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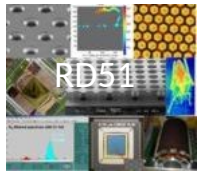
High-rate 3GEM detector with the SRS VMM for AMBER

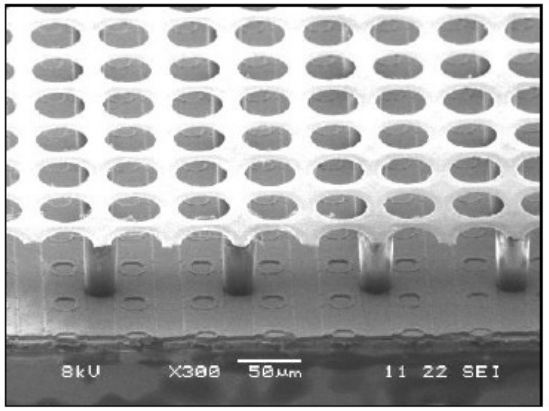
Michael Lupberger

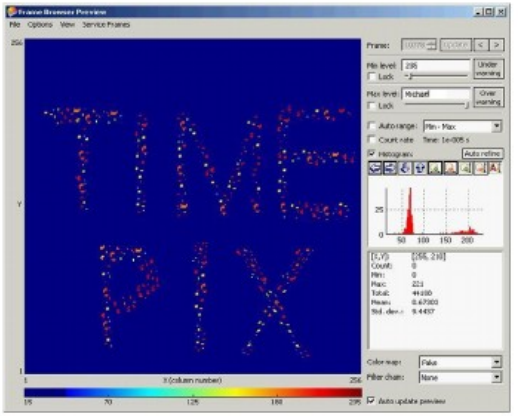
30th (and last) RD51 Collaboration Meeting
CERN, 05.12.2023,



AG Ketzer

AMBER
Apparatus for Meson and Baryon Experimental Research





Study of gain fluctuations with InGrid and TimePix

1st contribution to an RD51 meeting

Michael Lupberger

5th RD51 Collaboration Meeting

24-27 May 2010 Freiburg, Germany

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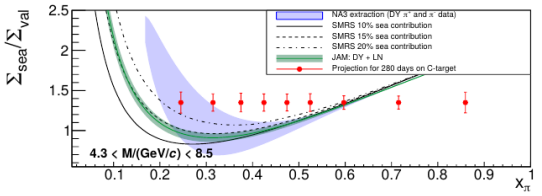
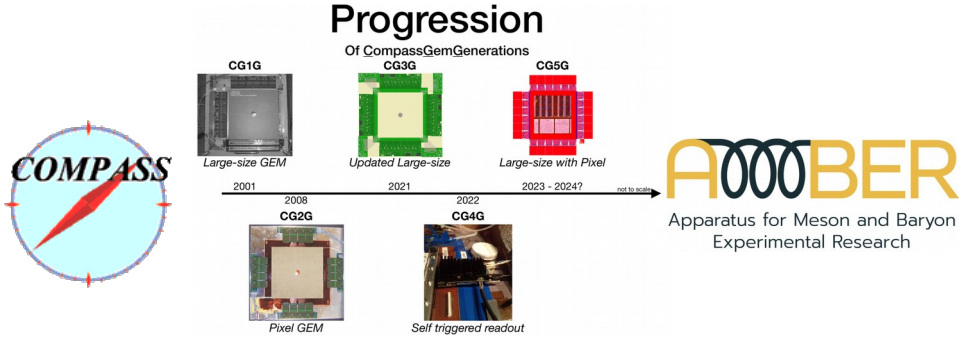
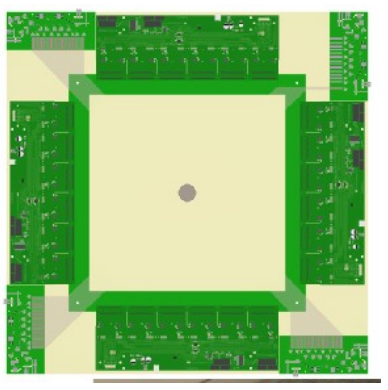
OUTLINE

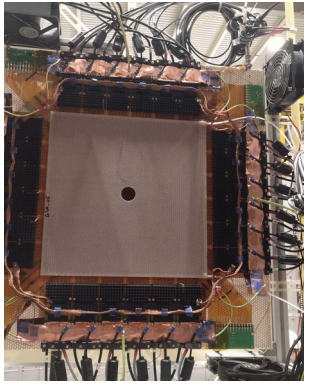
- AMBER and its Physics Program
- AMBER GEM Detectors
- 2023 Pilot Run with SRS VMM

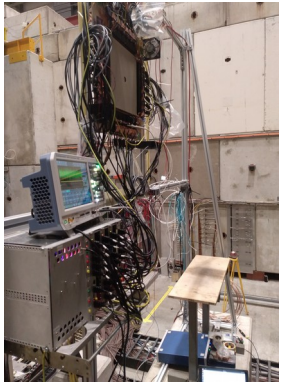
AMBER
Apparatus for Meson and Baryon Experimental Research











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Apparatus for Meson and Baryon Experimental Research

Apparatus for Meson and Baryon Experimental Research:

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Apparatus for Meson and Baryon Experimental Research

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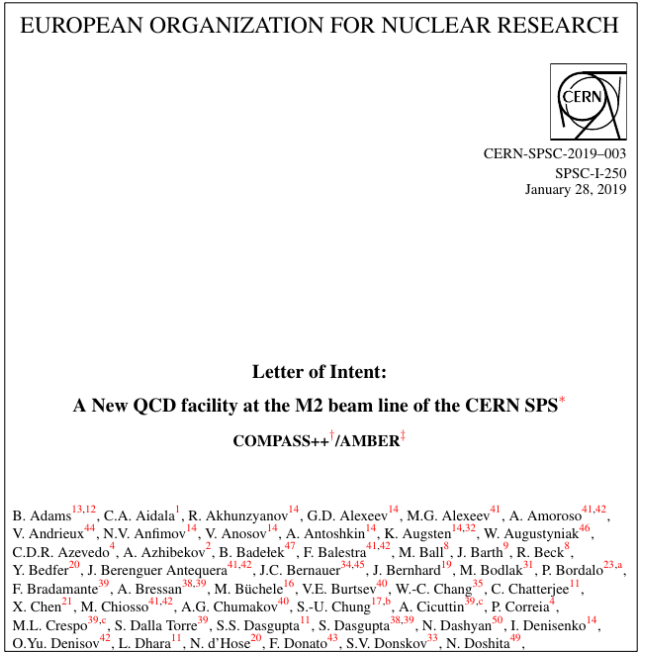
- In the context of CERN's *Physics Beyond Collider* initiative:
  Proposal for a *New QCD facility at the M2 beam line of the CERN SPS*



EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN

CERN-SPSC-2019–003
SPSC-I-250
January 28, 2019

Letter of Intent:

A New QCD facility at the M2 beam line of the CERN SPS*

COMPASS++†/AMBER‡

B. Adams[13,12], C.A. Aidala[1], R. Akhunzyanov[14], G.D. Alexeev[14], M.G. Alexeev[41], A. Amoroso[41,42], V. Andrieux[44], N.V. Anfimov[14], V. Anosov[14], A. Antoshkin[14], K. Augsten[14,32], W. Augustyniak[46], C.D.R. Azevedo[4], A. Azhibekov[2], B. Badelek[47], F. Balestra[41,42], M. Ball[8], J. Barth[9], R. Beck[8], Y. Bedfer[20], J. Berenguer Antequera[41,42], J.C. Bernauer[34,45], J. Bernhard[19], M. Bodlak[31], P. Bordalo[23,a], F. Bradamante[39], A. Bressan[38,39], M. Büchele[16], V.E. Burtsev[40], W.-C. Chang[35], C. Chatterjee[11], X. Chen[21], M. Chiosso[41,42], A.G. Chumakov[40], S.-U. Chung[17,b], A. Cicuttin[39,c], P. Correia[1], M.L. Crespo[39,c], S. Dalla Torre[39], S.S. Dasgupta[11], S. Dasgupta[38,39], N. Dashyan[50], I. Denisenko[14], O.Yu. Denisov[42], L. Dhara[11], N. d'Hose[20], F. Donato[43], S.V. Donskov[33], N. Doshita[49],

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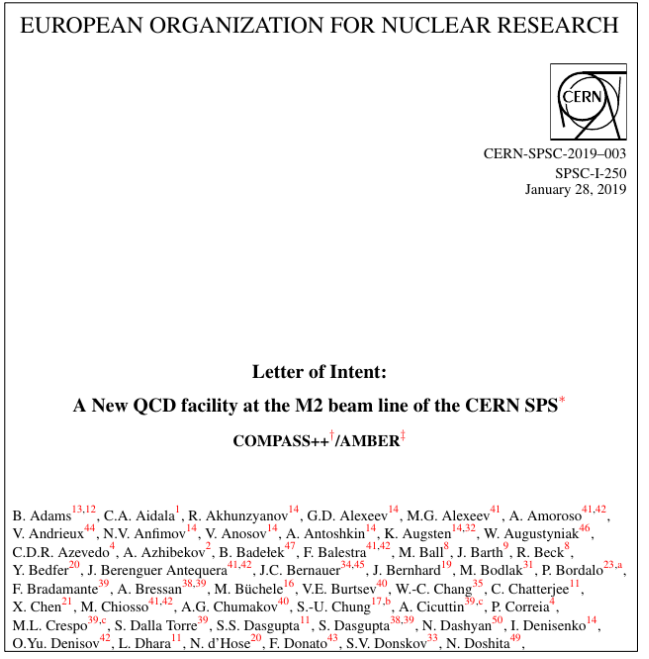

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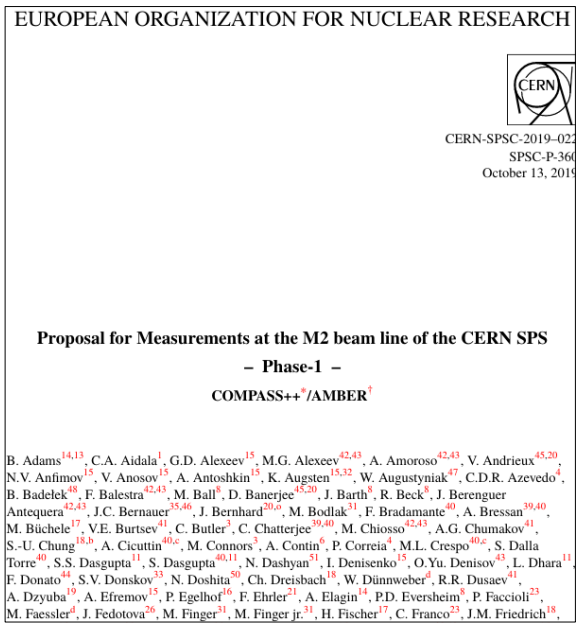

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN

CERN-SPSC-2019-022
SPSC-P-360
October 13, 2019

Proposal for Measurements at the M2 beam line of the CERN SPS

– Phase-1 –

COMPASS++*/AMBER†

B. Adams[14,13], C.A. Aidala[1], G.D. Alexeev[15], M.G. Alexeev[42,43], A. Amoroso[42,43], V. Andrieux[45,20], N.V. Anfimov[15], V. Anosov[15], A. Antoshkin[15], K. Augsten[15,32], W. Augustyniak[47], C.D.R. Azevedo[4], B. Badelek[48], F. Balestra[42,43], M. Ball[8], D. Banerjee[45,20], J. Barth[9], R. Beck[8], J. Berenguer Antequera[42,43], J.C. Bernauer[35,46], J. Bernhard[20,o], M. Bodlak[31], F. Bradamante[40], A. Bressan[39,40], M. Büchele[17], V.E. Burtsev[41], C. Butler[3], C. Chatterjee[39,40], M. Chiosso[42,43], A.G. Chumakov[41], S.-U. Chung[18,b], A. Cicuttin[40,c], M. Connors[3], A. Contin[6], P. Correia[8], M.L. Crespo[40,c], S. Dalla Torre[40], S.S. Dasgupta[11], S. Dasgupta[40,11], N. Dashyan[51], I. Denisenko[15], O.Yu. Denisov[43], L. Dhara[11], F. Donato[44], S.V. Donskov[33], N. Doshita[50], Ch. Dreisbach[18], W. Dünnweber[d], R.R. Dusaev[41], A. Dzyuba[19], A. Efremov[15], P. Egelhof[16], F. Ehrler[21], A. Elagin[14], P.D. Eversheim[8], P. Faccioli[23], M. Faessler[4], J. Fedotova[26], M. Finger[31], M. Finger jr.[31], H. Fischer[17], C. Franco[23], J.M. Friedrich[18],

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- Proposal for Phase 1 to SPSC: June (update Sept.) 2019
- Physics program recommended by SPSC: October 2020

SPSC 139, Oct. 2020

The Committee **recommends** approval of the proposal SPSC-P-360 by the AMBER Proto-Collaboration to use the M2 beam-line before LS3 to perform measurements related to:

(i) Drell-Yan and J/Psi production using the conventional M2 hadron beam;
(ii) proton-induced antiproton production cross sections for dark matter searches;
(iii) the proton charge radius using muon-proton elastic scattering.

The proton-radius program is contingent on a successful pilot run previously approved for the first year of SPS operation after the Long Shutdown LS2.

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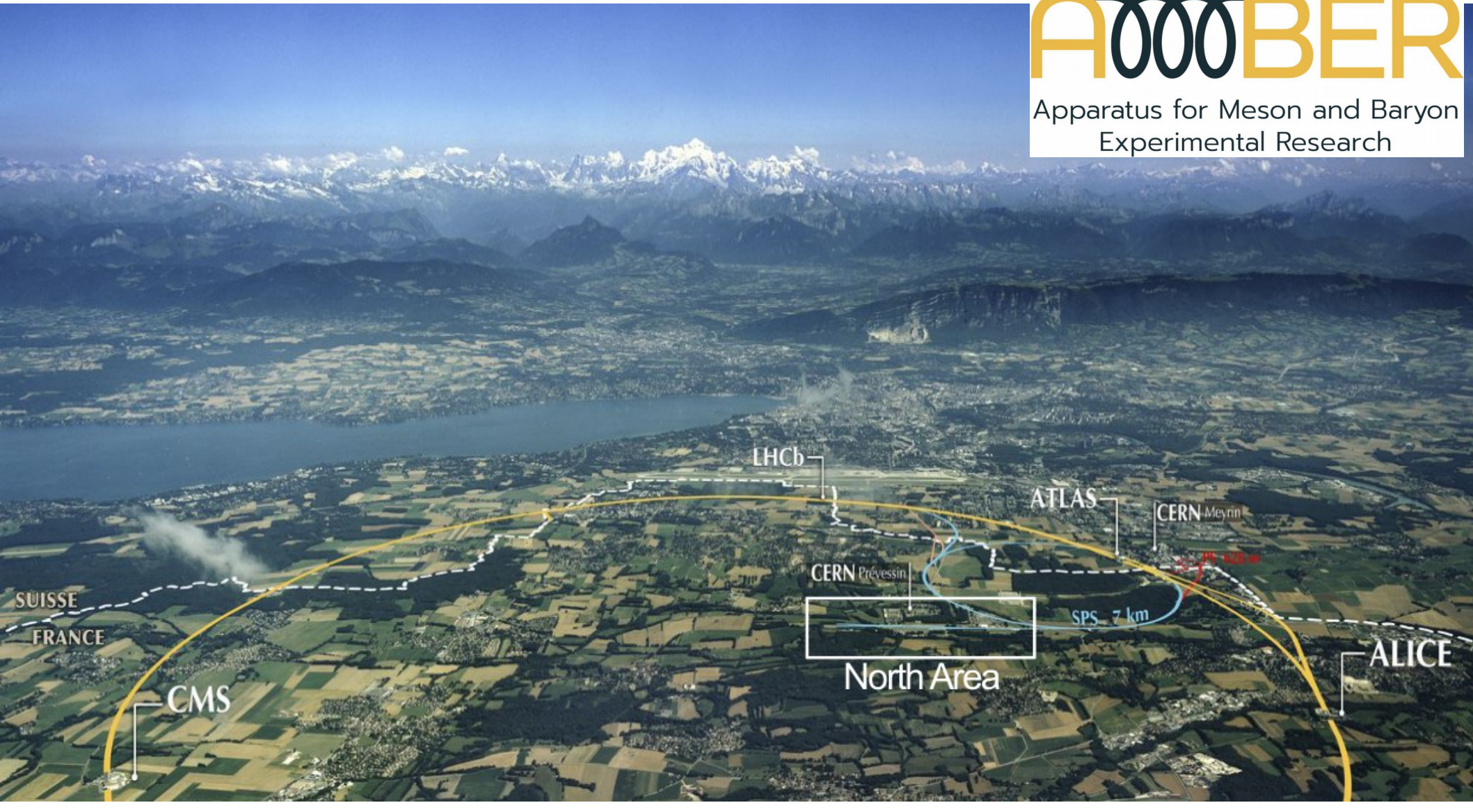
- Physics program recommended by SPSC: October 2020
- Approved as NA66 by the CERN Research Board: Dec. 2020

> proposals that are requesting beam there, NA64-mu and MUonE. **The Research Board approved AMBER for its Phase-1 measurements until LS3, with the beam allocation being subject to the optimisation of the overall schedule at the SPSC. The experiment will have reference number NA66.**

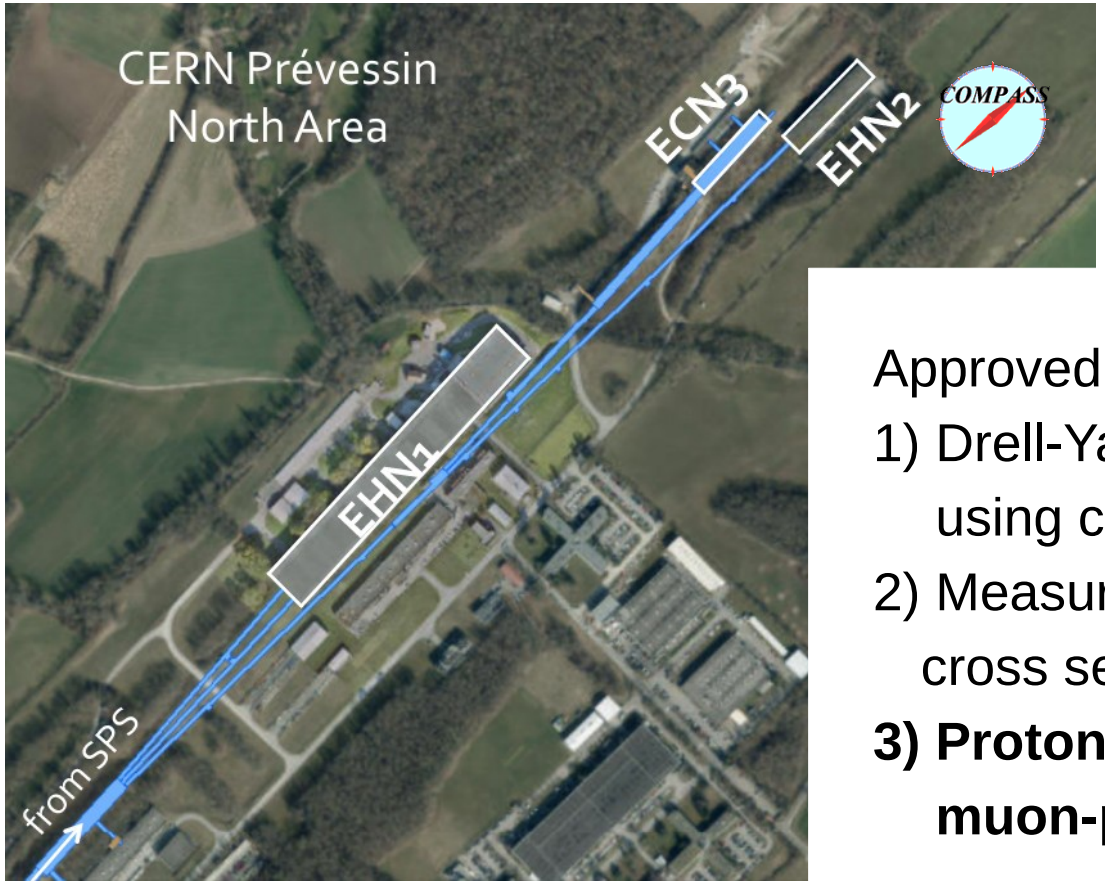
AMBER

Apparatus for Meson and Baryon Experimental Research



AMBER – WHERE?

