ALICE Hardware activities

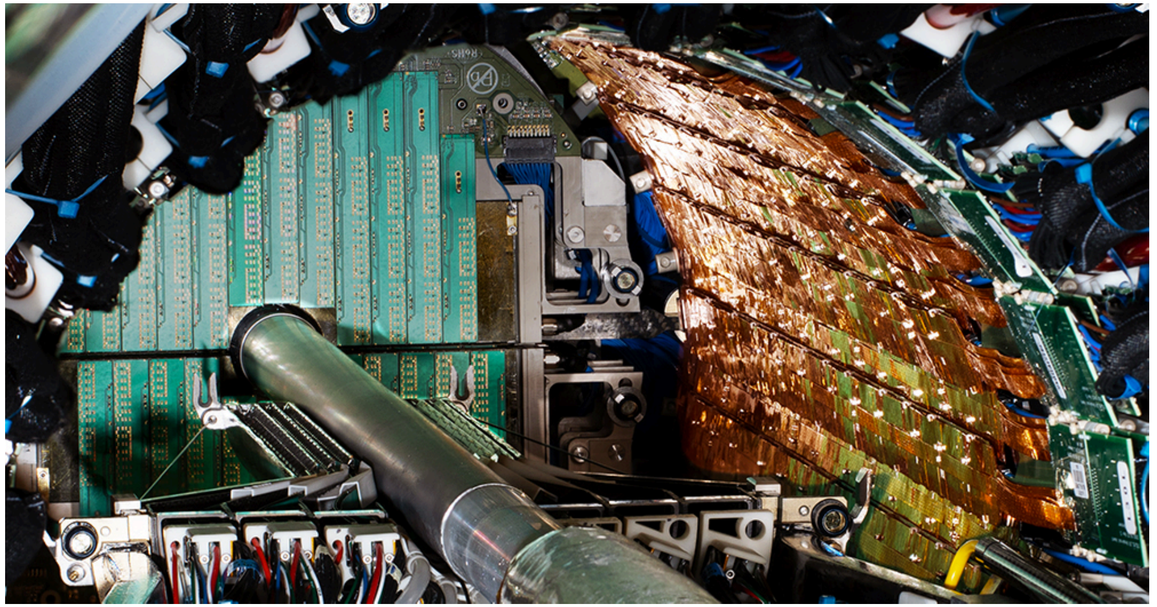
ALESSANDRO GRELLI

Nikhef

Nikhef Jamboree, *13th May 2024*

Hardware activities: ITS2

- ☑ New ALICE tracker (ITS2) taking data since 2021-2022. Largest MAPS pixel tracker ever made, ~10 m^2
- ☑ Tracking down to below p_T ~ 100 MeV/c with ~40-70% efficiency and pointing better than 20μm at 1 GeV/c
- ☑ Large Nikhef involvement from R&D to assembly and, commissioning, calibration and operation

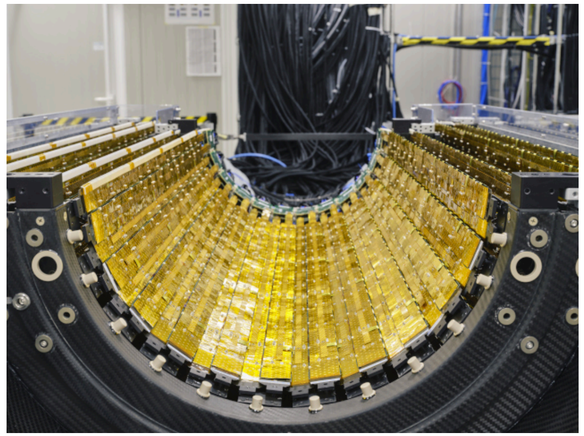


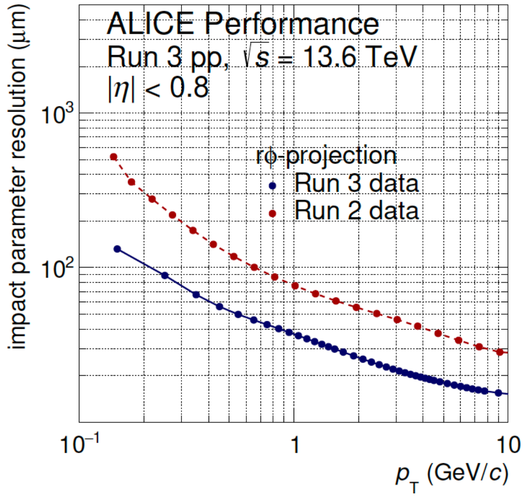
Jory Sonneveld

ITS2 System Run coordinator

Artem Isakov

ITS2 outgoing system run coordinator, now Deputy System Run coordinator and ITS2 DQ coordinator …

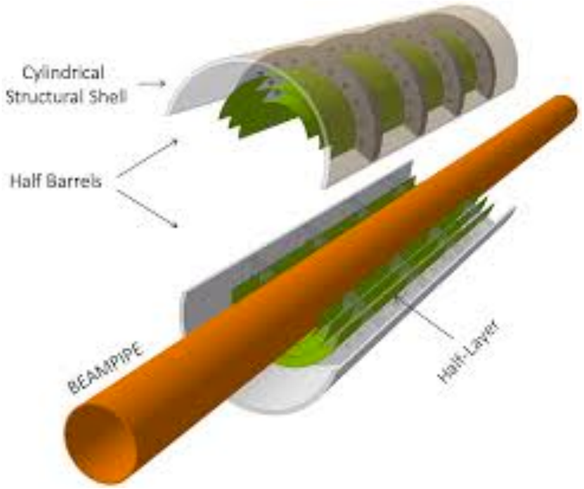




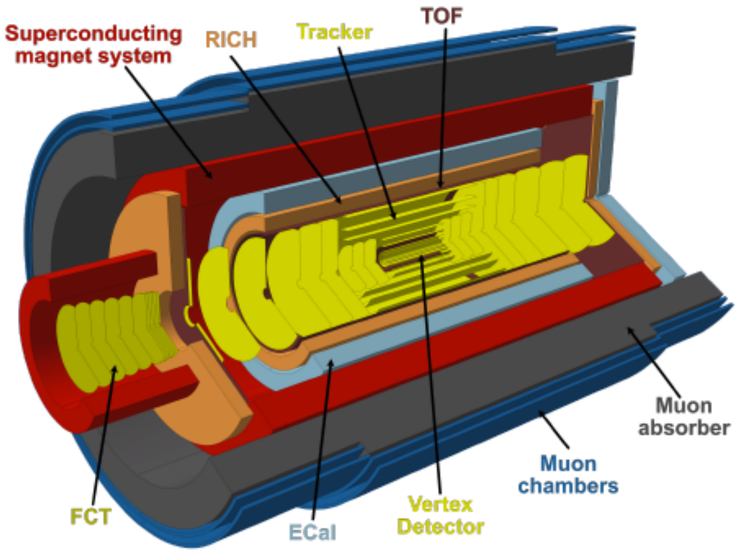
ALICE Hardware activities

≤ 2022: ITS2

2028: ITS3



2032: ALICE3



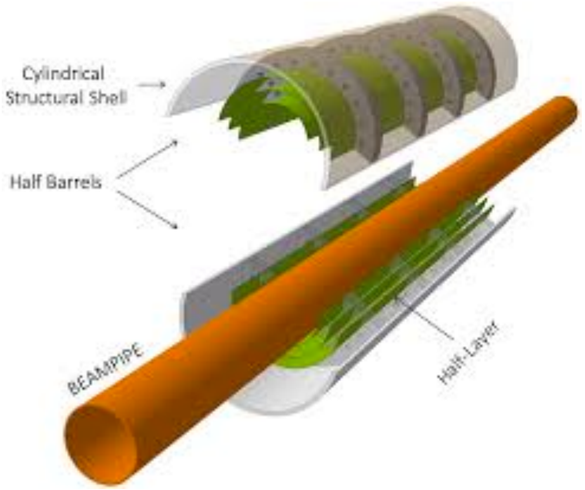
☑ **IDEA:**

Start sensor design activities on truly cylindrical ultra-light weight sensors (ITS3) with unprecedented spatial resolution targeting 2028. In the mean time profit of this development to start investigating timing technology. After 2028 the goal is to conjugate ps time resolution, low power and mum spatial resolution (ALICE3)

Coming soon

≤ 2022: ITS2

2028: ITS3



2032: ALICE3

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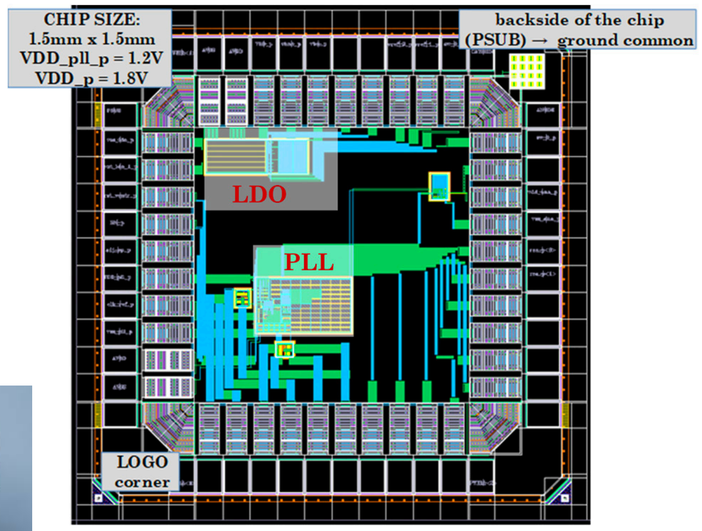
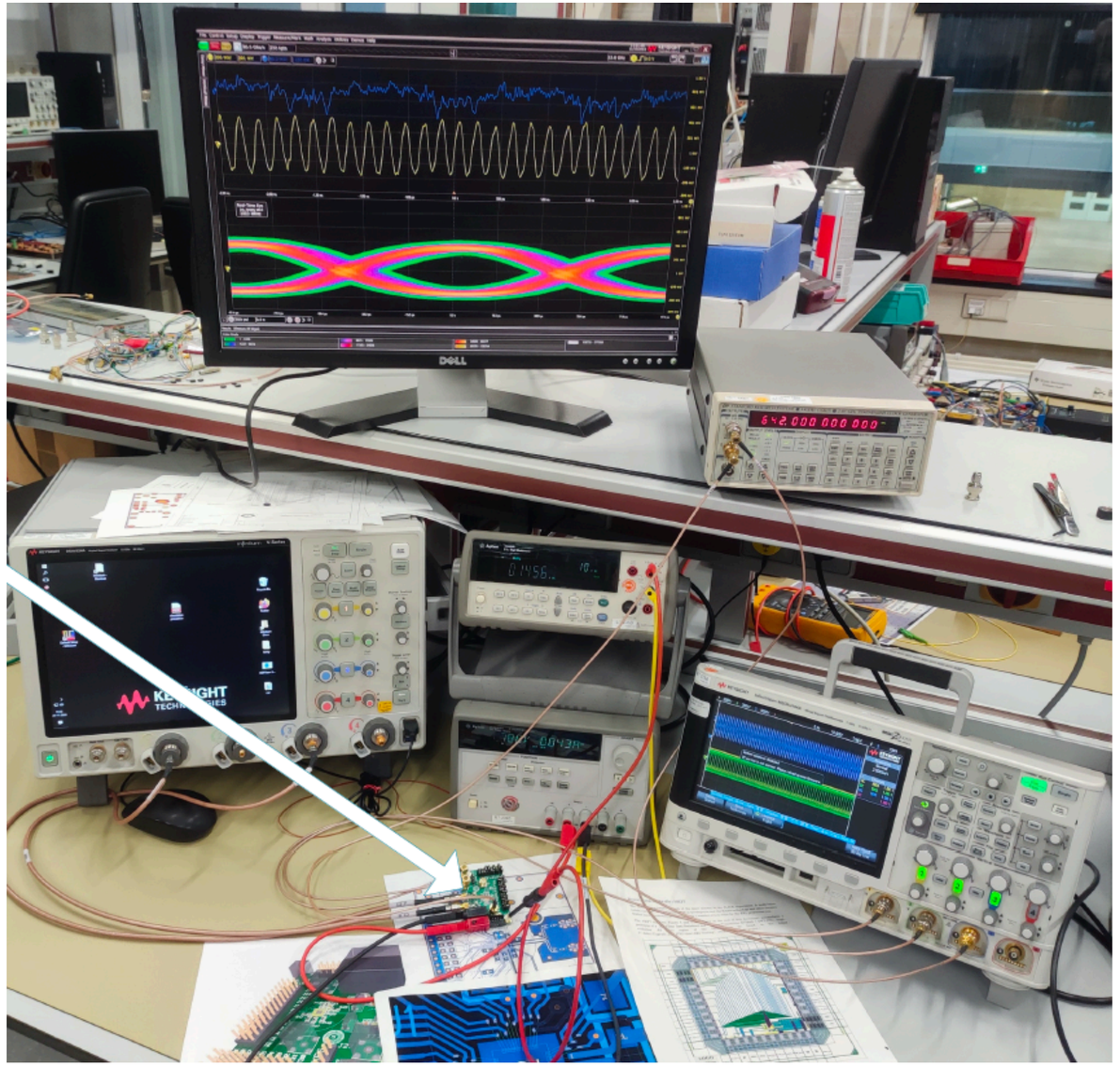
ALICE ITS3 @Nikhef

