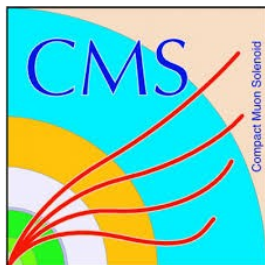


Experience with latest MC NLO codes: $b\bar{b}4l$ in CMS

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LHC Top WG Meeting

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CMS User experiences with latest MC NLO codes (for `WbWb`)

Powheg-RES `b_bbar_4l` [arXiv:1607.04538](https://arxiv.org/abs/1607.04538)

Status of Pythia8 matching interface

- C++ translation of alternative UserHook algorithm for setting shower starting scale inside resonance
- Integrated in CMS software:
<https://github.com/cms-sw/cmssw/pull/16546>
- For ISR use either wimpy shower or power shower + emission veto

"Trivial" difficulties with LHE production

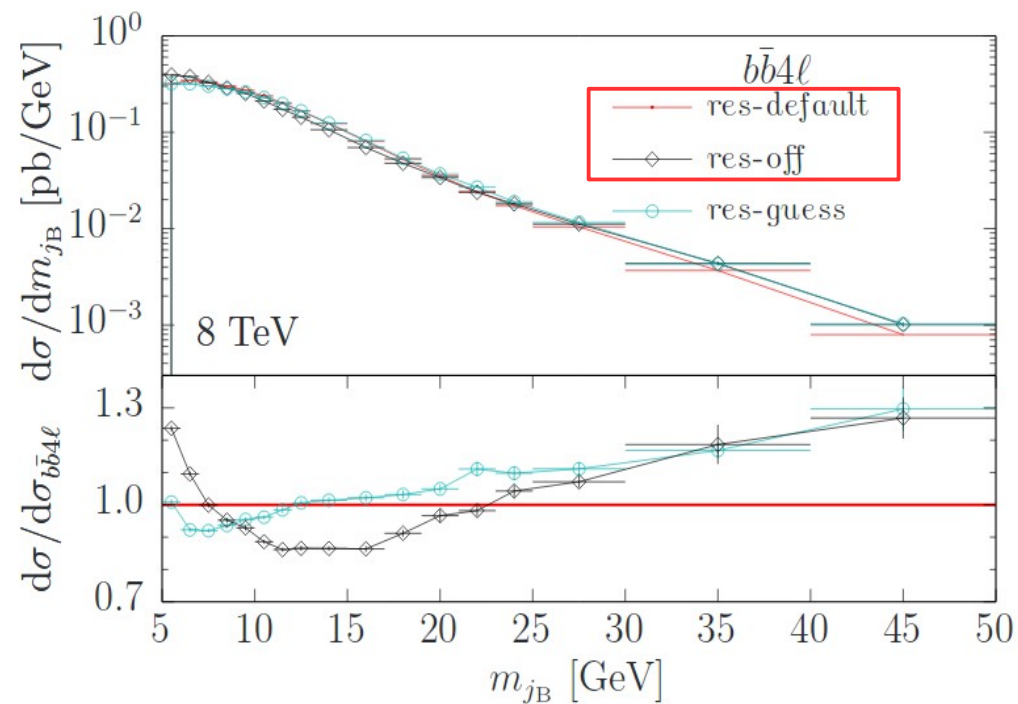
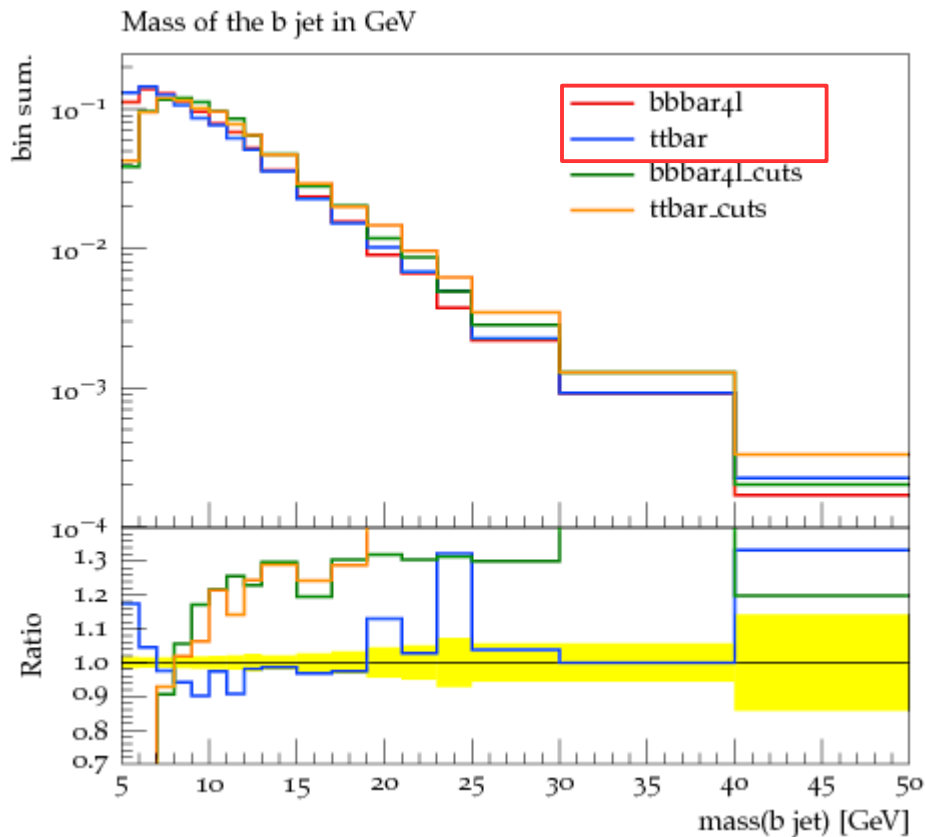
- OpenLoops does not install when path length > maximum fortran line length
- Requires gfortran ≥ 5 (CMSSW release for 2016 data analysis provides 4.8.1)
- Compressed LHE weights format cannot be read by CMS LHEReader

