A Large Ion Collider Experiment

ALICE
From RUN 2 to RUN 3 and beyond

Sarah Porteboeuf Houssais for ALICE-France

Conseil Scientifique IN2P3 – 27/10/2022

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Outline

- Why to study the Quark-Gluon Plasma ?
- What we learned from RUN 2 ?
- What are the plans for RUN 3 ?
- What was done to prepare for RUN 3 challenges ?
- What we expect from the ALICE-France community at the horizon of RUN 4 ?

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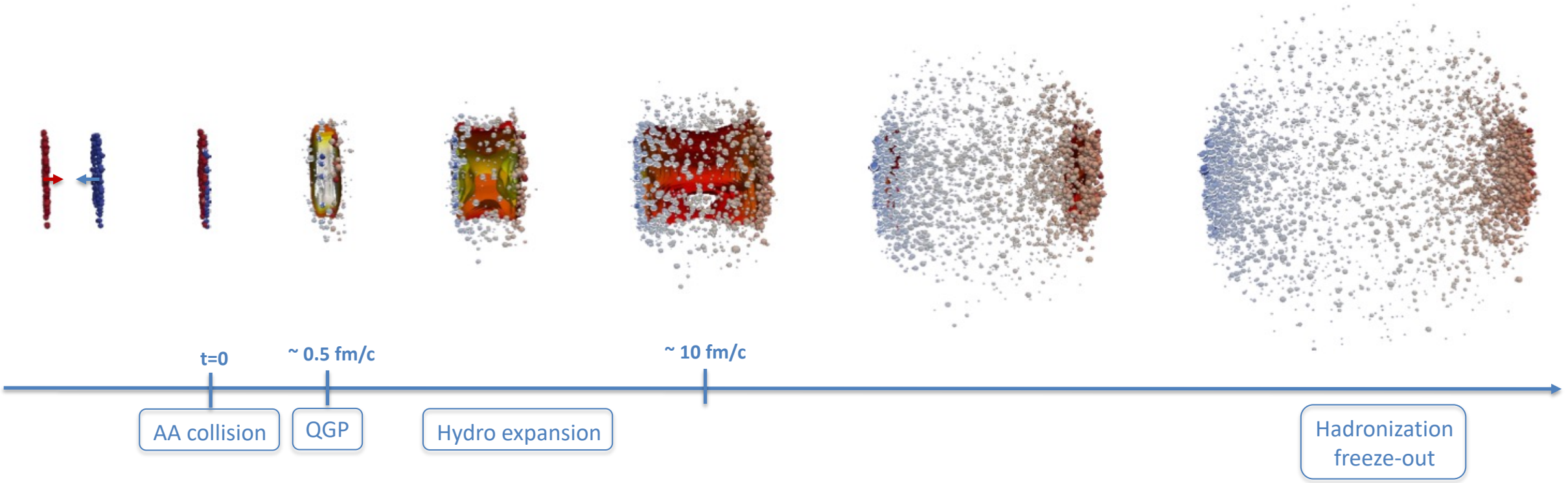
Studying the Quark-Gluon Plasma

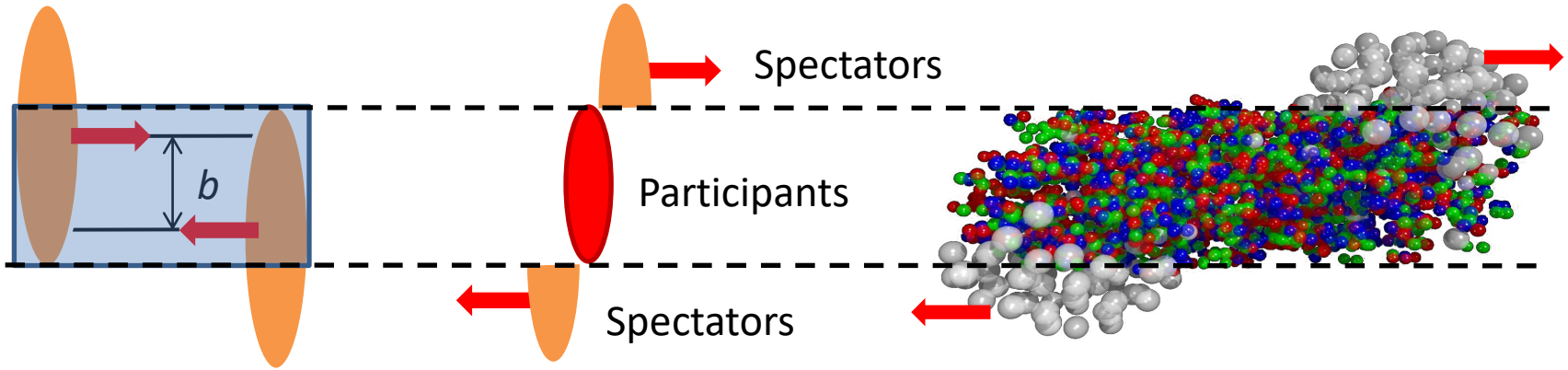
Quark-Gluon Plasma (QGP) is a deconfined state of quarks and gluons (asymptotic freedom regime) predicted by QCD and studied in high-energy heavy-ion collisions



Rendering by H. Elfner & J.E. Bernhard arXiv:1804.06469

Historical approach for QGP studies

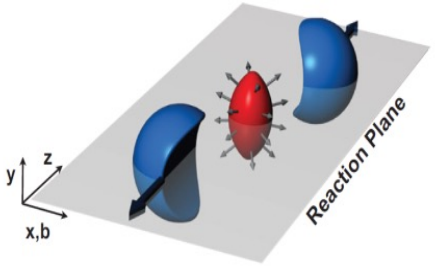
- pp collisions were considered as the vacuum reference
- p-A collisions are a control experiment to estimate cold matter effects
- AA collisions are described by a (geometrical) Glauber model defining the number of participants and the number of binary collisions (N_{coll}) for a given impact parameter *b*



- Emblematic observables for hard and soft probes

Nuclear modification factor

$$R_{\mathrm{AA}} = \frac{\mathrm{d}N_{\mathrm{AA}}/\mathrm{d}p_{\mathrm{T}}}{< N_{\mathrm{coll}} > \times \mathrm{d}N_{\mathrm{pp}}/\mathrm{d}p_{\mathrm{T}}}$$



Elliptic flow

Initial spatial anisotropy transferred into a momentum anisotropy of particles

$$\frac{\mathrm{d}N}{\mathrm{d}\varphi} \propto 1 + 2\sum_{\mathrm{n}=1}^{\infty} v_{\mathrm{n}} \cos(n(\varphi - \Psi n))$$

Characterizing the medium

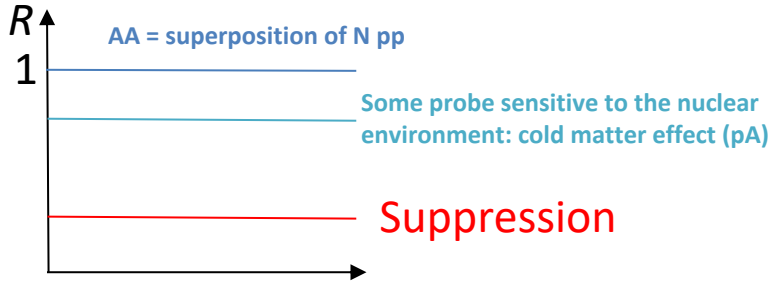
Nuclear modification factor

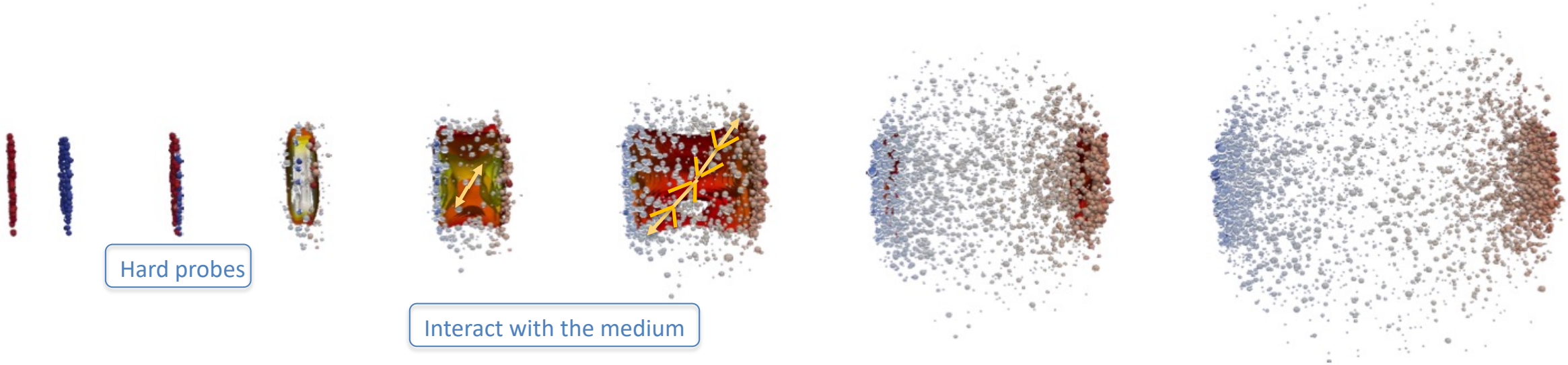
$$R_{\mathrm{AA}} = \frac{\mathrm{d}N_{\mathrm{AA}}/\mathrm{d}p_{\mathrm{T}}}{< N_{\mathrm{coll}} > \times \mathrm{d}N_{\mathrm{pp}}/\mathrm{d}p_{\mathrm{T}}}$$

Measurement in AA

Normalization by the number of collision (N_{coll})

Same measurement in min-bias pp





Characterizing the medium

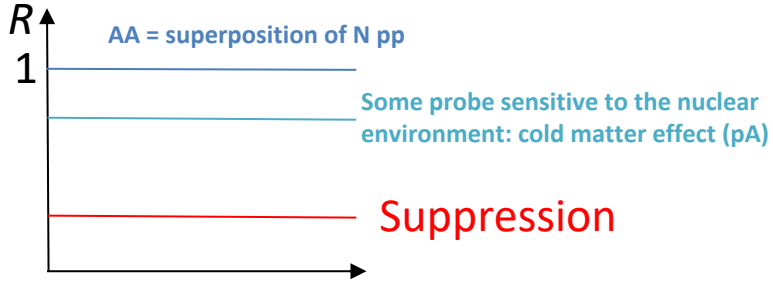
Nuclear modification factor

$$R_{AA} = \frac{dN_{AA}/dp_T}{< N_{coll} > \times dN_{pp}/dp_T}$$

Measurement in AA

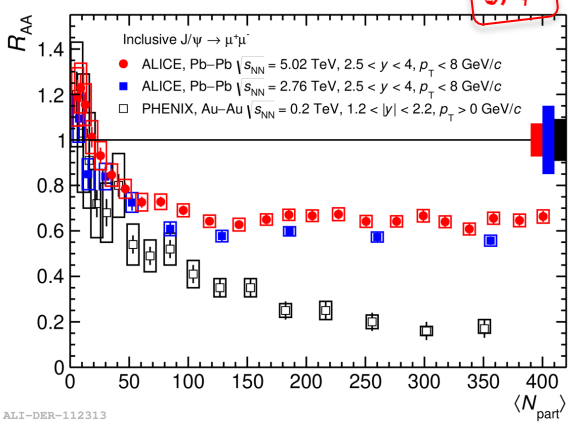
Normalization by the number of collision (N_{coll})

Same measurement in min-bias pp



PLB 766 (2017) 212

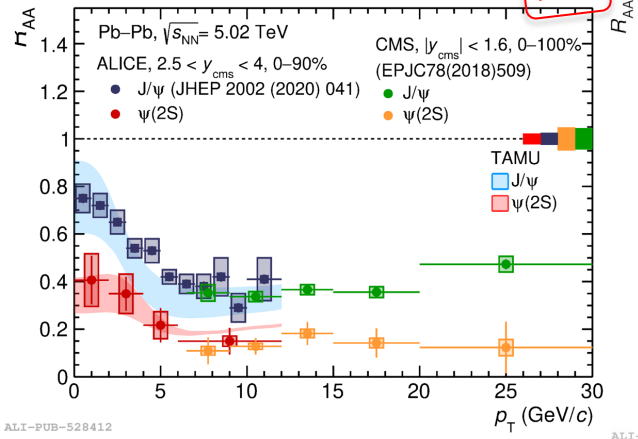
J/ψ



J/ψ less suppress than at RHIC energies
Understood with regeneration

Submitted PRL arXiv:2210.08893

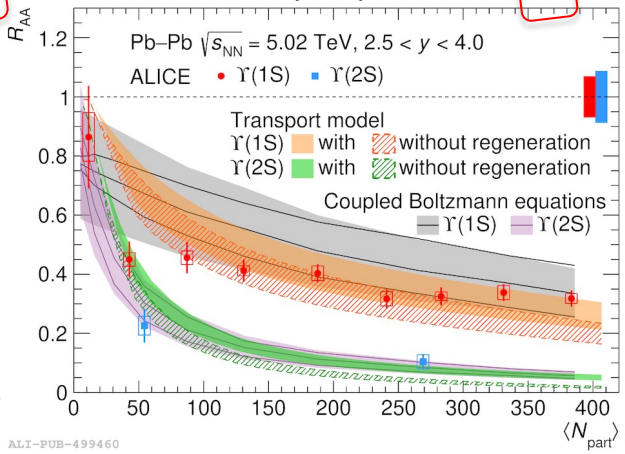
$\psi(2s)$



$\psi(2s)$ more suppress than J/ψ
Sign of regeneration at low p_T

PLB 822 (2021) 136579

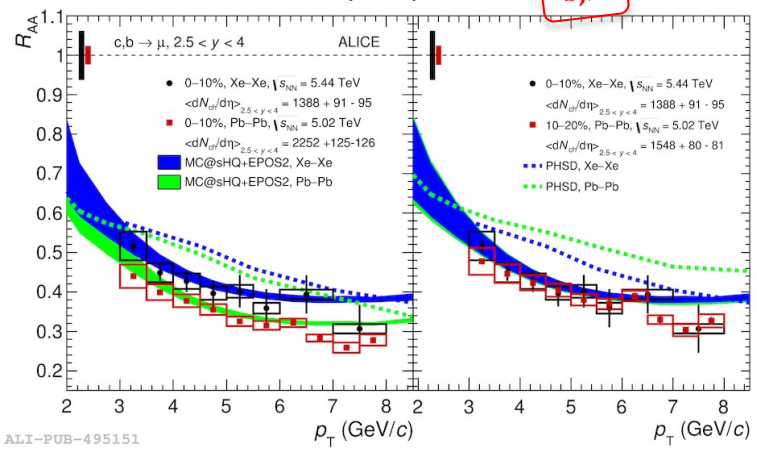
Υ



Υ(1s) suppressed by a factor ~ 3 w.r.t pp
Υ(2s) suppressed by a factor ~ 2 w.r.t Υ(1s)
Sequential dissociation scenario

PLB 819 (2021) 136437

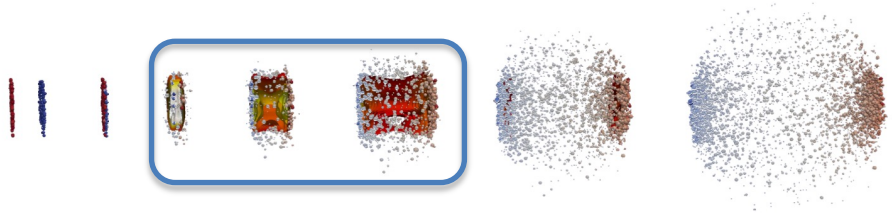
c,b

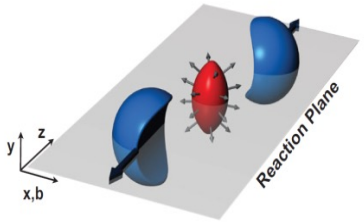


Open Heavy Flavor in Xe-Xe help to understand
system-size and geometry dependence of medium-induced parton energy loss

