

***Irradiation tests at GIF++ on ATLAS-NSW
MM production modules
SM1 M#4 [Italy] & SM2 M#5 [Germany]***

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Setup / goal @ GIF++

- Making sure humidity was controlled and known
- Chamber was well characterized before being exposed to irradiation
 - @ CS and @ Preparation zone just outside GIF++
- Serial Gas flow [SM1 ↔ SM2], 5-20 L/h, Ar:CO₂ (93:7)
- Not an ageing study, **focus is on HV stability**
- Never exceeded the HV maximum [i.e. 580 V] - *Muon Week Oct 2018*
https://indico.cern.ch/event/761784/contributions/3183298/attachments/1739026/2813558/Cleaning_HV_TF_Document.pdf
- limit voltages to established operating regime 560 – 580V

GOAL → Check for anomalous increase in current when switching on irradiation, and/or abnormal increase in spark rate

→ Verify current return to pre-irradiation levels with source off

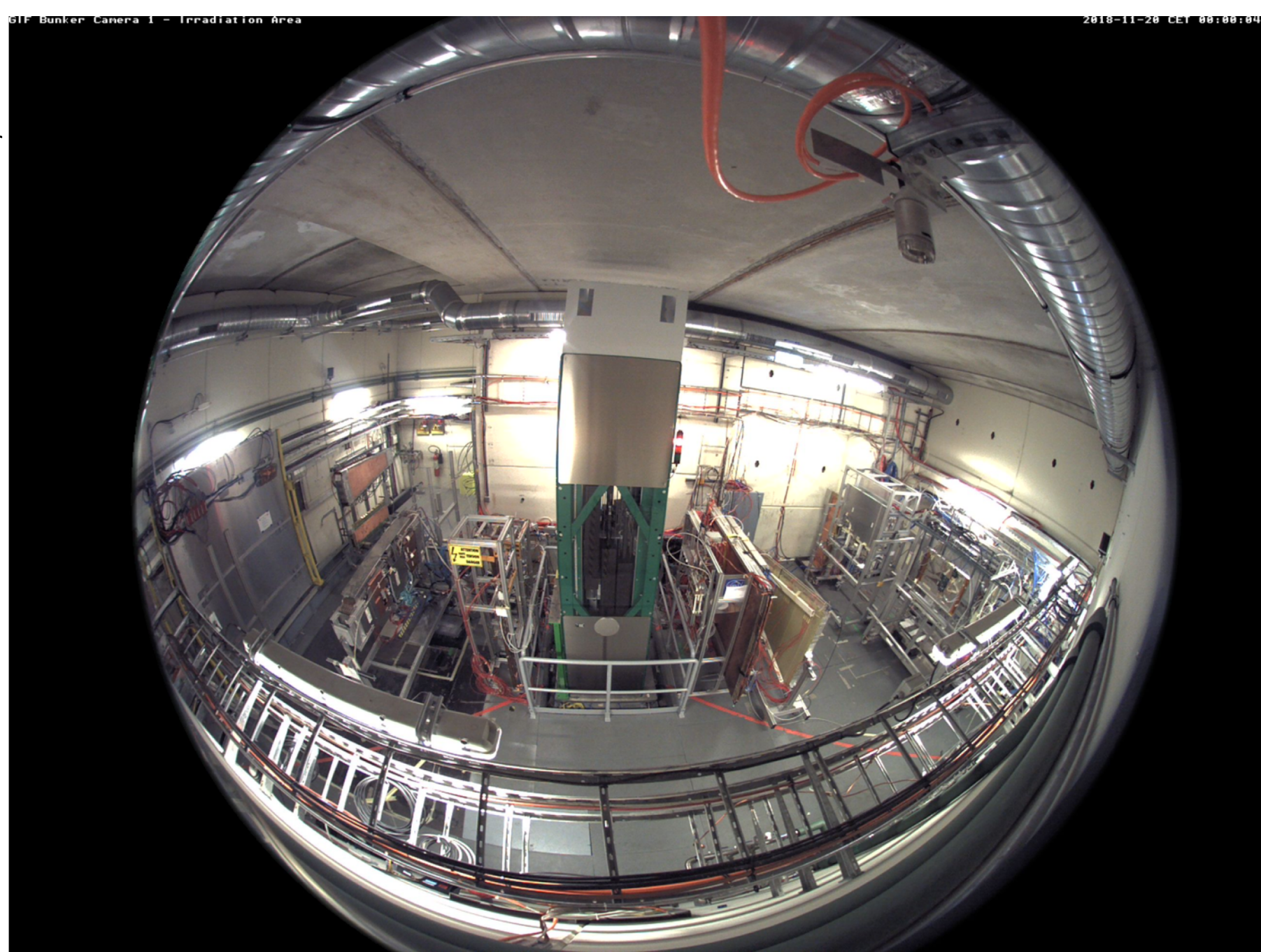
Typical setup @ the GIF++ bunker

high number of users

[ALICE, CMS...]

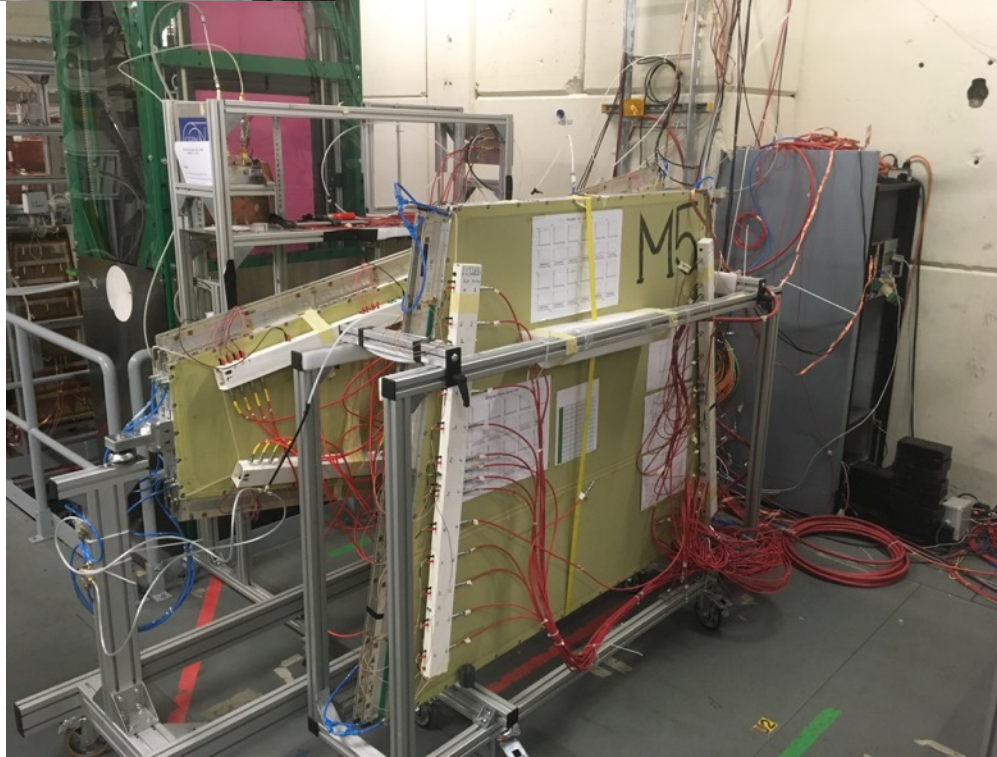
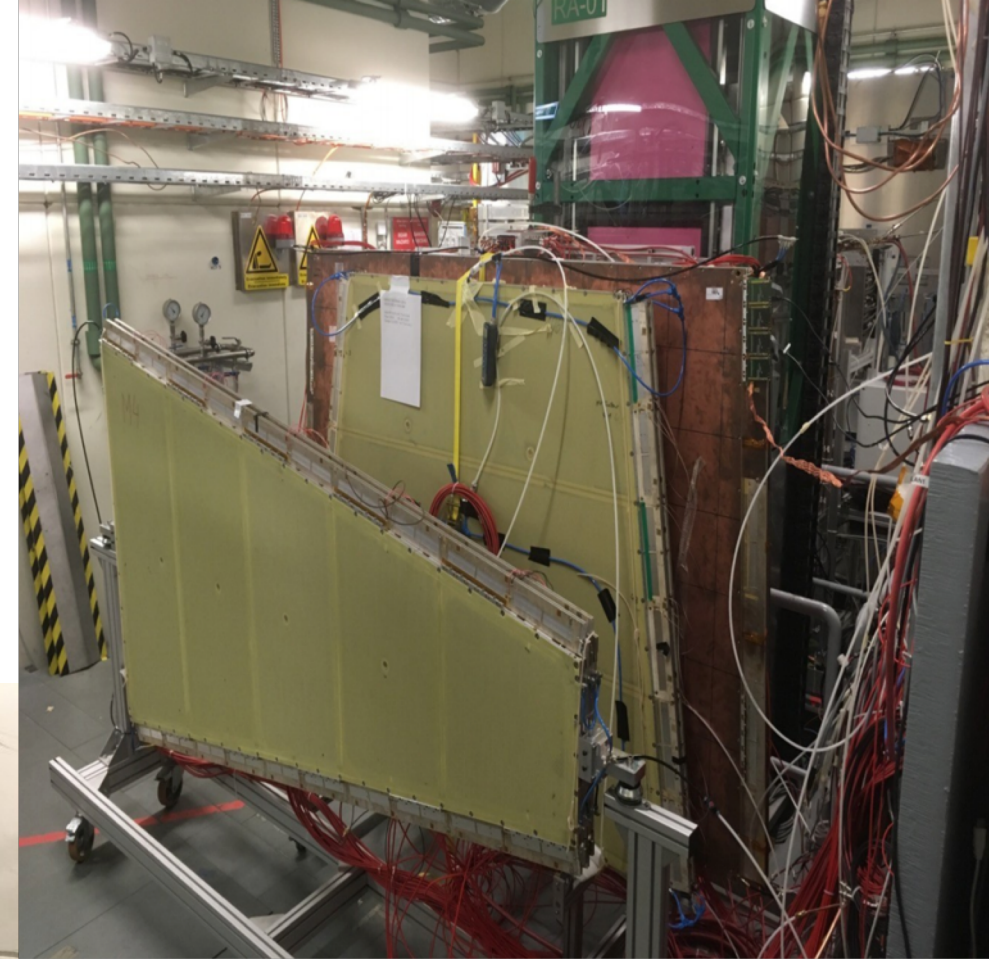
→ demand from users varies i.e. attenuation level, distance from source, shadowing, services...