- ☑ Nikhef is designing the ITS3 serialiser at 10.24 Gb/s and later The ITS3 fast link will be validated in Utrecht/Nikhef
- ☑ Serialiser analog core as well as PLL and LDO already available as test chips. Characterisation in house and at radiation facilities ongoing



Vladimir Arsenij Djan



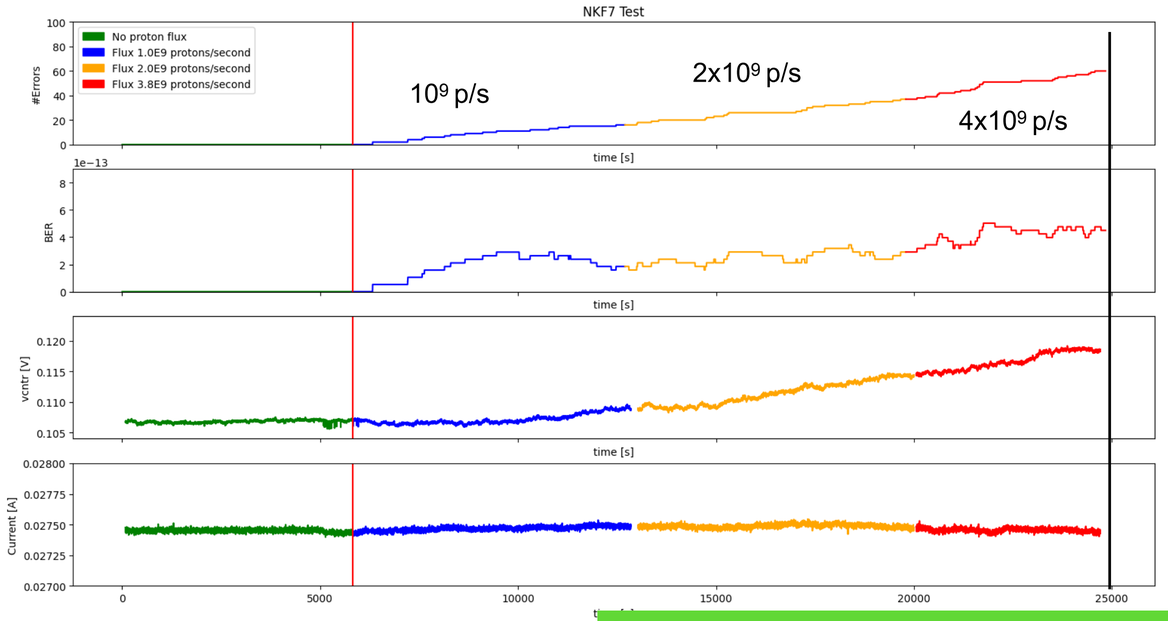
Super thanks to our ET group and especially to Ruud, Vladimir, Arsenij and Omar!!!

ALICE ITS3 @Nikhef

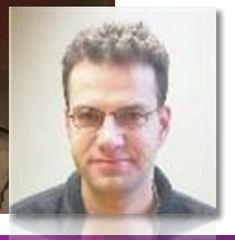
- ☑ Nikhef designed test structures tested for radiation last week in Prague cyclotron facility.
- ☑ Test beam has been successful, data are being analysed as we speak

Beam on

16 Mrad dose



Single event upset cross-section ~ 10^{-12}



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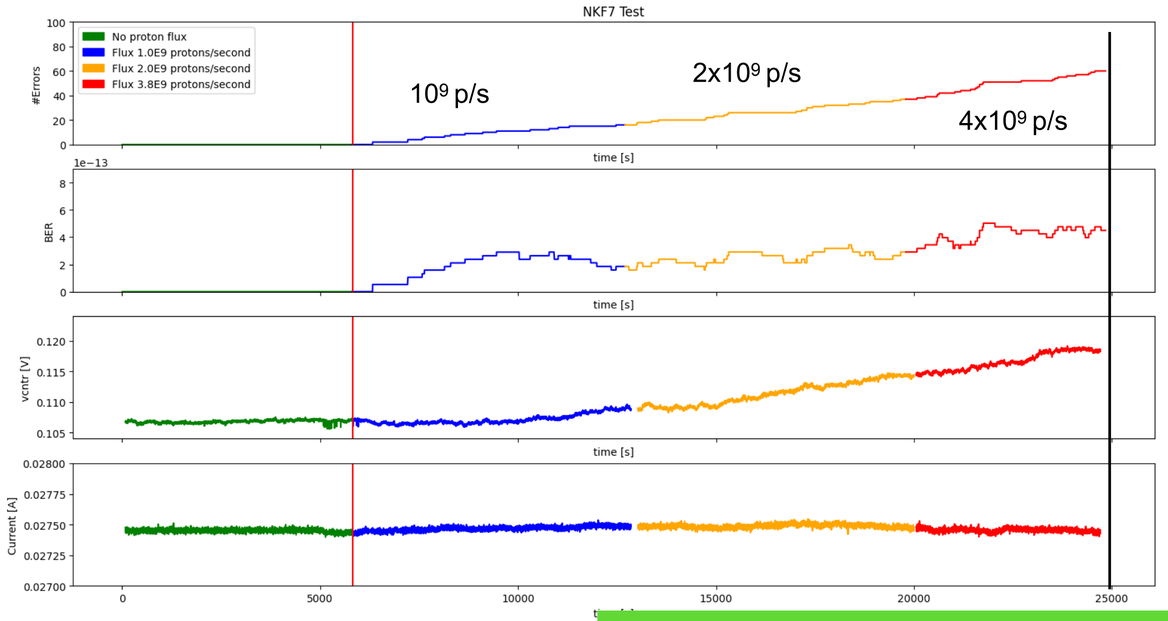
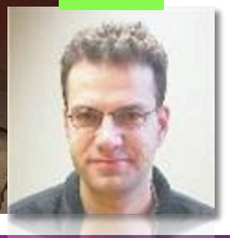


Single event upset cross-section ~ 10^{-12}

Theory meets experiment .. and it likes it

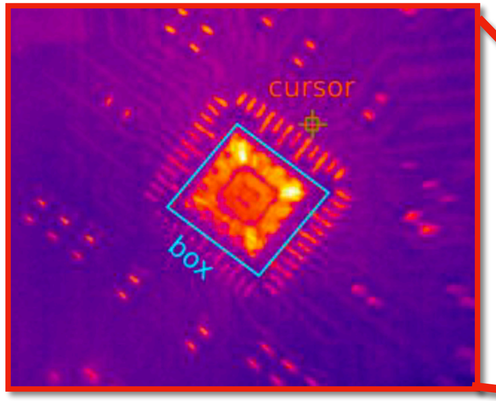
Marcel



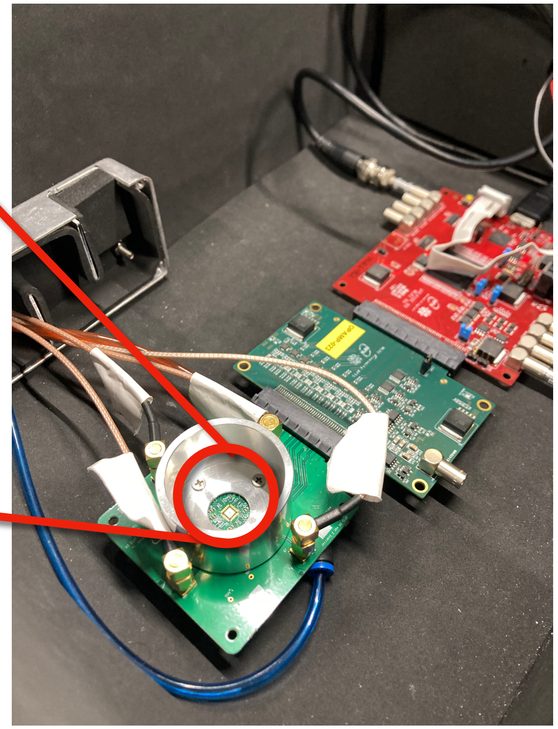
MAPS radiation hardness: APTS

- ☑ Analog test structure (APTS) at testy beam proved to survive 10^{15} neutron equivalent flux. Can we go higher? Can we prove that maps are still operational at 10^{16}?
- ☑ At present we have APTS chips irradiated up to 10^{16}. We prepared a setup to measure leakage currents and verify their operational status

