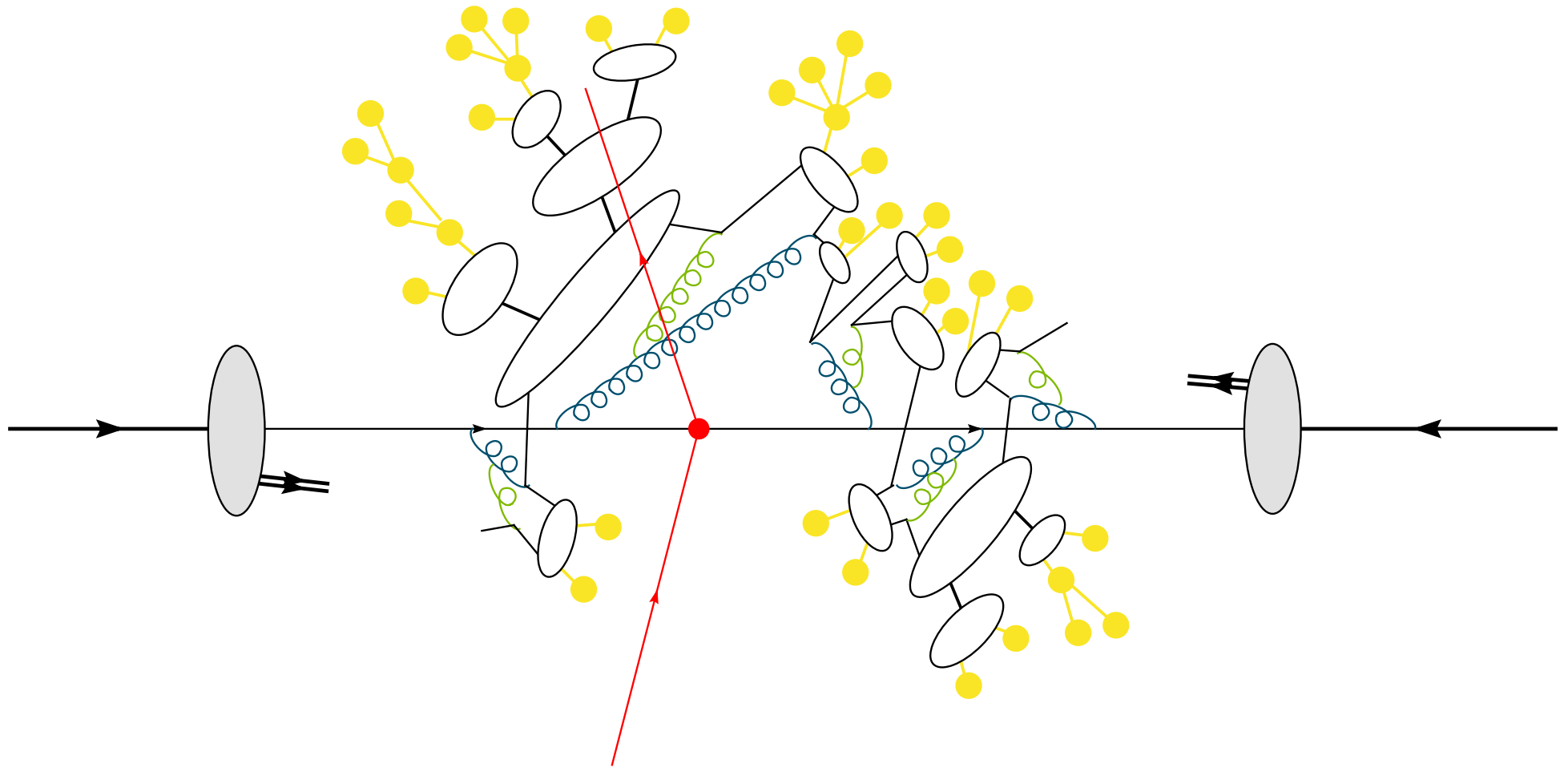
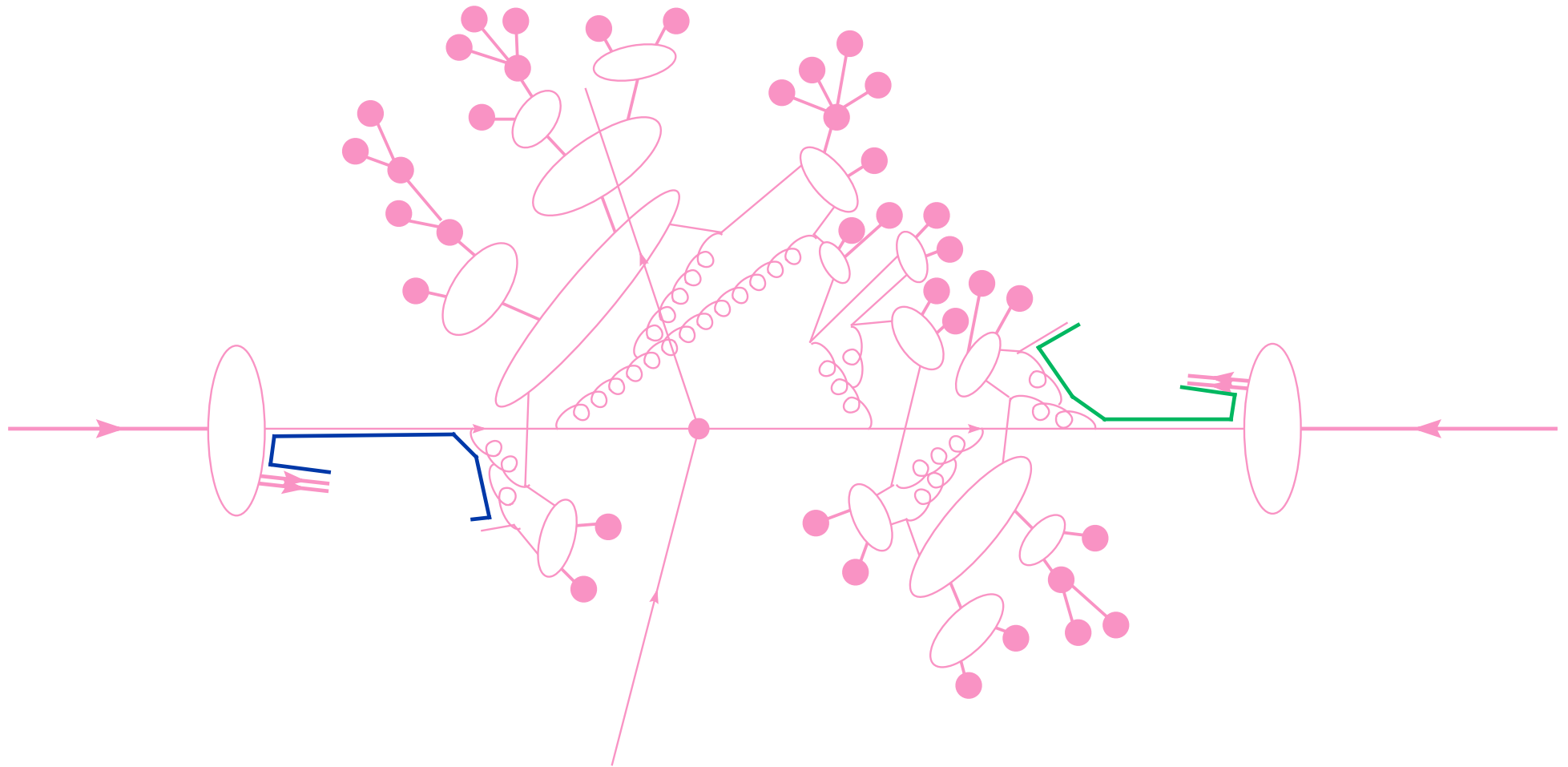


