Preparation status of the KURAMA spectrometer and decay particle spectrometer (HypTPC)

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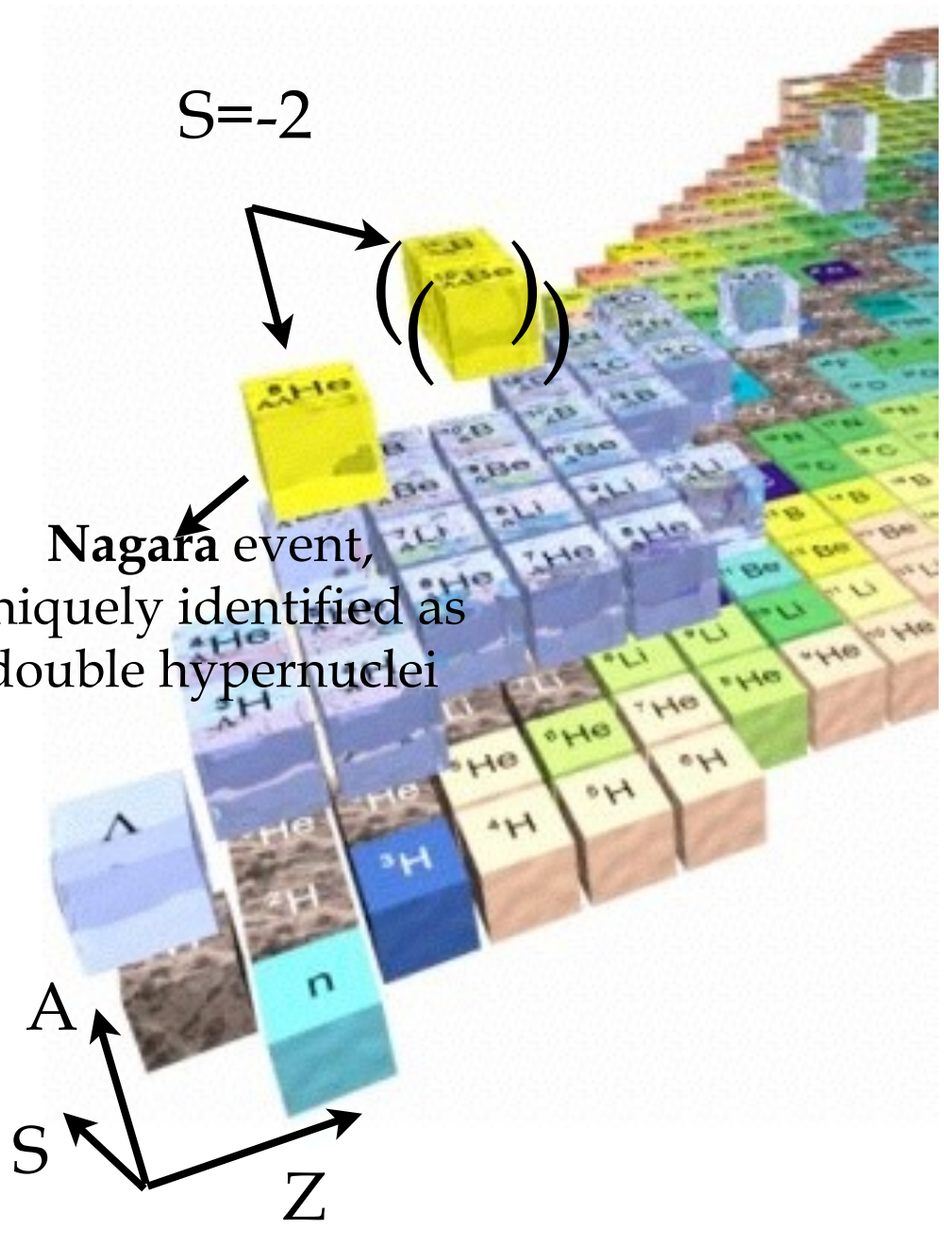
(For the E03, E07, E42 and E45 collaborations)

Outlook

- Introduction
- Status of the KURAMA spectrometer
- Progress of the Hyperon Time-Projection-Chamber (HypTPC)
- Summary

Double strangeness systems

Nuclear chart with strangeness



Why S=-2 systems?

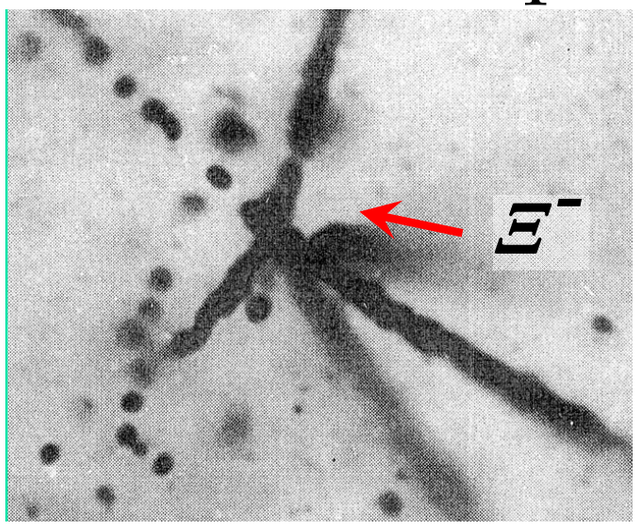
- B-B interaction in $SU(3)_{flavor}$
- H-dibaryon
- Understanding multi-strangeness matter

We are investigating S=-2 systems via (K-,K+) reactions with the KURAMA spectrometer and the HypTPC at the J-PARC K1.8 beamline

E07, Double hypernuclei in Emulsion Exp.

KEK-E176

in 80 Ξ^- stops



J-PARC E07

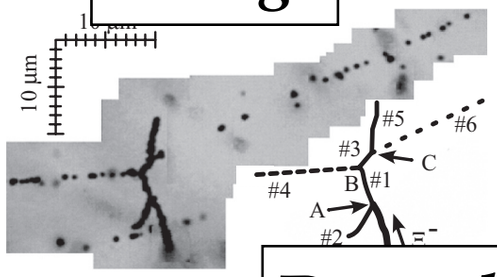
10^4 Ξ^- stops

with a high intensity K- beam

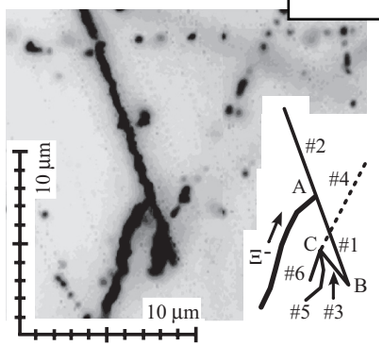
KEK-E373

in 10^3 Ξ^- stops

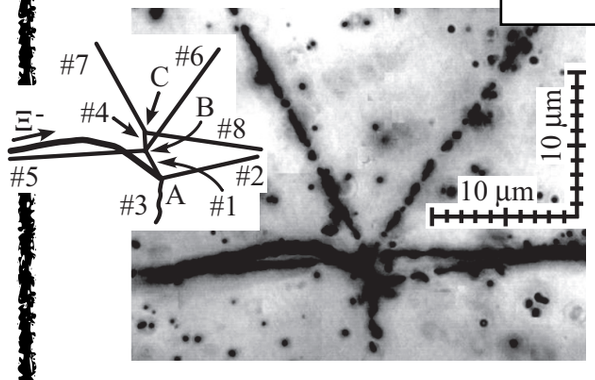
Mikage



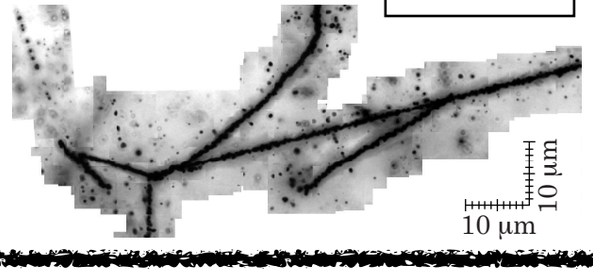
Demachiyanigi



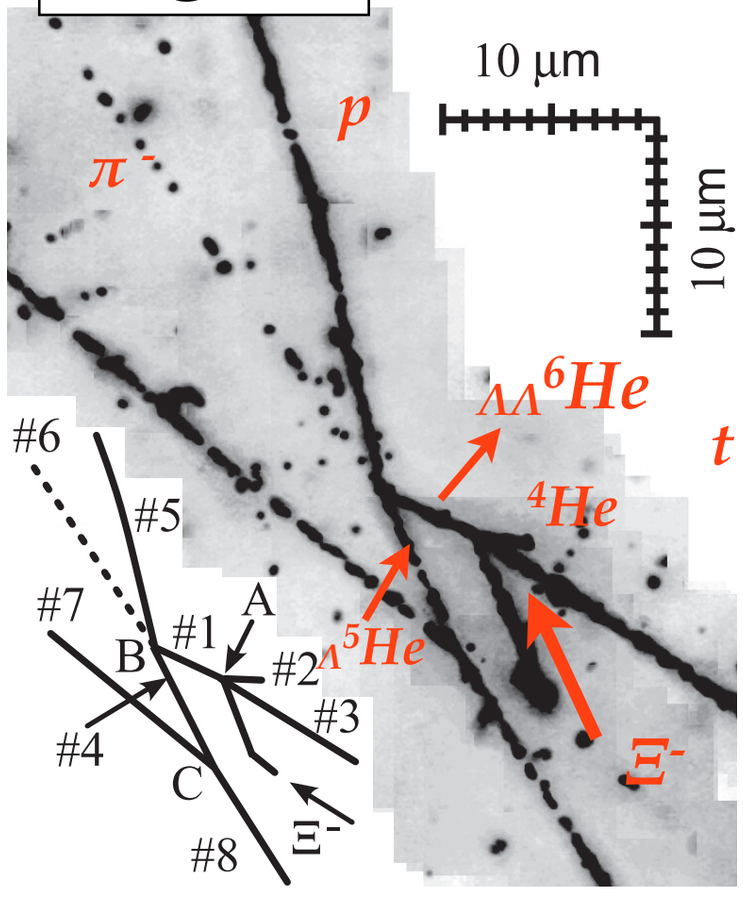
Hida



KISO



Nagara

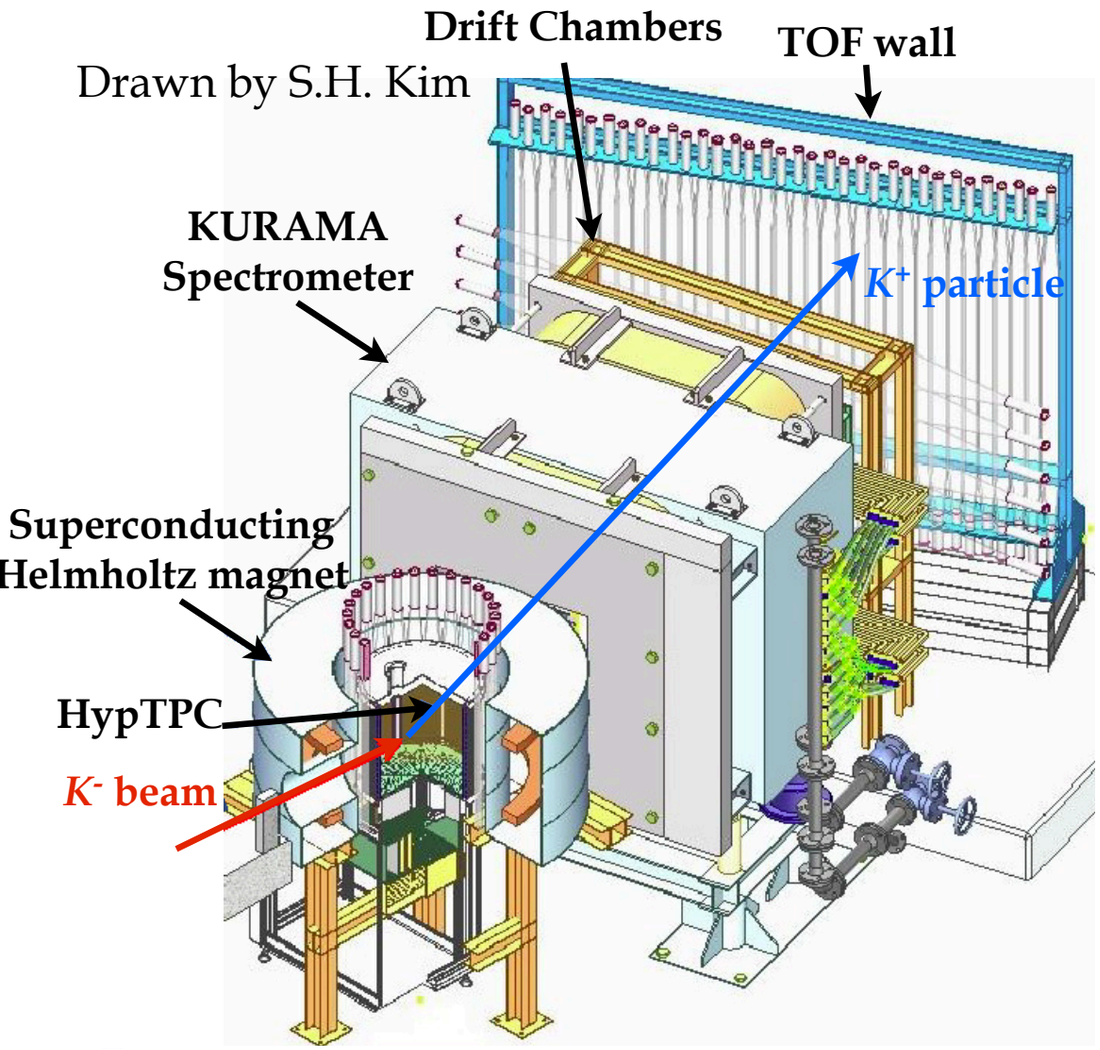


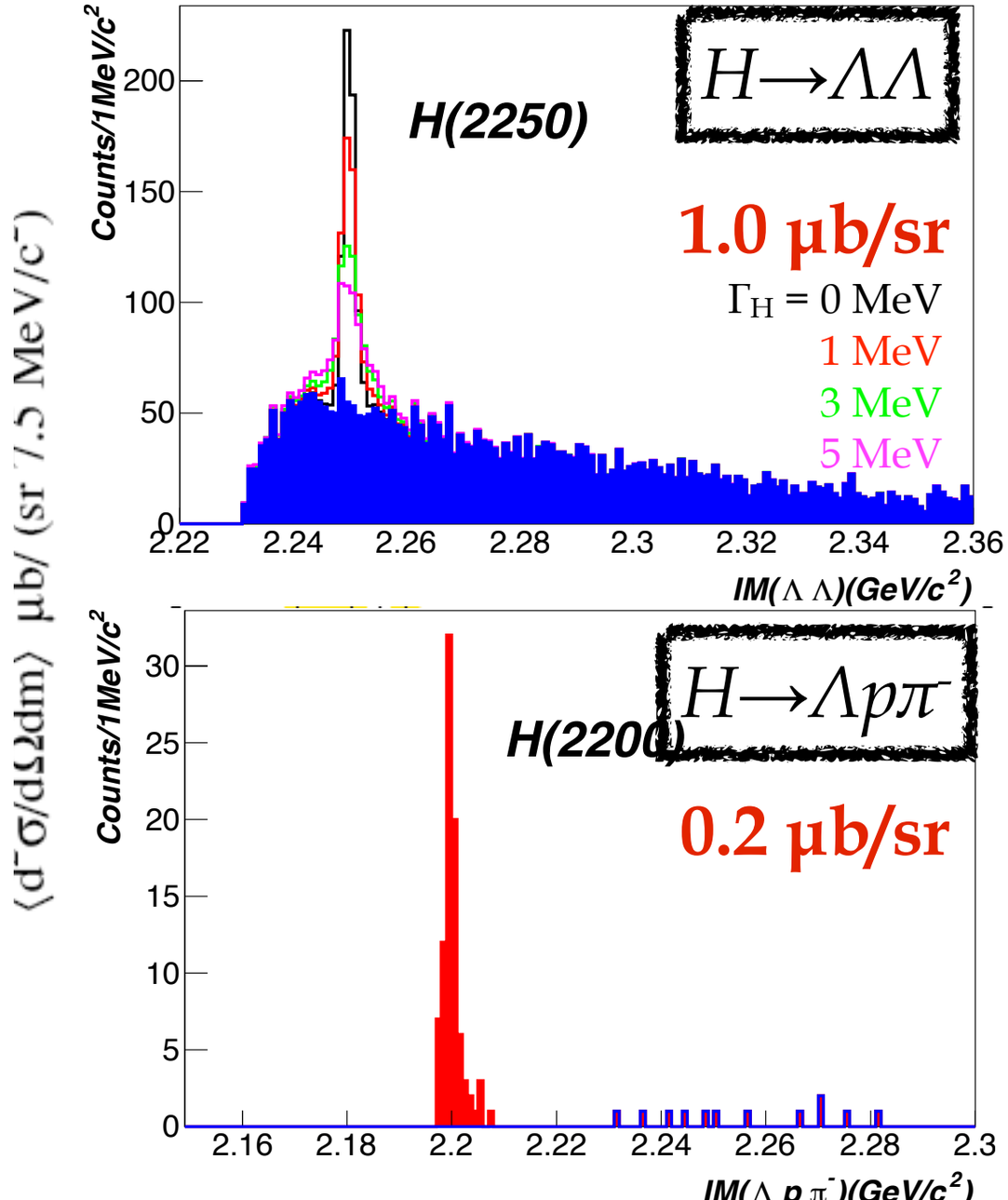
$^{12}C + \Xi^- \rightarrow {}_{\Lambda\Lambda}{}^{6}He + {}^{4}He + t$

$\rightarrow {}_{\Lambda}{}^{5}He + p + \pi^-$

E42, Hyperon TPC (HypTPC) with KURAMA spectrometer

Most stable spin and isospin singlet with 6-quarks (uuddss) compose was predicted by R. L. Jaffe. We search for H→ΛΛ→π⁻π⁻pp and H→Λπ⁻p→π⁻π⁻pp with Hyperon Time-Projection-Chamber (HypTPC), Yield : 11000 *ΛΛ*





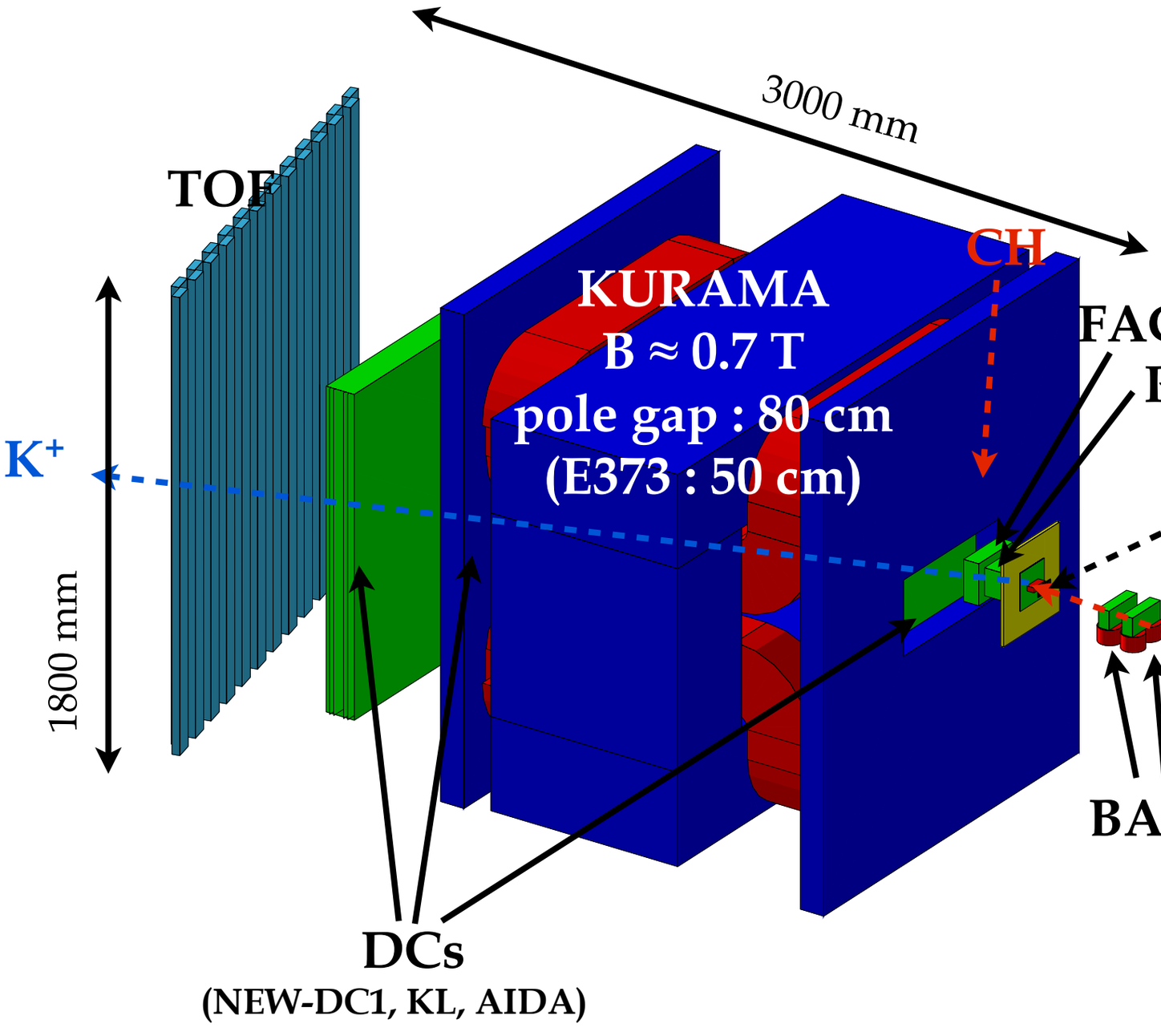
- Large Acceptance
- Target is inside TPC
- High resolution (~1 MeV/c^2) .