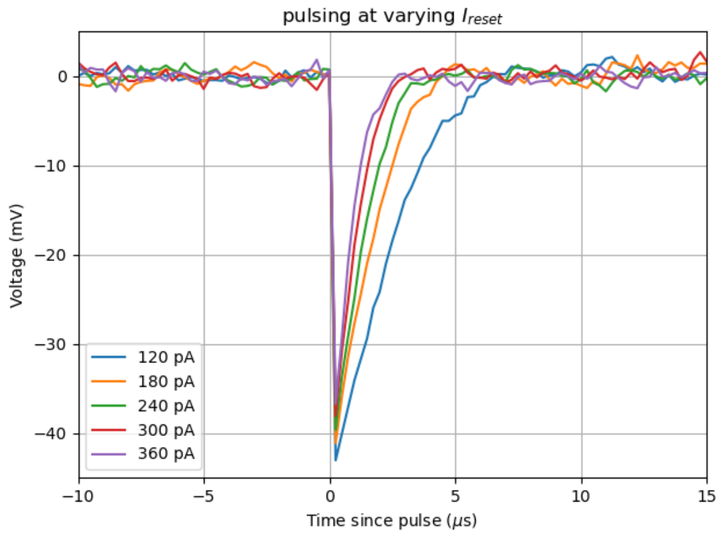
APTS chip under thermal camera



Charge calibration



Cooling test nikhef setup



Isis

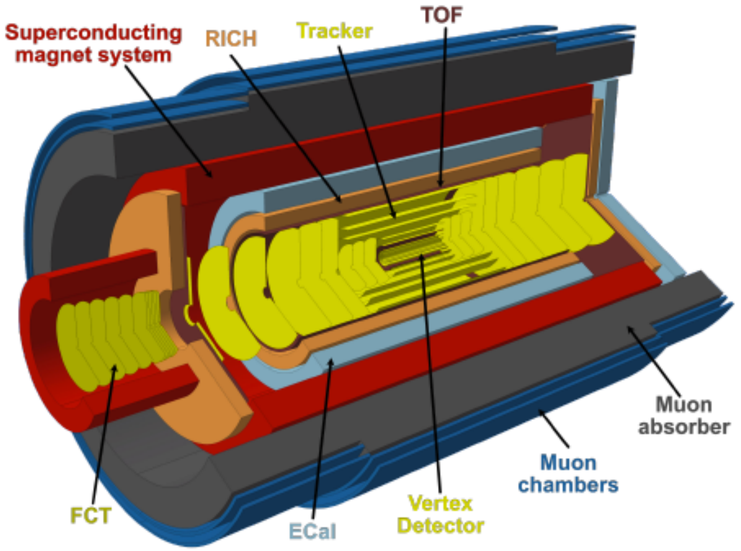
Work ongoing! Stay tuned

ALICE3: 2032 and beyond

≤ 2022: ITS2

2028: ITS3

2032: ALICE3



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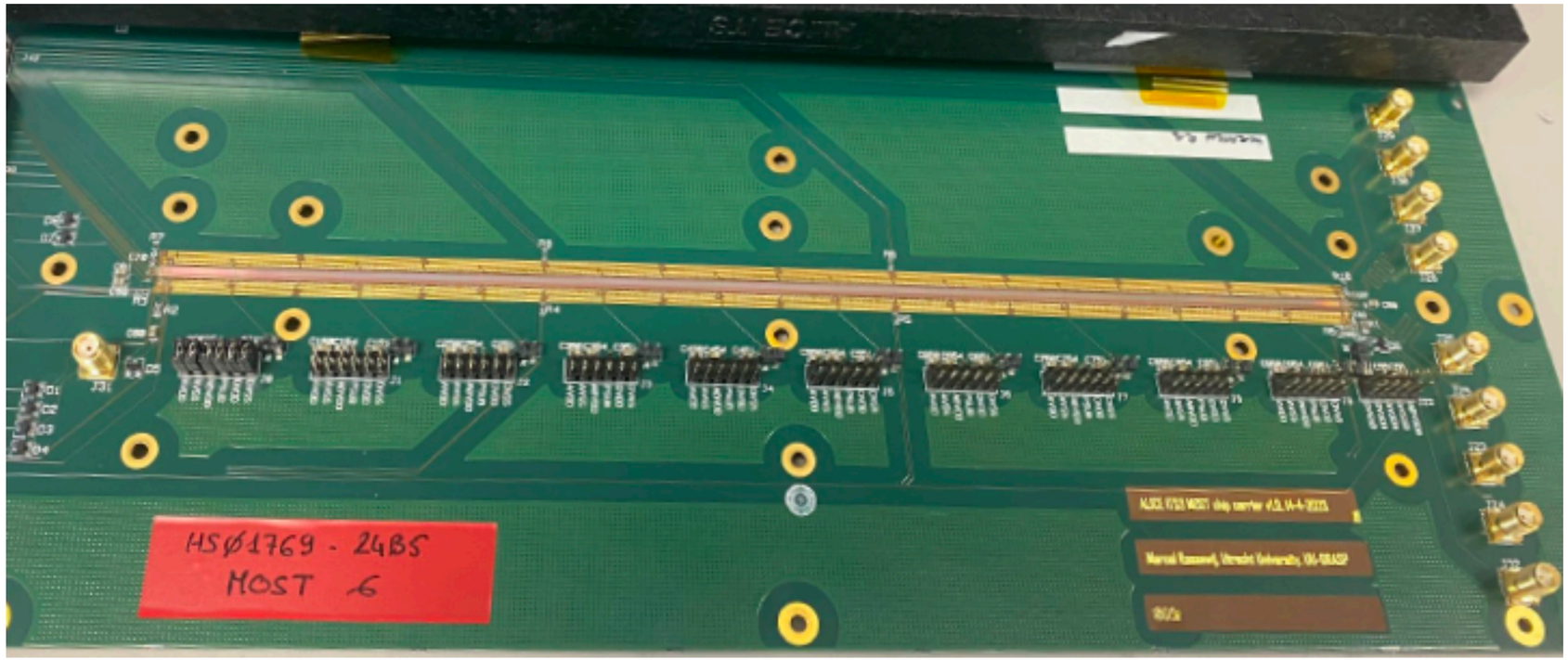
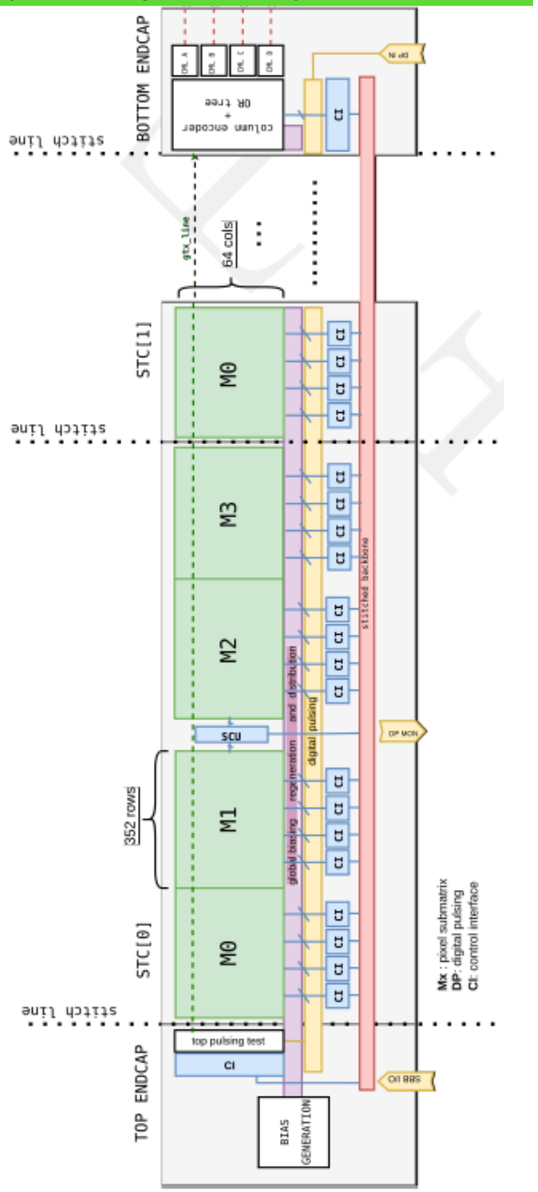
A selection of activities: MOST

Design: (Nikhef) Arsenij Vitkvsky and CERN

- ☑ **MOST**: **MO**nolithic **S**titched sensor with **T**iming
- ☑ First stitched sensor (25cm x 2 mm) with timing capabilities

