Current status of Nuclear Data Production System at RAON

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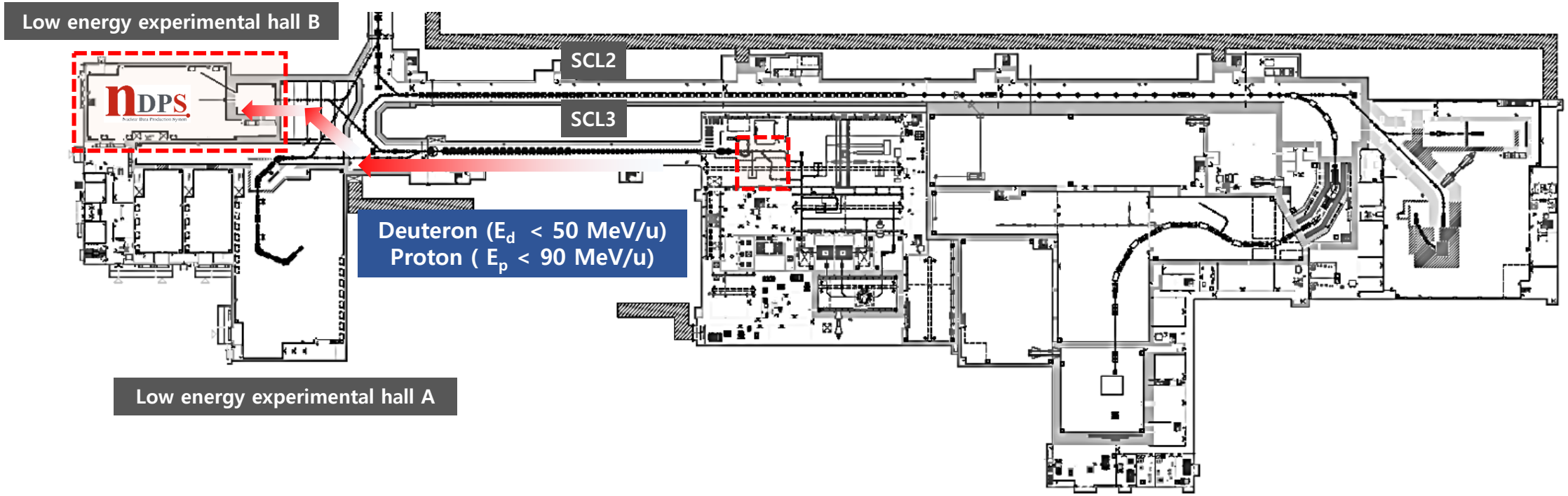
Experimental system team
Institute of Rare Isotope Science (IRIS)

Nuclear Data Production System (NDPS)

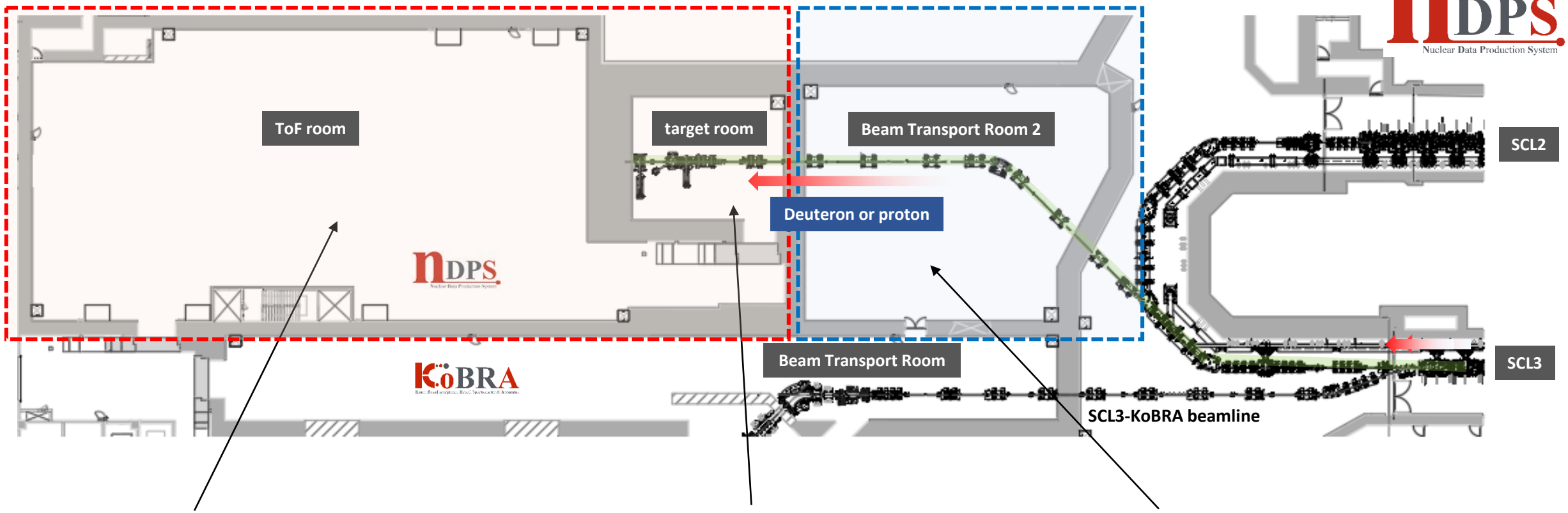
필요성

- ❖ 수십 MeV 에너지 영역의 중성자 유도 단면적 핵 데이터는 불충분하며 불확도가 큼.
- ❖ 물성변화시험, 국방, 비파괴검사, 반도체 검사 등 다양한 분야에서 고속 중성자 관련 핵 데이터에 대한 수요가 증가하고 있음.
- ❖ 가속기 구동 시스템(ADS), 방사성 폐기물 처리, 의료/산업 동위원소 생산 등 다양한 응용 분야에서 정밀한 핵 데이터 확보가 요구됨.

