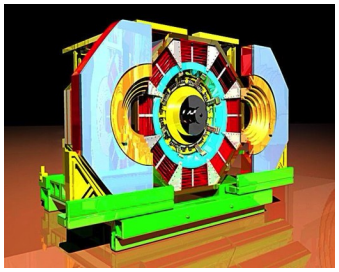


RD51 week meeting
CERN, Dec 09 2014

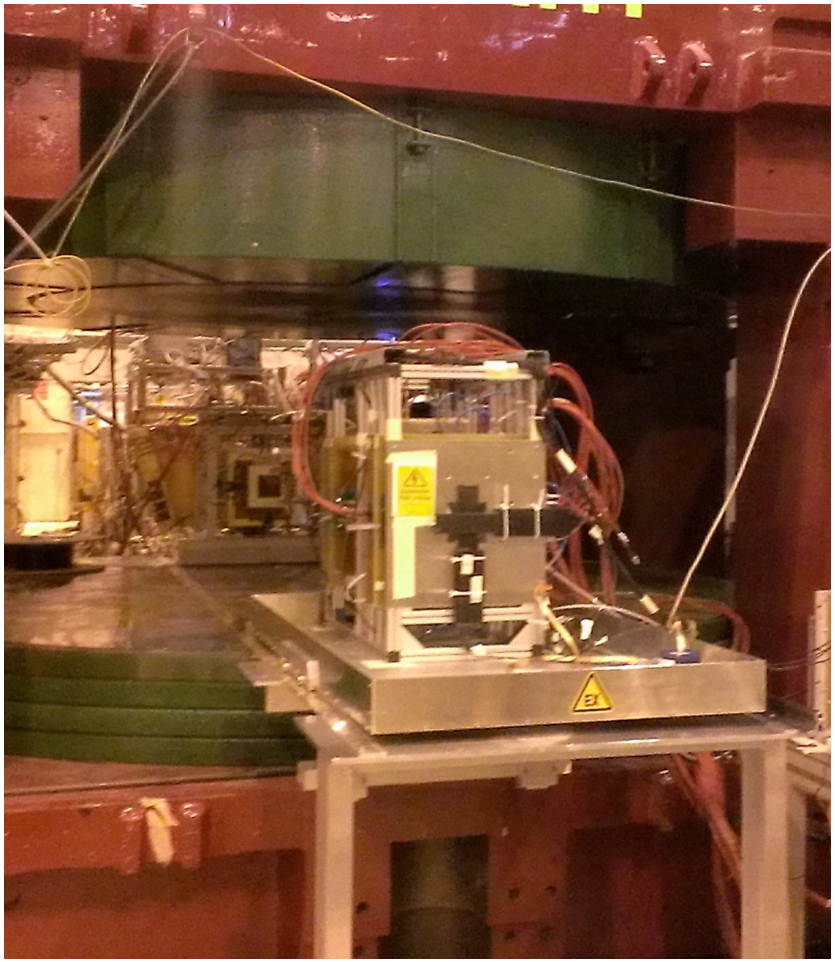
GEM beam test for the BESIII experiment

Riccardo Farinelli
(INFN Ferrara)
a joint Kloe / BES III CGEM groups effort (INFN Ferrara Frascati, Torino)

Partially supported by the Italian Ministry of Foreign Affairs under the Program of great Relevance PGR00136

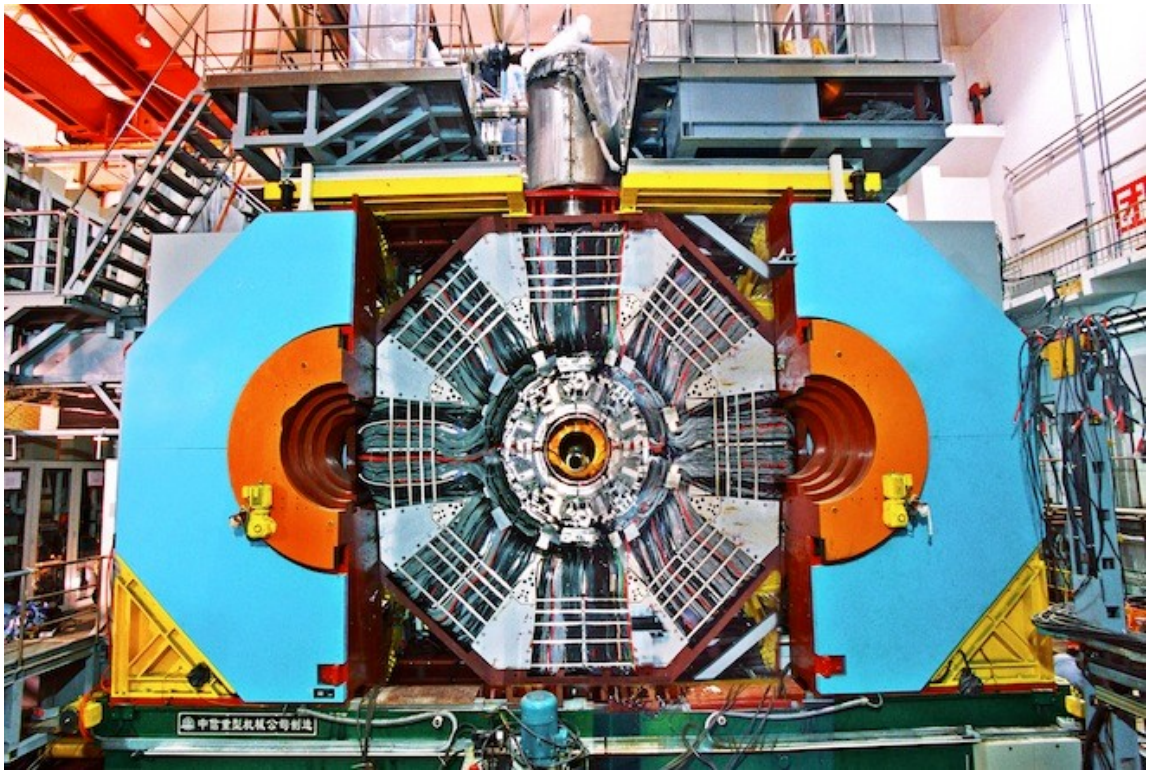
Outline

- The BES III Experiment
- The CGEM Project
- Our Goal
- Beam Test Setup
- Preliminary Results
- What Next



The BES III Experiment

- The Beijing Electron-Positron Collider BEPCII and the Beijing Spectrometer BESIII work at $\sqrt{s}$ from 2 to 4.6 GeV
- At least 8 more years of data taking
- The physics program includes:
  - High precision test of EW interaction
  - High statistic studies of light hadron spectroscopy
  - Studies of charm physics
  - Studies of τ physics



Discovery of tetraquark

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Scientists discover first tetraquark particle

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عربي

Quark quartet opens fresh vista on matter

First particle containing four quarks is confirmed.

Devin Powell

18 June 2013

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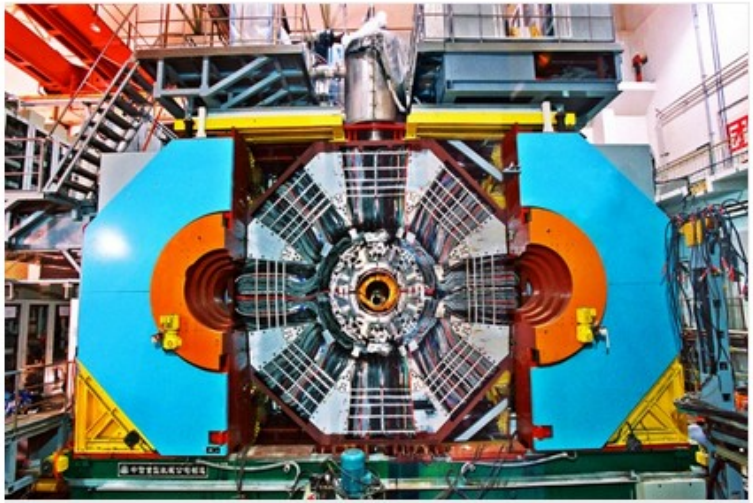

IHEP

The BESIII detector in China is one of two experiments to detect four-quark particles.

