

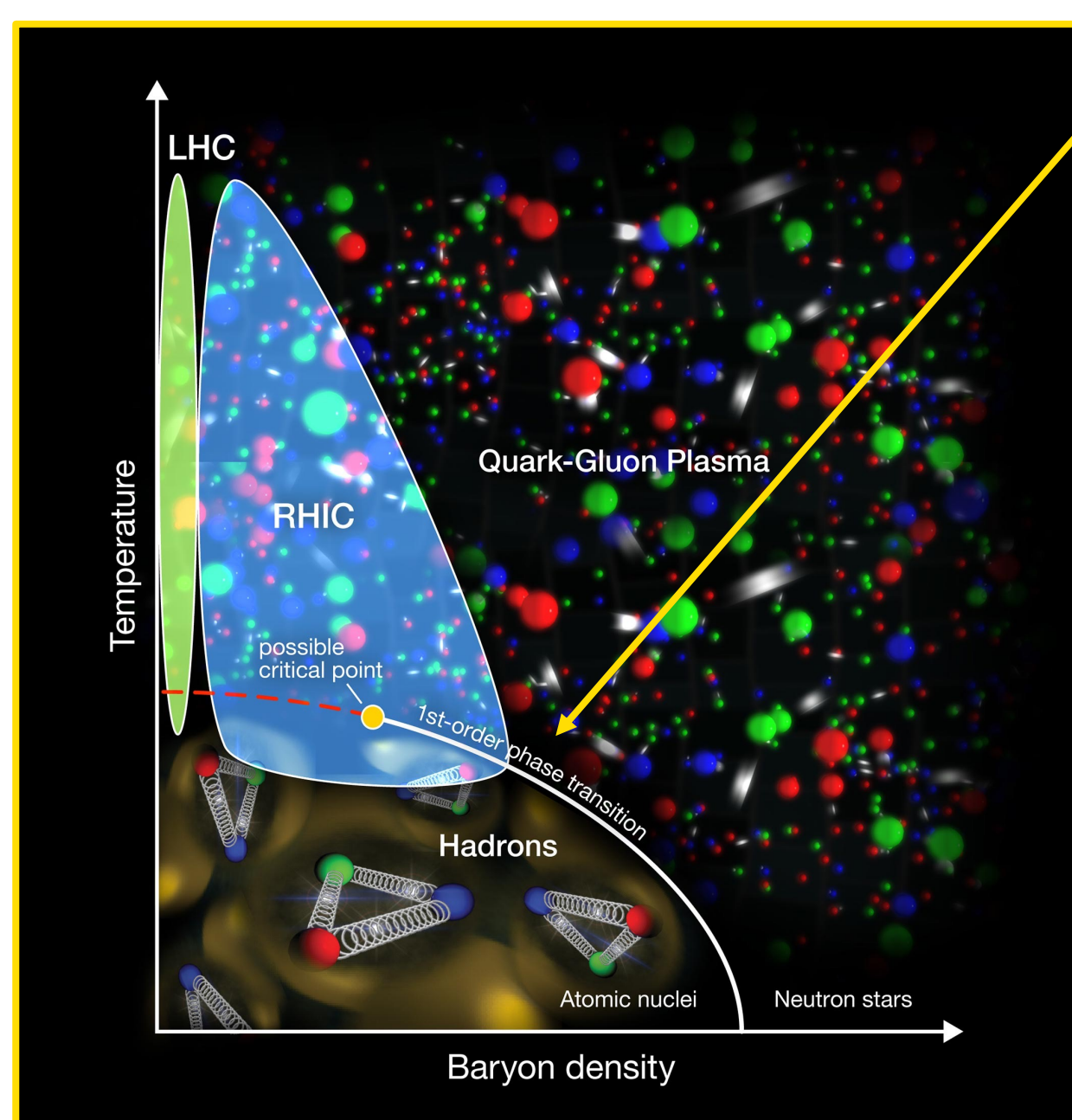


Heavy flavor probes of the Quark-Gluon Plasma

PhD in Physics

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Quantum Chromodynamics phase diagram



