How many interactions does it take to modify a jet?

And is that the whole story?

Chiara Le Roux
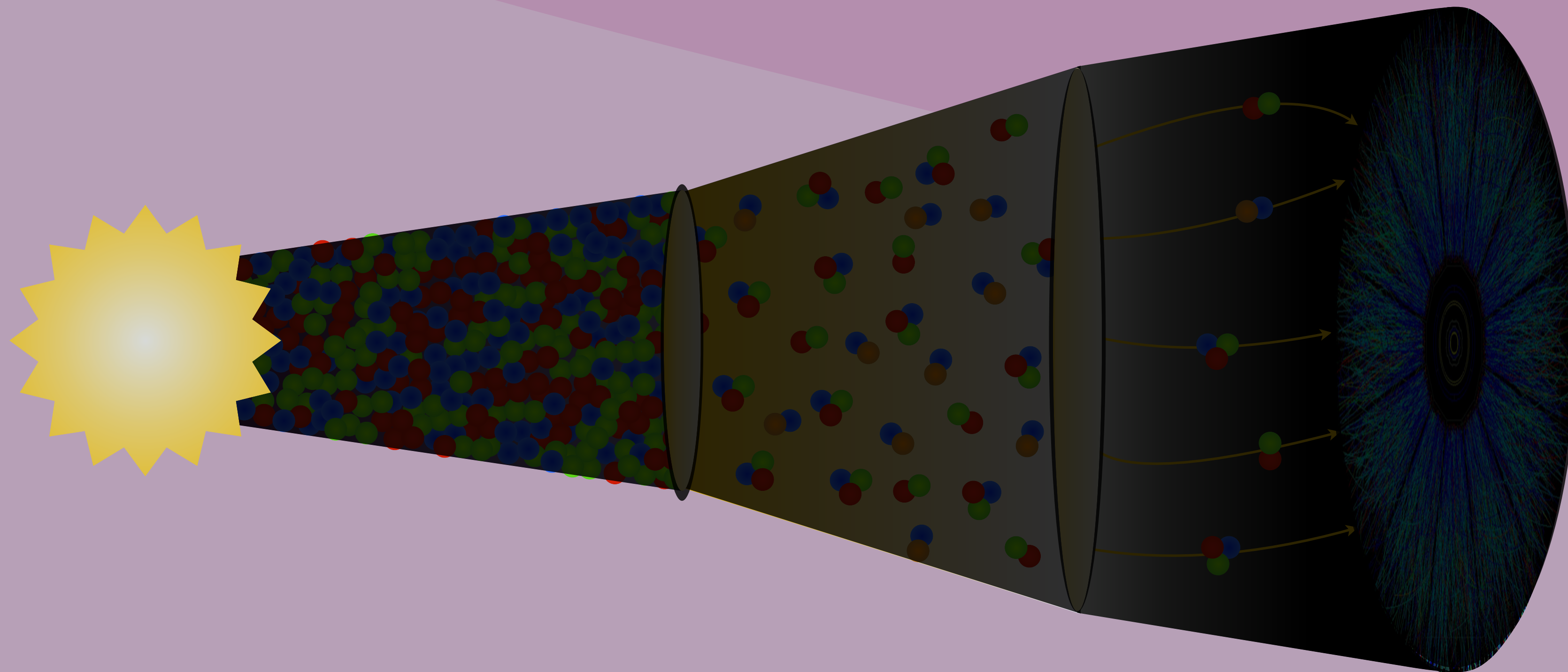
José Guilherme Milhano (LIP) and Korinna Zapp

