

Production status of the SBS GEM modules

Latest production issues and fixes

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Production status of SBS Back Tracker GEMs

Production of the SBS-BT-GEM Modules

- 40 modules + 5 spares to be built by mid 2017.
- 16 modules already built and tested
- Module #17 just completed and #18 started
- Cosmic bench test:
 - 12 first modules tested ✓
 - last tested modules (#13 to #16): Low efficiency ✗
- Only change with these 4 modules:
 - Aluminized Kapton replace plain Kapton as gas window
 - → solve two potential problems that we faced with SBSGEMs:
 - See next slides



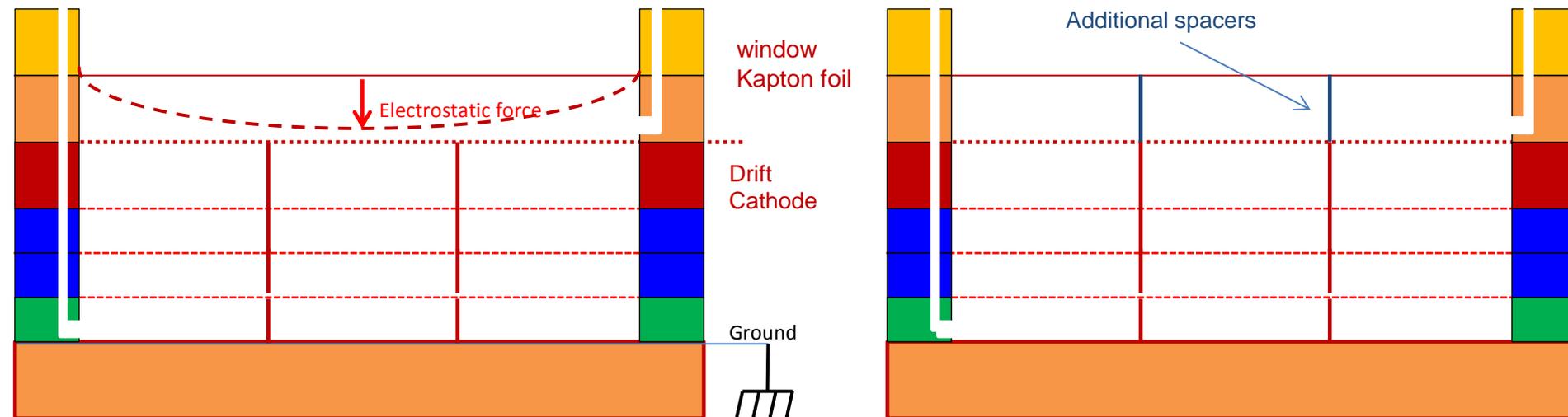
Solved issue: Collapsing gas window Kapton foil at high rate

Problem

- First observed at JLab during test of SBS GEMs: that the gas window foil collapse onto the drift cathode window below it during chambers operation → We easily reproduce in lab with x-ray source
- Caused by charging up of the Kapton foil at high particle rate → Electrostatic attraction between the gas window and the drift Cathode → Discharge is extremely slow (several weeks unless triggered) → **Strong distortion of the APV25 signal (timing and shape etc ...)**

