Initial Thoughts On
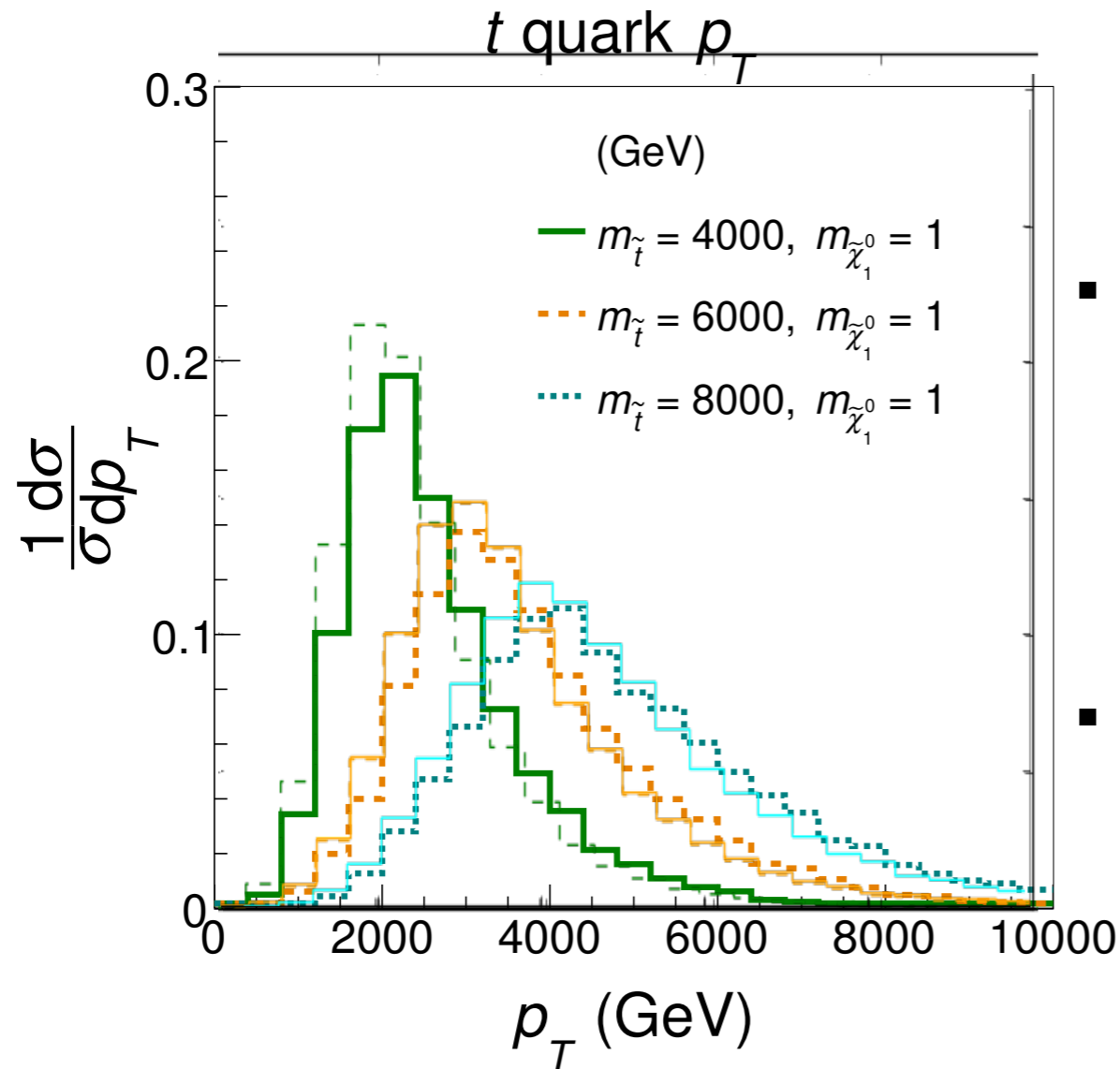# Stop Searches at 100 TeV :

Owen Colegrove (UCSB)

