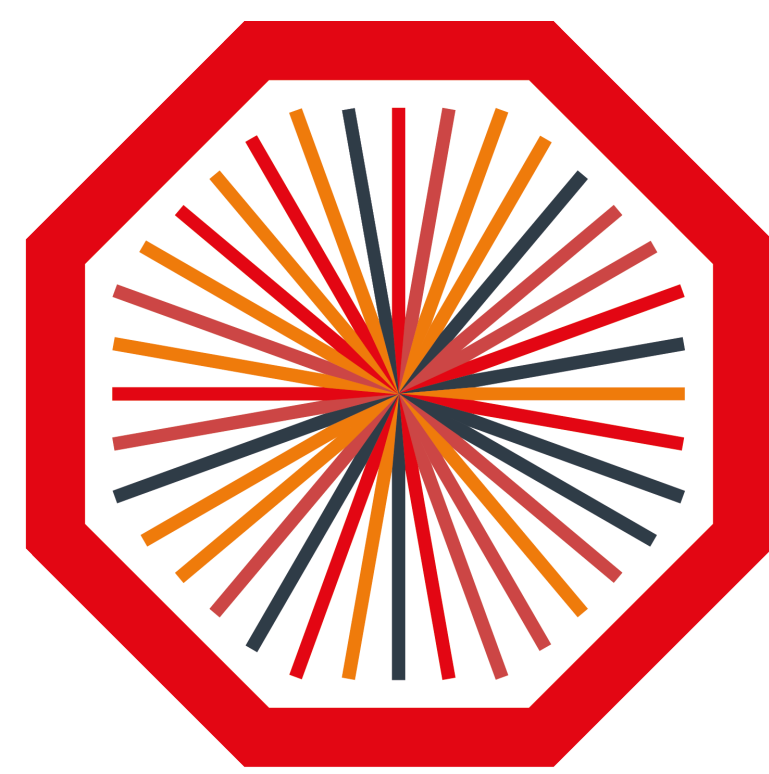




Istituto Nazionale di Fisica Nucleare  
Sezione di Bologna

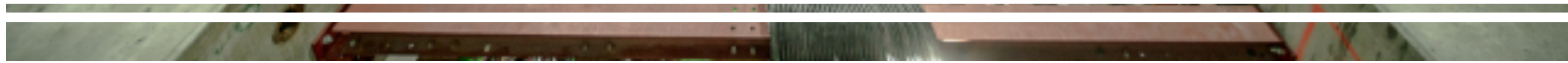


ALICE

# Attività gruppo ALICE Bologna

A. Alici (on behalf of the Bologna ALICE group)

Assemblea di Sezione - Bologna, 28 Marzo 2022



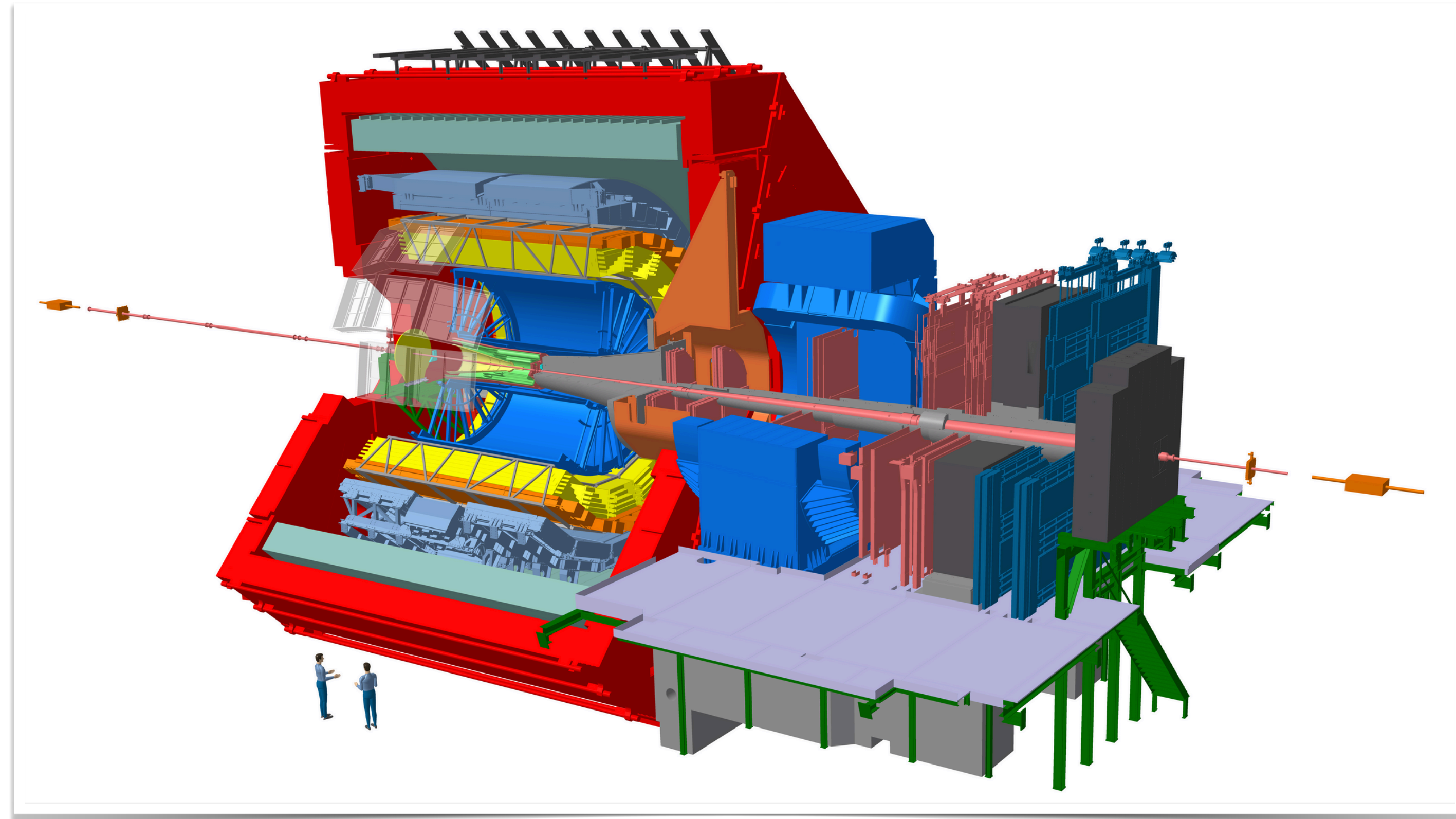
# Esperimento ALICE @ CERN Large Hadron Collider



**ALICE** (**A** Large **I**on **C**ollider **E**xperiment) è l'unico esperimento a LHC espressamente progettato per lo studio di collisioni di ioni pesanti ultrarelativistici.

Gli obiettivi scientifici dell'esperimento sono:

- la comprensione dei fenomeni non perturbativi della QCD;
- lo studio della materia nucleare in condizioni estreme di densità di energia e temperatura;
- lo studio della transizione di fase QCD e la caratterizzazione delle proprietà dinamiche e termodinamiche del QGP (plasma di quark e gluoni).



# Il rivelatore ALICE

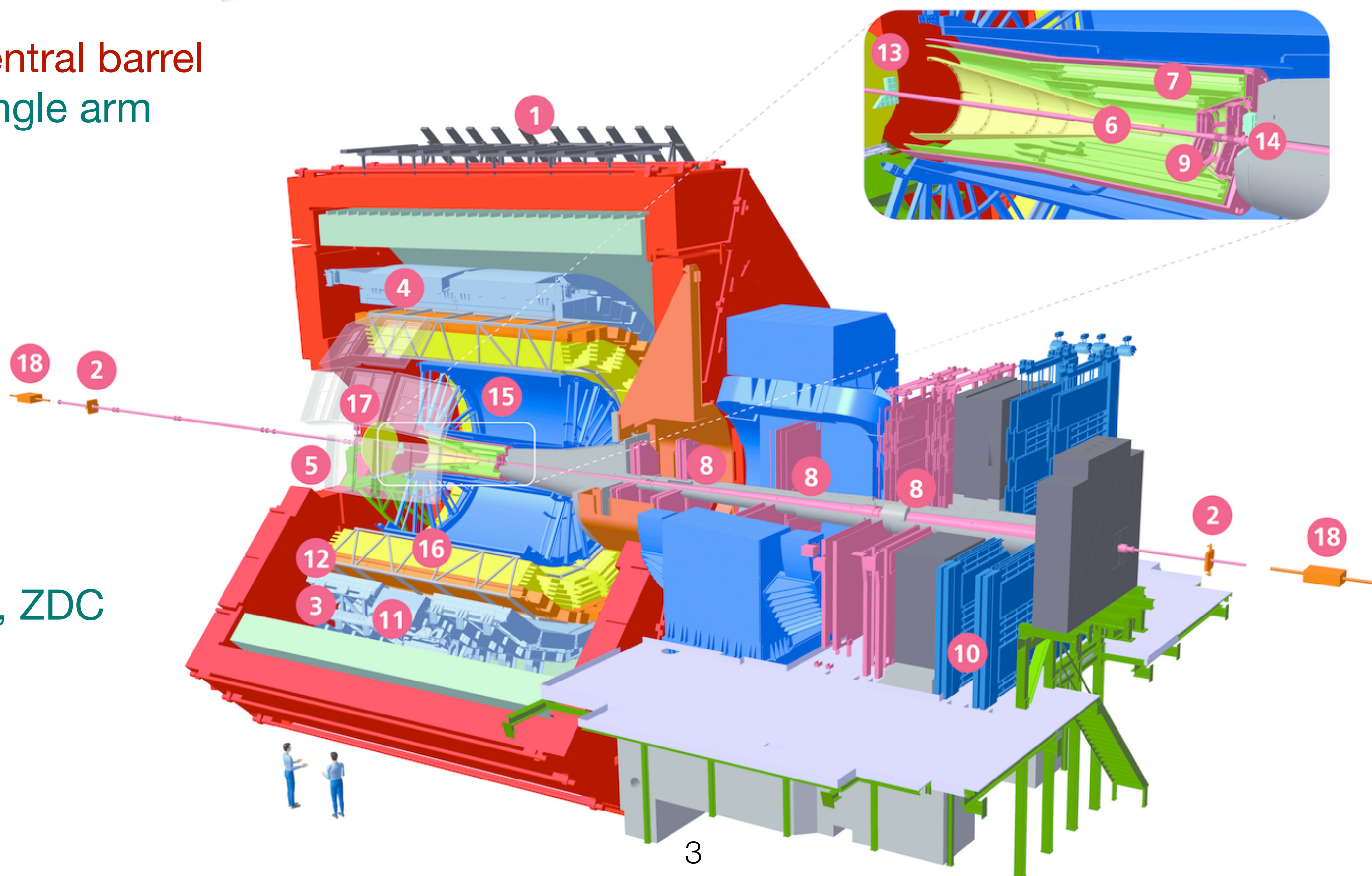
ALICE è un rivelatore general-purpose composto da un **central barrel** e da uno **spettrometro a singolo braccio in avanti per muoni**.

Le prerogative principali del rivelatore sono:

- la capacità di rivelare particelle cariche con **basso impulso trasverso** ( $p_T > 0.1 \text{ GeV}/c$ );
- l'eccellente capacità di **Particle Identification** (PID).

- **Topology decay**
  - ITS
- **Energy Loss**
  - ITS, TPC
- **Transition Radiation**
  - TRD
- **Time-of-Flight**
  - **TOF**
- **Cherenkov Radiation**
  - HMPID
- **Calorimetry**
  - EmCAL, DCAL, PHOS, ZDC
- **Preshower**
  - PMD
- **Muon Spectrometry**
  - MCH, MTR

central barrel  
single arm

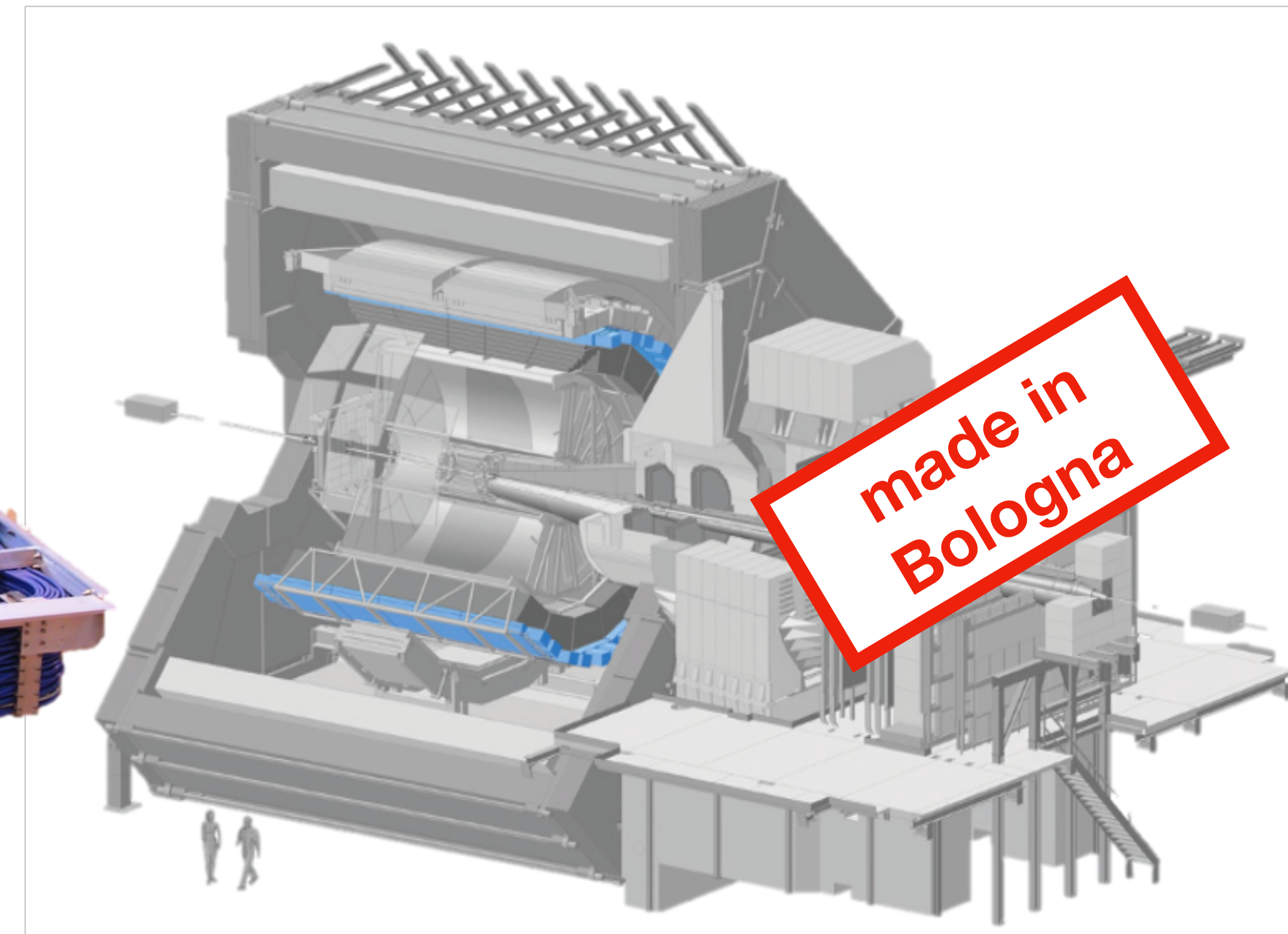
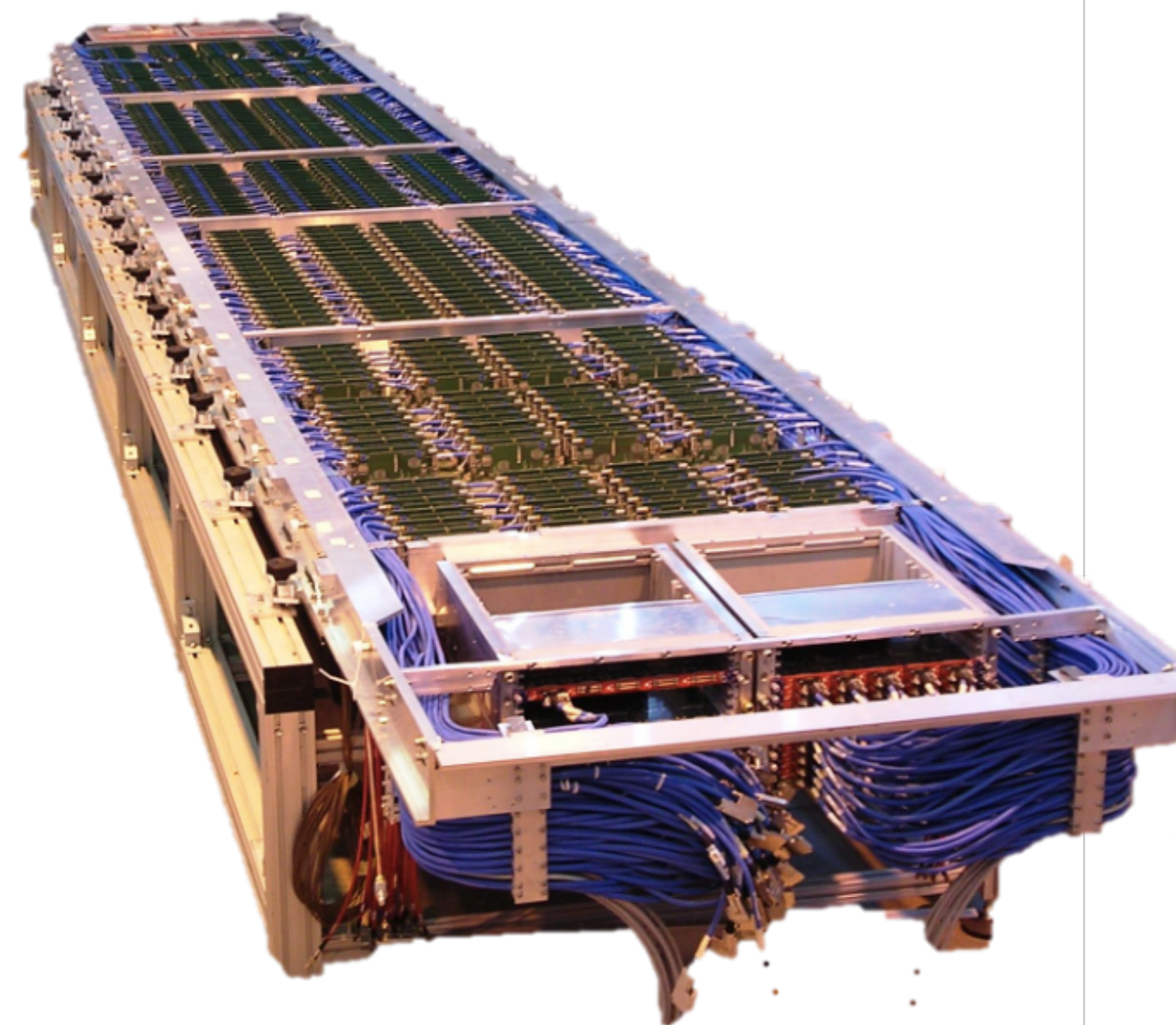
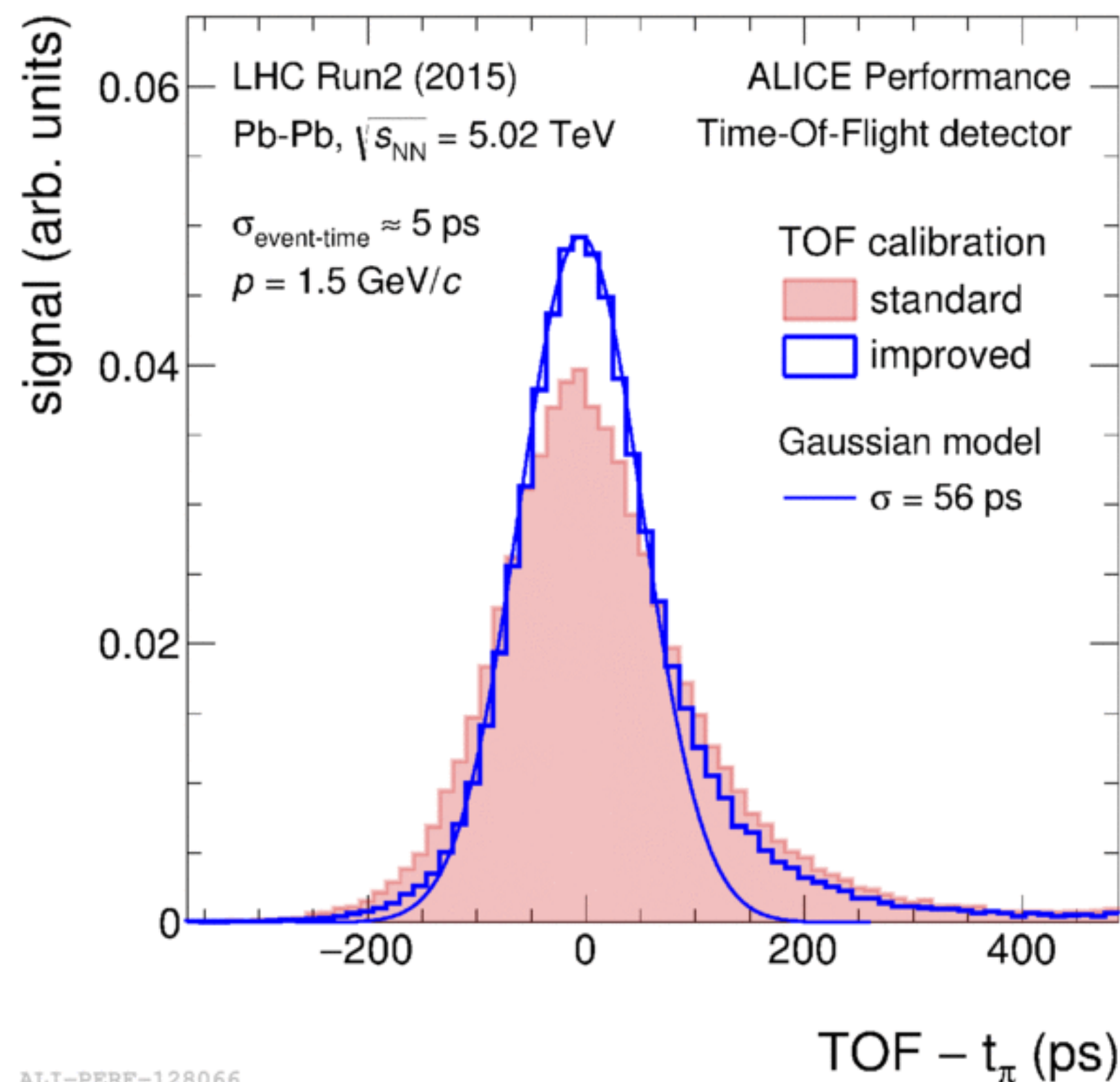
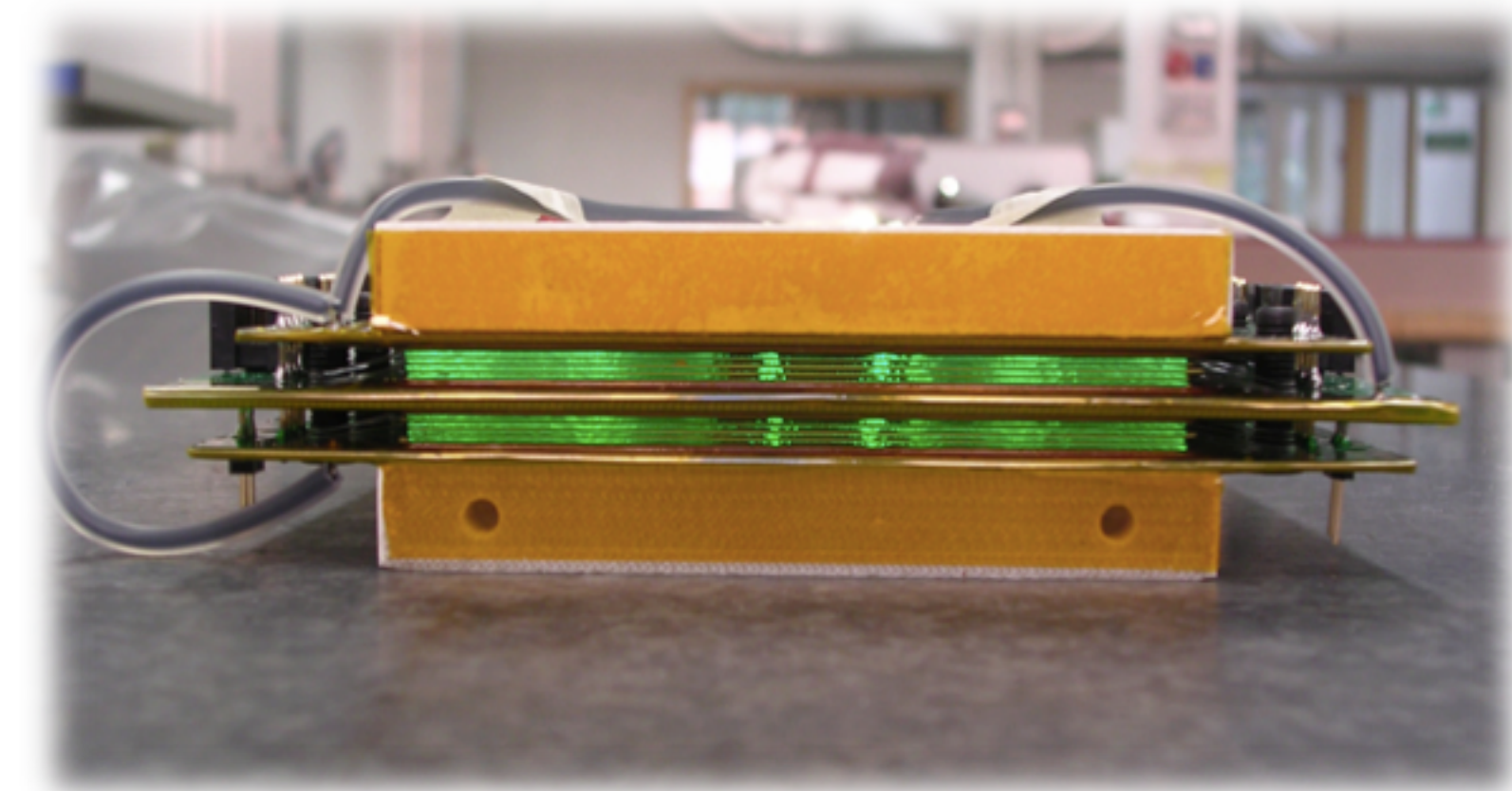


- 1 ACORDE | ALICE Cosmic Rays Detector
- 2 AD | ALICE Diffractive Detector
- 3 DCAL | Di-jet Calorimeter
- 4 EMCal | Electromagnetic Calorimeter
- 5 HMPID | High Momentum Particle Identification Detector
- 6 ITS-IB | Inner Tracking System - Inner Barrel
- 7 ITS-OB | Inner Tracking System - Outer Barrel
- 8 MCH | Muon Tracking Chambers
- 9 MFT | Muon Forward Tracker
- 10 MID | Muon Identifier
- 11 PHOS / CPV | Photon Spectrometer
- 12 TOF | Time Of Flight
- 13 T0+A | Tzero + A
- 14 T0+C | Tzero + C
- 15 TPC | Time Projection Chamber
- 16 TRD | Transition Radiation Detector
- 17 V0+ | Vzero + Detector
- 18 ZDC | Zero Degree Calorimeter

# Il rivelatore ALICE TOF

ALICE Time-of-Flight (**TOF**) detector made by **1593 Multigap Resistive Plate Chambers (MRPC)**:

- large coverage ( $\sim 140 \text{ m}^2$  active area)
- high efficiency  $> 95\%$
- **global time resolution** (including intrinsic time resolution, electronics jitter and calibration)  **$< 60 \text{ ps}$**
- high granularity ( $\sim 10^5$  channels)



# Composizione gruppo ALICE



N. Agrawal, A. Alici, P. Antonioli, S. Arcelli, F. Bellini, F. Carnesecchi\*, L. Cifarelli, F. Cindolo, G. Clai, M. Colocci, F. Ercolessi, D. Falchieri, M. Giacalone, M. Guerzoni, D. Hatzifotiadou, N. Jacazio\*\*, G. Malfattore\*\*, A. Margotti, R. Nania, F. Noferini, O. Pinazza, R. Preghenella, R. Rath, N. Rubini, E. Scapparone, G. Scioli, S. Strazzi, S. Tripathy, P. Veronesi, A. Zichichi.

Staff: 18 (5 UniBO, 12 INFN, 1 ENEA)  
1 RTDb, 1 RTDa, 3 INFN Fellow per stranieri  
5 PhD

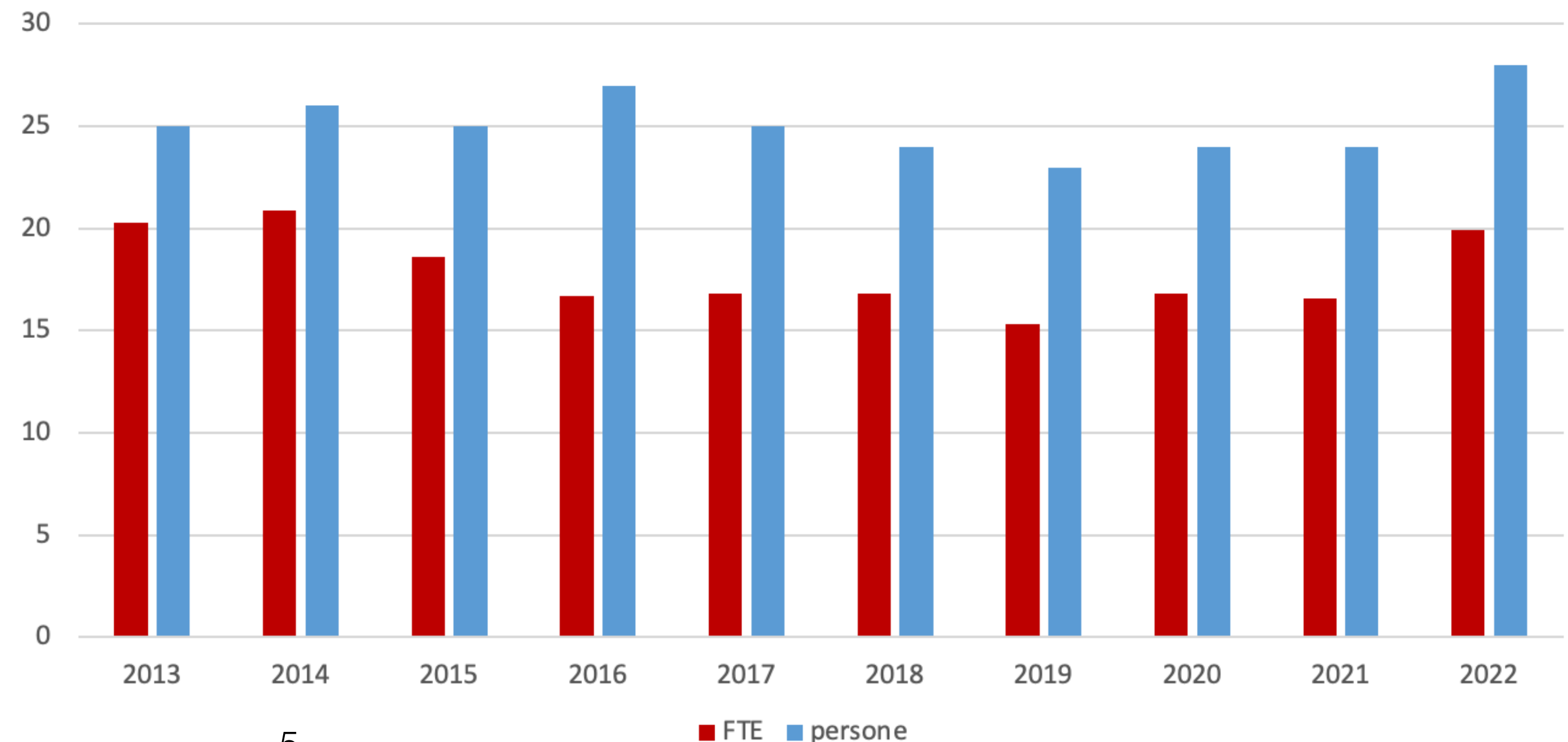
\* CERN Applied Fellow

\*\* contratti ERC CosmicAntiNuclei



ALICE @ Bo

**FTE (esclusi tecnici) 19.9**



## Gestione rivelatore ALICE-TOF:

- manutenzione ordinaria e straordinaria di tutta la parte hardware del rivelatore (LV e HV Power Supplies, sistema di gas e di cooling per elettronica di FE e RO);
- aggiornamento e adeguamento dei sistemi di acquisizione dati, calibrazione, data quality e detector control system alle specifiche dell'esperimento;
- gestione in loco del rivelatore (esperti in situ e on-call);
- partecipazione alla presa dati.

