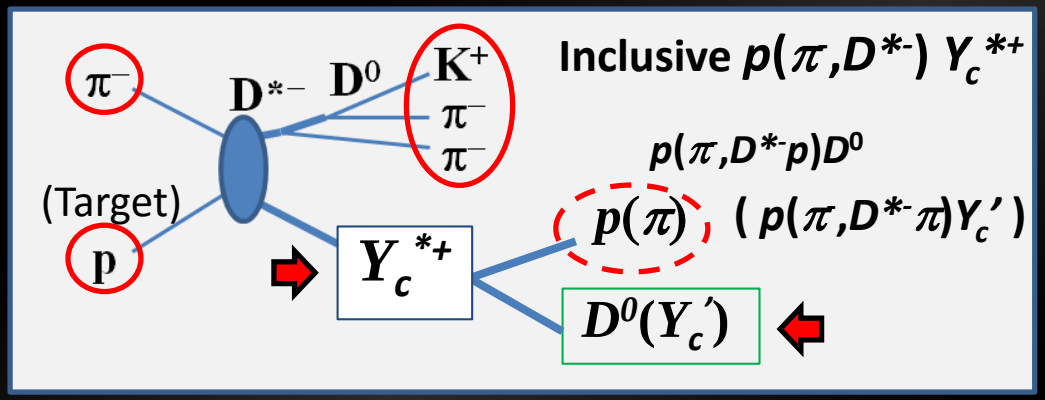
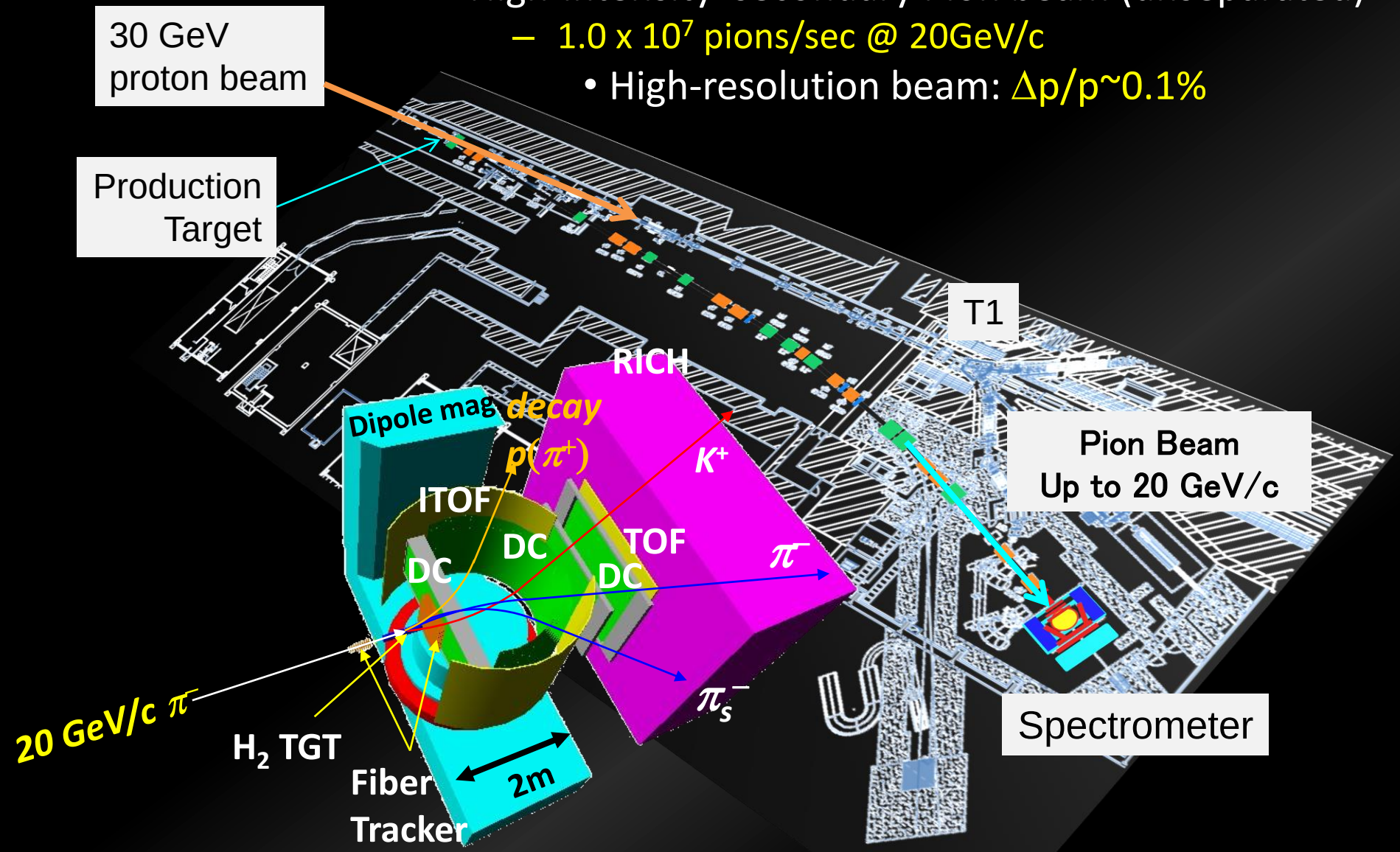
E50
Charmed Baryon Spectroscopy via the (π, D^{*-}) reactions

H. Noumi for E50, RCNP, Osaka University/IPNS, KEK

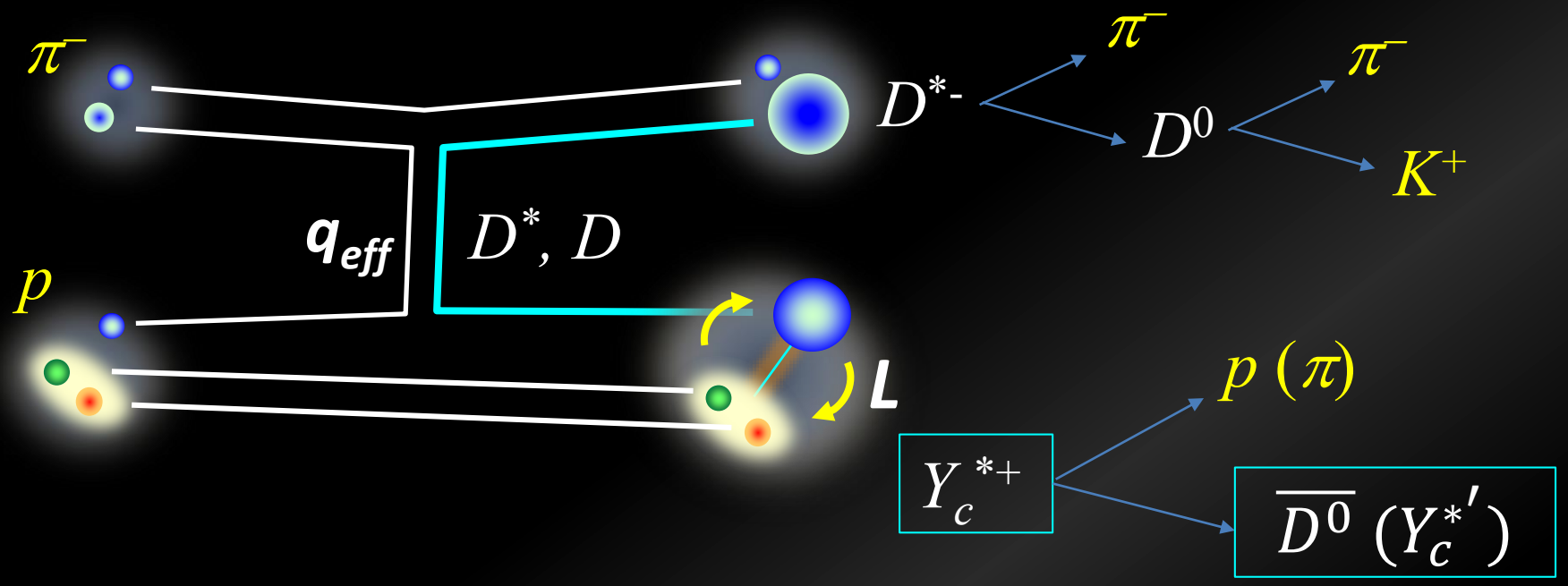


High-res., High-momentum Beam Line

- High-intensity secondary Pion beam (unseparated)
  - 1.0×10^7 pions/sec @ 20GeV/c
    - High-resolution beam: $\Delta p/p \sim 0.1\%$



