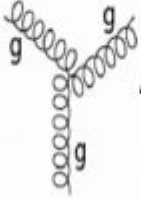


Gluodynamics



Project overview

Recent highlights

Michael Winn (DPhN/Irfu/CEA) for the collaboration
P2iO days 2022, 30.11.2022

- 1) Project goals and structure
- 2) Selected highlights in the 4 work packages
- 3) Outlook & conclusion

Hadron structure

- Understand the dominant matter constituents: mass, spin, interactions

Fluids of strongly interacting matter

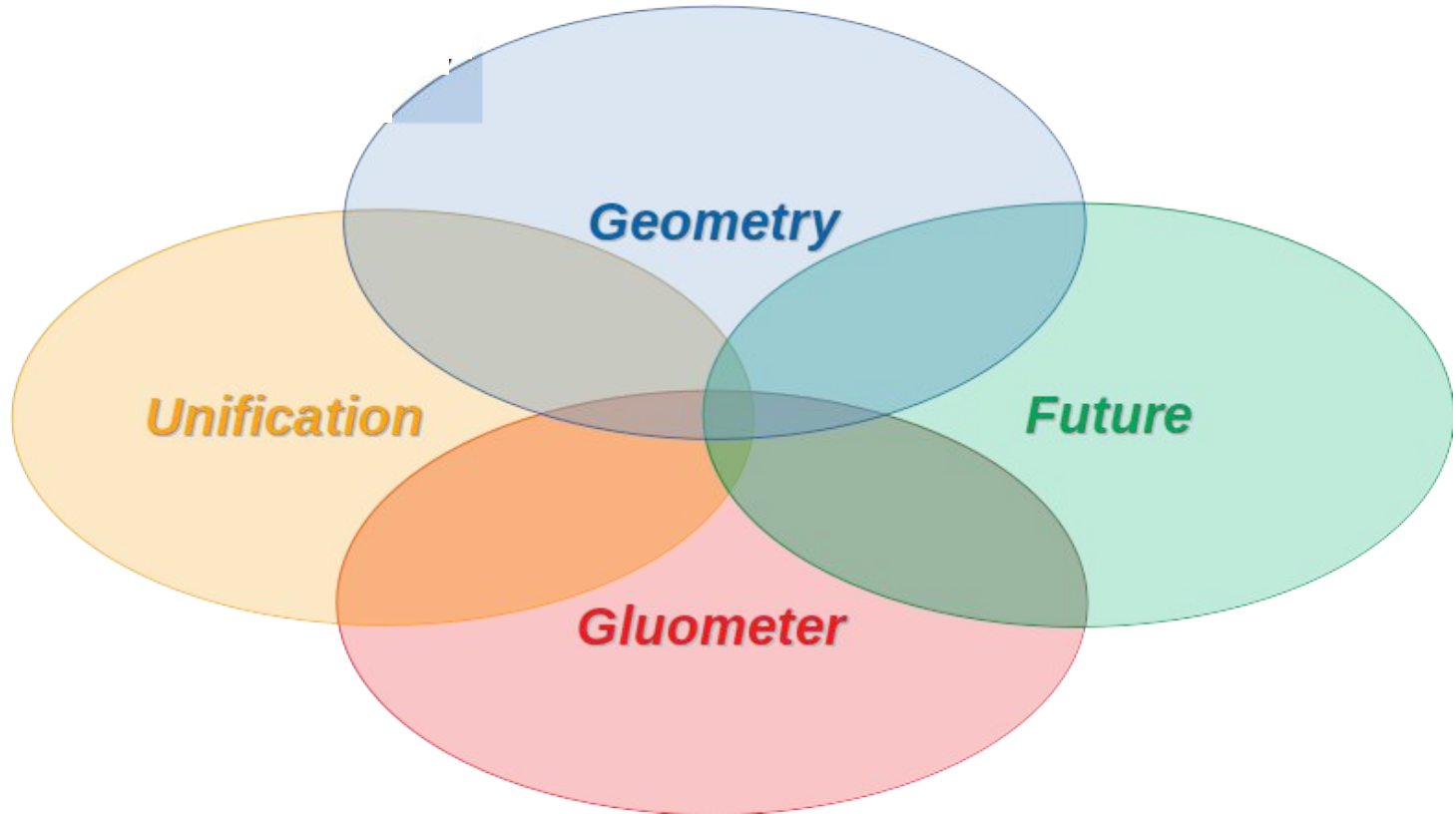
- Understand the internal structure in nucleus-nucleus collisions & understand initial state with hadron structure

