The status of MDC

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Outline

- Aging problems of MDC
- Status of MDC performance
- summary

Drift chamber aging

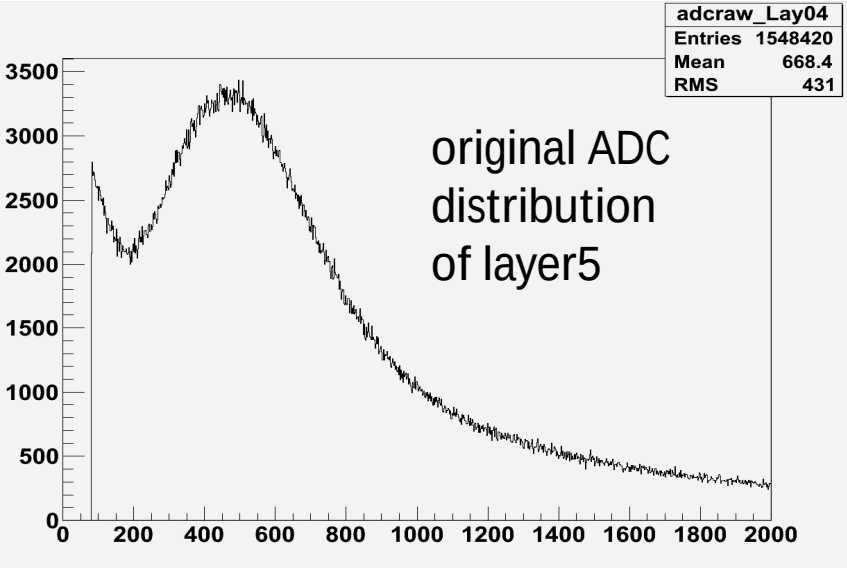
- Cathode aging
  - Malter effect: an insulating layer is formed on the cathode which feed a self-sustaining local discharge.
  - Possible reason: high hit rate
  - MDC encountered Malter effect in Jan. 2012, and 2000ppm water vapor @ 21 ˚C was added to the gas mixture to solve the problem
- Anode aging
  - Deposits on the anode cause a gain loss due to the increase in the effective diameter of the sense wires.
  - Related to accumulated charges of the wires

