Update on the $t\bar{t}HH$ data checking

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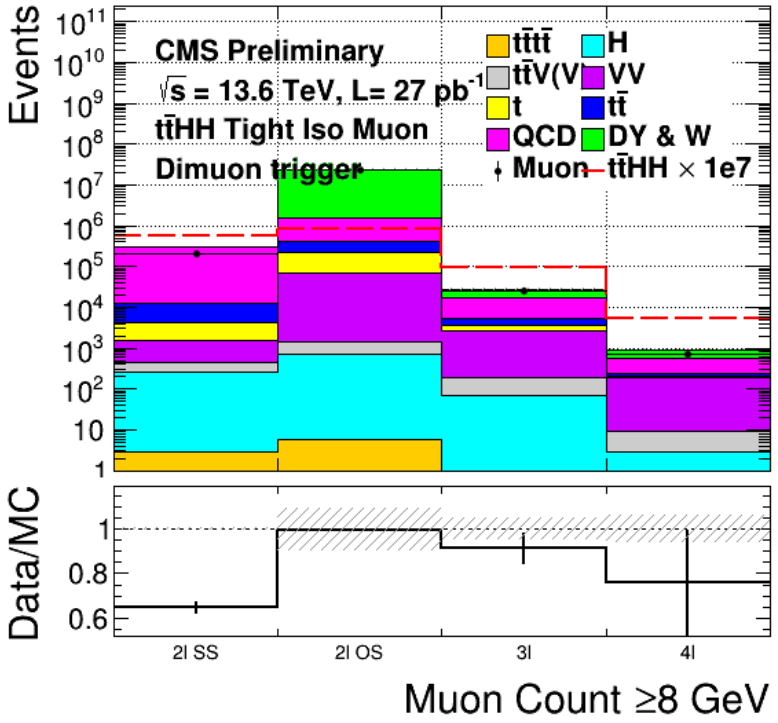
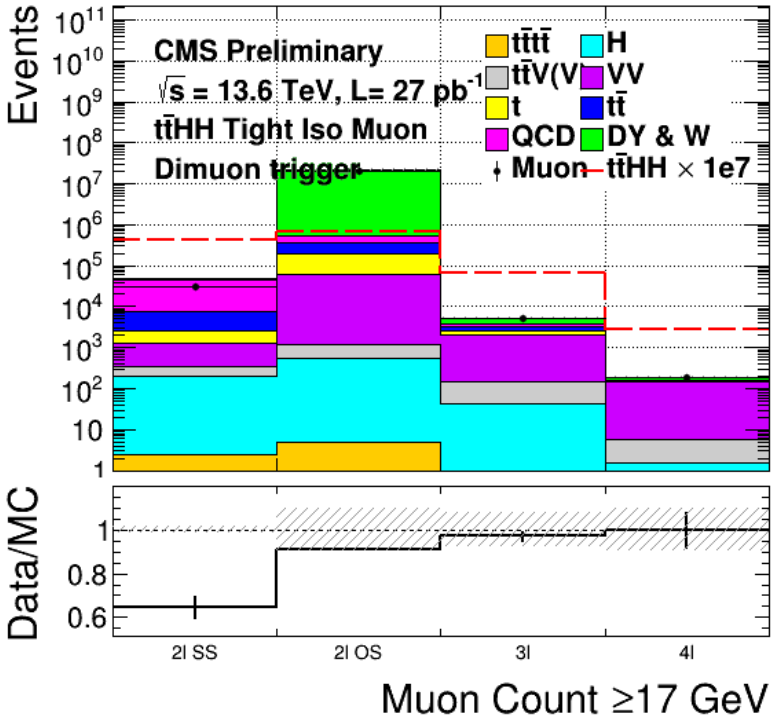
Recap of the previous issues

- The mis-matching of data & MC.
- The Muon p_T threshold.

