J-PARC E16 EXPERIMENT

- LOW-MAS E^+E^- MEASUREMENTS WITH DETECTOR CHALLENGES-

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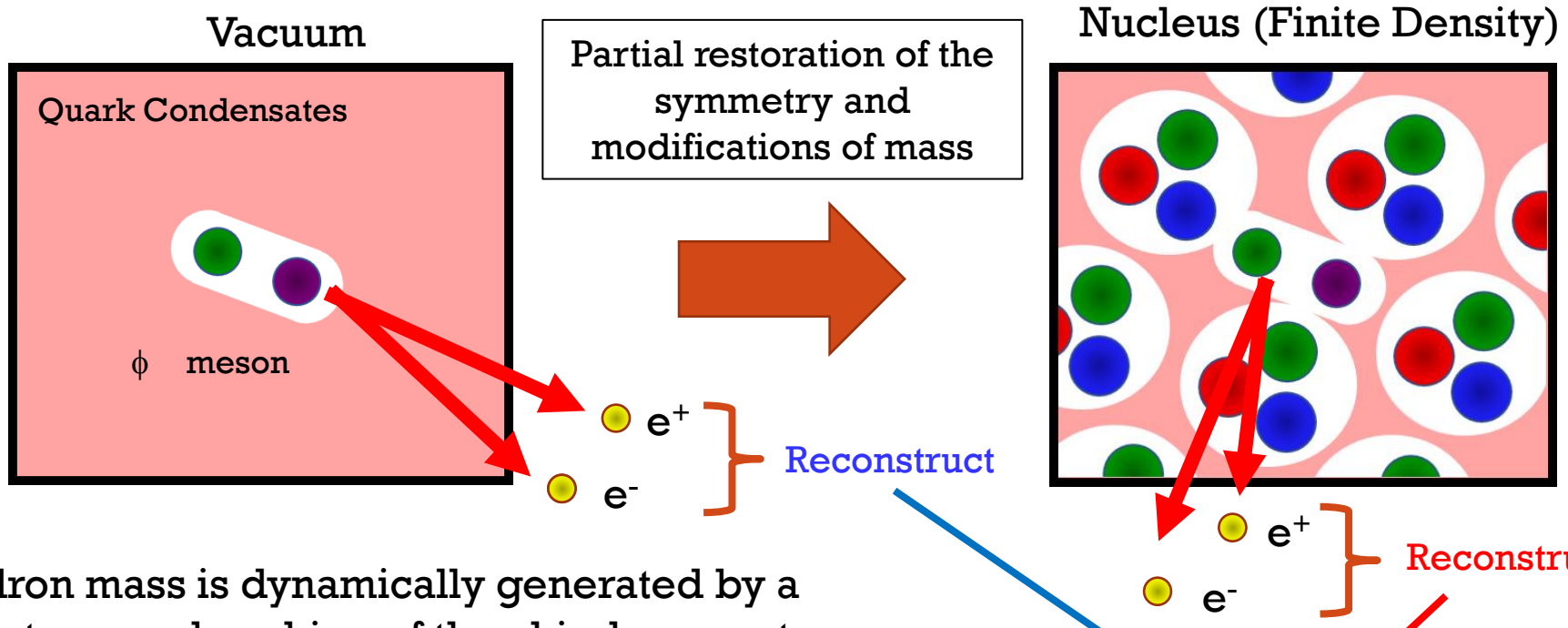
J-PARC E16 experiment
Spectrometer and detectors
Status of pilot data analysis
Summary

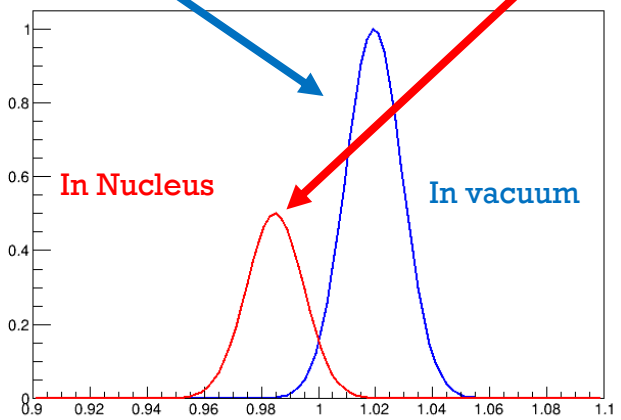
PHYSICS: HADRON MASS AND QCD MEDIUM



Hadron mass is dynamically generated by a spontaneous breaking of the chiral symmetry in "QCD" vacuum

The symmetry can be partially restored in a QCD medium and the hadron mass can be changed in the medium

ϕ meson mass in nucleus is measured



e^+e^- Invariant Mass

A SPECTROMETER FOR E^+E^- MEASUREMENTS

ϕ meson mass spectra are measured by e^+e^- decay modes

$p + A \rightarrow \rho/\omega/\varphi \rightarrow e^+e^-$

Construct a spectrometer for e^+e^- measurements

Tracking devices

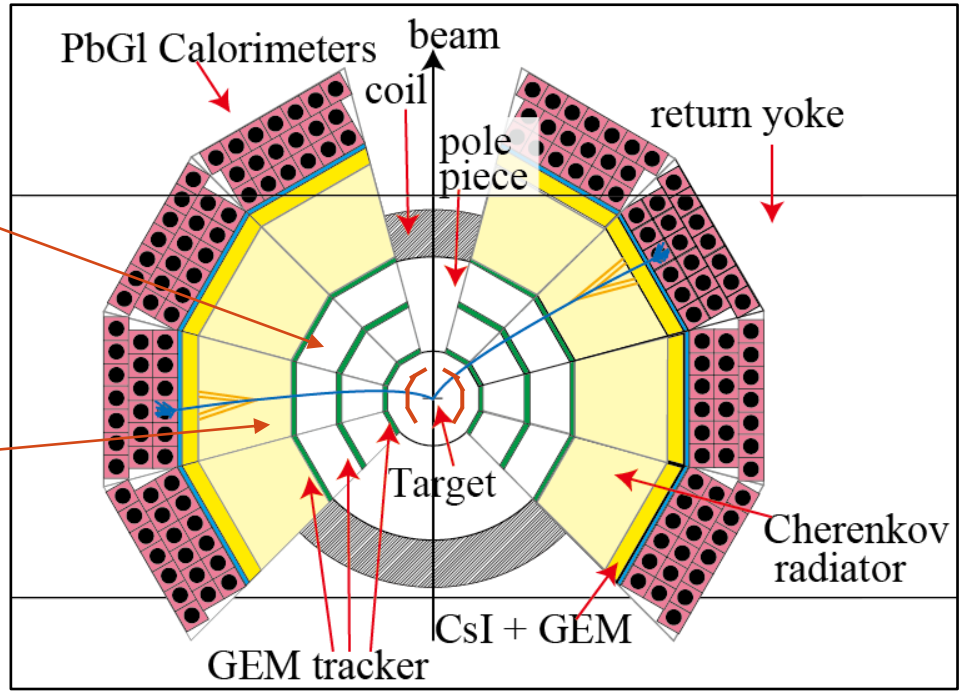
- GEM Tracker
- Silicon Strip Detector

Electron ID detectors

- Gas Cherenkov Detector
- (Hadron Blind Detector)
- Lead Glass EM Shower detector

Key technology:

- Gas Electron Multiplier (GEM)

