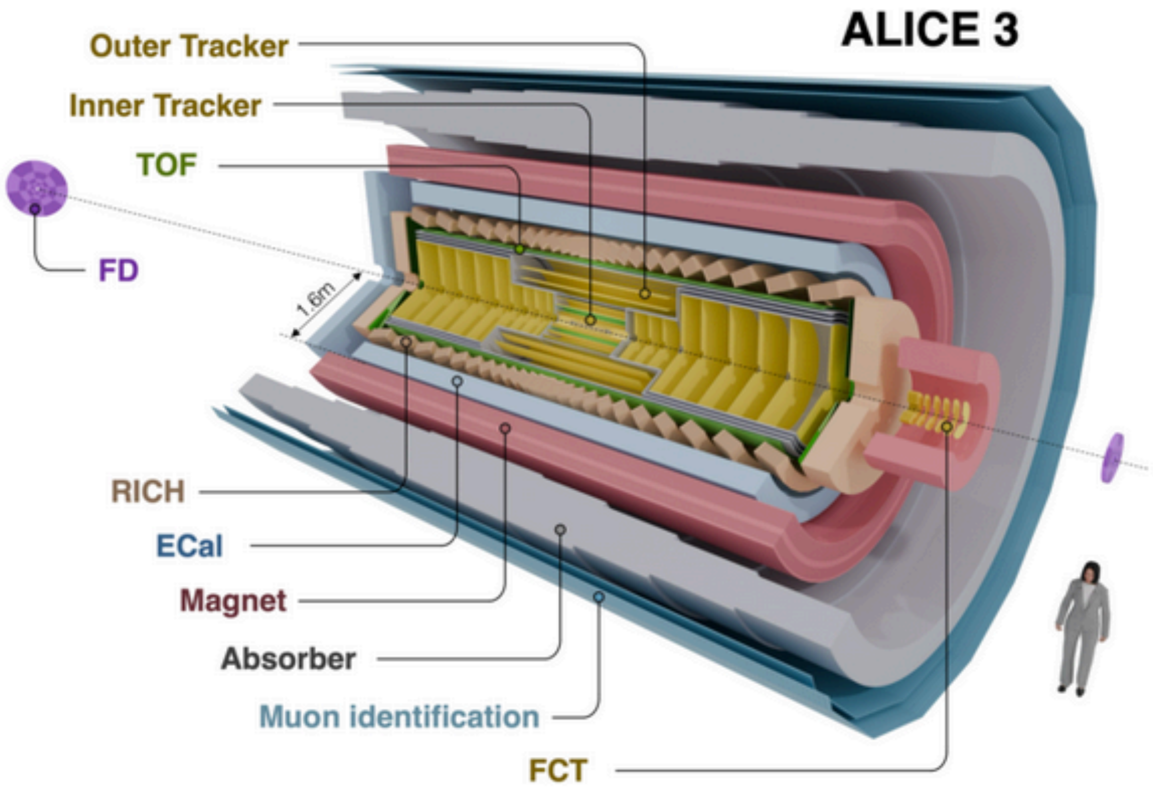
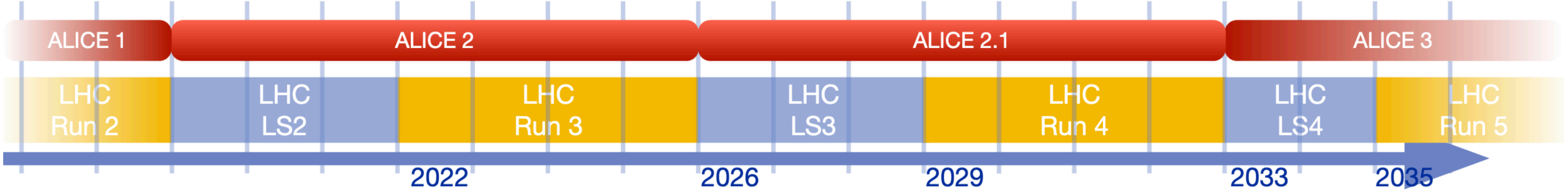
Richieste ai servizi di base 2026
ALICE 3 Time Of Flight

