Scale invariant SUSY searches
with simplified topologies

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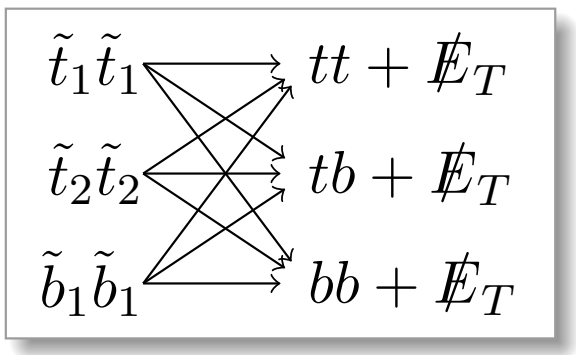
DESY

with M. Spannowsky and A. Weiler

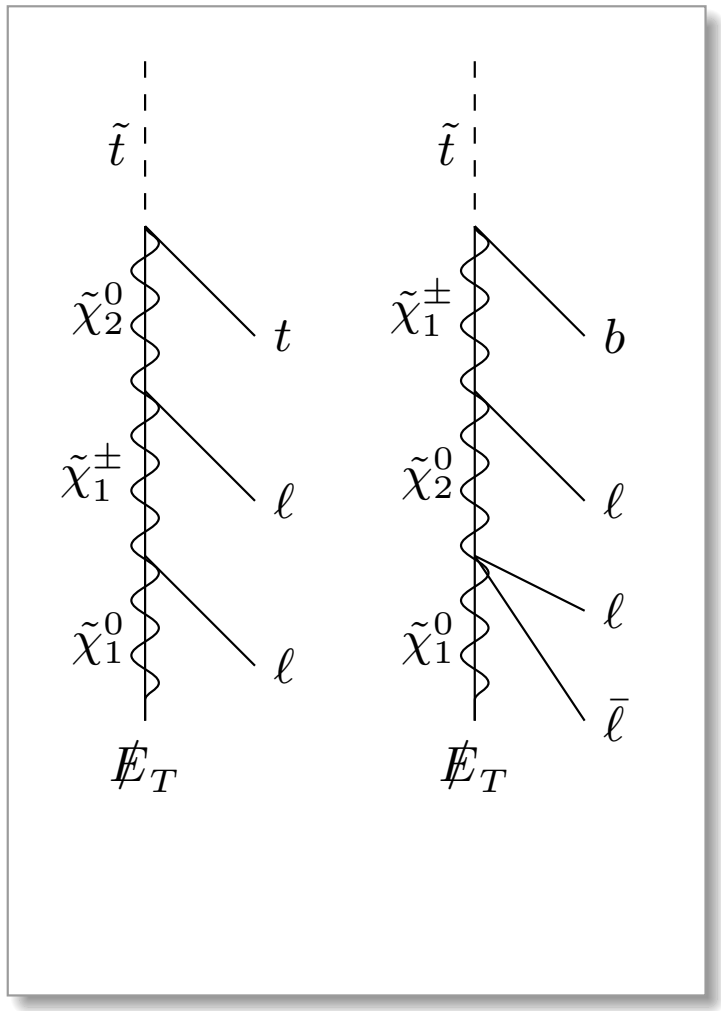
DESY Theory Workshop 2015

Why scale invariance?

- Many possible event topologies
- Use simplified topologies
- Natural SUSY with
  light $\tilde{t}_{1,2}$, $\tilde{b}_1$, and degenerate $\tilde{h}$
- Signal topologies:



fully hadronic channel



- Event shape depends on masses

$\Rightarrow$ Scale invariant reconstruction

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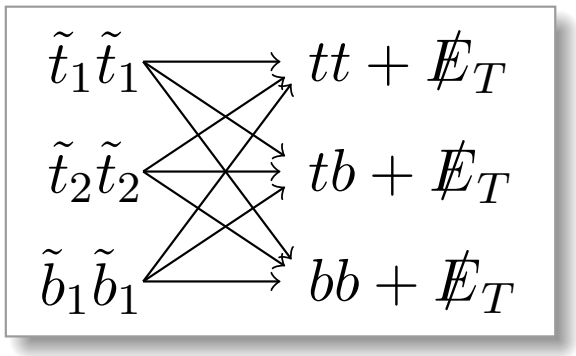

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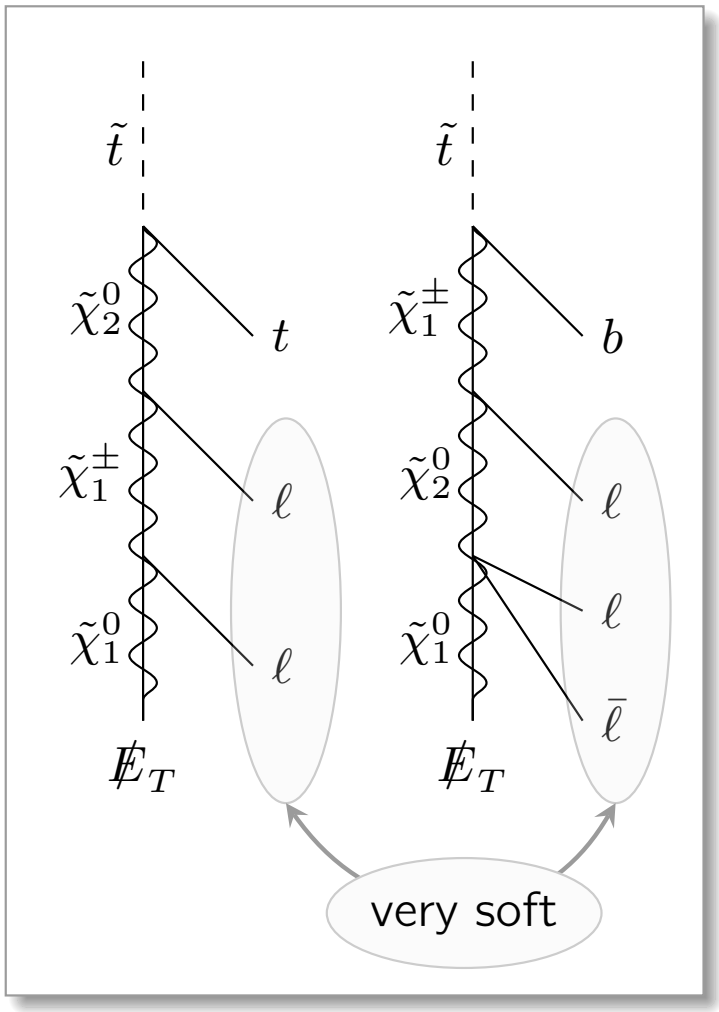

