LHC Physics Potential *vs.* Energy

Chris Quigg

Fermilab

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arXiv:0908.3660 lutece.fnal.gov/PartonLum

EHLQ, *Rev. Mod. Phys.* **56**, 579–707 (1984)
Ellis, Stirling, Webber, *QCD & Collider Physics*
MRSW08NLO examples + RKE Lecture 3, SUSSP 2009

LHC physics run begins soon . . .

The Large Hadron Collider will run in 2010–2011 at 3.5 TeV per beam, to accumulate $\sim$ 1 fb^{-1}.

- How is the physics potential compromised by running below 14 TeV?
- At what point will the LHC begin to explore virgin territory and surpass the discovery reach of the Tevatron experiments CDF and D0?

Parton Luminosities + Prior Knowledge = Answers

Taking into account $1/\hat{s}$ behavior of hard scattering,

$$\frac{\tau}{\hat{s}}\frac{d\mathcal{L}}{d\tau} \equiv \frac{\tau/\hat{s}}{1+\delta_{ij}}\int_\tau^1 \frac{dx}{x}[f_i^{(a)}(x)f_j^{(b)}(\tau/x) + f_j^{(a)}(x)f_i^{(b)}(\tau/x)]$$

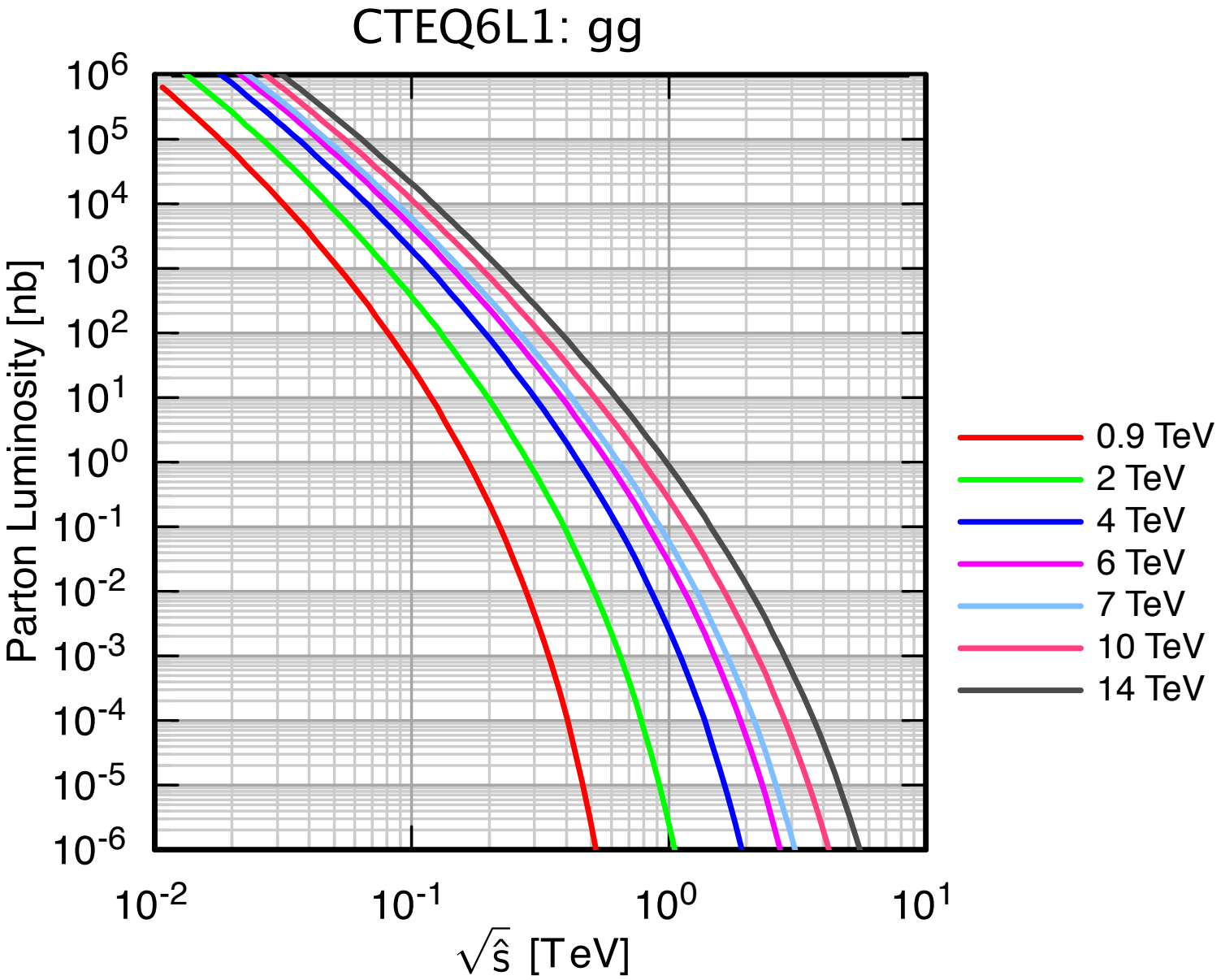
is a convenient measure of parton *ij* luminosity.

