KEK PF-AR Test Beamline

17–21.Apr.2023

11th Beam Telescopes and Test Beams Workshop @ DESY

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on behalf of ARTBL group
(KEK: Acc. Div., IMSS, IPNS and Univesities: Nagoya, Kobe, Kyoto, Kyushu..)

KEK

12.Jan.2018 from the way to Fudo-Toge

- KEK (高エ研)
  - 60km North-East of Tokyo (1.5 hour by train and bus)
  - IPNS, IMSS, Accelerator, ARL, J-PARC, QUP....
  - Many Accelerators, SuperKEKB, Linac, PF, PF-AR, ATF, J-PARC etc.
  - No Testbeam Facility after shutdown of Proton Synchrotron

PF-AR

- PF-AR (Photon Factory Advanced Ring)
  - Photon Source Facility (High Energy X-ray)
  - former booster (8 GeV) of TRISTAN e^+e^- collider
- Maximum 6.5 GeV, 60 mA, Single Bunch (Run at 6.5 or 5 GeV, 50 mA, Top-up)
- 377m Circumference (1.26 μs or 795 kHz)
- Four Expermental Halls North/East/West/South

PF-AR South Exp. Hall (1)

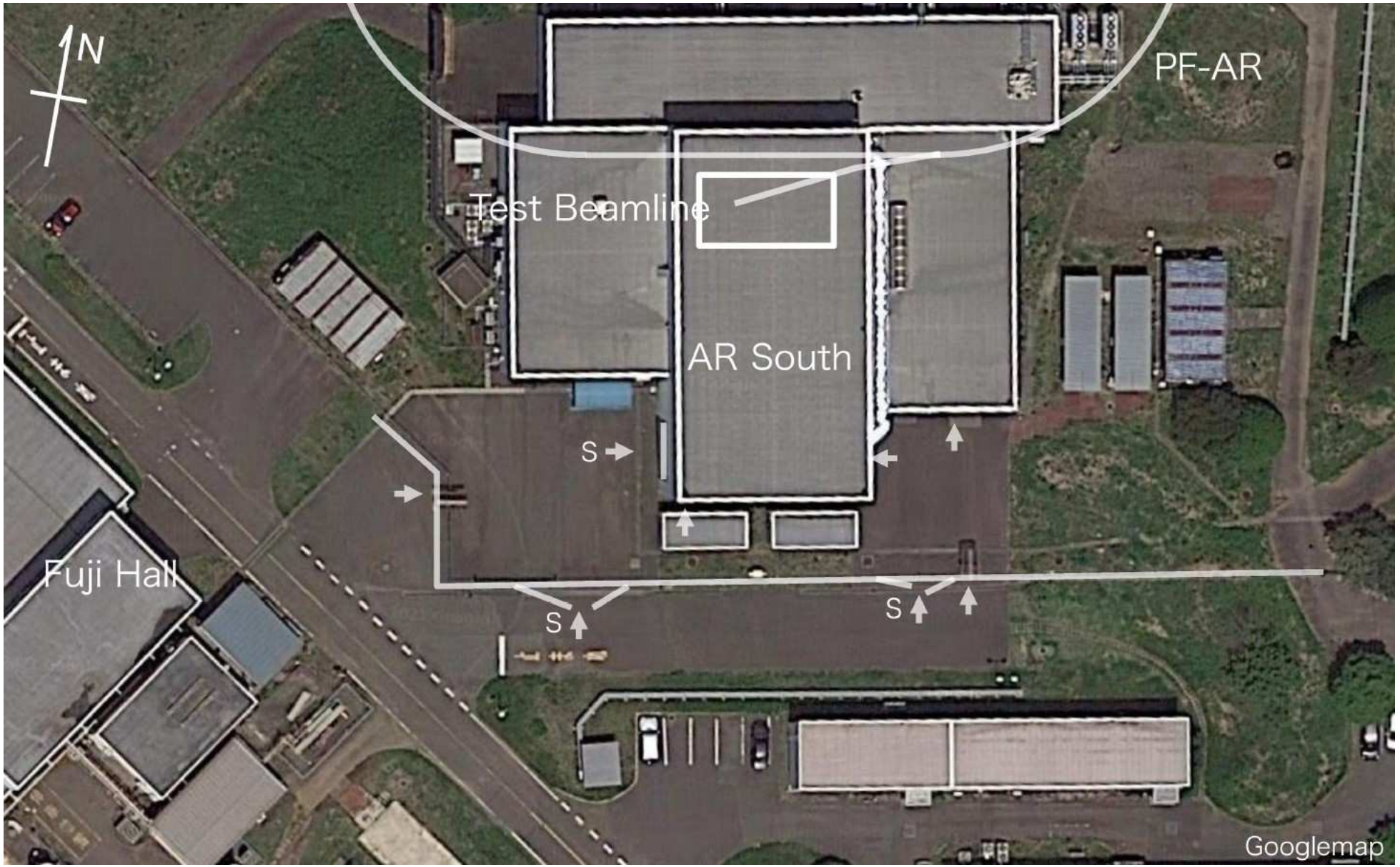
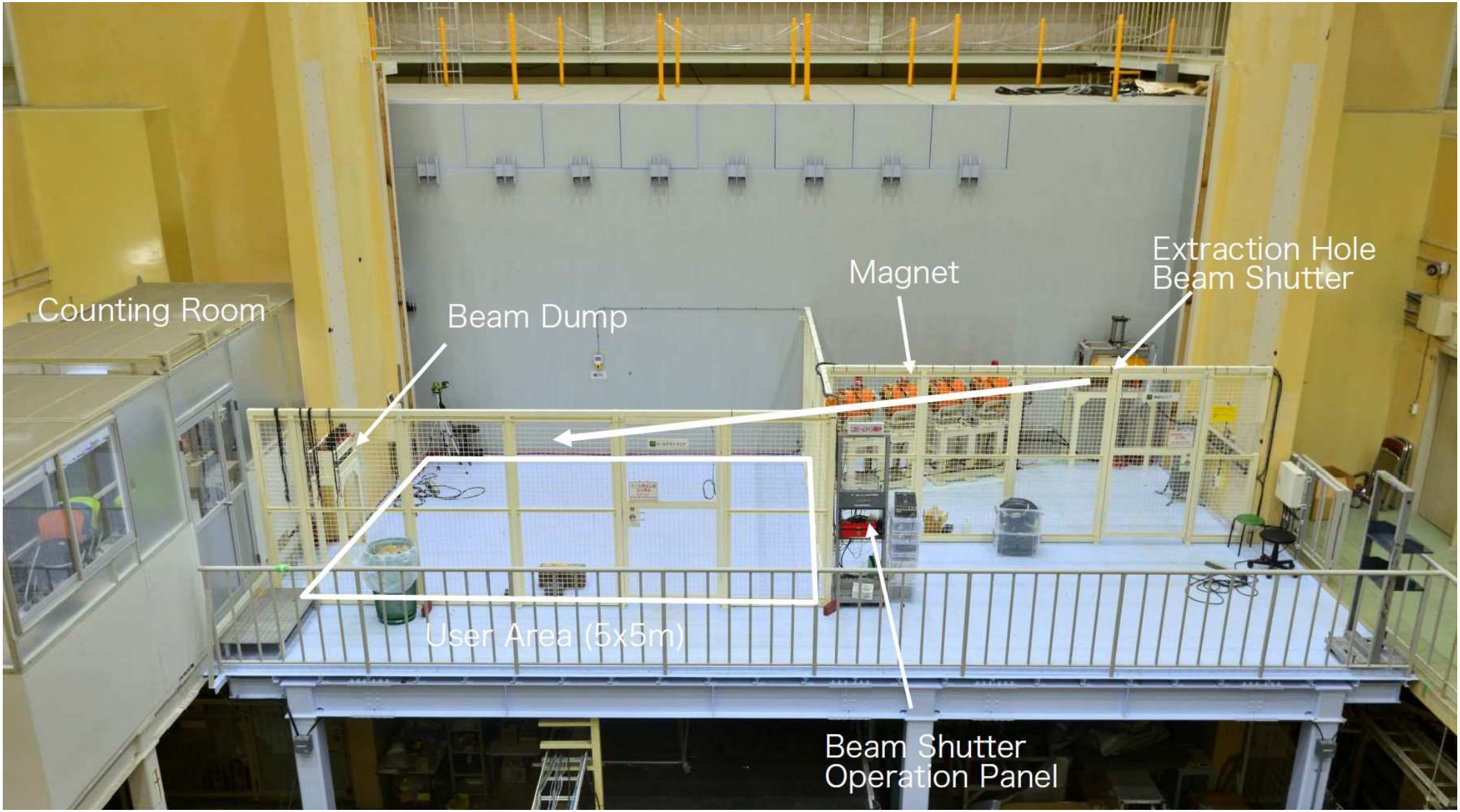


