25aK205-8

COMET-CDCの 宇宙線を用いた性能評価試験 (4)

森津 学

沖中香里[A]、久野良孝[A]、佐藤朗[A]、中沢遊[A]、中村有希[A]、松田悠吾[A]、元石尊寛[A]、吉田学立[A]、Ming Liang Wong[A], Ting Sam Wong[A], Chen Wu[A,B, C], Jie Zhang[B]、他COMET-CDCグループ

高エ研, 阪大理[A], IHEP[B], Nanjing Univ.[C]

2018/03/25

日本物理学会第73回年次大会@東京理科大学

講演の流れ

連続講演

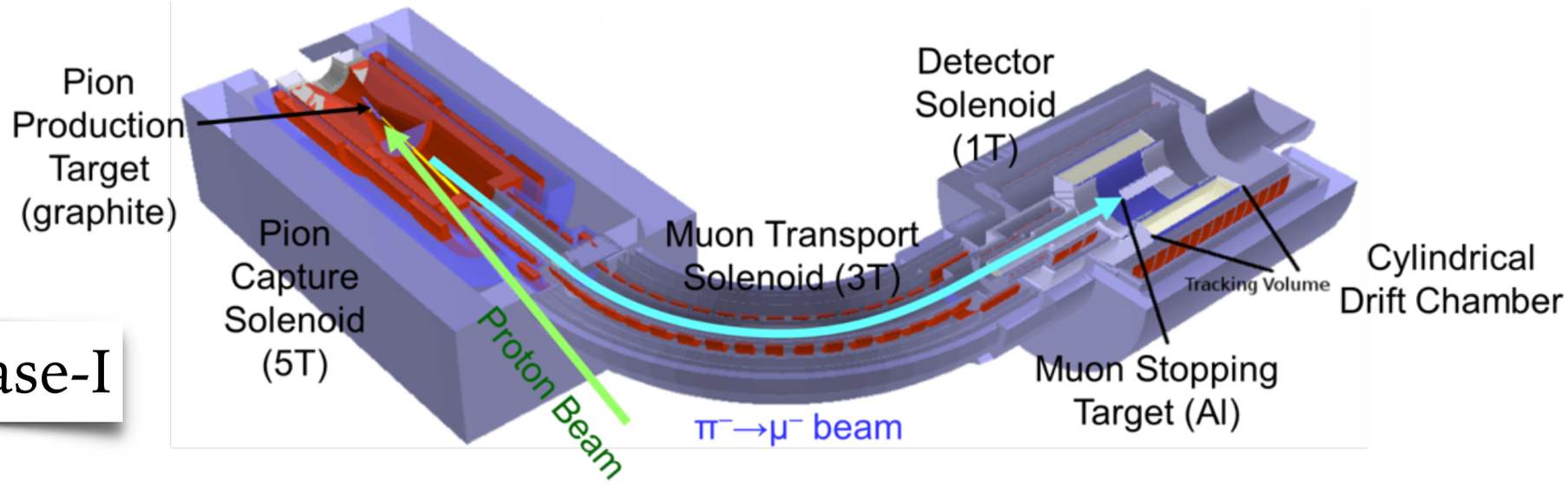
1. COMET-CDCの宇宙線を用いた性能評価試験 (4)　　森津

2. COMET-CDCにおける宇宙線試験の解析 (3)　　沖中

3. COMET-CDCにおける宇宙線試験のアライメント解析　　松田

Contents

Introduction

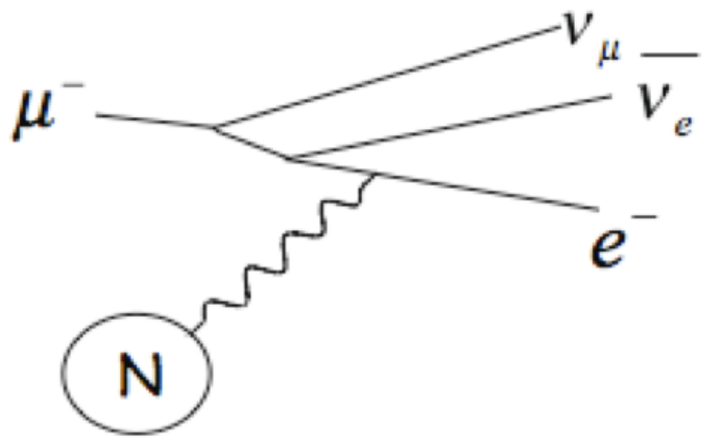


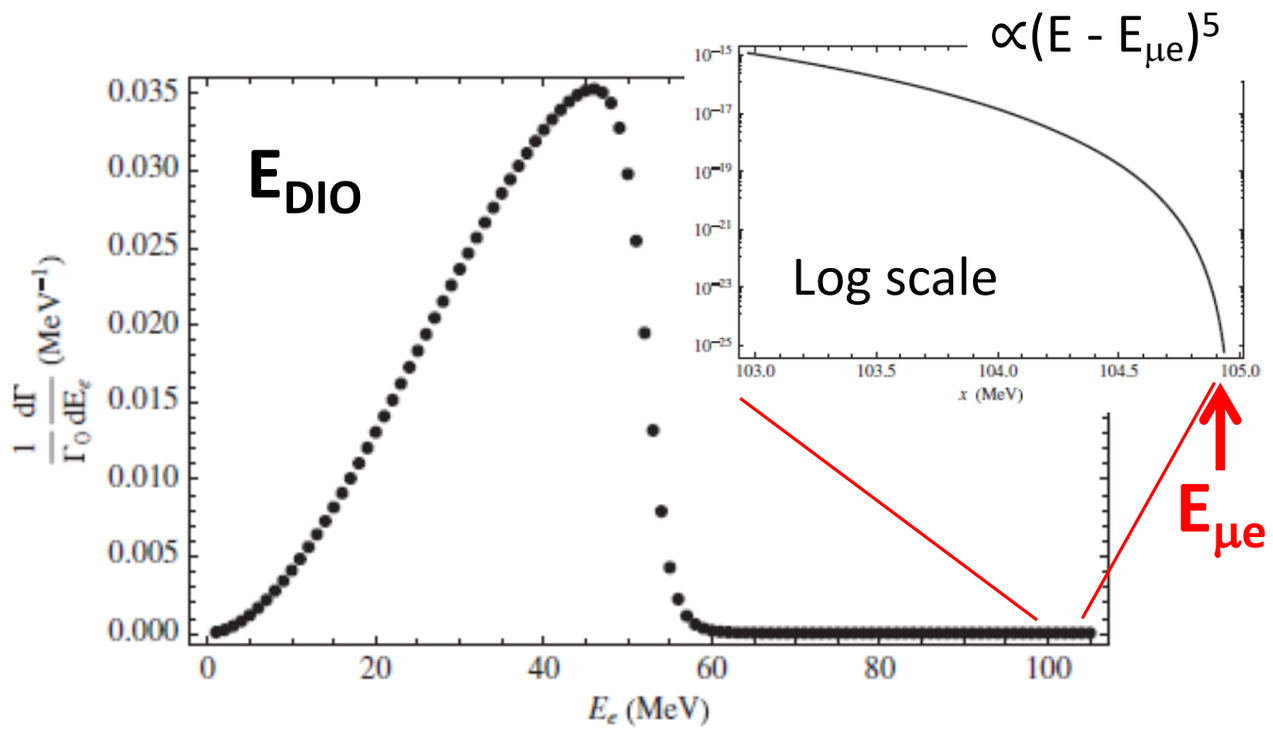
COMET Phase-I

- ミューオン・電子転換過程：　$\mu^- N \rightarrow e^- N$
- Charged Lepton Flavor Violation beyond the Standard Model
- 探索感度：　S.E.S. **~3 x 10^{-15}** at COMET Phase-I
- J-PARCの大強度ビームと超伝導ソレノイドにより大量のミューオンを生成・輸送
- 物理測定に**Cylindrical Drift Chamber (CDC)** を採用
- シグナルは **~105 MeV**の単色電子　(for Al標的)
- 主な背景事象は、
  1. Beam-related BG　—> 高純度パルスビーム@J-PARC Bunched SX
  2. Decay-In-Orbit electron (DIO電子)　—> 次のページ
  3. Cosmic-ray BG

Decay-In-Orbit BG

Muon Decay in Orbit (DIO)