S. Bufalino
Consiglio di Sezione 12/06/2025

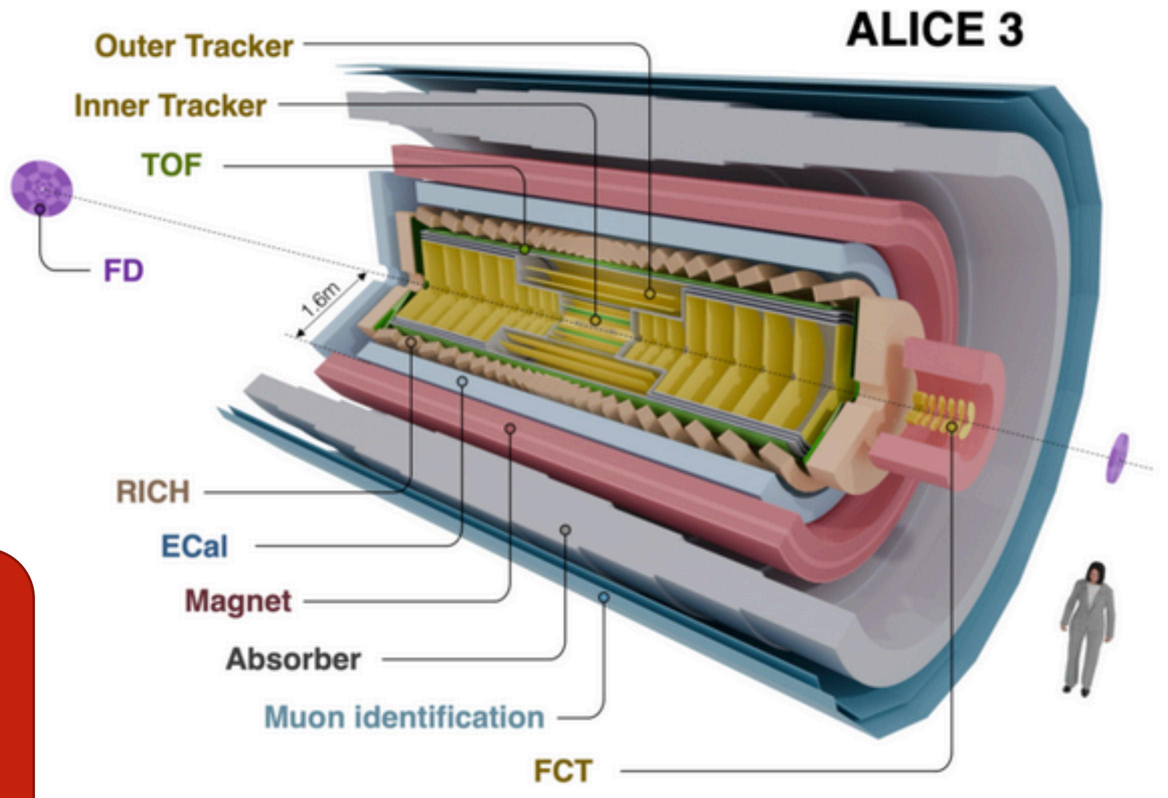
ALICE 3 Timeline





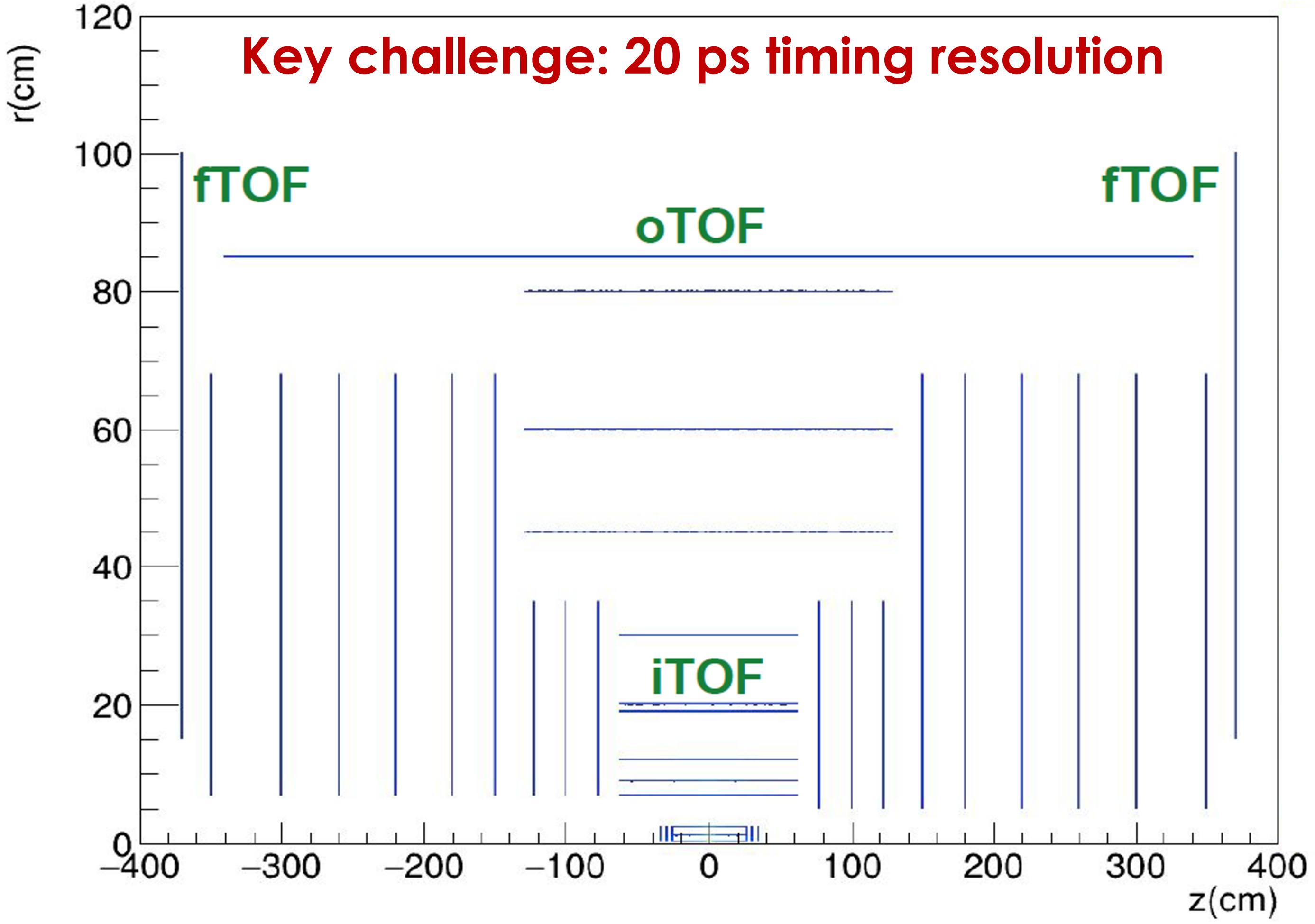
ALICE 3 Timeline

- **2026-27**: large-scale engineered prototypes (~75% of R&D funds)
  → Technical Design Reports and MoUs
- **2028-30**: construction and testing
- **2031-32**: contingency and pre-commissioning
- **2033-34**: Preparation of cavern, installation



- Aggressive R&D for the ALICE 3 TOF
- R&D of the Tracker in sinergy with ALICE ITS3
- Technology developed for ALICE 3 in synergy with those useful for FCC

ALICE 3 TOF: project layout

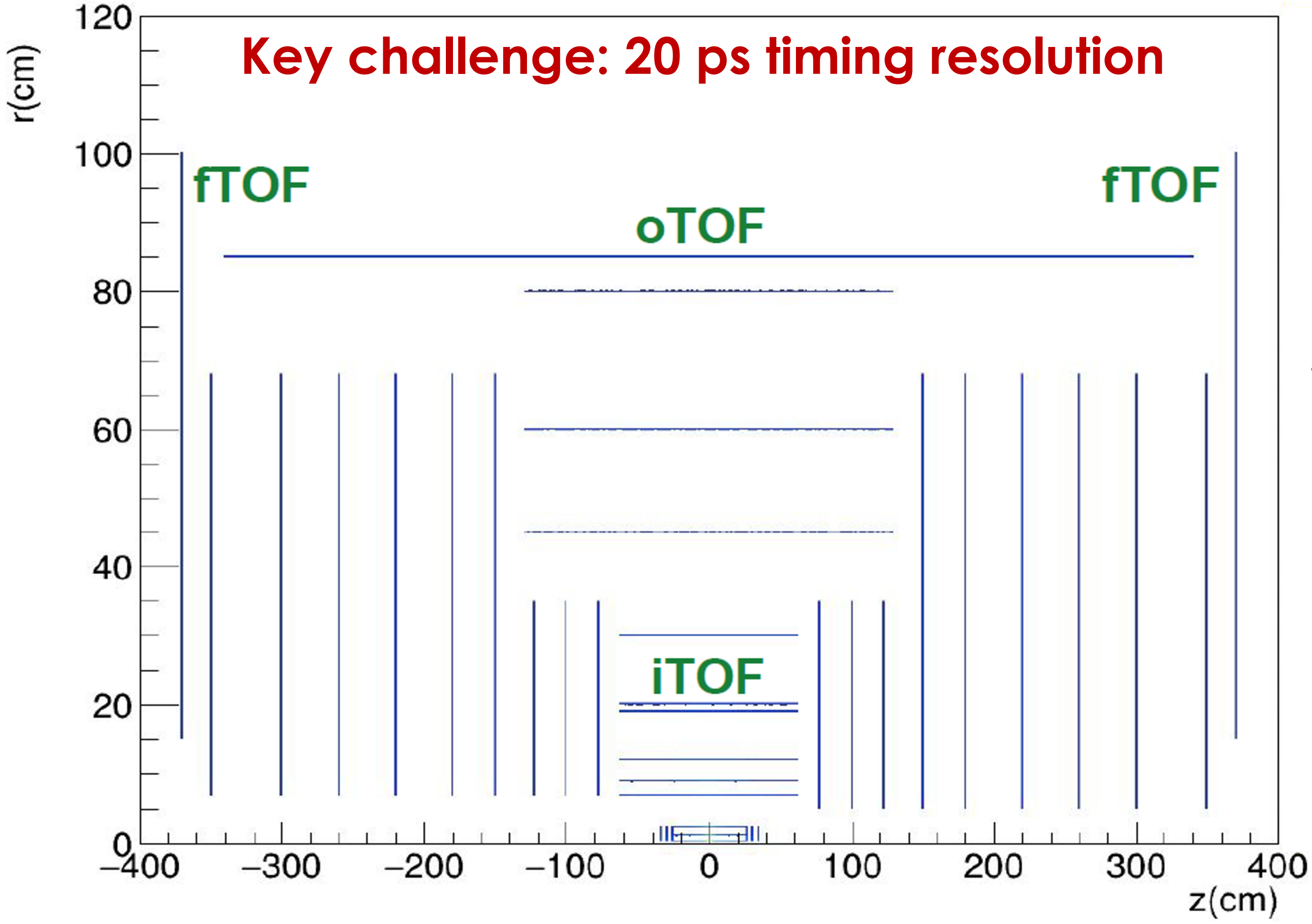


Total area ~45 m²

Table 10: TOF specifications. The Outer TOF barrel length, the Forward TOF radius and the hit rates have been updated with respect to the LoI values.