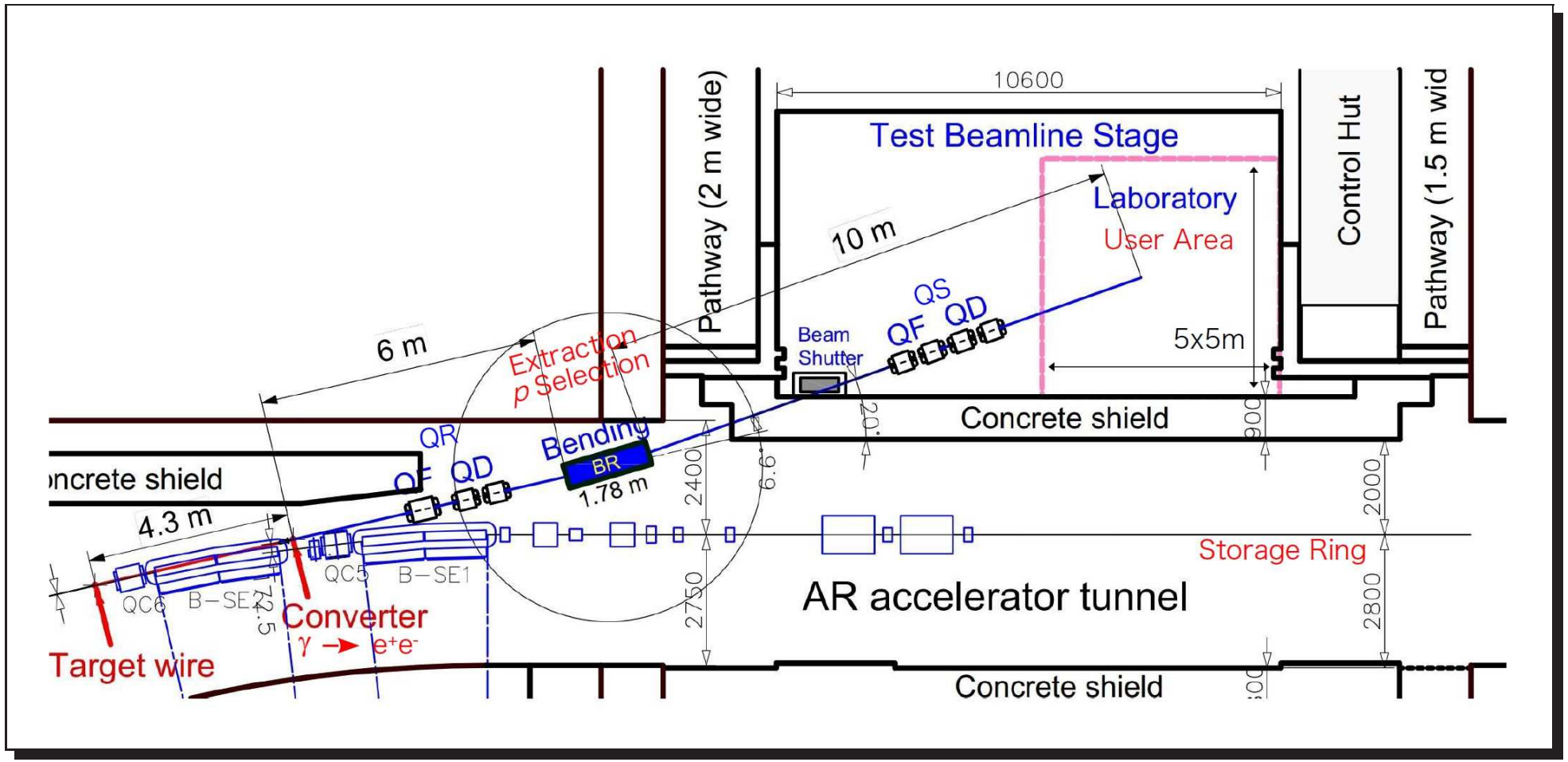
Photo around PF-AR South Exp. Hall

PF-AR South Exp. Hall (2)



Inside the Hall

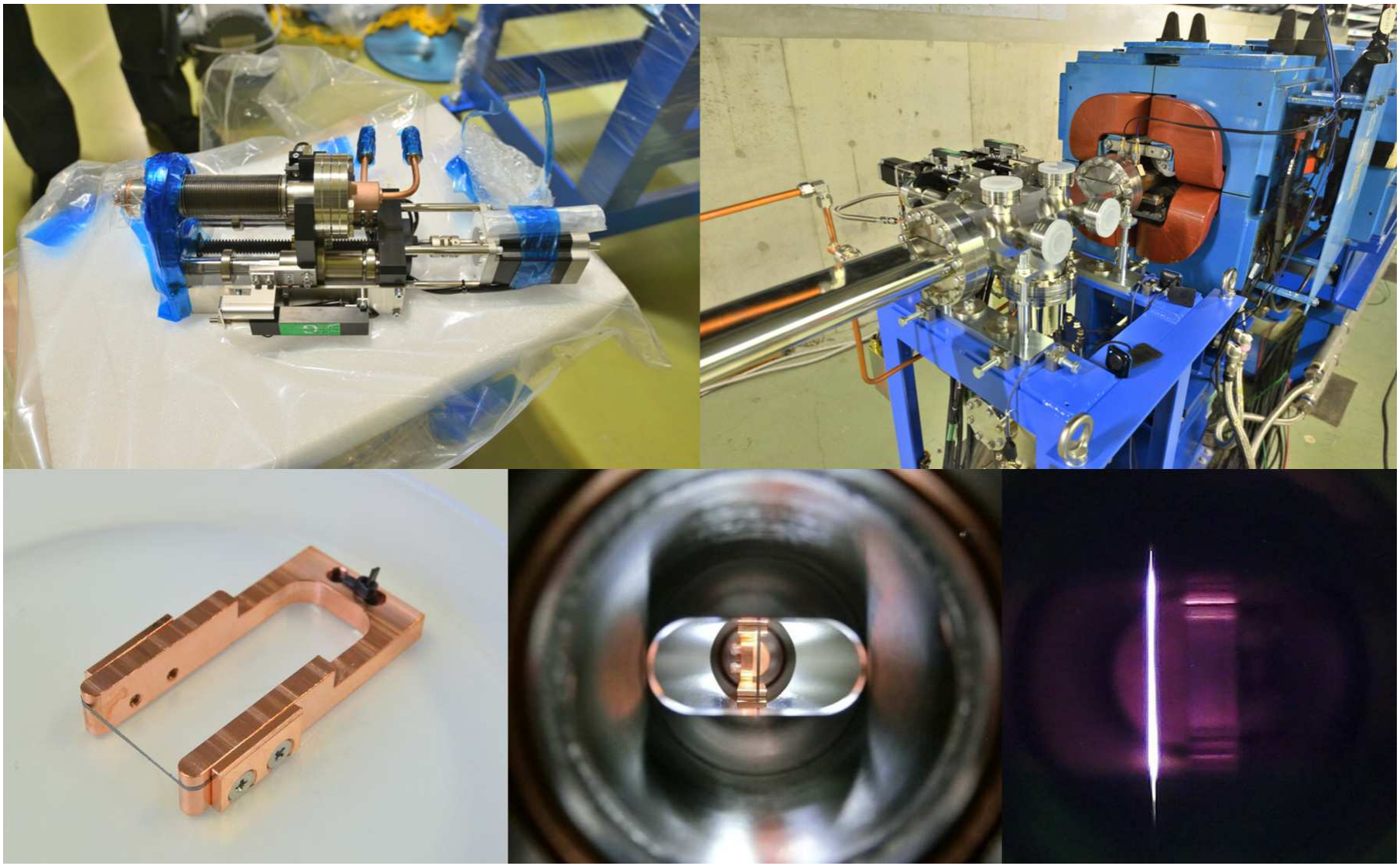
Beamline Overview



- Insert Carbon Target to Beam Halo
- Convert photon to e^+e^- with Copper converter
- Select Energy with Dipole(Bending) Magnet in the tunnel
- Transport beam through hole in the Concrete Wall

