Little Big Bang

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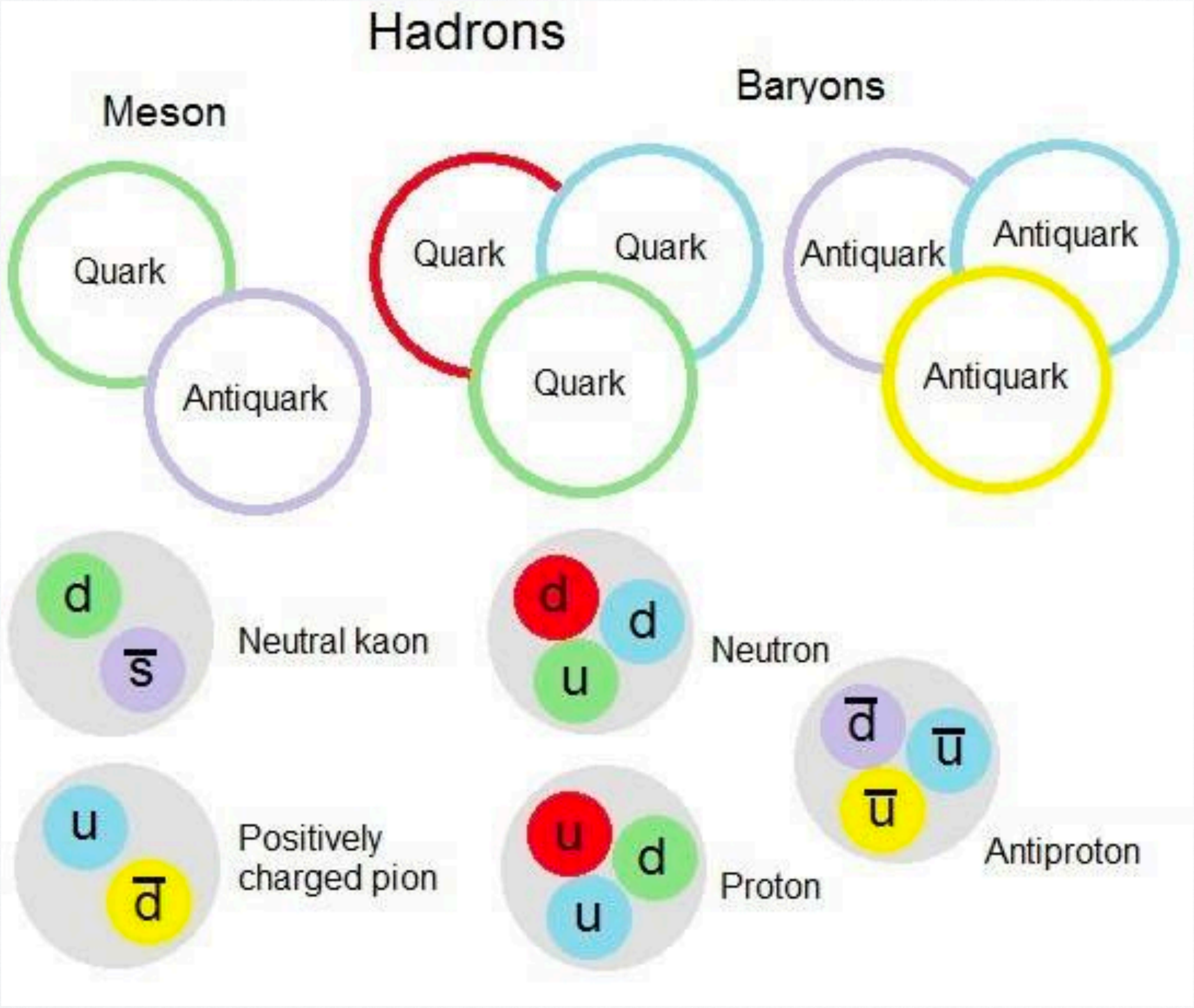
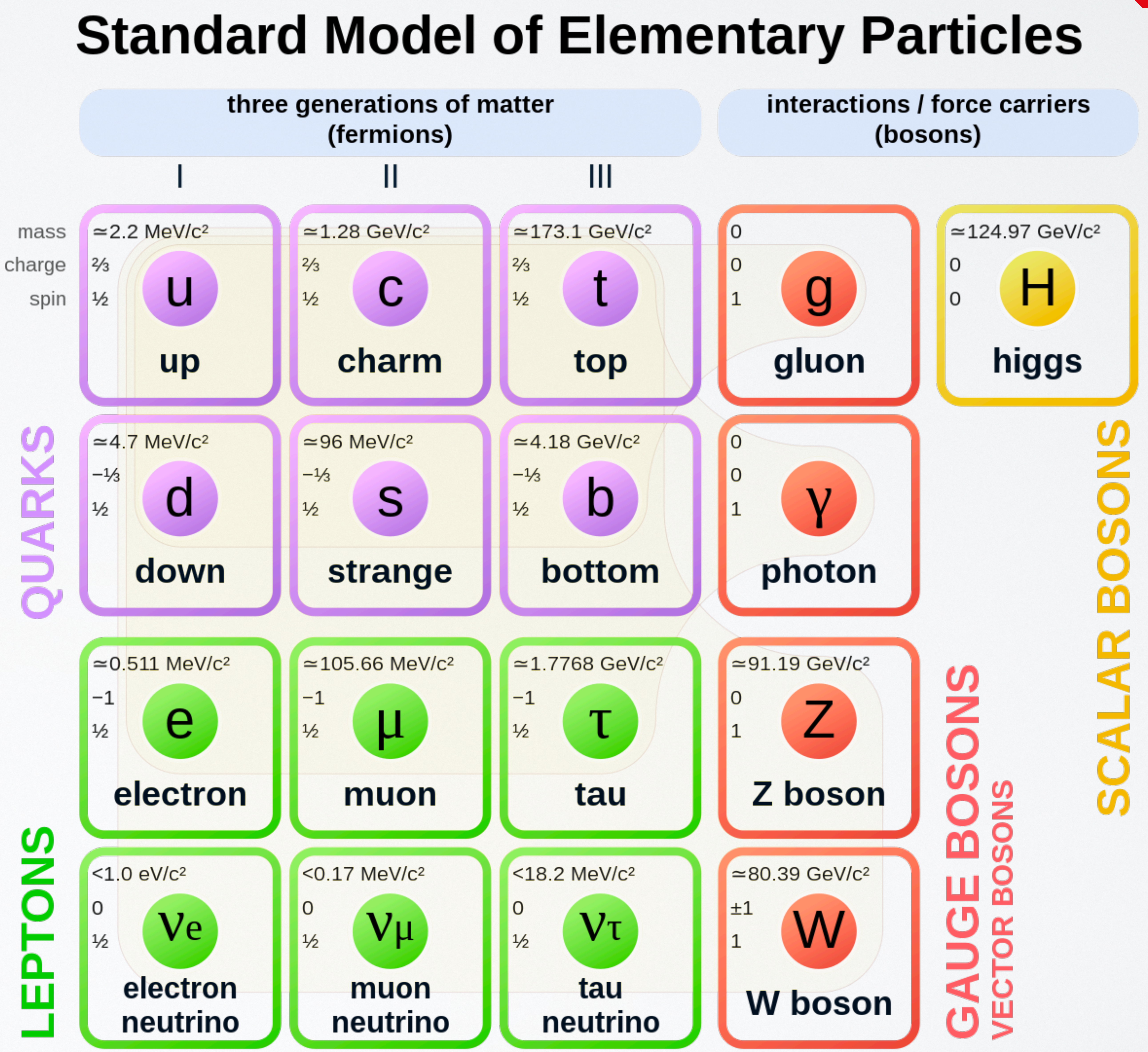
What we all know

