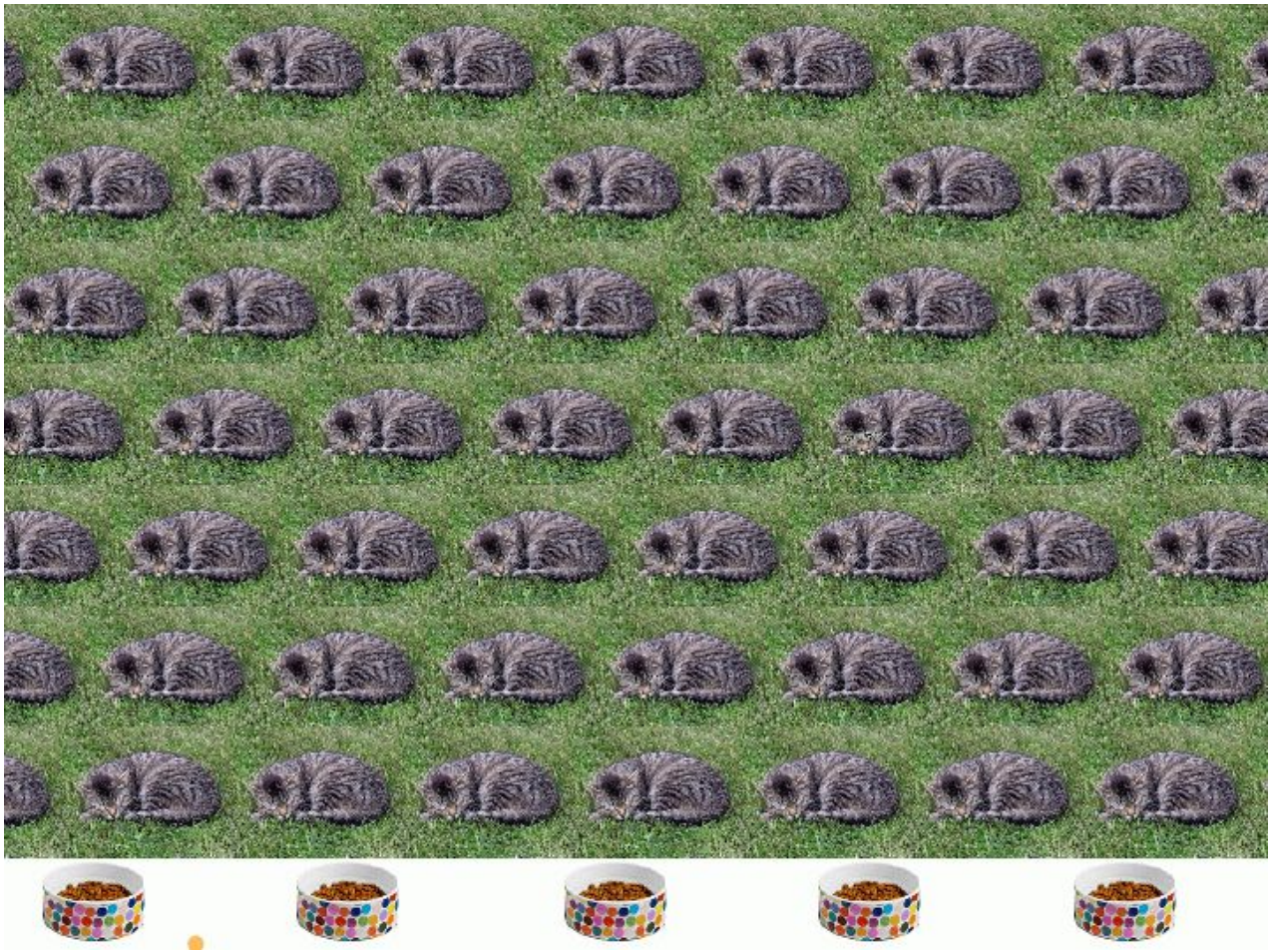
(W)HOLE NEW FIELD

GEM-OROC chambers for ALICE TPC assembly and testing at GSI, 2016-2018

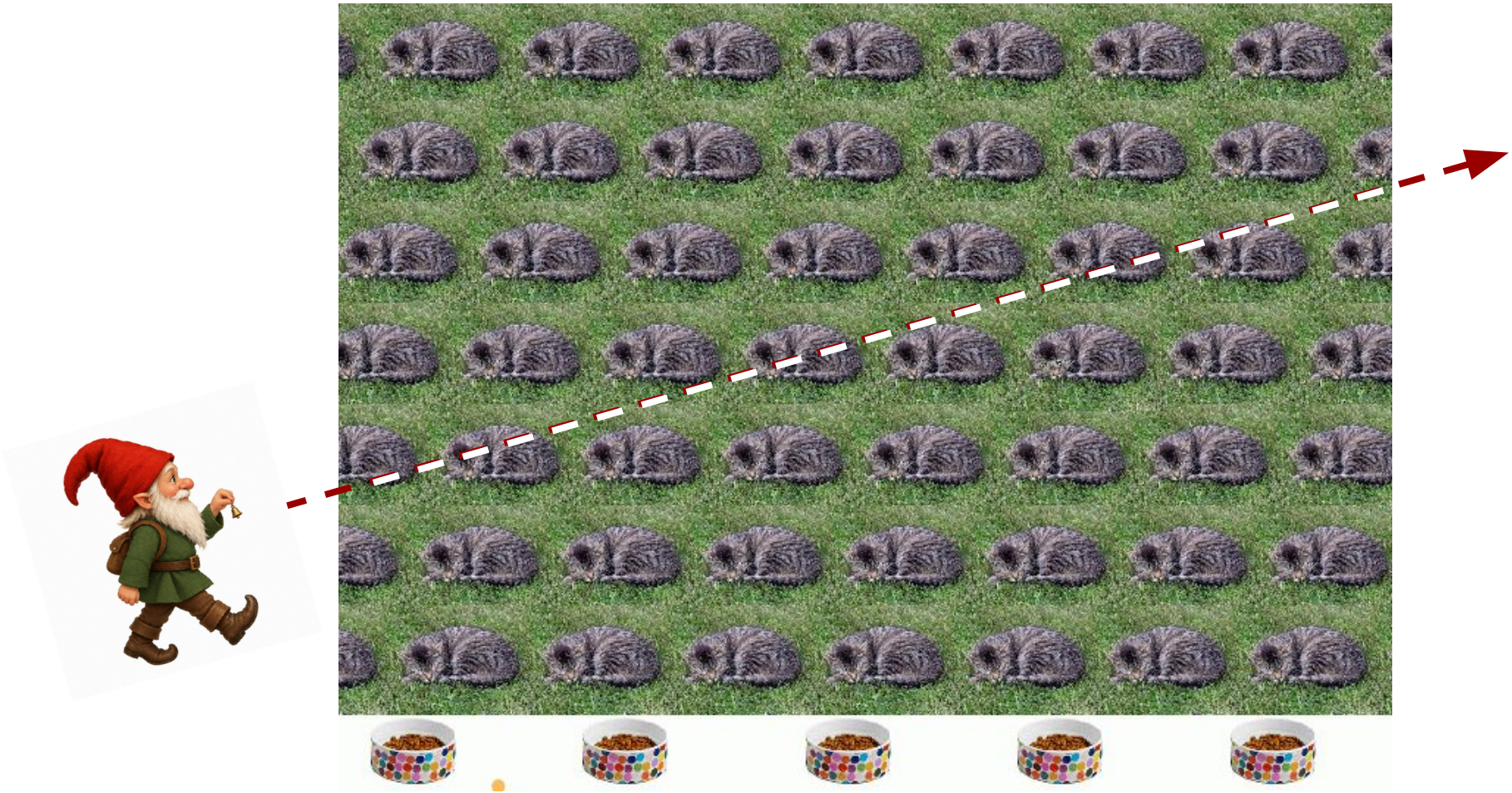
Dariusz Miśkowiec, GSI Darmstadt

TPC idea

Time Projection Chamber: principle of operation



Time Projection Chamber: principle of operation



ALICE Time Projection Chamber



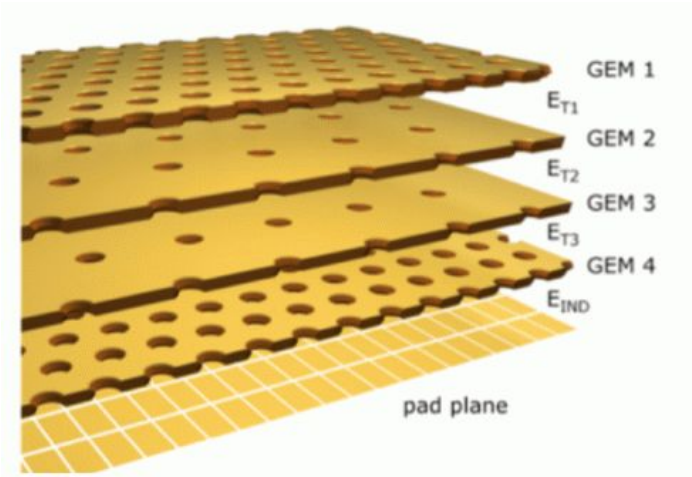


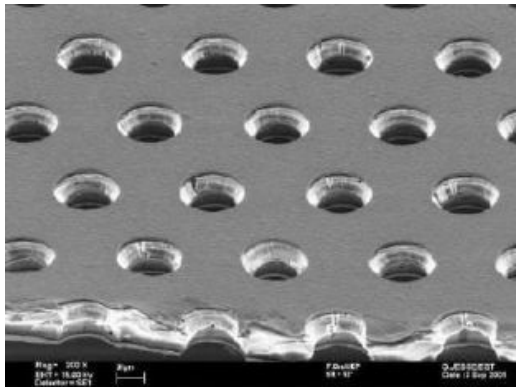
TPC upgrade after Run 2

getting rid of gating grid

- gating grid limits the maximum rate of a wire-based TPC
- use several amplification stages, keep total gain low, reduce ion backflow (IBF) by the choice of electric fields