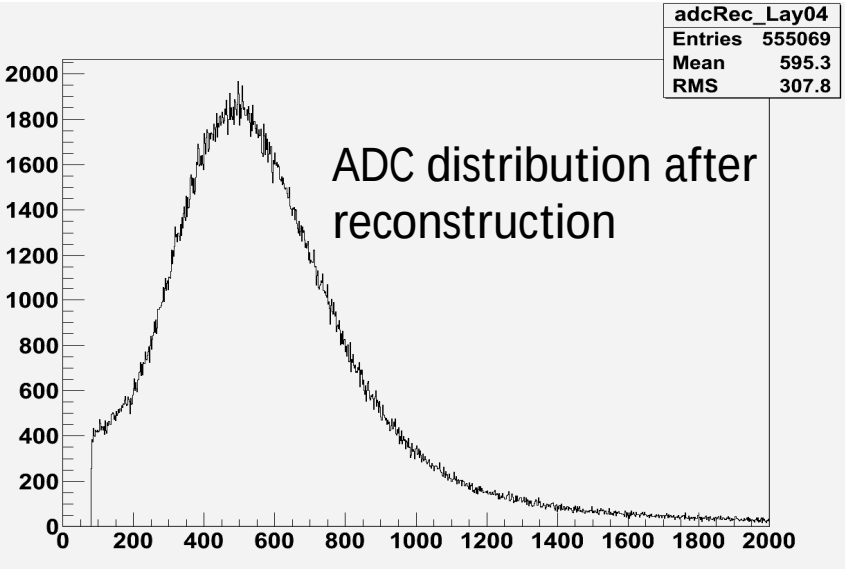
Anode aging of MDC

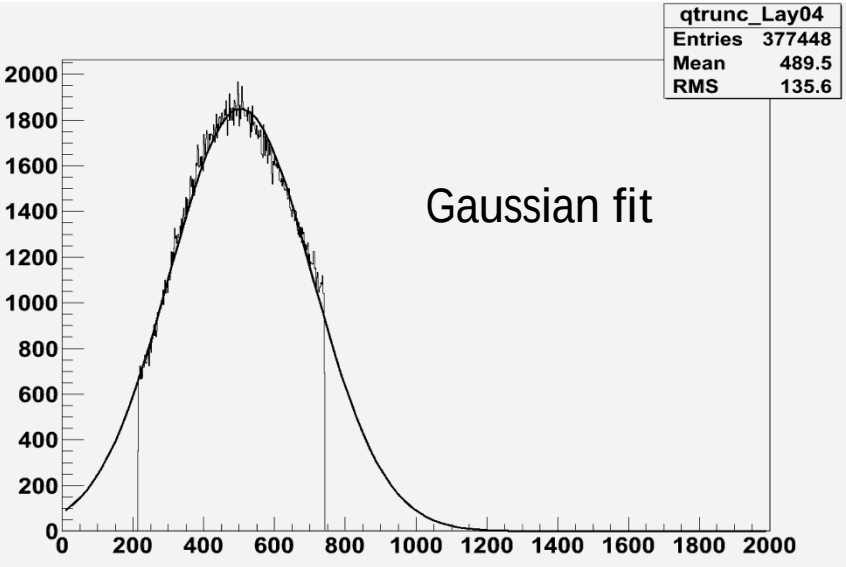
Two calculation methods:

- Calculate the gas gain decrease with Bhabha events
- Integrating the dark currents of the sense wires to get the accumulated charges, and then calculate the gain decrease with aging ratio

Q distribution from Bhabha events







- Get ADC distribution after reconstruction
- Gaussian fit
- The change of Q peak in each year gives the gain decrease of MDC