→ *A big thanks to the M. Jäkel, G. Pezzullo and the entire GIF++ community in letting us being "prime user" during that time.*





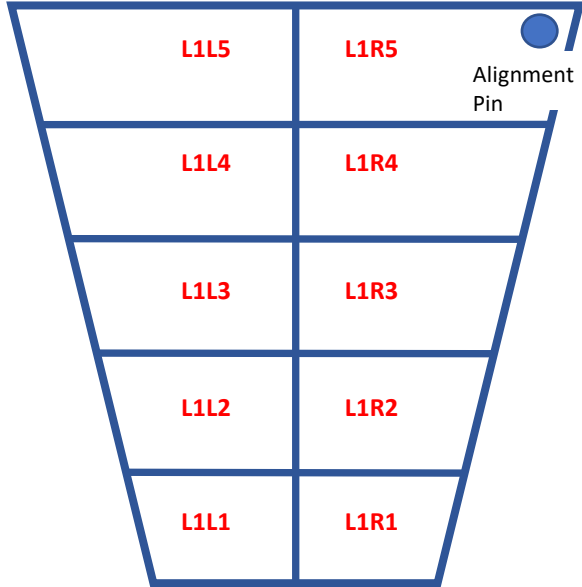
Different
config during
4 weeks
within the
GIF++ bunker



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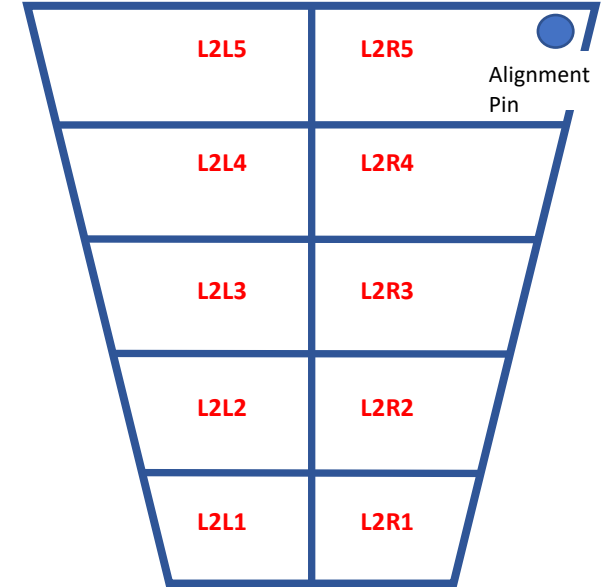
SM1 / LM1 Quads

L1 (ETA 1) - Spacer Frame side

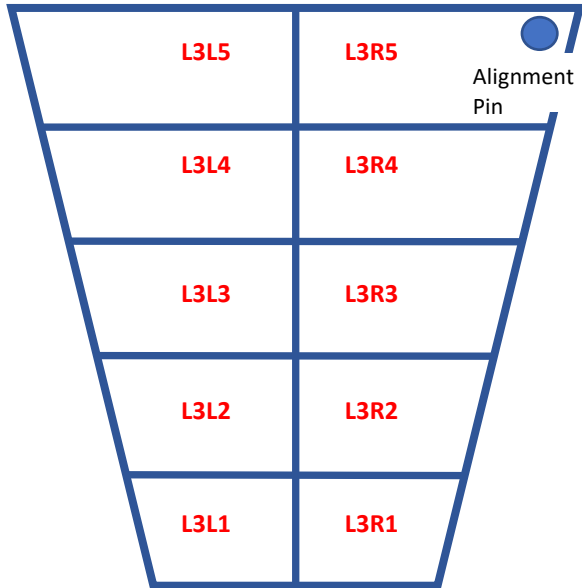


- L1=Eta_Out (1)
- L2=Eta_In (2)
- L3=Stereo_In (1)
- L4=Stereo_Out (2)

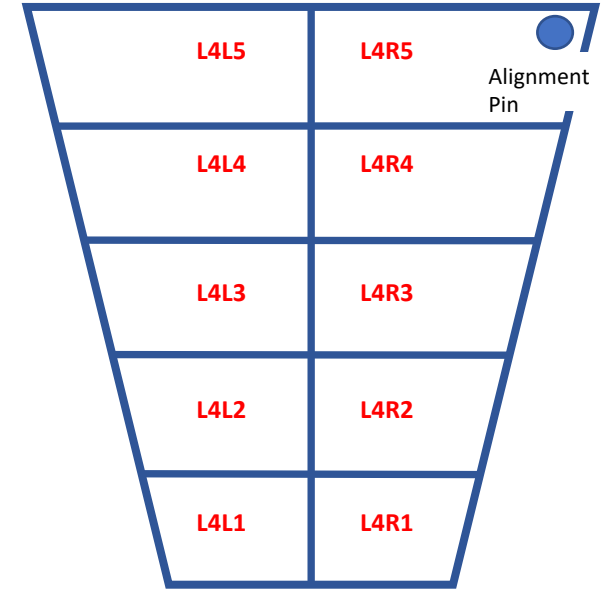
L2 (ETA 2)



L3 (STEREO 1) - Spacer Frame side



L4 (STEREO 2)



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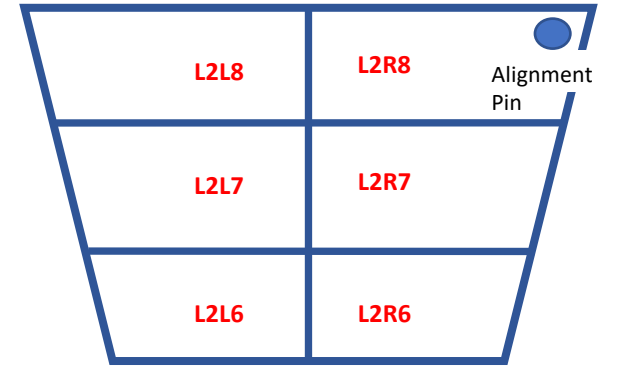
L1 (ETA 1) - Spacer Frame side



SM2 / LM2 Quads

- L1=Eta_Out (1)
- L2=Eta_In (2)
- L3=Stereo_In (1)
- L4=Stereo_Out (2)

L2 (ETA 2)



