

Dilepton anisotropic flow from hadronic transport

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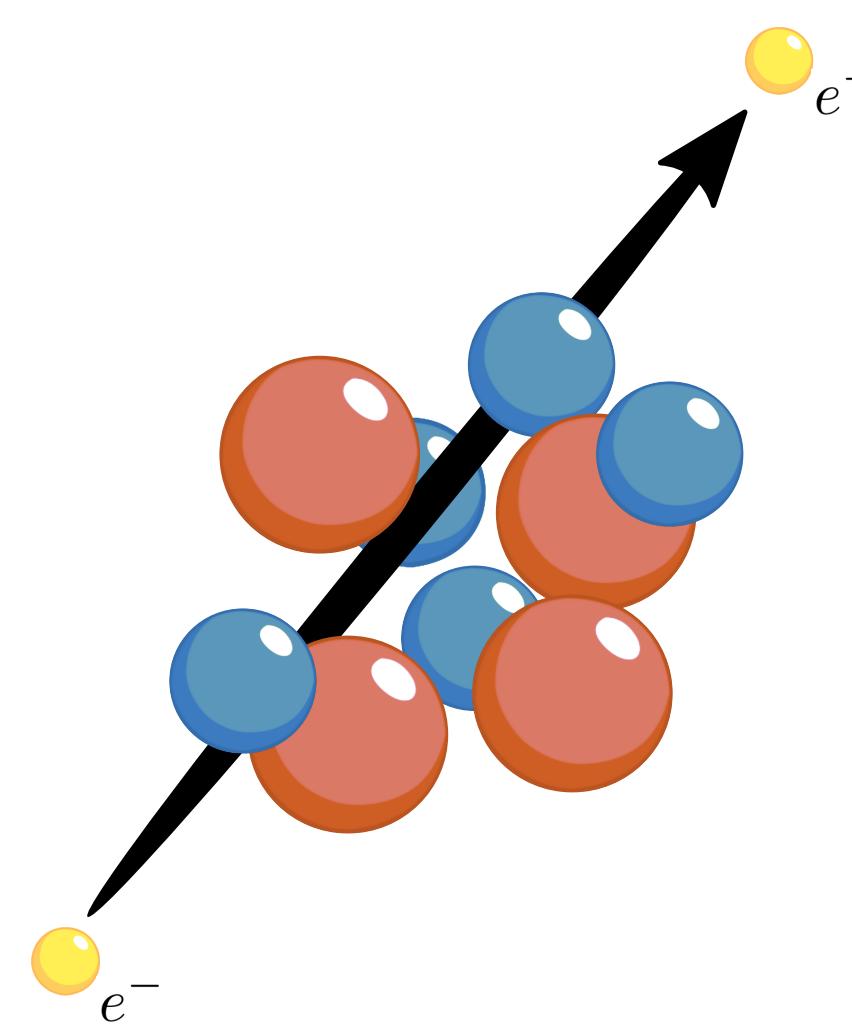
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Dileptons

- Lepton-antilepton pair from the same origin
- No interaction via strong force, therefore:
 - Leave the hadronic medium undisturbed
 - Multi-messenger for the whole evolution
 - Very rare: $\text{BR}(h \rightarrow l^+l^-) \sim 10^{-5}$
- Combinatorial background



