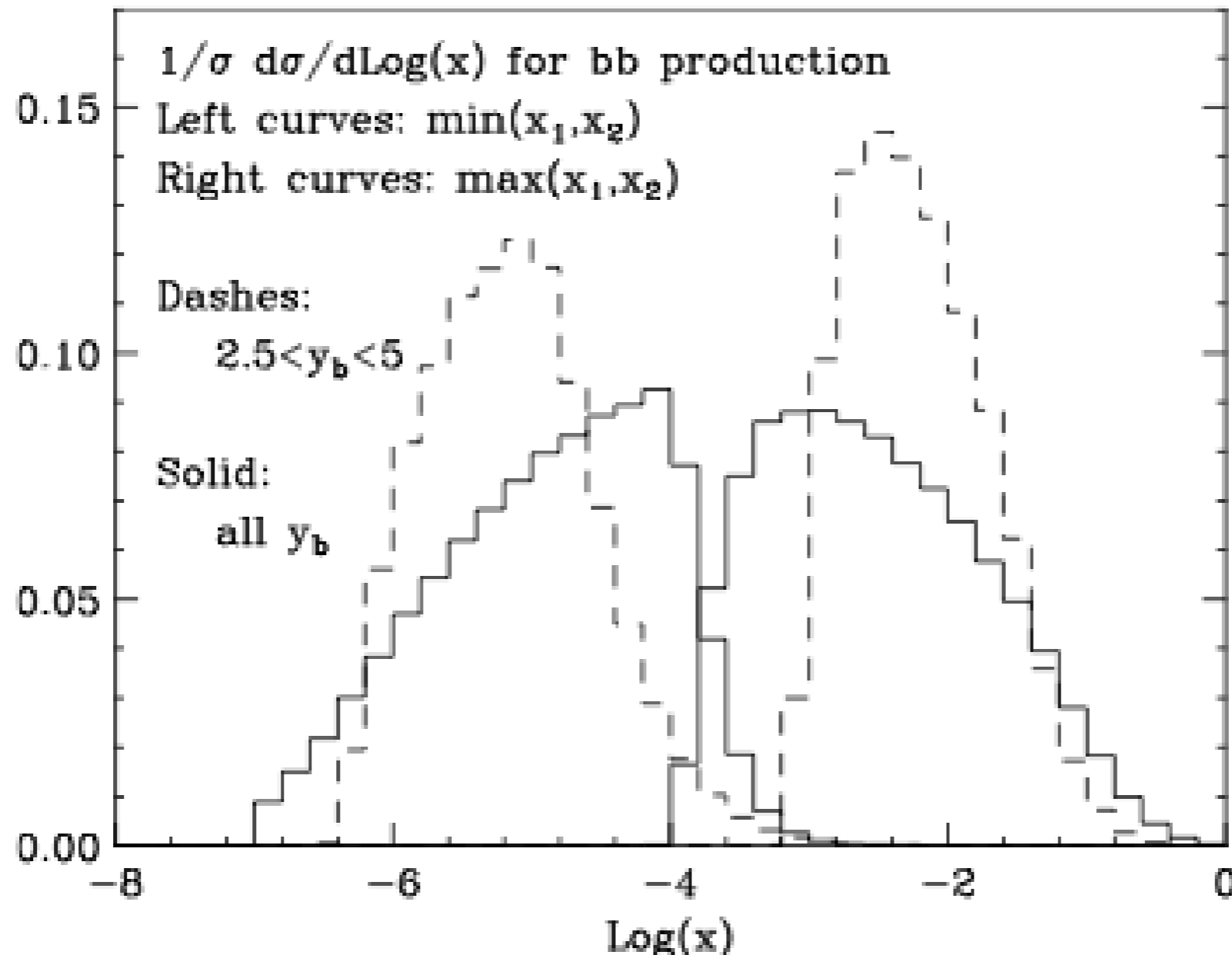


# Inclusive heavy quark production

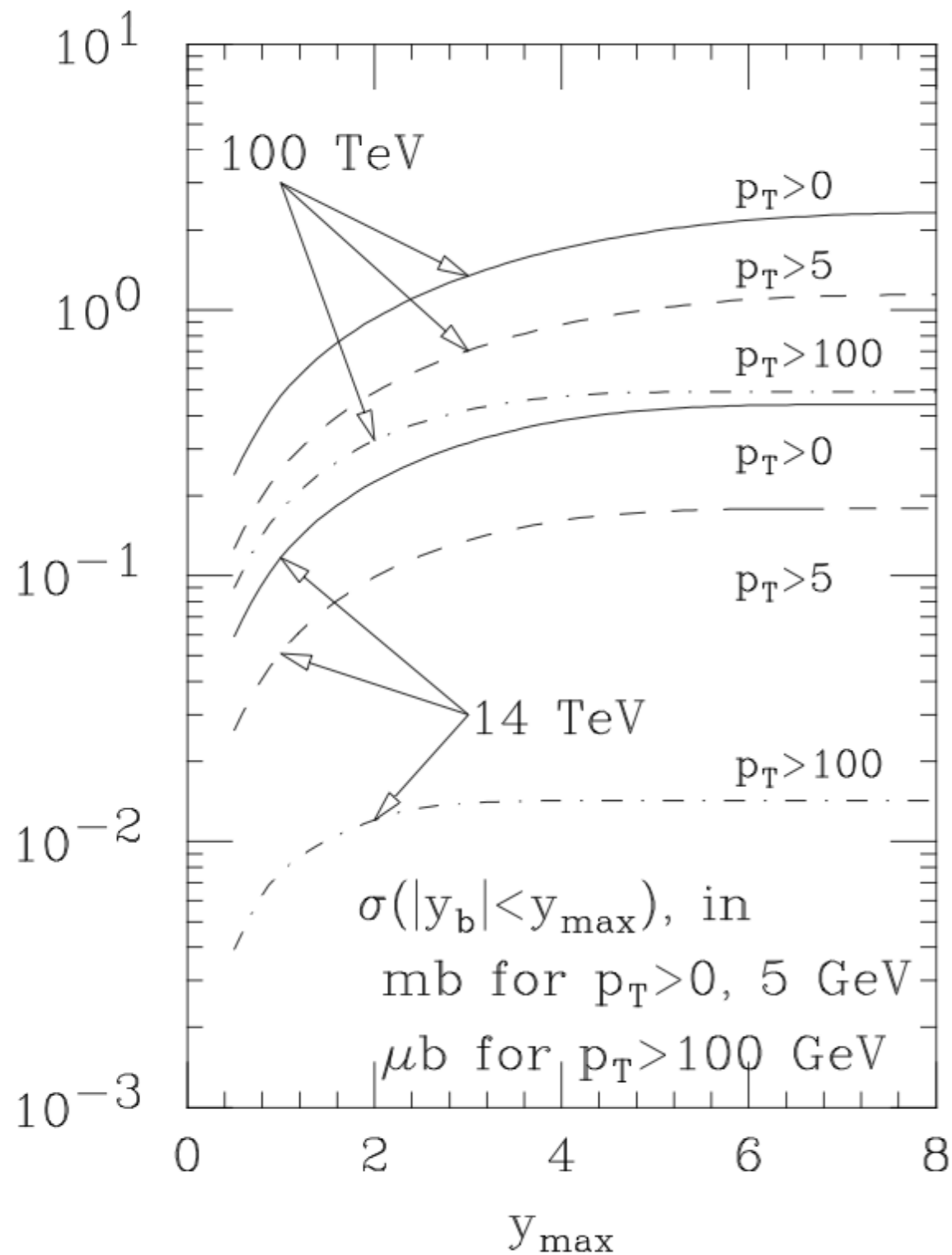
- Bottom quark production  $\sigma_{100\text{TeV}}(\text{bb}) \sim 2.5 \text{ mb} \sim 5 \times \sigma_{14\text{TeV}}(\text{bb})$

