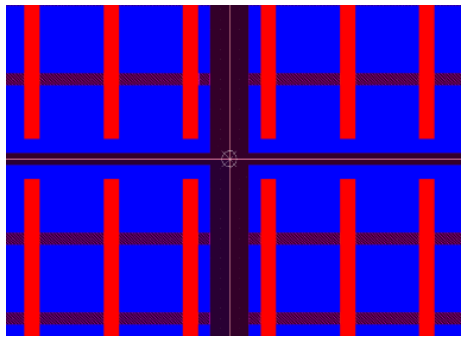
Status of the new GEM stations

Dmitri Schaab

19.07.2022

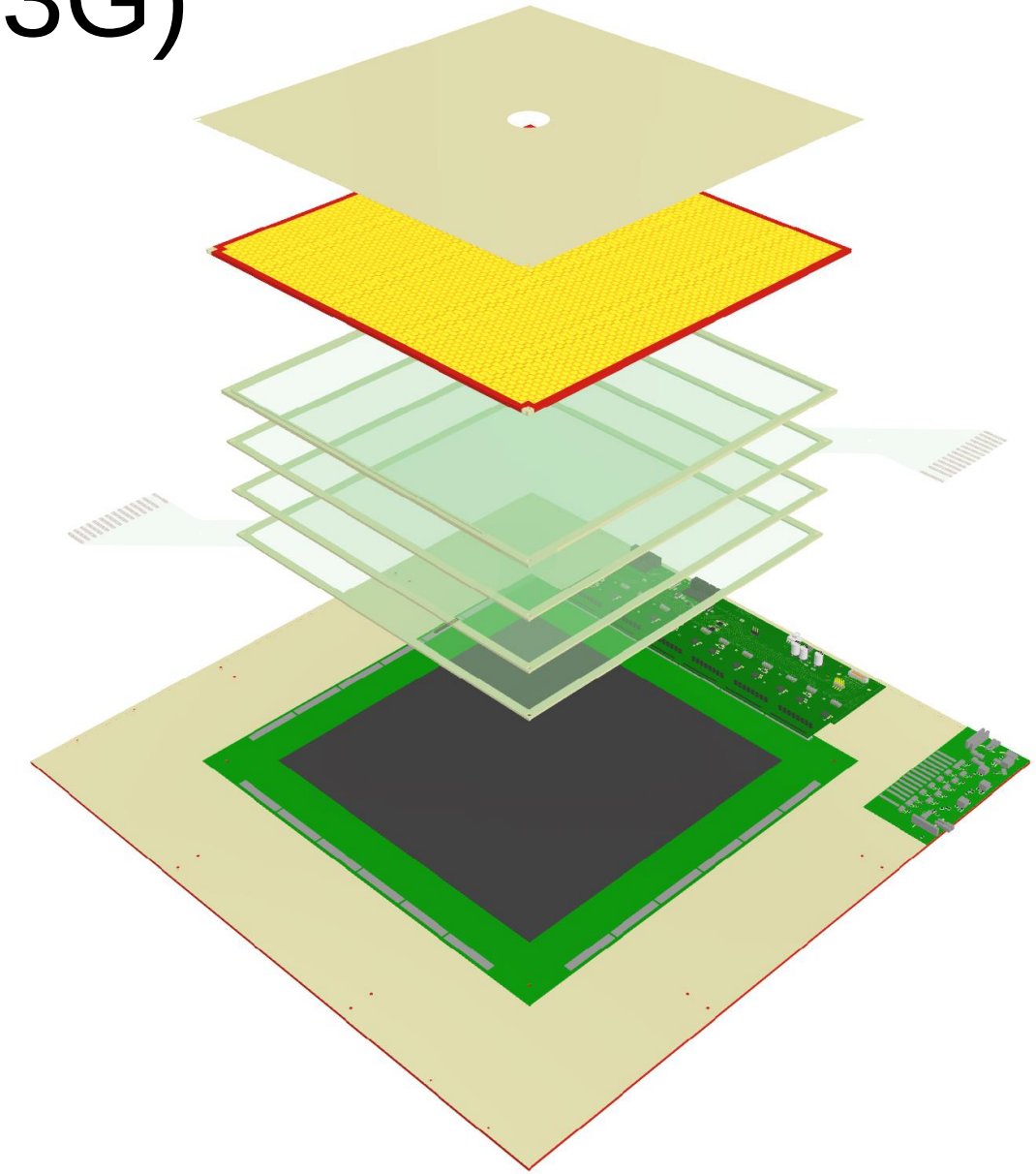
COMPASS GEM-3G (CG3G)

- Size of active area: 30.7 × 30.7 cm²
- Triple GEM
- Strips divided in center to reduce occupancy



On-detector electronics

- voltage divider (PVD): 3 +1 cards
- 6 × 4 = 24 APV front-end cards
- 4 supply cards (bus cards)



Status of detector production

	Support plates	Frames	Drift foil	GEM foils	Readout PCB	HV board	Assembly	Calibration	Installation
CG3G01	✓	✓	✓	✓	✓	**SVD**	✓	✓	**Prototype**
CG3G02	✓	✓	✓	✓	✓	**PVD**	✓	✓	**@GM11 test pos.**
CG3G03	✓	✓	✓	✓	✓	**PVD**	✓	✓	**@GM11 test pos.**
CG3G04	✓	✓	✓	✓	✓	**PVD 300µm**	✓	✓	
CG3G05	✓	✓	✓	✓	✓	**PVD 300µm**	✓	✓	

Assembly steps:
- QA: quality assurance
- G1, G2, G3: GEM i framed
- RO: R/O PCB glued
- D: drift foil glued
- S1, S2, S3: stack i glued
- DET: detector assembled
- GAS: gas pipes + tight
- HV: HV board assembled

Stations in question be replaced for 2022: GM05, GM08, GM04

test positions: @GM11 | between GM09 and GM10

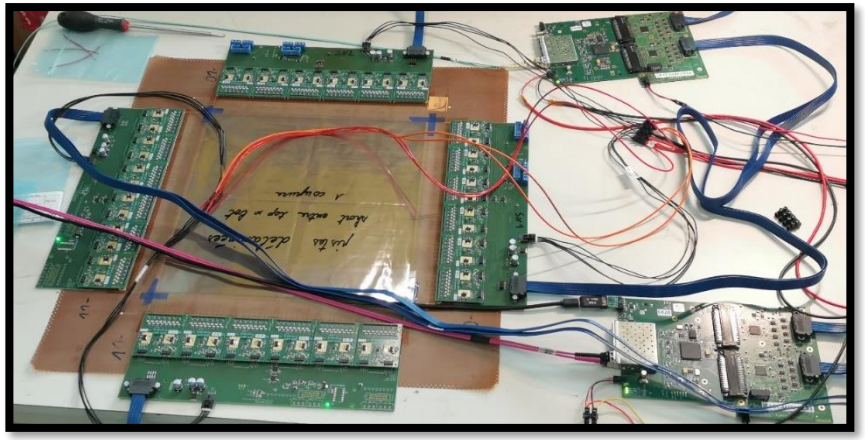
1. Station

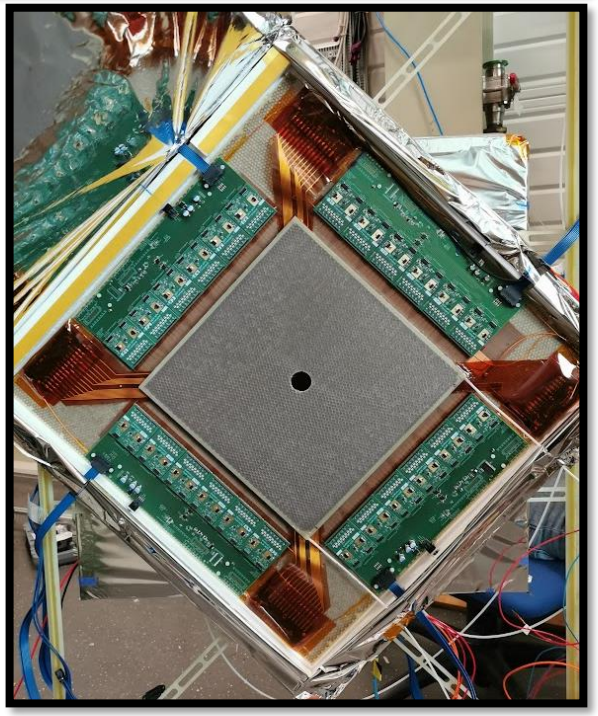
R/O electronics / DAQ tests

- initial tests w/ detector dummy (just r/o foil) @clean area
  - fully assembled with electronics

