Knucl特推/基盤S合同打ち合わせ
--- 実験まとめ ---

佐久間, 理研

2024 8/5

https://indico2.riken.jp/event/4942/

News 1

PHYSICAL REVIEW C **110**, 014002 (2024)

Measurement of the mesonic decay branch of the $\bar{K}NN$ quasibound state

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(J-PARC E15 Collaboration)

https://doi.org/10.1103/PhysRevC.110.014002

News 2

- PAC(7/30-8/1)の結果（unofficial）
  - E80はStage-2 approval
  - Beam line upgrade に関してもrecommendation
  - E73(2.5+13.5days)

  - １月中旬からSXが既定路線
    - 年度内は　E73(2.5+13.5days)　E70comm.+productionの一部　E72の4時間　T98の1day　E63 0.5 days
    - 2025夏前　E70 production

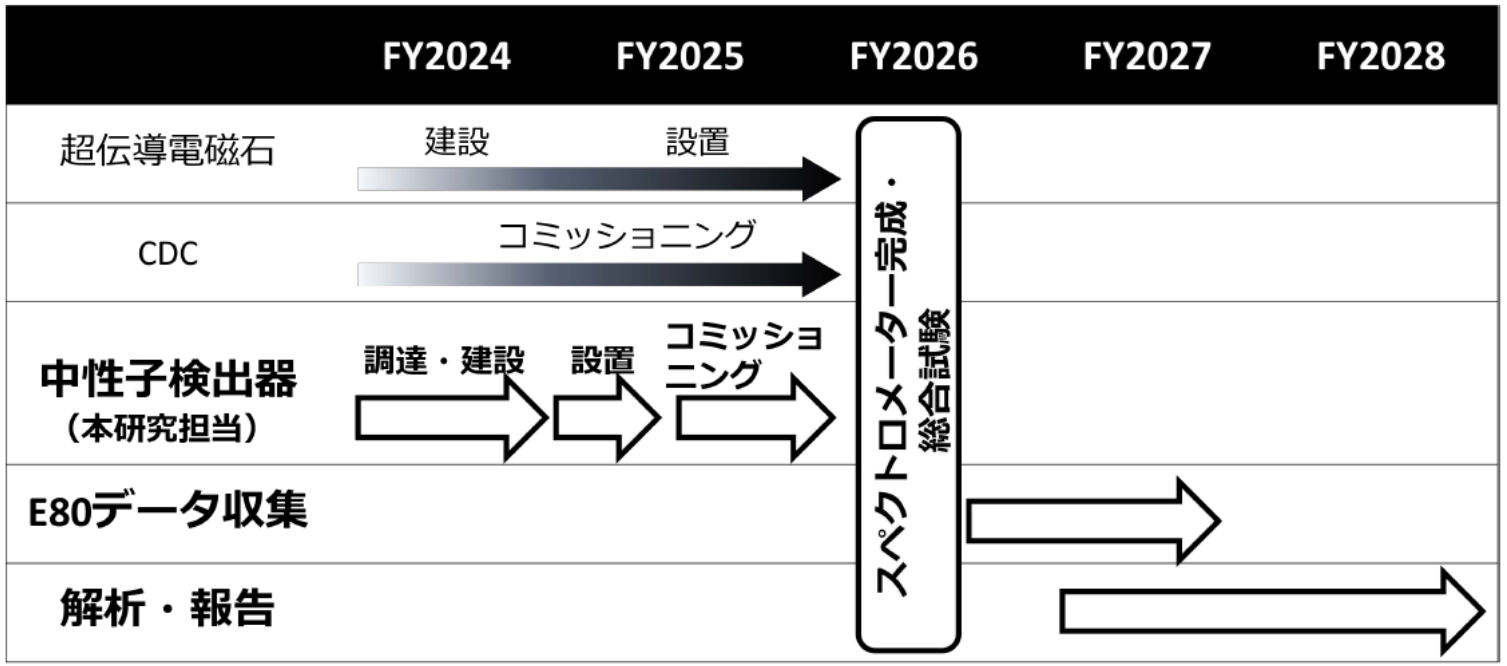
Original Schedule

now

特推

	2022				2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Magnet	–		Purchase (S.C. wires)		Construction				Test & Commissioning				Integration & Commissioninng	Physics Run			Analysis & Pblication			
Polarimeter/NC	Design		Purchase & Assembly						Test & Commissioning											
CDC	Design				Construction				Test & Commissioning											
Fiber tracker	Design								Construct.		Test & Commiss.									

基盤s



Expriments@K1.8BR

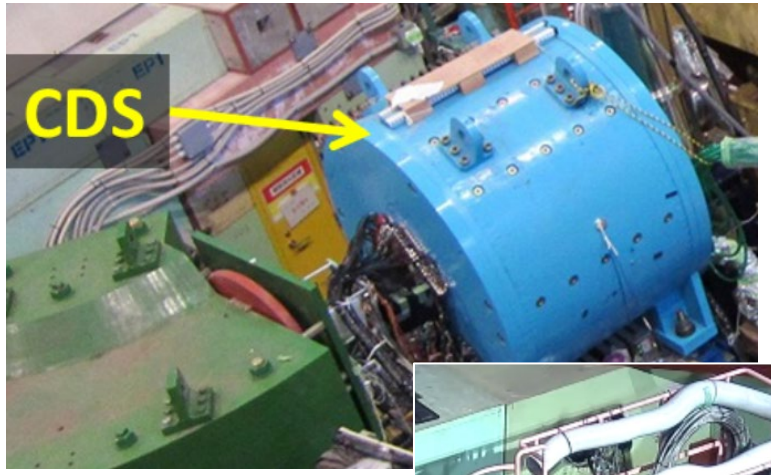
- **Present CDS** ~ within FY2024
  - ✓E73 ($^{3}_{\Lambda}$H lifetime) 25d@80kW

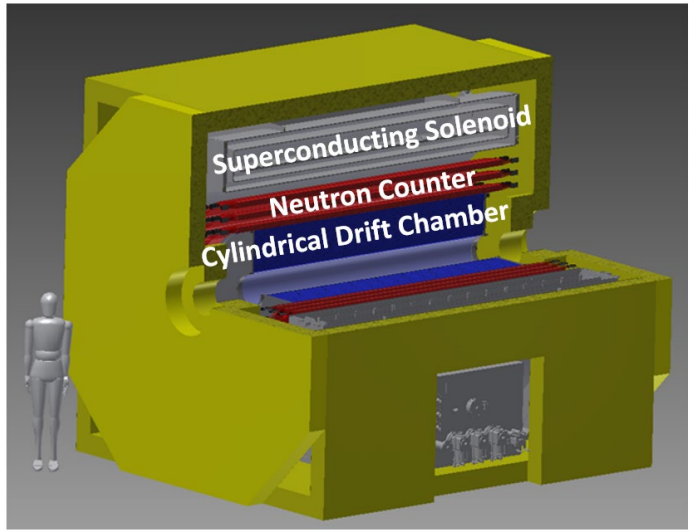
need 9 months

- **Hyp-TPC** ~ before summer of FY2025
  - ✓E72 (Λ*) 14d@80kW

need 1 year

- **New CDS with K1.8BR modification**
  - ✓E80 ($K^{-}ppn \rightarrow \Lambda d/\Lambda pn$) ~14+21d@90kW
  - ✓P89 ($J^{P}(K^{-}pp)$) 56d@90kW
  - ✓E57 (K^{-}d atm) 7d@80kW → ~30d@80kW