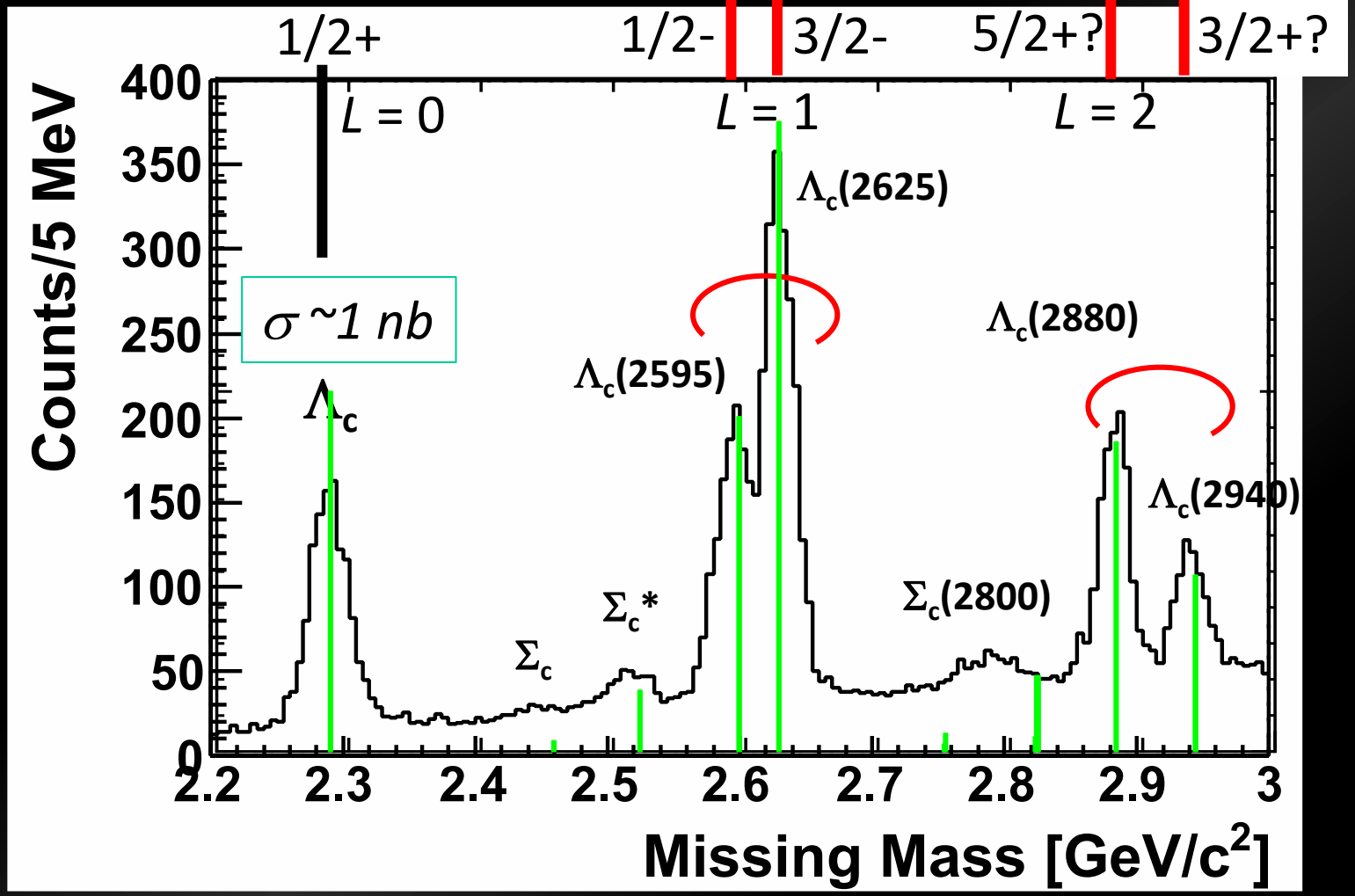
Charmed Baryon Spectroscopy Using Missing Mass Techniques



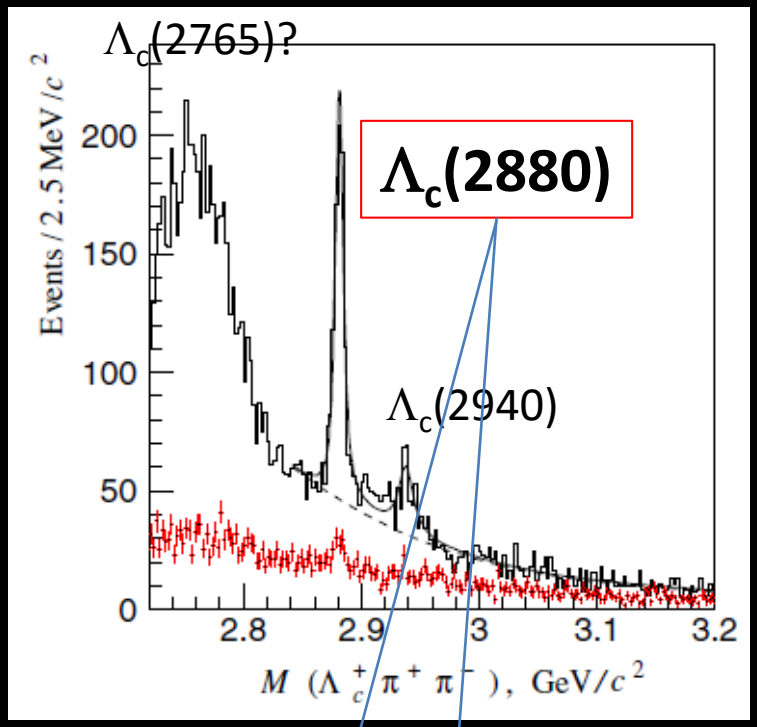
- ✓ Production and Decay reflect [qq] correlation in Excited Charmed Baryons
- ✓ C.S. DOES NOT go down at higher *L* when q_{eff} >1 GeV/c.

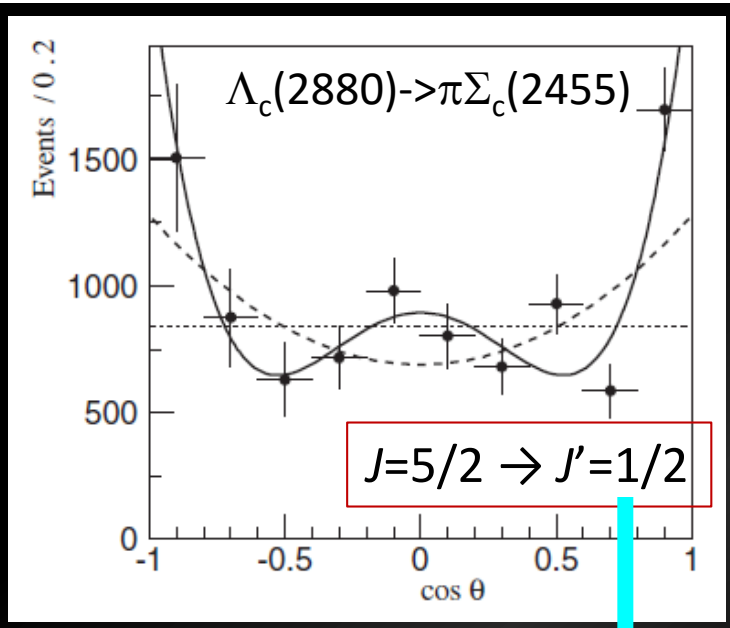
Missing Mass Spectrum (Sim.)

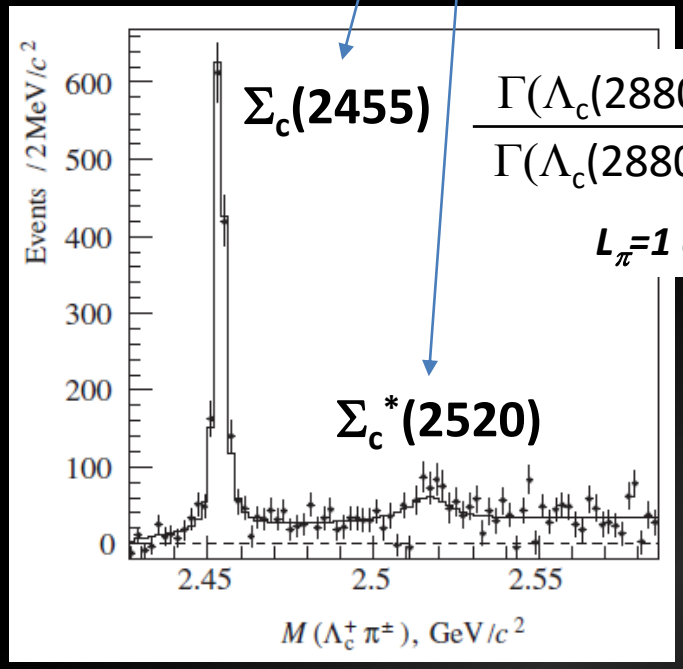
- ~1000 Y_c^*/nb/100 days
- Sensitivity: σ~0.1 nb for Y_c^* w/ Γ=100 MeV



Lc(2880)Belle, PRL98, 262001('07)







$$\frac{\Gamma(\Lambda_c(2880)\to\pi\Sigma_c^*(2520))}{\Gamma(\Lambda_c(2880)\to\pi\Sigma_c(2455))} = 0.23$$

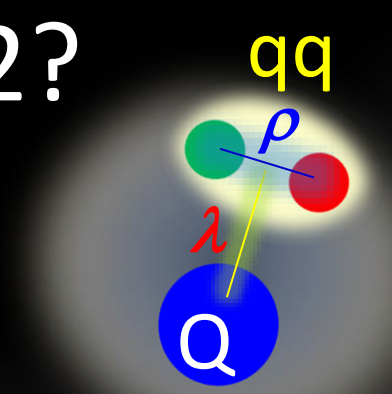
L_π=1 contribution may affect…

L_π=3 transition

$J^P=5/2^+$ for $\Lambda_c(2880)$

Is it a D-wave Lambda-c Baryon?
If so, where is a spin partner ?

Does $\Lambda(2880)$ have L=2?



