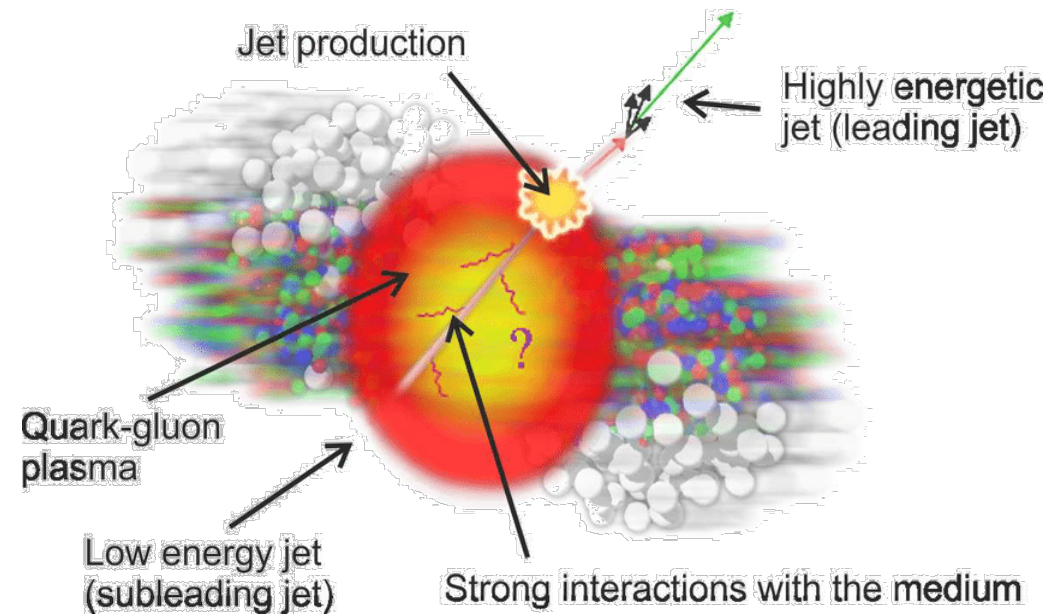


JET QUENCHING AND SEARCH FOR DIFFUSION WAKE IN HEAVY ION COLLISIONS

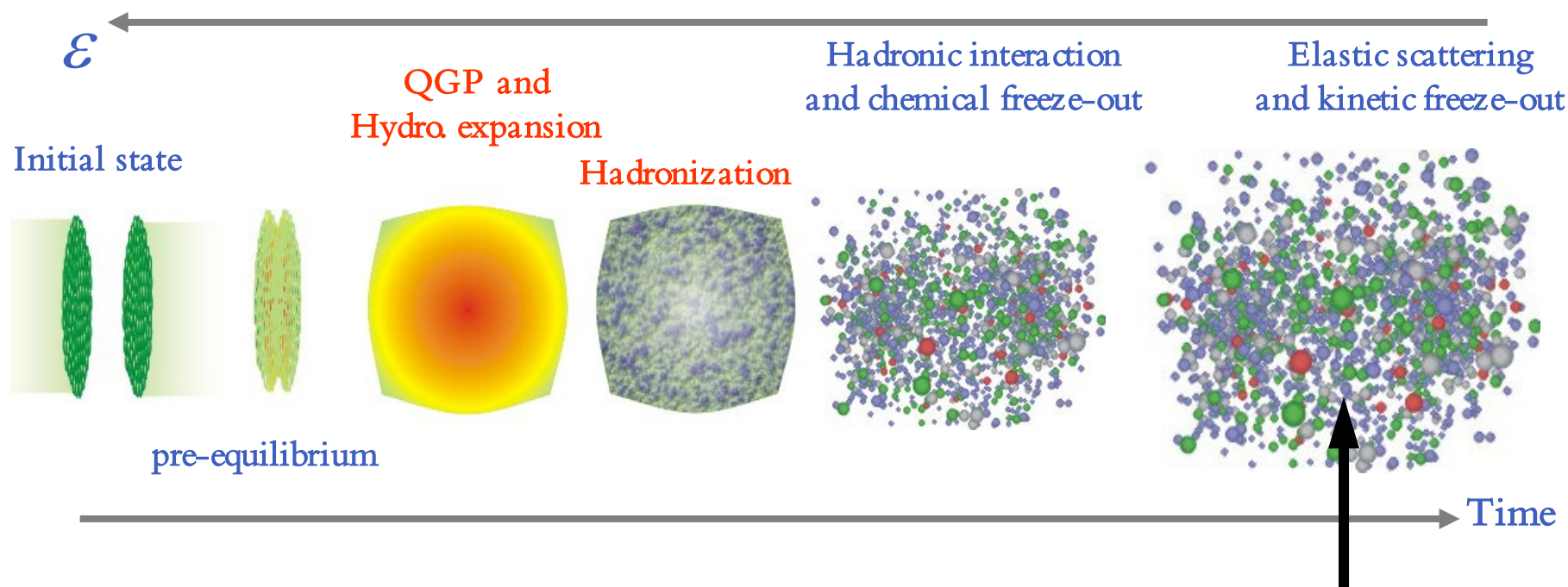


Olga Evdokimov

University of Illinois Chicago

SOFT SECTOR MEASUREMENTS

- “Standard Model” of heavy ion collisions: a complex dynamics of intrinsically many-body system



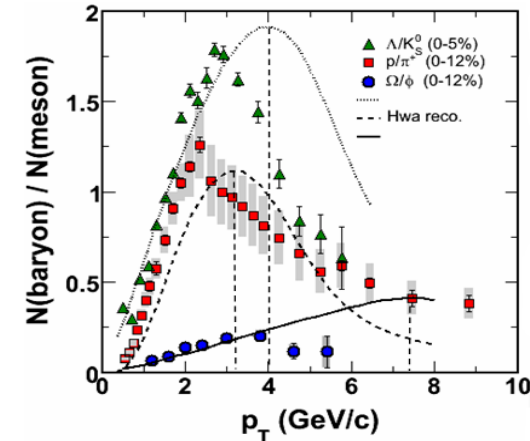
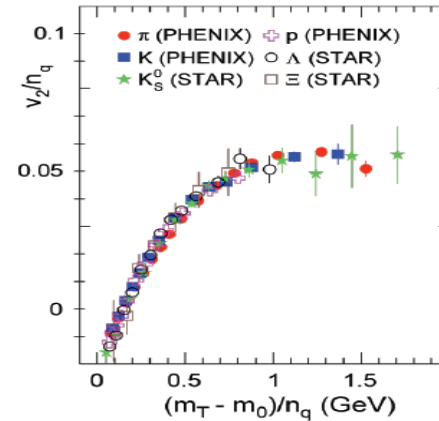
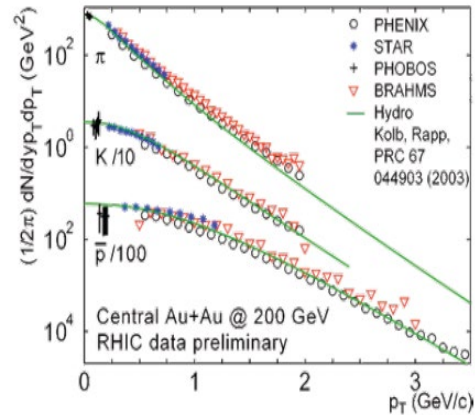
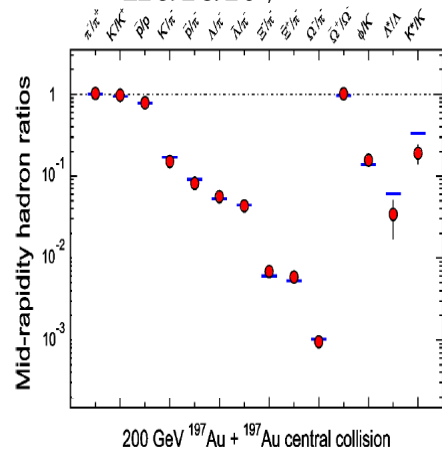
Bulk particle distributions

QGP hadronizes into soft hadrons; 99% of total yields
No direct access to details of QGP phase



(SHORT) SUMMARY OF “BULK” PROBES

- Bulk measurements provide experimental evidence of QGP formation in ultra-relativistic HIN collisions: a strongly interactive thermalized partonic matter with (near) perfect fluidity



Initial temperature/energy density is above predictions for the **phase transition**

Chemical freeze-out at predicted phase boundary; *thermalized* medium

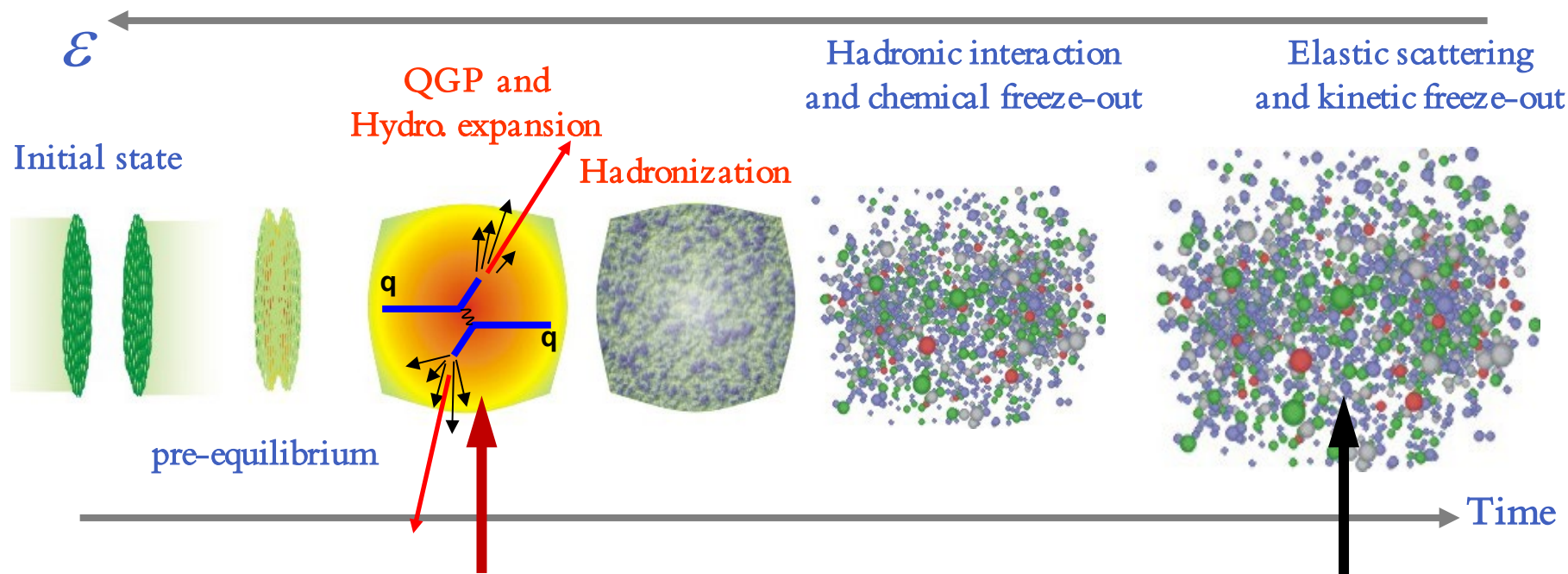
Hydrodynamics: strong radial and elliptic flow (in strange and charm sectors too!)

Partonic degrees of freedom are important at hadronization



DIRECT PROBES OF QGP

- Soft sector measurements allow to infer many important conclusions about QGP properties, but are always impacted by the entire evolution of the system.



WHY USE JETS FOR QGP STUDIES?

- What are Jets?

In theory: fragmented hard-scattered partons \rightarrow collimated spray of hadrons produced by energetic q or g

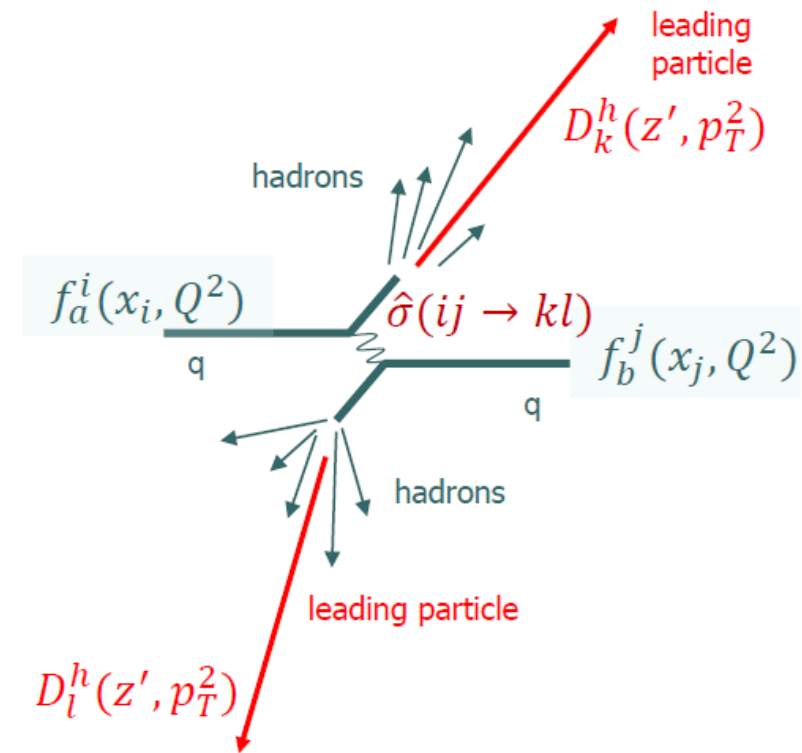
- Why Jets?

Jets are produced in the earliest phase of the collision

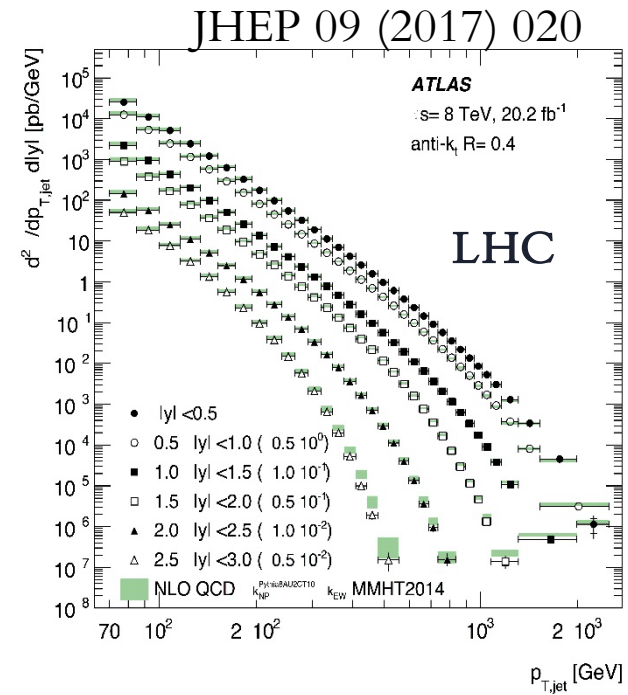
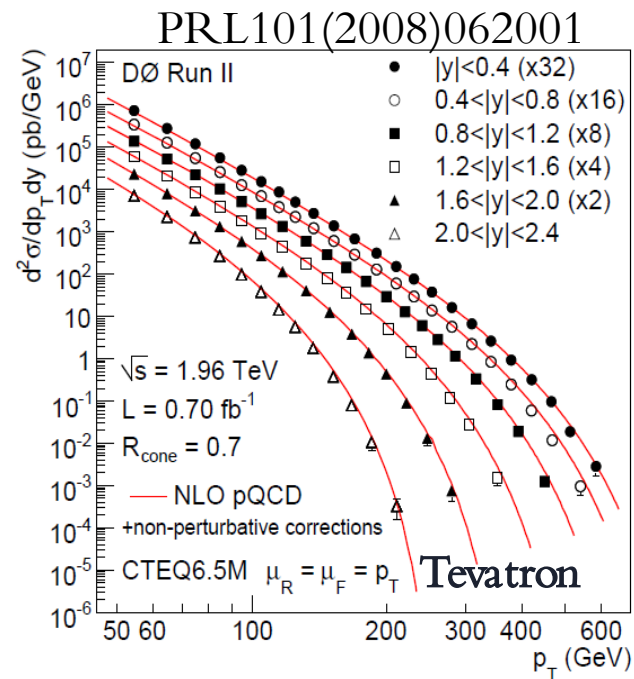
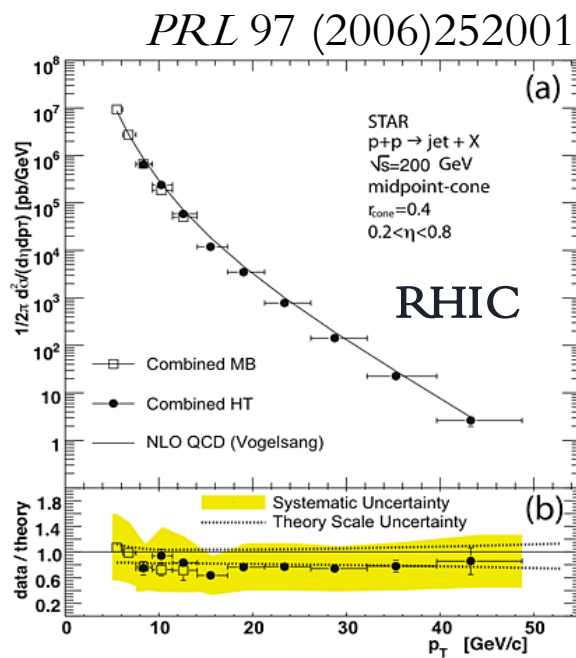
- Factorization of jet/particle production: yields described by the convolution of

$$f_a^i(x_i, Q^2) \otimes f_b^j(x_j, Q^2) \otimes \hat{\sigma}(ij \rightarrow kl) \otimes D_k^h(z', p_T^2)$$

- Jets are *calibrated* probes



JET PRODUCTION CROSS-SECTION



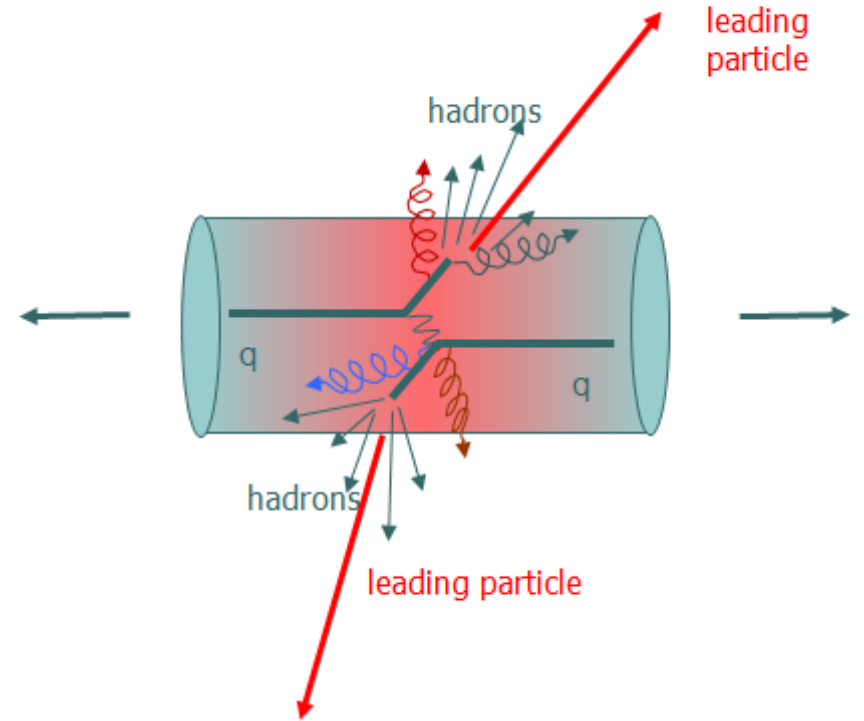
- Jets are well-calibrated probes: inclusive jet cross-sections described by NLO calculations over orders of magnitude in p_T and \sqrt{s}



QGP PROPERTIES VIA JETS

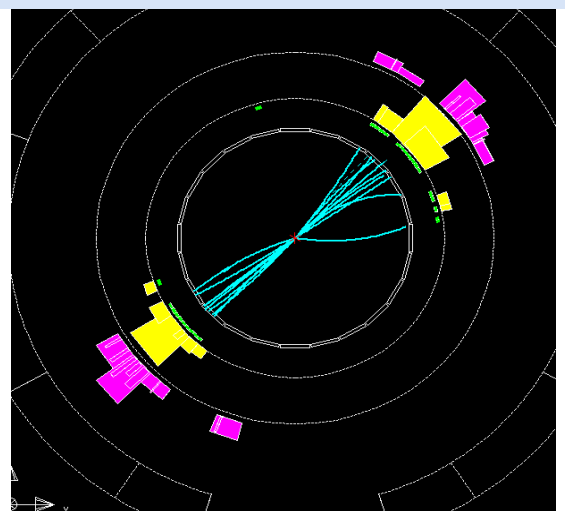
- Jet Tomography: What happens if partons traverse a high-energy-density colored medium?
- Production of jets is unmodified* – short-distance process ($\hat{\sigma}(ij \rightarrow kl)$ – unchanged)
- Jets are calibrated probes – well-understood (and measured!) in pp
- Jets studies allow to observe medium evolution and equilibration and explore medium properties at different scales

*except for nPDF effects

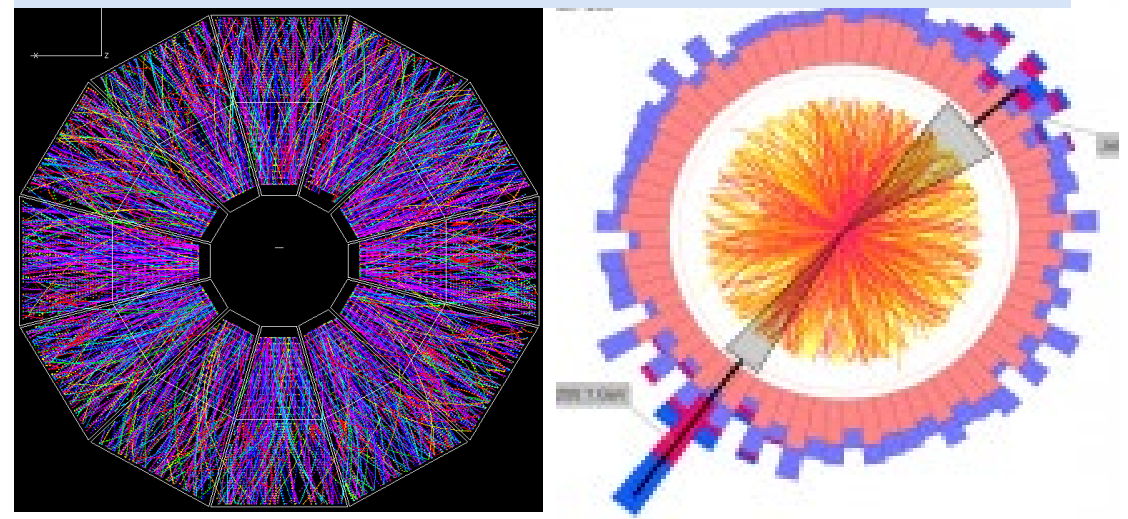


JET STUDIES, EXPERIMENTALLY

Jets in e⁺e⁻ collision



Jets in AA collisions



Choice of tools (in hard regime):