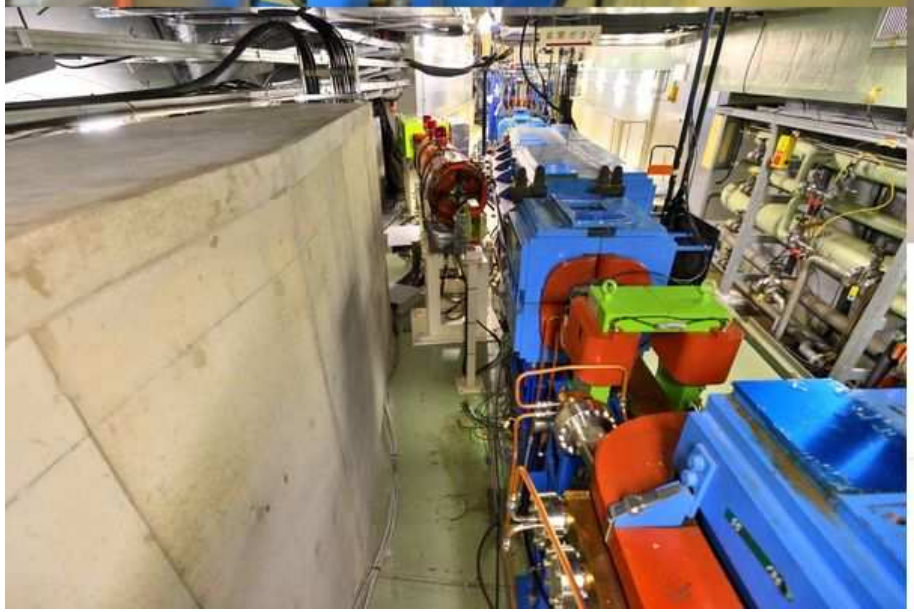
Photos inside the Tunnel

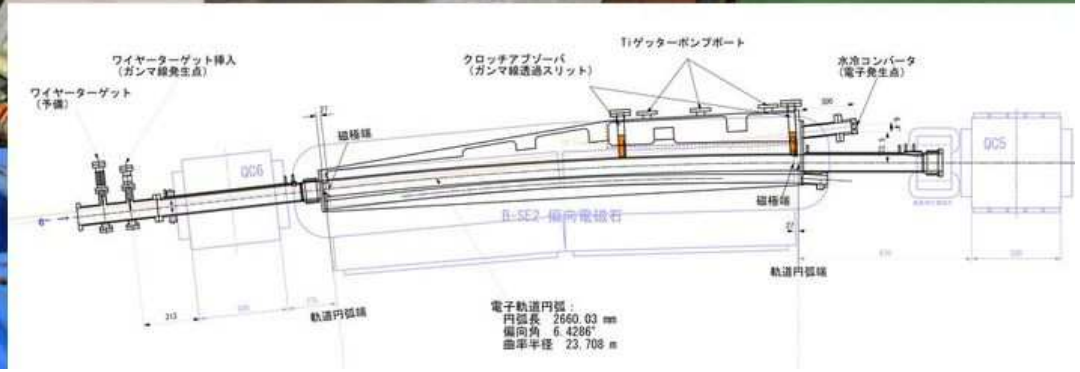
Carbon Target



- Graphene Target Foil (40μm Thick)
- Can see Target during machine operation

Converter

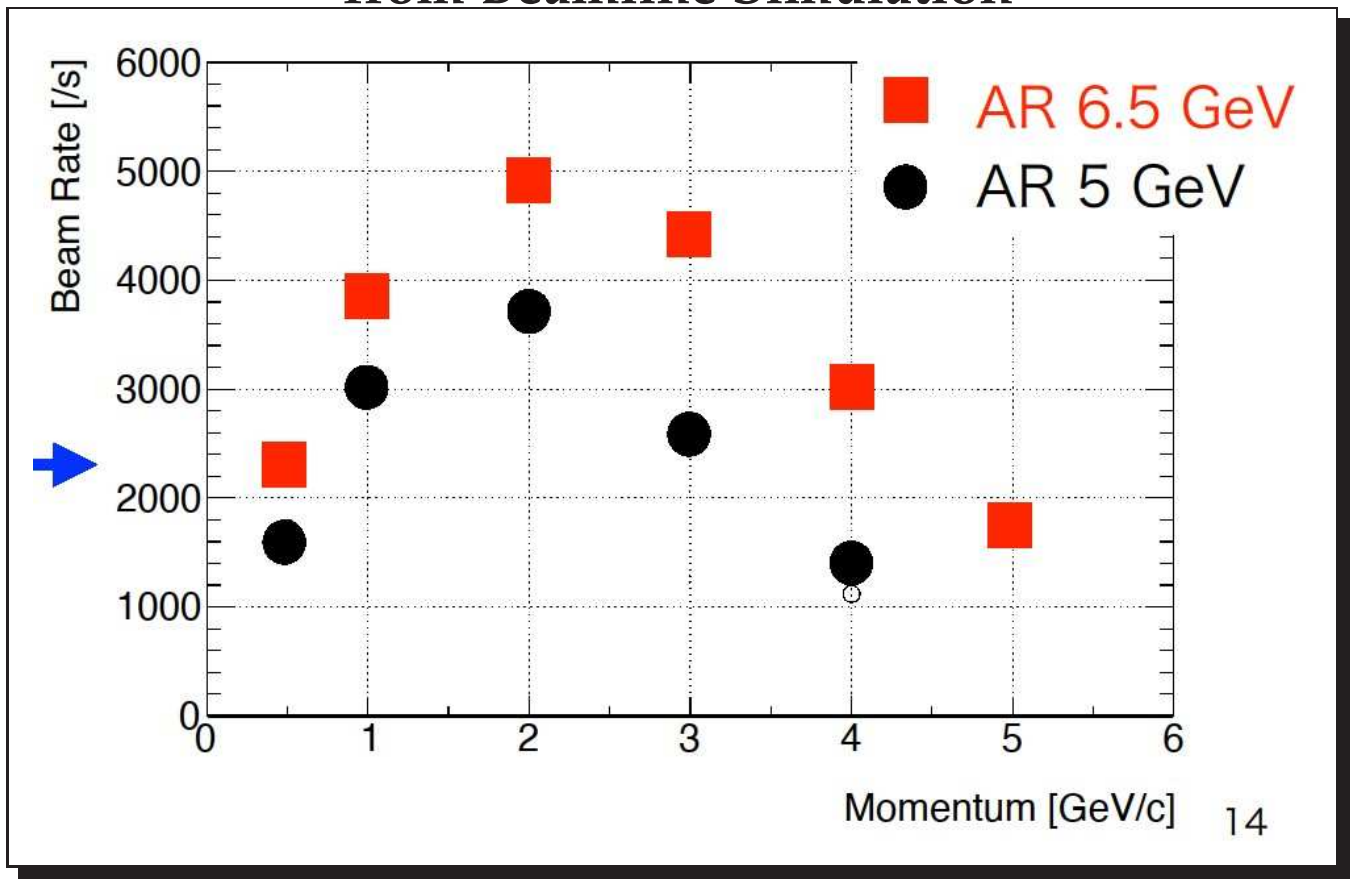




- Water cooled Copper Converter (14mm Thick, adjustable)