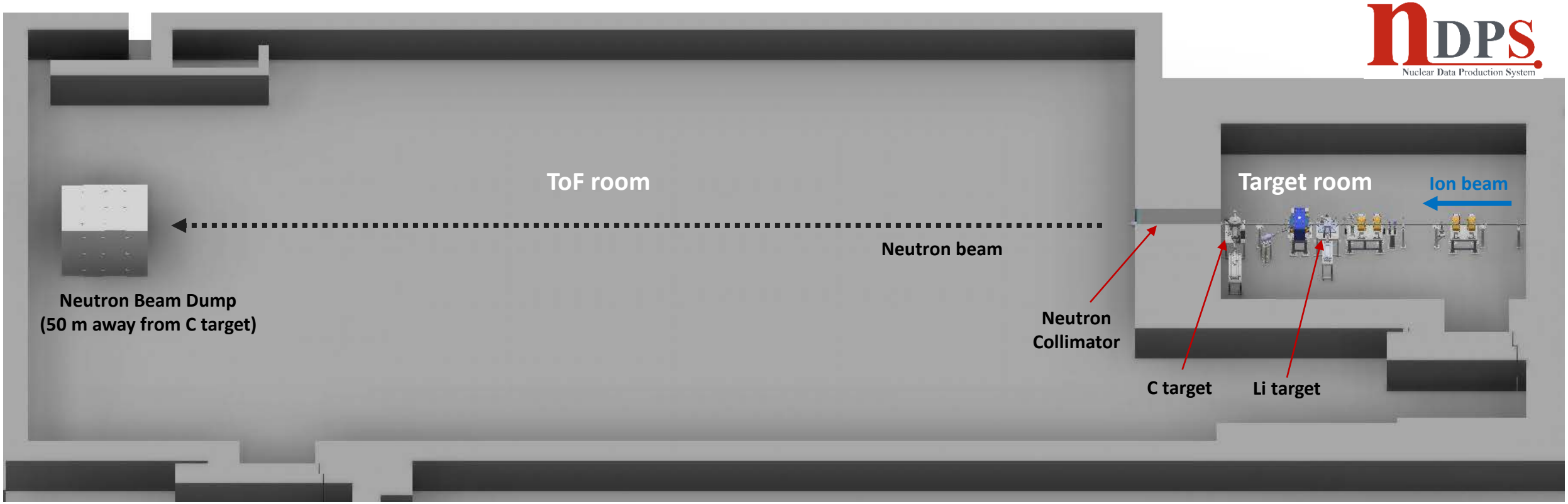


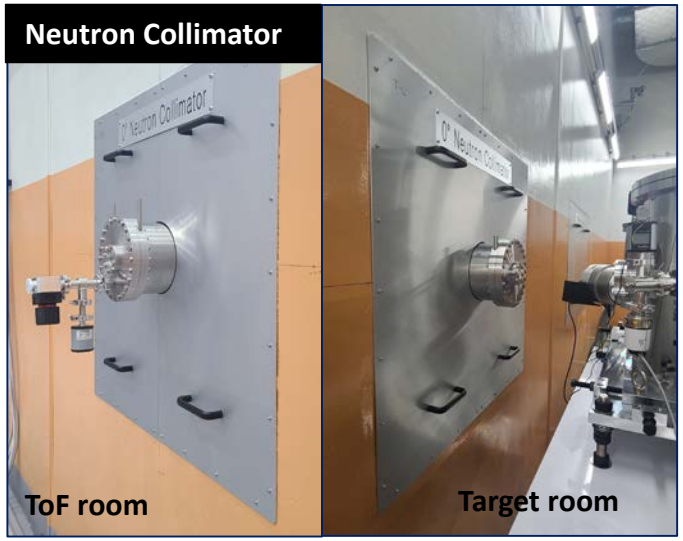
NDPS

SCL3-NDPS beamline



nDPS
Nuclear Data Production System

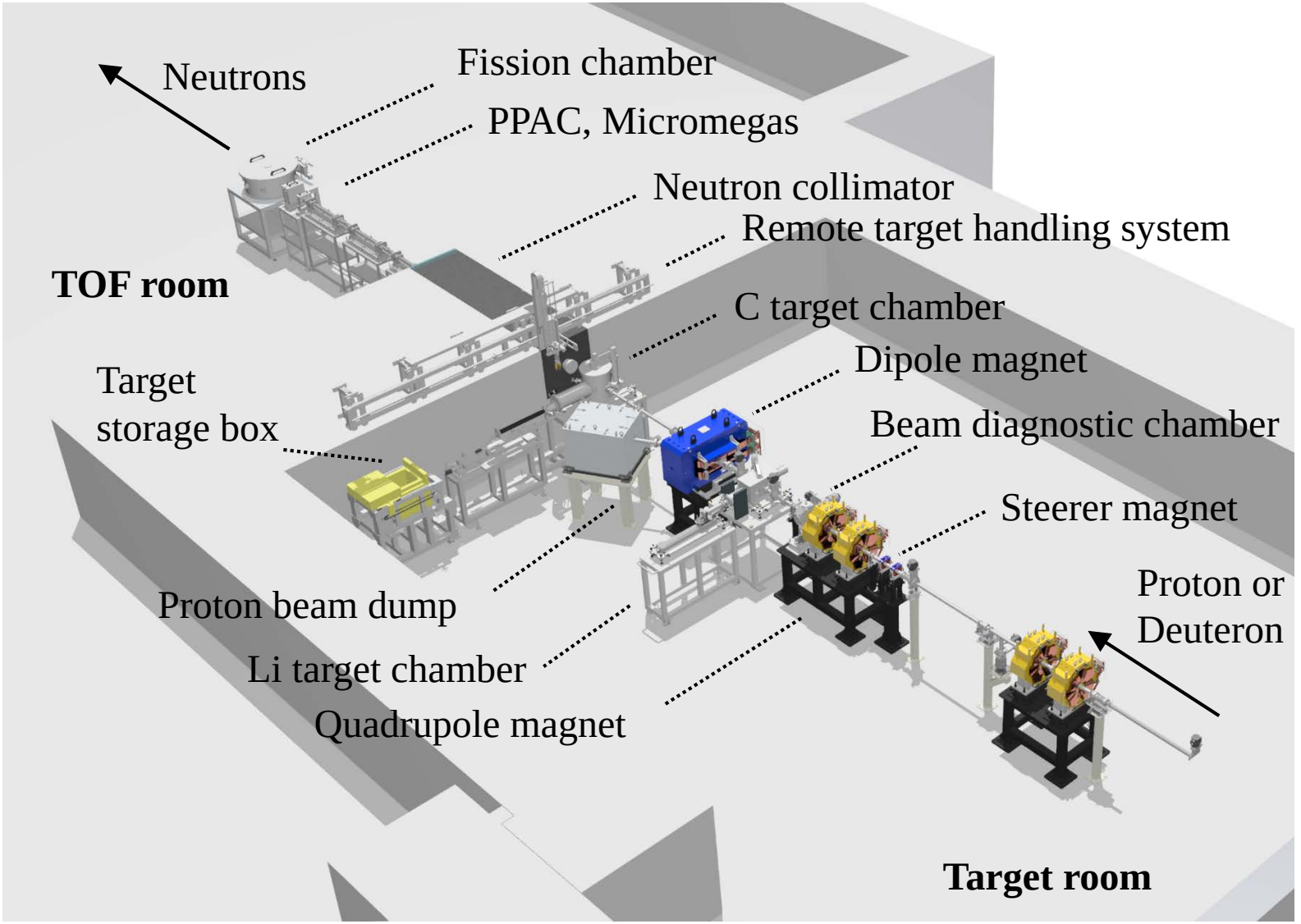




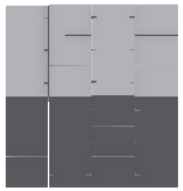
Nuclear Data Production System (NDPS)

❖ **Specification of NDPS**

Beam ion	Proton, deuteron
Maximum Beam energy	49 MeV/u for deuteron 83 MeV/u for proton
Maximum Beam current	~10 μA
Target	**C** for white neutron **Li** for monoenergetic neutron
Bunch length	~ 1 nsec
Repetition rate	1 – 200 kHz
Flight length	5 – 40 m
Neutron flux	~ 10^{8} cm^{-2} sec^{-1} at 5 m



Magnet



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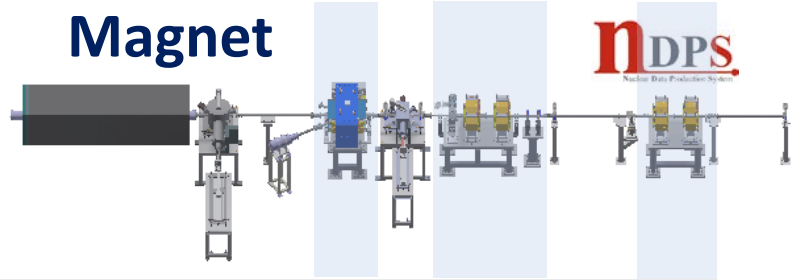
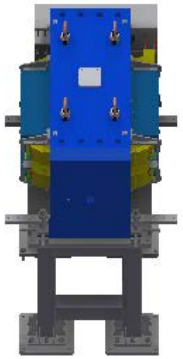
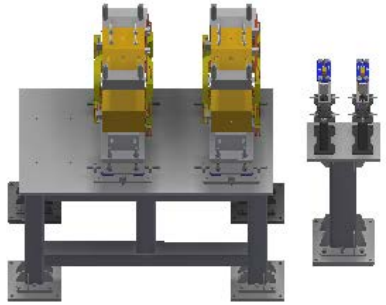


3D modeling



Dipole magnet



Quadrupole magnet

Steering magnet

Specification

1. Dipole magnet (1 ea)

Pole gap	80 mm
Maximum field	1.2 T
Effective length	570 mm
Power	17.6 kW

2. Quadrupole magnet (4 ea)

Aperture	70 mm
Max. gradient field	10 T/mm
Effective length	300 mm
Power	0.6 kW

3.Steering magnet (2 ea)

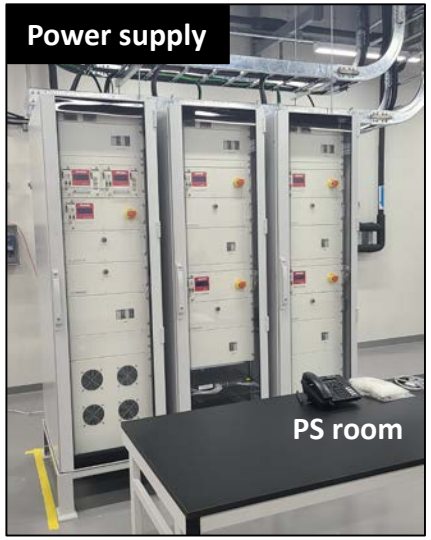
Pole gap	80 mm
Max. field integral	2.518 T mm
Power	22 W