- *Powheg `tth_NLO_dec`* [arXiv:1412.1828](https://arxiv.org/abs/1412.1828)
 - NLO top decays (**all decay modes**, exclusive), LO off-shell/interference effects
 - Standard Powheg-V2 LHE production, same Pythia8 interface as `b_bbar_4l` → ready to go!
- *aMCatNLO and Sherpa*: No working recipe for `WbWb` at NLO+PS yet?

- ◆ standalone production of up ~ 2 Mio $b\bar{b}4l$ events @ 13 TeV
 - $b\bar{b}4l$ (res-default):
 - ◆ up to 3 radiations
 - ◆ resonance aware matching
 - $t\bar{t}b\bar{b}$ (res-off):
 - ◆ single radiation
 - common settings:
 - ◆ CUET1P8M
 - ◆ TimeShower:MECorrections turned on (also for subsequent radiation)
 - ◆ stable b hadrons
 - ◆ no QED radiation

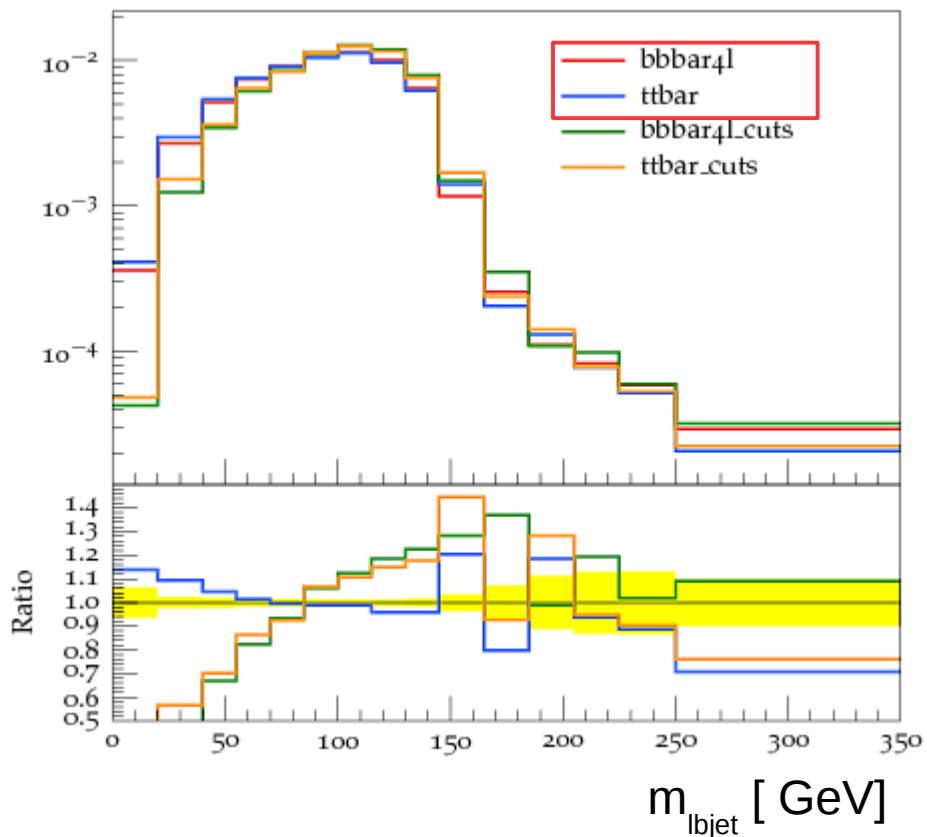
- ◆ note: event weights for now just +/-1

