Using Jet Substructure to probe Heavy-Flavor Energy-Loss

Steffen A. Bass, Wenkai Fan

Duke University

Gojko Vujanovic

Wayne State University

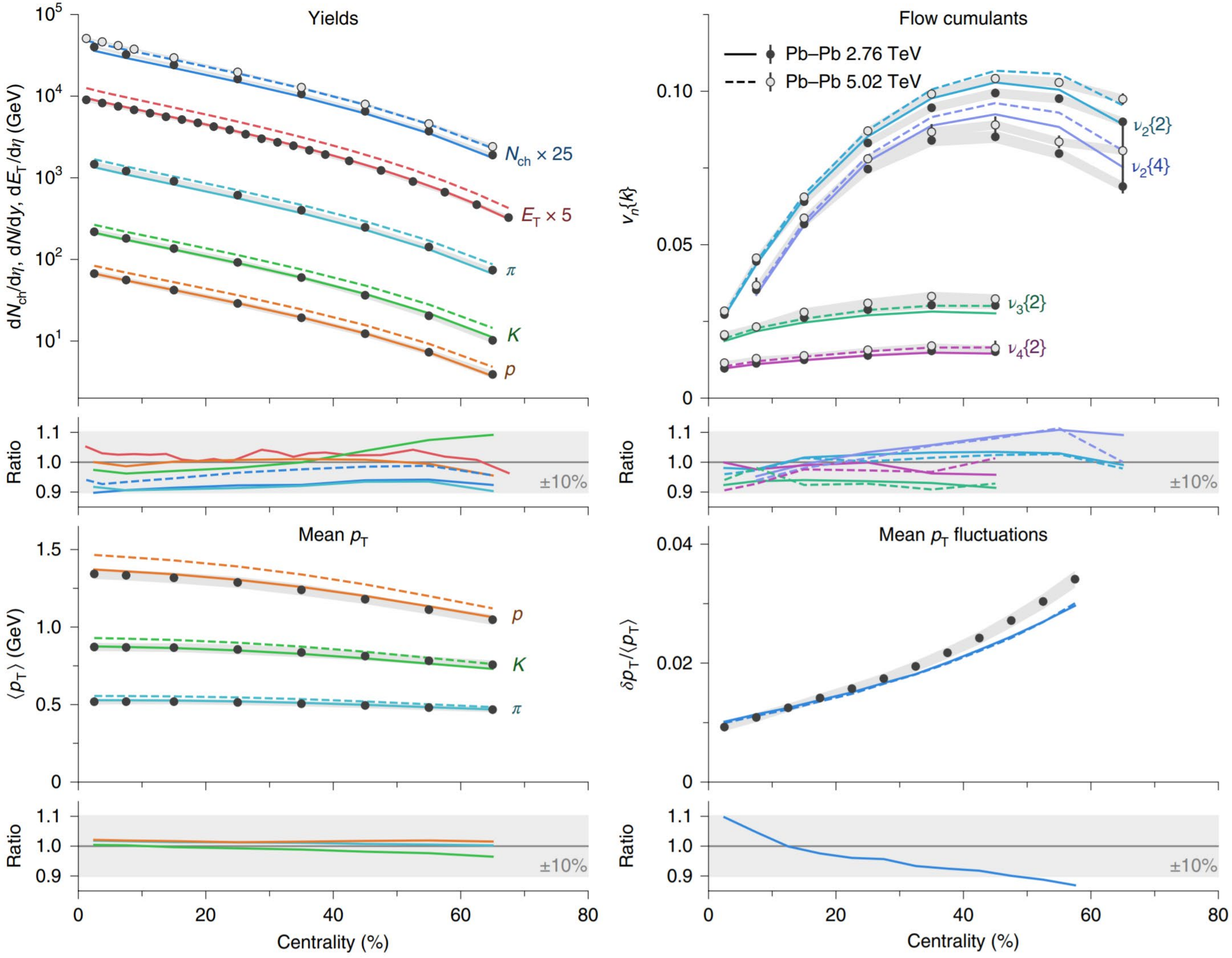
On behalf of the JETSCAPE Collaboration

This work has been supported by the U.S DOE DE-FG02-05ER41367 and NSF ACI-1550300.
Computational resources were provided by the Wayne State University Grid.