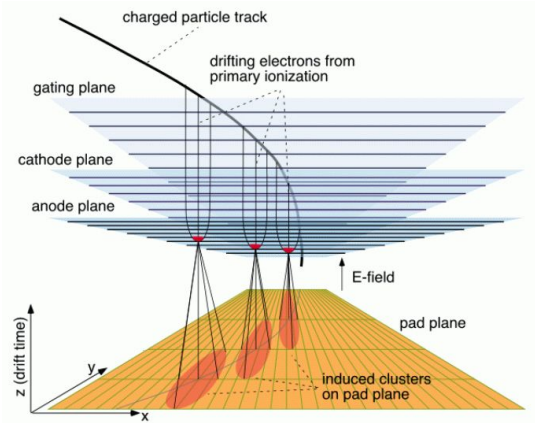
implementation: 4 Gas Electron Multiplier (GEM) foils

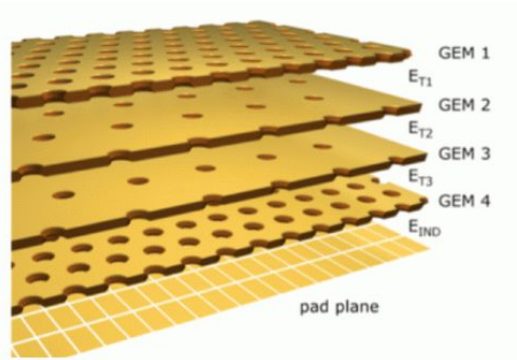




50 micron thick insulating foil with holes
Cu layers on both sides, ~300 V applied

getting rid of gating grid





	wire chamber		GEM chamber
	grid open	grid closed	
gain	8000	0	2000
ion backflow	0.13	<0.0001	<0.01

why at GSI?

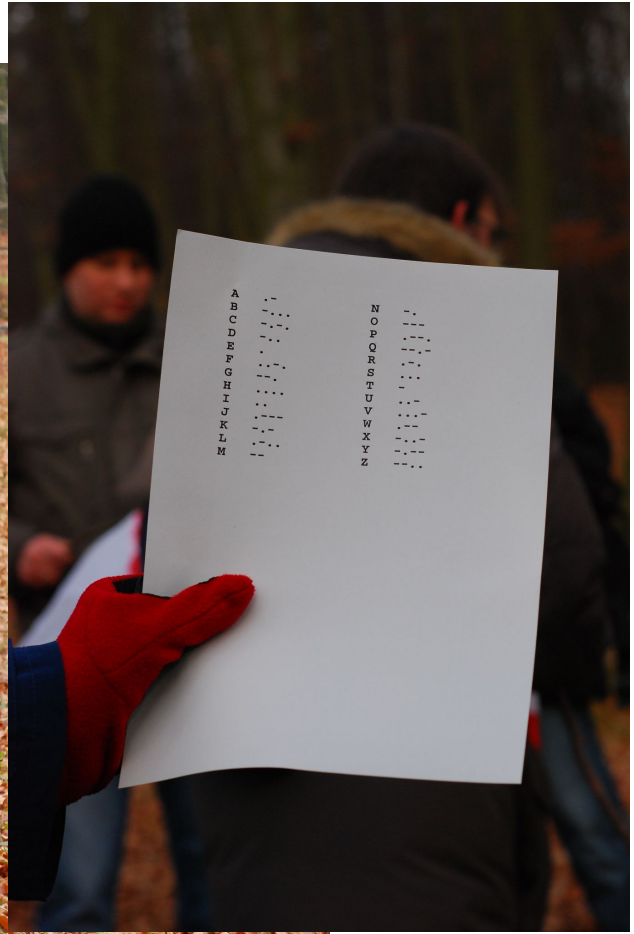
underground training in Darmstadt breweries





communication skills





trained to work at height, using eye protection





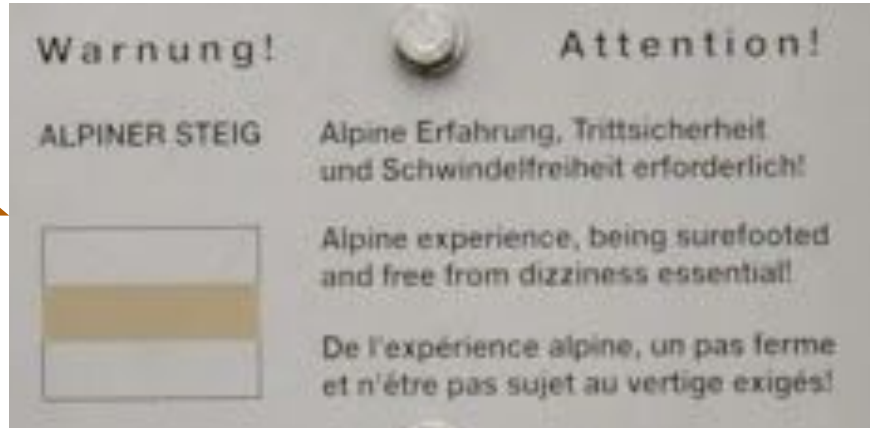


ability to understand and memorize complex schemes



accustomed to increased (cosmic) radiation environment






immunity to highly corrosive substances
(Chinese New Year celebration)

excellent motoric skills and sharp sensory awareness



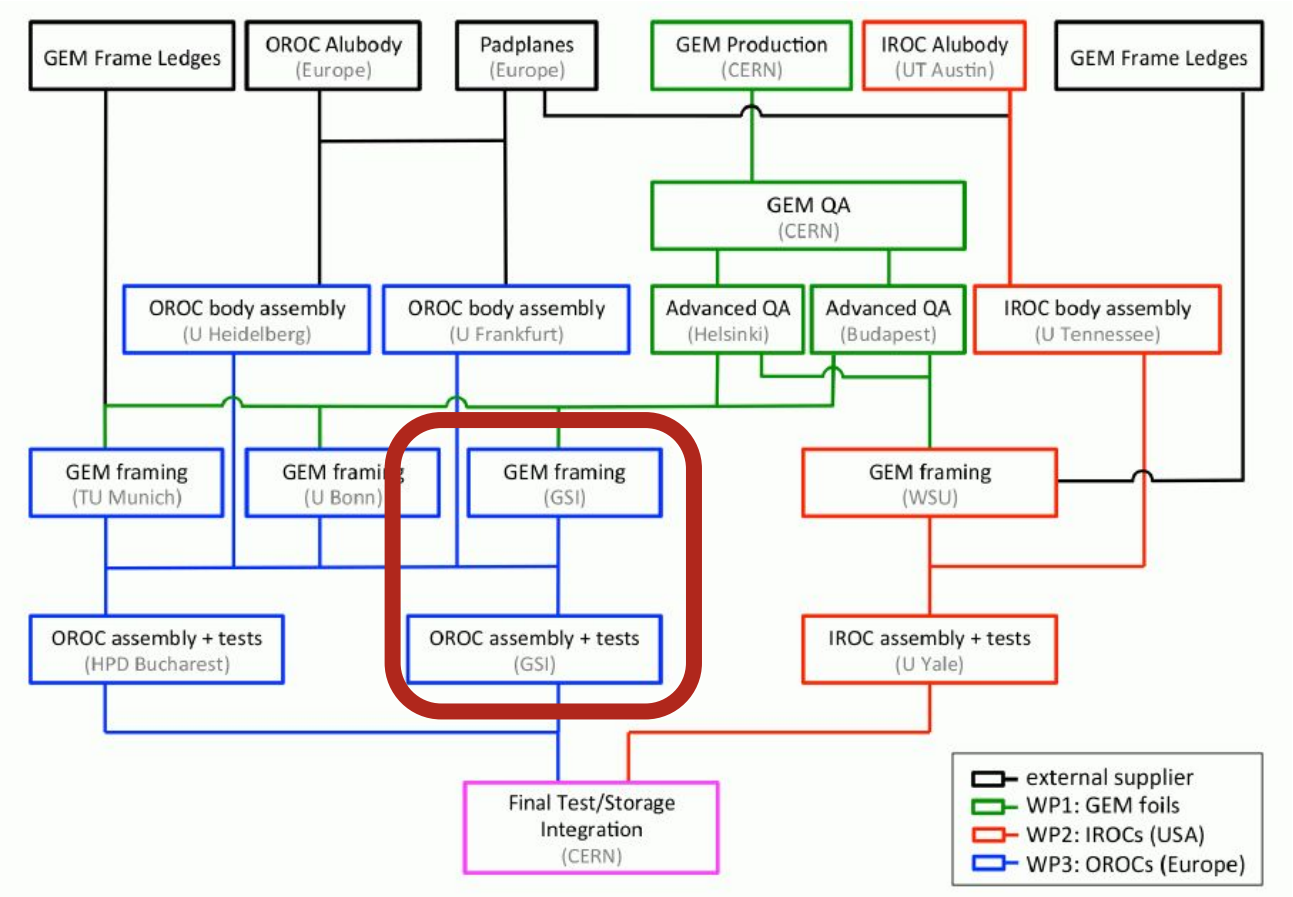
…and one more asset of GSI:

big and well equipped detector lab

+ expertise of its team

production

ALICE TPC upgrade project structure

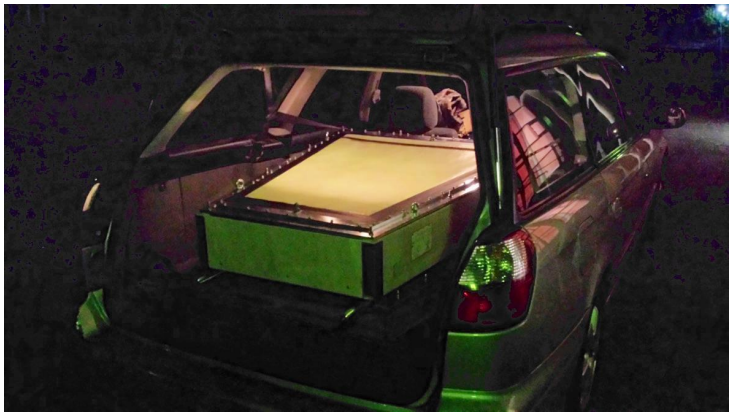


ALICE TPC upgrade - a very logistic-intensive project





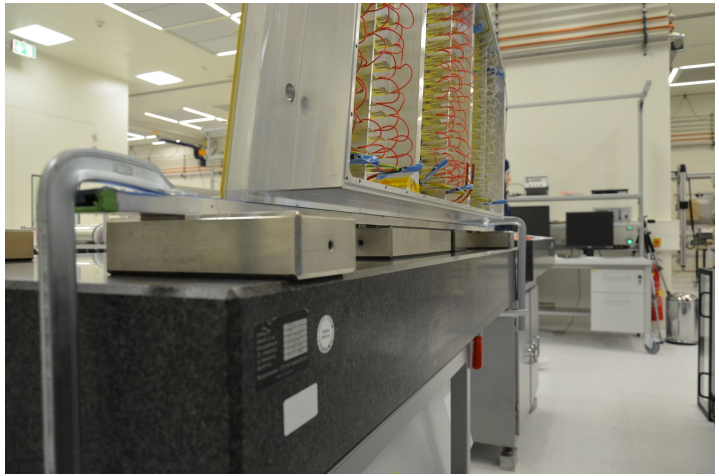




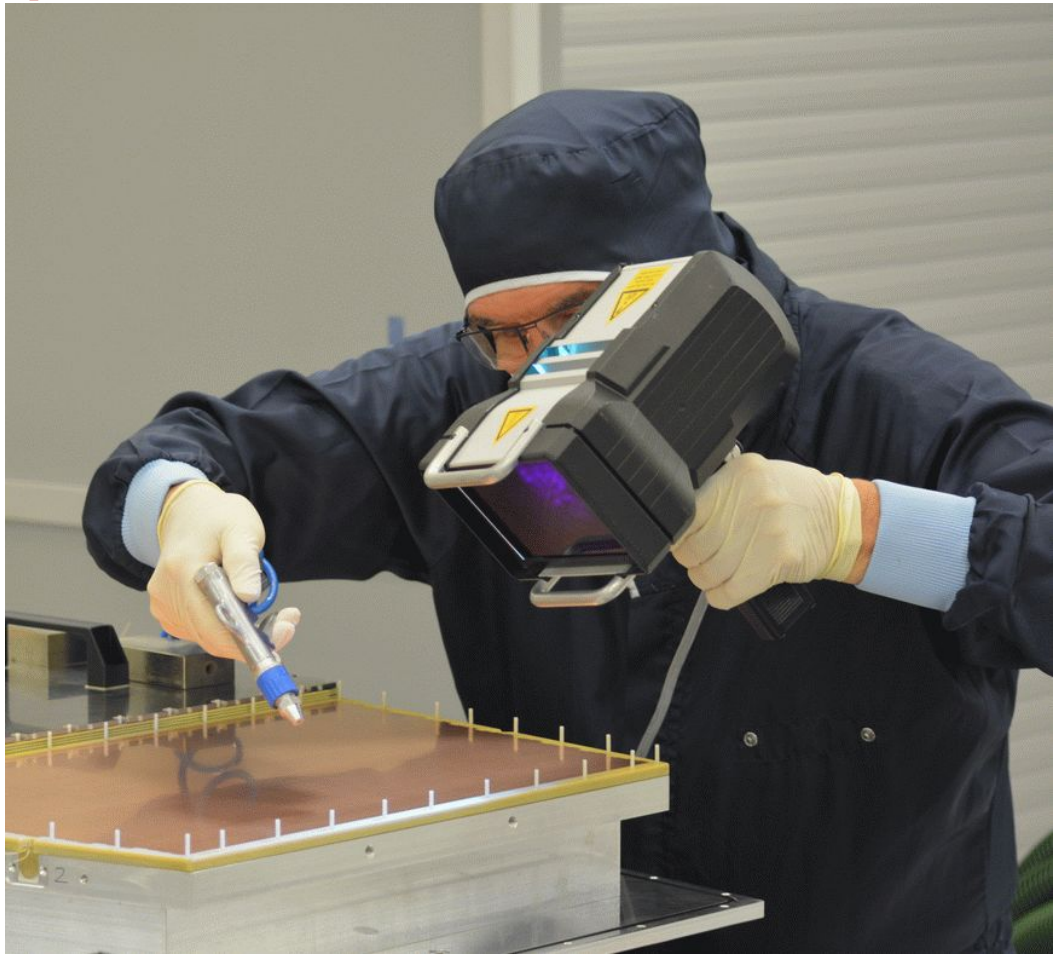
weightlifting and bodybuilding



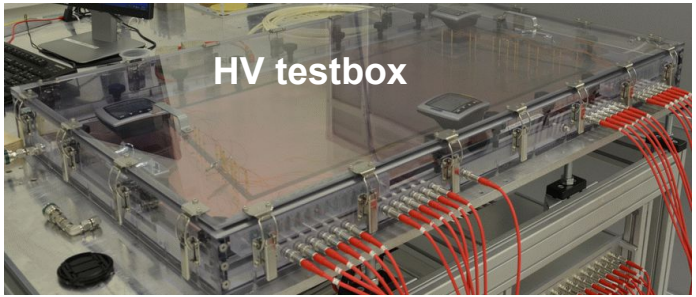


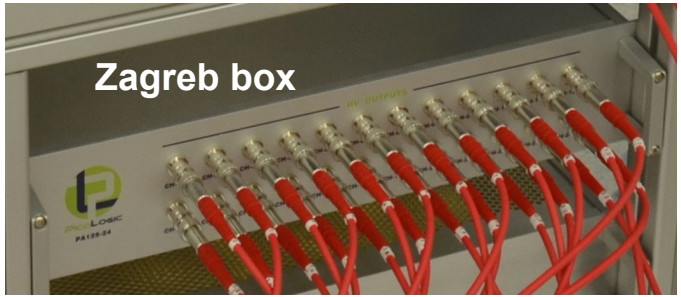


nature powers: wind and sun

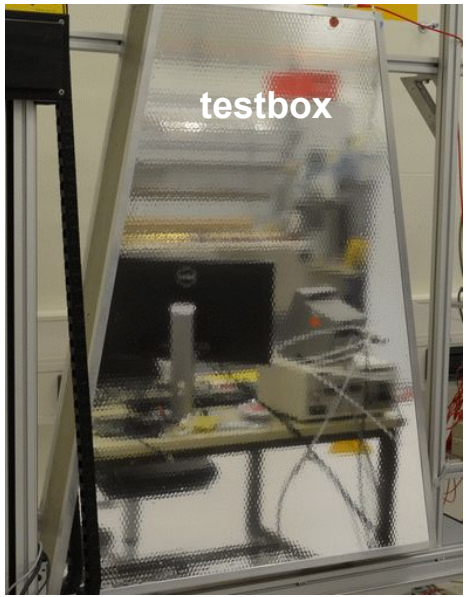


project equipment







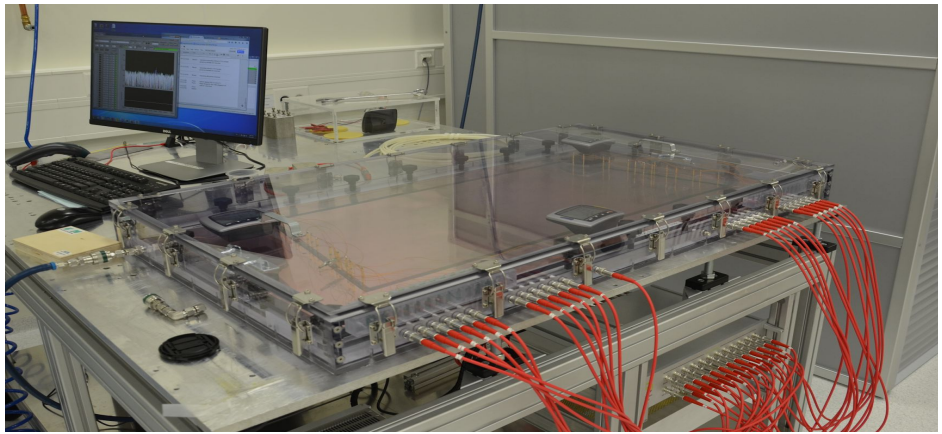


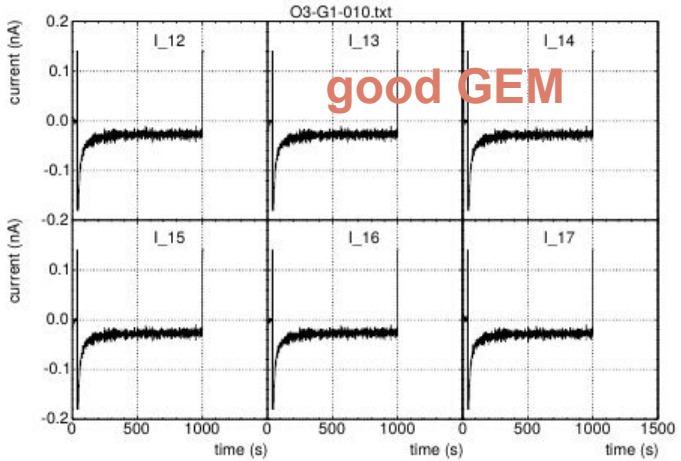


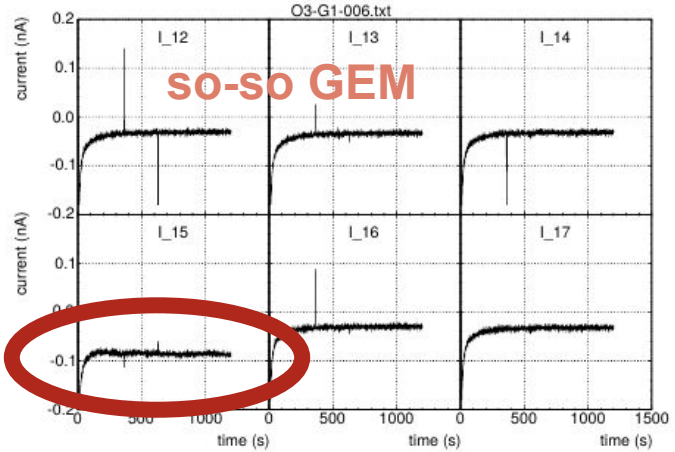


basic GEM test: leakage current at 500 V

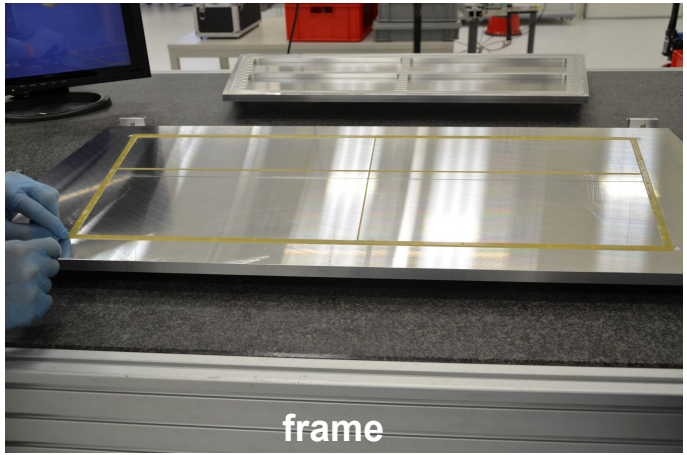


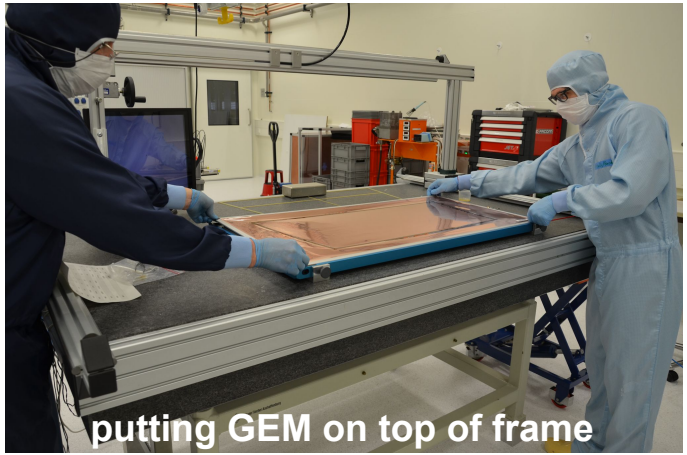


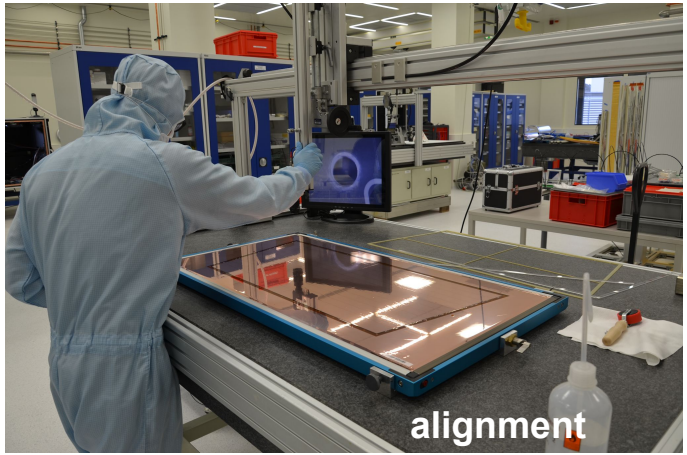


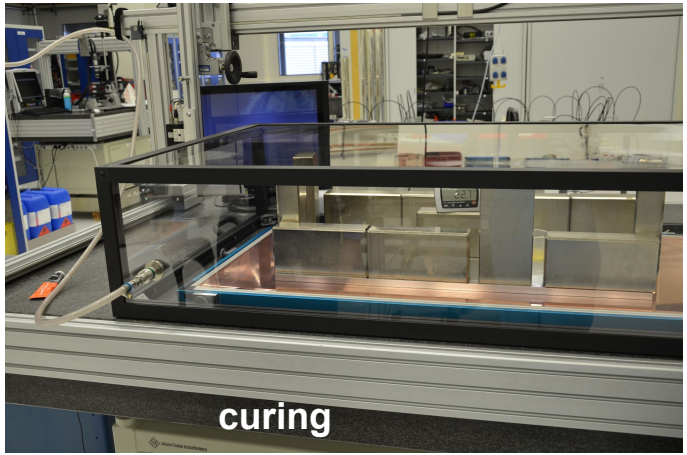


GEM framing

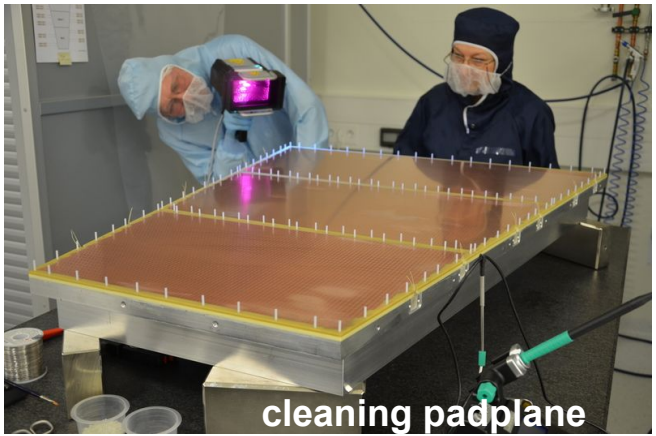




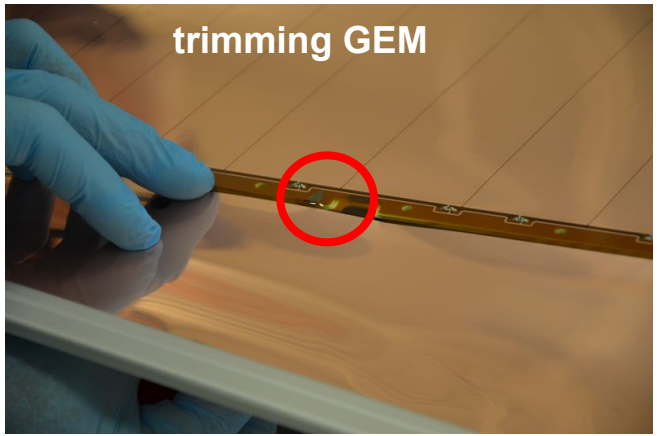




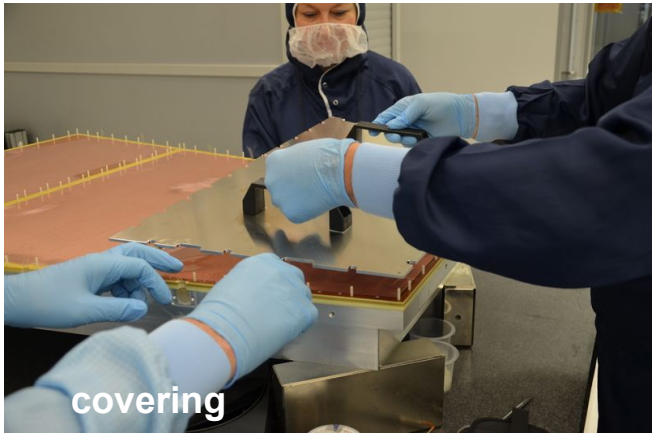
OROC assembly









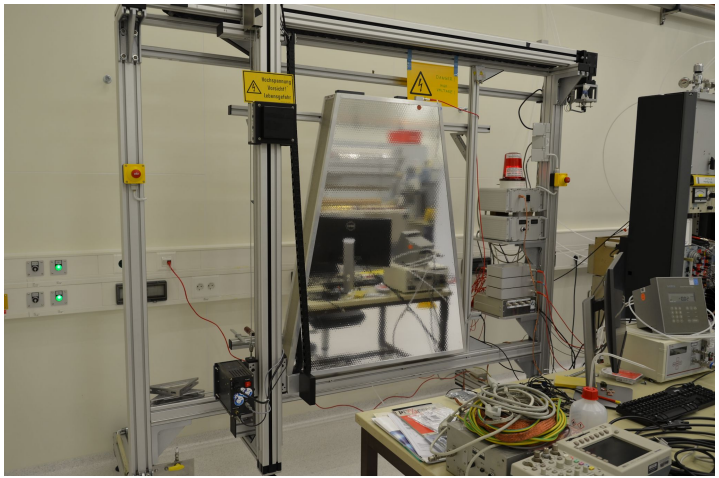

covering


soldering HV connections

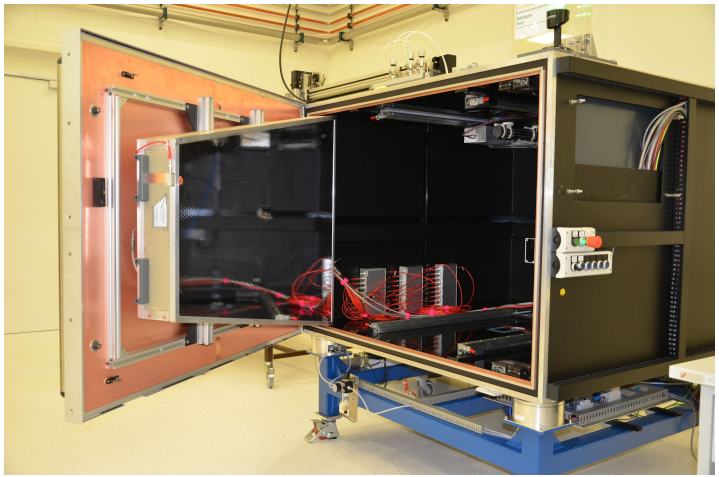

SUPER DRY
tightening nylon screws


SUPER DRY
done

OROC tests at GSI



moving an x-ray gun at 10 kV
moving a ^{55}Fe source of 6 keV x-rays
monitoring currents of padplane and cathode

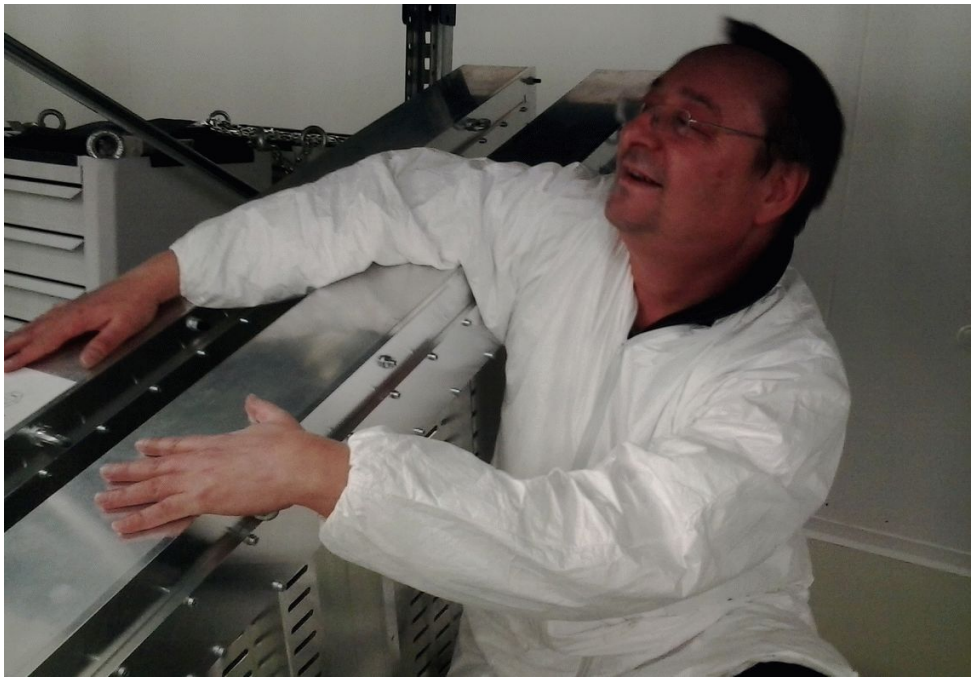


two x-ray guns at 60 kV, full illumination