- ◆ invariant mass of b-jets from top decay:
 - consider the 2 jets that have one of the 2 leading b hadrons Ghost-associated

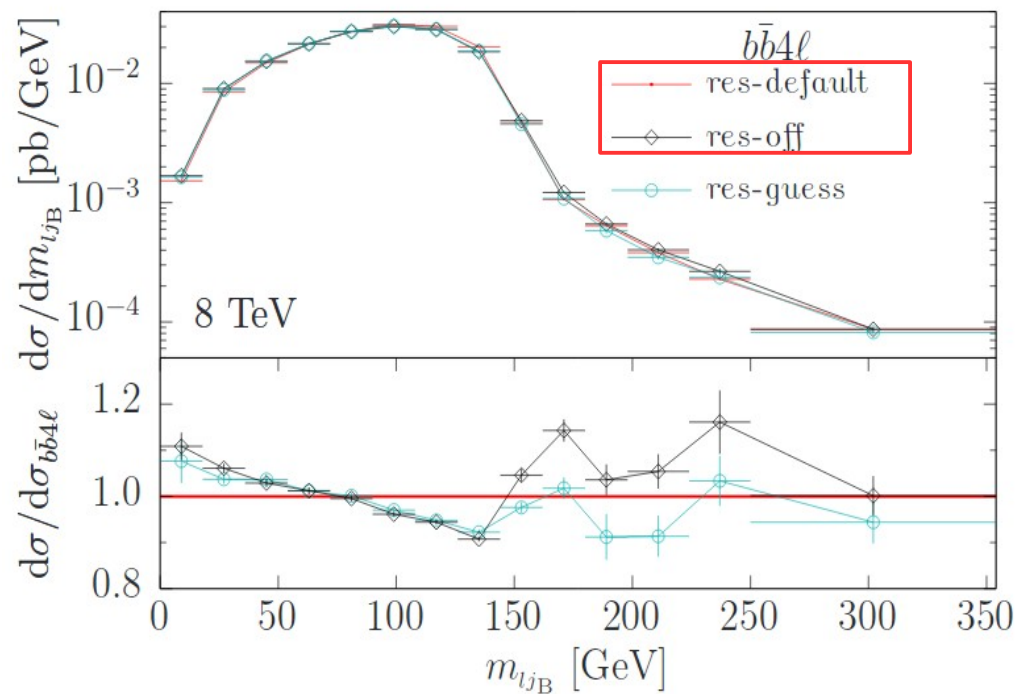


- ◆ reproduced trend of res-off (ttbar) vs. res-default (bbbar4l), deficit of ttbar slight less pronounced between 10 and 20 GeV → need to check with full statistics