## Ex: x-range accessed in inclusive production

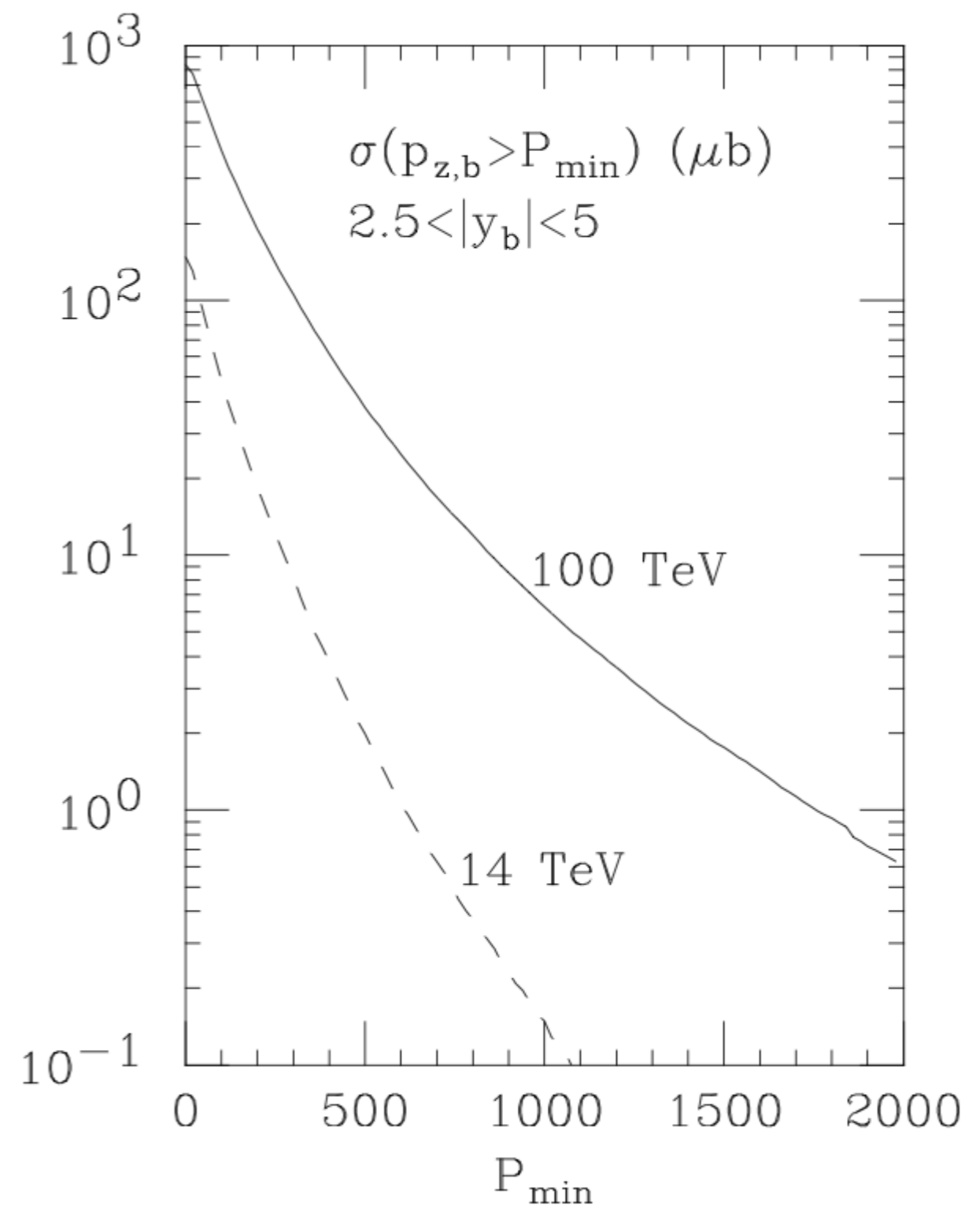
*Interest in QCD studies at large rapidity? PDF fits, small-x physics, hvq ( $\rightarrow$  neutrino) production in cosmic ray interactions, ...*



# Inclusive heavy quark production



Ex: integrated rates as a function of detector acceptance, for various  $p_T$  ranges



Ex: integrated rates vs total b momentum in the fwd region: impact on LHCb-like detector physics programme?

# Inclusive heavy quark production

- Top quark production  $\sigma_{100\text{TeV}}(tt) \sim 30 \text{ nb} \sim 30 \times \sigma_{14\text{TeV}}(tt)$

LO (CT14lo):  $\sigma_{\text{tot}} = 21.7 + 4.8 (22\%) - 3.6 (17\%) \text{ [nb]}$ . *Mitov et al*

NLO (CT14nlo):  $\sigma_{\text{tot}} = 32.1 + 3.6 (11\%) - 3.3 (10\%) \text{ [nb]}$ .

NNLO (CT14nnlo):  $\sigma_{\text{tot}} = 34.7 + 1.0 (2.9\%) - 1.6 (4.8\%) \text{ [nb]}$ .