Hadrons "melt" into their constituents

Quarks and Gluons form a collective medium known as

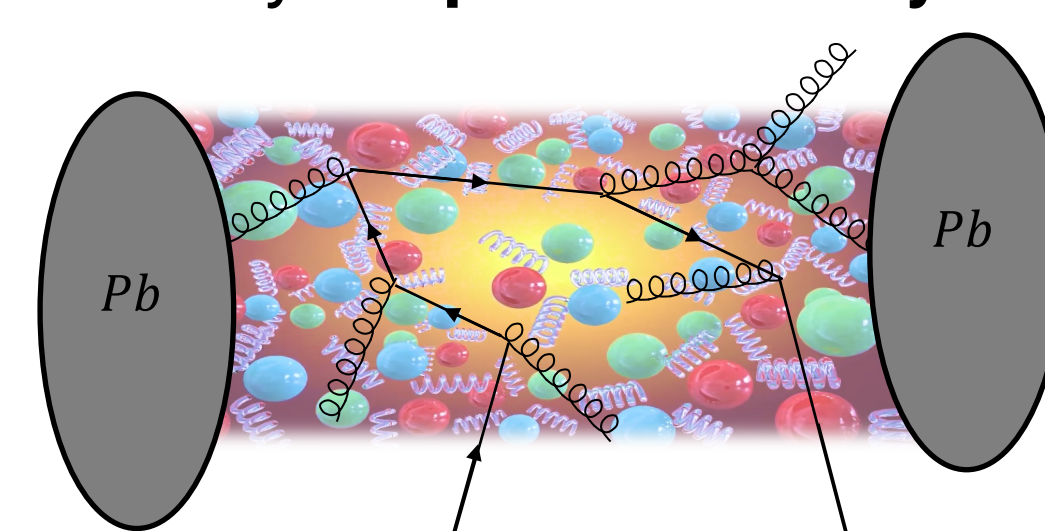
Quark-Gluon Plasma (QGP)

It reflects a fundamental change of the QCD vacuum
 $\langle \bar{\psi}\psi \rangle > 0 \rightarrow \langle \bar{\psi}\psi \rangle \sim 0$

Requires extreme conditions of density and temperature

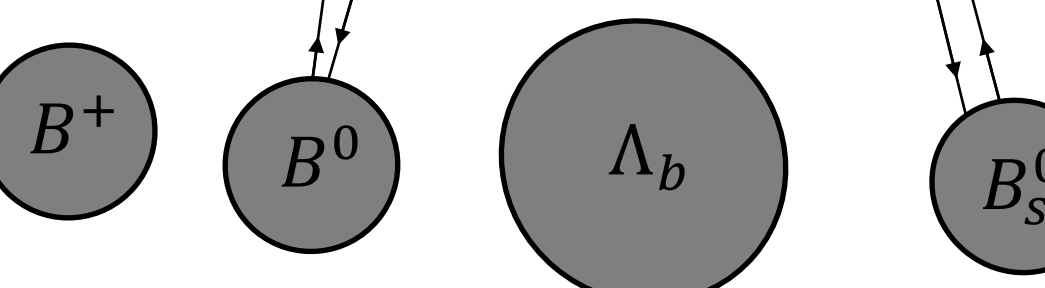
b-quarks as QGP probes

They are produced early!



b-quarks register QGP evolution!