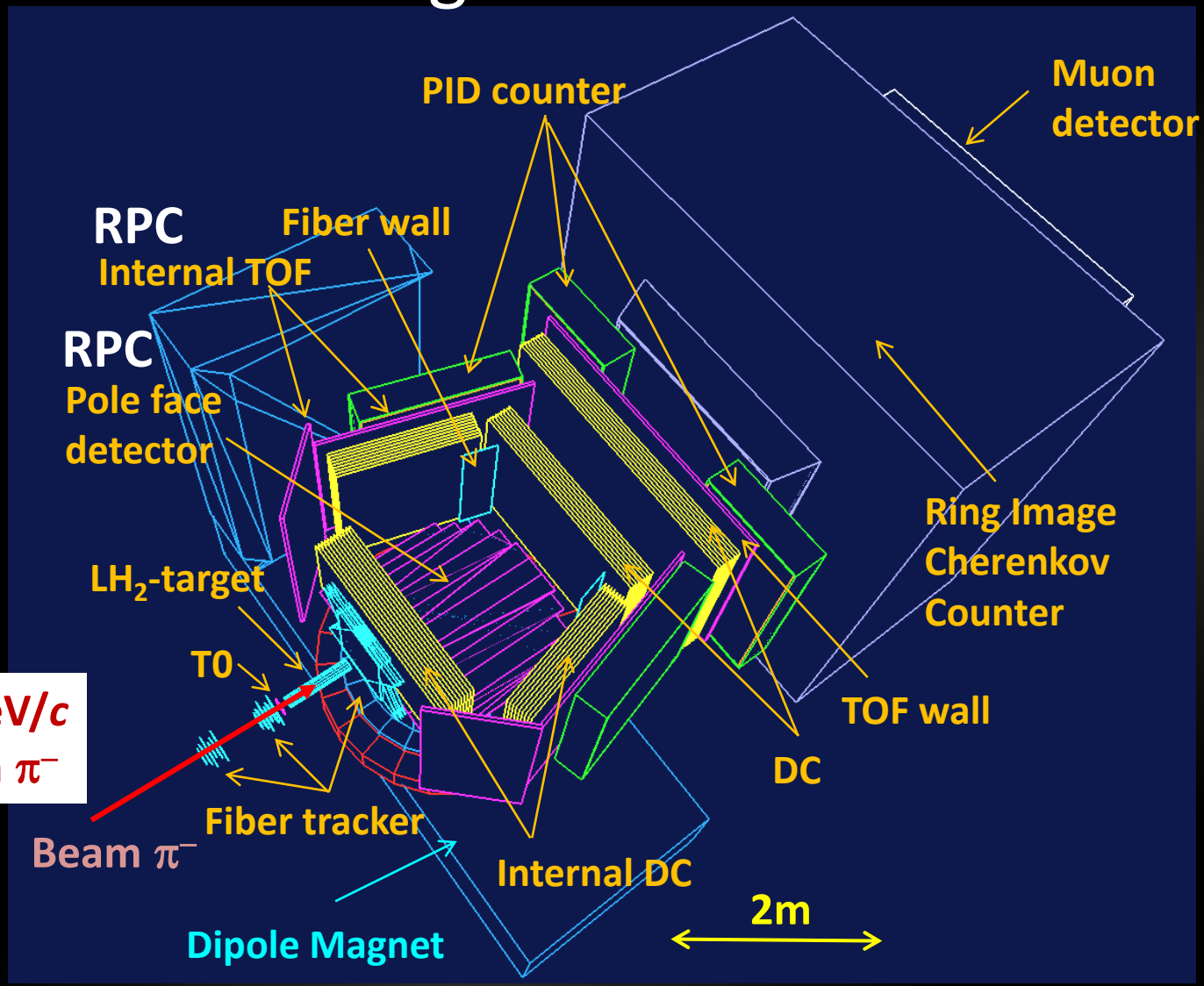
- P-wave transition seems to be suppressed in $\Lambda_c(2880)^{\frac{5}{2}+} \to \Sigma_c^*(2520)^{\frac{3}{2}+} + \pi(0^-)$.
- It would be forbidden only in the case of $J^P_{BM} = 3^+$:
  - Negative party states "5/2-" have large widths.
    (H. Nagahiro et al., arXiv 1609.01085, PRD accepted)

Λ_c(2880) 5/2+	λλ	λρ	ρρ
color	Asymm.		
Isospin	Asymm. (I=0)		
Diquark spin Diquark orbit	Asymm. 0 Symm. 0	Symm. 1 Asymm. 1	Asymm. 0 Symm, 2
Lambda orbit	2	1	0
$J_{BM}{}^P$	2+	1+, 2+, **3+**	2+

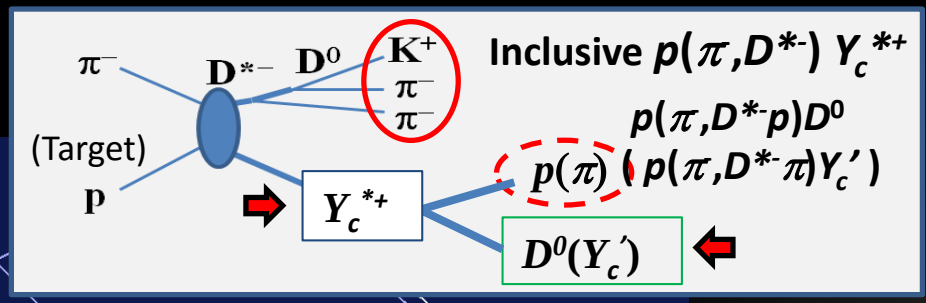
$\Sigma_c{}^*$(2520) 3/2+
Asymm
Symm. (I=1)
Symm. 1 Symm, 0
0
1+

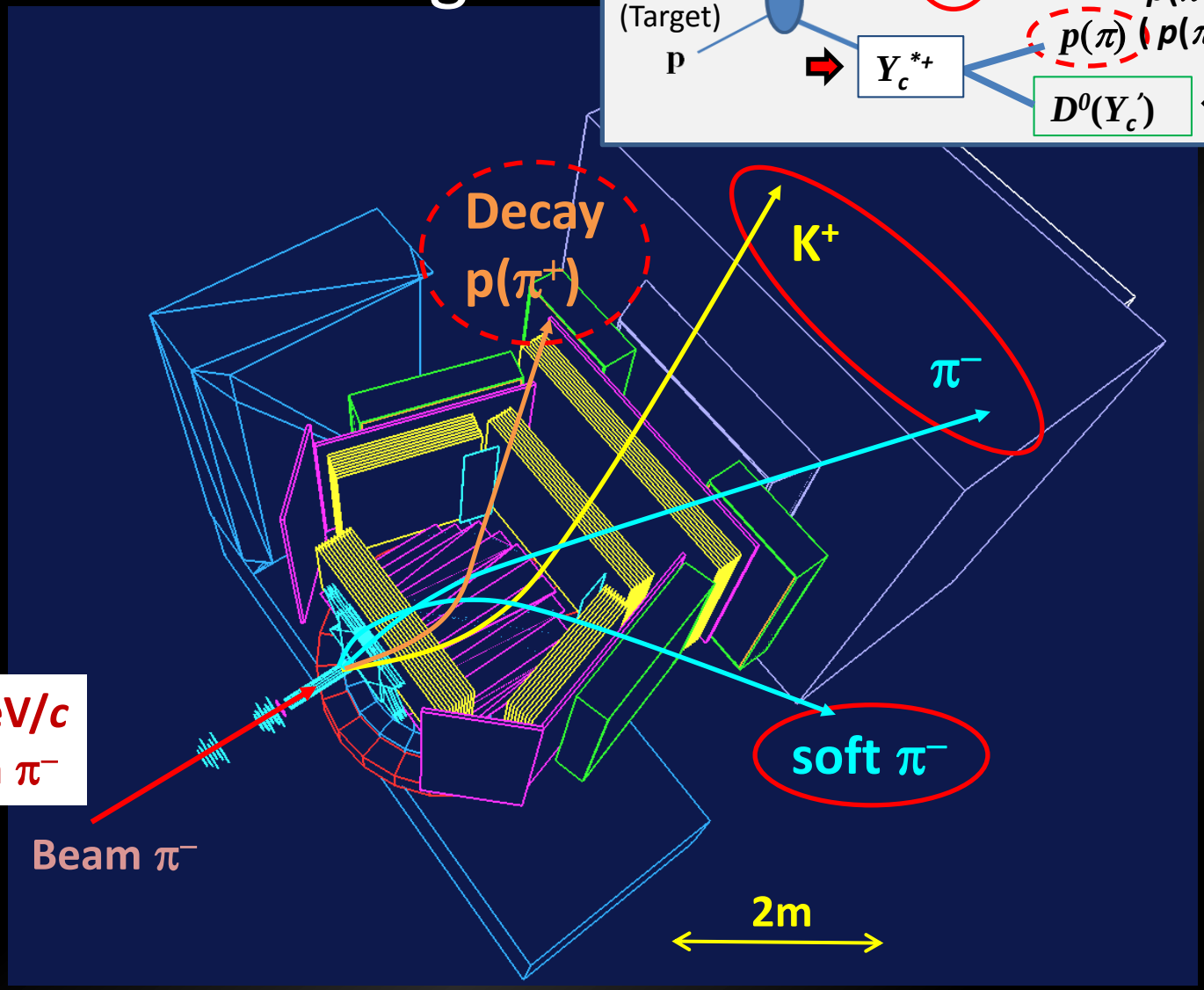
- $\Lambda_c(2880)^{\frac{5}{2}+}$ is likely to be λρ mode (λ=1, ρ=1).
- This can be tested by measuring its production rate.