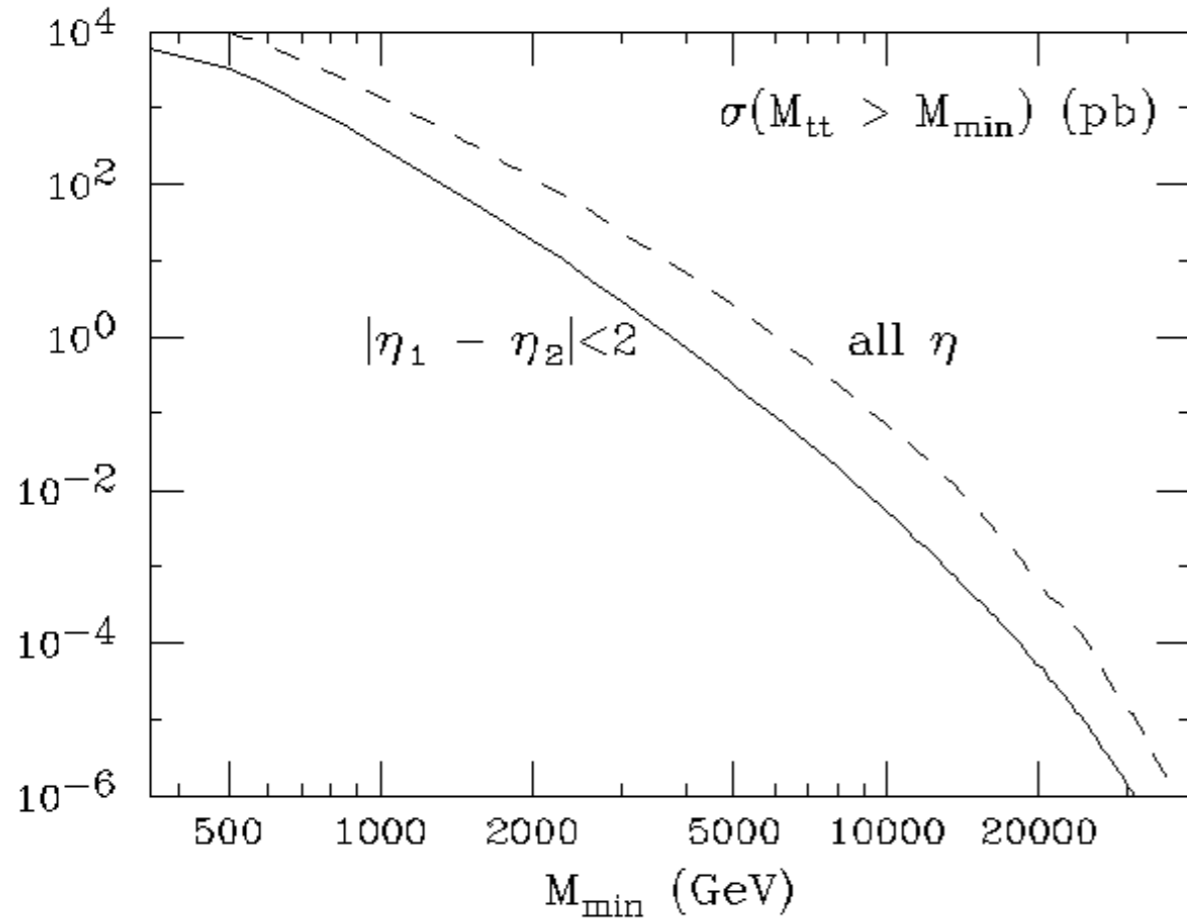
NNLO (NNPDF30\_nnlo\_as\_0118):  $\sigma_{\text{tot}} = 34.8 + 1.0 (2.9\%) - 1.6 (4.7\%) \text{ [nb]}$ .

- $\Rightarrow$  about  $10^{12}$  top quarks produced in  $10 \text{ ab}^{-1}$ 
  - rare and forbidden top decays
  - $10^{12}$  fully inclusive W decays, triggerable by “the other W”
    - rare and forbidden W decays
    - $3 \cdot 10^{11}$  W  $\rightarrow$  charm decays
    - $10^{11}$  W  $\rightarrow$  tau decays
  - $10^{12}$  fully charge-tagged b hadrons

	$t\bar{t}$	$t\bar{t}t\bar{t}$	$t\bar{t}W^\pm$	$t\bar{t}Z^0$	$t\bar{t}WW$	$t\bar{t}W^\pm Z$	$t\bar{t}ZZ$
$\sigma(\text{pb})$	$3.2 \cdot 10^4$	4.9	16.8	56.3	1.1	0.17	0.16

