

The Current Status of Beam Test

2016/11/03 @ DESY

LCTPC-Asia/Japan group

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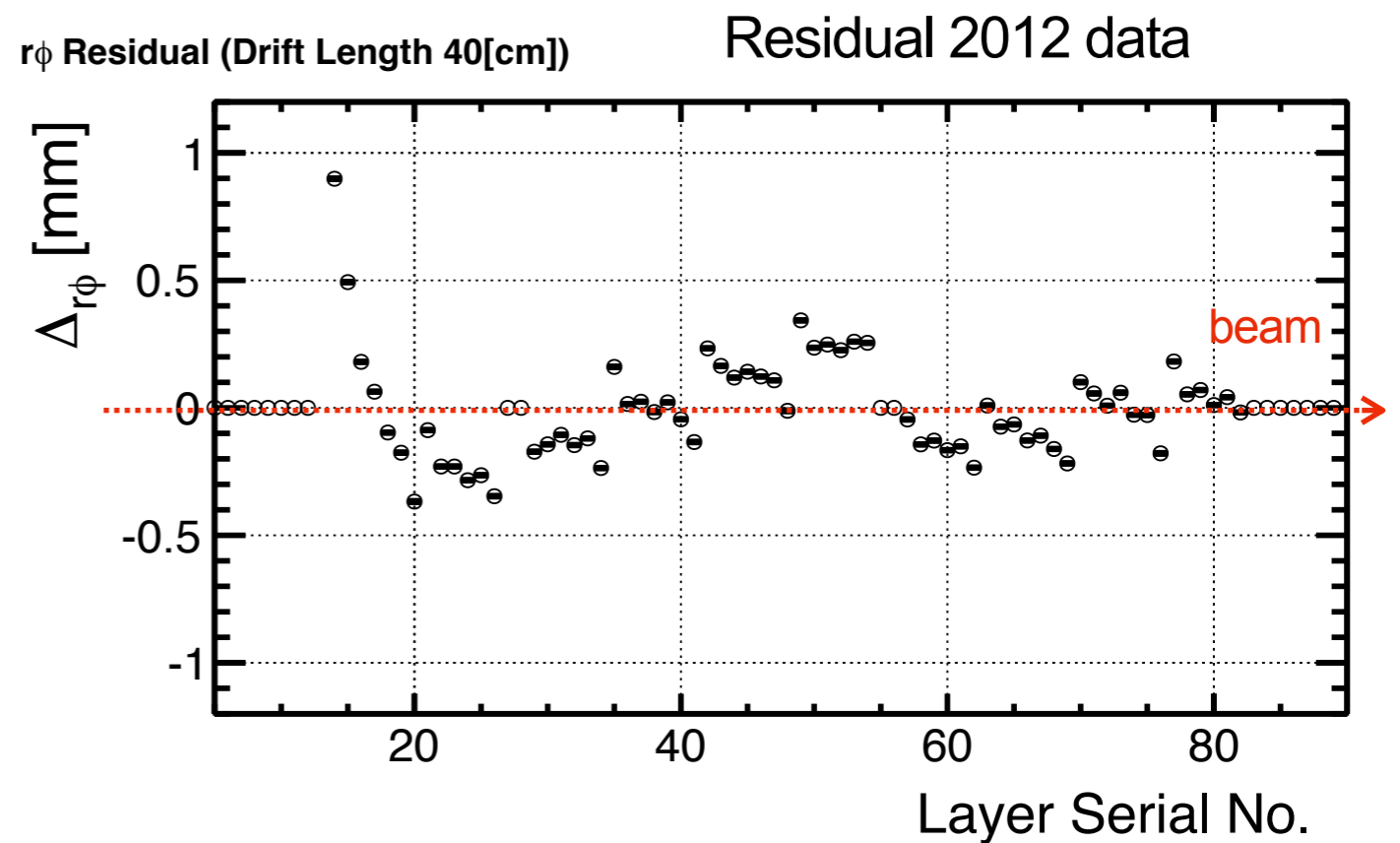
