Noise issues of MDC after installation of CGEM IT

Mingyi Dong

On behalf of the working group

dongmy@ihep.ac.cn

IHEP, CAS

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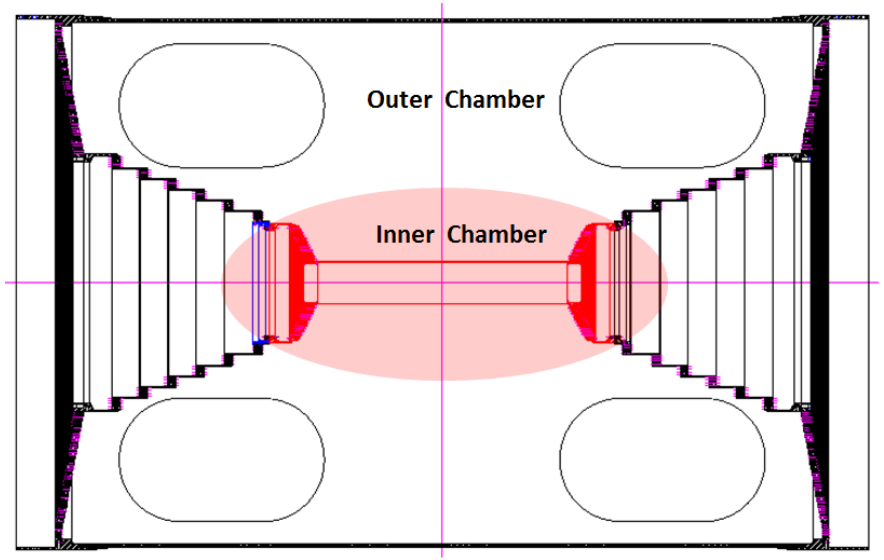
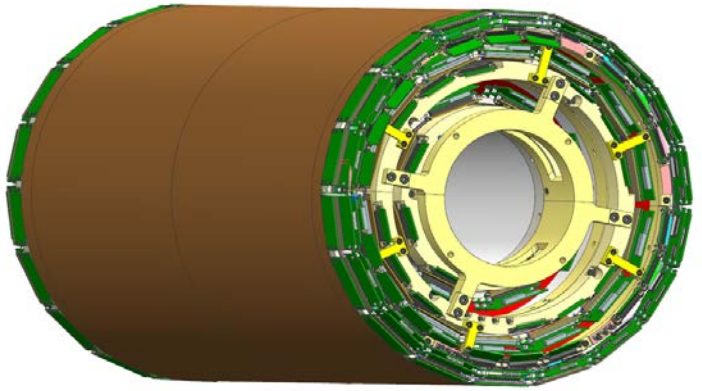
Outline

- Introduction of inner drift chamber upgrade
- System grounding
- Noise issues
- Summary and discussion

Upgrade inner drift chamber with CGEM IT

- Remove inner drift chamber safely
  - No damage to the outer chamber during operation
  - No damage to other detectors of BESIII
- Install cylindrical GEM (CGEM) successfully
  - No impact on MDC gas sealing
  - No damage to feedthroughs and preamps of the outer chamber
  - Solving the issues of limited space for CGEM cabling and installation of FEB
- Both MDC and CGEM can work normally without interference between them