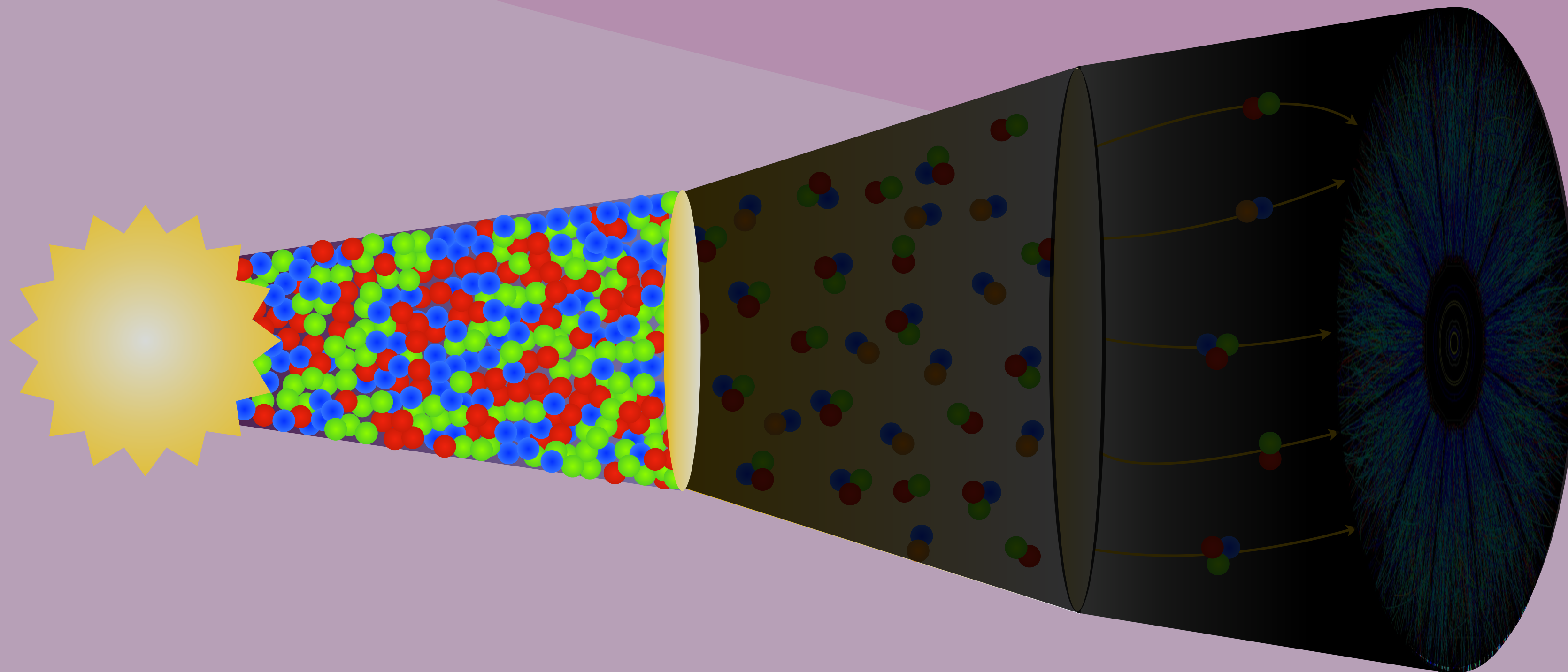LUND
UNIVERSITY

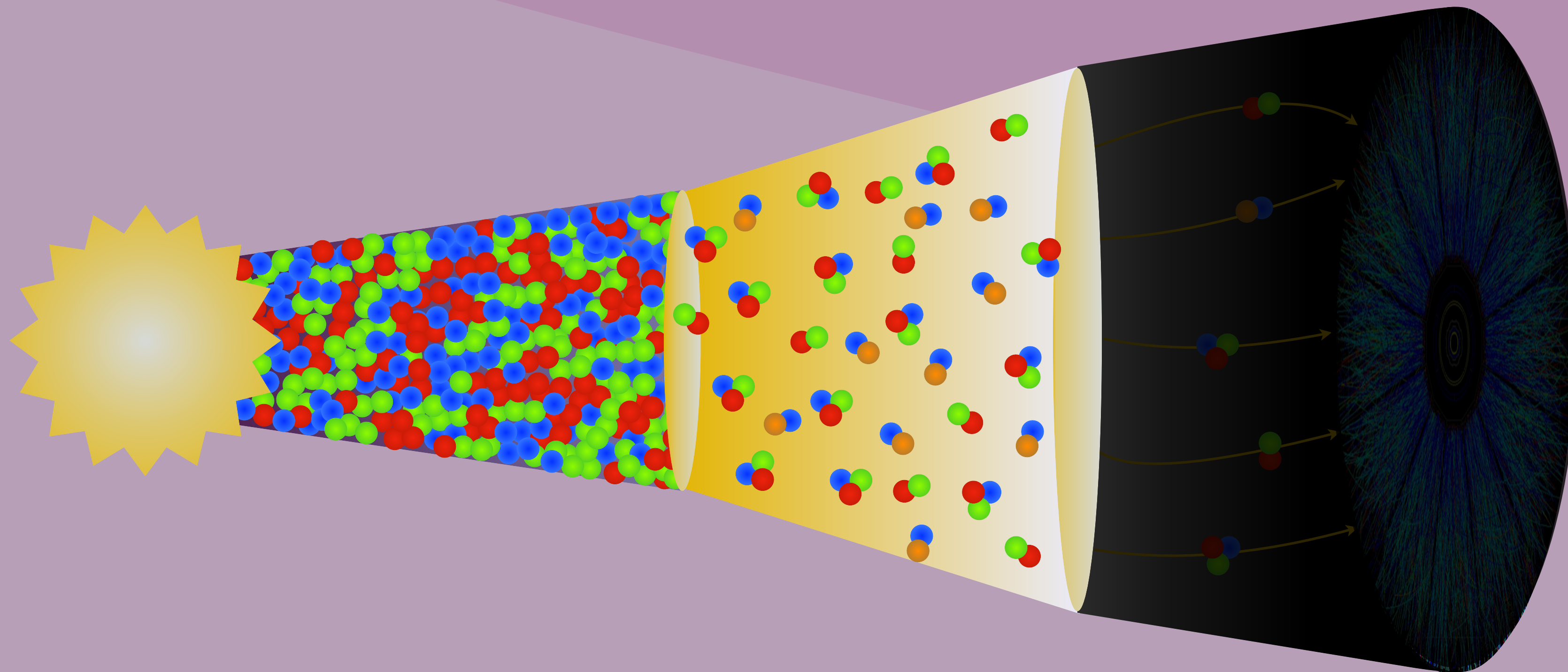# Relativistic Heavy Ion Collisions

- Heavy ions collide at high energies

Relativistic Heavy Ion Collisions

- 🔭 Heavy ions collide at high energies
- 🔭 A system of free quarks and gluons (QGP) is created and expands

Relativistic Heavy Ion Collisions

🎆 Heavy ions collide at high energies

🎆 A system of free quarks and gluons (QGP) is created and expands

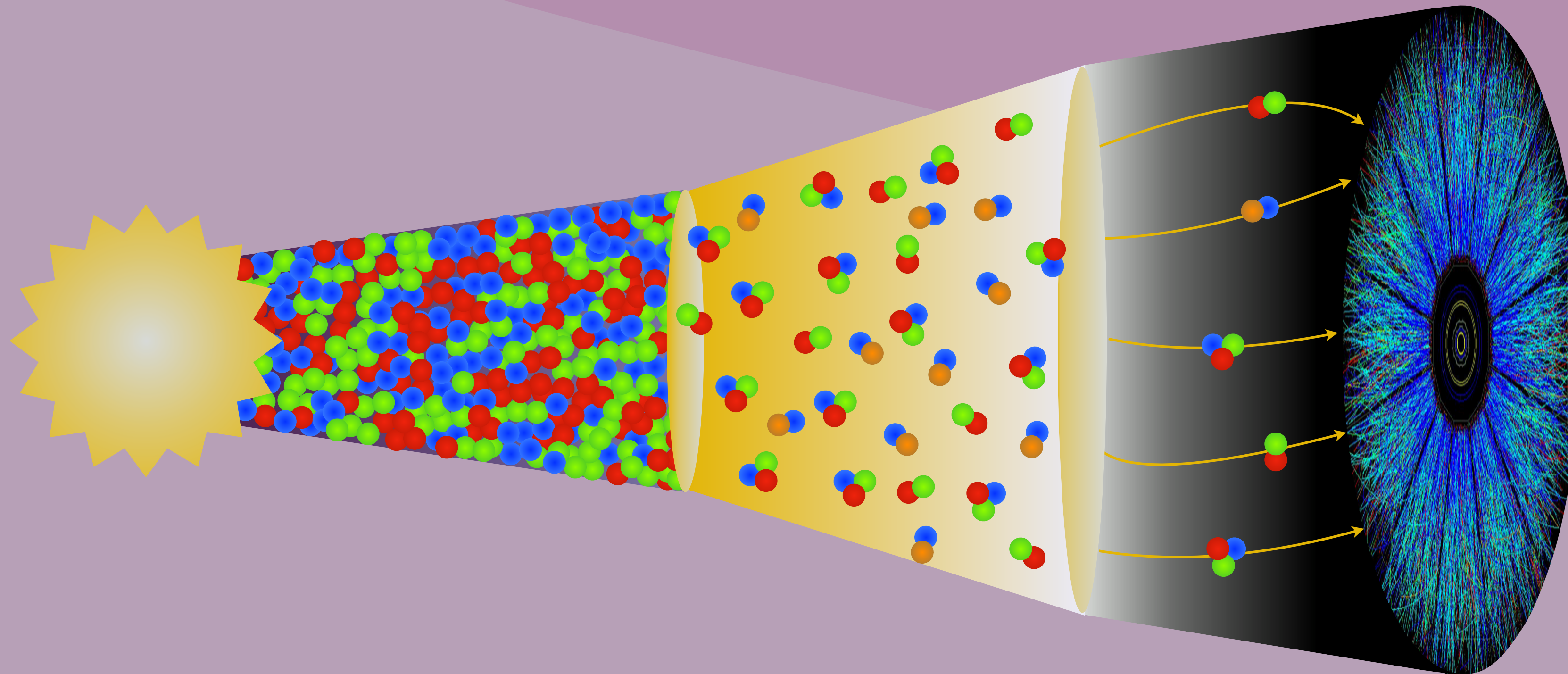🎆 Hadronization takes place and a hadron gas phase begins

Relativistic Heavy Ion Collisions

- Heavy ions collide at high energies

- A system of free quarks and gluons (QGP) is created and expands

- Hadronization takes place and a hadron gas phase begins

- The path length becomes large enough that no more interactions take place

Relativistic Heavy Ion Collisions

- Heavy ions collide at high energies
- A system of free quarks and gluons (QGP) is created and expands
- Hadronization takes place and a hadron gas phase begins
- The path length becomes large enough that no more interactions take place
- Different signatures to probe and study the free quark-gluon system
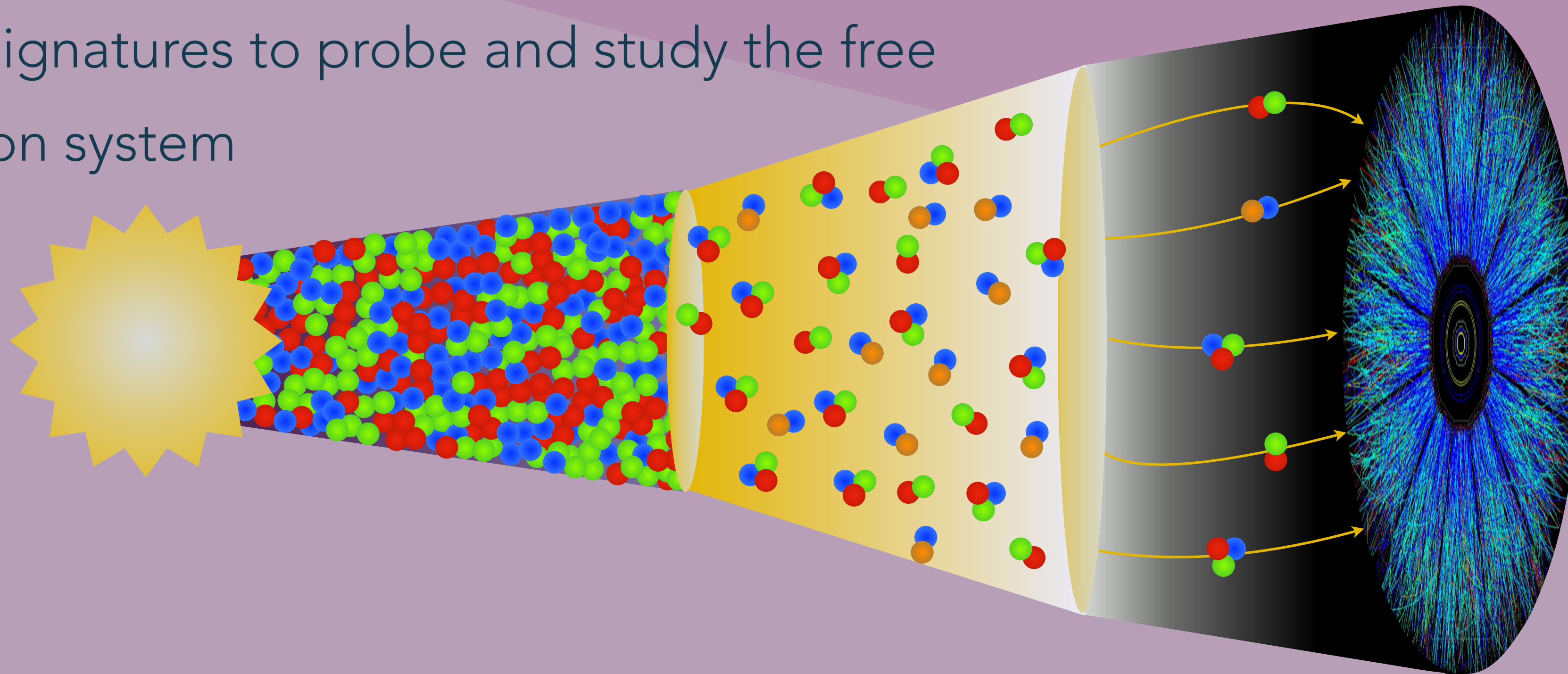
Jet quenching