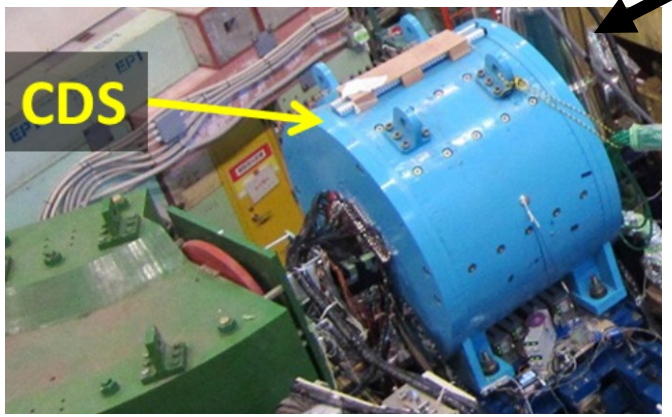


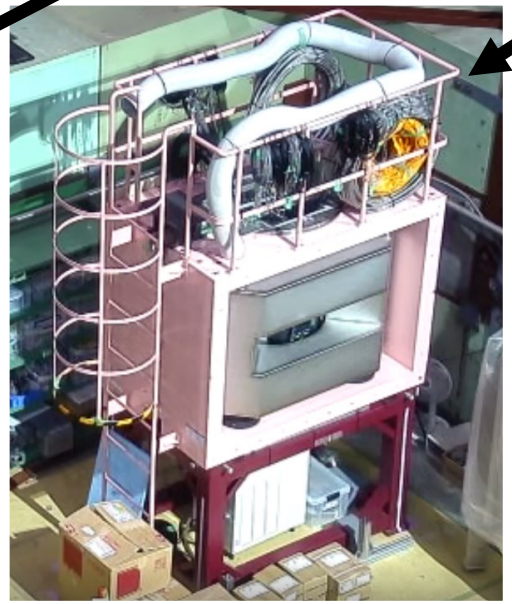


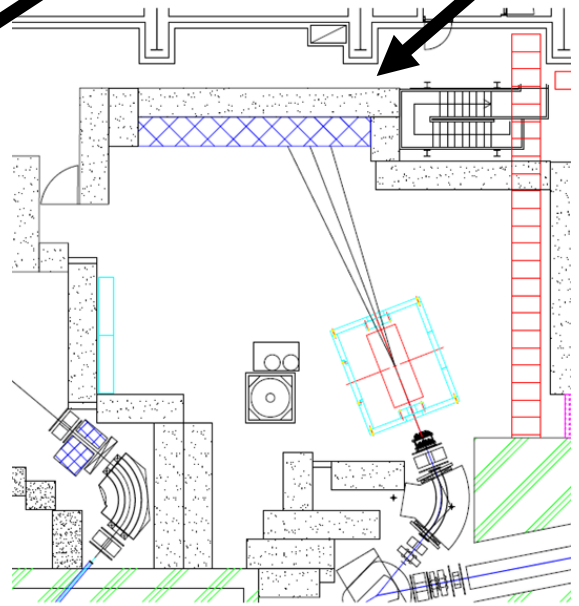
Current Schedule

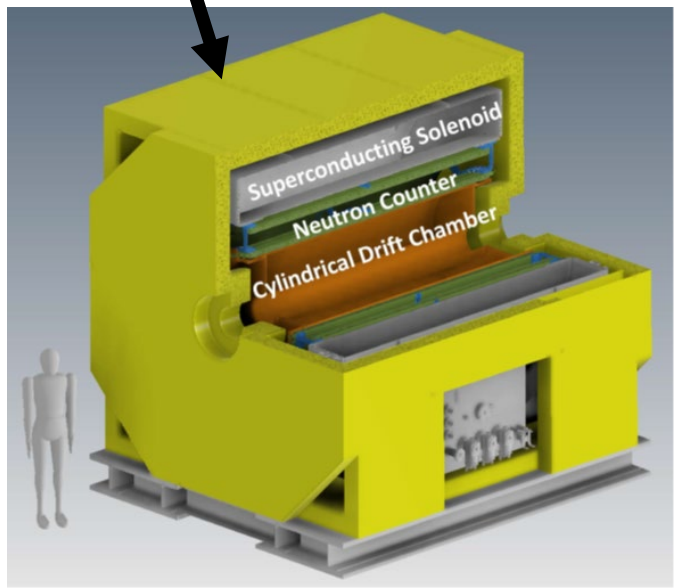
now

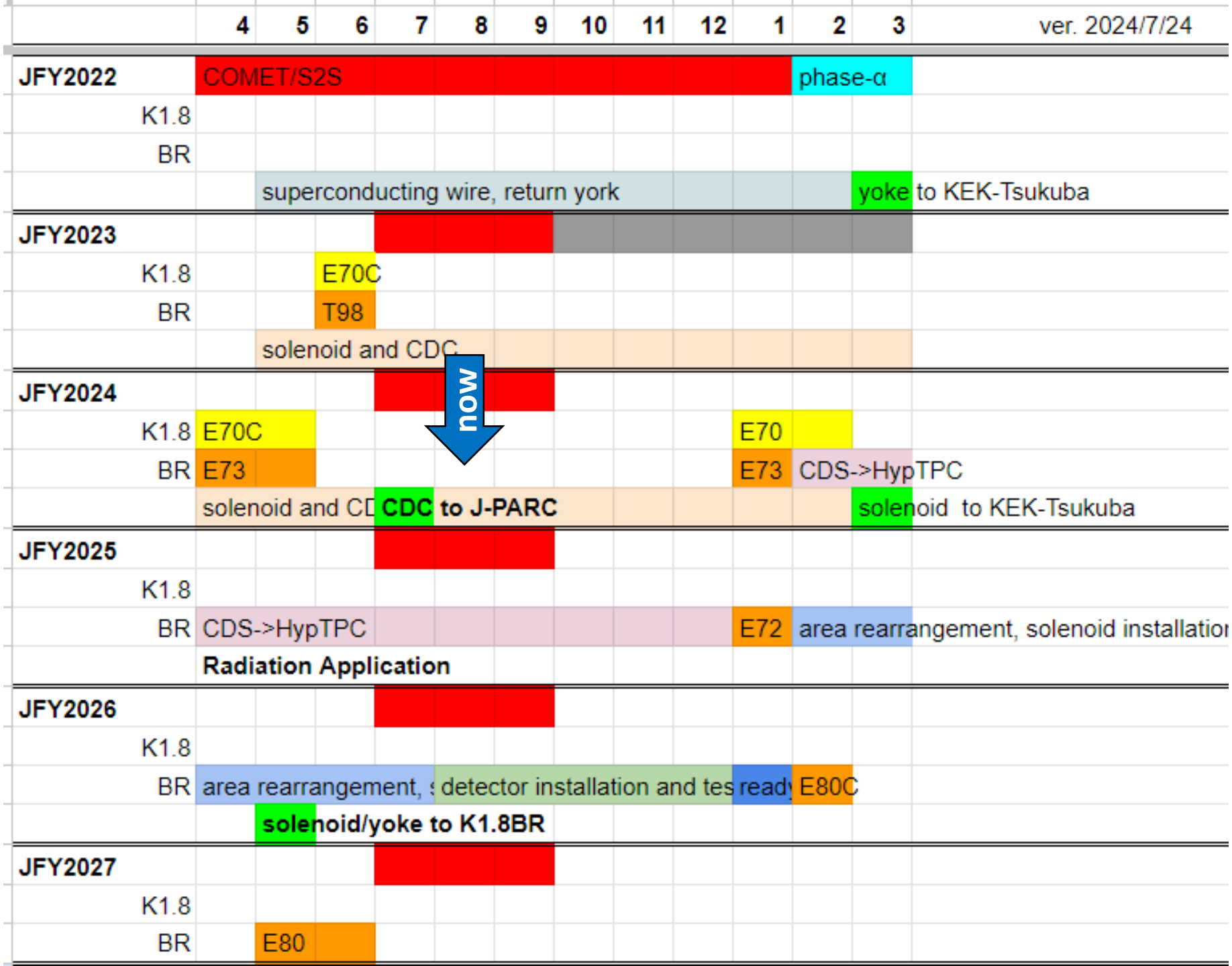
	FY2022				FY2023				FY2024				FY2025				FY2026				FY2027			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
SC Solenoid Magnet	Design		Purchase (SC Wire)		Construction								Stored at KEK				Install ation	Integration, Test & Commissioning		Commissioning w/ Beam	Physics Run	Analysis & Pblication		
CDC	Design				Construction				Test & Commissioning															
NC	Design & R&D										Purchase (Scinti.)		Asse mbly	Test & Commissioning										
K1.8BR Beam Line	E73(CDS) –> E72(HypTPC) Experiments															Upgrade	E80 Experiment							










4 5 6 7 8 9 10 11 12 1 2 3
ver. 2024/7/24
JFY2022
COMET/S2S
phase-α
K1.8
BR
superconducting wire, return york
yoke to KEK-Tsukuba
JFY2023
K1.8
E70C
BR
T98
solenoid and CDC
now
JFY2024
K1.8
E70C
E70
BR
E73
E73
CDS->HypTPC
solenoid and CD
CDC to J-PARC
solenoid to KEK-Tsukuba
JFY2025
K1.8
BR
CDS->HypTPC
E72
area rearrangement, solenoid installatio
Radiation Application
JFY2026
K1.8
BR
area rearrangement,
detector installation and tes
ready
E80C
solenoid/yoke to K1.8BR
JFY2027
K1.8
BR
E80

Budget Situation

We have already secured the budget to construct the CDS.

- The magnet and CDC cost have been covered by **"Grant-In-Aid for Specially Promoted Research by JSPS (FY2022-26)"**.

Superconducting solenoid magnet	~370M JPY
CDC (cylindrical drift chamber)	~54M JPY

- The CNC will be built with a new budget, **"Grant-in-Aid for Scientific Research (S) by JSPS (FY2024-28)"**.

