## **ALICE Hardware activities**



**ALESSANDRO GRELLI** 

# Nikhef



Nikhef Jamboree, 13th May 2024



## Hardware activities: ITS2

- Mew ALICE tracker (ITS2) taking data since 2021-2022. Largest MAPS pixel tracker ever made, ~10 m<sup>2</sup>
- $\mathbf{M}$  Tracking down to below  $p_T \sim 100 \text{ MeV}/c$  with  $\sim 40-70\%$ efficiency and pointing better than  $20\mu$ m at 1 GeV/c
- **Marge 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 ...













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### **ALICE Hardware activities**



### **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



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- The ITS3 fast link will be validated in Utrecht/Nikhef
- as test chips. Characterisation in house and at radiation facilities ongoing



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

### A selection of ALICE hardware activities





### ALICE ITS3 @Nikhef

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



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## Theory meets experiment .. and it likes it









### **MAPS** radiation hardness: **APTS**

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

### Cooling test nikhef setup



### Charge calibration

### APTS chip under thermal camera











Work ongoing! Stay tuned

lsis





### ALICE3: 2032 and beyond



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### A selection of activities: MOST

### **MOST: MOnolithic Stitched sensor with Timing**





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### Design: (Nikhef) Arsenij Vitkvsky and CERN







### A selection of activities: MOST

### MOST Characterisation



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### **Bonding tests**





### A selection of activities: MOST



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### **Milkhef work on MOST**

- Qualify for yield
- Measure time resolution

### Work on progress! Stay tuned







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## THANKS

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## **Extra Slides**





## Mechanics: Wind tunnel and assembly













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### 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 how we nicely failed with the first full size attempt ... but learning from it

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### Mechanics: wind tunnel studies









## Mechanics: Wind tunnel, what next

### Preparations for BBM2



### 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:	Uncosted	Coefficient of Thermal Expansion CTE (10°*/°C):	11 - 13
Flexural Modulus (psi):	(100-260) × 10 <sup>3</sup>	Index of Refraction n <sub>d</sub> :	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**