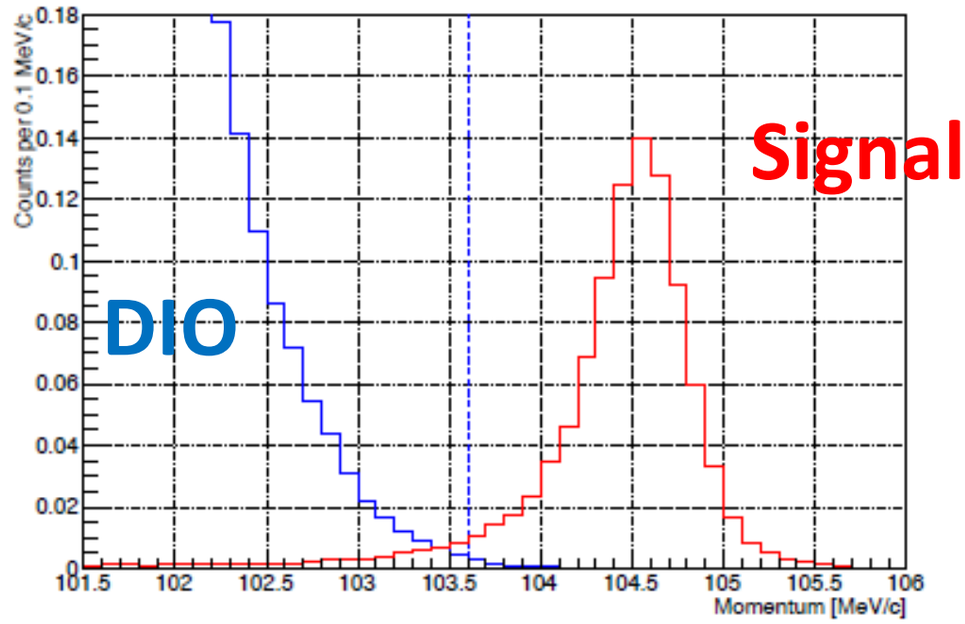




To distinguish signal from DIO BG,
Momentum resolution < 200 keV/c
for 105 MeV electrons

@ S.E.S. = 3 x 10^{-15} (Phase-1)

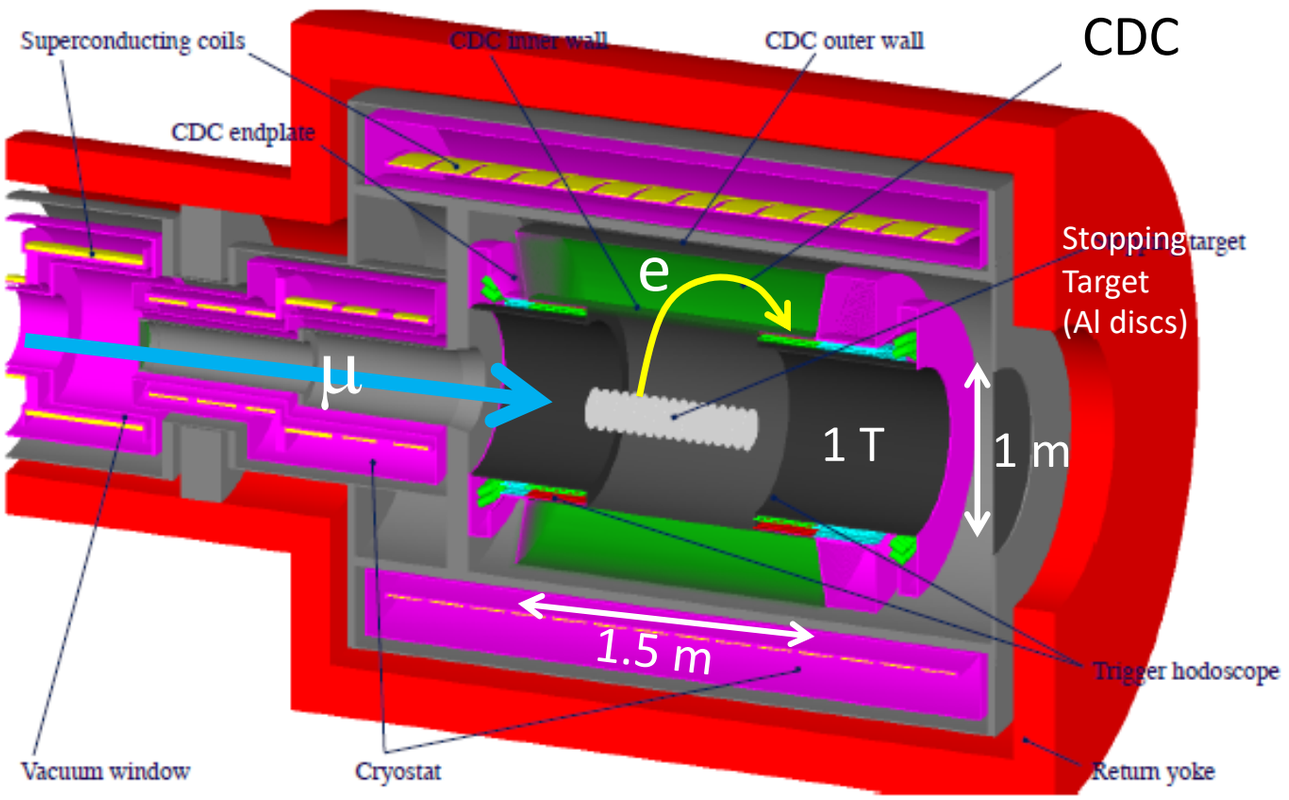
Simulation Signal and DIO (BR=3 × 10^{-15})

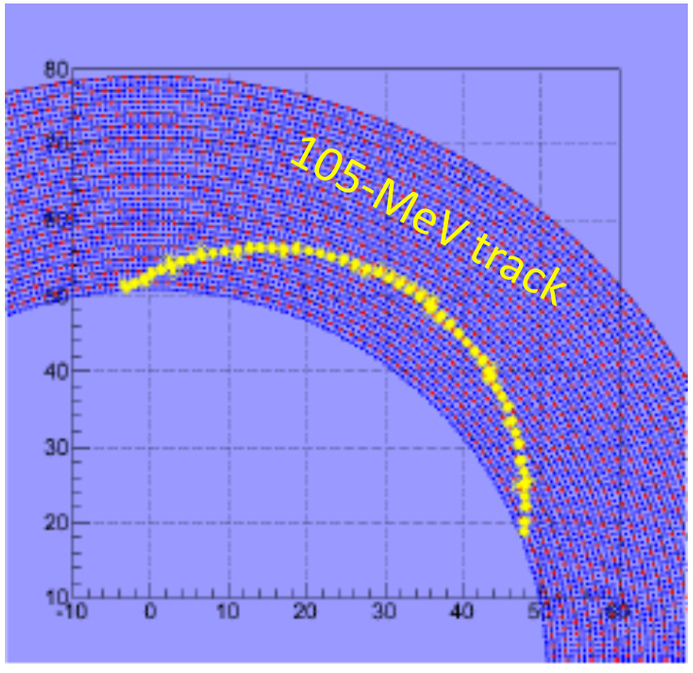


COMET CDC

Table 13.1: Main parameters of the CDC.

Inner wall	Length	1495.5 mm
	Radius	496.0~496.5 mm
	Thickness	0.5 mm
Outer wall	Length	1577.3 mm
	Radius	835.0~840.0 mm
	Thickness	5.0 mm
Number of sense layers		20 (including 2 guard layers)
Sense wire	Material	Au plated W
	Diameter	25 μm
	Number of wires	4986
	Tension	50 g
Field wire	Material	Al
	Diameter	126 μm
	Number of wires	14562
	Tension	80 g
Gas	Mixture	He:i-C_4H_{10} (90:10)
	Volume	2084 L





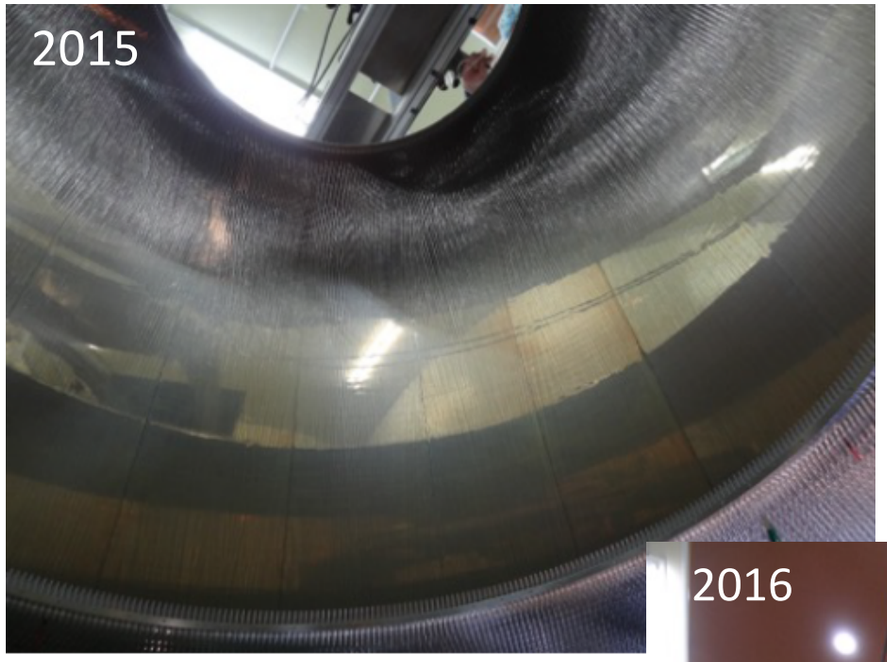
Feature of COMET CDC

- Large inner bore, φ1 m @1 T <- suppress DIO hits
- All alternative stereo wire, ±4 deg <- z-resolution
- Low mass gas = He:i-C_4H_{10} (90:10) <- *p* resolution