    → 24 APVs, 4 SupplyCards, 2x(TDC+ADC), 1MUX
  - integrated to standalone DAQ (V. Frolov)
  - connection to all APVs established (V. Frolov)
    - APVs send data on trigger signal
    - signal polarity issue solved on FPGA firmware

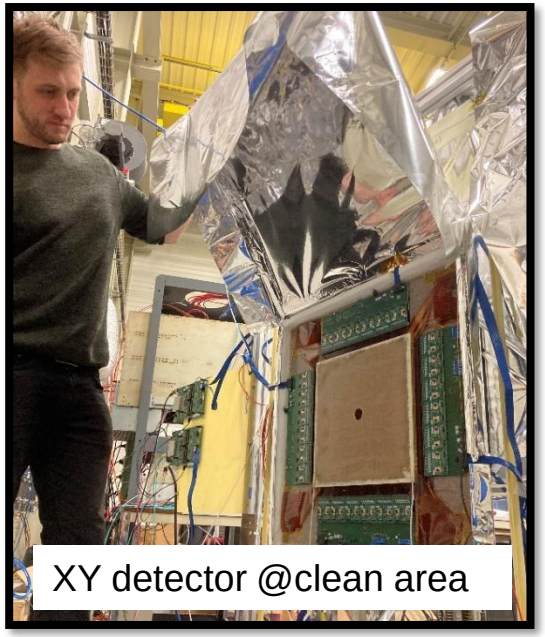
      (S. Huber / I. Konorov)
- tests w/ CG3G detectors @clean area
  - communication tested / data rate confirmed
  - power consumption checked after `LOAD` command
    - ➢ ~5A per detector (3.3V APV supply)

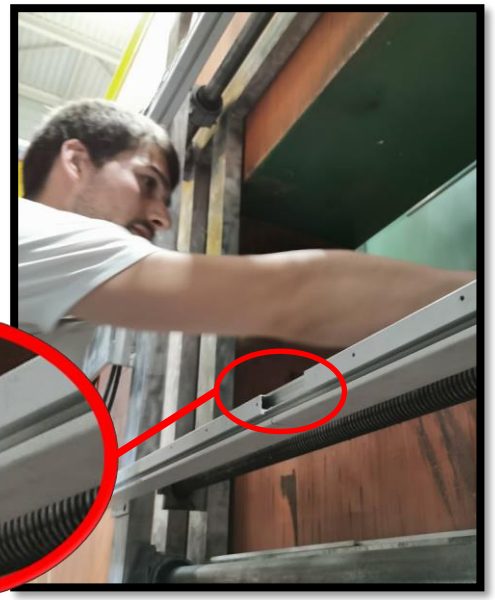




Installation

- preparation @Bonn
  - detector mechanics
  - detector electronics
  - cables: HV / Data
  - APV functionality test
- preparation while @CERN
  - cables/cable trees: LV (ADC/TDC, SupplyCards)
  - thread adaptors M3-M4 for mounting frame
  - detector shielding
    - shielding foil: aluminized PET-foil (“Mylar”)
    - ROHACELL (solid foam) frame
- installation
  - @GM11 position
  - due to bigger dimensions of shielding frame
    - GM11 mounting structure does not fit
    - UV detector installed downstream(!)
    - **holding structure to be adopted**

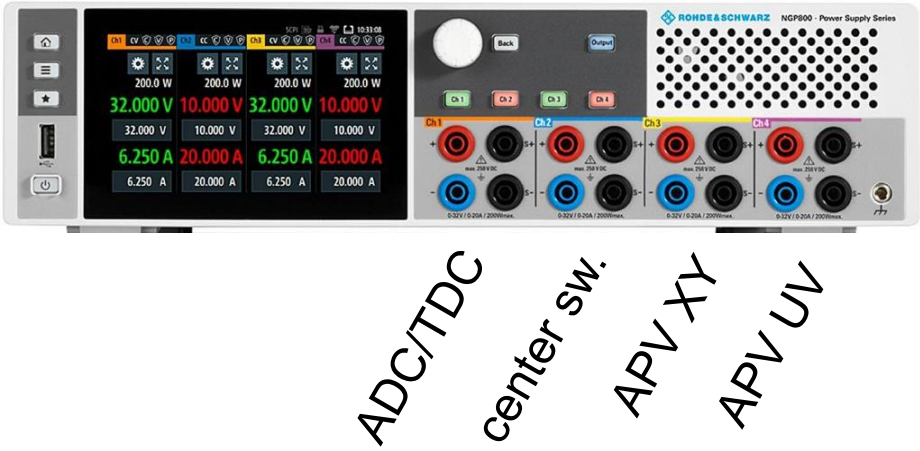

XY detector @clean area




1st station @GM11 pos.

Low voltage / center segment control

- Low Voltage R&S NGP800
  - one module (4ch) – supplying full station …
    - 1 ch: 4 ADC/TDC-cards
    - 2 ch: 2 detectors (8 SupplyCards/48APVs)
    - 1 ch: 2 center segment controls (**new**)
  - **issue with OVP** when sense wires connected
    - ➢ solved by firmware update (Karl/Christophe)
  - integrated to DCS (Karl/Christophe)



- center seg. switch box / ETH484-modules replaced by …
  - single Bourndy connector
  - remote control via NGP800 CH2 – in DCS

