Hadronic Rescattering in Pythia

With a focus on low-energy processes

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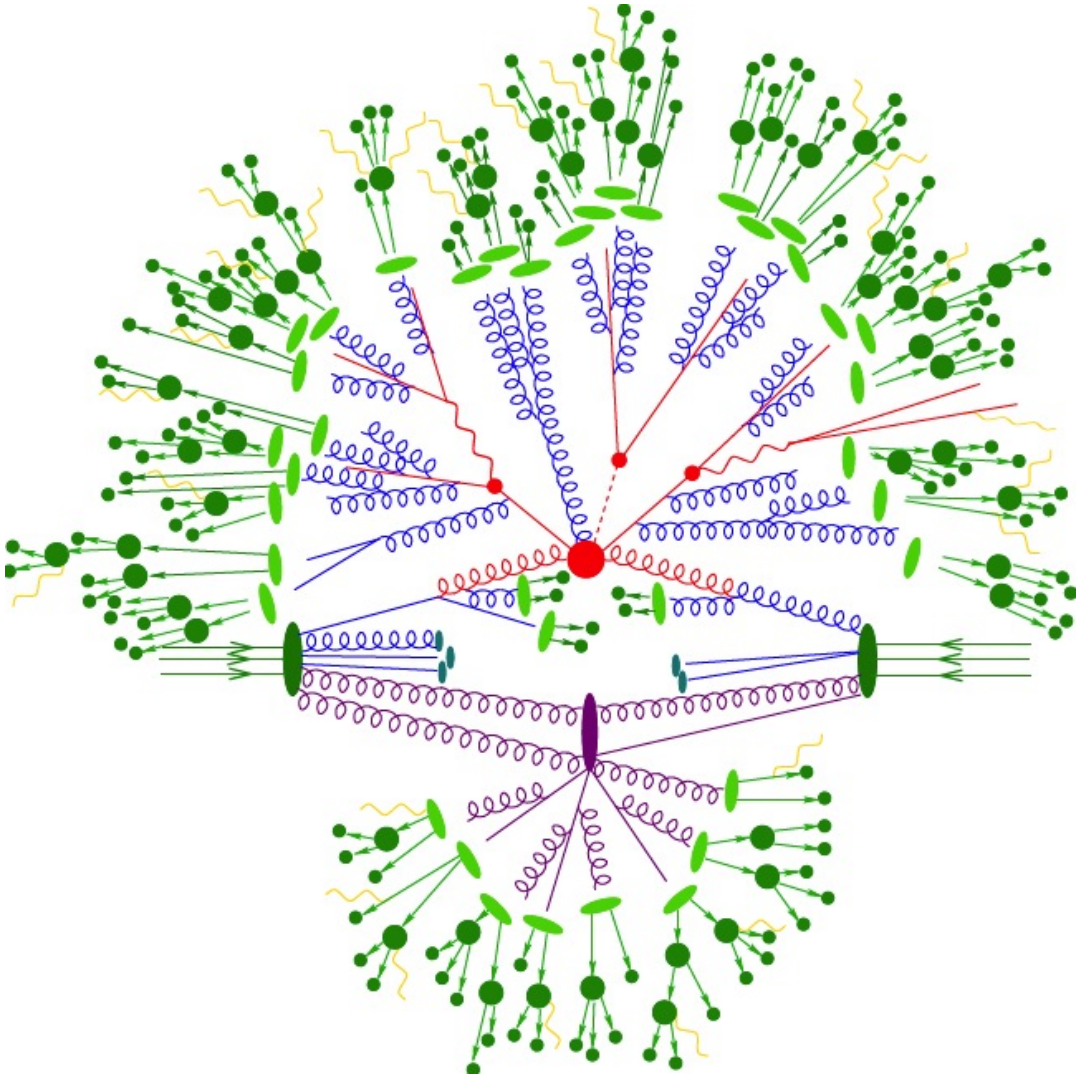
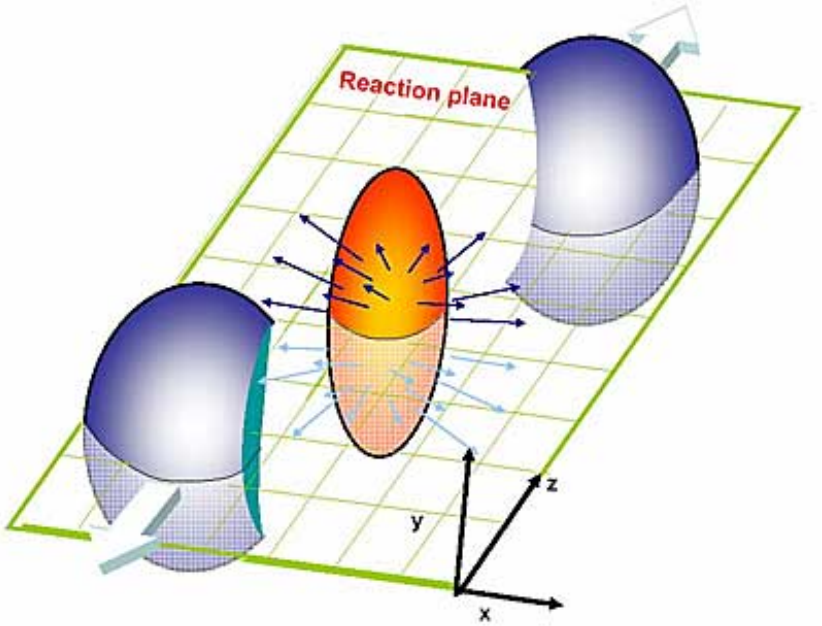
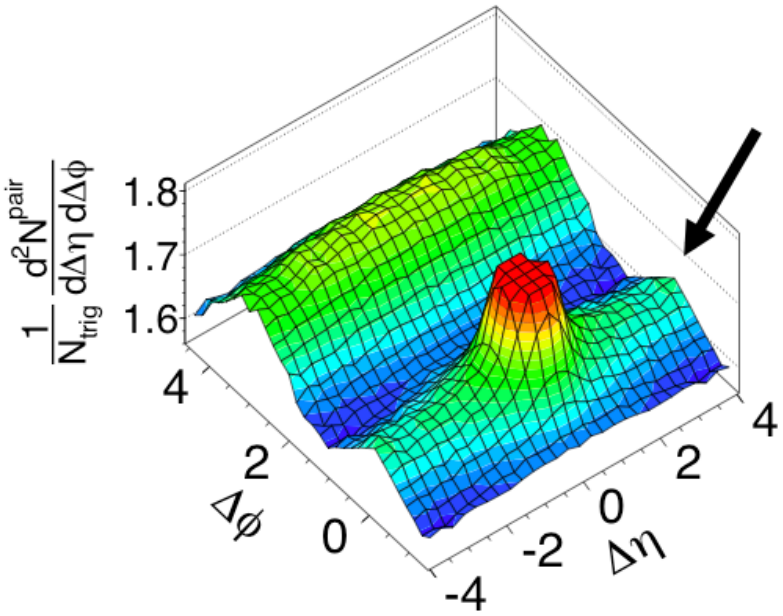
What is rescattering?



Why is rescattering important?

Phenomena: Flow, jet quenching, strangeness enhancement





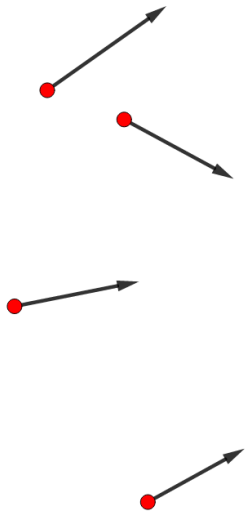
What causes these phenomena in pA and pp collisions?

Rescattering should contribute somehow

Outline

Outline

The rescattering algorithm



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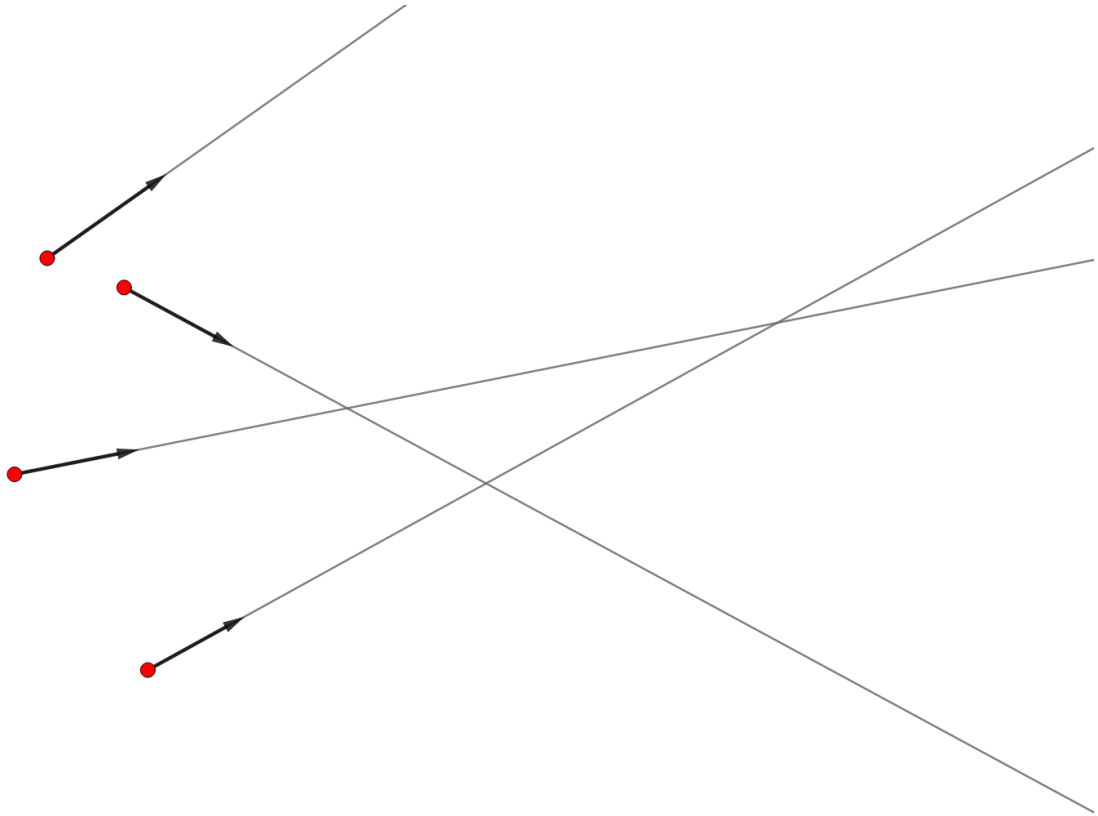