- Quarks confined in hadrons
  - $q\bar{q}$ = meson
  - qqq = baryon
  - + sea quarks and gluons





Motivation for this contribution

- ALICE is one of the four big LHC experiments
- So why nobody knows what we are doing? 😥
  - Yesterday during lunch "so ALICE only ran for a few weeks during LHC Run 2?"
- Also, QGP is not only studied by ALICE!

LHC Seminar

Systematic studies of parton-quark gluon plasma interactions with ATLAS

by Qipeng Hu (Lawrence Livermore Nat. Laboratory (US))

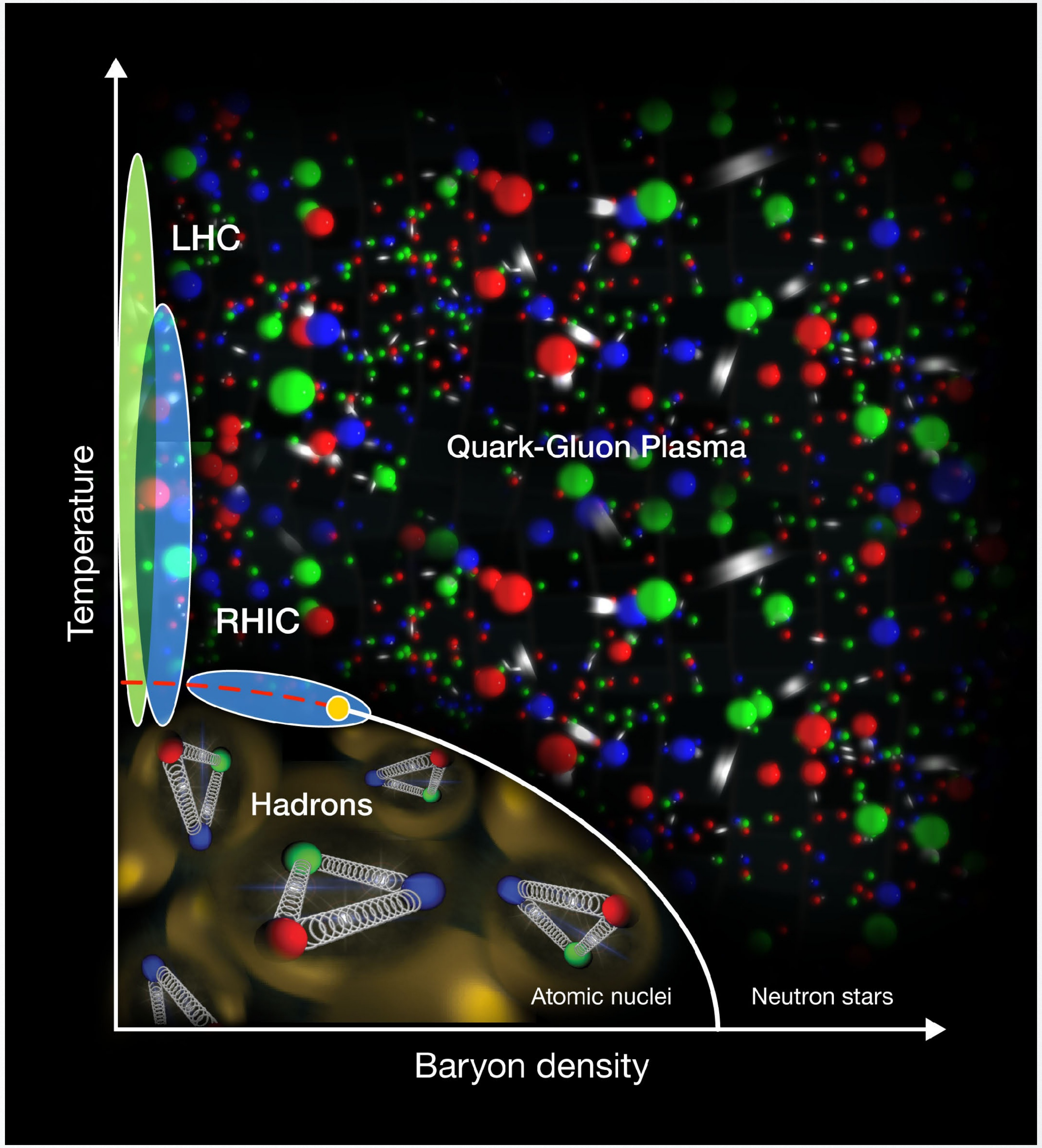
Tuesday 10 May 2022, 11:00 → 12:00 Europe/Zurich

