



Belle CDC

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- Introduction of Belle CDC
 - Performance
 - Current Operation Condition
 - Future Plan
 - Summary
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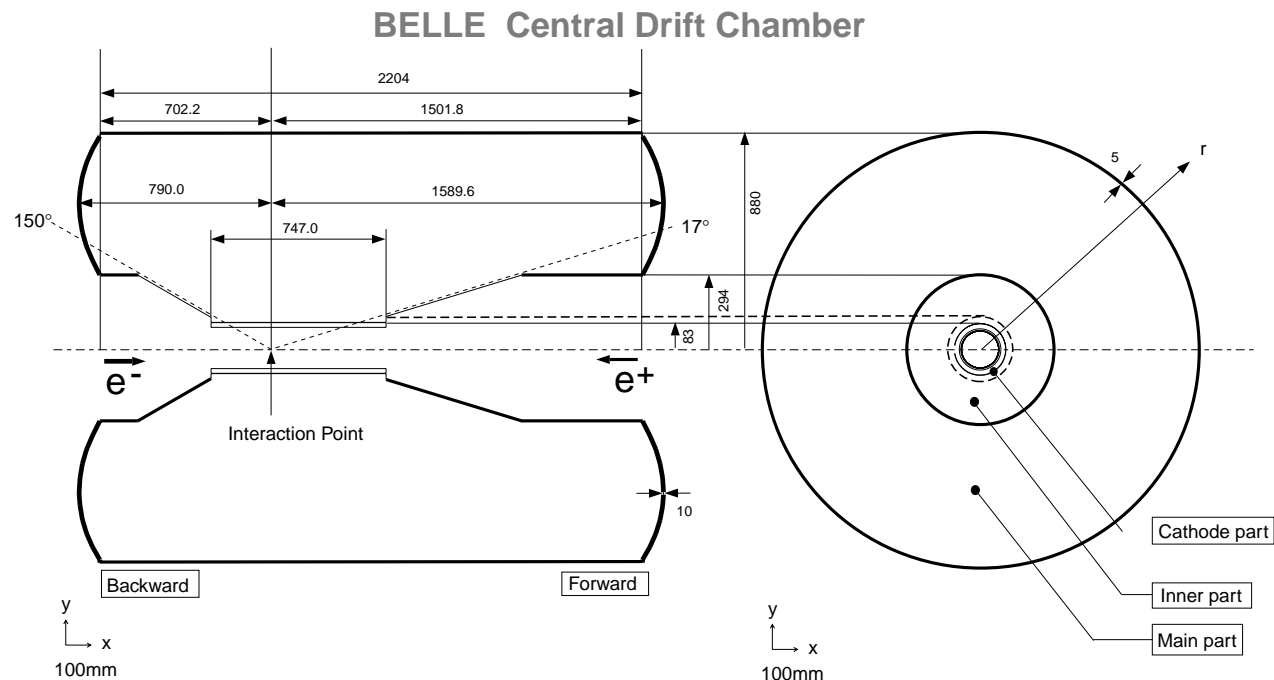
Structure

- Belle CDC consists of **three parts**(Main, Inner and Cathode).
- **Curved Aluminum enplates** for the main part.
 - Thickness : 10mm^t
- **Conical endplates** for the inner part to give a space for accelerator components.

- 5mm^t CRFP outer cylinder to support whole tension.

- Two thin CFRP cylinder for cathode readout.

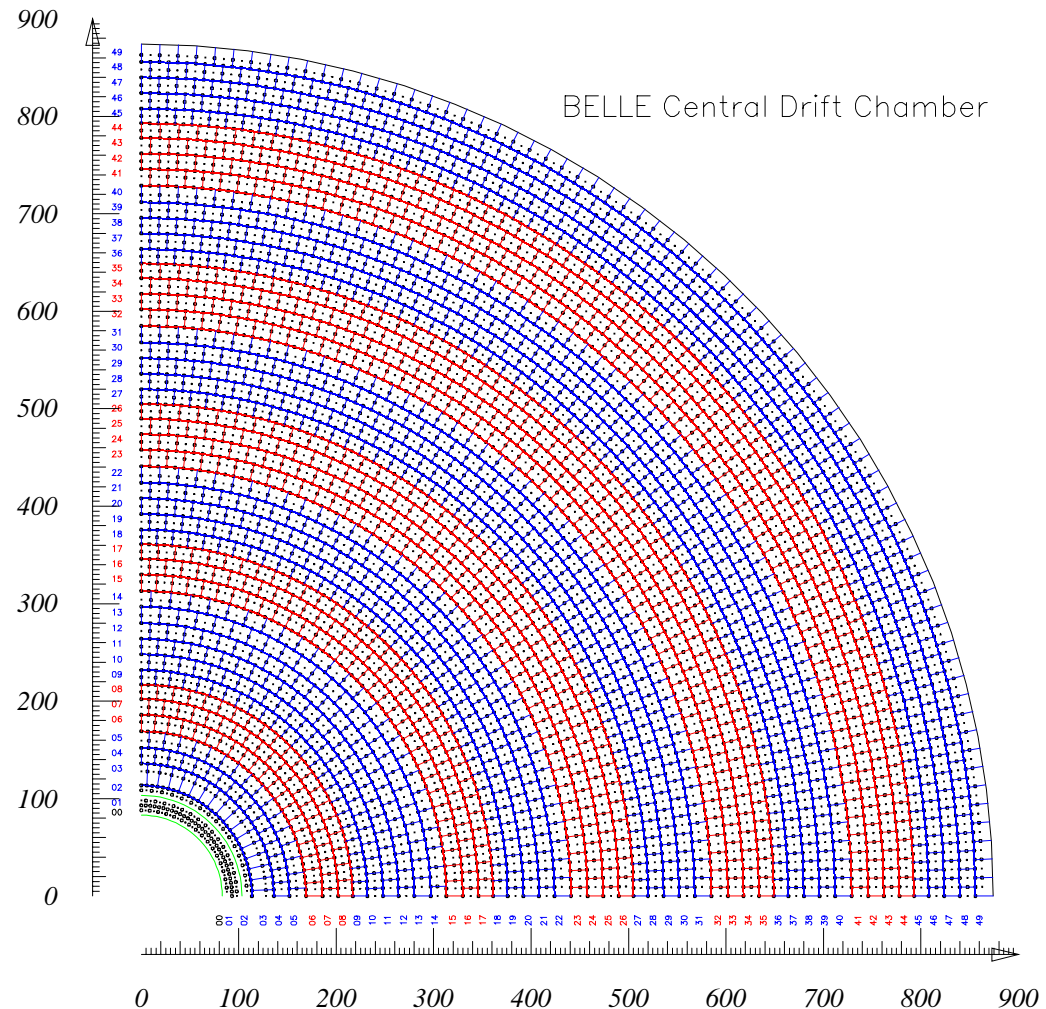
0.4mm^t x 2





Wire Configuration

- Active region
 - $R=88\text{mm}$: inner most sense wire
 - $R=863\text{mm}$: outer most sense wire
- Wires
 - $30\mu\text{m}\phi$ Au-W for sense wire
 - $126\mu\text{m}\phi$ Al for field wire
- Square cells
 - $16\text{mm}(r)\times\sim 18\text{mm}(r\phi)$
- 6(axial)+5(stereo) super layers
 - 50 layers in total
- Readout channels
 - 8400 for sense wires
 - 1792 for cathode strips