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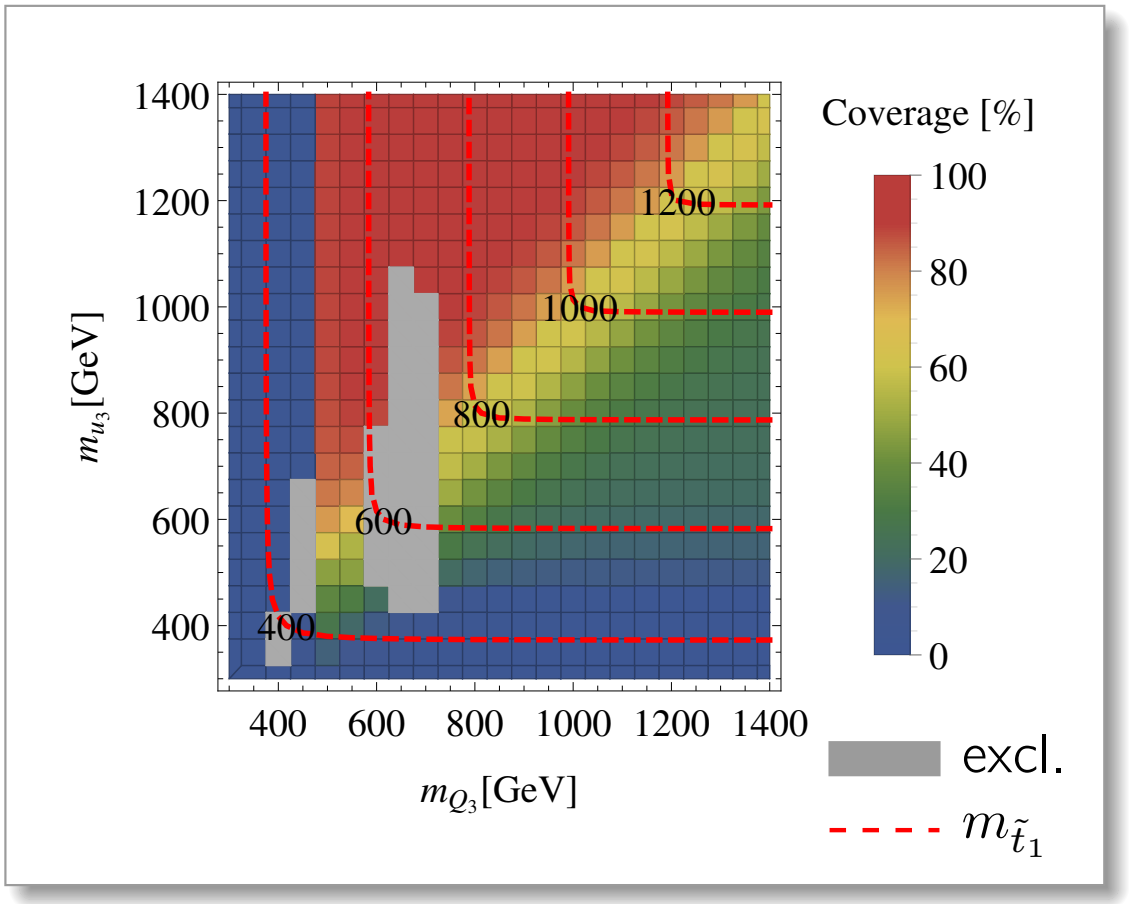
Coverage of the parameter space



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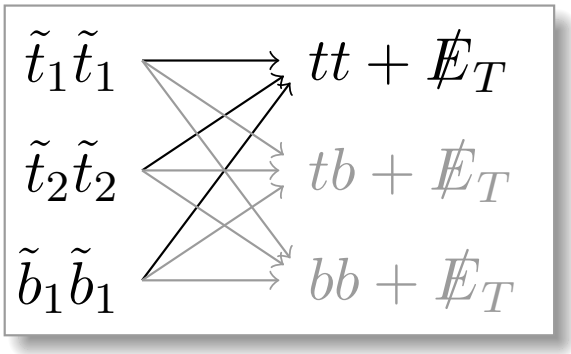