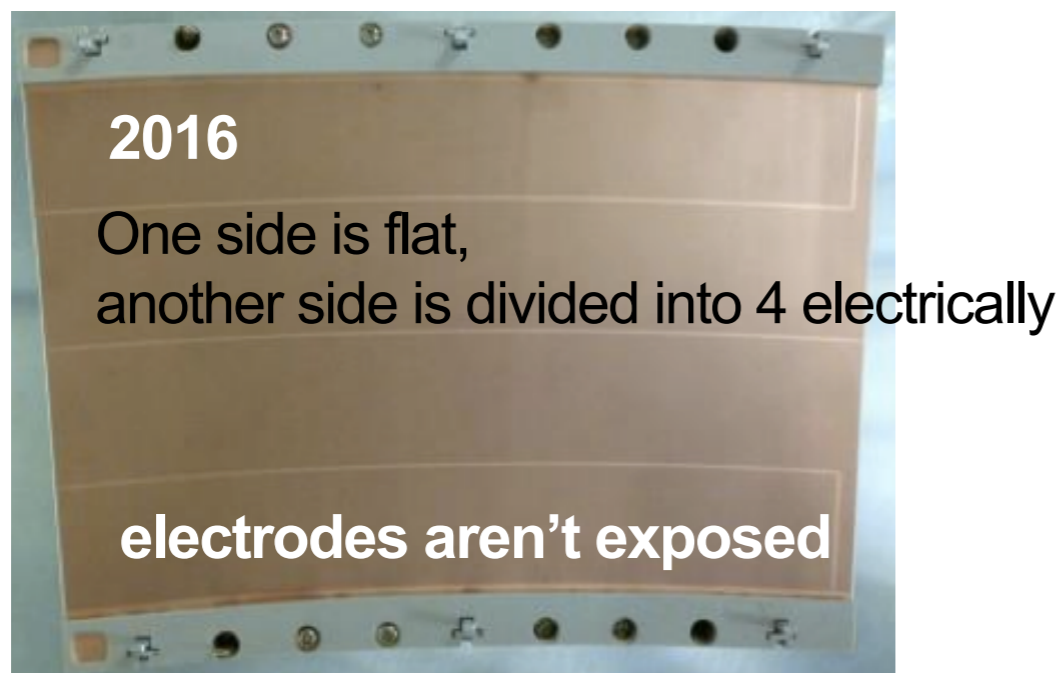
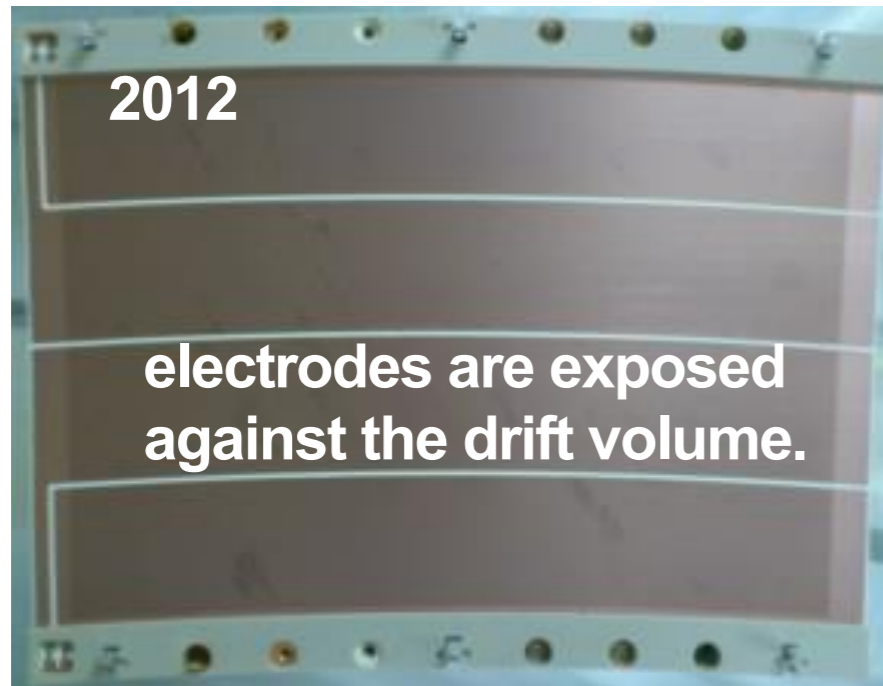
- Objectives of beam test
- The situation until today
- The Plan for Remaining Days