Dipole magnet

Quadrupole magnet

steering magnet

Power supply

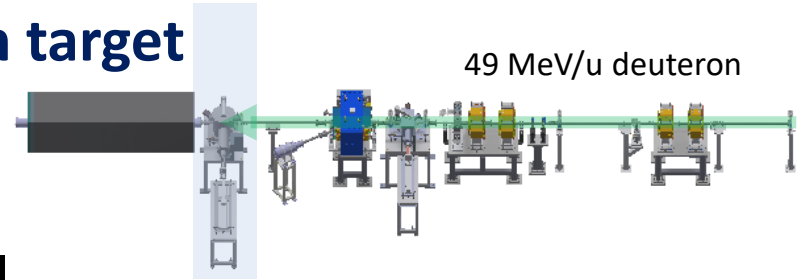


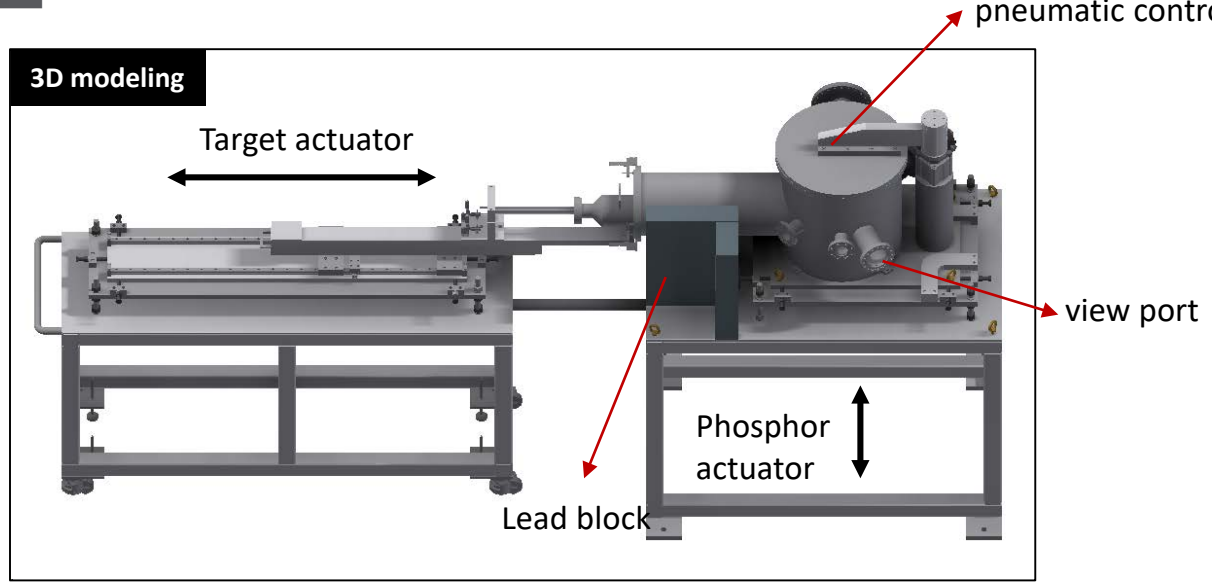
PS room

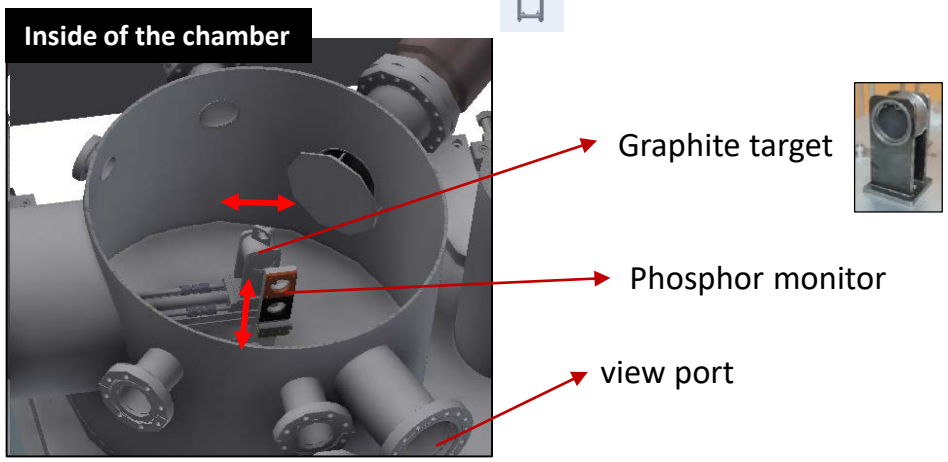
OPI program for the remote control

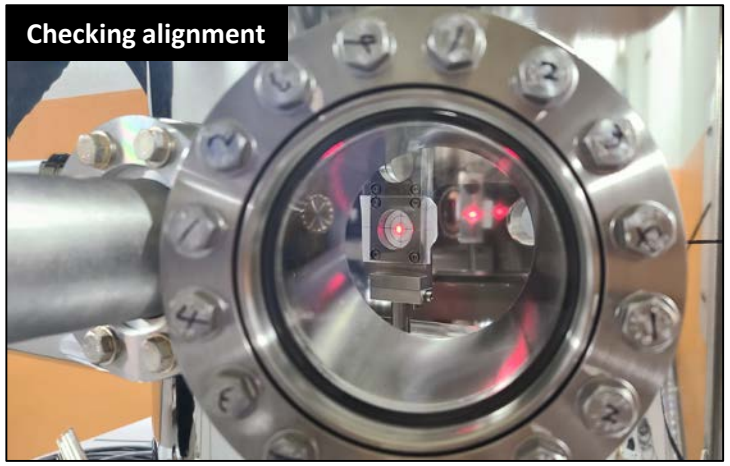
Carbon target

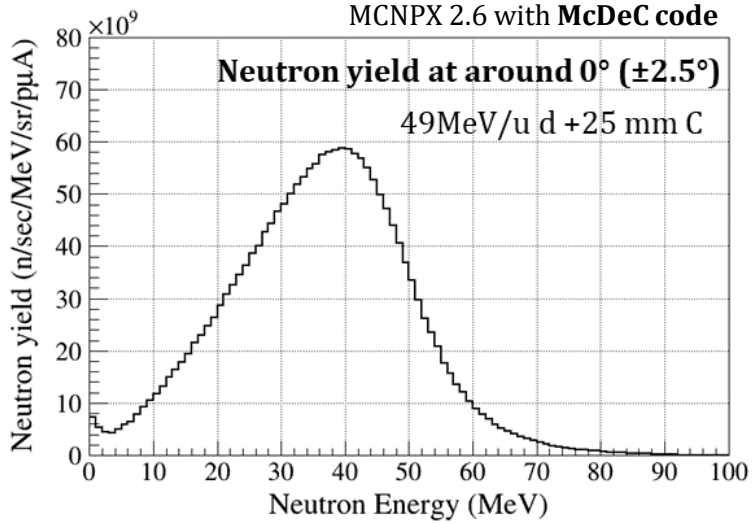
white neutrons







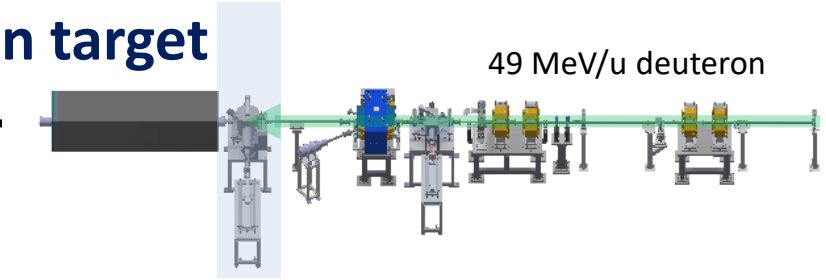




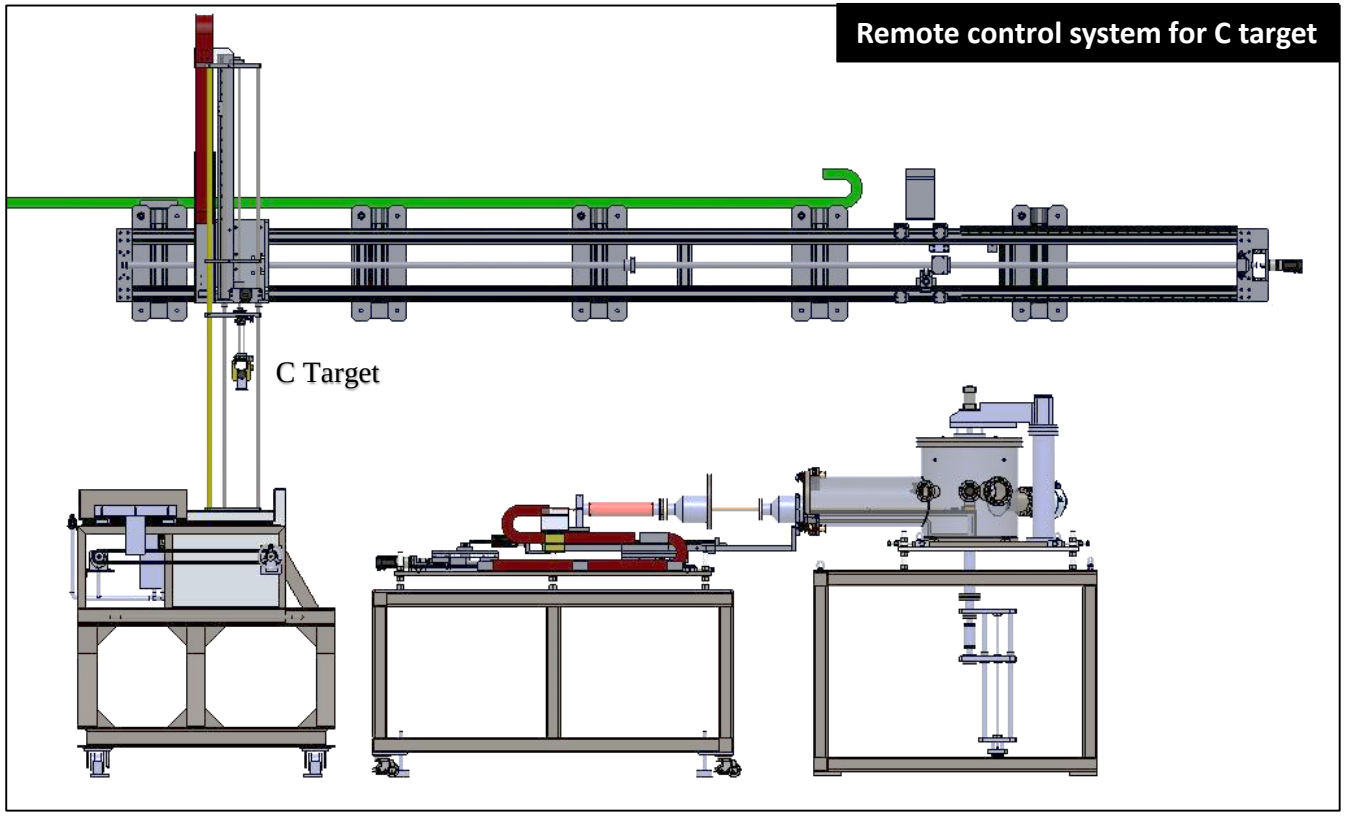
Neutron intensity at the end of the collimator
≃ 10^8 neutrons/cm^2/sec for 10 pμA

