QM2014 Summary

- Jets & low-mass dilepton results

In-Kwon YOO
Pusan National University

Outline

- Dilepton Results
- Jet Results

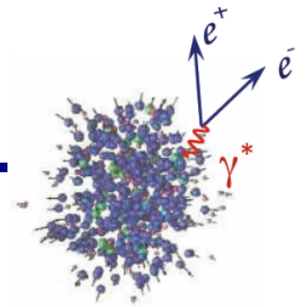
Dilepton Results

Penetrating probe of the hot, dense medium

Low mass dileptons (M_{ll}<1.1 GeV/c^2) (Spectrum and v_n versus M_{ll}, p_T) Intermediate mass dileptons (1.1<M_{ll}<3.0 GeV/c^2) (Spectrum and v_n versus M_{ll}, p_T)	vector meson in-medium modifications, link to Chiral Symmetry Restoration QGP thermal radiation, charm correlation modification.
Thermal photons (p_T<4 GeV/c) (p_T spectrum and v_n)	QGP thermal radiation, hadron gas thermal radiation

Energy and centrality dependence → Constrain T_0, t_0, lifetime, and density profile …

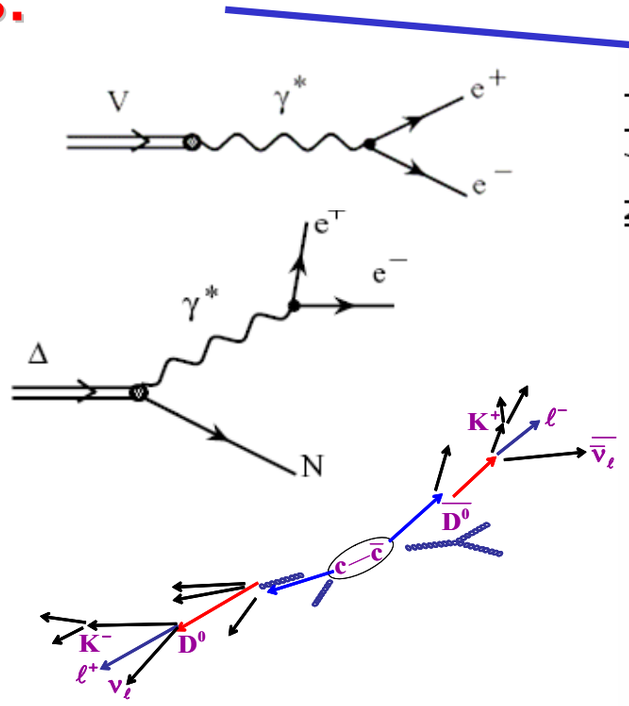
Dilepton sources

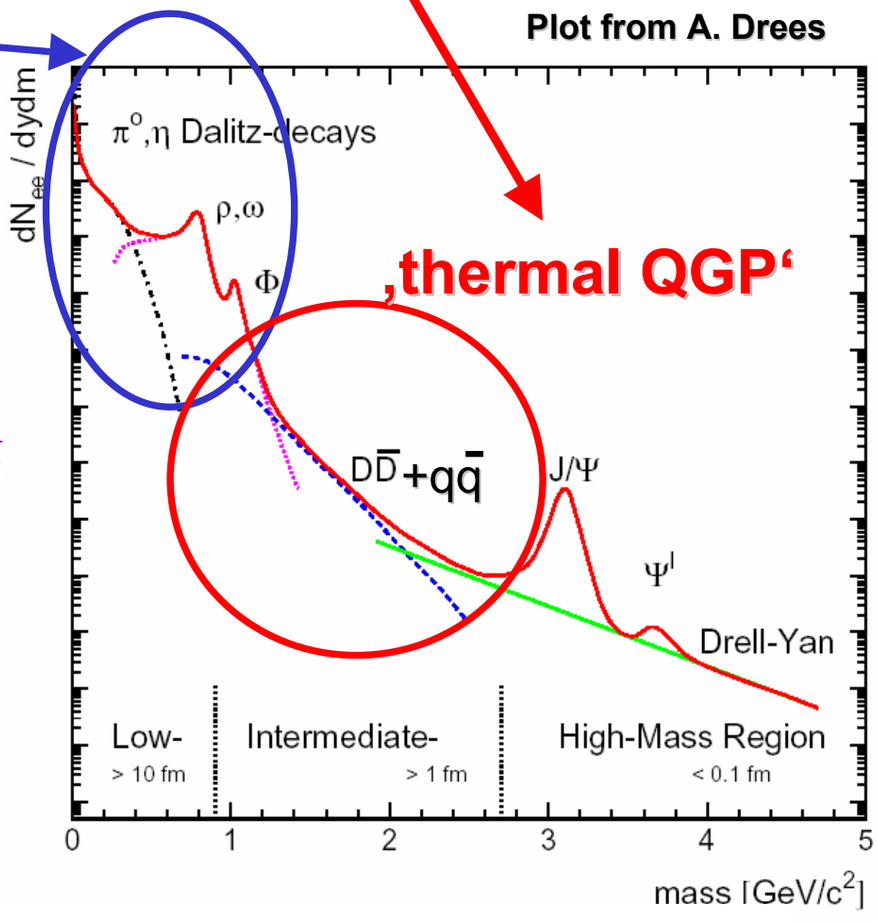


❑ from the QGP via partonic (q,qbar, g) interactions:

❑ from hadronic sources:

- **direct decay of vector mesons** (ρ,ω,ϕ,J/Ψ,Ψ‘)
- **Dalitz decay of mesons and baryons** (π^0,η, Δ,…)
- **correlated D+Dbar pairs**
- **radiation from multi-meson reactions** (π+π, π+ρ, π+ω, ρ+ρ , π+a_1) - **‚4π‘**





! Advantage of dileptons:
additional „degree of freedom“ (*M*) allows to disentangle various sources