monitoring currents of padplane and cathode

completion of the OROC assembly and tests

- 2015 planning
- 2016 planning and preparing
- 2017 3 OROCs assembled
- 2018 17 OROCs assembled

last OROC shipped to CERN in October 2018, one month before the start of the shutdown



Heiße Phase am Cern

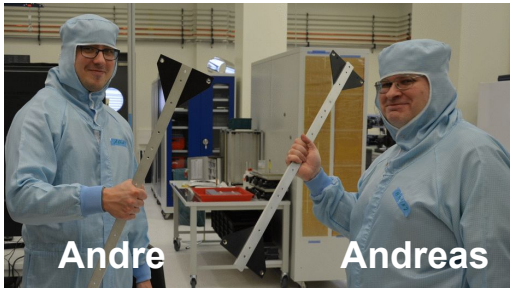
Physiker schicken Blei-Ionen auf Kollisionskurs

DARMSTADT/GENF (ine). Am Teilchenbeschleuniger in Genf hat die heiße Phase für das „Alice"-Experiment begonnen. Die Forschungsmaschine läuft bis 3. Dezember mit Blei-Ionen statt Protonen auf Hochtouren. Physiker schicken sie auf Kollisionskurs, um Erkenntnisse über die ersten Momente nach dem Urknall vor fast 14 Milliarden Jahren zu gewinnen. Nach dem Experiment folgt eine zweijährige Wartungsphase. Die „Alice"-Gruppe am GSI-Helmholtzzentrum rüstet derzeit die Detektoren auf. Die Forschergruppe stellt unter anderem 20 neue Auslesedetektoren für die Zeitprojektionskammer zusammen, die das Herz des Alice-Apparats darstellt. Wie es in einer Mitteilung des GSI Helmholtzzentrums heißt, sind Ende Oktober, nach vier Jahren intensiver Arbeit, die letzten fünf Detektoren an das Cern in Genf geliefert worden. Produziert waren die Detektoren im GSI-Detektorlabor.

AZwtet1a

Riedstädter Echo 22.11.18

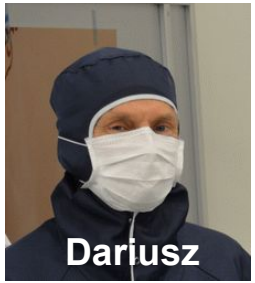

Alena


Andre
Andreas


Bernd


Bogdan


Daniel


Dariusz

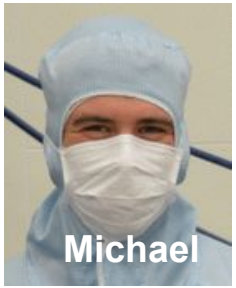

Holger


