



# R&D Status for Upgrade Plan

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- Hit rate and occupancy
  - Small cell drift chamber
  - New gas mixture
  - Summary
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# Background for CDC at $10^{35}$

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- Present beam currents

  - 0.88A(HER) + 1.37A(LER)

  - 2.25A in total

  - $L \sim 0.65 \times 10^{34} / \text{cm}^2 / \text{sec}$

- For  $10^{35}$  machine,

  - 4.1A(HER) + 9.4A(LER)

  - 13.5A in total

- We assume BG is proportional to the beam current.

  - BG is ~10 times higher than the present condition.

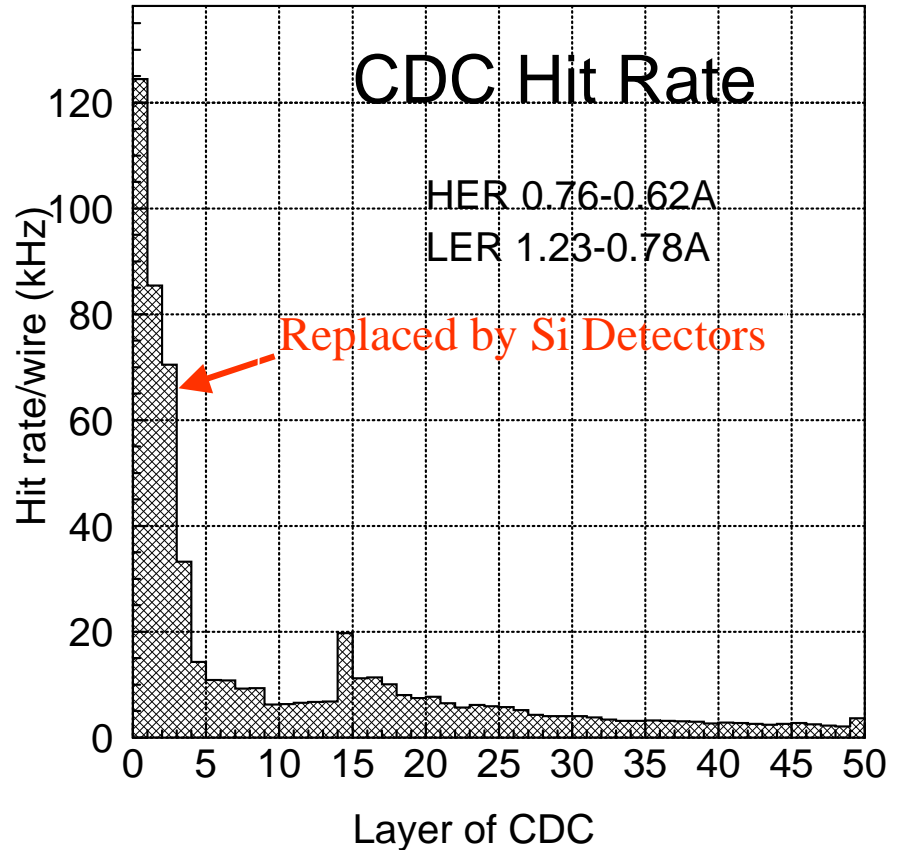
  - In this case, the vacuum condition will keep the same level even for higher current. → Better vacuum system is necessary.

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# Hit Rate

- Hit rates for most of layers are around 5kHz.
- At present, the chamber itself is working at layer 0 even with higher rate more than 100kHz.
- It means that the chamber itself will work at most of layers in 10 times higher BG condition.





# Aging Effect

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- Integrated charge on sense wires
  - >0.1 coulomb/cm at inner most layers for 2 years.
- No significant deterioration was observed.
  - All wires are active.
  - Very small dark current without beams.



- Most of layers can survive in 10 times higher BG condition.
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# Occupancy

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## ■ In order to reduce occupancy,

### → Smaller cell size

- More wires. → smaller hit rate for each wire.
- Shorter maximum drift length → shorter maximum drift time.



- Now, we are constructing a small cell drift chamber for upgrade of the present CDC (Maximum drift length is 0.25cm).