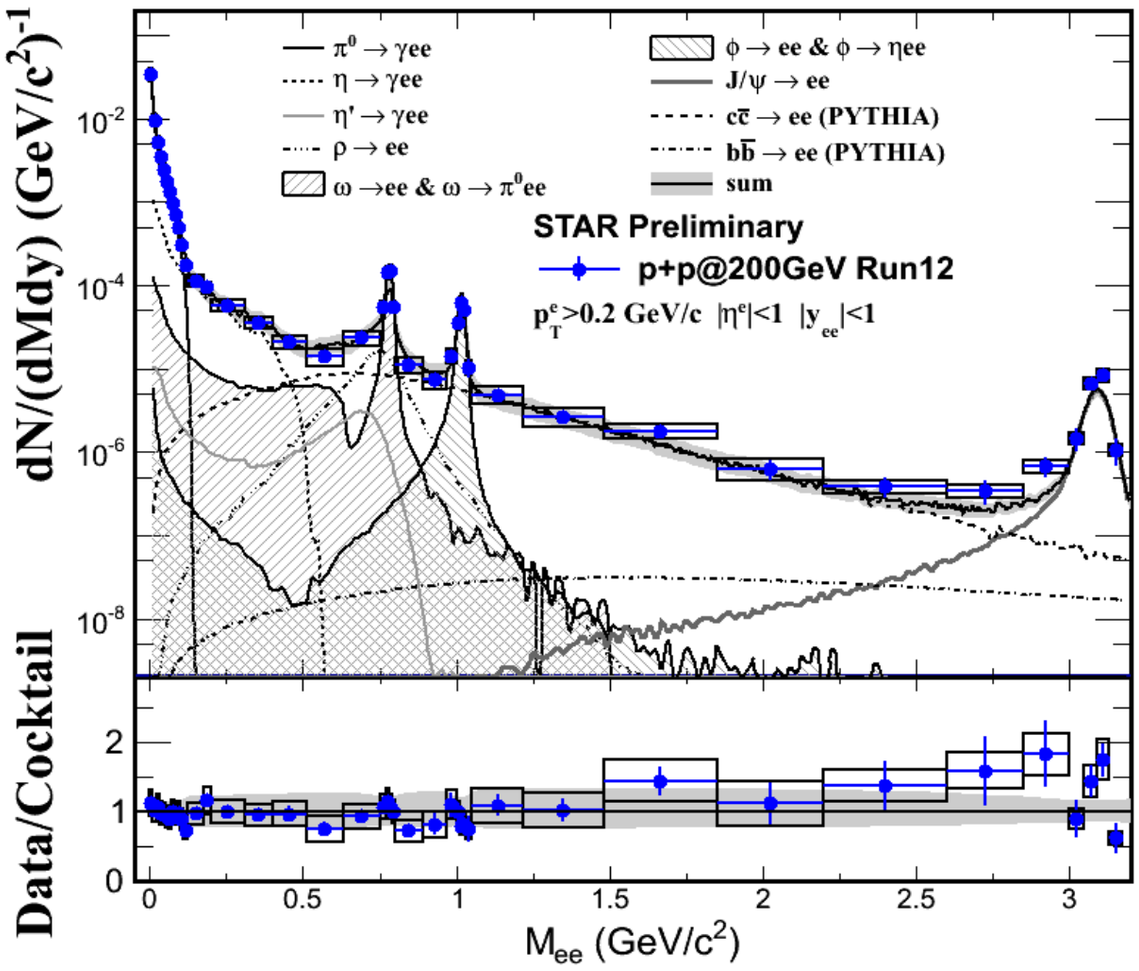
The measurements

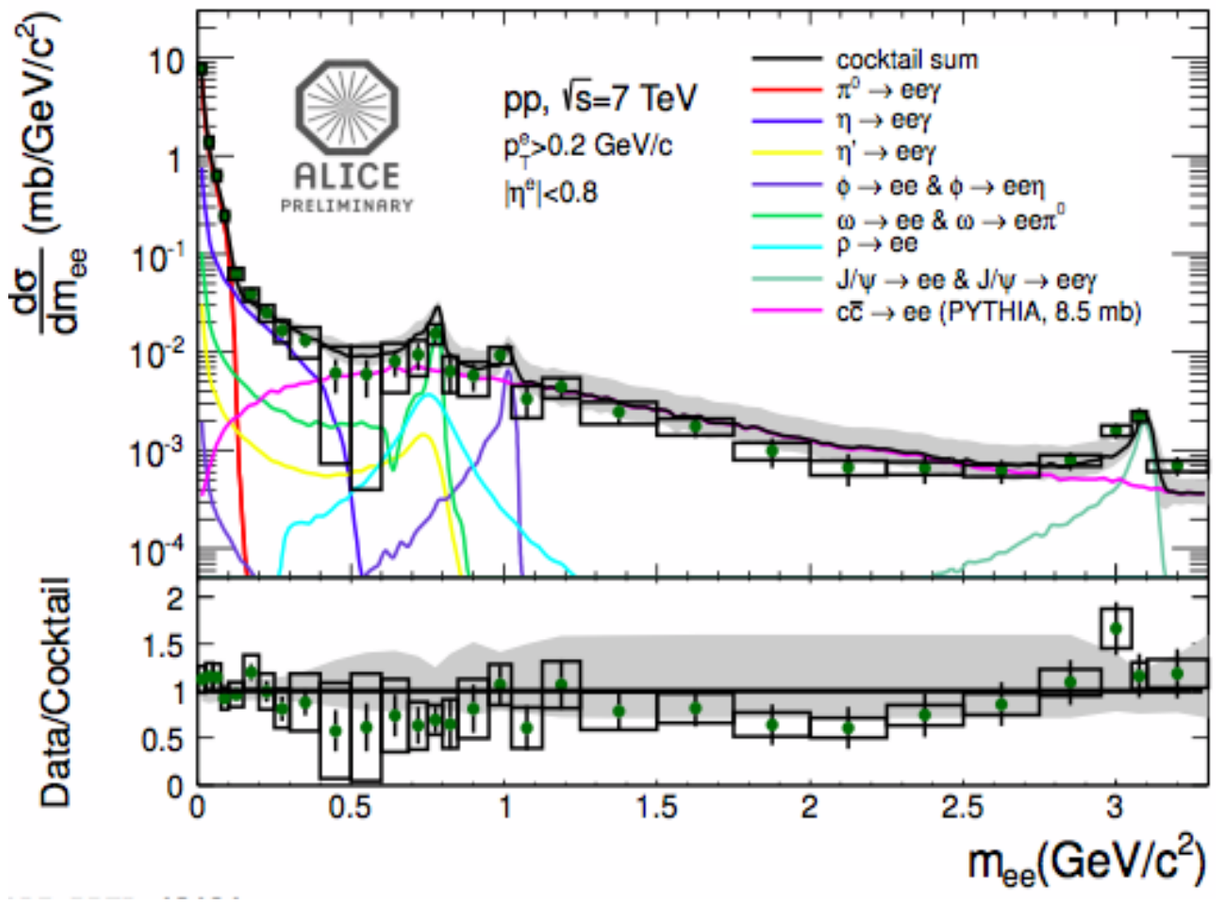
Experiment	dilepton	direct photon	S/B, purity, acceptance*
PHENIX	dielectron	internal and external conversion p_T>0.4 GeV/c	1/300, 70% in central, p_T>0.2 GeV/c, |η|<0.35
STAR	dielectron	internal conversion p_T>1 GeV/c	1/250, 93% in central, p_T>0.2 GeV/c, |η|<1
ALICE	dielectron	external conversion p_T>1 GeV/c	3-4%in p+p, 1.5-2% in p+Pb, 99% in p+p, 93% in Pb+Pb p_T>0.2 GeV/c, |η|<0.8
NA60	dimuon		1/7 for <S/B> in the whole mass region in In+In collisions without centrality cut.

***S/B for inclusive dileptons at M_{ll}=0.5 GeV/c^2, purity and acceptance for electrons.**

For HADES results, see T. Galatyuk for details.

Dielectron measurements in p+p collisions



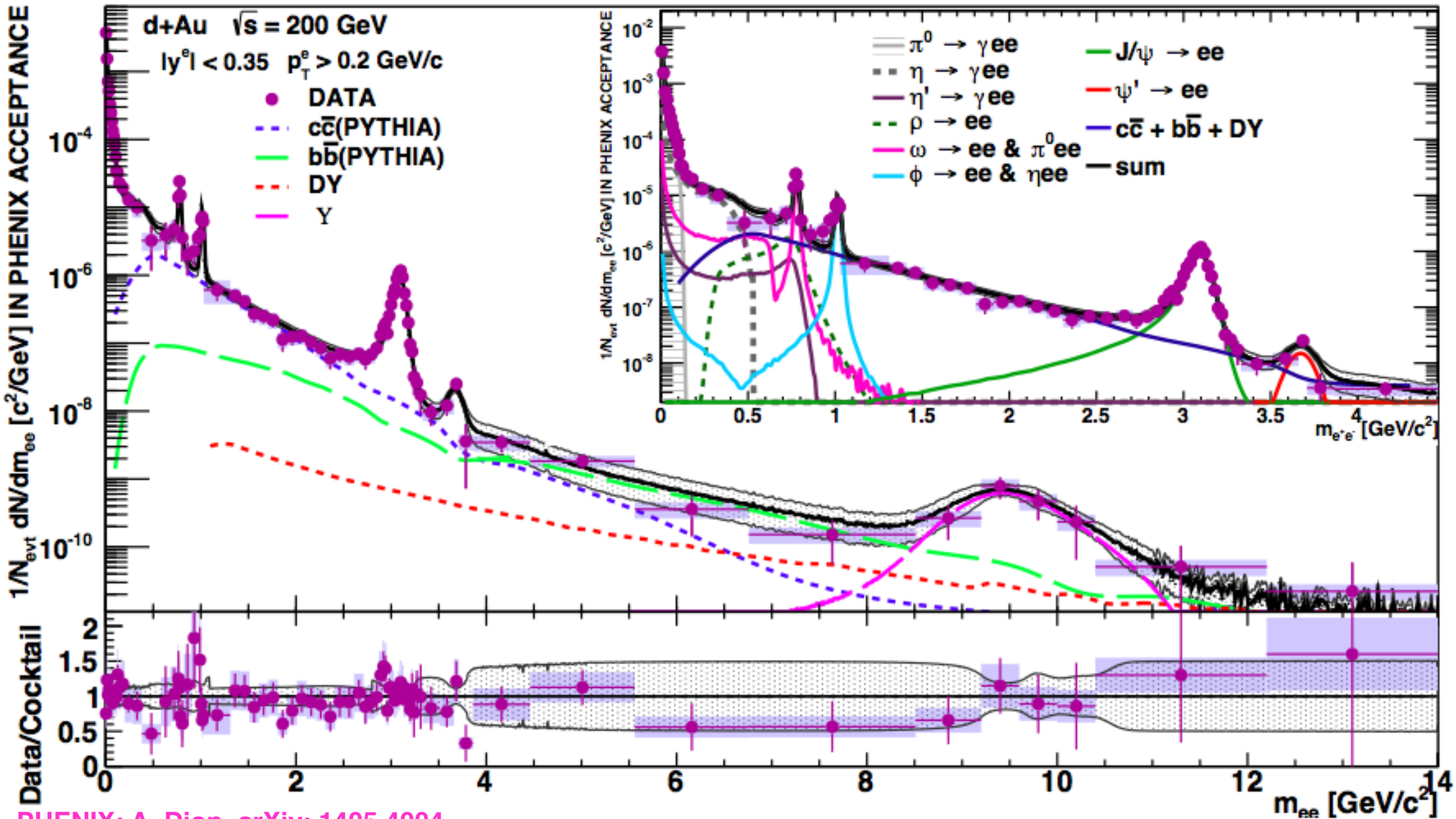


STAR: C. Yang, Y. Guo
ALICE: M. Kohler

Charm correlation contribution increases from RHIC to LHC at $0.4<M_{ee}<0.5$ GeV/c^2.

The cocktail simulation with expected hadronic contributions, is consistent with data in p+p collisions.

Dielectron measurements in d+Au collisions

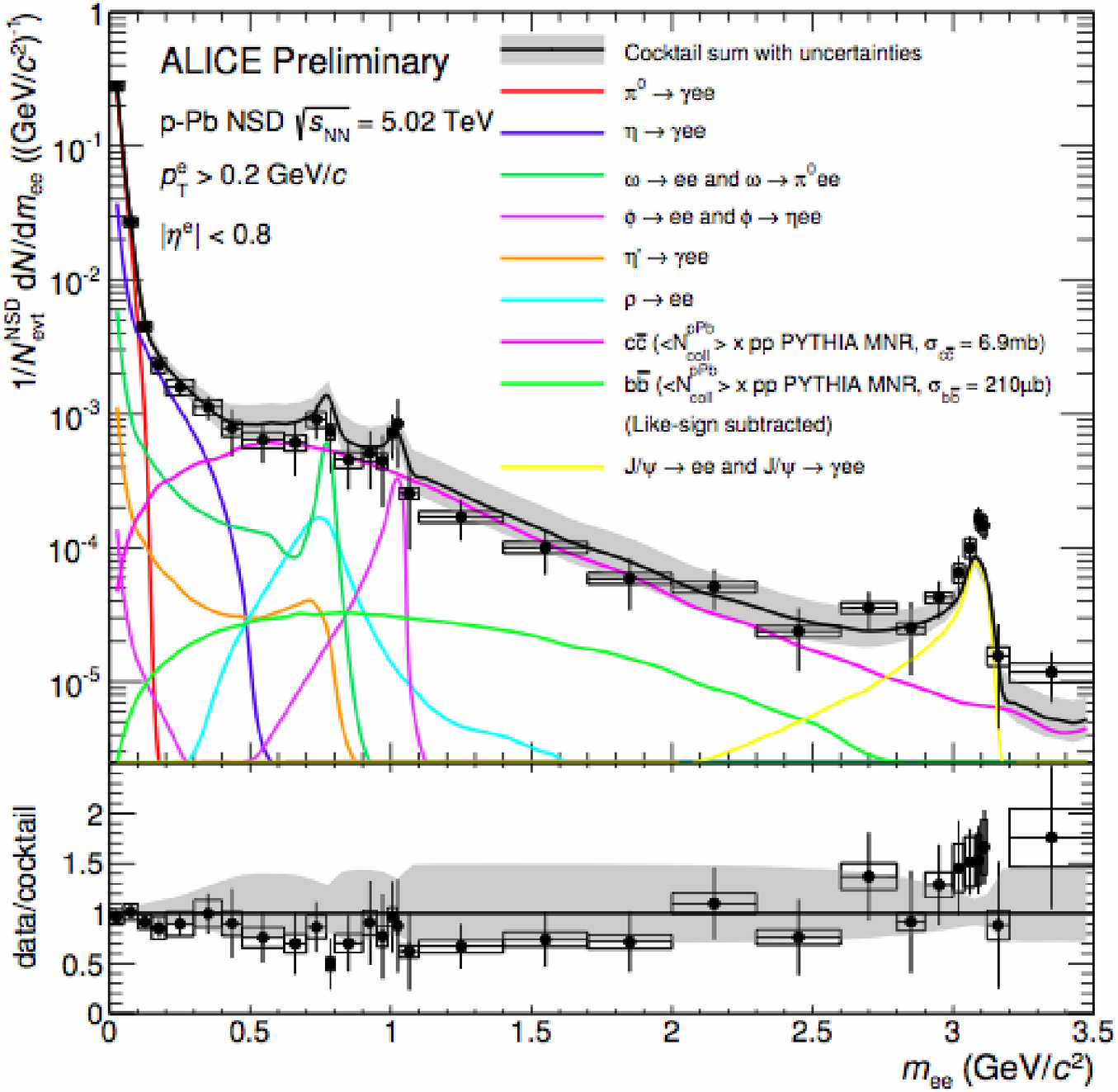


PHENIX: A. Dion, arXiv: 1405.4004

Hadronic cocktail is consistent with data in d+Au collisions.

Obtained bbbar cross section per NN at 200 GeV: $\sigma_{bbbar} = 3.4 \pm 0.28 \pm 0.46$ μb.