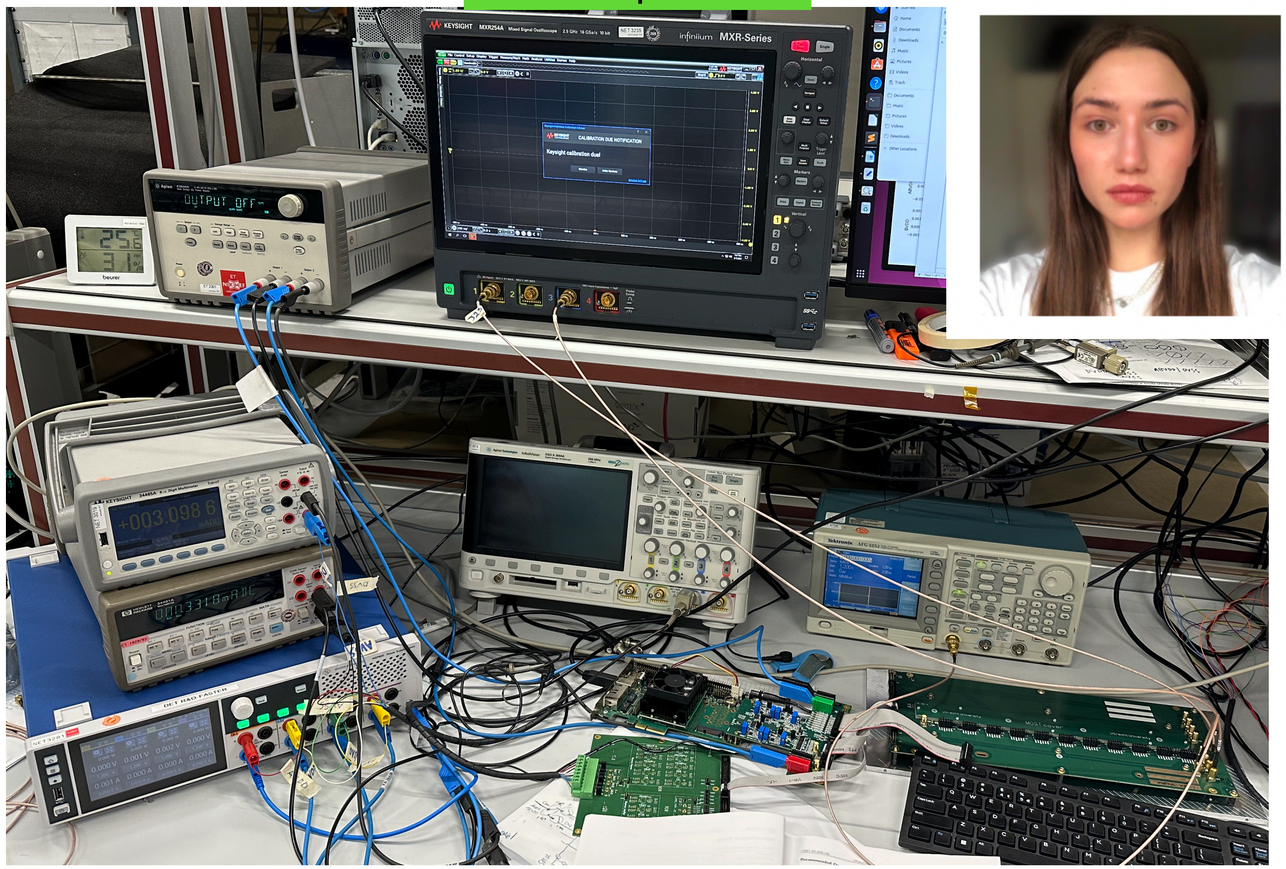




A selection of activities: MOST

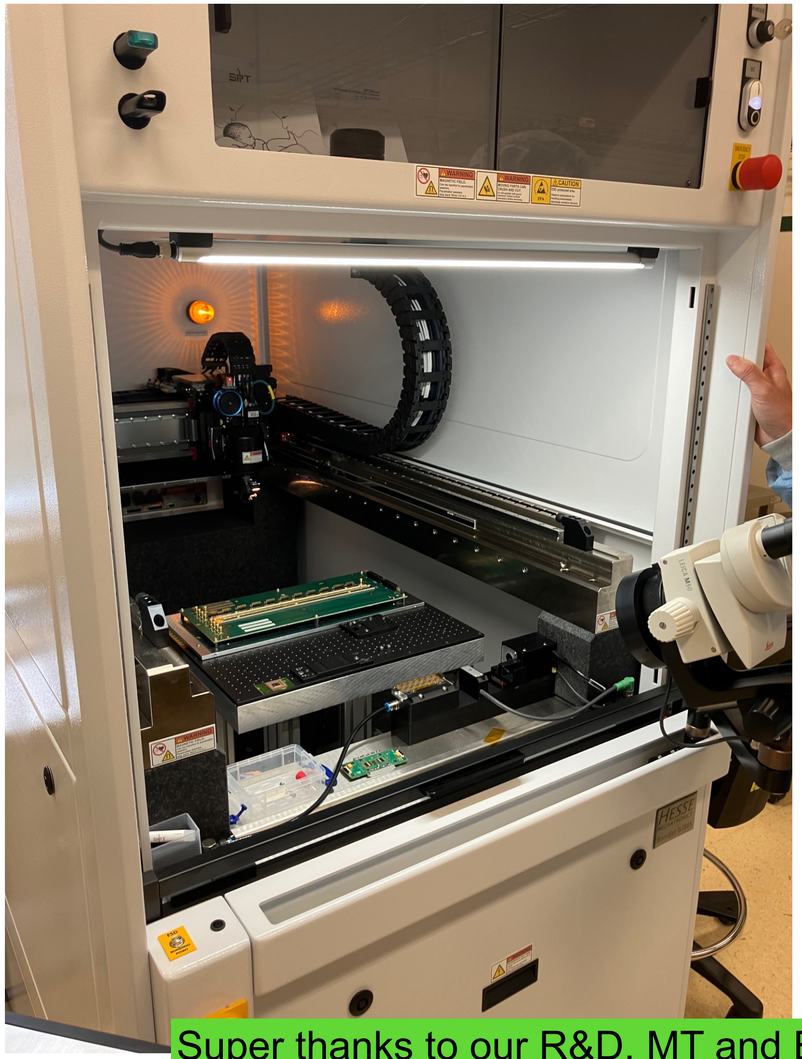
☑ MOST Characterisation

Test setup at R&D



Mariia

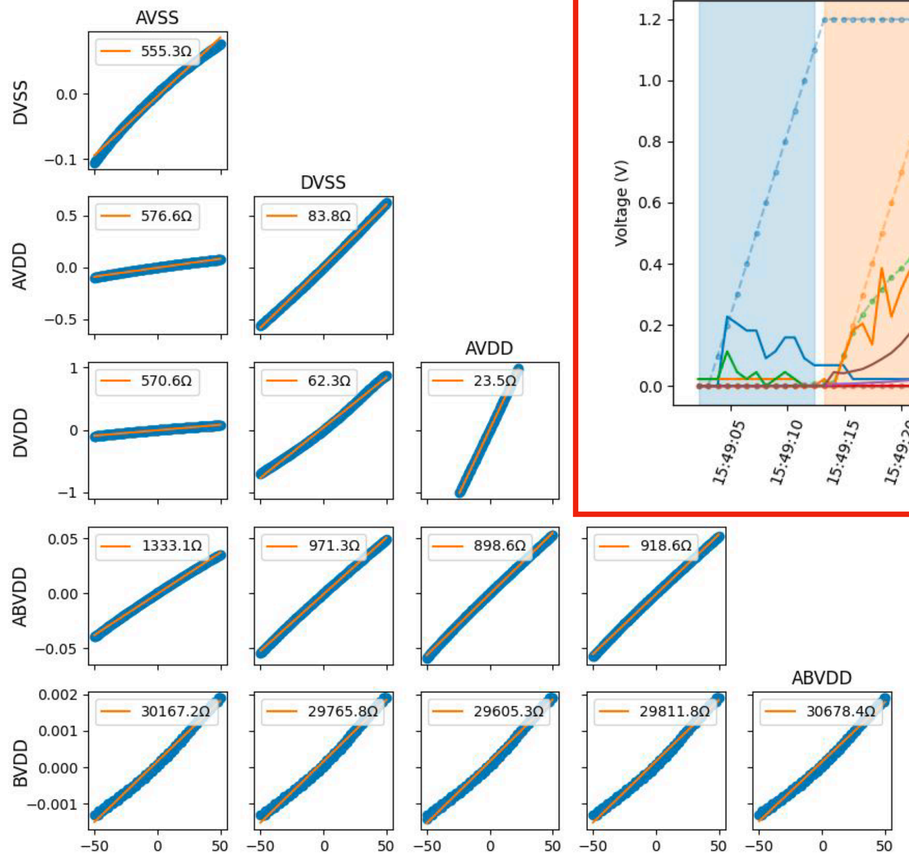
Bonding tests



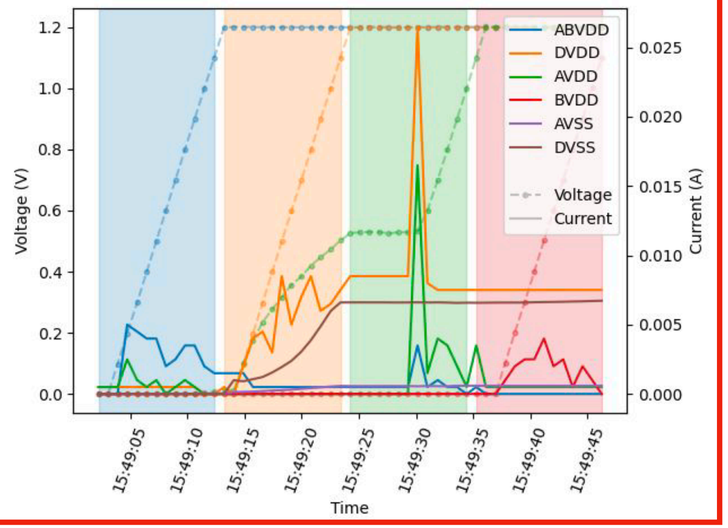
Super thanks to our R&D, MT and ET group!!!

A selection of activities: MOST

Impedance tests

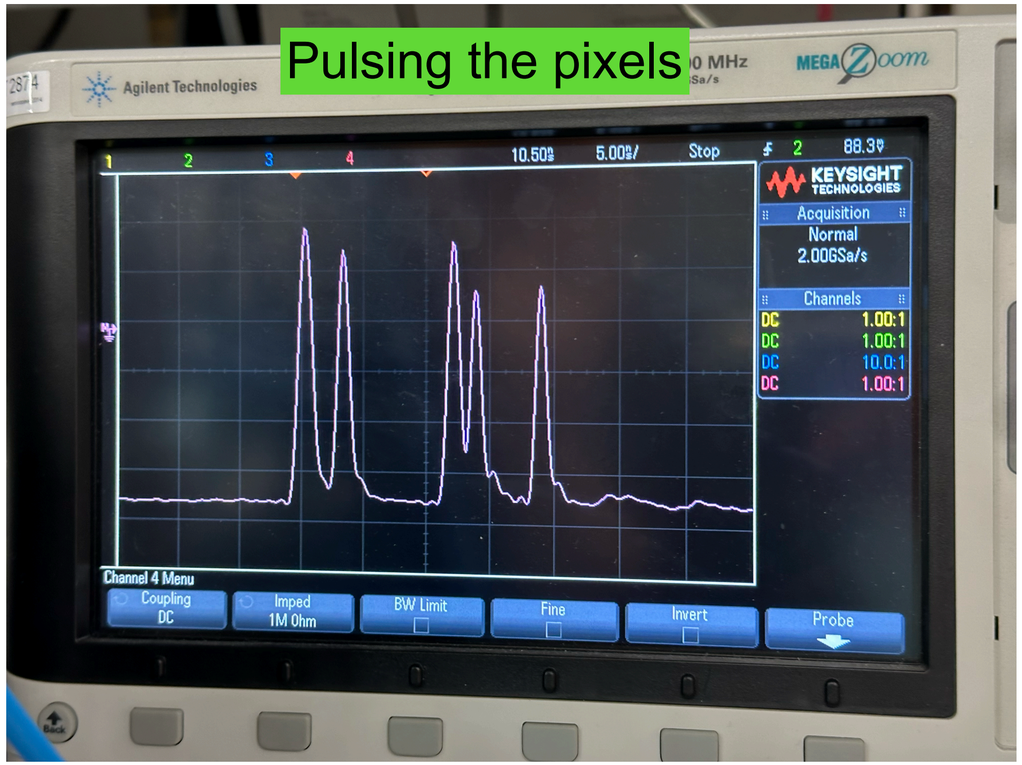


Powering up tests

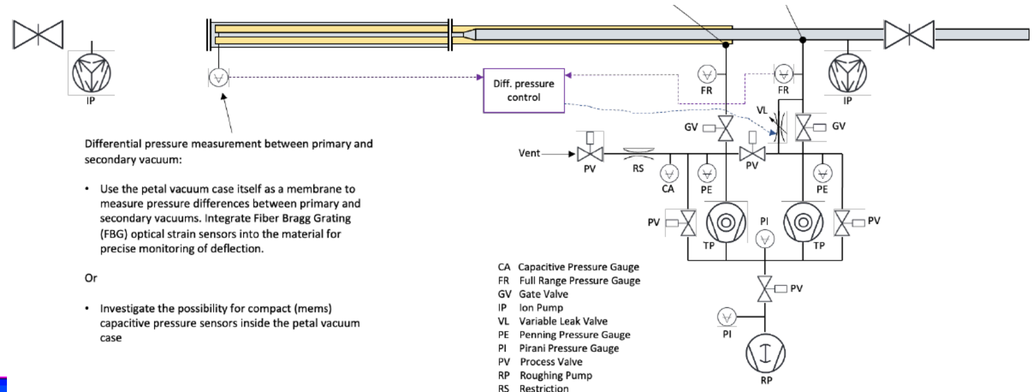


- ☑ Nilkhef work on MOST
  - Qualify for yield
  - Measure time resolution
- ☑ Work on progress! Stay tuned

Pulsing the pixels



Much more ongoing but time is up



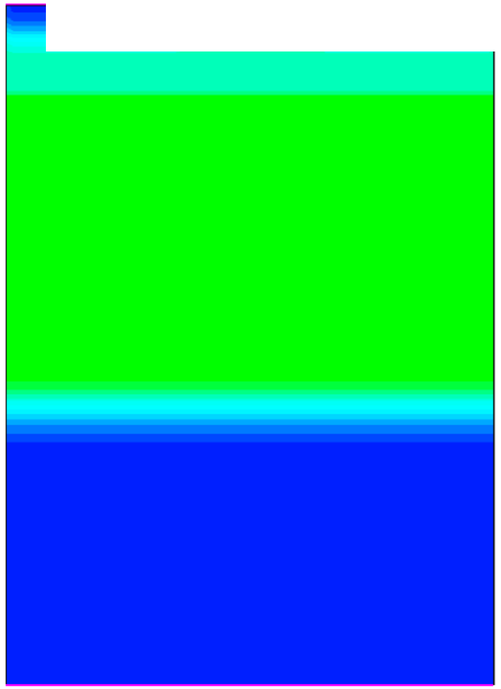
Differential pressure measurement between primary and secondary vacuum:

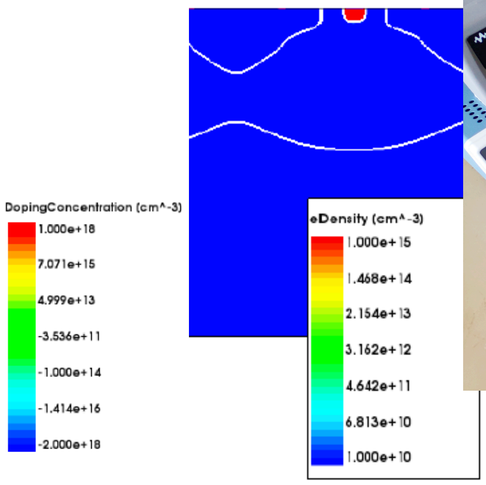
- Use the petal vacuum case itself as a membrane to measure pressure differences between primary and secondary vacuums. Integrate Fiber Bragg Grating (FBG) optical strain sensors into the material for precise monitoring of deflection.