🎆 High energy jets are created early in the collision

🎆 They traverse the medium and lose energy and momentum

🎆 Depending on how much medium they traverse they can lose more or less energy
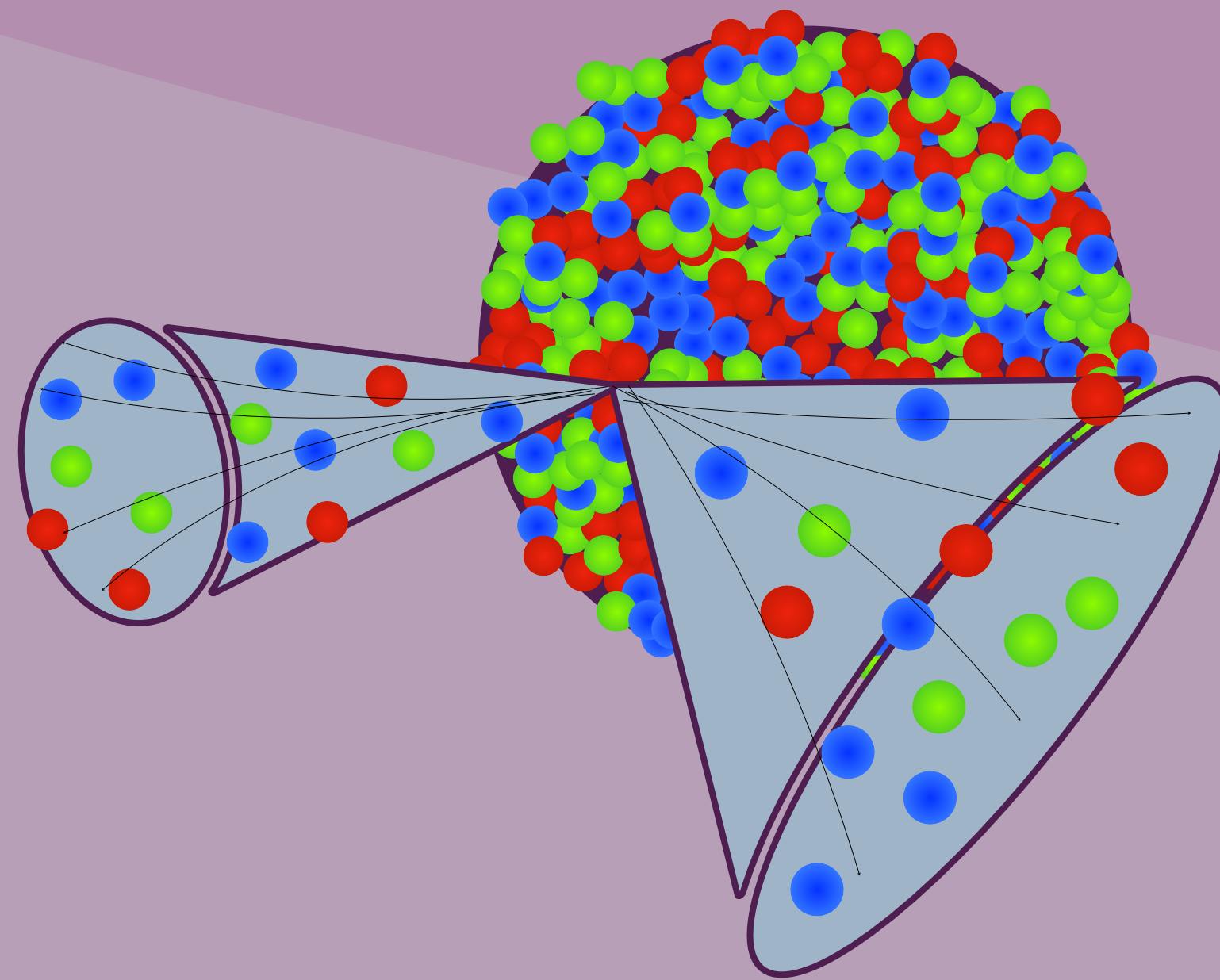
🎆 Jet quenching is measured with the R_{AA} (ratio between AA and pp collision)
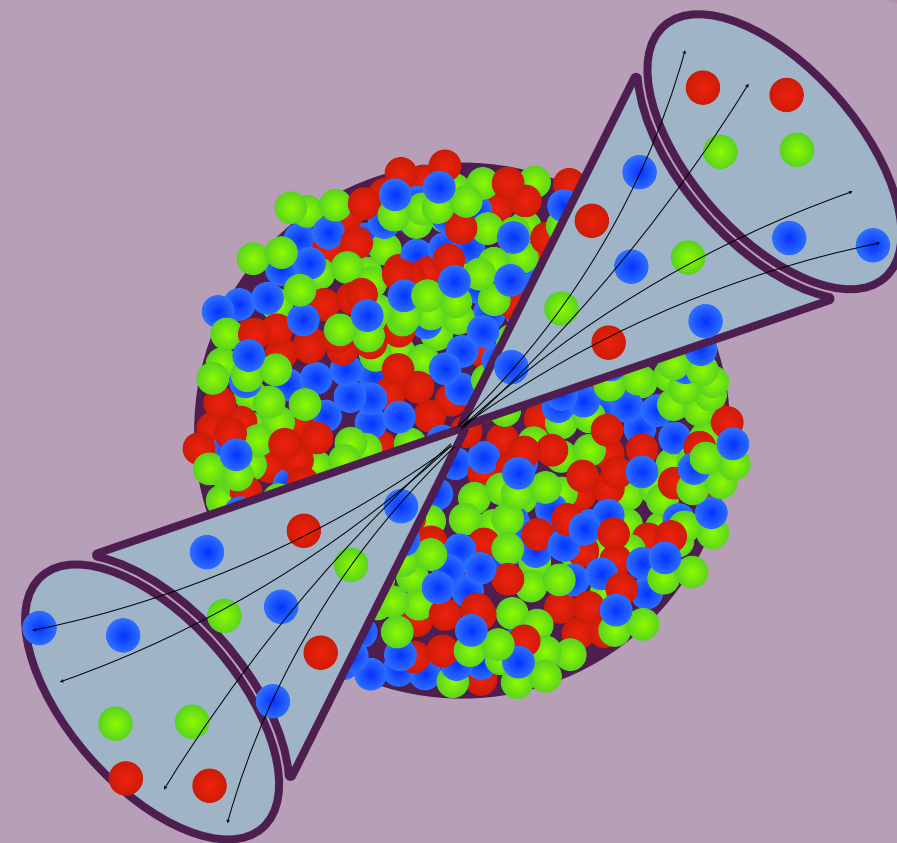
Collective behavior