SMASH

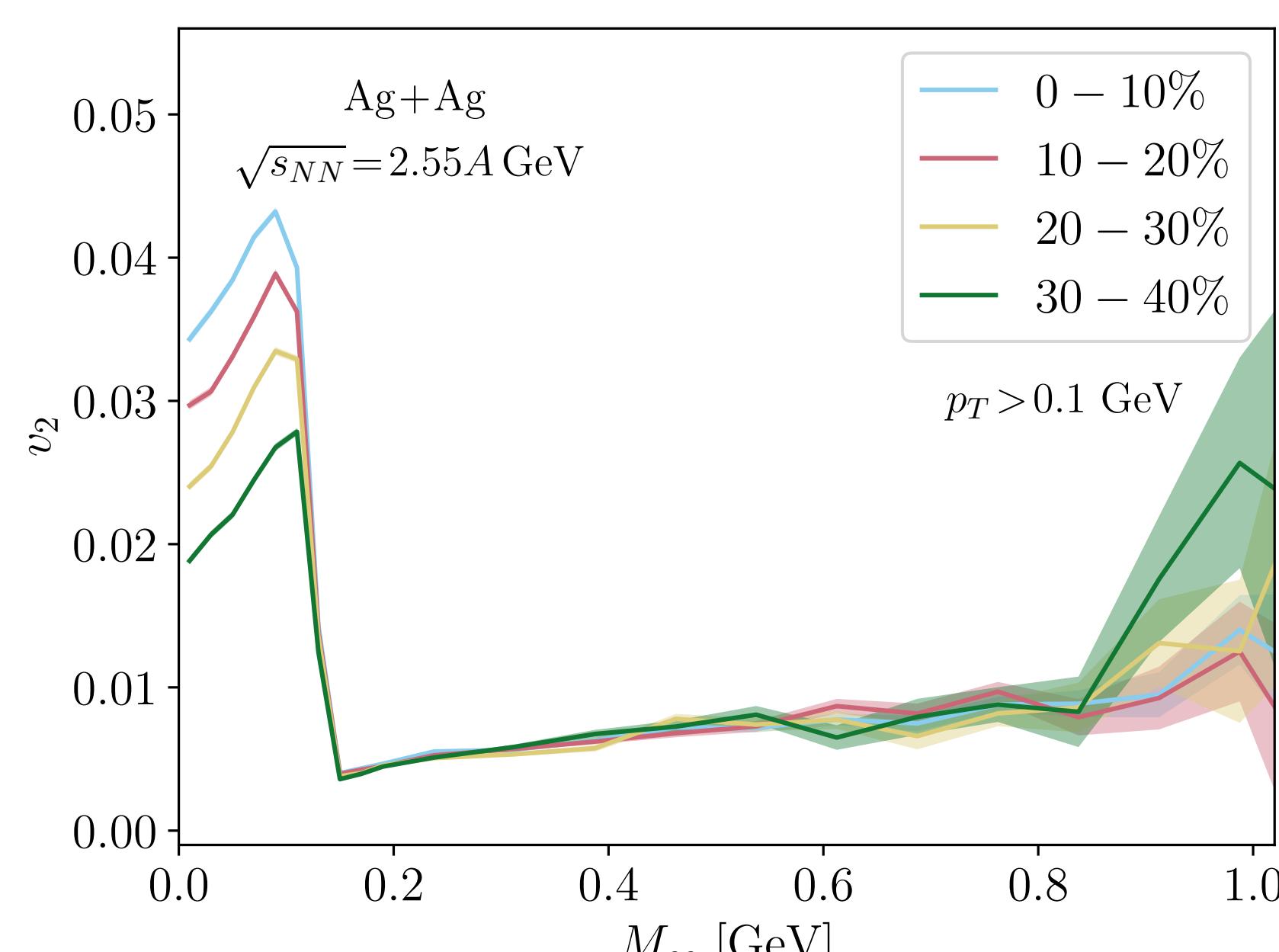
Simulating Many Strongly-interacting Hadrons

- Dileptons are rare \Rightarrow Perturbative emission [1]

