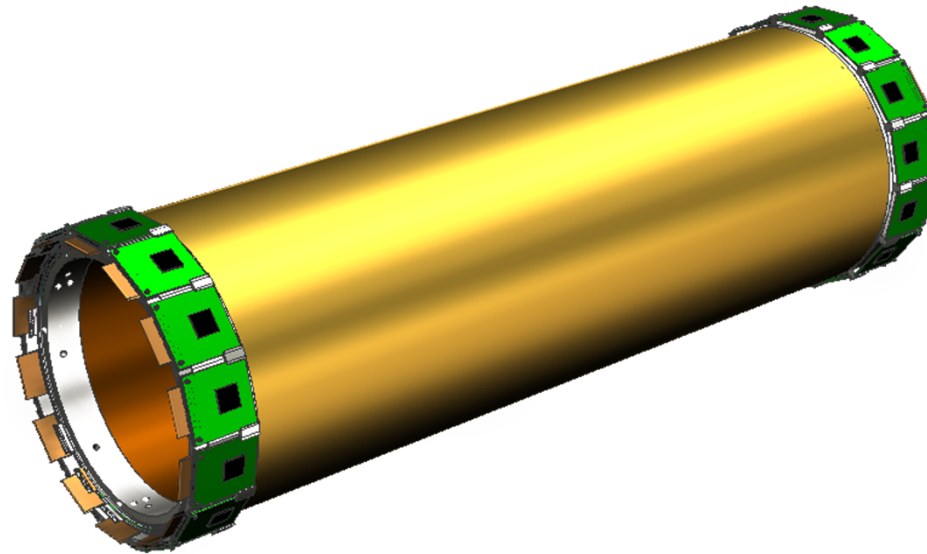




CGEM-IT project and beam test program



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

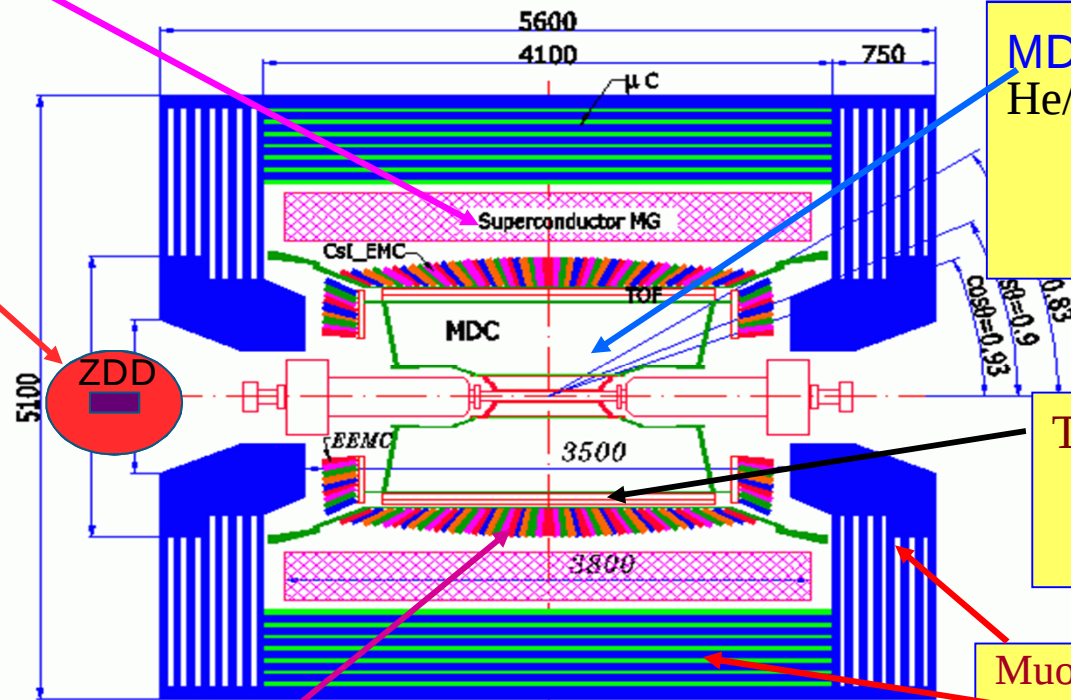
CSI calorimeter

Precision tracking

Time-of-flight + dE/dx PID

Magnet: 1 T Super conducting

Zero Degree
Detector
new (2011)



MDC: small cell & Gas:
He/C₃H₈ (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