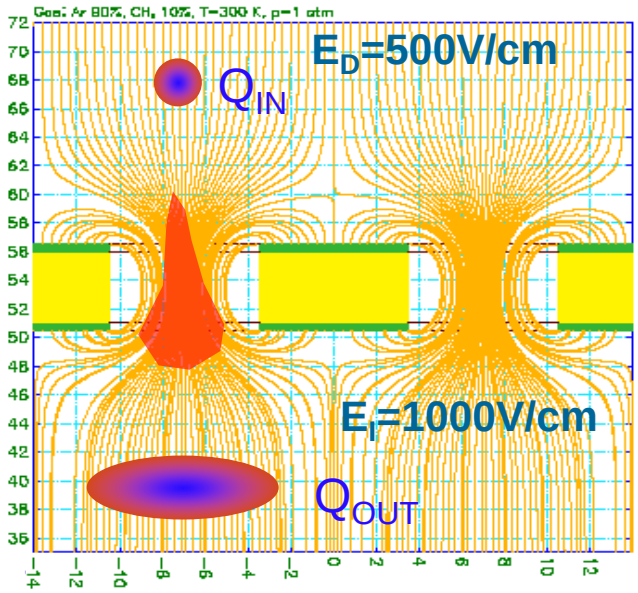


Schematic view of the spectrometer

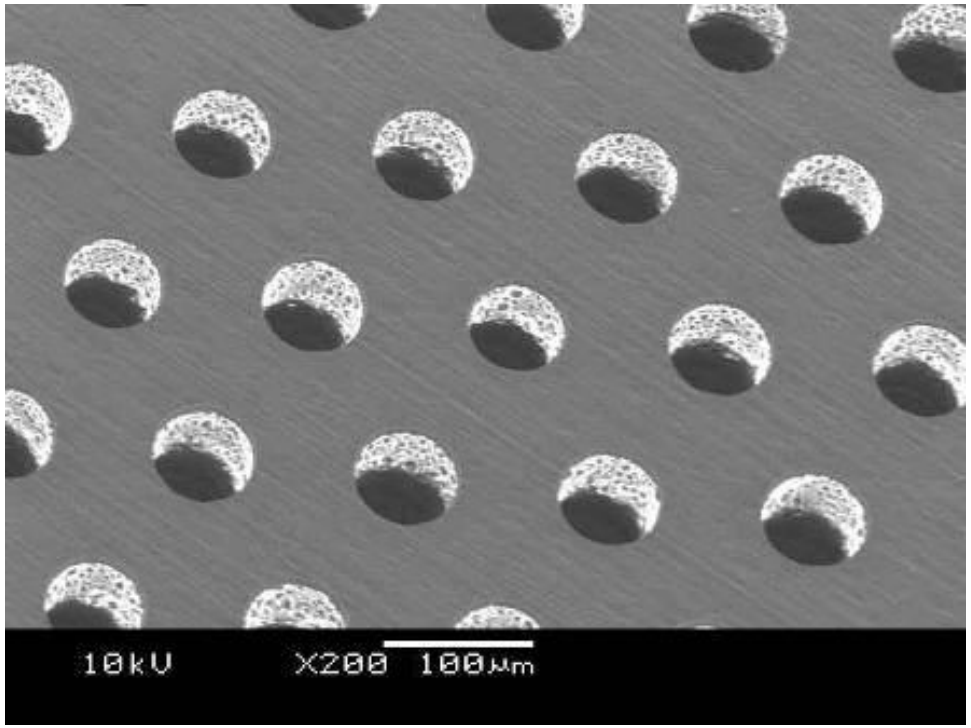
WHAT IS GEM?

A Micro Pattern Gas Detector (MPGD
Electro nodes on both sides of a foil insulator, which has small holes

