Jet substructure at the LHC

New Physics - new methods - new results

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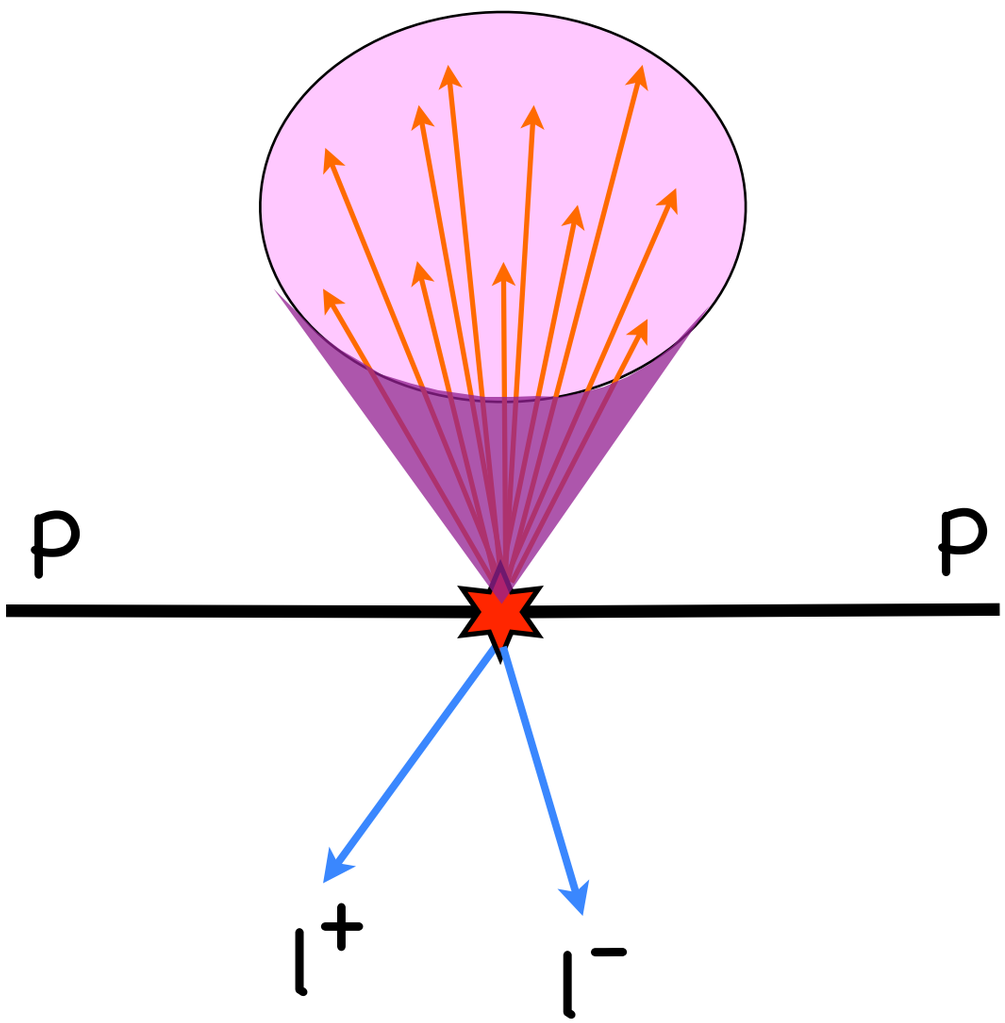
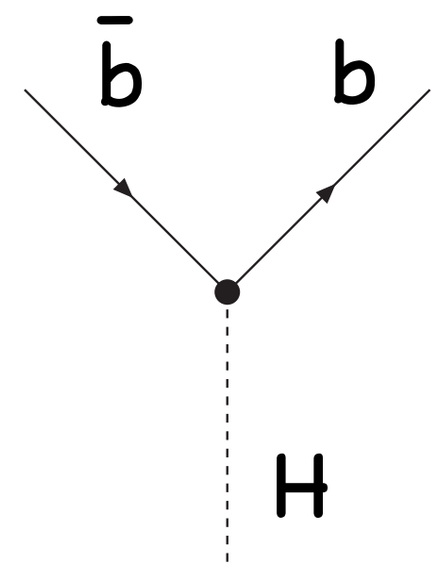
Shower deconstruction

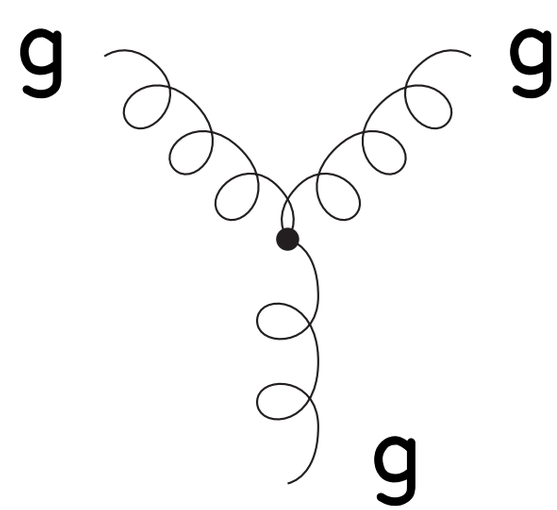
- a new method to search New Physics -

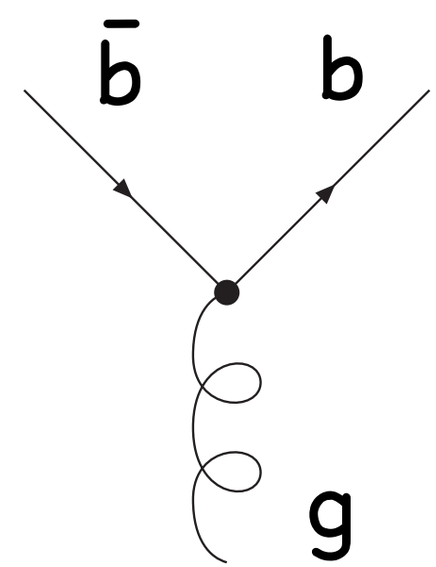


signal



background





Event selection cuts

- Cluster hadrons to 'detector cells' 0.1 x 0.1, ET > 0.5 GeV
- lepton pT > 15 GeV
- two hardest leptons mZ +- 10 GeV
- at least 1 fat jet (anti-kT, R=1.2, pT>200 GeV)