Apparatus for Meson and Baryon Experimental Research



M2 beamline (EHN2):

- most versatile beamline at CERN
- high-intensity beams of $\mu^{\pm}$, $\pi^{\pm}$, p
- intensity limited by radiation protection

Approved Phase-1 physics program:

1) Drell-Yan and charmonium production using conventional hadron beams (DY)
2) Measurement of antiproton production cross sections for dark matter search ($\bar{p}X$)
3) **Proton-radius measurement using elastic muon-proton scattering (PRM)**

AMBER – PHYSICS

Apparatus for Meson and Baryon Experimental Research

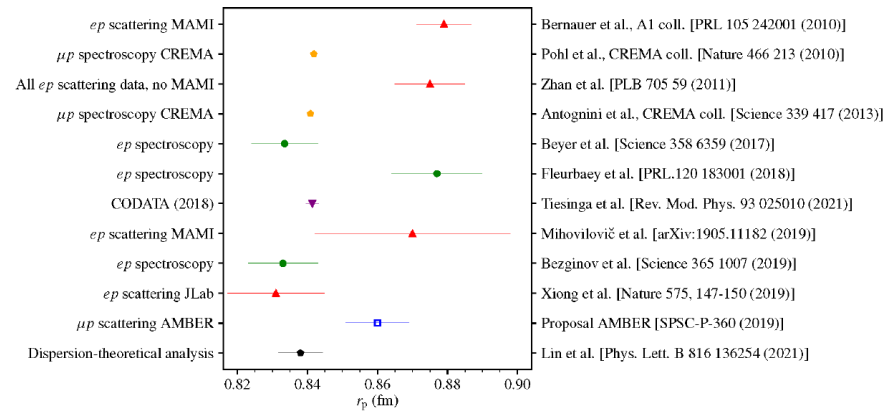
Proton-radius measurement using elastic muon-proton scattering

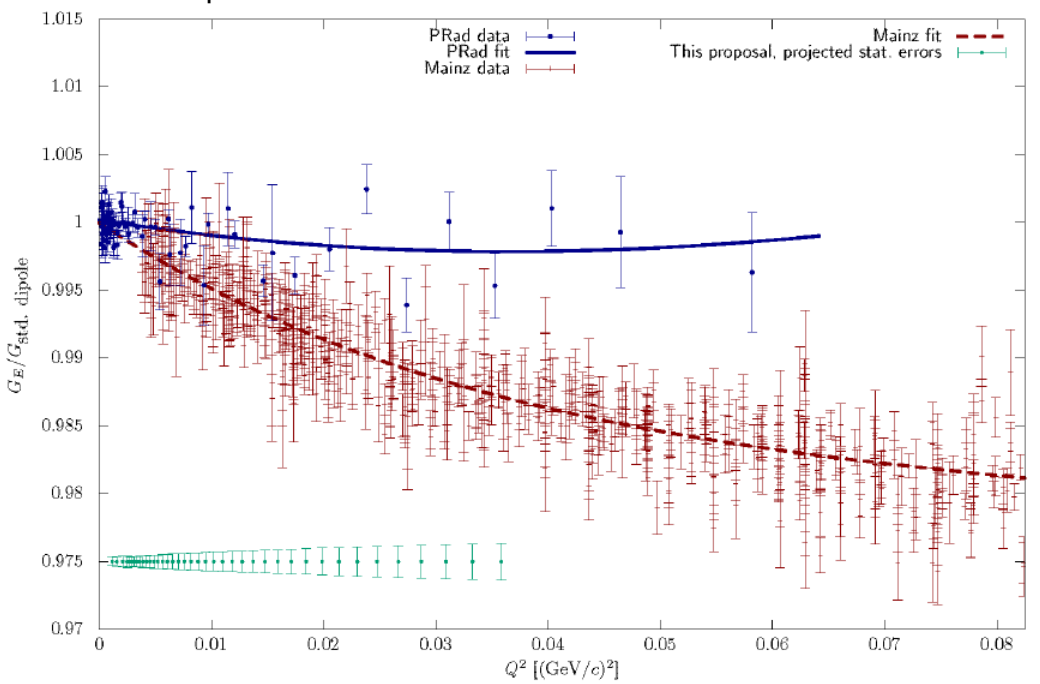
Goal: complement existing experiments to measure r_p with μ to resolve discrepancies

4 ways to measure r_p:

	ep	μp
Scattering	New measurements: • Lower systematics • Lower Q^2	Not measured yet • MUSE @ PSI • AMBER @ CERN
Spectroscopy	New measurements: • Lower systematics • New transitions	Done (CREMA)

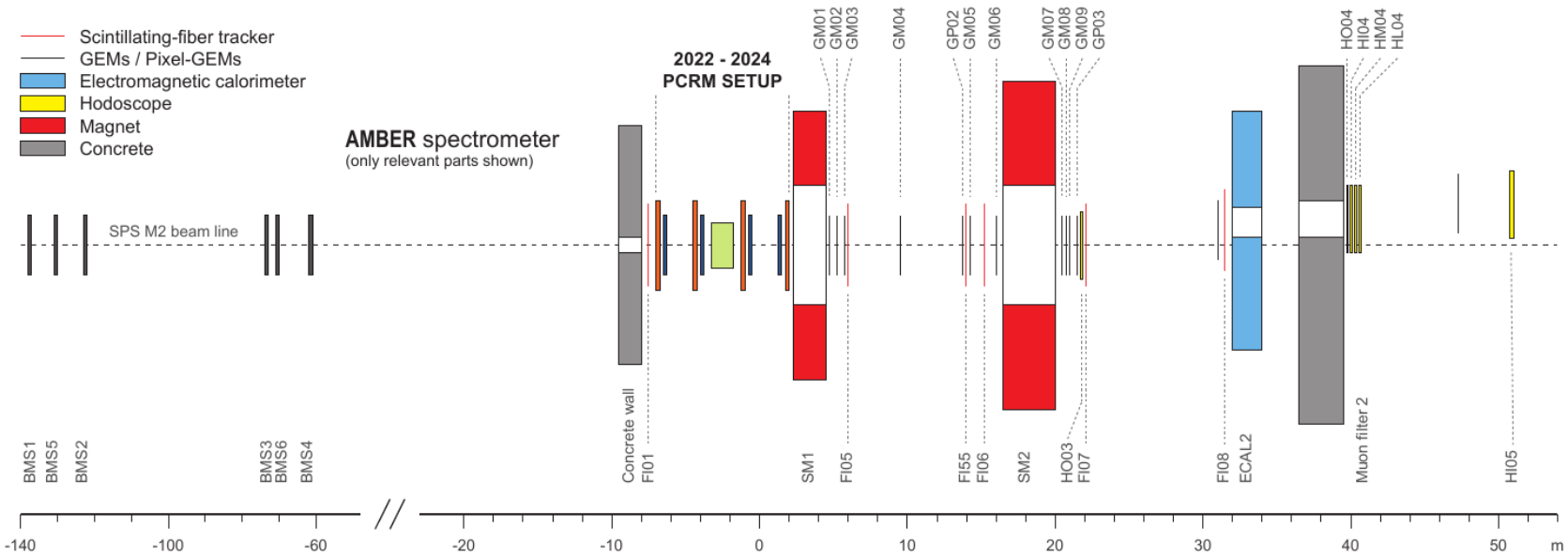
From: B.Ketzer, DPG2022





much smaller radiative corrections than ep

AMBER - PRM

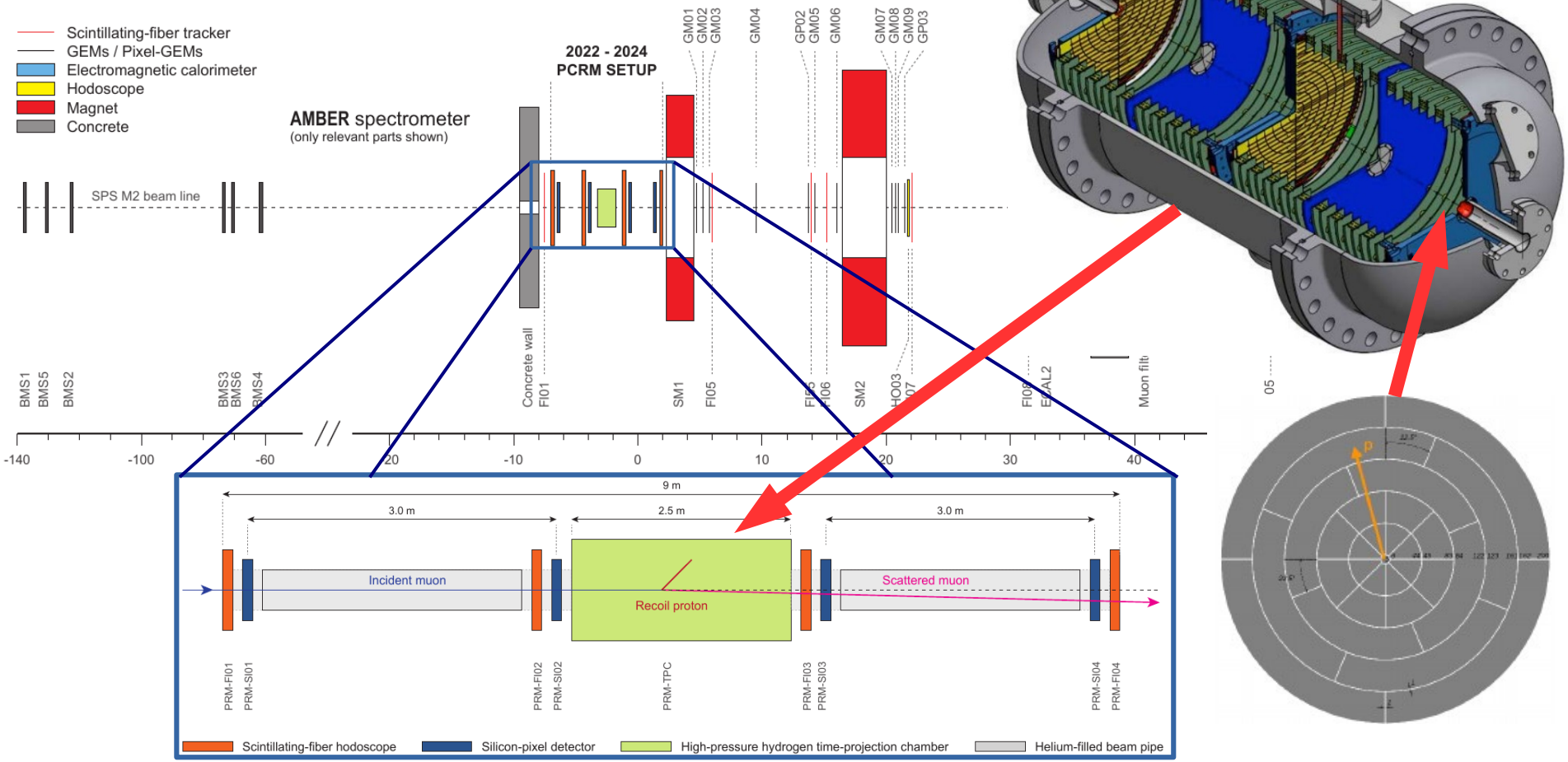


Proton Radius Measurement (PRM) by elastic muon-proton scattering

- High-intensity muon beam from SPS M2 beam line
- High-pressure hydrogen TPC as active target
- Muon spectrometer

Modified from: B. Adams et. al., COMPASS++/AMBER: Proposal for Measurements at the M2 beam line of the CERN SPS Phase-1: 2022-2024 (2019), CERN-SPSC-2019-022

AMBER - PRM



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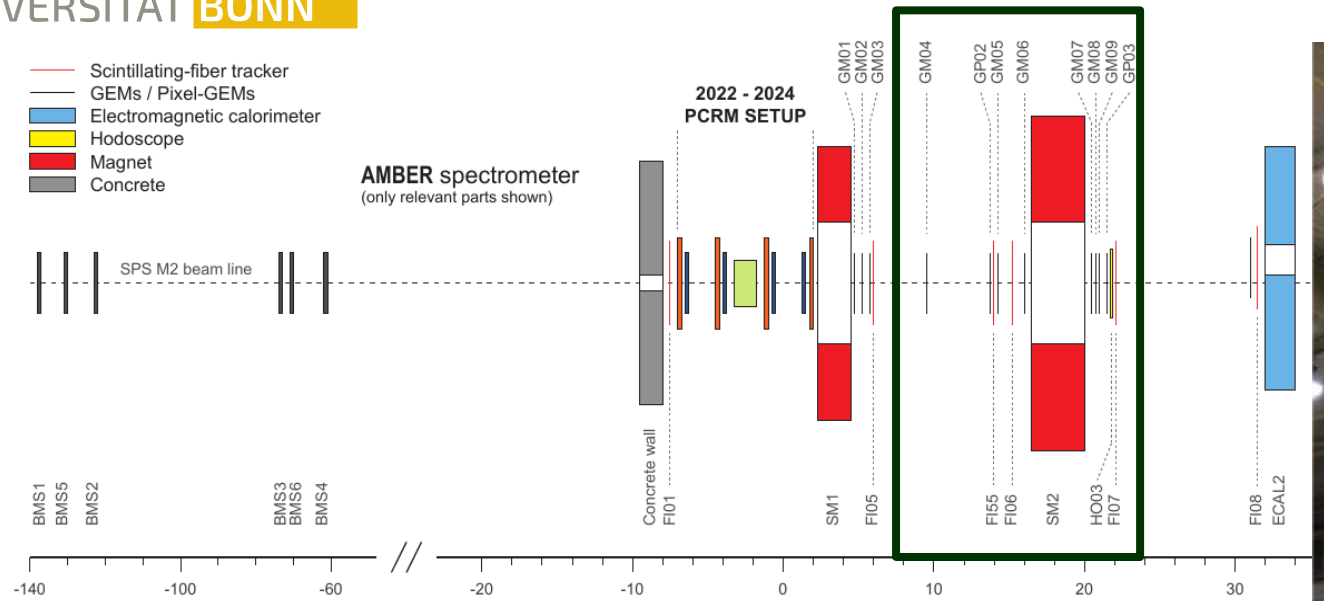
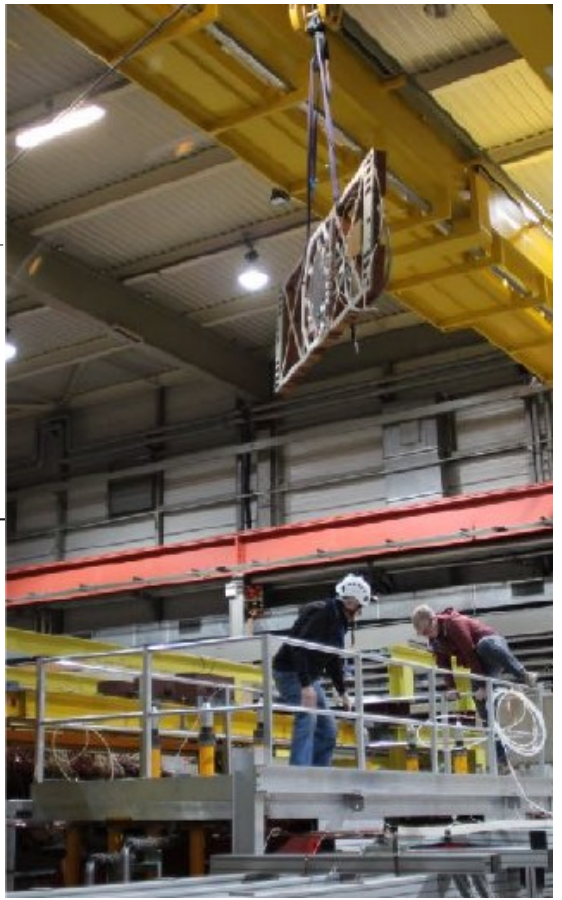


Large-area GEMs



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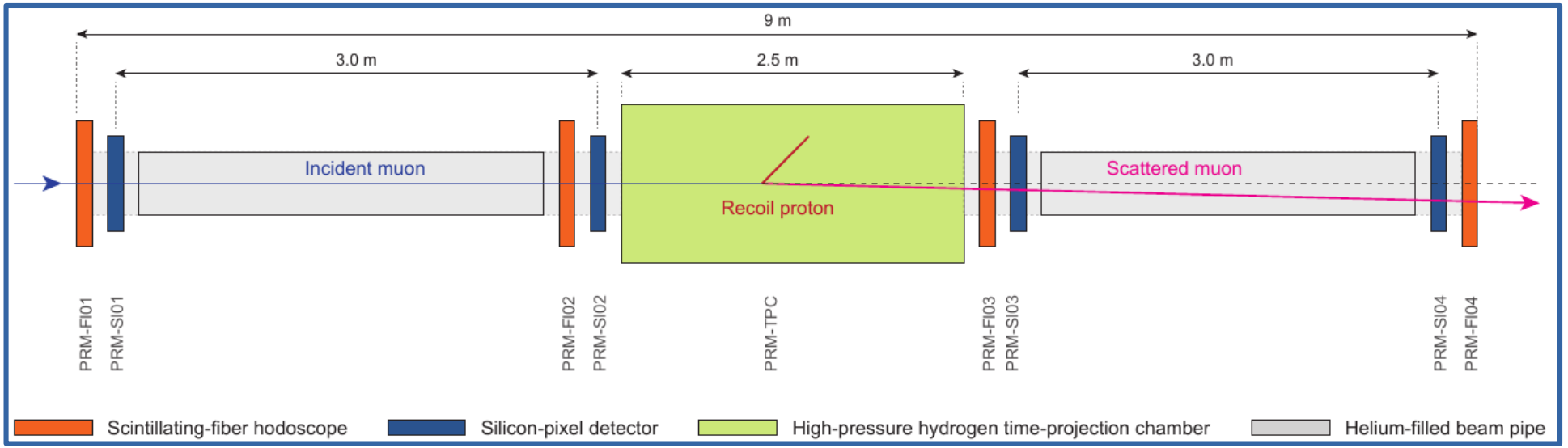
Minimum setup to allow PRM physics with required precision (from simulations): 3 stations with each large 2 GEM detectors

AMBER - PRM



AMBER PRM readout paradigm

- Incident and scattered muon instantly measured with trackers
- Recoil proton measured in (slow) TPC

$\Longrightarrow$ Assignment can only be done in high-level trigger

$\Longrightarrow$ Continuous readout and self-triggering required

Modified from: B. Adams et. al., COMPASS++/AMBER: Proposal for Measurements at the M2 beam line of the CERN SPS Phase-1: 2022-2024 (2019), CERN-SPSC-2019-022

GEM UPGRADE

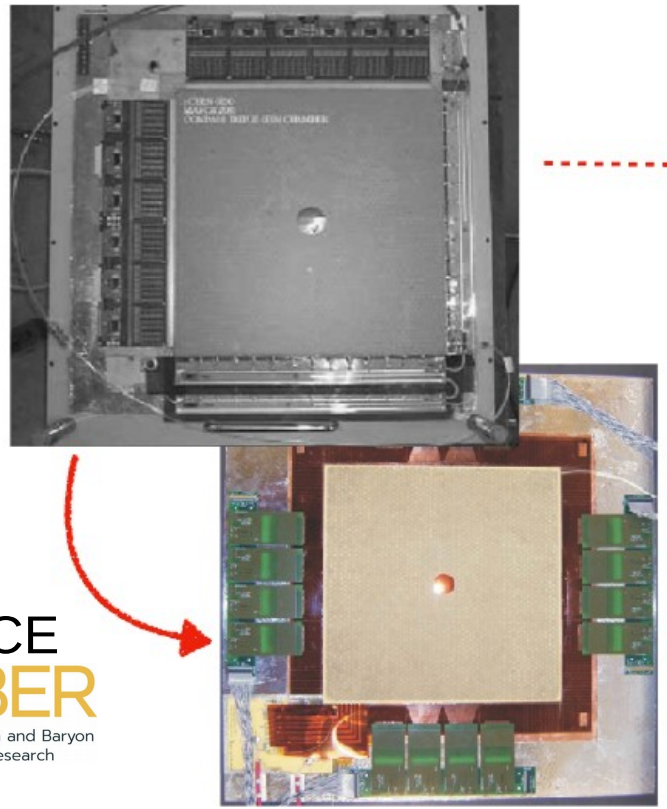
G1G → G3G

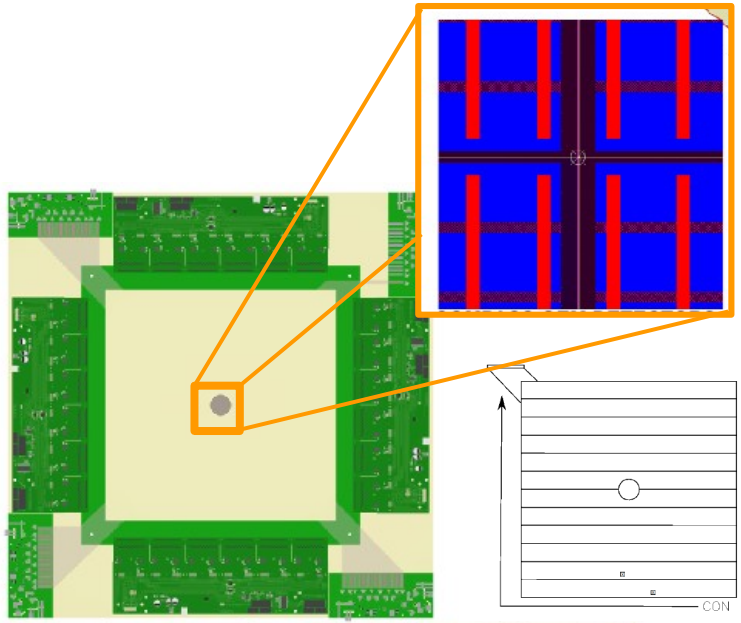
Large area GEMs (30.72 x 30.72 cm²)

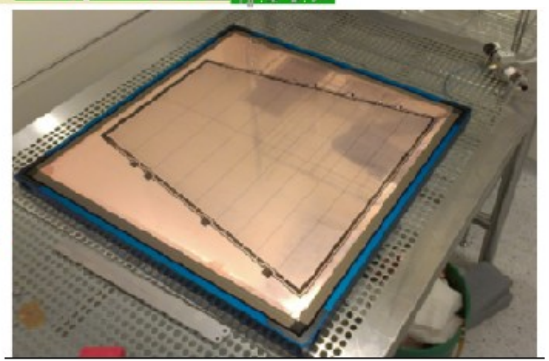
- G1G: from 2001
- (G2G: Pixel-GEMs from 2008)
- + Know-how from ALICE

⇒ G3G:

  - 768 strips per side
  - Strips split for higher rate → 4 quarters







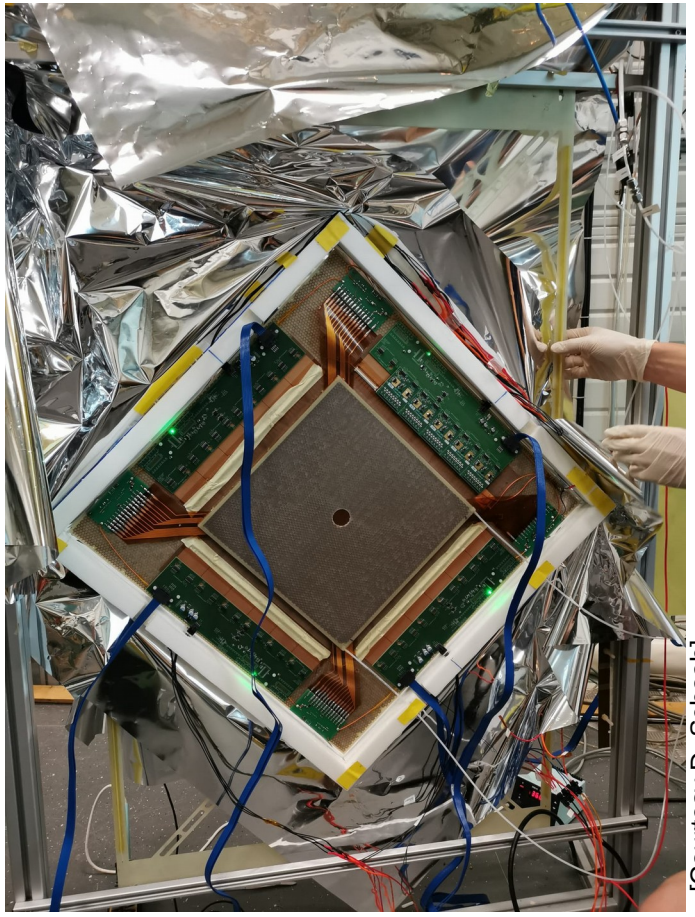
ALICE IROC GEM foil in stretching frame

GEM UPGRADE – INSTALLATION

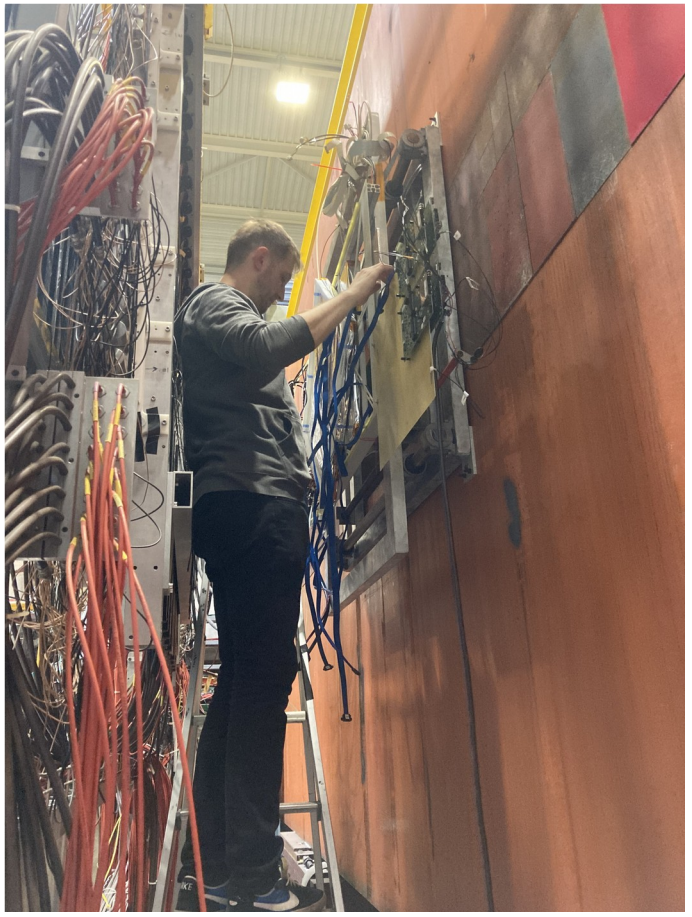
Final COMPASS run and AMBER $\bar{p}$X

- Cabling
- Shielding
- Installation

- Triggered APV25 readout in old COMPASS DAQ



[Courtesy D. Schaab]