Chamber Gas

■ He(50%)-C₂H₆(50%)

- Longer radiation length(680m).
- Drift velocity is higher than other He-based gas.
 - Average drift velocity : ~3.3cm/μsec in the chamber cell.
 - Maximum drift time : ~400nsec for 18mm cell size.
- Good dE/dx resolution.

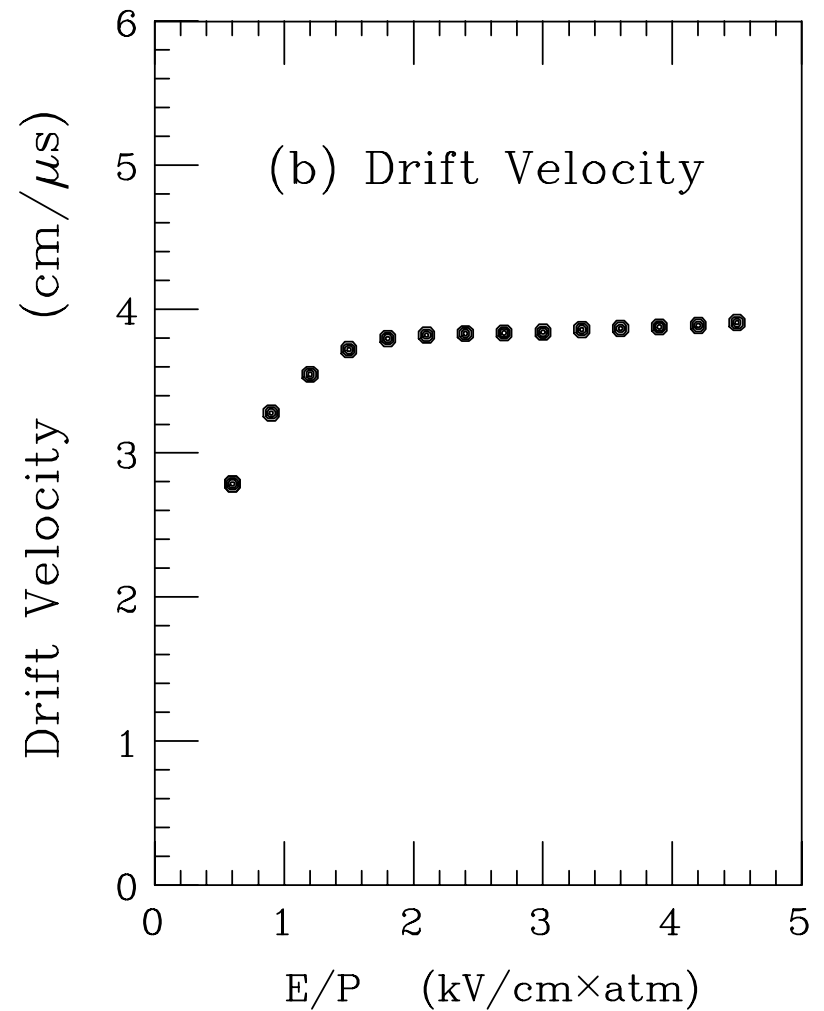
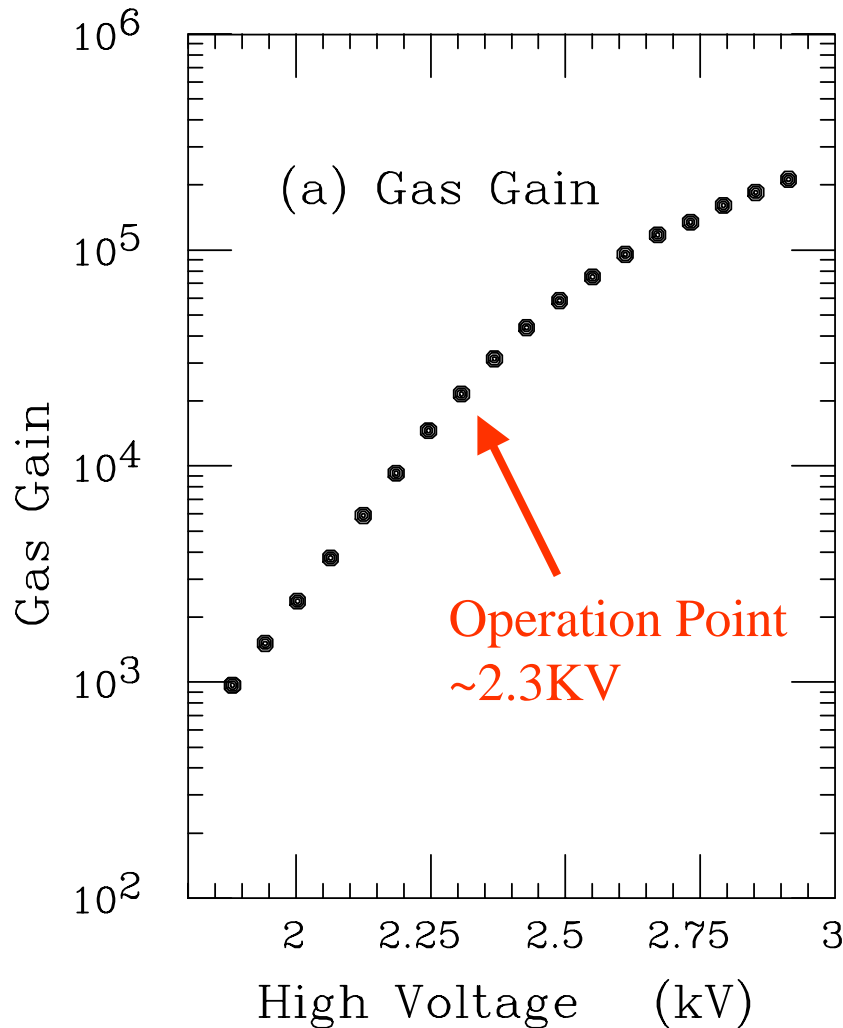
■ Gas system