$$f_i^{(a)}(x)\text{: pdf;} \quad \tau = \hat{s}/s$$

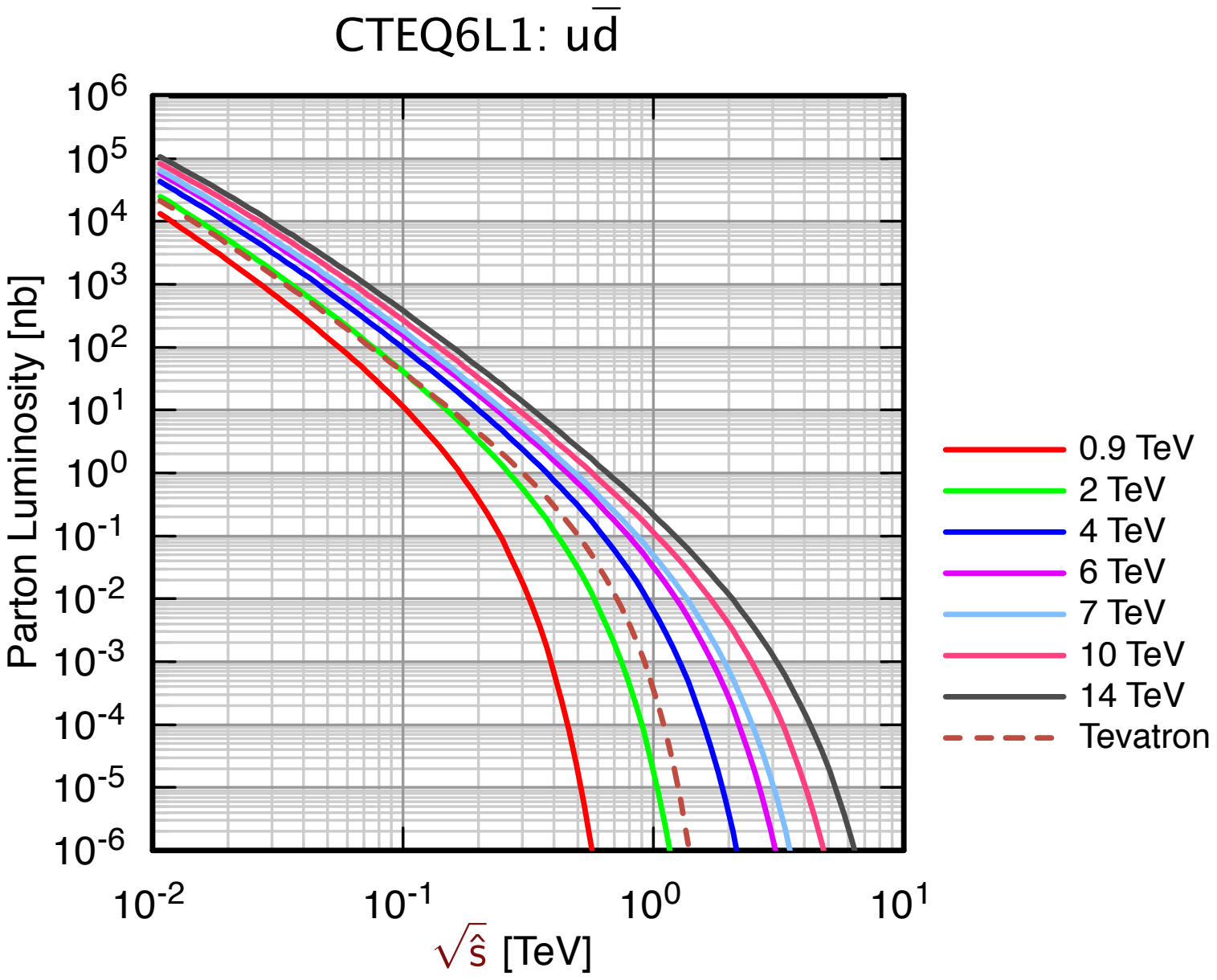
$$\sigma(s) = \sum_{\{ij\}}\int_{\tau_0}^1 \frac{d\tau}{\tau}\cdot\frac{\tau}{\hat{s}}\frac{d\mathcal{L}_{ij}}{d\tau}\cdot[\hat{s}\hat{\sigma}_{ij}(\hat{s})]$$