Spectra/Production rates

Dihadron correlations

Jets/Dijets

Pros: straightforward

Cons: least differential

versatile

multiple BG sources,
no direct E measure

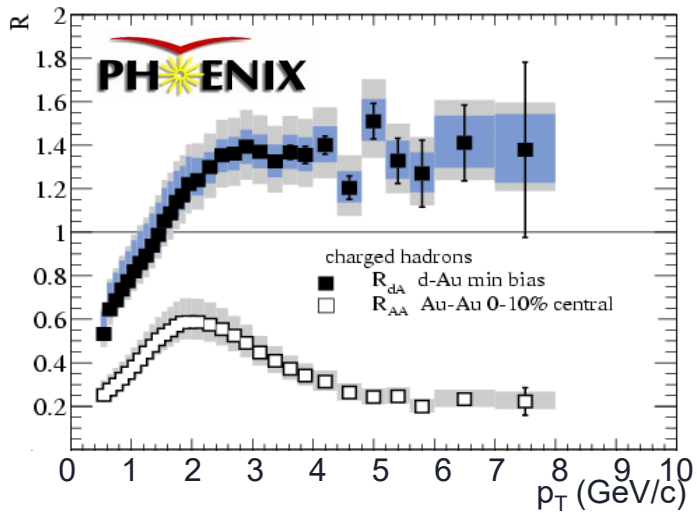
E_{parton}

ambiguous,
fluctuations

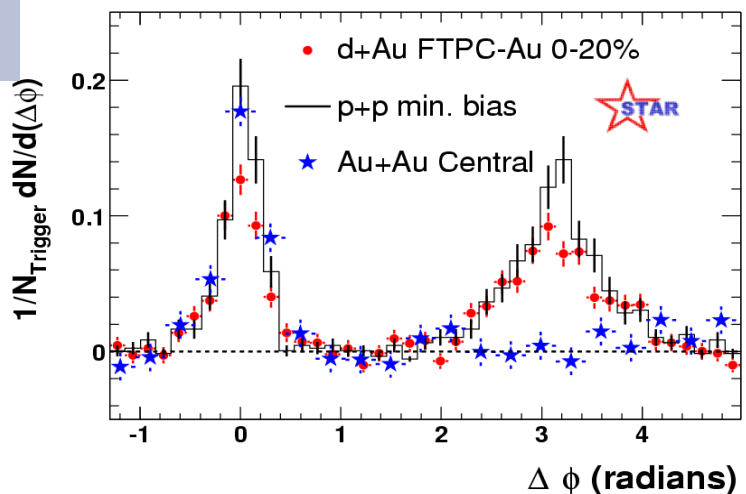


JET QUENCHING: EARLY RESULTS

PRL 91 (2003)
072303



PRL 91 (2003)
072304



- High p_T hadron suppression:

$$R_{AA}(p_T) = \frac{d^2 N^{AA} / dp_T d\eta}{\langle N_{bin} \rangle d^2 N^{pp} / dp_T d\eta}$$

- Final state effect in AuAu collisions
- Observation extended to all accessible p_T range

- Signature two-particle correlation result:

- Evidence of quenching: disappearance of the away-side jet in central AuAu collisions
- Evidence of non-quenching: effect vanishes in peripheral/dAu collisions



DISCLAIMER ON THE “DISAPPEARANCE”

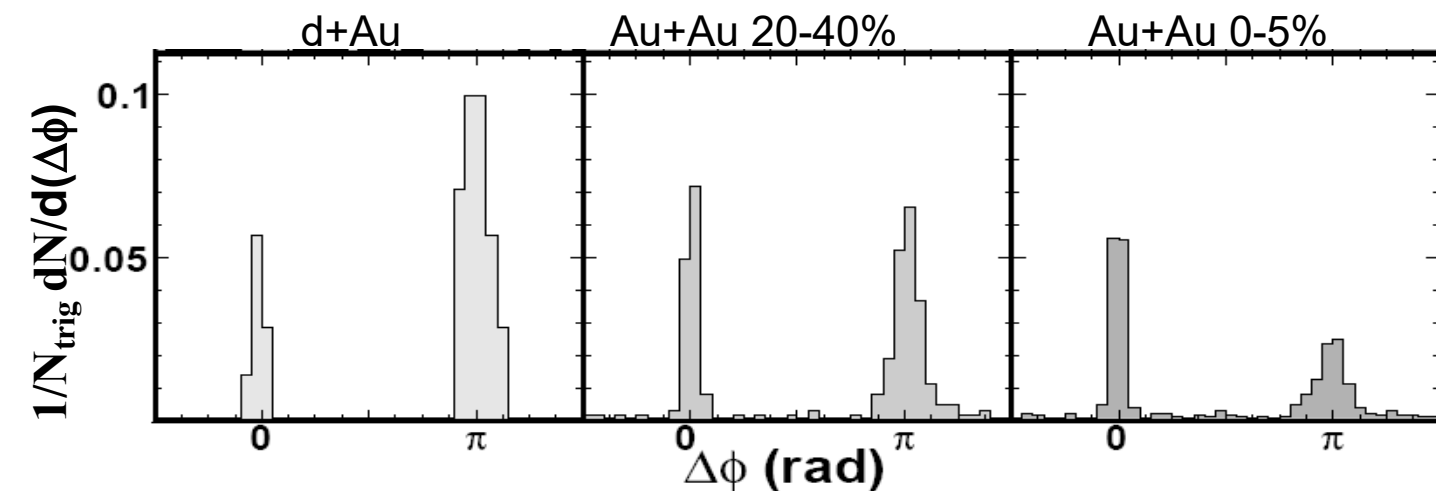
PRL 97 (2006)
162301

“*Disappearance*” is accidental!

- Two high- p_T hadrons (or high & low p_T combination): reappearance of the away-side jet.

• Recovering the away side:

- Away-side yield suppression
- Little modification of the near-side yields
- No broadening on near- or away-sides

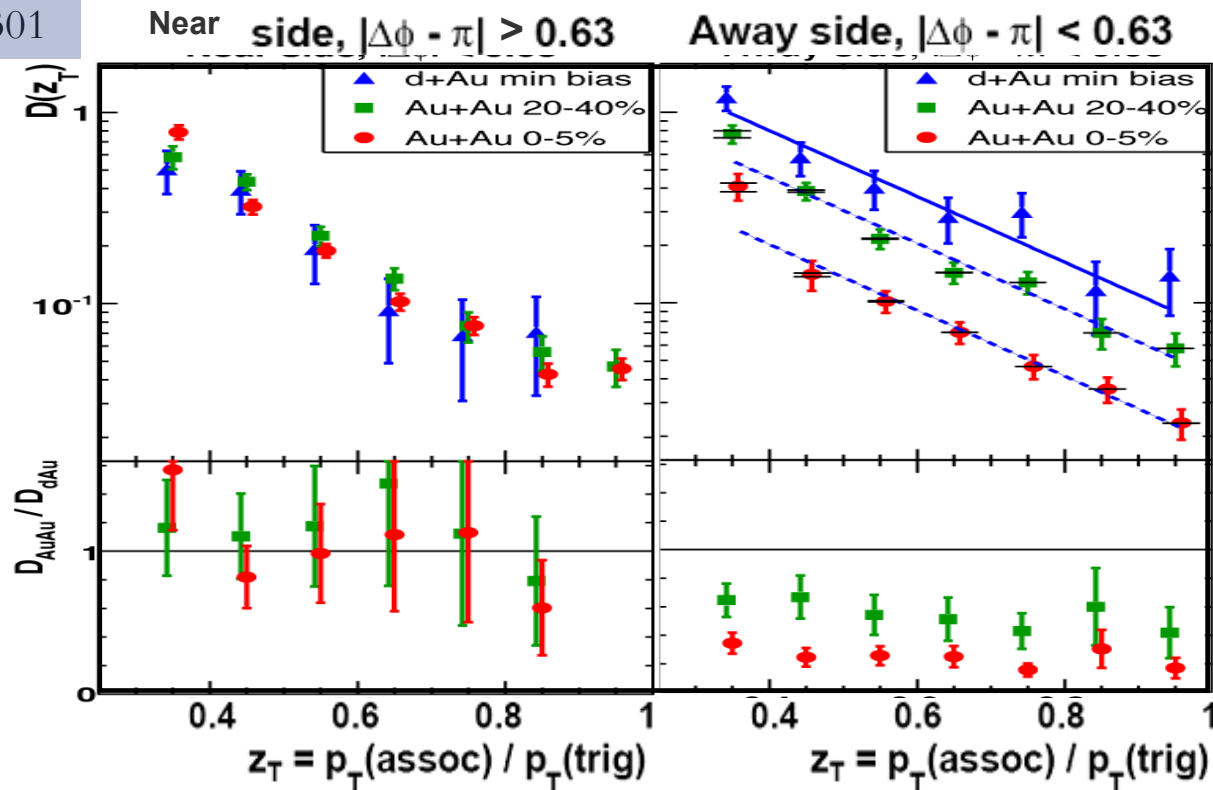


$$8 < p_T^{\text{trig}} < 15 \text{ GeV}/c, p_T^{\text{assoc}} > 6 \text{ GeV}/c$$

JET-MEDIUM INTERACTIONS

- High p_T correlations for early studies of medium-induced jet modifications

PRL 97
(2006) 162301

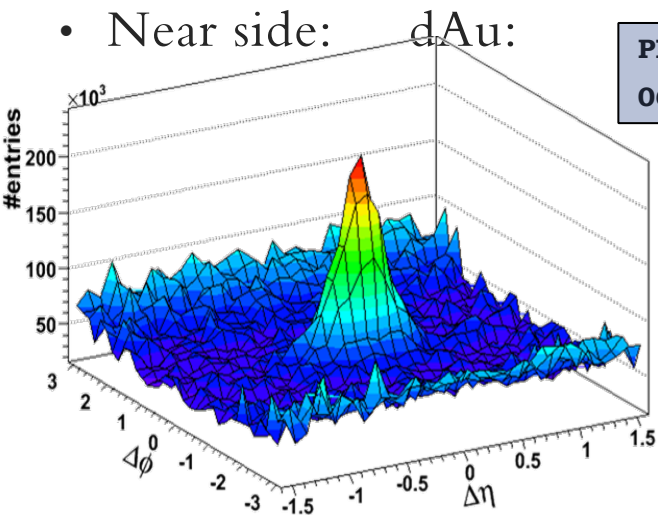


- Near-side: no dependence on z_T
- Away side: suppression \sim level of R_{AA} ; no z_T dependence

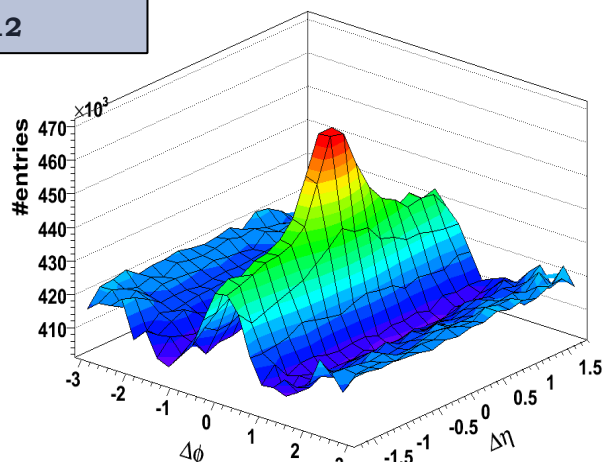


JET-MEDIUM INTERACTIONS

- Near side: dAu:



- AuAu:



- One high- p_T , one low- p_T hadron:

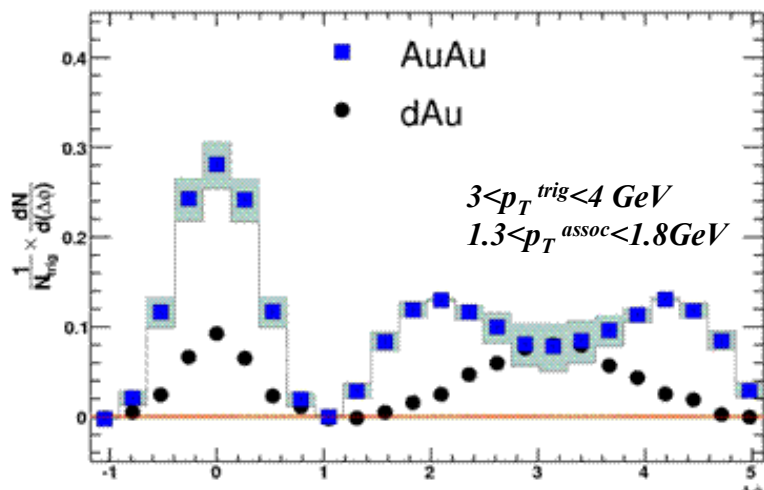
Near side: the **ridge**

Central AuAu: cone-like + ridge-like

Ridge extends to very high $\Delta\eta$

Away-side: reemergence of the peak with “shoulders.”

- Away-side:



Production mechanisms for jet and ridge are different

(mean- p_T , centrality-dependent behavior, particle composition)

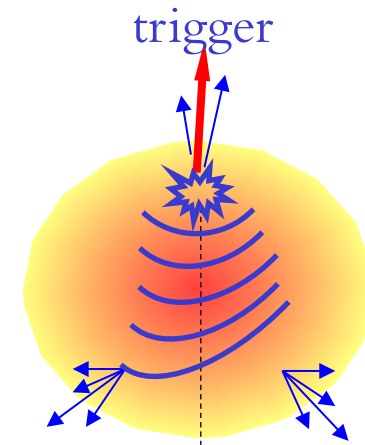
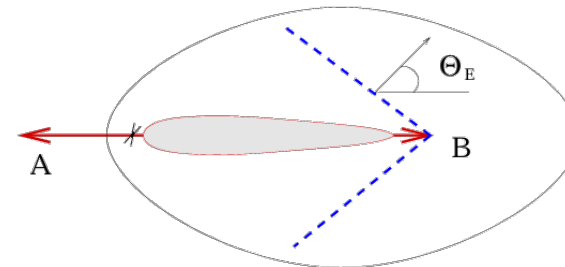
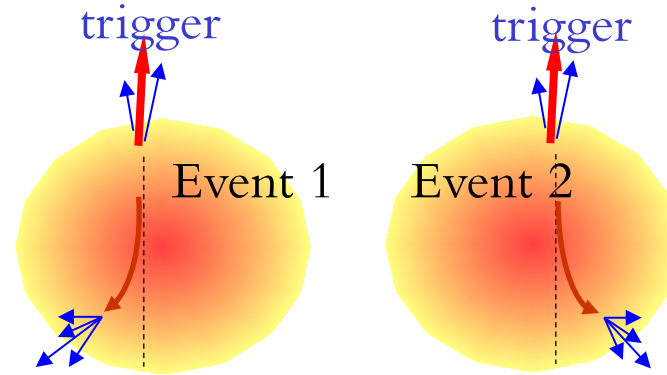
“Ridge” and “shoulders” show similar trends



WHY MACH CONES IN THE QGP?

- RHIC **ridge** and **away-side double-peak** dihadron correlations prompted many theory developments
- Models fell broadly into two classes:
 - **Hydrodynamic response models**, in which jet energy-momentum deposition produces Mach cones and diffusion modes in the medium.
 - **Non-hydrodynamic alternatives**, including Cherenkov gluon radiation, deflected jets, or emission into collective plasma modes
- **Early jet quenching** studies at RHIC showed that energetic partons deposit energy into the medium
- If deposited energy **thermalizes rapidly**, hydrodynamics predicts excitation of **sound modes**.
- **Supersonic jets** \Rightarrow **Mach cones**, with an angle

$$\cos \theta_M \sim c_s / v_{jet}$$



EARLY MACH CONE PREDICTIONS

- A jet propagating through a hydrodynamic QGP medium should induce a Mach cone

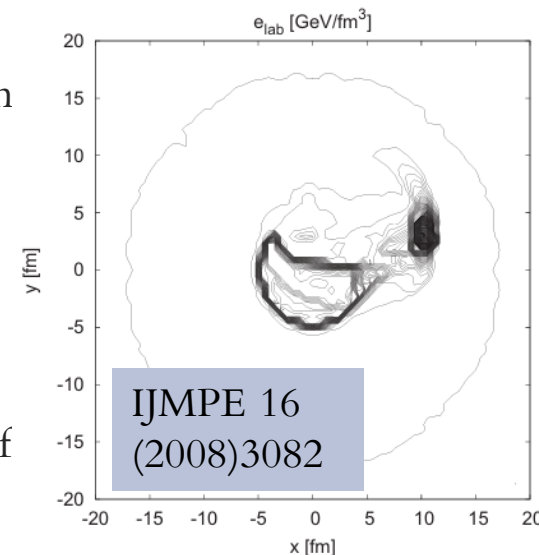
Stoecker, Nucl. Phys. A750(2005)121

Casalderrey-Solana, Shuryak, Teaney, J. Phys. 27(2005)22

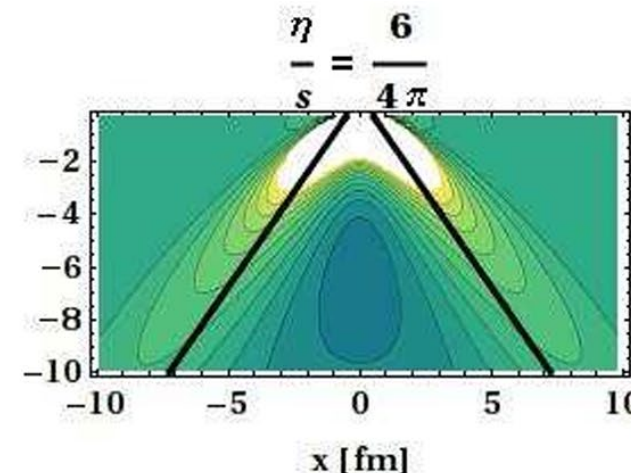
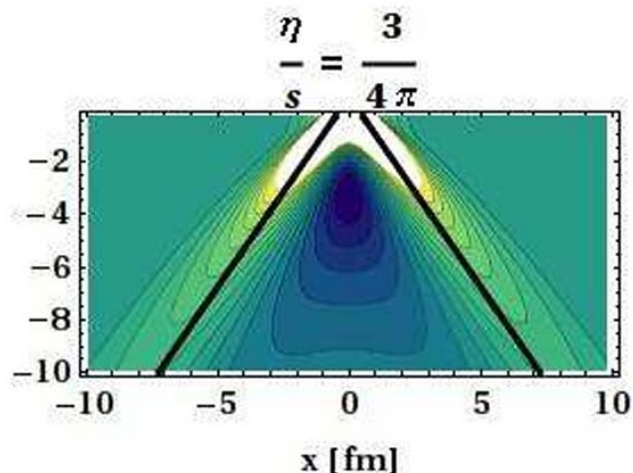
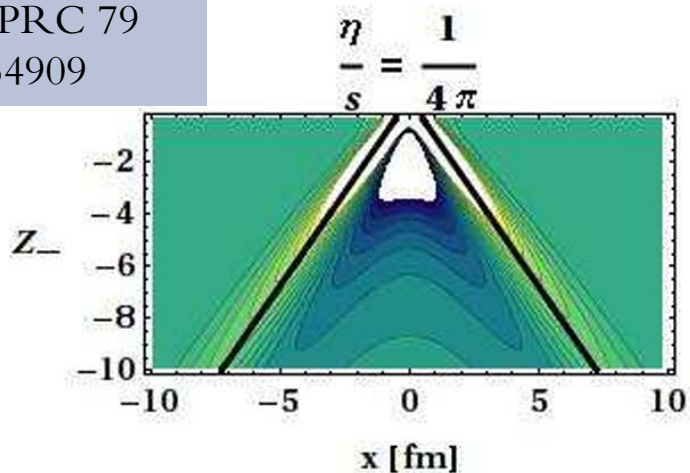
Ruppert, B. Muller, PLB 618 (2005) 123

Renk, Ruppert, PRC 76 (2007) 014908

From (3+1) ideal hydrodynamics: “The jet-induced shock front and a deflection of the jet in case of an EoS with phase transition to QGP is clearly visible.”

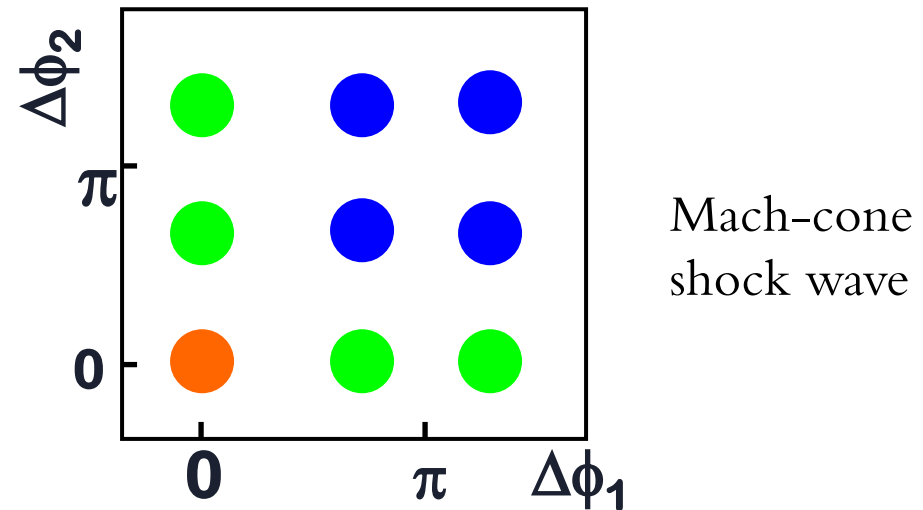
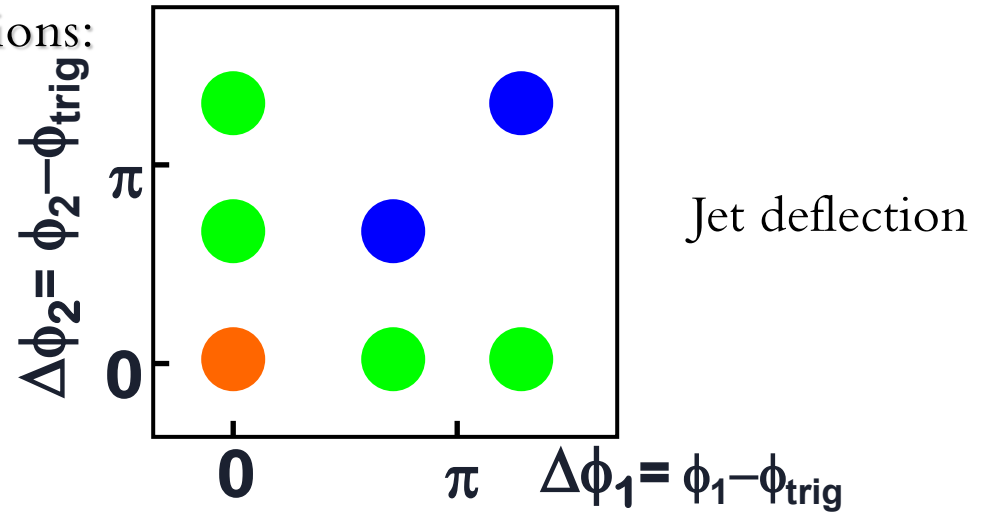
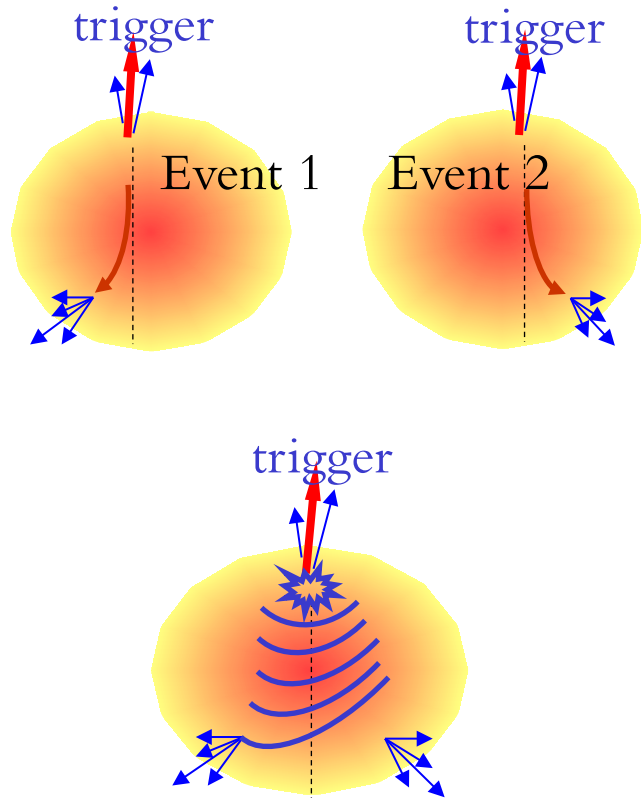