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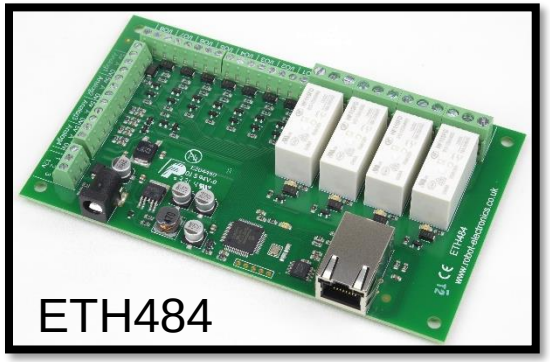
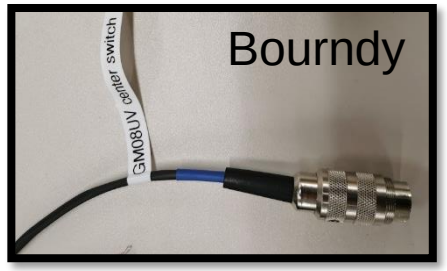
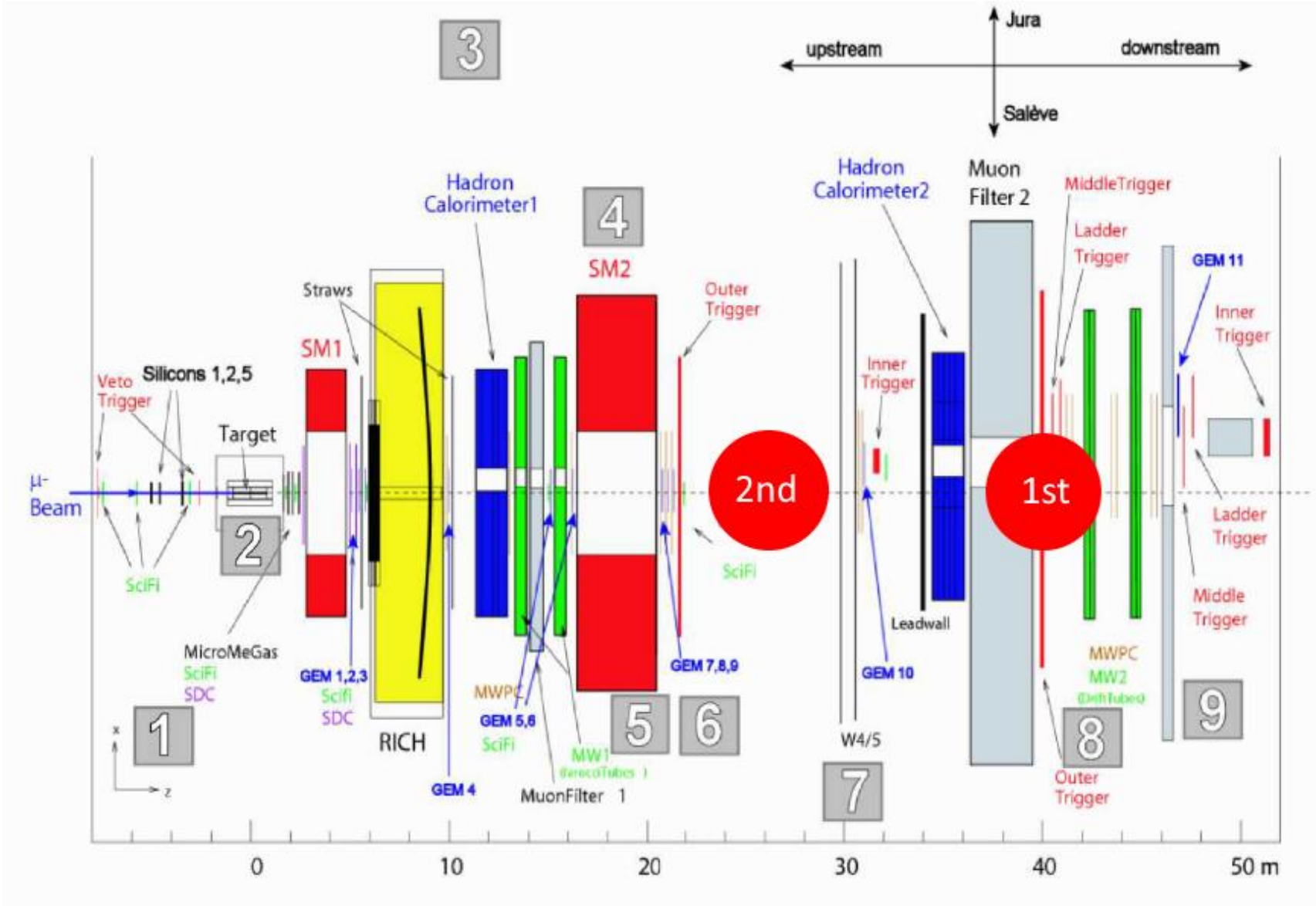
+





+

Test positions

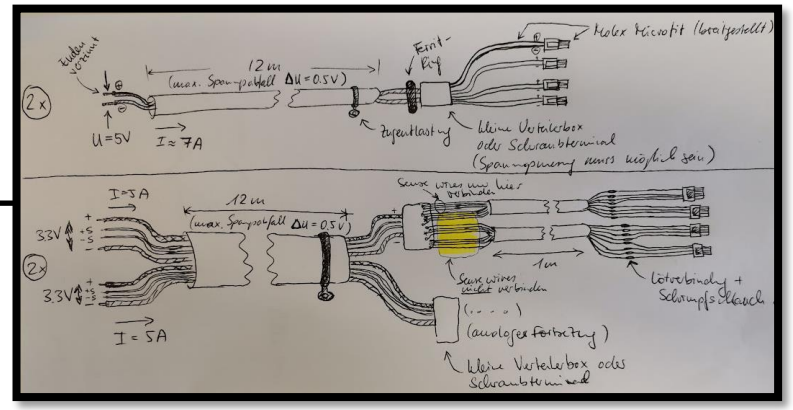


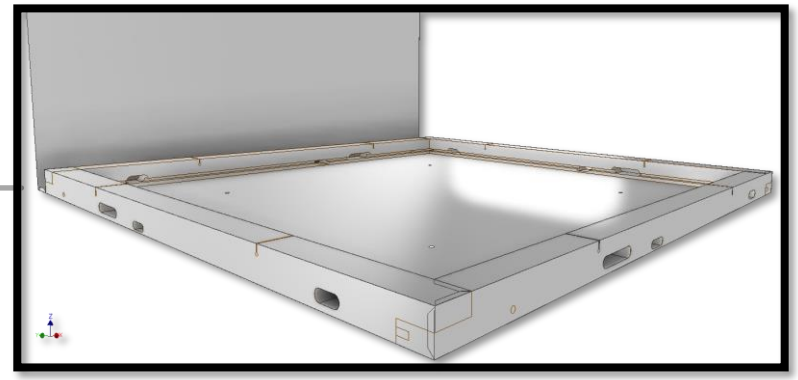
2. Station

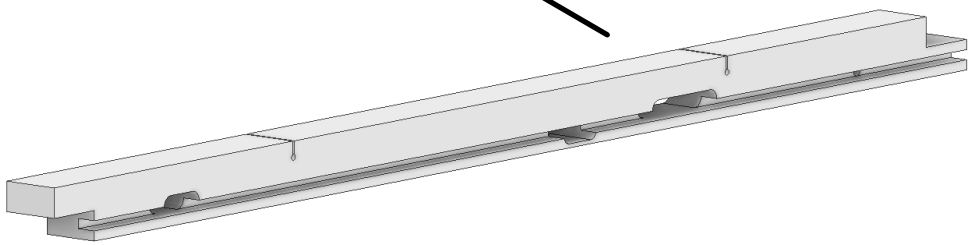
Optimization – 2nd station

preparation @CERN → **preparation @Bonn**

- cables/cable trees: LV (ADC/TDC, SupplyCards)
  - ➢ cable trees ordered at local e-workshop
- thread adaptors M3-M4 for mounting frame
  - ➢ manufactured by local workshop
- detector shielding
  - shielding foil: aluminized PET-foil (“Mylar”)
    - ➢ designed → laser cut / ext. company
  - ROHACELL (solid foam) frame
    - ➢ in progress – local workshop

