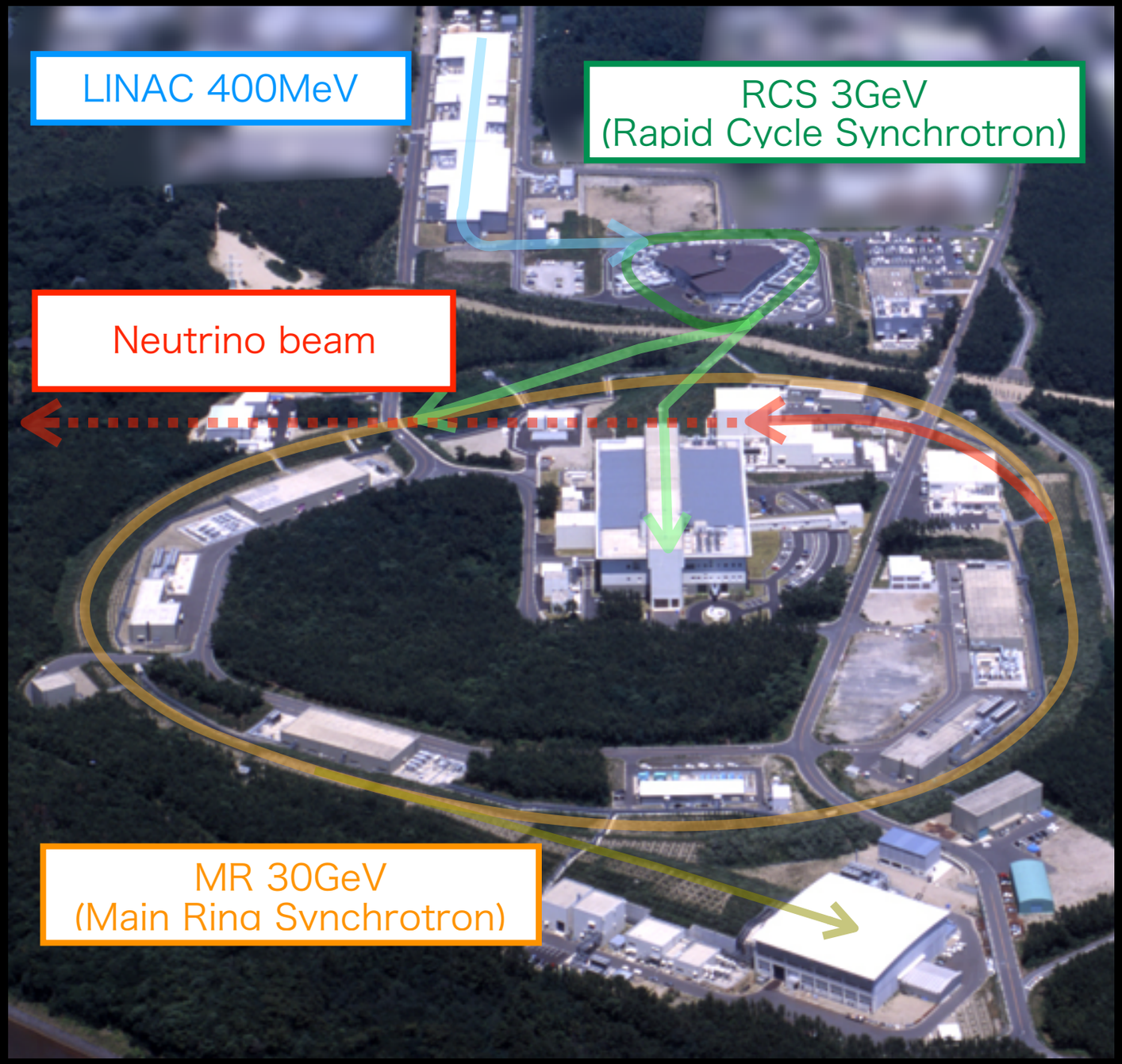
Accelerator/beam-line collaboration — Current & Future cooperation on engineering in J-PARC neutrino beam-line —