Min Bias/Underlying event in data

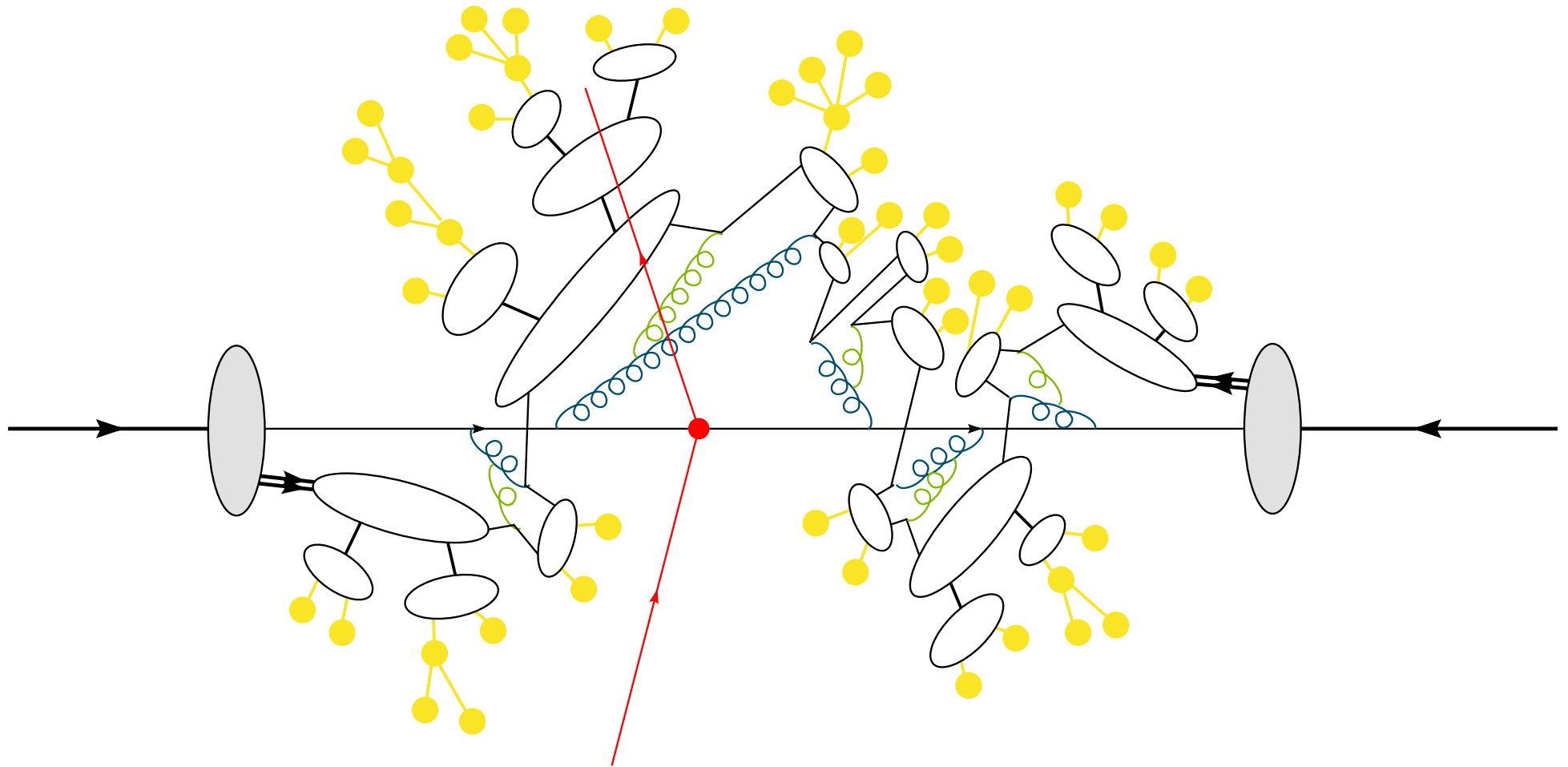
pp Event Generator



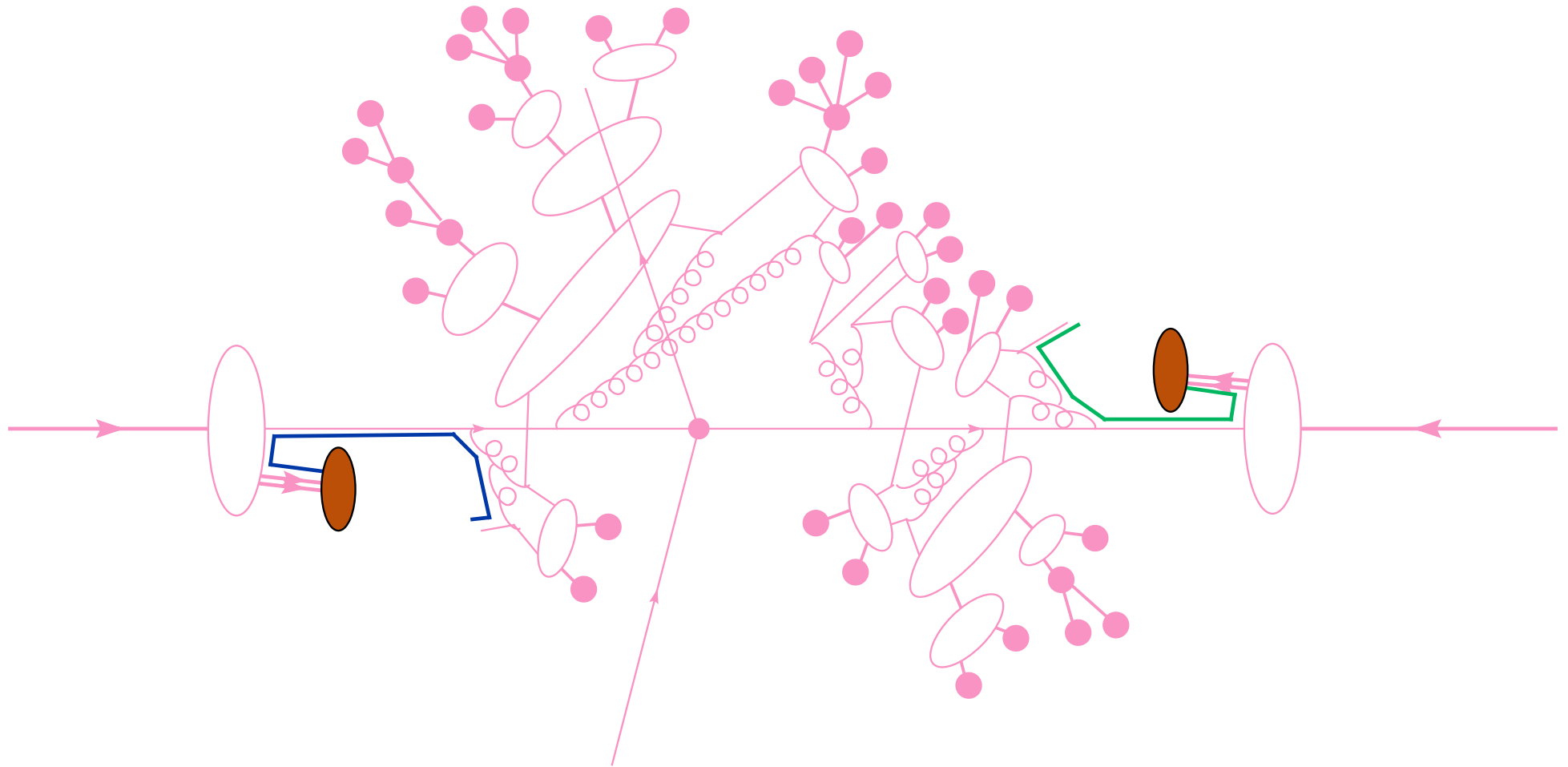
pp Event Generator



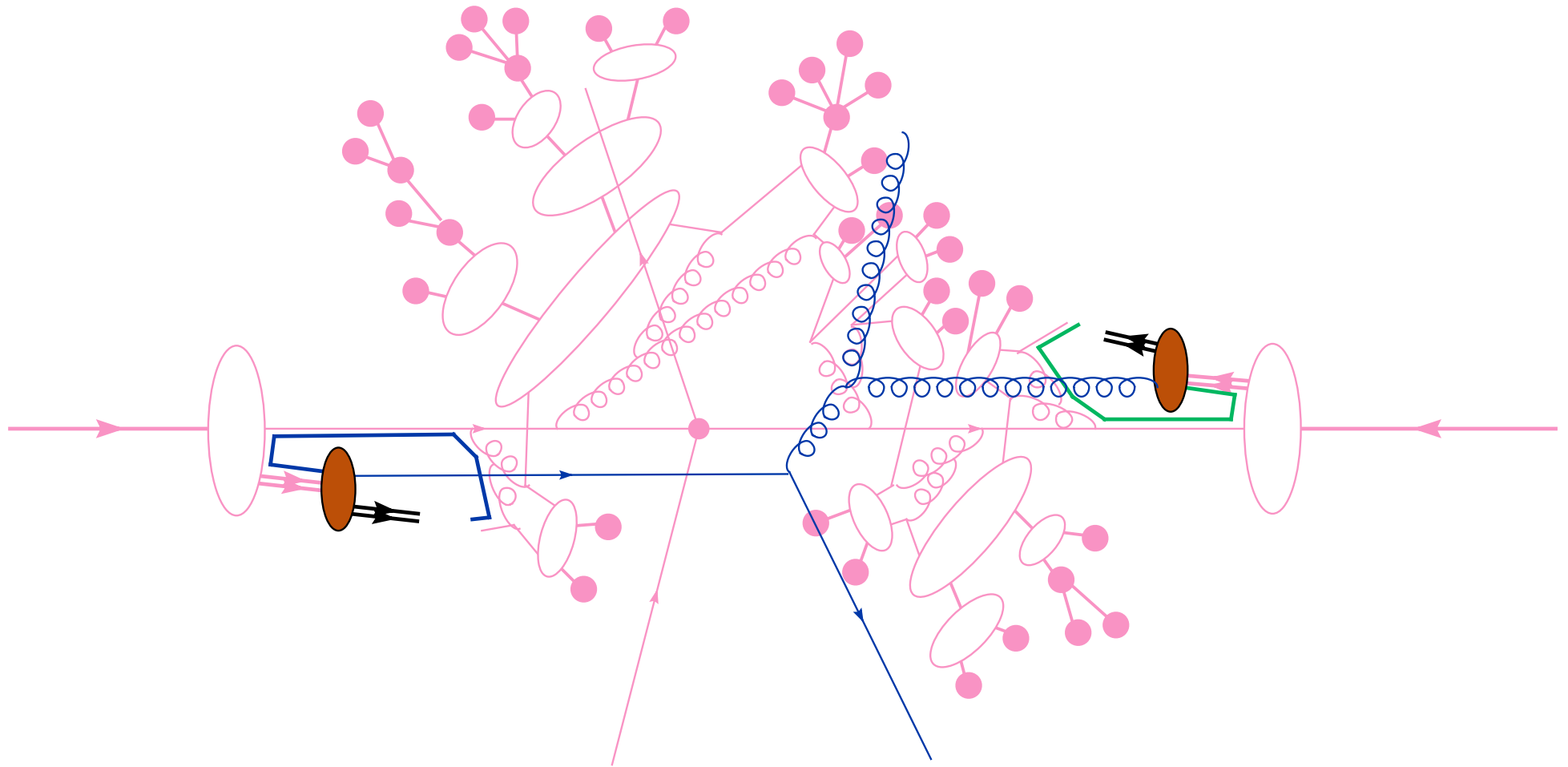
pp Event Generator



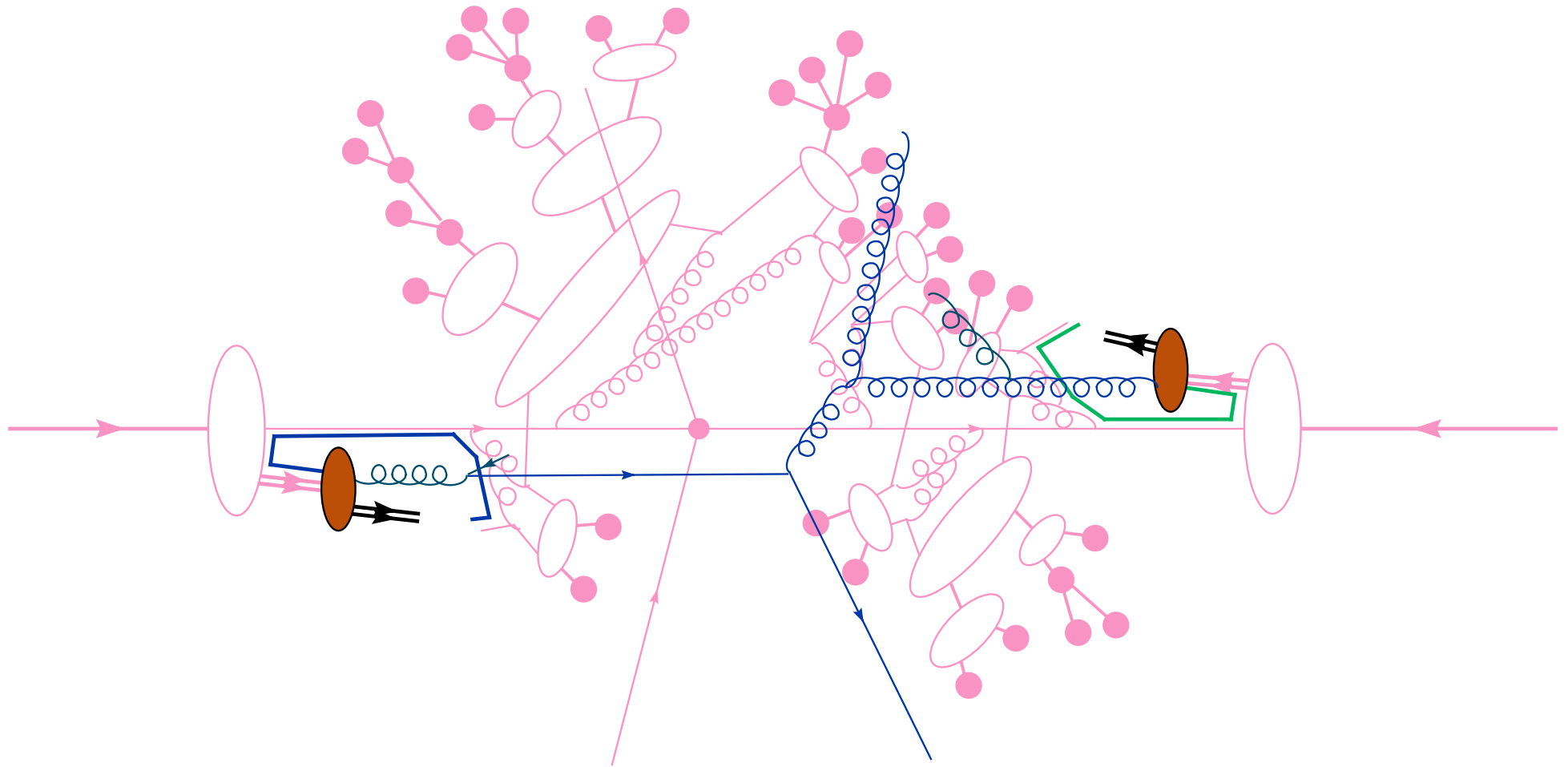