Beam Property (1)

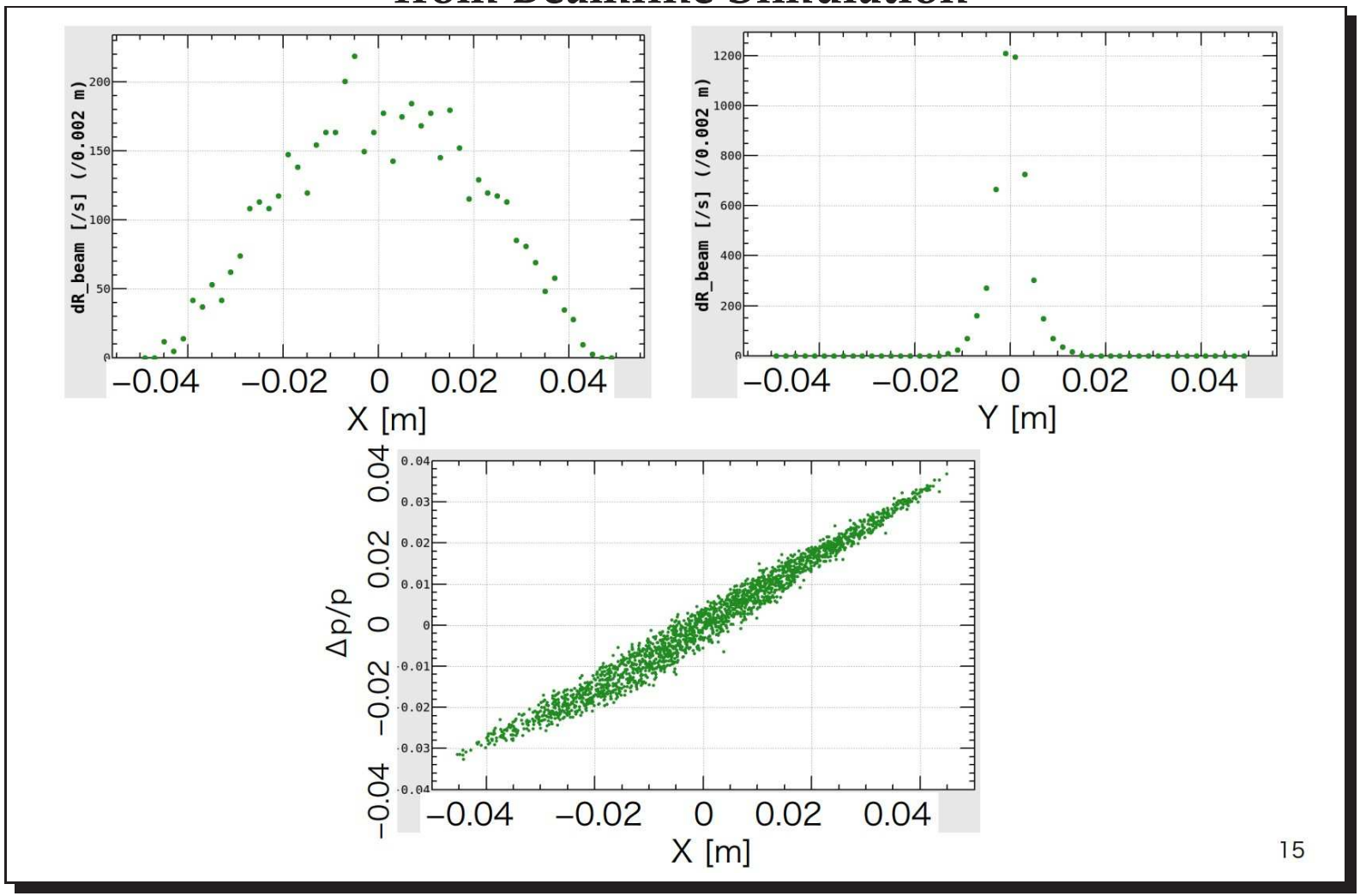
from Beamline Simulation



- Assume $I = 60$ mA, τ_{beam} 20 hours
- Peak of Rate O(kHz) around 2 GeV
- Beam Revolution ~800kHz $\Rightarrow$ once per hundreds of turns
- Beam Rate depend on Lifetime (i.e., Target Position)