Joerg

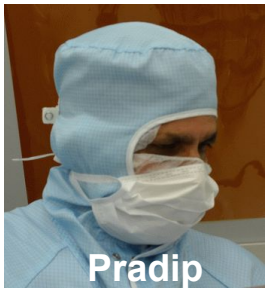

Lilit


Lukas


Manuel


Michael

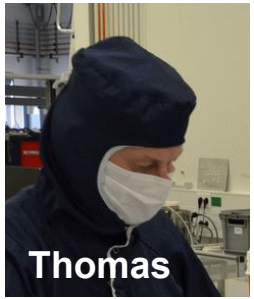

Pascal


Pradip

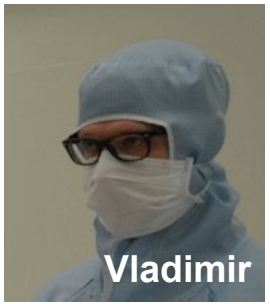

Rajendra


Sebastian


Silvia


Thomas


Thomi


Vladimir

personal summary: how well did things work?

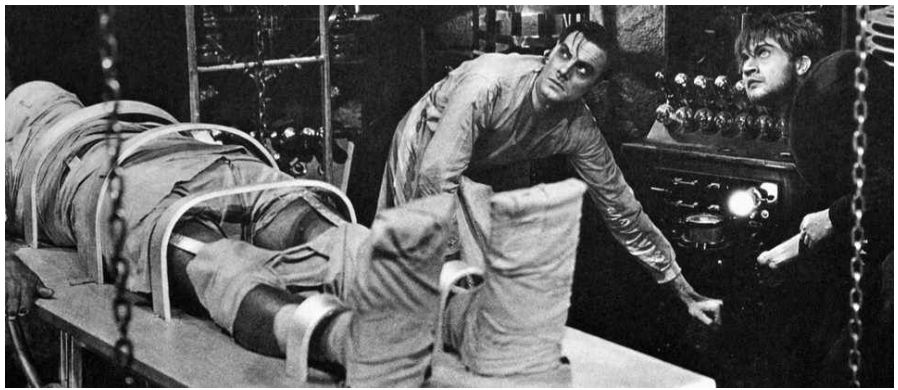
what	expectation	reality
flushing volumes with gas	rest gas = exp(-t/tau)	so-so
building tight volumes	you can debug by sniffing	sniffing worked only for big holes
keeping things clean	if you keep things clean, nothing bad can happen	if you keep things clean, you reduce the probability that something bad happens
electric discharges in equipment	just keep distance and isolation, then OK	calculate and test carefully, use a safety margin, then OK
electric discharges in gas	absent	statistical
bringing life into things ("Frankenstein effect")	put things together, apply HV, wake them up to live	yes!

bringing life into things ("Frankenstein effect")

But life functions very differently from the standard condensed-matter fare of metals or superconductors, which are “dead” things whose behaviors are predetermined. Living creatures can respond in seemingly disparate ways to the same stimulus. “Biological systems have this feedback loop that makes them very difficult to analyze using standard differential equations,” Goldenfeld says, adding that he doesn’t yet know how to address that problem.