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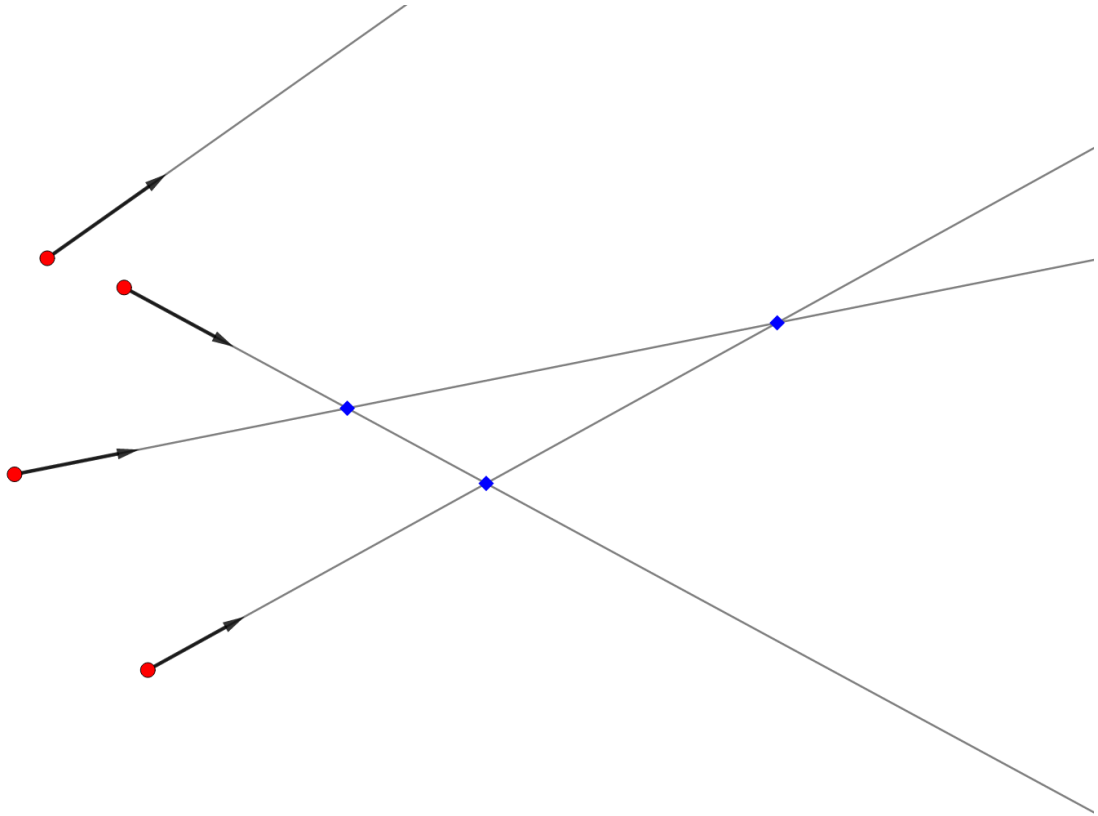

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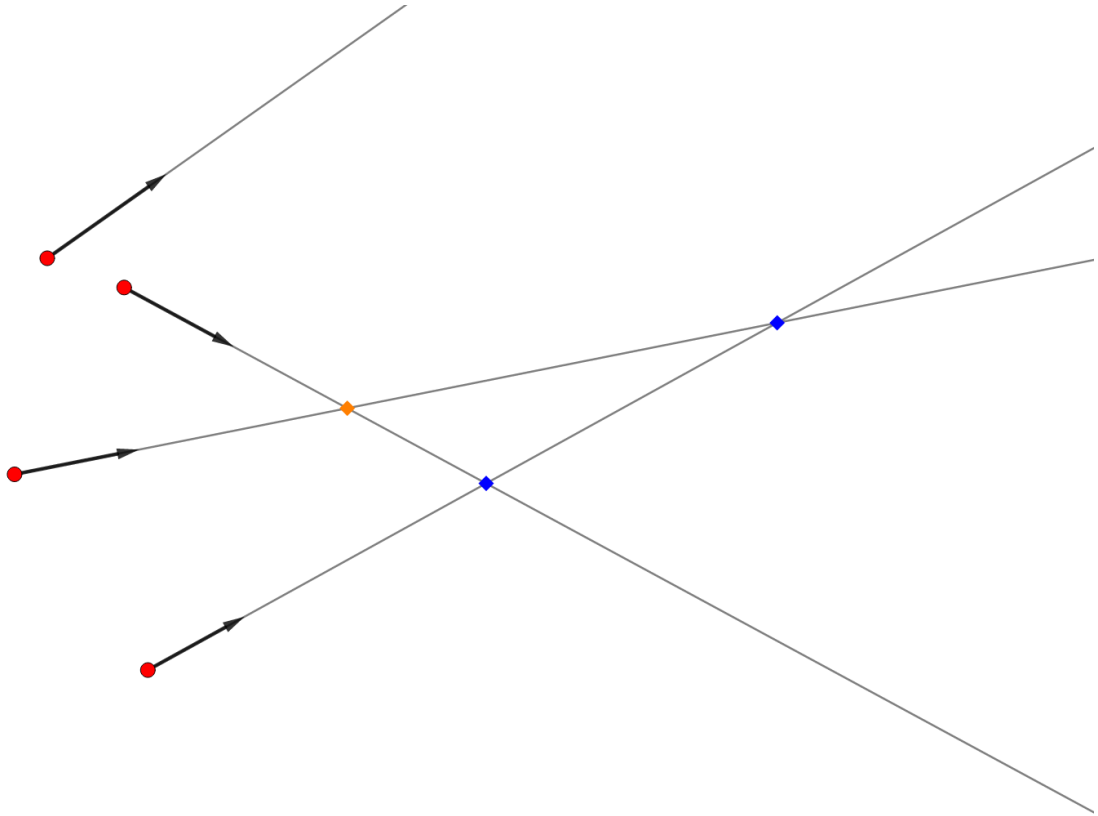

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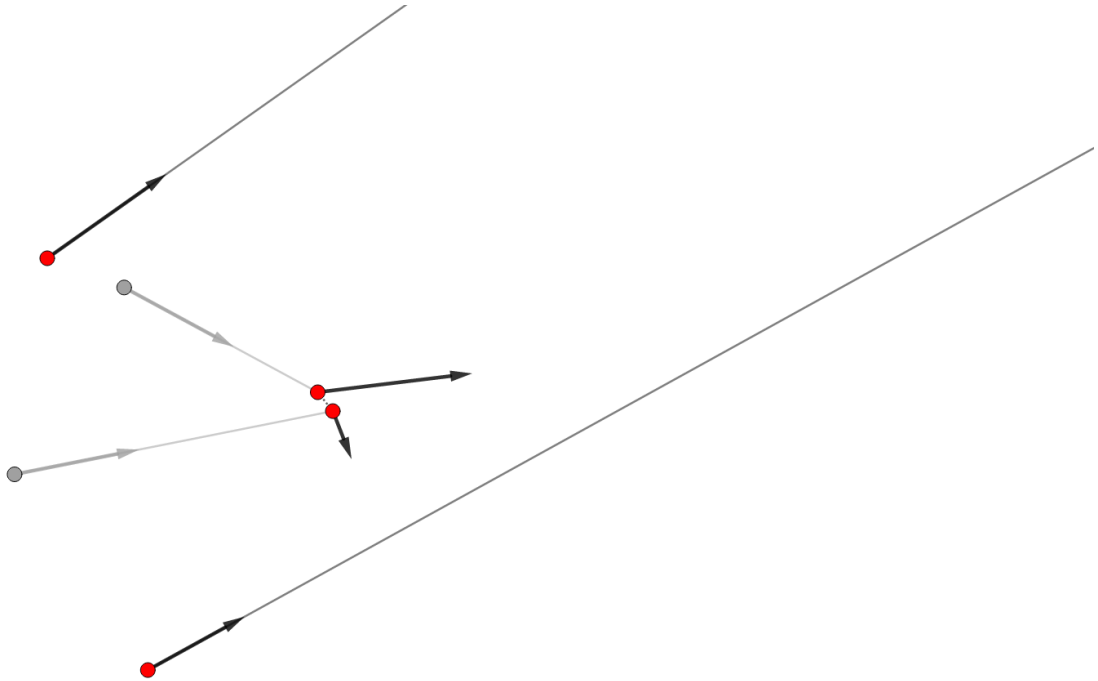

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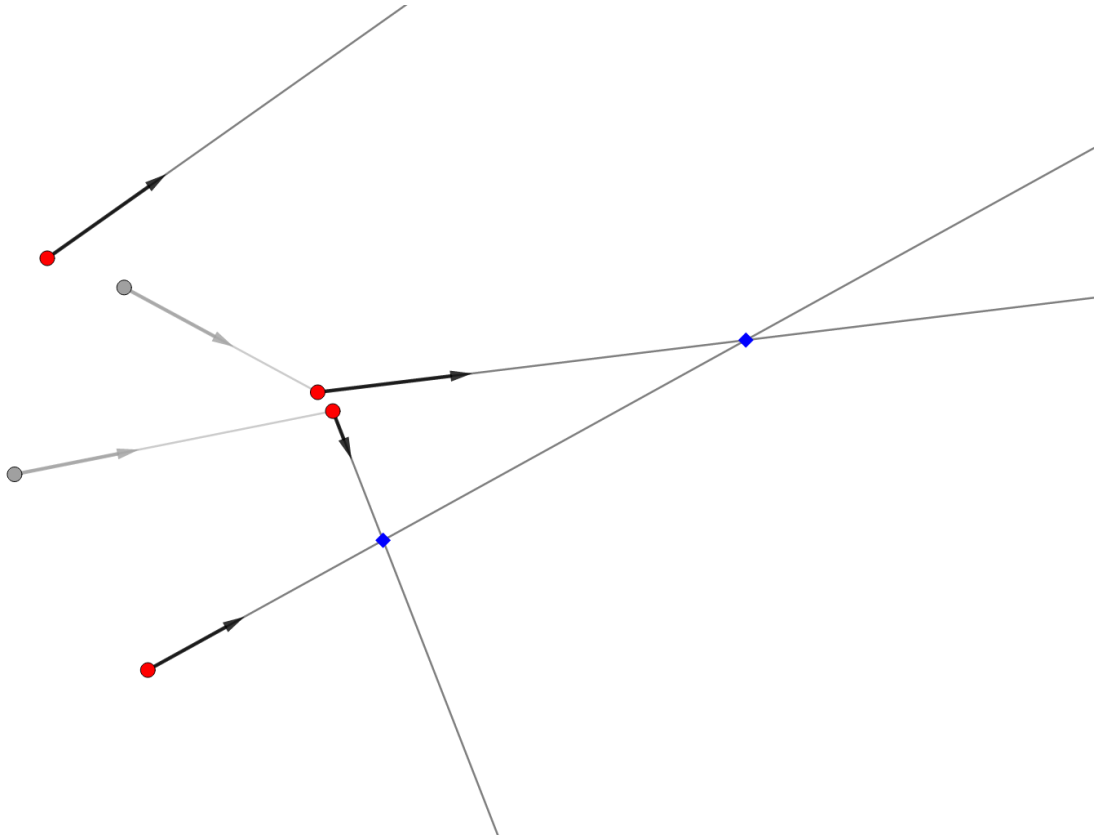

