Hadronic Rescattering in Pythia

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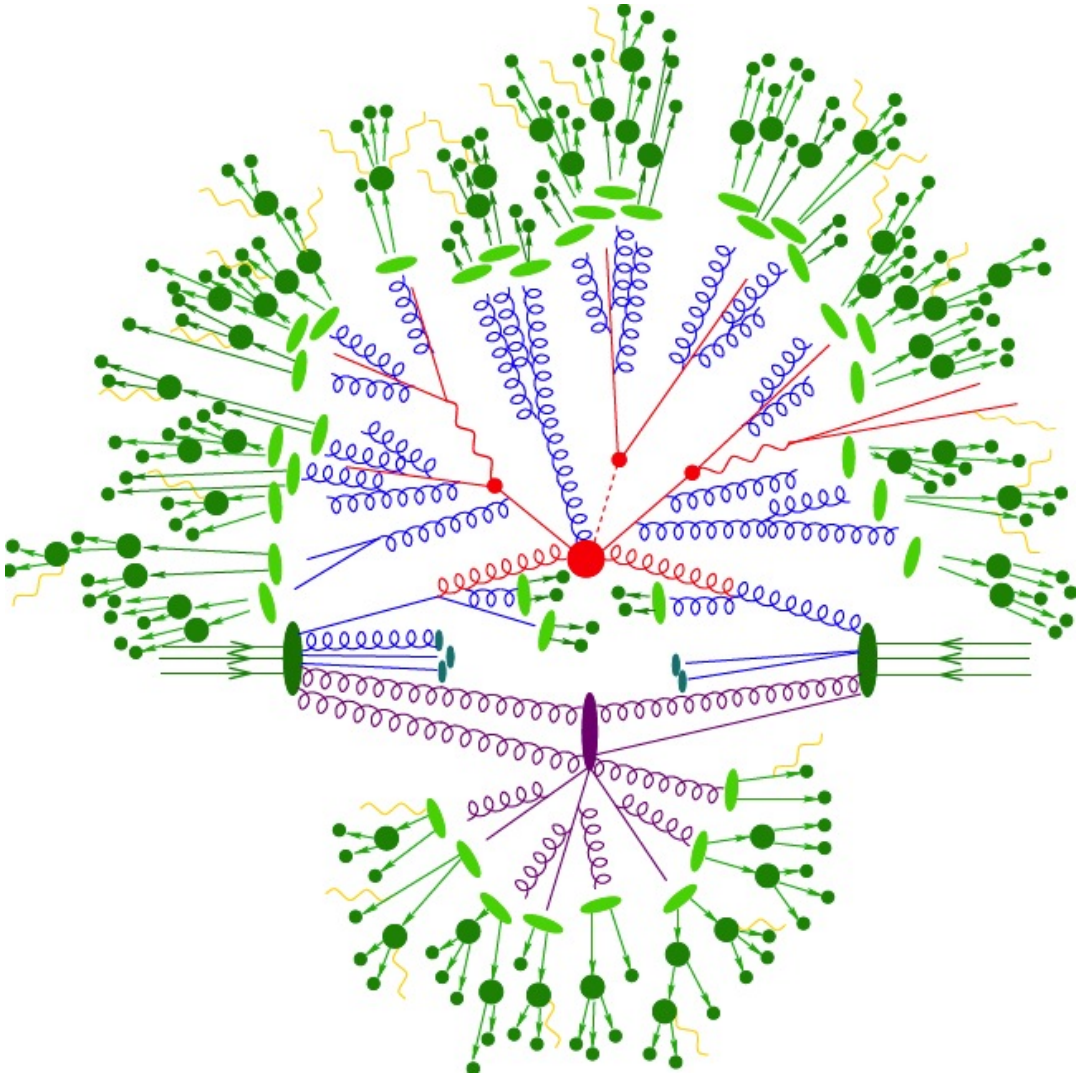
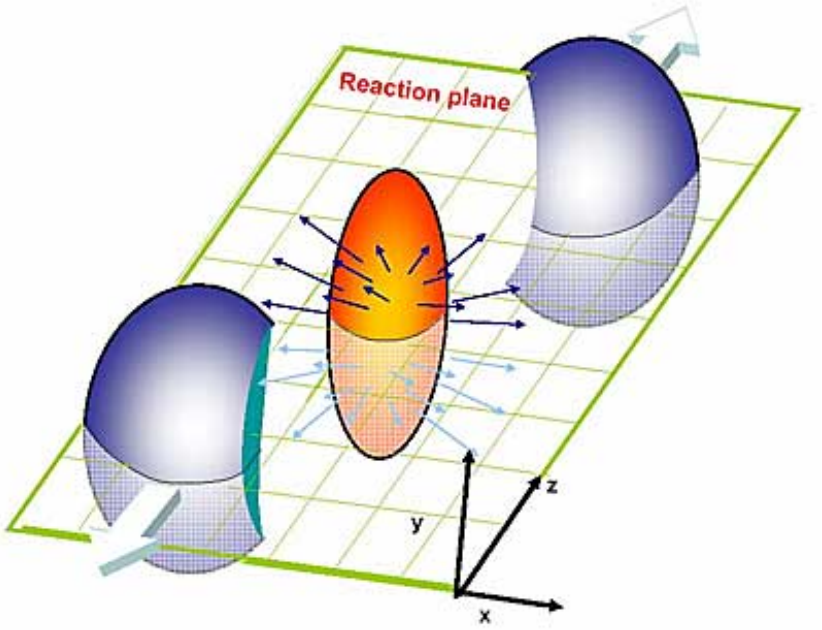
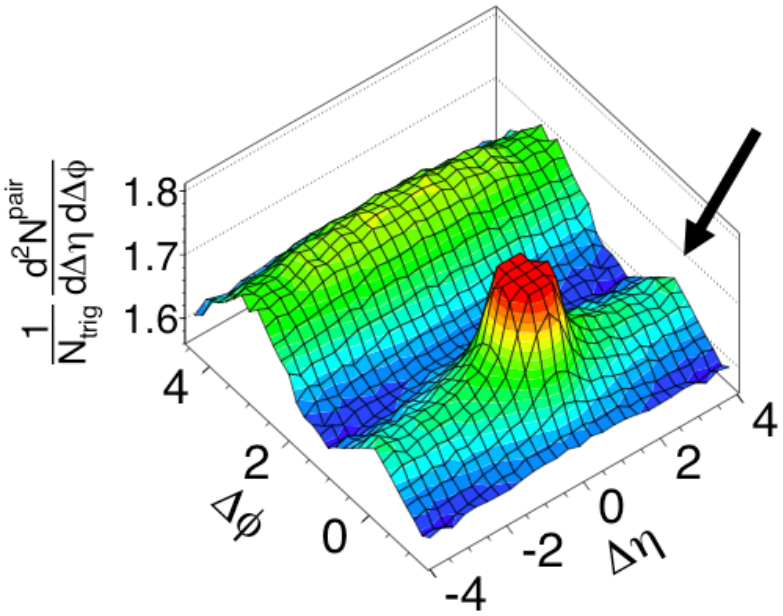
What is rescattering?



Why is rescattering important?

