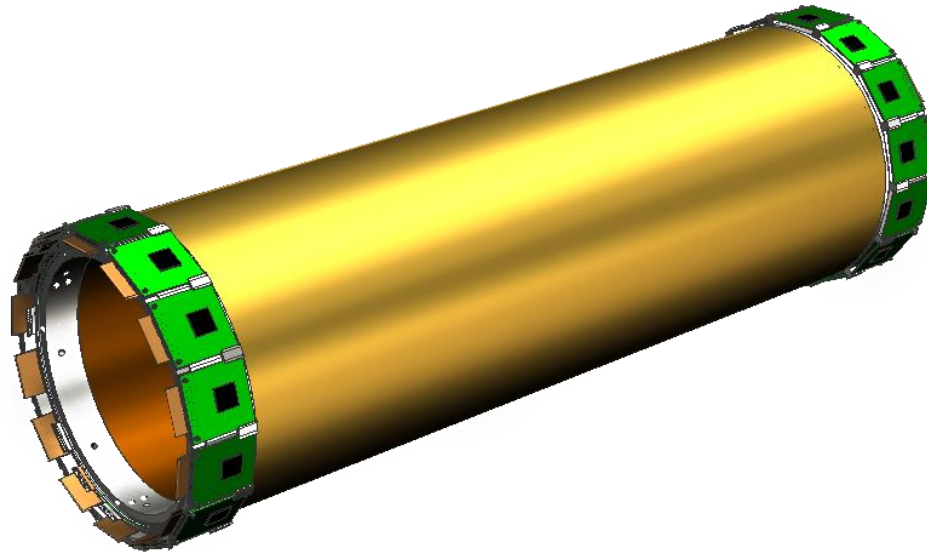




# CGEM-IT project and beam test program



*G. Felici for the FE-LNF-TO team*

*Partially supported by the Italian Ministry of Foreign Affairs under the Program of Great Relevance  
PGR-00136*

# Beijing Electron Positron Collider-II (BEPCII)





# The BESIII Collaboration

Political Map of the World, June 1999

<http://bes3.ihep.ac.cn>



# BESIII Detector

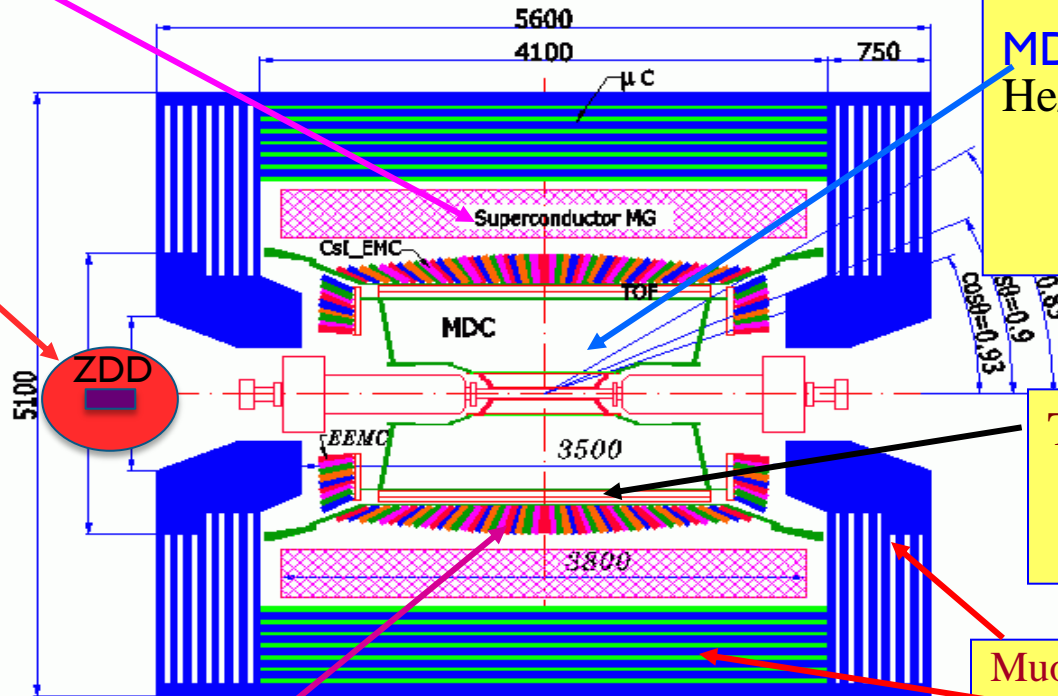
CSI calorimeter

Precision tracking

Time-of-flight +  $dE/dx$  PID

Magnet: 1 T Super conducting

Zero Degree  
Detector  
new (2011)



MDC: small cell & Gas:  
He/C<sub>3</sub>H<sub>8</sub> (60/40), 43 layers  
 $\sigma_{xy} = 130 \mu\text{m}$   
 $\sigma_p/p = 0.5\% @ 1\text{GeV}$   
 $dE/dx = 6\%$

TOF:

$\sigma_T = 100 \text{ ps}$  Barrel  
110 ps Endcap

Muon ID: 9 layers RPC  
8 layers for endcap

EMC: CsI crystal, 28 cm  
 $\Delta E/E = 2.5\% @ 1 \text{ GeV}$   
 $\sigma_Z = 0.6 \text{ cm}/\sqrt{E}$

