$t\bar{t}$ kinematics at 100 TeV with POWHEG $^{(*)}$

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LAPTh Annecy

QCD, EW and tools at 100 TeV

CERN, 7 October 2015

$^{(*)}$ preliminary results

generation details and cuts

- process: top-pair, dileptonic decay, same lepton flavour (at NLO+PS)
  [`POWHEG-BOX/hvq`]
- PDFs: NNPDF 3.0
- scale choice: $\mu^2 = p_{T,t}^2 + m_t^2$
- to generate events at high p_T (or $m_{t\bar{t}}$) at 100 TeV and efficiently:
  - used POWHEG "Born suppression factor" (I'll also try other F that could work even better)

$$F(p_{T,t}) = \left[\frac{p_{T,t}^2 + m_t^2}{(p_{T,t}^2 + m+_t^2) + B^2} \right]^3 \qquad B = 10 \text{ TeV}$$

- events showered with `pythia-6`, without MPI

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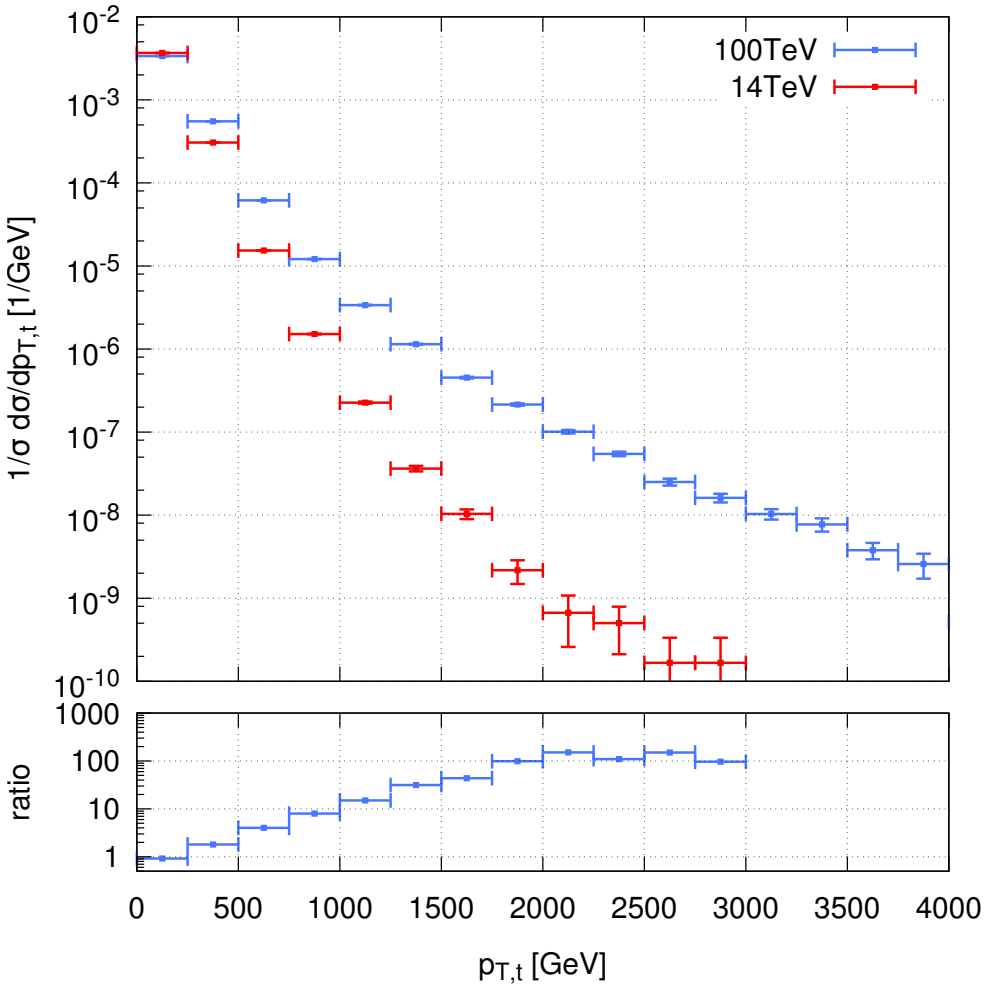
- order of magnitudes: total cross-sections (without branching ratios)