Phenomena: Flow, jet quenching, strangeness enhancement

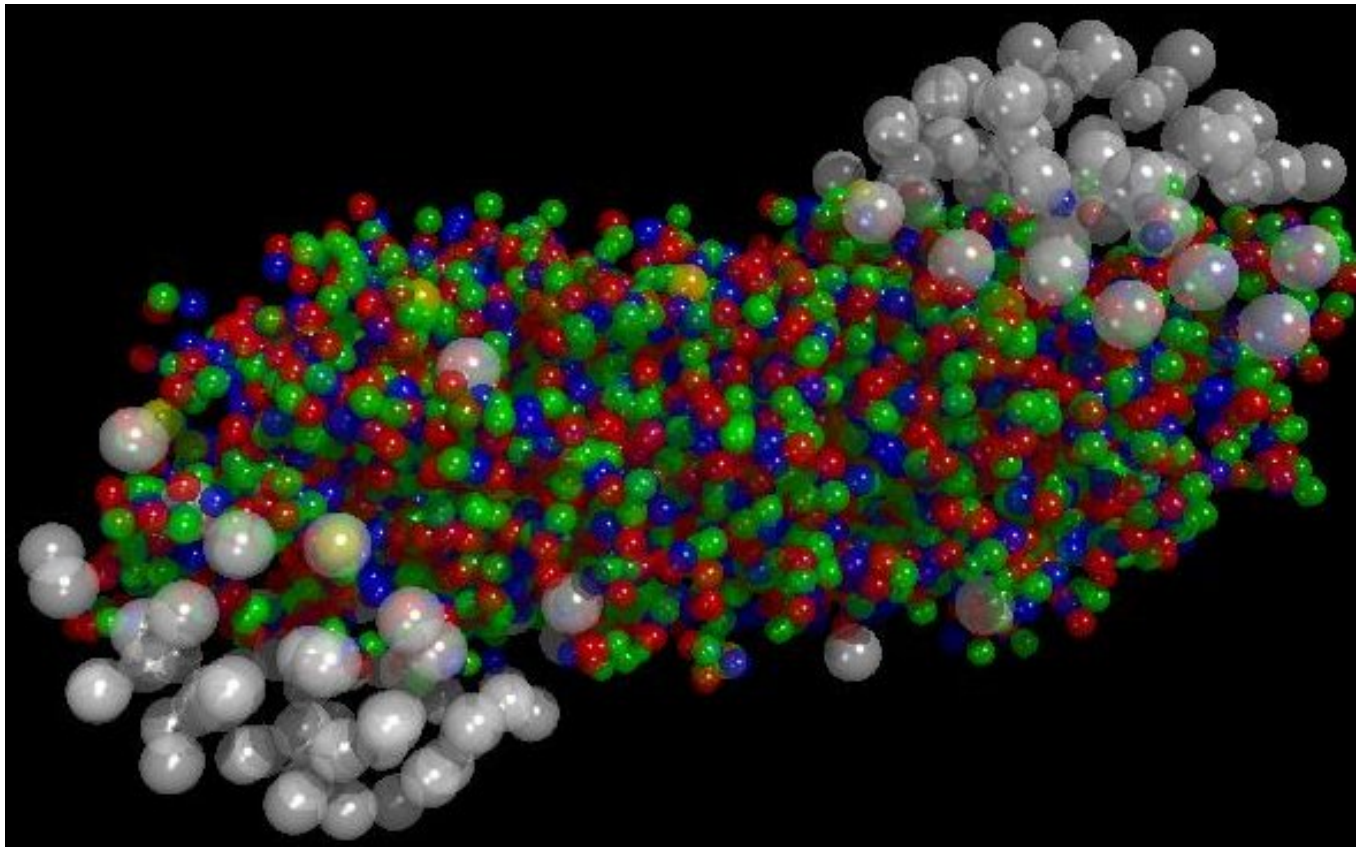




What causes these phenomena in pA and pp collisions?

Rescattering should contribute somehow

UrQMD (Ultra-relativistic Quantum Molecular Dynamics)



S. A. Bass et al., "Microscopic Models for Ultrarelativistic Heavy Ion Collisions." Progress in Particle and Nuclear Physics 41 (1998): 255–369.

Outline

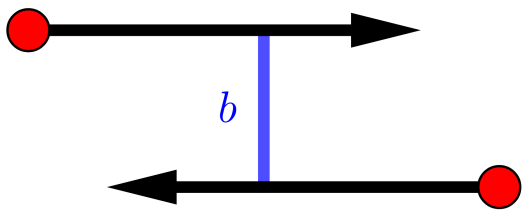
The Rescattering Algorithm

There are three questions that need to be answered:

1. When do two hadrons interact?
2. What happens when hadrons collide at low energies?
3. Looking at the whole event, which hadrons interact with each other?

1. When do two hadrons interact?

The probability of an interaction depends on the particle types, the center-of-mass energy, and the impact parameter



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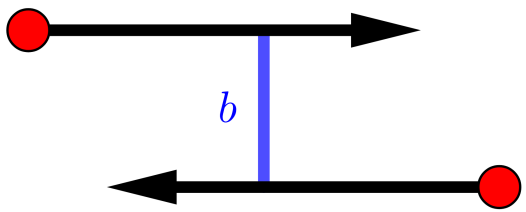

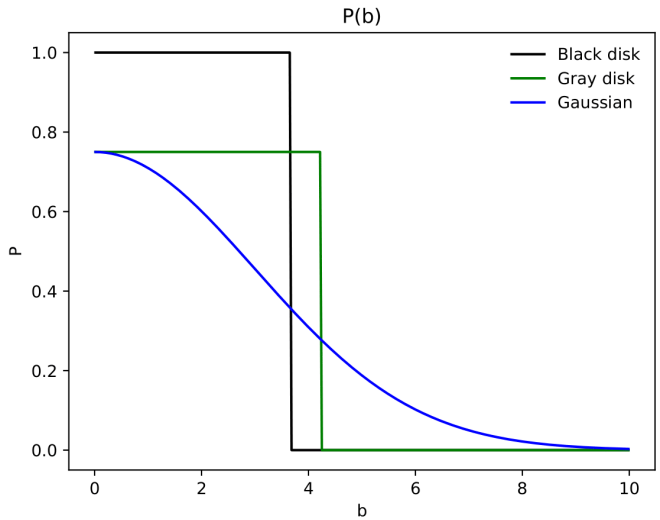

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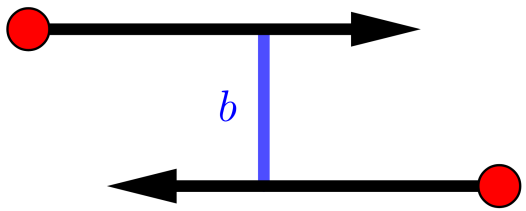
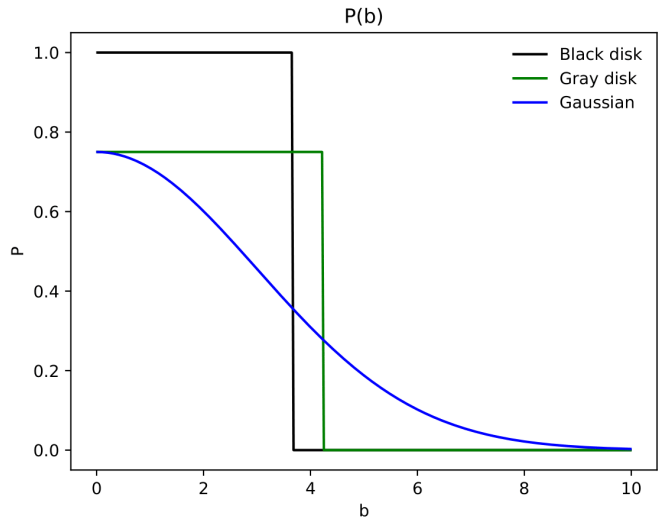
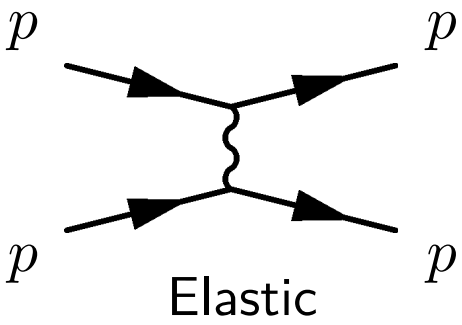




The characteristic range of the interaction is $b_{\text{crit}} = \sqrt{\sigma/\pi}$
This means we need to know the cross section σ.

2. What happens when two hadrons collide?



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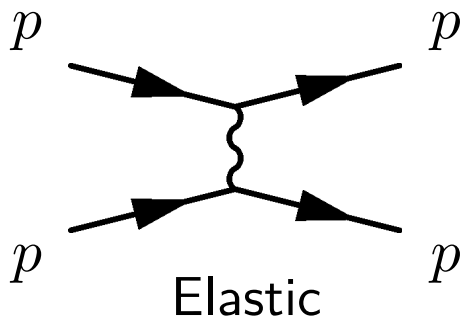
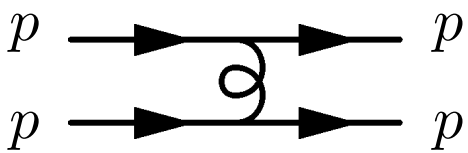


Elastic



Non-diffractive

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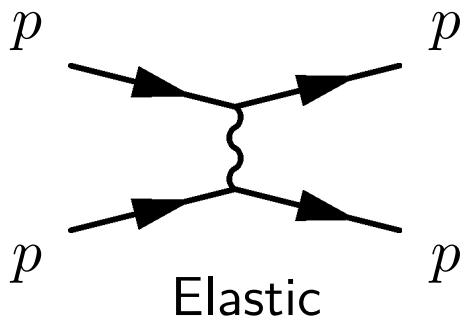

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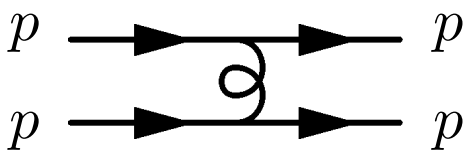

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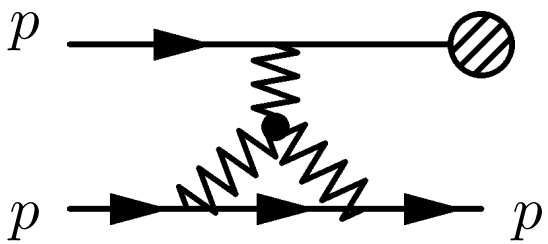

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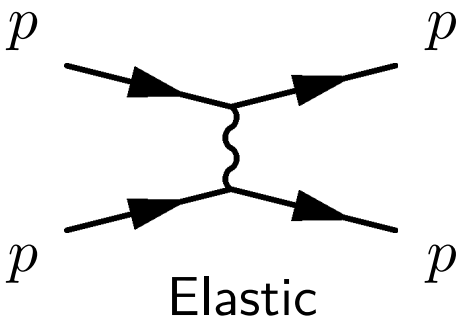

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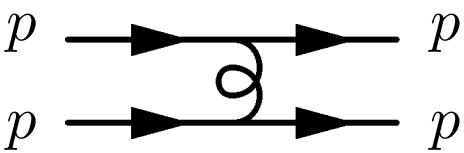

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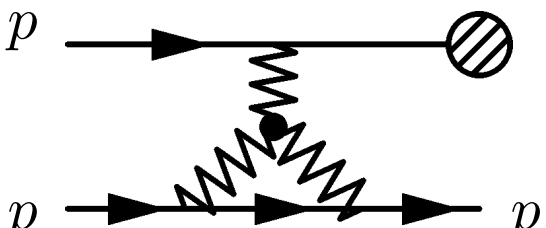