PART 1

Soft Observables

- **Calibrate the space-time profile of the plasma with Bayesian analysis** *[Nature Physics 15.11 (2019): 1113-1117.].*
- Event-by-event simulations consist of
  - TRENTO initial conditions
  - 2+1D Pre-equilibrium dynamics
  - 2+1D 2nd order dissipative hydrodynamics of QGP
- The same bulk evolution is used to study hard observables for both light and heavy flavor.



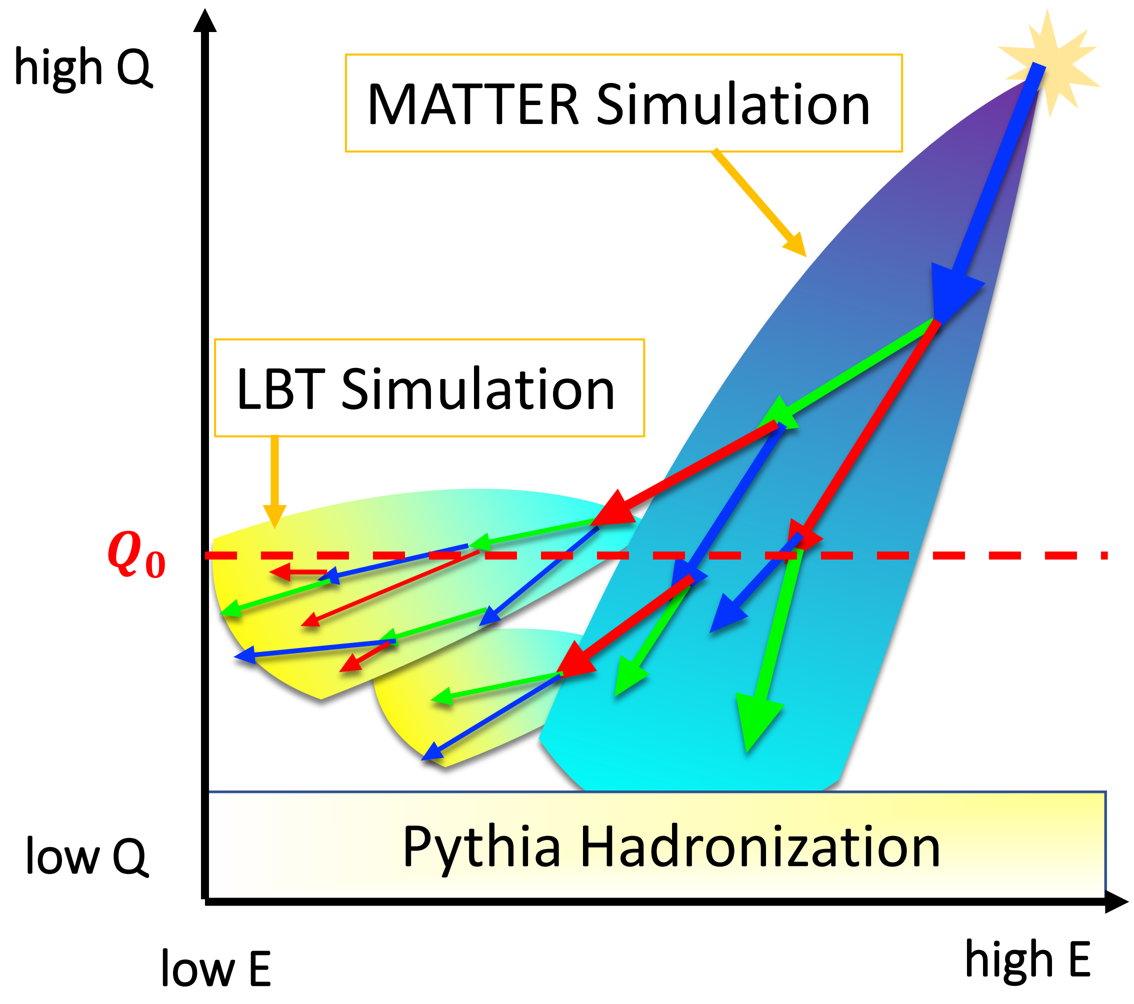
PART 2

Hard parton evolution