Neufeld, PRC 79 (2009) 054909



EXPERIMENTAL MACH CONE SEARCHES

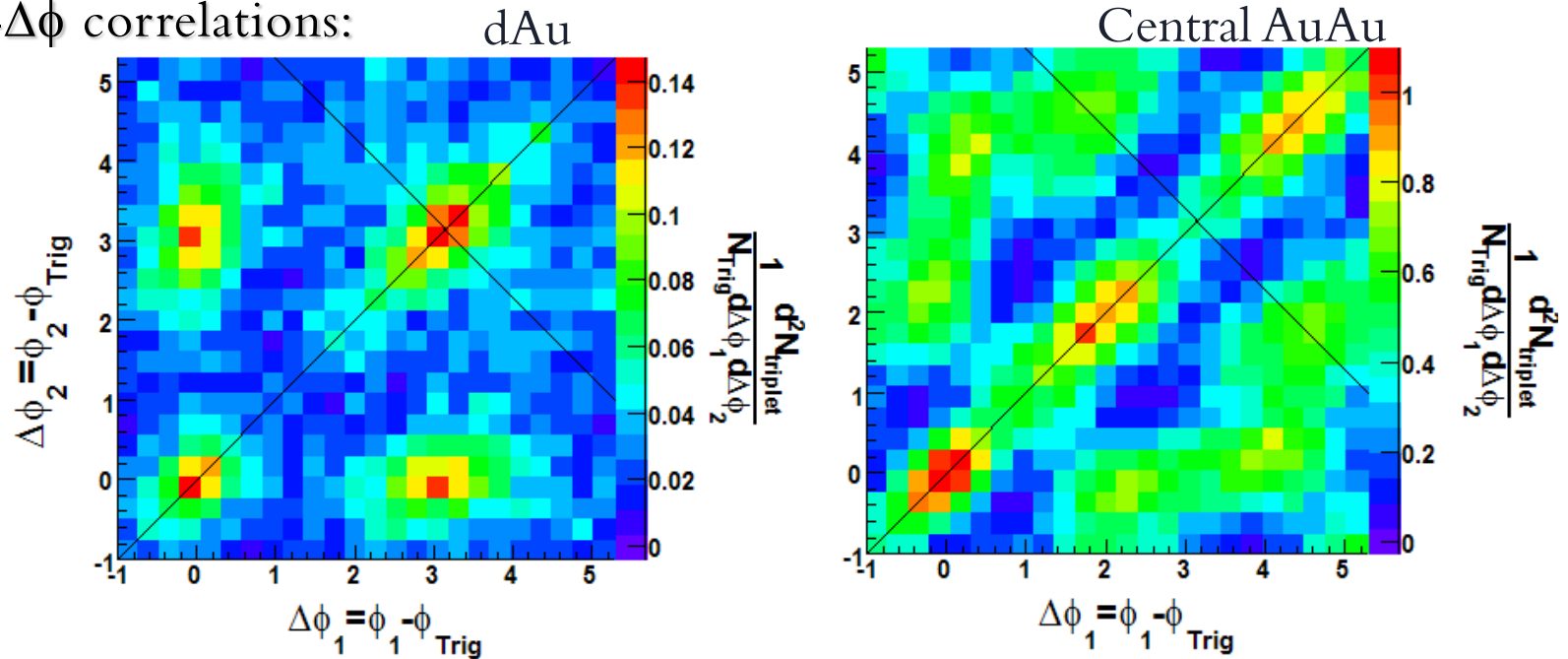
- 3-particle $\Delta\phi$ - $\Delta\phi$ correlations, expectations:



EXPERIMENTAL MACH CONE SEARCHES

- 3-particle $\Delta\phi$ - $\Delta\phi$ correlations:

STAR PRL 102
(2009)52302

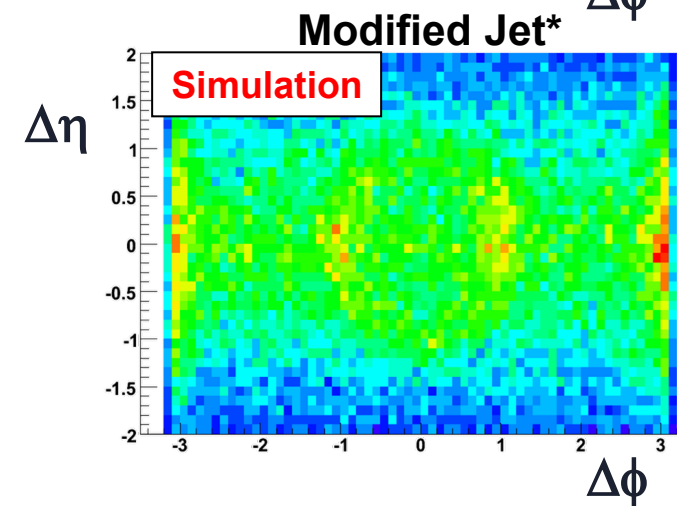
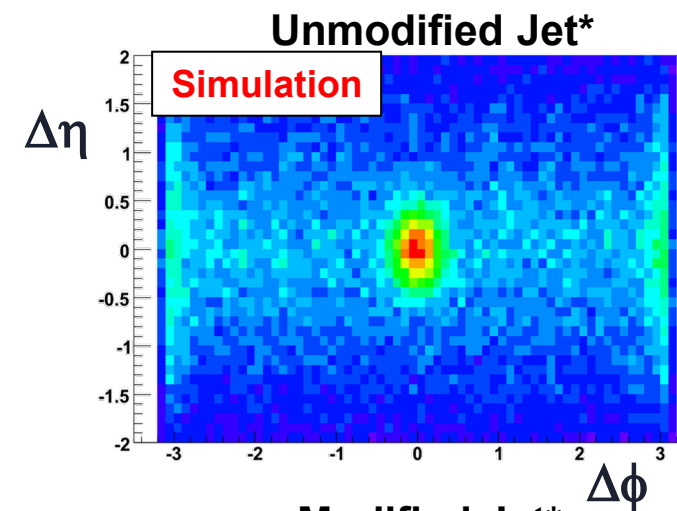
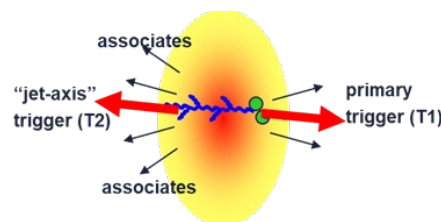
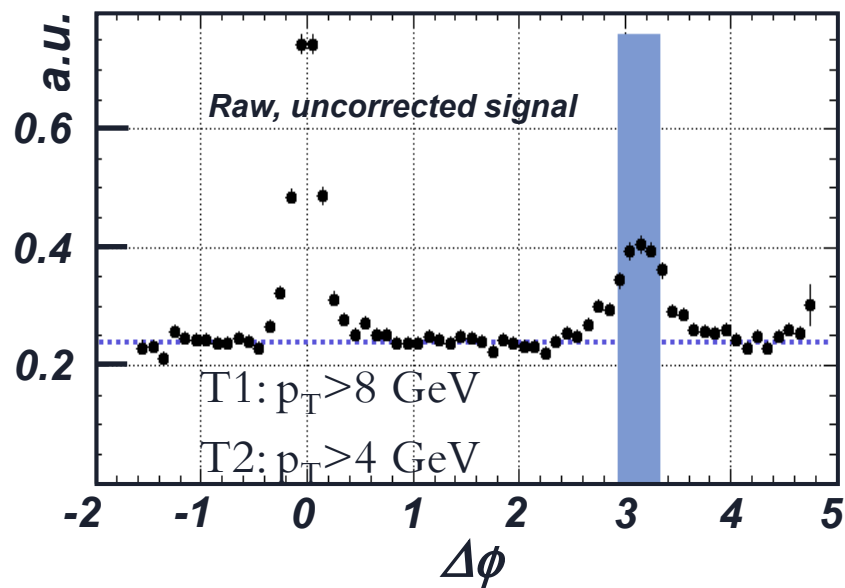


- STAR results indicated jet deflection (?)
- Sated experimental observation of conical emission:
 $\theta_M = 1.37 \pm 0.02$ (stat.) ± 0.06 (syst.)
 Constrains the speed of sound $c_s \sim 0.2$



NEAR & AWAY: DI-JET TRIGGER

Cor. Sig.



- “2+1” correlations:
 - Use di-jets to study jet-medium effects
 - “Pin” the jet axis selecting back-to-back triggers
 - Study correlation w.r.t. this axis



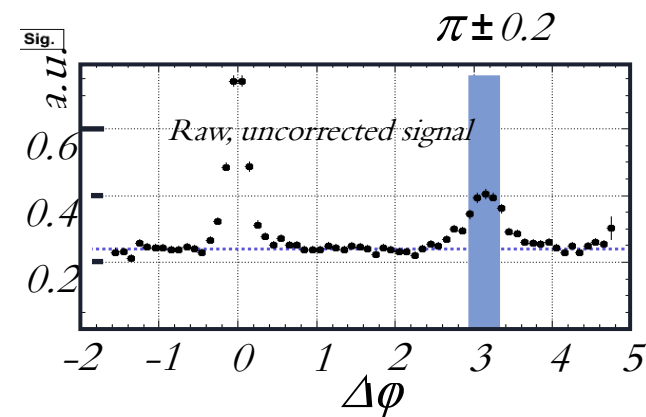
DI-JETS IN AuAu COLLISIONS

- 2+1 correlation results:

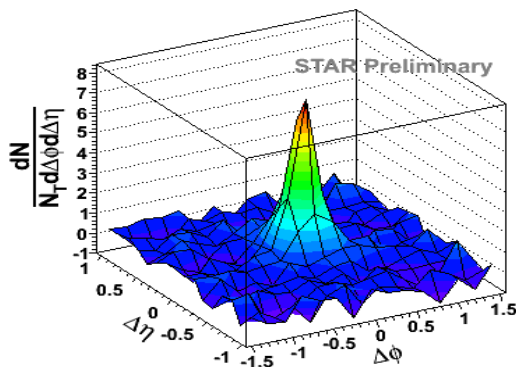
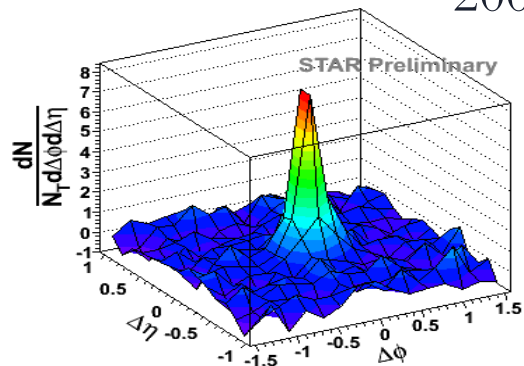
PRC 83
(2011) 61901

$$8 < p_{T,t1} < 10 \text{ GeV}/c, p_{T,t1} > 4 \text{ GeV}/c, p_{t,assoc.} > 1.5 \text{ GeV}/c$$

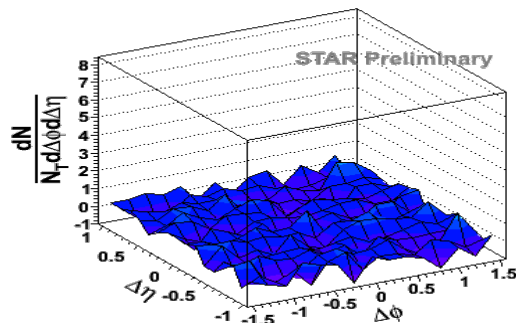
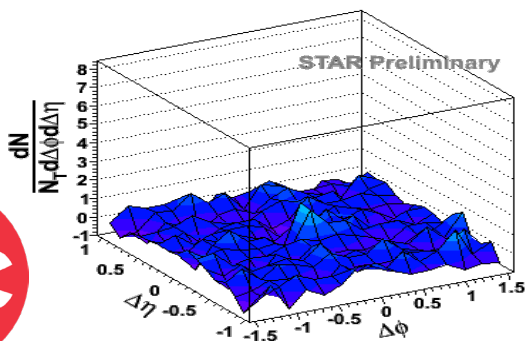
200 GeV Au+Au, 10%



- Central Au+Au ~ d+Au. No away-side suppression!
- Surface emission bias?



Residuals: Au+Au – d+Au

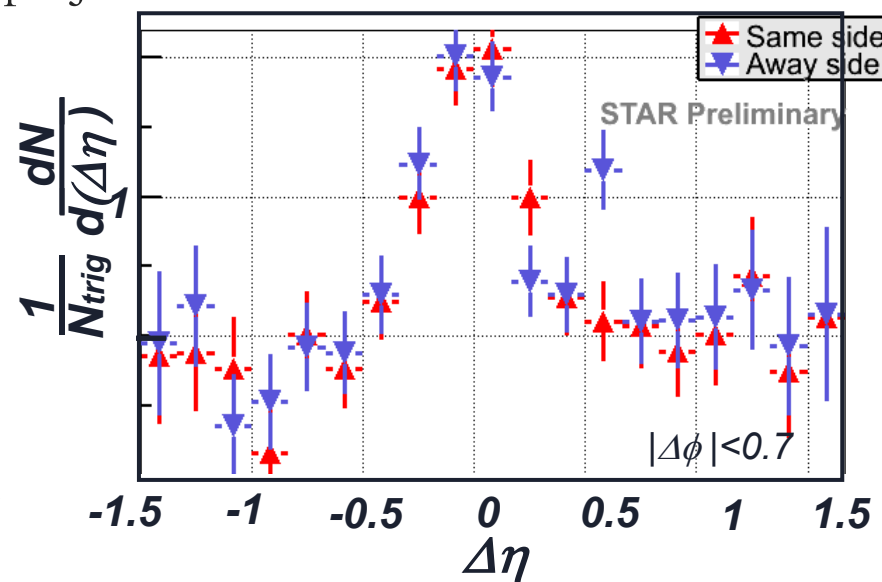
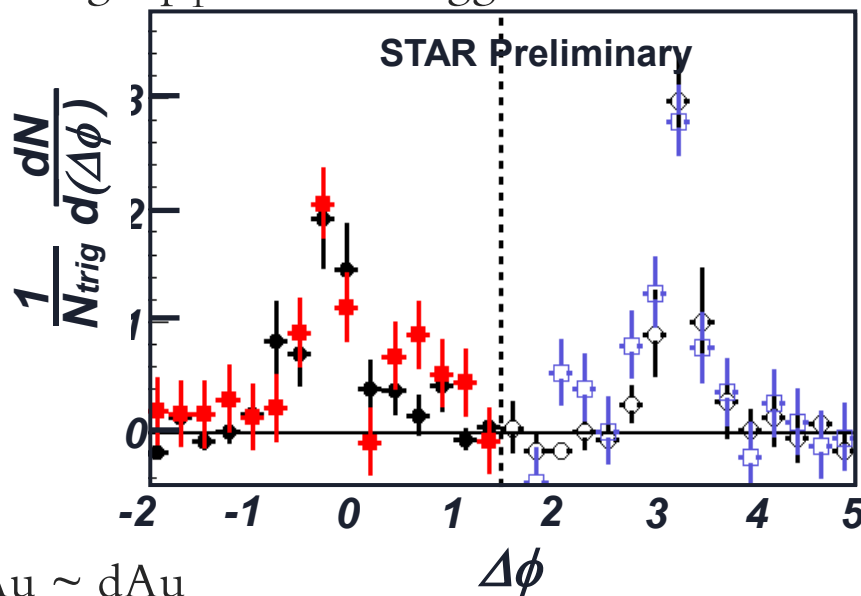


DI-JETS IN AuAu COLLISIONS

- Back-to-back high- p_T -hadron-triggered correlations projections:

PRC 83
(2011) 61901

$5 < p_{T}^{\text{Trig1}} < 10 \text{ GeV}/c$
 $4 < p_{T}^{\text{Trig2}} < p_{T}^{\text{Trig1}}$
 $1.5 < p_{T}^{\text{Assoc}} < 10 \text{ GeV}/c$

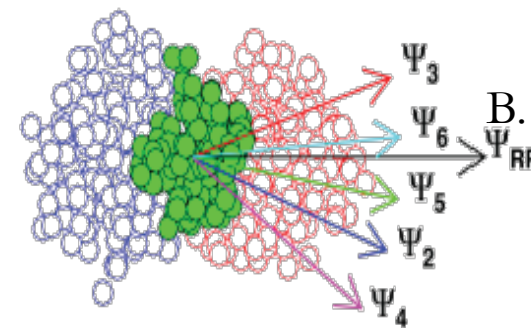
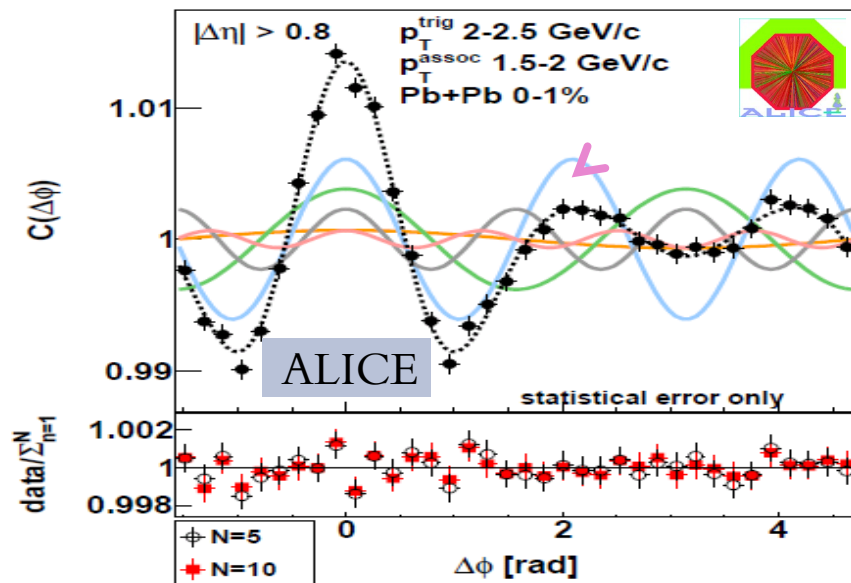


- Central AuAu \sim dAu
- Shapes:
No Mach cone evidence. No appreciable difference between the same and away sides.
- Spectra:
Significantly harder than an uncorrelated background
On both sides, associated hadron distributions from central AuAu are similar to dAu



ANOTHER SIGNATURE RESULT: FLOWS

- Ridge and shoulders:



B. Alver and G. Roland

PRC 81
(2010) 054905

One high- p_T , one low- p_T trigger

- Full correlation structure described by Fourier Coefficients v_1, v_2, v_3, v_4, v_5 ★
- Current Glauber-based picture: geometry dominates the elliptic flow term; higher harmonics reflect fluctuation in initial conditions

Multiple studies across RHIC/LHC indicated that these correlation features have a flow origin



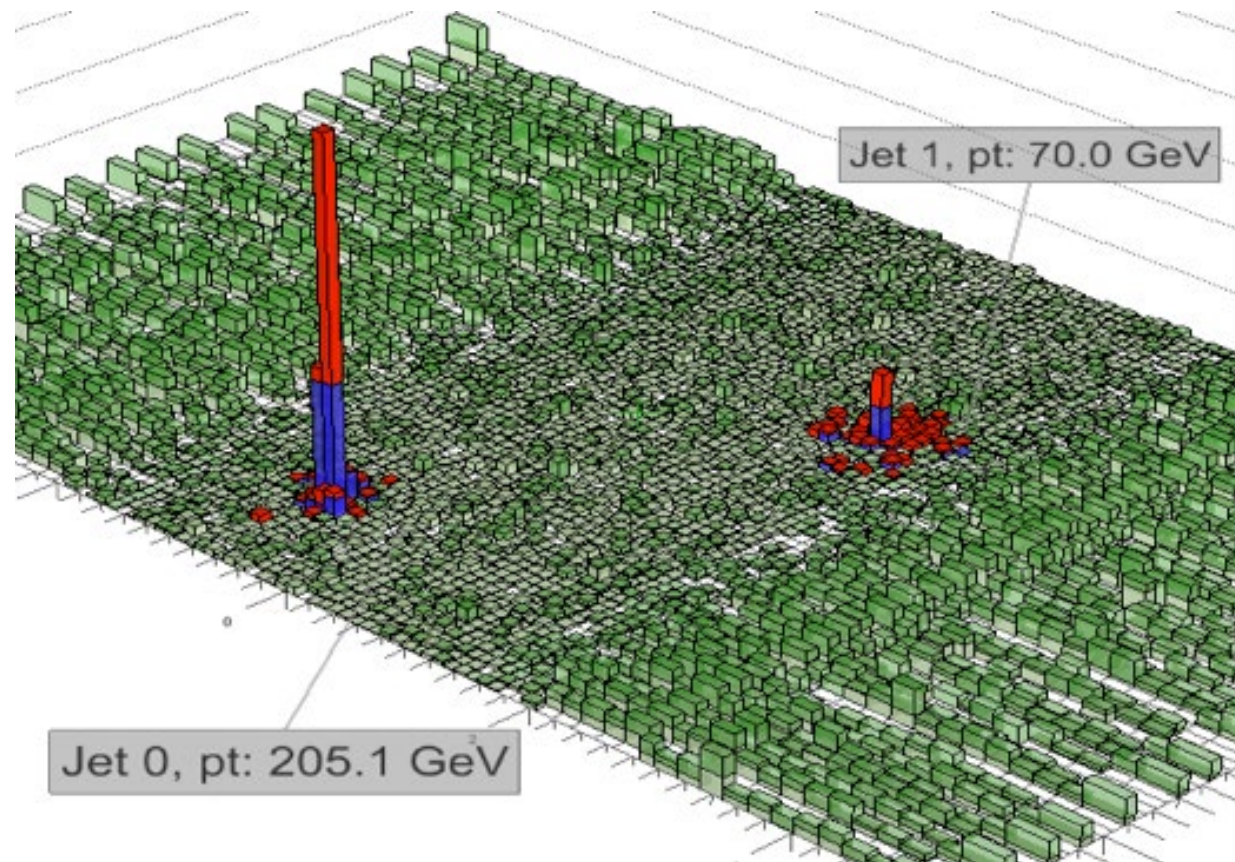
MACH CONE THEORY DEVELOPMENTS

From Models to Dynamics

- *What Controls Mach Cones? (2009–2015)*
 - Linearized hydrodynamics with realistic jet source terms → sound mode + **diffusion wake**.
 - Microscopic derivations (pQCD-based sources) clarified **energy vs momentum deposition**.
 - AdS/CFT showed Mach cones persist at strong coupling, but with strong **diffusion wakes**.
- Full (3+1)D **expanding backgrounds** revealed:
 - Radial flow and geometry **distort** cones,
 - Finite viscosity (η/s) **smears or suppresses** signals.
- Double peaks are **not unique** to Mach cones (flow harmonics, fluctuations).
- Mach cone, experimentally: for a time, the definitive Mach cone observation was deemed unattainable