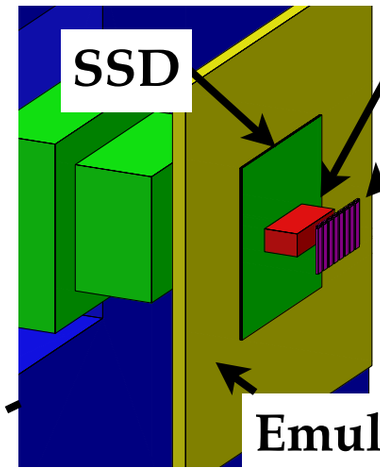
Development of the KURAMA spectrometer

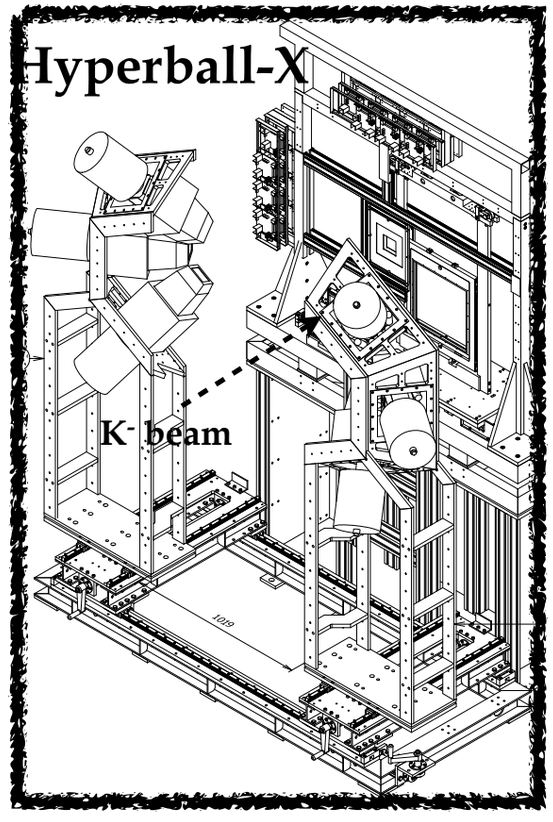
New KURAMA spectrometer

Beam : 1.67 GeV/c, 10^5 - 10^6 K^-/spill → Operation with a high counting rate

Solid angle : 280 msr (E373 : 170 msr) → Detectors w/ a large effective area



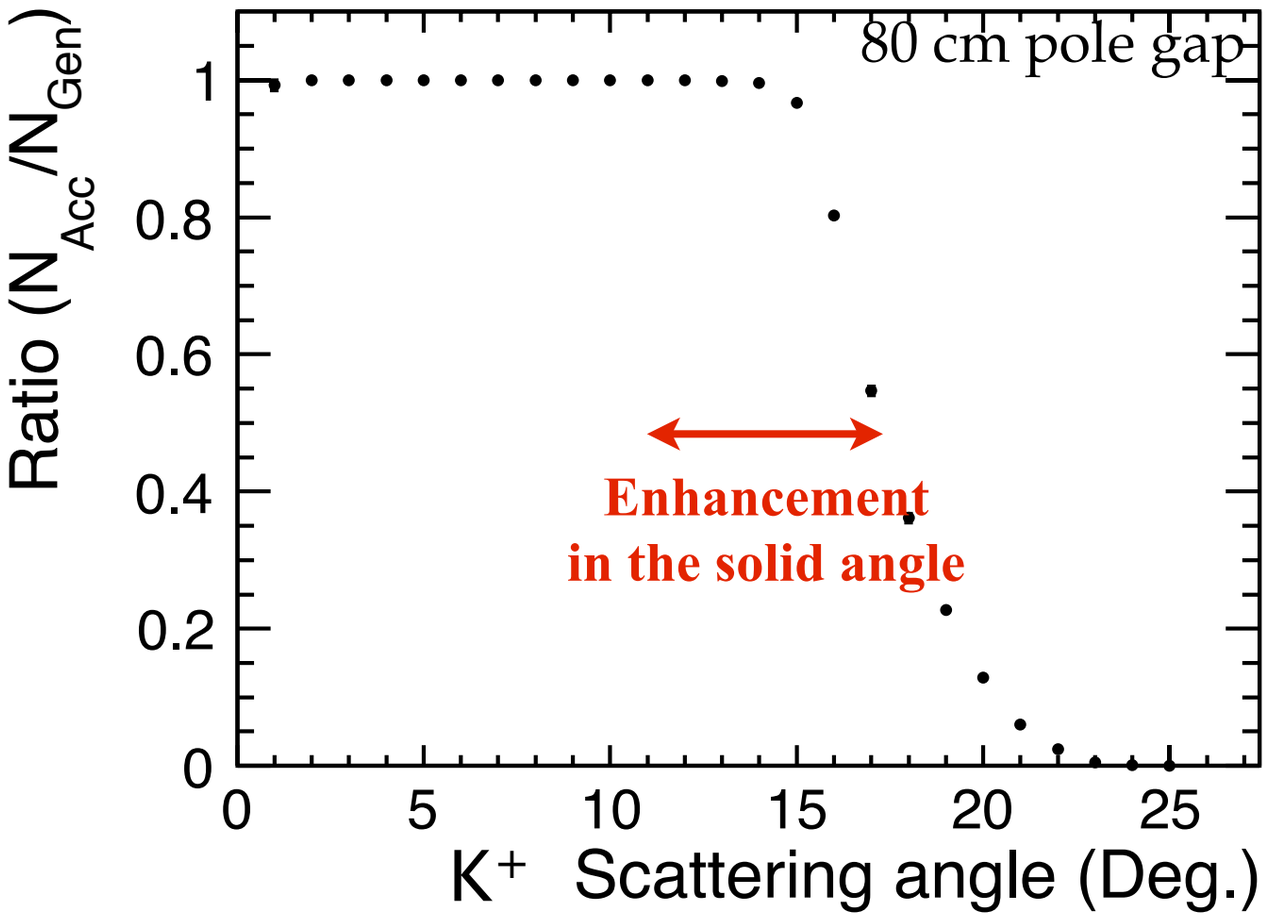


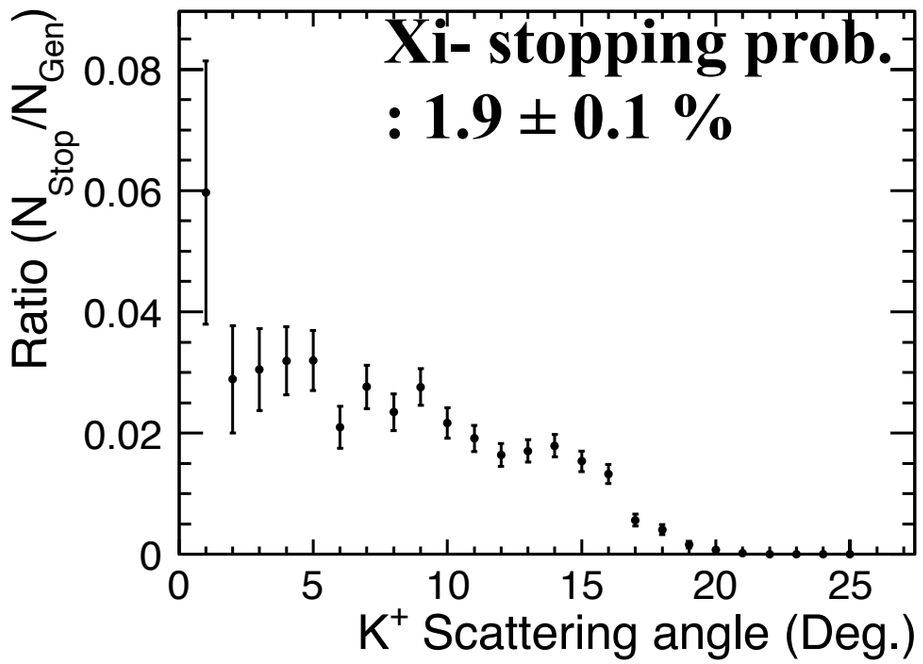


Solid angle with a Large pole gap

KEK-E373 experiment : 170 msr (pole gap : 50 cm)

E07 ⇒ 80 cm pole gap





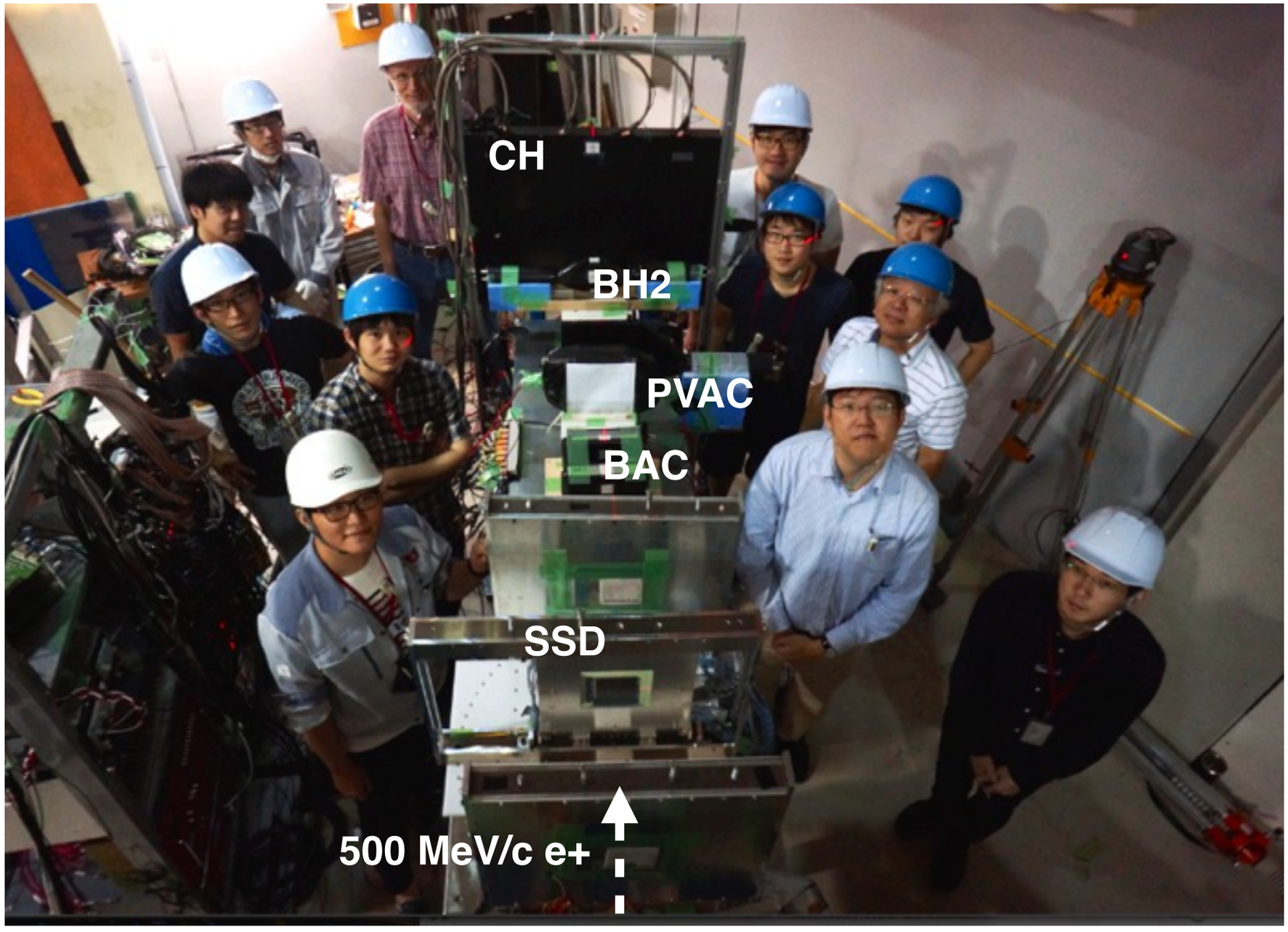
$$\Delta\Omega(\theta;\Delta\theta) = 2\pi \int_{\theta-\frac{1}{2}\Delta\theta}^{\theta+\frac{1}{2}\Delta\theta} d\cos\theta \times \frac{\text{number of accepted events}}{\text{number of generated events}} = \mathbf{282 \pm 1\ msr}$$

→ 65 % improvement

E03 : 214 ± 2 msr
(in proposal : 200 msr)
E42 : 162 ± 2 msr
(in proposal : 110 msr)

ELPH test experiment

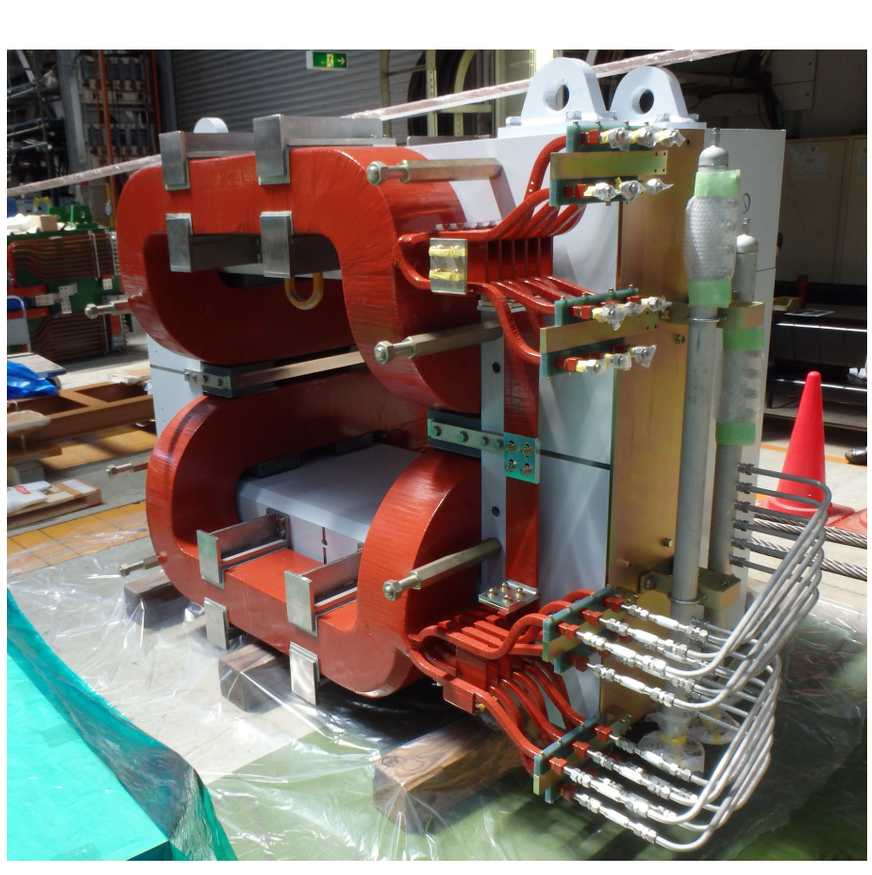
Beam time : June 23th - 26th at ELPH



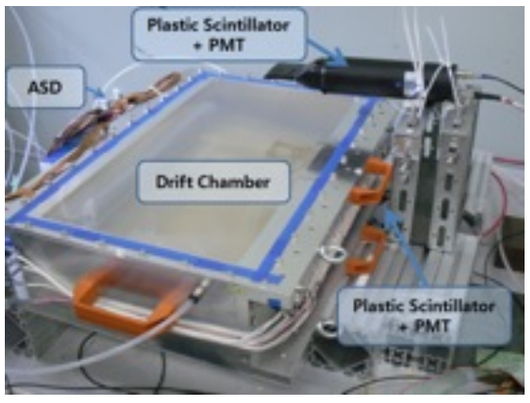
We performed a test experiment to evaluate a position dependency and an angular dependency for SSD, BAC, PVAC, BH2 and CH.