pp Event Generator



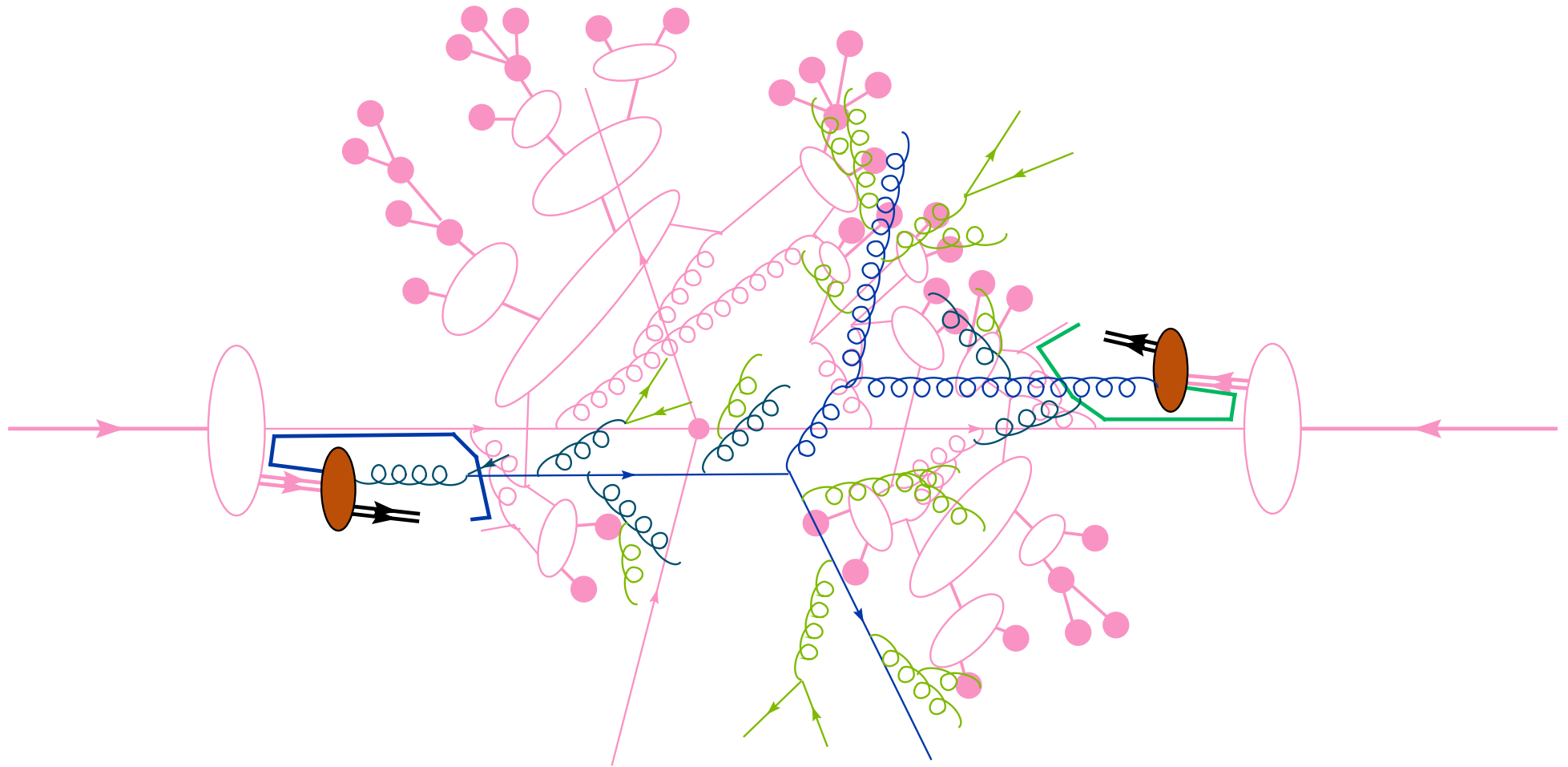
pp Event Generator



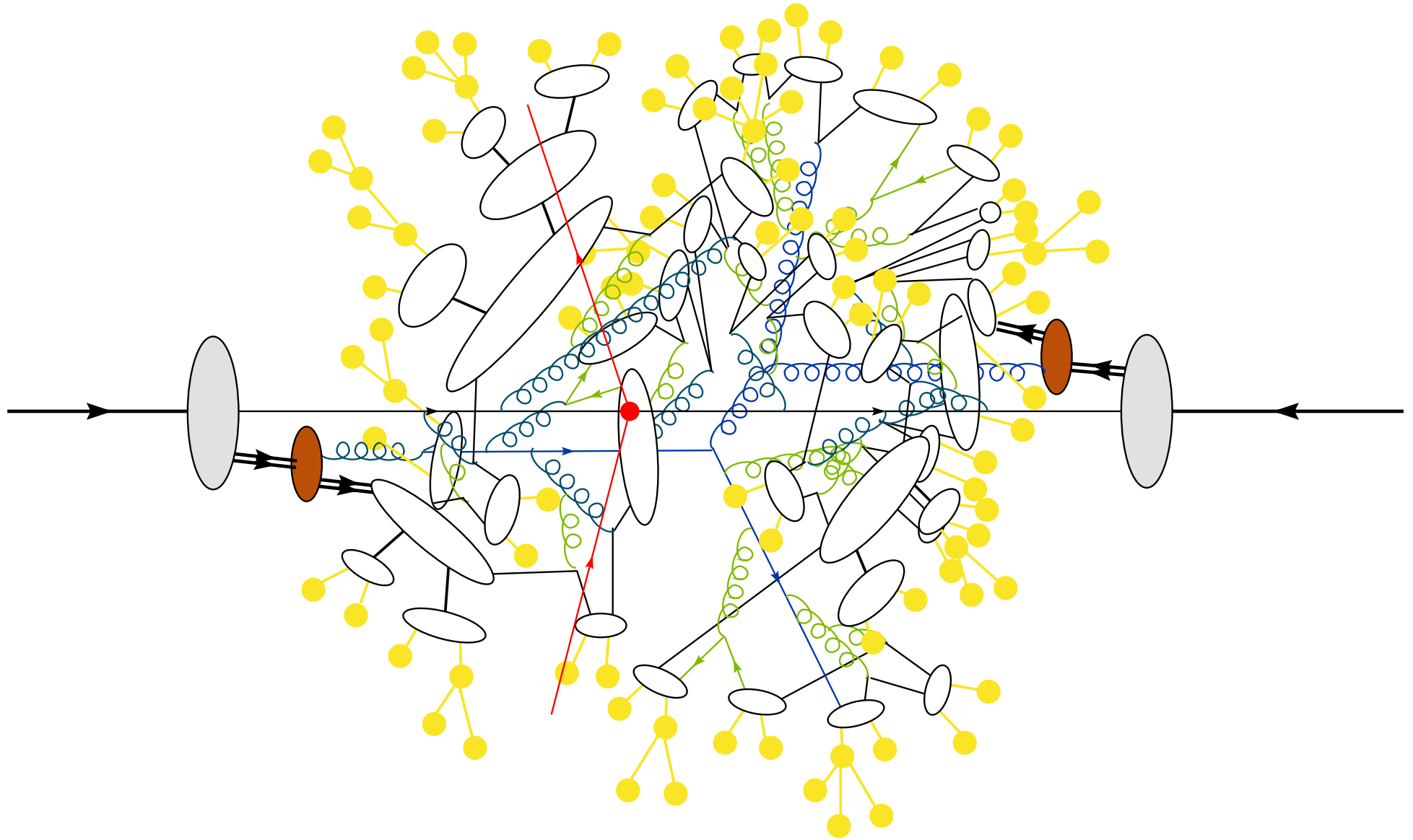
pp Event Generator



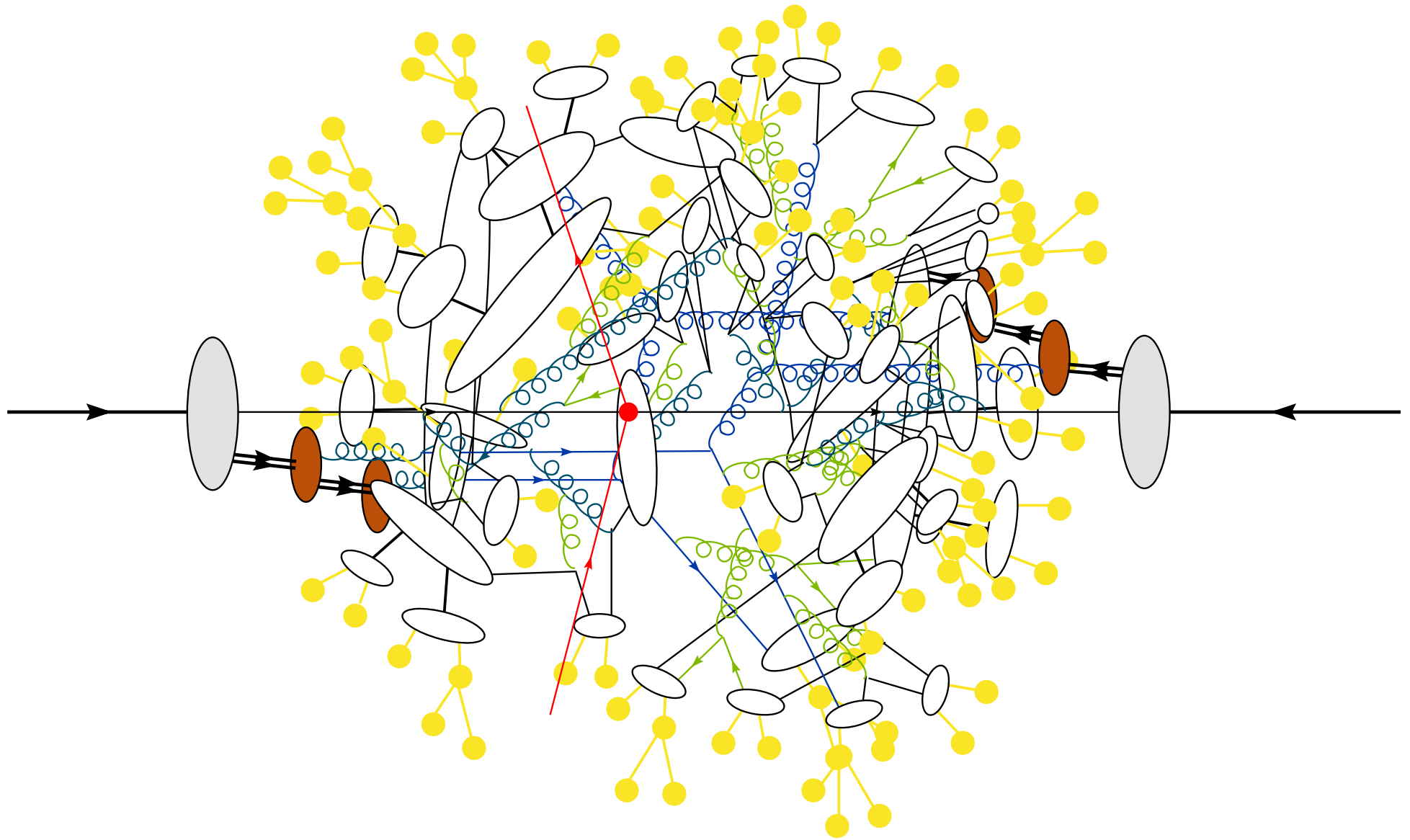
pp Event Generator



pp Event Generator



