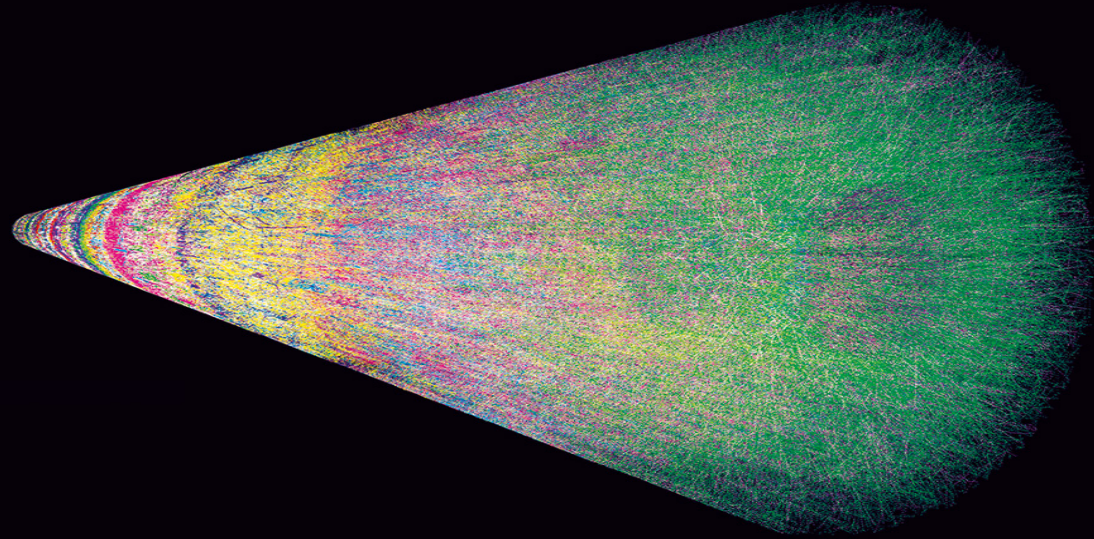


# New Ion Collisions in Run 4 - ALICE Perspective



Anthony Timmins





# Progress on Run 3 light-ions with ALICE

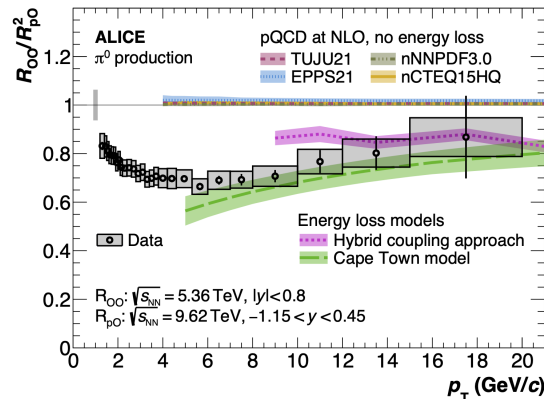
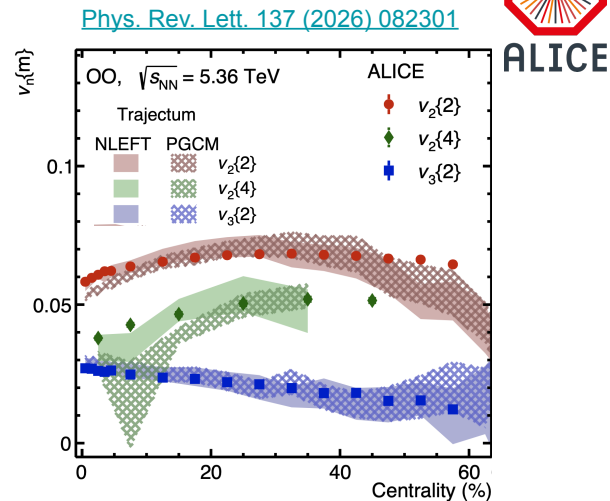
Two papers accepted by PRL - five currently under collaboration review

Around **50 light-ion analyses** approved for preliminary in 2026

- Presented at SQM, HP, LHCP and ICHEP and [here](#)
- Many more expected for QM 2027

Wide range of exploratory and precision studies to **pin down smallest possible QGP** enabled by:

- Successful LS2 ALICE upgrades
- Performance of LHC and ALICE during light-ion running



[arXiv:2606.19967 \(Accepted by RPL\)](#)