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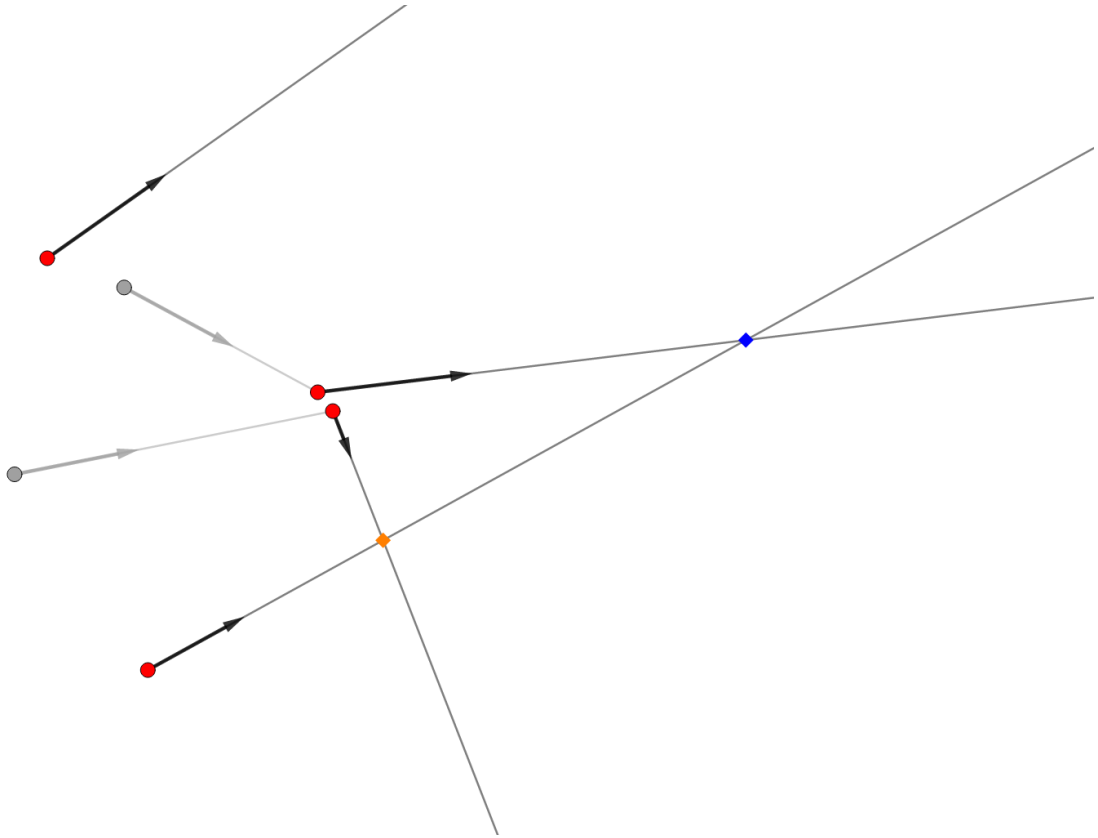

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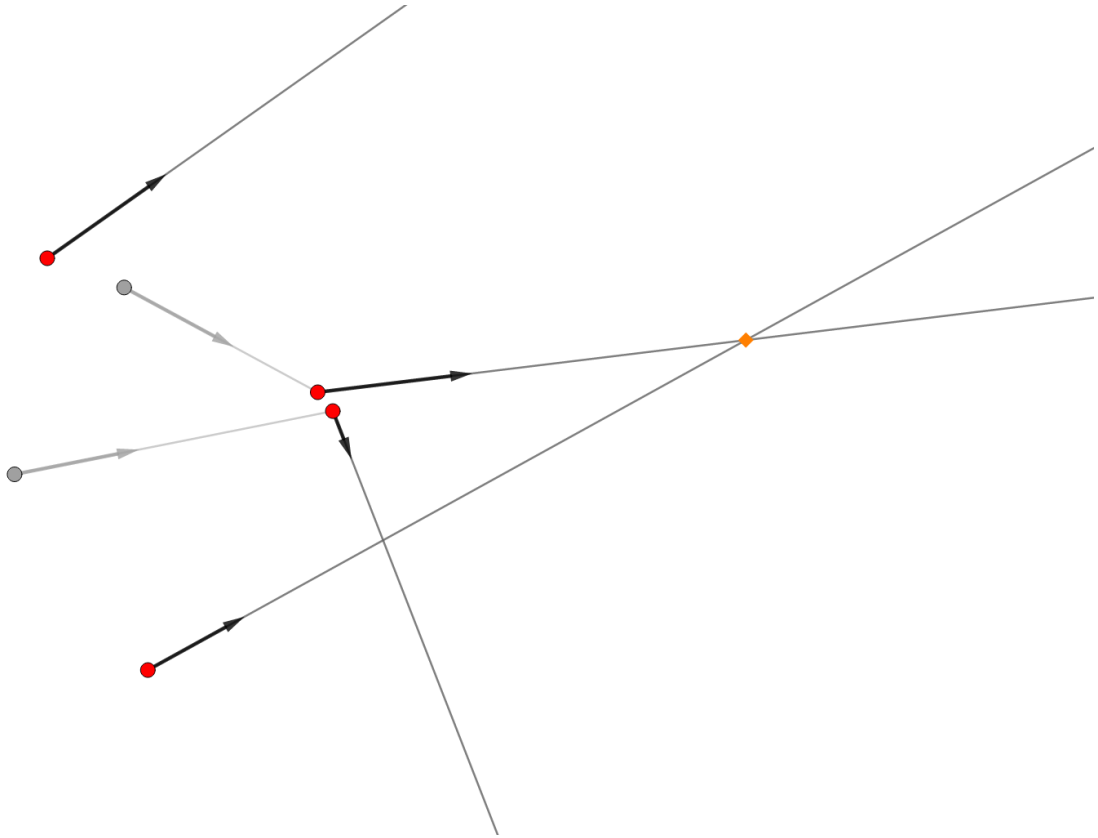

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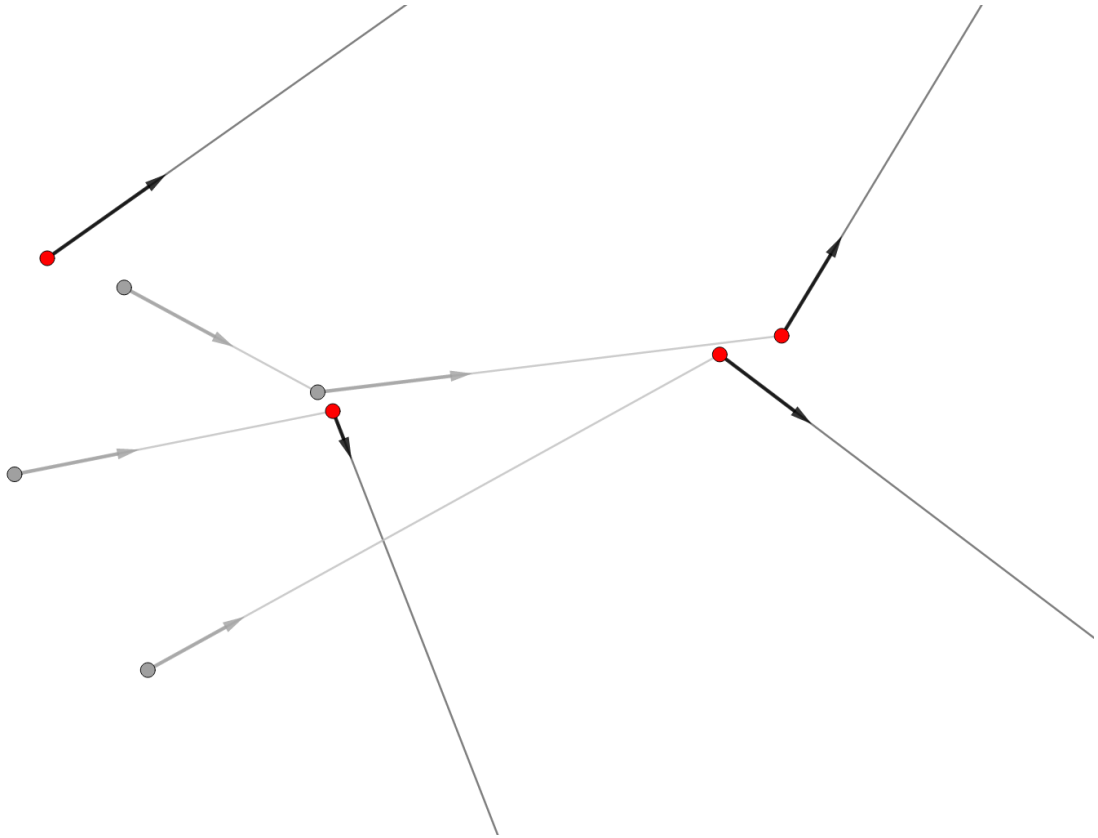
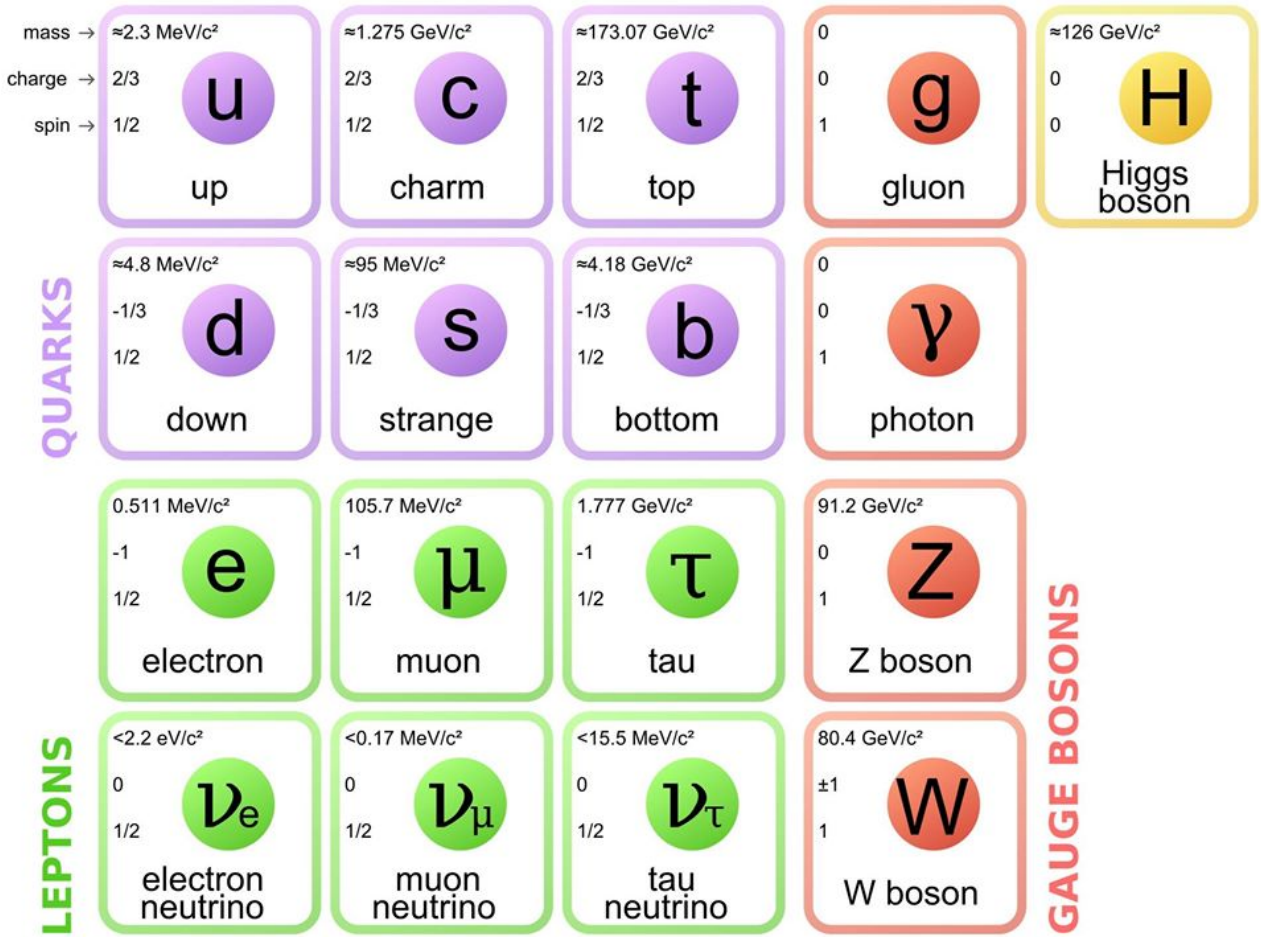