🎉 Different collision centralities create medium with different eccentricities

🎉 This anisotropy can be observed in the final distribution of particles
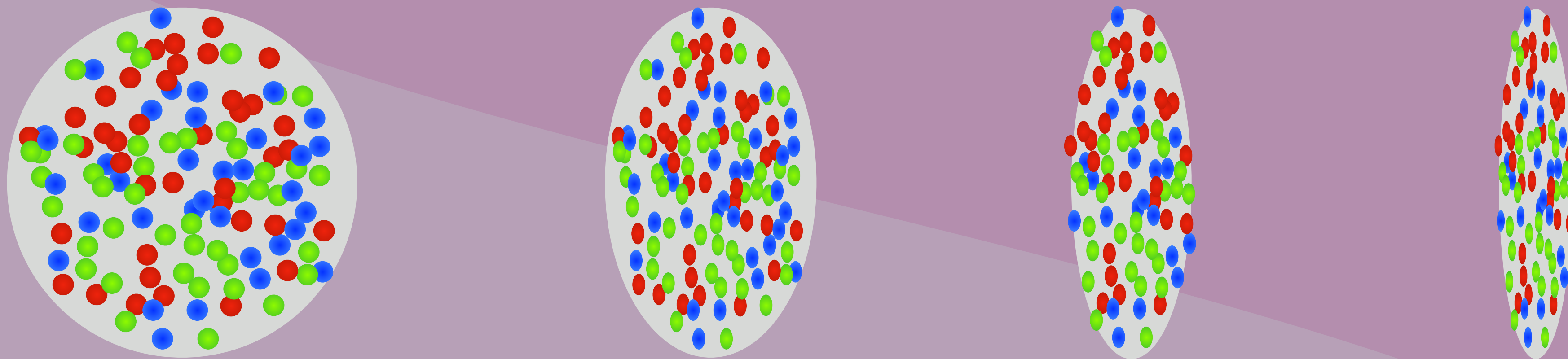
🎉 One way to quantify collectivity is to measure v_2 (related to the anisotropy in the final state partial distribution)
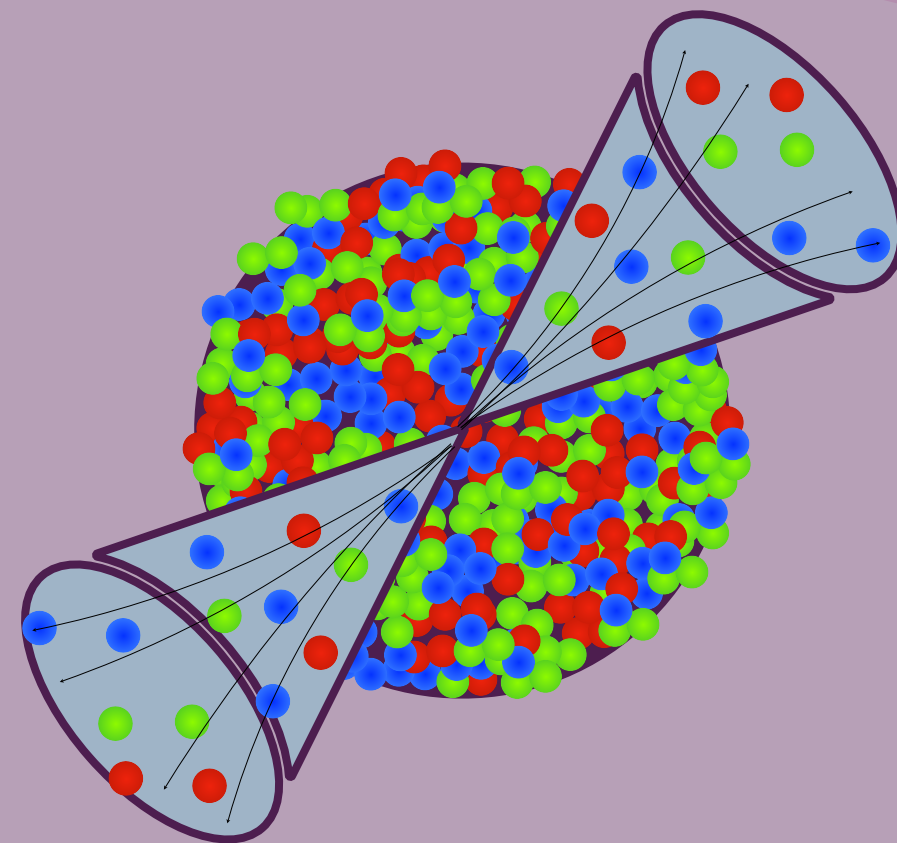
What is going on in small systems?

- Both signatures have been observed in heavy ion collisions
- Small systems collisions (pp, pA, etc.) are not dense enough to produce a medium
- Jet quenching has not been observed in small systems
- Collectivity has been observed in pA and even pp
- Other QGP signatures have also been observed in small systems

What is going on in small systems?

- Both signatures have been observed in heavy ion collisions
- Small systems collisions (pp, pA, etc.) are not dense enough to produce a medium
- Jet quenching has not been observed in small systems
- Collectivity has been observed in pA and even pp
- Other QGP signatures have also been observed in small systems

If there is medium formation in small systems, it must be very small

Too small to have enough interactions to produce a jet quenching signal?

What is going on in small systems?

- Both signatures have been observed in heavy ion collisions
- Small systems collisions (pp, pA, etc.) are not dense enough to produce a medium
- Jet quenching has not been observed in small systems
- Collectivity has been observed in pA and even pp
- Other QGP signatures have also been observed in small systems

If there is medium formation in small systems, it must be very small
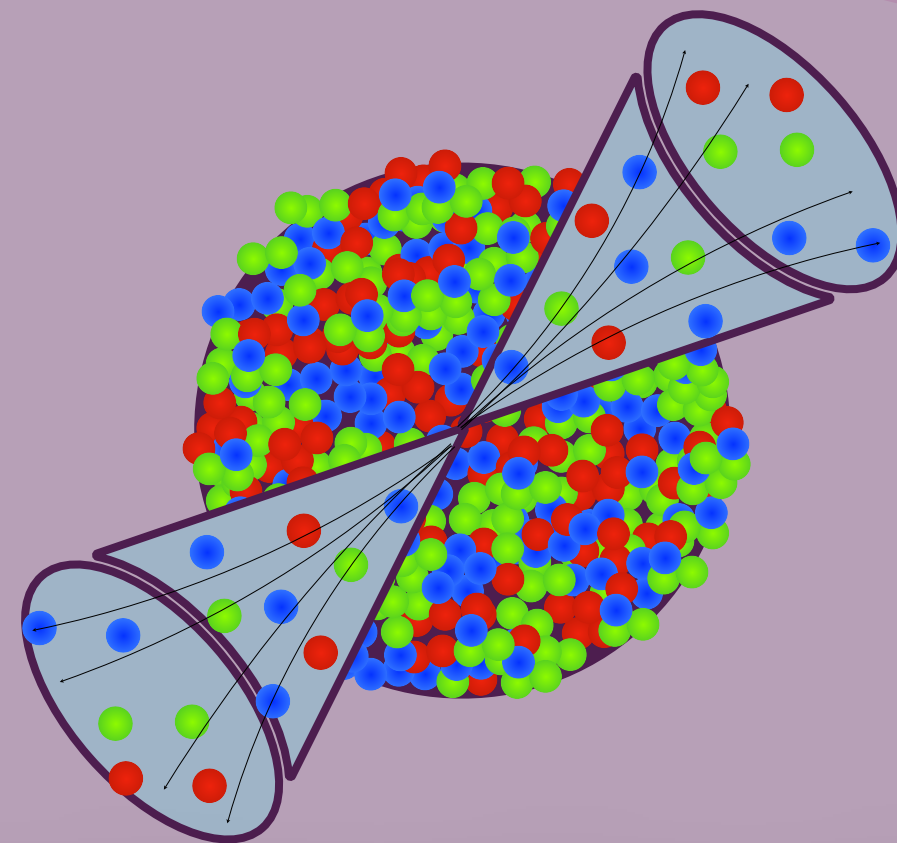
Too small to have enough interactions to produce a jet quenching signal?

How many jet-medium interactions does it take to quench a jet?

And to observe collectivity?

