Future interest in high-p_T physics

‘Where high-density QCD and perturbative QCD meet’

Marco van Leeuwen

Hot and dense QCD matter

Exploring the QCD phase diagram
Testing our understanding of QCD phenomena

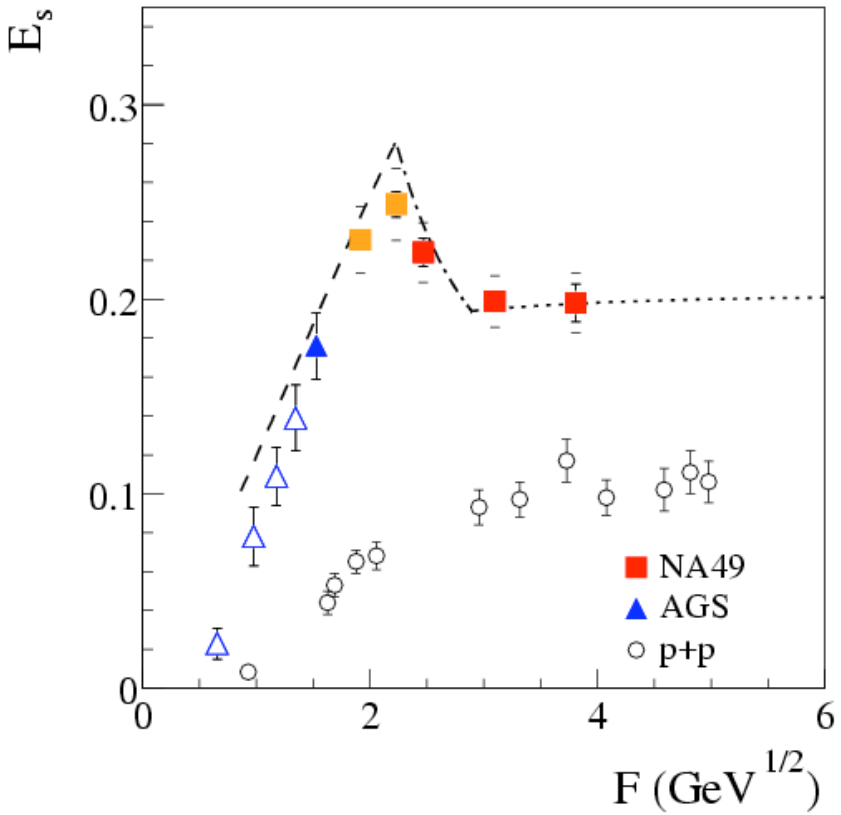
- Locating the QCD phase transition
  - Look for transition phenomena
    - Quick changes, fluctuations
- Determining the properties of the QGP (EOS)
  - Need quantitative treatment
    - Find probes that are quantitatively understood

Locating the QCD phase transition

Or: can we create a QGP in the lab?

Experience shows: a very difficult task

- Slow approach of transition with beam energy
- Experimental system is very dynamic, observables integrate over evolution
- At relevant energies (ε≈1 GeV), all particles, processes, are soft => difficult to establish sound baseline