## Analisi Dati:

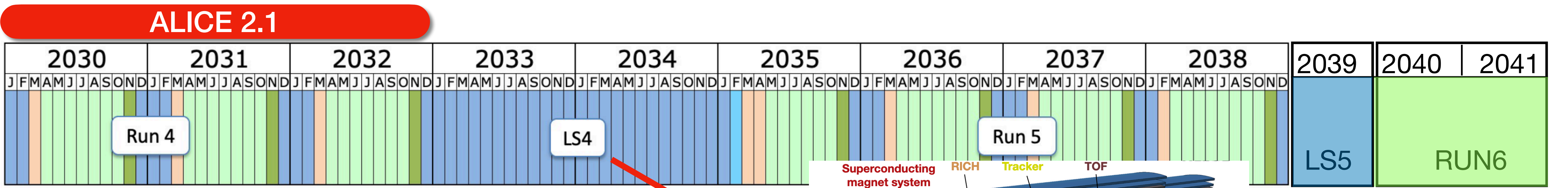
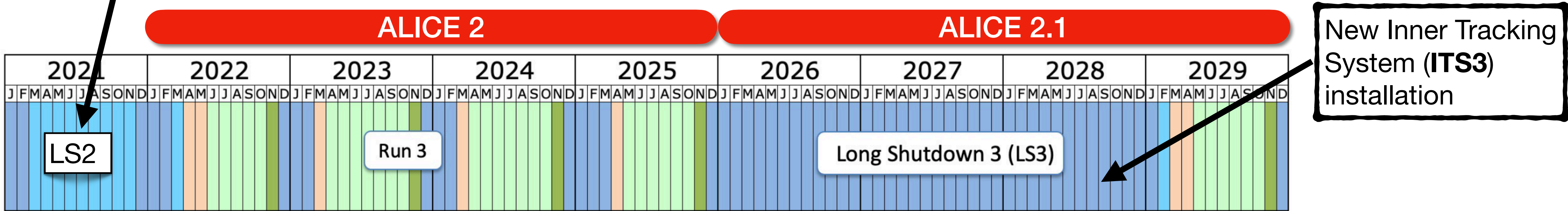
- analisi dati, attività di convenership di Physics Working Group, diretto coinvolgimento nella scrittura di paper come membri dei Paper Committe e degli Internal Review Committee

## Sensor R&D:

- attività di R&D su sensori al silicio per tracking (MAPS) e con elevate risoluzioni temporali (LGAD, SiPM)

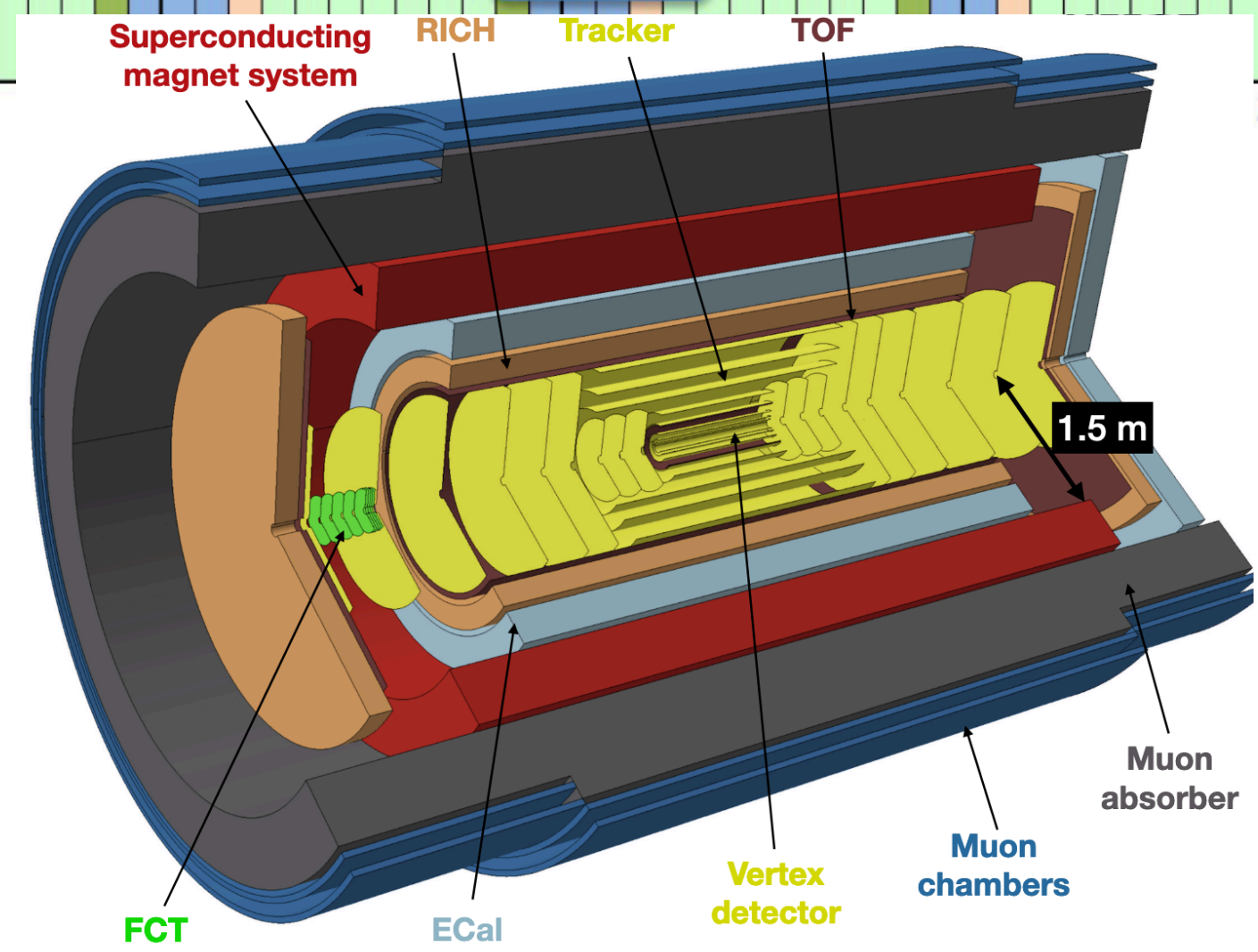
# ALICE Upgrades

Main ALICE upgrades



- Shutdown/Technical stop
- Protons physics
- Ions
- Commissioning with beam
- Hardware commissioning/magnet training

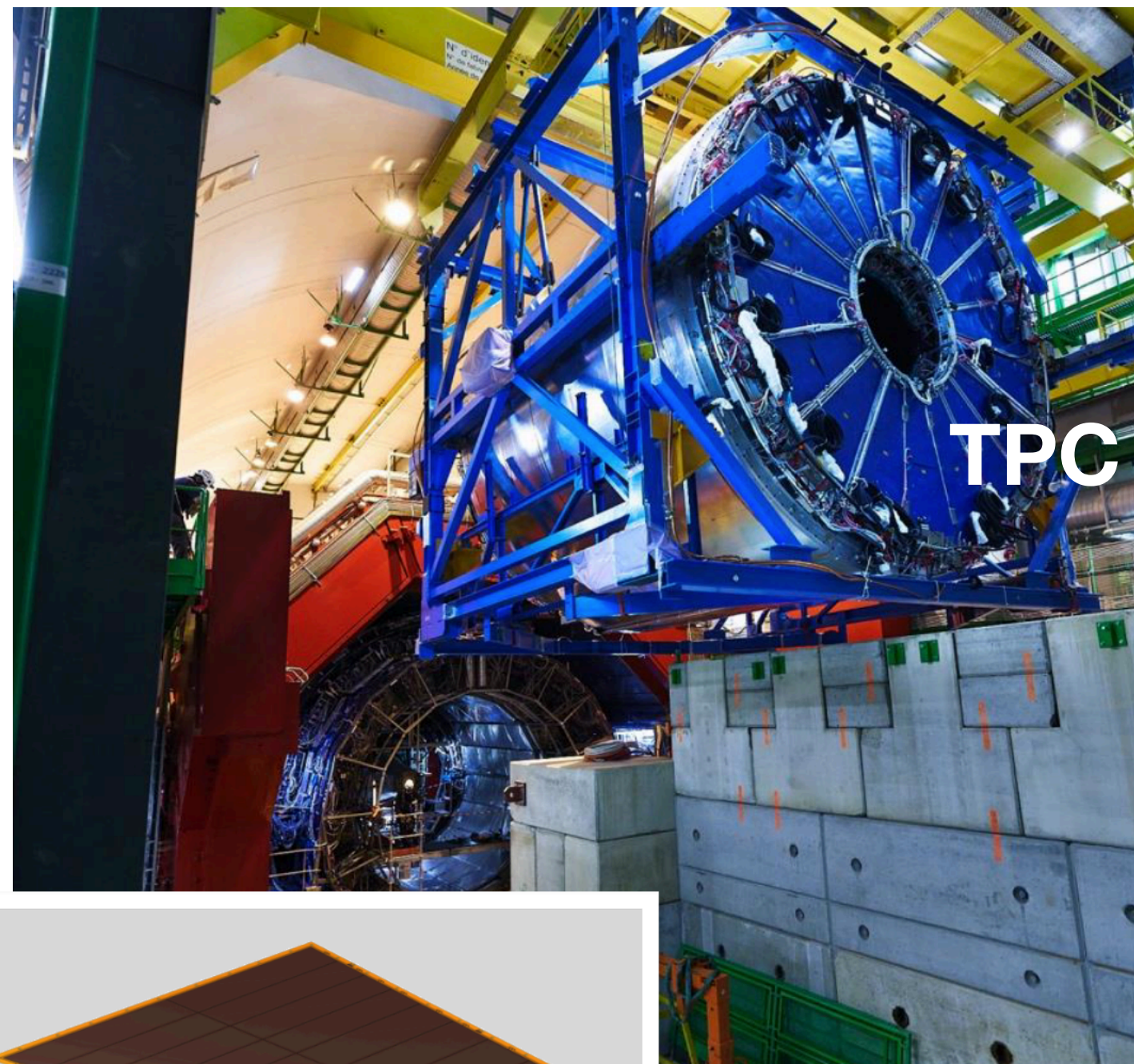
**ALICE 3**  
ultra-light all-silicon  
based heavy-ion  
experiment



# ALICE Upgrade in LS2

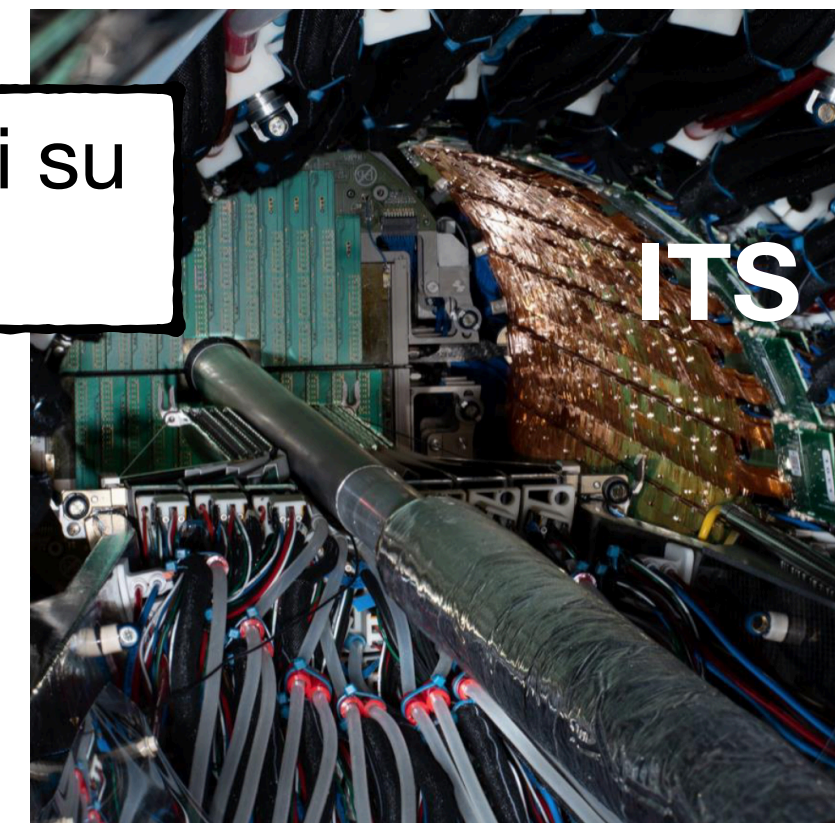
Obiettivi principali per Run 3+4:

- raccogliere  $\mathcal{L}_{INT} \approx 13 \text{ nb}^{-1}$  di collisioni Pb-Pb  $\rightarrow$  x50 - x100 aumento in statistica per la maggior parte degli osservabili
- sostenere un rate di acquisizione di 50 kHz in collisioni Pb-Pb, con **readout continuo** e **online data reduction**
- migliorare sostanzialmente le capacità di **vertexing** e **tracking efficiency**

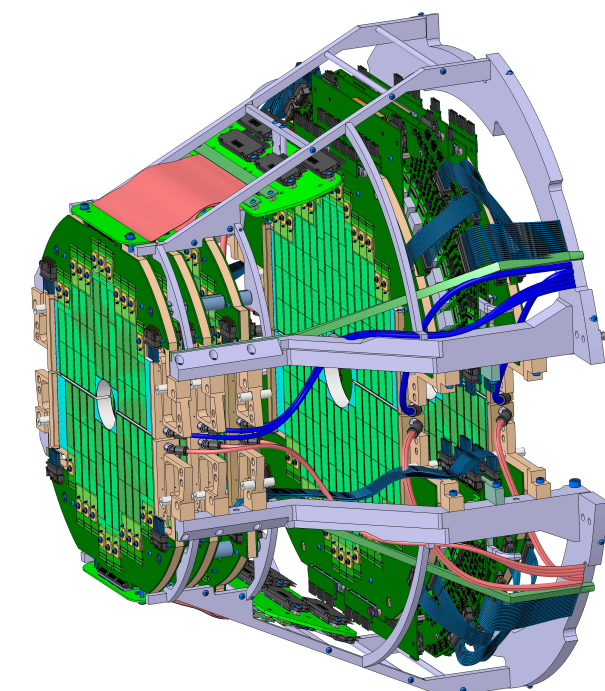


TPC

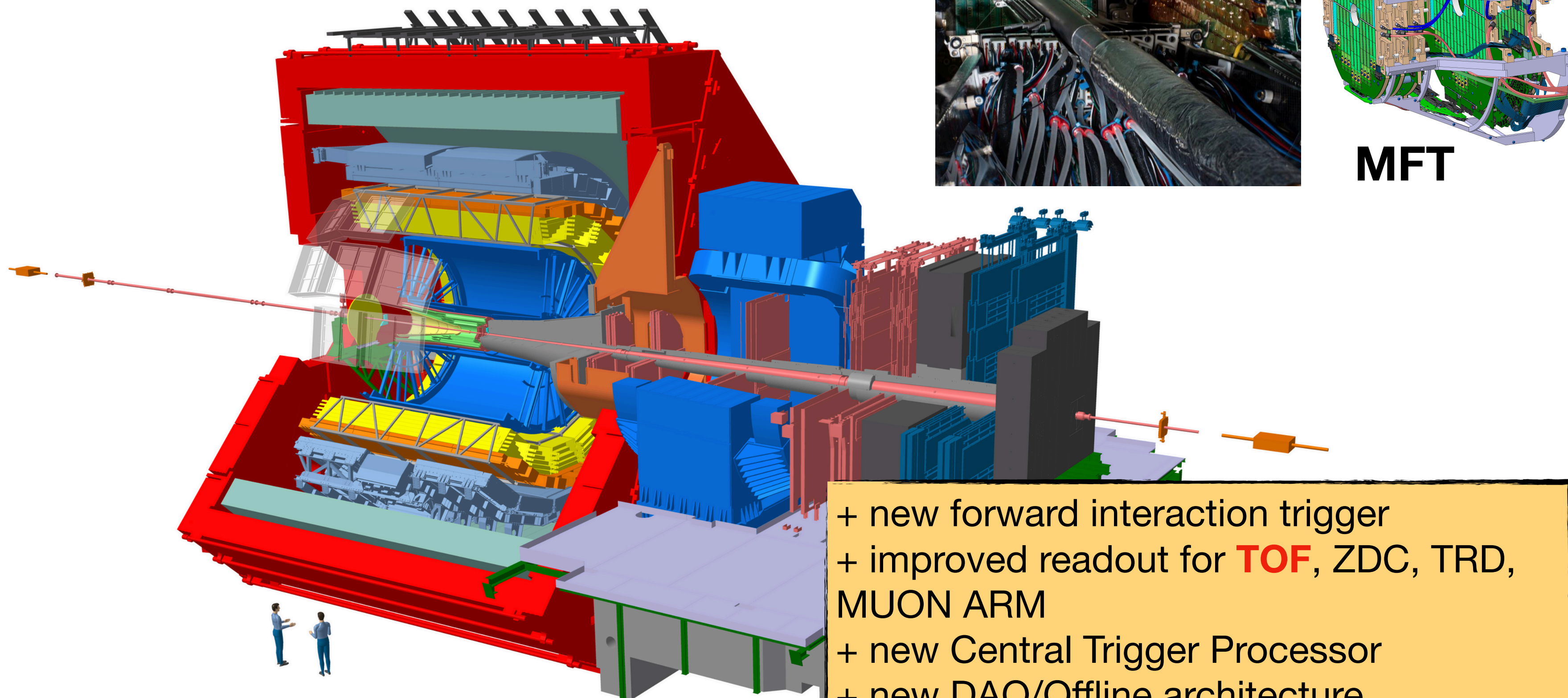
nuova beam pipe, nuovo ITS e MFT, basati su monolithic active pixel sensors (**MAPS**)



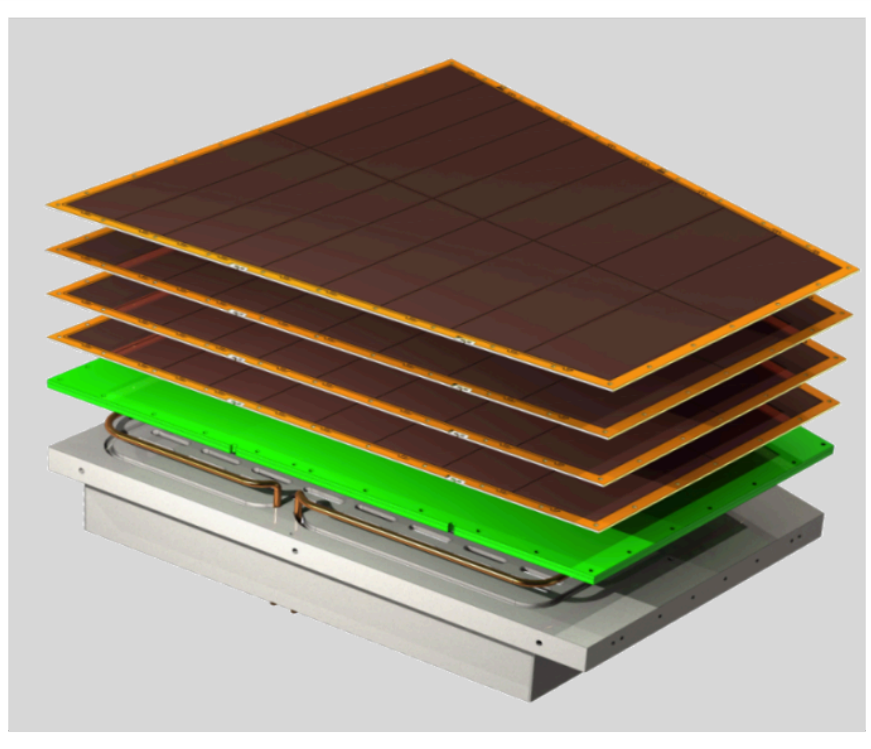
ITS



MFT



- + new forward interaction trigger
- + improved readout for **TOF**, ZDC, TRD, MUON ARM
- + new Central Trigger Processor
- + new DAQ/Offline architecture



TPC with GEM readout based



# ALICE TOF Upgrade in LS2 - I



New **Data Readout Module (DRM2)** to allow **continuous readout**:

- Project and firmware @INFN-BO (**D. Falchieri, C. Baldanza**)
- Sviluppo, validazione, inclusi test di irraggiamento (TIFPA): 2014-2018
- Produzione terminata nel 2019, test di produzione completati
- **72/72 cards installate e operative**
- continuous readout over GBTx link + HPTDC

Some refs:

Master thesis M. Giacalone

<http://amslaurea.unibo.it/17075/>

D. Falchieri

<https://pos.sissa.it/313/081/pdf>

D. Falchieri et al., IEEE 6 64 (2017)

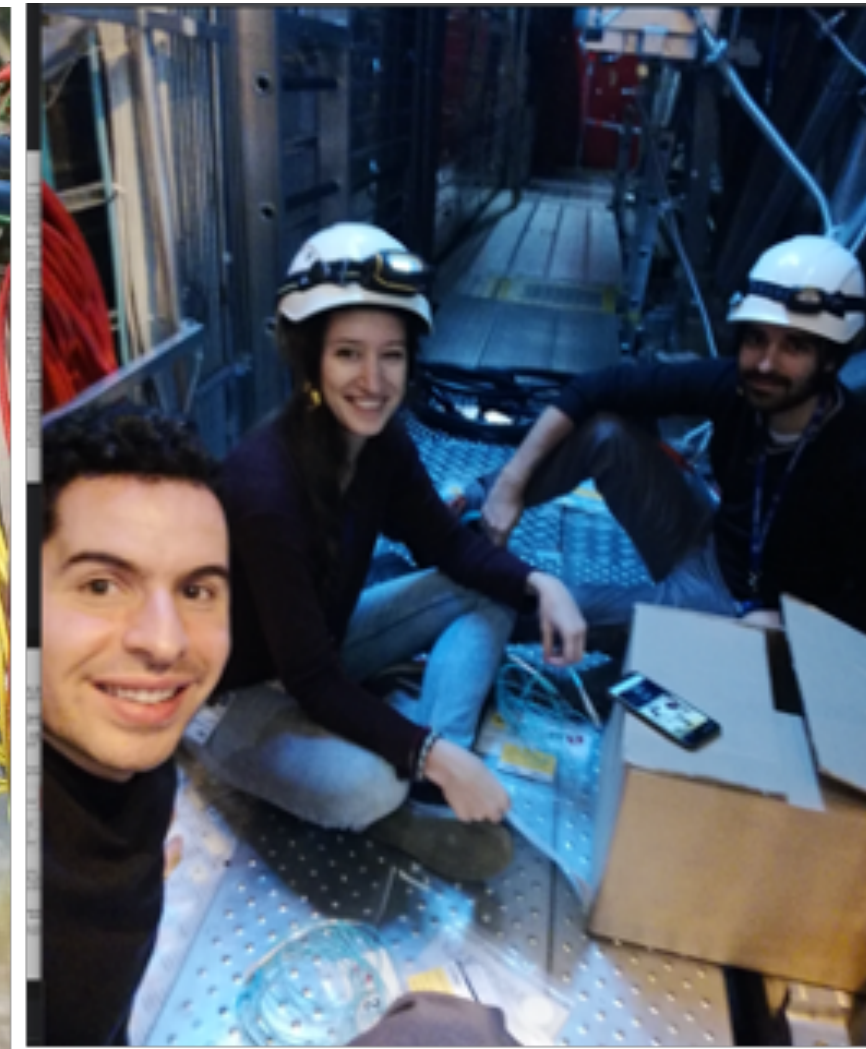
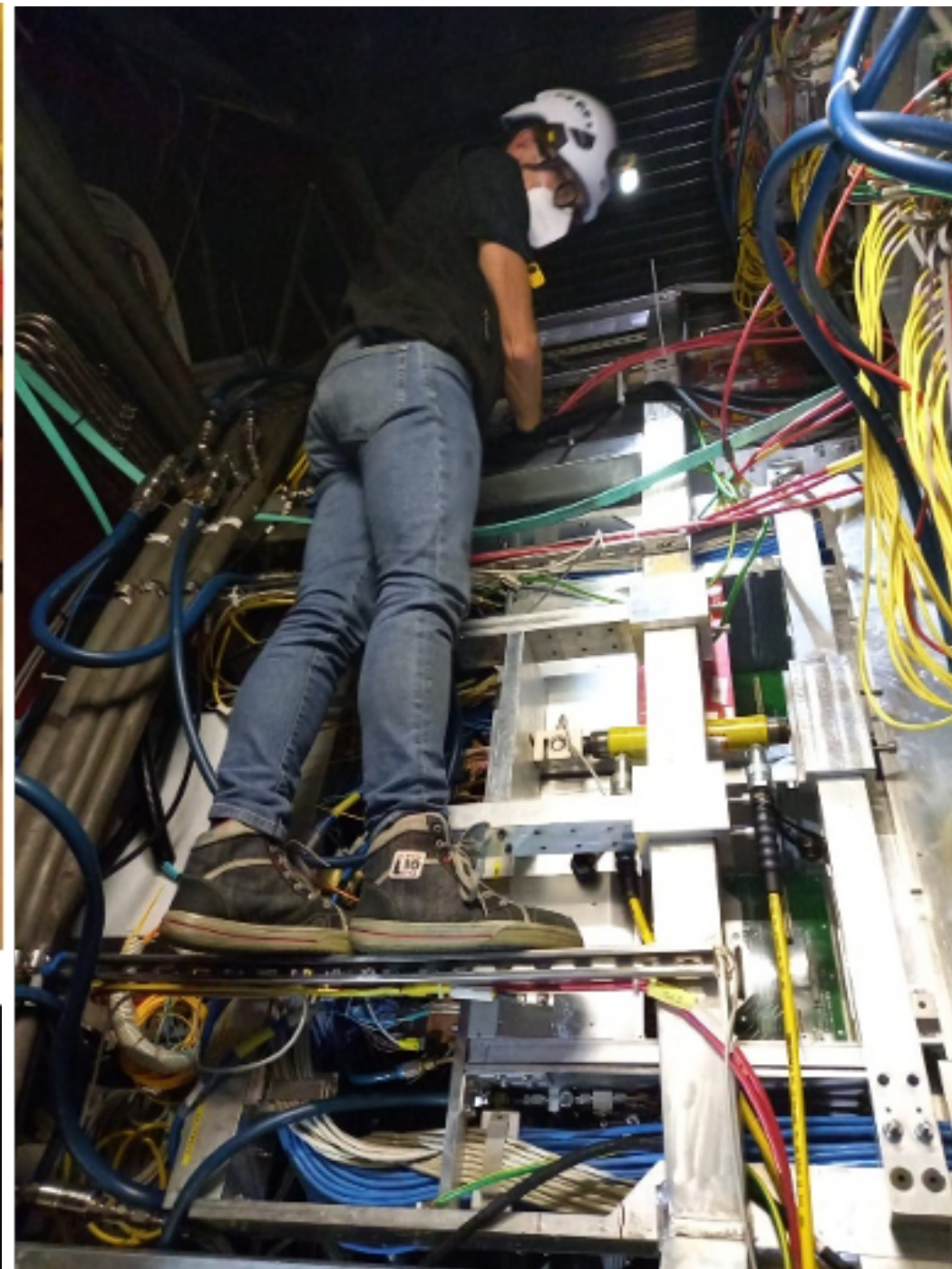
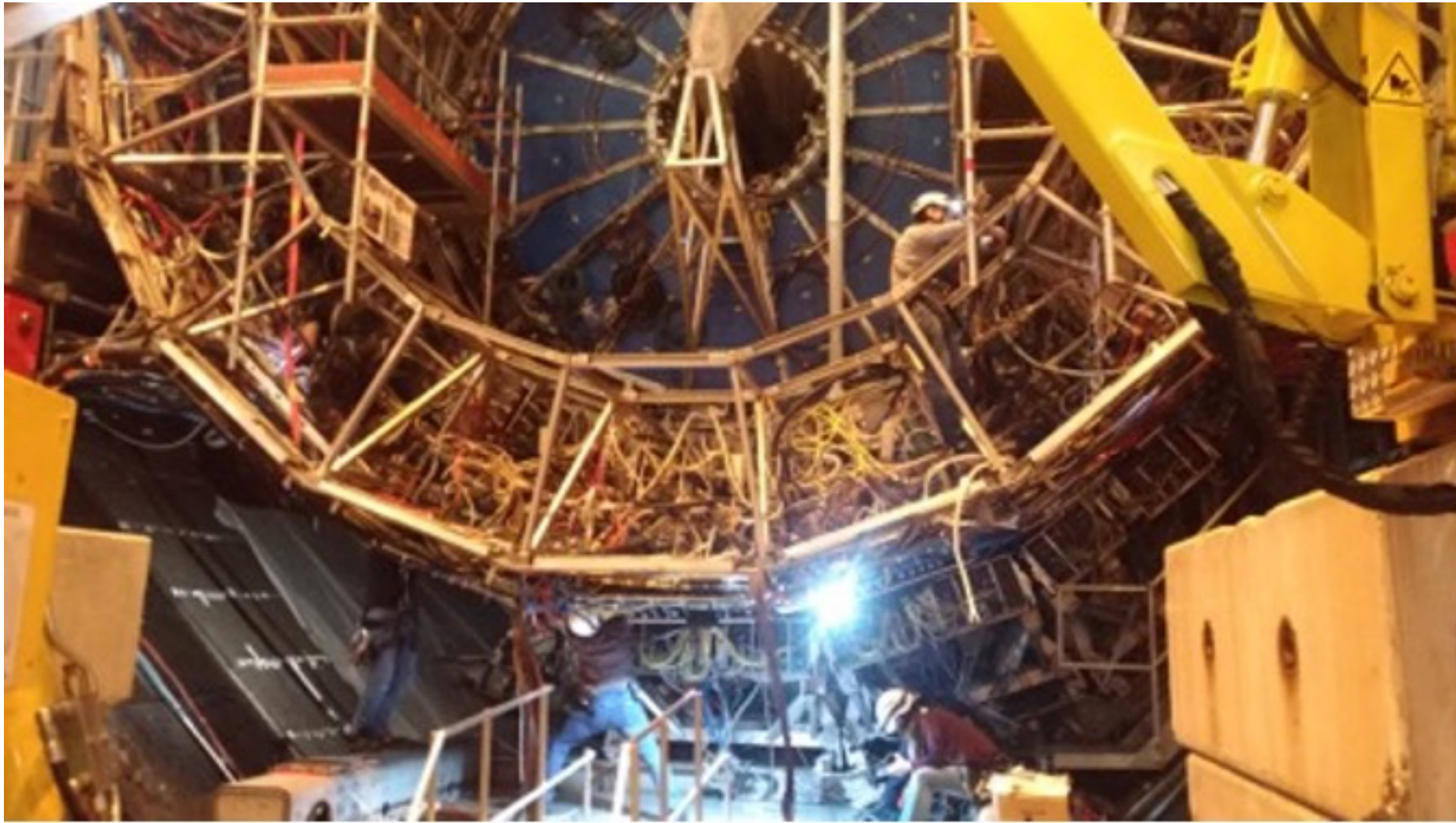


- During high-rate interaction tests (Pb-Pb equivalent load) in 2018 we got **SEU in DC/DC converters** (in particular for A1396 loss of communication, power cycle needed for full recovering)
- Rate is worrying: projected a MTBF = 5.4 hours in the whole TOF
- After irradiation campaign, problem found in **A1396 microcontroller (ST10F269)** and fixed adding a filtering capacitor in the reset line of the microcontroller
- **72 DCDC replaced with SUE protection + 144 DCDC refurbished to improve robustness and replaced**

## Maintenance:

- faulty TDC Readout Boards (TRM) replaced
- declogging of cooling plates in crates with high temperatures
- fixing of broken HV cables and connectors

