Event-by-Event Simulations of Jet Modification Using the MATTER Event Generator

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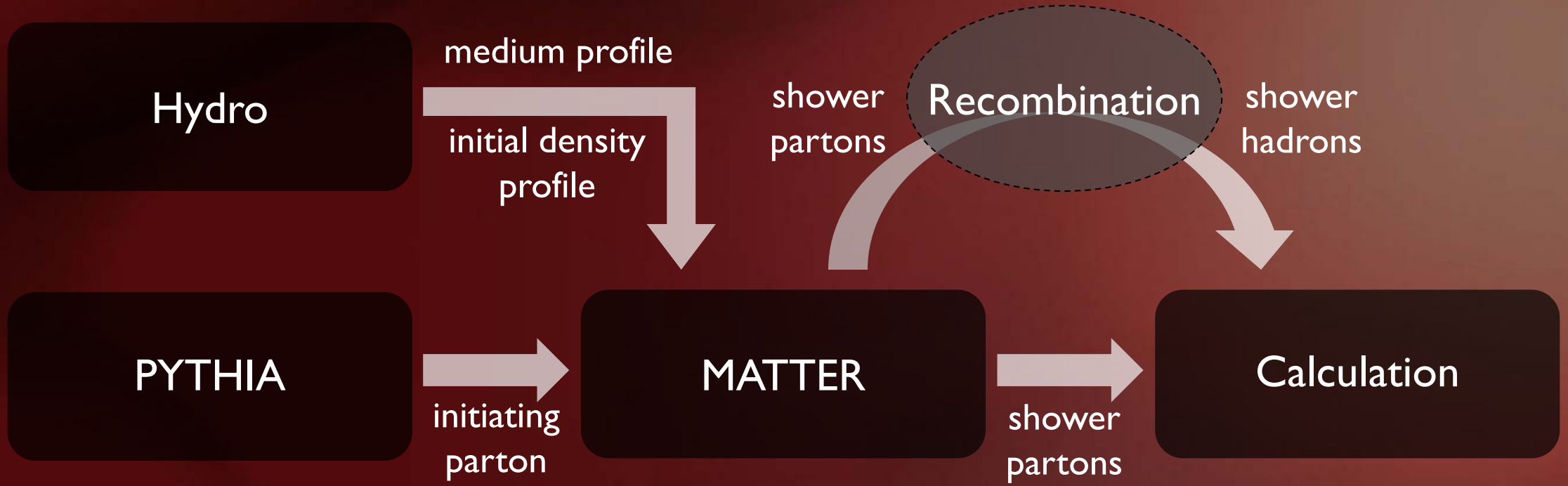
Overview

- Purpose
- Code Flow and Details
- Calculations
- Results
- Summary

Purpose

- Wish to simulate jet modification in a medium
- Want to do this simulation on an event-by-event basis
- To perform this, we constructed a Monte-Carlo event generator

Code Flowchart



PYTHIA

- Used to generate hard event for jet
- Gives cross-section for jet production
- Generate bins of hard event pT, then sum over all events (after jet simulation) with each bin weighted by its cross-section