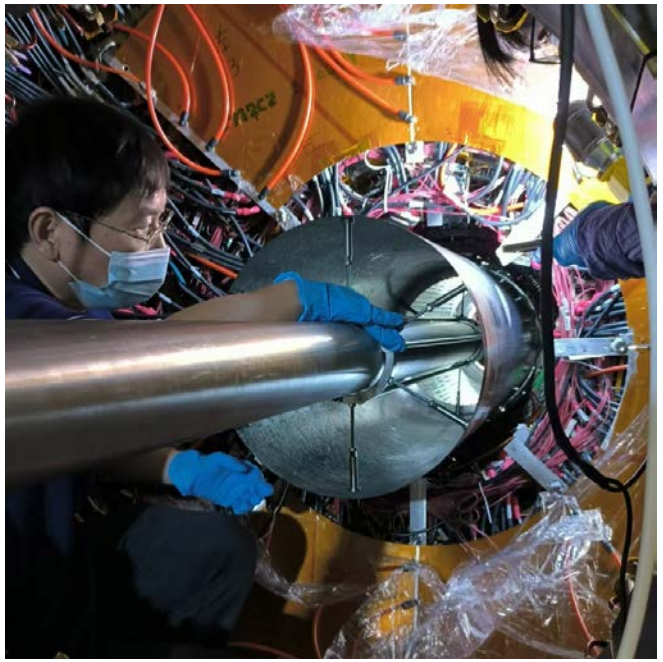
CGEM inner tracker

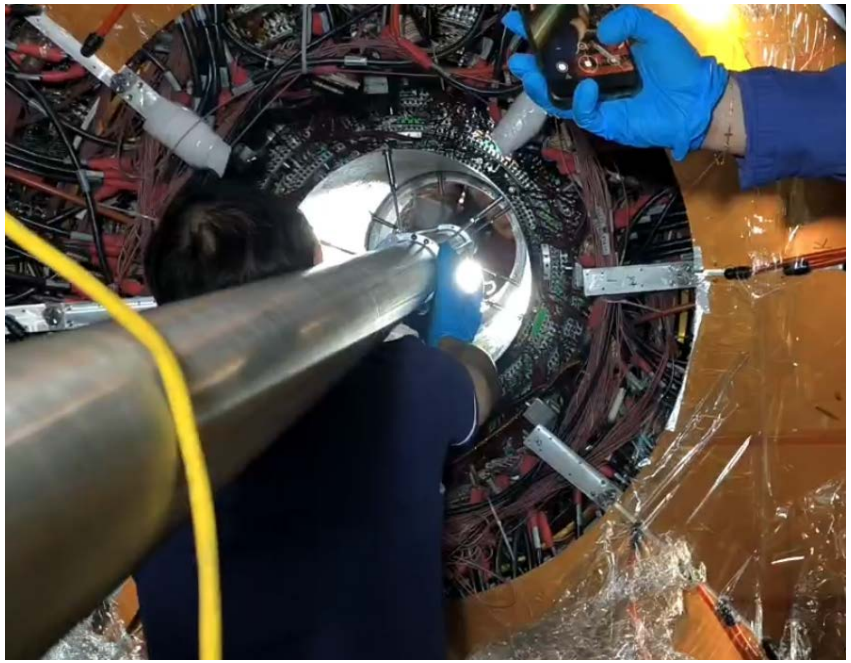
Milestones of inner chamber upgrade

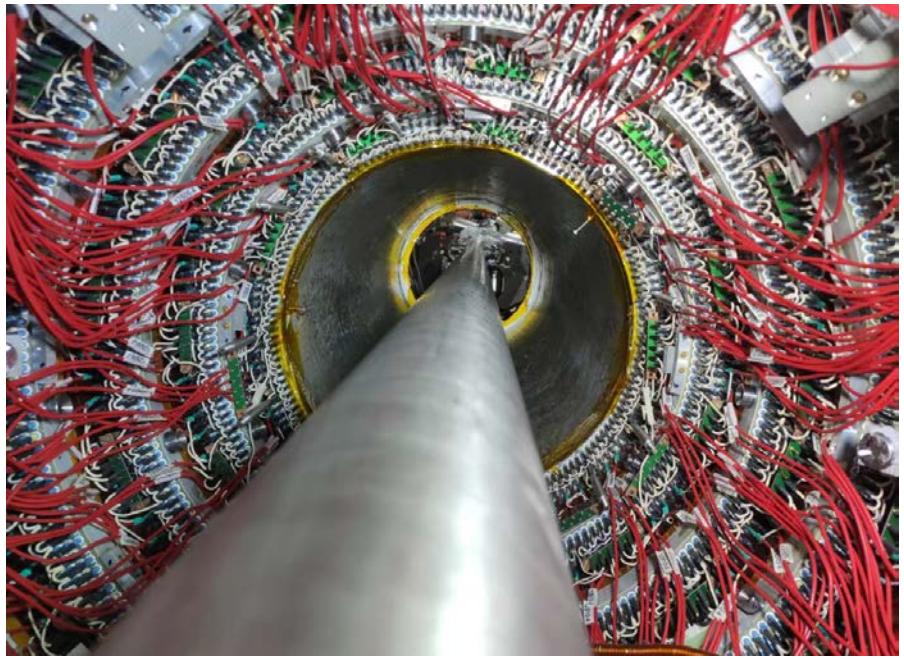
date	milestones
July. 1	Removed the shielding brick wall on both sides of IP area, started upgrading iMDC
Aug. 19	Review of extraction of IMDC
Sep. 14	Pulled out IMDC safely
Sep. 15	Installed new inner CF cylinder successfully
Sep. 28	Finished sealing of MDC and the first cosmic-ray test. MDC can work normally with nominal HV , no noise
Oct. 5	Inserted CGEM IT successfully
Oct. 9	Laser measurement of both MDC and CGEM, no position change of MDC after upgrade of inner tracker
Oct. 19	Powered on the electronics and HV of CGEM with nominal values successfully
Oct. 31	Finished sealing and leakage check of MDC after installation of CGEM. the average leakage rate is about 3×10^{-5} pa m^3/s on both sides, which is acceptable
Nov.6	Finished problematic preamp boards after installation of CGEM, all layer of MDC can work normally with nominal HV
Nov.12	First joint test of MDC and CGEM, both system can work, but large noise was found in step part of MDC

Installation of new inner CF cylinder

- After extraction of the inner chamber, new inner CF cylinder was installed as the inner wall of MDC
- Aluminum foils are coated on both sides of inner CF cylinder for shielding

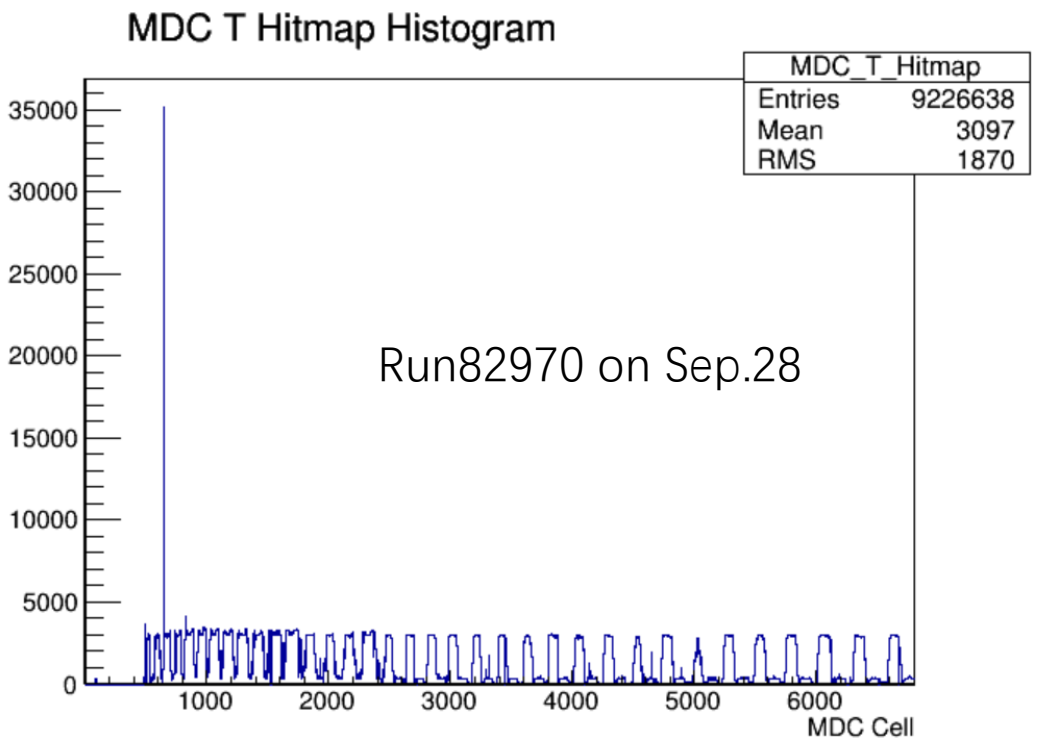


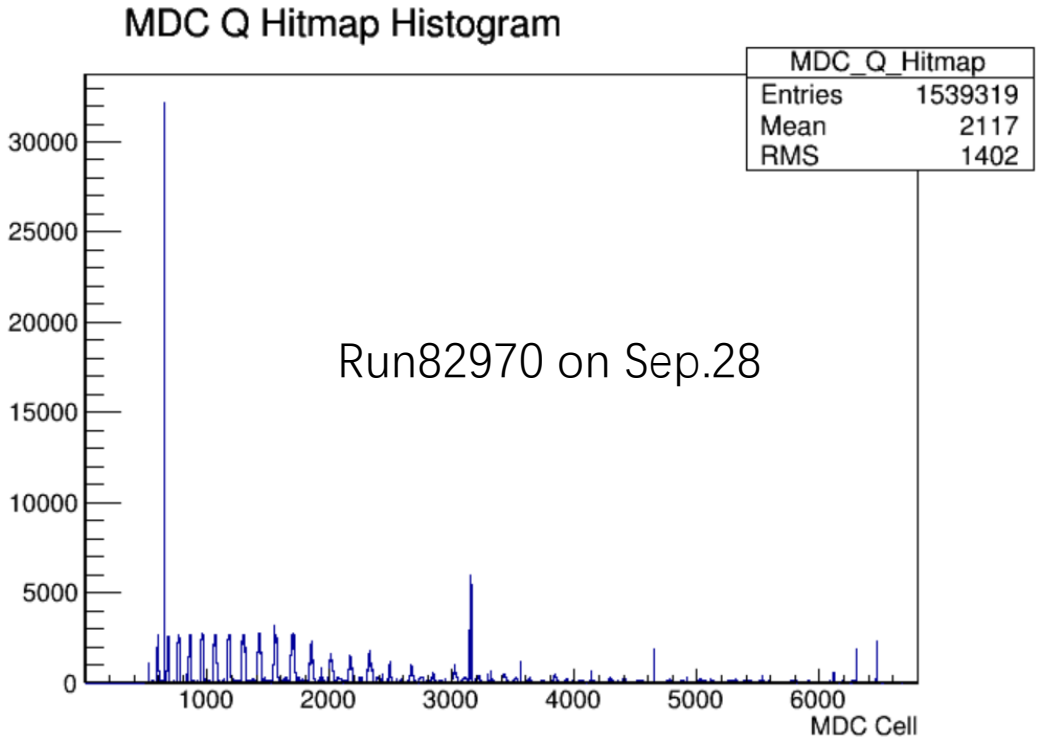




Cosmic-ray test of MDC after removal of iMDC

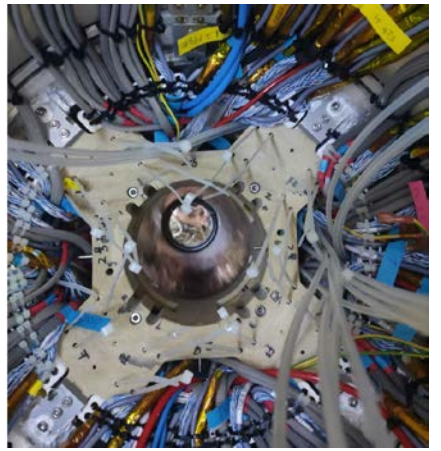
- After gas sealing and HV training, first cosmic-ray test showed that MDC could work normally with nominal HV (reference : 2200V) on Sep.28
- T and Q Hitmaps show the channels are normal
- No noise was found in T and Q measurements, except one noisy channel