- High virtuality **in medium** parton showering is solved by the **MATTER** model which employs the Higher Twist formalism. Generates virtuality-ordered shower with splittings above $Q \gg Q_0$. *[Adv.Ser.Direct.HEP, 573 (1989); NPA 696, 788 (2001)]*

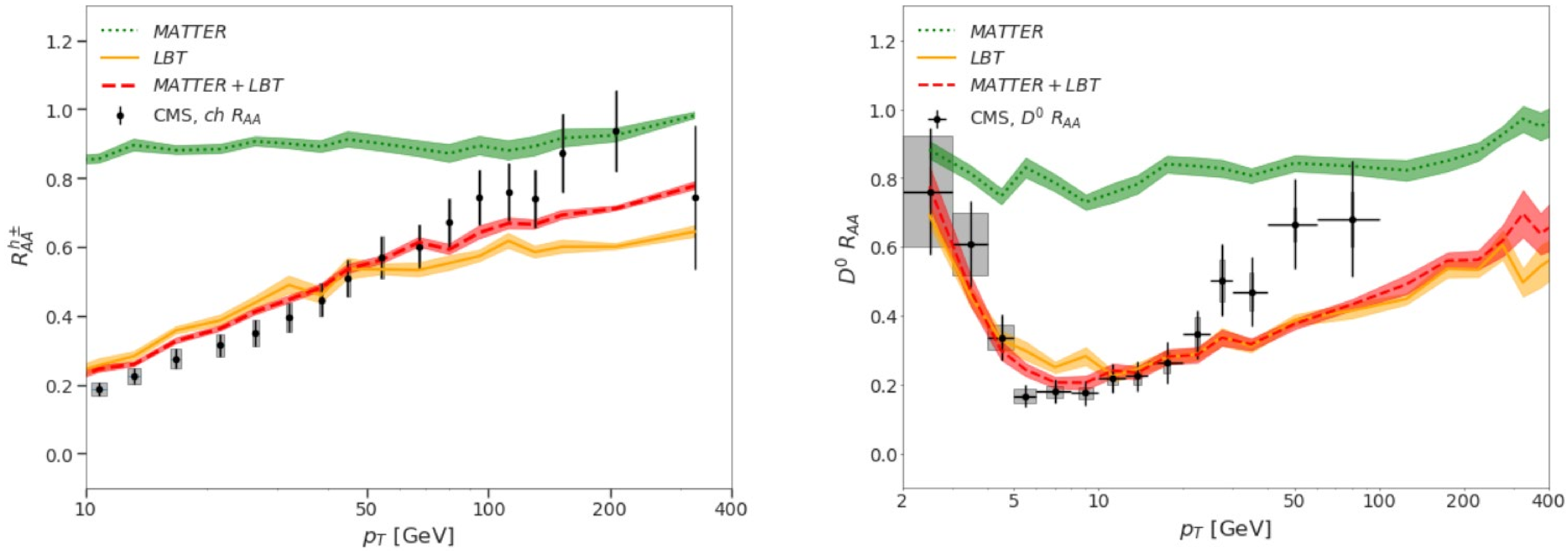
- The virtuality dependent $\hat{q}$ *[Phys. Rev. C101, 034908 (2020)]* with a simple parametrization:
$$\hat{q}(Q) = \hat{q}^{HTL} \frac{c_0}{1 + c_1 \ln^2 Q^2 + c_2 \ln^4 Q^2}$$
where $c_0 = 1 + c_1 \ln^2 Q_0^2 + c_2 \ln^4 Q_0^2$.