# ALICE TOF Upgrade in LS2 - II



**ALICE TOF** Team at work (*INFN Bologna, INFN Salerno, ITEP Moscow*)

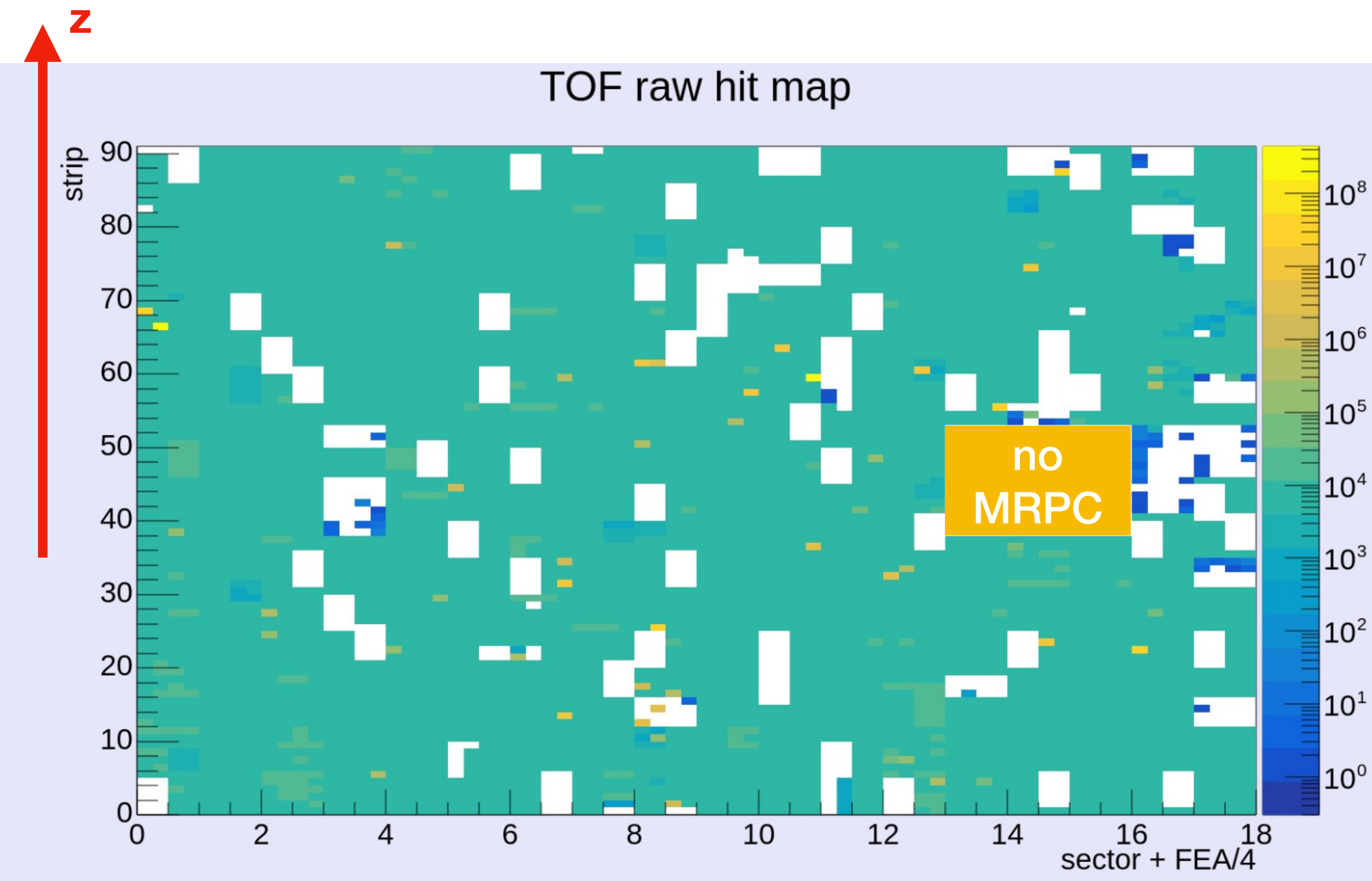


# Situazione TOF

- Tutti gli interventi di upgrade e di manutenzione sul rivelatore sono terminati, TOF fully operational e pronto per la ripresa del data taking;
- **72/72 crate in acquisizione;**
- **7.5%** canali spenti per problemi nelle schede di readout + **4.5%** canali spenti per failure su connettori HV + certo numero di canali noisy da mascherare (nostro target 90% canali attivi)

Dopo 14 anni dall'accensione del rivelatore TOF:

- **nessun canale è stato spento per malfunzionamenti di un rivelatore MRPC**
- **nessun segno evidente di ageing: corrente totale assorbita dalle oltre 1500 MRPCs ~ 2uA**



0

$2\pi$

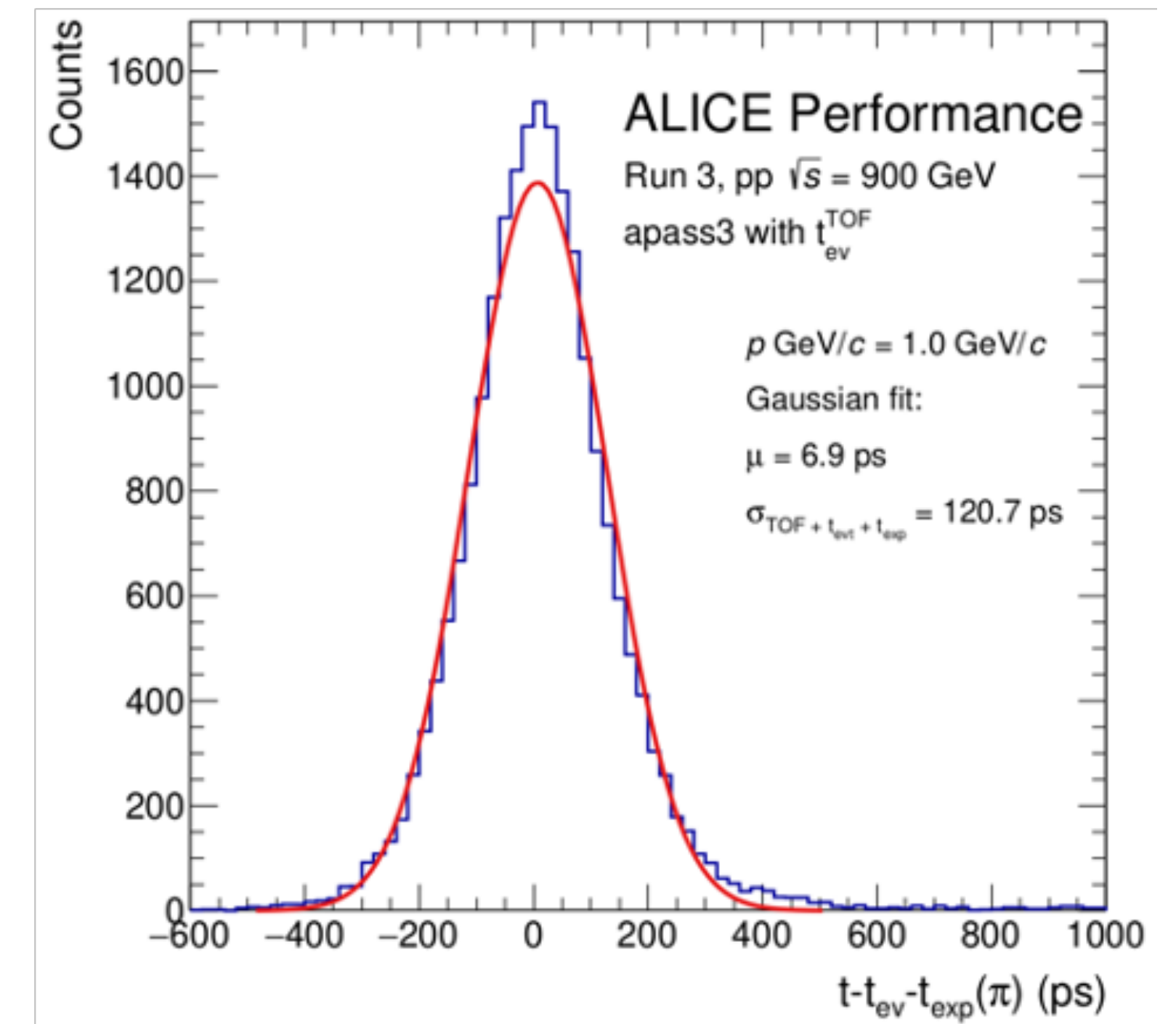
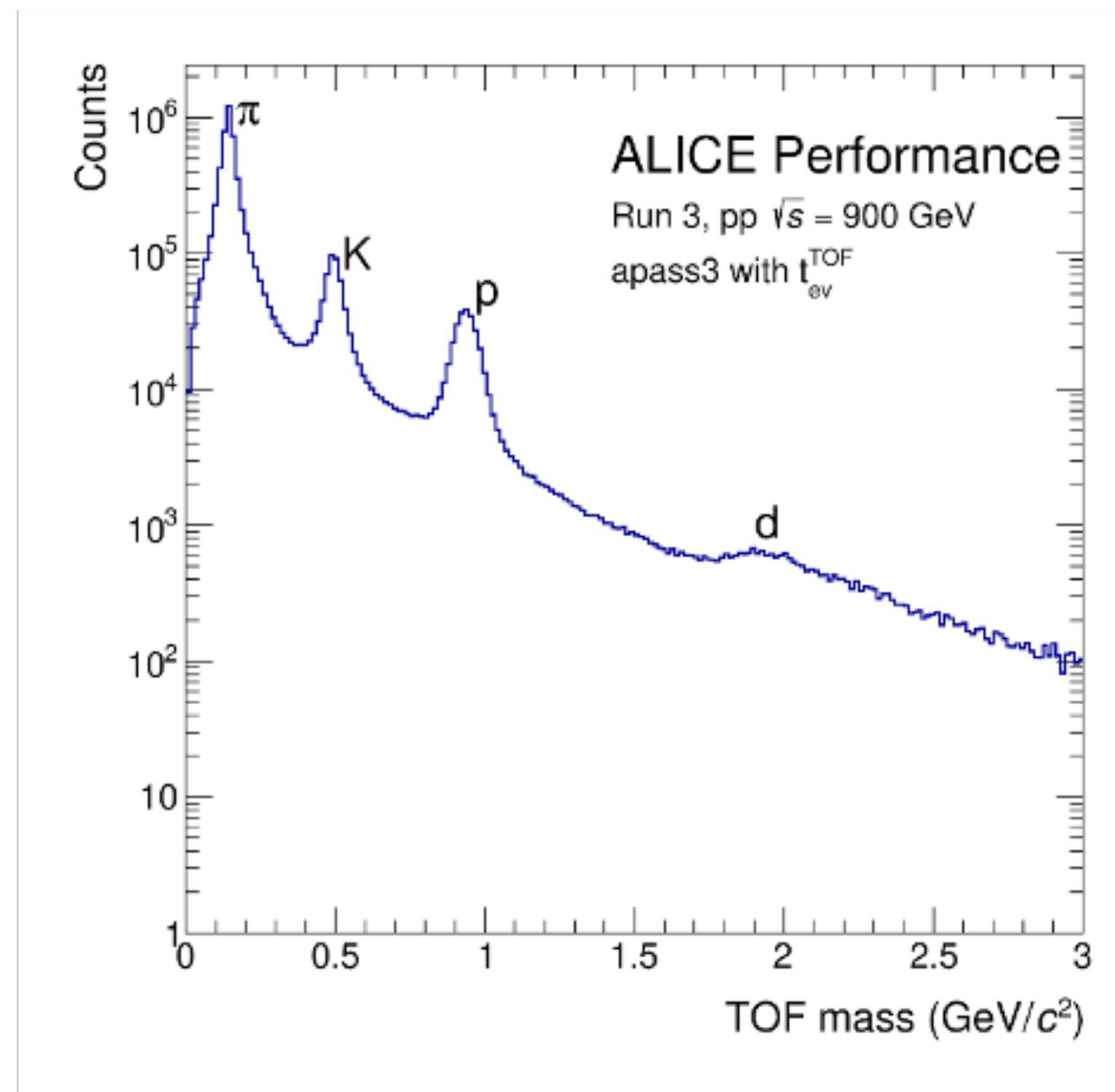
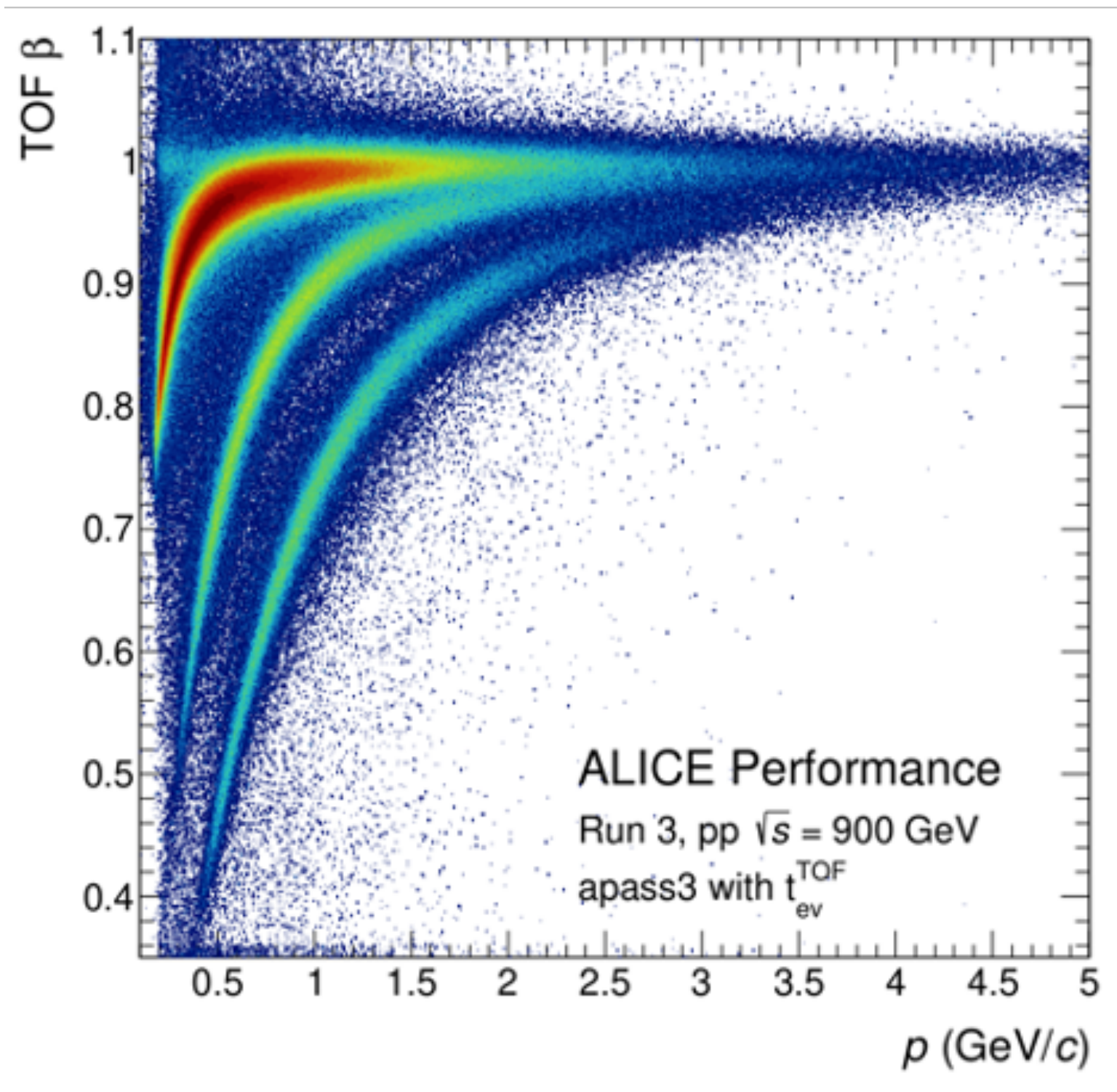
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# 2021 LHC pilot run

20/10/2021 - 01/11/2021 circulating beams at injection energy, pre-commissioning of LHC key systems

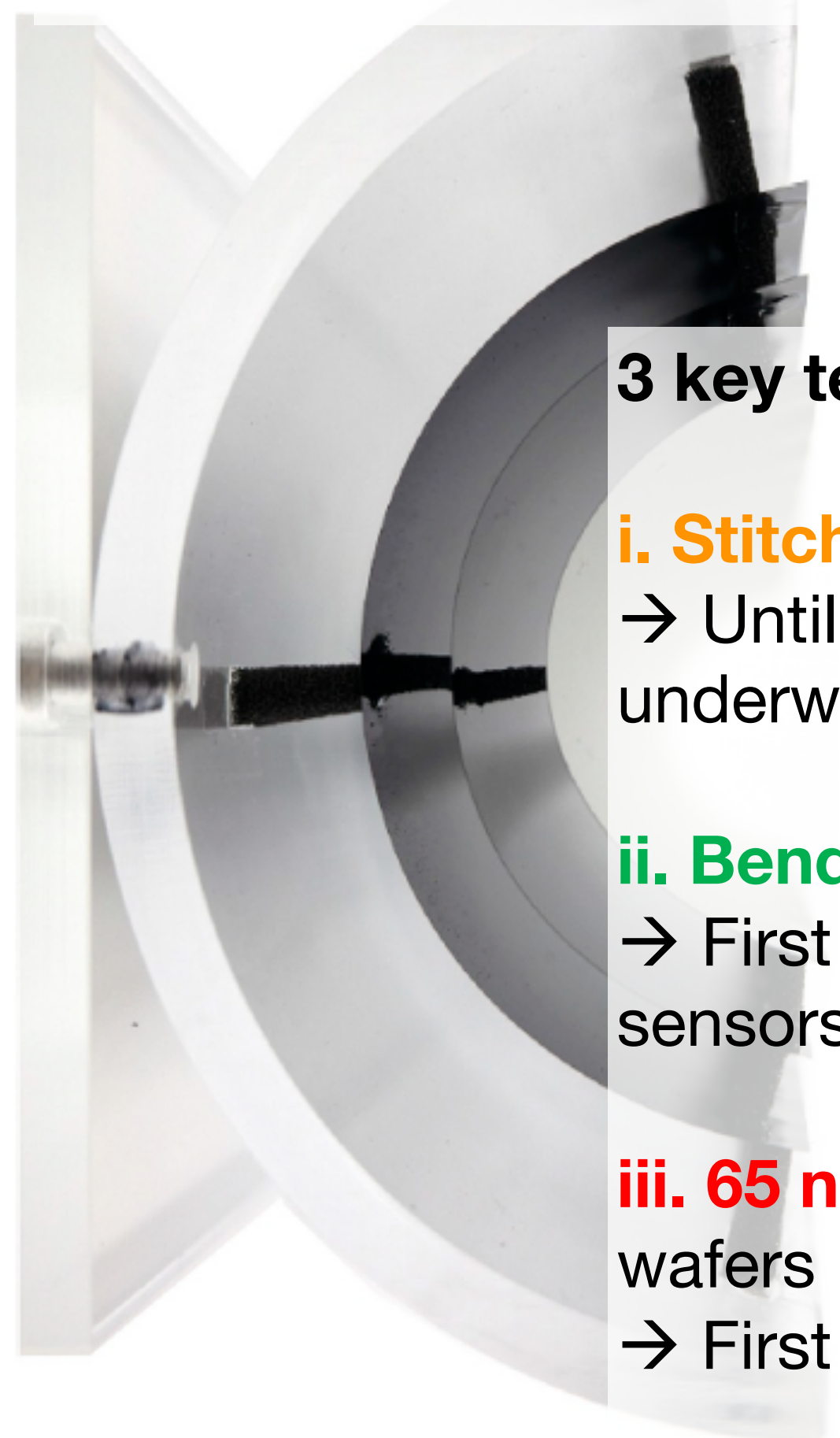
**Wed 27/10 Stable Beam for the first time after LS2**

TOF already able to provide physics



# Attività di R&D: ITS 3

New **ultra-light**, **truly cylindrical** and **wafer scale** Inner Tracking System layers based on **MAPS**, replacing the 3 inner layers of ITS2 (from 432 to 6 sensors)



## 3 key technologies:

**i. Stitching**, wafer scale-chips

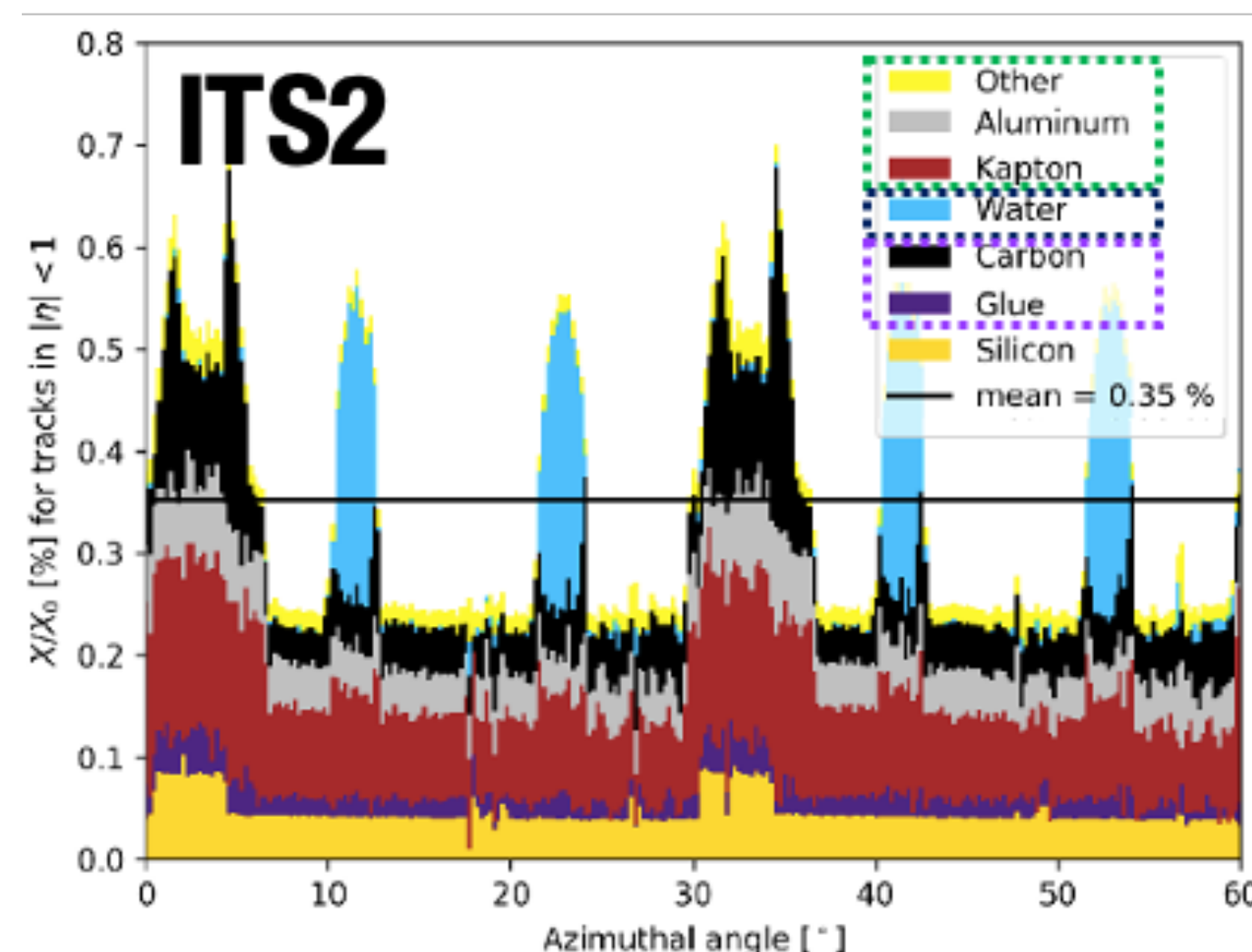
→ Until now only large dummy chips, first large sensor structures underway

**ii. Bending**, 3 target radii: 18 mm, 24 mm, 30 mm

→ First proof of concept already done, **R&D started**: first working bent sensors with different radii

**iii. 65 nm MAPS**, larger, lower consumption and better integrate wafers

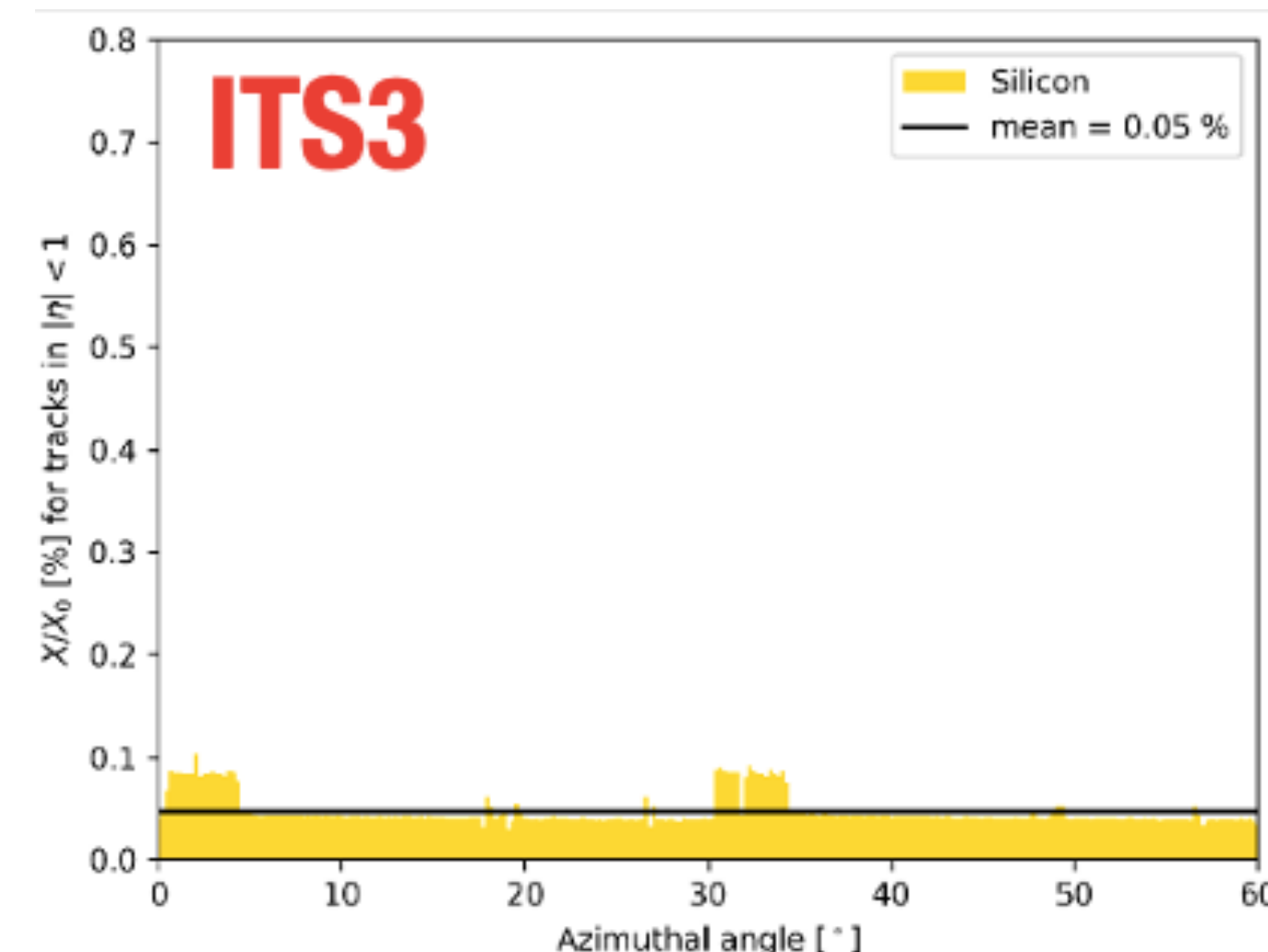
→ First prototypes received end of 2021, **testing R&D ongoing**



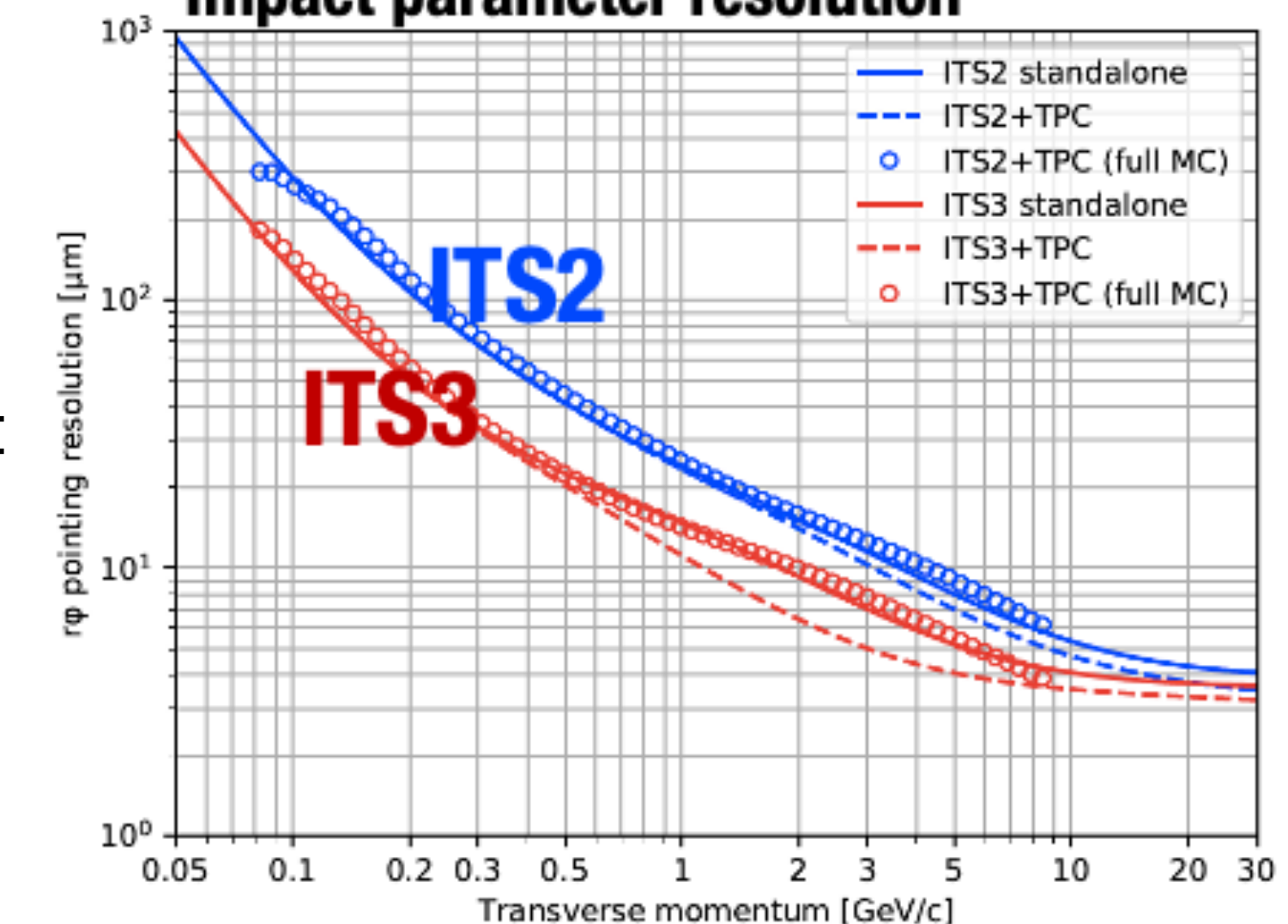
< 1/7 material budget



Basically only Si remains



## Impact parameter resolution



# Attività di R&D: ITS 3

## Bending

Bologna people participated at preparation and realization (**F. Carnesecchi**) and analysis (**M. Colocci, N. Jacazio**) of beam tests in **2021**

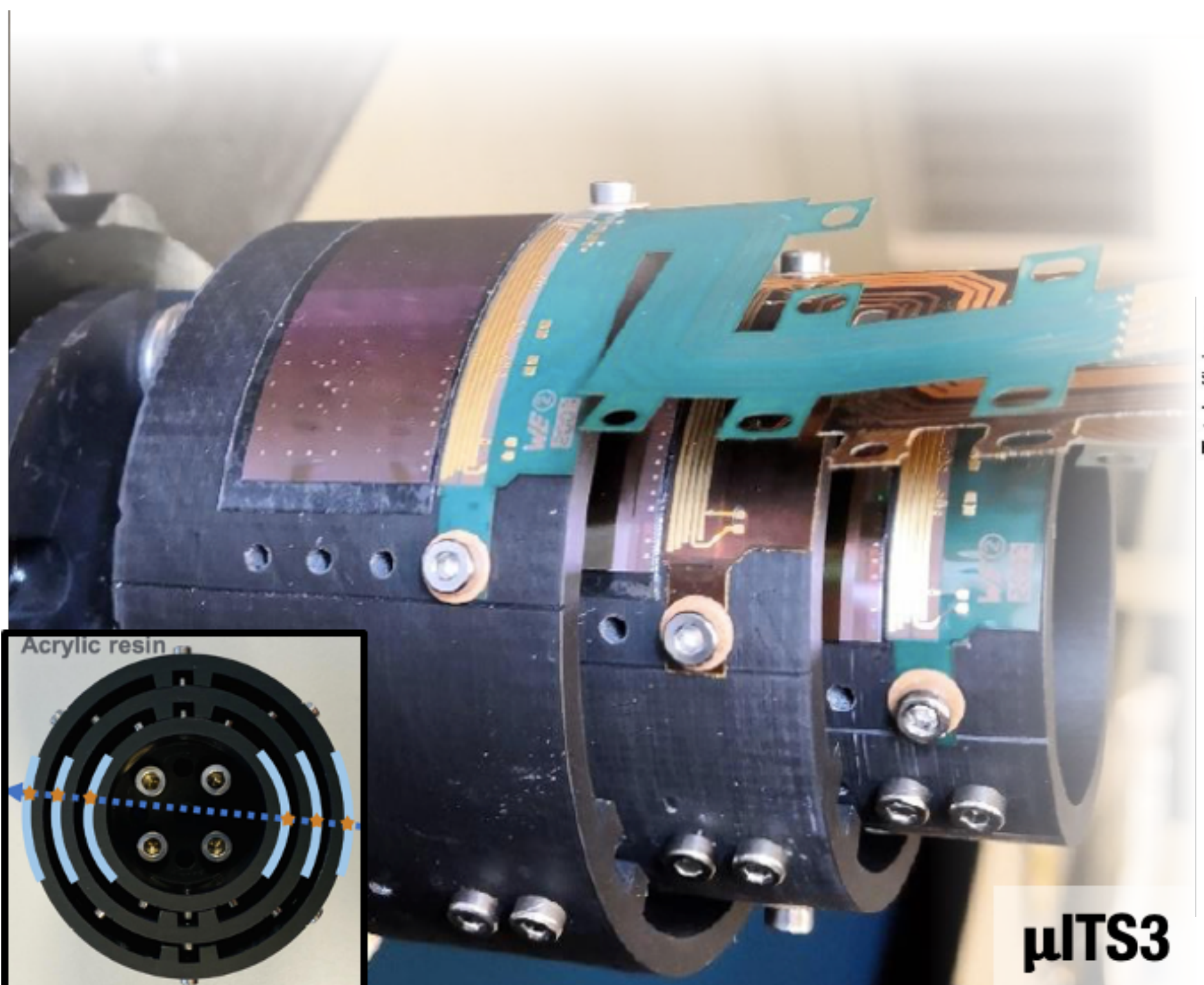
In order to **proof the uniformity of the results** (efficiency and spatial resolution) **between different radii** → **in progress**

## 65 nm MAPS

A total of 3 different flavours have been realized (MLR1): **APTS (analogue MAPS)**, DPTS (analogue MAPS) and CE65 (different redout structures).