The Main Objective of Beam Test

- The required $\sigma_{r\phi}$ is ~ 100 [um] 2.2 m ahead (with a gating-device) at 3.5T.
- Question:
- Can we really achieve the required “ $\sigma_{r\phi}$ ” with the gating module for ILD-TPC ?
- Confirm that the degradation of “ $\sigma_{r\phi}$ ” is proportional to $1/\sqrt{\text{transmission}}$.
- **Get a proof that the spatial resolution “ $\sigma_{r\phi}$ ” with a gating-GEM is less than 100 [um].**
- **Comparison of “ $\sigma_{r\phi}$ ” by using a module equipped with and without a gating-GEM.**

Additive Objectives of Beam Test


- Check track distortions which comes from exposed electrodes.




- Distortions are expected to be less small than that of 2010/2012 beam data.

Additive Objectives of Beam Test

- Create a Z-resolution formula as Ryo & Keisuke did for position resolution in 2012.



Resolution Formula



Since TPC operates on the nice and old “gas physics”; ionization, diffusion, gas amplification and fluctuation, etc., it is possible for the GEM TPC (option (1)) to formulate a fully analytic expression of its spatial resolution **to understand the LP TPC results, to optimize parameters of the GEM TPC, and to extrapolate them to the ILD TPC** (R. Yonamine / KF)

$$\sigma_x^2(z; w, L \tan \phi, C_d, N_{eff}, \hat{N}_{eff}, [f]) = [A] + \frac{1}{N_{eff}} [B] + [C] + \frac{1}{\hat{N}_{eff}} [D]$$

[A]: Hodoscope effect/S-shape at the short drift distances

$$[A] := \int_{-1/2}^{+1/2} d\left(\frac{\tilde{x}}{w}\right) \left(\sum_a (aw) \langle \langle F_a(\tilde{x} + y \tan \phi + \Delta x) \rangle \rangle_{\Delta x} \right)_y - \tilde{x} \Bigg|_{\text{systematics}}^2$$

[B]: Diffusion + finite pad size term

$$[B] := \int_{-1/2}^{+1/2} d\left(\frac{\tilde{x}}{w}\right) \left\langle \left(\sum_a (aw) F_a(\tilde{x} + \Delta x) - \sum_a (aw) \langle F_a(\tilde{x} + \Delta x) \rangle_{\Delta x} \right)^2 \right\rangle_{\Delta x}$$

$\approx [A]_{z=0} + \sigma_d^2$

[C]: Electronics noise

$$[C] := \left(\frac{\sigma_G}{G}\right)^2 \left\langle \frac{1}{N^2} \right\rangle_N \sum_a (aw)^2$$

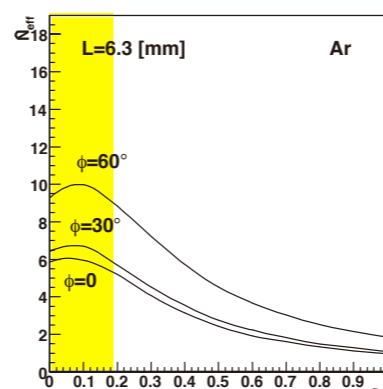
[D]: Angular pad effect

$$[D] := \frac{L^2 \tan^2 \phi}{12}$$

asymptotic formula ([B] term)

$$\sigma_x^2 = \frac{1}{N_{eff}} (\sigma_0^2 + C_d^2 z)$$

The constant term also scales as 1/N_{eff}!



$$\hat{N}_{eff} \ll N_{eff}$$

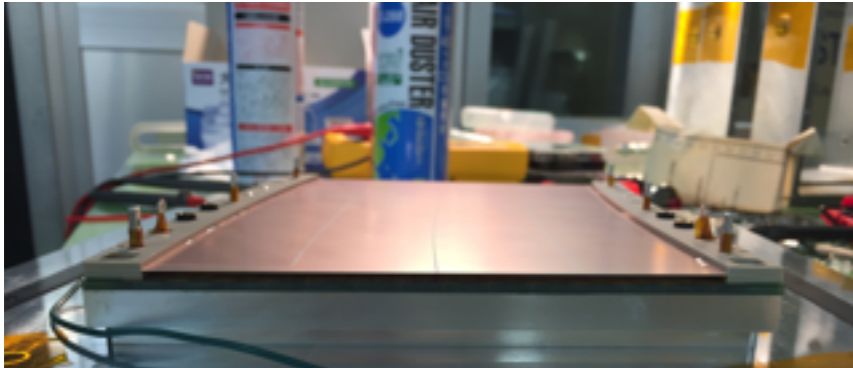
$\sigma_{r\phi}$ quickly deteriorates with ϕ !