Also single-μ in Pb-Pb: PLB 820 (2021) 136558
J/ ψ R_{AA} PLB 805 (2020) 135434

Collective behavior with charm and beauty

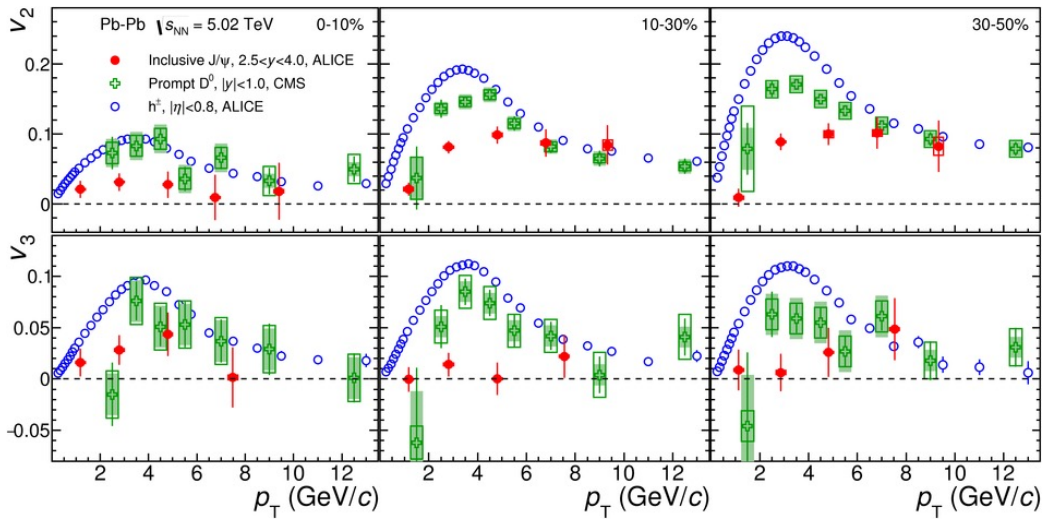




$$\frac{dN}{d\varphi} \propto 1 + 2\sum_{n=1}^{\infty} v_n \cos(n(\varphi - \Psi n))$$

If quarkonium are regenerated, they acquire collective properties of the expanding medium $v_2 > 0$

JHEP 1902 (2019) 012

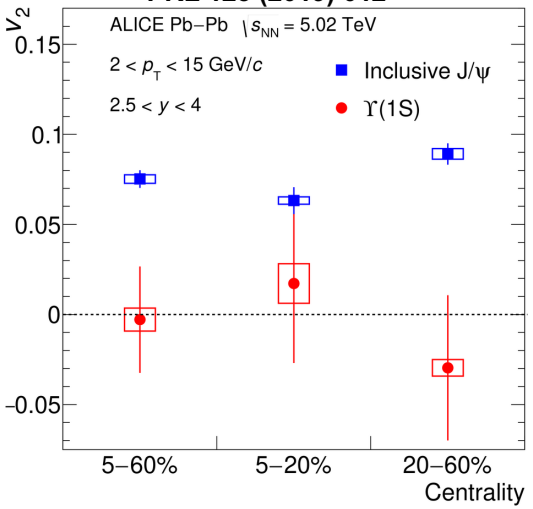


Unambiguous observation of non-zero J/ψ v_2

At high p_T, stronger effect than expected: possible path-length dependence effect

At low and intermediate p_T: v_n(J/ψ) < v_n(D) < v_n(h)

PRL 123 (2019) 012

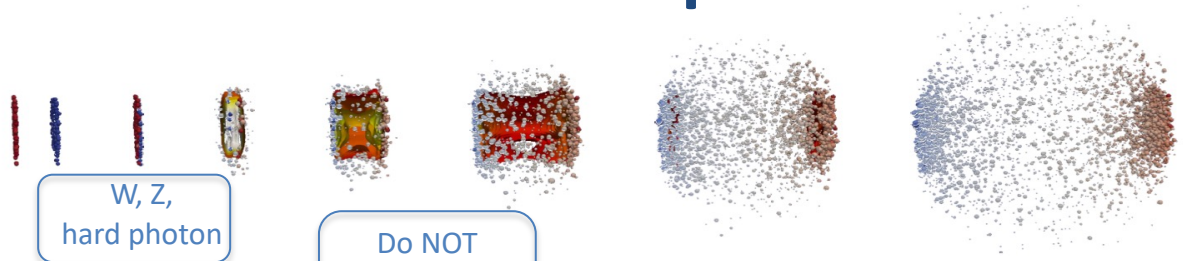


Υ(1s) – *b* quark – not regenerated

Opposite to J/ψ – *c* quark

Also
Jet azimuthal anisotropy, submitted to PRL arXiv:2110.15852
φ meson in Pb-Pb EPJC 78 (2018) 559 and pp EPJC 81 (2021) 772

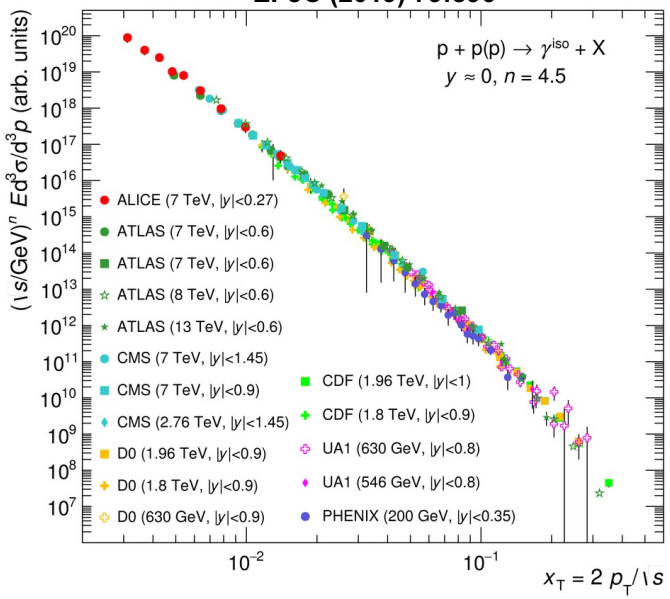
Hard and electroweak probes as reference



Allow to understand the nuclear structure with PDF in pp and nPDF in nucleus.

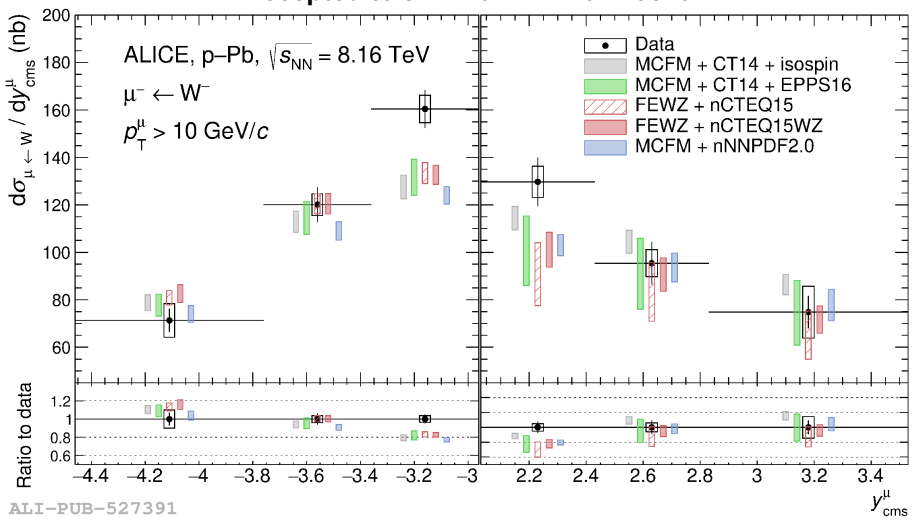
Also Z0: PLB 780 (2018) 372-383
J/ photoproduction in Pb-Pb: accepted by PLB arXiv:2204.10684

EPJC (2019) 79:896



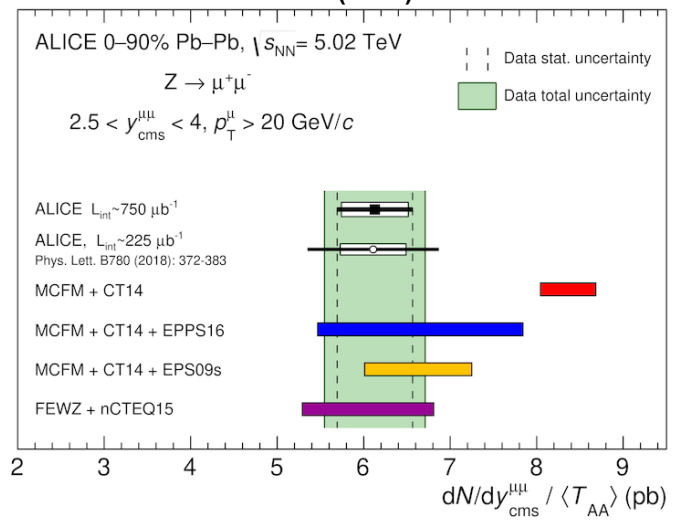
Isolated photons extend x_T world coverage and confirm n = 4.5 scaling: same production mechanism

Accepted to JHEP arXiv:2204.10640



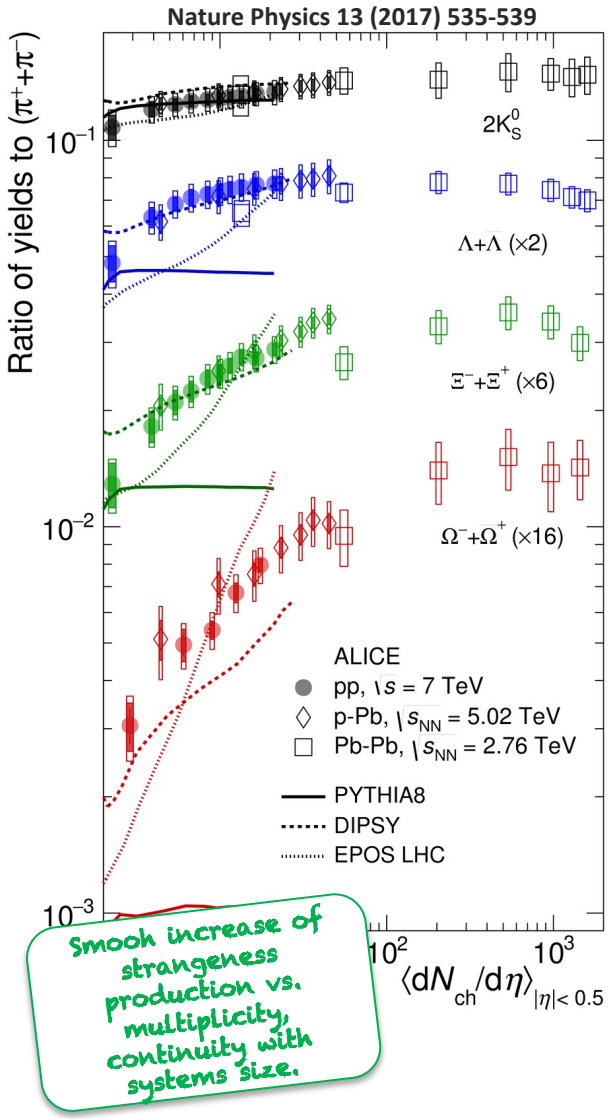
Significant deviations from the free-nucleon PDF predictions, up to 3.5σ. Correspond to the shadowing region of the nuclear modifications at low Bjorken-x.

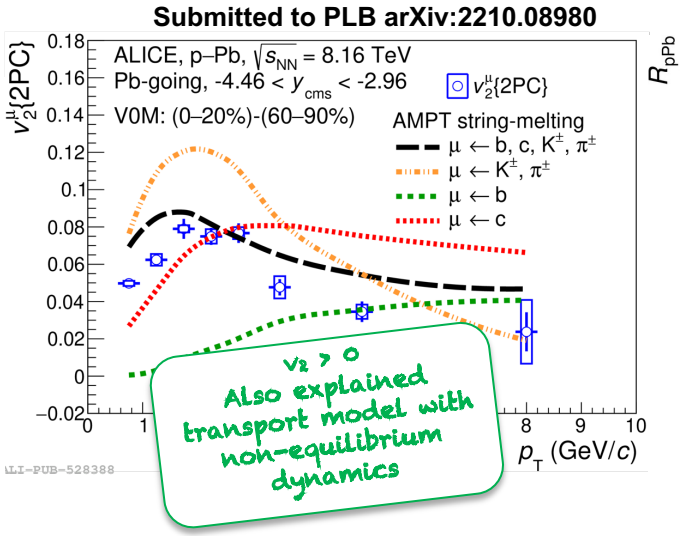
JHEP 09 (2020) 076

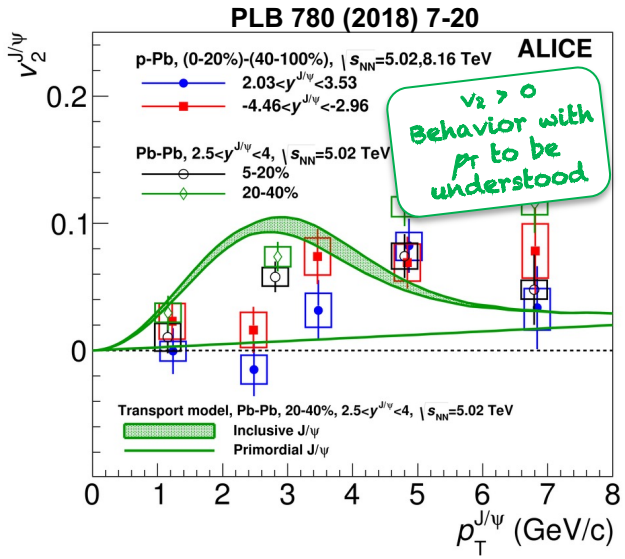


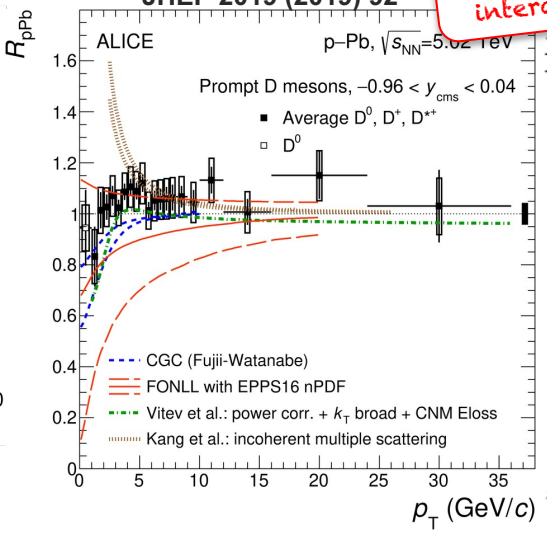
The **calculations using nuclear PDFs describe the yield** measured in Pb–Pb collisions.

