Detector R&D: J-PARC-E16

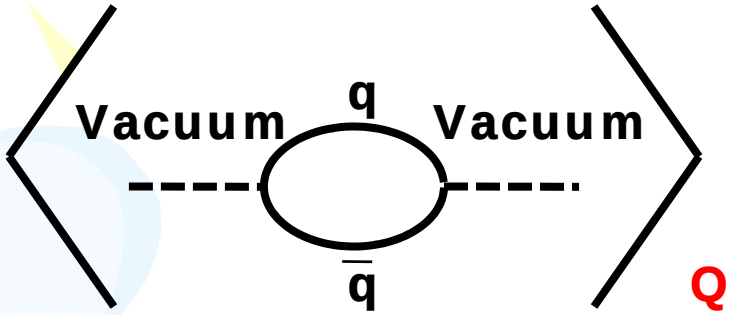
K. Ozawa (Univ. of Tokyo)
for the E16 collaboration

Condensates and Spectrum

We can link condensates and vector meson spectrum.

The relation is established robustly.

T.Hatsuda and S. Lee, PRC 46 (1992) R34



QCD sum rule

Average of Imaginary part of $\Pi(\omega^2)$
vector meson spectral function

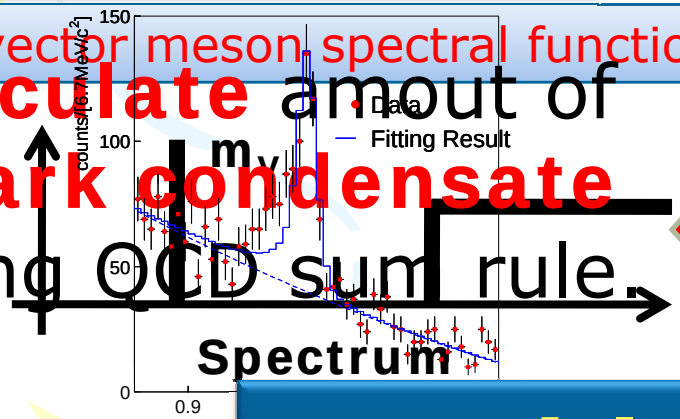
Next Experiment

vector meson spectral function

Model Calculation

measured spectra

Calculate amout of **quark condensate** using QCD sum rule.

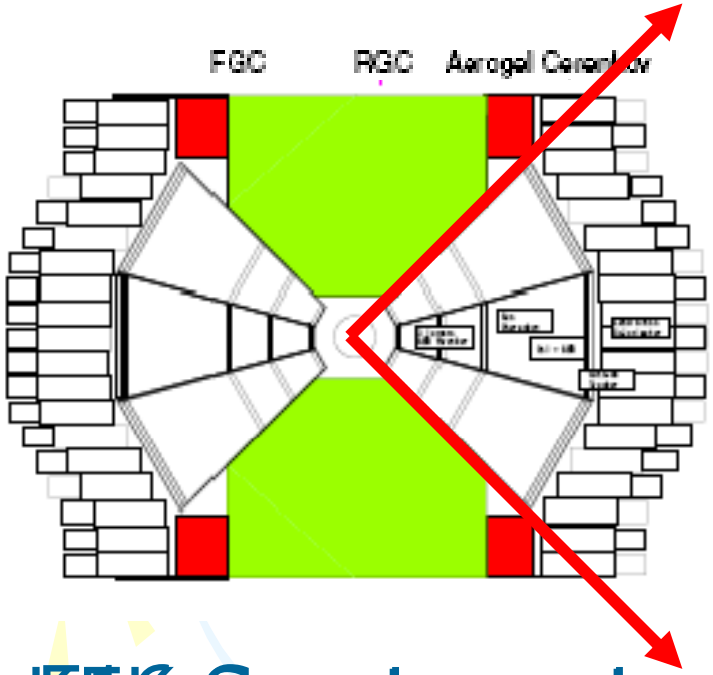


Mass Shift:
$m_\phi = m_0 (1 - \alpha \rho/\rho_0)$ for
$\alpha = 0.03$

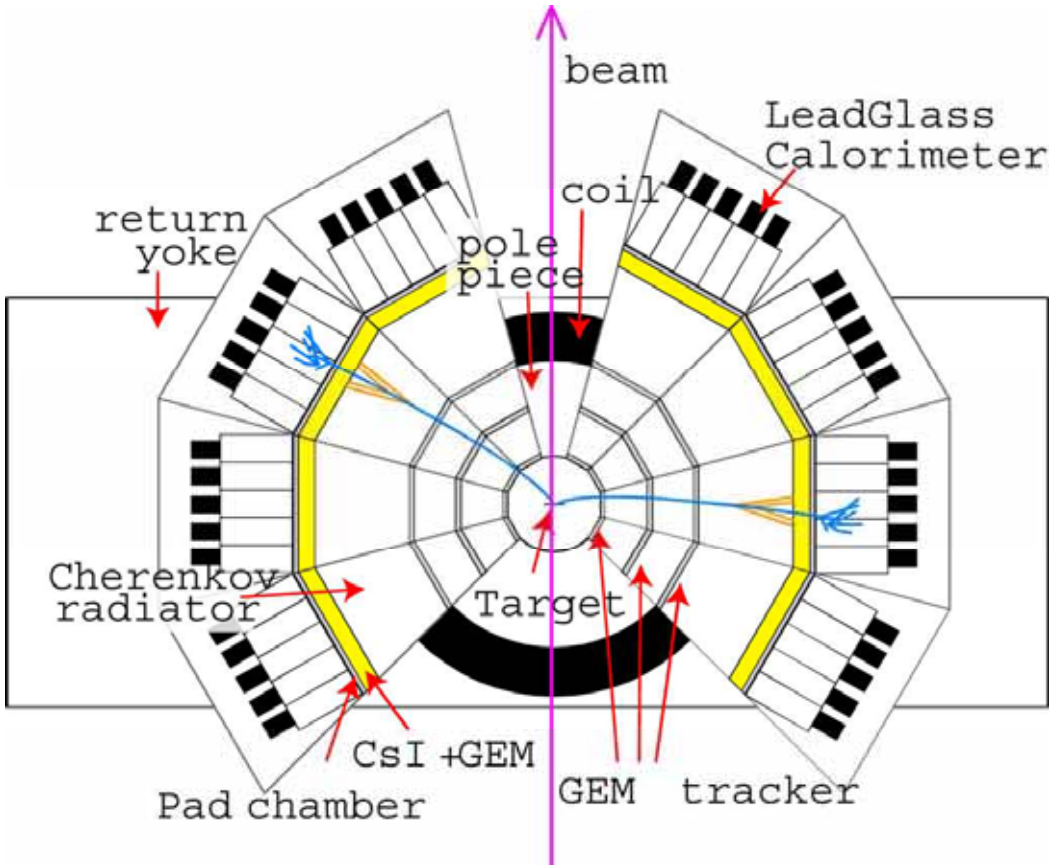
p

Need large statics

New Spectrometer



KEK Spectrometer



5 times larger acceptance for pairs

Cope with 10 times larger beam intensity!!

2 times larger cross section

Total, 100 times higher statistics!!