CERN COURIER

Apr 26, 2013

BESIII observes new mystery particle

In a striking and unexpected observation from new studies aimed at an understanding of the anomalous Y(4260) particle, the international team that operates the Beijing

BESIII spectrometer

alert

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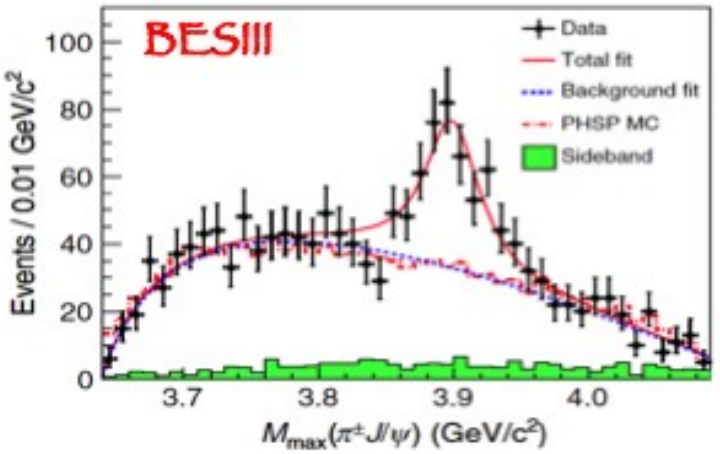
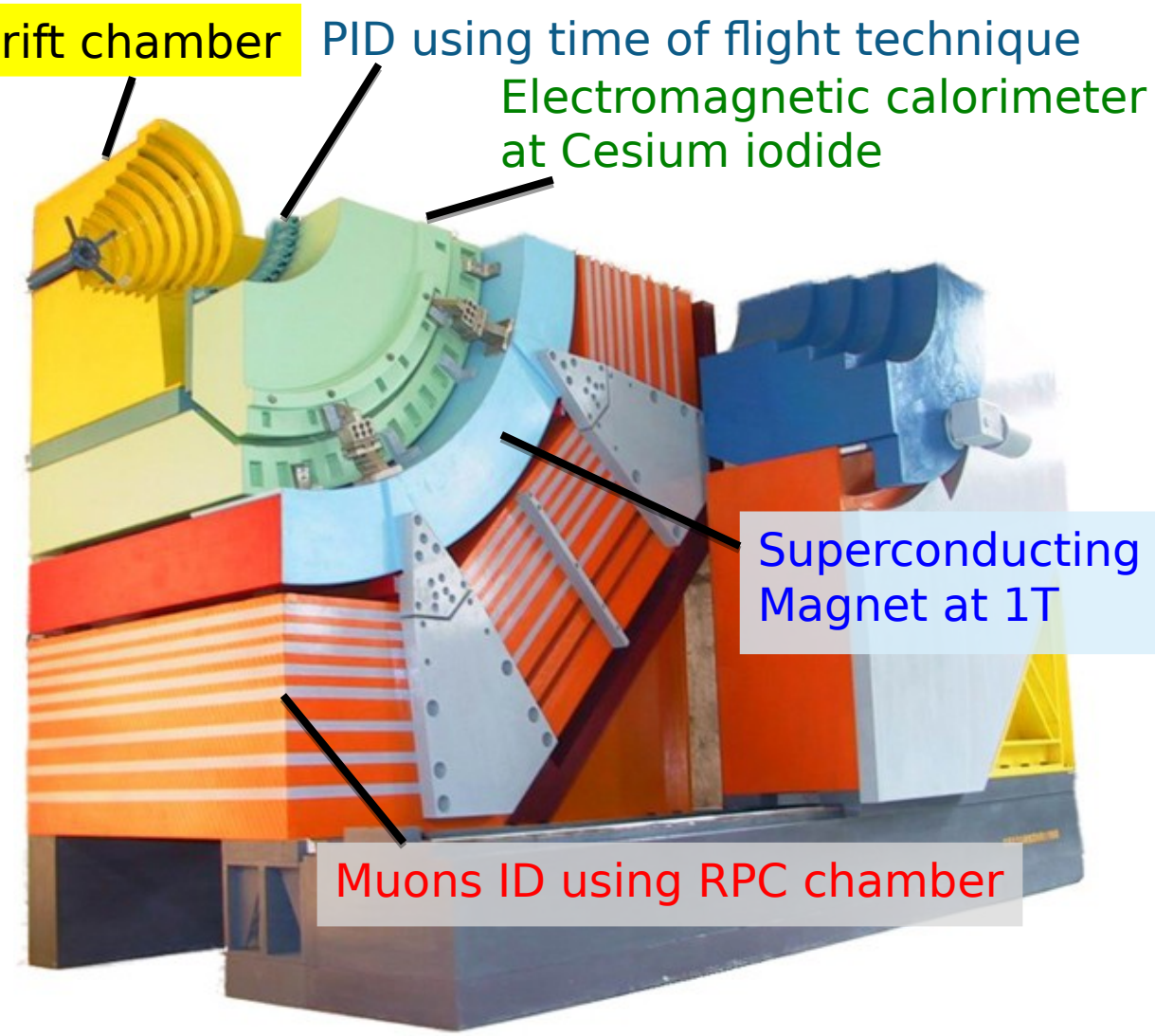


The BES III Experiment

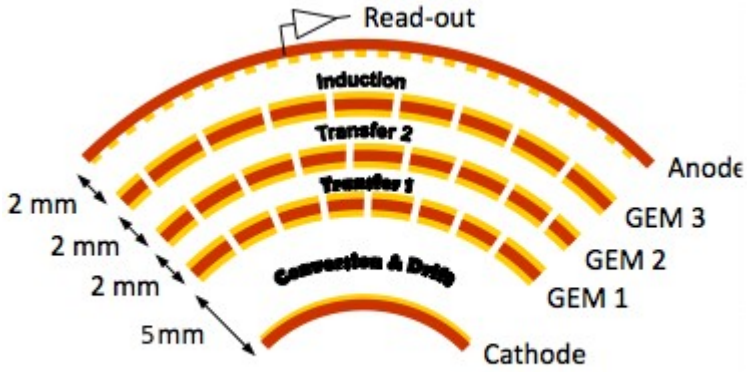
- A multipurpose magnetic spectrometer with an effective geo-metrical acceptance of 93% of 4π is built up by a series of detectors for PID and to measure the particles characteristics.

- The italian groups proposed the replacement of the inner part of the drift chamber that is loosing efficiency for aging effect with 3 layers of cylindrical GEM.