International impact by internal collaborations

- Between theory & experiment
- Between the three poles: Orsay, Saclay and Palaiseau

Common long-term hardware projects for strong interaction research after 2030

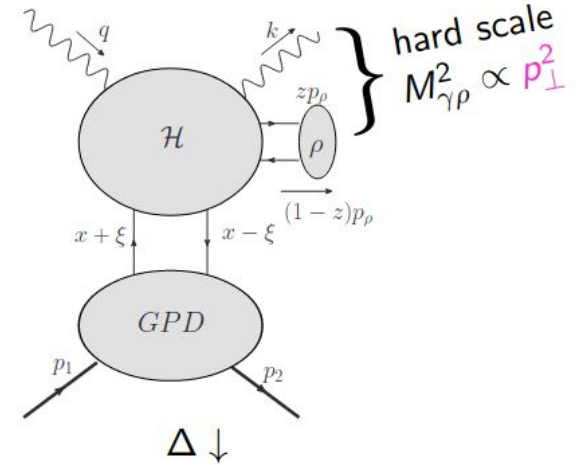
- Electron-ion collider & LHCb Upgrade 2



New observable: exclusive photon-meson production

Access to transversity generalised parton distribution functions (GPD)

- Need to be controlled for clean extraction of unpolarised GPDs in deeply-virtual compton scattering

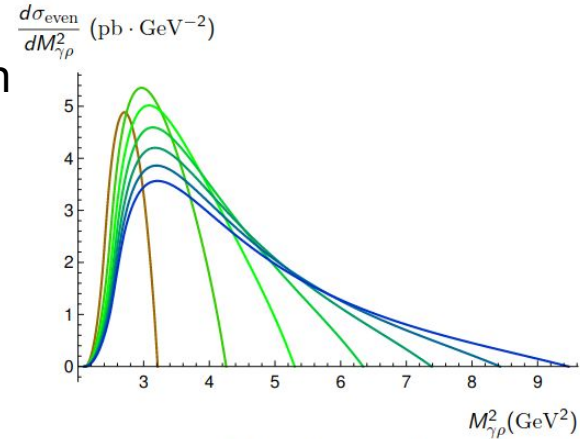


Saad Nabeebaccus (Gluodynamics postdoc) in the group of S. Wallon at IJClab , collaboration with Polish group and R. Boussarie CPhT (Palaiseau), publication under preparation

[Link to detailed presentation](#)

New observable: exclusive photon-meson production

From theory calculation up to phenomenology for JLab, Compass, EIC & LHC



proton target, "valence" scenario, asymptotical DA

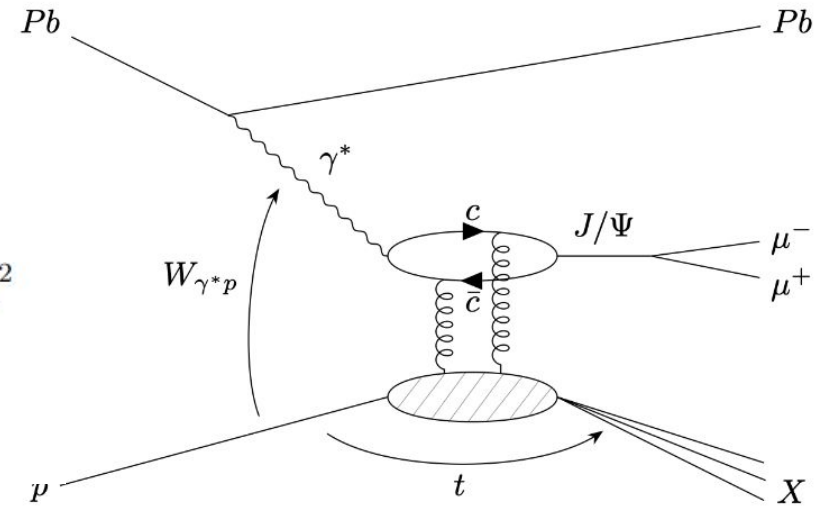
$$S_{\gamma N} = 8, 10, 12, 14, 16, 18, 20 \text{ GeV}^2 \text{ (typical JLab kinematics)}$$