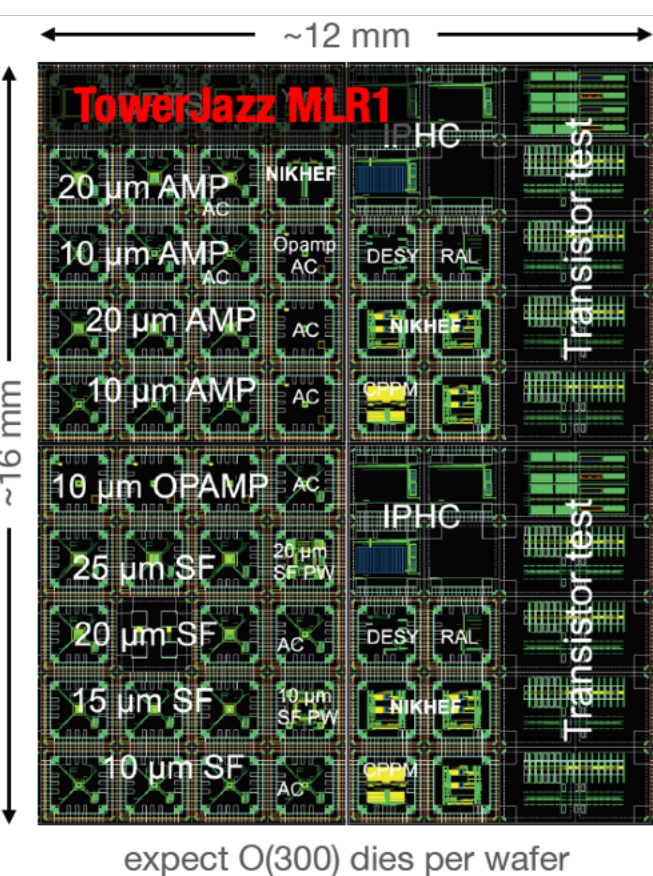
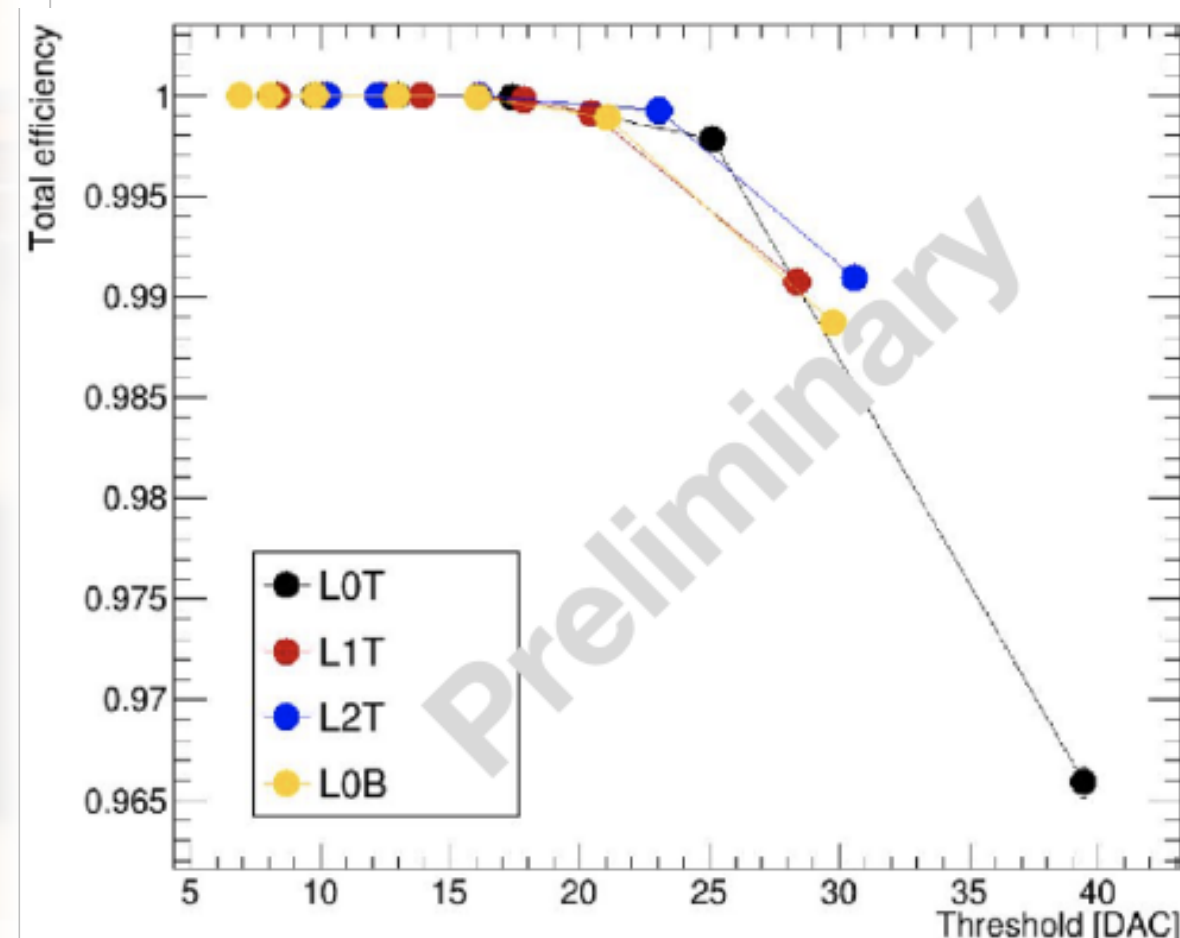
Bologna is now (**2022**) mainly involved in **first testing, validation, calibration and beam test participation and analysis of the analogue MAPS.**

In order to proof this new technology and give feedback for the next sensors submission to TowerJazz (MLR2).



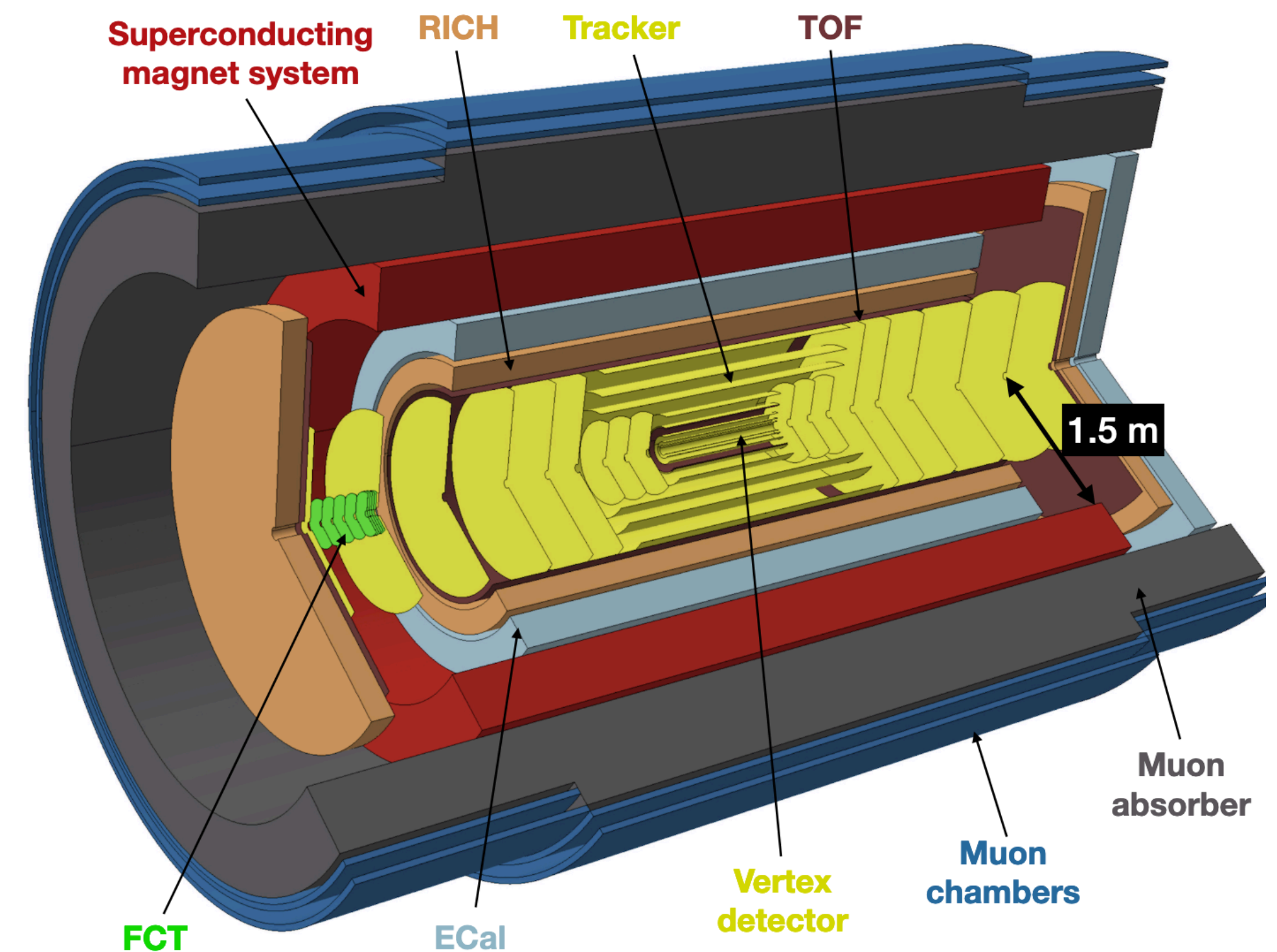
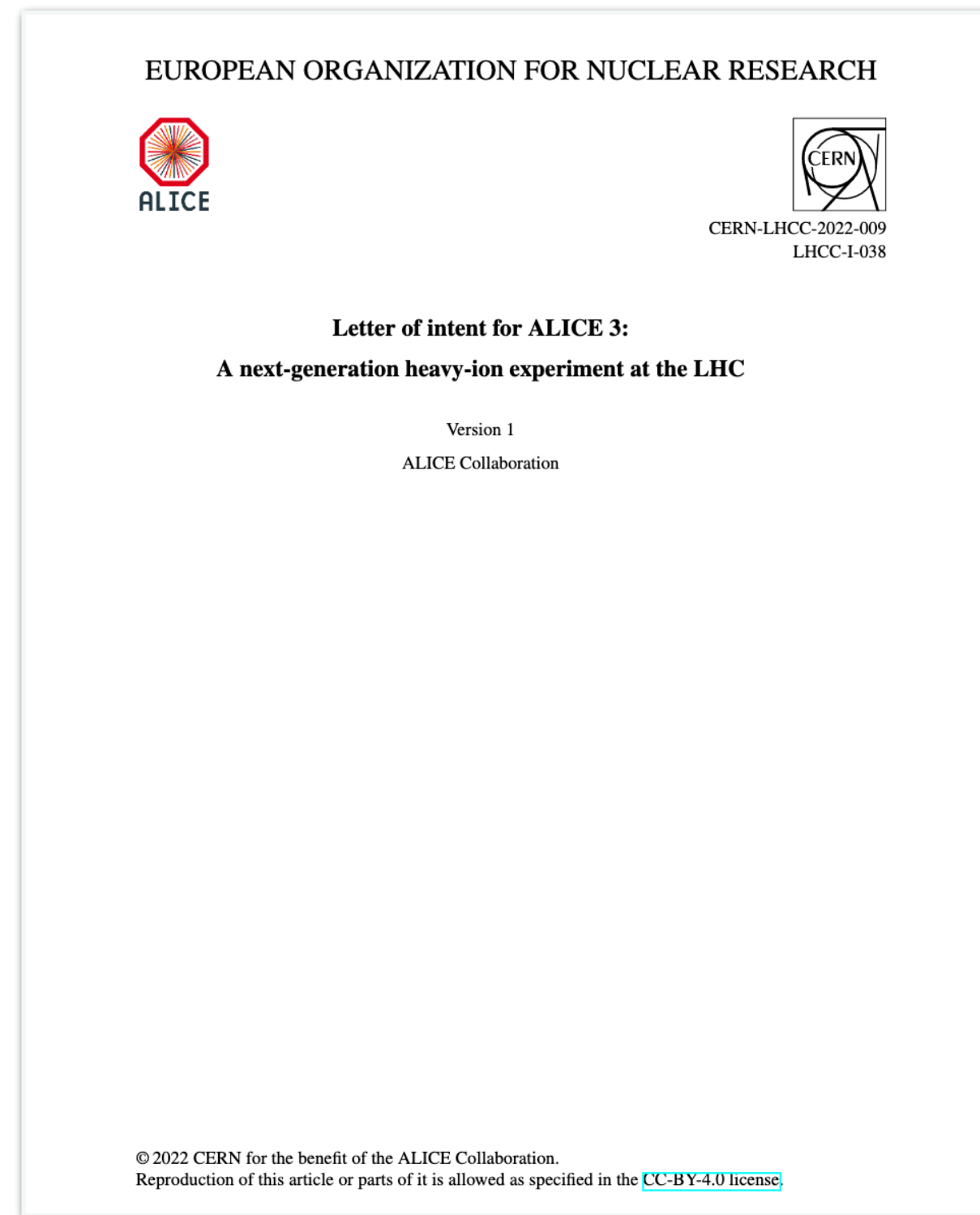
## Uniform efficiency

at 18 mm (LOT, LOB), 24 mm (L1T), 30 mm (L2T)



Sorgente di  $^{55}\text{Fe}$  necessaria per le misure di calibrazione delle strutture di test, un ringraziamento alla Sezione che si sta adoperando per il suo acquisto.

# Attività di R&D: ALICE 3 Timing Layer



LHCC has now completed the review of the ALICE 3 Letter of Intent (LoI)

Next steps

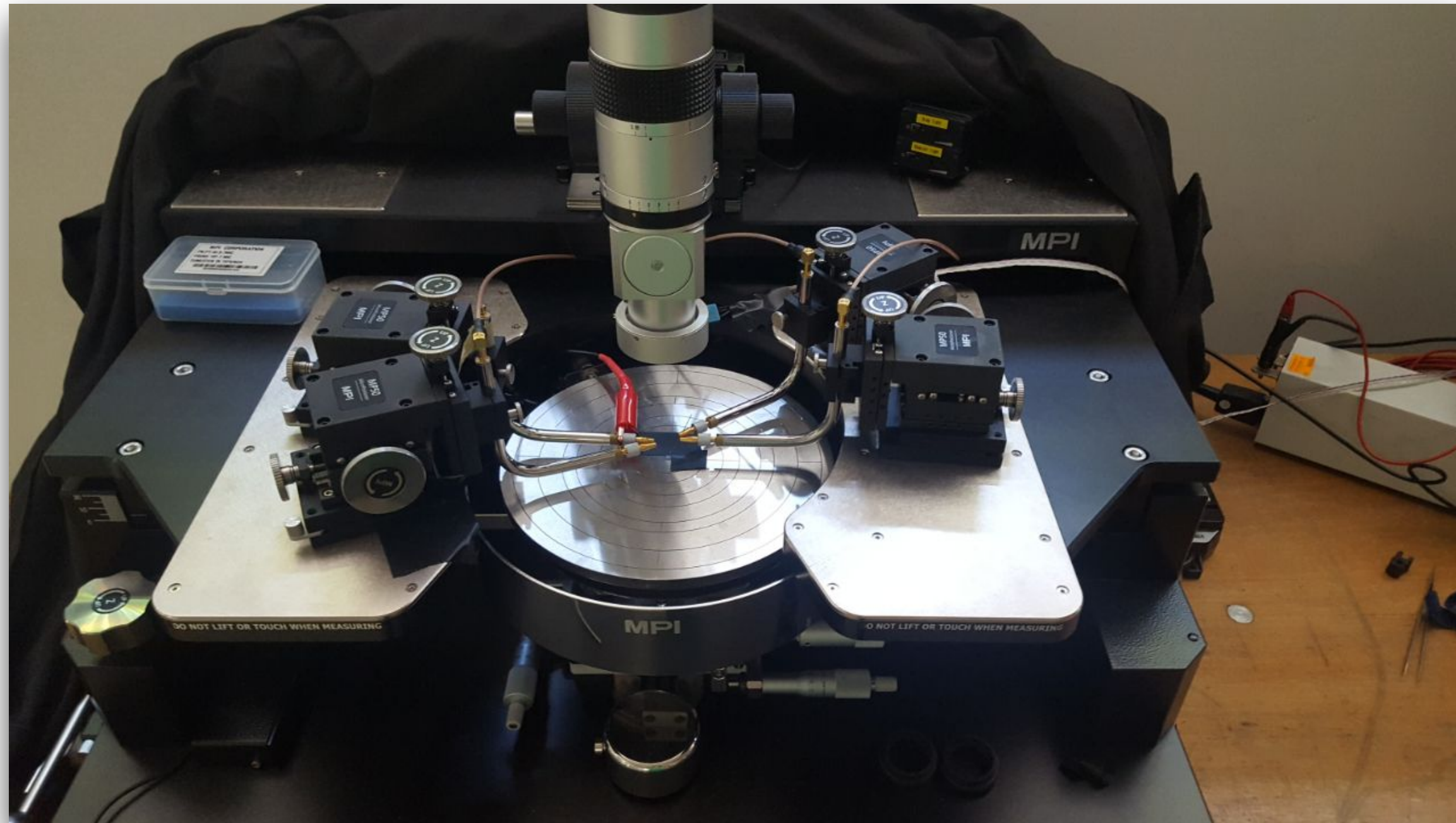
- LHCC final assessment and recommendations to Research Board: March 2022
- LoI public version (CDS): end of March

ALICE 3 Timing Layers:

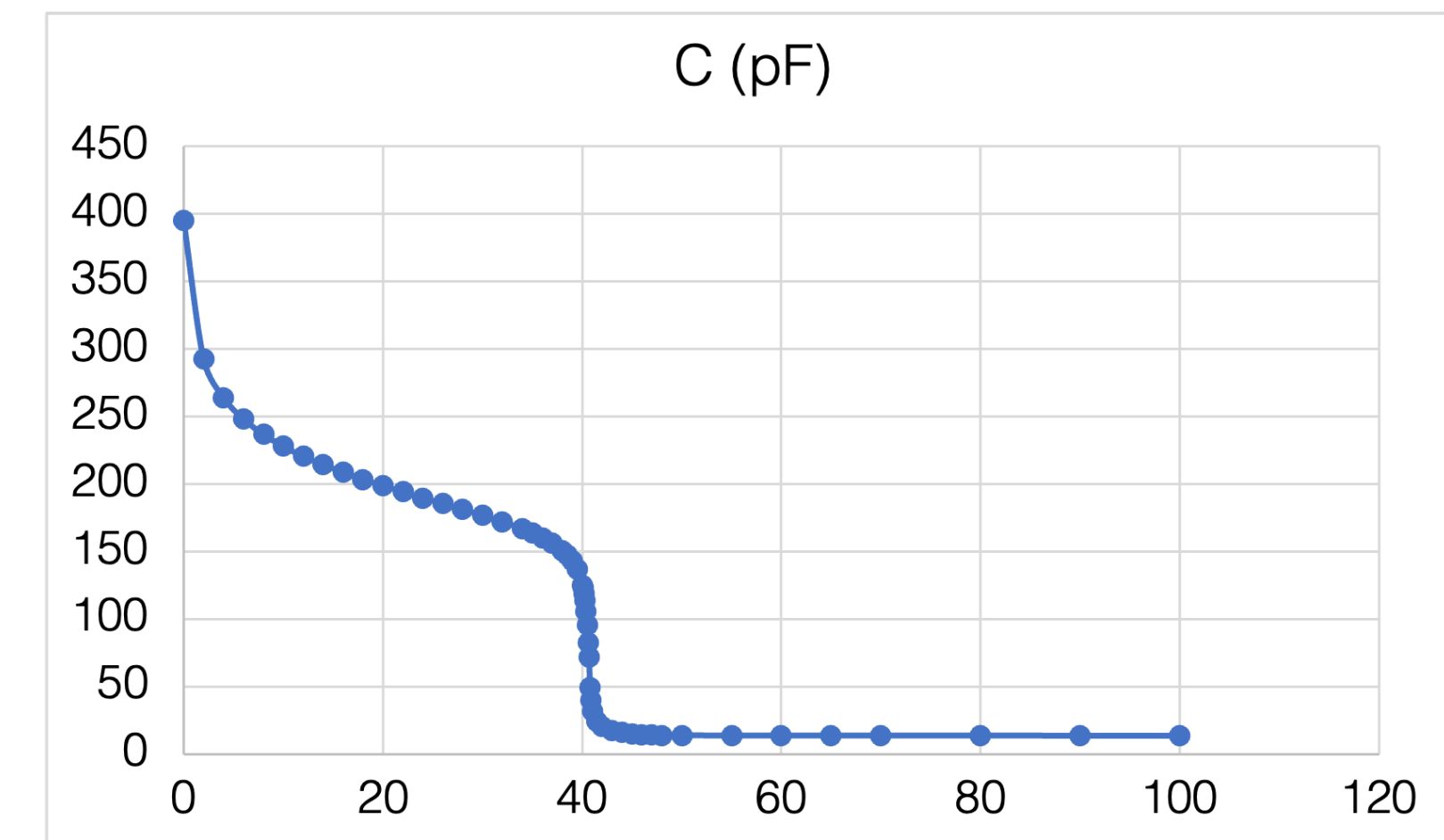
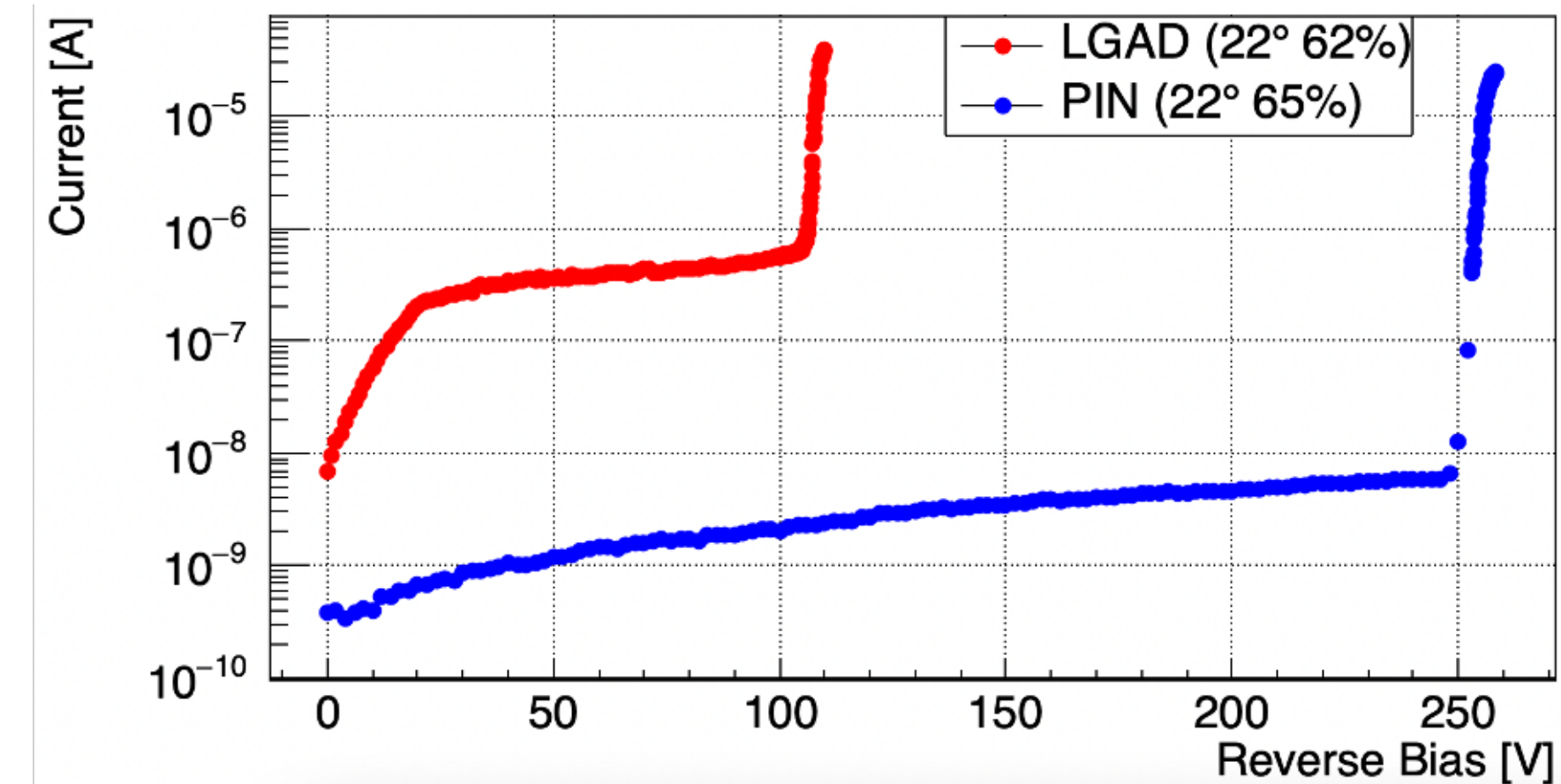
- 45 m<sup>2</sup> silicon detector (2 barrel layers + 2 forward disks)
- **target time resolution of ~20 ps**

# Attività di R&D: ALICE 3 Timing Layer

- Caratterizzazione di sensori al Silicio con eccellenti proprietà di timing:  
**LGAD**, **SiPM** e single **SPAD**



Attività svolta nel Laboratorio Silici in V.le Berti, con il contributo fondamentale di **D. Cavazza!**