	Inner TOF	Outer TOF	Forward TOF disks
Radius (m)	0.19	0.85	0.15 to 1.0
z range (m)	−0.62 to 0.62	−3.50 to 3.50	±3.70
Area (m^2)	1.5	37	6
Acceptance	$\|\eta\| < 1.9$	$\|\eta\| < 2$	$2 < \|\eta\| < 4$
Granularity (mm^2)	1×1	5×5	1×1 to 5×5
Hit rate (kHz/cm^2)	200	15	280
Material thickness (%X_0)	1 to 3	1 to 3	1 to 3

ALICE 3 TOF: project layout



Total area ~45 m²

International Collaboration with INFN Leadership:
Brasil, South Africa, Japan, China, Netherlands

INFN Units involved: Bologna, Torino and Trento

Project Leader: Angelo Rivetti

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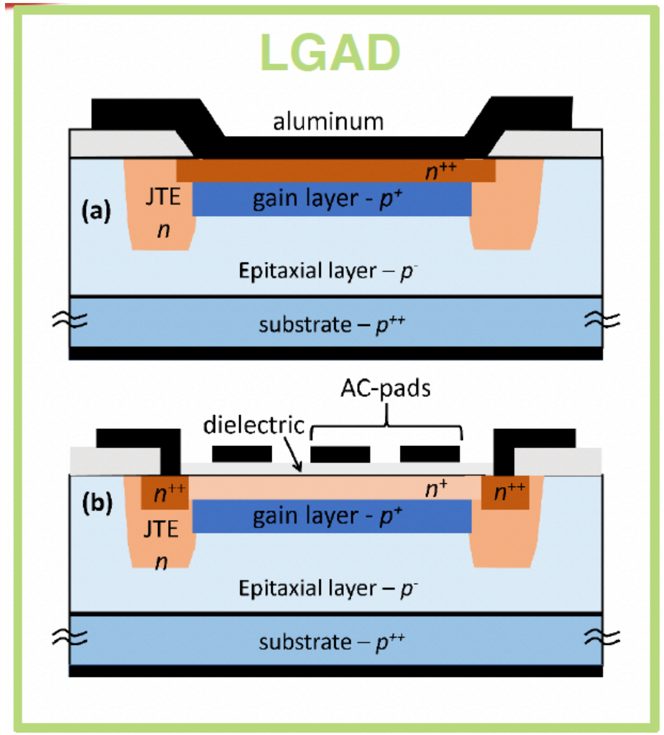
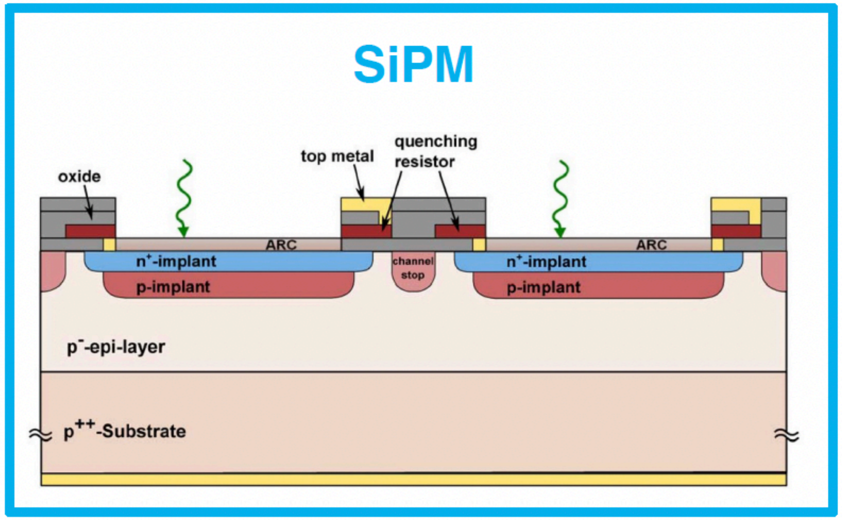
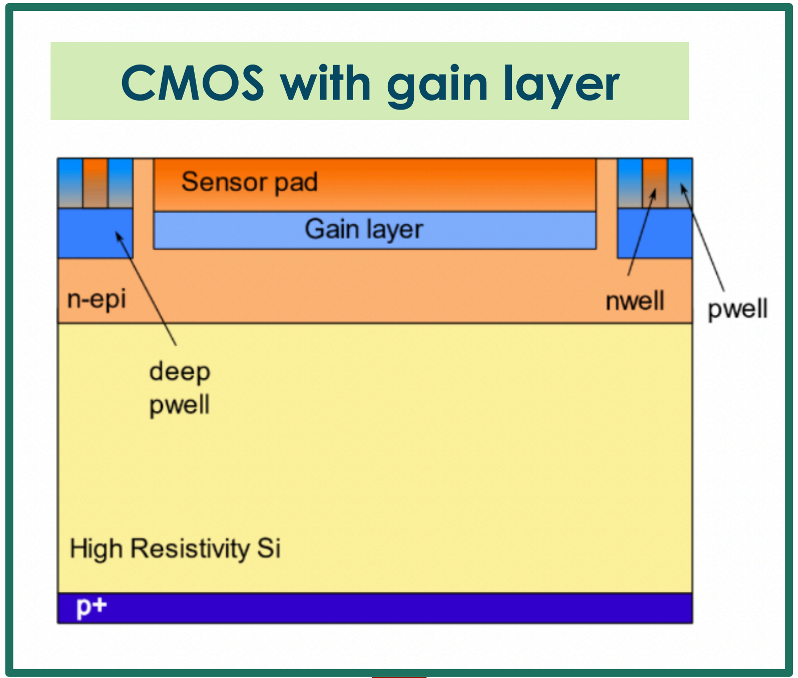
ALICE 3 TOF: technology options







- Fall back solution
- Most mature technology in terms of timing resolution
- Less cost effective

- Investigation on innovative design to proof timing performance

Leadership of the INFN Torino for the CMOS technology development

R&D strategy in 2024-2025

- Focus on **monolithic sensors**
  - need to push the timing resolution well beyond the state of the art

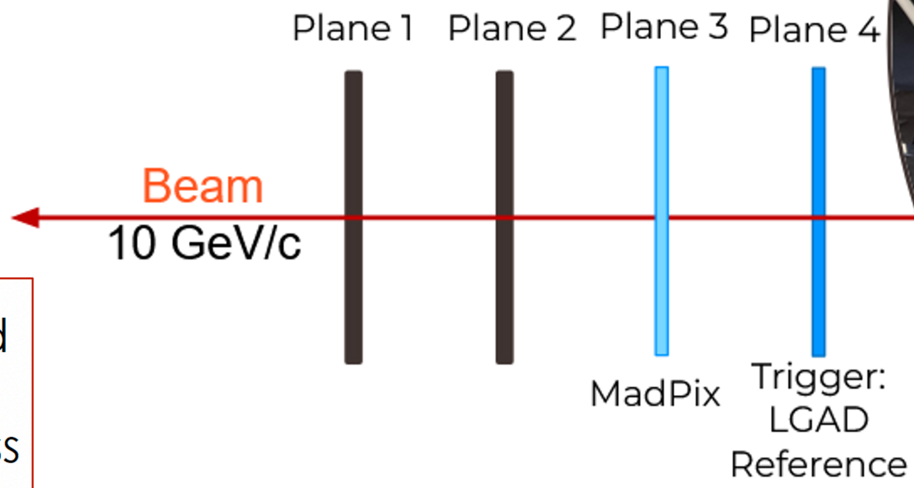
- Chosen approach: **add a gain layer to a standard CMOS process**
  - synergy with the INFN ARCADIA project (LF 110 nm): re-use of existing masks with custom substrates and addition of a gain layer
  - 3 short loop runs so far (1 in 2023, 2 in 2024)
  - CMOS-LGAD chip with sensor and front-end electronics (Madpix)