Major components

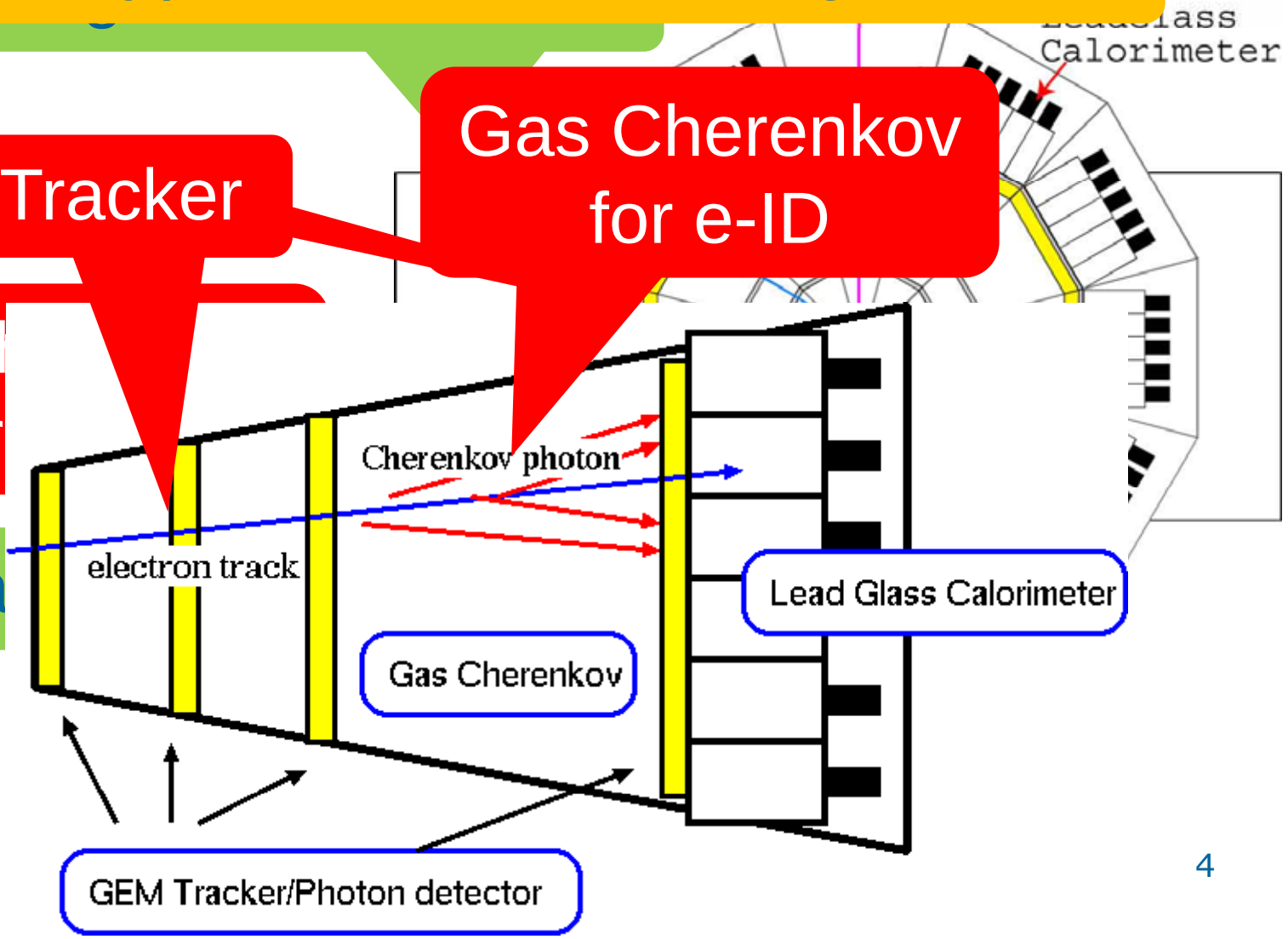
Prototype is made and being tested

GEM Tracker

Gas Cherenkov for e-ID

Gas Cl
for

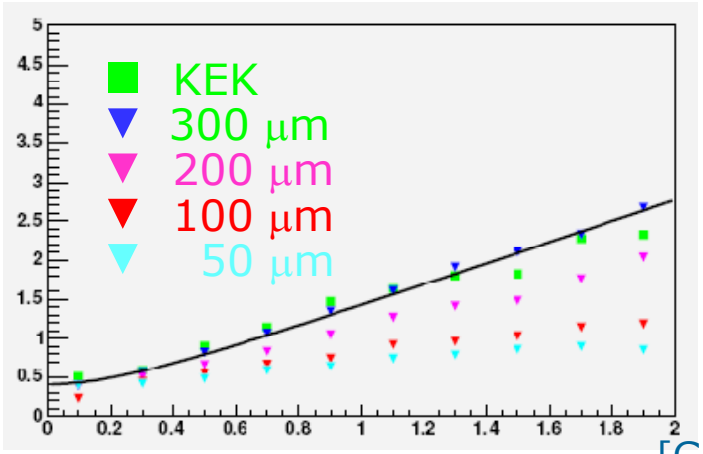
EM Ca



GEM TRACKER

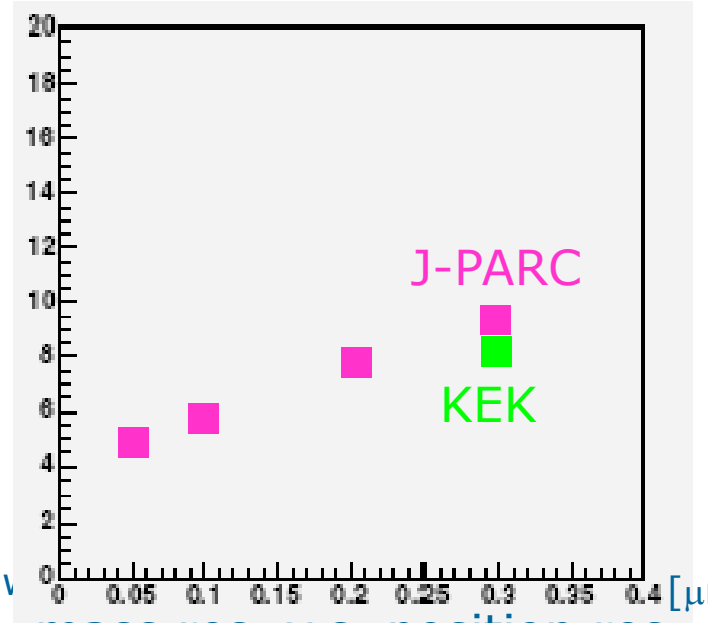
Required Resolution

- Momentum and mass resolution are evaluated based on KEK knowledge.
  - Position resolution:
    - 300 μm for E325
    - 50 μm, 100 μm, 200 μm, and 300 μm for J-PARC
  - Multiple scattering
    - Radiation length of detectors are increased for GEM foils
  - Larger acceptance for J-PARC



Momentum Resolution

To have the improved mass resolution,
Target Resolution is 100 mm
It can be achieved 0.7 mm pitch
and strip charge information.



mass res. v.s. position res.