JEWEL jets in a brick-like medium

🎆 JEWEL is a parton shower that can be evolved inside a medium

🎆 Between each splitting, partons can interact with medium particles

JEWEL jets in a brick-like medium

- JEWEL is a parton shower that can be evolved inside a medium

- Between each splitting, partons can interact with medium particles

- Define a brick-like medium in JEWEL with a given density, temperature and geometry
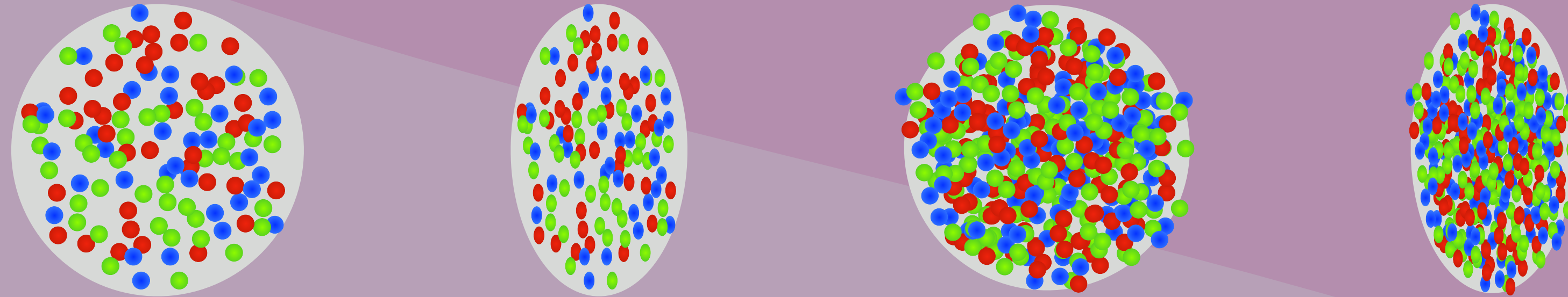
JEWEL jets in a brick-like medium