APS Physics, "Life is Physics", January 11, 2019

following this definition, gaseous chambers are living beings



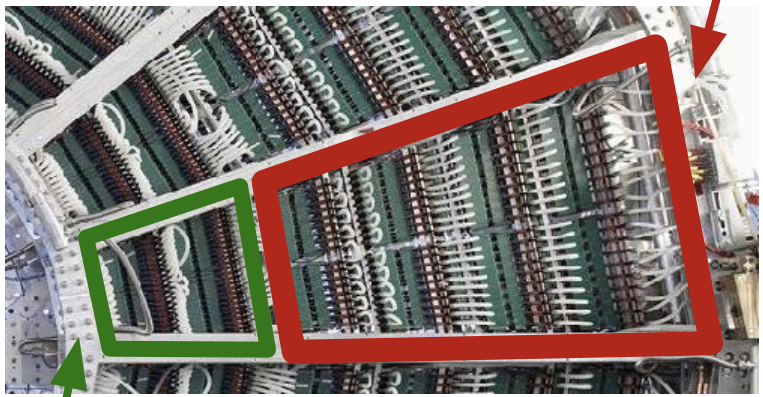
under HV, they always wake up



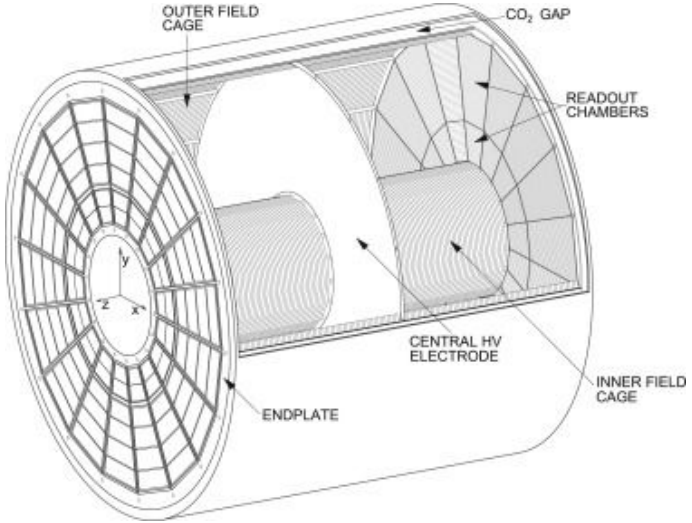
end

upgrade of the TPC

Outer Readout Chamber (OROC)



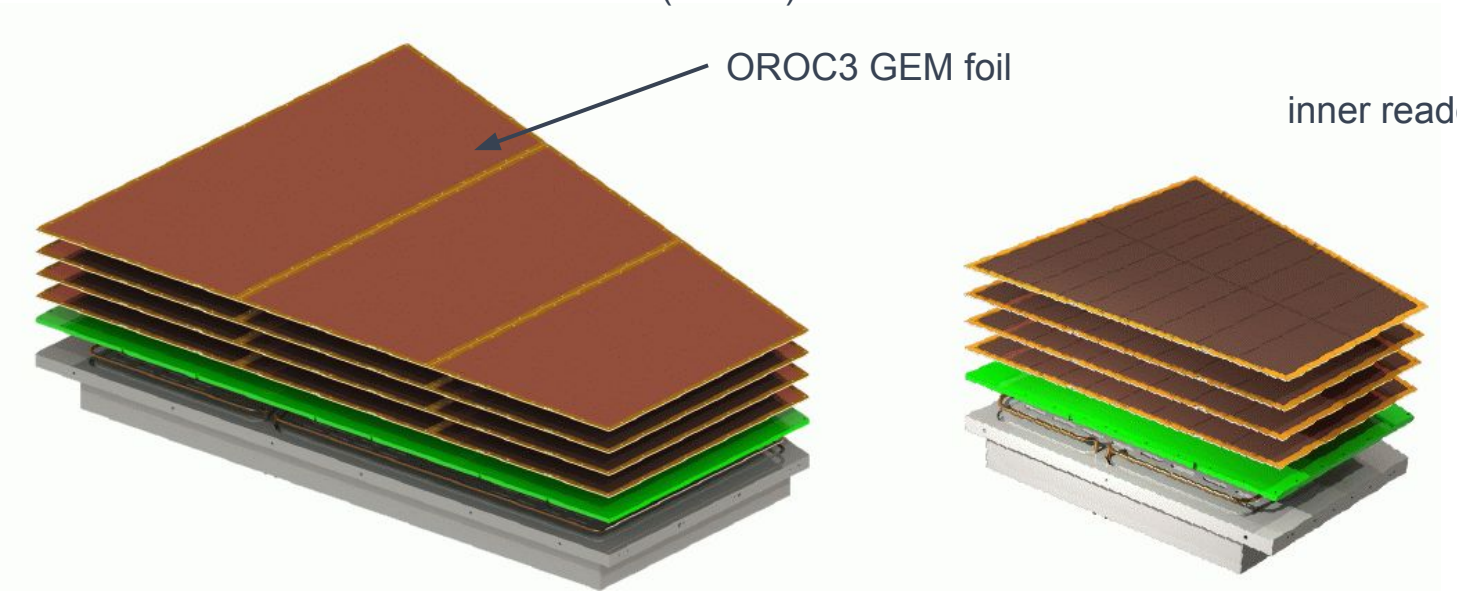
Inner Readout Chamber (IROC)



36 IROCs and 36 OROCs to be replaced with new GEM chambers
GSI assembling 20 OROCs

ALICE Time Projection Chamber upgrade 2019

outer readout chamber (OROC)

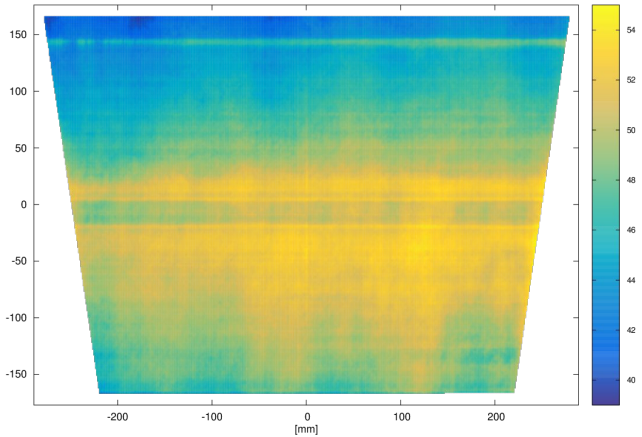


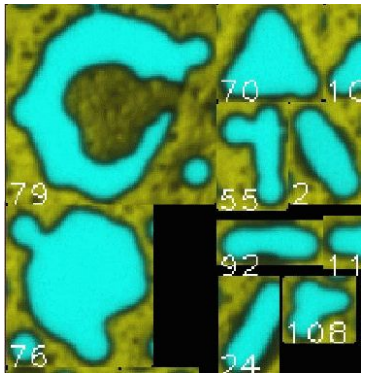
GSI contribution:

- frame 160 OROC3 GEM foils (= 100% of all)
- assemble and commission 20 OROCs (= 50% of all)