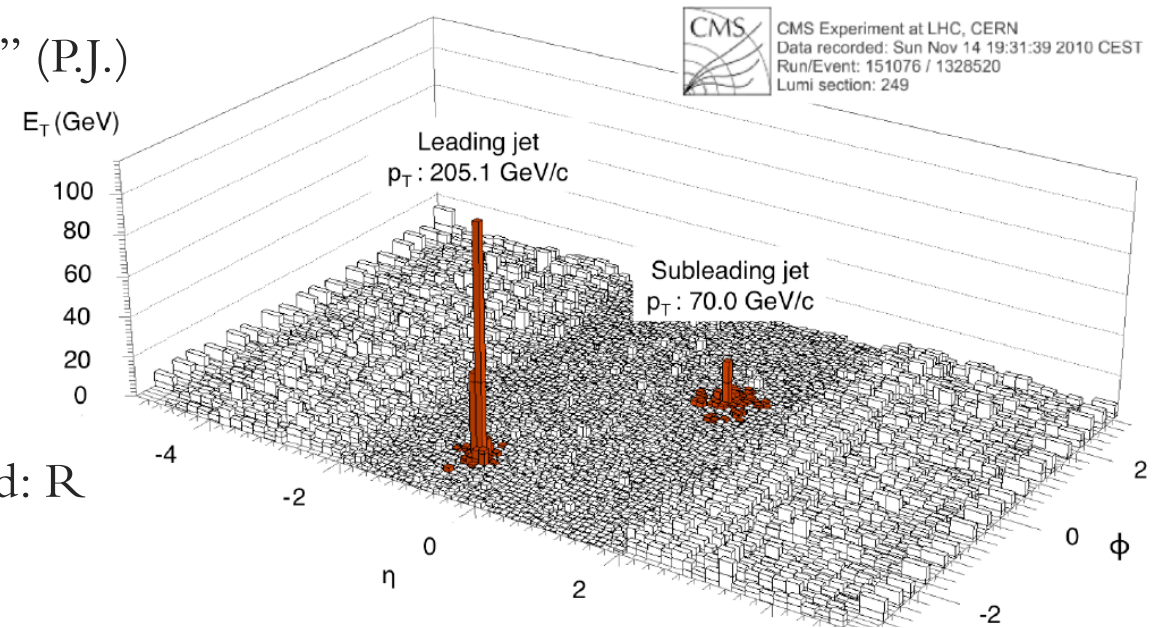
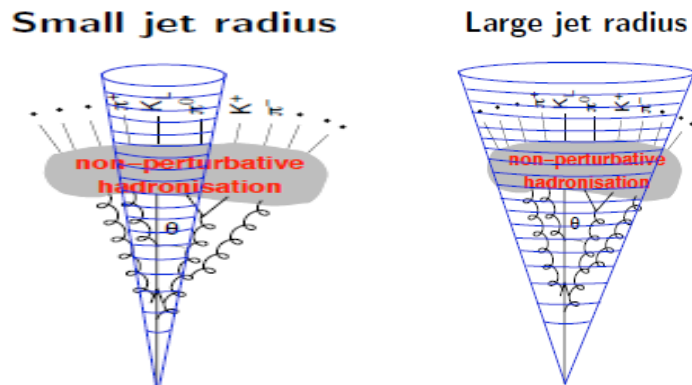
JET QUENCHING WITH JETS



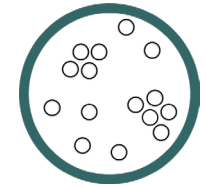
JETS IN HEAVY ION COLLISIONS

- In Theory: jets are proxies for hard-scattered partons
- In Experiment: “Jet is what your jet-finder gives you” (P.J.)
- Jet is defined by the reconstruction algorithm:
 - 1) What particles belong to a jet
 - 2) How particle momenta are combined into jet p_T

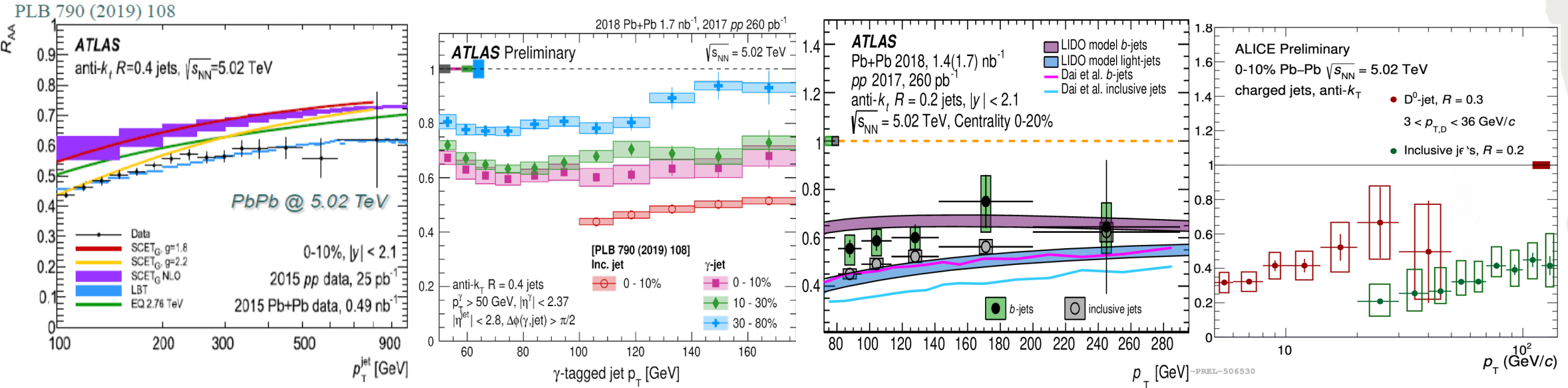
Particularly difficult for AA data due to UE background: R choice dilemma



QUENCHING EFFECTS IN JETS



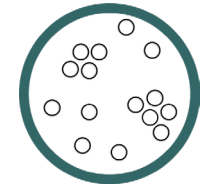
- Details of the energy loss: jet R_{AA} maps quenching effects in PbPb from 30 GeV to 1 TeV



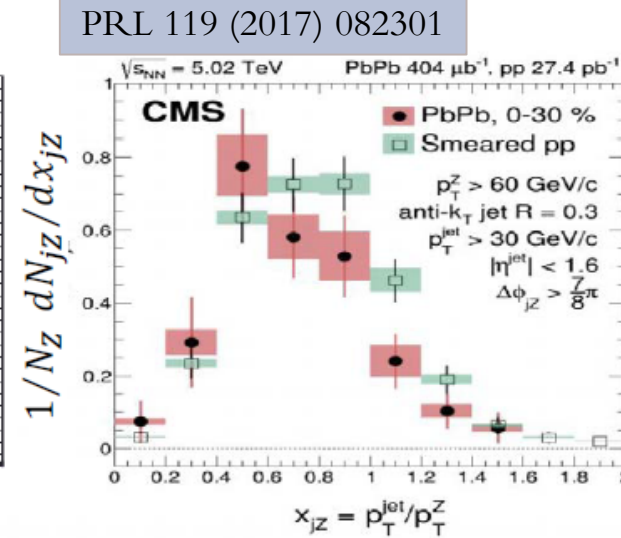
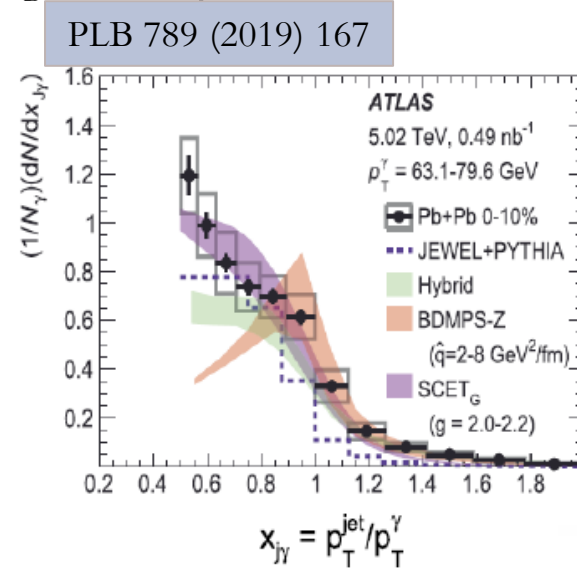
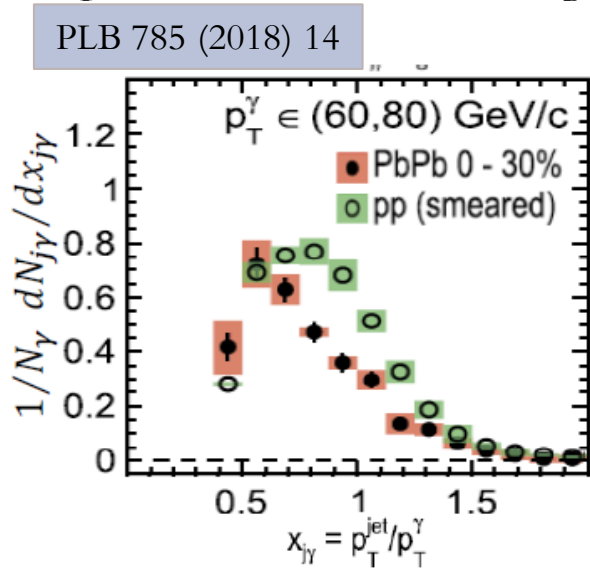
- Color-charge, mass, and/or flavor effects in energy loss:
 - Photon-tagged jets (higher fraction of q-jets): less suppressed compared to inclusive jets
 - b-jets (muon tagger): less suppressed compared to inclusive jets
 - D 0 -tagged jets – indications of smaller suppression compared to inclusive jets



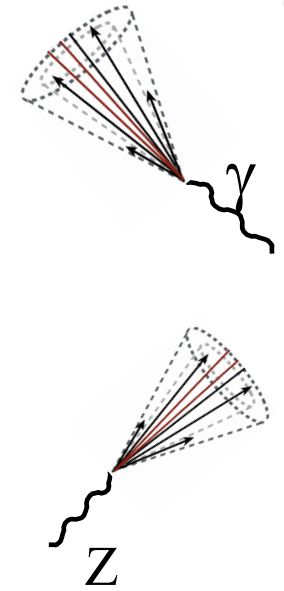
QUENCHING EFFECTS IN JETS



- Both sides of the dijet are quenched \rightarrow dijet collection is surface-biased \rightarrow Use colorless probes to reduce/change geometry bias

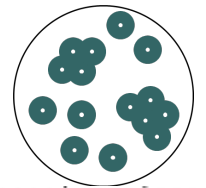


PbPb @ 5.02 TeV



- Details of the energy loss:
Dijet, γ -jet, Z-jet – energy balance is disturbed by QGP
(Centrality-dependent) changes in x_{JY} , x_{JZ} momentum balance

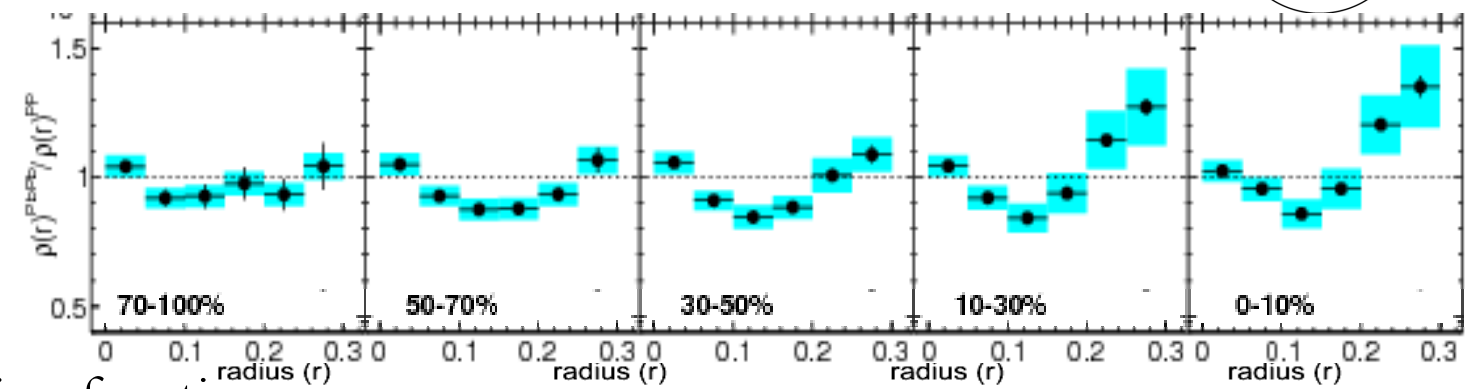




MODIFICATIONS OF JETS

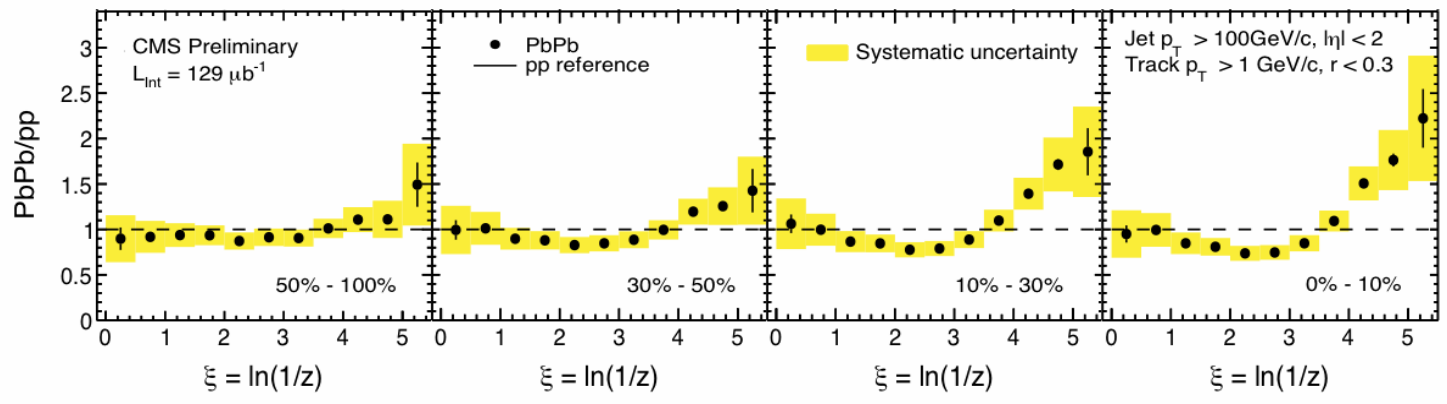
- Jet shape modifications

PLB 730 (2014) 243

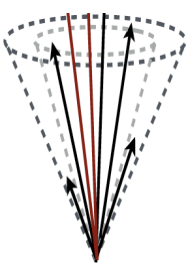
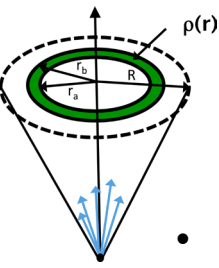


- Changes in jet fragmentation functions

PRC 90 (2014) 024908



- Jets are not just “shifted”:
 - Little/no medium effects in peripheral events
 - Enhancement at soft momenta and at large r in central collisions



QUENCHING BECOMES VISIBLE IN DIJETS

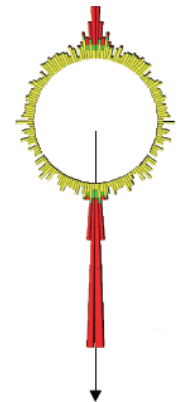
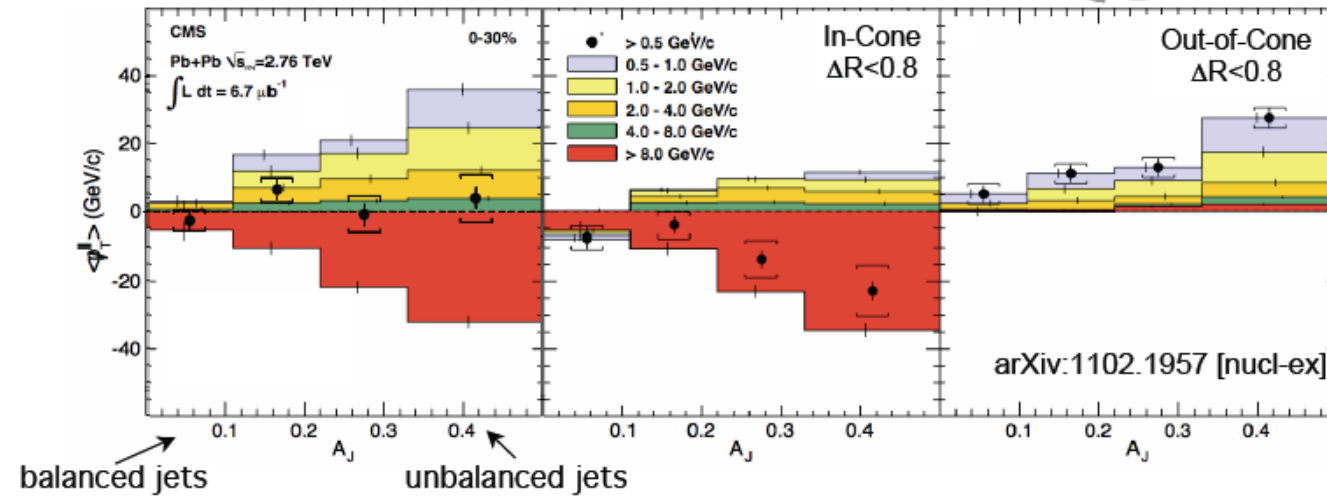
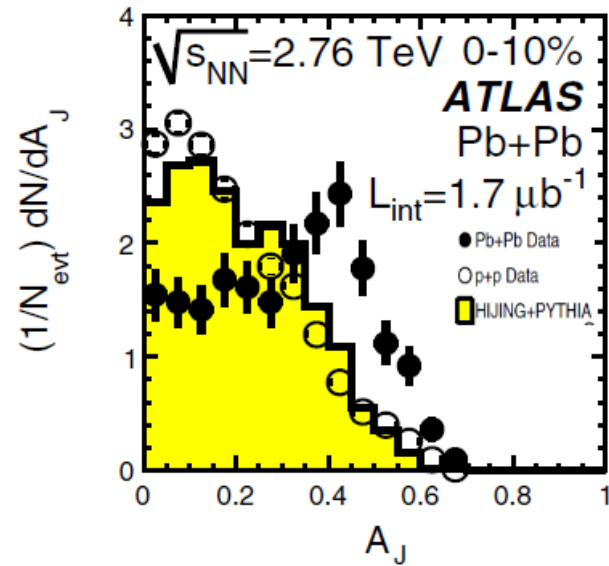
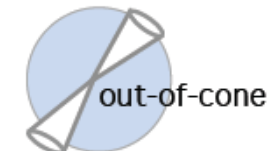
Di-jet momentum imbalance: $A_J = \frac{p_{T,1} - p_{T,2}}{p_{T,1} + p_{T,2}}$

PbPb @ 2.76 TeV

PRL 105 (2010) 252303

JHEP 01 (2016) 006

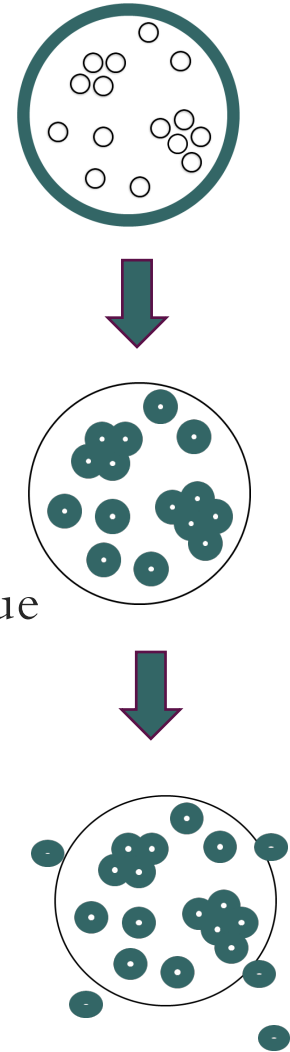
0-30% Central PbPb



- Di-jets in PbPb: back-to-back, but fraction of imbalanced dijets grows with collision centrality (no modifications in pPb collisions)
- Momentum balance is preserved over the entire event; “missing” p_T in hard sector is balanced by soft hadrons away from jet-axis

DECOMPOSING JET ENERGY “FLOW”

- Jets are modified...
 - Strong suppression in jet R_{AA}
 - Softening of jet fragmentation functions
 - Broadening of jet shapes
 - ...and show significant reshuffling of energy in PbPb events compared to pp
- To get a coherent picture, we developed the jet-track correlation technique
- Differential studies of energy flow (shapes and fragmentation)
- Extension to large radii/interplay with medium changes

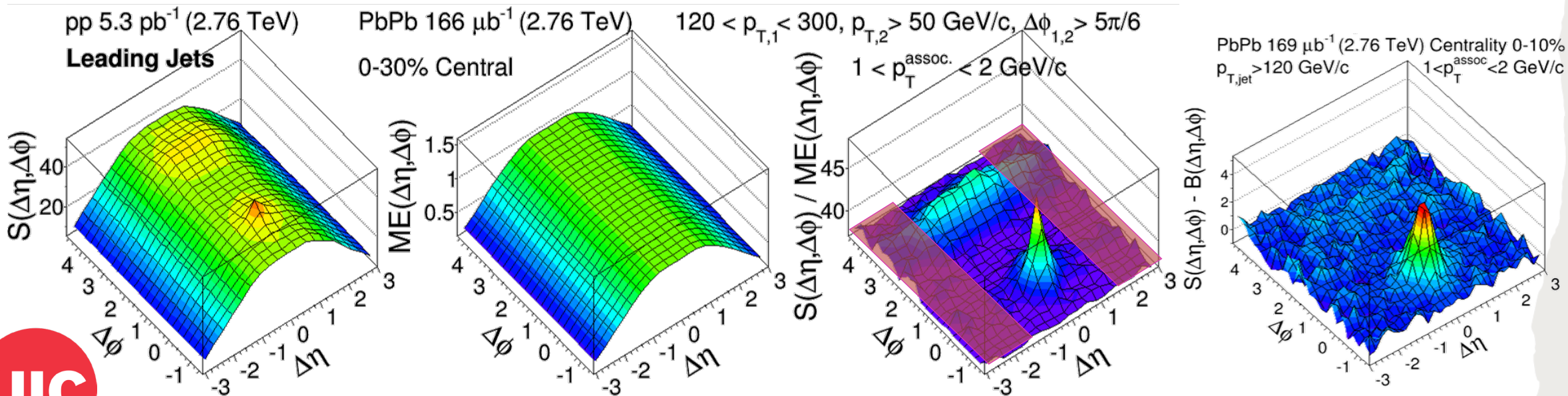


Cartoons courtesy Yi Chen

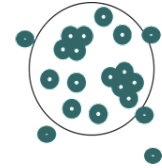
JET-TRACK CORRELATIONS

- Construct 2D $\Delta\eta\Delta\phi$ correlations about jet (or each side of a dijet)
- Correct for pair acceptance by the Mixed Event technique*
- Use a data-driven approach to remove underlying event UE correlations

(*also correct for tracking, background fluctuation, jet swapping, fragmentation bias)