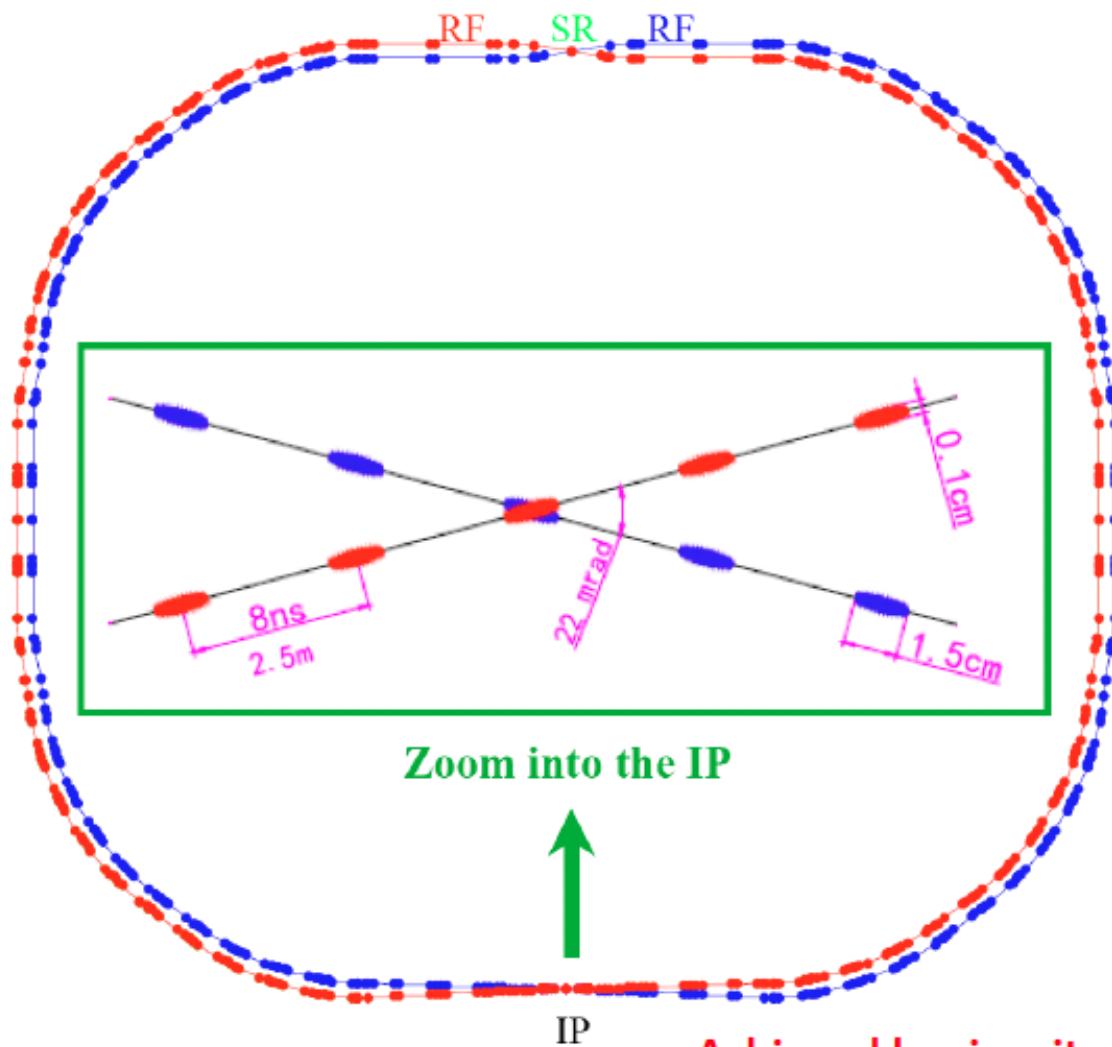
Data Acquisition:

Event rate = 4 kHz

Total data volume ~ 50 MB/s

The detector is hermetic for neutral and charged particle  
with excellent resolution, PID, and large coverage.

# BEPCLII storage rings



Beam energy:

**1.0-2.3 GeV**

Design Luminosity:

$1 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$

Optimum energy:

**1.89 GeV**

Energy spread:

$5.16 \times 10^{-4}$

No. of bunches:

**93**

Bunch length:

**1.5 cm**

Total current:

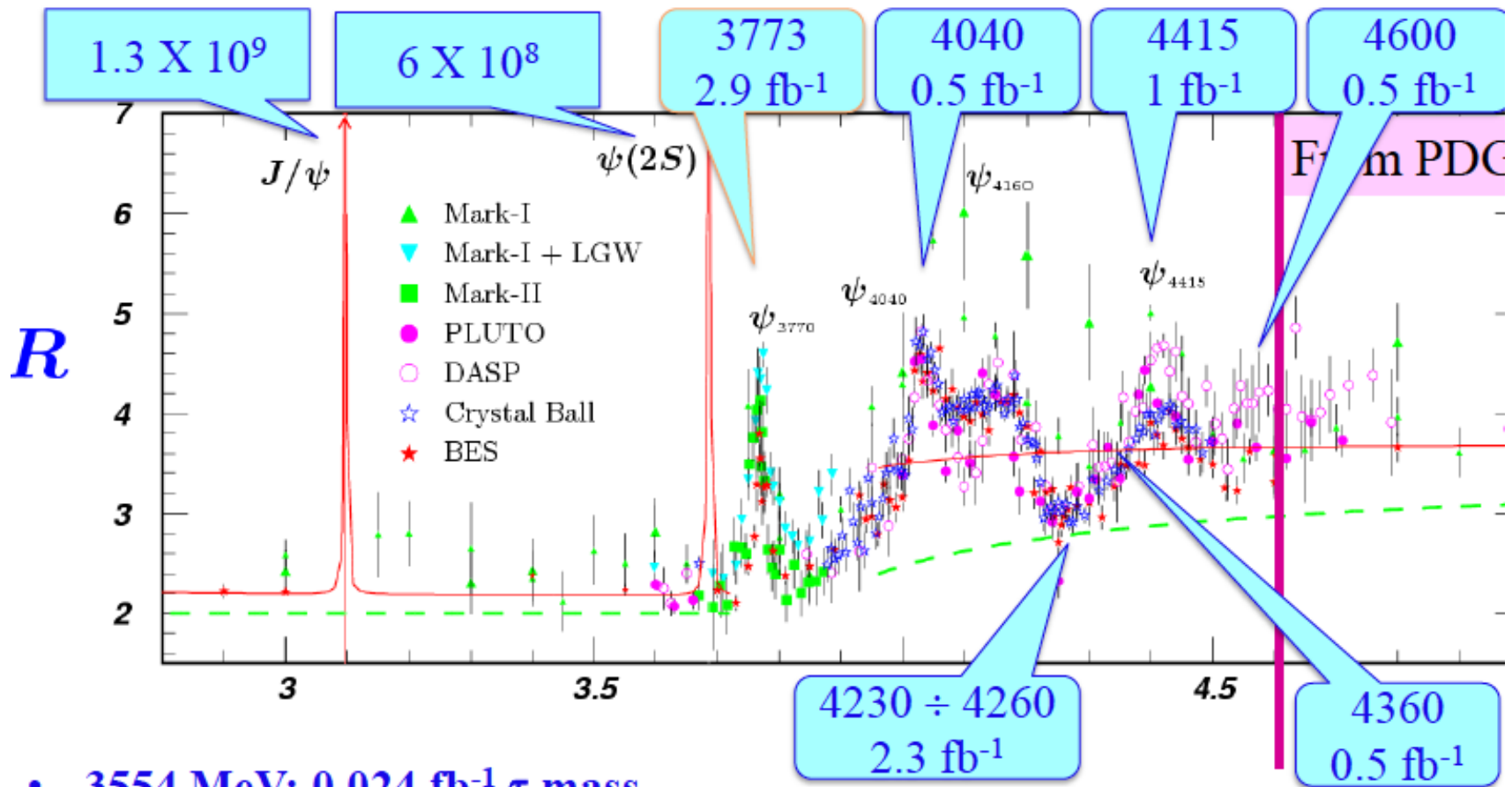
**0.91 A**

Circumference:

**237m**

**Achieved luminosity:  $0.7 \times 10^{32} \text{ cm}^{-2}\text{s}^{-1}$  @3770MeV**

# BESIII data set



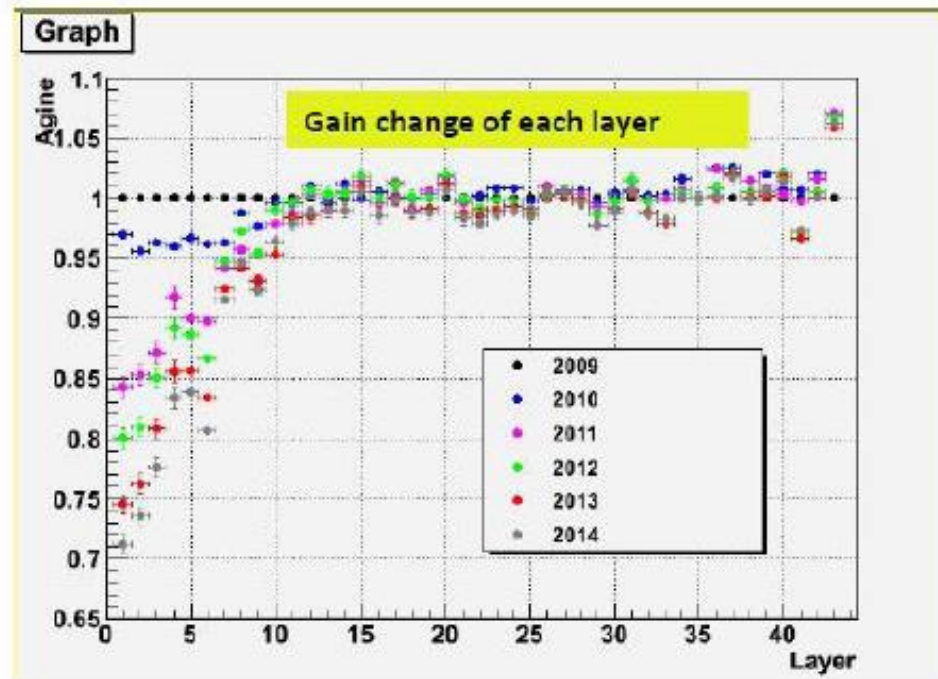
BEPCII can reach here!

- 3554 MeV: 0.024 fb<sup>-1</sup>  $\tau$  mass
- 4100 ÷ 4400 MeV: 0.5 fb<sup>-1</sup> coarse scan
- 3850 ÷ 4590 MeV: 0.5 fb<sup>-1</sup> fine scan



# BESIII Inner Tracker: MDC aging problems

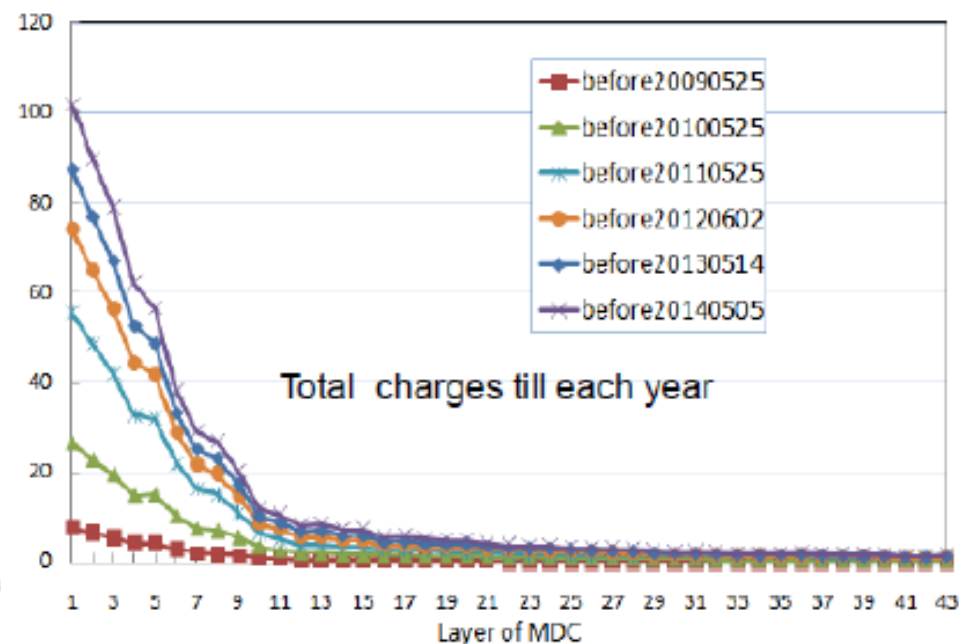
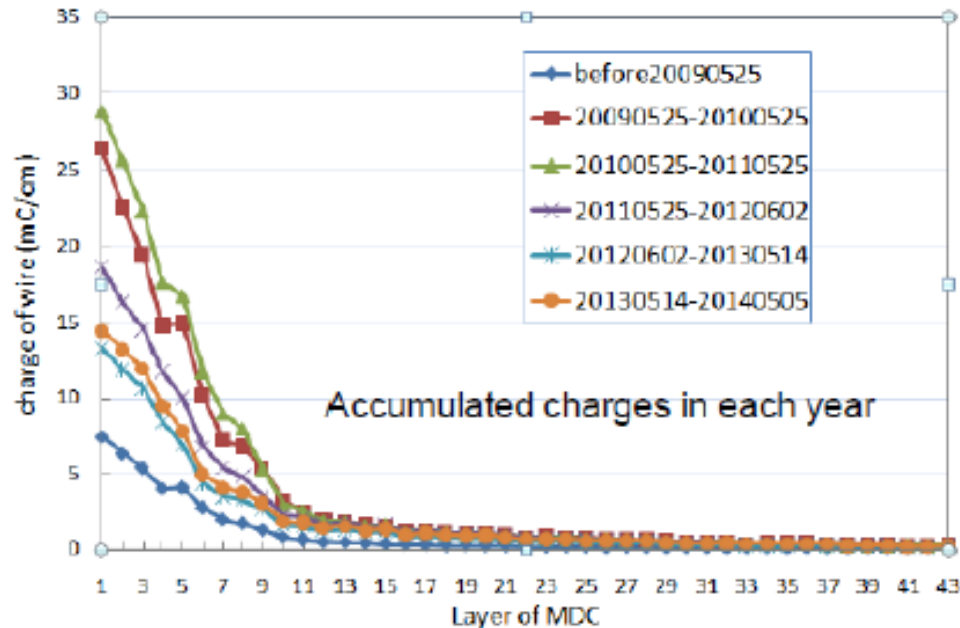
## Gain change from 2009-2014 with Bhabha events