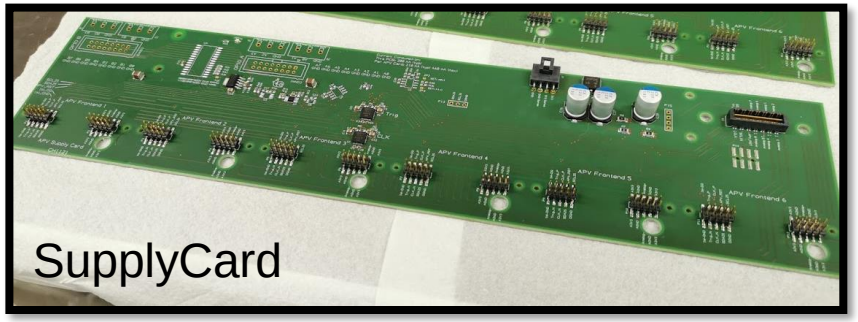


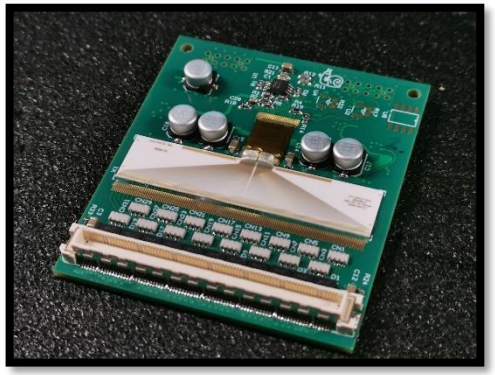


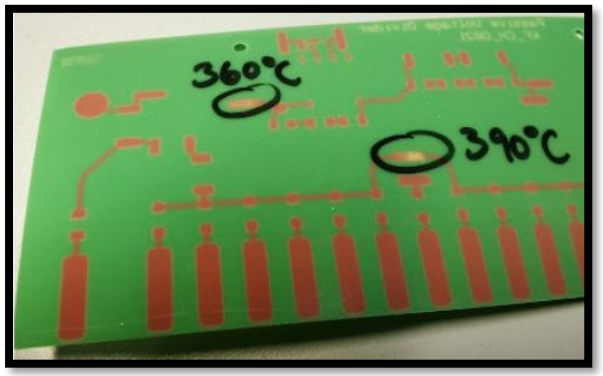


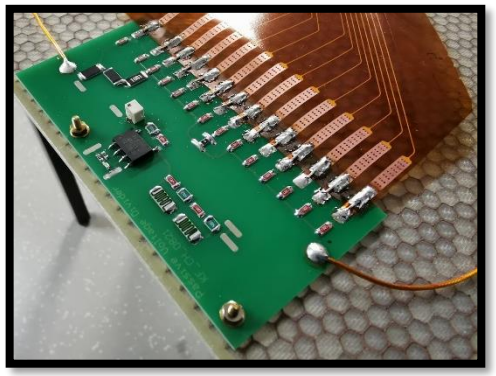
Electronics – 2nd station

- SupplyCards
  - ready for 2nd station (except 0.15Ohms res.)
- APV boards
  - except for APV chip – fully assembled
  - bonding of APVs ongoing
    - amount > 10 ready (~40 missing)
    - bonding priorization for ATLAS
    - ➢ hard to get time estimation ~ mid/end August
- voltage divider (PVD)
  - material budget: 300µm PVD boards (1.6mm for 1st)
  - mechanical instabilities noticed (J. Paschek)
    - ➢ partial delamination of tracks after soldering
    - ➢ electric instabilities at measurements


SupplyCard


APV card




300µm PVD delamination

Data acquisition (GM11)