KURAMA magnet and Drift chamber

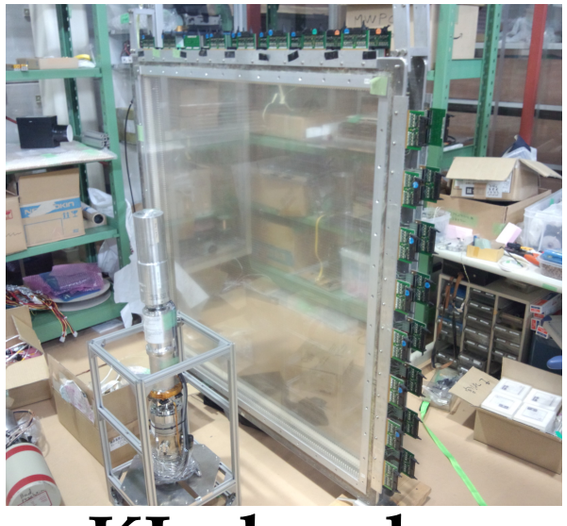
- KURAMA magnet is ready.
- Check the signal of the DCs
- Development of a new Multi-hit TDC module (NOTICS KOREA)



KURAMA magnet



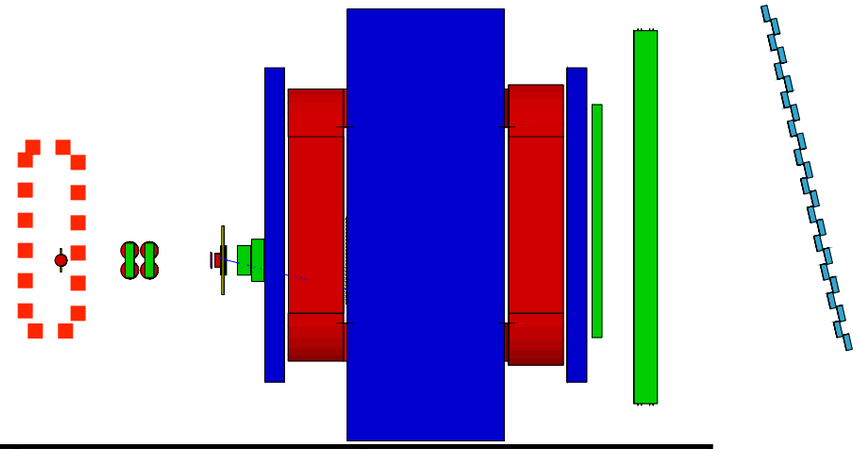
New-DC1

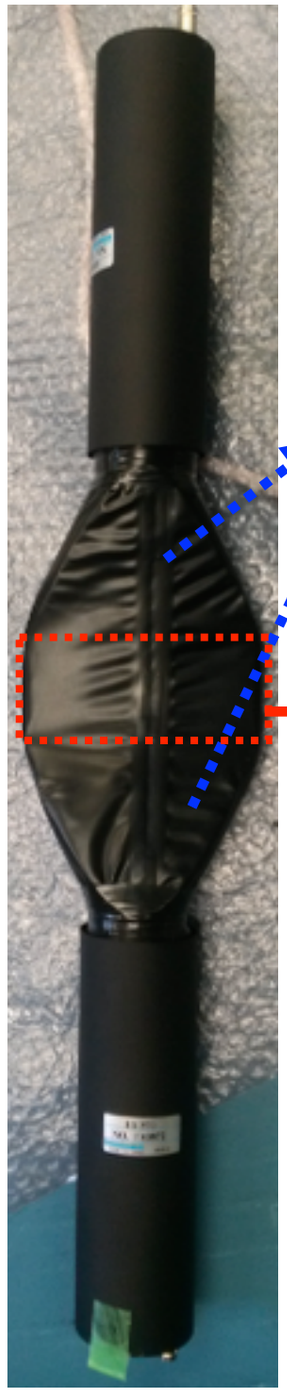


KL chamber

AIDA chamber

Timing counter





Fishtail light guide

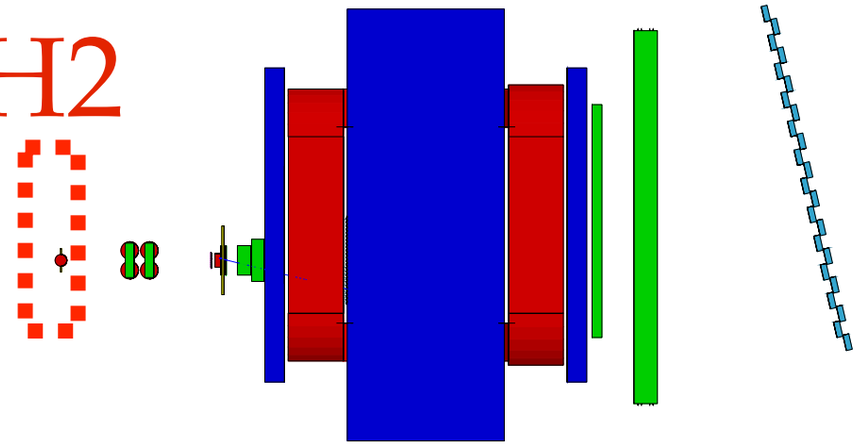
Scintillator
120 x 40 x 6 mm^3

PMT	H10570	H2431-50
Gain	5 x 10	2.5 x 10
T.T.S	0.25 ns	0.37 ns
Max HV	-1750 V	-3500 V

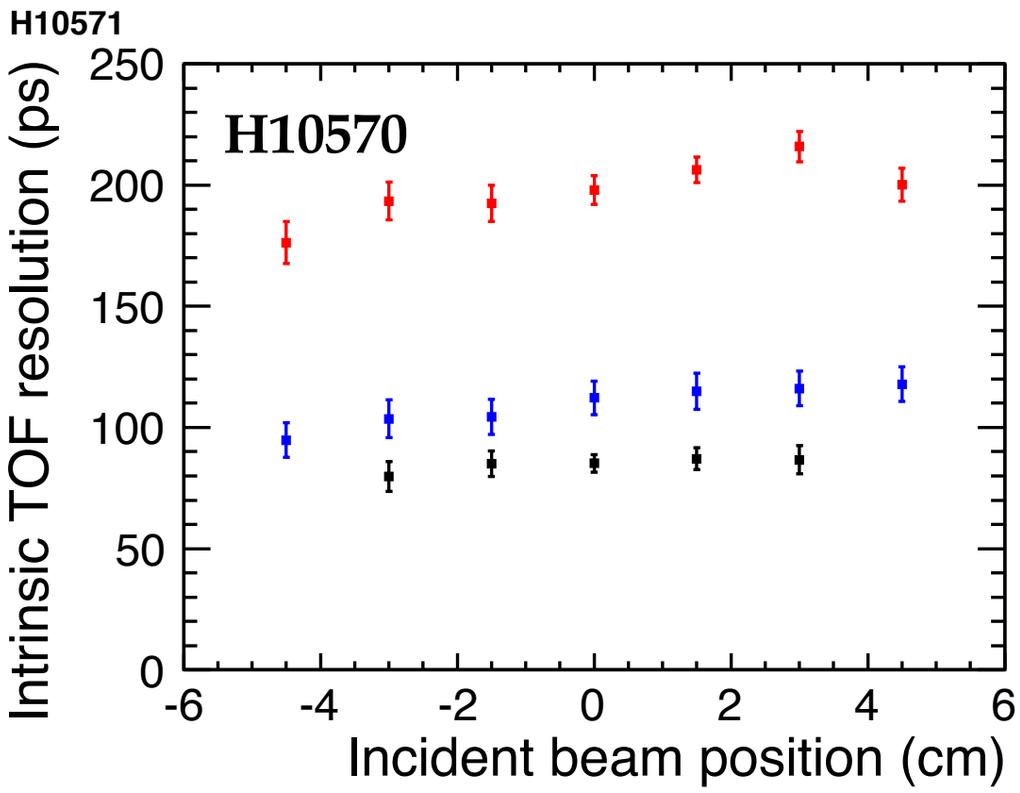
OLD, more then 20 years.

Scintillator	EJ-212	EJ-230
Purpose	Thin scinti.	Fast timing
W.L.	423 nm	391 nm
Rise time	0.9 ns	0.5 ns

Intrinsic TOF resolution of the BH2



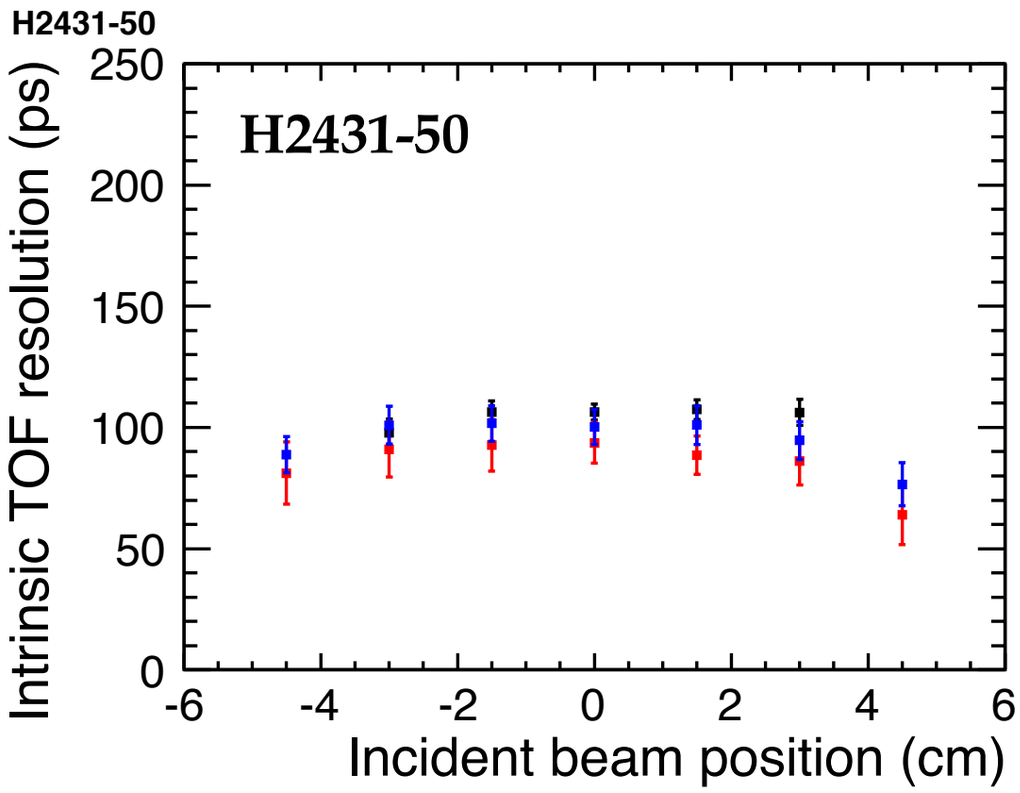
Position dependency from the ELPH text experiment.
By combining three timing counters (two BH2's and downstream trigger), the intrinsic resolution of the BH2 were estimated.



EJ-212, Al Mylar (MIP : 280 ch)

EJ-230, Al Mylar (MIP : 100 ch)

EJ-230, Teflon (MIP : 230 ch)



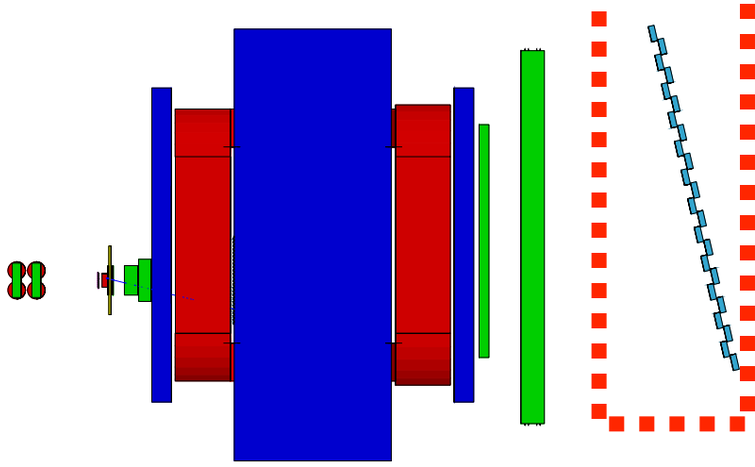
EJ-230, Al Mylar

EJ-212, Al Mylar

EJ-212, w/o reflector

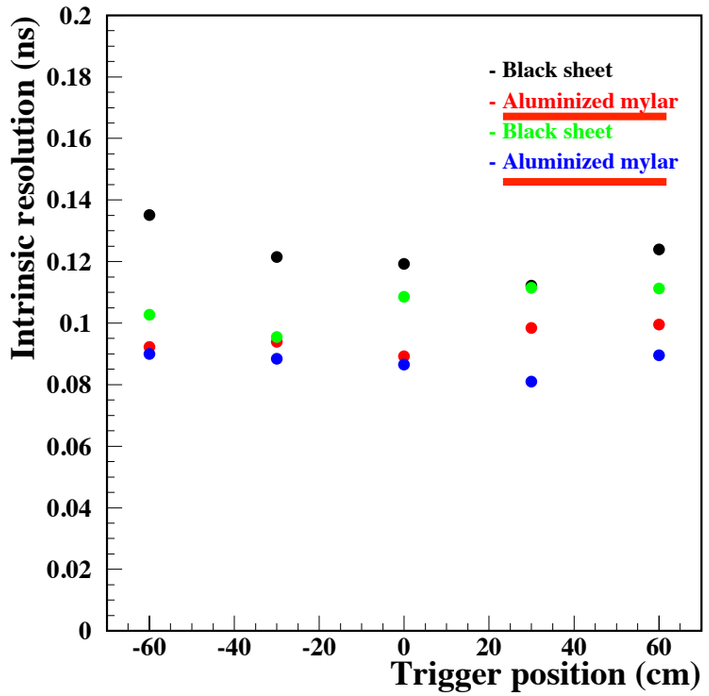
Bad TOF resolution comes from low gain, but 80 ps is good enough to identify the scattered Kaon.

Time-of-Flight wall



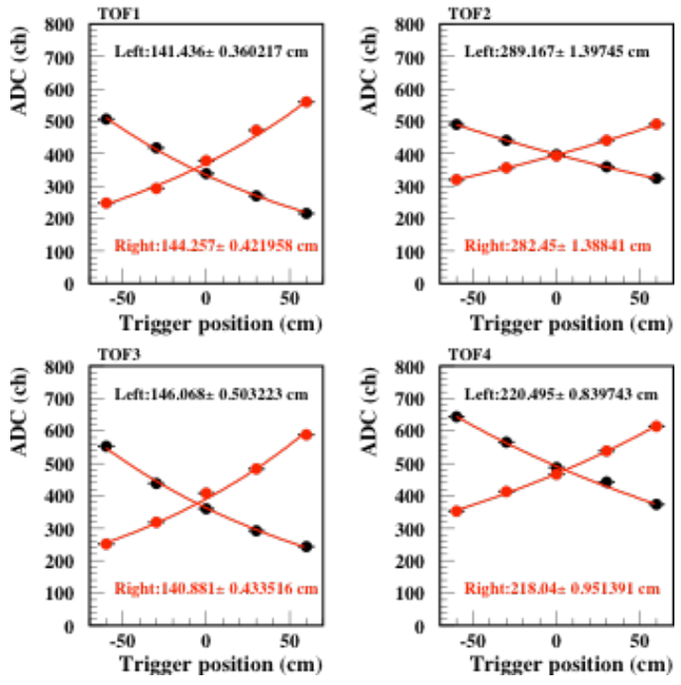
Number of Segment: 24 segments
Scintillator: EJ-200, **1800** x 80 x 30 mm^3
PMT: Hamamatsu H1945 (30 years old)
Active area : 1805 x 1800 mm^2

ToF resolution



$\sigma_{Int} \cong$ 90 ps
with aluminised Mylar

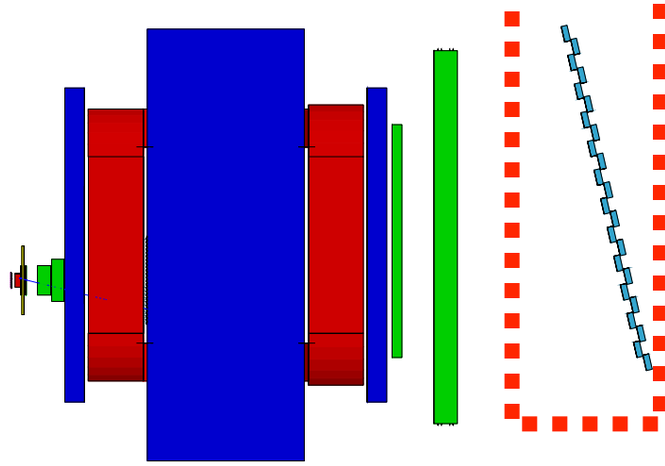
Attenuation length



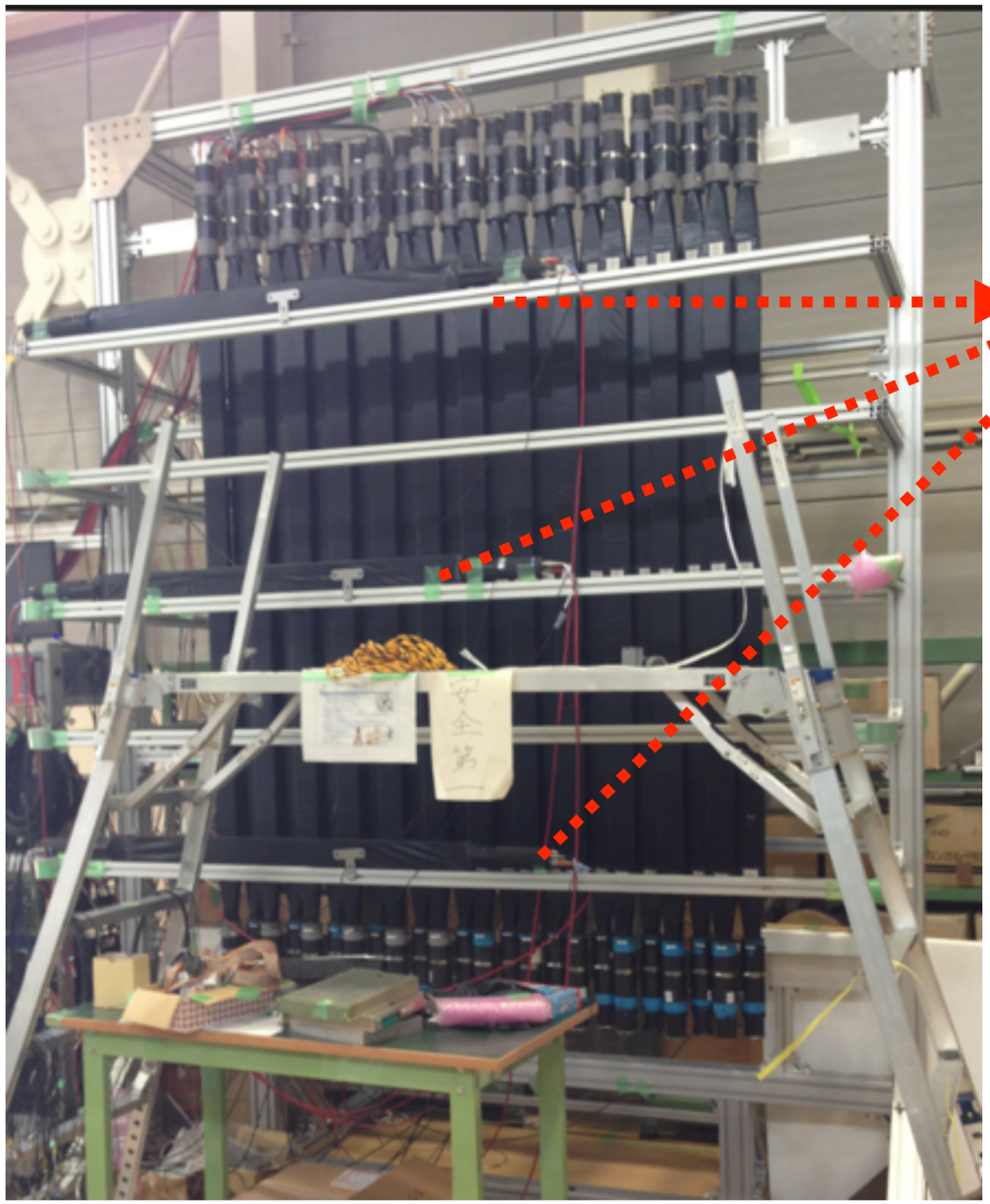
black sheet aluminized mylar
Att : 140 cm **Att : 290 cm**

