

Commissioning of the CGEM Inner Tracker

Stefano Gramigna on behalf of the CGEM-IT Working Group - gramigna@fe.infn.it
16th Pisa Meeting on Advanced Detectors • 26/05-01/06, 2024 • La Biodola, Isola d'Elba, Italy



MOTIVATION

The **Cylindrical GEM Inner Tracker (CGEM-IT)** was built to replace the innermost layers of the Multilayer Drift Chamber (MDC) of the **Beijing Spectrometer III (BESIII)** experiment, whose performance has been degrading due to aging-related phenomena.

The new detector aims to restore tracking efficiency, **improve the resolution along the beam axis**, and provide the necessary aging resistance for prolonged operation in the face of the luminosity upgrade of the Beijing Electron Positron Collider II (BEPCII).

Upgrade requirements:

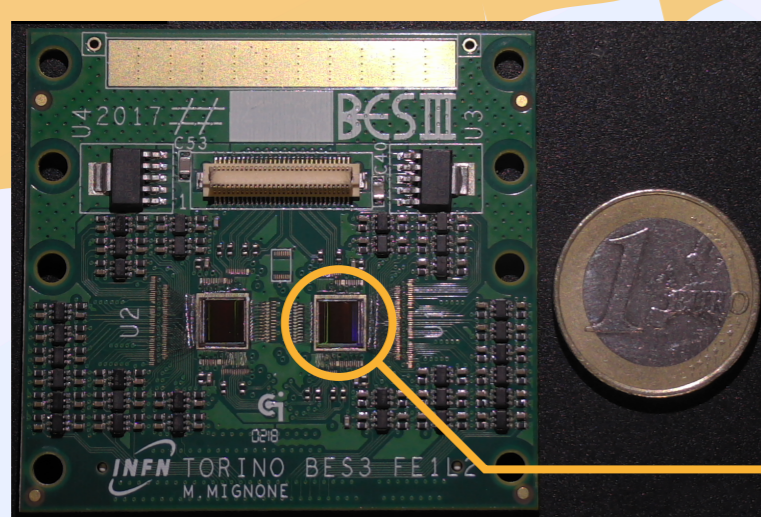
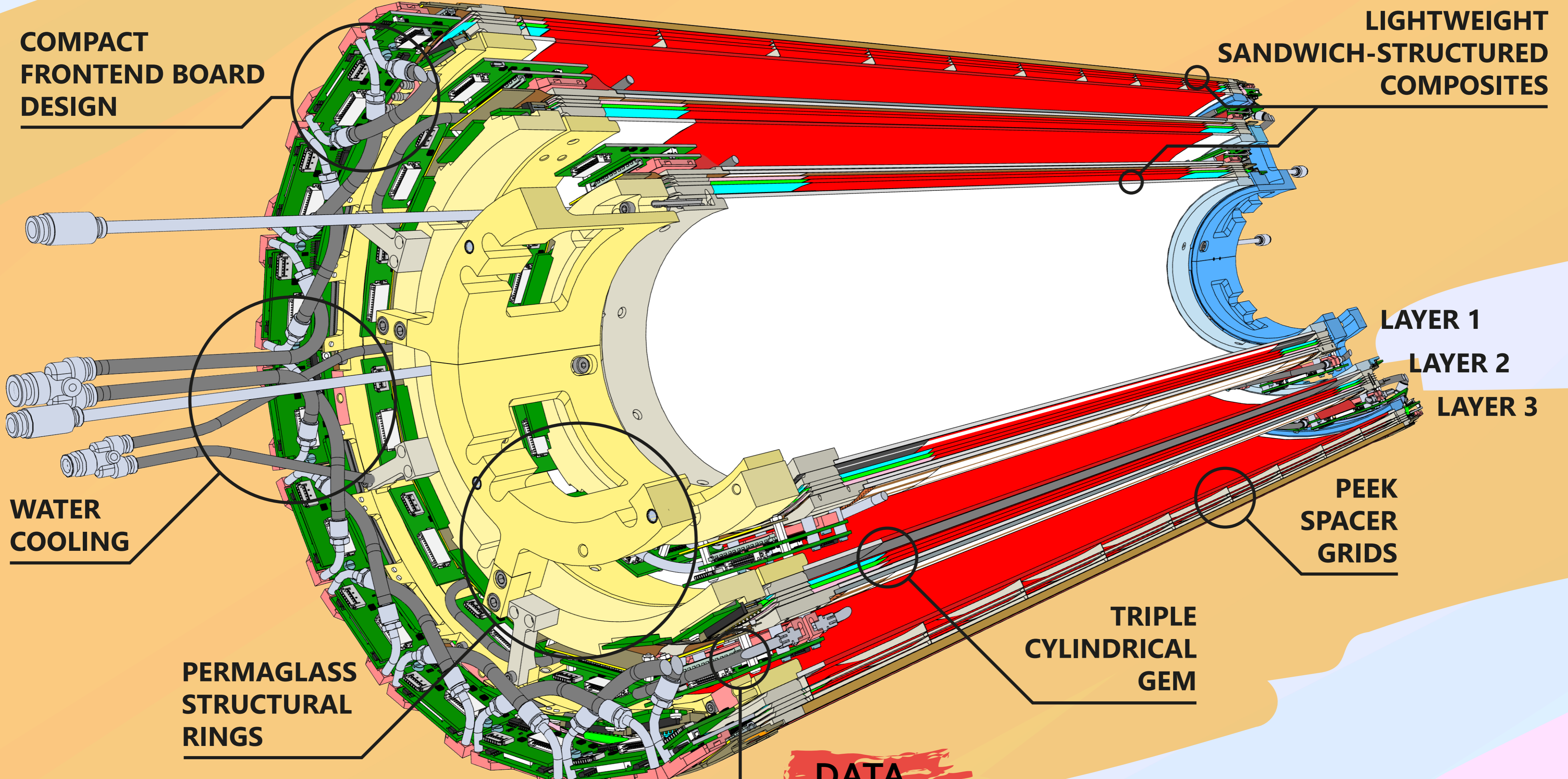
- $\sigma_{r\phi} \sim 130 \mu\text{m}$
- $\sigma_z < 1 \text{ mm}$
- $\text{MB} < 1.5\% X_0$
- $\sigma_{pt}/P_t < 0.5\% @ 1 \text{ GeV}/c$