Initial proposed solution

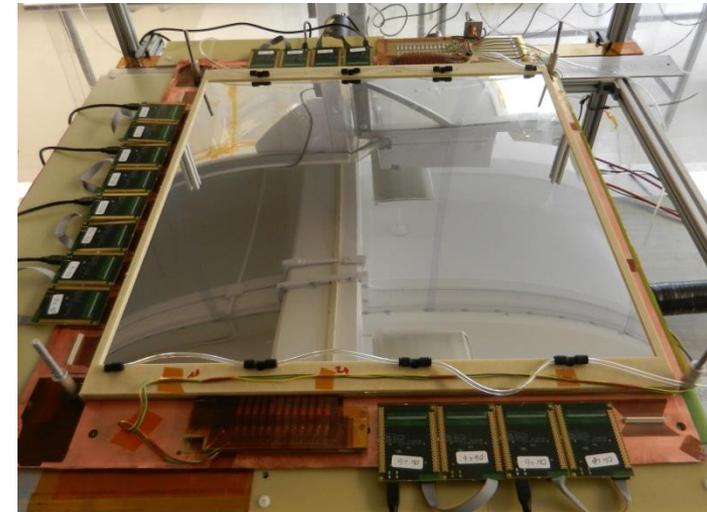
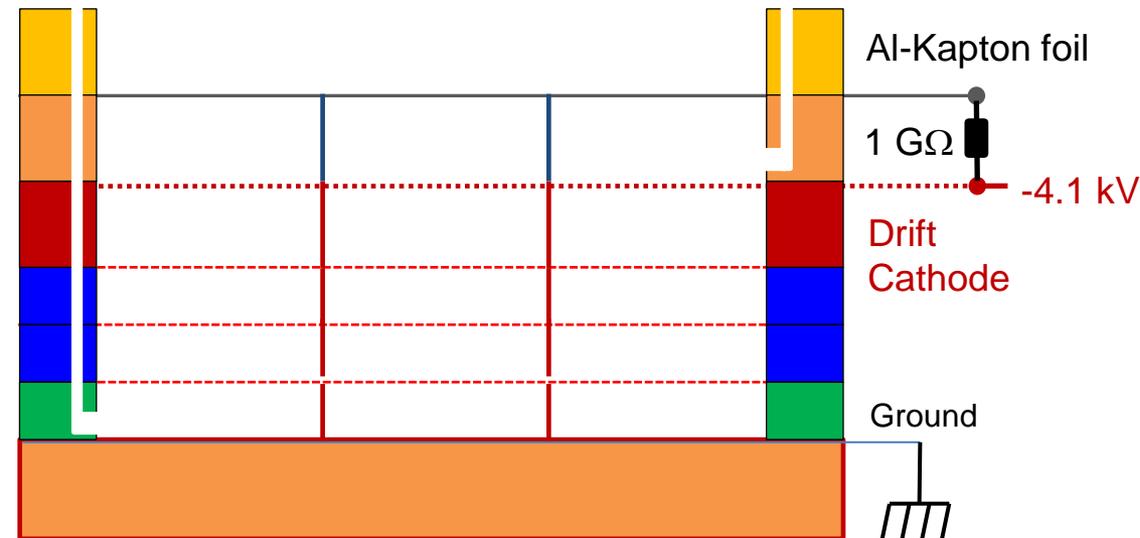
- A simple fix we tried was to add some spacers in the gas window region of the chamber
- We saw a clear improvement **but not sure about long term stability** of the fix high rate condition



Solved issue: Collapsing gas window Kapton foil at high rate

Final proposed solution

- Use aluminized gas window foil and set it to the same potential as the drift cathode → Faraday cage like to prevent charges accumulation on the gas window as well as the top Kapton layer of the drift
- Tested with SBS-BT-GEM proto I with x-ray source at high rate ($> 1 \text{ MHz/cm}^2$ equivalent MIP).
 - Without the HV on the gas window → foil collapse after a few hours of x-ray exposure
 - **With the HV on, we did not observe any collapse after 5 days of almost continuous exposure**



Aluminized Kapton replace plain Kapton in production chambers starting with SBS-BT-GEM prod#13