Spectrometer Design



Spectrometer Design





20 GeV/*c*
Beam π^-

Large acceptance ~ 60% (for *D), ~85% (for decay π^+)**
Good resolution: $\Delta p/p$~0.2% at ~5 GeV/*c*

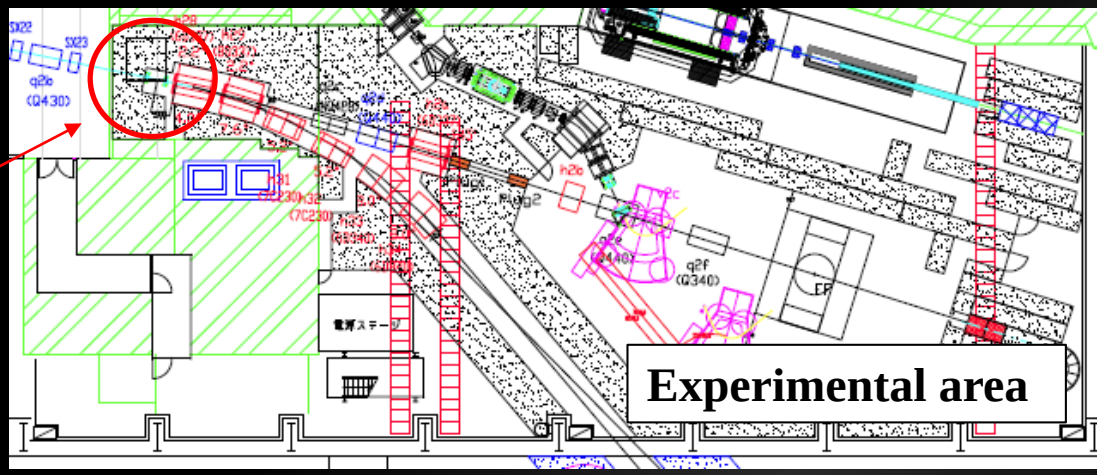
High-p Collaboration

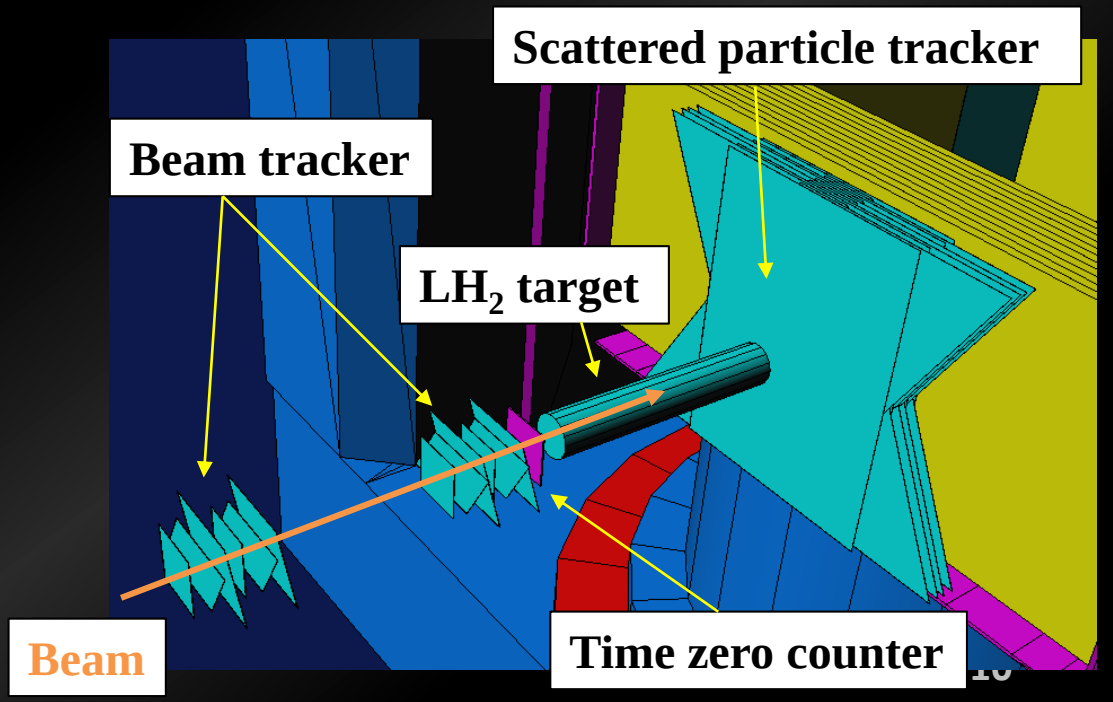
- Cooperative works of activities at High-p BL
  - E50+E16+J-PARC-HI+Potential Users+Facility Group
- Detectors
  - High rate counter/Tracker
  - Large Strip RPC in cooperation with LEPS2
  - Muon ID: J/ψ, dimuon detection
- High Speed DAQ/Electronics
  - ALICE O2 as associate members (approved recently)
  - Pipelined High Resolution TDC (~20ps)
- Facility
  - For 2ndary Beam Line

High-rate detectors

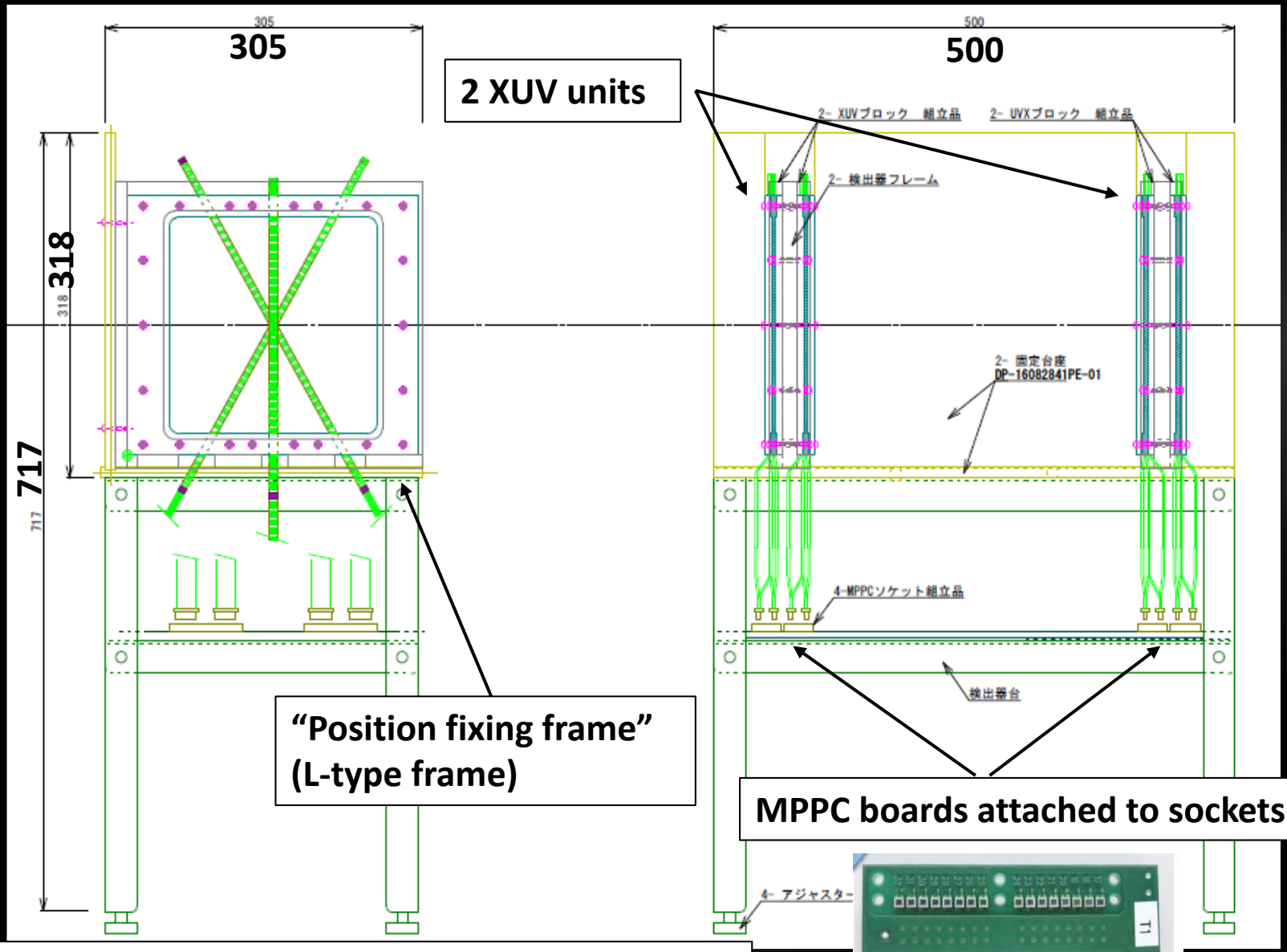
* High-rate beam
  - 6×10^7 /spill

  (30 MHz @ 2 sec spill)
- Focal plane detector
  - Focal plane region
  - Beam momentum analysis
    - Position and angle
- Beam tracker
  - At the target upstream
  - Size: 100 mm × 100 mm
- Scattered particle tracker
  - At the target downstream
  - 600 mm × 800 mm
- Time zero counter
  - At the target upstream
  - Reference timing for TOF