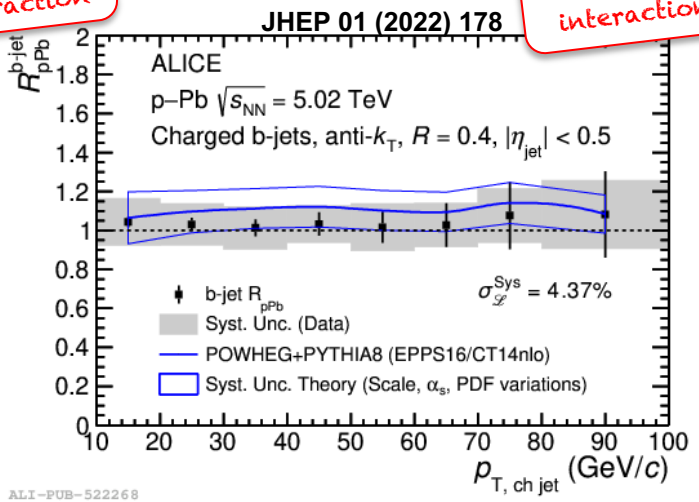
QGP droplets in p-Pb and pp?











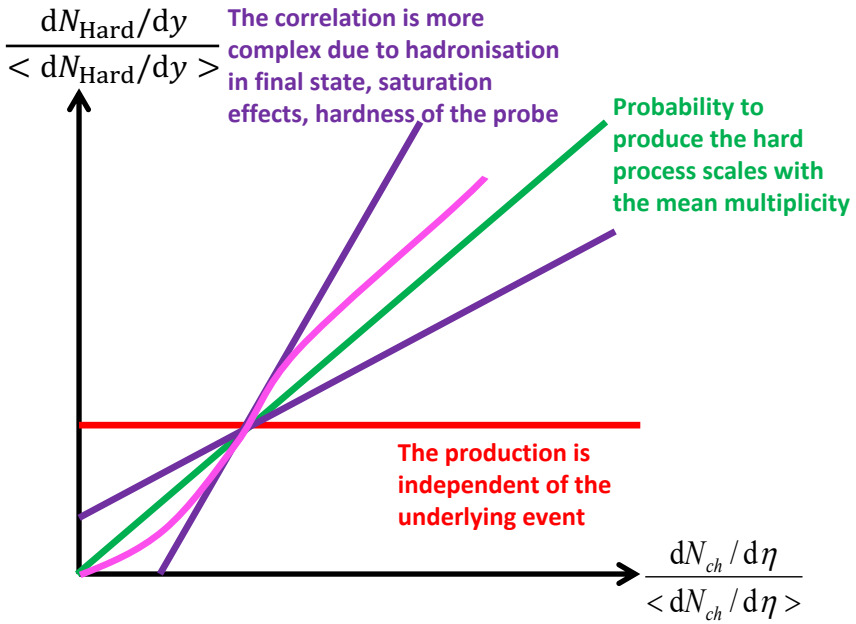
- **Ambiguous results for probes** directly related to a possible formed hot medium
- **No sign of in-medium interaction with energy loss** within the current experimental precision
- Role of initial state, saturation, final stat, hadronization, fluctuations under investigation

Also single-μ azimuthal anisotropy to be submitted to PLB
J/ψ – hadron correlations in pp to be submitted to JHEP
Quarkonium inclusive production submitted to EPJC arXiv:2109.15240
Jet cross section in pp PRD 100, 092004 (2019)

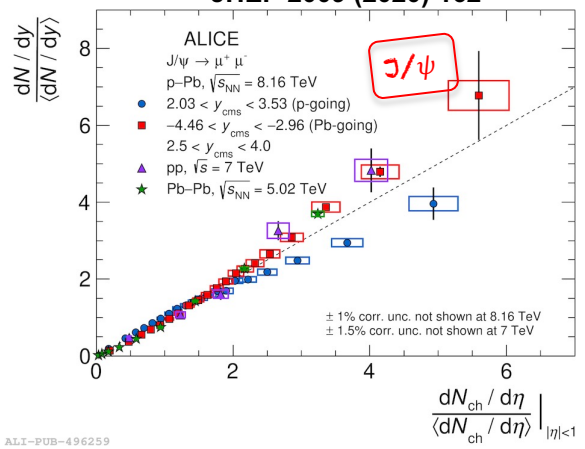
Searching new scaling paradigm in pp and p-Pb

- Differential study of hard probe production **as a function of charged particle multiplicity**

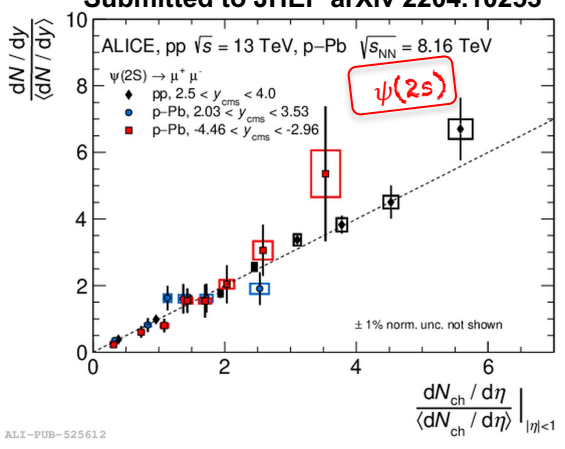
- **Similar behavior measured for all probes**
  - Close to linear when the hard probe is measured in the forward-*y* and multiplicity in central-*y* region
  - Deviation from linearity when both are measured in central-*y* region



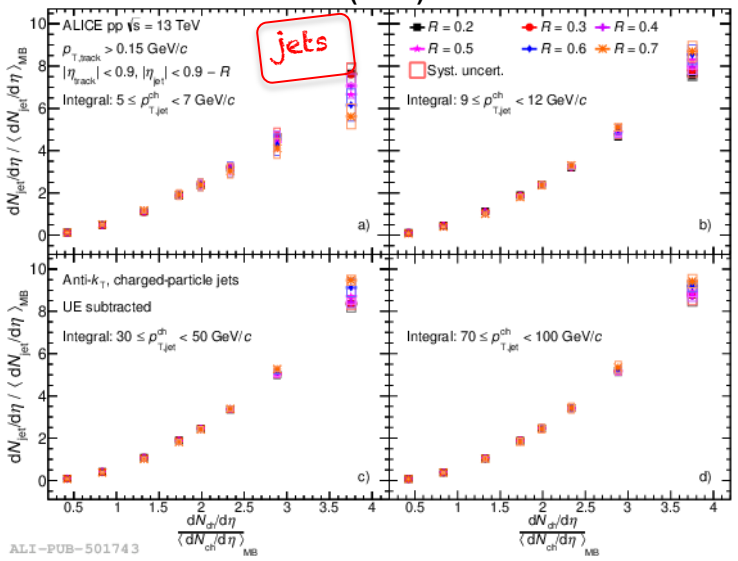
JHEP 2009 (2020) 162



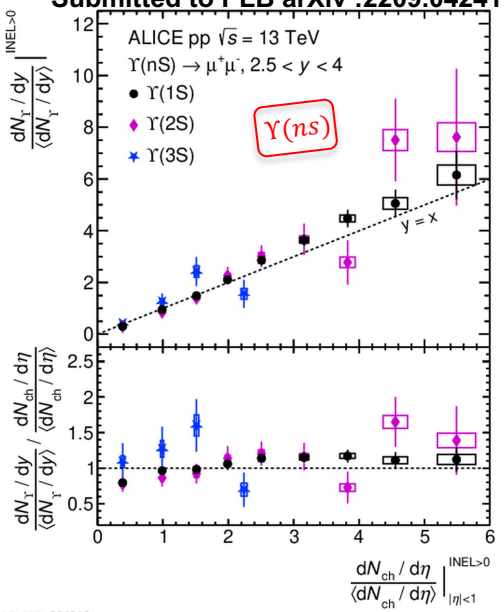
Submitted to JHEP arXiv 2204.10253



EPJC (2022) 82:514



Submitted to PLB arXiv :2209.04241



Also strangeness: submitted to EPJC arXiv:1908.01861

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RUN 3

- **Better probe QGP with heavy flavor quarks**
- **Study hadronic collision scaling quantity from pp to Pb-Pb and onset of collectivity in hadronic collisions**

- **Improve vertexing capabilities** in the central barrel allowing better reconstruction of primary and secondary vertices
  - Better rejection of background
  - Better reconstruction of decay chain, especially at low p_T
- **Charmonia and Open heavy flavors: separation of charm and beauty**
  - **Prompt Charmonium production**
    Prompt/non-prompt J/ψ separation down to $p_T = 0$. ψ(2S) measurement in central Pb-Pb collisions
  - **In the HF sector**
    Charm measurement down to $p_T = 1$ GeV/c in the single muon channel
    Beauty measurement down to $p_T = 0$ in the non-prompt J/ψ channel
- **Low-mass dimuons**
  Improved mass resolution for light resonances. Sensitivity to prompt continuum
- **Open possibilities for central-forward correlation of many probes**
- **Increase statistics by a factor 10 (muons) to 50 (central barrel)**

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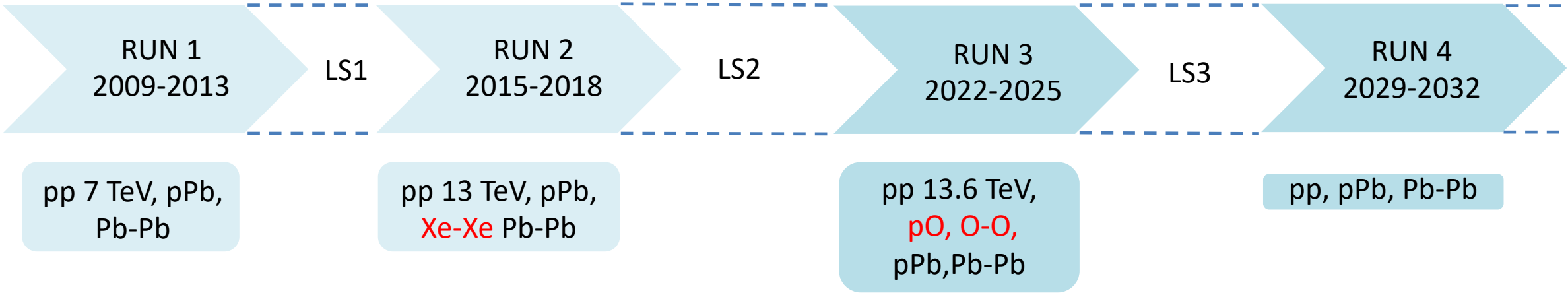
RUN 3 challenges



RUN 3 challenges

RUN 1 2009-2013	LS1	RUN 2 2015-2018	LS2	RUN 3 2022-2025	LS3	RUN 4 2029-2032
pp 7 TeV, pPb, Pb-Pb		pp 13 TeV, pPb, Xe-Xe Pb-Pb		pp 13.6 TeV, pO, O-O, pPb,Pb-Pb		pp, pPb, Pb-Pb

Total integrated Luminosity RUN 1+2

Pb-Pb: 1.5 nb^{-1} in ALICE

2.54 nb^{-1} in ATLAS/CMS, 0.26 nb^{-1} in LHCb

p-Pb: 75 nb^{-1} in ALICE

~220 nb^{-1} in ATLAS/CMS, 36 nb^{-1} in LHCb

In ALICE, Pb-Pb: interaction rate ~8 kHz with trigger event → Readout ≈ 1 kHz

Target Luminosity RUN 3+4

Pb-Pb: 13 nb^{-1} in ALICE/ATLAS/CMS,

2 nb^{-1} in LHCb

p-Pb: 0,5 pb^{-1} in ALICE

1 pb^{-1} in ATLAS/CMS, 0.2 pb^{-1} in LHCb

(initial RUN 3 plan, to be reviewed with schedule constraints)

In ALICE, Pb-Pb: interaction rate 50 kHz, continuous readout

Statistics from x10 to x50 depending on probe

Online data compression

RUN 3 challenges

RUN 1 2009-2013 | LS1 | RUN 2 2015-2018 | LS2 | RUN 3 2022-2025 | LS3 | RUN 4 2029-2032

pp 7 TeV, pPb, Pb-Pb

pp 13 TeV, pPb, Xe-Xe Pb-Pb

pp 13.6 TeV, pO, O-O, pPb,Pb-Pb

pp, pPb, Pb-Pb

ALICE 2 is a new experiment !

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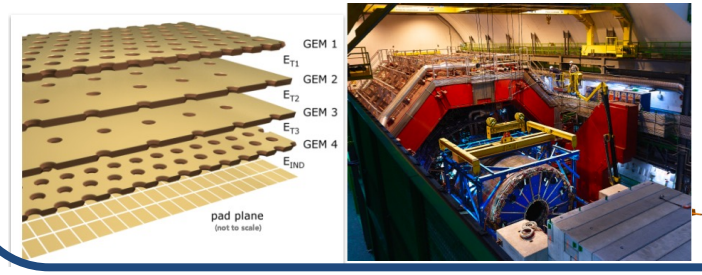
ALICE 2 – Upgrades for RUN 3

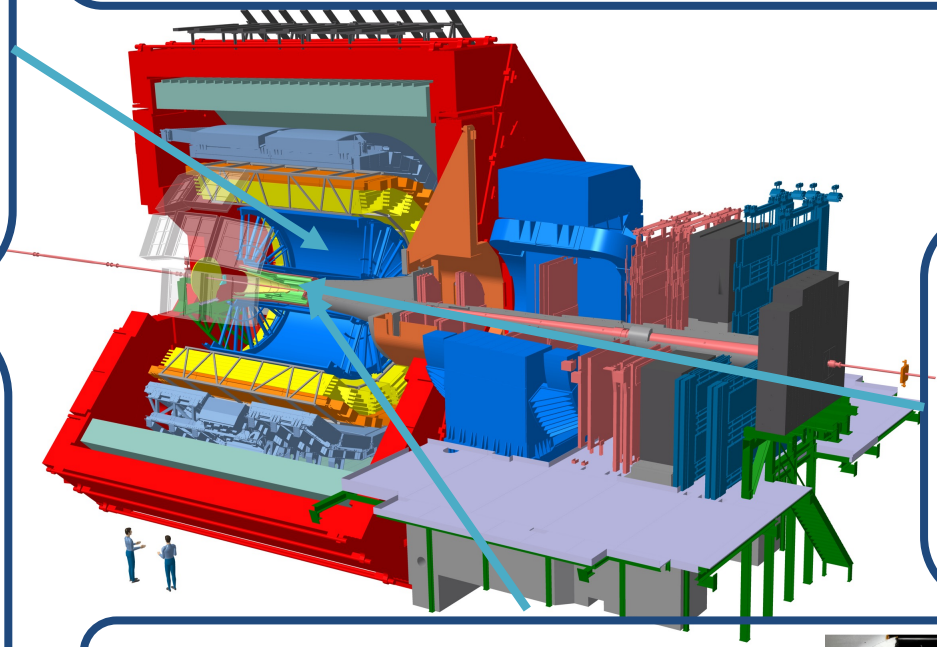
Time Projection Chamber (TPC)

New readout chambers: from Multi Wire Proportional Chamber (MWPC) to Gas Electron Multiplier (**GEM**)

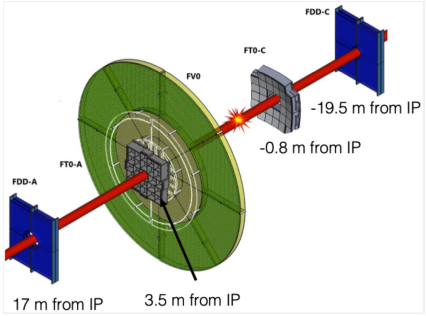


Consolidation and readout upgrade of all subsystems with Common Readout Unit (CRU)

- **MCH** upgrade with SAMPA ASIC
- **MID** (upgrade of MTR) with FEERIC ASIC

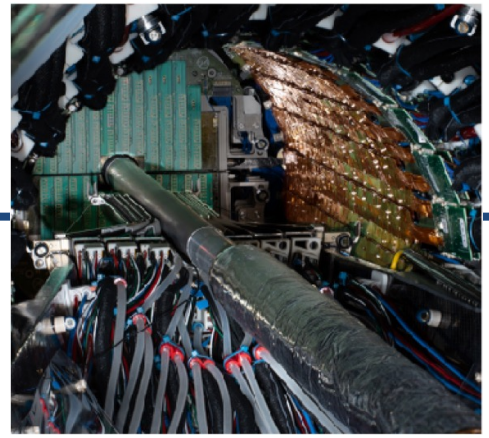


Fast Integration Trigger



Inner Tracking System (ITS 2)