FCC-hh Physics Analysis Meeting

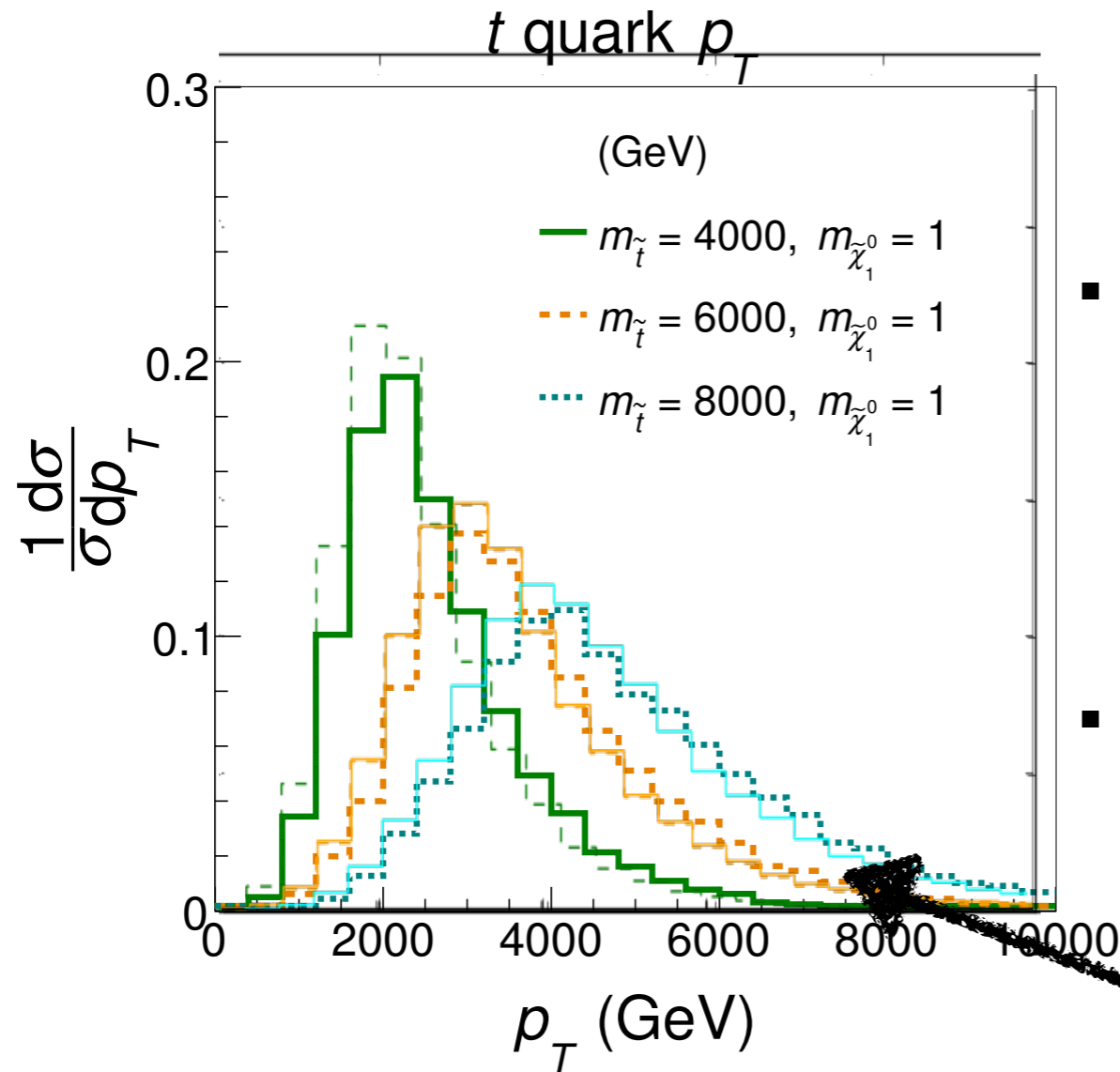*Feb. 21, 2017*

Top P$_T$ Spectrum

t quark p_T

(GeV)

— $m_{\tilde{t}} = 4000$, $m_{\tilde{\chi}_1^0} = 1$

- - - $m_{\tilde{t}} = 6000$, $m_{\tilde{\chi}_1^0} = 1$

⋯ $m_{\tilde{t}} = 8000$, $m_{\tilde{\chi}_1^0} = 1$

$\dfrac{1}{\sigma}\dfrac{d\sigma}{dp_T}$

p_T (GeV)

$\tilde{t} \rightarrow t\,\tilde{\chi}_1^0$, $\sqrt{s} = 100$ TeV

$\Delta R = 0.8$

$\Delta R = 0.5$

$\Delta R = 0.2$

$m_{\tilde{t}}$(GeV)

- Decayed LHE files generated from Madgraph for 100 TeV pp collisions.

- 90,000K Events for M_stop in [4,6,8 [GeV]], M_lsp = 1 GeV.

- Gen-lvl distributions for tops from stop decay are shown to the left.

- Our LHE samples are overlayed w/ inverted line-style to compare results from "Boosting Stop Searches", ref to come.

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- 90,000K Events for M_stop in [4,6,8 [GeV]], M_lsp = 1 GeV.