# Progress on Yellow Report Run 3+4 luminosity targets

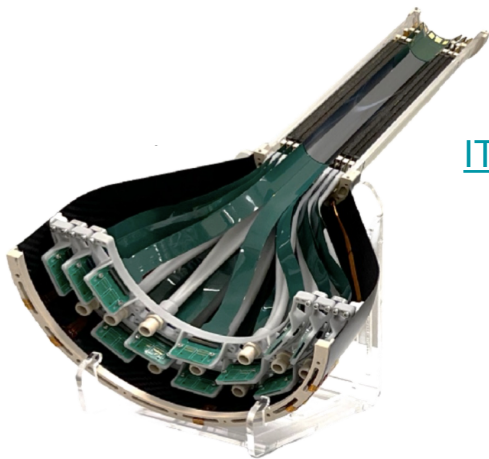
| Year | Systems, $\sqrt{s_{NN}}$ | Time     | $L_{int}$                                                                                    |
|------|--------------------------|----------|----------------------------------------------------------------------------------------------|
| 2021 | Pb–Pb 5.5 TeV            | 3 weeks  | $2.3 \text{ nb}^{-1}$                                                                        |
|      | pp 5.5 TeV               | 1 week   | $3 \text{ pb}^{-1}$ (ALICE), $300 \text{ pb}^{-1}$ (ATLAS, CMS), $25 \text{ pb}^{-1}$ (LHCb) |
| 2022 | Pb–Pb 5.5 TeV            | 5 weeks  | $3.9 \text{ nb}^{-1}$                                                                        |
|      | O–O, p–O                 | 1 week   | $500 \mu\text{b}^{-1}$ and $200 \mu\text{b}^{-1}$                                            |
| 2023 | p–Pb 8.8 TeV             | 3 weeks  | $0.6 \text{ pb}^{-1}$ (ATLAS, CMS), $0.3 \text{ pb}^{-1}$ (ALICE, LHCb)                      |
|      | pp 8.8 TeV               | few days | $1.5 \text{ pb}^{-1}$ (ALICE), $100 \text{ pb}^{-1}$ (ATLAS, CMS, LHCb)                      |
| 2027 | Pb–Pb 5.5 TeV            | 5 weeks  | $3.8 \text{ nb}^{-1}$                                                                        |
|      | pp 5.5 TeV               | 1 week   | $3 \text{ pb}^{-1}$ (ALICE), $300 \text{ pb}^{-1}$ (ATLAS, CMS), $25 \text{ pb}^{-1}$ (LHCb) |
| 2028 | p–Pb 8.8 TeV             | 3 weeks  | $0.6 \text{ pb}^{-1}$ (ATLAS, CMS), $0.3 \text{ pb}^{-1}$ (ALICE, LHCb)                      |
|      | pp 8.8 TeV               | few days | $1.5 \text{ pb}^{-1}$ (ALICE), $100 \text{ pb}^{-1}$ (ATLAS, CMS, LHCb)                      |
| 2029 | Pb–Pb 5.5 TeV            | 4 weeks  | $3 \text{ nb}^{-1}$                                                                          |

**Pb-Pb goal:  $13 \text{ nb}^{-1}$ .** Approximately  $7 \text{ nb}^{-1}$  collected in Run 3.

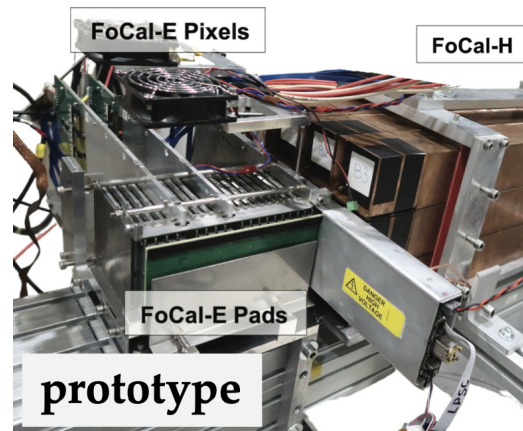
**OO goal:  $0.5 \text{ nb}^{-1}$ .** Target exceeded by factor of 10 (also for p-O).