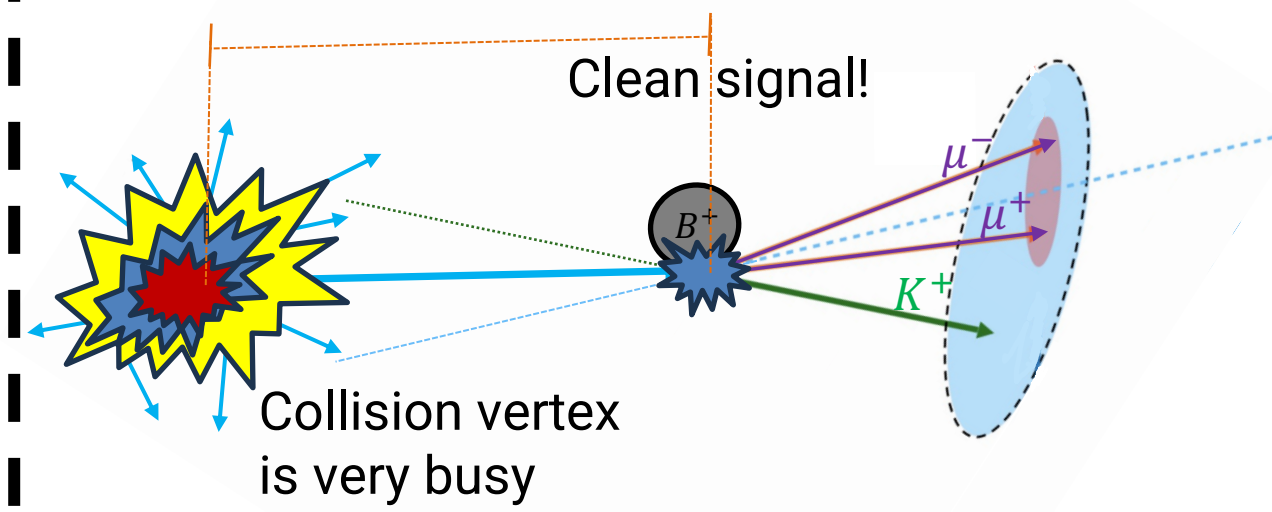
and then hadronize into b-hadrons



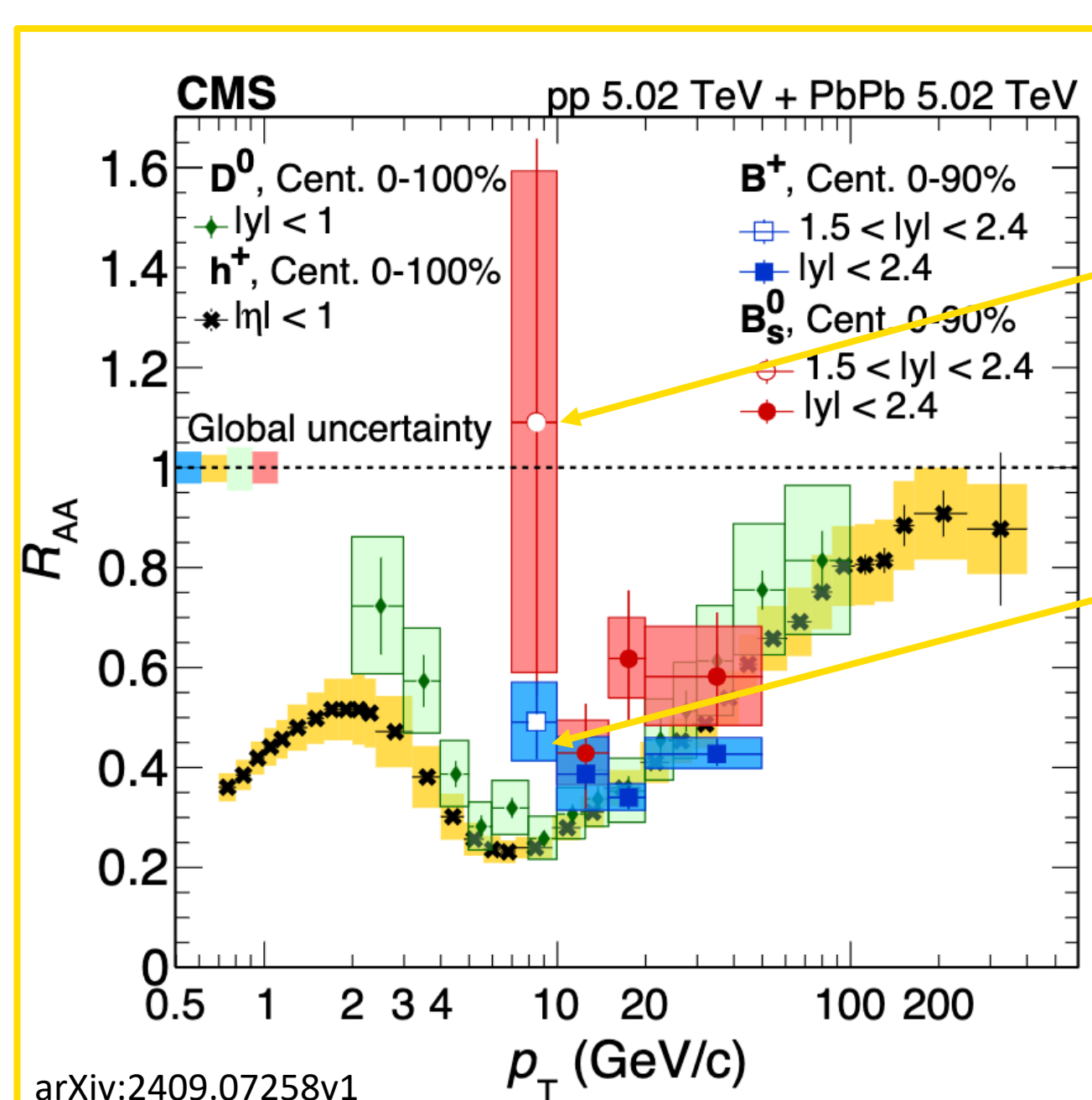
They are long lived!