K.Fujii @ FKPPL/TYL 2013, June, 2013
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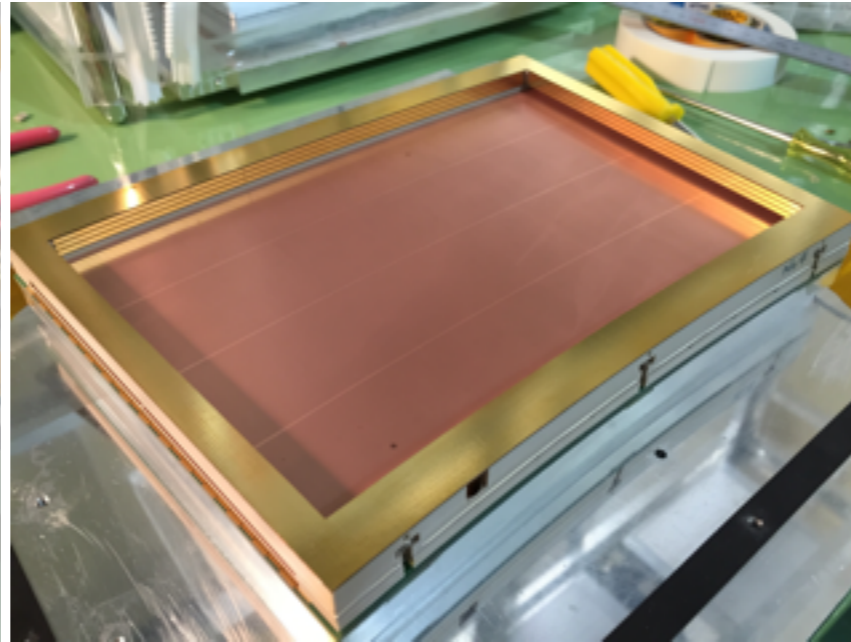
- Nobody knows feasible Z-resolution formula.

The Current Status of Beam Test (Dead FEC?)