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$\Delta R \sim 2\, m_T / p_T$

Expect small jet radii

- Our LHE samples are overlayed w/ inverted line-style to compare results from "Boosting Stop Searches", ref to come.
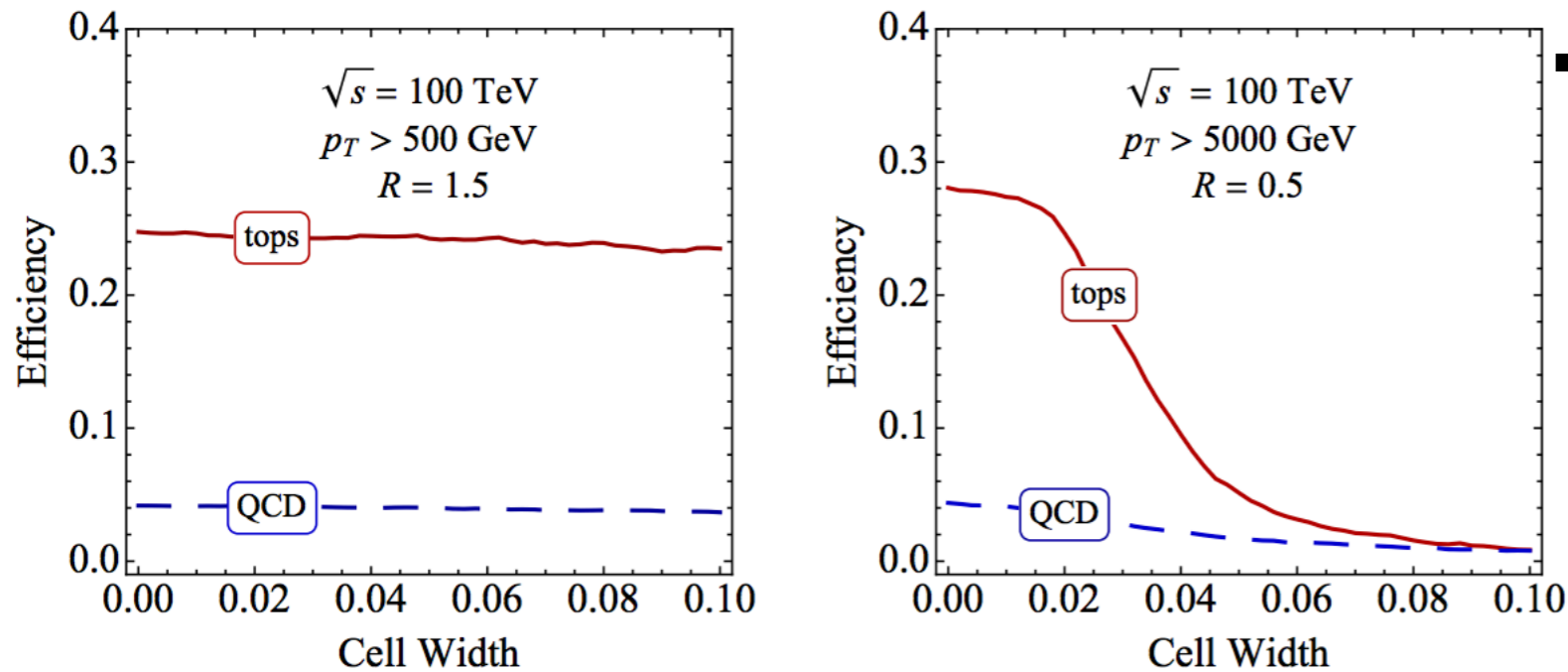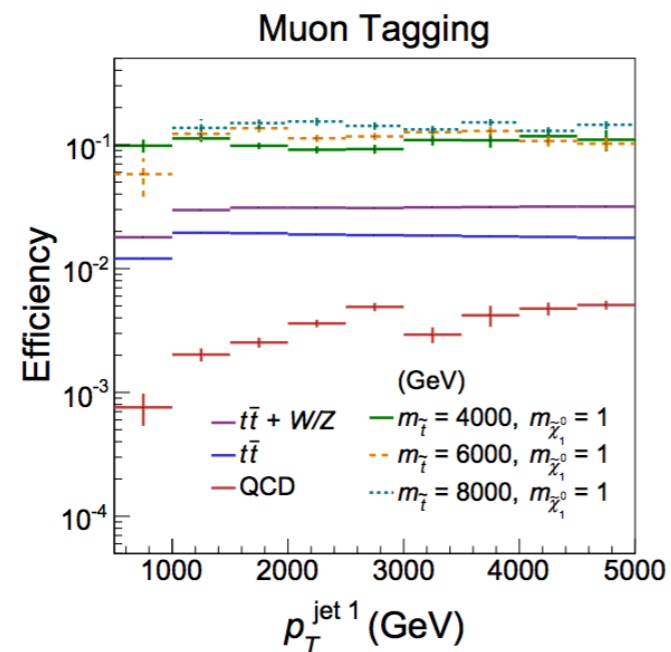
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Top Tagger Efficiency vs. Granularity

FIG. 2: HEP top tagger performance for jets with $p_T > 500$ GeV [left] and > 5 TeV [right]. The red solid curve shows the tagging efficiency for top quarks, and the blue dashed curve shows the mis-tag rate for light-flavor QCD jets.