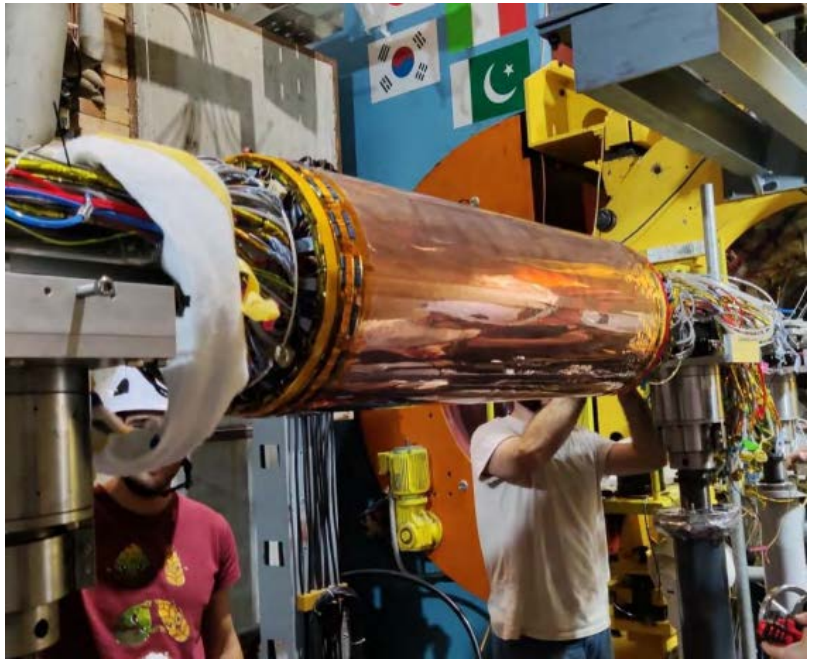


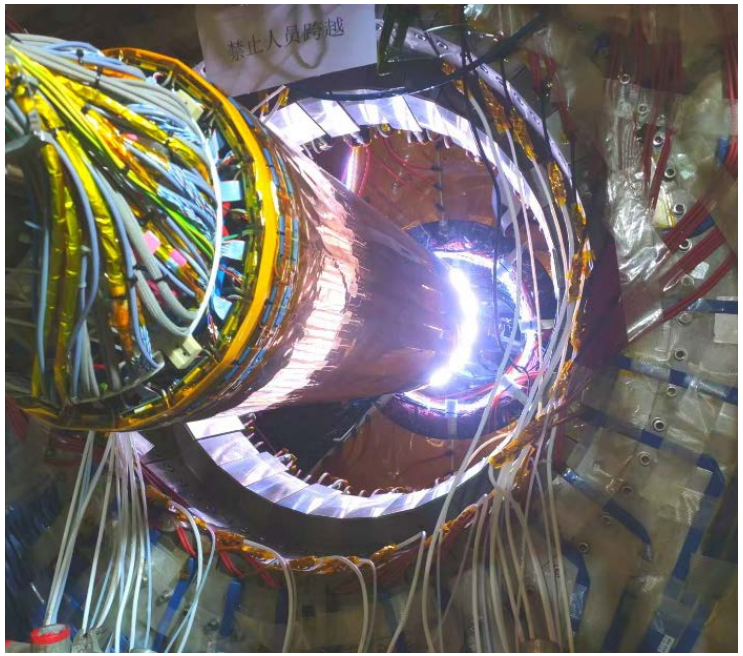


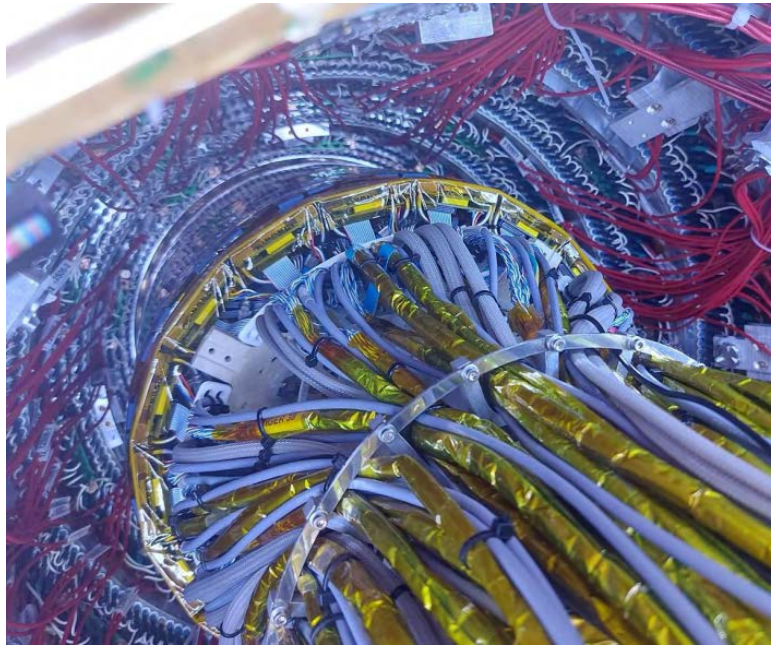
Installation of CGEM

- CGEM was inserted into the BESIII successfully on Oct.5
- It is fixed on MDC flange2 through FR4 flanges on both sides
- Grounding was separated from MDC physically