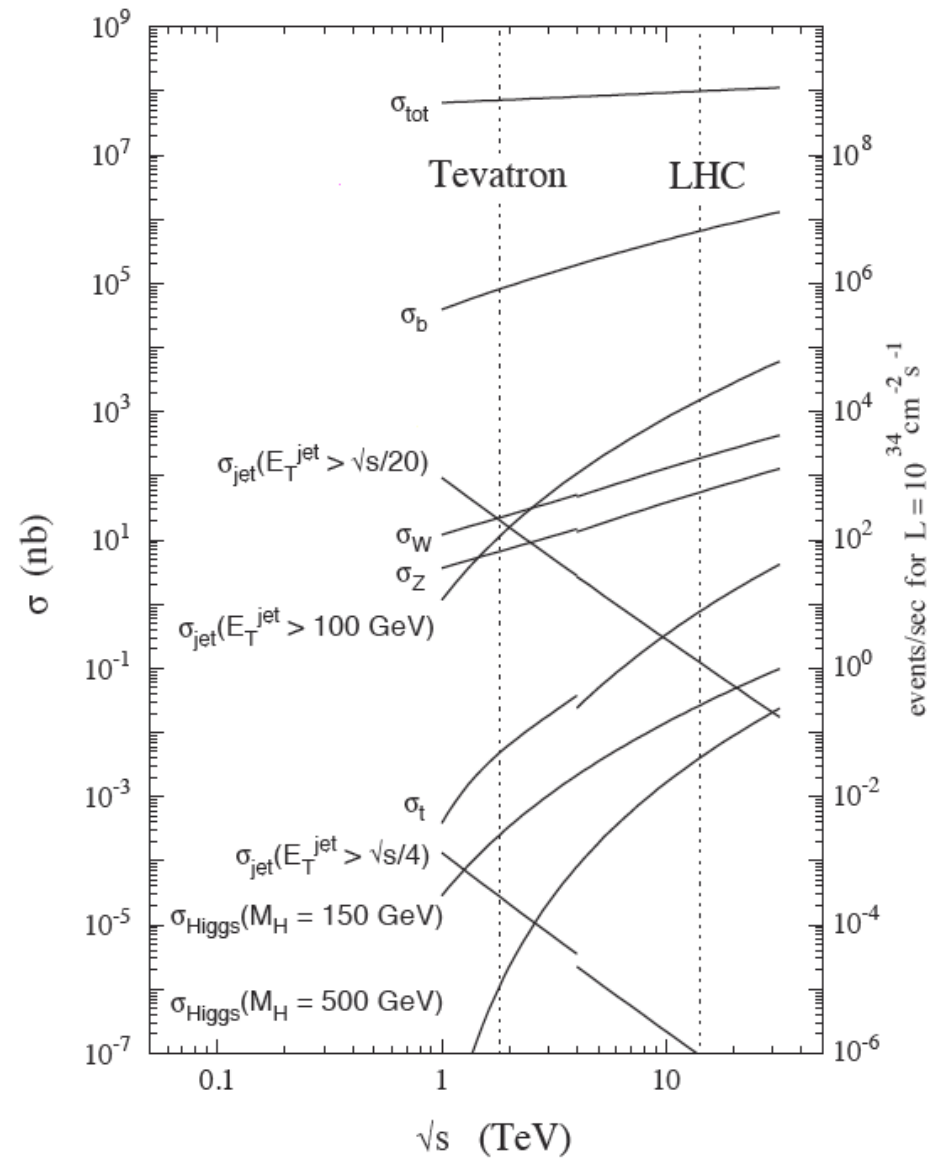
pp Event Generator



Collider cross sections

$$\sigma_{\text{tot}} = \sigma_{\text{el}} + \underbrace{\sigma_{\text{SD}} + \sigma_{\text{DD}}}_{\sigma_{\text{Diff}}} + \underbrace{\sigma_{\text{soft}} + \sigma_{\text