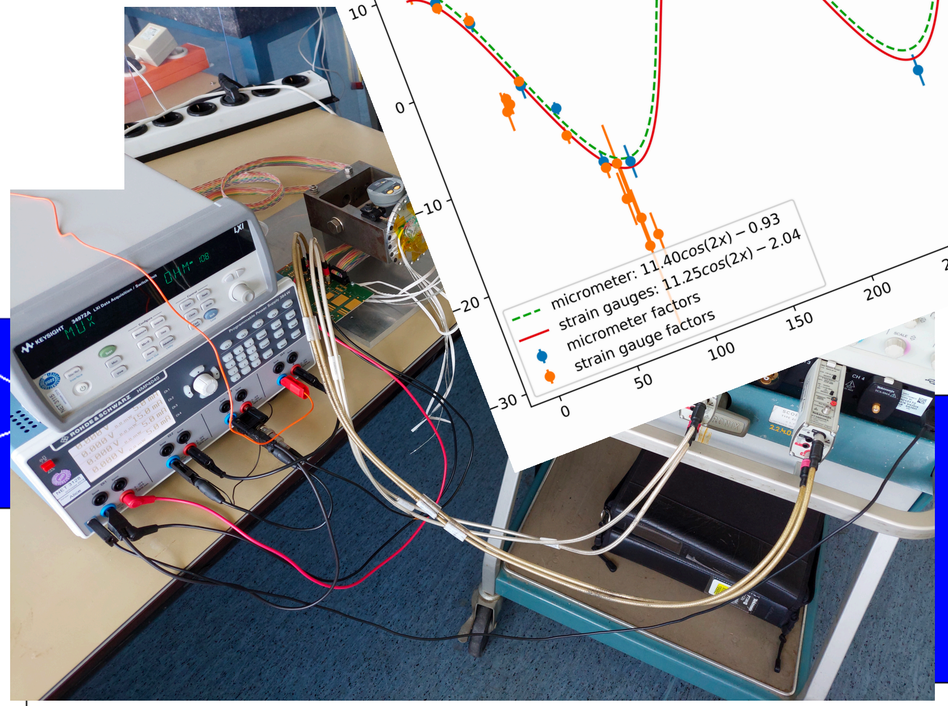
Or

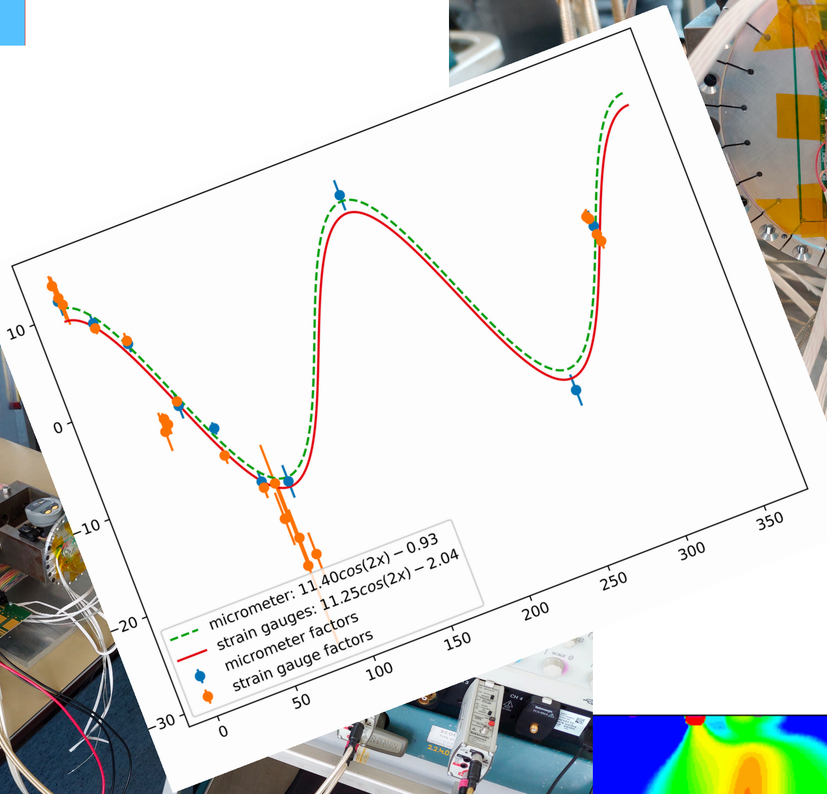
- Investigate the possibility for compact (mems) capacitive pressure sensors inside the petal vacuum case

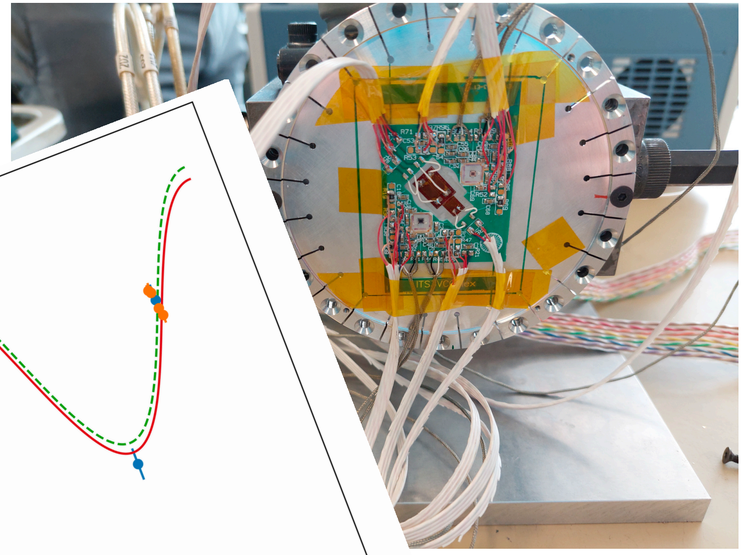
CA Capacitive Pressure Gauge
FR Full Range Pressure Gauge
GV Gate Valve
IP Ion Pump
VL Variable Leak Valve
PE Penning Pressure Gauge
PI Pirani Pressure Gauge
PV Process Valve
RP Roughing Pump
RS Restriction
TP Turbo Pump

