

WG2 : Collective effects in nucleons and nuclei, phase diagram of QCD

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GDR QCD
08/03/21

- (1) Subatech, Nantes**
(2) IPHC, Strasbourg

Coordinators

Antonin Maire

- CNRS
- ALICE exp.

Baryons, flavour production (s , c), collectivity in small systems

- IPHC, Strasbourg



Marlène Nahrgang

- Enseignant-Chercheur
- Théorie

In/Out of equilibrium properties of the QGP, transport coefficients of heavy quarks and critical fluctuations at the phase transition.

- Subatech, Nantes



Maxime Guilbaud

- Enseignant-Chercheur
- ALICE exp.

Collectivity in small systems, quarkonia production

- Subatech, Nantes



WG2 : What do we cover?

Collective effects in nucleons and nuclei, phase diagram of QCD



QCD under extrem conditions

*Understanding the dynamics of the strong interaction in vacuum and under extreme conditions of **temperature** and **density***

WG2 : What do we cover?

Collective effects in nucleons and nuclei, phase diagram of QCD



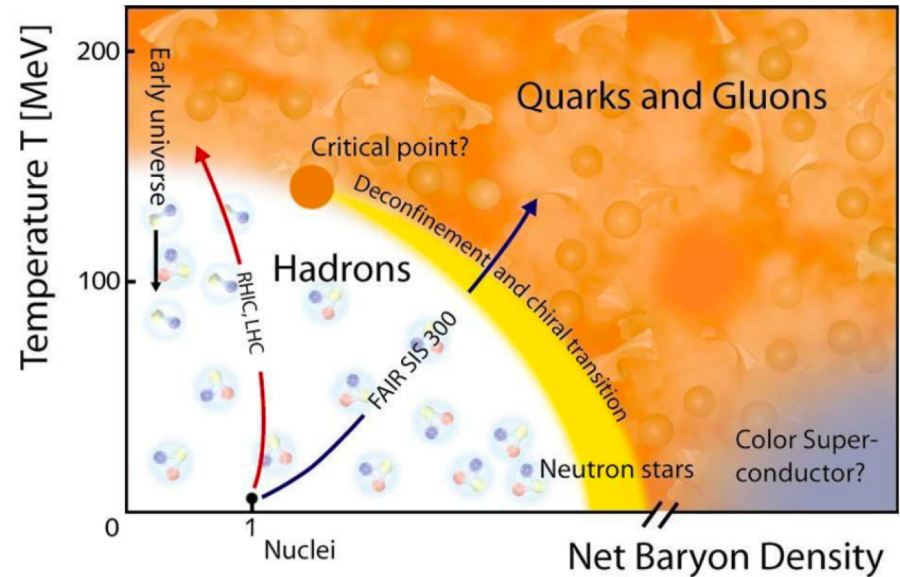
QCD under extrem conditions

*Understanding the dynamics of the strong interaction in vacuum and under extreme conditions of **temperature** and **density***

*baryon density but also **energy** density*

QCD phase diagram

- **Connects to :**
 - High energy physics
 - Cosmology
 - Compact stars
- **Features :**
 - Strongly coupled quantum fluids and EoS
 - Deconfinement
 - Chiral symmetry restoration



GSI Helmholtzzentrum für Schwerionenforschung

Connect first-principle QCD calculations with experimental observables

via realistic modeling of (ultra-) relativistic collisions (hadrons, nuclei, ...) and astrophysical events!

Important (selected) questions ...

Onset of deconfinement?

- How is it related, if related, to the onset of collectivity?
- What happen in small colliding systems?

Onset of chiral symmetry restoration?

Properties of the strongly coupled QGP?

Existence of a phase transition with critical end point?

Degree of freedom in the core of compact stars?

QCD under extreme conditions: from low to high μ_B

➤ Interest of the WG spanning over a large range in (T, μ_B)

- EoS : LHC → FAIR → Neutron stars

low μ_B

very large μ_B

Lattice QCD

QCD under extreme conditions: from low to high μ_B

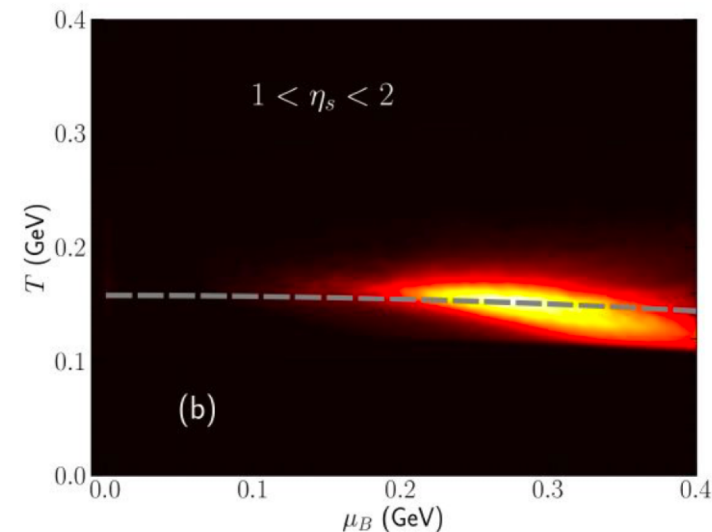
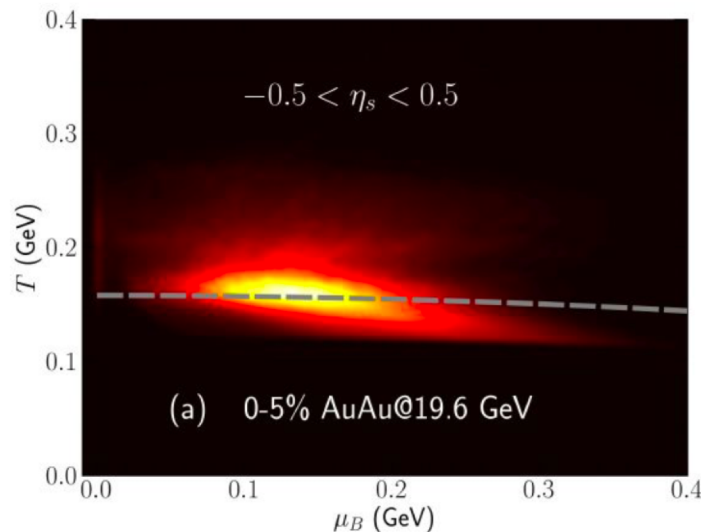
➤ Interest of the WG spanning over a large range in (T, μ_B)