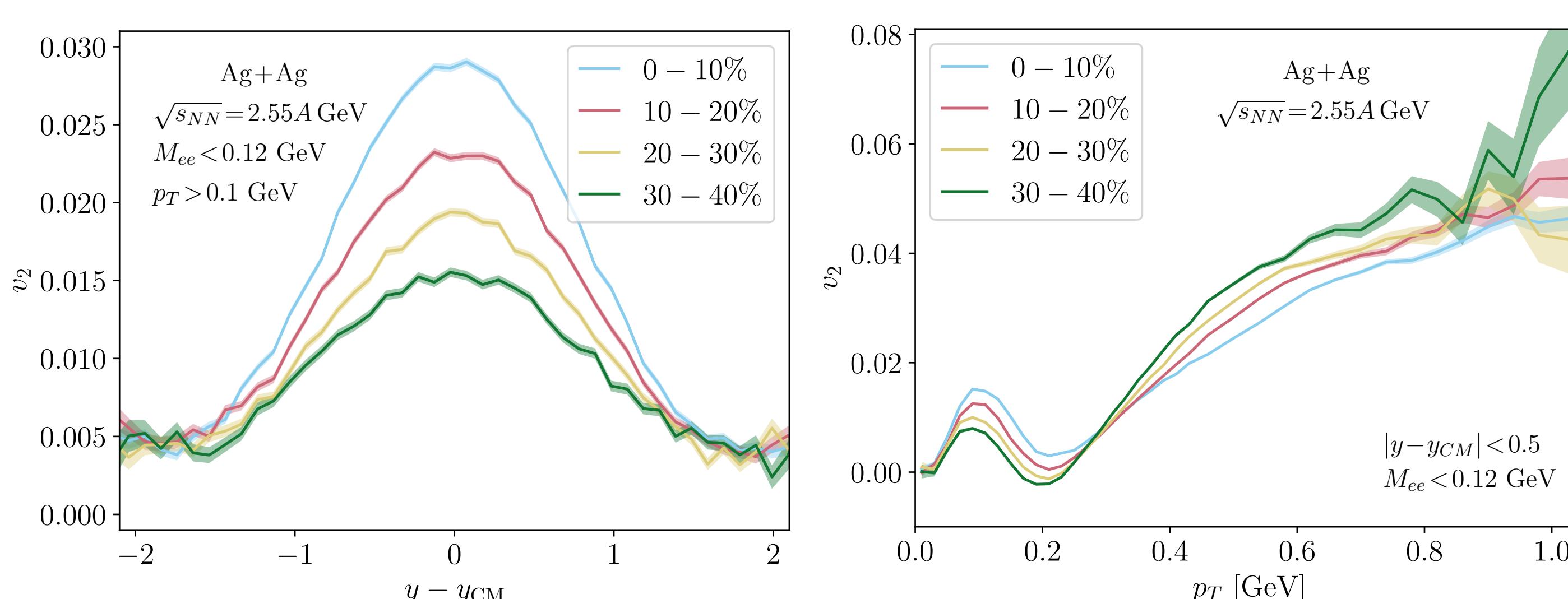
$$N_{R \rightarrow l^+l^-}(\tau) = \int_{t_i}^{\tau-t_i} \frac{dt}{\gamma} \Gamma_{R \rightarrow l^+l^-}$$

- At every timestep, R emits a dilepton with the corresponding *shining weight*
- Caveat: collisional broadening does not account for full medium effect in resonance region [2]

Initial results



- Significant flow below the pion mass, from Dalitz decays $\pi^0 \rightarrow \gamma e^+ e^-$
- Little to no flow in resonance region
- Overall consistency to HADES preliminary results and reaction plane
- Reverse centrality dependence from expected



- Proportional to dilepton yield at midrapidity
- No pions beyond $|y - y_{CM}| \sim 2$ (HADES preliminary)
- Peak structure at low p_T
- Centrality dependence flips at $p_T \sim 0.3$ GeV
- No impact by cut in midrapidity