  LHC: 800 pb , pp @ 100 TeV: 30000 pb

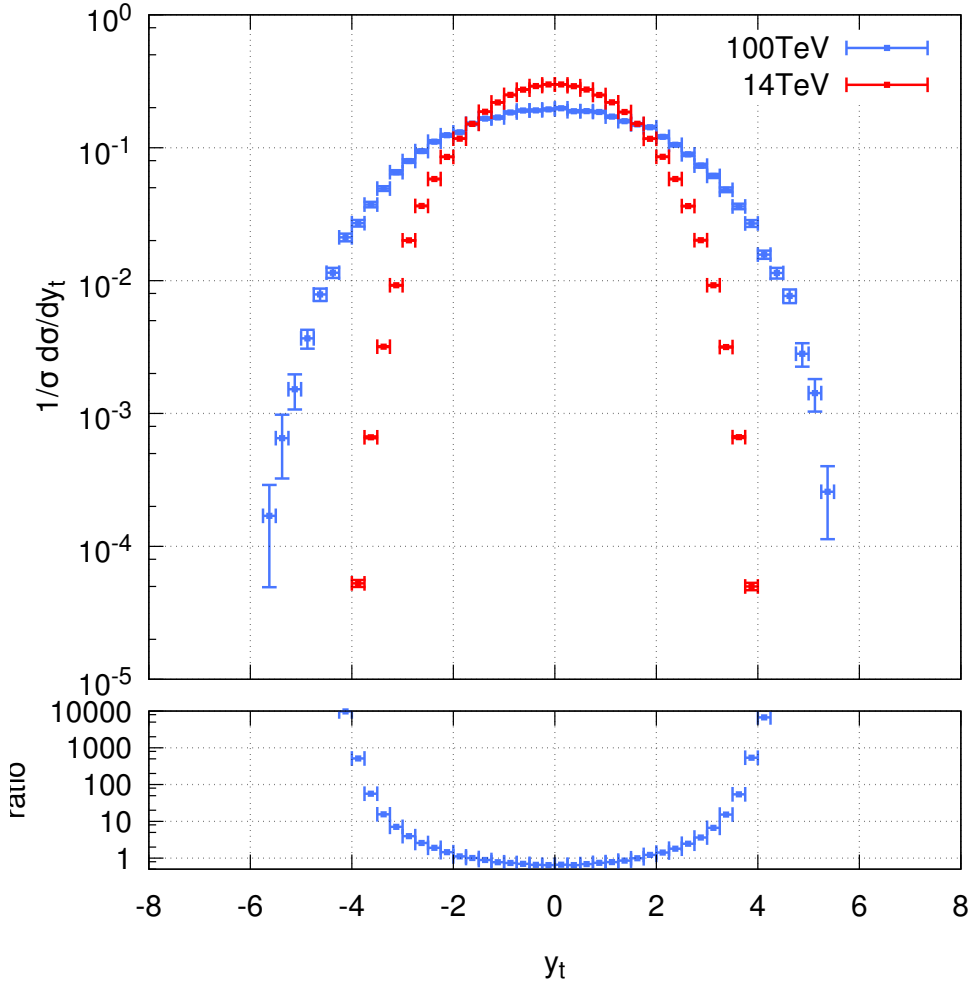
- in the following, "LHC cuts":
  - 2 leptons and 2 B (MC truth) within fiducial cuts
  - $p_{T,\ell} > 20$ GeV, $|y_\ell| < 2.5$, $E_{t,\text{miss}} > 20$ GeV
  - $p_{t,B} > 30$ GeV, $|y_B| < 2.5$
- plots: $1/\sigma_{\text{tot}}(d\sigma/dX)$, where σ_{tot} is total x-section with no cuts, $d\sigma$ can contain cuts

top p_T [MC truth]