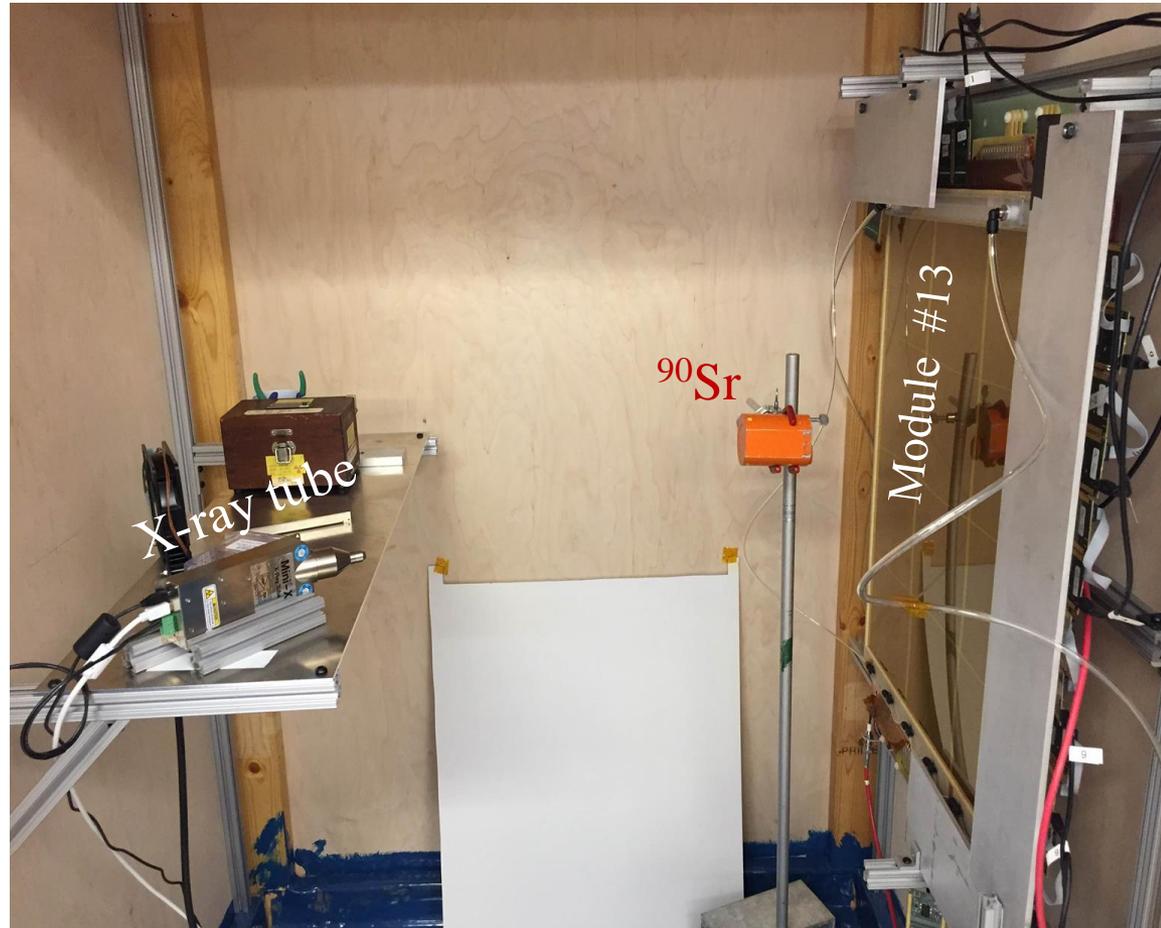
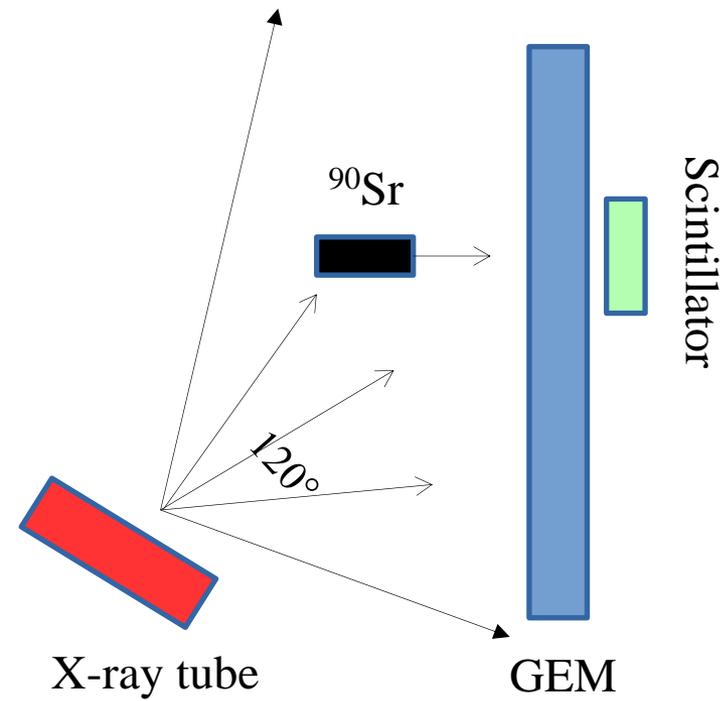
- Prevent the collapsing of the gas window foil onto the drift cathode
- **Aluminized Kapton (~×10) more waterproof than plain Kapton → reduce water contamination**