{hard}}}_{\sigma_{\text{ND}}} + \sigma_{\text{NSD}}$$

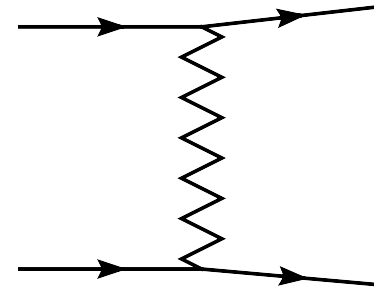
Collider cross sections



What is the Underlying event?

$$\sigma_{\text{tot}} = \sigma_{\text{el}} + \sigma_{\text{SD}} + \overbrace{\sigma_{\text{DD}} + (\sigma_{\text{soft}} + \sigma_{\text{hard}})}^{\sigma_{\text{NSD}}}$$

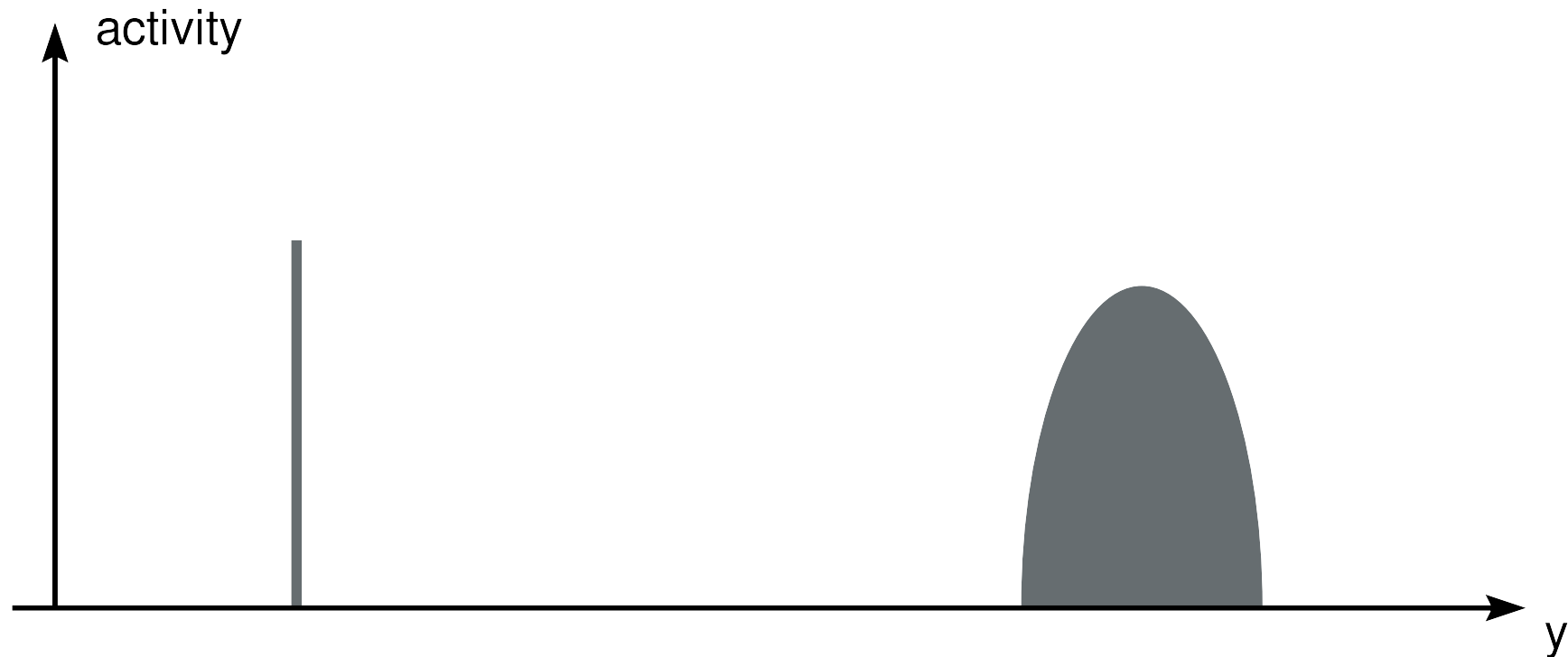
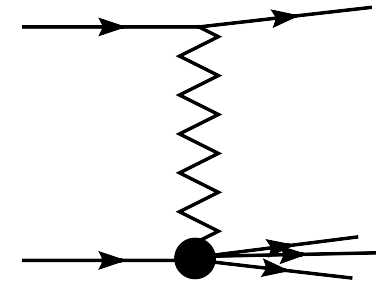
$\underbrace{\hspace{10em}}_{\sigma_{\text{ND}}}$



elastic

What is the Underlying event?