L3 (STEREO 1) – Spacer frame side

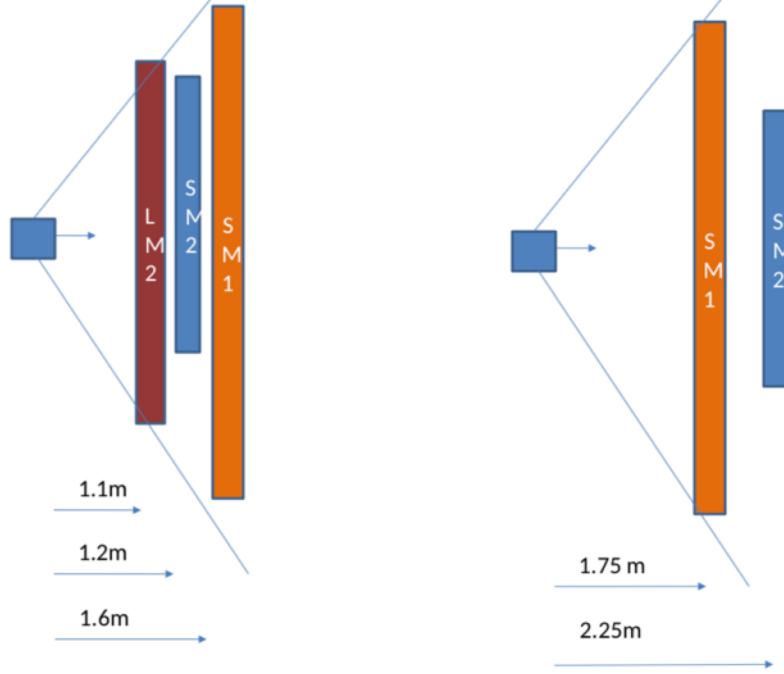


L4 (STEREO 2)



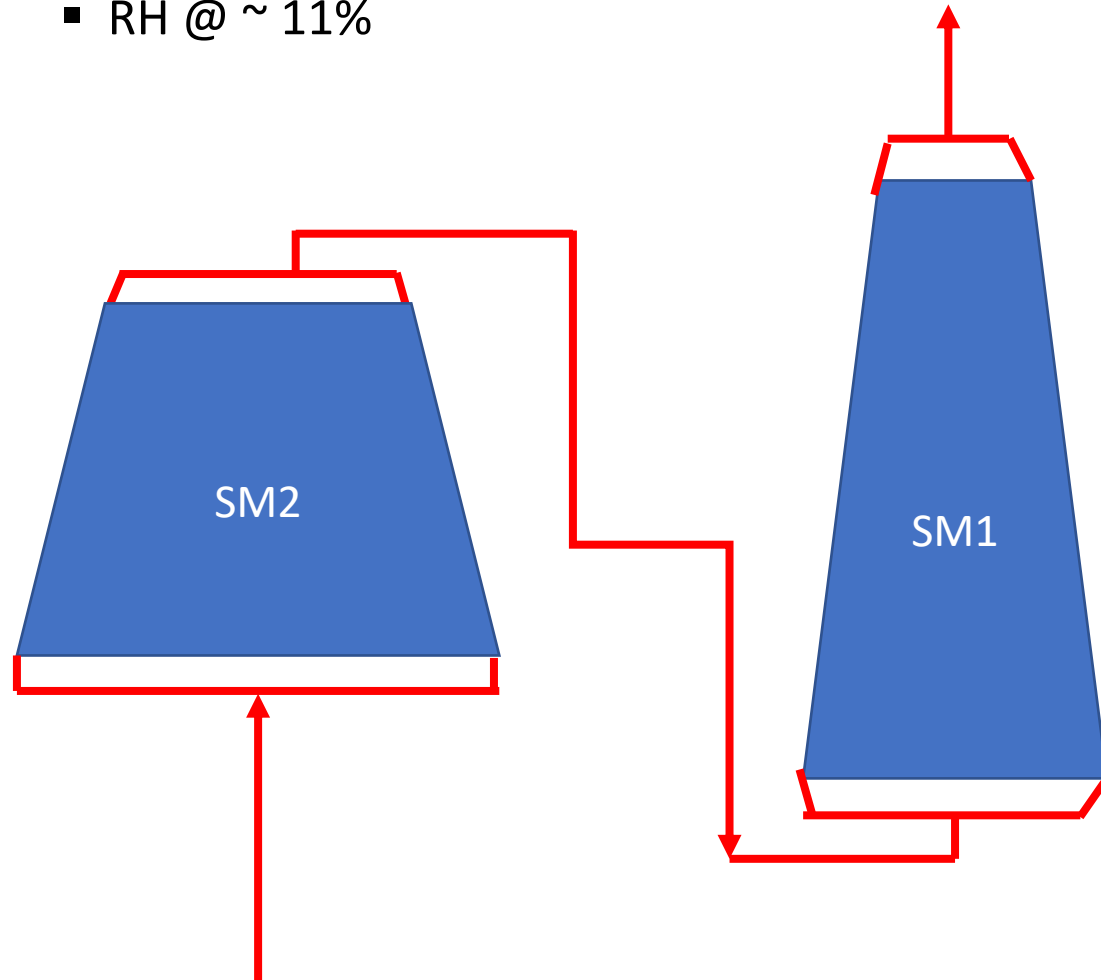
Schematics (Gas+Mech) @ GIF++15th Nov 2018

Schematics (Gas+Mech) @ GIF++22th Nov 2018

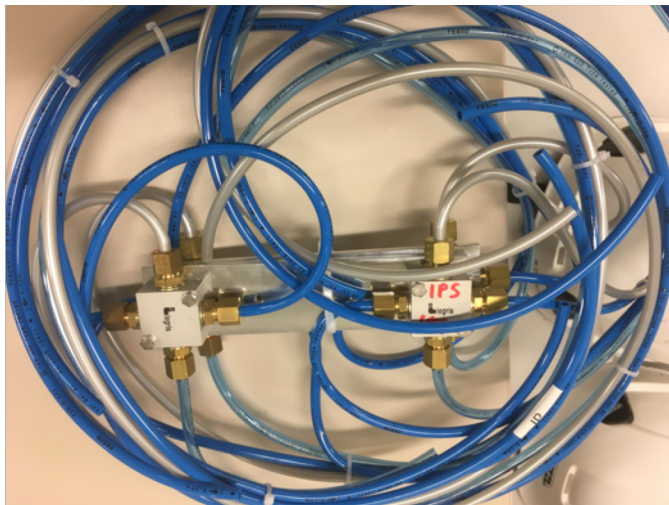


Exhaust to Vaisala – length ~30m / ~ 90 %
made of copper / stainless steel

- RH @ ~ 11%



Gas Inlet from mixer – length ~
30m - gas tubes made of made
of ~90% copper / stainless steel



Nov. 22 SM2 OVERVIEW

HV Station Setup Node 1-SM2 Node 2-SM1 Settings Exit 11:50:24 PM 11/22/2018

HV Channels
 SM2

L118	569.8 V	0.000 uA	✓
L117	0.000 uA	✓	
L116	0.020 uA	✓	
L115	0.000 uA	✓	
L114	0.000 uA	✓	
L113	0.000 uA	✓	
L112	0.000 uA	✓	
L111	0.500 uA	✓	
L110	0.000 uA	✓	
L109	570.0 V	0.000 uA	✓
L108	569.8 V	0.000 uA	✓
L107	499.8 V	0.000 uA	✓
L106	499.8 V	0.000 uA	✓
L105	569.5 V	0.000 uA	✓
L104	569.8 V	0.000 uA	✓
L103	569.8 V	0.000 uA	✓
L102	569.5 V	0.000 uA	✓
L101	569.5 V	0.000 uA	✓
L100	500.0 V	0.000 uA	✓
L099	569.8 V	0.000 uA	✓
L098	569.8 V	0.000 uA	✓
L097	569.8 V	0.000 uA	✓
L096	569.5 V	0.000 uA	✓
L095	299.8 V	0.000 uA	✓
L094	299.8 V	0.000 uA	✓
L093	299.8 V	0.000 uA	✓
L092	299.2 V	0.000 uA	✓

HV Plots

HV Actions
 Alarm Mode: V I <300 >555 [V]
SM2 - 20NMMMMS200005

Layer 1 (Eout)

Layer 2 (Ein)

Layer 3 (Sin)

Layer 4 (Sout)

Set Voltage: OFF ON [V]