CNC (cylindrical neutron counter)	~80M JPY

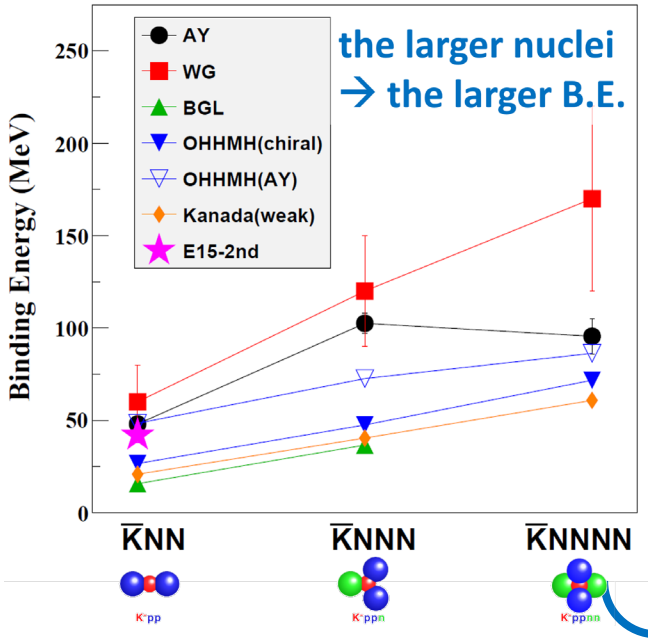
Systematic investigation of the light kaonic nuclei

- Systematic measurement will be promoted
  - Mass number dependence
    - Binding energy, Branching ratio, *q* dependence, ..
  - Spin/parity determination

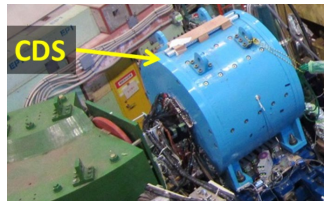
➢ Extract internal structure with theoretical investigations

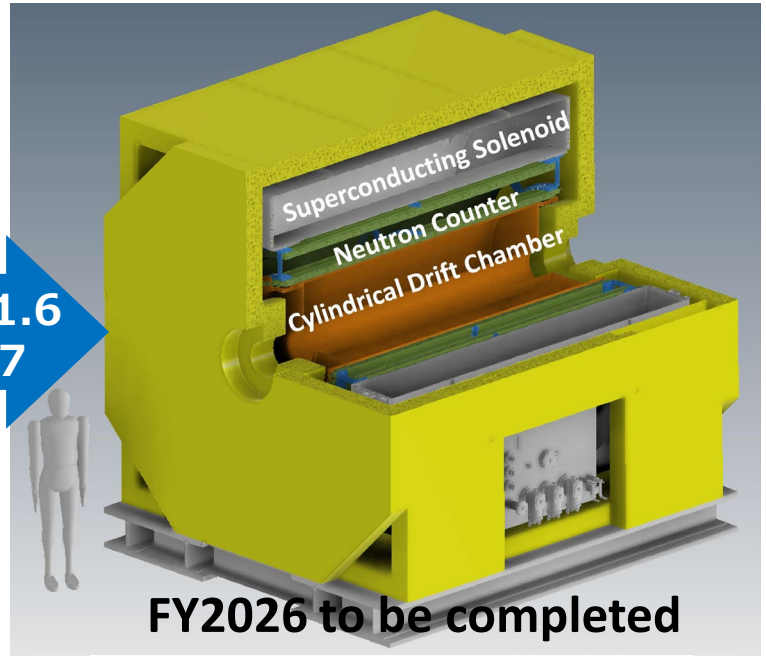
	Reaction	Decays
$\bar{K}N$	d(K^-,n)	$\pi^{\pm 0}\Sigma^{\mp 0}$
$\bar{K}NN$	^{3}He(K^-,N)	$\Lambda p/\Lambda n$
$\bar{K}NNN$	^{4}He(K^-,N)	$\Lambda d/\Lambda pn$
$\bar{K}NNNN$	^{6}Li(K^-,d)	$\Lambda t/\Lambda dn$
$\bar{K}NNNNN$	^{6}Li(K^-,N)	$\Lambda\alpha/\Lambda dd/\Lambda dpn$
$\bar{K}NNNNNN$	^{7}Li(K^-,N)	$\Lambda\alpha n/\Lambda ddn$
$\bar{K}\bar{K}NN$	$\bar{p}$ + ^{3}He	$\Lambda\Lambda$

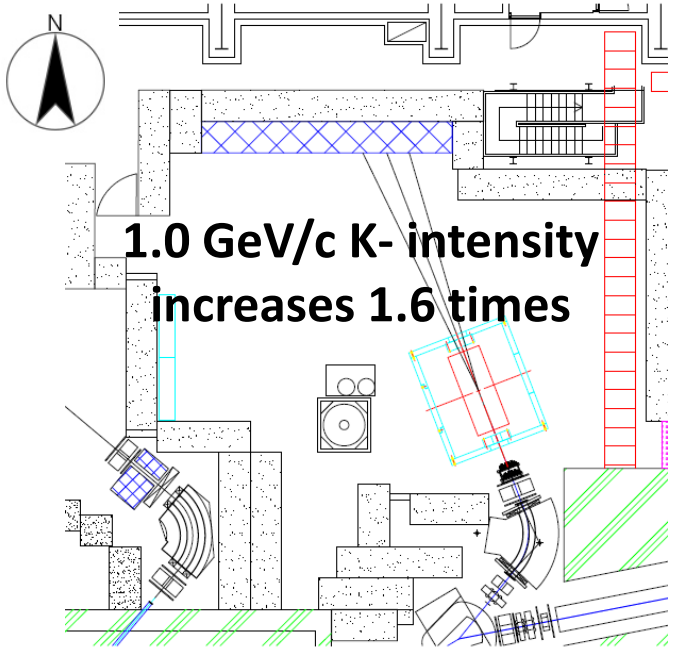
E80 ← first step

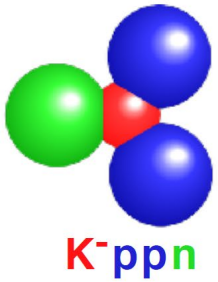


✓Solid angle: x1.6
✓Neutron eff.: x7









a first step of the systematic investigation

$\bar{K}NNN$ @ E80

via ^{4}He(1 GeV/c K^-, n) reaction

① **Establish the existence of $\bar{K}NNN$**

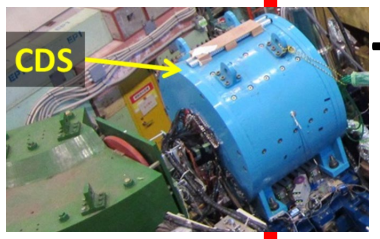
- "K-ppn"→Λd 2-body decay

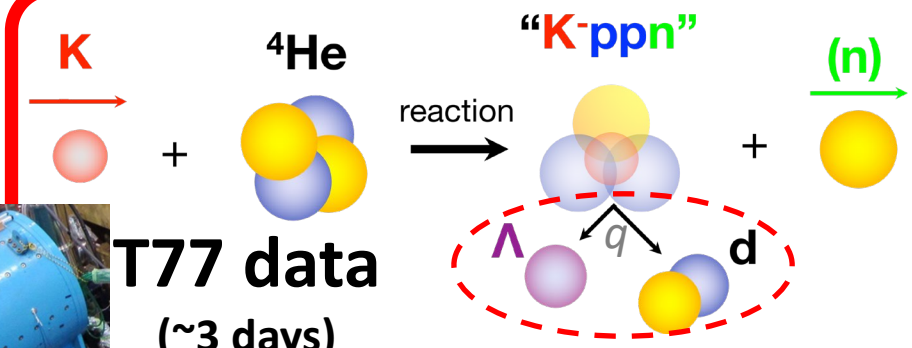
② **Study the multi-particle decay mode of $\bar{K}NNN$ toward understanding its internal structure**

- "K-ppn"→Λpn 3-body decay

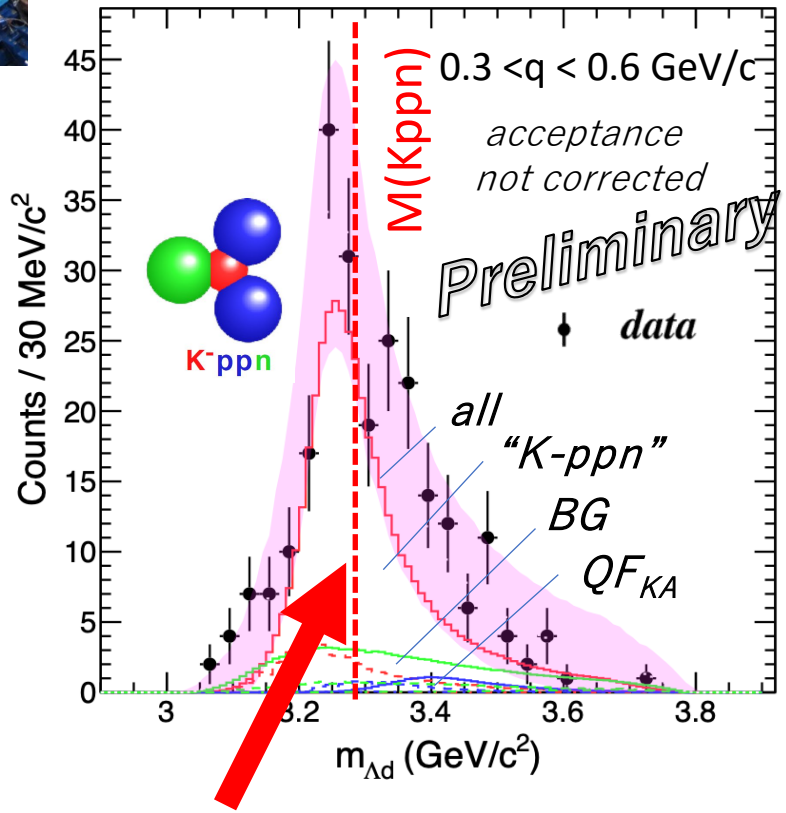
- **Feasibility study of spin-spin correlation measurement for P89 (J^P determination of $\bar{K}NN$)**
  - *e.g.*, installing a prototype module of a polarimeter tracker