Gas gain correction

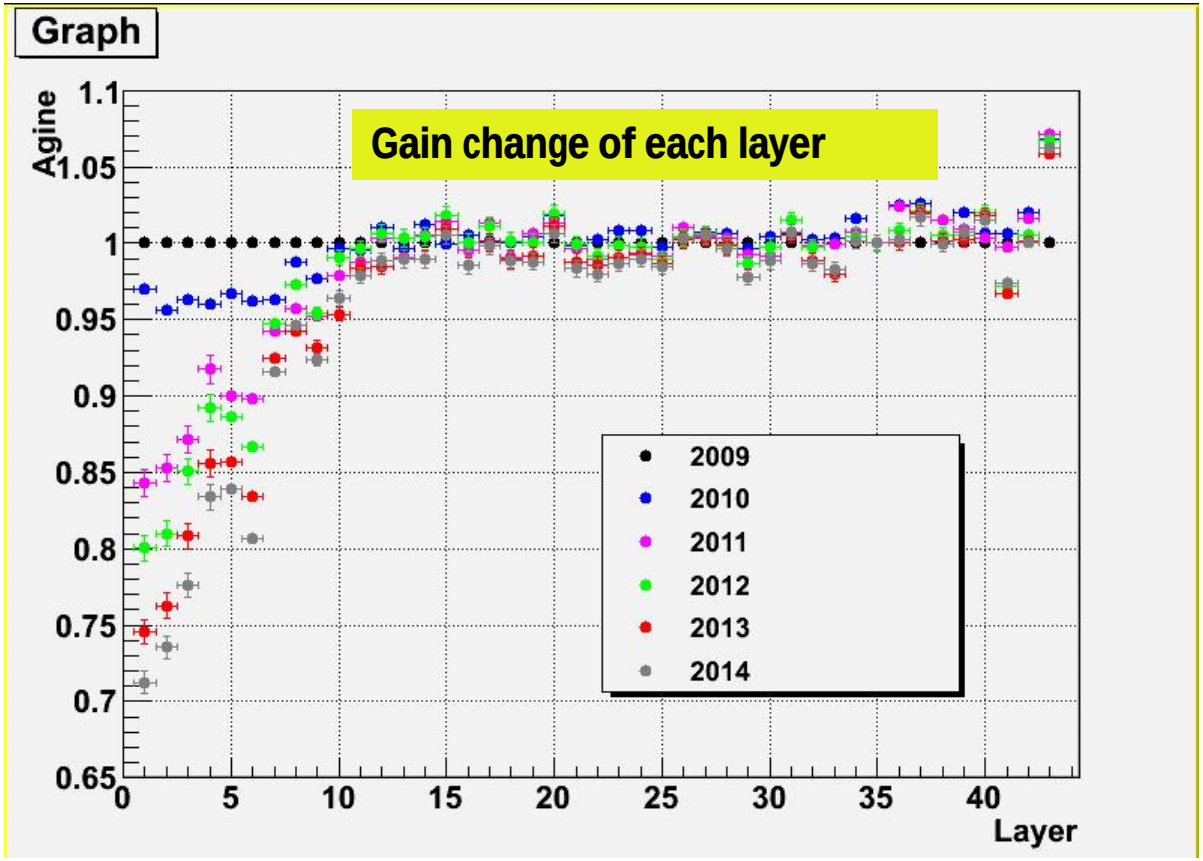
- The gas temperature and pressure

Diethorn formula : $\frac{dG}{G} = -\frac{\lambda \ln 2}{\Delta V 2\pi\varepsilon_0}\frac{d\rho}{\rho} = \frac{\lambda \ln 2}{\Delta V 2\pi\varepsilon_0}(\frac{dT}{T} - \frac{dP}{P})$

$$\frac{dG}{G} = (1.97 \pm 0.24)(\%/^{\circ}C) + (-5.2 \pm 2.5)(\%/kPa)$$

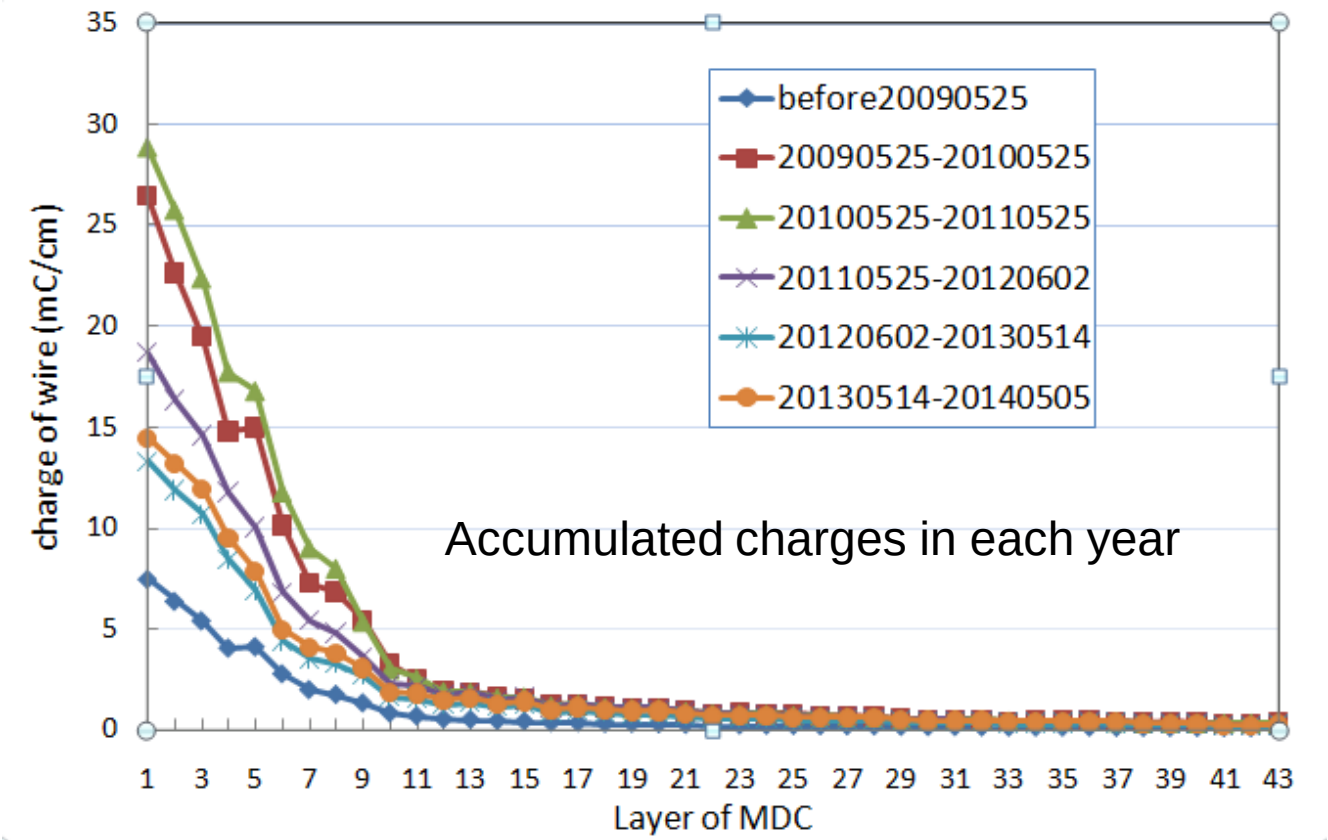
- The gas components
- The high voltage: $\frac{\Delta G}{G} = k\lambda\frac{\Delta\lambda}{\lambda} = k\lambda\frac{\Delta V}{V} = (20.1 \pm 0.2)\frac{\Delta V}{V}$