- ■ Granularity
  - ■ **Cell width $\Delta\varphi \times \Delta\eta \approx 0.02 \times 0.02$ or less is necessary for hadronic sub-structure (~4 × current CMS granularity)**
  - ■ Similar results obtained by S. Chekanov https://indico.cern.ch/event/382815/contributions/910644/attachments/1139429/1666195/PhysicsRequirementsHCAL_boost2015.pdf

*Source : Boosting Stop Searches with a 100 TeV Proton Collider*
https://arxiv.org/abs/1406.4512

Muonic Top Tagger?

Muon Tagging

(GeV)
- $t\bar{t} + W/Z$ — $m_{\tilde{t}} = 4000$, $m_{\tilde{\chi}_1^0} = 1$
- $t\bar{t}$ — $m_{\tilde{t}} = 6000$, $m_{\tilde{\chi}_1^0} = 1$
- QCD — $m_{\tilde{t}} = 8000$, $m_{\tilde{\chi}_1^0} = 1$

- Muonic Top Tagger
  - Look for muonic W decay + collaminated hadronic b decay or vice versa
  - An efficient top tagger for a low granularity detector
  - Can be combined with "QCD" cuts for better bkg rejection.

FIG. 3: Efficiency for finding a $\mu^{\pm}$ with $p_T > 200$ GeV within $\Delta R < 0.5$ of the leading jet for three choices of stop mass, along with the $t\bar{t} + W/Z$, $t\bar{t}$ and QCD backgrounds. ("Boosting Stop Searches")
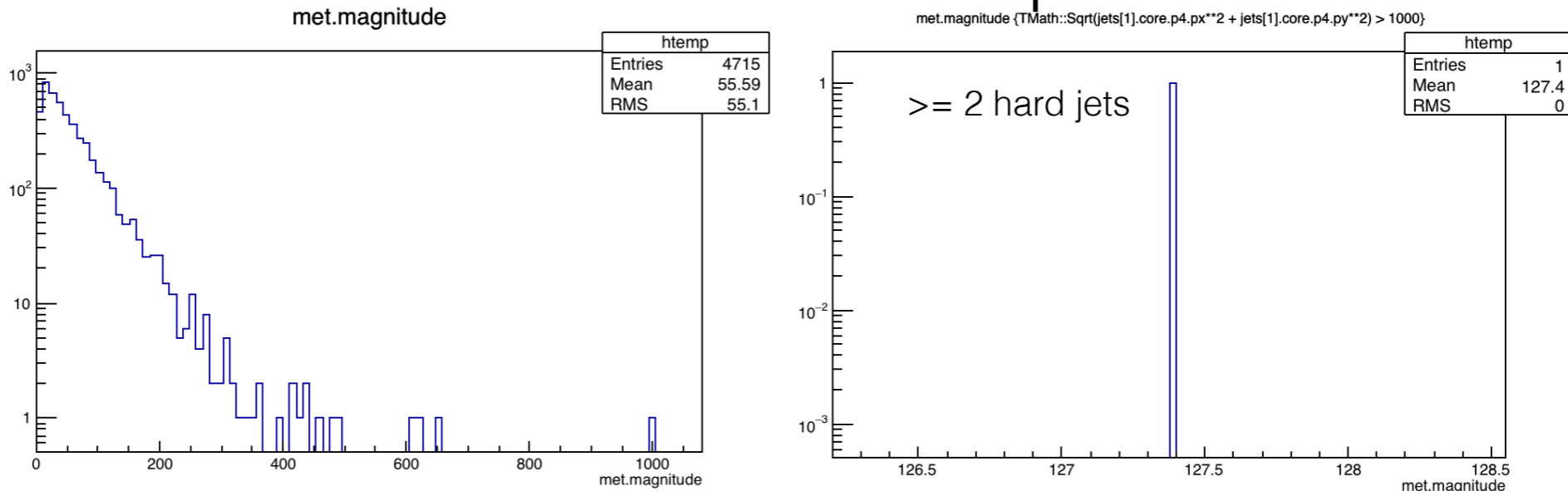
Expected Backgrounds
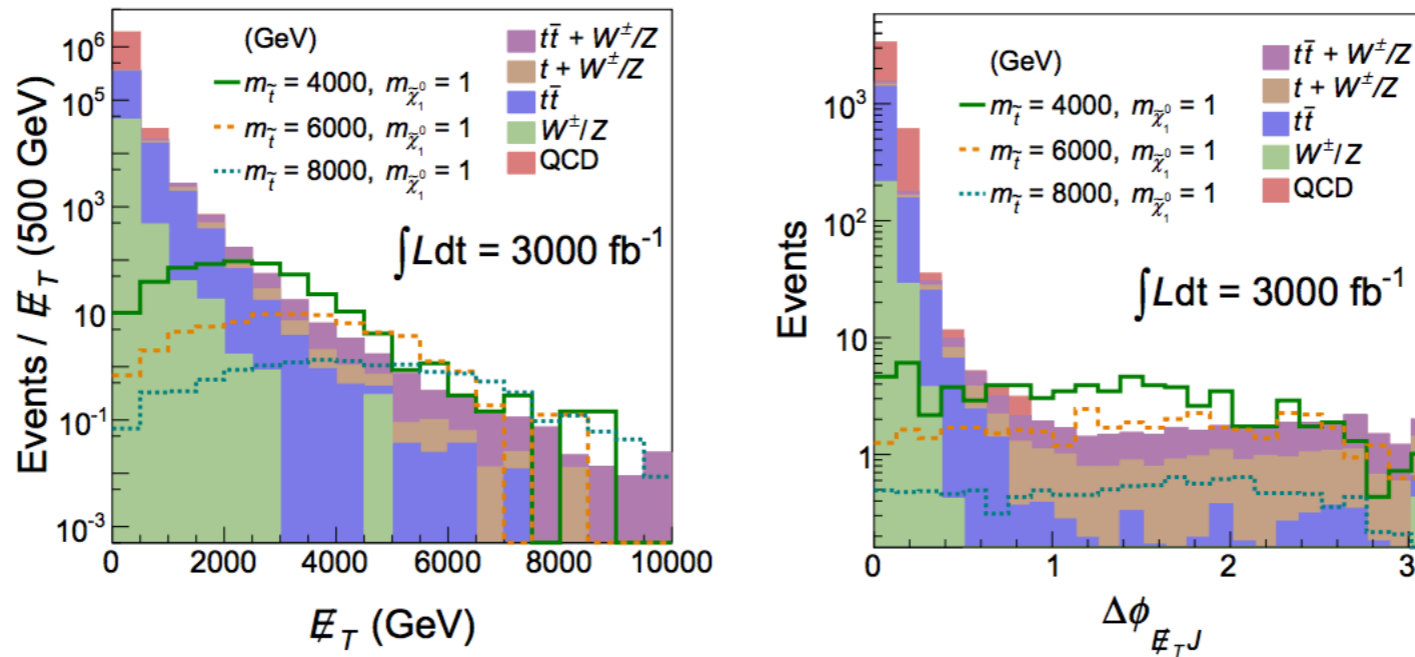
*QCD cut performed w/ p_T > 200 GeV jets