Opened issue: Low gain & efficiency of 4 last modules built and tested (#13, #14, #15, #16)

Standard cosmic test after completion of the modules reveals:

- Very low gain of each of the 4 chambers → even **at 4300 V** efficiency and gain are low compared to what we expect and observe **at 4100 V** from the 12 first modules + 5 prototypes we built before ...
- **After > 14 days** on gas (Ar/CO₂) on the cosmic bench module #13 still have the low efficiency and gain
 - Doesn't look like water contamination of Kapton **or does it?**
 - Can other source of contamination explain the behavior?
- **All 4 modules built with CERN foils from the same batch**
 - Module #13 has one foil from an older batch and 2 from the "*suspicious*" batch
 - Could it be something to do with the foils from this batch? → Holes geometry?
 - Optical inspection of the foil from this batch do not reveal anything special compared to other foils
 - Electrical test for all these foils are excellent with no problem
- **Could it be that we are doing something wrong?**
 - We tested our Ar/CO₂ gas with other chambers (modules #12, #4, small 10x10 GEMs) → saw nothing wrong with the gas line
 - We checked the HV board, connections **and the resistive dividers** → Everything looks OK

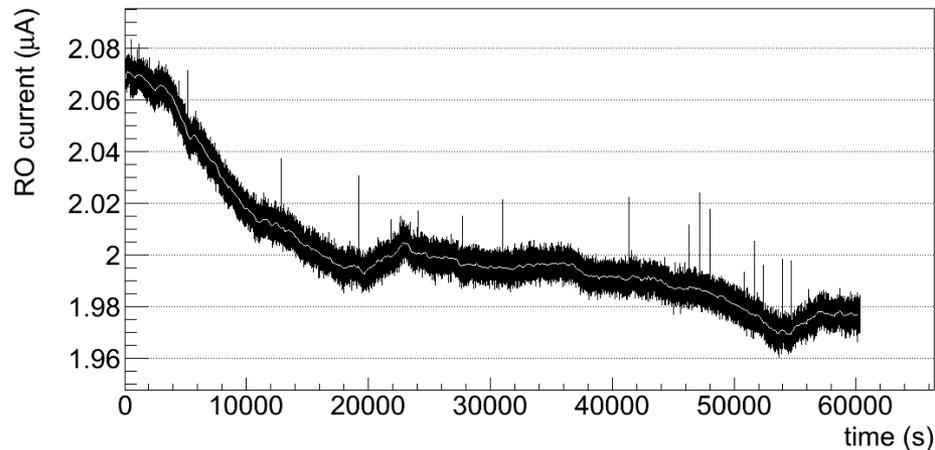
Opened issue: Test in X-ray and ^{90}Sr box Experimental setup