- Gas circulation(Flow rate : 3.0 liter/min).
- Fresh gas(Input flow rate : 0.3 liter/min).
- Keeping an absolute pressure constant.
- O₂ contamination ~50ppm (with O₂ filter)
- H₂O contamination ~500ppm (no control)



Gas Gain and Drift Velocity

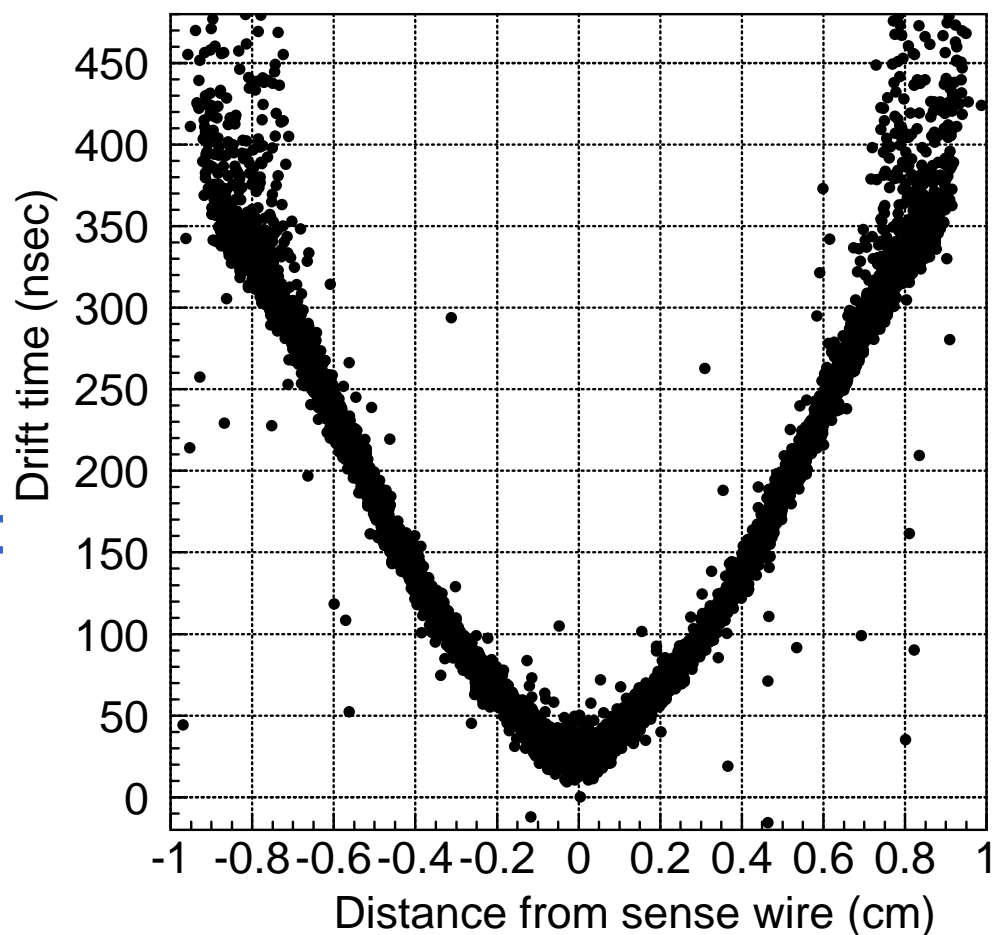
He-C₂H₆(50/50)





X-T Curve

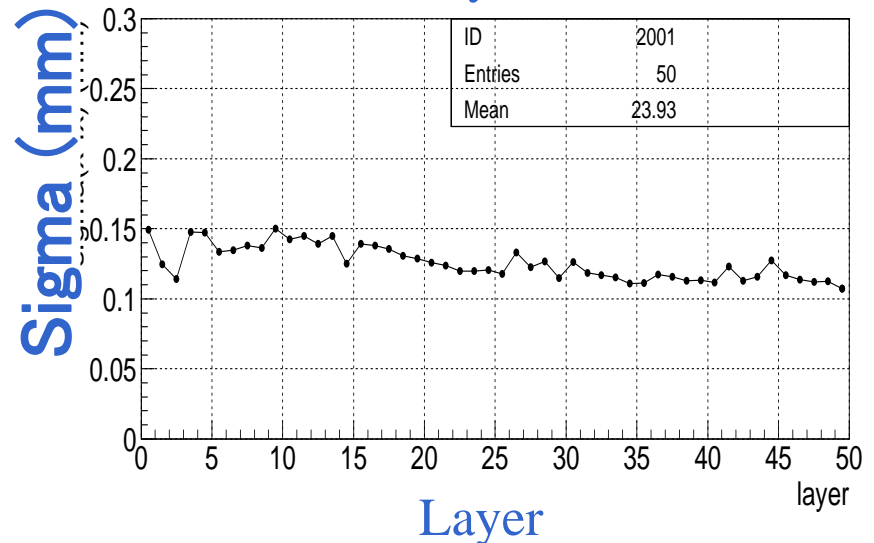
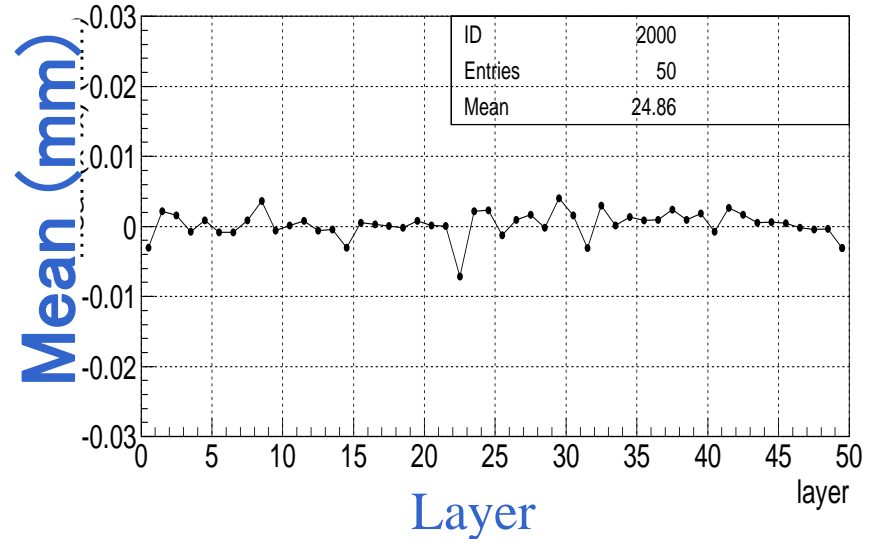
- He(50%)-C₂H₆(50%)
- B=1.5Tesla
- HV : 2.3KV
- Cell Size:18mm
- Maximum Drift Time :
~400nsec