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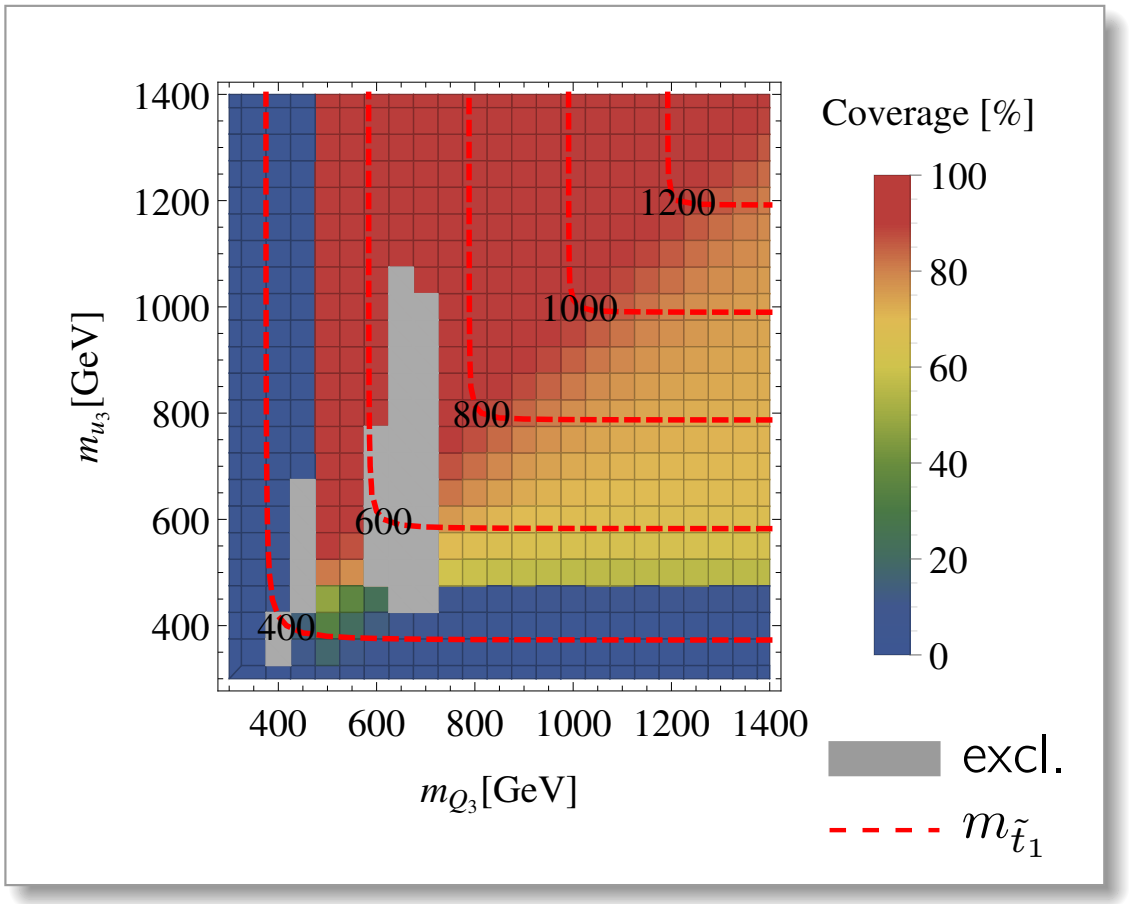

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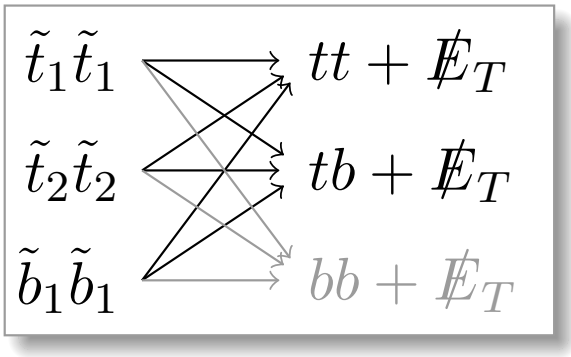

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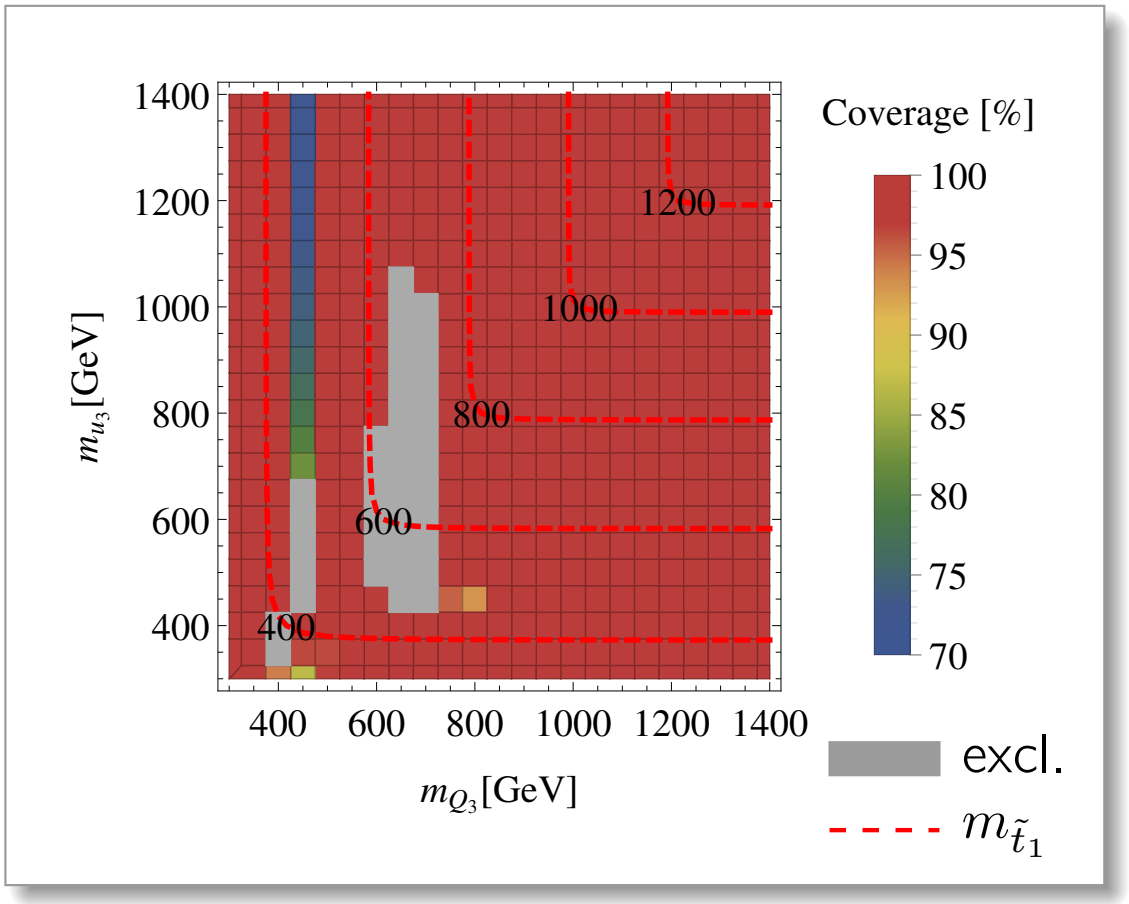