7 cylindrical layer of MAPS (~ 10m^2)
Improved vertexing at high rate



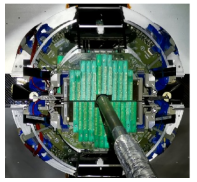
Integrated on-/off-line System

Continous Readout with First Level Processors (FLPs), O2-CRU
Event Processing Nodes (EPNs) for GPU-based Synchronous reconstruction

Online Data Compression

Muon Forward Tracker (MFT)

5 planes of MAPS
Forward vertexing for Muons



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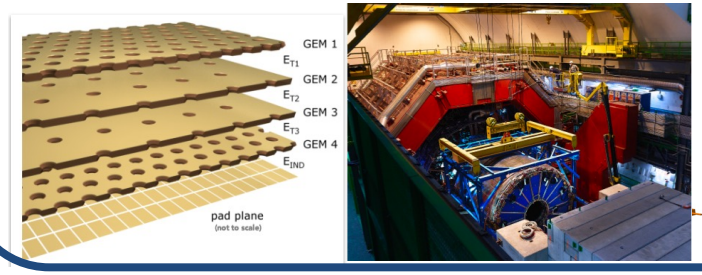

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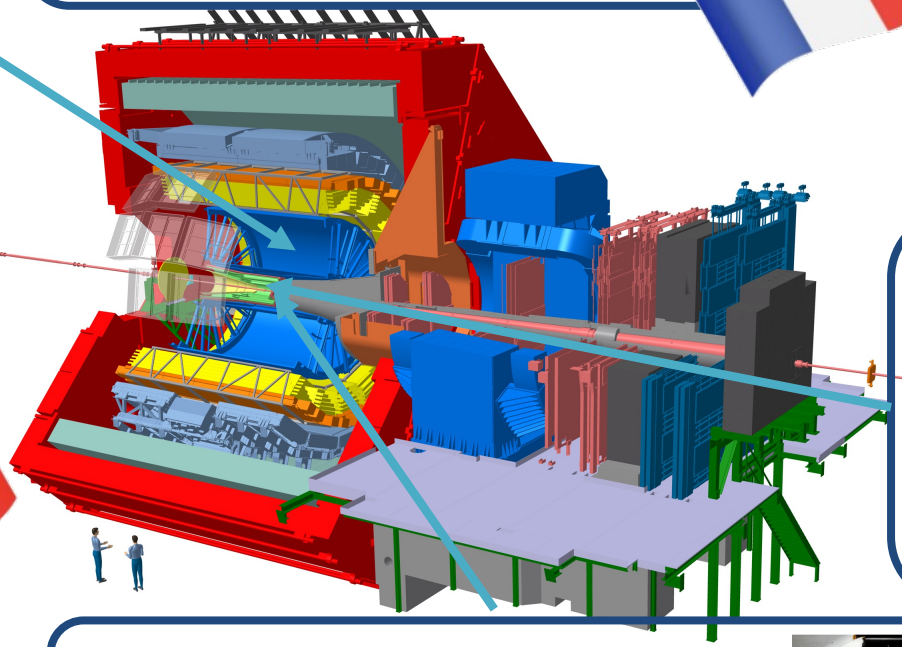

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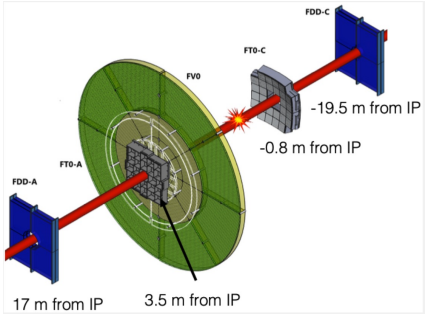

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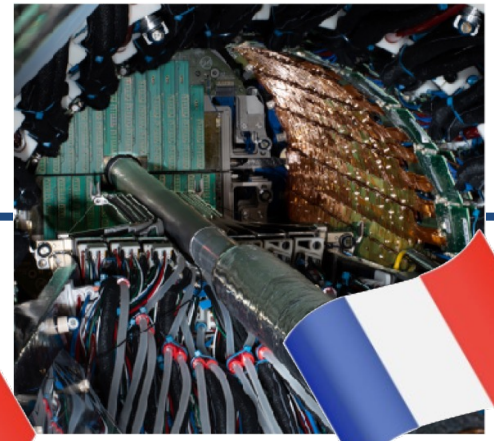

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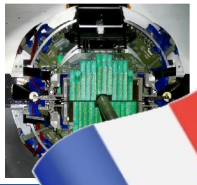

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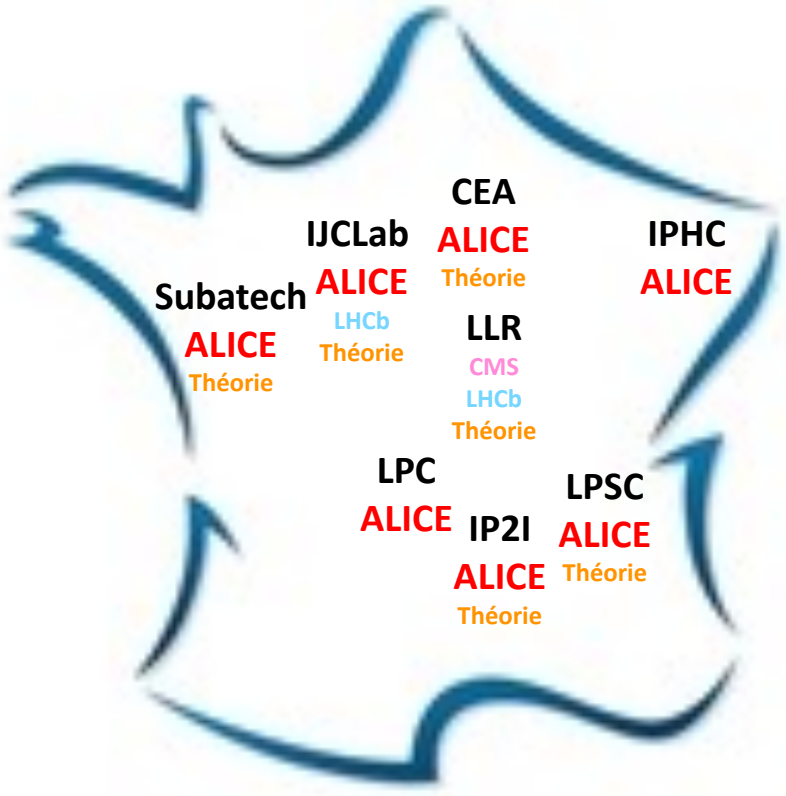
ALICE-France (IN2P3) community

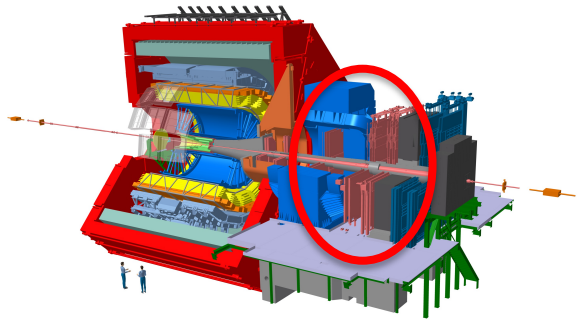
- O(100) physicists in the French QGP community
- + Ingenieers and technicians
- **ALICE-IN2P3 permanent physicists = 34**
- QGP-France annual meeting
- **High level of implication and recognition in the ALICE Collaboration**
  - **Projects : ITS2, MCH, MID, MFT, O2**
  - **Implied at all levels of the collaboration**
    - Spokesperson office
    - Management Board
    - Physics Board
    - Technical Board
    - Editorial Board
    - Run coordination
    - Scientific coordination
      - Management
      - Physics Working Group
      - Physics Analysis Group

Level of responsibility	2021	2022
L1	4	3
L2	4	6
L3	16	15



+ Linked to the GDR QCD
+ Linked to the SFP Division Nucléaire and Division Champs et particules

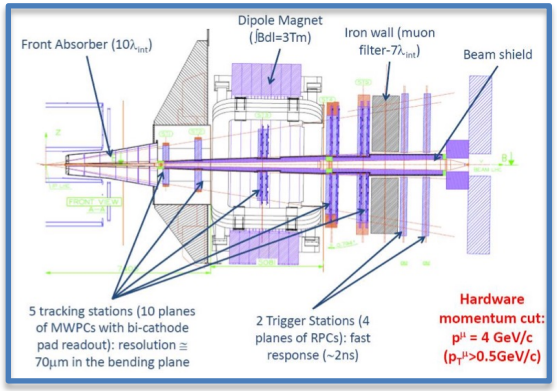
MUON CHAMBER - MCH

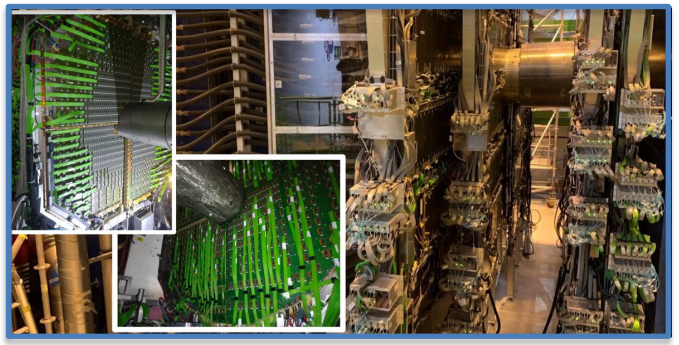


- 5 tracking stations (2x5 Multi-Wire Proportional Chambers)
- complemented with an absorber system

- **Redesign of Readout electronic with DualSampa cards**

IJCLab Production of Dual Sampa cards. Design and production of PCB





- **Rejuvenation of high/low voltages** (quadrant opening and cleaning)

IJCLab station 1

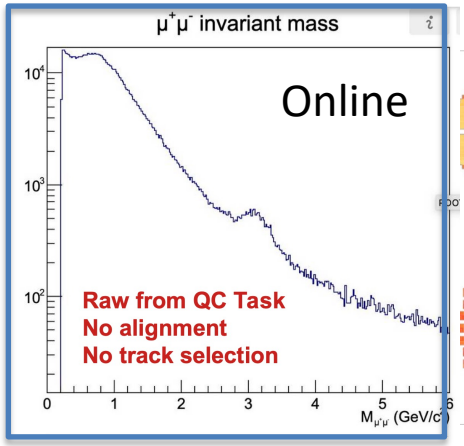
- **Successfully Installed, cabled and integrated**

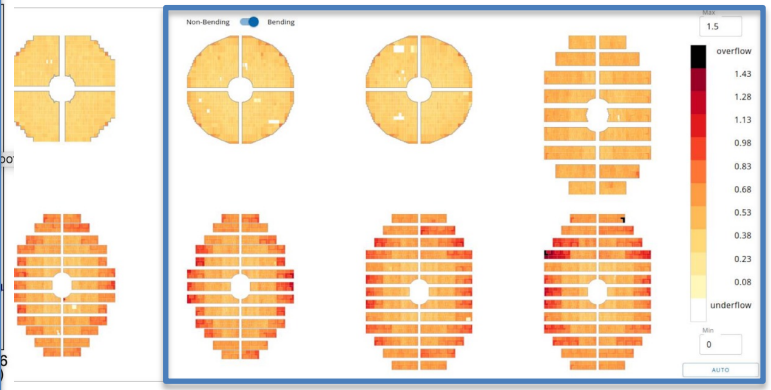
IJCLab station 1
Subatech station 3,4,5

- **Software**

Subatech

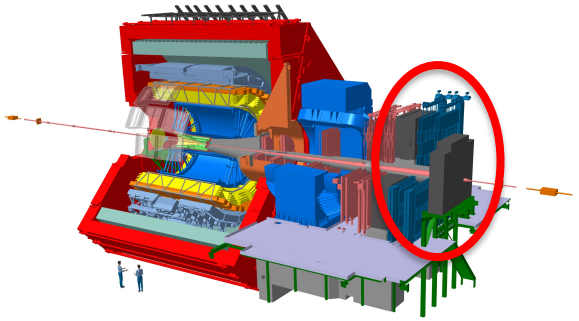
  - Simulation
  - Clusterisation
  - Calibration
  - Alignement





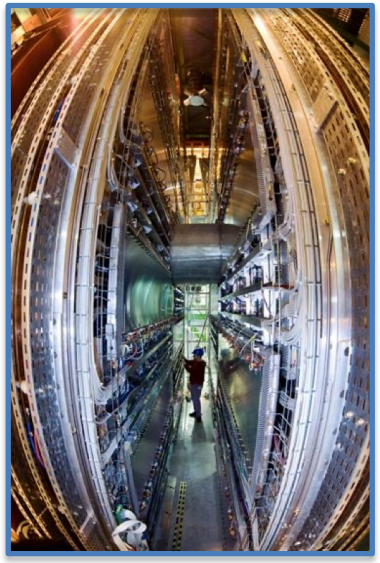
- **Commissioning finalised**, successful data taking at 500 kHz pp interaction rate

MUON IDENTIFIER - MID



- 72 Resistive Plate Chambers (RPCs) in 2 stations of 2 planes
- total surface ~150 m^2
- 21k readout channels.