TOF resolution is estimated to be about **120 ps**

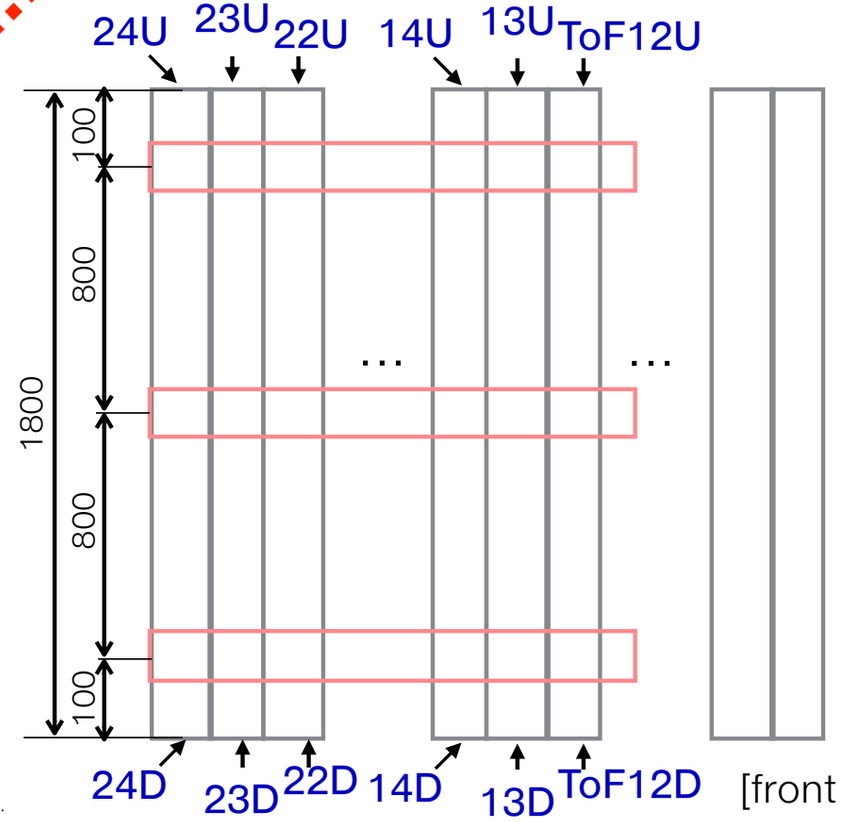
TOF cosmic test bench



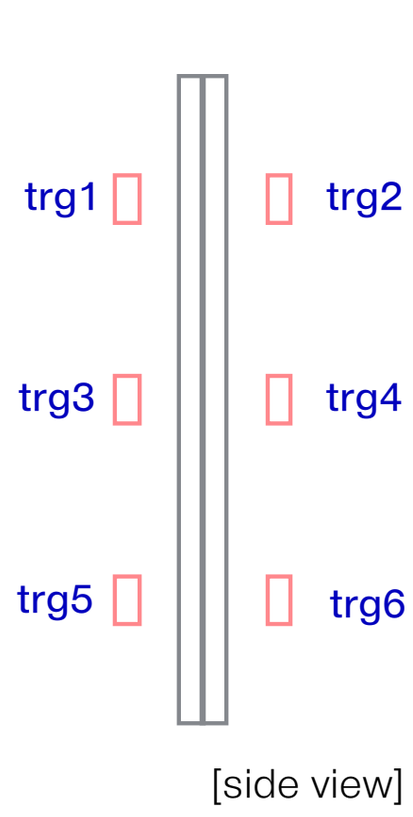
We are performing the cosmic test with six large size trigger counter



Trigger counter
(1200 x 80 x 30 mm^3)

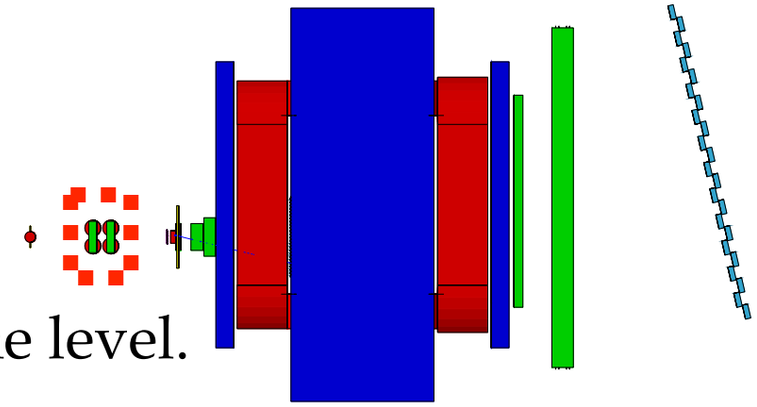


[front view]

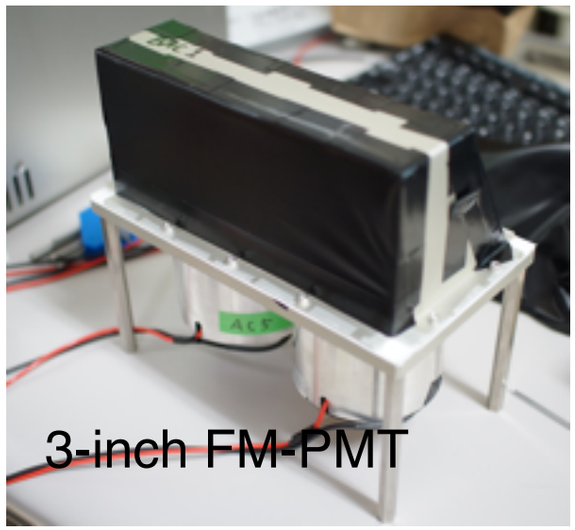


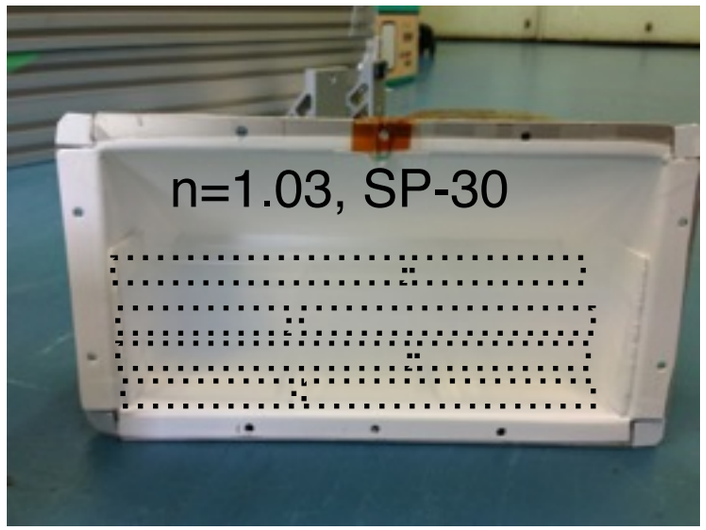
[side view]

BAC

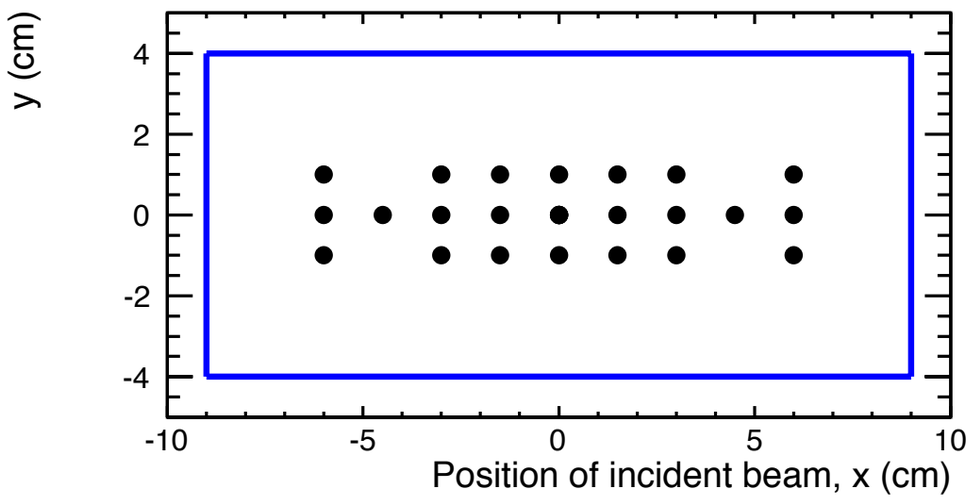


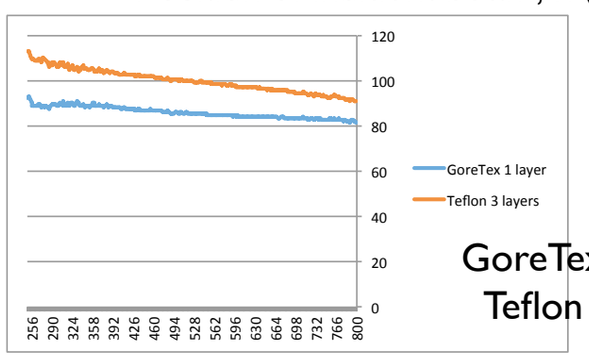
BAC identifies the pion background from the K- beam in the online level.



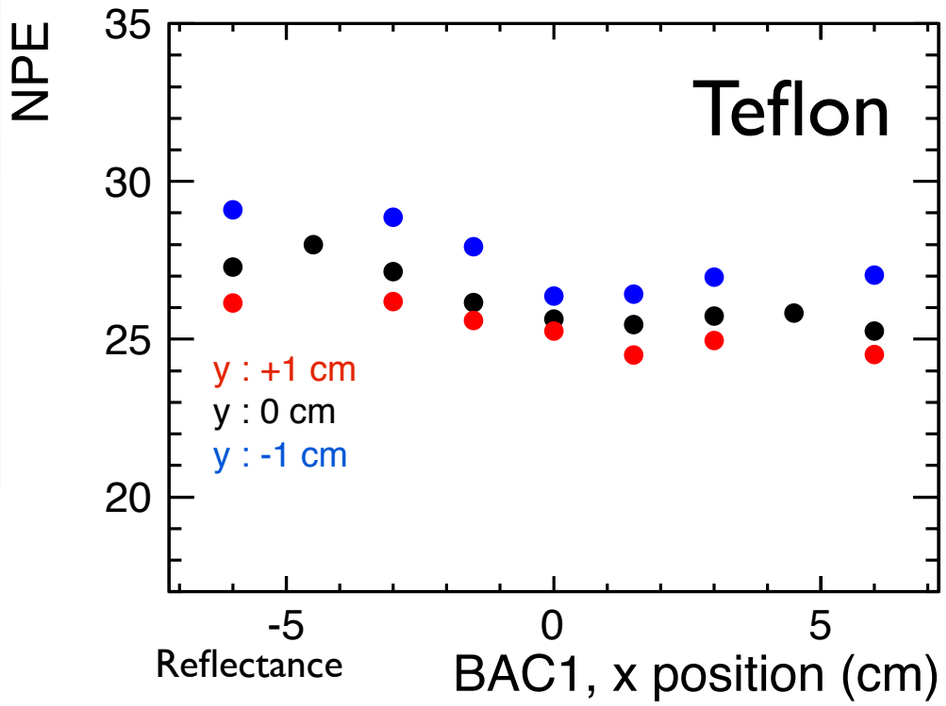


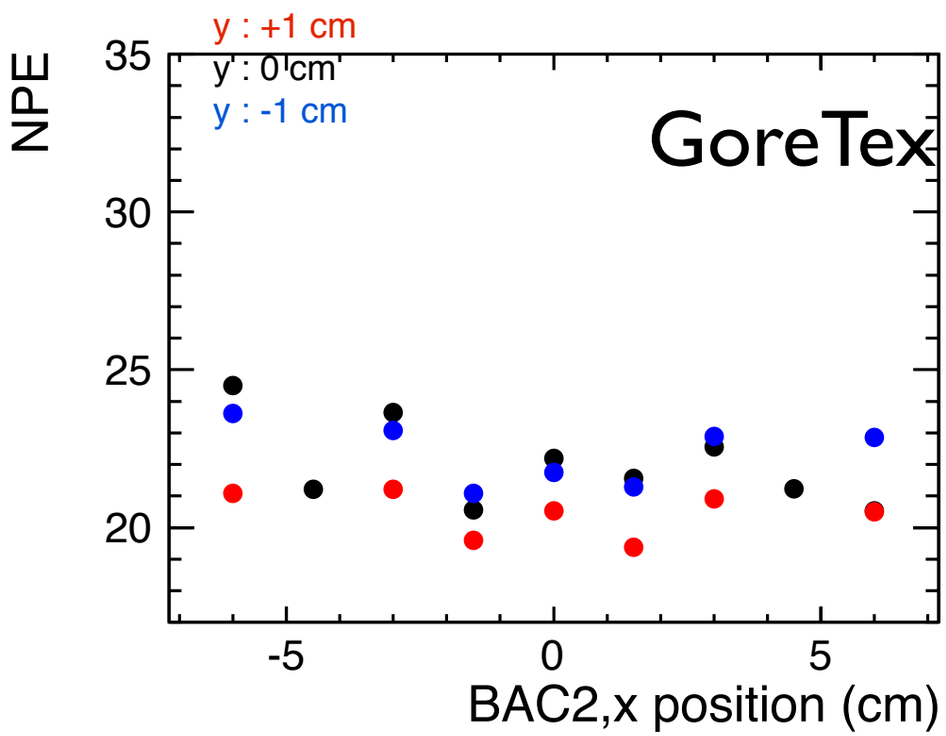
e+ Beam injection positions



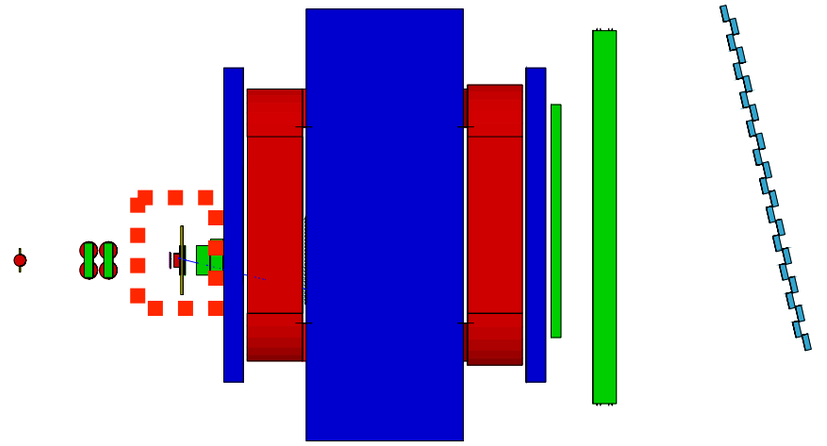


GoreTex 1 layer : 250 um
Teflon 1 layer : 100 um

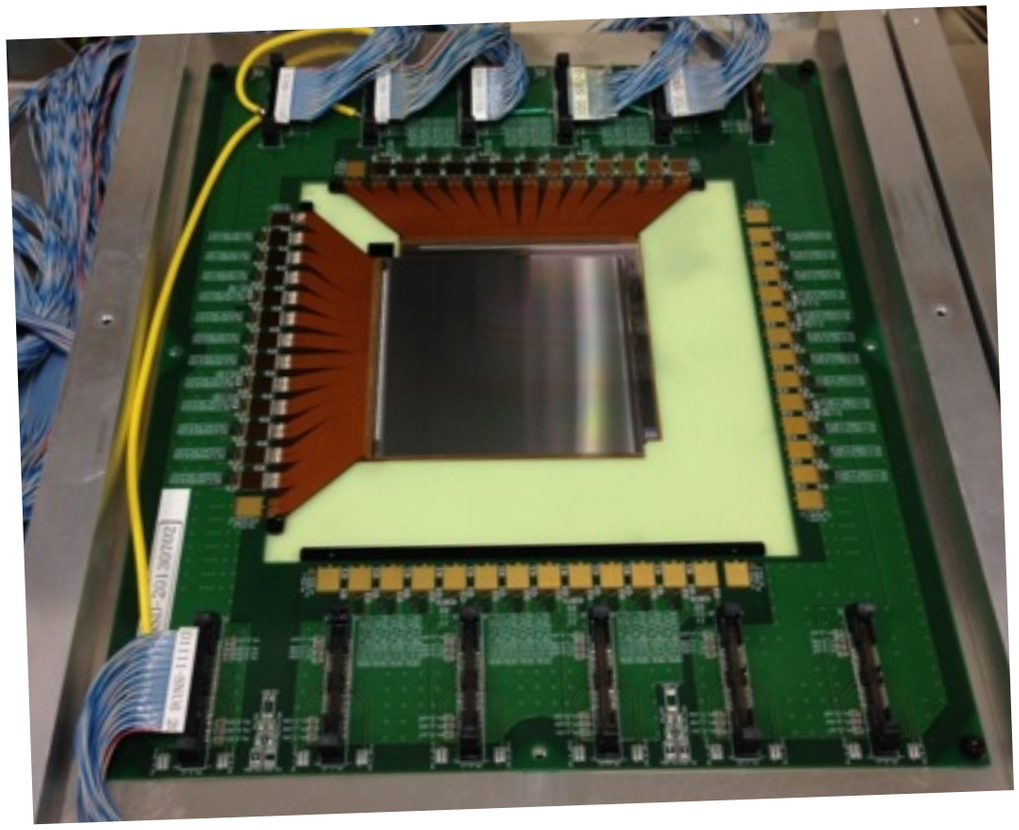




New SSD system

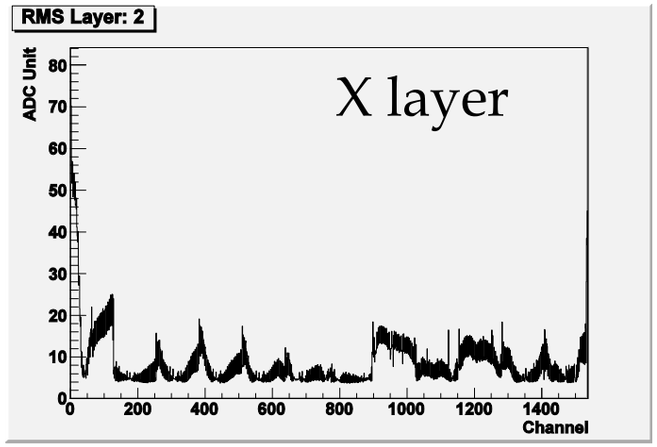


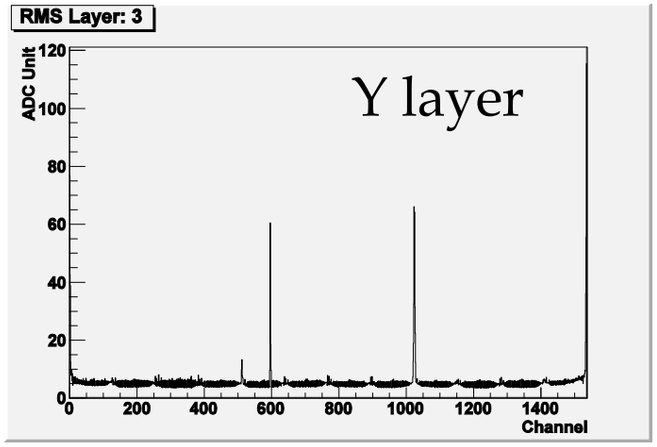
The SSD identifies Ξ^- track from the diamond target to the emulsion stack with high counting rate and resolution.



