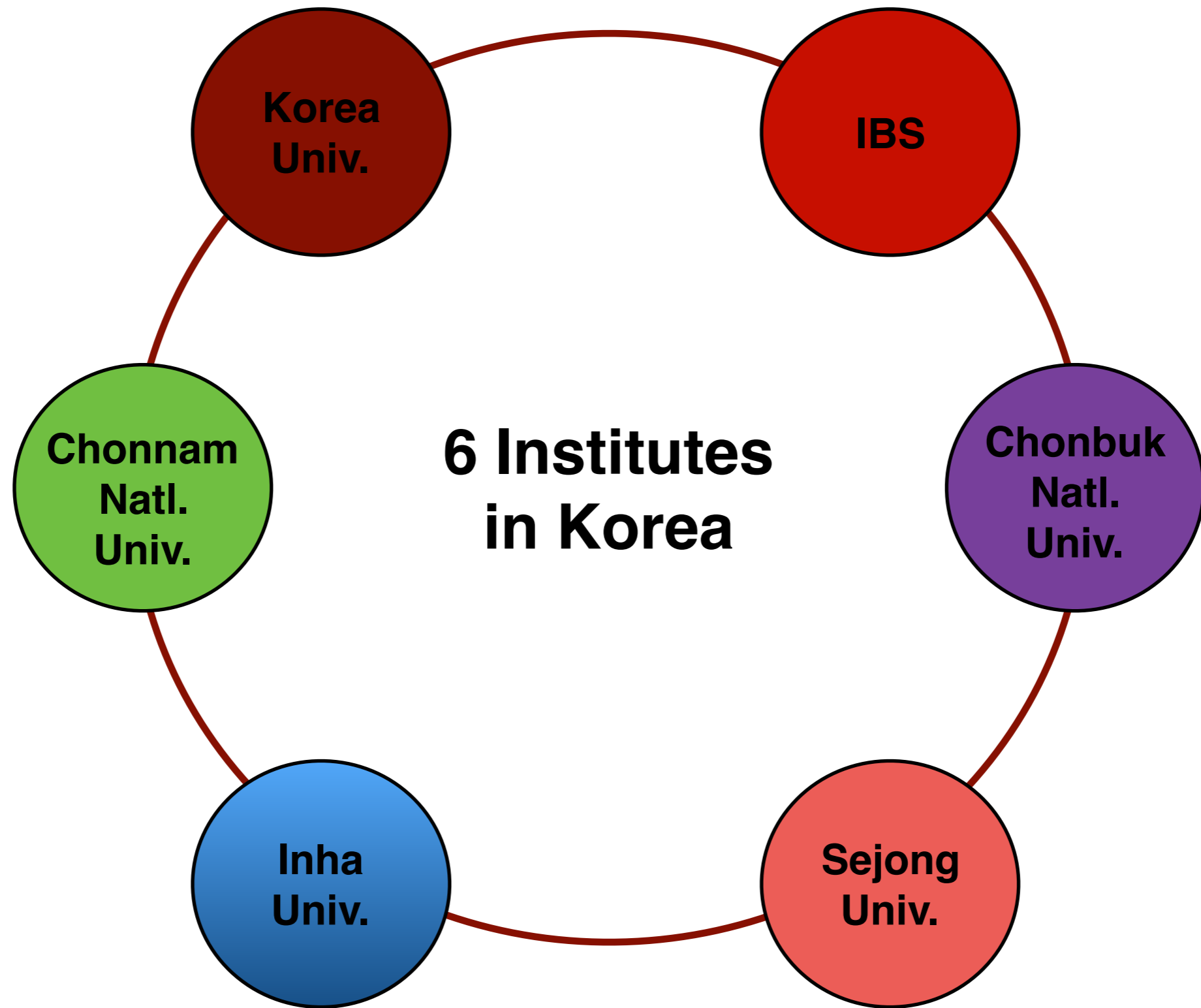
Position resolution



Status & Plan

	2014	2015	2016	2017	2018	2019	2020	2021
Facility	Prototype development							
		Accelerator and experimental system installation and commissioning						
		ECR beam ISOL beam (¹⁵ /12)		SCL demo beam (¹⁷ /12)		Utility Supply (¹⁸ /09)	Day-1 experiment (²⁰ /07)	ISOL RI beam (²⁰ /12)
TPC	Prototype development & beamtest			R&D Realsize TPC		Production	Installation & commissioning	
Solenoid magnet					Design	Production		Installation & commissioning
NDA	Prototype development & beamtest			Readout system development	Production	Installation & commissioning		
Target/ T0 detector					Design	R&D & Production	Installation & commissioning	
TOF detector					Design	R&D & Production	Installation & commissioning	

LAMPS Collaboration



We want more Collaborators and Physics.