F. Sauli, Nucl. Instr. and Meth. A386(1997)531



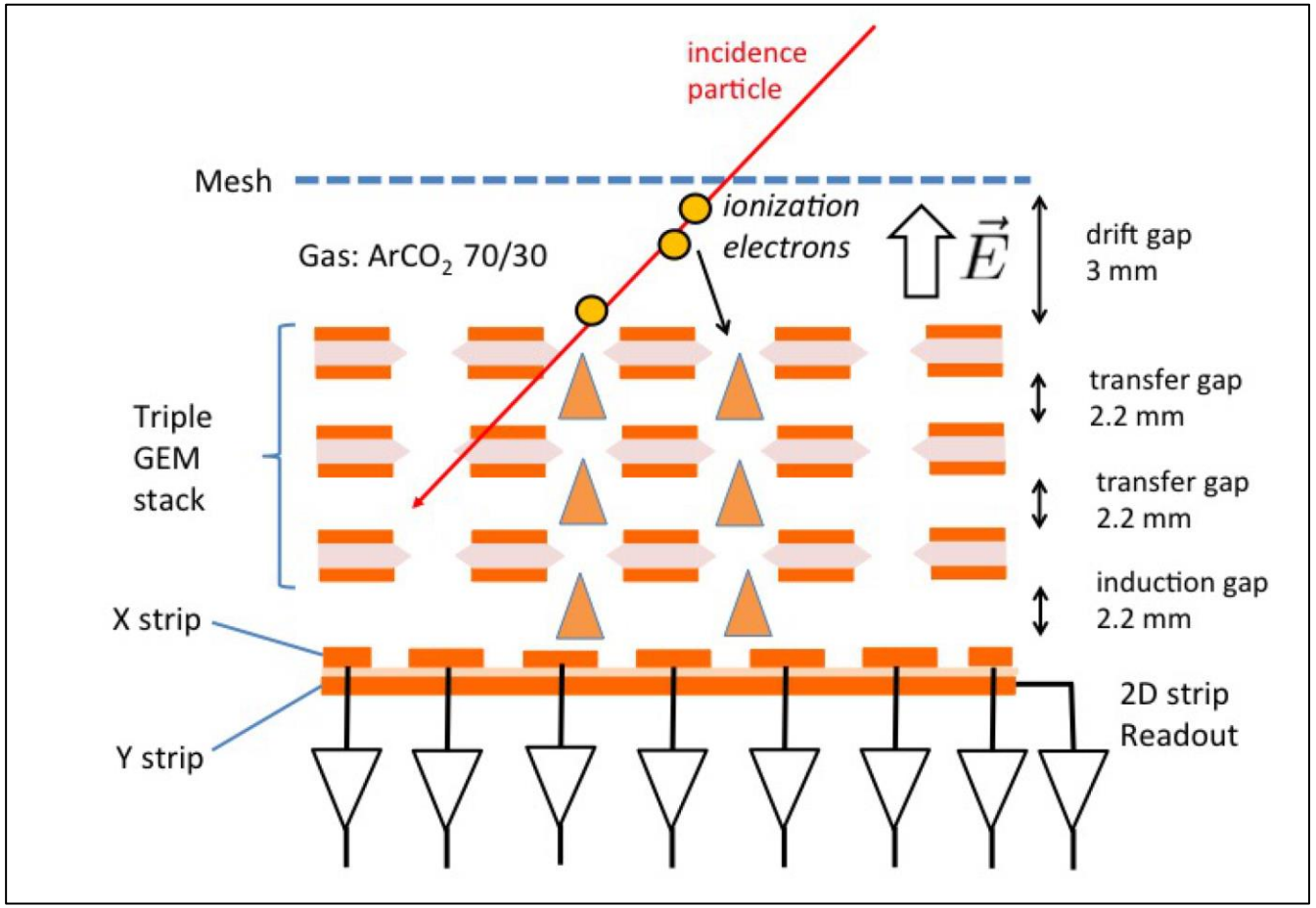
GAIN = Q_{OUT} / Q_{IN}
10~30 per foil



TYPICAL GEM: 50 µm Kapton, 5 µm Copper
70 µm holes at 140 µm pitch

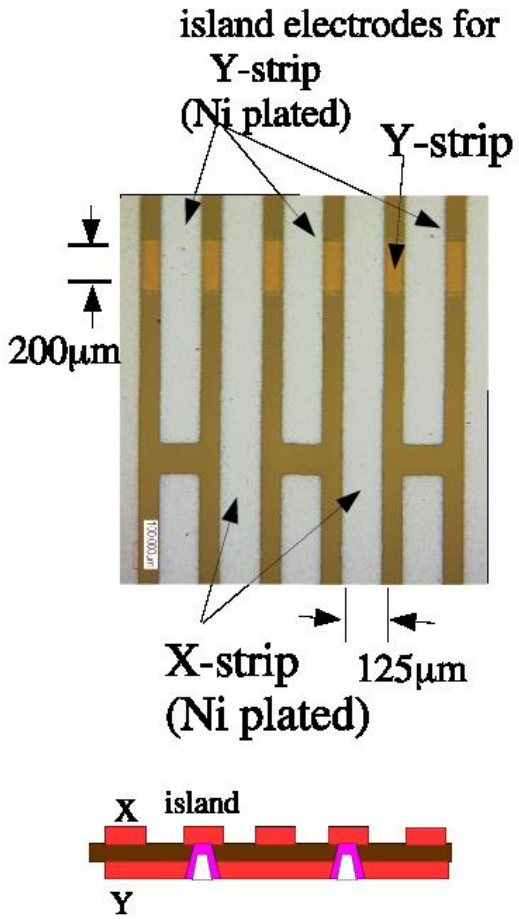
GEM TRACKER

- Ionization electrons in the drift gap are collected and amplified by GEMs.
- 2D strip readout
  - X: 350um pitch
  - Y: 1400um pitch
- Three Trackers
  - 100 cm^2
  - 200 cm^2
  - 300 cm^2

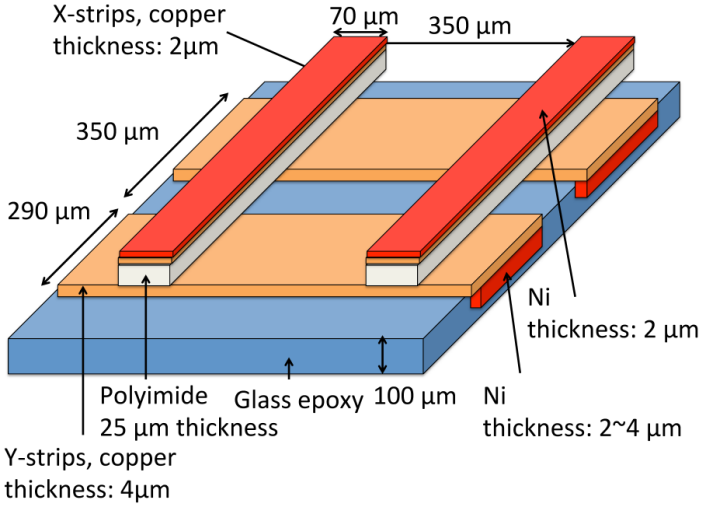


2-D STRIP READ OUT

Blind Via Hole type

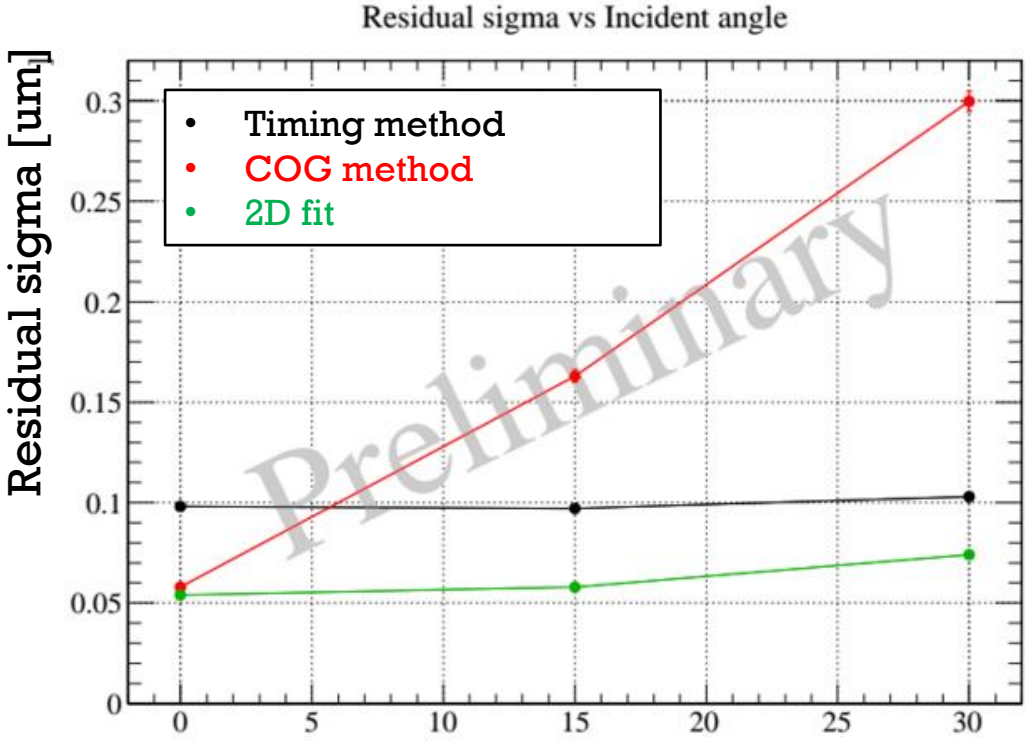


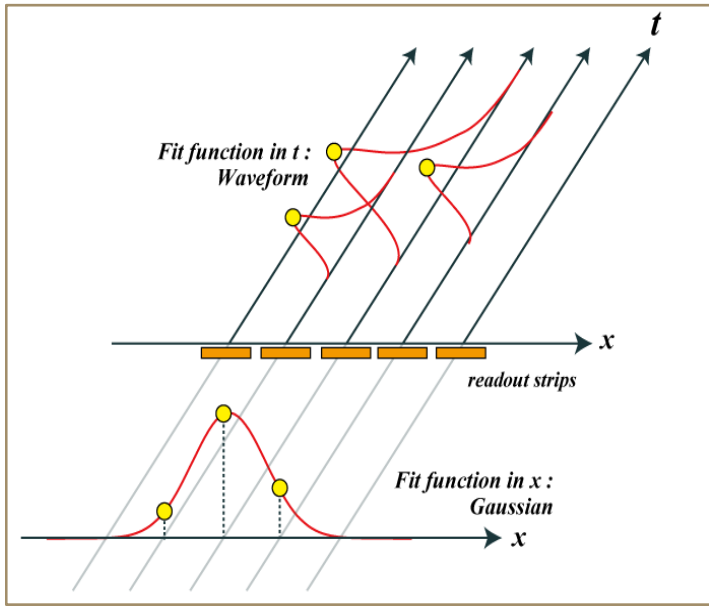
PI-removed type



"MINI TPC" LIKE ANALYSIS

Performance test is done for prototype detectors
In the test, we develop a new analysis method to improve a position resolution using
Both position and timing information