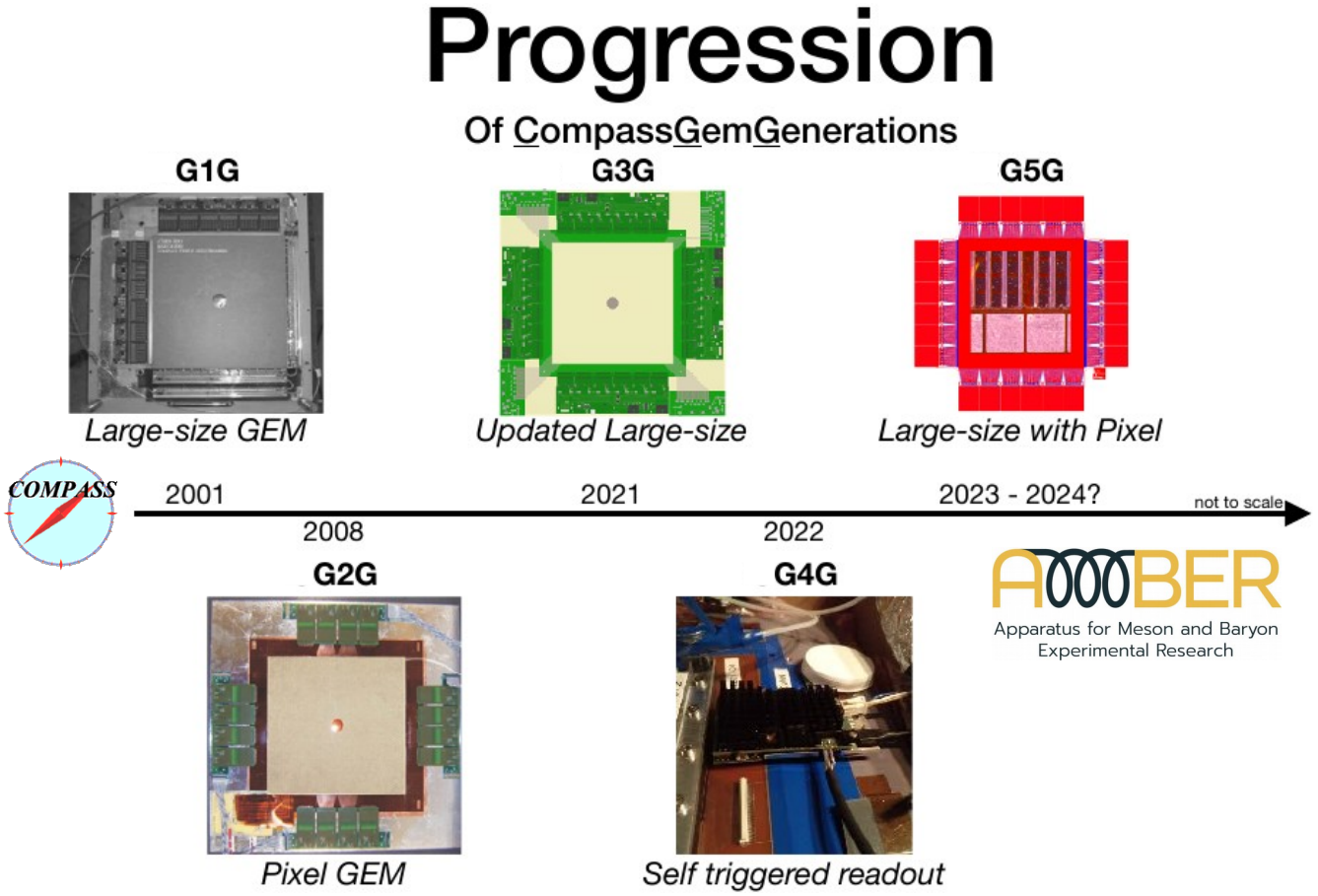
[Courtesy D. Schaab]

AMBER GEMS

G3G → G4G → G5G

- G4G: Large area GEM
  as for COMPASS
  with self-triggered readout

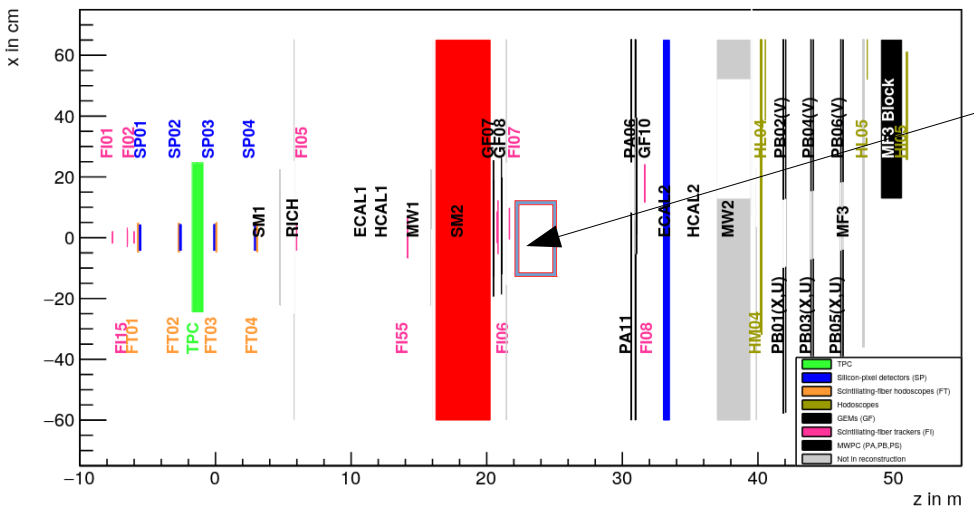
- *G5G: Large are GEM*
  with pads in the centre
  (as PixelGEMs)
  and self-triggered readout

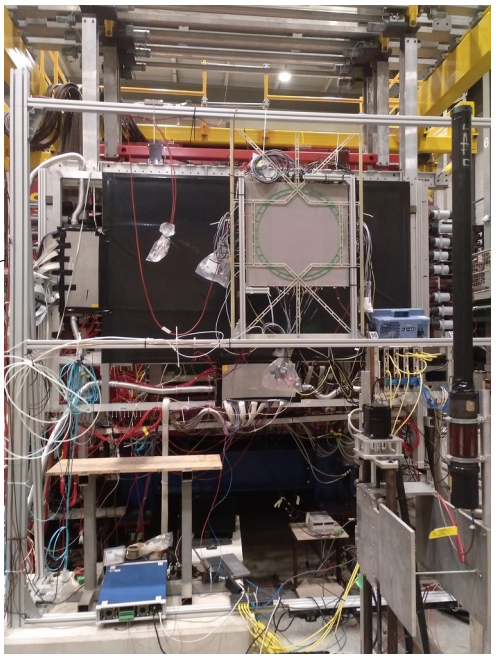


GOALS FOR PRM PILOT RUN SEPT. 2023

1. Test G3G detector with SRS- VMM readout → G4G prototype
2. Increased number of VMM chips (8+1 → 48+1) compared to Pilot Run 2021
3. Scan operation parameter space → find working point
   - GEM gain (HV)
   - VMM gain (preamplifier)
   - VMM threshold (noise acceptance)
4. More/better data compared to 2021 Pilot Run

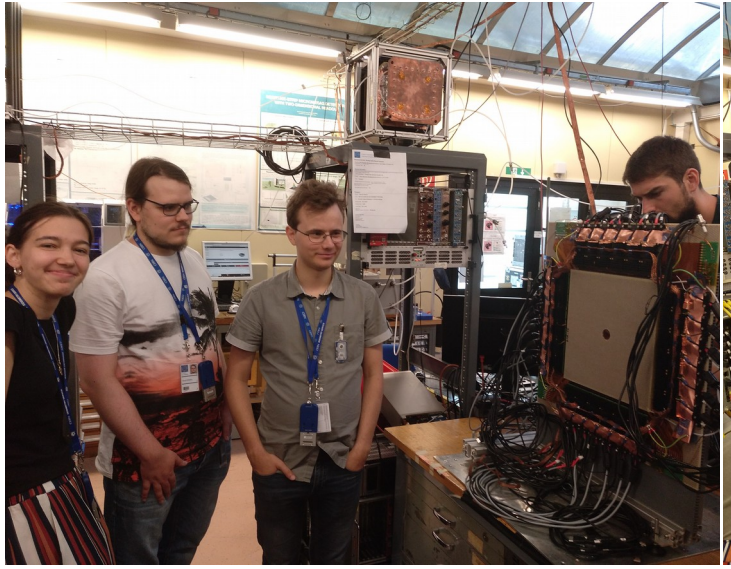
From: Martin Hoffmann : https://indico.cern.ch/event/1174775/contributions/5051692/attachments/2513760/4321354/hoffmann-PRM_Setup_2023_Simulation-2022-09-22.pdf

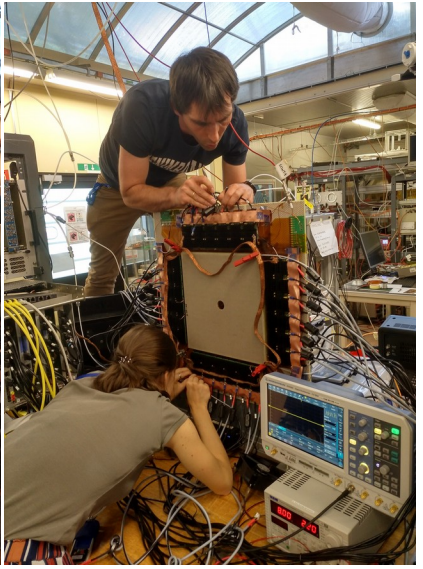




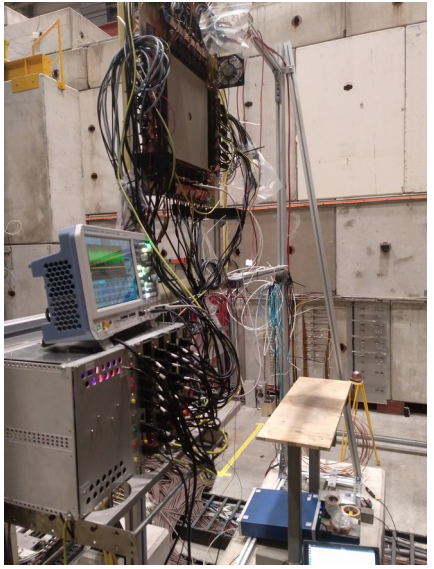
Installation position behind magnet SM2

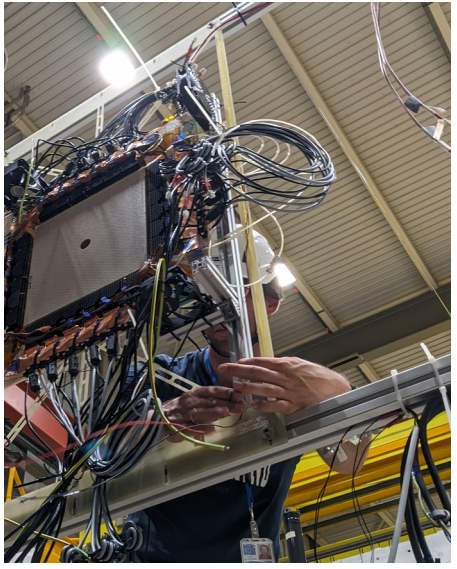
INSTALLATION





Detector equipment with VMM electronics in GDD lab





Detector installation in AMBER hall

- Detector/Electronics much more noise at beam position than in GDD lab.
- Spikes on VMM baseline, when HV (GND) connected. Not seen in GDD lab.

NOISE STATUS AFTER INSTALLATION 1

To evaluate noise:

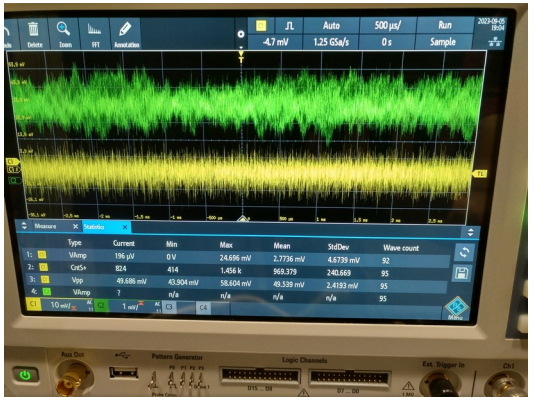
- BNC cable attached to monitoring output (shaper out) of one random VMM chip
- Connected to oscilloscope
- Look at baseline of a random channel of that VMM chip
- Quantitative noise measures:
  - Automatic measure of amplitude → statistics amplitude RMS
  - Automatic measure of peak to peak → statistics peak to peak mean
  - Oscilloscope trigger rate at given threshold

Status after installation:

- RMS ≈ 12 mV
- Peak to peak mean ≈ 100 mV
- Rate at 20 mV threshold several kHz

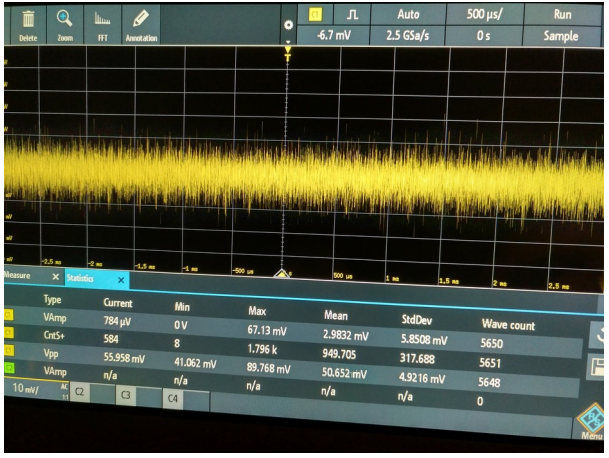
Main impact: Strange spikes from HV GND

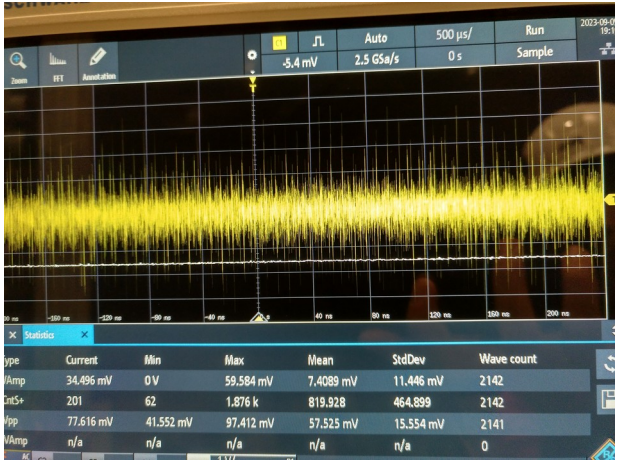
INSTALLATION 2



2 main issues to solve:
A) Noise and spikes
B) One quadrant much more noisy than others (different noise)

A) Noise and spikes
Observation: Spikes disappear/reduce, when, in addition to BNC cable, another GND connection between osci and detector is established e.g. a probe needle GND



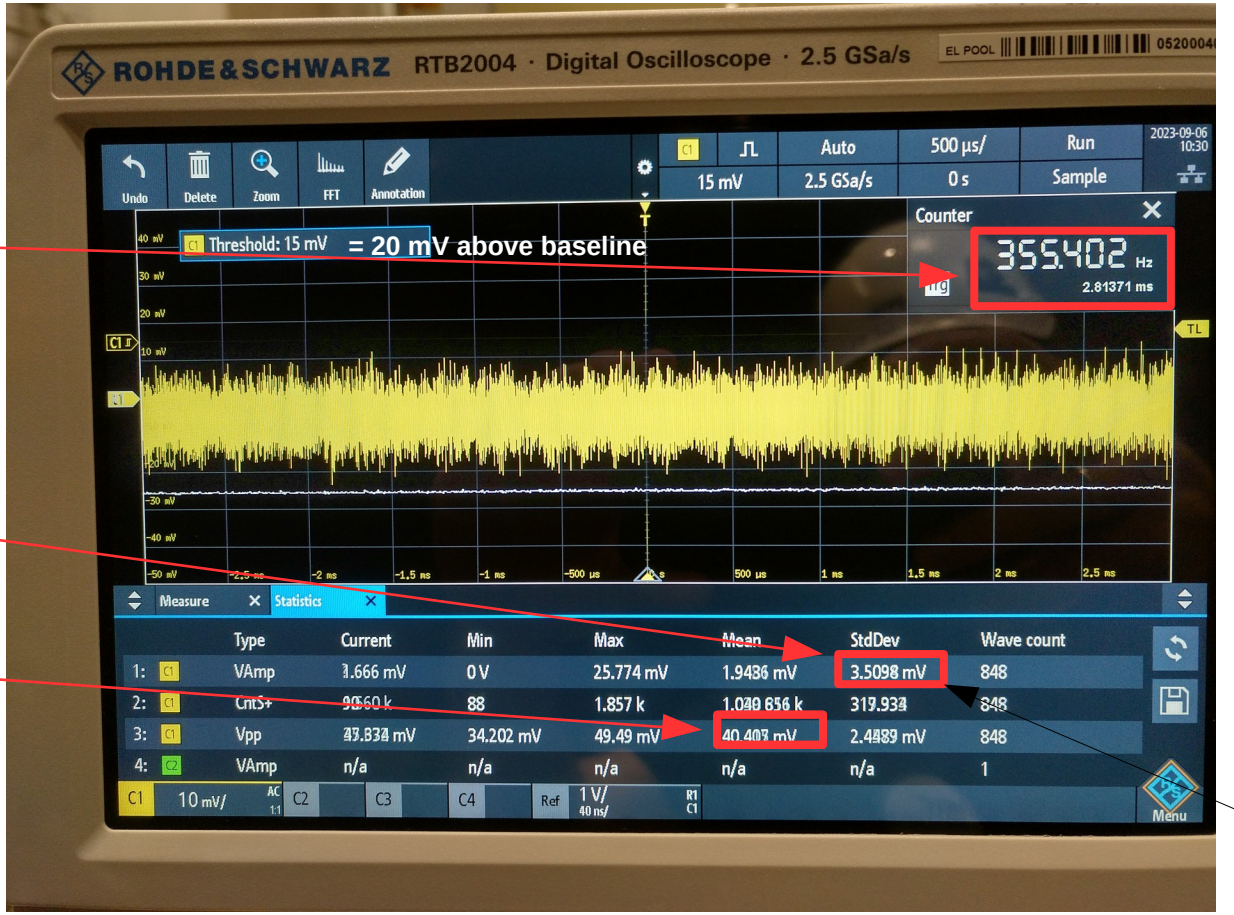


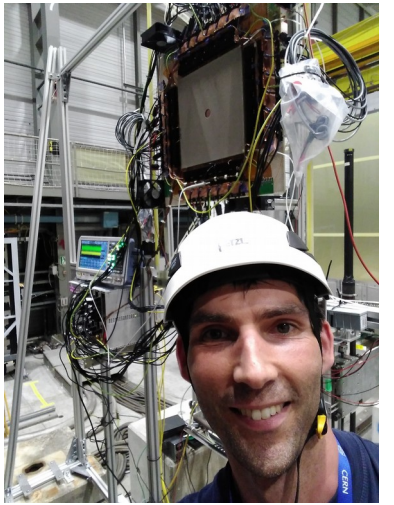
INSTALLATION 2 – SOLUTIONS A+B

Long story short:
A) Noise and spikes
→ GND loop closed, when osci connected → better GND between osci and detector
⇒ remove osci for measurements, HV filter box
B) One quadrant much more noisy than others (different noise)
→ one of the four SRS adapter cards = power supply for VMMs introduced noise
⇒ exchanged

C) Further increase GND, close open loops on GND calbes, ...