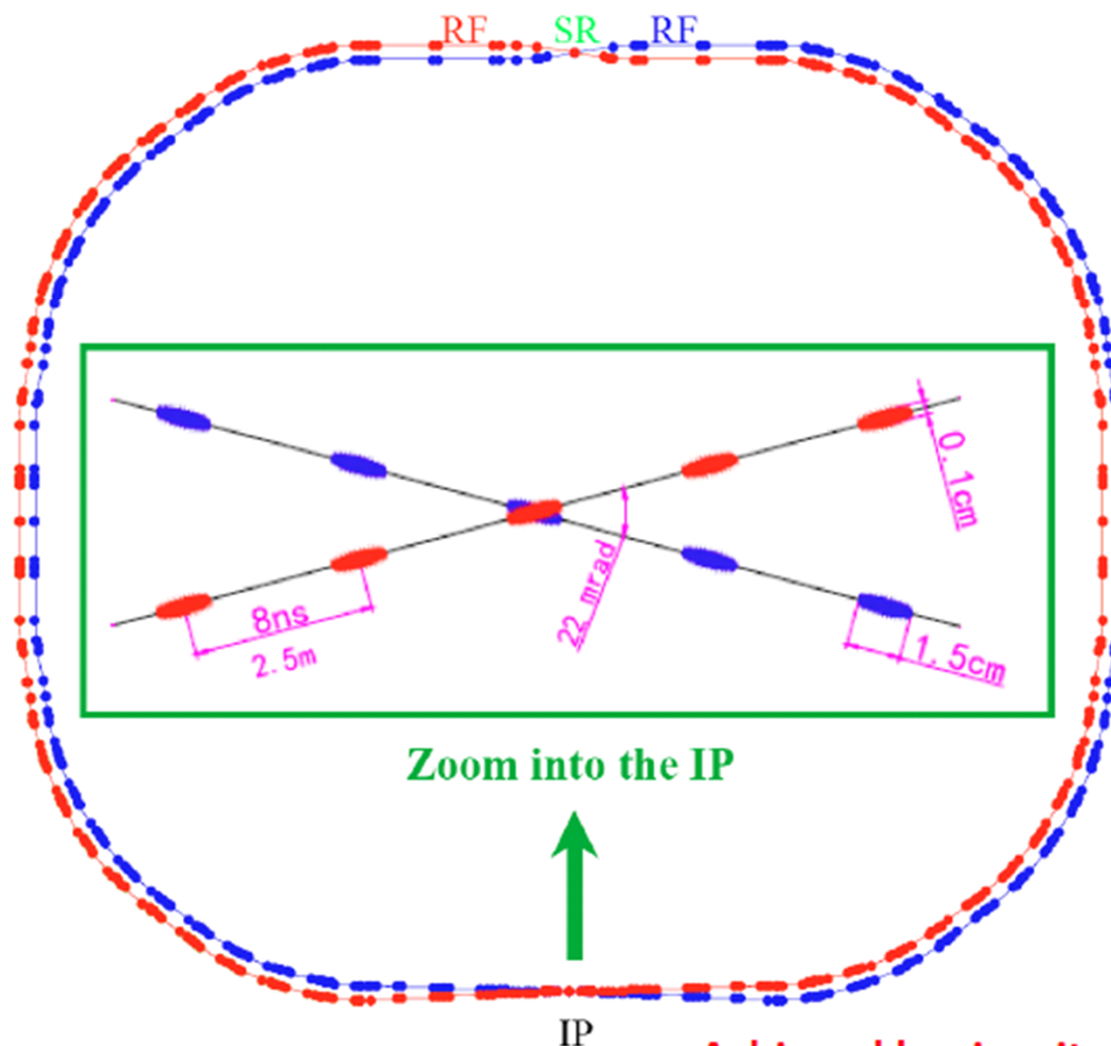
Muon ID: 9 layers RPC
8 layers for endcap

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.

BEPCII 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:

5.16×10^{-4}

No. of bunches:

93

Bunch length:

1.5 cm

Total current:

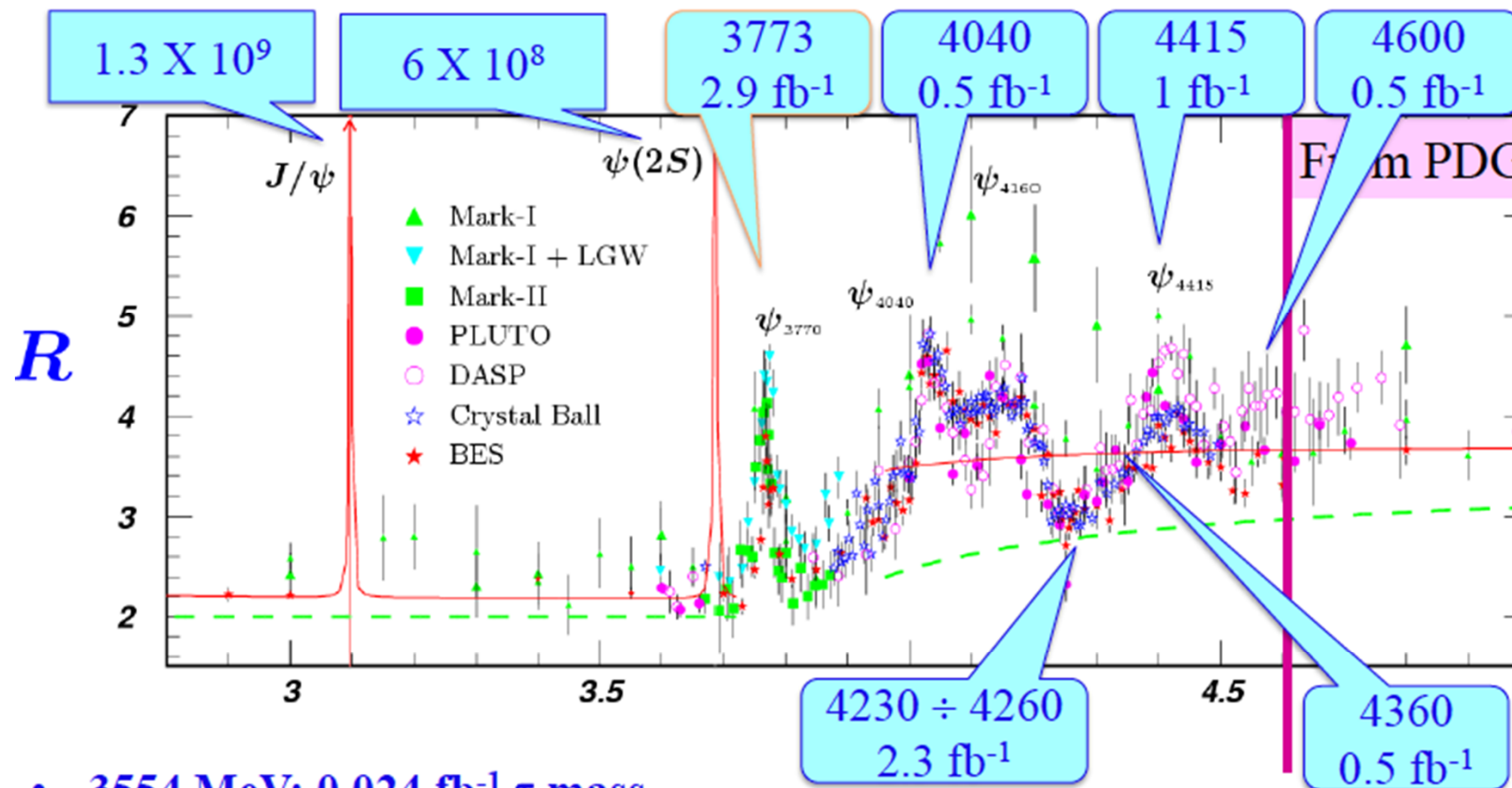
0.91 A

Circumference:

237m

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

BESIII data set

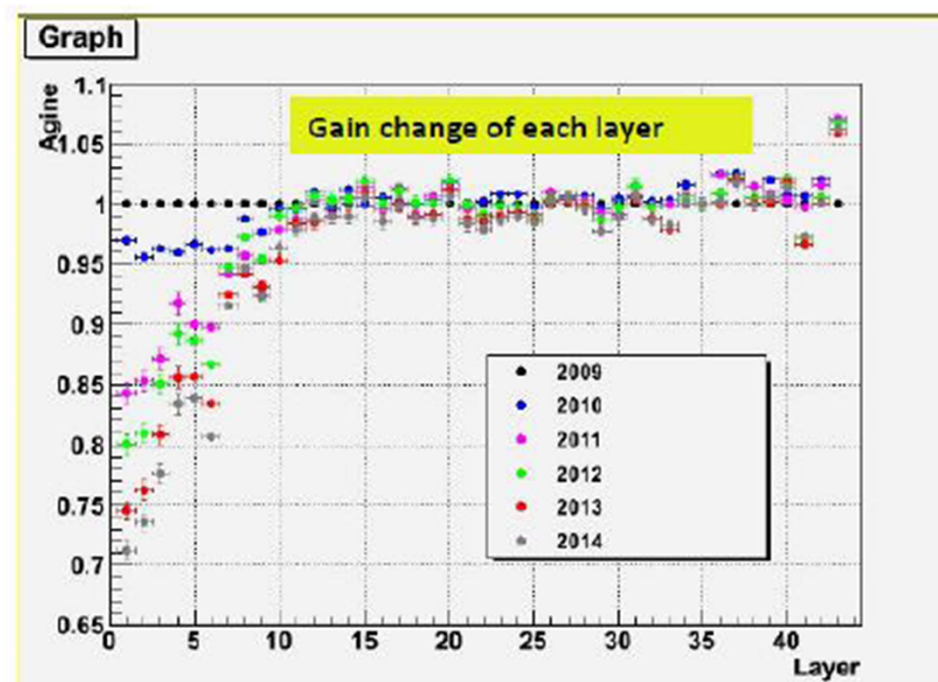


- 3554 MeV: 0.024 fb^{-1} τ mass
- 4100 ÷ 4400 MeV: 0.5 fb^{-1} coarse scan
- 3850 ÷ 4590 MeV: 0.5 fb^{-1} fine scan

BEPCII can reach here!

BESIII Inner Tracker: MDC aging problems

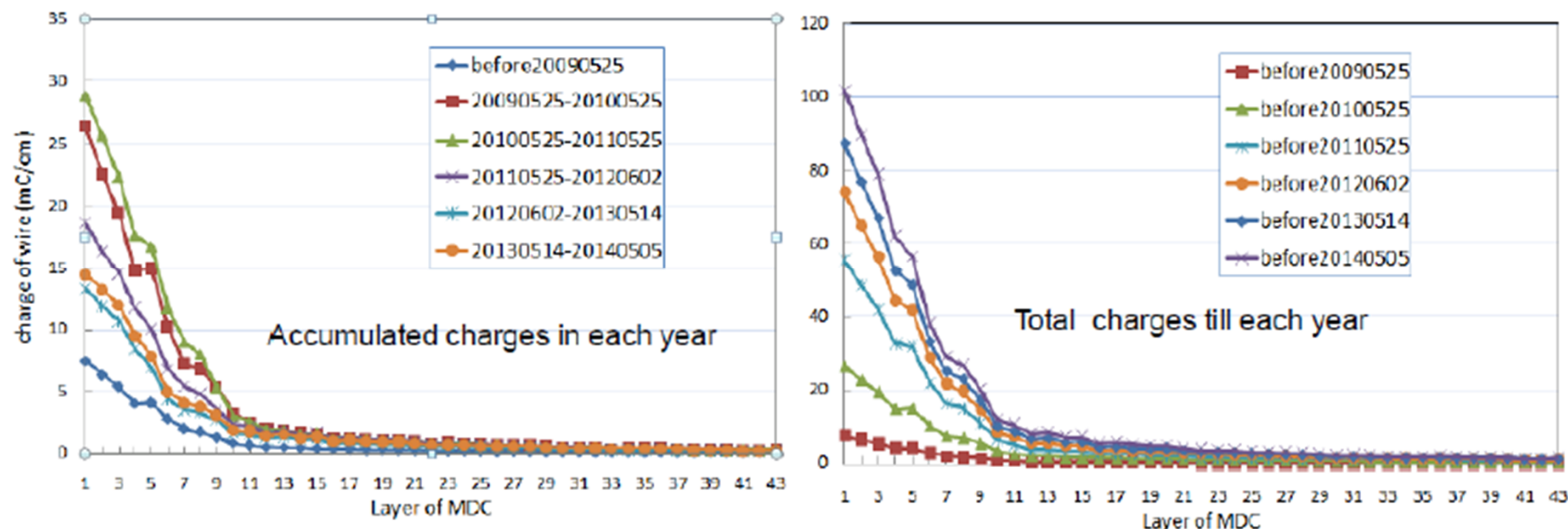
Gain change from 2009-2014 with Bhabha events



