Black Holes Chromospheres at the LHC?

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Matching at $r = R$ and requiring $M_* \simeq$ TeV gives $R \simeq 1$ mm (100 fm) for $d = 2$ (6).

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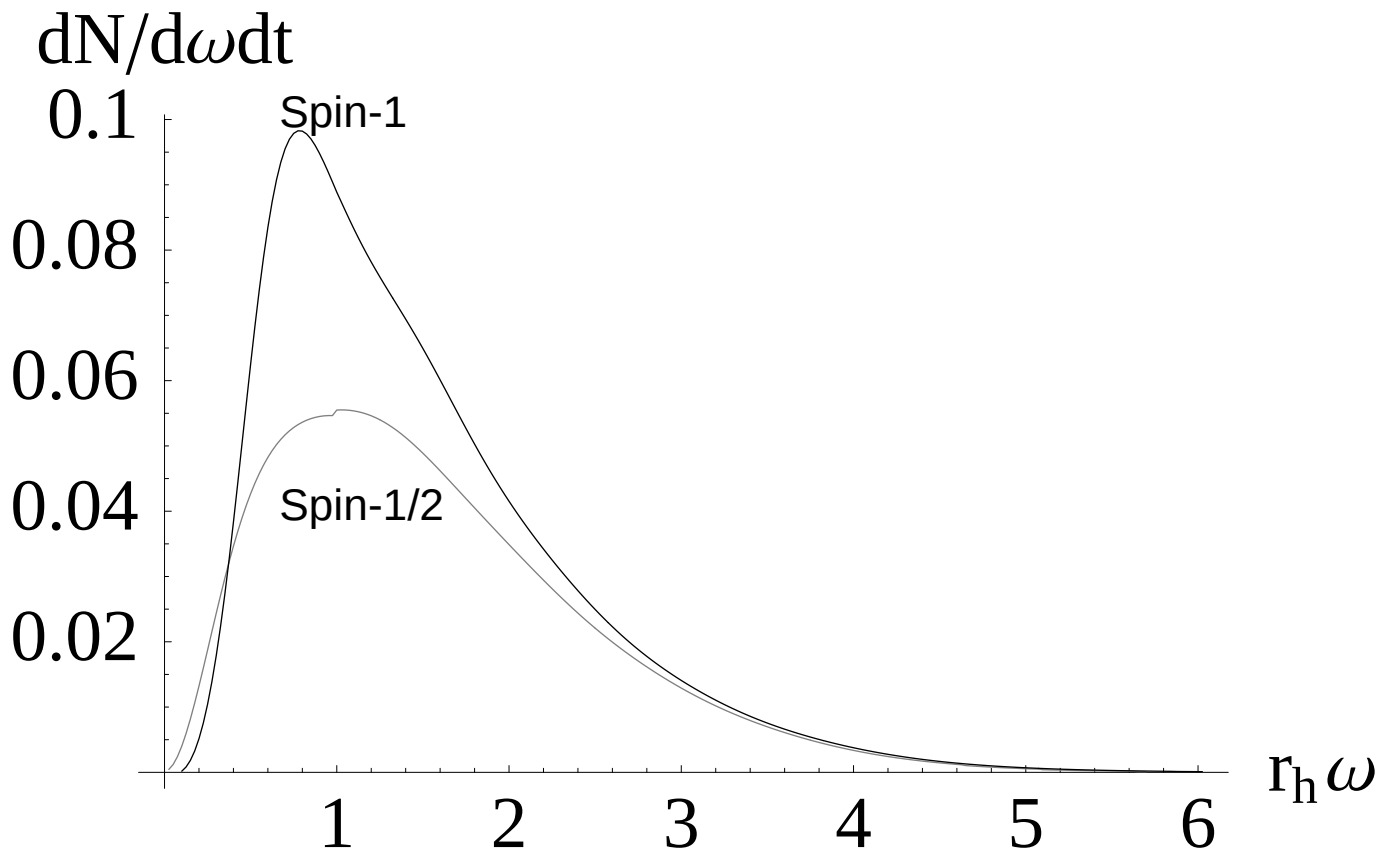
- Decay through Hawking radiation, with temperature