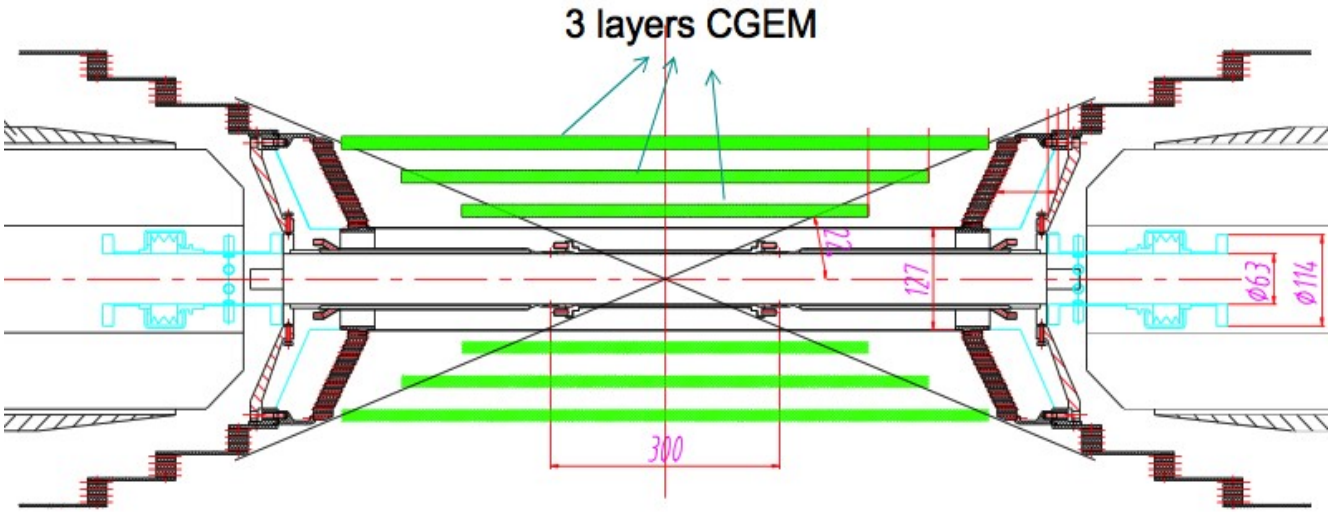
A CGEM based Inner Tracker

A cylindrical triple GEM



Requirements

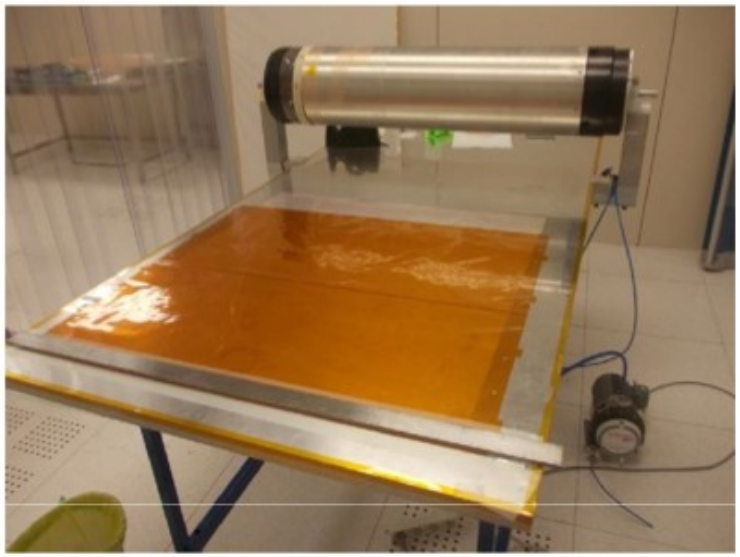
- Rate capability: ~10^4 Hz/cm^2
- Spatial resolution: σ_{xy} =~100μm : σ_z=~1mm
- Momentum resolution:: σ_{pt}/P_t =~0.5% @1GeV
- Efficiency = ~98%
- Material budget ≤ 1.5% X_0 in all layers
- Coverage: 93% 4π

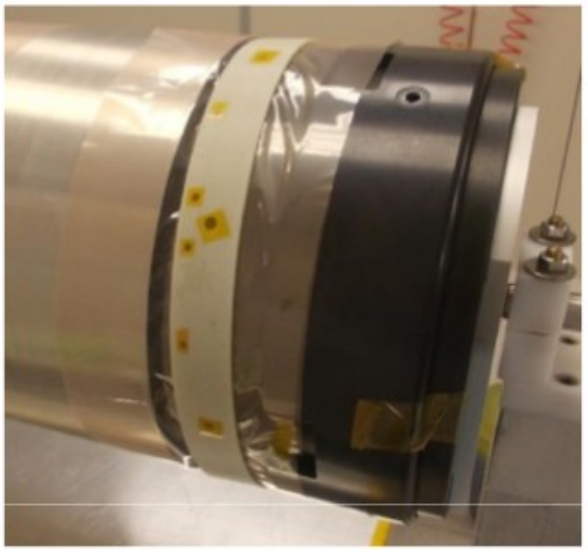


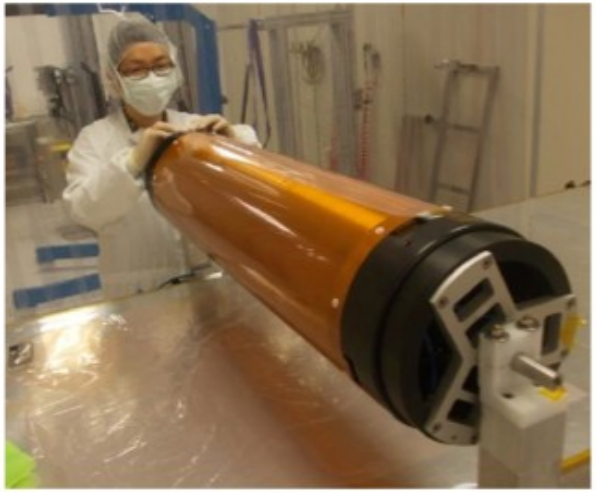
- Active area
  - L1: length 532 mm
  - L2: length: 690 mm
  - L3: length: 847 mm
- Inner radius: 78 mm
- Outer radius: 178 mm

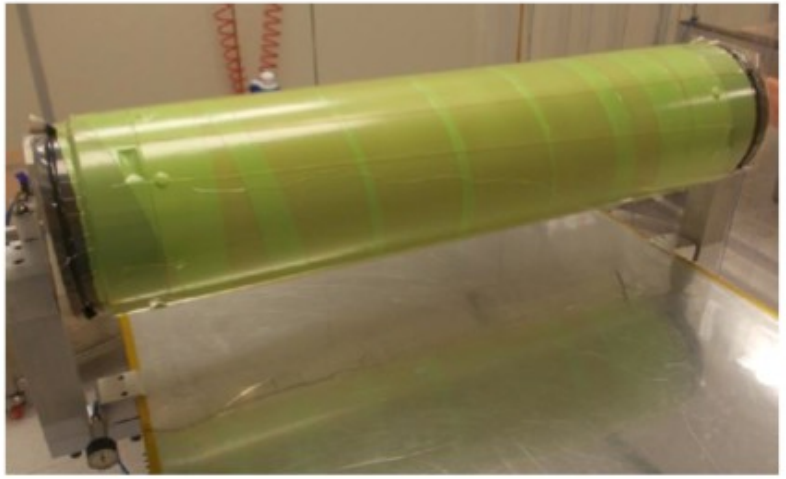
Green bars show the active area, the layers length is the same.