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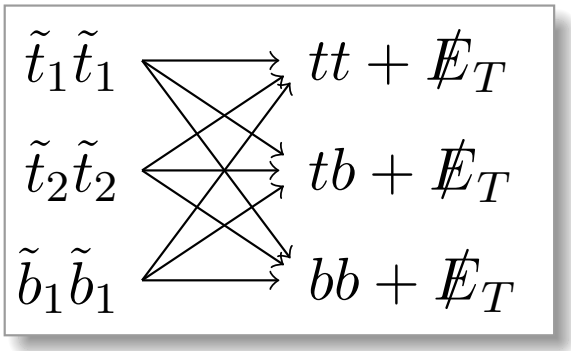


Most of parameter space is covered by the considered final states

Top reconstruction

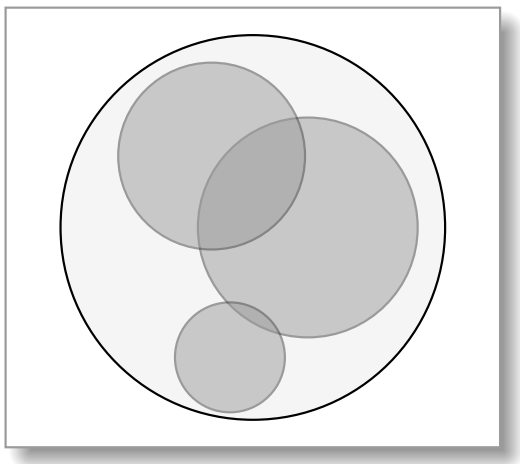
Event shape depends on $m_{\tilde{Q}} - m_{\tilde{h}} - m_t \equiv \Delta m > 0$:

large Δm

very boosted top

HEPTop Tagger

[Plehn *et.al* 09, 10]