Beam Property (2)

from Beamline Simulation

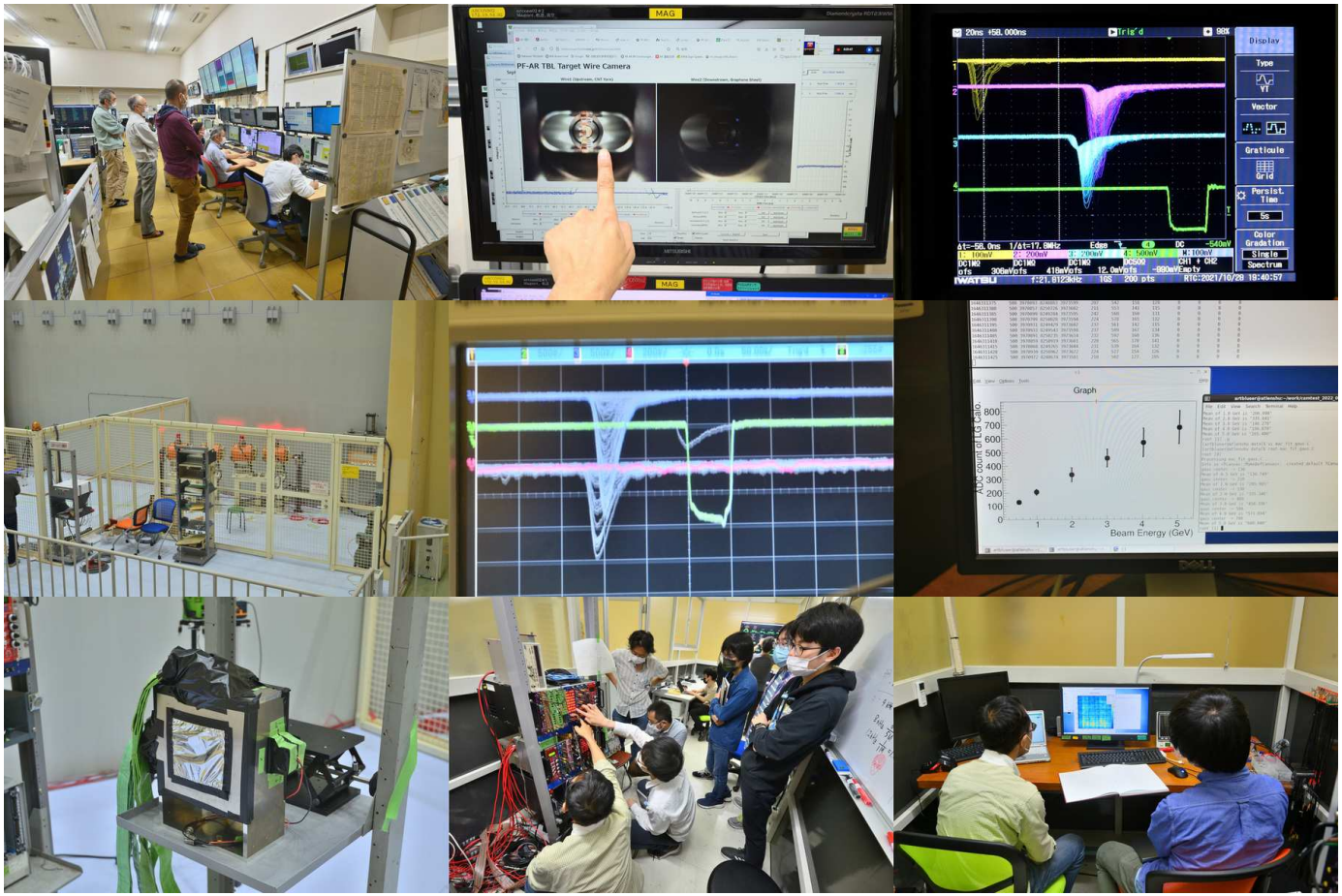


- roughly 8cm x 2cm beamsize
- Strong Correlation between Energy and Horizontal position

History (1)

- Apr. 2020 Kick-off (total ~1 Oku Yen in 2 years Assigned)
- Mar. 2021 Floor Construction Completed
- Oct. 2021 Beamline Construction Competed (Authorization given)

History (2)



- Oct. 2021 1st Run Target Insertion Test (No instability, No HOM, No evil)
- Mar. 2022 2nd Run First beam extraction (Rate Measurement)
- Jun. 2022 3rd Run Profile Measuremnet
- Nov. 2022 4th Run 6.5 GeV Top-up with established. (First “beamline user” invited)

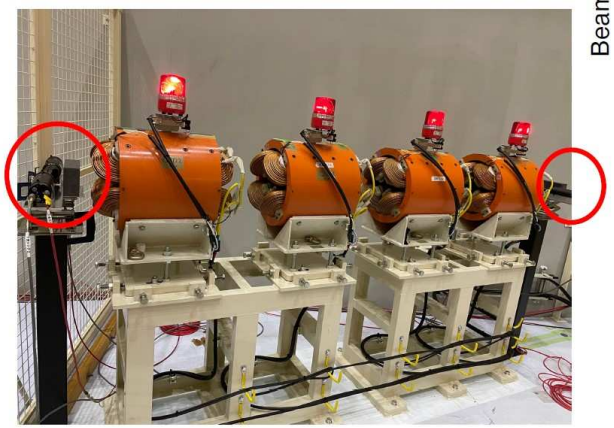
Some Preliminary Measurement Result (1) – Beam Rate