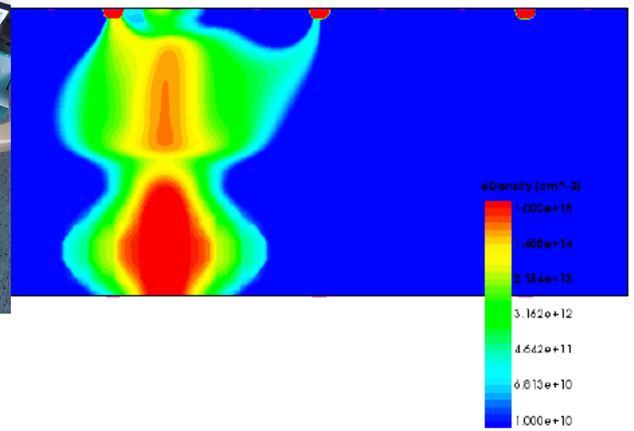






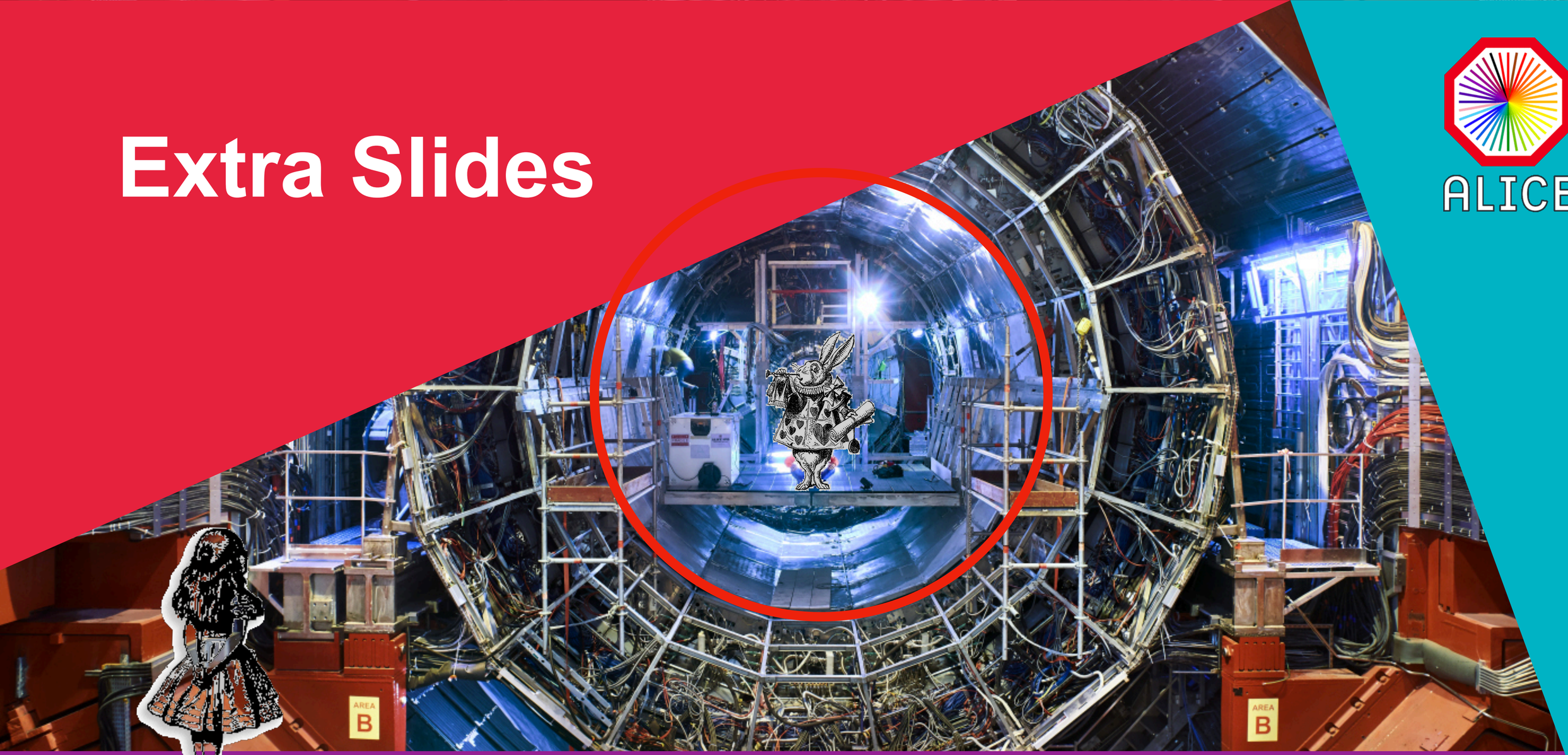






THANKS

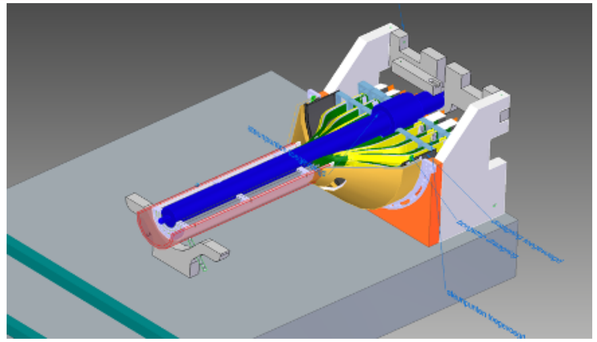
Extra Slides

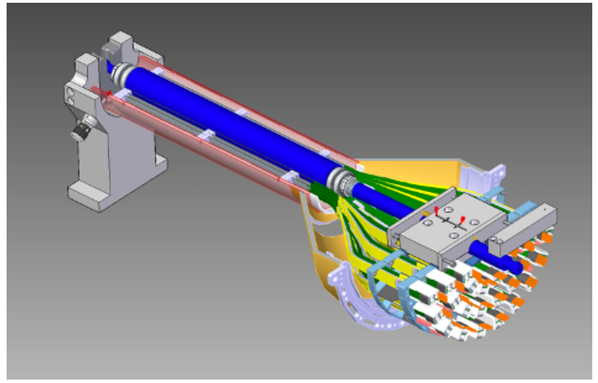


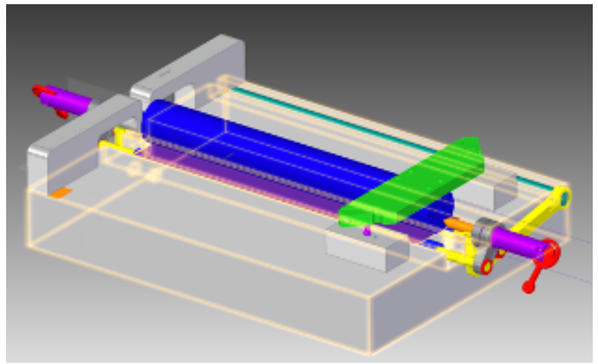
ALICE

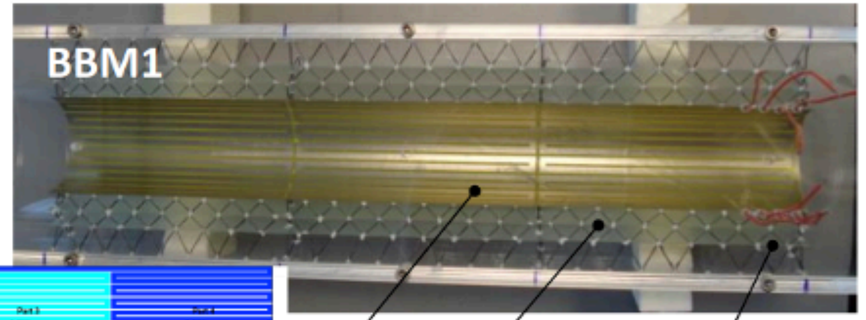
Nikhef

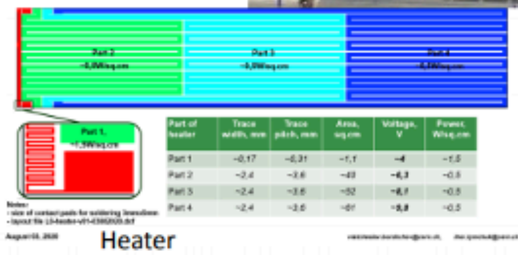
Mechanics: Wind tunnel and assembly







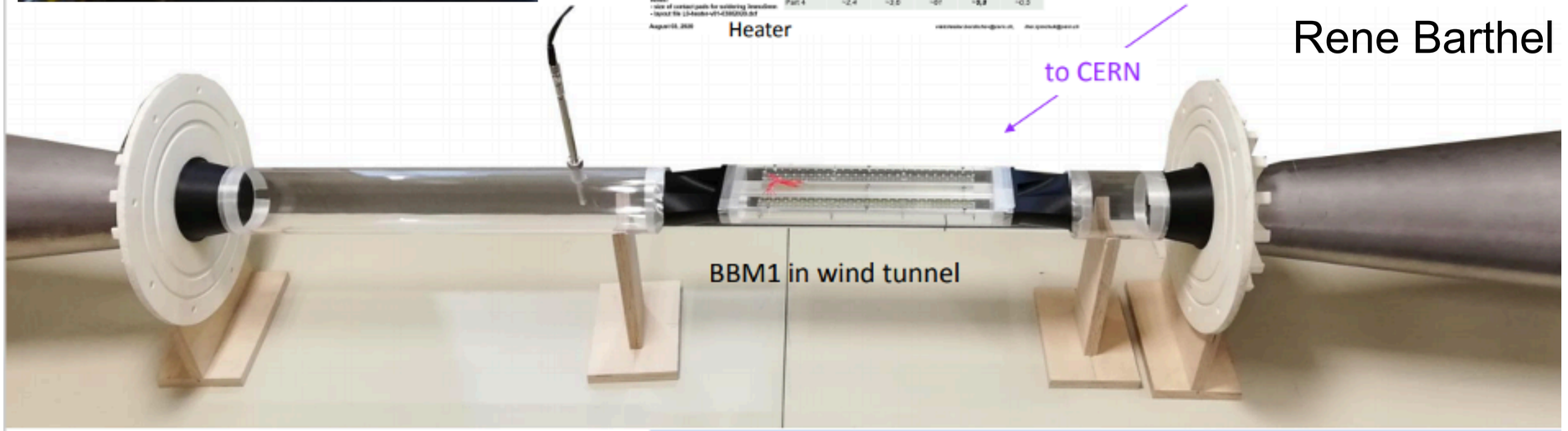




from Nikhef

Rene Barthel

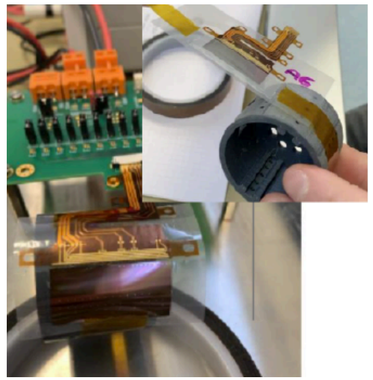
to CERN

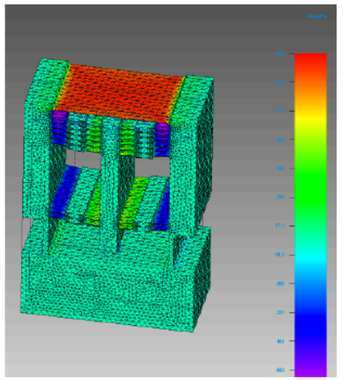


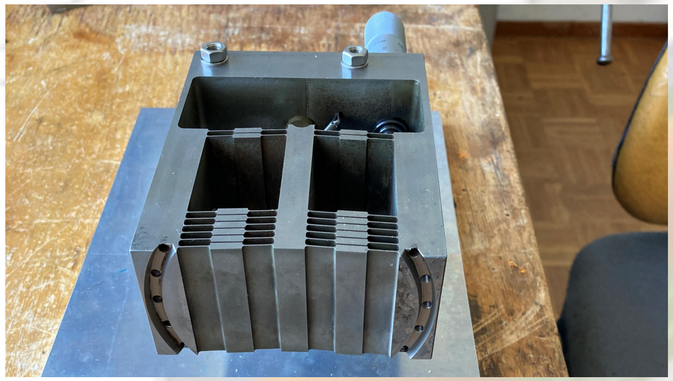
ALICE ITS3 @Nikhef

- ☑ Quite some nice activity in the last two years for what concerns mechanics, chip design and electronic

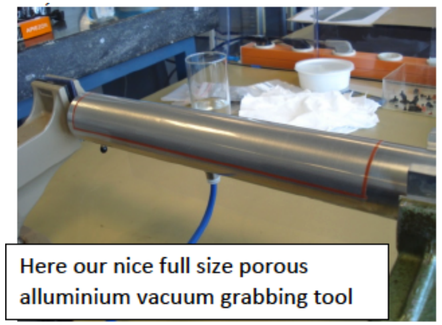
Piezoresistive effect: stretching and bending



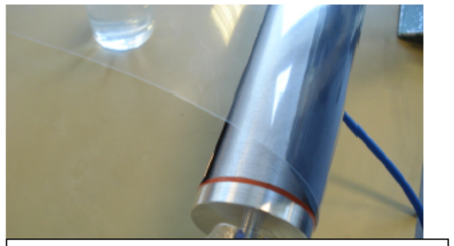




Tooling: Assembly tools

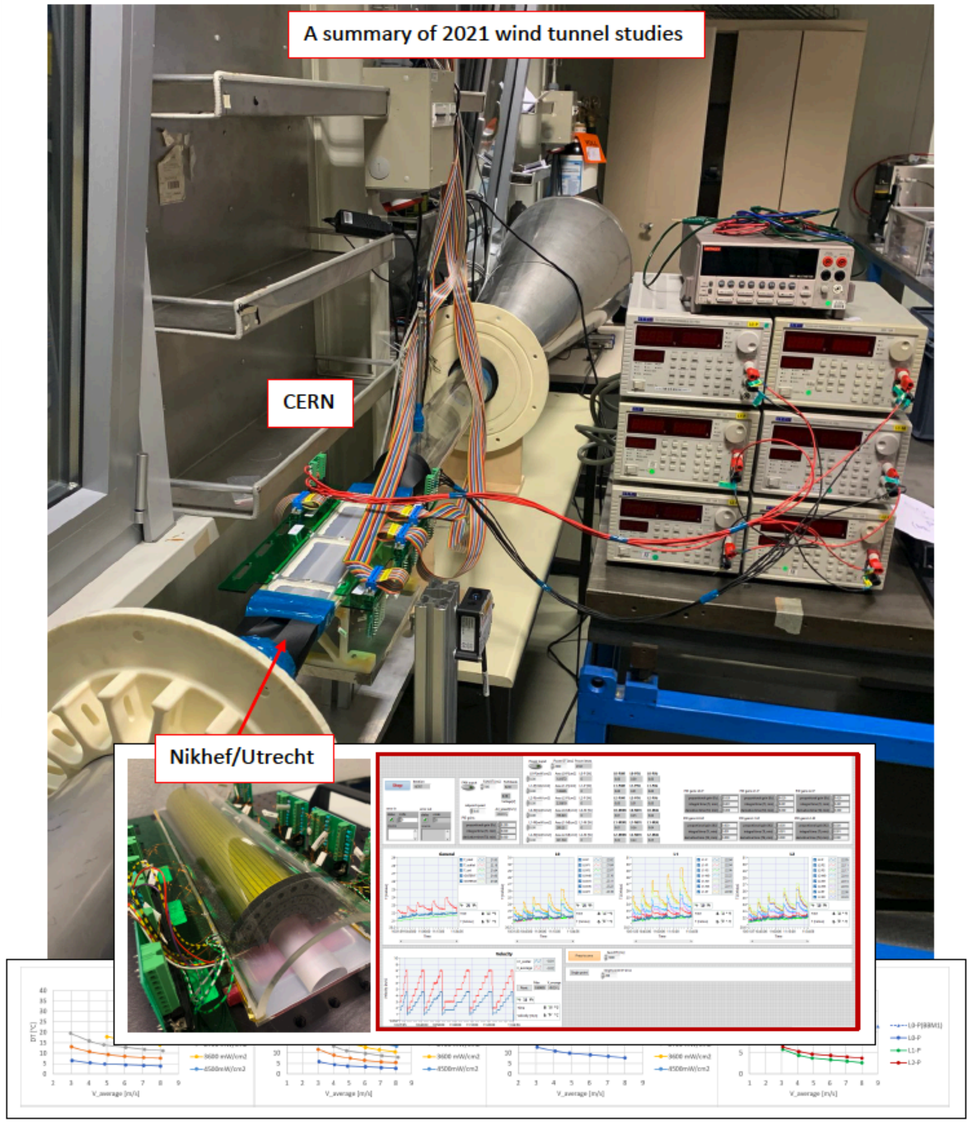


Here our nice full size porous alluminium vacuum grabbing tool



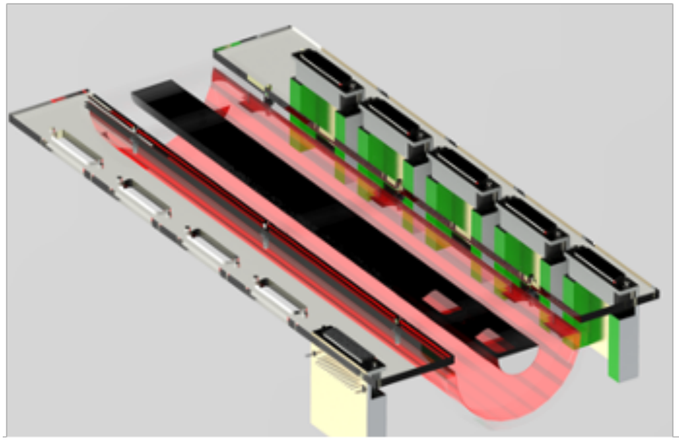
Here how we nicely failed with the first full size attempt … but learning from it