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3	10-M0-GND	5180-0-2	BLACK	10-p0-dry-GNO	5460-5-2	Cl-p0 div GND	5450-3-2	(2-p0-devGNO	5180-3-2	(Advertision-dev CAD)	5180-4-2
4	IO-ME-GND	5080-0-3	BLACK	04pLsens 040	5960-5-5	Ci-pl serv 640	5800-3-5	the Lines (A0)	5100-3-3	U-extra-sp-sers GND	50004-3
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6	11-P -940	5080-6-5	BLACK	00-m8 sens GMD	9868-5-5	L3-m0 sens 6NB	9808-8-5	Liberrid pains GMD	5090-3-5	University-parts (240)	5080-4-5
٤.)	11-M0-6240	3090-0-6	BLACK	so-me dry SNR	9090-0-5	US-moldry-SND	3000-2-5	Come dry SND	1000-3-6	12-6X019-02-079-020	5080-1-6
10	11-M1-6MD	3080-0-7	BLACK	solution sense (AND)	2000-0-7	13-ML 0010 5ND	300-2-7	LEVIC HIRIS GND	3000-0-7	10-0379-00-0010 SND	5040-1-7
1	11-MD-498D	1002-0-0	BLACK	some dry and	1000-010	L3-M4-DY-SPEC	1002-24	comp dry and	1002-0-0	ID-6X33-UN-ON-MID	3040-1-8
	12-P -952	1080-0-9	BLACK	10-60 same GND	1010-019	L2-ebsenceAD	1010-019	12-eb sees GND	1040-0-0	LL-extra-on-cent 342	5U80-1-9
n	L1-M0 -GMD	1082-0-08	BLACK	10-05 dry 3ND	1080-0-10	13 ebdy 350	1080-0-10	12-sb dry 950	1040-0-08	Line of a service of the	NUMP-0-00
0	LEWS KIND	1040-0-03	BLACK	March Service GNID	100.0-0-11	13 et sessitivo	1010-011	Charl serve GND	3282-8-03	Destroyees 355	\$U\$D-0-03
п	LEMO (CMD)	SURD-0-12	RIACC	Martine RAD	NUMBER 12	13 et dev 850	100.012	Chart dry BAD	UAD-112	Charles and a GMD	SUBD-4-12
4		\$140.013			5450-0-15		5850-215		5180-313		5080415
8	10-P +	5080-0-04	PAK	10-p0 sens *	5850-0-84	Cl-pOpens #	5850-244	Chapteries #	5150-3114	Westwoppers t	51804-04
4	00-540 +	5100-0-15	ACD-	00-p0-dry 1	5660-5-15	Ci-plicity (	5000-2-15	Chefoldey #	5100-3-15	Westmop.dm 1	50004-15
0	00-ME +	5000-0-05	GROOM	00-p1.5683 -	2000-0-16	Ci-pi sero i	5000-2-16	Uppl.mms+	5000-3-16	L1-extra-op-sens+	50004-36
	4 SM-00	5090-0-17	0006	00-p1-dry 4	9000-5-17	L1-p1 dry 4	9866-247	theidy+	5080-3-12	11-6x019-02P-07F -	5080-4-17
	11-P 4	1000-0-08	PINE	30-m0 sens 4	5050-0-18	13-m0 sens +	3000-2-18	12-m0 (ent) 4	1000-3-18	12-0379-02-0810-4	50904-38
	11-940 +	1080-0-18	REP	so-molenv+	2080-0-12	L3-modev+	3000-0-02	us-medry+	1000-1-12	12-6X73-02-07V +	5040-1-29
п	11-9/1+	1080-0-28	OF USA	sol-maleens +	3080-0-20	12-012-0010-0	1010-2-20	121102-0010-4	1040-1-28	20-6X313-081-0616+	50/80-1-20
	11-M2+	1080-0-25	BUUR .	so-moldry+	3080-0-22	L3-m3-dev+	1010-0-25	Comp dry+	1040-0-25	20-6X312-08-09(+	NUMD-1-23
	12-P +	1080-0-23	PINK	50-sib sams +	808.0-0-20	C3-eDreesc+	1080-3-22	12 with spens +	1040-1-22	Literature cent +	NUMD-0-23
М	13-M0+	1000-0-05	830	Schools day +	100.000	Circledry #	1010-0-01	12 mile day +	1040-1-01	Contractories +	\$URD-0-28
1	LL-MD +	1000-024	OR MAN	Mari sera +	100.000	Clief sees 4	1002-0120	Charl sens +	10.0013-04	Distances where the	5180-4-24
ч	13-MQ +	\$1.50.625	ALC: N	Month date *	5460-5-25	Client day #	5460-2-25	Chart dra tr	5180-325	Chestropaulos +	5.80.4.21
the state of the s											

### Wil provide list with connections



e.t.c.



## Mechanics: Vacuum bending tools and carbon foam





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### **Rene Barthel**

## Really a major success











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



**M** 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







- 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.





## Test of designed structures









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### Marcel Rosswji, Shi, Vladimir + MT bonding lab







## Fast Link: Cable studies and intermediate board

Rate	Pre-emphasis		Cable length							
Mbps	DS25BR120		0m	4m		8m		3+5m		
		0			3,17			-		
2000		1			4,8		2,6		2,4	
2000		10			6,8		3,4		3,1	
		11			11.6		5.1		4.3	
		0			3		1,6		1,6	
2500		1			4,2		2,2		1,9	
2500		10			5,6		2,5		2,3	
		11			8,1		3,7		3	
		0	12,4		2,2		1,6	-		
3000		1	6,9		3,4		1,7	-		
5000		10	5,2		4,4		1,9	-		
		11	4,8		6,6		2,5	-		





### Marcel Rossewji, (and Vladimir in 2020)



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### Check if buffer between 3+5m cable improves rate











## ALICE3 tracker concept

### **Vertex detector**

A marvel of technology





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### Tracker A big, improved ITS2



