

# **Ionization chamber**

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**Collaboration meeting, 7 Sep. 2020**

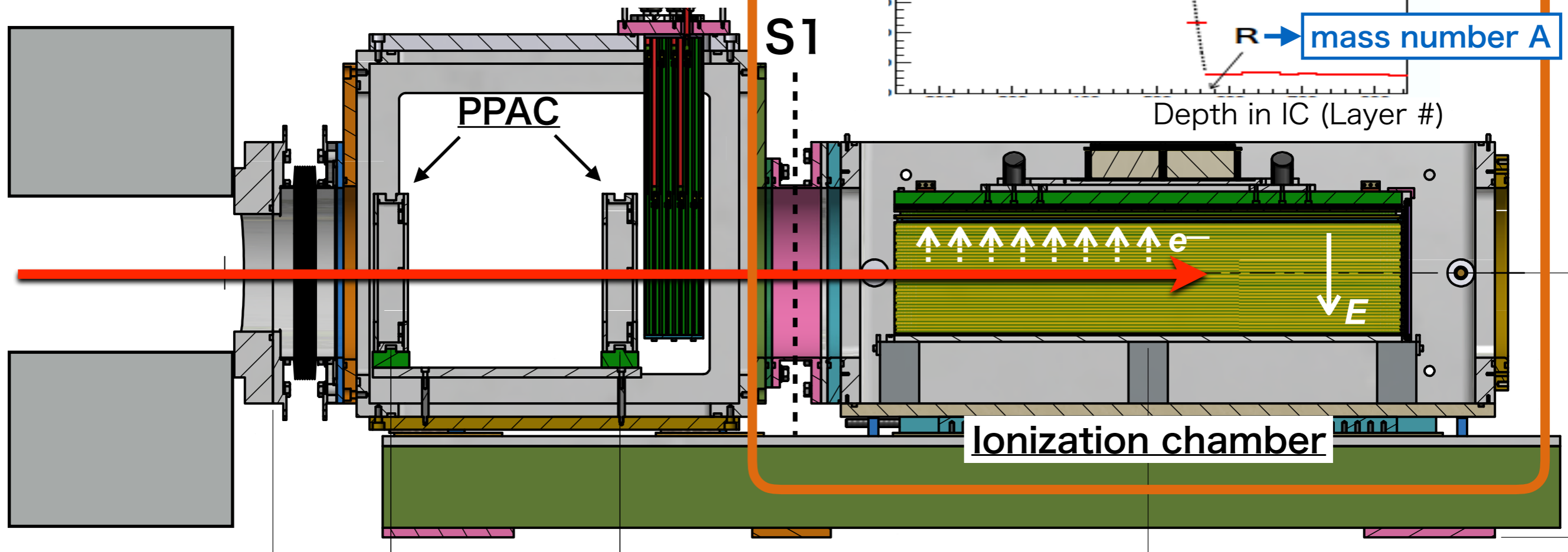
# S1 Ionization chamber

## - Specifications

- 280 mm<sup>W</sup> x 150 mm<sup>W</sup> x 760 mm<sup>D</sup>
- 30 pad layers
- CF4 @ ~0.1 atm
- ~50 V/cm

## - Signal processing

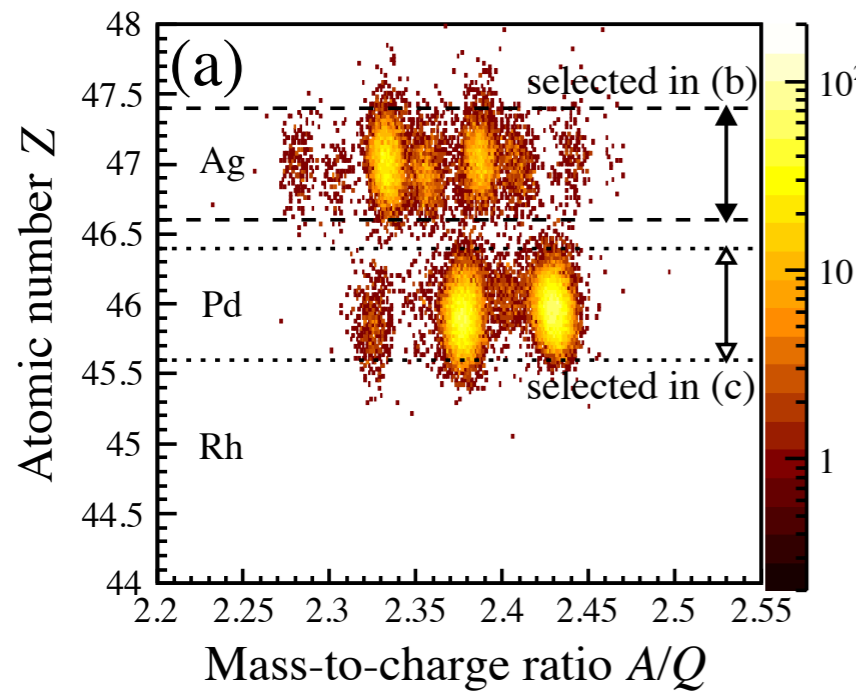
- Pad → Preamplifier
- Shaping amplifier
- Peak sensing ADC



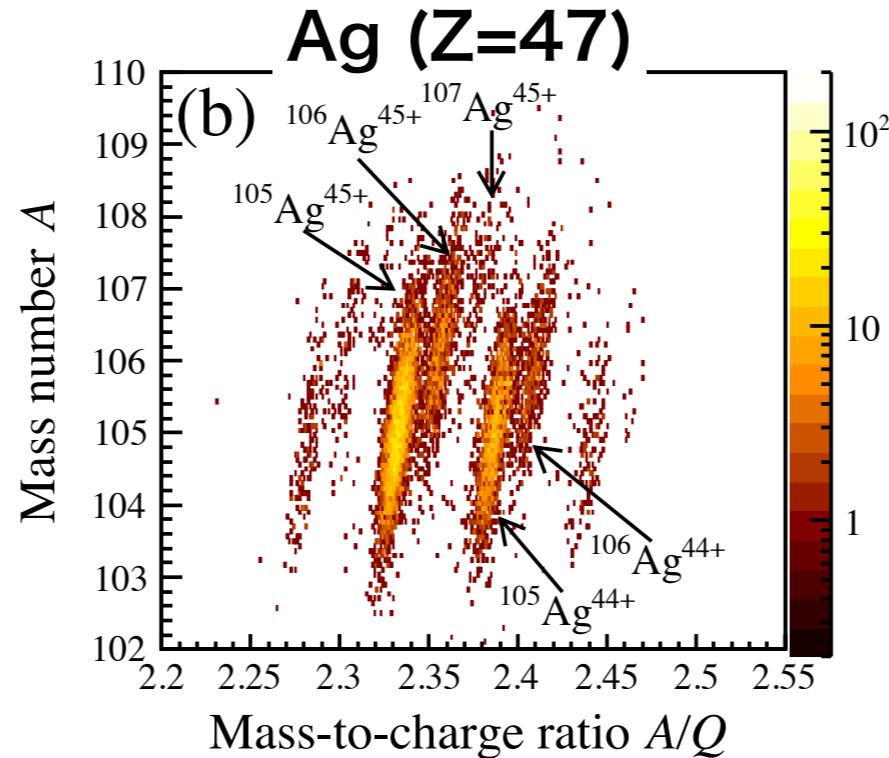
# Particle identification @ OEDO-Day0 exp.

- $^{107}\text{Pd} + p @ \sim 30 \text{ MeV/u}$

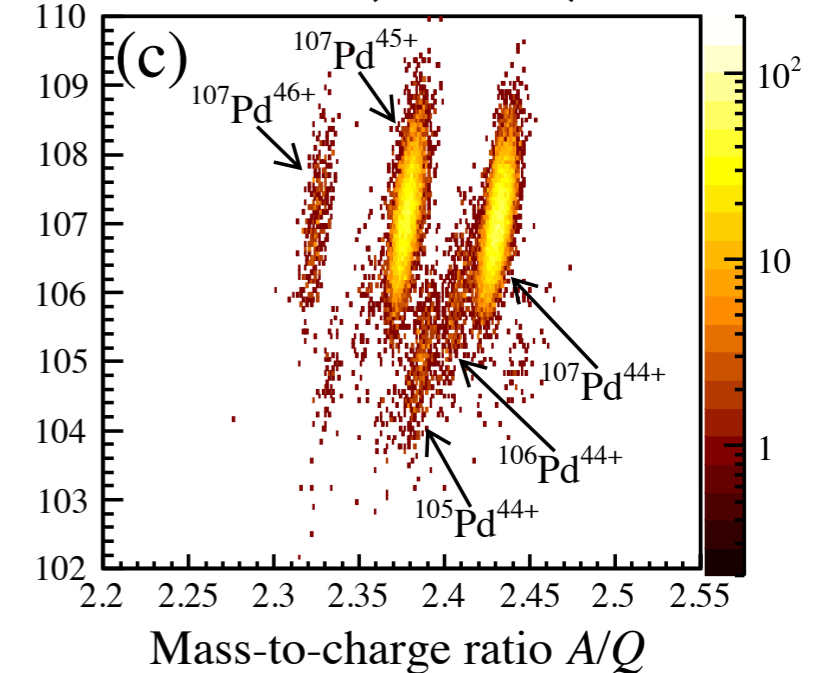
Z vs A/Q



A vs A/Q



Pd (Z=46)



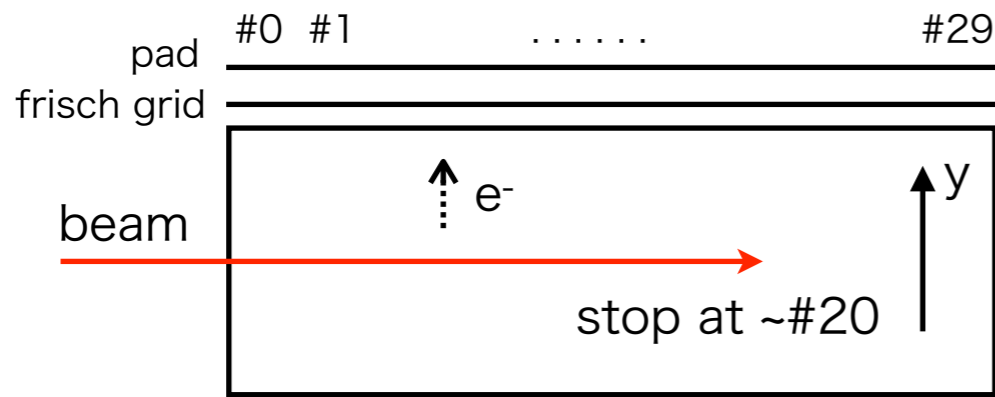
$$\sigma(Z) = 0.17, \quad \sigma(A/Q) = 5.6 \times 10^{-3}, \quad \sigma(A) = 0.67$$

$\sigma(Z)$  and  $\sigma(A)$  are limited by IC

→ We'd like to improve IC performance

# Problem : Induced charge

□ Y position dependence  
of charge



Y-dependence is  
due to induced charge

Correction was performed phenomenologically,  
but correction was not perfect in low charge region.