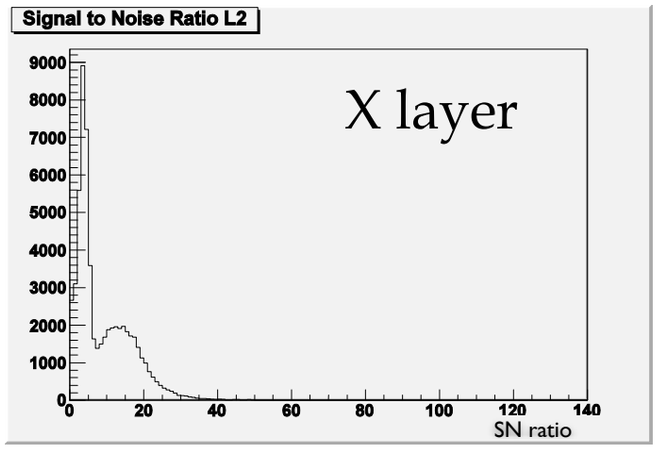
Type	Single-Sided, p-in-p
Number of Strips	1536 per one plane
Effective Area	77 x 77 mm
Pitch, Thickness	50μm, 300μm
Planes	x,y,x′,y′

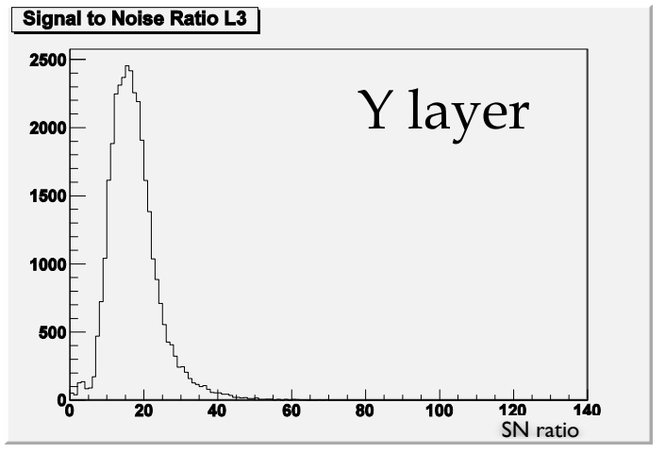
RMS of pedestal at the ELPH facility





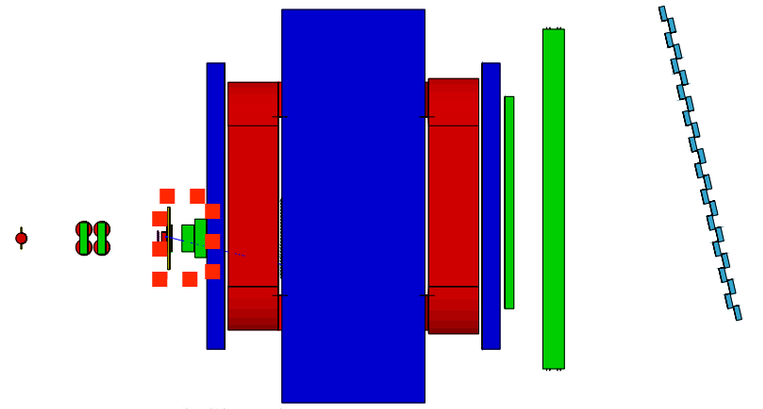
S/N ratio



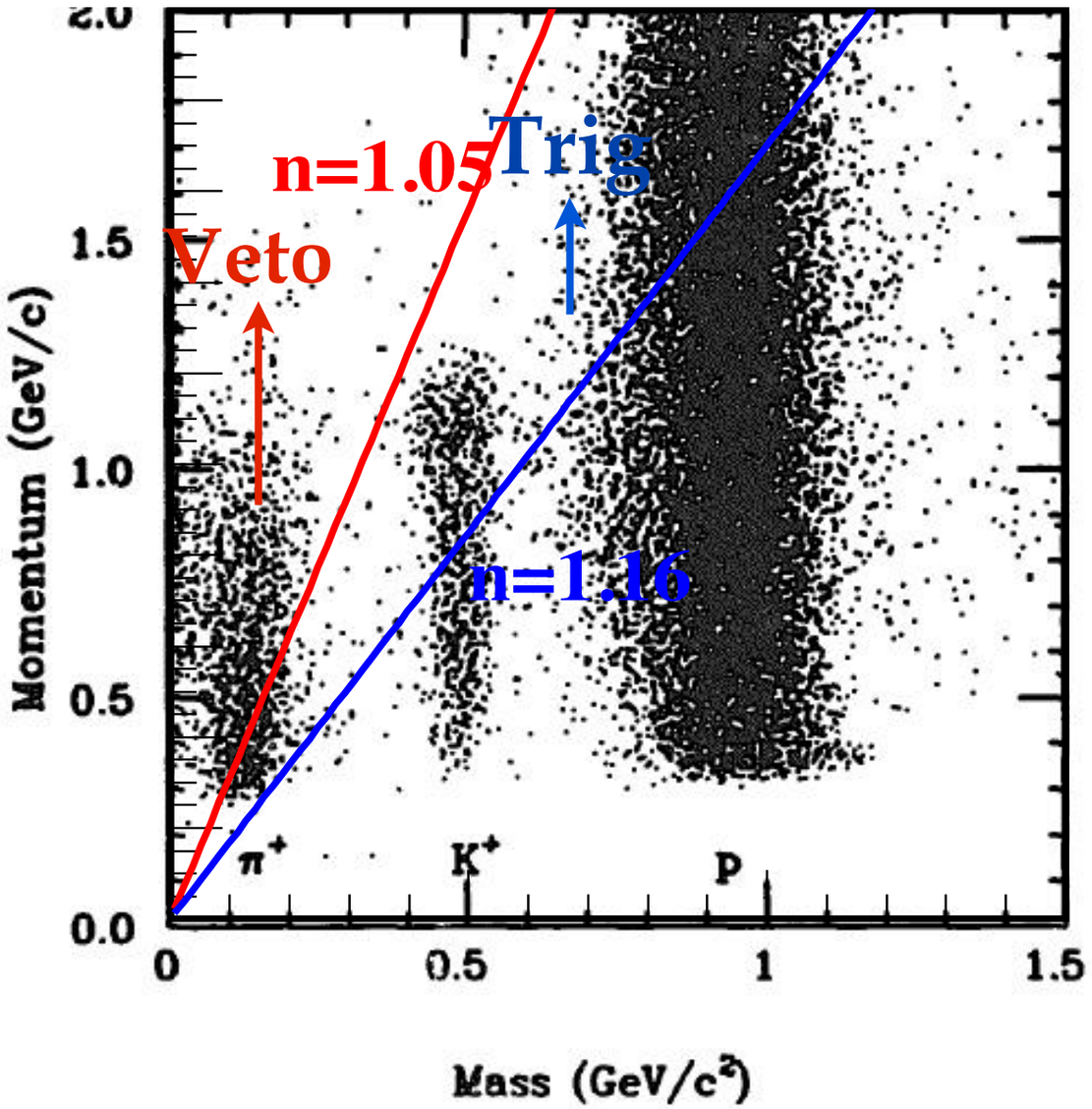


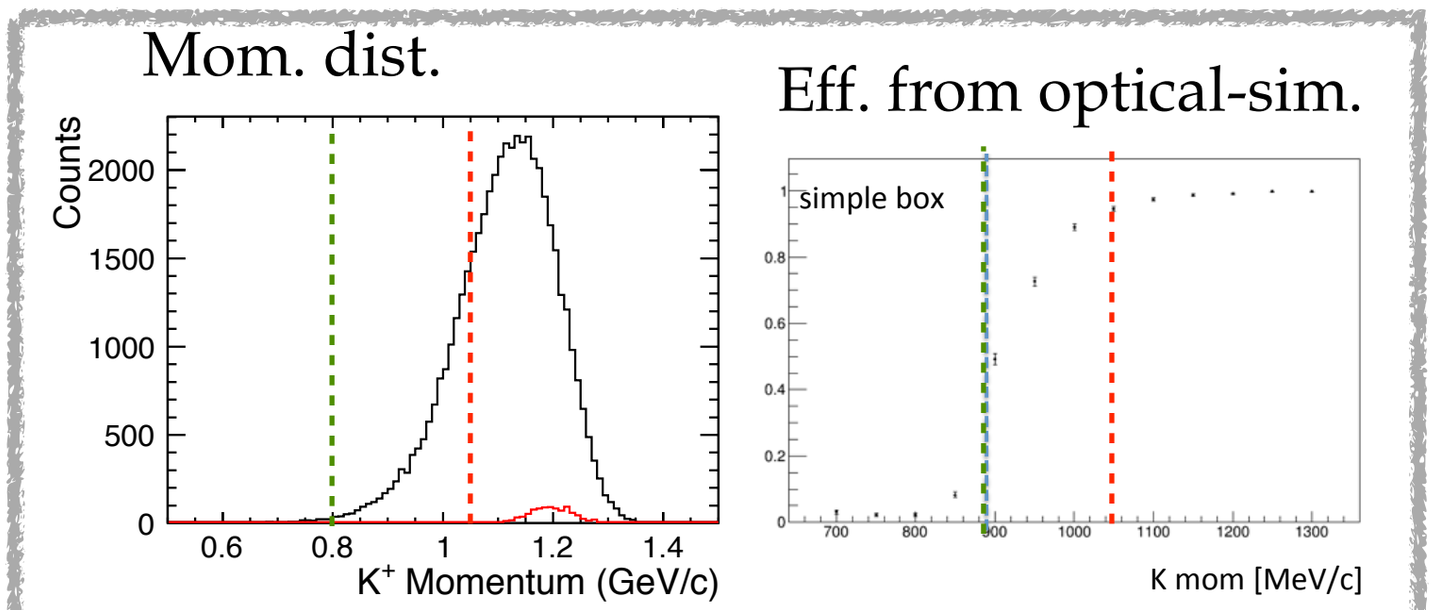
cf. S/N ratio for the old sensor (E10 sensor)
: about 20

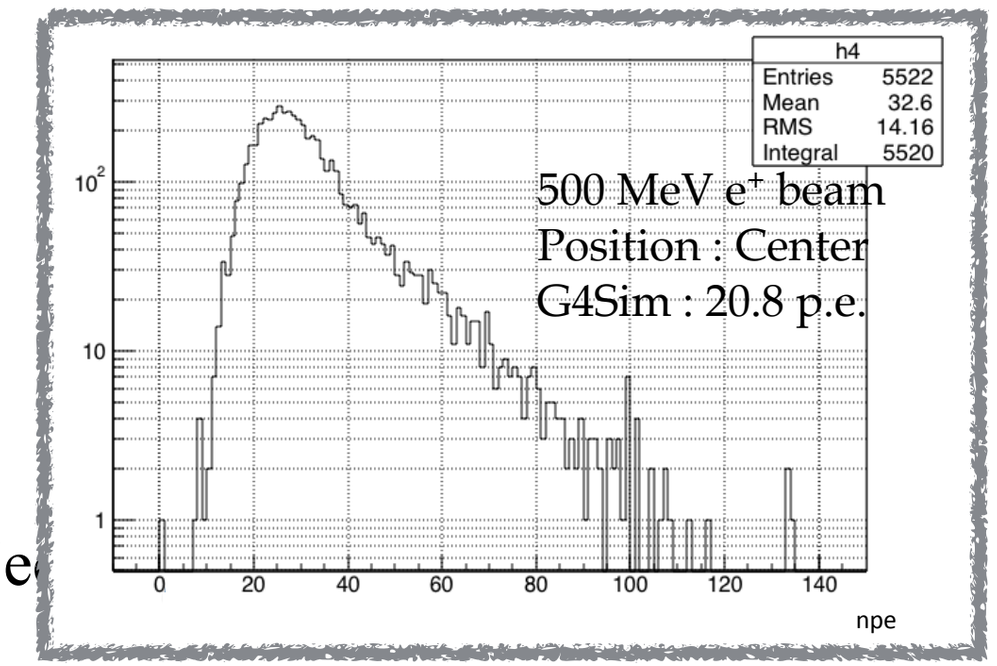
Proton Veto Aerogel Counter (PVAC)



The PVAC will be used for improving the 1st level trigger efficiency.





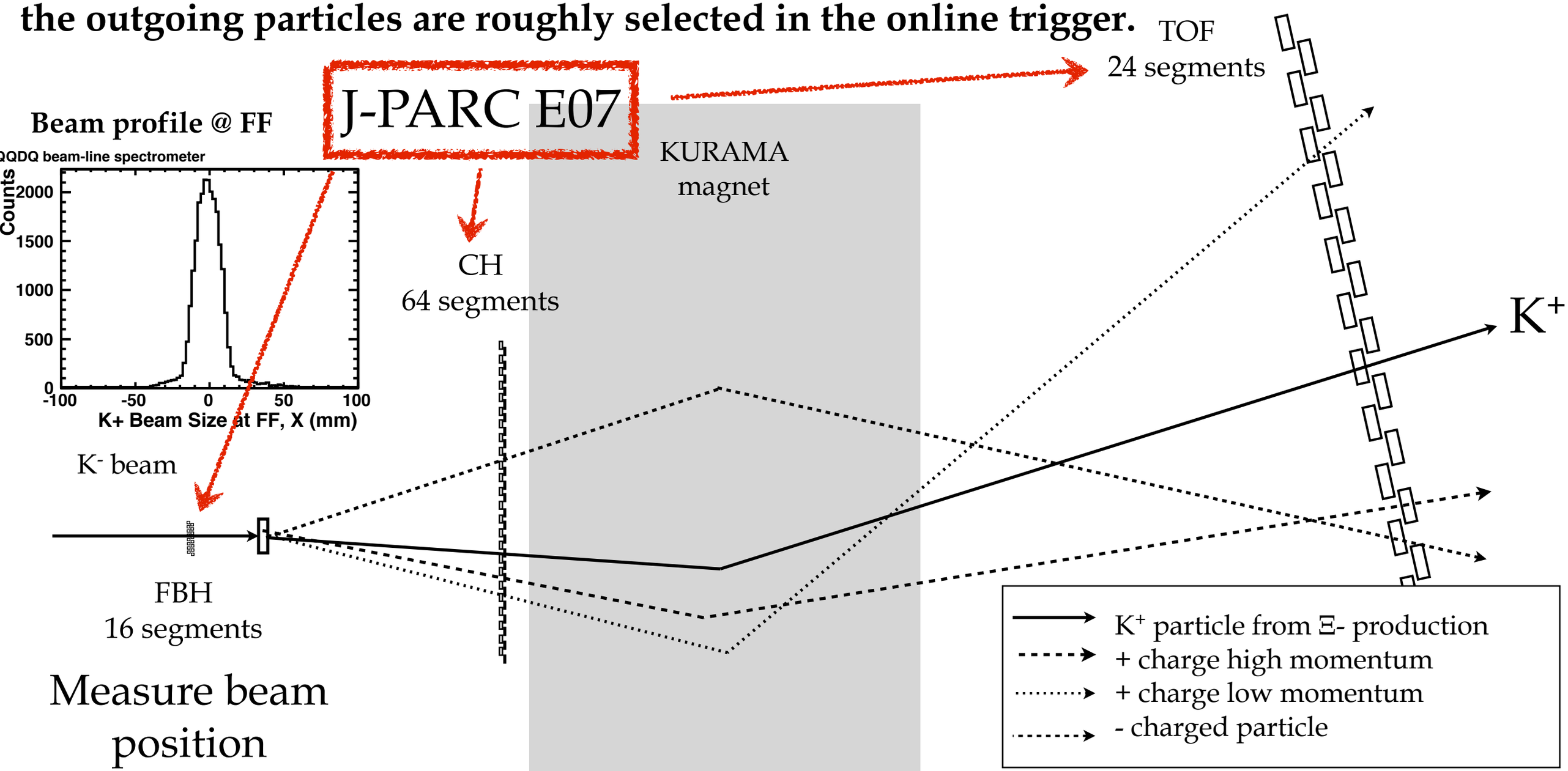


PVAC : Trigger high momentum K^+ ($P_K > 0.84$ GeV/c).

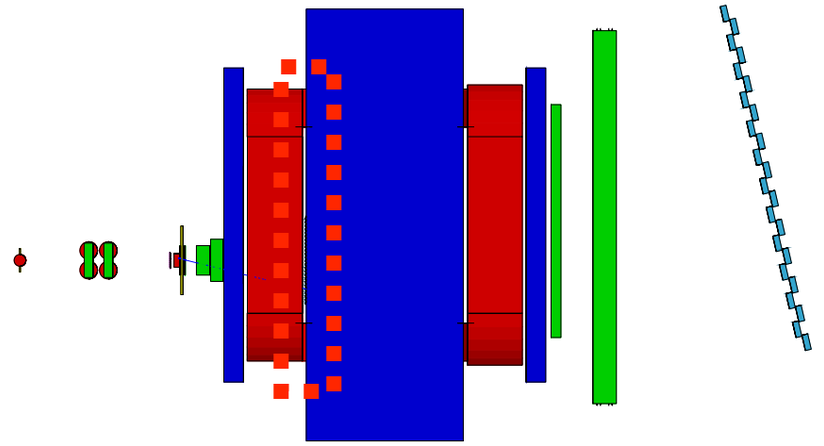
Low momentum protons (<1.6 GeV/c) can be reje

3D-Matrix Trigger

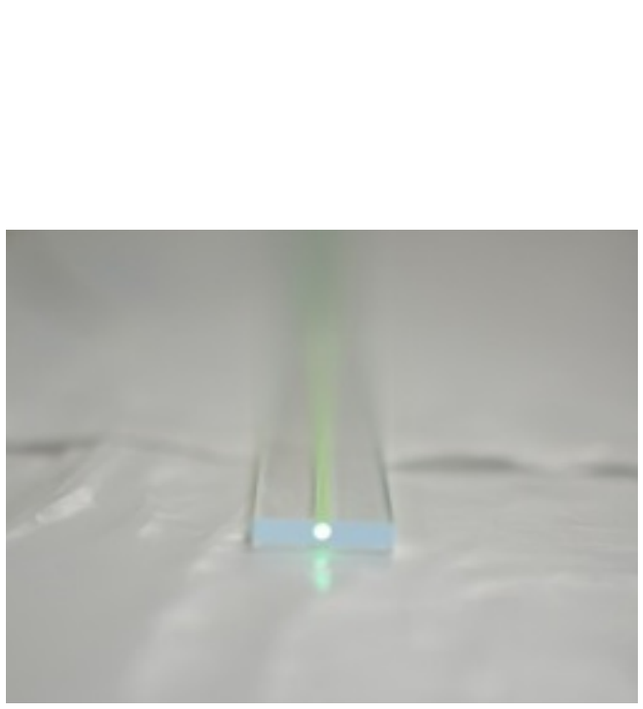
By taking the matrix coincidence of the CH and the TOF, the charges and momenta of the outgoing particles are roughly selected in the online trigger.

