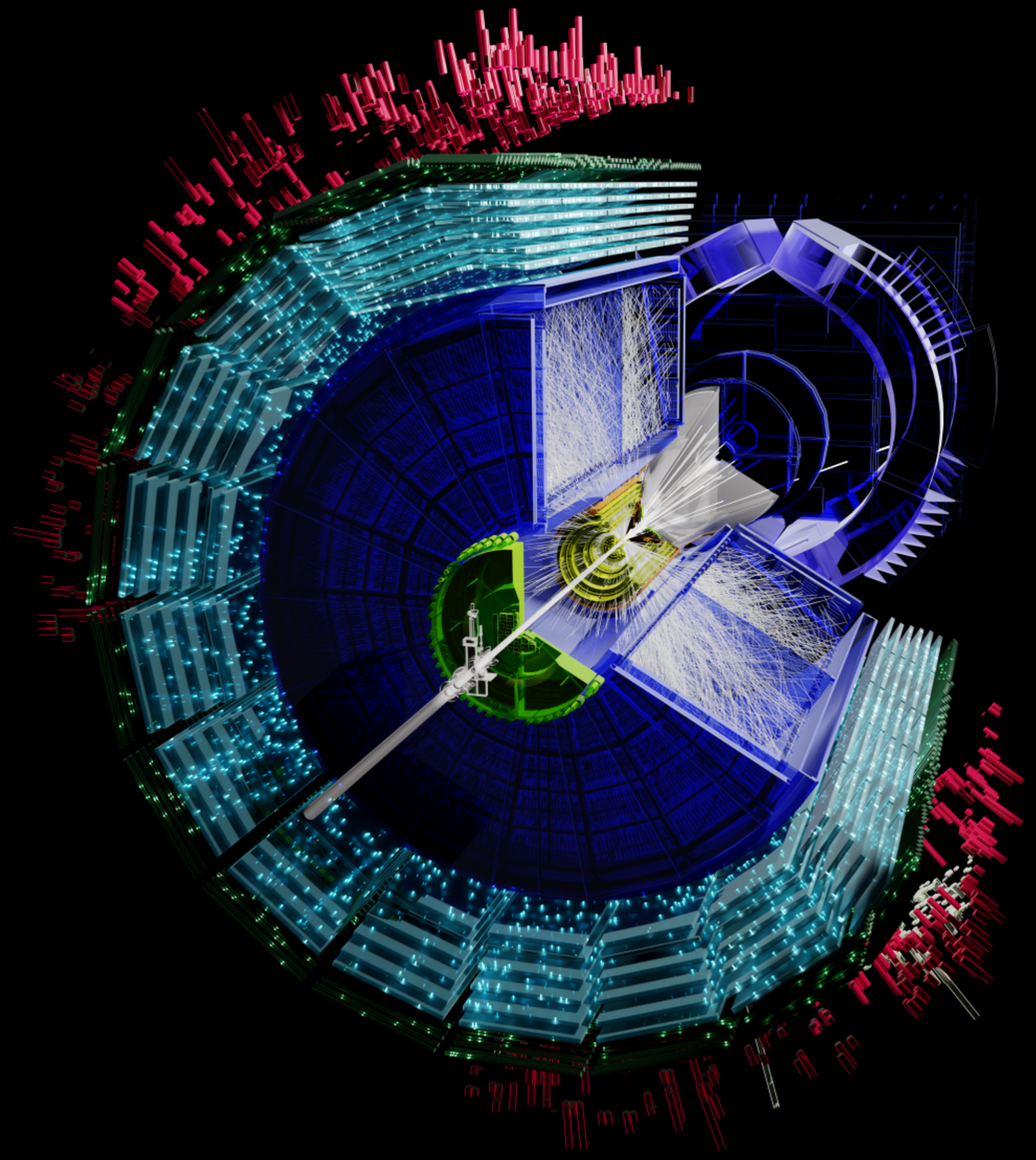


Perspektiven mit ALICE: Status + langfristige Vision

Yvonne Pachmayer
(Physikalisches Institut, Heidelberg University)

ALICE
Pb-Pb 5.36 TeV
LHC22s period
18th November 2022
16:52:47.893

FSP ALICE
Erforschung von Universum und Materie

KHuK2022

UNIVERSITÄT HEIDELBERG
ZUKUNFT SEIT 1386

ALICE Germany

FSP ALICE
Erforschung von Universum und Materie

- **Experiment**: 9 Teams
  - Uni Bonn
  - Uni Frankfurt (4)
  - Uni Heidelberg
  - TU München
  - Uni Münster
  - GSI
- **Theorie**: 3 Teams
  - Bielefeld
  - Münster
  - Tübingen



- Leading functions of German ALICE members:
  - **TPC Project Leader**: Harald Appelshäuser (Uni Frankfurt)
  - **TRD Project Leader**: Johanna Stachel (Uni Heidelberg)
  - **O²-EPN Project Leader**: Volker Lindenstruth (Uni Frankfurt)
  - **Conference Committee Chair**: Dariusz Miskowiec (GSI)
  - **Service Work Board Chair**: Kai Schweda (GSI)
  - **Collaboration Board Chair** (until summer): Silvia Masciocchi (GSI)
  - **Physics Working Group convenors**: Raphaelle Bailhache (Uni Frankfurt), Laura Fabbietti (TU München)
- Starting from Jan 1st 2023
  - **Deputy Spokesperson**: Kai Schweda (GSI)
  - **Deputy Physics coordinator**: Igor Altsybeev (TU München)

ALICE Germany @ FSP Meeting 2022

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Erforschung von
Universum und Materie

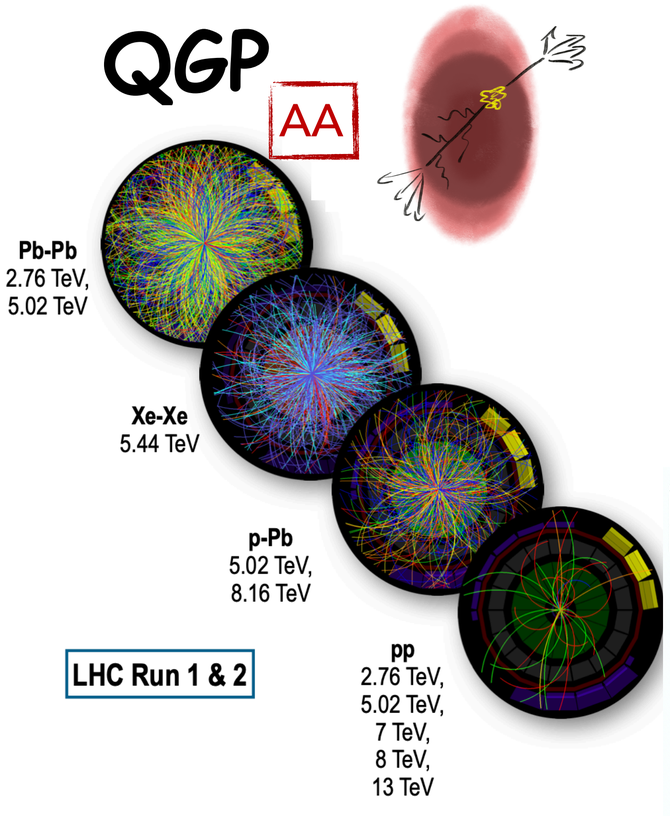


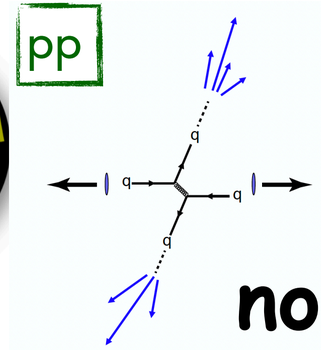
ALICE schedule

Today

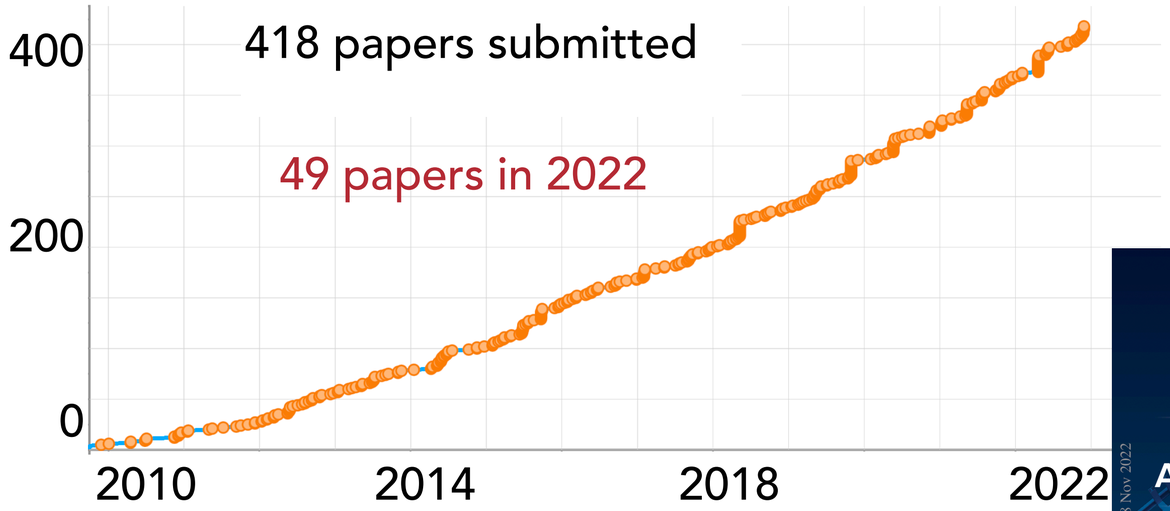
2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Run 2		Long Shutdown 2 (LS2)				Run 3				LS3		Run 4				LS 4		Run 5