Gain change of each layer from 2009-2014



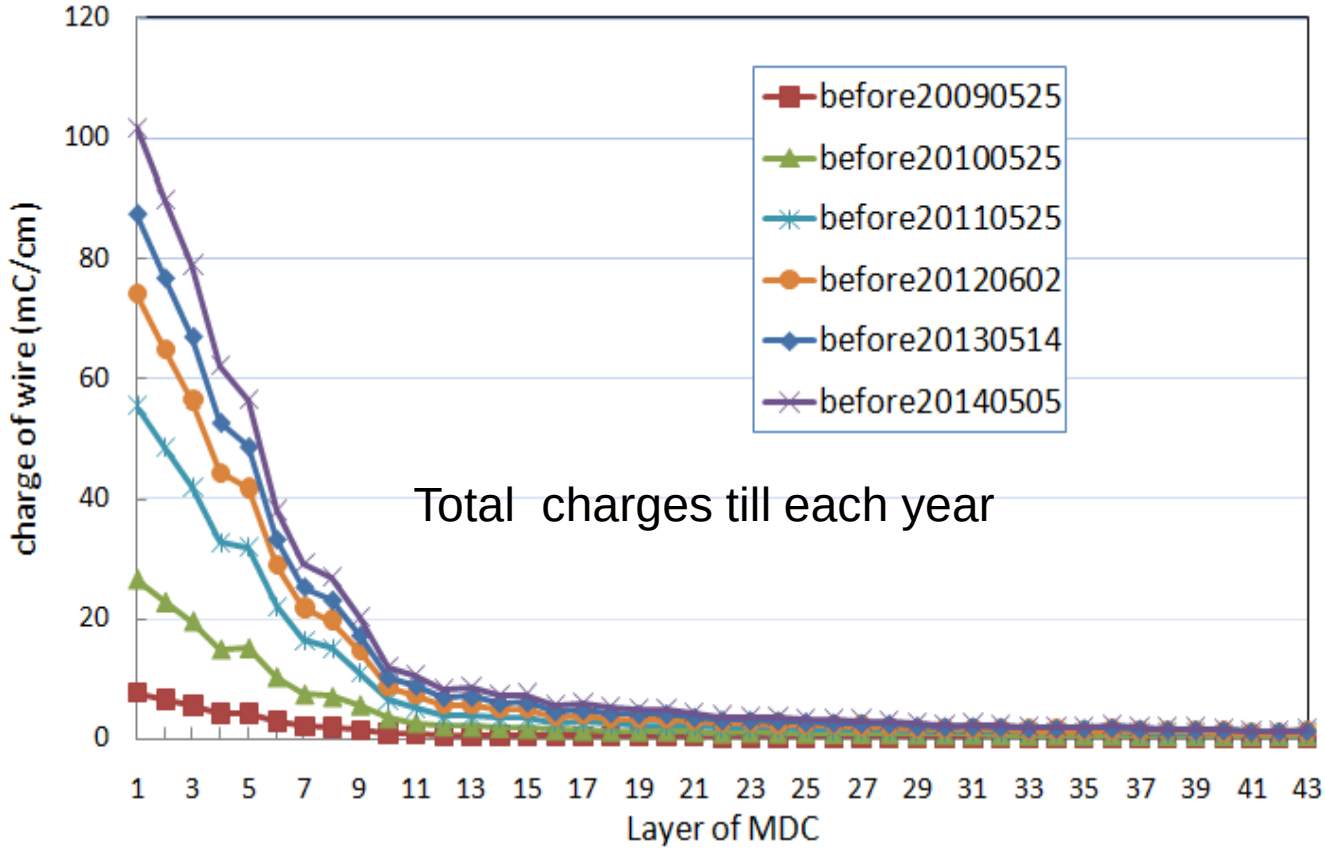
- The gains of the first 10 layers have an obvious decrease, but the gains of the outer layers have almost no change
- Compared with 2009, the gains of first 5 layers decreased about 29% — 16%