Strips Strips+Drift

Configuration Status: Unconfigured ●

19 Sections at 570 V
 VERY GOOD ! NO Sparks
 5 Sections at 500 V for this test.
 Can go up to 560 V with some discharge

DRIPT

Export

Destination folder: /home/bb5user/Desktop/

Start: 21/11/2018 16:14:09

End: 22/11/2018 16:14:09

Hide Extra Info

GIF++ | Humidity

Environmental Parameters

Atmos Pressure: 964.1 mbar

Humidity Inside: 35.9 %

Humidity Outside: 35.5 %

Temp Inside: 21.4 C

Temp Outside: 21.7 C

Emergency Stop: ●

Moving: ●

Siren: ●

Source: ●

Veto: ●

Attenuator: PPE1 S4

UpStream: A: 3.0, B: 3.0, C: 3.0, Eff: 16000.0

KeySt: All Keys Pre

Mode: CLOSED

PPEDoorSt: Closed

PPXDoorSt: Closed

Start

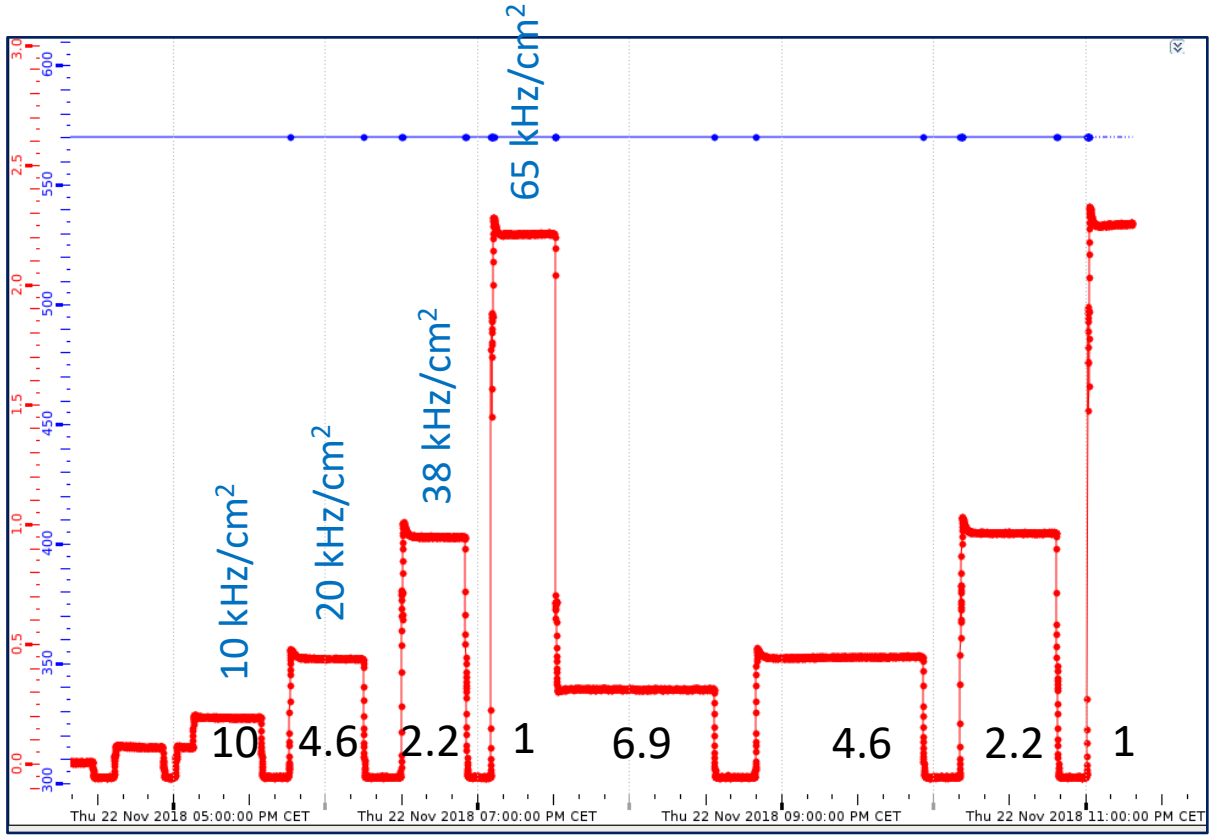
MM Humidity: 12.25 %

RadMon S7: 517.56

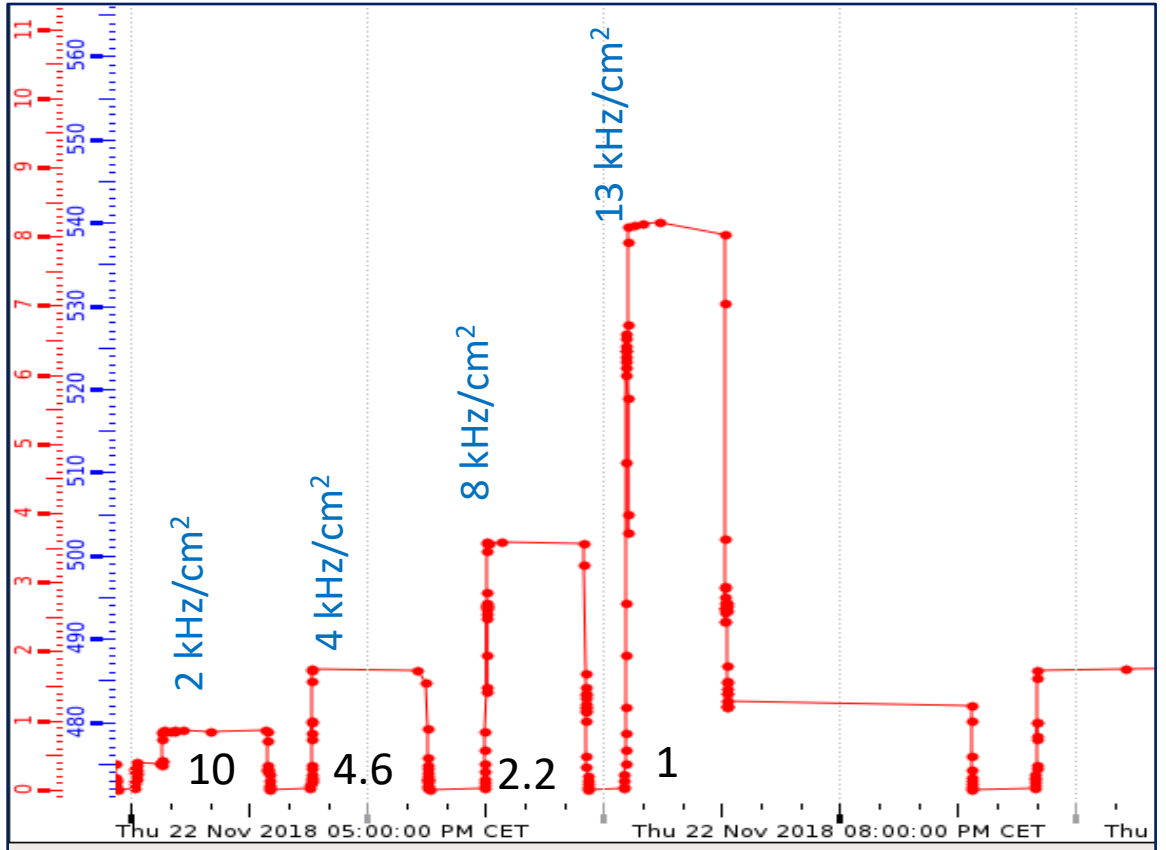
Plots

Perfect behaviour of MOST of the HV Sections

SM1 L1L1 (small section)



SM2 L4R8 (largest section)

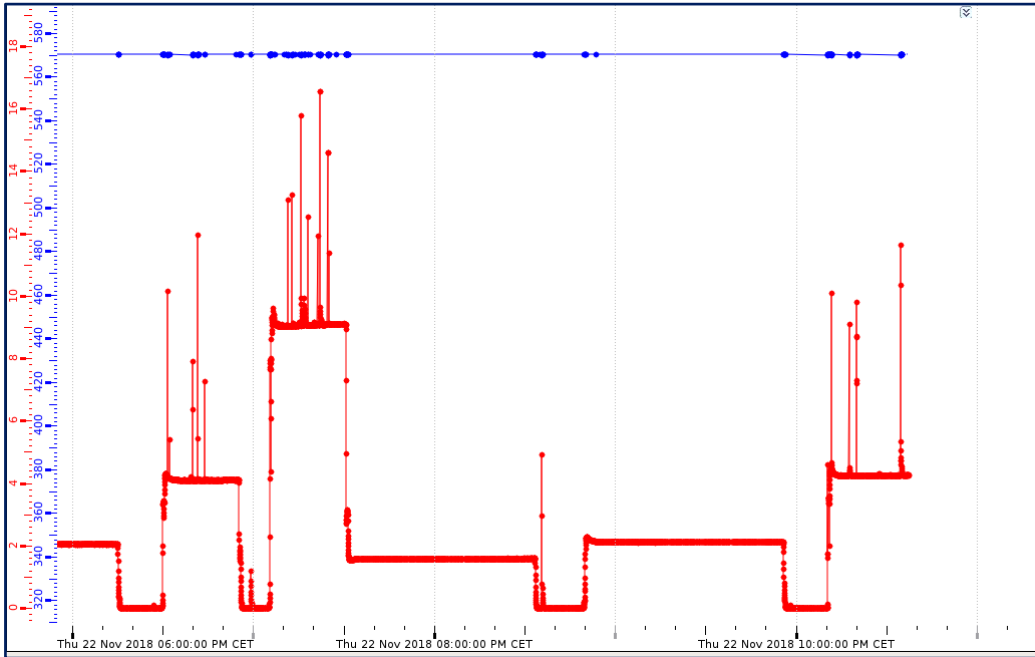


(rates [kHz/cm²] are rough estimates)