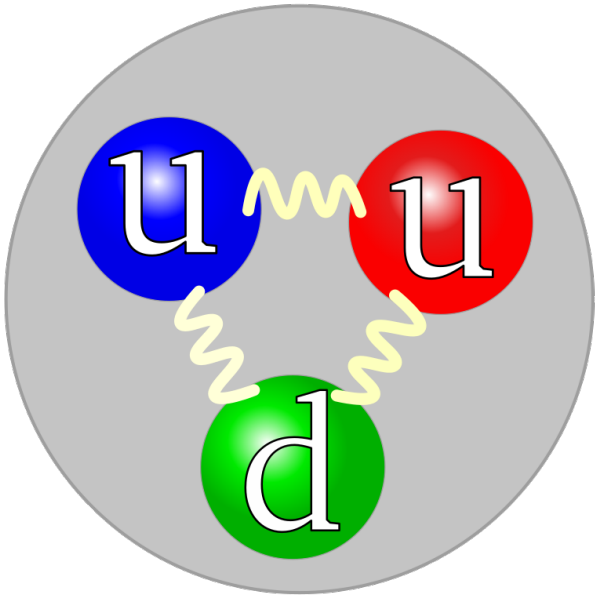
Outline

The strong force



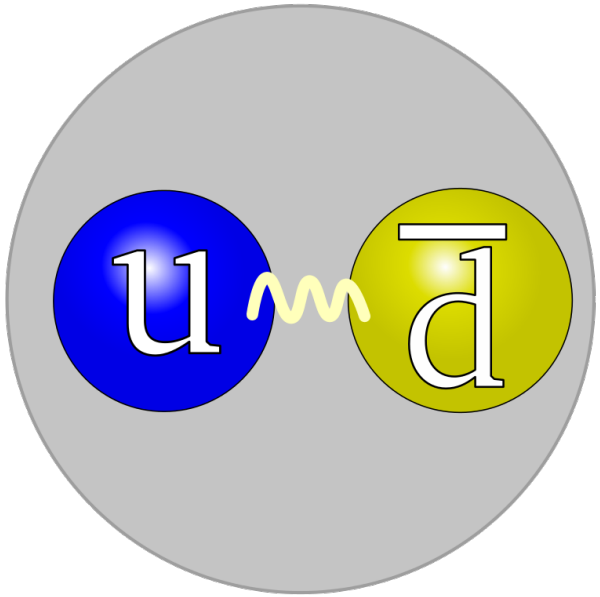
Hadrons

Proton p



Baryons: $r + g + b =$ neutral

Pion π^+

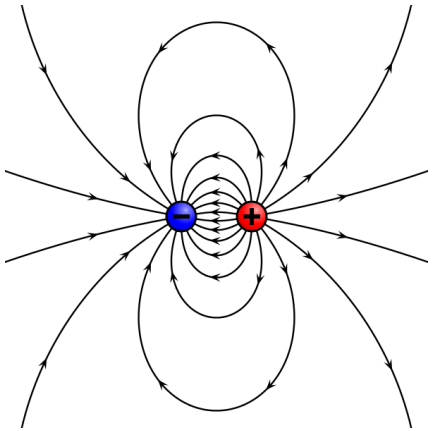


Mesons: $b + \bar{b} =$ neutral

Electromagnetism vs. the strong force

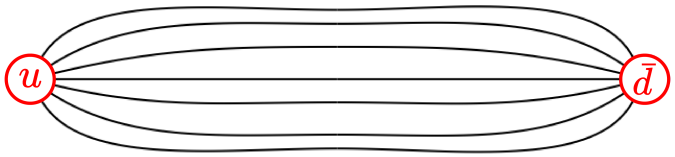
Electromagnetism

$$V(r) = \frac{k}{r}$$



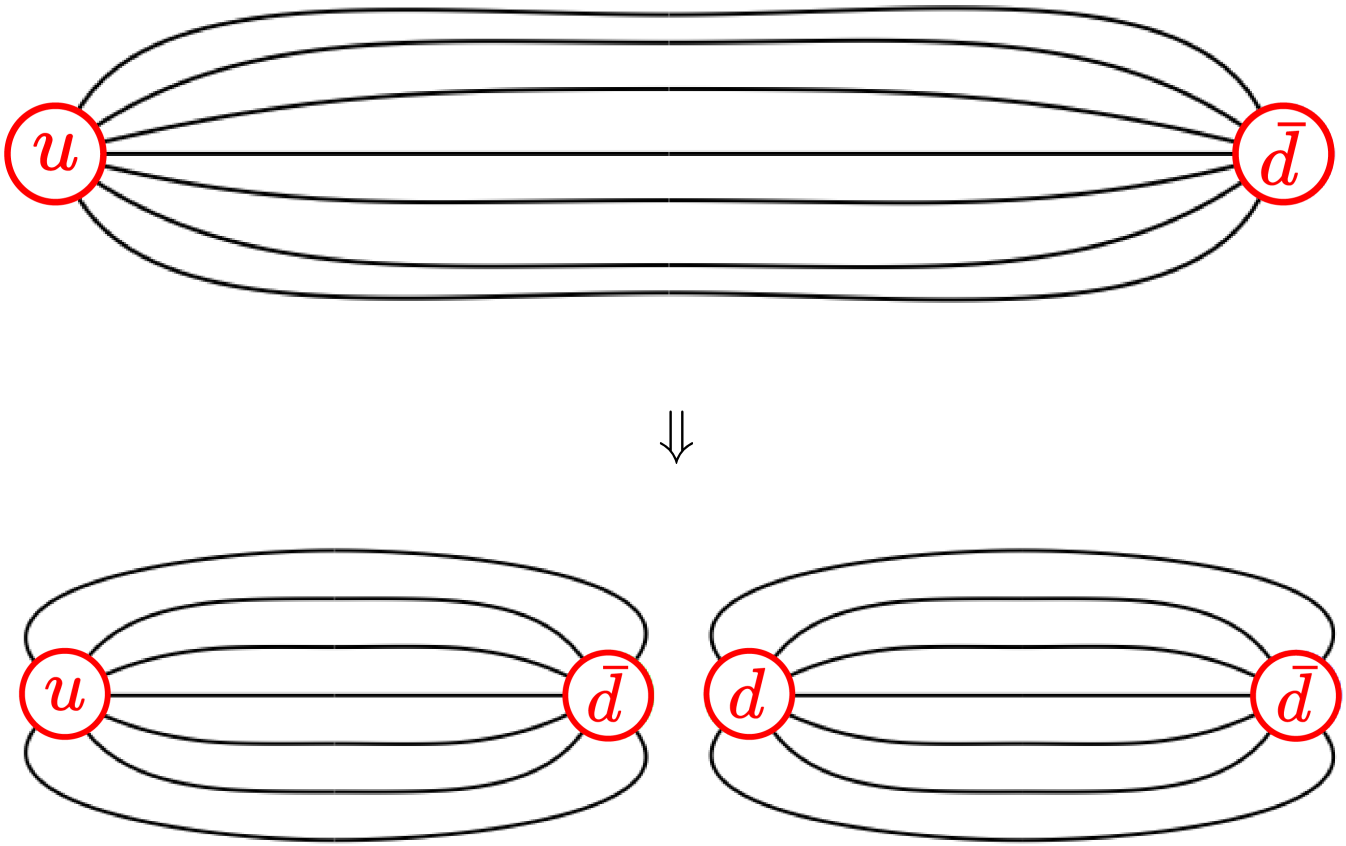