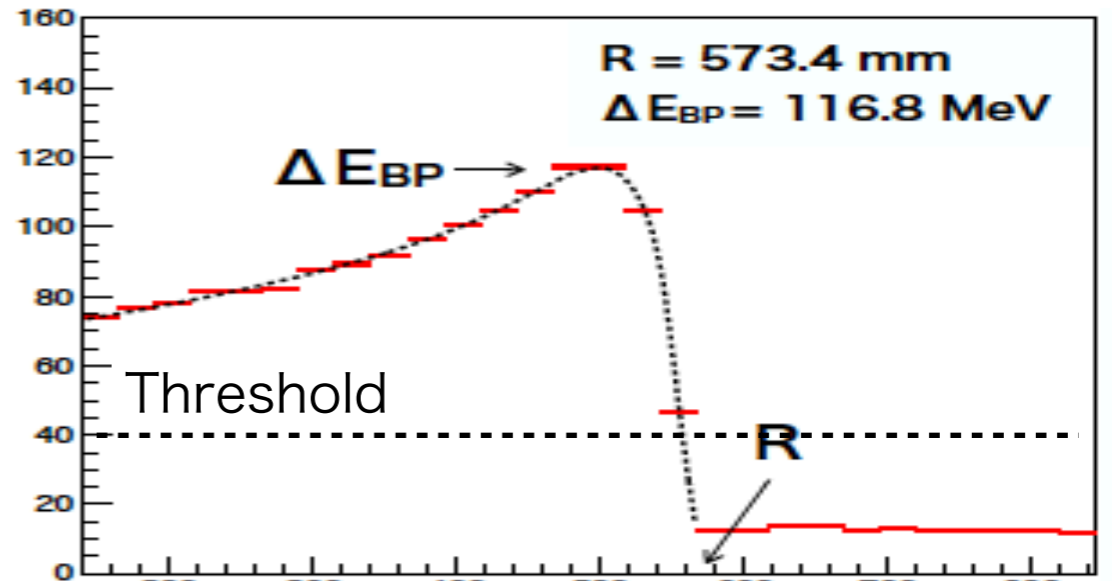
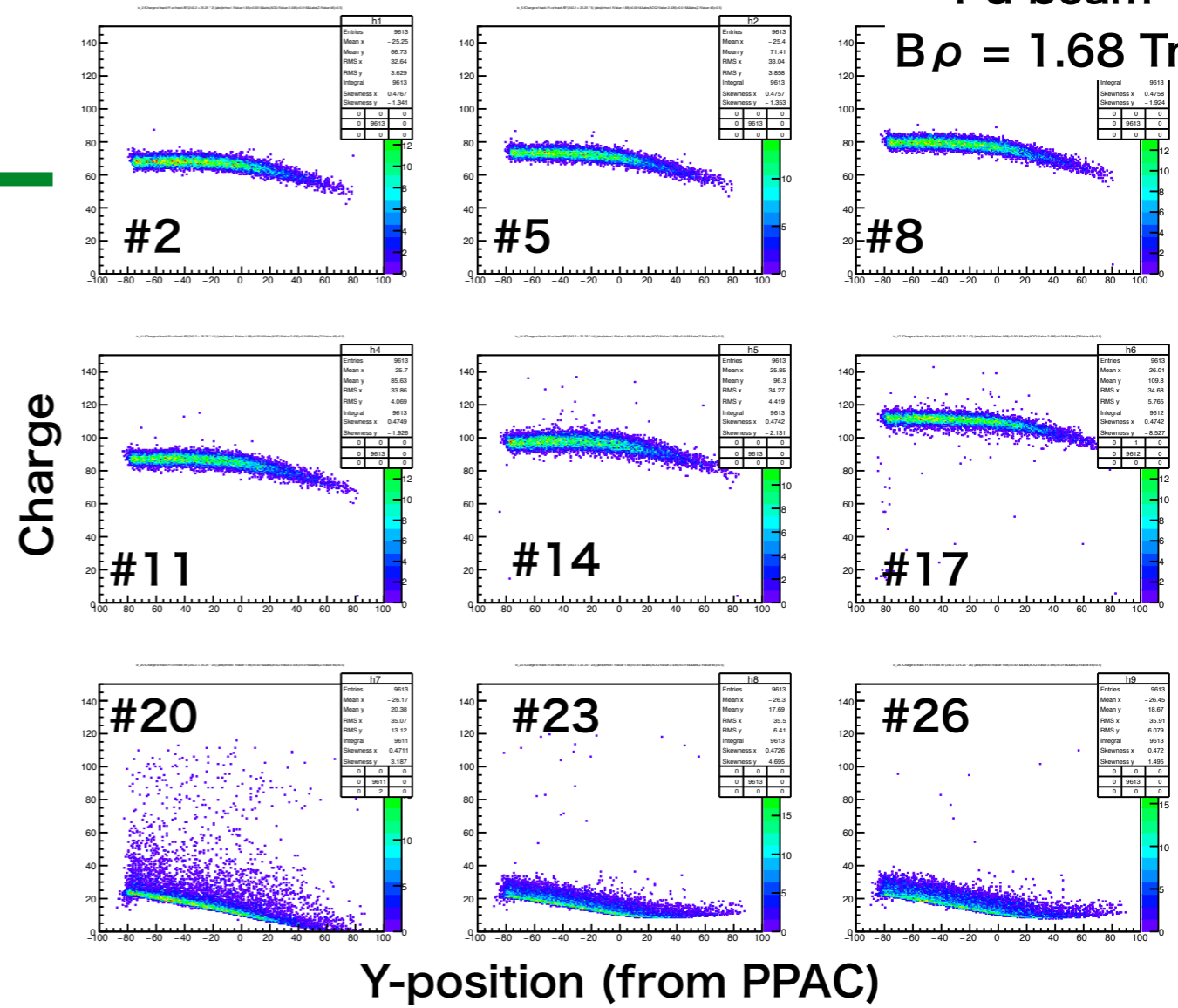
Thus, the information was not used

in the fitting procedure.

If we can estimate induced charge more correctly,  
fitting performance will be improved.

## Charge vs Y-position

<sup>107</sup>Pd beam  
 $B\rho = 1.68 \text{ Tm}$



Should be zero !

# Solution : Flash ADC

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## Take pulse shape with Flash ADC

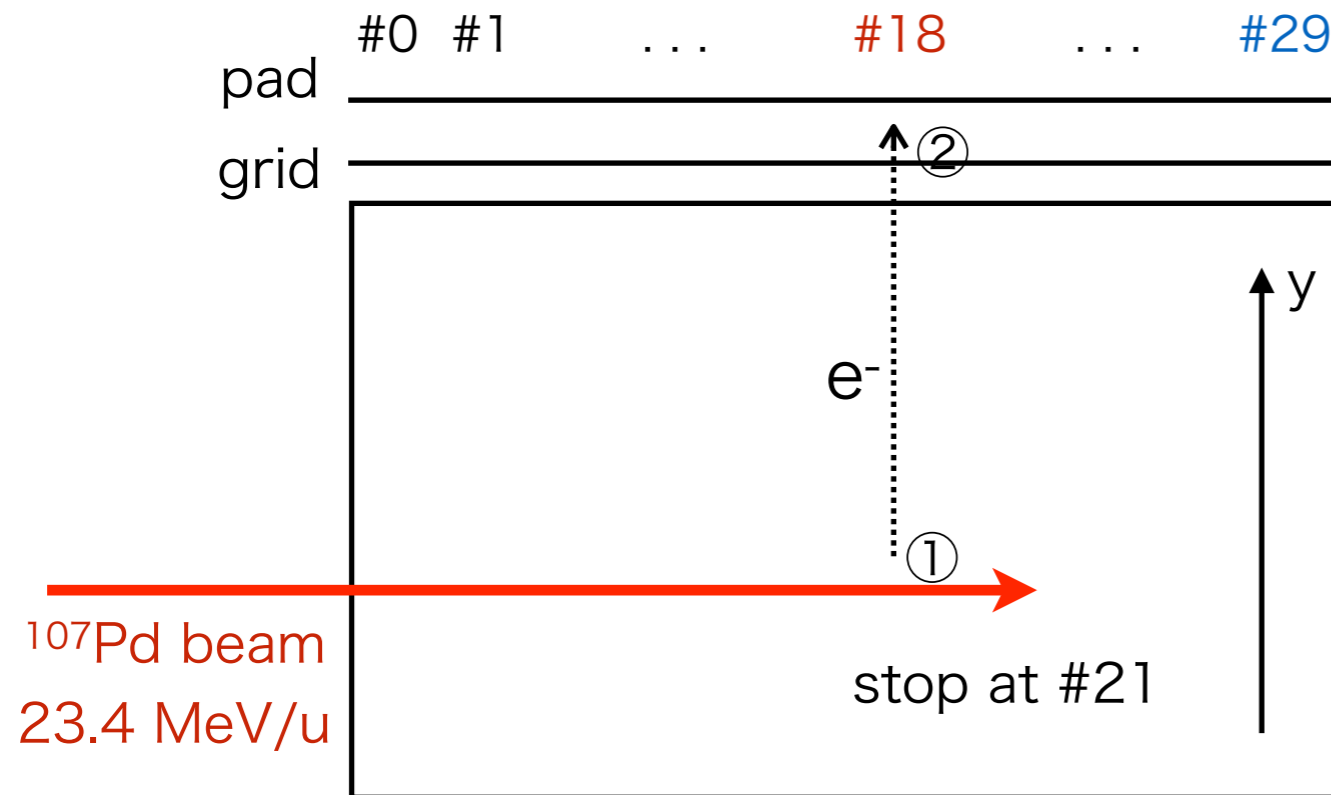
PAD signal → Preamp. → Shaping amp. → Peak sensing ADC

