# The CGEM-IT of the BESIII experiment

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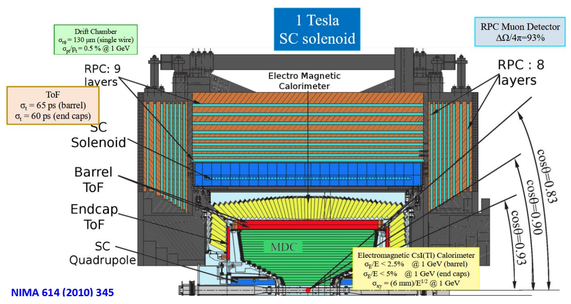
on behalf of the **CGEM-IT group**

## BESIII, BEPCII, and the upgrades programs


NIMA 614 (2010) 345

**BESIII**[1] is a general purpose detector optimized for **tau-charm physics** [2,3]

It is taking **data** since **2009** in the **center-of-mass energy** region **2-4.95 GeV,** hosted at the **BEPCII collider,** at the **Institute of High Energy Physics (IHEP)** in **Beijing**

Innermost detector showed aging effects. **Replaced** in **October 2024** with a new inner tracker based on **Cylindrical GEM technology,** the **CGEM-IT** [3,4]

At the same time, **BEPCII** has been **upgraded,** to increase **luminosity three times** at **2.35 GeV beam energy**[2]**. In 2028 energy upgrade up to 5.6 GeV in the center of mass.**[3]

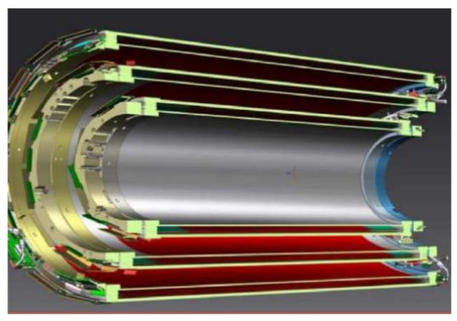
## The CGEM-IT project

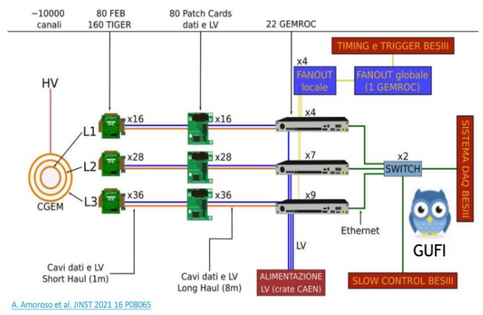
The **CGEM-IT project** is an international project under italian leadership effort to replace the **innermost layers** of the BESIII MDC (INFN (IT), JGU/HIM-Mainz (DE), Uppsala (SW), IHEP (PRC))

The CGEM-IT consists of **three** co-axial layers of **cylindrical triple GEM** and an innovative **readout chain** (TIGER-GEMROC) to reconstruct time and charge information from its about 10000 channels [5-6]

Using both **Charge Centroid** (CC) and **microTPC readout** algorithm[7], it aims to measure the position with comparable performance in the XY plane ($\sigma_{xy}$ **= 150 um**) and **improve** the previous chamber performance along beam axis by a **factor three** ($\sigma_z$ **= 300 um**), to reconstruct better secondary vertexes in (charmed) hyperons decays and separate better tracks in complex topology events

The CGEM-IT has increased **radiation hardness** and **rate capability**, and a **low material budget** (1.5% $X_0$)



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## CGEM-IT standalone cosmic commissioning

The full CGEM-IT has performed a **one-year long cosmic stand standalone test** to extract the **performance** and to investigate the **operational stability**

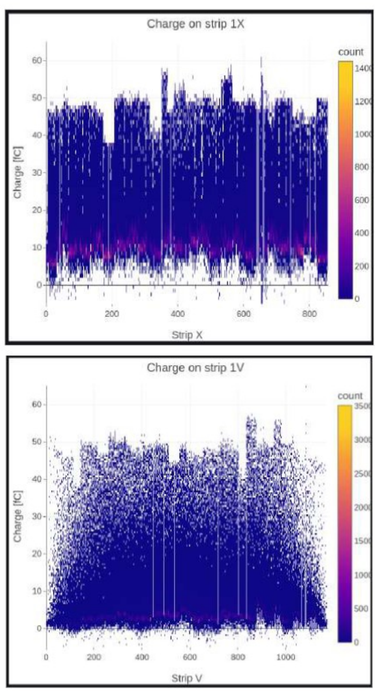
This test was also relevant to study different **grounding configuration**, in a clean and safe environment, before actual installation in the spectrometer