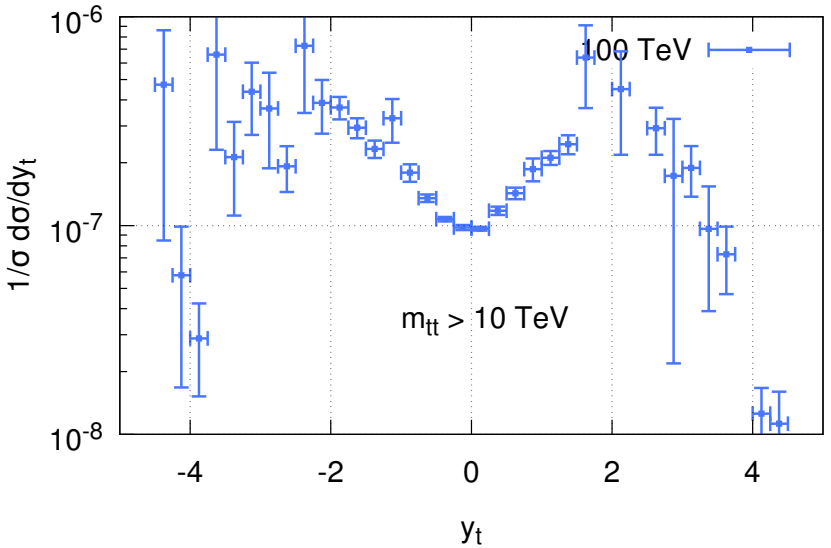


- as expected: harder spectrum at 100 TeV
- fraction of cross-section sitting at $p_{T,t} > 3$ TeV is much larger at 100 TeV

top rapidity [MC truth]

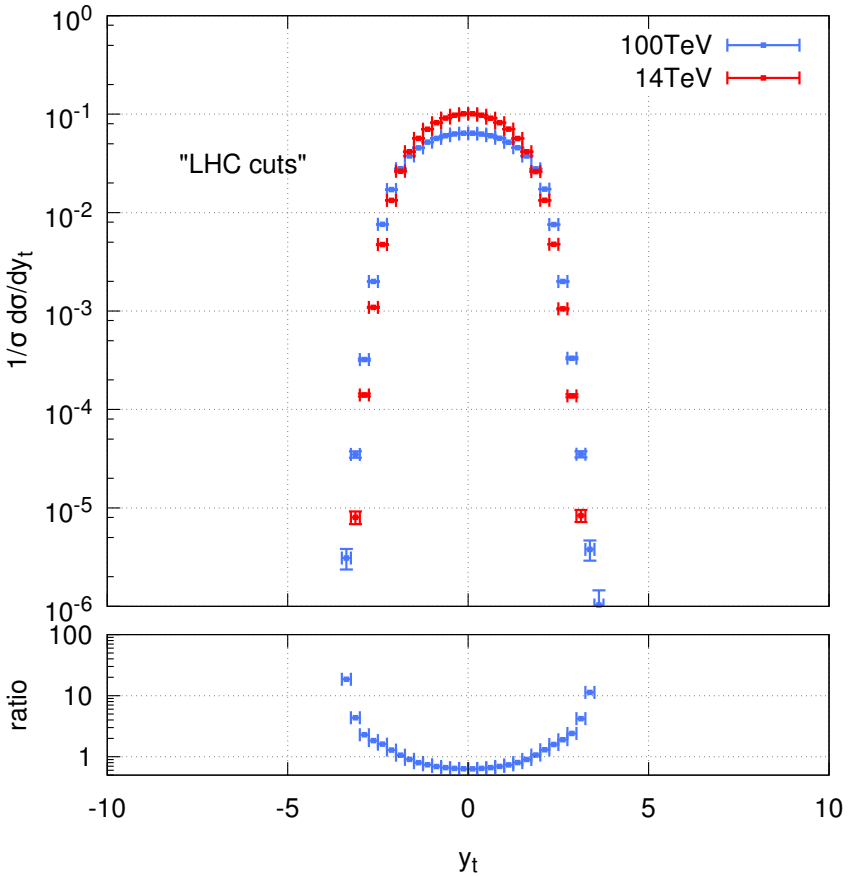


- at 100 TeV, tops are less central
- particularly true when $m_{t\bar{t}}$ is large