OSU Hydro

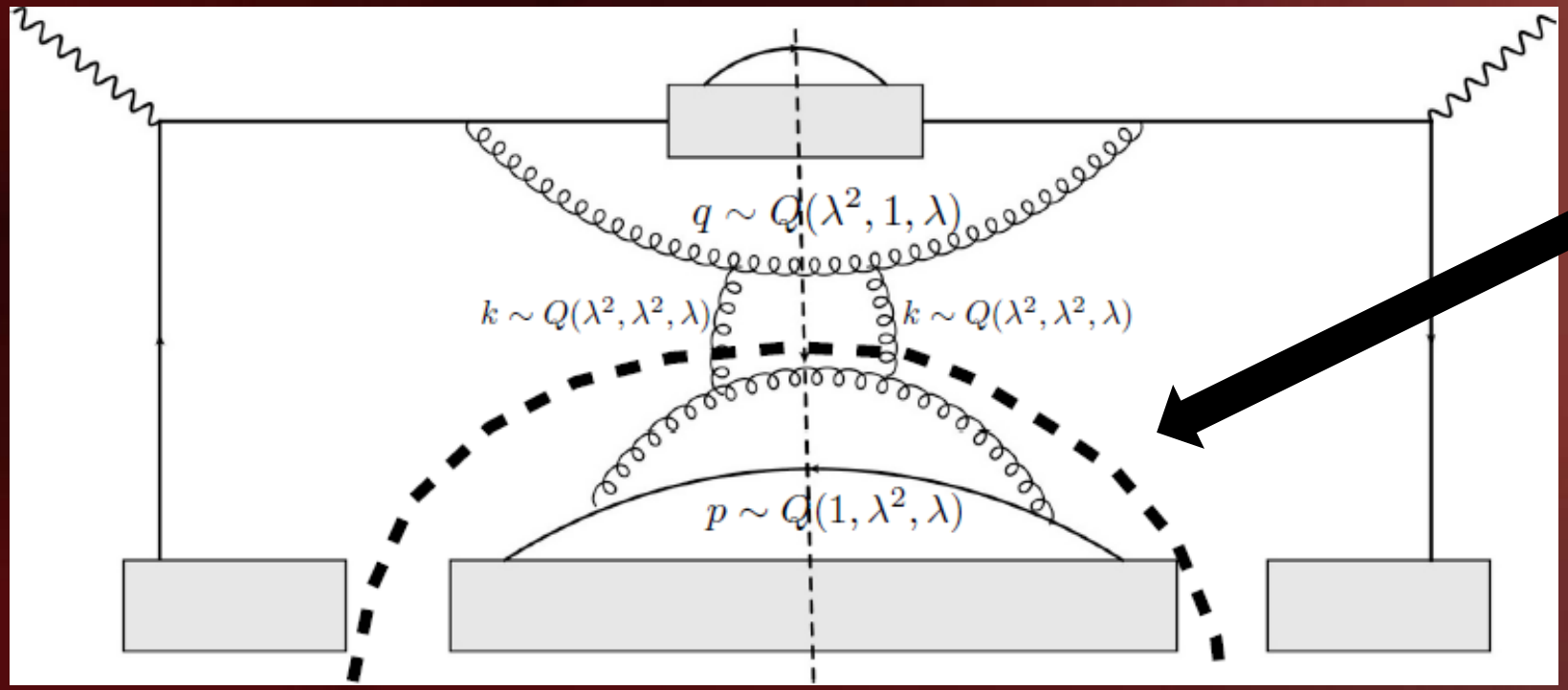
- Is a 2d+1 Hydro Simulation
- Provides medium profile (entropy density) for jet quenching
- Initial density profile T_{AA} sampled to determine jet start location

MATTER

- Uses Higher-Twist formalism to simulate jet showering in both vacuum and in medium
- Reads in initial parton id and pT from PYTHIA
- Reads in T_{AA} and entropy density from hydro
- Takes the initial hard parton and creates a shower using the hydrodynamic profile
- Outputs a shower of quarks and gluons for hadronization and/or analysis