- Compared with 2009, now the gas gains of first 5 layers decrease about 29% —14%
- The gains of the first 10 layers have an obvious decrease
- The gains of the layers in the outer chamber have nearly no change

# BESIII Inner Tracker: MDC aging problems

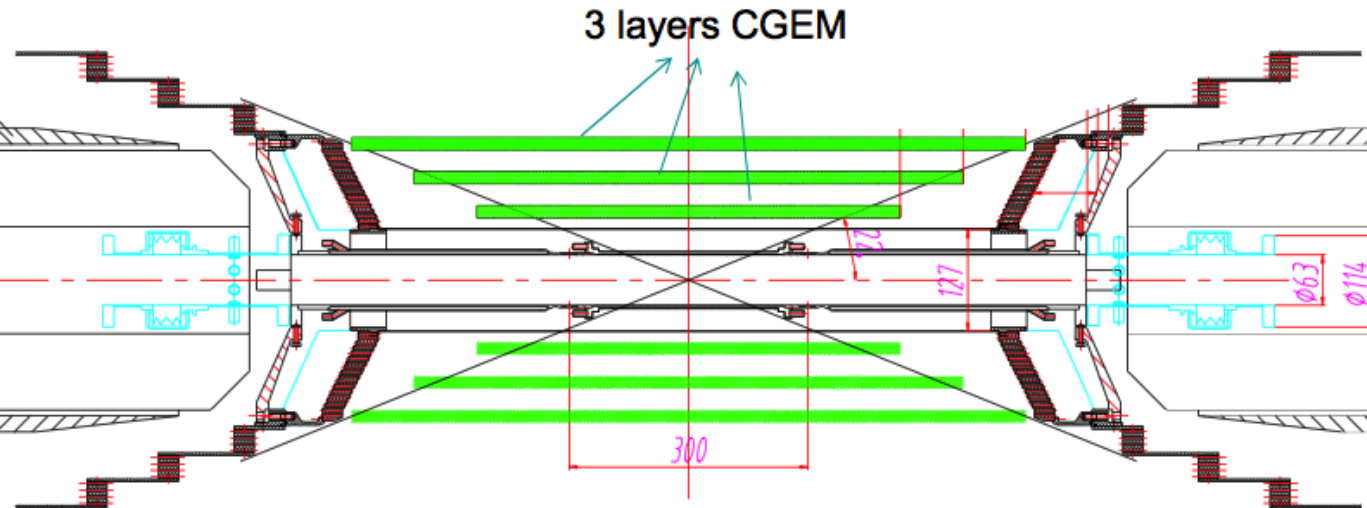
## Charge accumulation on INNER MDC



- accumulated charge evaluated by integrated dark currents on each wire
- total accumulated charge on first layer at 100mC/cm
- in the last two years the accumulated charges are at lower levels



# CGEM detector for BESIII

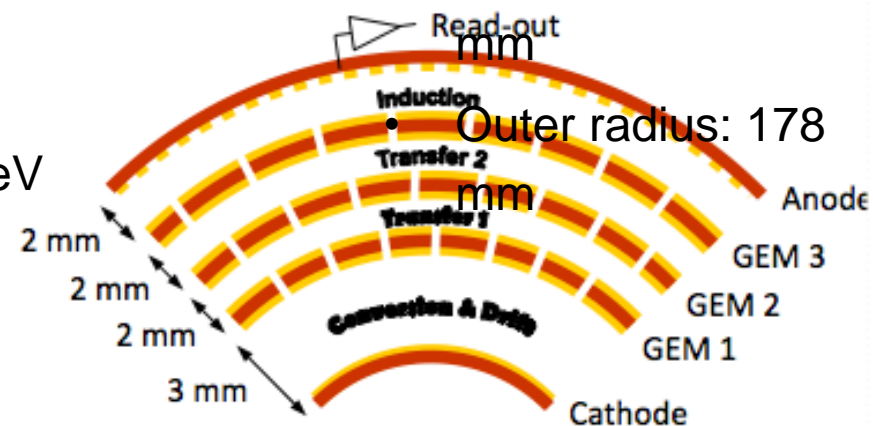


- Three active layers
- Active area
  - L1 length 532 mm
  - L2 length: 690 mm
  - L3 length: 847 mm

## Requirements

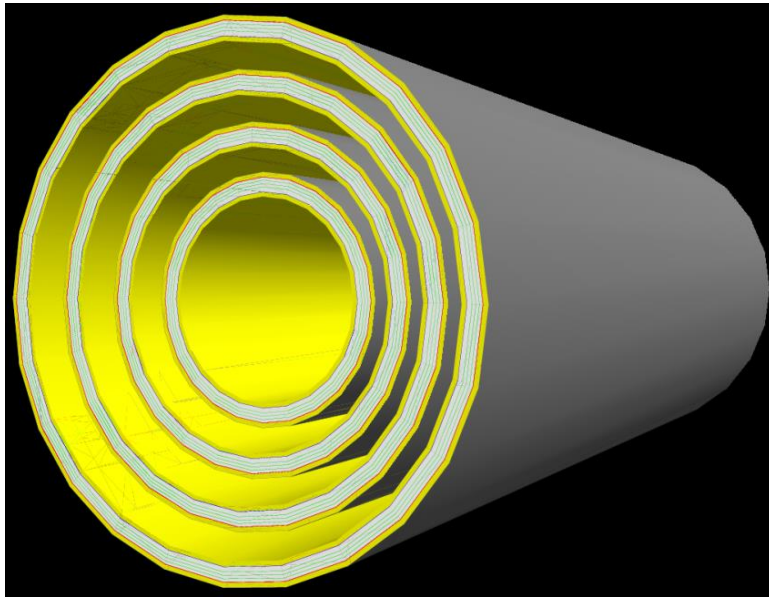
- Rate capability:  $\sim 10^4$  Hz/cm<sup>2</sup>
- Spatial resolution:  $\sigma_{xy} \sim 100\mu\text{m}$  :  $\sigma_z \sim 1\text{mm}$
- Momentum resolution:  $\sigma_{pt}/P_t \sim 0.5\%$  @ 1GeV
- Efficiency =  $\sim 98\%$
- Material budget  $\leq 1.5\%$  all layers
- Coverage: 93%  $4\pi$
- Operation duration  $\sim 5$  years