EHLQ §2; *QCD & Collider Physics*, §7.3

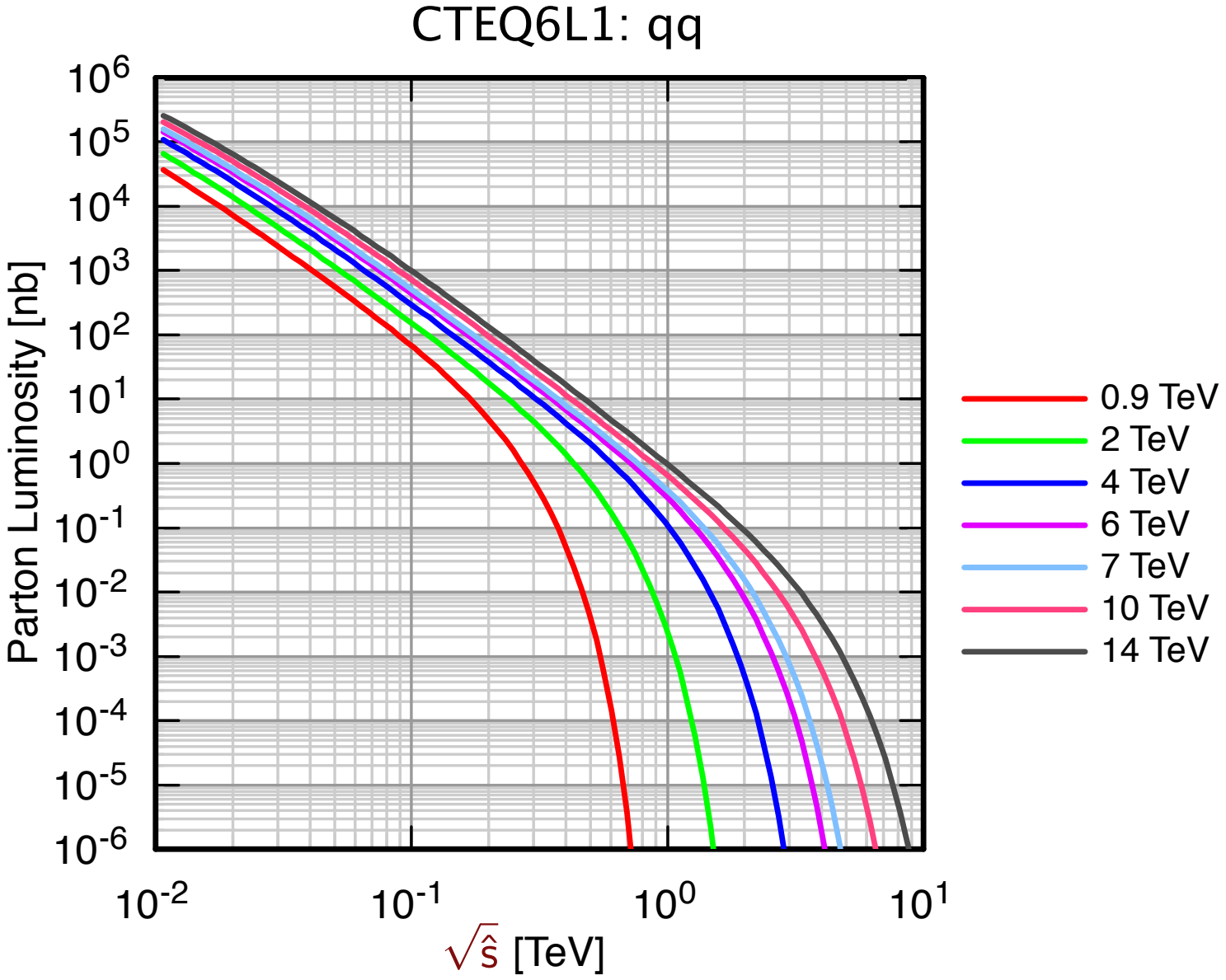
Parton Luminosity



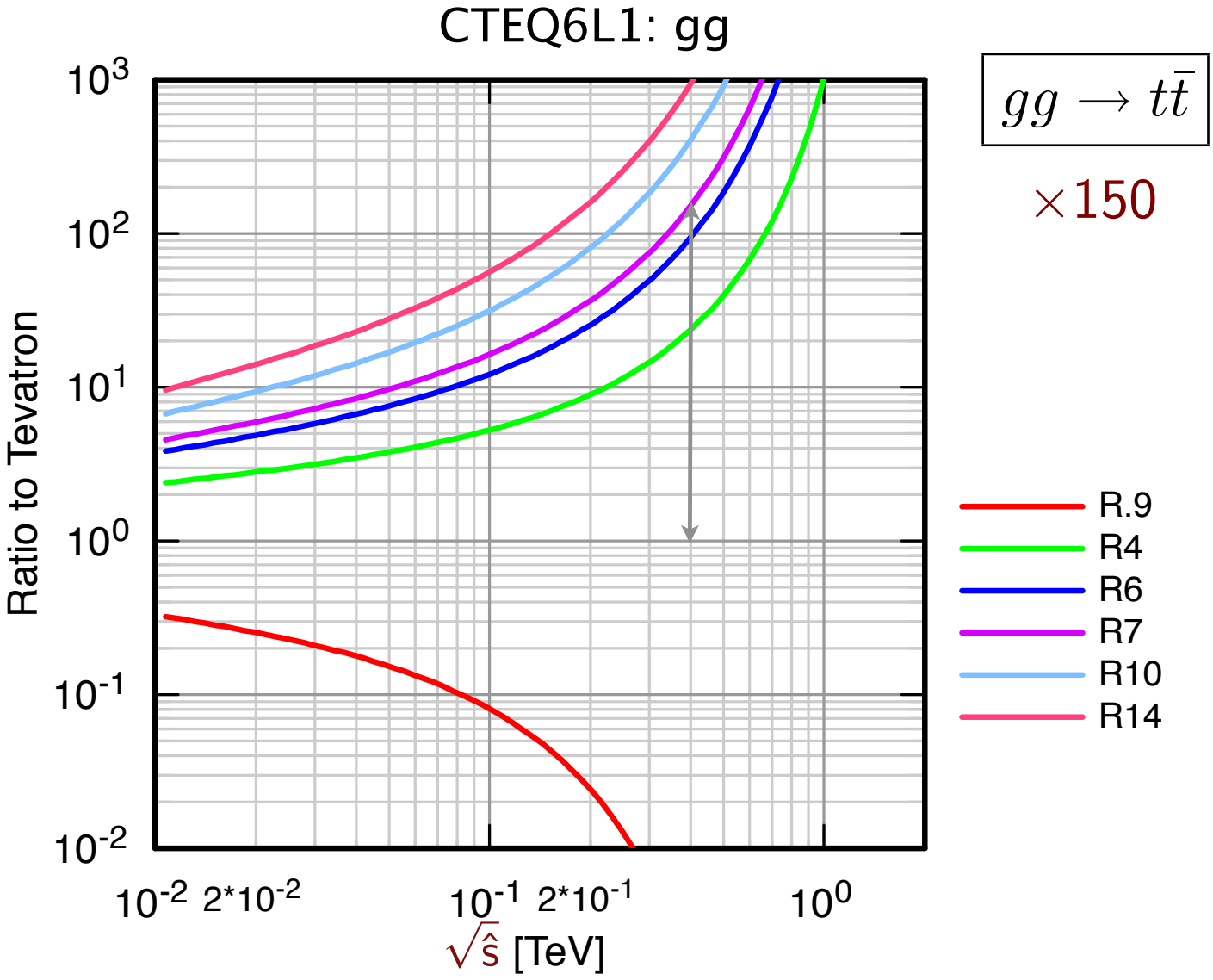
Parton Luminosity



Parton Luminosity (light quarks)