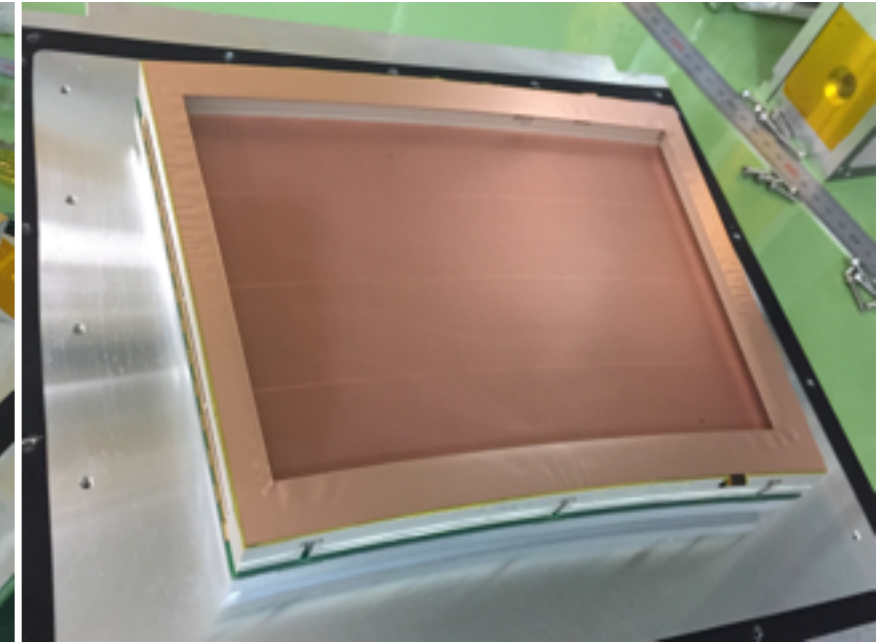
- A side view of our module



- A view of the field shaper



- A view of the gating-GEM



- Pole to stretch GEM



- Covered by electrodes

- No cover

Chamber w/
the gating-GEM



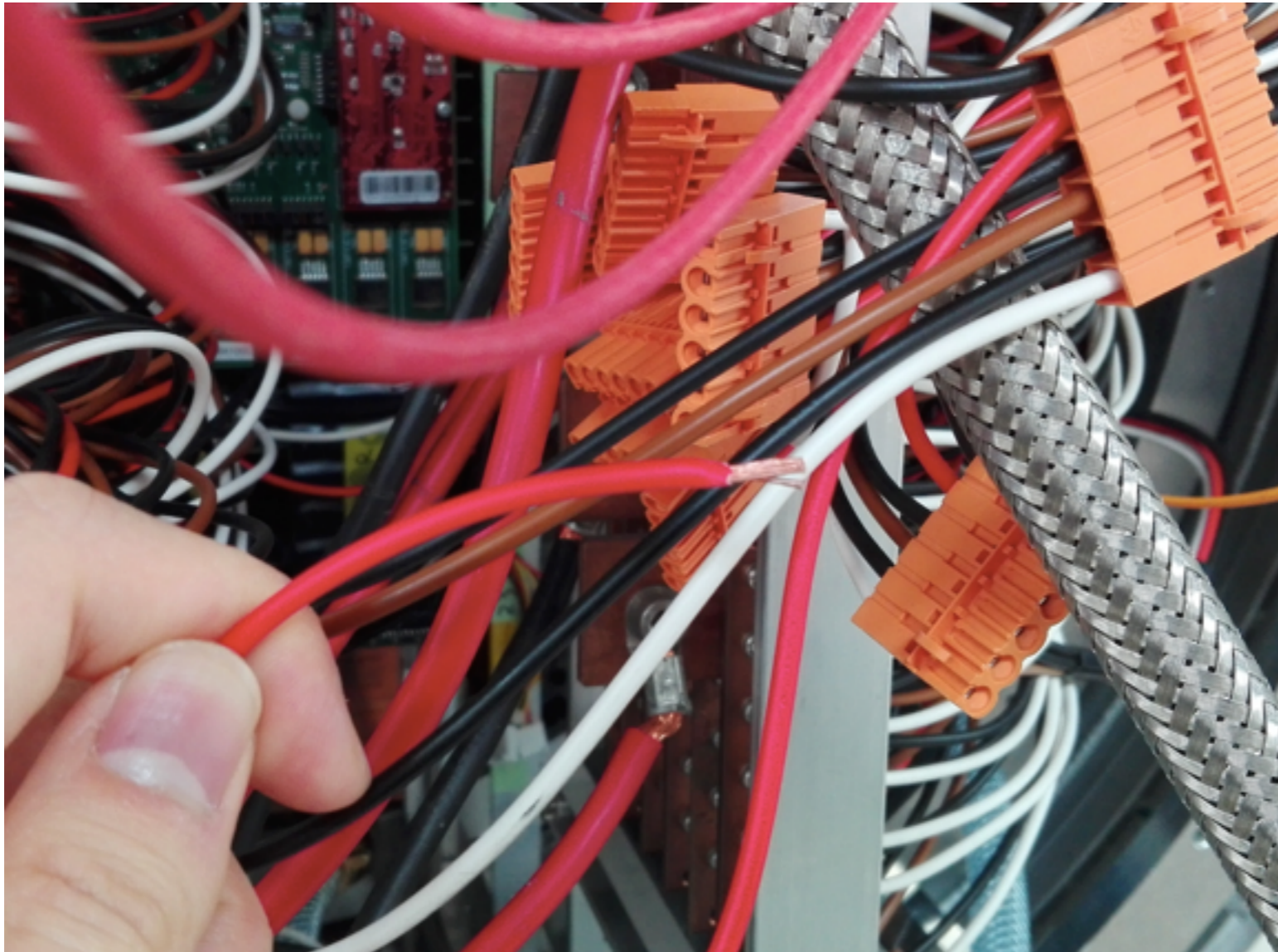
Chamber w/
the field shaper



- We judged this FEC was dead because pedestal levels were ~ 500

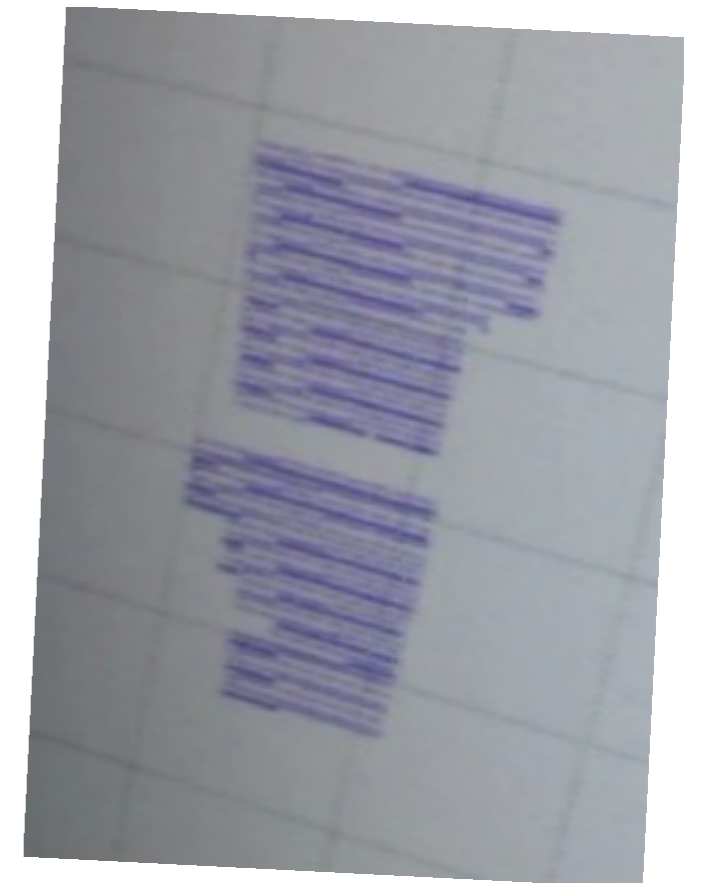
Yesterday, we decided to exchange this FEC.