KEK/J-PARC

J-PARC: Proton driver

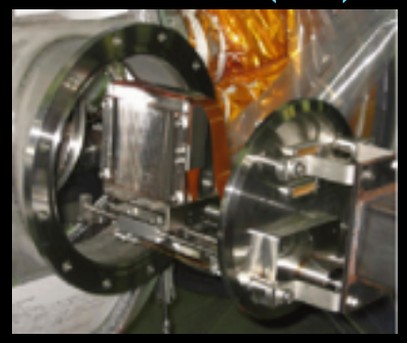
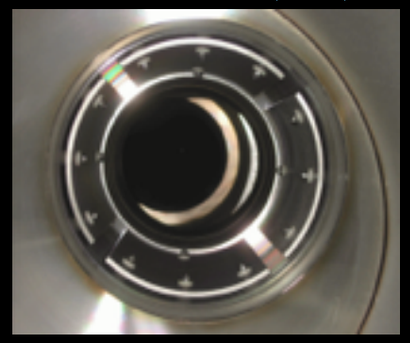
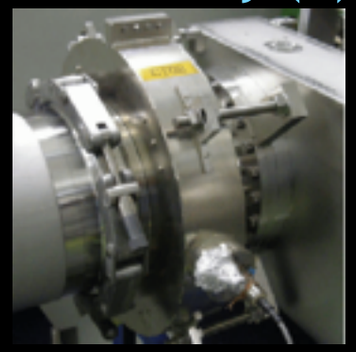
- Neutrino beam is produced with 30GeV protons from MR.
  - Fast-extraction
- Proton intensity of J-PARC MR determine the neutrino flux.
  - Original design values:
    - Beam power: 750 [kW]
    - Intensity: 3.3×10^{14} [p/pulse]
    - Repetition cycle: 2.1[s]
  - Achieved performance:
    - Beam power: 470 [kW]
    - Intensity: 2.4×10^{14} [p/pulse]
    - Repetition cycle: 2.48[s]



J-PARC ν beam line :Primary-line

Beam monitors are install along the proton beam transport

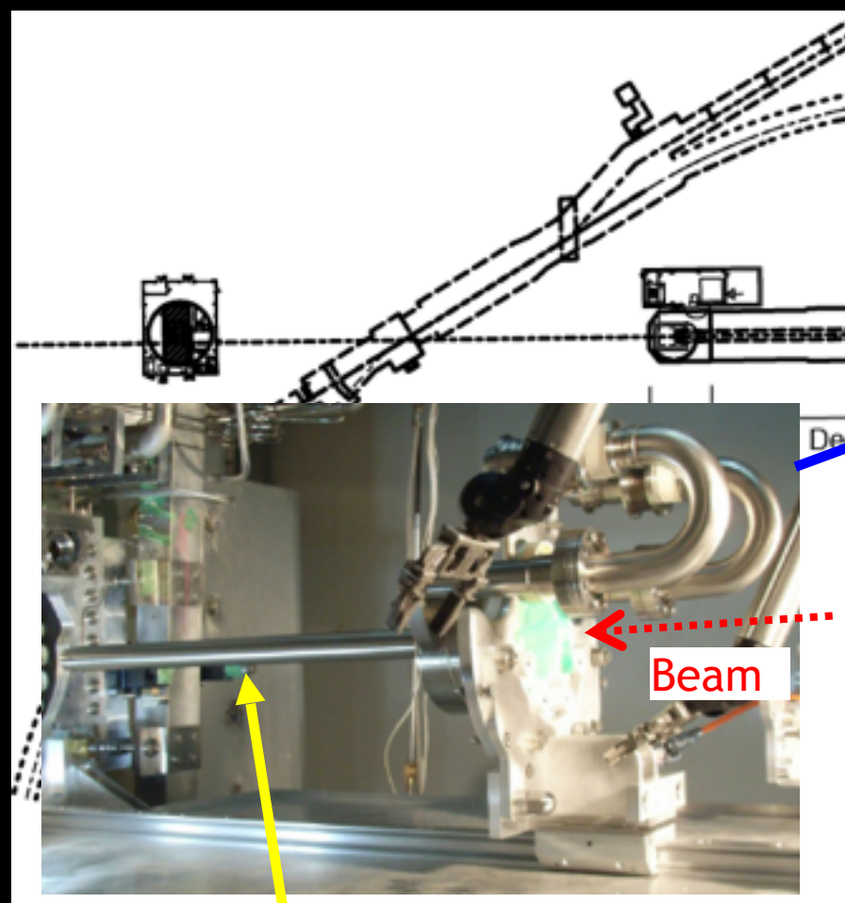
Profile (19) Position (21) Intensity (5) Beam loss (50)