Normalize signal/background cross section
to the NLO results obtained from MCFM

$$\sigma_{\mathrm{MC}}(\mathrm{S}) = 1.48 \text{ fb}$$

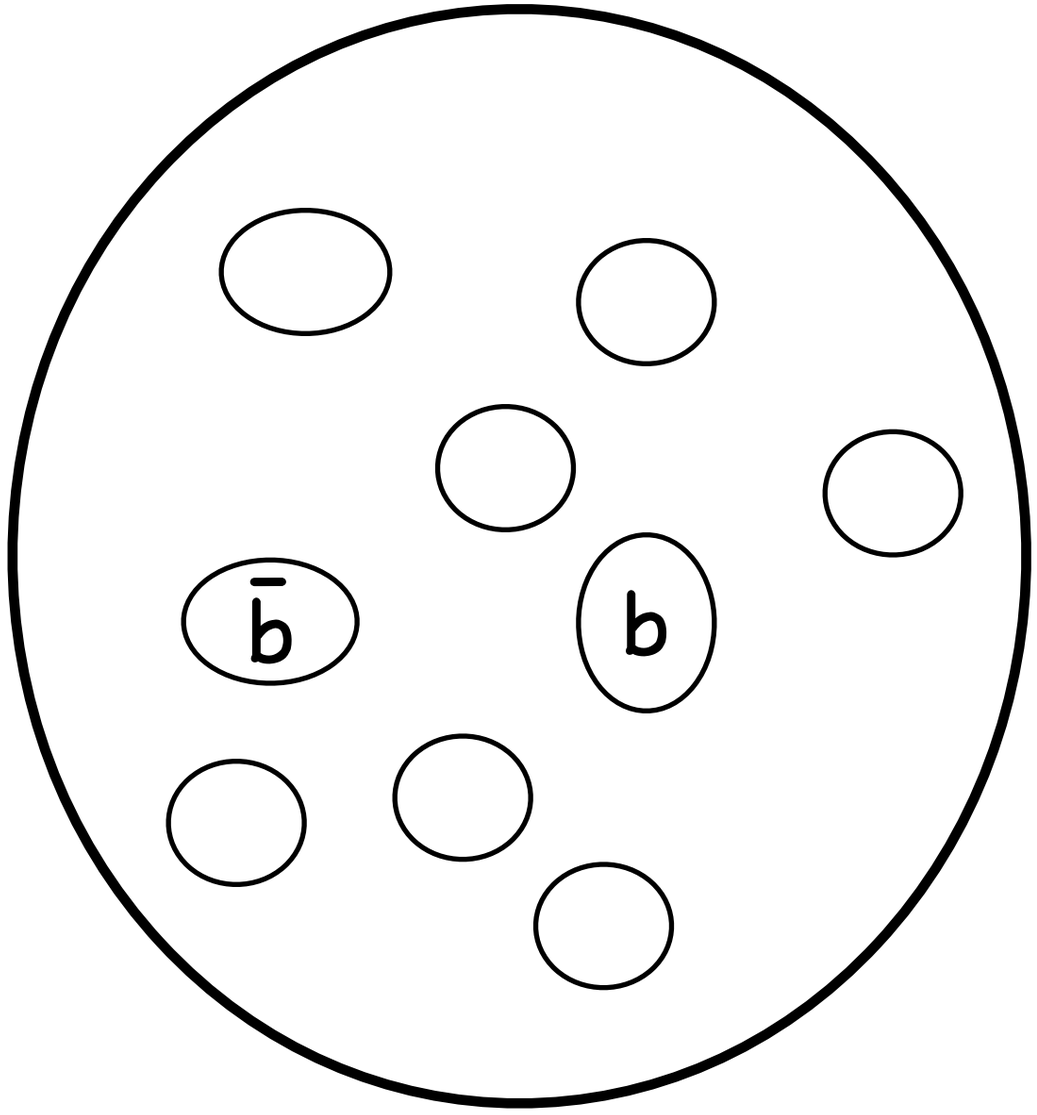
$$\sigma_{\mathrm{MC}}(\mathrm{B}) = 2610 \text{ fb}$$

$$\frac{\sigma_{\mathrm{MC}}(\mathrm{S})}{\sigma_{\mathrm{MC}}(\mathrm{B})} = \frac{1}{1760}$$

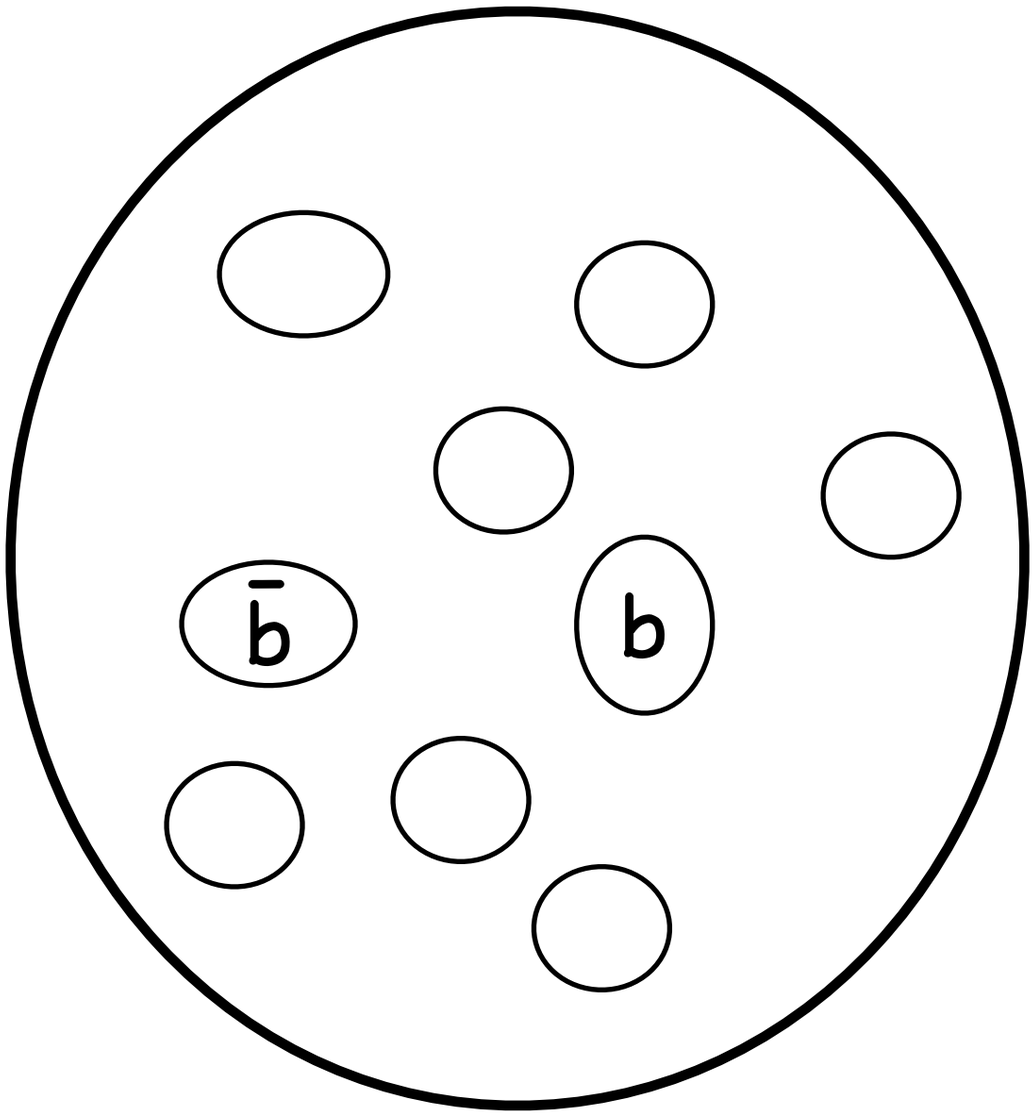
Recombine fat jet's constituents to microjets

(kT, R=0.15, pT > 1 GeV)

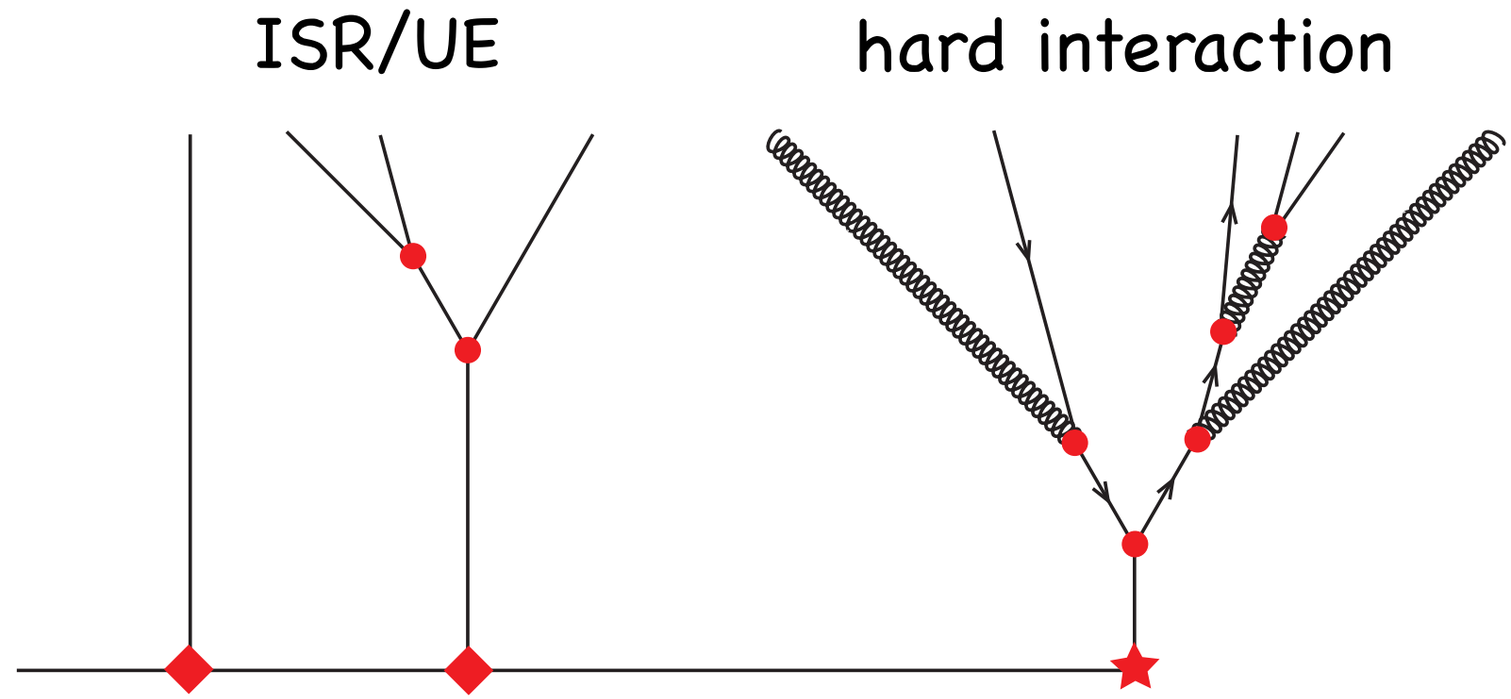
b-tag if among hardest 3 AND pT > 15 GeV