*Largest source of multi-W final states*

# Inclusive heavy quark production



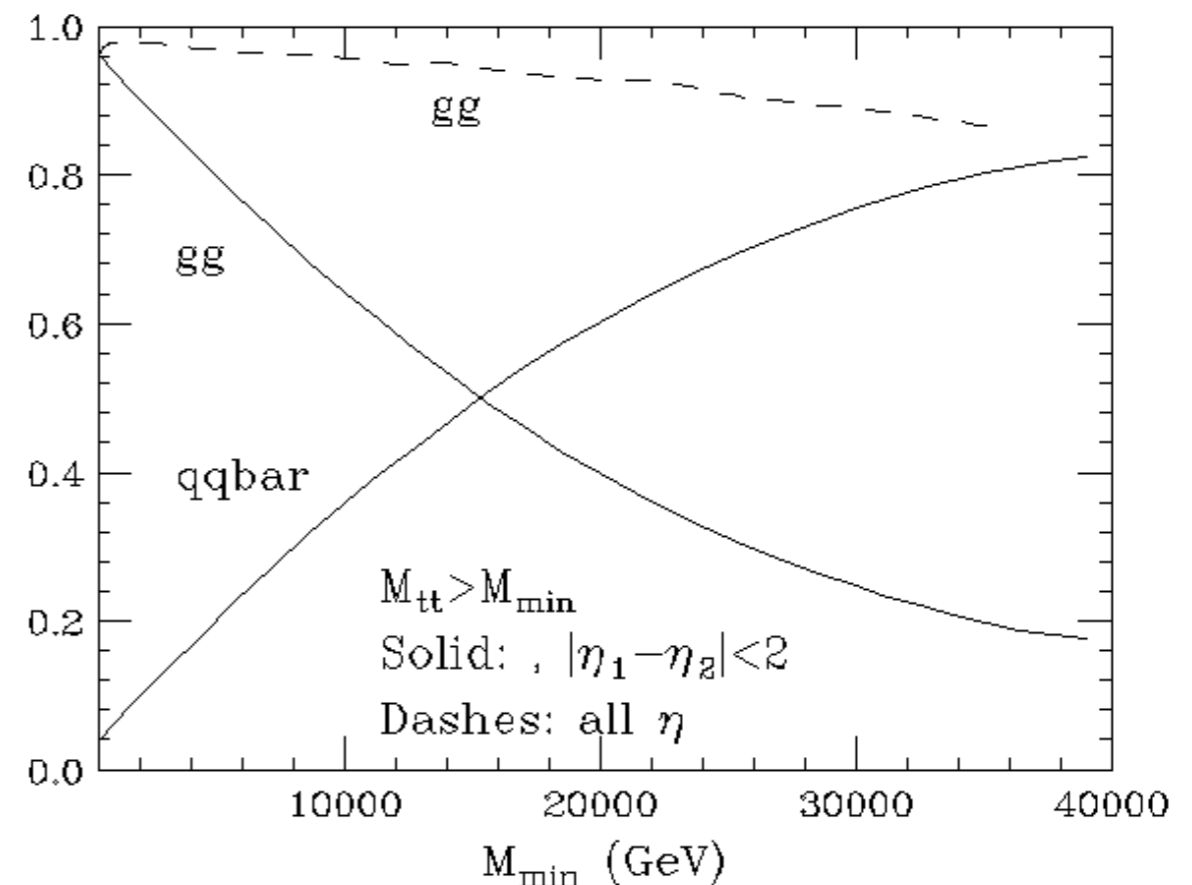
Ex: integrated rates as a function of t-tbar invariant mass for centrally (inclusive) produced tops

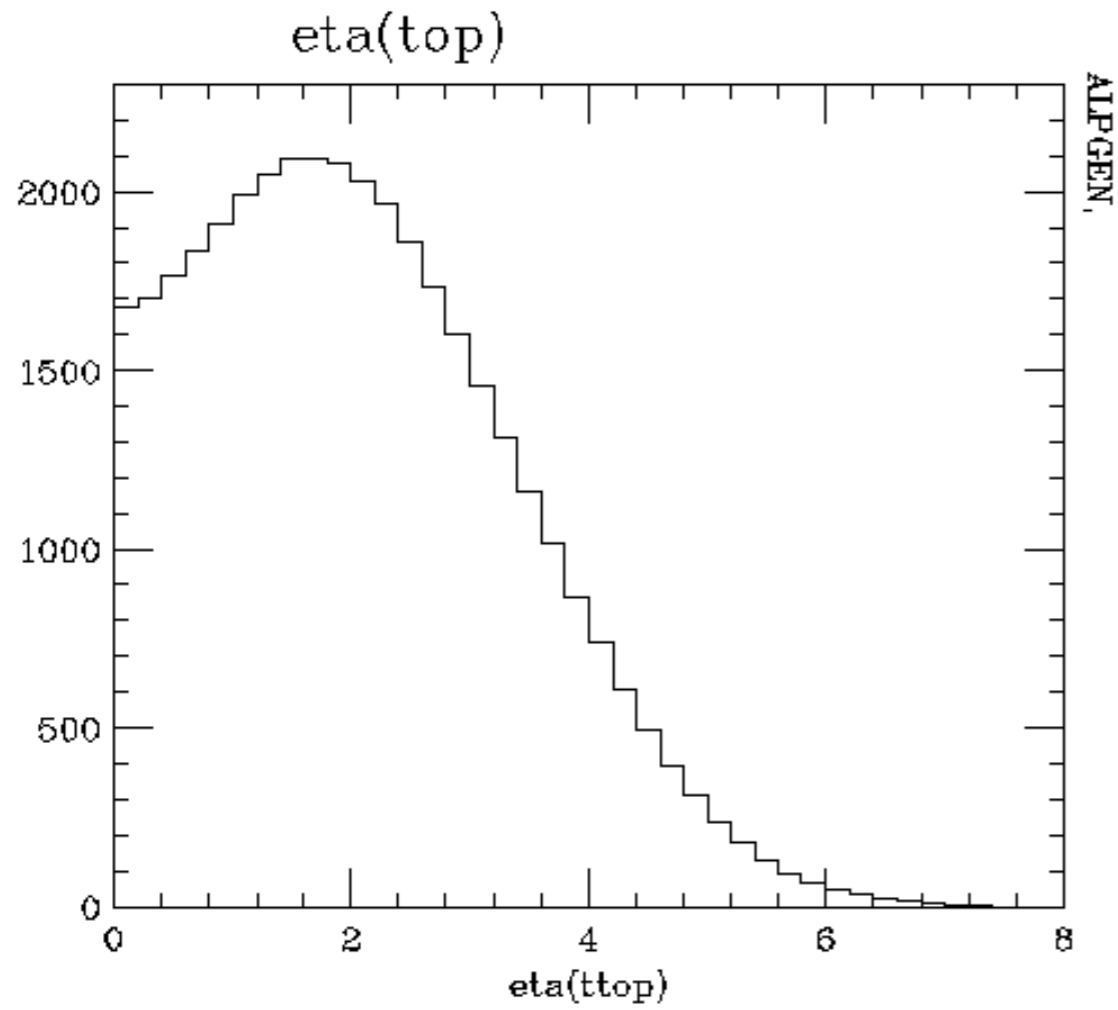
*Statistics out to over 30 TeV with  $10ab^{-1}$   
Inclusive rate  $\sim 10$  times larger at highest mass*

Ex: gg initial state content for central (vs inclusive) t-tbar pairs, vs  $M(tt)$

*In central production, dominated by gg up to  $\sim 15$  TeV. Still 20% gg at the kinematic edge of  $\sim 30$  TeV*