NEW  
↓  
Flash ADC

## Flash ADC data of OEDO commissioning exp. was analyzed → Next page

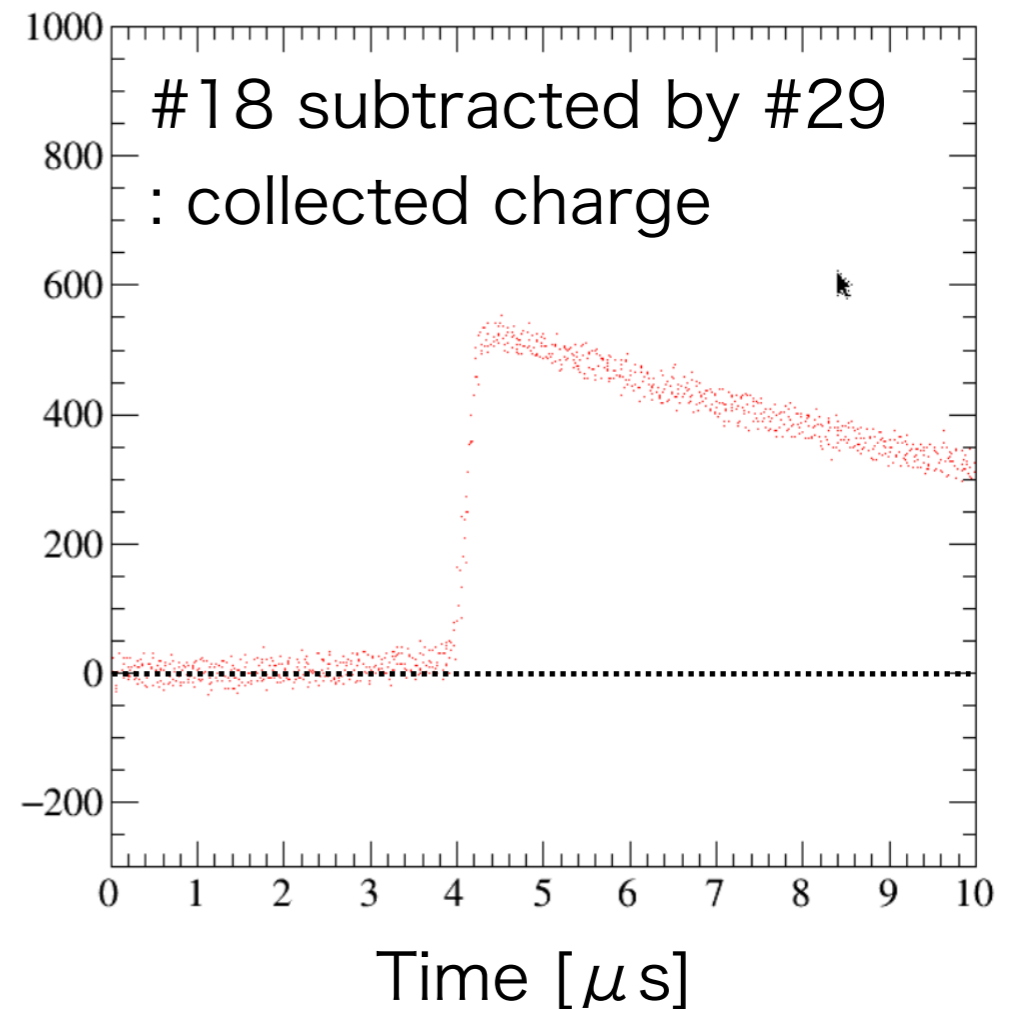
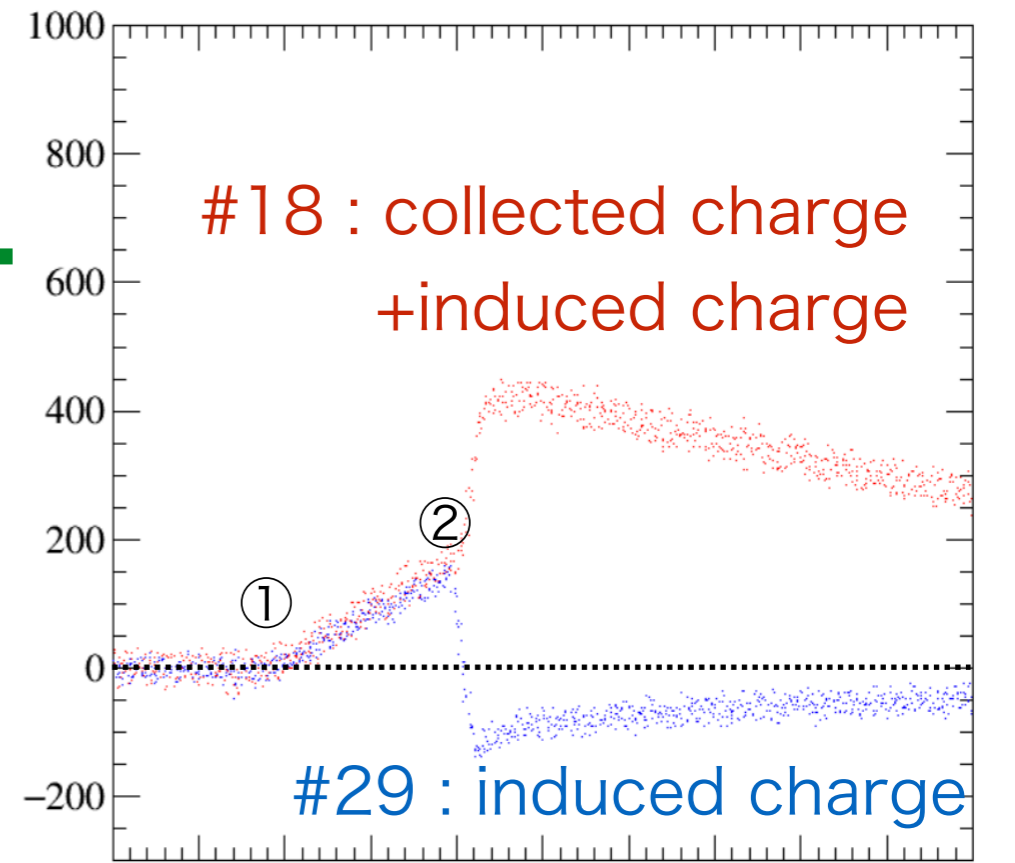
# Flash ADC data

## □ Pulse shape



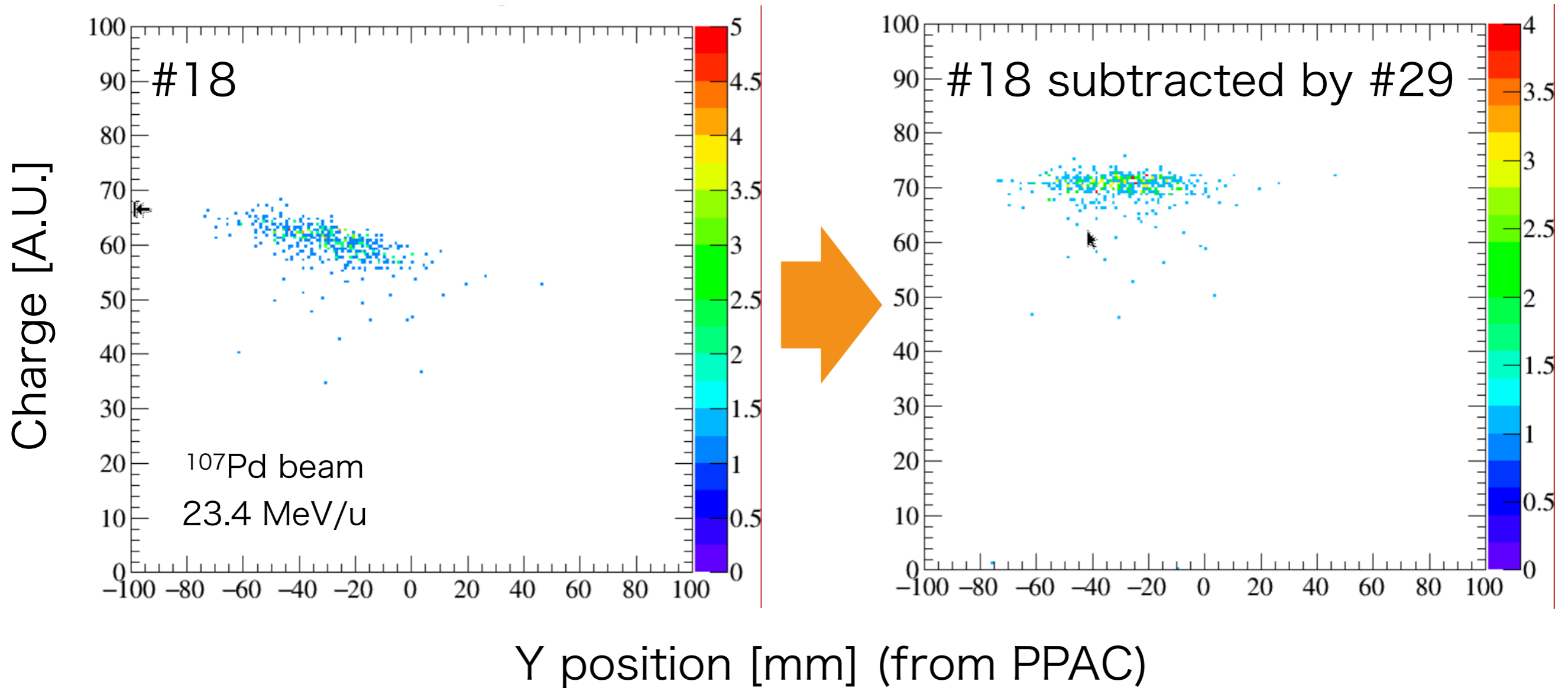
Induced charge can be estimated using the data in no beam region

Preamp. output [mV]



# Flash ADC data

□ Y dependence



Y-dependence disappeared !

Flash ADC is useful for induced charge subtraction

# Tasks

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- **Improvements of setup and system**

- Module type : peak sensing ADC → Flash ADC ?
- Flash ADC data for OEDO commissioning exp.
  - Flash ADC is useful for induced charge subtraction
  - Data analysis for range determination is on going
- Flash ADC is also useful for analysis of pile-up events
- Optimization of counter gas ?
  - CF<sub>4</sub> was used in previous exp.
    - fast drift velocity & small diffusion, but bad charge collection (attachment) ?
  - Several gases will be tested using mini IC
    - CF<sub>4</sub> → Ar + CF<sub>4</sub> mixture ?