Saad Nabeebaccus (Gluodynamics postdoc) in the group of S. Wallon at IJClab , collaboration with Polish group and R. Boussarie CPhT (Palaiseau), publication under preparation

[Link to detailed presentation](#)

New observable for saturation at the LHC

$$\begin{aligned} \frac{d\sigma}{dt}(\gamma p \rightarrow J/\psi X) &= \frac{1}{16\pi} \sum_i \sum_{f \neq i} |\langle f | \mathcal{A}^{\text{incoh}} | i \rangle|^2 \\ &= \frac{1}{16\pi} \sum_i \langle i | (\mathcal{A}^{\text{incoh}})^* \mathcal{A}^{\text{incoh}} | i \rangle - |\langle i | \mathcal{A}^{\text{incoh}} | i \rangle|^2 \\ &= \frac{1}{16\pi} \left(\left\langle |\mathcal{A}^{\text{incoh}}|^2 \right\rangle - \left| \langle \mathcal{A}^{\text{incoh}} \rangle \right|^2 \right) \end{aligned}$$



- measure fluctuations around the average!

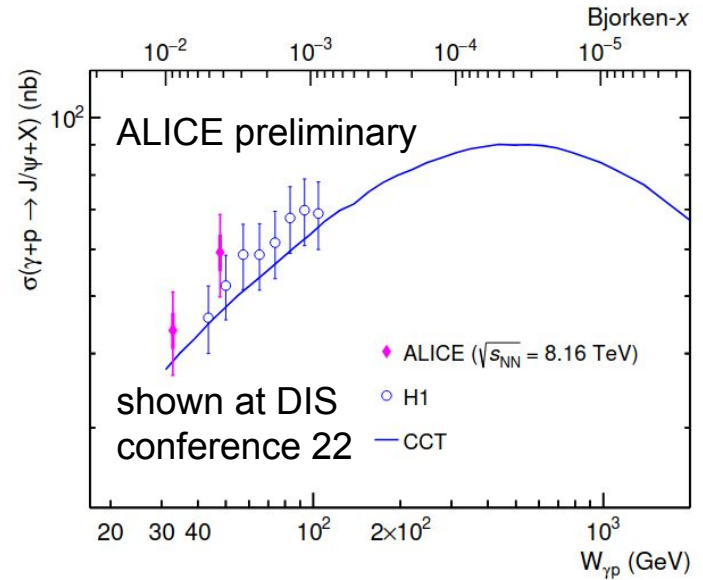
New observable for saturation at the LHC

Proof of principle with decent precision and compatible with HERA!

Article Submission expected in 2022

LHC: measure this process at W -values above 1 TeV far beyond HERA reach

Major input for saturation physics

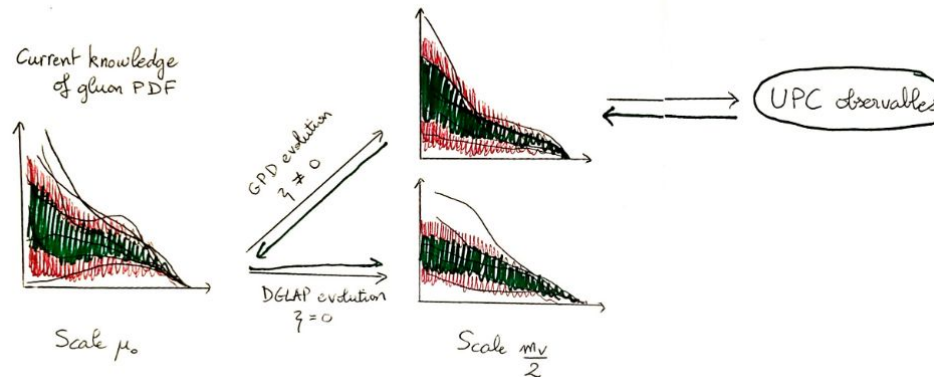


'Unification' of exclusive and inclusive parton distributions

- constrain parton densities for $p + \gamma \rightarrow X$, so-called 'PDF's at high energy colliders with exclusive production channels
 - A lot of constraining power, but missing theory to connect