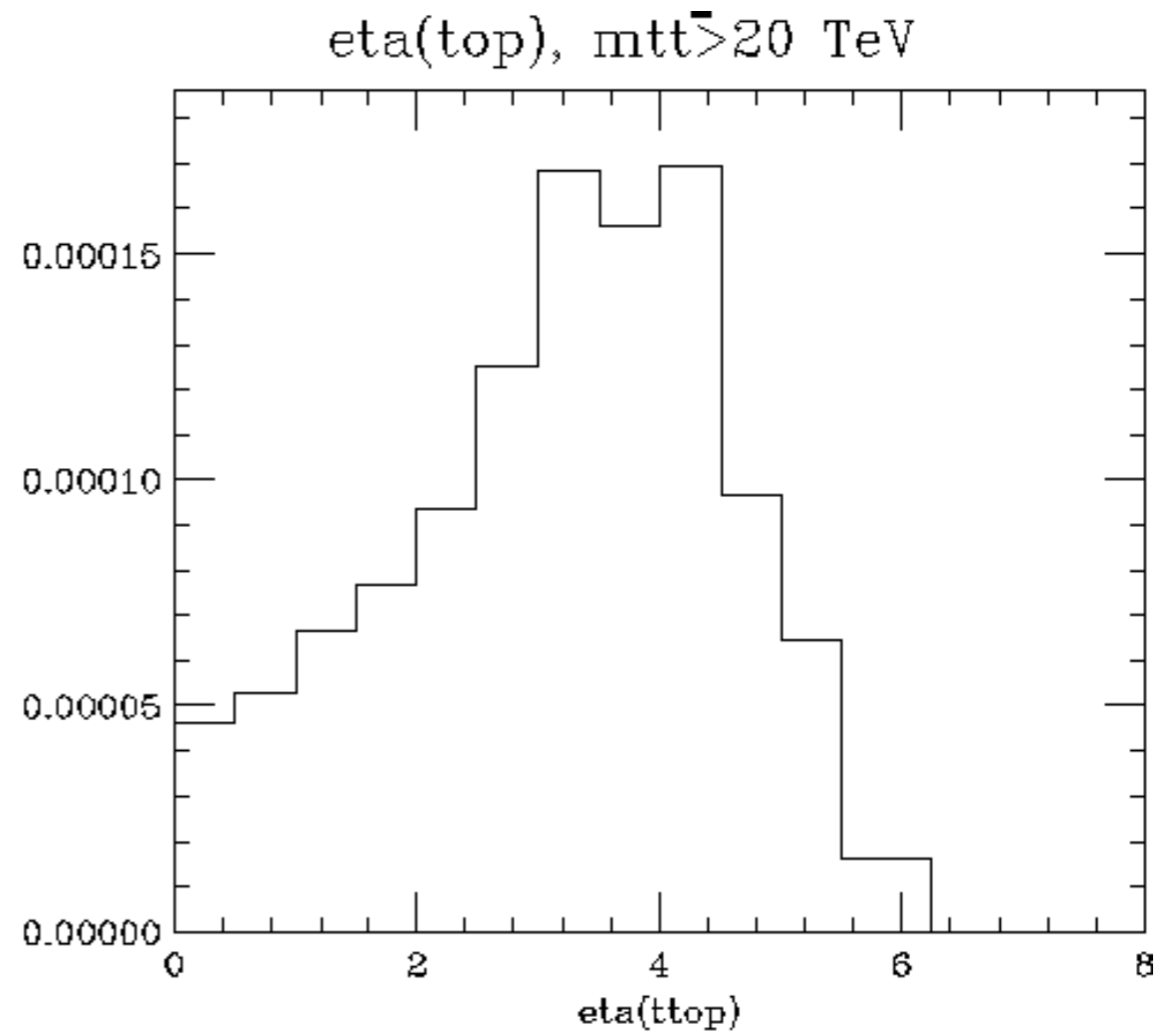
*For inclusive production,  $>90\%$  gg!*