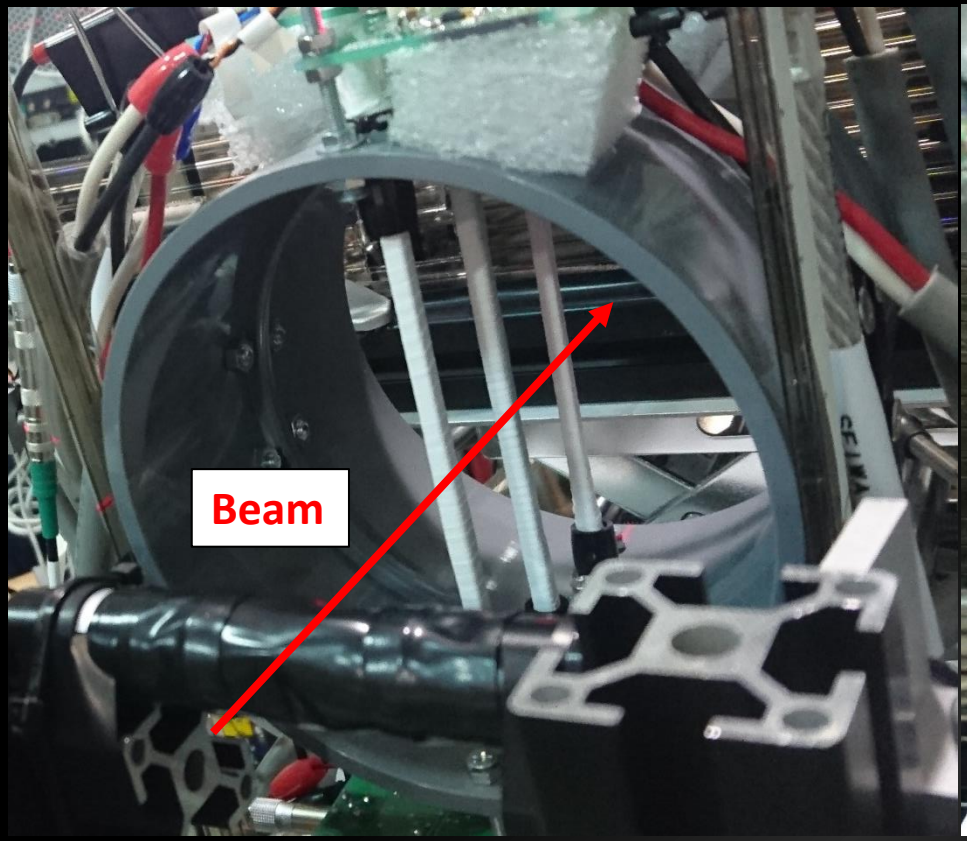
Prototype beam tracker: in preparation



- **Design can be used for actual one.**

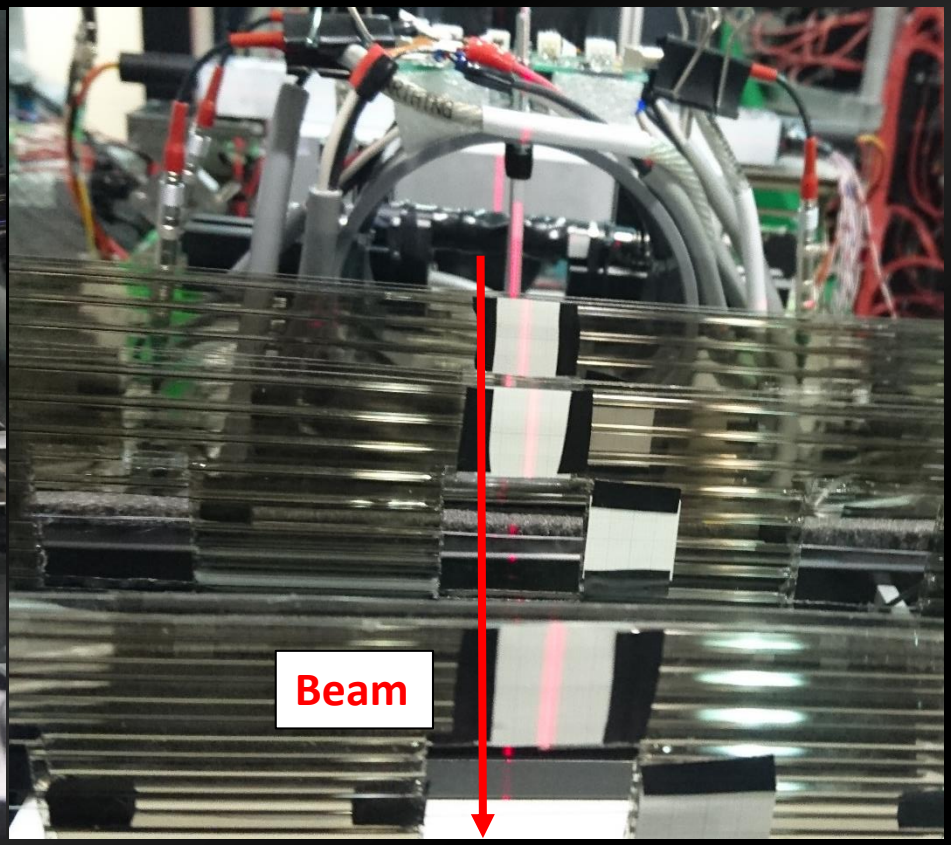
Beam Test at ELPH

Timing counter: T0



150-mm scintillator + MPPC

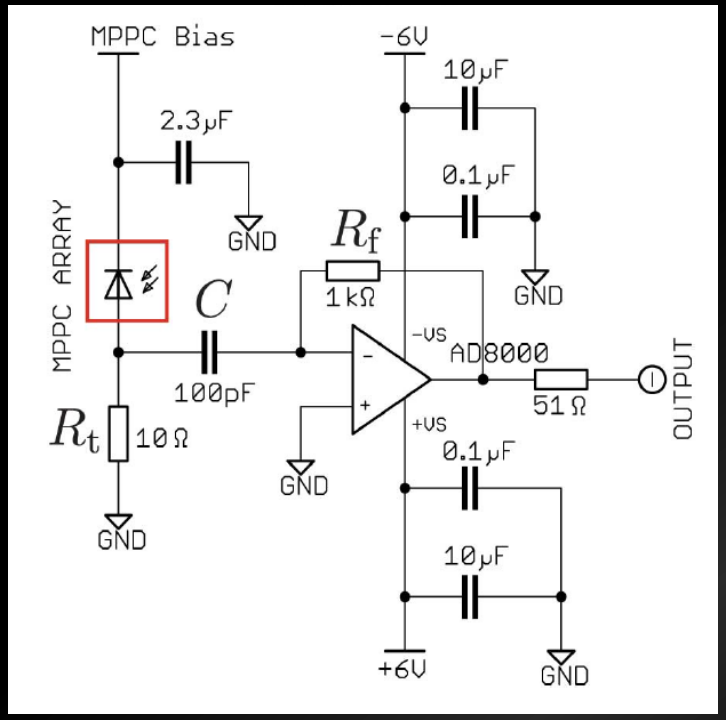
Fiber test

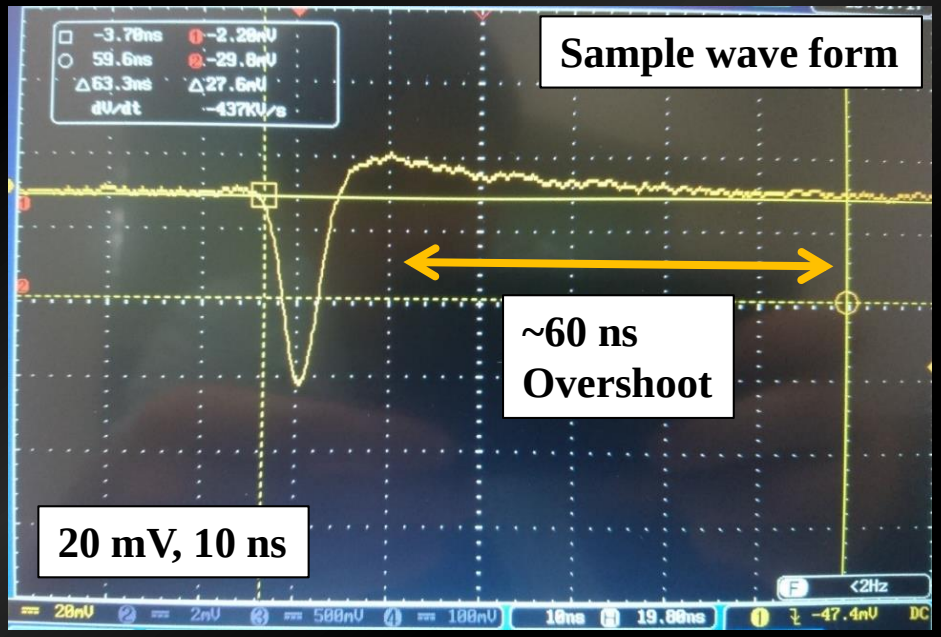


1 mm, 0.5 mm 0.25 mm fiber

T0 : □3mmx150mm + MPPC + Preamp

- Time Resolution for MIP: ~70 ps
- Photoelectron: ~100
- Overshot Pulse to be reduced