🎇 JEWEL is a parton shower that can be evolved inside a medium

🎇 Between each splitting, partons can interact with medium particles

🎇 Define a brick-like medium in JEWEL with a given density, temperature and geometry
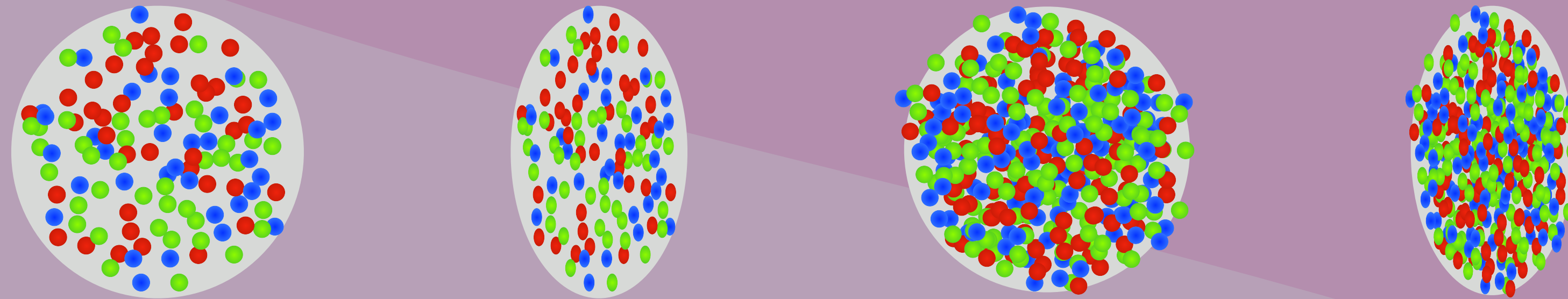
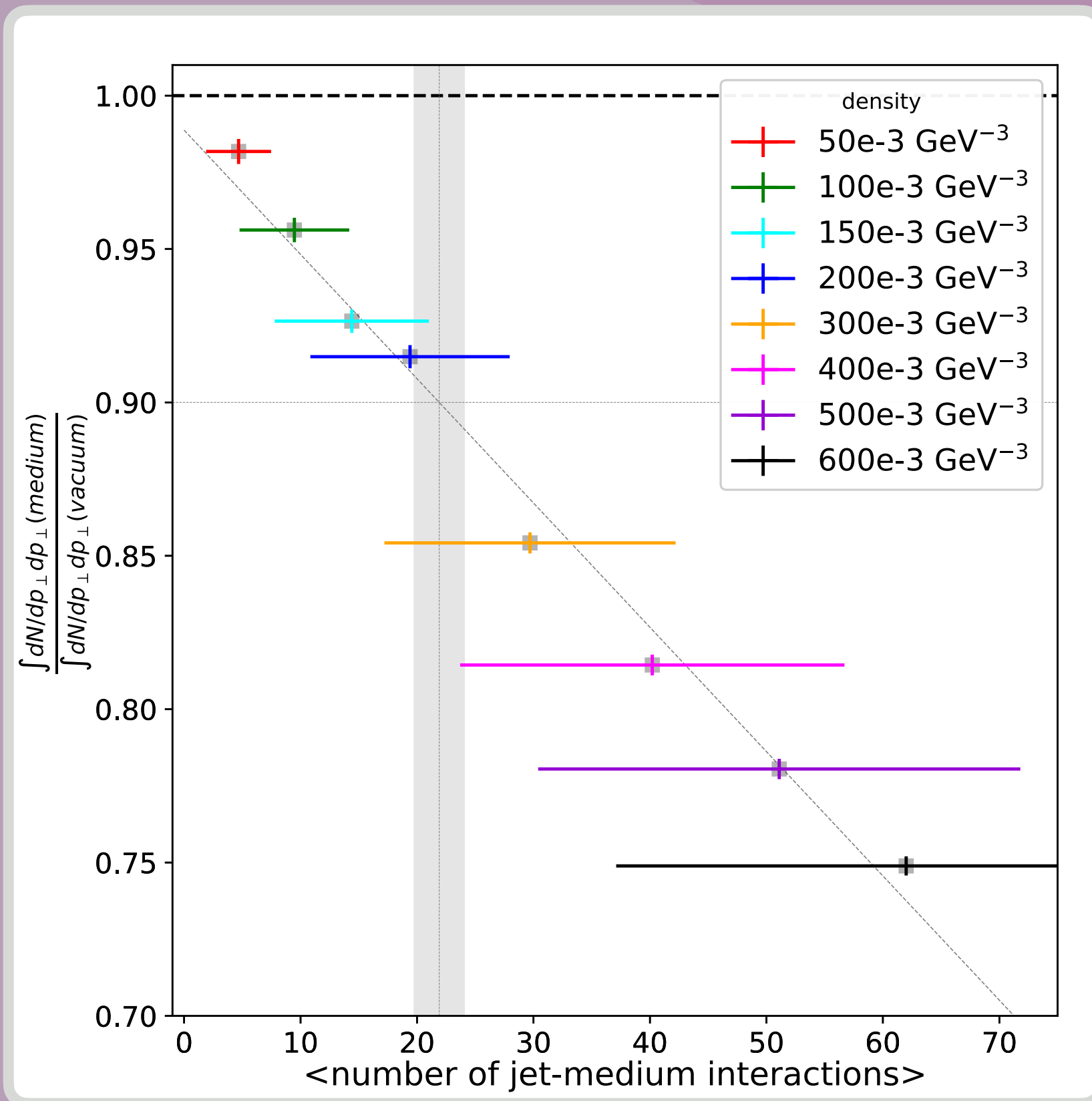🎇 Let jets evolve inside the brick while counting the number of jet-medium interactions
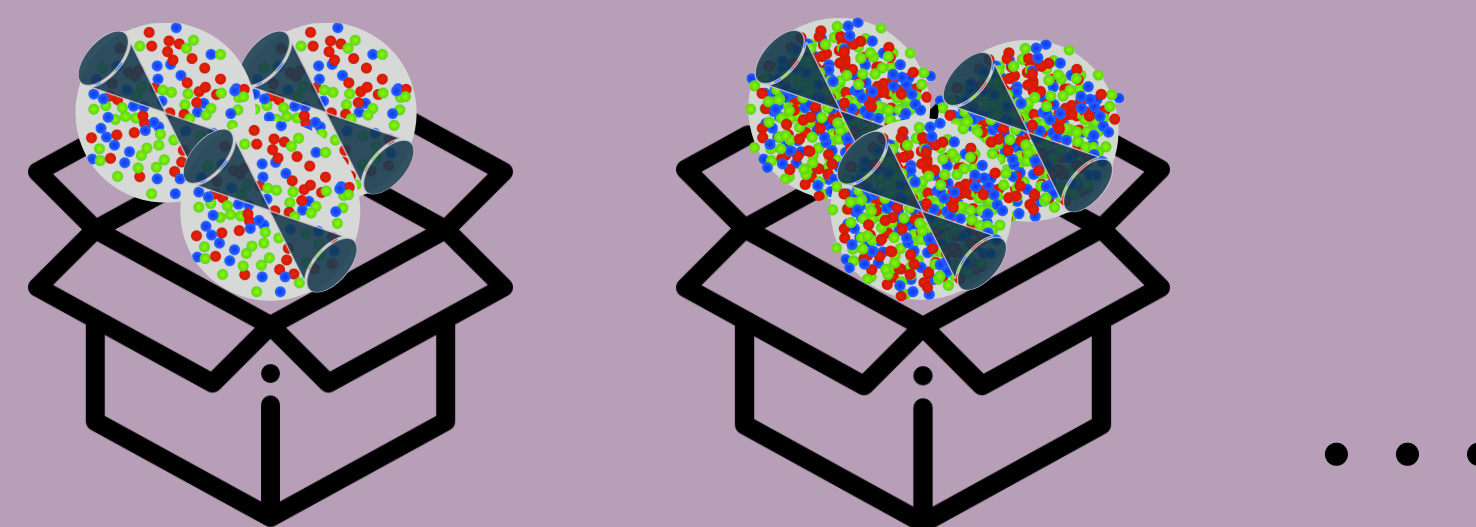
0-5
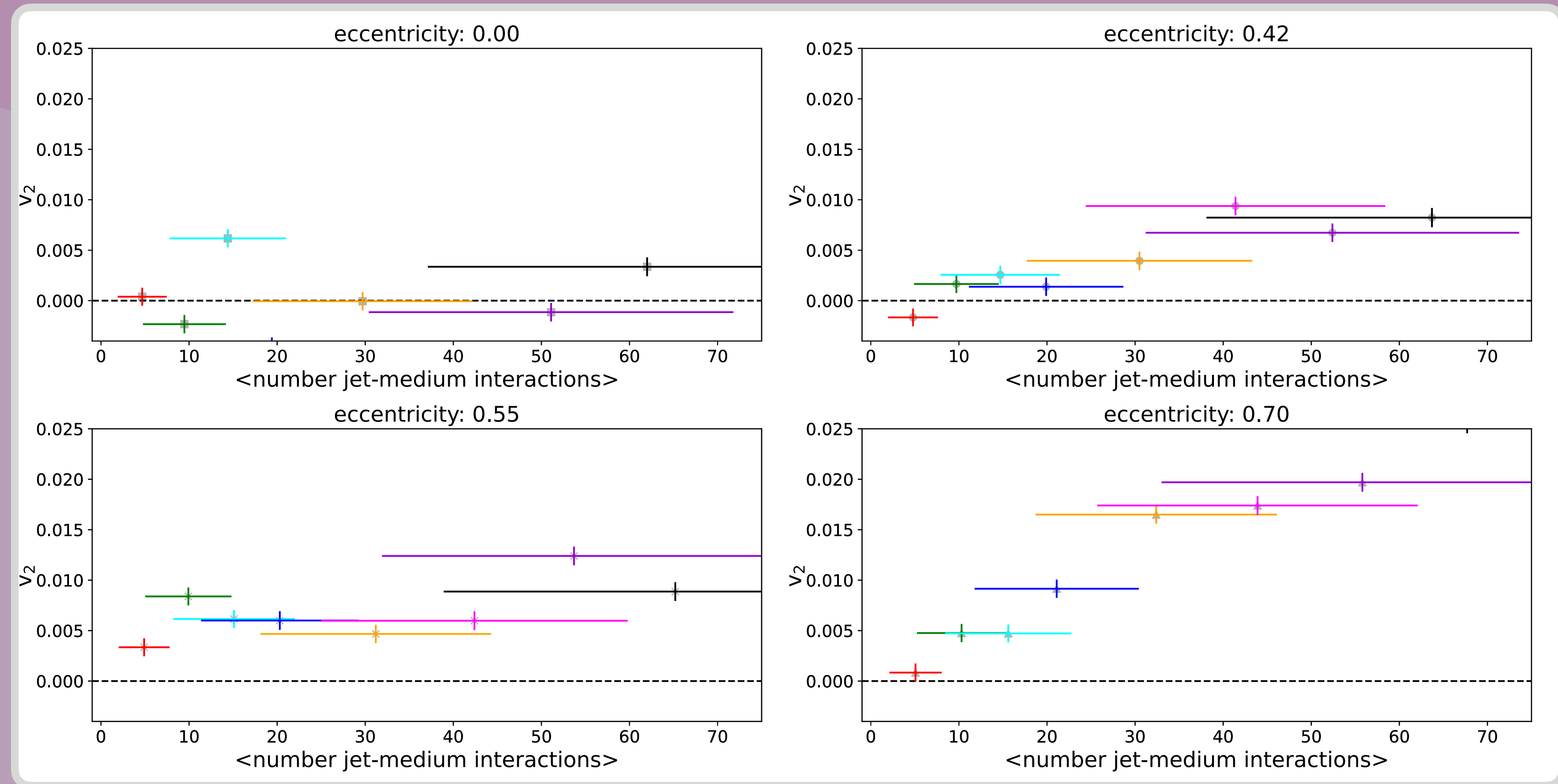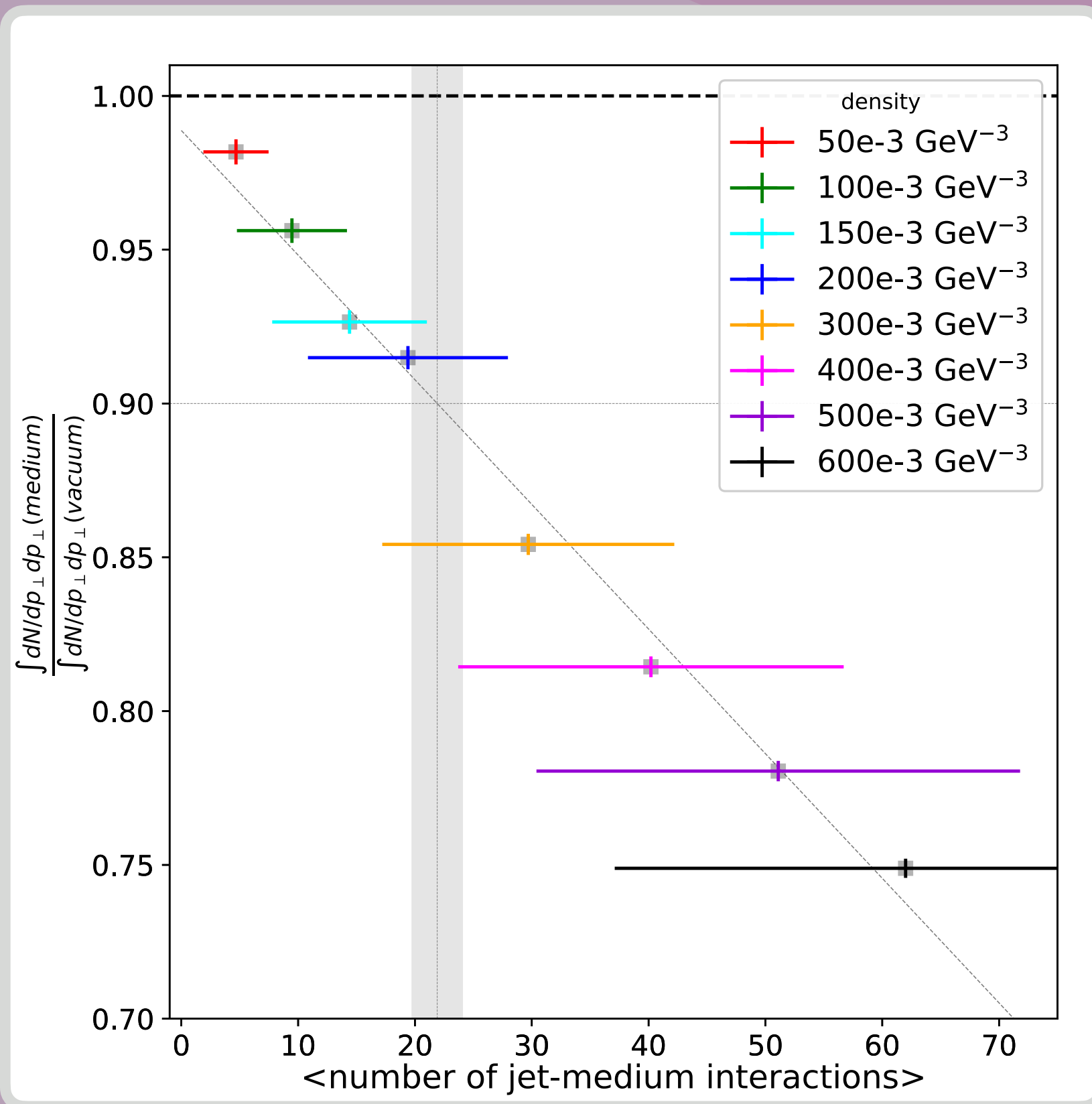interactions

6-10
interactions

. . .

