HV noise tests D.A. 9/7/2025

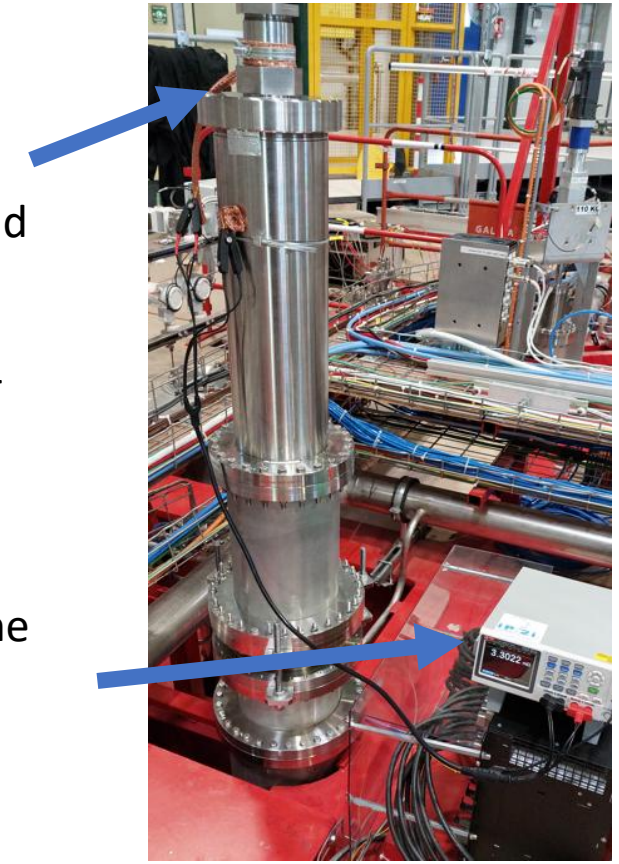
- The issue of the noise induced by the HV cathode system was the subject on intensive investigations during the last week

- A detailed summary of all was presented at the last TB on June 25th: https://indico.fnal.gov/event/70001/contributions/318487/attachments/189192/261216/HV_noise.pdf

- **Last week (Thursday and Friday) Dario, Dominique, Francesco and Gajendra continued the foreseen program to improve the grounding of the HV cable**

- **The new grounding connection piece in stainless steel,** designed by Francesco in order to ensure the electrical contact between the HV cable shield and the HV FT, was mounted and tested.

- The threads of the connection piece had been threated with a conductive spray (GRAPHIT 33) to improve the contact and lubricate.



- After implementation we also measured the resistance in between the cable shield and the FT with a high accuracy milliOhmeter brought from Lyon

- The resistance of the connection amounted to a few mOhm after the connection piece installation.

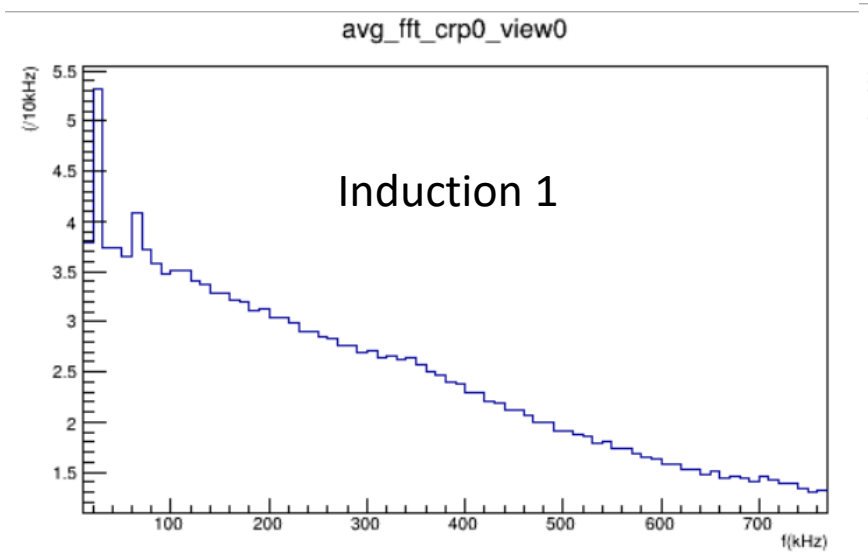
- **The result from the implementation of the new connection piece was that the HV noise due to bad grounding was eventually gone.**