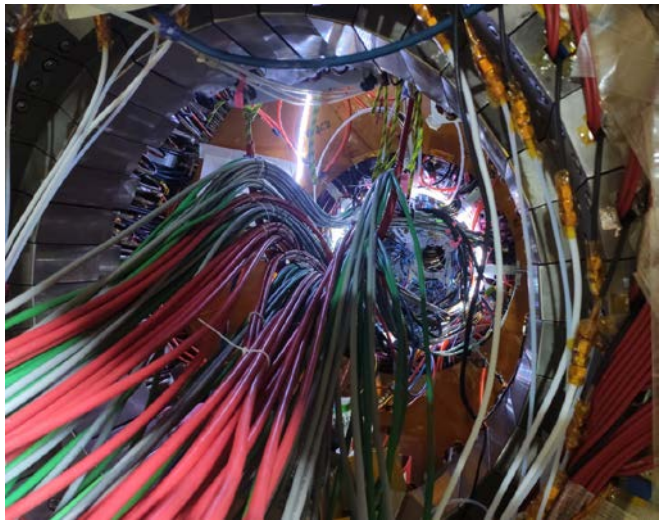


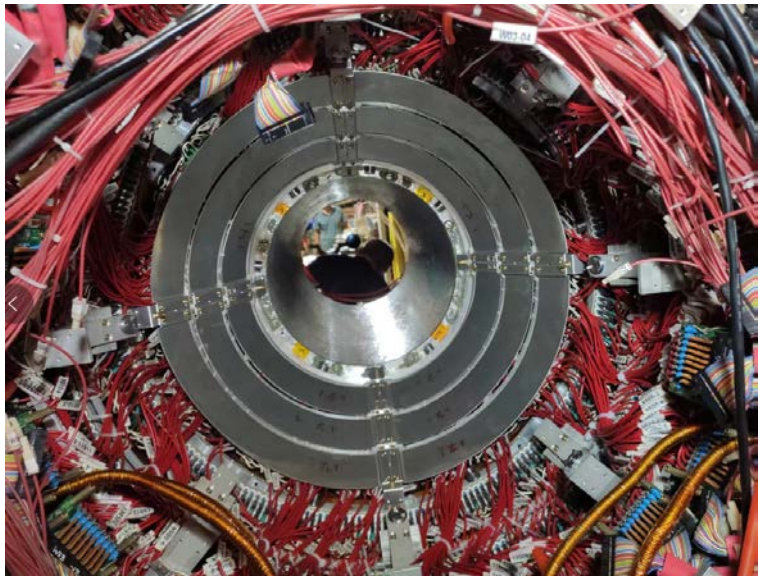


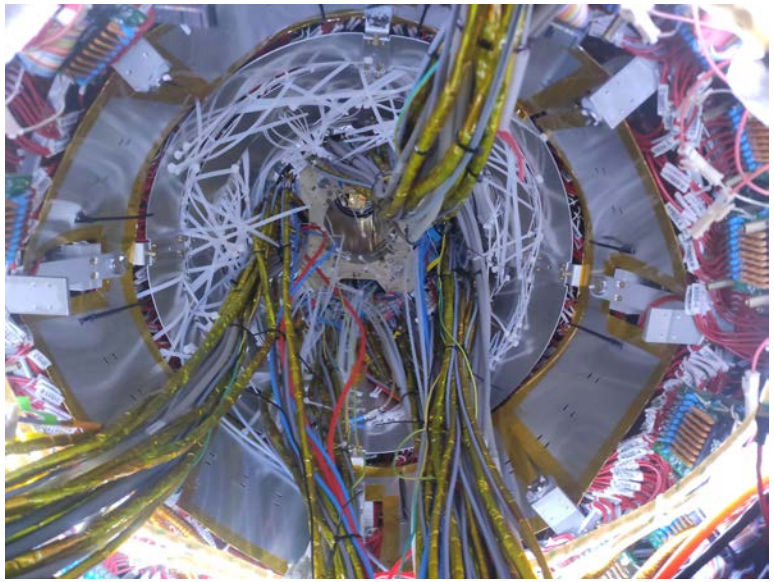


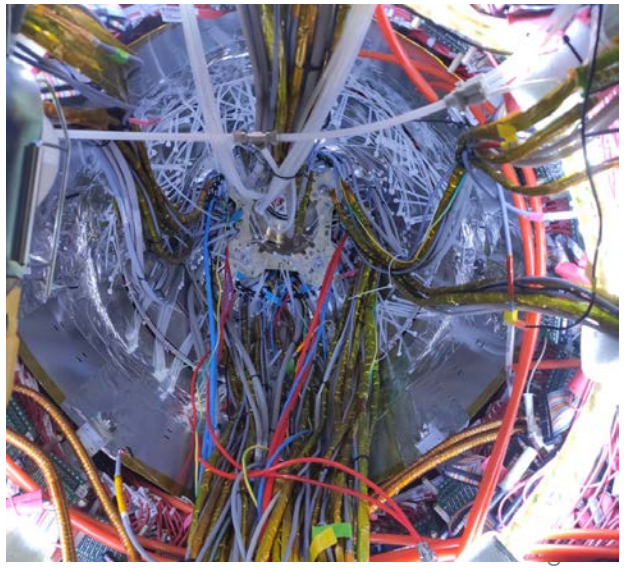
Installation of CGEM

- A aluminum shielding layer was installed to separate MDC cables and CGEM cables
- CGEM patch cards are fixed on the “tower” of the MDC preamplifier boards
- Due to the limited space, there is no shielding layer between MDC preamplifier boards and CGEM patch cards