Luminosity Ratios



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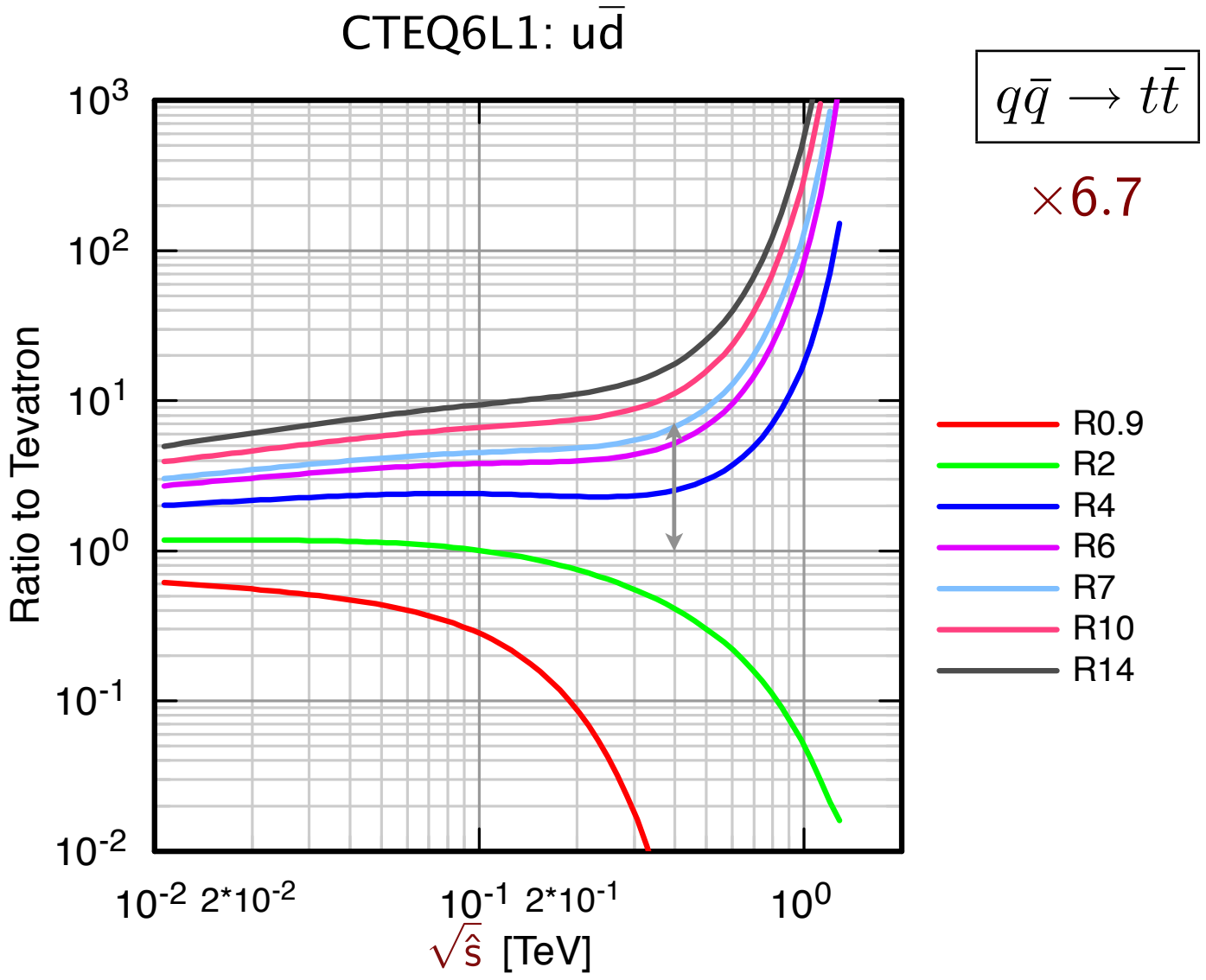