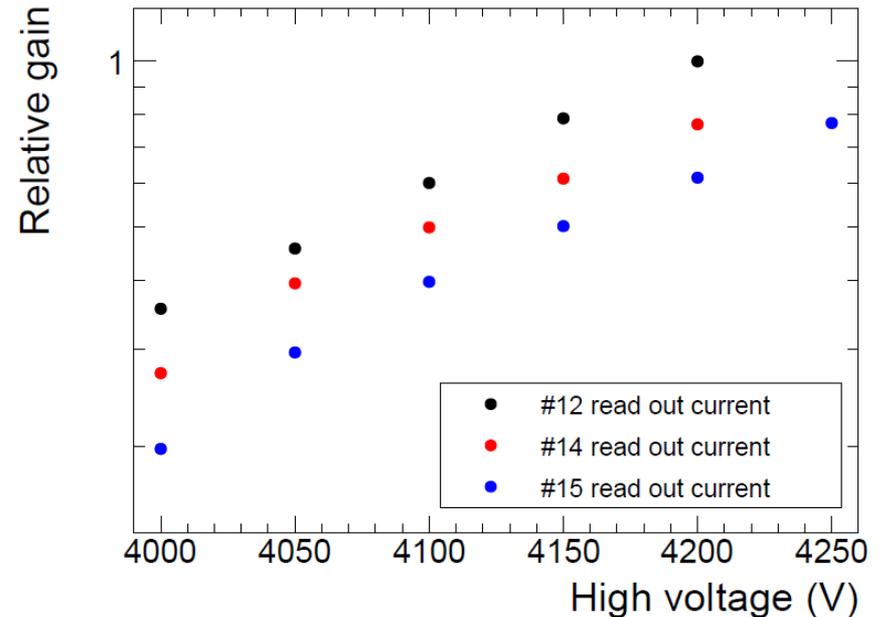
Opened issue: Measurement with x-ray

- The chamber is exposed to the X-ray for about 14 hours
- X-ray parameters: Voltage = 15 V, current = 60 μA
- We monitor the current from 128 strips of the readout board with pico-ammeter
- Module #12 is the reference \rightarrow measured current (gain) are normalized to the current on #12 at 4200 V