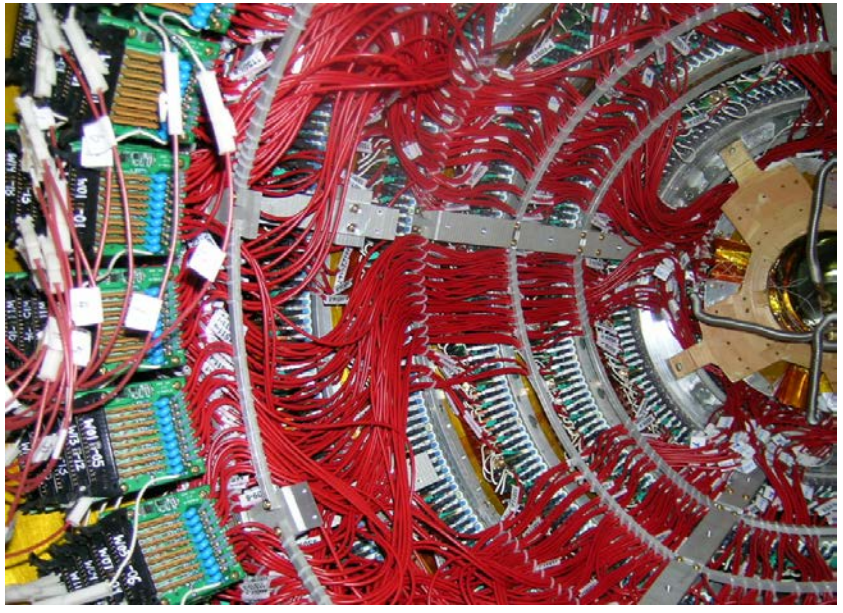


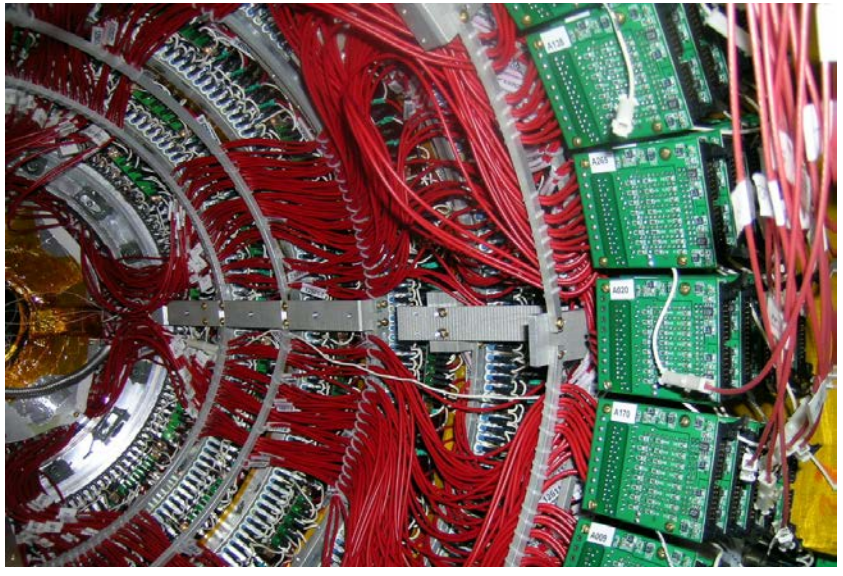


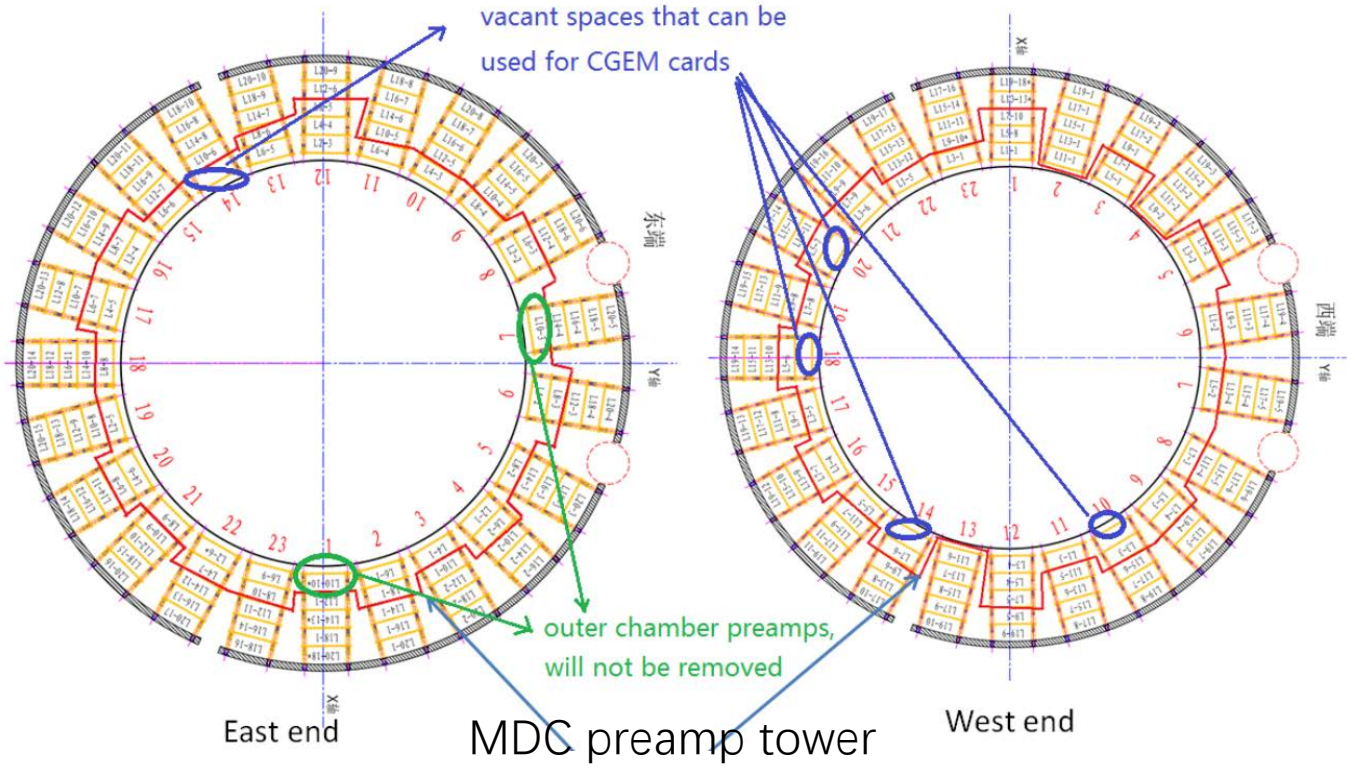




CGEM Patch cards installation

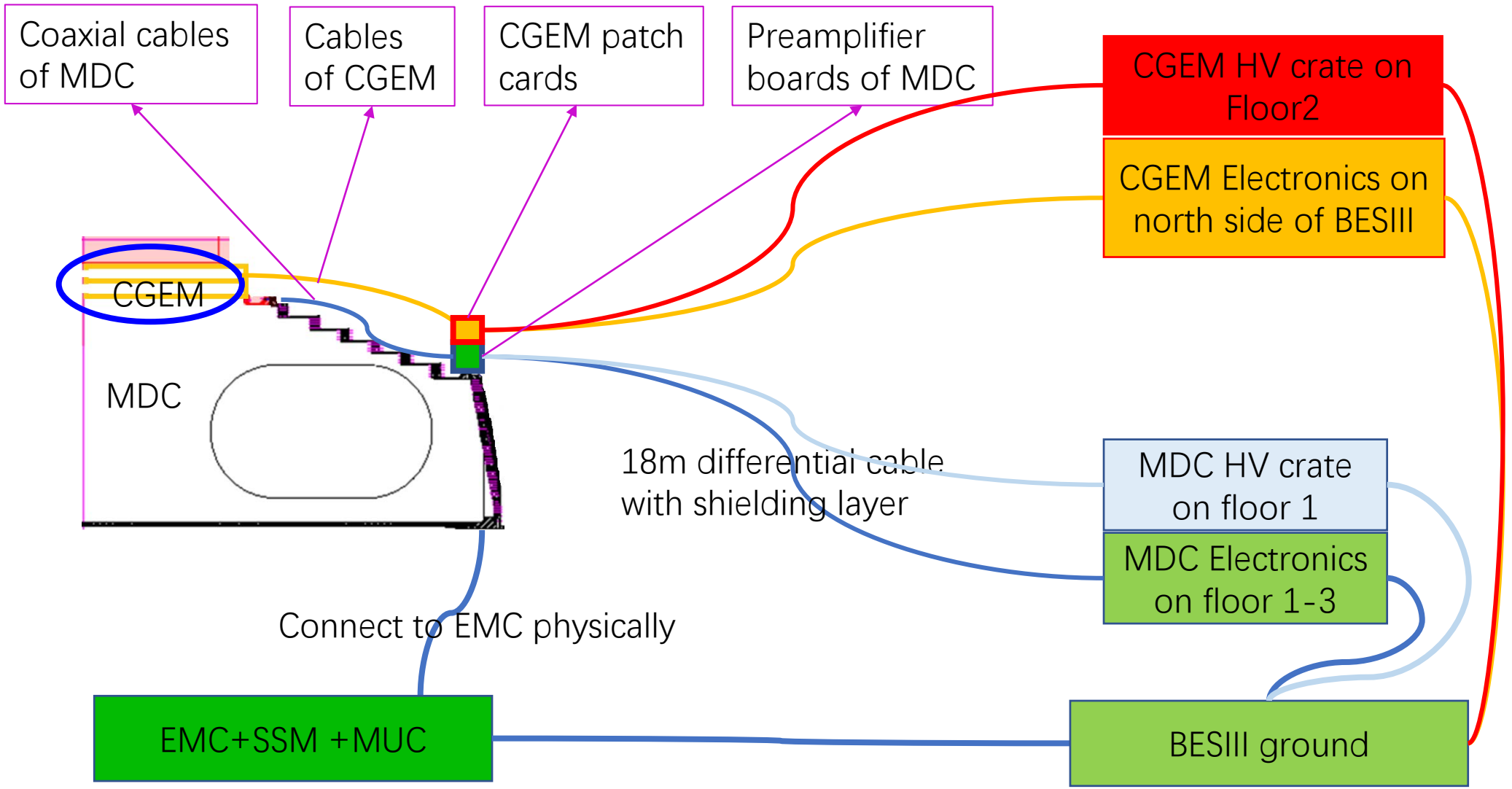