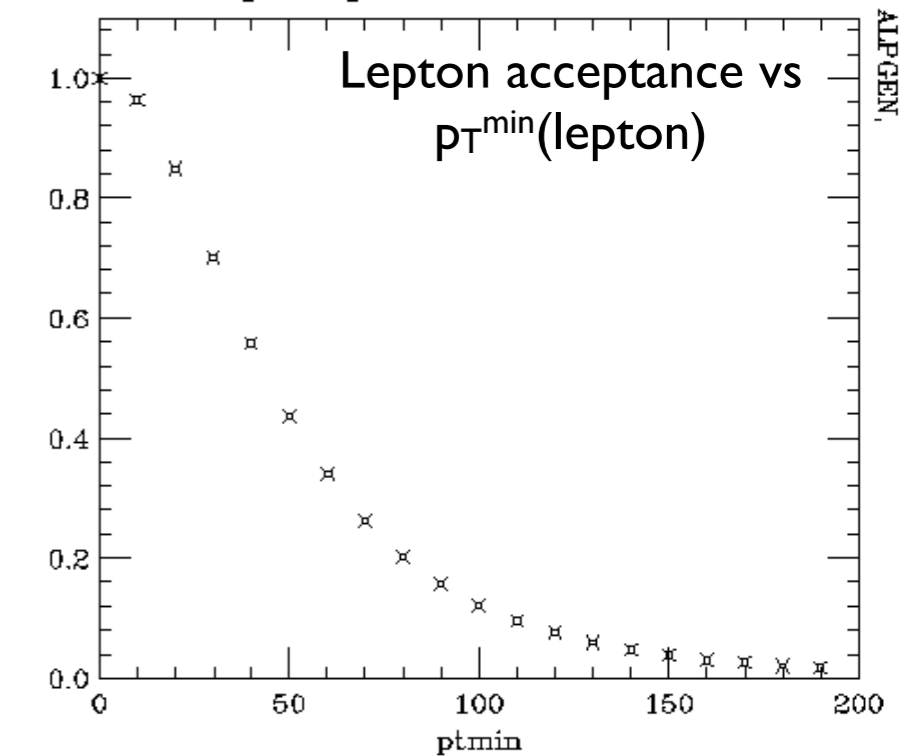
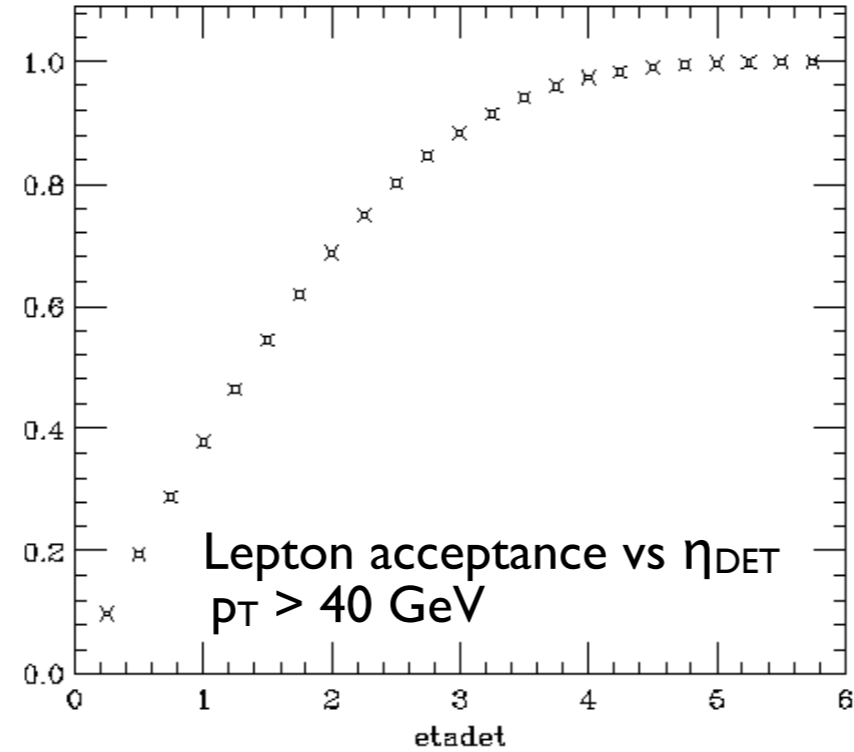
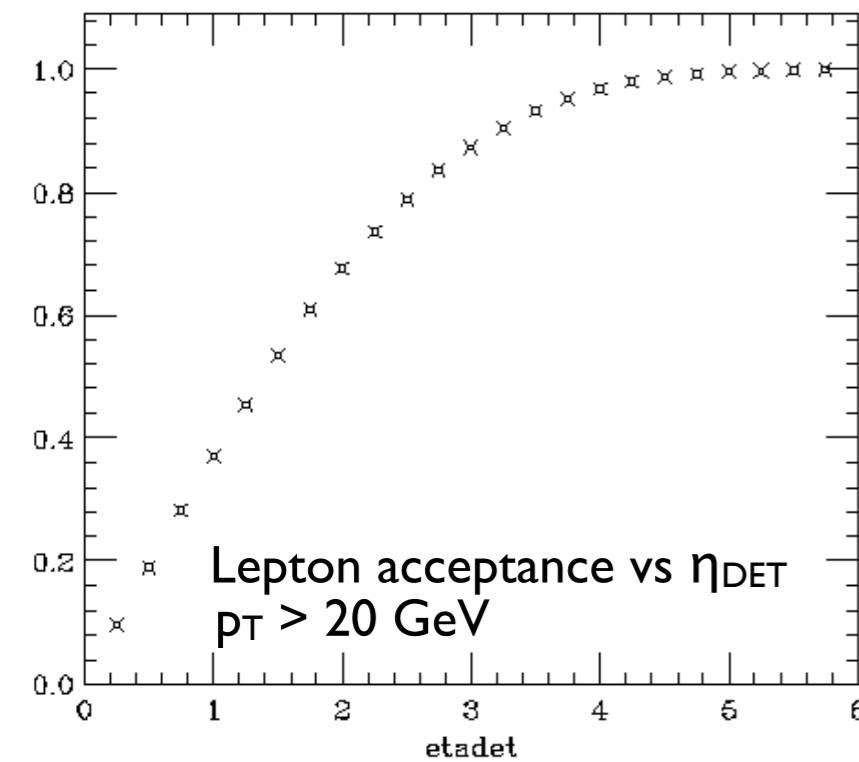
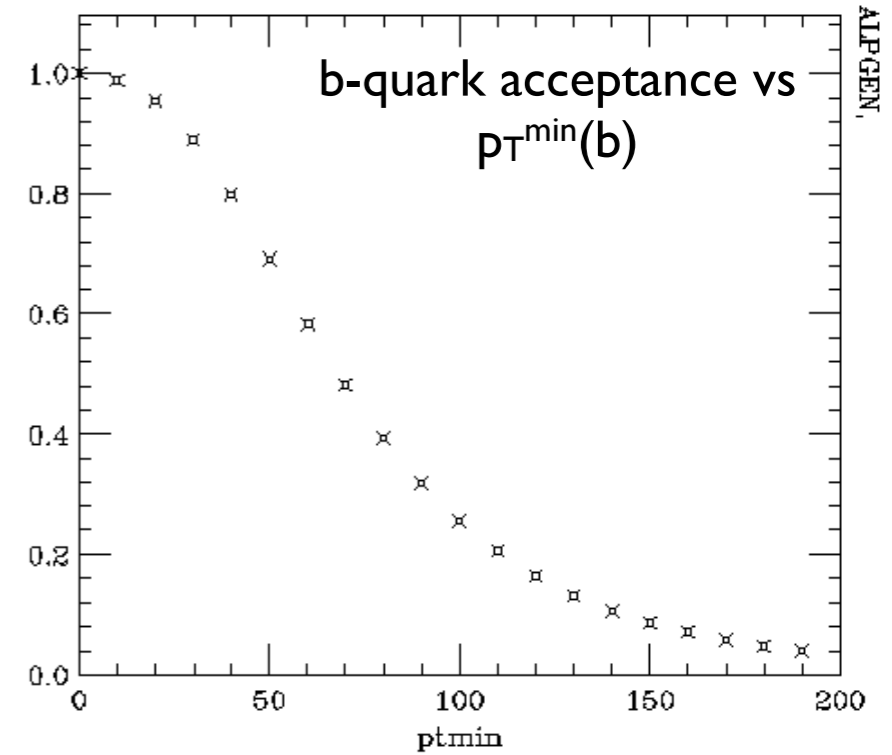
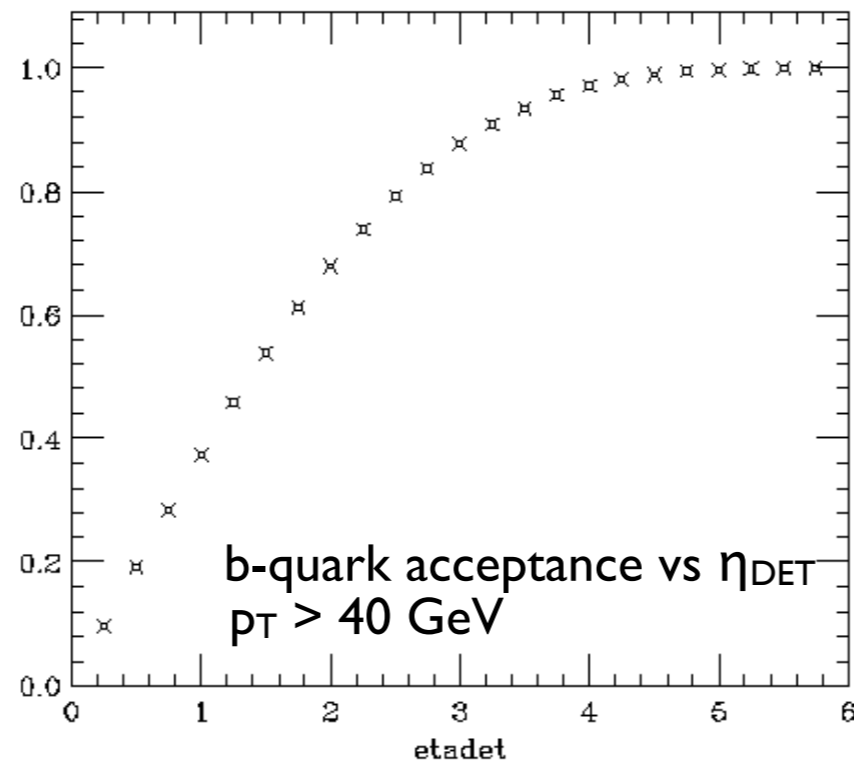
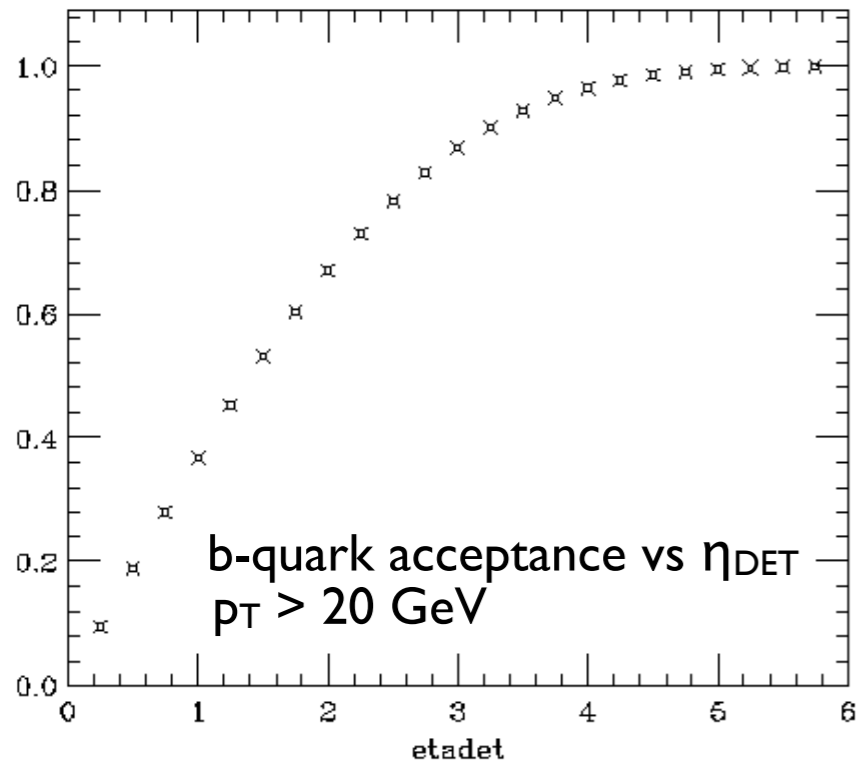
Ex: eta spectrum for  $m(\text{tt}) > 350$  GeV