Beam intensity	90kW
Beam time	1+1+3 weeks



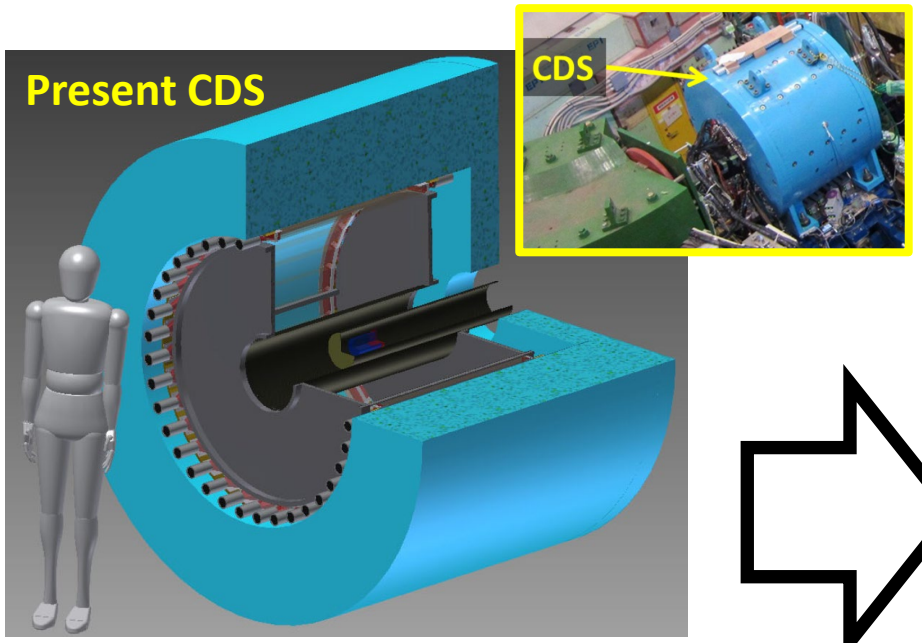


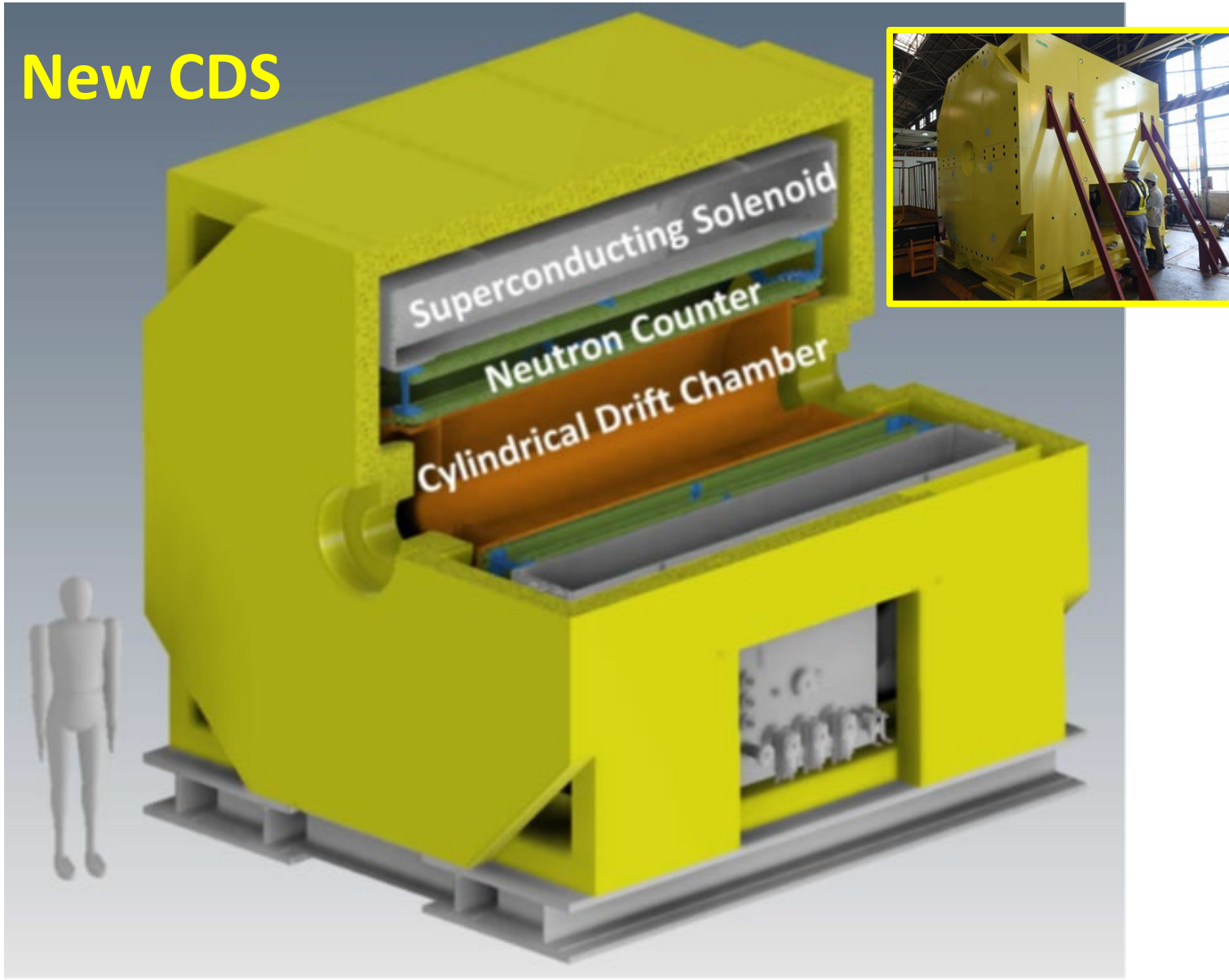
T77 data
(~3 days)



the sign of the "K⁻ppn"

New Cylindrical Detector System (CDS)





- ✓**Solid angle: x1.6** (59% → 93%)
- ✓**Neutron eff.: x7** (3% → 12%x1.6)

Superconducting Solenoid Magnet

- Same design as “the detector solenoid magnet” for COMET-I

being constructed in cooperation with the J-PARC Cryogenics Section

- 3.3m x 3.3m x 3.9m, ~108t in total
- Max. field of 1.0T @ center
  - 189A – 10V
- NbTi/Cu SC wire, 98km in total
- **Conduction-cooling with GM*3**
- Semi-active quench-back system
- **Will be completed in FY2024**

SHI FA-50
(air cooling)

RDE-418D4

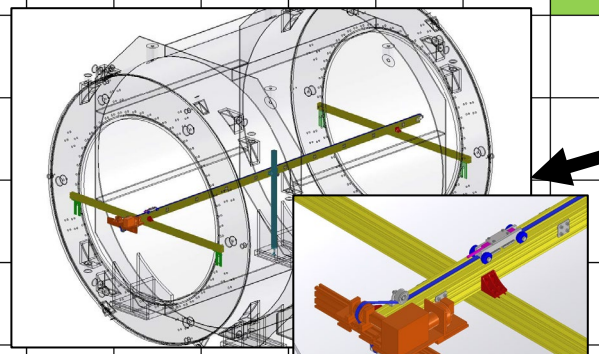
Schedule of Superconducting Solenoid Magnet