- **Onsite preparation**

- installation of chambers, detectors, electronics, cable connection, . . .
- Man power : Several students from Kyushu University
  - will join preparation in ~Feb. 2021 (A3F budget)



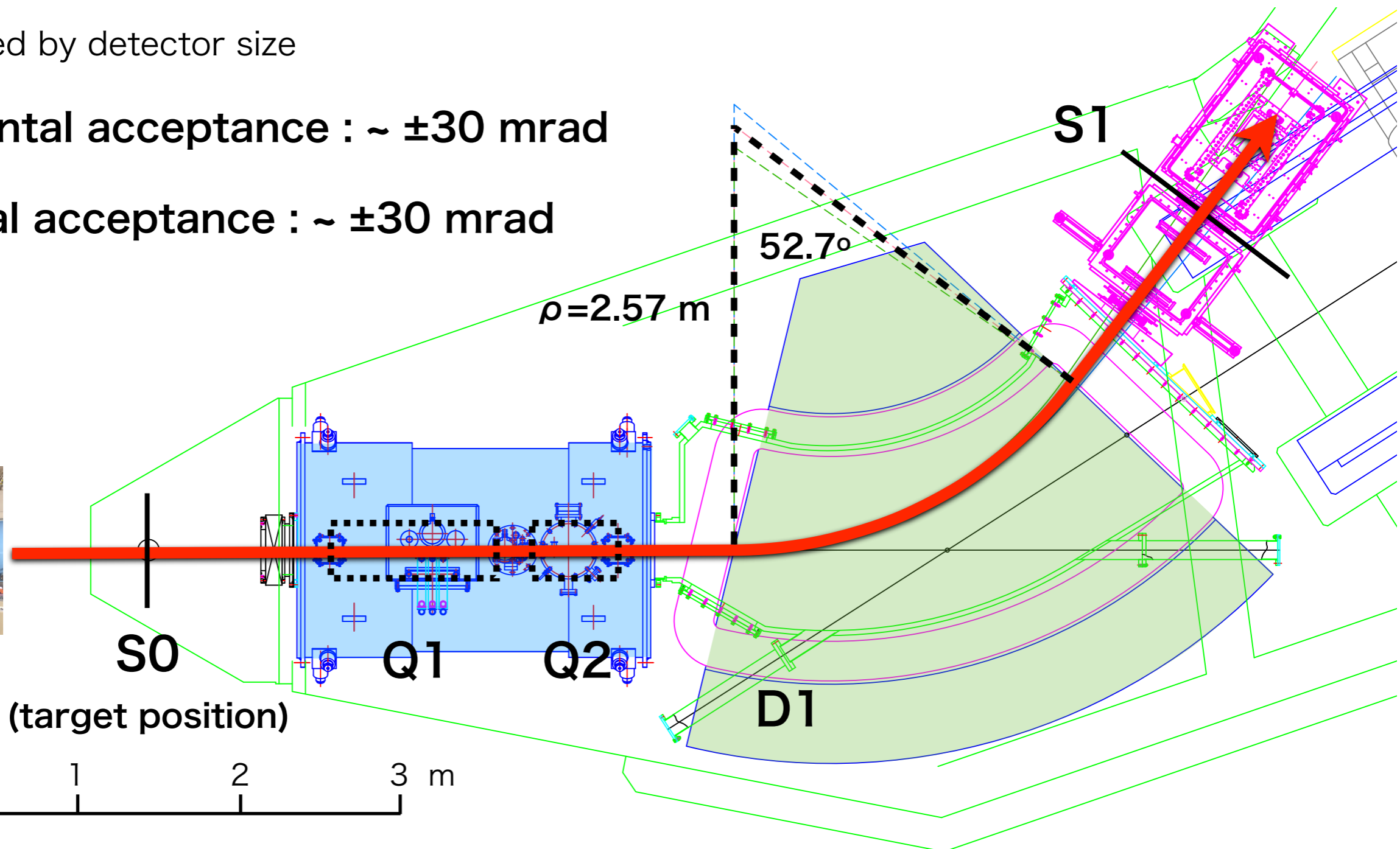
# Backup



# SHARAQ-S1 spectrometer

- Resolving power (for 1mm-image size) : 3490
- Momentum acceptance : ~ 8%
  - Limited by detector size
- Horizontal acceptance : ~  $\pm 30$  mrad
- Vertical acceptance : ~  $\pm 30$  mrad

OEDO



# S1 focal plane setup

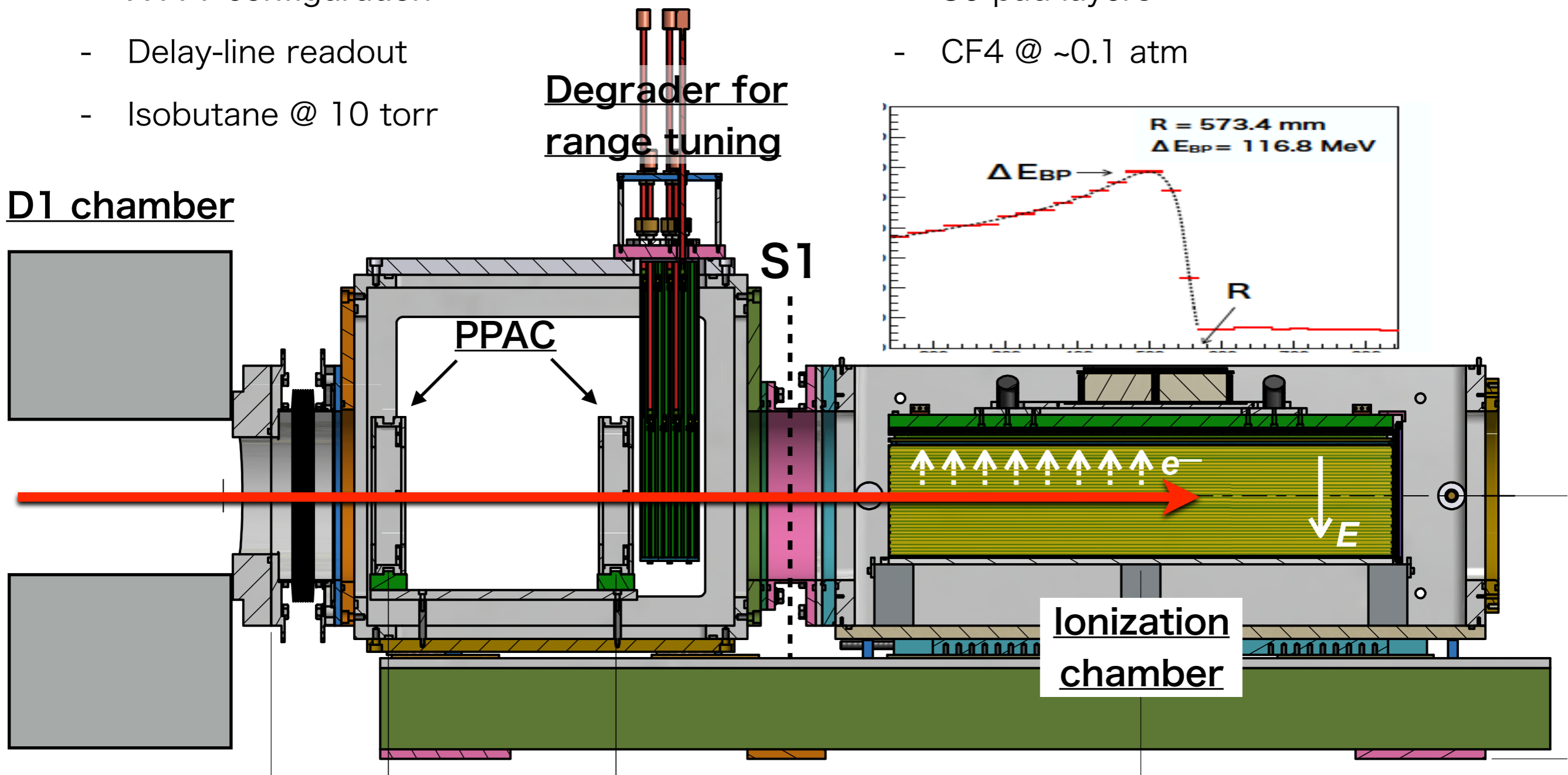
- PPAC (position, timing)

- 240 mm<sup>W</sup> x 150 mm<sup>H</sup>
- X-A-Y configuration
- Delay-line readout
- Isobutane @ 10 torr

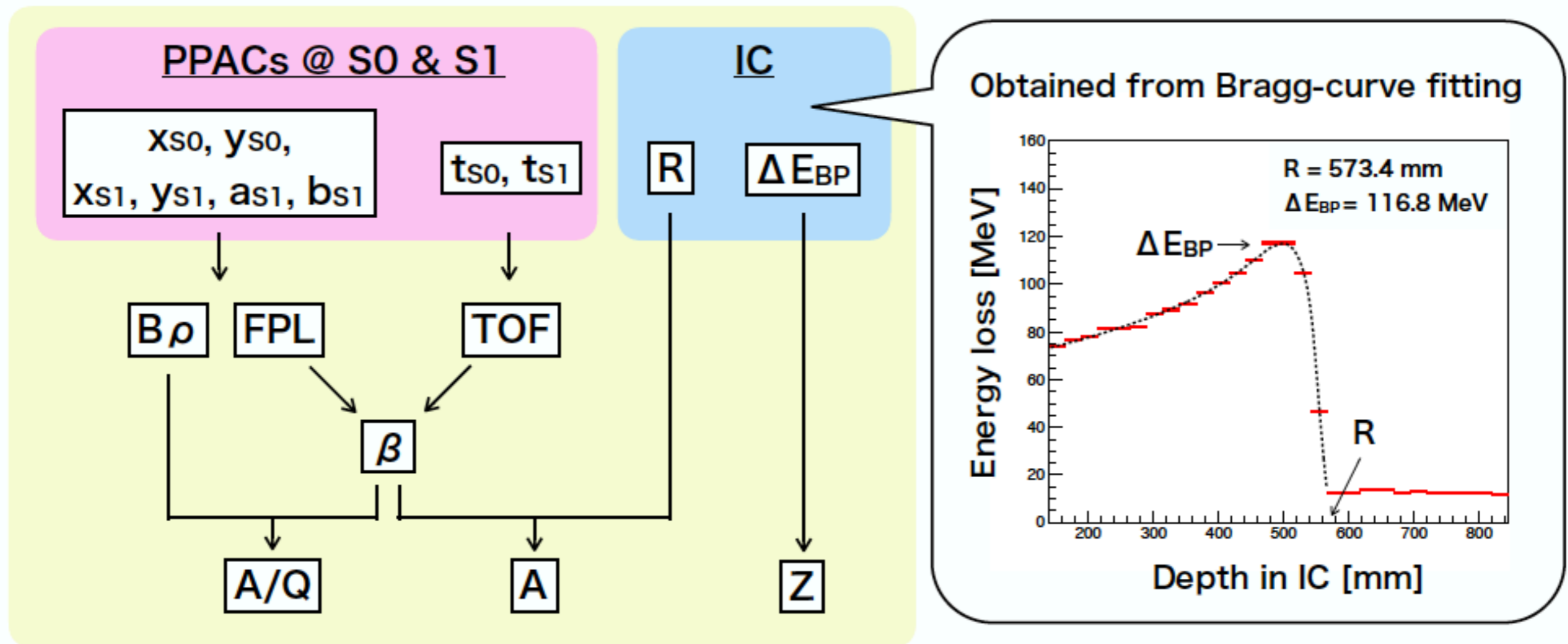
- Ionization chamber (bragg curve)