Construction of CDC

これまでの学会で報告

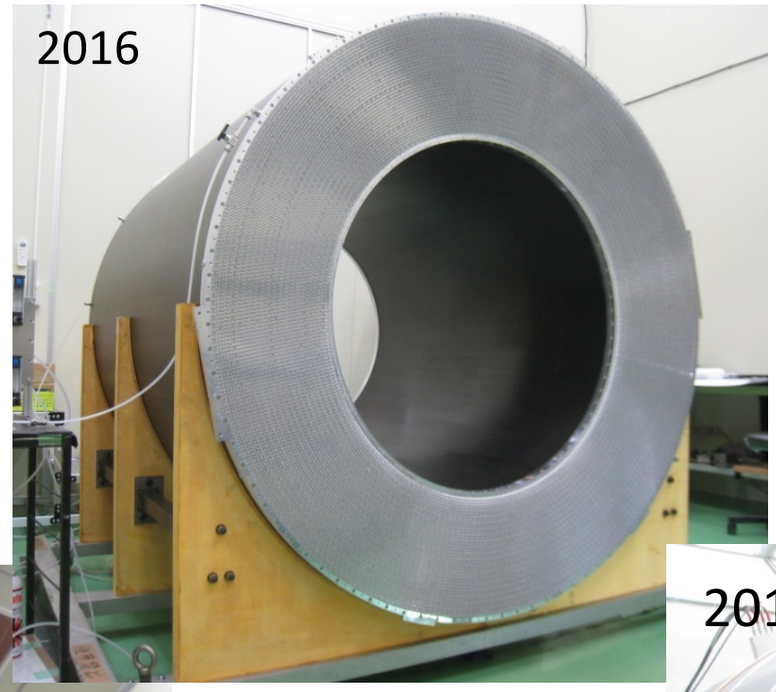
高エネルギーニュース Vol.35, No.3 (2016)「COMET Phase-I Cylindrical Drift Chamber」吉田・森津



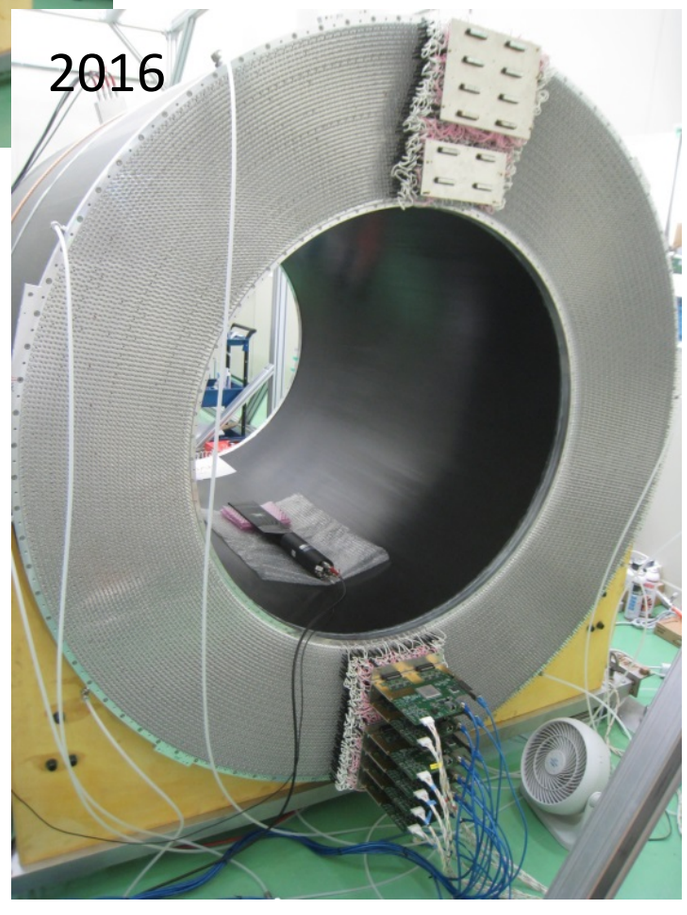
ワイヤー張り
張力測定

@KEK富士実験棟
B4Fクリーンルーム

内筒のインストール



構造体完成



宇宙線試験
を開始

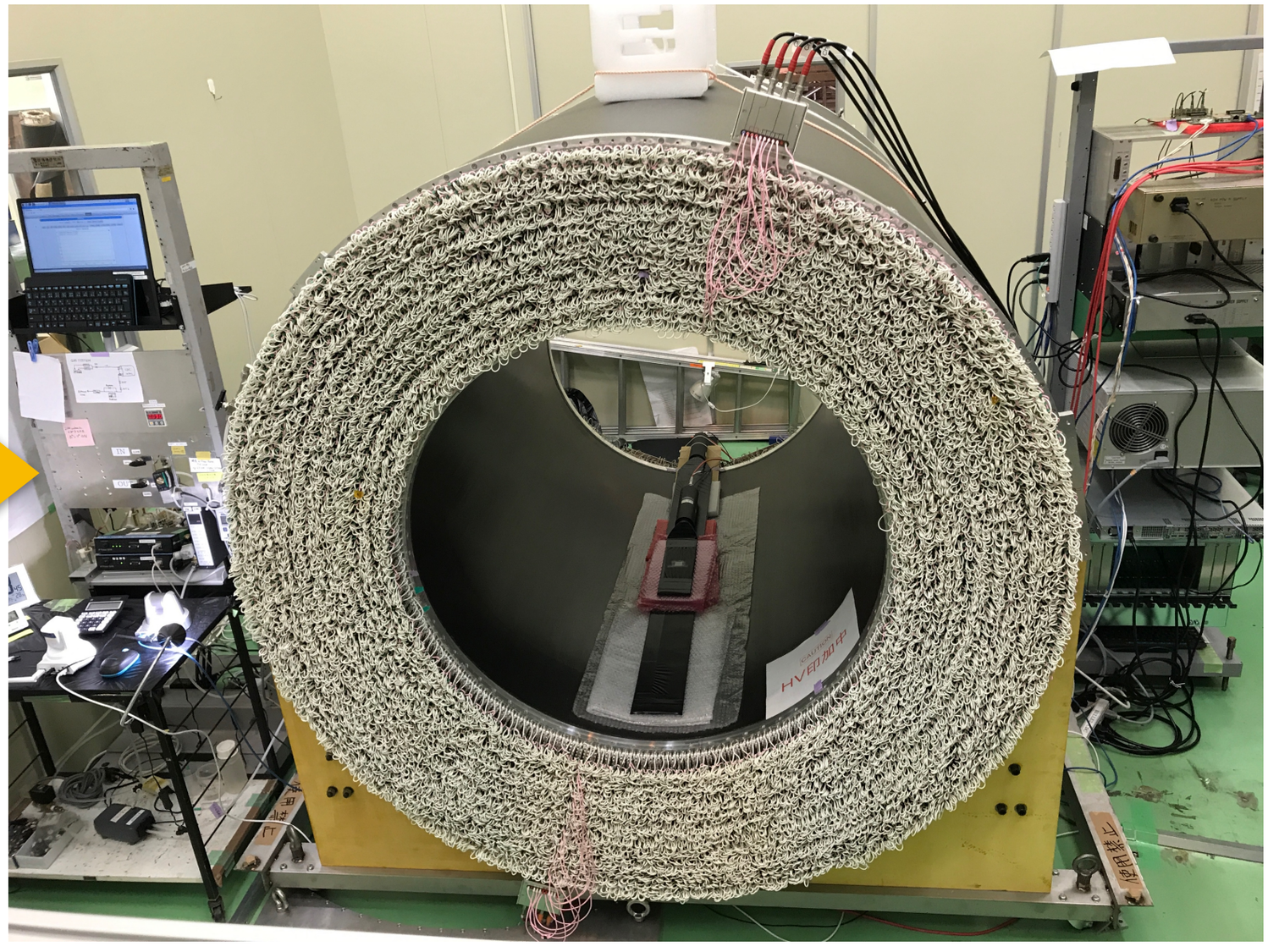
不良ワイヤーの張り替え

Cabling

Number of wires	
Sense:	4986
Field:	14562

2016

2017/June HV side



After finishing whole HV cabling, we found **3 bad wires**.

Only 3 wires / 19548 —> failure rate = 0.015%

(during ~1 year since completion) *Good !!*

Summary of bad wires

Bad wires

① Field wire above L19-W268
layer39-wire537 (field)

② L15-W204
layer31-wire410 (sense), wire411 (field)