Results

🎳 At about 20 interactions, a 10% effect in R_{AA} (jet quenching) is observed
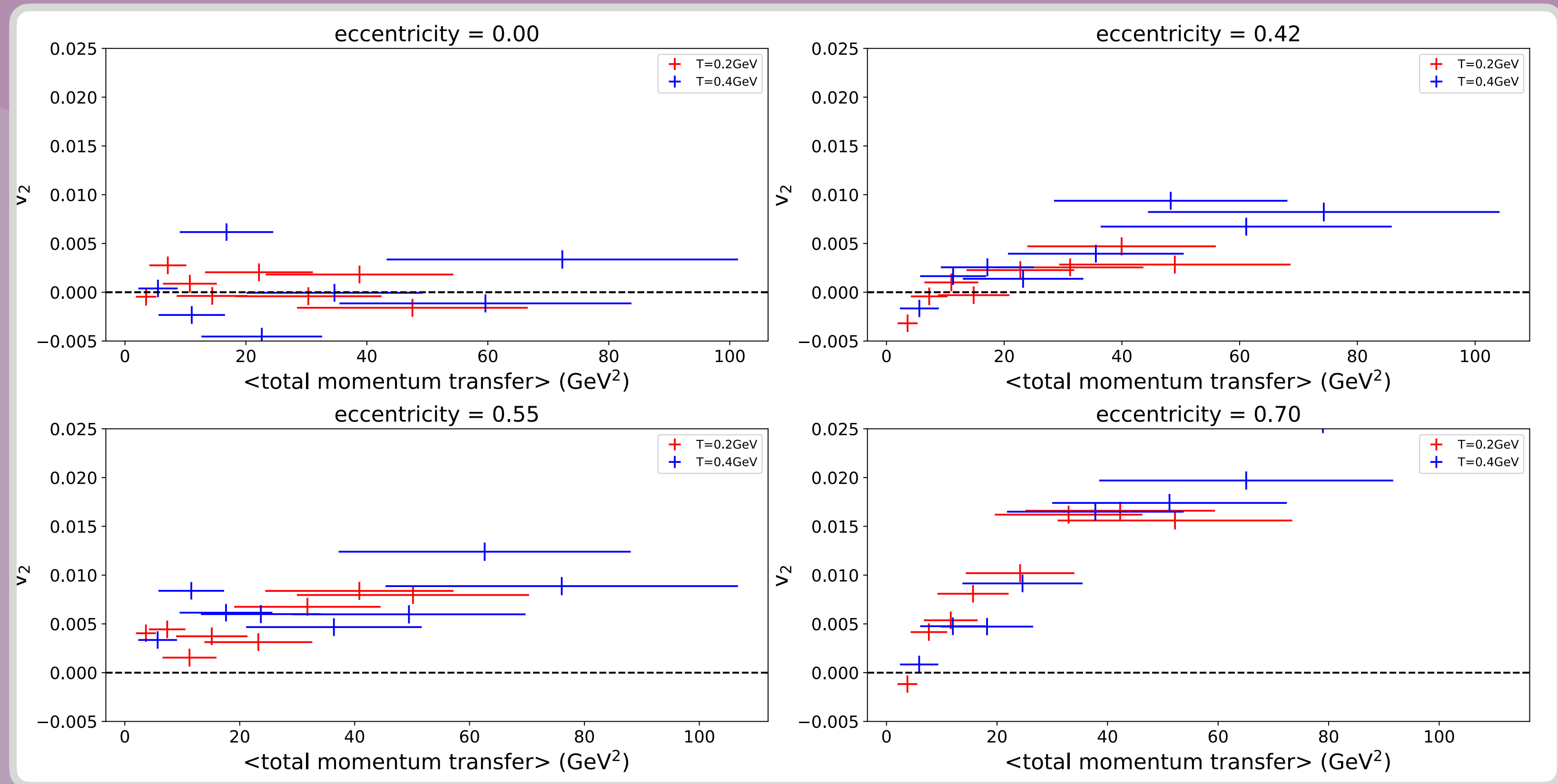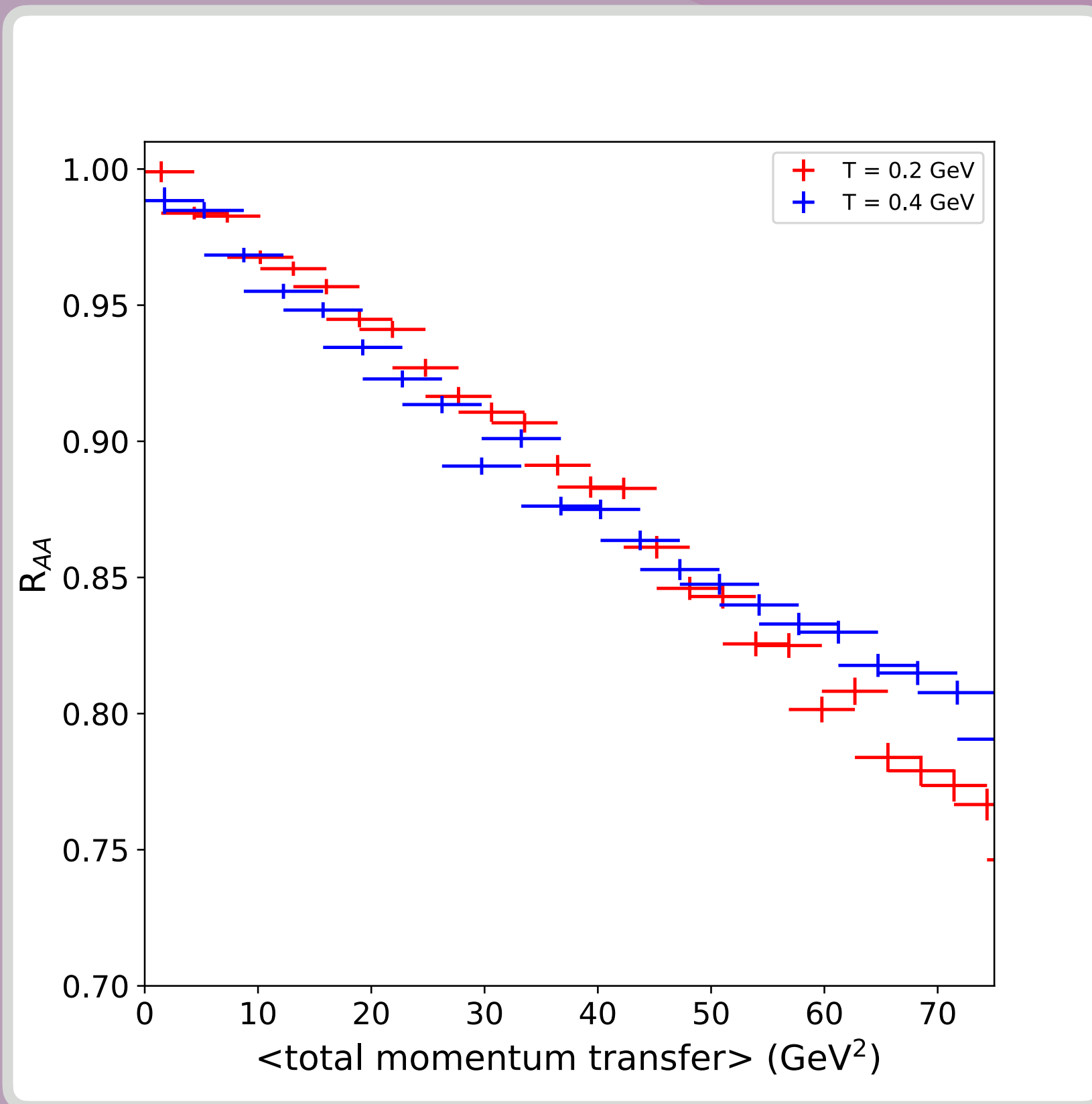
Results

🔭 At about 20 interactions, a 10% effect in R_{AA} (jet quenching) is observed

🔭 v_2 (collectivity) can be seen well before that in certain eccentricities

But that is not all...