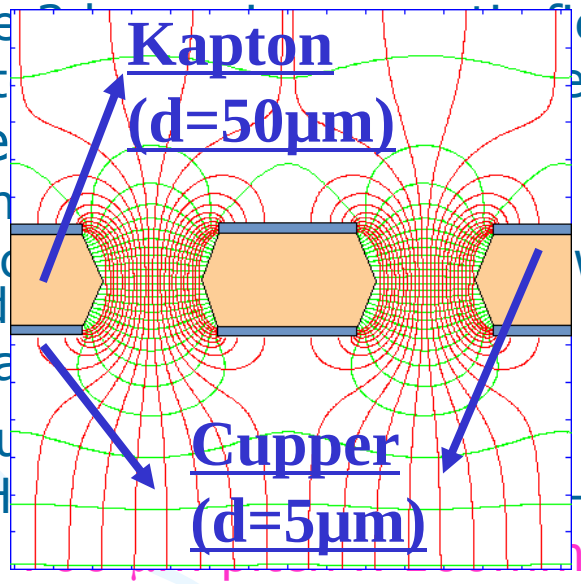
GEM Tracker

Collaboration with KEK

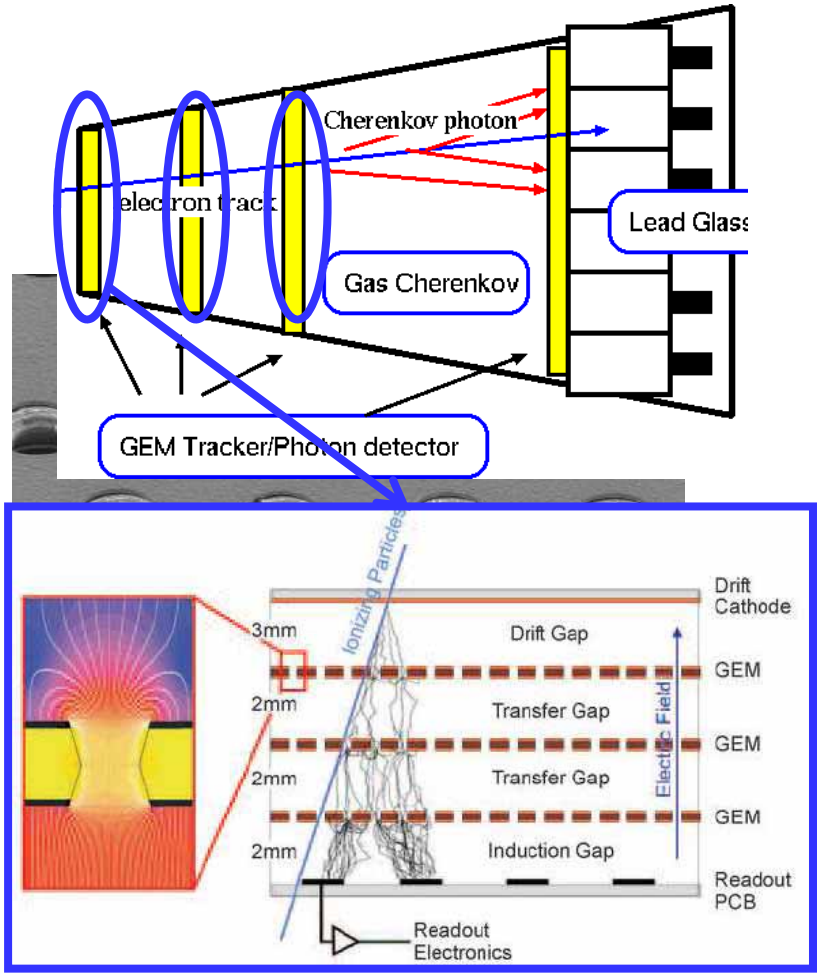
- To cover large acceptance and cope with high counting rate, 3 layers of GEM trackers are used.
- Similar to COMPASS detector
  - Use[illegible]eld
  - Ext[illegible]e
- Challe[illegible]
  - Lon[illegible]
  - Mec[illegible]w rad[illegible]
  - Rea[illegible]

Rate issu[illegible]

5 kH[illegible]-PARC with [illegible]h height



COMPASS detector is working
Up to 25 kHz/mm^2 (400 μm pitch)
GEM detector will work

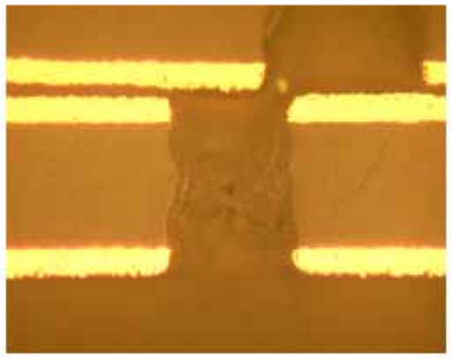


COMPASS detector
(NIM A535, 314)

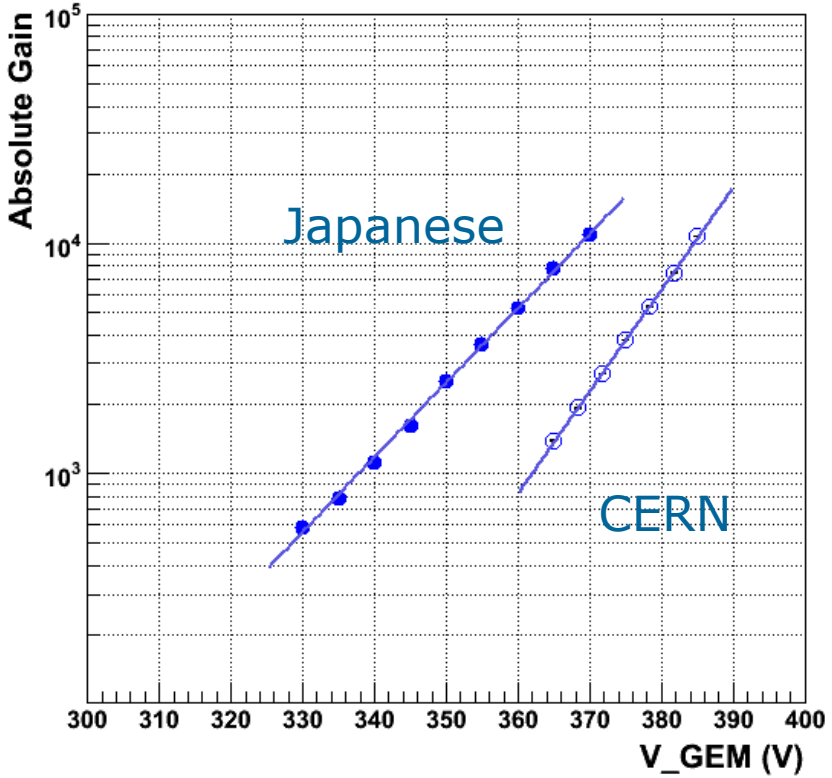
GEM and Read out

- GEM foils made in Japan (SciEnergy)

Collaboration with KEK



Relative Gain with 3 GEM foils



NIM A425(1999)254

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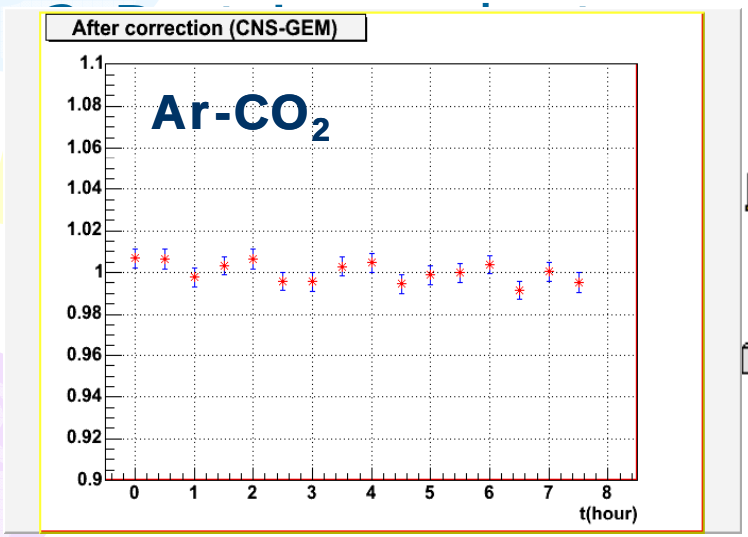
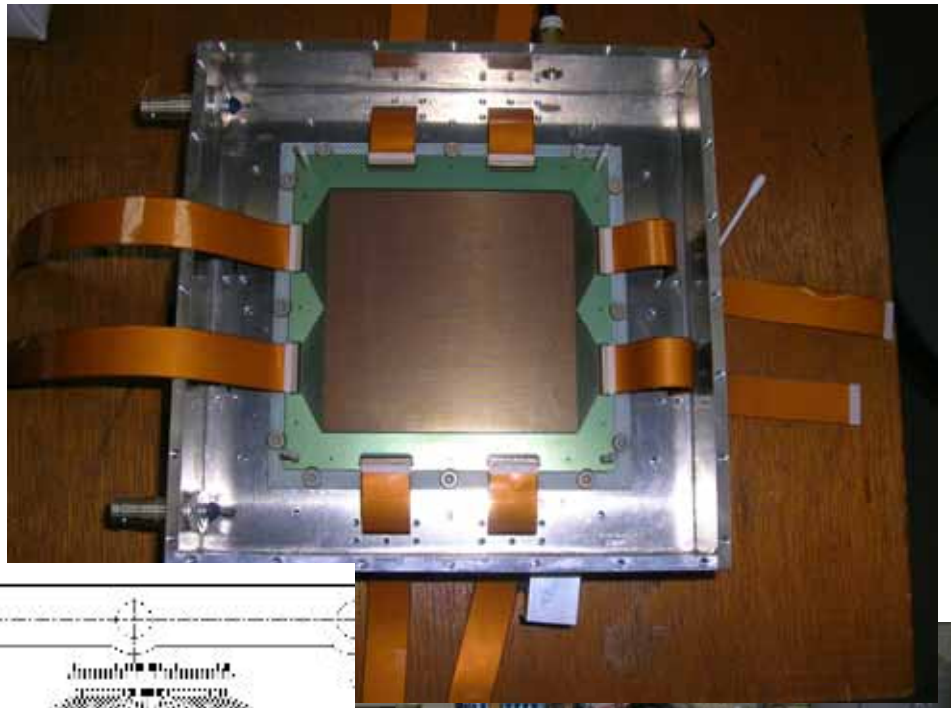