Strong force

$$V(r) = \kappa r$$

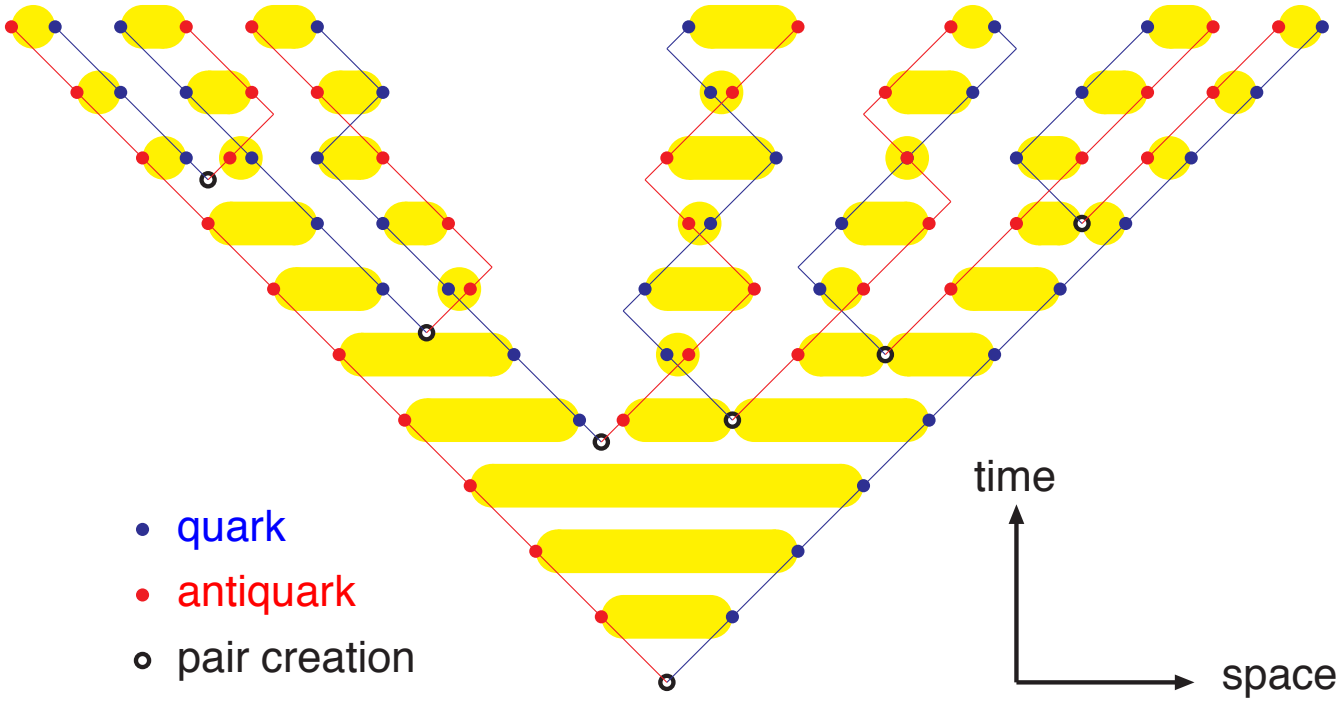


$$\lim_{r \to \infty} V(r) = \infty$$

String breaking



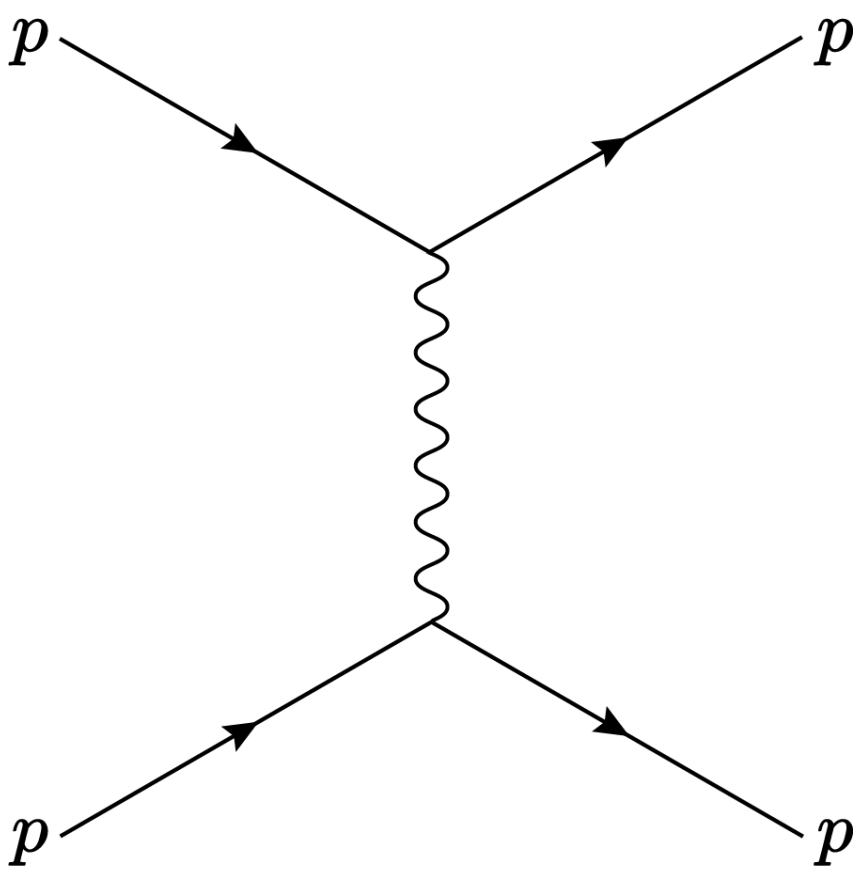
String breaking



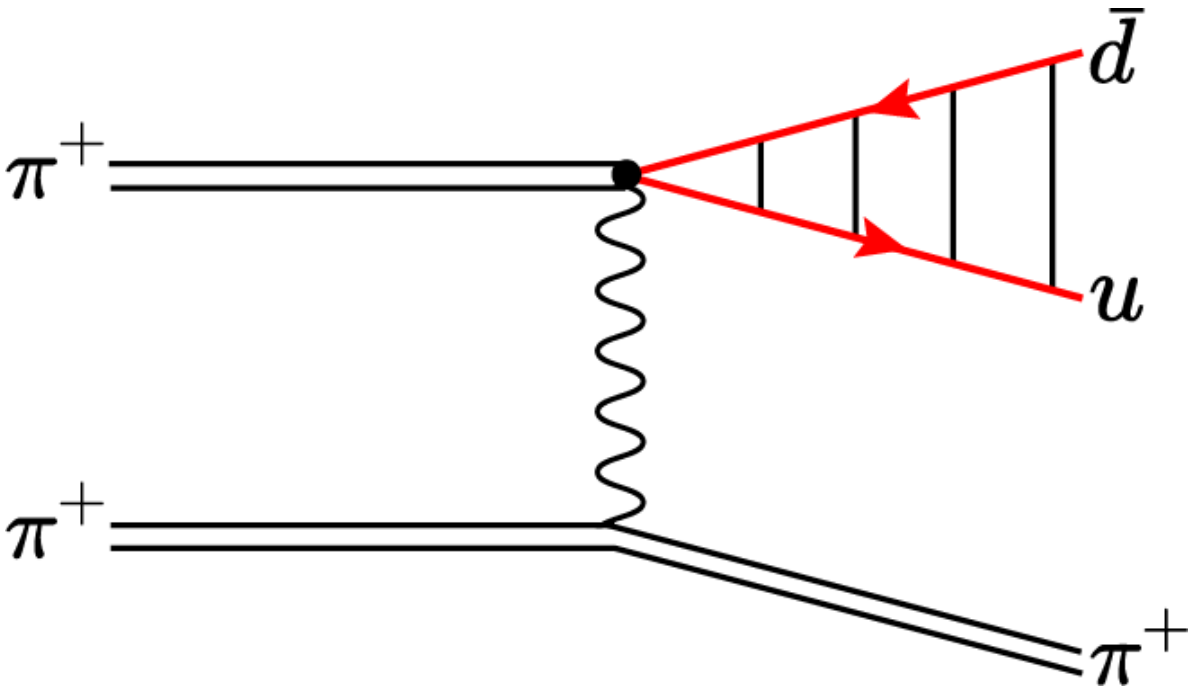
Low-energy processes

- Elastic scattering
- Diffractive scattering
- Non-diffractive scattering
- Baryon annihilation
- Resonance formation