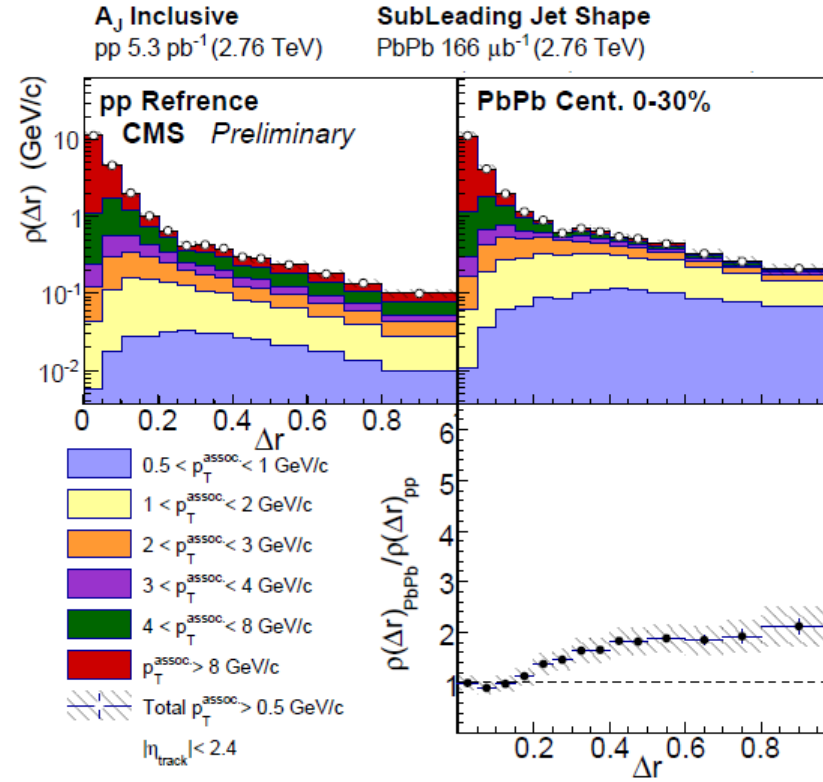
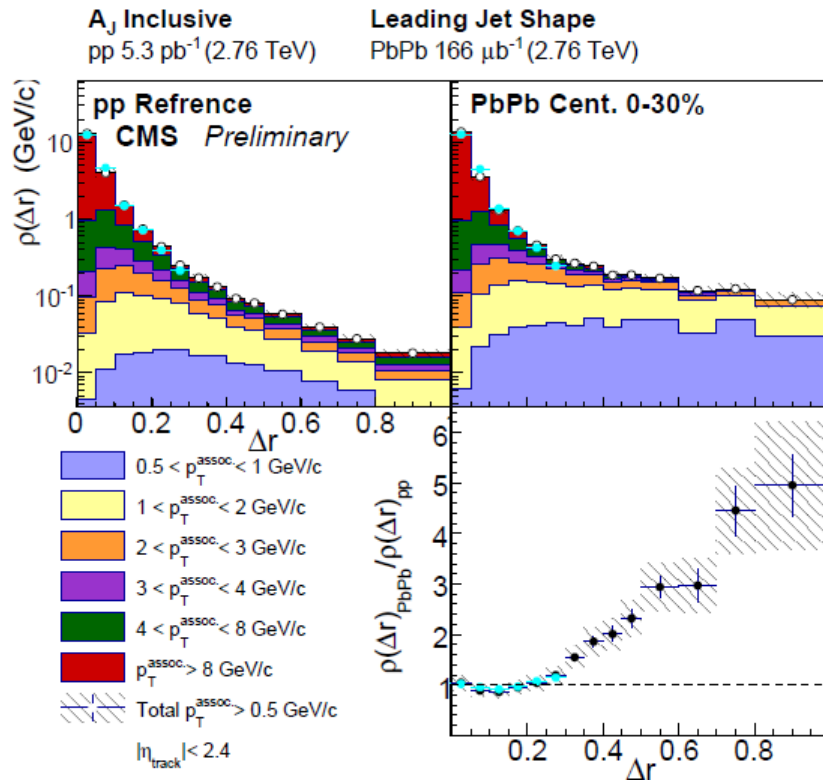
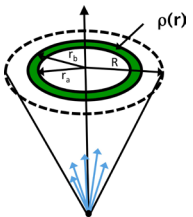


JET SHAPES, FULL FLOW



- Multi-differential reanalysis of 2.76 TeV data

JHEP 11
(2016) 055

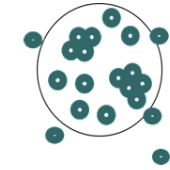


- Jet shapes at large radial distances: Capture the full extent of medium-induced changes

*Compared to earlier/traditional measurement in light blue

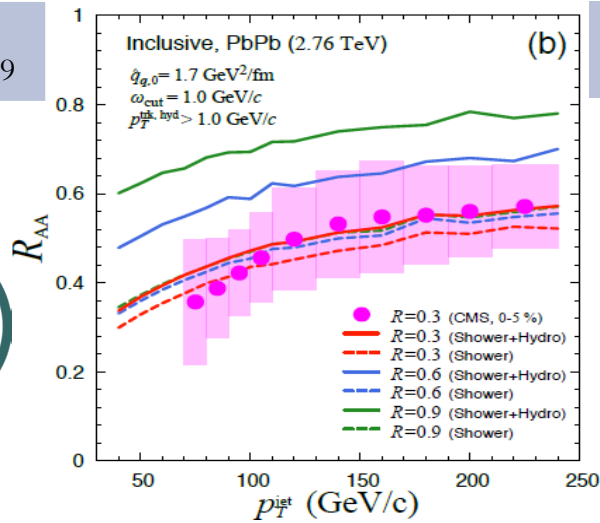
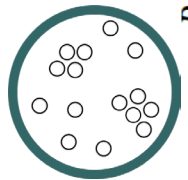


JET-MEDIUM INTERACTIONS

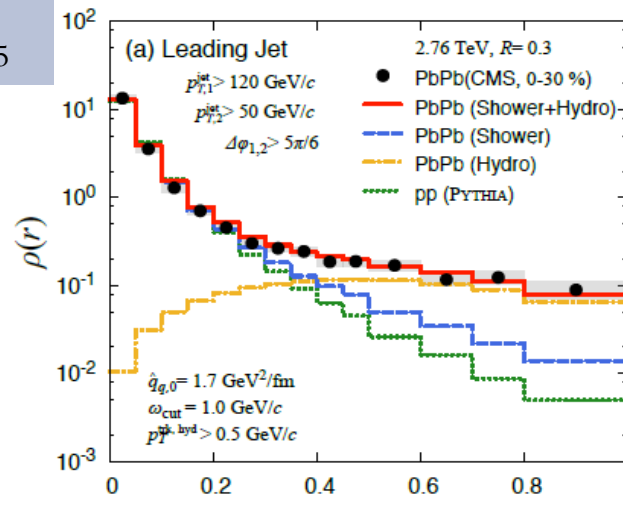


- Full jet evolution in QGP with hydrodynamic medium response

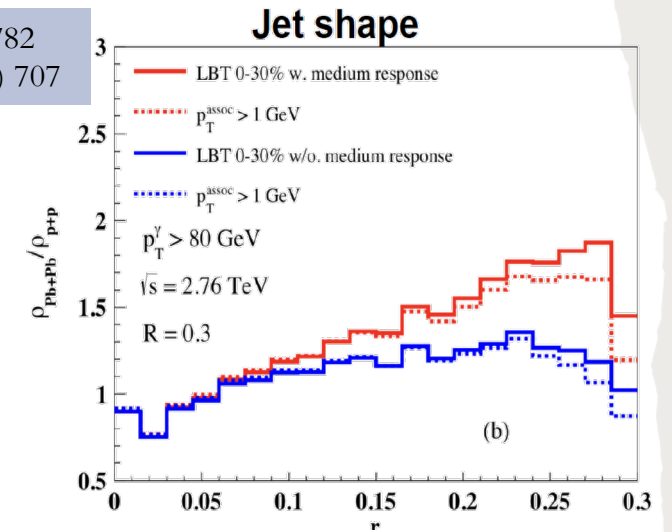
PRC95 4
(2017) 044909



JHEP 11
(2016) 055



PLB 782
(2018) 707



- Jet R_{AA} :

- Inclusion of the jet-induced medium flow decreases suppression
- The effect is small for small cone sizes, while large cones are challenging

- Jet Shapes:

- Soft shower thermalization – more collimated core
- Medium-induced radiation – broader shape
- Jet-induced medium flow – critical at large r

- Years of technical advances, yet no experimental way of extracting/separating the wake signal

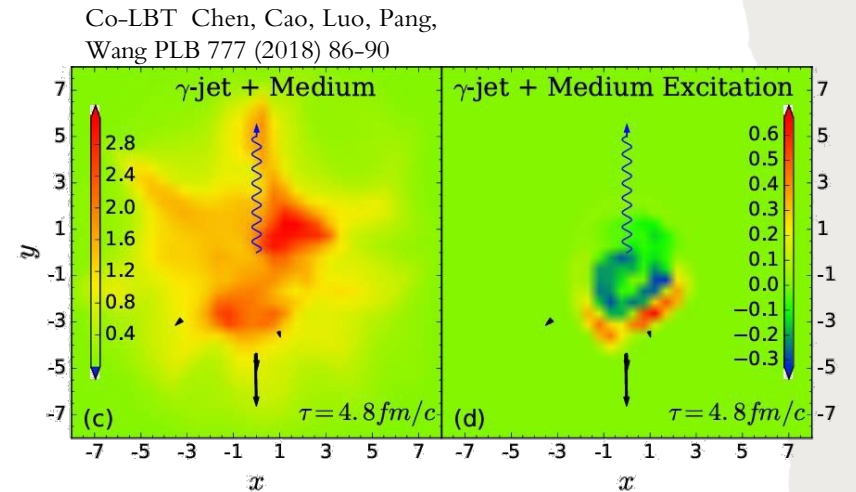
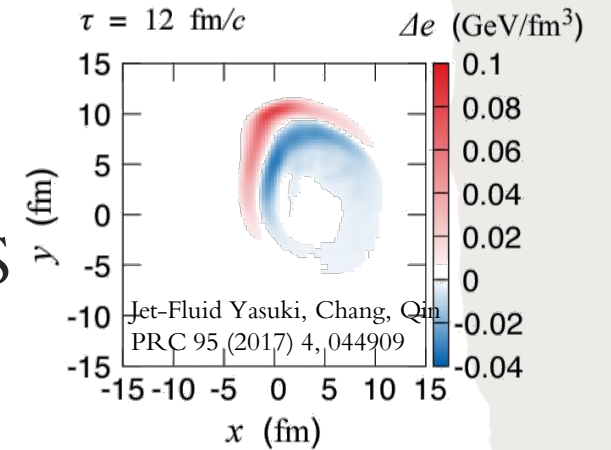


BACK TO (FOR?)
MACH CONES AND WAKES

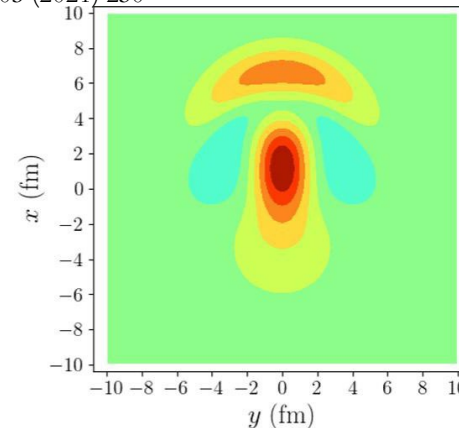
OR: one more time about the importance of theory &
experiment cross-pollination

MACH CONE: THEORY ADVANCES

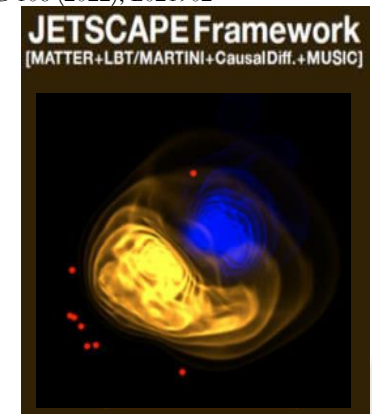
- *Jet-Induced Medium Response: a broader range of jet wake phenomena*
 - **Mach cone** in the direction of propagation
 - **Diffusion wake** (dominant depletion behind jet)
 - Coupling to background flow
- State-of-the-art frameworks developed:
 - LBT, CoLBT-hydro, Hybrid, ...
- New observables:
 - Rapidity–azimuth correlations
 - γ -jet correlations, Z-jet correlations
 - ML-assisted jet tomography?

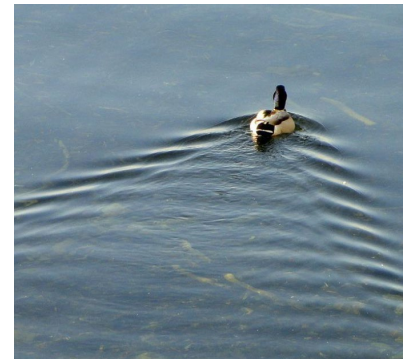


Casalderrey-Solana, Milhano, Pablos, Rajagopal, Yao
JHEP 05 (2021) 230



JETSCAPE framework Tachibana, Shen, Majumder
PRC 106 (2022), L021902





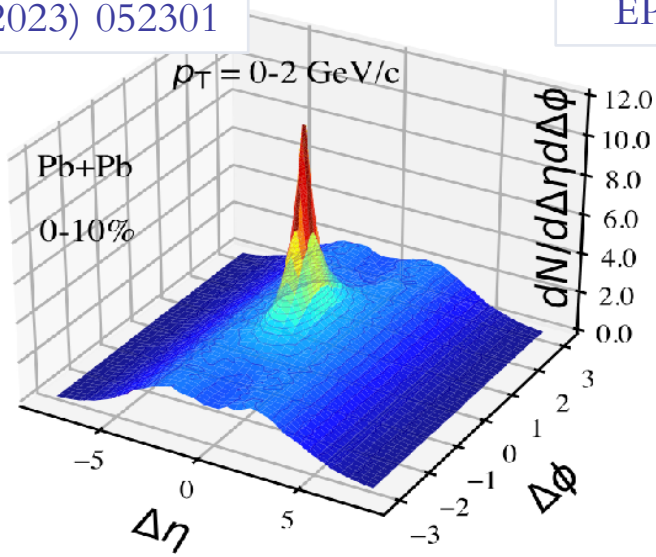
JET-MEDIUM VS MEDIUM-JET

- **Jet-medium:** medium-induced gluon radiation in the jet direction
- **Medium-jet:** medium response produces soft-hadron excess in the jet direction

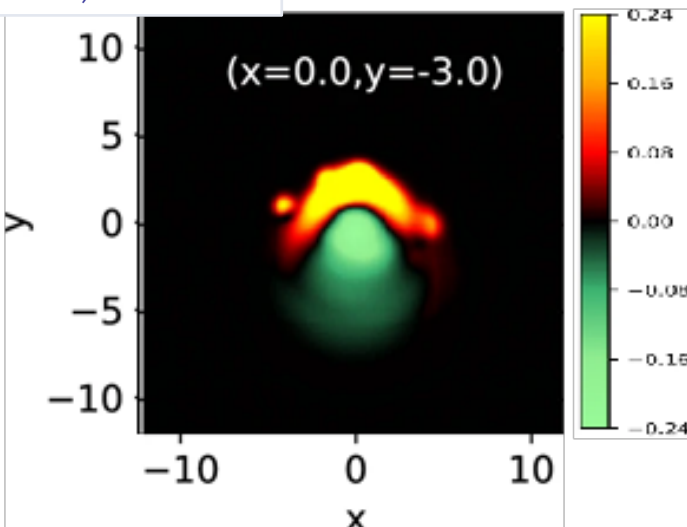
No unambiguous way to disengage the two!

- BUT: 2D jet tomography consistently indicates that diffusion wake trailing behind the jet is an unambiguous medium response signal → soft-hadron yield depletion

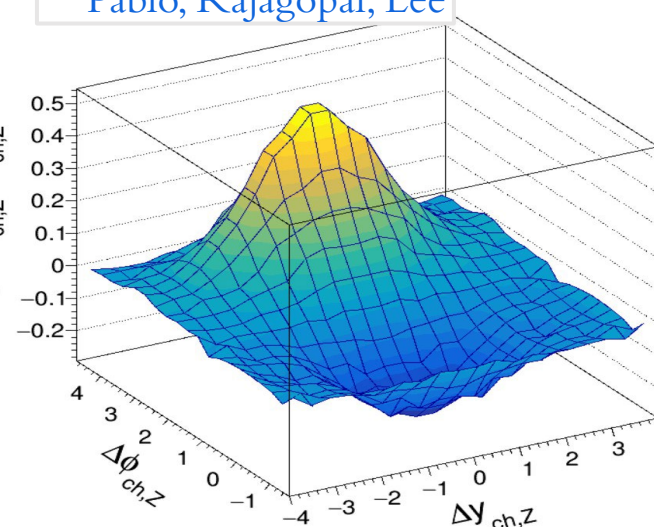
CoLBT, γ -jet
PRL 130(2023) 052301



CoLBT, γ -jet
EPJC (2023) 83:652

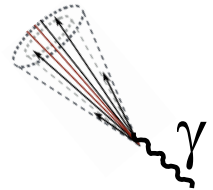
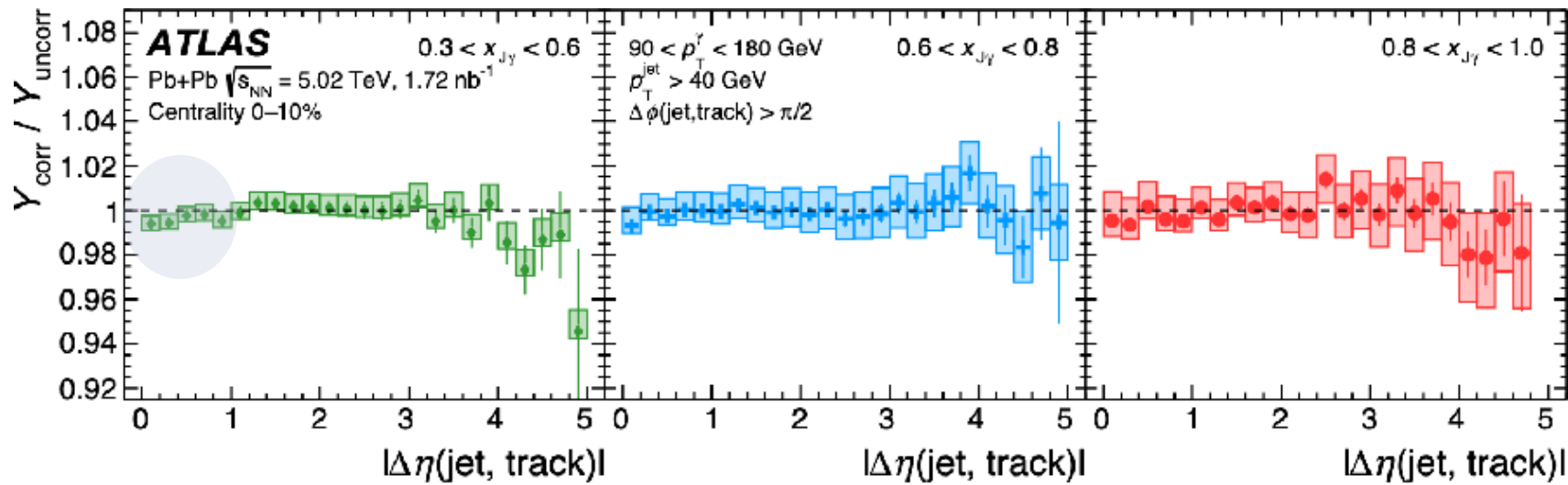


Hybrid Model, Z-jet
Pablo, Rajagopal, Lee



WAKE SEARCH WITH COLORLESS PROBES

- Idea: remove the jet-medium/medium-jet ambiguity by removing jet! (on one side)
- Correlations measured for γ -jet:



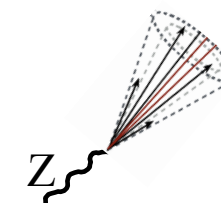
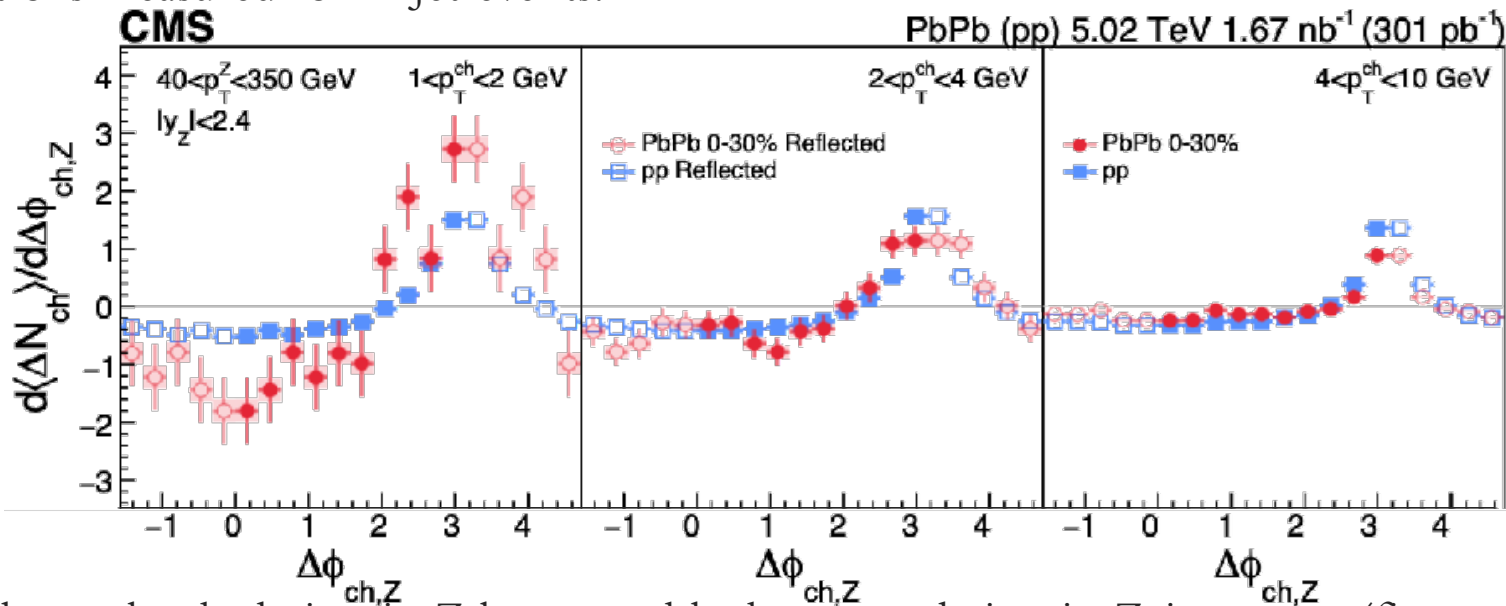
- ATLAS: data indicate no significant diffusion wake in jet and hadron correlation within the uncertainties in γ -jet events (but expected signals are small; **not** inconsistent with wake predictions).
- Large uncertainties due to analysis complexity (S/B) and low cross sections for γ -jet events

PRC 111
(2025) 044909



WAKE SEARCH WITH COLORLESS PROBES

- Idea: remove the ambiguity between jet modification and jet-induced medium response by removing jet! (on one side)
- Correlations measured for Z-jet events:



- CMS: shows the depletion in Z boson and hadron correlation in Z-jet events (first evidence in data with $> 3\sigma$ significance).
- Large statistical uncertainties (due to low cross sections of Z-jet events)

The first evidence of the negative QGP wake!