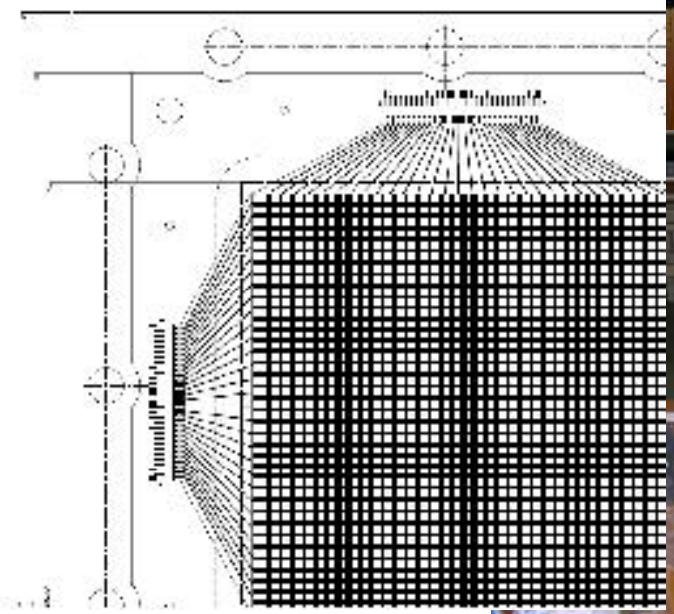
X-COORDINATE

R&D @ Tokyo

Purpose:
- Develop a GEM tracker
- Evaluate specifications
  - Position resolution
  - Efficiency
  - Rate dependence

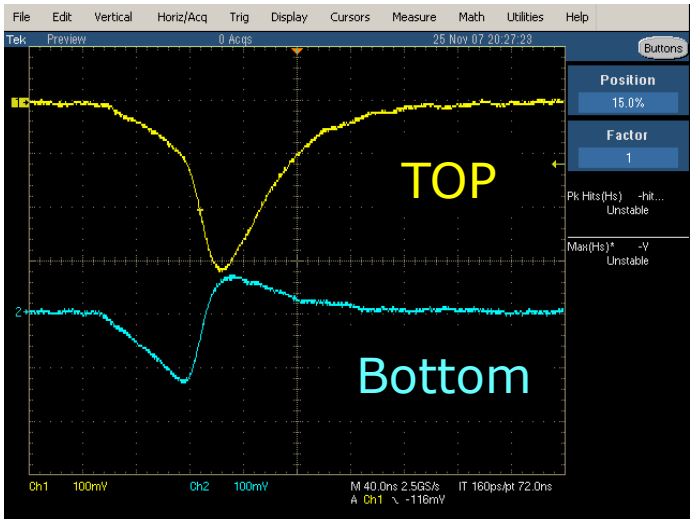


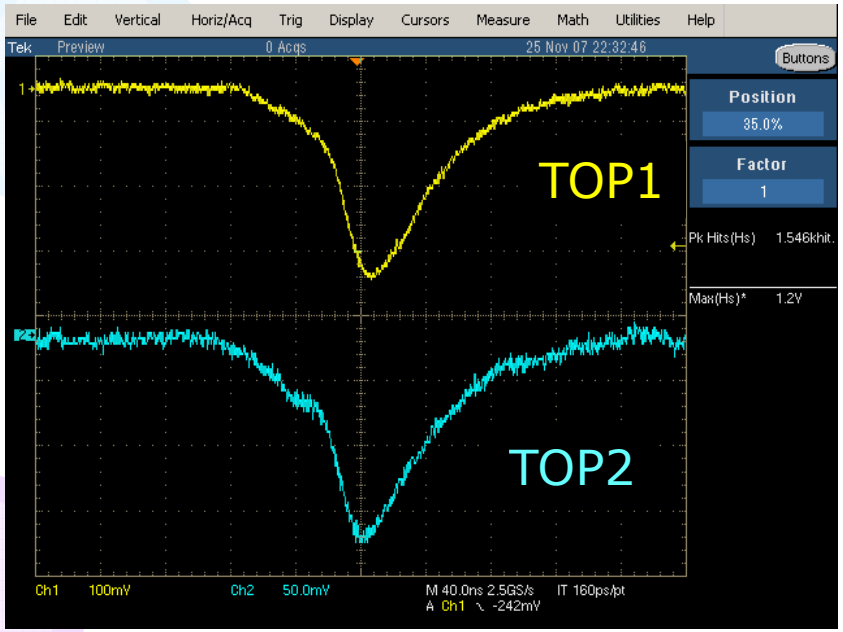
Current Configuration:
- 3 GEM foils
- p-10 gas
- 2-D strip
  - Both side
  - 0.8 μm pitch
  - Copy of KEK's



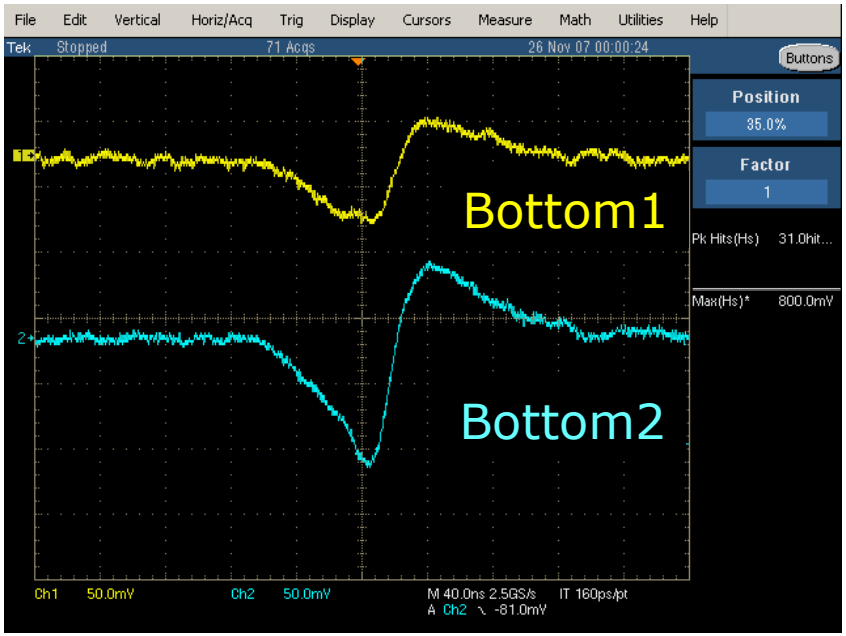
Signals

We can see signals from both sides.
Signal from bottom surface is distorted.
Already known problem by KEK group.