MATTER details

Few scatterings per emission limit

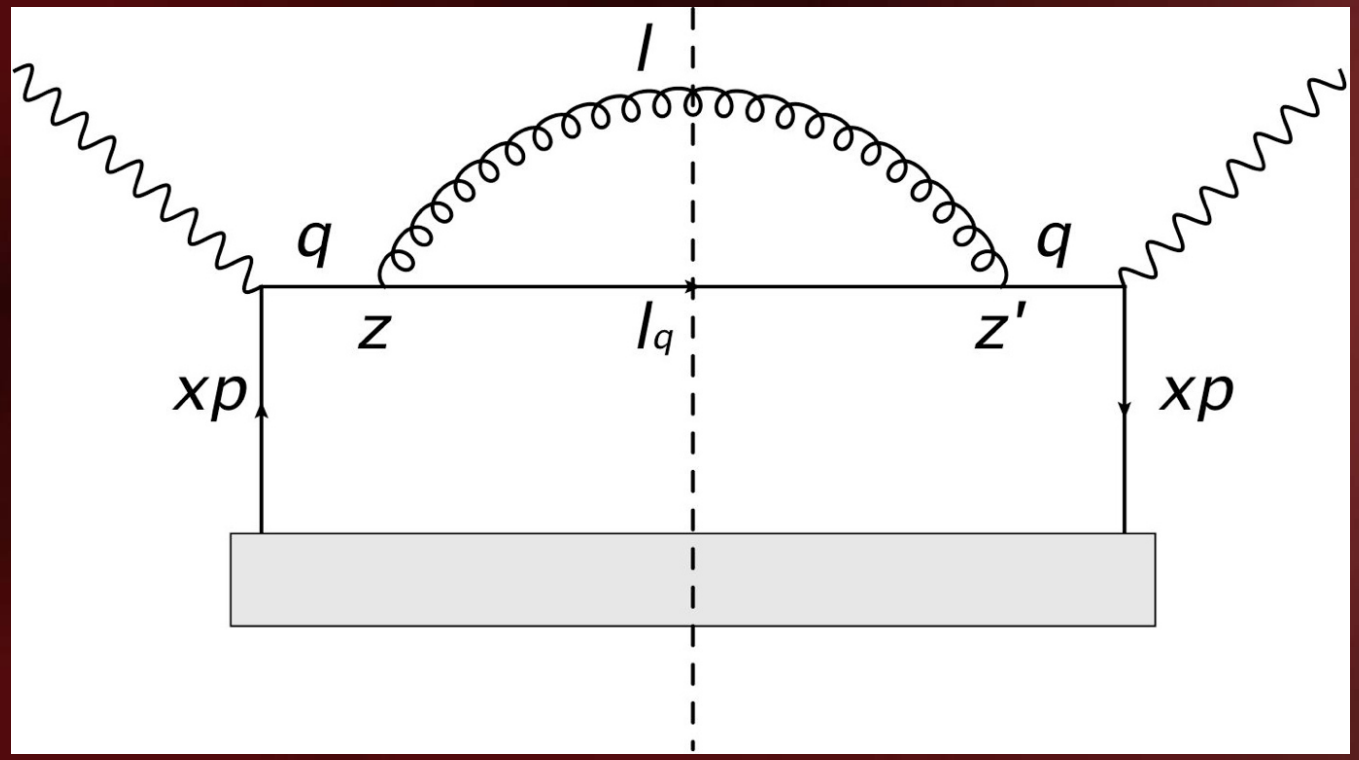


All of this evolution is hiding within $\hat{q}$.

Light quark modification is sensitive to the high Q^2, low-x part of the in-medium gluon distribution.

Abhijit Majumder, Quark Matter 2014

MATTER details II



$\bar{z} = z+z' / 2 \qquad \partial z = z - z'$

$$\int_0^\infty d^4\,\bar{z}\,\exp[i(\partial q)\bar{z}]$$

$$\int d^4\,\partial z\,\exp[i\partial z\bar{q}]$$

∂q is the uncertainty in q

Abhijit Majumder, Quark Matter 2014

MATTER details III

A reasonable uncertainty is: $\partial q \ll q$

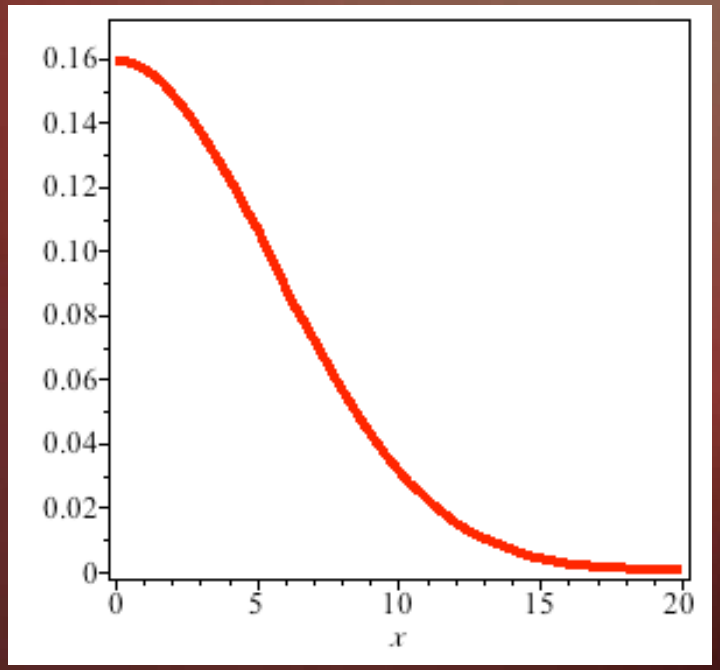
Assume a Gaussian distribution around q+

$$\rho(\delta q^{+}) = \frac{\exp[-\frac{(\delta q^{+})^2}{2[2(q^{+})^2/\pi]}]}{\sqrt{2\pi[2(q^{+})^2/\pi]}}$$

Set functional form for the width by imposing:
$\langle \tau \rangle = 2q^{--} / Q^2$