Accumulated charges of MDC sense wires



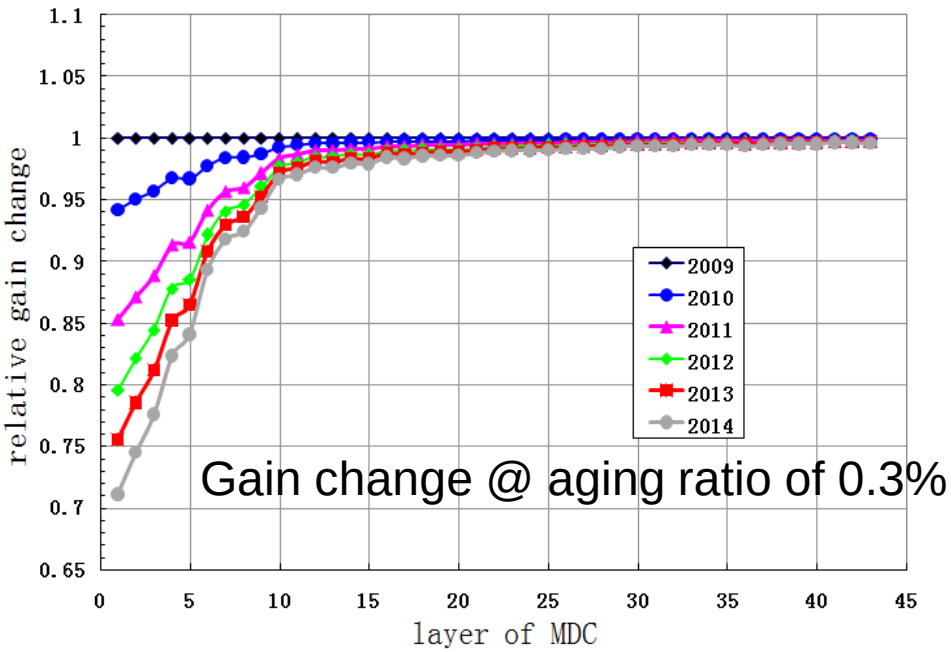
- The accumulated charges of MDC have been calculated by integrating the dark currents of each wire
- In the last two years the accumulated charges are at a low level, about 14mC/cm for the first years