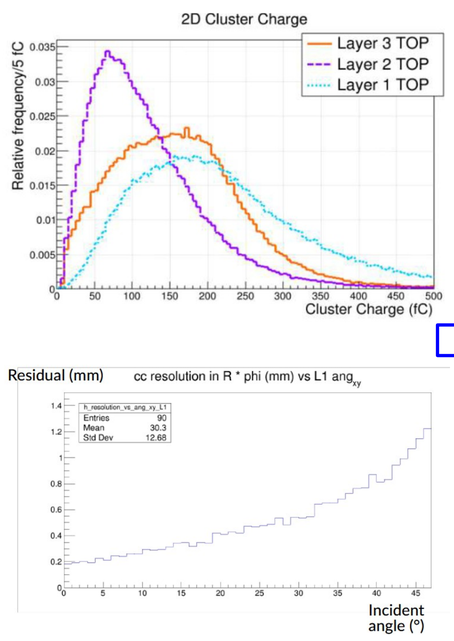
During this year we collected more than **10M cosmic rays** unfer different **HV conditions**, **gas ratios**, and grounding conditions.

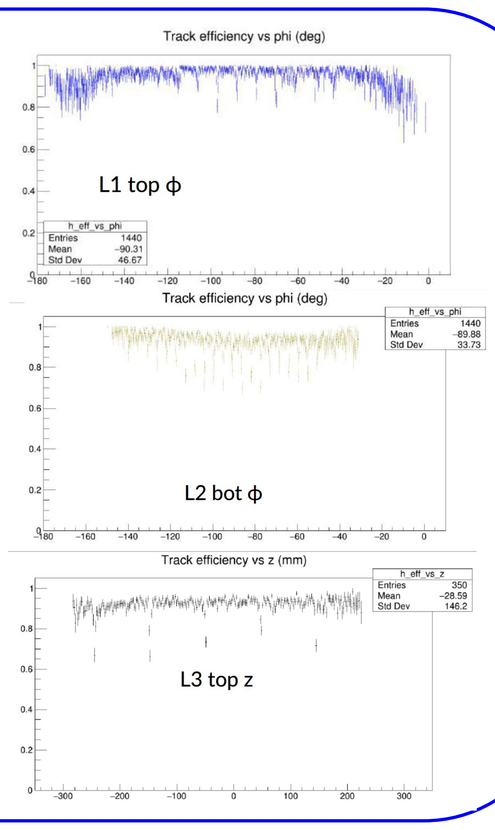
It is possible to see that a **high level of charge** was recorded in **all the strips**. By combining information from X and V strips into 2D clusters, it is possible to **reconstruct** the **3D position** of the passage of the track.

To evaluate the CGEM-IT **performance**, each layer is split in half (six halves in total). When one half is under test, the **"real" track is reconstructed** using the other **5 planes**.

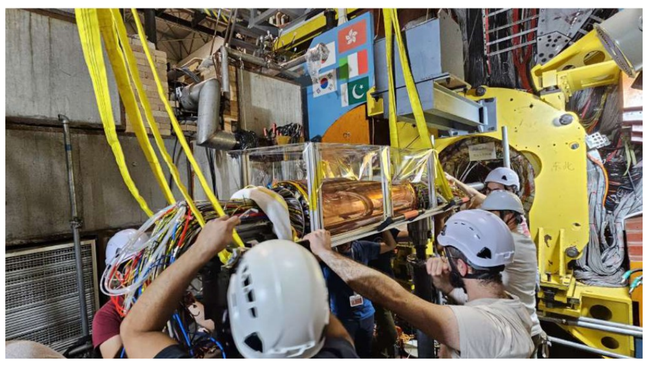
**Efficiency** is extracted within 10 sigma of the residual distribution on individual layers. **Each layer** shows an efficiency of **about 95%** on the investigated regions