GEM foil assembly test







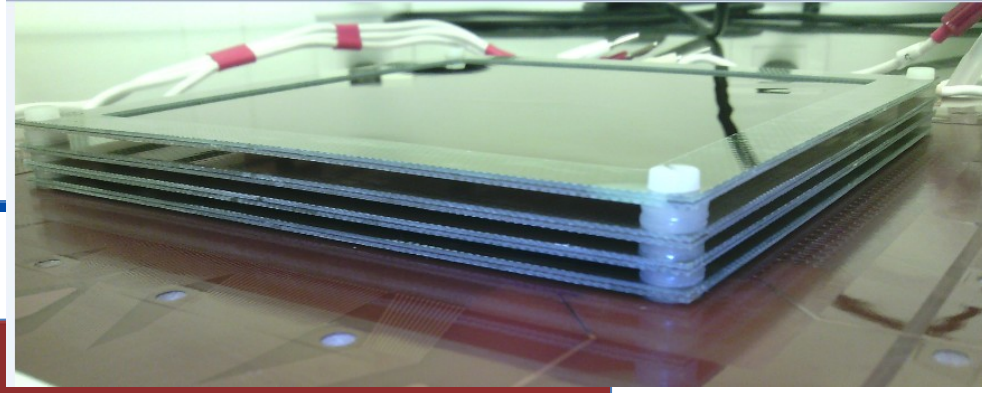


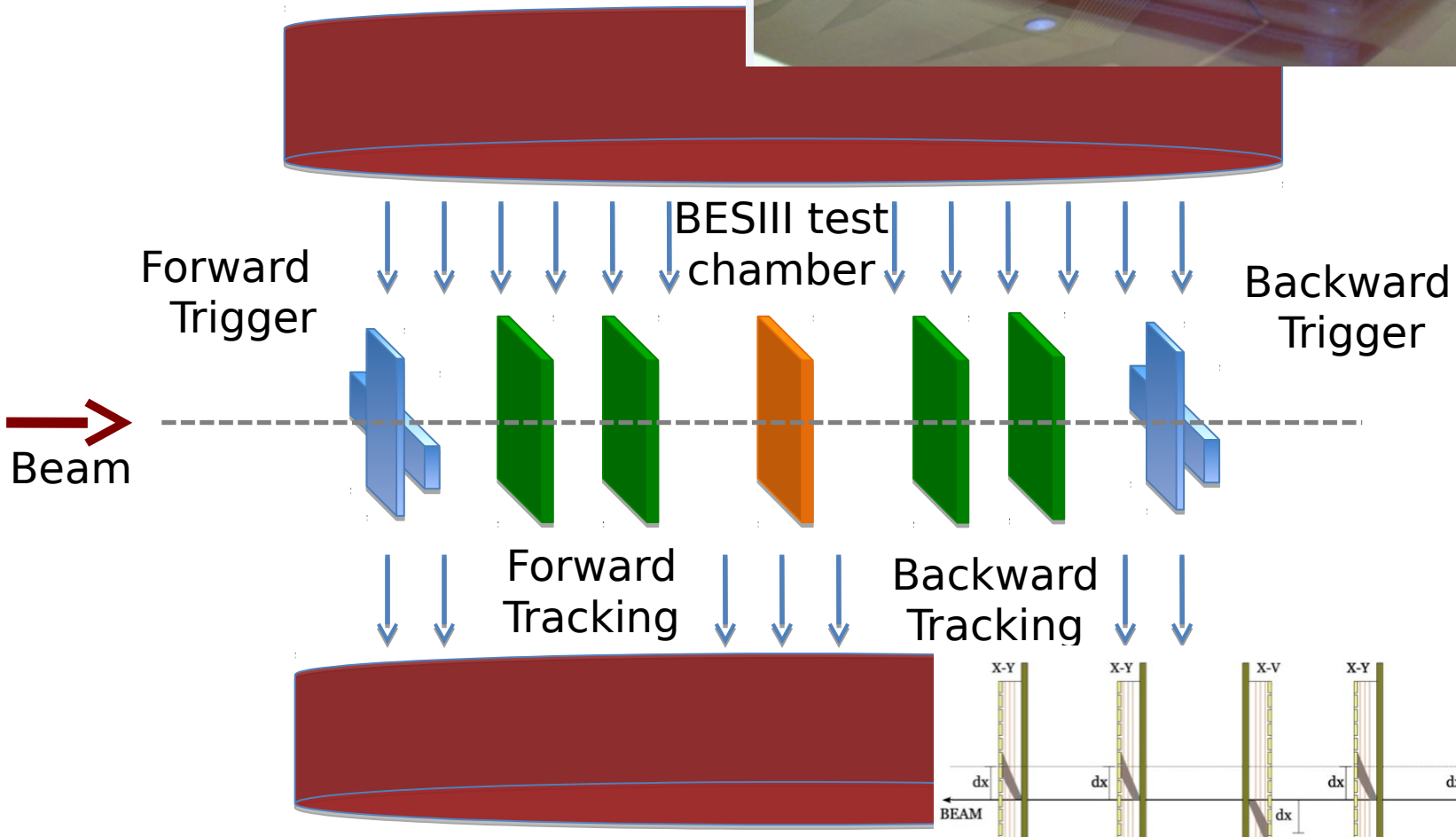
Beam Test

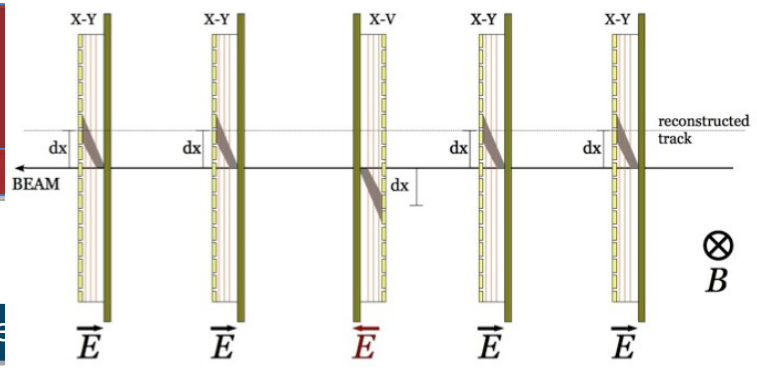
Purpose and measurements

- The purpose of this beam test is:
  - Validate GEM analog readout in magnetic field.
  - Validate Garfield simulation and extract useful information for hit digitization.
- The planning is to perform the following measurements with a 5/2/2/2mm GEM:
  - Spatial resolution as function of the magnetic field
  - Cluster size as function of the magnetic field
  - Efficiency measurements at different gain
  - Test different gas mixtures: Ar/CO2 (70/30) and Ar/Isobutane (90/10)

BESIII setup

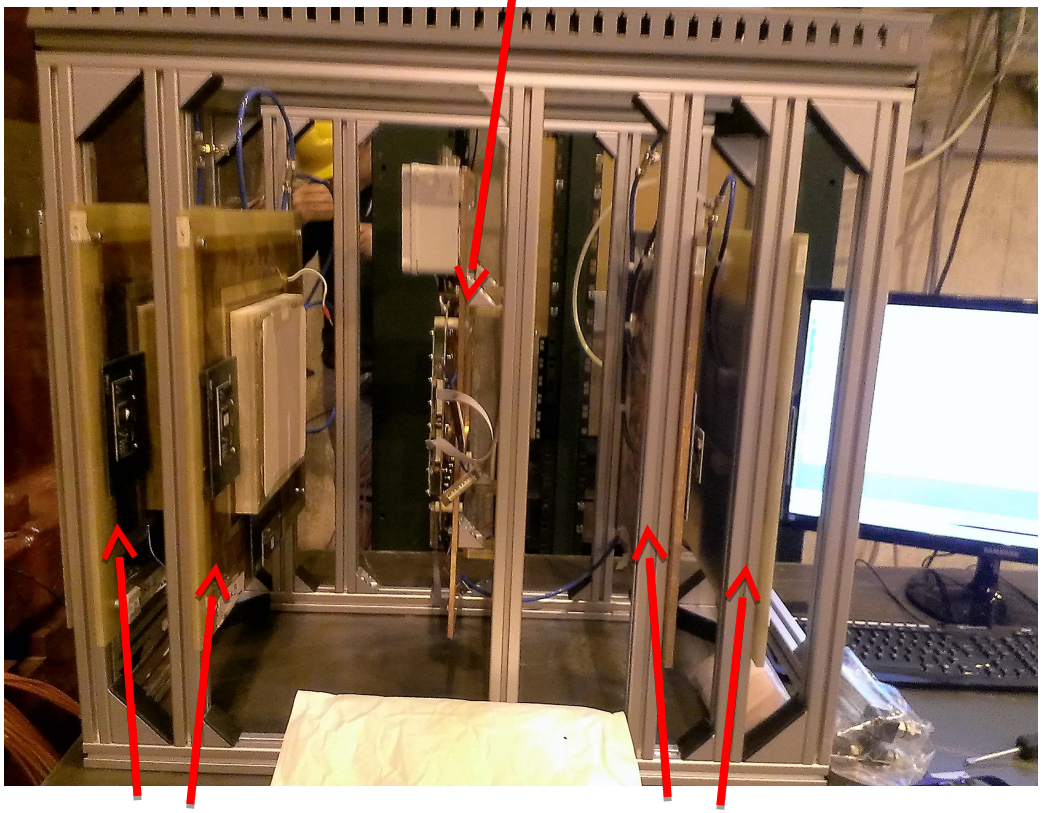






BESIII setup

The BESIII prototype



Forward Tracking

Backward Tracking

The BESIII prototype

BESIII setup

BESIII setup

- Every chamber has 128 (X) + 128 (Y) channels that are read by APV 25 : 1280 channels
- A CAEN single channel system is used to supply the HV to the 7 different electrode in every chamber : 35 = HV channels
- mmDAQ system is used to on-line monitoring and SRS system to acquire data