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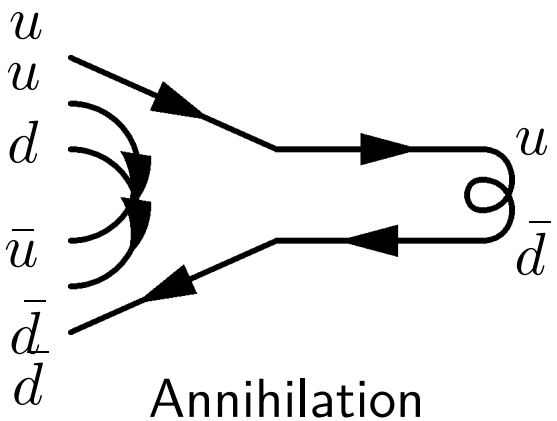

Annihilation

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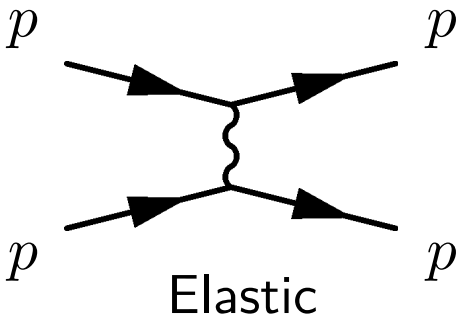

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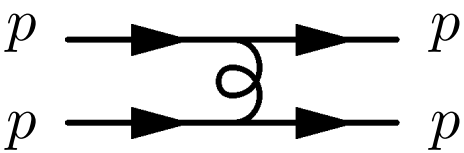
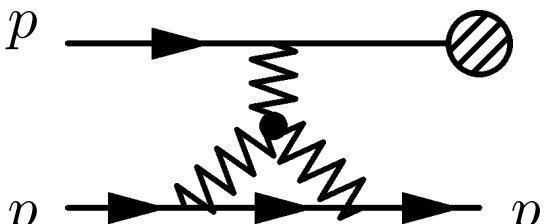
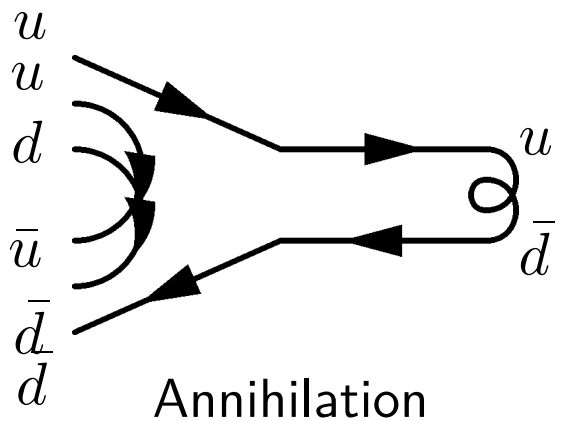


Non-diffractive



Diffractive



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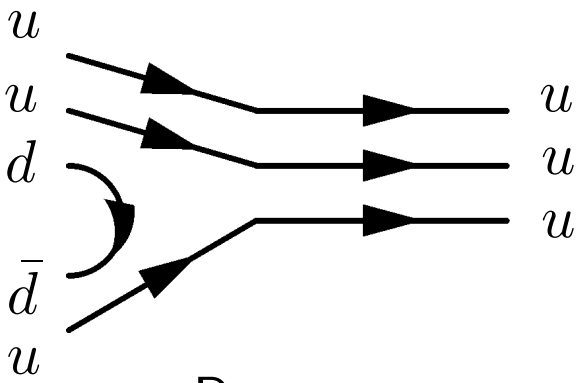
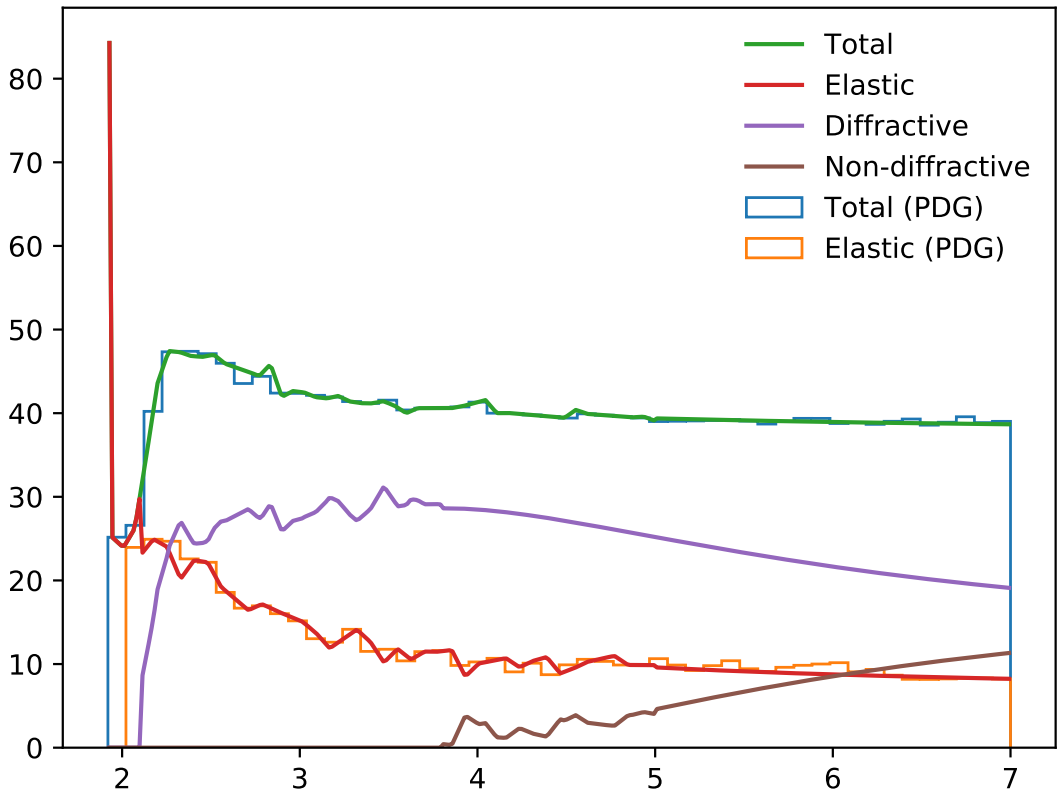


Resonant

pp cross sections

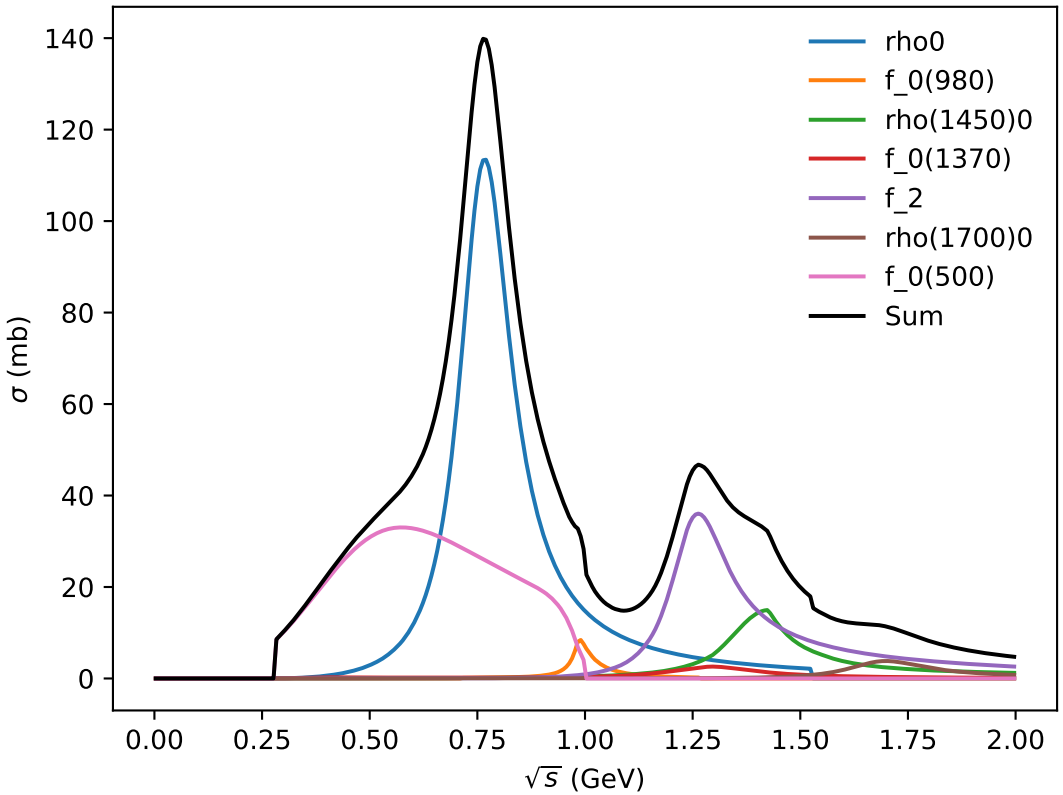


Total: PDG, HPR_1R_2

Elastic: PDG, HERA

Diffractive: SaS, UrQMD

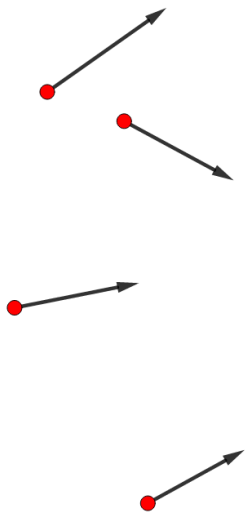
$\pi^+\pi^-$ resonance formation cross sections



Resonant: UrQMD

$f_0(500)$: Garcia-Martin et al.