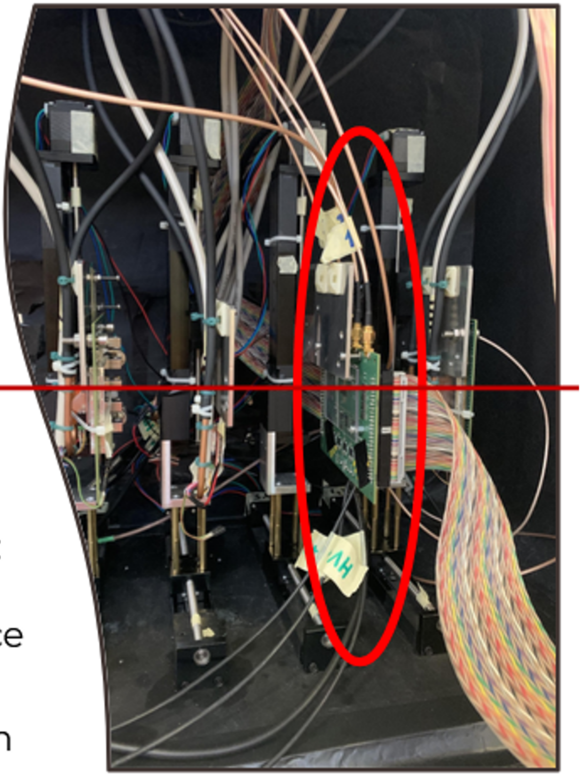
- **Advantages**:
  - Implementation with a novel sensor concept at a very reduced cost
  - Provides enough information to understand key issues
  - Fine-tuning of sensor simulations in TCAD with inputs from measurements

- **Drawbacks**:
  - Constraints on collection electrode geometry
  - Not possible to reach the ultimate time resolution without a full set of dedicated masks
    → **full Engineering Run needed in the near future (2026)**

ALICE 3 TOF: R&D status

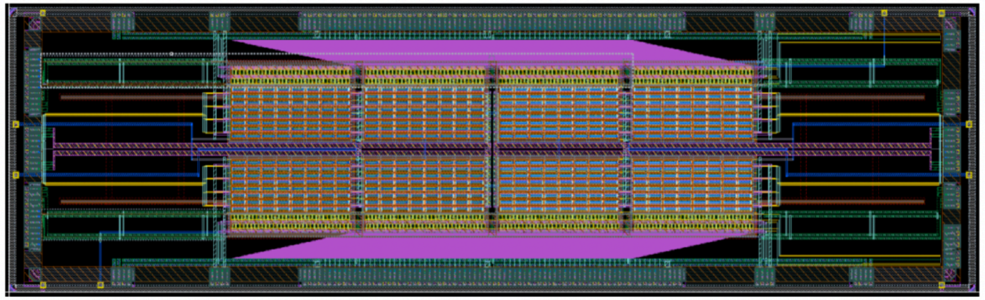
Beam-test setup (INFN-BO-TO) @ CERN-T10





- 4 planes telescope
- MadPix linked to a Xilinx FPGA controlled in control room
- Readout → Oscilloscope for signal acquisition

First **prototype with integrated electronics** and gain layer produced by LFoundry in 110 nm commercial CMOS Process