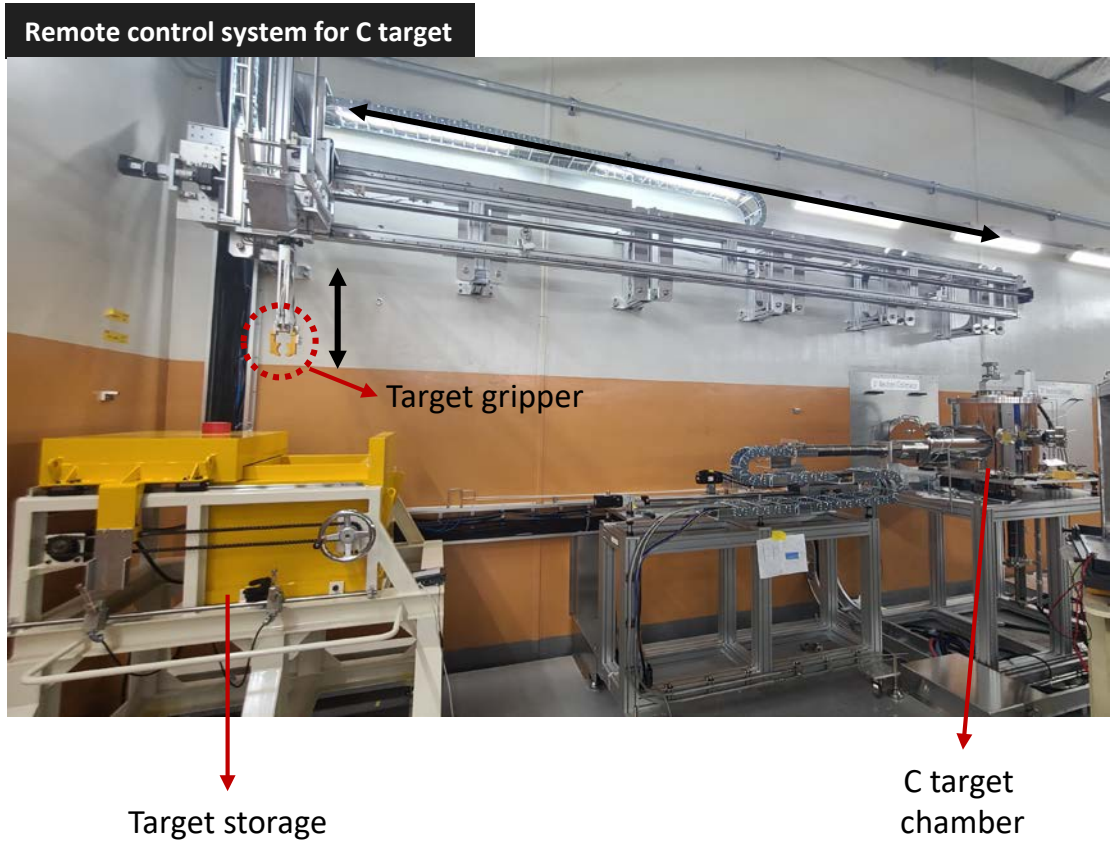
white neutrons

Carbon target



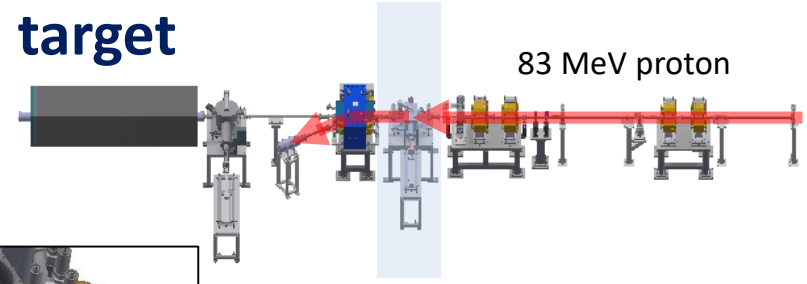
49 MeV/u deuteron

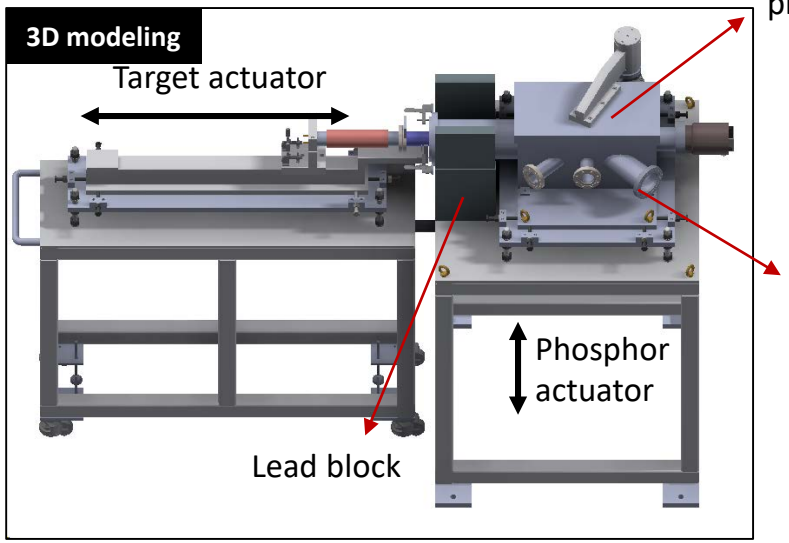


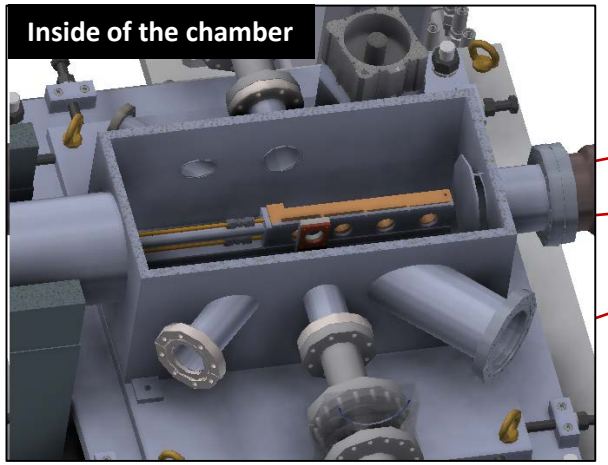


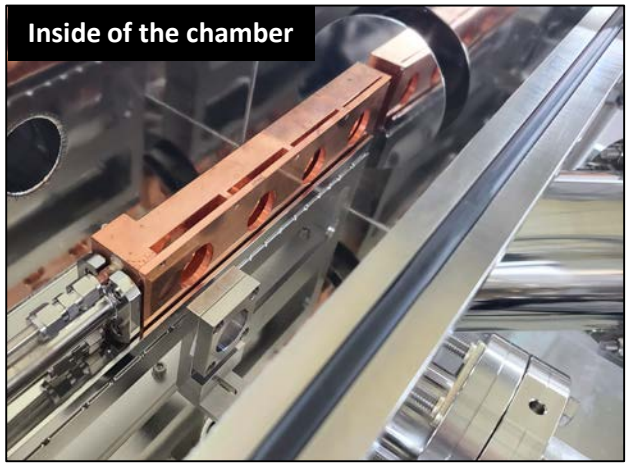
Lithium target

Monoenergetic neutrons

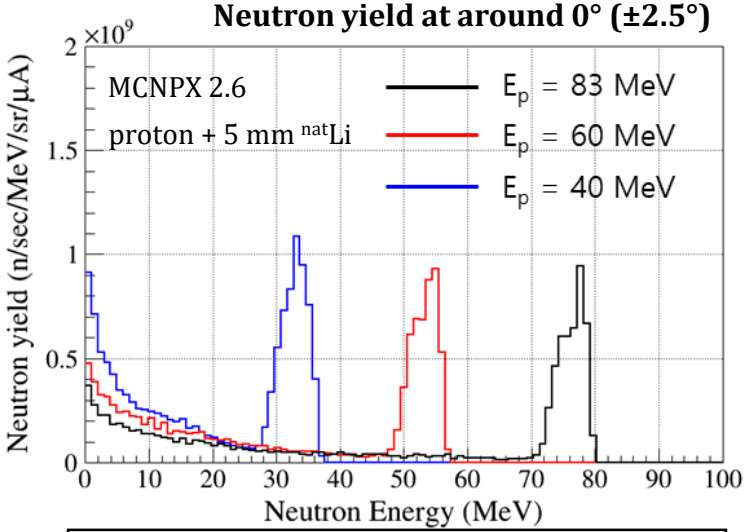








Neutron yield at around 0° (±2.5°)