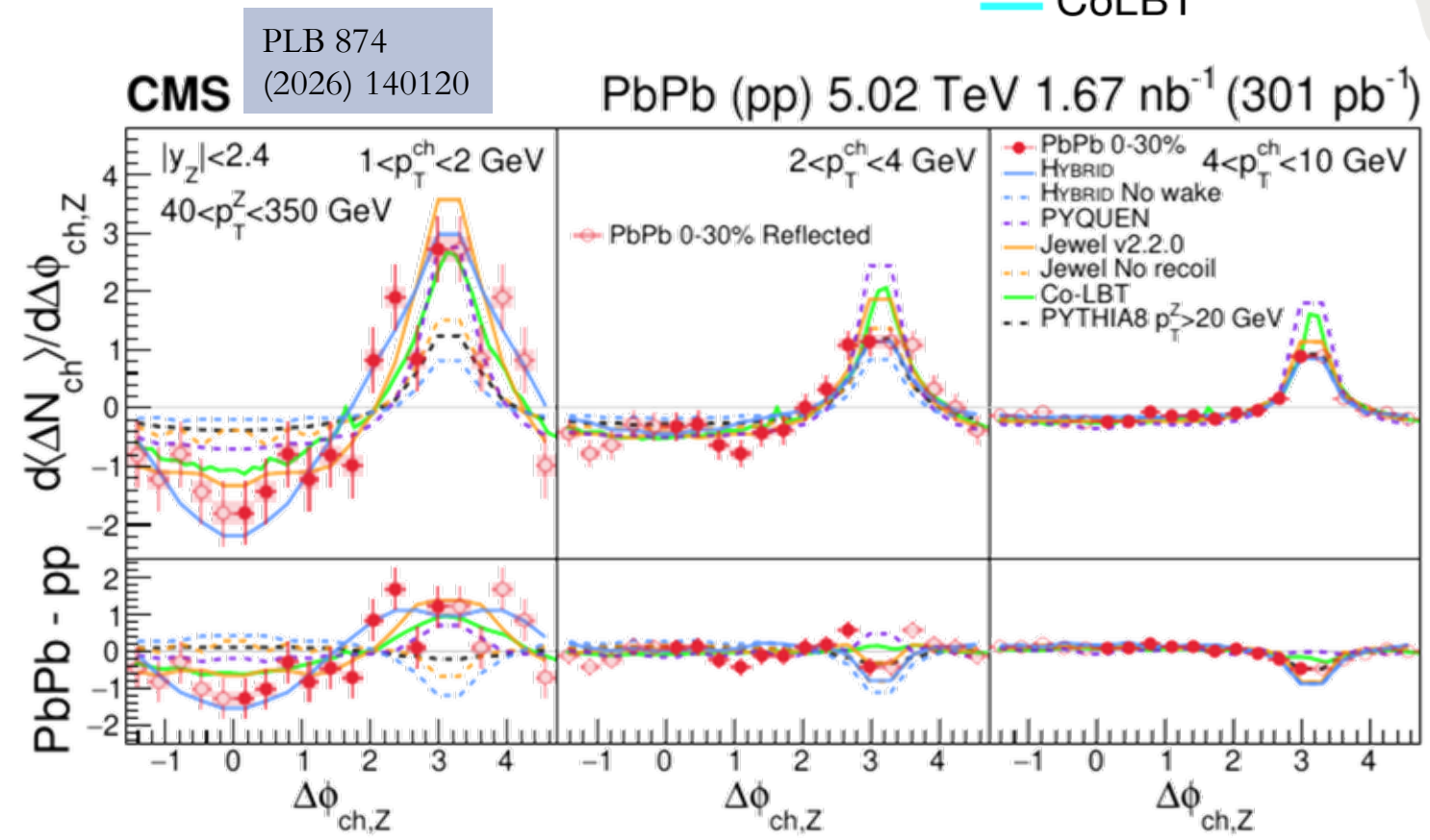
PLB 874
(2026) 140120



Z-JET: MODEL PREDICTIONS

- Hybrid
- - Hybrid No wake
- Jewel v2.2.0
- - Jewel No recoil
- CoLBT

- Hybrid no-wake and Jewel no-recoil (dashed) underpredict magnitude at low hadron p_T
- *Z*-tagged **PYTHIA8** does not describe the data for hadron $p_T < 4$ GeV
- Hybrid with wake, Jewel with recoil, and CoLBT (solid) show better agreement with data



*Sidenote (for later): CoLBT predicts a smaller wake dip than Hybrid

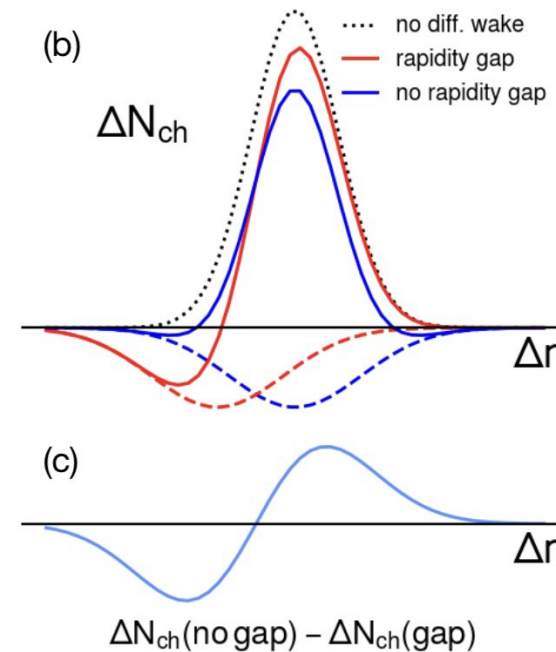
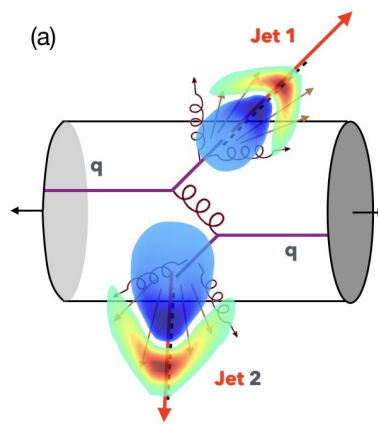
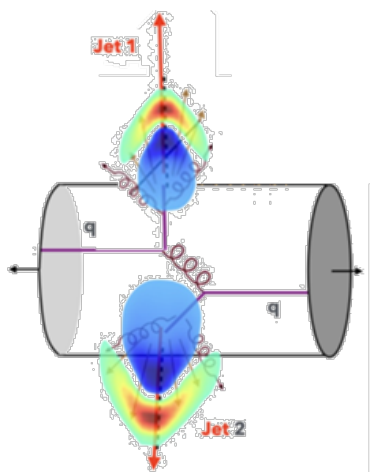


HOW ABOUT JET WAKE WITH (DI)JETS?

- Recent theory advances paved the way for wake discovery in dijet events:

PRL 135 (2025) 7, 072302 by Zhong Yang and Xin-Nian Wang

- The idea is simple and elegant:
 - Back-to-back jets dilute/mask the diffusion wake signal
 - If we separate two back-to-back jets in pseudorapidity space, we can measure the diffusion wake signal



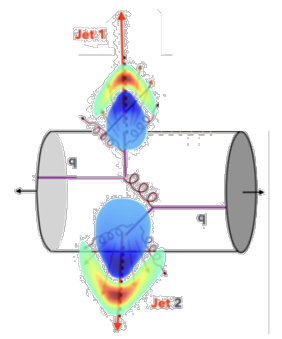
Diffusion wake effect from one jet (side) to another jet (side) in the jet-hadron correlations
 (b) Red (blue): dijets with (without) rapidity gap
 (c) The rapidity asymmetry of red-blue



[nucl-ex]
2602.19431

SEARCH FOR JET WAKE WITH DIJETS

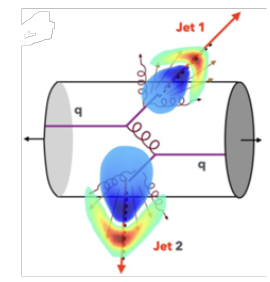
- Jet-triggered 5.02 TeV datasets of pp and PbPb collisions
- Anti- k_T $R=0.4$ jets
- Well-established 2D jet-track correlations technique:



“Symmetric”
No gap
 $|\Delta\eta^{j1,j2}| < 0.5$

$$\frac{1}{N_{\text{dijet}}} \frac{d^2 N_{\text{corr}}}{d\Delta\eta d\Delta\phi} = \frac{1}{N_{\text{dijet}}} \frac{d^2 N_{\text{sig}}}{d\Delta\eta d\Delta\phi} \left[\frac{\text{ME}(\Delta\eta = 0, \Delta\phi = 0)}{\frac{1}{N_{\text{dijet}}} \frac{d^2 N_{\text{mix}}}{d\Delta\eta d\Delta\phi}} \right]$$

Leading jets: $p_T > 130$ GeV, $|\eta| < 1.0$
Subleading jets $p_T > 50$ GeV, $|\eta| < 2.0$



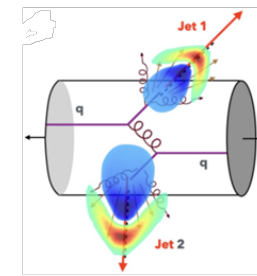
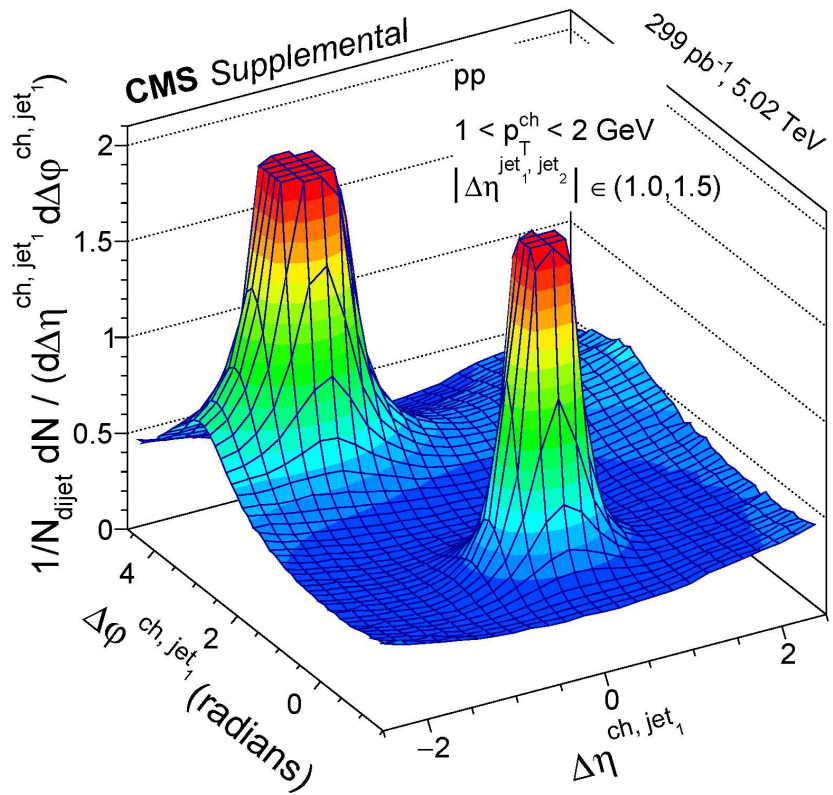
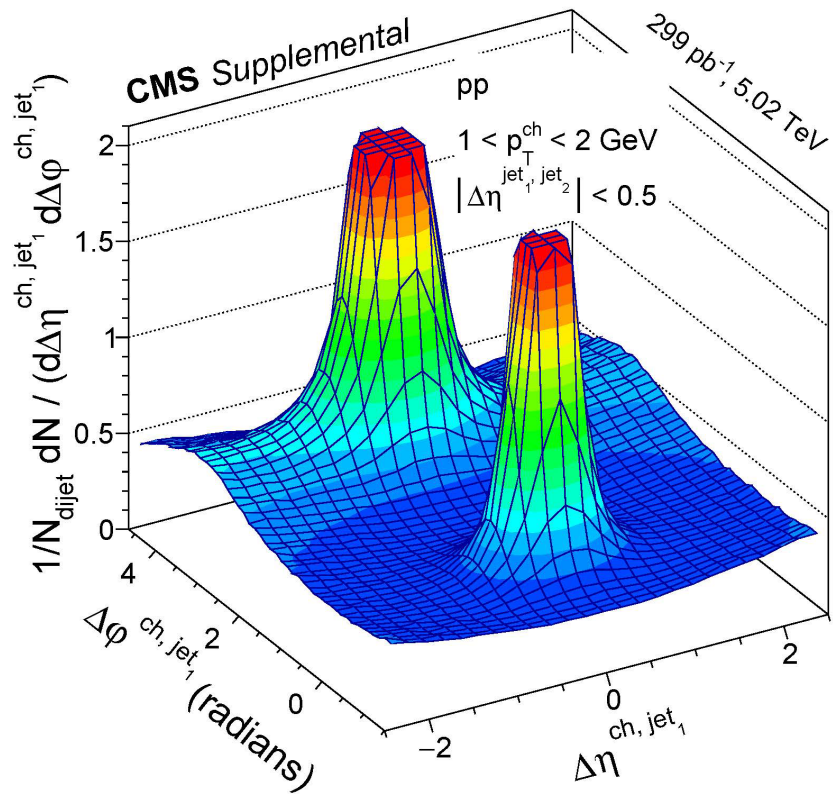
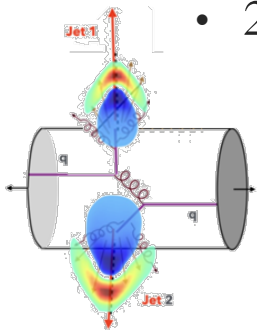
“Asymmetric”
Variable gap
 $|\Delta\eta^{j1,j2}| \in (0.5-1.0), (1.0-1.5) (1.5-2.0)$



SEARCH FOR JET WAKE WITH DIJETS

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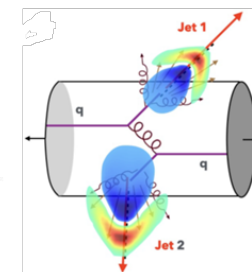
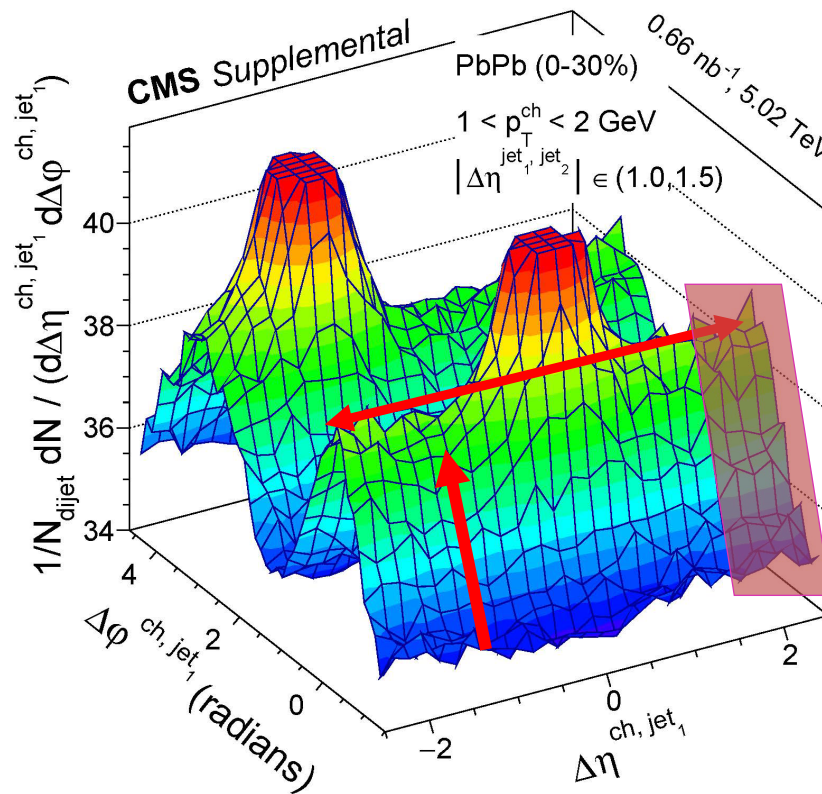
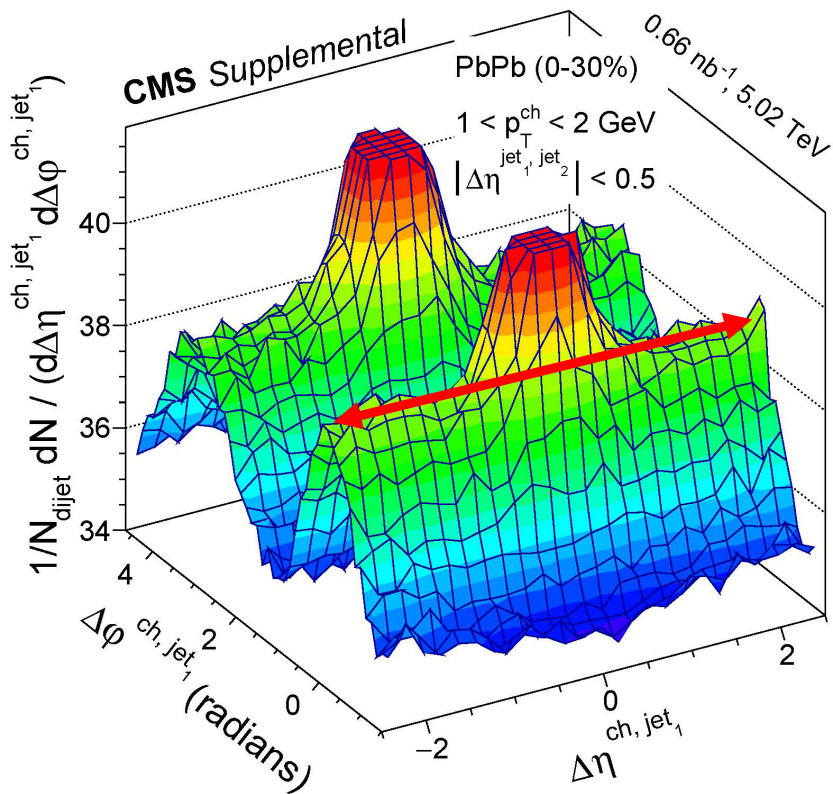
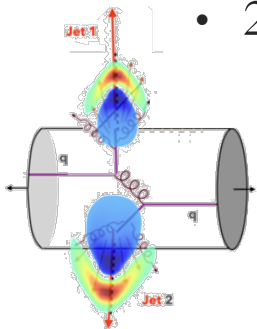
- 2D correlations measured: 5.02 TeV pp



SEARCH FOR JET WAKE WITH DIJETS

[nucl-ex]
2602.19431

- 2D correlations measured: 5.02 TeV PbPb



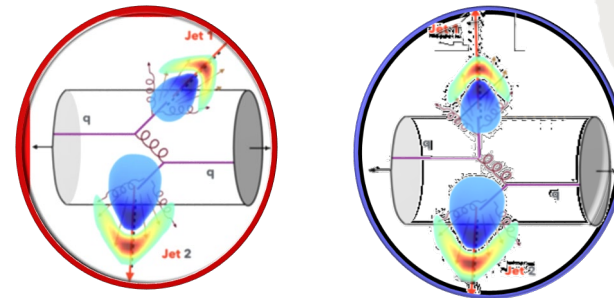
The underlying event is subtracted using the long-range correlations from 1.5 < Δη < 2.5

SEARCH FOR JET WAKE WITH DIJETS

[nucl-ex]
2602.19431

Emergence of the wake signal:

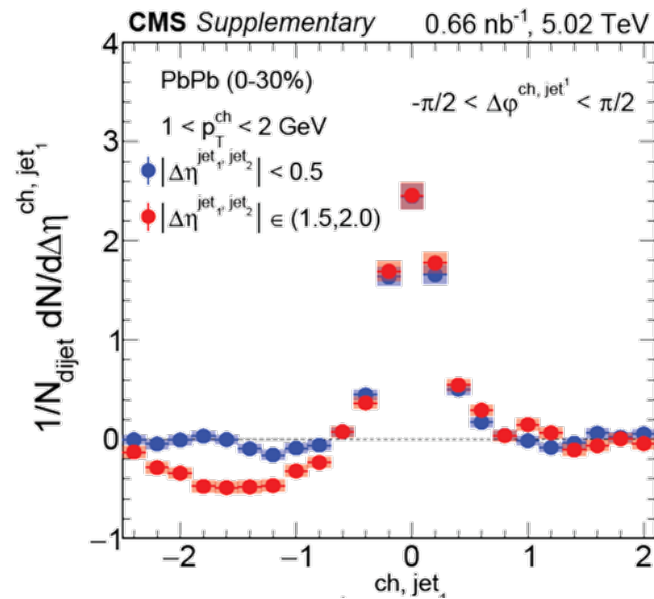
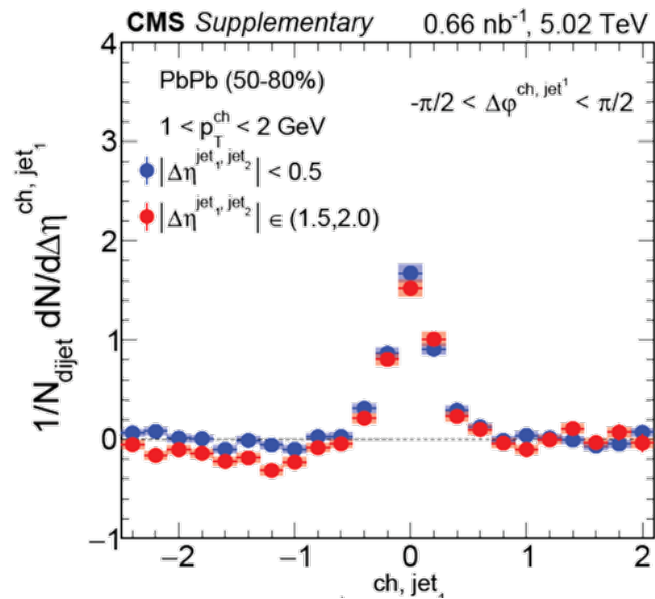
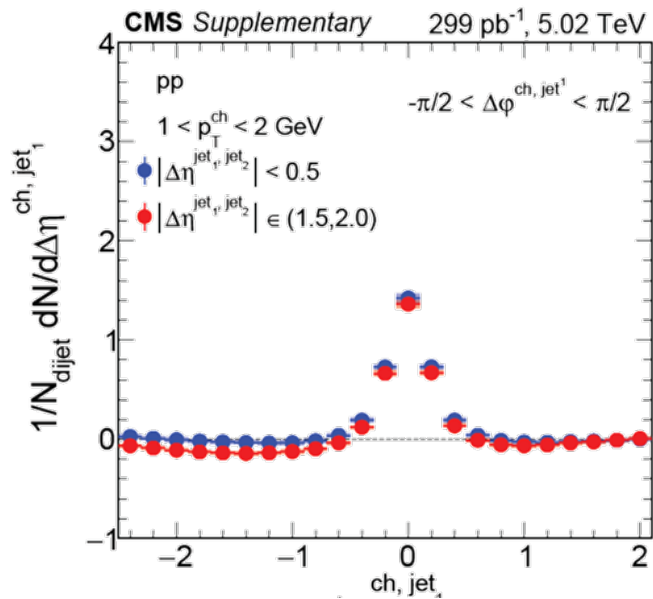
- Near-side projections: centrality evolution



pp

peripheral PbPb

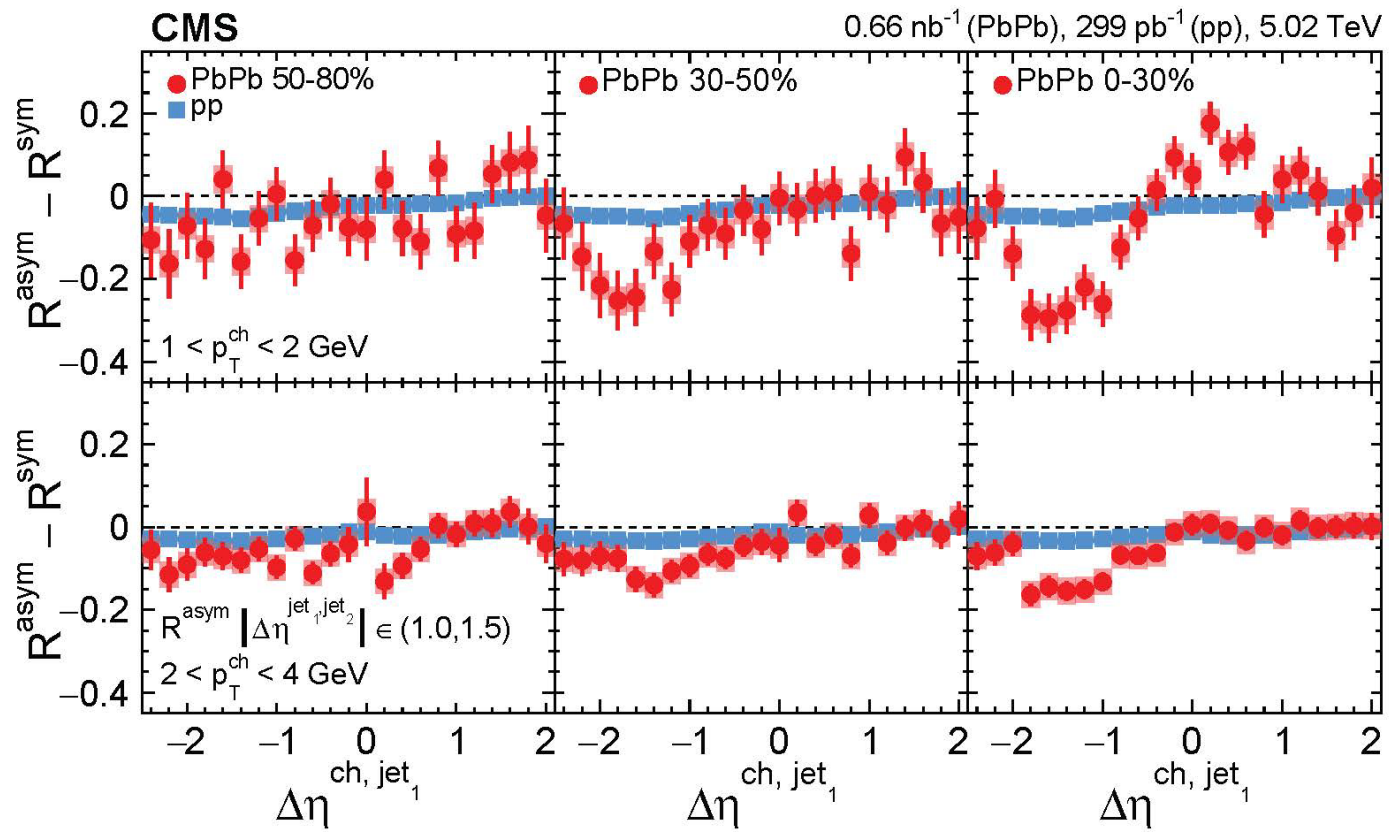
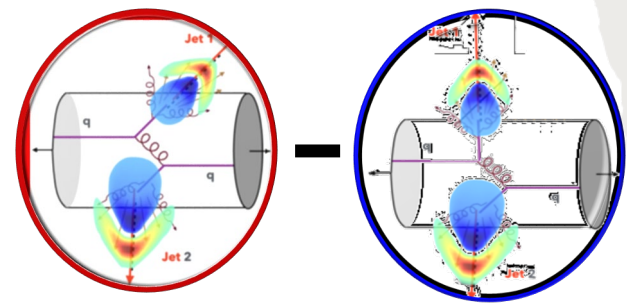
central PbPb