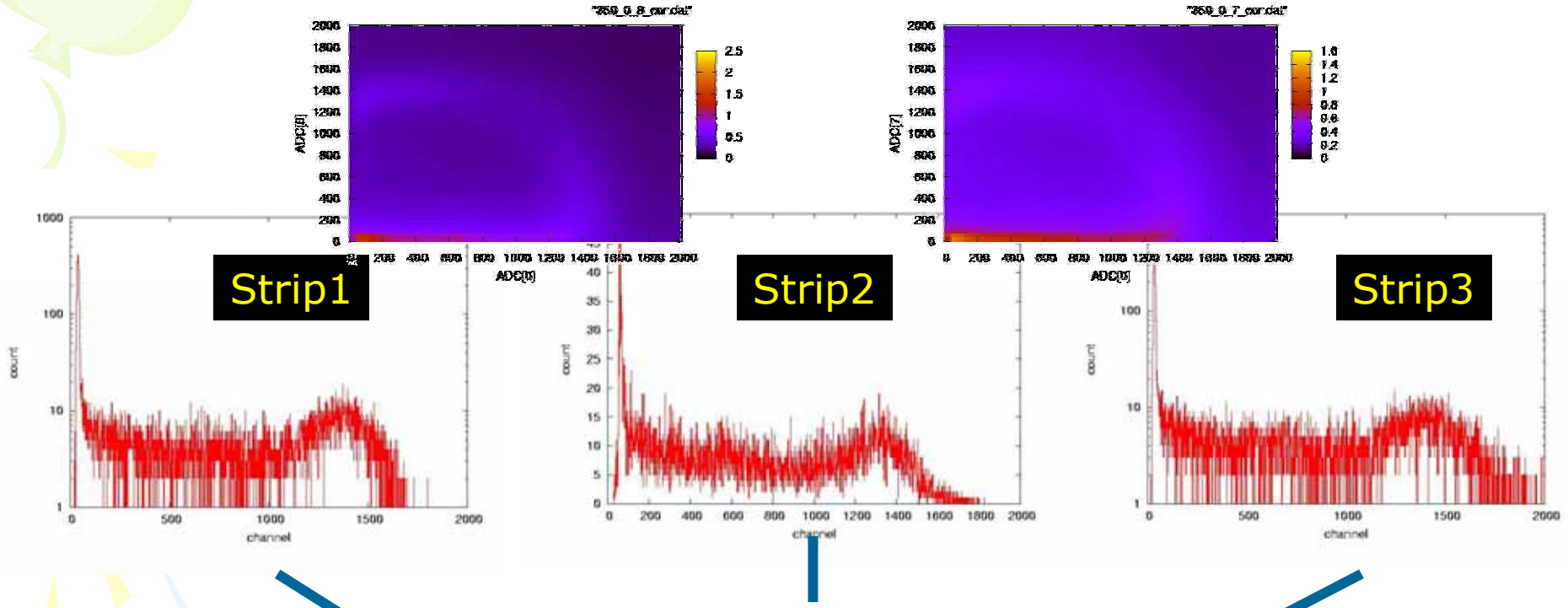


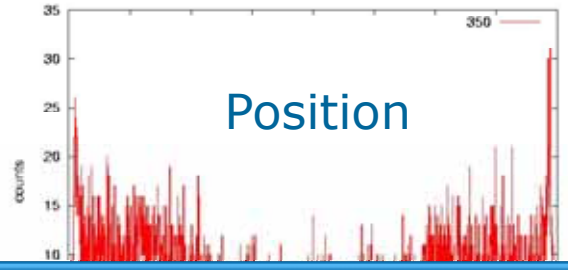
Strips on top surface



Strips on bottom surface

Check with X-ray





Fe-55 X-ray Source

Position distribution is

Beam test is done.
Results of resolution will be appeared soon.

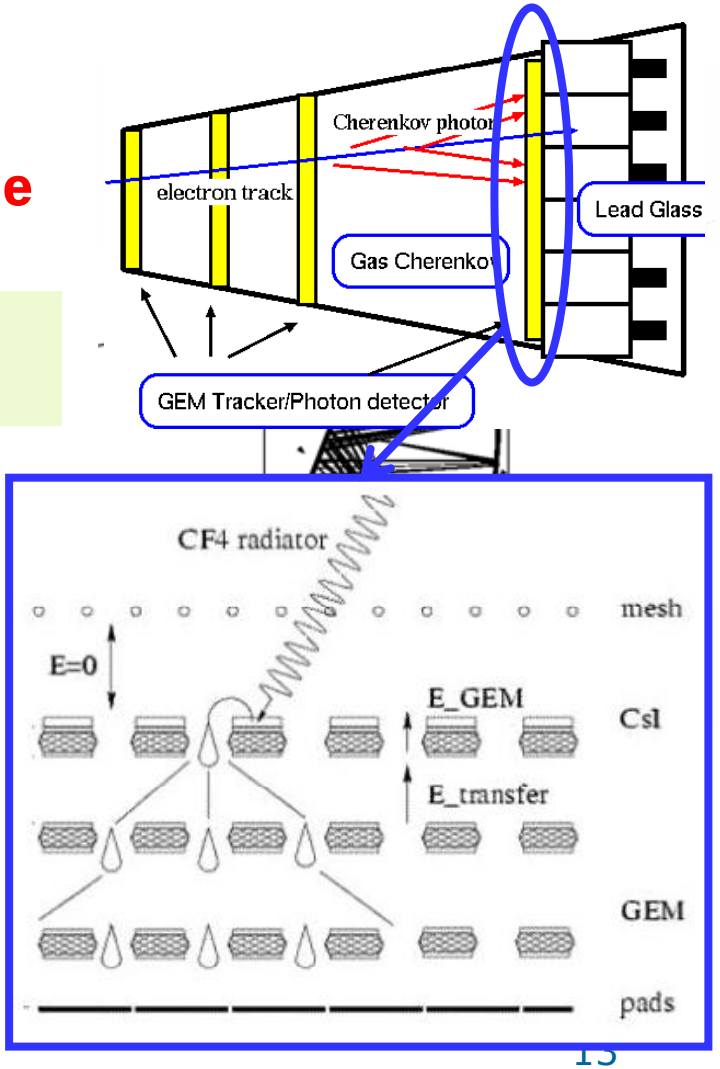
GAS CHERENKOV

Gas Cherenkov Detector

- Electron Identification using gas cherenkov
  - Used for low momentum electron
  - Mirror and PMT, traditionally
    - **Difficulty for Large acceptance**

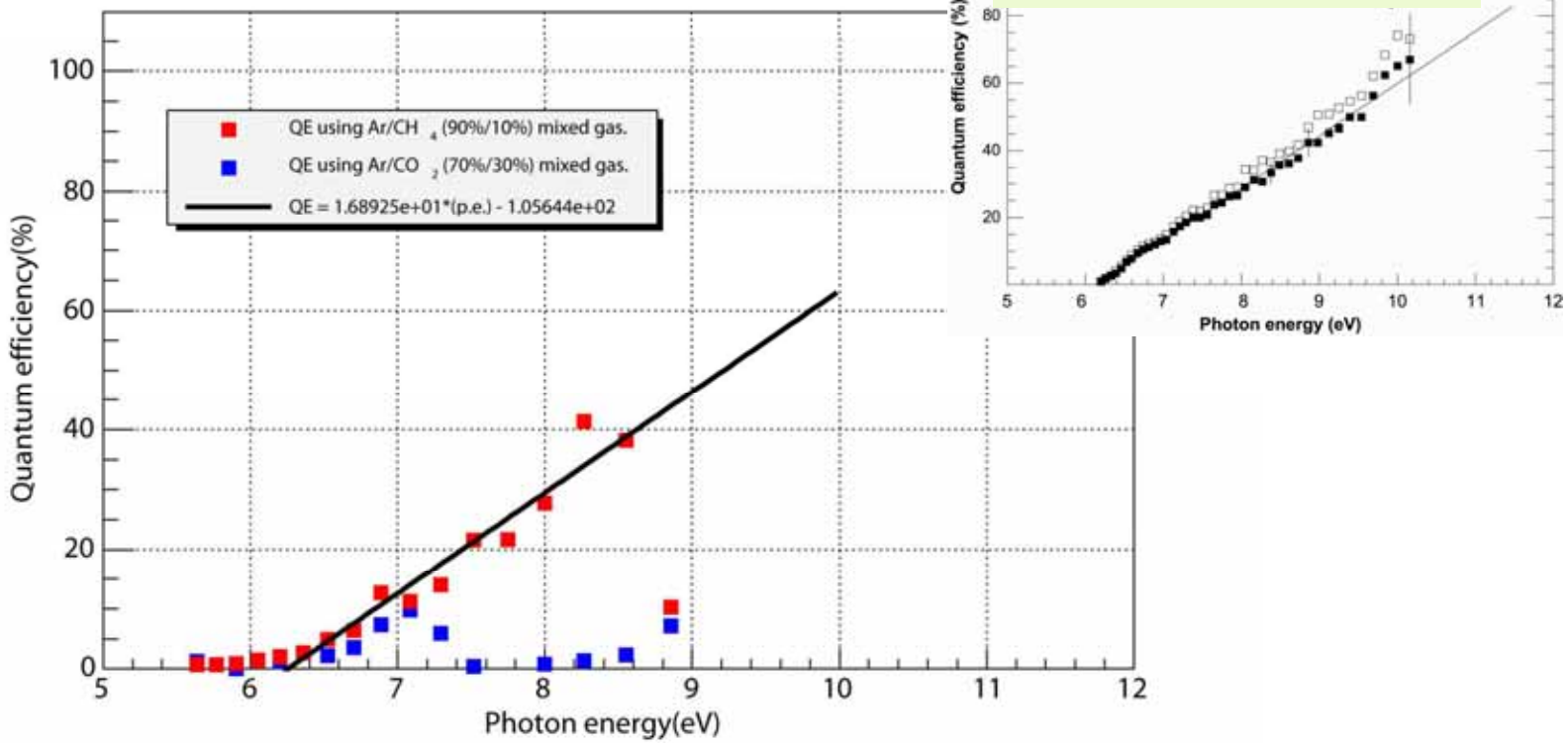
Requirement of large acceptance at J-PARC E16 experiment