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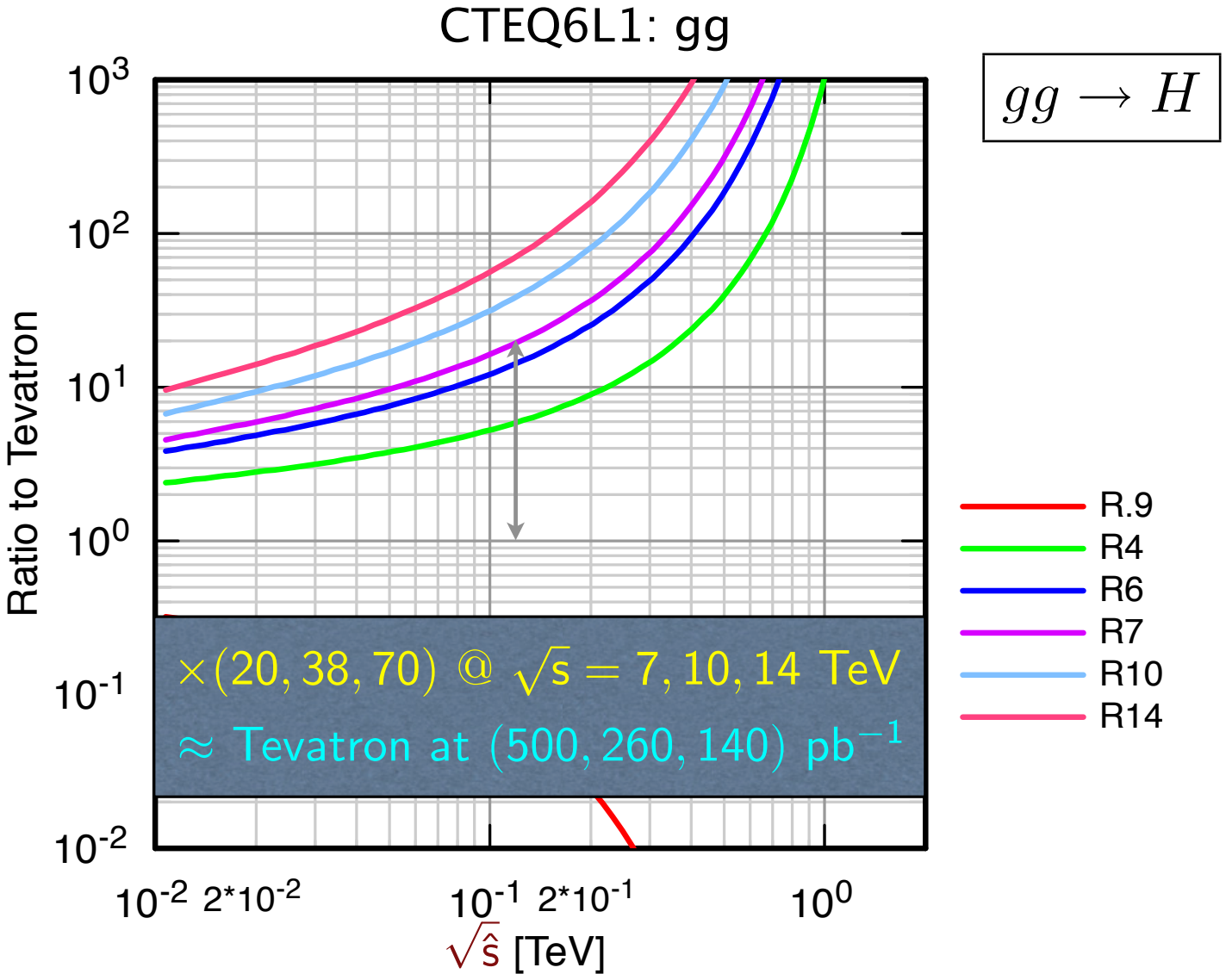

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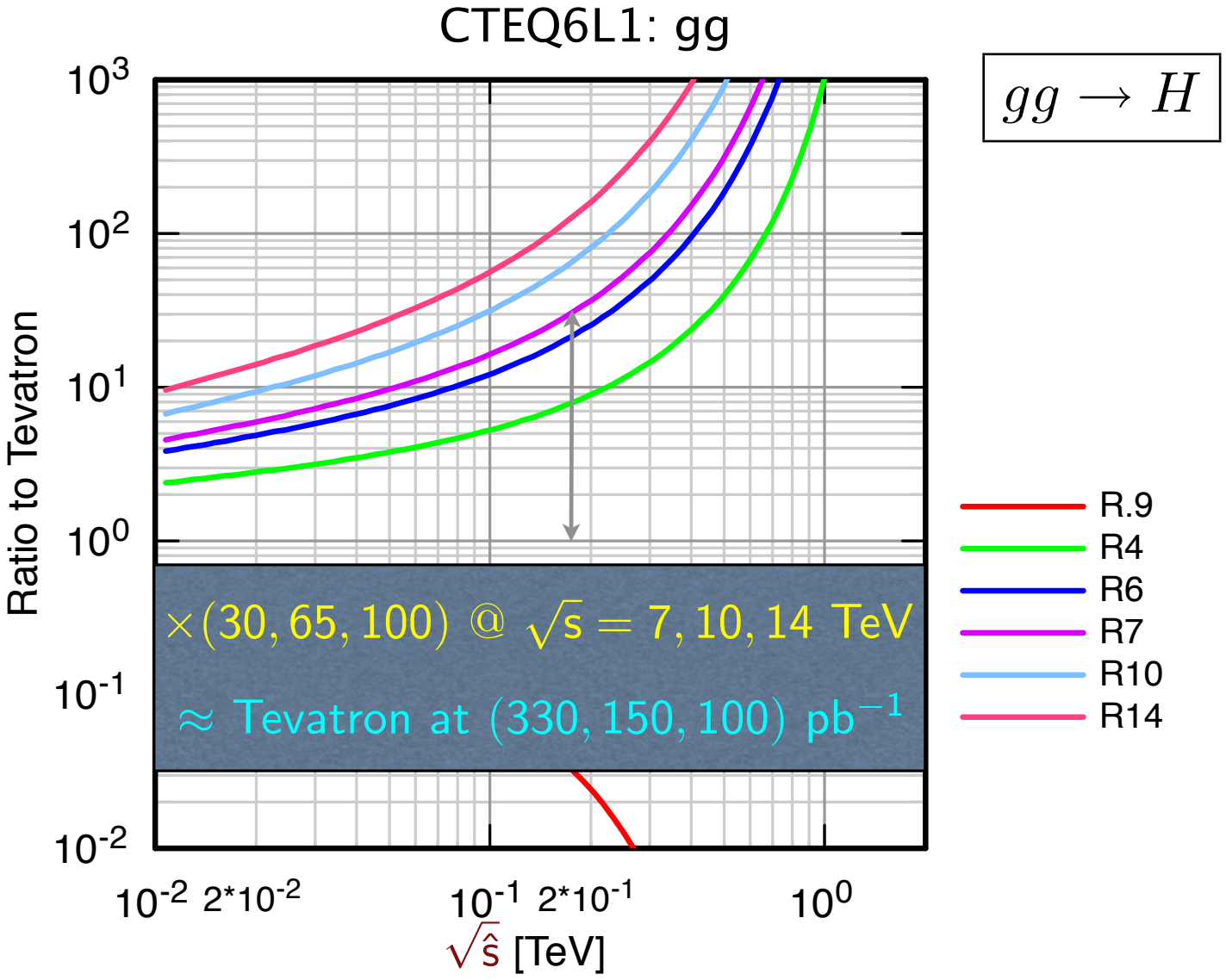