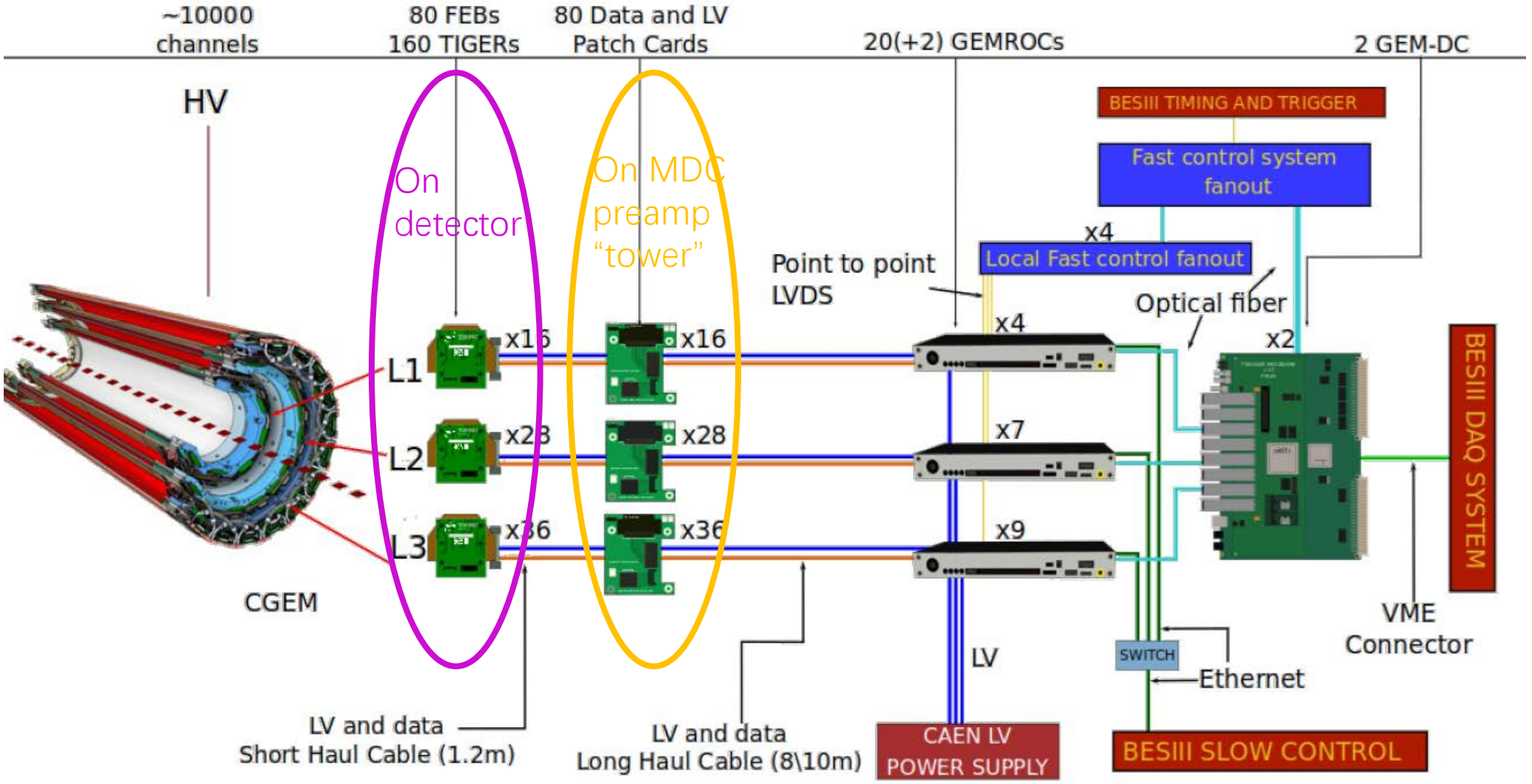


- The preamplifier boards of inner chamber were removed, and the space was used to install CGEM patch cards
- Insulated screws are used to separate the grounding of CGEM and MDC