To get z^{-} distribution, only need to assume ∂q^{+} distribution

Sample the in medium modified Sudakov form factor to get virtuality at each step



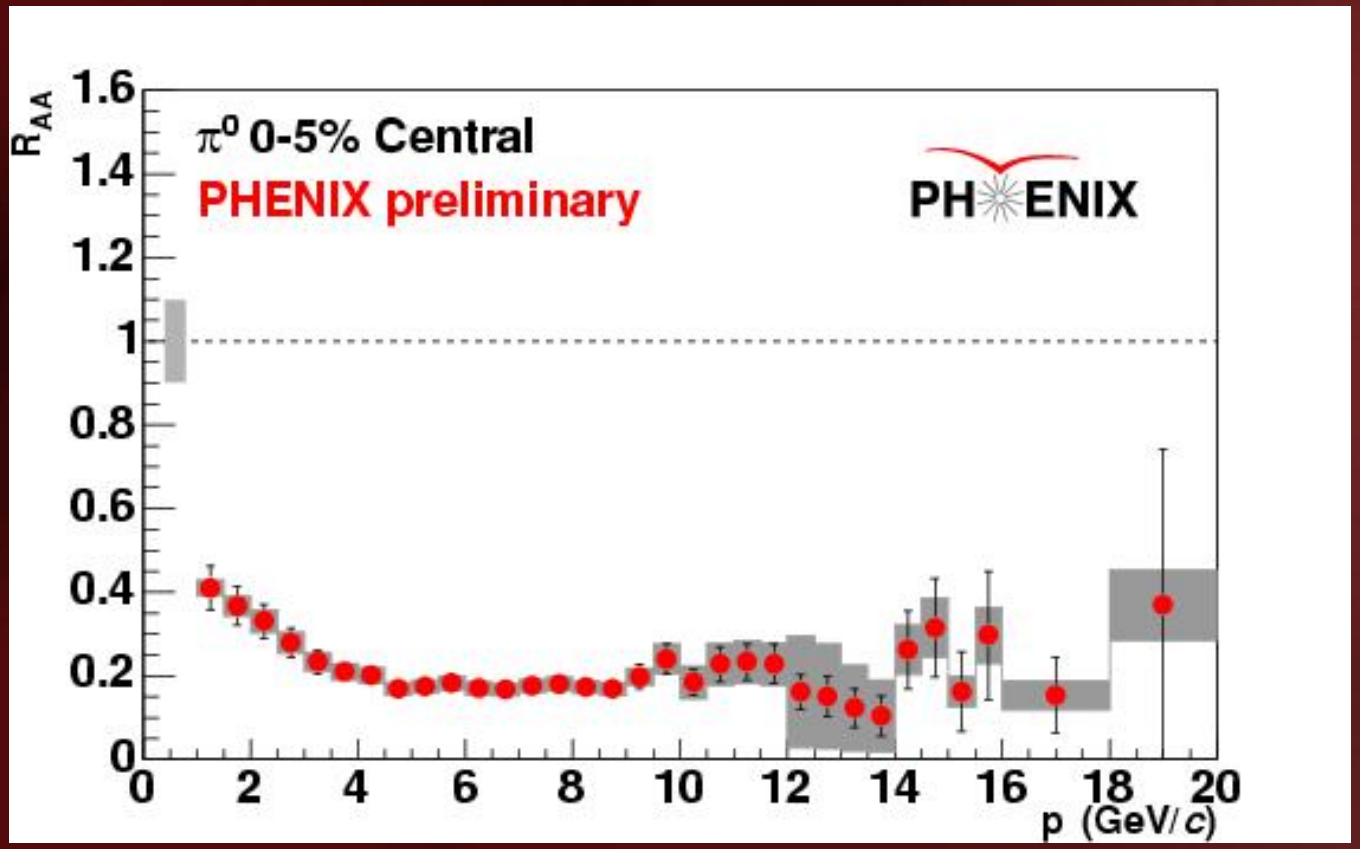
Abhijit Majumder, Quark Matter 2014

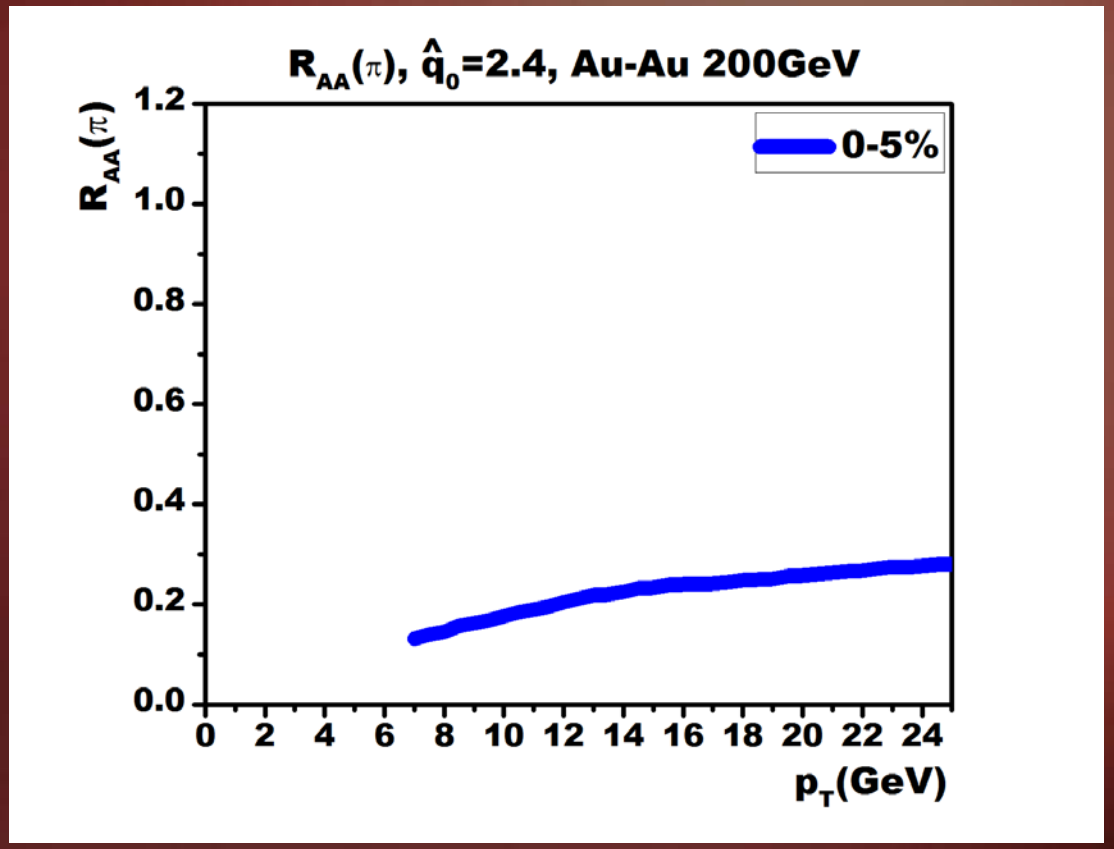
Calculations

- MATTER returns list of partons with corresponding momentum and position for each
- Fastjet used to cluster partons (not hadrons!) into jets