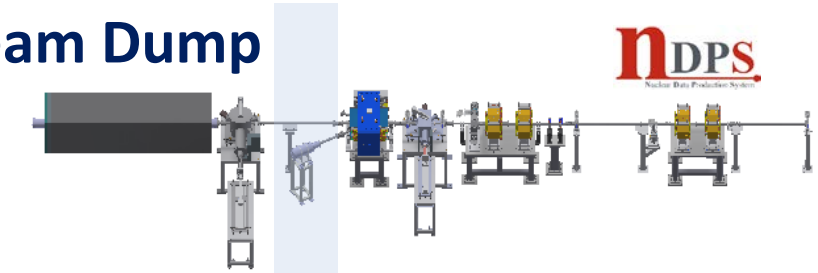


Neutron intensity at the end of the collimator

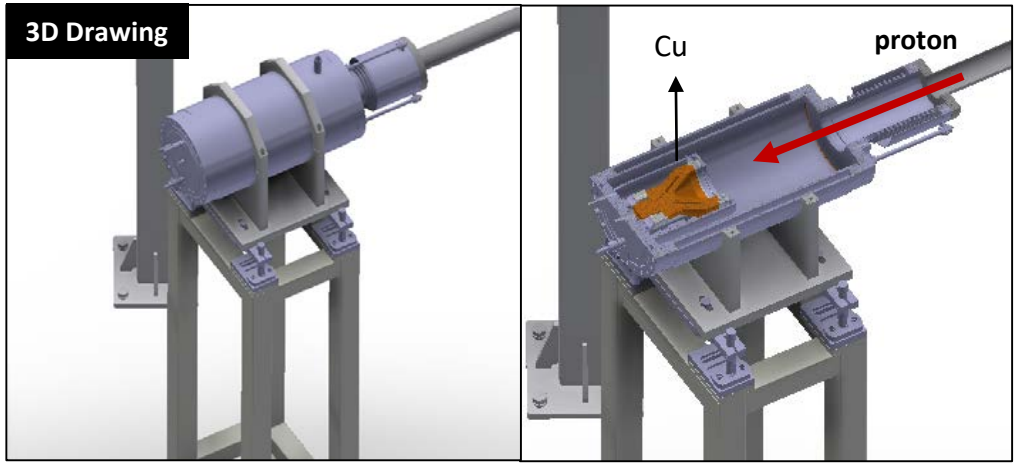
≃ **10^5 neutrons/cm²/sec for 10 pμA**

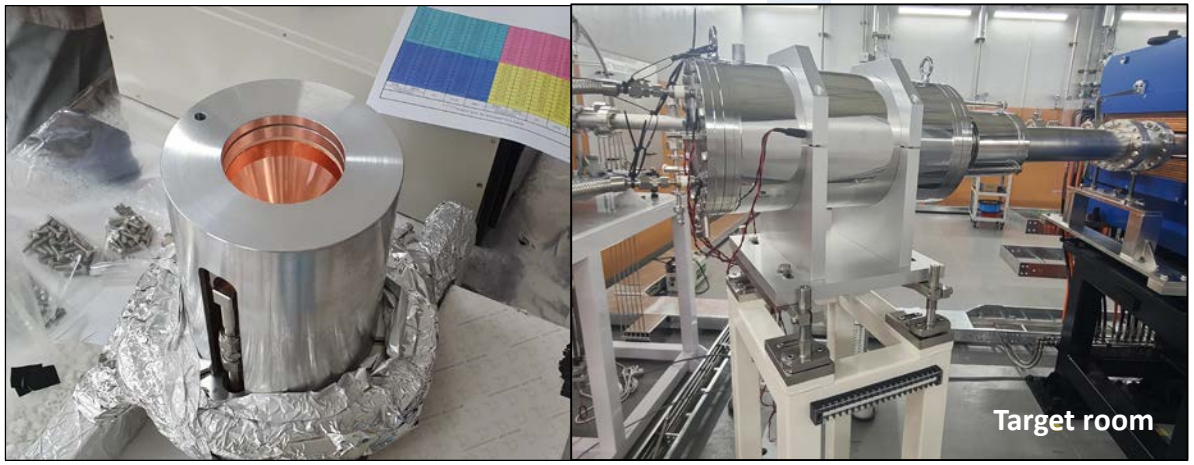
Proton Beam Dump

n

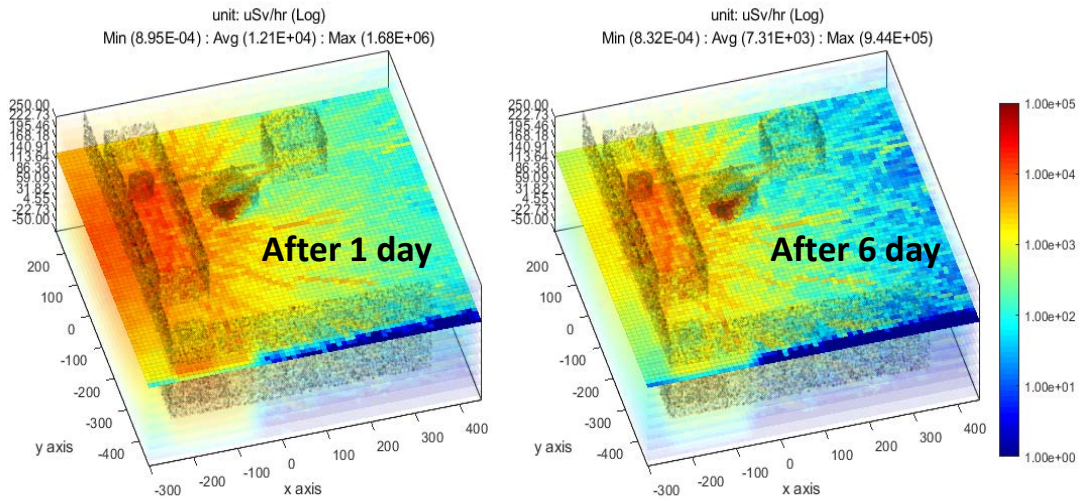


3D Drawing





Radiation analysis



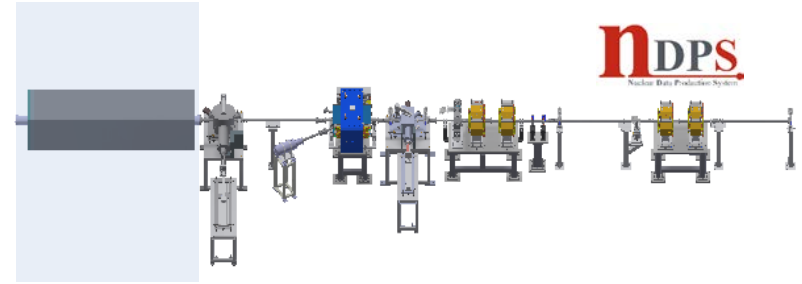
Simulation result from J. C. Kim (IBS)

Design and photo of lead shield structure

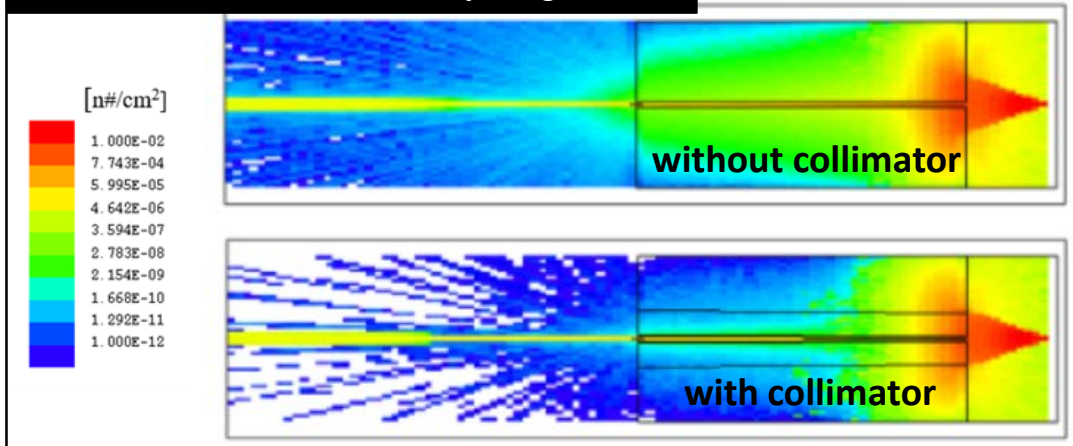
J. C. Kim (IBS)

Neutron Collimator

n



Neutron distribution simulated by using MCNPX



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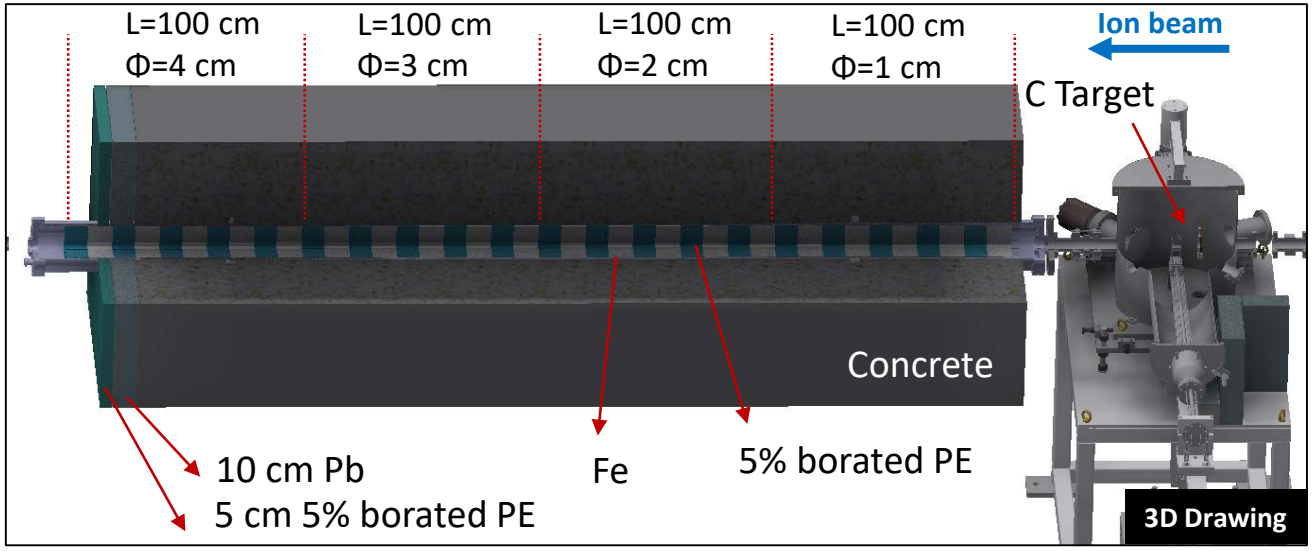
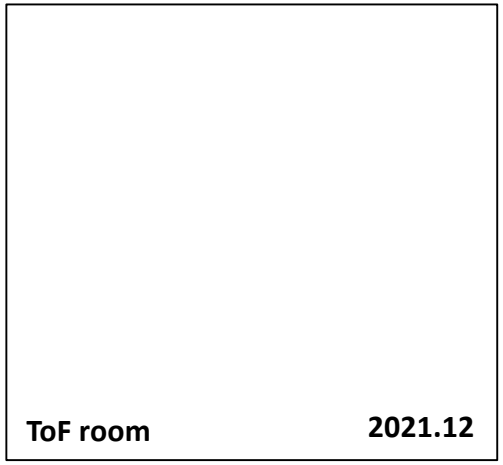
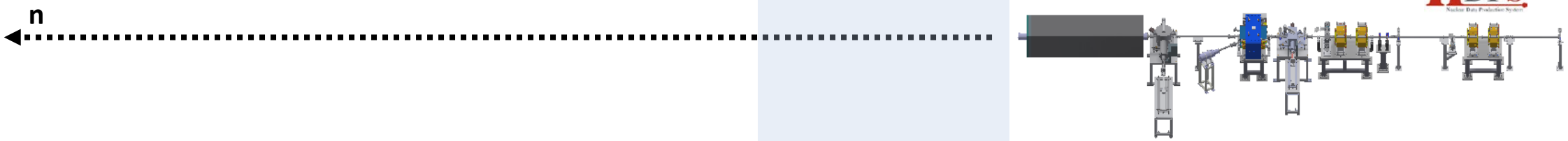
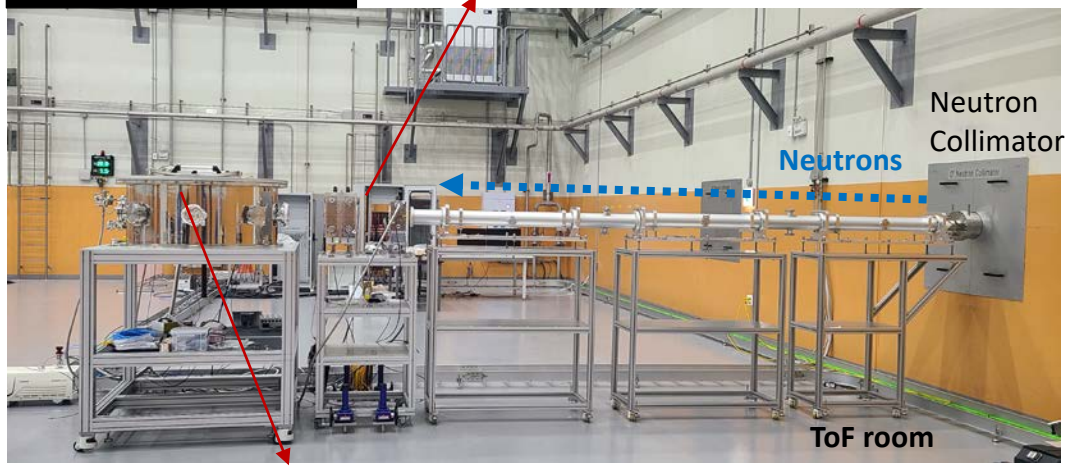