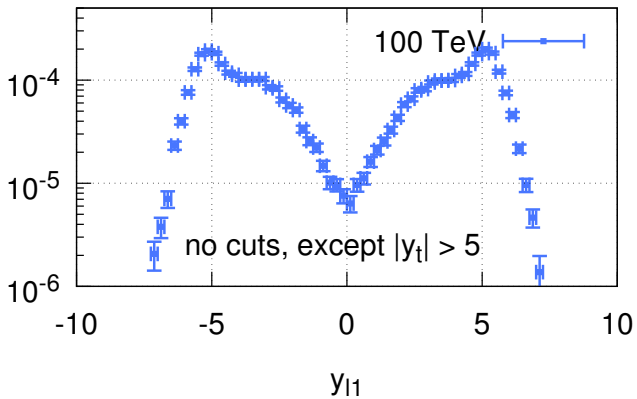


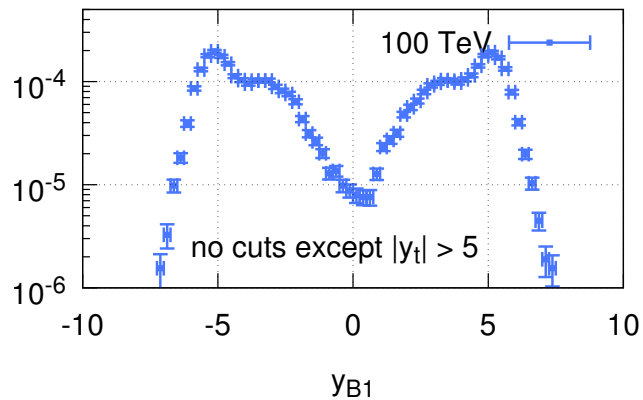
[see also talk by M. Mangano at TOP 2015]

top rapidity [MC truth]



- LHC leptonic cuts at 100 TeV cut away the large-rapidity regions
- lepton and b-hadron kinematics if $|y_t| > 5$