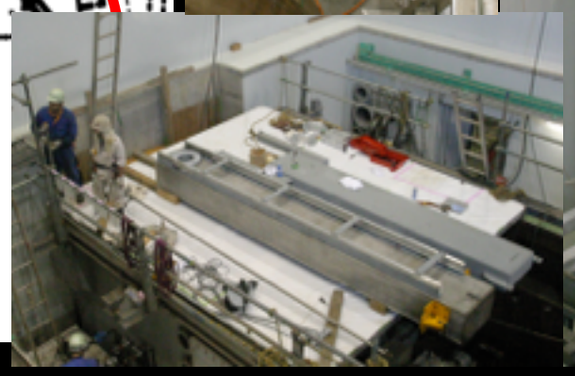

Primary proton transport line


Super-conducting combined-function magnets

Normal-conducting magnets





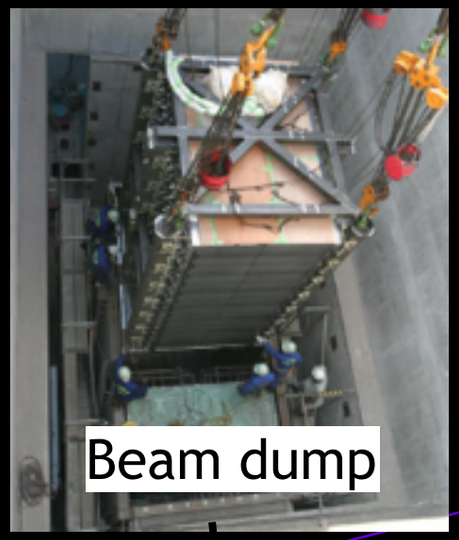



Target :graphite rod
ϕ26mm,L=900mm

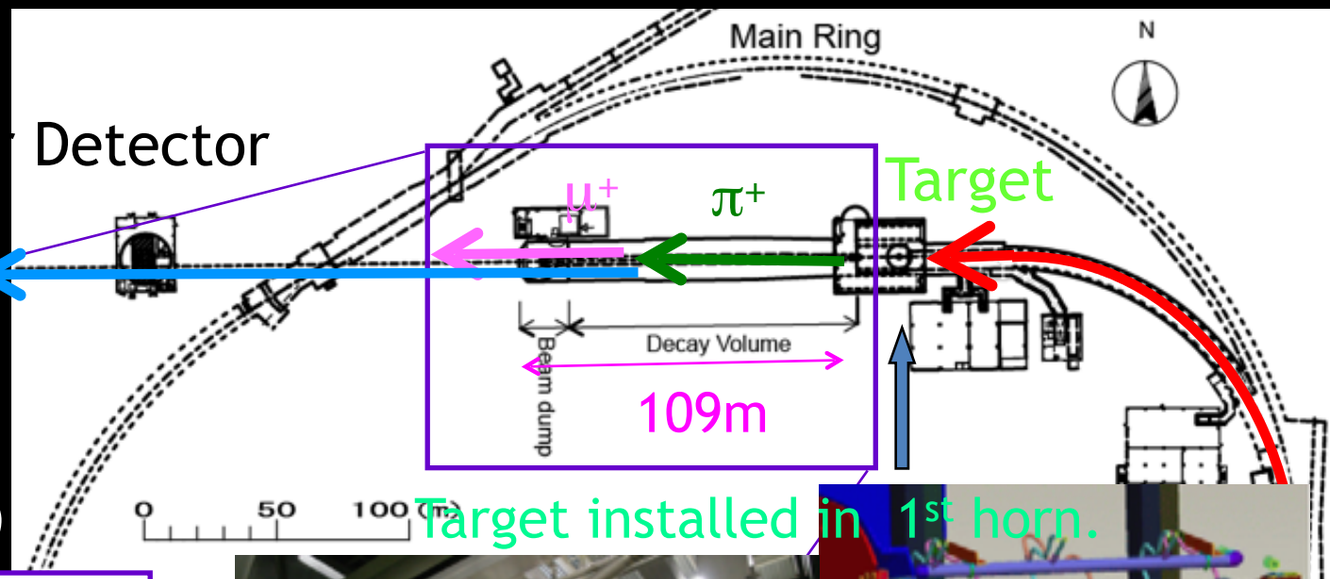
Optical Transition Radiation (OTR) Profile monitor

