Aging effect in the BESIII Main Drift Chamber

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Introduction

- **MDC in BESIII**
  - cylindrical chamber with 43 layers of sense wires
  - helium based mixture gas(He/C_3H_8=60:40)
  - avarage gas gain ~ 3 x 10^4
- **Aging effect**
  - obvious gain decrease
  - some cells tripping all the time
  - including anode and cathode aging

Indicator of the aging effect

- The aging effect depends on the **total radiation dose**, which has positive correlation with

  hit rate and cell accumulated charge

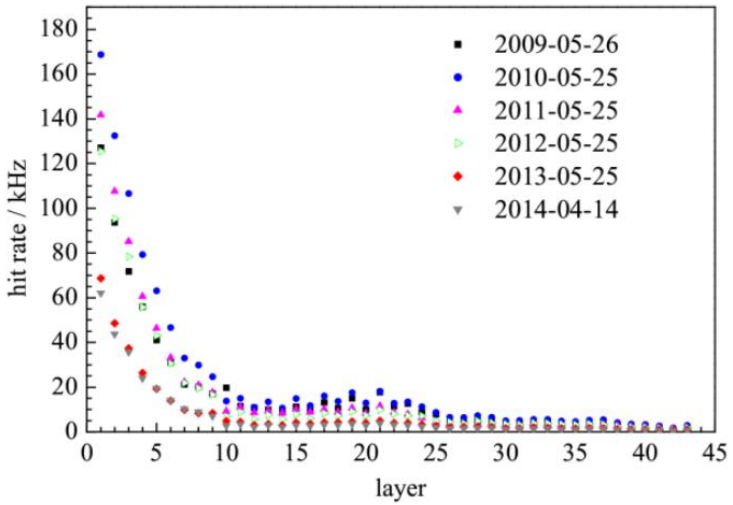


Fig. 1 Single wire hit rate each year as a function of MDC layer

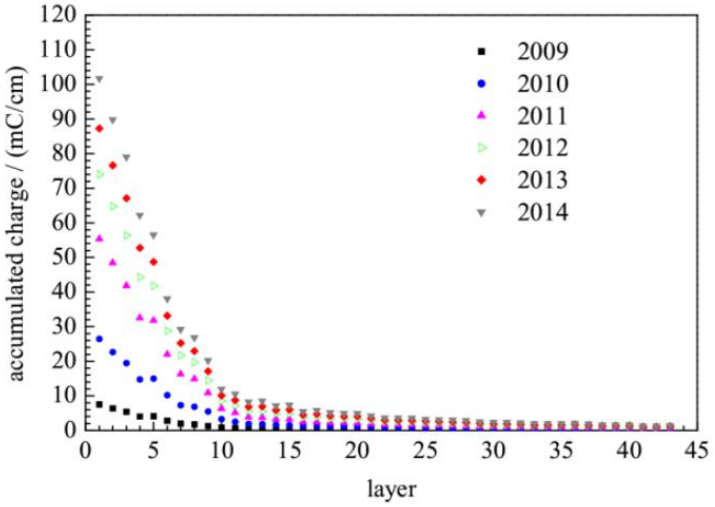


Fig. 4 Accumulated charge of the cells as a function of MDC layer in each year

mainly beam related background

Anode aging effect

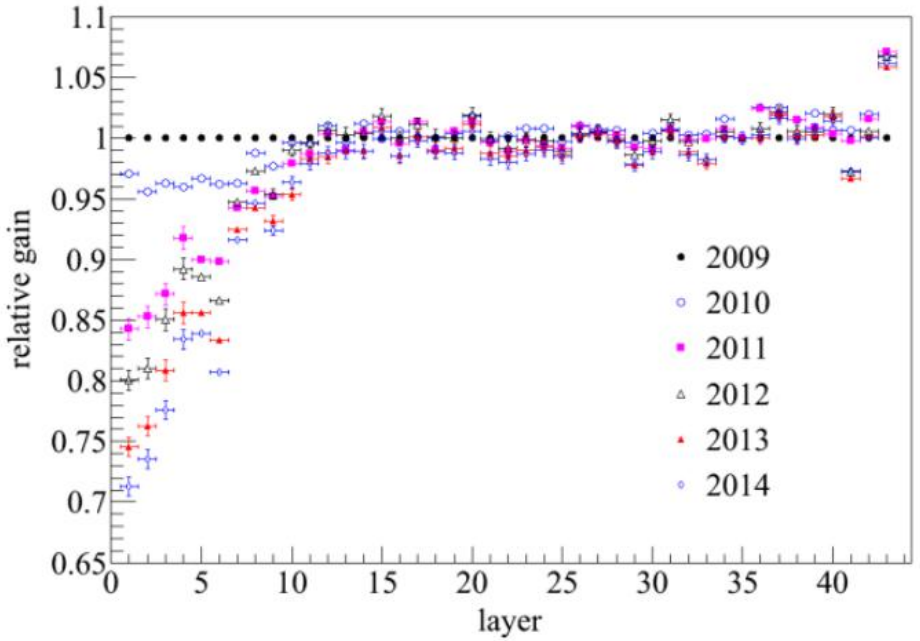
Physics Picture of Anode Aging

gas polymer condenses on the sense wire

- **cause gain loss due to**
  - the increased effective diameter of the sense wire
  - reduction of electric field due to charge accumulation on the insulating layer.
- **worse pulse-height resolution**
  - variation of the deposit thickness along the sense wire.