INSTALLATION 2 – RESULT A+B





Starting at

Several MHz

≈ 12 mV

≈ 100 mV

All at 16 mV/fC
VMM preamp
gain

as/better than
in GDD lab

Not any noisy
channel
At 40 mV
threshold

= 0.22 fC
= 1370 e ENC

COMMISSIONING

DAQ PC

- Update software vmmdcs, DAQ scripts, monitoring, prepare file system, logbook
- Channel mapping and geometry file
- Threshold calibration at VMM preamp gain 9mV/fC to 30 mV above baseline
- Could be easily lowered to 25 mV, few noisy channels
- 20 mV should be reachable without tooo much effort (13.8 ke threshold)
- Remote control and network connection

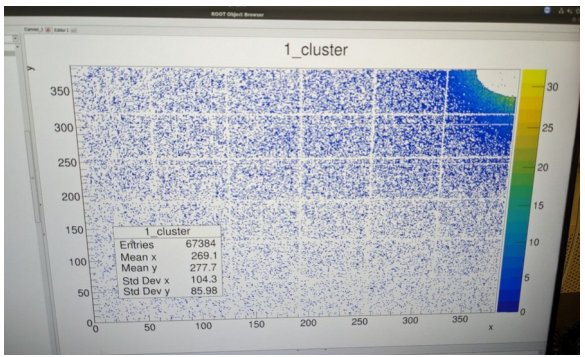
Services, interconnection

- LEMO cables for COMPASS trigger BOS, EOS, PHY (+ AMBER time slice)
- Test trigger, tune gain and thl for reliable trigger time stamps data in VMM DAQ
- Safety inspection → Better fixation of SRS crate, minor re-cabling
- Noise and stability tests with HV on, define HV measurement points
- Gas

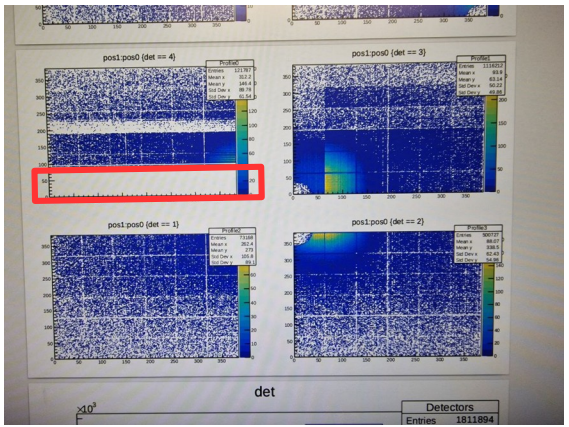
COMMISSIONING & FIRST DATA TAKING

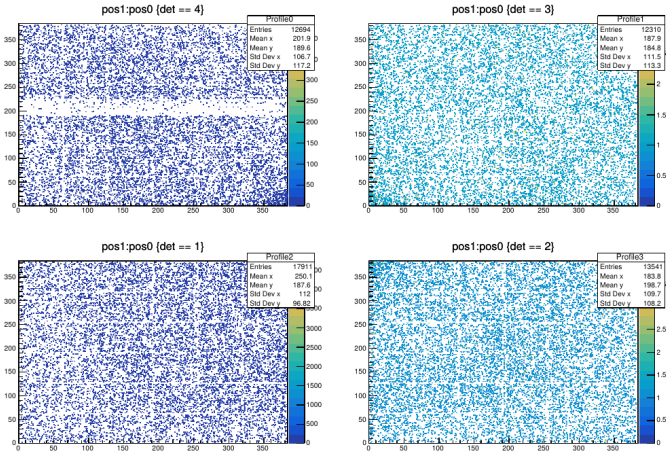
Week 11.-15.09. (first days of primary user)

- Student shift crew Jan Glowacs, Pascal Henkel + ML remote
- Training (dcs, SRS tools,…), commissioning (prev. slide)
- Cosmics data taking
- First beam → monitoring → first online event display (central sector off, sync between FECs wrong)
- Loose hybrid on detector connector



Detector quadrant 1
first online event display



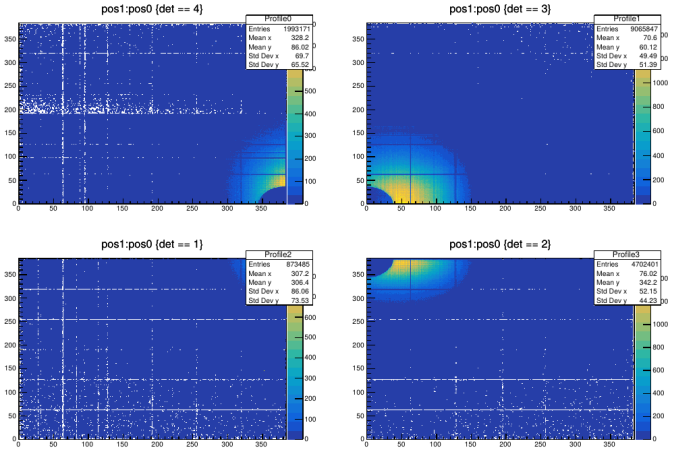


Cosmics flat field, all (but ½ VMM) work, few dead channels

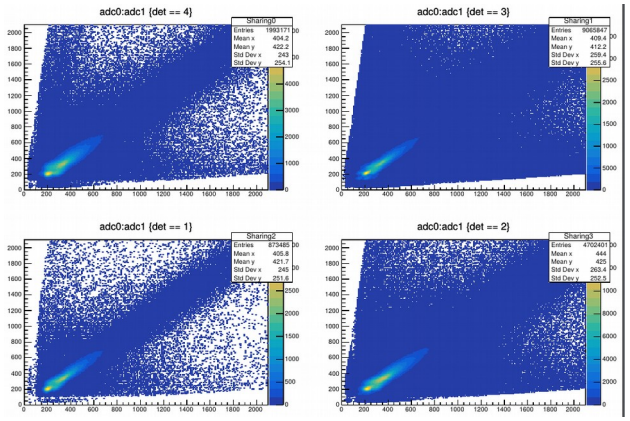
DATA TAKING

From day 4 (14.09.)

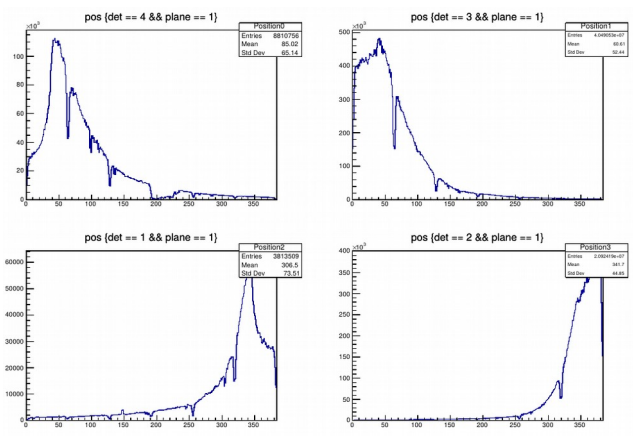
- First GEM HV scan, 9 mV/fC, 30 mV thl (center off here)



Beam position



ADC correlation planes



Plane 1 spatial profiles

- SRS crate and all VMMs in operation till end of run
  - Excellent system stability
  - One power cycle due to DAQ control mishandling
  - 3x test data taking (before taking spills) unveiled out of sync (ACQ OFF/ON)

DATA TAKING – PROGRAM

GEM HV scans (3950 V to 4350 V ~ gain 20k), 2 spills for each point, usually at standard beam conditions

- VMM preamp gain 9 mV/fC
  - VMM thl (mV over baseline): 20, 25, 30, 40, 50
- VMM preamp gain 12 mV/fC
  - VMM thl (mV over baseline): (20), 25, 30, 40, 50
- Hadron, high-intensity and wide beam runs
- Long-term measurements (up to 1 run = 200 spills)
  - GEM HV 4300 V (~gain 10 k), VMM preamp gain 12 mV/fC, VMM thl 25 mV,
  - Partially entirely from remote
- This time, the full spills were recorded ;)

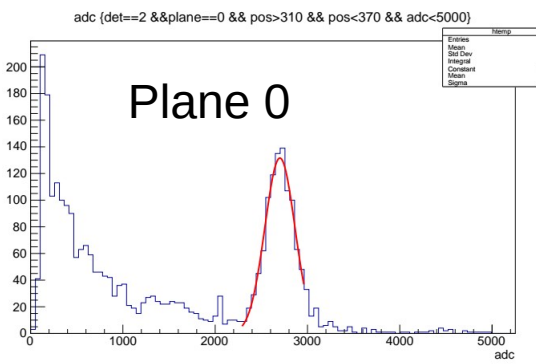
VMM GEM almost always ready for data taking,
> 90 % no data taking due to SPS issue or access, CO2 empty
⇒ Data taking stopped on last night of beam time due to full disk

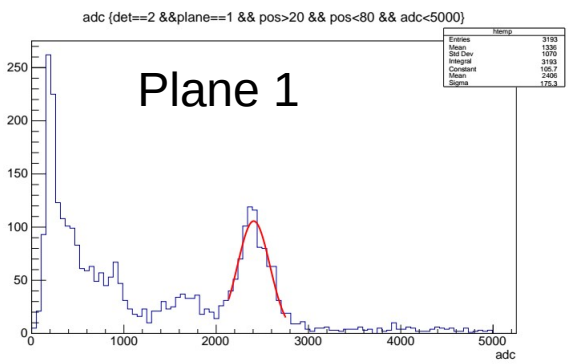
POST BEAM ^{55}FE MEASUREMENTS

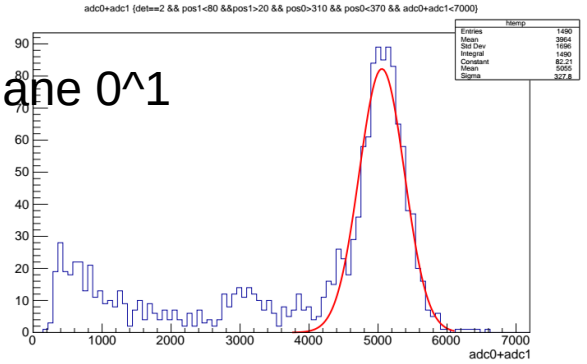
Reason:
Seen in lab: *Hot spot* = region in detector (corner) with higher gain
Detector in lab on table, hot spot at gas inlet corner
⇒ Check detector at AMBER setup (hanging, gas in at outlet)

Allowance by RP to use ^{55}Fe source from in AMBER Hall by our own

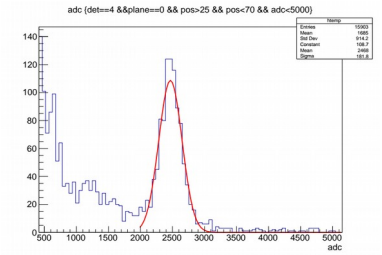
Loose-cut reco for cluster in plane 0/1 and detector, look at ADC spectra
Restricted to source position, gaus tip fit to photo peak

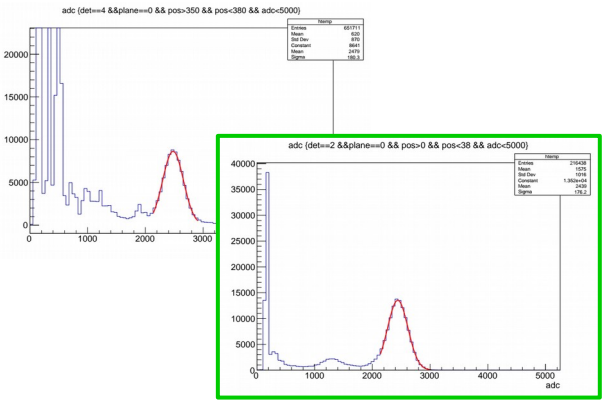


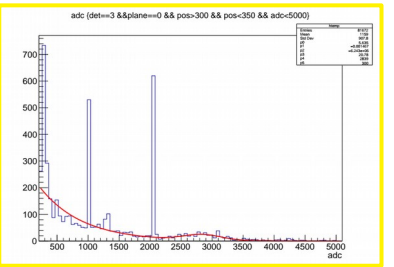


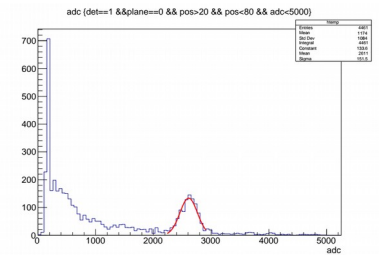


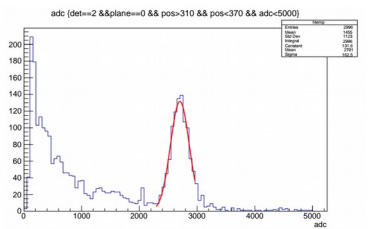
DATA EVALUATION – PLANE 0











FINAL RESULT: PEAK POSITIONS

ADC0+ADC1						ADC0						ADC1					
4711					5638	2468					2839	2243					2695
∓10		∓1.3			∓55	∓6		∓0.8			∓28	∓7		∓0.7			∓21
		4775						2479						2286			
			4927						2439						2482		
∓10			∓1		∓12	∓6			∓0.6		∓6	∓6			∓0.5		∓8
4957					5055	2611					2701	2335					2406
Mean		5011				Mean		2590				Mean		2408			
Stddev		303	6,05	%		Stddev		144	5,57	%		Stddev		150	6,24	%	

⇒ ≈ 6 % gain variations from ^{55}FE peak position

DATA ANALYSIS

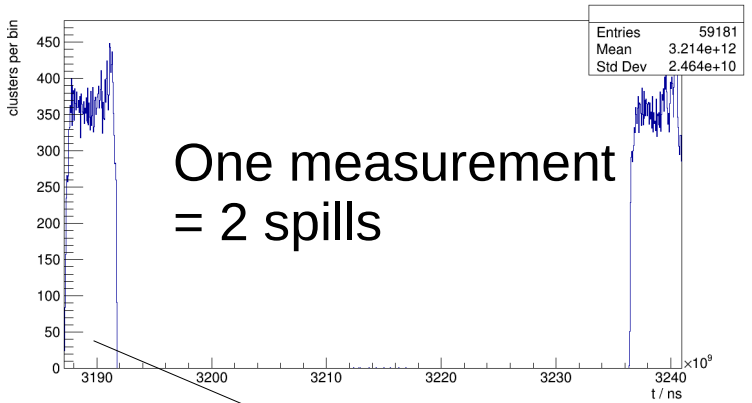
Has started ☺

Pascal Henkel will start a master thesis on the topic on December 16 ☺

Currently: Working on data synchronization between COMPASS and SRS using tools and experience from Pilot Run 2021

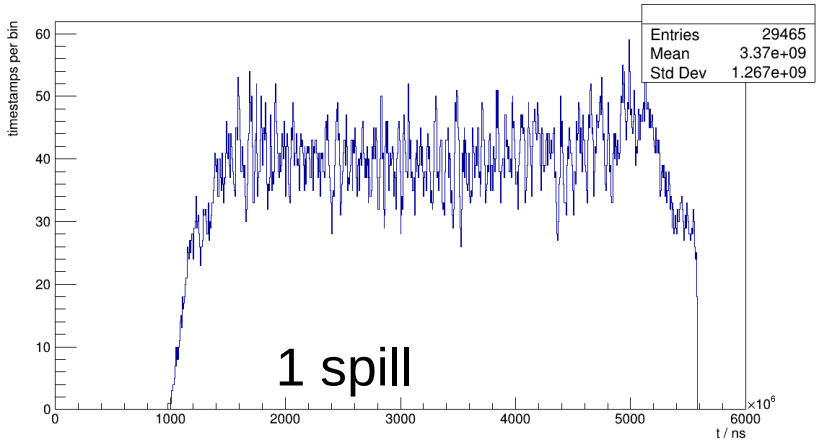
- As in 2021, SPS debunching is not good in first ~500 ms of spill
- This time, we have data also for > 500 ms ☺
- Working on 1-2 runs/spills to develop software
- Sync between:
  VMM clusters, COMPASS triggers in VMM system, COMPASS track times