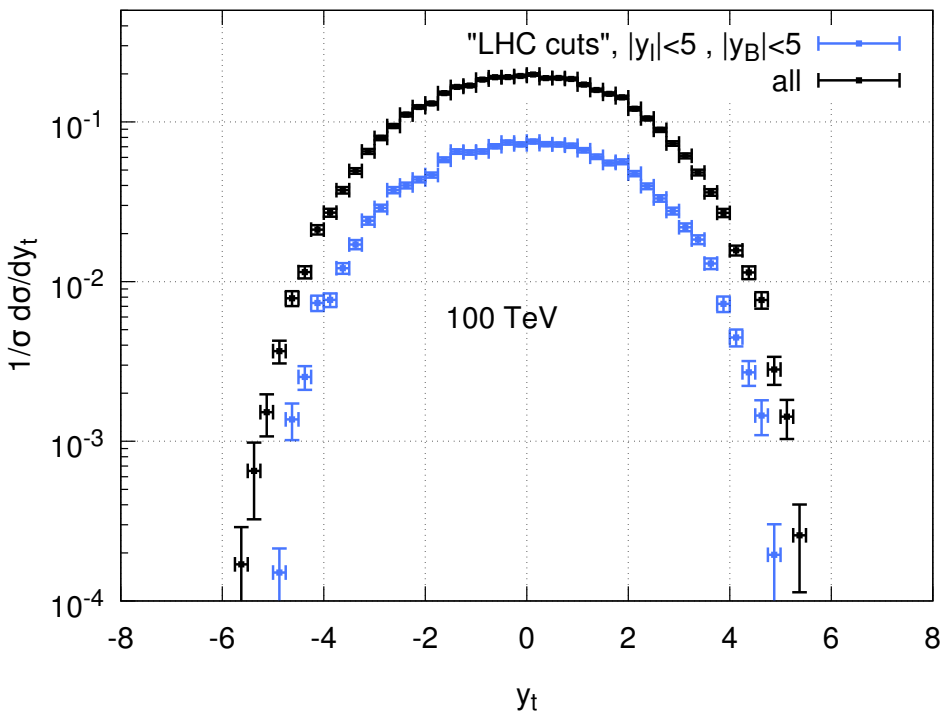




$\Rightarrow$ allowing up to $|y_\ell| = 5$ and $|y_B| = 5$ should help...

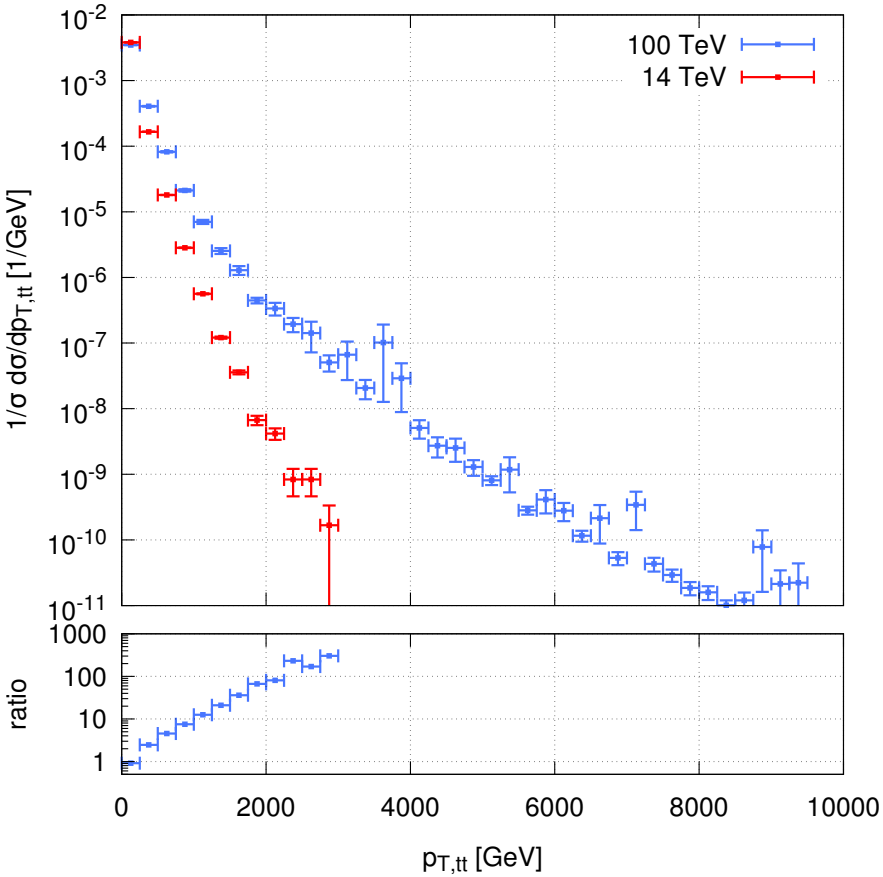
top rapidity [MC truth]