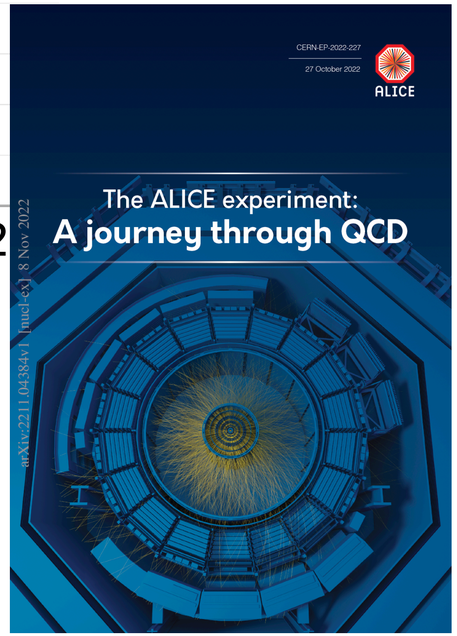
→ Major detector upgrades completed
→ Finalisation of Run 2 analyses





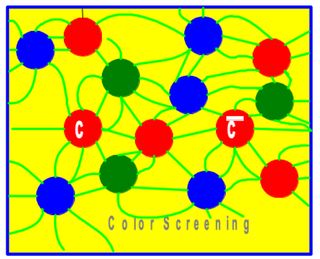
no QGP

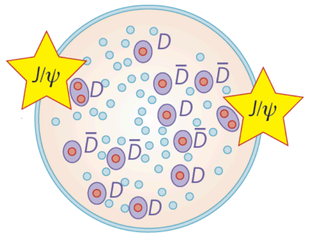


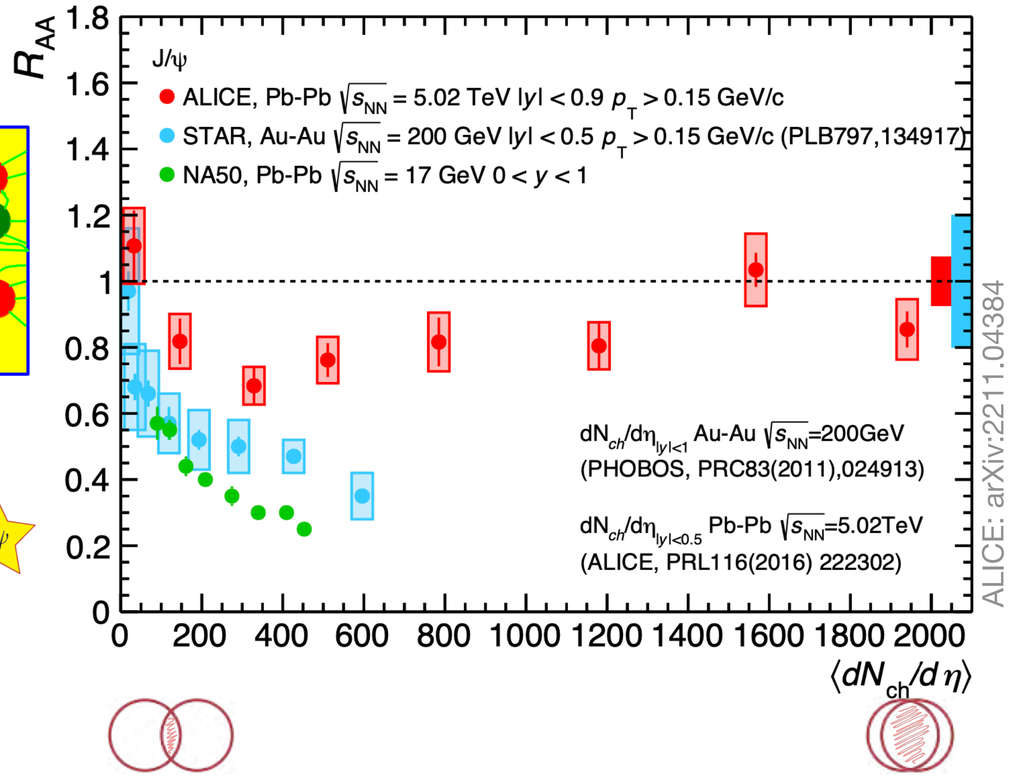


ALICE: The ALICE experiment: A journey through QCD, Review paper, arXiv:2211.04384

Pb-Pb at full energy: J/ψ (re-)generation







AA

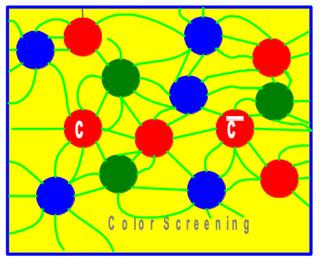
$$R_{\mathrm{AA}} = \frac{1}{\langle N_{\mathrm{coll}} \rangle} \frac{\mathrm{d}N^{\mathrm{AA}}}{\mathrm{d}N^{\mathrm{pp}}}$$

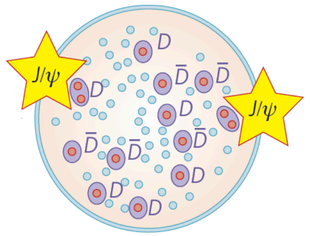
- Quarkonium production mechanism
  - Suppression due to colour screening
  - Production via (re)generation during QGP phase/at hadronisation

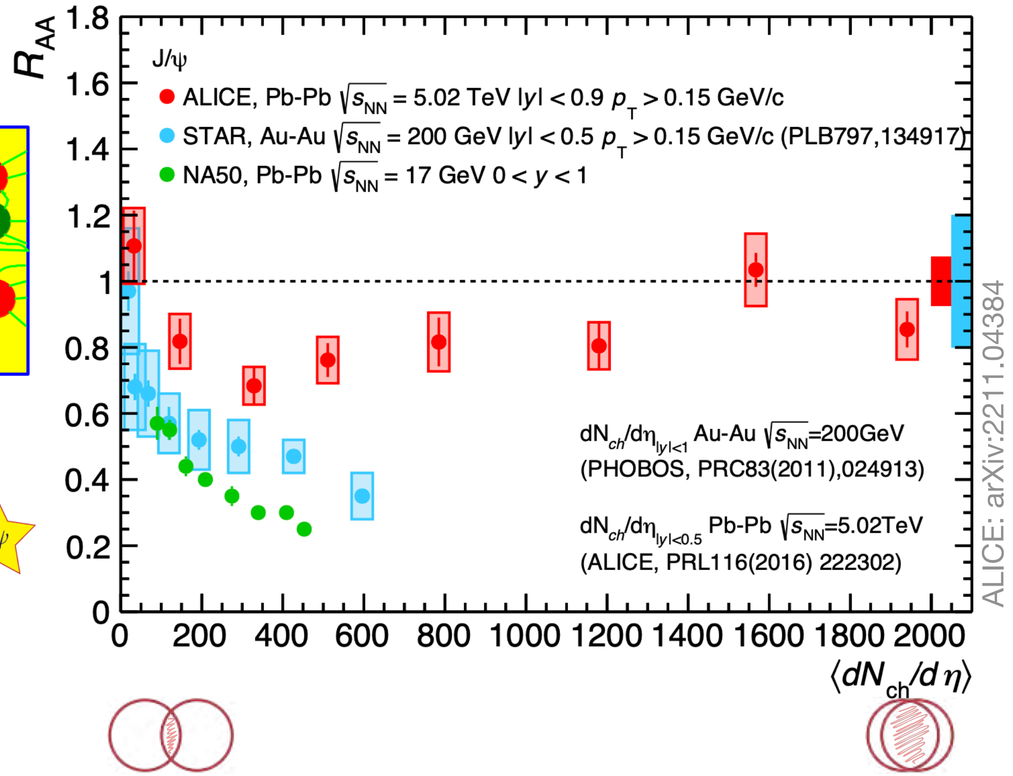
→ Suppression at SPS and RHIC energies
→ No suppression at LHC full energy

T. Matsui and H. Satz,PLB178(1986)416, P. Braun-Munzinger and J. Stachel,PLB490(2000)196,
L.Grandchamp and R.Rapp, PLB523(2001)60

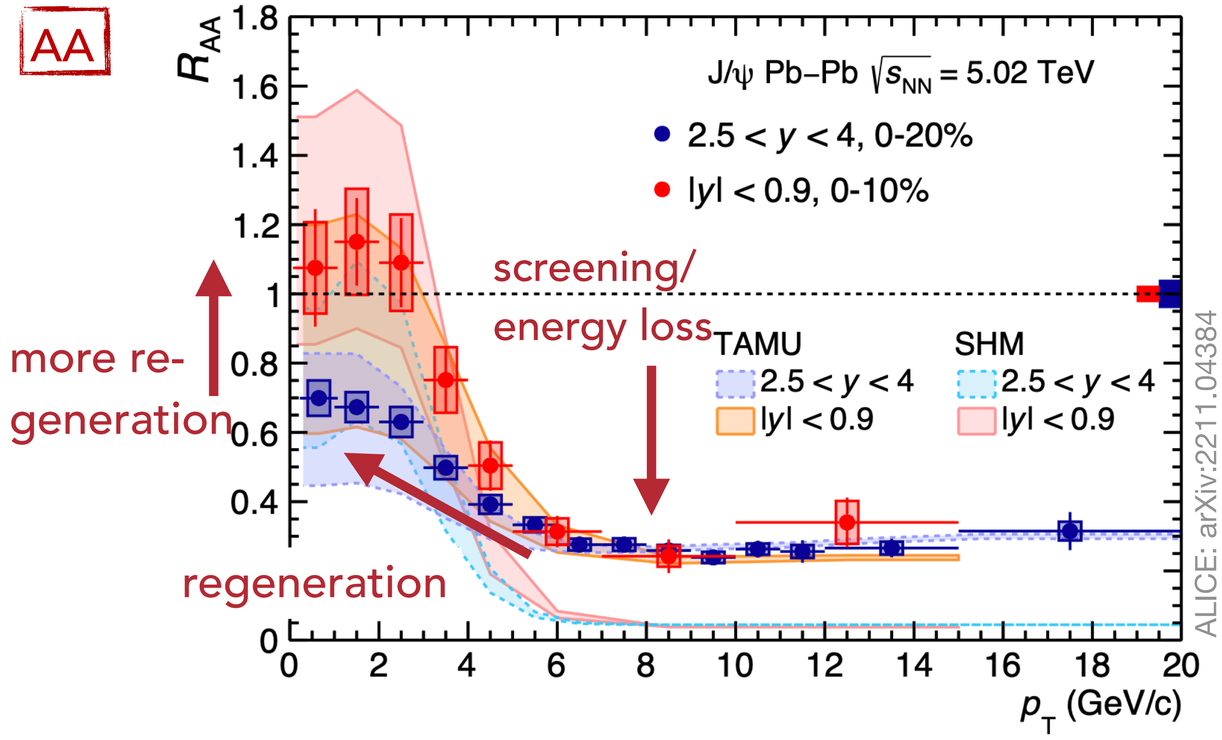
Pb-Pb at full energy: J/ψ (re-)generation