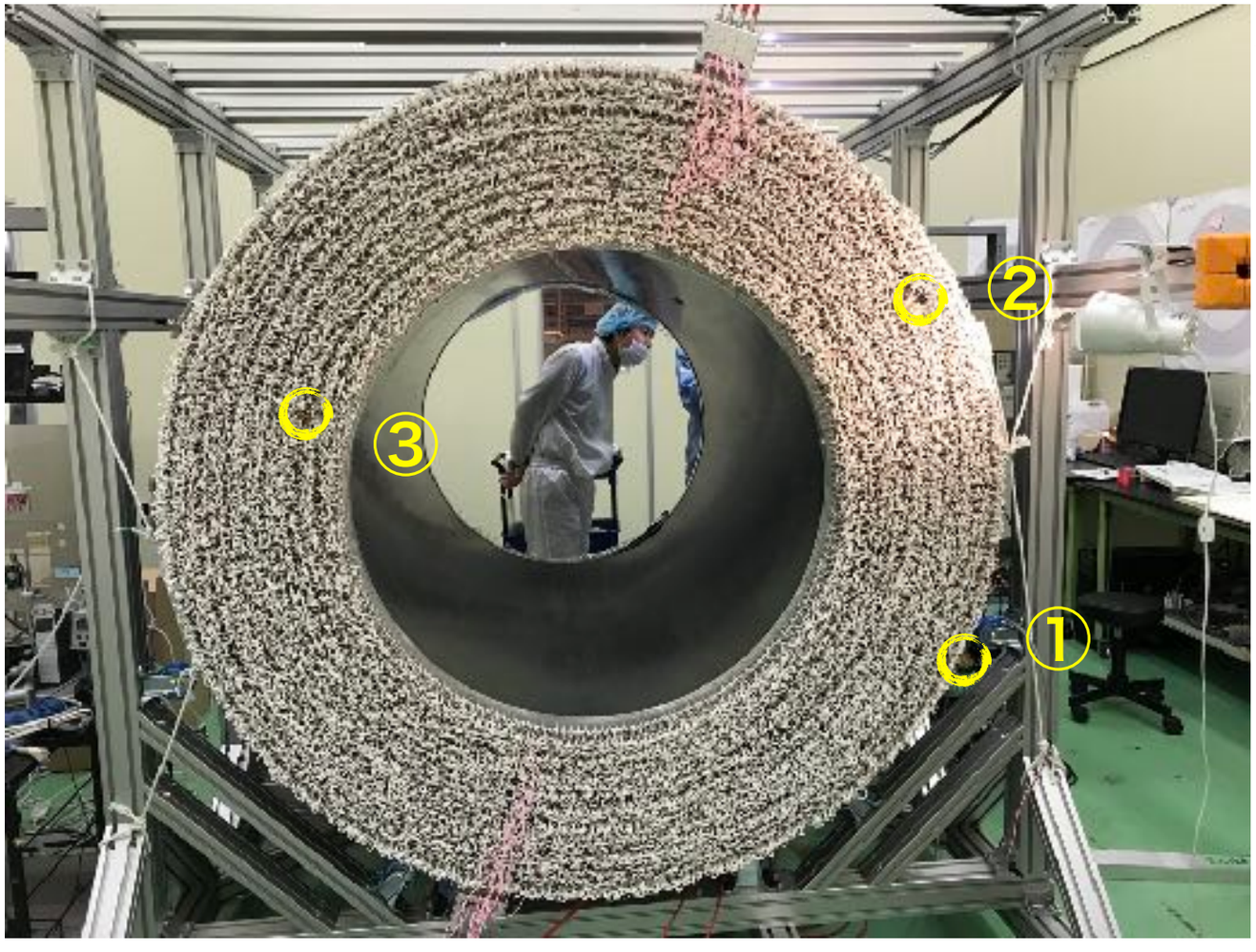
③ L4-W67
layer9-wire135 (sense), wire136 (field)

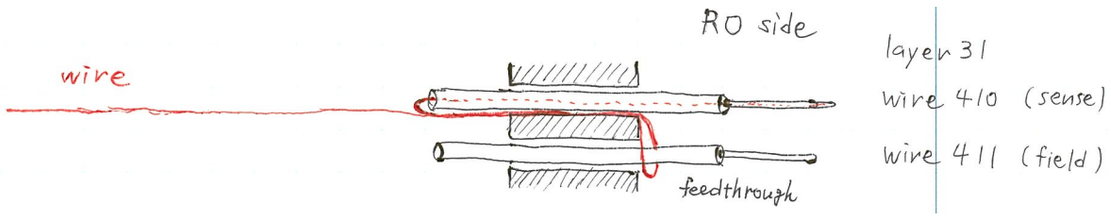
Causes

Weak tension 69.82 g <— 80.24 g

Stringing mistake

Unknown
maybe sense wire broken





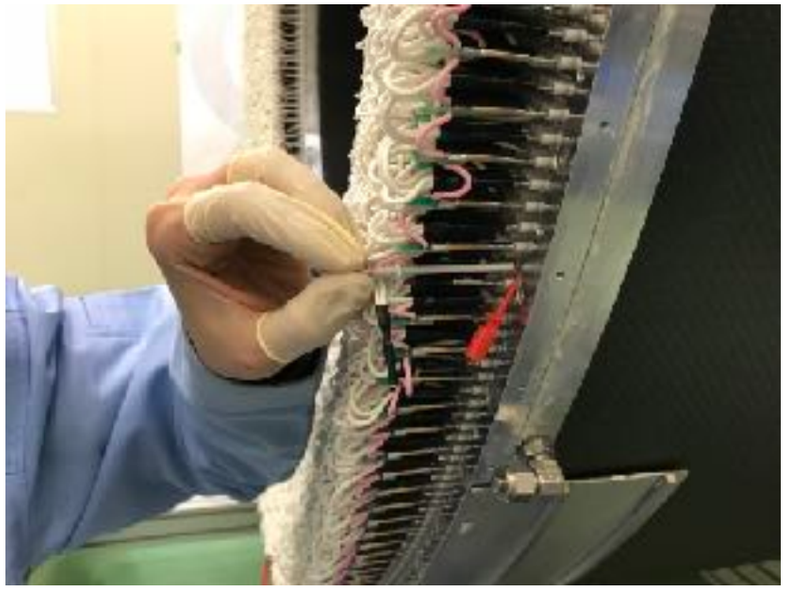
A wire loop surrounding a neighbor feedthrough was missed.
This rarely happens in pushing feedthroughs.

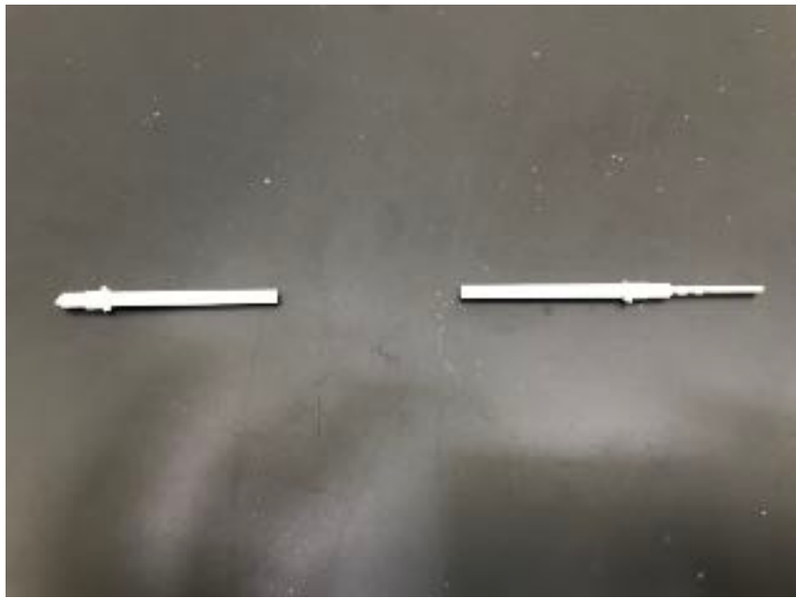
To replace a sense wire, a neighbor field wire have to be re-strung together as a sacrifice.