Gluedynamics: first steps to enable theoretically sound global fits with exclusive and inclusive measurements in the future by theory uncertainties

[Link](#), publication in preparation



Hervé Dutrieux

collaboration with V. Bertone and M. Winn

Strengthen connections to the US and European partners

Source of ideas for future projects
at the LHC and the EIC

[link](#)

Gluedynamics

P2IO
Physique des 2 Infinis et des Origines

From initial gluons to hydrodynamics: Gluons inside hadrons and their thermalization

24-25 Oct 2022
Institut Pascal
Europe/Paris timezone

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- Registration
- Participant List

The goal of this workshop is to progress on the question to which extent the physics studies of the initial state of heavy-ions can be related to hadron structure physics as well as how the initial state in hadron collisions relaxes into a hydrodynamic description.

Starts 24 Oct 2022, 09:30
Ends 25 Oct 2022, 19:00
Europe/Paris

Institut Pascal
530 Rue André Rivière
91400 Orsay

<https://www.institut-pascal.universite-paris-saclay.fr/en>
[Go to map](#)

Cyrille Marquet
Francesco Bossu
Jean-Yves Ollitrault
Michael Winn

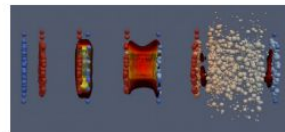
logo.jpg

Contact for our young students and postdocs in international community

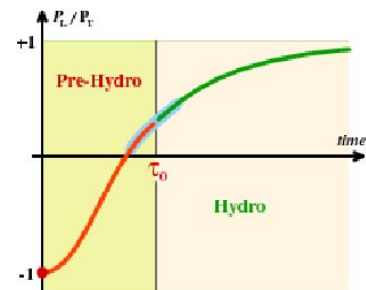
Example:

Siggi Hauksson (IPhT) on
2 point function interaction
formalism for thermalisation

- State of the art uses glasma + kinetic theory.
- Glasma can never thermalize, no scattering.
- How does transition between classical fields and quasiparticles work?
- **2PI captures both.**
- Understand thermalization better with one description.
 - Isotropization.
 - Fixed points.
 - Role of vacuum fluctuations.



[Bernhard et al. (2019)]



[Gelis (2015)]

Matthew Luzum (university of São Paulo, Brasil): long-term visit at IPhT/CEA in '22

- Black-board course on hydrodynamics (validated by [école doctorale](#))
- Hydrodynamic modelling of LHC data
- Strategic partnership with large US-driven collaborations
- Workshop participation

Sören Schlichting (university of Bielefeld, Germany): long-term visit at DPhN (Irfu/CEA) in '22

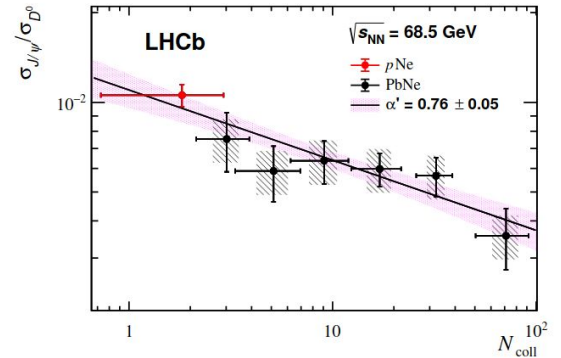
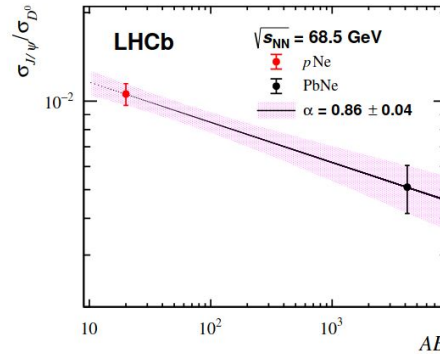
- Cooperation with IPhT, DPhN and CPhT on theory projects
- Future LHC and heavy-ion measurements
- Strategic partnership with German community
- Workshop participation