Fiber x MPPC: Based on Beam Test

ϕ [mm]	MPPC pixel	PDE [%]	P.E. [Single]	Resol. [Single] [ps(rms)]	P.E. [Both/OR]	Resol. [Both] [ps(rms)]	Comments
1.00	PMT	25	12	420	24	300	
1.00	25	30	15	380	30	270	Better
1.00	50	50	30	270	60	190	Improved
0.50	25	30	7	650	14	460	
0.50	50	50	14	460	28	330	Less Material
0.25	25	30	3	1000	6	700	Low eff.
0.25	50	50	6	700	12	500	

- Acceptable combination of Fiber and MPPC
  - ϕ1.00 mm ⇒ 25/50 μm MPPC + Single edge
  - ϕ0.50 mm ⇒ 50 μm MPPC + Single edge
  - ϕ0.25 mm ⇒ 50 μm MPPC + Both edge (OR readout)

Facility: Beam Line Issue

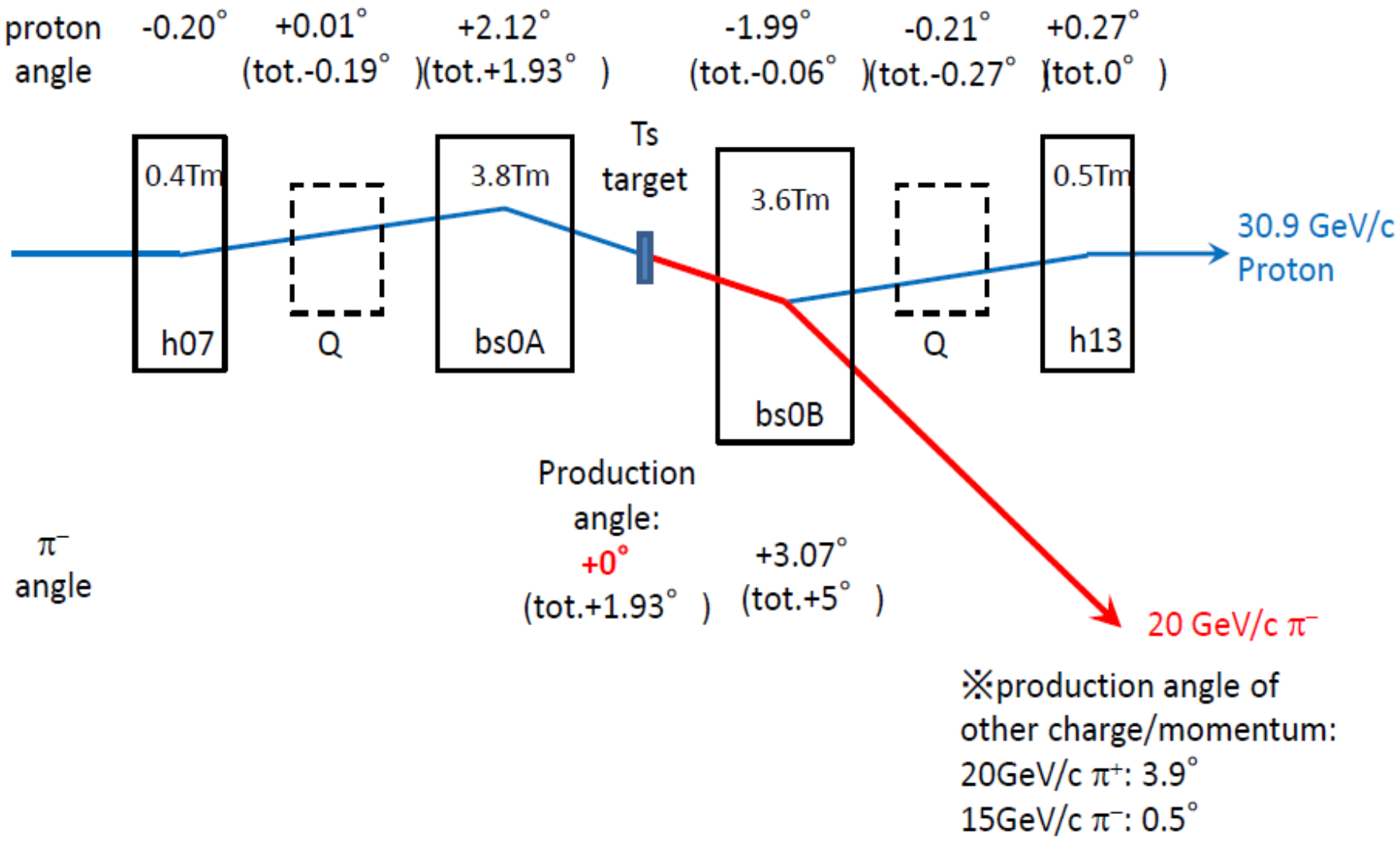
- High-p/COMET Line Construction Status
  - SY: Magnets have been installed. Lambertson, Collimators, and monitors will be installed in next summer.
  - HD: Magnets are ready to be installed in 2017~2018.
- Design for Secondary Beams at the High-p BL
  - A PD has been hired at RCNP (OU J-PARC Br.)
  - Discussion under the PN phys. div. of J-PARC started.

Issue for 2ndary BL

- Production Target: essentially same as current T1 system
  - Au/Cu indirect water-cooling system
  - Air-tight Chamber with He-gas circulating radiation monitor
  - Beam Window : Ti for current system, Be under developing
- Radiation Shielding:
  - Soil activation limit : 15kW Loss@SM
  - 0.5uSv/h at a border of Radiation Controlled Area
  - Activation around the Target Station (for Maintenance)
- Beam Swinger Optical elements :
  - by which the branching magnets (Lambertson/septum mags) will be replaced
  - Swinger magnets will be made with Mineral Insulation Cable (MIC)
  - Beam Piping: cooling system if necessary
- Vacuum System
  - Pillow Seal at BSO
  - Vacuum Pump: Storage tank for exhaust gas and valve control system

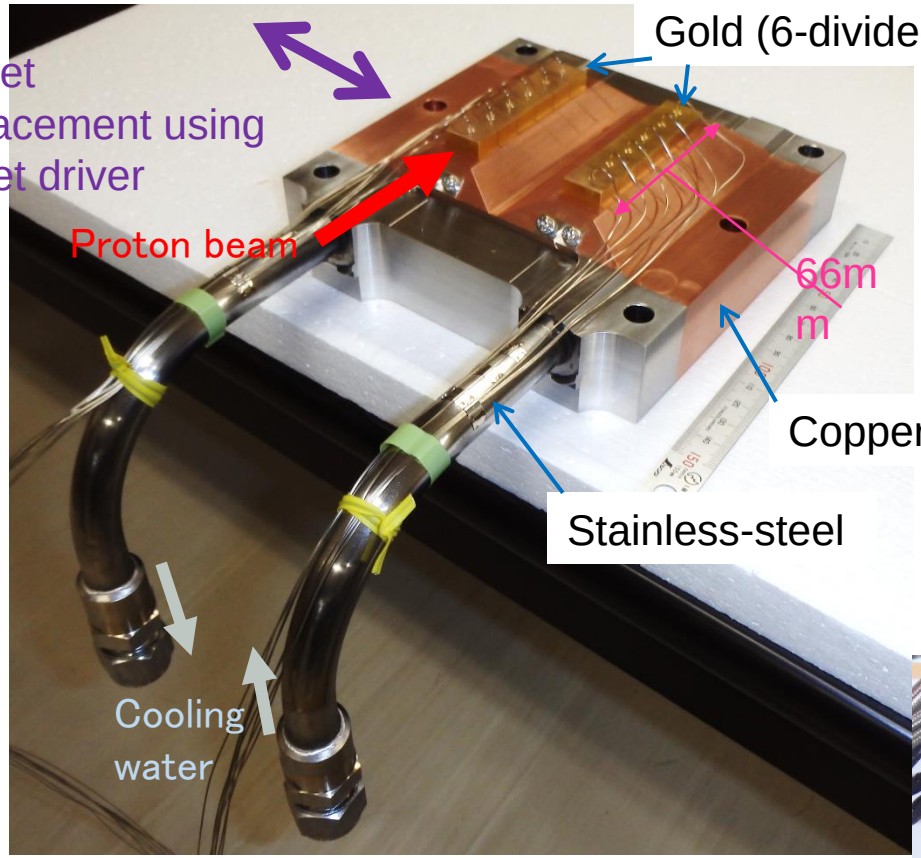
π20 beam extraction - New

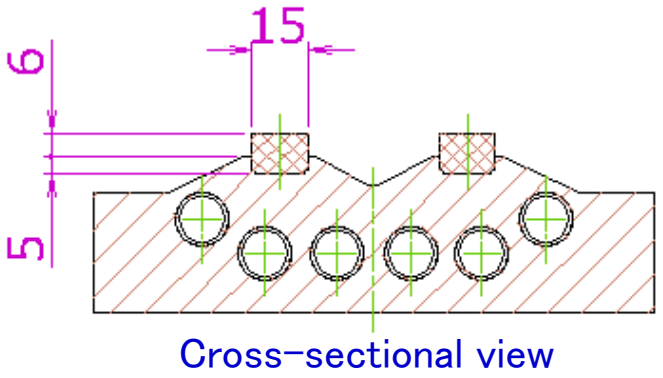
beam swinger optics optimized for
20GeV/c π^- beam production