Photo Cathode +
GEM for amplification
No Mirror



- CSI photo-cathod
  - UV sensitive (6 eV, 200nm)
  - High quantum efficiency

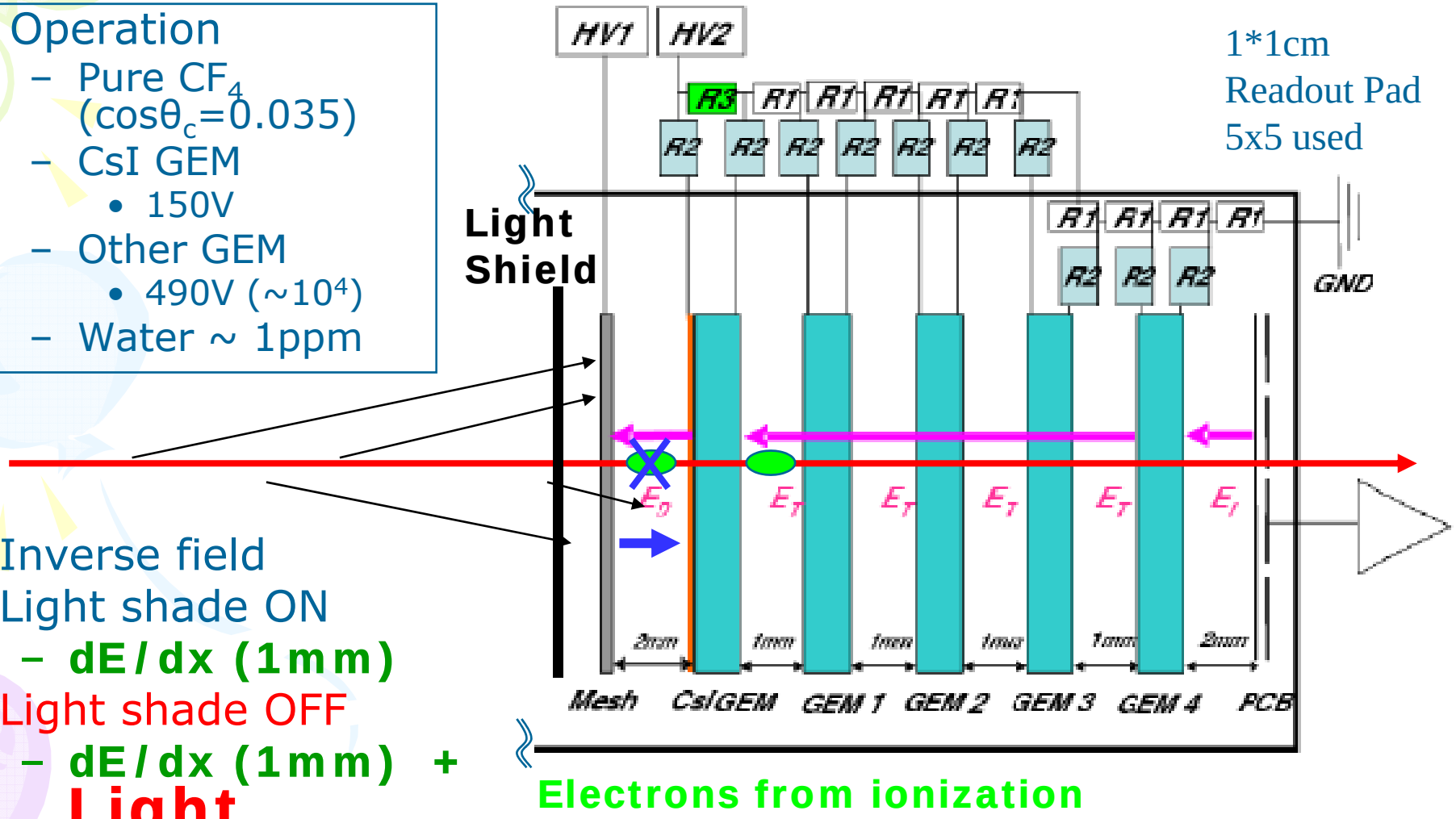
Measurements of Q.E.



- We got a consistent result with existing data.
  - Based on this measurements, the number of photo-electron with 84 cm long radiator is estimated as 65.

Old beam test @ Hiroshima

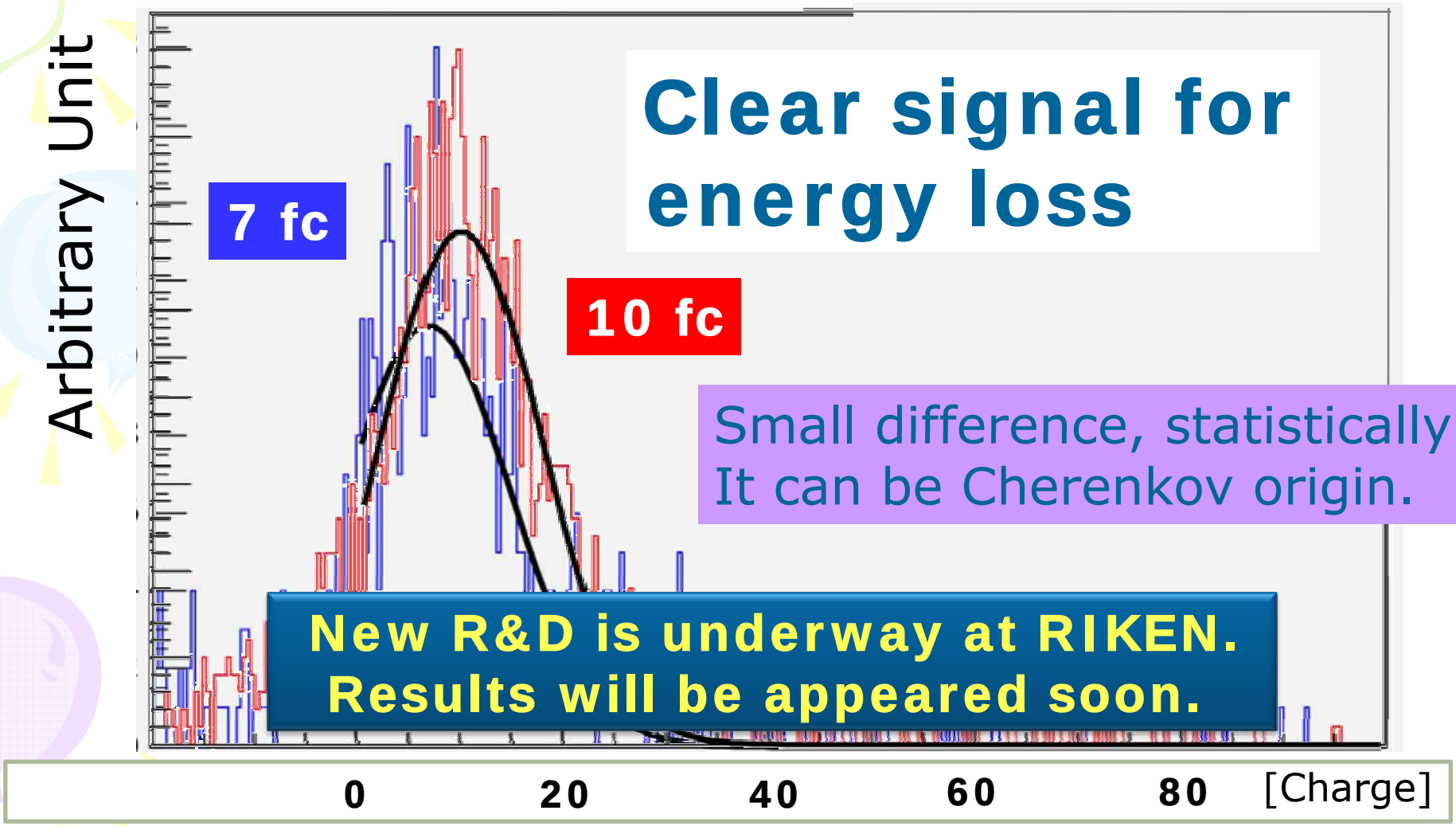
- Operation
  - Pure CF_4 ($\cos\theta_c$=0.035)
  - CsI GEM
    - 150V
  - Other GEM
    - 490V (~10^4)
  - Water ~ 1ppm