	FY2022				FY2023				FY2024				FY2025				FY2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
SC Wire	purchase																			
Return Yoke	Construction				stored at KEK															
GM Refrigerators	purchase																			
Cold Mass					Construction															
Power Supply w/ DAQ					Construction															
Vacuum Vessel									Construction											
Assembly																				
Cooling Tests																				
Excitation Tests w/o Return Yoke																				
On-site Assembly																				
Excitation Test																				
Magnetic Field Measurement																				

now

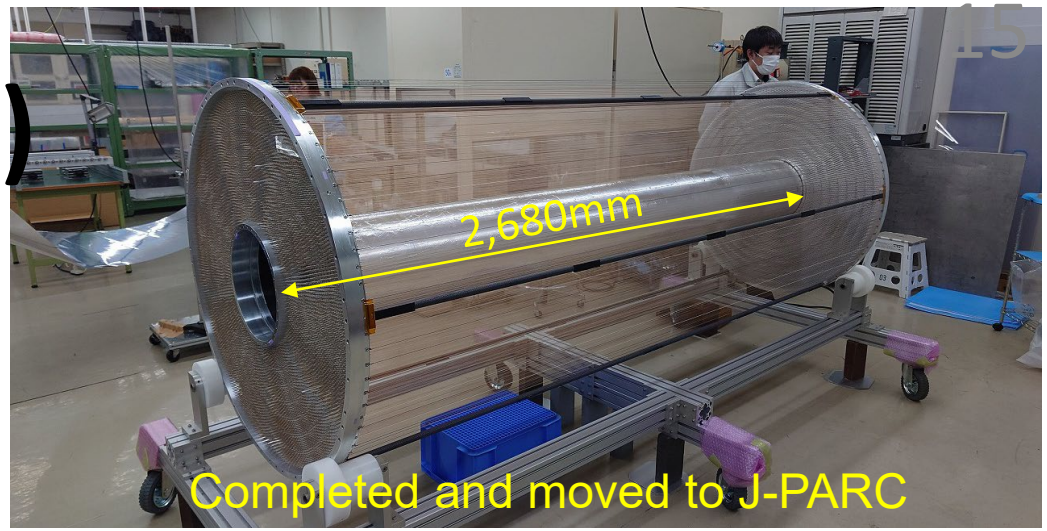
completion

stored at KEK

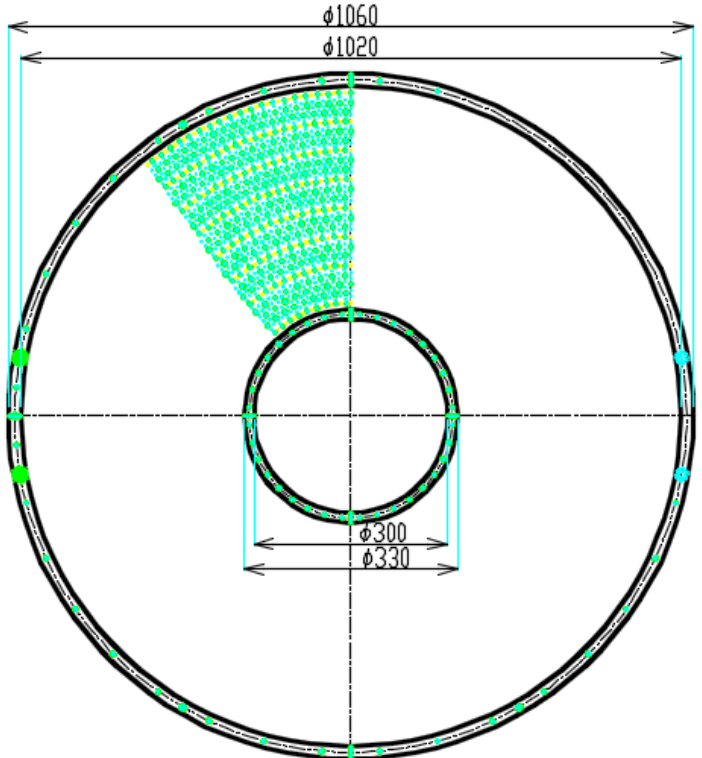


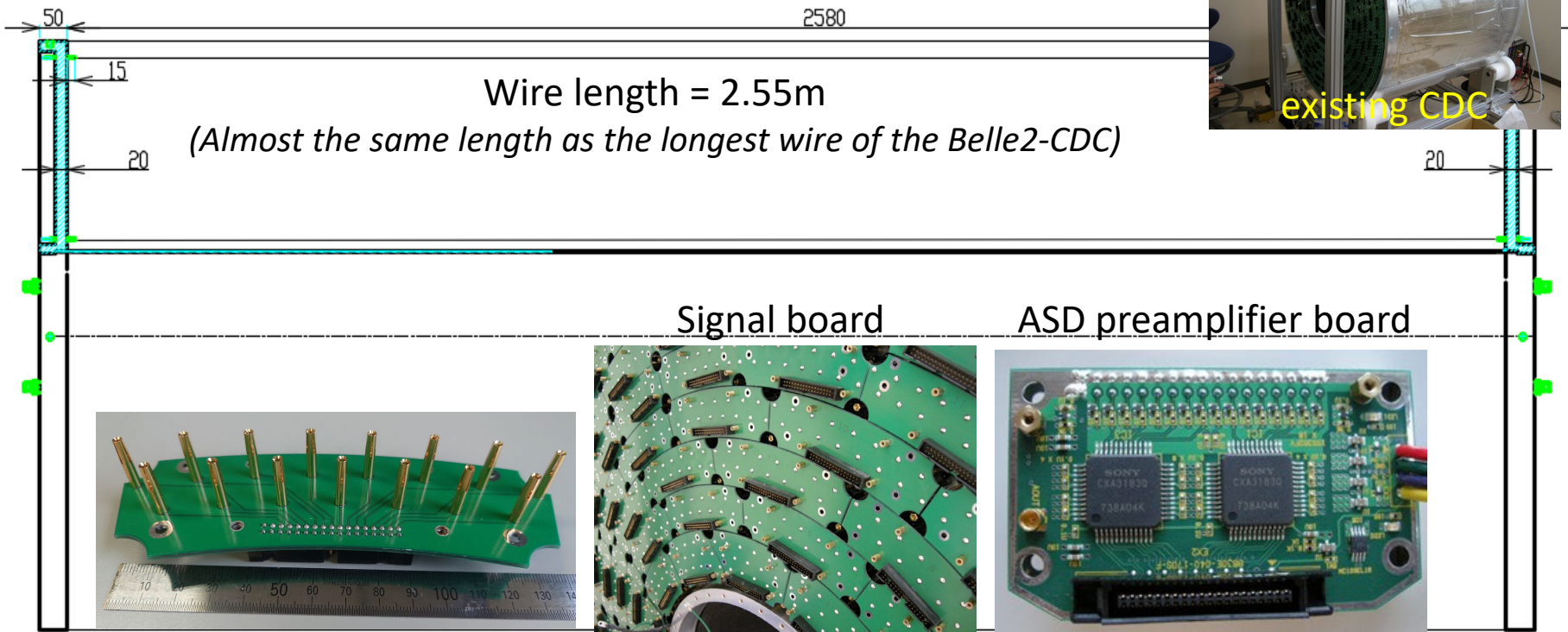
Cylindrical Drift Chamber (CDC)

- 3 times the length of the existing CDC
  - Gas: Ar/CO_2=90/10
- The same design of the present end-cap
- Readout systems are reused



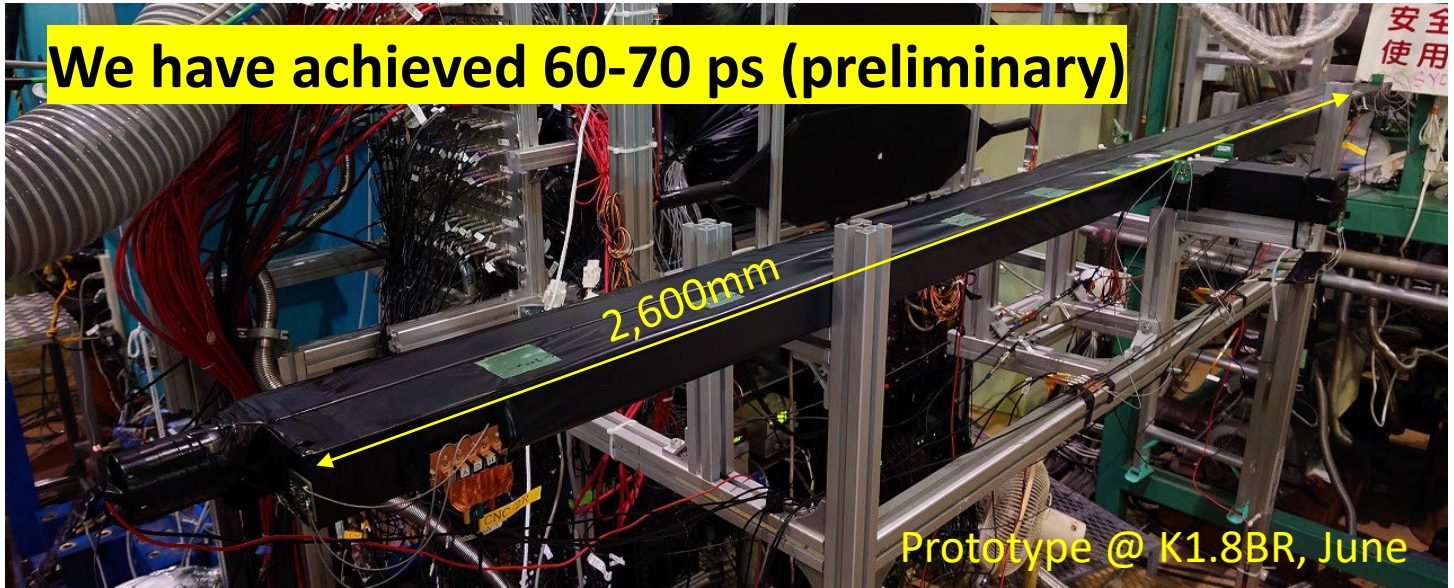
Completed this month, and commissioning will soon start @ J-PARC