$$b \rightarrow c, u \quad \left. \begin{array}{l} \text{W} \\ \text{V}_{ckm} \text{ matrix element is small!} \end{array} \right\} |\mathcal{M}|^2 \propto |V_{b \rightarrow c, u}|^2$$

Due to Lorentz contraction b-hadrons propagate a few millimeters



B meson Nuclear Modification Factor

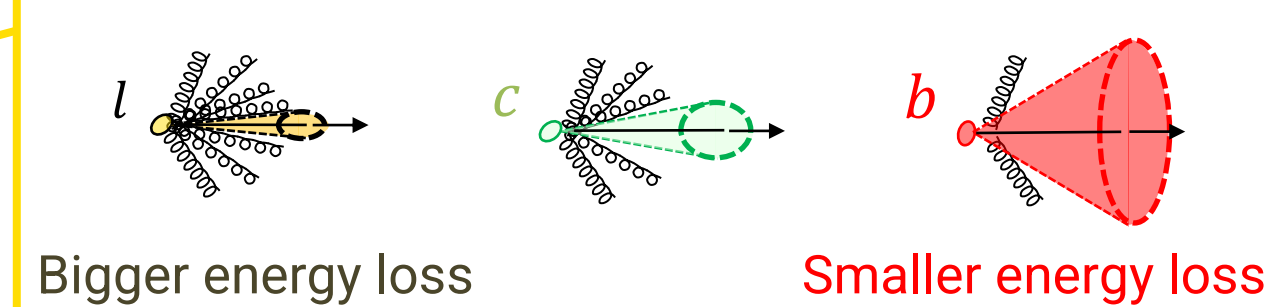


B mesons exclusively reconstructed for the first time in PbPb collisions

Hint of strangeness enhancement!

Flavor hierarchy of the energy loss!

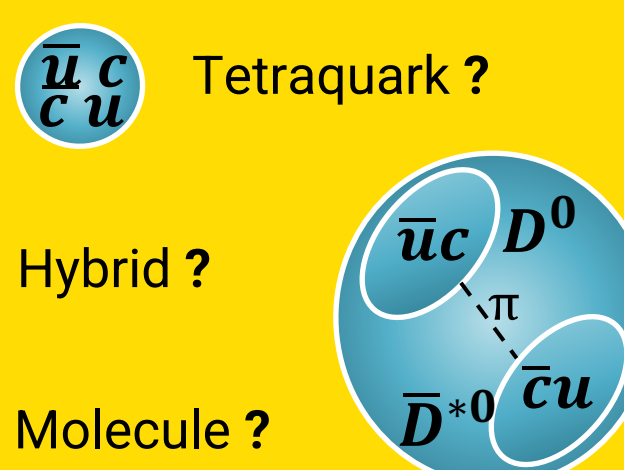
Dead cone effect: $\Delta E \propto m/E$