DATA ANALYSIS



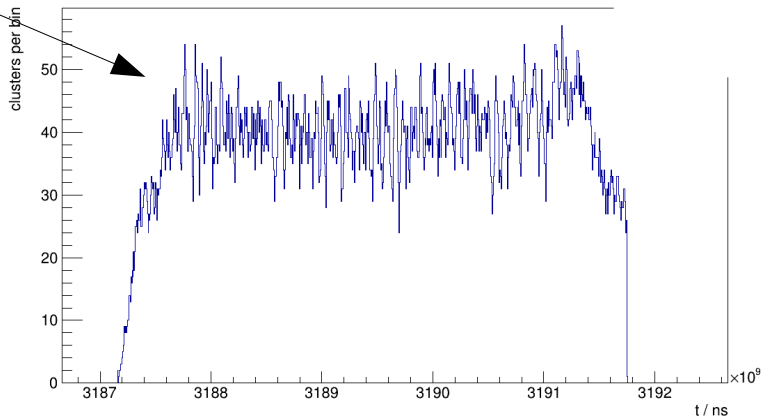
One measurement
= 2 spills

COMPASS triggers in VMM DAQ

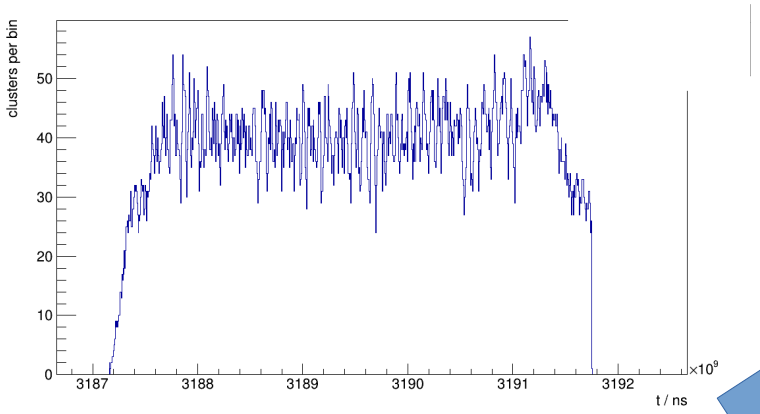


COMPASS track timestamps

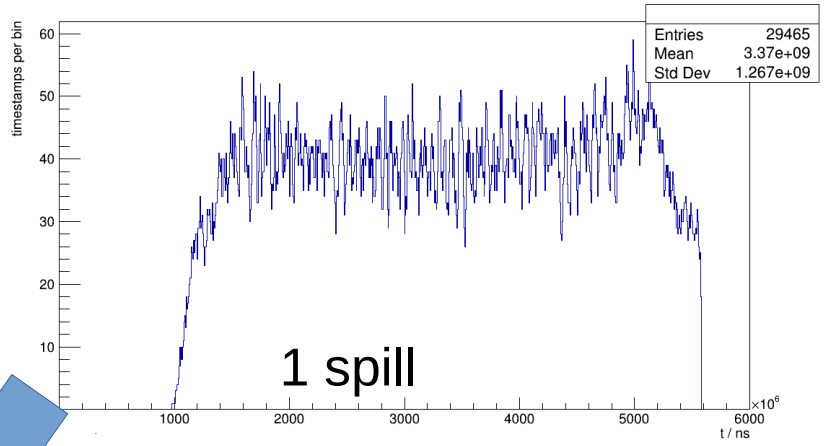
Select correct spill



DATA ANALYSIS



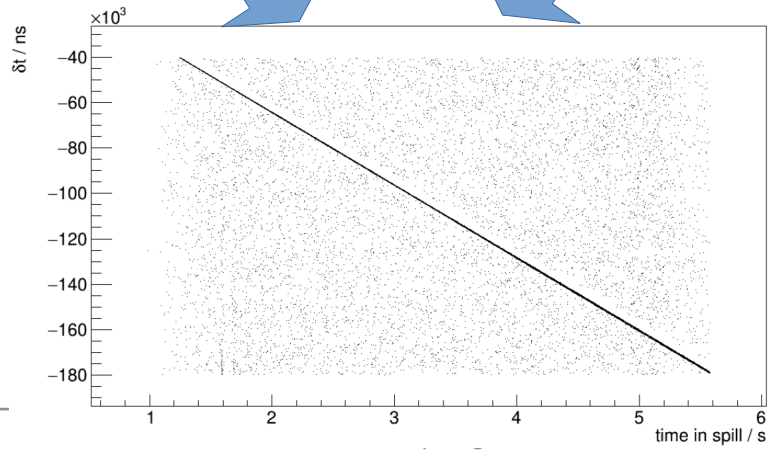
COMPASS trigger in VMM DAQ



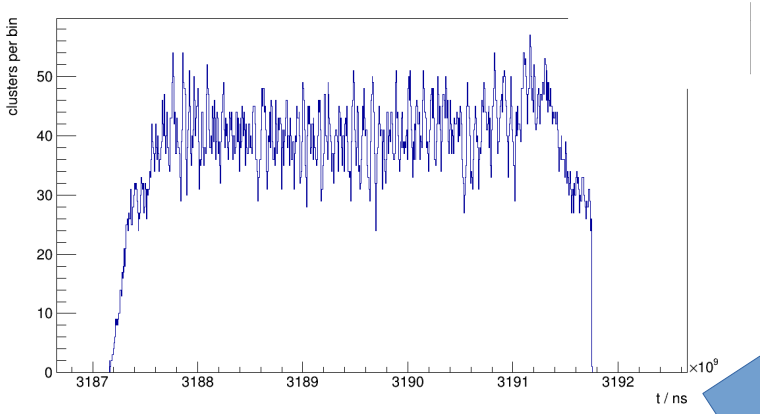
COMPASS track timestamps

Delta times between
all timestamps

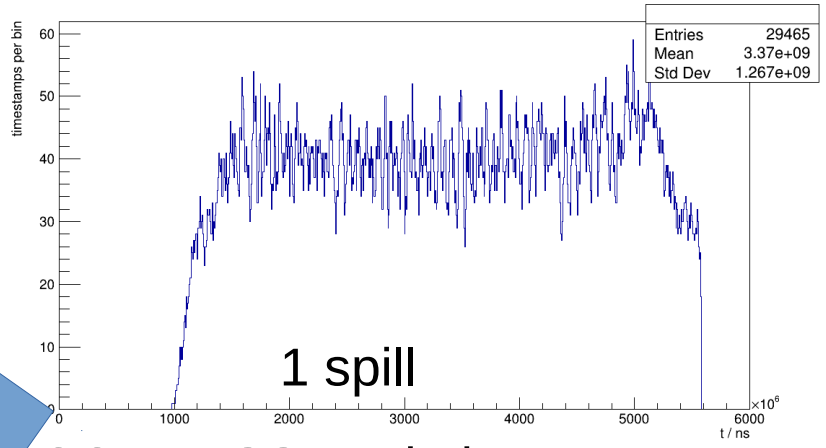
Not sync yet



DATA ANALYSIS

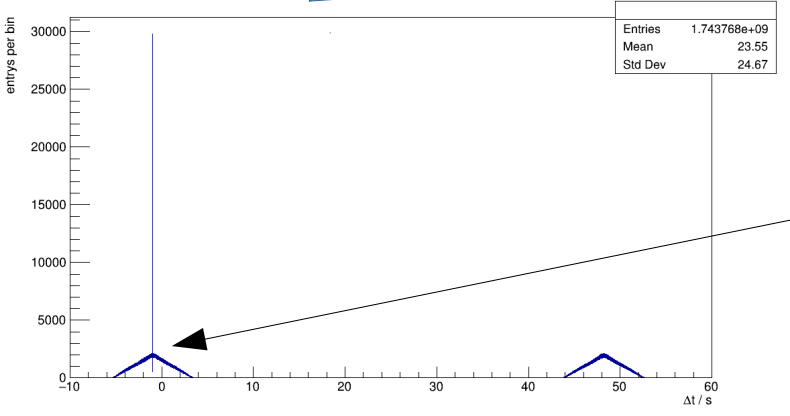


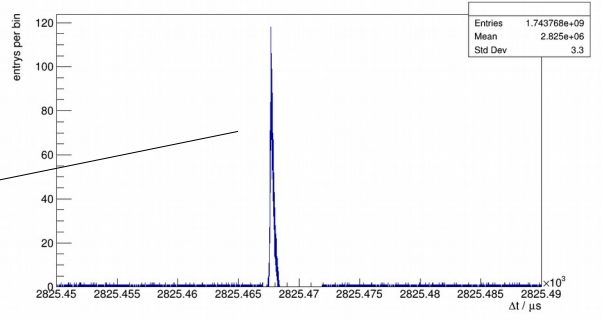
COMPASS trigger in VMM DAQ



COMPASS track timestamps

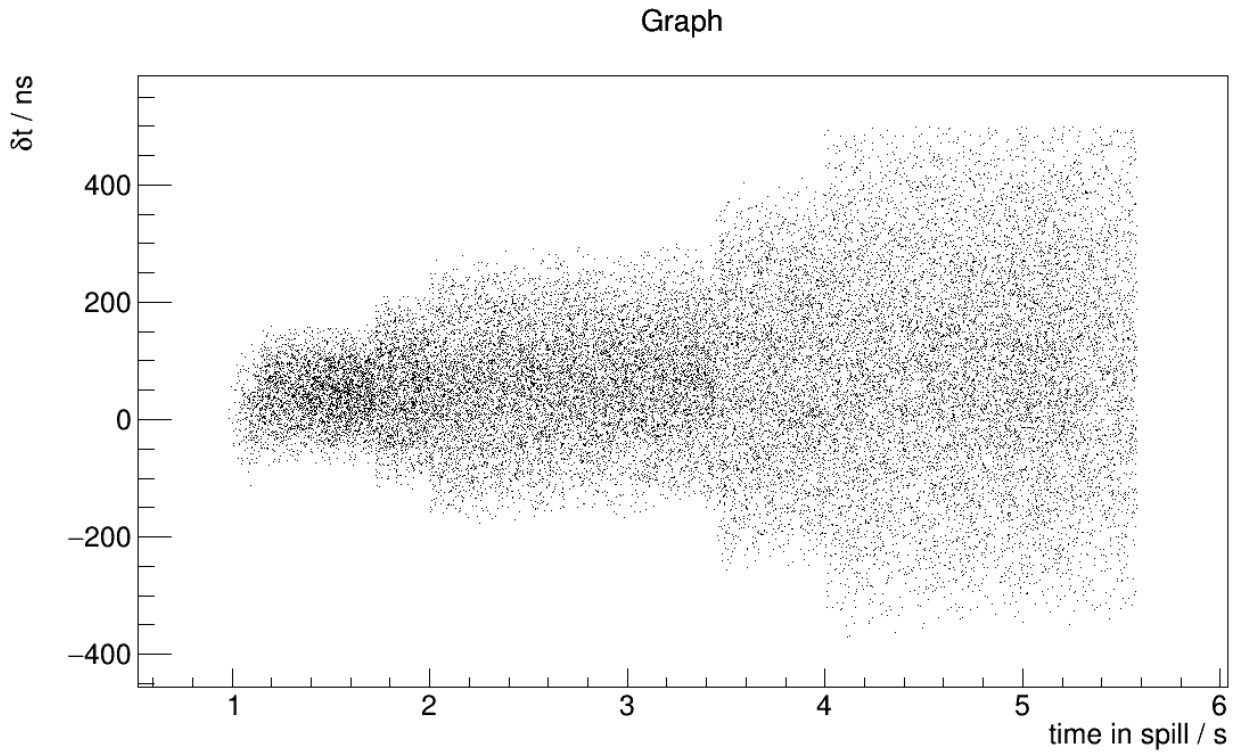
DAQ clock sync factor multiplication of timestamps
(no fit yet)





DATA ANALYSIS

Currently working on:



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SUMMARY

3 GEM stations (6 detectors) w/ triggerless readout min. requirement for AMBER PRM

- 3rd generation large area GEMs (G3G): 6 detectors built and qualified in lab
- G3G detector with SRS VMM-based triggerless readout = G4G prototype
  - Assembled and tested in GDD lab
  - Operated in AMBER PRM Pilot Run 2032 and in post-beam ^{55}Fe measurement
  - Data in large parameter space of GEM HV, preamp gain and thl taken

- Satisfied with the large area GEM detectors → some improvements in mind
  ⇒ maybe build 1-3 new detectors
- VMM frontend chip behaved reliable and as expected
- SRS VMM worked extremely nice and very reliable
  - No hardware failures after commissioning
  - Convenient slow control software
  - Helpful online monitoring
  - Reliable data acquisition, know-how to sync to COMPASS DAQ

OUTLOOK

SRS VMM works nice and reliable, but

- VMM hybrid = frontend board not suited perfectly
  - Too much material budget in acceptance regions
  - FPGA close to detector (radiation damage)
  - Too many cables, difficult integration in large system
  - Limited hardware availability

  ⇒ Dedicated VMM-based frontend board
- Several options
  - Bus card with multiplexer + new cooler (FPGA remains)
  - New stretched VMM hybrid (FPGA far outside) + bus card
  - GBT + VL VMM frontend board like e.g. ALICE TPC board for SAMPA
- Design and testing 🕐, integration into AMBER DAQ 🕐🕐

- Or: Use SRS VMM still next year with 6 detectors?

  Need: 144 hybrids, 24 FECs+DVMMs, 3 CTFs, 3 Eurocrates(or eq. Minicrates) with new ATX, ... + spares
  Available our group: 14 hybrids, 4 FECs+DVMMs, 1 CTF, 2 Minicrates

GridPix@CEA 2009

Learning SRS@CERN 2011

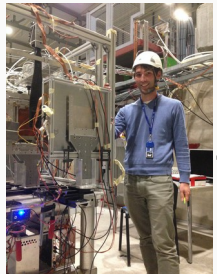
Zaragossa 2013

Electronics School 2014

Thanks to all for making (not only) working in this collaboration so much fun and RD51 a success!

Rehovot 2022

Let’s continue in DRD1!



Test beam 2017

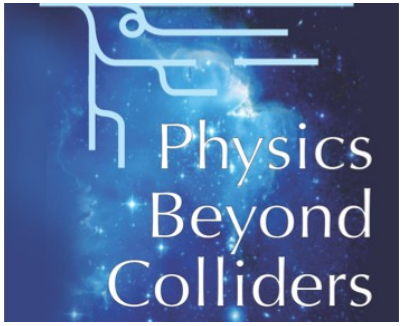
Philly 2017

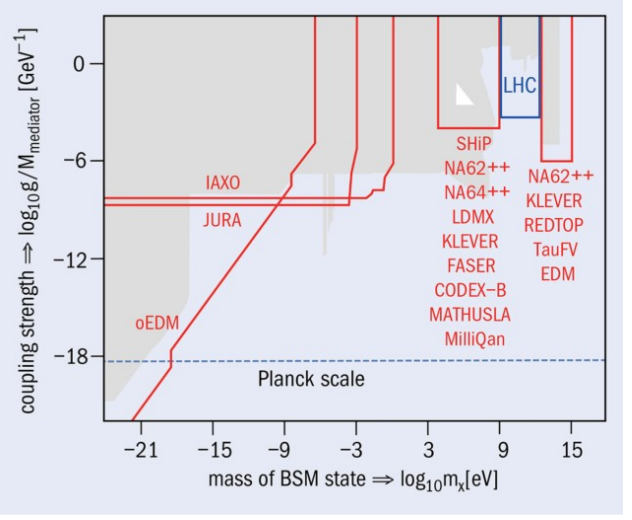
La Rochelle 2019

CERN: PHYSICS BEYOND COLLIDER

CERN's *Physics Beyond Collider* initiative:

- Study group launched 2016
- exploiting the full scientific potential of the CERN's accelerator complex and scientific infrastructures
- Complementary to LHC and other future colliders
- CERN impact on physics landscape in next 10-20 years

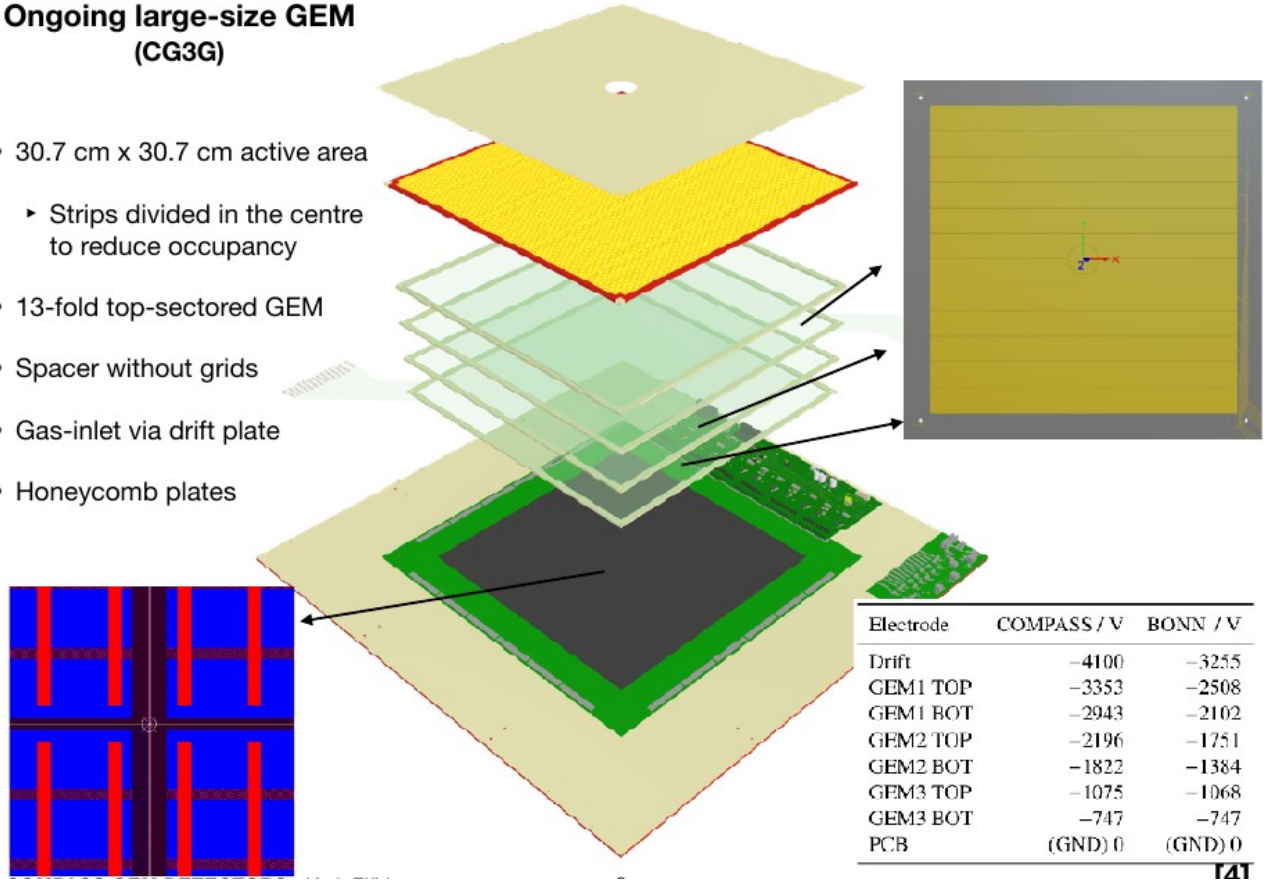




GEM UPGRADE - LAYOUT

Ongoing large-size GEM (CG3G)

- 30.7 cm x 30.7 cm active area
  - Strips divided in the centre to reduce occupancy
- 13-fold top-sectored GEM
- Spacer without grids
- Gas-inlet via drift plate
- Honeycomb plates

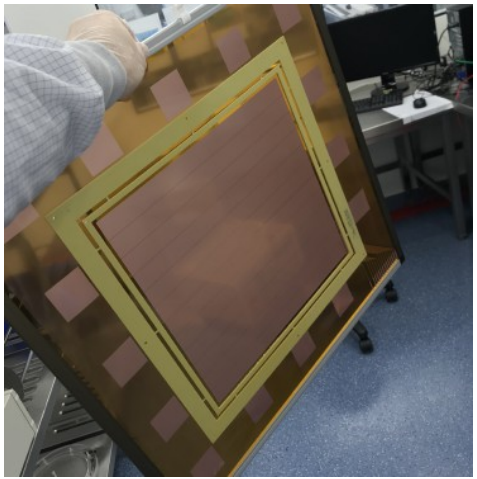


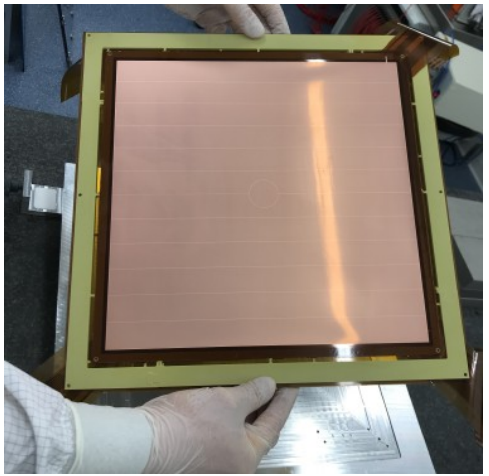
Electrode	COMPASS / V	BONN / V
Drift	−4100	−3255
GEM1 TOP	−3353	−2508
GEM1 BOT	−2943	−2102
GEM2 TOP	−2196	−1751
GEM2 BOT	−1822	−1384
GEM3 TOP	−1075	−1068
GEM3 BOT	−747	−747
PCB	(GND) 0	(GND) 0

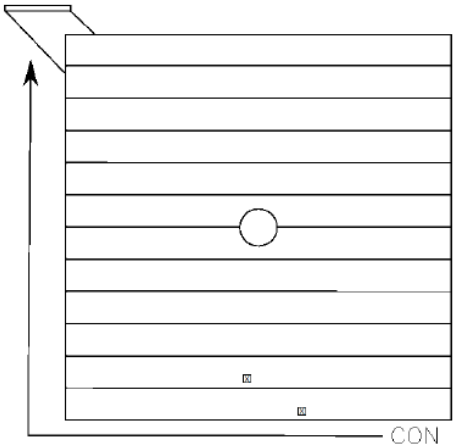
[41]

Jonathan Ottnad, Optimierung der GEM-basierten Verstärkungsstufe einer TPC für das CB/TAPS-Experiment, PhD thesis: Rheinische Friedrich-Wilhelms-Universität Bonn, 2020, url: http://hdl.handle.net/20.500.11811/8516

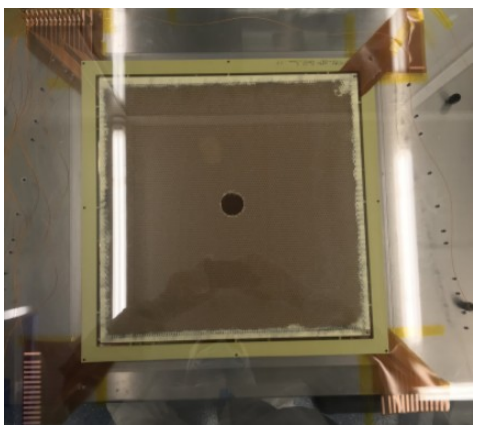
GEM UPGRADE - PRODUCTION

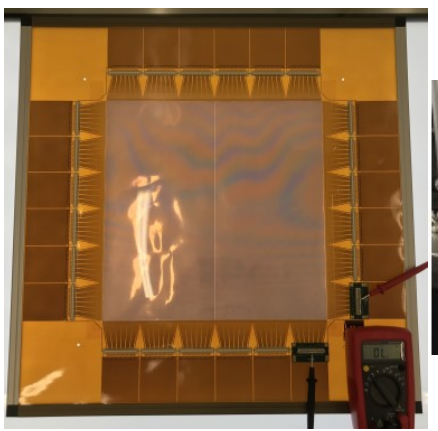


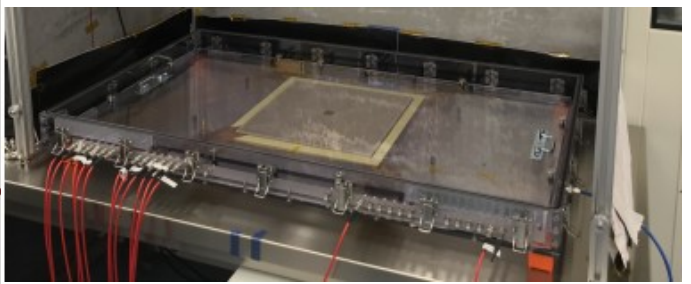




Segmented GEMs







[Courtesy all pictures J. Pascheck

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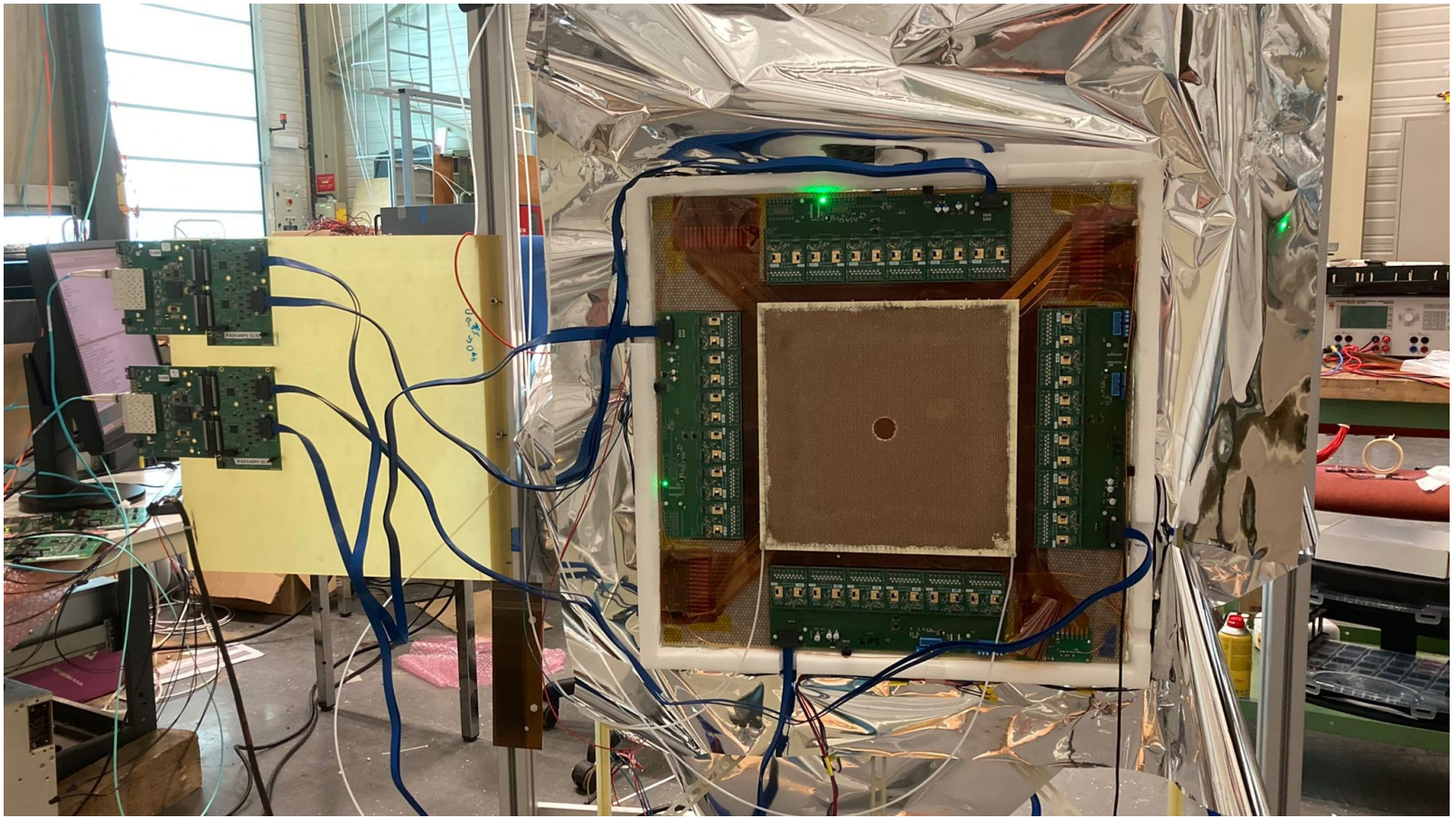
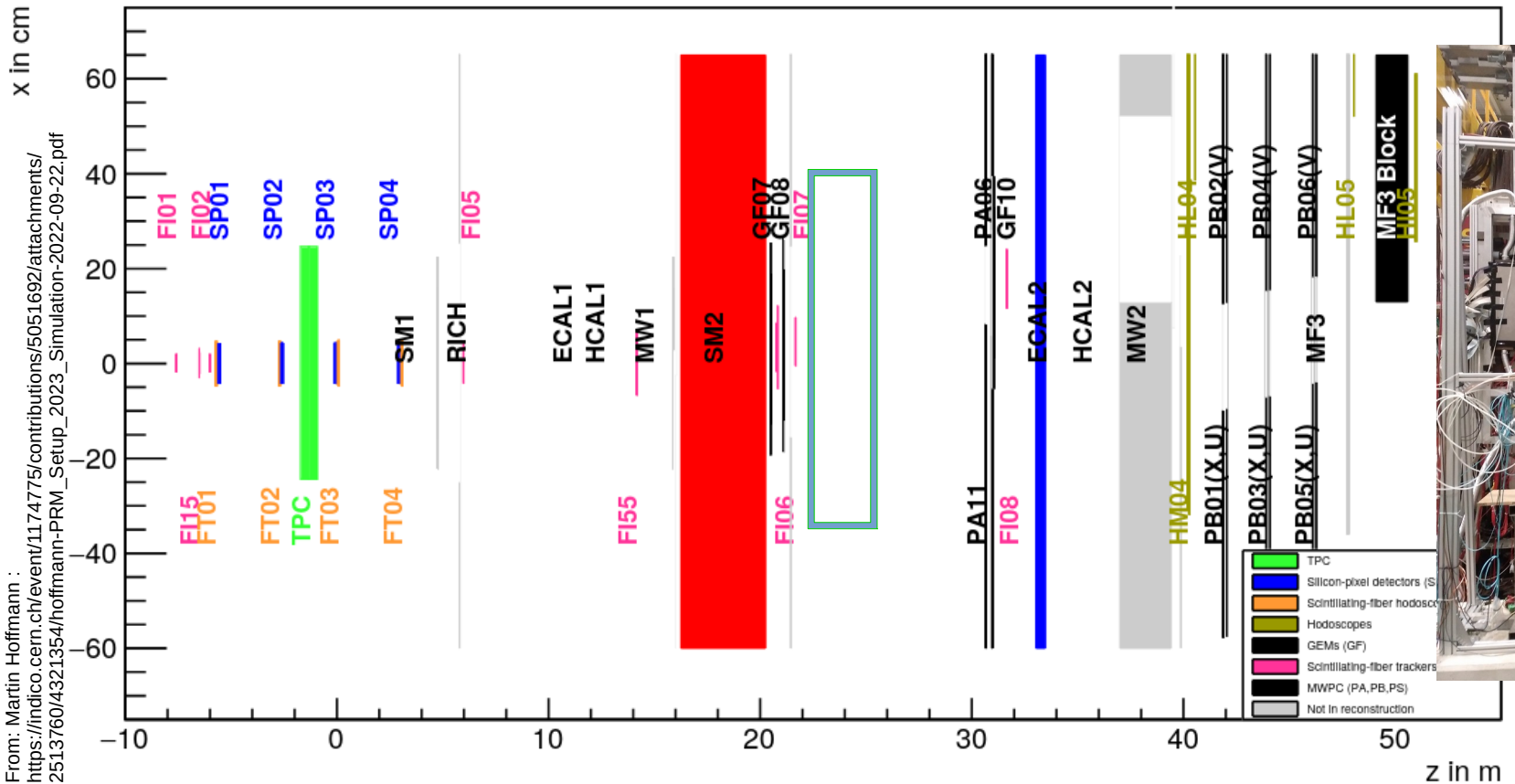
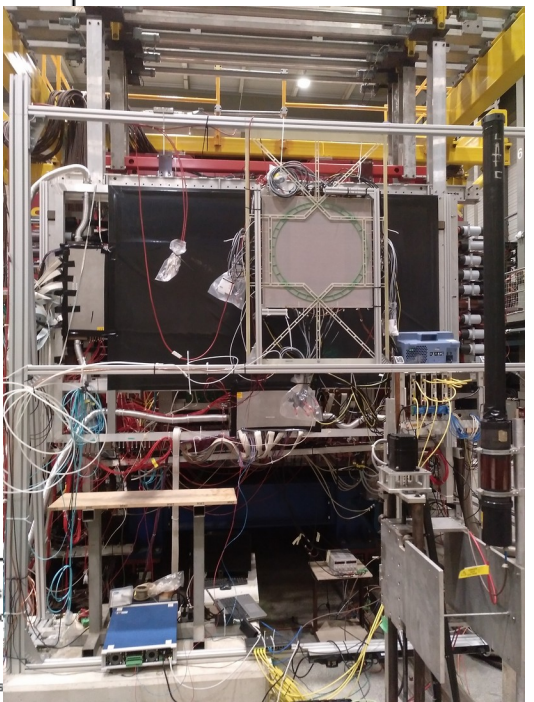
GEM UPGRADE – FINAL TESTING (APV)