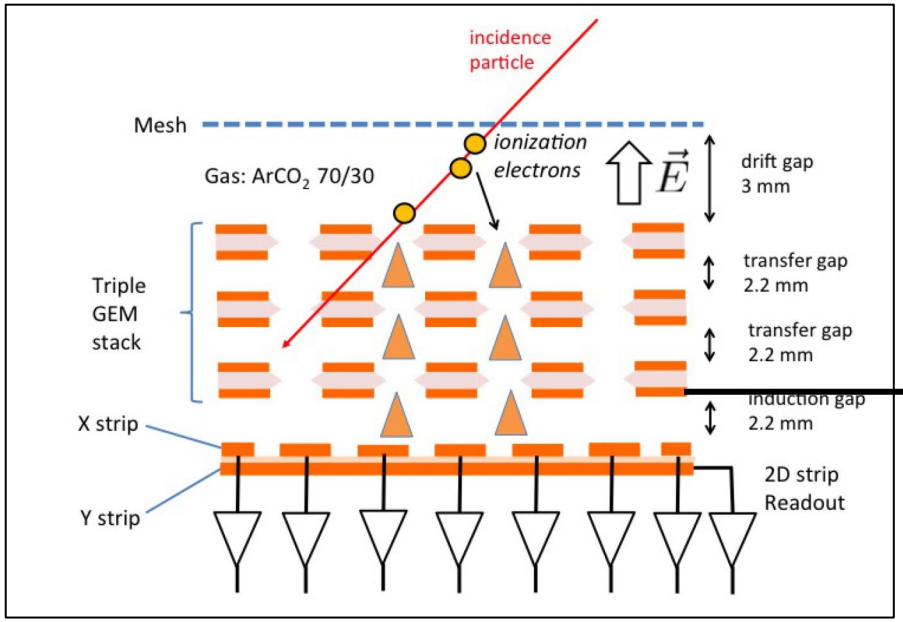


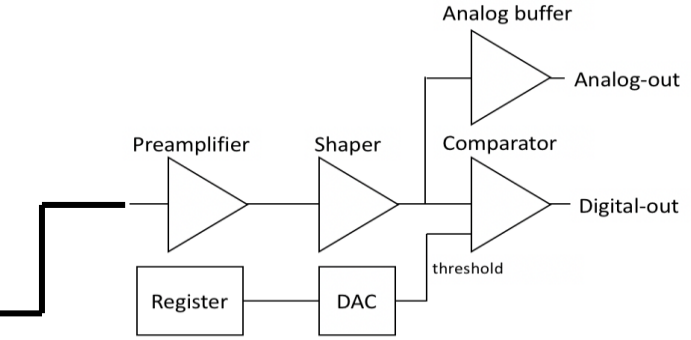


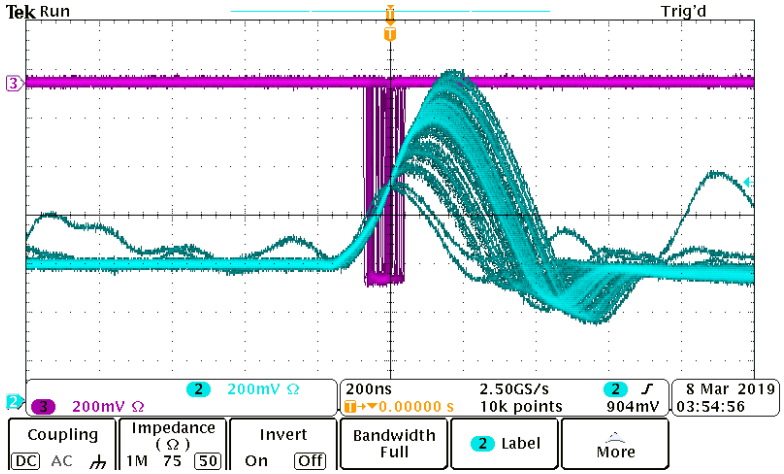
Finally, we got a good performance as a tracker

TRIGGER SIGNAL FROM A GEM FOIL

Amplifier Shaper Discriminator (ASD)