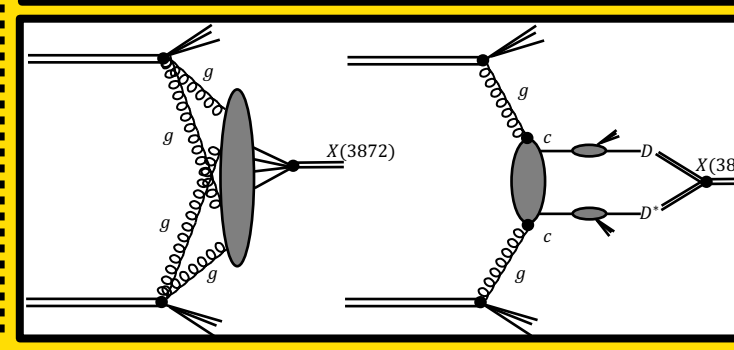
$$R_{AA}(p_T) = \frac{1}{\langle N_{coll} \rangle} \frac{(d\sigma/dp_T)_{PbPb}}{(d\sigma/dp_T)_{pp}} \quad \frac{d\sigma}{dp_T} = \frac{1}{\epsilon LB} \frac{Y_s}{\Delta p_T}$$

The X(3872) as a novel probe

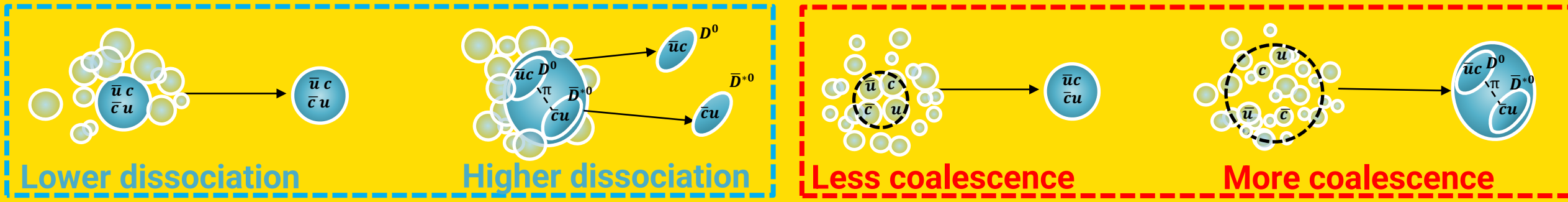
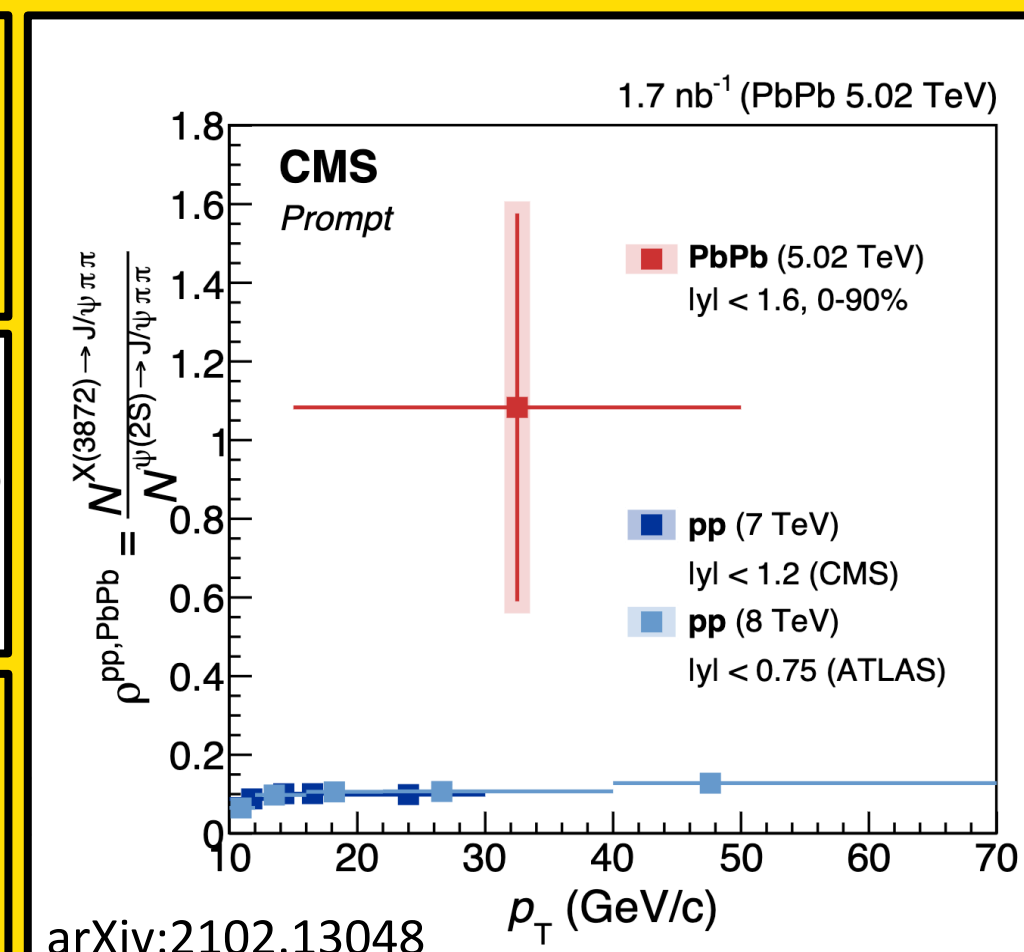
Unknown structure



