



Beam Line Detector for SHARAQ

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Requirements for beam-line detectors



- A) Materials as thin as possible (< 1 mrad, $t/L_R \ll 10^{-3}$)
 - $^{12}\text{N}(200\text{A MeV}) + \text{Si } 10\mu\text{m}$ ($t/L_R = 10^{-4}$)
 $\theta_{\text{rms}} = 0.1$ mrad, $\sigma(\Delta E) = 120$ keV @ $\Delta E = 400$ keV
 - i-C₄H₁₀ ($L_R = 169.3$ m @ 1 atm) 10-20 kPa x 6 cm: $t/L_R \sim 10^{-4}$
 - Mylar ($L_R = 29$ cm) 3 μm : $t/L_R \sim 10^{-5}$
- B) Counting rate ~ 1 MHz
- C) Easy treatment of circuits (# of channels)
- D) As large efficiency as possible
- E) Position resolution $\sim 300 \mu\text{m}$ (FWHM)

D), E) $\rightarrow$ Difficult by PPAC? $\rightarrow$ Wire chamber

Prototypes in Developments

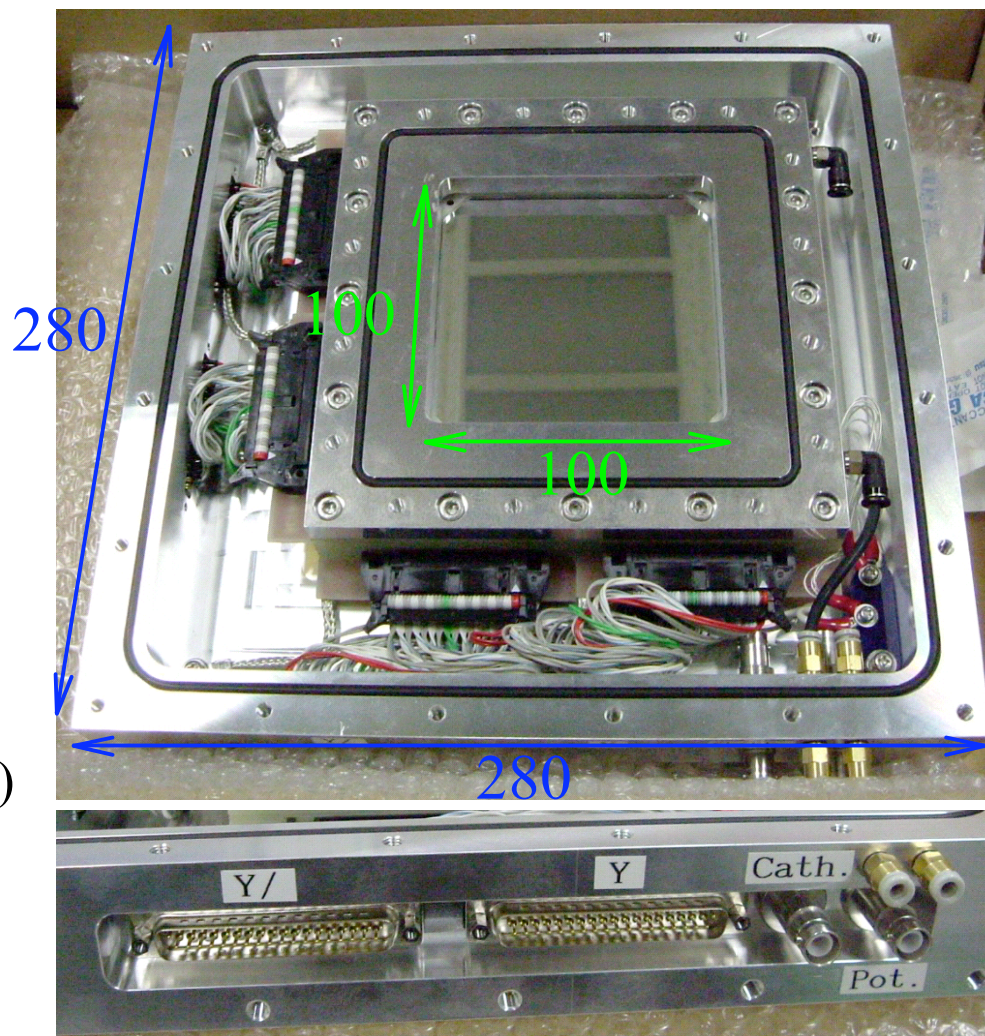


- Low-pressure MWDC
 - To be operated with 10-20 kPa $i\text{-C}_4\text{H}_{10}$
- Low-pressure MWDC with stripped cathode & delay-line readout
 - Hybrid readout
 - Anode: same as Low-pressure MWDC
 - Cathode: delay-line readout, 4 channels
- Electronics
 - Preamp+discri. card: REPIC RPA-130 (128-ch LVDS output)
 - Multi-hit TDC: CAEN V1190A (128 ch) or V1190B (64 ch)

Low-pressure MWDC (SDC1, SDC2, SDC6)