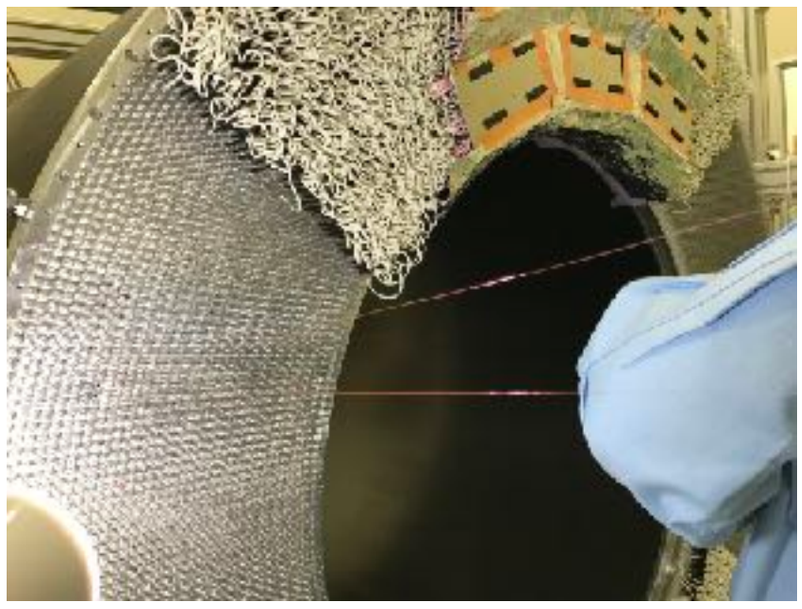
—> **5 wires were re-strung in total.**

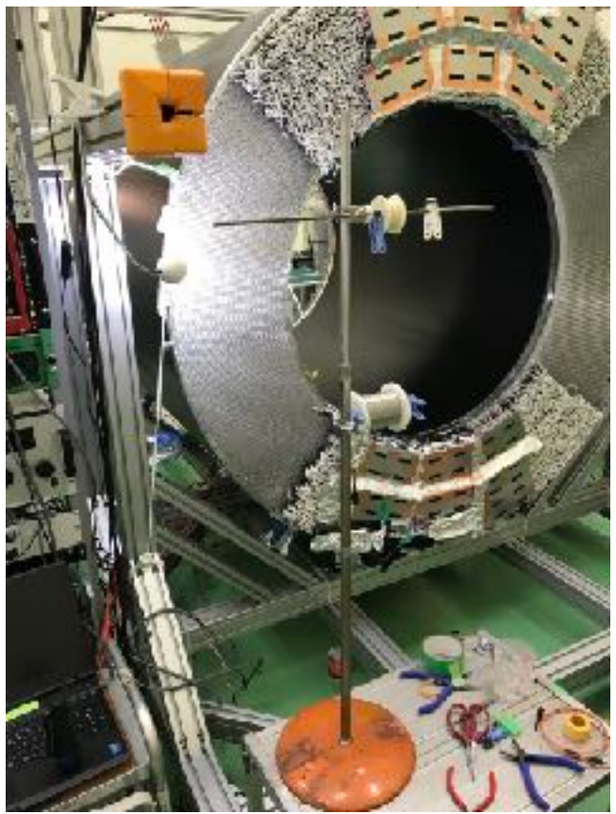
Pictures of the operation

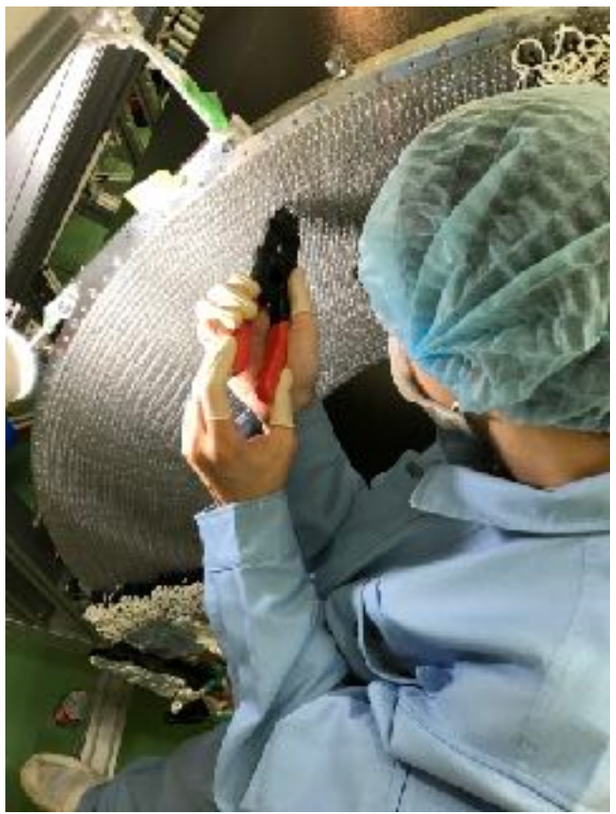
- This is the first time to re-string wires after closing the CDC wall and putting transversely.
- It takes typically **1 hour per wire**.





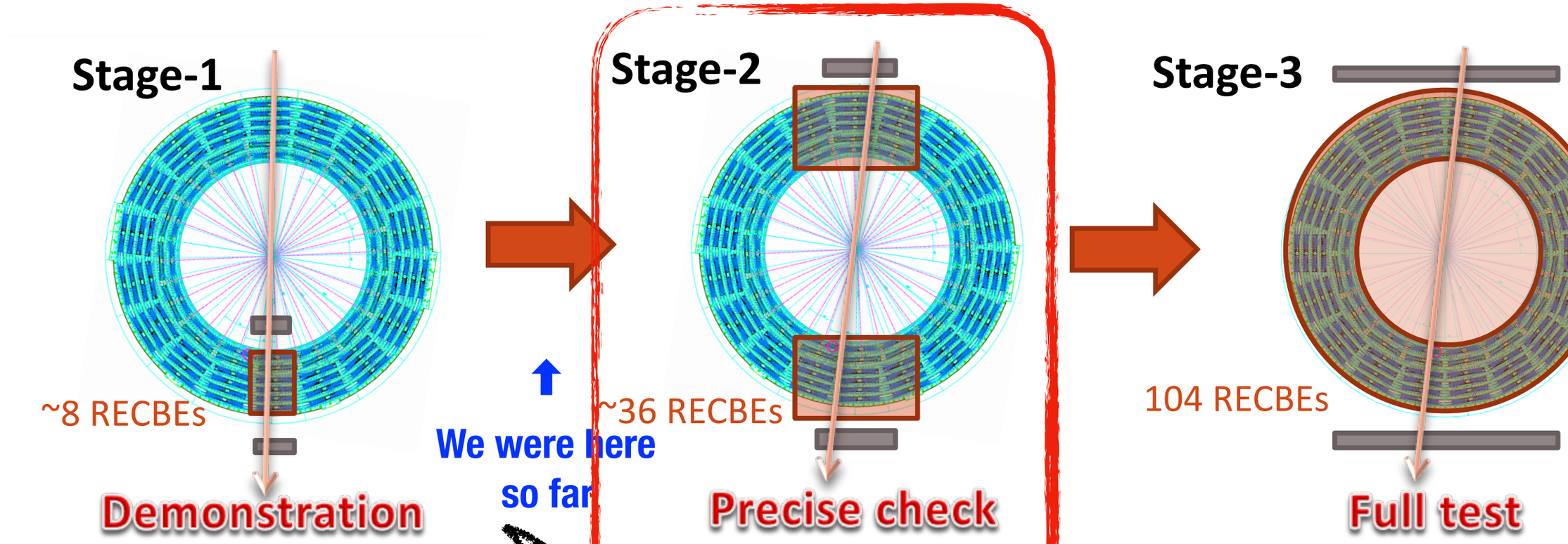




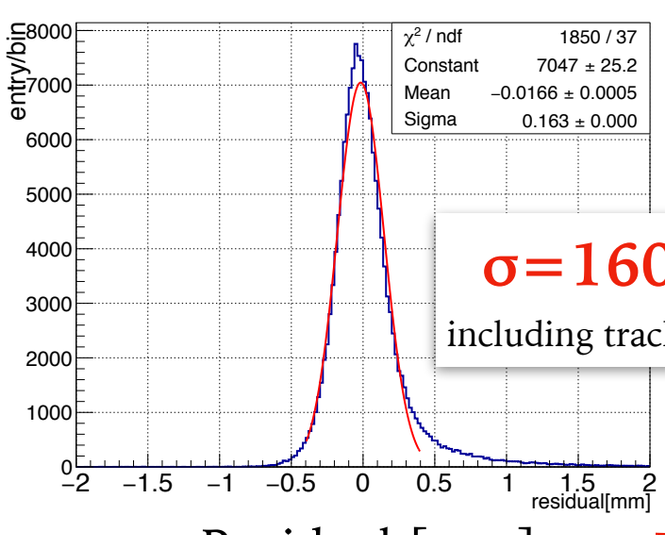


宇宙線を用いた性能評価試験の進捗

Plan of cosmic-ray test

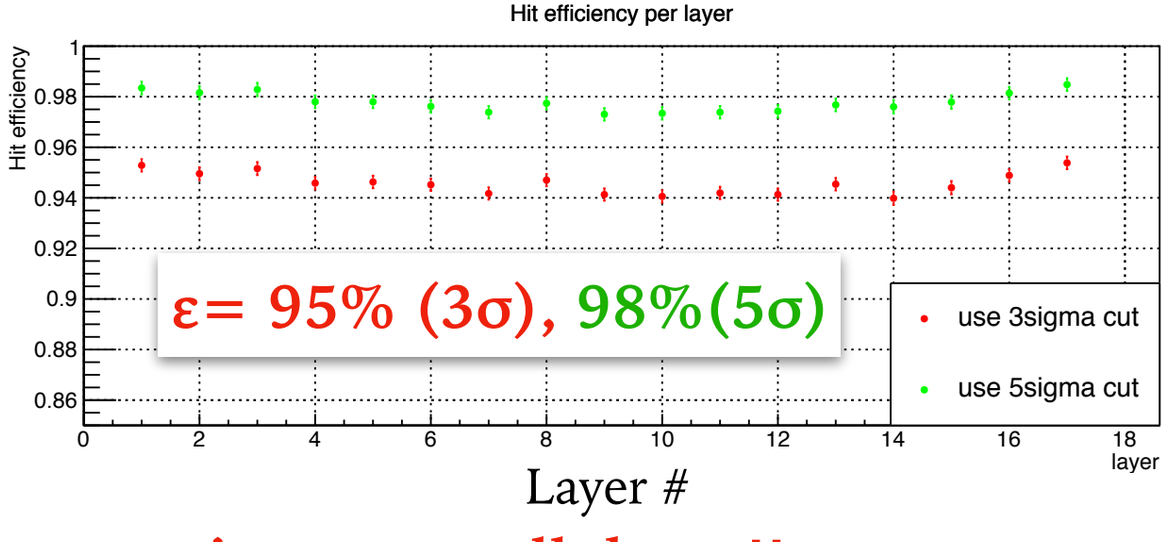


(a)



Residual [mm]

