A Cylindrical GEM Detector with Analog Readout for the BESIII Experiment

THE BESIII CGEM GROUP

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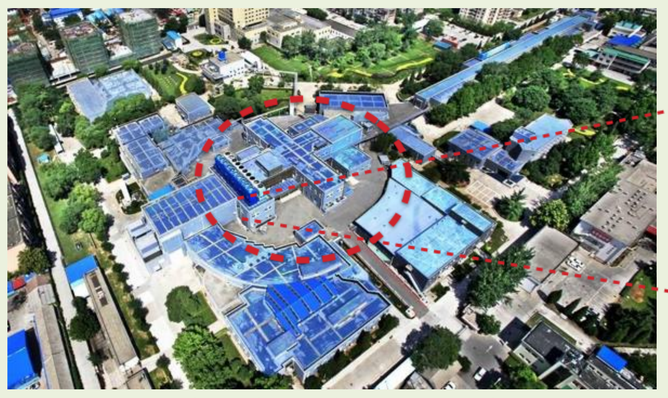
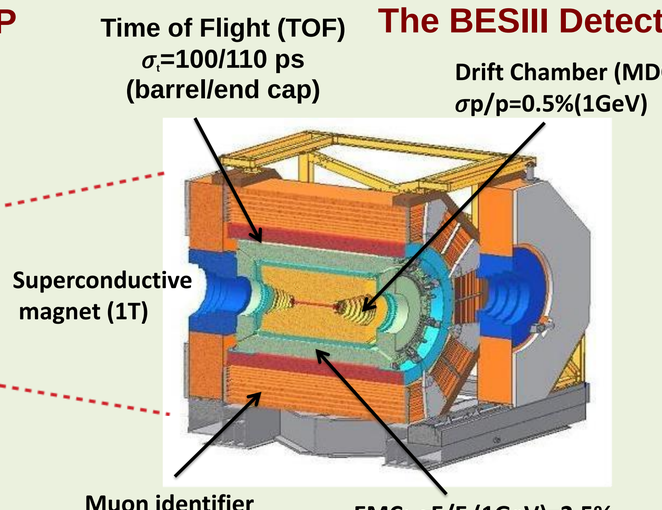
Beijing Electron Positron Collider @ IHEP



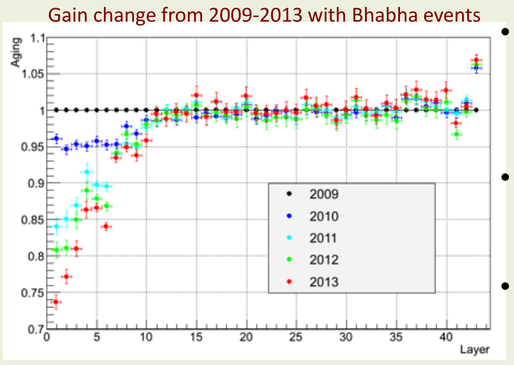
- Storage Ring circumference of about 237 m
- Center of mass energy [2-4.6] GeV
- Peak luminosity ~ 10^{-33} $cm^{-2}s^{-1}$

The BESIII Detector



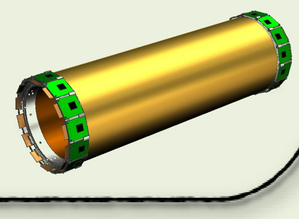
NIM A614 (2010)

MDC aging issue



- The Inner Drift Chamber gain and efficiency are decreasing due to Malter effect
- Aging speed up due to increasing of the luminosity
- Significant effect in the eight innermost layers

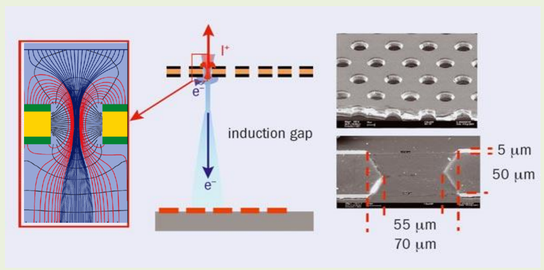
A cylindrical GEM Inner Tracker is under development to replace the Inner Drift Chamber by 2017



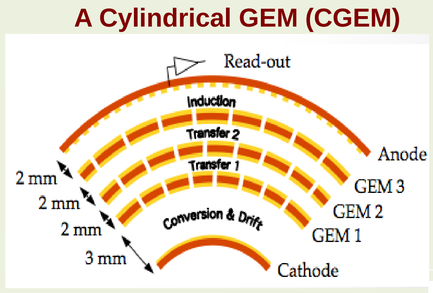
CGEM BASED INNER TRACKER FOR BESIII

GAS ELECTRON MULTIPLIER

A thin polymer foil, metal-coated on both sides, is chemically pierced by a high density of holes.
On application of a voltage gradient, electrons released on the top side drift into the hole, multiply in avalanche and transfer to the other side.