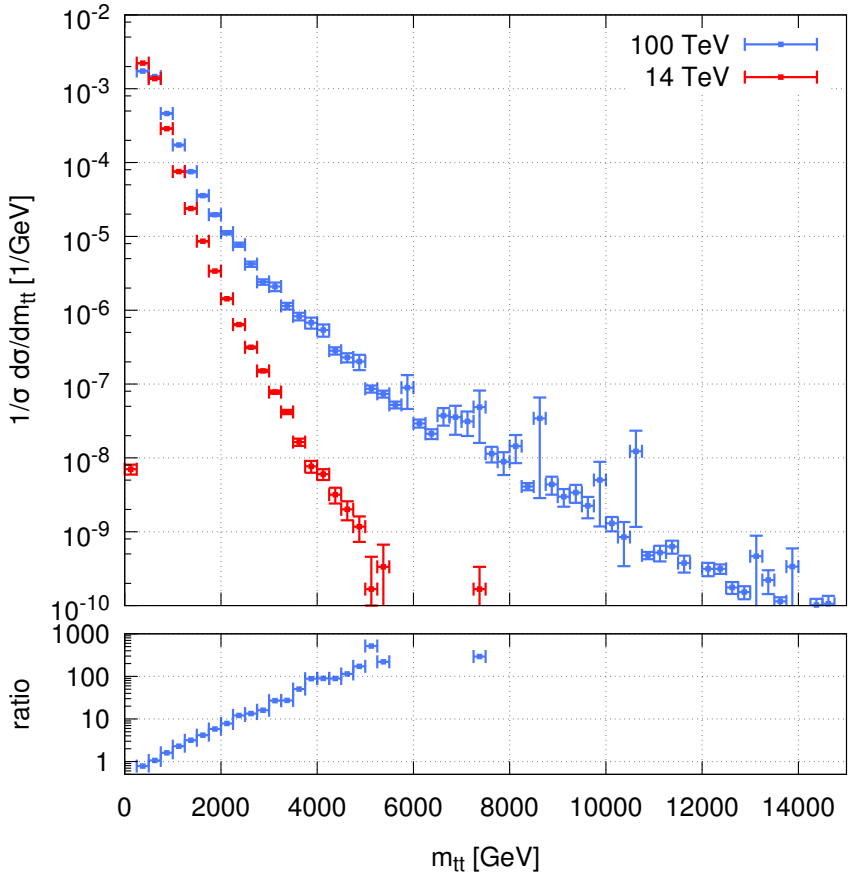
...and it does...



- kept LHC transverse momentum thresholds on leptons, B and missing energy (probably not realistic at 100 TeV)
- allow for larger values in rapidity ($|y| \leq 5$) for B-hadrons ad leptons
- at the LHC, hardly any difference. At 100 TeV, more (potentially interesting) cross-section is kept, as shown in this plot.

top pair p_T and inv. mass [MC truth]





- similar considerations to top p_T
- one might be interested to look at (effectively) large values of $m_{t\bar{t}}$

