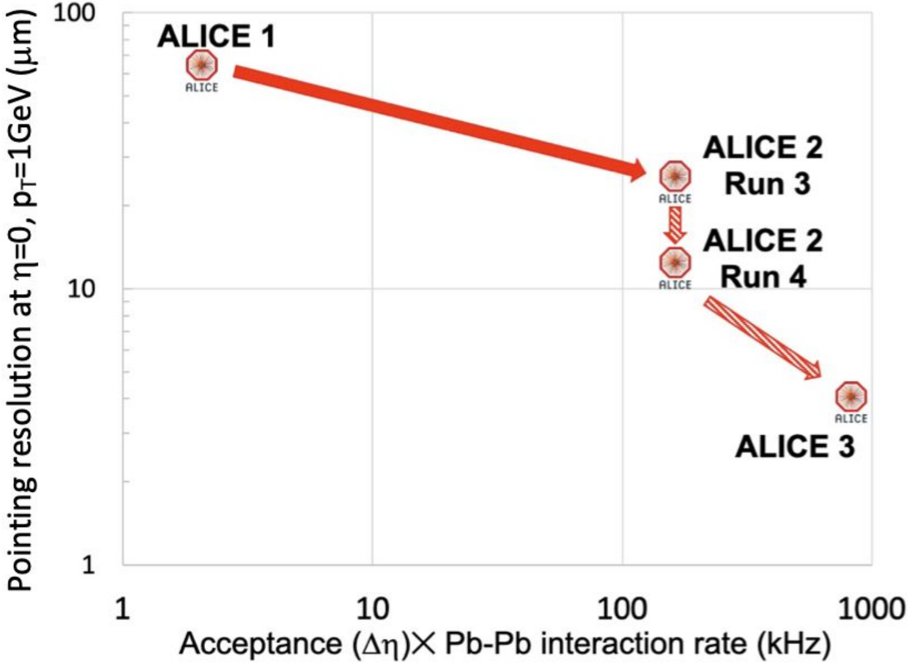
ALICE Upgrades: introduction

Riunione INFN ALICE-Referees, 10 July 2025

Andrea Dainese (INFN Padova)

ALICE upgrades strategy

Large steps in pointing precision and "effective acceptance"



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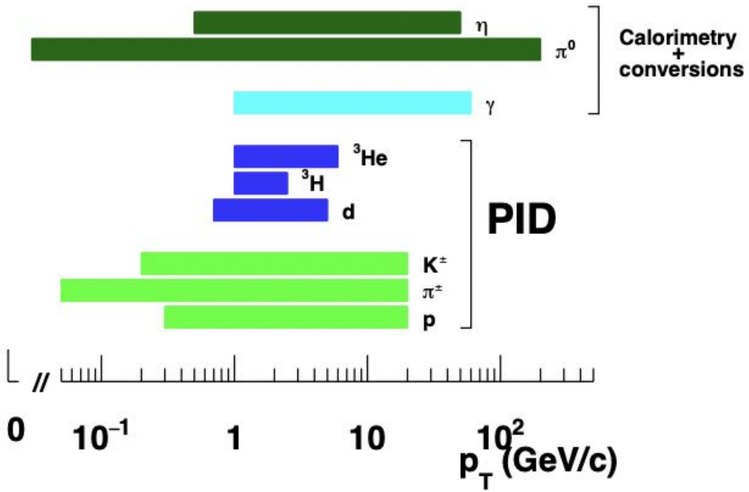
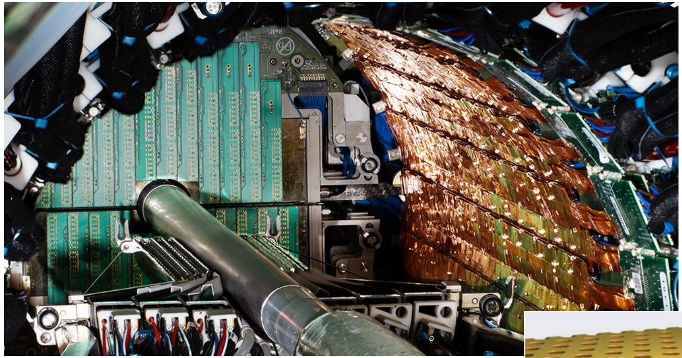
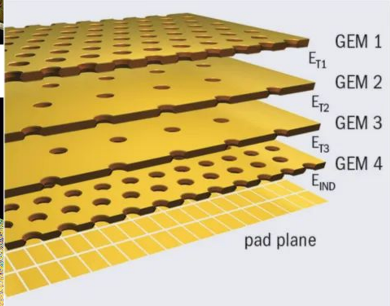
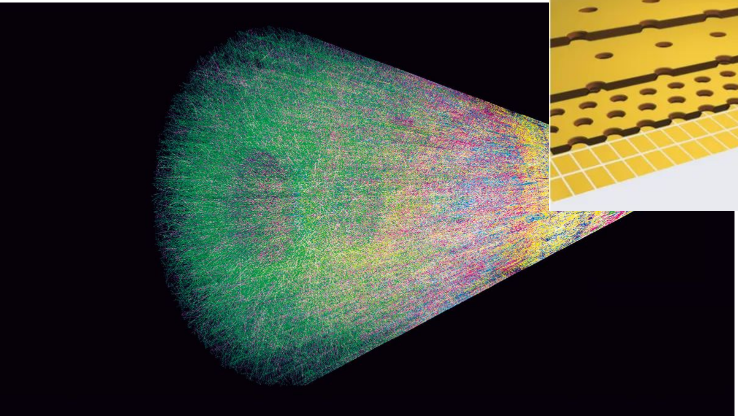
Keep/strengthen ALICE unique reach in particle identification

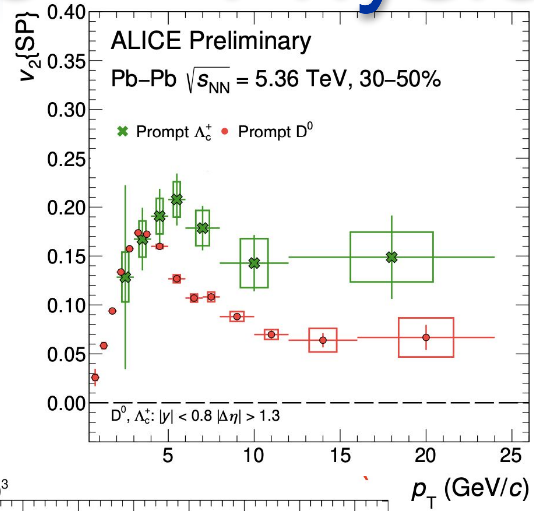


ALICE 2 upgrade → Physics!

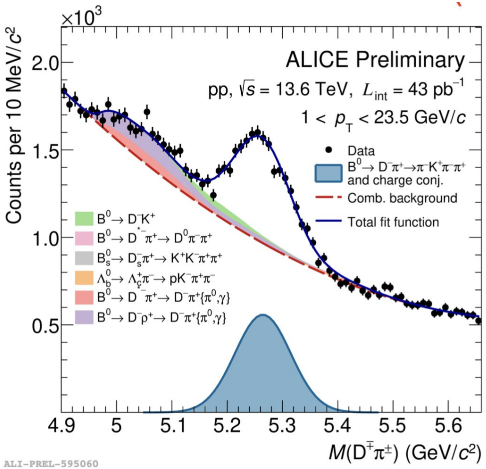








Charm baryon flow → charm recombination



Full reconstruction of B decays (B→Dπ) at low p_T in pp

Timeline of future upgrade projects

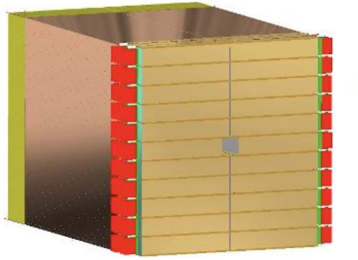
LS3: FoCal & ITS3

- Specific upgrades for Run 4
- TDRs approved in March 2024
- Now proceeding towards final sensors in view of start of production

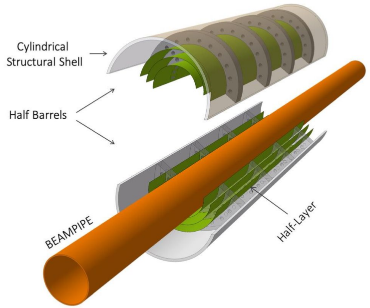
LS4: ALICE 3

- New detector for Run 5
- LoI reviewed in 2022
- Scoping Document reviewed March 2025

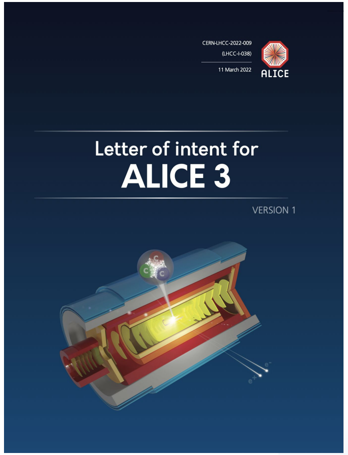
FoCal TDR: [CERN-LHCC-2024-004]

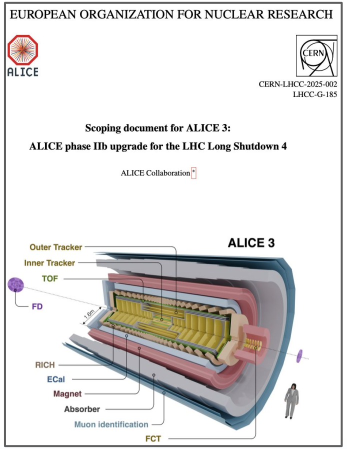


ITS3 TDR: [CERN-LHCC-2024-003]



LoI: [CERN-LHCC-2022-009]



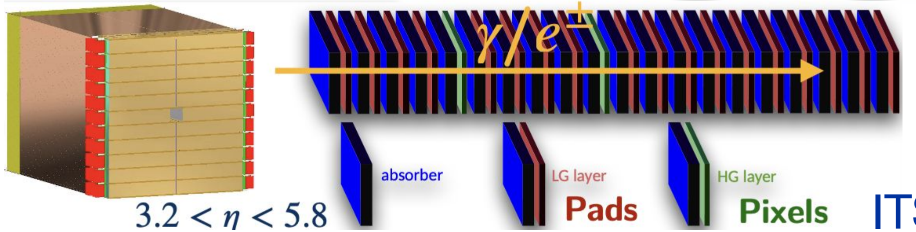

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

CERN-LHCC-2025-002
LHCC-G-185

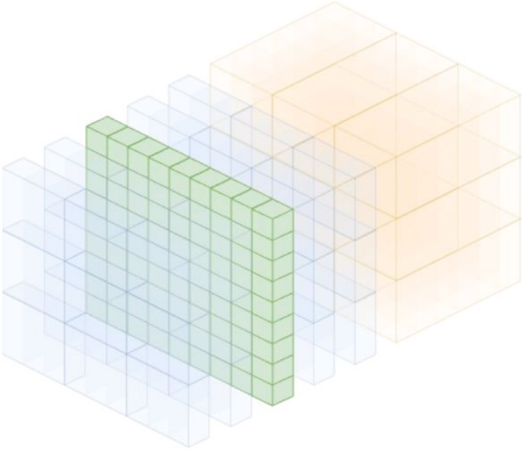
Scoping document for ALICE 3:
ALICE phase IIb upgrade for the LHC Long Shutdown 4

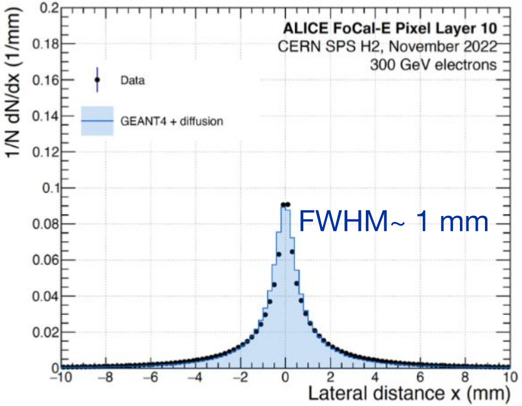
ALICE Collaboration

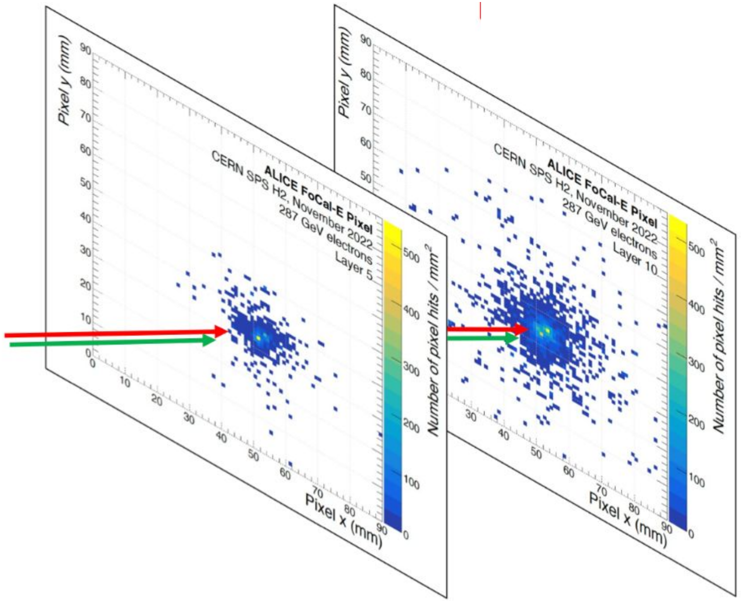
FoCal recent highlights



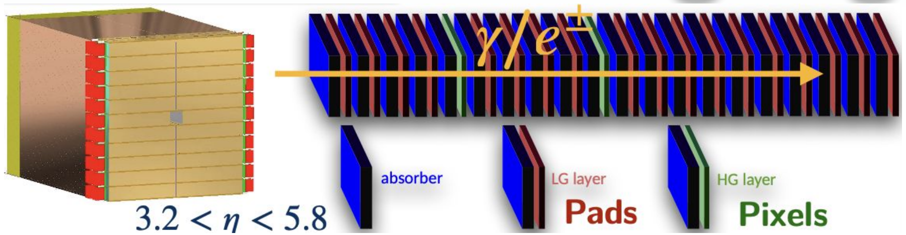
ITS2 ALPIDE sensors





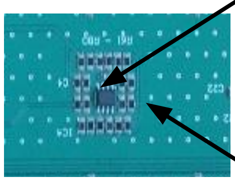


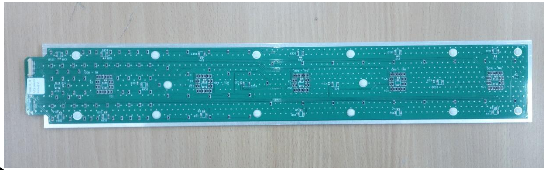
FoCal recent highlights



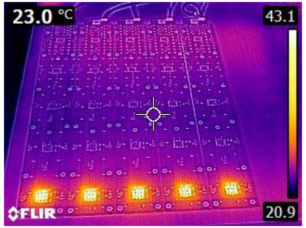
Mechanical mock-up of FoCal-E cooling system