Fat jet: R=1.2, anti-kT



microjets
R=0.15, kT

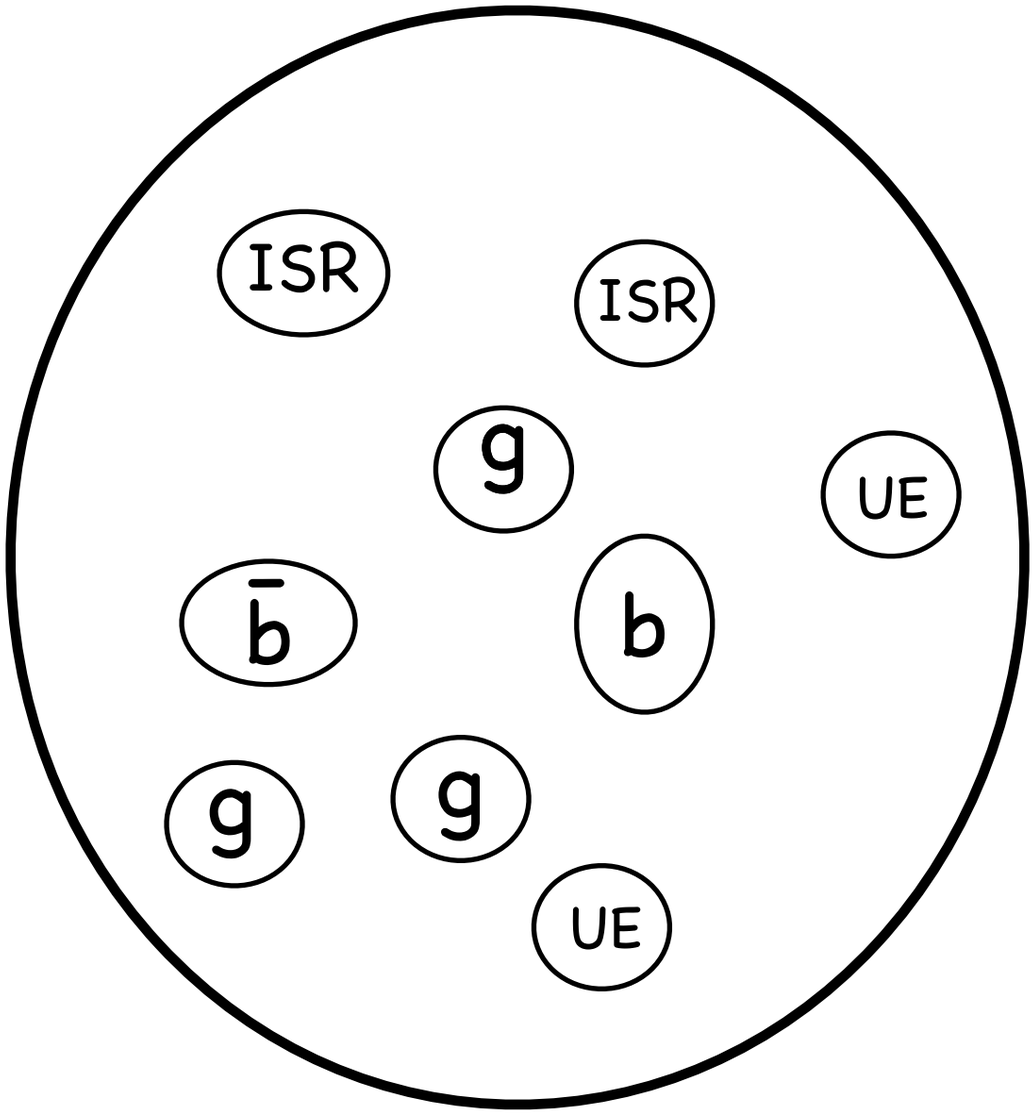


Build all possible shower histories

signal vs background hypothesis based on:

- Emission probabilities
- Color connection
- Kinematic requirements
- b-tag information

Fat jet: R=1.2, anti-kT



microjets
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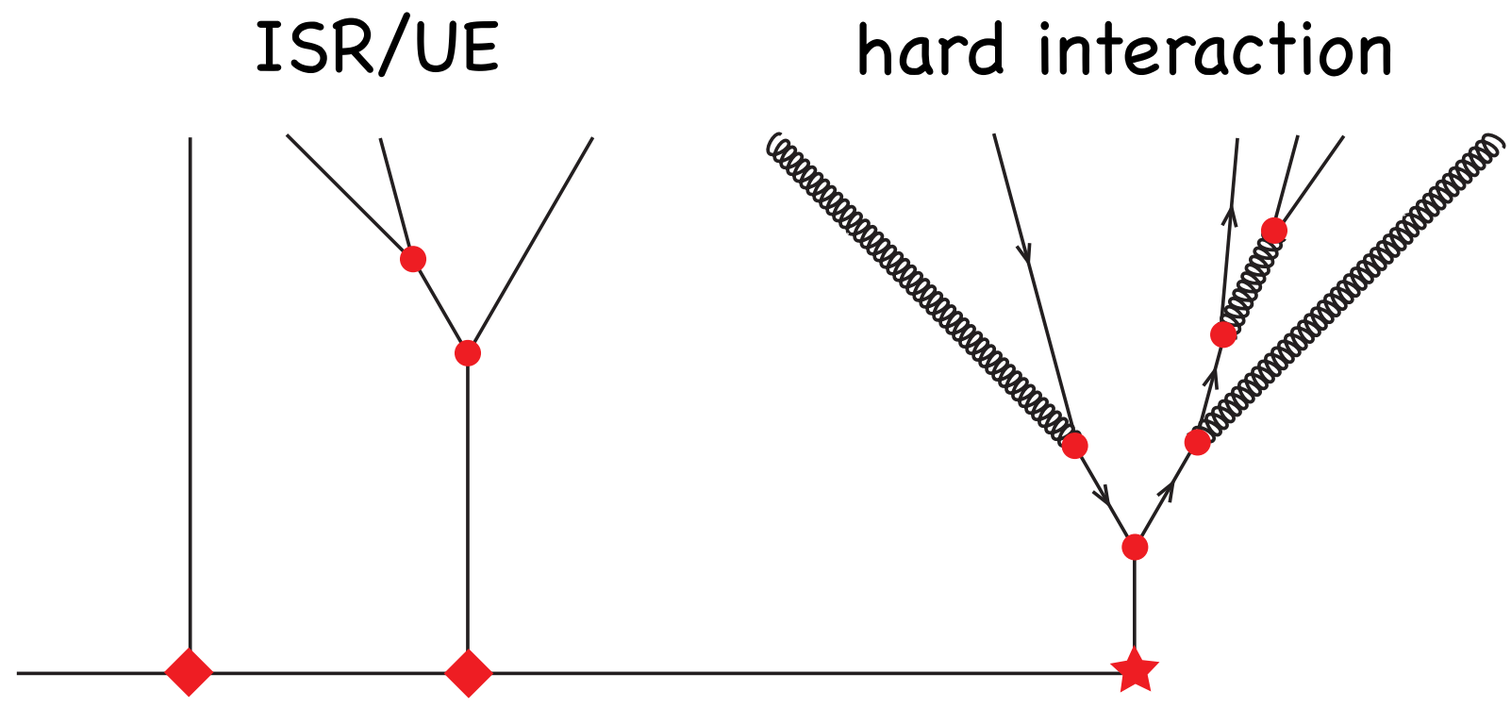