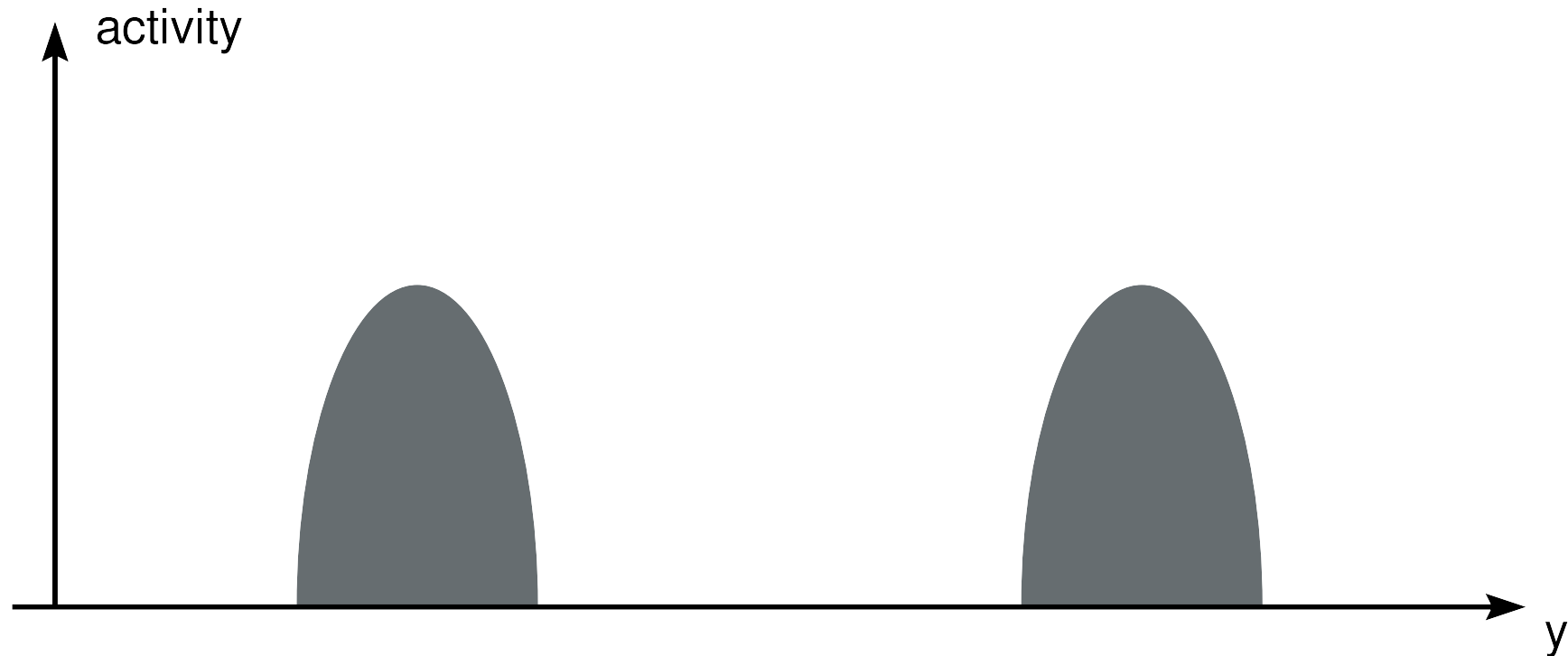
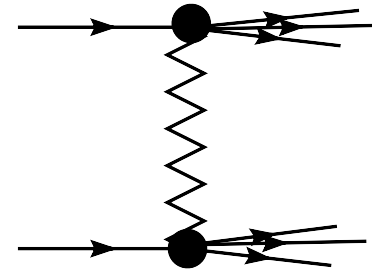
$$\sigma_{\text{tot}} = \sigma_{\text{el}} + \sigma_{\text{SD}} + \overbrace{\sigma_{\text{DD}} + (\sigma_{\text{soft}} + \sigma_{\text{hard}})}^{\sigma_{\text{NSD}}} \underbrace{\hspace{10em}}_{\sigma_{\text{ND}}}$$



single diffractive

What is the Underlying event?

$$\sigma_{\text{tot}} = \sigma_{\text{el}} + \sigma_{\text{SD}} + \sigma_{\text{DD}} + \underbrace{(\sigma_{\text{soft}} + \sigma_{\text{hard}})}_{\sigma_{\text{ND}}} \underbrace{\hspace{10em}}_{\sigma_{\text{NSD}}}$$

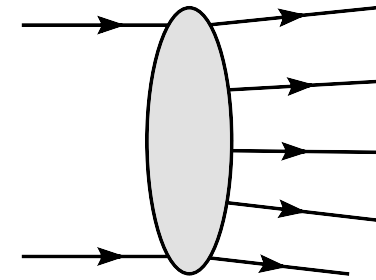


double diffractive

What is the Underlying event?

$$\sigma_{\text{tot}} = \sigma_{\text{el}} + \sigma_{\text{SD}} + \overbrace{\sigma_{\text{DD}} + (\sigma_{\text{soft}} + \sigma_{\text{hard}})}^{\sigma_{\text{NSD}}}$$