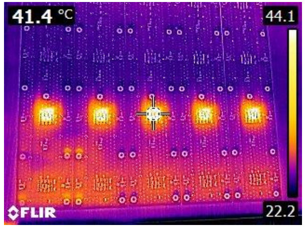
Temperature sensor





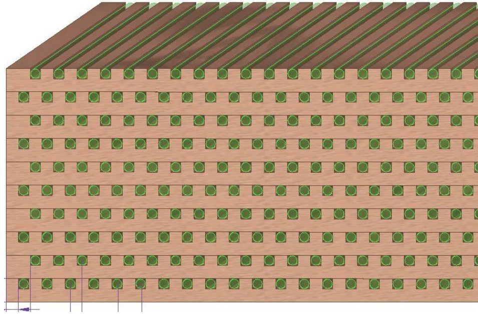
Heaters

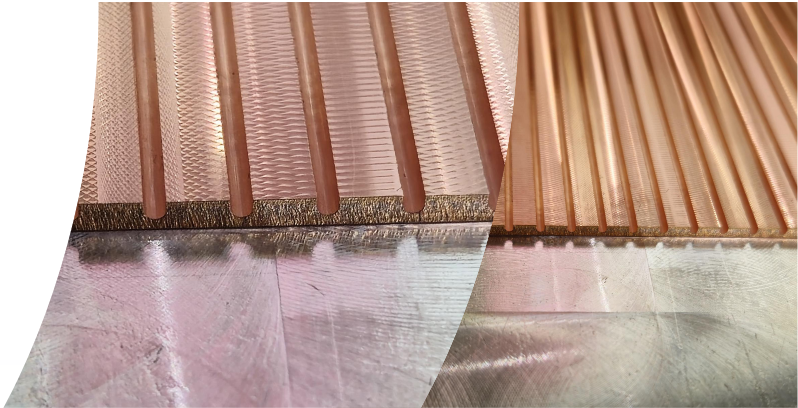




FoCal-H Prototype 3:

- Copper sheets with grooves (4mm pitch), as alternative to capillary tubes
- Final readout system
- Test-beams in September, October



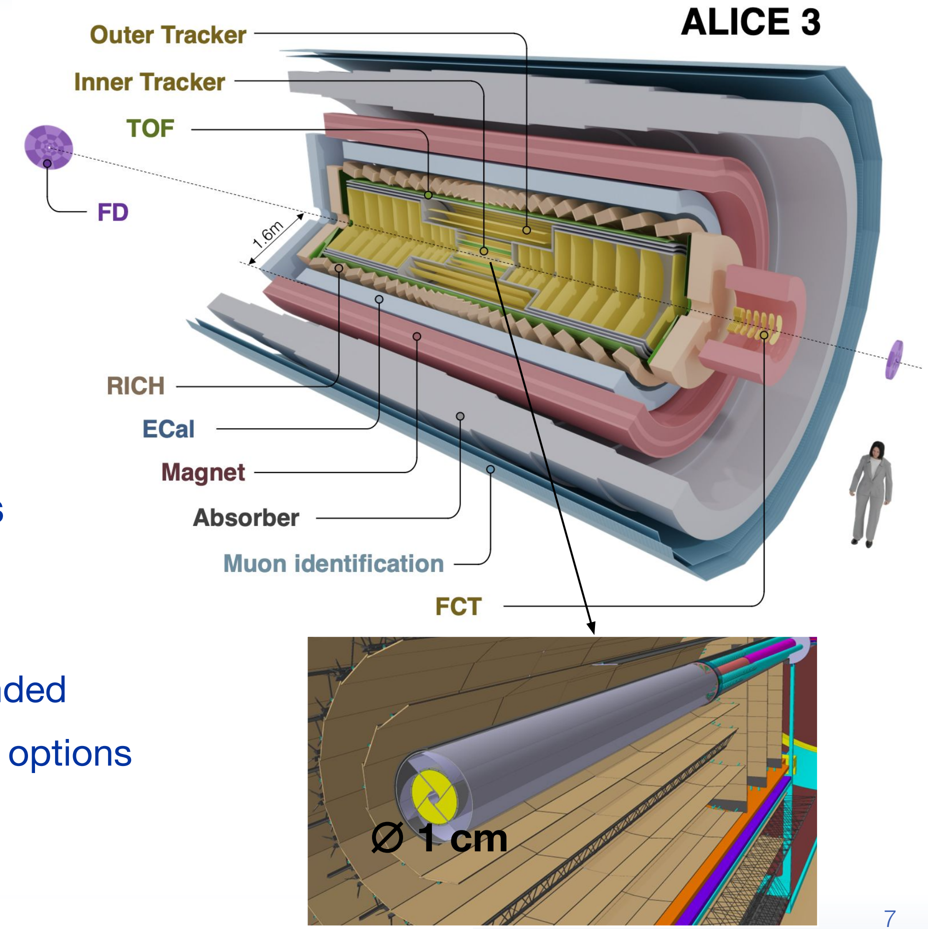


ALICE 3 detector

LoI: CERN-LHCC-2022-009
SD: CERN-LHCC-2025-002

➡ Novel detector concept

- Compact and lightweight all-silicon tracker
- Retractable vertex detector with R_{min}= 5 mm
- Extensive particle identification
- Large acceptance $|\eta|<4$
- Superconducting solenoid, B=2T
- Continuous read-out and online processing



➡ Scoping Document review by LHCC referees completed March 2025

→ Unique and compelling programme recognised

→ Intermediate scoping option w/o ECal recommended

→ New SC magnet needed, ideally B=2T, + backup options

Unique ALICE 3 physics goals

- **Understanding thermalisation in the QGP**
  - ➡ direct access to charm diffusion: D-Dbar azimuthal correlations
  - ➡ degree of thermalisation of beauty: high-precision beauty measurements
  - ➡ approach to chemical equilibrium: multi-charm hadrons
- **Access to temperature as function of time**
  - ➡ high-precision di-electron mass spectra, p_T dependence, elliptic flow
- **Fundamental aspects of the QCD phase transition**
  - ➡ net-baryon and net-charm fluctuations
  - ➡ mechanism of chiral symmetry restoration in the QGP: di-electron mass spectrum
- **Laboratory for hadron physics**
  - ➡ hadron-hadron interaction potentials
  - ➡ explore nature of exotic hadrons (e.g., tetraquarks, charm-nuclei)

Also summarised in Scoping Document (CERN-LHCC-2025-002 **p9**) **and endorsed in LHCC report:**
"**ALICE 3 is a unique detector at the LHC** in terms of having a low material budget, a few-micron pointing resolution, a large acceptance in eta, and hadron, electron and muon identification."
"The **LHCC recognises** that the different scoping options presented would enable a **compelling and unique heavy ion physics program** in Run 5."

ALICE 3 & Community inputs to ESPP2026

ALICE 3 supported and prioritised in several community inputs to European Strategy for Particle Physics 2026

- NuPECC
- French QCD Comm.
- German Nuclear and Hadron Phys Comm.
- Italian Heavy Ion Comm. & INFN CSN3
- Polish input
- Romanian input
- US HI Community
- …

First item in the document from the CERN Heavy Ion Town Meeting

unique potential for progress on these and other fundamental questions, the town meeting concludes that **the top priority for quark matter research in Europe is to fully exploit the physics opportunities presented by nuclear beams throughout the entire HL-LHC program.**

With the upgrades planned for HL-LHC run 4 and run 5, all four major LHC experiments are well-positioned for heavy ion programs that will significantly advance our understanding of fundamental questions in the field and that complement each other. the The upgraded detectors will give access to the 3D structure, microscopic dynamics, and substructure of quark matter. This provides an optimized, multi-pronged approach for the most comprehensive characterization of the QCD high-temperature phase by the end of HL-LHC run 5. Specifically:

- **ALICE 3** is a completely new dedicated high-energy nuclear physics experiment, based on innovative detector concepts, with particle identification and unprecedented pointing resolution over large acceptance in rapidity and transverse momentum. It offers unique opportunities to advance quark matter research in HL-LHC Run 5, in particular via measurements of electromagnetic radiation, heavy flavour, and particle correlations.
- The **LHCb Upgrade2**, motivated mainly by the LHCb flavor physics programme, will offer unique opportunities for quark matter research in run 5 at the HL-LHC, in particular with measurements of heavy-flavour and the initial stages in collider mode at forward rapidity and in fixed-target mode.
- The **Phase-2 CMS and ATLAS** feature increased pseudorapidity coverage, high-rate capability and particle identification. They will significantly advance quark matter research by precisely characterizing high-momentum transfer and photonuclear processes that require high statistics.

- [Indico page]
- [Hot and dense QCD plenary]
- [Detectors plenary]
- [Summary talk]

The view of the national HEP communities

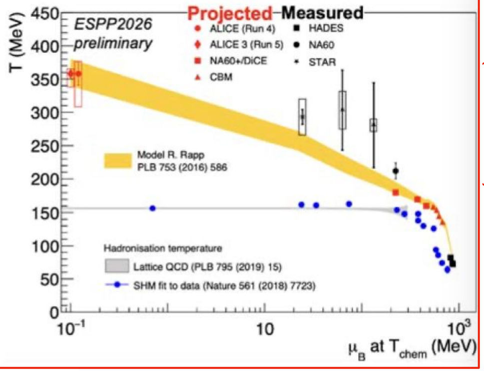
- **Completing the full HL-LHC programme** is essential and must remain a high priority for CERN;

It is paramount to fully exploit the High-Luminosity LHC (HL-LHC) to maximise scientific returns

Summary talk (K. Jakobs)

Hot and dense QCD and QCD connections

- **HL-LHC:** rich physics programme in non-perturbative QCD
  (full exploitation already encouraged in 2020 strategy, ongoing)
  - **High-temperature QCD**
    → quark-gluon plasma equilibration with heavy quarks, temperature and its time evolution
  - Hadron nature (exotica) and interactions
    (very relevant for astro(particle) physics)
- **Post-HL-LHC:** programme **at SPS** essential to keep HI activities



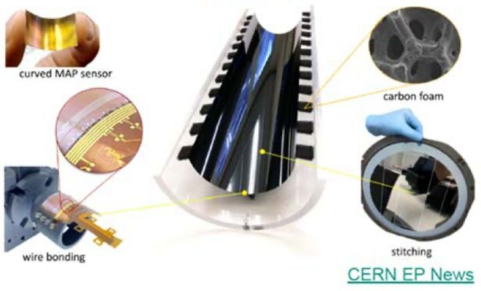
Summary talk (K. Jakobs)

- Indico page
- Hot and dense QCD plenary
- Detectors plenary
- Summary talk

Key messages on Detector R&D

- Detector R&D remains a **high priority** and adequate investments have to be made, also for detectors beyond colliders
- DRD Collaborations successfully established, however, **more solid funding support** needs to be secured
- Significant **technological limitations and challenges** to overcome for future projects;

ALICE ITS3



CERN EP News

Ongoing upgrades also provide technology demonstrators

Summary talk (K. Jakobs)

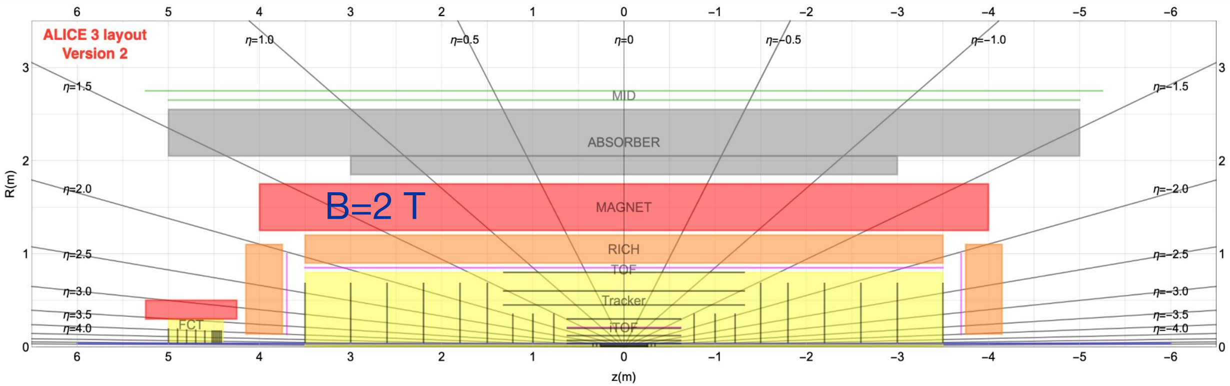
Key requirements (Eras 1 and 2, #70):