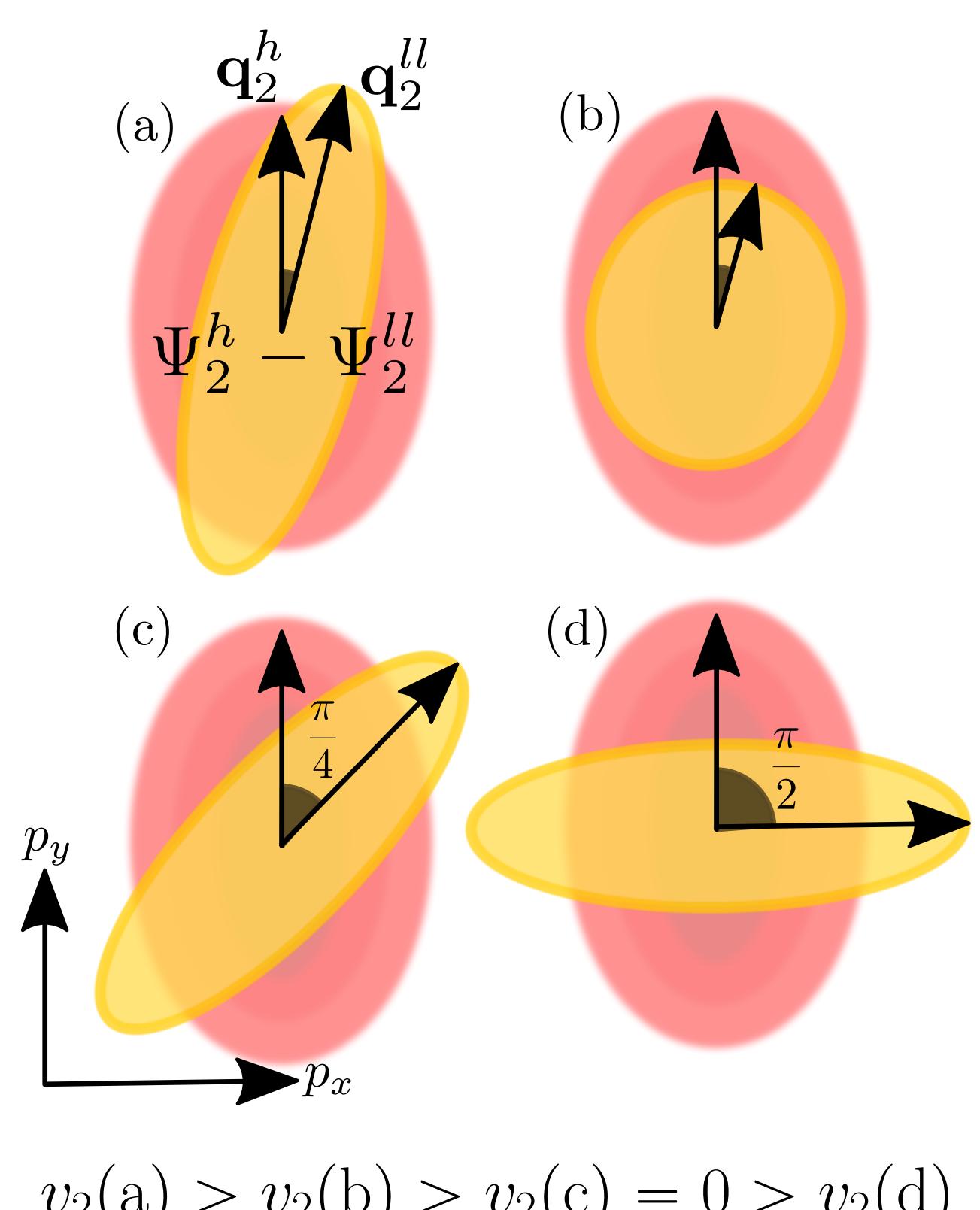
Outlook

- Hadronic transport allows for particle tracking
- Relate measurable dileptons with time evolution of resonances
- Dilepton-hadron correlation may reduce statistical power needed
- Dilepton-dilepton correlations
- Predictions: other systems, $v_1, v_3 \dots$