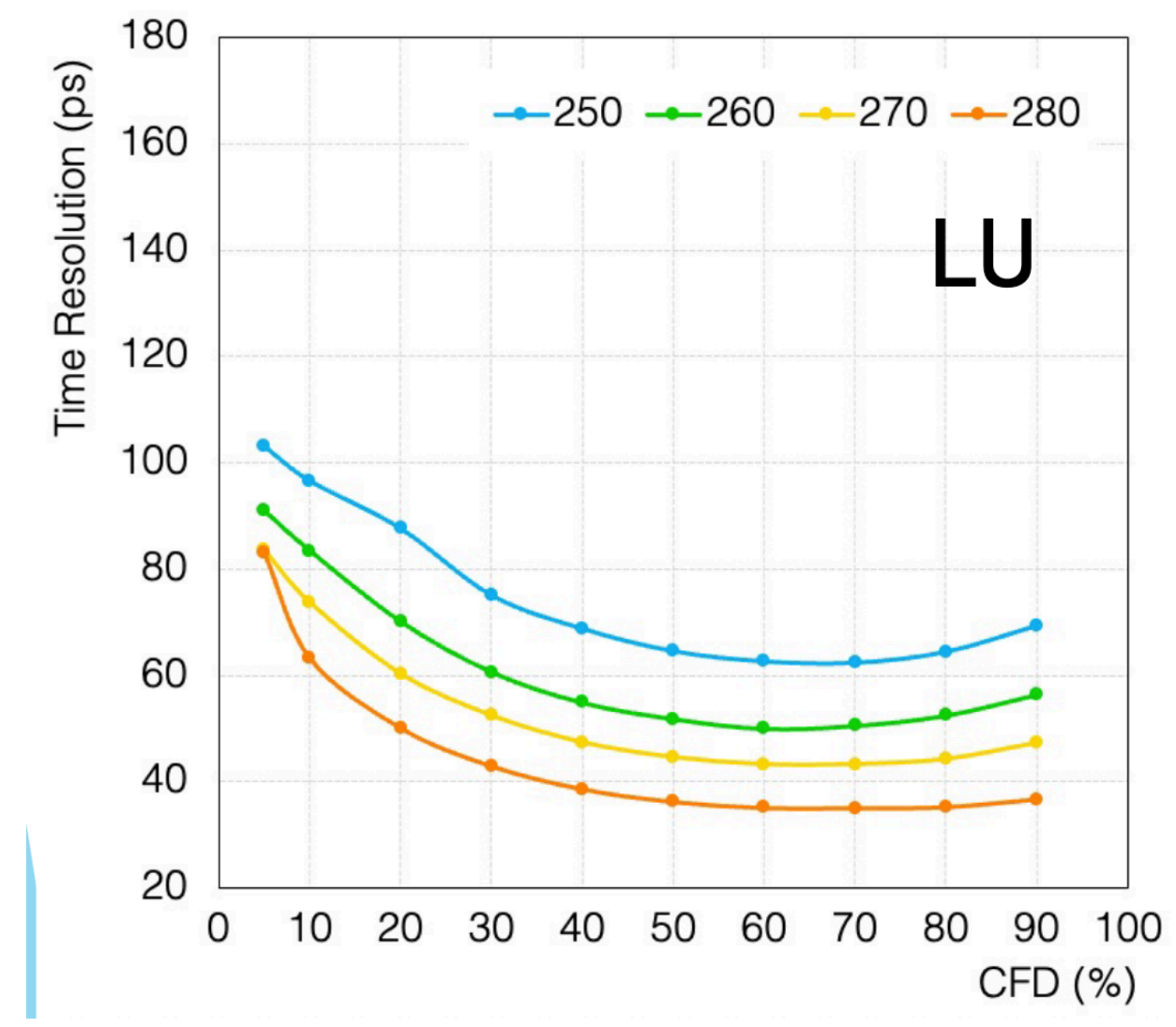
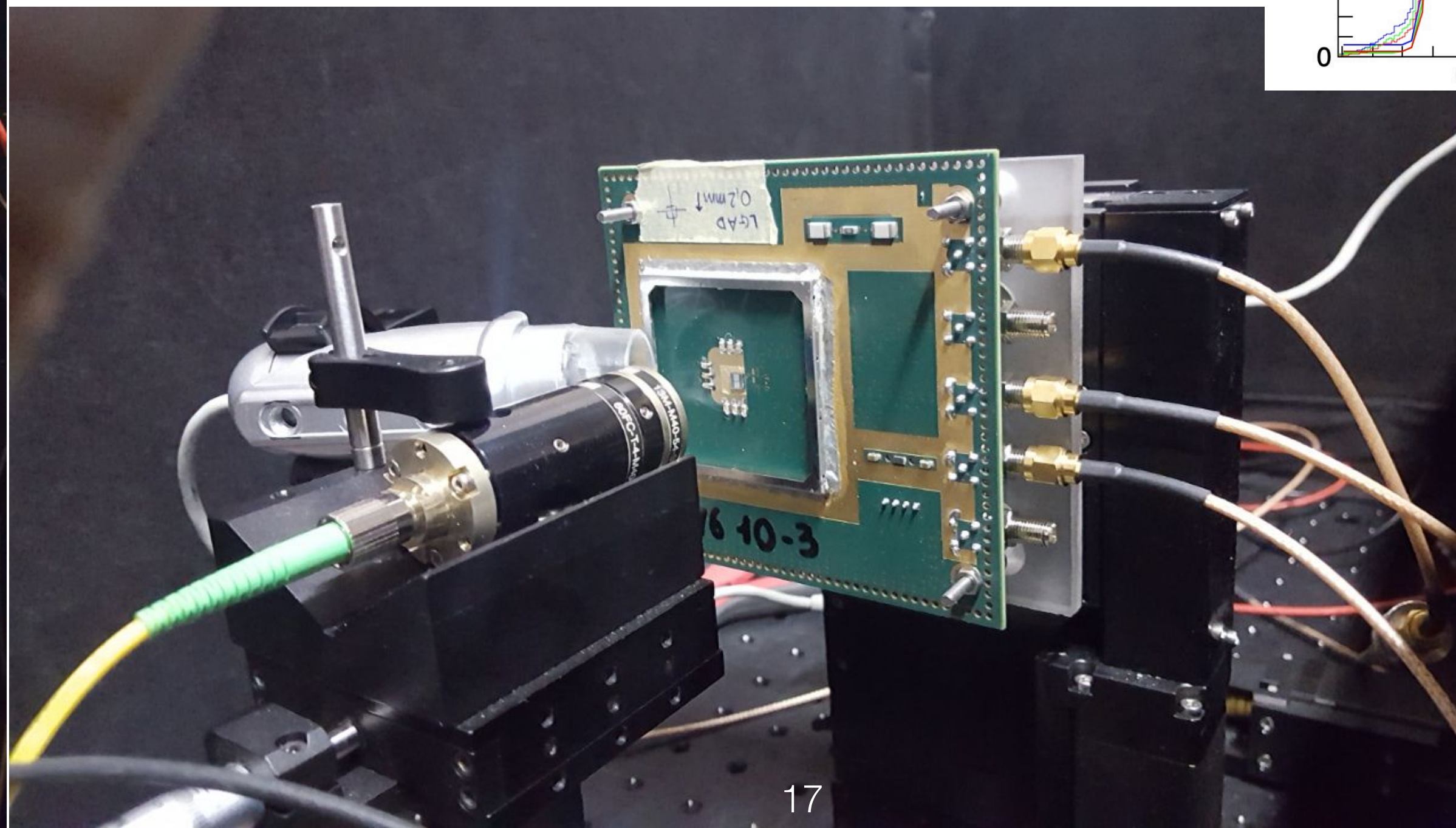
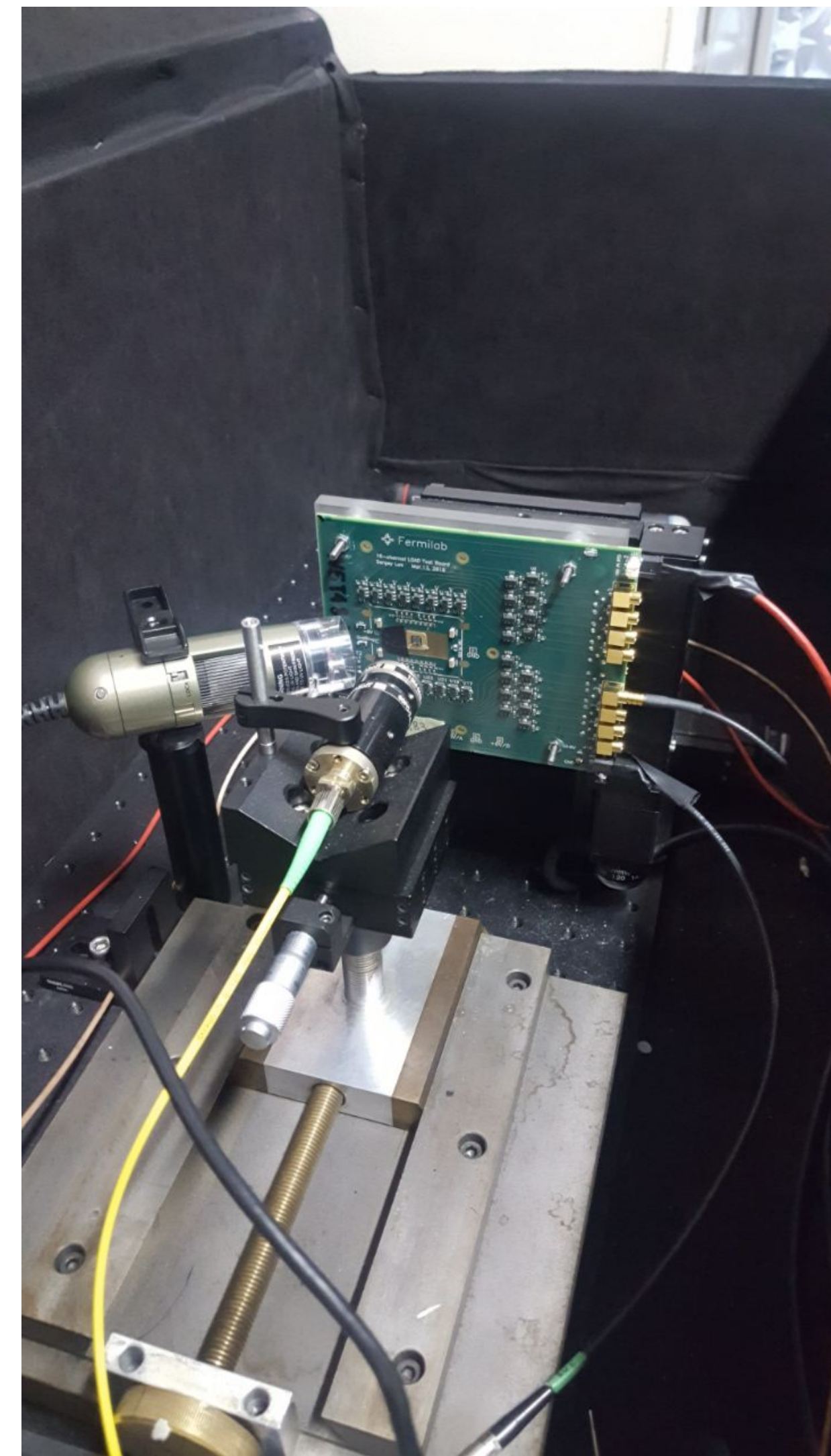
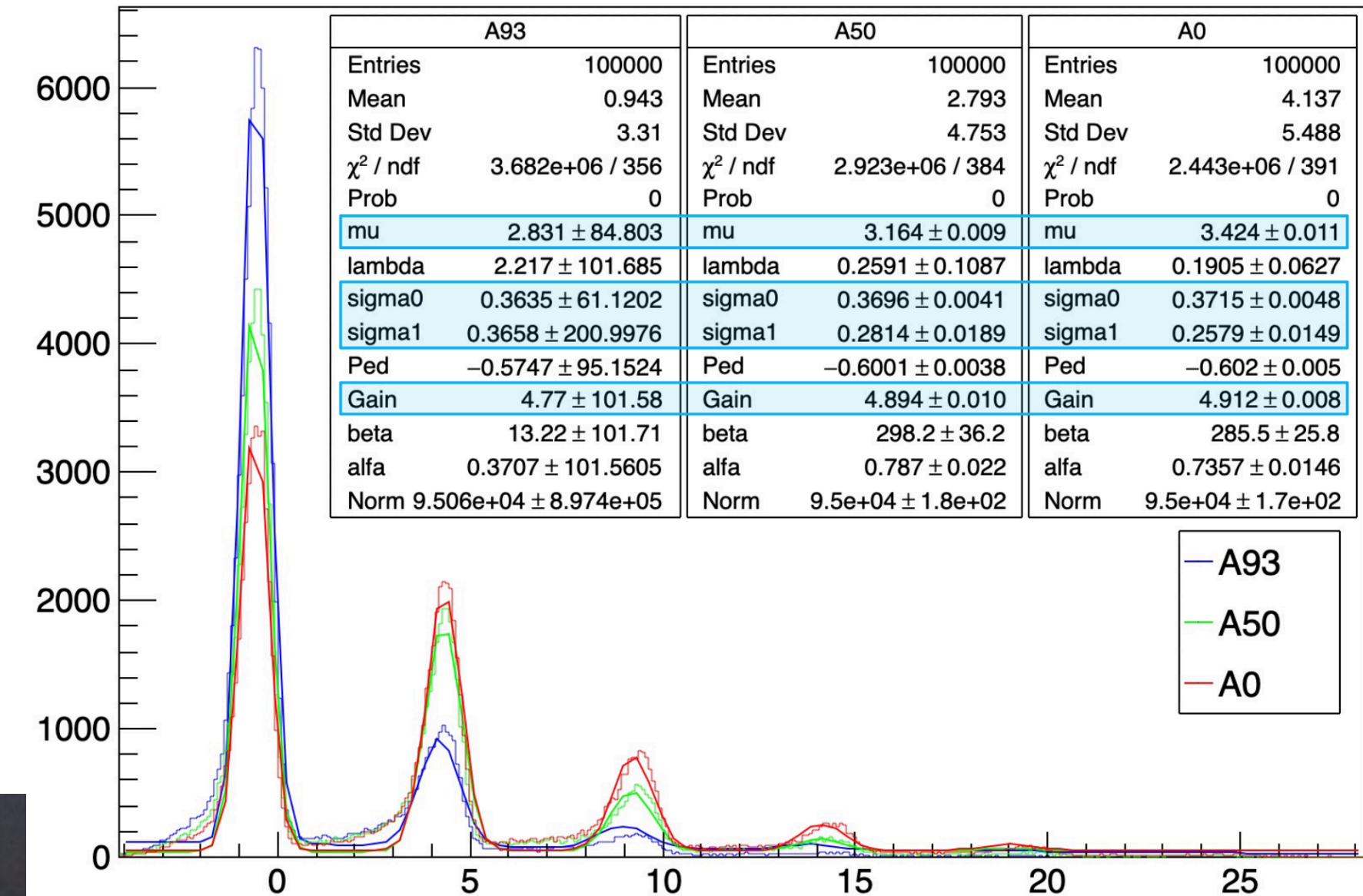
D. Cavazza, F. Carnesecchi, S. Strazzi



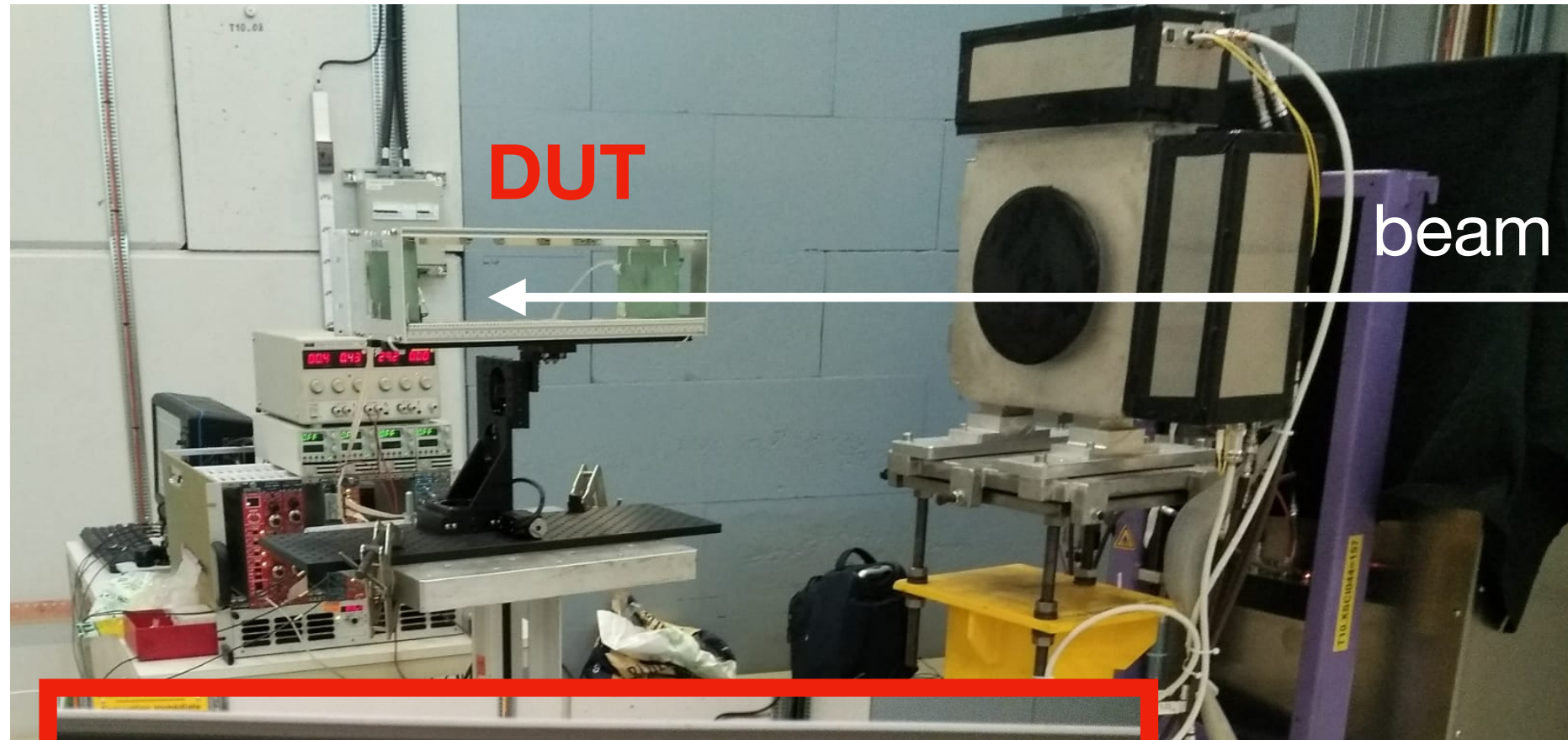
# Attività di R&D: ALICE 3 Timing Layer

- Calibrazioni e misure di risoluzione temporale con **setup laser**

Attività svolta nel Laboratorio Silici in V.le Berti, con il contributo fondamentale di **D. Cavazza!**



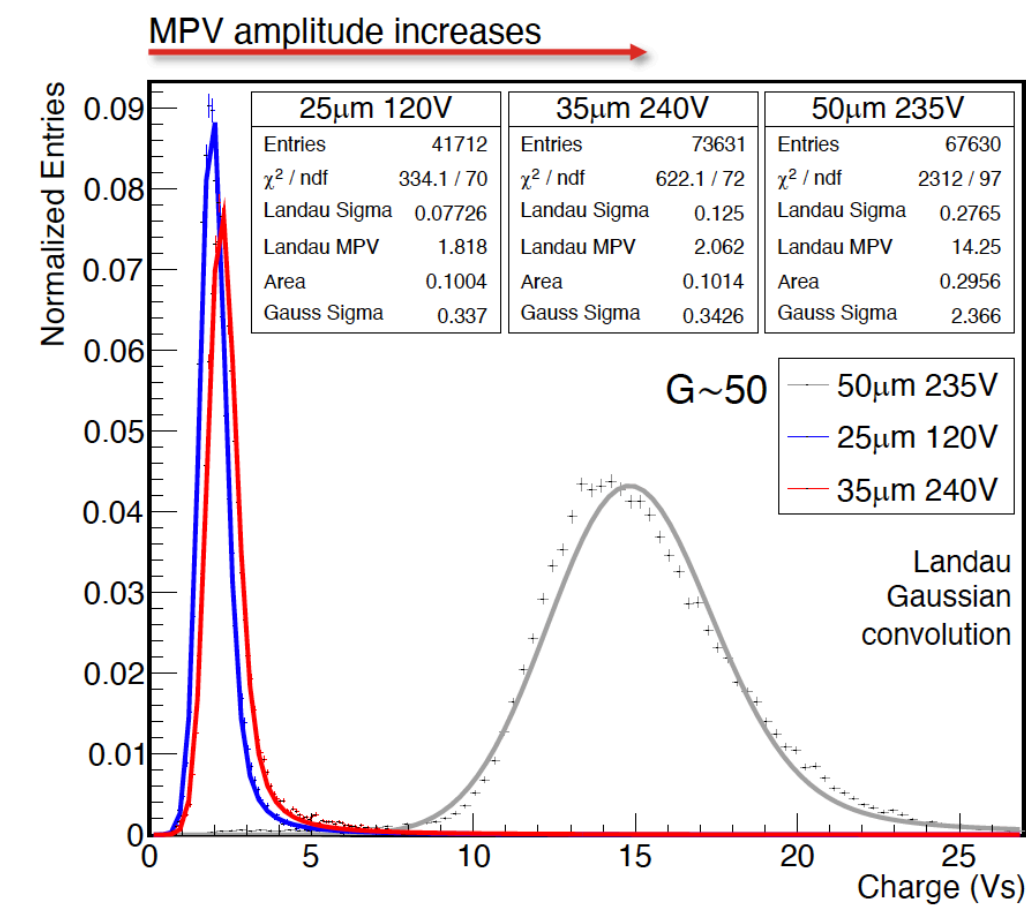
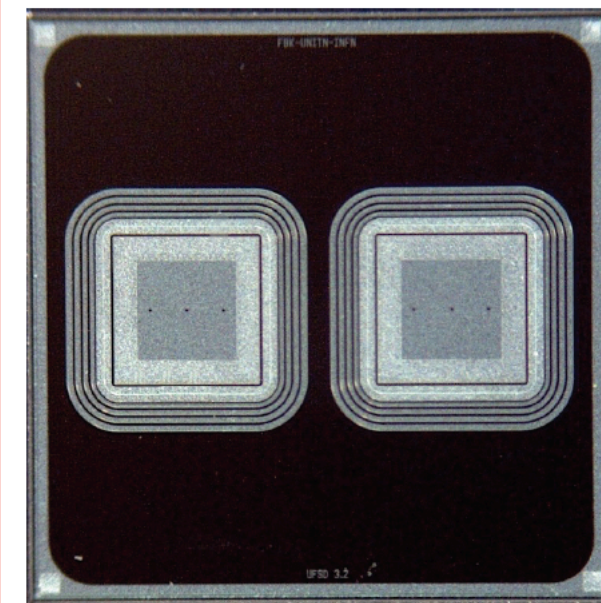
# Attività di R&D: ALICE 3 Timing Layer



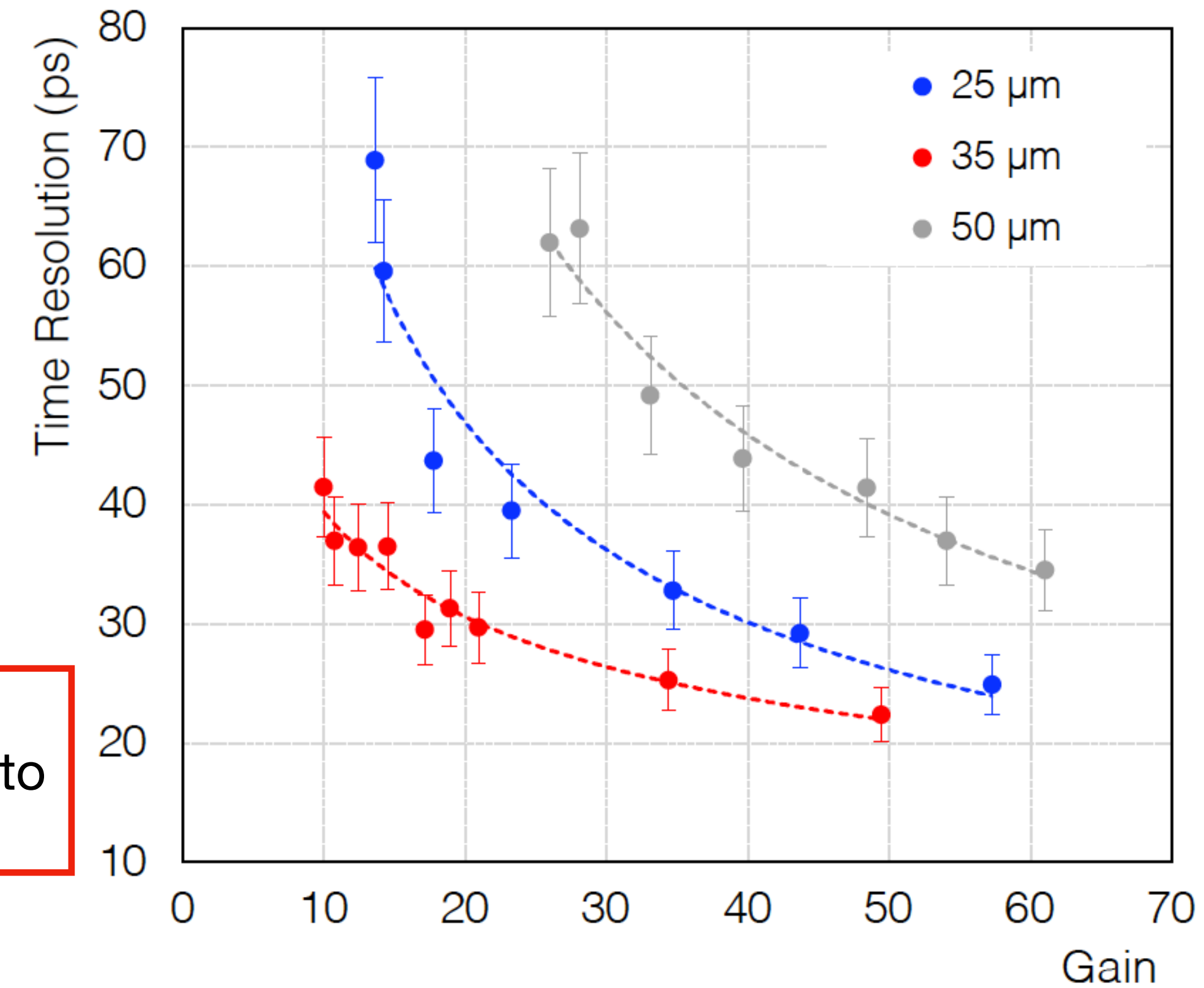
Attività svolta nel Laboratorio Silici in V.le Berti, con il contributo fondamentale di **D. Cavazza** (anche ai test beam al CERN PS)!



Area = 1x1 mm<sup>2</sup>



time resolution with thin LGADs (25 ,35 um) close to target resolution of 20 ps



Paper su misure con SiPM sottomesso a JINST, paper su misure con LGAD in preparazione



D. Cavazza, F. Carnesecchi, S. Strazzi

# Responsabilità del gruppo in ALICE



## ALICE

Management Board: **P. Antonioli**  
Editorial Board: **F. Bellini, P. Antonioli**  
Computing Board: **F. Noferini**  
Conference Committee: **R. Preghenella**  
Outreach Coordinator: **D. Hatzifotiadou**  
DPG Convener: **F. Noferini**  
DPG-AOT Track Selection Coordinator: **N. Jacazio**  
PWG-LF-Spectra Coordinator: **N. Jacazio**  
PWG-MM-Underlying Event Coordinator: **S. Tripathy**  
Responsabile Nazionale Calcolo ALICE: **F. Noferini**

## TOF

Deputy Project Leader: **L. Cifarelli, P. Antonioli**  
Team Leader: **P. Antonioli**  
Technical Coordinator: **G. Scioli**  
System Run Coordinator: **M. Colocci**

## ALICE3 Working Groups

Simulation and Performance  
Coordinator: **R. Preghenella**  
Time-of-Flight Coordinator: **A. Alici**

# Pubblicazioni ALICE



## ALICE publications in 2021/2022:

- **42** (33 + 9) published articles
- **21 with TOF information**
- **5** con **contributo diretto del gruppo di Bologna** nel Paper Committee o nell'Internal Review Committee
  - 2 Phys. Rev. Lett.
  - 1 Phys. Rev. C
  - 1 JHEP
  - 1 EPJC

## Articoli sottomessi a riviste internazionali:

- **23** (submitted + accepted)
- **13 with TOF information**
- **6** con **contributo diretto del gruppo di Bologna** nel Paper Committee o nell'Internal Review Committee

# Risultati (recenti) selezionati di ALICE



Lista non esaustiva, criterio "forte contributo da Bologna"

## DISCLAIMER

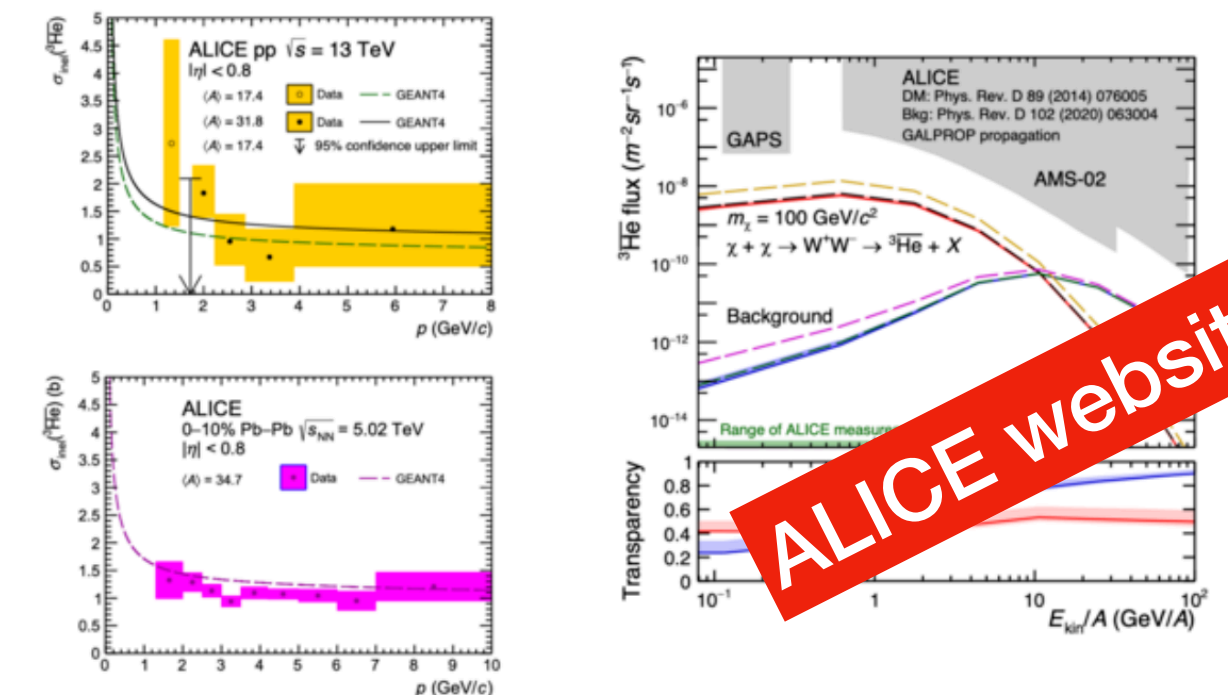
Alcuni dei più recenti ed interessanti risultati di fisica verranno presentati a QM 2022 tra pochi giorni e non possono quindi essere (ancora) mostrati...

<https://indico.cern.ch/event/895086/>



## Recent highlights

### On the transparency of our Galaxy to anti-3He nuclei



The anti-<sup>3</sup>He inelastic interaction cross-section was measured for the first time, using the ALICE detector material as an effective target in proton-proton and lead-lead collisions at the LHC: [arXiv link](#).

## ALICE Charm baryons constrain hadronisation

Understanding the mechanisms of hadron formation represents one of the most interesting open questions in particle physics. Hadronisation is a non-perturbative process that is not calculable in quantum chromodynamics and is typically described with phenomenological models, such as the Lund string model. Ultrarelativistic nuclear collisions, where a high-density plasma of deconfined quarks and gluons, the quark-gluon plasma (QGP), is created, provide an ideal setup to test the limits of this description. In these conditions,

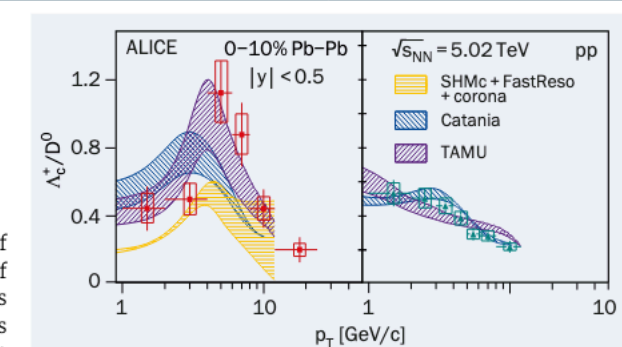
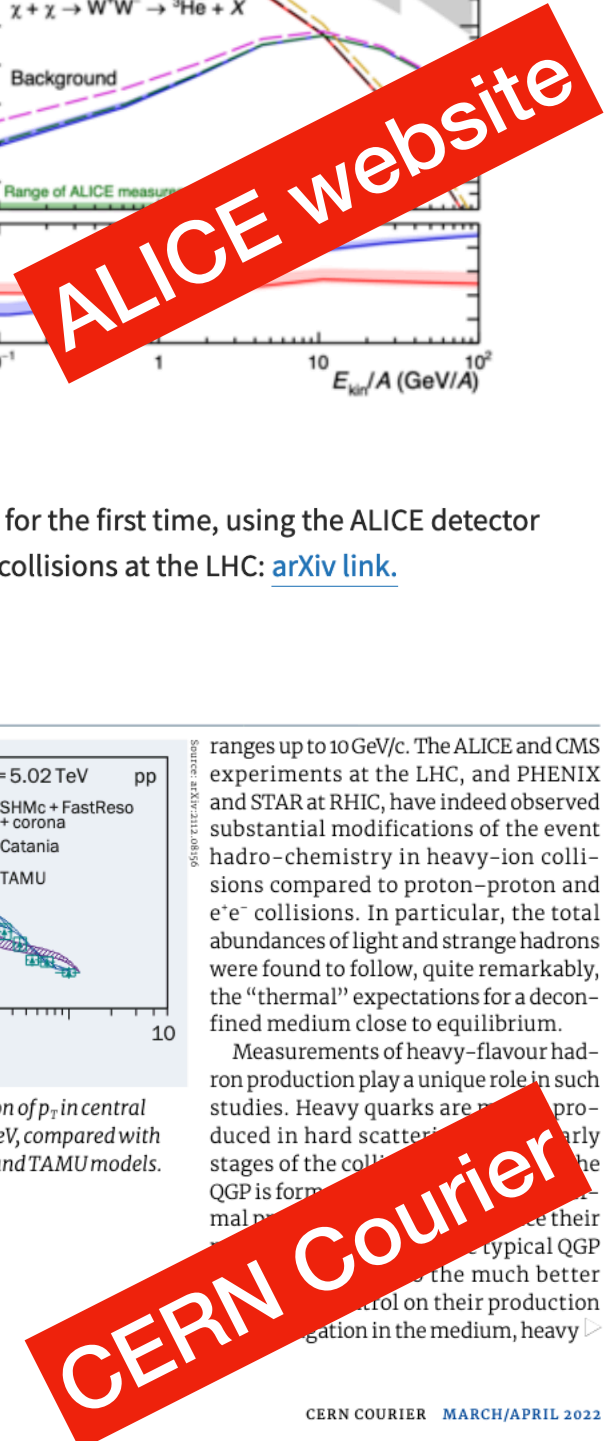


Fig. 1. The  $A_c/D^0$  production ratio as a function of  $p_T$  in central Pb-Pb (left) and pp (right) collisions at 5.02 TeV, compared with theoretical predictions of the SHMc, Catania and TAMU models.

hadrons may be formed via a combination of deconfined quarks close in phase space. This process can lead, for example, to increased production of baryons with respect to mesons in momentum

ranges up to 10 GeV/c. The ALICE and CMS experiments at the LHC, and PHENIX and STAR at RHIC, have indeed observed substantial modifications of the event hadro-chemistry in heavy-ion collisions compared to proton-proton and e<sup>+</sup>e<sup>-</sup> collisions. In particular, the total abundances of light and strange hadrons were found to follow, quite remarkably, the "thermal" expectations for a deconfined medium close to equilibrium. Measurements of heavy-flavour hadron production play a unique role in such studies. Heavy quarks are not produced in hard scattering in the early stages of the collision. The QGP is formed and they thermalise. Their production is then governed by the typical QGP hadronisation mechanisms. The much better control on their production in the medium, heavy