	ITS3	ALICE 3 VTX	ALICE 3 TRK	ePIC	FCC-ee
Single-point res. (μm)	5	2.5	10	5	3
Time res. (ns RMS)	2000	100	100	2000	20
In-pixel hit rate (Hz)	54	96	42		few 100
Fake-hit rate (/pixel/event)	10^{-7}	10^{-7}	10^{-7}		
Power cons. (mW / cm^2)	35	70	20	<40	50
Hit density (MHz/cm^2)	8.5	96	0.6		200
NIEL (1 MeV n_{eq}/cm^2)	$4 \cdot 10^{12}$	$1 \cdot 10^{16}$	$2 \cdot 10^{14}$	few 10^{12}	10^{14} (/year)
TID (Mrad)	0.3	300	5	few 0.1	10 (/year)
Material budget (X_0/layer)	0.09%	0.1%	1%	0.05%	˜0.3%
Pixel size (μm)	20	10	50	20	15-20

Key technology: **MAPS** – monolithic active pixel sensors

Detectors plenary (U. Husemann)

New baseline layout: v2-2T



- Cost (CORE): 145 MCHF (-15% compared to version with ECal)
- Impact on specific aspects of the physics programme: photon and jet-based measurements
- Unique measurements based on heavy-flavour and thermal dielectrons not impacted

ALICE 3 timeline

2022: **Letter of Intent reviewed by LHCC → very strong support**

2023 – 2025: **detector scoping, resource planning, sensors selection, small-scale prototypes**

2026 – 2027: **large-scale engineered prototypes → Technical Design Reports**

2028 – 2031: **construction and assembly**

2032 – 2033: **contingency and pre-commissioning**

2034 – 2035: **Long Shutdown 4 - installation and commissioning**

2036 – 2041: **physics campaign, Pb-Pb ~35 nb^{-1}, pp ~ 18 fb^{-1}**

ALICE 3 coordination team

Subsystem WGs:

- Inner Tracker: **G. Contin** (Trieste), **F. Reidt** (CERN)
- Outer Tracker: **H. Büsching** (Frankfurt), **L. Fabbietti** (Munich), **A. Maire** (Strasbourg)
- Forward Conversion Tracker: **K. Reygers** (Heidelberg)
- TOF Detector: **S. Bufalino** (Torino), **M. Colocci** (Bologna), **A. Rivetti** (Torino)
- RICH Detector: **G. Volpe** (Bari)
- MID: **A. Ortiz** (Mexico City)
- Data flow and online processing: **V. Barroso** (CERN), **P. Hristov** (CERN), **T. Kollegger** (Frankfurt)

Contacts for general items and other activities:

- General infrastructure, integration: **TC - W. Riegler, A. Tauro, C. Gargiulo, E. Laudi** (CERN)
- Detector readout, links: **EC - A. Kluge** (CERN)
- Forward Detectors: **J. Otwinowski** (Krakow)

Simulation and Physics Studies WGs

- Simulation and Performance: **N. Jacazio** (UniPO)

Interests of national groups and organisation

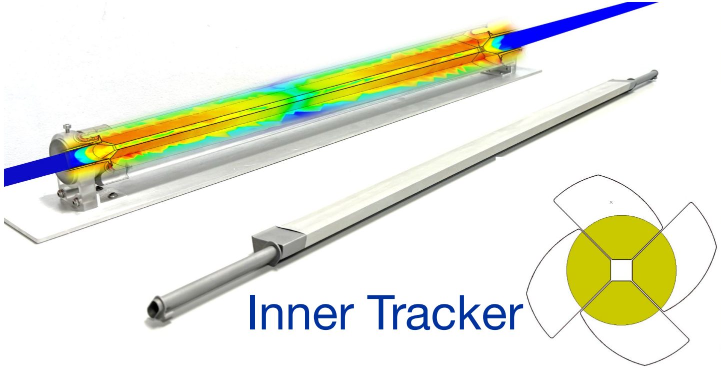
Experiment subsystems	National groups
Inner Tracker	CERN, China, Czech Republic, Italy, Netherlands, Norway, Ukraine
Outer Tracker	Austria, Finland, France, Germany, Japan, South Korea, Sweden, UK, US
Forward Conversion Tracker	Germany
TOF Detector	Brazil, China, India, Italy, Japan, Netherlands, Romania, South Africa
RICH Detector	Bulgaria, Hungary, India, Italy, Malta, Mexico, Poland
Muon Identification Detector	Czech Republic, Hungary, India, Mexico, US
Data flow and online processing	CERN, Germany, Romania
Detector readout, links, clock distribution	CERN, Hungary, Slovakia, UK
Forward Detectors	Denmark, Mexico, Poland
Superconducting magnet design	Brazil, CERN, Italy

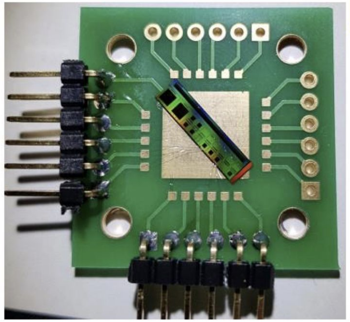
- New institutes from: Italy (Pisa, LNGS), China, Japan, India, Poland, Bangladesh
- Additional participations under discussion
- Institutes interested in each subsystem are organising the activities (e.g. Work Packages towards TDR goals) and preparing the formation of Detector Projects
  → Angelo Rivetti (INFN To) endorsed by TOF institutes as Project Leader

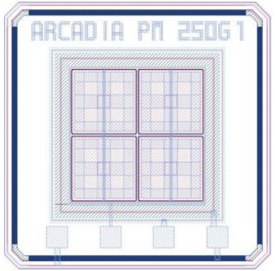
ALICE 3 R&D

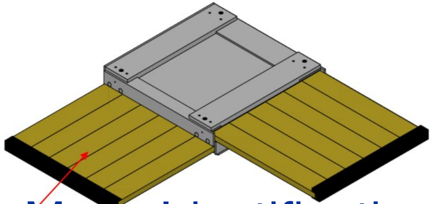
- R&D for sensors and subdetectors steadily progressing
- Several sensor test-beams this year: TOF, RICH, MID, Trackers (with ITS3)
- Regular updates and reviews at “ALICE 3” Days (February and May 2025)

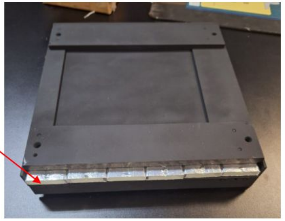
ALICE 3 R&D in full swing (examples)

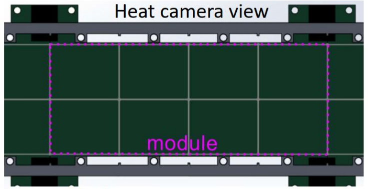


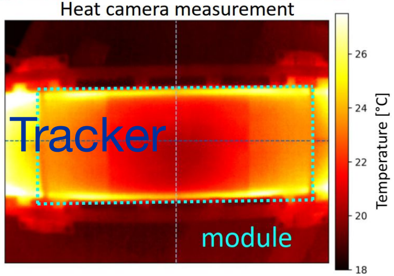


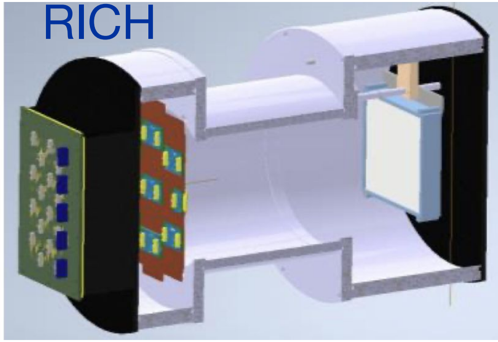












R&D activities and test beams

Subsystem	Ongoing activities (2025)	Prototype tests with beam
SC Magnet	• **Initial design** in view of CDR • Contacts/tests with **SC cable vendors** (Furukawa-BR, ICAS-IT, Wuxi-Toly-CN) for production of aluminum-coextruded Nb-Ti/Cu cable	
Inner Tracker	• Preparation of **laboratory setups for highly-irradiated pixel test structures at temperatures ~ -20 °C** • **Sensor layout studies** to achieve the 10μm pixel pitch for the Vertex Detector • Feasibility study of ultra-lightweight Middle Layers • Vertex Detector mechanics and vacuum laboratory tests • Start of detailed mechanical design of ML barrel and discs	• Test of highly-irradiated pixel test structures and building of sub-zero test-beam setups (up to 1 week per month, with ITS3) • New Analogue Pixel Test Structure (APTS) optimizations in ITS3 ER2 (**Q1 2026**)
Outer Tracker	• **Mechanical prototype for a barrel "sector"** and studies for disks support structure • Module design and industrialisation • Wafer mass test protocol • **Sensor specs, design and simulation** of very front-end (grouping) and of readout logic (asynchronous) • Preparation of small test-structures characterization	• Small test structures SPARC + APTS "large pitches" in ITS3 ER2 (**Q1 2026**)

R&D activities and test beams

Subsystem	Ongoing activities (2025)	Prototype tests with beam
TOF	• **Time resolution of irradiated CMOS-LGAD sensors** • Time resol. of **thinned CMOS-LGAD sensors** (down to 15μm) • Characterization of SiPMs for timing with digital acquisition system and cooling at -40 °C	Beam tests at CERN PS • Irradiated CMOS-LGADs (**July**) • New CMOS-LGAD sensors with reduced thickness (**October**) • SiPM with digital R/O and cooling (**April**)
RICH	• Finalize setup for measuring aerogel refractive index, **characterization of focusing aerogel tiles** • Study of the prototype interposer and cooling system • **SiPM irradiation and Dark Count Rate characterization with cooling and annealing** • Construction of module mock-up for installation test	Beam tests at CERN PS • Gaseous radiator for el PID (**July**) • New frontend prototype ALCORv2, enlarged photon sensor acceptance, irradiated SiPMs (**October**)
MID	• Construction of a **1x1 m^2 scintillator-based prototype** • Design and construction of the **first version of the Frontend Card** (FEC) with 32 channels	Beam tests at CERN PS • Scintillator-based chamber vs MWPC, CAEN readout electronics vs custom made FEC (**August**)
FD	• New **Frontend Electronics R&D** (leveraging FIT FEE upgrade for Run 4)	• Scintillator radiation tests in ALICE cavern at P2

Summary

- **ALICE 3 recognised by LHCC as “a unique detector at the LHC”, which “enables a compelling and unique HI physics programme in Run 5”**

- **Strong community support and visibility within Eu Strategy process**

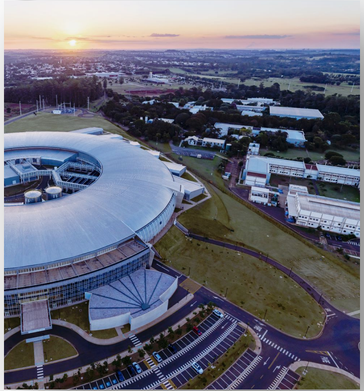
- **v2-2T, w/o ECal, but with full field and acceptance, is now the baseline**
  - CORE cost 145.3 MCHF - bulk investment 2028-2032
  - Target contributions per FA → ongoing discussions between ALICE National Contact Physicists and FAs

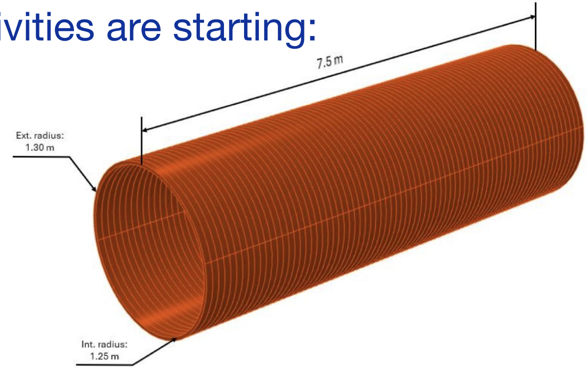
- **R&D in full swing: design, prototyping, test beams**
  - First design / technology choices in the coming year
  - **Crucial to continue supporting R&D in this phase**

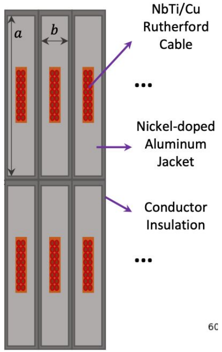
Additional material

Superconducting magnet: design plans

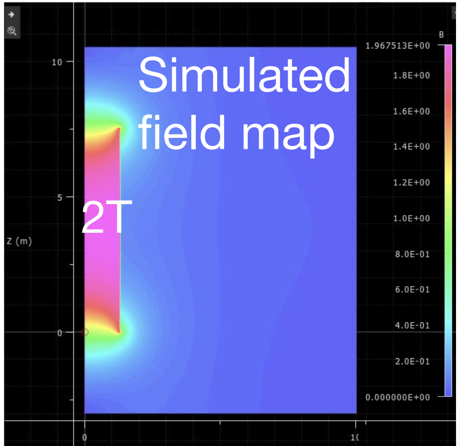
- **Brazilian Center for Research in Energy and Materials (CNPEM)** and **University of Sao Paulo (USP)** intend to lead the magnet project, from design to construction
  - In collaboration with ALICE Techn. Coord., CERN EP R&D Magnet group, and **INFN Genova**
- CNPEM in contact with **Furukawa Brazil** to resume SC cable production
- Magnet design activities are starting:



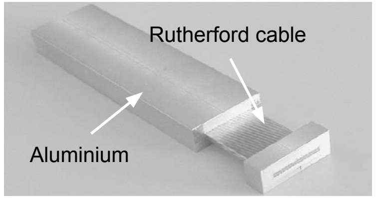




CNPEM Brazilian Center for Research in Energy and Materials
MINISTRY OF SCIENCE TECHNOLOGY AND INNOVATION
BRAZILIAN GOVERNMENT BRASIL UNITING AND REBUILDING
USP 90 ANOS 1934 2024



Superconducting cable: procurement options



Baseline:
Aluminium-cladded
Nb-Ti conductor

Fallback option:
Copper-cladded
Nb-Ti conductor (Luvata, US)

Furukawa Electric (Brazil)

FURUKAWA ELECTRIC GROUP

Production can be re-established

CERN R&D program with ICAS (Italy)

icas

Plan to establish production chain

Wuxi-Toly (China)

统力电工 TOLY ELECTRIC

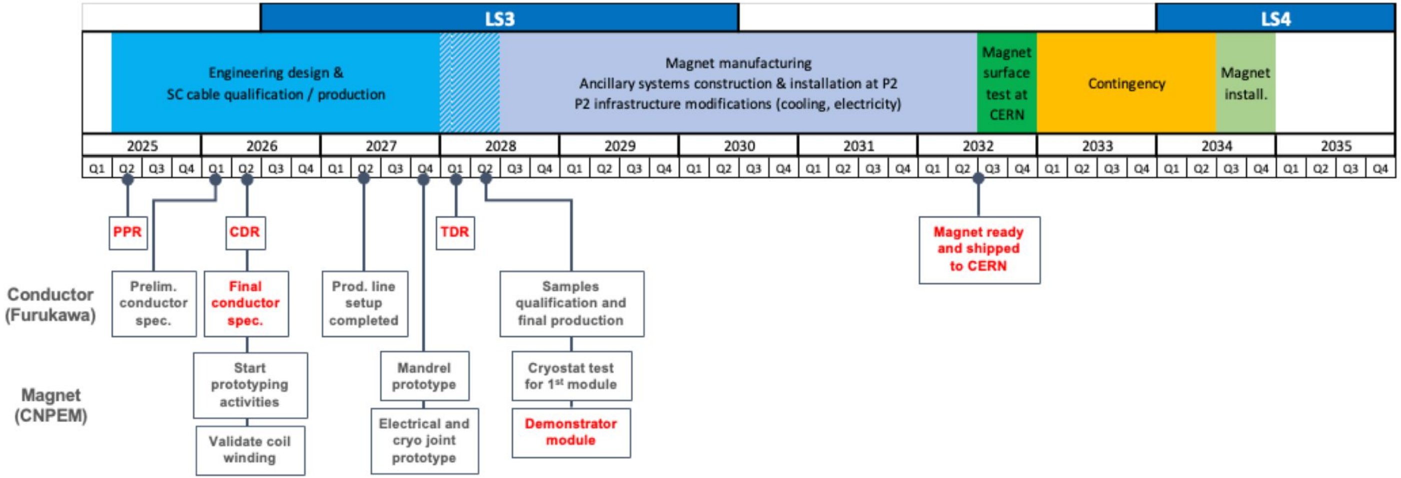
EMuS cable samples under test

EMuS conductor sample

Superconducting magnet: schedule

SC magnet planning review on 18 June:
→ Revised schedule

- **1.5 years** contingency
- Review panel considers project feasible, provided that the outline workplan begins in Jan 2026 without delays



MINISTRY OF SCIENCE TECHNOLOGY AND INNOVATION
BRAZILIAN GOVERNMENT BRASIL UNITING AND REBUILDING

LHCC report: v2-2T becomes the goal

From LHCC minutes:

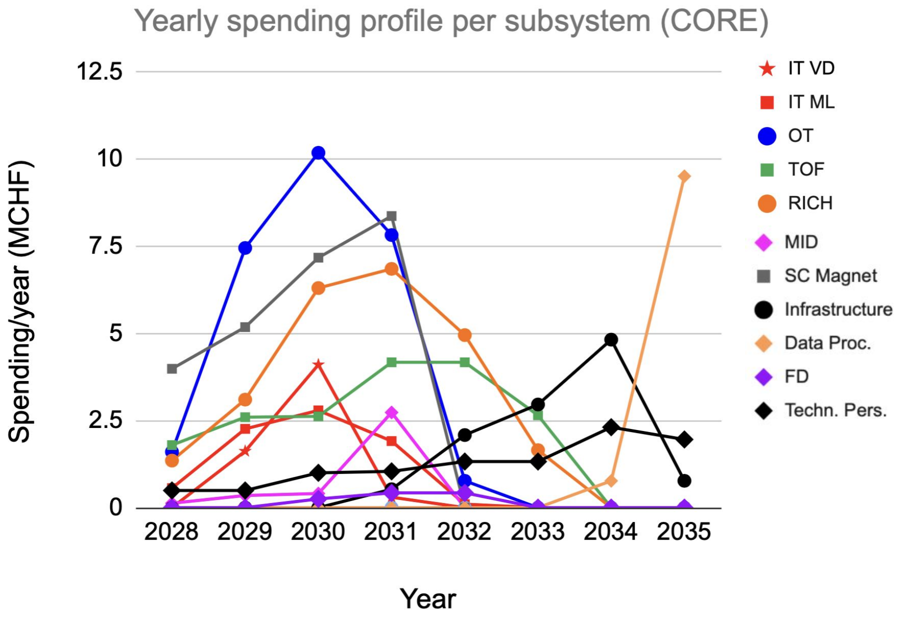
- **All scoping options enable compelling and unique programme**
  - **Impact of ECal descoping limited to some physics areas**
  - **Stronger impact for acceptance decrease**
- **LHCC recognises that a new SC magnet is needed: ideally 2T**

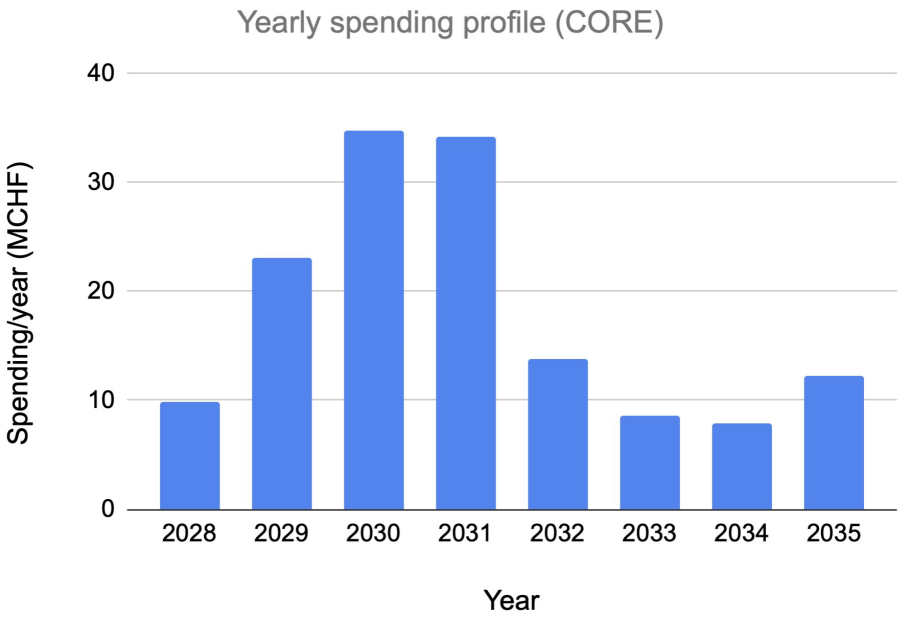
CORE cost of v2-2T: 145.3 MCHF

Target contributions per FA: refer to discussions between NCPs and FAs

System	Technology	V2-2TCost (MCHF)
Inner Tracker	MAPS	13.7
Outer Tracker	MAPS	27.8
TOF	Monolithic LGADs	18.0
	Hybrid LGADs	+13.4
RICH	Aerogel, SiPMs	24.2
MID	Iron absorber, scintillators, SiPMs	3.6
FD	scintillators, PMTs	1.1
Magnet system	Superconducting solenoid	24.7
Online computing	CPU and GPU nodes, disk buffer	10.3
TOTAL		123.4
Common items	Beampipe, infrastructure, services	+11.1
	TC design and engineering	+10.9
FCT	MAPS, dedicated dipole magnet	+3.45

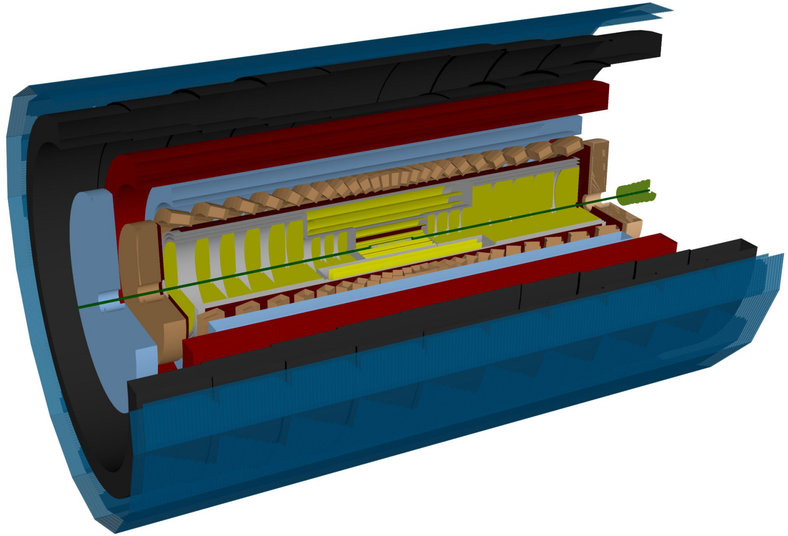
Spending profiles (v2-2T)



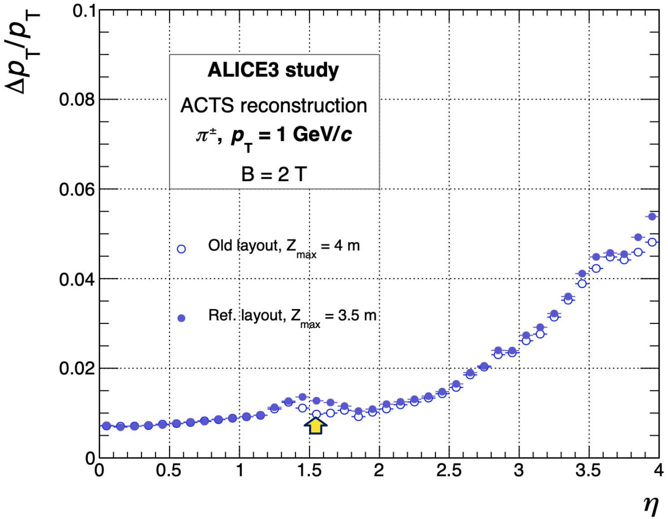


- Construction spending starts in 2028, after TDRs approval
- Peak in 2029-32, depending on the total construction time
- Lower yearly cost peaks with new schedule (LS4 shift)

Software geometry and tracking

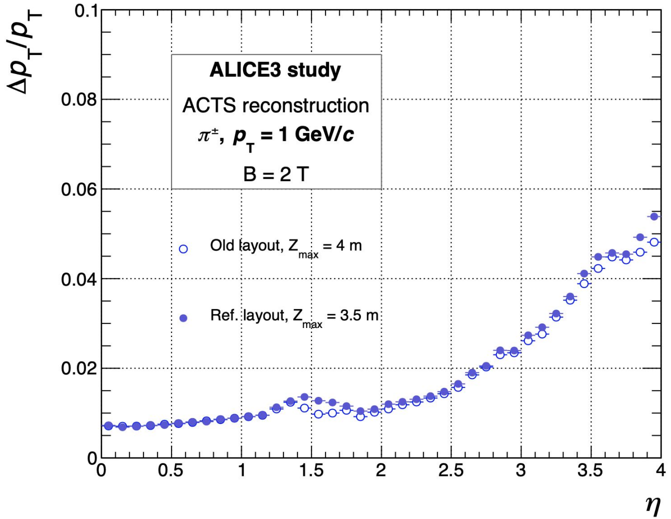


All subsystems implemented in ALICE O^2 software geometry

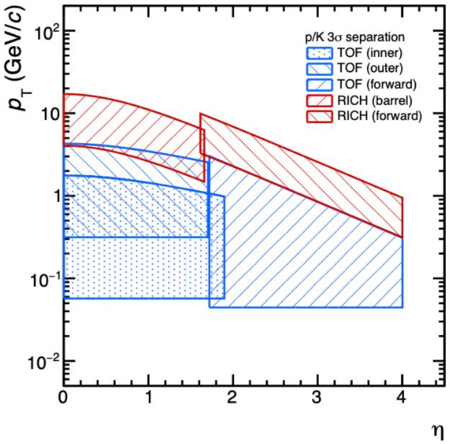


Minor effect of layout changes on tracking performance (momentum resolution)

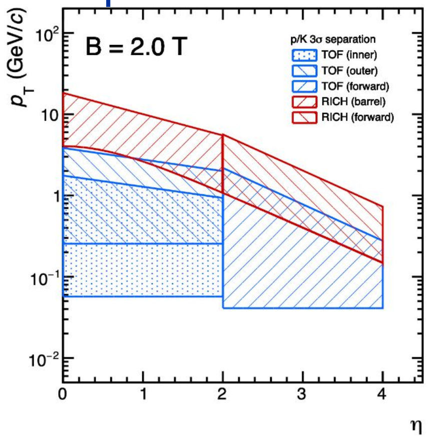
Layout update: p_T resolution ~unaffected