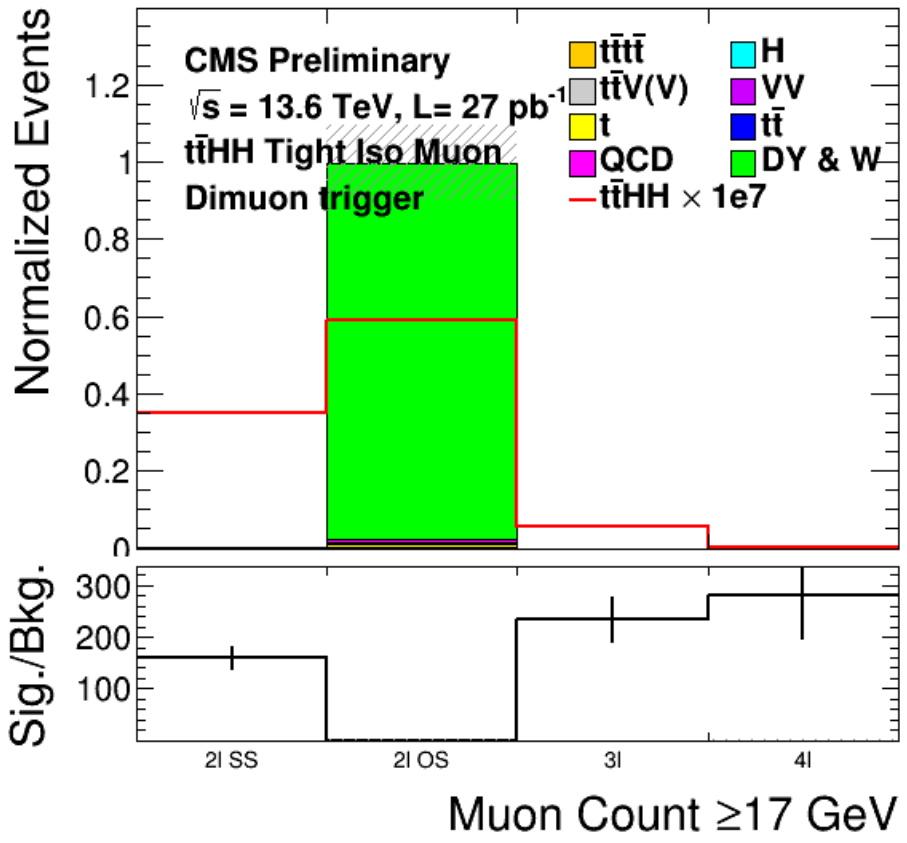
Run 2023 data & MC matching in global CR





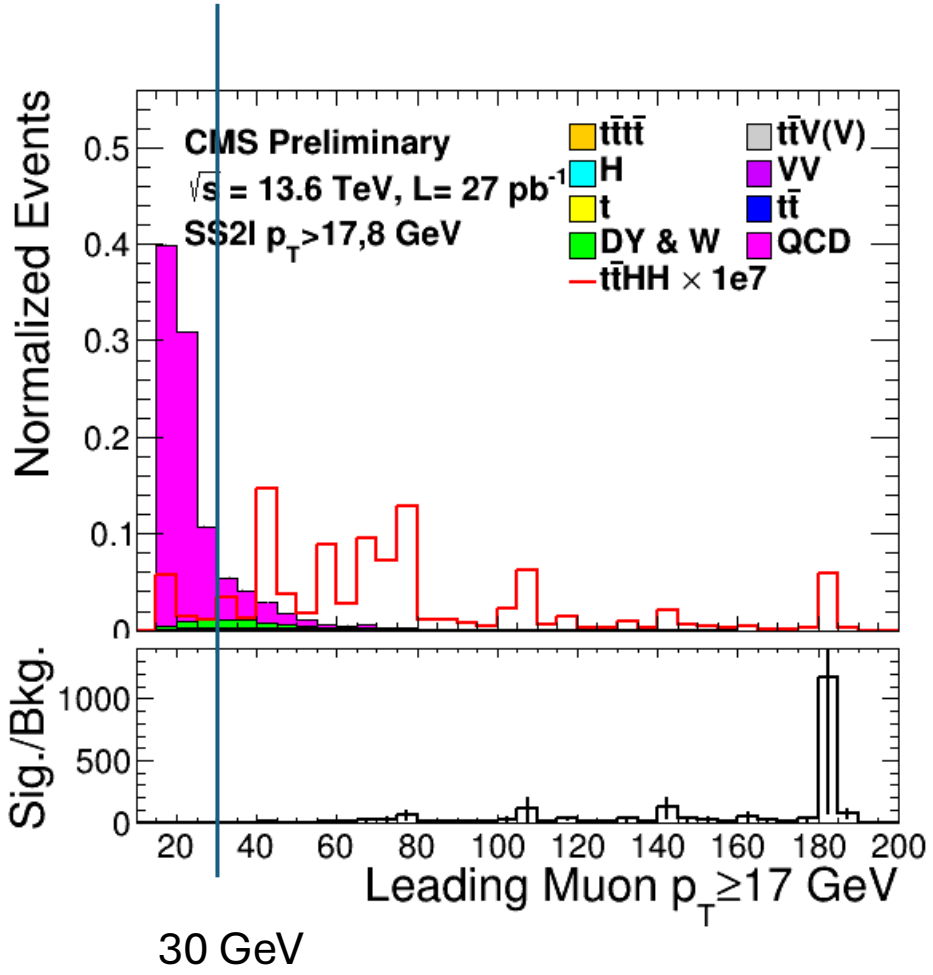
- Global CR, with only dimuon trigger applied.
- Multiplicity matching is already ok.
- The 2lSS mis-matching could be a result from MC uncertainties, as it is QCD-dominant.