- Inner radius: 78 mm



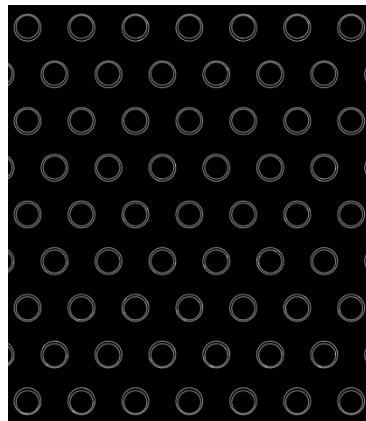
- Outer radius: 178 mm

# GEANT4 simulation

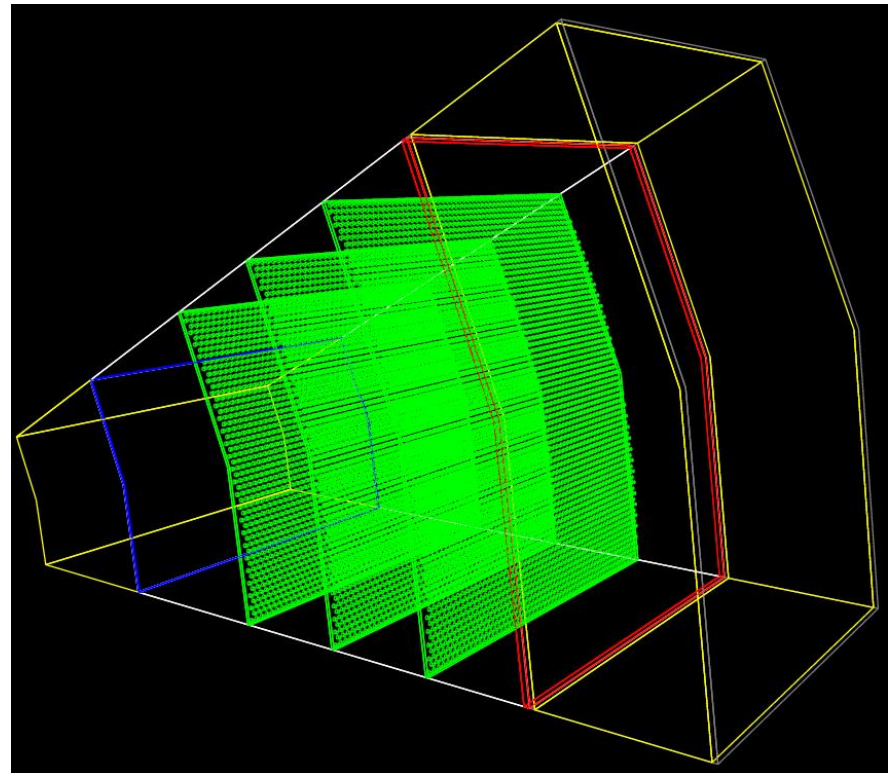


A lot of details in the simulation.

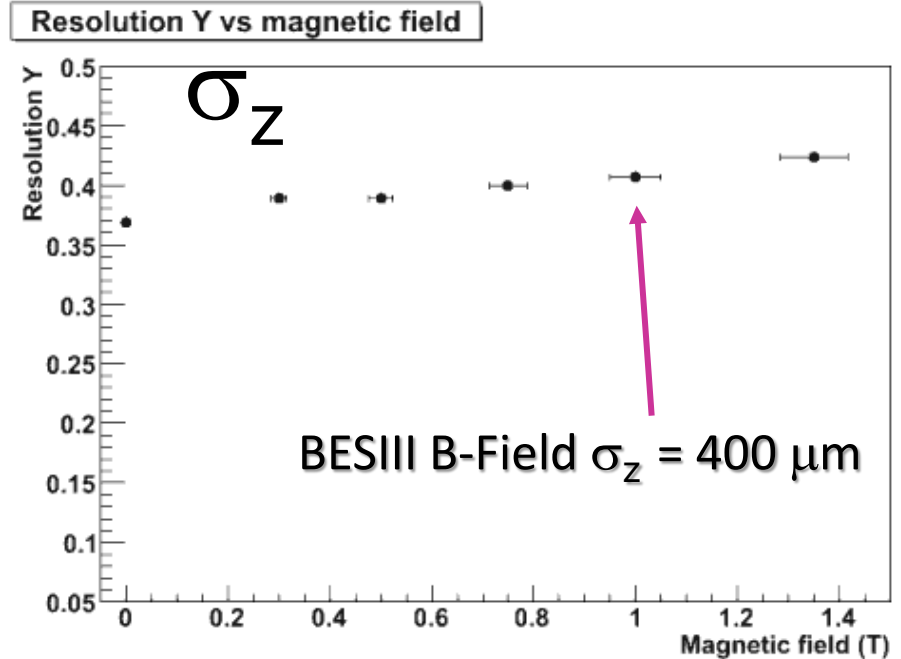
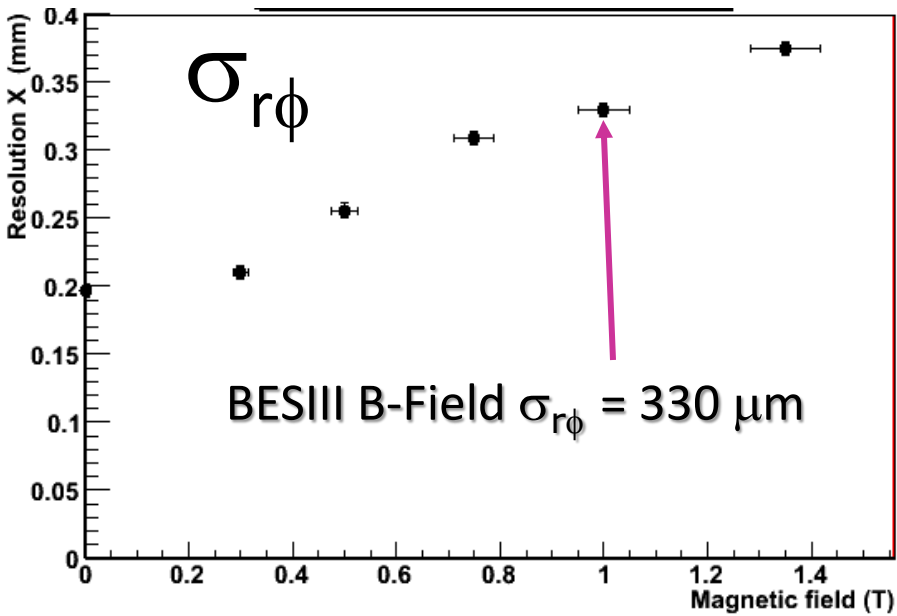
Reconstruction code needs to be developed to fully evaluate the impact on the physics.



A CGEM detector has been added to the BESIII simulation in order to preliminary evaluate its possible performance.