AA



- Quarkonium production mechanism
  - Suppression due to colour screening
  - Production via (re)generation during QGP phase/at hadronisation

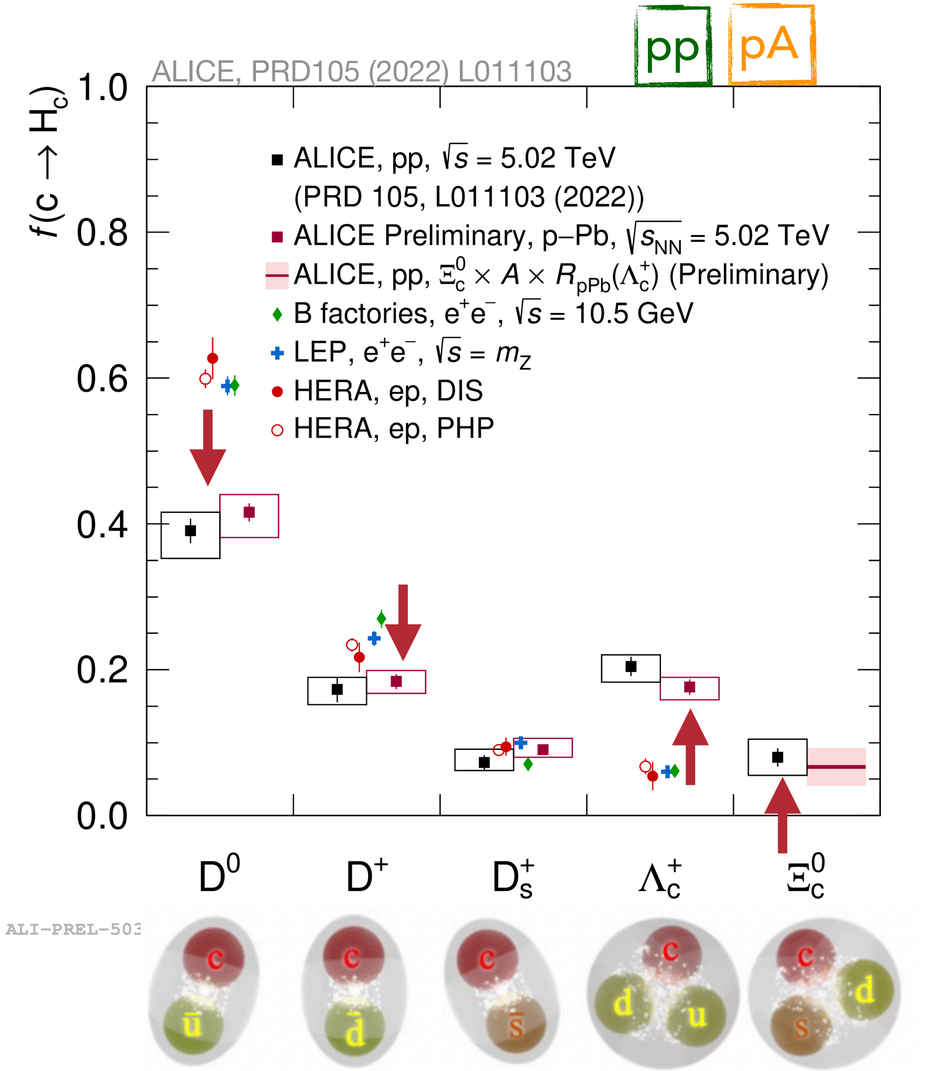
→ Suppression at SPS and RHIC energies
→ No suppression at LHC full energy
→ (Re)generation scenario dominates at low p_T

Future: more differential, higher precision; ψ(2S), …

T. Matsui and H. Satz,PLB178(1986)416, P. Braun-Munzinger and J. Stachel,PLB490(2000)196,
L.Grandchamp and R.Rapp, PLB523(2001)60

Hadronisation of heavy quarks from pp to Pb-Pb

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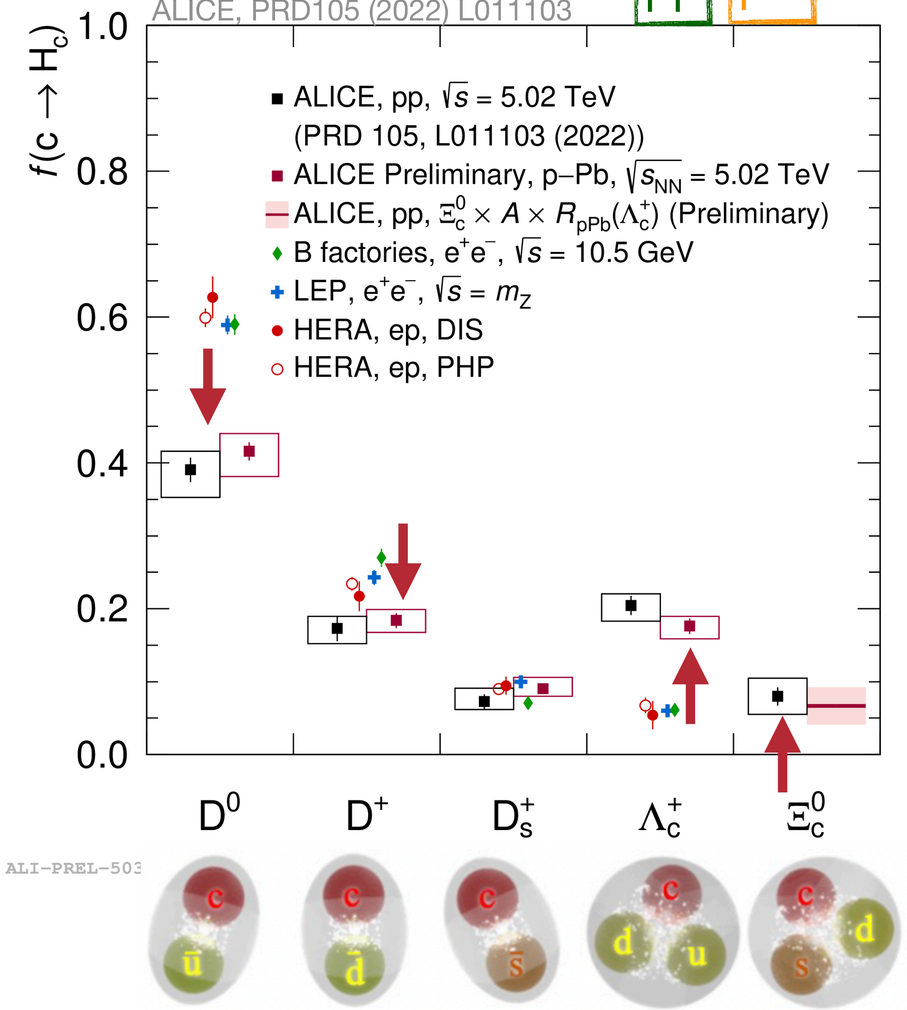
→ Charm-fragmentation fractions not universal