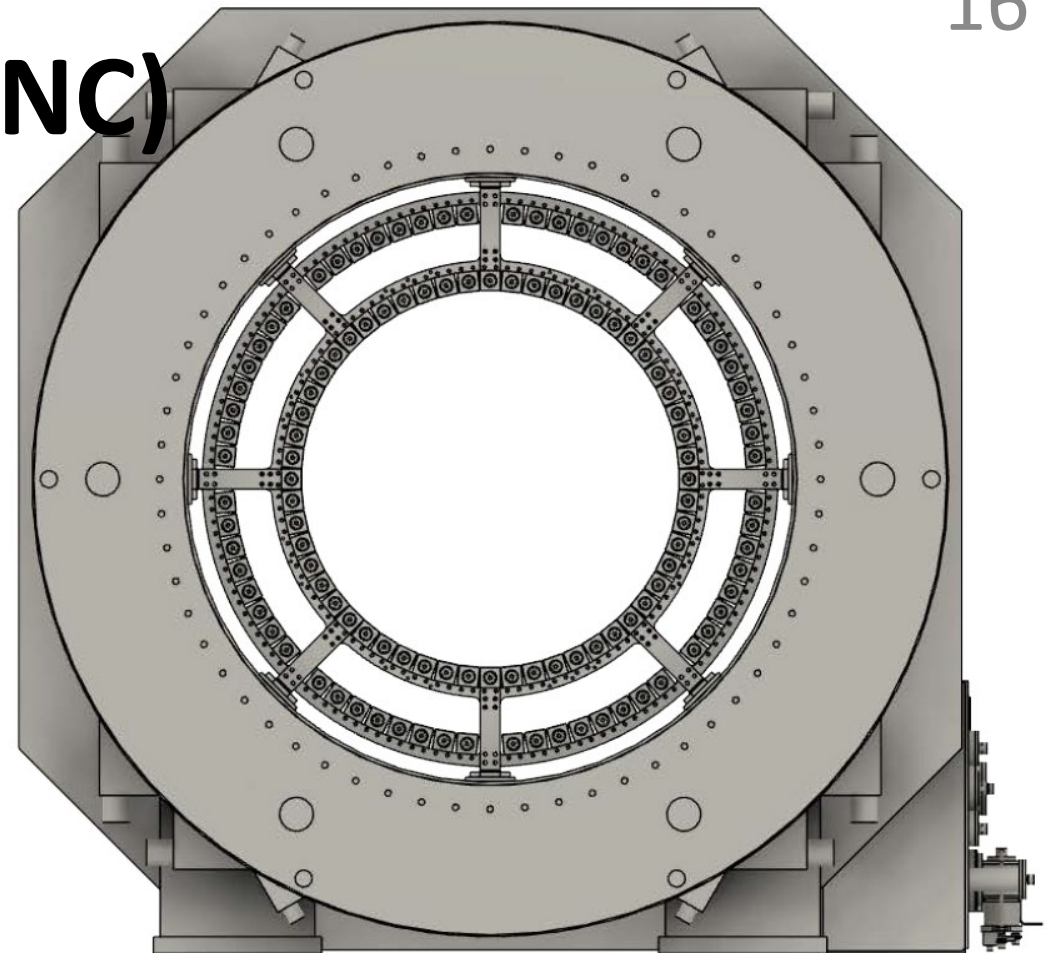




Cylindrical Neutron Counter (CNC)

- scintillator array: 2 layers, 12cm thickness
- Neutron detection efficiency of 12~36%
- 56+80=136 modules
  - ELJEN EJ-200: (T)60mm, (W)60mm, (L)3,000mm
- 1.5-inch FM-PMT [H8409(R7761)]
  & MPPC array [S13361-6050AE-04]
- **Will be completed in FY2025**