The Current Status of Beam Test (Dead FEC?)



One L.V. line had been off.

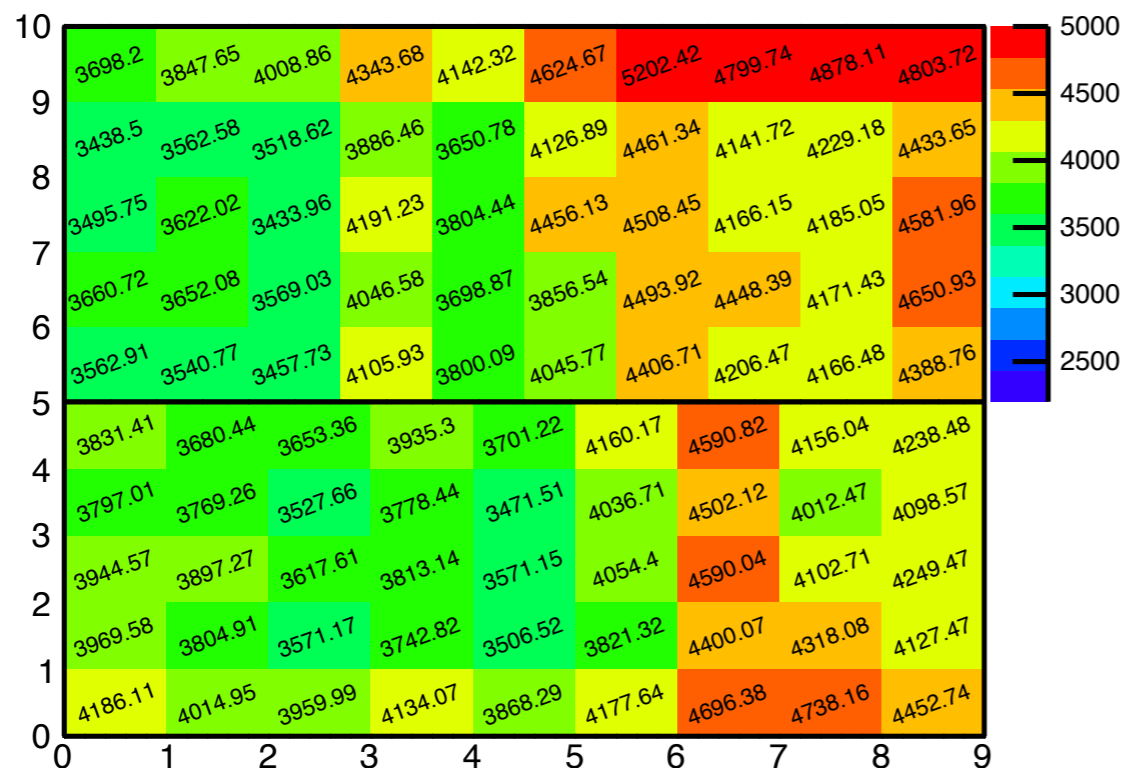
→ Solved !



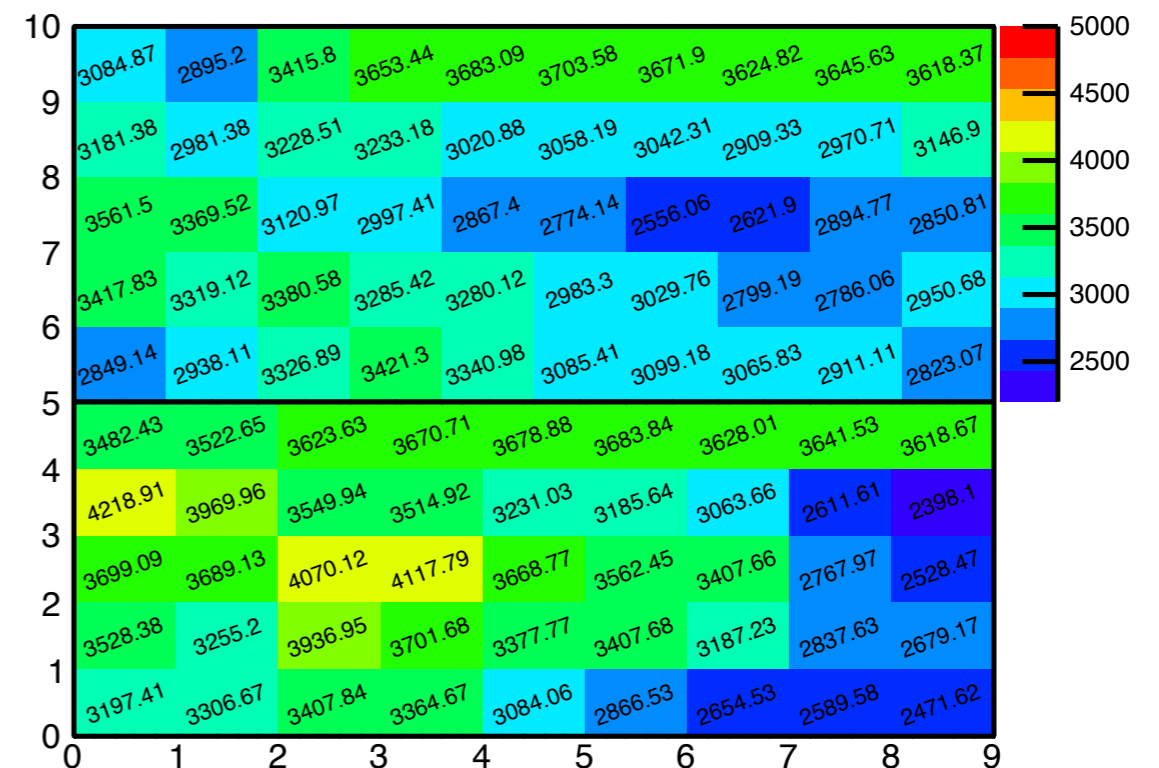
The Current Status of Beam Test (Gas Gain)