3. Looking at the whole event



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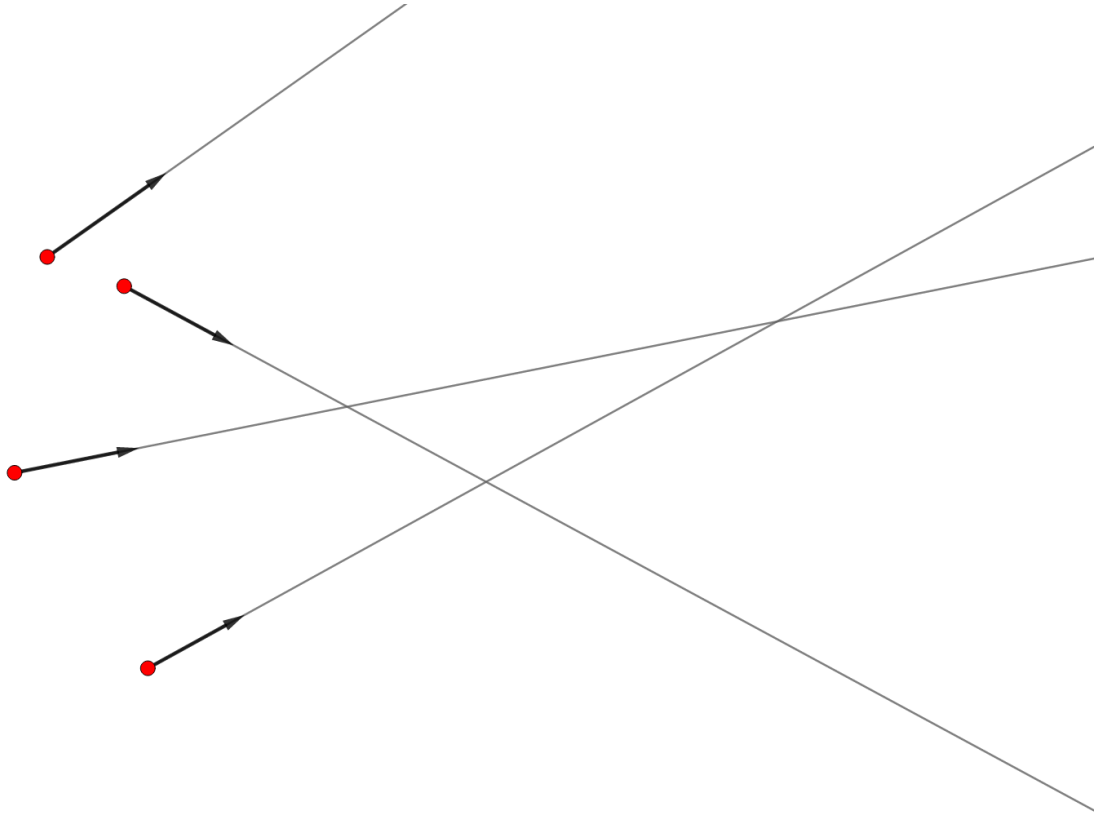

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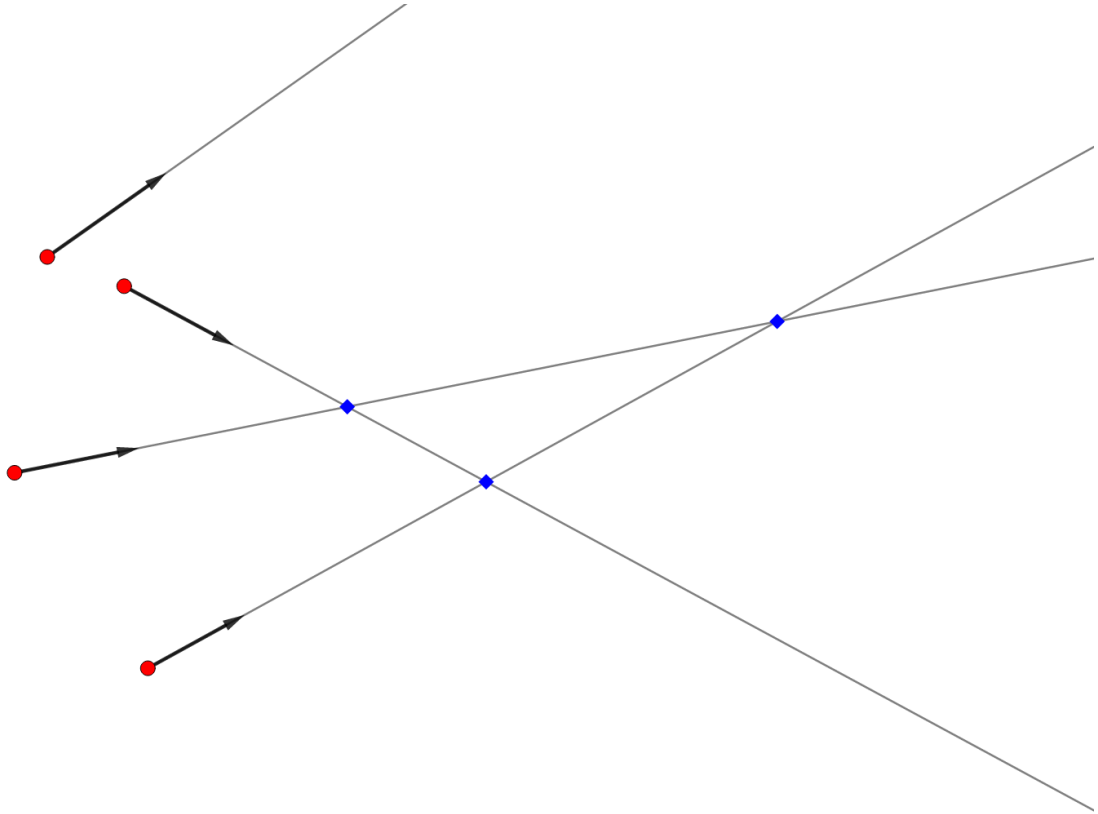

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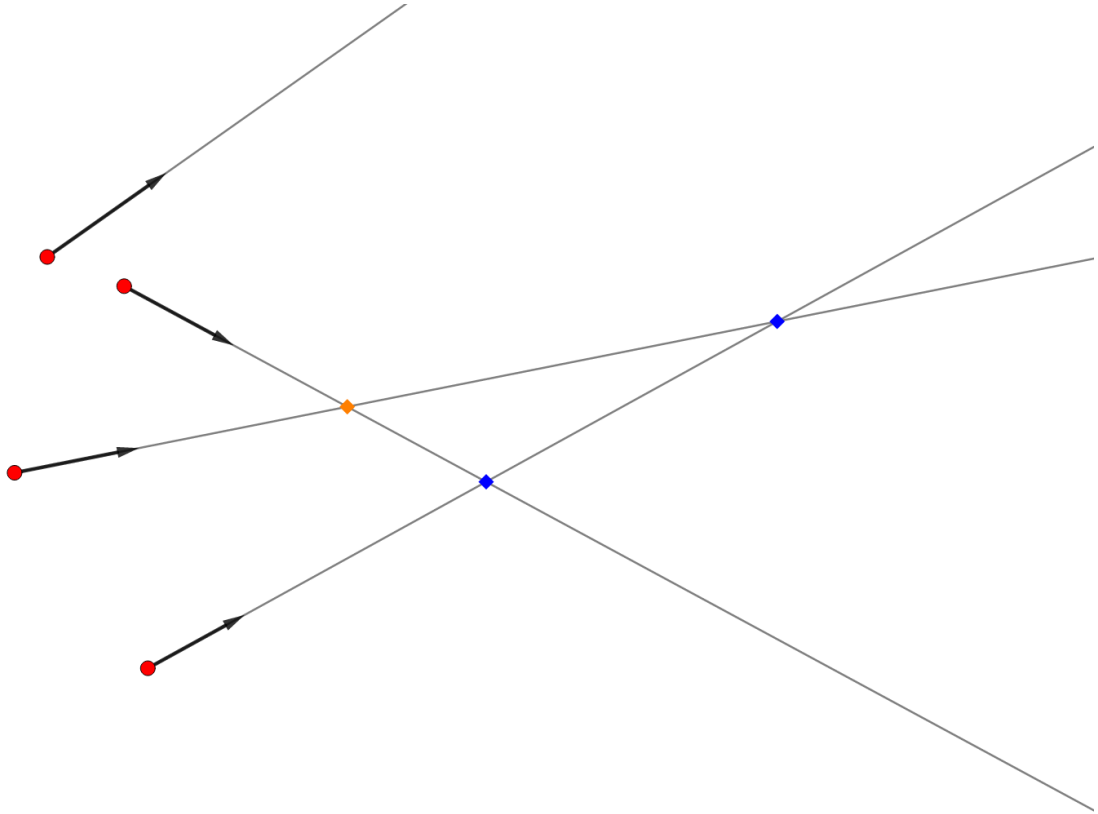