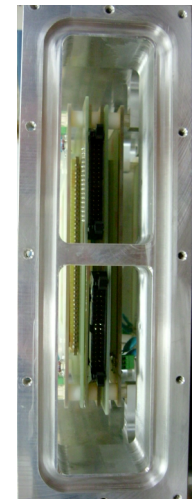
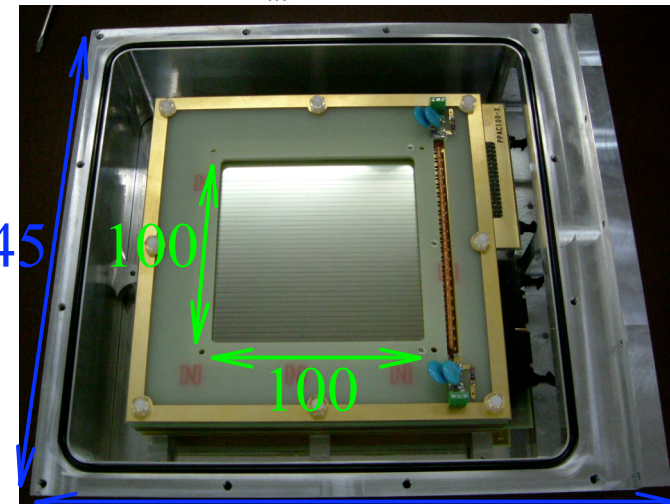
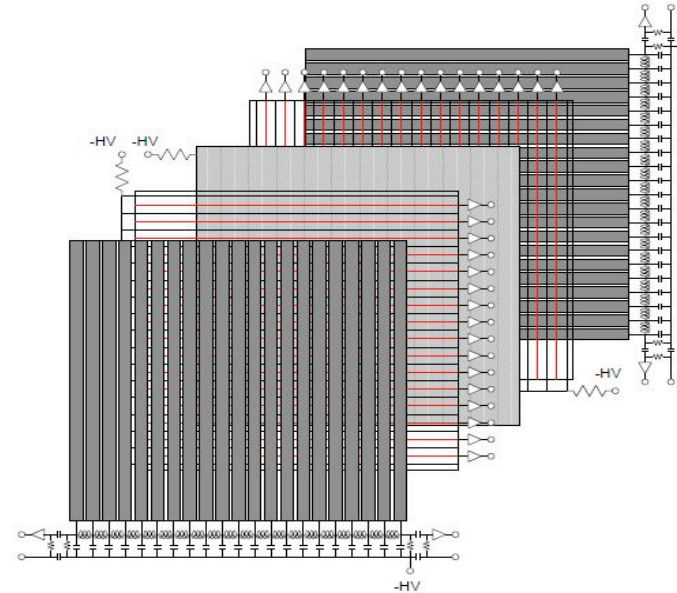
- Thickness of each layer
 - Window: $12\ \mu\text{m}$
 - Cathode: $2.2\ \mu\text{m}$
 - Anode wire: $12.5\ \mu\text{m}$
 - Total: $t/L_R \sim \text{a few} \times 10^{-4}$
- Size: $100 \times 100\ \text{mm}^2$
- Anode-cathode gap: $2.4\ \text{mm}$
- Anode readout
 - 16 wires $\times$ 8 layers = 128 channels
- Gas: $i\text{-C}_4\text{H}_{10}$ 10-20 kPa (to be tested)
- Position resolutions: $< 0.3\ \text{mm}$ (FWHM)
for $Z=2$ @ 200-300 A MeV