- 280 mm<sup>W</sup> x 150 mm<sup>W</sup> x 760 mm<sup>D</sup>
- 30 pad layers
- CF4 @ ~0.1 atm

D1 chamber



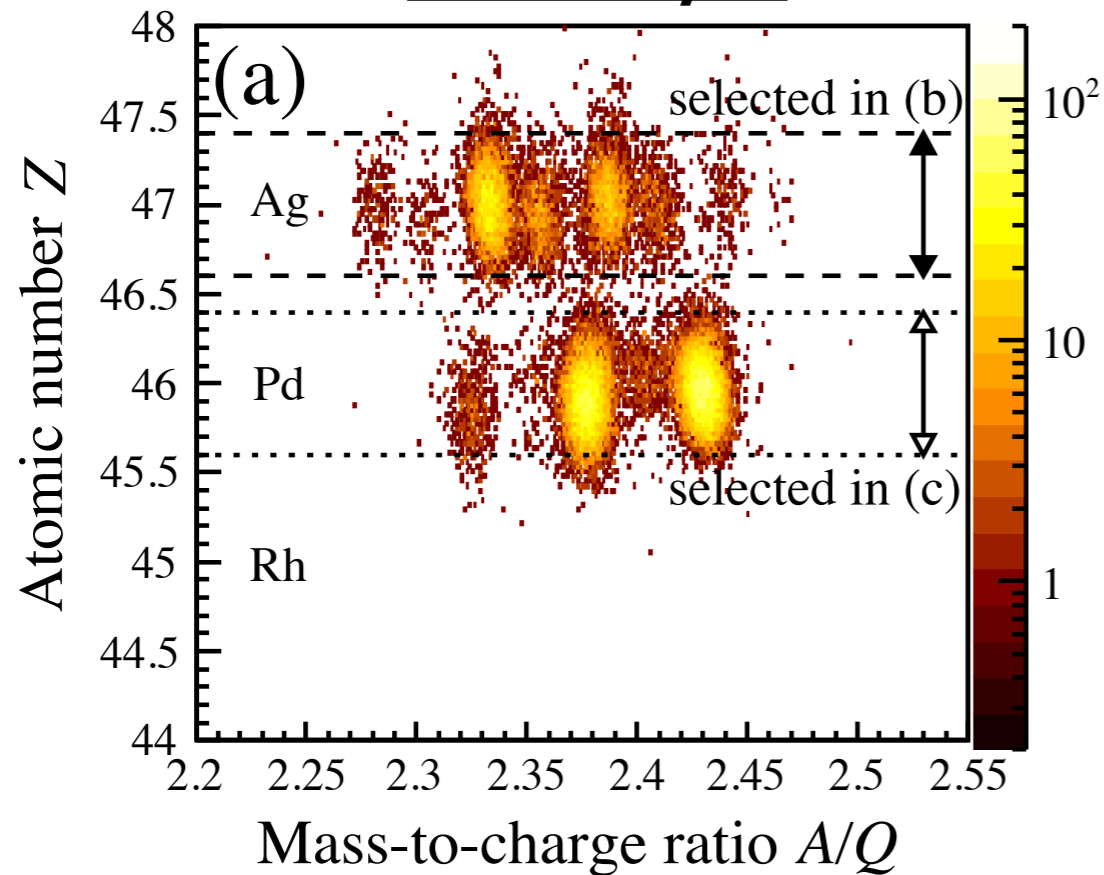
# Reconstruction procedure for PID



# Power of SHARAQ-S1 spectrometer

- $^{107}\text{Pd} + p @ 25 - 30 \text{ MeV/u}$

## Z vs A/Q



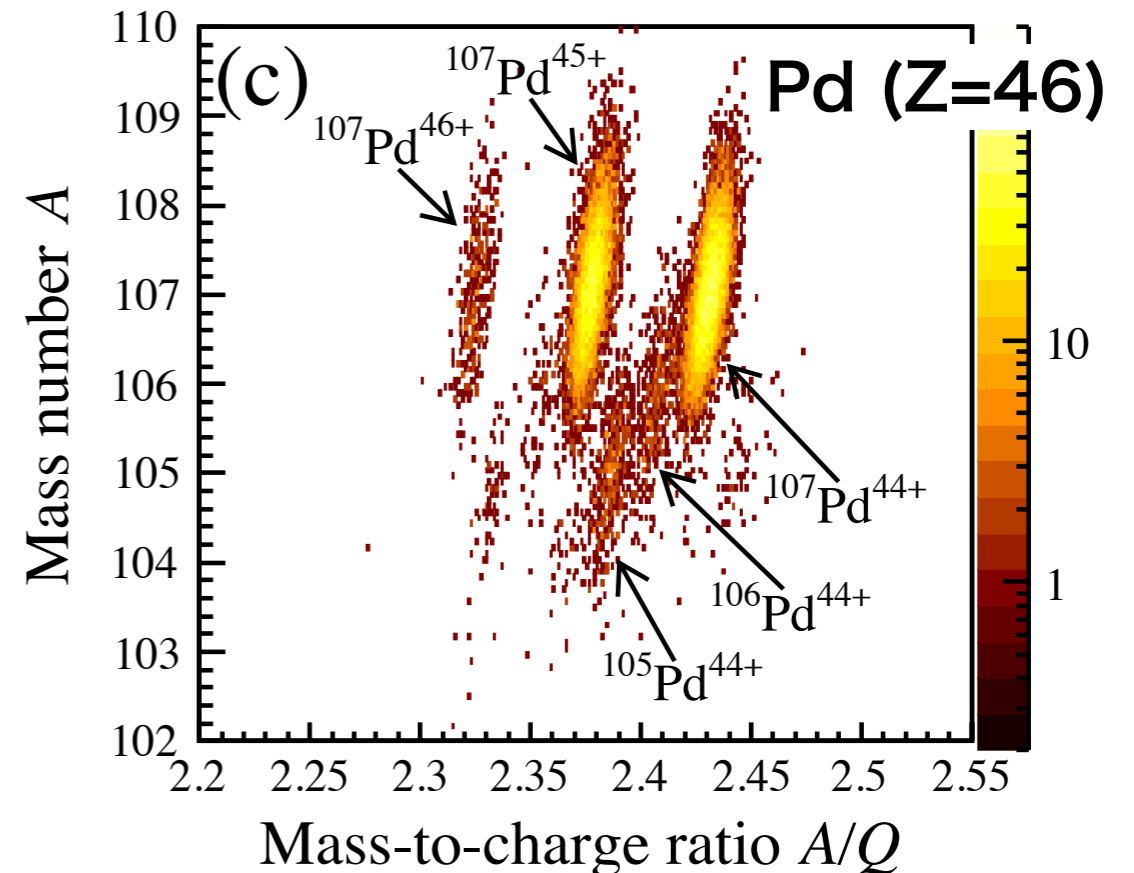
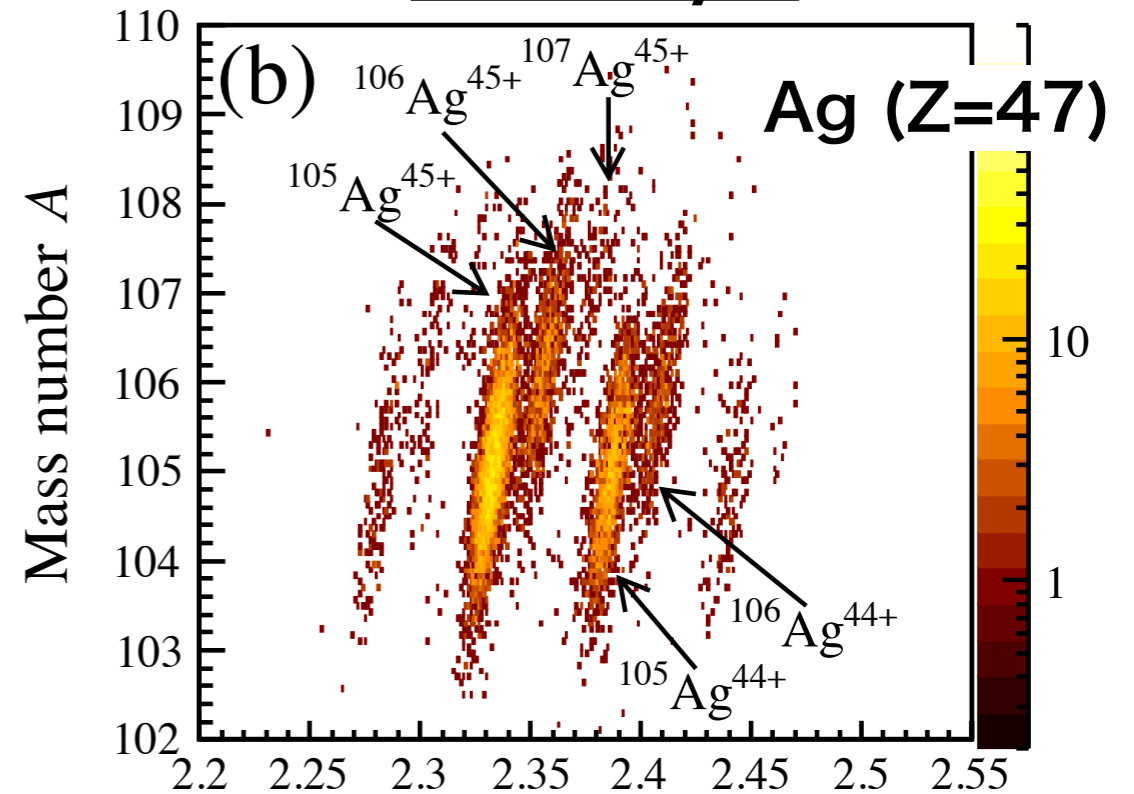
$$\sigma(Z) = 0.17$$

$$\sigma(A/Q) = 5.6 \times 10^{-3}$$

$$\sigma(A) = 0.67$$

→ Good particle separation

## A vs A/Q



# Ion-optical design

- Matrix elements (1st-order)

- $(x|x) = -0.54$ ,  $(x|a) = 0.00$ ,  $(x|\delta) = -1.889$
- $(a|x) = -1.04$ ,  $(a|a) = -1.84$ ,  $(a|\delta) = -0.838$
- $(y|y) = -6.12$ ,  $(y|b) = 0.00$
- $(b|y) = -1.28$ ,  $(b|b) = -0.16$