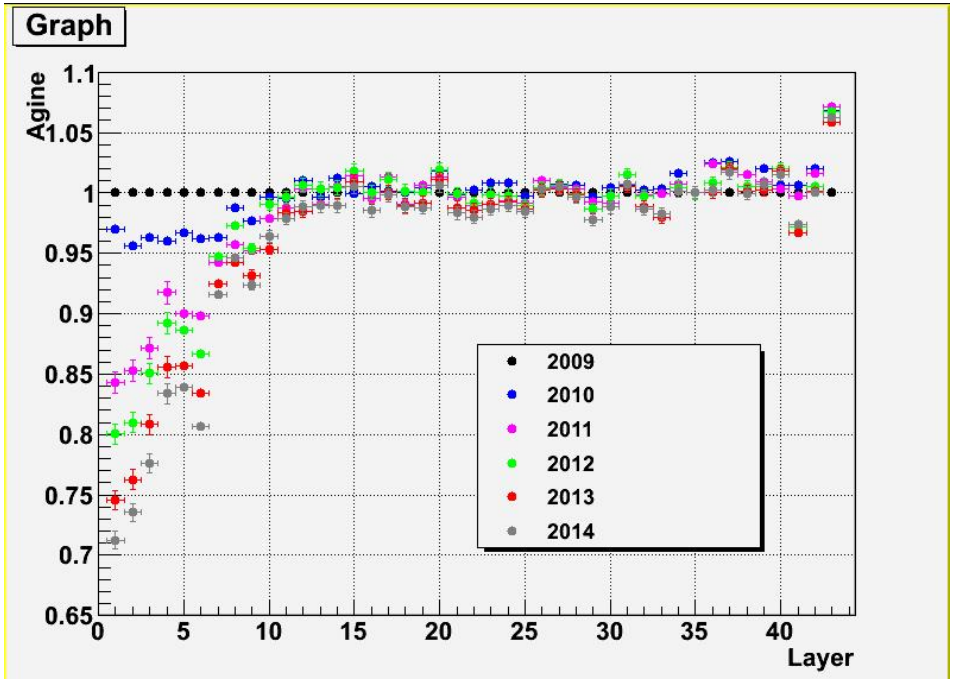
Total accumulated charges



- The accumulated charges are about 100mC/cm for the first layer by now
- Far away from the IP, the charges of the sense wires reduce rapidly

Change of gain by aging ratio





- According to the aging test, the aging ratio R of the inner cell is about 0.3%
- Using the aging ratio R and accumulated charges , we can get the gain change, which is consistent to the one calculated by Bhabha events