$$T = \frac{1+d}{4\pi r_h} \propto M_* \left(\frac{M_*}{M} \right)^{1/(1+d)} .$$

Decay spectrum



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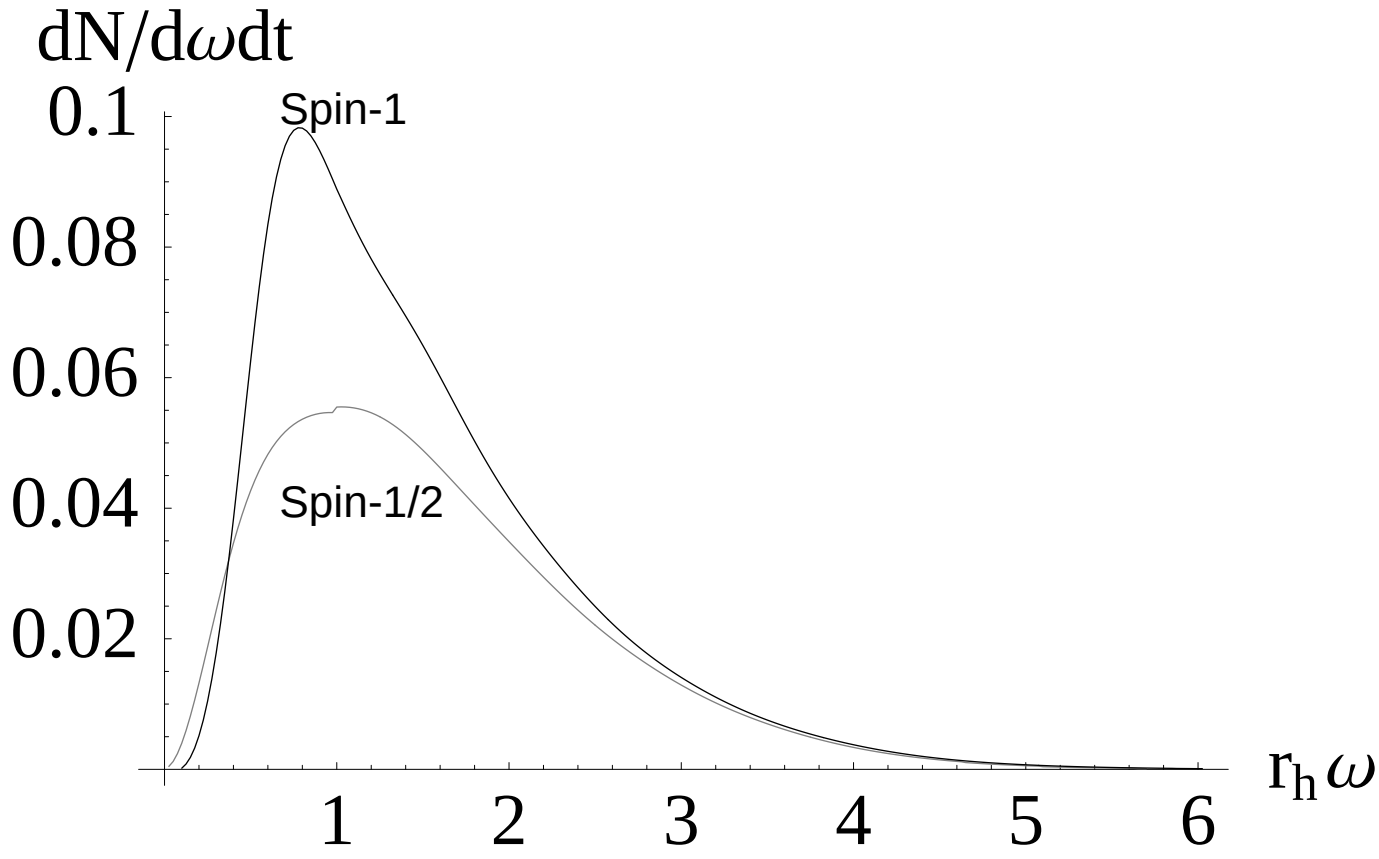

$\langle N_q \rangle = 8.4\ (18.6),\ \langle N_g \rangle = 3.8\ (8.3)$ for $d = 6$, minimal allowed M_*, $M = 5\ (10)$ TeV.