Data plan

- High voltage scan with a gain range of 0.8K - 22K :
  - 730/760/775/790/805/820/835/850 V in Ar/iso
  - 1050/1080/1110/1140 V in Ar/Co2
- Magnetic field scan from -1.0 T to 1.0 T for both mixtures
- Incident beam angle 0/10/30/45° in Ar/iso and magnetic field of -1/0/1 T

Data plan

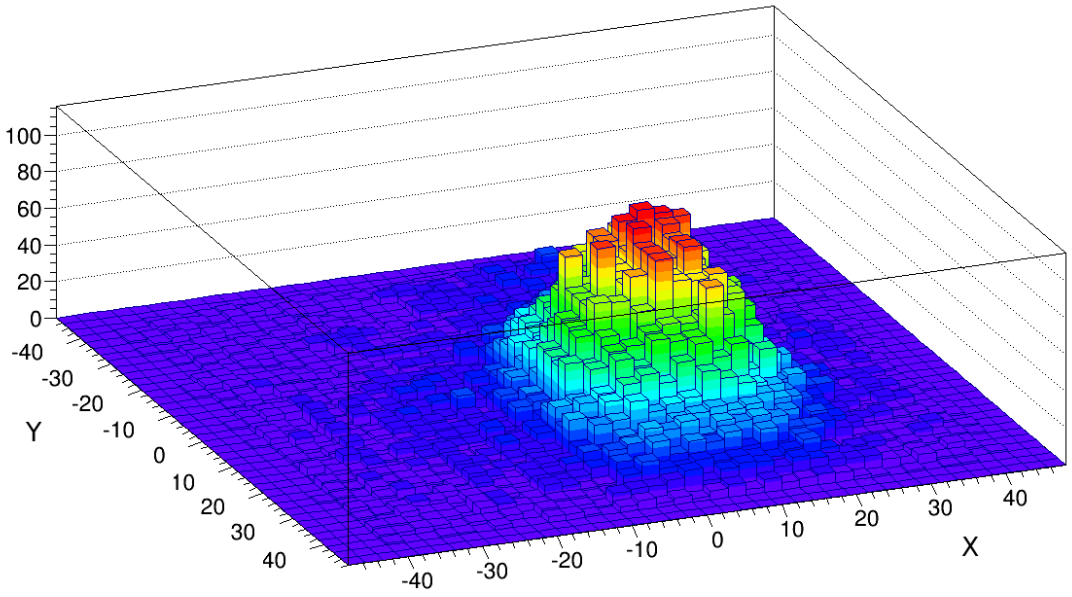
Number of event acquire for different value of HV and Bfield

	B = 0 T	B = -0,5 T	B = -1 T	B= 1T
V = 730V	24K	X	X	X
V = 760V	21K	15K	22K	21,5K
V = 775V	16,2K	20K	24K	20K
V = 790V	20K	15K	20K	21K
V = 805V	5,5K	15K	20K	20K
V = 820V	48K	20K	20K	21K
V = 835V	24K	15K	20K	20K
V = 850V	15K	20K	19K	20K

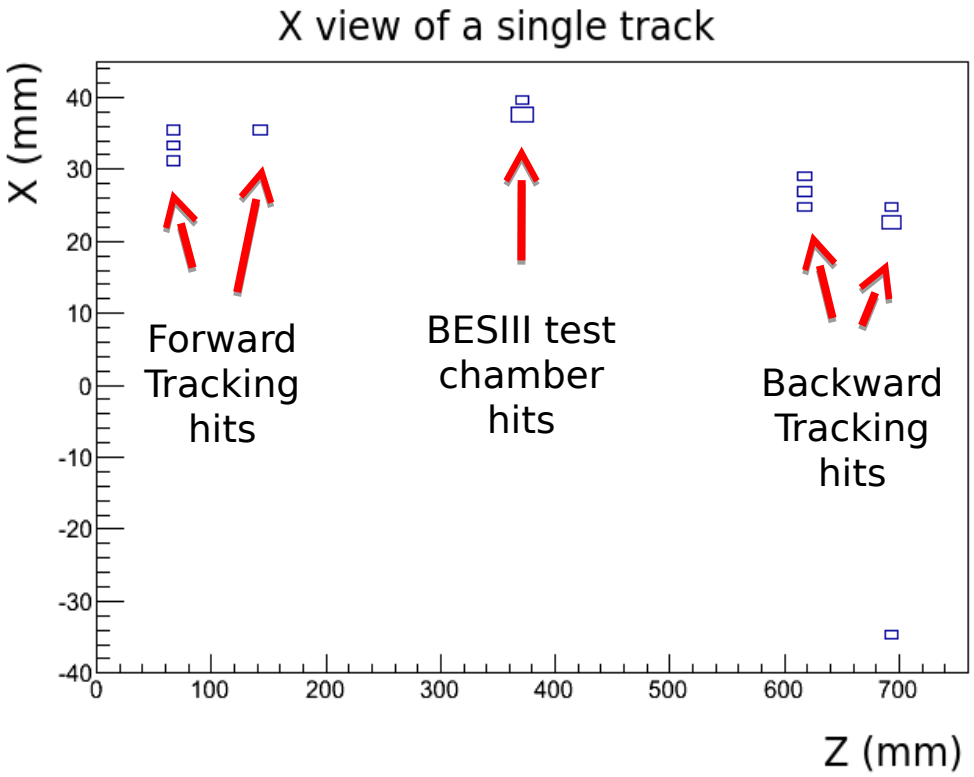
Beam profile

- With preliminary thresholds and no alignment we look for the beam profile of every plane.
- Cluster's position is calculated using the strip geometry information and the charge deposited.

Beam profile from BESIII test chamber at 790 V – B = 0T – Ar/iso mixture

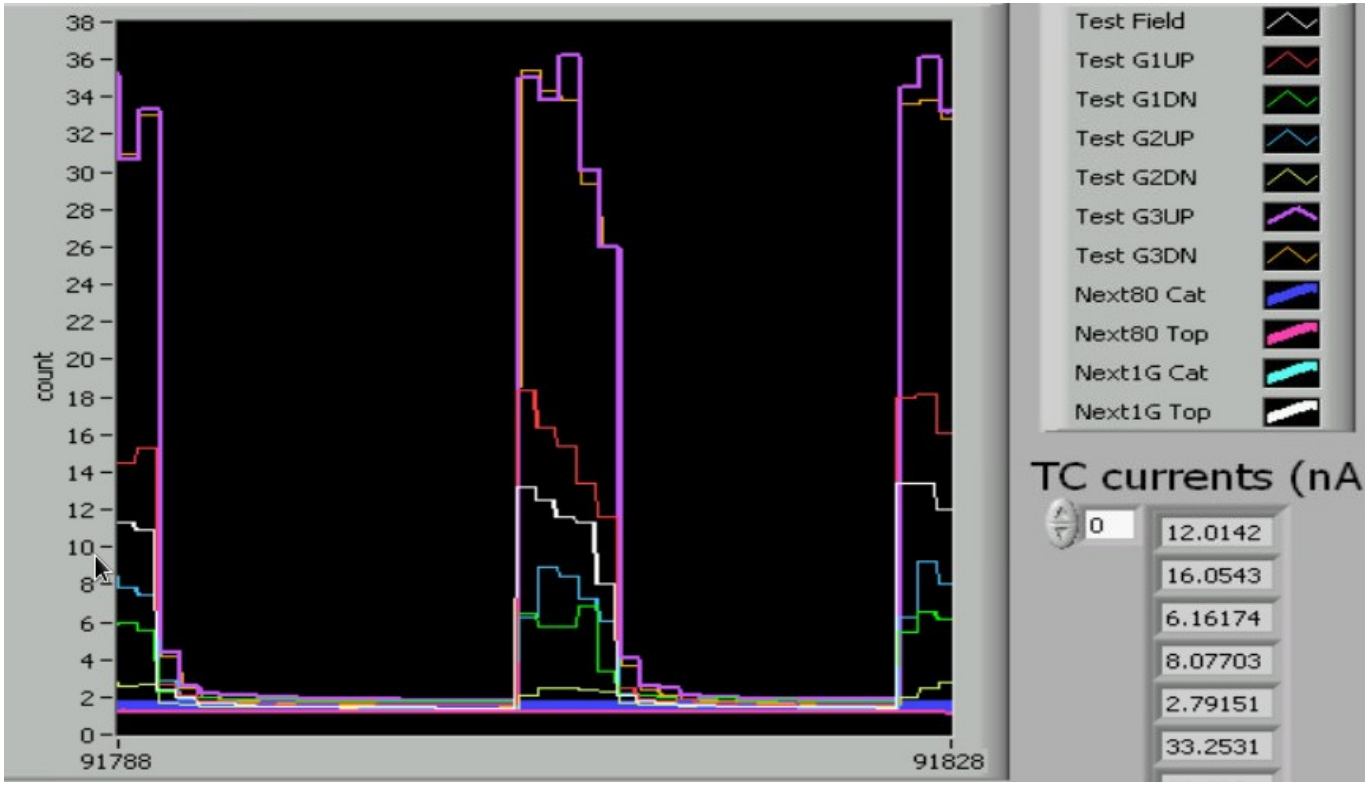


Looking for tracks



- with no alignment we look for tracks using all the chambers.