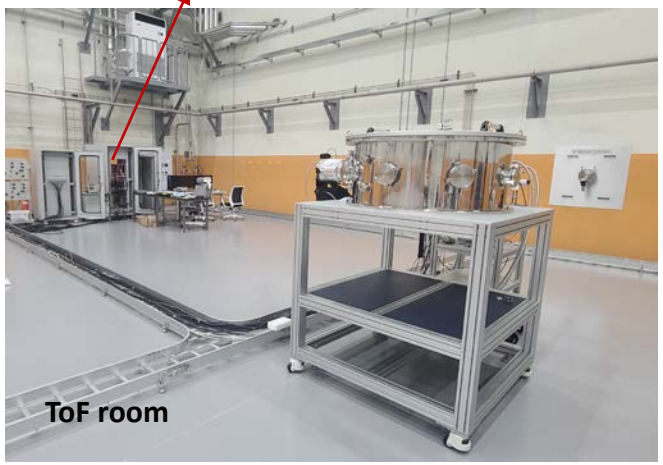


Detector

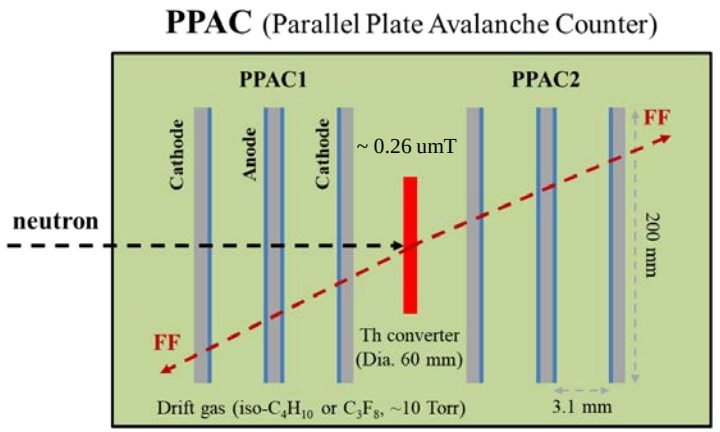


Detectors in ToF room

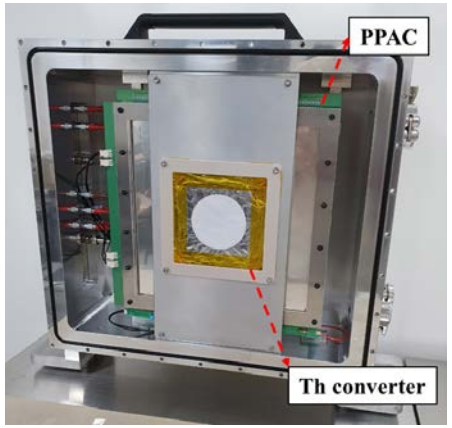




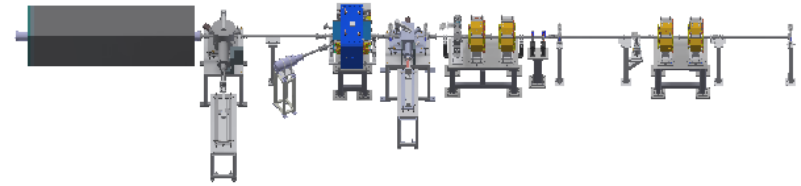
2'' EJ-301 liquid scintillator



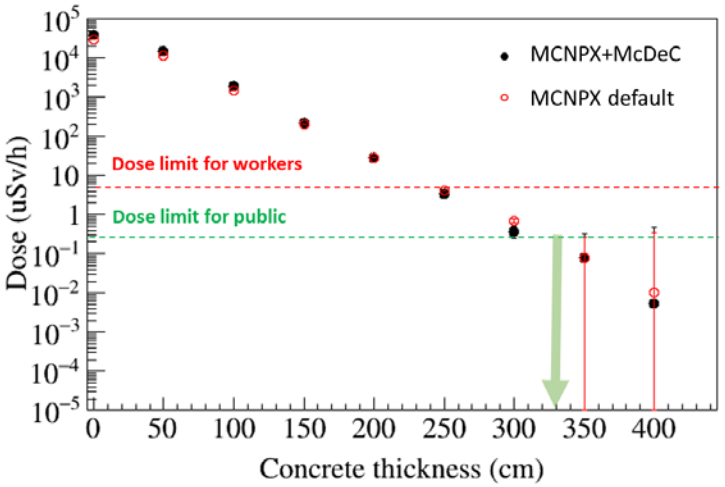
From D. Moon (SKKU)



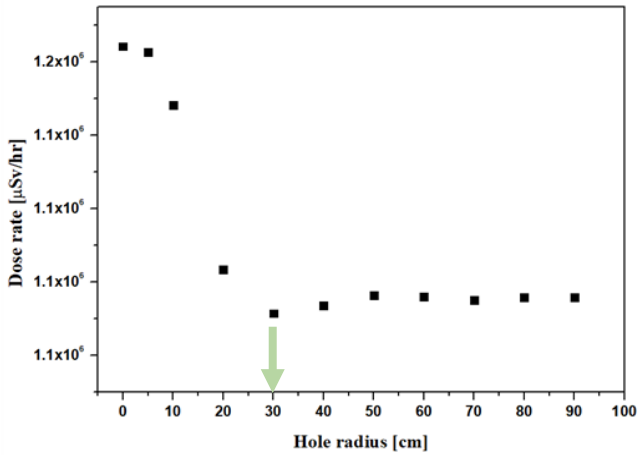
Neutron Beam Dump



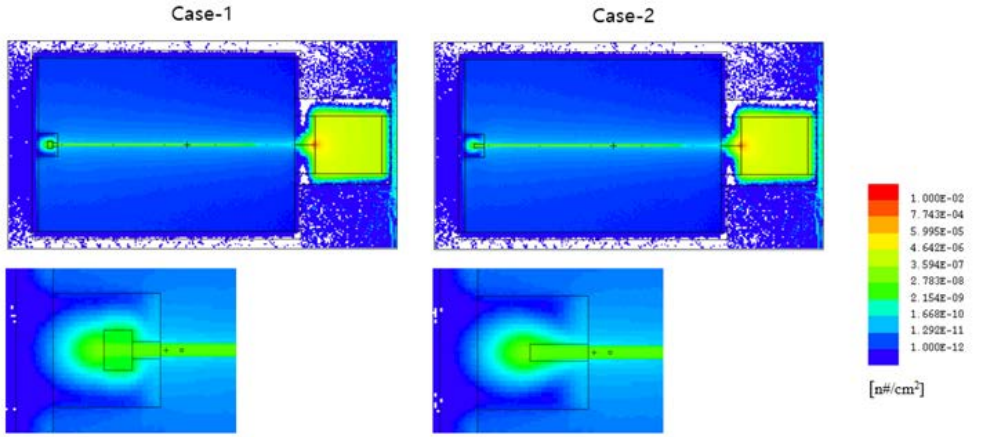
Dose calculation with the concrete thickness change



Dose calculation with the different hole radius



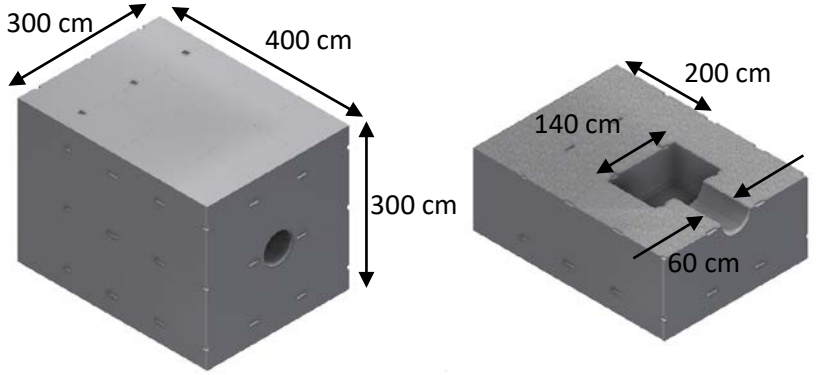
MCNP simulation with the different beam dump structure



※ Scattered neutrons: case 1 < case 2

- Concrete thickness = 330 cm
  - Beam dump = 200 cm
  - Wall thickness behind the dump 130 cm
- Hole radius = 30 cm
- Dump structure → case 1