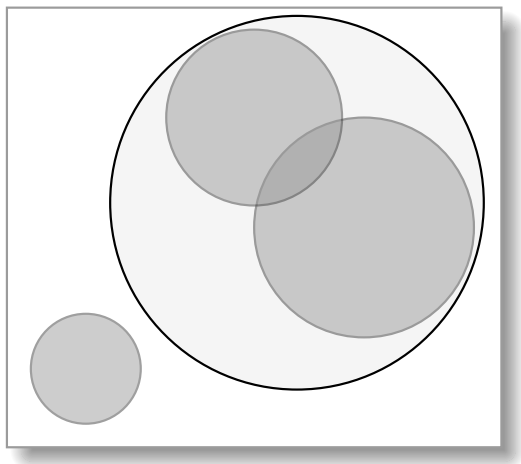


medium Δm

boosted top

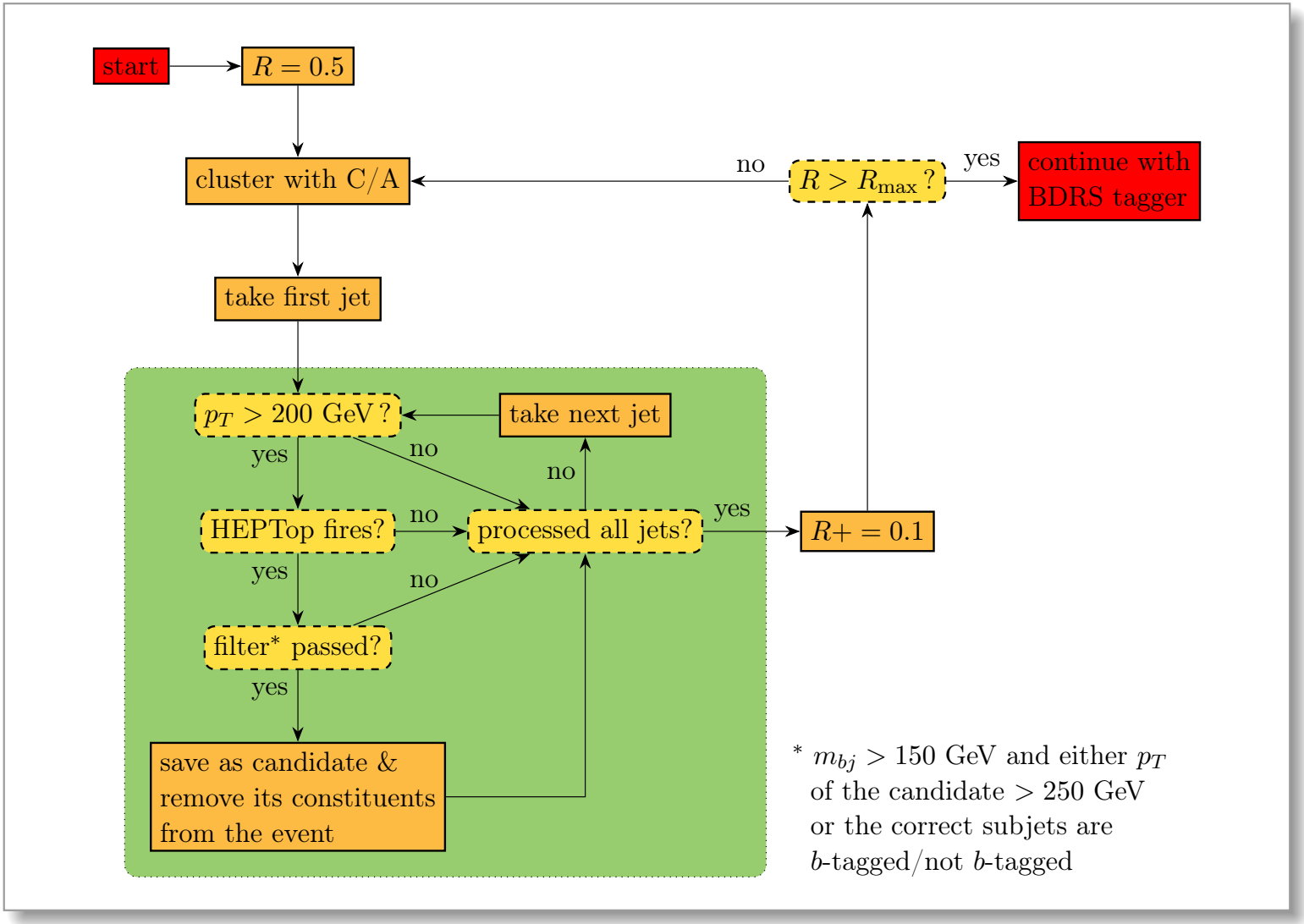
BDRS Tagger

[Butterworth *et.al* 08]



Combine taggers to reconstruct all kinds of top quarks

Detailed HEPTop reconstruction

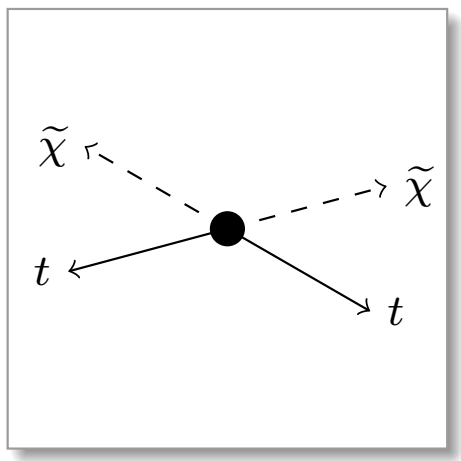


similarly for BDRS reconstruction

Scale invariant cuts

Candidates = t- and b-tagged jets

- hadronic decay mode $\Rightarrow$ 0 leptons
- 2 candidates
- no other hadronic activity:
  - < 4 jets
  - $p_T(j_1) < 100$ GeV
- Balanced event:
  - $\Delta\phi(\boldsymbol{p}_{T_{c1}} + \boldsymbol{p}_{T_{c2}}, \not{\boldsymbol{p}}_T) > 0.9\pi$
  - $\dfrac{|\boldsymbol{p}_{T_{c1}} + \boldsymbol{p}_{T_{c2}} + \not{\boldsymbol{p}}_T|}{\not{E}_T} < 0.25$
- Missing energy form both candidates:
  - $\Delta\phi(\boldsymbol{p}_{T_{c1}}, \not{\boldsymbol{E}}_T) < 0.9\pi$



S/B between 0.4 and 2×10^{-3}

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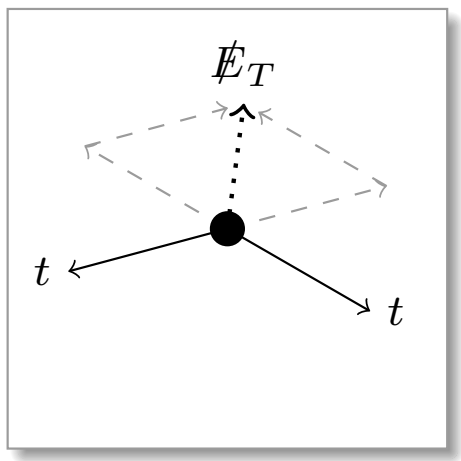

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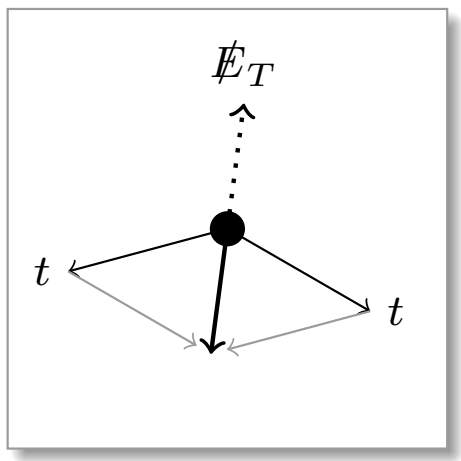