Vacuum chamber and structure for most downstream beam monitors

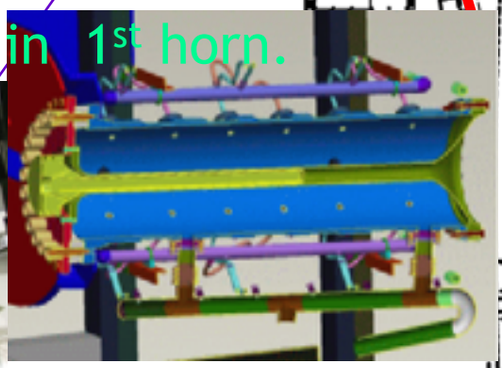
J-PARC ν beam line: secondary line

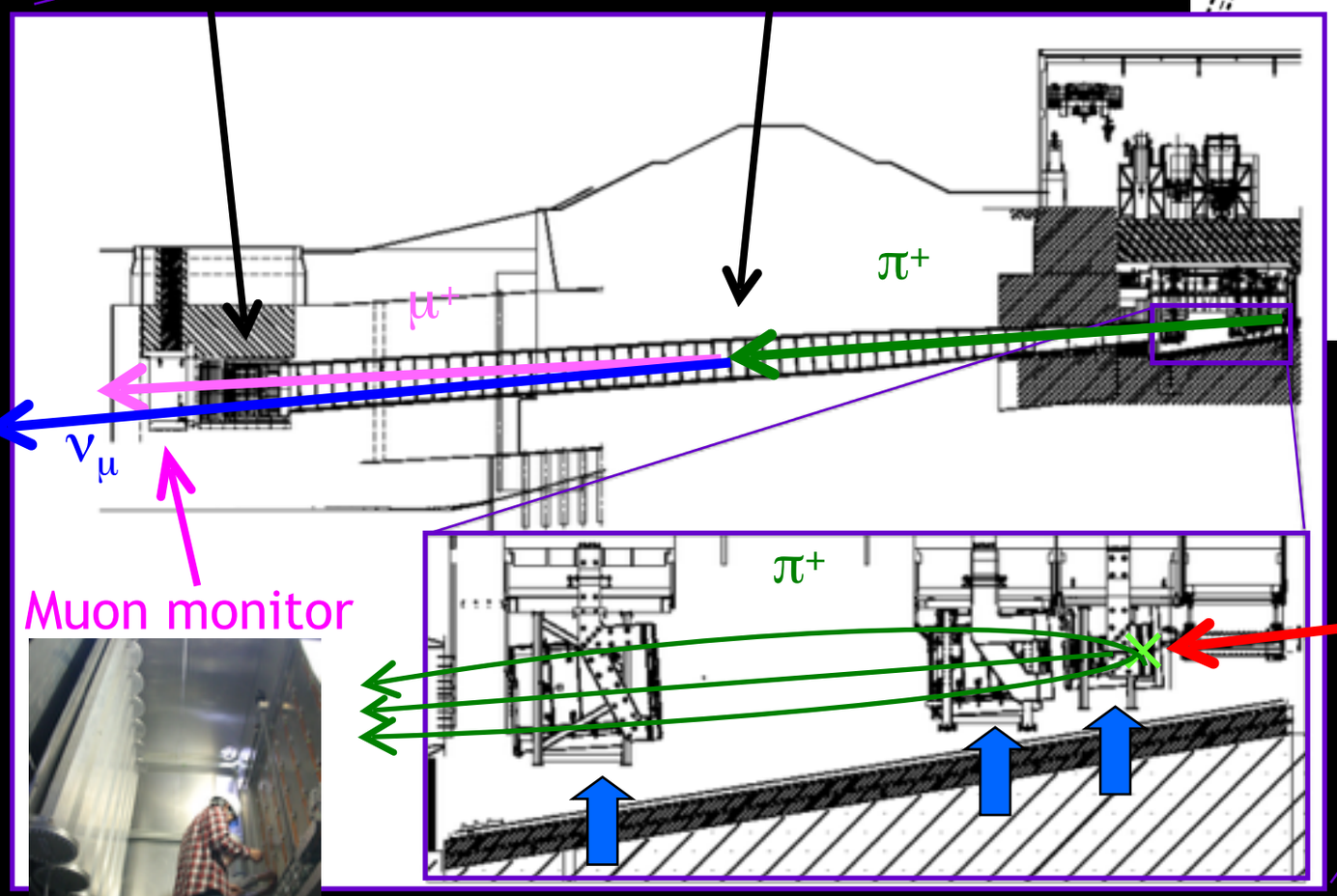


Decay volume (He gas filled)



Target installed in 1st horn.

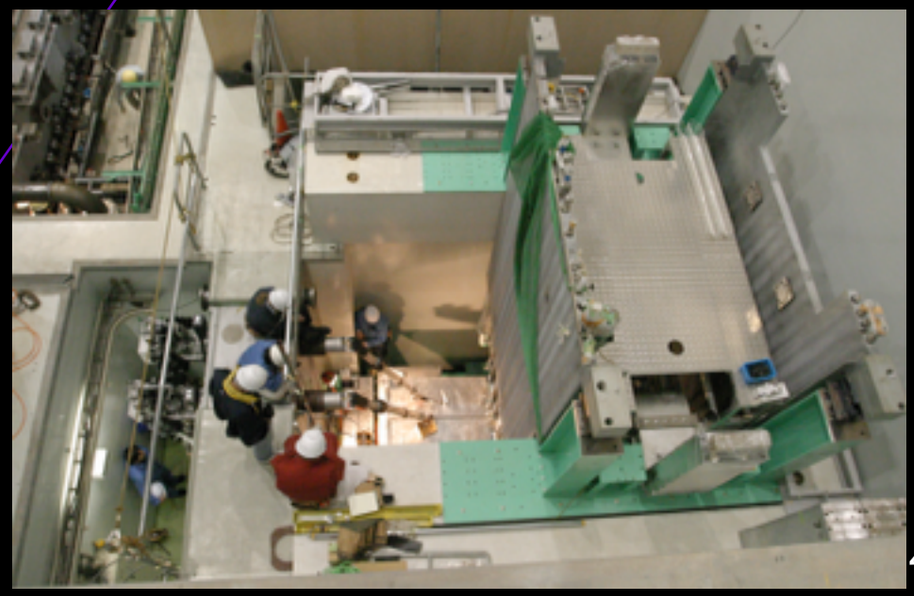




Muon monitor

Pions are focused by 3 electromagnetic Horns.