Determining properties of the QGP

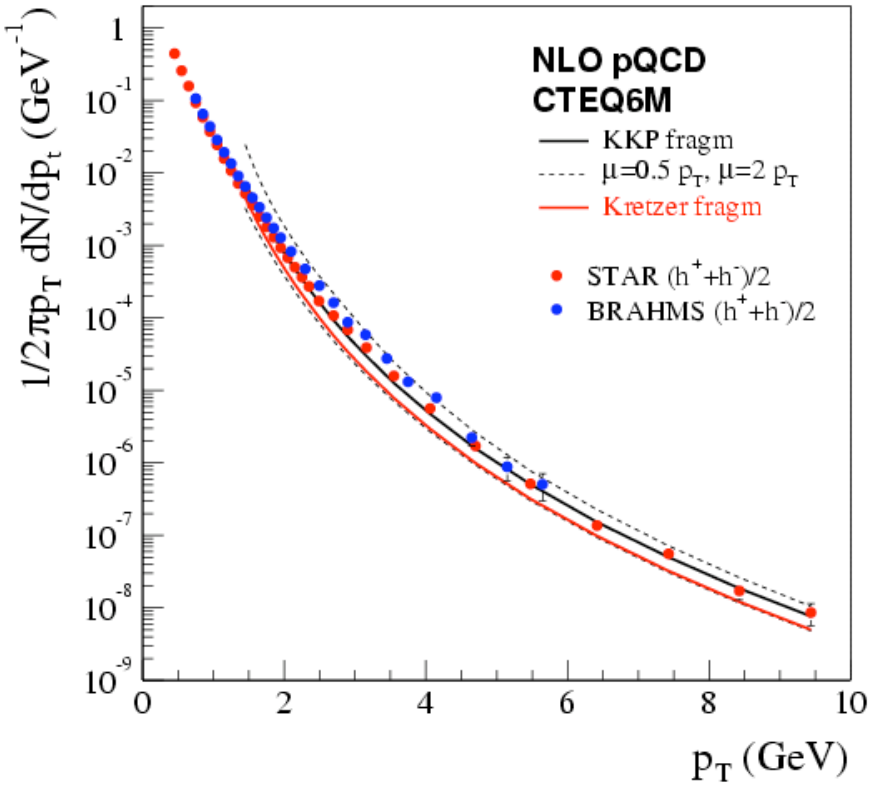
Important note: with enough quantitative detail also proof of existence of QGP

Can use long-lived systems, far from transition region

- Bulk properties
  - See previous slide
- Probes:
  Quantitative description of
  - Initial production
  - Interactions with medium