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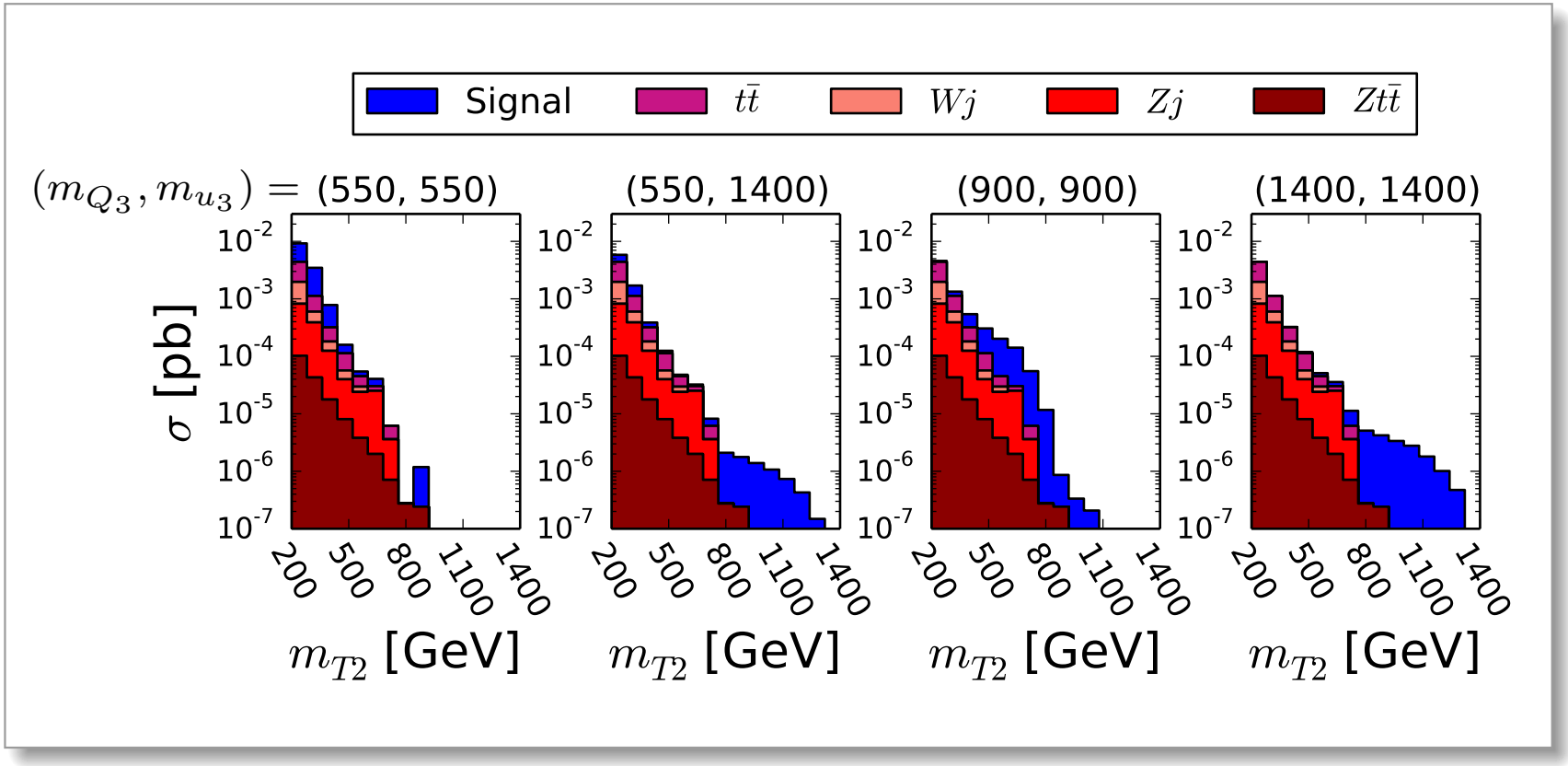
m_{T2} distribution @ 13 TeV