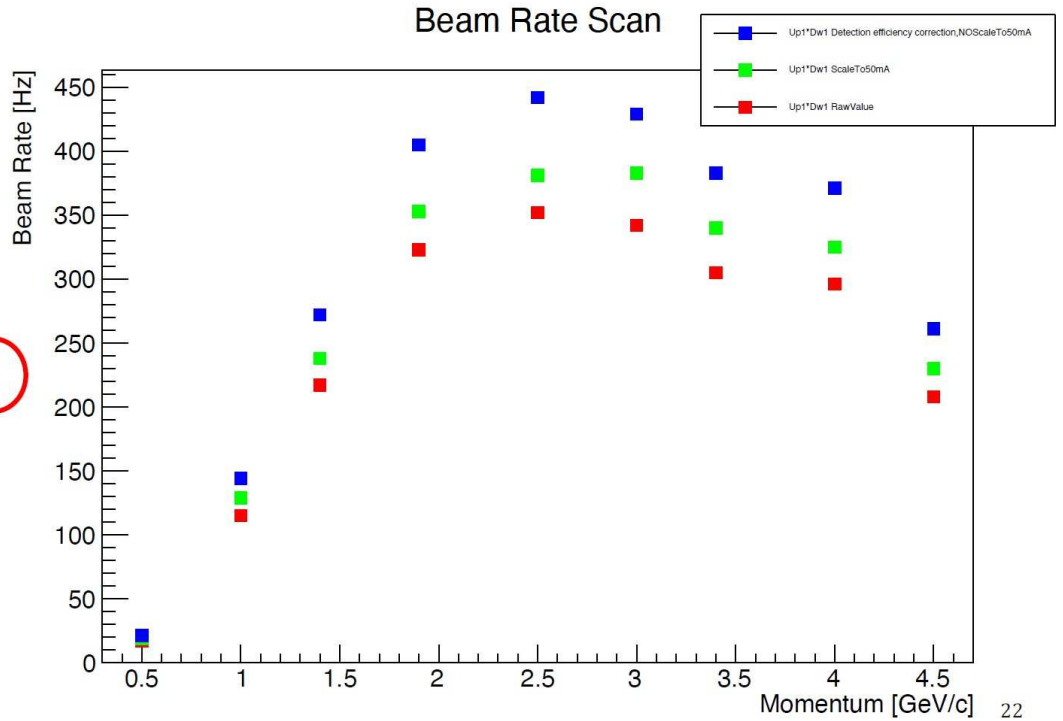
Rate Measuremnet by Kyushu Univ. Jun.2022

Beam Rate

・上流と下流の "シンチ+PMT" を各１組ずつ使用してビームレート測定。 (Up1 × Dn1)
・Up2, Dn2 は検出効率が低かったため、使用していない
・Up1 detection efficiency : 89.3%
・Dn1 detection efficiency : 89.2%
・Up1*Dn1 detection efficiency : 79.7%

・**2.5~3.0GeVあたりがrate最大**





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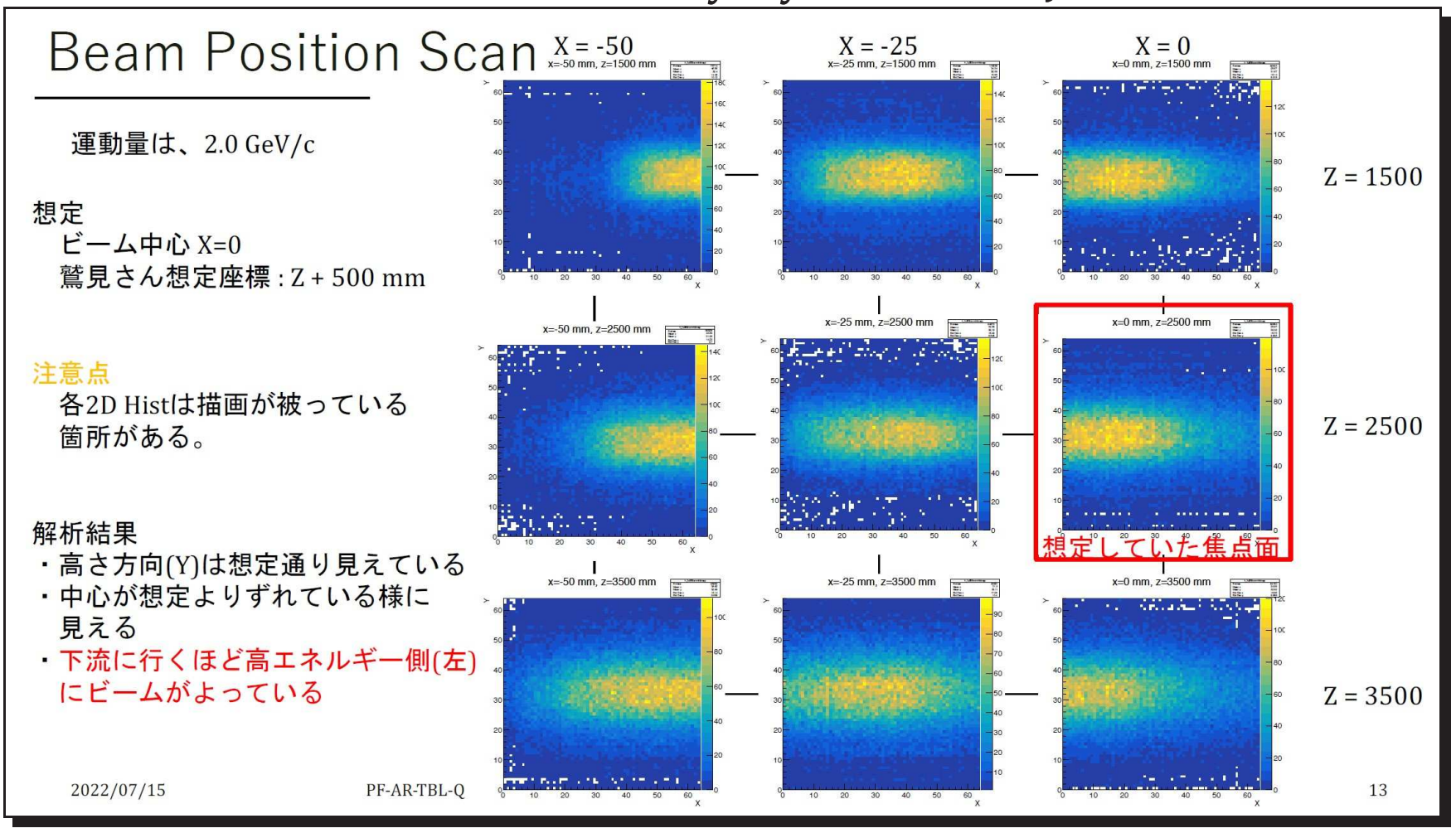
- Very stable beam
- Beam Rate strongly depend on Target Positon
- seems Peak of rate slightly shifted to higher energy