- Resolving power (for 1mm-image size) : **3490**

- Momentum acceptance :  $\sim \pm 3\%$

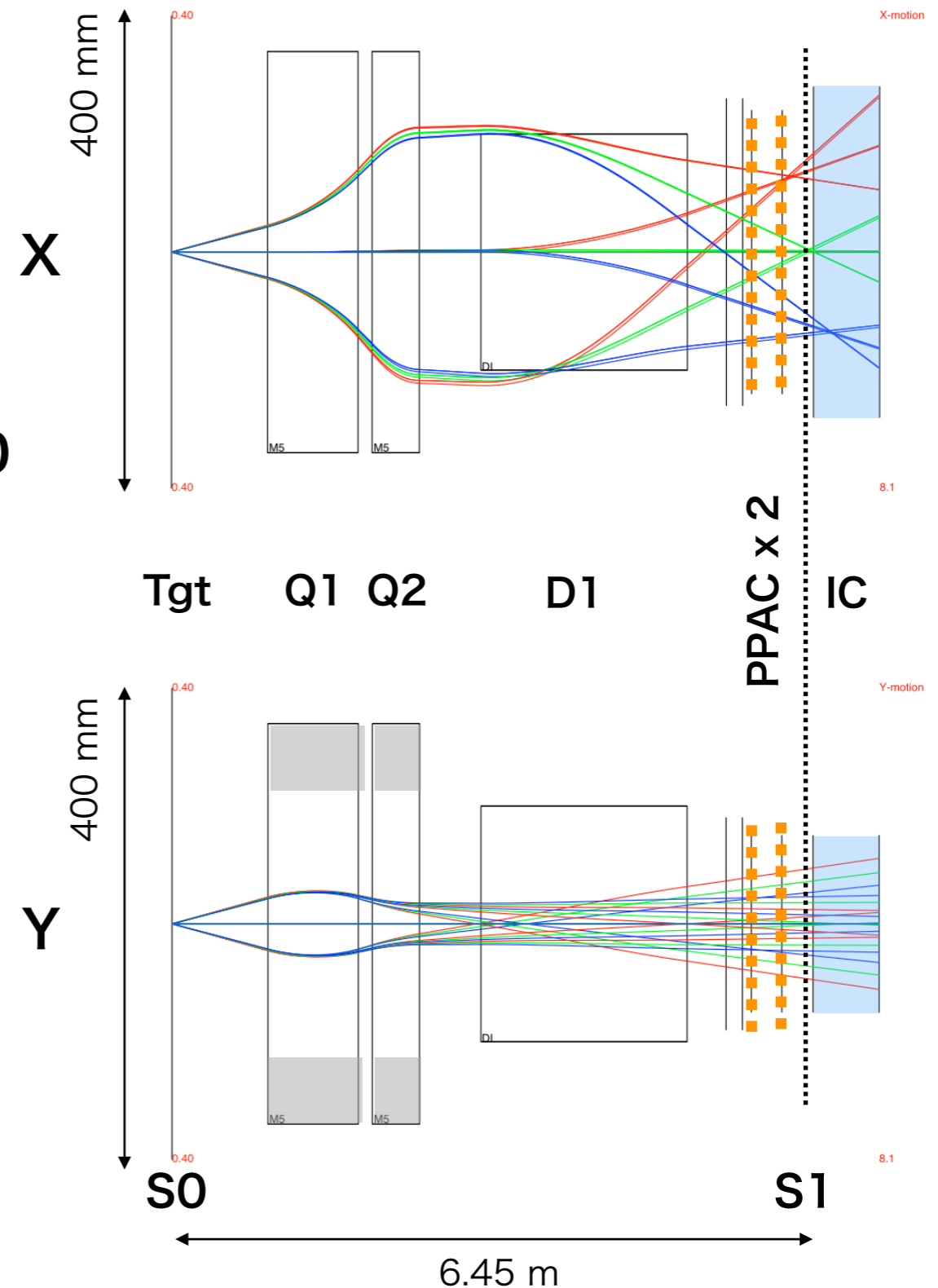
- Limited by detector size

- Horizontal acceptance :  $\sim \pm 30$  mrad

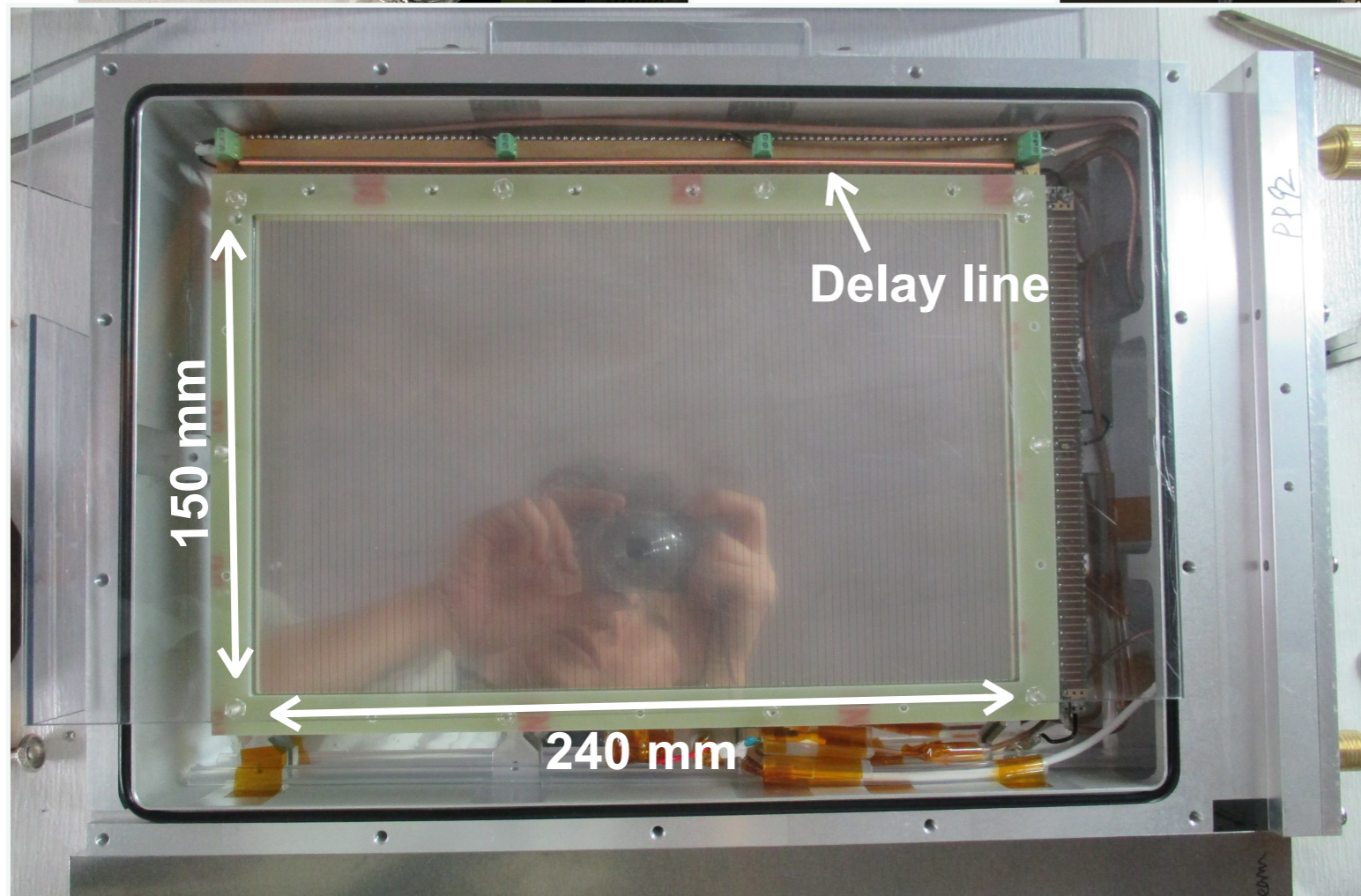
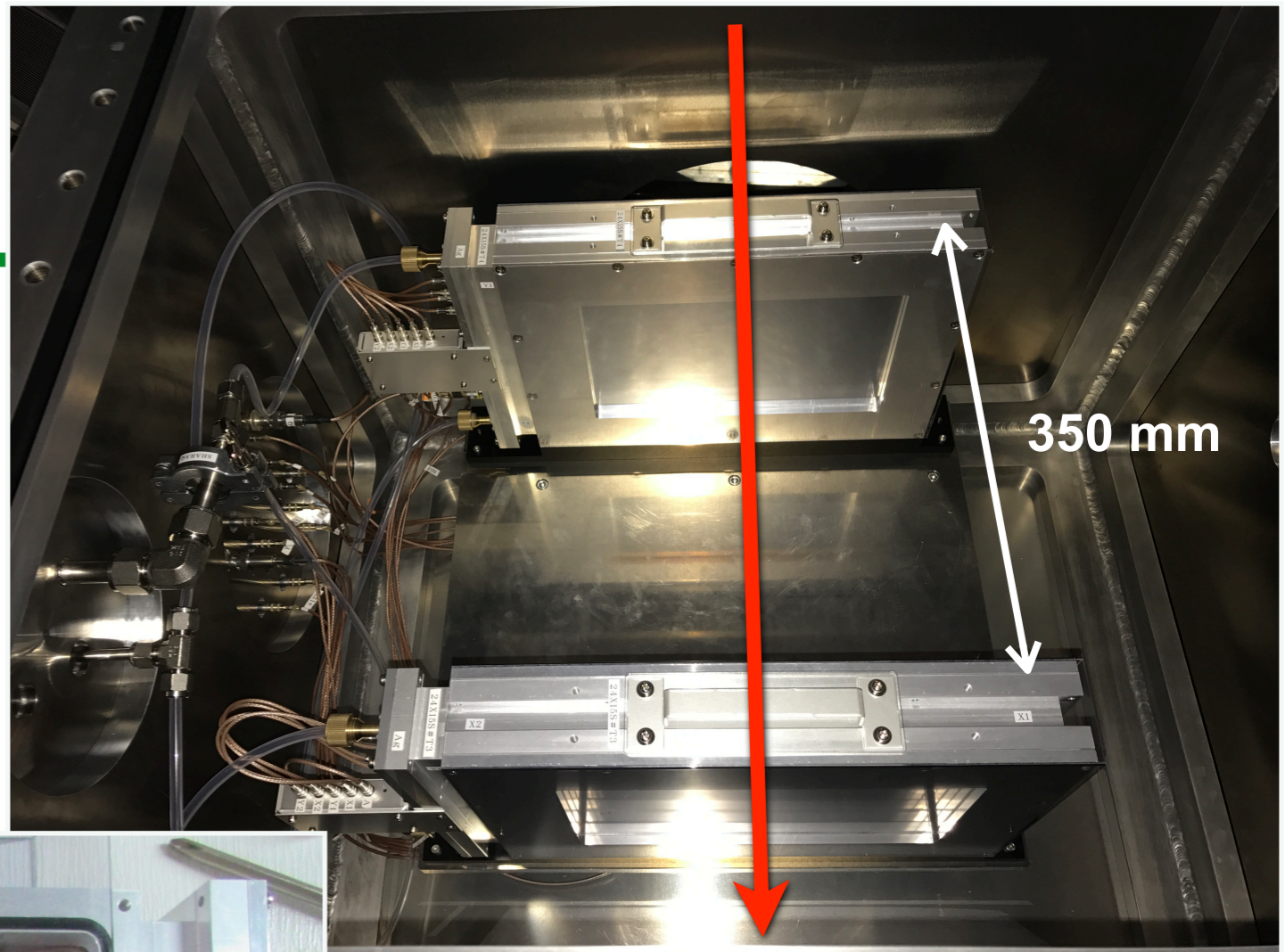
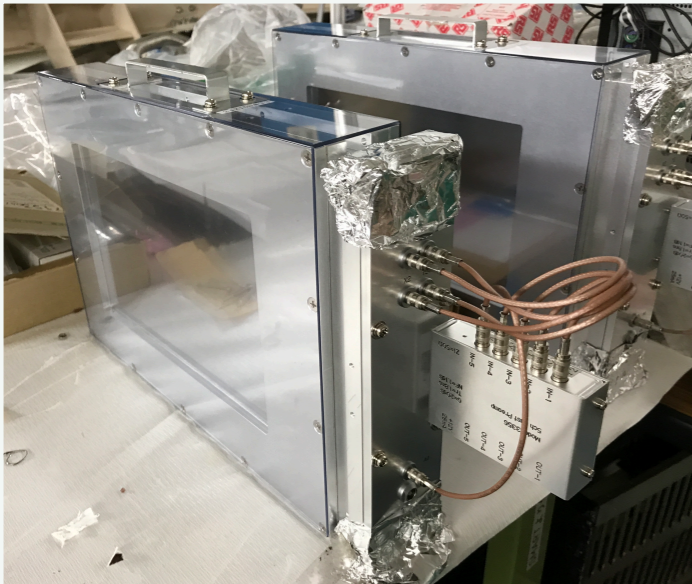
- Vertical acceptance :  $\sim \pm 30$  mrad