Mapping

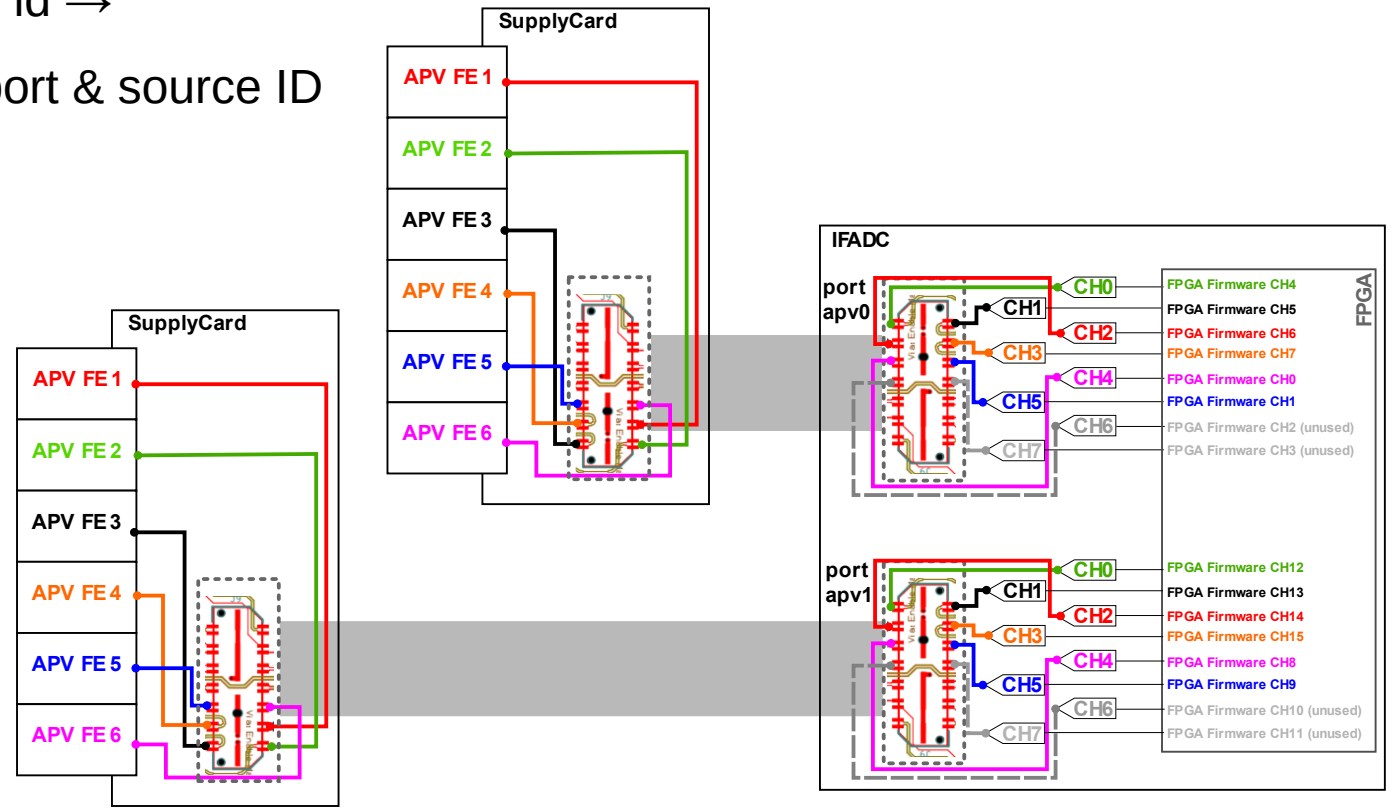
electronics mapping

- APV → connector pin → ADC input ch → FPGA firmware ch

geographic mapping

- geographic location / orientation → APV id →

  ADC port & FPGA firmware ch & MUX port & source ID



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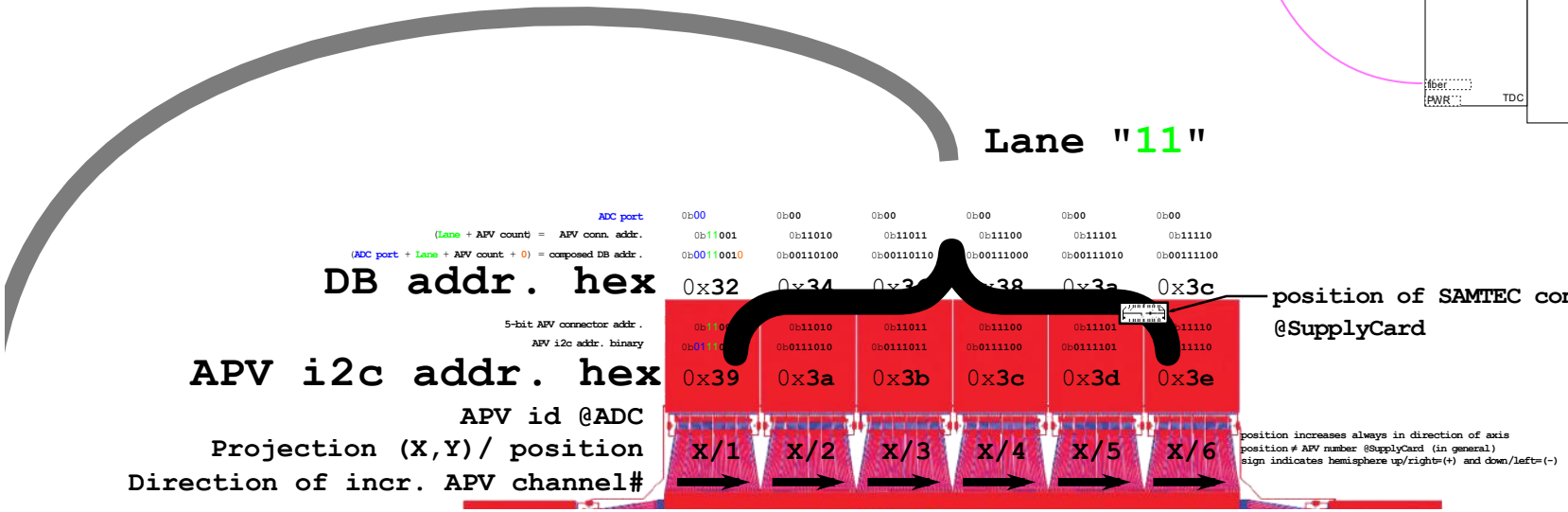
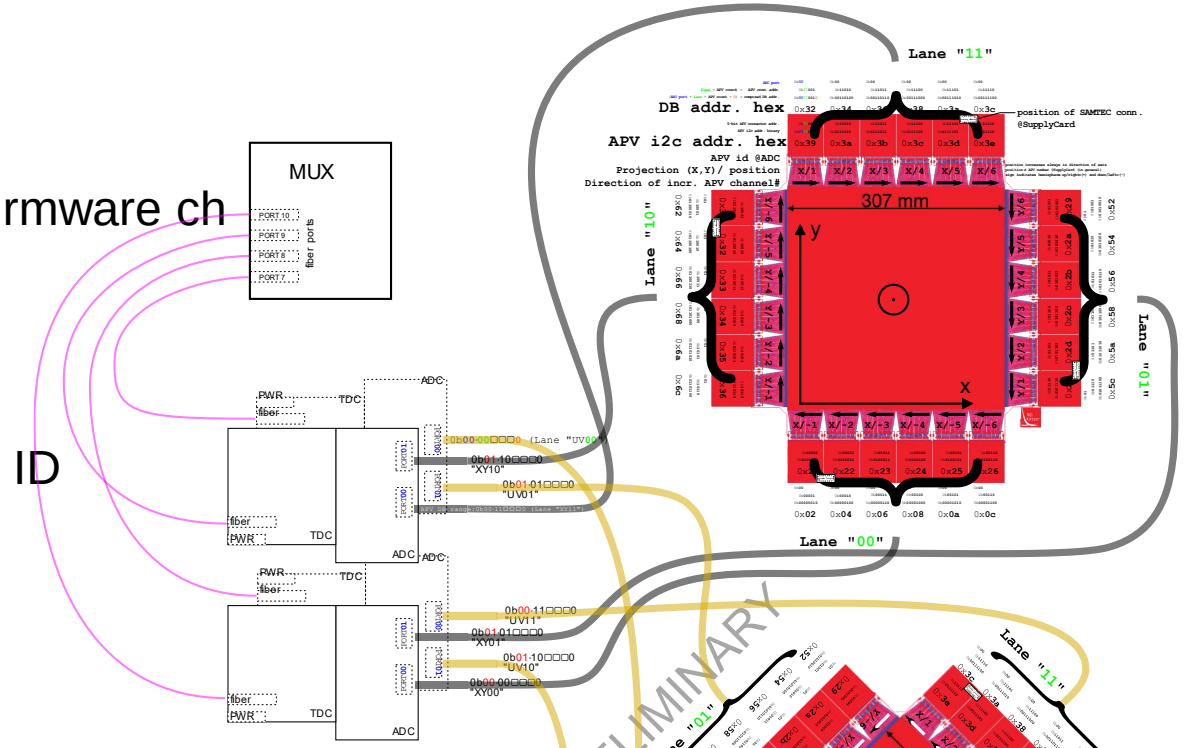
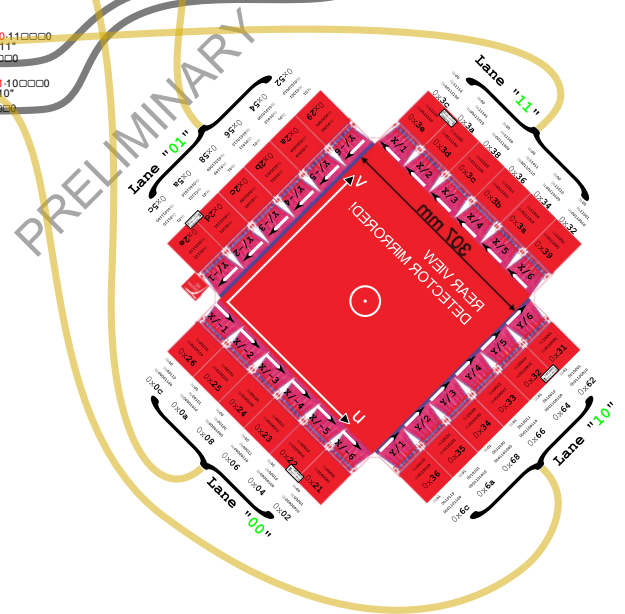
  ADC port | FPGA firmware ch | MUX port | source ID

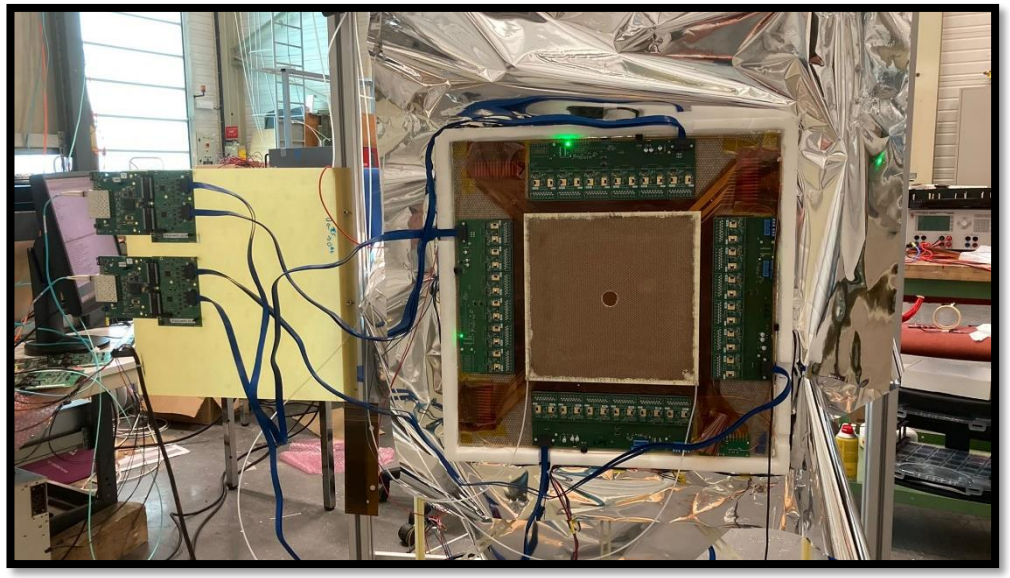






DAQ

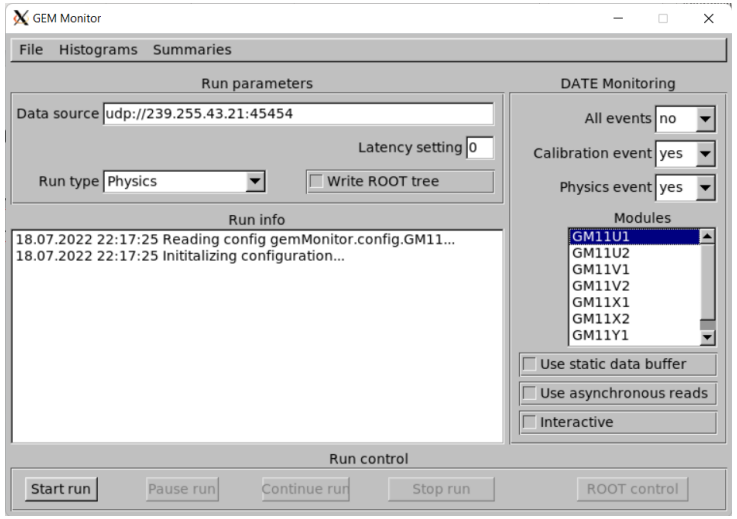
- First station @GM11 fully equipped
  - 2 x (24 APVs, 4 SupplyCards, 2 ADC/TDC-cards)
  - 4 fibers connected to MUX (sID 770) – ports 7,8 / 9,10
  - data stream on `udp://239.255.43.21:45454`
  - APV mode `0x29` – e.g. readout with 40MHz