FIG. 4: The $\not{E}_T$ [left] and $\Delta\phi_{\not{E}_T J}$ [right] distributions after all other cuts described in Section III A have been applied, for 3000 fb^{-1} of integrated luminosity. ("Boosting Stop Searches")
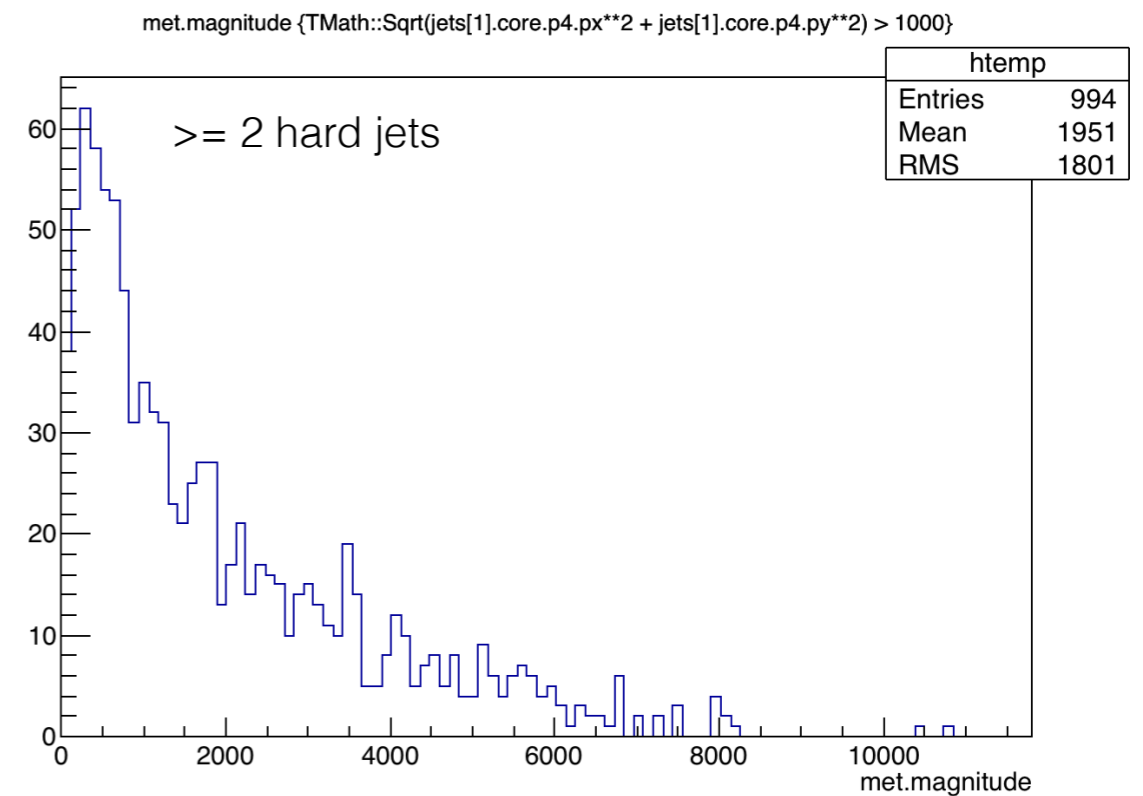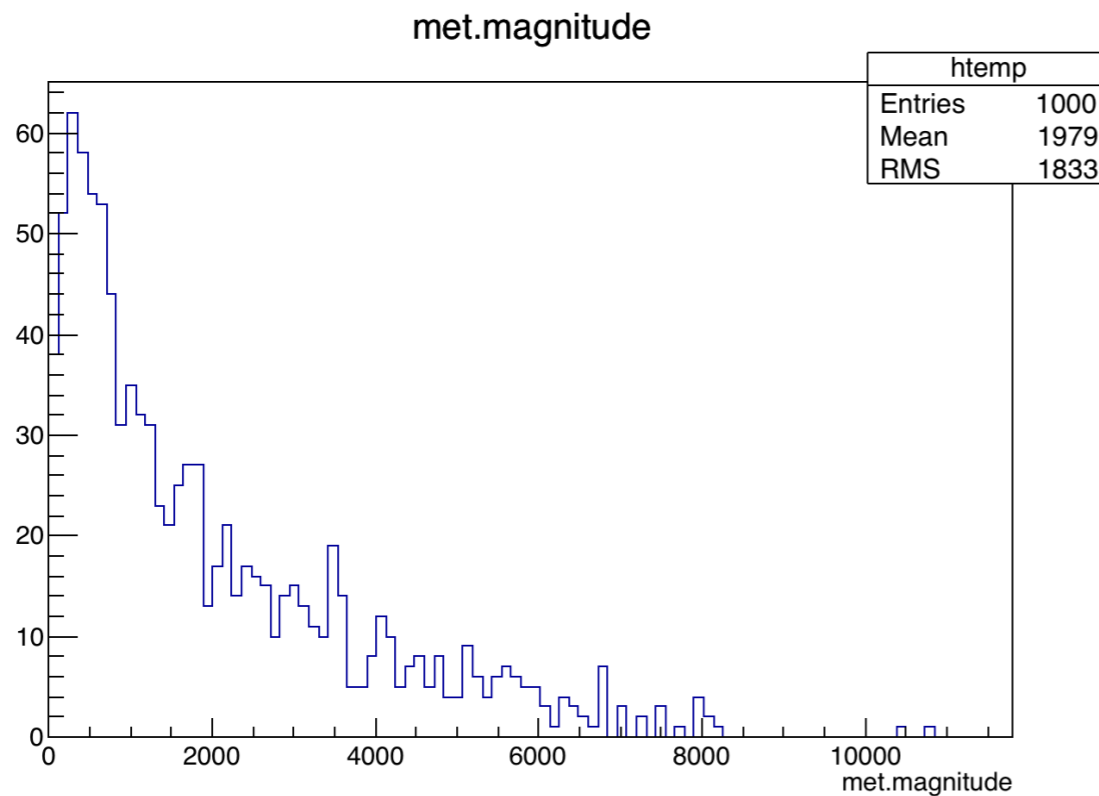