Hadronisation of heavy quarks from pp to Pb-Pb

FSP ALICE
Erforschung von Universum und Materie

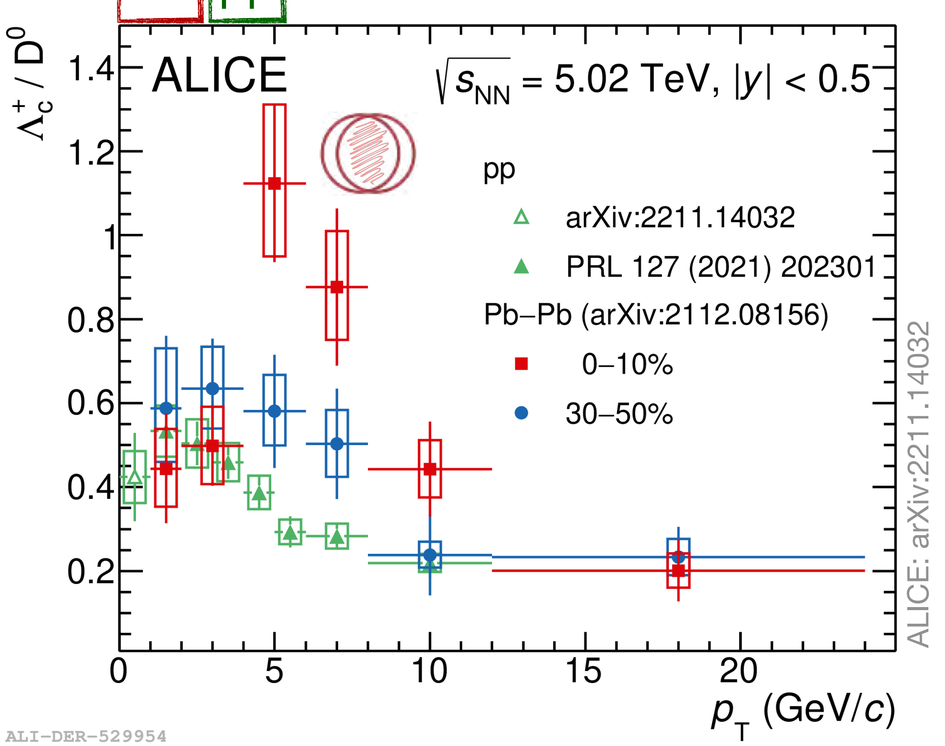
pp pA

ALICE, PRD105 (2022) L011103



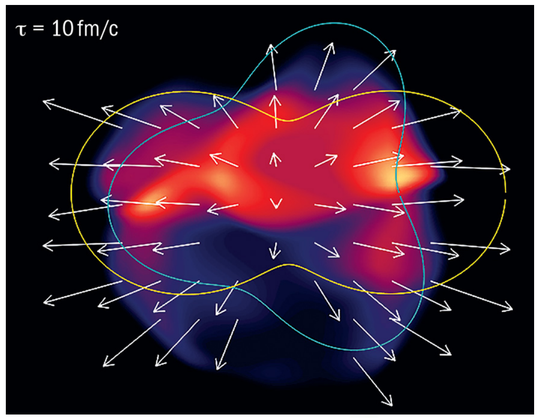
ALI-PREL-503

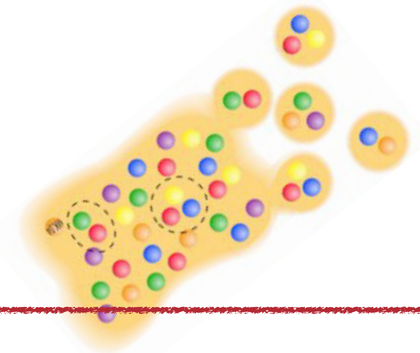
AA pp



ALI-DER-529954

MUSIC: C. Gale et al., PRL(2013) 012302



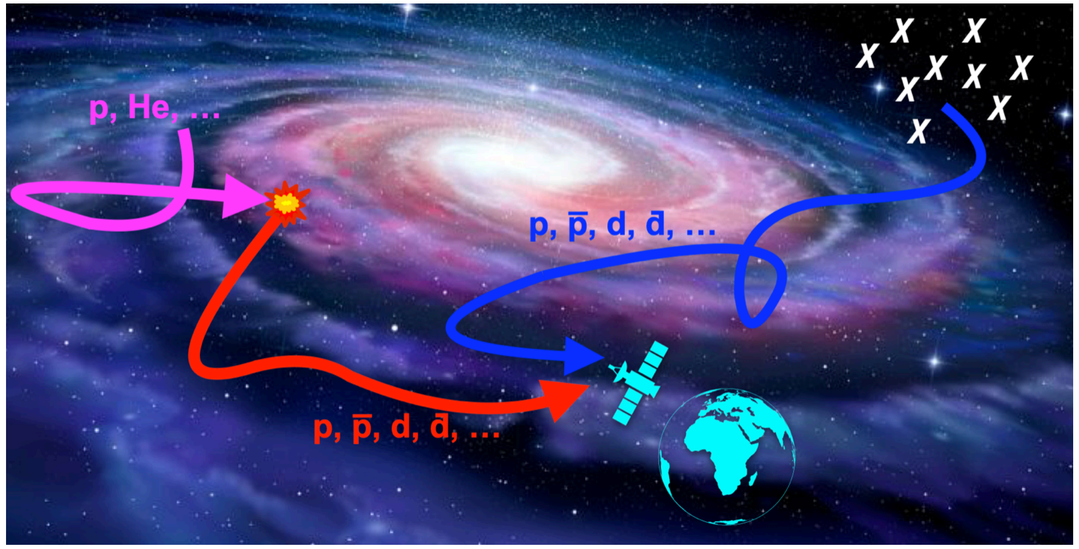


→ Charm-fragmentation fractions not universal

→ Hadronisation via recombination + mass-dependent p_T shift by collective expansion in central Pb-Pb

Future: precision frontier; beauty sector

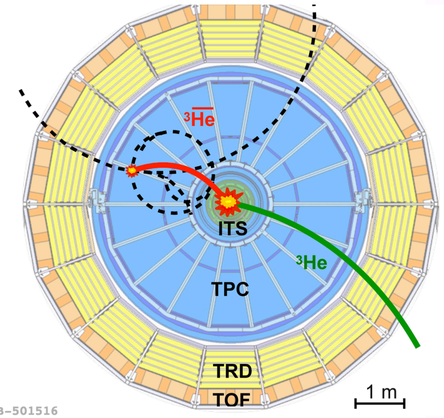
Input for searches for dark matter signals

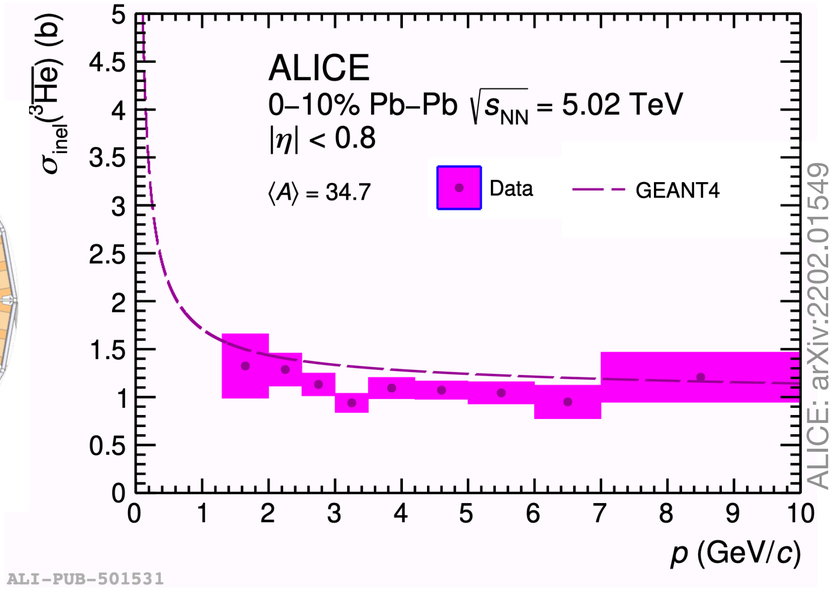


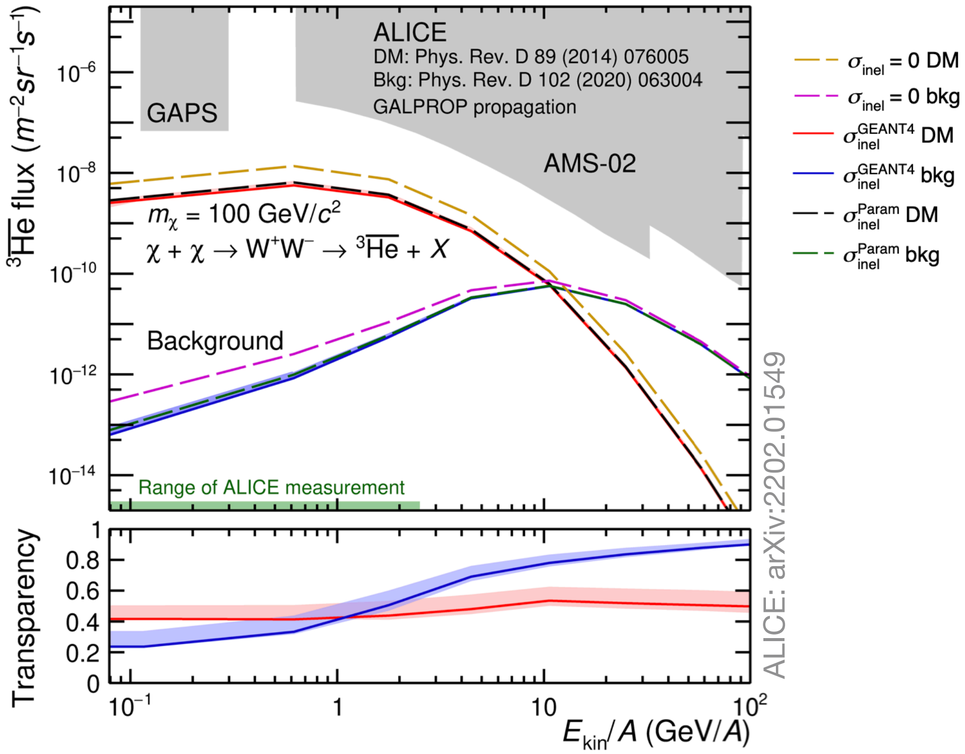
- Understand antinuclei production and absorption

  → tune event generators …

- Detector as absorber to study antinuclei inelastic cross section





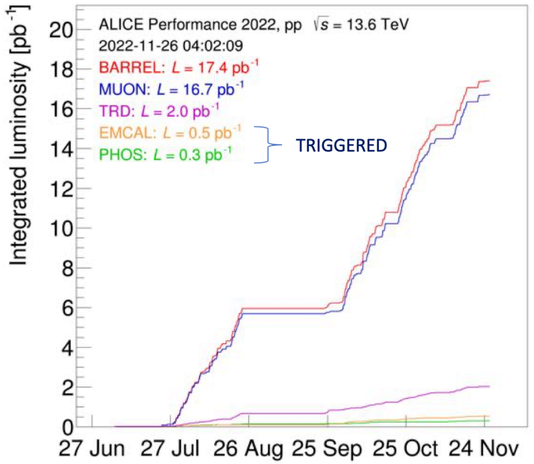


Future: more differential, higher precision; antitriton, …

ALICE schedule

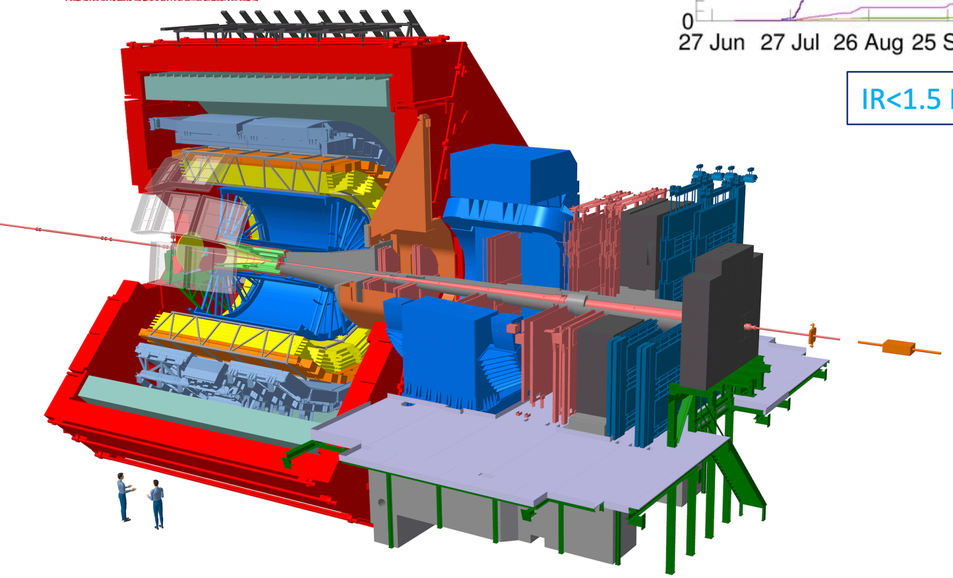
Today

2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Run 2				Long Shutdown 2 (LS2)		Run 3			LS3			Run 4				LS 4		Run 5



IR<1.5 MHz

ALICE 2



Future is now!