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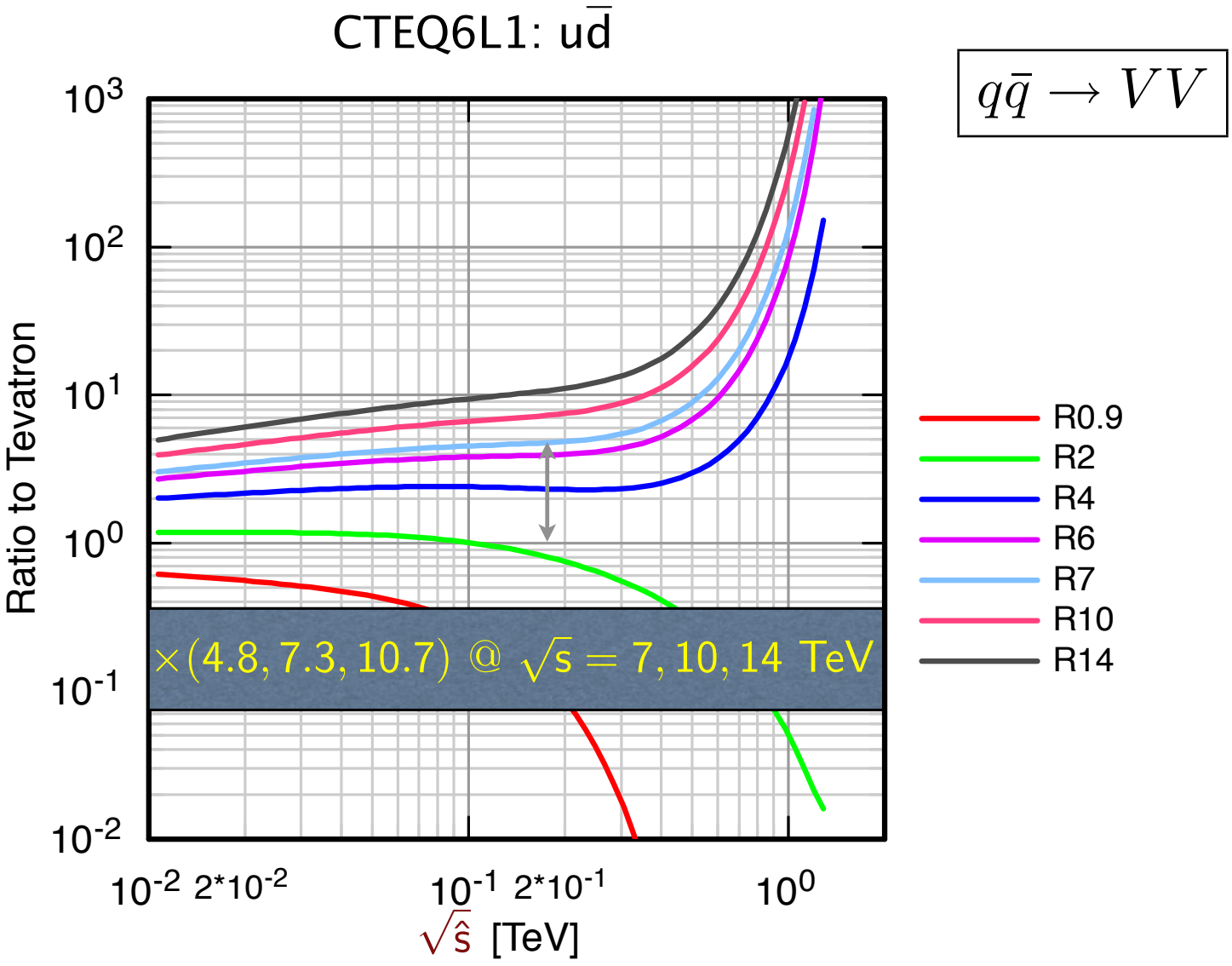