# CGEM expected performance



Readout	$\sigma_{r\phi}$ ( $\mu\text{m}$ )	$\sigma_z$ ( $\mu\text{m}$ )
Digital readout (Beam test @2009)	330	400
Analog readout (magnetic field effect avoided)*	80	150

\* Taken as expected spatial resolution





# Purpose of beam test(s) ...

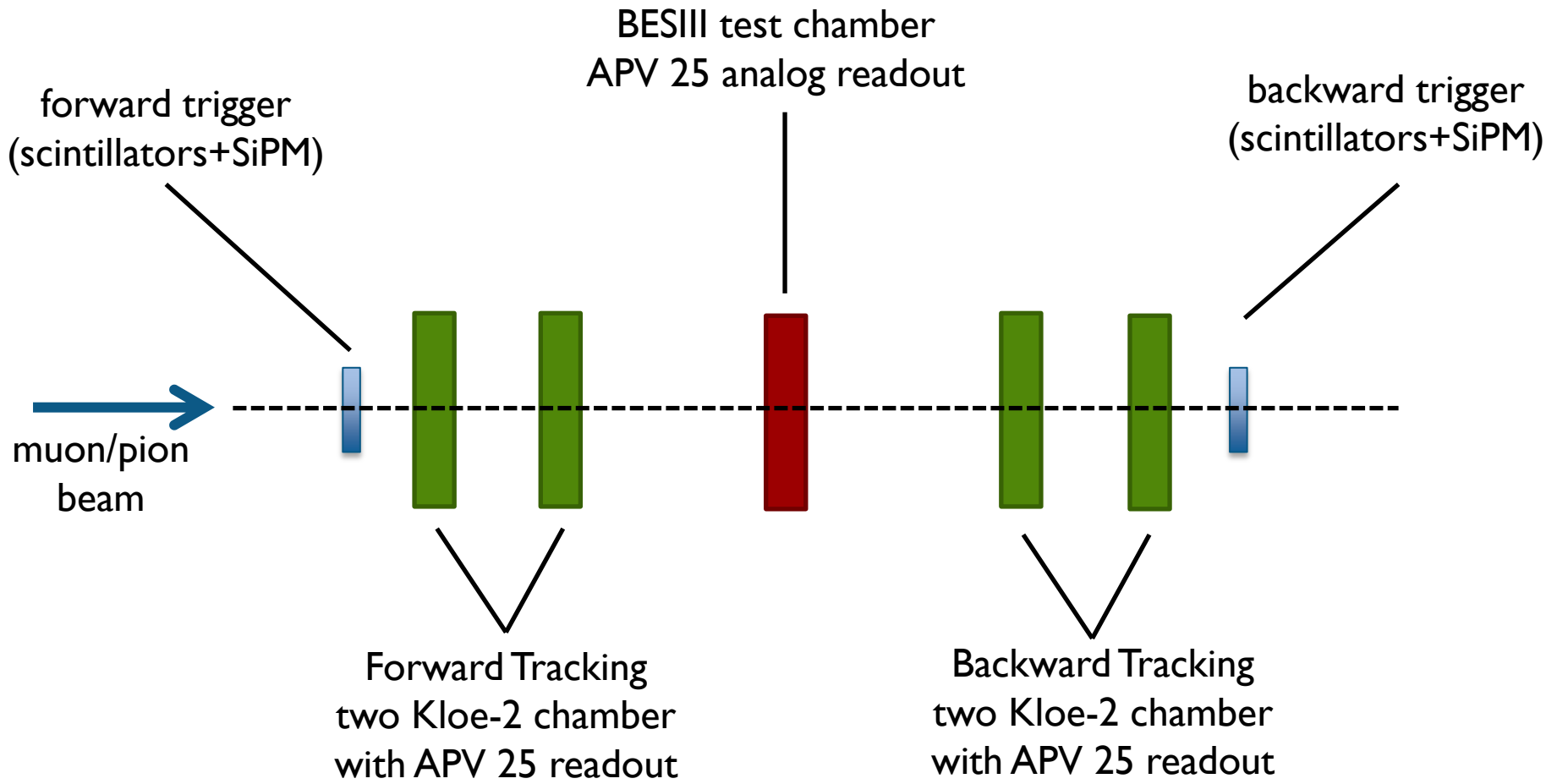
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- Validate GEM analog readout in magnetic field.
- Validate Garfield simulation and extract useful information for hit digitization.
- Validate the BESIII anode structure.

## ... & Some possible measurement to perform

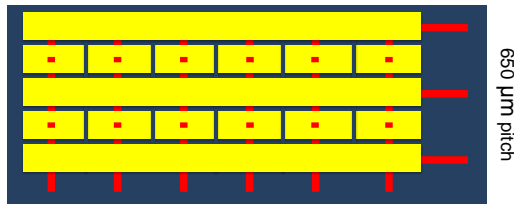
- Spatial resolution as function of the magnetic field
- Cluster size as function of the magnetic field
- Perform the same measurements at different gain
- Other measurements:
  - efficiency
  - different gas mixture