Summary

- ➔ The LAMPS experiment will search and explore new area of the nuclear interaction and gives us new information about nuclear matter.
- ➔ We prepare the LAMPS experiment toward the completion of RAON.
- ➔ We accomplished R&D of two main detectors(TPC, NDA).
- ➔ We will complete the NDA assembly in this year(2018).
- ➔ Assemblies and productions of TPC and Magnet are in progressing, and will be ended in 2020.

I want to close my presentation
with the famous phrase.

鞠躬盡瘁 死而後已*

I shall bend to the task until I am worn out, and not stop until I am dead.

*제갈량 출사표

*諸葛亮之 出師表

*Zhuge Liang's "Later Chu Shi Biao"

鞠躬盡瘁 死而後已*

This word is too heavy...

鞠躬盡瘁 成而後已。

Thanks

謝謝

감사합니다.

ありがとうございます。

Backup

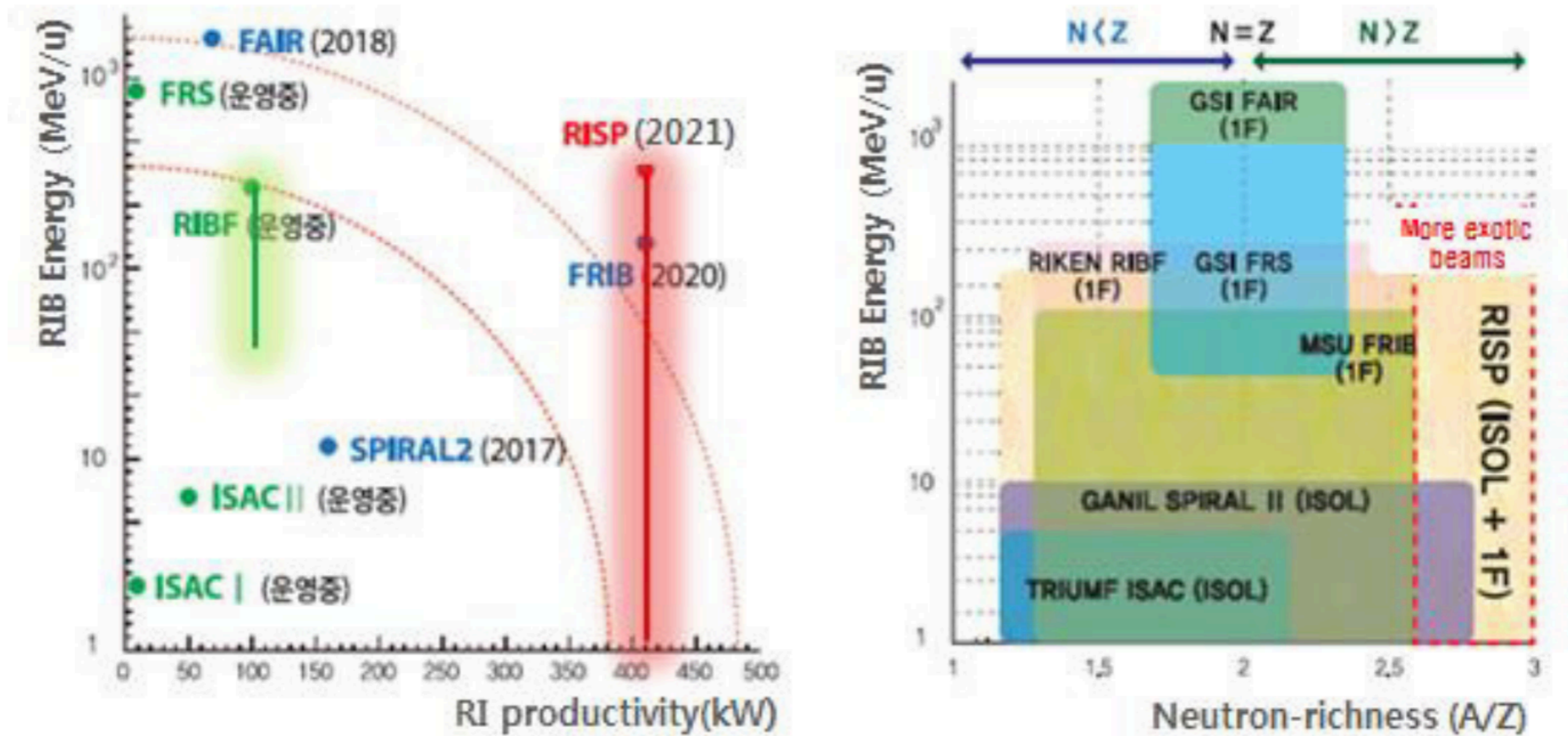


Figure 3: Characteristics of RISP. RISP will provide RIBs with energies ranging from tens of keV to intermediate energies of around 200MeV/nucleon with a high intensity and neutron richness. (*FAIR and FRS in GSI, Germany; ISAC I and II in TRIUMF, Canada; RIBF in RIKEN, Japan; SPIRAL2 in GANIL, France; FRIB in MSU, USA.*)