[nucl-ex]
2602.19431

SEARCH FOR JET WAKE WITH DIJETS

- Characterizing the wake “strength” at different hadron p_T :



$1.0 < p_T^{ch} < 2.0 \text{ GeV}$

$2.0 < p_T^{ch} < 4.0 \text{ GeV}$

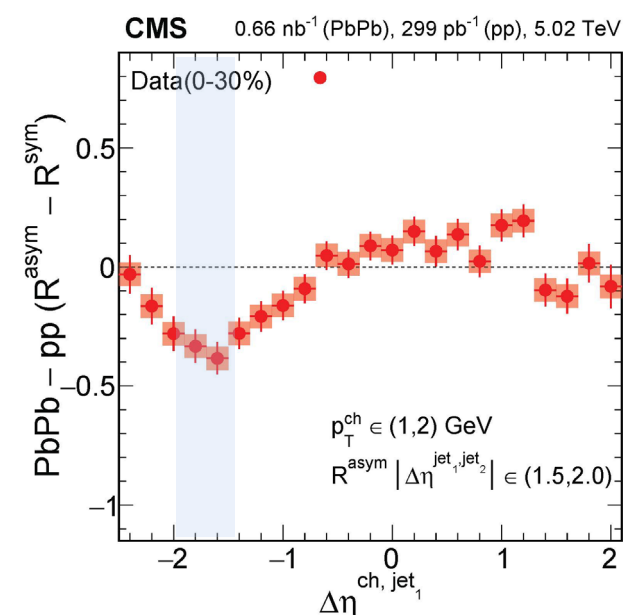
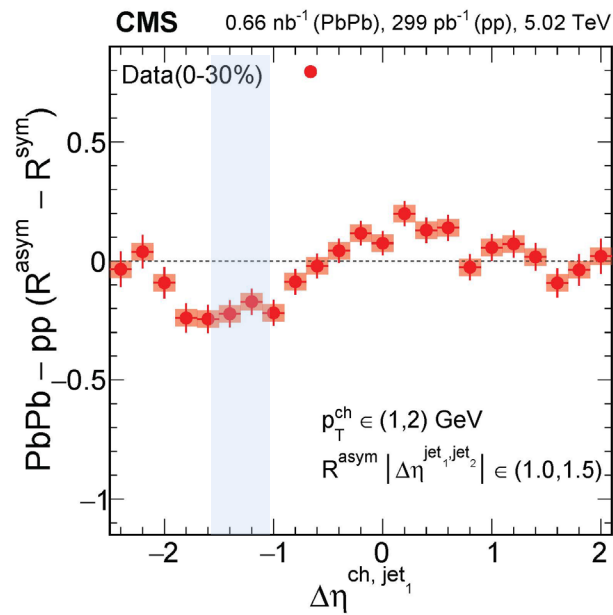
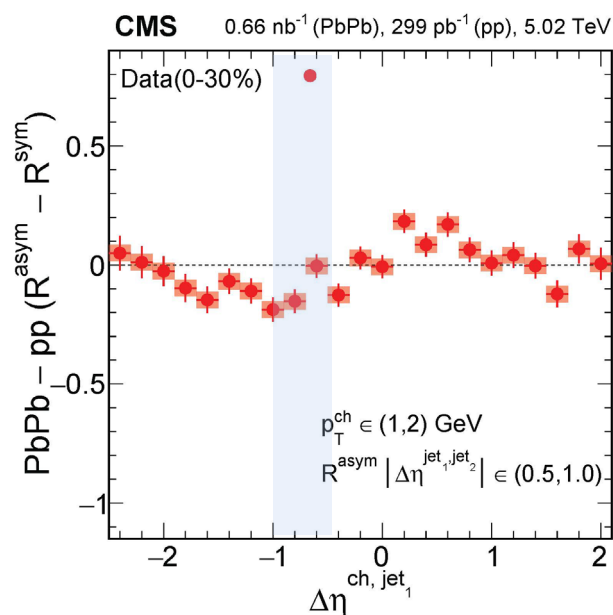
- Clear depletion in the central 0-30% PbPb collisions wrt. to pp
- Depletion strength decreases with increasing centrality and hadron p_T



SEARCH FOR JET WAKE WITH DIJETS

[nucl-ex]
2602.19431

- Rapidity gap scan – does the depletion follow dijet separation?



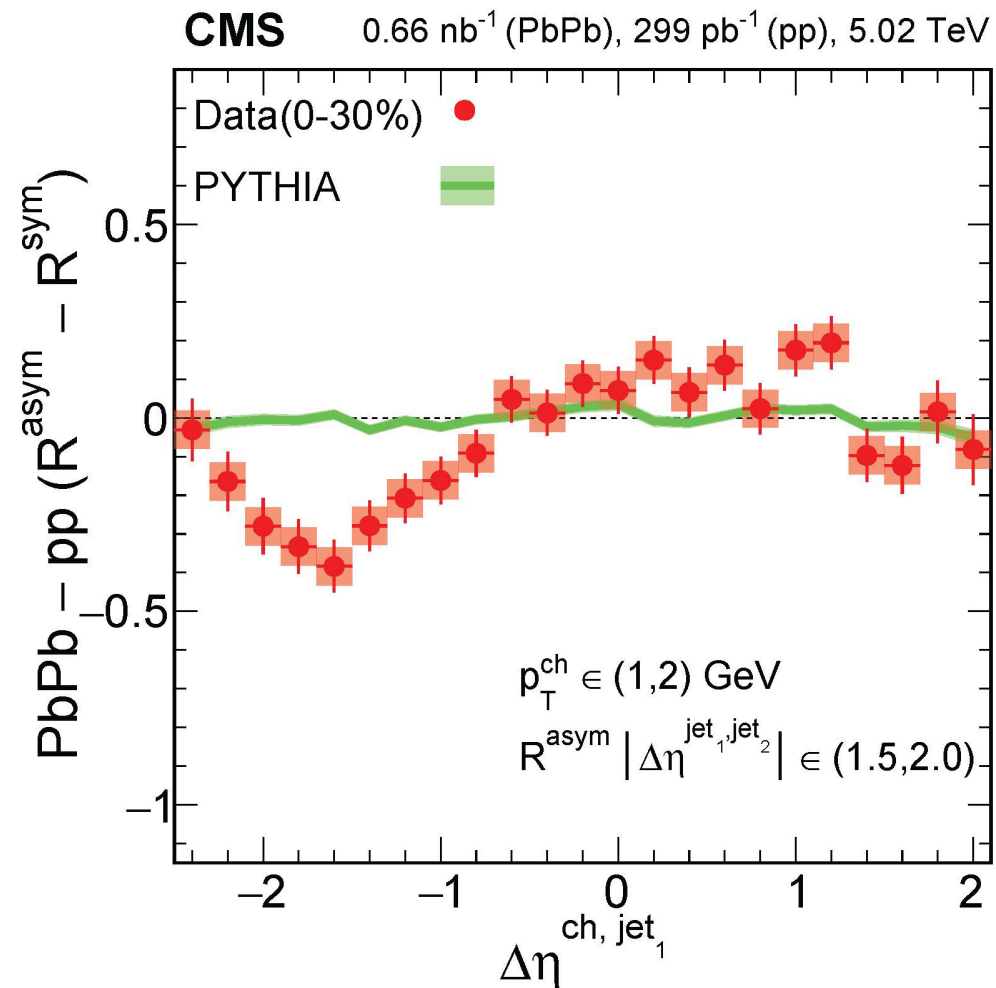
- It does! The signal becomes stronger for larger gaps, hinting at some interference effects between the near-side positive wake/shower evolution and the away-side jet negative wake



SEARCH FOR JET WAKE WITH DIJETS

[nucl-ex]
2602.19431

- Finally, isolating the signal: PbPb-pp
- Model comparisons:
 - PYTHIA (PYTHIA+HYDJET):
Flatlines to a zero-signal baseline, as expected
The signal in the data is very robust with little sensitivity to JES and JER uncertainties

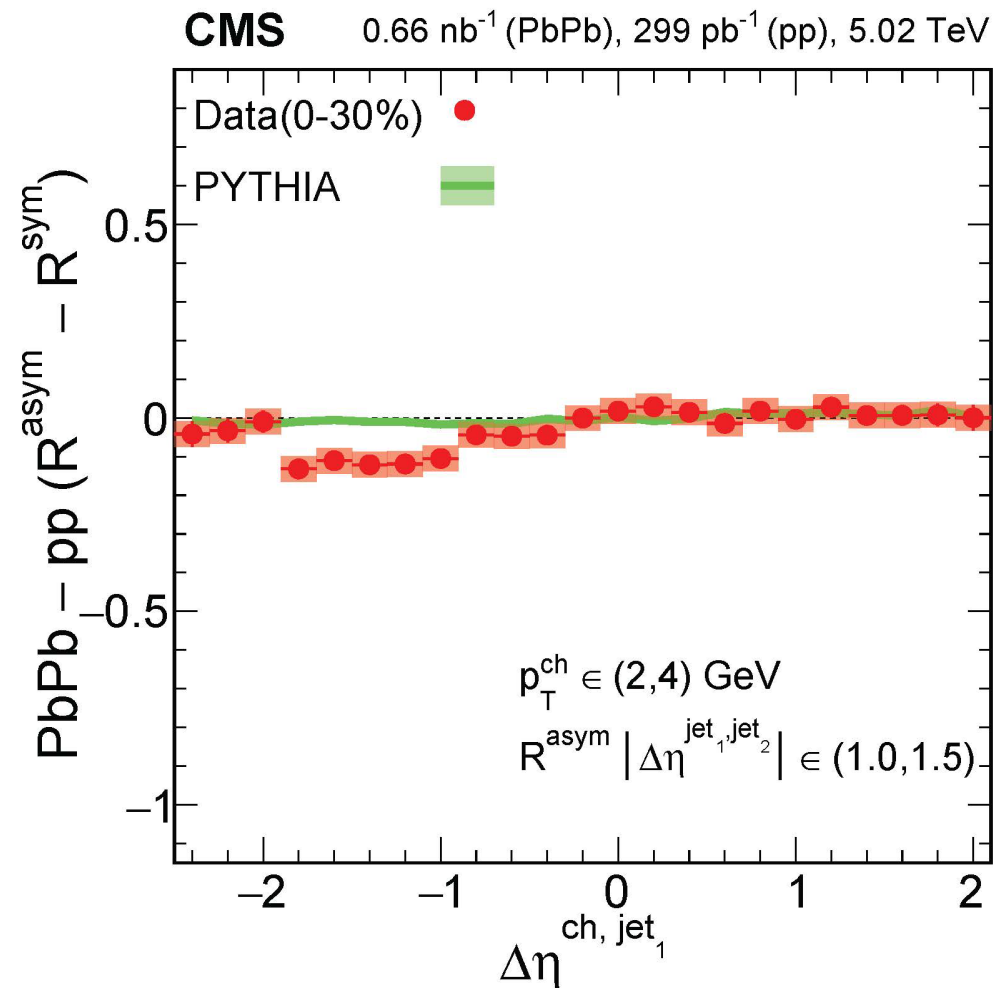


SEARCH FOR JET WAKE WITH DIJETS

[nucl-ex]
2602.19431

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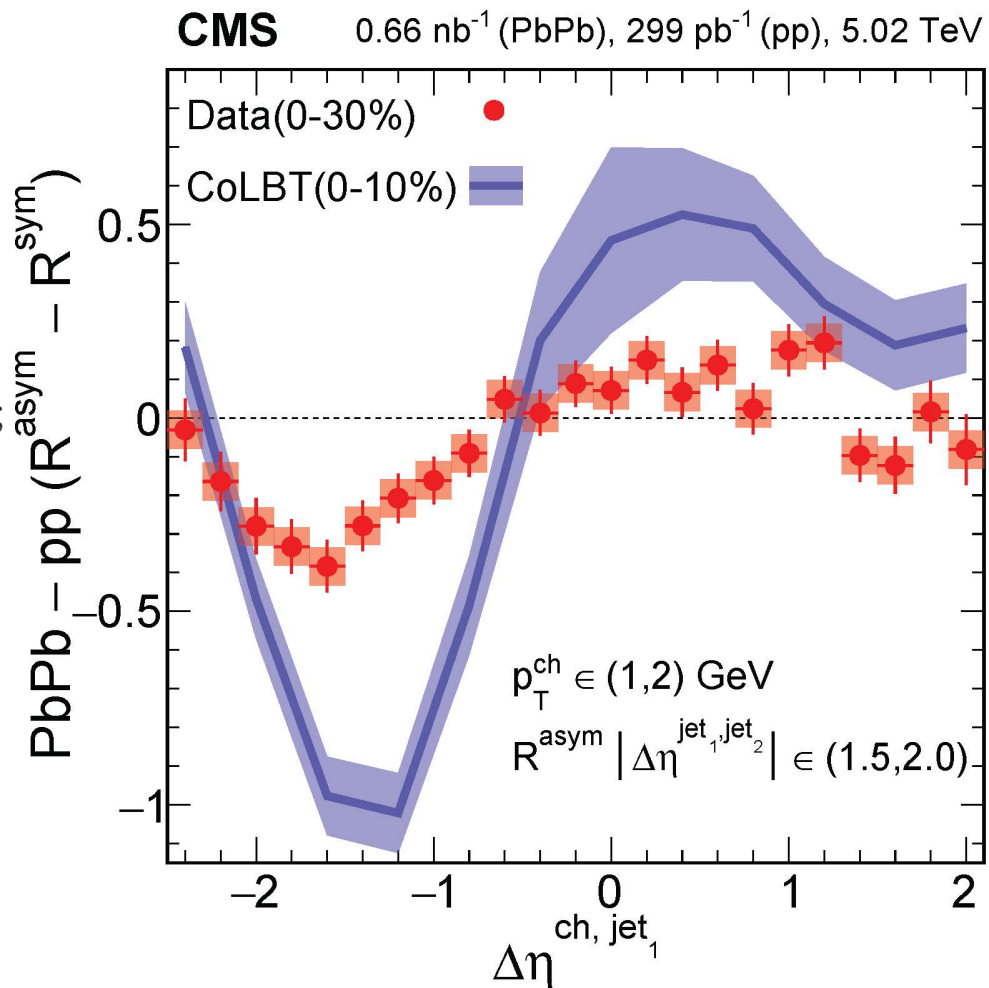
Same trend for higher hadron p_T selection



SEARCH FOR JET WAKE WITH DIJETS

[nucl-ex]
2602.19431

- Finally, isolating the signal: PbPb-pp
- Model comparisons:
- CoLBT:
 - Shows observed negative/positive wake structures;
 - Overpredicts the magnitudes (?)
 - (not fully “apples-to-apples,” *prediction for 0-10%* centrality; strong centrality dependence is seen in the data)



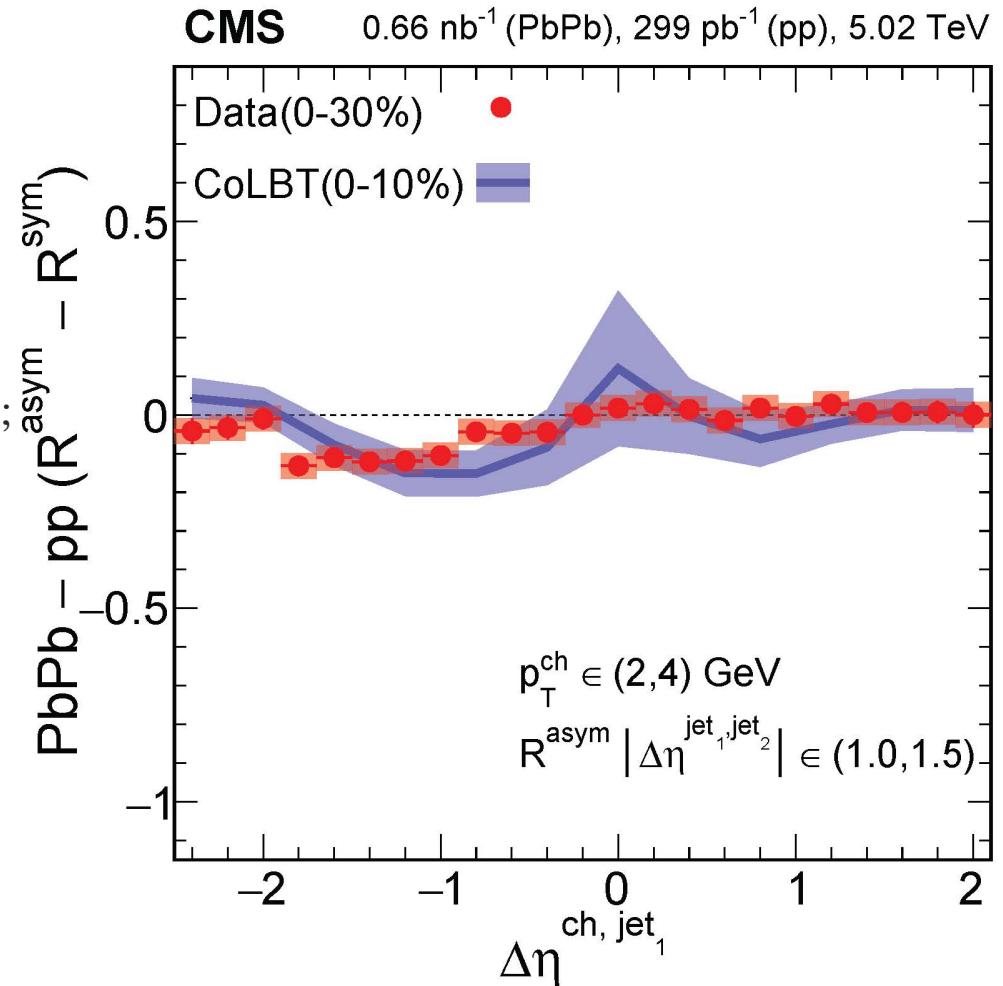
SEARCH FOR JET WAKE WITH DIJETS

[nucl-ex]
2602.19431

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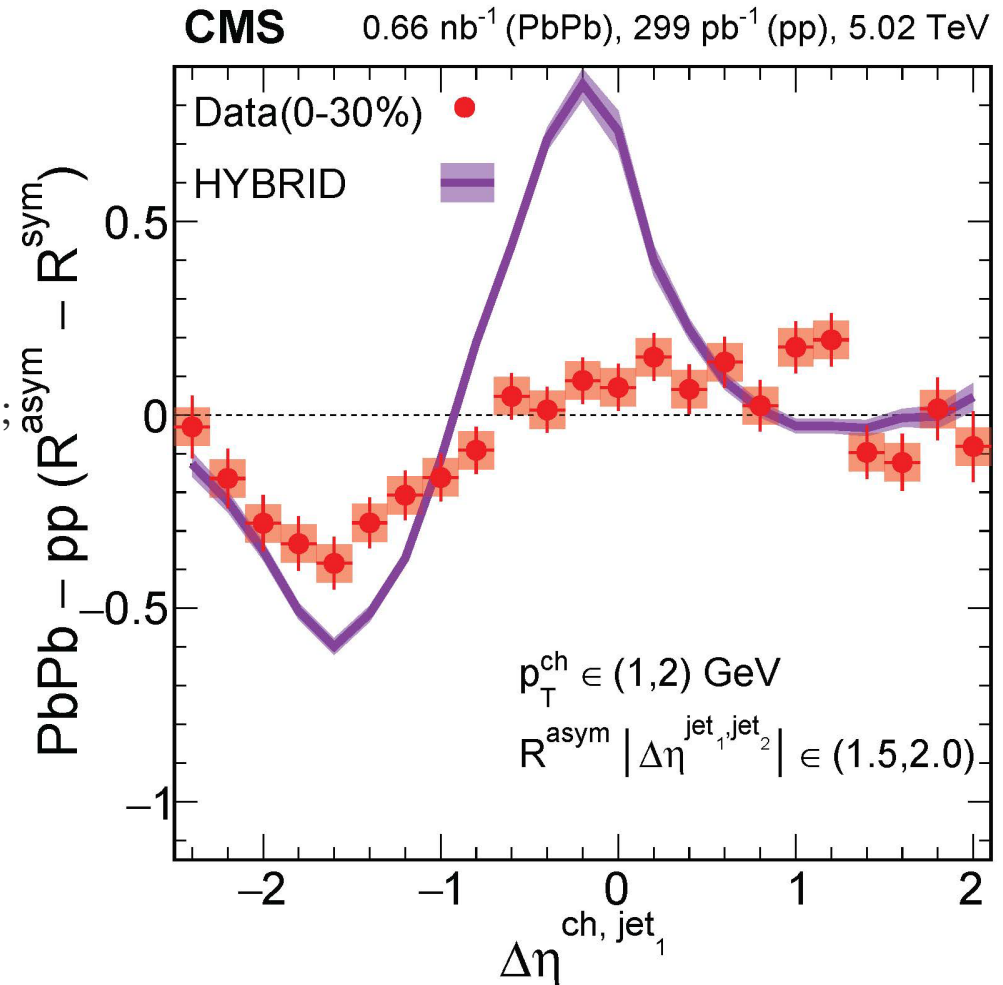
On-the-data for higher hadron p_T selection



SEARCH FOR JET WAKE WITH DIJETS

[nucl-ex]
2602.19431

- Finally, isolating the signal: PbPb-pp
- Model comparisons:
 - Hybrid:
 - Shows observed negative/positive wake structures;
 - Closer to the data for the negative wake
 - Overshoots (by a lot) the positive excess

