LPCC Heavy-Ion Working group

Theory Perspective

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Kickoff Meeting

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Heavy-Ions @ LHC

- After 10 years of LHC operation with heavy-ions, there are (more) **open questions** on the characteristics of the produced matter:
  - QGP-like effects in small systems?
  - Intrinsic scale(s) of the QGP?
  - How to describe macroscopic behaviour from microscopic degrees of freedom?
  - Evolution of QGP constitution with different probing wavelengths?
  - Is Hadronization process dependent?
  - Saturation physics or alternative scenarios to describe initial state?
  - …

Theory in the LPCC HI WG

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- Interplay between theory and experiment:
  - Benchmark the present
  - Prepare for the future

Benchmark the present

- Extract meaningful **QGP properties** from current observables taking advantage of **common theory-experiment discussion forum**
  - Determination of the **theoretical uncertainties** towards identification of needed experimental requirements
  - **Identification** of minimum set of observables
  - **Standardisation** across experimental collaborations towards **higher experimental accuracy**

Data-theory Comparison

- *Examples*:
  - LHC data-combination working group (Honexcomp) — See G. Manca's talk
    - On-going project to perform combined open charm results from LHC collaborations
  - Strong-2020: NA2-Small-x and NA3-Jet-QGP
    - Strengthening the communication and collaboration between the European groups involved in theoretical and phenomenological studies in small-x physic
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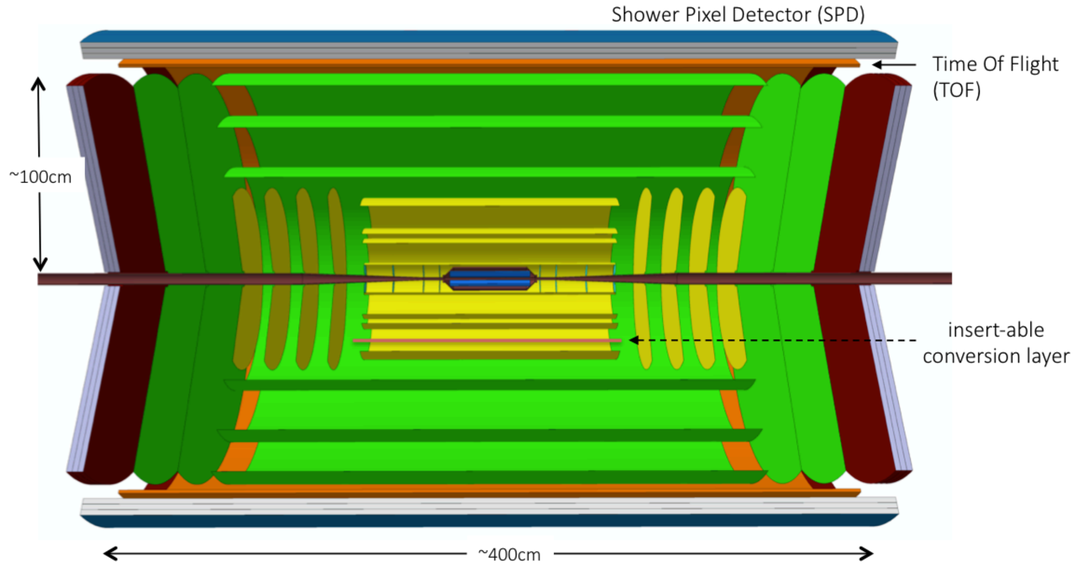
Can the WG provide a review on the scientific achievements to leverage future efforts?

Prepare for the future

- Exploring physics opportunities for:
  - Lighter ion run at LHC (Run 3)
  - Experiments upgrades (Run 4)
    - Ex: ALICE, LHCb,…
  - HE-LHC



Lighter Ions

- *Example* of a “template action” that may profit from the LPCC HI Working Group:
  - Dedicated workshop (J. Brewer, A. Mazeliauskas and W. Van der Schee) to explore the physics opportunities of OO and pO collisions.
  - Benefit from cross-talk between:
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  - Benefit from cross-talk between:
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  - LPCC HI working group could further develop these opportunities
    - We have reached out to the workshop organisers and we ask for your feed-back

A dedicated sub-group on Lighter Ions ?