- Low virtuality parton showering is solved by Linear Boltzmann transport (LBT) equation.
$$p_1^{\mu} \partial_{\mu} f_1(x_1, p_1) = \mathcal{C}_{el}[f_1] + \mathcal{C}_{inel}[f_1]$$



Phase space evolution, figure credit: Gojko Vujanovic

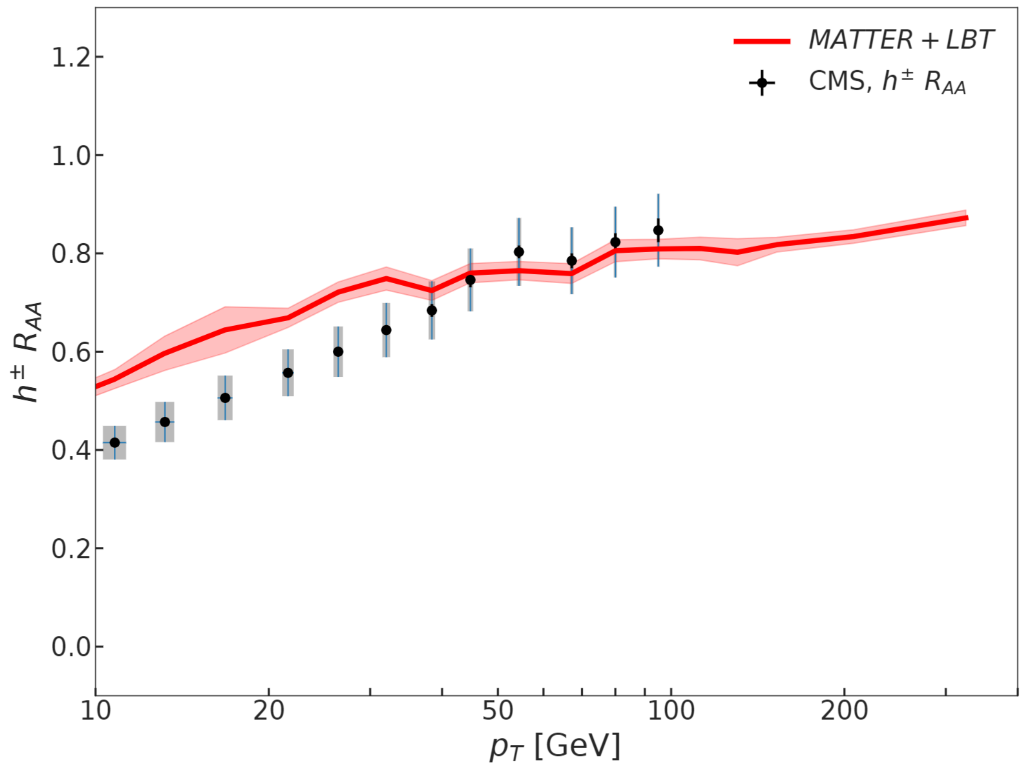
The JETSCAPE framework – PbPb 0-10%, 5.02TeV