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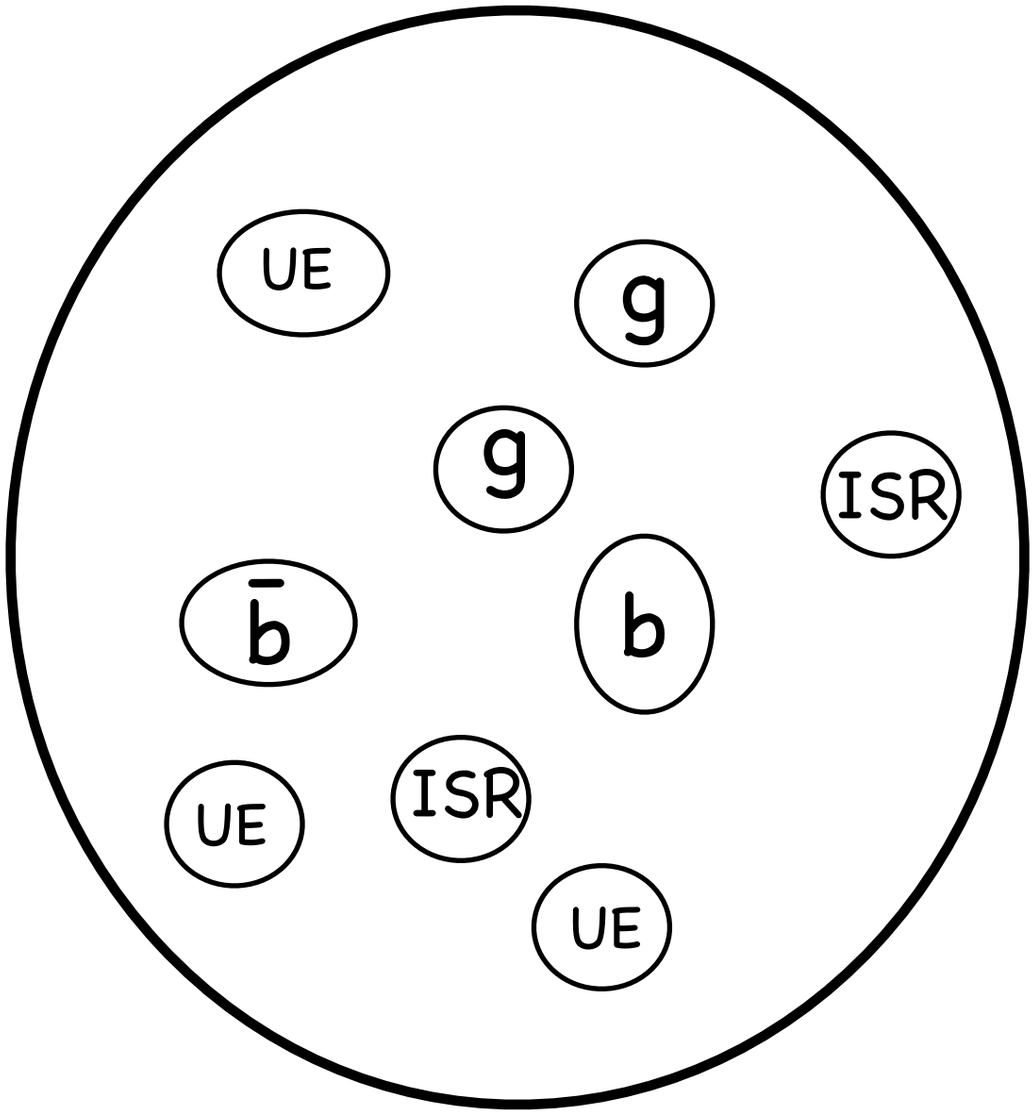
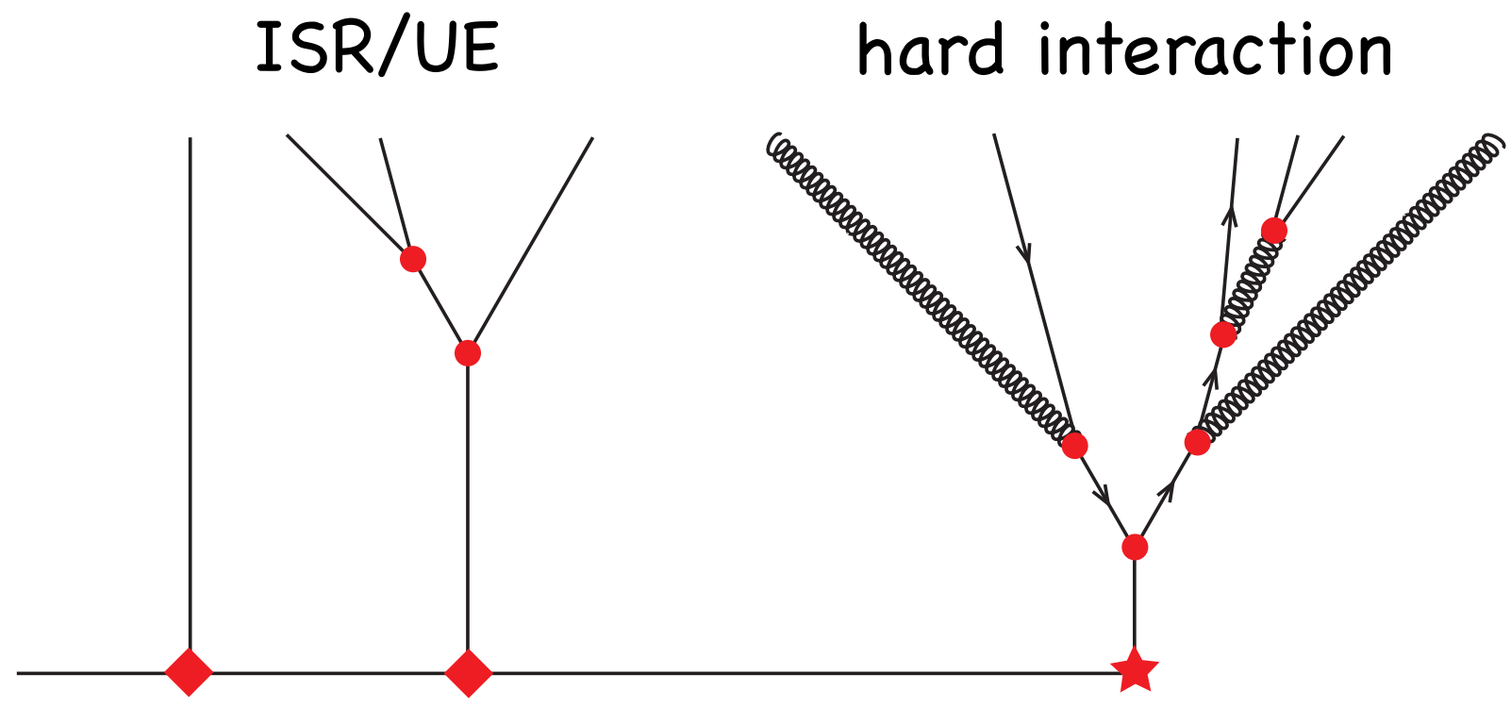


microjets
R=0.15, kT



Build all possible shower histories

signal vs background hypothesis based on:

- Emission probabilities
- Colour connection
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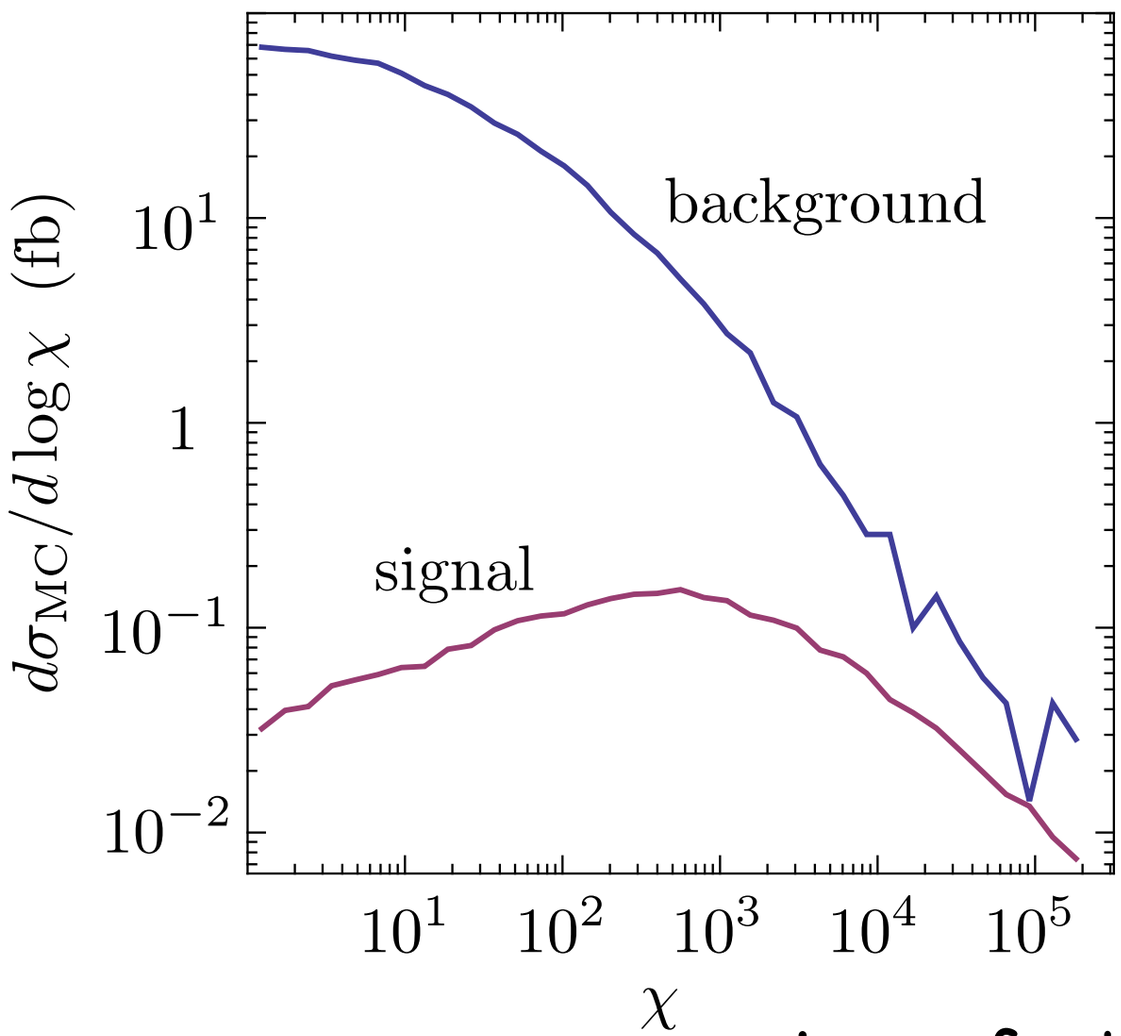
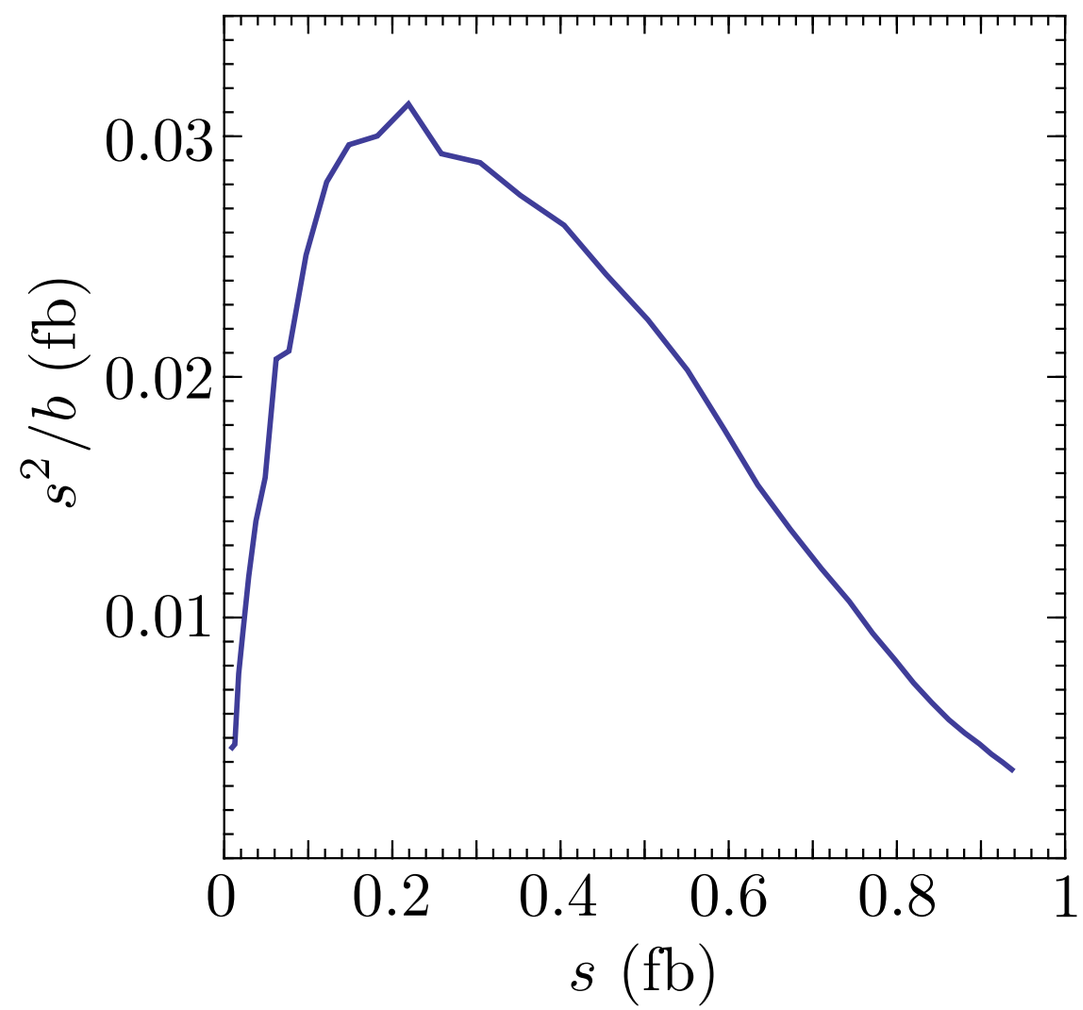
Results of shower deconstruction (SD)