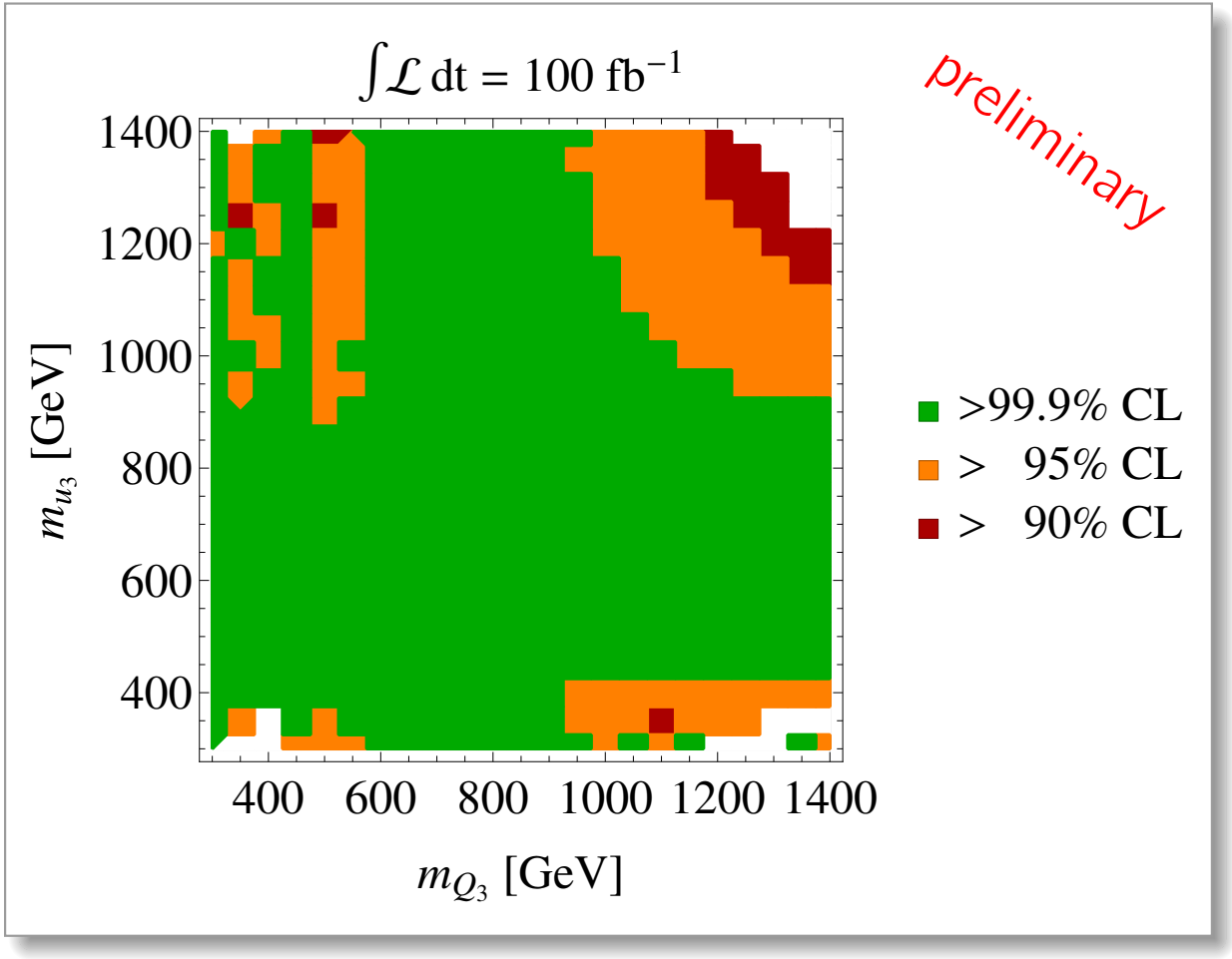
m_{T2} gives lower bound to the $\tilde{t}$, $\tilde{b}$ mass



$\Rightarrow CL_s$ method for limits

Results: CL_s in parameter plane ($\sqrt{s} = 13$ TeV)

systematic error: 15%, MC error: 10^{-3} fb



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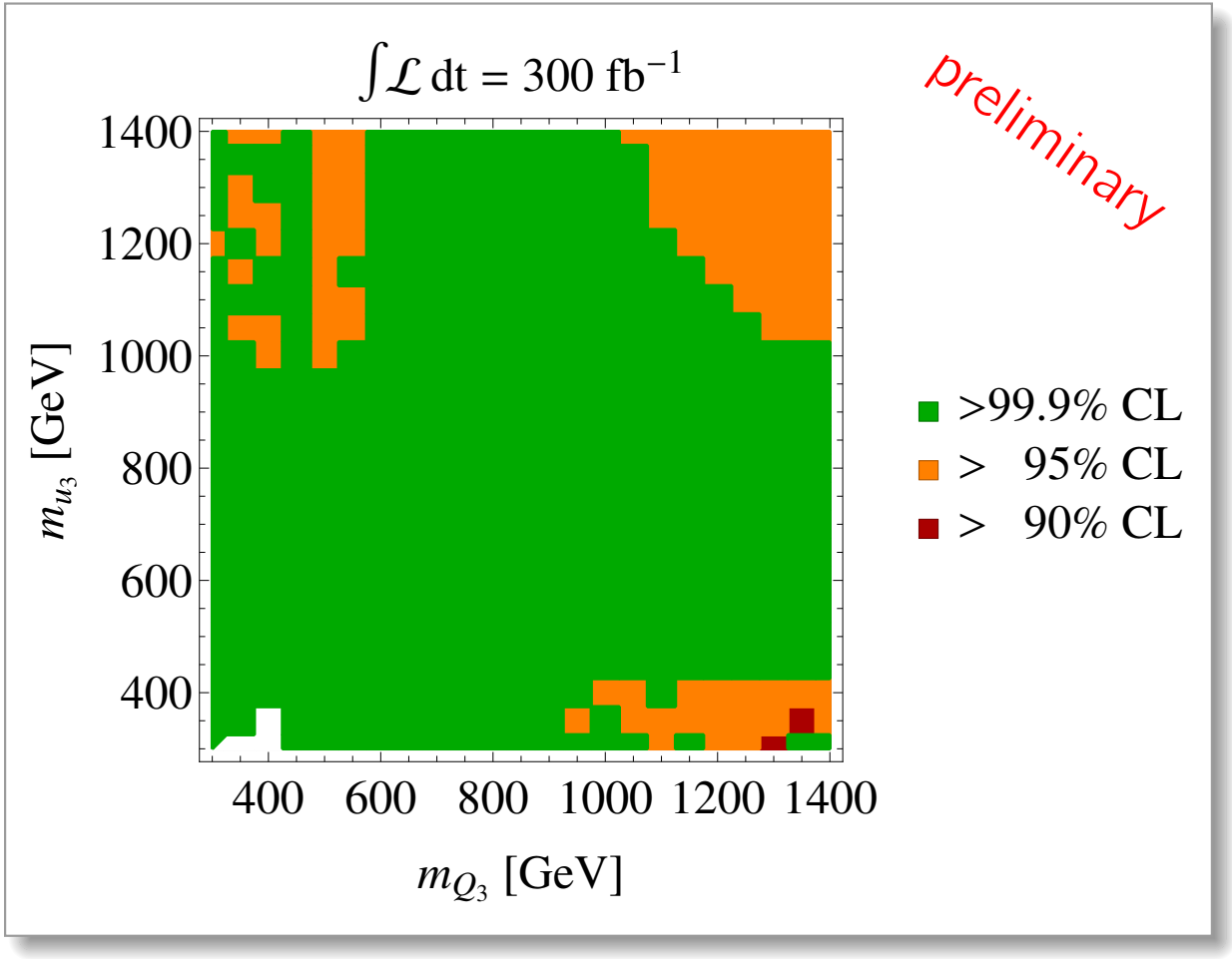