**p-Pb goal:  $600 \text{ nb}^{-1}$ .** Very hard to achieve due to no p-Pb running in Run 3.

# Two world-class heavy-ion detectors for Run 4



ITS3 letter of  
intent



FoCal letter of  
intent

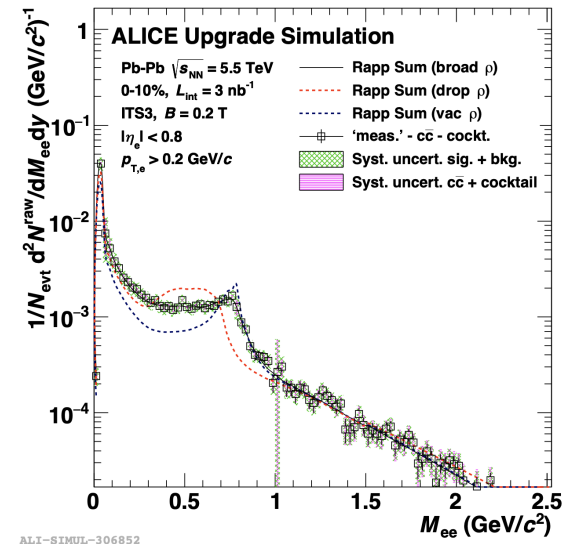
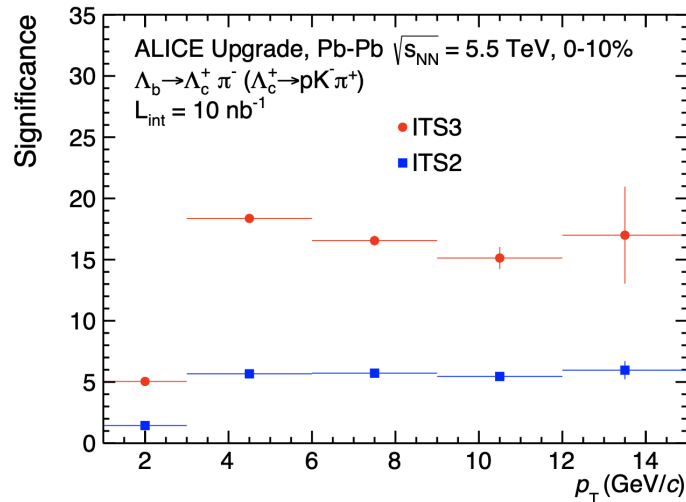
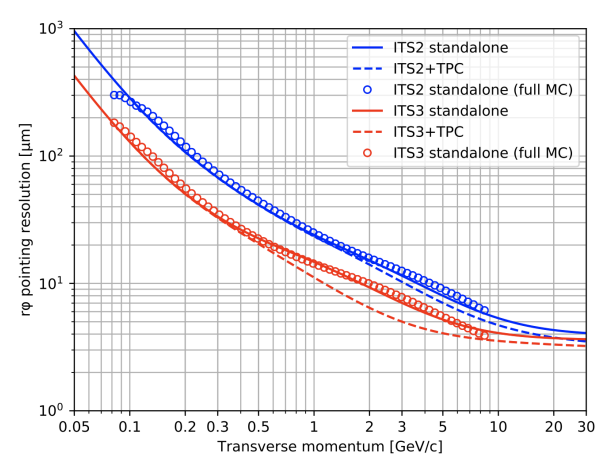
Letters of Intent for **ITS3** and **FoCal** submitted **2019** and **2020**

- Approved by CERN, funded, and currently under construction

**Groundbreaking technologies** developed from our field:

- Wafer-thin silicon detectors and highly granular calorimeters critical for our and future experiments