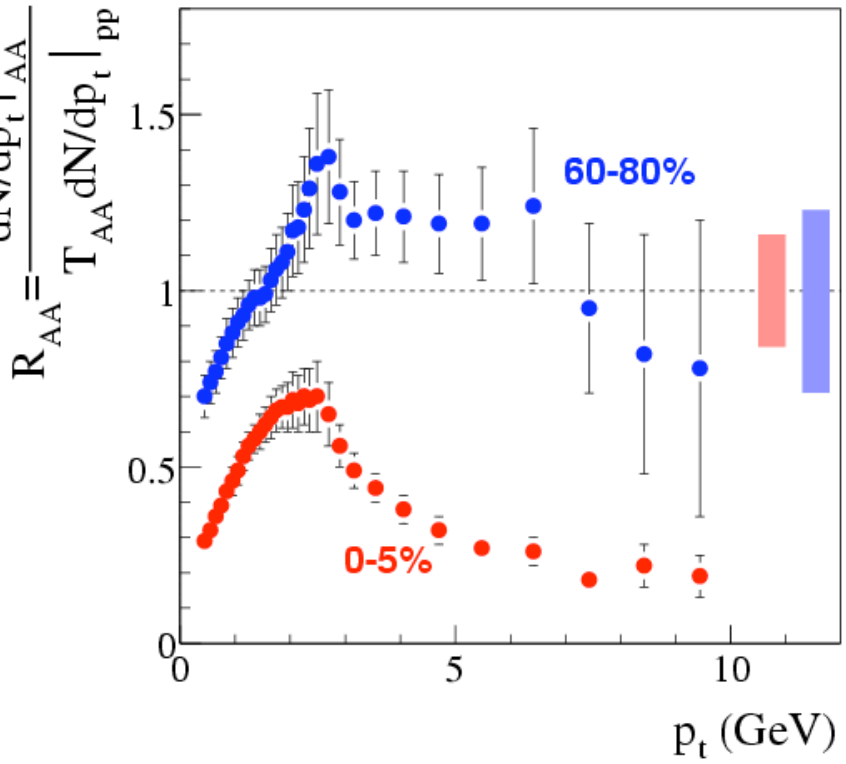
Make contact with other (sub-) fields

High-p_T probes from STAR



NLO pQCD describes high-p_T particle production at RHIC:
We have a baseline

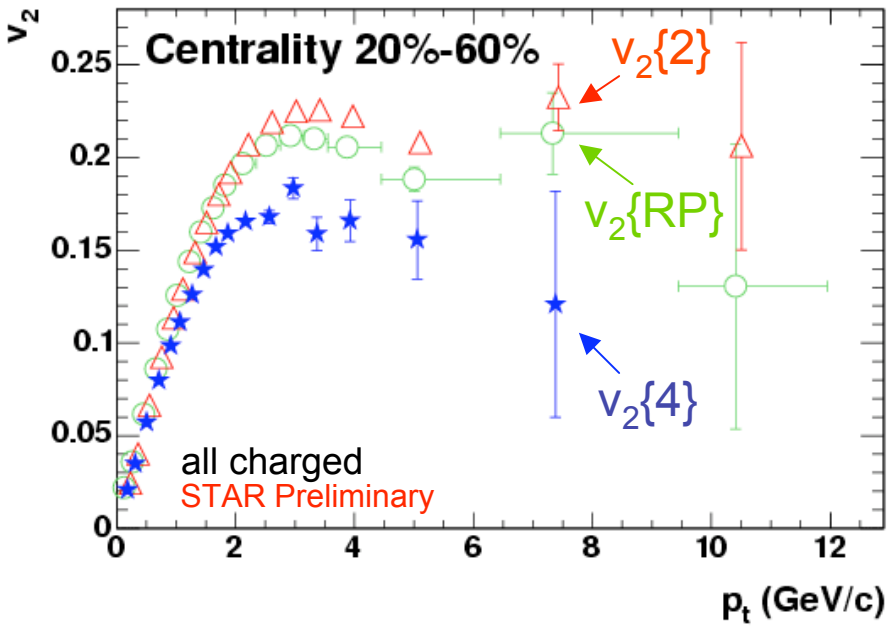
Need to substantiate
(photons, charm, Drell-Yan?)

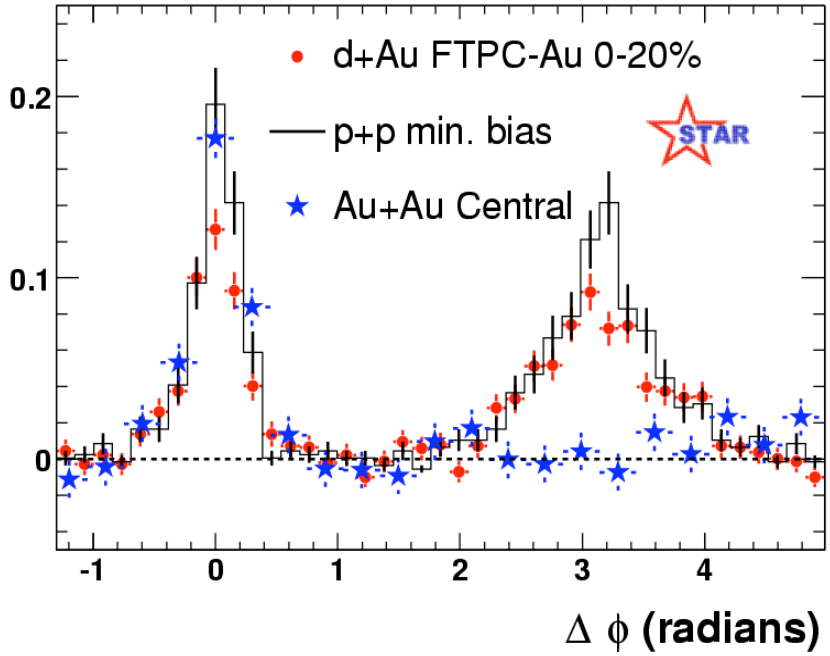


Suppression central A+A

So far: mainly qualitative in terms of medium properties

Progress so far II





High-p_T suppression depends on path length

Centrality + measurements relative to reaction plane can eventually provide quantitative information on path length dependence

Future steps

Calibrate, quantify, cross-check

- Jet reconstruction
  - Calibrate partonic processes (I)
  - Quantify, characterise energy loss
- γ-jet
  - Calibrate partonic processes (II)
  - Calibrate jet energy, fragmentation

Make connection to 'traditional (hard) QCD' physics(-community): need to measure p+p

Note: need high-p_T photon detection (electromagnetic calorimetry) to make this progress