### → Faster drift velocity

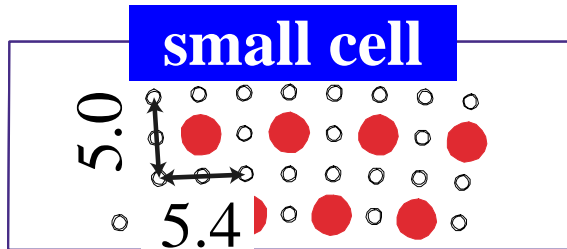
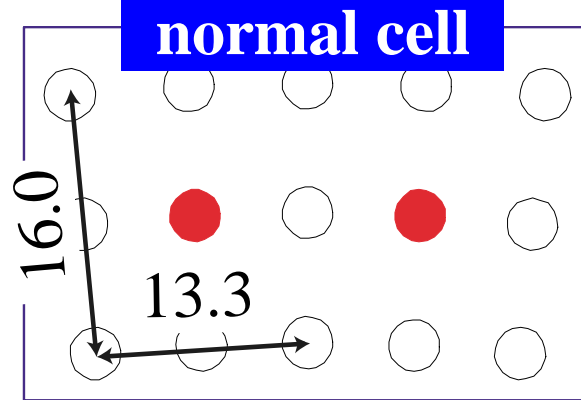
- Shorter maximum drift time.



- One candidate : 100% CH<sub>4</sub>
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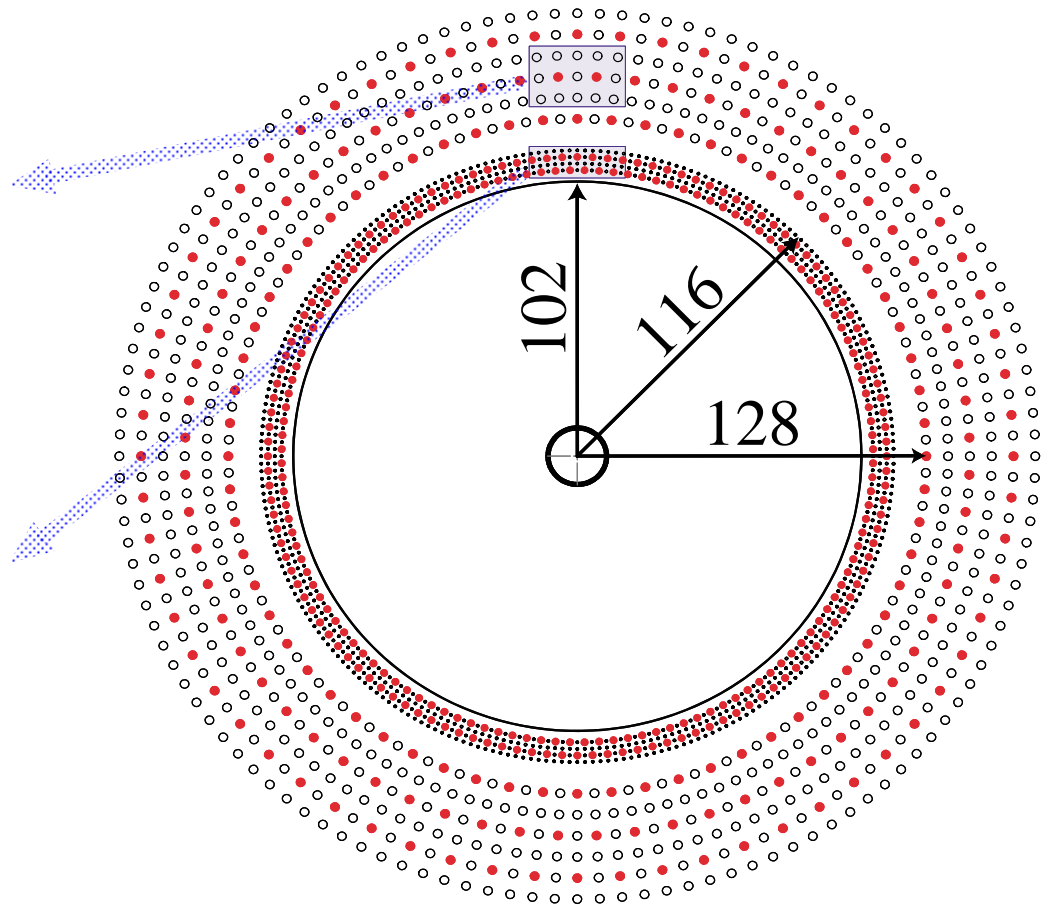
# Small Cell Drift Chamber