Dielectron measurements in p+Pb collisions

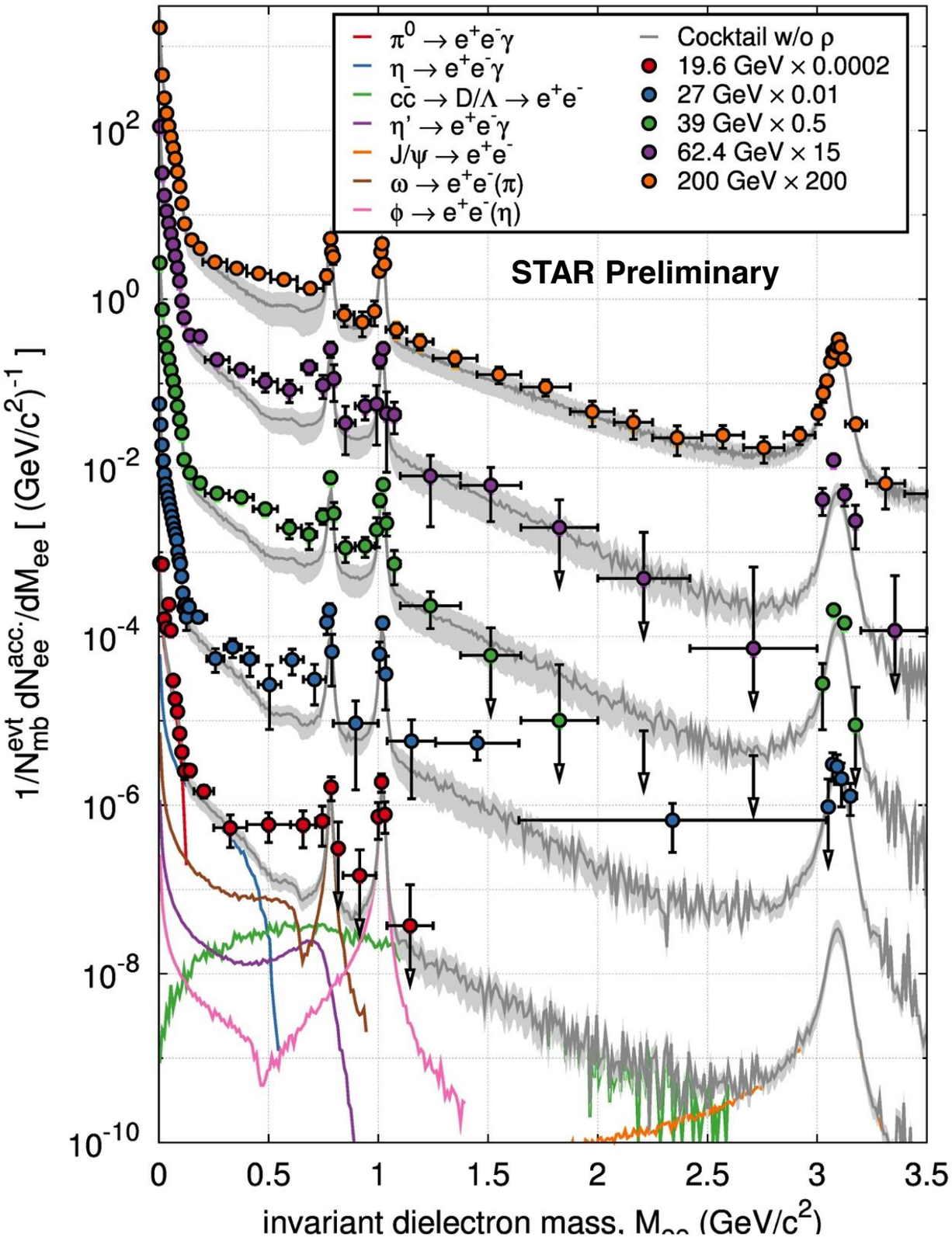


ALICE: M. Kohler

Hadronic cocktail is consistent with data in p+Pb collisions.

There is no medium radiation observed in p(d)+A collisions.

Energy dependence of di-electron spectra

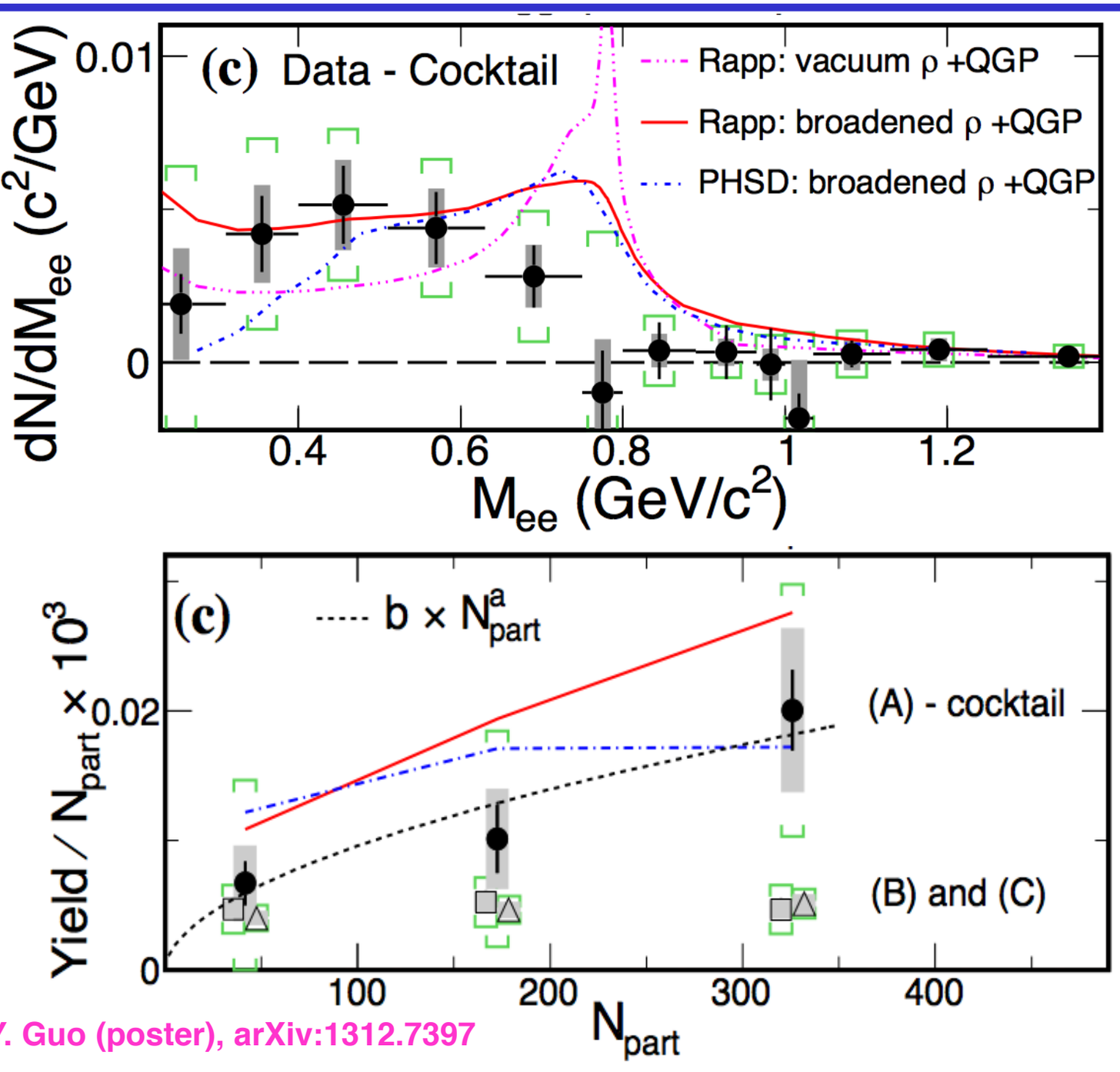


STAR results: systematically study the di-electron continuum from 19.6, 27, 39, 62.4 and 200 GeV.

Low mass excess is observed for all the energies.