[Courtesy D. Schaab]

PRM PILOT SETUP–VMM GEM POSITION



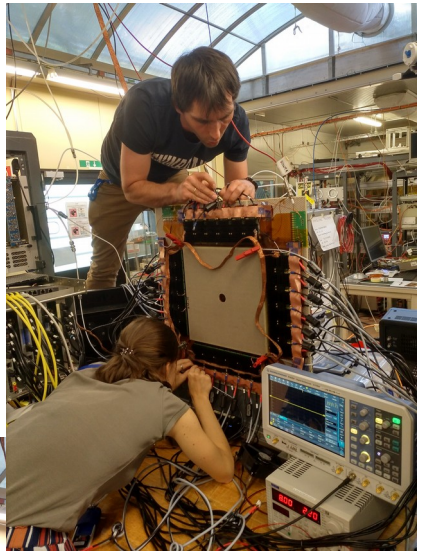


From: Martin Hoffmann :
https://indico.cern.ch/event/1174775/contributions/5051692/attachments/2513760/4321354/hoffmann-PRM_Setup_2023_Simulation-2022-09-22.pdf

INSTALLATION

From 7.-11. August by Virginia, Jan G., Karl, Pascal and Michael

7. August:
Travel, arrival to GDD lab,
8. August:
Equipping detector in GDD lab, first tests
9. August:
Noise reduction in GDD lab, ^{55}Fe spectrum
10. August:
Installation
11. August:
Installation, noise reduction, PC setup



Detector equipment with VMM electronics in GDD lab

INSTALLATION

From 7.-11. August by Virginia, Jan G., Karl, Pascal and Michael

7. August:
Travel, arrival to GDD lab,
8. August:
Equipping detector in GDD lab, first tests
9. August:
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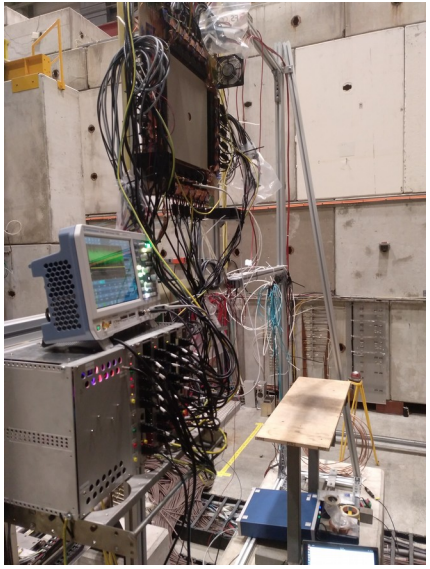
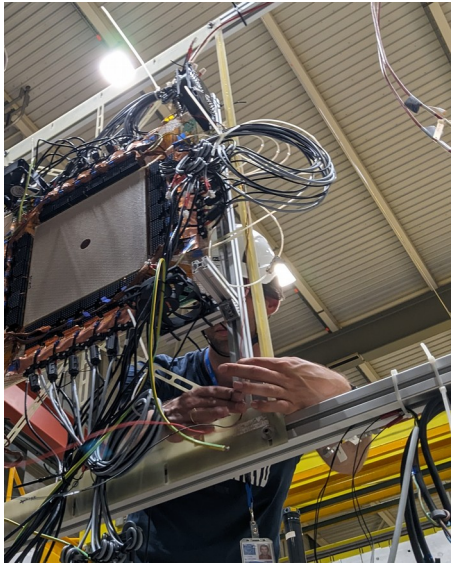




Detector equipment with VMM electronics in GDD lab

- Detector/Electronics much more noise than in GDD lab
- Spikes seen in hall, when HV connected. Comes via HV GND. Not seen in GDD lab

NOISE REDUCTION, PC SETUP

After Installation 1: Karl installed noise filter on HV line

- Reduced spikes from $\approx$ 100 mV to $\approx$ 70 mV
- Baseline RMS not much reduced

From 5.-7. September by Karl and Michael
5. September: Travel, RD51 test beam experience from Karl, noise reduction
6. September: Spike identification, noise reduction
7. September: PC setup, threshold equalisation, detector ready for beam

INSTALLATION 2 - A

Artifact on oscilloscope?
No! Difference can also be seen when data is acquired.

- Noise free data taking, when no spikes on screen (probe GND connected)
- Much noise, when disconnecting probe GND

Disconnecting both probe GND and BNC cable

- Noise free data taking
- Both probe GND and BNC cable connected gives very slightly less noise in DAQ

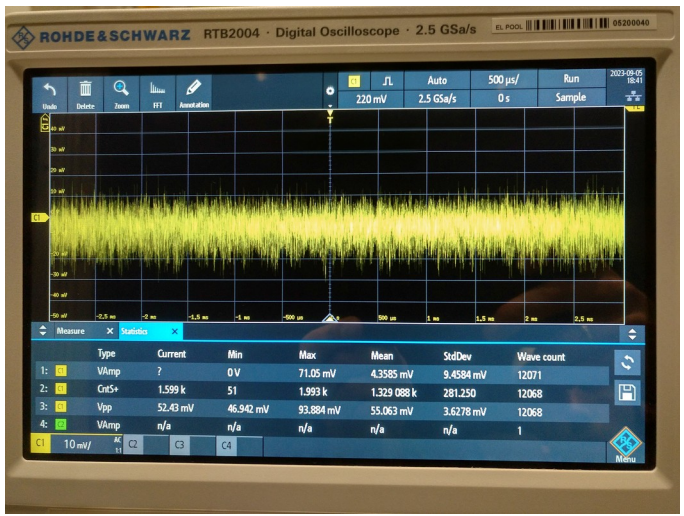
Disconnecting HV also removes spikes
⇒ Connecting both HV and oscilloscope GND closes a GND loop !?
⇒ Why connecting a second GND between osci and Detector resolves the issue, Spikes only disappear completely, when probe GND connected at specific point

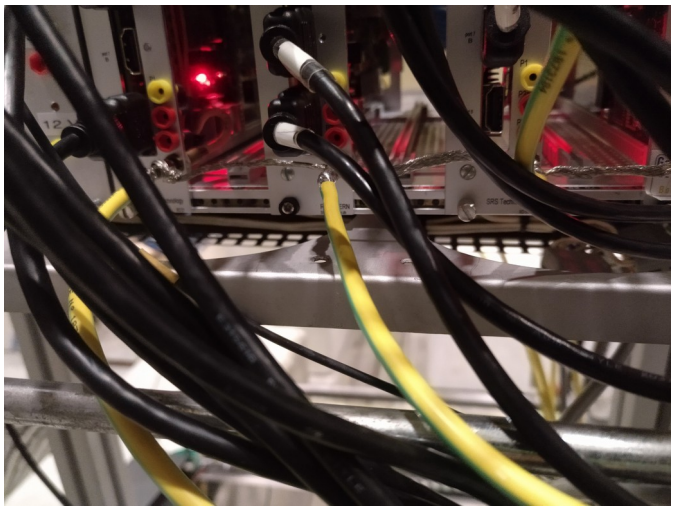
⇒ Solution: Disconnect oscilloscope (would anyhow have been done), best unsolder BNC cable on hybrid

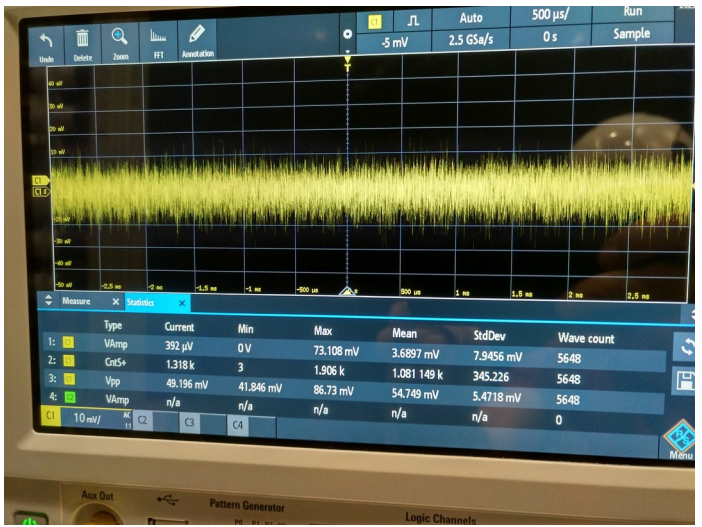
INSTALLATION 2 - A

For further investigations on general noise: need oscilloscope
⇒ connect both BNC and probe GND

Find noise reduction possibilities –> Better GND interconnection between SRS cards





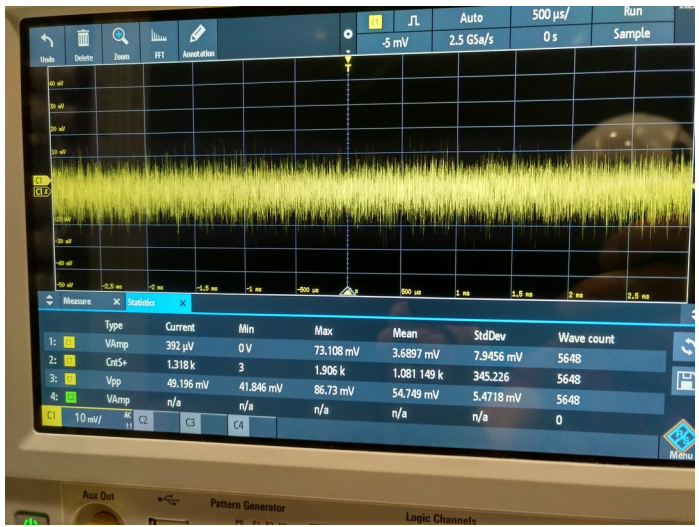


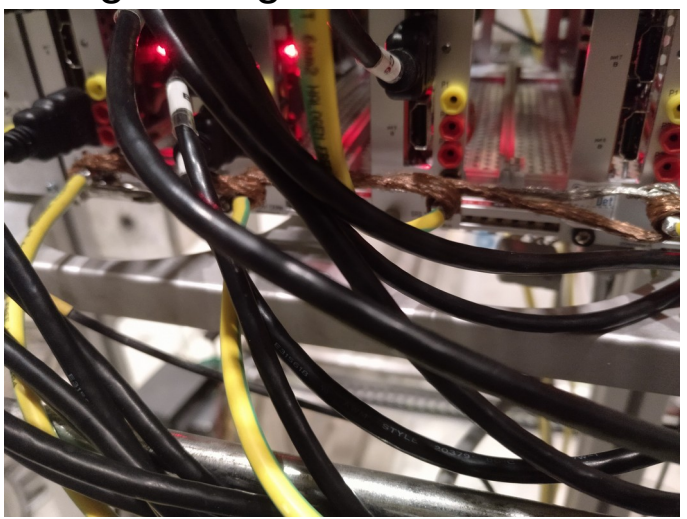
INSTALLATION 2 - A

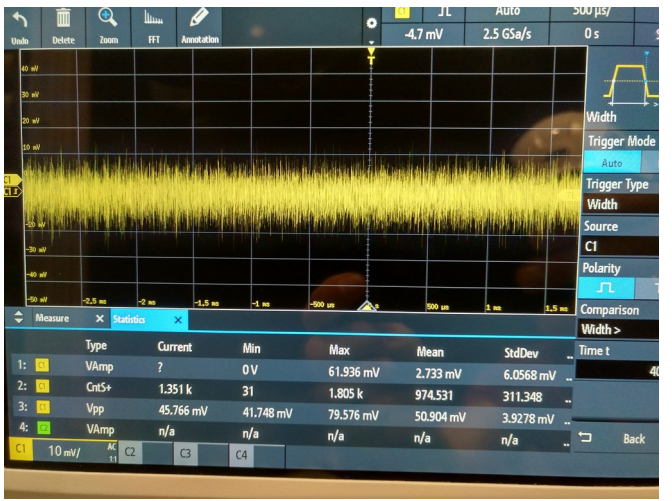
For further investigations on general noise: need oscilloscope
⇒ connect both BNC and probe GND

Find noise reduction possibilities –> Better GND connection SRS ↔ detector

+ tightening GND screws





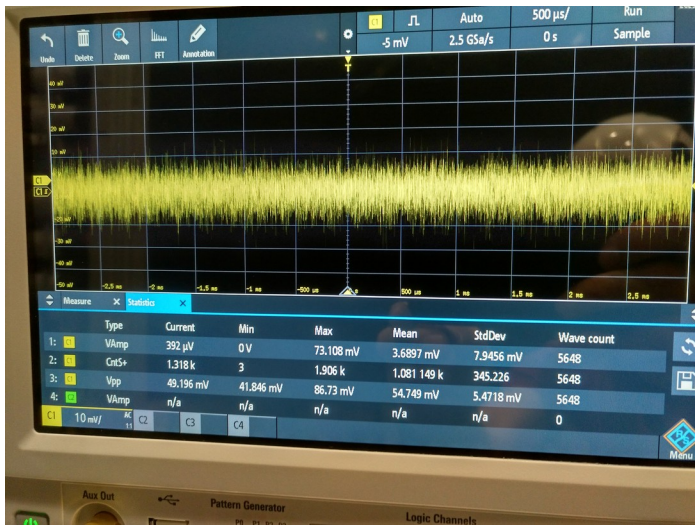


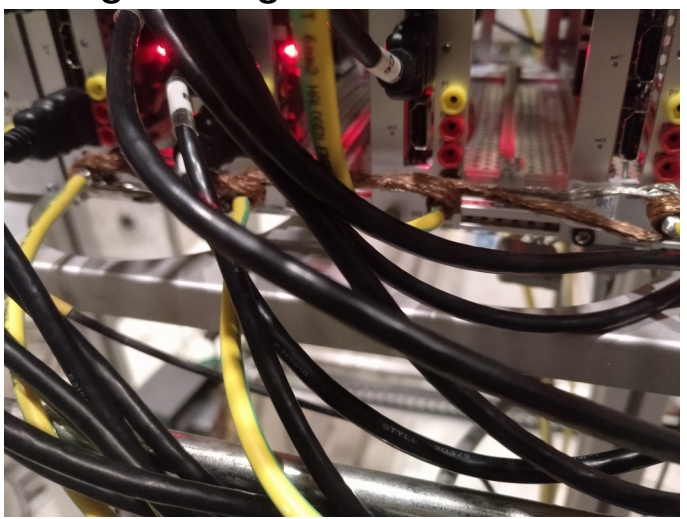
INSTALLATION 2 - A

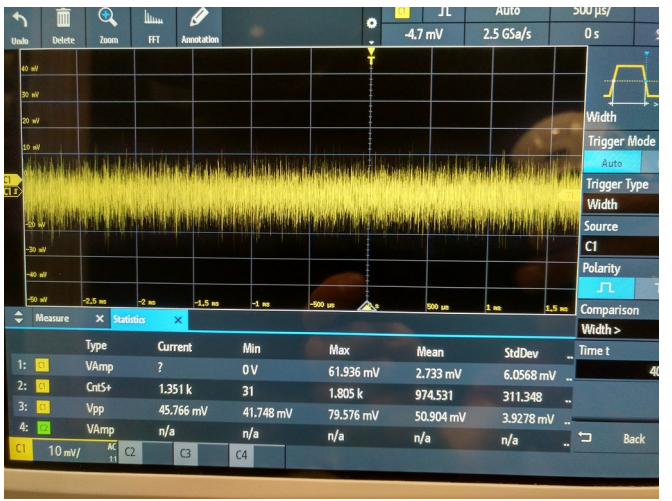
For further investigations on general noise: need oscilloscope
⇒ connect both BNC and probe GND

Find noise reduction possibilities –> Better GND connection SRS ↔ detector

+ tightening GND screws



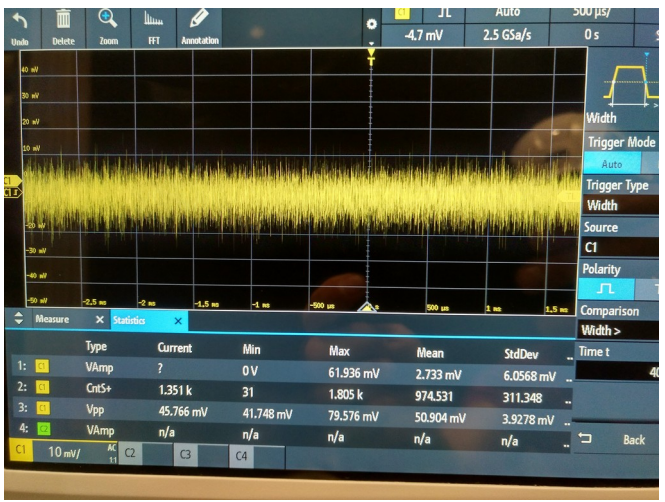


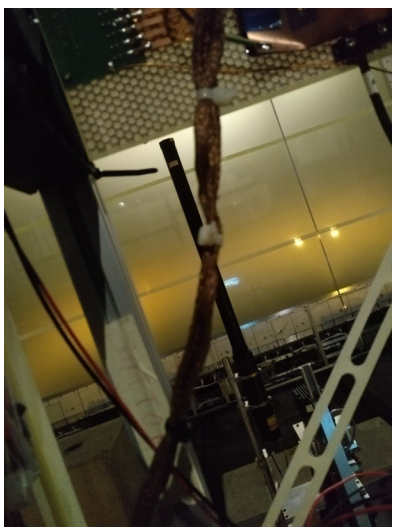


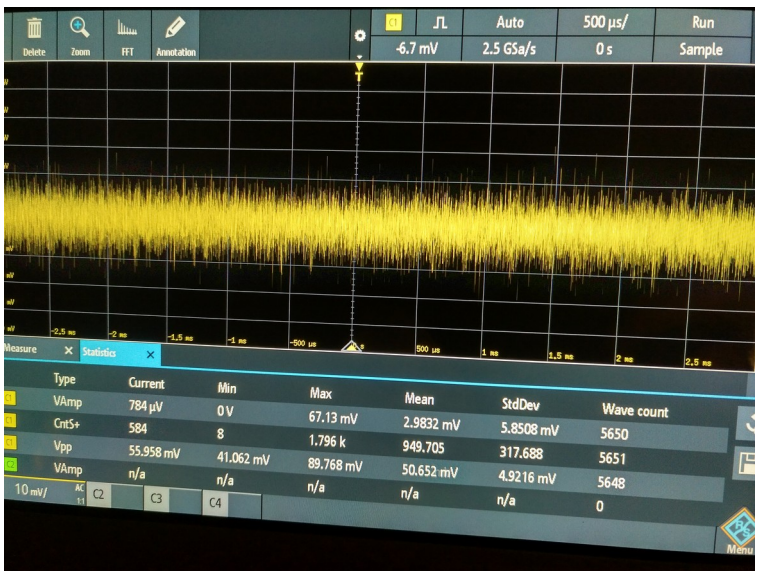
INSTALLATION 2 - A

For further investigations on general noise: need oscilloscope
⇒ connect both BNC and probe GND

Find noise reduction possibilities –> Closing GND loops in cables and on detector
+ many many small things