Target/Horn Remote Maintenance area.

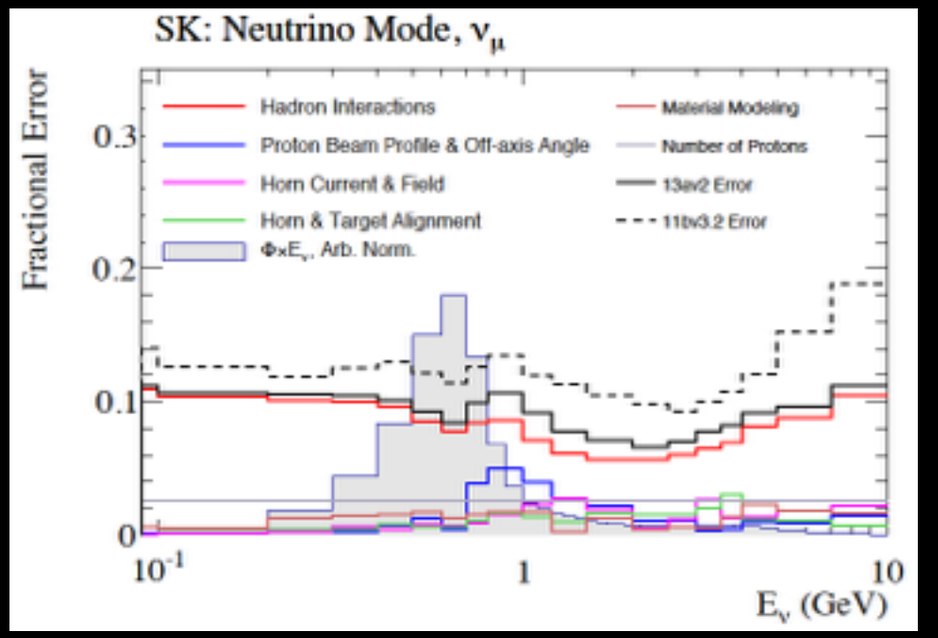


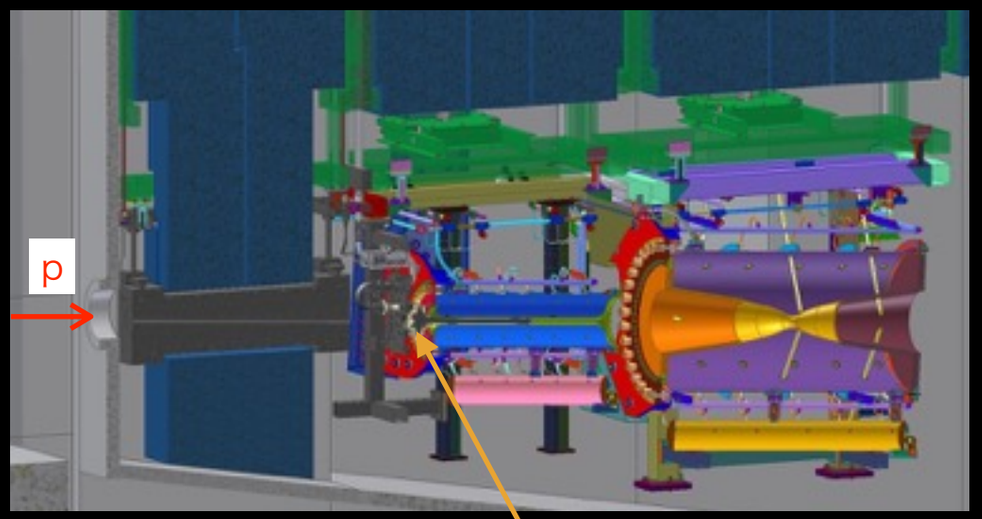
Canadian contribution for T2K

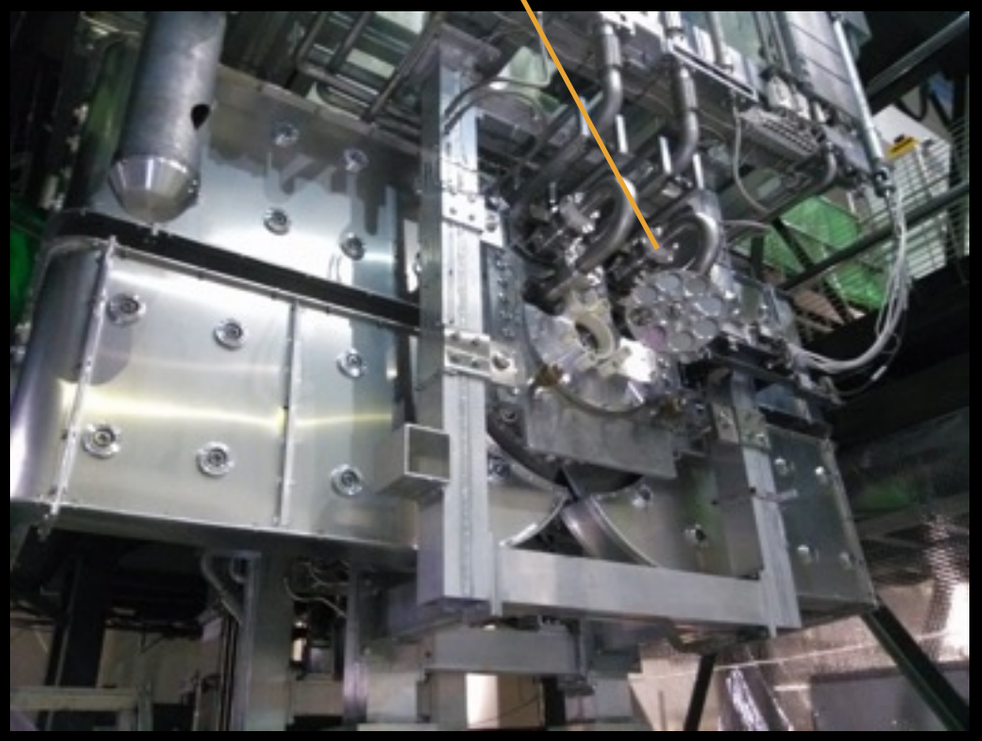
- Founding member of T2K collaboration
  - ~2nd largest effort in Canada after ATLAS/LHC
  - Flagship project in 2017-22 NSERC Long Range Plan for subatomic physics
  - 1 of 3 international projects with highest priority in 2015-20 TRIUMF Five Year Plan
  - complements experiments at SNOLAB
- Play very important roles
  - Proton beam profile monitor at the production target
  - Design, Construction and Maintenance of beam-line equipment
  - Beam data analysis for Neutrino flux estimation
  - Core sub-directors of Off-axis Near Detector
    - Active interaction-target detector (FGD)
    - TPC
    - Slow control-system, Database, Network design, …
    - Near detector Analysis to predict the ν-interaction at SK
  - Far Detector (SK) analysis (Precise BG estimation, New event detection algorithm)
  - Computing for data/information sharing, MC production

OTR

- OTR plays crucial role in beam-line operation.
  - OTR measurement is essential to reduce the uncertainty of neutrino flux.
  - OTR is installed at flame of 1st horn.
    When 1st horn is replaced, OTR is also to be replaced with new one.
  - Spears production, Initial setup is necessary.
  - OTR optical system should be evacuated when TS-vessel is opened for maintenance.
    The expert work is necessary to re-install optical system.
  - Improvement of OTR disk rotation system is necessary because current system met the trouble. It requires the expertise of mechanical engineering under high radiation environment.
- Canadian contribution on OTR is strongly desired.