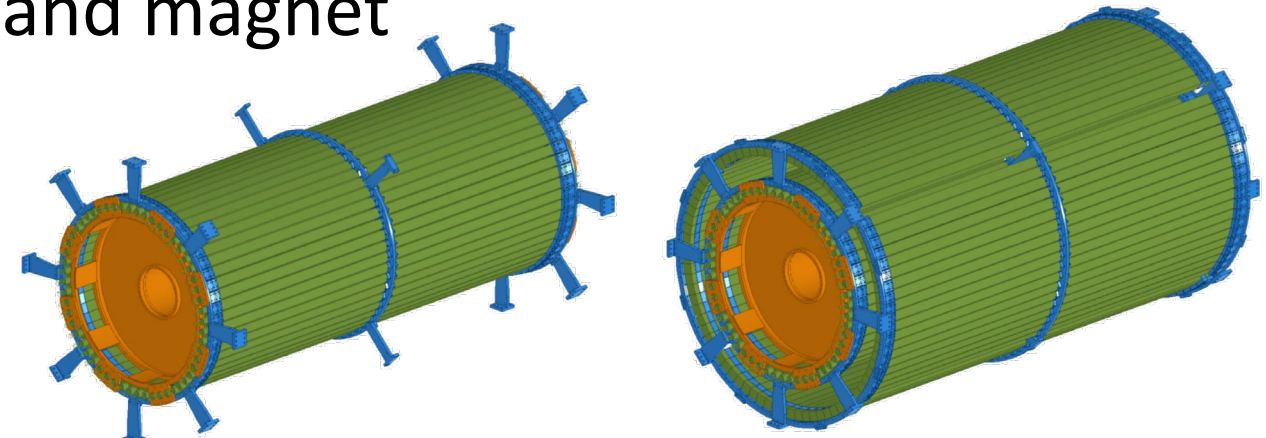


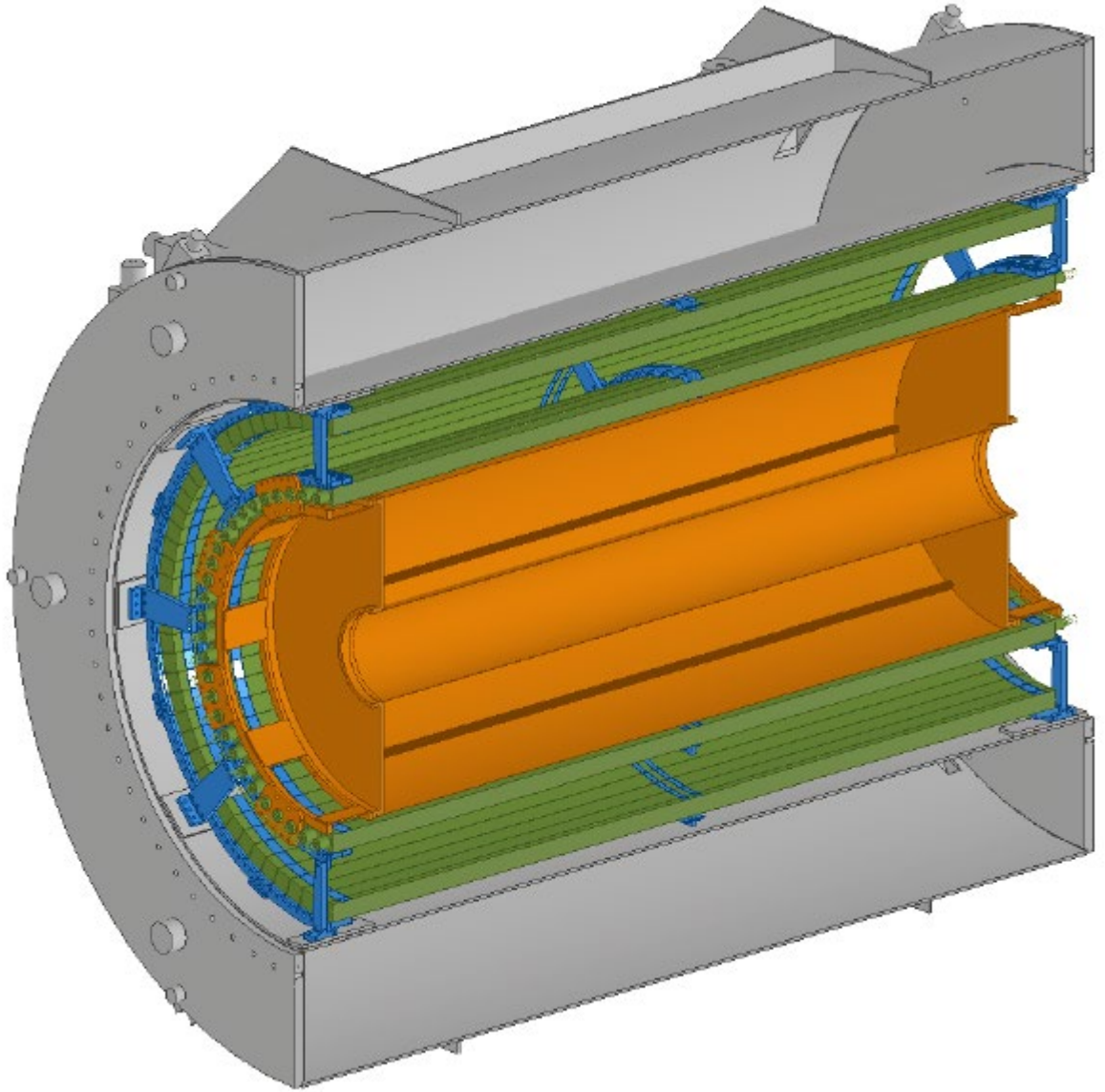


136 scintillators in total
- 56 segments @ r548~608mm
  - ➢ 112 FM-PMTs
- 80 segments @ r780~840mm
  - ➢ 160 MPPC-arrays

Support Structure

- CNC is supported at upstream, downstream and middle position
  1. pillars are mounted on the inner cylinder of the magnet
  2. ring structures are installed on the pillars
  3. each module is mounted on the ring structures
- CDC is installed by inserting a long frame bar into the center of the CDC and magnet





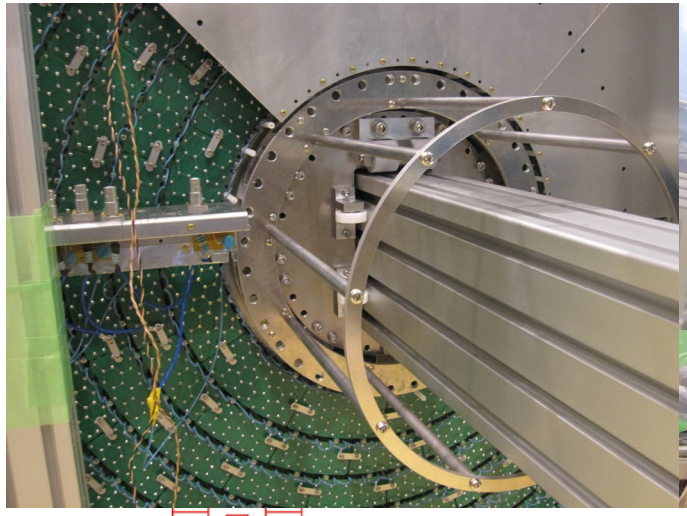
Will be prepared in FY2025-26

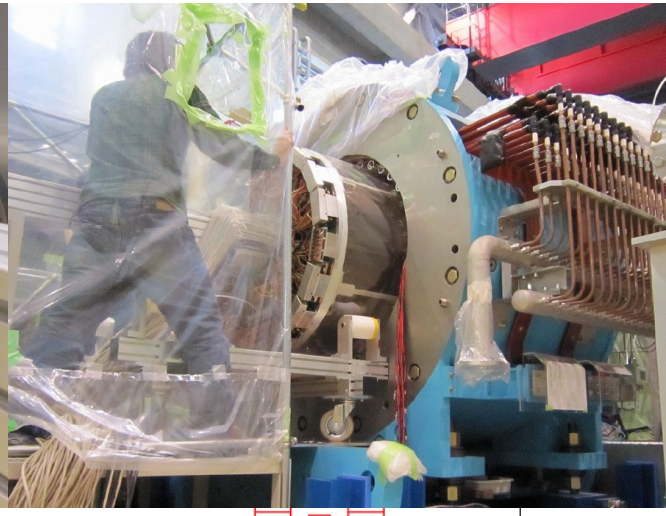
CDC Installation

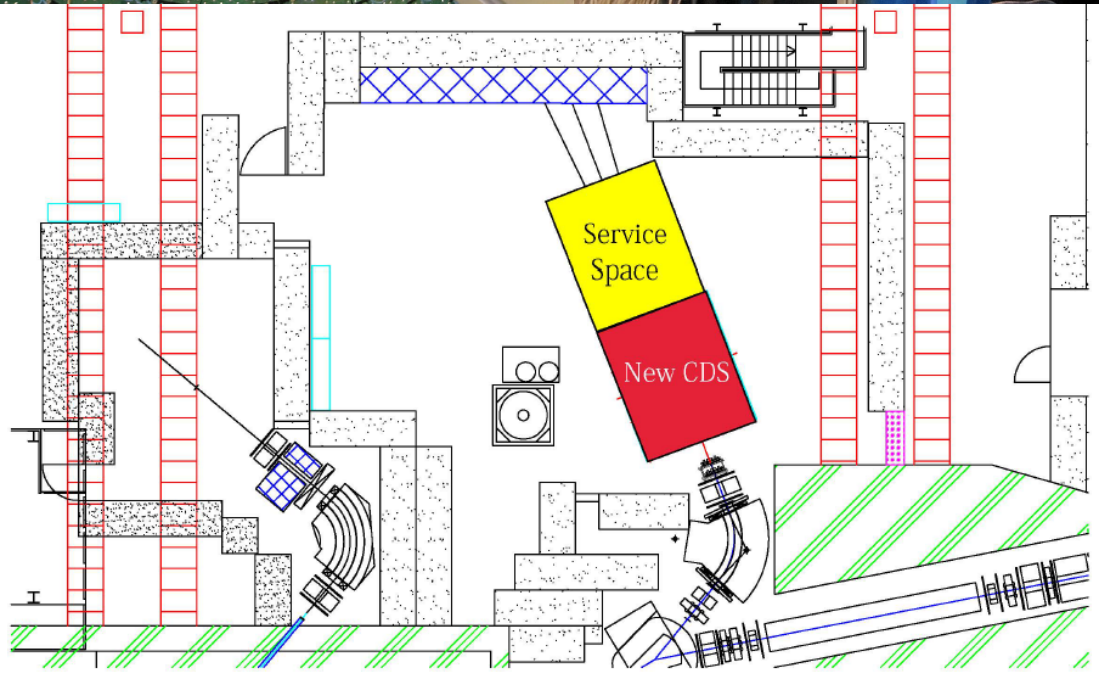
- CDC is installed by inserting a long frame bar into the center of the CDC and magnet
  - We plan to use a splittable bar twice the length of the solenoid.

Will be prepared in FY2025-26

- Service space equivalent to the installation area of the magnet is required downstream of the magnet
  - to prepare and install the CDC by rolling it in and out of the magnet







K1.8BR Upgrade

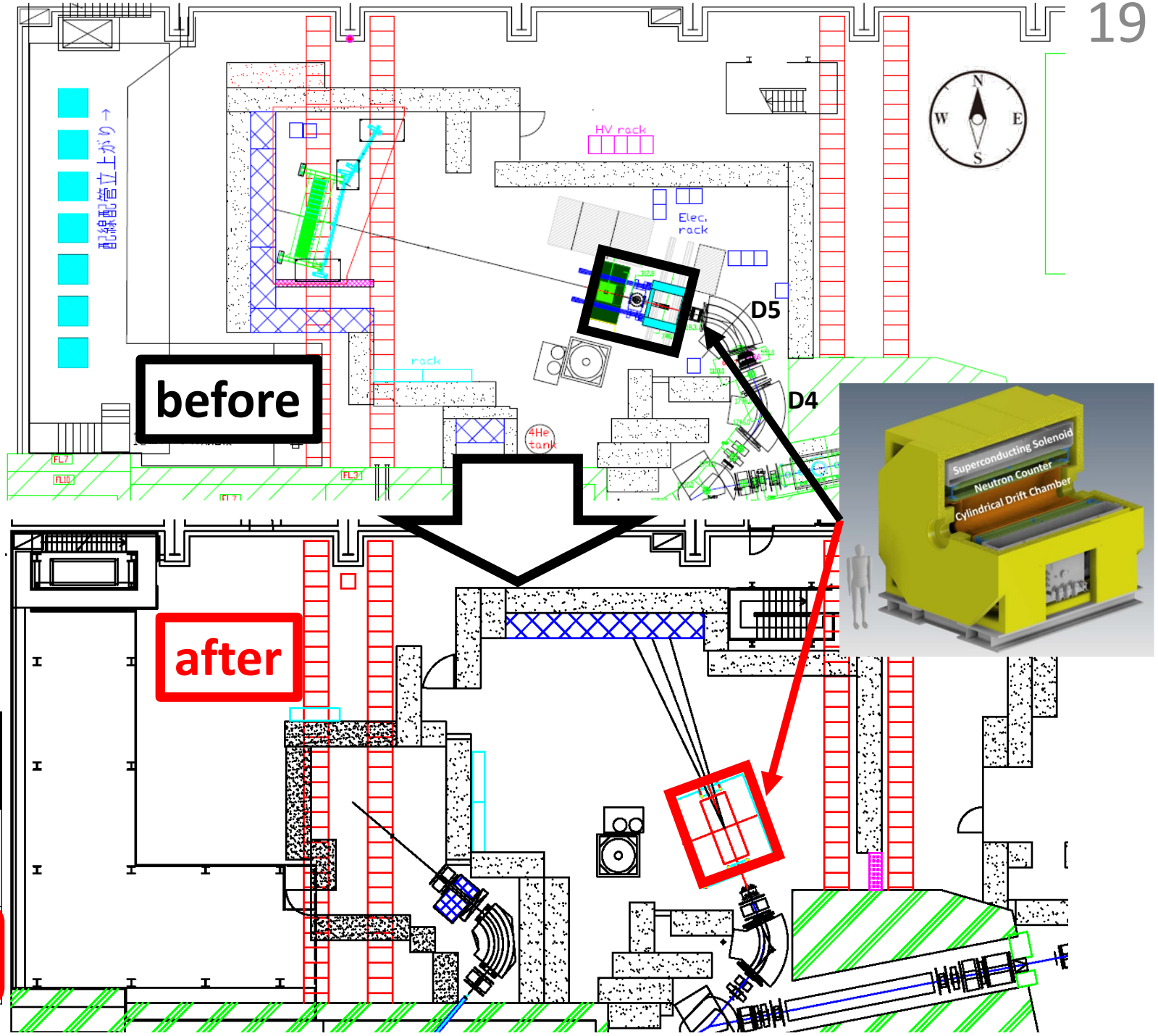
- **We have proposed a new configuration of the beam line**