- R_{AA} calculated by generating spectra over each hard pT bin, weighting each bin by its cross-section, then summing over them to get the total spectra; Dividing in-medium by vacuum spectra gives R_{AA}
- For leading hadron RAA, the KKP fragmentation function was used on the quark/gluon spectra to generate hadron spectra.

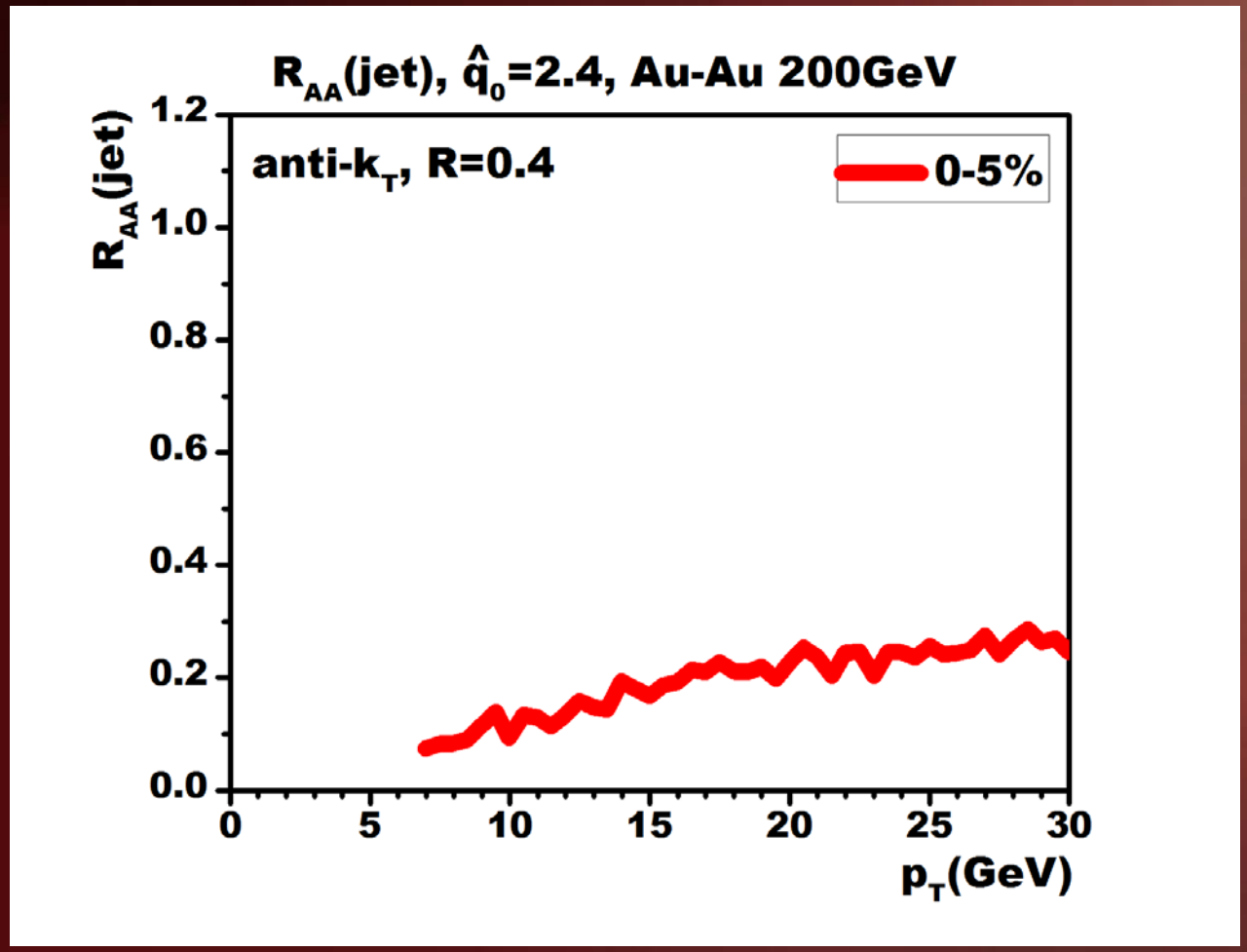
Now for some PRELIMINARY RESULTS!