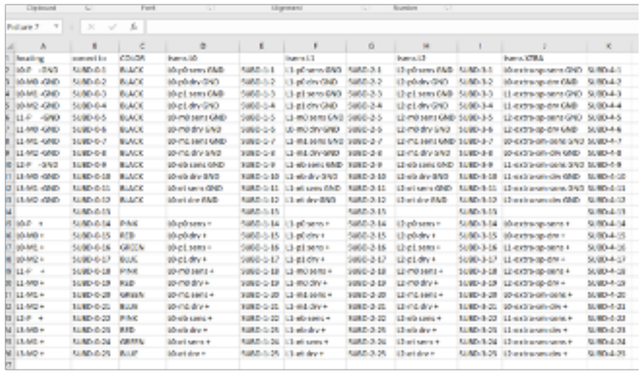
Mechanics: wind tunnel studies



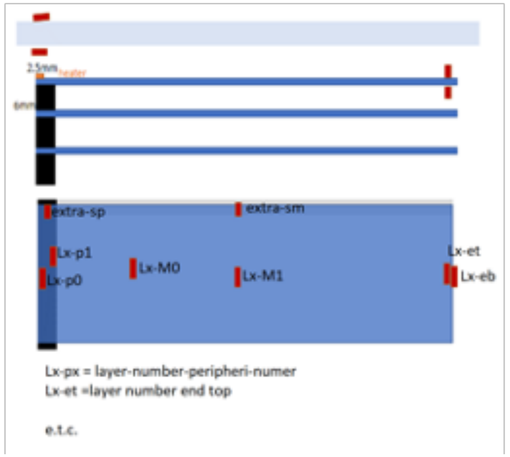
Mechanics: Wind tunnel, what next

Preparations for BBM2

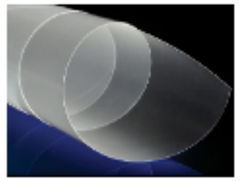




Wil provide list with connections



Infrared (IR) Material Windows



- Excellent Optics for Infrared Detectors
- Minimal Absorption Loss from 8 - 14µm
- Easily Cut to Size

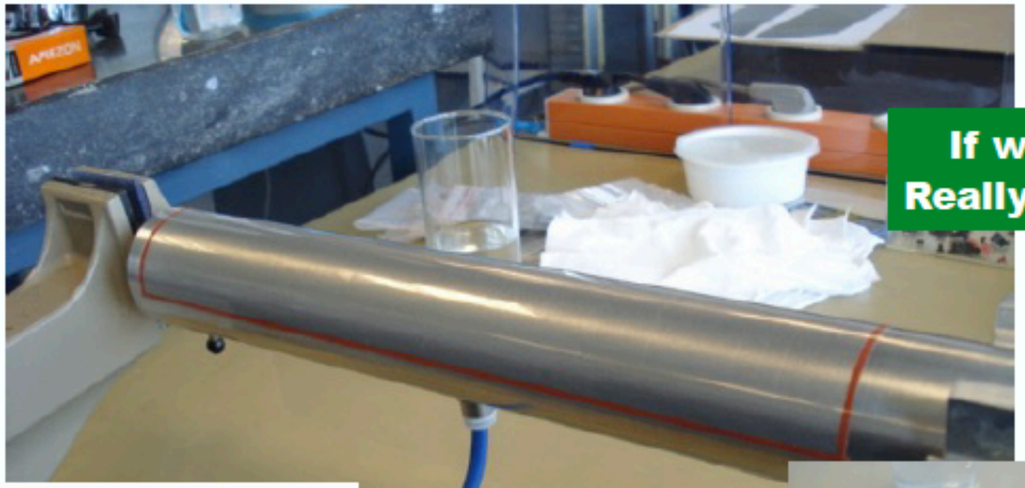
Common Specifications

Thickness (mm):	0.38	**Thickness (inches):**	0.015
Coating:	Uncoated	**Coefficient of Thermal Expansion CTE (10^{-6}/°C):**	11 - 13
Flexural Modulus (psi):	(100-260) x 10^3	**Index of Refraction n_d:**	Visible (Sodium D Line): 1.52 8-14µm: 1.53 15µm+: 1.48
Operating Temperature (°C):	100 (Max.)	**Shore Hardness:**	D60-70
Substrate:	Polymer Film	**Wavelength Range (nm):**	8000 - 14000
Young's Modulus (GPa):	0.40 - 1.24		

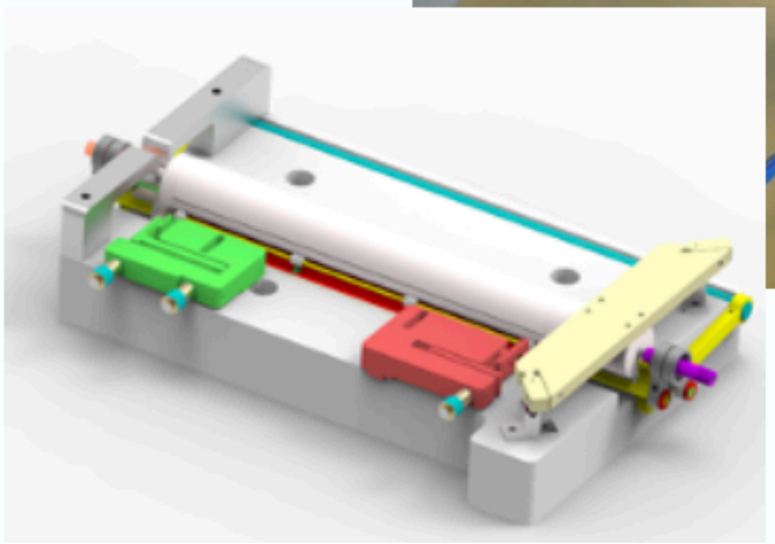
Rene Barthel

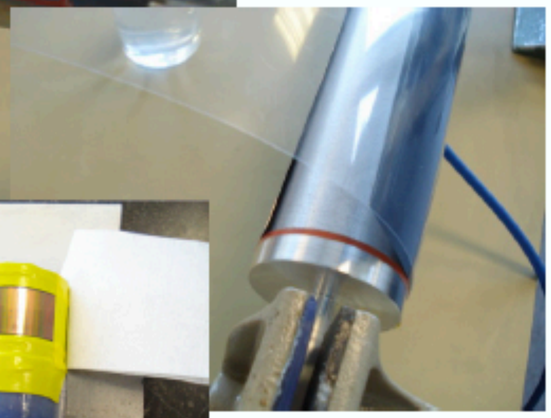
Mechanics: Vacuum bending tools and carbon foam

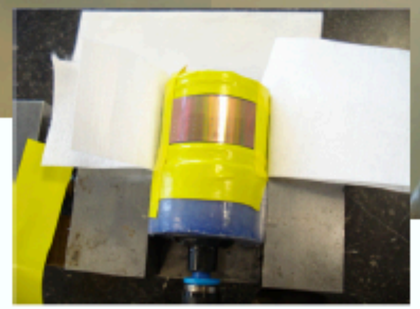
Rene Barthel

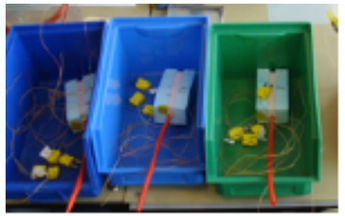


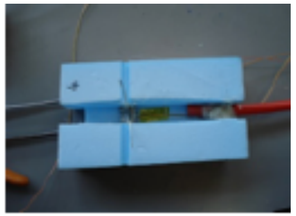
If work this will be
Really a major success