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Anchordoqui & Goldberg 2002

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- Resulting number of interactions per parton:

$$\mathcal{N}_{\rm int} \simeq 0.15 \frac{N_{q,\rm init}}{10} \left(\frac{\alpha_s(Q_{\rm min})}{0.2}\right)^3 \ln\left(\frac{2Q}{Q_{\rm min}}\right) \ln\left(\frac{\Gamma_{\rm bh}}{Q_{\rm min}}\right).$$

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- Gives $\mathcal{N}_{\rm tot} \simeq 3\ (30)$ for $N_{q,\rm init} = 10,\ Q = 400$ GeV, $Q_{\rm min} = 9\ (1.8)$ TeV.

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- Uncertainty principle: partons only “have time” for one interaction with $\Lambda = 1/r$ while travelling distance r.
- No onset of chromosphere formation seen in 6–jet events (UA2, CDF).

Simulation

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- Allow scattering only with $Q_{\mathrm{scatt}} \simeq p_T >$ initial virtuality!

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- Further details in hep–ph/0610269.

Numerical Results

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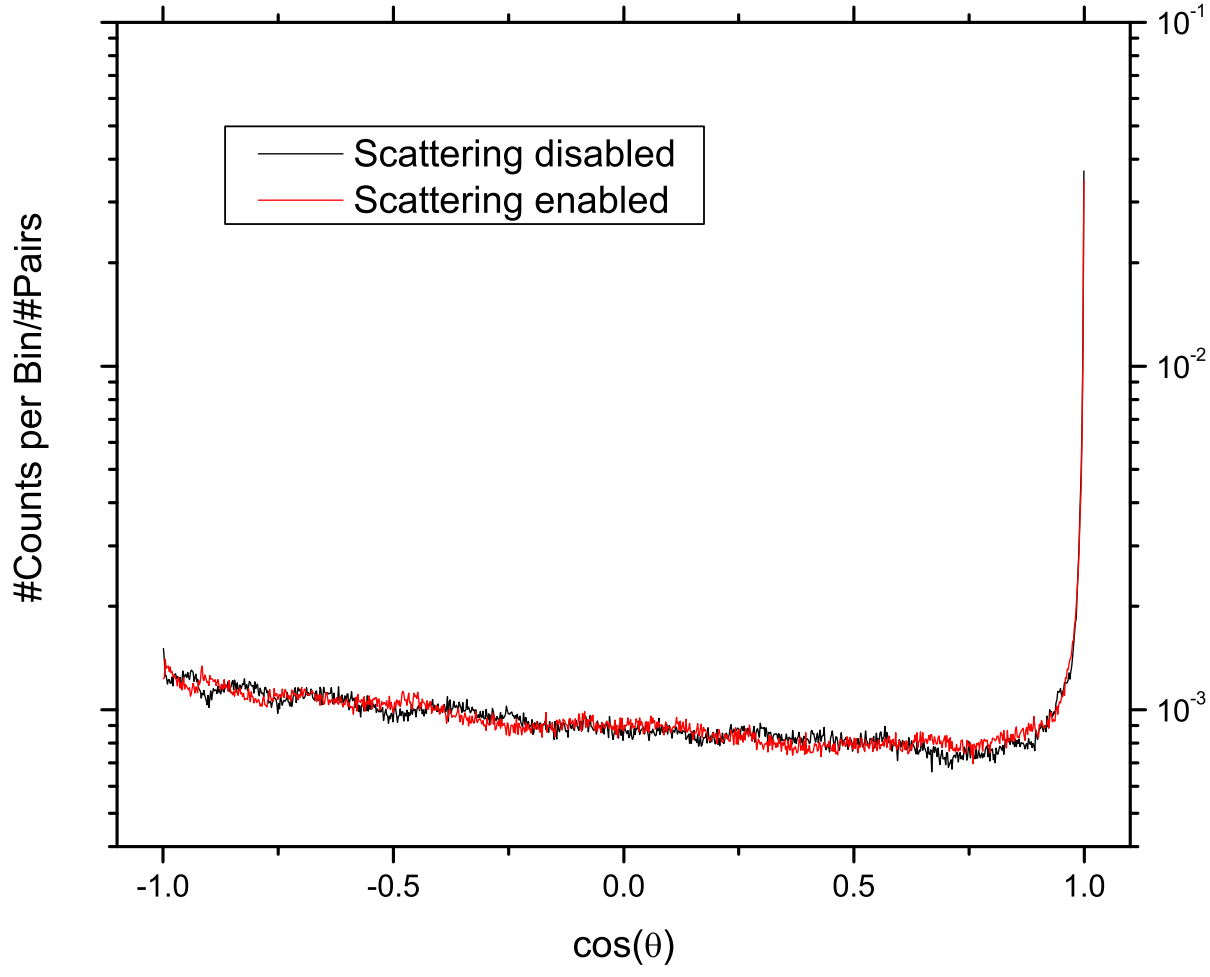
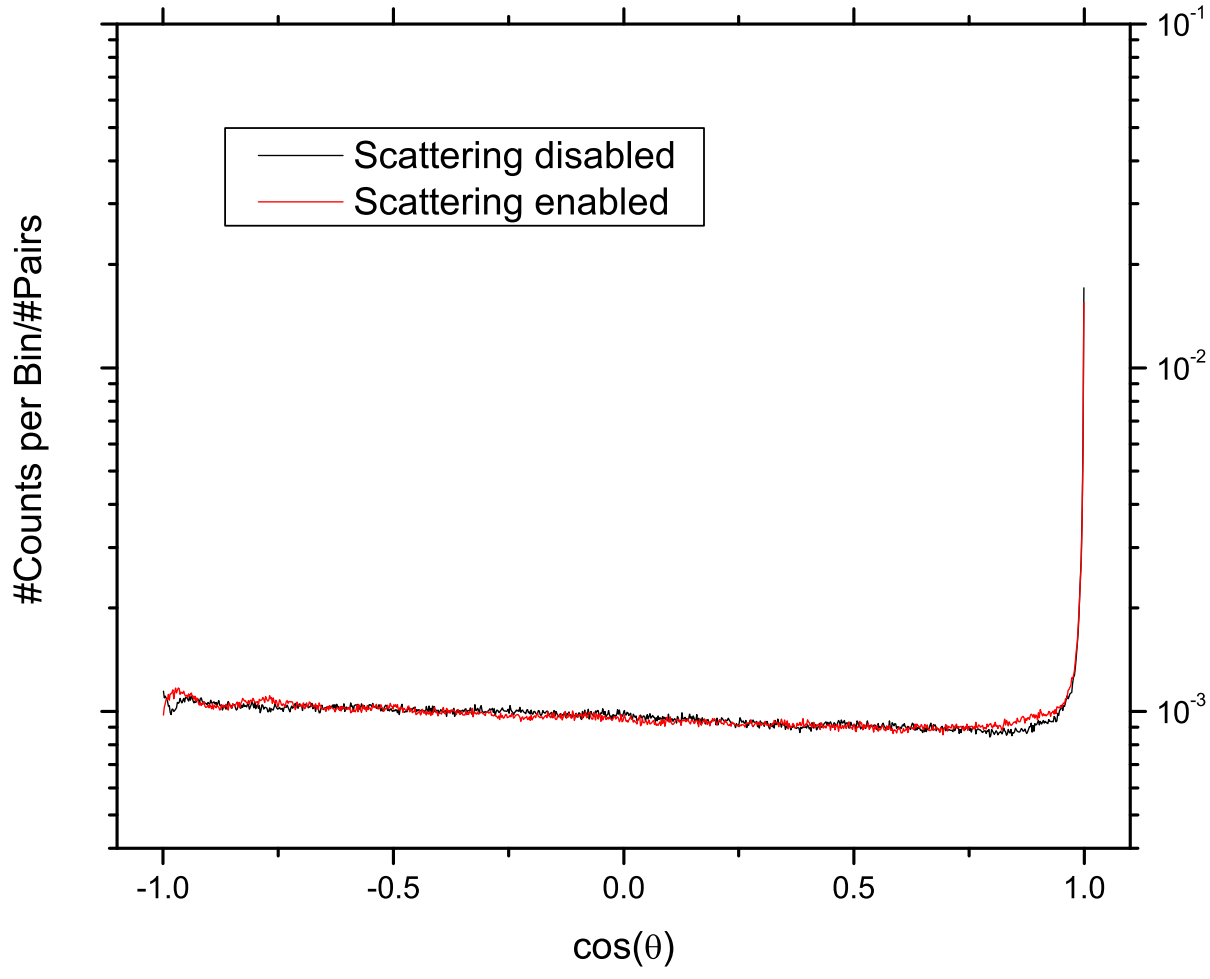
- Angular correlations between energetic charged particles
- Overall energy flow pattern

Angular Correlations, $M = 5$ TeV

Angle between pairs of charged particles with $E > 4$ GeV.