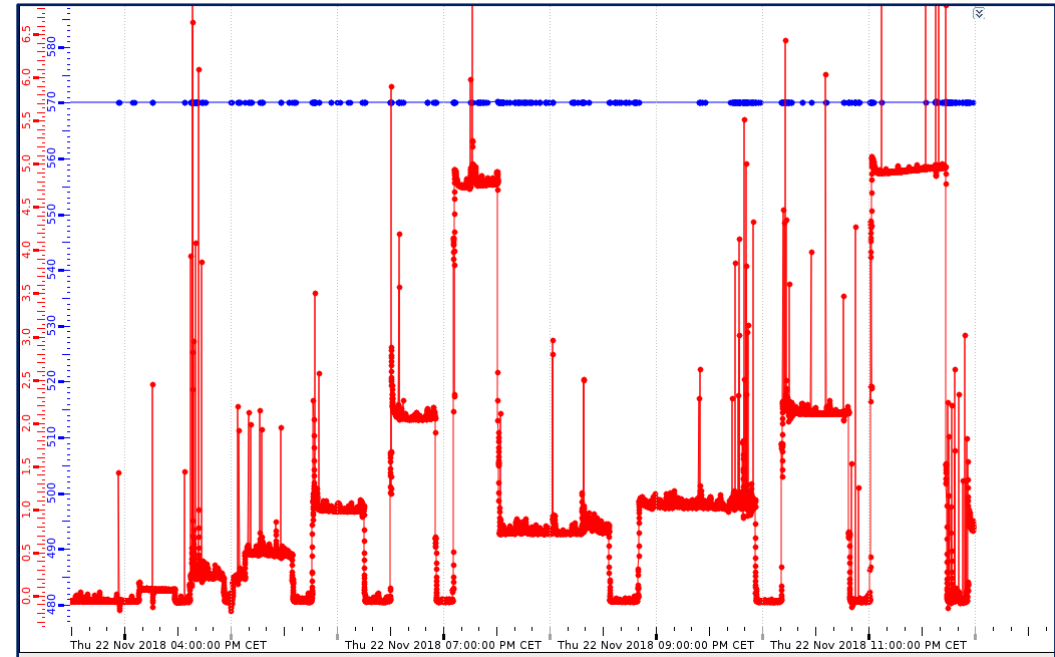
SM1 @ 1.4m from the source ; SM2 @ 2.0 m

DISCHARGES (on only few sections)

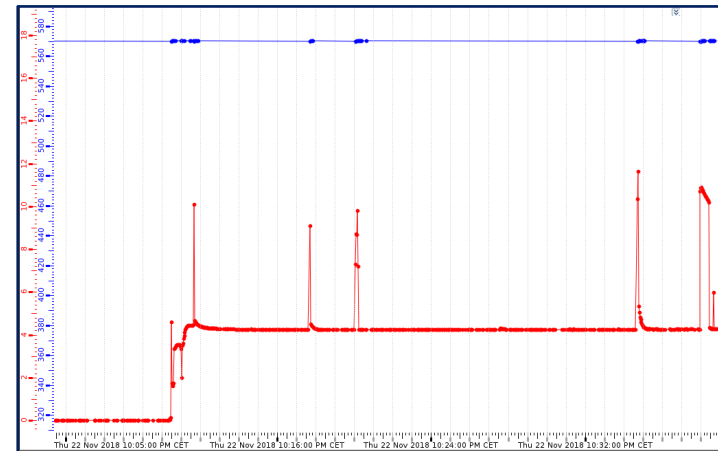
SM1 – L1L5



SM1 – L4R2

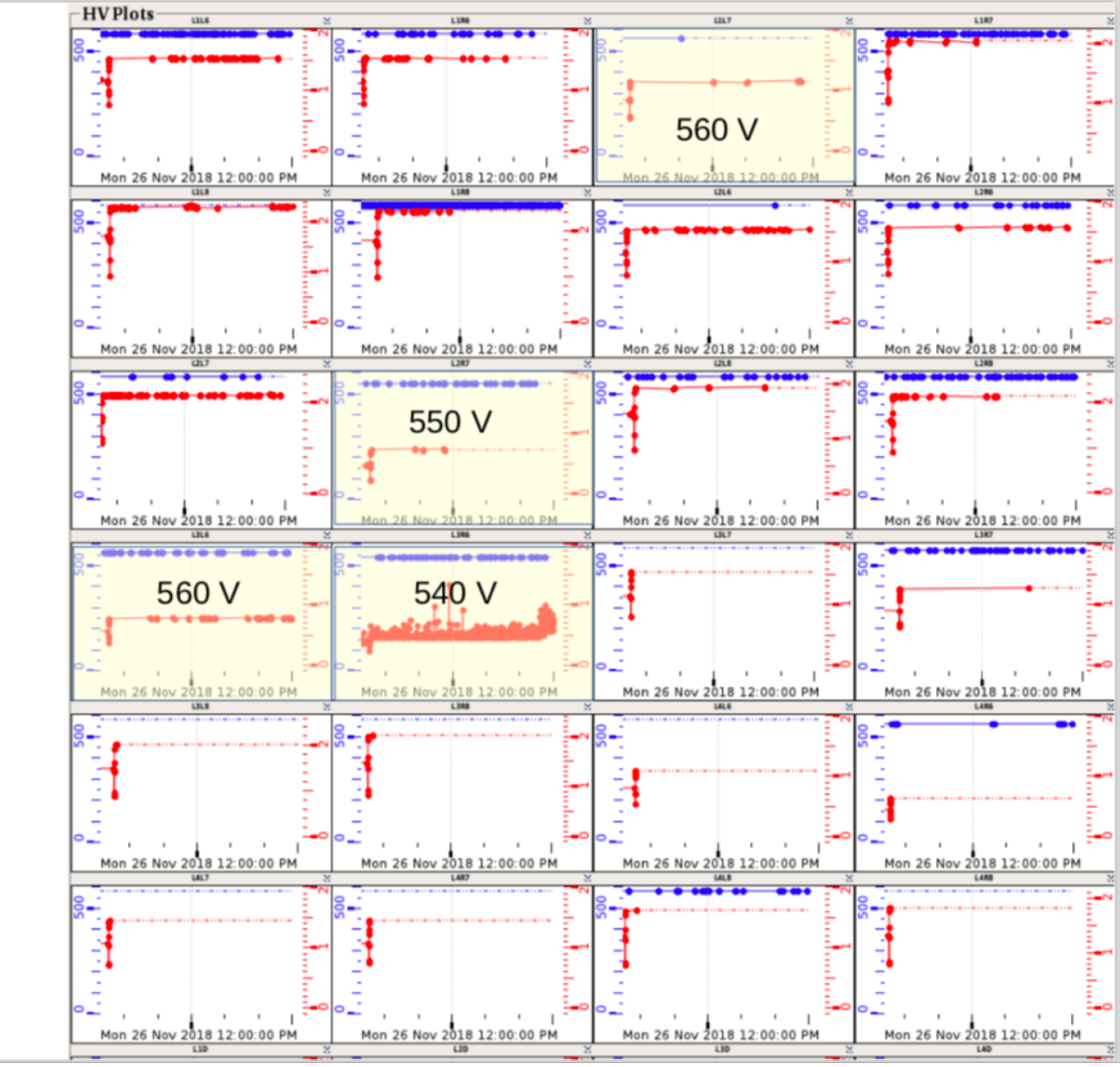
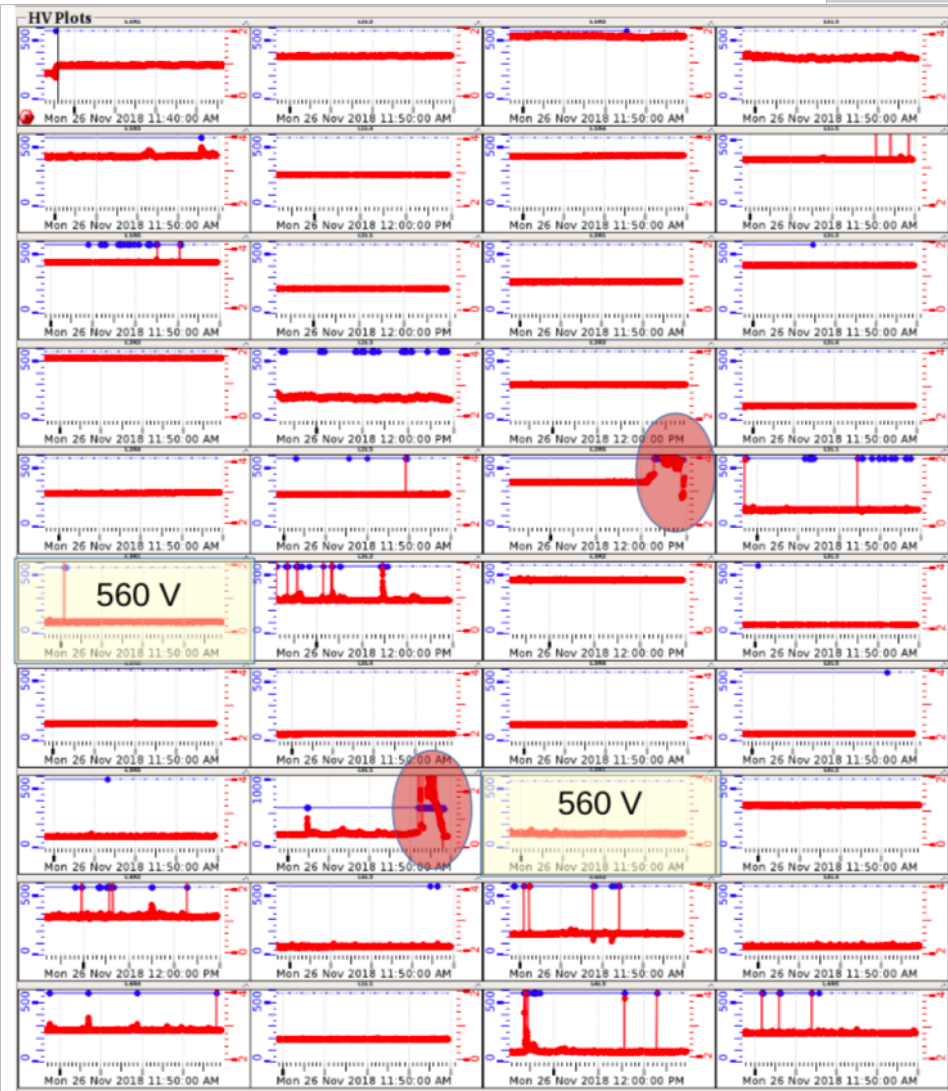