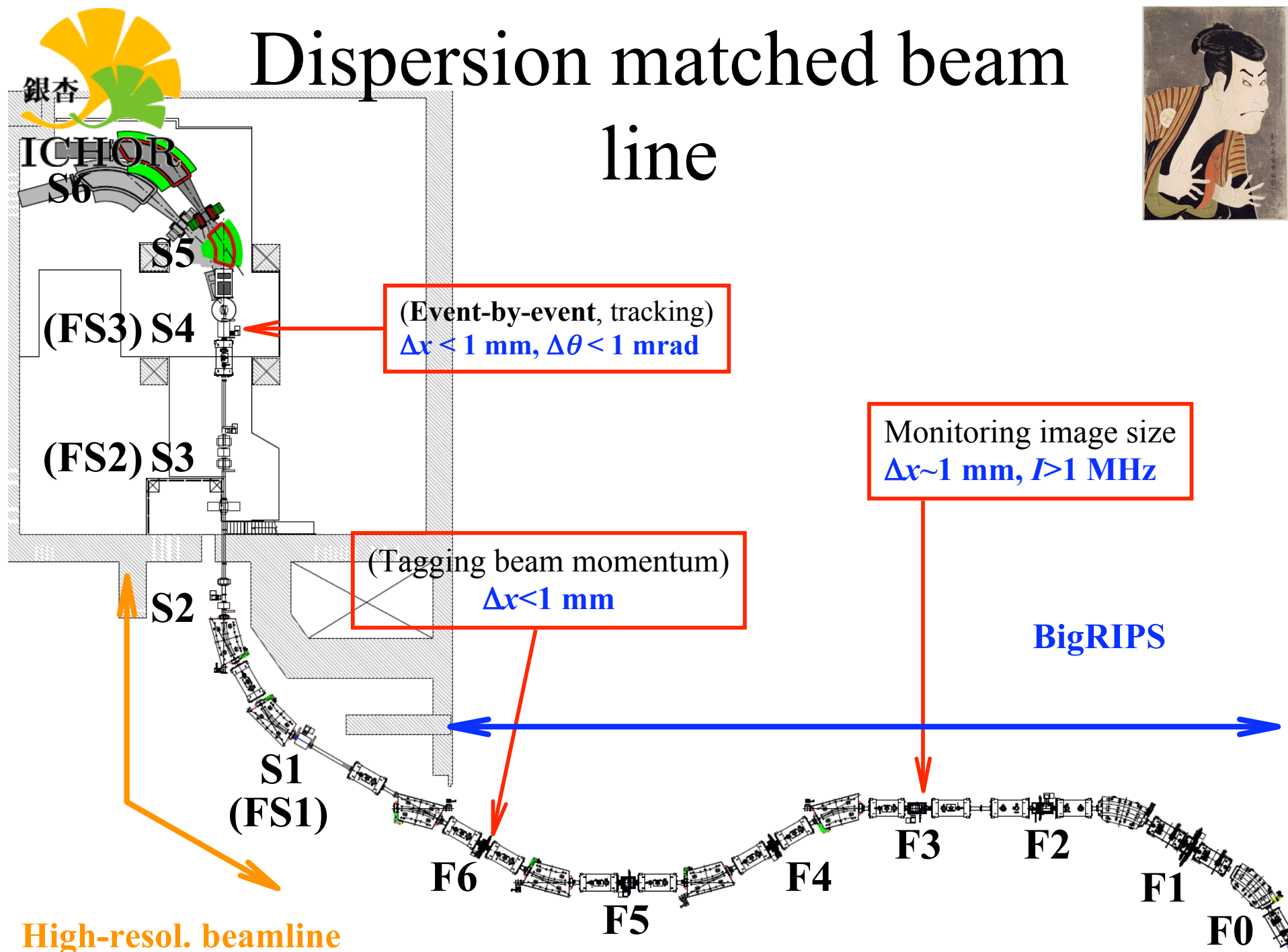
Low-pressure MWDC with stripped cathode & DL-readout (SDC9)



- Thickness of each layer
 - Window: Al-mylar $12\ \mu\text{m} \times 2$
 - Cathode: $1.5\ \mu\text{m} \times 2$ (X & Y)
 - Cathode foil: Al-mylar $1.5\ \mu\text{m}$
 - Anode wire: $20\ \mu\text{m} \times 2$ (X & Y)
 - Total: $t/L_R \sim \text{a few} \times 10^{-4}$
- Cathode readout
 - Delay-line readout + multi-hit TDC
- Anode readout
 - ~ 50 wires/plane $\times 2$ planes $\times 2$ -4 detectors
 $= \sim 200$ -400 channels
 (Prototype: 16 wires/plane $\times 2$ planes = 32 channels)
- Gas: $i\text{-C}_4\text{H}_{10}$ or C_3F_8 10-20 kPa (to be tested)
- Position resolutions
 - Cathode: $< 1\ \text{mm}$ (FWHM) for $Z=2$
 - Anode: $< 0.3\ \text{mm}$ (FWHM) for $Z=2$