- Output: identification of open questions and prioritisation of future efforts
  - Proton-proton reference at same √s
  - pO collisions for nPDF determination and cosmic ray muon air shower problem
  - OO Minimum luminosity to accurate energy loss determination
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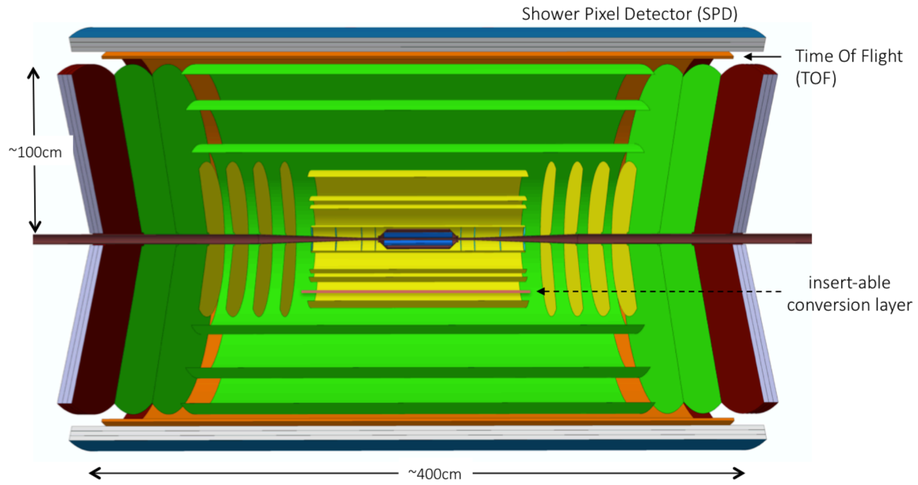
- Creation of a **dedicated sub-group** targeting follow-up efforts
  - **Should we discuss today concrete steps for setting up this sub-group?**

ALICE Upgrade

- Compact, next-generation multi-purpose detector
  - Higher luminosities: factor of 100 gain in statistics
  - **Rich physics program**
    - Heavy-flavour and quarkonia
    - Low-mass dileptons ($0 < m < 3$ GeV)
    - Chiral Symmetry Restoration
    - Soft and ultra-soft photons ($1 < p_T < 100$ MeV)

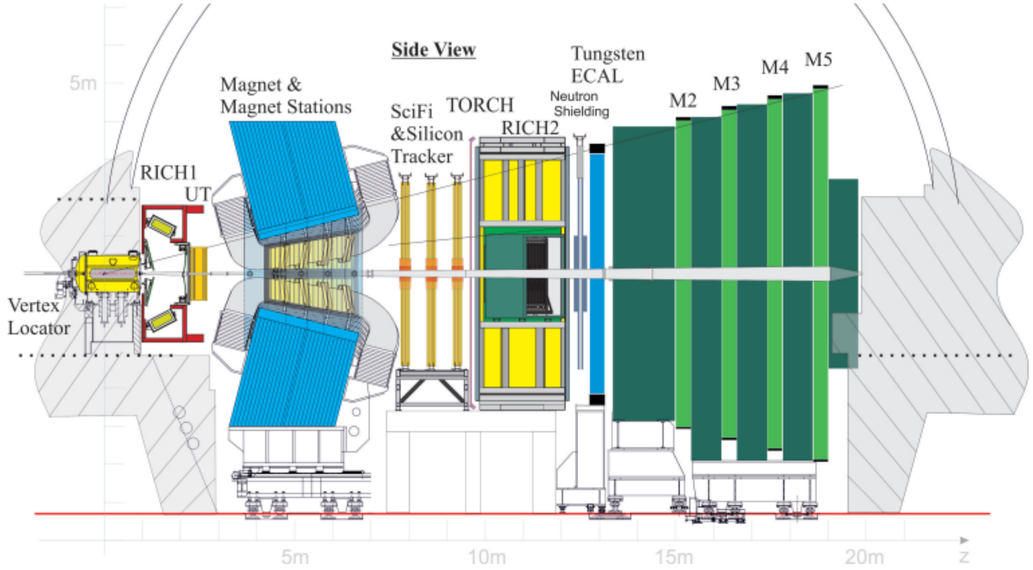


Promote further synergies between theory and experiment

Interplay between soft and hard sector

LHCb Upgrade

- LHCb: forward General-Purpose Detector at the LHC ($2 < \eta < 5$)
  - nPDF at small-x through Drell-Yan production in pPb
  - Precision measurements for heavy-quark sector (charm and beauty)
  - **Fixed target system:**
    - Opportunities for innovative measurements in unexplored regions of kinematic plane



HE-LHC

- Increase of centre-of-mass energy: $\sqrt{s_{NN}}$ = 10.6 (PbPb) and $\sqrt{s_{NN}}$ = 17 (pPb)
- Exploration of **energy frontier** and increased luminosity:
  - Stronger and larger volume of strongly-interacting matter
  - “Rare” channels as calibrated probes of the QGP: tops, W, …
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Identify best strategy to prepare for the upcoming upgrades

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  - Working group **purpose**:
    - Common discussion ground between theory and experiments
      - Preliminary results and data-theory comparison facilitated
    - Identification of questions with a particular focus (as to avoid divergences)
      - Limited human resources
      - Aims should align with individual physics interests

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- Theory perspective:
  - Working group **activities**:
    - Standardisation of current HI analysis
      - Require a first exercise to identify needed actions
    - Preparation for the future heavy-ion runs at the LHC
      - Dedicated workshops allowed to prioritise efforts
      - Follow-up activities in a dedicated sub-group (ex: lighter ions)