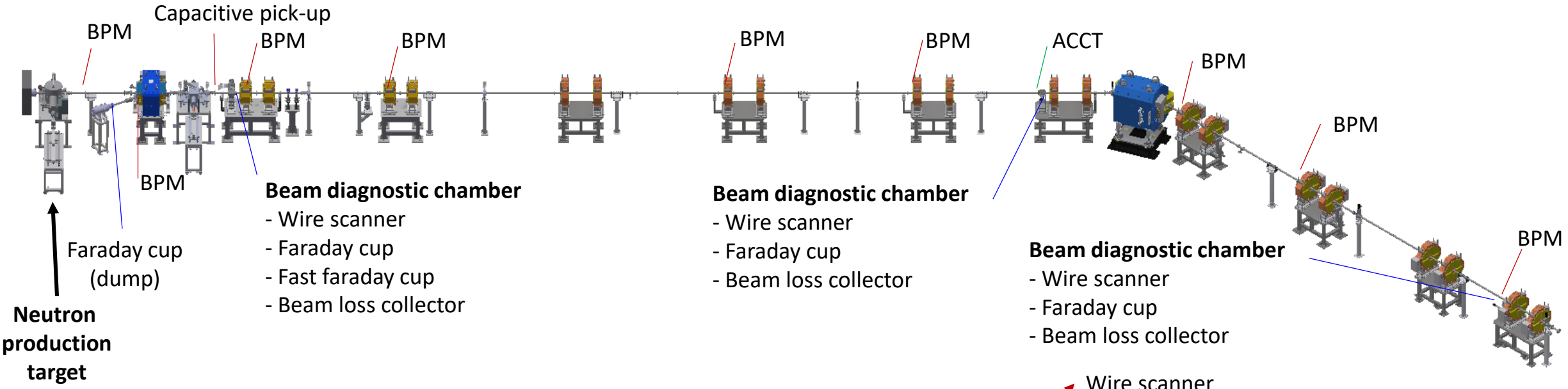
3D Drawing

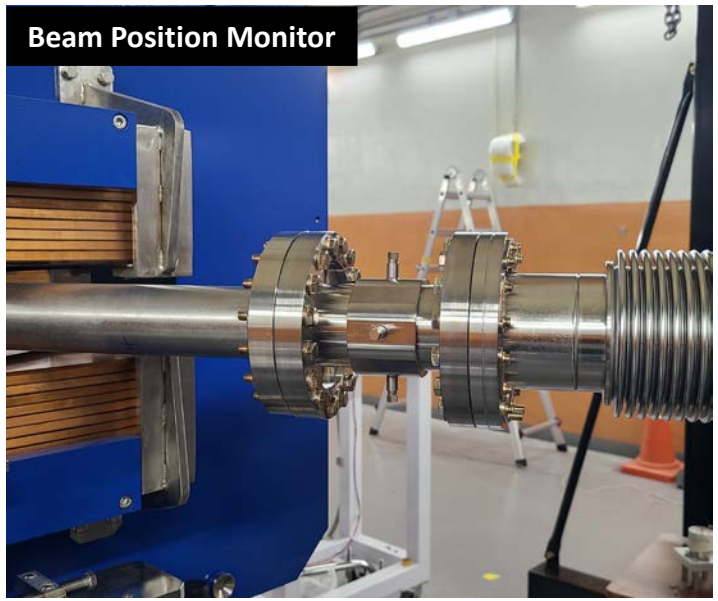


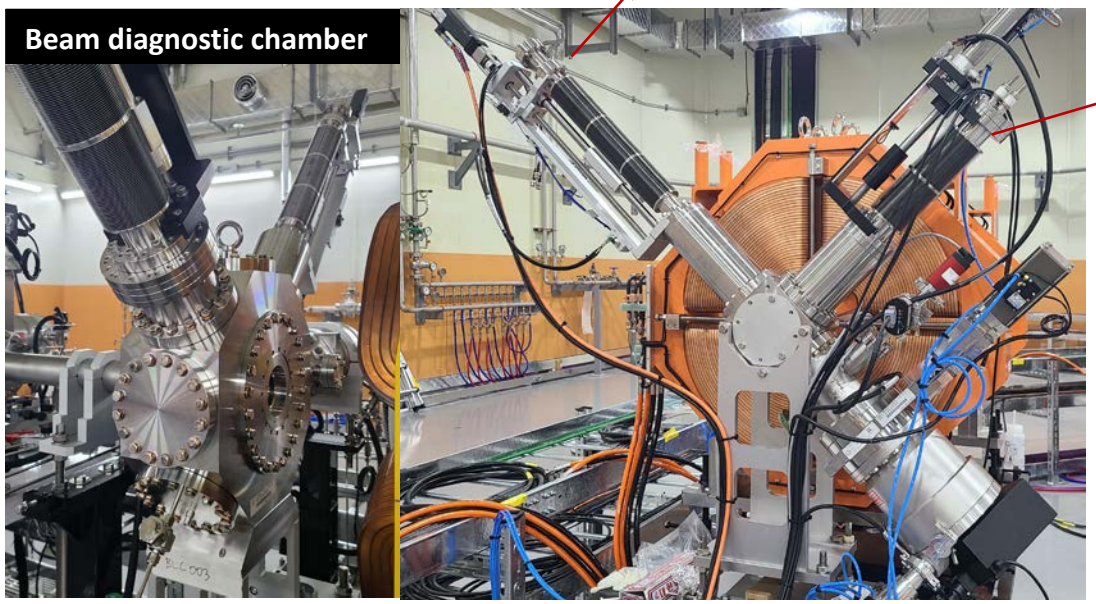
Photo

Simulation results from S. C. Yang (KAERI)

Beam diagnostics

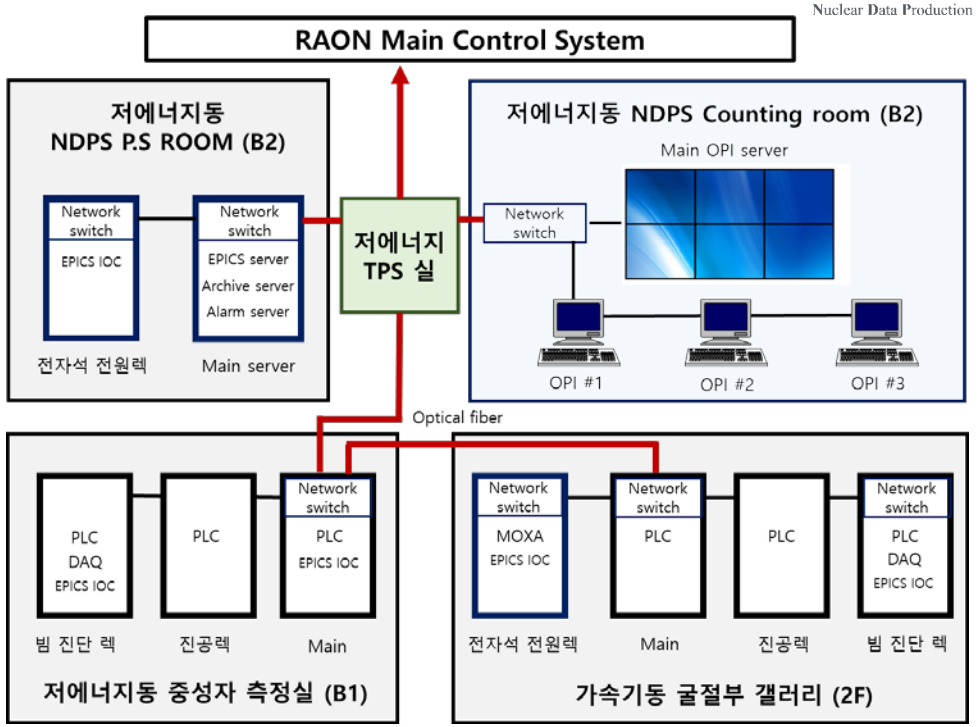


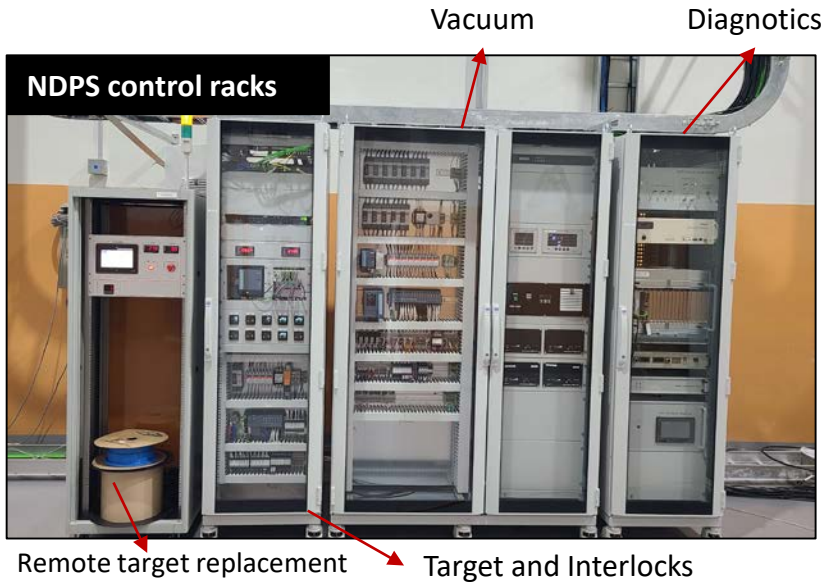


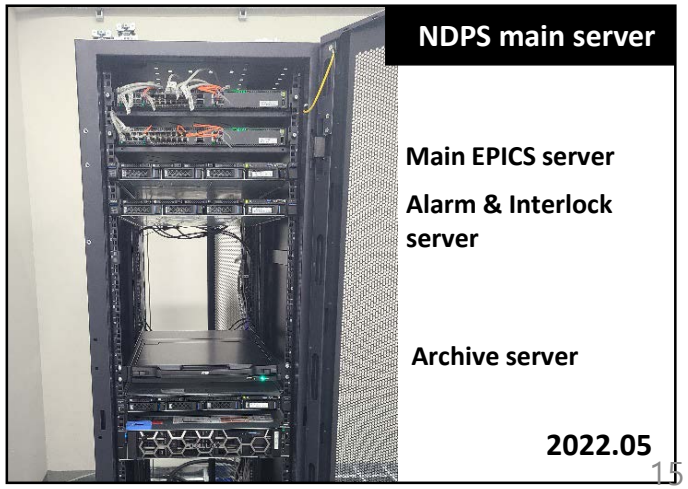


Control system

- Remote control system
  for target, diagnotics, vacuum, and magnet control
- Programmable Logic Controllers (PLC) and
  Experimental Physics and Industrial Control System (EPICS) based
- Developments of the system was completed in 2022.