FCC-hh ttbar sample :
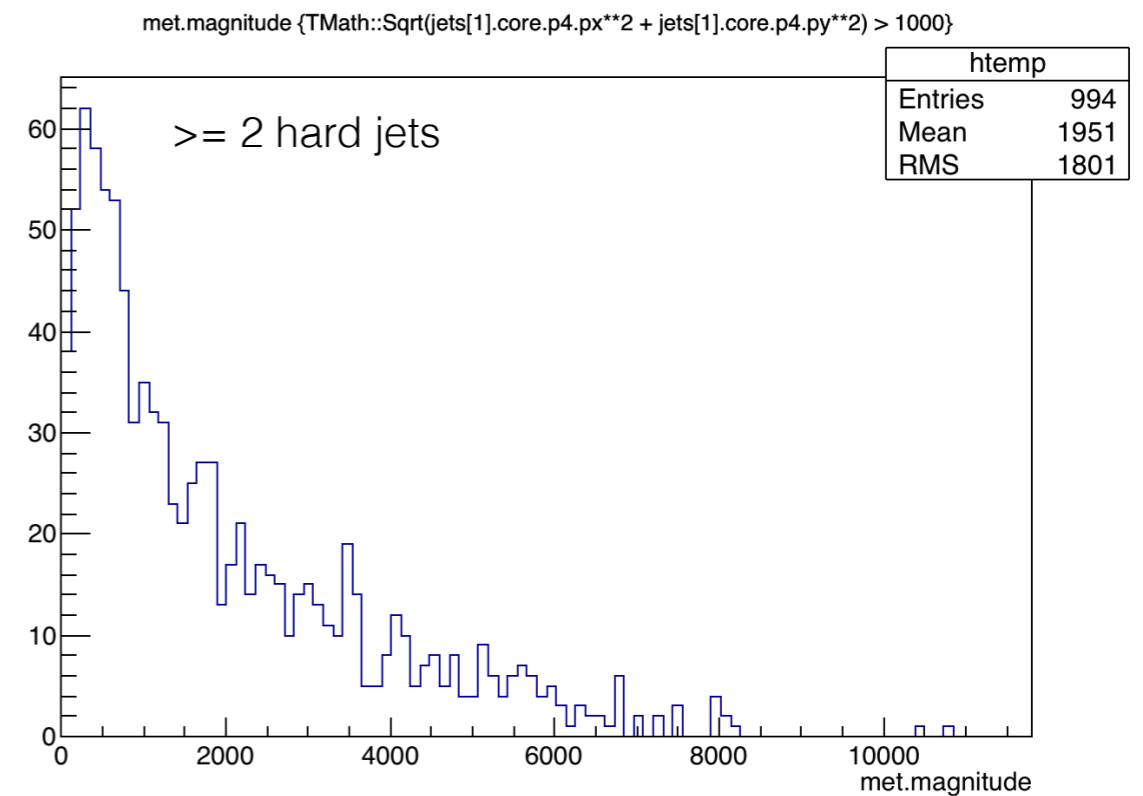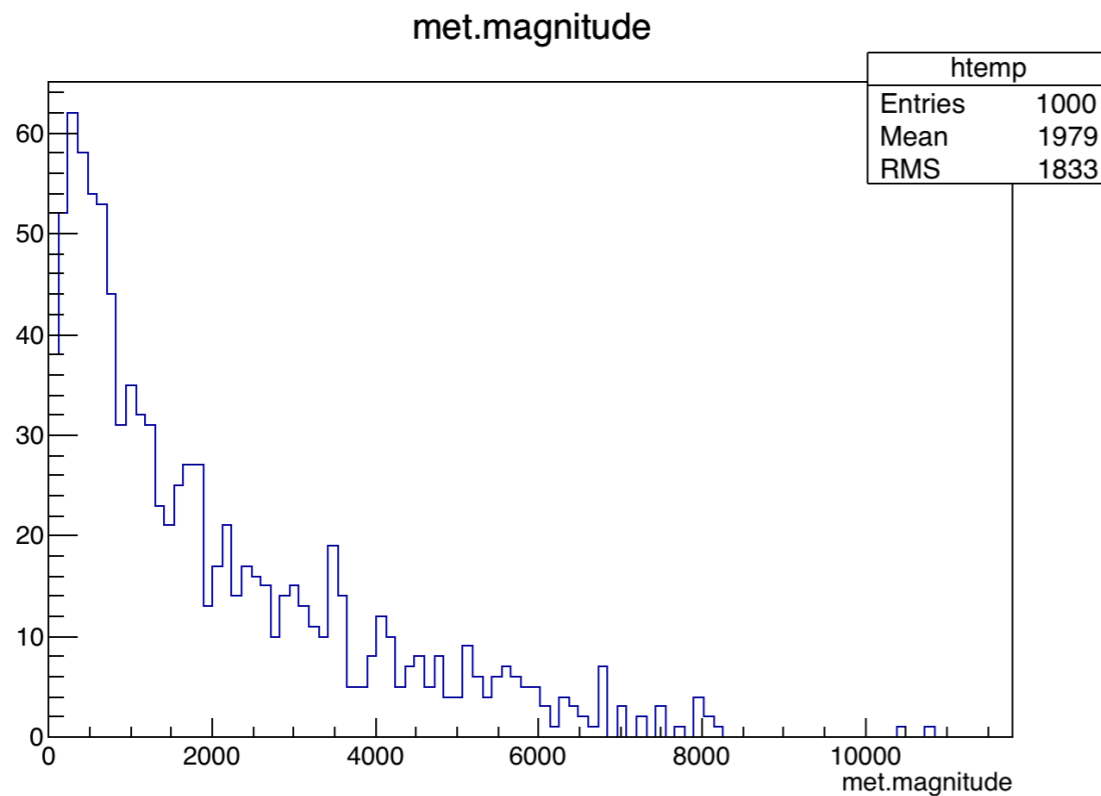
(1/1000th of avail. stats in /eos/fcc/hh/)