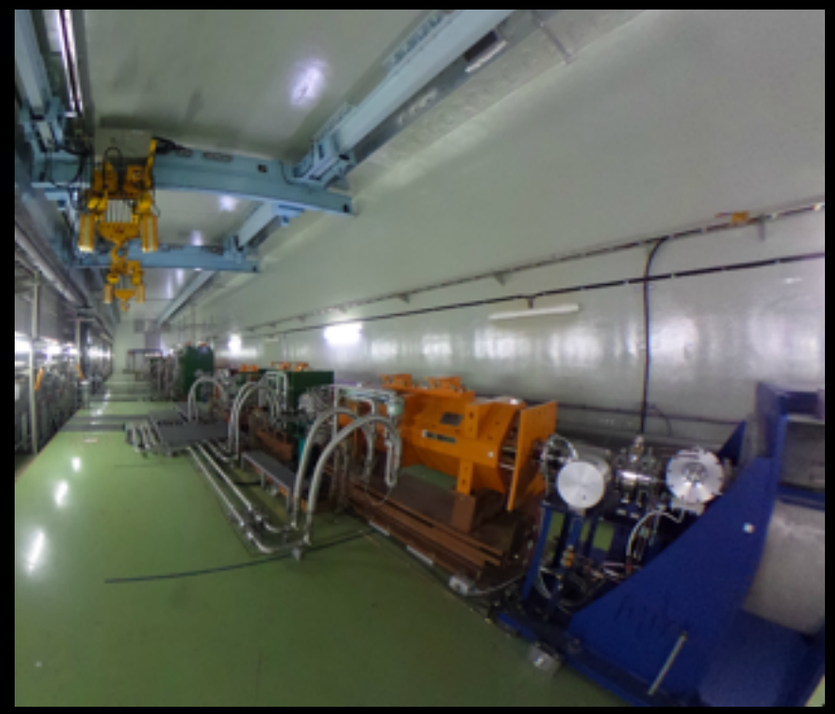


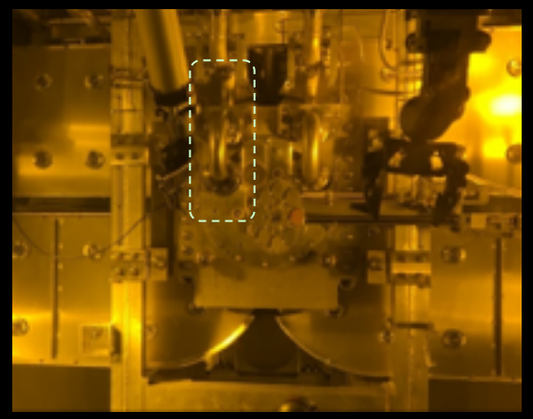
Remote handling

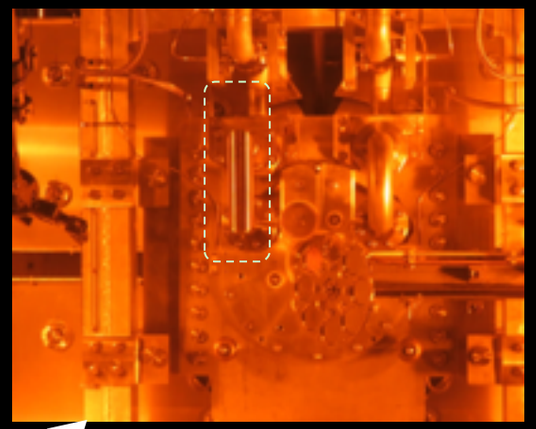
- Development of remote maintenance where it become severe due to 1.3MW beam power upgrade.
  - Final Focusing Section of primary proton transport:
    - Beam monitors at FF section will be highly activated because it is near the target.
  - Upgrade the target cooling system inside TS.
- Lessen learned from Target He trouble in 2015
  - Cause of the trouble should be identified by remote operation
  - The necessity of parts exchange that is not originally designed for remote maintenance can happen.

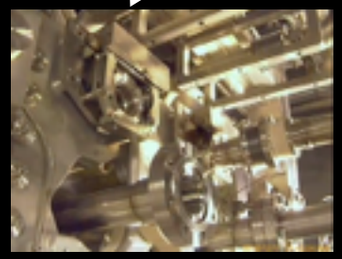
    → It may be necessary to design/construct/operate remote-operation on demand, when unexpected issue happens.

    → Keep the cooperation between the experts of each lab.