Utility (NDPS)

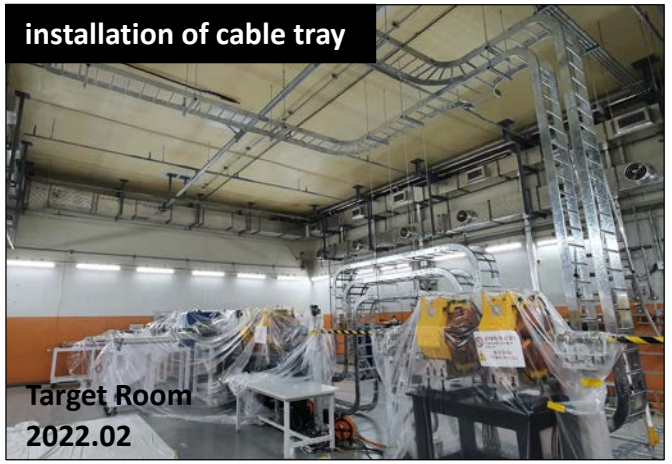
Installation of gas storage

Outside of the building
2021.11

Plumbing of gas pipes for the detectors

ToF room
2022.01

installation of cable tray

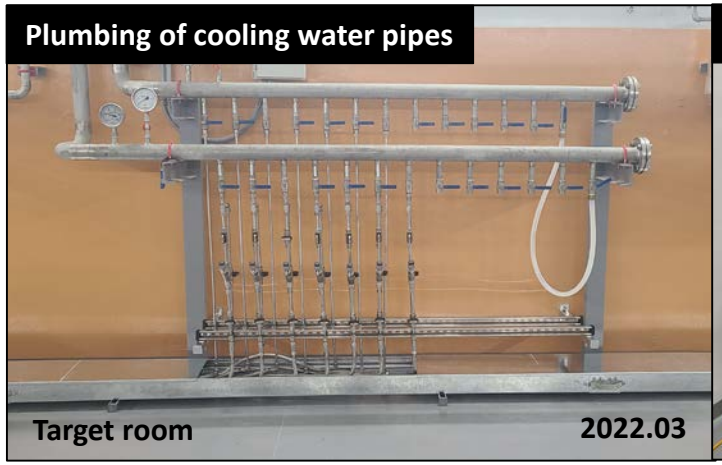


Target Room
2022.02

Cabling for magnet power supply

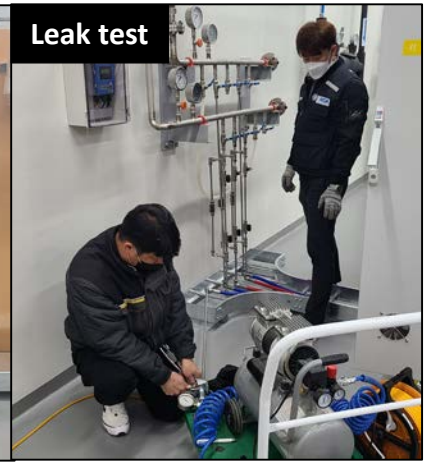
ToF Room
2022.02

Plumbing of cooling water pipes

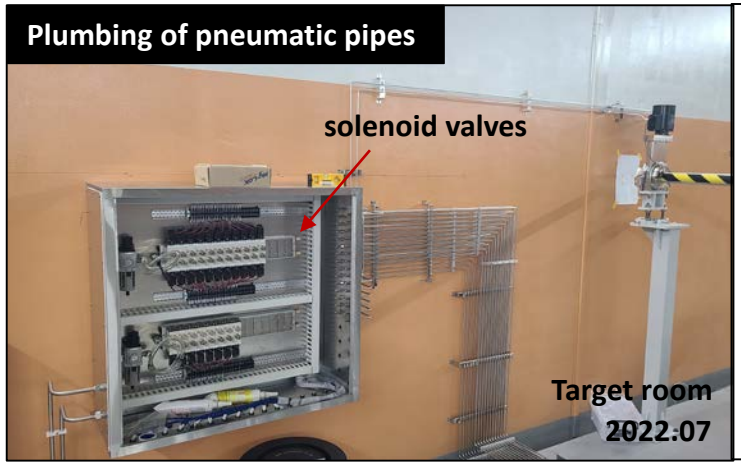


Target room 2022.03

Leak test



Plumbing of pneumatic pipes



Target room
2022.07

Summary

- Main devices of NDPS were assembled and installed at the end of December 2021.
- Main devices of SCL3-NDPS beam line were assembled and installed at the end of December 2022.
- Remote control system for C target and target storage box was installed at the end of December of 2022.
- Development for control system were completed at the end of December of 2022.
- **Integral test and preparation of beam commissioning will be performed in 2023/2024.**
- **Beam commissioning is planned with proton beam or Ion beam(^{16}O and ^{40}Ar) in 2024.**
- **The beam will be provided to users starting from 2024.**

Collaborators

nDPS Nuclear Data Production System

Korea Atomic Energy Research Institute

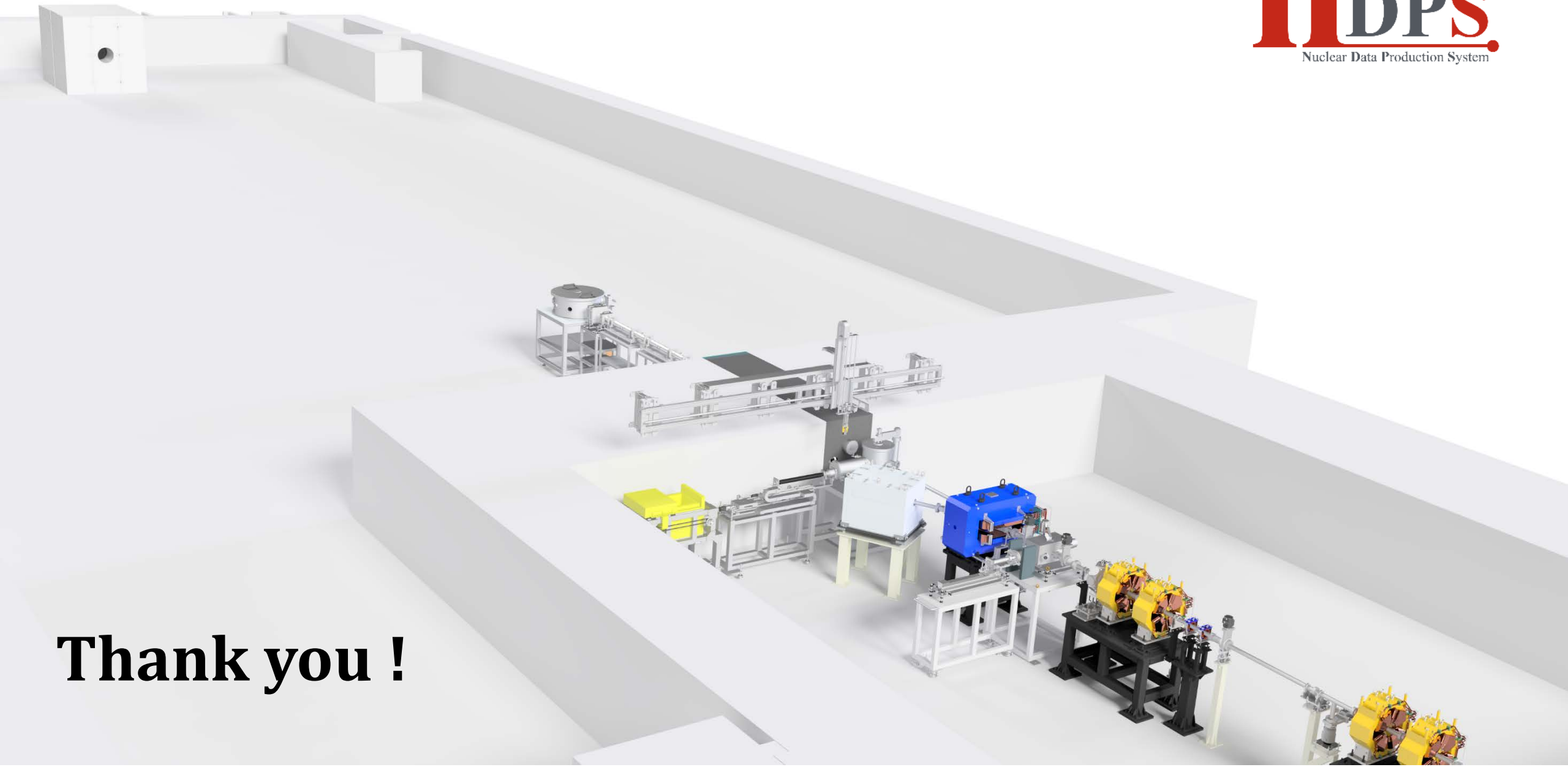
SUNG KYUN KWAN UNIVERSITY

UNIST

CENS

Collaboration are always welcome!!

nDPS
Nuclear Data Production System



Thank you !