- Inverse field
- Light shade ON
  - **dE/dx (1mm)**
- Light shade OFF
  - **dE/dx (1mm) + Light**

Results

Inverse field, light shield on, dE/dx (1mm) Only
Inverse field, light shield **off**, dE/dx (1mm) + **Light**



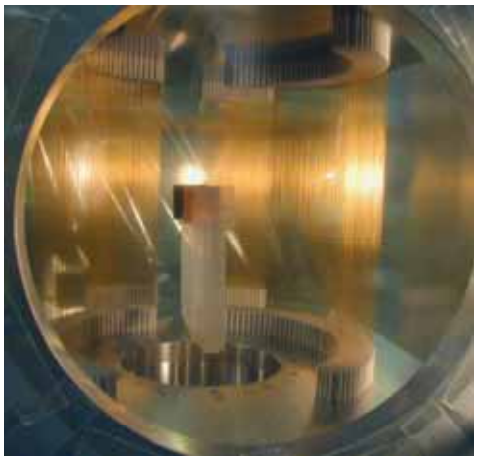
Summary

- For J-PARC E16, a GEM based spectrometer is proposed to cope with high interaction rate and have large acceptance.
- R&D has started for J-PARC at Tokyo and RIKEN. GEM tracker with 2-D strip read out is being developed. First brief result of R&D is appeared.
- Cherenkov counter using CSI photocathode and GEM readout is the essential part to extend the acceptance. R&D is on-going.

Back up

Issue: counting Rate

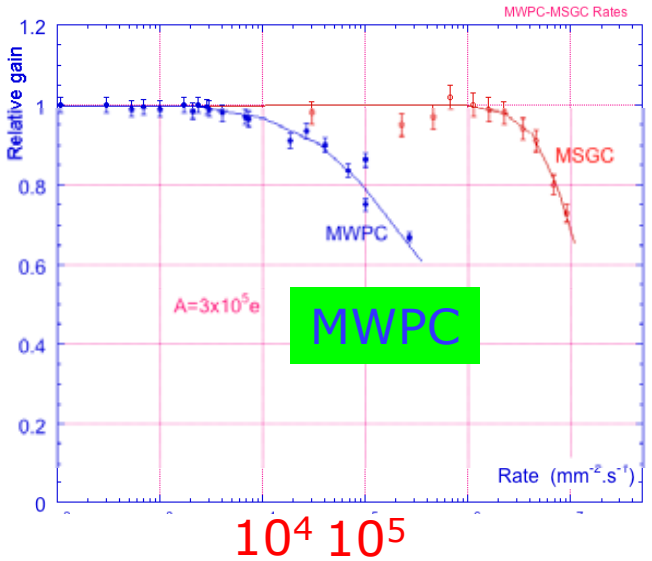
- Interaction rate is 10^6 Hz at KEK (x10 @J-PARC)
- However, beam halo can not be ignored
- For example, actual condition at KEK is following.
  - 350 kHz at the most forward cell of Drift Chamber
    - At radius of 200 mm and the horizontal angle of 6 °
    - 3.5mm width and 220 mm height
  - Mostly from beam halo
- Extrapolate to J-PARC
  - 10 times higher beam intensity
  - shorter beam-extraction duration
  - 3.5 MHz is expected.
  - 10 times finer segments are required
    - 0.7 mm pitch x 100mm height



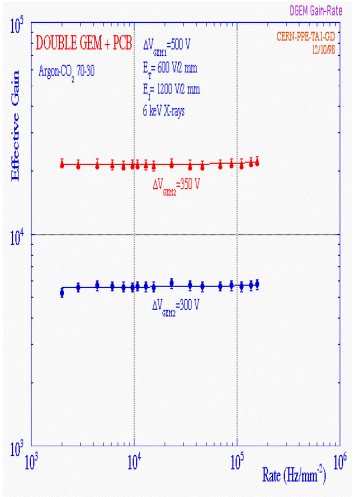
That's the main issue for spectrometer design.
We have to develop the detector which cope with 10 times larger rate.

Detectors in high counting

- MWPC limitation
  - Wire spacing: 1~2 mm
  - Gain dropping @ high rate
- Micro strip gas chamber
  - Discharge problem
- Micromegas
  - Another candidate
- GEM
  - **Flat gain up to 10^5 Hz/mm²**
  - I like flexibility of configuration
  - Good characteristics of signal
    - Signal is generated by electron
    - Not by ion
    - No ion tail and pole cancellation electronics