The future at LHC

LHC energies provide abundant high-p_T probes

- Beat background
  - Background ~1 GeV per particle, need ~50 GeV jets to stick out
- Reach the 'pure perturbative regime'?
  - For jets of 100-200 GeV, energy loss might be a minor perturbation
- γ-jet cross-section
  - Power law at LHC much flatter: larger p_T-reach

STAR with EMCAL and large data samples (e.g. 2004 data) can also contribute

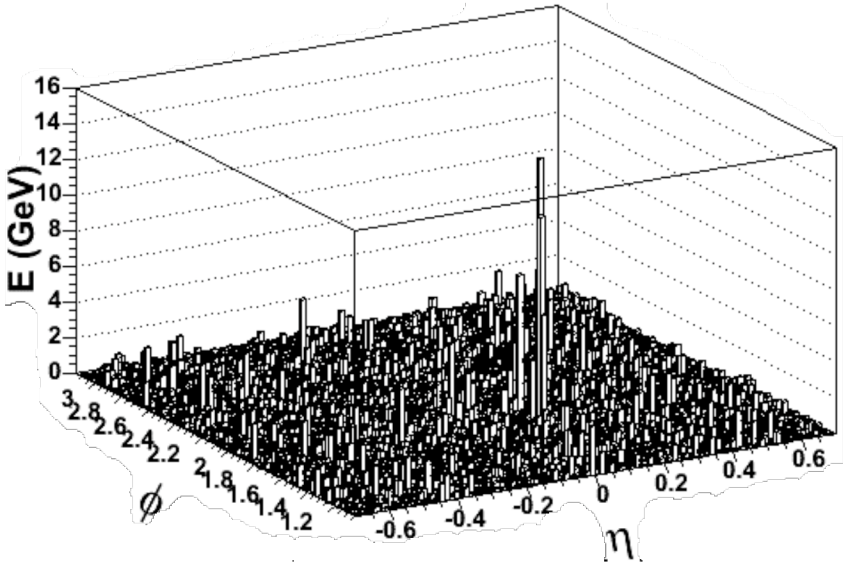
Summary

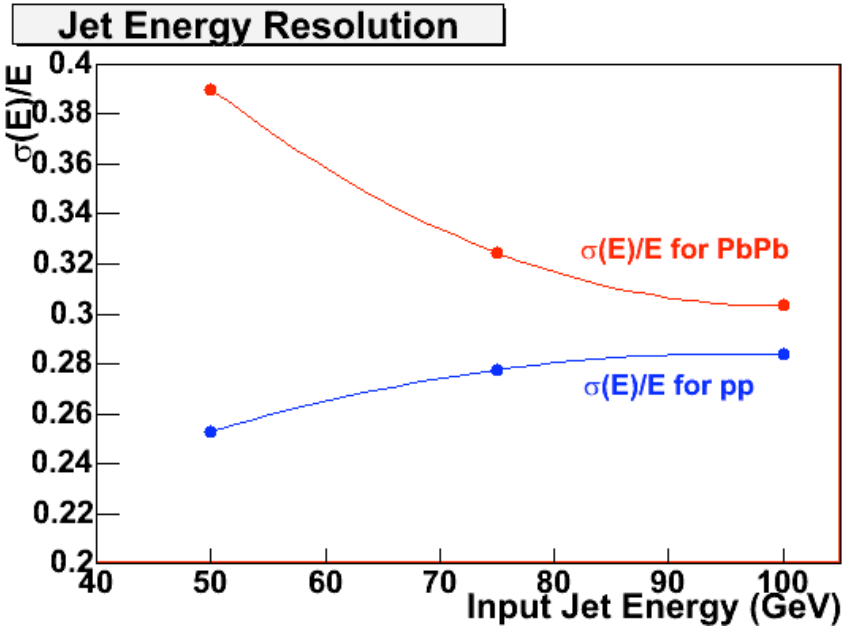
- High–p_T measurements provide a natural connection to existing QCD phenomenology
  - Quantitative analyses possible
  - Bridge to HEP community (`Nature article')
- Interesting phenomena have been established, but need next generation (LHC) experiments to make quantitative

Extra Slides

Jet-finding in A+A

50 GeV jet on Hijing (LHC energy)





Jet energy resolution in Alice