# BESIII beam test setup

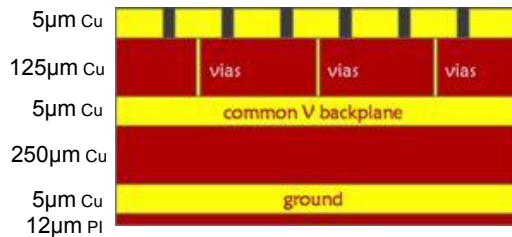


# BESIII beam test - readout anode design

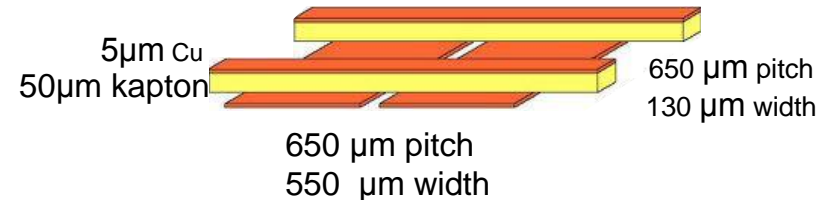
## KLOE strips design TRACKING CHAMBERS



650  $\mu\text{m}$  pitch

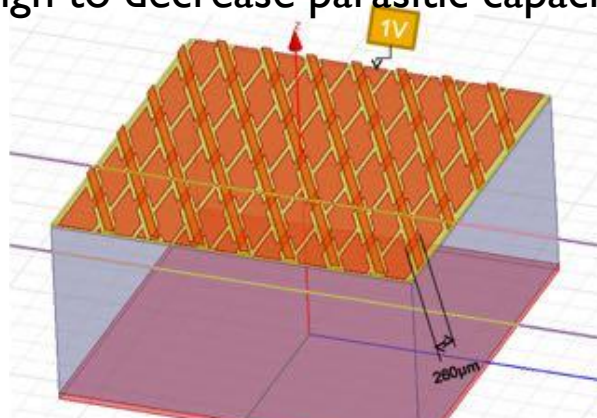


## BES strips design – rel COMPASS LIKE



## BES strips design – rel2

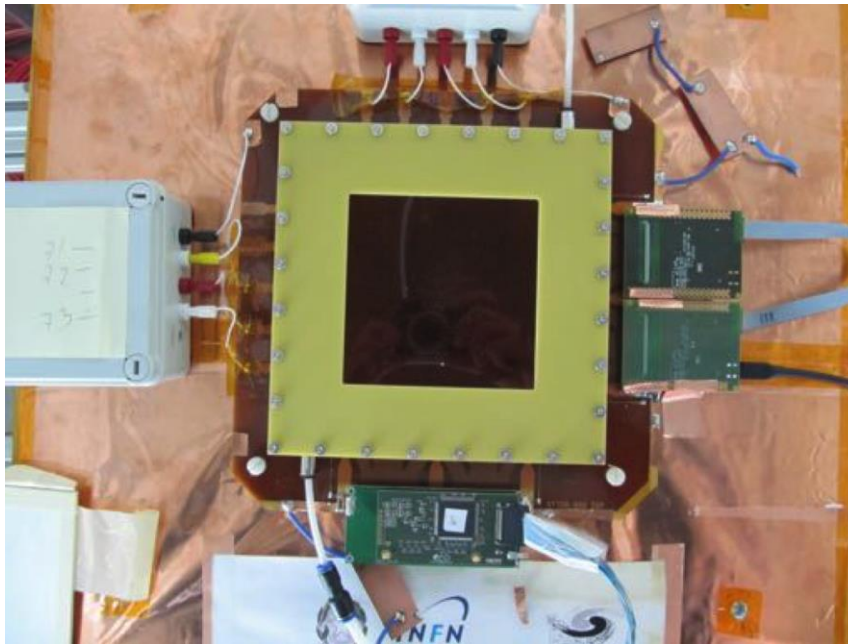
Tilted Angle + Jagged design to decrease parasitic capacitance (-30% from simulations)





# BESIII beam test – Readout

DATA ACQUISITION SUPPORTS FULLY ANALOG, FULLY DIGITAL AS WELL AS MIXED MODE READOUT



GASTONE  
(DIGITAL – 128 chs)

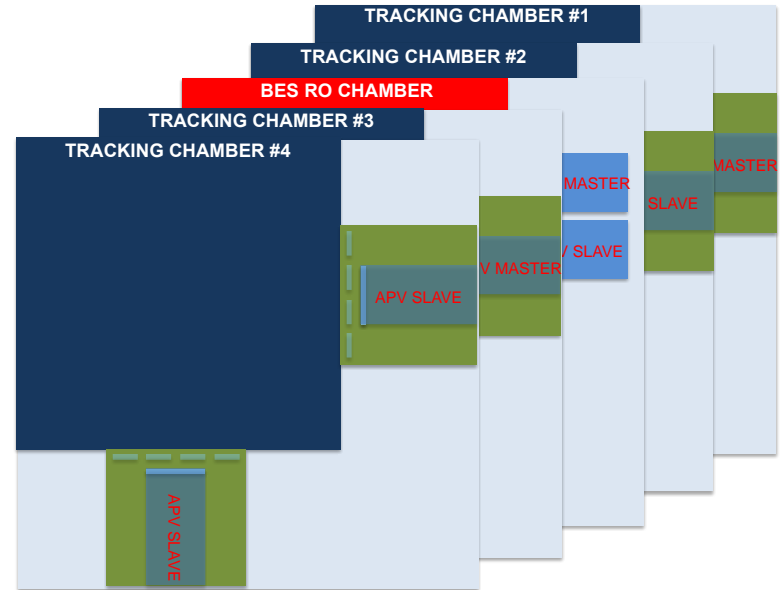
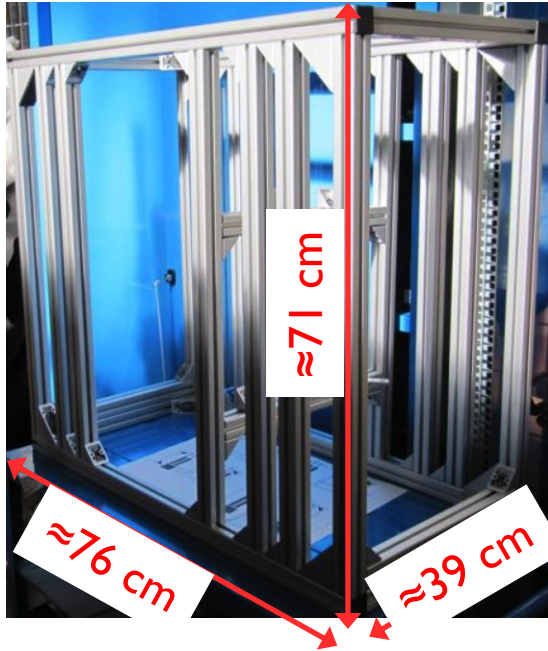
APV25  
(ANALOG – 128 chs)