● sense wire

○ field wire

unit : [mm]





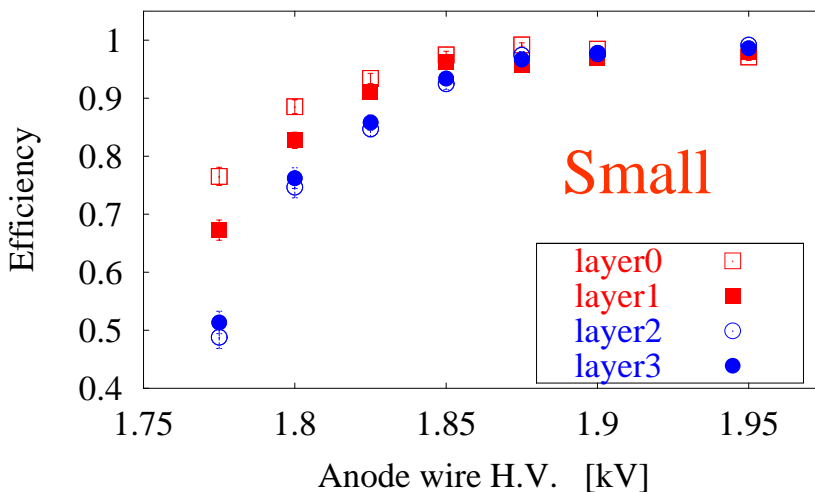
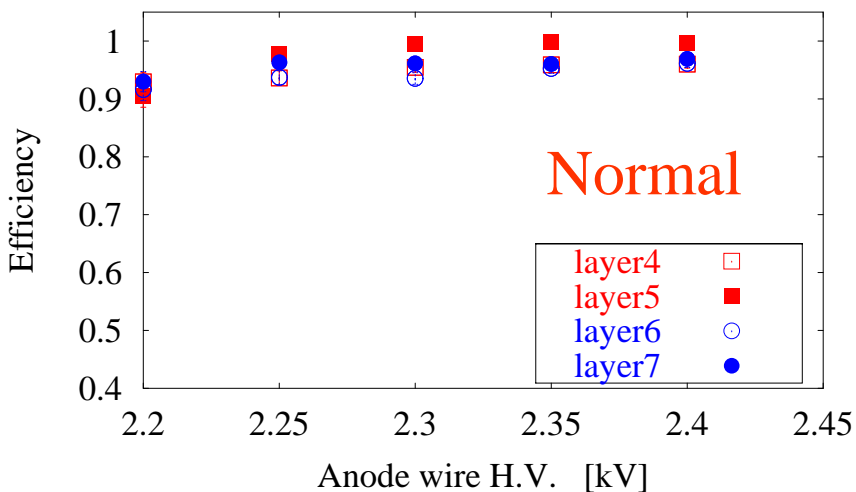
# Prototype for Small Cell Chamber





# Cosmic Ray Test

- We could construct a prototype for the small cell drift chamber.
- Cosmic ray test was performed to check basic performance of the chamber filled with He(50%)-C<sub>2</sub>H<sub>6</sub>(50%).
- **Results**
  - Good efficiency
  - Shorter maximum drift time