DESIGN

The detector consists of **three coaxial tracking layers**, each of which is an independent **triple GEM** detector operating with an Ar-iC4H10 (90:10) gas mixture.

Designed to fit the volume of the current inner MDC, the CGEM-IT has an inner diameter of 131 mm, an outer diameter of 361.4 mm, and an overall length of 1070 mm. Permaglass rings at the endcaps maintain the spacing between the electrodes and provide mounting points for HV connections, frontend electronics, and gas pipes. Cathodes and anodes are supported by **lightweight sandwich-structured composites**, while the GEM electrodes of all but the largest layer are floating. Layer 3's GEM foils are supported by **PEEK spacer grids** to prevent buckling-induced deformation.

The anodic circuits are segmented by two layers of strips, whose direction form stereo angles of 46.72° , -31.033° , and 32.9244° for Layer 1, Layer 2, and Layer 3 respectively.



TIGER ASICS

DATA

The three layers of the CGEM-IT were assembled in October 2023 and deployed in a **cosmic ray** telescope setup for validating the now complete system.

The data acquired until February 2024 was submitted to an internal review committee, who **endorsed the installation of the CGEM-IT in BESIII**.

Layer 3 has now been separated from the other two to allow for some final maintenance in preparation to the installation of the detector, planned to begin in **September 2024**.