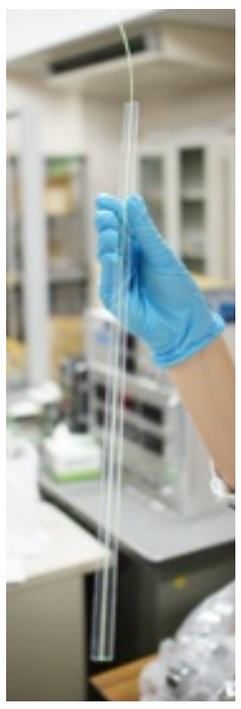


Charge Hodoscope



# of Channel	64
thickness	2 mm
width	11.5 mm
spacing	10.5 mm
read-out	1x1 MPPC w/ WLS fiber
effective area	674 x 450 mm

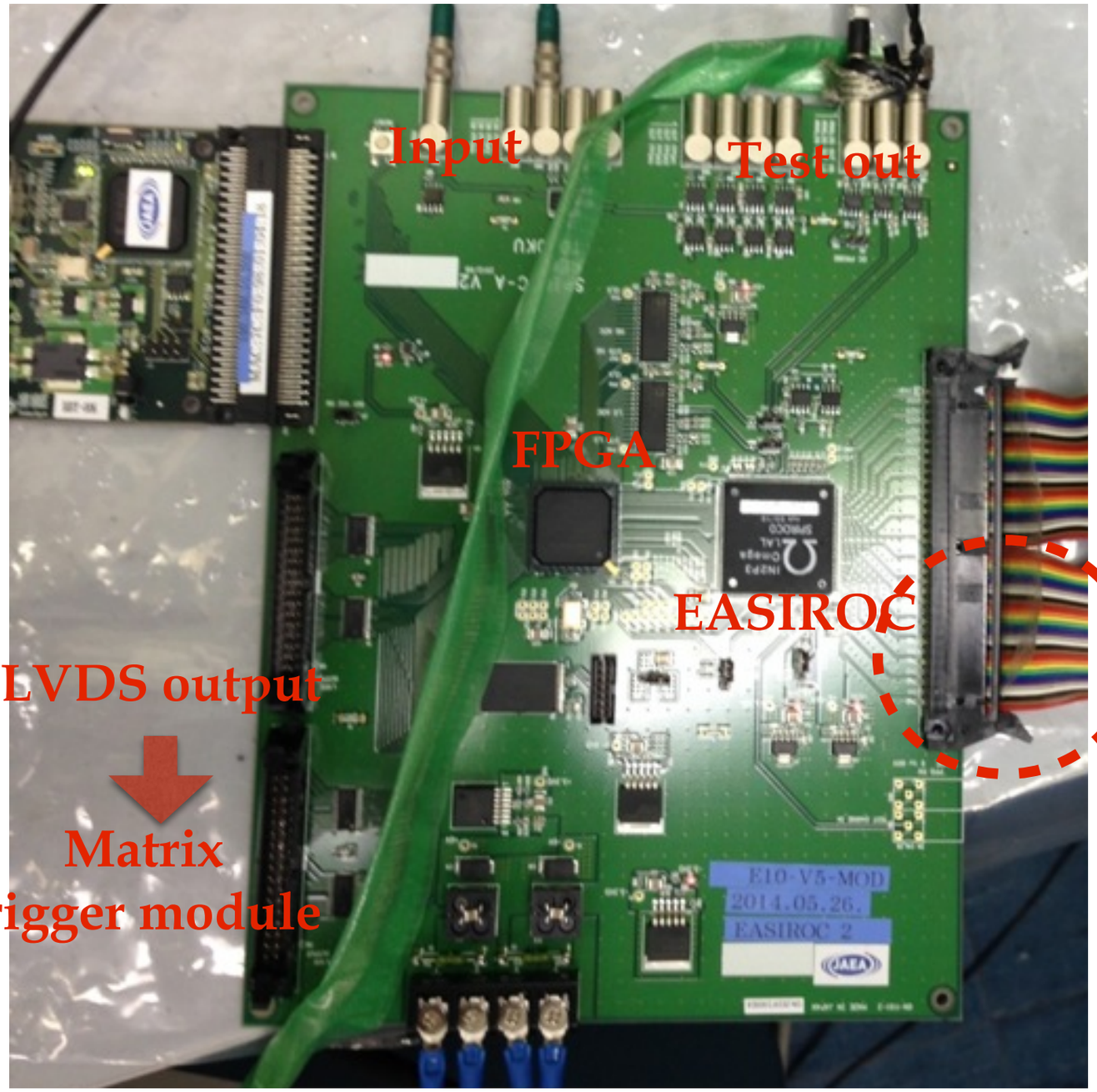




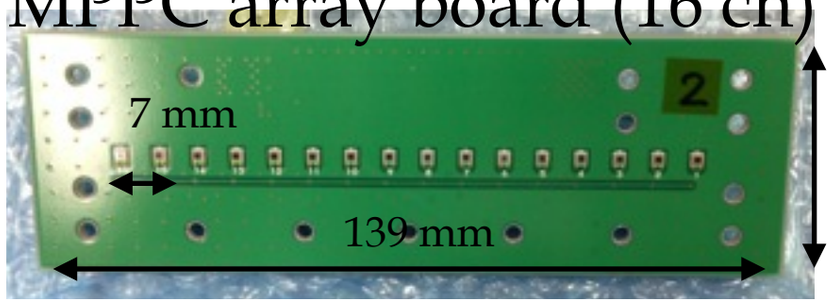
MPPC readout, CH

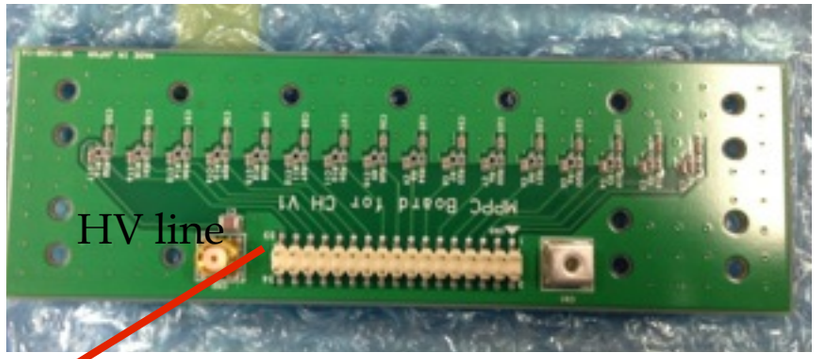
SOY
Ethnet

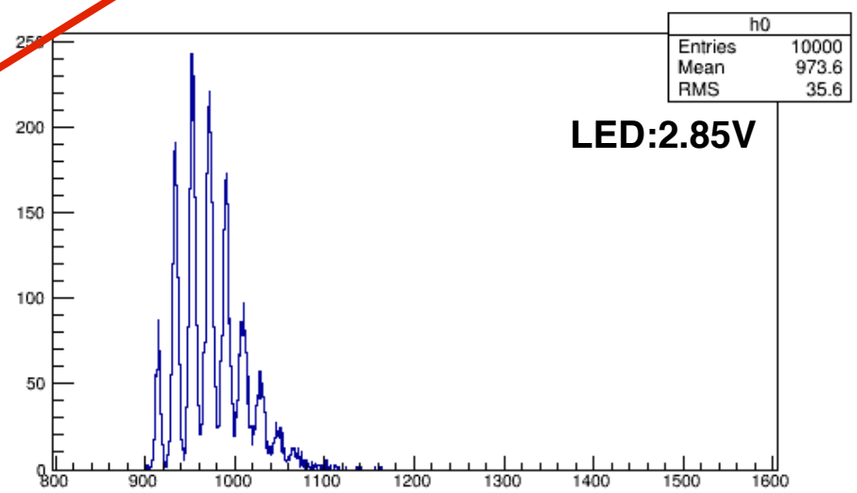
EASIROC board



MPPC array board (16 ch)

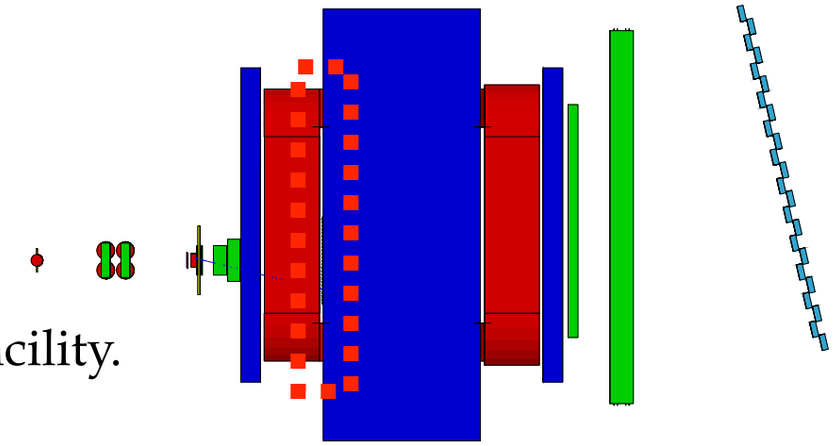






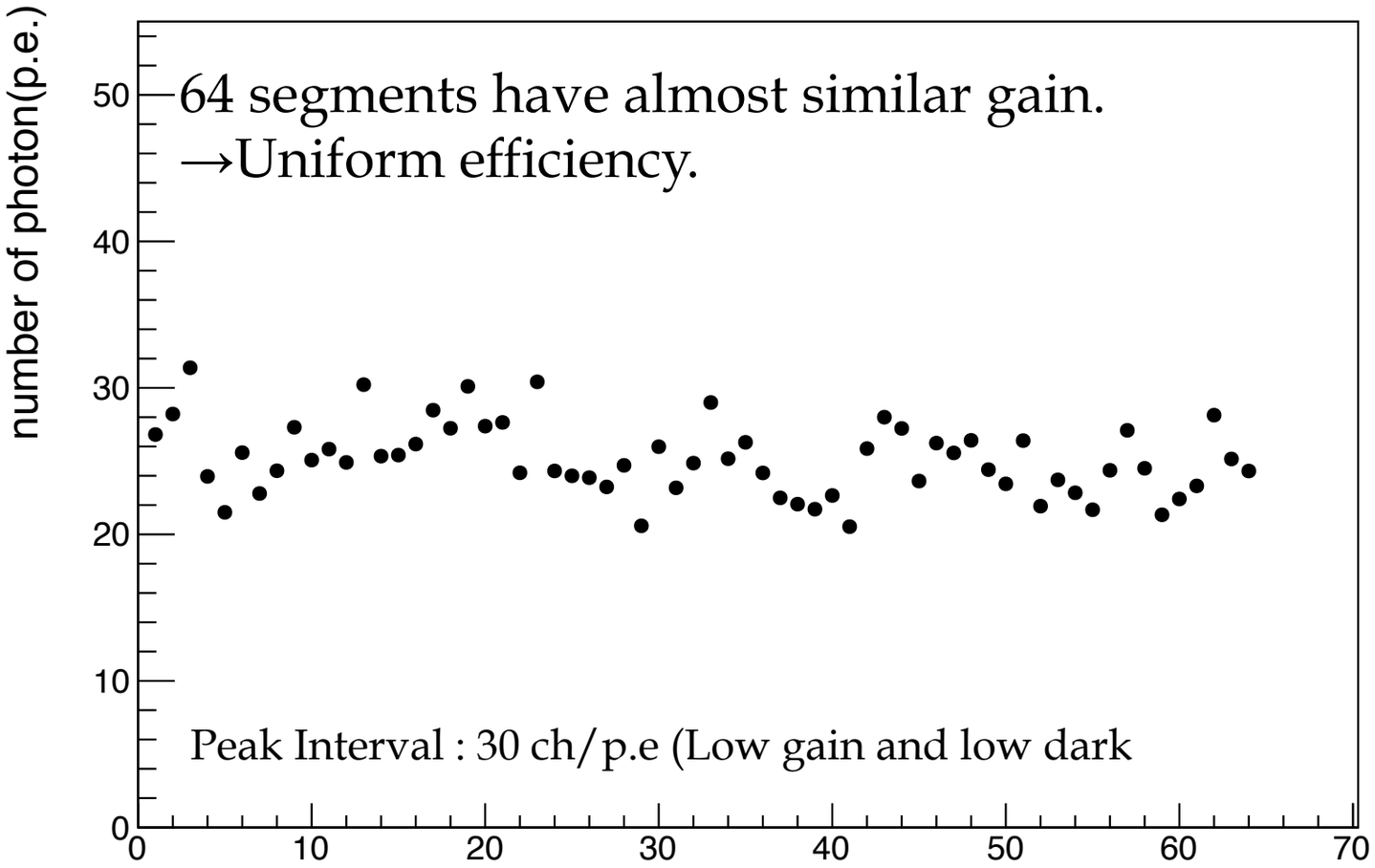
- HV gain tuning
- ADC (Peak height)
- MHTDC (16 hits, 1 ns)
- LVDS(discriminator) output

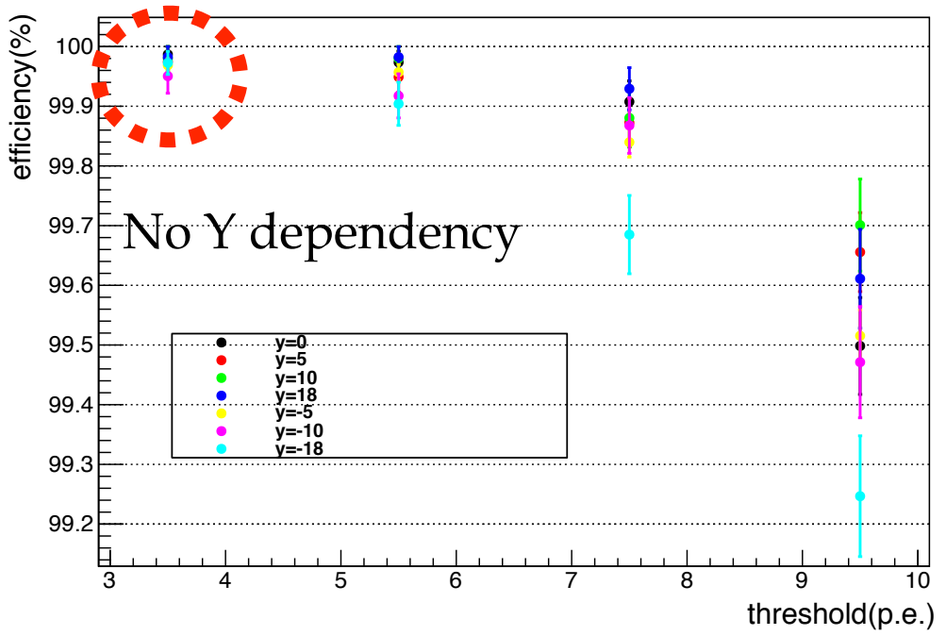
Gain and Efficiency

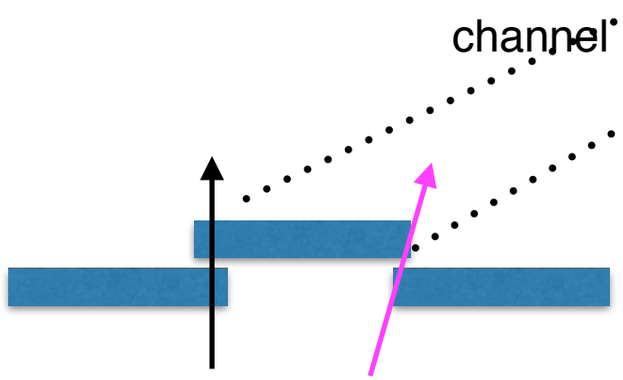


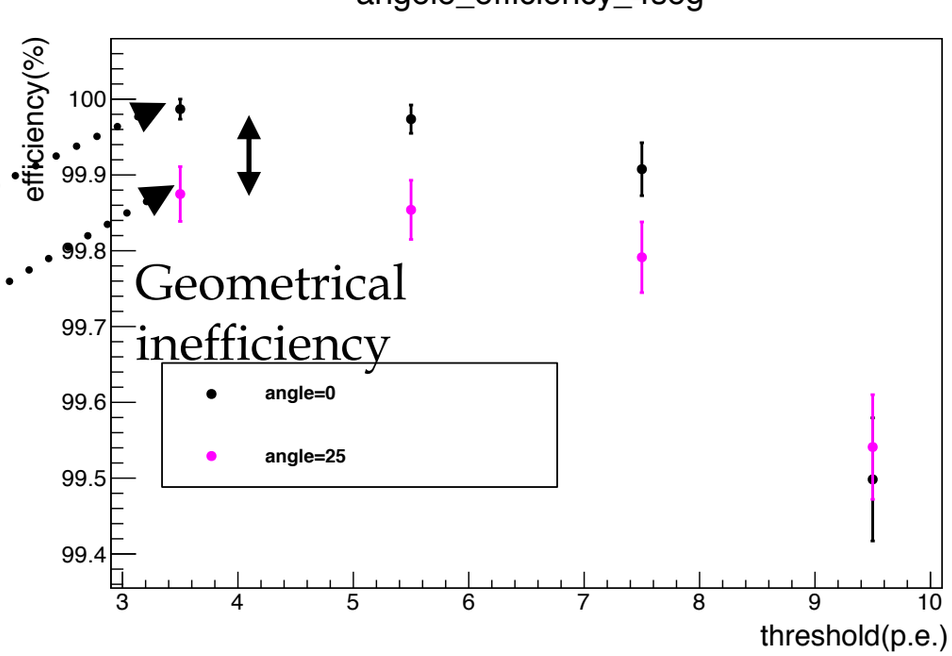
We measured the gain and position & angular dependency at the ELPH facility.

gain

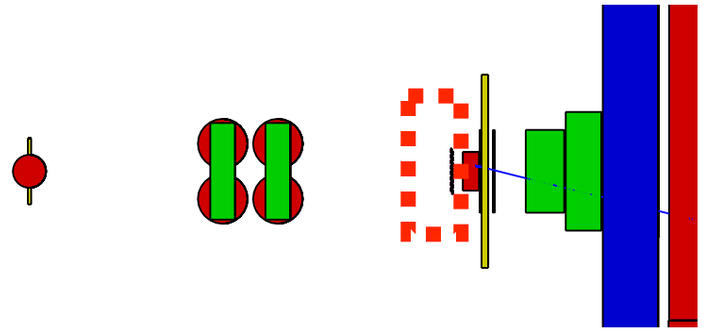








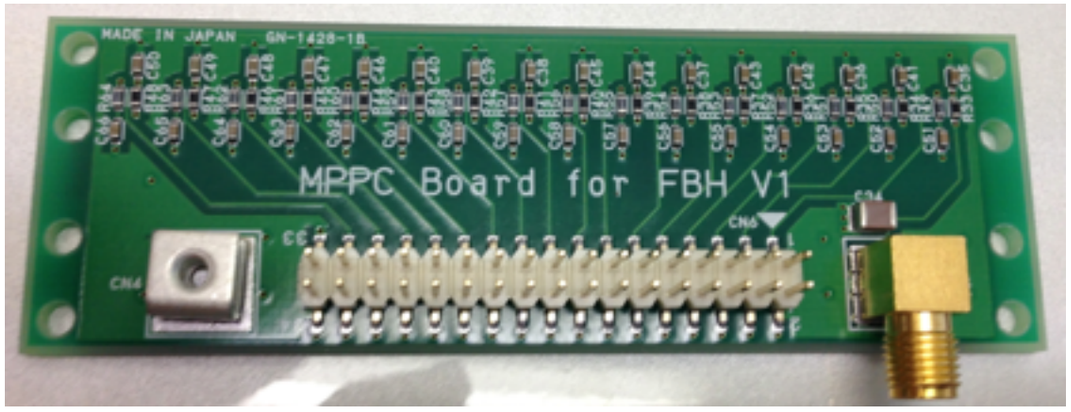
MPPC array board for FBH



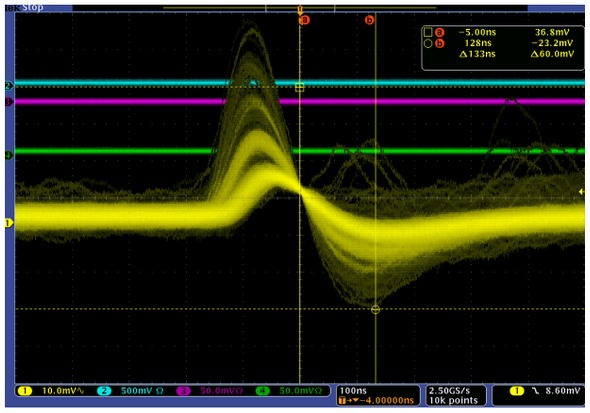
- Fine beam Hodoscope (FBH)

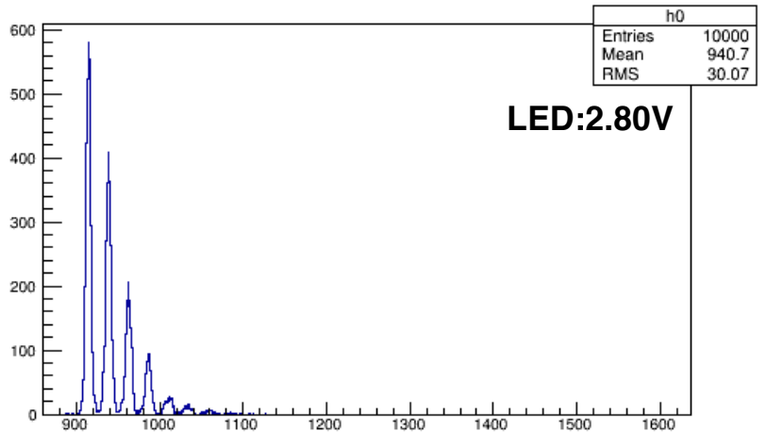
Measurement of the beam position with fine segment.
We used the improved MPPC (S12571-100P)