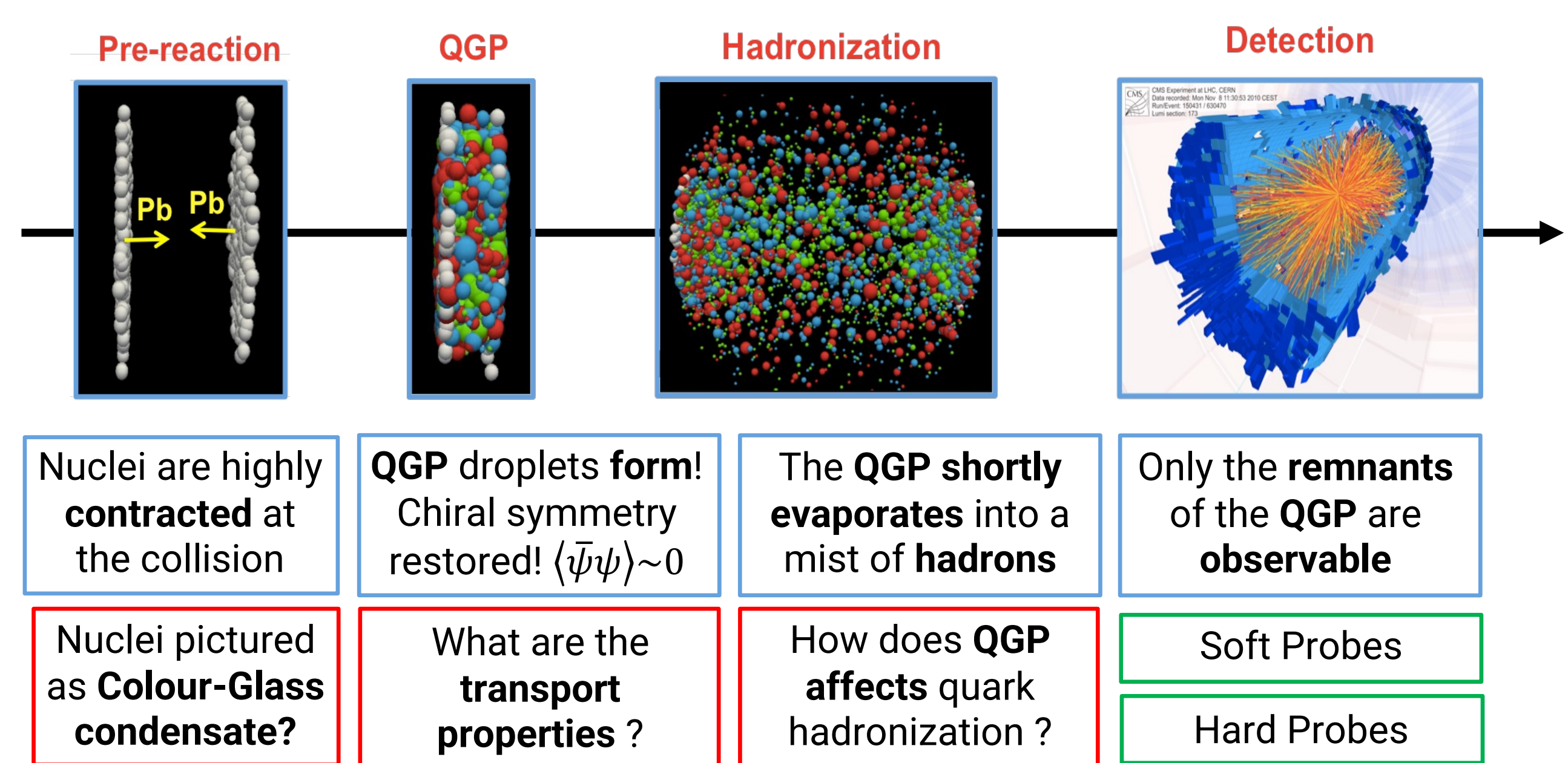
Evidence of X production in a PbPb collision system