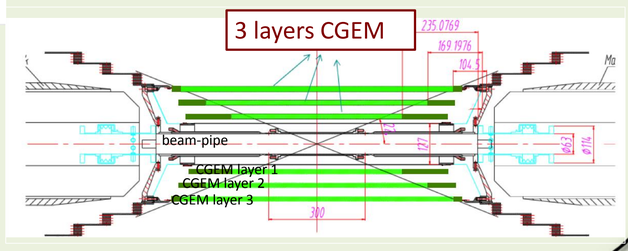


A Cylindrical GEM (CGEM)



- Proportional gains above 10^3 are obtained in most common gases.
- Cascaded GEMs permit to obtain larger gains
- Spatial resolution determined by chamber and readout electrode geometries

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

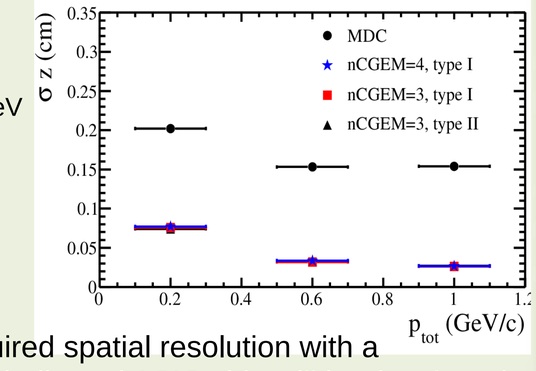


REQUIREMENTS AND INNOVATIONS

Detector Requirements

- Rate capability: ~10^4 Hz/cm^2
- Spatial resolution: σ_{xy} =~120 μm : σ_z=~1 mm
- Momentum resolution:: σpt/Pt =~0.5% @1 GeV
- Efficiency = ~98%
- Material budget ≤ 1.5% of X_0 for all layers
- Coverage: 93% 4π
- Operation duration ~ 5 years

Significant improvement in the secondary vertex resolution expected



➡ Analogue readout to reach the required spatial resolution with a reasonable number of channels. A dedicated ASIC chip will be developed.

➡ Anode plane with jagged strips to limit the parasitic capacitance

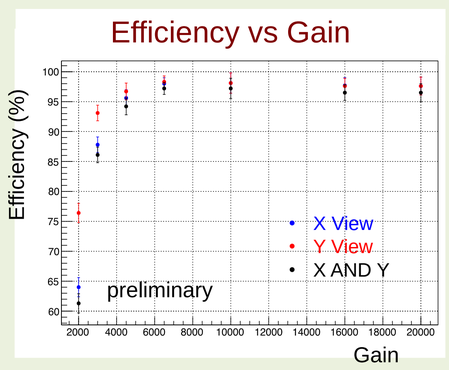
➡ Rohacell will replace the honeycomb in the cathode and anode structure with a substantial reduction of the thickness of the detector.

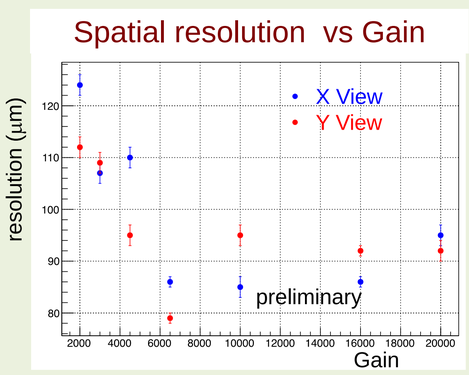
PROTOTYPE BEAM TEST

Results from Test Beam @ CERN

- gas mixture (Ar/Isobutane - 90/10).
- APV25 readout electronics.

- 2-dimensional efficiency ~97%.
- Efficiency plateau starts at ~6000.



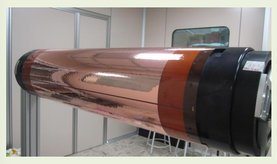


- Spatial resolution evaluated as the σ of the residual distribution w.r.t. the fitted track.

- Spatial resolution ~90 μm in the plateau region, including tracking error.

A new beam test is planned to perform measurement in the magnetic field up to 1 Tesla. μTPC mode readout will be tested.

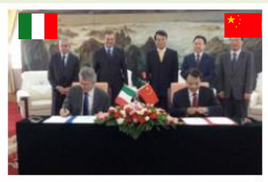
PROJECT STATUS, PLANS AND CONCLUSIONS



- Cathode and three GEM layers of the first cylindrical prototype have been assembled.
- Final assembly detector expected by September 2015.

- Final Inner Tracker design will be finalized by 2015.
- Frontend electronics design ongoing.
- Full detector production, assembly and test by 2016.
- Installation and commissioning in 2017.

Design, construction and test of a CGEM prototype and readout electronics funded by the Foreign Affairs Ministry agreement of scientific cooperation for a Joint laboratory “INFN-IHEP”.


BESIII Winter Collaboration Meeting,Guilin

The BESIIICGEM project has been recently selected as one of the project funded by the European Commission within the call H2020-MSCA-RISE-2014.

HORIZON 2020 European Commission

FRONTIER DETECTORS FOR FRONTIER PHYSICS
13th Pisa Meeting on Advanced Detectors
24-30 May 2015 - La Biodola, Isola d'Elba (Italy)

More information @ http://www.lnf.infn.it/esperimenti/bes3/

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