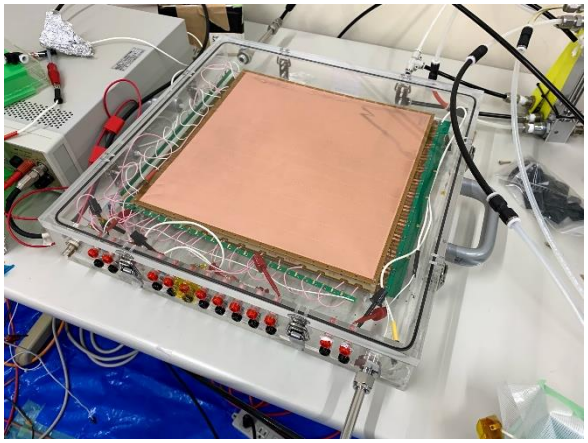




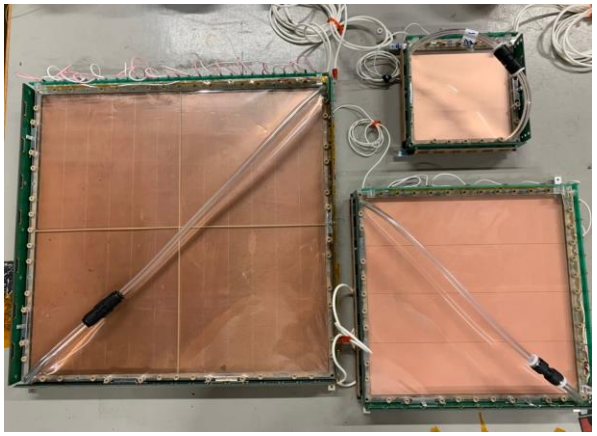


CONSTRUCTION OF GEM TRACKER

GEM Foil check

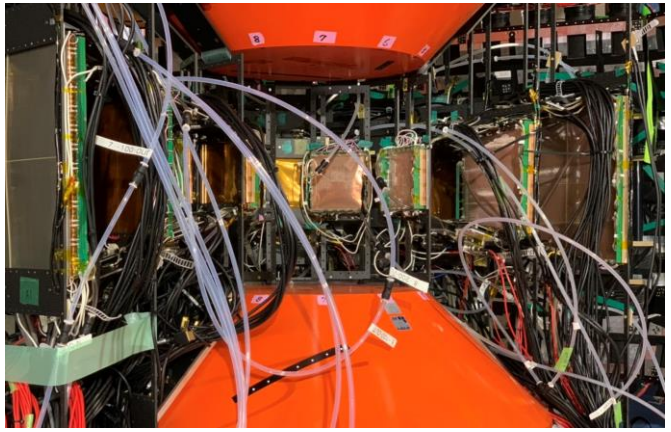


GEM Trackers

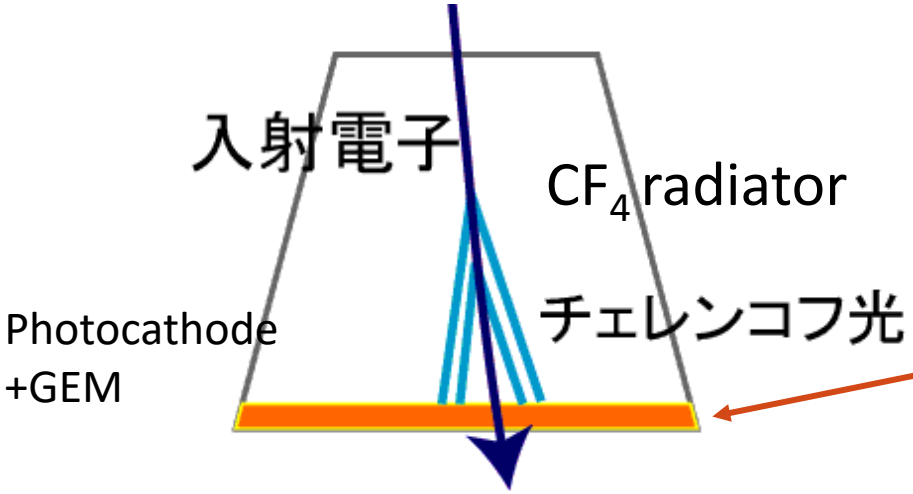


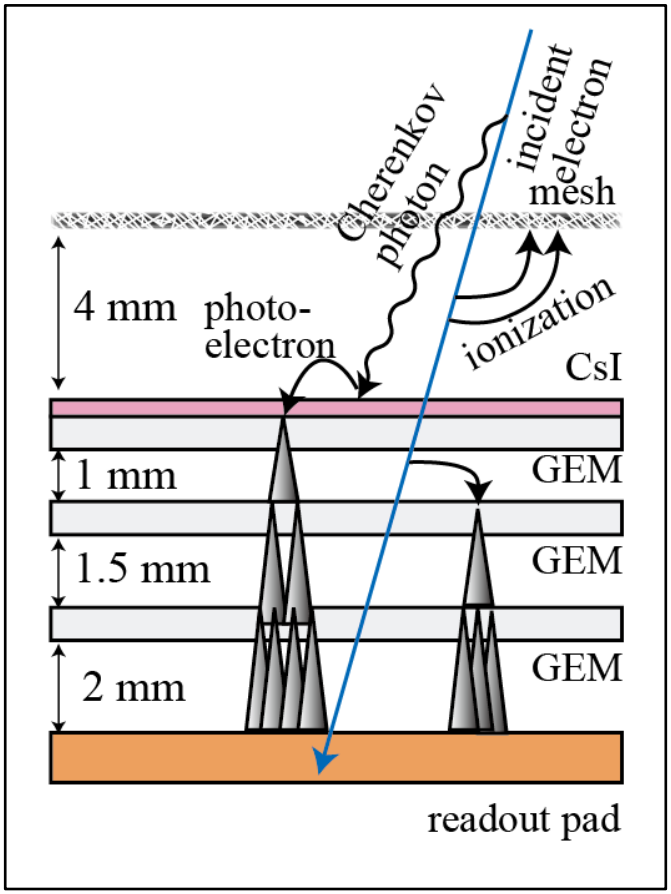
GEM Assemble

GEM Trackers@Spectrometer



HADRON BLIND DETECTOR





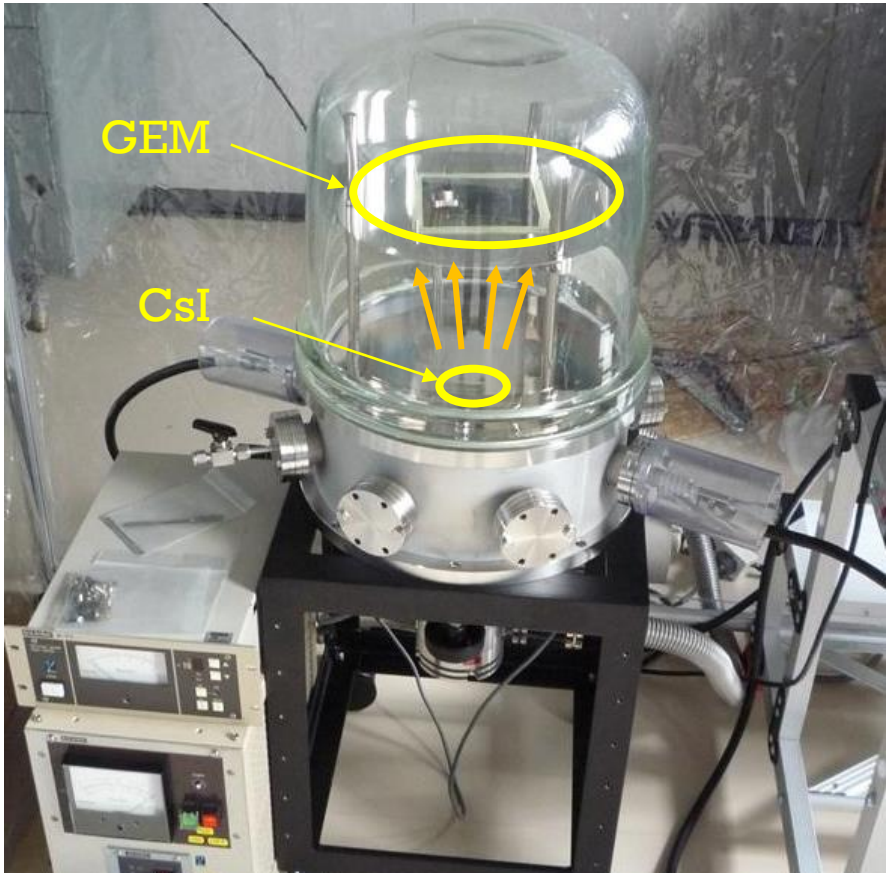
CF4 gas is used both for
- Radiator for Cherenkov lights
- Gas Avalanche of photo-electrons

Window-less, mirror-less Gas Cherenkov Detector

It is originally proposed by G. Charpak and realized by the PHENIX exp.