- EoS : LHC → **FAIR** → Neutron stars

low μ_B
Lattice QCD

very large μ_B

Large interest from
theoretical point of view



QCD under extreme conditions: from low to high μ_B

➤ Interest of the WG spanning over a large range in (T, μ_B)

- EoS : LHC \rightarrow FAIR \rightarrow Neutron stars
low μ_B very large μ_B

Lattice QCD

- QGP properties :
 - hydro/transport coefficients
 - dynamics of critical fluctuations
 - ...

} **Mostly soft physics**

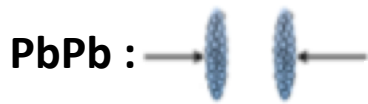
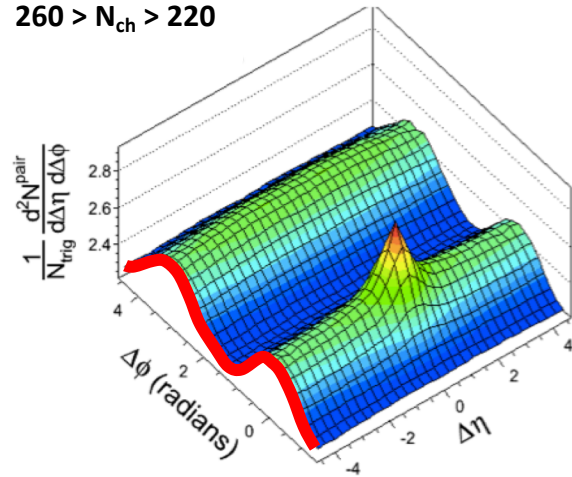
➤ Hard-soft interplay : **Overlap with WG3**

- jets/hard probes/heavy quark needed for a solid description of the underlying QGP medium properties and evolution
- Hard-soft coupling highly relevant

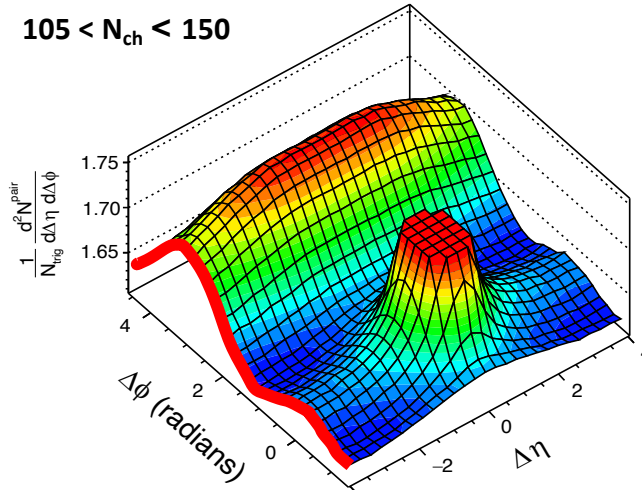
QCD under extreme conditions: Collectivity

➤ Historical example : The Ridge (long-range particle correlation)

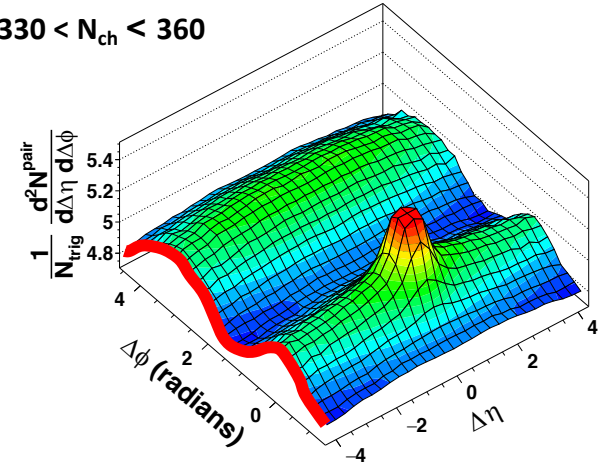
$260 > N_{ch} > 220$



$105 < N_{ch} < 150$



$330 < N_{ch} < 360$



- Exact origin not yet fully established in pA and pp :
 - MPI to be studied with care, hard probes matter a lot
 - Deeply rooted in the Initial Stages of the collisions
- Interesting prospective at **EIC** or **FCC**

Overlap with WG1

Events and future activities

- **Work in progress!**
- 1 or 2 workshops per year on selected topics
 - Can be organized together with other WG where overlaps exist
- Communication in national meetings
 - Overview with selected/invited speakers

Thanks!