Spatial Resolution

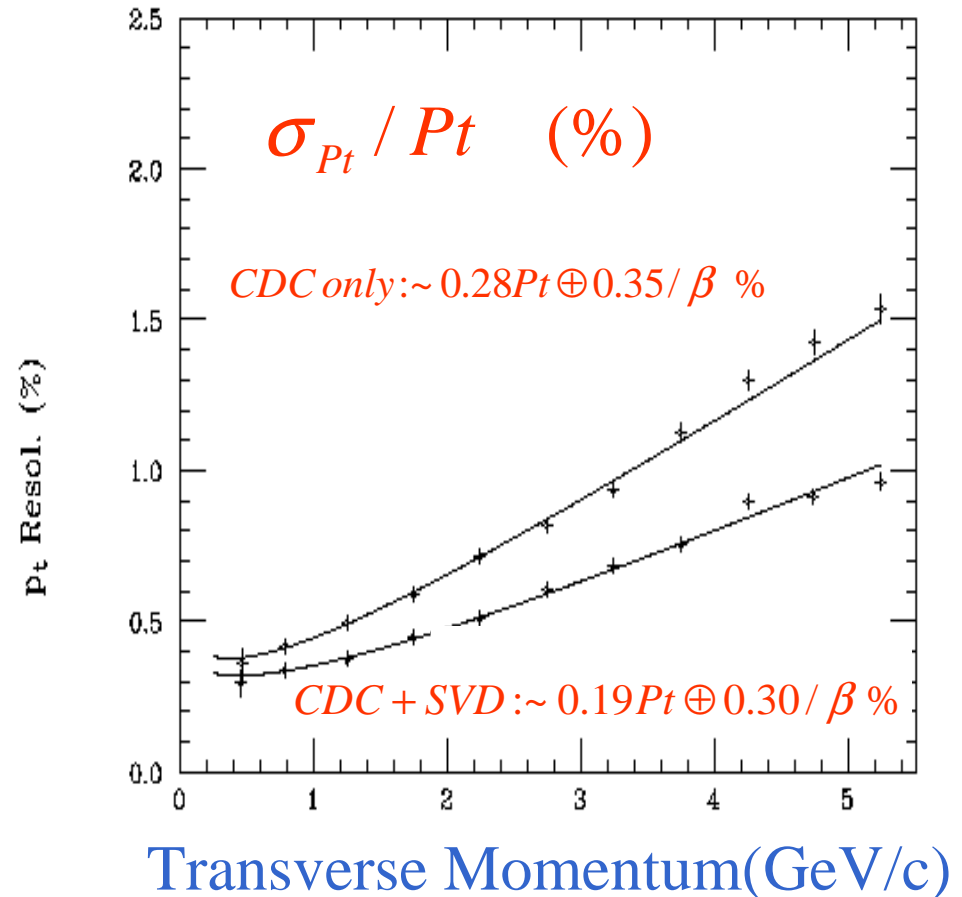
- 110-150 μm spatial resolutions are obtained.
 - Design value : 130 μm
- Resolutions for the inner part are slightly worse.
 - Resolution for Layer 1 and 2 is better due to higher HV, which is set to get better efficiency for the cathode readout.





Momentum Resolution

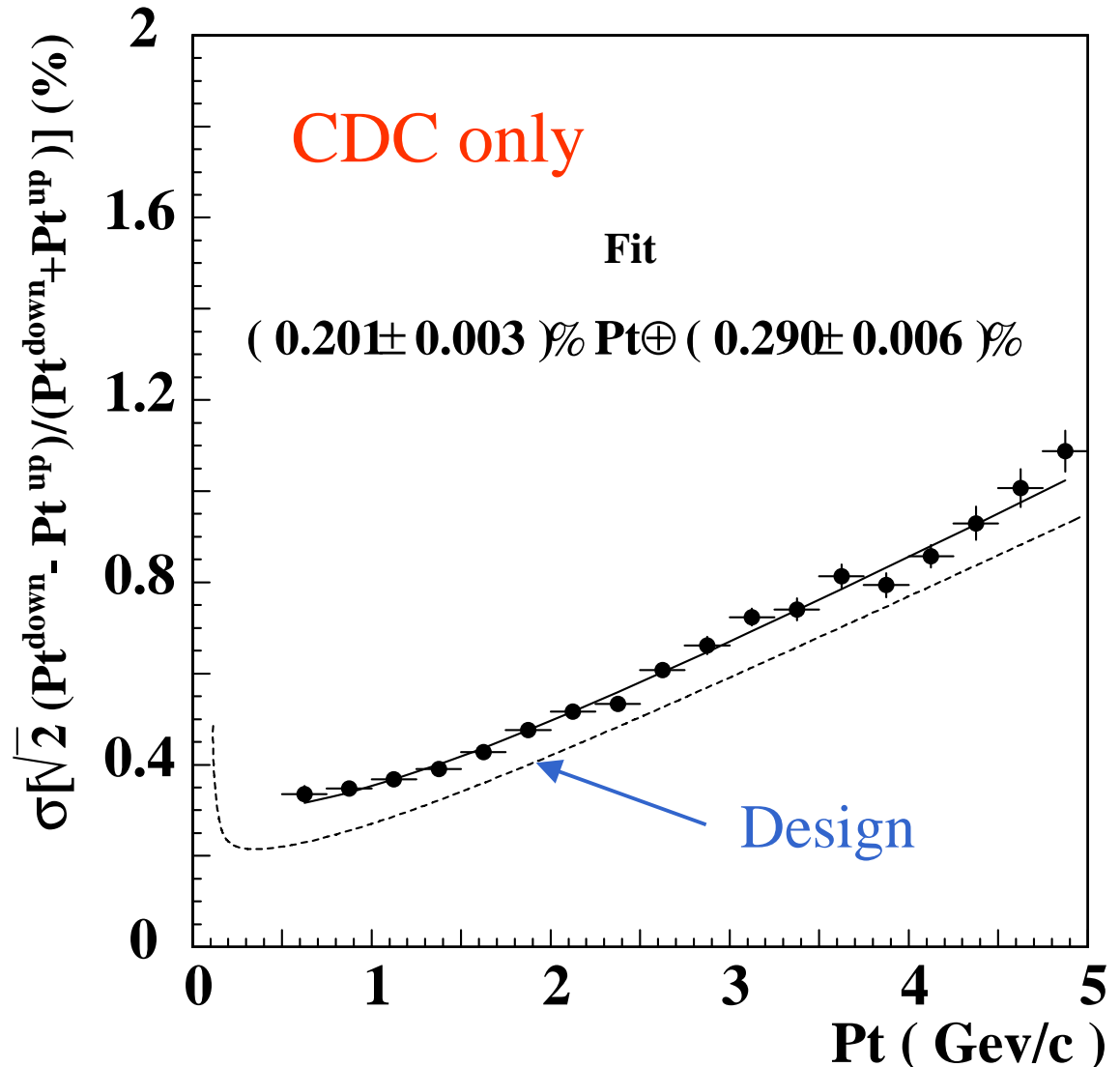
- We could obtain a small constant term using He-based gas and aluminum field wires.
- Slop parameter is not so good as compared with expected value.
 - We had to change the electronics parameters to reduce the cross talk.
 - HV is slightly lower than the original value.
 - Alignment is not perfect.
 - More tuning to reject bad points.
 - Some effects from the beam background.