RAA for leading pions compared to PHENIX

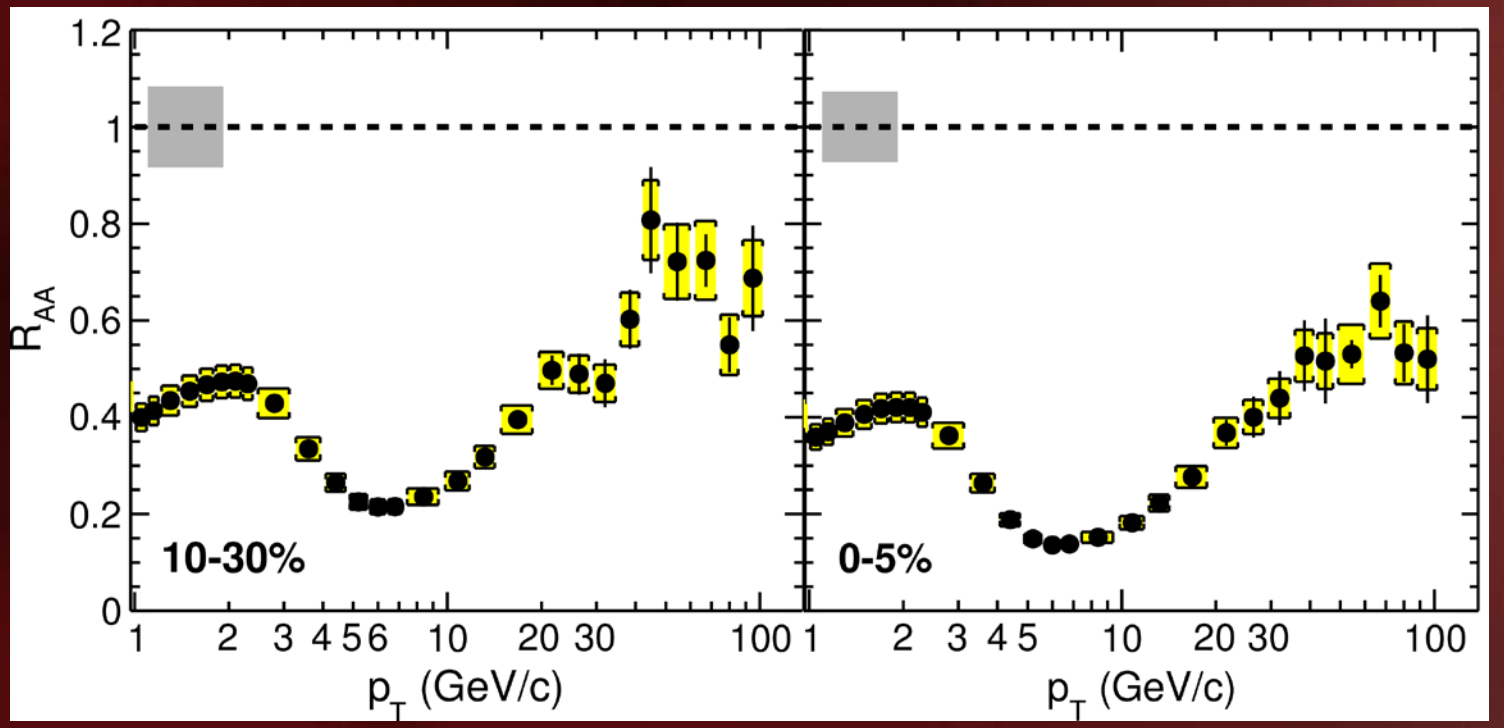


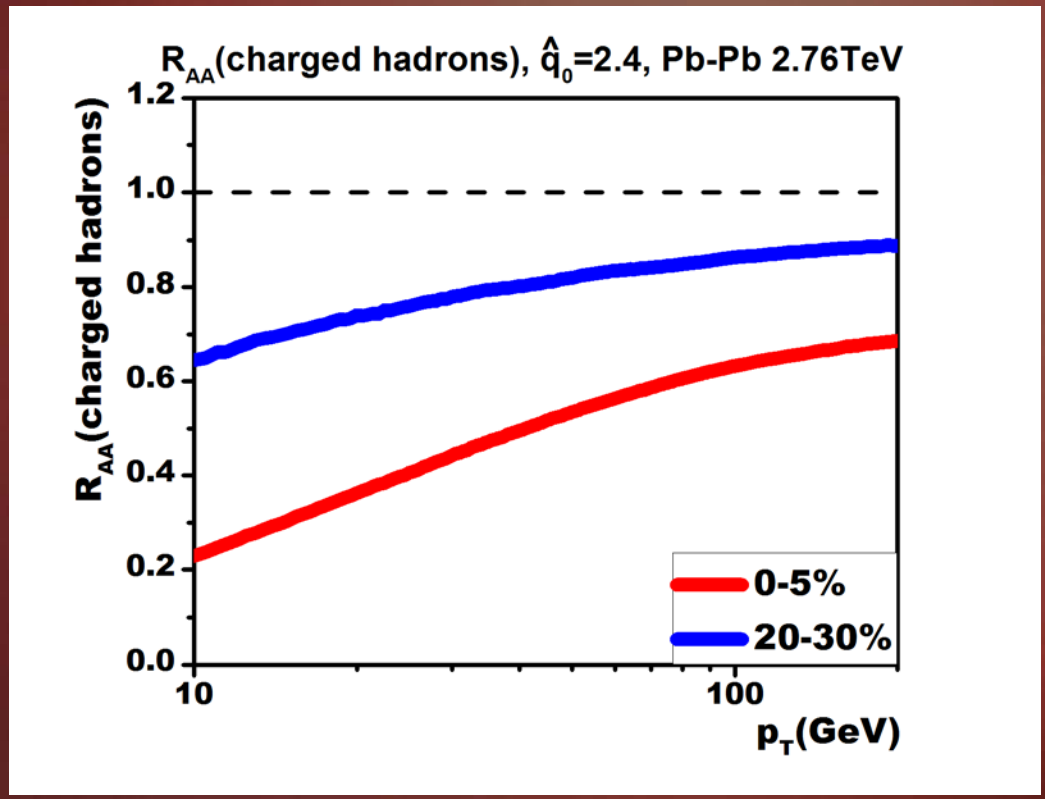