MC signal-background comparison



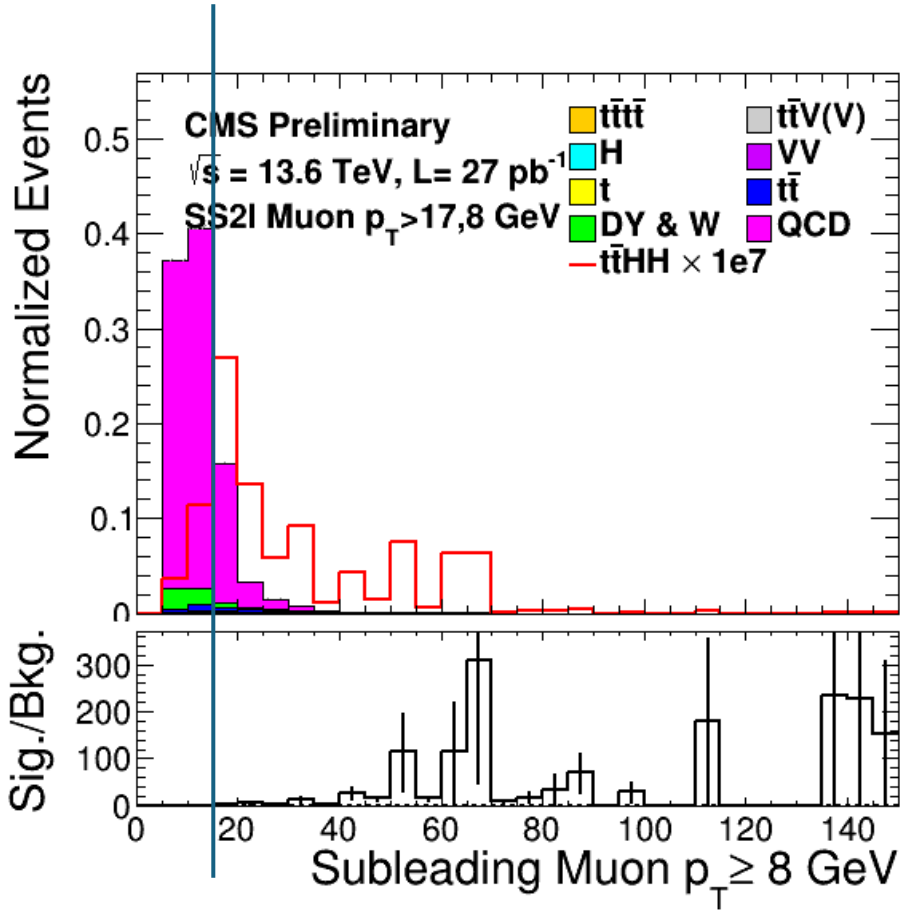
- Global CR, with only dimuon trigger applied.
- Normalized signal and background comparison.
- As a complementary plot of previous log-scale plots, where the contribution of signal topology is not clearly shown.