Description: Jet quenching, in which partons lose energy through interactions with a colour-charged medium, is one of the major signatures of quark-gluon plasma (QGP) formation in relativistic heavy-ion collisions. The seminar presents recent jet quenching measurements based on Run-2 data collected with the ATLAS detector. Using the results of inclusive jet production as a baseline, these new studies systematically explore how jet quenching depends on the mass and colour charge of the initiating parton, the parton shower's path-length in the QGP medium, and the jet substructure.

ALICE representation at tCSC 2022

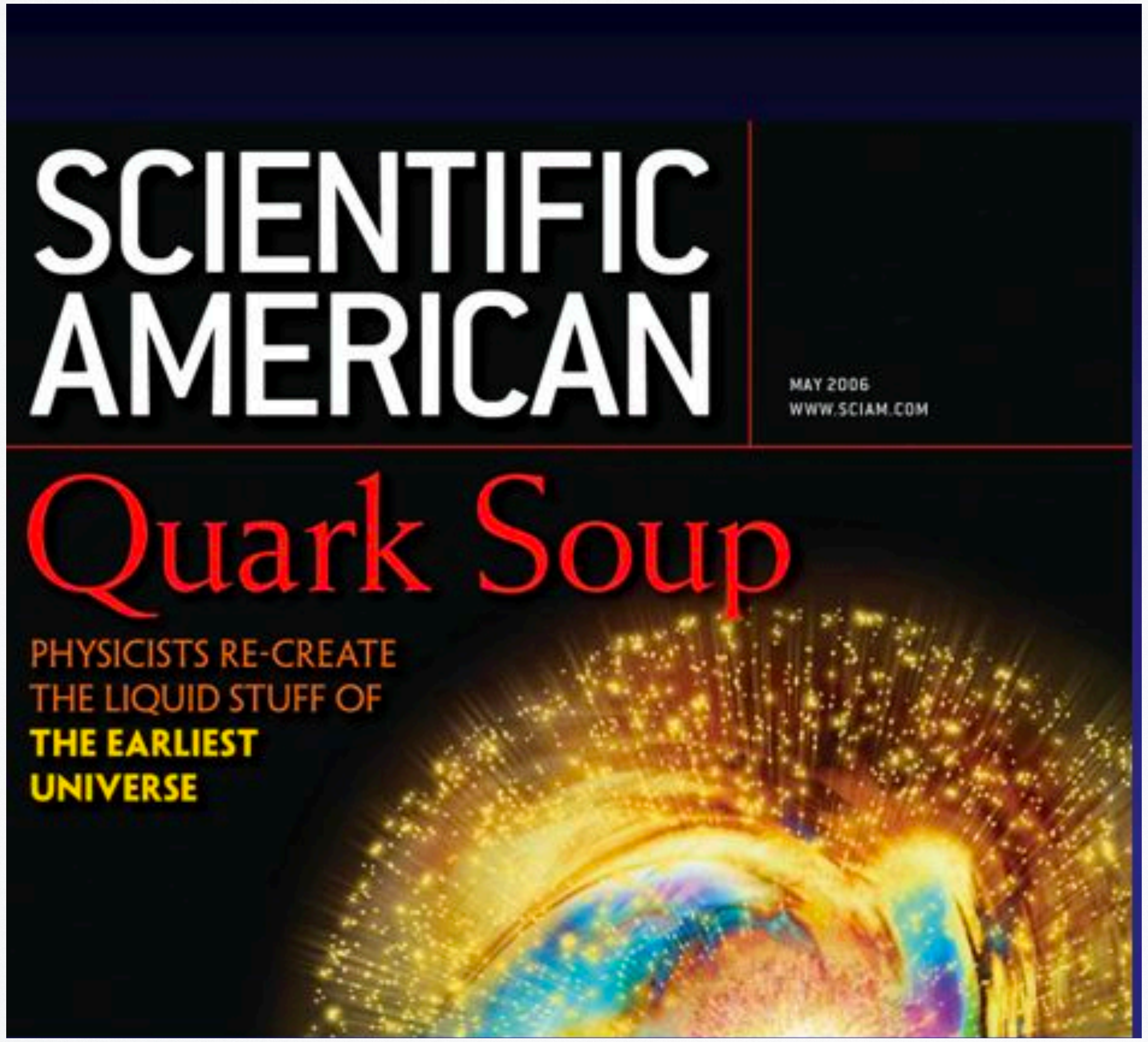
What happens when we increase the temperature?

