

A Cylindrical GEM Inner Tracker for the BESIII experiment

G. Cibinetto on behalf of the CGEM group

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The BESIII experiment at IHEP in Beijing



Beam Energy: 1.0 - 2.3 GeV 2009 - now: BESIII physics run Lpeak= $1.0 \ge 10^{33}$ /cm²s (4/5/2016)

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A Cylindrical GEM Inner Tracker for BESIII

The inner Drift Chamber is suffering for ageing.

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- The new Inner Tracker is based on three layers of cylindrical GEM.
- Inherit the construction technique from the KLOE-2 CGEM.



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- Low Material budget $\leq 1.5\%$ of X₀ for all layers
- High Rate capability: ~10⁴ Hz/cm²
- Coverage: 93%
- Spatial resolution $\sigma_{r\phi}$ ~130 $\mu m,$ σ_z <1 mm in 1 T magnetic filed
- Operation duration at least 5 years

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INFN, Mainz, Uppsala, IHEP.

Construction of a cylindrical GEM



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	KLOE-2	BESIII	action
Number of detector layers	4	3	→ 5 mm drift gap
Drift gap	3 mm	5 mm	also for µTPC
Material budget per layer	0.5% X ₀	0.4% X ₀	rohacell and anode
Momentum resolution @1 GeV	not used	$\sigma_{pt}/P_t = \sim 0.5\%$	
Rate capability – radiation hardness	< 10 kHz/cm ²	few 10 kHz/cm ²	
Spatial resolution $\boldsymbol{\varphi}$	250-350 μm (B=0.5T)	100-150 μm (B=1T)	with μTPC
Spatial resolution Z	~1 mm	<500 μm	with μTPC
Magnetic filed	B = 0.52 T	B = 1 T	→ µTPC
Internal/external diameter	244/440 mm	156/356 mm	higher rate
Readout	digital	charge + time	new ASIC chip

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Spat Mag Inter Readout	B = 0.52 T 244/440 mm digital	$\begin{array}{c} 4 \\ 3 \\ 2 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0.2 \\ 0.4 \\ 0.6 \\ 0 \\ 0.6 \\ 0.6 \\ 0 \\ 0.6 \\ 0 \\ 0.6 \\ 0 \\ 0.6 \\ 0 \\ 0.6 \\ 0 \\ 0.6 \\ 0 \\ 0 \\ 0.6 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0$	σ_p resolution p_T (GeV/c) p_T (GeV/c)

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POSTER: Implementation of the code for the simulation of the response of a triple-GEM tracker and its comparison to the experimental data. Lia Lavezzi (INFN Torino and IHEP).

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micro-TPC clusterization

- combining CC and µTPC stable spatial resolution over a large range of incident angle.
- possibility to perform 3D track reconstruction with only one layer.







The TIGER chip



Possibility of a pixelated version for large area and high rate

Time-based readout

- Timestamp on rising/falling edge (sub-50 ps binning quad-buffered TDC)
- Charge measurement with Time-over-Threshold
- Time and amplitude sampling
 - Timestamp on rising edge (sub-50 ps binning quadbuffered TDC)
 - Sample-and-Hold circuit for peak amplitude sampling
 - Slow shaper output voltage is sampled and digitized with a 10-bit Wilkinson ADC

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Noise as a functions of strip capacitance. I O

463.8 ± 13.55

100 C_{in} [pF]

 10.42 ± 0.1862

Red- measurement, Blue- simulation

MAMI Test Beam for GEM + TIGER



- Two planar triple GEM XY readout
- ArCO2 (70:30) gas mixture
- electron E(855 MeV)



- The beam profile was properly reconstructed.
 - Beam intensity correctly estimated from triggerless data.





Comparison with previous test beam

the cluster size

For the first time we

time bi-dimensional

reconstructed on-

clusters from two

chambers.

the cluster charge













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Noise VS ch

64

18.65



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CGEM Electronics





Status of the Detector Construction

- layer 1: assembled, tested with beam
 - layer 2: vertical assembly in progress
- Iayer 3: assembled: ready to be tested.
- on- and off-detector electronics in production







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- BESIII is building a Cylindrical GEM Inner Tracker to replace the Inner Drift Chamber.
- The construction technique is inherited by the KLOE-2 experiment with several modifications and innovations
 - lighter design

- different electronics
- new clusterization approach
- Detector and electronics are under construction, everything is expected to be shipped to PRC by September.
- Installation \rightarrow fall 2019

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Thanks

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