>= 2 hard jets

No stats for high MET + boosted jets in existing sample

P$_T$ >= 8 TeV ttbar Production

met.magnitude

htemp	
Entries	1000
Mean	1979
RMS	1833

met.magnitude {TMath::Sqrt(jets[1].core.p4.px**2 + jets[1].core.p4.py**2) > 1000}

>= 2 hard jets

htemp	
Entries	994
Mean	1951
RMS	1801

- ## Generated via ".cmd" file
  - W/ a reasonable generator level cut we can produce necessary statistics
  - Verified that signal LHE files can be ran through FCC-hh FWK w/ appropriate ".cmd" setup

$P_T >= 8\,TeV$ ttbar Production

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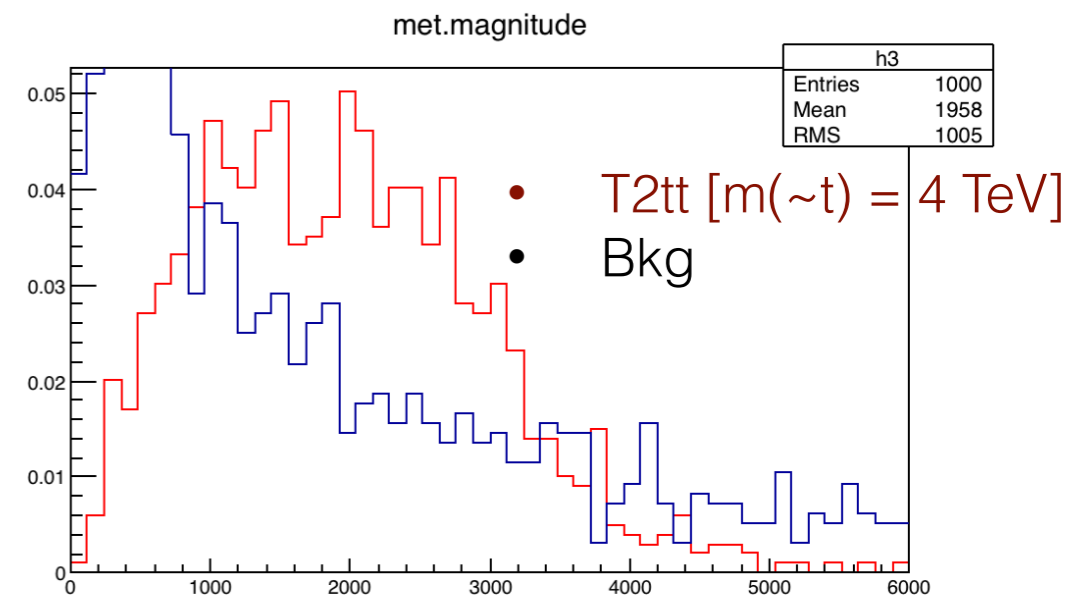| htemp	
Entries	994
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  - W/ a reasonable generator level cut we can produce necessary statistics
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met.magnitude

h3	
Entries	1000
Mean	1958
RMS	1005

- T2tt [m(~t) = 4 TeV]
- Bkg

Thoughts

- Reproduce "boosted tops" analysis results?
  - It would be a nice starting point to build confidence

- Generate relevant samples?
  - High p_T ttbar, ttbar+X, single t, X+jets, diboson, QCD?

- Compare w/ a granularity driven search?

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