σ=160 μm
including tracking error



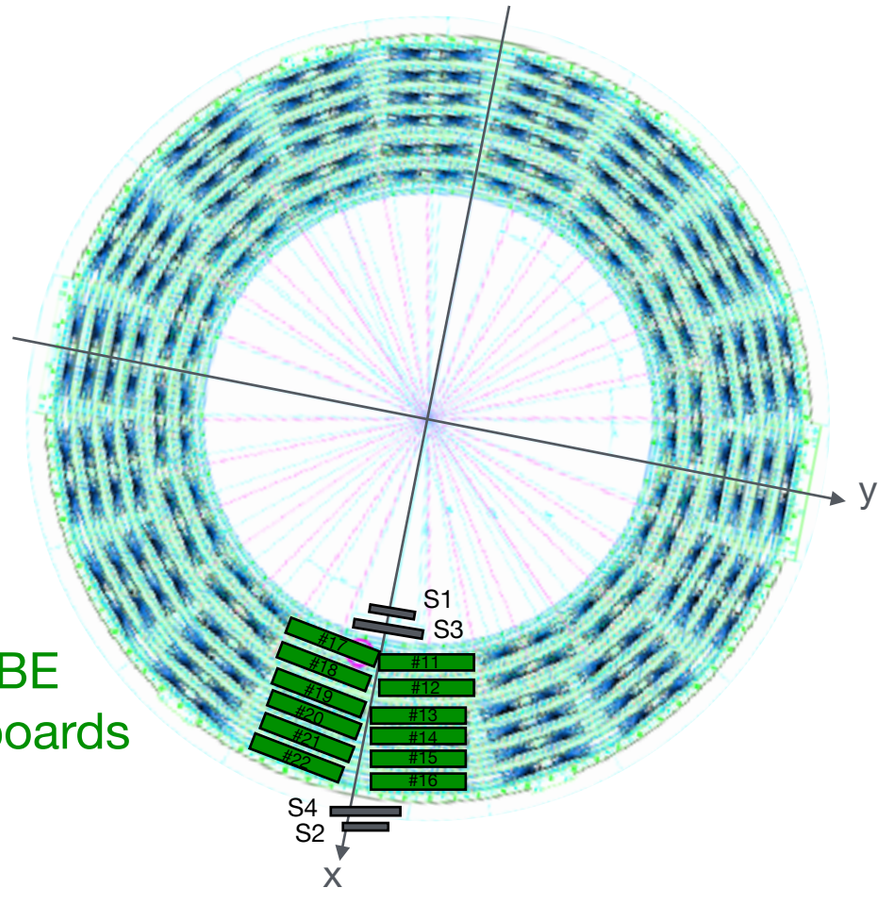
ε= 95% (3σ), 98%(5σ)

Layer #

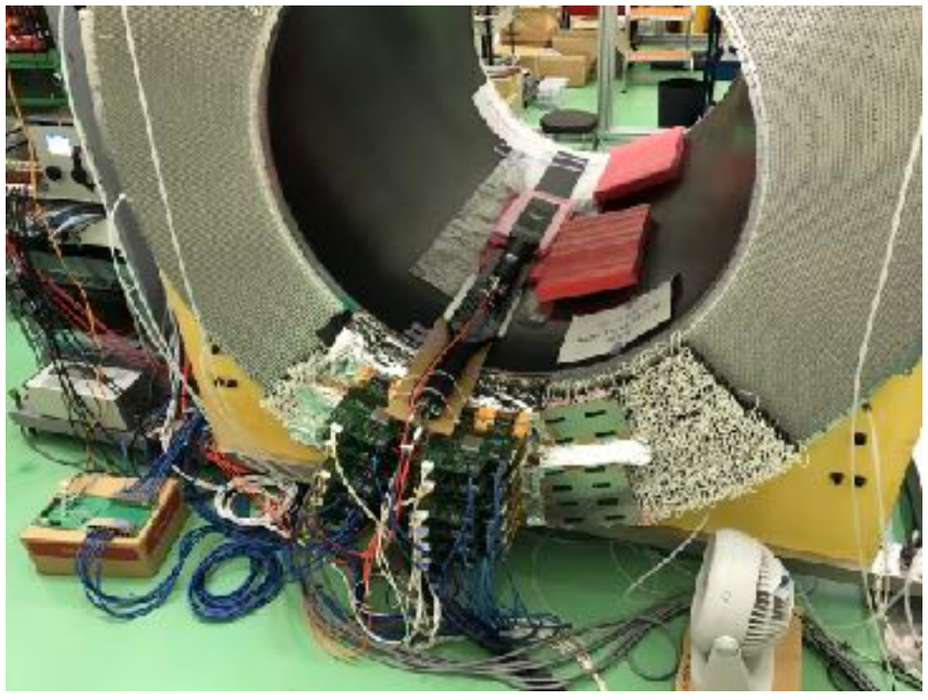
First demonstration was well done !!

Setup-A

2017/10/26~11/16
Gas: He:i-C_4H_{10} = 90:10, 100CCM
HV: 1750, 1775, 1800, 1825, 1850 V
V_{thre}: 3600 mV
Trigger: S3 x S4 (1303 x 120 x 5 mm), ~3.7 Hz

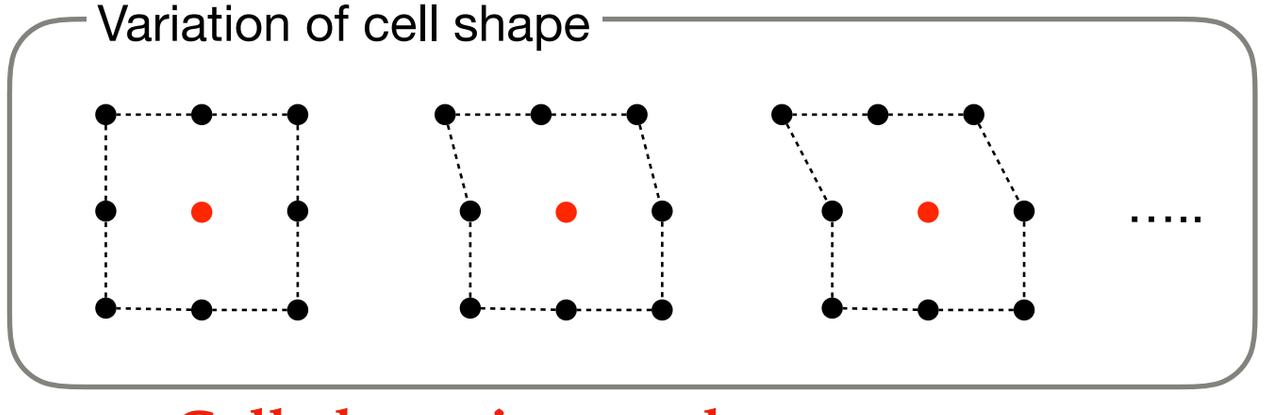


RECBE
12(+1) boards



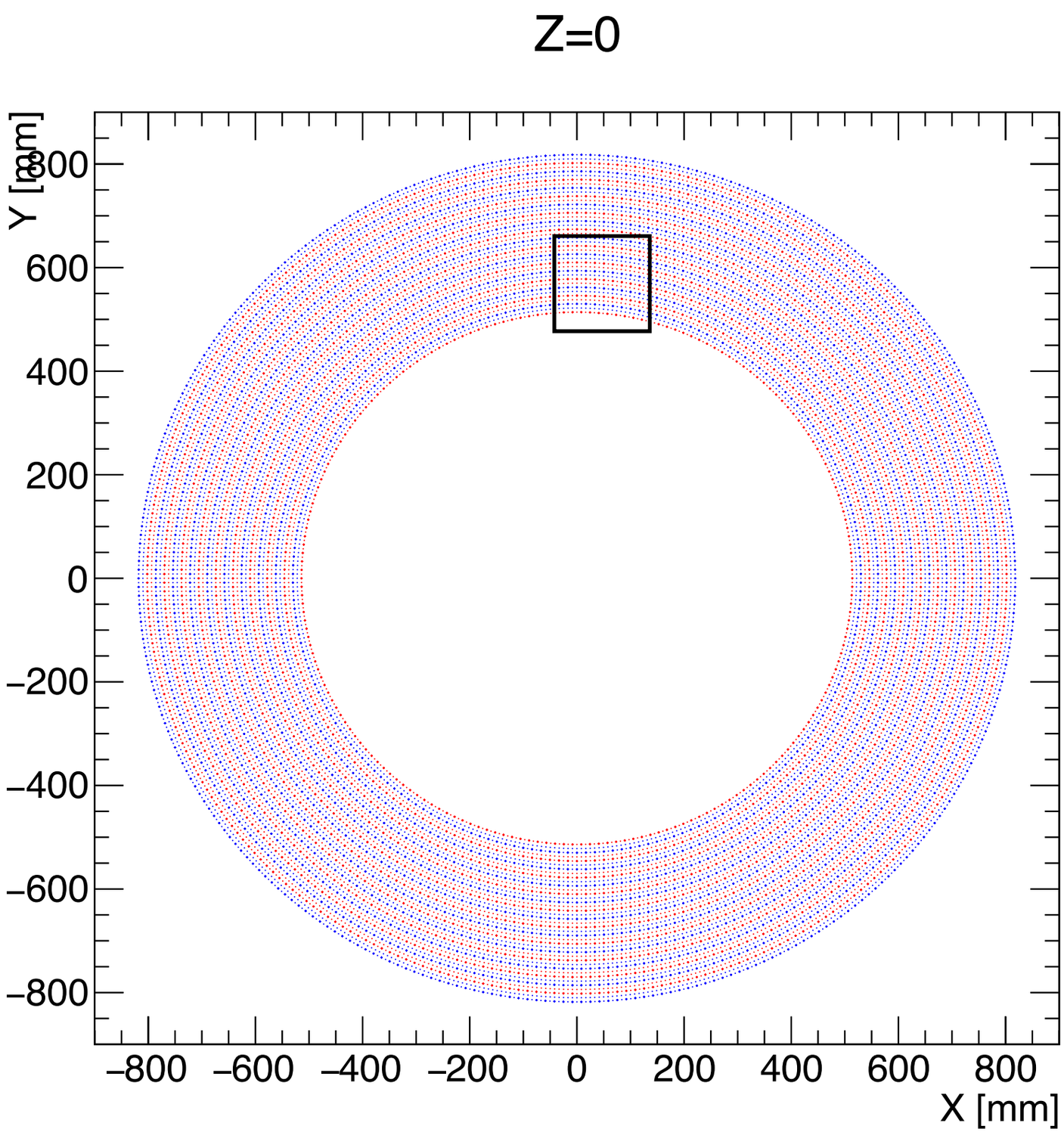
Goal of Setup-A

- Due to the alternative stereo layer configuration, the cell shape varies with respect to wire positions and along to z-direction.
- X-T relation should be prepared for shape by shape. --> need precise study !!