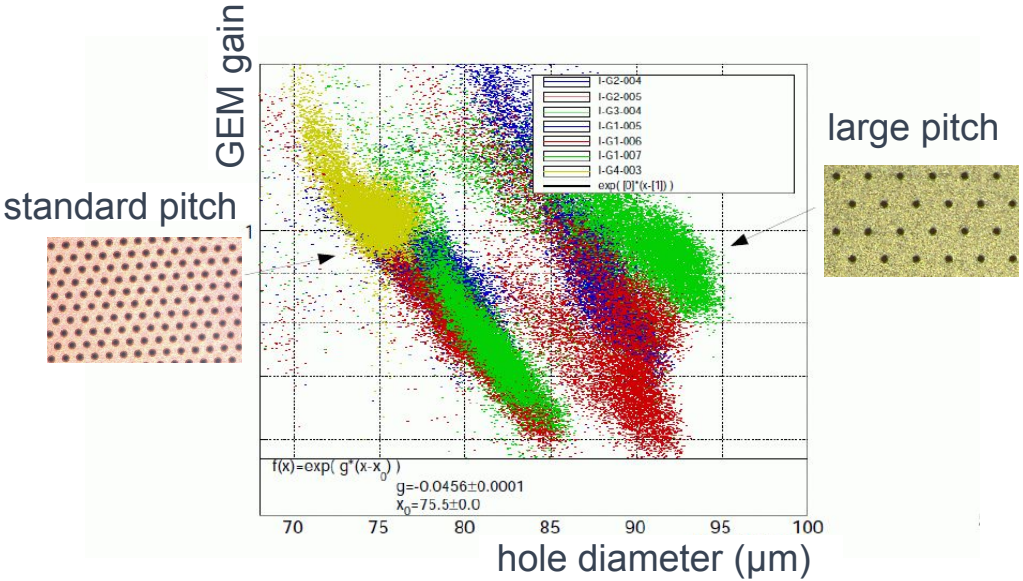
advanced GEM tests: optical scan

hole-size map





etching defects



clear anticorrelation between hole size and single-GEM gain

...gets lost once several GEMs are stacked together

GEM database documenting 923 foils

Home | Category: OROC | Stock | Shipping | Information | logged in: Dariusz

ALICE TPC production database

Show selected stock items link to bookmark this selection

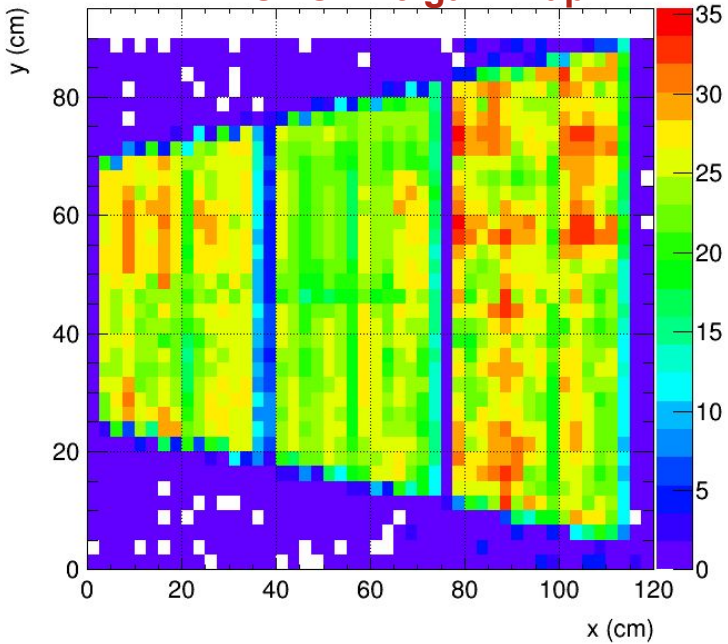
Selection — specific QA step selection: off / not done / passed / failed

category	part	batch	type	QA status	serialno/bc wildcards %, _	sent?	select location or 'used'	search string within comment regular expressions accepted
OROC	OROC3 GEM foil	any	all types	any				

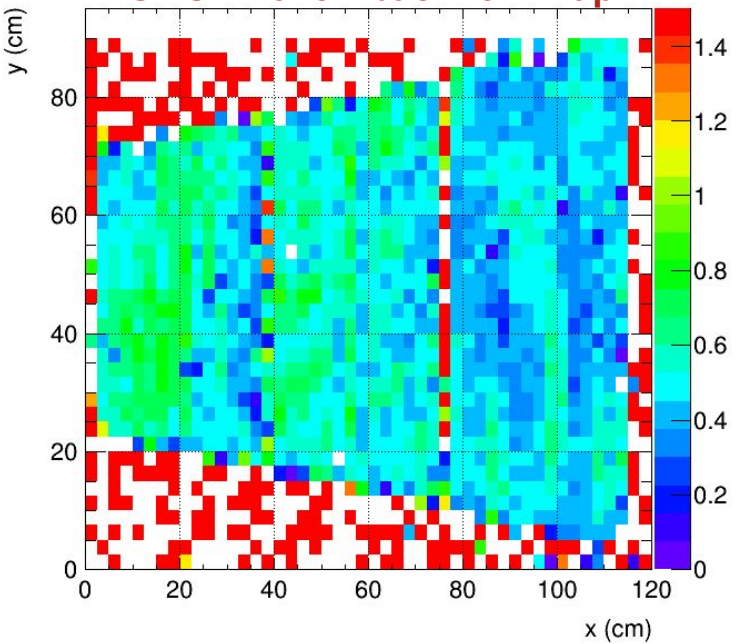
part	item	batch	sent from	sent to	date	location or link to parent	QA status			link	comment
OROC3 GEM foil	O3-G1-001	5				OROC/02	A	20.07.17	CERN	X	
OROC3 GEM foil	O3-G1-002	5				OROC/01	3	15.01.17	CERN	X	
OROC3 GEM foil	O3-G1-003	5				OROC/04	B	30.01.18	CERN	X	
OROC3 GEM foil	O3-G1-004	7				Bonn	QA-A	05.11.18	CERN	X	
OROC3 GEM foil	O3-G1-005	7				GSI	3	17.01.17	CERN	X	GSI: GEM stripped from frame
OROC3 GEM foil	O3-G1-006	7				GSI	QA-A	23.11.18	CERN	X	GSI long term tested
OROC3 GEM foil	O3-G1-007	8				OROC/35	B	19.12.18	CERN	X	GSI long term tested. from CERN
OROC3 GEM foil	O3-G1-008	8				OROC/05	C	30.10.17	CERN	X	GSI tested, framed, tested

OROC tests

OROC/23 gain map

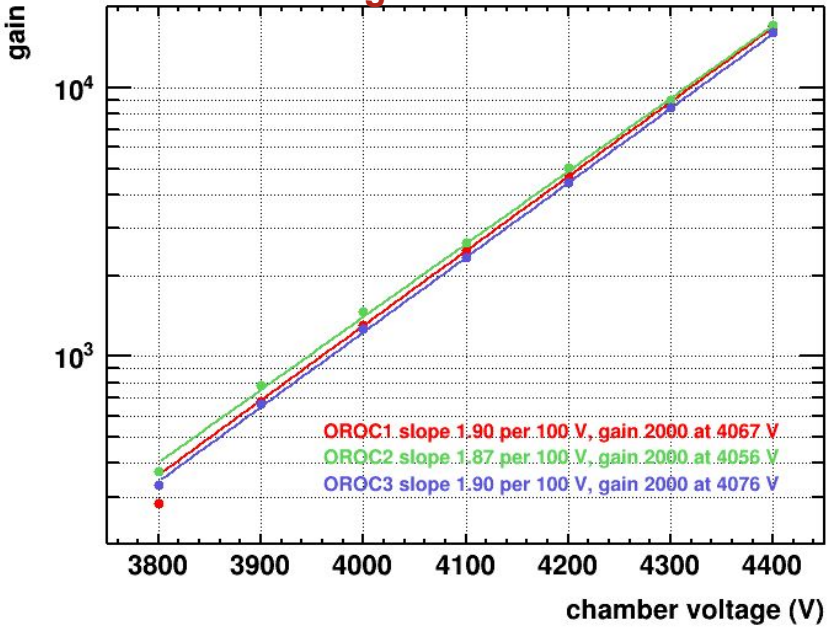


OROC/23 ion-backflow map

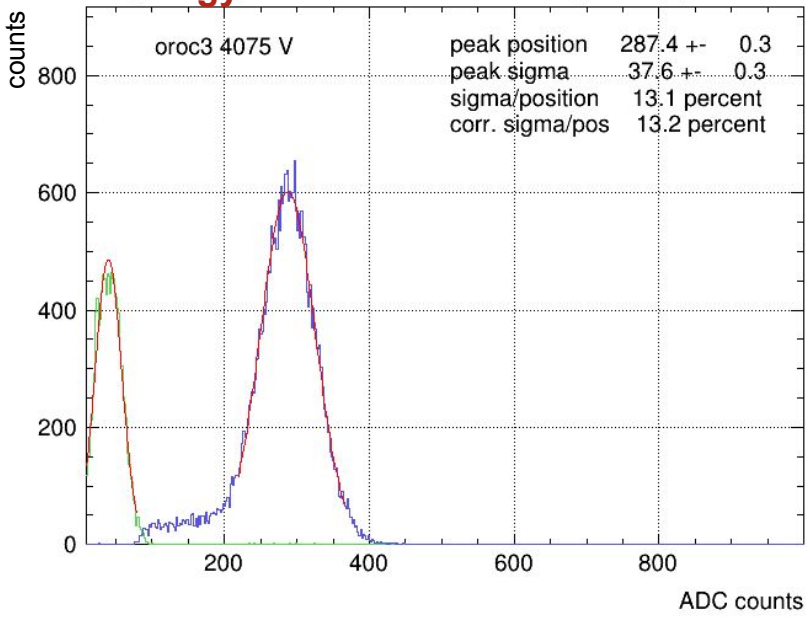


- gain uniformity 11% (standard deviation), requirement <20%
- average ion backflow 0.5%, requirement <1%