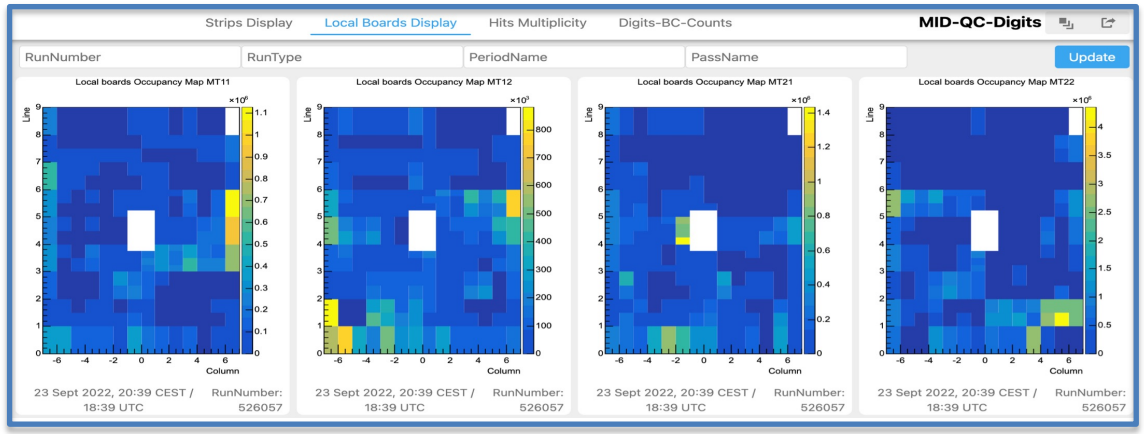
- **Upgrade of Front-End electronic with amplification** (FEERIC) **to prevent ageing**:
  - Design
  - Production LPC
  - Installation
  - Distribution of the thresholds via wireless systems



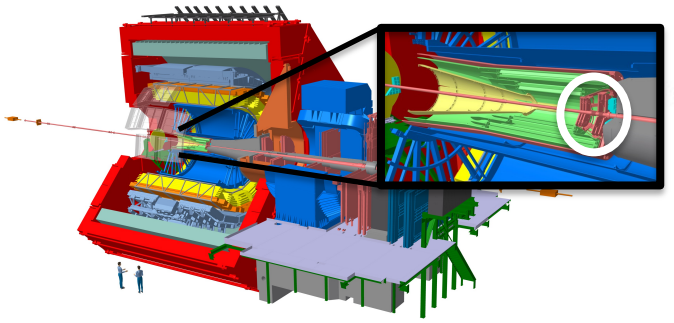
- **Upgrade of readout electronics**, slow control, detector simulation Subatech

- **Software**
  - reconstruction Subatech
  - QC LPC

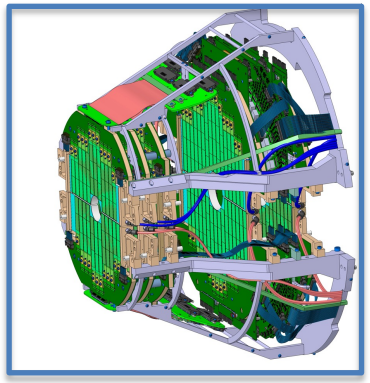
- **Commissioning finalized**, successful data taking at 500 kHz pp interaction rate

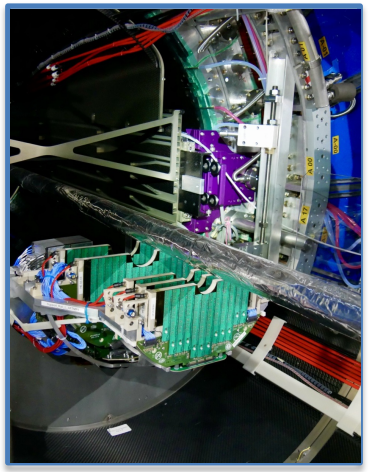


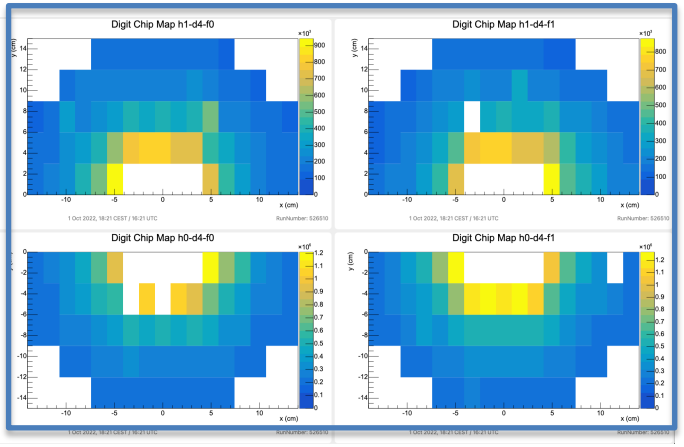
MUON FORWARD TRACKER - MFT

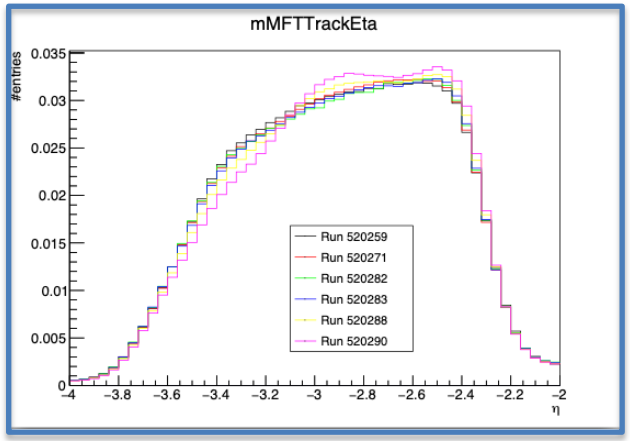


- Vertex tracker for the Muon Spectrometer, installed between the interaction point and the hadron absorber ($-3.6 < \eta < -2.5$)
- 920 ALPIDE silicon pixel sensors (0.4 m^2) in 280 ladders of 2 to 5 sensors each (same sensor as ITS2)
- **Hardware and Services**
  - Ladder assembly — LPC + Subatech
  - Cooling system — Subatech
  - Power Supply Unit — Subatech
  - Readout System and Firmware — IP2I
  - Slow Control (ALF-FRED) — Subatech + IP2I
- **Installation and commissioning** — Subatech + IP2I + LPC
- **Software**
  - Geometry — LPC
  - Reconstruction — Subatech + LPC
  - Tracking
  - MCH-MFT matching — Subatech
- **Commissioning finalized**, successful data taking at 500 kHz pp interaction rate

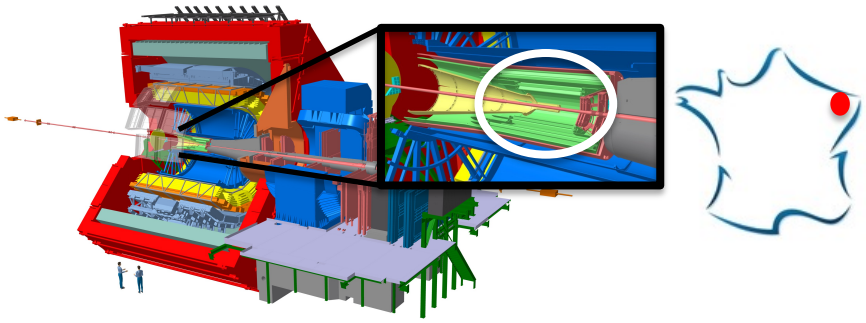






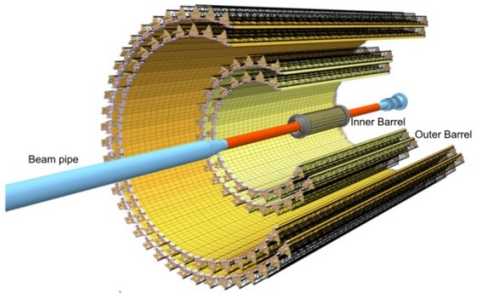


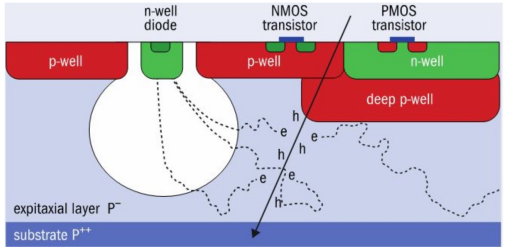
INNER TRACKING SYSTEM 2 – ITS2



- **Monolithic active sensors** (MAPS) called **ALPIDE**, integrating both pixel sensor and read-out electronics in a single device

IPHC ALPIDE Design participation



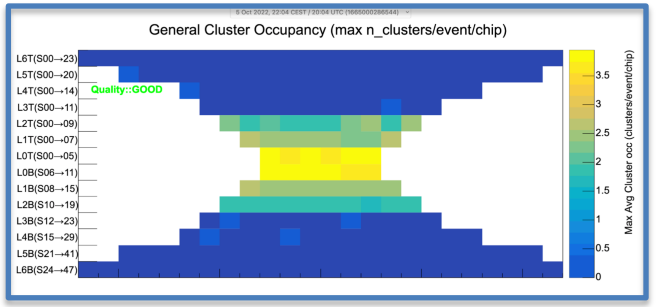


- **7 coaxial layers to cover** $|\eta| < 1.3$ divided into 2 groups:
  - the 3 internal layers installed closest to the beam pipe
  - 4 outer layers

IPHC Module assembly

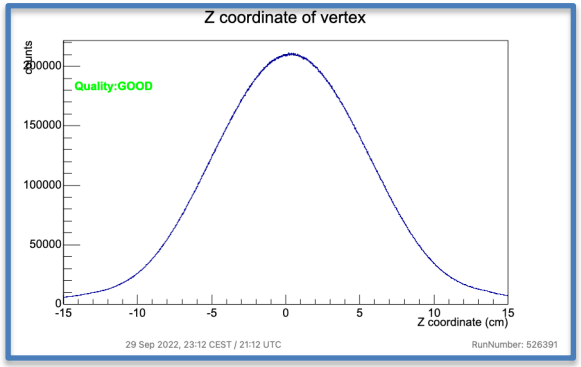
- **Successfully installed**, cabled and integrated in May 2021,

IPHC installation + cabling



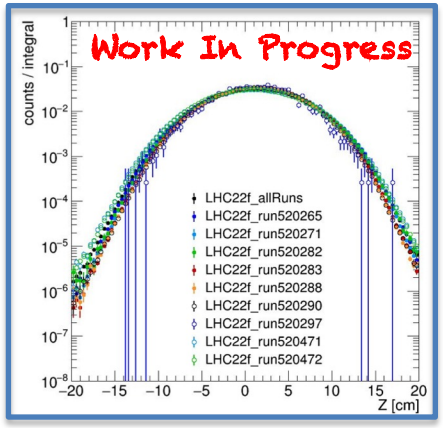
- **Commissioning finalized**, successful data taking at 500 kHz pp interaction rate
  - Online reconstruction and data compression
  - Tracking and dedicated QC
  - Performance studies with comparison to Monte Carlo
  - Alignment

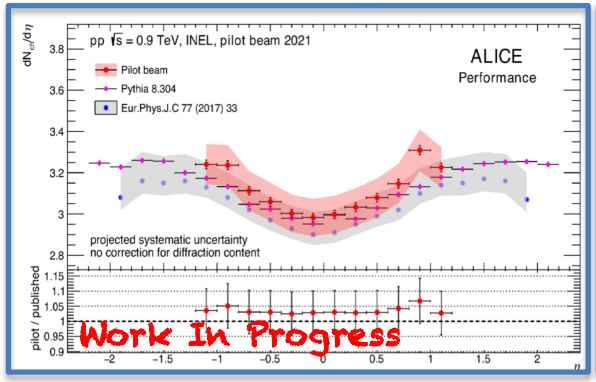
IPHC chair of software working group

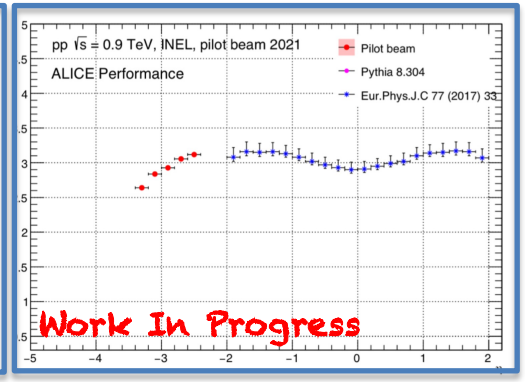


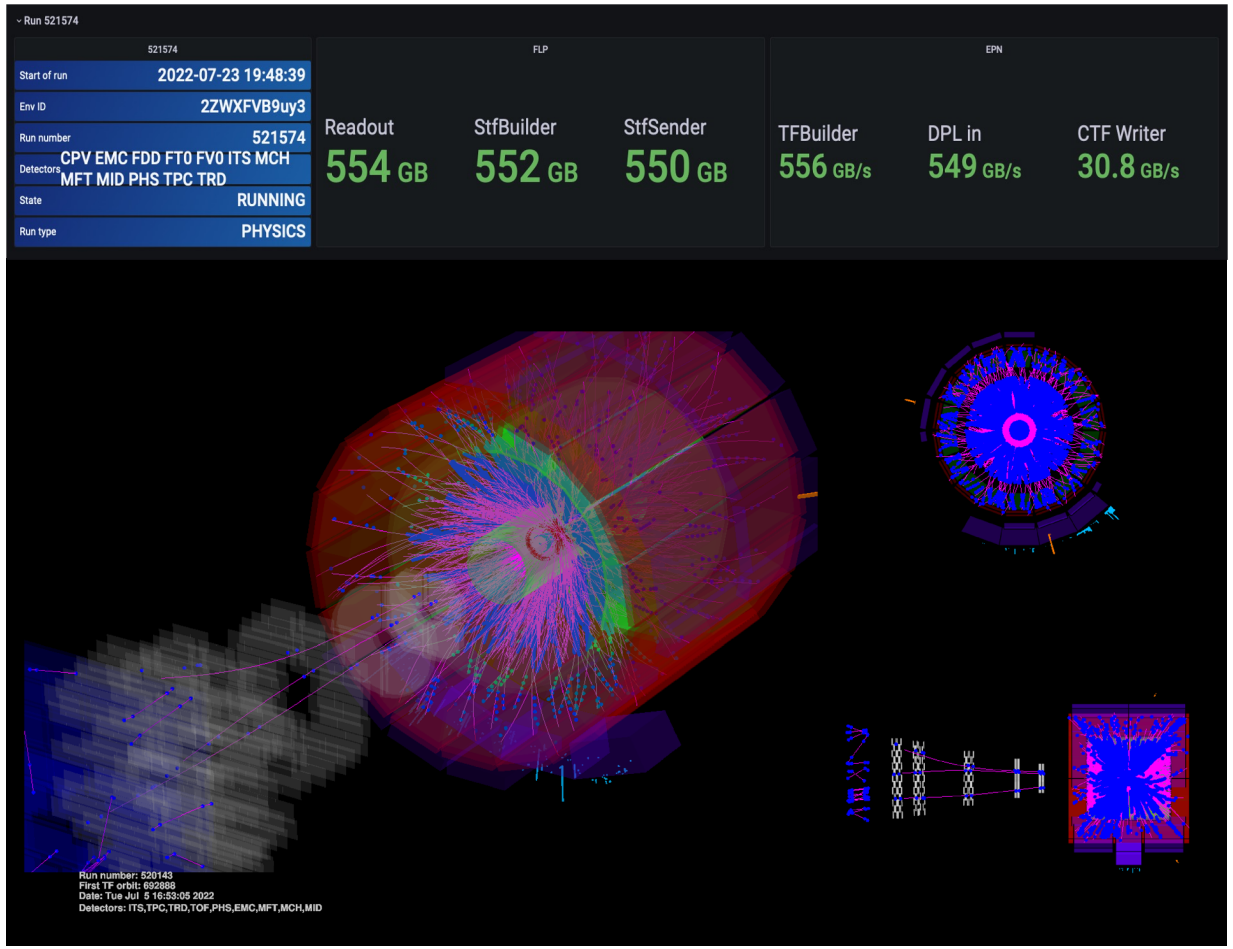
ALICE 2 Commissioning

- **Physics data taking at 500 kHz**
  - Online data compression of a factor 18
  - Commissioning and validation of all components
  - Preparation of Physics
- **Preparation of Pb-Pb program**
  - 1 MHz (pp ref run)
  - Intensity scan up to 4 MHz in pp (equivalent track load of Pb-Pb 50 KHz)









First physics output under preparation !