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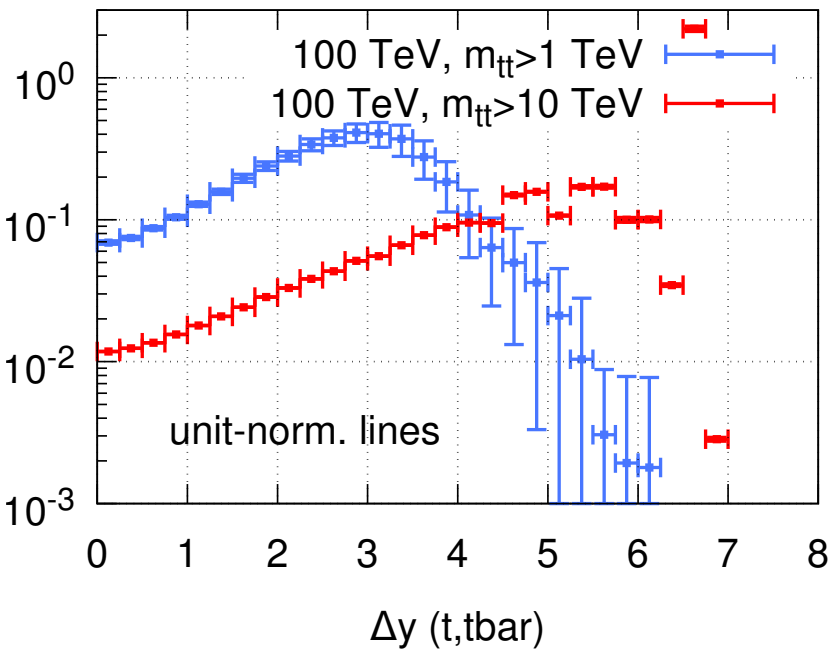
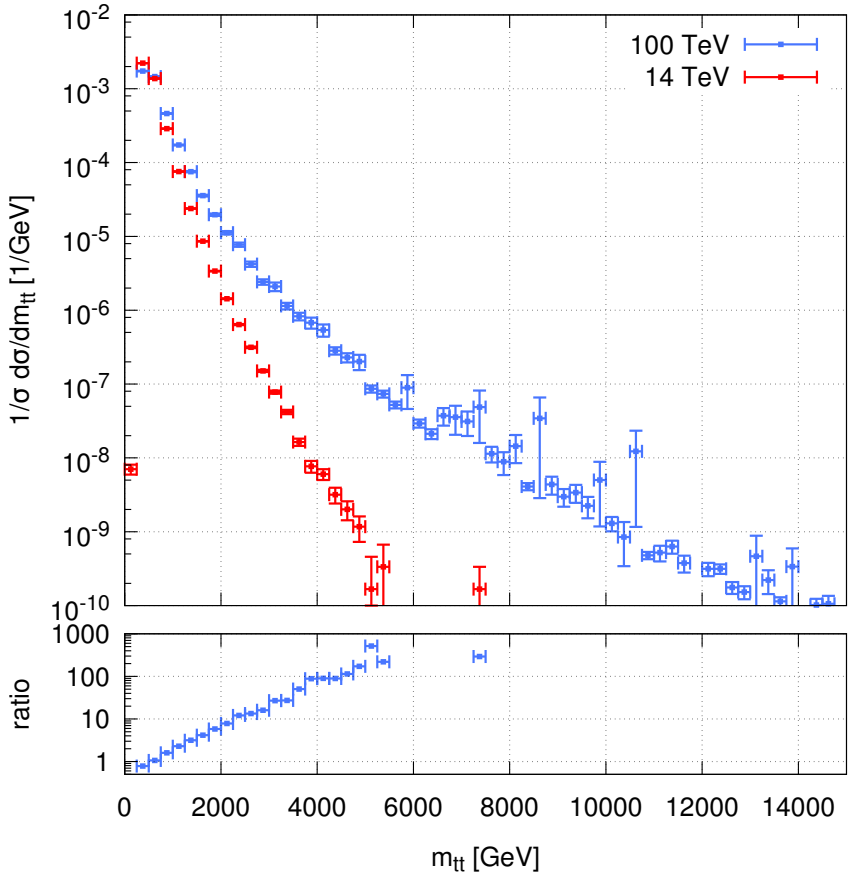
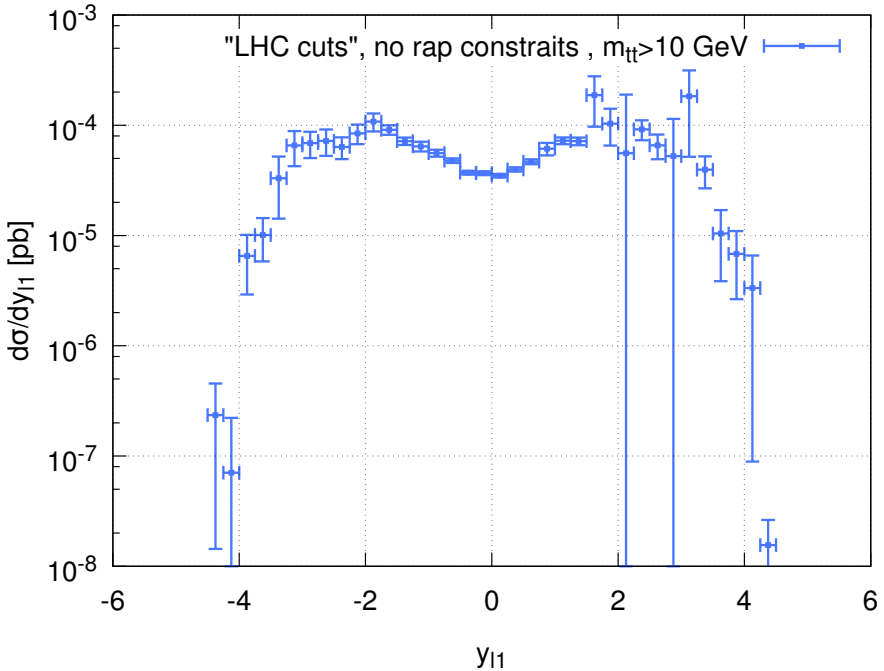