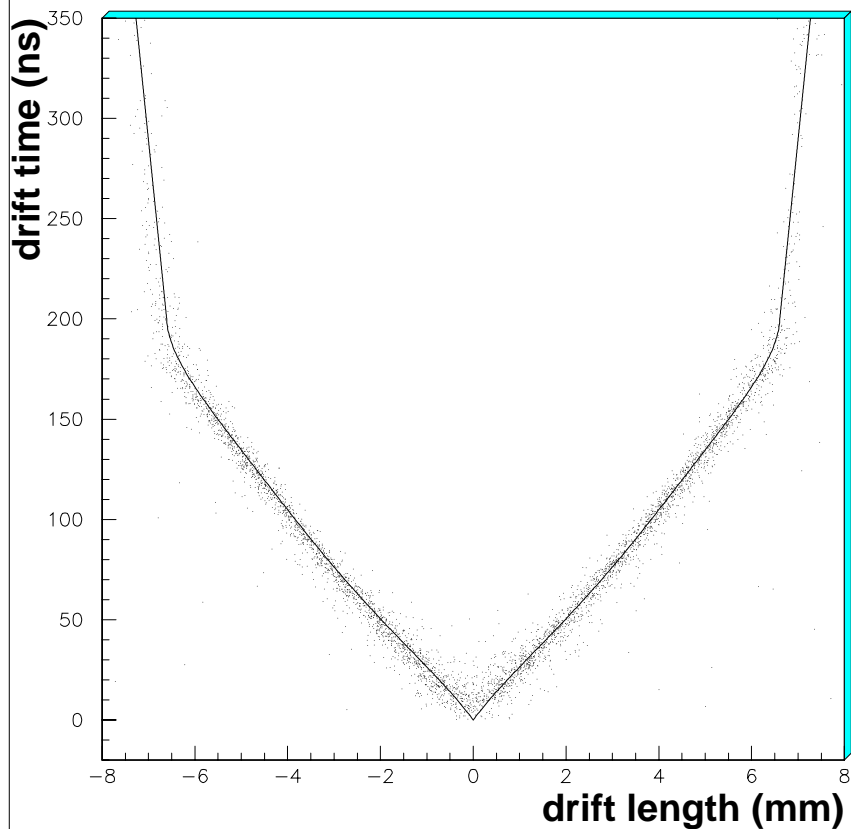




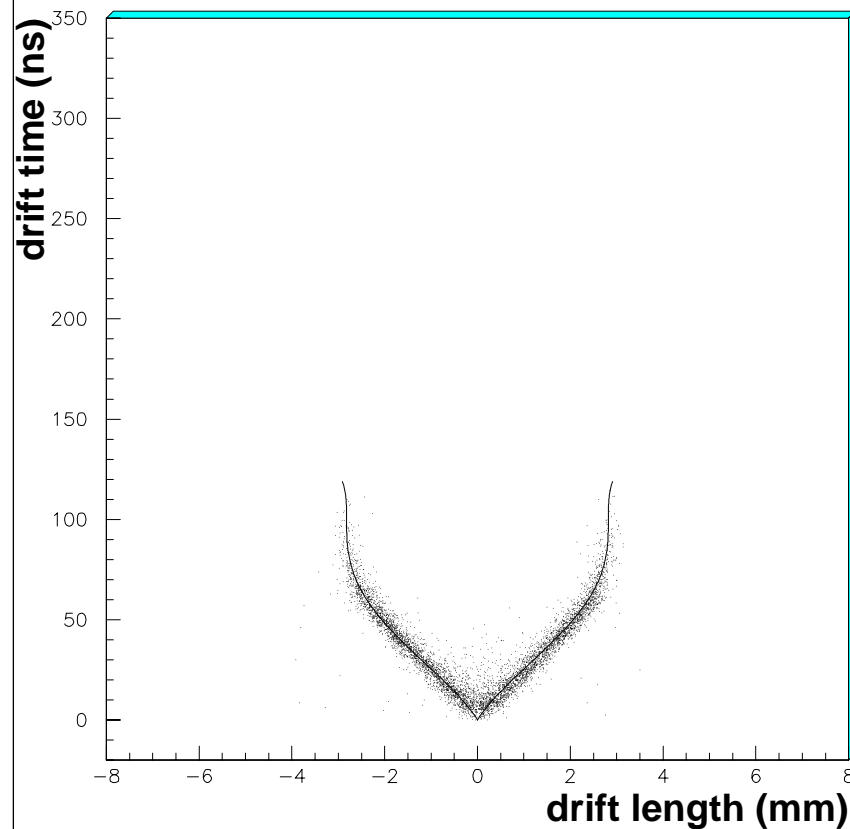


# XT Curve & Max. Drift Time

Normal cell



Small cell





# New Gas Mixture

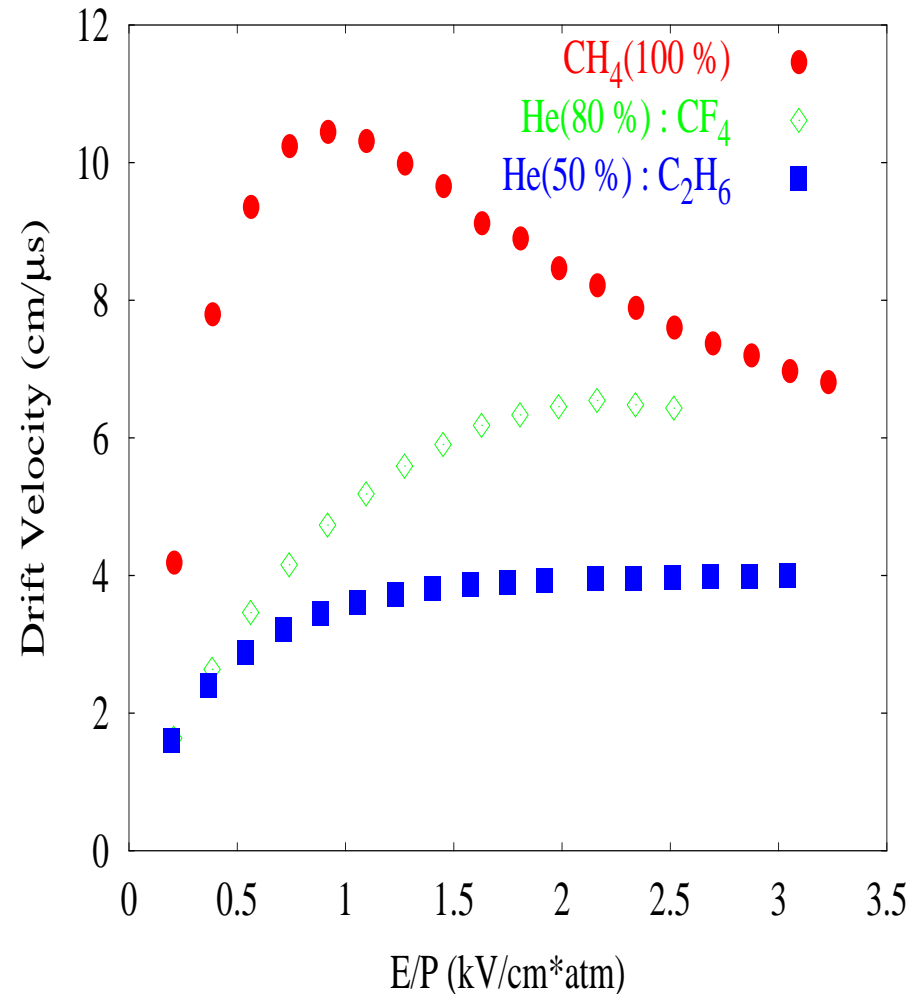
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- Faster drift velocity
    - $\text{CF}_4$  and  $\text{CH}_4$
  - Long radiation length
    - He(80%)- $\text{CF}_4$ (20%) and pure  $\text{CH}_4$
  - Good  $dE/dx$  resolution
    - A simple test using electron from  $^{90}\text{Sr}$ .
  - Small radiation damage
    - On going
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# Drift Velocity