ALICE-France for RUN 3 and RUN 4

1. **Ensure the maintenance and operations of all projects handled by French teams**

2. **Exploit the full physics output**

Person–power anticipated evolution

Permanent only (not including post-doc, PhD and emeritus)
Including known retirements and thematic changes
No permanent recruitment taken into account

Team	"M&OA" (2022)		Due service work FTE/year (2022)	Main detector activities in Runs 3 *(+ Run 4)*	"M&OA" *(projected end Run 3, 2026)*		"M&OA" *(projected early Run 4, 2029)*	
IJClab Orsay	4 + 1	5	1.5	MCH, O^2	4 + 1	5	4 + 1	5
IPHC Strasbourg	5 + 1	6	1.5	ITS2 *(+ ITS3)*	4 + 1	5	4 + 1	5
IP2I Lyon	3 + 0	3	0.75	MFT *(+ ITS3)*	2 + 0	2	2 + 0	2
LPC Clermont	2 + 5	7	1.75	MID, MFT	2 + 5	7	1 + 4	5
LPSC Grenoble	2 + 2	4	1	readout, DPG *(+ ITS3)*	2 + 2	4	2 + 1	3
Subatech Nantes	7 + 2	9	2.75	MID, MCH, MFT	4 + 2	6	3 + 2	5
TOTAL	23 + 11	34	9.25		18 + 11	29	16 + 9	25

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Conclusions

- **Important physics results** for the comprehension of QGP physics have emerged **during RUN 2** data analysis with strong leading role from the French community

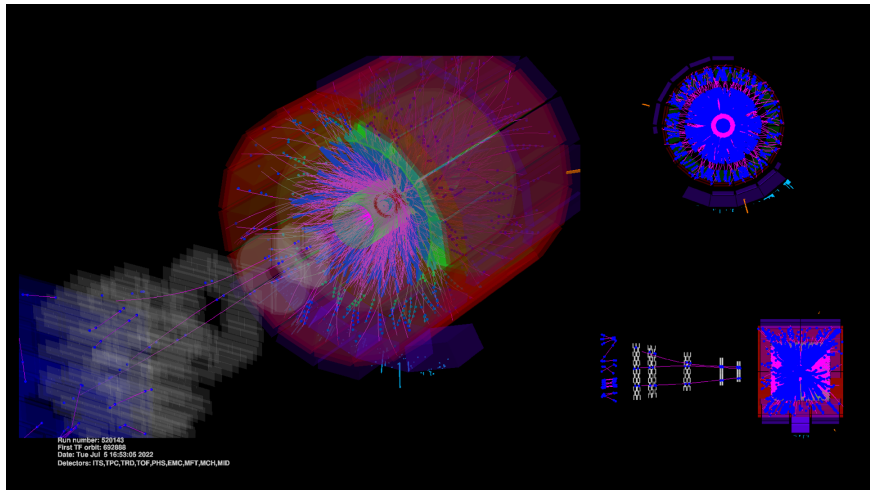
- **Successful upgrade** conducted during LS2 in preparation for RUN 3
  - Leading role in major ALICE projects MCH, MID, MFT, ITS2
  - Upgrade in time despite worldwide situation (Covid pandemic)

- **Successful installation and integration** into the global ALICE data taking

- **Preparation of RUN 3 physics analysis** ongoing

- **Engagement of the French community until end of RUN 4**
  - Maintenance and operations of ITS2, MCH, MID, MFT, O2-CRU
  - Exploitation of physics data through data analysis

- **Preparation of LS3/LS4 and upgrades upon IN2P3 approval**



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Thanks

Thanks to the ALICE-France community for the help in preparing the slides !
And more specifically to
Antonin, Antonio, Boris, Christophe, Cvetan, Cynthia, Diego, Marie, Nicole, Philippe, Xavier

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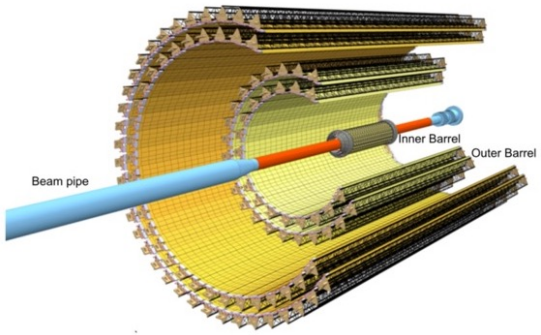
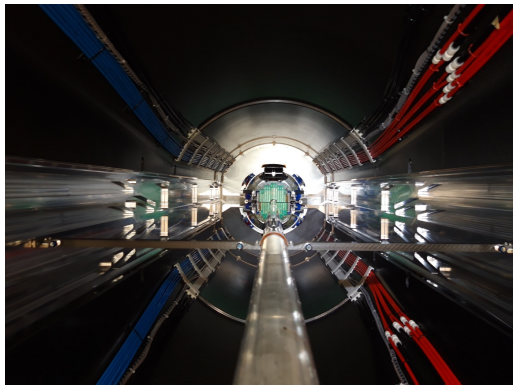
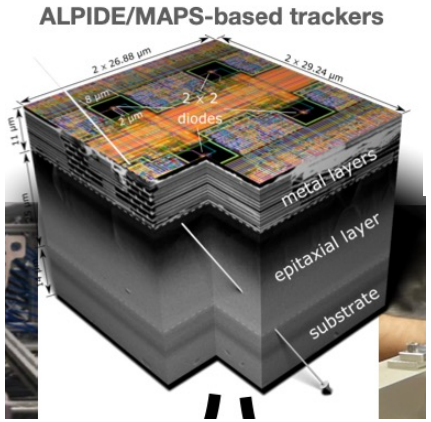
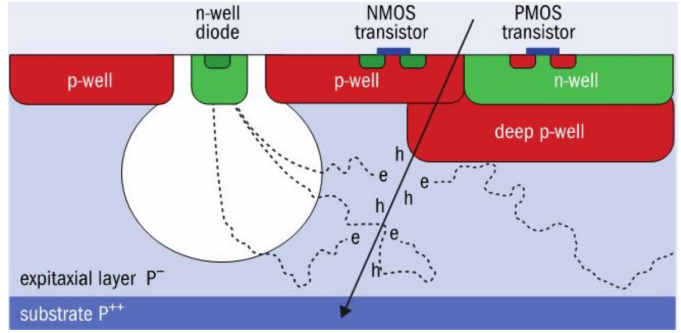
ITS2 and MFT : ALPIDE









- monolithic active pixel sensor chip (MAPS), called ALPIDE, integrating both pixel sensor and read-out electronics in a single device
- p-type substrate with a thin, high-resistivity epitaxial layer (see diagram) in a 180 nm CMOS process provided by Tower Semiconductor
- includes a 512 x 1024 matrix of 29.24 x 26.88 mm^2 pixel cells, together with analogue biasing, control, readout and interfaces

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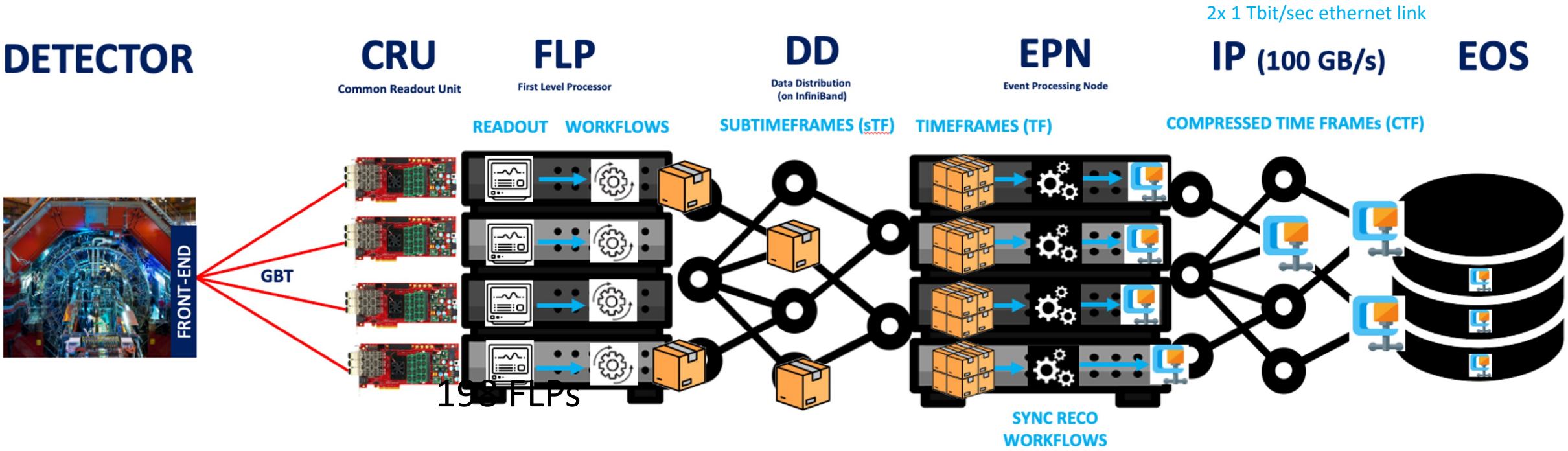
READOUT TO RECONSTRUCTION

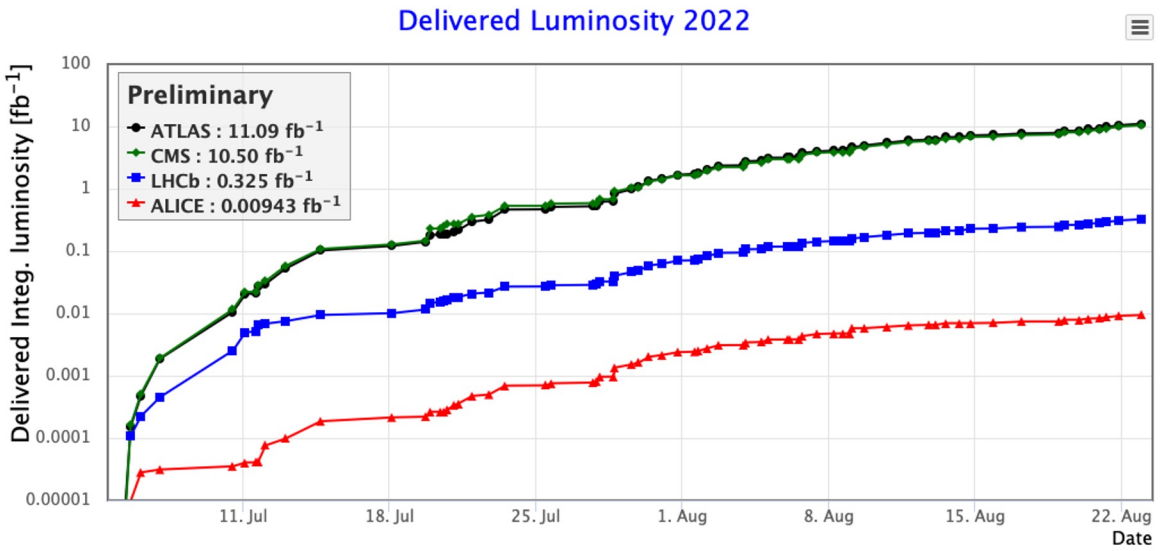


Stable 500 KHz running was achieved with further optimisation of :

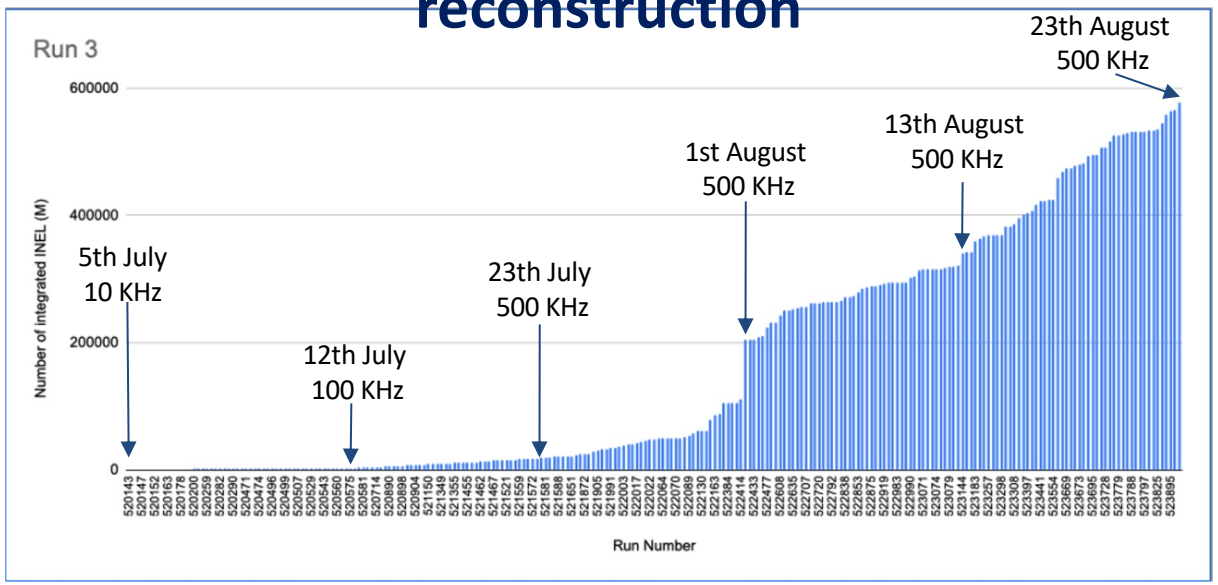
- The Common Readout Unit (CRU) FirmWare (FW) **to prevent from data corruption**
- The ReadOut process configuration with **better memory buffers allocation**
- The Data Distribution software and its **shared Memory Management**

COLLECTED 13.6 TeV DATA until end of August

Delivered integrated luminosity 9.4 pb^{-1}



Statistics collected used for asynchronous reconstruction



Ongoing:

- **Allocation of EPN resources for Async Reconstruction**: started async pool of 20 nodes.
- Use the LHC downtime to allocate more nodes (not needed by COSMIC runs) and to automate the management

Organisation et Structures opérationnelles (L1 & L2)

- Porte-parole adjoint: Barbara Erazmus (L1, jan.2020→)
- Management Board: Alberto Baldisseri (MUON, L1), Philippe Crochet (Elect. L1), Barbara Erazmus (L1, jan.2020→), Stefano Panebianco (MFT, L1, nov.2020→)
- Physics Board: Cvetan Cheshkov (Physics Coord. adjoint, L2, jan.2020→), Marie Germain (PWG-GA, L2, mar.2020→avr.2022), Michael Winn (PWG-DQ, L2, nov.2019→dec.2021), Laure Massacrier (PWG-DQ, L2, jan.2022→)
- Run Coordination: Sarah Porteboeuf (Physics Coord. adjoint, L2, jan.2022→),
- Technical Board: Alberto Baldisseri (MUON, L1), Stefano Panebianco (MFT, L1,nov.2020→)
- Editorial Board: Javier Castillo Castellanos (EB co-Chair, L1, jul.2020→)
- Data Preparation Group: Gustavo Conesa Balbastre (L2, mai 2021→)

Organisation et Structures opérationnelles (L3)

- Conference Committee: Gustavo Conesa Balbastre (oct.2018→),Zaida Conesa del Valle (oct.2018→)
- Physics Analysis Group: Nicole Bastid (HF-PAG, jul.2021→), Maxime Guilbaud (MM-PAG, oct.2022→)

  Laure Massacrier (DQ-PAG, avr.2020→avr.2022)
- Technical Board: Guillaume Batigne (MFT adjoint, jun.2013→), Xavier Lopez (MID adjoint, jan.2015→oct. 2021),

  Diego Stocco (MID adjoint, jan.2015→, Muon Trigger Project Leader, jan 2017→dec.2020), Christophe Suire (MCH adjoint, avr.2021→)
- Common tools and System Infrastructure: Ivana Hrivnacova (O2, jan.2021→)
- Tracking: Iouri Belikov (ITS, mar.2013→)
- Upgrade: Antonio Uras (ALICE3 Heavy Flavour, avr.2021→)
- Thesis Award Committee: Philippe Crochet (co-Chair, mar.2020→)
- Spokesperson Search Committee: Marie Germain (Chair, oct.2021→mar.2022)
- Collaboration Board Chair Search Committee: Philippe Crochet (oct.2021→dec.2021)

Coordination Scientifique

- Coordination de Physique: Cvetan Cheshkov (adjoint)

- Coordination de Physics Working Groups (total: 8 PWGs)
  - PWG-GA→JE (gamma→jet), Marie Germain (mai.2020→mai.2022)
  - PWG-DQ (dileptons & quarkonia): Laure Massacrier (jan.2022→)

- Coordination de Physics Analysis Groups (total: 26 PAGs)
  - Quarkonium Muon Decays (PWG-DQ): Laure Massacrier (avr.2020→jan.2022) Maxime Guilbaud (jan.2022→)
  - Heavy Flavour Leptons (PWG-HF): Nicole Bastid (jul.2021→)