LoI:



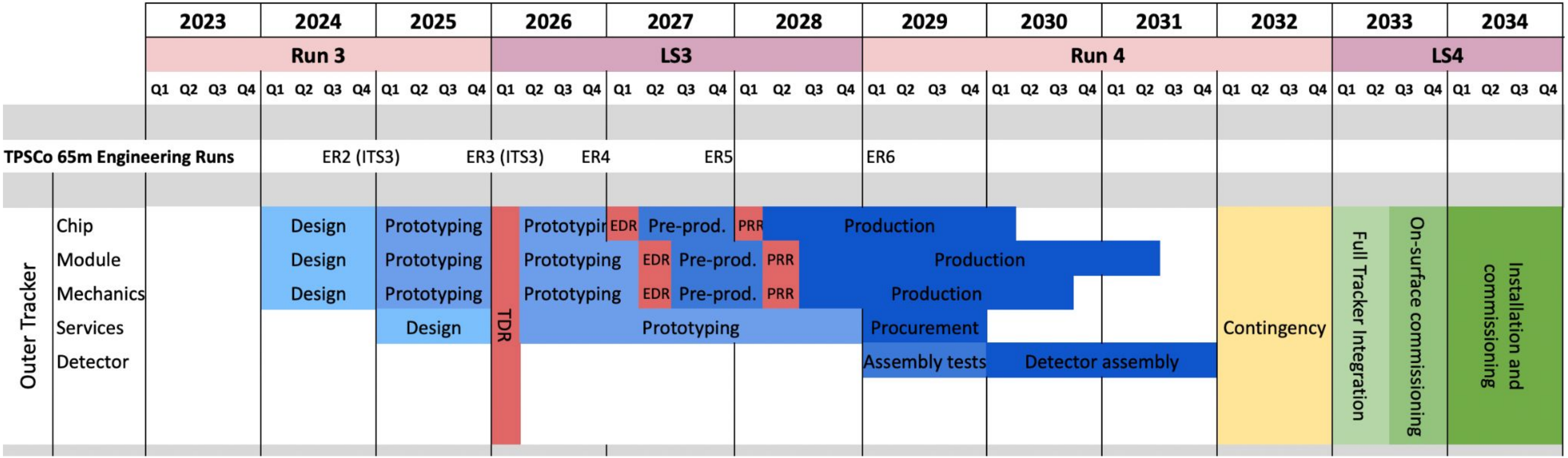
Updated:



- Smaller and shorter OT endcaps don't worsen p_T resolution at $|\eta|>2.5$
- 10-20% worsening at $1.4<|\eta|<1.6$

- PID coverage is preserved

Detailed schedules example (OT)



Summary of impact of scoping options

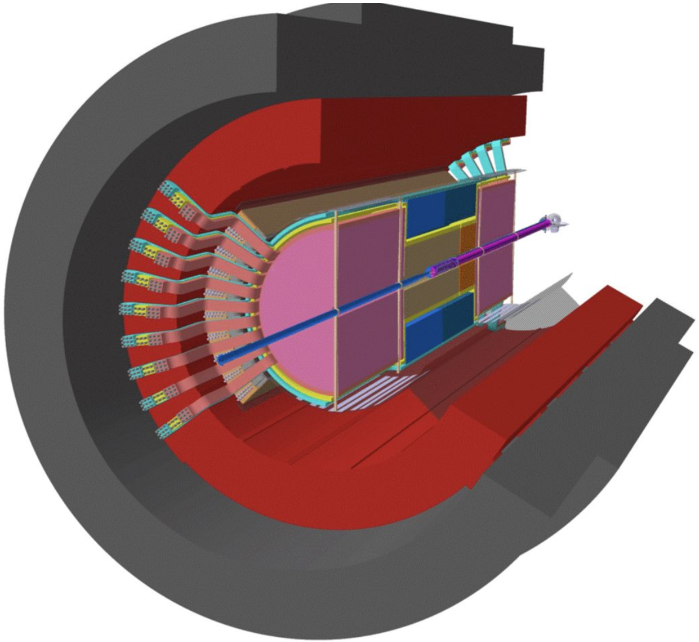
Measurement	Layout v2-2T	Layout v2-1T
ALPs searches in $\gamma\gamma \to \gamma\gamma$	strongly limited ($m_a < 2$ GeV/c^2, $1/\Lambda_a > 0.2$ TeV^{-1})	
$\chi_{c1,2} \to J\psi\gamma$	measurement limited to $p_T > 4$ GeV/c	
		minor additional impact
γ–jet correlations	limited improvement w.r.t. ALICE 2	
$\chi_{c1}(3872) \to J\psi\pi\pi$	not affected	minor impact
Ξ_{cc} yield	not affected	minor impact
Ξ_{cc} rapidity dependence	not affected	large impact
B^+ yield and flow	not affected	moderate impact at low and high p_T
Λ_c and Λ_b flow	not affected	large impact at $2 < \|y\| < 4$
D^0–$\overline{D^0}$ vs. $\Delta\varphi$	not affected	minor impact
D–D* vs. k^*	not affected	significant impact
Dielectrons	not affected	can exploit full integrated luminosity

→ **B = 2 T is the preferred field strength**

→ **B = 1 T not the ideal option, but still enables a strong programme**

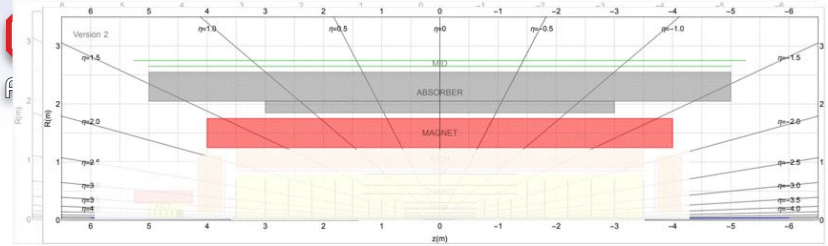
→ an intermediate value of magnetic field (e.g. 1.5T), can be considered as well

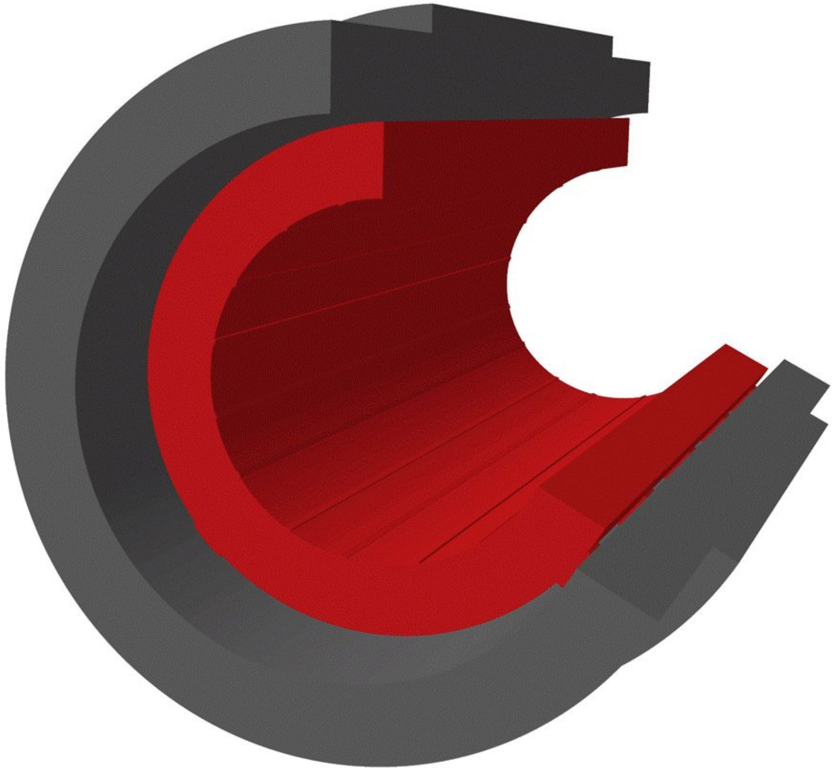
Services and installation



- Main guideline: **optimise installation sequence and add flexibility to the LS4 schedule**
- Integration scheme with alternating services on the two sides
- **Enables modular and independent installation** of: Outer Tracker endcaps, RICH and TOF barrels, forward RICH and forward TOF endcaps
- In case of delay, any of these **components can be installed during a YETS, without affecting the LHC schedule**

1



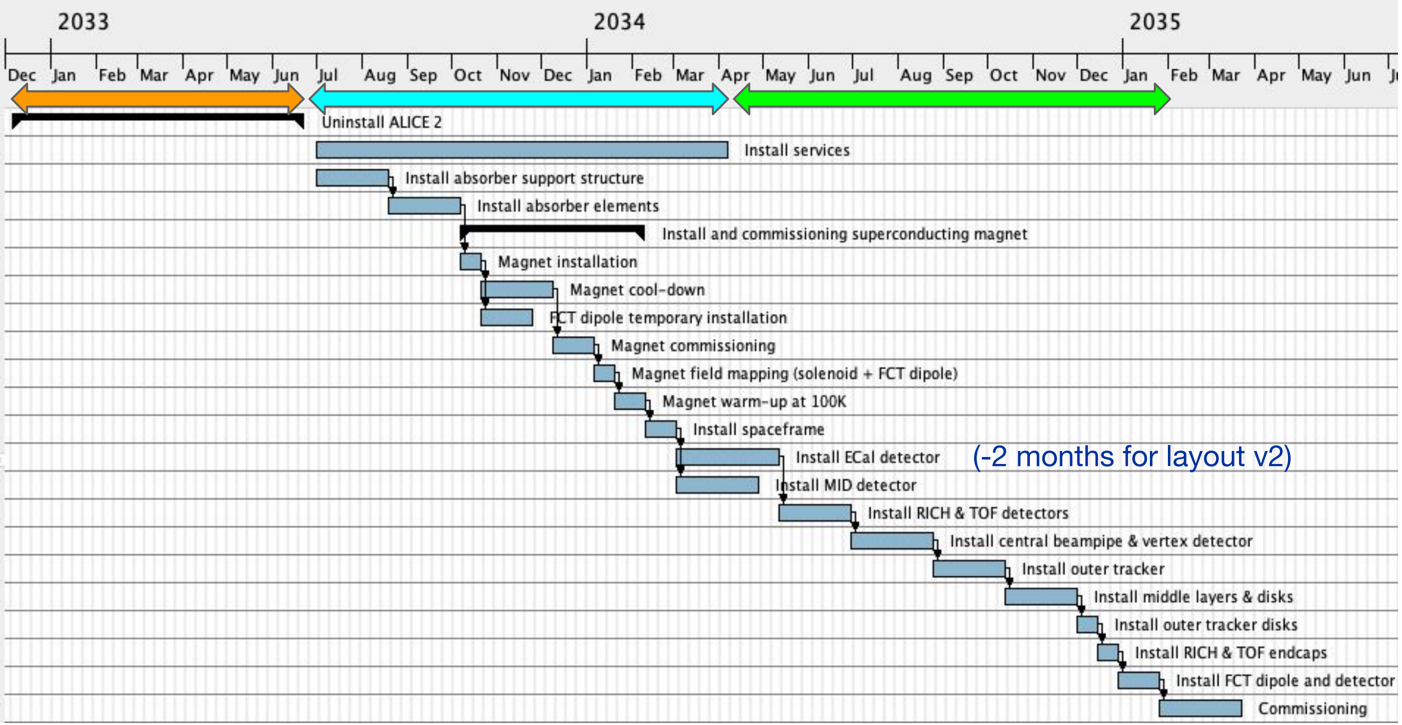


Magnet

LS4 schedule

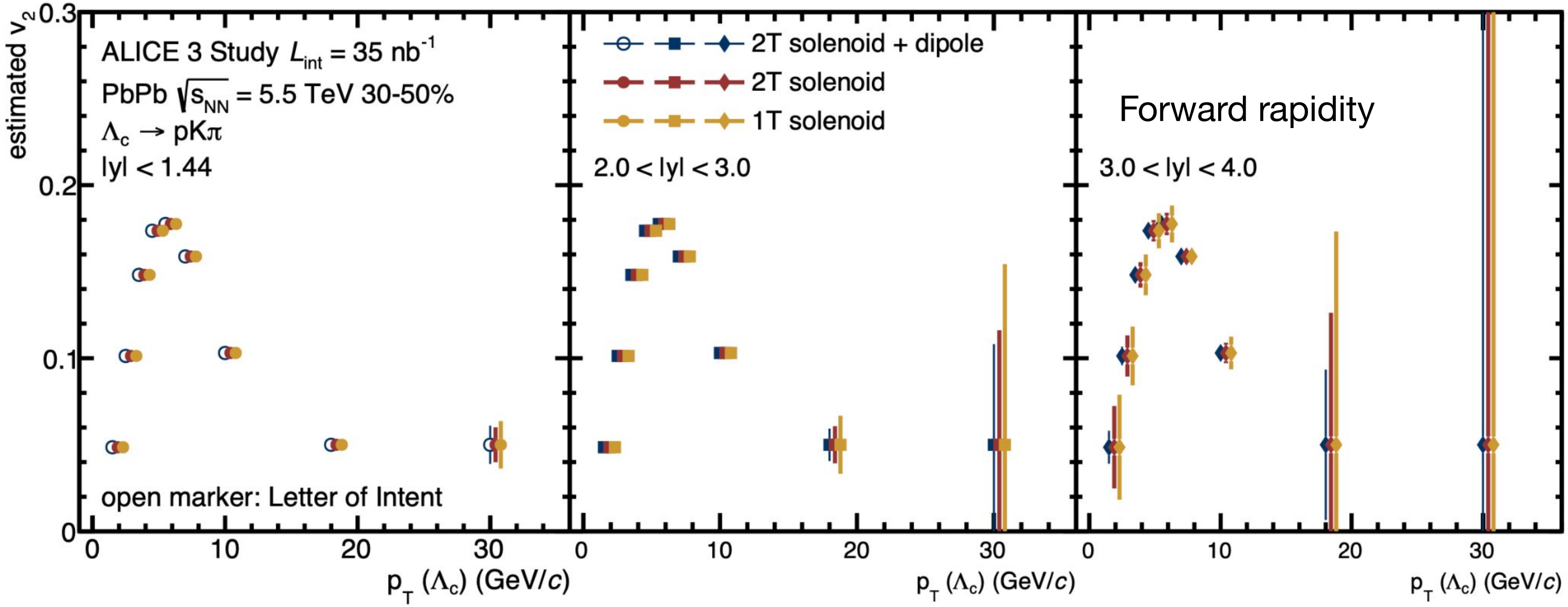
Dismantling of ALICE 2, installation of magnet and services, and of ALICE 3 fit in LS4