💣 At different screening masses, the number of interactions changes

💣 R_{AA} and v_2 scale with total momentum transfer

Conclusions and outlook

🔭 Results indicate that there are more interactions required to observe R_{AA} than v_2

🔭 Implement an improved method to select on number of jet-medium interactions avoiding selection biases

🔭 Understand how deflection angle and momentum transfer separately affect the v_2 signal

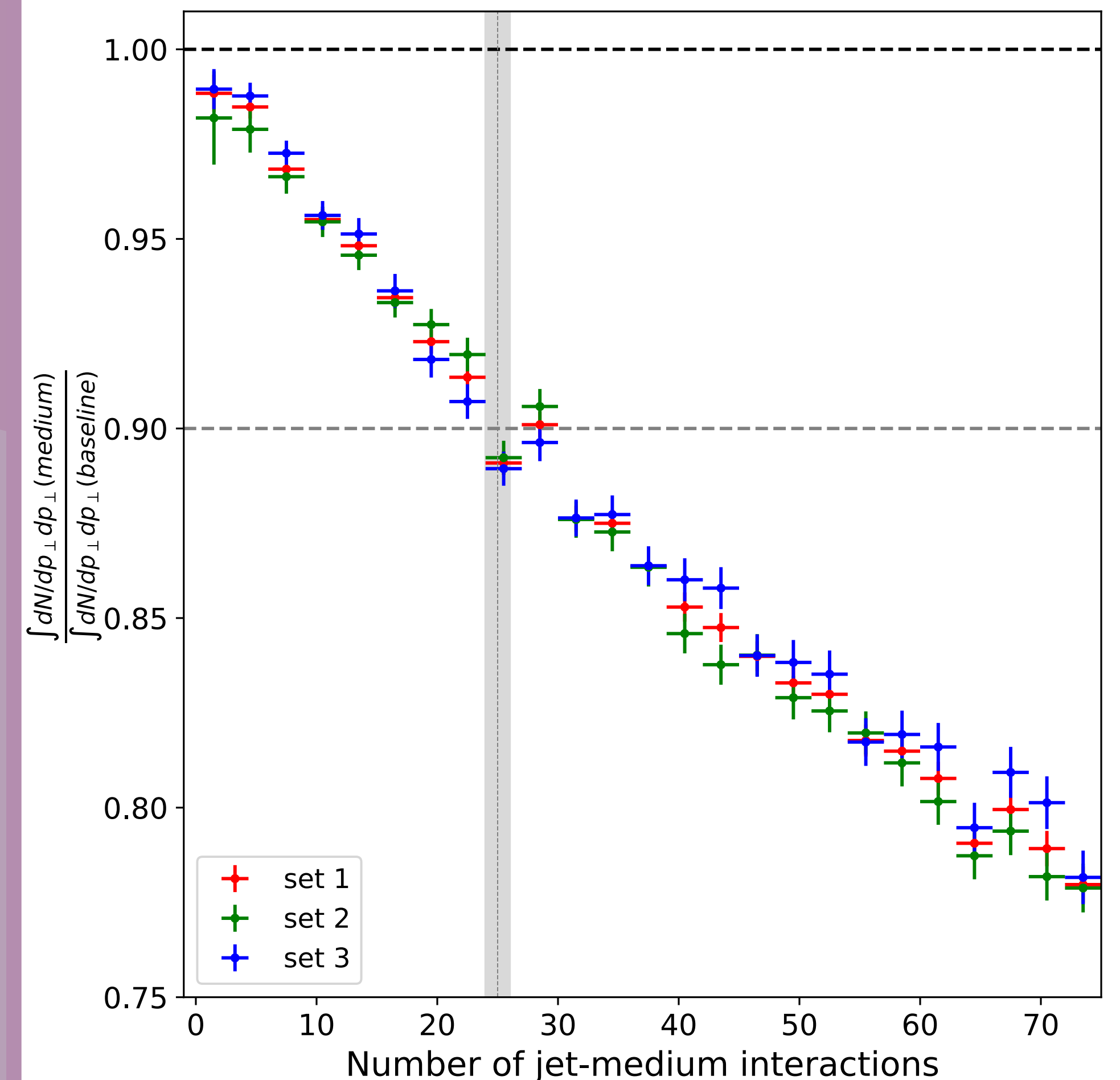🔭 Compare our results with a more realistic medium model

Conclusions and outlook

- Results indicate that there are more interactions required to observe R_{AA} than v_2

- Implement an improved method to select on number of jet-medium interactions avoiding selection biases

- Understand how deflection angle and momentum transfer separately affect the v_2 signal

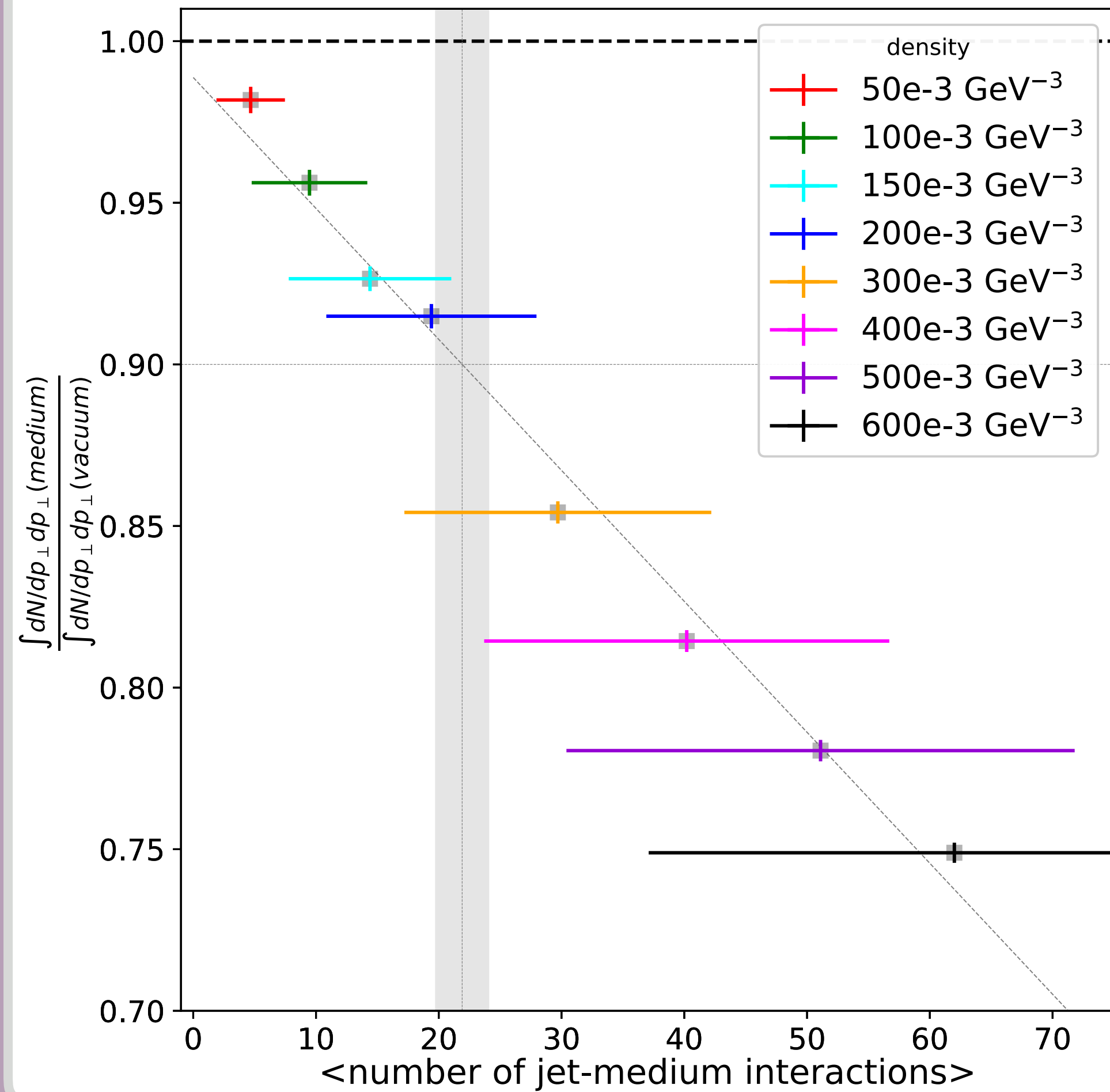- Compare our results with a more realistic medium model

Thank you!

Back up

Back up