- 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

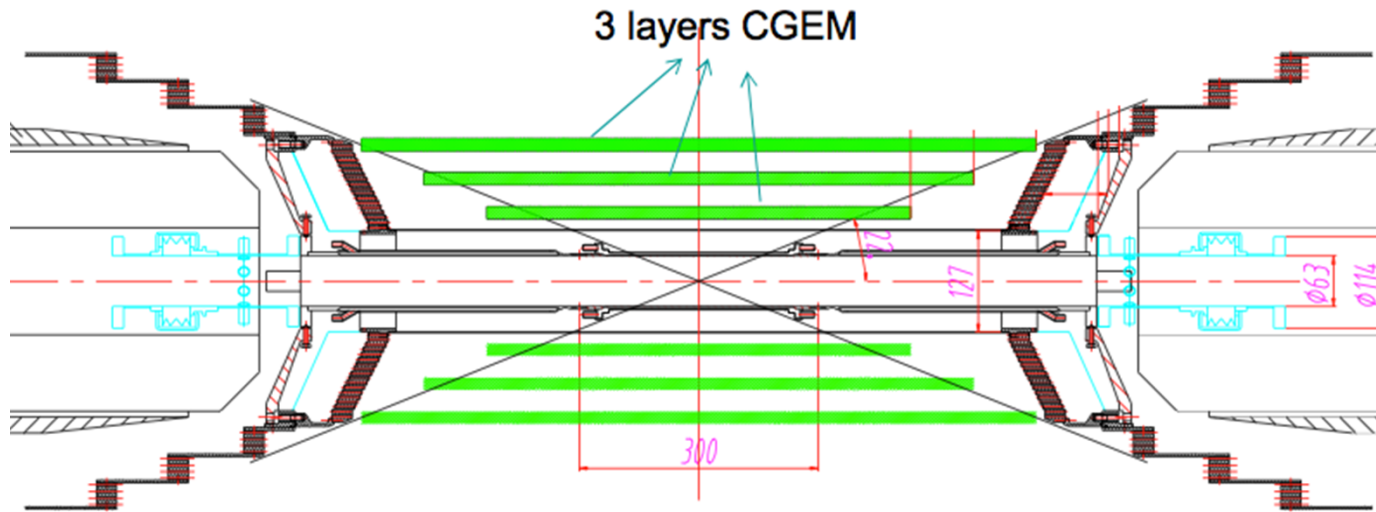
BESIII Inner Tracker: MDC aging problems

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

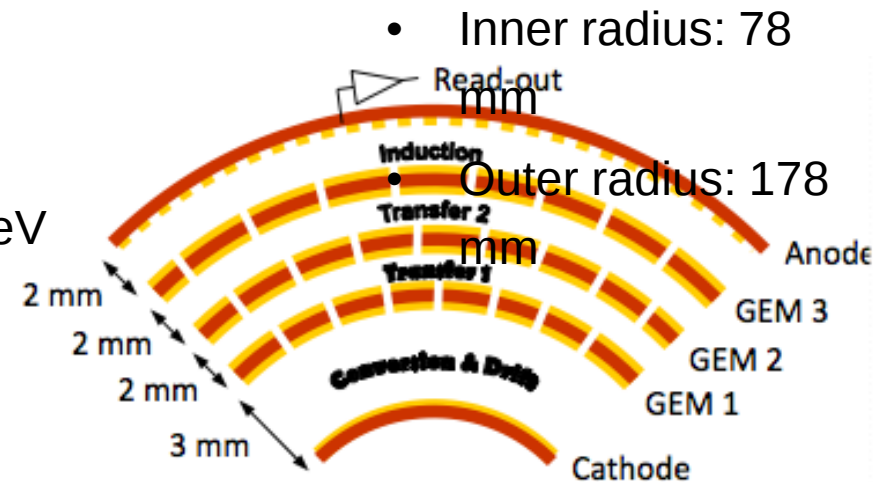
CGEM detector for BESIII



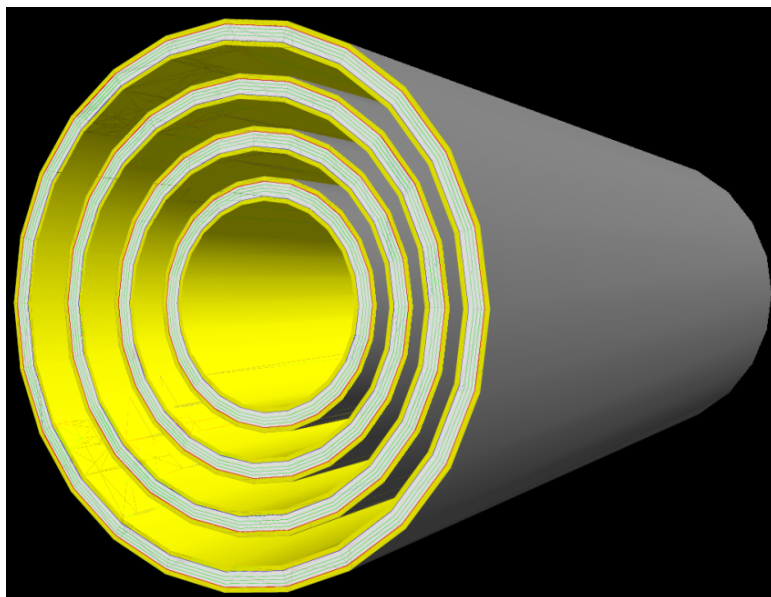
- Three active layers
- Active area
 - L1 length 532 mm
 - L2 length: 690 mm
 - L3 length: 847 mm

Requirements

- Rate capability: $\sim 10^4$ Hz/cm²
- Spatial resolution: $\sigma_{xy} \sim 100 \mu\text{m}$: $\sigma_z \sim 1$ mm
- Momentum resolution: $\sigma_{pt}/P_t \sim 0.5\%$ @ 1 GeV
- Efficiency = $\sim 98\%$
- Material budget $\leq 1.5\%$ all layers
- Coverage: 93% 4 π
- Operation duration ~ 5 years