gain curves

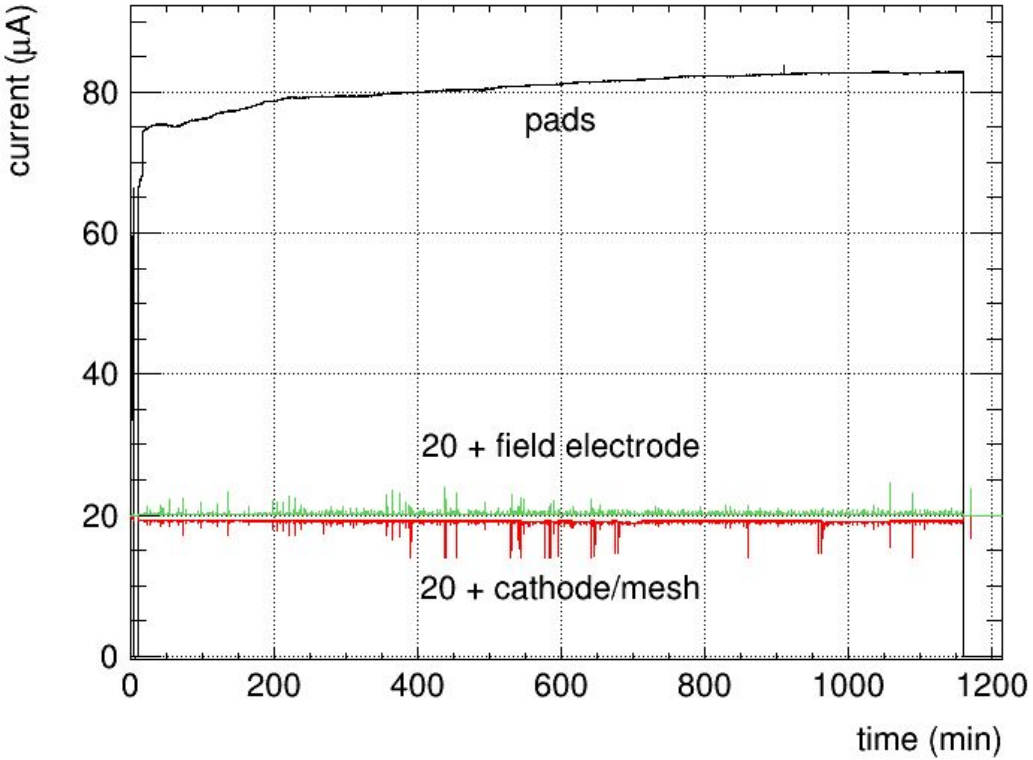


energy resolution with ^{55}Fe source



- gain exponential within 300-15000, nominal gain 2000
- energy resolution 12-14%, requirement <12%

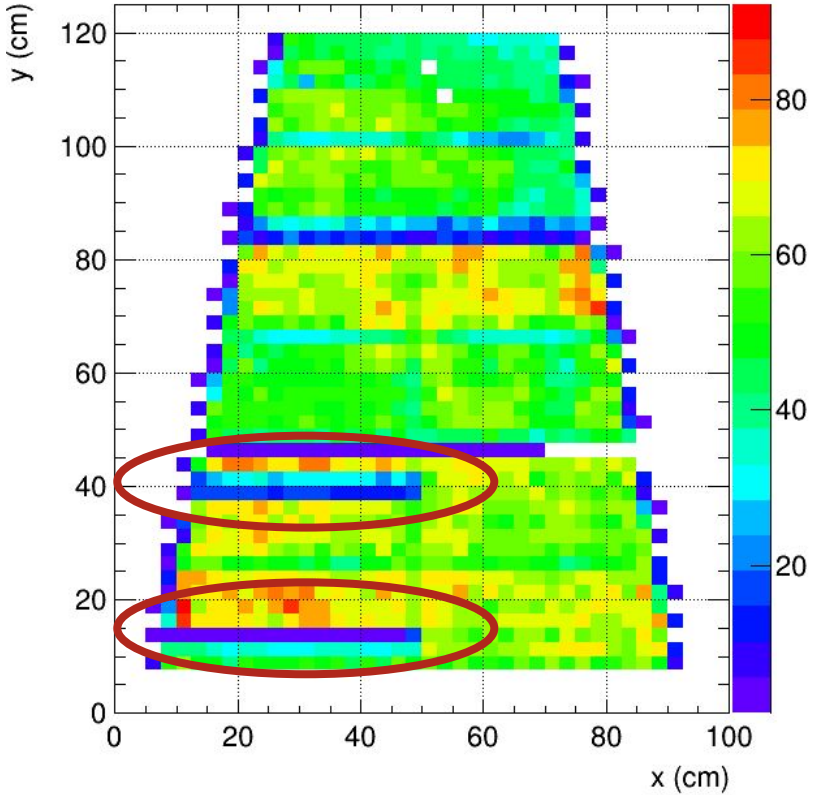
full illumination with x-rays, pad current 10 nA/cm^2



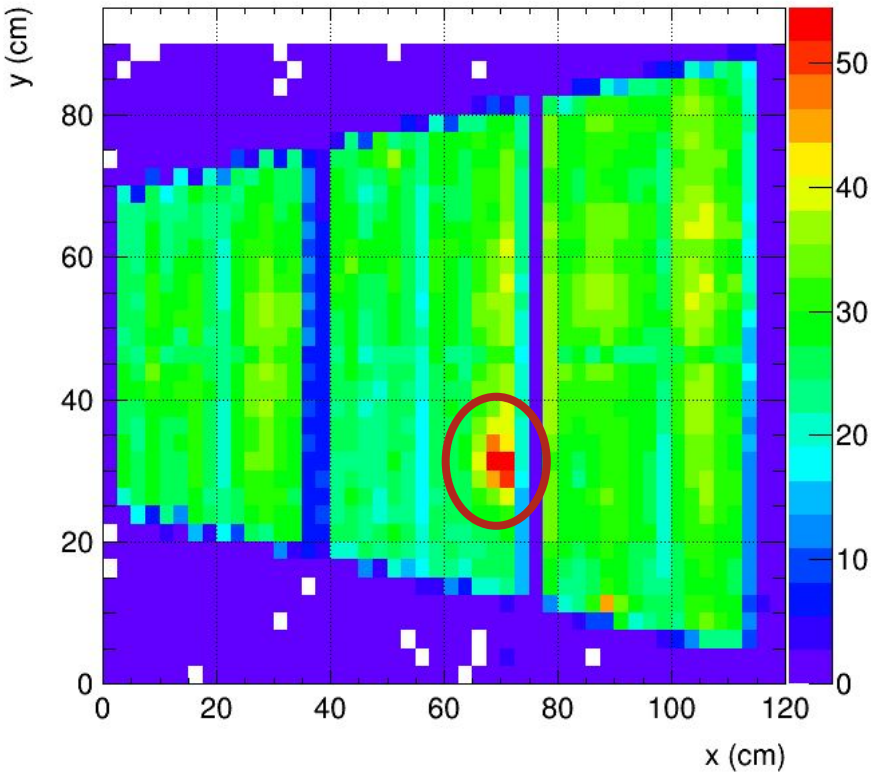
long x-ray irradiation at high intensity, chamber stable

encountered problems

OROC/00 missing segments

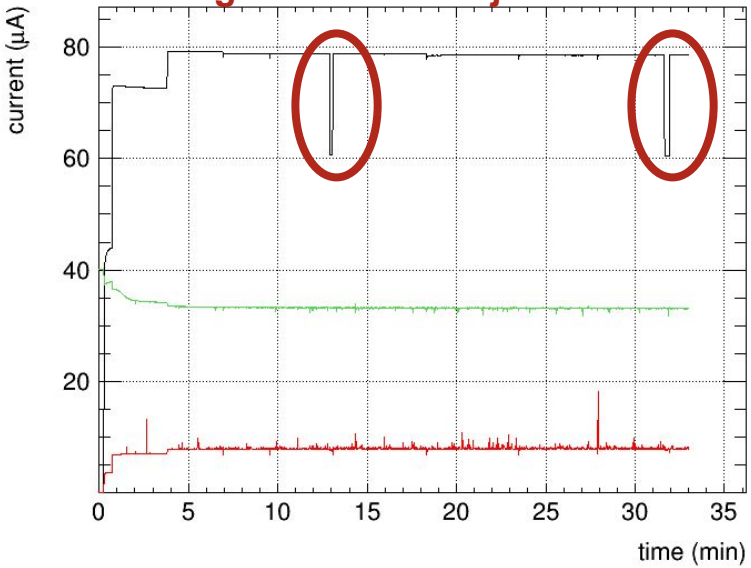


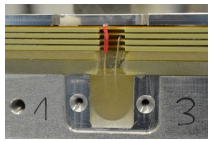
OROC/10 gain hotspot



encountered problems

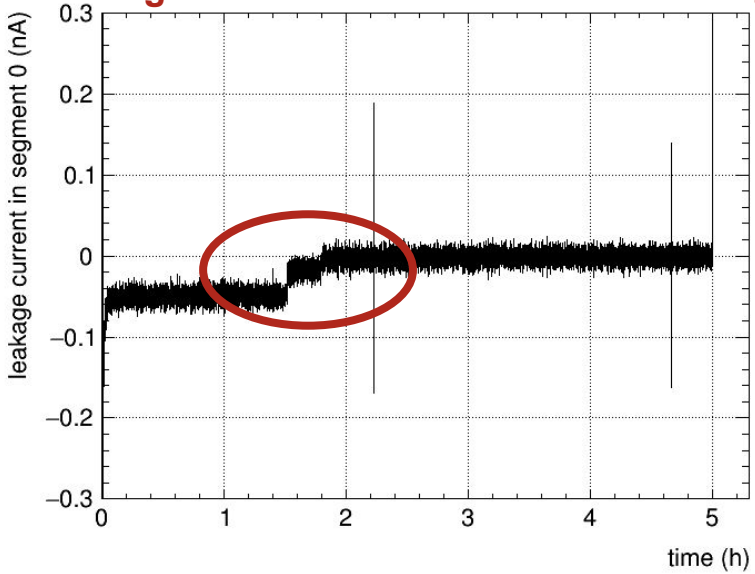
discharges between adjacent HV wires





2.1 kV between GEM3 top
poor fix of the GEM1 top wire

leakage current test sensitive to room light



not really a problem