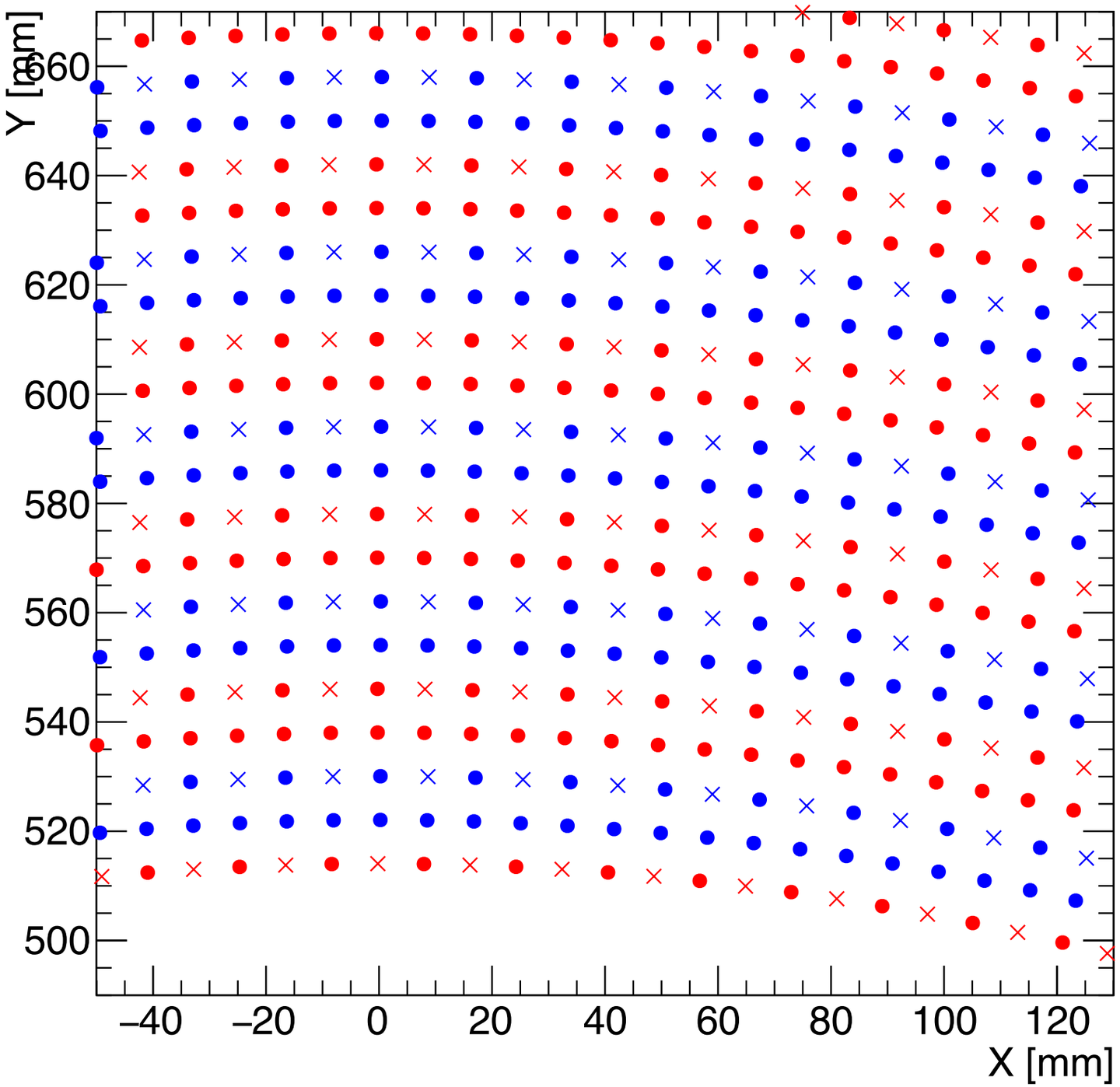


Cell shape is not always square.

All alternative stereo layer config.



All alternative stereo layer config.



× sense wire

● field wire

Stereo angle
64~75 mrad

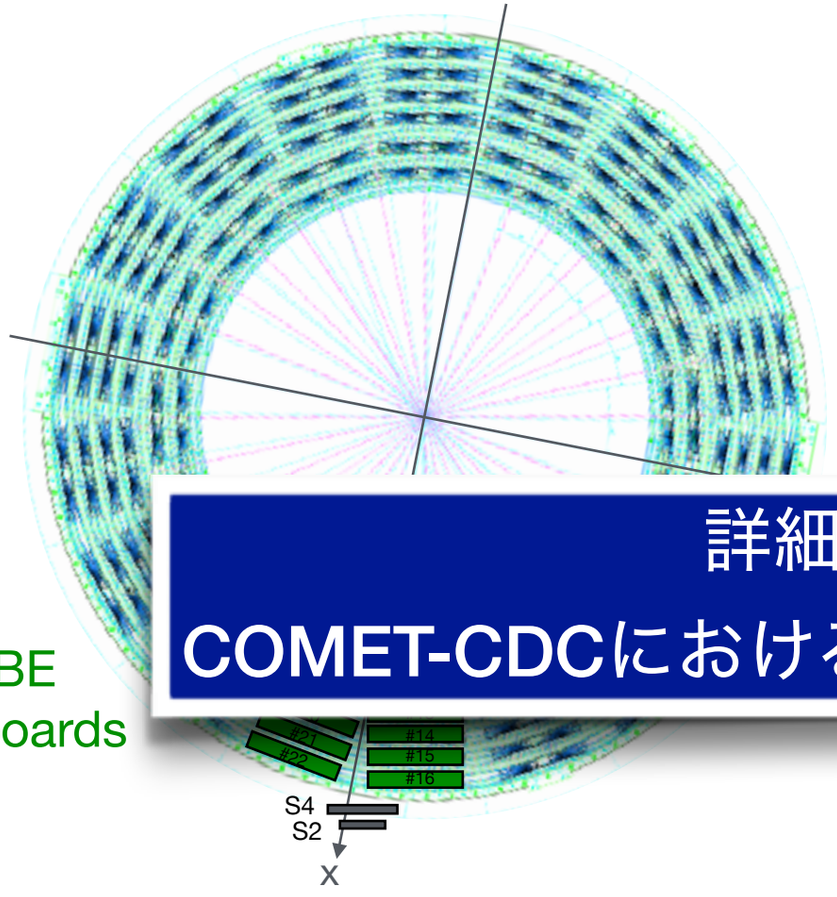
\+

\-

END

Setup-A

2017/10/26~11/16
Gas: He:i-C_4H_{10} = 90:10, 100CCM
HV: 1750, 1775, 1800, 1825, 1850 V
V_{thre}: 3600 mV
Trigger: S3 x S4 (1303 x 120 x 5 mm), ~3.7 Hz