- Very low frequency (depends on HV Sections)
- Very high charge/current (several μA)
- Duration few sec. Exceptionally up to 30 sec
- Not clear how it scales with irradiation intensity
 - Negligible frequency at low irradiation
 - Develop “discharge trains” from time to time.



Spark duration few sec. Here one case up to 30 sec

Nov. 26th Test SM1 and SM2 at 580 V -- Att. 4.6 → SM1 at 20 kHz/cm² – SM2: 4 kHz/cm²



SM1 at 580 V

- 2 Sections at reduced HV.
- 2 sections with sudden increase of current

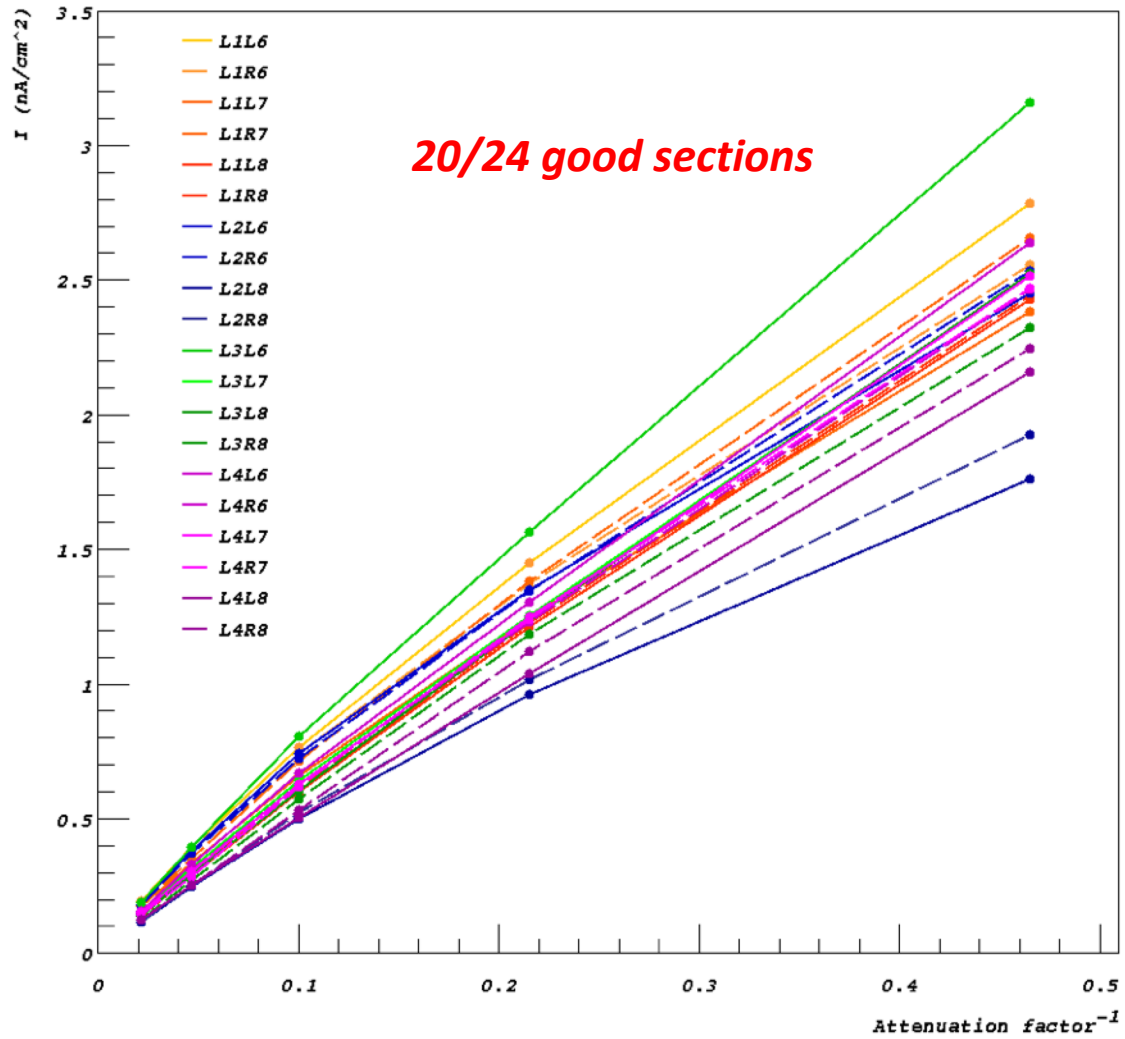
SM2 at 580 V

- 4 Sections at reduced HV.

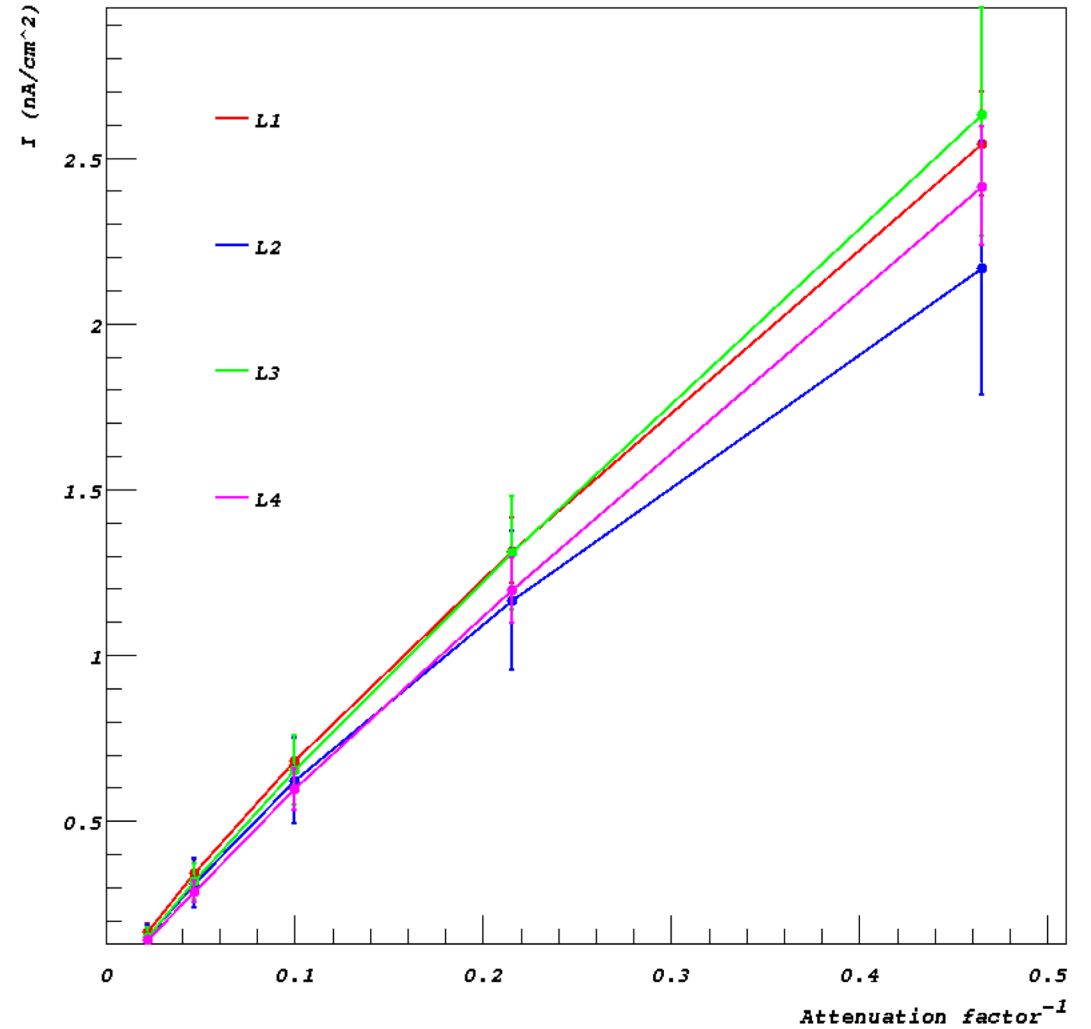
Linearity of currents/gain Vs Irradiation rates (inverse of attenuation)