- Gas gain measurement @ KEK
- H.V. configuration : **315 and 350** for **lower and upper GEM**

Chamber w/ the gating-GEM



Chamber w/ the field shaper



! Gain correction was applied for both modules because gas condition changed during measurement. (H₂O, O₂)

H₂O: 670 → 450 ppm
 O₂ : ~ 25 ppm
 T ~ 24, P ~ 1030

H₂O: 550 → 450 ppm
 O₂ : ~ 70 ppm
 T ~ 24, P ~ 1030

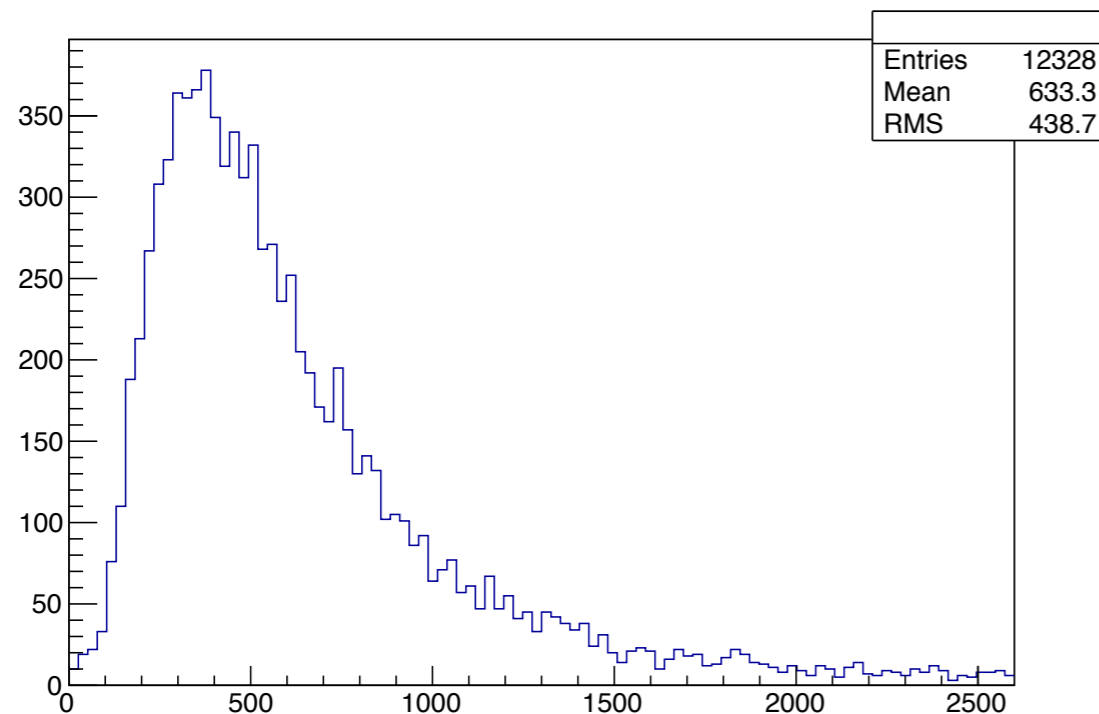
- **Expected gas gain was around ~ 3000 at least with the configuration of 315 V and 350 V.**

The Current Status of Beam Test (Gas Gain)