# Misura della trasparenza della galassia ai nuclei ${}^3\overline{\text{He}}$

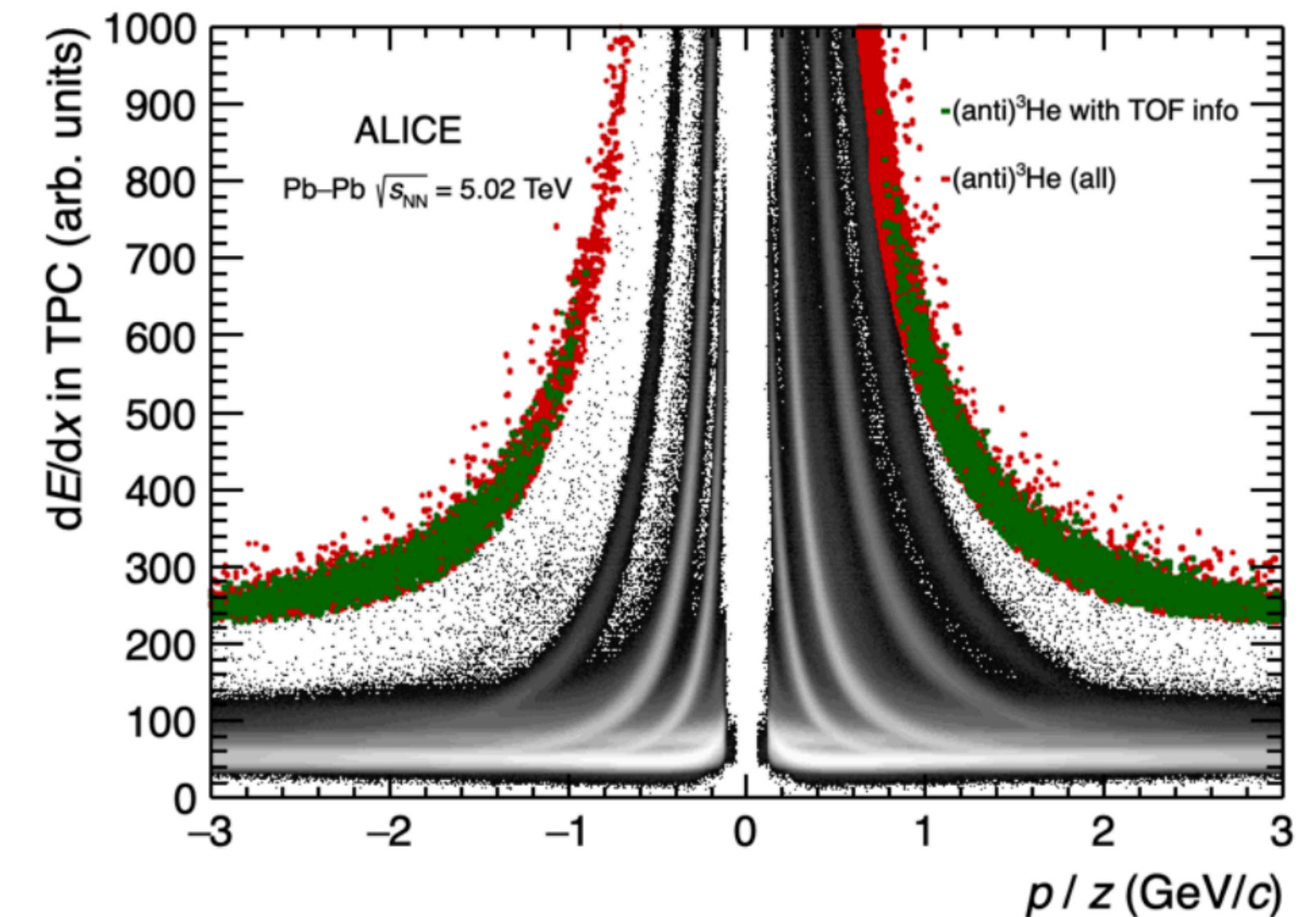
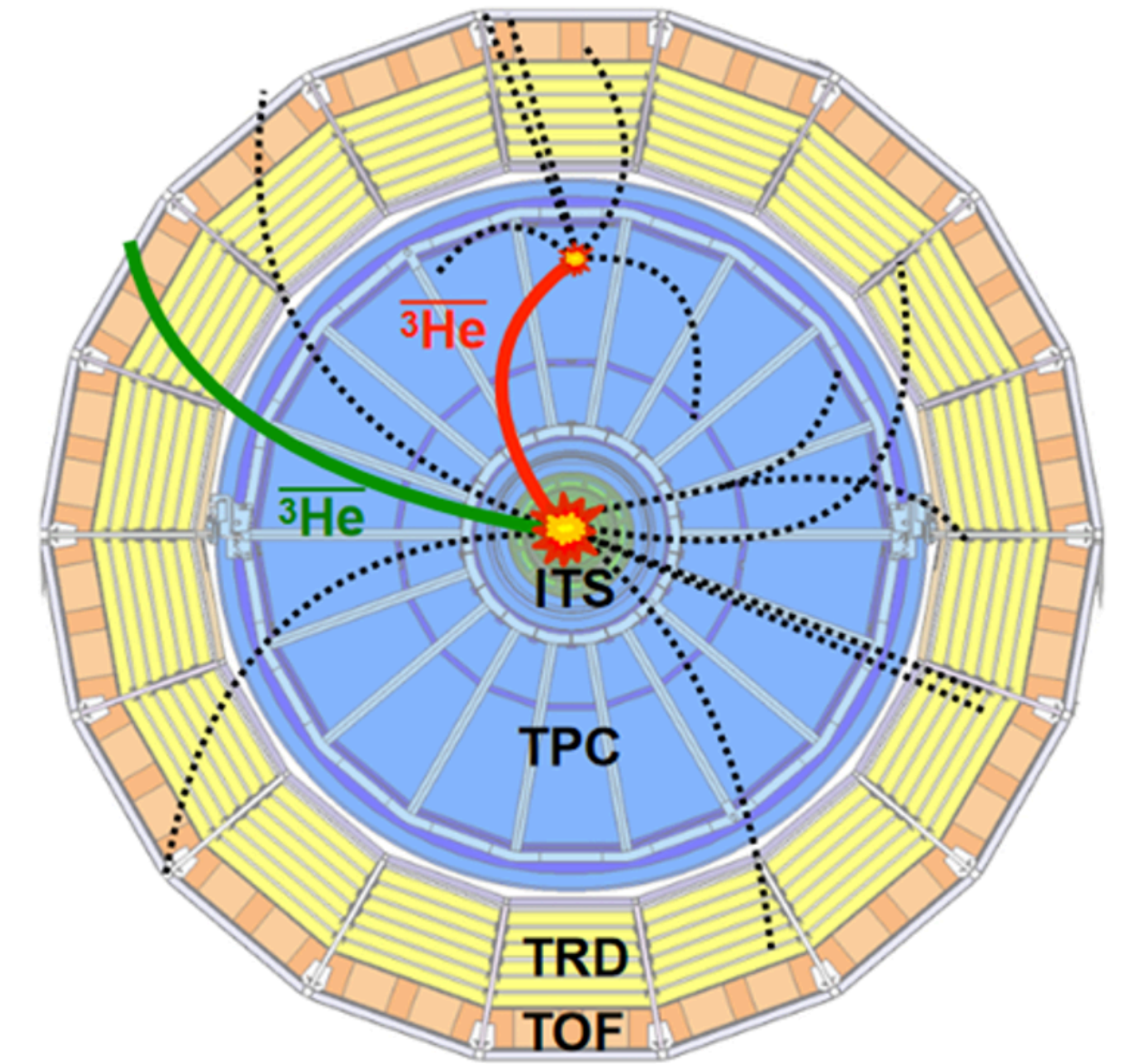
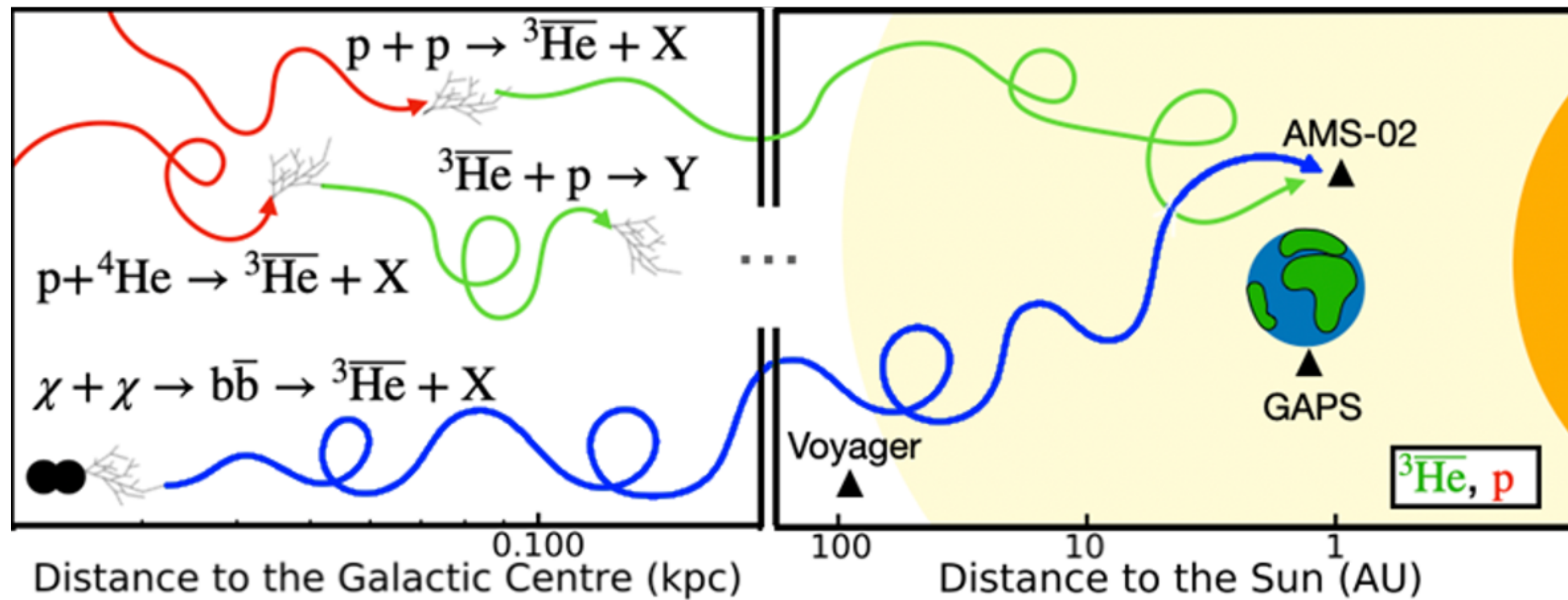


Antinuclei in space (searched by AMS-02, GAPS) may result from:

- Dark Matter annihilation (or decay) and/or segregated antimatter (**signal**)
- Interaction of cosmic rays with the interstellar gas (**background**)

Yields (for both channels) depend mainly on:

- Antinuclei formation mechanisms
- Particle transport in the galaxy (e.g. diffusion, convection)
- Attenuation due to inelastic scatterings with the interstellar gas



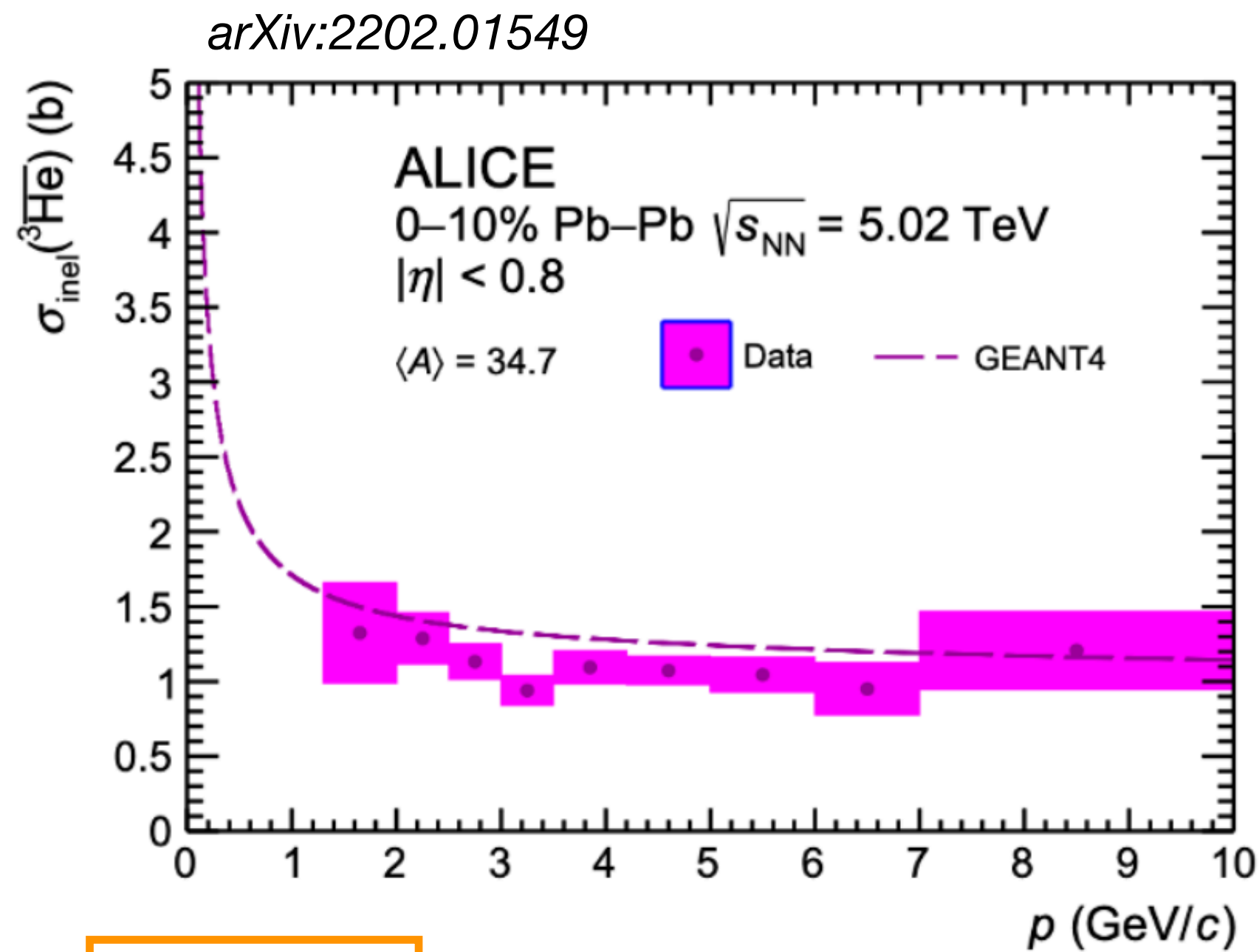
Perchè ALICE?

- LHC antimatter factory
- rivelatore leggero e elevata PID

# Misura della trasparenza della galassia ai nuclei ${}^3\overline{\text{He}}$

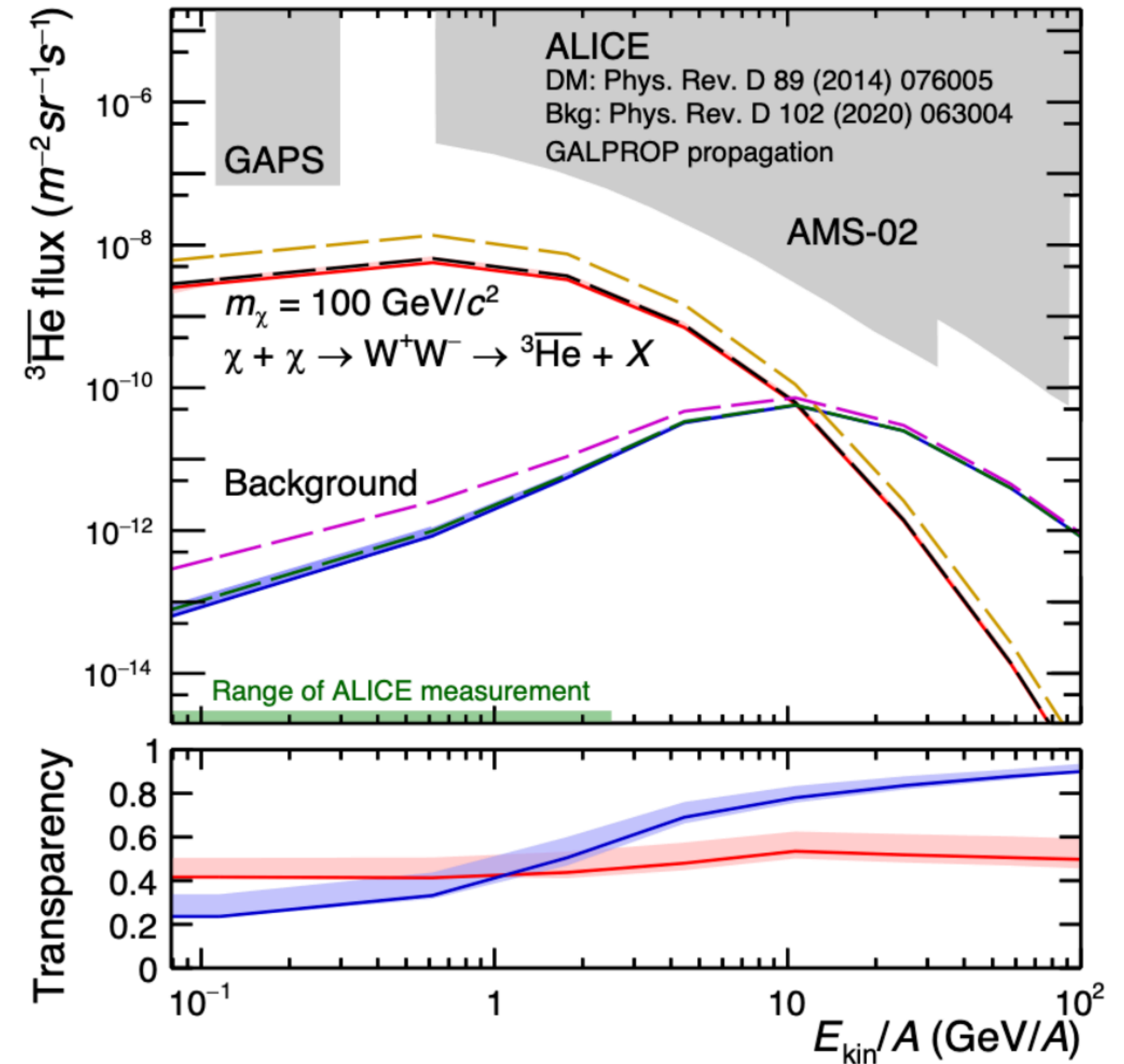


I risultati confermano le previsioni di GEANT4 ma con una precisione estremamente maggiore (gli errori in GEANT4 sono del 50%)

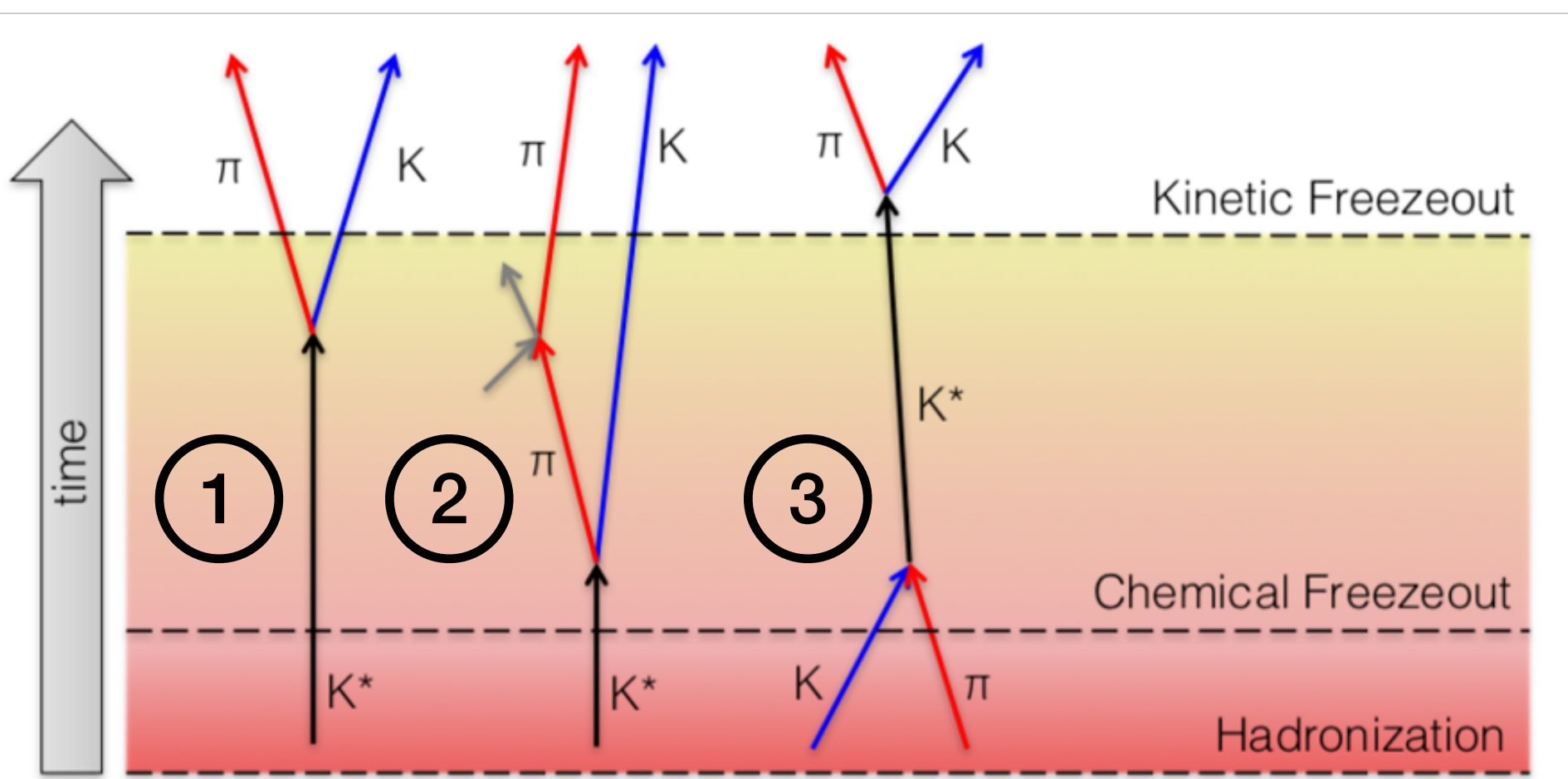


M. Colocci

arXiv:2202.01549



# Studio della fase adronica tramite risonanze



La formazione di un **QGP** in collisioni tra ioni pesanti è seguita da una fase in cui il sistema è un gas denso e caldo ( $T \sim 100-150$  MeV) formato da adroni e risonanze che possono interagire in maniera (pseudo-)elastica.

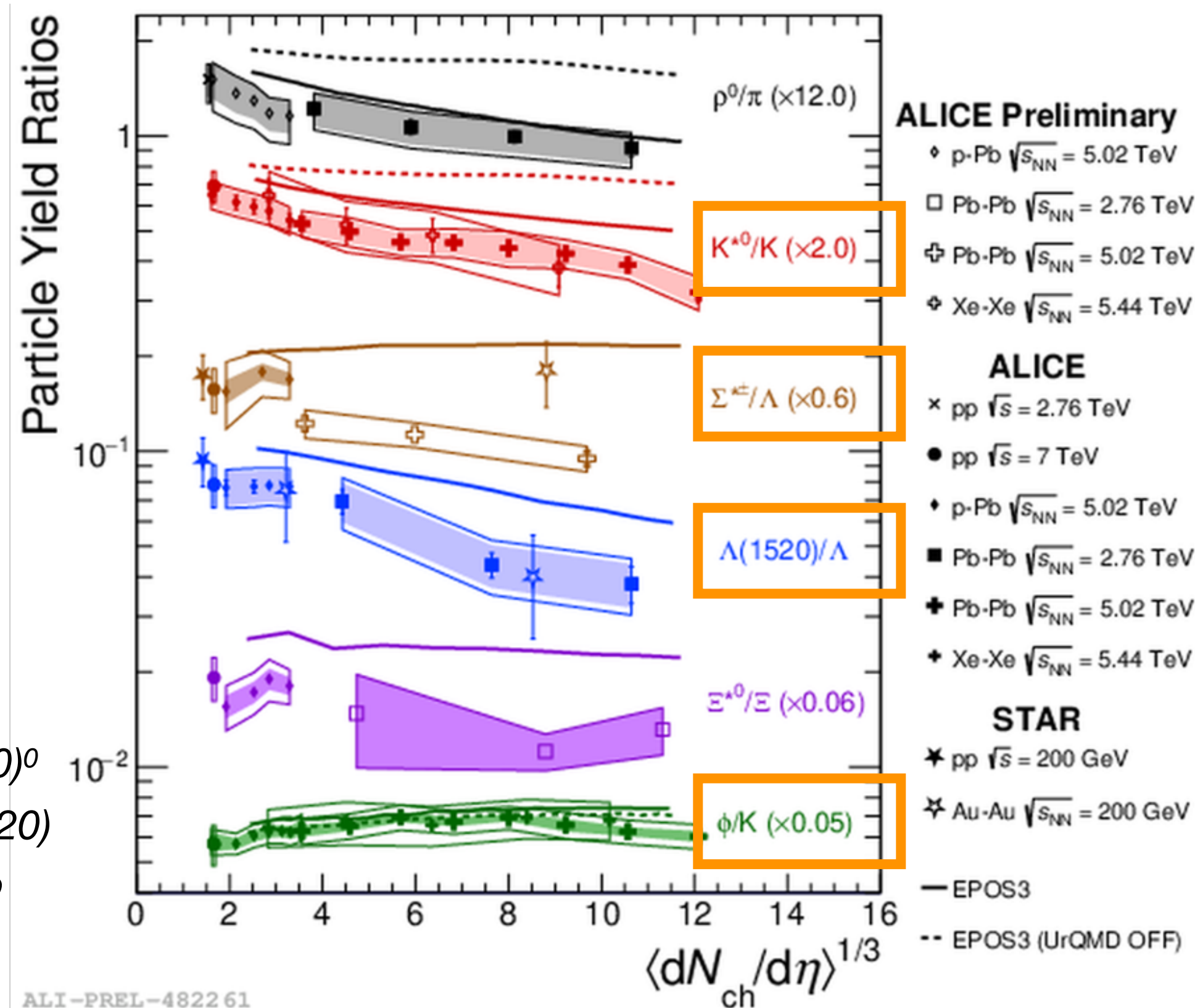
La durata di questa fase è 1-10 fm/c, circa pari alla vita media di risonanze che decadono per interazione forte, che quindi possono essere usate come **sonde per studiare le interazioni nella fase adronica e le sue proprietà (durata)**.

1. Scenario standard: decade durante la fase adronica
2. Una delle figlie può avere scattering  $\rightarrow$  non si ricostruisce
3. "Regeneration": pseudo-elastic scattering

Due meccanismi "in competizione": rigenerazione e rescattering dei prodotti di decadimento.  
A parte  $\phi/K$  tutte hanno soppressione in Pb-Pb: fenomeni di rescattering dominanti

N. Agrawal, F. Bellini, R. Preghenella, S. Tripathy  
2 papers in preparation ( $\Lambda(1520)$  and  $\Sigma(1385)$  in Pb-Pb @5.02 TeV)

*PRC* 99 (2019) 064901  $\rho(770)^0$   
*PRC* 99 (2019) 024905  $\Lambda(1520)$   
*PLB* 802 (2020) 135225  $K^* \phi$





# Light exotic states: $f_0(980)$ in pp collisions at 5.02 TeV

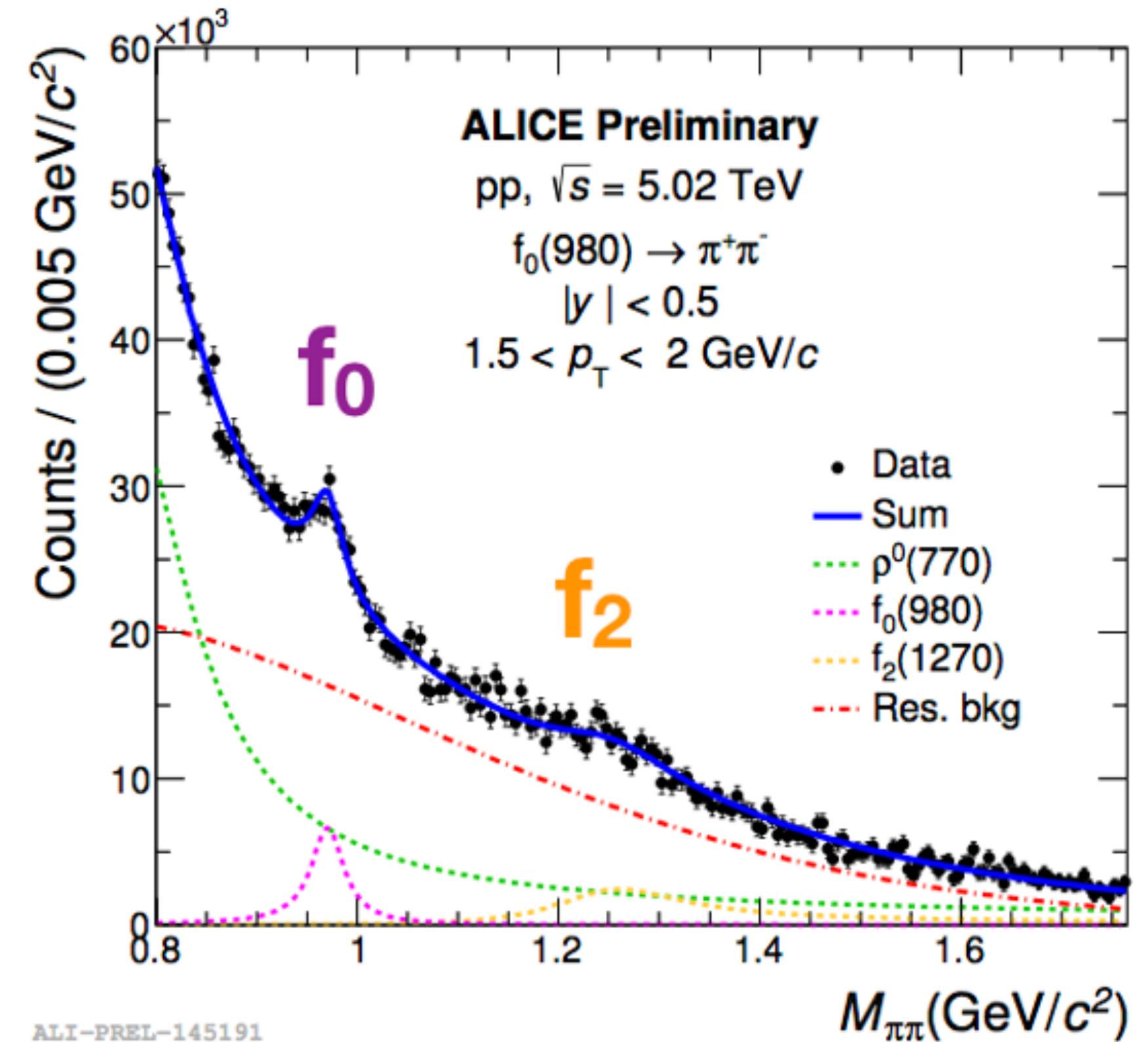
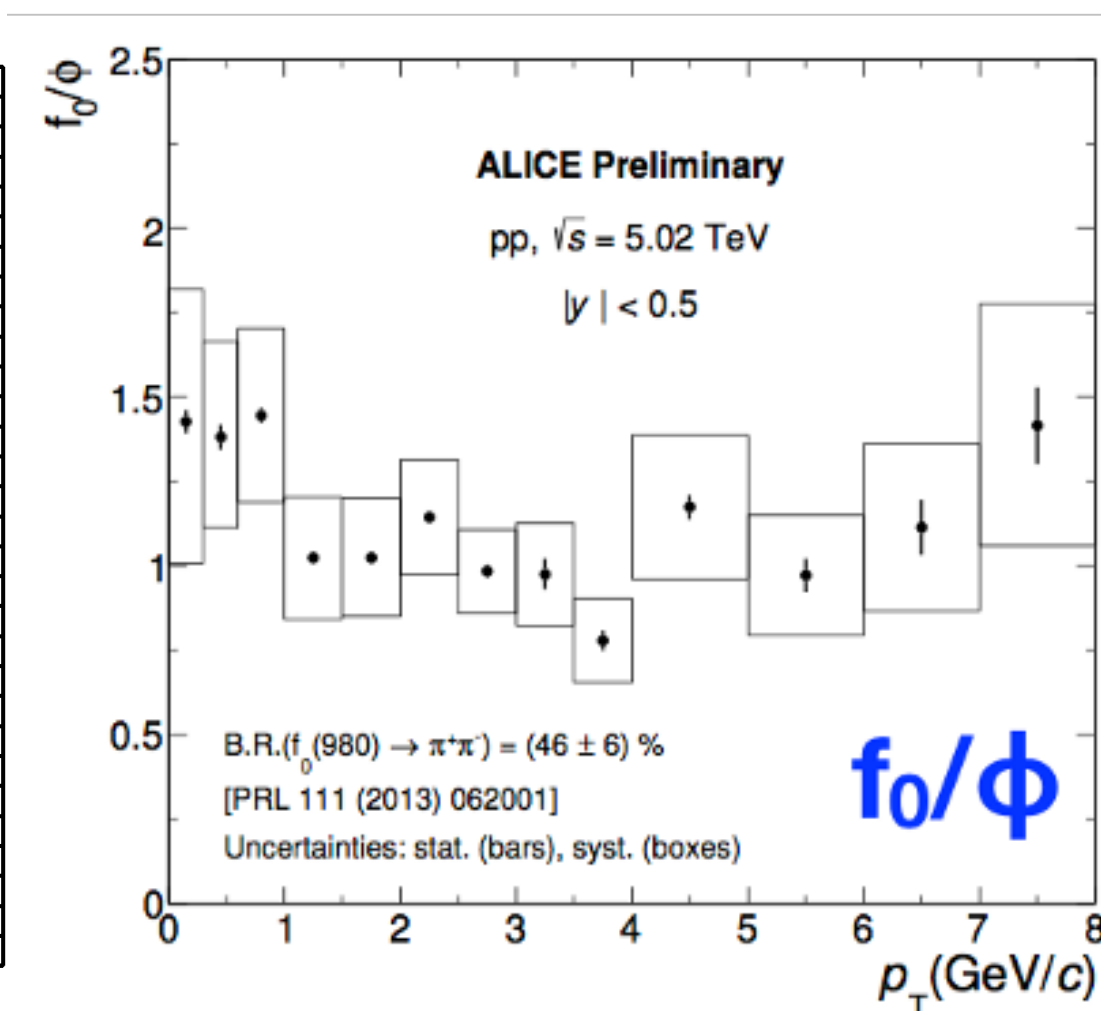
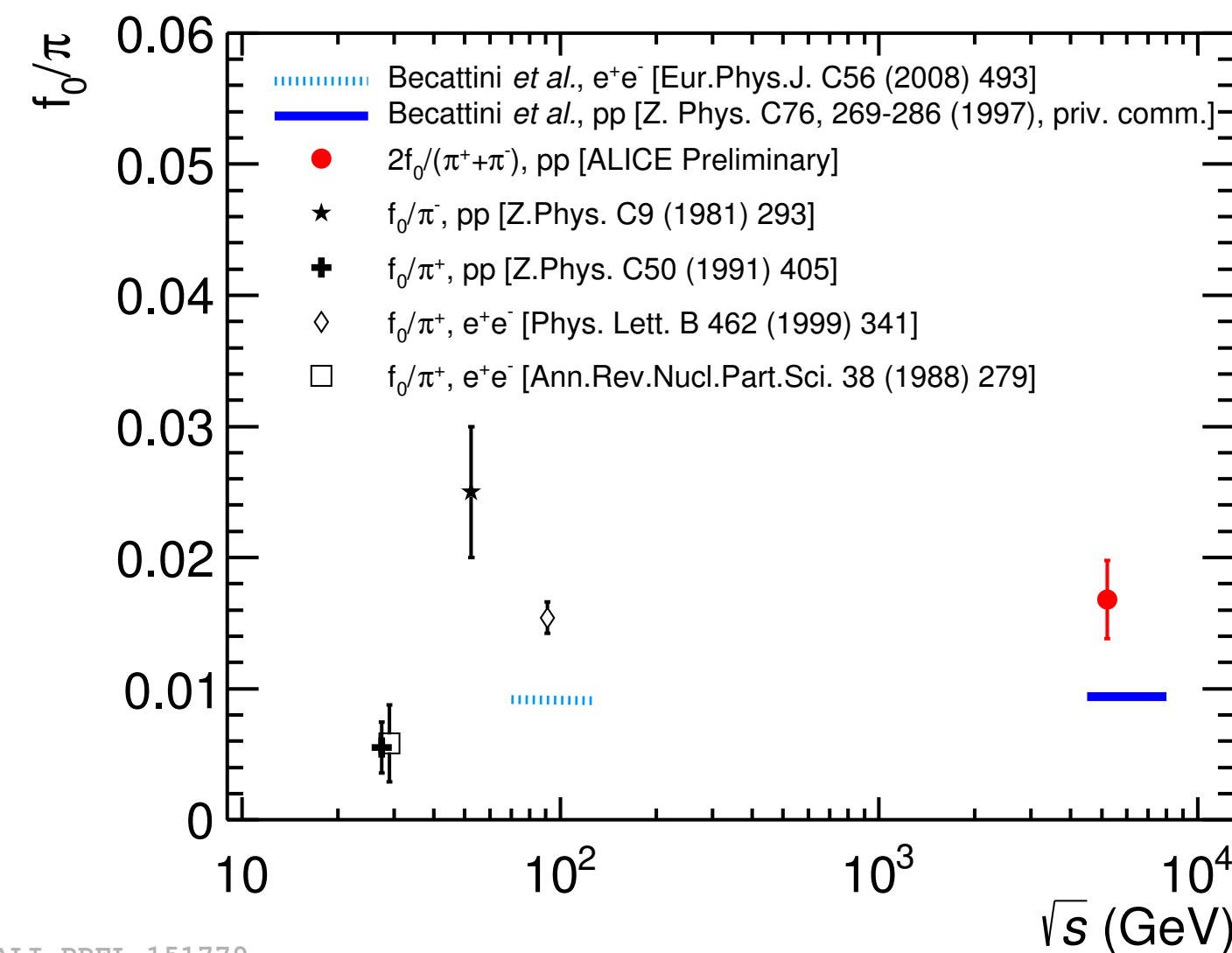