## 3rd-order calculation (COSY)

( $a_0 = \pm 20$ mr,  $b_0 = \pm 20$ mr,  $\delta = 0, \pm 3\%$ )



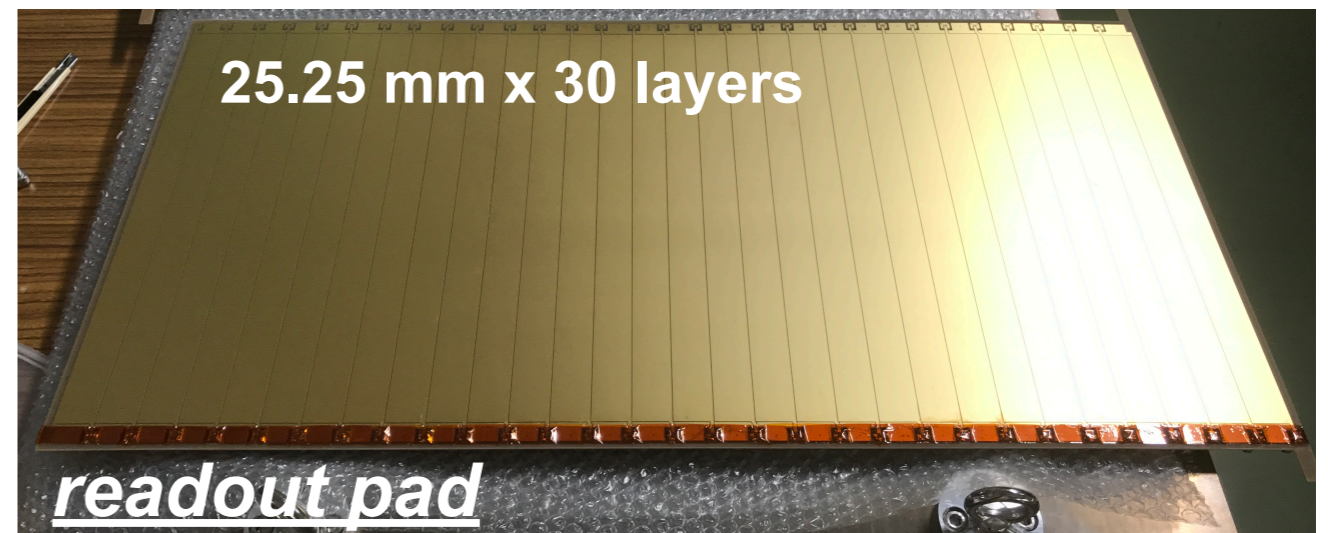
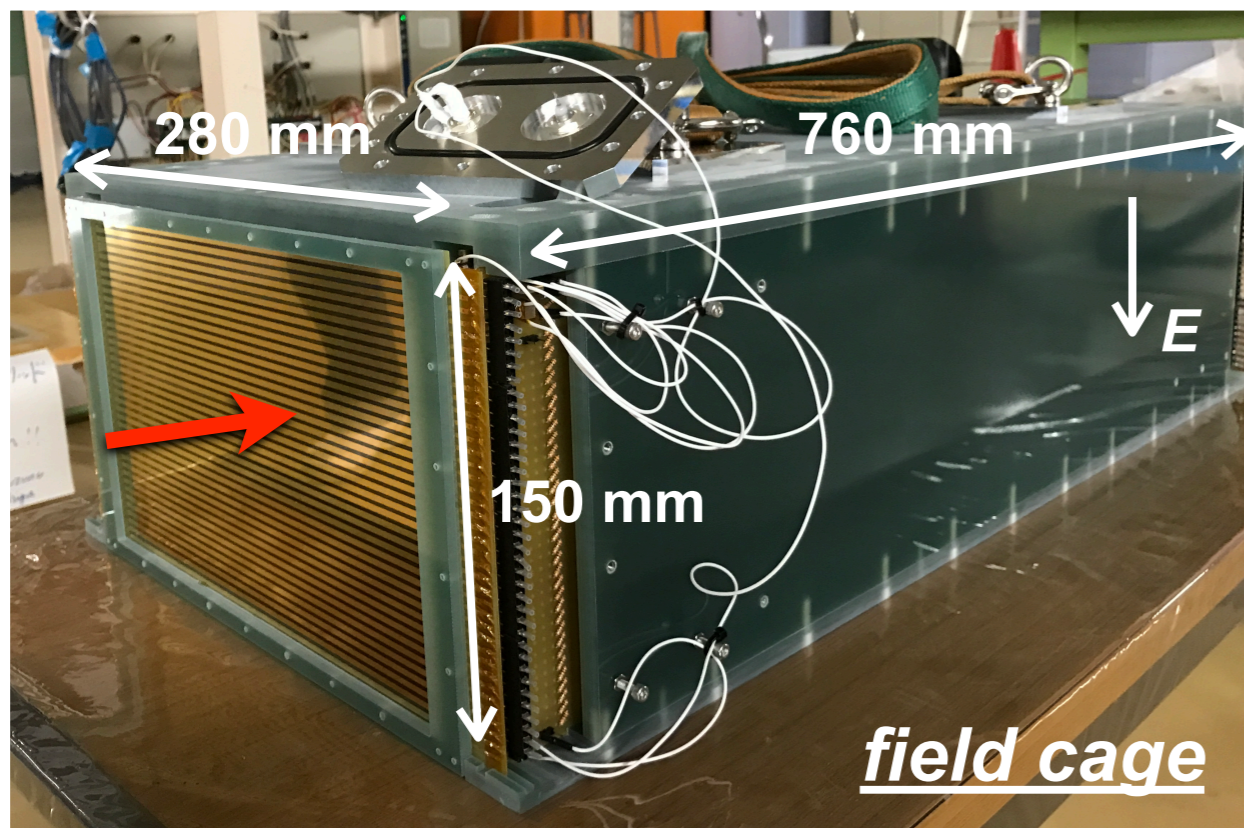
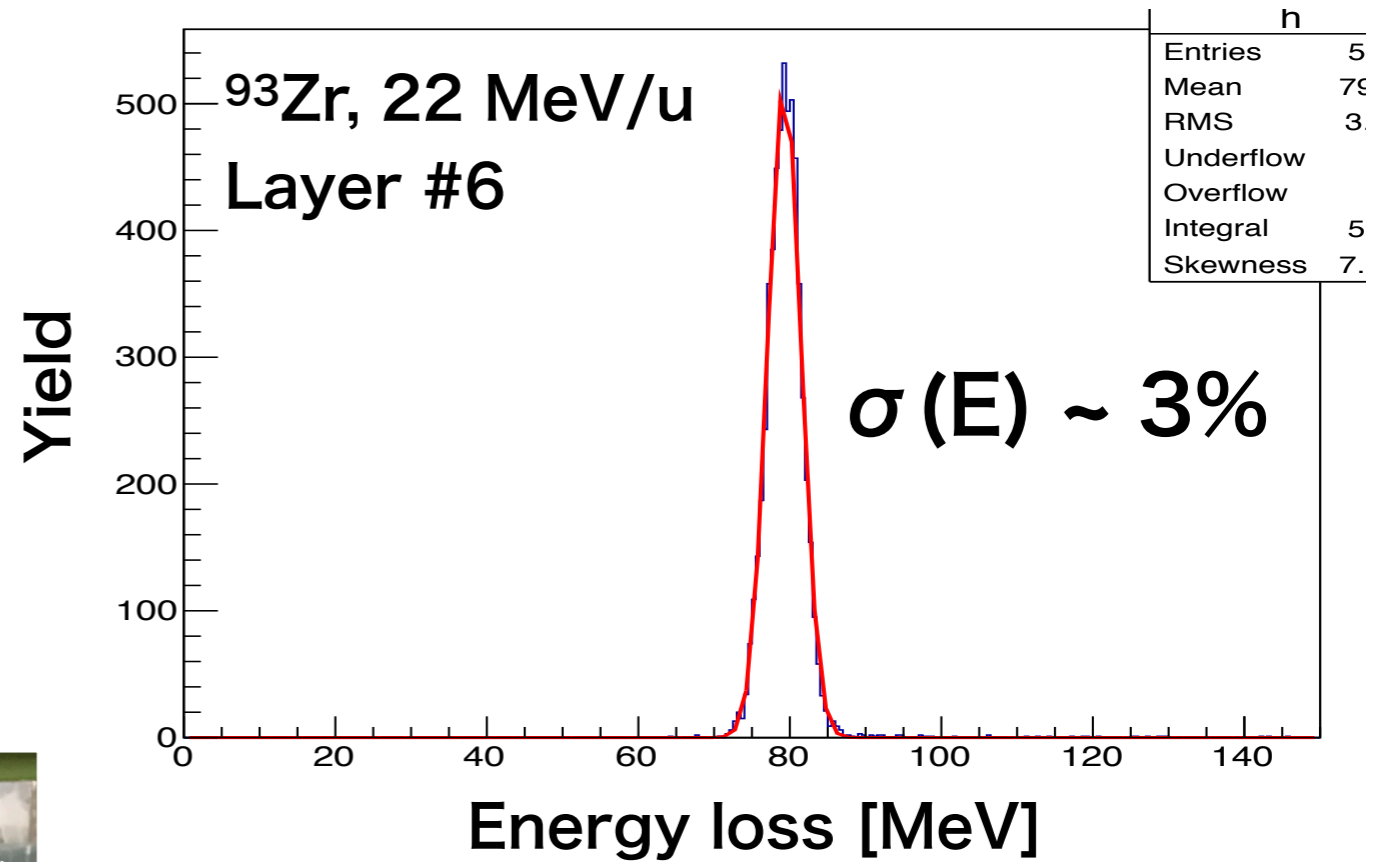
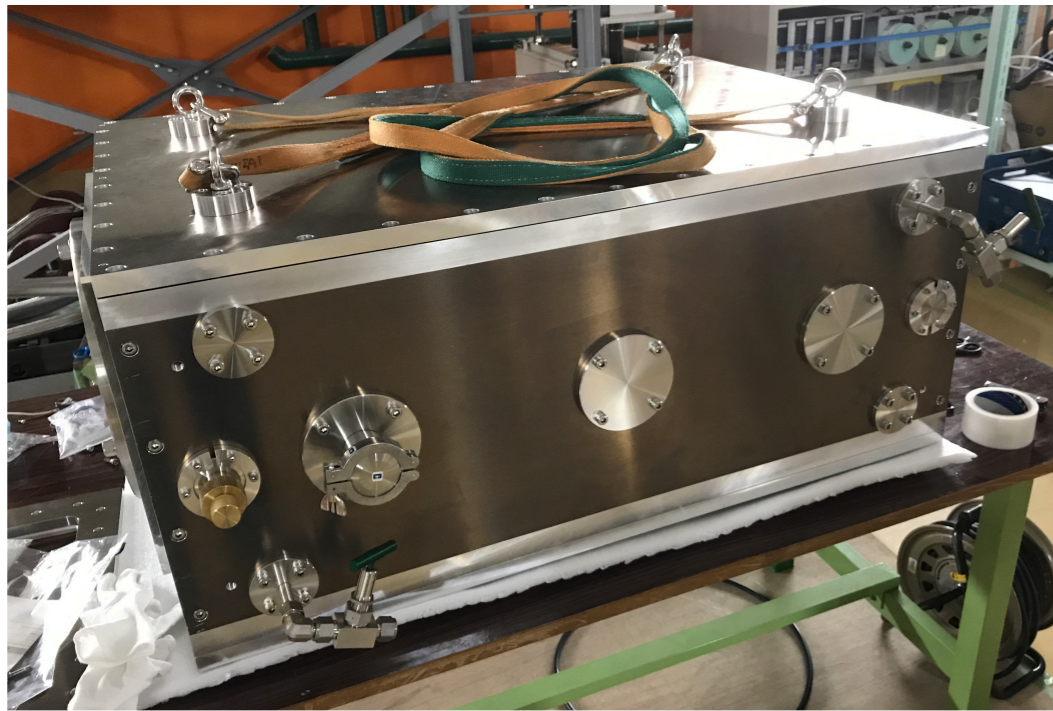
# PPAC