Begin date	End date	Dura...	Task
12/6/32	6/22/33	143	Uninstall ALICE 2
7/1/33	4/6/34	200	Install services
7/1/33	8/18/33	35	Install absorber support structure
8/19/33	10/6/33	35	Install absorber elements
10/7/33	2/9/34	90	Install and commissioning superconducting magnet
10/7/33	10/20/33	10	Magnet installation
10/21/33	12/8/33	35	Magnet cool-down
10/21/33	11/24/33	25	FCT dipole temporary installation
12/9/33	1/5/34	20	Magnet commissioning
1/6/34	1/19/34	10	Magnet field mapping (solenoid + FCT dipole)
1/20/34	2/9/34	15	Magnet warm-up at 100K
2/10/34	3/2/34	15	Install spaceframe
3/3/34	5/11/34	50	Install ECal detector
3/3/34	4/27/34	40	Install MID detector
5/12/34	6/29/34	35	Install RICH & TOF detectors
6/30/34	8/24/34	40	Install central beampipe & vertex detector
8/25/34	10/12/34	35	Install outer tracker
10/13/34	11/30/34	35	Install middle layers & disks
12/1/34	12/14/34	10	Install outer tracker disks
12/15/34	12/28/34	10	Install RICH & TOF endcaps
12/29/34	1/25/35	20	Install FCT dipole and detector
1/26/35	3/22/35	40	Commissioning

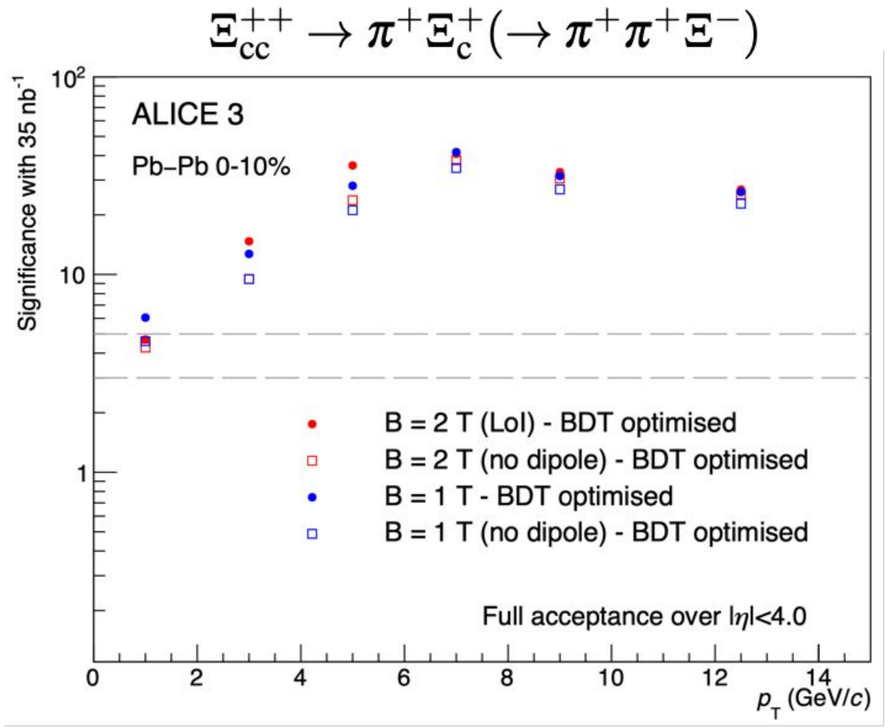


Layout v2-1T: Λ_c elliptic flow

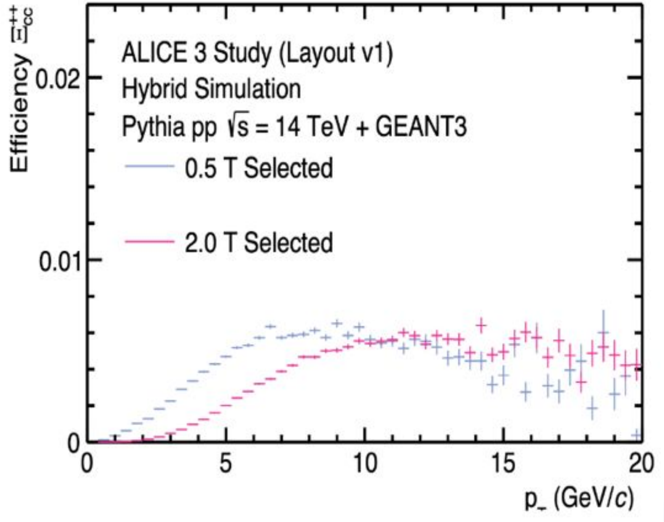
- **Measurement at central rapidity |*y*|<3 remains precise** also with solenoid 1 T
- **Measurement at forward rapidity 3<|*y*|<4 is degraded**, especially with 1T



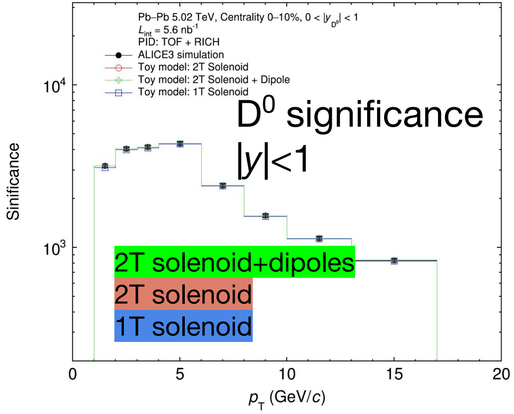
Layout v2-1T: multicharm baryon Ξ_{cc}

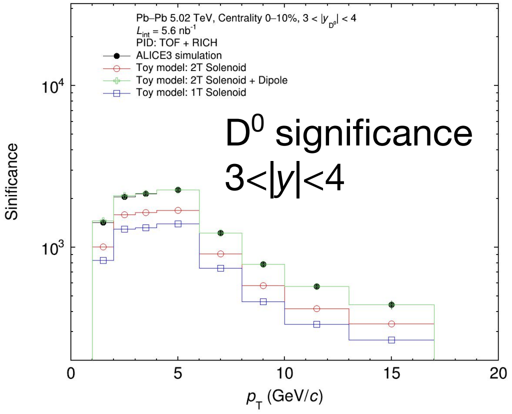


- **Significance ~30% lower without dipoles, at 2-6 GeV/c**
- 1T quite similar to 2T: a bit higher at low p_T, a bit lower at intermediate p_T
- Larger background due to lower p_T resolution partly compensated by larger acceptance for soft pions

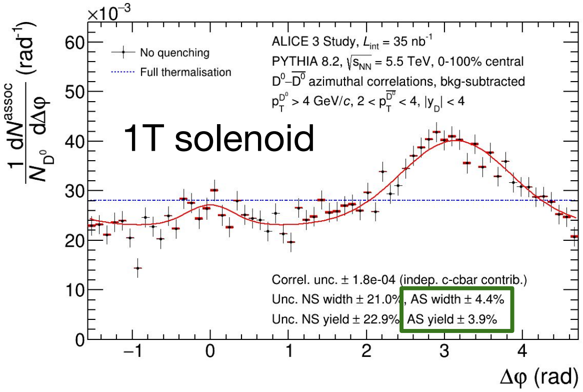


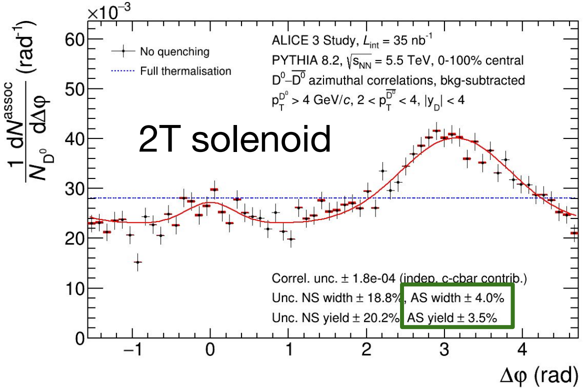
Layout v2-1T: D^0 and D-$\bar{D}$ correlations



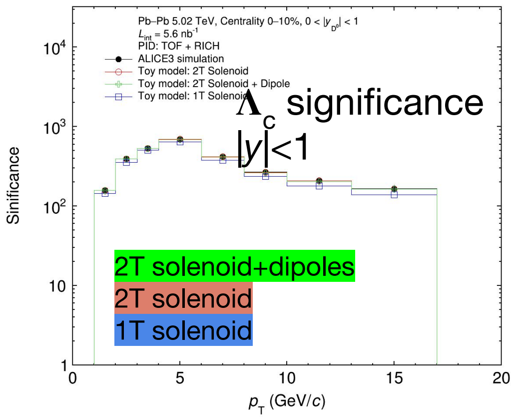


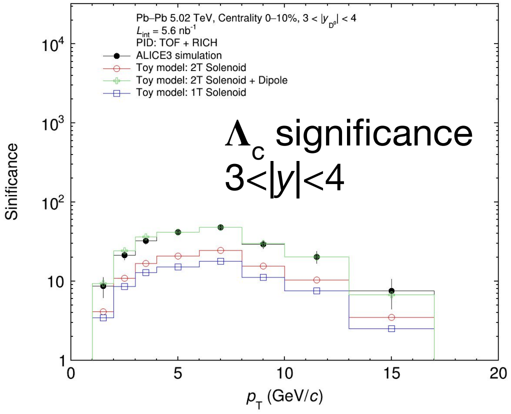
- D^0 meson significance:
  - no impact of field value/configuration at $|y|<3$, because S/B >>1
  - large reduction of S/B and significance in $3<|y|<4$
- Effect propagated to D-Dbar azimuthal correlations:
  - minor impact on precision of near-side and away-side peak yields and widths
  - e.g.: away-side width precision is 4.4% with 1T solenoid-only, 4.0% with 2T solenoid-only and 3.8% with 2T solenoid+dipoles



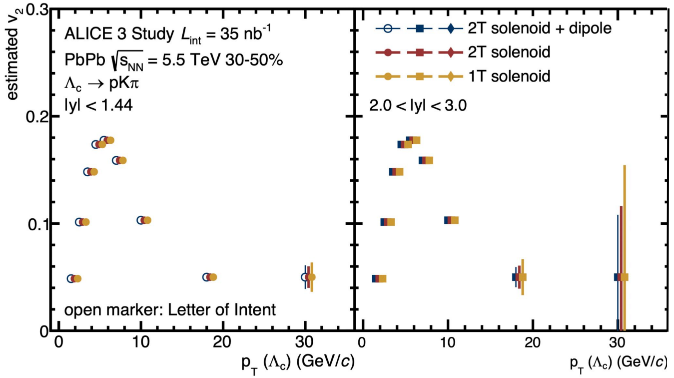


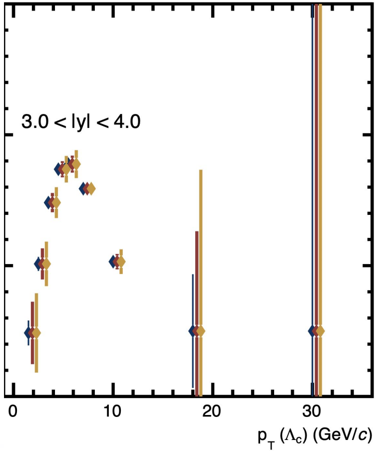
Layout v2-1T: Λ_c significance and flow





- Λ_c meson significance:
  - no impact of field value/configuration at |*y*|<2, because S/B >>1
  - large reduction of S/B and significance in 3<|*y*|<4 without dipoles, but small difference between 2T and 1T
- Λ_c Elliptic flow:
  - measurement at |*y*|<3 remains very precise also with solenoid only and with 1 T
  - measurement at 3<|*y*|<4 degraded without dipoles, especially with 1T





ECal descoping

Physics loss without ECal:

- Strong limitation in performance for BSM searches in $\gamma\gamma \rightarrow \gamma\gamma$
- $\chi_{c1,2}$ measurement starts at p_T 4-5 GeV/c instead of 1-2 GeV/c
- No possibility of full-jet and gamma-jet measurements