- FBH's MPPC array board

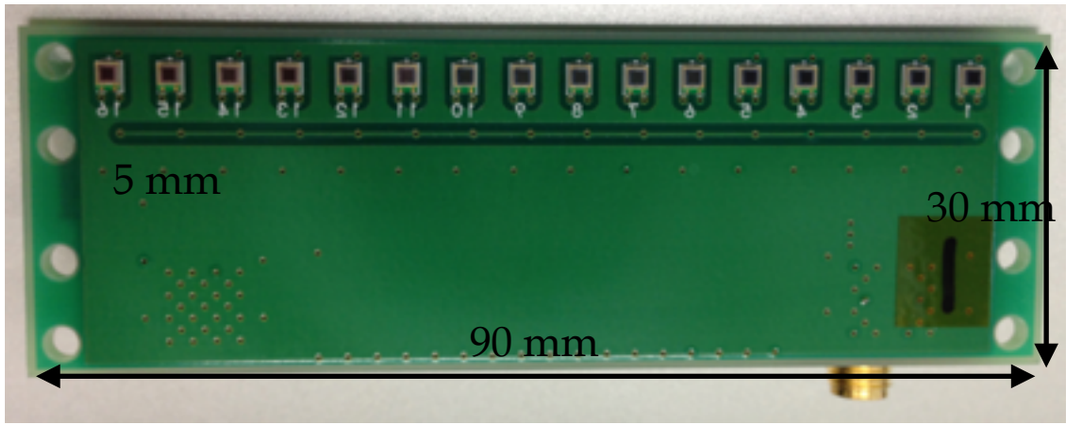


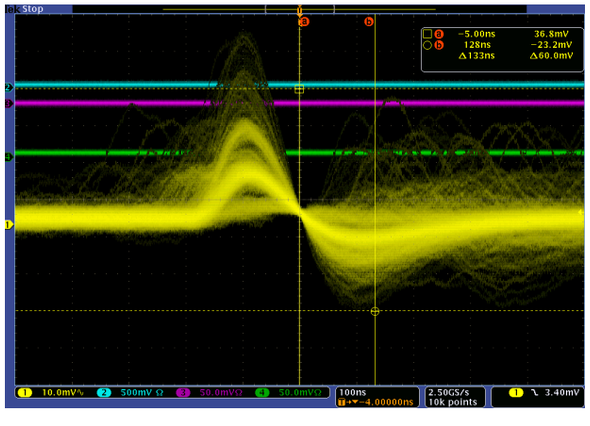
HV line

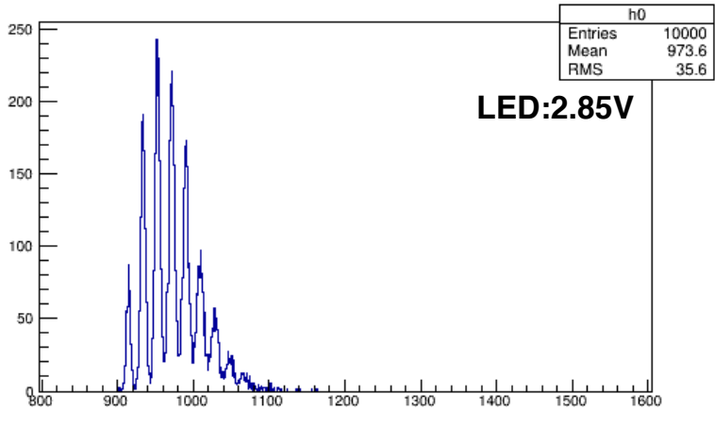




- cf. CH's MPPC array board (S10361-100P)

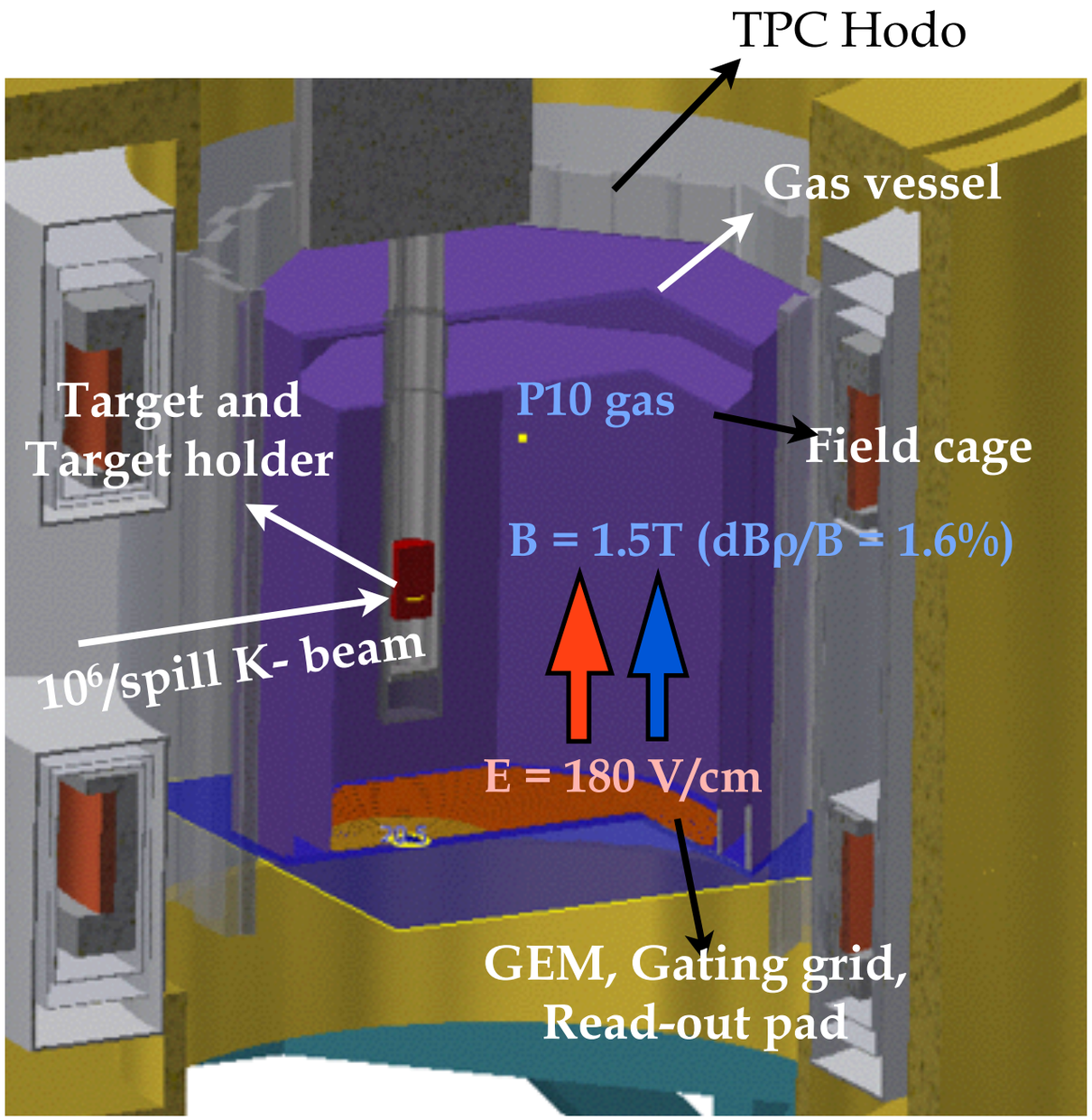


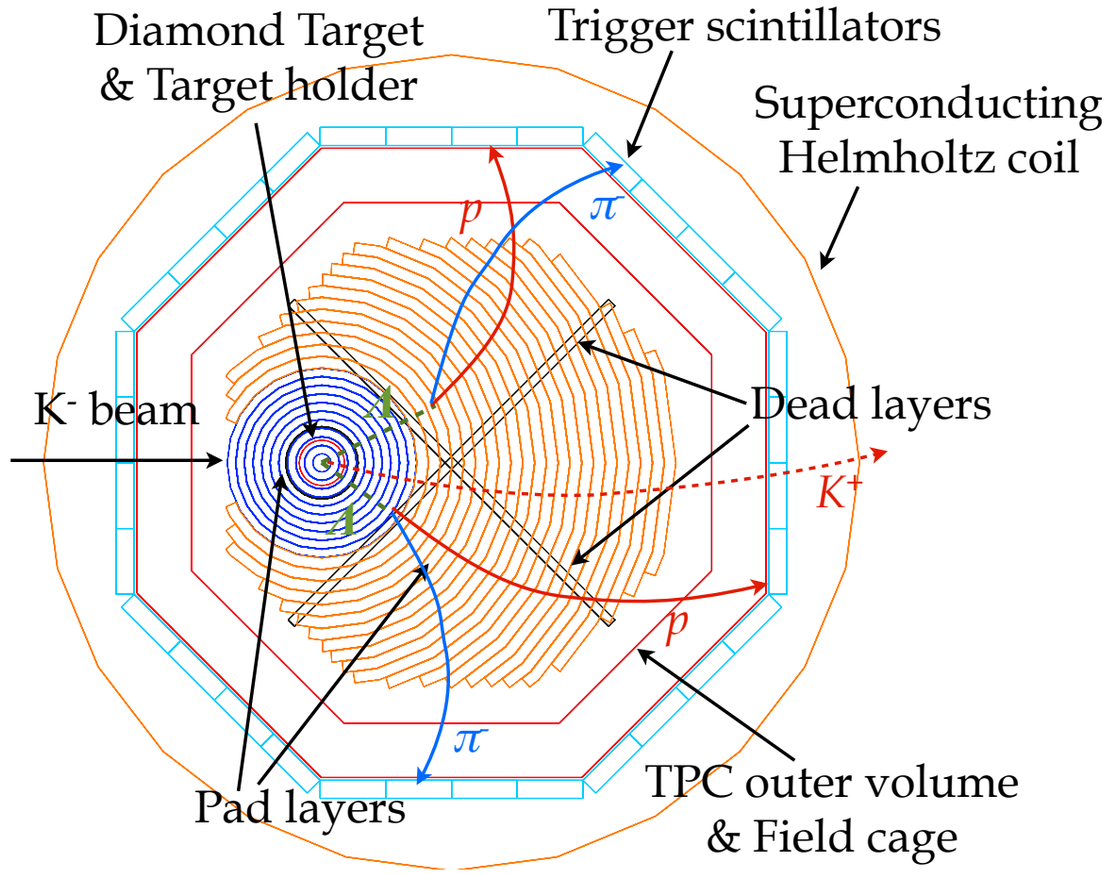




Development of the HypTPC

Hyperon Time-Projection-Chamber

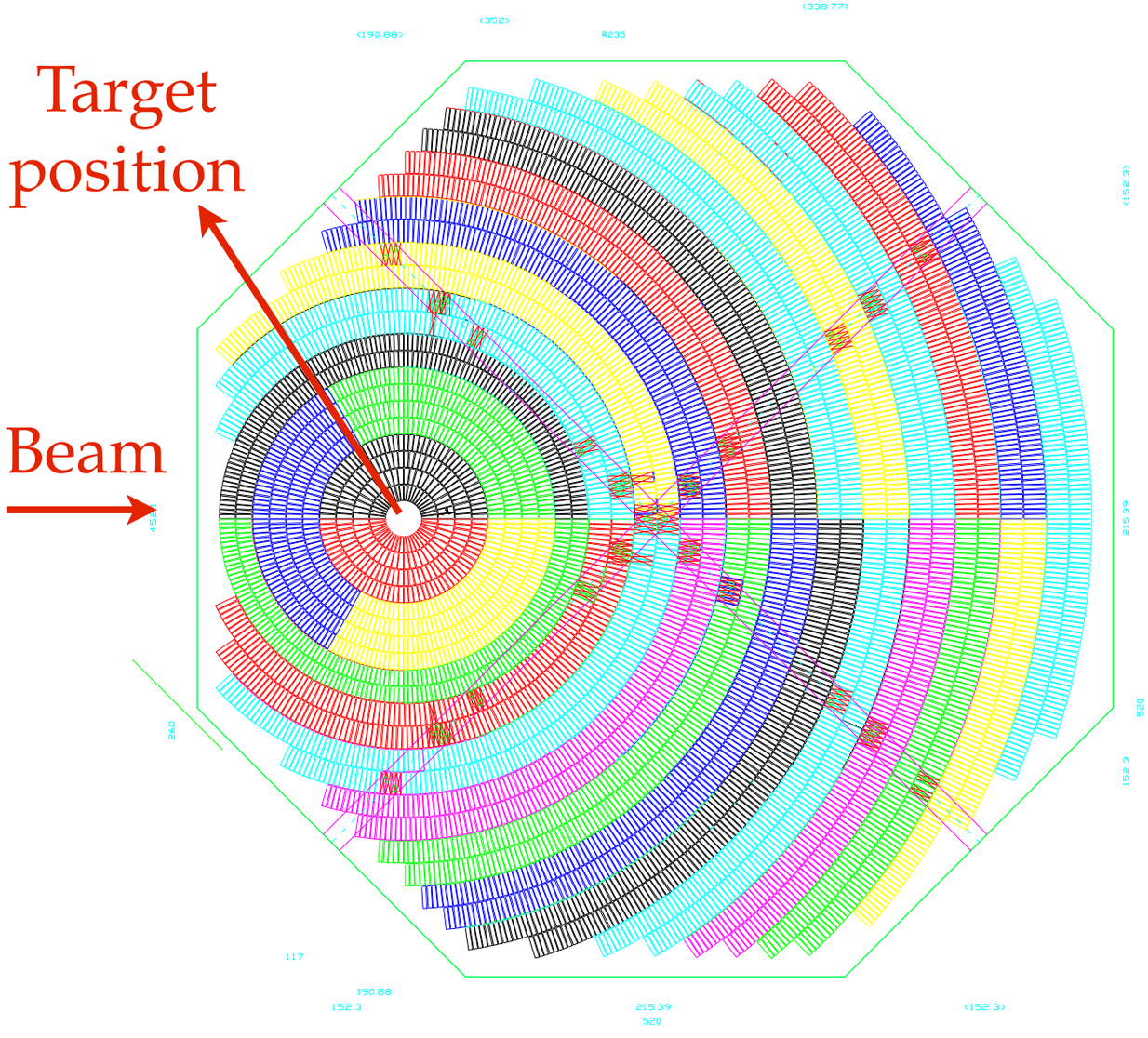


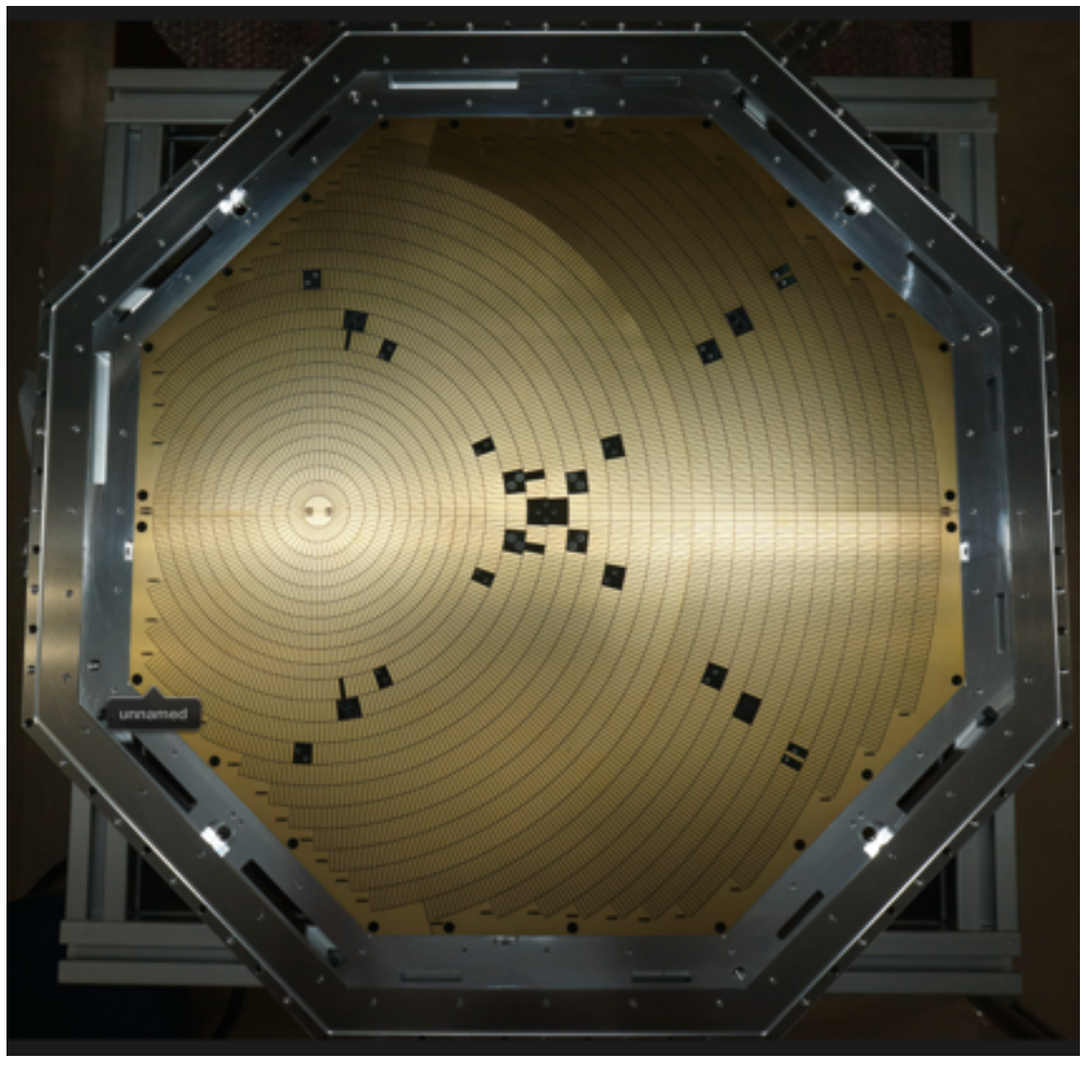


- High counting operation, GEM and gaiting grid are adopted.
- Small pad size (5678 pads)
- Large acceptance

Configuration of Readout-PAD

Colours show read-out channels for each AsAd board.