Publications

- Total de 401 publications soumises

avec 41 publications soumises en 1 an

(49 publications soumises pour 2020→21)

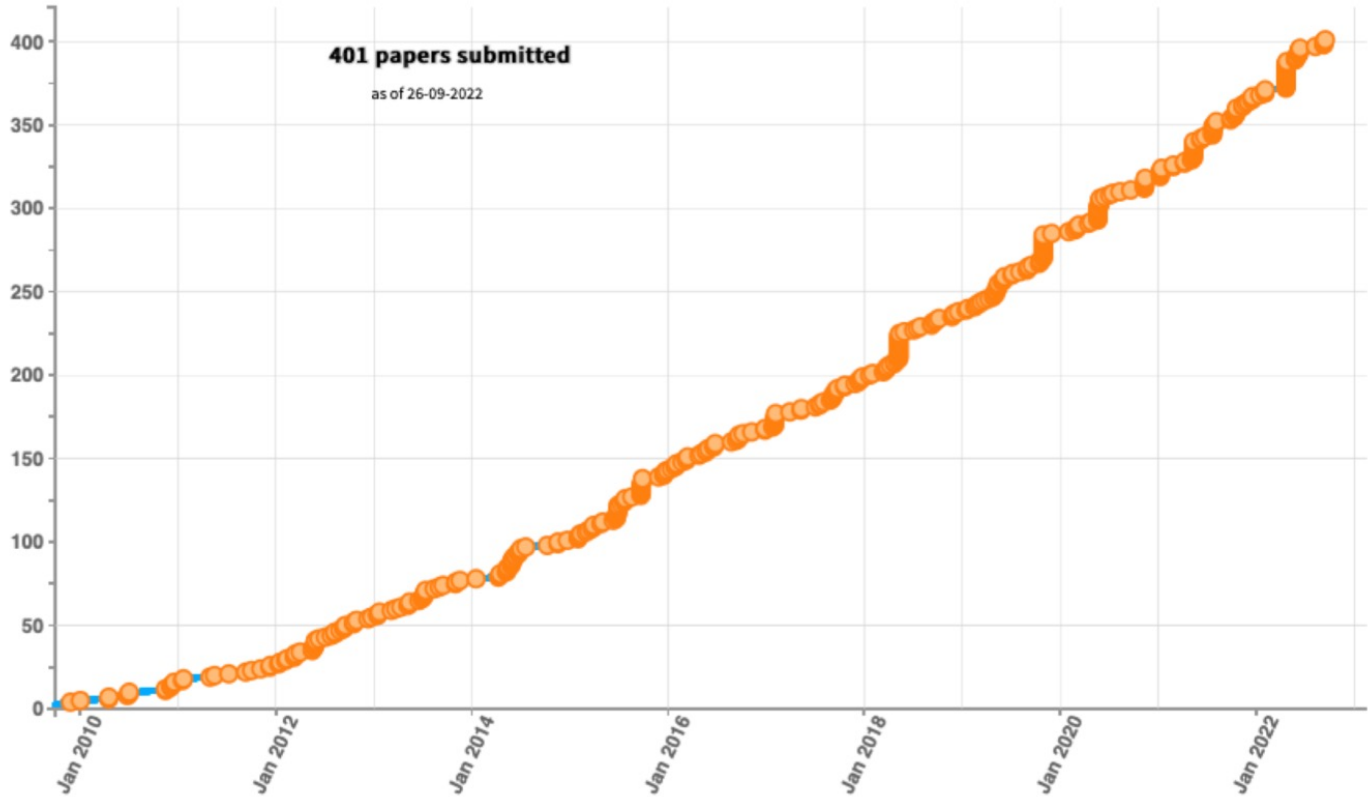
(46 publications soumises pour 2019→20)

(32 publications soumises pour 2018→19)

  - 13 (11) renommées
  - 35 (33) célèbres
  - 74 (68) réputées

- “pics" corrélés avec QM, SQM et ICHEP 2022

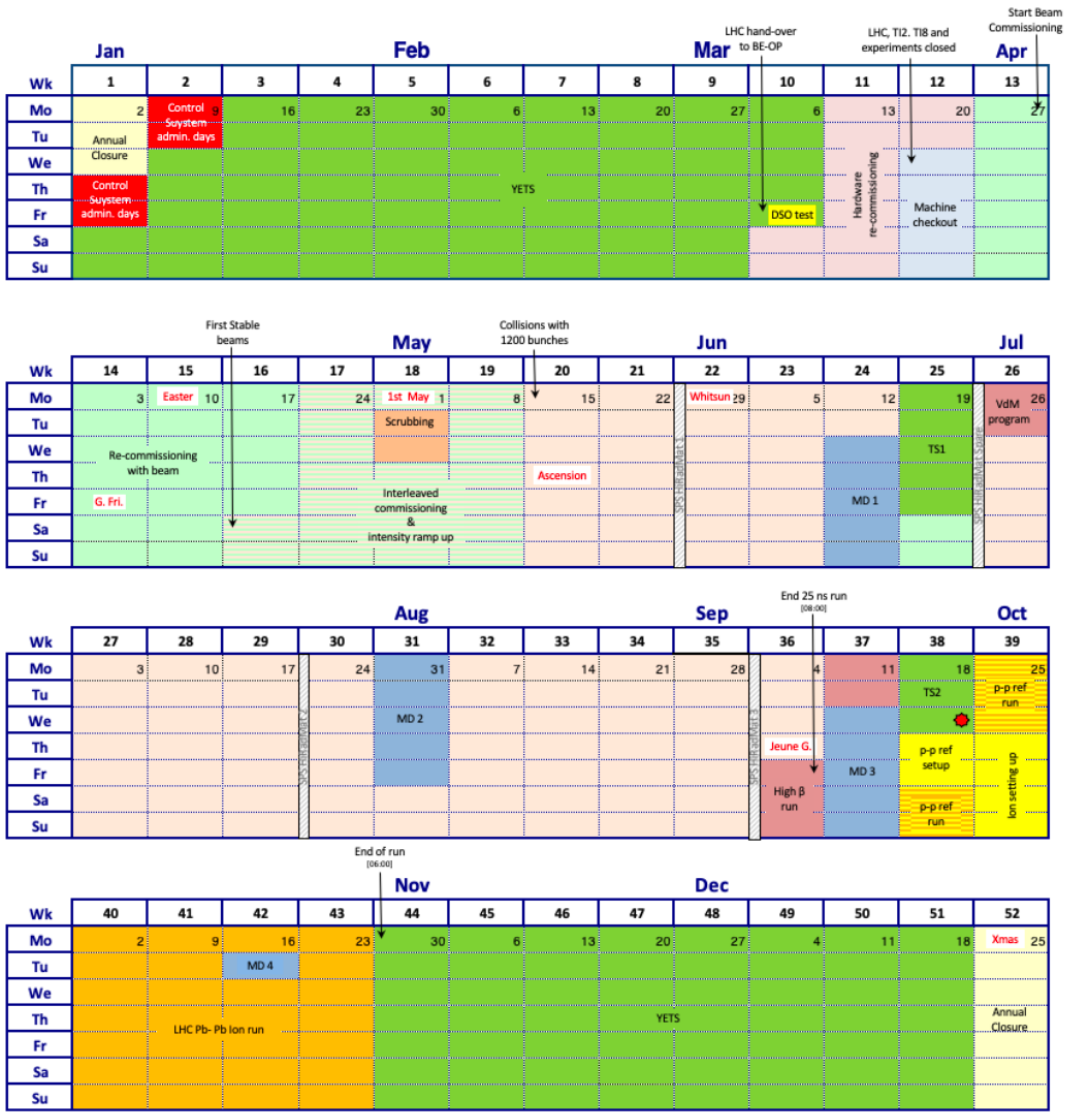
(QM en avril à Cracovie, SQM en juin à Pusan et ICHEP en juillet à Bologne)



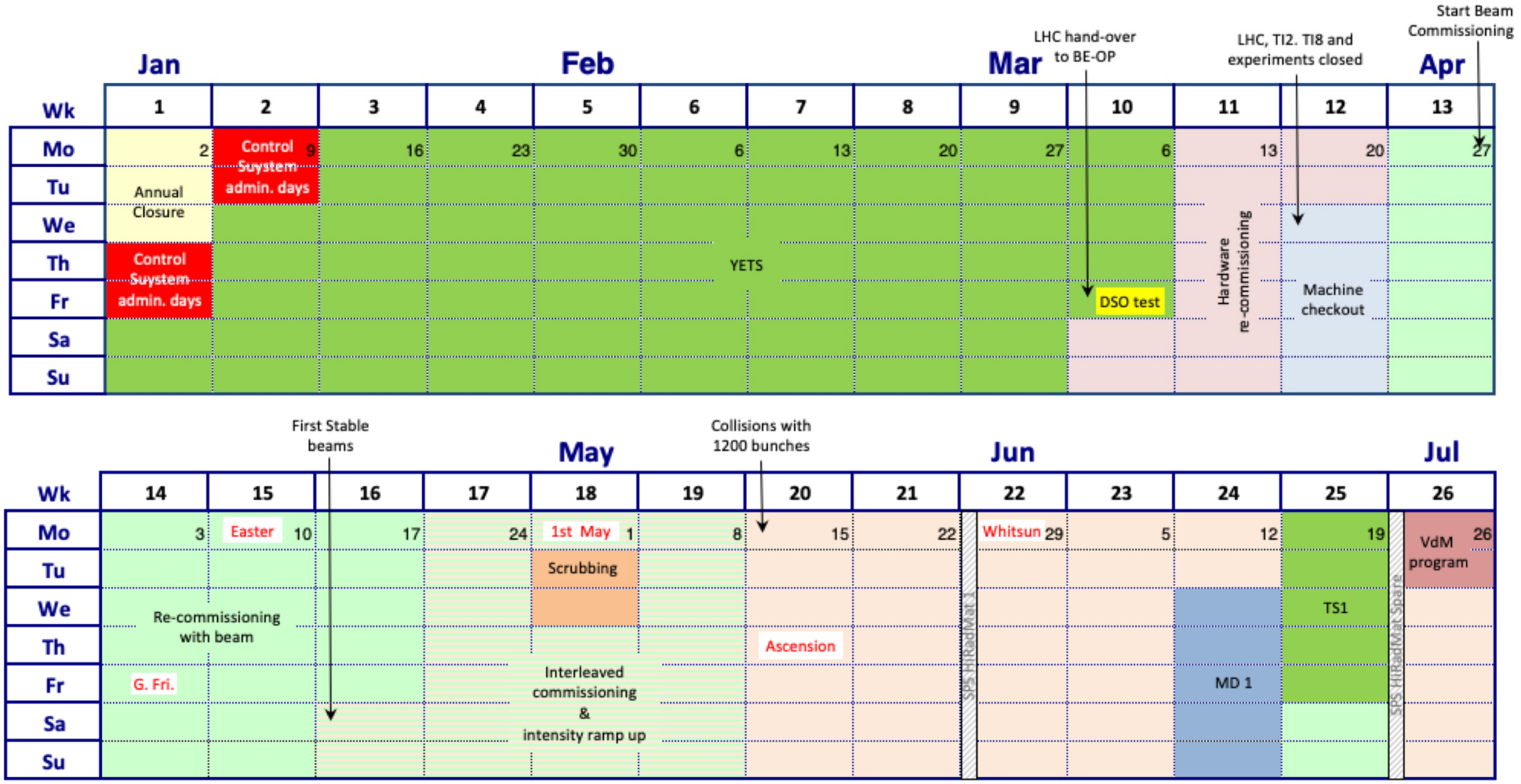
- 13 sur 29 publications avec au moins un collaborateur/trice français/e dans le “Paper Committee" ou l’ “Internal Review Committee” (en général restreint à 3 personnes)

The 2023 Draft LHC Schedule in Numbers

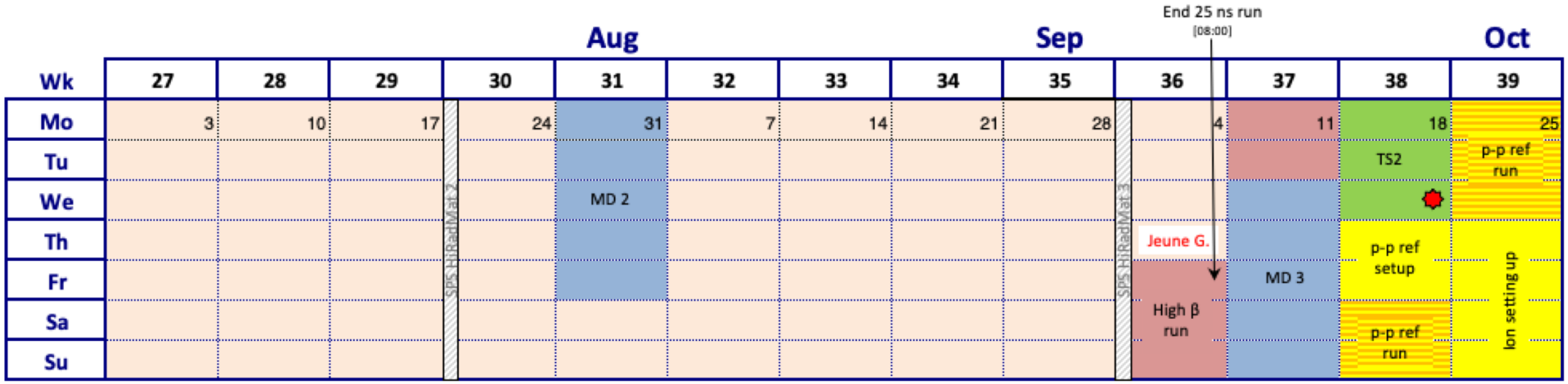
Activity	Duration [days]	Ratio [%]
Beam Commissioning & Intensity ramp-up	47	21.7
Scrubbing	2	0.9
25 ns physics (>1200 bunches)	**97**	**44.7**
Special physics runs (incl. setting-up)	**7**	**3.2**
Pb-Pb ions & p-p ref. setting-up	6	2.8
Pb-Pb ions physics & p-p ref. run	**32**	**14.7**
Technical stop	8	3.7
Technical stop recovery	2	0.9
Machine Development blocks (incl. floating MDs)	16	7.4
Total:	**217**	**100%**



2023


Jan
Feb
Mar
Apr
LHC hand-over to BE-OP
LHC, TI2. TI8 and experiments closed
Start Beam Commissioning
Wk
1 2 3 4 5 6 7 8 9 10 11 12 13
Mo 2 9 16 23 30 6 13 20 27 6 13 20 27
Tu
We
Th
Fr
Sa
Su
Annual Closure
Control System admin. days
Control System admin. days
YETS
DSO test
Hardware re-commissioning
Machine checkout
First Stable beams
Collisions with 1200 bunches
May
Jun
Jul
Wk
14 15 16 17 18 19 20 21 22 23 24 25 26
Mo 3 10 17 24 1 8 15 22 29 5 12 19 26
Tu
We
Th
Fr
Sa
Su
Easter
1st May
Whitsun
Scrubbing
Re-commissioning with beam
Ascension
G. Fri.
Interleaved commissioning & intensity ramp up
MD 1
TS1
VdM program
SPS HiRadMat's
SPS HiRadMat Spare

2023



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2022: Pb test

- Commission ALICE 2 with ions with ZDC as lumi input
- Use pp optics (as was done for Xenon in RUN 2)
- Top energy 6.8Z TeV with crystal collimation
- Low intensity 0.5 to 1 KHz (w.r.t 50 KHz in Phyiscs)