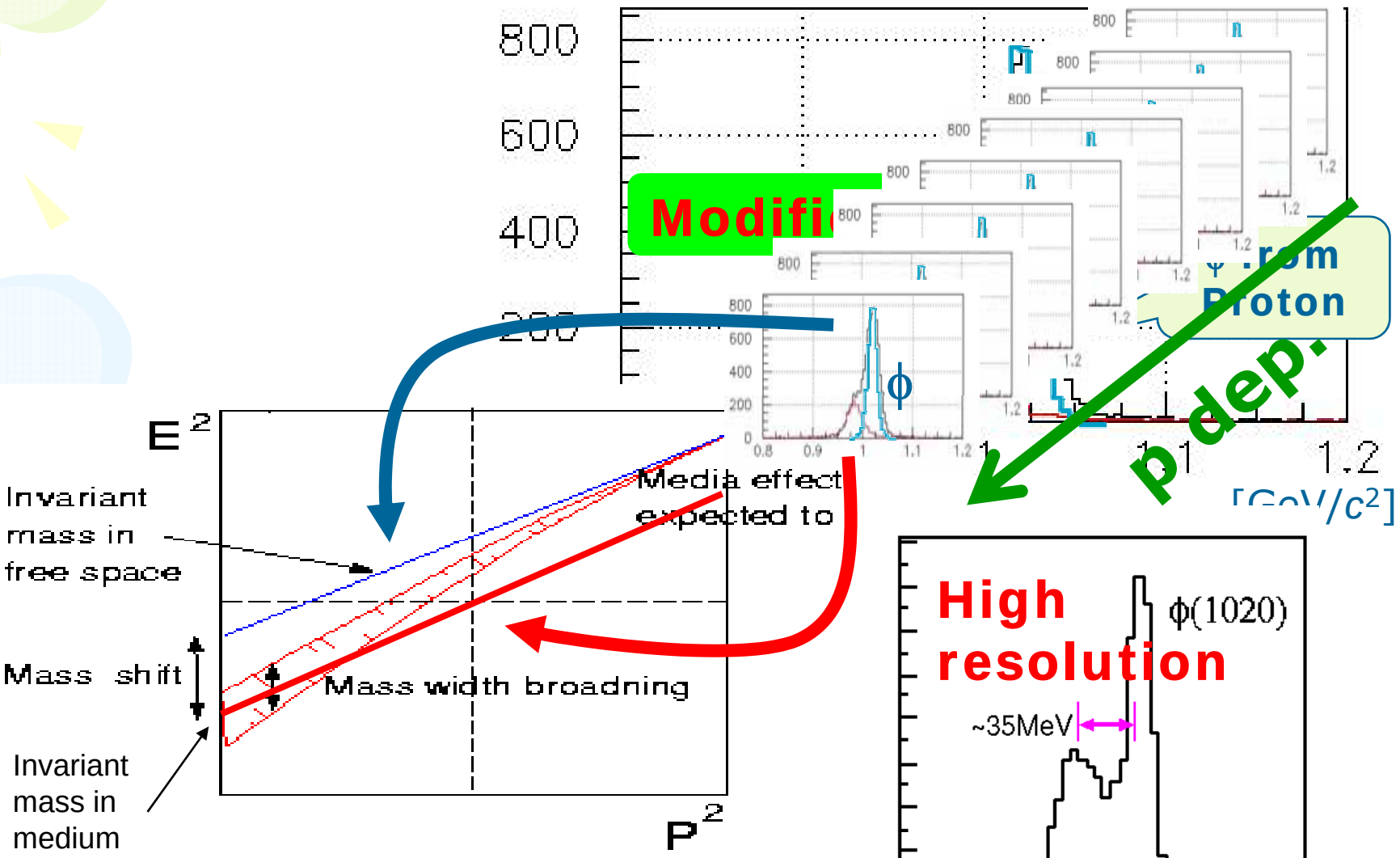
MWPC



GEM

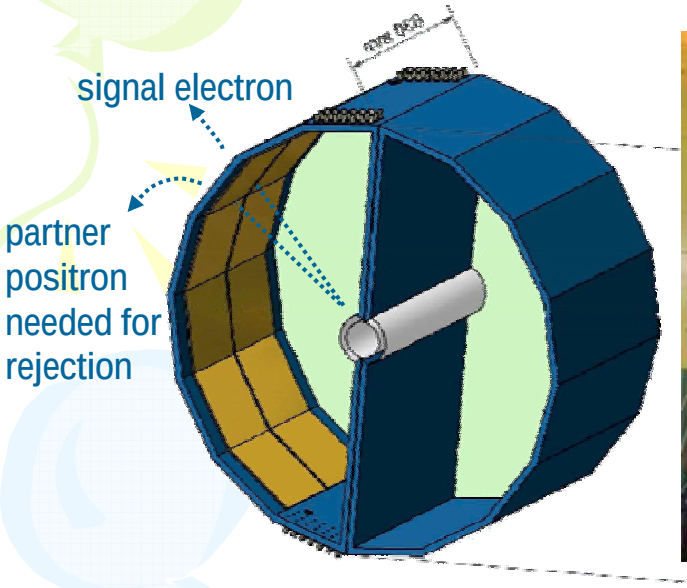
I took these ideas and figures from F. Sauli's presentation at *XIV GIORNATE DI STUDIO SUI RIVELATORI Villa Gualino 10-13 Febbraio 2004*

What can be achieved?



calculate quark condensate

Pictures from PHENIX

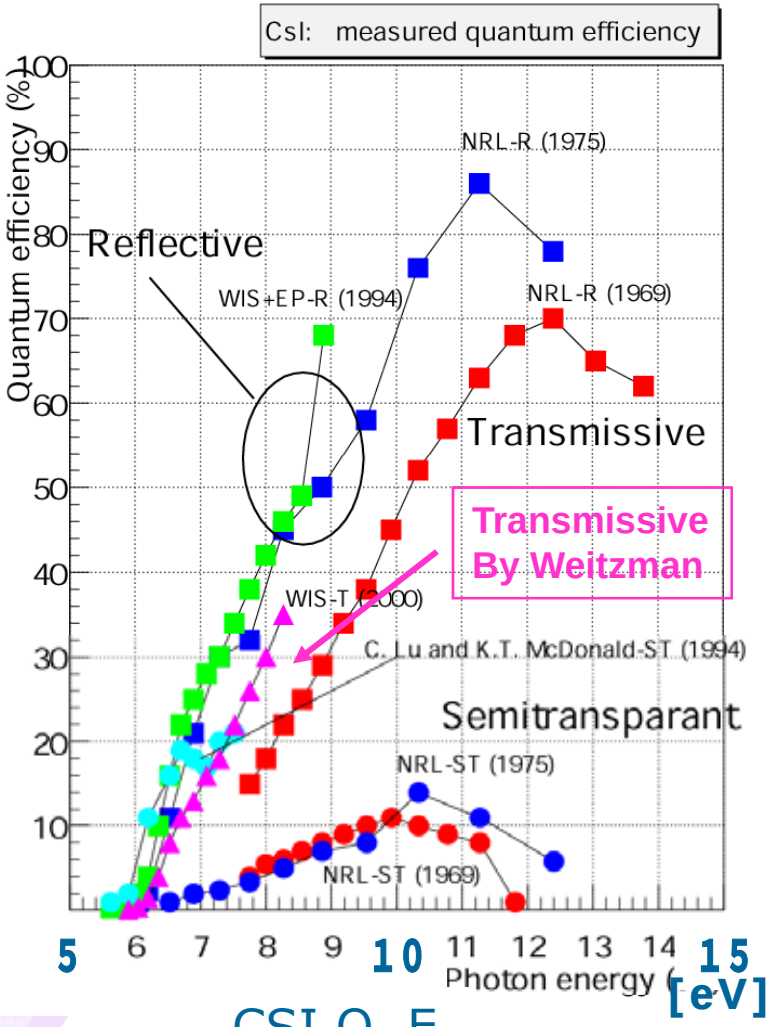


In PHENIX IR

Globe box

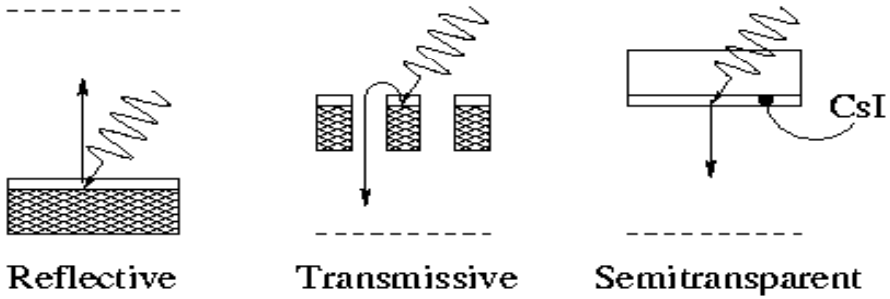
Evaporate machine

CSI photo cathode

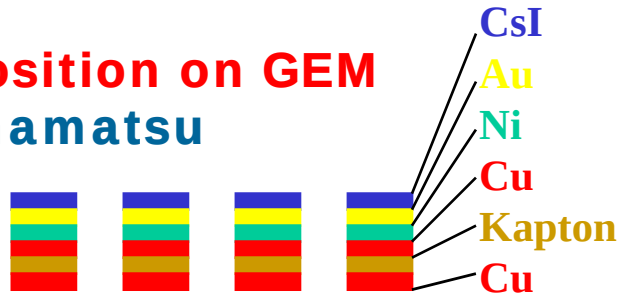


CSI Q. E.

- Transmissive type is used
  - Suitable with GEM
  - Relatively high quantum efficiency
  - Low photon feedback



Vapor deposition on GEM
By Hamamatsu



In reality