Ex: eta spectrum for  $m(\text{tt}) > 20$  TeV



# Acceptance distributions for inclusive t-tbar production

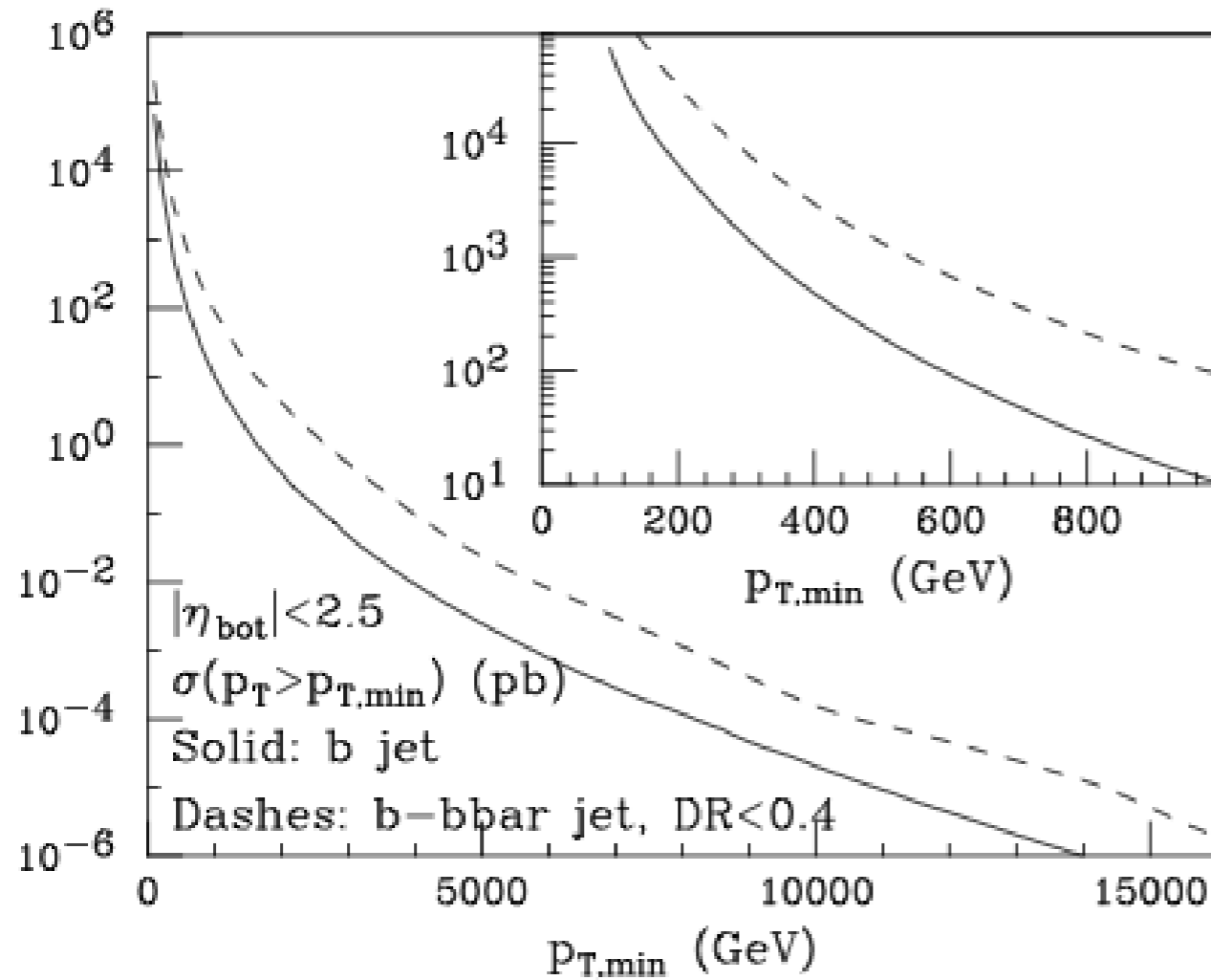
*How many tops can a dedicated detector possibly trigger on?*