STAR: P. Huck, C. Yang, J. Butterworth, Y. Guo

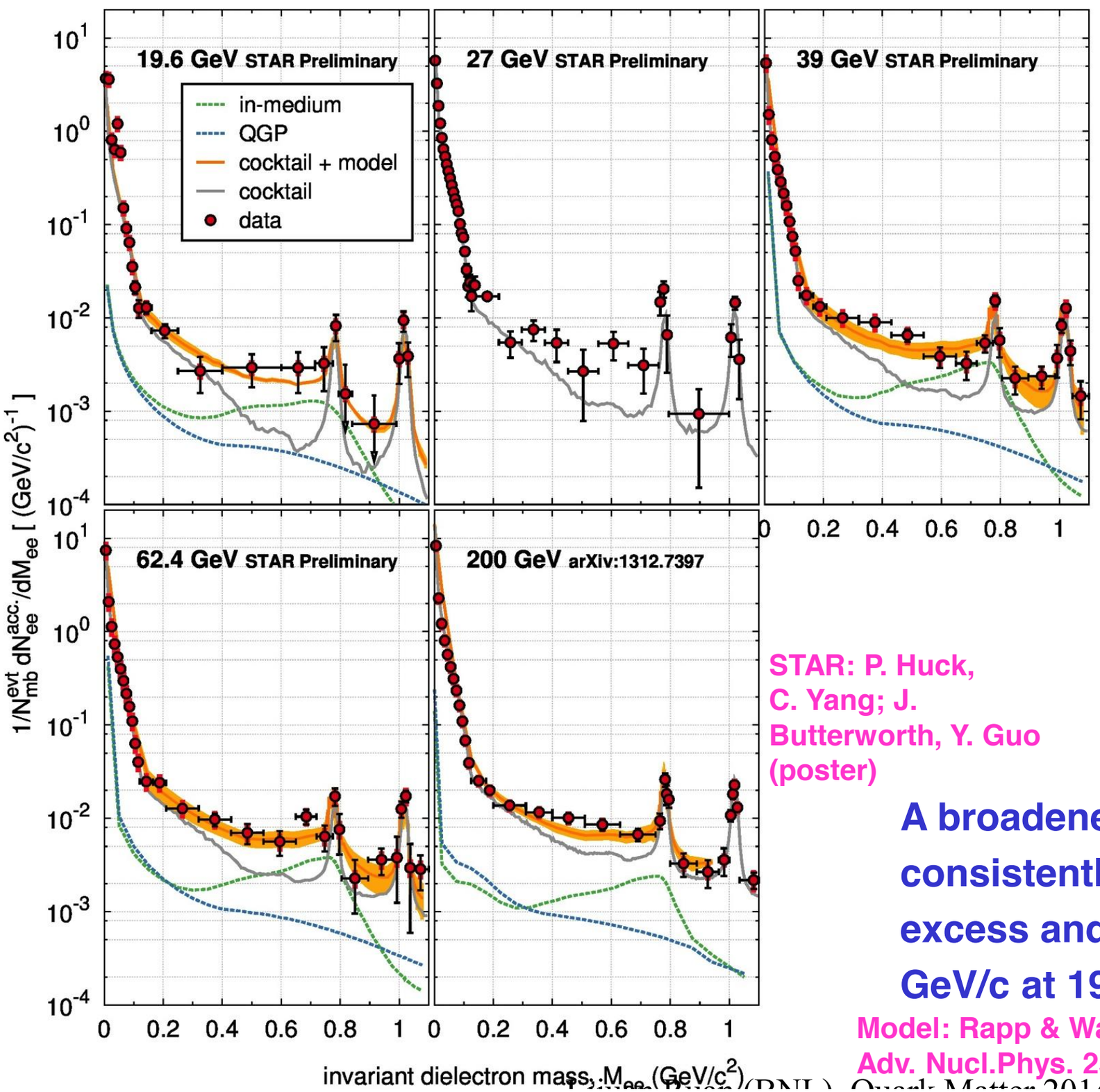
Excess di-electron spectra

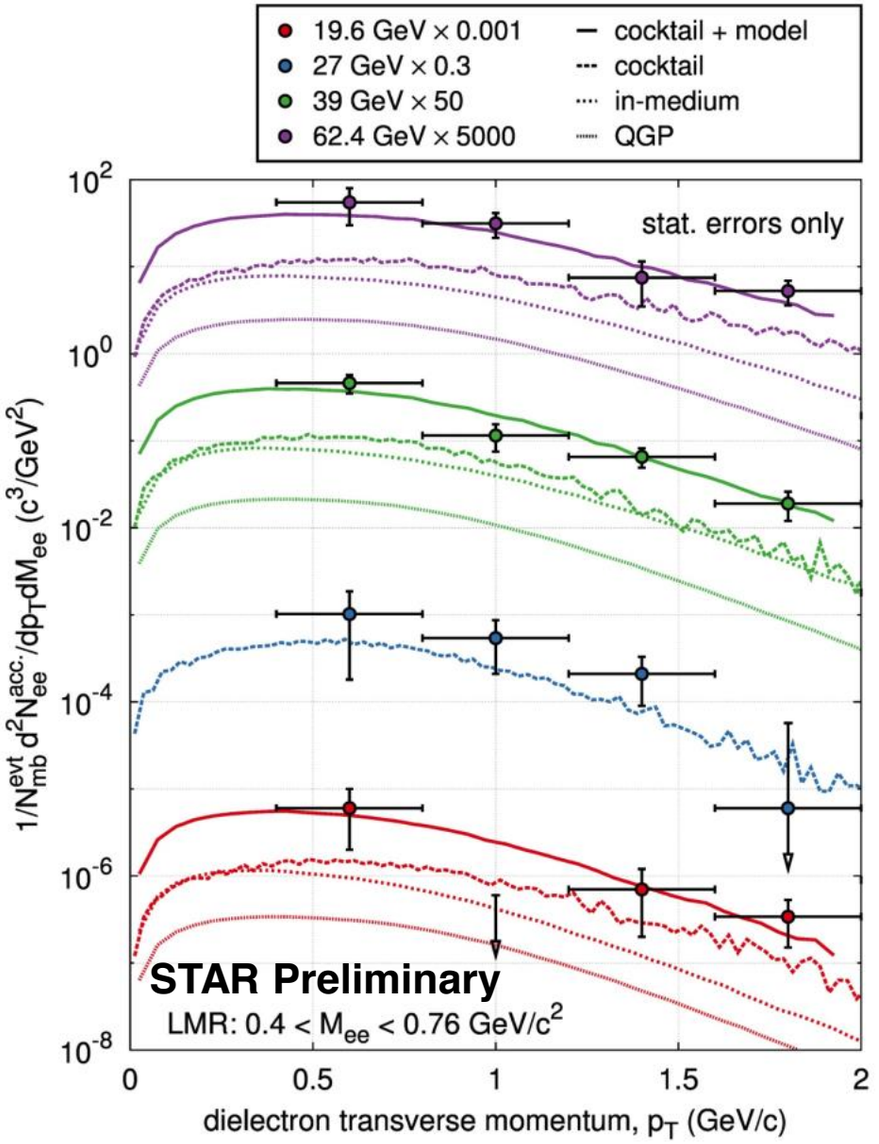


STAR: C. Yang, Y. Guo (poster), arXiv:1312.7397

Excess dielectron mass spectrum in the mass region 0.3-0.76 GeV/c^2 in 200 GeV Au+Au collisions follows Npart$^{1.54\pm0.18}$ dependence.

Energy dependence of di-electron spectra





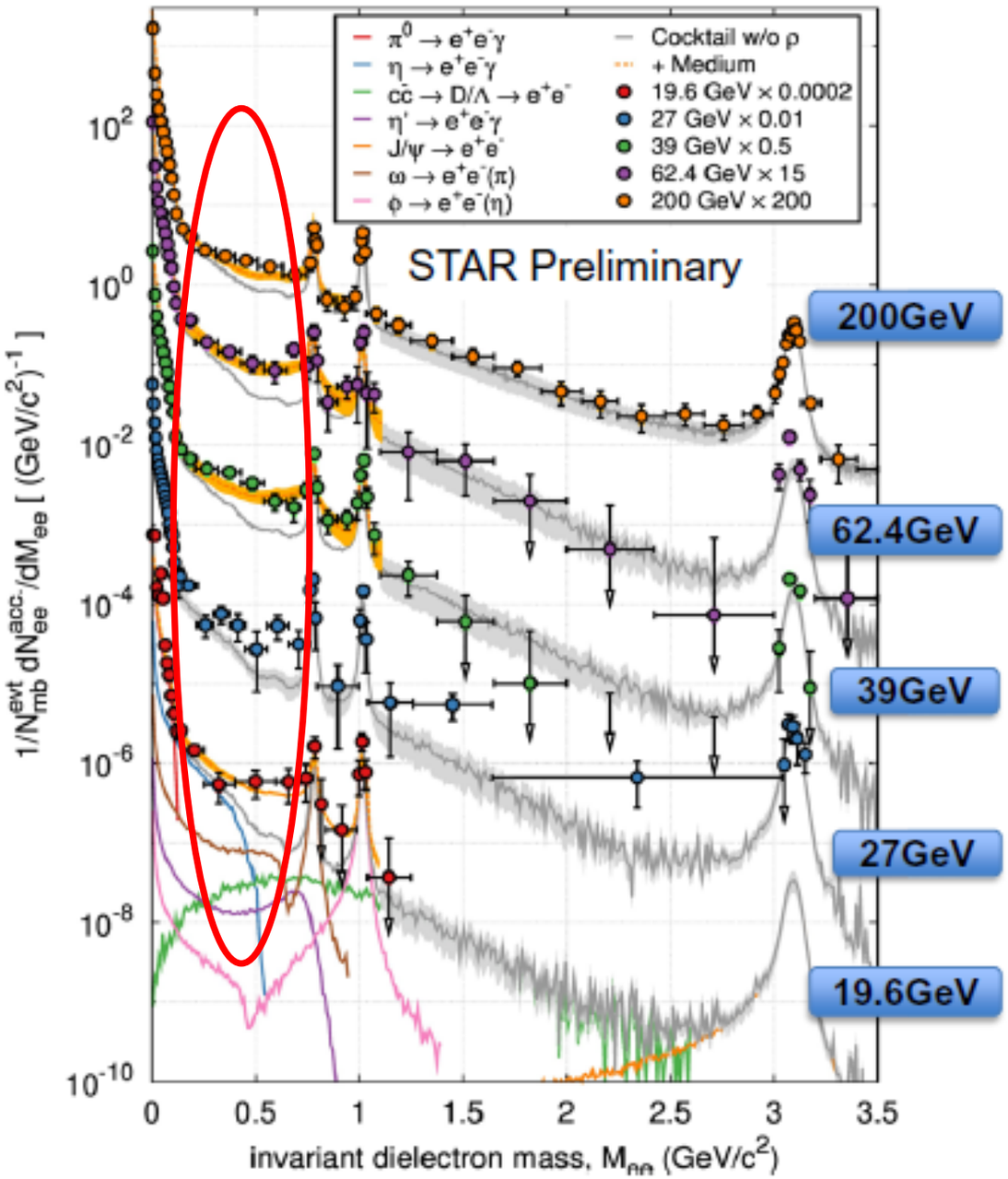
STAR: P. Huck, C. Yang; J. Butterworth, Y. Guo (poster)

A broadened ρ spectrum function consistently describe the low mass excess and its p_T dependence up to 2 GeV/c at 19.6, 39, 62.4 and 200 GeV.

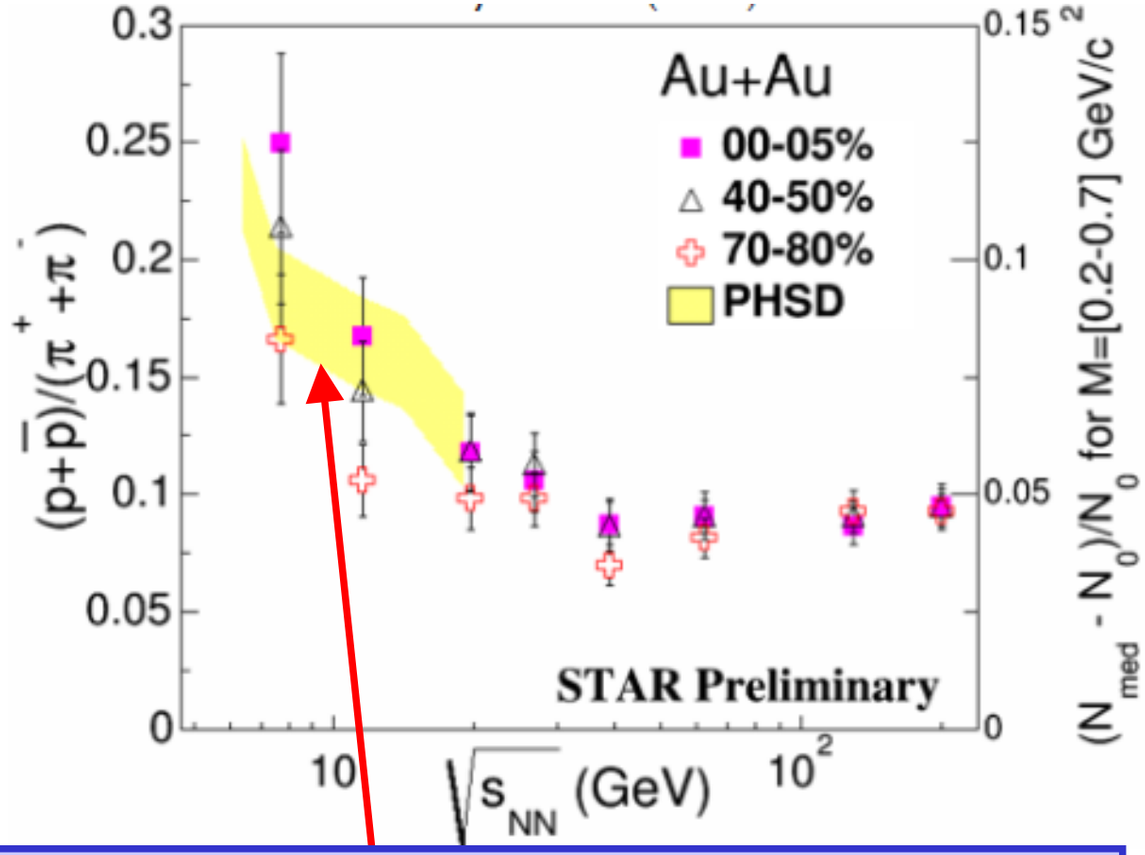
Model: Rapp & Wambach, priv. communication
Adv. Nucl.Phys. 25, 1 (2000); Phys. Rept. 363, 85 (2002)

Dileptons from RHIC BES: STAR

(Talk by Nu Xu at QM'2014)



(Talk by Nu Xi at 23d CBM Meeting'14)