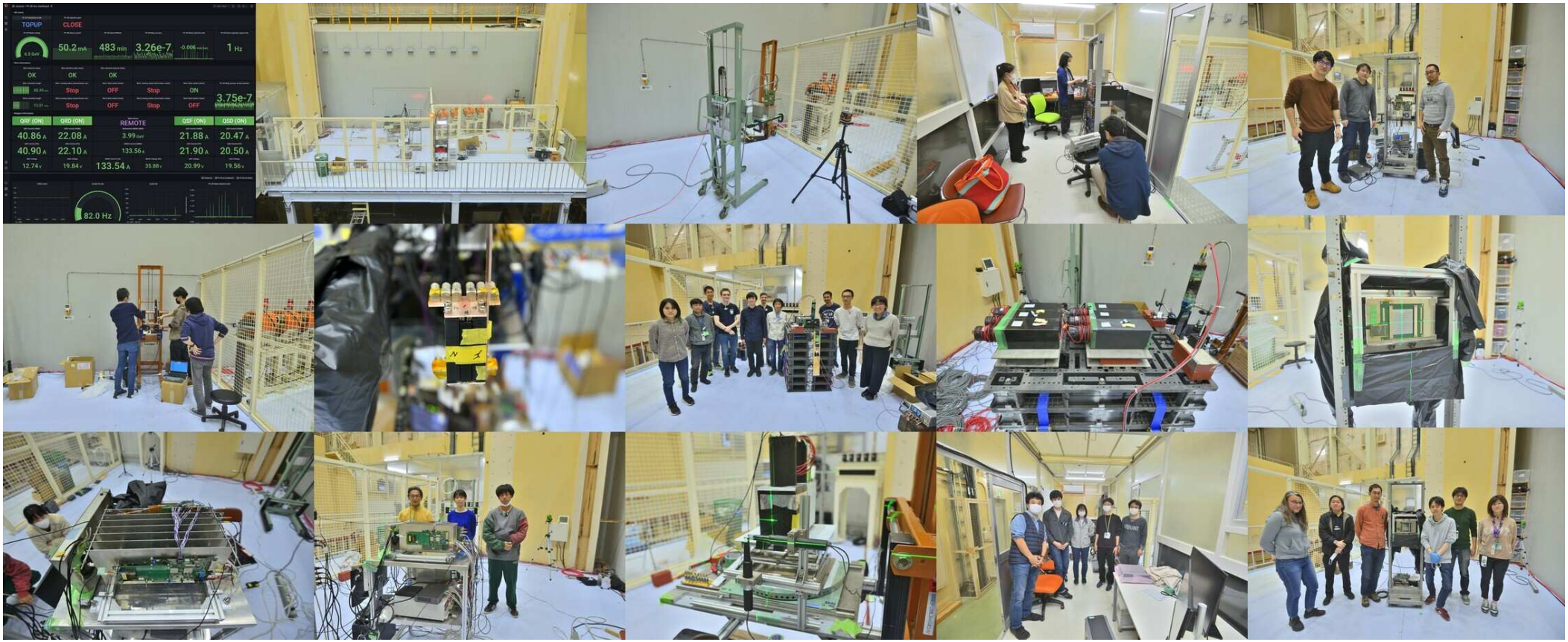
Some Preliminary Measurement Result (2) – Beam Profile

Profile Measuremnet by Kyushu Univ. Jun.2022



- Broader than expected both Horizontal and Vertical
- Beam center shifted by ~1 cm to High energy side

Invited “User” during Commissioning Run



- Test Beamline is stable but not Yet “Officially” open to user
- Invited users with limited Support from Acc. for beamline staff to gain experience
- So far we accepted 7 Groups during Two Run Periods Nov.2022 – Mar.2023
- convinced beamline can co-exist with Photon Source (5 GeV needs extra study)

Summery and Plan

- Construction of KEK PF-AR Test Beamline is completed
- Stable ~1 kHz e^- beam obtained
- No bad effect to Photon Source seen so far
- Measured Rate and Profile different from expectaion
  - need More Precise Profile Measuremnet
  - need to adjust Magnet setting
- Performance already good enough for Test Beam Facility
- Need extra study (Top-up) at 5 GeV (2 days allocated in the next Run)
- Open to public from the Next Run for 6.5 GeV (Jun. 2023)

終り