Shorten the beamline (~3.7m) by removing the final D5 magnet

➢ **1.0 GeV/c K^- intensity increases 1.6 times**

with $\pi/K \sim 2$

Relative beam-line length (beam yield)	D4+D5	D4
Present CDS	0 (x1)	-3.7m (x1.6)
New CDS	+1.2m (x0.9)	**-2.5m (x1.4)**

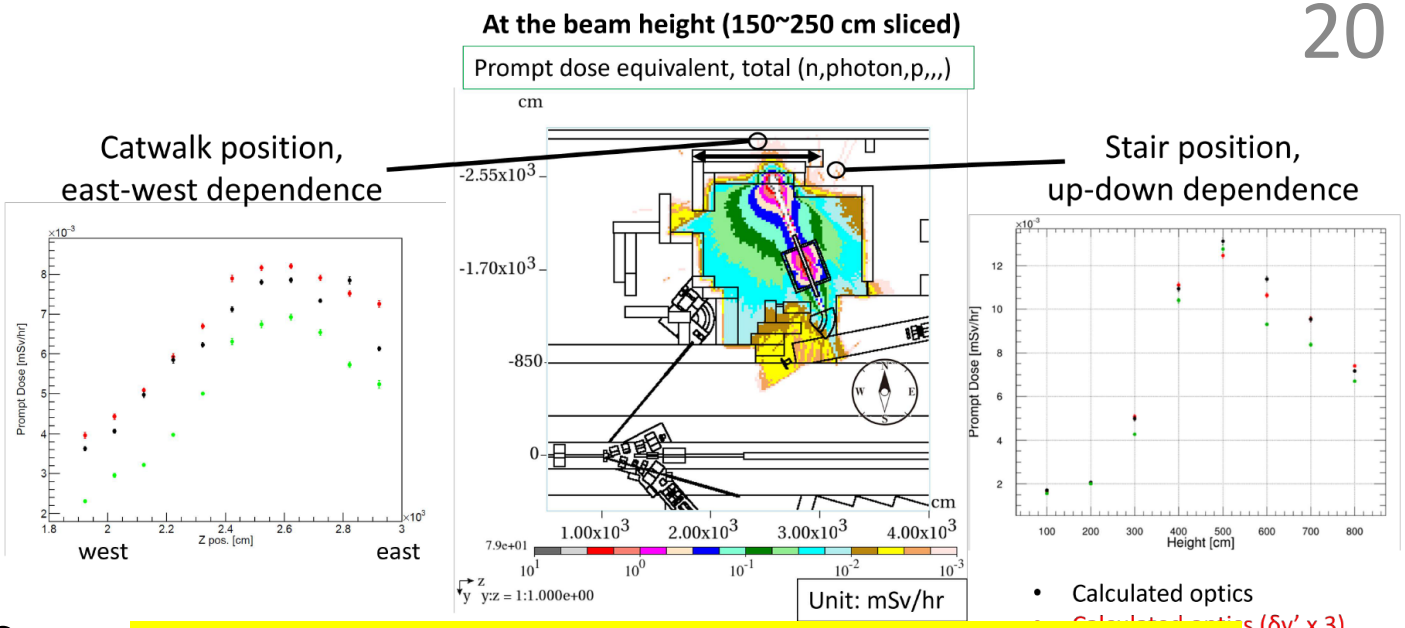


K1.8BR Upgrade

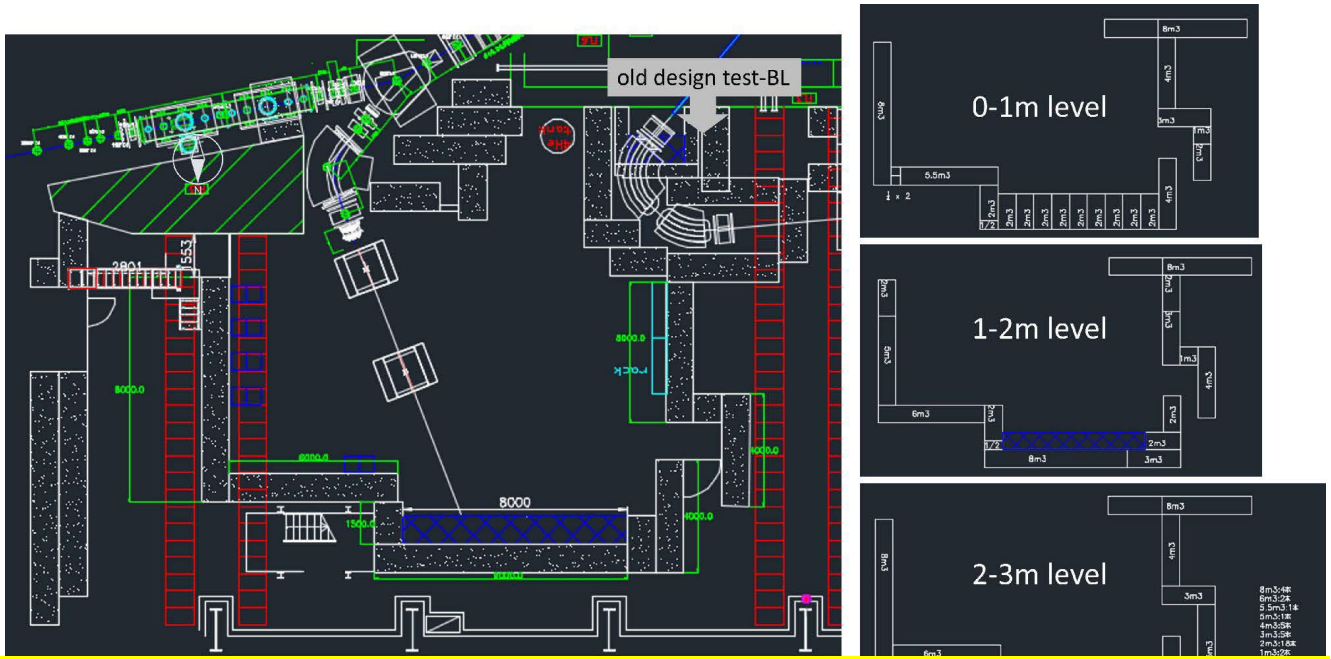
- We have consulted with the HD-G and the Radiation Control Section
  - ➢radiation application is required
- Process
  1. Removal of D5/detectors/cables/etc.
  2. Installation of new solenoid
  3. Re-arrangement of shield
  4. Re-installation of cables/PPS/etc.

  It will take ~6 months

- **We would like to upgrade K1.8BR in late FY2025 – early FY2026**
  - ➢the application should be submitted in early FY2025



the radiation level is well below the 25 μSv/h limit



possible to rearrange the shields without purchasing new ones

Estimated Cost of the K1.8BR Modification

Item	Cost (k JPY)
Cable removal	3,000
Shield reconfiguration	7,000
D5 removal	1,000
PPS and other interlocks rearrangement	5,000
total	**16,000**

We are now trying to reduce costs further.

議論のネタ

- 山縣さんE62のペーパー
- K+(中須賀・慈道)
- 慈道計算、サイズ？
- 緒方さん（九大）と議論