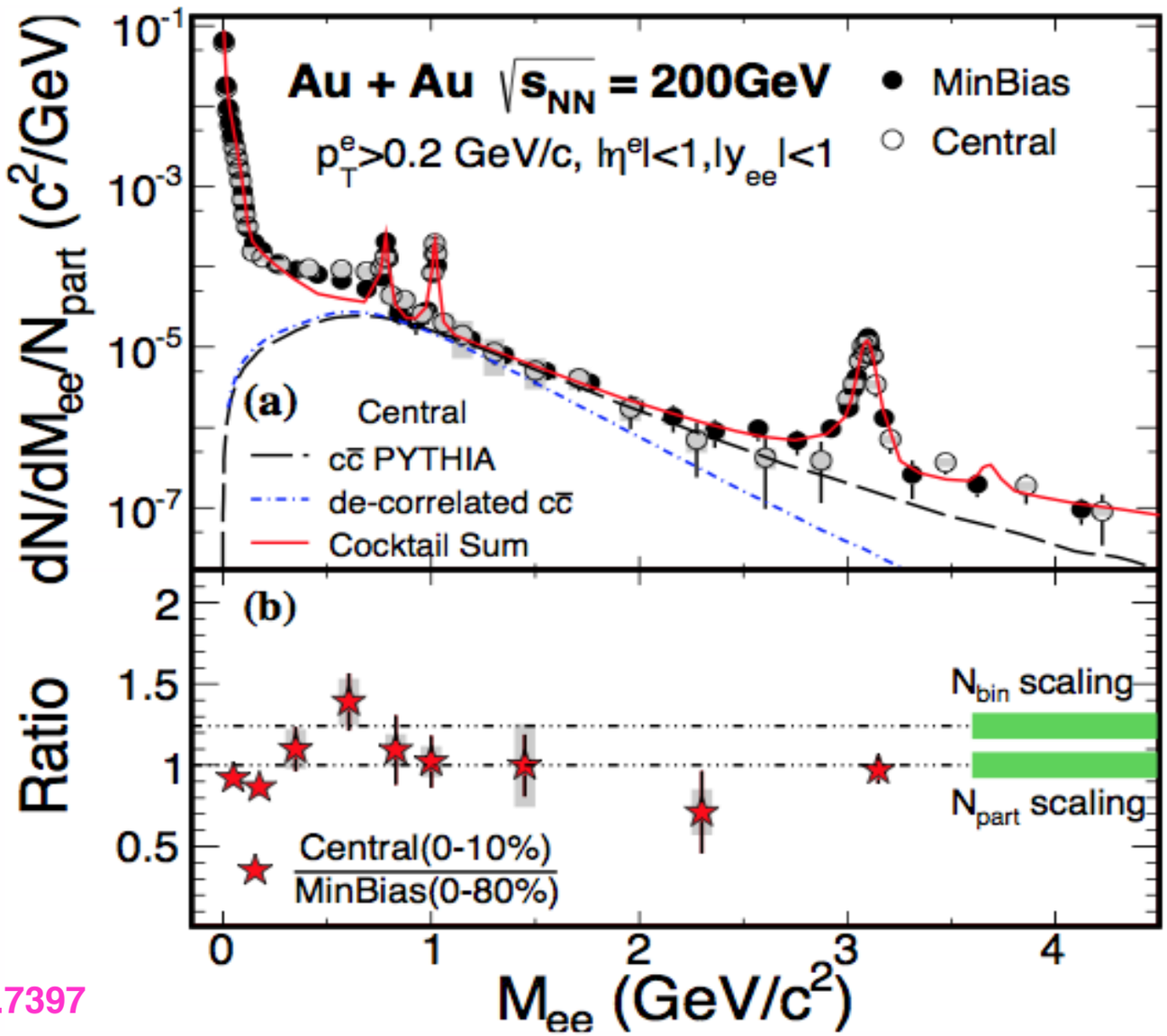


Message:

- **BES-STAR data show a constant low mass excess (scaled with N(π^0)) within the measured energy range**
- **PHSD model: excess increasing with decreasing energy due to a longer ρ-propagation in the high baryon density phase**

➔ **Good perspectives for future experiments – CBM(FAIR) / MPD(NICA)**

Towards intermediate mass region

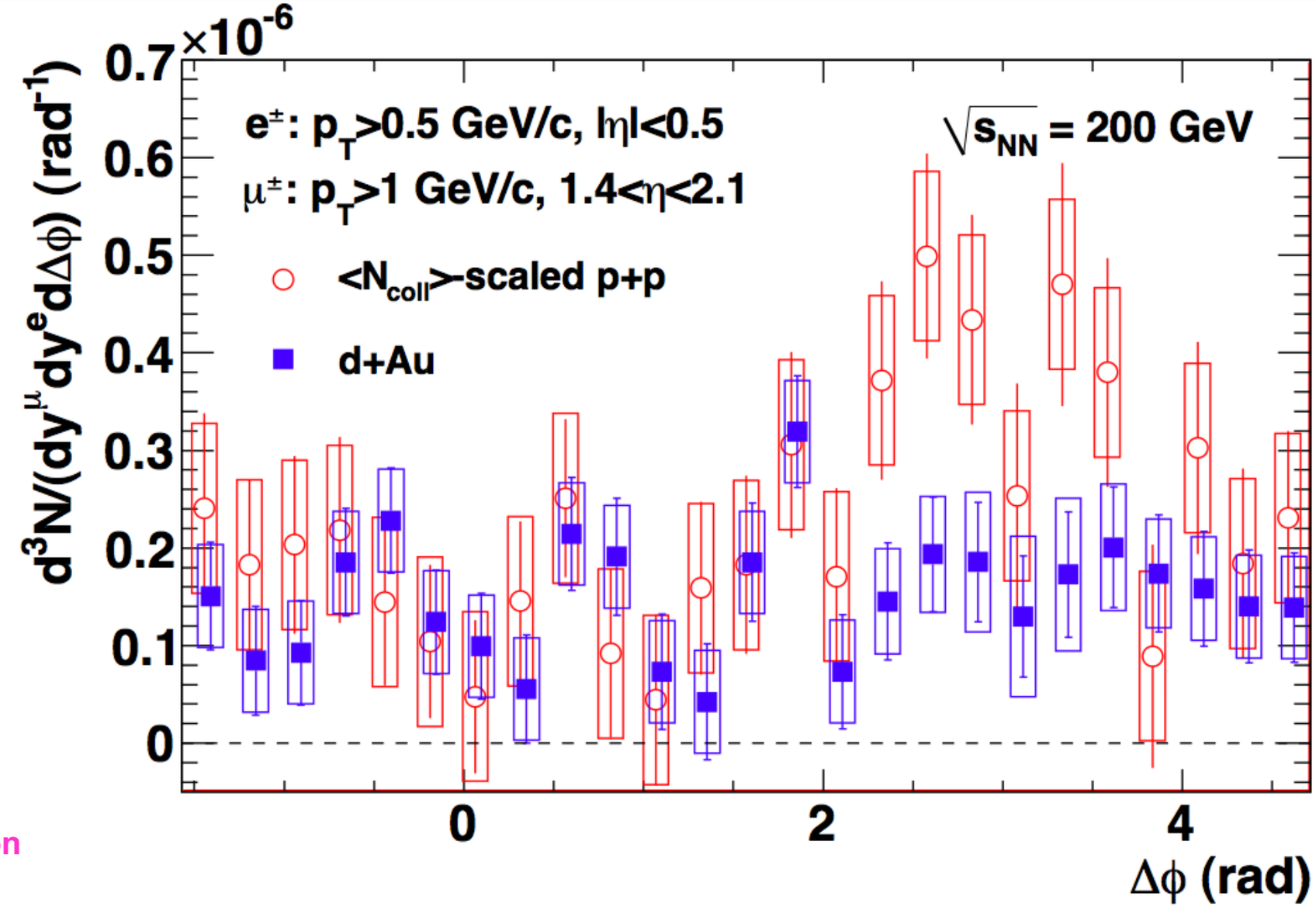


STAR: Y. Guo, arXiv:1312.7397

Need independent measurements (e.g. e-muon) of the charm correlation contribution to dilepton continuum in order to access the possible signature of QGP thermal radiation.

e-muon correlation with the Muon Telescope Detector in 2014.