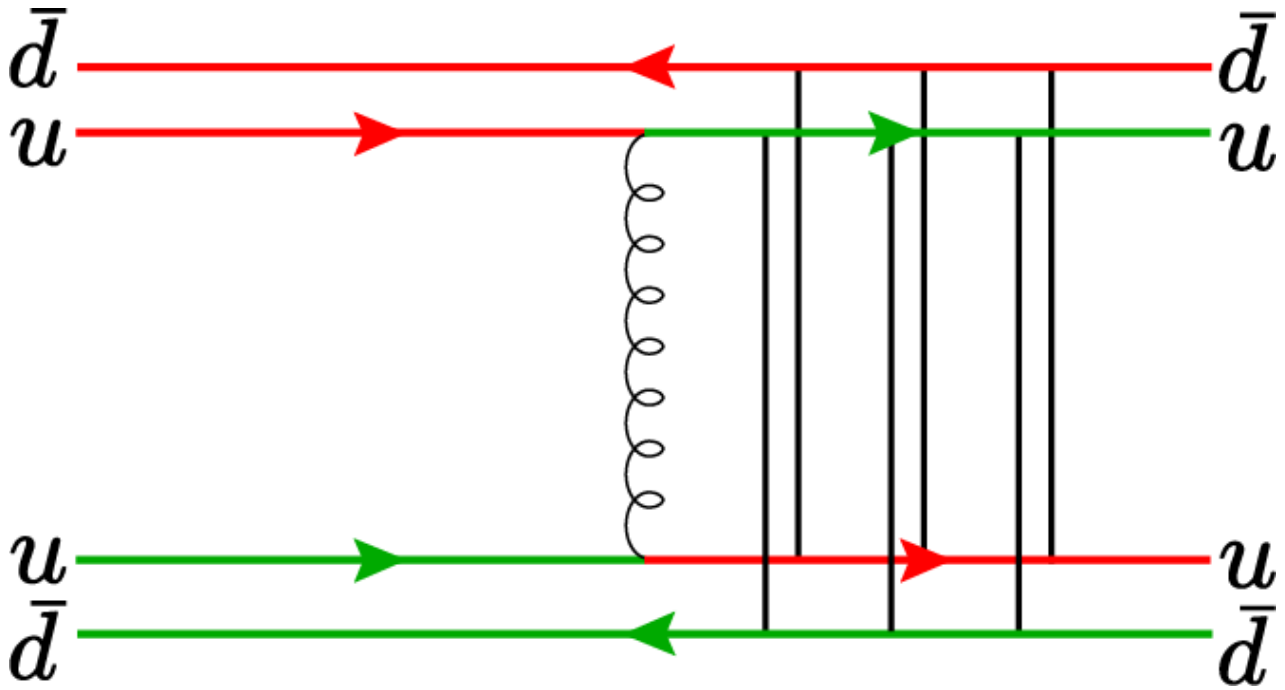
Elastic scattering



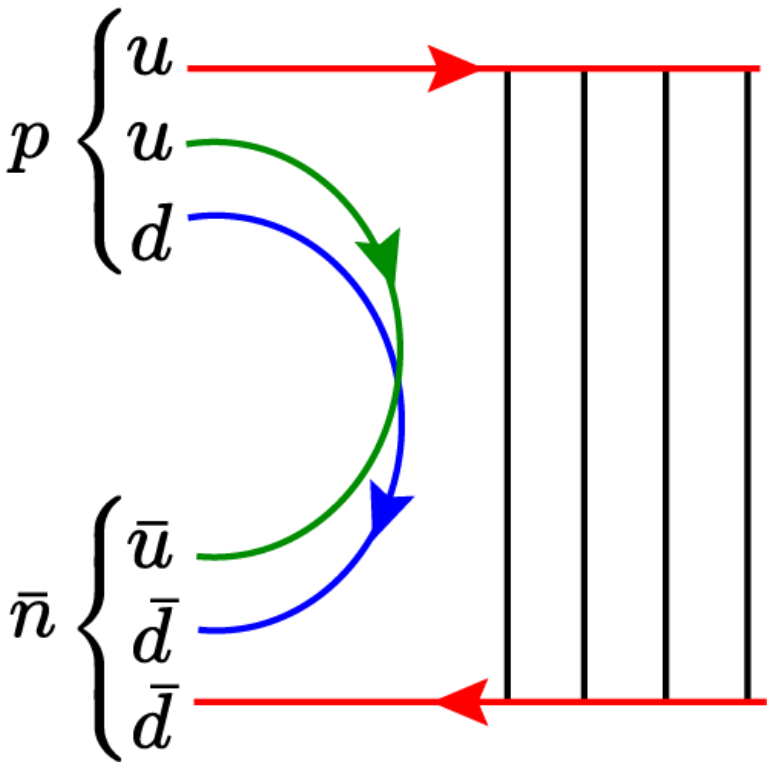
Diffractive scattering



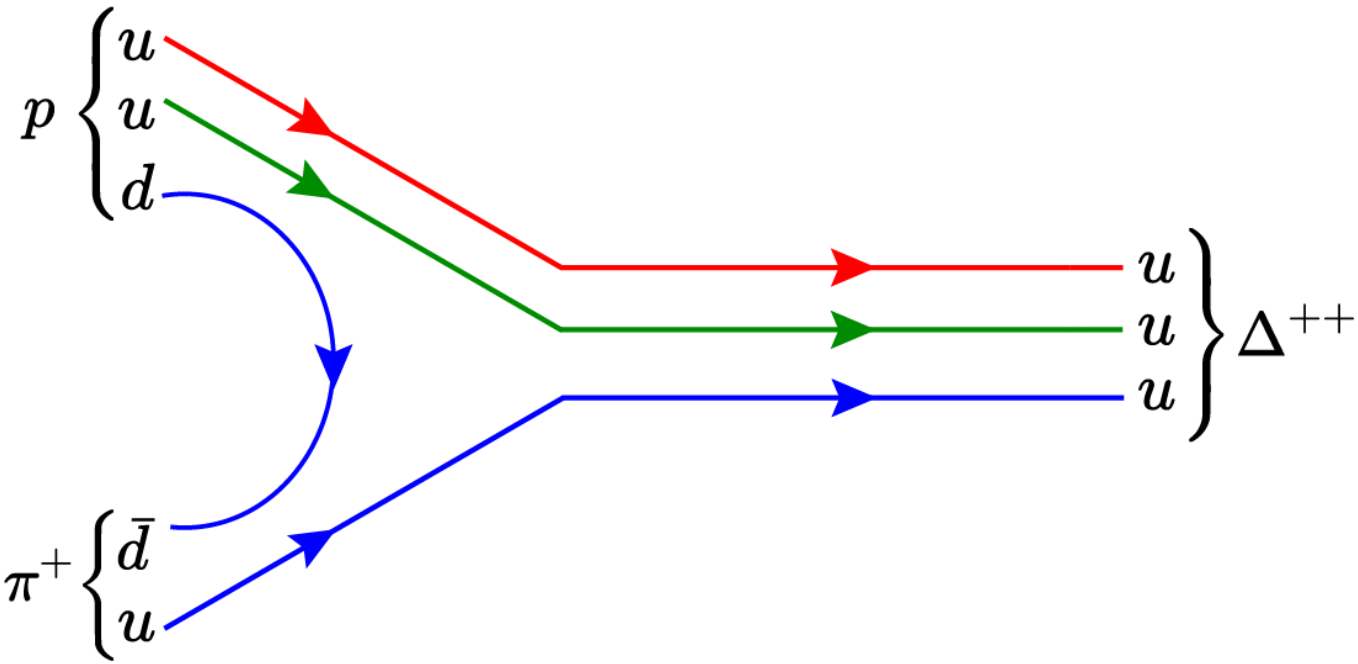
Non-diffractive scattering



Baryon annihilation

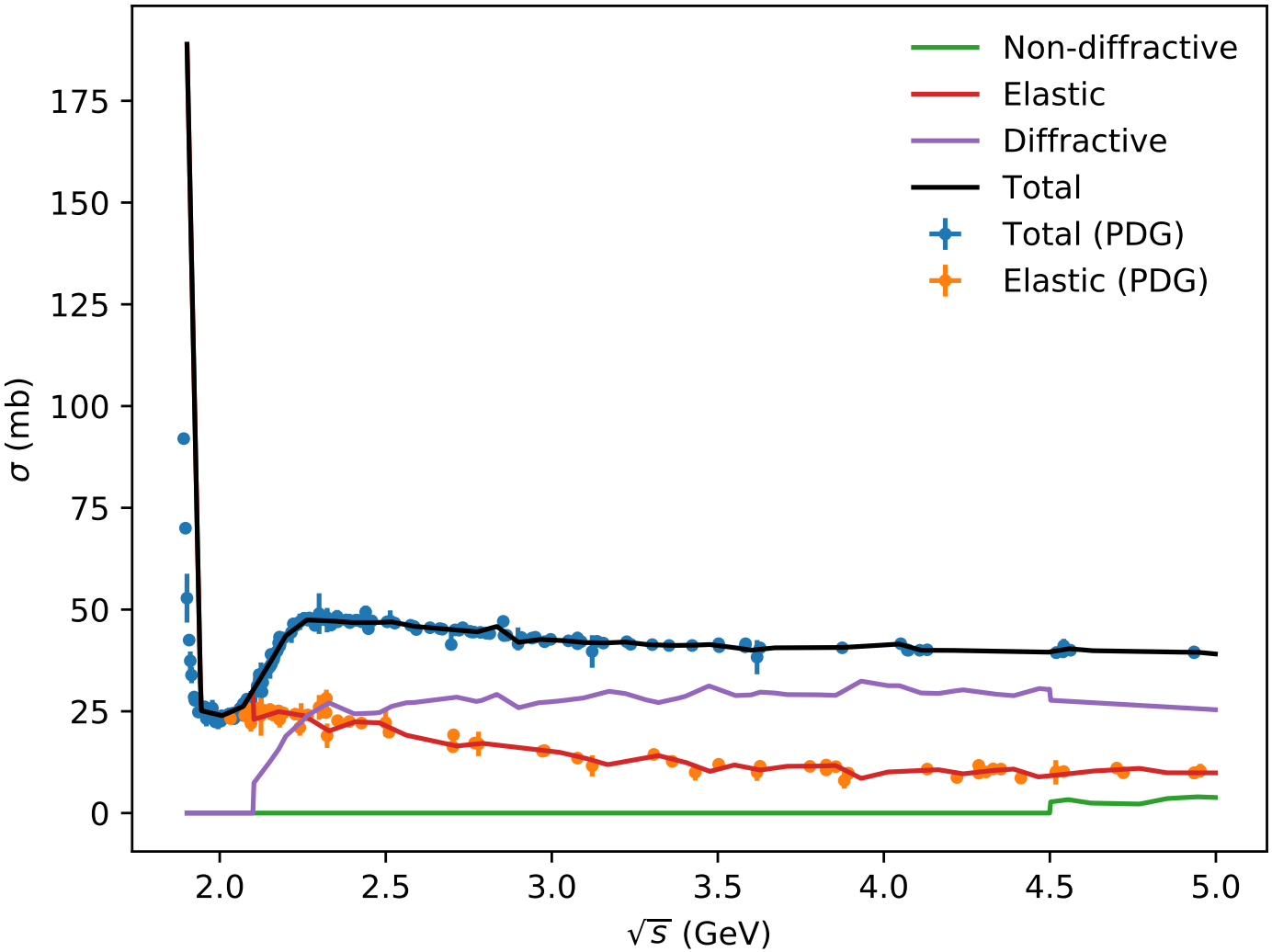


Resonance formation

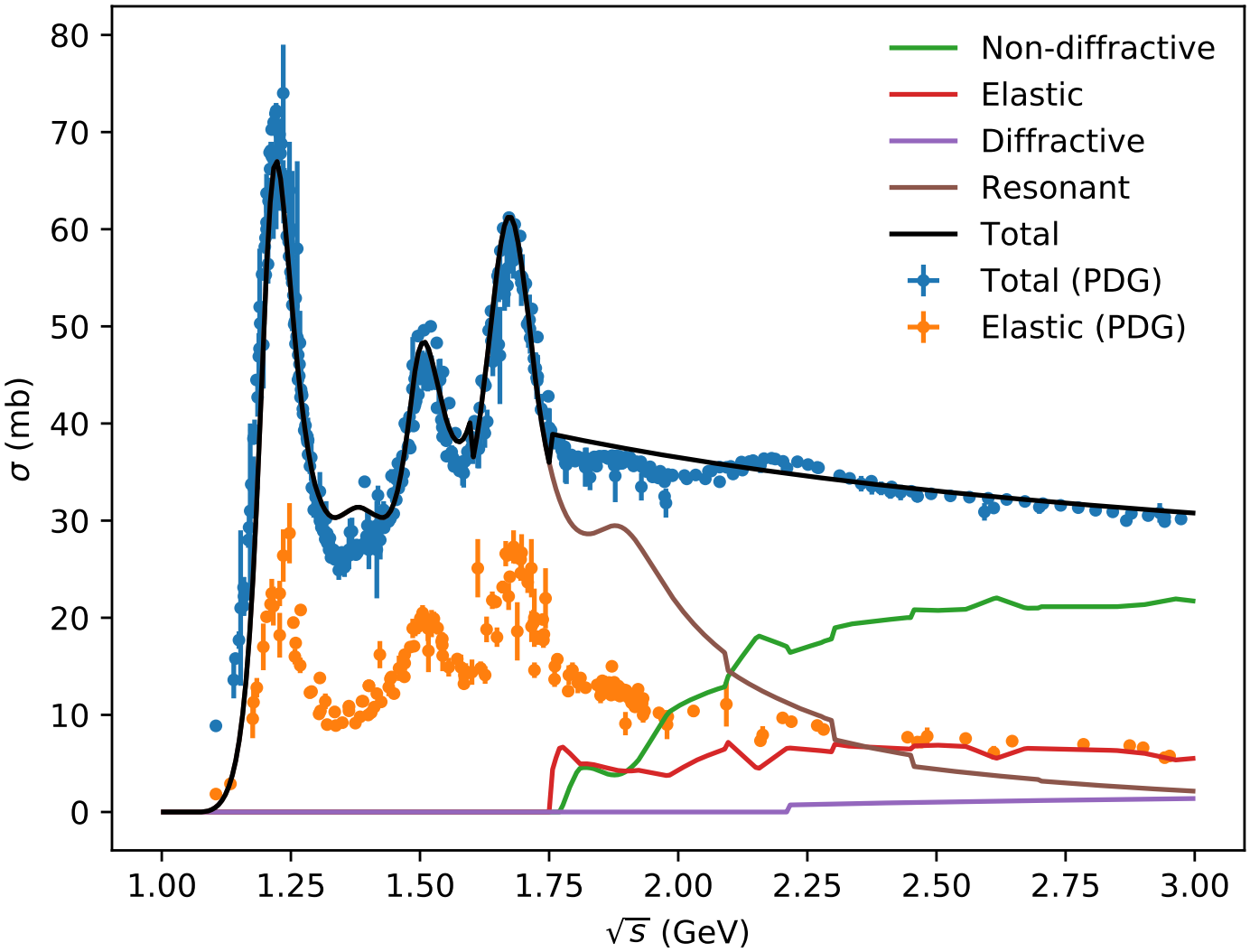


Outline

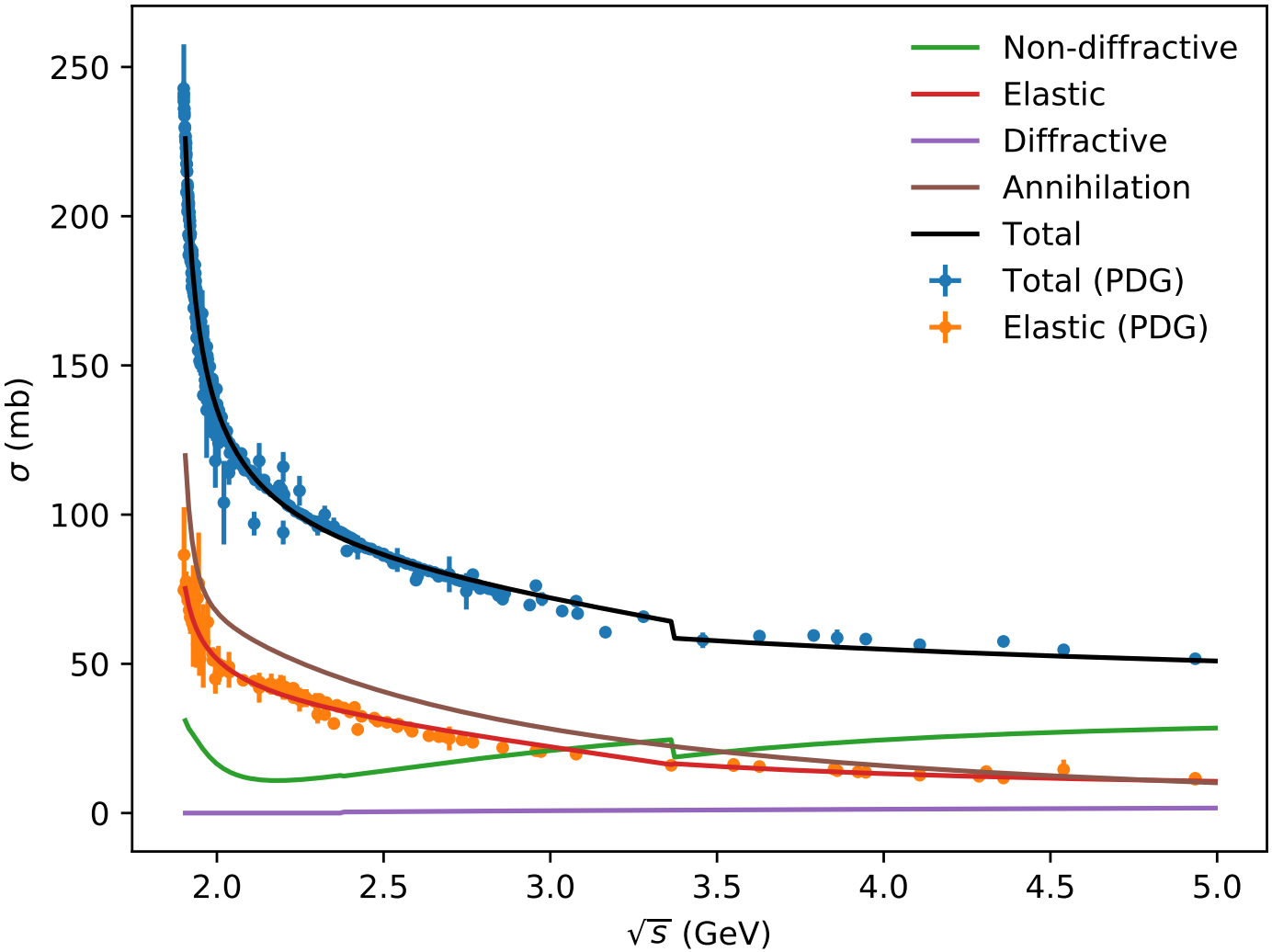
pp cross sections



$p\pi^-$ cross sections

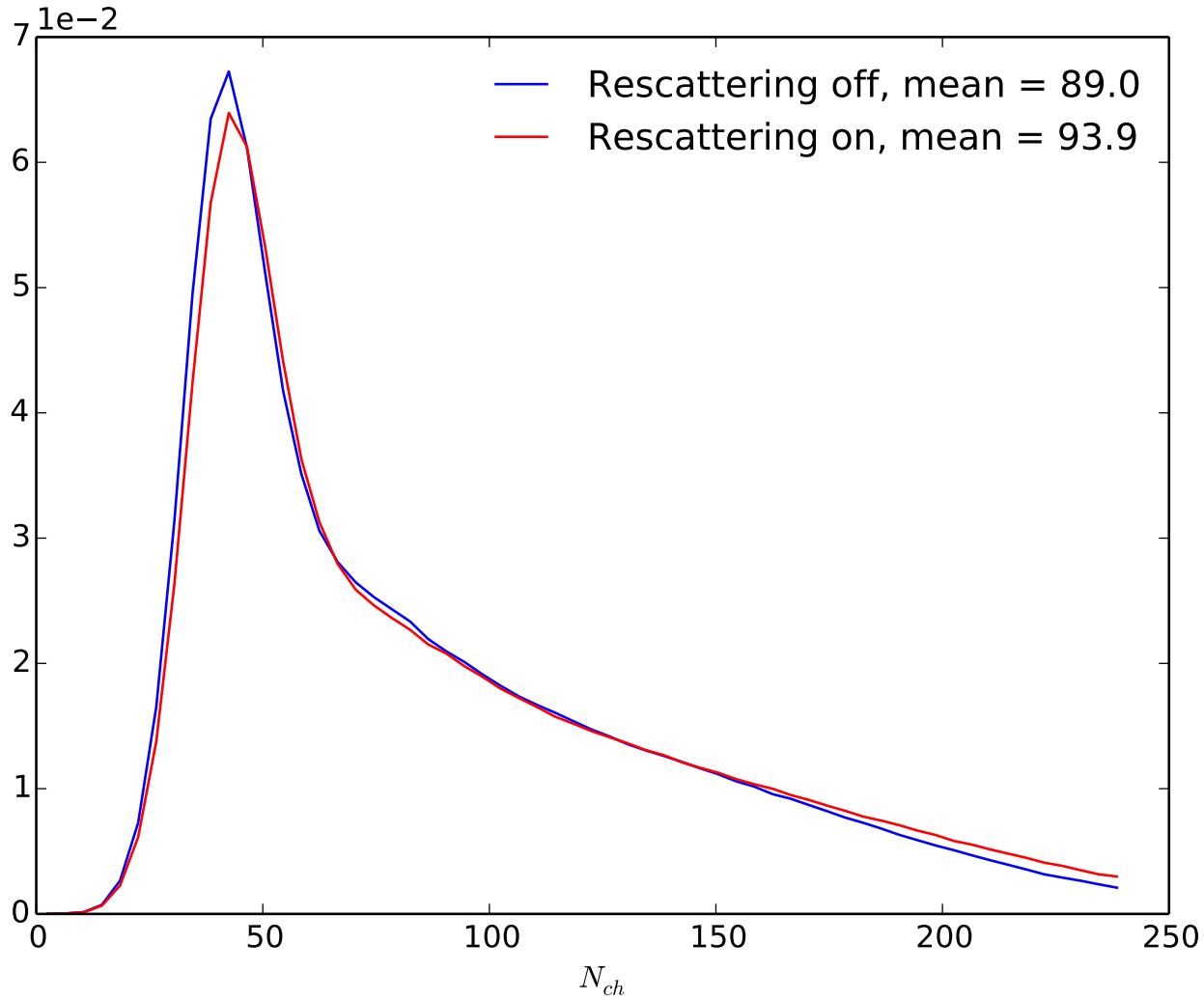