$$\chi(\{p,t\}_N) = \frac{P(\{p,t\}_N|\mathrm{S})}{P(\{p,t\}_N|\mathrm{B})}$$

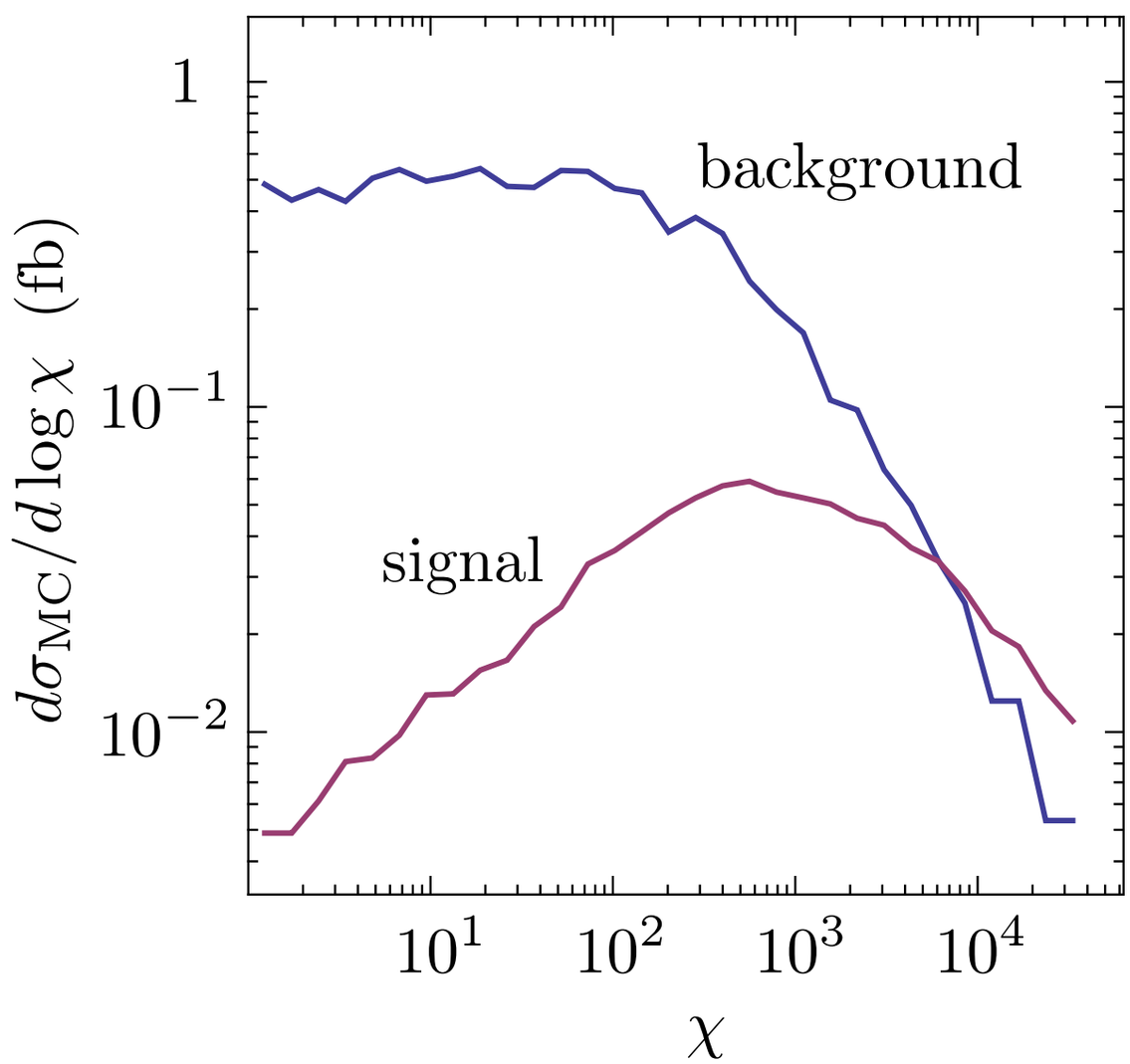


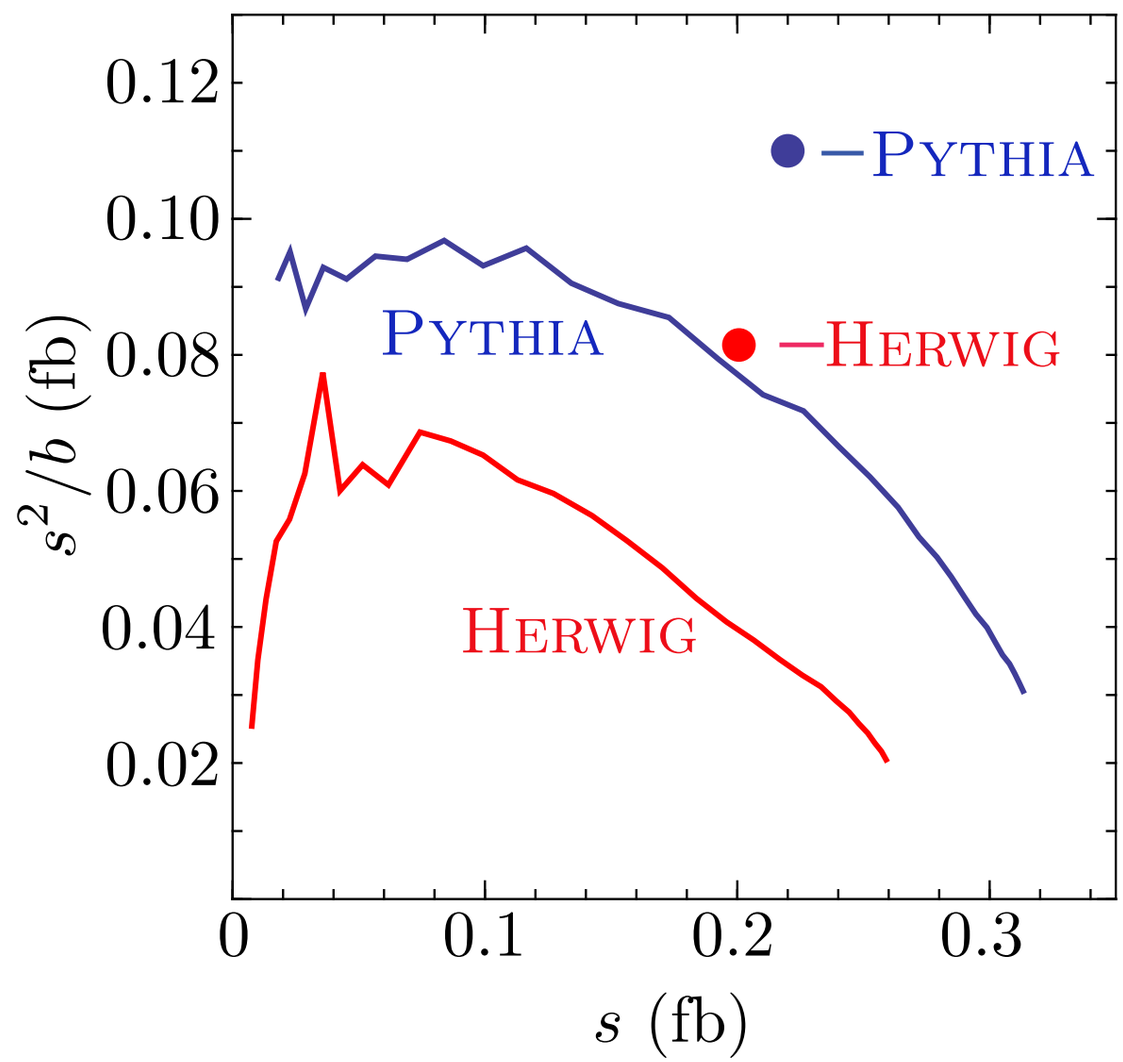


imperfect b-tagging

Results of shower deconstruction (SD)