Throw X into the QGP to constrain its binding energy and probe the in-medium effects interfering with its production!



Heavy Ion Collisions



Nuclei are highly contracted at the collision

Nuclei pictured as Colour-Glass condensate?

QGP droplets form! Chiral symmetry restored! $\langle \bar{\psi}\psi \rangle \sim 0$

What are the transport properties?

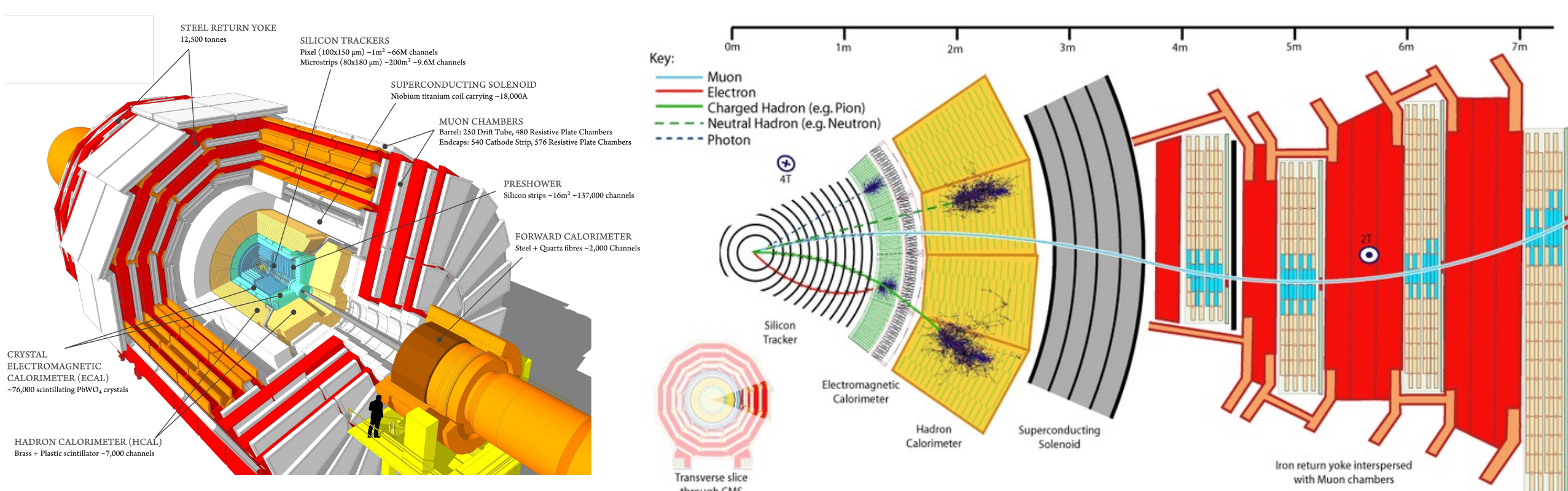
The QGP shortly evaporates into a mist of hadrons

How does QGP affects quark hadronization?

Only the remnants of the QGP are observable

Soft Probes
Hard Probes

Compact Muon Solenoid



CMS is a general purpose detector located at the LHC

The Silicon Tracker and the Muon Chambers are the main CMS sub-detectors used in this analysis

Measures charged particles

Identifies Muons