- Cargèse today ~ 295 K
- Temperature in the middle of the Sun:
  15 700 000 K
- Temperature needed for the creation of QGP:
  2 000 000 000 000 K
- Very extreme conditions (both temperature and density) lead to a creation of the different state of the matter where quarks and gluons are deconfined — and **quark-gluon plasma** is created!
  - Existed shortly after the **Big Bang**, recreated in ultra-relativistic heavy-ion collisions (at LHC and RHIC) — our **Little Big Bangs**



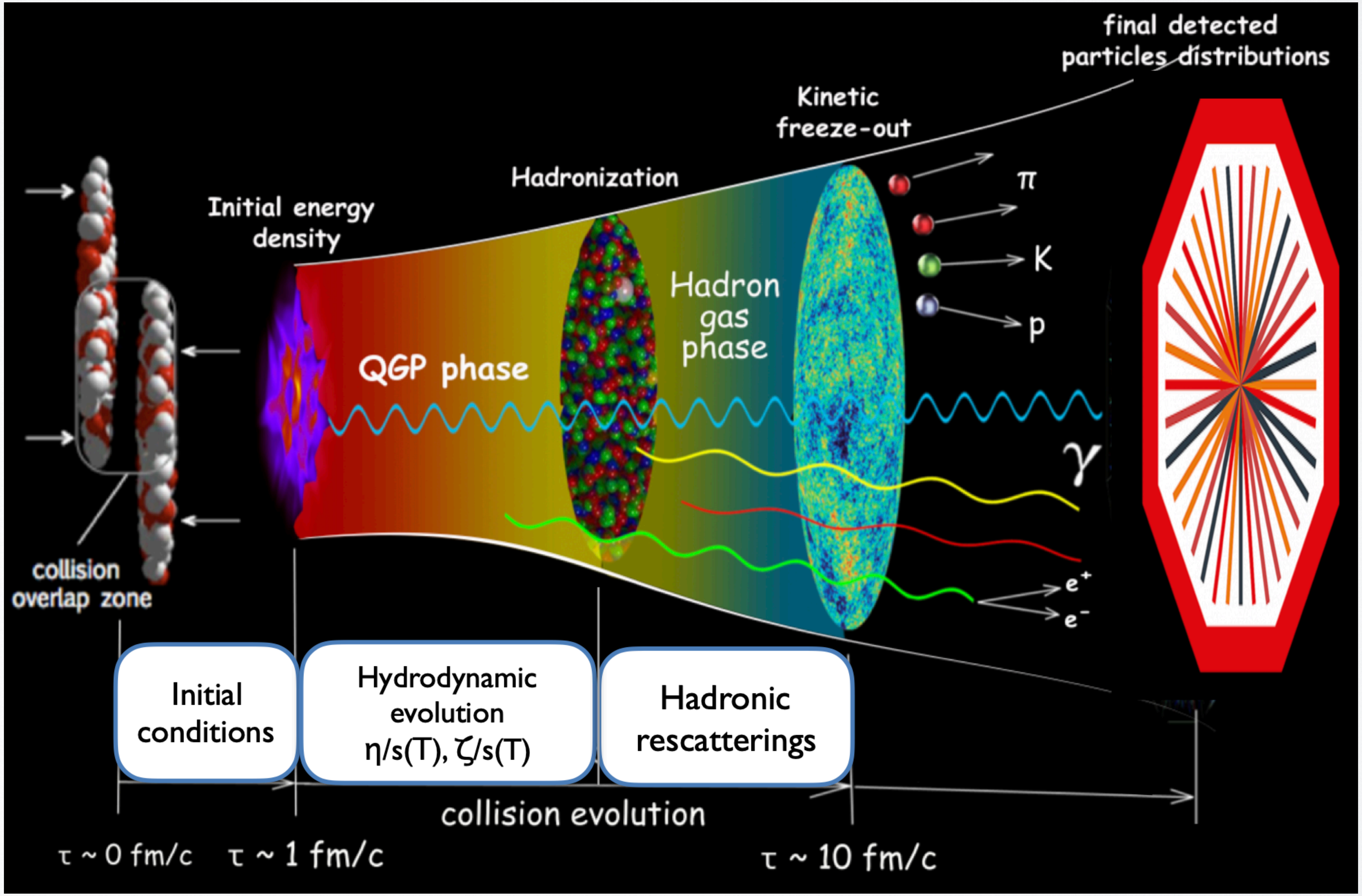
Properties

- Most **perfect fluid** — at the theoretical limit of viscosity
- It means we can describe it by hydrodynamics!