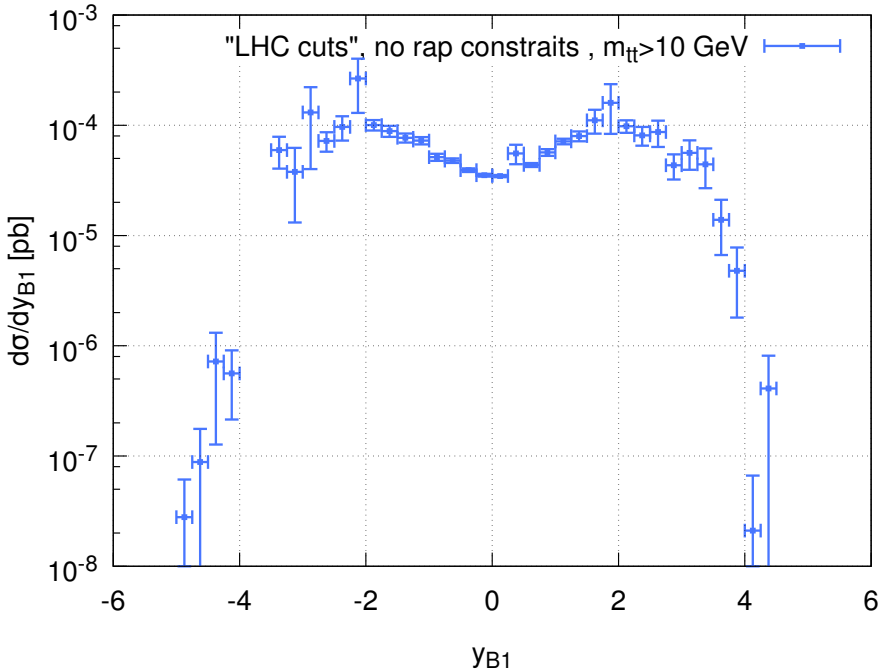


- similar considerations to top p_T
- one might be interested to look at (effectively) large values of $m_{t\bar{t}}$
- in that region tops are typically at large rapidity, and with a large rapidity gap

decay kinematics

- assume that one is interested in phase space where $m_{t\bar{t}}$ large. How are decay products typically distributed in phase space? What is the cross-section?
- in these plots: kept LHC p_T thresholds, but removed y cuts. Added m_{tt} cut at 10 TeV on "MC-truth" tops.





summary

- preliminary study of top-pair production and decay at a 100 TeV collider, at NLO+PS.

  to be done:

- improve statistics
- look at jets (also to define b-jets)
- look at other leptonic observables, and check if and how are affected by generic hard cuts on e.g. $m_{t\bar{t}}$ (or H_T-type)
- include MPI, and use `Pythia 8`
- show also LO results ?
- present results differently ?
- a setup for more accurate runs, and with more cut scenarios/plots, is almost ready to be run:

comments/suggestions very welcome