Currents

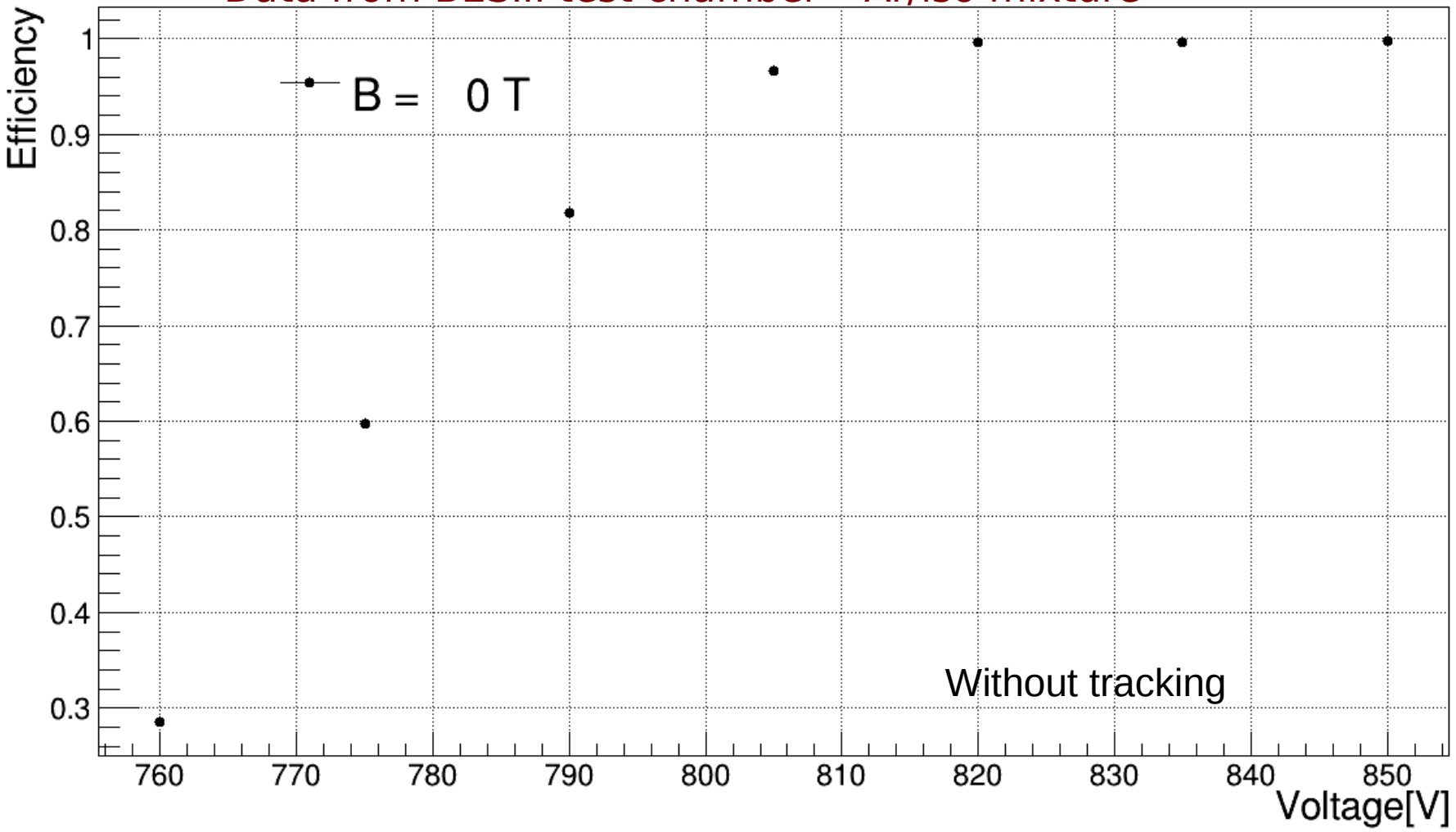


Sceenshot of the current monitor that show the differents current picks for evey electrod in a single event (nA).