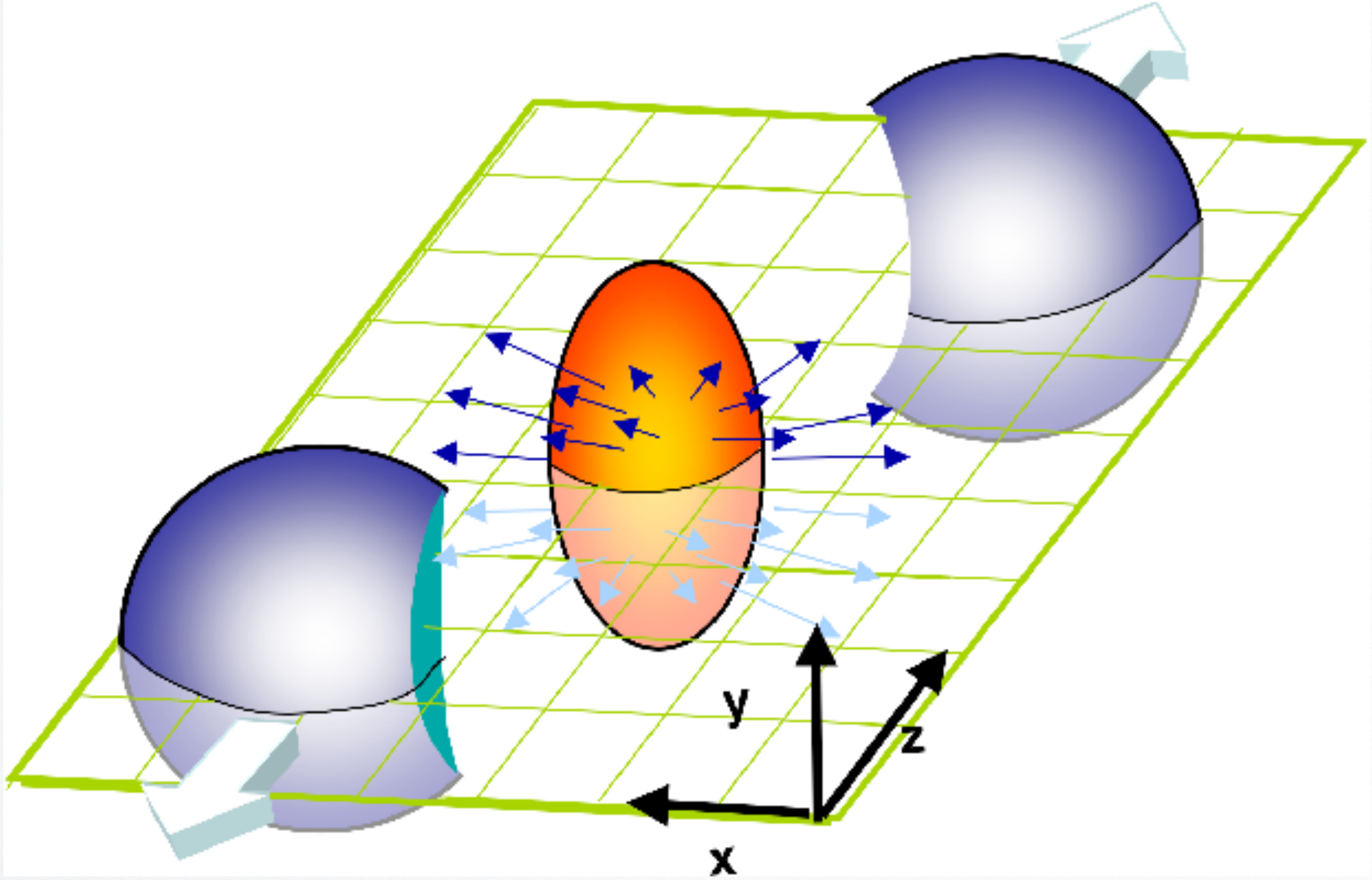
Evolution of QGP

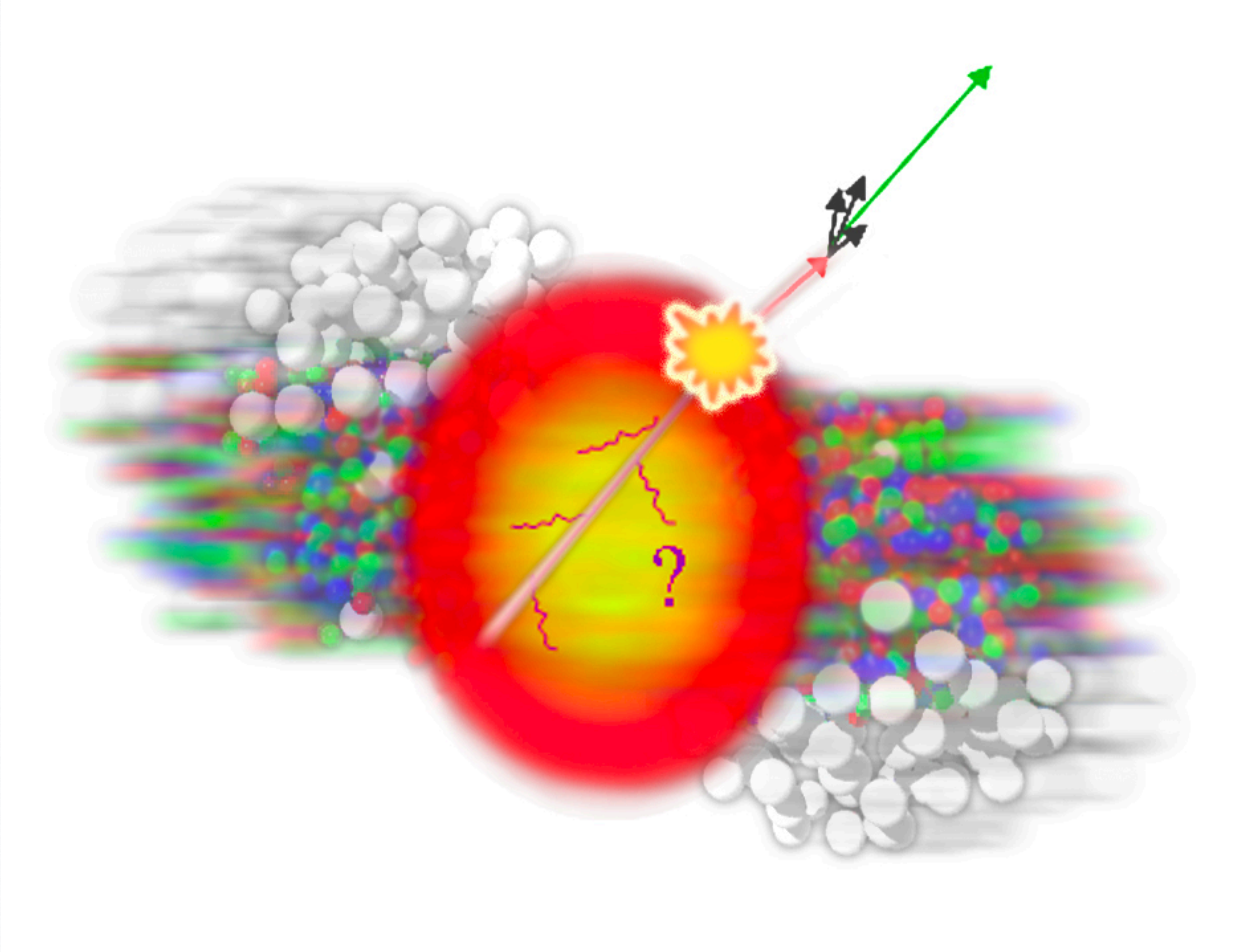
- Lorentz-contracted heavy-ion "pancakes" collide
- QGP is created
- QGP very quickly expands, cools down, and hadronizes
- We see "only" final-state particles, not QGP itself
- Very nice **animation**