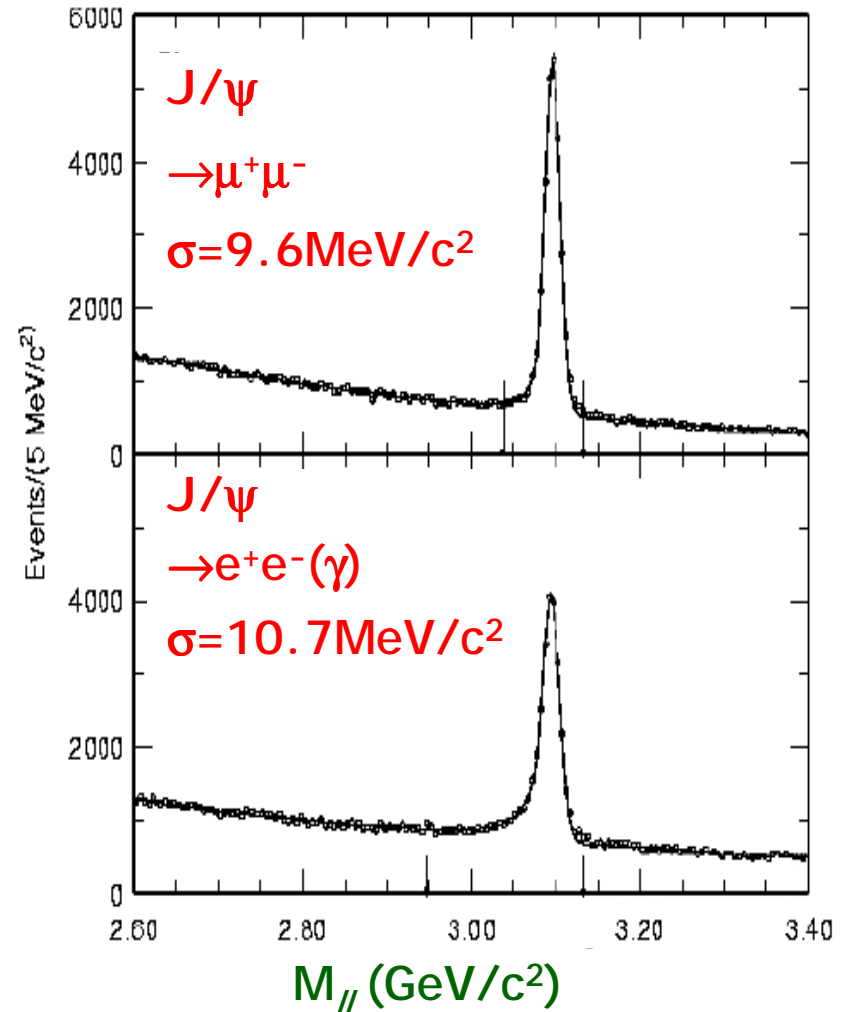
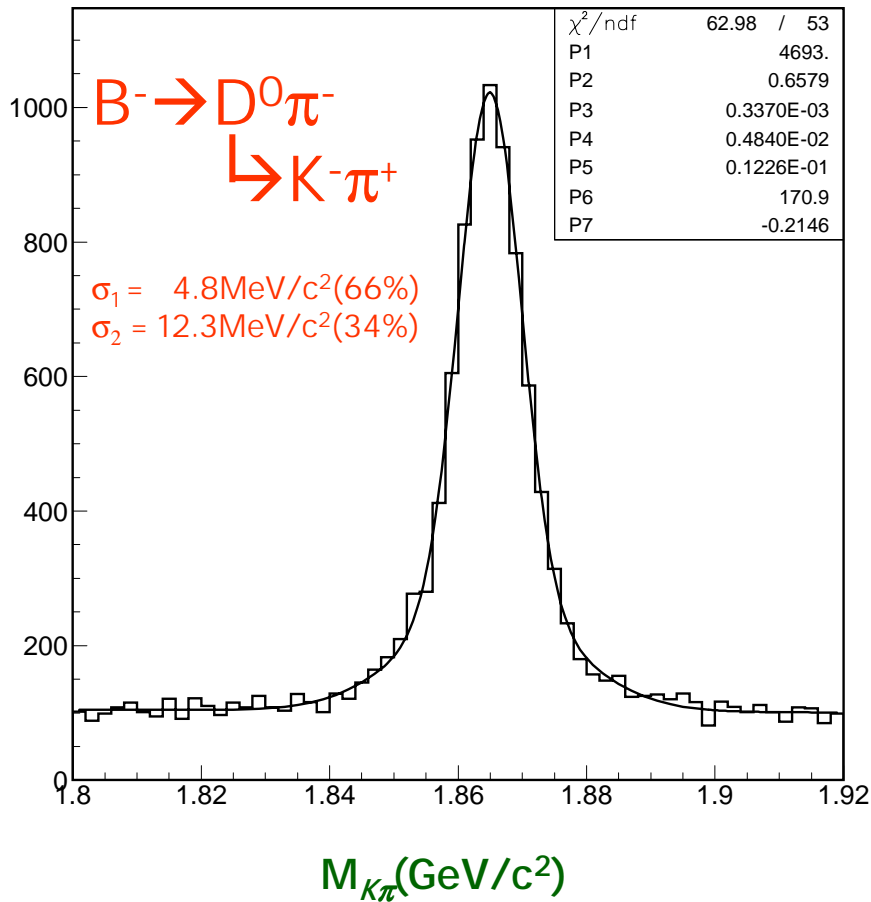
Pt Resolution in Cosmic Ray Test

- Before roll in.
- Original setting for electronics parameters.
- Slightly higher HV.
- Different calibration constants.