Dispersion matched beam line



Beam-line optics

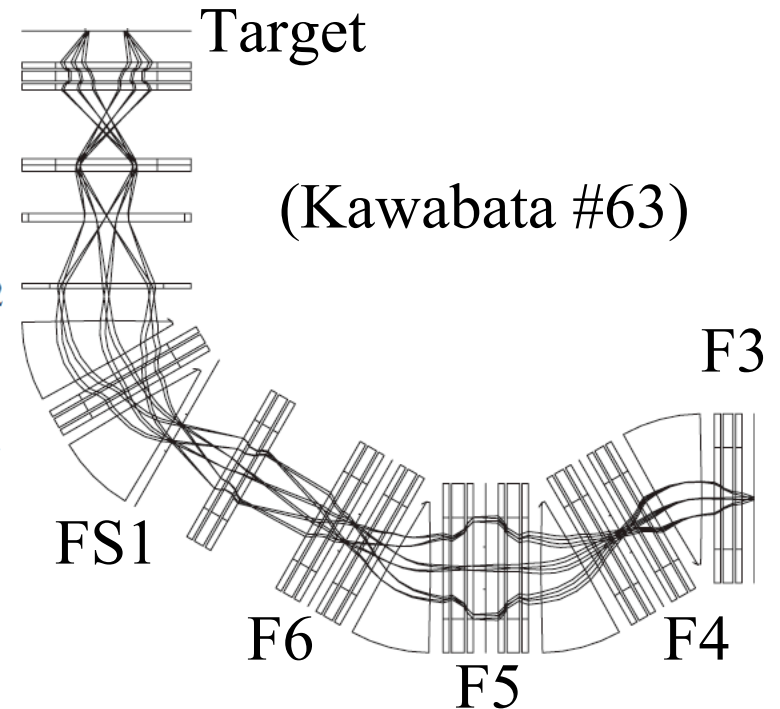
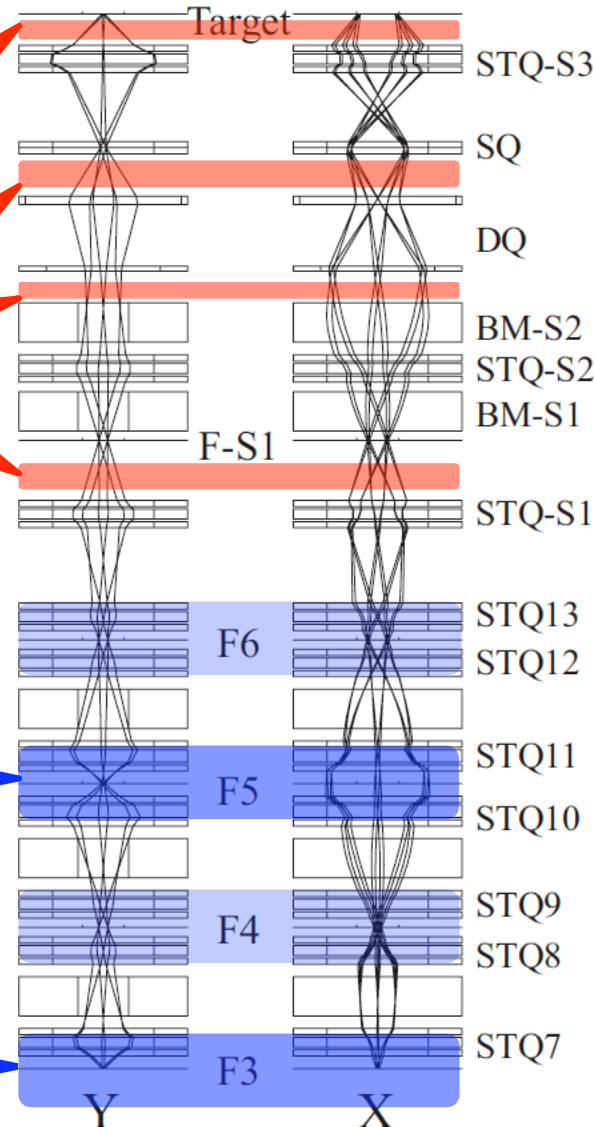


Event-by-event
beam tracking
Tuning + Actual DAQ

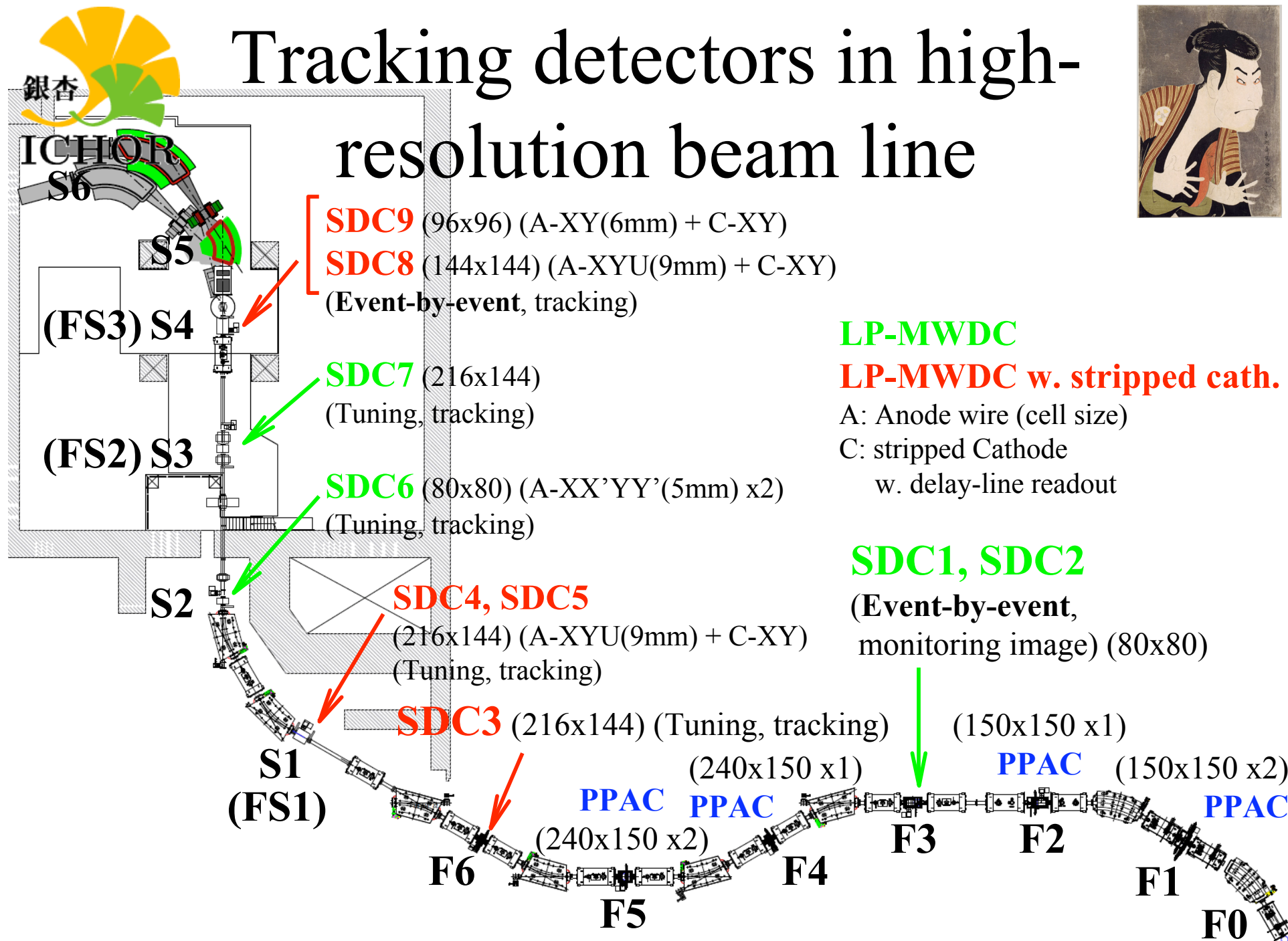
Tune Focus at SQ
Tracking is needed
Tuning only