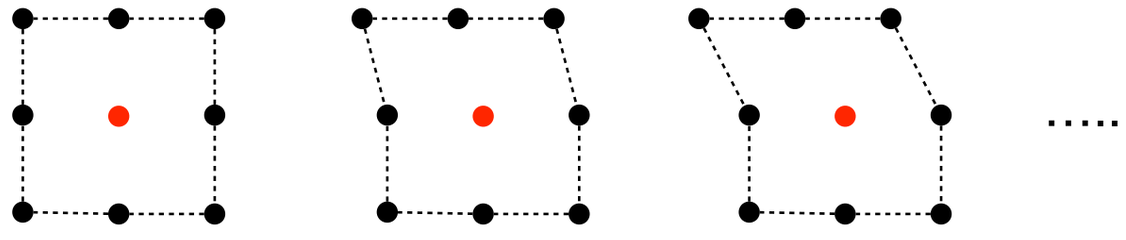


詳細は次の講演：
COMET-CDCにおける宇宙線試験の解析 (3)　沖中

Goal of Setup-A

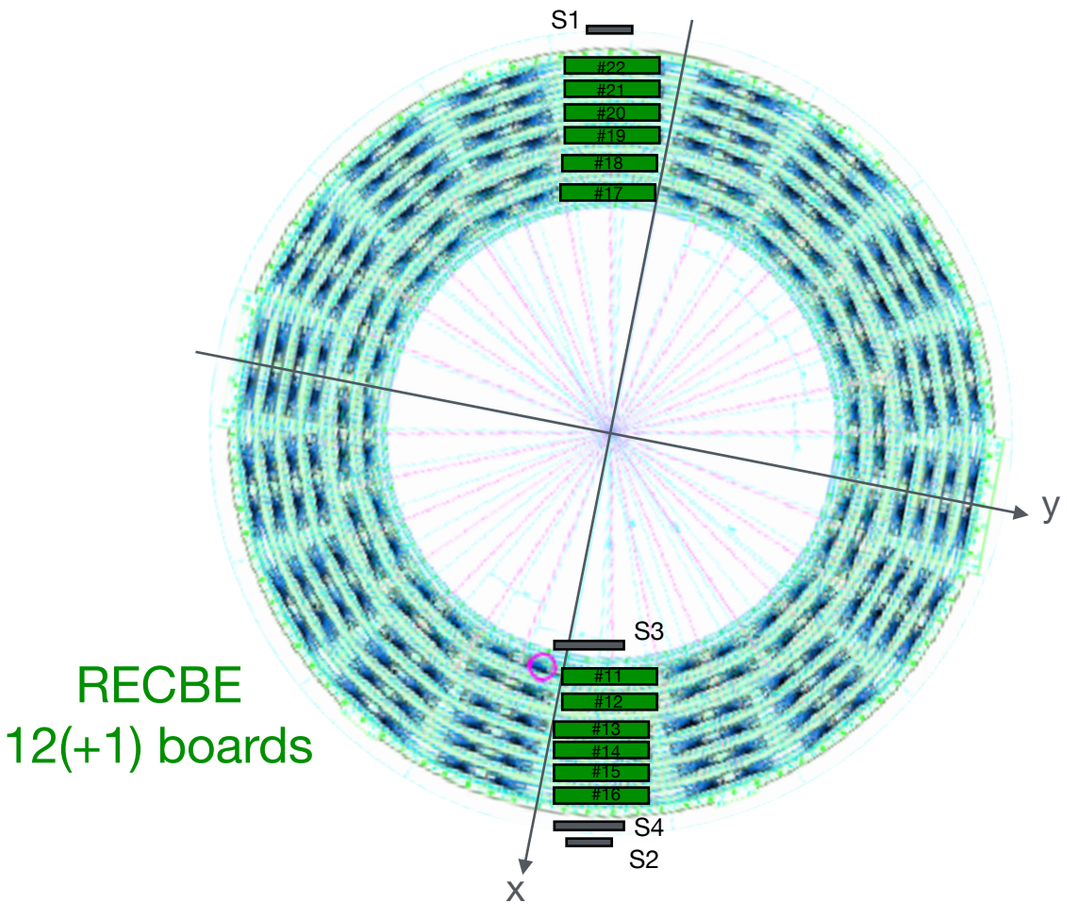
- Due to the alternative stereo layer configuration, the cell shape varies with respect to wire positions and along to z-direction.
- X-T relation should be prepared for shape by shape. --> need precise study !!

Variation of cell shape



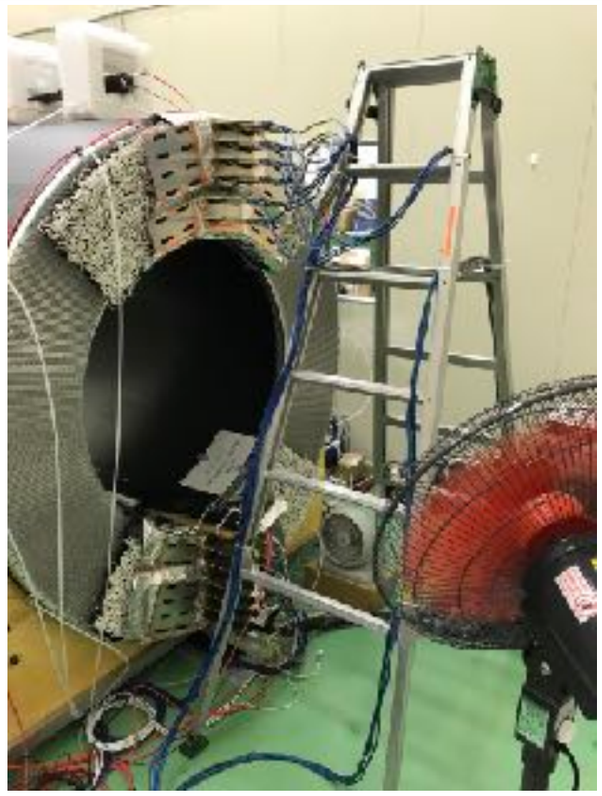
Cell shape is not always square.

Setup-B



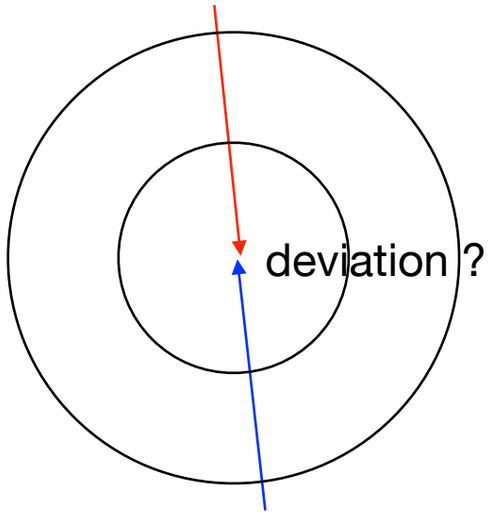
RECBE
12(+1) boards

2017/11/21~12/11
Gas: He:i-C_4H_{10} = 90:10, 100CCM
HV: 1825 V
V_{thre}: 3600 mV
Trigger: S1 x S2 (300 x 90 x 10/5 mm), ~0.03 Hz



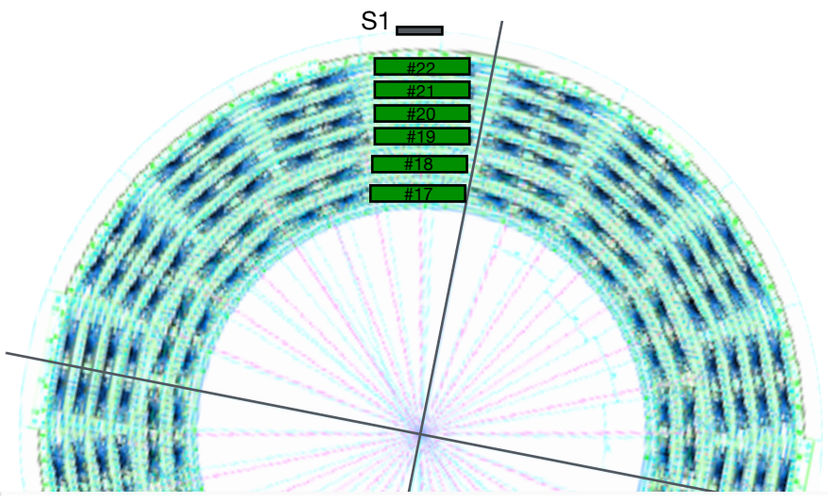
Goal of Setup-B

- Wire position alignment calibration
- Separate tracking in top & bottom region is carried out, and then deviation b/w the 2 tracks indicates wire misalignment.



Setup-B

2017/11/21~12/11
Gas: He:i-C_4H_{10} = 90:10, 100CCM
HV: 1825 V
V_{thre}: 3600 mV
Trigger: S1 x S2 (300 x 90 x 10/5 mm), ~0.03 Hz

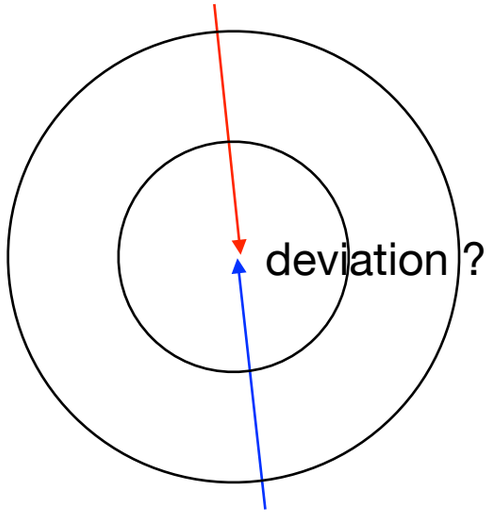


詳細は次の次の講演：
COMET-CDCにおける宇宙線試験のアライメント解析　松田

RECE
12(+1) boards

Goal of Setup-B

- Wire position alignment calibration
- Separate tracking in top & bottom region is carried out, and then deviation b/w the 2 tracks indicates wire misalignment.



Summary

- COMET実験Phase-Iに向けてCDCの試験が進んでいる。
- 不良ワイヤーの張り替えをおこなった。３ヶ所、計５本を張り替え。

  ➡ワイヤー修理保守体制を確立
- 宇宙線試験は第２段階に入り詳細な性能評価をおこなっている。

  1. セル形状の違いによるX-T関数の評価　　—> 沖中
  2. ワイヤーアラインメントの評価　　—> 松田

今後の予定

- 性能評価試験を進めながら読出し領域を増やしてフルセットアップでの試験を目指す。
- 2019年にはCDCをKEKからJ-PARCに移設し、検出器磁石へのインストールを予定している。