Physics motivation:

- $f_0(980)$  scalar meson has a debated nature: tetraquark in the LF sector or KKbar molecule or hybrid
- yield, nuclear modification factors can be used to learn about nature of particle à pp baseline for measurements in p-Pb and Pb-Pb

## First measurement of production yield in INEL pp collisions at the LHC

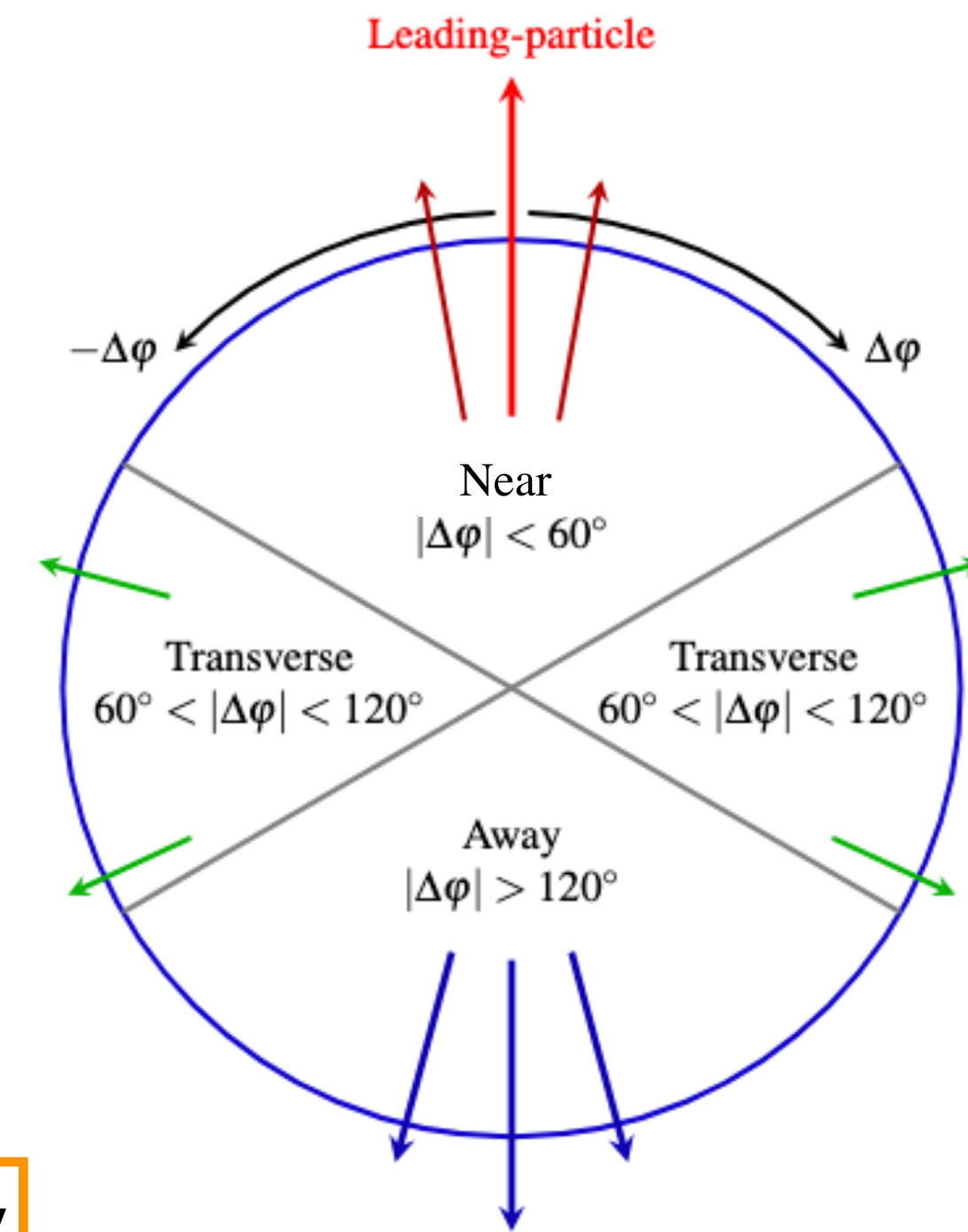
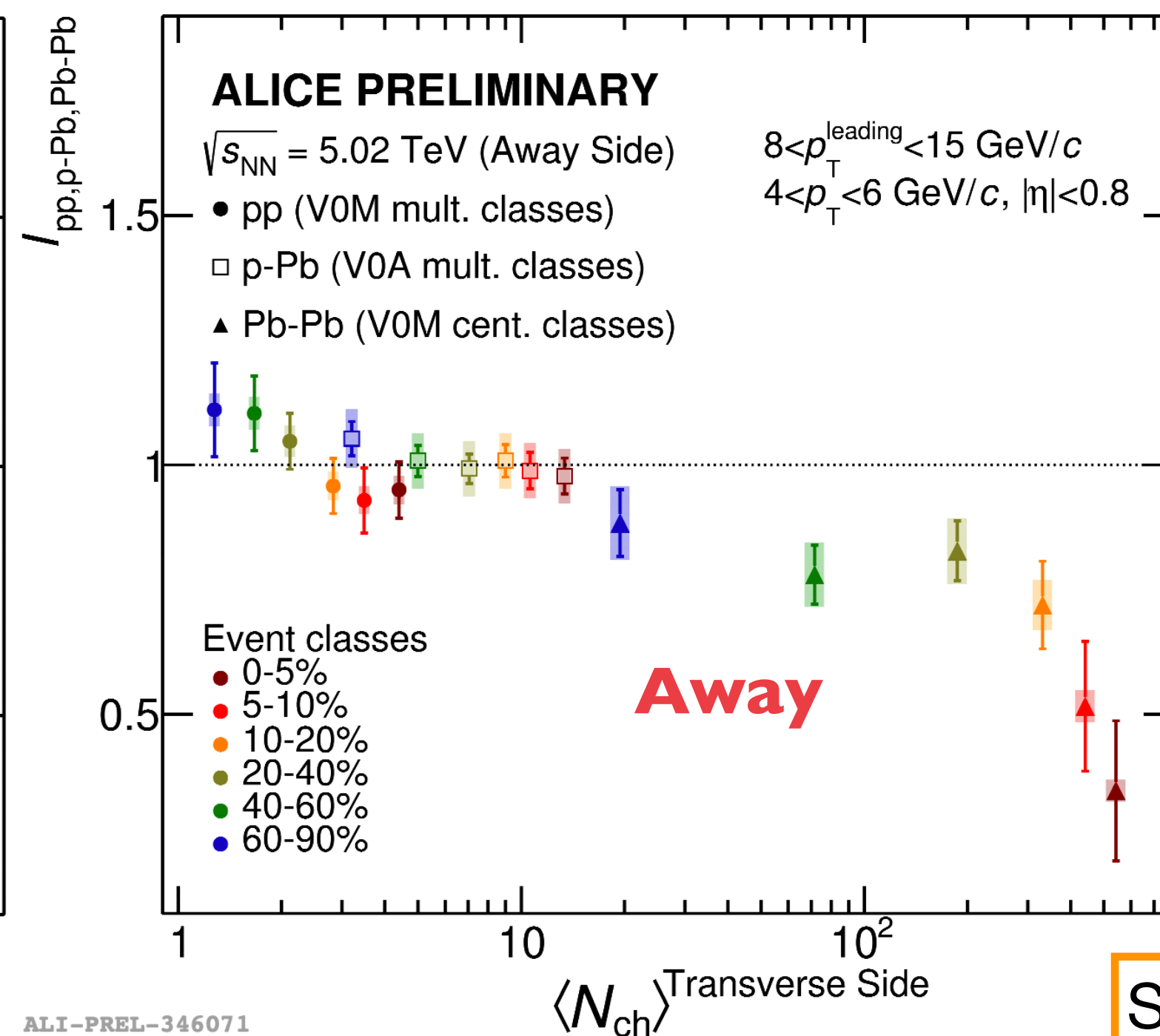
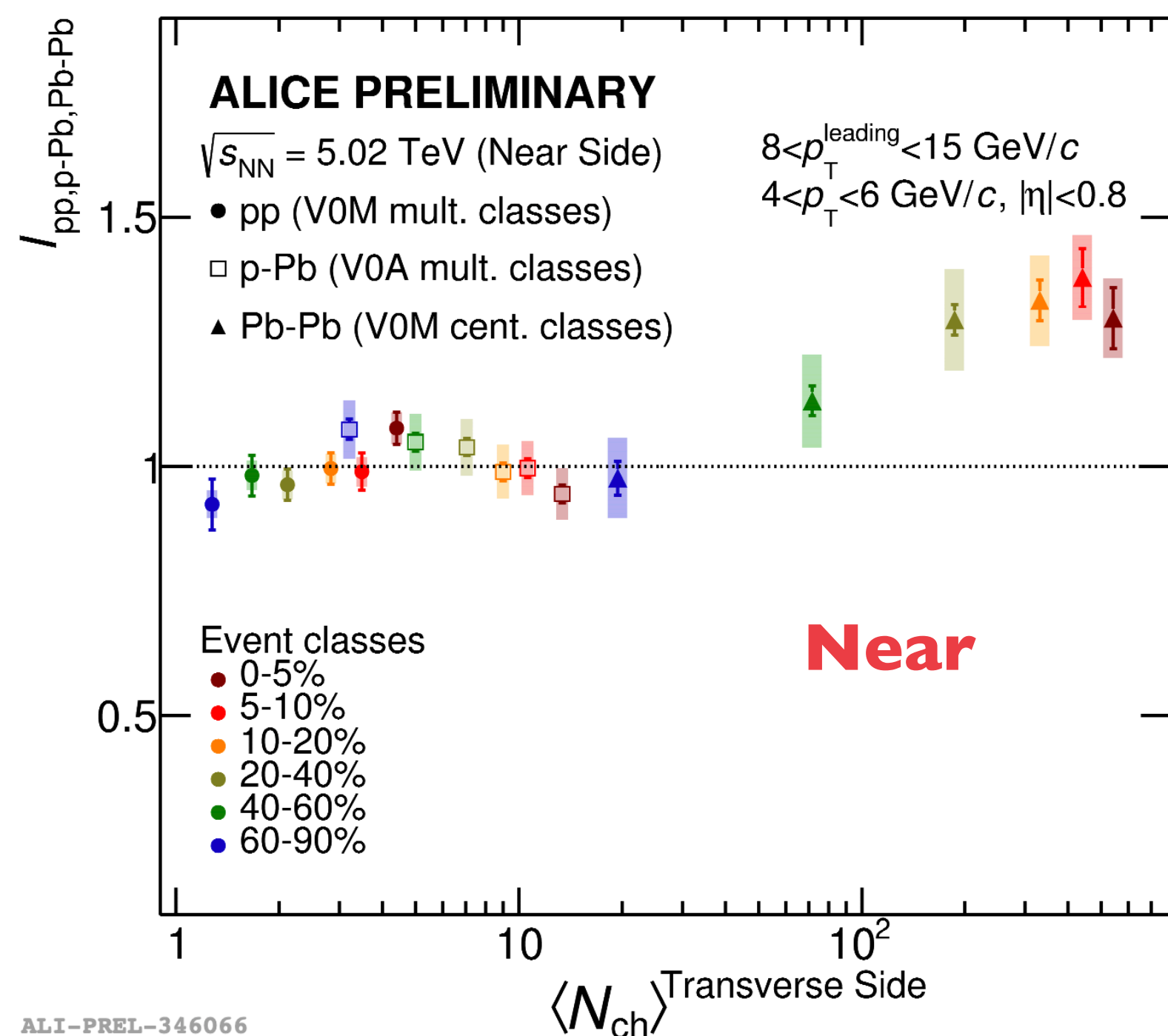
- Mild increase with  $\sqrt{s}$  in pp collisions
- Production at the LHC underpredicted by statistical hadronization models.
- Similar production as that of phi meson (ratio ~1)



N. Agrawal, F. Bellini, R. Preghenella, S. Tripathy  
Paper in preparation

# Search for jet modifications in small systems

$$I_{pp,p-Pb,Pb-Pb} = \frac{Y_{pp,p-Pb,Pb-Pb} - Y_{TS}^{pp,p-Pb,Pb-Pb}}{Y_{pp \text{ min.bias}} - Y_{TS}^{pp \text{ min.bias}}}, \text{ } Y \text{ is the yield in different topological regions}$$



S. Tripathy

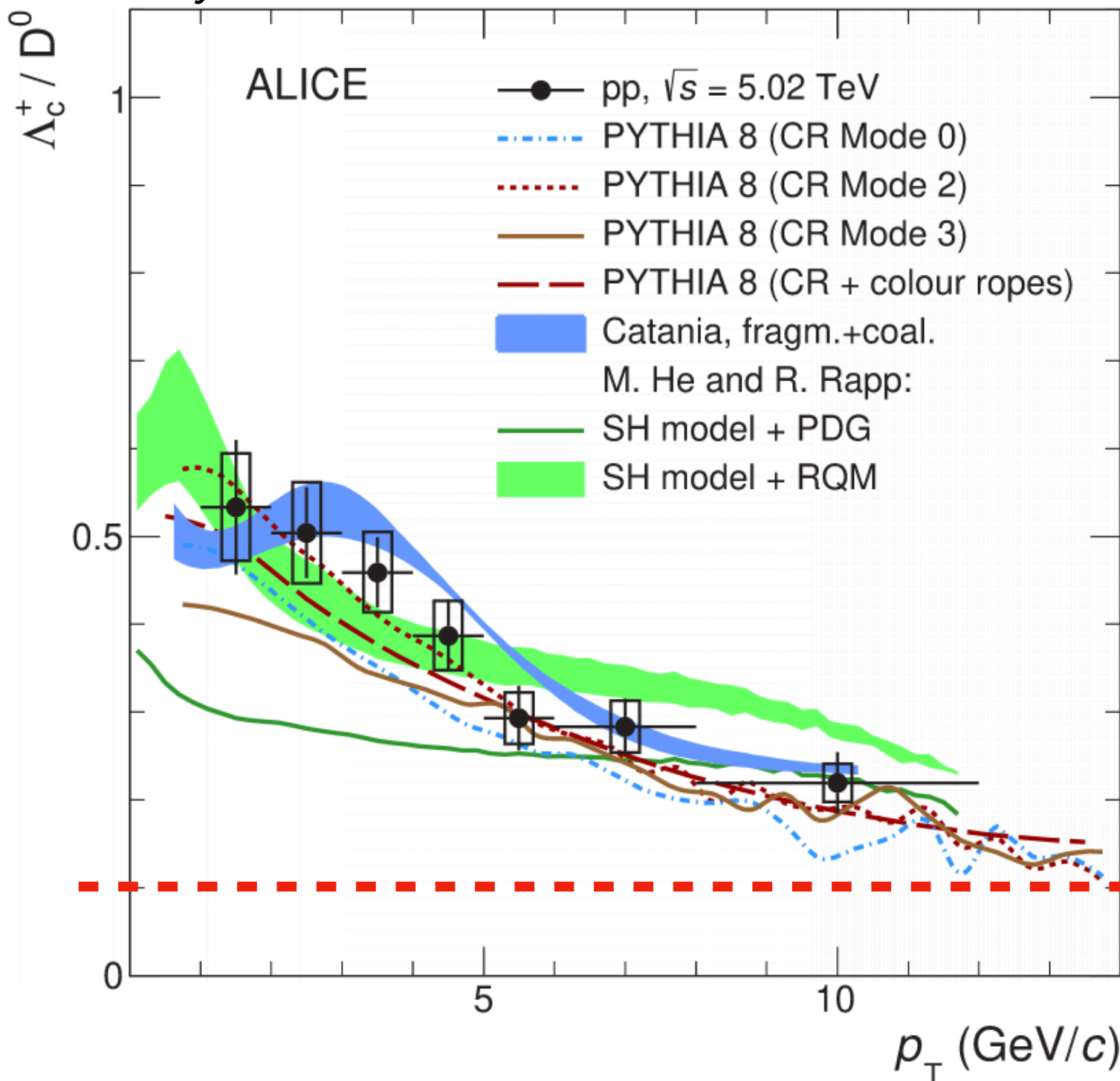
Effetti collettivi in collisioni pp ad alta molteplicità: formazione di QGP in small systems?  
 Nessuna evidenza di fenomeni di **jet suppression (quenching)** in collisioni pp

# Heavy-flavour: rapporto $\Lambda_c/D^0$ in collisioni pp

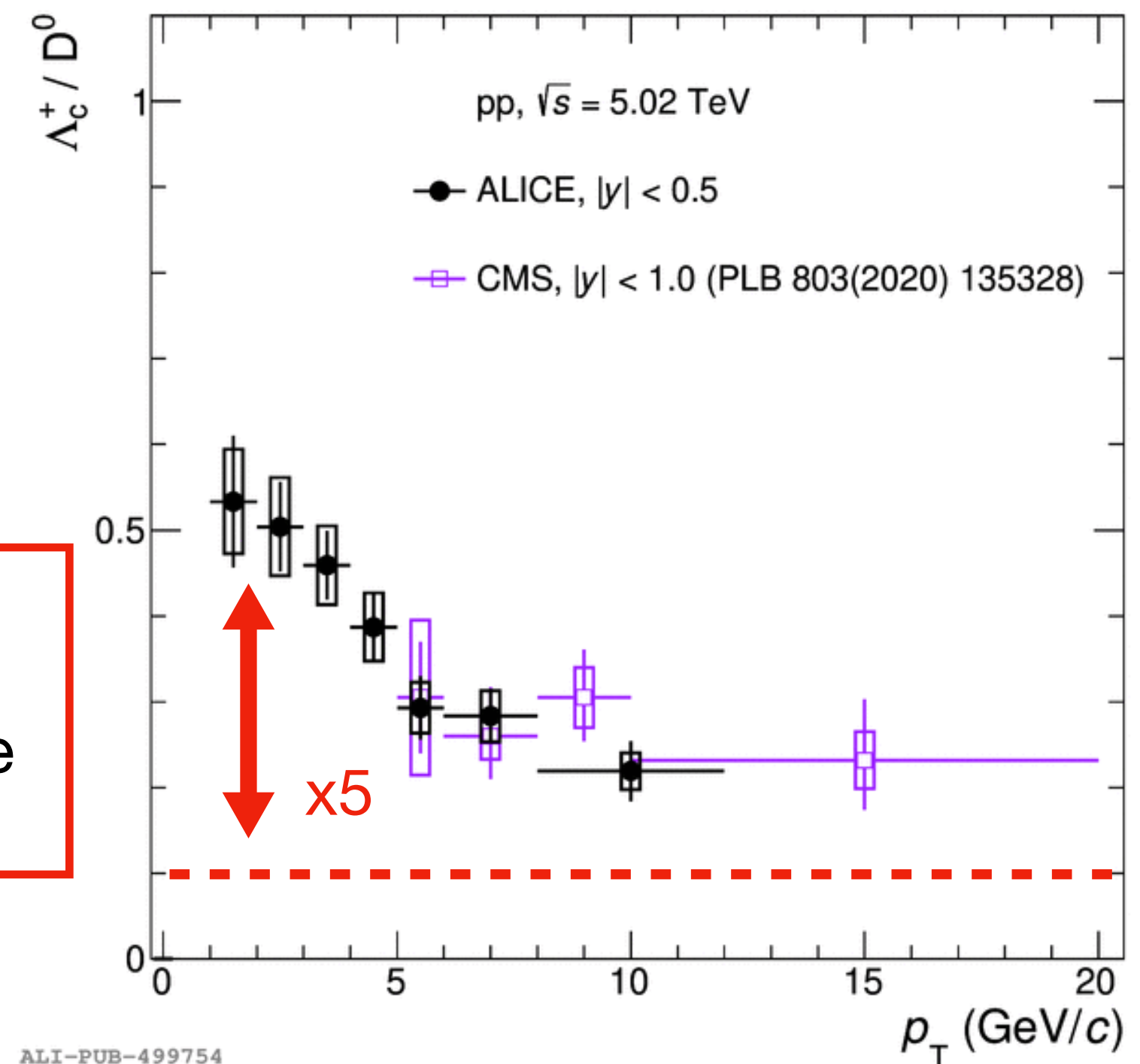
Phys. Rev. C 104, 054905  
Phys. Rev. Lett. 127 202301

La misura della sezione d'urto e dell'abbondanza relativa dei vari adroni charmati fornisce un test dei modelli di adronizzazione.

- **PYTHIA8 with String Formation beyond Leading Colour**  
nuove topologie di connessioni tra partoni in un ambiente denso favoriscono la produzione di barioni
- **Catania Model**  
coalescenza (ricombinazione di quark già esistenti, originariamente introdotta per le collisioni nucleo-nucleo) + "vacuum" fragmentation in un mezzo in espansione
- **Statistical Hadronization Model**  
le abbondanze dipendono solo alla massa degli adroni e dalle proprietà del sistema collidente + feed-down da stati eccitati non ancora misurati ma previsti dal Relativistic Quark Model (RQM).



standard fragmentation tuned on  $e^+e^-$ , ep colliders



- complementarità con misure di CMS
- fondamentale fare misure a basso  $p_T$

REMEMBER

$$\frac{d^2\sigma_{pp}^h}{dy dp_T} \propto \sum_{abcd} \int dx_a dx_b f_a(x_a, Q^2) f_b(x_b, Q^2) \frac{d\sigma}{dt}(ab \rightarrow cd) \frac{D_{h/c}}{\pi z_c}$$

Tuned by (successfully) reproducing D-meson cross-sections @LHC

**Breaking FF universality at the LHC?**

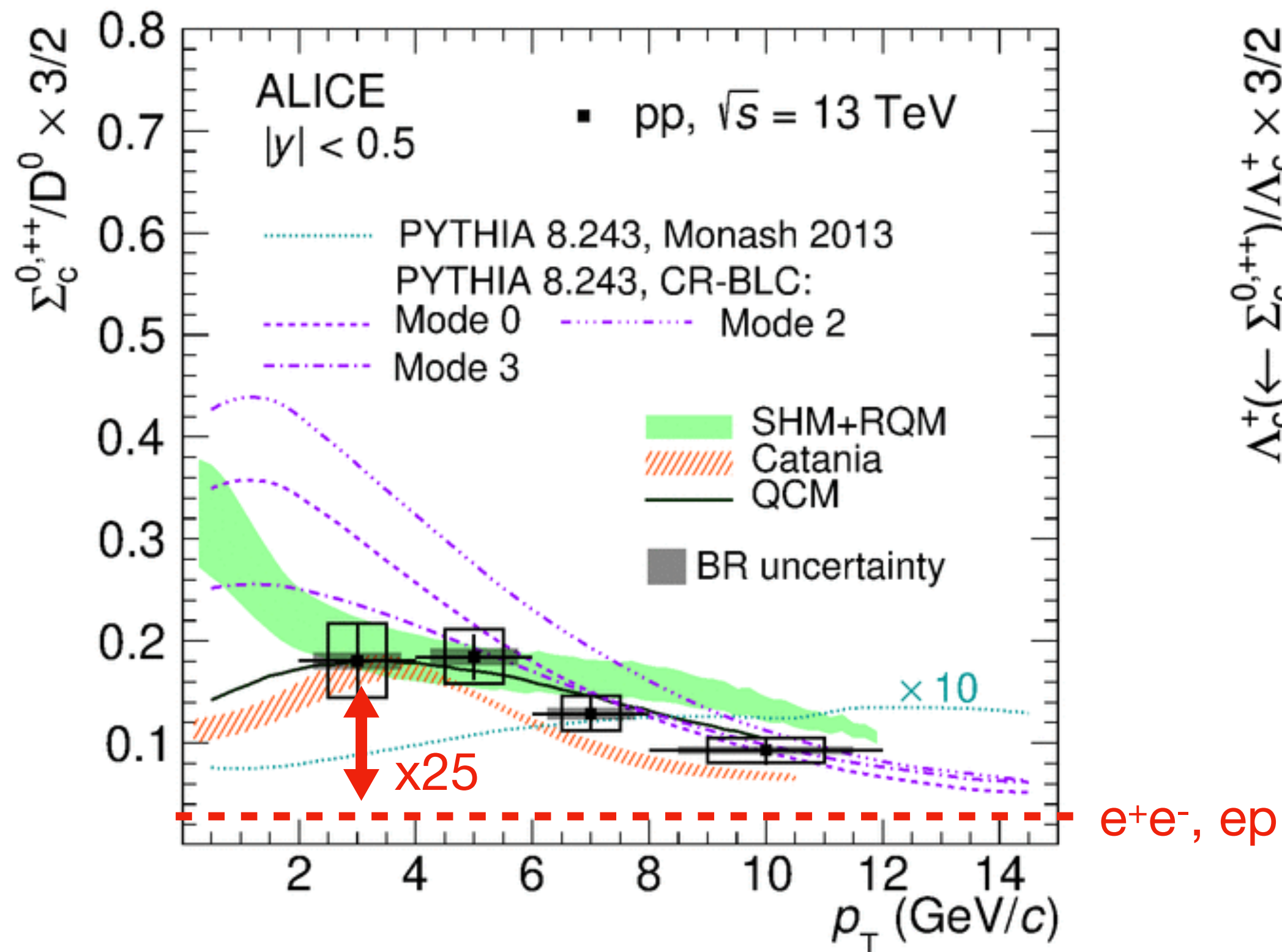
NOTE:  $f(c \rightarrow \Lambda_c)$  in GM-VFNS tuned on  $e^+e^-$

# Heavy-flavour: rapporto $\Lambda_c/D^0$ in collisioni pp

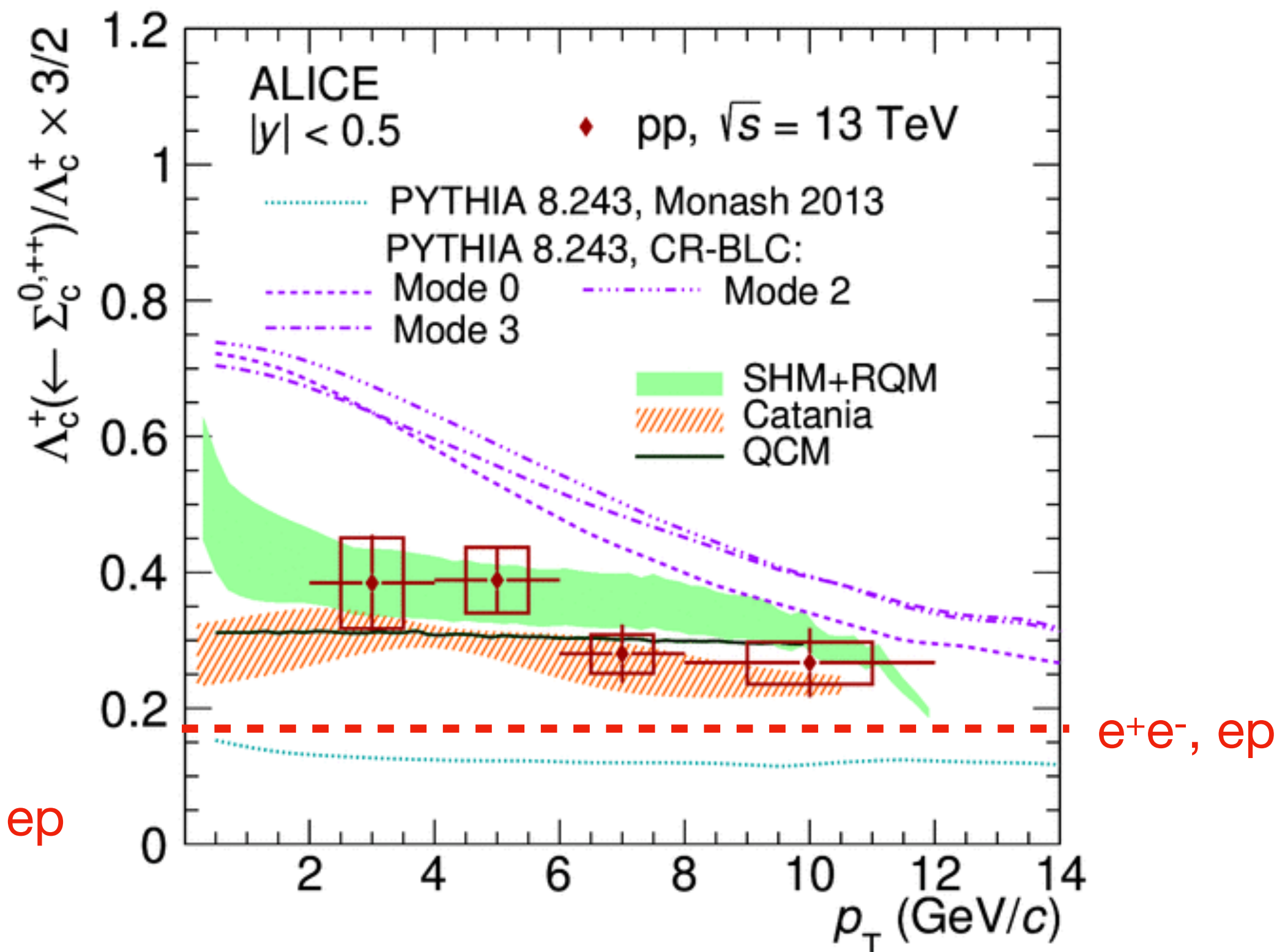
## prima misura del barione $\Sigma_c$ in collisioni adroniche

- $\Sigma_c$  "enhancement" maggiore rispetto a quello misurato per la  $\Lambda_c$
- circa il 40% delle  $\Lambda_c$  primarie provengono da decadimenti di barioni  $\Sigma_c$