3 unique measurements in fixed-target mode at the LHC on arxiv

<https://arxiv.org/pdf/2211.11652.pdf>

<https://arxiv.org/pdf/2211.11645.pdf>

<https://arxiv.org/pdf/2211.11633.pdf>



- First ion-ion physics result in Pb-Ne! No anomalous suppression related to deconfinement
- First psi2s result in fixed-target mode in pNe compatible with previous results at lower energy
- Unique results on charm production constraining hadronisation close to the beam particle

New collaboration between Saclay and Palaiseau on these type of measurements established:

Thesis co-direction of Gabriel Ricart started this year on charm in fixed-target and U2 tracking

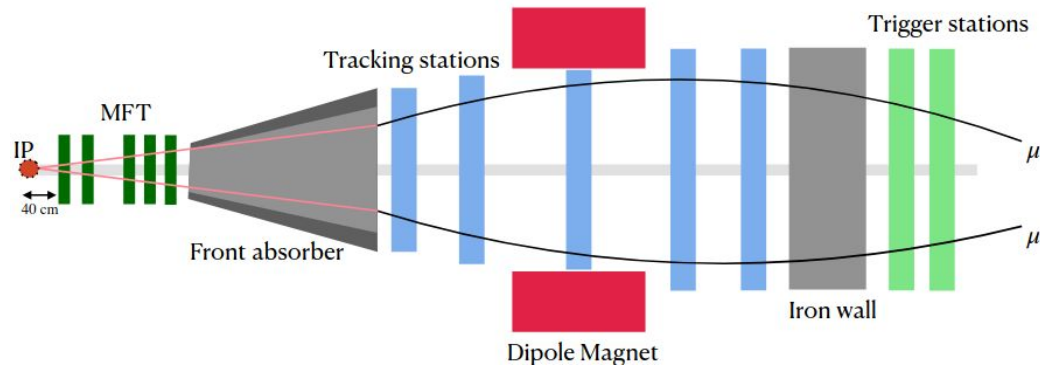
Main focus on Run 3 data

- Accumulate 2 years of delay for heavy-ion data taking at LHC

Batoul Diab (Gluodynamics postdoc at DPhN) now main responsible for key reconstruction aspect:

- MFT-MCH matching efficiency

P2iO key player in a major LHC experiment upgrade realisation

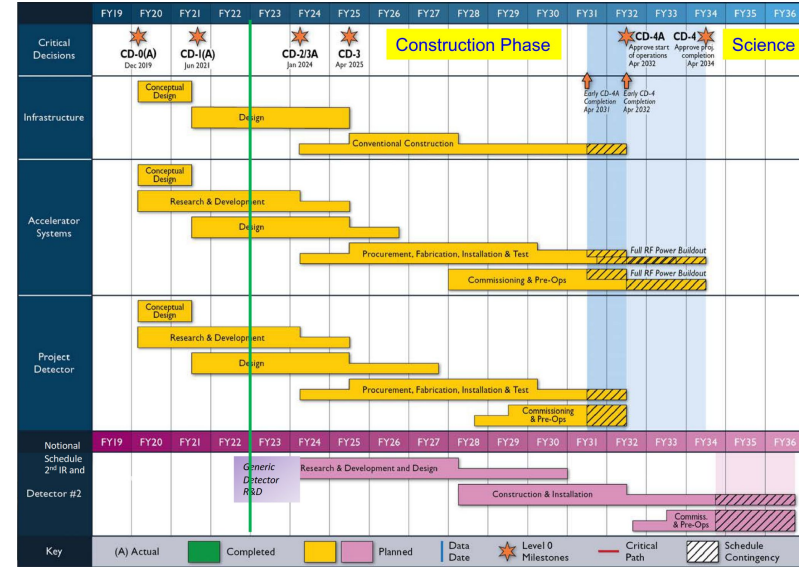
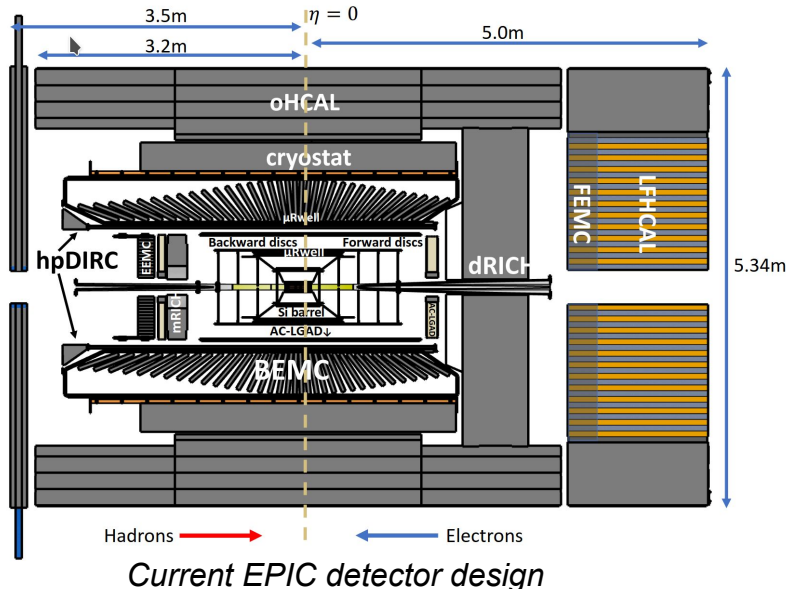