ELECTRONICS

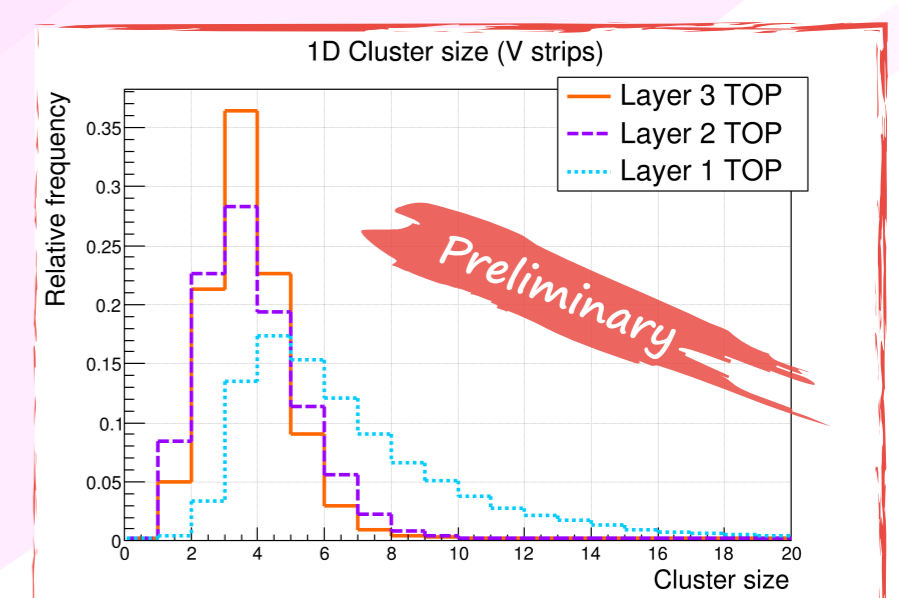
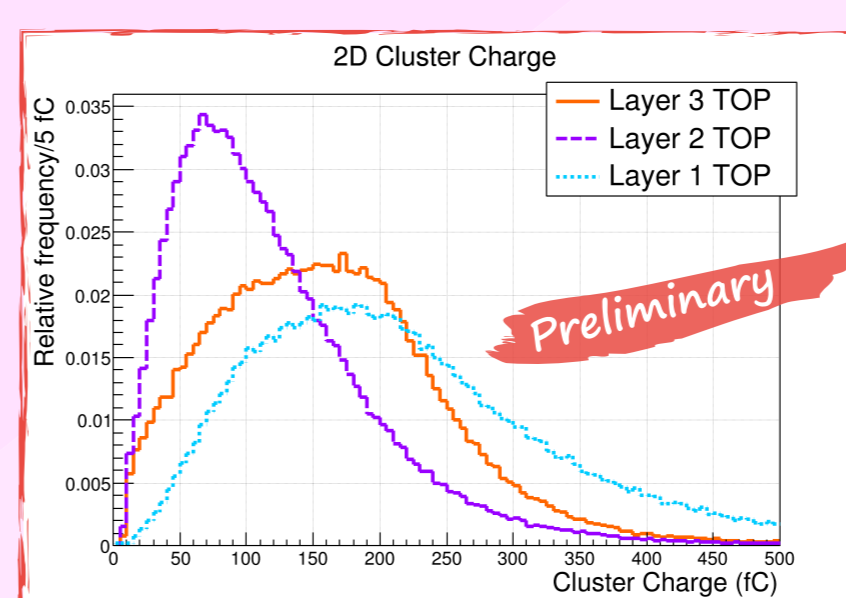
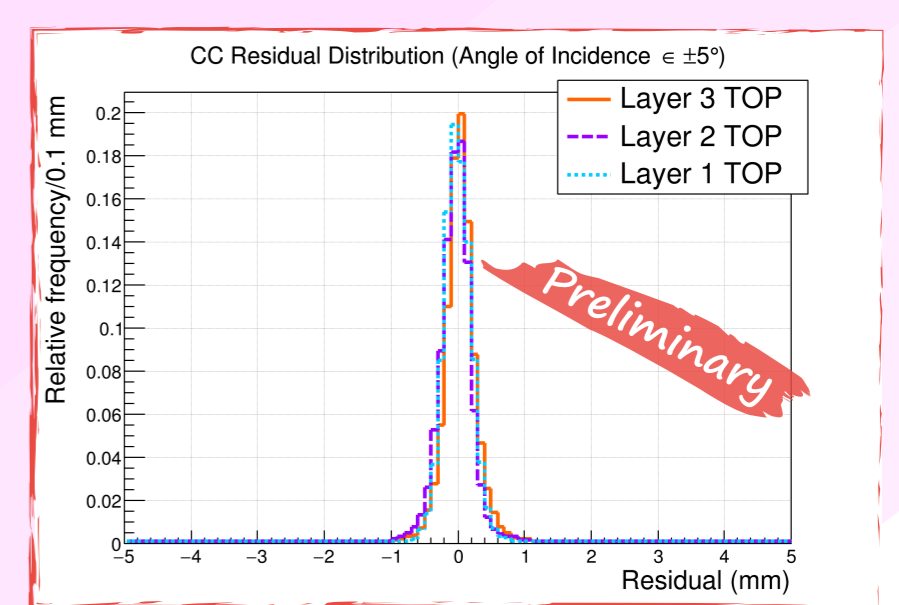
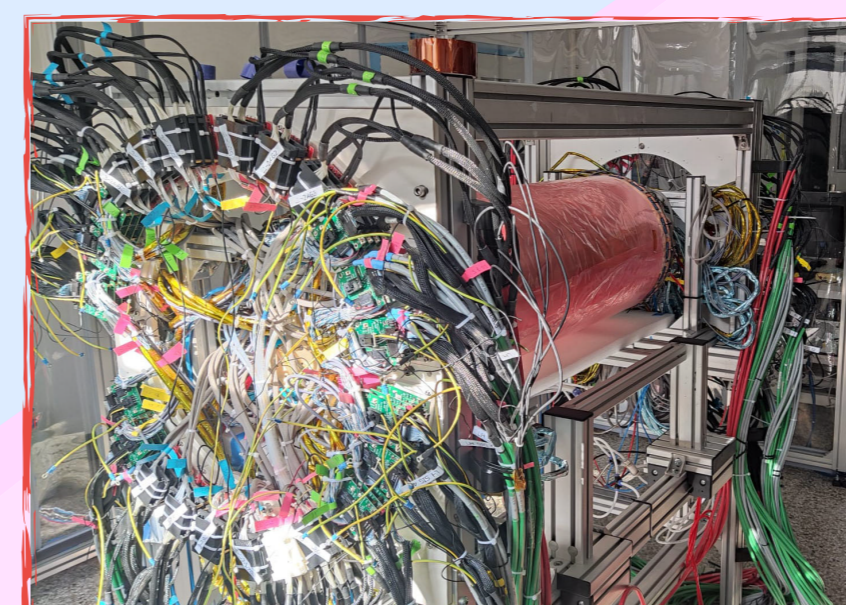
The about 10000 strips of the three layers of the CGEM-IT are read by a **TIGER-GEMROC** readout chain.

TIGER (Torino Integrated GEM Electronics for Readout) is a 64-channel mixed signal **ASIC** capable of performing **simultaneous charge and time measurements**. Each frontend board of the CGEM-IT carries two TIGER chips and was designed according to the strict spatial requirements.

GEMROC is an **FPGA** based backend module for configuring the TIGERs, powering them, and managing data flow during acquisition.

TIGER Parameters

- Input capacitance up to 100 pF
- Input dynamic range from 2 to 50 fC
- Noise on the Energy branch $< 1800 e^- \text{ ENC}$ (0.29 fC)
- Jitter on the Time branch $< 4 \text{ ns}$
- Thermal load 12.5 mW per channel
- Rate capability 60 kHz per channel



TO KNOW MORE

The CGEM-IT: An Upgrade for the BESIII Experiment

Balossino, I., Cossio, F., Lavezzi, L., Farinelli, R., Symmetry 14 (2022) 5, 905, DOI: 10.3390/sym14050905

The CGEM-IT readout chain

Amoroso, A., et al., JINST 16 (2021) 08, P08065, DOI: 10.1088/1748-0221/16/08/P08065