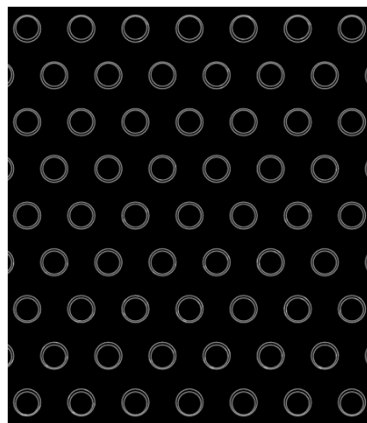


GEANT4 simulation

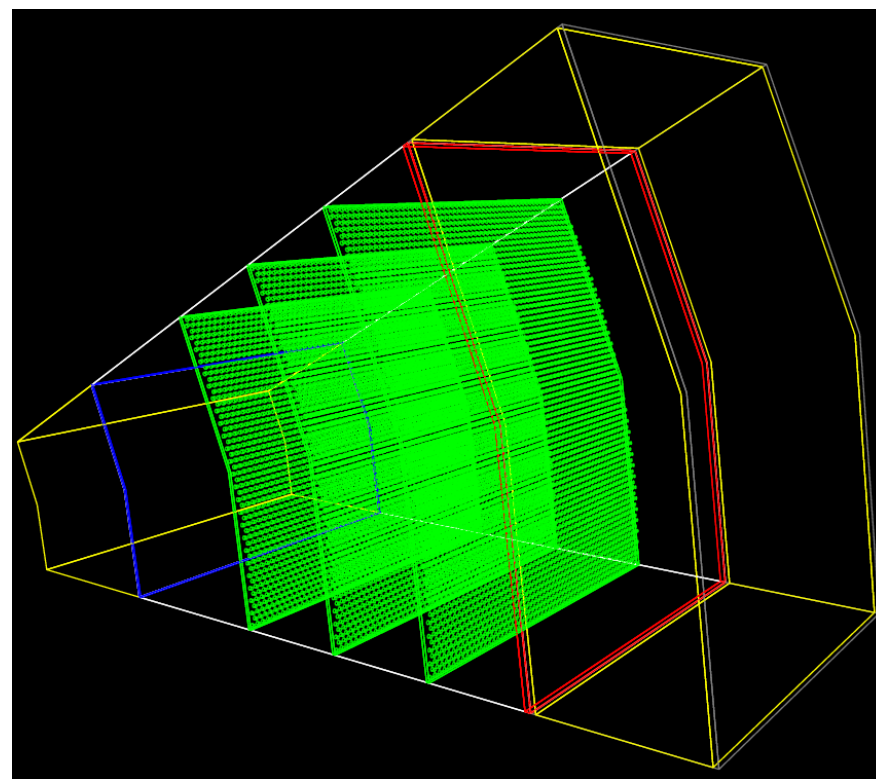


A lot of details in the simulation.

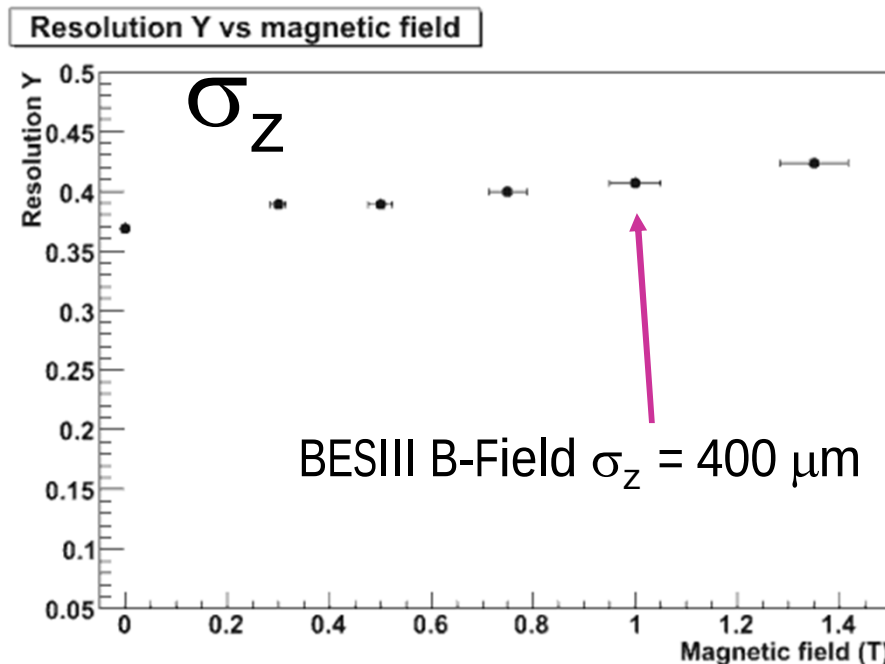
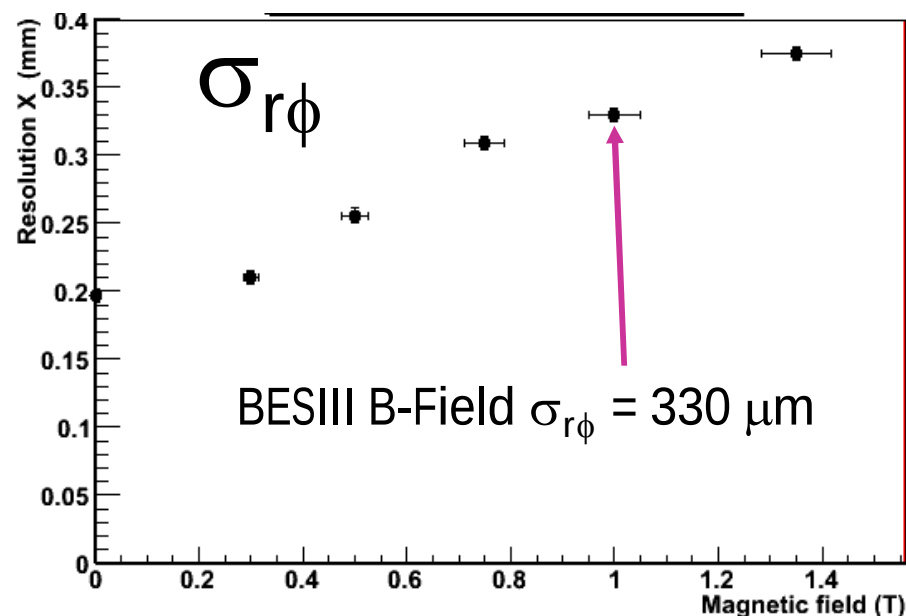
Reconstruction code needs to be developed to fully evaluate the impact on the physics.