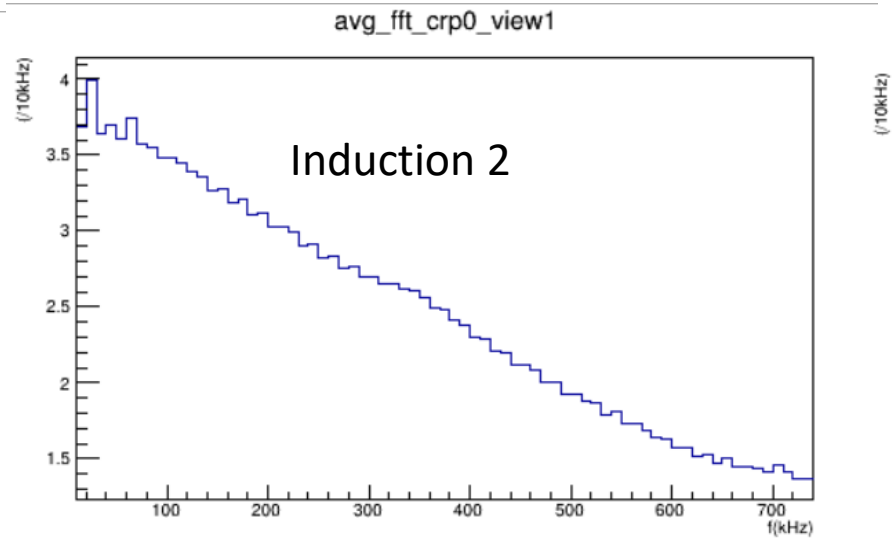
- This is a good news also for the far detector since it is a solution independent on the position of the power supply just based on the correct grounding of the HV cable.

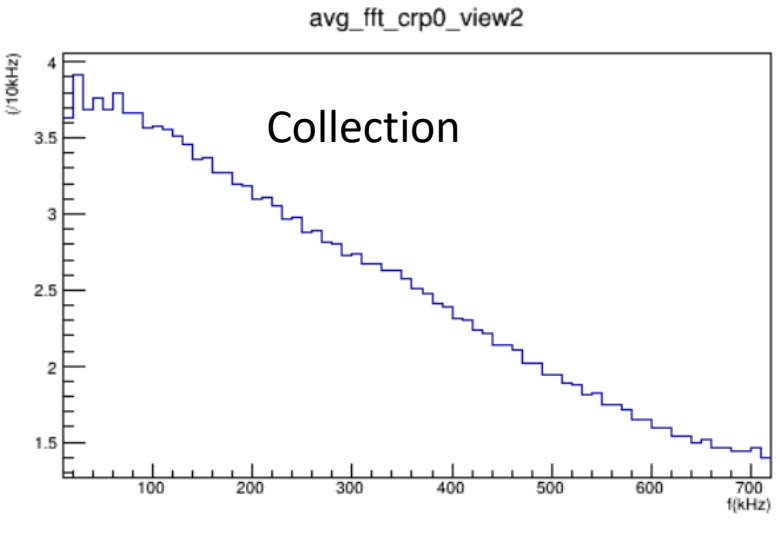
- We also improved, as planned, the grounding loop affecting the Heinzinger grounding connection (see TB slides) but this had no effect

- Having solved the grounding issue, a second order effect, the ripple of the HV PS, became visible at 70 kV.

This consists in two peaks (10 kHz binning). The first one in the bin 20-30 kHz and the second one in the bin 60-70 kHz. These two peaks are mostly visible on induction1 of both CRPs but they are present in reduced amount also on the other views. It is very clear that these two peak appear and disappear with the HV on/off. We completed these tests on Thursday evening