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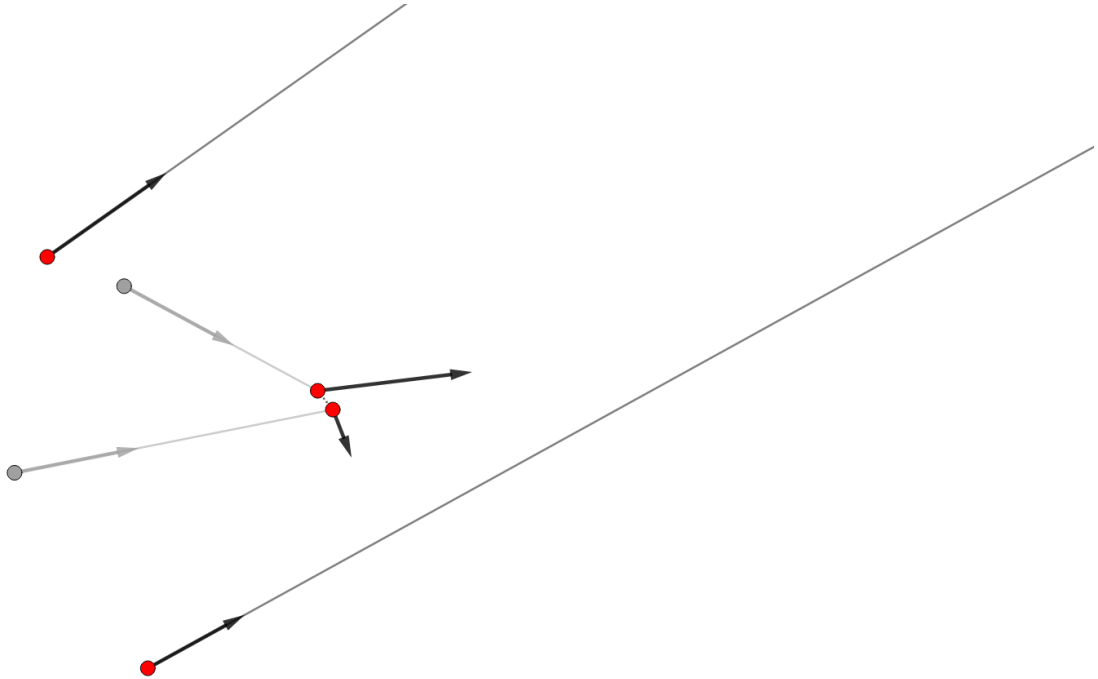

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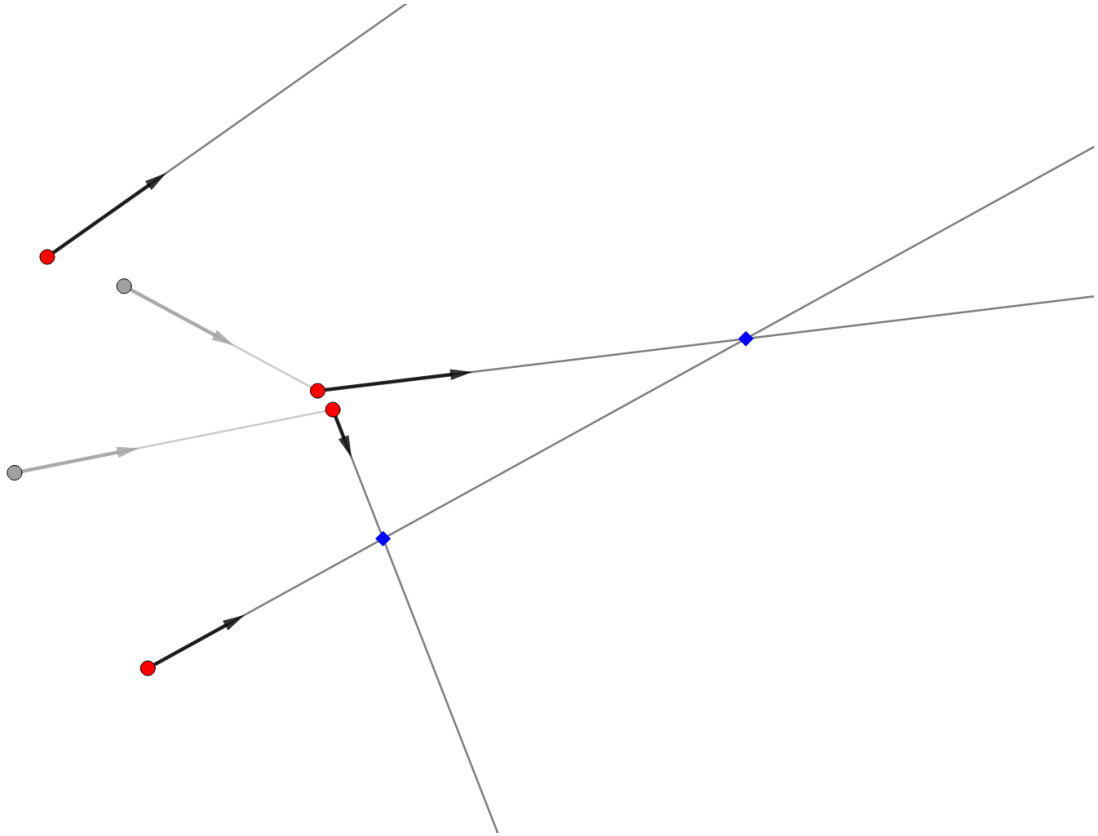

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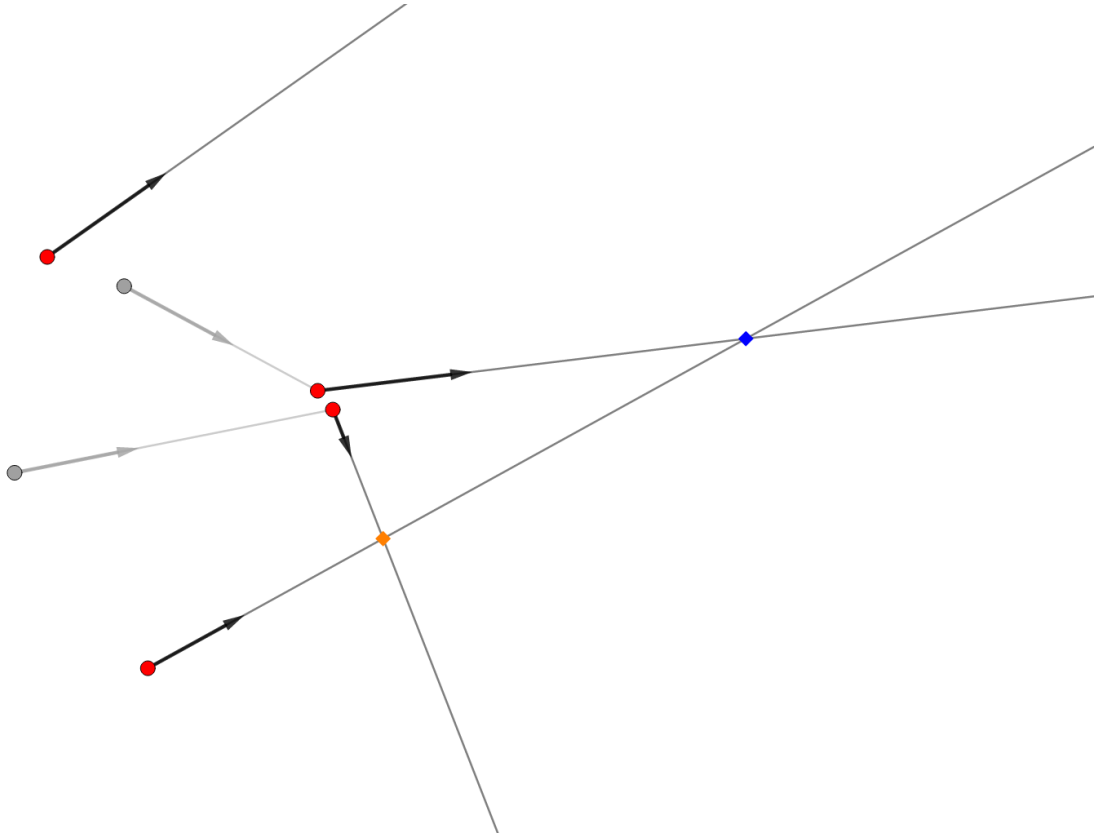