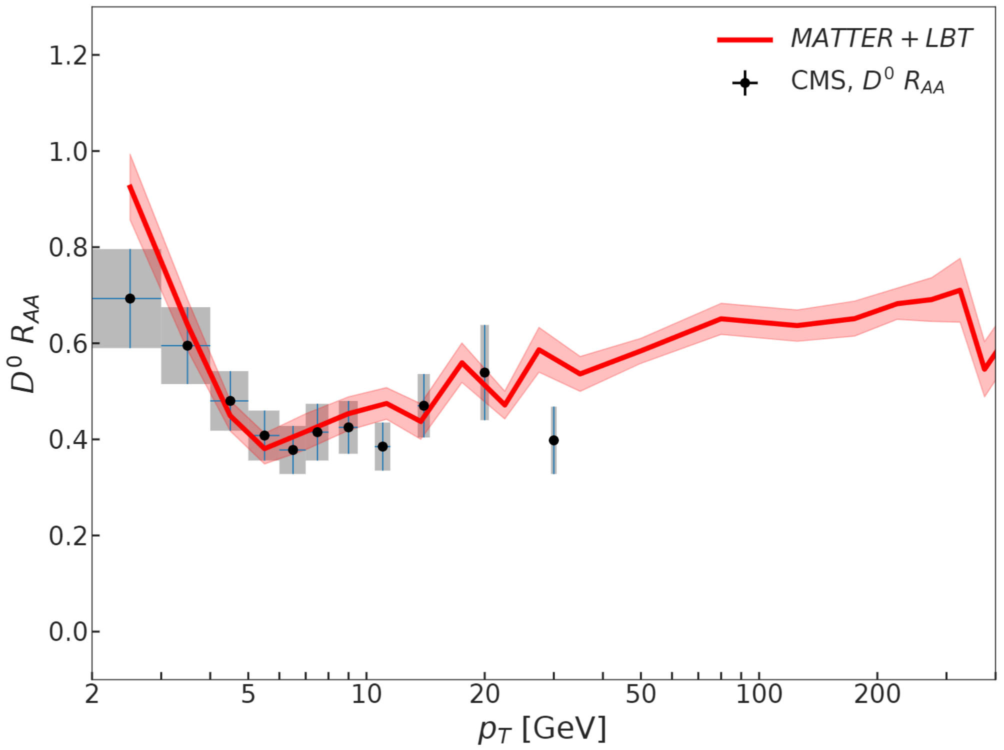


- **Left:** charged hadron R_{AA}. **Right:** D meson R_{AA}.
- Simultaneous description of charged and D meson R_{AA}. Compared with LBT only simulation, we achieved a better agreement with data at both low p_T and high p_T.