Inner pad : 10 layers, 2.1 - 2.7 x 9 mm^2

Outer pad : 23 layers, 2.3 - 2.4 x 12.5 mm^2

Read-out pad :5768

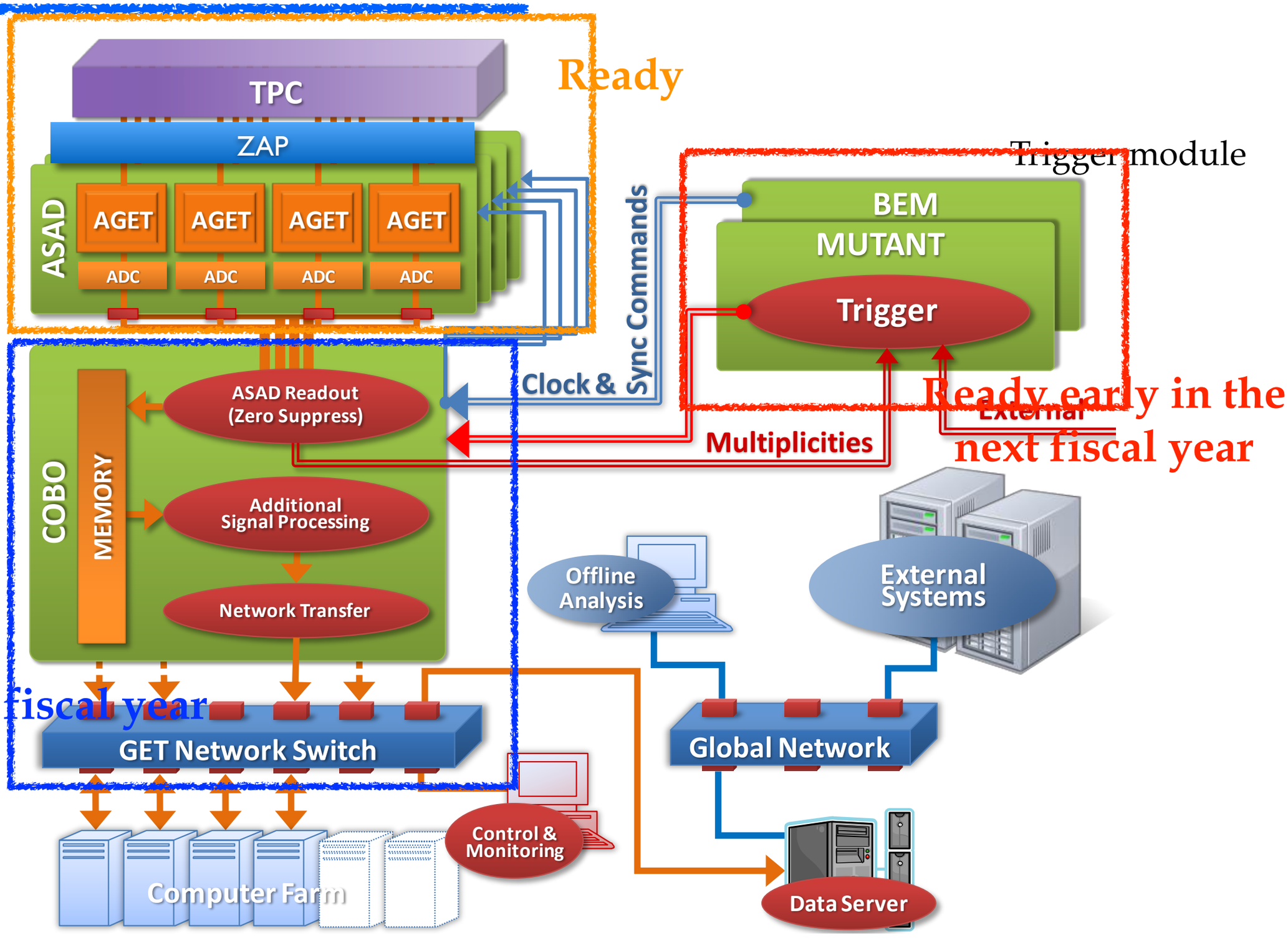
ASIC for Generic Electronic for TPC (AGET)

ZAP board

256ch/board
12bit ADC,
512 SCAs

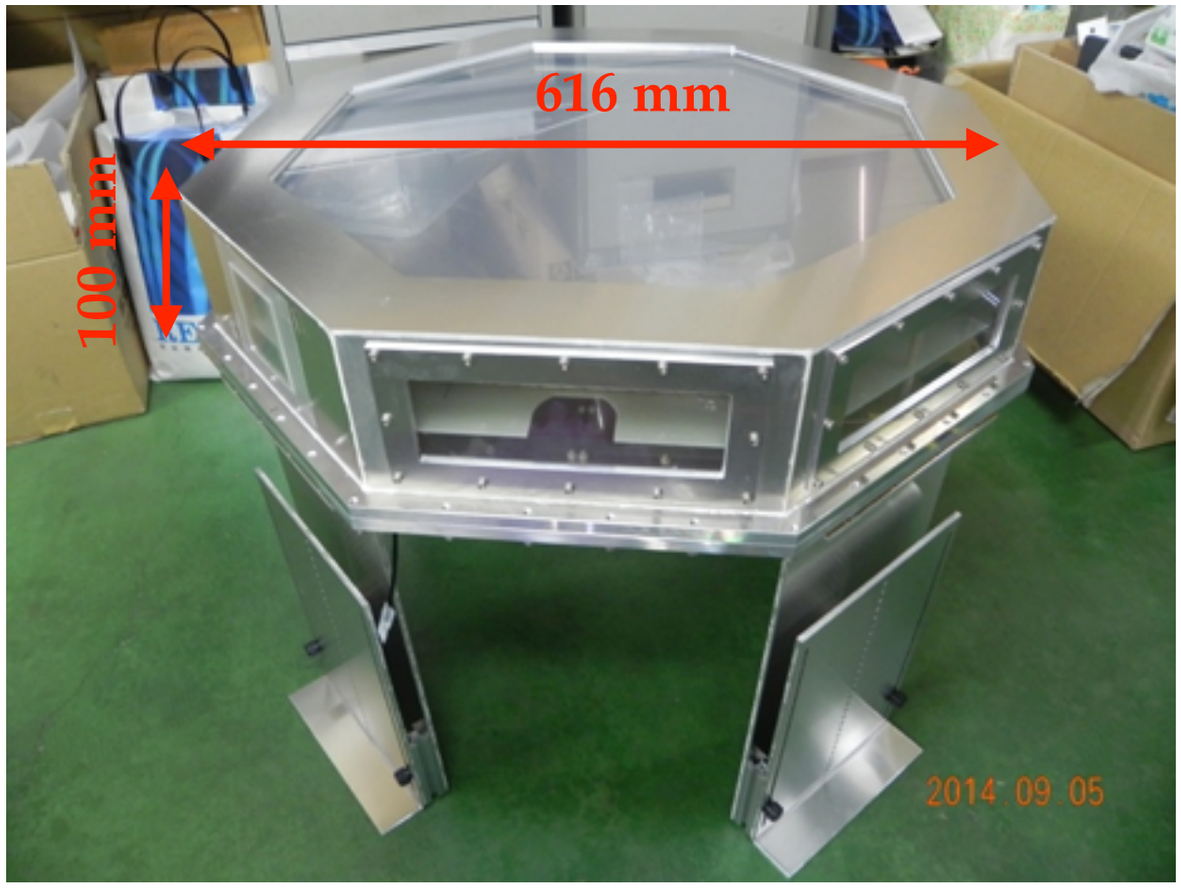
CoBo controls
AGET circuit,
Zero suppression,
Data transmission
by Jumbo frame

Ready in this fiscal year

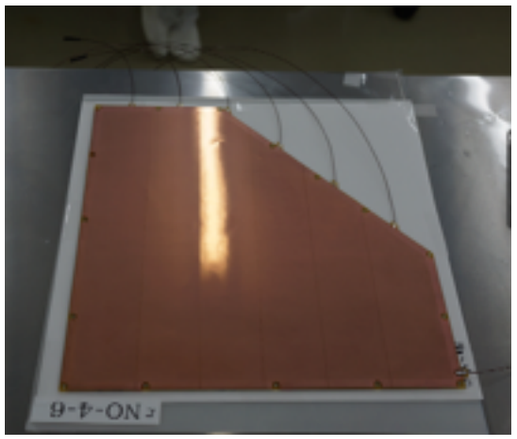


HypTPC

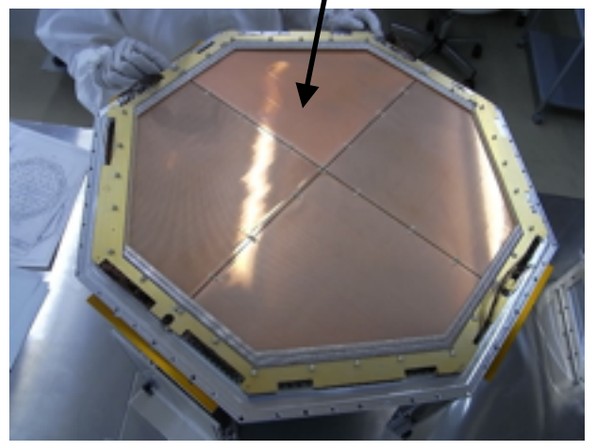
HypTPC without field-cage

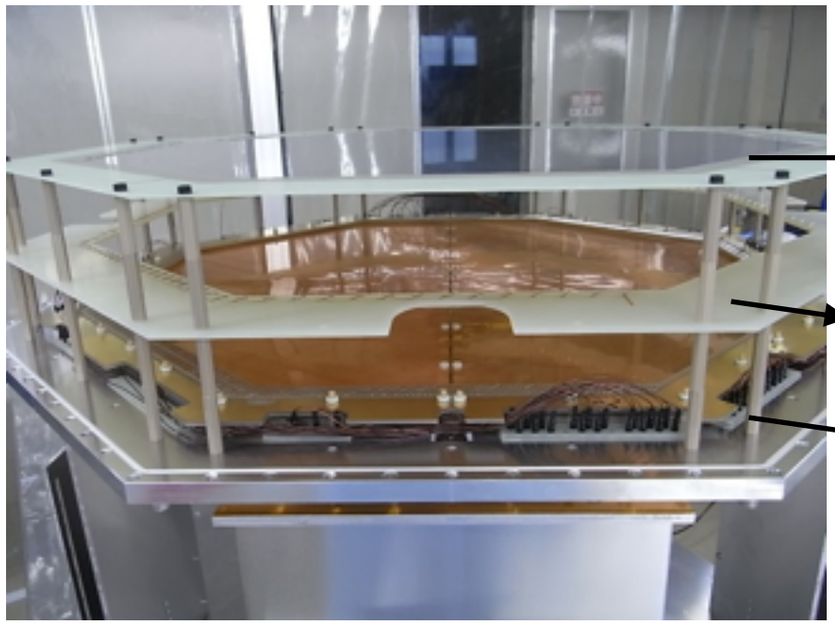


GEM sheet

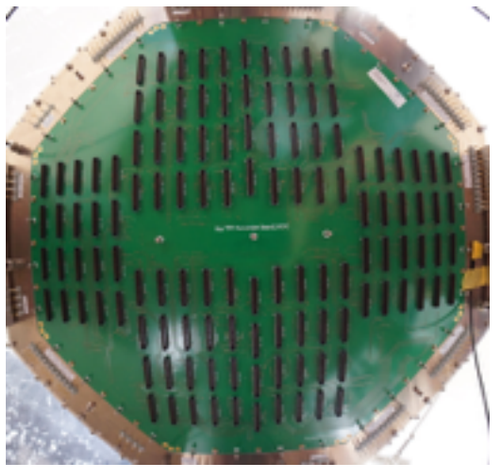


3 layers of GEM sheet

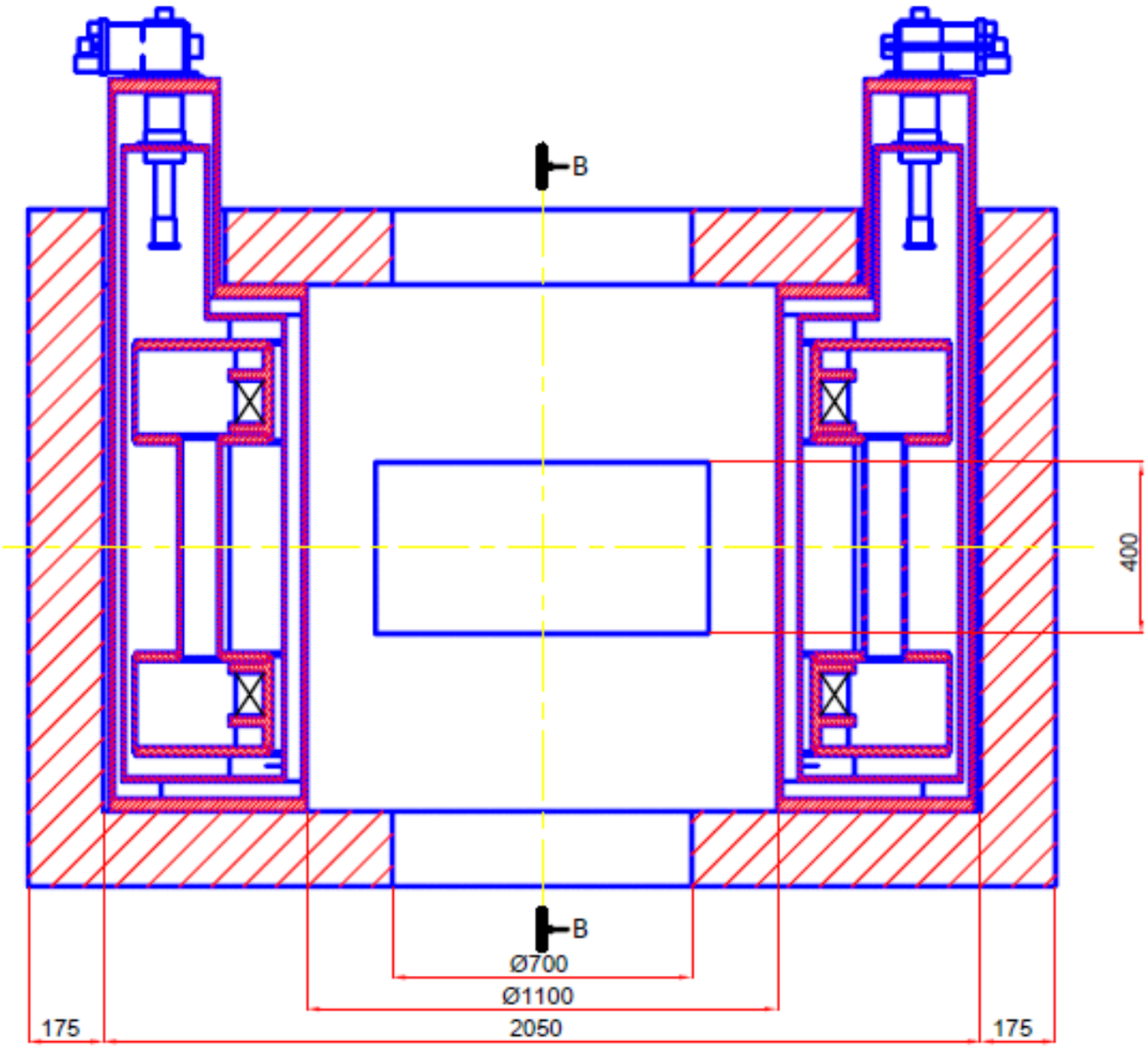




Conversion board



Hyperospectrometer Magnet

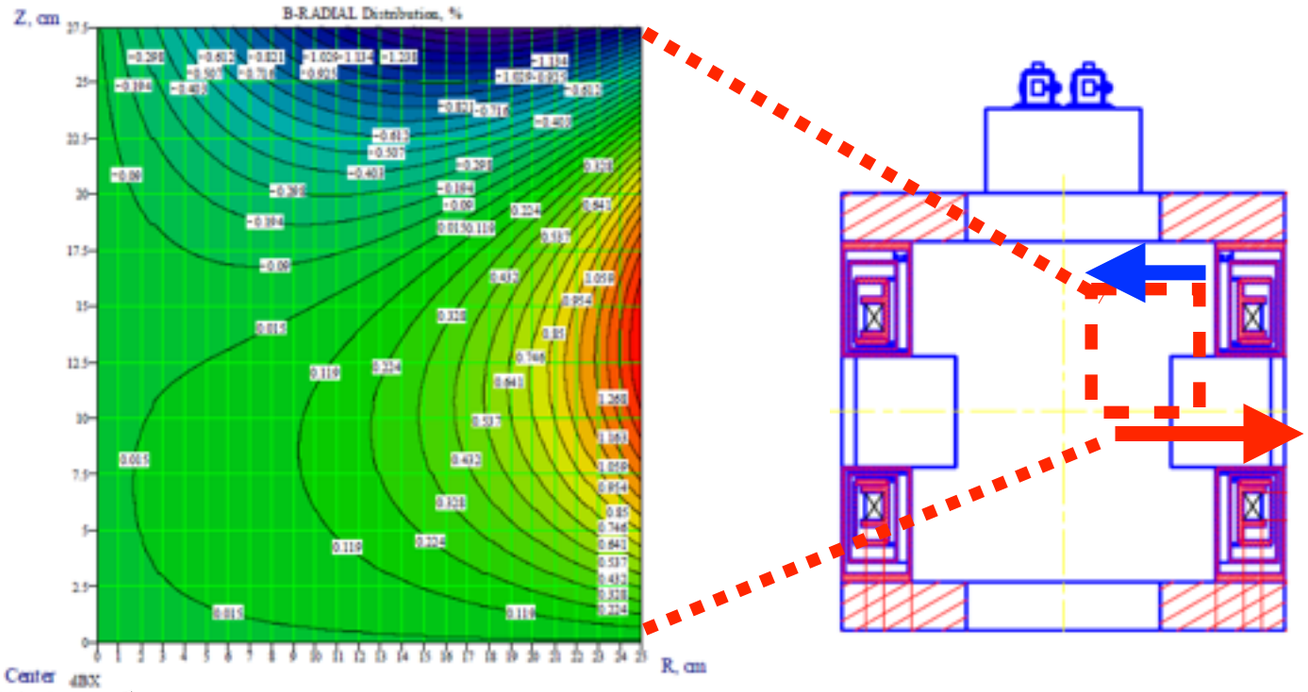


- Uniform B-field with TPC active volume (**500 D and 550 H**) at **B = 1.5 T**
- Large Opening window, 400 (H) and 90^{o} opening angle.
- The design of Helmholtz-coil was done by KR-tech (Korean company).

Transverse B

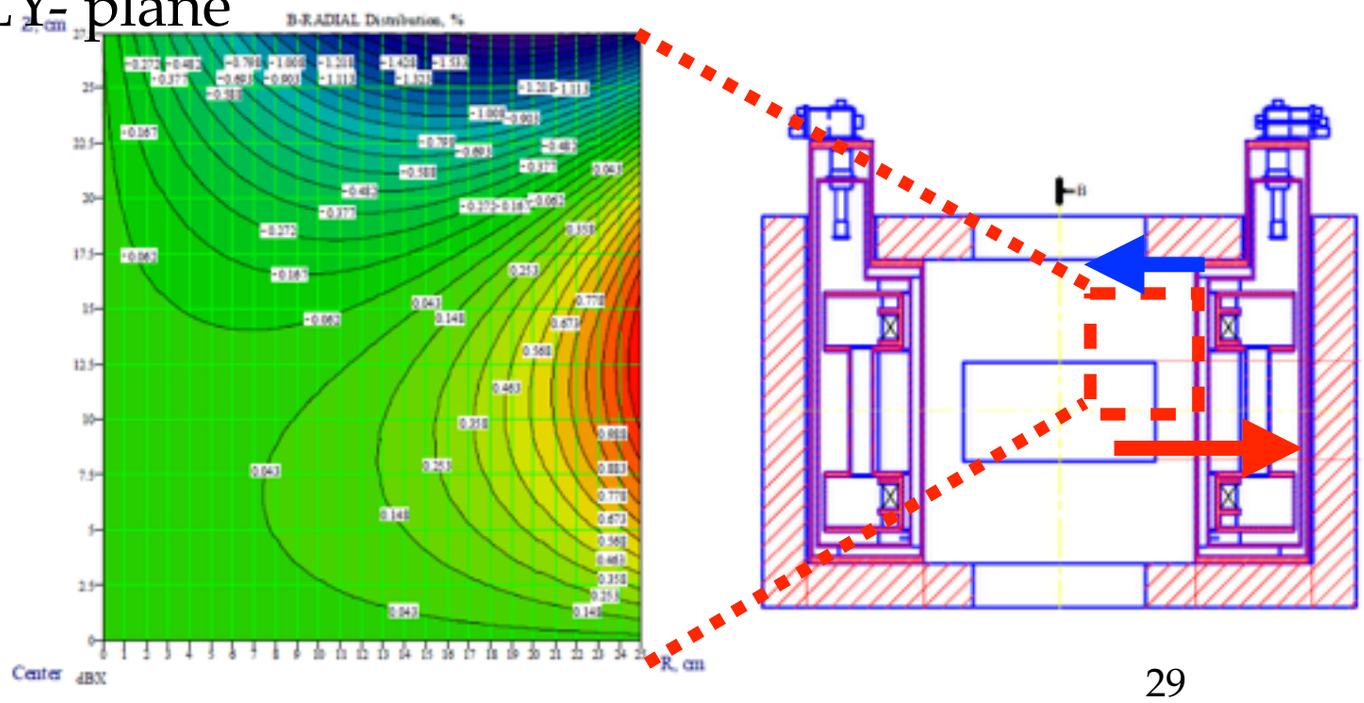
B-field calculation by KR-Tech's own softwa

XY- plane



R <150 mm : dBr/B0 < 0.3 %
Corner : dBr/B0 ~ 1.3 %

ZY- plane



R <150 mm : dBr/B0 < 0.3 %
Top : dBr/B0 ~ 1.6 %

Summary

- The KURAMA spectrometer is almost ready!!
- We performed a beam test at the ELPH facility. Characteristic of BAC, PVAC, CH and BH2 were evaluated.
- We just got the HypTPC and it will be tested soon.
- Full read system will be ready early in the next fiscal year.
- Fabrication of the SC-Helmholtz-coil will be start in this fiscal year.

ありがとうございます

Thank you

감사합니다