RAA for jets – RHIC energies



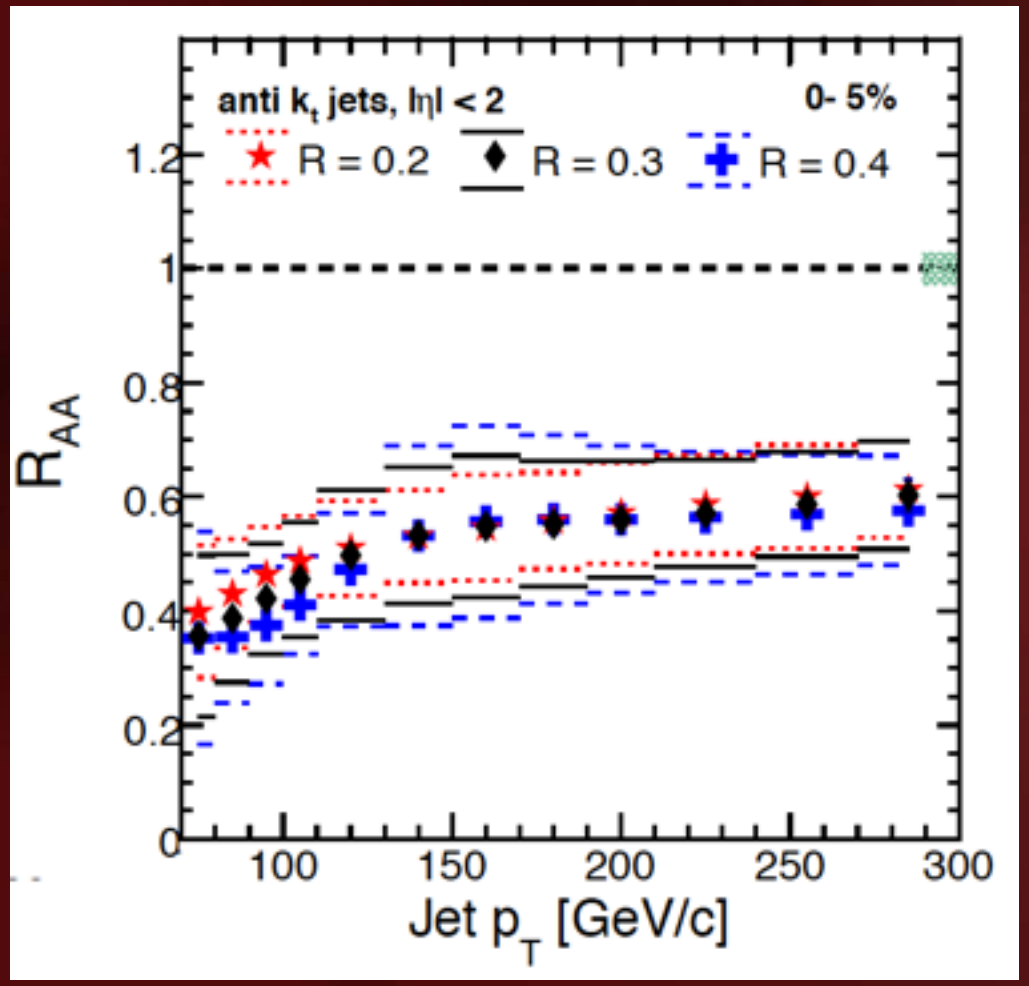
R_{AA} for charged hadrons compared to CMS