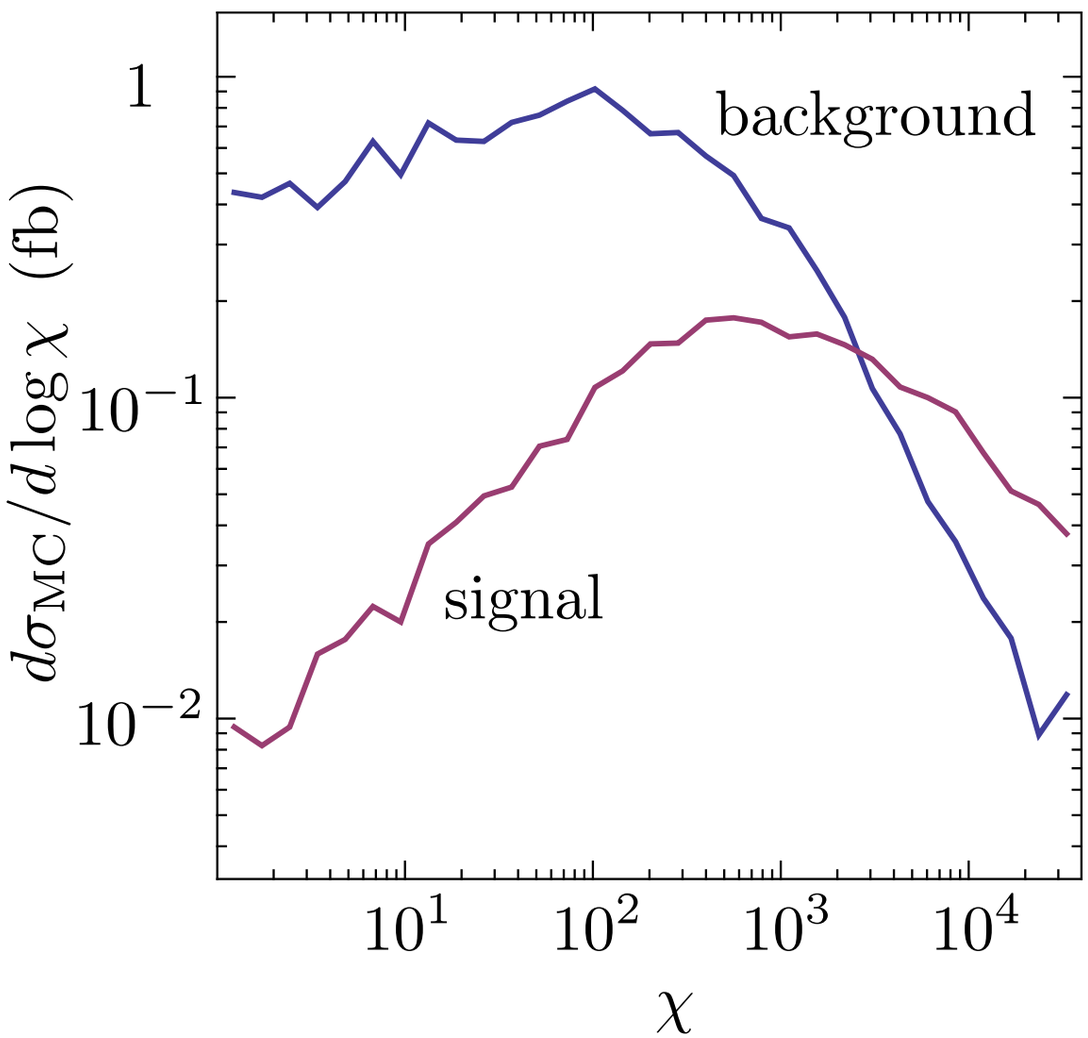
imperfect b-tagging -- 2 positively tagged microjets

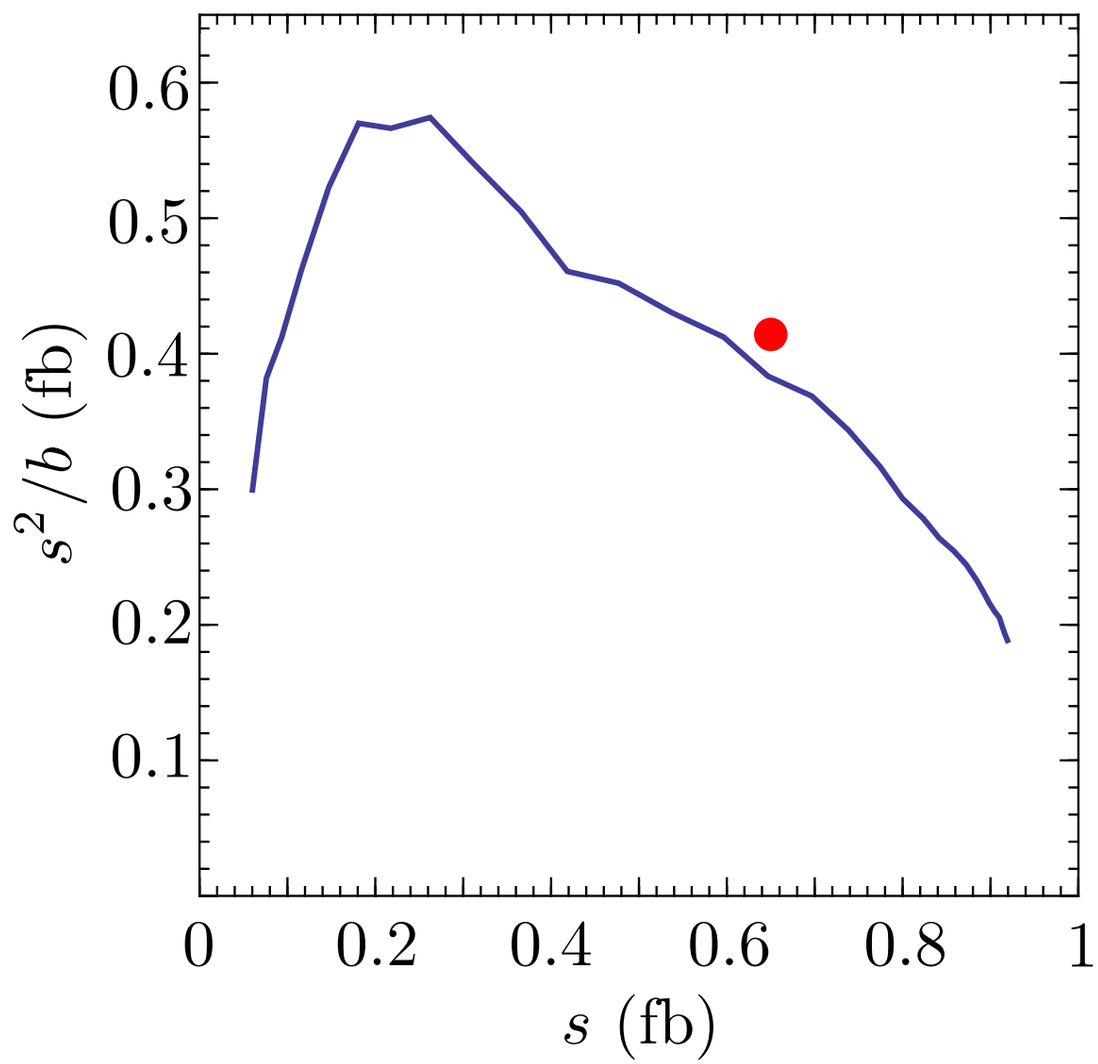




$\sigma_{\rm BDRS}({\rm S}) = 0.22$ fb $\quad \sigma_{\rm BDRS}({\rm B}) = 0.44$ fb $\quad \sigma_{\rm MC}({\rm S}) = 0.34$ fb