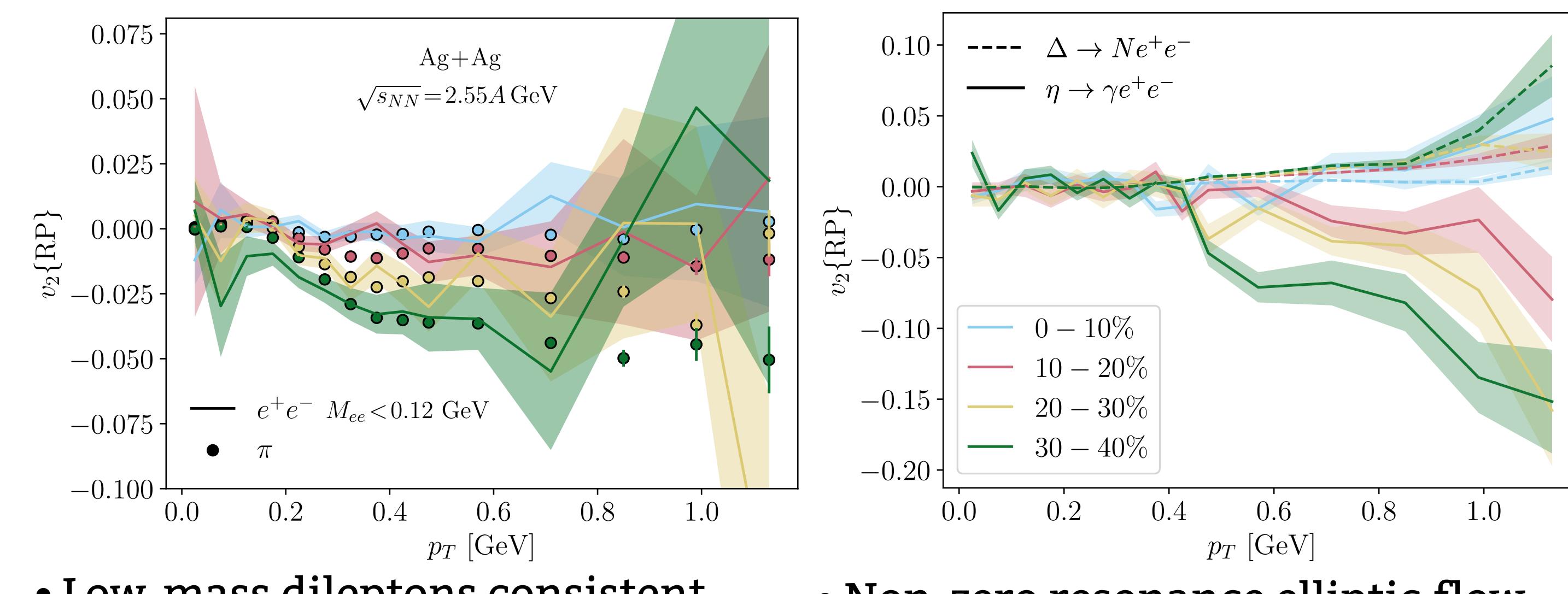
Anisotropic flow

- Particle yields can be Fourier decomposed in azimuthal momentum:
- $$\frac{dN}{d\phi} \propto 1 + 2 \sum_{n=1}^{\infty} v_n \cos[n(\phi - \Psi_R)]$$
- Anisotropic flow coefficient $v_n = \langle \cos[n(\phi - \Psi_R)] \rangle$
 - Reaction plane angle Ψ_R : span { impact parameter, beam direction }
 - Sometimes cannot be reconstructed \Leftarrow scalar product method
 - In each event the momentum of each particle is correlated with an event flow vector \mathbf{q}_n , computed with the remaining particles
 - Dileptons: rare + combinatorics
 - Measuring correlations between two dileptons may be unfeasible
 - Correlate the dilepton flow with the hadron flow! [3]

$$v_2^{ll}(X) = \frac{\langle |\mathbf{q}_n^h| |\mathbf{q}_n^{ll}(X)| \cos[n(\Psi_n^h - \Psi_n^{ll})] \rangle_{ev}}{\sqrt{\langle |\mathbf{q}_n^h|^2 \rangle_{ev}}}$$