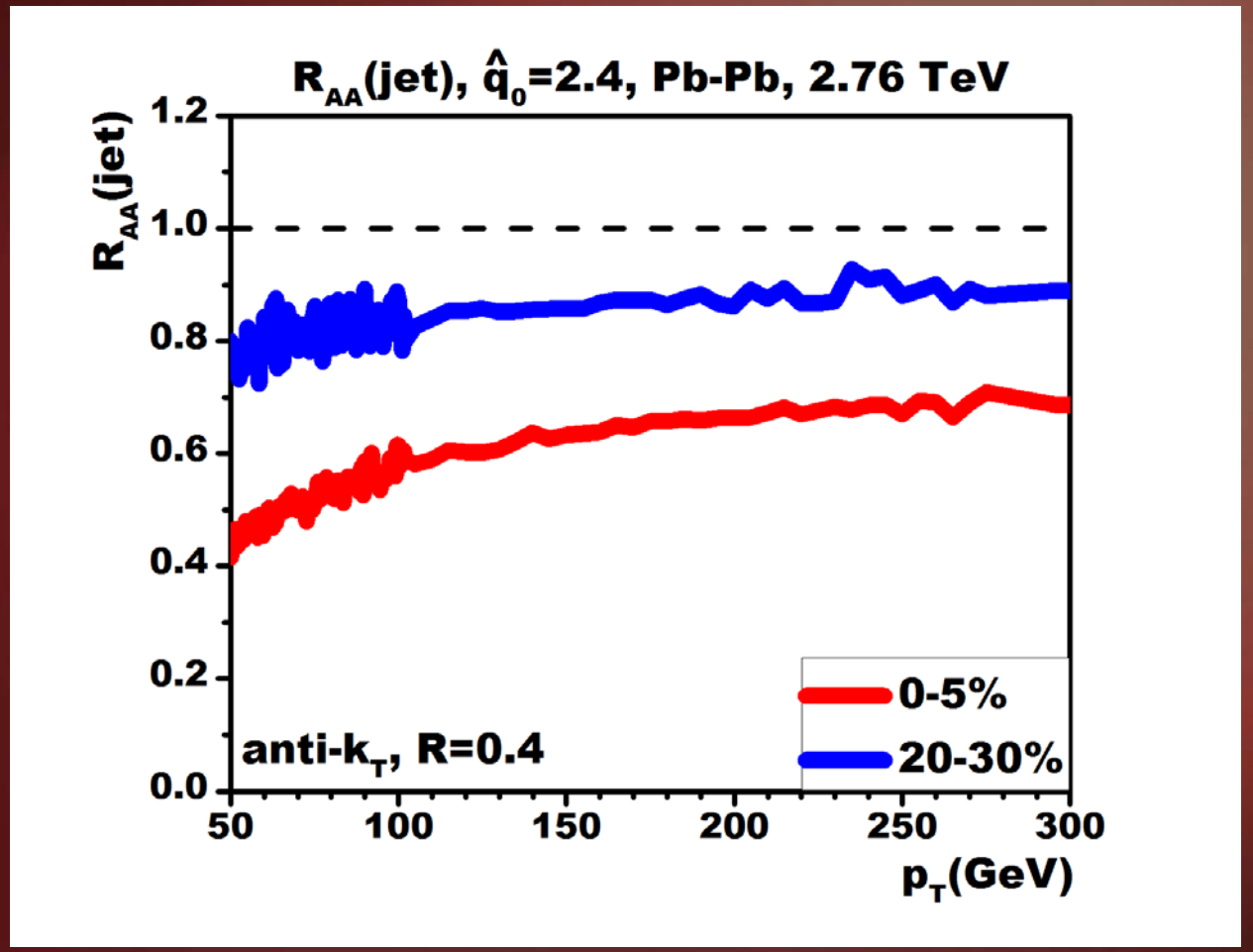




http://cms-results.web.cern.ch

R_{AA} for jets compared to CMS





Doga Gulhan – Report from CMS; HP2016

Summary

- Showed some prelimary results
- Need to handle partons with virtuality of 1GeV or less
- Need to incorporate medium response via source term
- Further calculations to be simulated, such as v_2, jet shapes, etc.

Fin.

Questions?