# BESIII beam test – Setup

≈ 1300 ANALOG RO channels

MAGNET

CHAMBERS SUPPORT

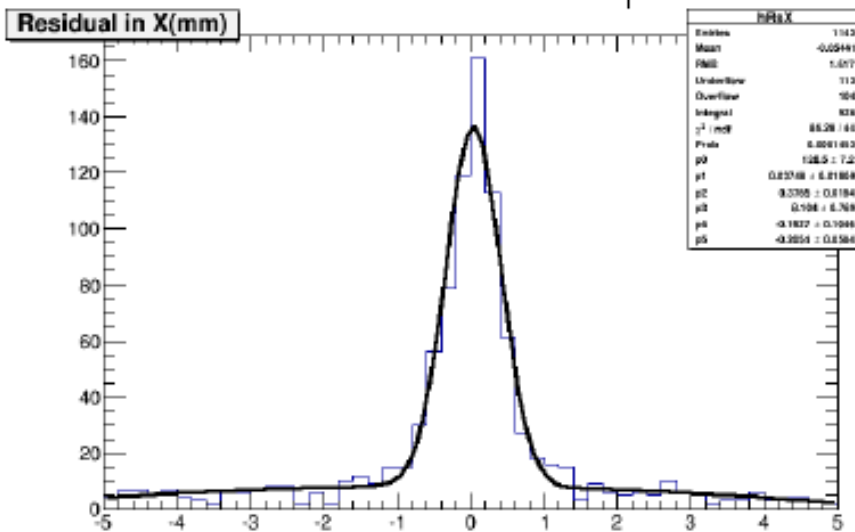


BEAM AREA



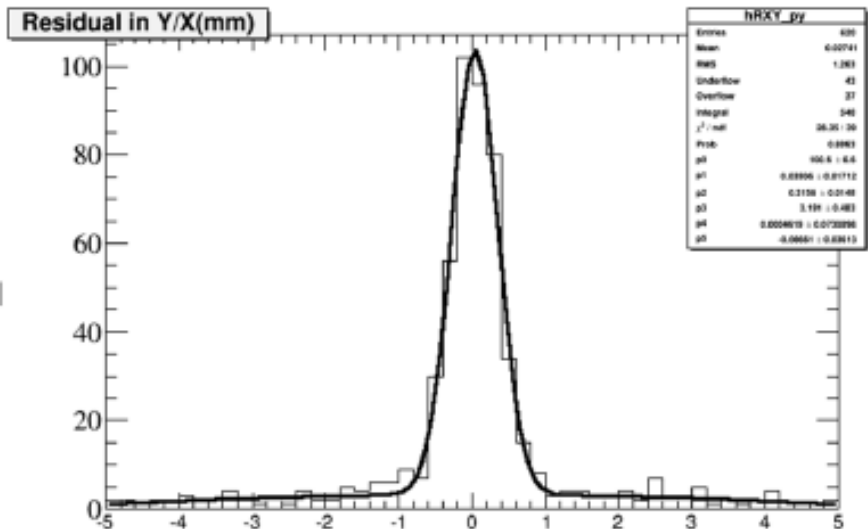
# Cosmic data: Spatial resolution

with digital readout



$$\sigma_x = (402 \pm 23) \mu\text{m}$$

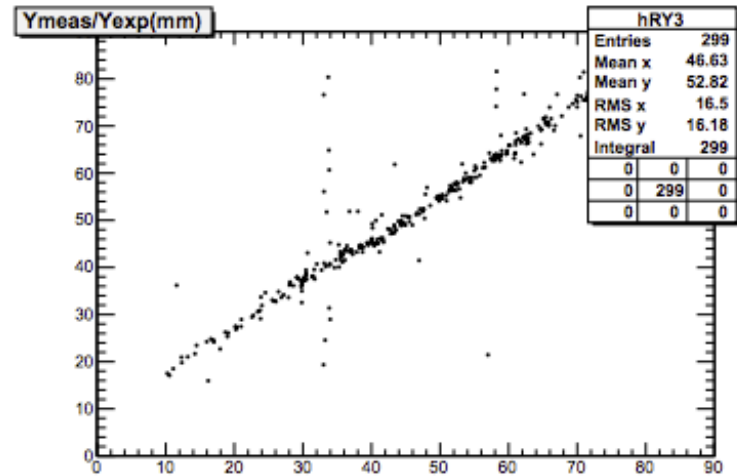
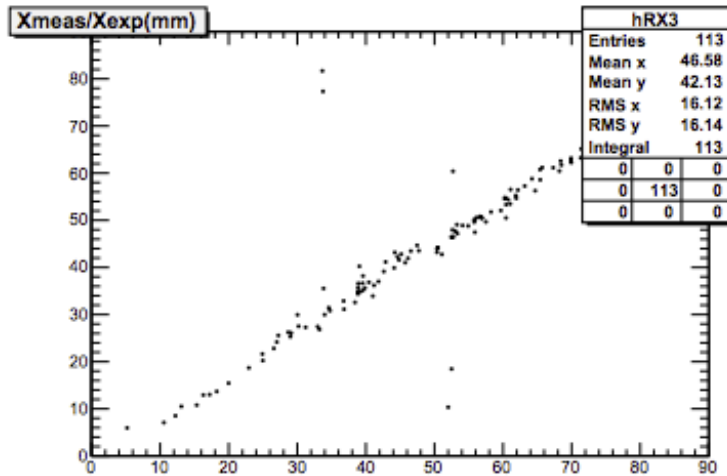
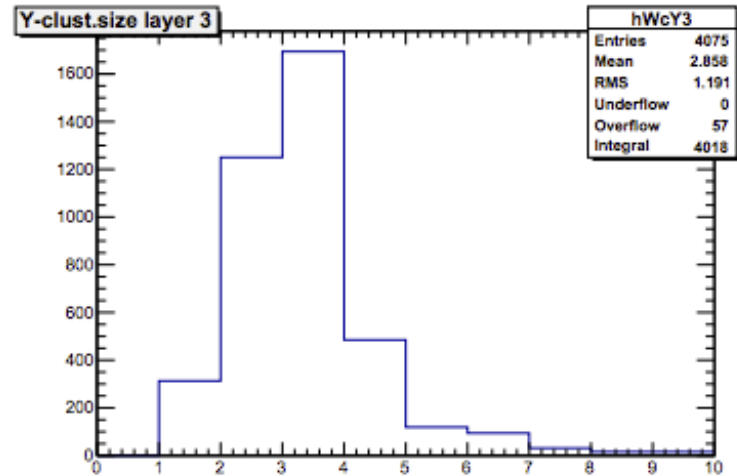
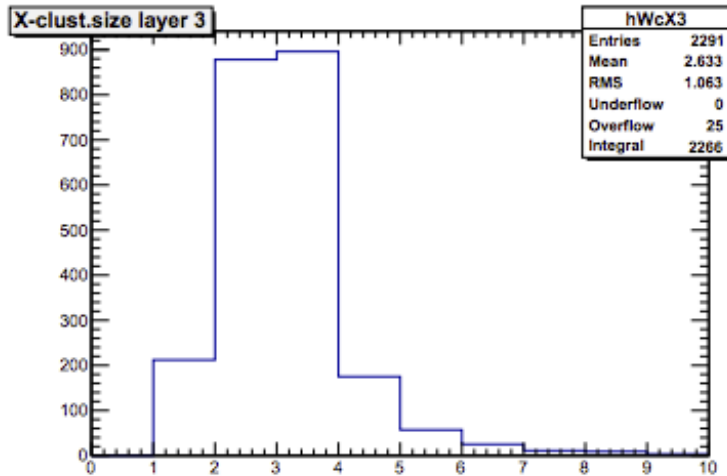
$$\sigma_y = (316 \pm 15) \mu\text{m}$$



courtesy of Sandro Calcaterra



# Cosmic data: Cluster size



courtesy of Sandro Calcaterra

# Summary

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- Data acquisition based on APV25 system run smoothly (ATLAS parameters setup and DAQ system).
- Integration of tracking chambers, BES proto and mechanical structure is going on
- Setup details have been already discussed with RD51 collaboration.
- Beam test will start on Nov 26 and end on Dec 14