※production angle of other charge/momentum:
20GeV/c π^+: 3.9°
15GeV/c π^-: 0.5°

Current Hadron Target





*Gold, copper, and stainless-steel are bonded by HIP (Hot Isostatic Pressing)

target chamber

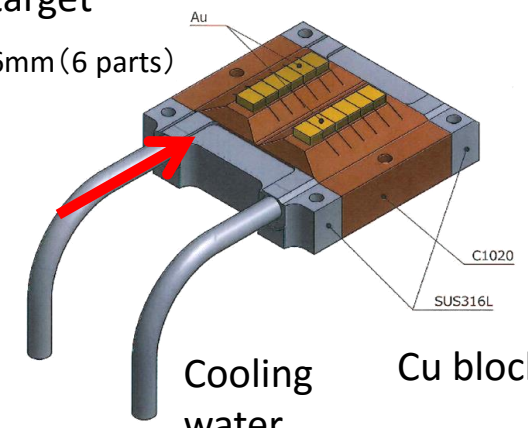
- Up to 50 kW beam
- Indirectly water-cooled
- Gold was chosen due to the good thermal conductivity and thermal expansion coefficient close to that of copper
- Involved in airtight chamber and He gas is circulated to monitor the target soundness

Target

IAC、2016

Au target

66mm（6 parts）



Proton beam

Cooling water

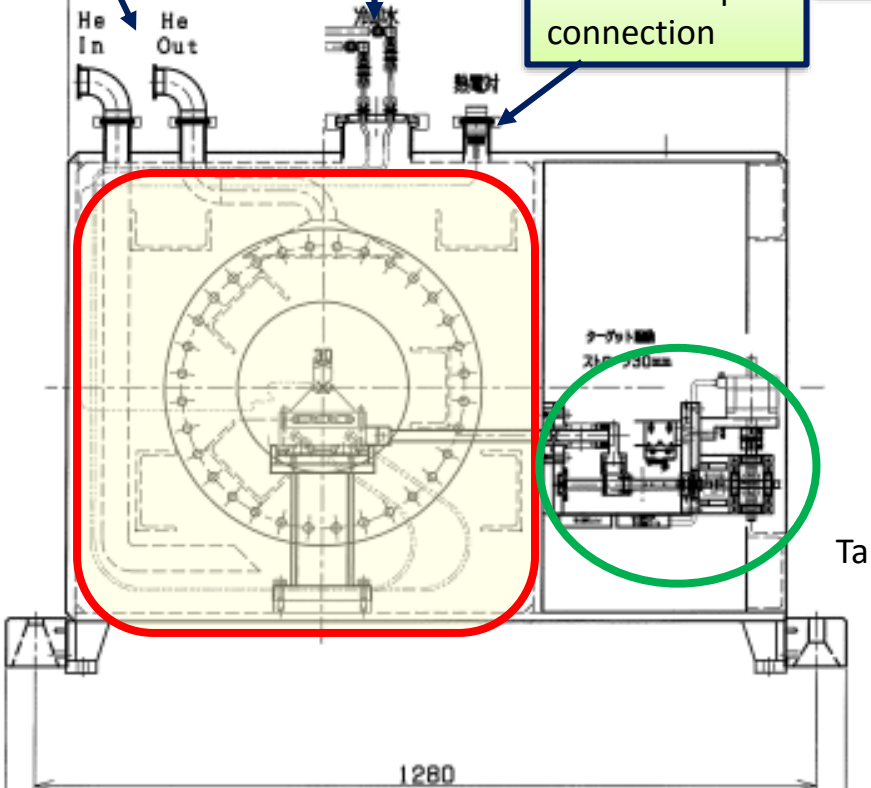
Cu block

He gas

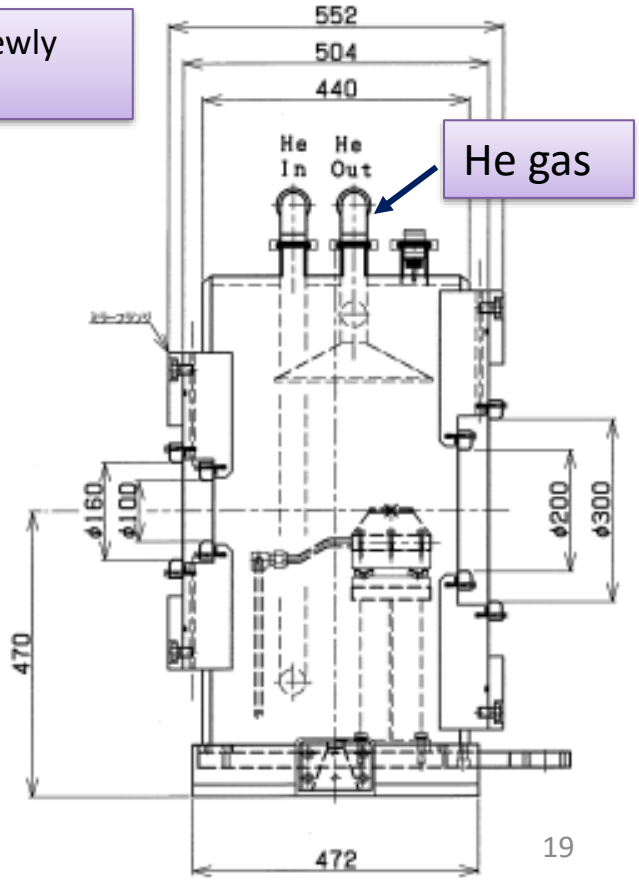
Cooling Water

Thermocouple connection

He gas system be newly constructed.

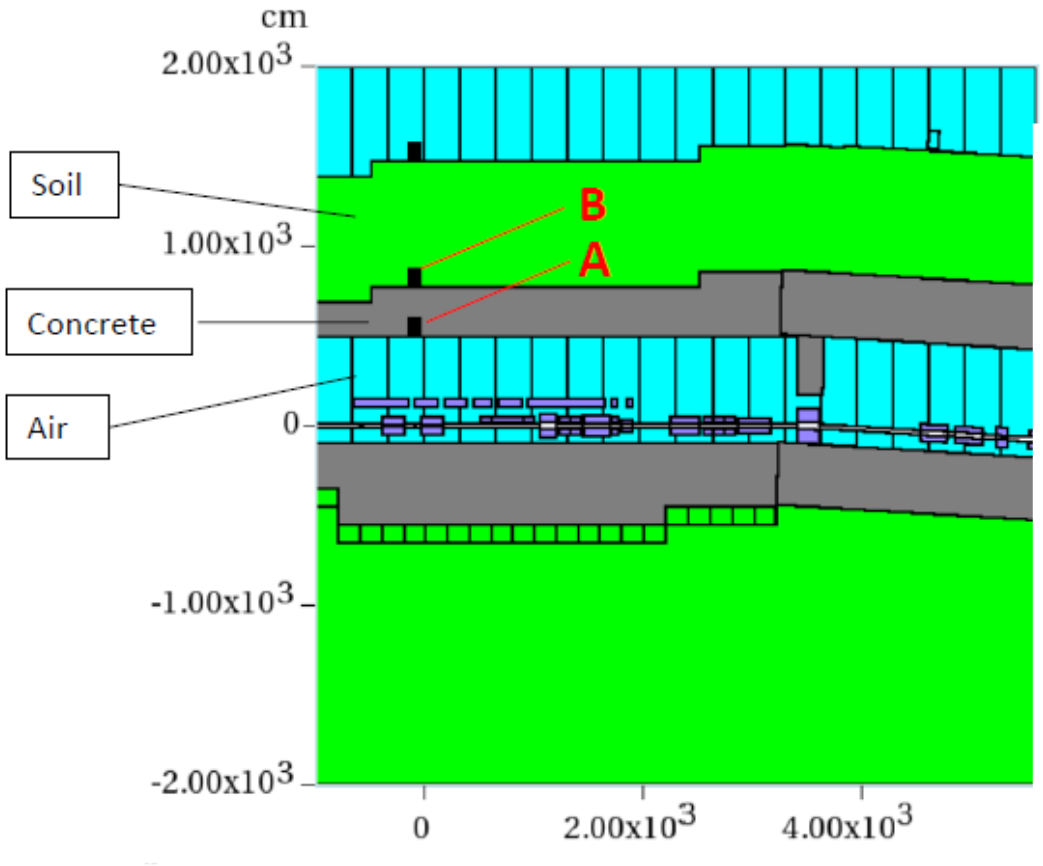


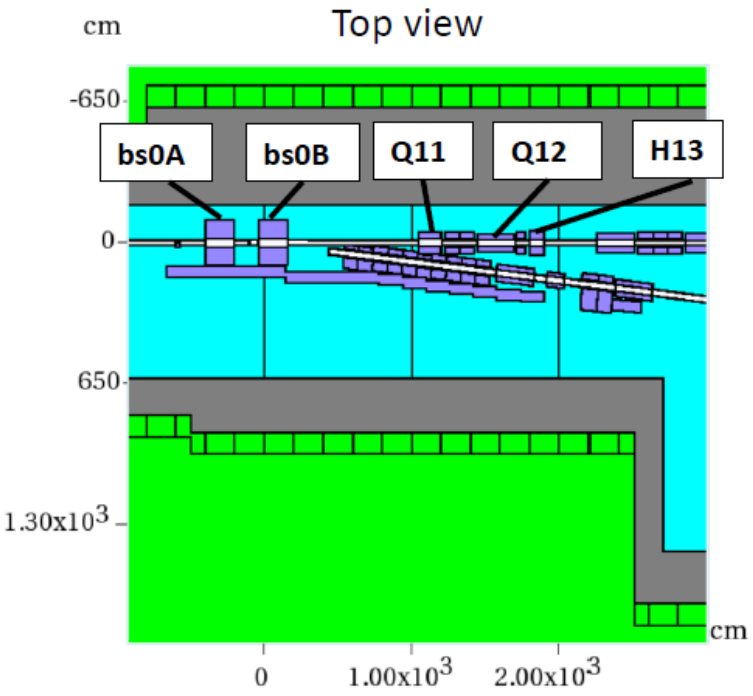
Target driver



Radiation Level estimated by MARS

by Y. Komatsu





We put 15 kW loss TGT to start shield designing.