Influence on MDC performance

--gain decrease

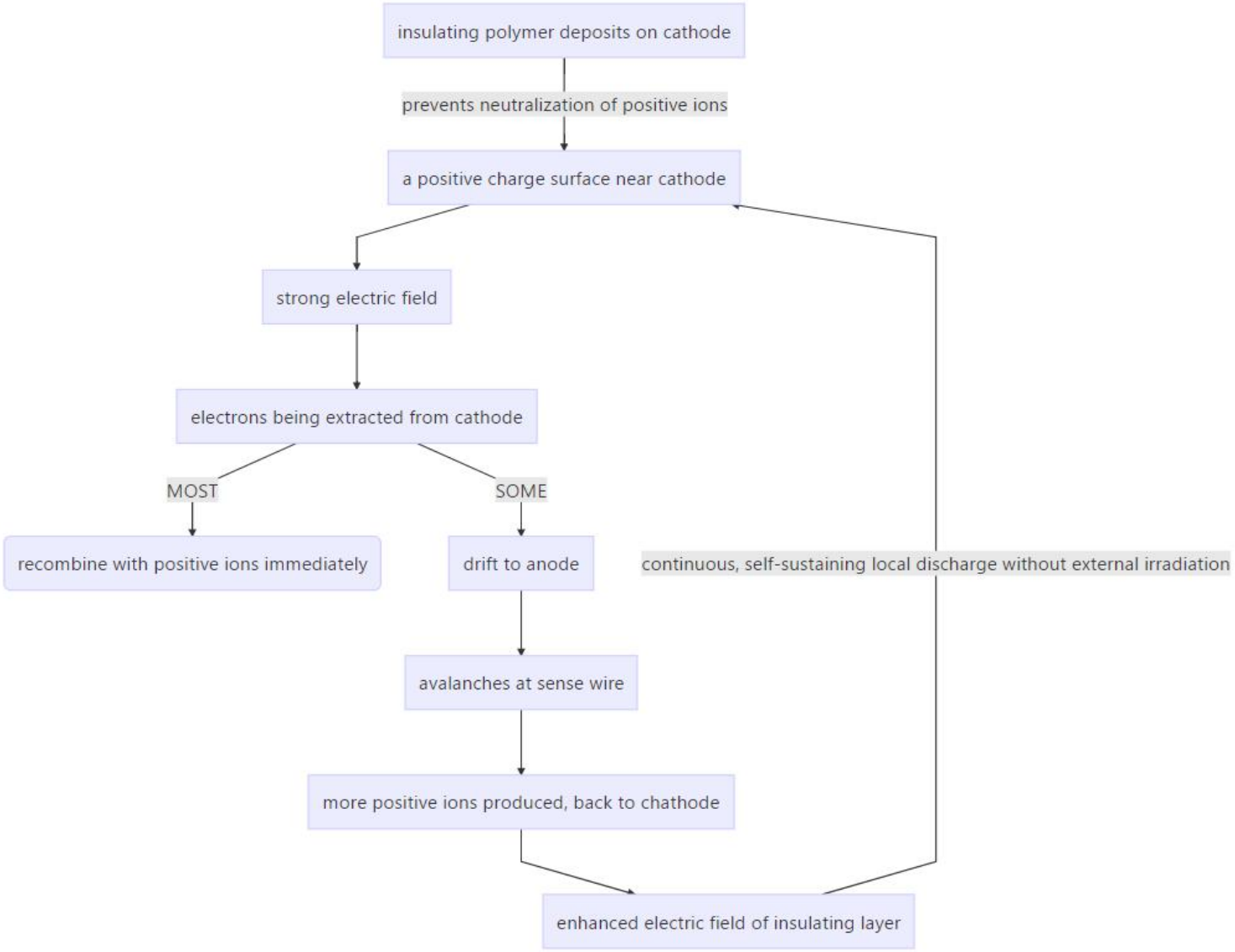


- Get from Bhabha sample in real data
- assuming the gain in 2009 to be one
- The relative gain shows the gain decreases year by year.

gain loss and worse pulse-height resolution cause lower hit efficiency in real data, which has a positive correlation with the tracking efficiency.

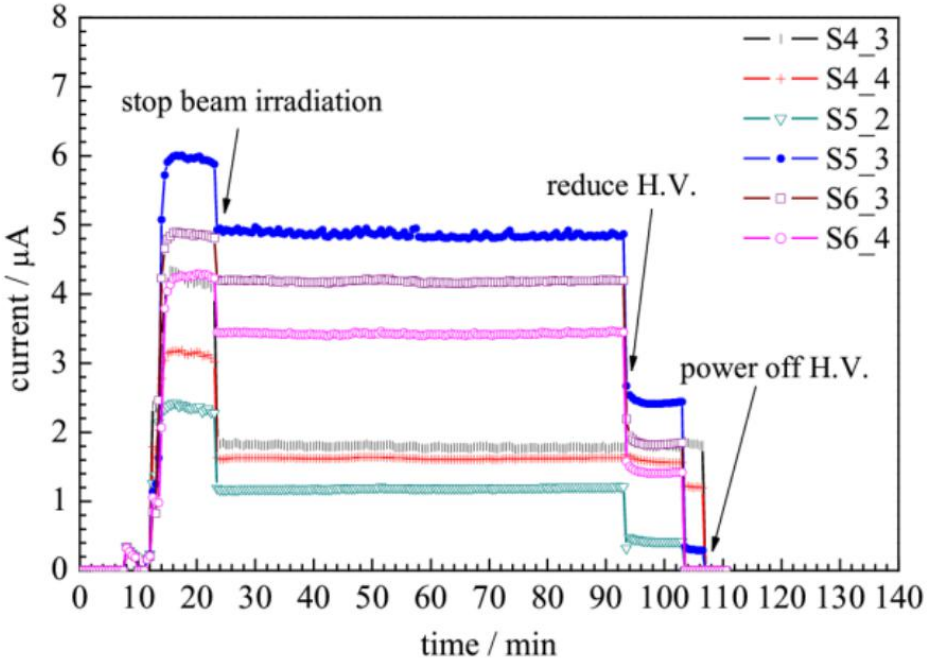
Cathode Aging Effect

Physics Picture of Malter effect



Influence on MDC performance

- BESIII drift chamber met the Malter effect in **January 2012.**
  - lots of cells, especially inner layers, tripped when taking data.
  - the large current did not disappear even after stopping the beam irradiation, until the high voltage in the cell was powered off.



➢ neighboring cells share the same field(cathode) wires, Malter discharge spread fast in the inner chamber

- more and more affected cells that cannot work.

Solution Method

- From February 27 to March 30, added 5% CO_2 to the operating gas
  - but gas gain lost obviously (23%)
- Since April 1, about 0.2% water vapor, which replaced the previous CO2, added to the operating gas.
  - worked well
  - gain decreased about 9%.
  - No Malter discharge has been observed since then

Summary

- After many years' data taking, the Main Drift Chamber meets aging effects.
- **For anode aging**
  - the cell gain decreases year by year
  - the influence on data is **under control** and **could be calibrated**
- **For Cathode aging**
  - seriously affect the data taking
  - solved by changing the operating gas
- If you need to use the 2012 Psip data sample, *be careful* !
  - for example, Ryuta's work. two charged pions should be reconstructed in MDC.