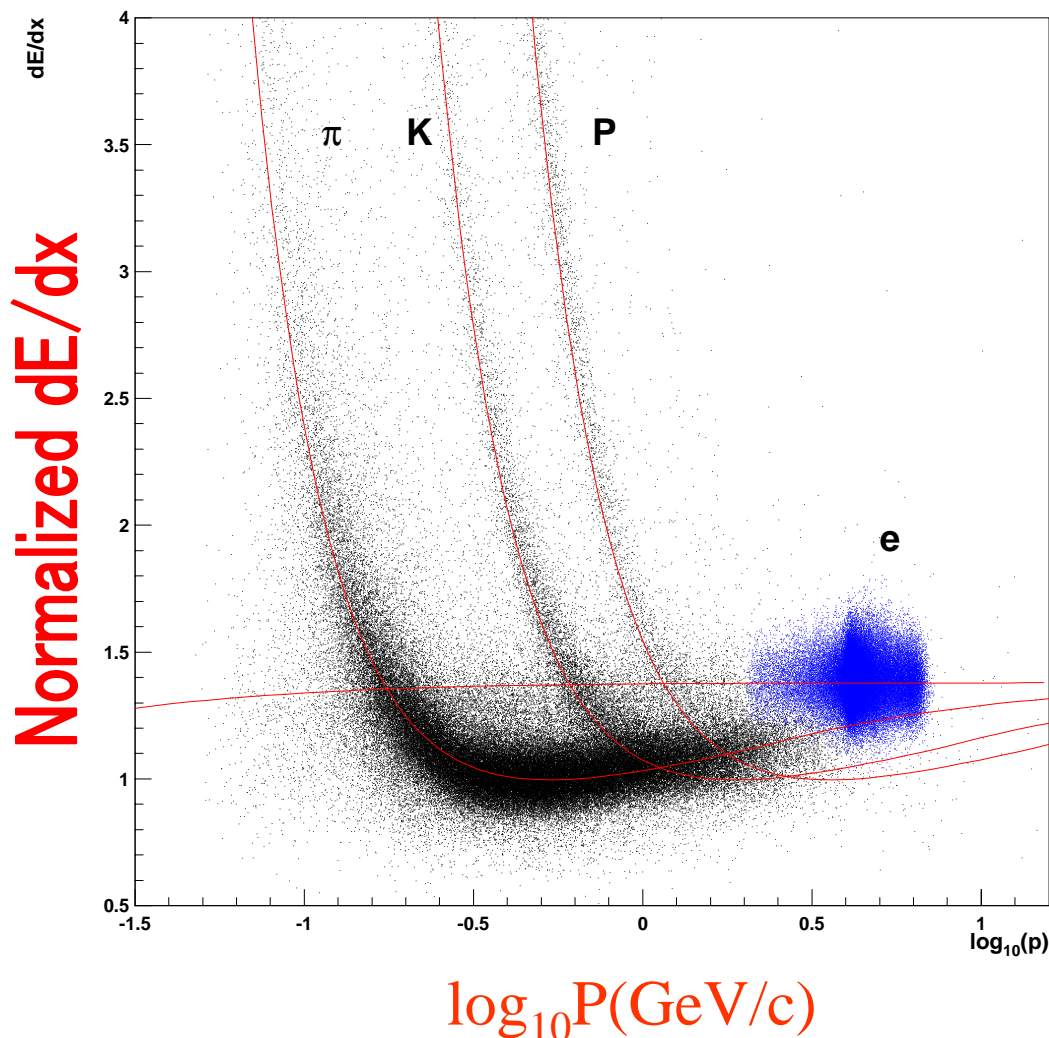
Mass Resolution





dE/dx Measurement

- MQT chip (Charge to Time conversion) and multi-hit TDC.
- 80% truncated mean.
- Relativistic rise.
 - 1.4 for electron.
- Good PID performance for lower momentum region.
- dE/dx information helps to separate high momentum K/ π .

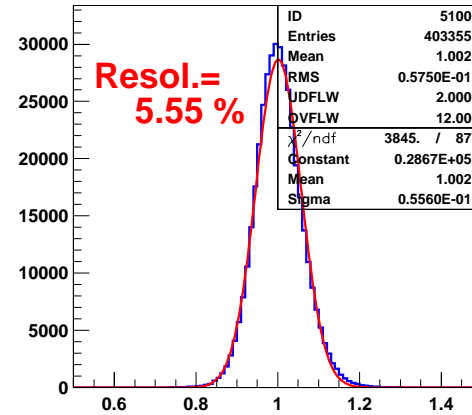




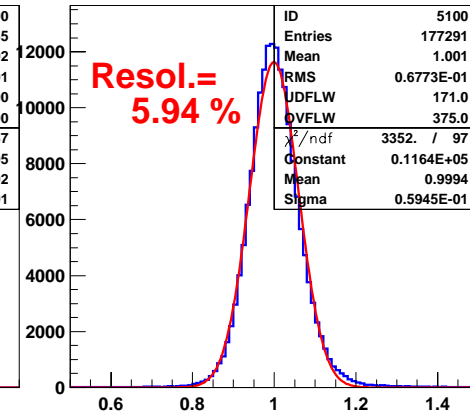
dE/dx Resolution

- Various calibrations are being done to keep performance better.
- The most sensitive calibration is to correct the gas gain saturation around $\theta=90^\circ$.
 - Max. ~30% correction.
- Performance is slightly worse than expected value.
 - Some effects from beam background.
 - Calibration is not perfect.
 - Etc.