→ Major upgrades installed
→ Successful operation in beam
→ Preparatory tests in view of Pb-Pb run

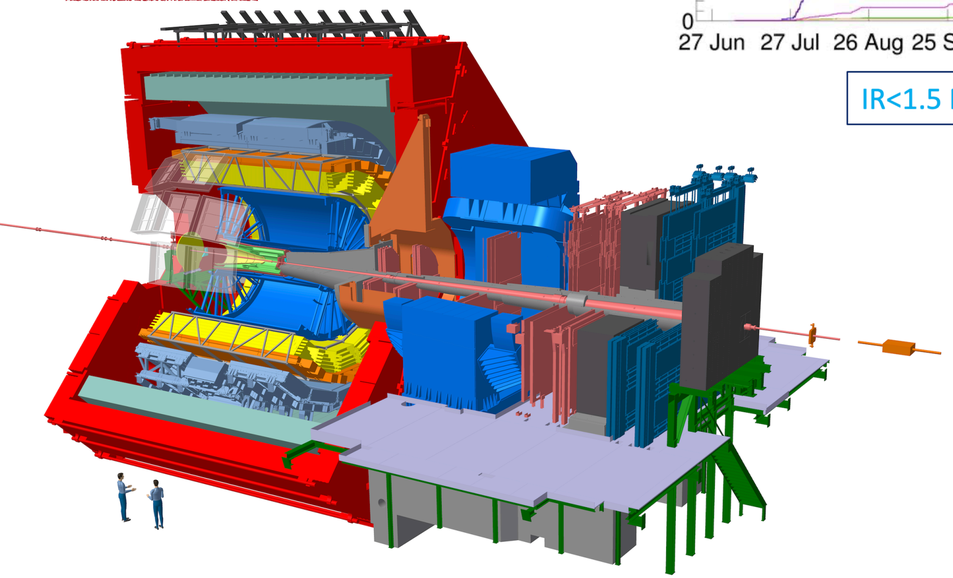
ALICE schedule

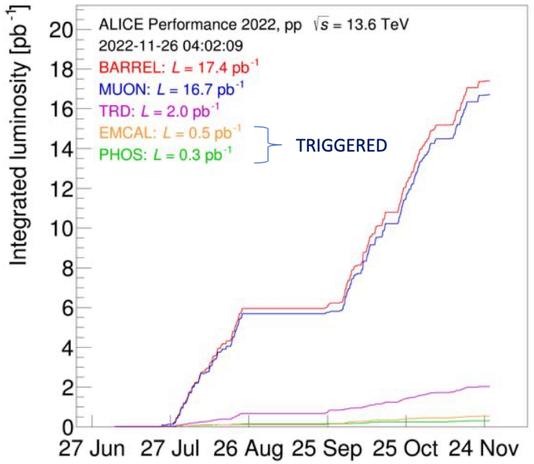
Today

2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035

Run 2 | Long Shutdown 2 (LS2) | Run 3 | LS3 | Run 4 | LS 4 | Run 5

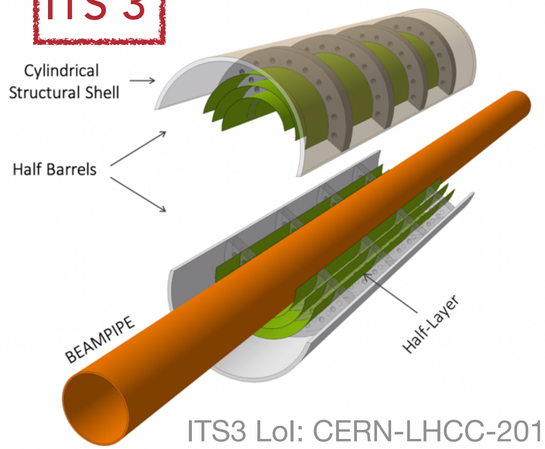
ALICE 2





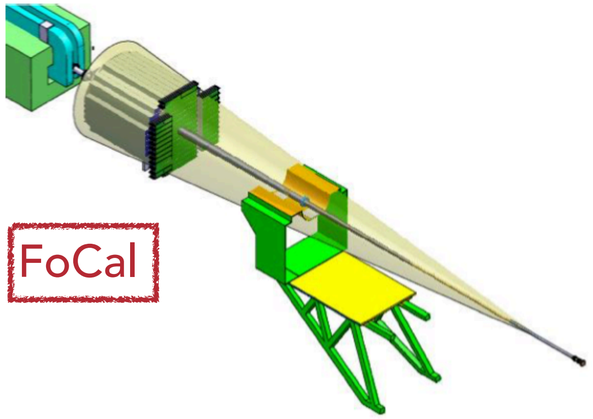
IR<1.5 MHz

ITS 3



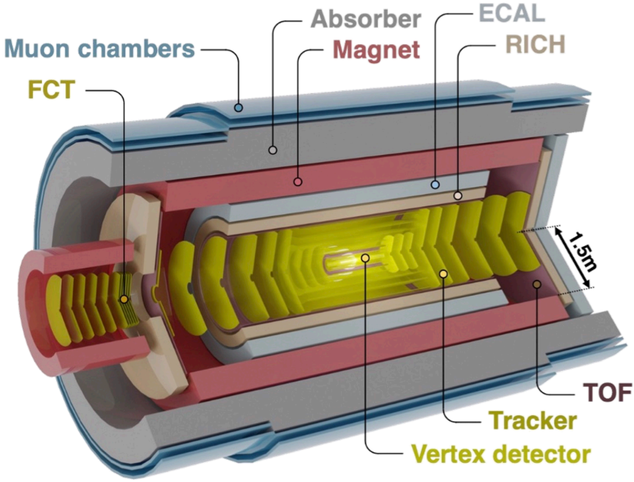
ITS3 LoI: CERN-LHCC-2019-018

FoCal



FoCal LoI: CERN-LHCC-2020-009

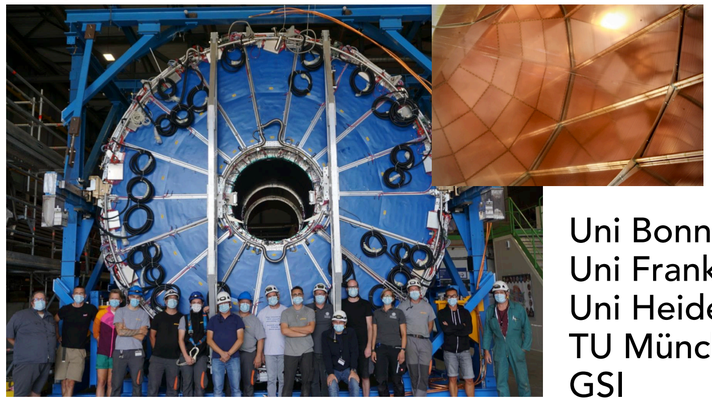
ALICE 3



ALICE 3 LoI: CERN-LHCC-2022-009

→ see talk by Raphaelle Bailhache

ALICE LS2 upgrades



Uni Bonn
Uni Frankfurt
Uni Heidelberg
TU München
GSI

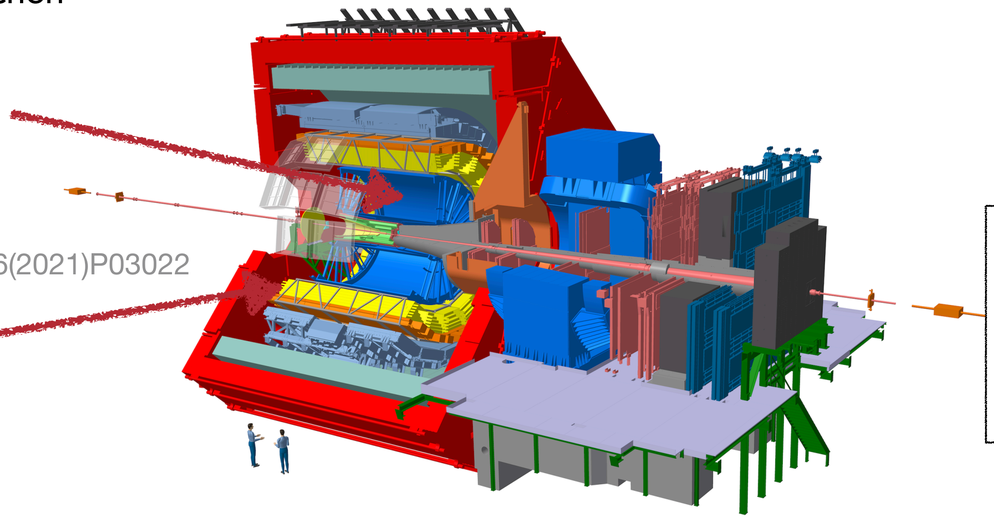
→ Continuous readout, Pb-Pb @ 50 kHz
→ Improve tracking efficiency and resolution at low p_T
→ Preserve excellent particle identification