INSTALLATION 2 - B

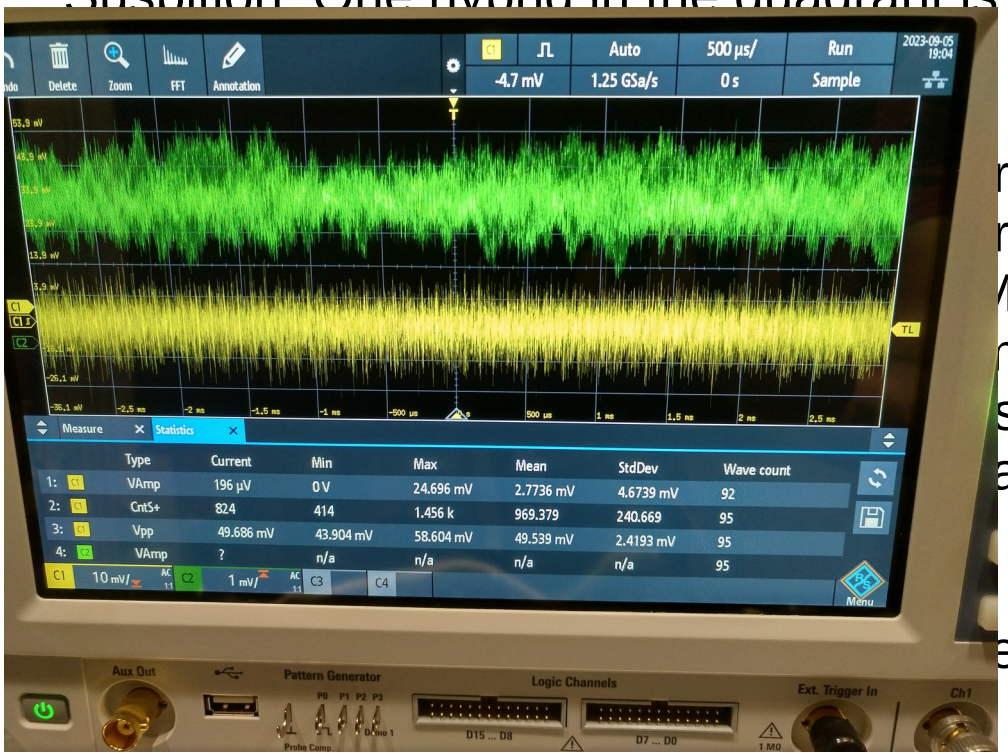
Suspicion: One hybrid in the quadrant is not correctly powered and «swings»
Coupling to others via crossed strips

→ removing one after the other hybrid from detector → seems to be gradual effect
→ removing one after the other hybrid from SRS DVMM → gradual effect
→ check power to hybrids → P2 (for VMMs) a bit low for FEC 2 → increasing
⇒ gets a bit better, but not removed completely
→ interchanging HDMI cables of hybrids on SRS DVMM to other cards
→ noisy sector gone, but increase spread over full detector
→ exchanging DVMM of FEC 2 (thanks to Karl/GDD for lending the DVMM)

⇒ noisy sector gone + noise of whole detector decreased

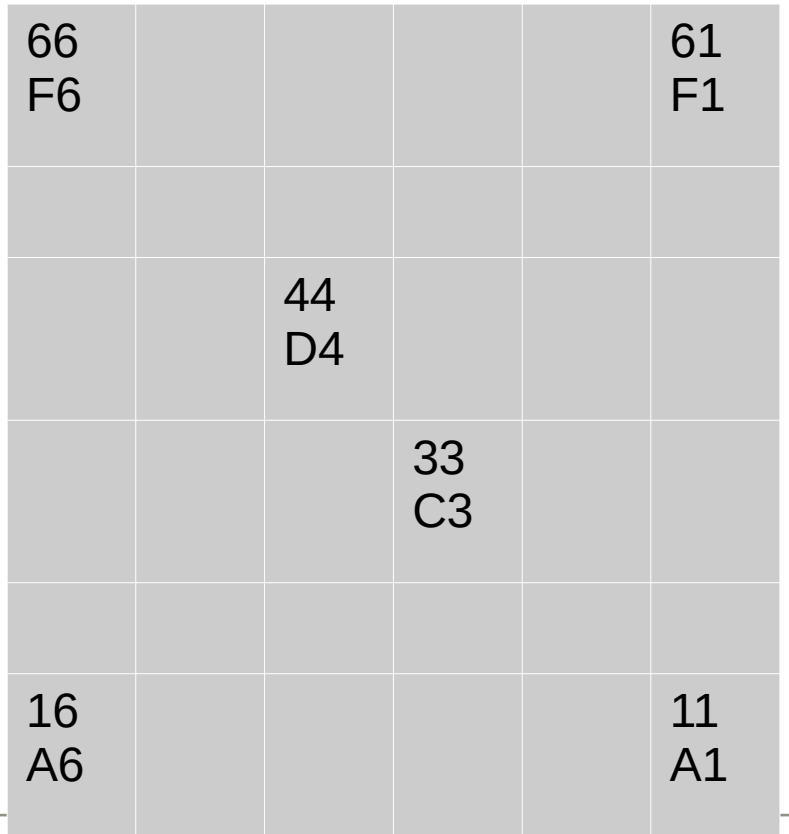
INSTALLATION 2 - B

Suspition: One hybrid in the quadrant is not correctly powered and «swings»



DATA EVALUATION

Detector configuration and comparison to Jan’s notation from the lab

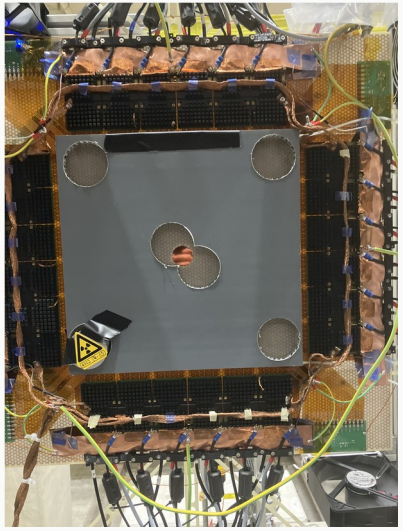


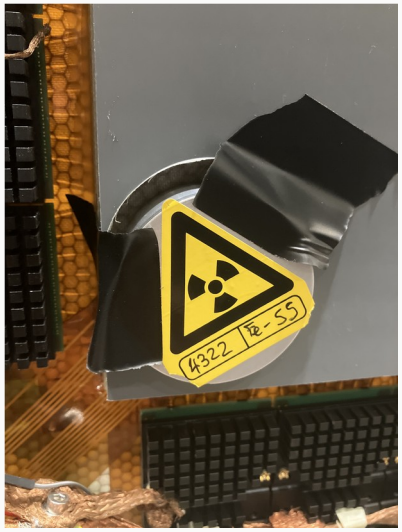
Gas in
Design: gas out

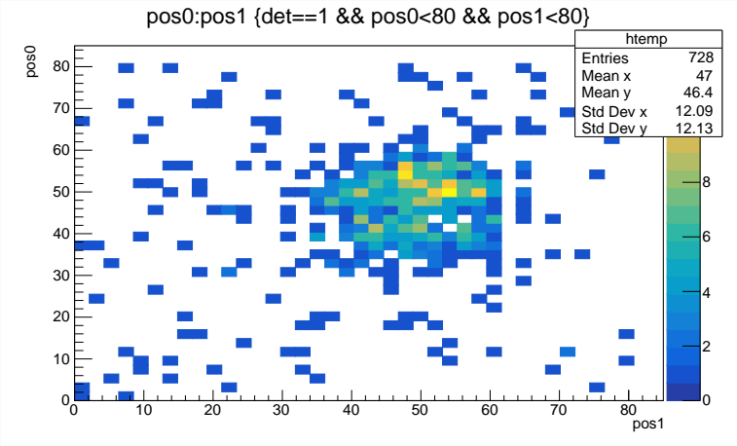
Gas out
Design: gas in

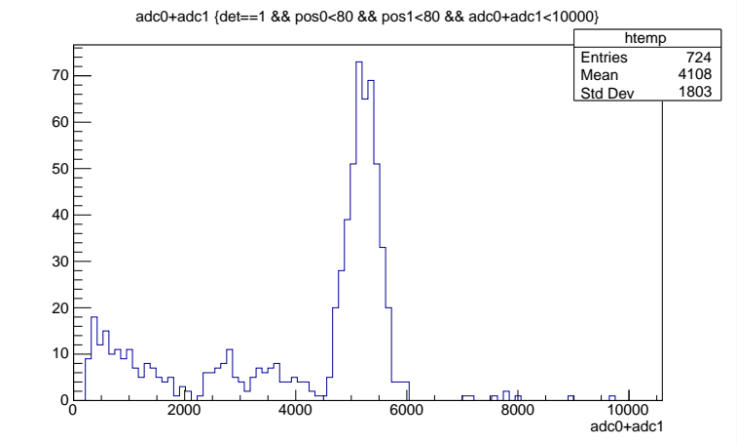
SOURCE HOLDER

Source holder prepared by Karl Flöthner and Miranda van Stenis









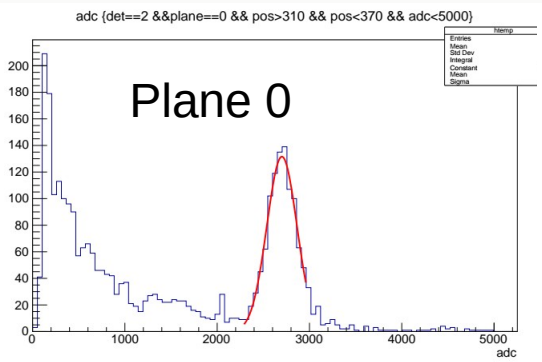
Tested with 5 minutes exposure, worked ok

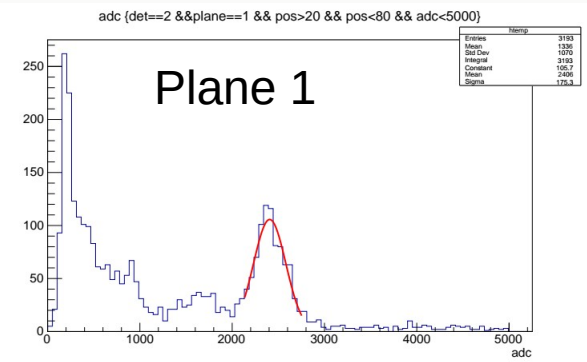
- Need ~5-10 minutes exposure per position
- Reduce number of positions due to time limitations
- Hot spot included

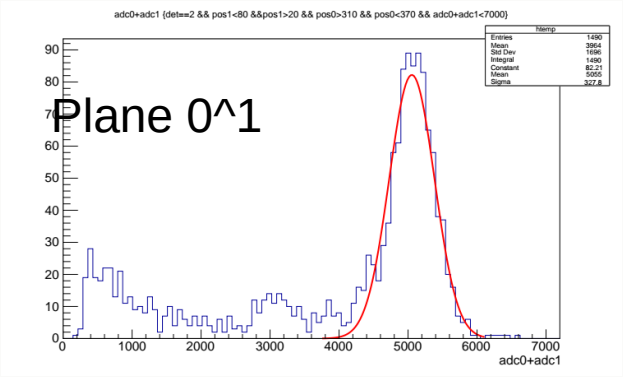
DATA EVALUATION

Loose-cut reco for cluster in plane 0/1 and detector, look at ADC spectra
Restricted to source position, gaus tip fit to photo peak

Pos 66 10 min.					Pos 61 10 min.
		Pos 44 5 min.			
			Pos 33 5 min.		
Pos 16 10 min.					Pos 11 10 min.







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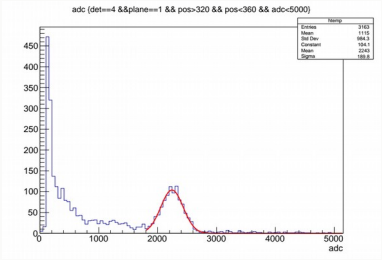
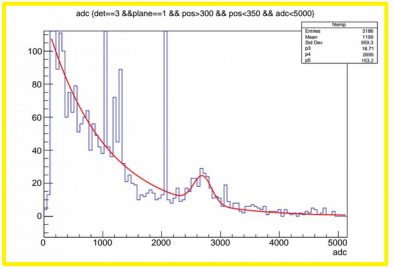
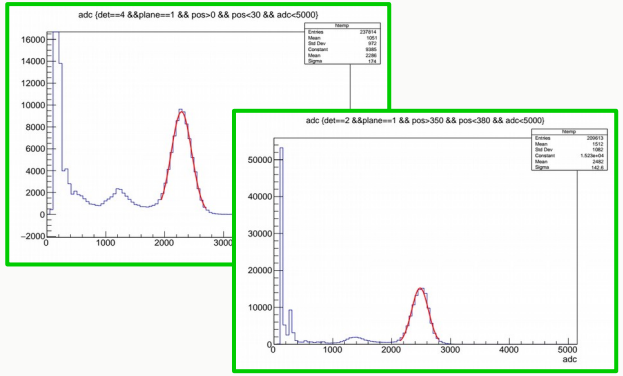
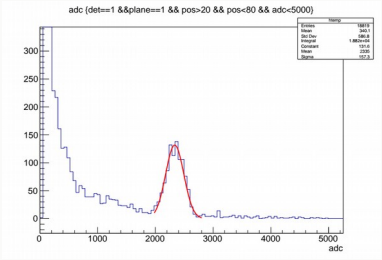
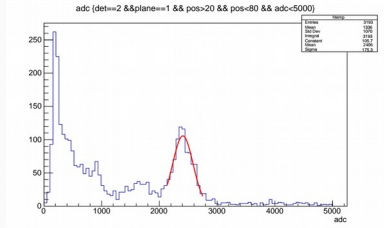
DATA EVALUATION – PLANE 1



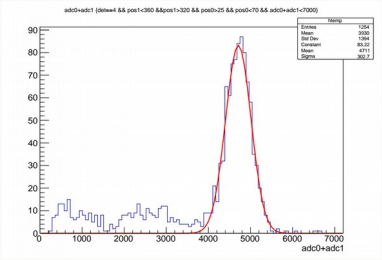


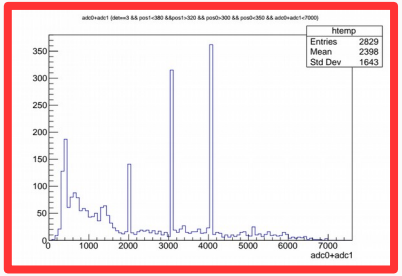


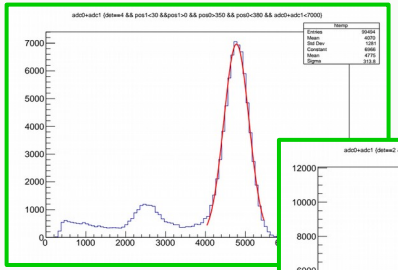


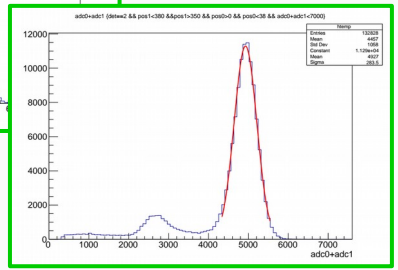


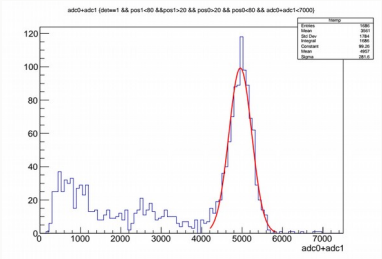
DATA EVALUATION – PLANE 0^1

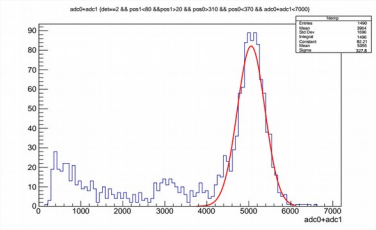












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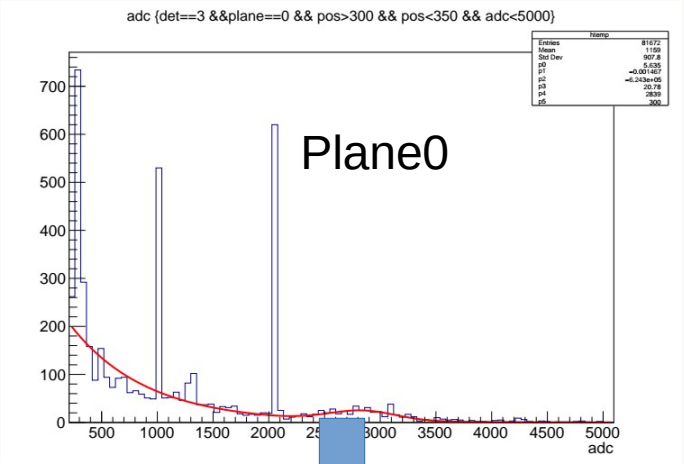
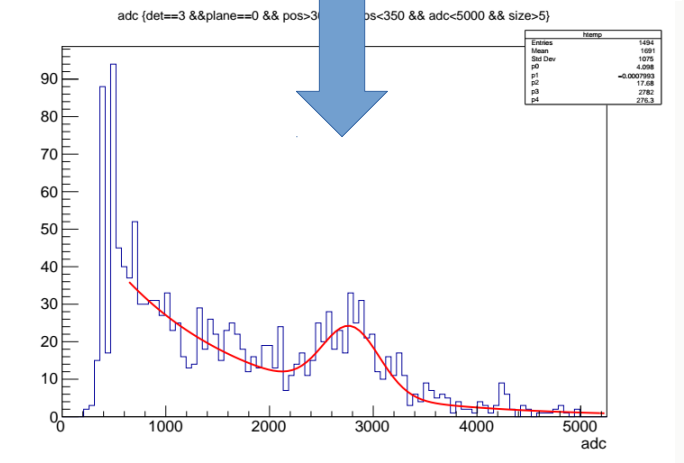
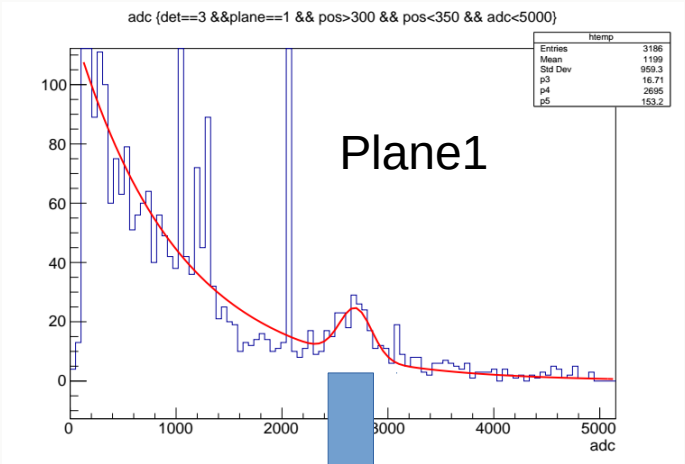
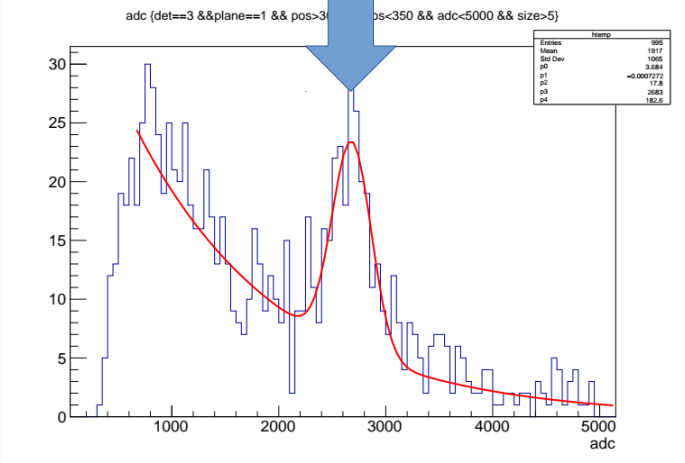
SIZE CUT IMPACT ON POSITION 61