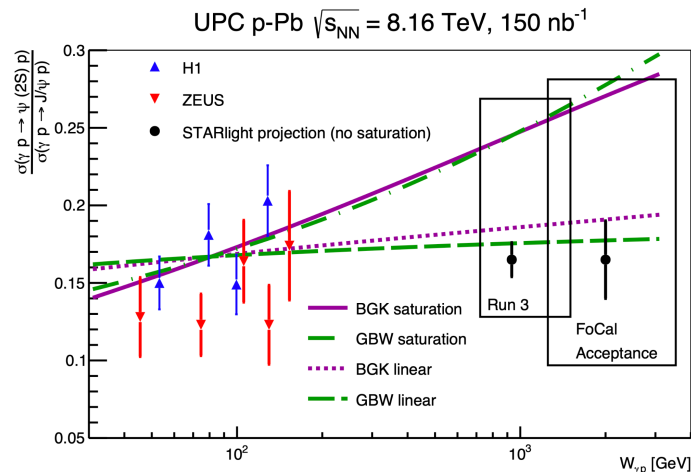
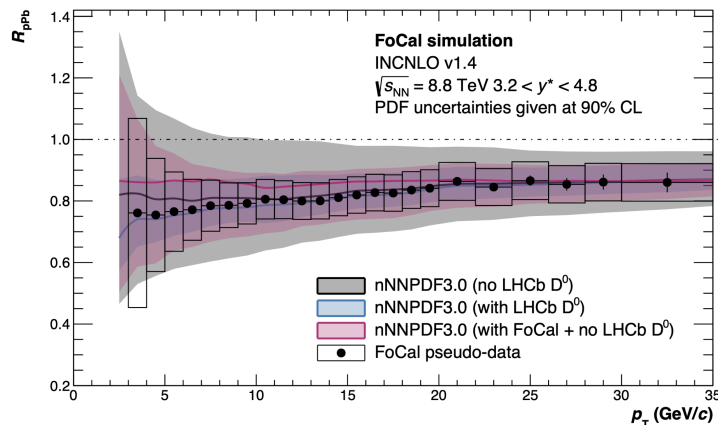
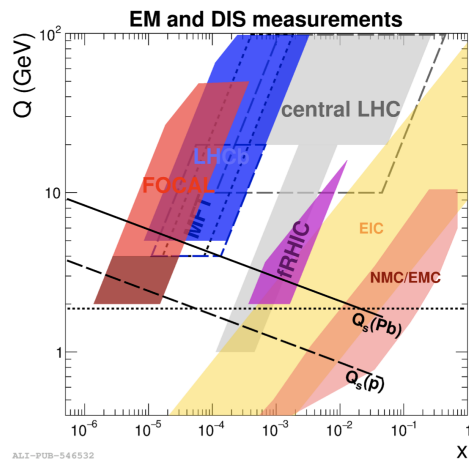
# A new Hot QCD frontier for Run 4



**ITS3:** Dramatic increase in open-charm & di-electrons signal/background in **Pb-Pb** enables new tests:

- Microscopic mechanisms of **QGP equilibration and hadronization via charm and beauty** (full B-field)
- **Direct probes of QGP thermal emission** with di-electrons (low B-field)

# A new Cold QCD frontier for Run 4



**FoCal: Forward Electromagnetic Calorimeter p-Pb at largest possible 8.5 TeV energy enables:**

- Multi-messenger program to explore **low- $x$  ( $10^{-6} < x < 10^{-4}$ ) partons in lead and proton**
- Direct photons, di-hadron and photon-jet correlations, UPC vector-mesons etc

# ALICE Run 4 ion running priorities

- 29 days of Pb-Pb 5.36 TeV at full B-field:  $\sim 3 \text{ nb}^{-1}$
- 29 days of p-Pb 8.5 TeV in both directions:  $\sim 150 \text{ nb}^{-1}$  each way
- 29 days of Pb-Pb 5.36 TeV at low B-field:  $\sim 3 \text{ nb}^{-1}$
- 9 days of pp 5.36 TeV:  $\sim 3 \text{ pb}^{-1}$
- 6 days of pp 8.5 TeV:  $\sim 1.5 \text{ pb}^{-1}$
- **102 days total (87 available)**

Days needed represent best estimates from LHC to reach ITS3 and FoCal luminosity goals

- Include setup, ramp-up, VDM scans and physics with ALICE running at max data-rates

**Currently 15 days or 20% over budget to fulfil existing plans**

# Perspectives from ALICE

**ALICE** is fully committed to exploiting the physics potential of **Run 3 light-ion data samples**

- Key protagonist of OO running at LHC
- Broad capabilities and resources as dedicated heavy-ion experiment are being fully utilized

Run 4 physics programs of the **ITS3** and **FoCal** centered on **Pb-Pb** and **p-Pb** running must succeed:

- Expected 87 days for Run 4 heavy-ions **reduced by nearly 2 weeks** compared to Yellow Report
- Challenging trade-offs will be evaluated within default plan
- Difficult to imagine additional ion species can be accommodated in Run 4 from heavy-ion budget

We will keep an **open mind** and pay close attention to developing **new ion species running proposals**

- Support new species outside current heavy-ion budget with an extremely compelling physics case