Parallel for X
Tracking is needed
Tuning only

Standard tuning
event-by-event
monitoring of image



Tracking detectors in high-resolution beam line



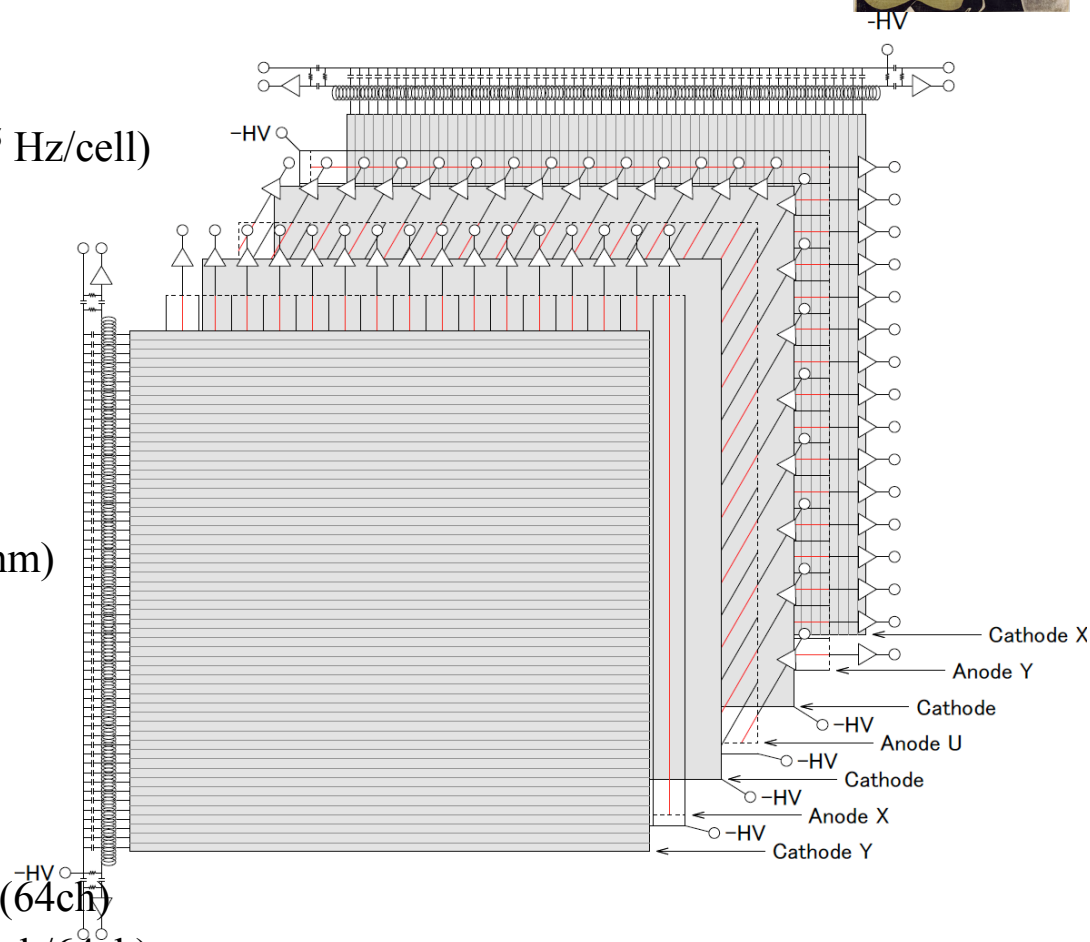


ICHOR

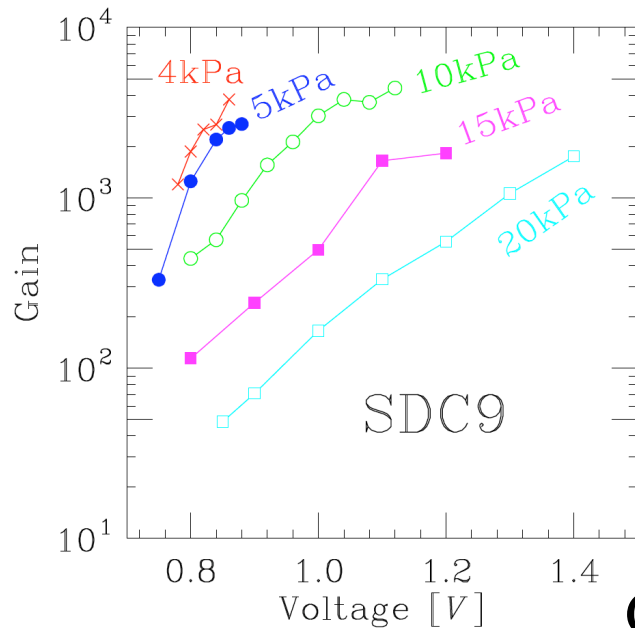
SDC4, SDC5, and SDC8



- Total thickness
 - $t/L_R < \text{a few} \times 10^{-4}$
- Counting rate
 - $\sim 1 \text{ MHz}$ for dispersive transport (10^{4-5} Hz/cell)
- Anode
 - Sense wire: Au-W $12.5 \mu\text{m}^\phi$