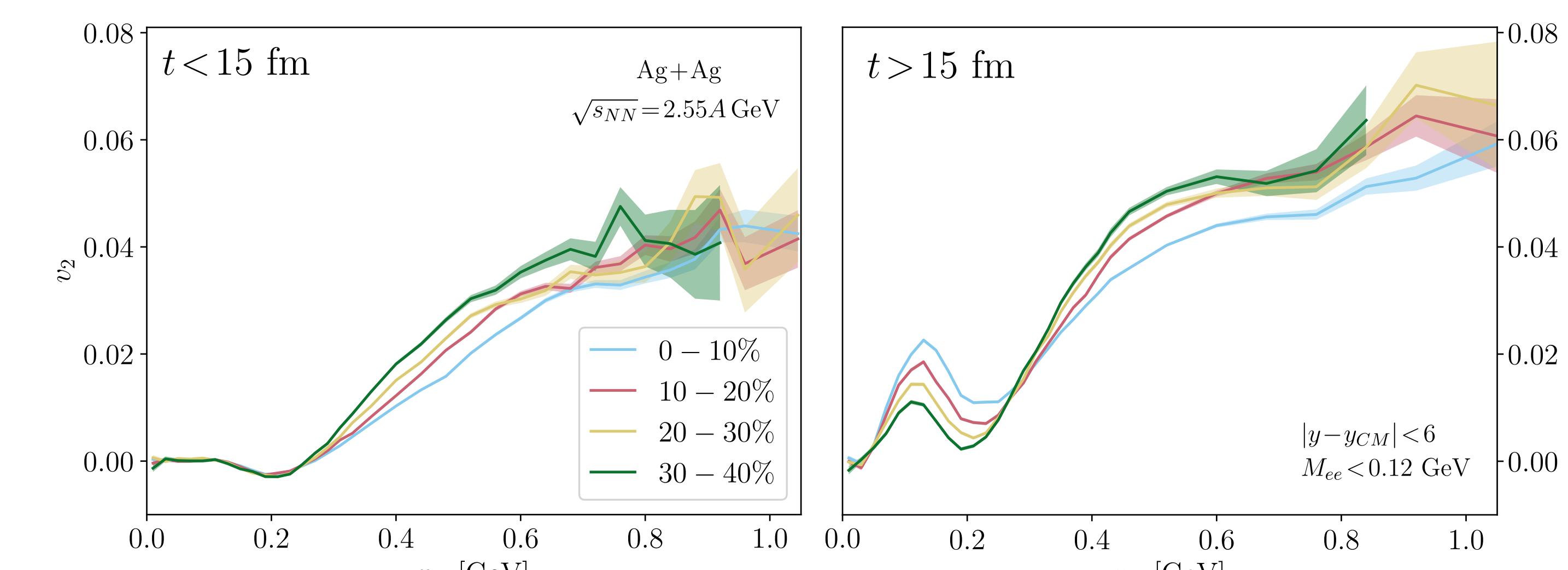


Reaction plane checks



- Low-mass dileptons consistent with SMASH pions
- Non-zero resonance elliptic flow
- Shining Δ , stable η

Time dependence



- This system becomes dilute at around $t \sim 15$ fm [2]
- In the dense stage, there is no peak
- In the dilute stage, the peak arises and flow is higher at all p_T
- Non-flow (π from decays) or spurious correlation?

References

- [1] Jan Staudenmaier, et al. (2018). Phys. Rev. C 98(5), 054908. [1711.10297]
- [2] Renan Hirayama, Jan Staudenmaier, and Hannah Elfner (2023). Phys. Rev. C 107(2), 025208 [2206.15166]
- [3] Jean-François Paquet, et al (2016). Phys. Rev. C 93(4), 044906. [1509.06738]