Uni Frankfurt
GSI

Time Projection Chamber
- GEM-based readout chambers
- New front-end electronics



ALICE TPC:JINST16(2021)P03022



Uni Frankfurt
Uni Heidelberg
Uni Münster
GSI

Integrated Online-Offline System (O^2)
- Online processing of Pb-Pb data at 50 kHz
- Highly-selective software-based event skimming
- Event Processing Nodes (usage of GPUs)

Transition Radiation Detector
- Repair of supermodules
- Upgraded readout scheme

- Further upgrades
  - New Inner Tracking system: CMOS Monolithic Active Pixel Sensor technology
  - New Fast Interaction Trigger (FIT) Detector (centrality, event plane)
  - Readout upgrade: TOF, MUON, ZDC, Calorimeters
  - New Muon Forward Tracker (CMOS Pixels, MAPS technology)

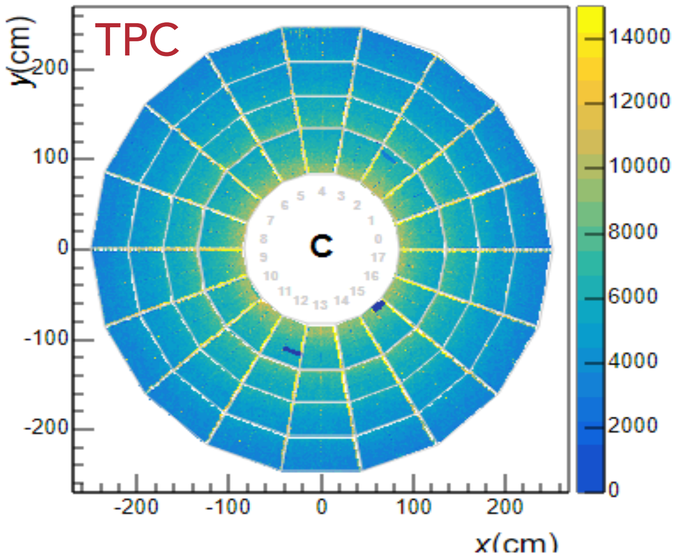
GSI Analysis Facility (Darmstadt, Germany)
- 2022 pledges: 50 kHS06 and 5.2 PB (~5.0K job slots)
- Worker nodes have direct mount of the cluster file system Lustre
- Optimised I/O throughput: custom XRootD Plugin provides direct access to data (expected 115 GB/s)

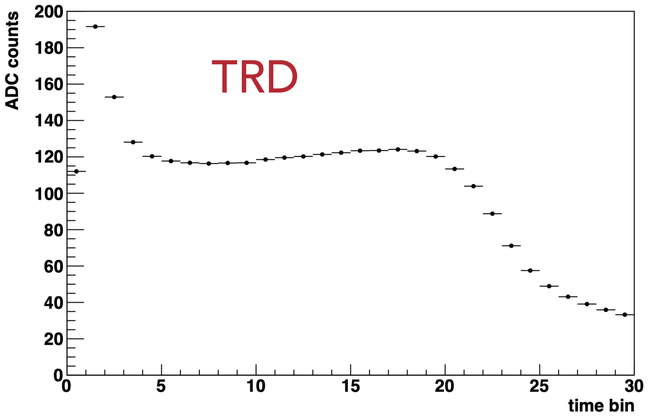
Performance in 2022

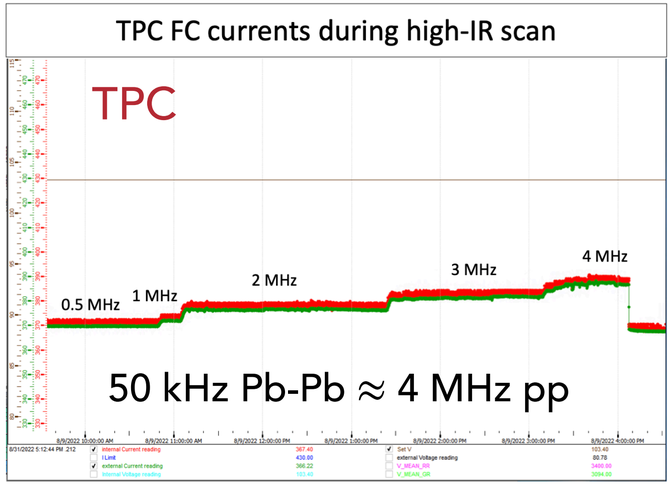
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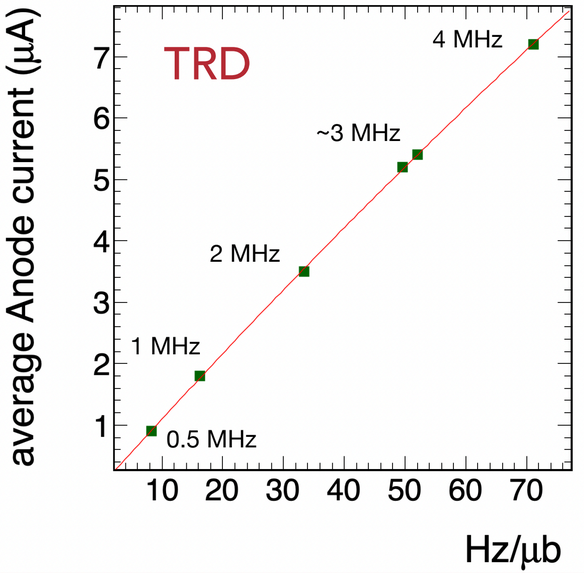
- Successful detector commissioning and physics data taking
  - TPC - GEM acceptance: 99.8% of nominal active area
  - TRD: thanks to repair work regained 12% of detector acceptance
  - FLP + EPN: Full synchronous processing and online quality control

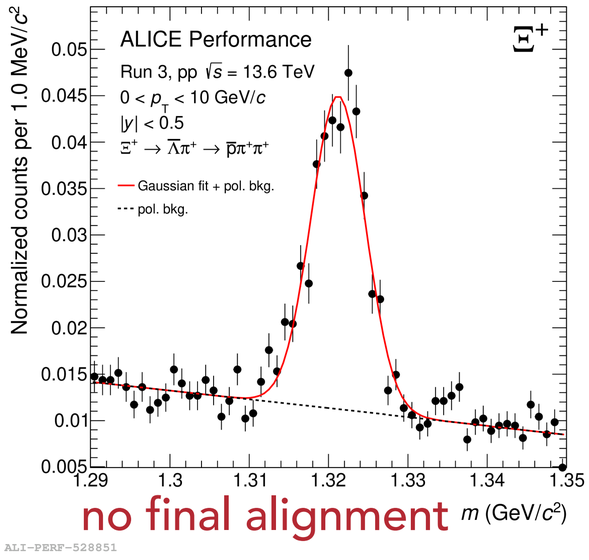
    (no instabilities or data corruption)
- Online quality control and calibration almost fully in production stage
- Heavy-ion preparation: rate scans at 2/3/4 MHz pp collisions - stable operation







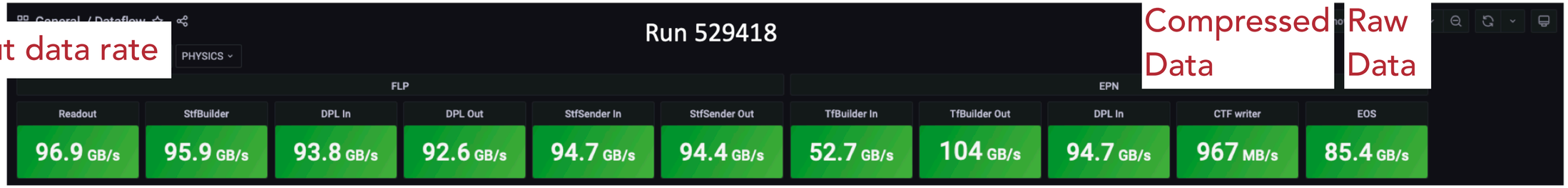




Pb-Pb Test Run

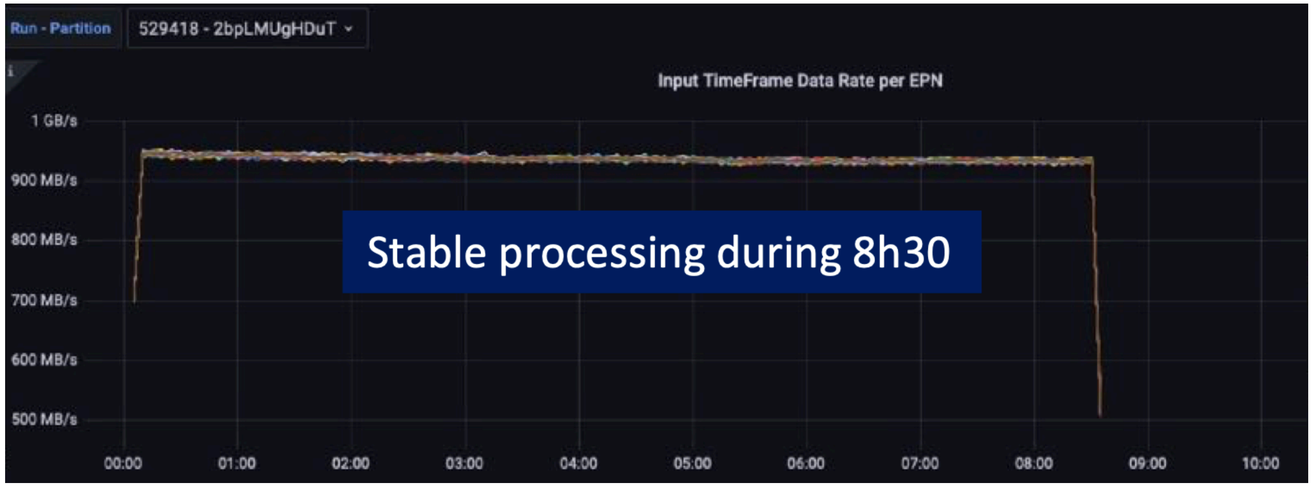
- All 15 detectors in data taking
- Online calibrations and reconstruction (incl. most central events)
- 3.68 PB of data recorded (CTF and Raw TF) → 1.1M minimum bias events
- FILL 8413, 8h30, efficiency 97.6%