Studies of QGP & small system puzzle

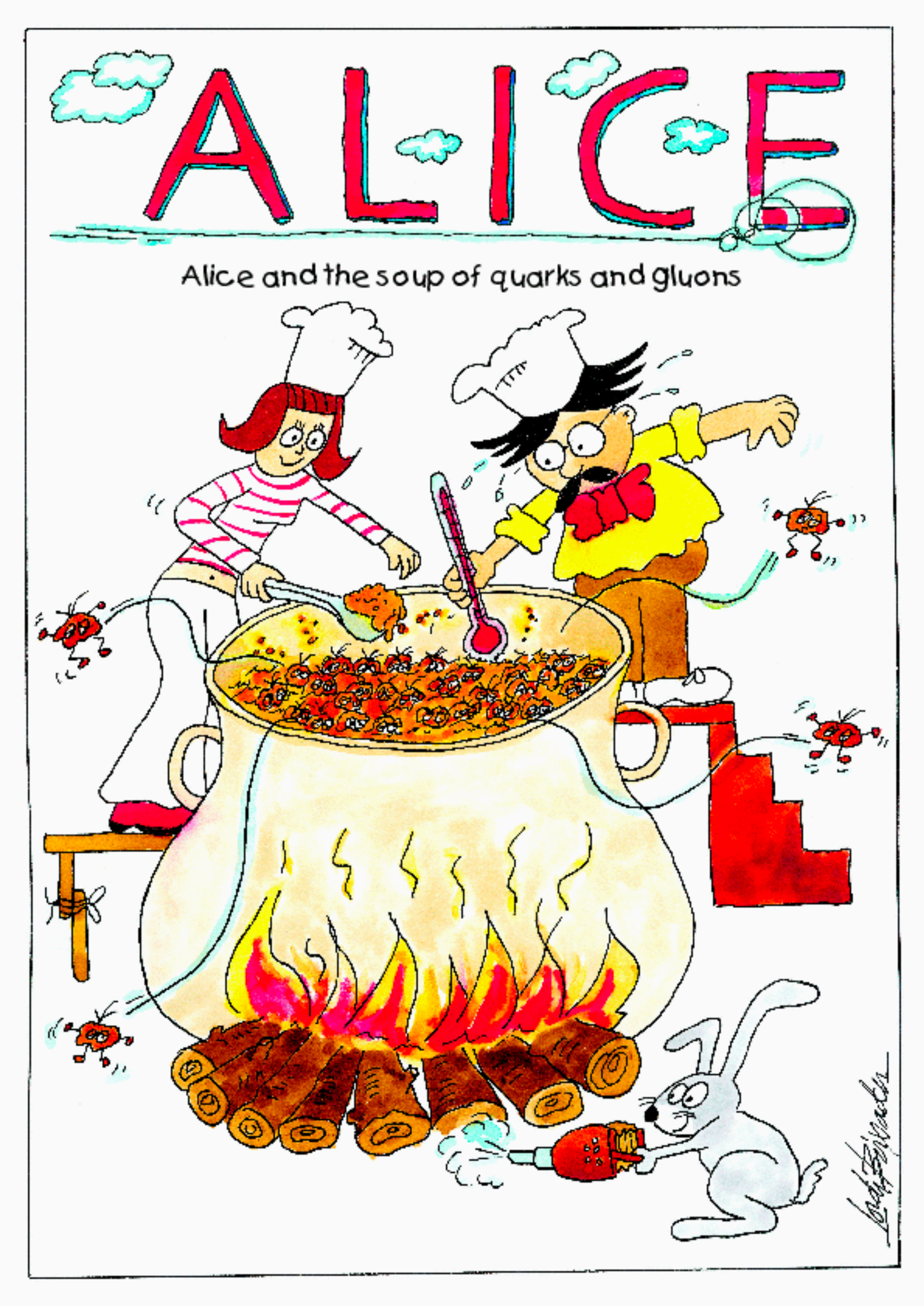
- Not possible to observe or study QGP directly, fortunately, we have:
  - **Anisotropic flow** — in both large and small collision systems
  - **Jet quenching** — only in large systems
  - And other things for which I don't have time now 🤷‍♀️