$p\bar{p}$ cross sections

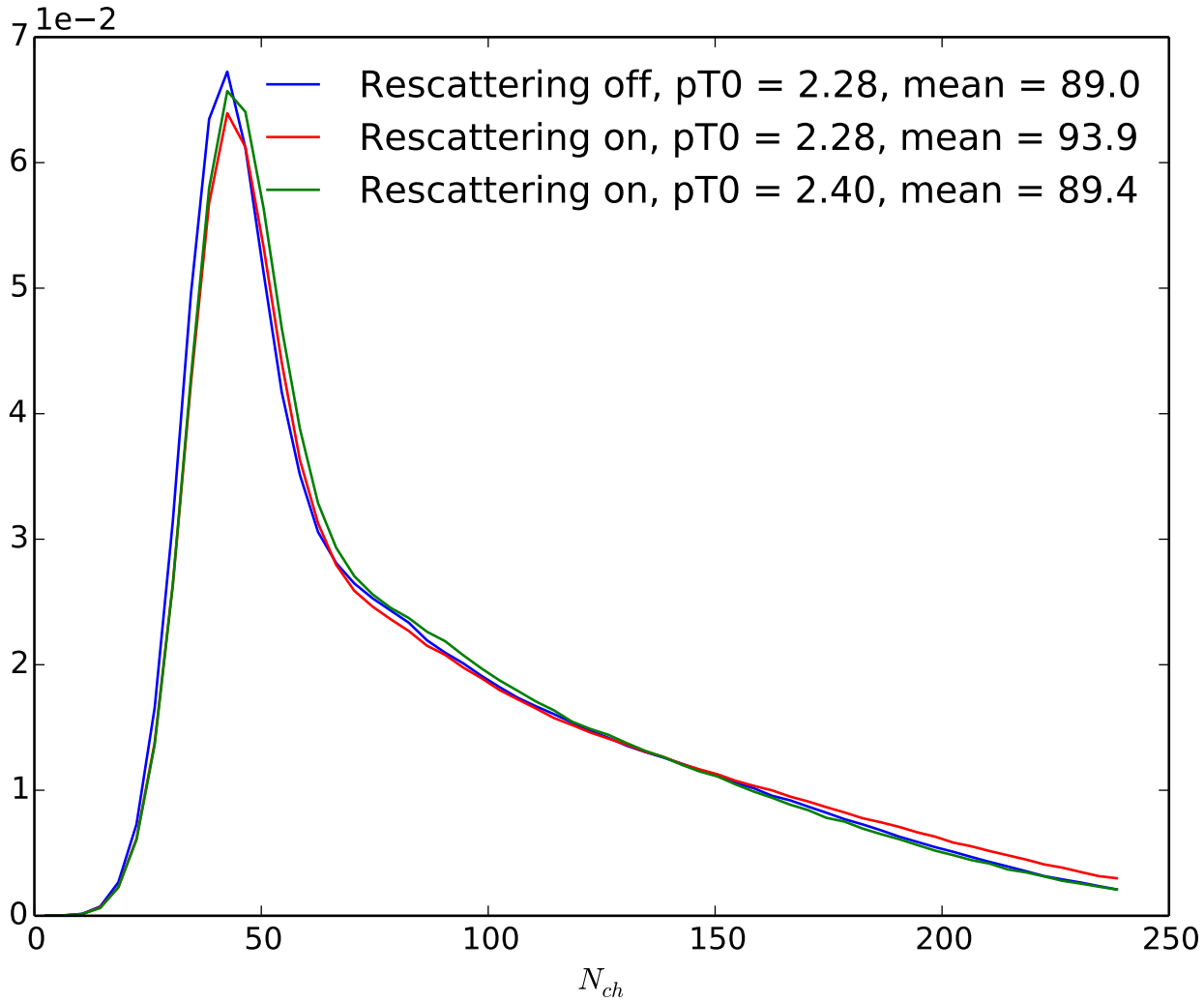


Outline

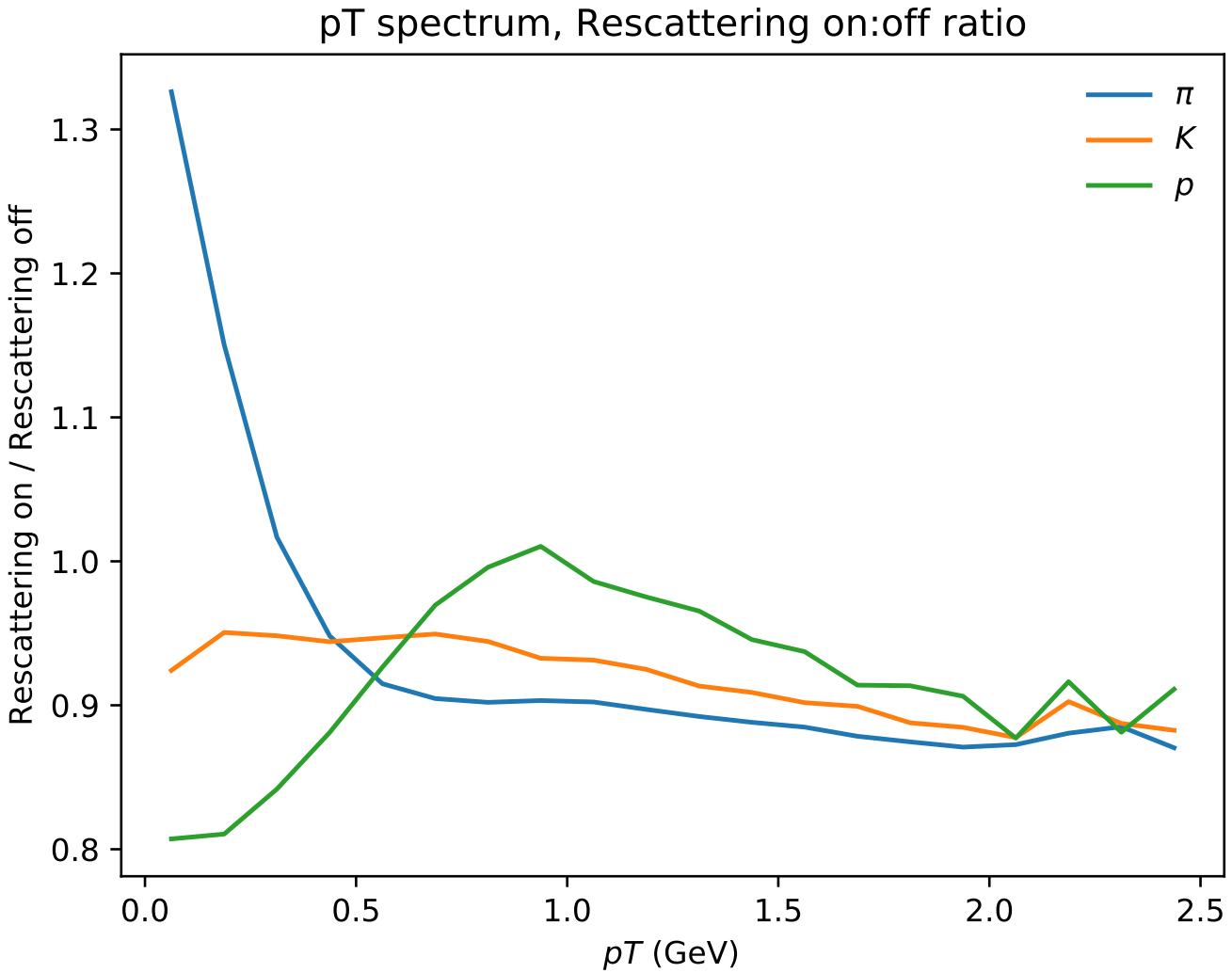
Results - Number of outgoing charged particles



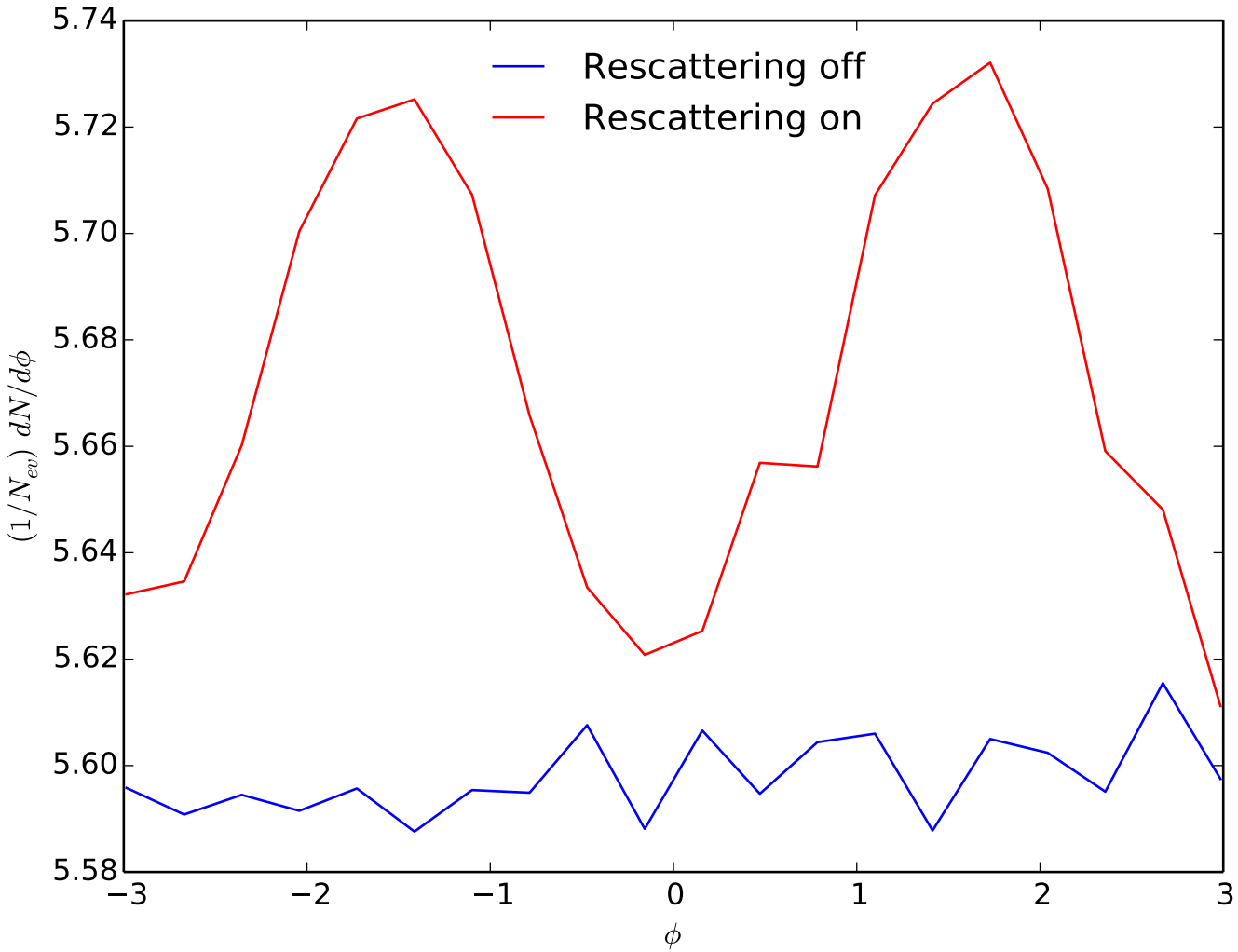
Results - Number of outgoing charged particles



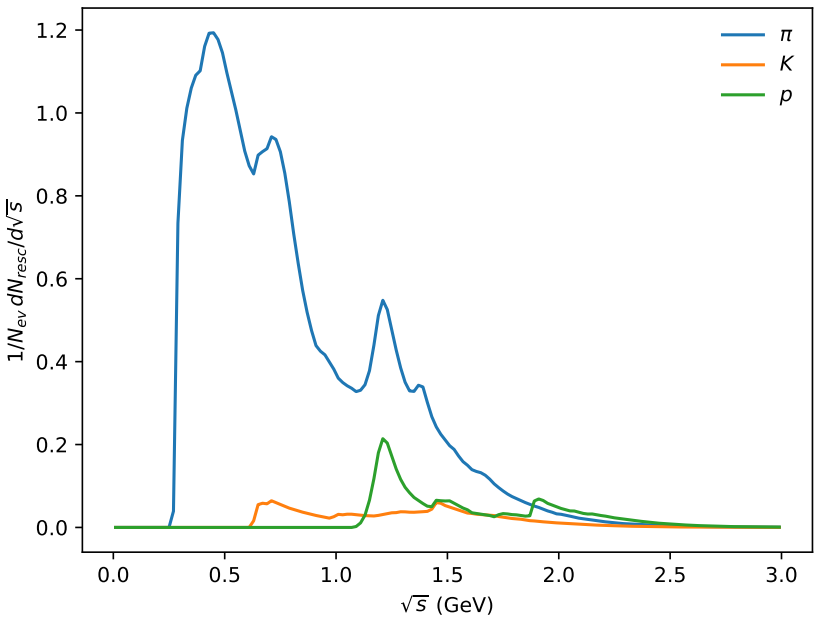
Results - Pion wind



Flow


Rescattering off
Rescattering on
5.74
5.72
5.70
5.68
5.66
5.64
5.62
5.60
5.58
$(1/N_{ev})\ dN/d\phi$
−3
−2
−1
0
1
2
3
ϕ

Process frequency



Proc	Ratio
Res	47.32 %
ND	31.11 %
Ela	20.56 %
Ann	0.97 %
Diff	0.04 %

Type	N/event
$\pi\pi$	24.41
$N\pi$	4.49
$\rho\pi$	4.27
$K\pi$	3.22
$\Sigma\pi$	0.55
$N\bar{N}$	0.53
NK	0.49
$\Lambda\pi$	0.38
NN	0.06

Outlook

- We see that rescattering produce some of the expected phenomena, but we have not yet compared to data, so it is hard to quantify how significant these effects are.
- When the first paper 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.