 - Field wire: Cu-W $75 \mu\text{m}^\phi$
 - X, Y, & U (30-deg. to X)
- Cathode
 - Thickness: $1.5 \mu\text{m}$
 - **Stripped cathodes: X & Y** ($w=2.58 \text{ mm}$)
 - **Delay-line readout**
(H. Kumagai et al., NIMA470(2001)562.)
- Gas: **i-C₄H₁₀** at $< 20 \text{ kPa}$
- Window: Al-mylar $12 \mu\text{m}$
- Electronics
 - REPIC RPA-130 preamp+discri. card (64ch)
 - CAEN V1190A/B multi-hit TDC (128ch/64ch)

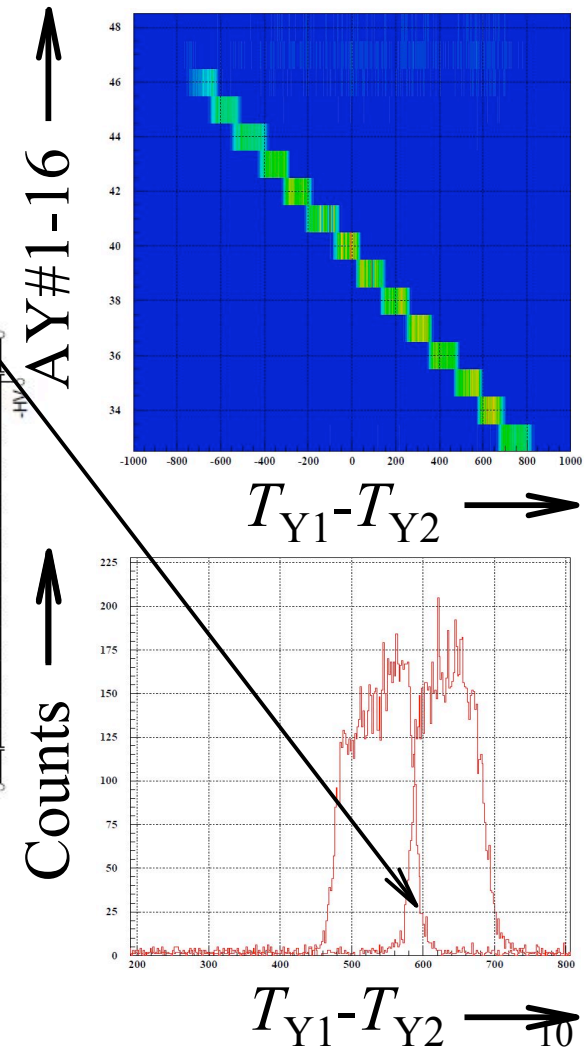
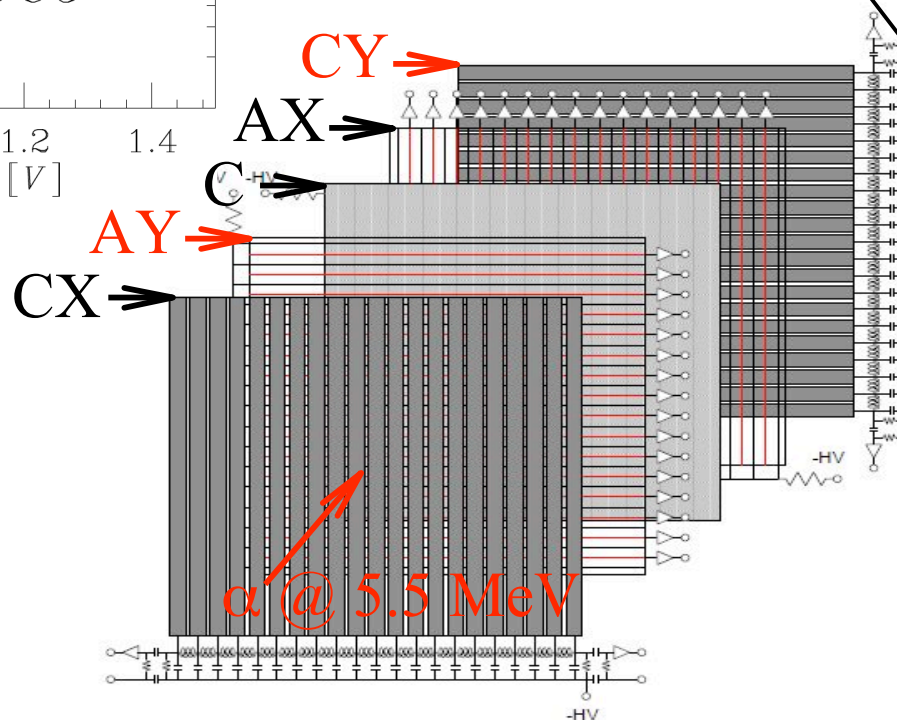