16 hours exposure of module #14



Relative current variation as function of the HV

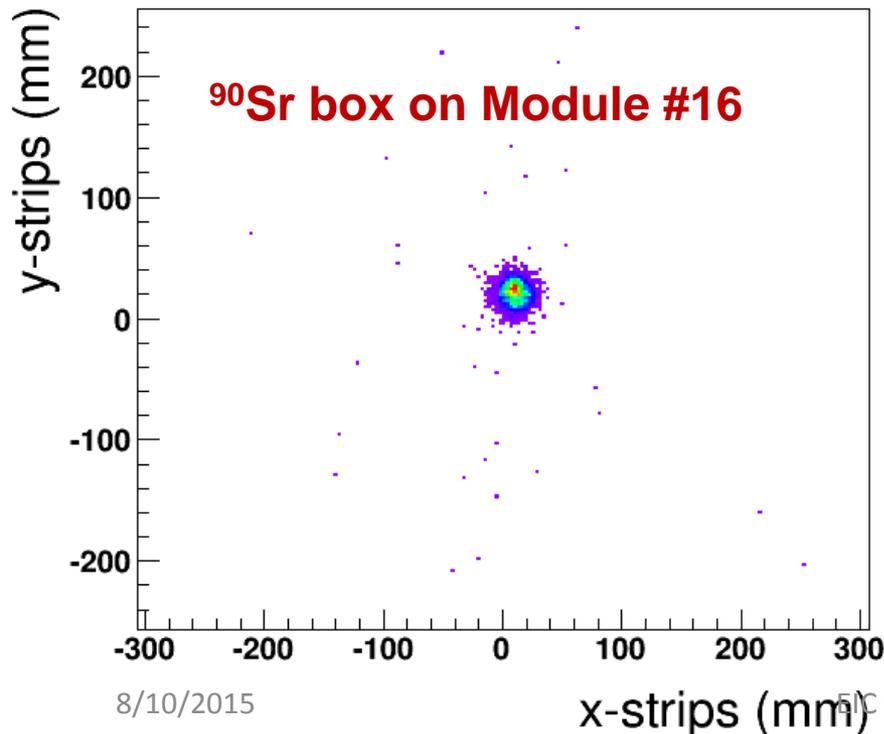


Opened issue: Measurement with ^{90}Sr box

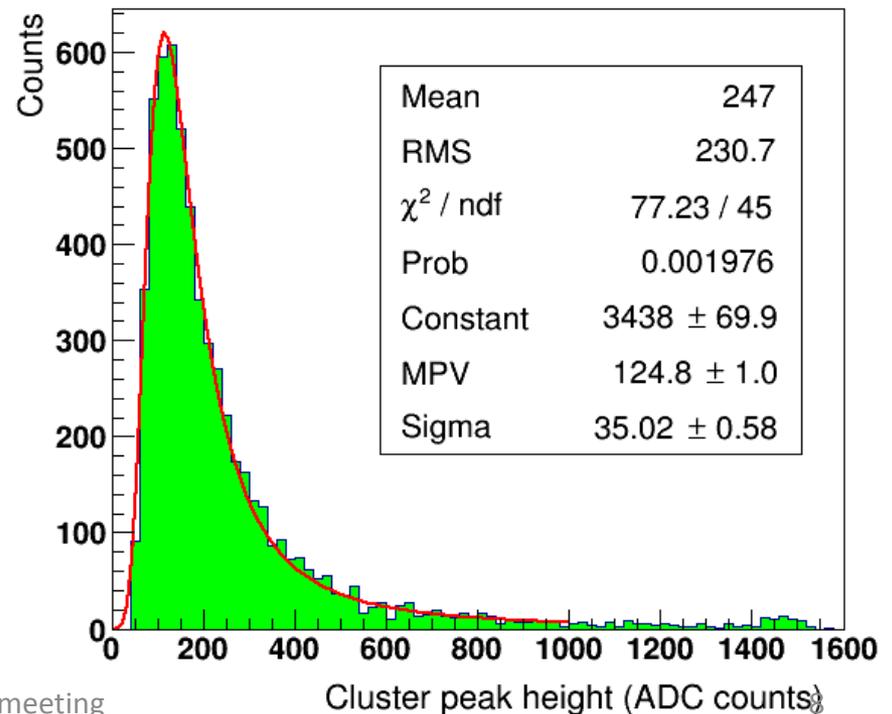
Standard cosmic test after completion of the modules reveals:

- We use for relative gain is the MPV of the Landau fit of the ADC distribution as a comparison tool between different modules
- To remove any uncertainty from charge sharing, we use the sum MPV (x-cluster) + MPV(y-cluster)
- Measurement are done in the same conditions before and after exposure to X-ray (typically 14 hours)

SBSGEMProd16: Cluster Position Map



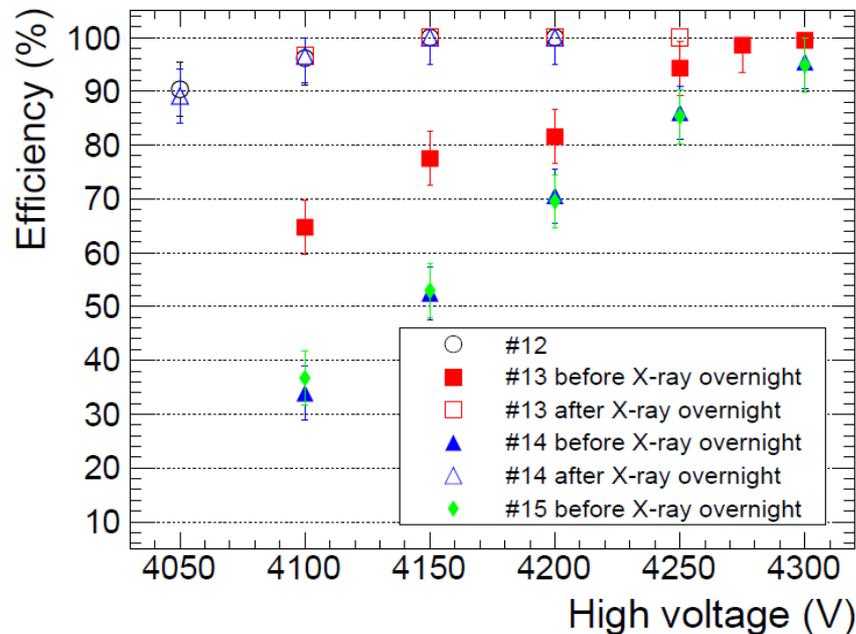
SBSGEMProd16: cluster ADCs Distr in Y-strips