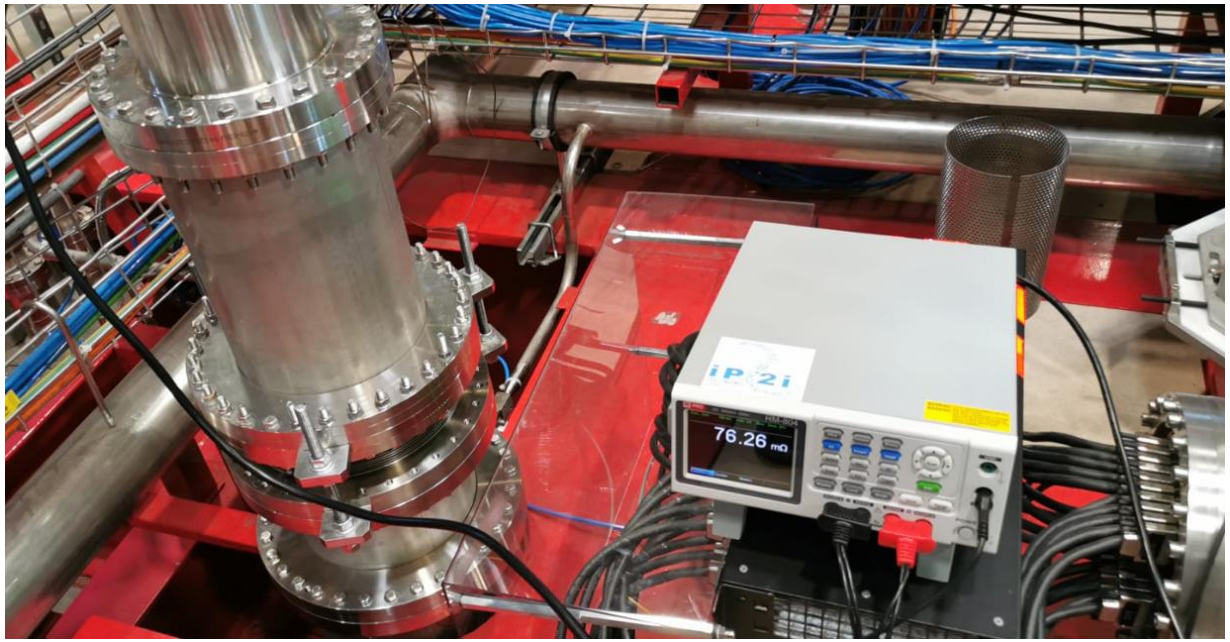




- On Friday morning we observed a new very large noise source (>4 times the nominal noise), even with the HV off. This has started appearing on Friday morning around 7:30 and then increased by a large factor and became stable at 9:00.

- We spent good part of the morning in hunting this noise by switching off/disconnecting various sources. **At a certain point we realized that this was again related to the grounding of the HV cable**, we raised the HV to a few kV and the noise increased by another factor 2 → clear sign that the new noise was related to the HV grounding

- We went to inspect the HV FT → the piece ensuring the grounding was of course still there screwed on the HV FT, however **it became slightly loose during the night due to a thermal contraction of the polyethylene insulation inside the FT.** During the night there has been some rain and a temperature drop, the polyethylene slightly contracted



- We measured that the resistance of the HV cable grounding had increased from a few mOhm to 76 mOhm.

- We could tighten the piece by 1/8 of turn, the resistance became again a few mOhm and the noise disappeared.

- **This shows how critical is this connection piece ensuring the HV cable grounding**
- **Francesco is studying a new design of the connection piece for the FD ensuring stable contact independently on thermal contractions**

- On Friday afternoon the grounded cable tray for HV cable was also installed from the Heinzinger to the HV FT

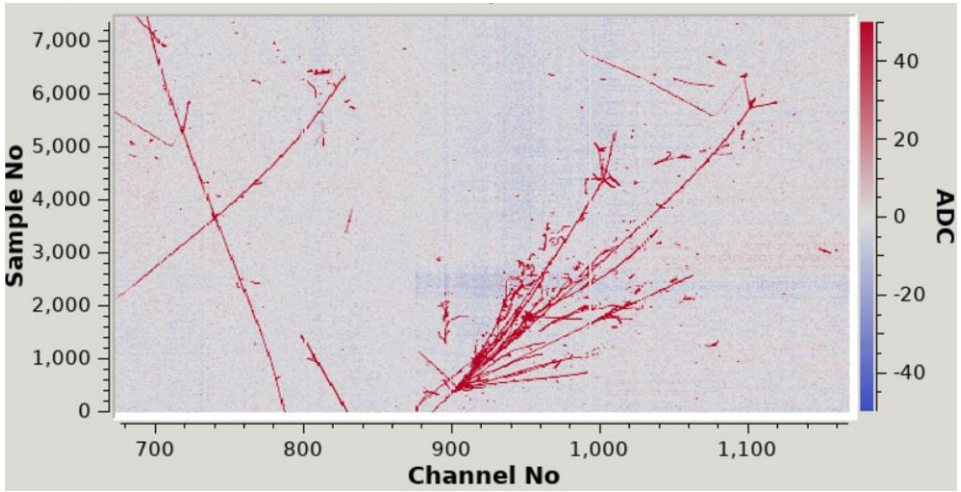
- The addition of the tray did not make any difference in the noise since the noise was already good given the grounding connection piece at the HV FT

- On Monday morning Francesco inspected the HV FT and found out that the grounding connection piece became again loose by ½ turn. This was due to a new temperature drop. Francesco tightened the connection piece

- Then Francesco tried on Monday morning to improve the filtering of the ripple by adding a new resistor in the chain. Unfortunately the value of the resistor is too low to get an effect. Francesco is purchasing a higher resistor which maybe be available on Friday.

- When the resistor is changed we should put on the connection piece threads also a conductive grease (Multicomp premium conductive grease) used for the warm flanges which should ensure a better contact of the spray

- On Monday afternoon we took cosmic data with the cathode biased at 70 kV in order to characterize the CRP efficiency (data being analyzed) and debug the top CRPs mapping.



- Clean tracks were observed (see the TDE event at the side) and a large sample of events necessary for the studies was collected for the top and bottom CRPs

- On the top CRPs noise from the PS grounding was OK, the PS ripple still present. Some additional coherent noise was coming and going forth an back with time. These additional noise sources have not been identified yet since the largest effort was on the HV noise coming from the grounding issue which was by far the most important contribution.

- Nevertheless, in order to complete the commissioning, also other noise sources should be traced and improved

- **The observation of the tracks allowed already to correct a few cable swaps in the mapping of the top CRPs**

- It is foreseen to repeat a cosmic run when it will be possible to reach the nominal cathode voltage and with the new resistor for the HV ripple filtering installed (hopefully on Friday ?)