Test of SDC9 using α -source



Position resolution:
~1mm (FWHM)
including multiple scat.
(deduced from overlap)

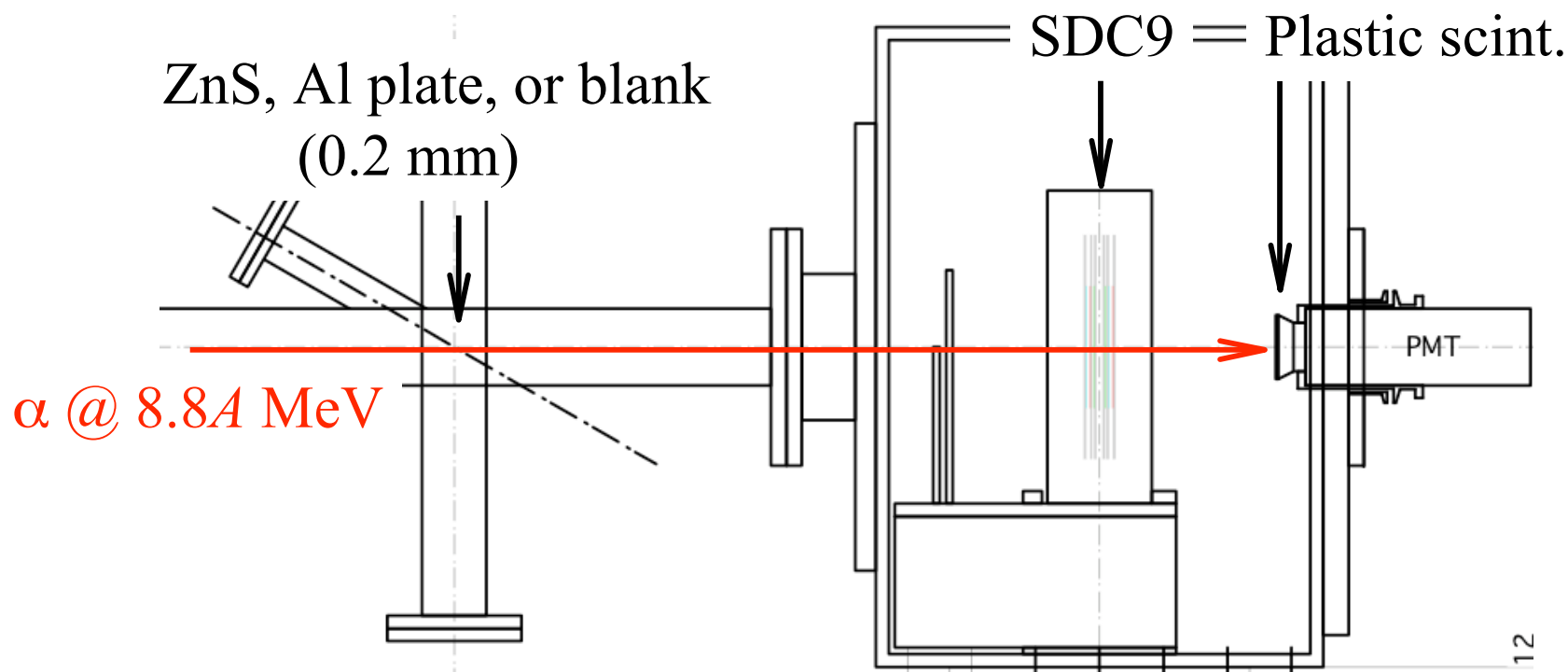
Gas gain



Performance of SDC9



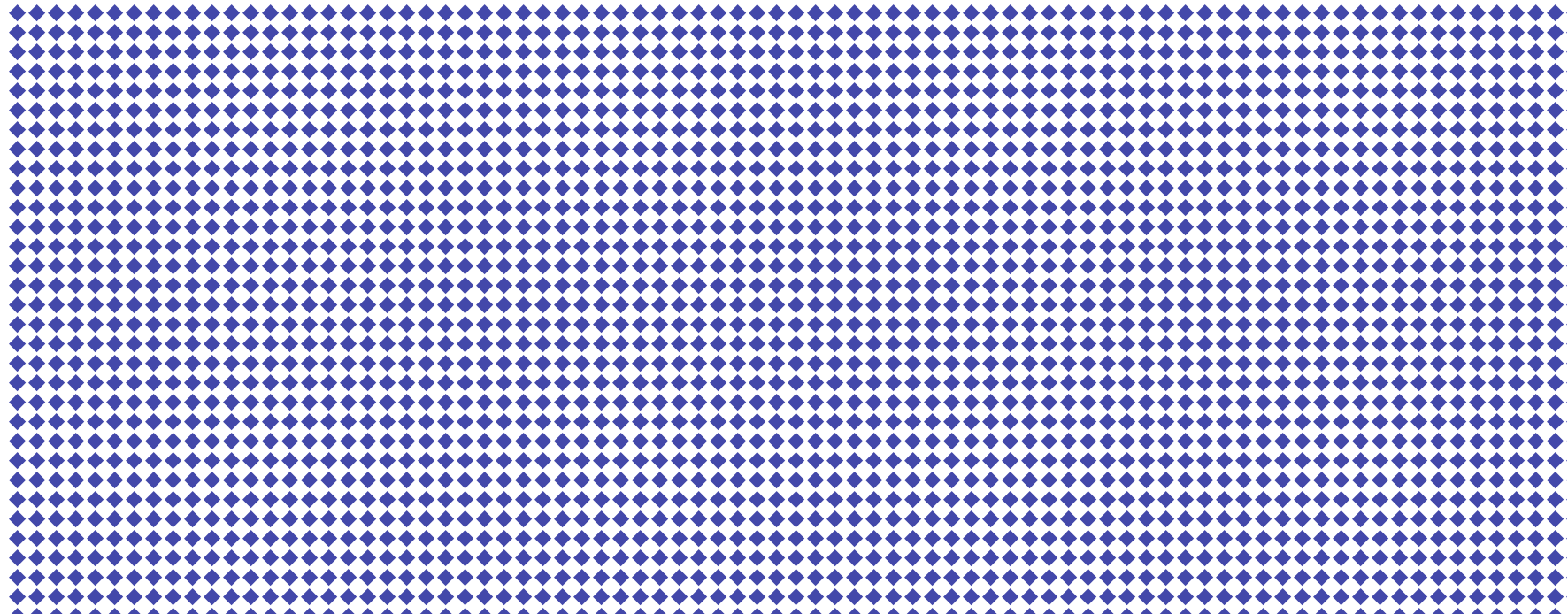
- Test experiment using α @ 8.8A MeV beam from RIKEN AVF cyclotron
DD07-02: Mar. 14 9:00 - 17 17:00 (running now)



Performance of SDC9



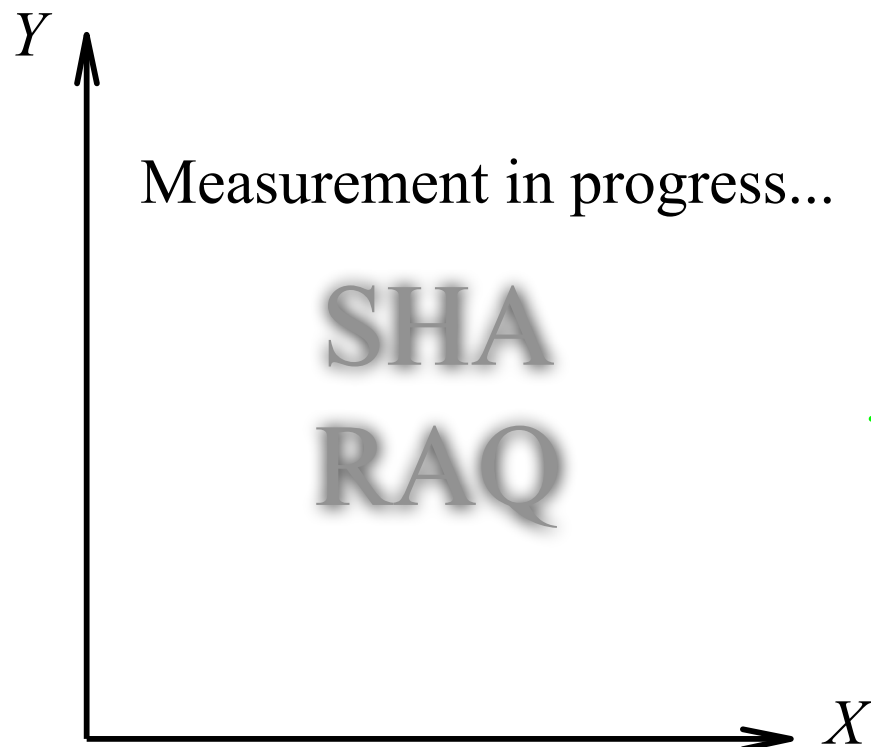
- Test experiment using α @ 8.84 MeV beam from RIKEN AVF cyclotron
 - Efficiencies of **stripped cathode** & **anode wires** available region of HV is limited.



Performance of SDC9



- Test experiment using α @ 8.84 MeV beam from RIKEN AVF cyclotron
 - Looking at “SHARAQ” with LP-MWDC



Summary



- Requirements for beam line detectors
- Low-pressure Multi-wire drift chambers
 - Specifications
 - LP-MWDC with stripped cathodes & Delay-line readout
- Performance of SDC9
 - Checked with α source and α beam from RIKEN AVF
 - Further analysis to deduce correct pos. information
 - Efficiencies for α @ 8.8A MeV
 - Further analyses to deduce gas gain & pos. resol.