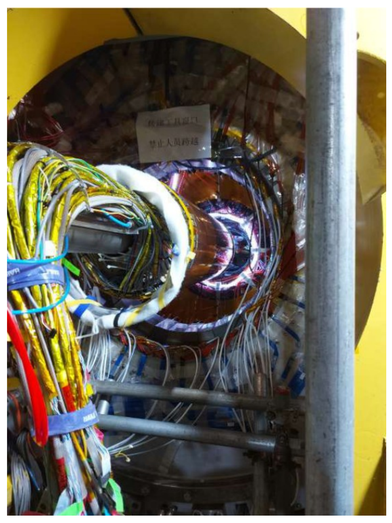



## CGEM-IT installation - first look





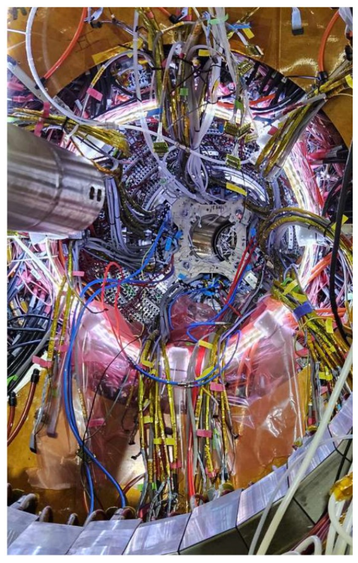


**Photo of the installation**:
1) the detector is lifted from the south side of the detector
2) the CGEM-IT is placed on top of the insertion pole in front of the spectrometer
3) the detector slides inside the BESIII "heart"
4) the CGEM-IT is fixed at the center, ready for cabling

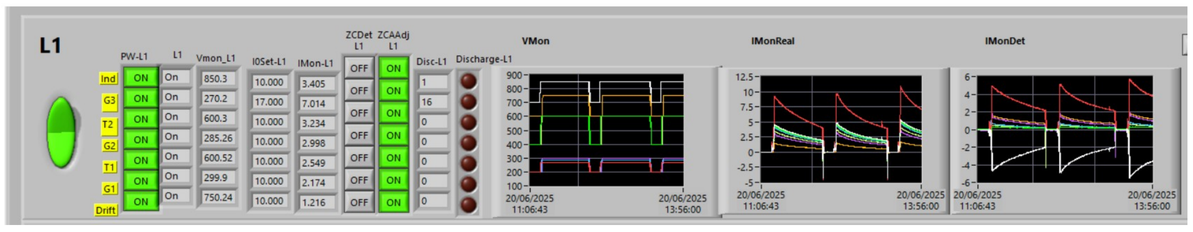
The **CGEM-IT detector** was installed starting from **Oct 1, 2024**. It has reached **nominal HV** for the first time on **Oct 19, 2024**

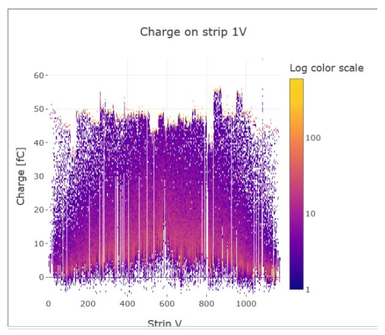
Long tests of noise level and grounding were performed before completing the installation and closing of the apparatus in the end of February 2025

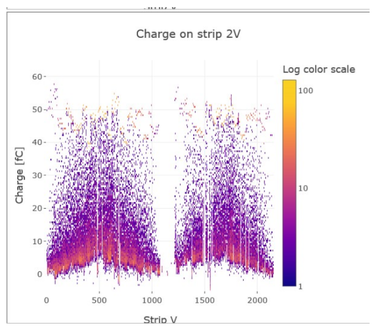
**Noise level is good** on all the layers apart from X strips of L1, where it is higher than expected.. An electronics configuration was found that allows **data** to be taken from **most of the strips**

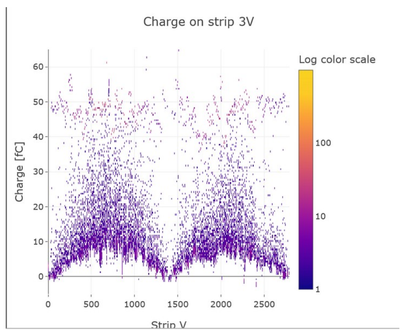
From **March to May, cosmic rays** has been collected together with the spectrometer to test the **DAQ** and **detector stability**

From **June**, a first **commissioning with the beam** is ongoing, to check detector stability and performance. We observe **a stable operation** with limited number of HV discharges (1 or 2 per day)




**Charge on V strips of three layers during the beam commssioning (still on-going).** The missing part of L2V is due to a disconnected HV sector, while a few of L1 are missing since the electronics channels are off due to the high noise level

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Reference:
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[2] D.M. Asner et al. (BESIII Collaboration), Int. J. Mod. Phys. A 24 (2009) S1-794
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[4] I. Balossino et al., Symmetry 14 (2022) 5, 905
[5] A. Rivetti et al., NIM A 924 (2019) 181-186
[6] A. Amoroso et al., JINST 16 (2021) 08, P08065
[7] M. Alexeev et al. JINST 14 (2019) 08, P08018