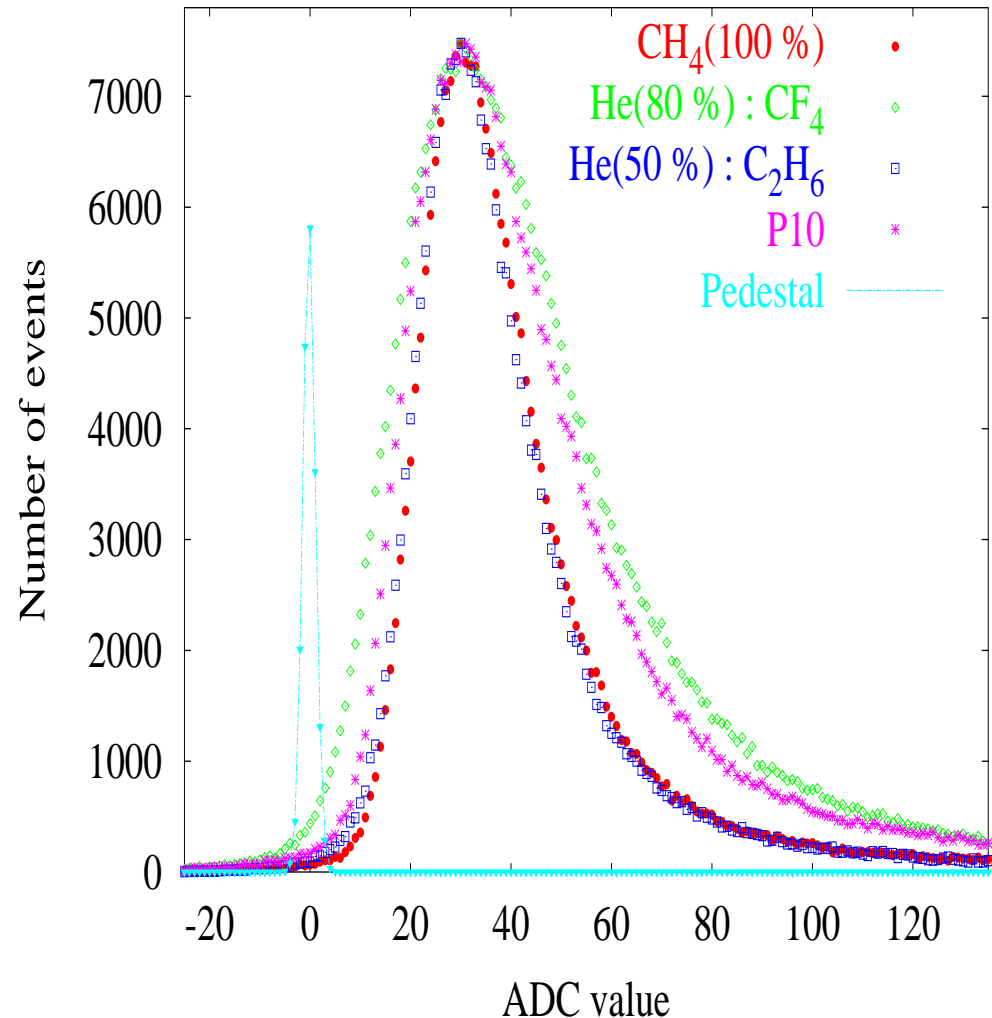
- Two candidate gases were tested.  
→  $\text{CH}_4$  and  $\text{He-CF}_4$
- In case of  $\text{He-CF}_4$ , higher electric field is necessary to get fast drift velocity.
- In case of  $\text{CH}_4$ , faster drift velocity by factor two or more can be obtained, even in rather lower electric field.





# dE/dx Resolution

- The pulse heights for electron tracks from  $^{90}\text{Sr}$  were measured for various gases.
- The resolutions for  $\text{CH}_4$  and  $\text{He}(50\%)-\text{C}_2\text{H}_6(50\%)$  are same.
- The resolution for  $\text{He}-\text{CF}_4$  is worse than Ar-based gas(P-10).





# Summary

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- We are constructing a small cell drift chamber for upgrade.
    - Prototype chamber is working correctly.
    - Good milestone for future upgrade.
  
  - R&D for future upgrade is on going.
    - $\text{CH}_4$  is a good candidate gas for a future CDC.
      - Faster drift velocity.
      - Similar  $dE/dx$  resolution.
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