- **SM2 570 V @ 10L/h**

SM2 @ 570 V, Normalized currents

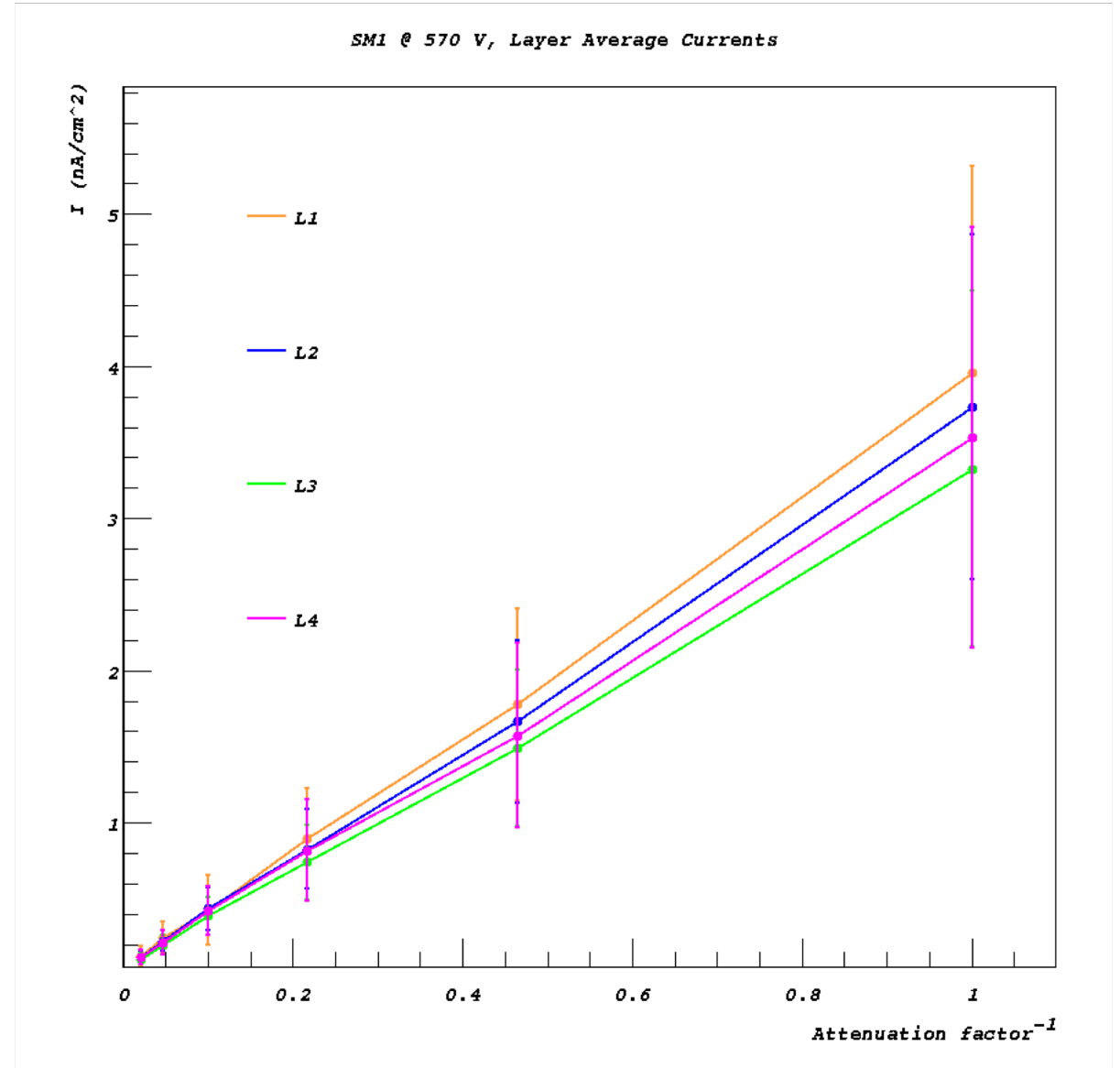
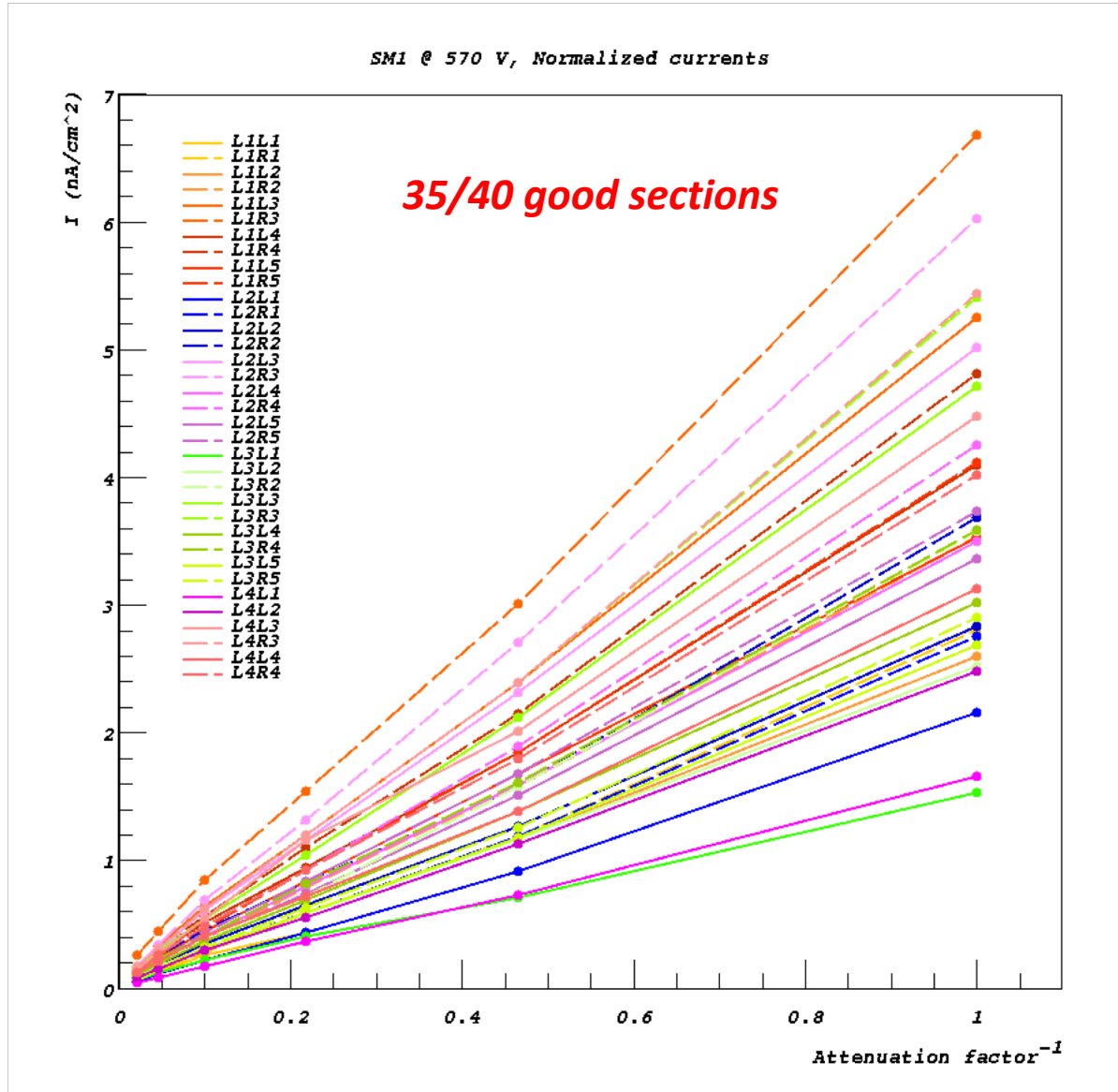