Angular Correlations, $M = 10$ TeV



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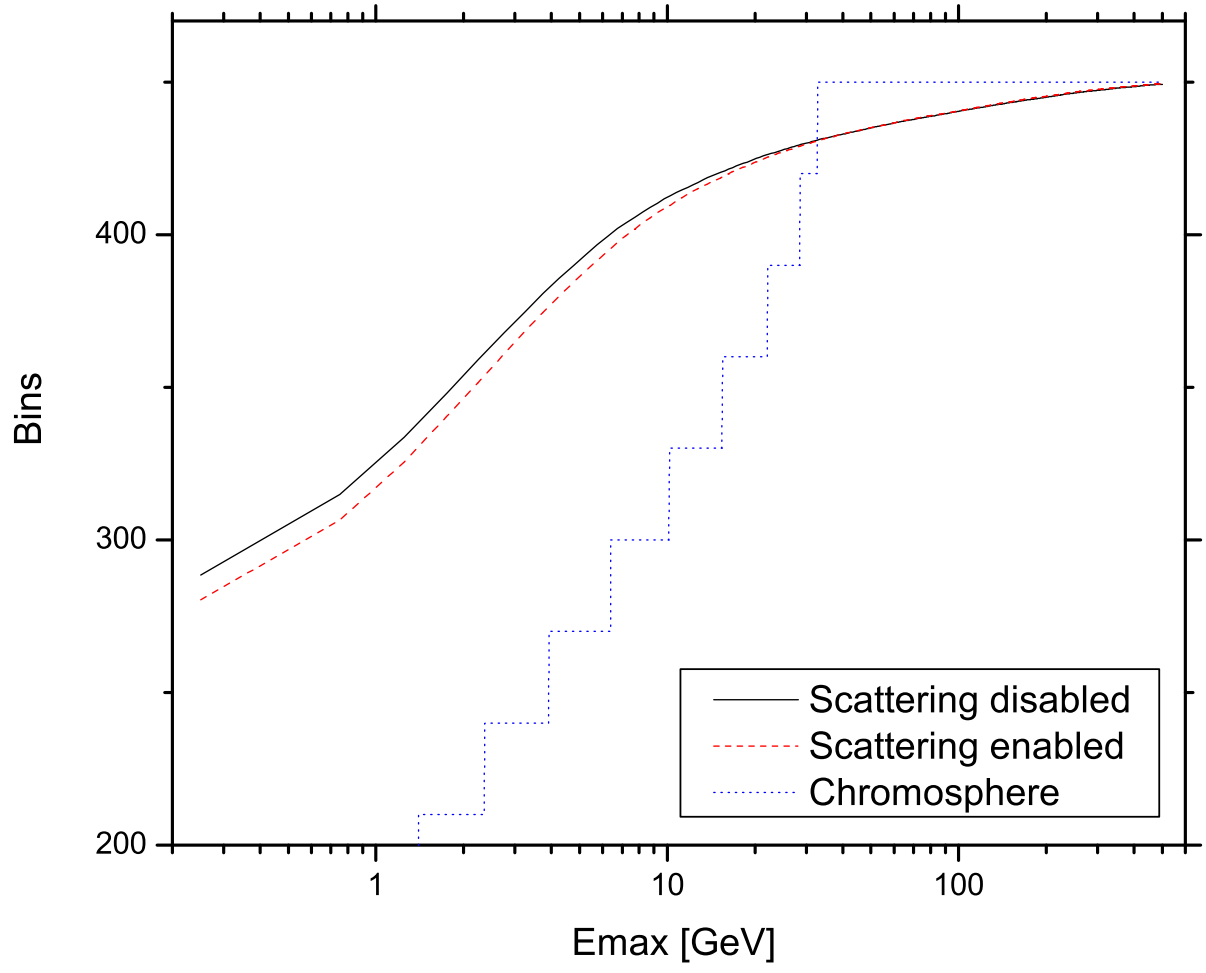
- Mild increase towards $\cos\theta = -1$ due to momentum conservation (angle measured in bh rest frame!)