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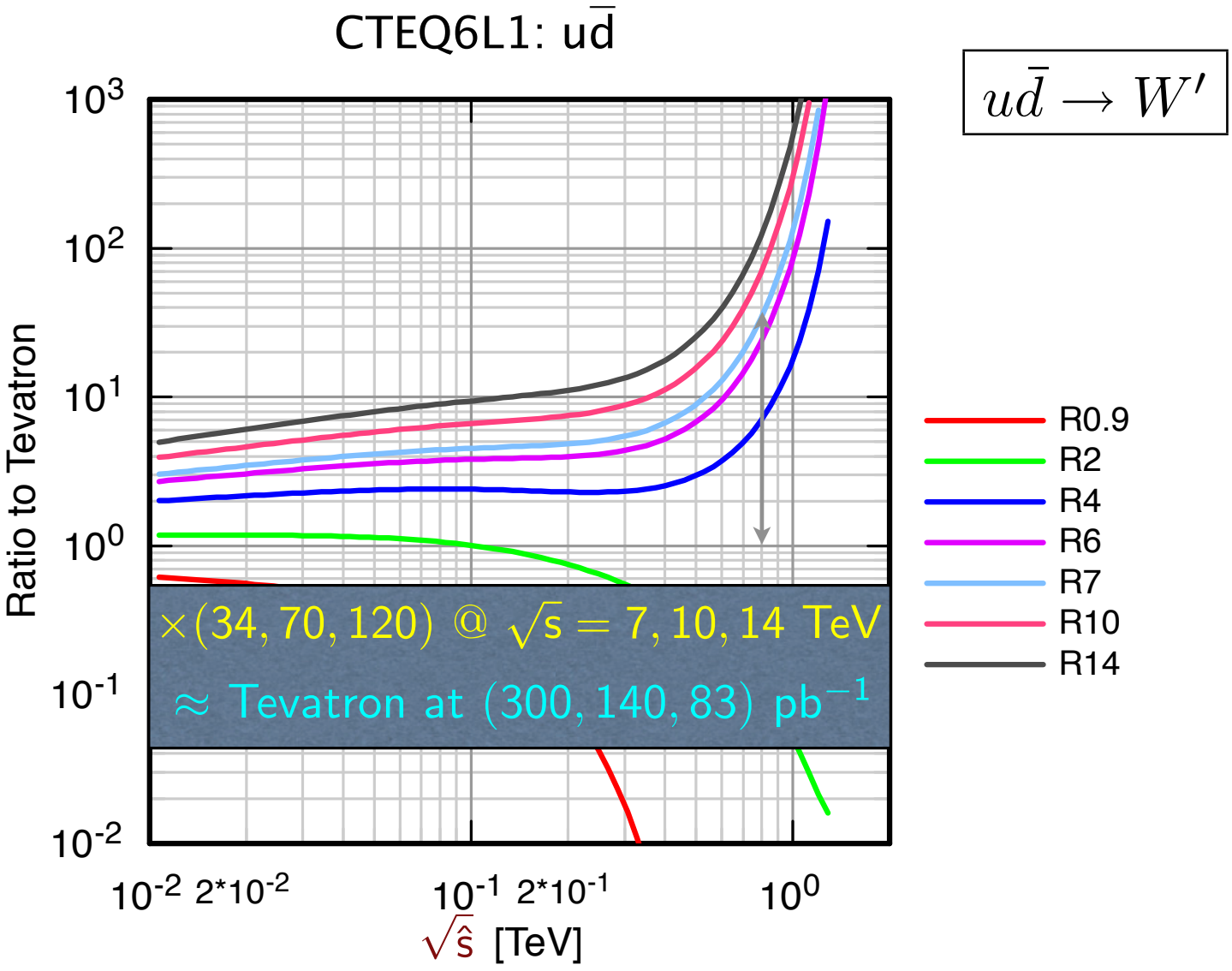

