





Innovative design and construction technique for the Cylindrical GEM detector for the BESIII experiment

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On behalf of CGEM-IT group



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Outline

- BES3 experiment
- Why CGEM on BES3
- CGEM-IT project
- Building method
- Beam test on CGEM prototype
- Status of the CGEM Project and Future Plan





• Total current: 0.91 A

BES3 @ BEPCII



Data Taking since 2009

2016/04/05 22:29:47		
Lumino	sity 10.00	E32/cm^2/s
	e+	e-
Energy [GeV]	1.8831	1.8831
Current [mA]	849.18	852.31
Lifetime [hr]	1.53	2.30
Inj.Rate	0.00	0.00

INNER TRACKER - Current status – Multilayer Drift Chamber

Inner Tracker: 8 stereo layers • Outer Tracker: 12 axial layers 16 stereo layers **7** axial layers



INNER TRACKER - Near Future – Cylindrical GEM



Low material budget < 1,5%

of X_0 for the whole detector

At least 5y operation duration

Coverge: 93% 4π

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3 layers CGEM



- \circ LI \rightarrow 532 mm
- \circ L2 \rightarrow 690 mm
- Inner radius 78 mm
- Outer radius 178 mm ٠



INNER TRACKER - Near Future – Cylindrical GEM





CGEM Project - New Development Feature

Anode and Cathode support made with ROHACELL 31 and permaglass ring for cylindric layout \rightarrow low material budget



TIGER - Torino Integrated GEM Electronics for Readout - ASIC







Jagged Strip Anode - The x strip pitch is shrinked in coincidence of v strip crossings in order to decrease the inter-strip capacitance. ~ 30% reducing





How-To Build a CGEM -I

Gems and Anode foils visual inspection

Visual test of foils for checking compliance to the drawing. Problematic sector can be checked under microscope. Some minor defects may be no danger for further using of this foil in the chamber.





How-To Build a CGEM – II

Gem foils HV Test

Plastic box with low humidity level inside (less than 5%), flush with nitrogen, permanently, during test.



From 0 to 400 V - with step 50 V. From 400 to 600 V - step 20 V. Wait 5 min for each step (600V for 30min)



If discharges: check the sector! If at least one sector is out of condition, foil must be rejected.



How-To Build a CGEM – III

The right quantity of glue (2mm strip) on the overlap area gives safety margin





Apply vacuum bag and wait until the glue is fully cured Control overlap quality and size (2.8mm)





How-To Build a CGEM – IV

Cylindrical Gluing Gem/Anode foils

The 5 electrodes (Anode, Cathode, 3 GEM folis) are cylindrically shaped on aluminum mandrel





Apply vacuum bag and wait until the glue is fully cured



How-To Build a CGEM - V

Assembly with the Vertical Insertion Machine (Clessidra)





How-To Build a CGEM - VI



Detector layer equiped with HV, gas and FE electronics









TEST BEAM on CGEM Layer 2





@CERN H4 beam line (SPS) and @MAMI:

- June 15 & May 16 17: planar chambers (3&5 mm gap)
- October 16: Prototype L2 cylinder (3 mm gap)
- July 17: L1 cylinder (5mm gap)





TEST BEAM on CGEM Layer 2

- gap)
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STATUS OF CGEM CONSTRUCTION and FUTURE PLAN

- LI: work in progress at LNF clean room (cylindrical gluing)
- L2: GEMs at LNF, new anode shipped from CERN
- L3: design are being defined in Ferrara
- GOAL: finish construction by the end of 2017
- April 2018: shipping from LNF to IHEP
- August September 2018: Installation!



Multiple-GEM: principle of operation

GEM foil: high-quality polymer foil coated on both sides with thin metal layers; shaped holes with a large electrical field inside

- Amplification avalanche in the hole region
- Mostly "transparent" for electrons
- Very small percentage of ions backflow
- reduced space charge effect
- reduced field distortion

F. Sauli, Nucl. Instr. and Meth. A386(1997)531





Multiple-GEM allowing: High gain obtained with electrodes at "low voltages"



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