CsI Photo Cathode

CsI Photo cathode evaporated by myself

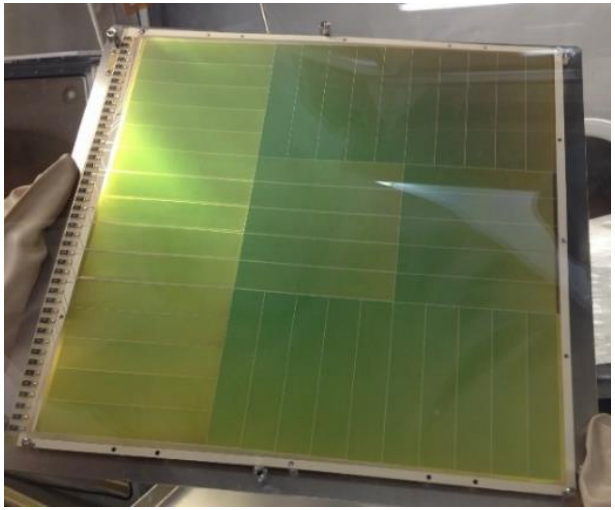


CsI: Sensitive wave lengths are in ultra-violet region

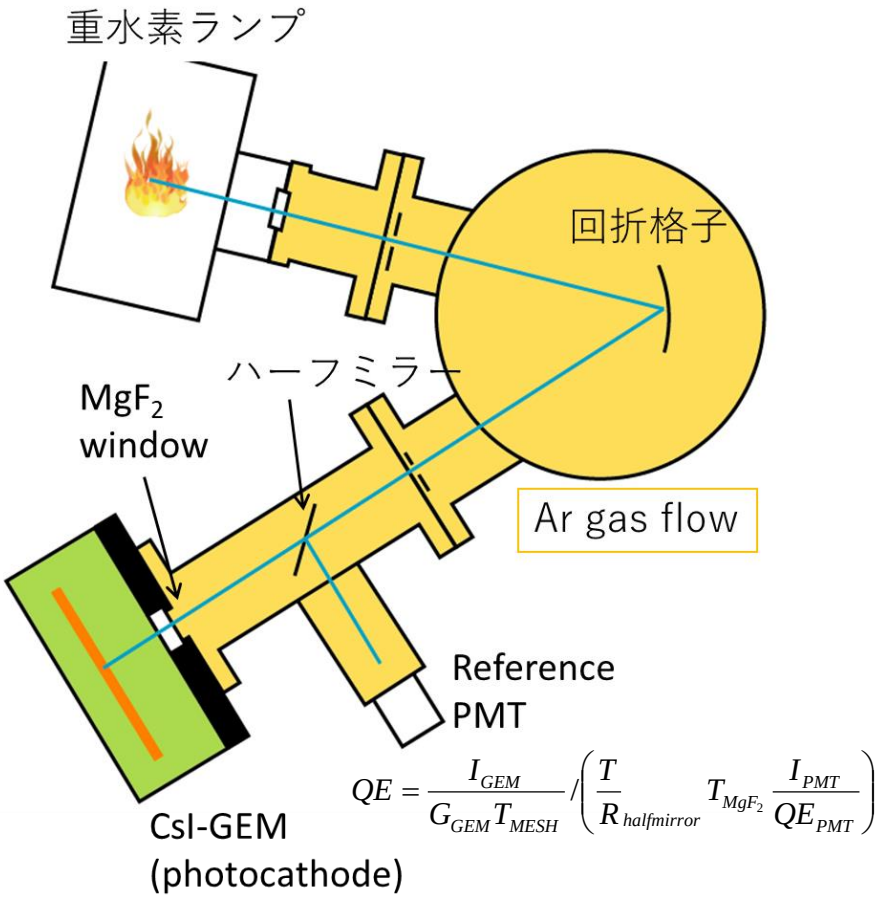
- Suitable for Cherenkov radiation

Evaporation on a GEM Foil

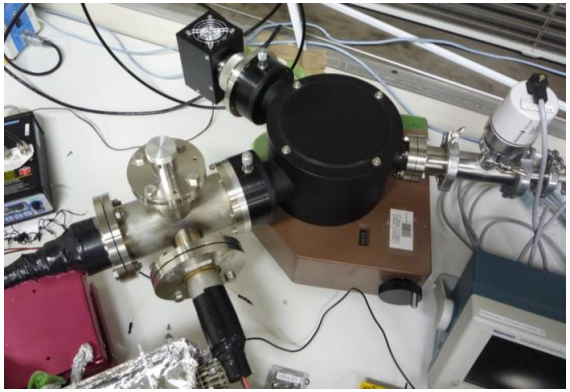
- ~350nm thickness
- Prototype: 100 mm^2 @ RIKEN
- Actual model: 300 mm^2 by Hamamatsu

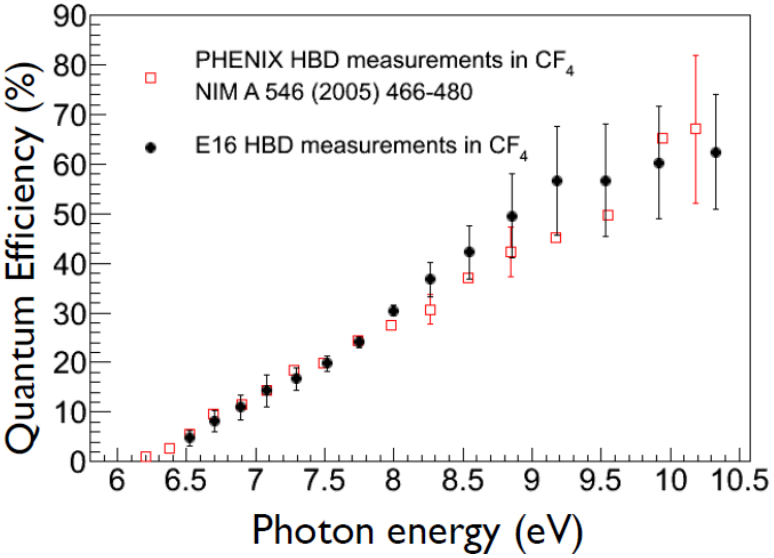


MEASUREMENTS OF QUANTUM EFF.



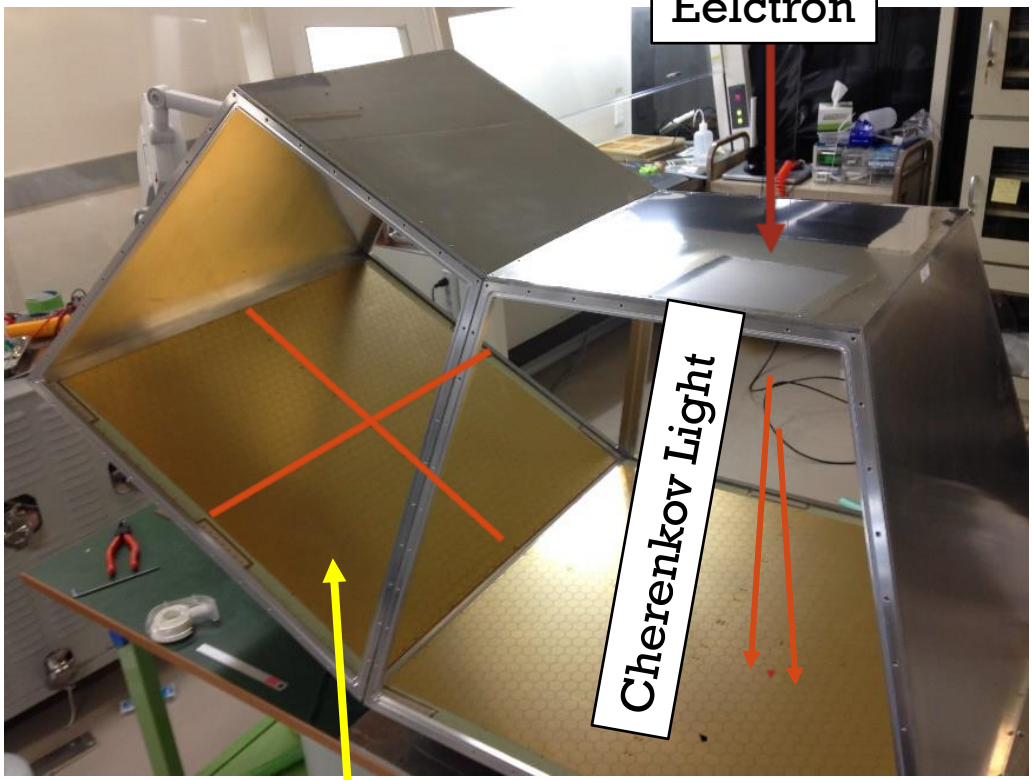
$$QE = \frac{I_{GEM}}{G_{GEM} T_{MESH}} \Big/ \left(\frac{T}{R_{halfmirror}} T_{MgF_2} \frac{I_{PMT}}{QE_{PMT}} \right)$$