Input data rate



Compressed Data

Raw Data

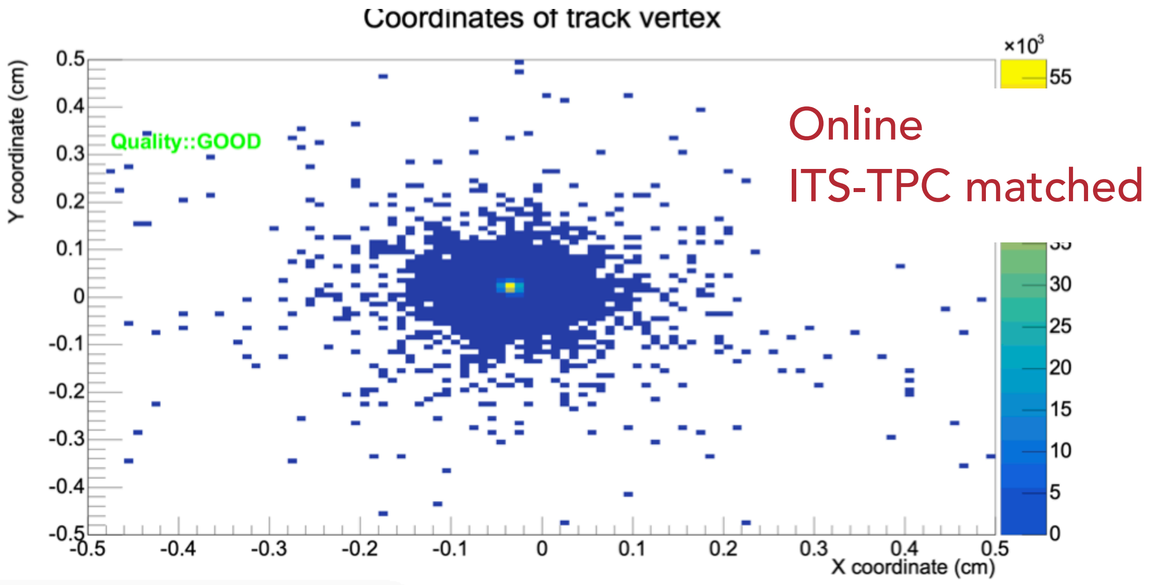


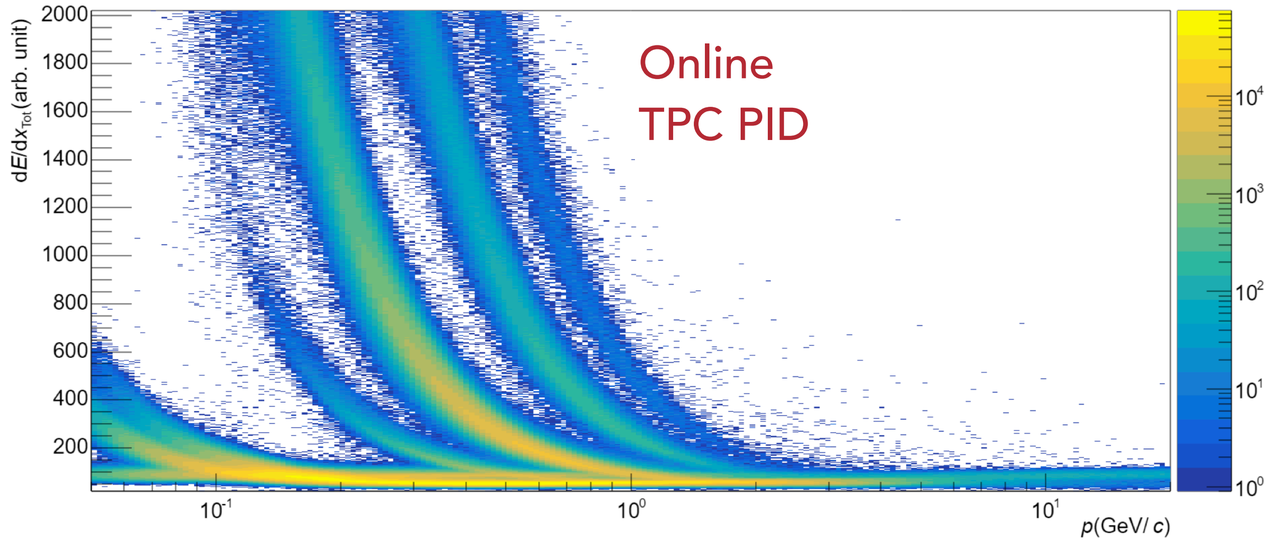
Pb-Pb Test Run

Synchronous processing

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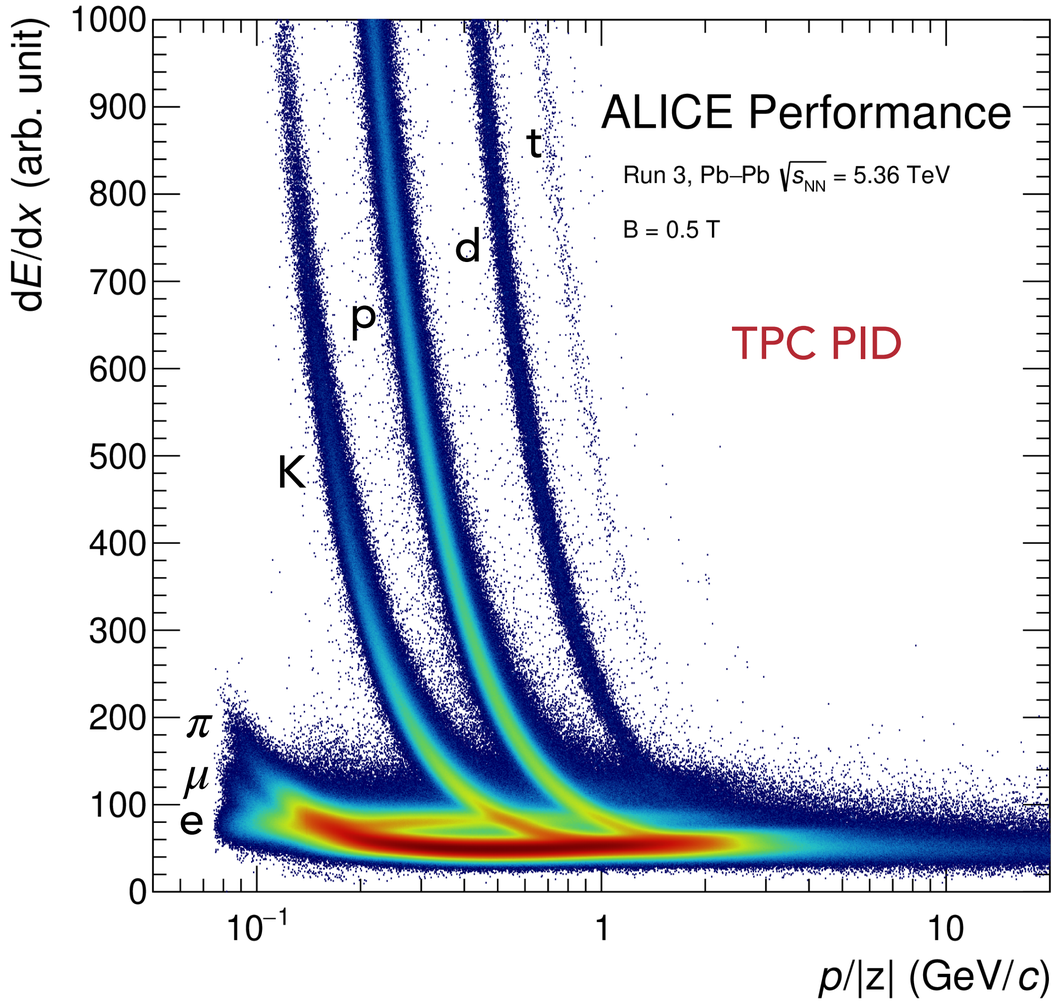
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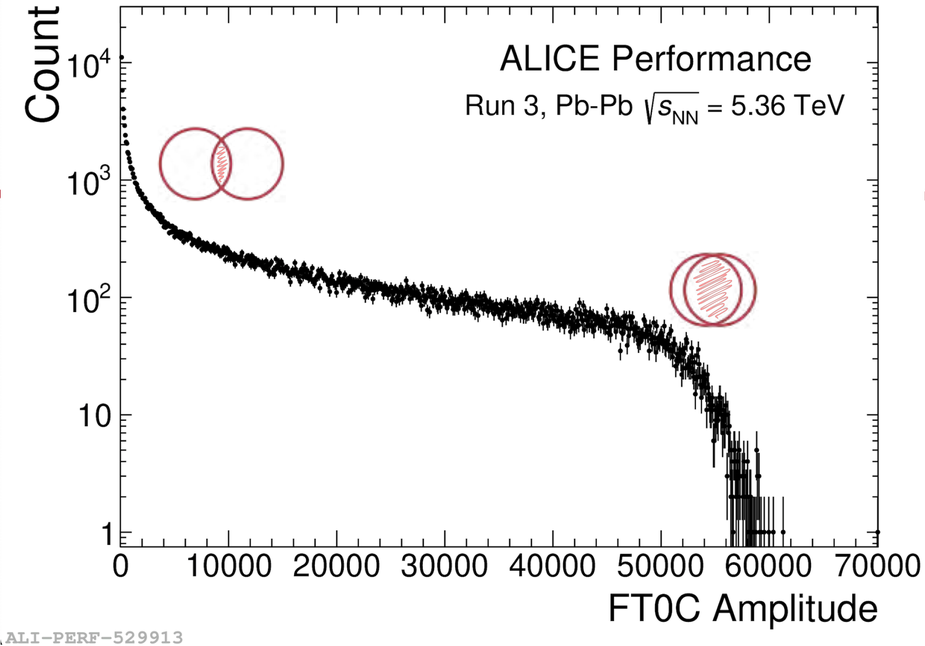