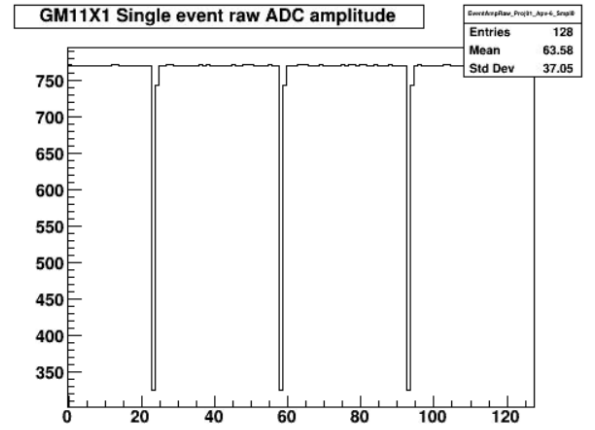
Data decoding

- gemMonitor
  - changes due to slightly different data format

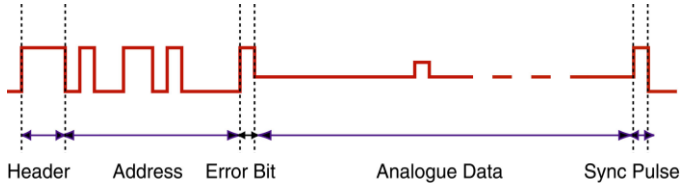
    (I. Konorov / B. Ketzer)
  - mapping implemented to config file (H.Pekeler/D.Schaab)
  - faulty data
    - ➢ sync pulses (“tick marks”)
      - ➢ should not appear when triggered
      - ➢ should not be seen in decoded data (in gemMonitor)
- suggestion: decoding error on detector hardware level
- task force GM11 → next MD (20.07.22)
  - tuning of APV chip configuration
  - check clock / trigger / offset / phase shift
  - also: ramp up HV



gemMonitor GUI



tick marks in data

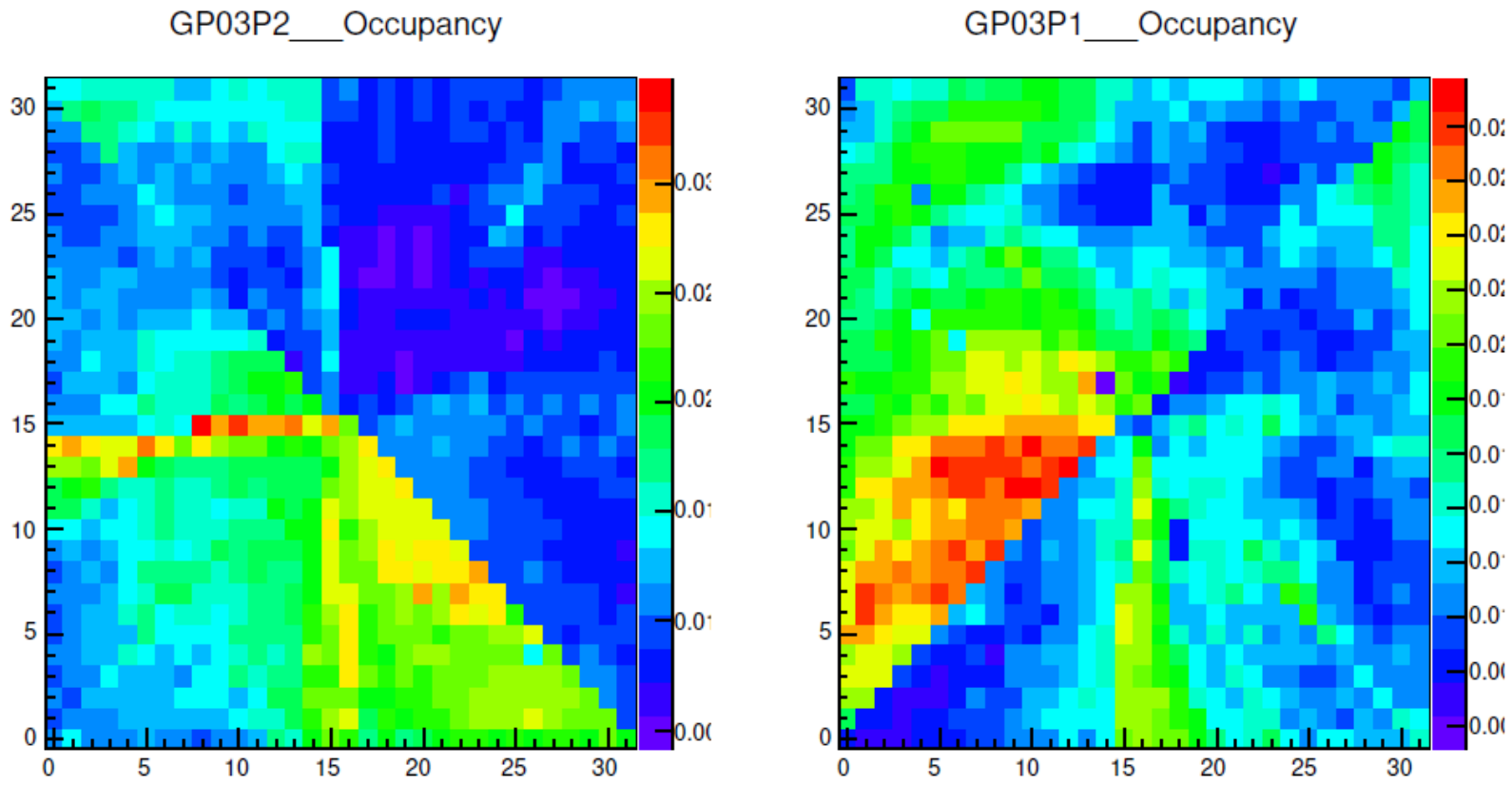


APV25-S1 data format (illustrated)