e-muon correlation

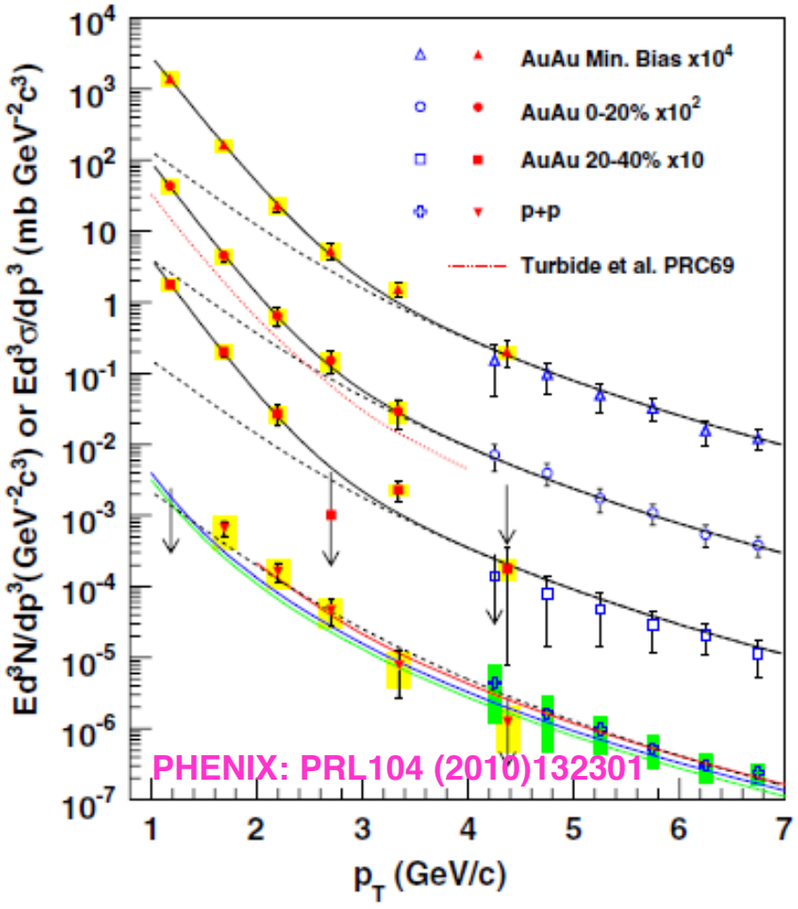


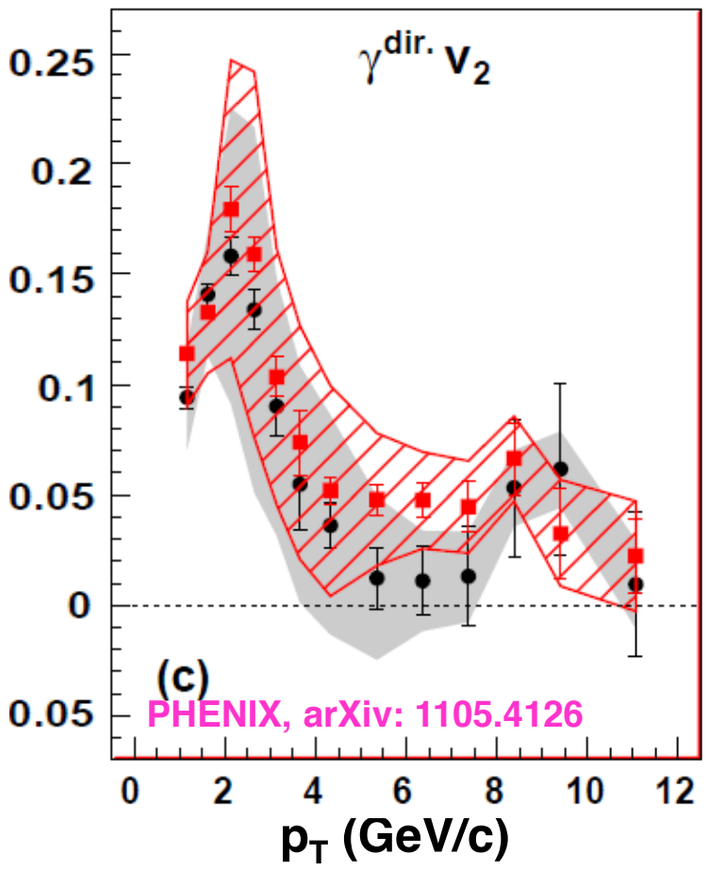
PHENIX: A. Dion

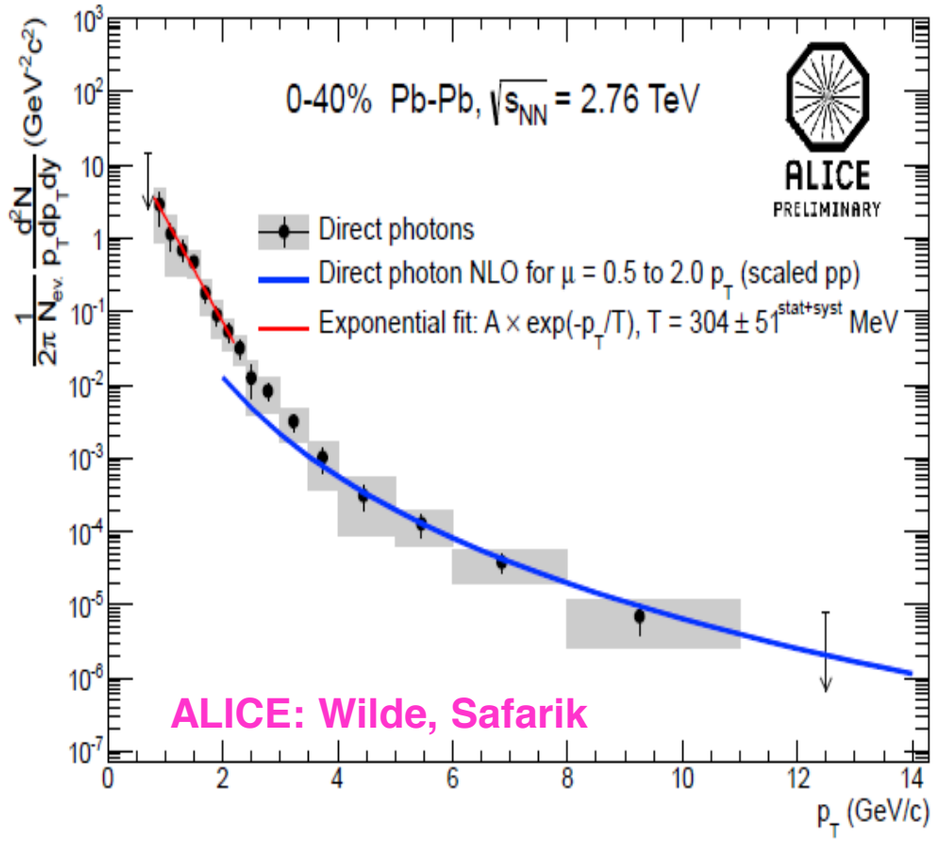
e-muon (mid-forward rapidity) correlations in d+Au and p+p collisions at 200 GeV.

How to connect this mid-forward e-muon correlation to mid-rapidity dilepton physics, need further investigation.

Direct photon spectra and elliptic flow v_2 at QM2012



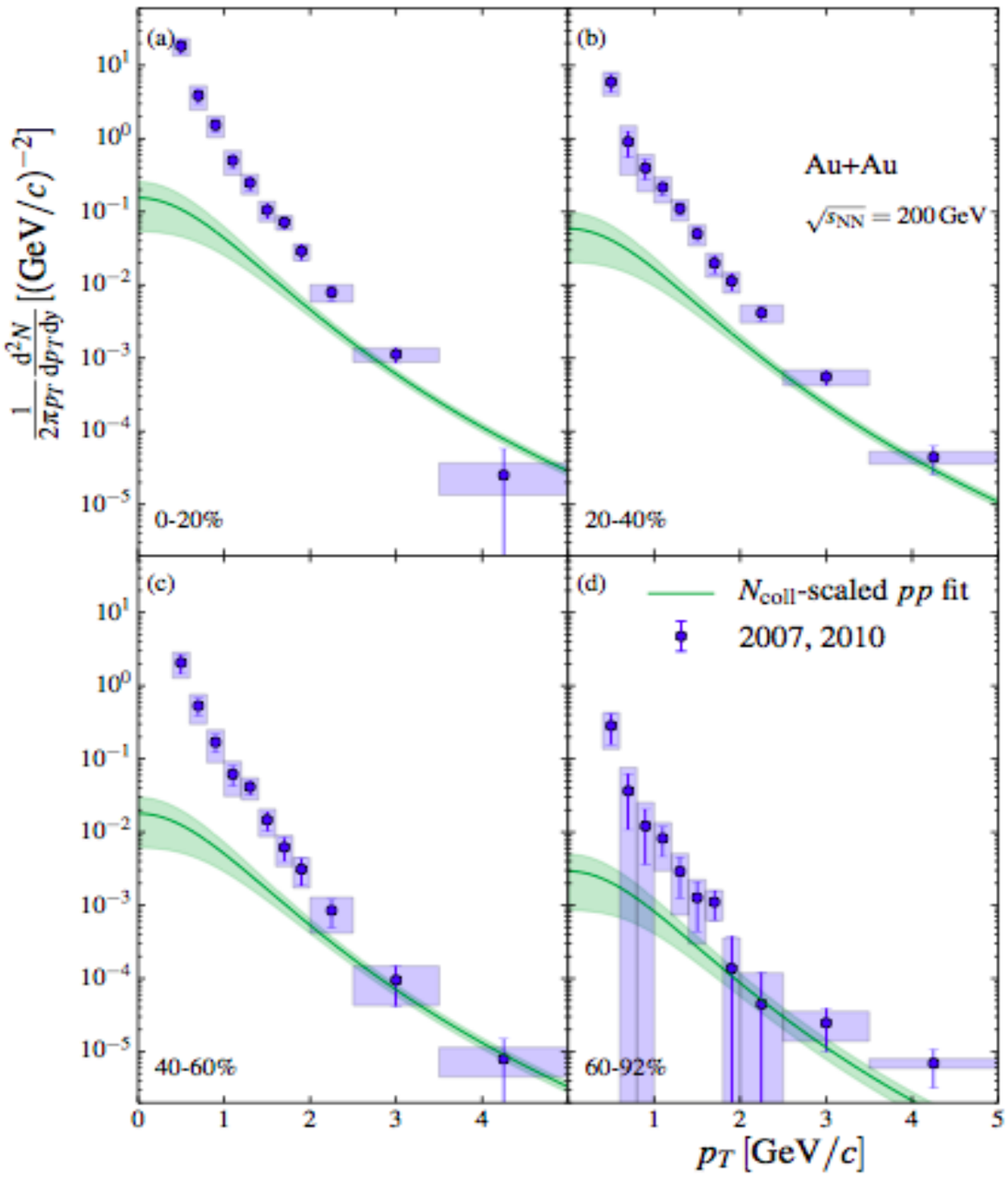


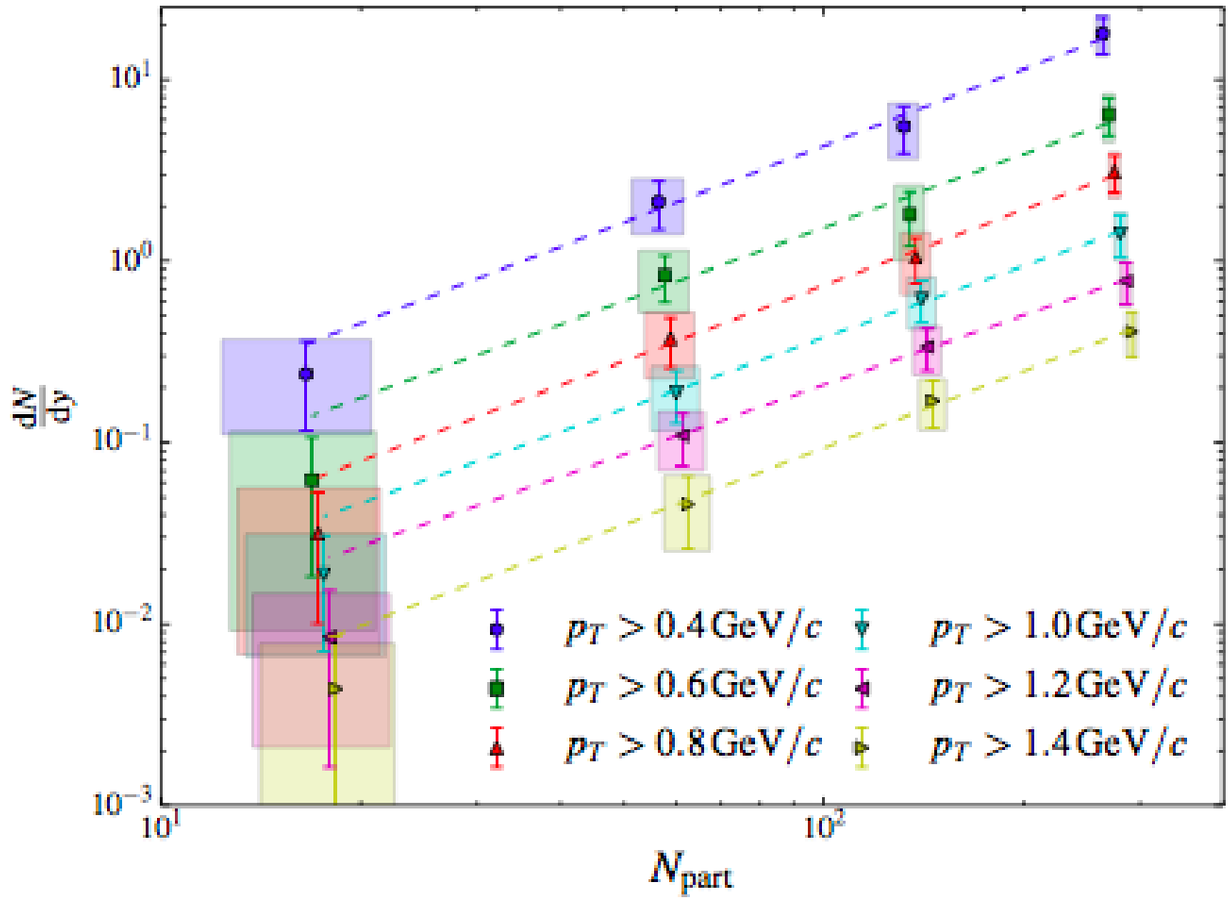


- Low p_T direct photon elliptic flow measurement could provide direct constraints on QGP dynamics (η/s, T, t_0…).
- Excess of direct photon yield over p+p: T_{eff}=221 ± 19 ± 19 MeV in 0-20% Au+Au;

  substantial positive v_2 observed at p_T<4 GeV/c.
- Excess of direct photon yield over p+p at p_T<4 GeV/c: T_{eff}=304 ± 51 MeV in 0-40% Pb+Pb.