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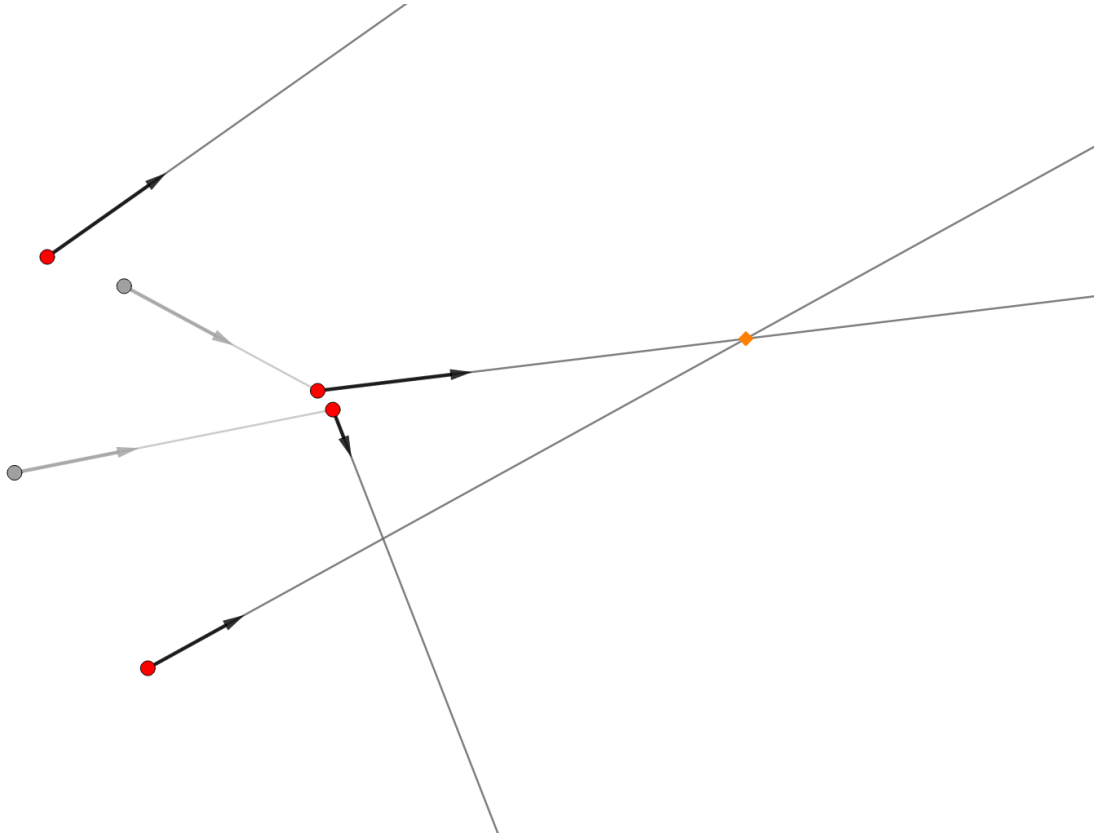

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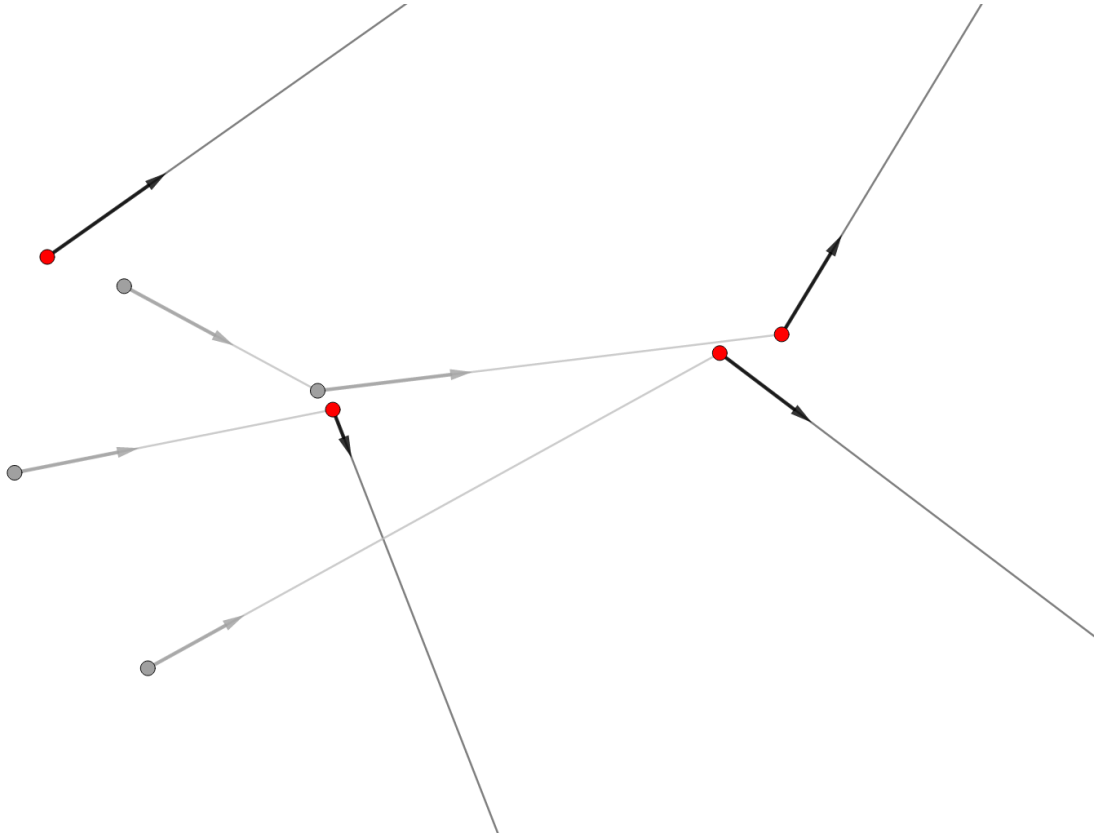
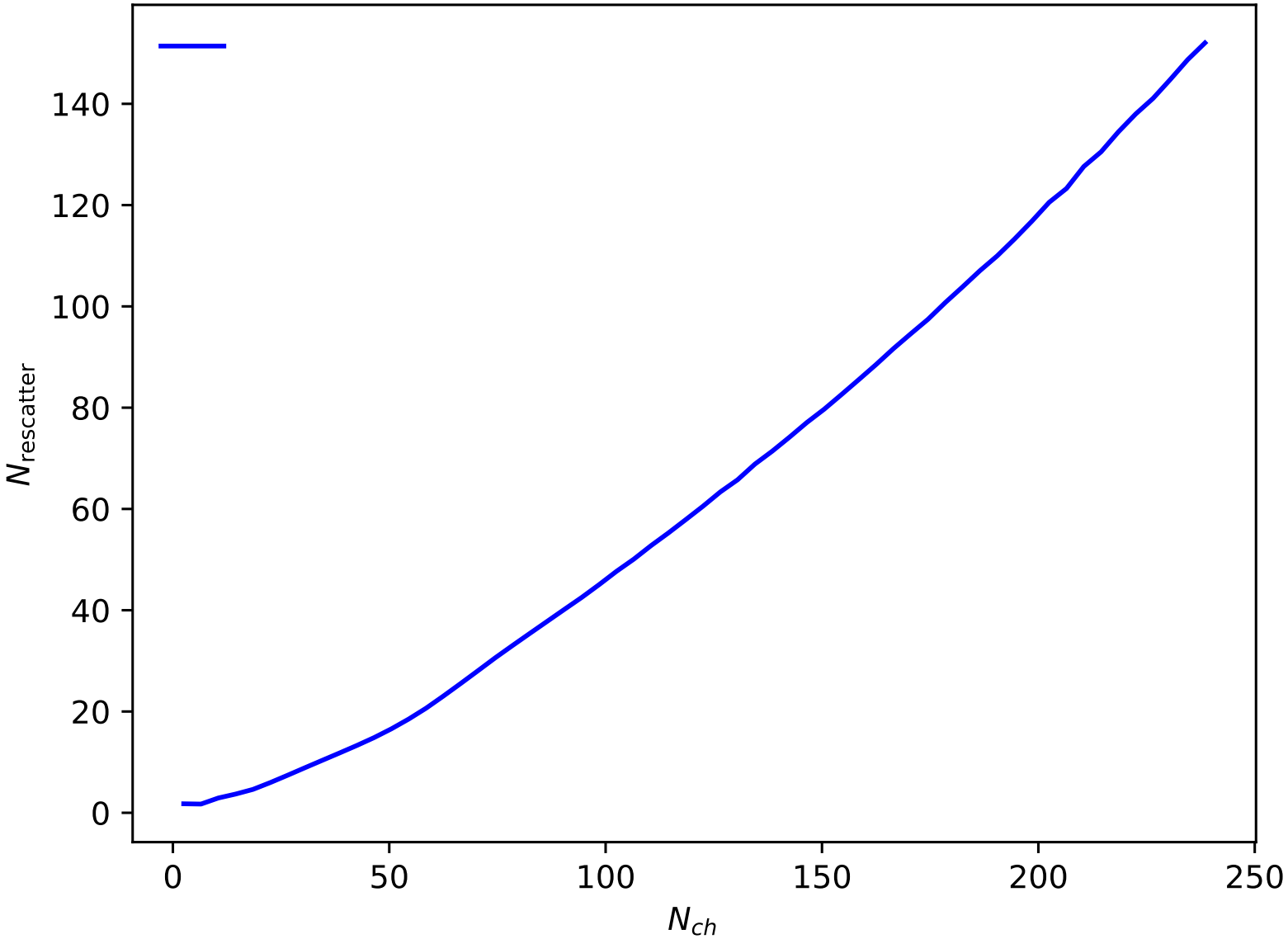