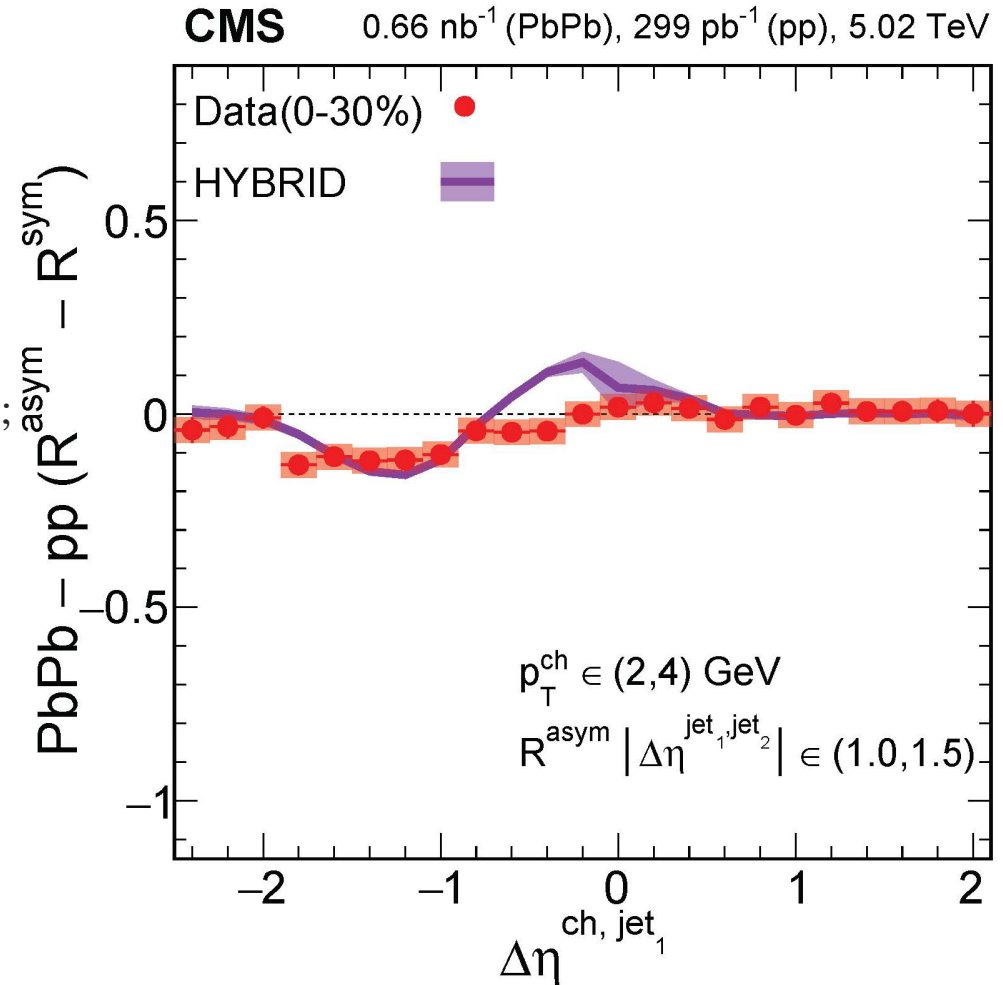


SEARCH FOR JET WAKE WITH DIJETS

[nucl-ex]
2602.19431

- Finally, isolating the signal: PbPb-pp
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- Hybrid:
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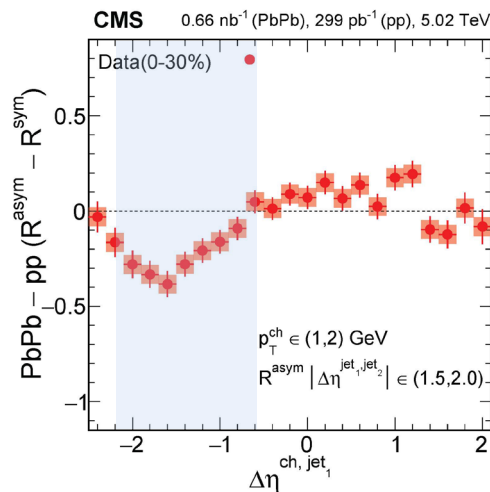
On-the-data for higher hadron p_T selection for wake



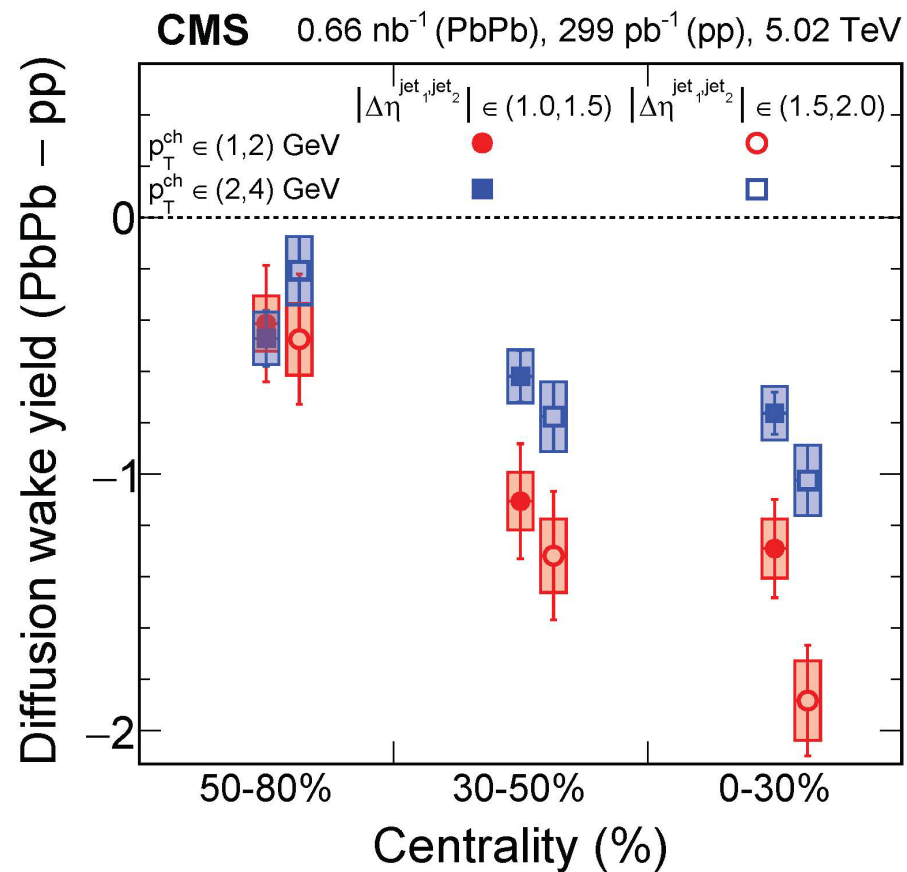
[nucl-ex]
2602.19431

OBSERVATION OF WAKE WITH DIJETS

- Diffusion wake (negative) “yield”:
Integrated over the region $-2.2 < \Delta\eta < -0.6$



- Diffusion wake yield is stronger for
 - More central events
 - Lower hadron p_T
 - Larger rapidity gap

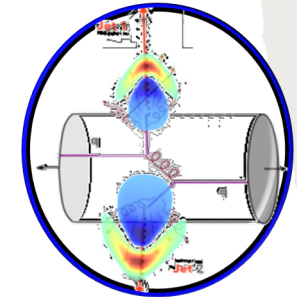
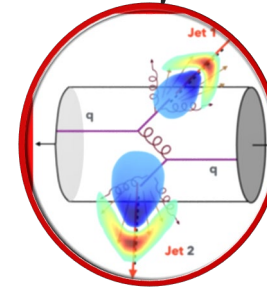


- Over 5σ separation between central PbPb and pp baseline!
- First unambiguous observation of diffusion wake with dijets



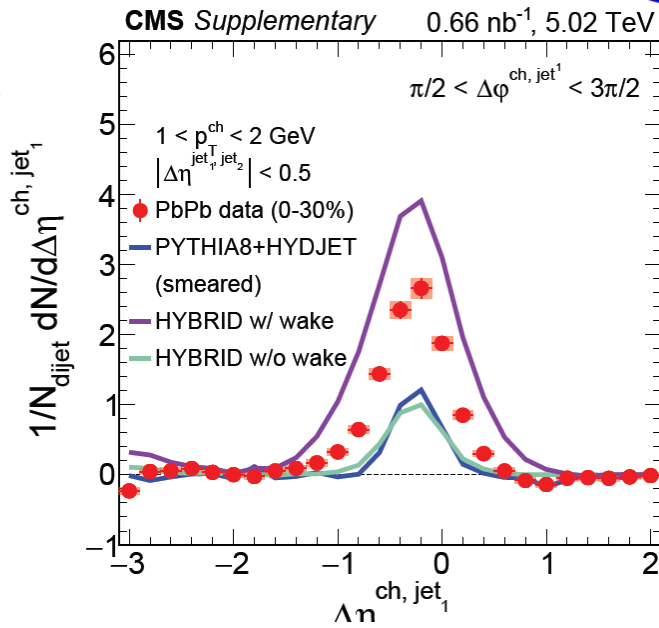
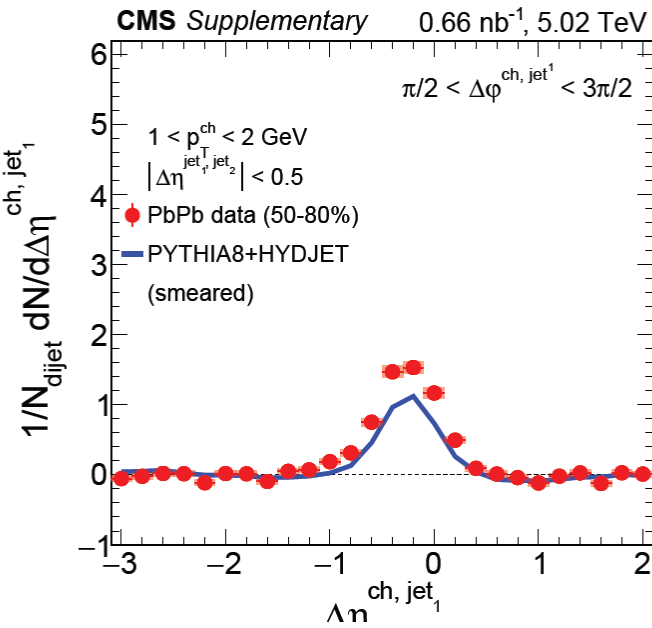
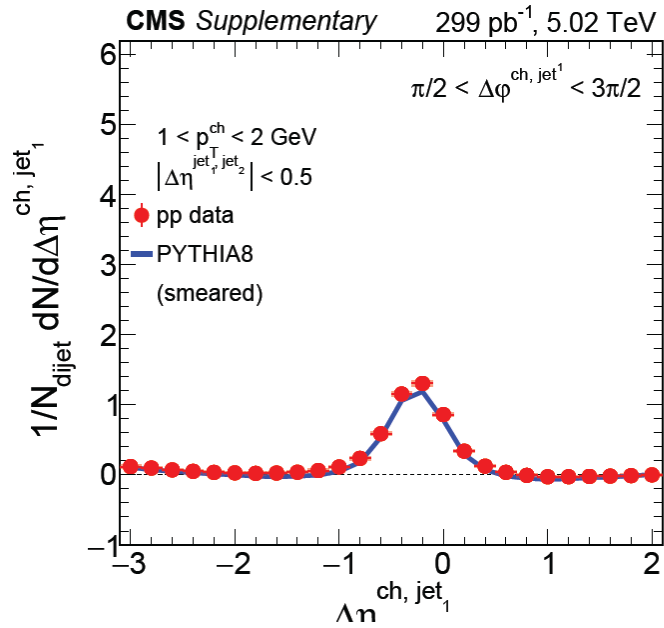
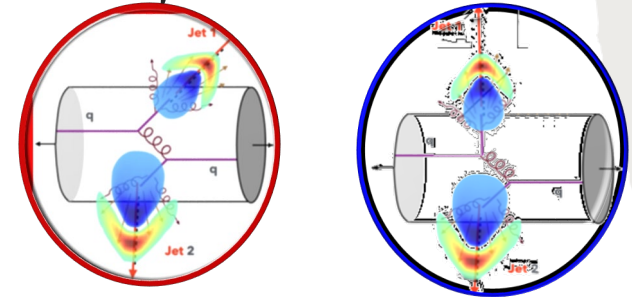
OBSERVATION OF WAKE WITH DIJETS

- Bonus feature: what about the wake from the *leading jet*??



OBSERVATION OF WAKE WITH DIJETS

- Bonus feature: what about the wake from the *leading jet*??
- Away-side projections of the same “*symmetric*” correlations

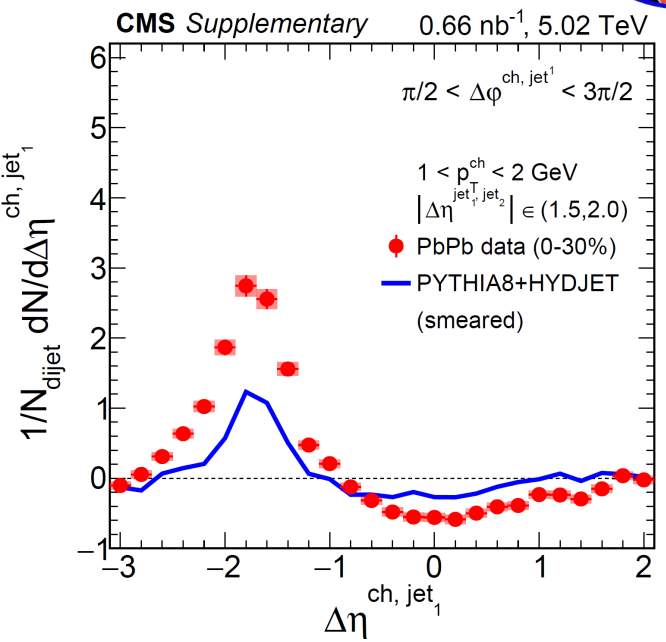
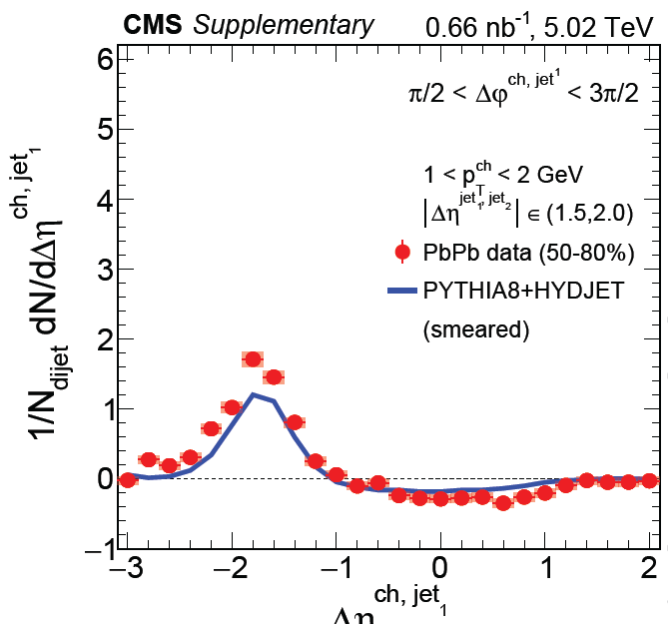
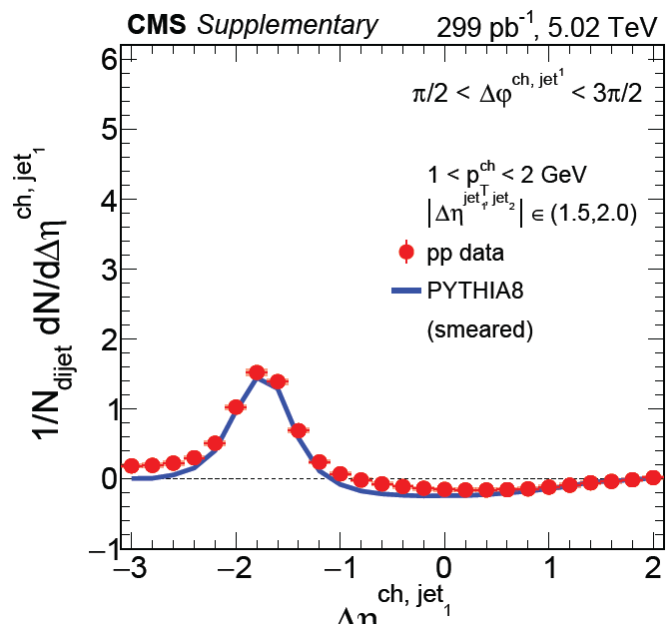
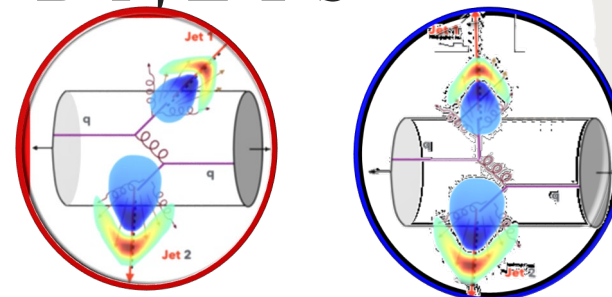


No depletion signal on the away-side for the leading jets of **non-separated dijets**, as expected



OBSERVATION OF WAKE WITH DIJETS

- Bonus feature: what about the wake from the *leading jet*??
- Away-side projections of the same “*asymmetric*” correlations!

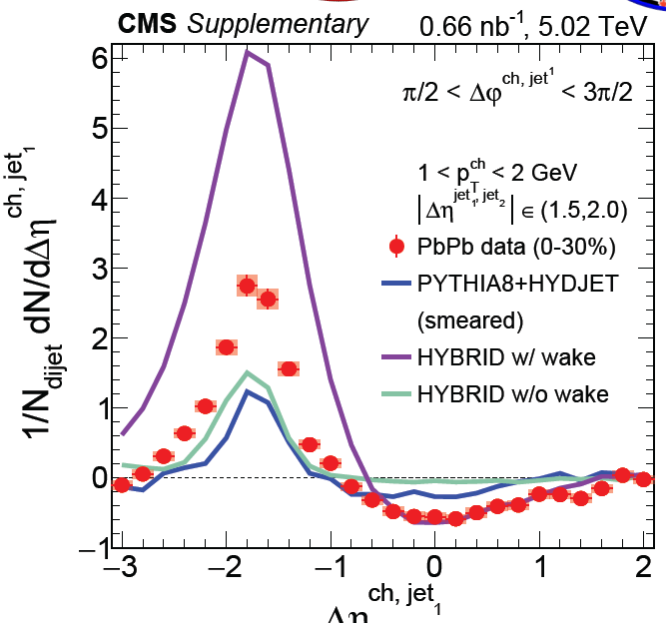
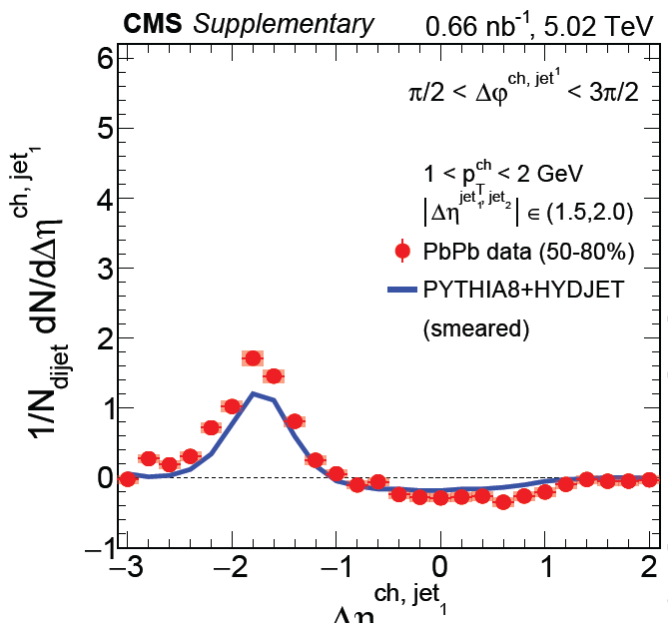
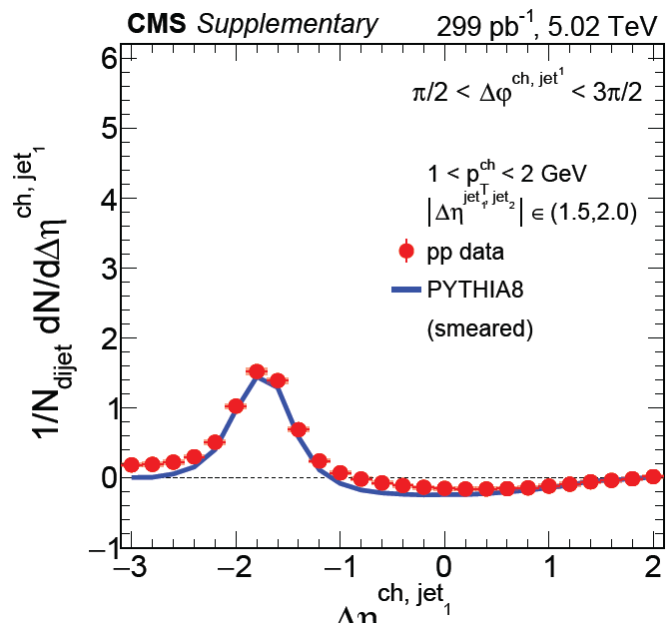
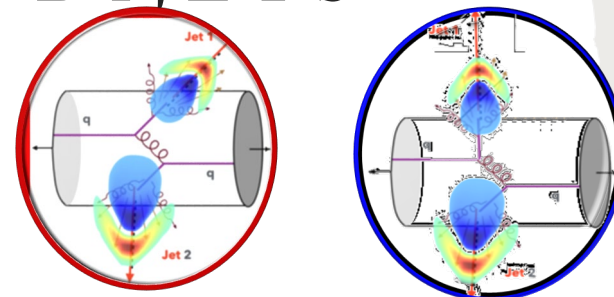


Depletion signal on the away-side for the leading jets from *rapidity-separated dijets*!



OBSERVATION OF WAKE WITH DIJET

- Bonus feature: what about the wake from the *leading jet*??
- Away-side projections of the same “*asymmetric*” correlations!

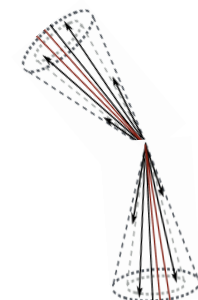
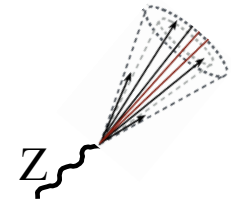
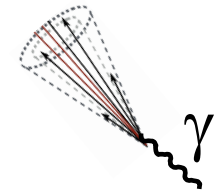


Hybrid: no-wake – similar to Pythia; with wake - on the data in the wake region
CoLBT: No calculations available; we’re looking forward to future comparisons



SUMMARY AND OUTLOOK

- Jet quenching has many manifestations: energy balance shift in two-prong probes, energy redistribution in jet shapes, fragmentation functions, modification of jet splitting functions, etc.
- Full understanding of medium properties and dynamics is impossible without studying jet-induced medium response.
- A unique 3D structure of diffusion wake is predicted by the theory advances on medium response/jet tomography
- CMS reports the first unambiguous observation of diffusion wake in dijet events from 5.02 TeV PbPb collisions
- Only theoretical models w/ jet energy loss and medium response show trends similar to data – looking forward to detailed studies/comparisons



Special thanks to Xin-Nian Wang, Zhong Yang, and Yen-Jie Lee for inspiration and theory calculations from our research team!



THANK YOU!

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