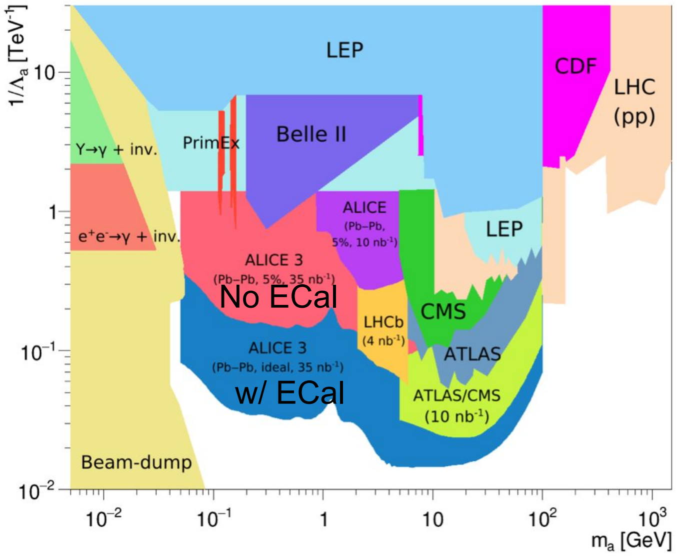
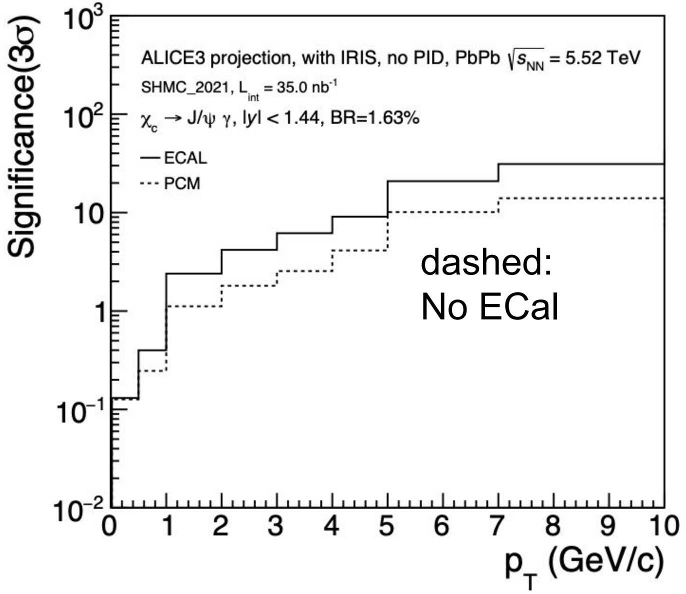
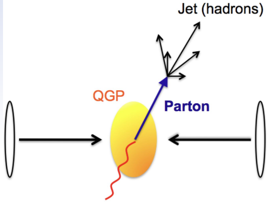


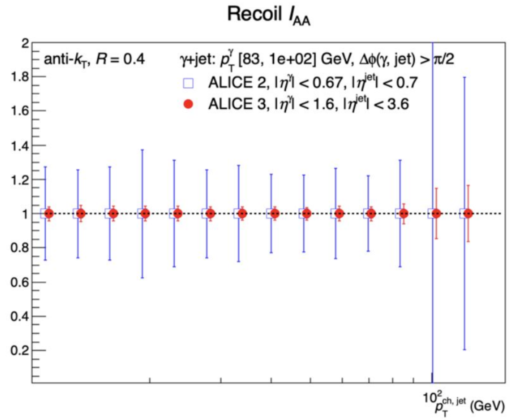
Figure 76: Bounds in the $(m_a, 1/\Lambda_a)$ plane from existing and future ALP searches.

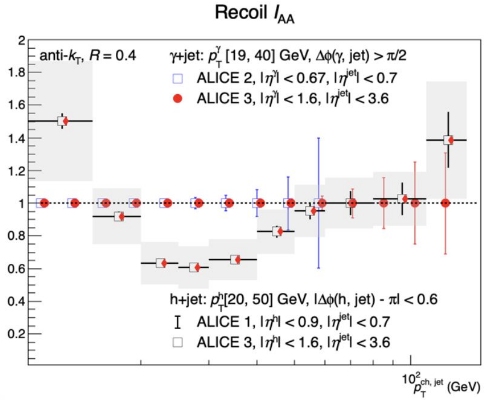


ECal: gamma-jet



- ECal can measure photons with x10 larger acceptance than ALICE 2 (EMCal)
- Photon can be correlated with charged-jets in |eta|<4 (exploiting ALICE 3 tracker acceptance)
- Uniqueness:
  - wrt ATLAS/CMS: low p_T
    - p_{Tjet}>10 GeV in ALICE 3 (same ALICE), vs 50 in ATLAS/CMS
    - p_{Tgamma}>10-20 GeV in ALICE 3, vs 50 in ATLAS/CMS
  - wrt ALICE 2: x10 larger acceptance for the photon (EMCal vs ECal), x2 larger L_{int}, ch. jets in |eta|<3.6 vs |eta|<0.5
- Projections for recoil jet R_{AA} and I_{AA}

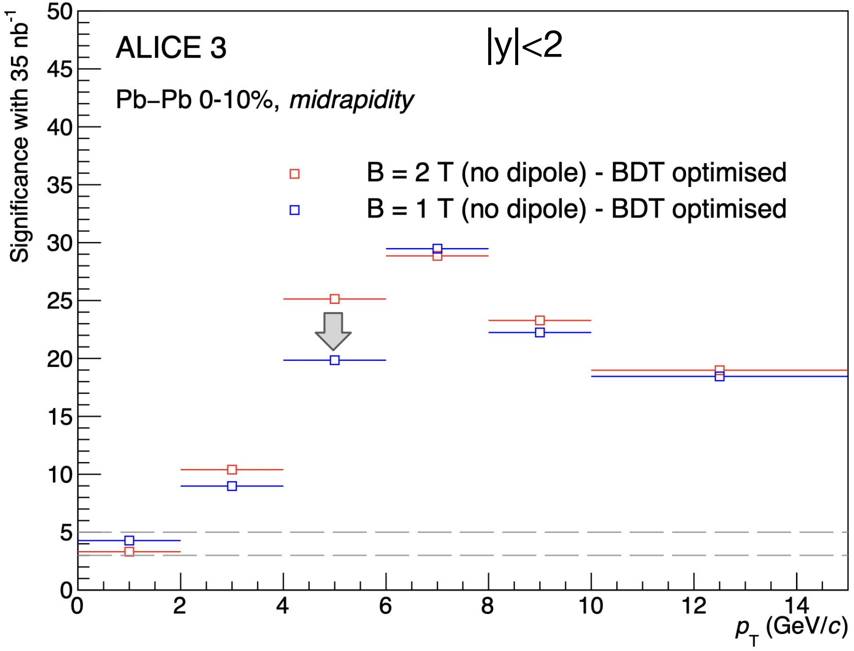


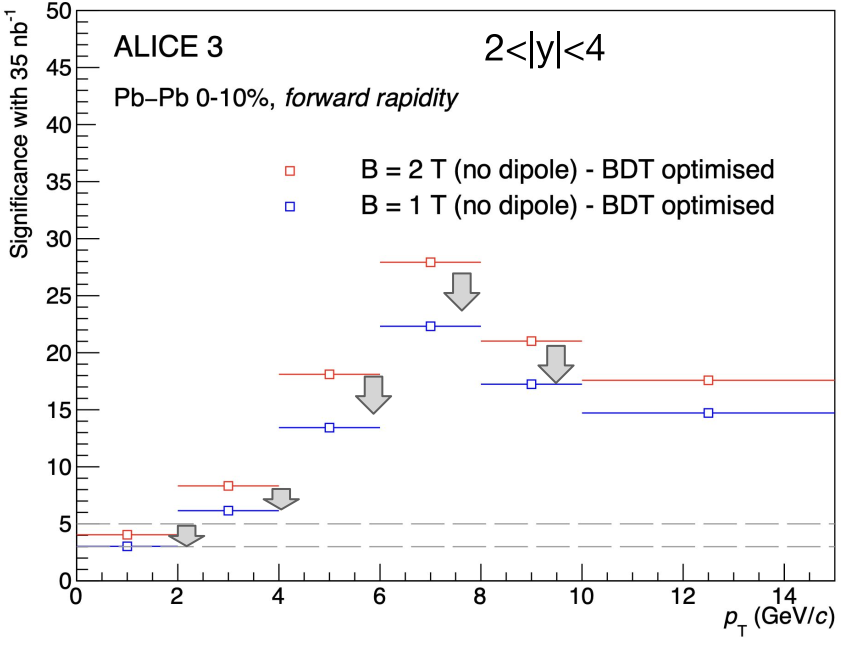


2T vs 1T: multicharm baryon Ξ_{cc}

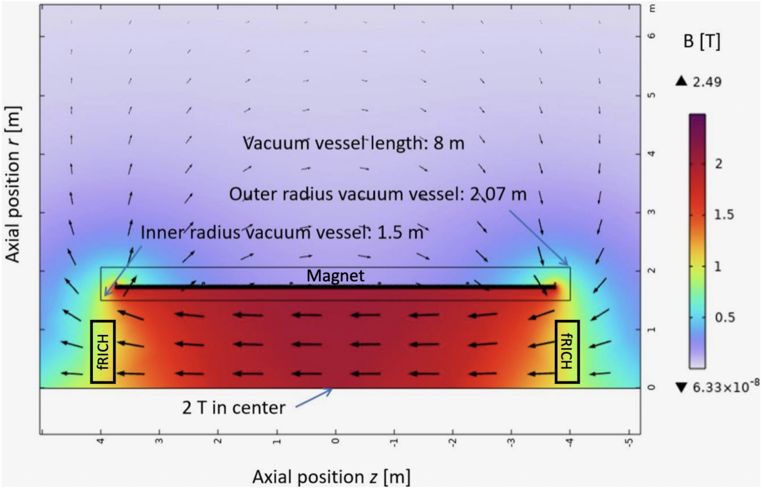
$$\Xi_{cc}^{++} \rightarrow \pi^{+}\Xi_{c}^{+}(\rightarrow \pi^{+}\pi^{+}\Xi^{-})$$

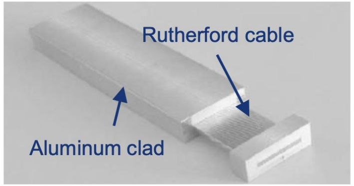
- **Significance at forward rapidity is reduced by ~25% with 1 T compared with 2 T**





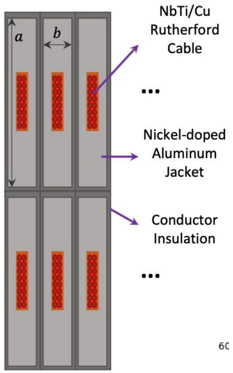
Superconducting 2T Magnet





Aluminum co-extruded cable

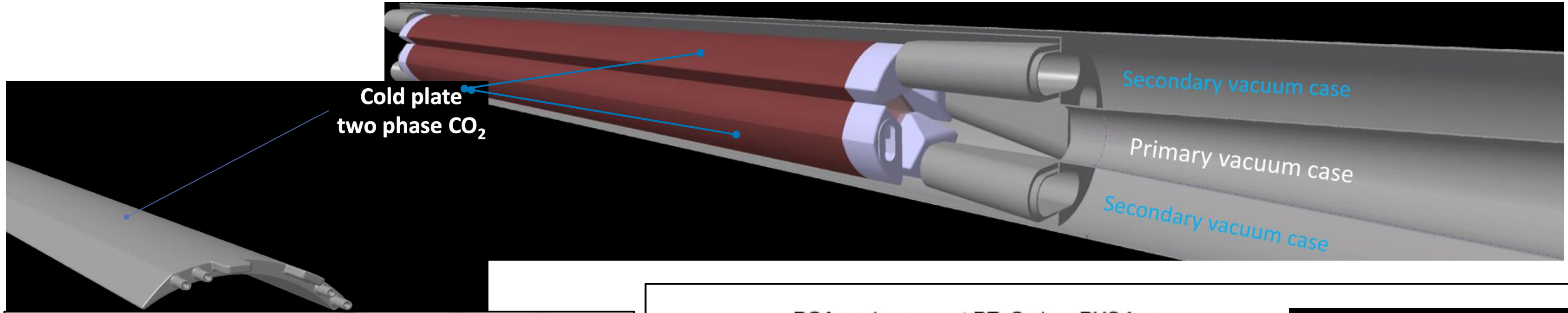
EMuS conductor sample

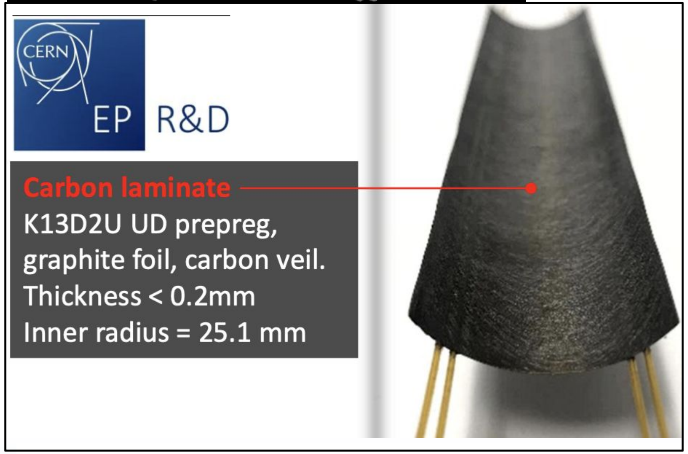


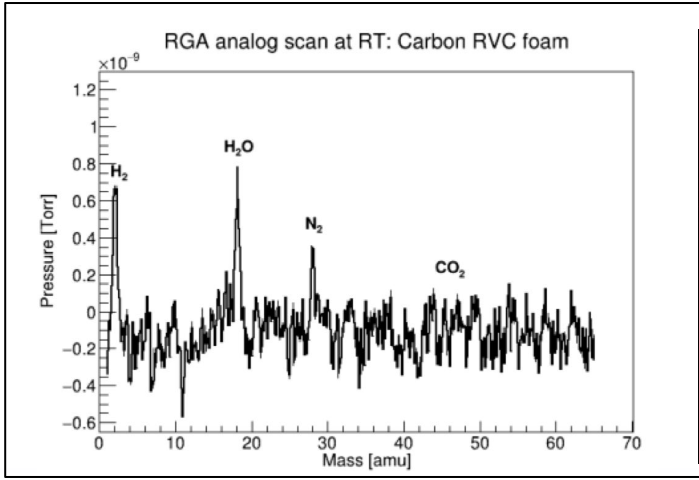
- Baseline plan is a long SC solenoid (~8 m, with R_{in}~1.25m) with Al-cladded Nb-Ti Rutherford cable
  - Similar design as all existing detector solenoids
- Several options followed-up for cable procurement, including a dedicated CERN R&D programme
- Brazilian Centre for Research on Energy and Materials (CNPEM) pursuing plan to design and build the magnet
- Design activity starting up