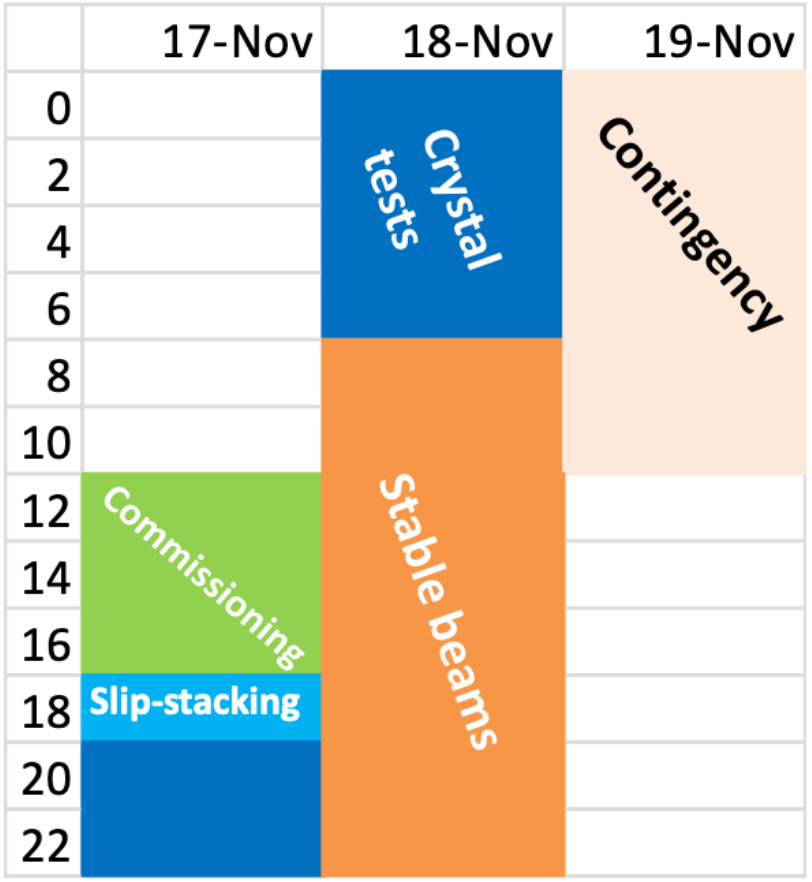
2022: Pb test

Overview of planning

- Plan (**Total: 36h**)
  - Commissioning → **6h**
  - Slip-stacking tests at injection → **2h**
  - Crystal collimation test → **12h**
  - Stable beams, 2 fills → **16h**
    - Maybe TCLD test as end-of-fill
  - Have 2 days allocated, i.e. we have some contingency in case of unexpected problems, machine downtime etc.

- Advantages of doing things in this order:
  - If beam quality is satisfactory, we can do stable beams with short slip-stacked trains
  - If there are no issues, we can do stable-beam Pb ion operation with crystal collimation (first time ever!)
  - If we start only at noon on Nov. 17, start of stable beams does not end up in the night

Tentative planning – present proposal
(assuming we start at 8am on Nov. 17)



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R. Bruce, 2022.10.26

2022: Pb test

Expected luminosity

- Assume we keep each fill 5h, assign 6h for cycle, injections, setting up etc.

- Very rough estimate of integrated luminosity in two 5h-fills:
  - 0.25 μb^{-1} at ALICE, 1 μb^{-1} at ATLAS/CMS with 8 collisions
    - ALICE loses slightly from fast burn-off at ATLAS/CMS, with small β*
    - Using offset-leveling at ATLAS/CMS, we can reduce burn-off – under discussion
  - 0.07-0.2 μb^{-1} at LHCb depending on filling scheme

- Very high error bar!
  - Beam parameters in collision still uncertain (emittance, intensity …)
  - Very sensitive to actual machine availability

Max instantaneous luminosity, at start of fill (in $cm^{-2}s^{-1}$)

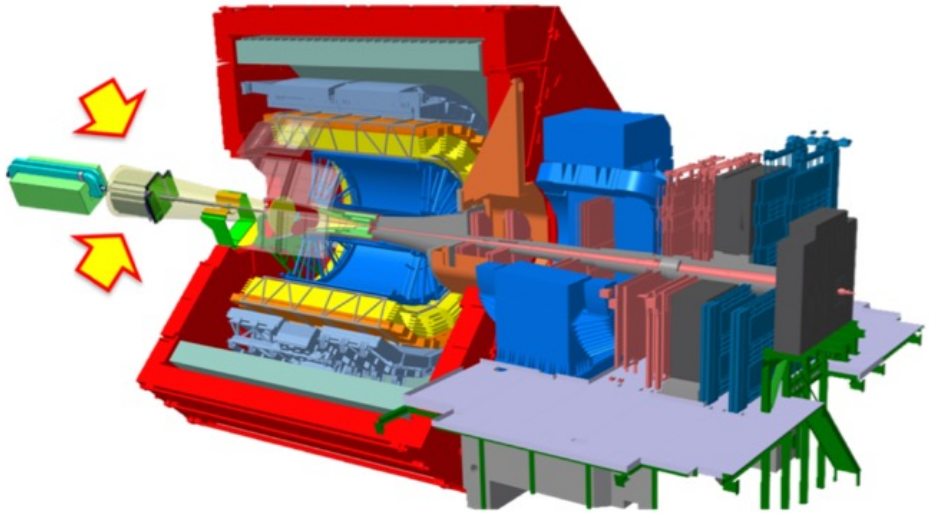
	IP1/5	IP2	IP8
20b_8_16_8_8 (single bunches)	5.4×10^{25}	$8. \times 10^{24}$	1.6×10^{25}
20b_2_18_2_2 (slip-stacked)	1.4×10^{25}	9.1×10^{24}	3.9×10^{24}
20b_8_20_8_3 (slip-stacked)	5.4×10^{25}	$1. \times 10^{25}$	5.9×10^{24}

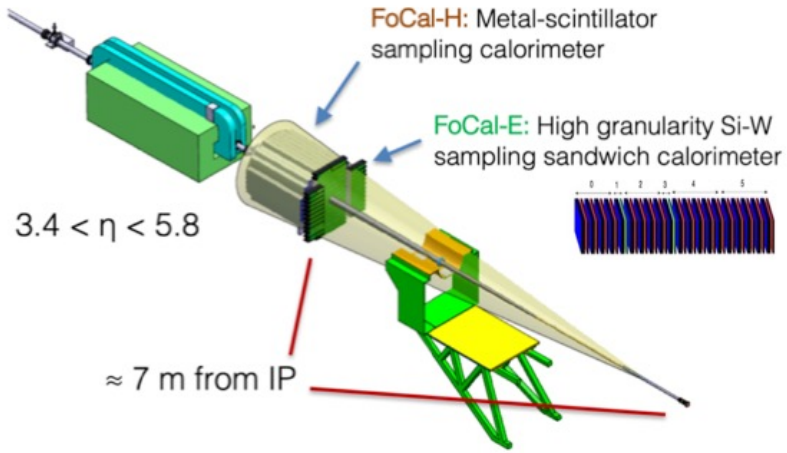
Integrated luminosity over 5h (in µb)

	IP1/5	IP2	IP8
20b_8_16_8_8 (single bunches)	0.51	0.1	0.19
20b_2_18_2_2 (slip-stacked)	0.13	0.15	0.06
20b_8_20_8_3 (slip-stacked)	0.52	0.14	0.077

En prévision du LS3: FoCal-E

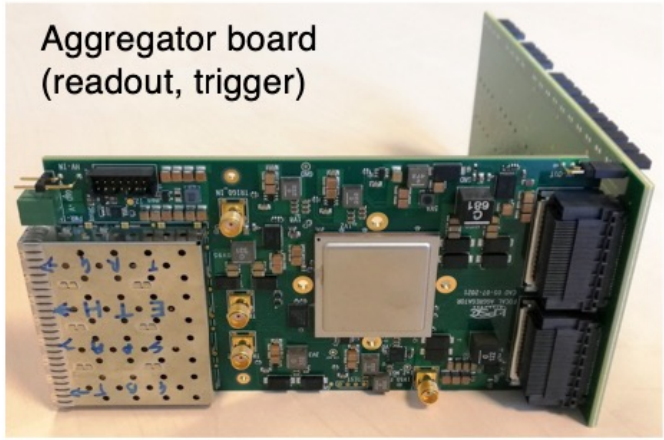
ALICE LoI LHCC-I-036 CERN-LHCC-2020-009

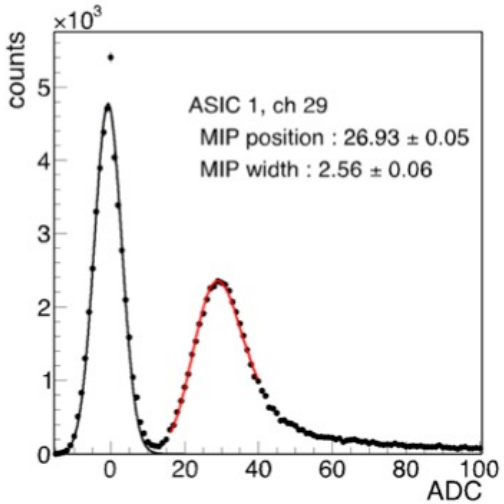




- **Calorimètre EM en région avan avec lecture Si-W de haute granularité**
- Dédié à la mesure de photons directs en région avant

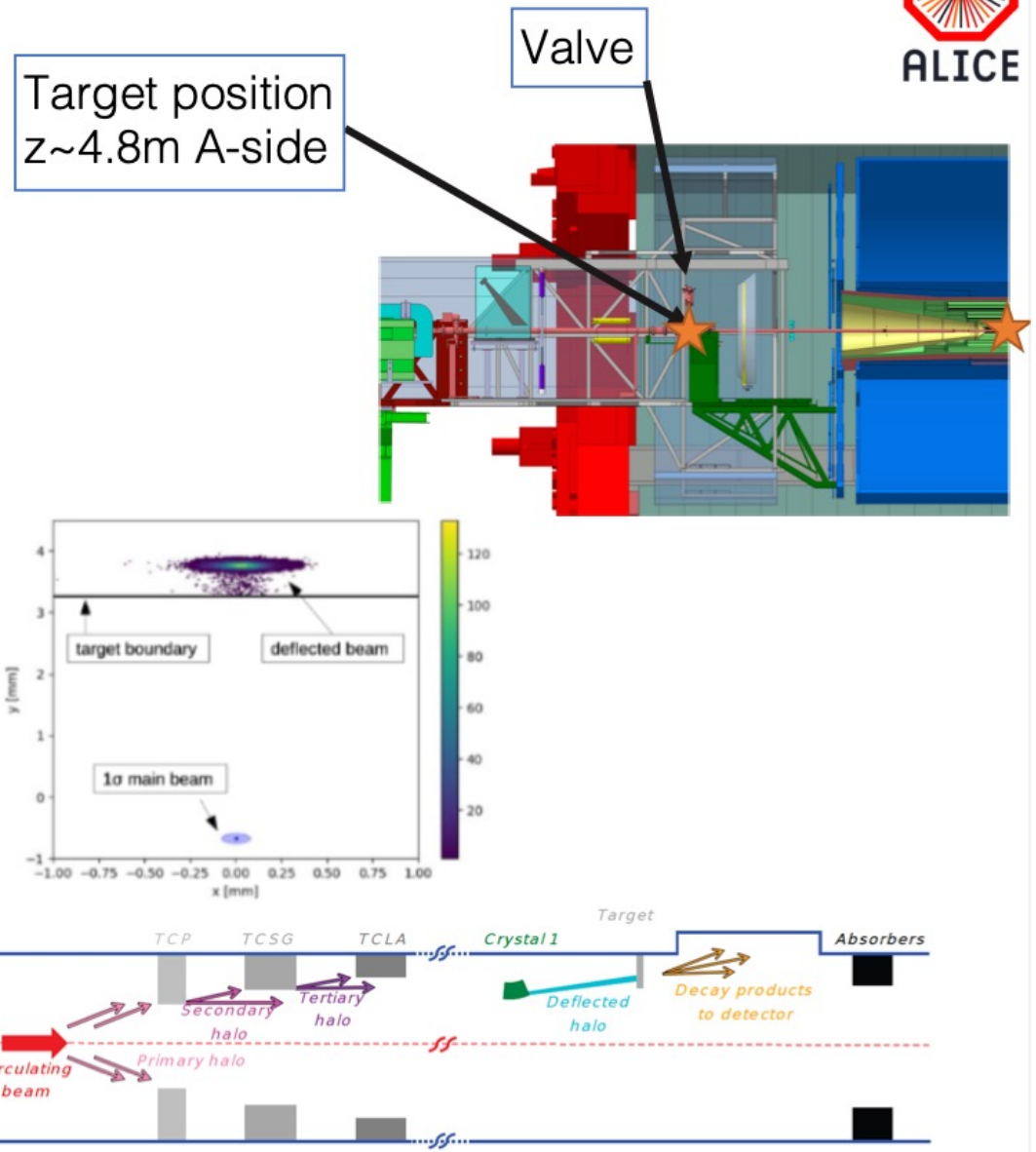
- **Démonstrateur FoCal-E PAD**
- Construction d'un prototype (1/5 du module final) en collaboration avec le C4Pi
- Tests sous faisceau au CERN (PS & SPS) avec readout O2 (CRU)





En prévision du LS3: Fixed Target

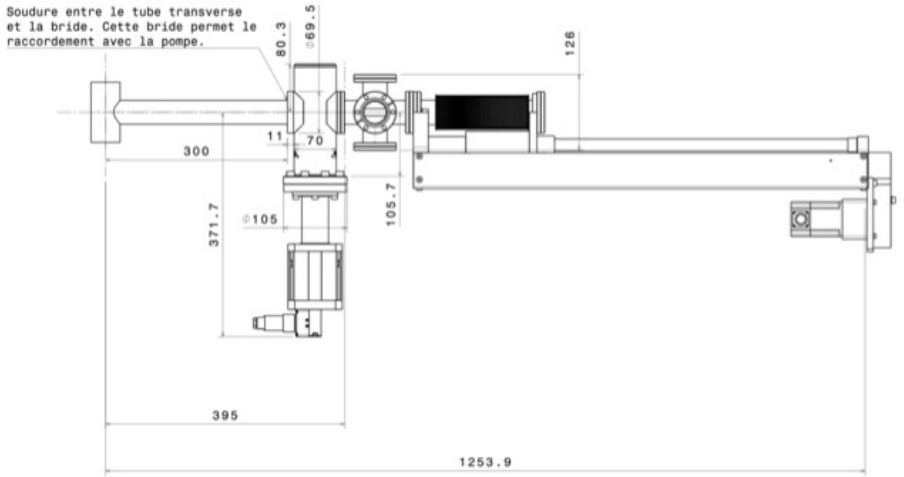
- Dispositif de fonctionnement en Cible Fixe non polarisée
- **Proposed layout for ALICE with bent crystal**
  - → Beam splitting thanks to a bent crystal
  - → LHC collimation studies done for ALICE with proton beam, started with Pb beam
  - → Coupled to a retractable solid target in front of ALICE
- Aim at an installation in LS3 (2026-2027)
- Probe high-*x* gluon, antiquark and heavy-quark content in the nucleon and nucleus
- Provide inputs for astrophysics (charm and antiproton production)
- Study the nuclear matter properties in heavy-ion collisions towards large rapidity



En prévision du LS3: Fixed Target

Target design and integration

– Target position: ~5 m from IP2 with material budget outside of FoCal acceptance
– Conceptual design of the target system performed
– Mechanical integration within ALICE ongoing



Physics performance in pW at 115 GeV

– Tracking performance of the central barrel with displaced vertex for charged particles D and Λ
– PID performance ongoing

Towards a LoI (2022)

Next studies

– Vacuum and impedance integration, machine protection studies

ANR JCJC 2022 (Laure Massacrier): 2 years postdoc (performance studies), 1 IE (2 years) for vacuum studies, 1 AI (1 year) for impedance studies, material and missions