Schematic diagram of grounding

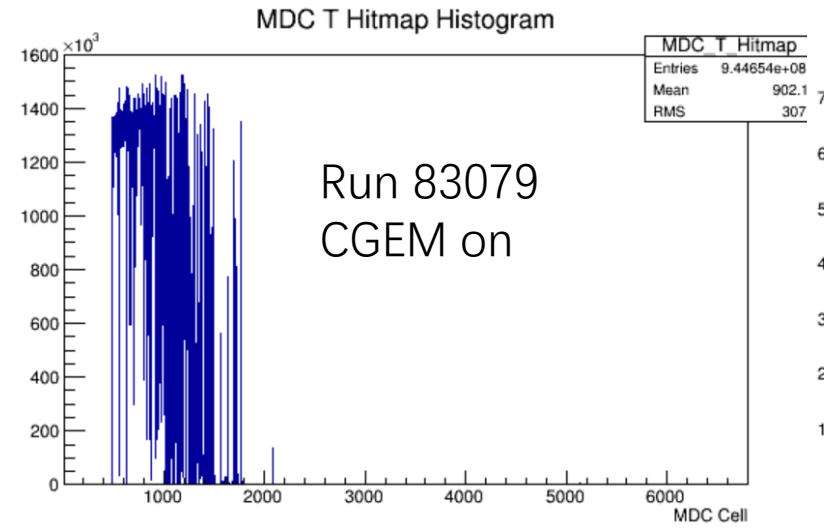


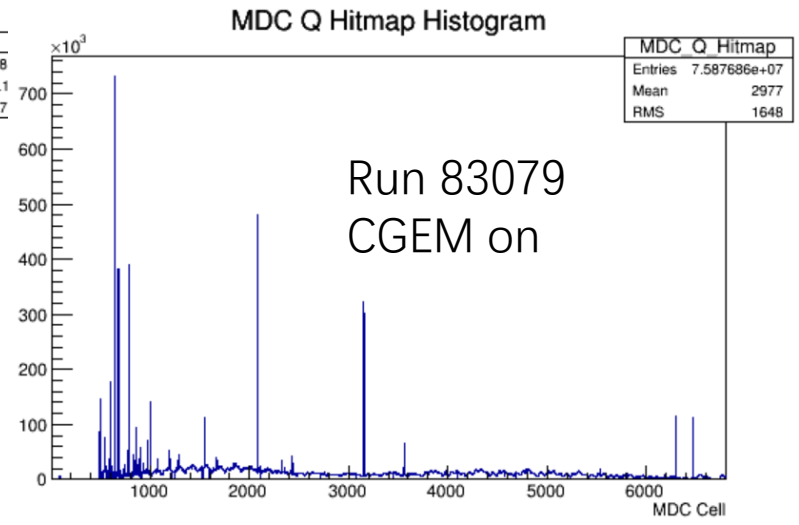
CGEM readout

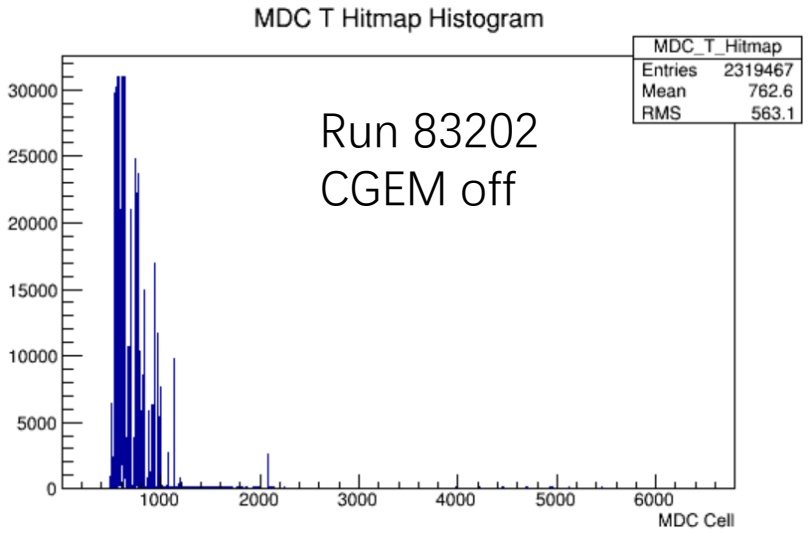


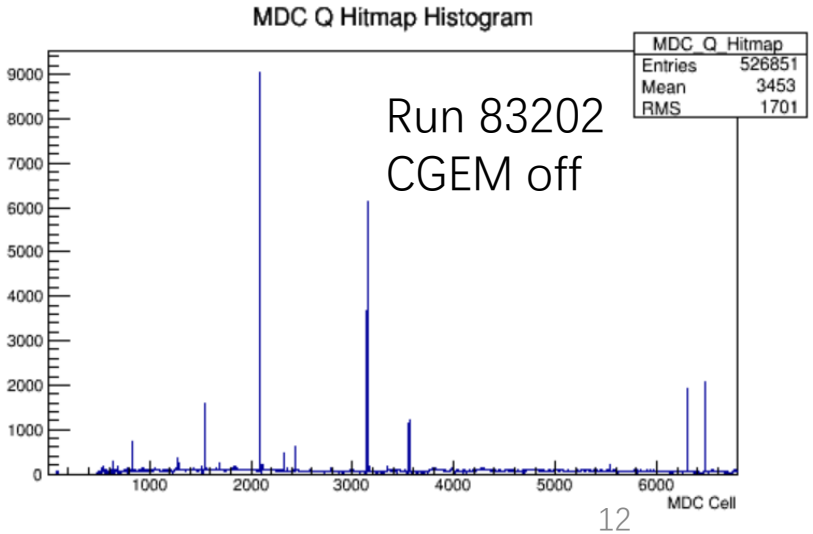
Noise issues

- In the joint testing of CGEM and MDC, both detectors can work well with nominal voltage
- Noise was found in MDC during the joint test.
  - The noise is in the step part of the MDC
  - The inner layers are larger, and the outer layers become smaller
  - Noise mainly impact on Time measurement, almost no impacts on Charge measurement
  - Noise has a larger impact on the even layers of MDC (readout electronics is at the east end)
  - Even if CGEM is powered off, there are still some channels with noise