SM2 @ 570 V, Layer Average Currents



Linearity of currents/gain Vs Irradiation rates (inverse of attenuation)

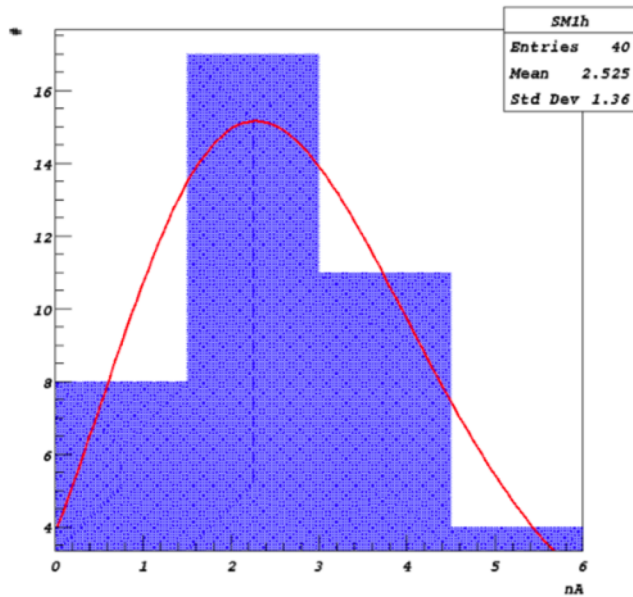
- **SM1 570 V @ 10L/h**



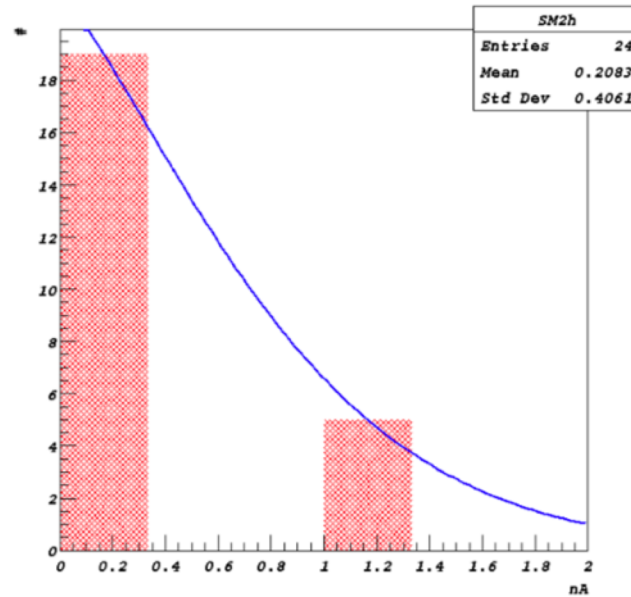
SM1-SM2 main results

- both chambers stable at 560-570-580 V with few spiky channels
- tested at high rates:
 - both at rate > 60 kHz/cm²
 - SM2: 34/40 very good sectors (no spikes)
 - SM1: 19/24 very good sectors (no spikes)
- uniform currents: std dev per layer < 10% for both SM1 and SM2
- dark current stability below the resolution of HV cards

SM1 Current Baseline fluctuation when switching off the source



SM2 Current Baseline fluctuation when switching off the source

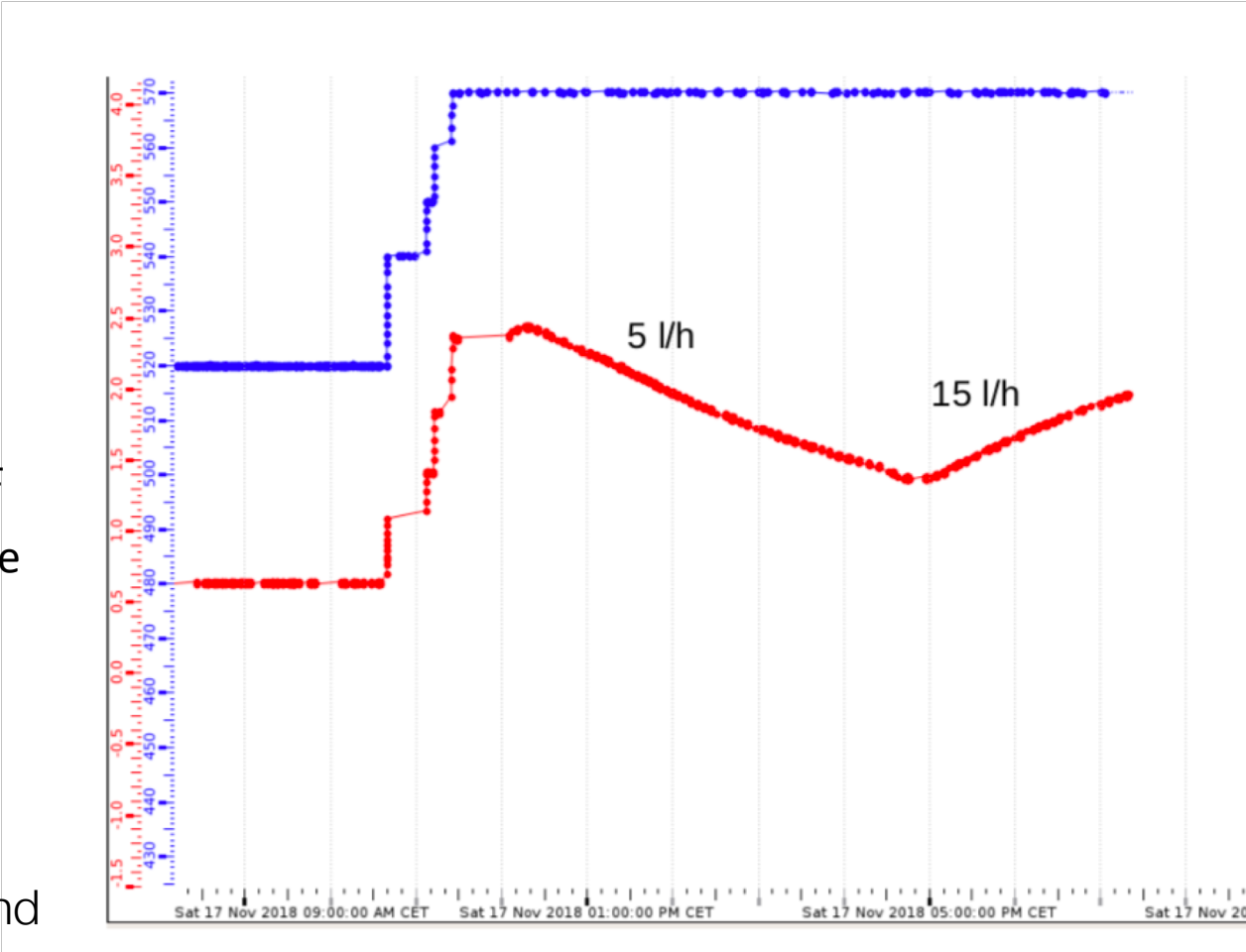


Strong Dependence of gain/currents Vs Gas flow

Investigating chamber gas leaks meas. done on the 21 Nov 2018 in the bunker

- SM2 leak 2xNSW_LIMIT at LMU and confirmed at GIF
 - QL = 55 mL/h --> 2.1 x Acceptance Limit (Acceptance Limit: 25.9 mL/h)
- SM1 leak ~2.5 x NSW_LIMIT at Frascati
 - QL = 23mL/h (Acceptance Limit: 23.3 mL/h)

Investigation underway as a few issues happened and will be shared soon



- SM1 M#4 and SM2 M#5 tested at the GIF++
 - **clean** and **linear** response to the irradiation
- 21/24 and 35/40 good channels
- Recovering « difficult channels » after irradiation...
- Tested up to **high particle fluxes**: very clean response, very few « spiky » channels
- Very good **stability** (tested up to 48 hours during each WE @ attenuation 6.9), only few tripped
- Still preliminary results
- Investigations on the gas flow contribution to efficiency
- SM1 and SM2 tested at 580 V with very good results

FUTURE PLANS AT GIF++ for ATLAS-NSW

- Some upgrade for our working env. will be performed
- GIF++ bunker is going to be upgraded “floor plan wise” with the addition of ~100 sq.meters upstream

[planning is April / May 2018]

- Long term irradiation on a production module is foreseen
- By sampling, a fraction of production modules is projected to be tested at GIF.
 - A universal trolley to accommodate two modules independently of any type
 - the first “n” modules per construction site should be tested - then it could become a random pick
 - Time estimatation to test any type of 2 modules is one week