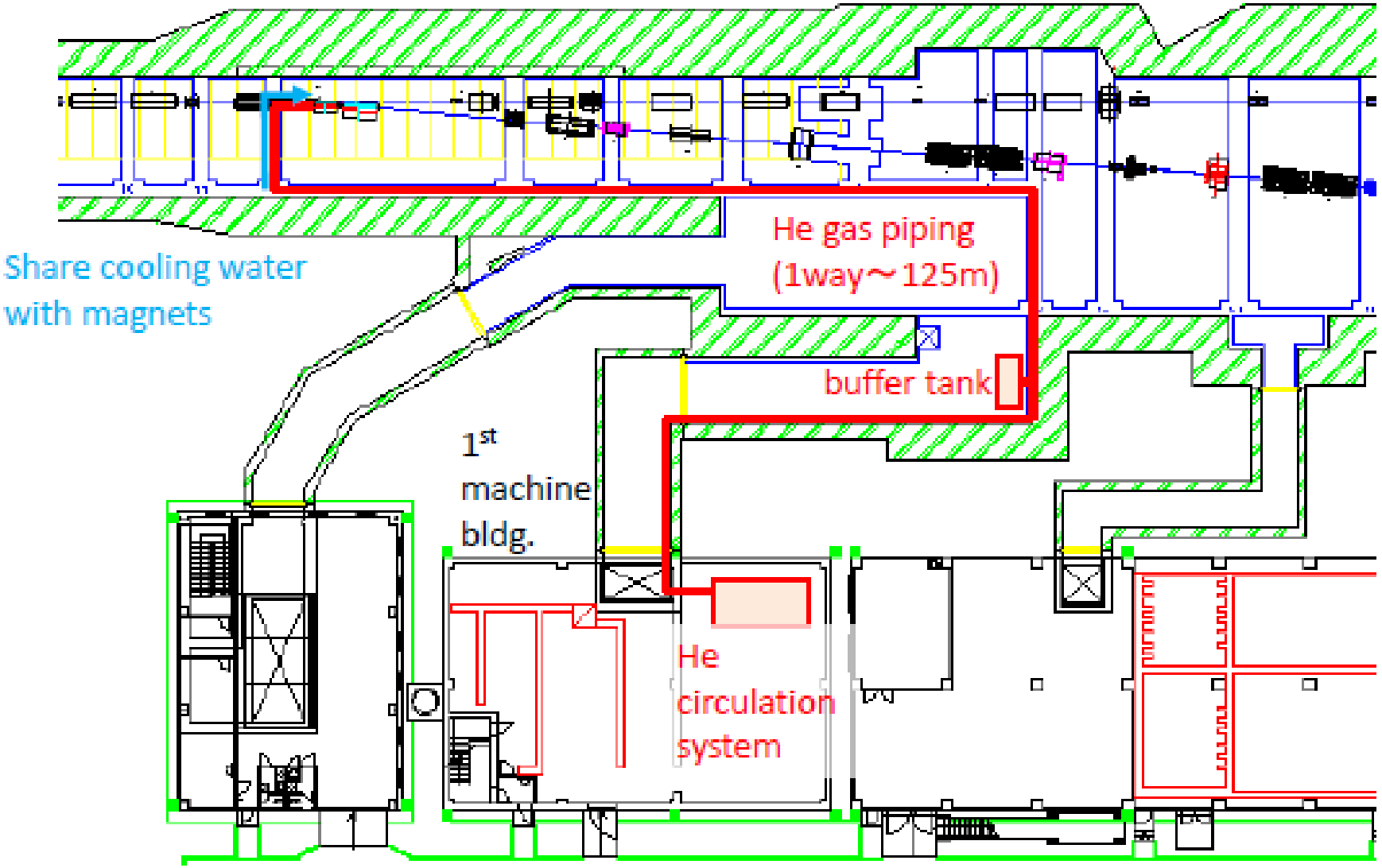
- Currently just confirm the Soil Activation at B is as small as 1.3 mSv/h.

Safety Issue

- Monitoring system
  - Target temperature
  - He-gas circulating radiation monitor
    - Piping route: SY to M1
  - Radiation Monitor
    - Beam Intensity, Beam Profile, Beam Loss
    - Area Monitor (Air-dust sampling monitor)
    - Air-born radio-activities in SY
- Maintenance Scenario
  - Radiation Shielding in opening the target station
  - (Semi-)remote handling system
    - quick and remote connection/disconnection of power/signal lines, water cooling/vacuum pipes, and so on
    - Remote alignment system
- Safety Simulation for Severe Accident
  - Short pulse extraction->Target melt down, Beam window broken
  - Magnet failure -> Beam Displacement -> Protection against unexpected beam irradiation to BL elements
  - …

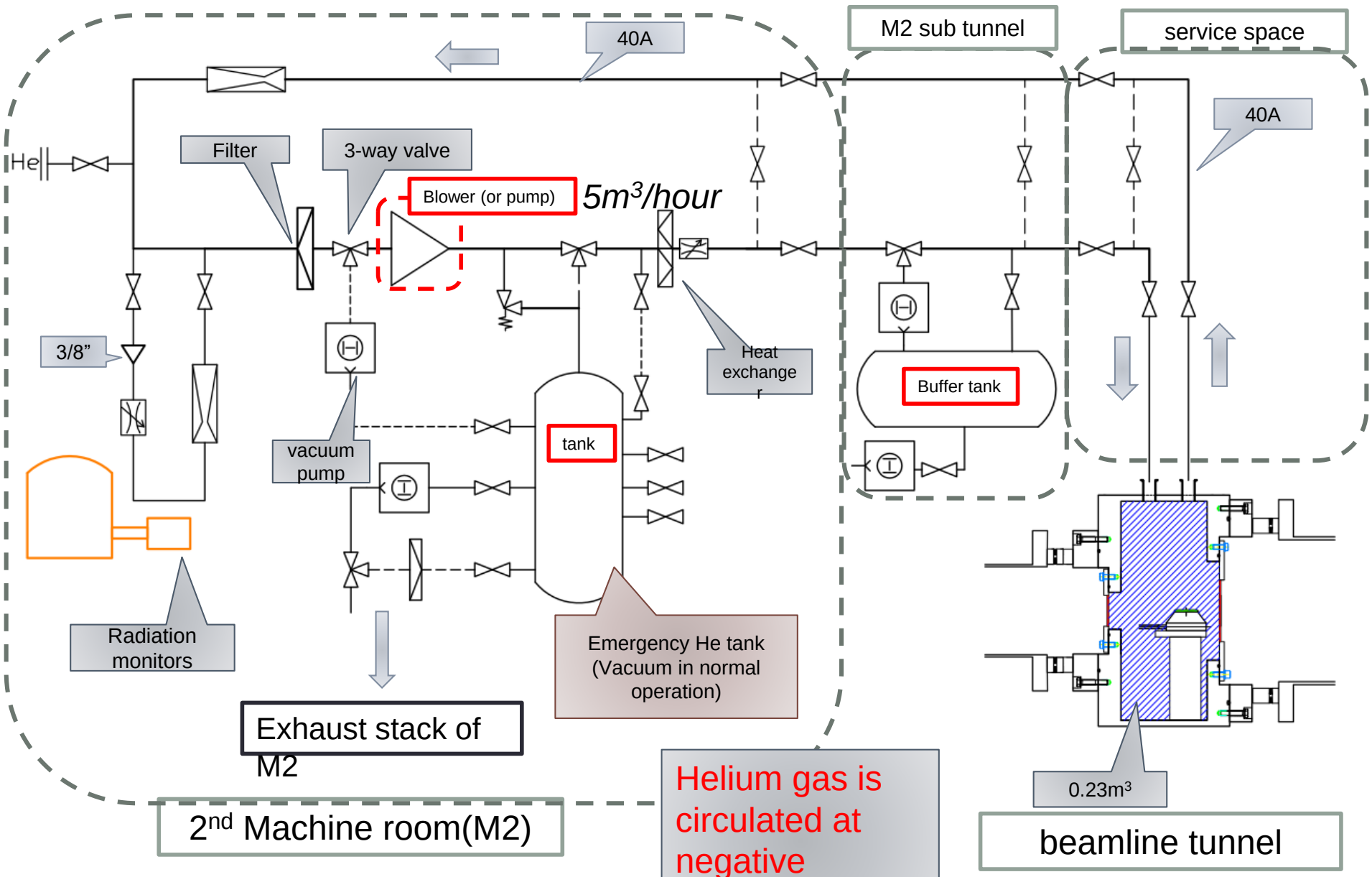
Cooling Water and Helium Gas

H. Takahashi, Dec., 2015



Helium circulation system

IAC、2016



Helium gas is circulated at negative pressure, -1kPa.

Summary

- R&D Works for Spectrometer Detectors are in progress
  - Beam test for Timing Counter/Fiber Tracker
    - Time resolution for MIPS is measured to be ~70 ps.
    - ϕ0.5mm Fibers to be considered to reduce materials.
- Secondary Beam Line Facility
  - Discussion under the PNP div. started