- Assumed gas gain @ DESY
- Hit charge distribution of one row on each module

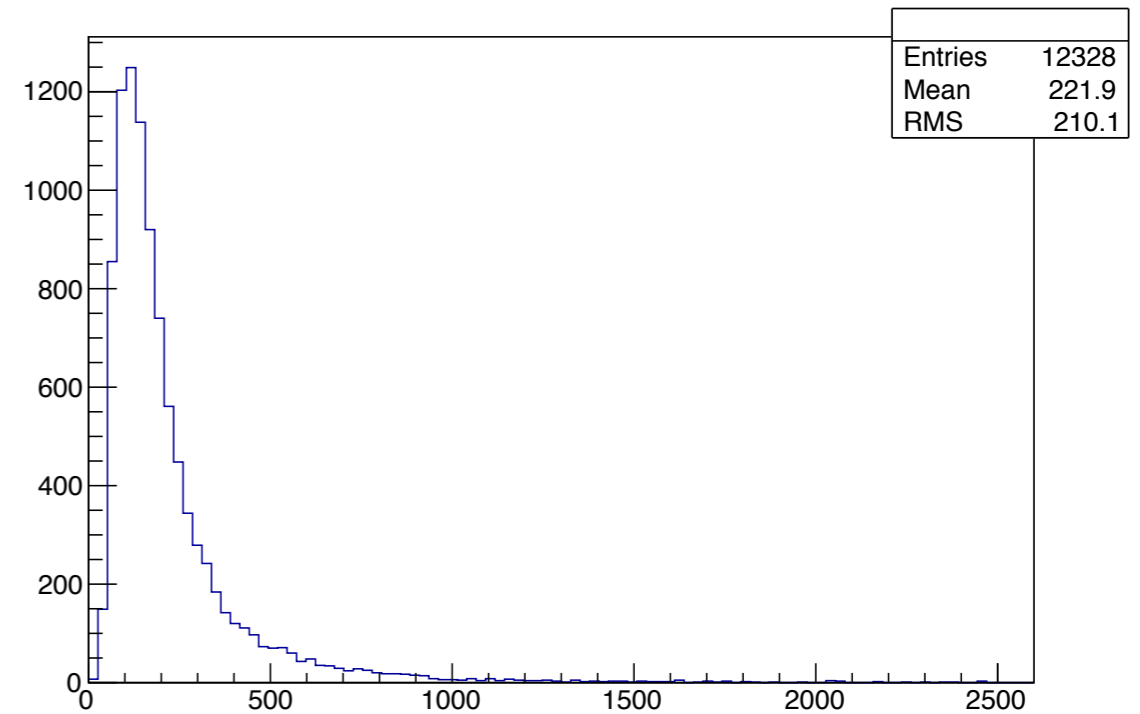
Chamber w/ the gating-GEM

ch35



Chamber w/ the field shaper

ch13



- PCA16 and ALTRO config: 12mv/fc, 1.17 mV/ADC
- Assuming that The #N primary elec. of 5 GeV is ~ 160, evaluated gas gain are ~ 2000 and 1000

The Plan for Remaining Days

- Now we are retaking data passing through the center region under 1 T and 0 T.
- Data taking with angles is planning.
- But we have to resolve gain problem especially for the module of the field shaper , otherwise we can not get reasonable spatial resolution, Z-resolution.

BACK UP

Gas Gain of Asian-GEM

D1	D15	D30	D43	D57	D70	D86	D101	D117	D130	D144	D159
D2	D16	D31	D44	D58	D71	D87	D102	D118	D131	D145	D160
D3	D17	D32	D45	D59	D72	D88	D103	D119	D132	D146	D161
D4	D18	D33	D46	D60	D73	D89	D104	D120	D133	D147	D151
D5	D19	D34	D47	D61	D74	D90	D105	D121	D134	D148	D152
D6	D20	D35	D48	D62	D75	D91	D106	D122	D135	D149	D153
D7	D21	D36	D49	D63	D76	D92	D107	D123	D136	D150	D154
D8	D22	D37	D50	D64	D77	D93	D108	D124	D137	D155	
D9	D23	D38	D51	D65	D78	D94	D109	D125	D138	D156	
D10	D24	D39	D52	D66	D79	D95	D110	D126	D139	D157	
D11	D25	D40	D53	D67	D80	D96	D111	D127	D140	D158	
D12	D26	D41	D54	D68	D81	D97	D112	D128	D141	D85	
D13	D27	D42	D55	D69	D82	D98	D113	D129	D142	D100	
D14	D28	D29	D56	D84	D83	D99	D114	D115	D143	D116	

Correction of Gas Gain

- Gain correction