Outline

Results - Number of rescatterings



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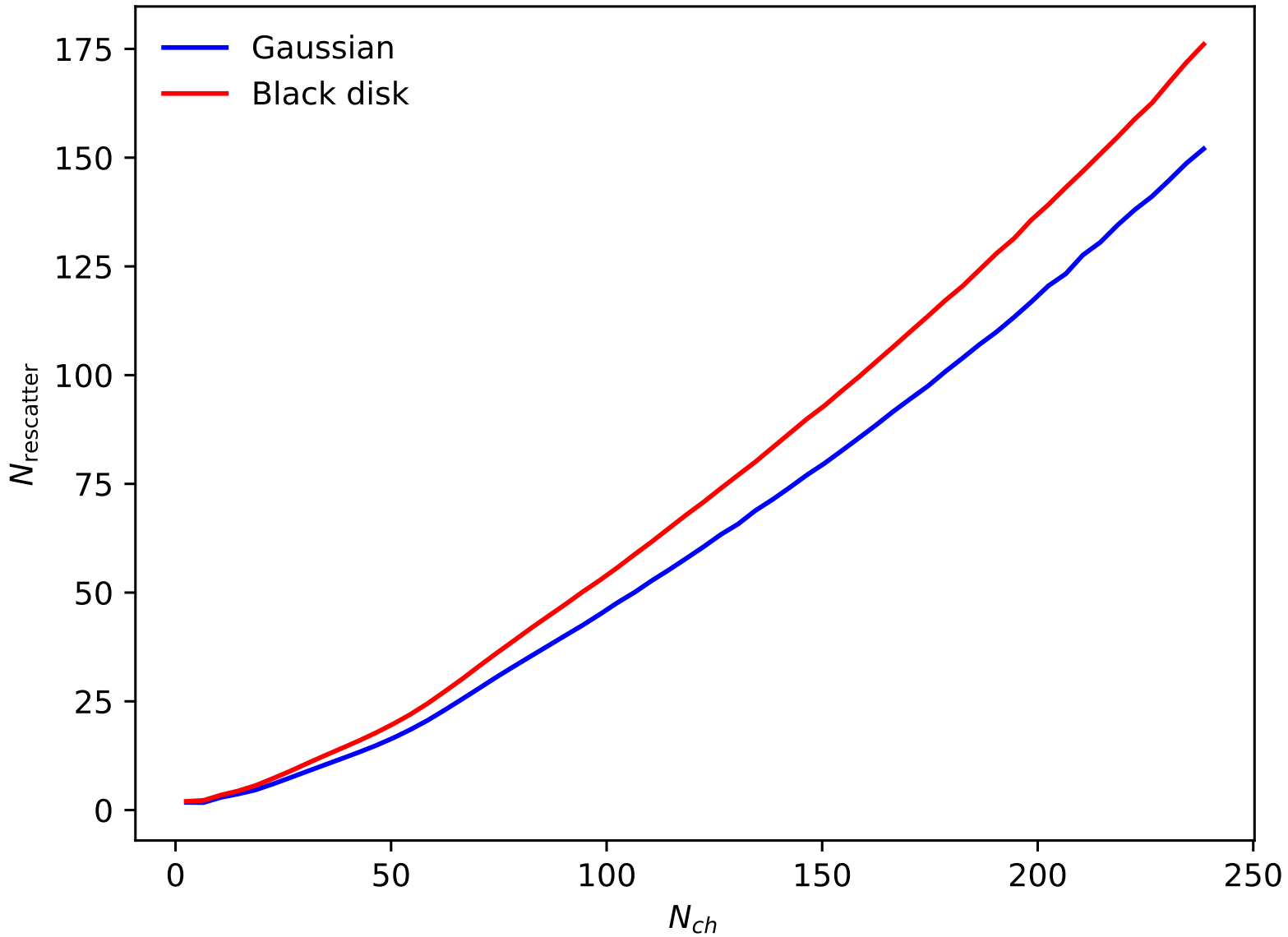
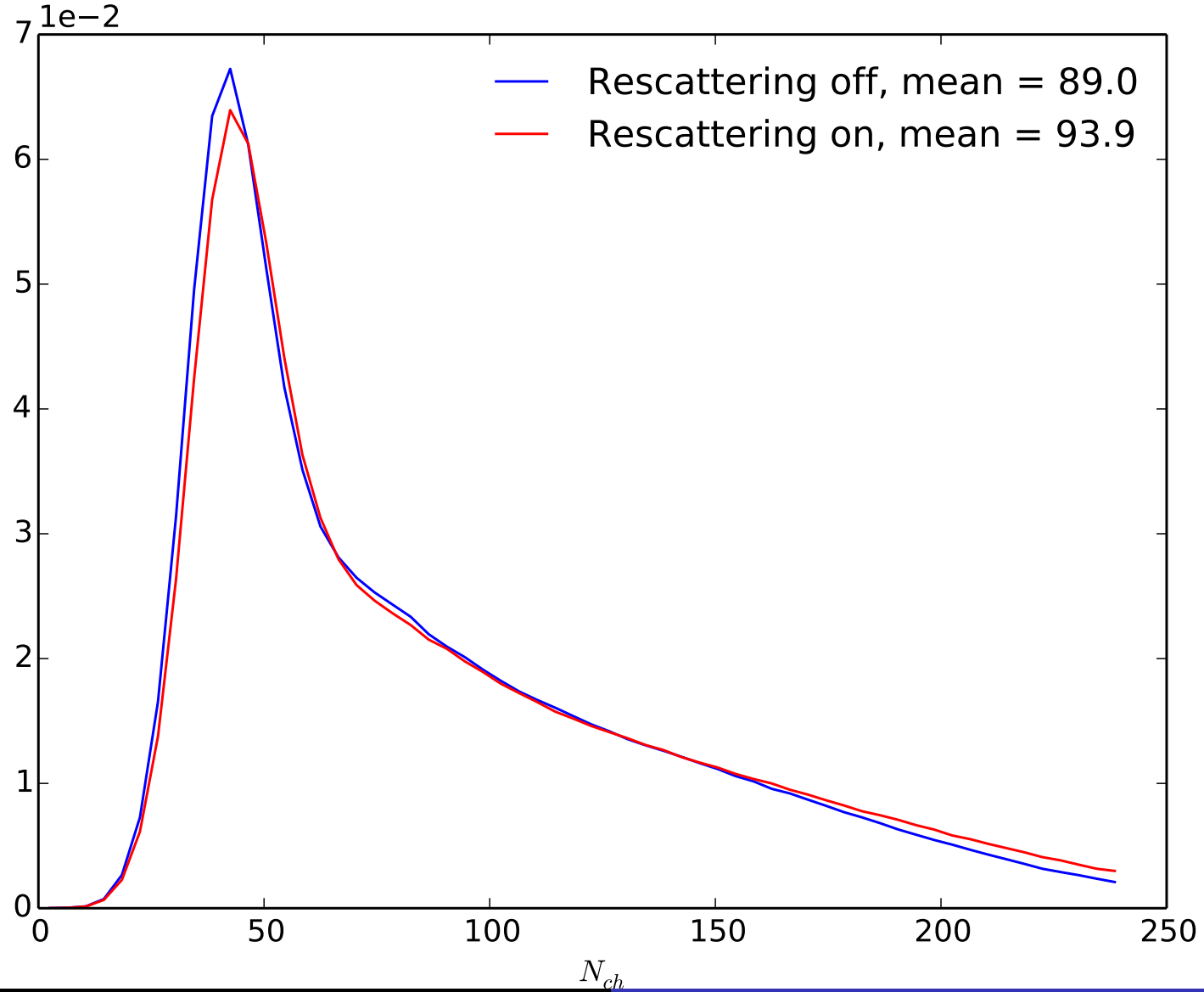