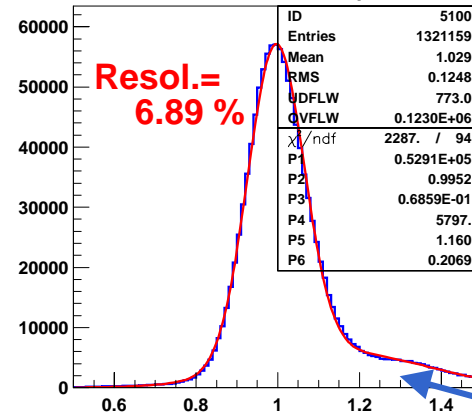
Bhabha



Mu pair



Bhabha dEdx/exp



MuPair dEdx/exp

HadronC(0.35<p<0.88) dEdx/exp

M.I.P
in Hadronic events
0.35<P<0.88GeV/c
without any PID

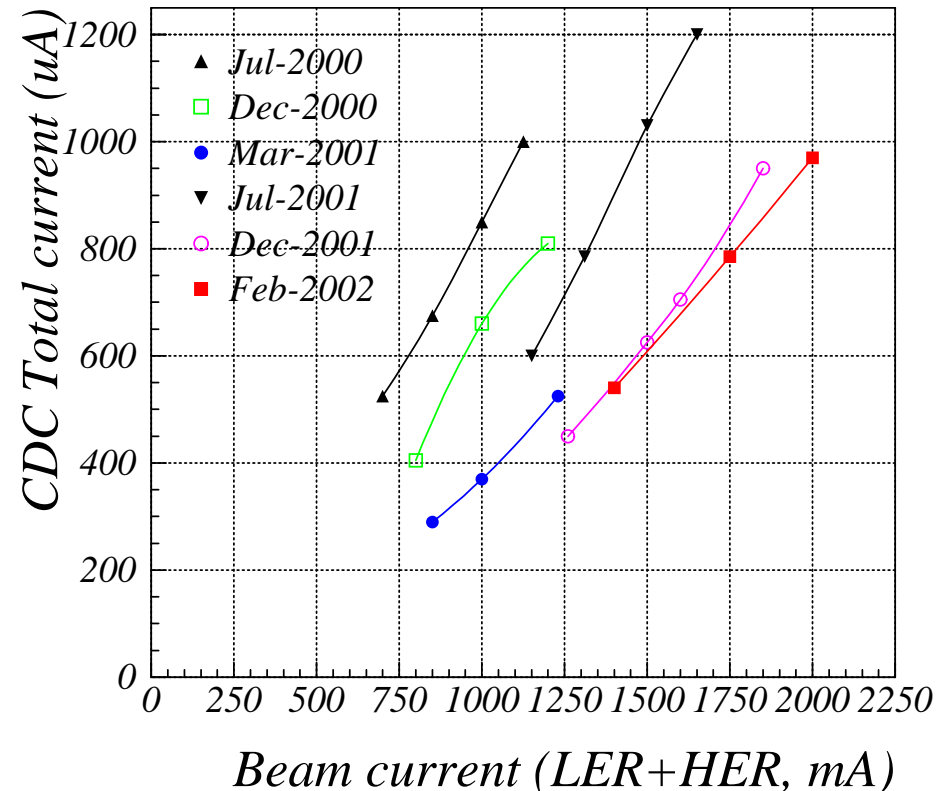
Electron



Total Current Draw

- Total CDC current (8400 wires) is about 1mA at the maximum beam current.
- Vacuum condition is improving from year to year.
- We have not observed any dark current without the beams, so far.