$$\sigma(x) \sim 0.55 \text{ mm}$$

$$\sigma(t) \sim 150 \text{ ps}$$

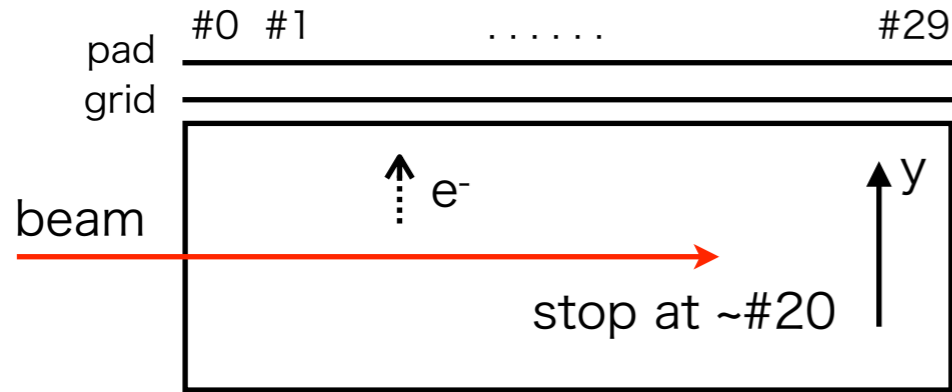
# Ionization chamber





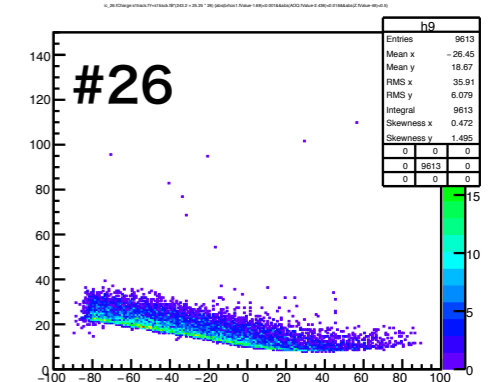
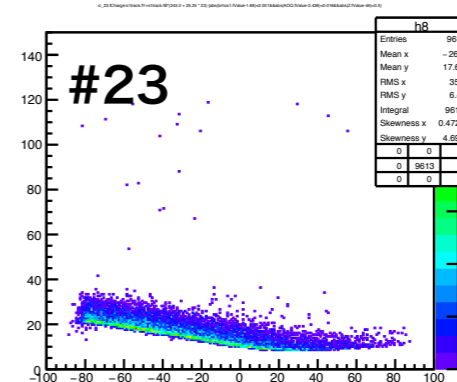
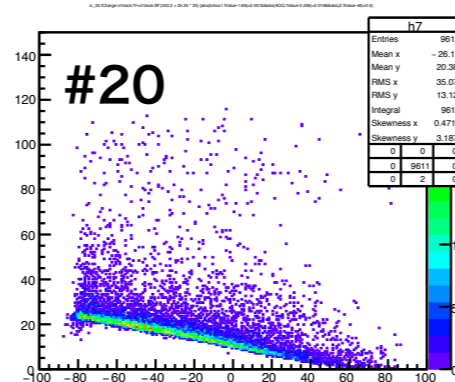
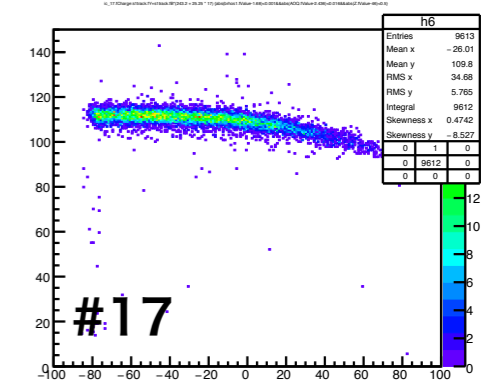
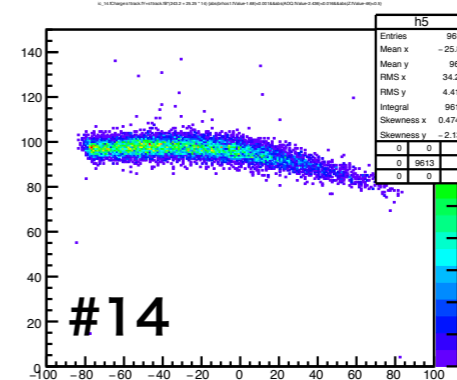
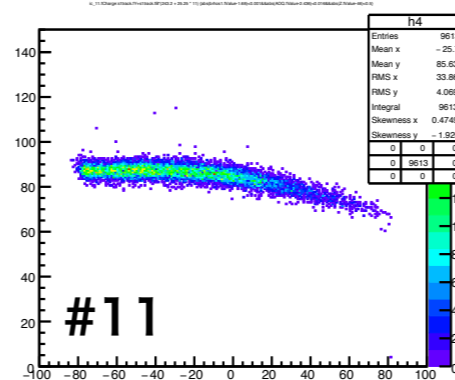
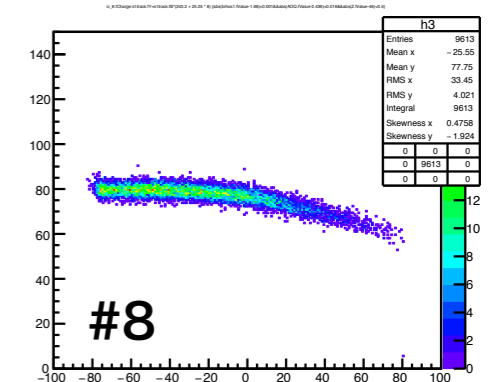
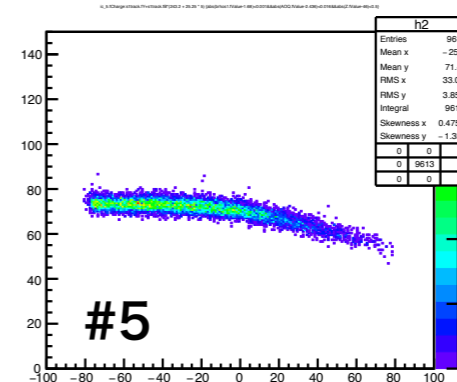
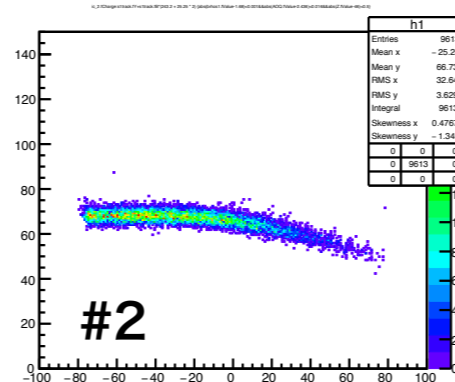
# Effects of Induced charge

## □ Ionization chamber



<sup>107</sup>Pd beam  
Bρ = 1.68 Tm

## Charge vs Y-position



Y-dependence is seen due to the contribution of induced charge.

Correction can be performed phenomenologically, but correction function is very complicated (especially in low charge region)