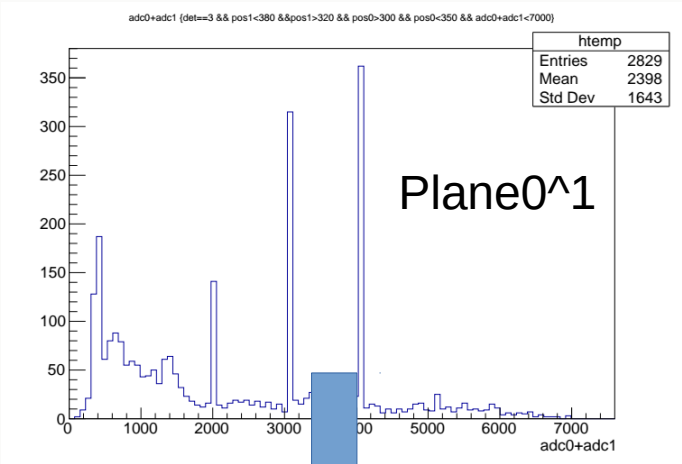
Slightly harder cuts on cluster size

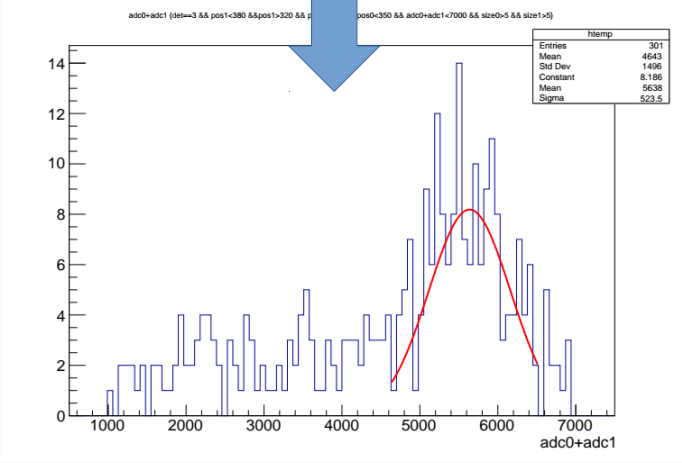




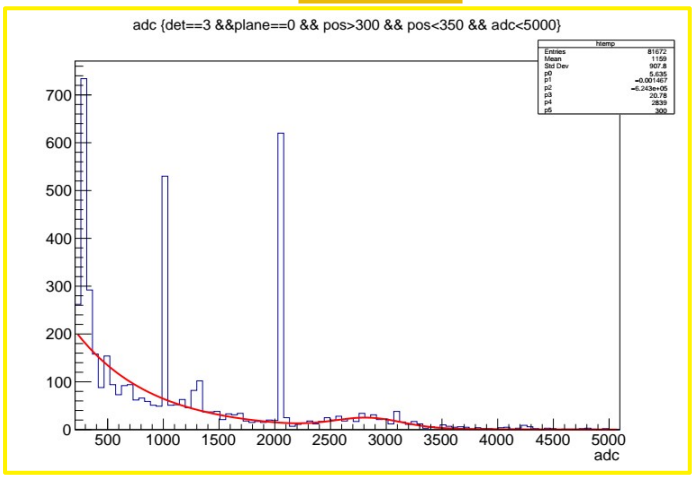


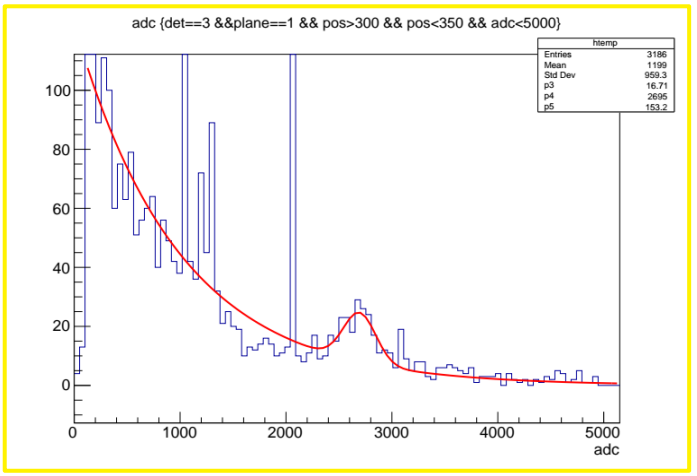


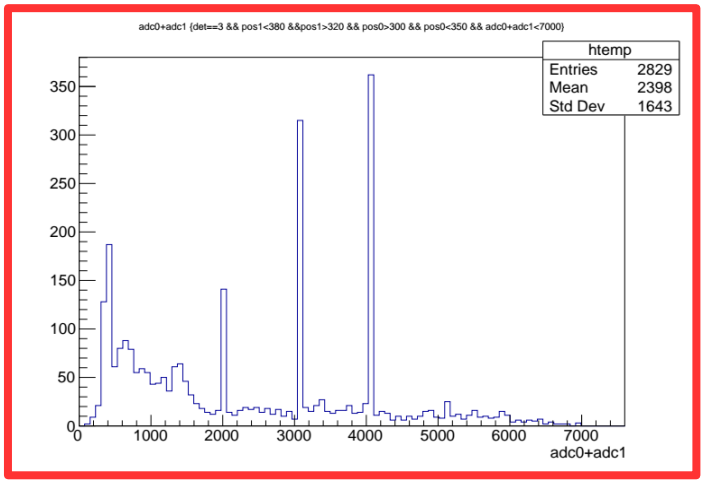




DATA EVALUATION – POSITION 61



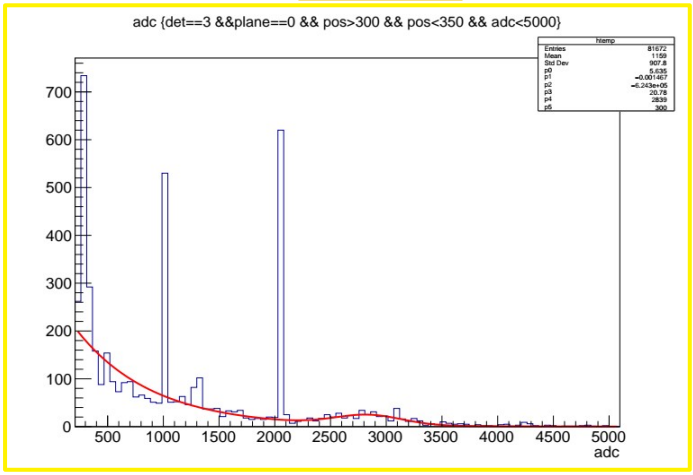


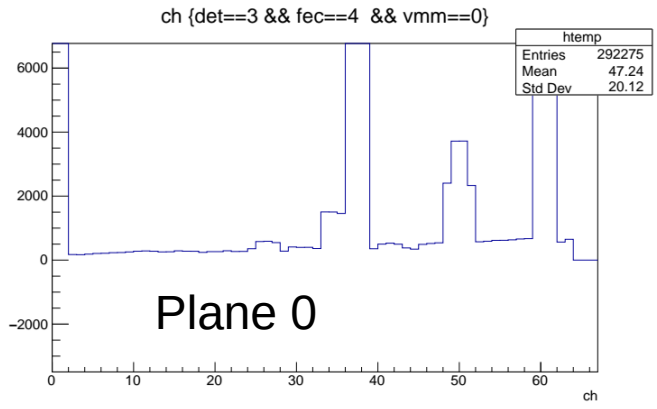


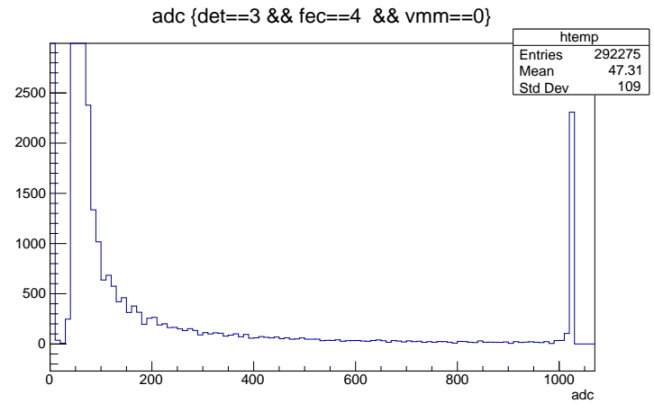
Observation: many noise hits, spikes at multiples of 1024

Noise: yes, there are some noisy channels, prominent at low source rate
Spikes: saturation? → look at hit ADC

DATA EVALUATION – POSITION 61

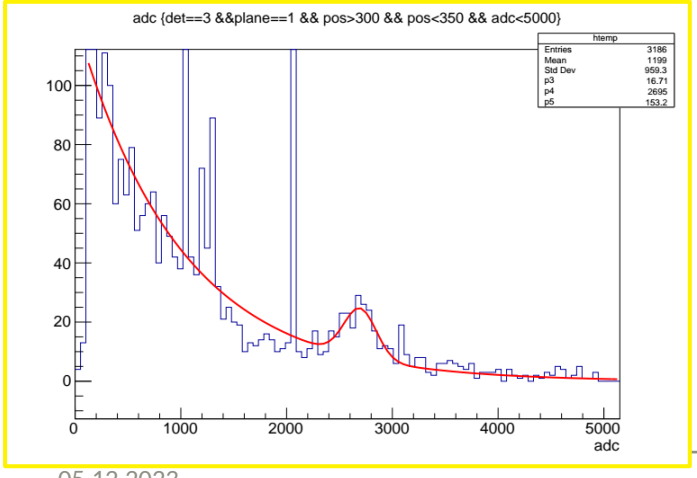


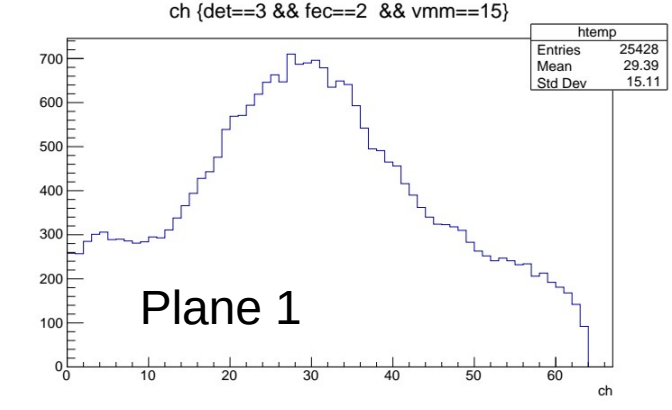


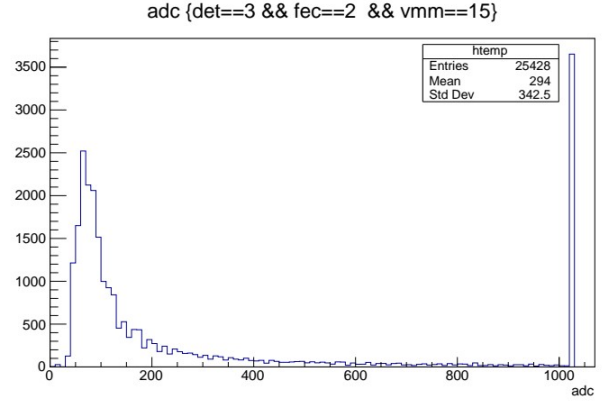


Plane 0: few very noisy channels+neighbors, source profile hidden

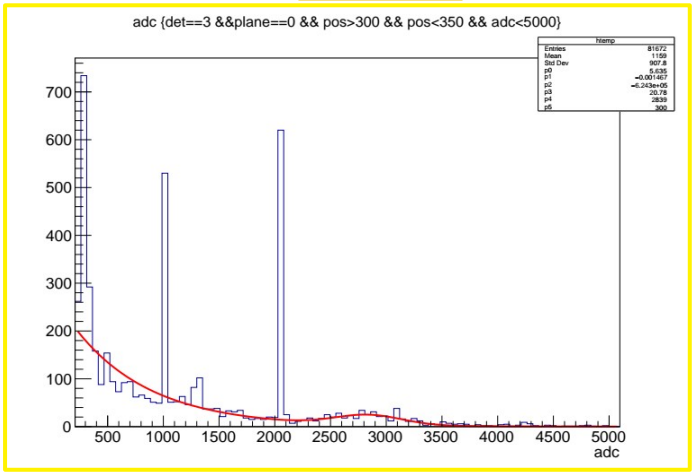
Plane 1: profile ok, even more channels in saturation than plane 0

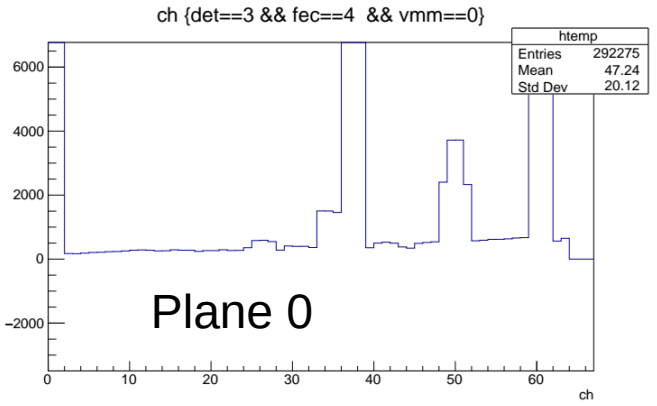


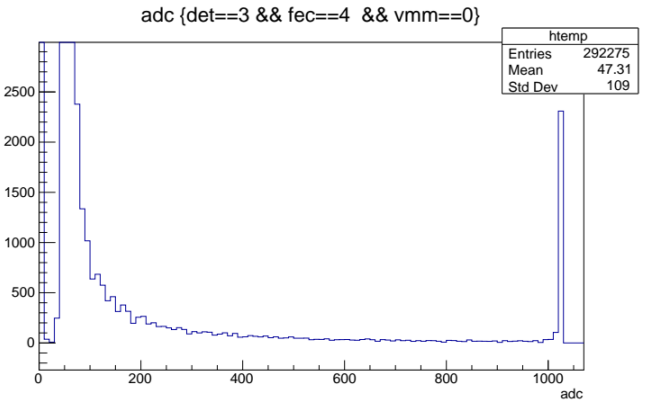




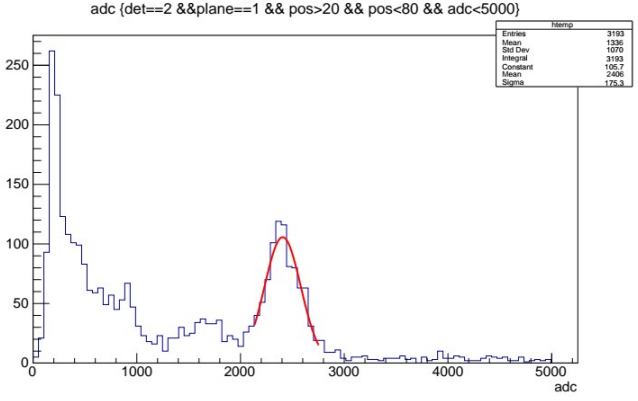
COMPARISON – POSITION 61 - 11

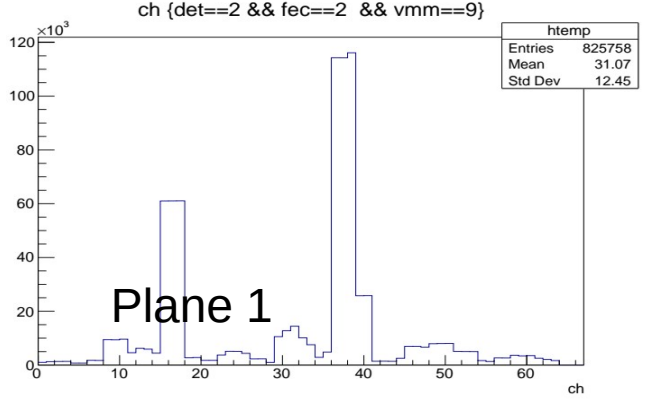


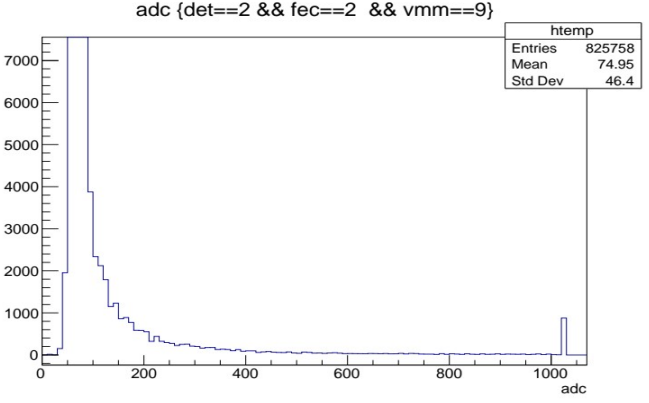




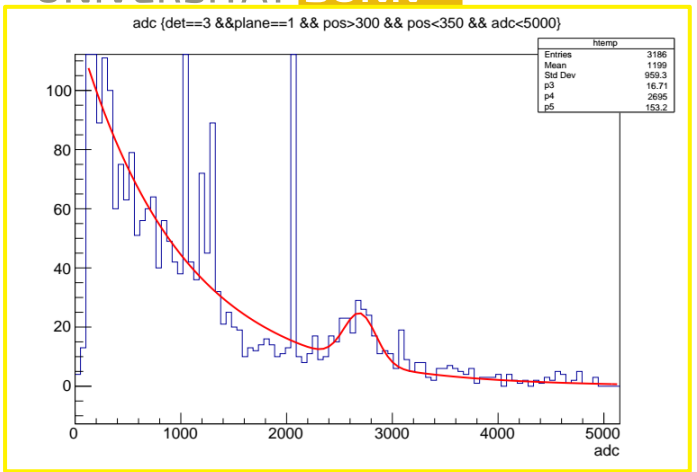
Plane 0 at 61 profile similar to Plane 1 at 11: Only half amount of channels in saturation in same time, spectrum ok

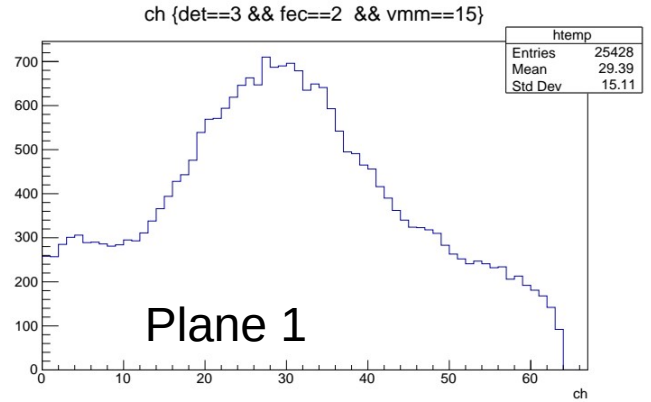


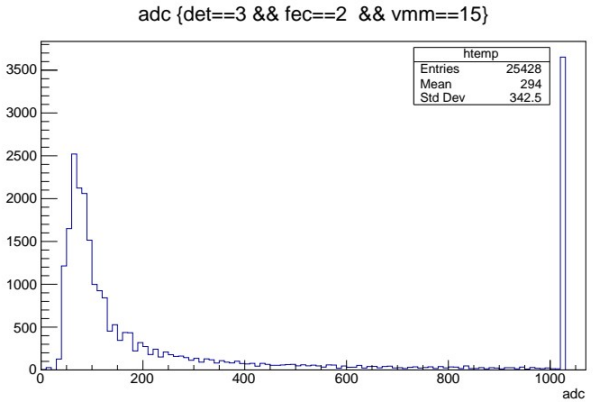




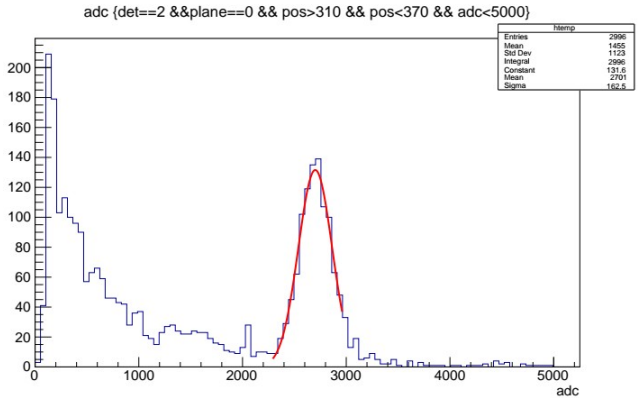
COMPARISON – POSITION 61 - 11

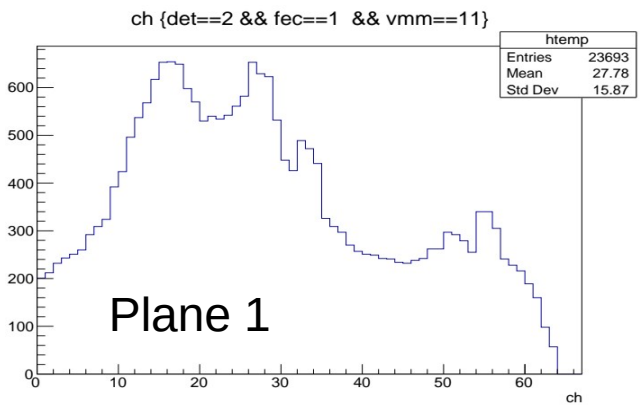


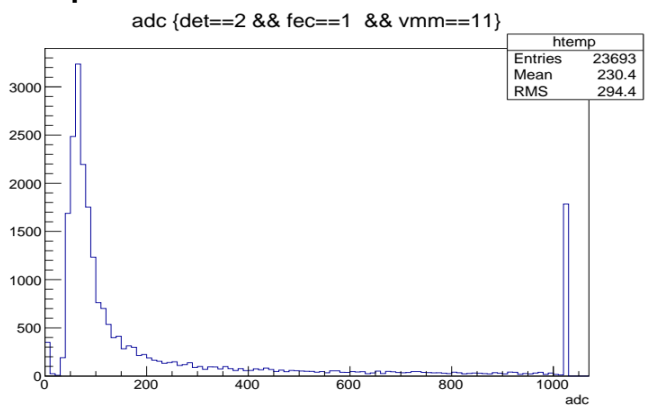




Plane 1 at 61 profile similar to Plane 0 at 11: < half amount of channels in saturation in same time, spectrum ok

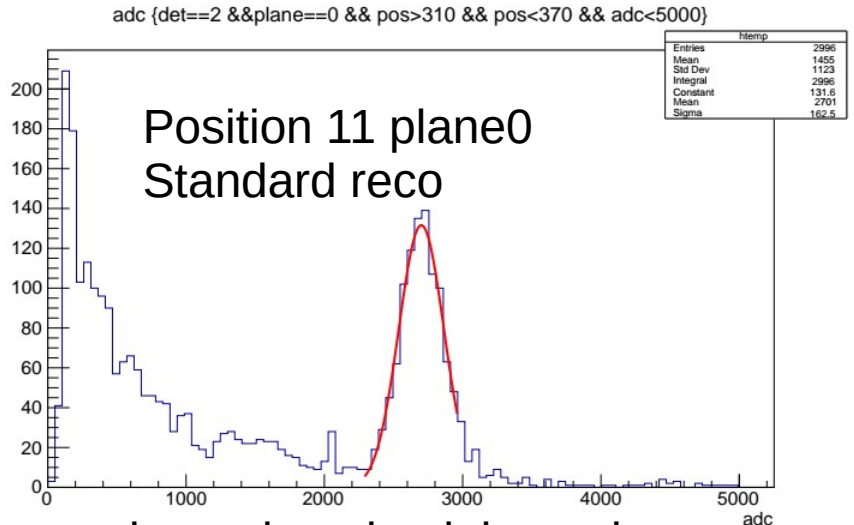


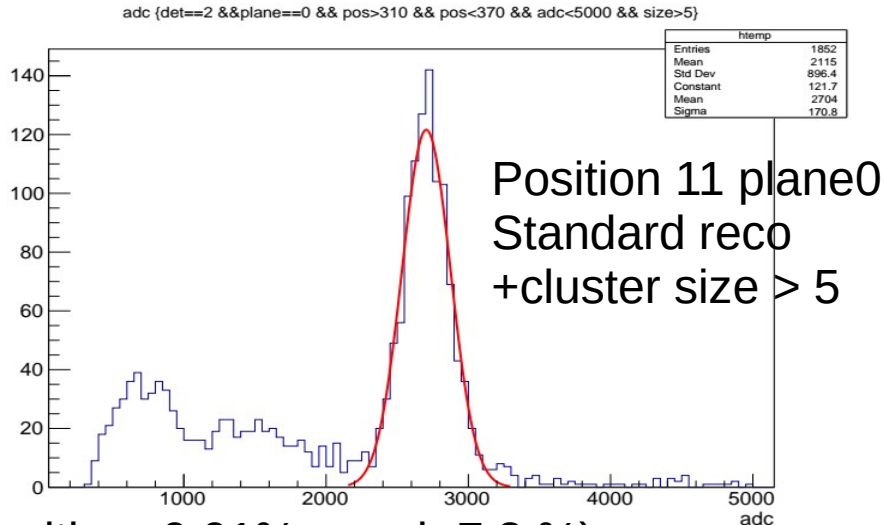




SUSPENSIONS, CHECK OF CUT

Position 61 looks like too noisy – could be misleading due to low source rate
More channels in saturation compared to other positions
- Spikes from HV line? Would not lead to saturation, but much noise, many coinc. channels
- Corrupted data? Seen for high noise channels, could be saturation → 1 hit +2 neighbors
=> more stringent cut on cluster size (was 1 => all hits taken) to 5
=> should not affect photo peak, expect large clusters for Fe55 (check → yes around 8)





=> noise reduced, minimum impact on photopeak (position -0.01%, ampl -7.8 %)