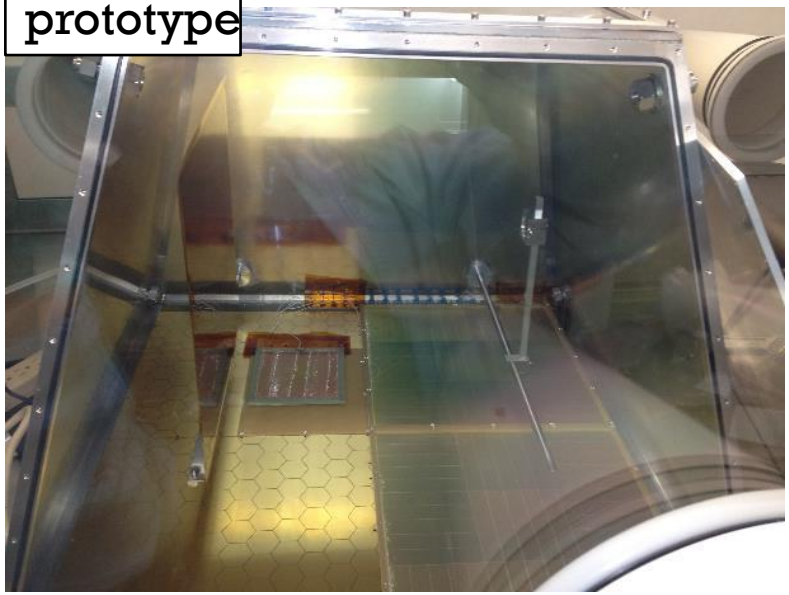




GAS VESSEL FOR HBD

Gas Tightness is essentially important, since CsI has a strong deliquescency





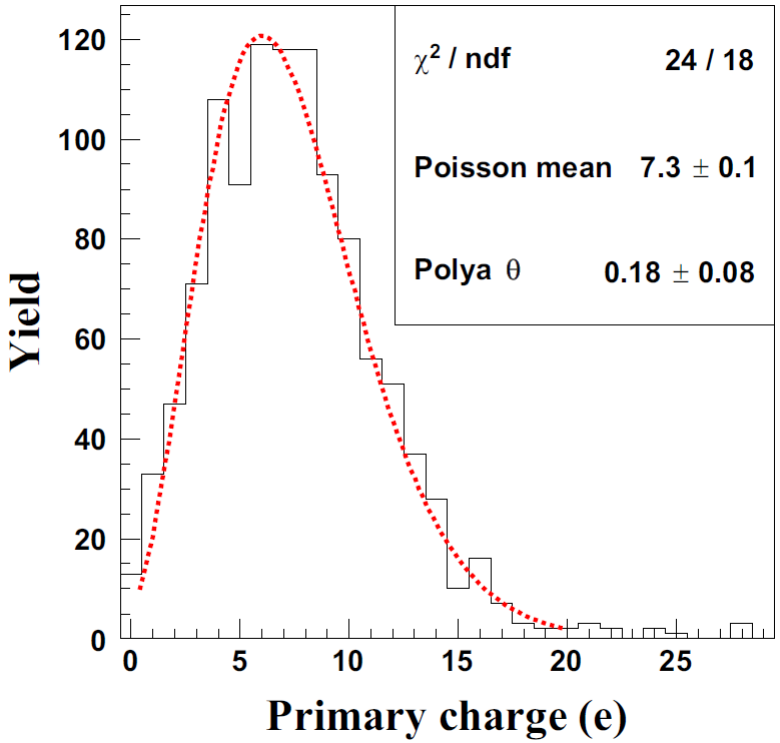
O_2: < 2 ppm
H_2O: < 10 ppm を実現

PERFORMANCE TEST WITH A BEAM

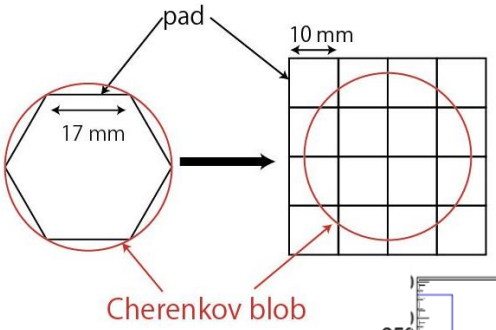
K. Kanno *et al.*, NIM A819(2016)20

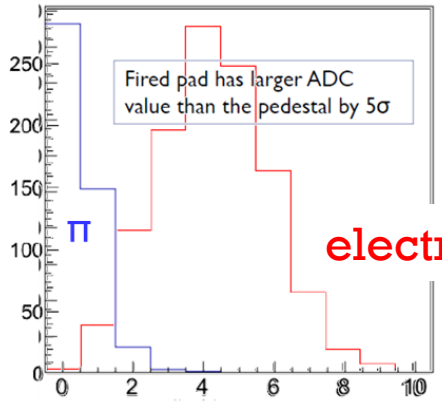
Performance test is done for a proto-type