Energy Flow, $M = 5$ TeV

Divide phase space in 15×30 cells in ϕ and η. Plot number of cells with $E < E_{\max}$:



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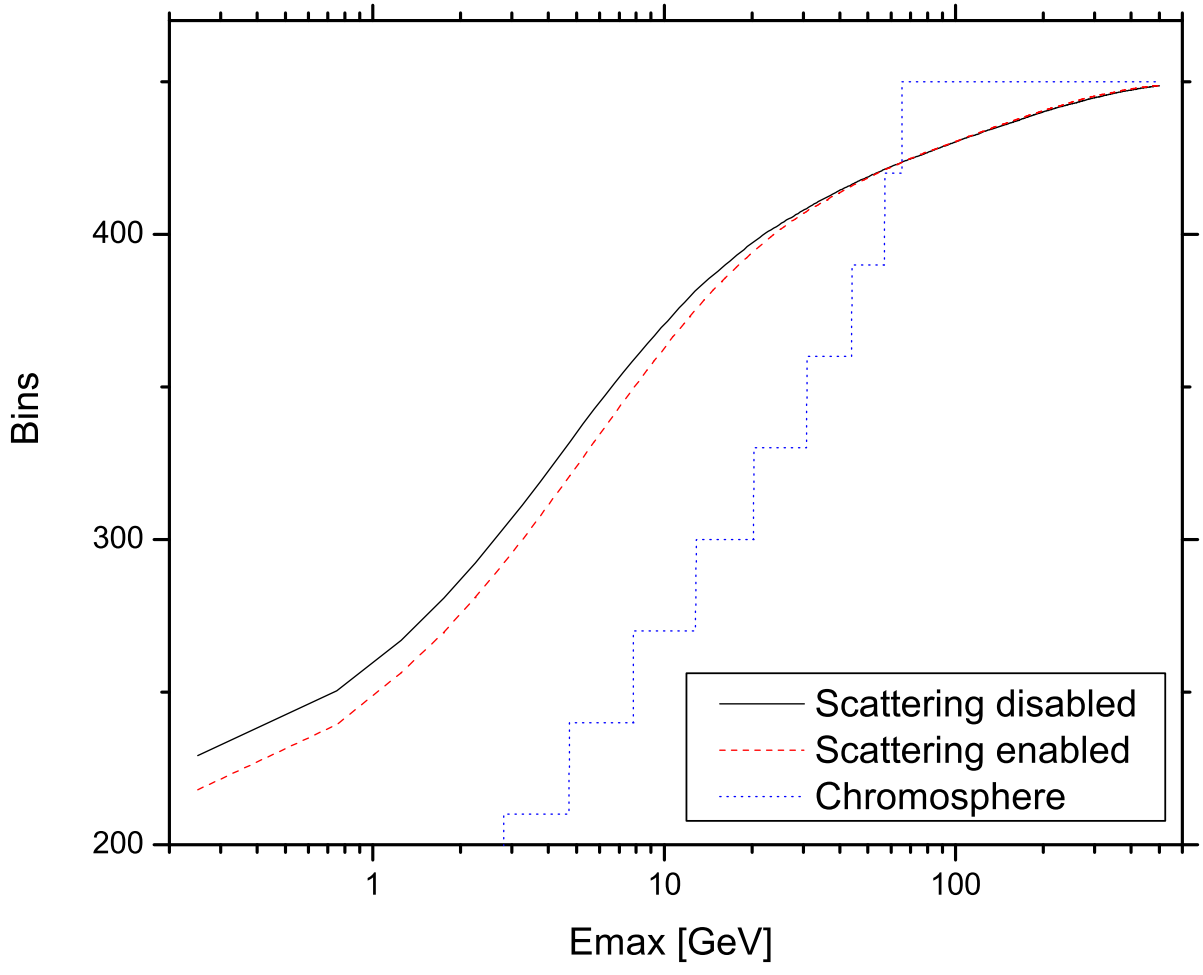