Direct soft photon spectra from PHENIX



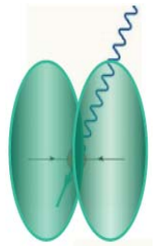


PHENIX, S. Mizuno, arXiv: 1405.3940

- Direct photon spectrum down to 0.4 GeV/c: T_{eff} from the excess p_T spectrum, has no centrality dependence.
- The excess follows $Npart^{1.48 \pm 0.08 \pm 0.04}$ dependence.

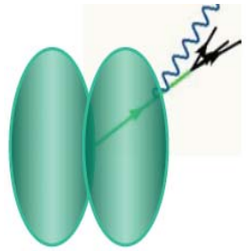
Production sources of photons in p+p and A+A

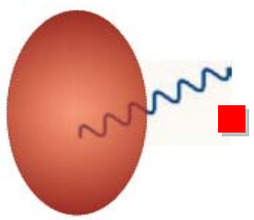
- **Decay photons** (in pp and AA):
  $m \rightarrow \gamma + X$, $m = \pi^0, \eta, \omega, \eta', a_1,$



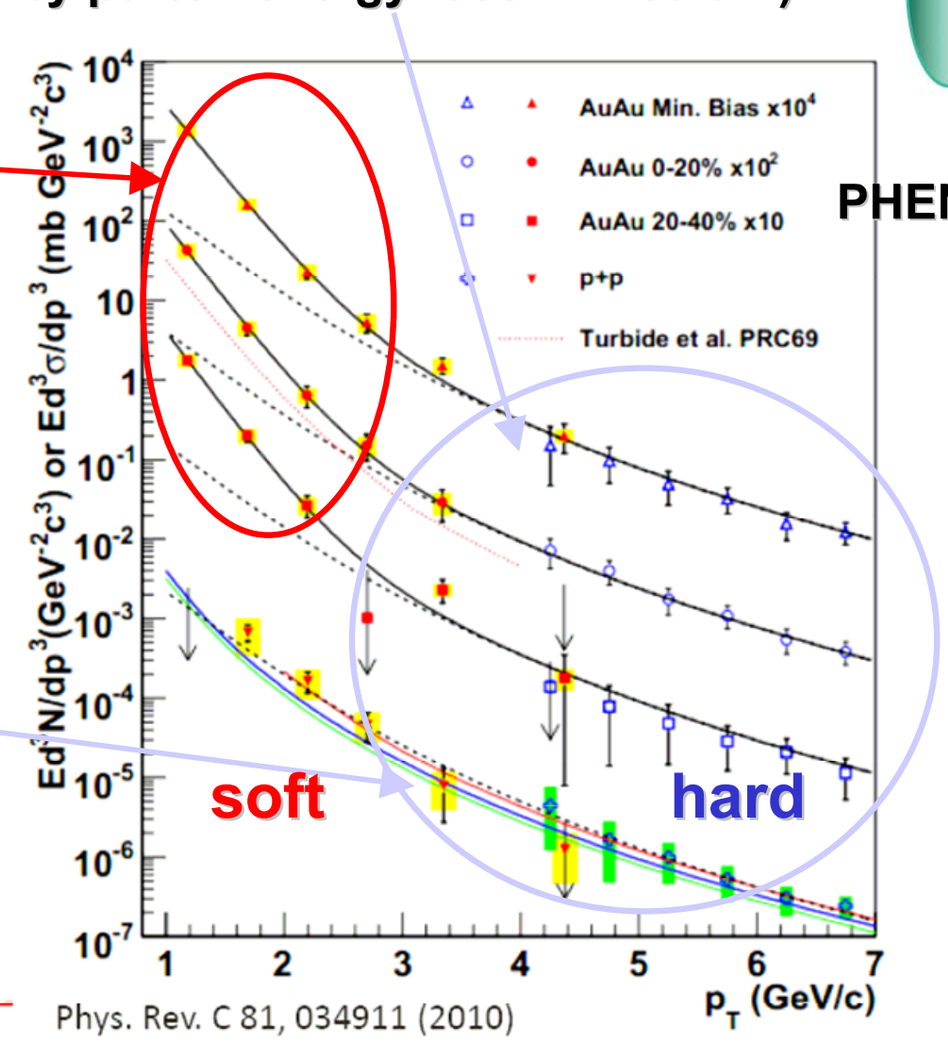
- **Direct photons:** (inclusive(=total) – decay) – measured experimentally

  - **hard photons**:
    (large p_T, in pp and AA)
    - **prompt** (pQCD; initial hard N+N scattering)
    - **jet fragmentation** (pQCD; qq, gq bremsstrahlung)
      (in AA can be modified by parton energy loss in medium)

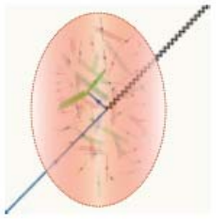




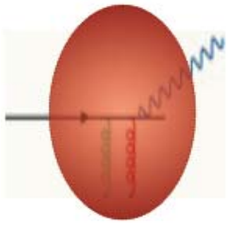
  - **thermal photons**:
    (low p_T, in AA)
    - **QGP**
    - **Hadron gas**



PHENIX



  - **jet-γ-conversion** in plasma
    (large p_T, in AA)

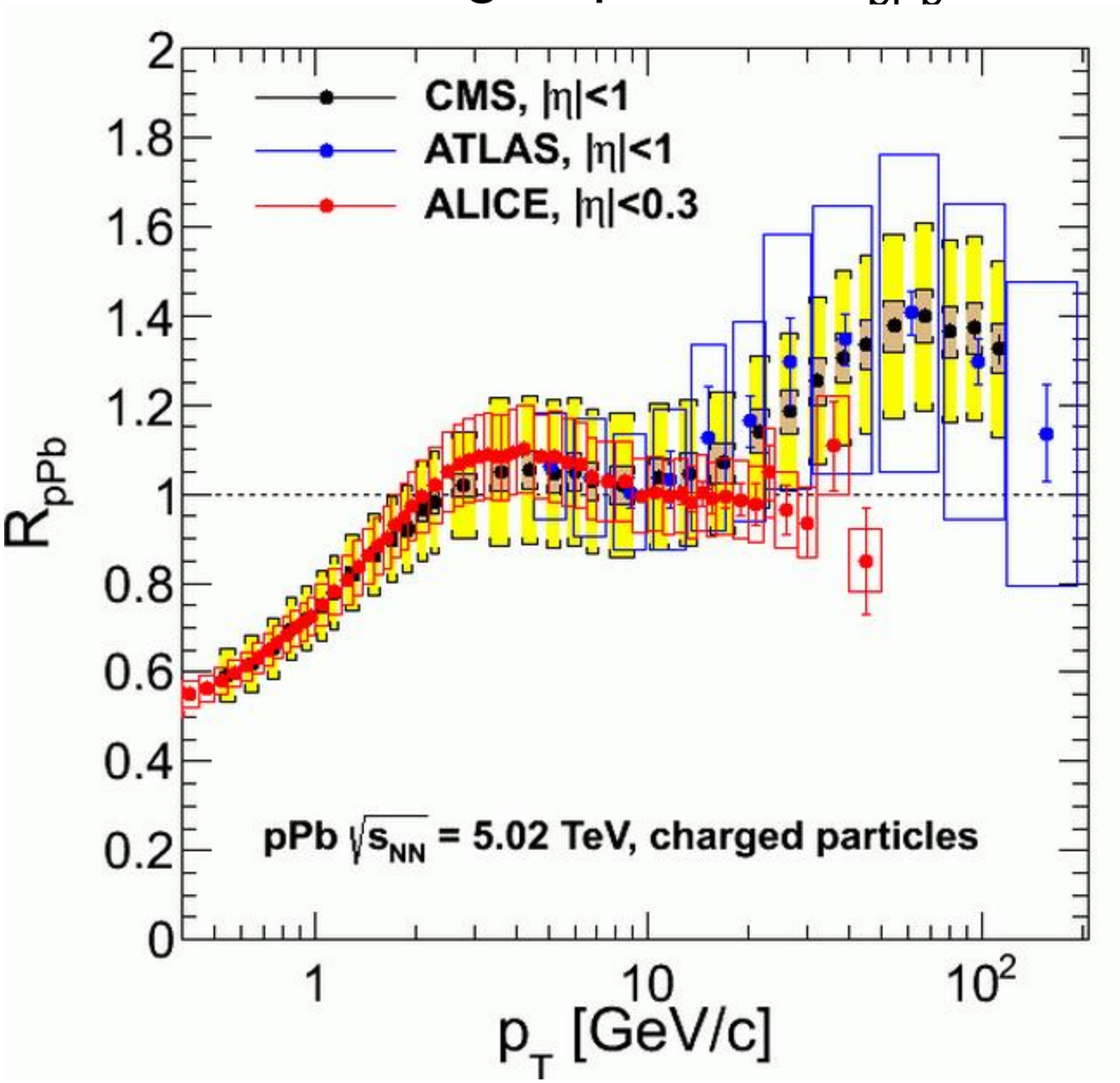


  - **jet-medium photons**
    (large p_T, in AA) - scattering of hard partons with thermalized partons $q_{hard}+g_{QGP} \rightarrow \gamma+q$, $q_{hard}+qbar_{QGP} \rightarrow \gamma+q$

Jet Results

Charged particle R_{pPb} (QM2014)

Charged particle R_{pPb}



Excellent agreement between ATLAS and CMS.