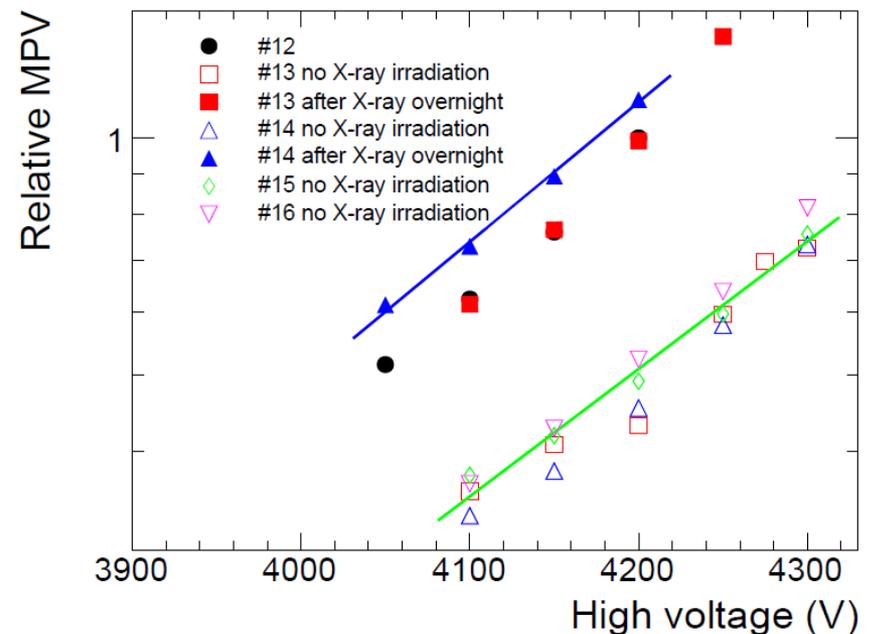
Opened issue: Measurement with ^{90}Sr box

- Module #12 is the reference → measured MPV (gain) are normalized to the current on #12 at 4200 V
- Before exposure, module #13, #14, #15 and #16 are all at least 3 time lower than #12
- After a few hours of exposure → all current are at a comparable level and the gain curve are similar
- After exposure of module #13, we tested the chamber again one week later without exposing it again to x-ray → MPV seems to decrease slowly but if charging up was causing the gain increase, should we not expect the charges to disappear after a week of non exposure?

Efficiency



Relative MPV (ADCs) variation w.r.t. module #12



Summary:

- Gain drop observed in Module #13 to 16
- Seems that whatever caused the gain drop is recovered after a few hours of exposures to high rate x-ray
 - Before exposure, module #13, #14, #15 and #16 are all at least 3 time lower than #12
 - After a few hours of exposure → all current are at a comparable level and the gain curve are similar
 - Does look like x-ray create some space charges effects in the chambers that modify the amplification property of the GEM and increase the gain → **Can we explain it right now ? NO**
- Is it a problem from a specific batch of GEM foil from Rui? → **new modules #17 and 18 about to be completed might provide an answer to the question or not**
- After exposure of module #13, we tested the chamber again one week later without exposing it again to x-ray → MPV seems to decrease slowly but if charging up was causing the gain increase, should we not expect the charges to disappear after a week of non exposure?
- **The tests is continuing with module #13 (and later #14) to see the time effect on gain drop as well as newly built chamber #17 and #18**