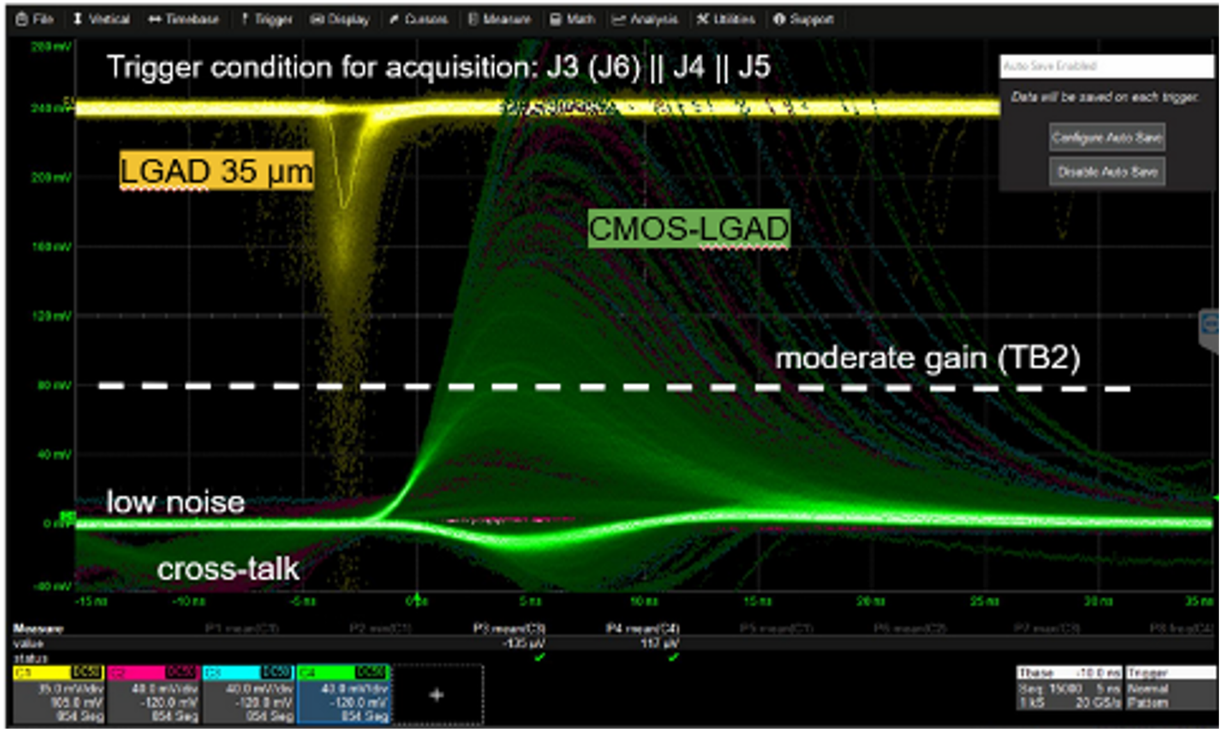


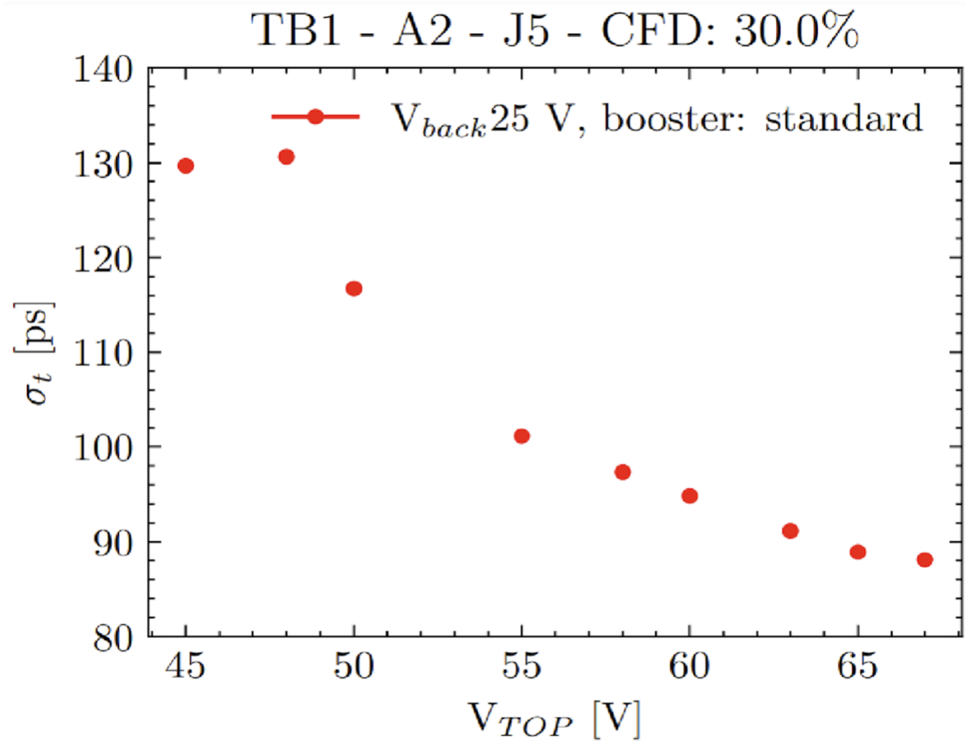
MadPix

CMOS-LGAD: timing resolution

Time resolution sensor + front end (@0.18mW/ch): 88 ps

Time resolution sensor: ≈ 75 ps (with increased power)



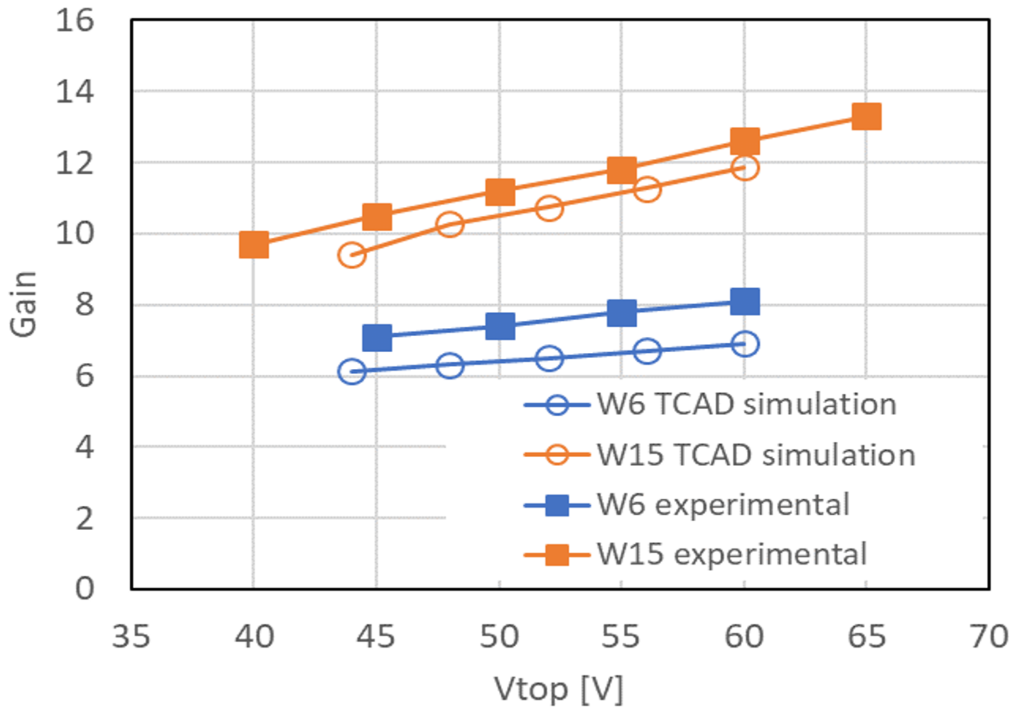


→ Timing resolution limited by sensor thickness

- Latest test beam @DESY with a tracker
- Next test beam at CERN on irradiated sensors

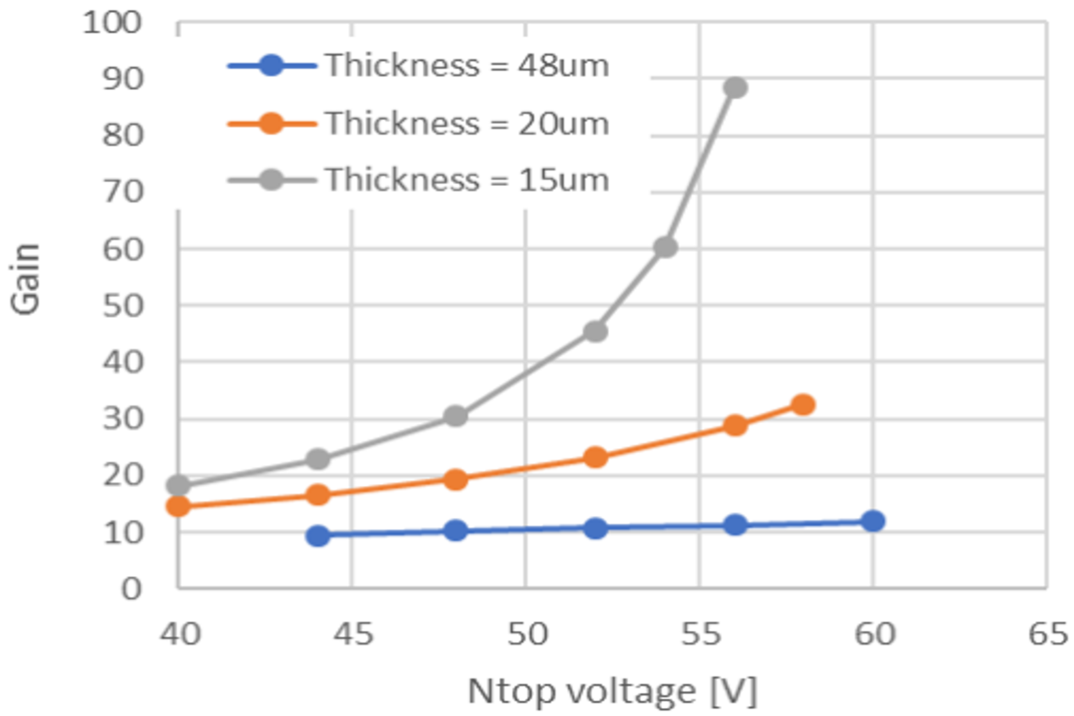
CMOS-LGAD: next short loop

Comparison: TCAD simulation (after parameters tuning) and Gain measured with ^{55}Fe X-rays



Good matching of simulated and experimental gain after TCAD parameter tuning on experimental data.