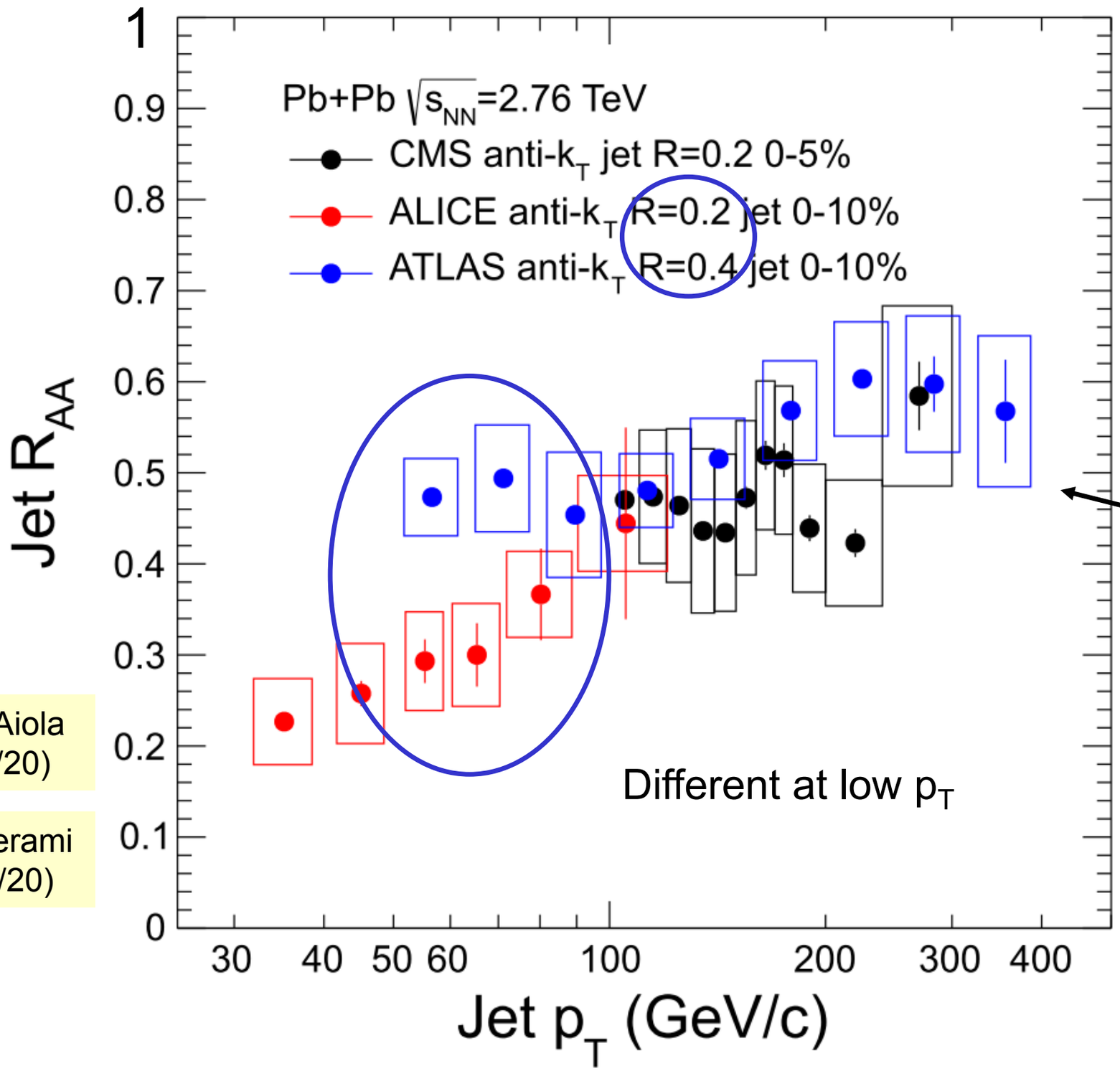
Discrepancy between ALICE and (ATLAS+CMS)

Eric Applet (CMS 5/20)

Petr Balek (ATLAS 5/20)

Jan Fiete Grosse-Oetringhaus (ALICE 5/22)

Jet R_{AA} in PbPb collisions at LHC



~ Agreement between CMS and ATLAS at high jet p_T

Agree with charged particle R_{AA} at high p_T

Salvatore Aiola (ALICE 5/20)

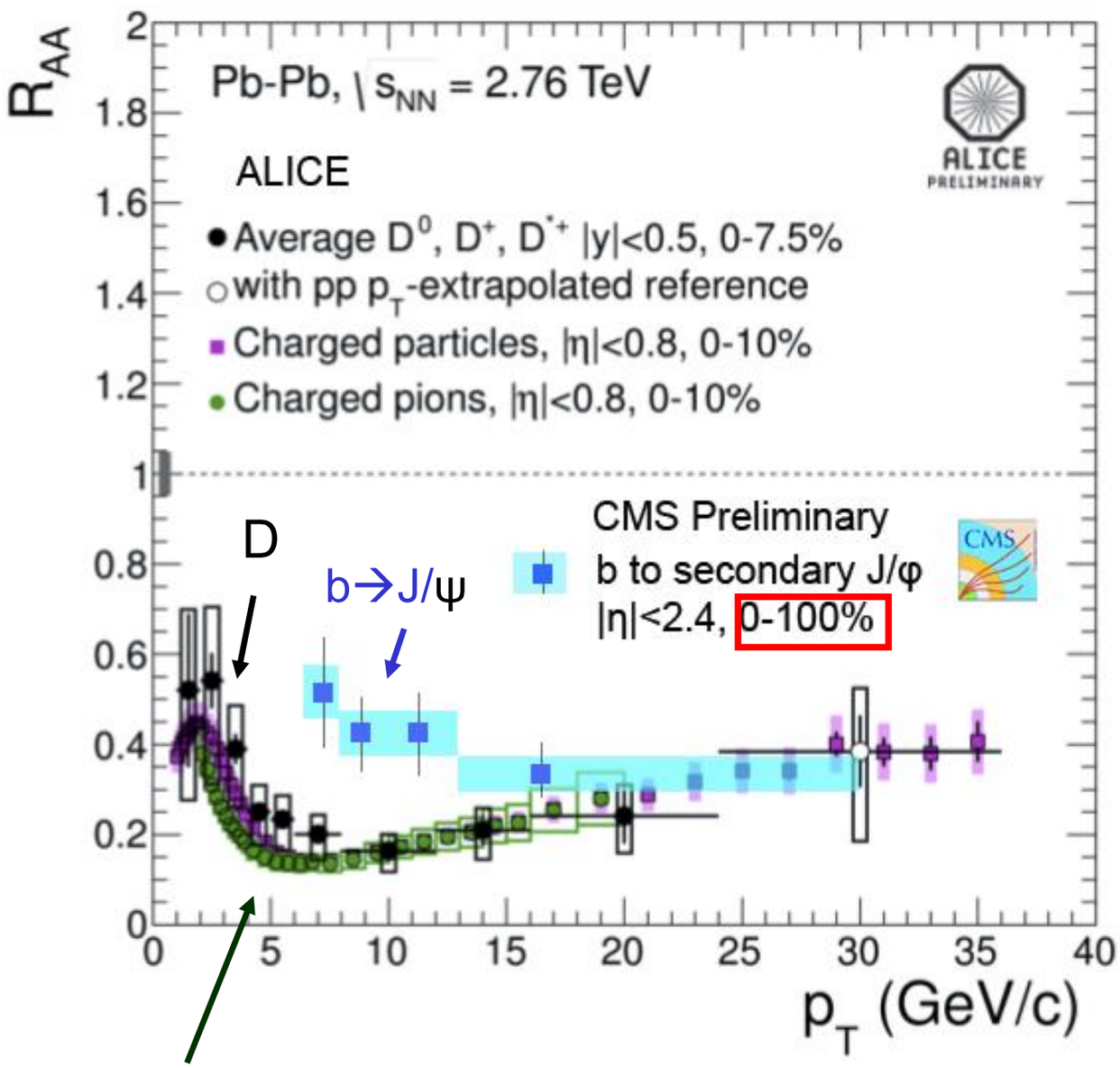
Aaron Angerami (ATLAS 5/20)

It would be nice to have low p_T CMS data / ATLAS R_{AA} with R=0.2 / ALICE high p_T data

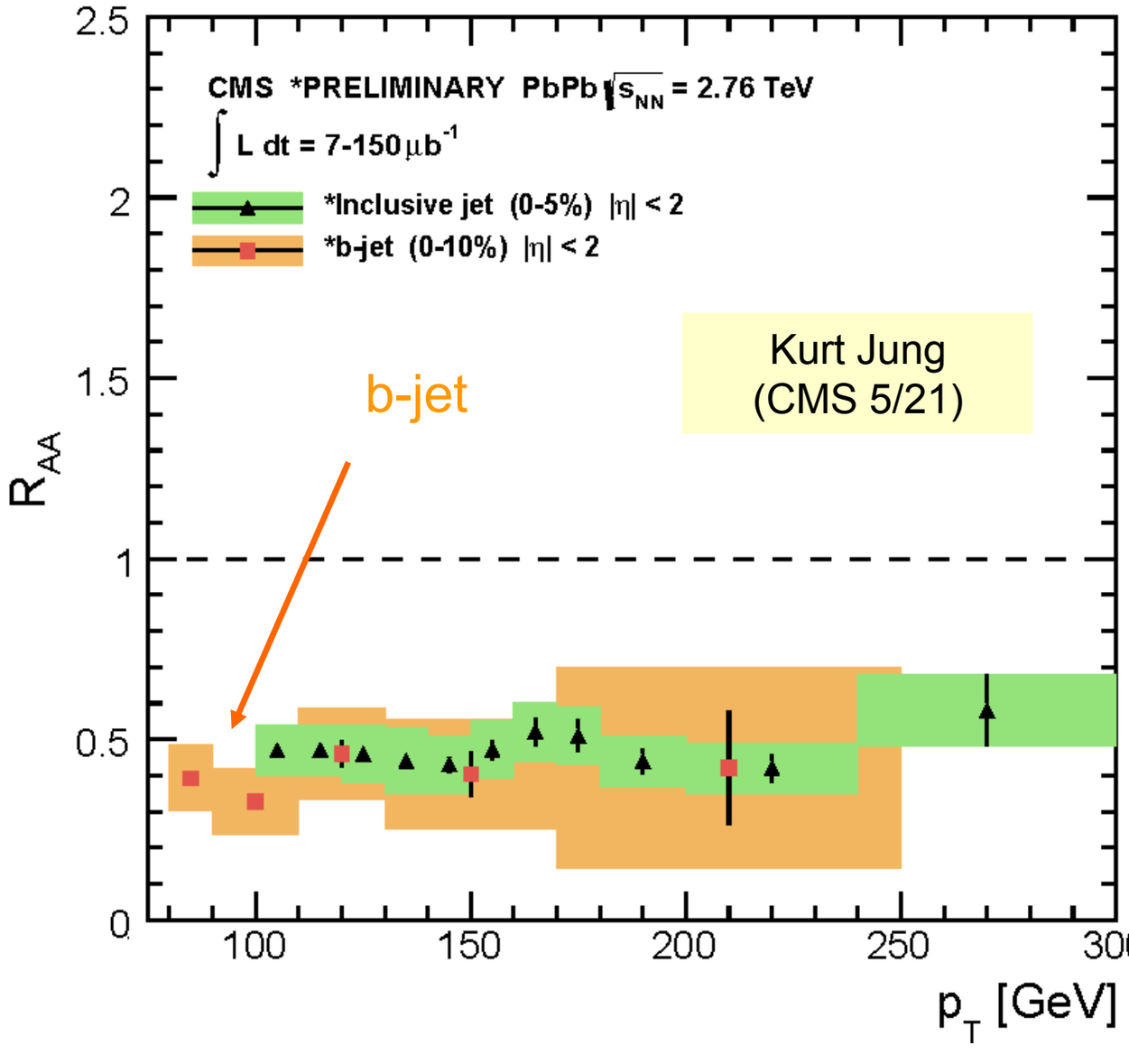
Flavor Dependence of Jet Quenching

Indication of $R_{AA}(B) > R_{AA}(D) > R_{AA}(\pi)$ at low p_T

(However, spectra slope are different)



Indication of R_{AA}(b-jet) ~ R_{AA}(all jets) at high jet p_T



b quark jet ~ inclusive jet (mainly gluon jets), contribution from gluon splitting?