EIC project is well within the design phase

The newly formed EPIC collaboration is optimizing the detector design

Aiming at preliminary TDR in 2024

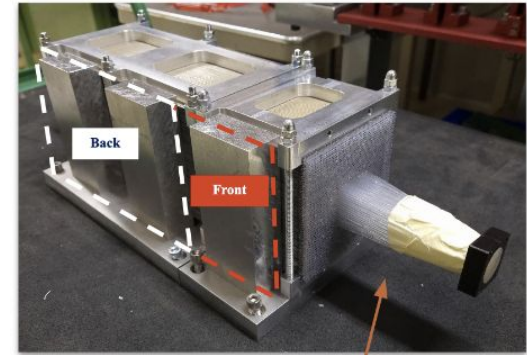
P2iO highly involved in the EPIC collaboration. Convenership of several WGs:
Exclusive physics, Calorimetry, Tracking, Detector Integration



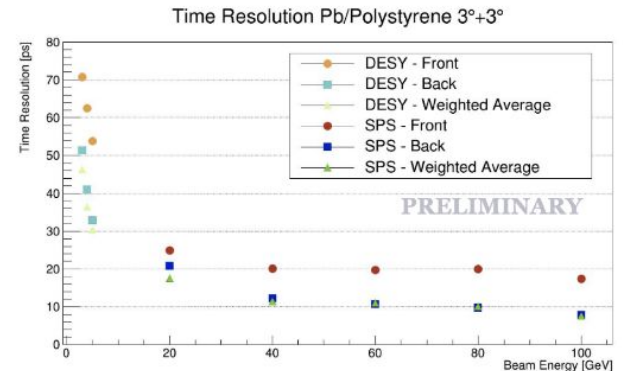
Niveditha Ramasubramanian (Glodynamics postdoc at DPhN) is involved in the optimisation of the EIC tracking system

Electromagnetic calorimeter upgrade for LHCb upgrade 2

- Manuel Guttière Gludynamics postdoc working on simulation included in Framework Technical design report & test-beam data takings at DESY and CERN
- First results from the test-beam show that 10ps resolution on the timing can be achieved
- Timing & granularity to cope with harsh pile-up conditions of upgrade 2
- Benjamin Audurier (former Gludynamics postdoc) hired as researcher by DPhN CEA:
 - Work on LHCb Upgrade 2 tracker gaining momentum



Fibres bundle (1 cell)



Organisation of QCD evolution by Gluodynamics next year

Most results well under way and many expected next year

Momentum increase for beyond-'30 activities: current upgrades soon commissioned

LHCb Upgrade and Electron-Ion collider as main flagships on French road-map with P2iO at the heart of both activities

- Next year's In2p3 scientific council as important milestone

Posterior funding applications (ERC, French-German applications) to be designed

Gluodynamics flagship project: not a flagship, but a fleet

- Capable to attack the key questions of strong interaction together

Hadronisation

Thermalisation

Mass/spin decomposition of hadrons

Saturation

towards future projects to answer these questions quantitatively