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

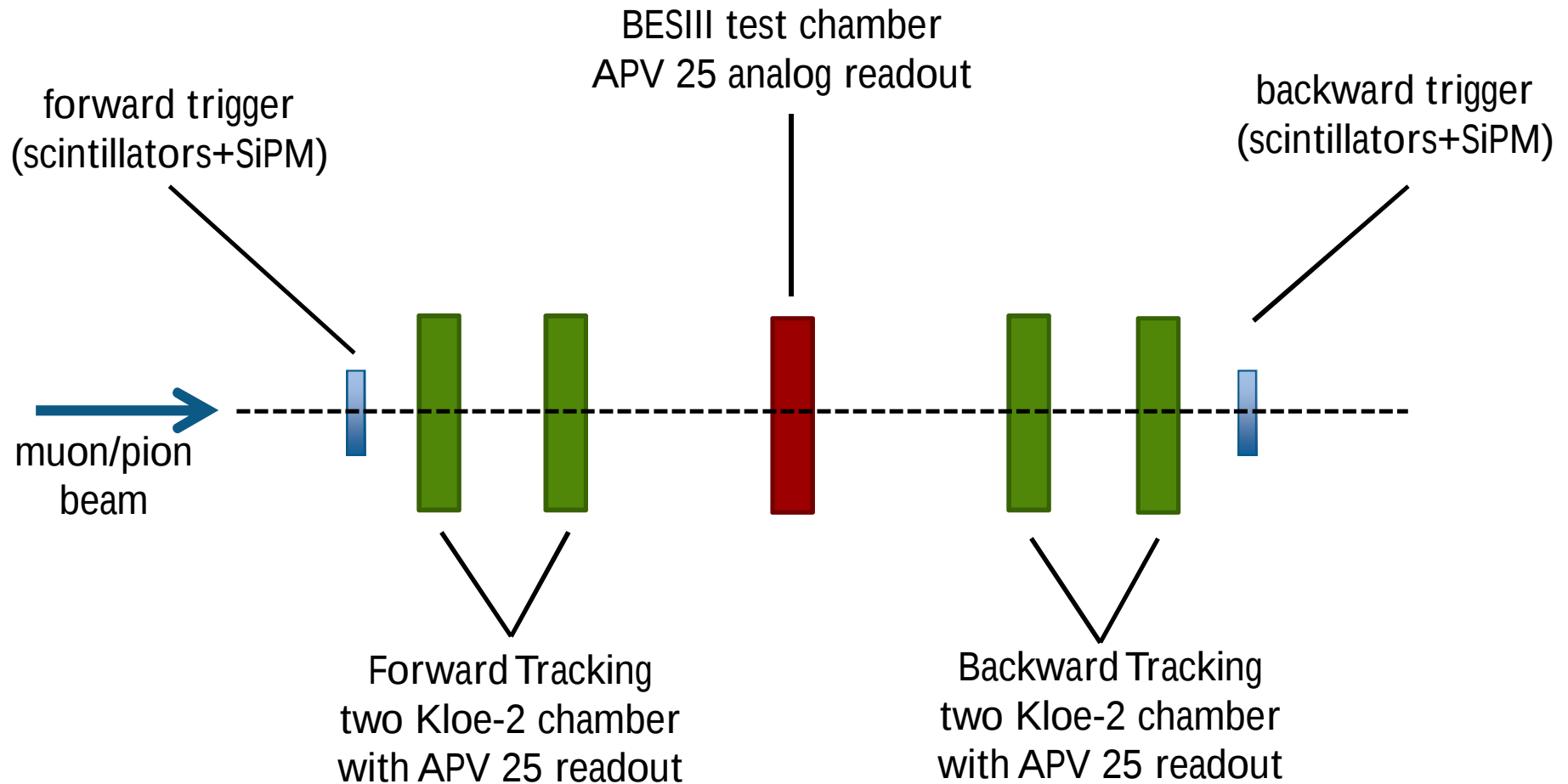
Purpose of beam test(s) ...

- 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

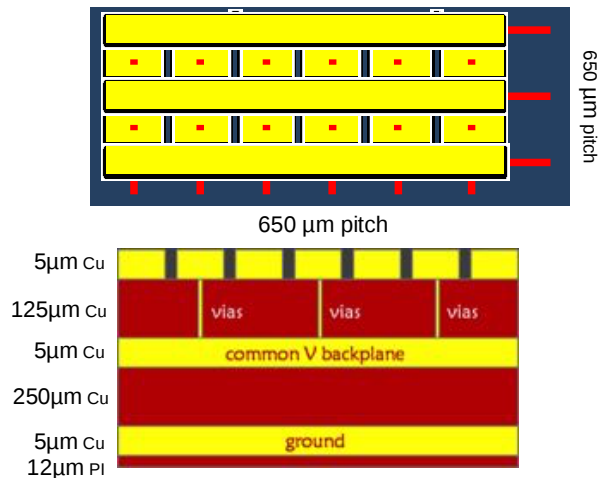
- Spatial resolution as function of the magnetic field
- Cluster size as function of the magnetic field
- Perform the same measurements at different gain
- Other measurements:
 - efficiency
 - different gas mixture