off-topic

PGEM issues

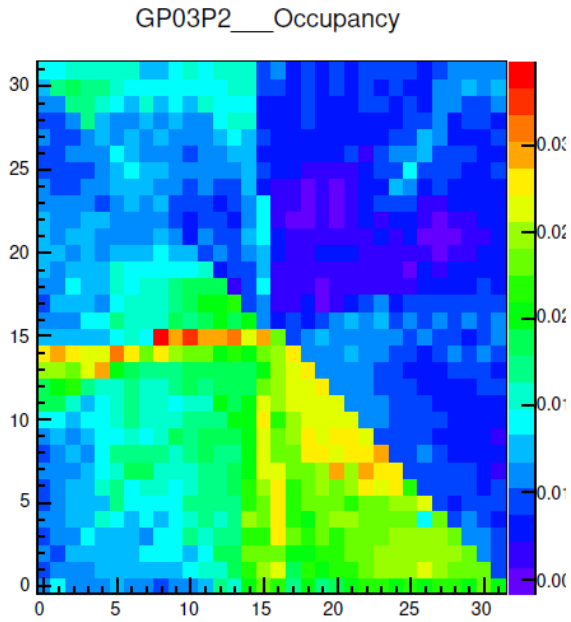
PGEM – GP03 occupancies

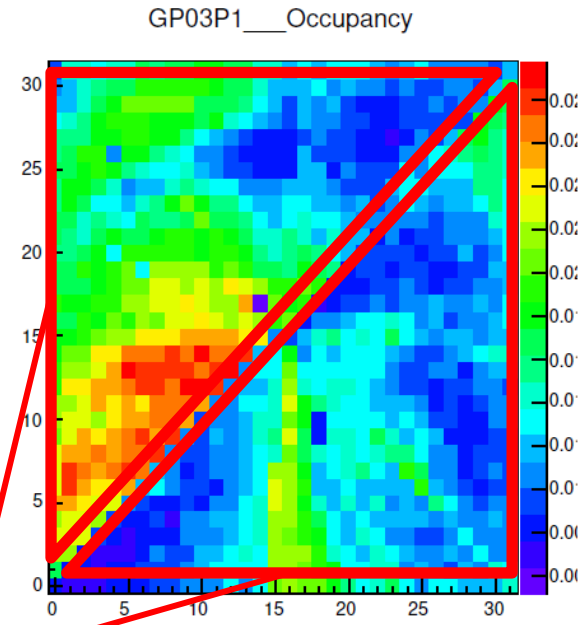


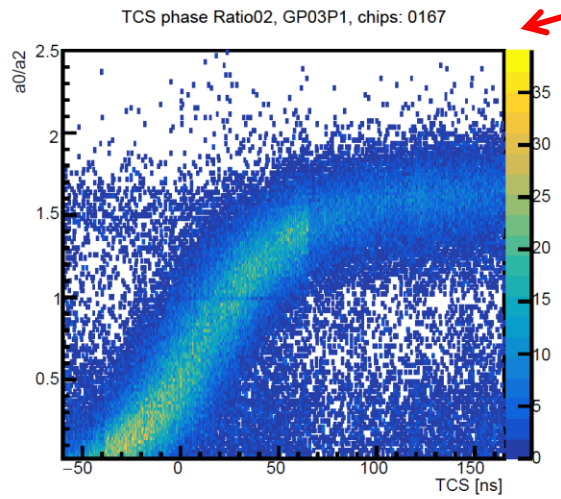
since ~2018..2021

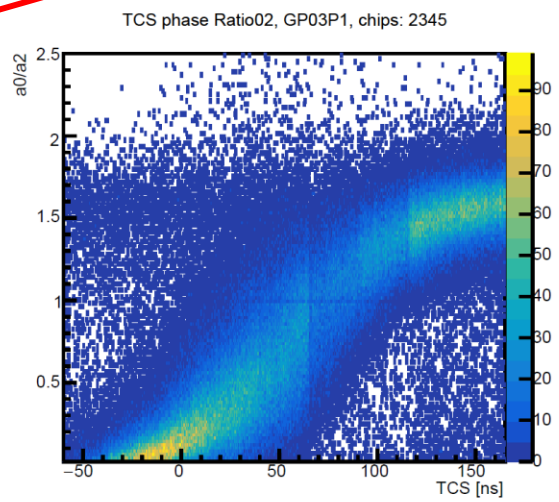
PG03 – TCS phase

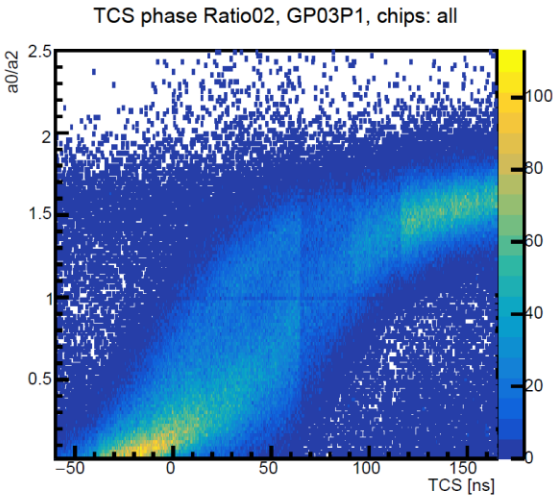
- different s-curves on TCS phase
- groups of 4APVs connected to same ADC port
  - ➢ different latencies / different amplitudes
- possible suggestions
  - BusCard
  - ADC transition card (replaced last year)
  - LV powering (Deutronics – not to be touched)