Results - Multiplicity



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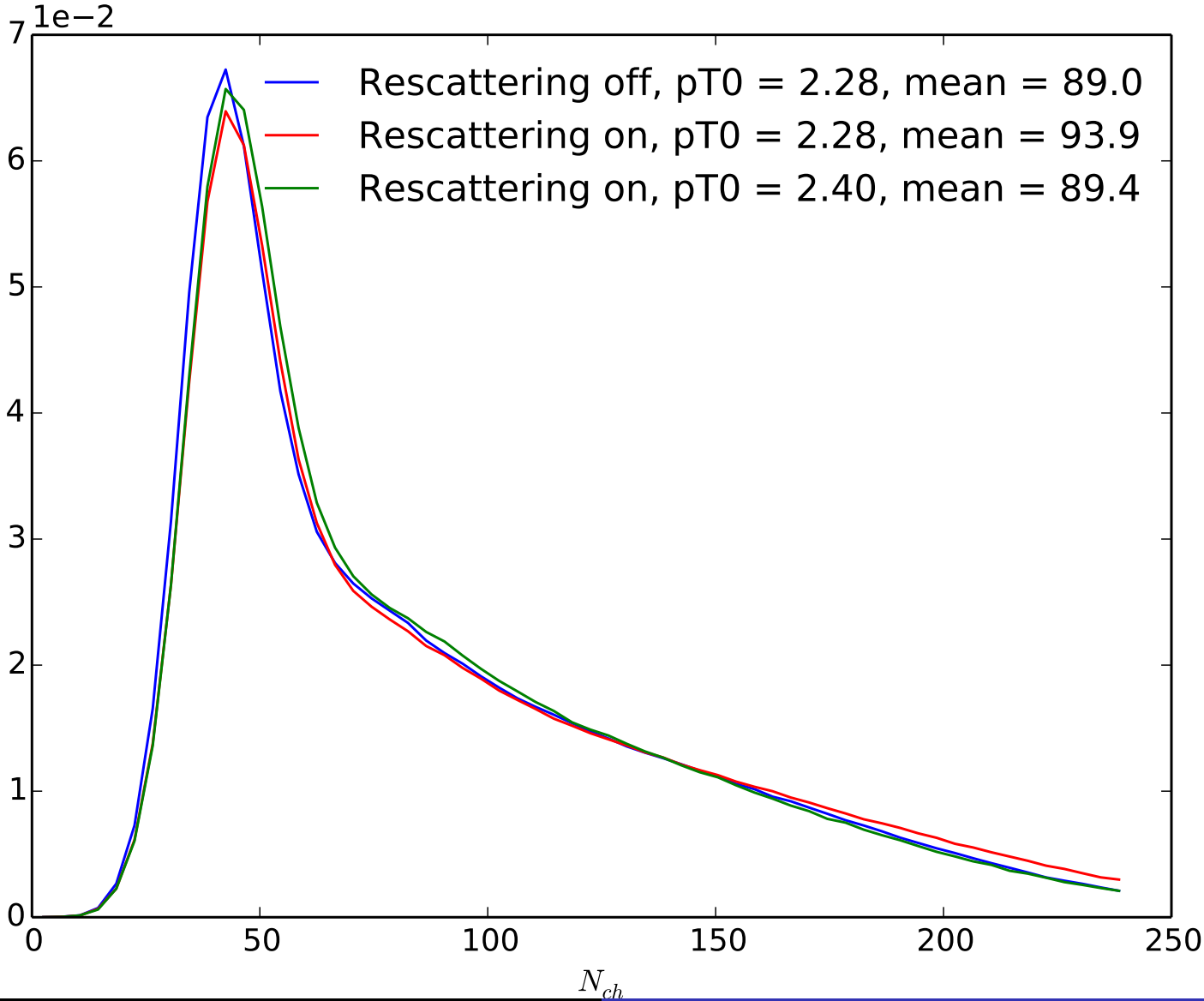
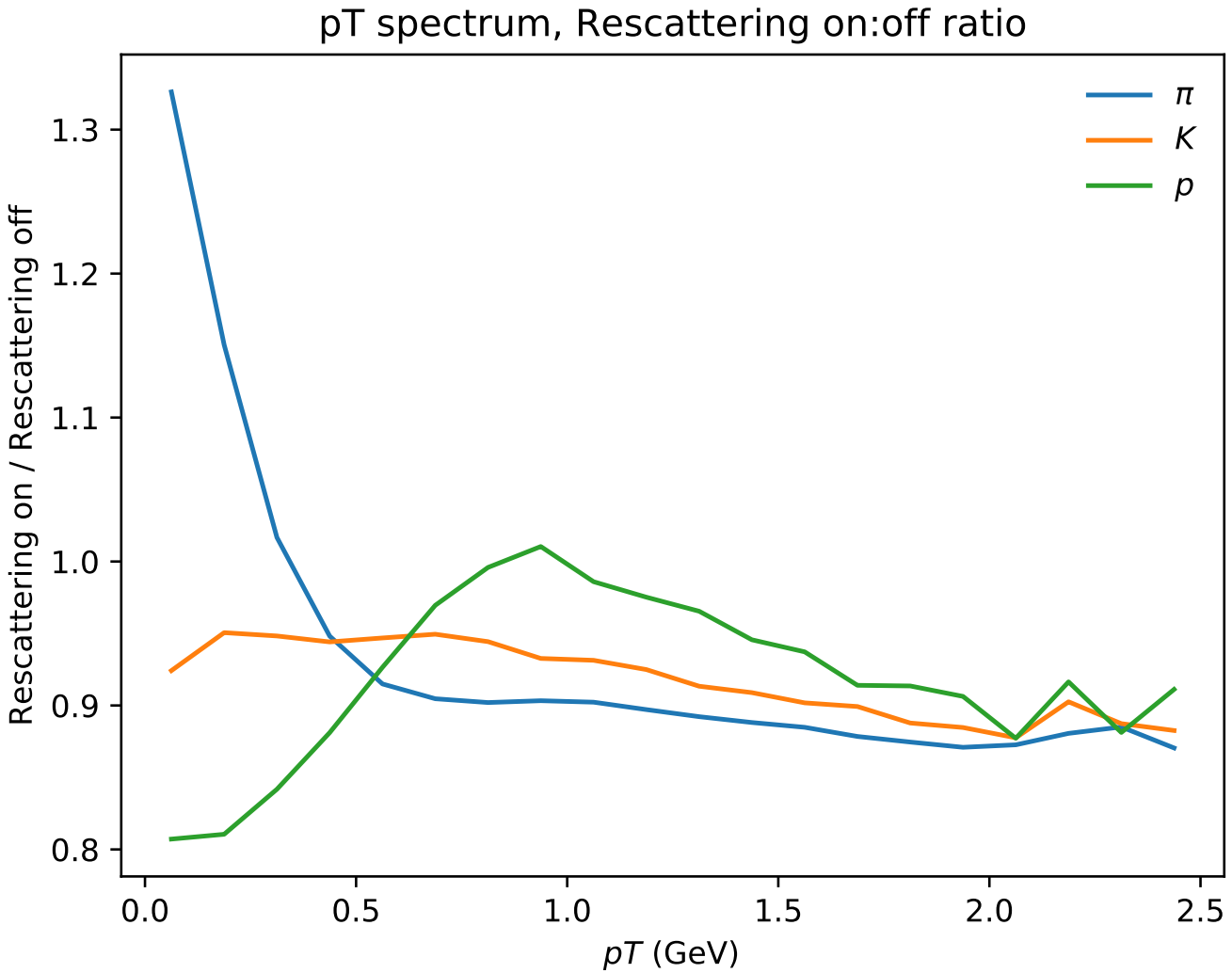
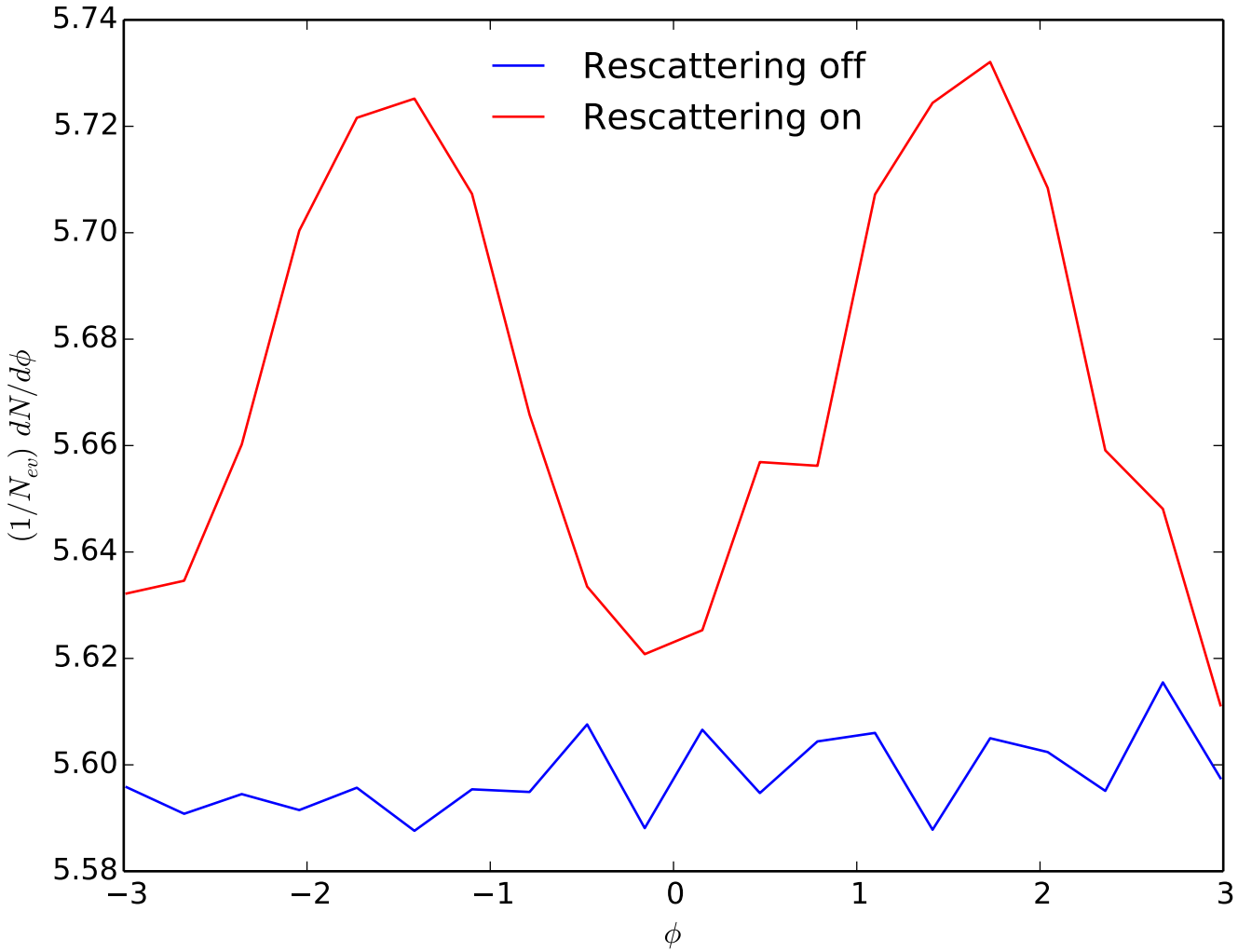


Results - Pion wind



Results - Flow



Outlook

- Preliminary results show that rescattering can contribute to several of the expected phenomena, but more detailed study is needed before we're ready to publish.
- When the first version is done, the natural next step is looking at rescattering in Angantyr.
- Another direction is using the rescattering framework to study cosmic rays.
- The code will hopefully be released in Pythia 8.302.