Preliminary results

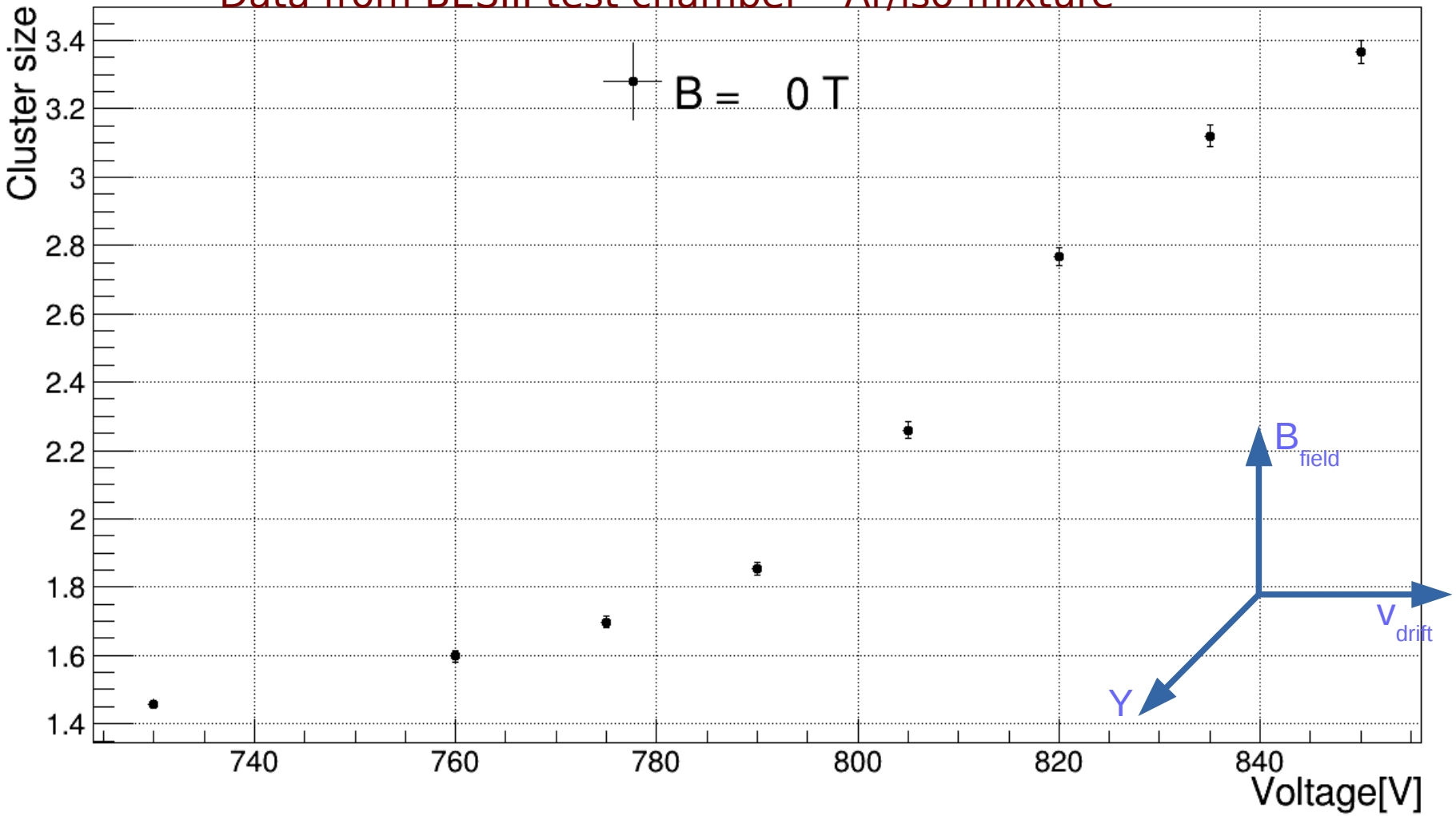
Preliminary efficiency vs HV in Ar/iso

Data from BESIII test chamber – Ar/iso mixture



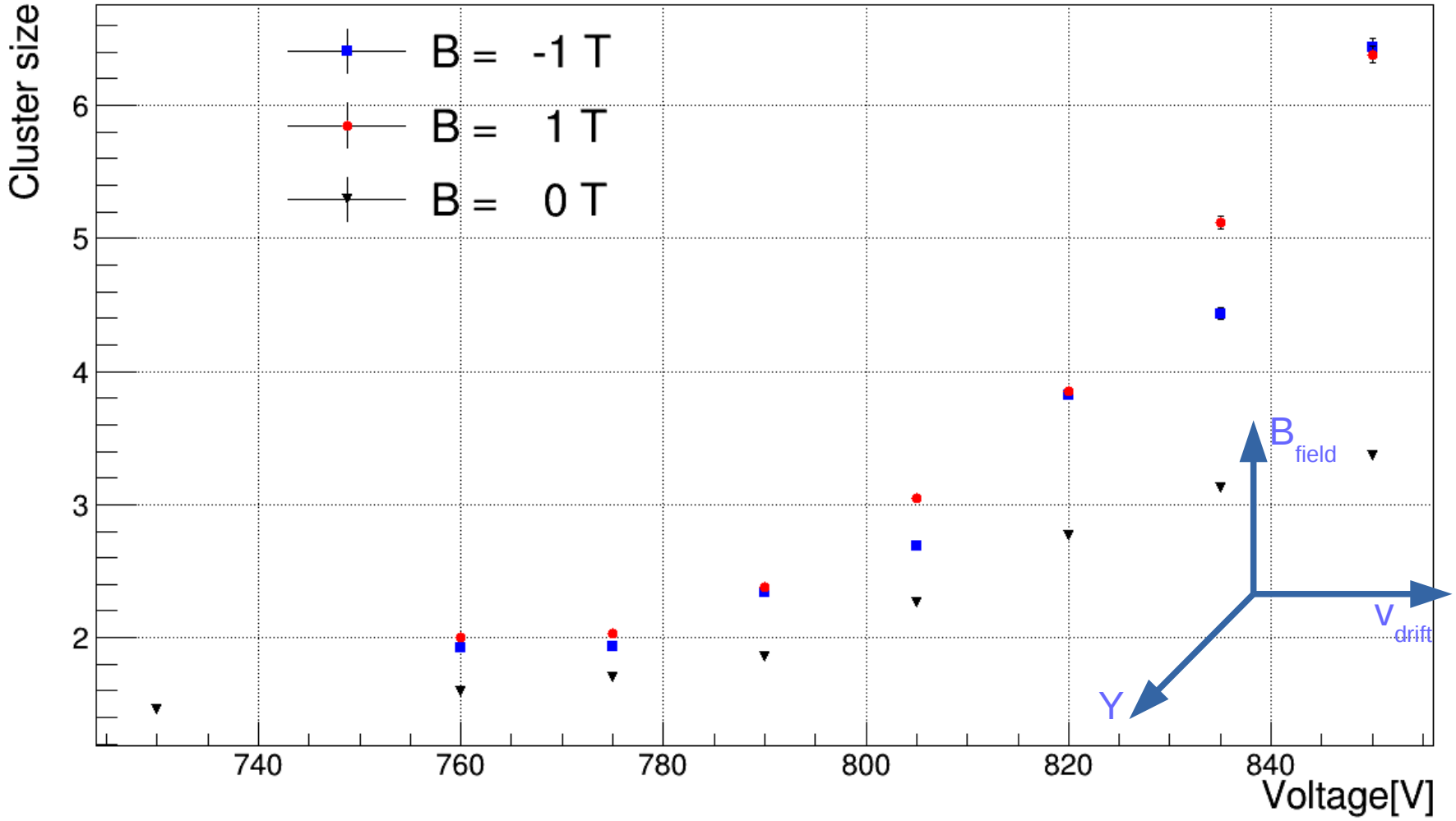
Cluster size Y vs HV in Ar/iso

Data from BESIII test chamber – Ar/iso mixture



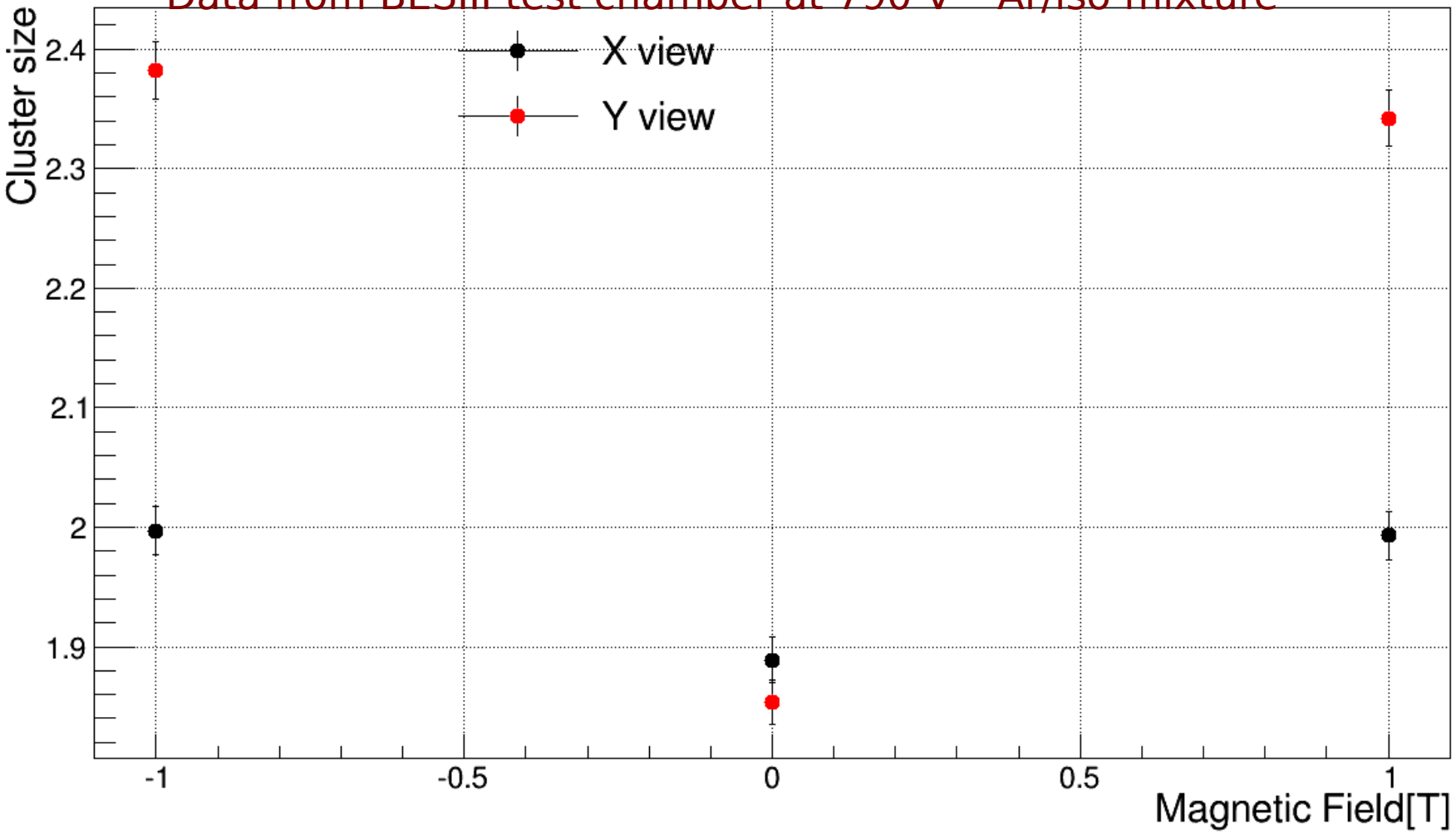
Cluster size Y vs HV in Ar/iso

Data from BESIII test chamber – Ar/iso mixture



Cluster size vs B Field in Ar/iso

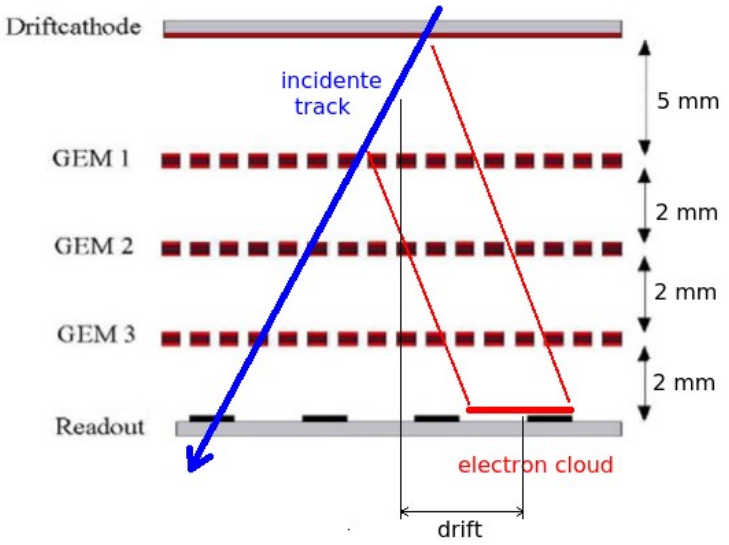
Data from BESIII test chamber at 790 V – Ar/iso mixture



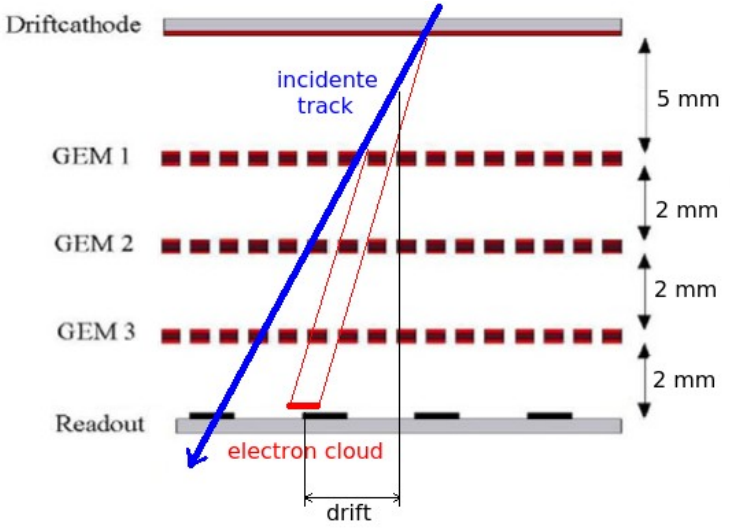
What next

Incident angle in Ar/iso