MC signal-background comparison



- Cut:
  - Triggered by 17,8 GeV dimuon HLT
  - N(Muon)==2, same-sign
  - Both muon tight ID & tight Iso
  - $p_{T,1} > 17$ GeV, $p_{T,2} > 8$ GeV
- Maybe 30 GeV would be a proper Muon p_T threshold to maximum the significance intuitively.
- The background is still dominated by QCD with SS2l requirement only.
- Signal is not sufficient to get a smooth distribution for optimization: need a larger set of generation.

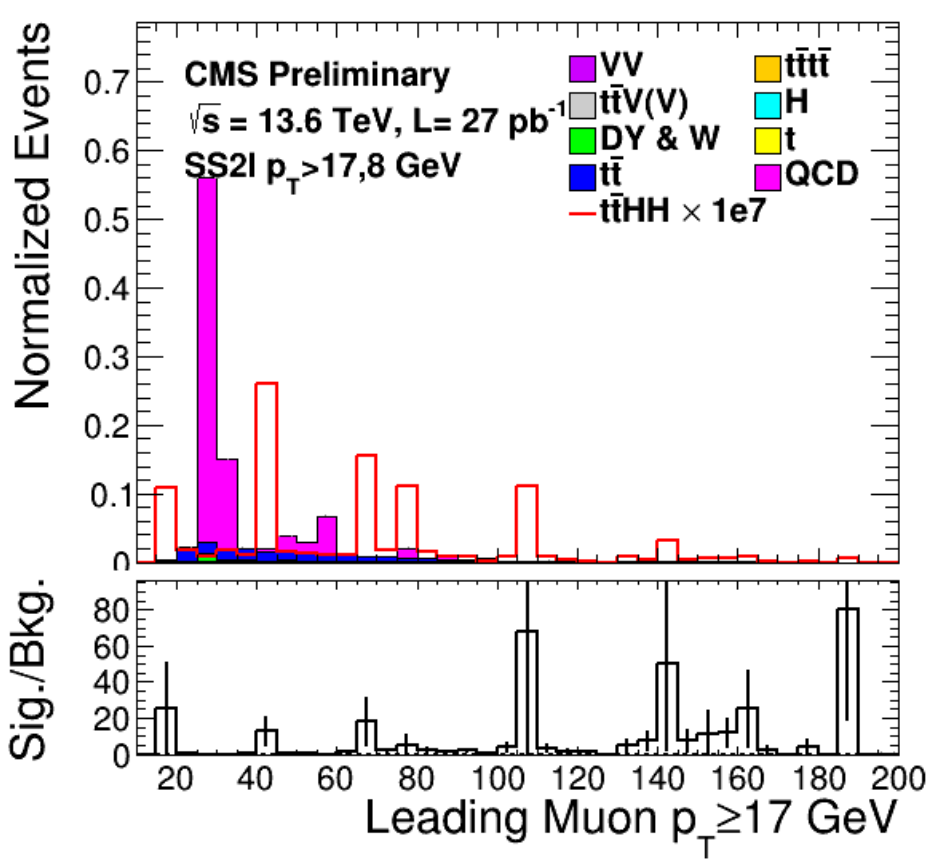
Subleading Muon



15 GeV

- Cut:
  - Triggered by 17,8 GeV dimuon HLT
  - N(Muon)==2, same-sign
  - Both muon tight ID & tight Iso
  - $p_{T,1} > 17$ GeV, $p_{T,2} > 8$ GeV
- Subleading Muon at 15 GeV seems to be a proper choice of p_T threshold to suppress the QCD.
- Still low stats for signal MC. A larger dataset of signal is needed.

MC signal-background comparison



- Add the b-jet multiplicity.
  - Using the 35 GeV tight jetID on the 85% PNet WP.
  - Require at least 3 b-jets.
- Signal too few for drawing any conclusion.

New signal MC generation

- Currently generating private TTHH samples with 100k events.
  - TTHH DL bbWW, including τ-lepton.
  - TTHH SL bbWW, including τ-lepton.
- Generating using condor got some trouble in the pythia. With condor job-splitting, pythia cannot find the lhe files from MG5 in the temporary folder. Keep checking why this happens now.
- Meanwhile, checking running locally on the KNU (lxplus running using too many cores would be killed by administrator).