Conclusion

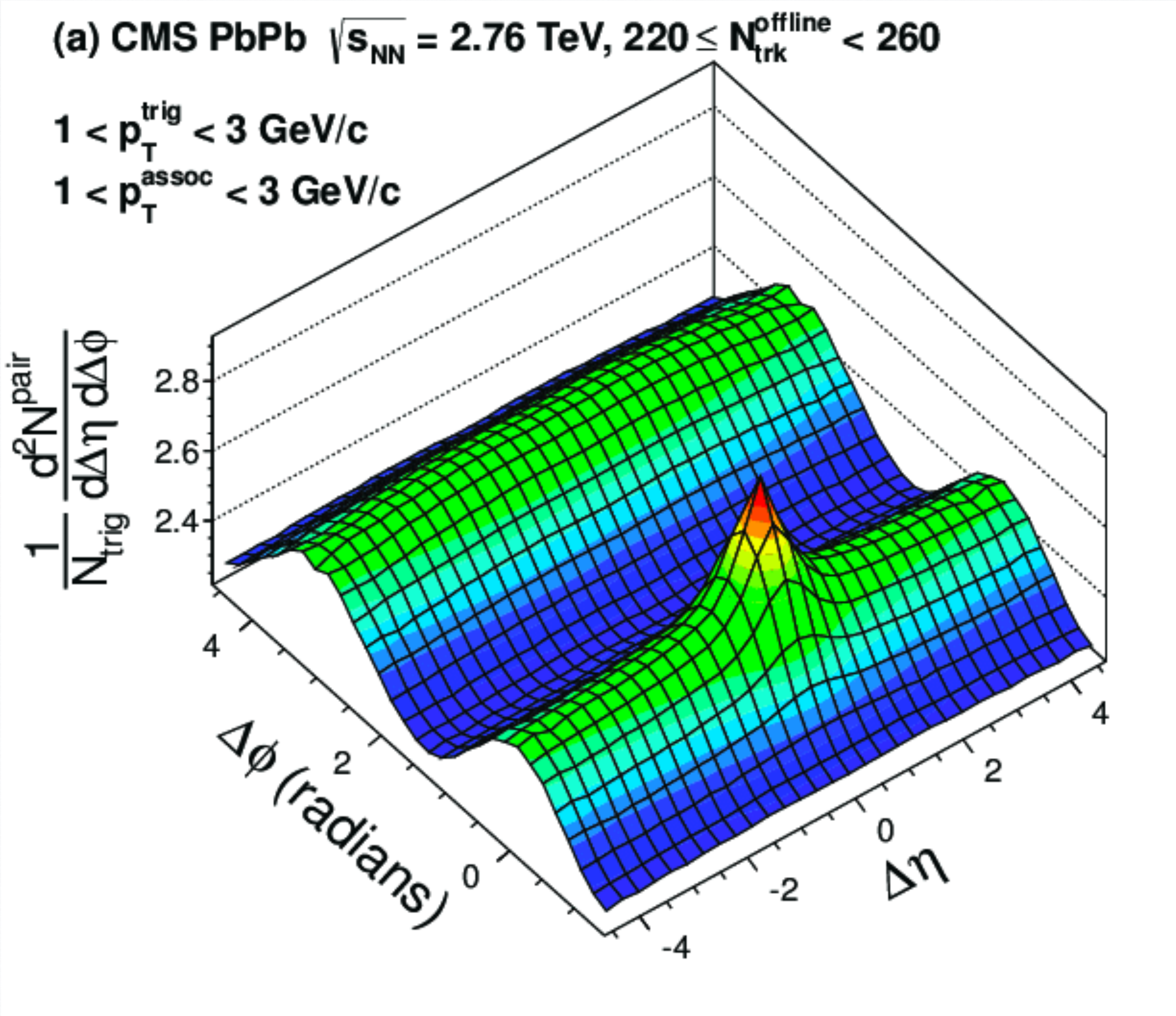
- At ALICE, we are creating **Little Big Bangs** by colliding ultra-relativistic heavy-ion collisions
- With conditions just like after the **Big Big Bang**, we can melt hadrons into the soup of quarks and gluons
- Quark-gluon plasma is a different state of matter, a perfect fluid following hydrodynamics
- Studying quark-gluon plasma is tricky as we only see final-state particles affected by the it
- There are signs that **a droplet of QGP** *might* be also in small collision systems



Back up

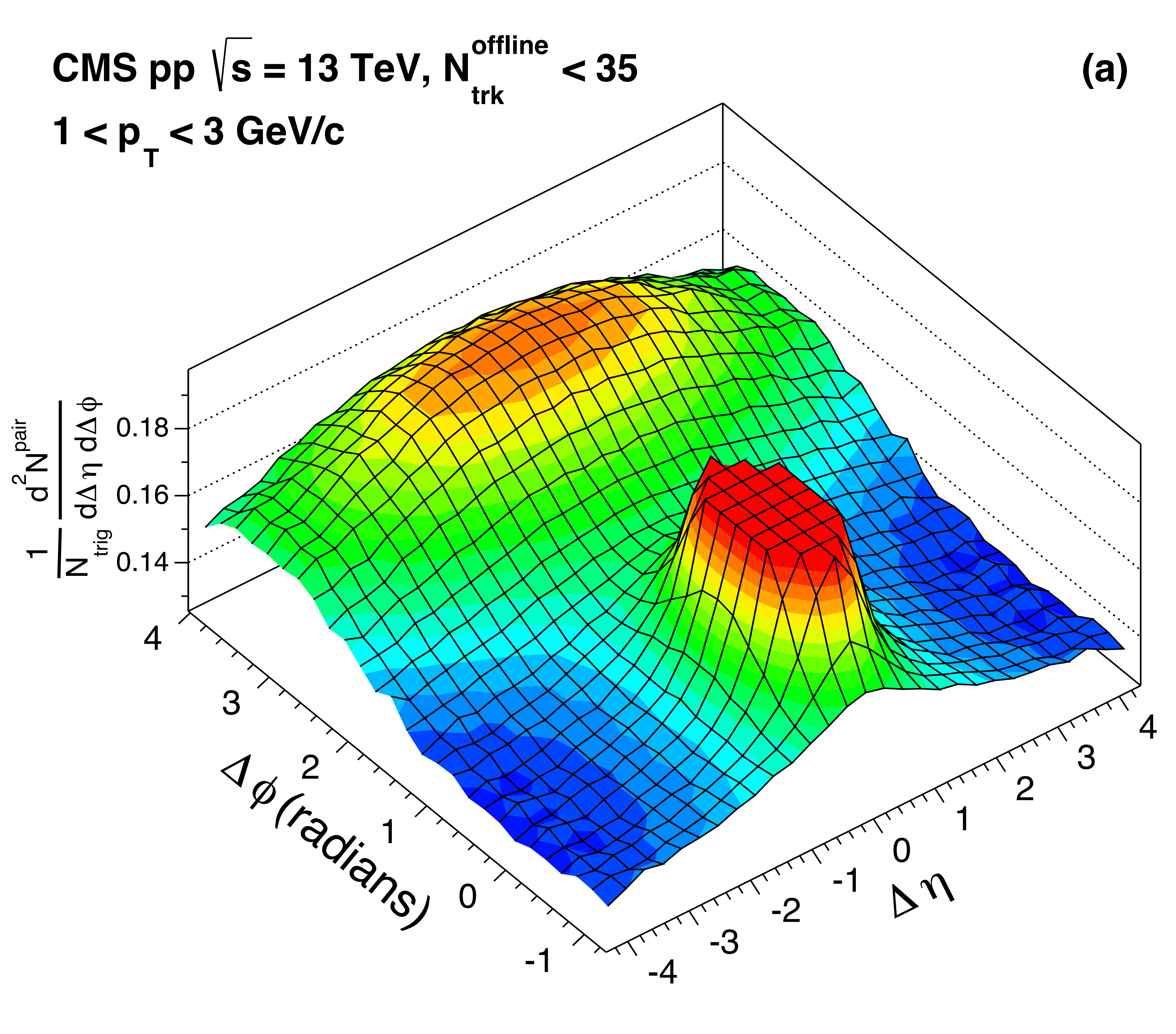
A droplet of QGP in small systems?