- Angle studies are fundamental to get information for hit digitization in the cylindrical GEM



B = 1 T
defocussing effect



B = -1 T
focussing effect

Future studies

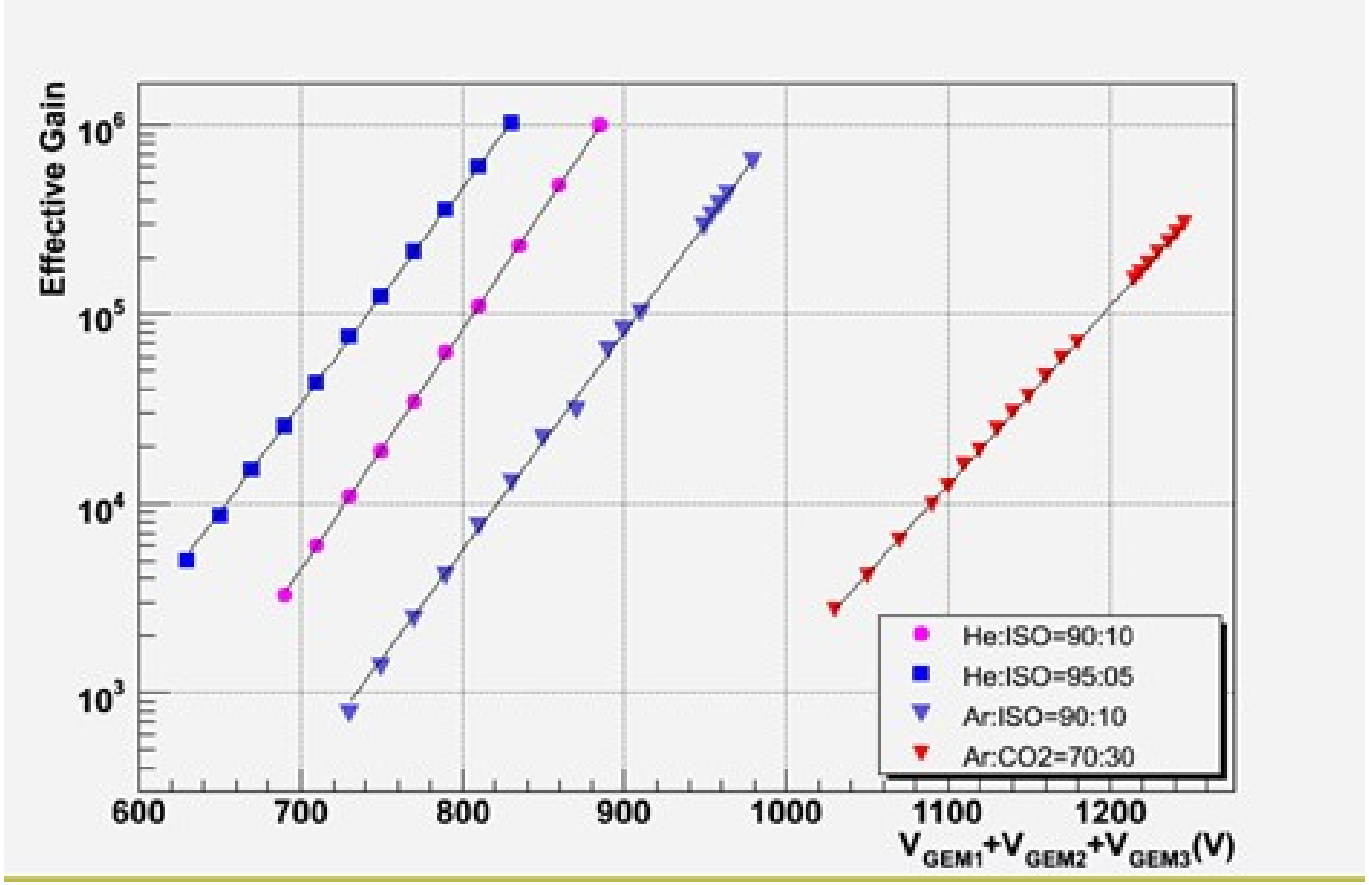
Future studies

- Alignment and track reconstruction
- Measure the resolution
- Optimize gain and gas mixture for safe operation of the cylindrical GEM detector
- Measurement of efficiency in high voltage/magnetic field phase space
- Study of the charge distribution and magnetic effect at anode to tune Garfield and Geant4 simulation.

Special
acknowledgement to
Silvia, Eraldo, Yorgos
and RD51 group
for their support


Thanks

Backup – Gain vs Tension



from GDD measurements