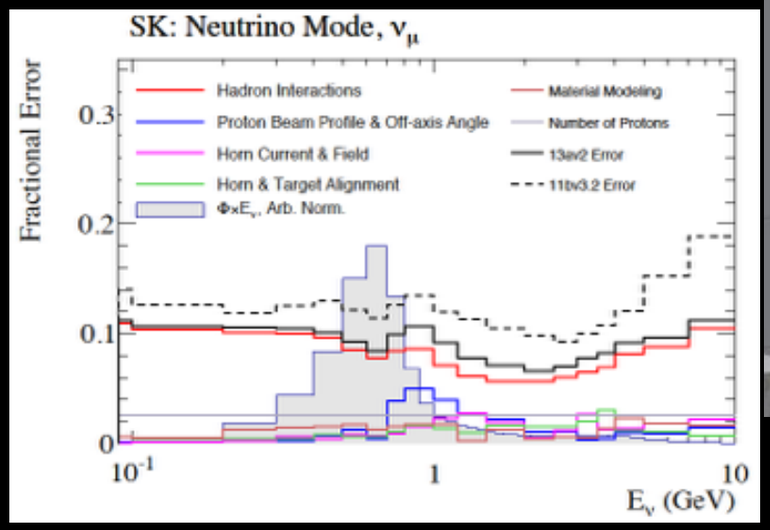


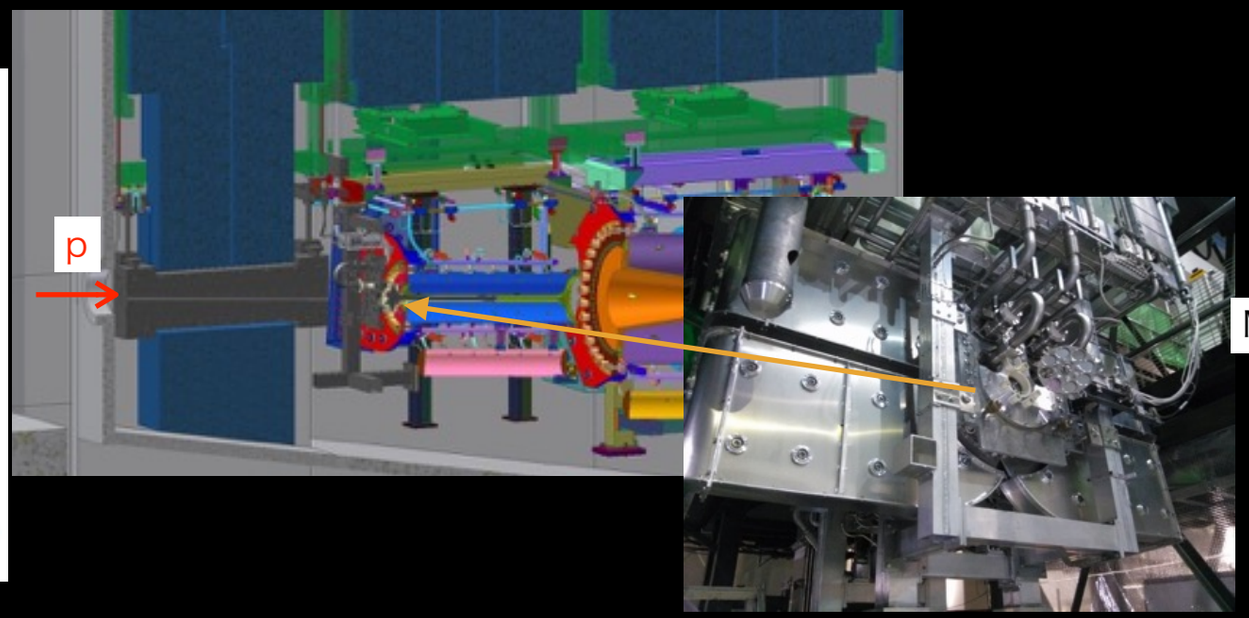




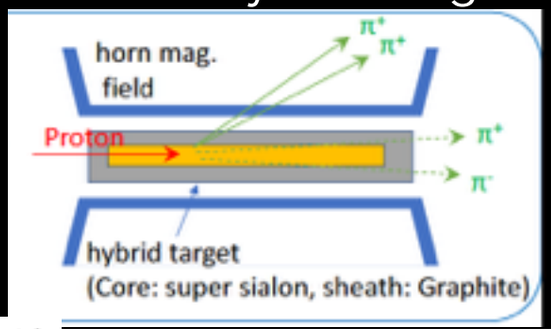
Ideas to improve beam quality.

- Intensity improvement: 750kW → >1.3MW
- Quality of beam:
  - Current dominant uncertainty: Hadron production @ target
    → Analysis improvement of NA61 data, Another NA61 run or other Hadron Production measurement …
  - Sub-leading uncertainty: Proton beam orbit control @ target
    - This is mainly comes from the uncertainty of vertical proton orbit at target.
- If there is new idea to reducing “wrong-sign” component, it may enhance the T2K-II / HK CPV sensitivity.

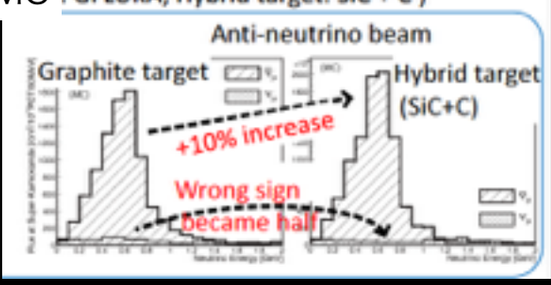




Idea of Hybrid target



MC : GFLUKA, Hybrid target: SiC + C)



Summary

- For the beam-line, the beam monitoring under the high radiation environment and remote handling of highly activated has been built/operated by Canadian contribution/expertise.
  - Those are very crucial part to realize the high-power neutrino beam.
  - The role of those components/efforts will become more and more important according to the beam power upgrade.
- Request to TRIUMF/Canadian communities.
  - Continue the activities of OTR, hadron production studies to improve beam flux prediction.
  - Keep the cooperation on remote maintenance expertise between the exports of each labs.