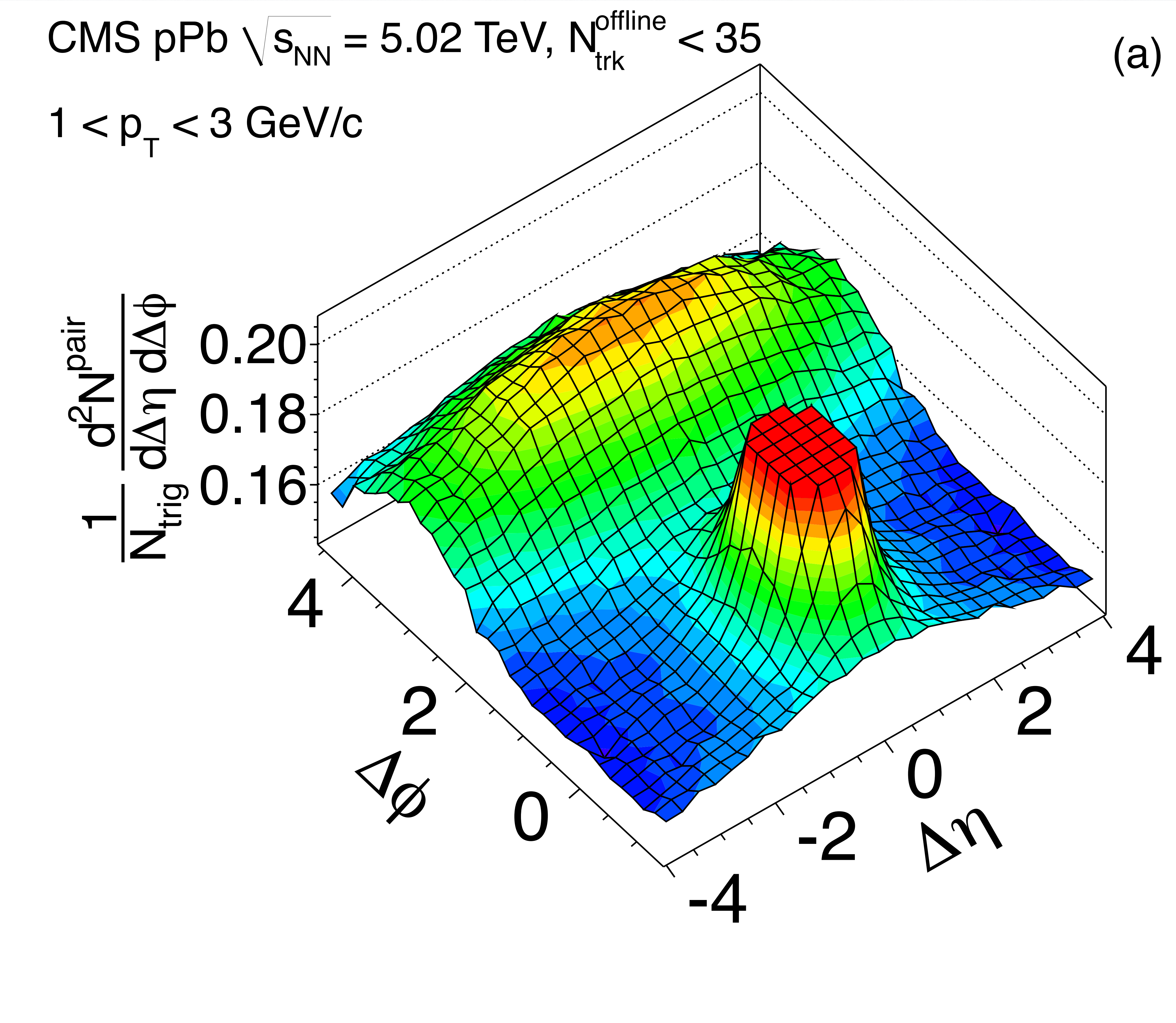
- My PhD project is about flow in small systems
- Flow needs collective effects
- Collectivity = long-range multi-particle correlations, a sign of QGP
- Double ridge, observed in Pb-Pb collision, is a clear sign of collectivity
- Measurements at next slides served as a "motivation" for my studies — telling us we should look into all systems!
- Flow now measured across all systems



A droplet of QGP in small systems?

- Low multiplicity collisions in p-Pb and pp collisions





A droplet of QGP in small systems?

- High multiplicity collisions in p-Pb and pp collisions — double ridge is there!