$$R = -\frac{1}{Q}\cdot\frac{\Delta G}{G}\% \Big/ (mC/cm)$$

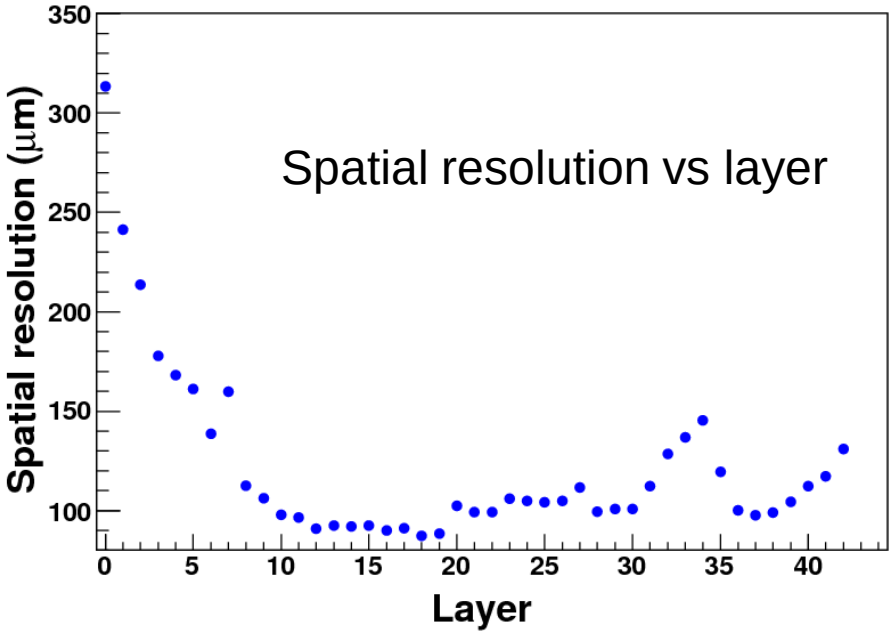
$$\frac{\Delta G}{G}\% = -RQ$$

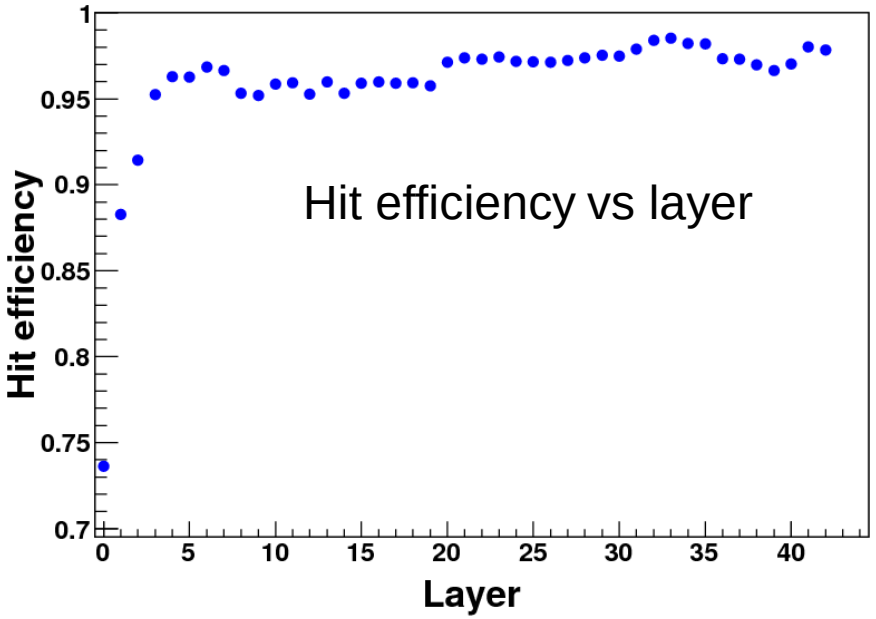
MDC high voltage

- In the data taking, the high voltages of the first 4 layers were set to 96%, 97%, 98%, and 99% of the normal values because of the huge beam related background
- We can improve the gas gain of the first 4 layers by increasing the high voltage, but this will lead to an additional increase of accumulated charge , and accelerate the aging

$$\frac{\Delta G}{G} = k\lambda \frac{\Delta \lambda}{\lambda} = k\lambda \frac{\Delta V}{V} = (20.1 \pm 0.2) \frac{\Delta V}{V}$$

Status of MDC performance





- Spatial resolution: 115μm for all layers
- Hit efficiency: >95% except the first 3 layers
- The performance is much better in the last two years, which is due to low beam background and noise

Summary

- The accumulated charges in the last two years is smaller than before, due to the low beam related background
- After 6 years running, the gains of the first 10 layers decrease obviously with a maximum of 29% for the first layer. Two calculation methods (Bhabha events and accumulated charge) get almost the same results.
- According to the beam related background level in the last two years, the gain decrease about 4% for the first layer every year. We can estimate that the gain will become 67% next year

Thanks for your attention

New inner drift chamber

- A backup new inner drift chamber is under construction, which will be finished by the end of August
- Stepped end plates are used to shorten the wire length out of the effective solid angle, which will reduce the dark current of the wires