BESIII beam test setup

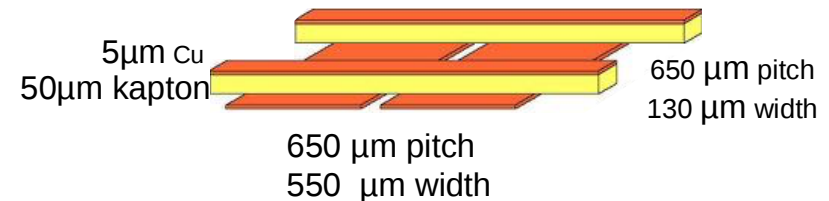


BESIII beam test - readout anode design

KLOE strips design TRACKING CHAMBERS

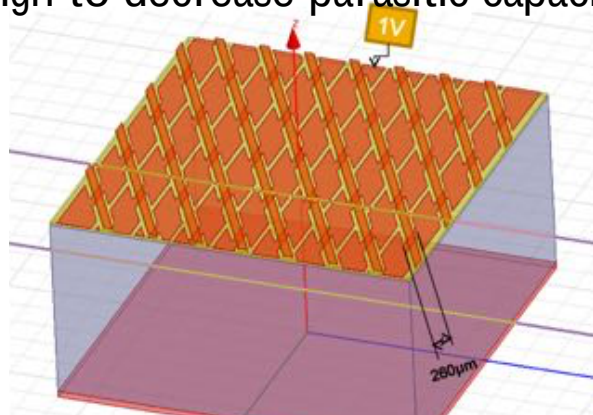


BES strips design – rel1 COMPASS LIKE



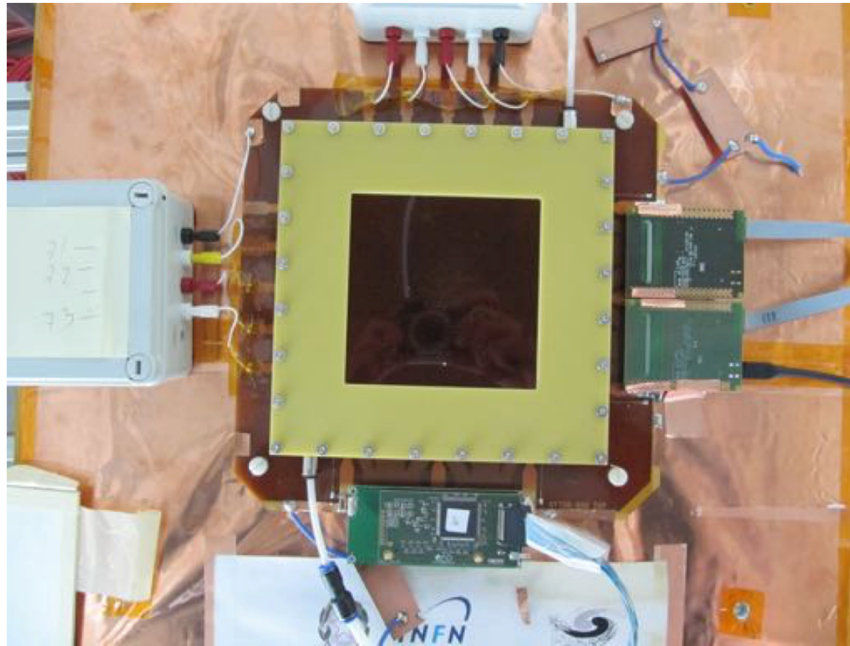
BES strips design – rel2

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



APV25
(ANALOG – 128 chs)

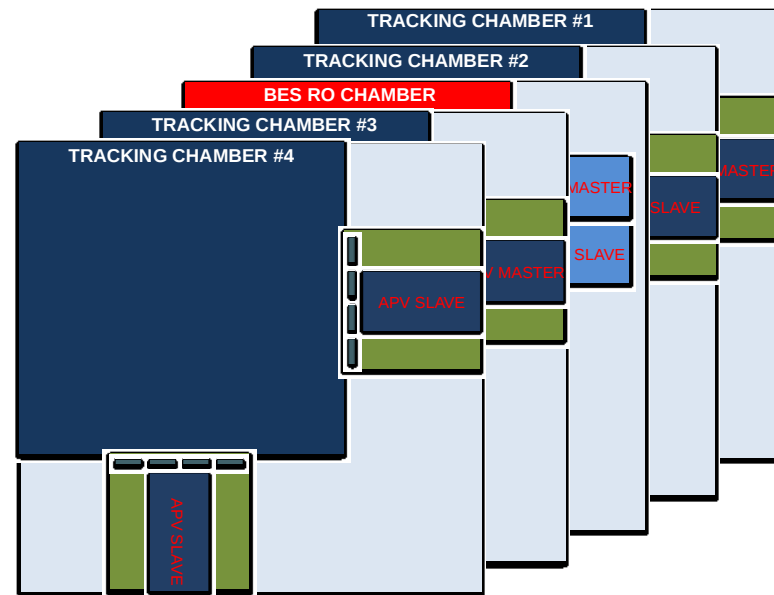
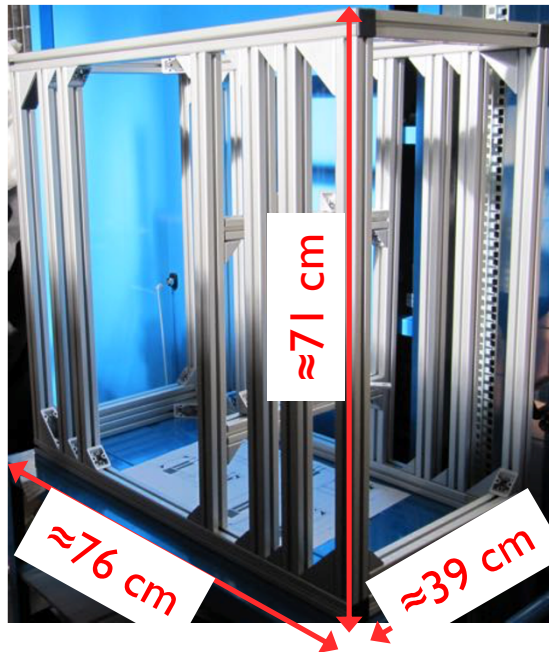
GASTONE
(DIGITAL – 128 chs)