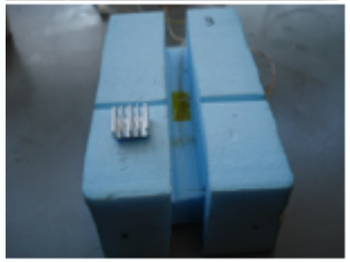


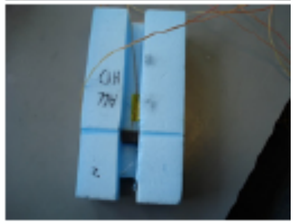


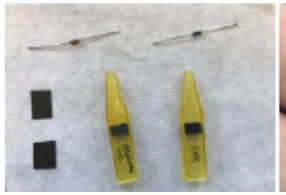


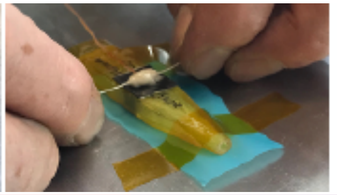




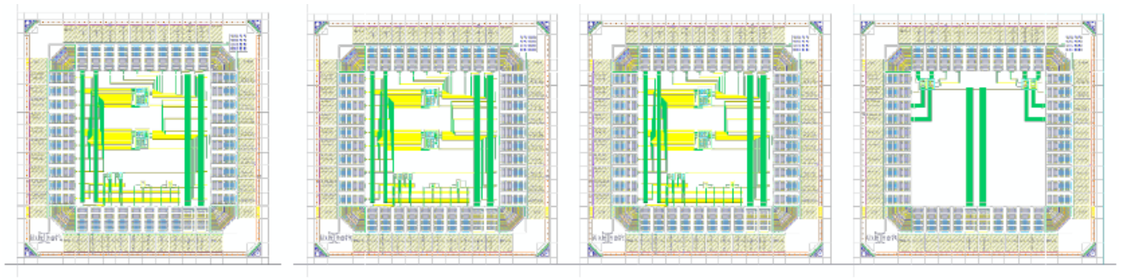






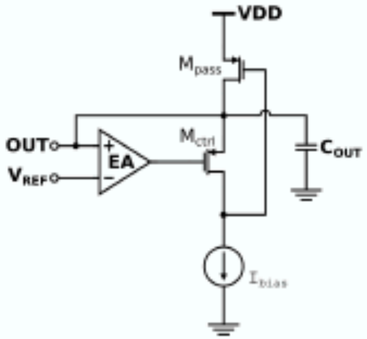


Design: Band Gaps (x4), VCO, Tsensor, LDO and PLL

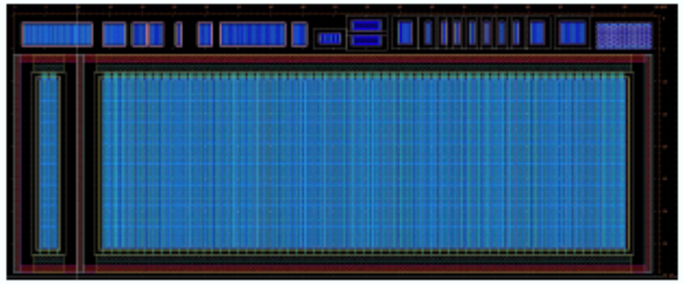


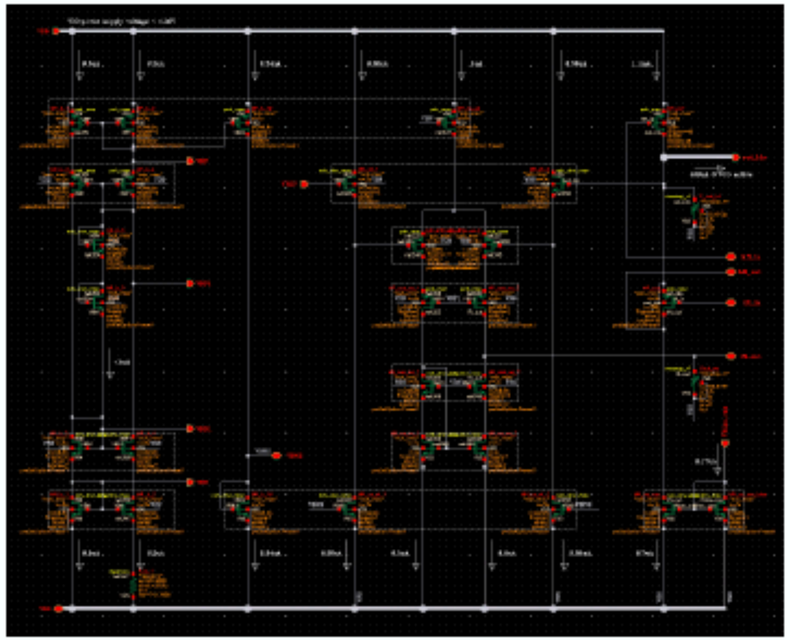
- GDS, along with DRC, ESD and LVS summary of four dies delivered to CERN.
- Die I – Diode and PNP BGR circuits.
- Die II – DTMOS and diode gated BGR circuits.
- Die III – Diode and PNP TS circuits.
- Die IV – pch IMOST varactor and nch IMOST varactor VCOs.

LDO



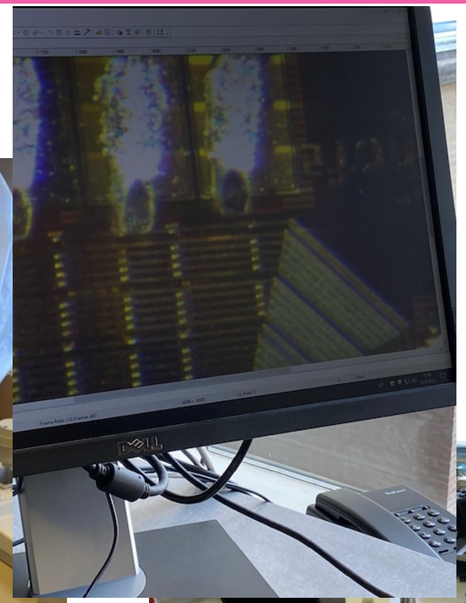
☑ LDO and PLL already designed.
Still a month of checks needed but we will be ready by the end of November 2021 (perfectly in time)

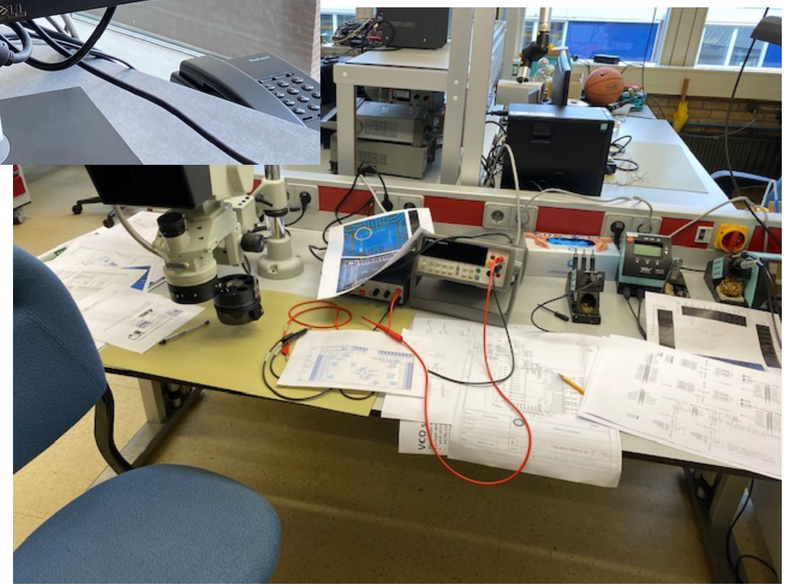




Deepak, Vladimir, Asli

Test of designed structures

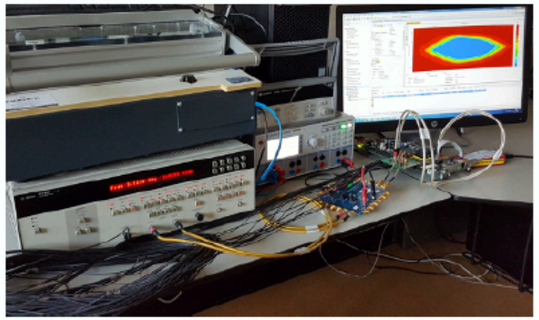




Marcel Rosswji, Shi, Vladimir + MT bonding lab

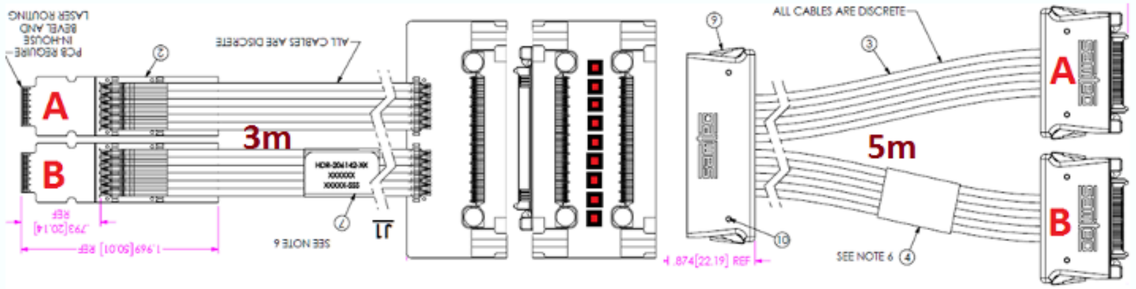
Fast Link: Cable studies and intermediate board

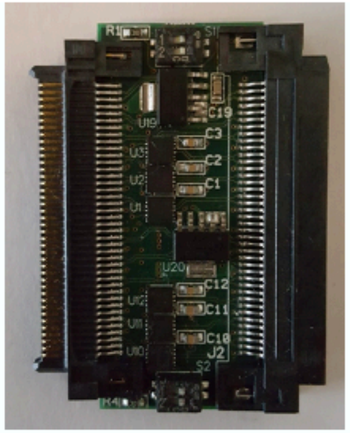
Rate Mbps	Pre-emphasis DS25BR120	Cable length 0m	4m	8m	3+5m
2000	0		3,17	-	
	1		4,8	2,6	2,4
	10		6,8	3,4	3,1
	11		11,6	5,1	4,3
2500	0		3	1,6	1,6
	1		4,2	2,2	1,9
	10		5,6	2,5	2,3
	11		8,1	3,7	3
3000	0	12,4	2,2	1,6	-
	1	6,9	3,4	1,7	-
	10	5,2	4,4	1,9	-
	11	4,8	6,6	2,5	-



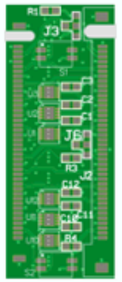
Marcel Rossewji, (and Vladimir in 2020)

Check if buffer between 3+5m cable improves rate

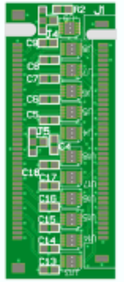


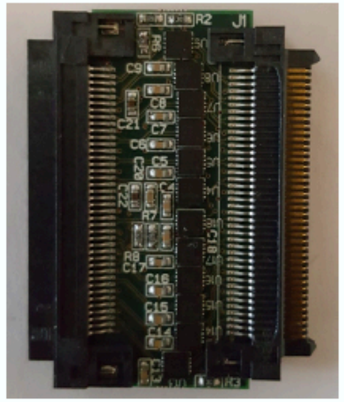


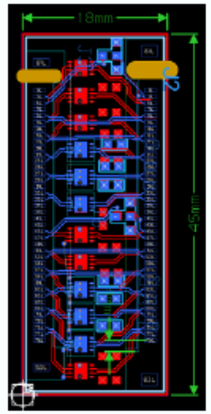
Top



Bottom

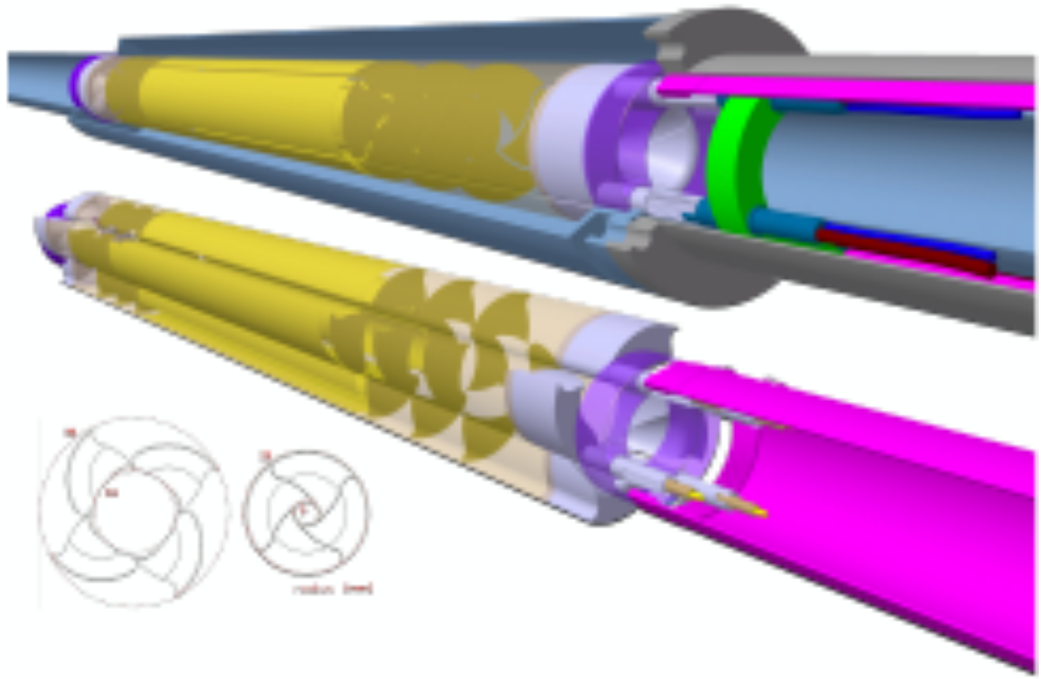






ALICE3 tracker concept

Vertex detector
A marvel of technology



Tracker
A big, improved ITS2