Response for electron



Difference of cluster sizes of pions and electrons



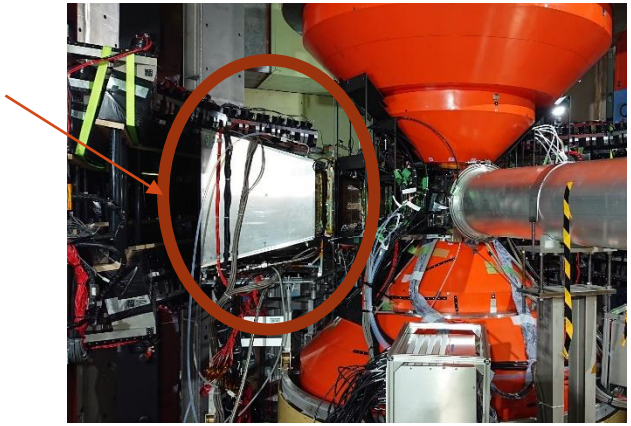


Cluster size - 1

We got an enough performance

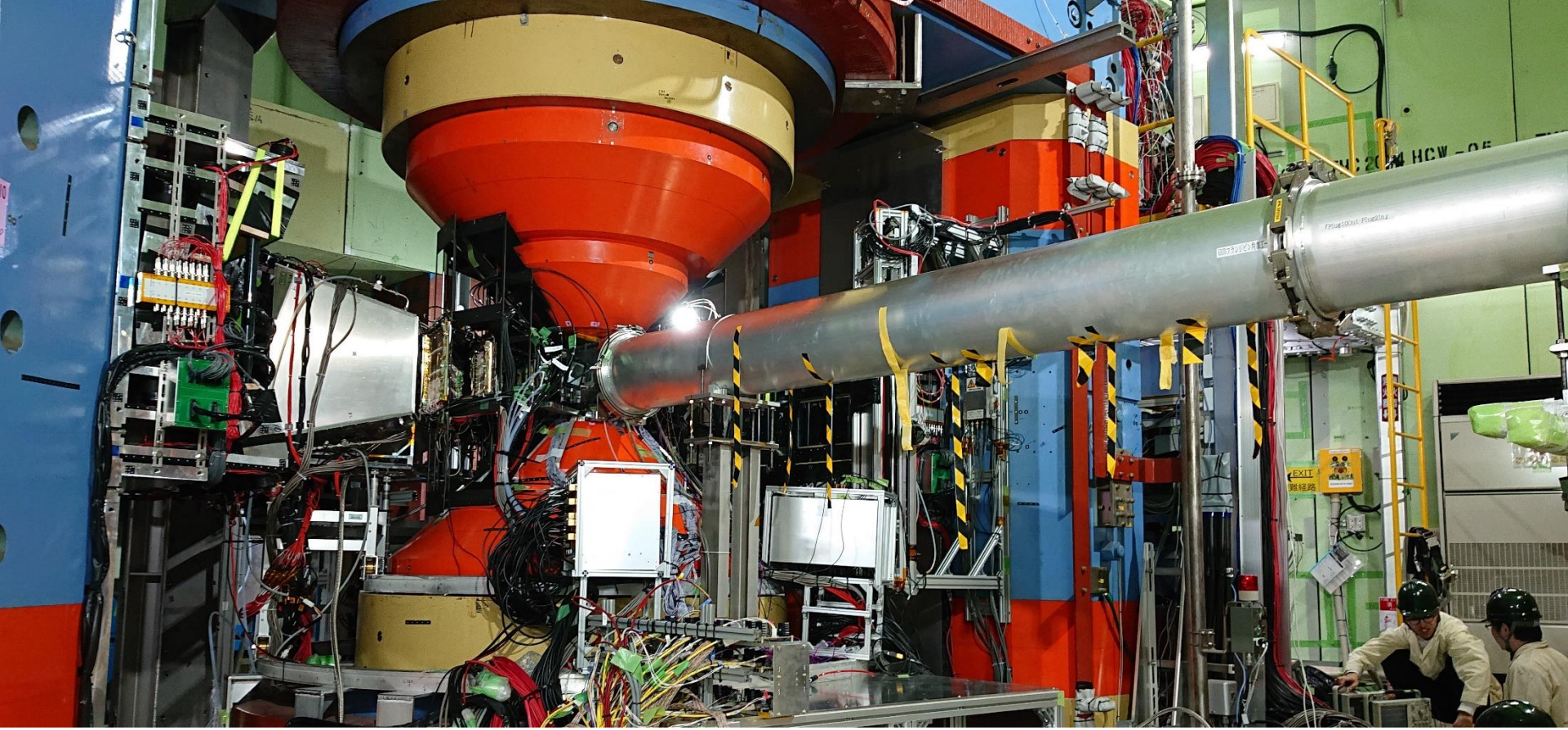
CONSTRUCTION OF ACTUAL DEVICE

Detectors



Assembly at RIKEN

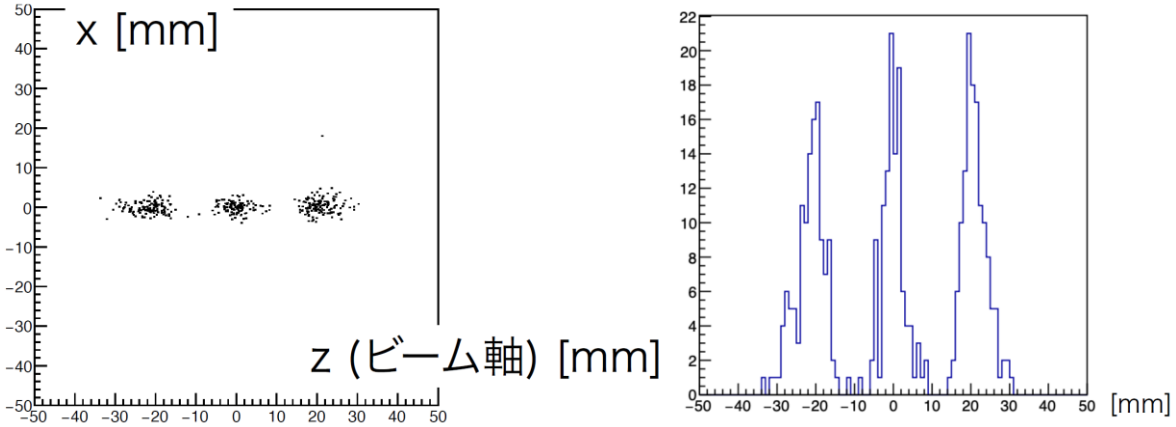
Install works



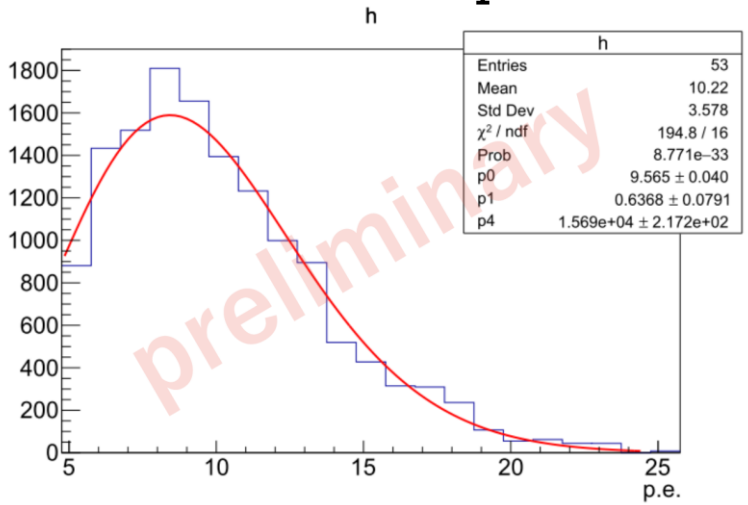
WE HAVE A PILOT RUNS IN THE LAST YEAR

SNAP SHOTS OF PILOT DATA ANALYSIS

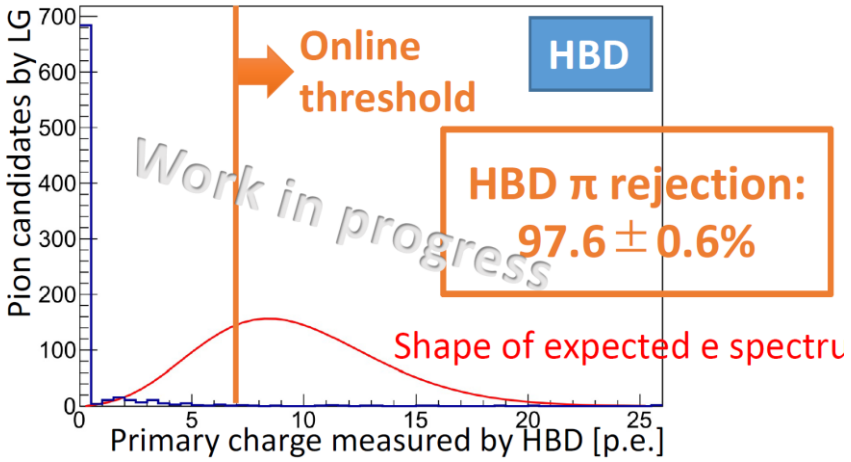
Reconstructed Vertexes
There are Three Targets



Gas Cherenkov Counter performance



Electron response



Pion response

SUMMARY

We developed and constructed new detectors for measurements of vector meson mass spectra in nucleus by electron-positron decays.

Gas Cherenkov detectors and Trackers based on GEM technologies are constructed

We have carried out evaluations of detector performance using a prototype detector and test beams. Enough performances are obtained for the experiment.

Pilot data are collected in the last year and analysis of pilot data is on-going.