Pb-Pb Test Run

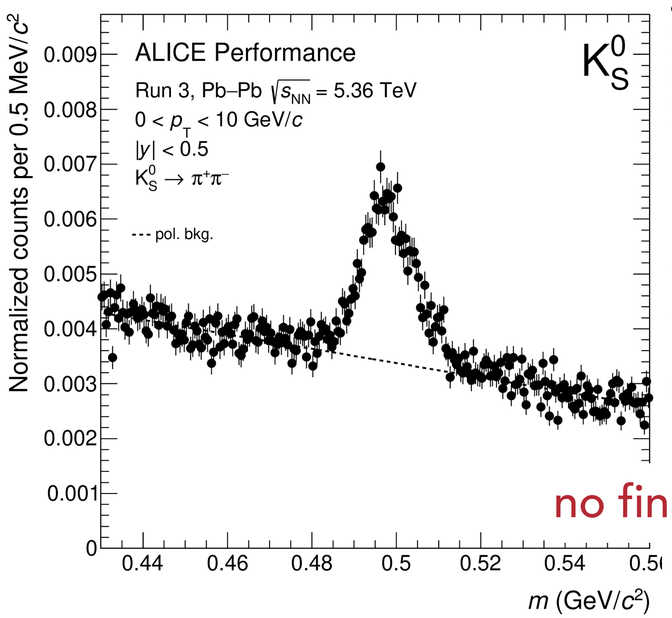
Asynchronous reconstruction



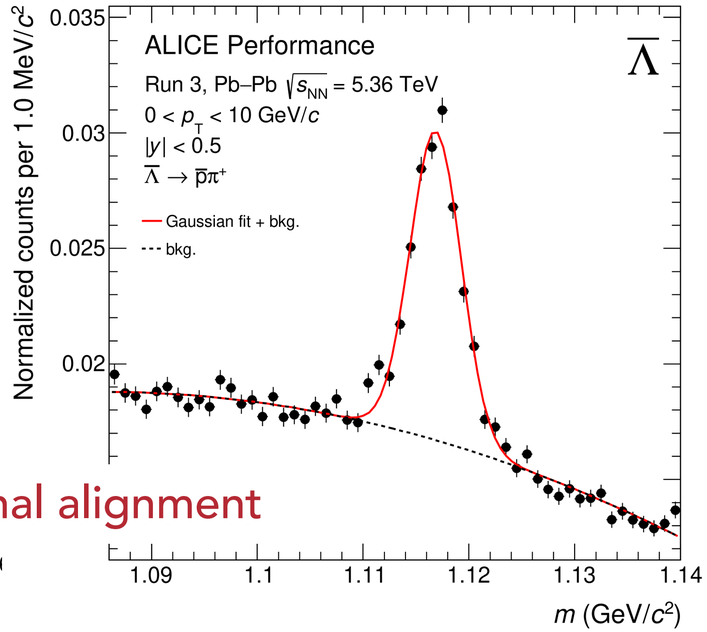
ALI-PERF-529718



ALI-PERF-529913



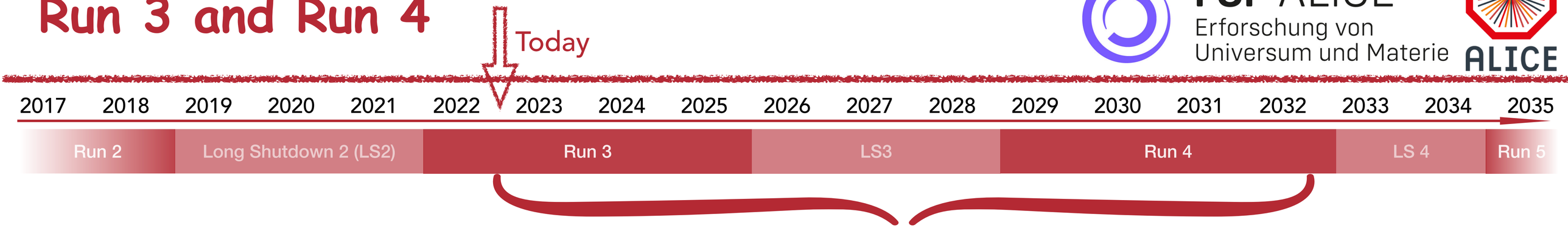
ALI-PERF-529737



no final alignment

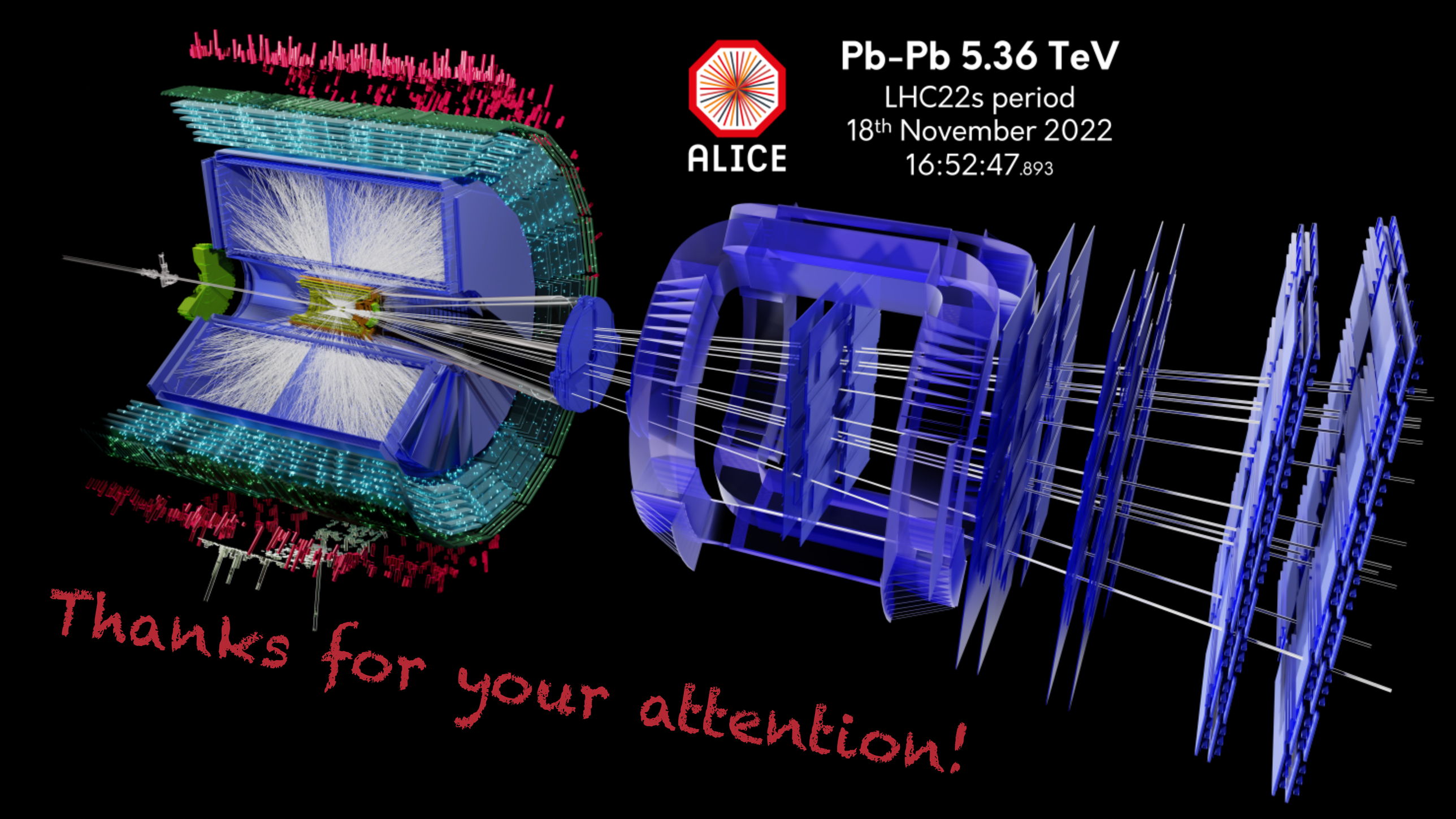
ALI-PERF-529729

Run 3 and Run 4



- ALICE heavy-ion plans for Run 3 and Run 4 (approved in 2013)
  - Pb-Pb high *B*-field: 10 nb^{-1}; Pb-Pb low *B*-field: 3 nb^{-1}; pp-reference: ~13 pb^{-1}; p-Pb: 300 pb^{-1}
  - Run 3: heavy-ion runs in 2023/2024/2025 taking about half of the data sample sizes
  - **Goal: Map out in detail the inner workings of the QGP incl. improving precision/reach for rare probes**
- pp run at 13.6 TeV
  - MB and pp high-multiplicity (HM) programme (200 pb^{-1})
  - **Goal: study possible QGP effects in HM pp (multiplicity as in semiperipheral Pb–Pb collisions), light nuclei and hyper-nuclei production cross sections and production mechanisms, rare QCD processes, virtual low-p_T photons**
- O-O, p-O run
  - **Goal: Search for possible jet quenching effects, study flow effects, open and hidden charm bridging the multiplicity range from pp and p-Pb to Xe-Xe and Pb-Pb**

Run 3 + 4 physics programme: Z. Citron et al., arXiv:1812.06772
ALICE high-energy pp programme: ALICE-PUBLIC-2020-00
ALICE oxygen-beam run: ALICE-PUBLIC-2021-004


ALICE
Pb-Pb 5.36 TeV
LHC22s period
18th November 2022
16:52:47.893
Thanks for your attention!