Predicted gain (TCAD) for different thicknesses (same gain dose as W15)



Signal lost for reduced thickness is compensated by the higher gain

TOF: piani per R&D e richieste

Laboratorio di Elettronica

Il risultati dei prossimi test beam, previsti al CERN, a fine giugno e novembre 2025 saranno importanti per la scelta della tecnologia:

- Engeneering run di sensori monolitici con guadagno ottimizzati per misure di tempo di volo previsto a metà 2026
- Caratterizzazione in laboratorio e poi su fascio (giugno e novembre 2026)

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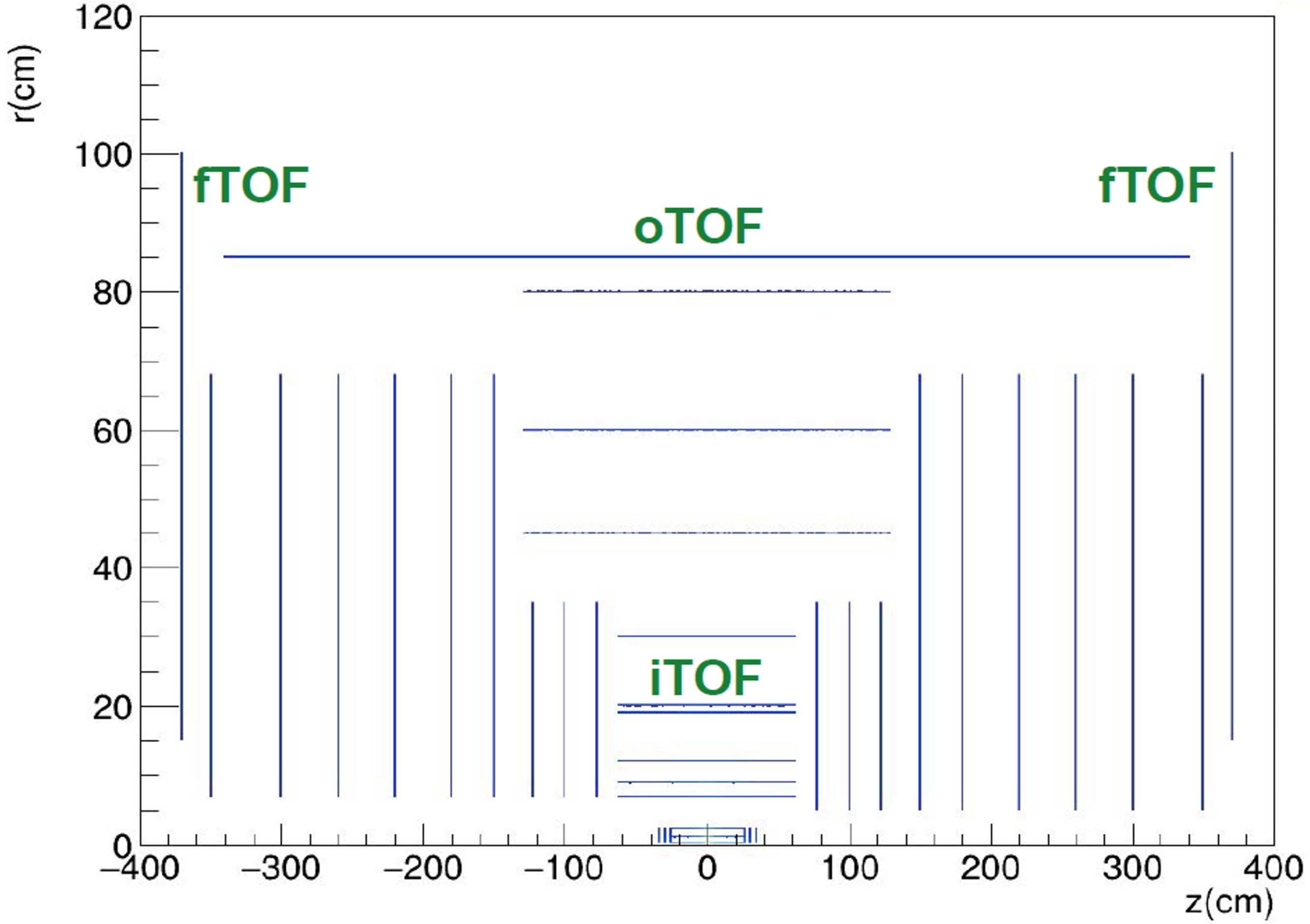
Si richiede la collaborazione di:

- Marco Mignone (2 mesi uomo) per progettazione PCB per caratterizzazione strutture di test per monolitici con guadagno che verranno prodotti nel prossimo ER

- 1 mese uomo per le microsaldature (wire e TAB bond) sui prototipi

Tecnologi coinvolti nel 2026: A. Rivetti, F. Cossio, G, Dellacasa, G. Mazza

ALICE 3 TOF: layout



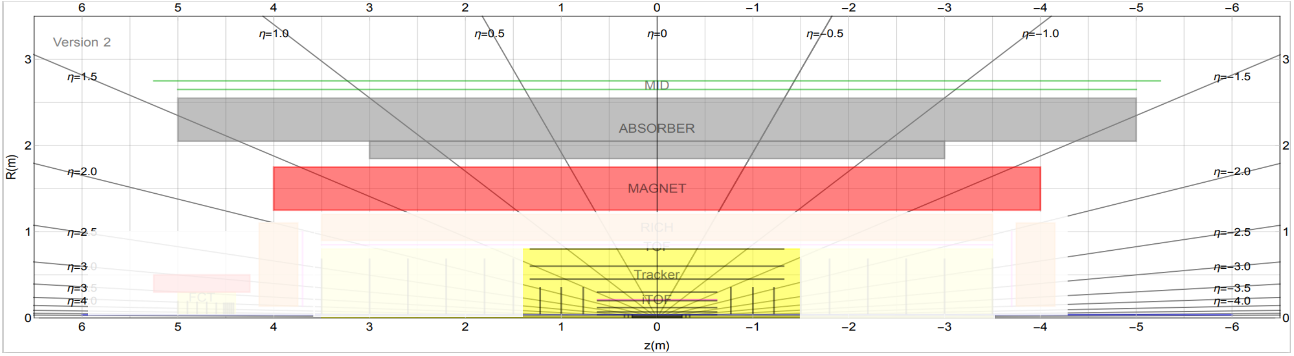
	iTOF	oTOF	fTOF
Radius (m)	0.19-**0.20***	0.85	0.15 to 1
z range (m)	-0.62 to 0.62	-3.5 to 3.5	±3.7
Surface (m^2)	1.5	37	6
Thickness (% X_0)	1 to 3	1 to 3	1 to 3

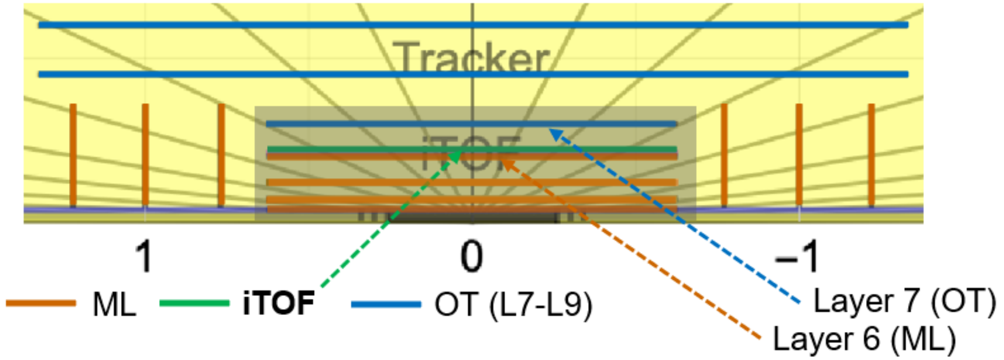
Major challenges (among others) towards detector construction:

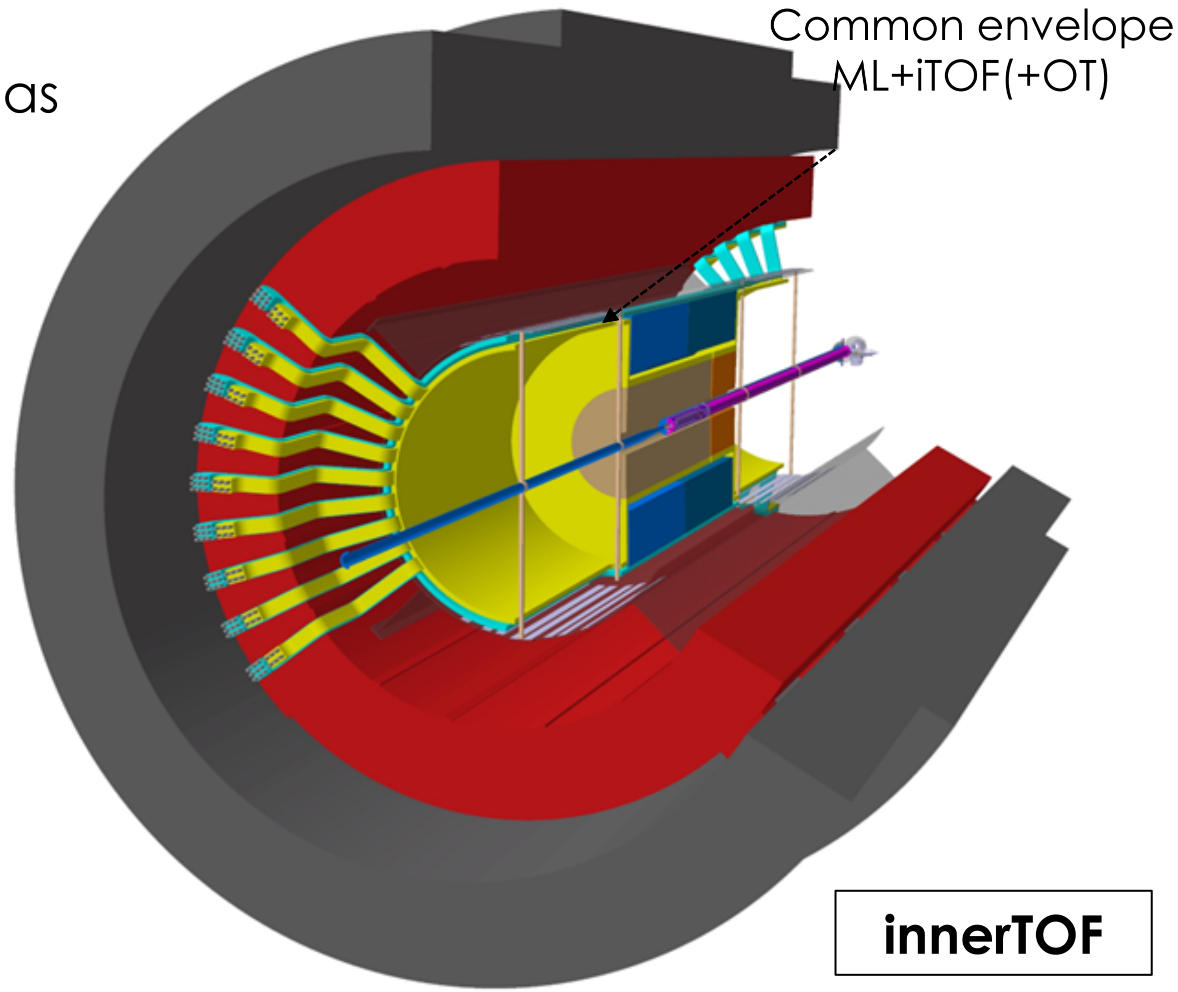
- **Tight envelope**, especially for **iTOF**
- **Long barrel** layer (**oTOF**)
- **Material budget as low as possible**

ALICE 3 TOF: implementazione

- Sensors as large as the reticle size (2.4 x 3.6 cm^2)
- First thoughts about 2x4 sensors module (à la OT)
- (Half-)stave concepts yet to be defined (as well as of forwards disks)
- Half-stave concept better suited for oTOF







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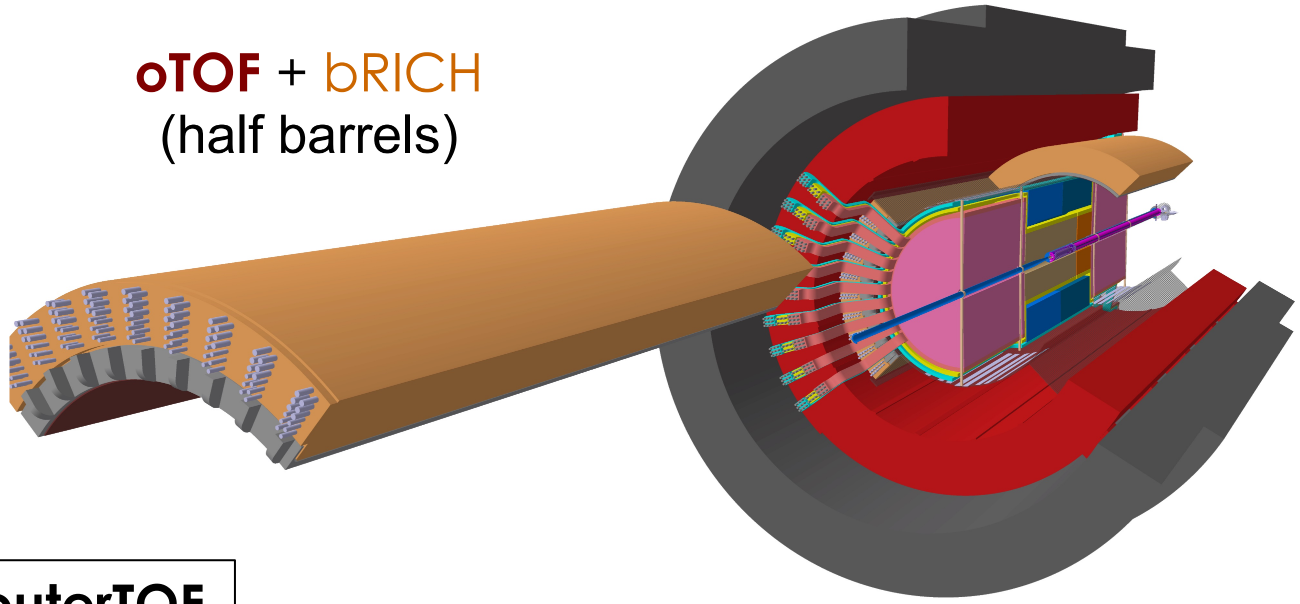
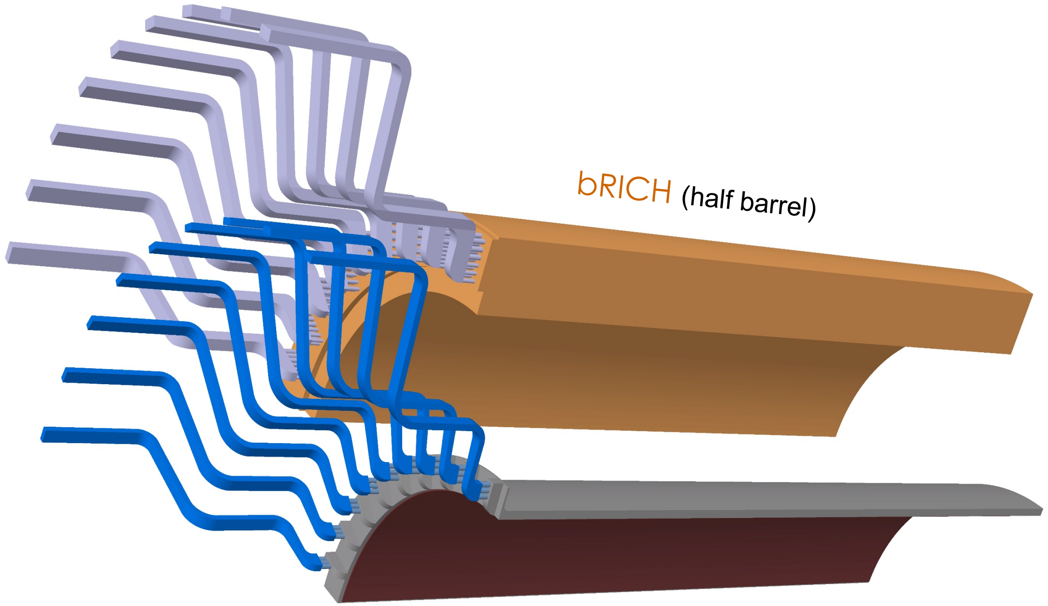
oTOF + bRICH
(half barrels)