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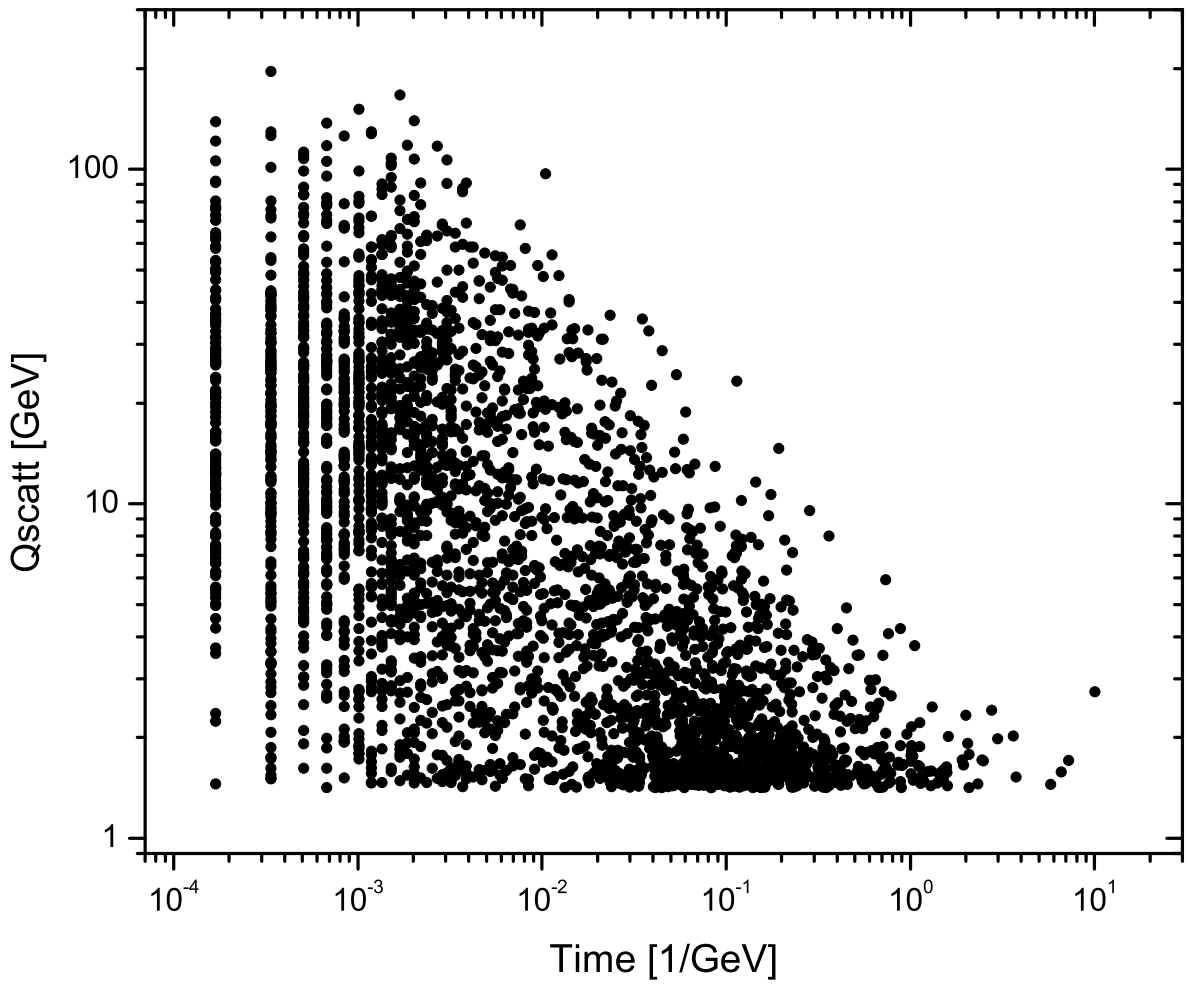
- Scattering slightly reduces number of empty cells; but: underlying event not included!
- Find on average 16 (53) scattering reactions for $M = 5\ (10)$ TeV.

Scatterings from 100 bh decays ($M = 10$ TeV)



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- Effects of scattering are small: No evidence for formation of “chromosphere”; well–defined jets should be detectable
- Energy spectrum of jets is sensitive to M, M_*, d.