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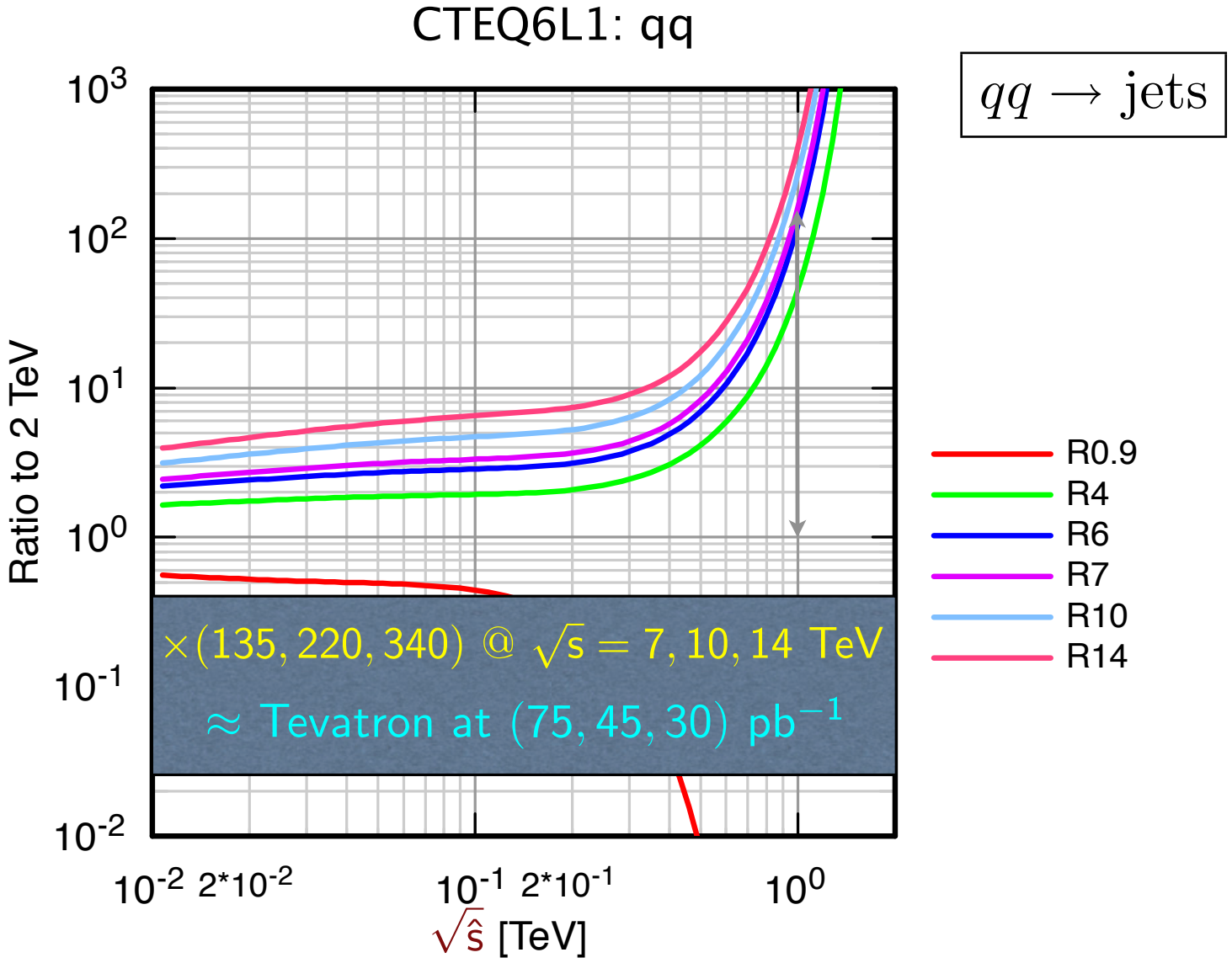
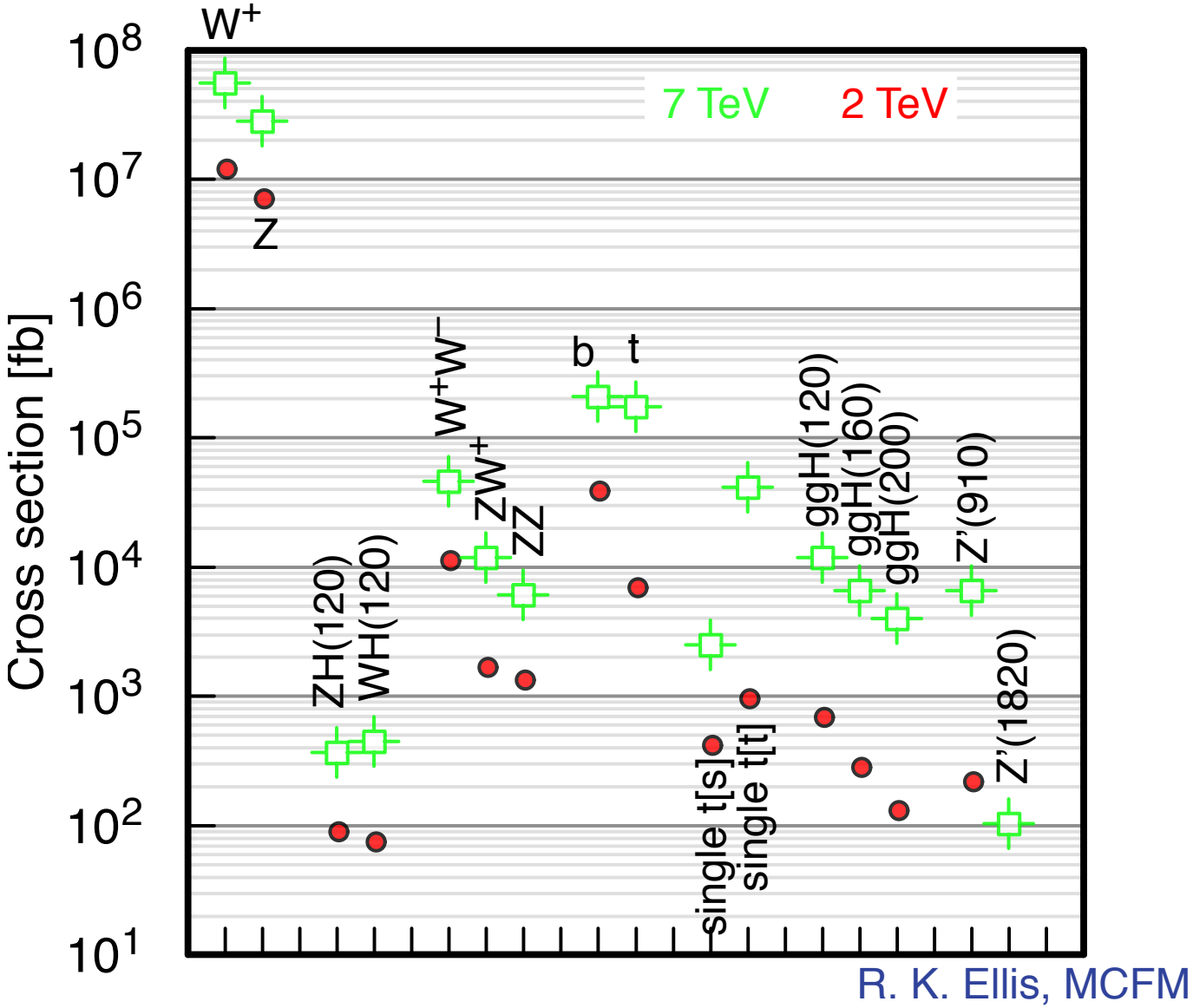


Some Absolute Rates



R. K. Ellis, MCFM

Details . . .

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