outerTOF

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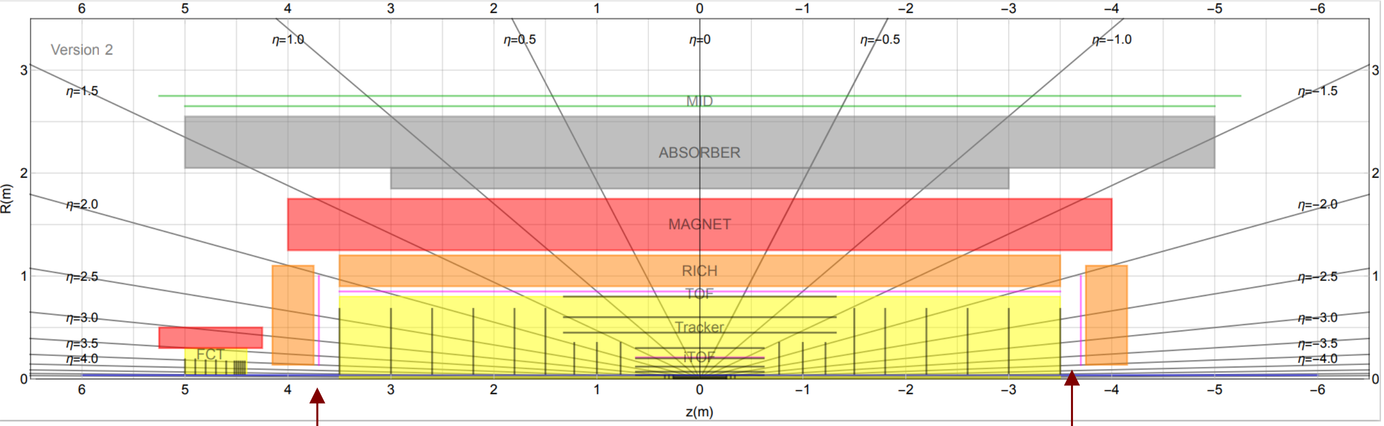
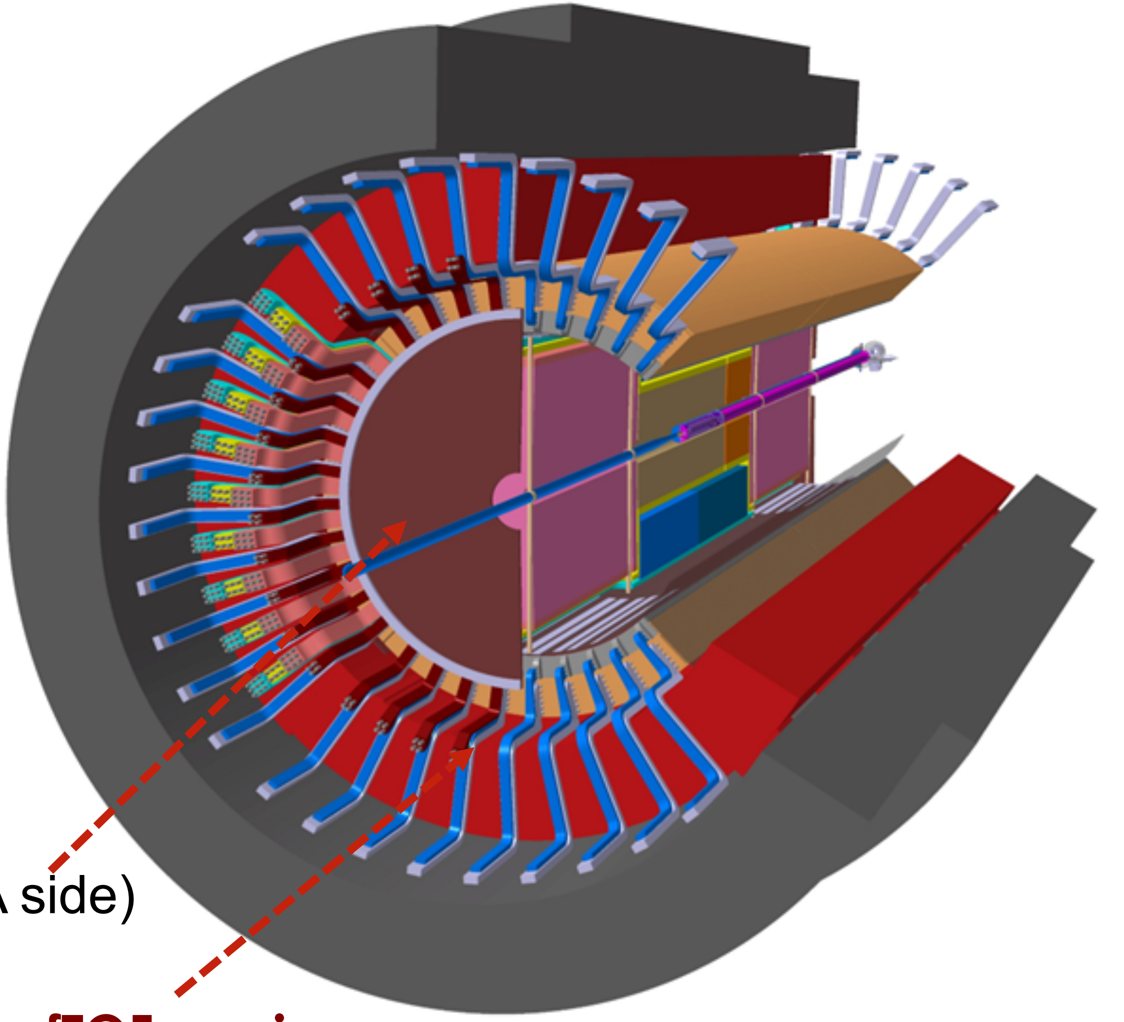


fTOF

fTOF



fTOF (A side)

fTOF services

Forward TOF disks

ALICE 3 TOF: richieste

Servizio di progettazione meccanica

Come discusso con i colleghi della progettazione meccanica, l'attività di progettazione meccanica legata ad ALICE 3 TOF **richiederebbe nel 2026 circa 1- 1.5 FTE di tecnologi** per la definizione di soluzioni per la geometria del rivelatore e per rendere indipendente l'inserimento del TOF tra il tracciatore e il RICH.

Si richiede inoltre la collaborazione del servizio di progettazione meccanica per:

- 4 mesi uomo per progettazione del sistema di raffreddamento.

Milestones

- Definizione di possibili soluzioni per la geometria del rivelatore (fine del 2026)
- Progettazione del sistema di raffreddamento (prime specifiche a giugno 2026 con una versione più dettagliata a fine 2026).

Il TDR di ALICE 3 TOF è previsto nella prima metà del 2027