Phys. Rev. Lett. 128, 012001



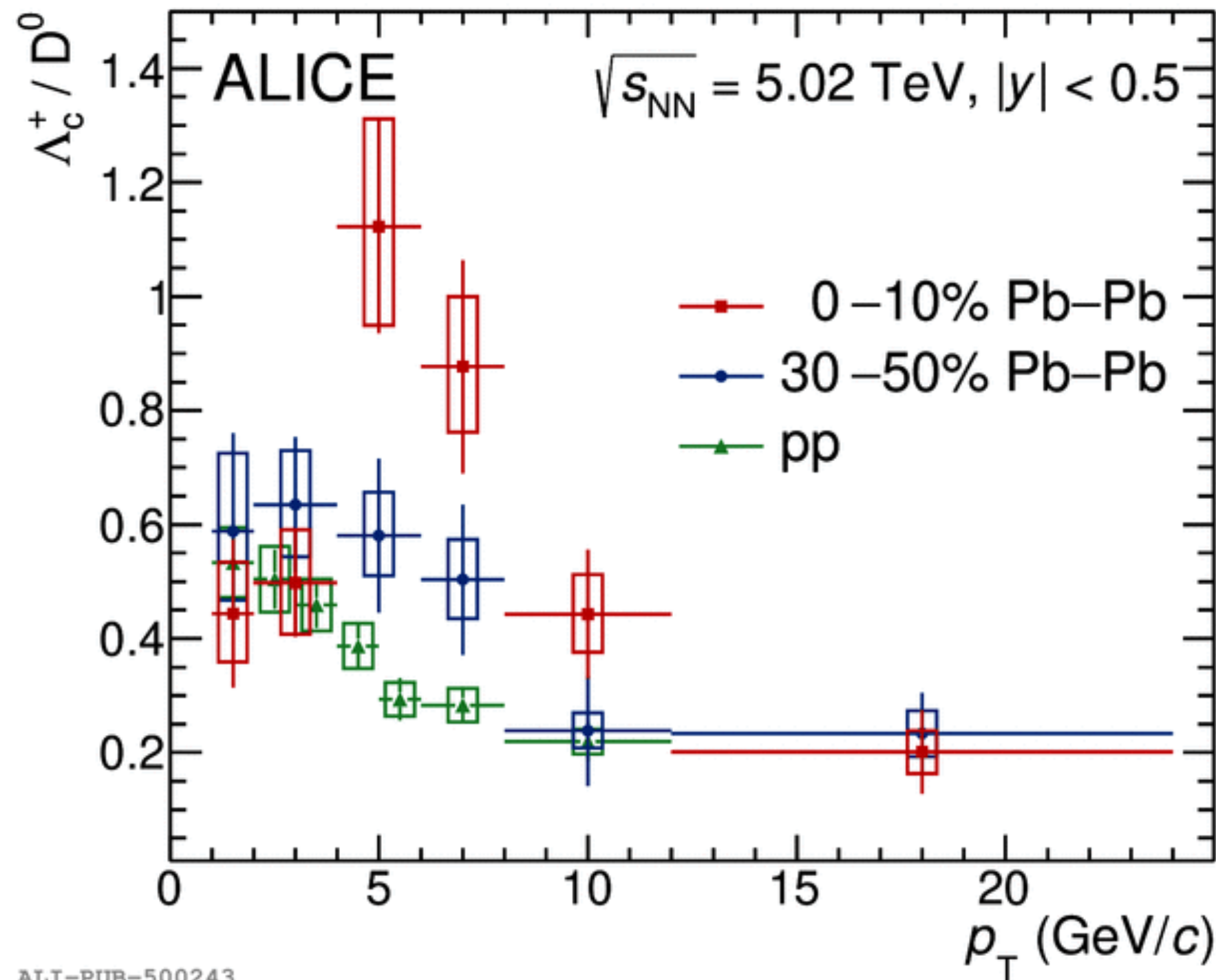
ALI-DER-493901



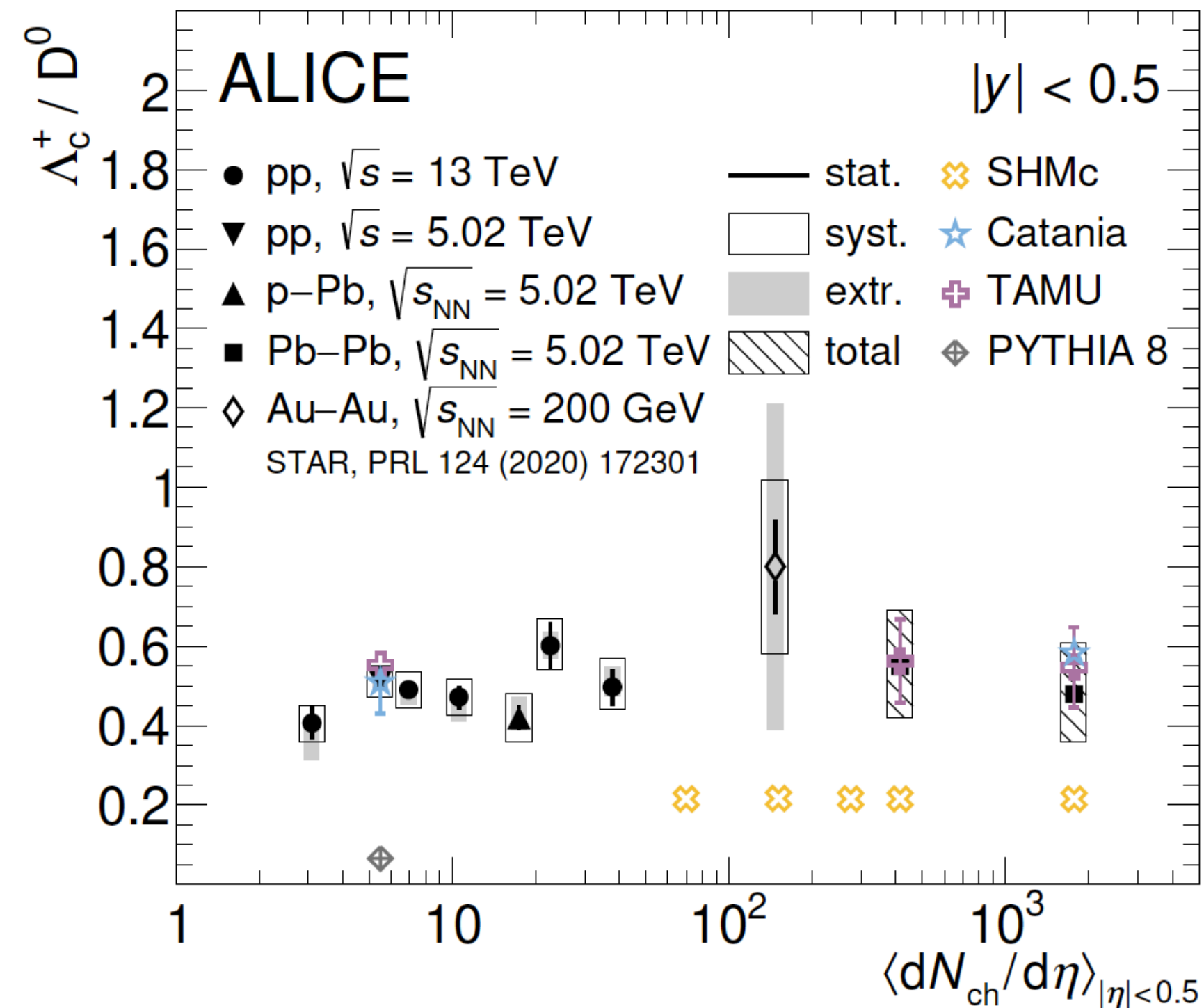
ALI-DER-493906

# Heavy-flavour: rapporto $\Lambda_c/D^0$ in collisioni Pb-Pb

arXiv:2112.08156



ALI-PUB-500243

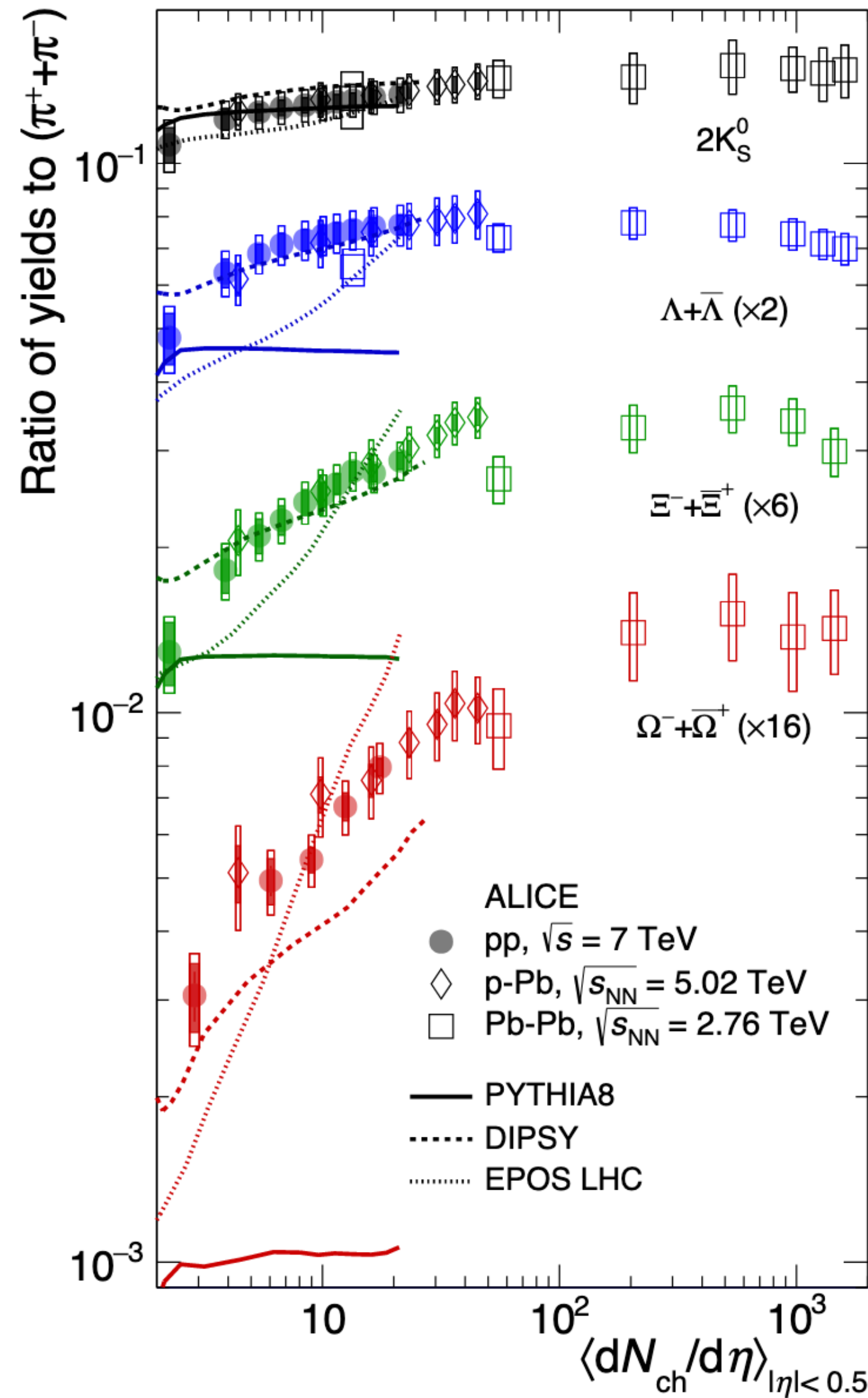


Rapporto  $\Lambda_c/D^0$   
integrato per  $p_T > 0$

Il rapporto  $\Lambda_c/D^0$  integrato per  $p_T > 0$  sembra non differire in maniera significativa tra collisioni pp e Pb-Pb

- **stesso meccanismo di produzione in pp e Pb-Pb?**
- il diverso comportamento in funzione di  $p_T$  sembra dipendere da diversi spettri in  $p_T$  per barioni e mesoni, dovuto a rescattering nella fase adronica, piuttosto che da un aumento della produzioni di barioni.

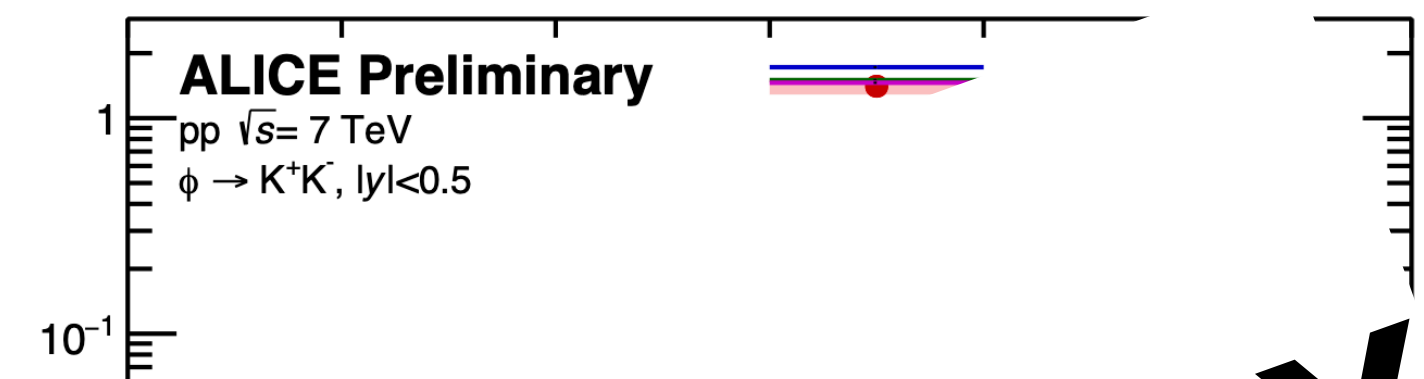
# Prospects - strangeness enhancement



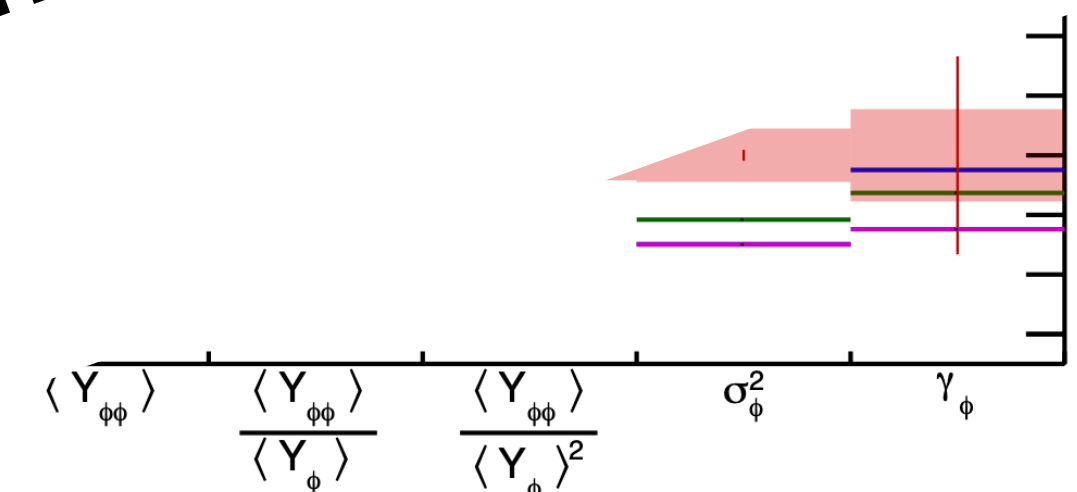
- **aumento della produzione di stranezza**: uno dei primi segnali proposti per il QGP, **ma osservata anche in collisioni pp (ad alta molteplicità)**;
- aumento direttamente correlato con il contenuto in stranezza degli adroni
- l'effetto aumenta con la molteplicità, smooth transition tra i vari sistemi collidenti
- i MC non descrivono i dati in maniera soddisfacente

misura della produzione di coppie di mesoni  $\phi$  ( $s\bar{s}$ ) in collisioni pp può fornire ulteriori informazioni sui meccanismi alla base dello strangeness enhancement

N. Rubini, poster a QM 2022

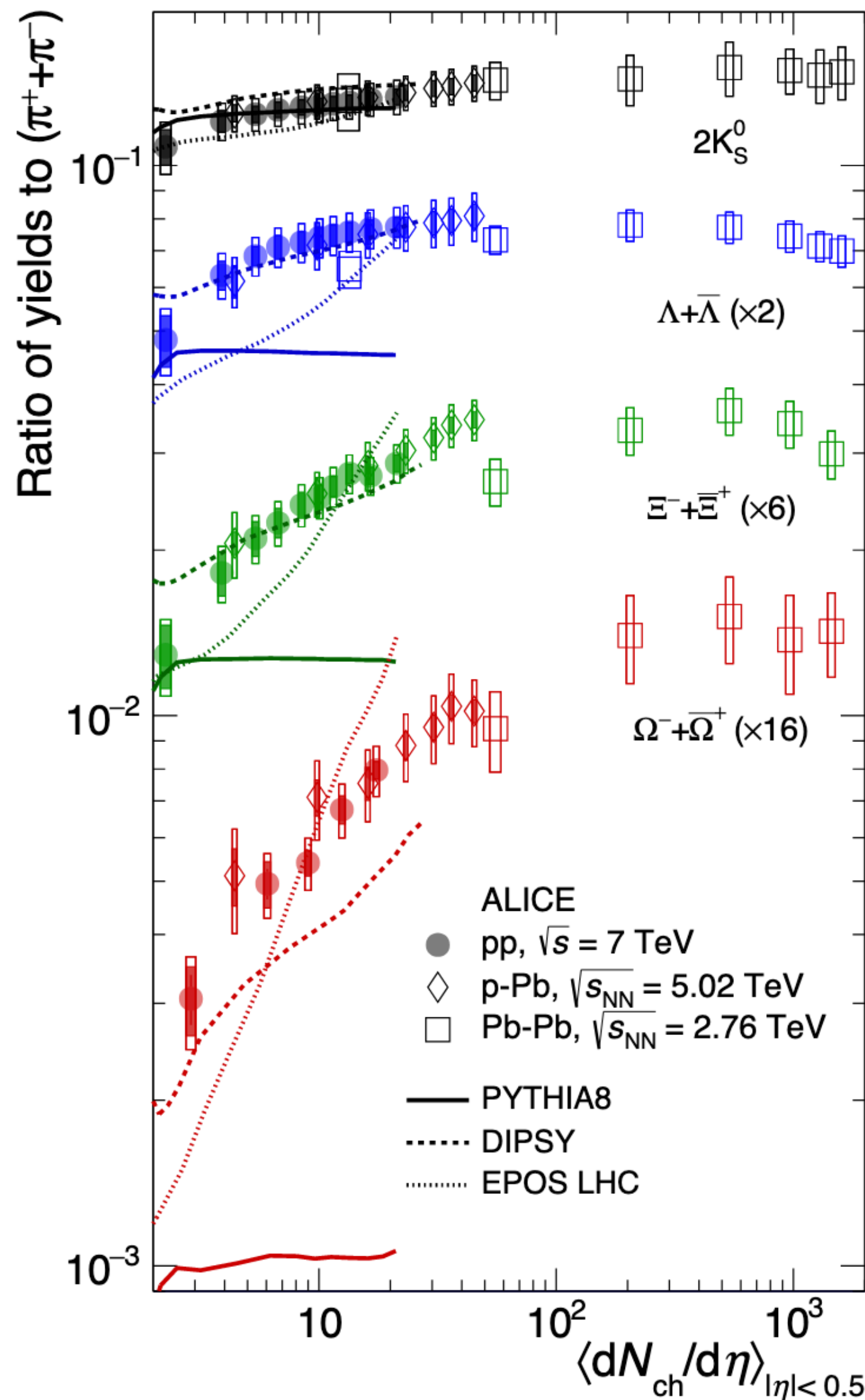


**PRELIMINARY**



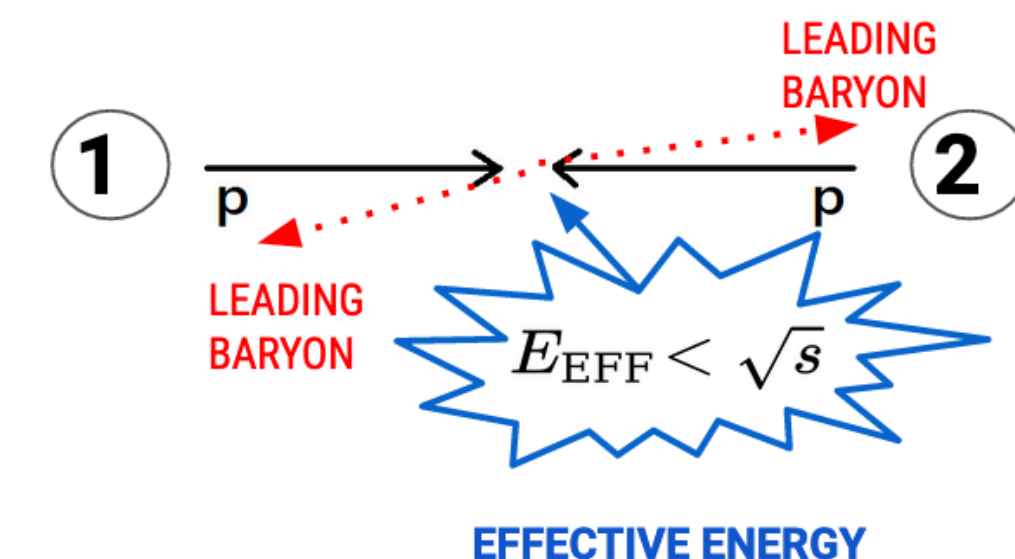
R. Preghenella, F. Bellini, F. Noferini, F. Ercolessi, N. Rubini, G. Clai

# Prospects - strangeness enhancement

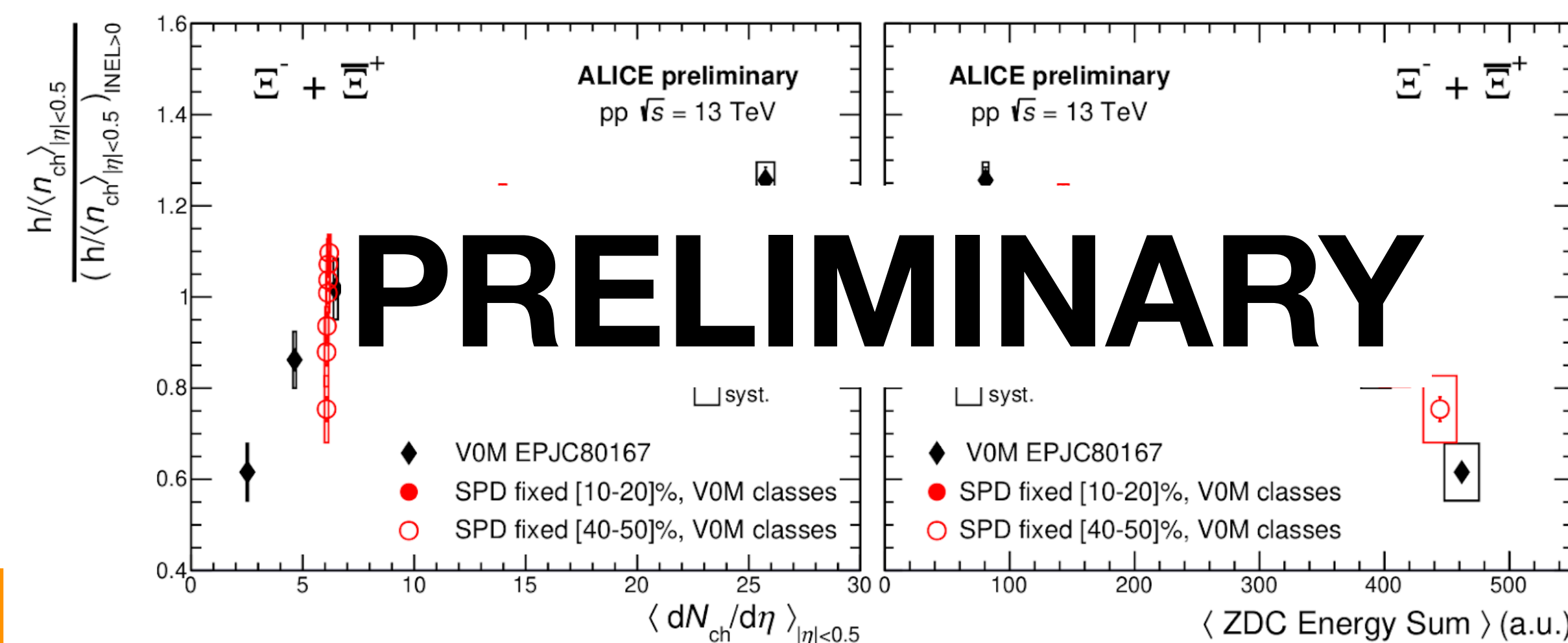


- **aumento della produzione di stranezza: uno dei primi segnali proposti per il QGP, ma osservata anche in collisioni pp (ad alta molteplicità);**
- aumento direttamente correlato con il contenuto in stranezza degli adroni
- l'effetto aumenta con la molteplicità, smooth transition tra i vari sistemi collidenti
- i MC non descrivono i dati in maniera soddisfacente

strangeness production scales with forward energy detected by ALICE Zero Degree Calorimeters (ZDC). **Hint of initial state effect?**



F. Ercolessi, poster a QM2022



R. Preghenella, F. Bellini, F. Noferini, F. Ercolessi, N. Rubini, G. Clai

# Prospects - The ERC-STG CosmicAntiNuclei



The ERC-STG CosmicAntiNuclei project started in July 2021

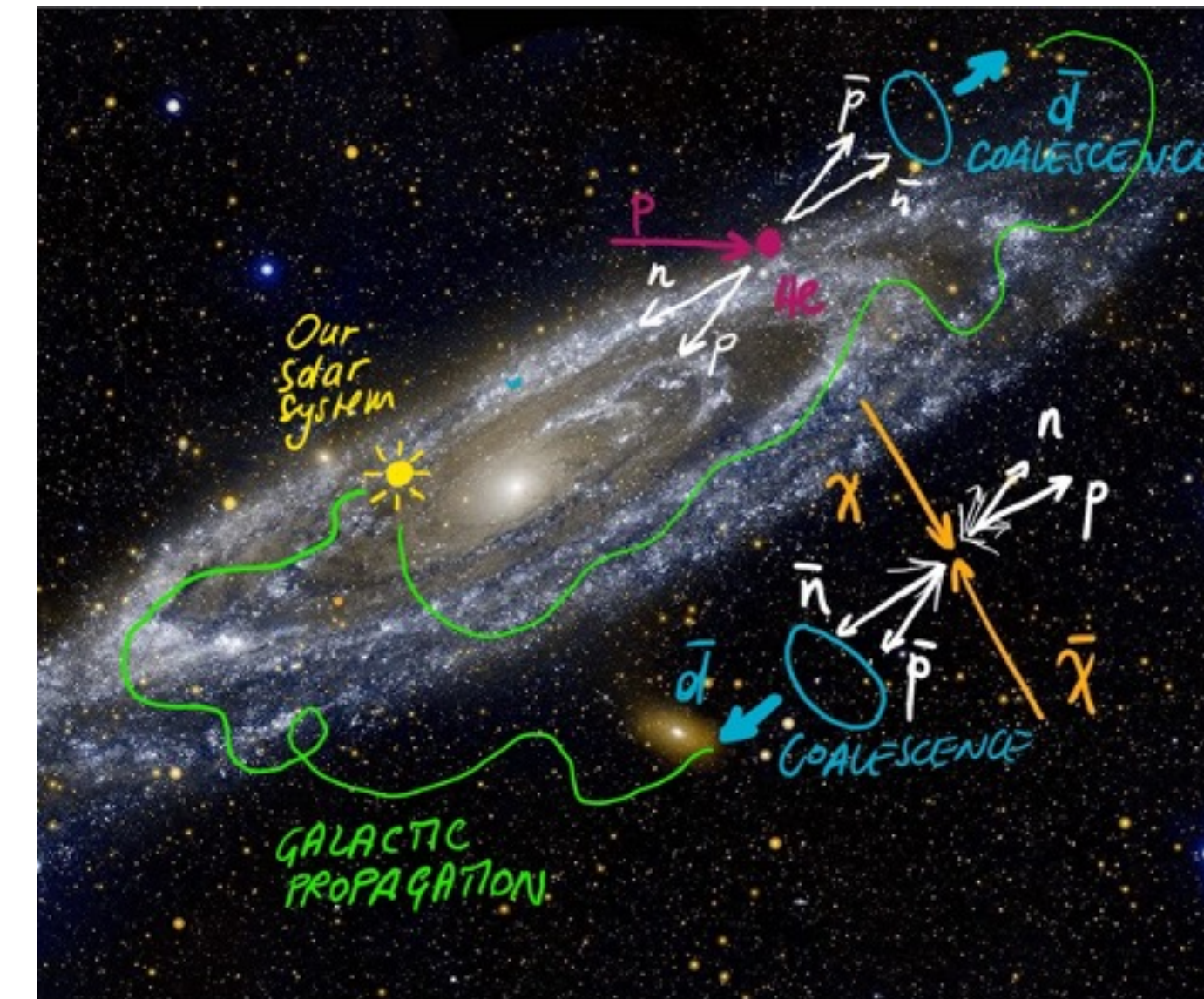
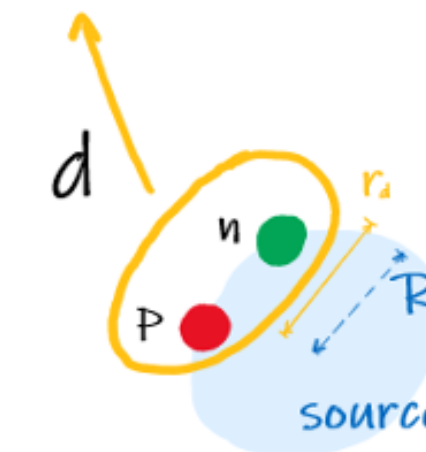
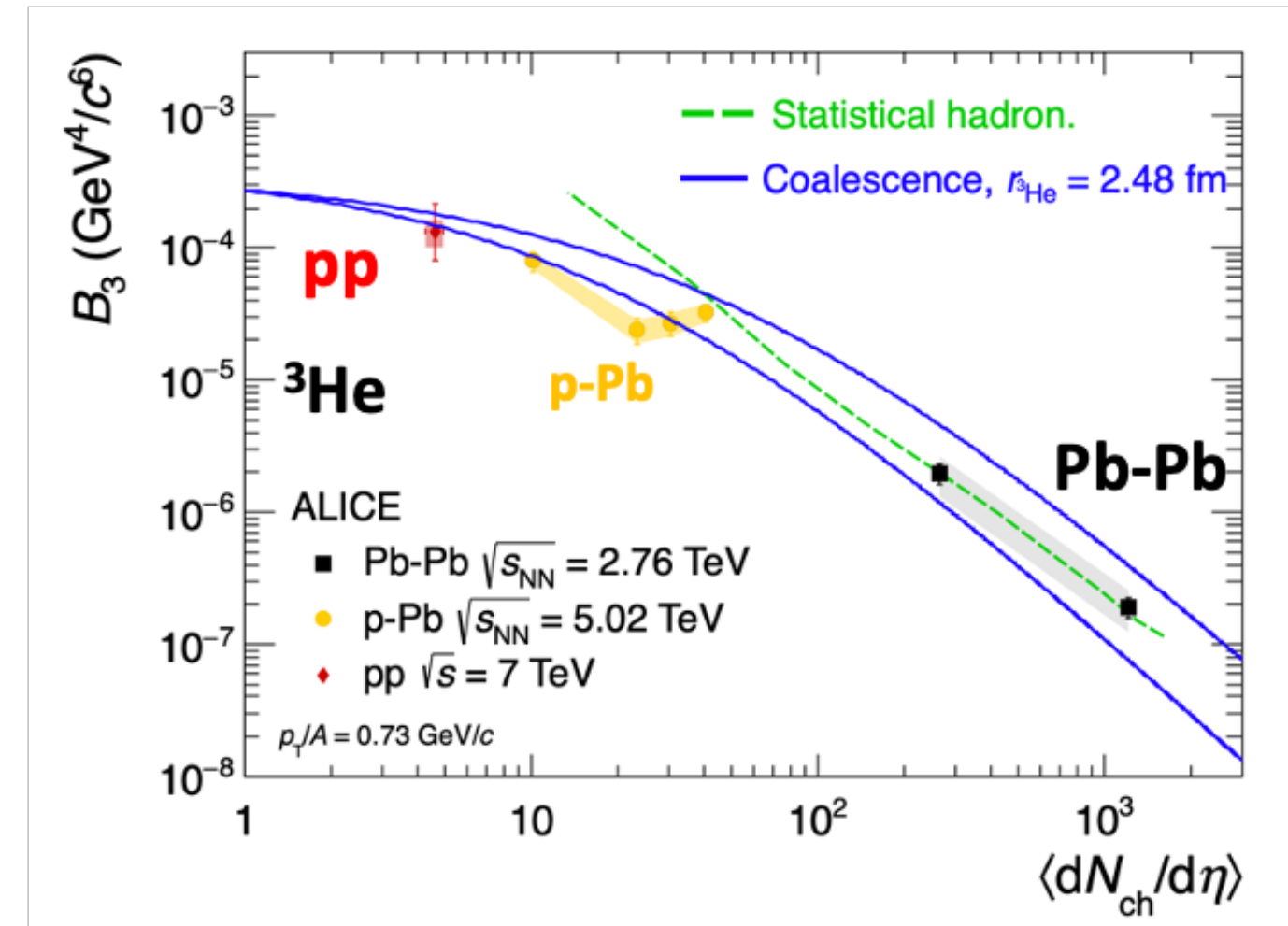
Team: **F. Bellini (PI), N. Jacazio, G. Malfattore, S. Tripathy**  
 Collaboration within INFN-Bo: **A. Oliva, N. Masi (AMS group)**  
 Collaboration with INFN-To: **M. di Mauro (th.)**

Focus on providing an experimental test of coalescence as the mechanism for formation of light (anti)nuclei in high-energy interactions

- Focus on anti-helium  $\rightarrow$  high precision reachable with Run 3!
- Measure simultaneously the particle source via femtoscopy technique and the production of light (anti)nuclei with ALICE and Run 3 data
- Modeling of coalescence process

Impact:

- Clarify production mechanism of nuclear clusters in high-energy interactions, from pp to heavy-ion collisions
- Apply to the calculation of expected fluxes of cosmic (anti)nuclei for indirect dark matter searches with AMS, GAPS



[+] Aperitivo Scientifico 16/04/2021: <https://agenda.infn.it/event/25976/>



# Conclusioni



ALICE ha terminato il suo major upgrade durante LS2, l'esperimento sta ora ultimando il commissioning per essere pronto all'inizio della presa dati di RUN 3.

Rivelatore TOF 100% fully operational. Dopo oltre 14 anni dalla sua prima accensione, accettazione ~90% e nessun segno evidente di ageing delle oltre 1500 MRPC che lo compongono.

Gruppo ALICE Bologna attivo con progetti di R&D su sensori al Silicio, fondamentale e proficua collaborazione con i tutti servizi della sezione.