σ_{ND}

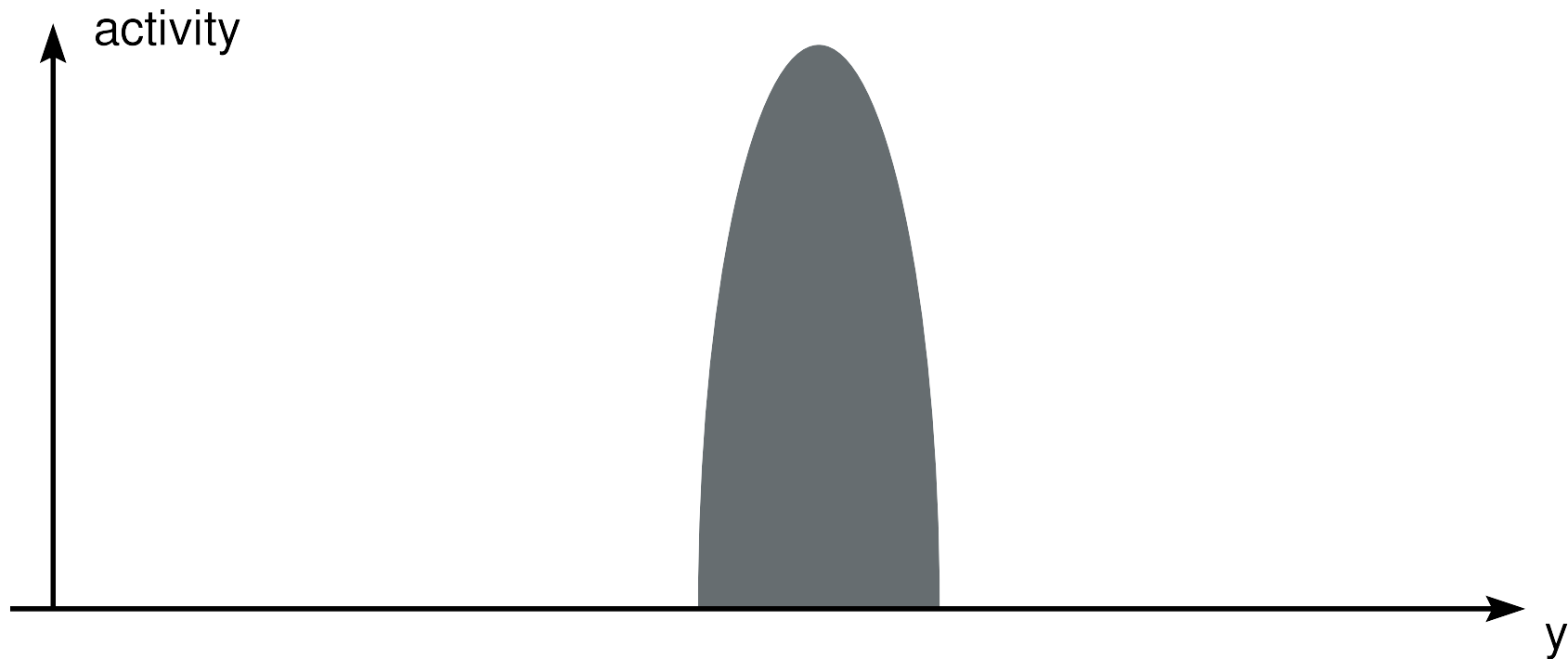
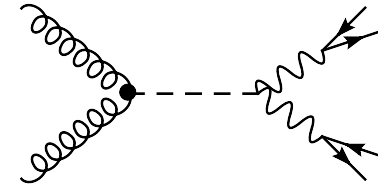


(multiple/soft) interactions

What is the Underlying event?

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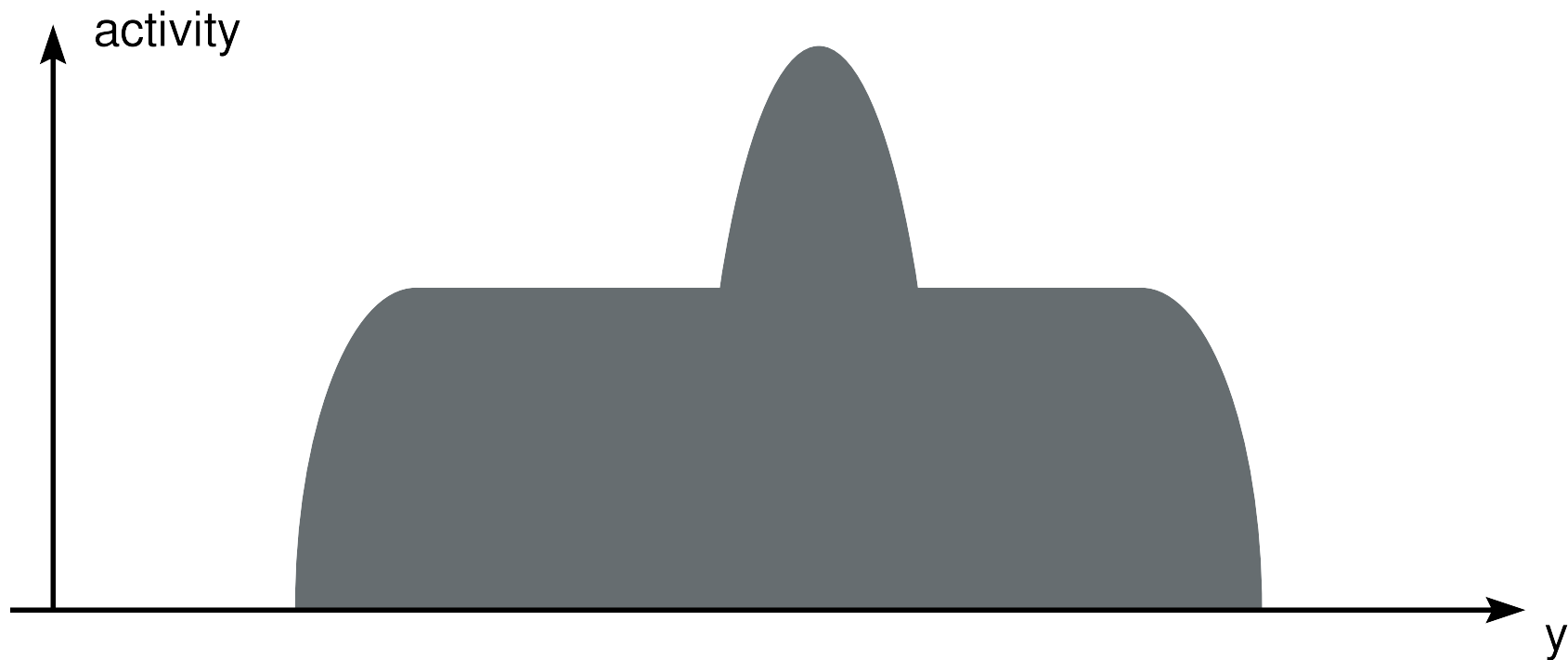
σ_{ND}



hard scattering

What is the Underlying event?

$$\sigma_{\text{tot}} = \sigma_{\text{el}} + \sigma_{\text{SD}} + \underbrace{\sigma_{\text{DD}} + \underbrace{(\sigma_{\text{soft}} + \sigma_{\text{hard}})}_{\sigma_{\text{ND}}}}_{\sigma_{\text{NSD}}}$$



hard scattering + underlying event

What is the Underlying event?

“Everything except the process of interest.”

- Experimentalist: “includes parton showers etc.”
- MC author: “everything on top of primary hard process.”

The Underlying event (UE) is everywhere in the detector.

- Cannot select UE
- May spoil measurements.
- What characteristics?
- Hard?
- Soft?

Why should I learn about it?

- UE comes with every event.
- Can't trigger/select it away.
- Gives additional tracks and calorimeter hits, in the same cells as your signal.
- Jet energy scale determination.
- Important systematic error.
- Jets where your signal shouldn't give any (VBF).

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 - *Every* event in a perfect 4π detector.

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 - Require “some activity”
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 - small number of tracks of charged tracks (e.g. 1, 2, 6),
 - forward calorimeter hits,
 - → with some minimum p_{\perp} .
 - Often want non–single–diffractive

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 - Very selective trigger
 - BUT accompanied by soft stuff \rightarrow underlying event.

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Physics in MB and UE very similar.