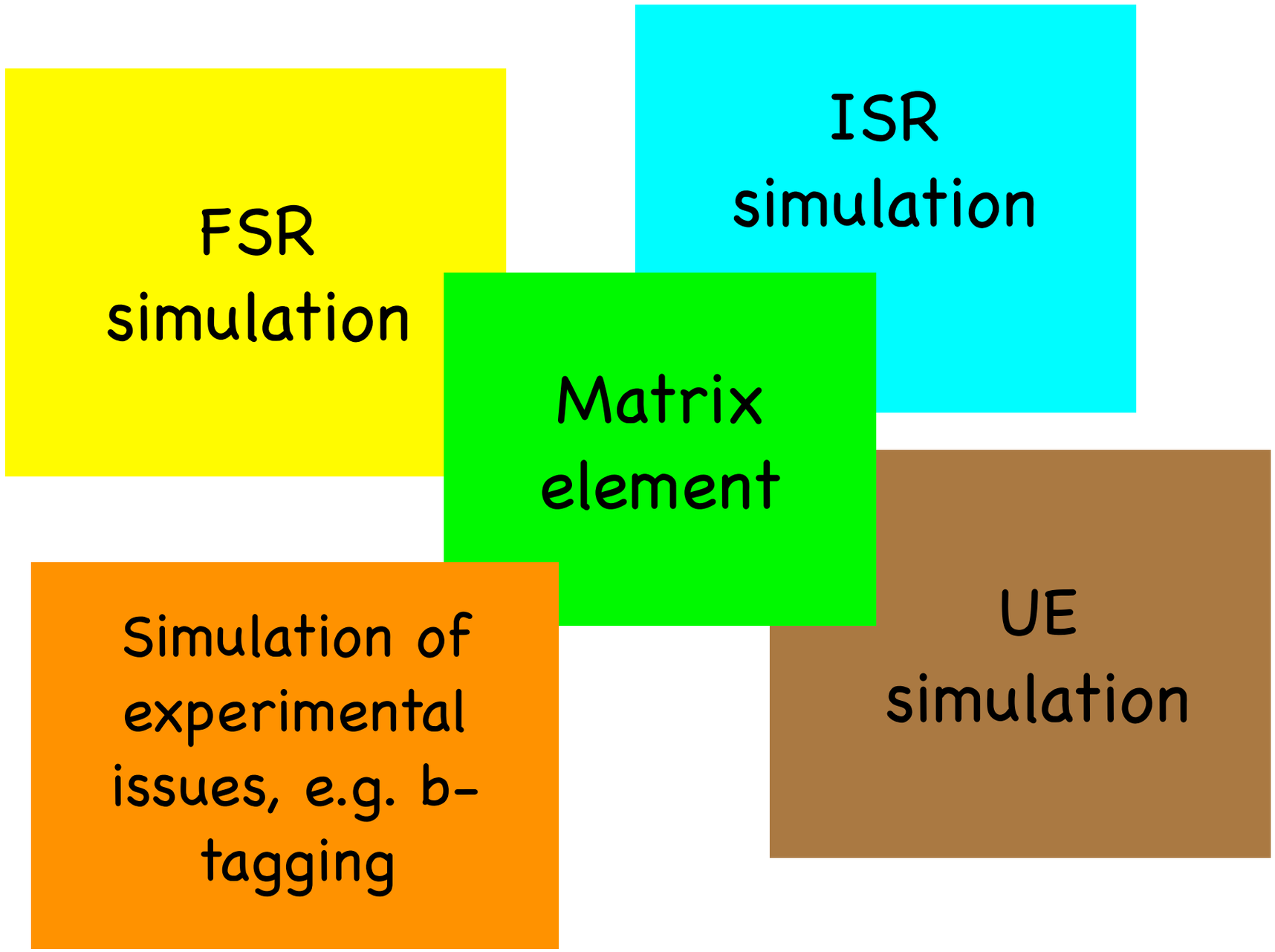
perfect b-tagging -- 2 positively tagged microjets





$\sigma_{\rm BDRS}({\rm B}) = 1.02$ fb $\quad \sigma_{\rm BDRS}({\rm S}) = 0.65$ fb $\quad \sigma_{\rm MC}({\rm S}) = 1.48$ fb

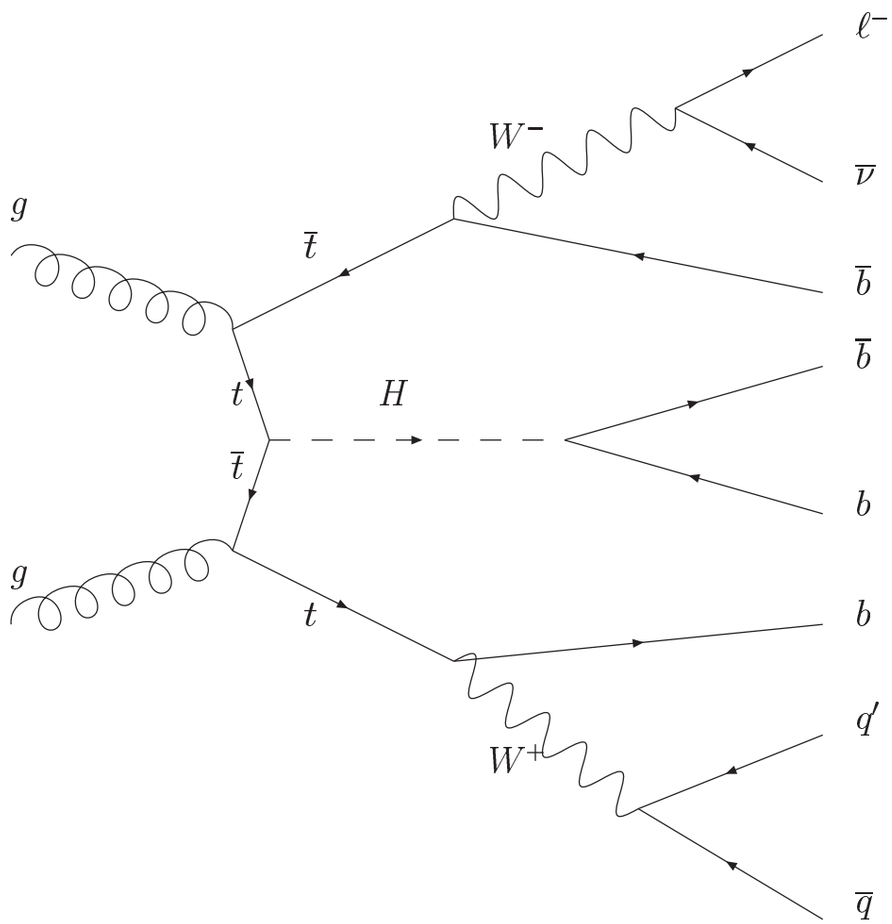
Lots of room for improvement:

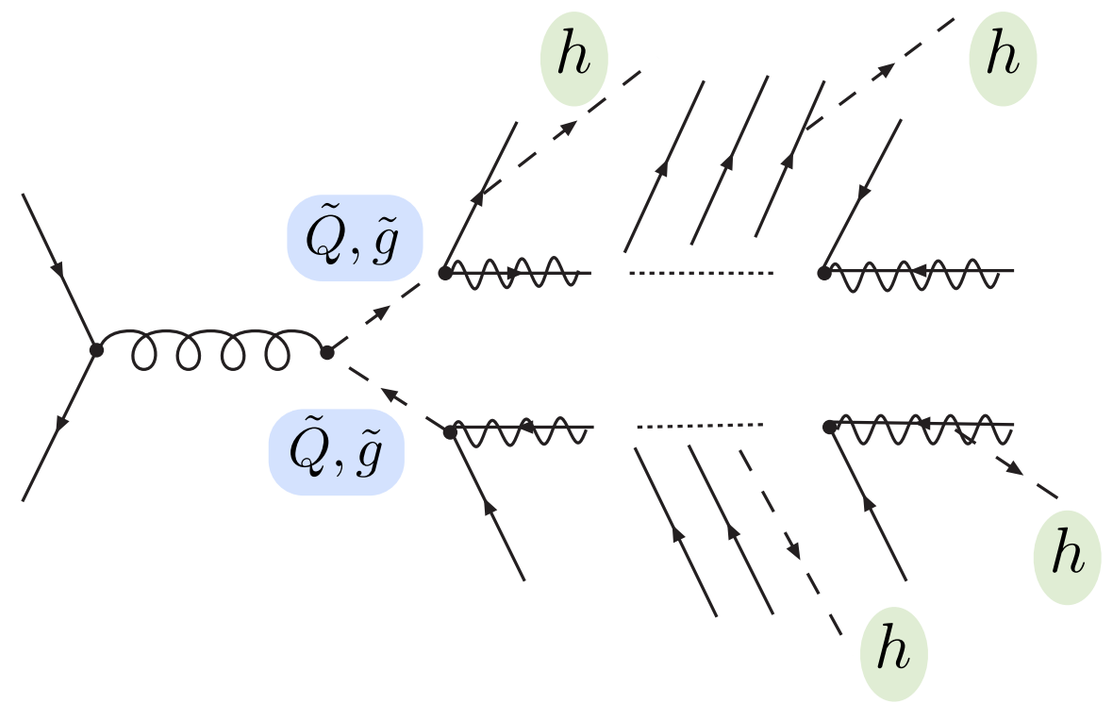


Modular build -> improvements are additive

Targeted scenarios:

- Busy final states -- e.g. tth, susy cascades





- Difficult processes with low stat. significance

Conclusions

- SD realization of 'maximal information approach'
- In simple HZ final state not as good as BDRS
- Theoretical Systematic uncertainty similar to BDRS
- Profits more from information than BDRS, e.g. b-tagging
- Might be useful for busy final states
- Modular set-up -> parts can be improved independently