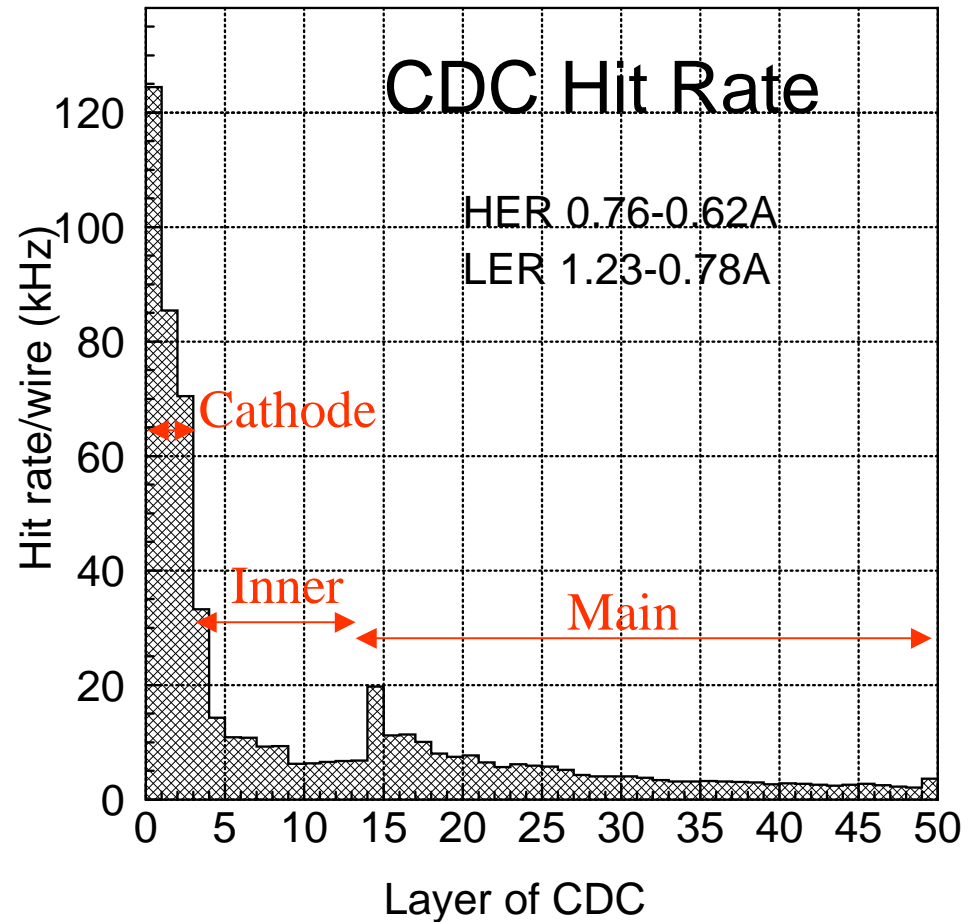
CDC current vs Beam current





Hit Rate

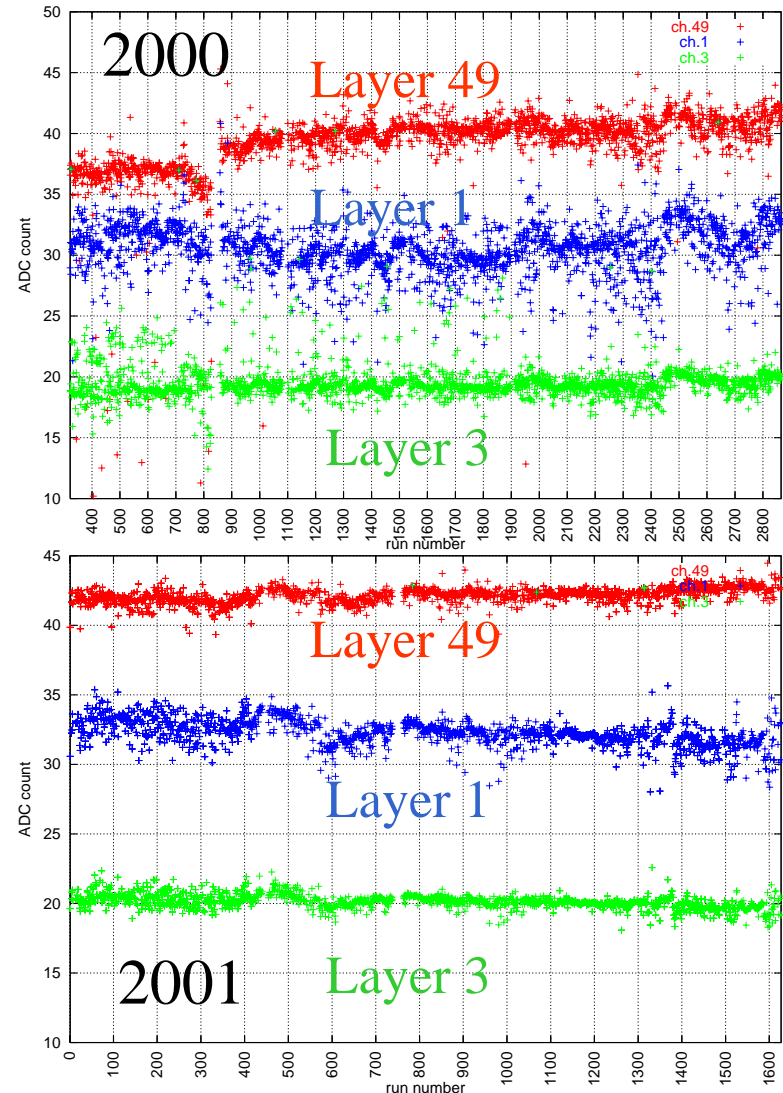
- ~100kHz for inner most layers.
 - Chamber itself is working.
 - Inefficiency (~10%) due to dead time related to electronics.
- 5-10KHz for most of layers.
 - Small enough.
- Higher rate at layer 14 is related to the cylinders, which connect the inner part to main endplates.





Pulse Height Variation

- Total accumulated charge.
→ >0.1 coulomb/cm at inner most layer.
- No significant deterioration, so far.
- The pulse height for inner most region may be decreasing, slightly?





Problems

■ Cross Talk

- Low energy photons from the beam background convert to electrons in the gas volume.
- Then, the electrons produce huge pulses.
- Many hits are produced due to the cross talk.
- We had to change the electronics parameters to reduce the cross talk in 1999.
- Better grounding was more effective.

■ High background around inner most layer

- We can not supply designed HV in the inner most layers to get better performance for the cathode readout.
- ~10% inefficiency due to the electronics.

■ 3D Tracking(especially, low momentum tracks)

- Better track reconstruction program is needed.
-



Future Plan

- In near future(2002 or 2003),
 - We will remove the cathode part.
 - Small cell drift chamber(5mm cell size) will be installed. → Chamber construction is on going.
 - New electronics with shorter dead time will be used.
 - At super KEKB(Lum.= $10^{35}\text{cm}^{-2}\text{sec}^{-1}$),
 - We think a gas chamber can work as a CDC.
 - New chamber with smaller cells.
 - New gas with a faster drift velocity.
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Upgrade for Inner Tracker

- Smaller beam pipe.

 - Radius = 1.5cm

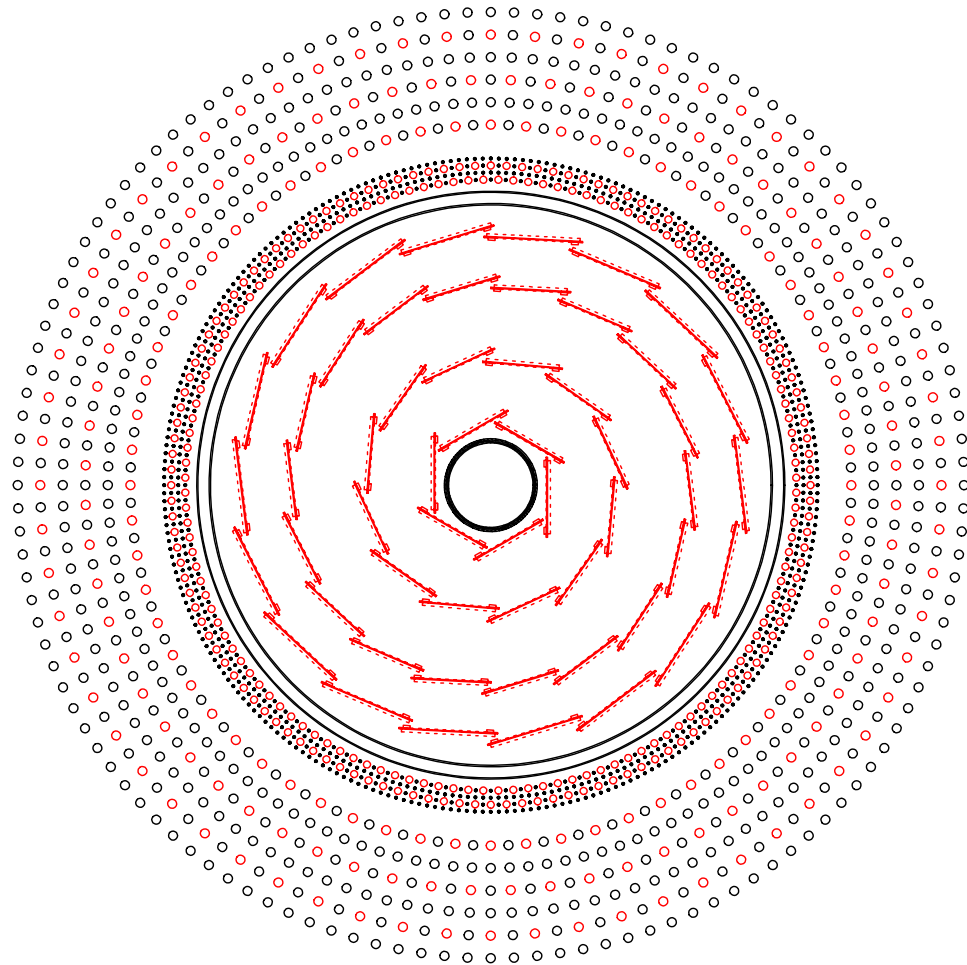
- Four layers SVD.

- Two layers small cell drift chamber.

 - Reduce the hit rate/wire.

 - Shorter maximum drift time.

 - Trigger signal for SVD.





Summary

■ Present CDC is working well.

→ Good momentum resolution.

- We have a room to improve the resolution for high momentum tracks.

→ Good dE/dx resolution.

→ Beam background is very severe for the inner most region. → Upgrade plan.

■ R&D for upgrade is on going.

→ Small cell drift chamber.

→ New gas with a fast drift velocity.