ALPGEN

ALPGEN

# Heavy quark jets

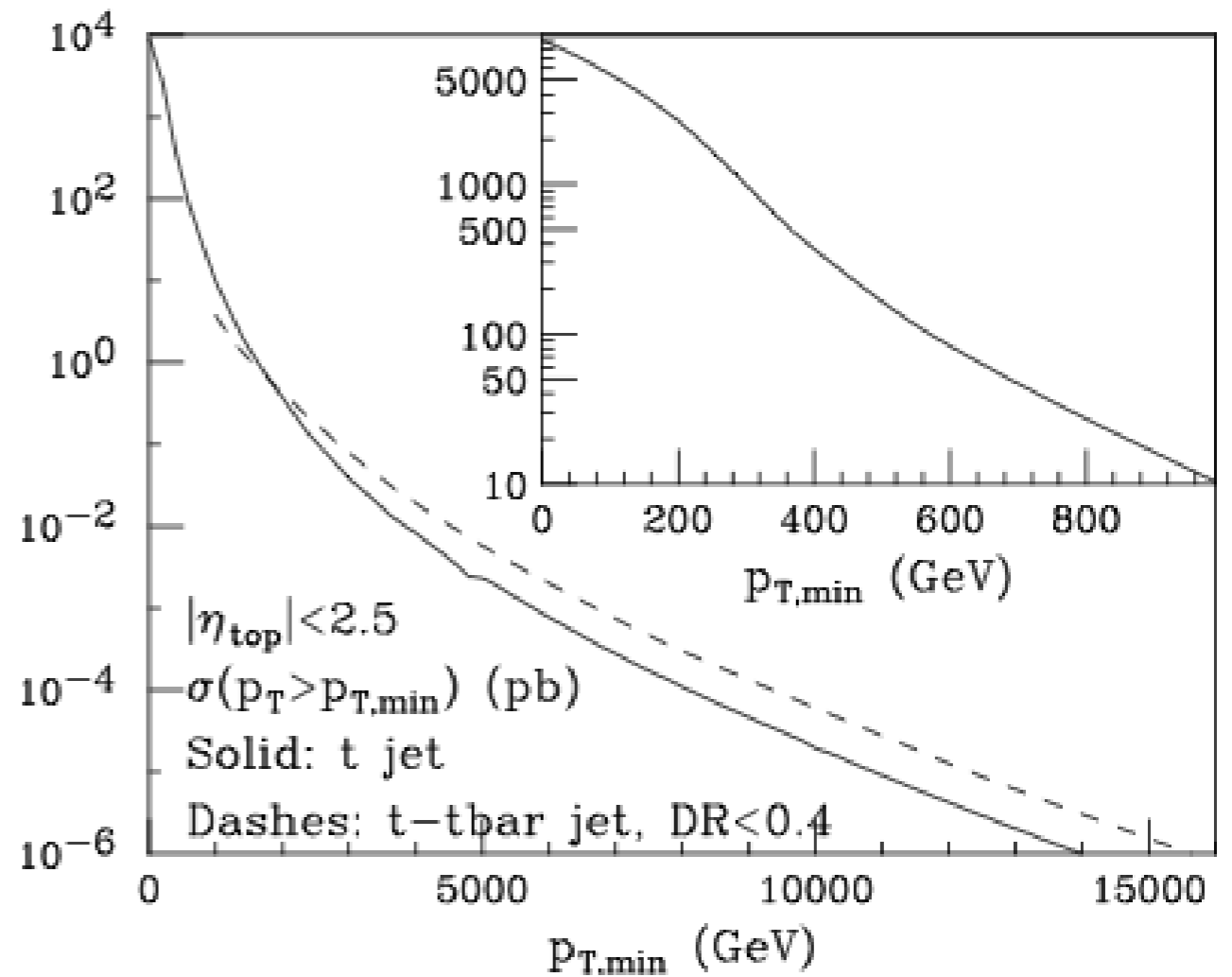


Ex: b (and b-bbar) jets

*b-bbar jets  $\sim 10 \times$  b jets*

Ex: t (and t-tbar) jets

*t-tbar jets  $\sim$  few  $\times$  t jets for  $E_T > 5$  TeV*



# Heavy quarks in the report

8	Heavy flavour production <sup>8</sup> . . . . .
8.1	Inclusive bottom production . . . . .
8.2	Inclusive top pair production . . . . .
8.3	Bottom and top production at large $Q^2$ . . . . .
8.4	Single top production . . . . .
9	Physics with top quarks <sup>9</sup> . . . . .
9.1	$t\bar{t}Z$ production . . . . .
9.2	$t\bar{t}W$ production . . . . .
9.3	$t\bar{t}\gamma$ production . . . . .
9.4	Top properties <sup>10</sup> . . . . .
10	Vector boson and heavy flavours <sup>11</sup> . . . . .
11	Production of multiple heavy objects <sup>12</sup> . . . . .
11.2	Multi top-quark production . . . . .
11.4	Multi Higgs boson production in association with top pairs or gauge bosons .
13.9	$t\bar{t}H$ production . . . . .
16	SM physics of boosted objects <sup>15</sup> . . . . .

we may decide to  
reshuffle things/  
reorganize sections  
following discussion,  
or once we see the  
material available