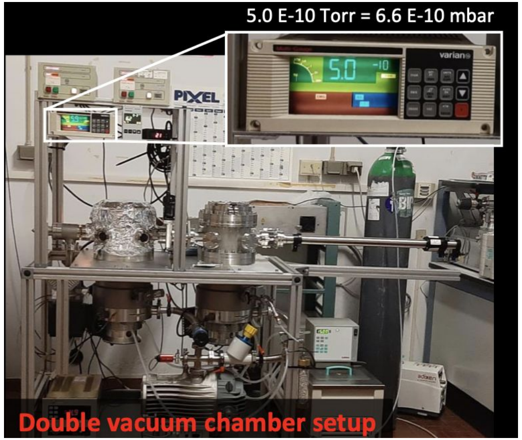
R&D for Vertex Detector

- Design and prototyping of thin carbon-fibre cold plate for CO_2-based cooling of movable petals
- Outgassing studies to qualify materials for secondary vacuum (~10^{-9} mbar)



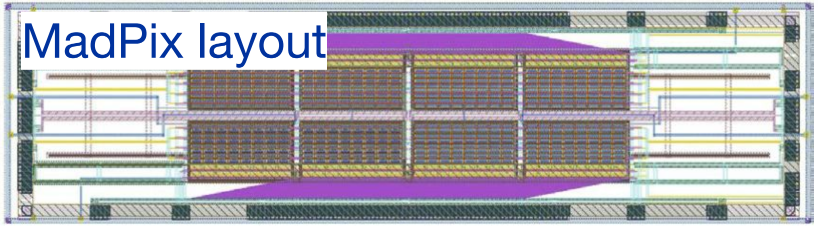


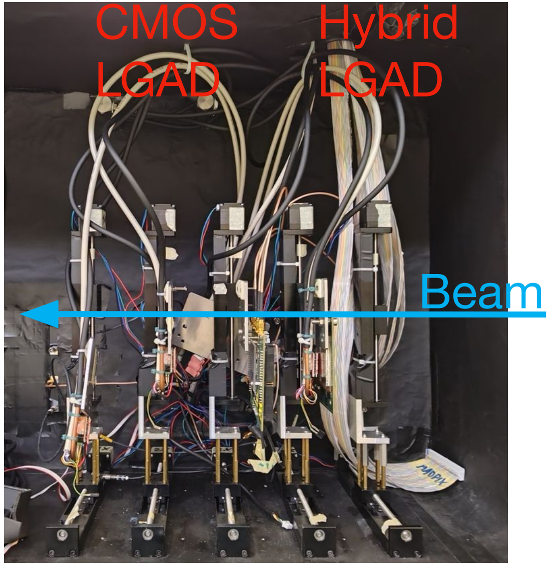


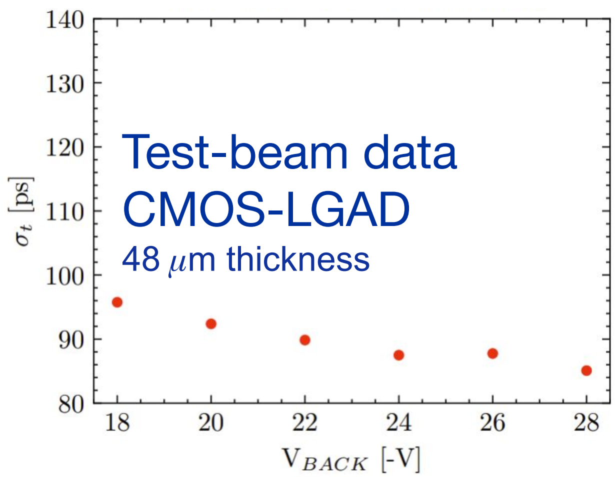


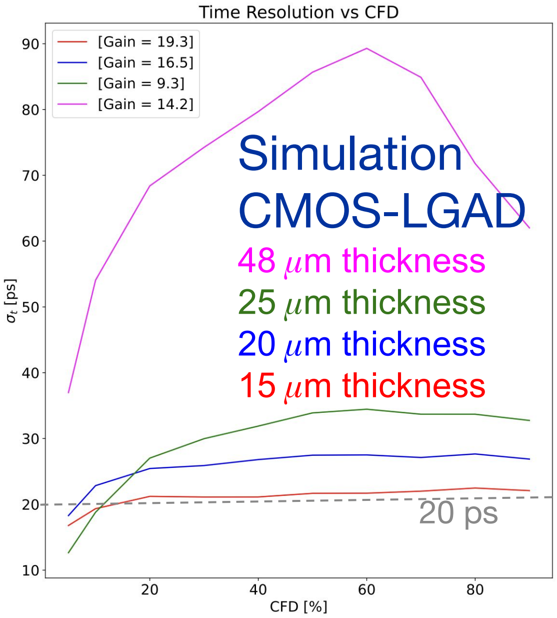
R&D for silicon Time Of Flight

- Time resolution requirement: σ_t ~ 20 ps
- Main R&D direction: **Novel monolithic CMOS-LGAD with gain layer**
  - MadPix sensor with 48 μm thickness gives ~75 ps
  - Upcoming thinner versions expected to reach 20 ps

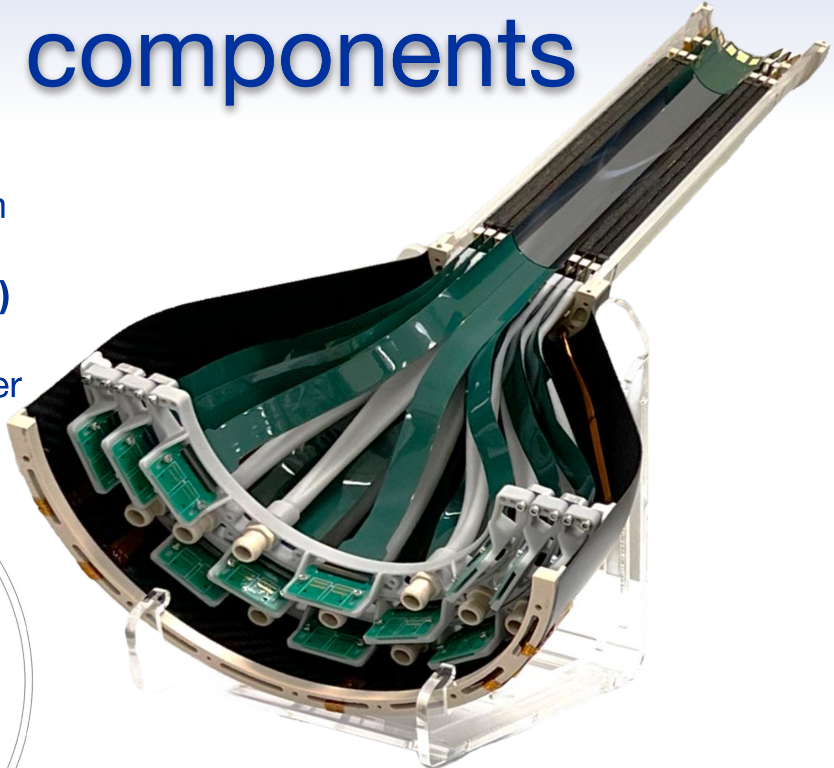








ITS3: towards final components

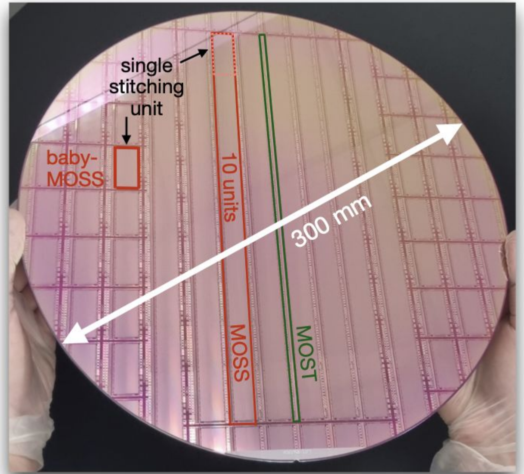


Pixel sensor Engineering Run 1

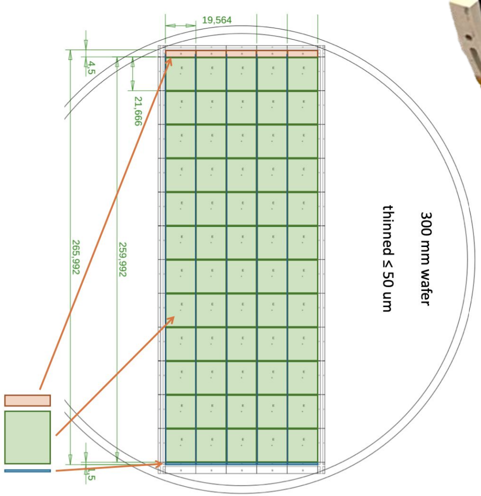
- Monolithic Stitched Sensor (MOSS): 259x14 mm^2 x50 μm
- Extensively tested and validated

Preparation of Engineering Run 2, for final sensor (MOSAIX)

- Stitched in both directions: 259x105 mm^2 x50 μm
- Final verification ongoing; expected delivery after summer



Engineering Run 1 wafer with various dies

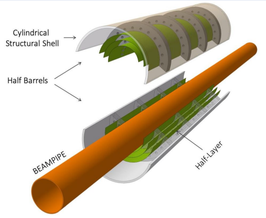


Monolithic Stitched Sensor (MOSS)

Engineering Model 3

- All three layers, with dummy sensors
- Mechanical support structure (carbon foam longerons and spacers)
- FPCs integrated on both sides

ITS3 recent highlights

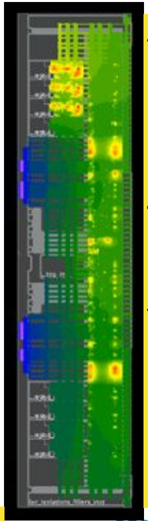


ITS3 prototype sensor "MOSAIX"

- full-size, fully-functional
- final dimensions and interfaces

ER2 submission for "MOSAIX"

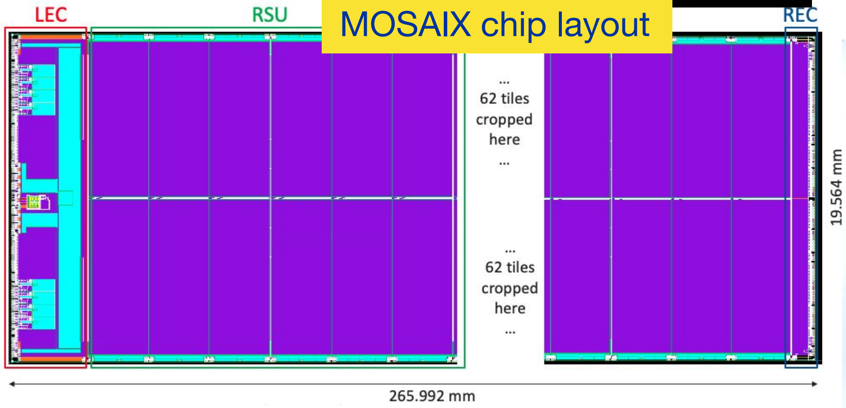
- final simulation checks ongoing, including detailed power dissipation
- tape out this month → sensors expected back in fall



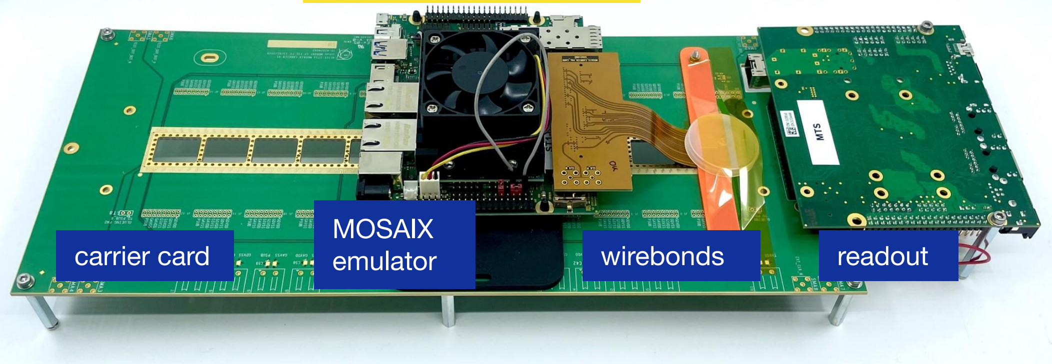
MOSAIX power simulation (left end cap, LEC)

MOSAIX testing preparation

- Carrier cards, wafer-probe cards, test system (DAQ) produced
- Firm- and software development ready for first tests
- FPGA-based hardware emulation platform developed



MOSAIX chip layout



MOSAIX test setup