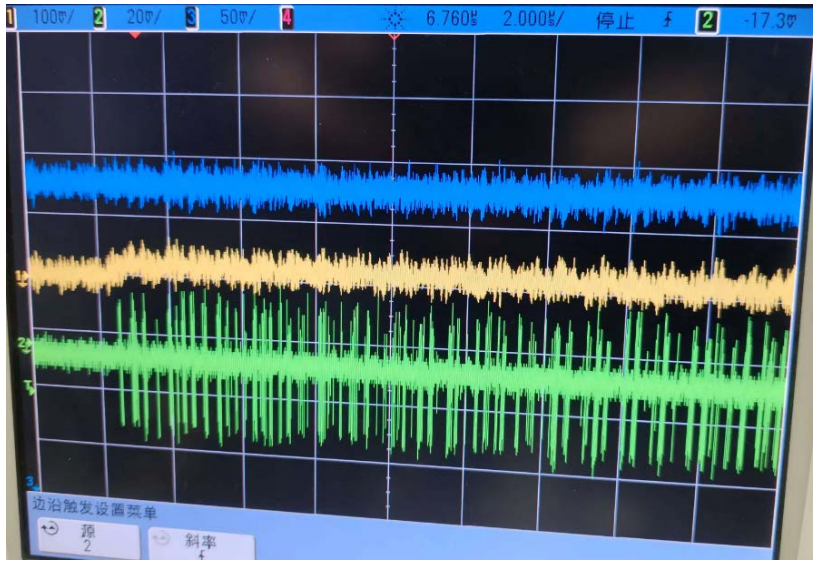






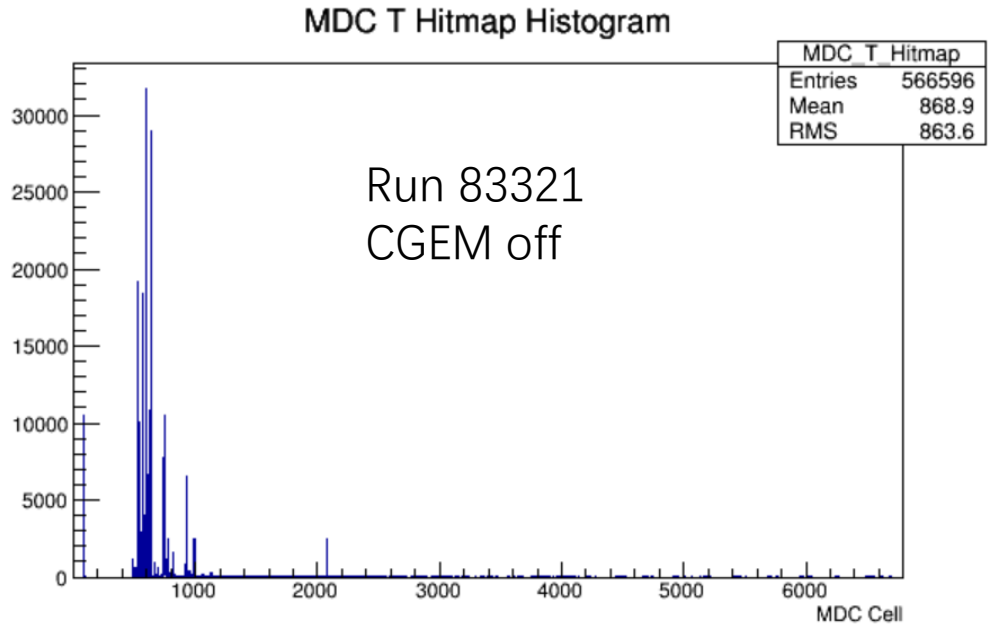
Testing for noise issues

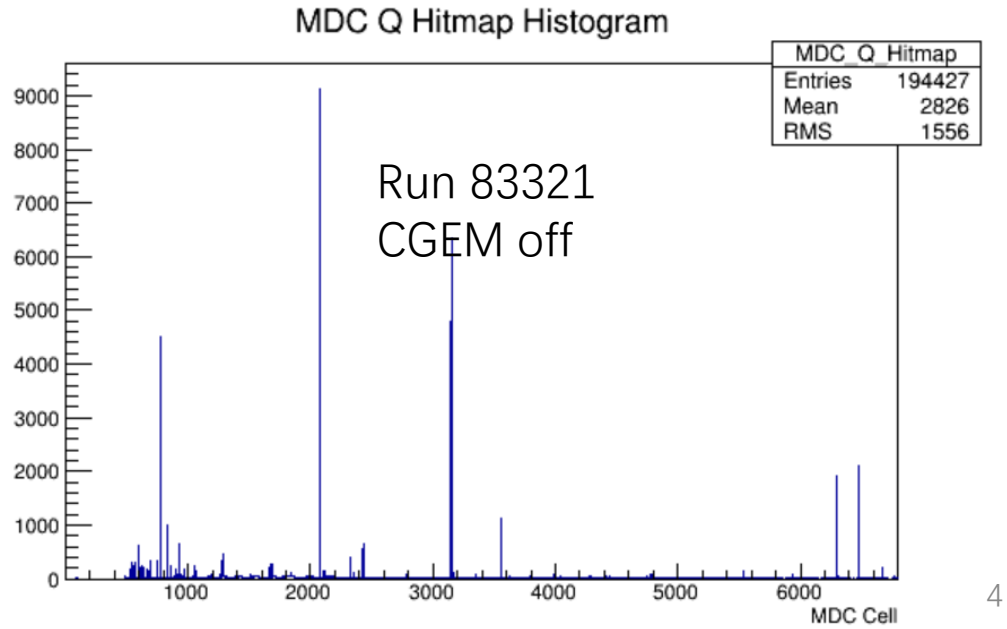
- Lots of tests have been done in the last two weeks
  - Grounding tests:
    - Different grounding connections of CGEM
    - Different grounding connections between CGEM and MDC
    - Disconnecting the preamplifier of MDC from the “tower” ground
  - Shielding tests:
    - Adding shielding boxes for MDC preamplifier boards
    - Adding shielding layers for the end of CGEM signal cables
    - Installation the final shielding plates for CGEM and MDC
  - Noise waveform tests:
    - Testing the signals from daughter board of MDC MQT with a oscilloscope (good channel and noisy channels)
  - Threshold scan:
    - Measuring the noise count rate with different MDC time threshold



Test results

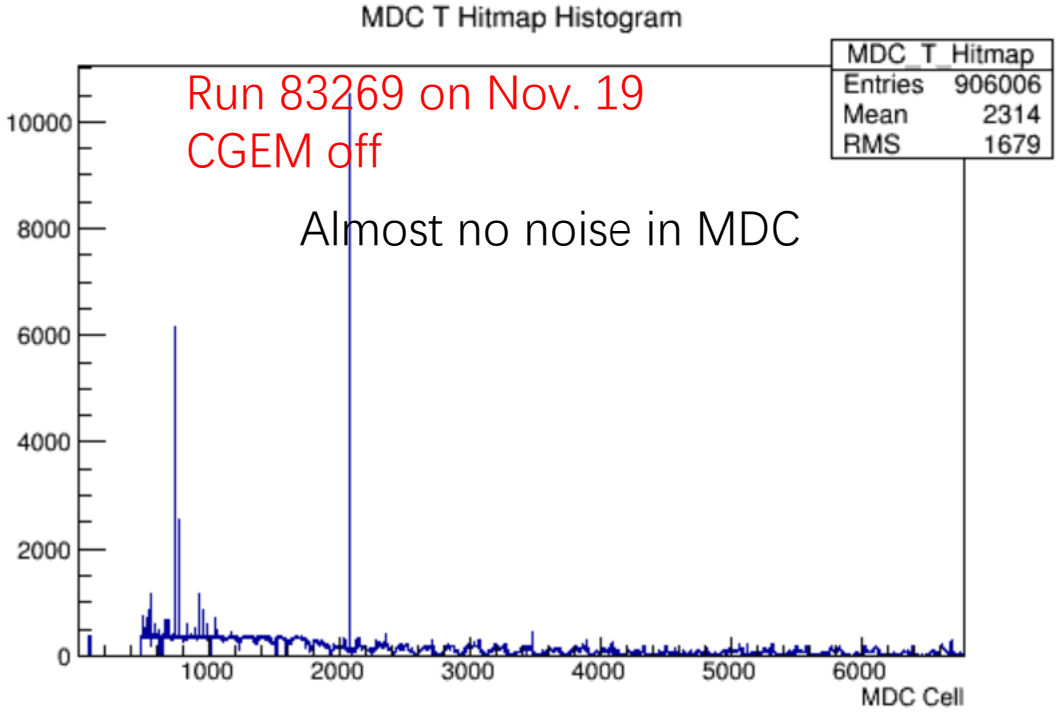
- Grounding and shielding have no significant effect on reducing noise
- The ground the CGEM is separated from MDC at the front end (the resistance between them is about 350 kΩ when the crates of the CGEM is disconnected from the ground)
- As each device in the CGEM system is powered off and disconnected from the ground one by one, the noise of MDC becomes smaller and smaller
- Compared to the case before CGEM installation, there is baseline noise because even if CGEM is powered off, there are still some channels with noise present

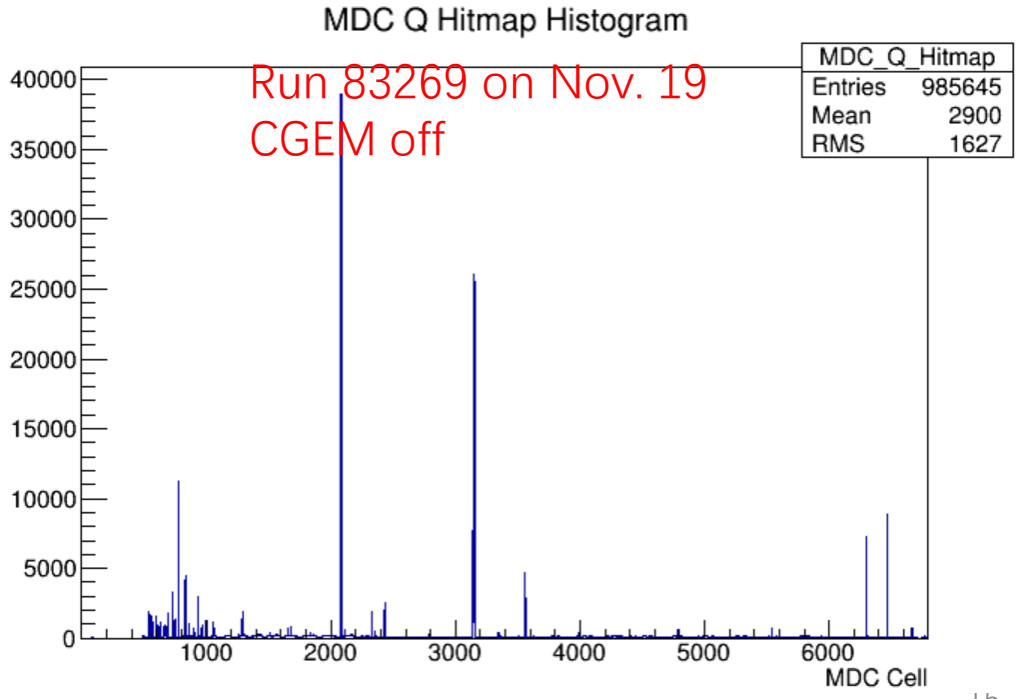




Test results

- The baseline noise does not seem to come from CGEM, as it disappeared between 14:00-16:00 on Nov.19. No operation related to this change was found (SCQ test system, SSM, interlock door)
- When CGEM is powered on, the noise become serious, and even if the T threshold is increased by 2.5 times, the noise count rate is still very high





Some planed tests

- Isolation transformers will be used for testing CGEM and MDC related equipment
- Testing will be conducted on CGEM cables using filtering magnetic rings
- We powered off accelerators and other related equipment one by one to search for the basic noise sources this morning， no noise source was found (everything was powered off, baseline noise still existed)

- After discussing with the machine people, we have postponed the installation and recovery of IP region. The start time will be discussed and finalized in the meeting on this Wednesday or Friday

Summary

- Both MDC and CGEM can work normally at nominal HV in joint cosmic-ray testing
- Noise issues was found during the test and extensive tests was done
- Grounding and shielding have no significant effect on reducing noise

Thanks for your attention!