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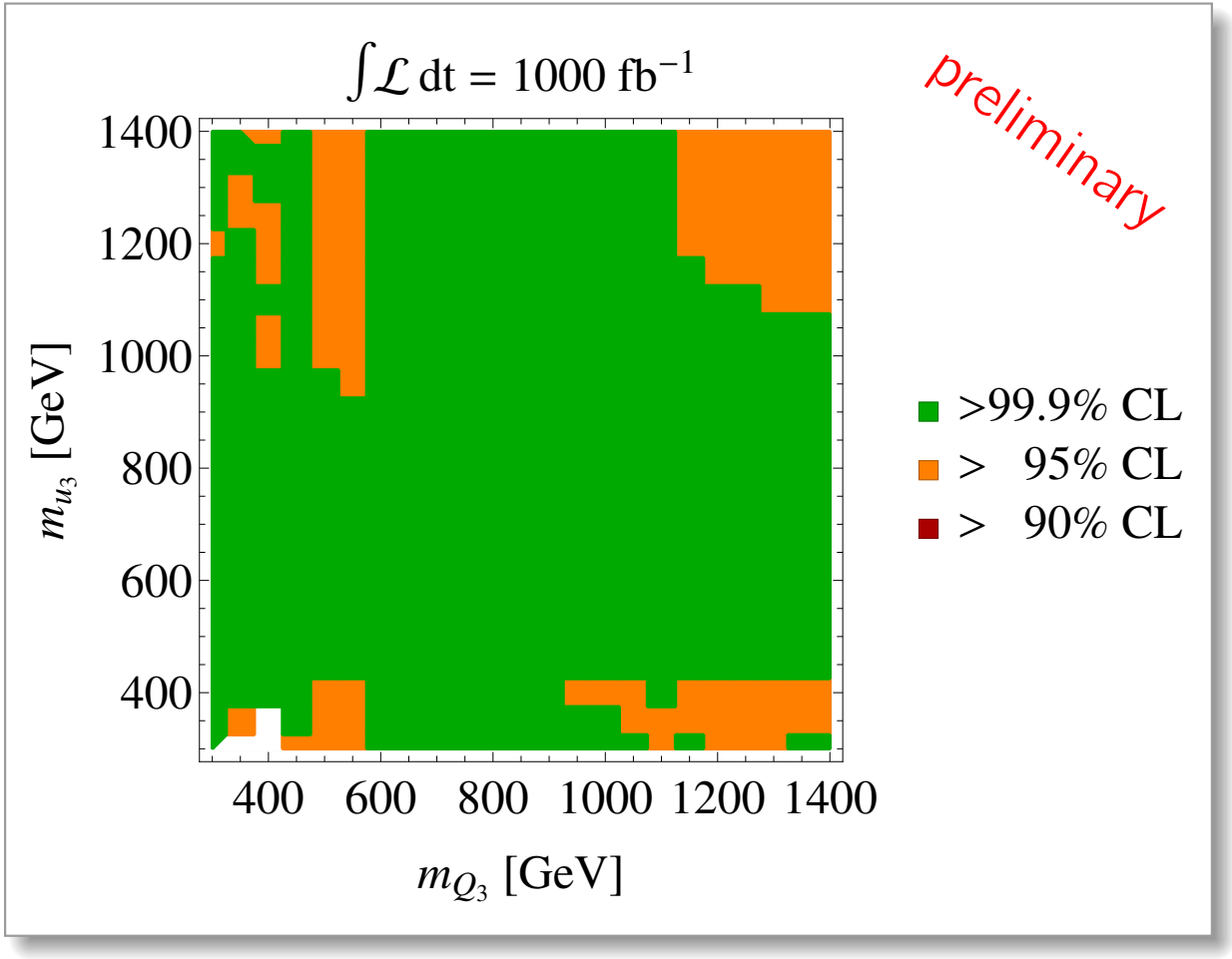

Conclusions

- Status so far
  - Stop and sbottom decaying to bottom or hadronic top quark + $\not{E}_T$
  - Combination of HEPTop & BDRS tagger
  - Scale invariant cuts
  - For $m_{\tilde{\chi}} \approx 300$ GeV exclude up to

$$m_{\tilde{t}_1} \lesssim 1.2 \text{ TeV } @ 95\% \, CL \text{ with } 100 \text{ fb}^{-1}$$

Thank You

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- Outlook
  - Another slice with $m_{\tilde{\chi}} \approx 150\ \mathrm{GeV}$ is currently generated
  - The paper will appear soon!

Thank You