PART 3

The JETSCAPE framework – PbPb 30-50%, 5.02TeV

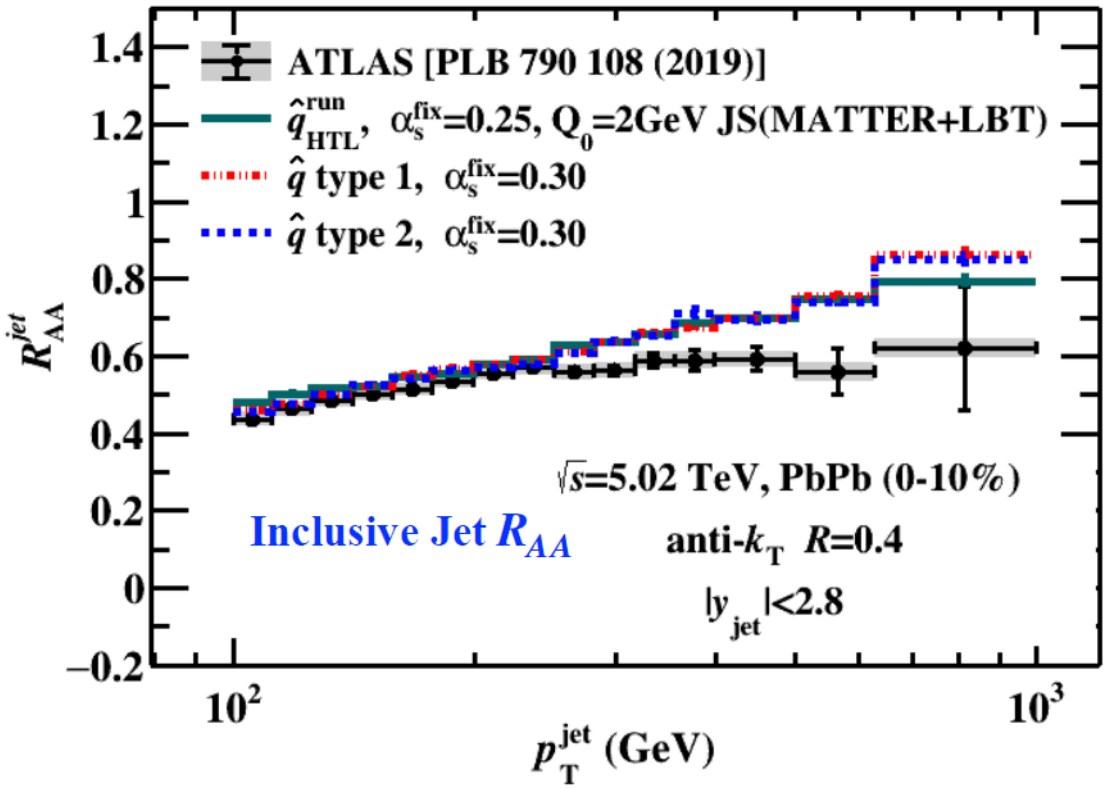


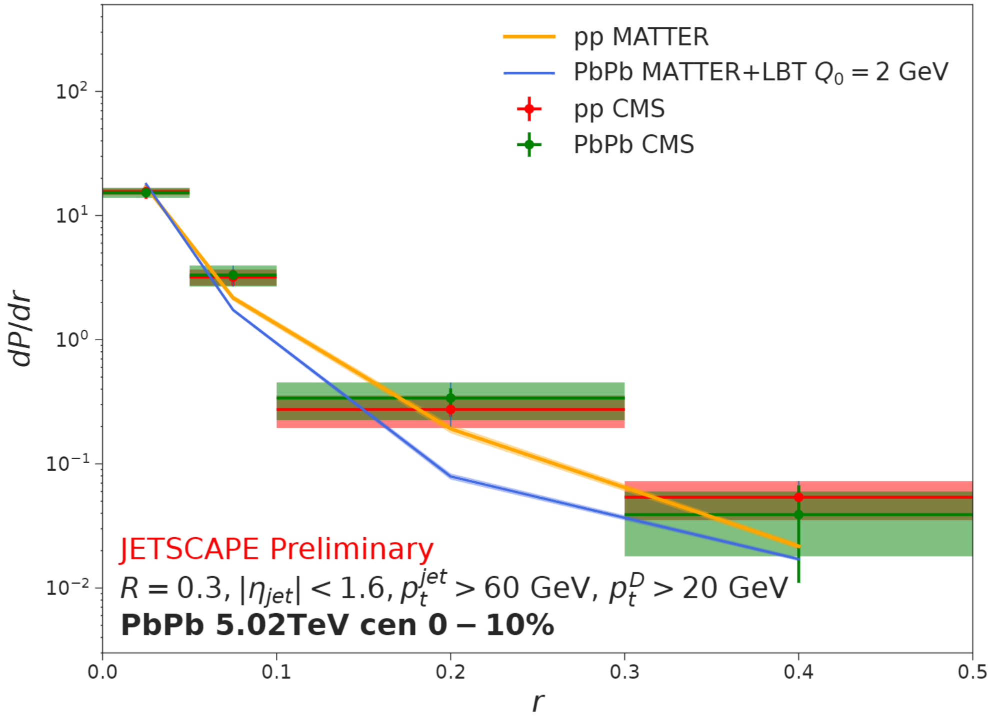


- **Left:** charged hadron R_{AA}. **Right:** D meson R_{AA}.
- Simultaneous description of charged and D meson R_{AA}.

PART 3

The JETSCAPE framework – PbPb 0-10%, 5.02TeV





- **Left:** Inclusive jet R_{AA}. **Right:** D meson radial distribution inside a jet.
- D meson are more collimated in PbPb collisions than pp.