BESIII beam test – Setup

≈ 1300 ANALOG RO channels

MAGNET

CHAMBERS SUPPORT

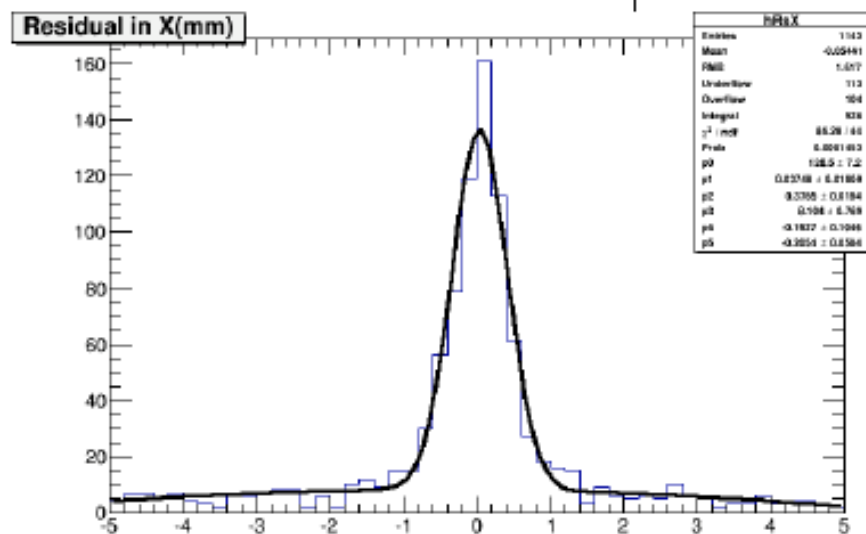


BEAM AREA



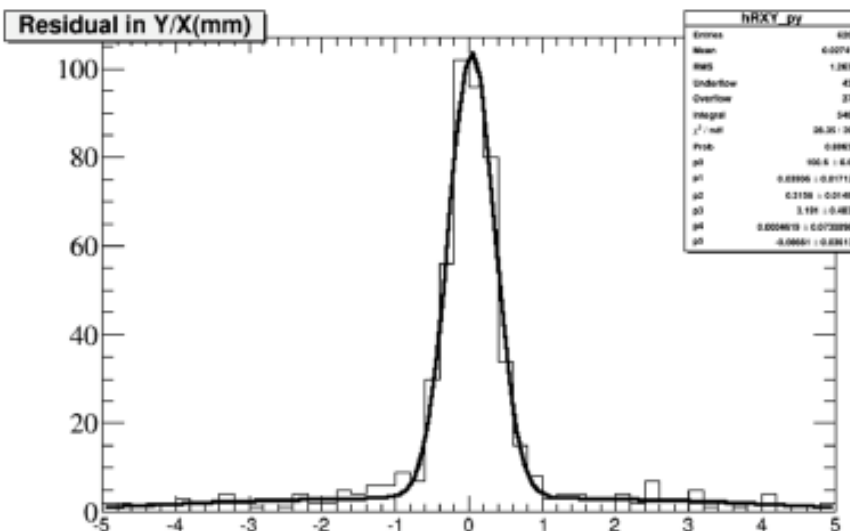
Cosmic data: Spatial resolution

with digital readout



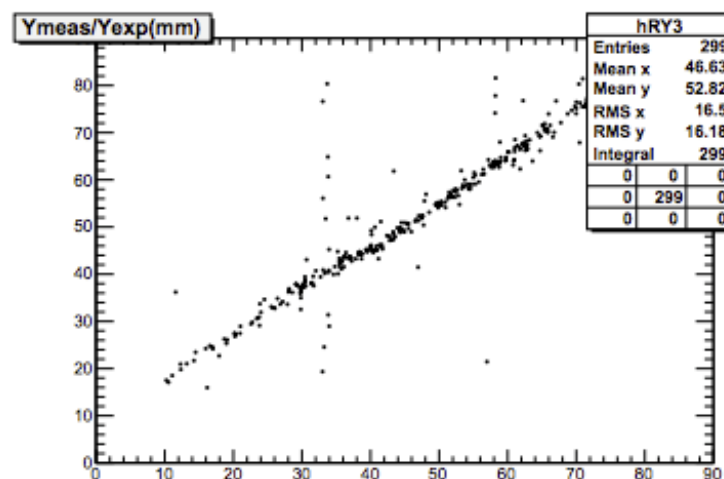
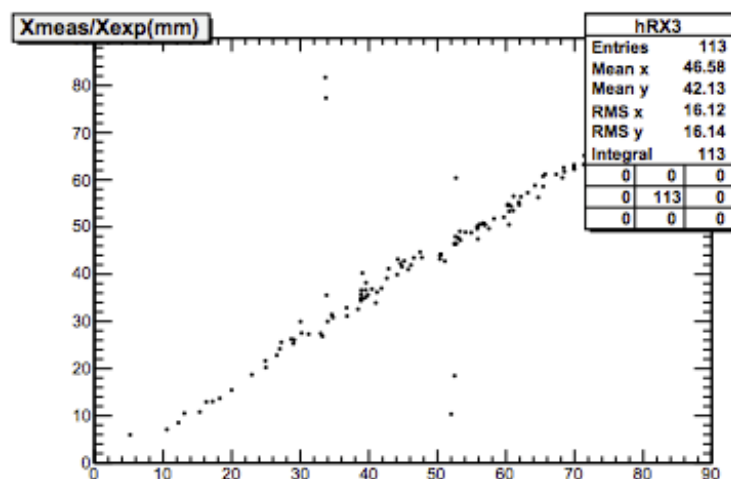
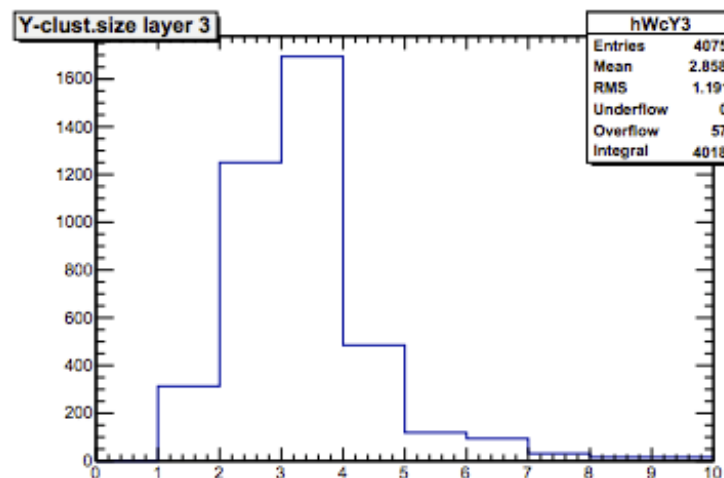
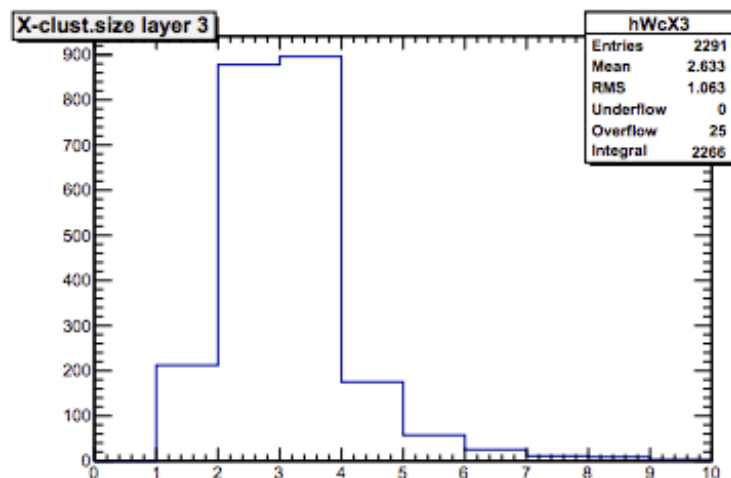
$$\sigma_x = (402 \pm 23) \mu\text{m}$$

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



courtesy of Sandro Calcaterra

Cosmic data: Cluster size



courtesy of Sandro Calcaterra

Summary

- 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