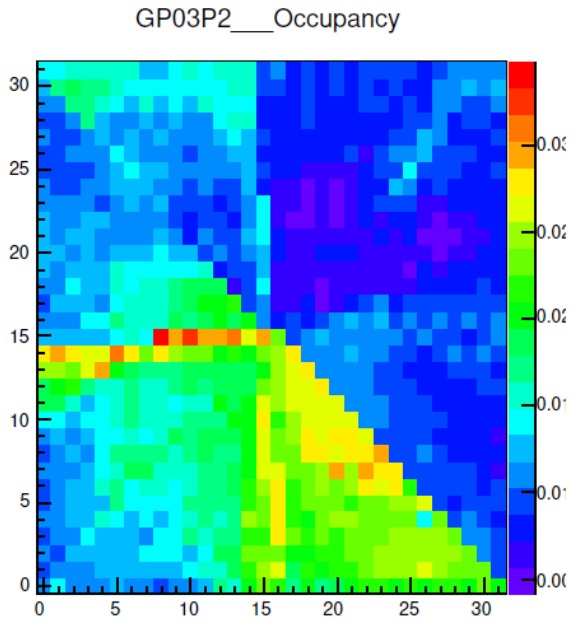


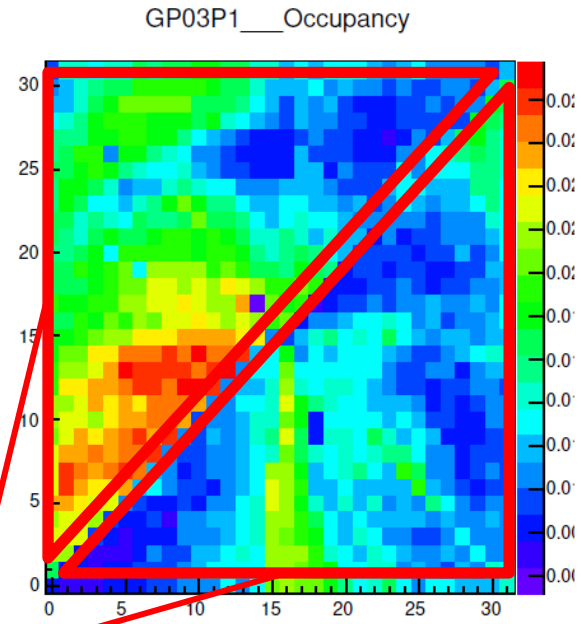


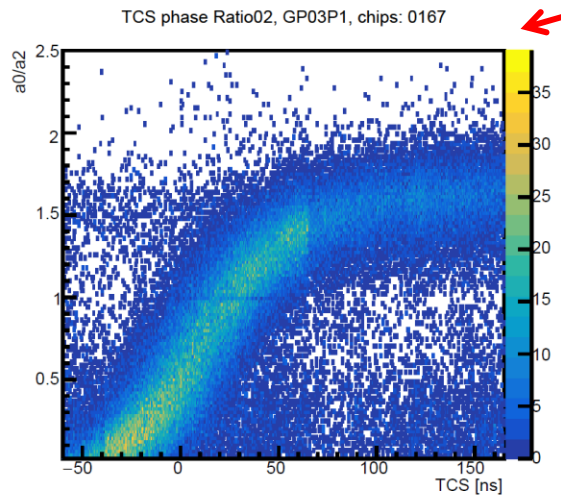


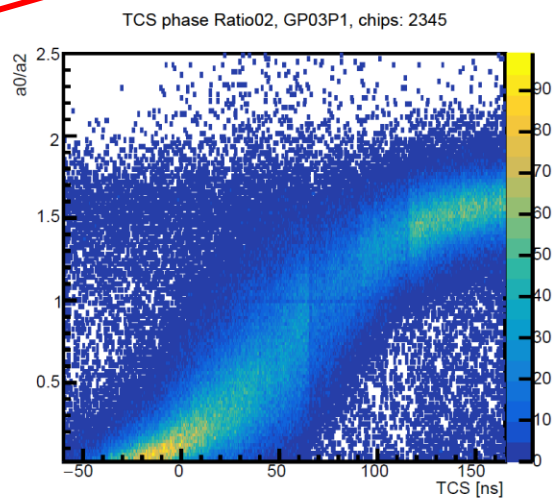
PG03 – approaches

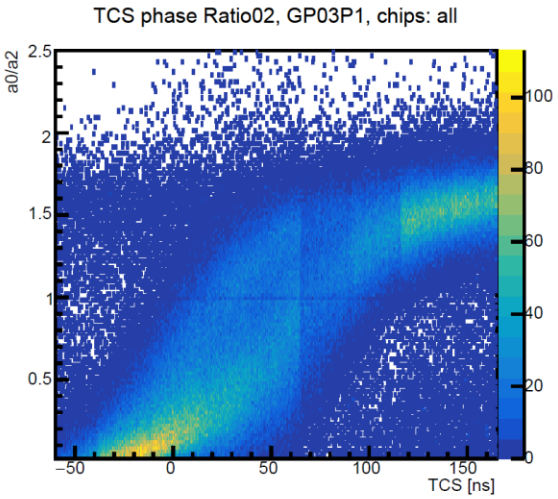
- adjust latency (today, M. Hoffmann)
- replace Deutronics by lab power supply
- ADC transition card
  - replace by spare (?)
  - repair old one
- replace detector











Thanks for your attention

Status of detector parts (drift foils + GEMs + R/O-foils)

- **CERN Batch 1:** shipped 20.10.2020
  - 6 GEM foils (2μm Cu) ⇒ 1 bad (high current), **5/6 good**
  - 3 drift foils (2μm Cu) ⇒ **3/3 good**
  - 2+1 R/O foils ⇒ 1 repaired (strip short), **3/3 good**
- **CERN Batch 2:** shipped 30.8.2021
  - 10 GEM foils (2μm Cu), ⇒ 1 (bad→recovered by HV cleaning), **10/10 good**
  - 2 drift foils (2μm Cu), shipped 30.8.2021 ⇒ **2/2 good**
  - 2+1 R/O foils, shipped 27.10.2021 ⇒ 1 bad (known), **2/3 good**
- **CERN Batch 3:** delivered 13.04. (delay > 1 month)
  - 7 GEM foils (minor design improvements)
  - 1 drift foil
  - 1 R/O foil

➢ **GEMs:** 15 good + 7 not tested ⇒ **≥6 detectors**

➢ **Drift**: 6 good ⇒ **6 detectors**

➢ **R/O:** 4 good + 1 repaired + 1 not tested ⇒ **6 detectors**

Status of local production (support structures + QA)

- **Honeycomb plates** (Piekenbrink)
  - Batch 1a: 2 drift plates, 2 R/O plates (potted, bent) ⇒ re-treated, flattened — **2 detectors (avail./spare)**
  - Batch 1b: 2 R/O plates (GFK frame) ⇒ good
  - Batch 2: 2 R/O plates, 2 drift plates, ⇒ good — **4 detectors (available)**
  - Batch 3: 2 sets of R/O and drift plates — **2 detectors (available)**
- **GEM frames** (local workshop):
  - full frame sets for 3 detectors available (drift, transfer, induction) — **3 detectors (available)**
  - 10 parts for 2.5 transfer frames available
  - spare material for segmented frames available — **~2 detectors (backup material)**
  - delivered material for 10 drift frames + 20 transfer/induction frames — **≥6 detectors (available)**

➢ **Currently:**

- ➢ Honeycomb plates for 8 detectors (incl. backup)
- ➢ Frames for ≥ 6 detectors total (partly backup material used) / avail. material for ≥8 detectors total

- **QA improved:** intersegment test automated (J. Paschek)
- **Production database** set up for COMPASS (taken over from ALICE / P. Glässel)

Database for Production

- Stock keeping integrated
- QA steps/files included
- Trackable construction chain

Item G3M/G3M01 (batch 1) contains (only next level):

part	type	prefix	num	serialno	batch	date	status	link	comment
GEM stack		GMS	0	GMS-01	1	2022-01-28		X	
R/O plate		RP	0	RP-01		2022-01-28		X	

define/modify contained parts

Item GMS/GMS-01 (batch 1) contains (only next level):

part	type	prefix	num	serialno	batch	date	status	link	comment
Drift plate		DP	0	DP-01		2022-01-28		X	
Drift GEM		GM1	0	GM1-01	1	2022-01-28	0	X	
intermediate GEM		GM2	0	GM2-01	1	2022-01-28	0	X	
R/O GEM		GM3	0	GM3-01	1	2022-01-28	0	X	

define/modify contained parts

Item GM2/GM2-01 (batch 1) contains (only next level):

part	type	prefix	num	serialno	batch	date	status	link	comment
GEM foil		CG3G	0	CG3G-003	1	2022-01-28	2	X	

define/modify contained parts

HISKP Compass production database, category Compass

link color code	serial no	barcode	unnumbered
prefix color code:	parent part	daughter part	both
part color code:	QA defined		

							unnumbered stock at institutes		numbered stock		
link	category	part	batch	type	prefix	ordered	sent	Bonn	used	inventory	finished	used
X	Compass	Drift foil			CD3G-nn					5		1
X	Compass	Drift frame	1		D-frame			2	1			
X	Compass	Drift GEM			GM1-nn							1
X	Compass	Drift plate			DP-nn							1
X	Compass	GEM foil			CG3G-nnn					13		3
X	Compass	GEM stack			GMS-nn							1
X	Compass	honeycomb plate large	1		HCL			1	1			
X	Compass	honeycomb plate large	2		HCL			3				
X	Compass	honeycomb plate small	1		HCS			1	1			
X	Compass	honeycomb plate small	2		HCS			1				
X	Compass	intermediate frame	1		I-frame			4	2			
X	Compass	intermediate GEM			GM2-nn							1
X	Compass	R/O foil			CR3G-nn					5		1
X	Compass	R/O frame	1		R-frame			2	1			
X	Compass	R/O GEM			GM3-nn							1
X	Compass	R/O plate			RP-nn							1
X	Compass	readout chamber			G3Mnn					1		

step (link)	status	data field (hover cursor for explanations)	value	n	date	QA step/file comment	author	condition	true?
1	1	quick defect map	defectmap.txt show		2022-01-25 11:22:26	ok 0 0 0 2 defects	Karl	file txt	
2	2	HV cleaning	done	2	2022-01-26 13:21:07		Karl	eq done	
3	3	intersegment test						eq ok	
6	6	leakage current [pA] at 500 V	15		2022-01-26 13:32:27		Karl	<= 167	
7	7	spark map	do the spark map					file txt	
8	8	absolute humidity [ppmV]	2800		2022-01-26 13:32:27		Karl	<= 6000	
9	9	spark map upload possibility to upload existing spark map	Upload datafile: Datei auswählen Keine Datei ausgewählt upload file **after choosing file!**			file comment:		file ok	
10	QA-B	I_leak histo data	06_CG3G_01_03_N2_framed_corrected.txt evaluate		2022-01-26 13:31:59	no comment	Karl	file txt	
15	QA-A	long term leakage current data	04_CG3G_01_03_N2_longterm_corrected.txt evaluate		2022-01-26 13:31:41	no comment	Karl	file txt	
20	20	frame glueing	ok	3	2022-01-26 13:33:12		Karl	eq ok	
25	25	quality	A		2022-01-26 13:32:36		Karl	le C	

AMBER PRM readout requirements

Starting point: 30x30 cm² with **divided strips** and **active central sector / self-triggering VMM**

- Readout of all 4 sides (1 detector)
- 768 channels per side (1 detector)
- 2 detectors per station in 6 stations

Requirements

- number of **channels per projection**: 2x768= **1536**
- number of **projections per station**: **4**
- number of **stations**: **6**
- number of **bits per hit**: **38 raw** from VMM / **48** with additional **time stamp**
- **in progress**: amount of information produced by one projection for nominal PRM beam (conditions in streamed mode $\Rightarrow$ noisy hits + induced by charged particles)