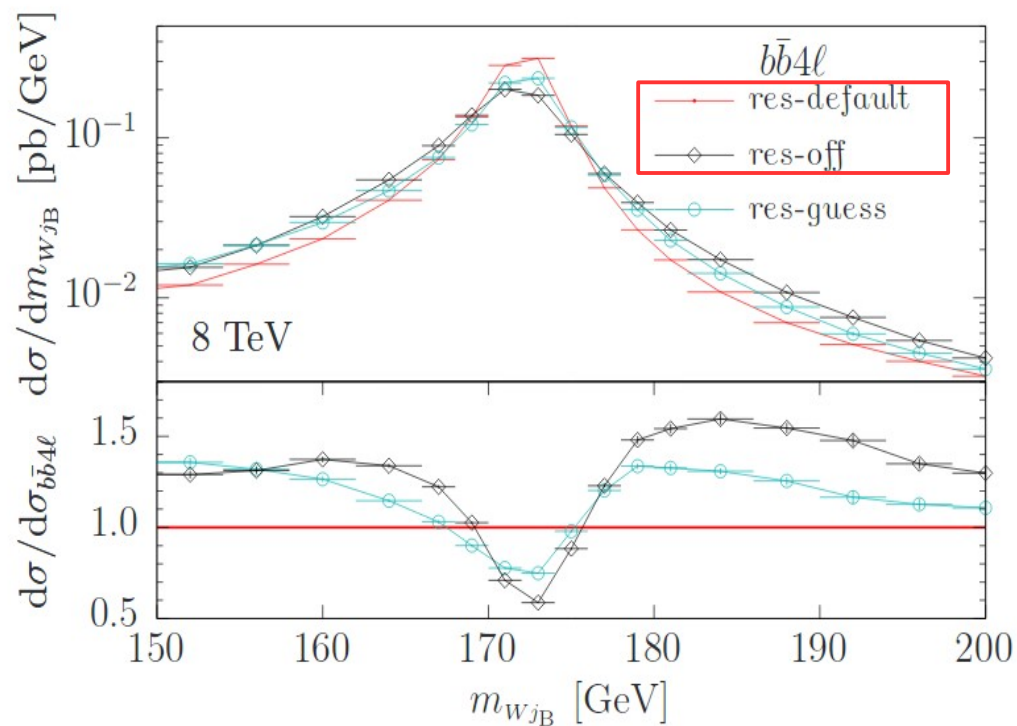
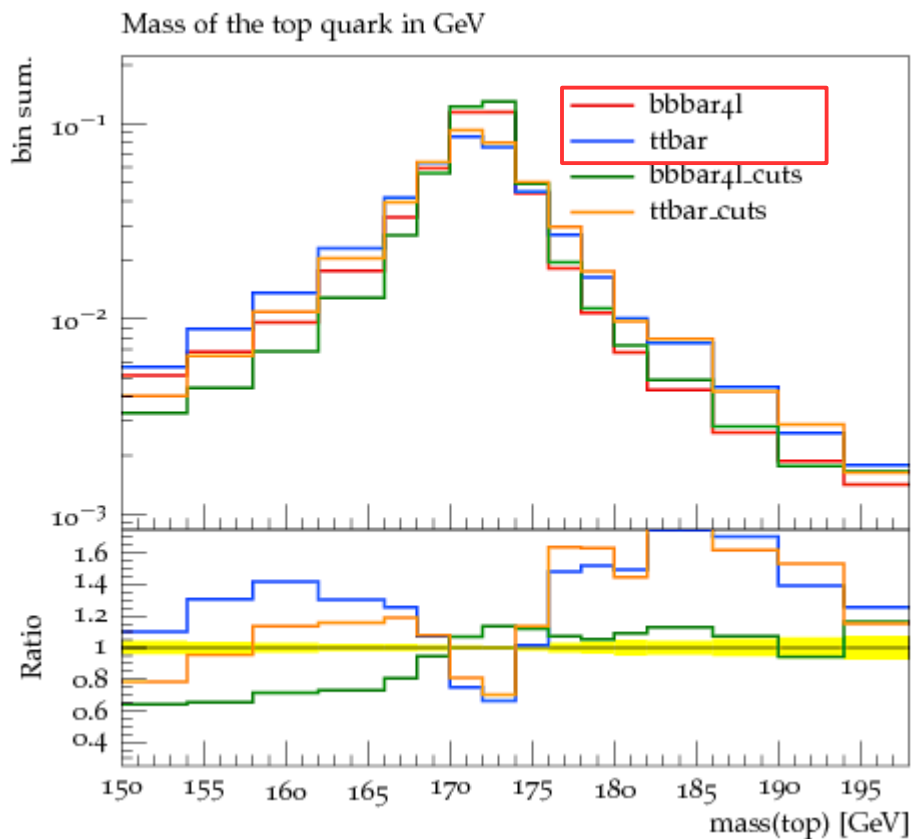
- ◆ invariant lepton + b jet mass:
 - combine lepton (no radiation, no dressing) with corresponding b-Jet using charge of B-hadron



- ◆ similar behavior of $bb\bar{b}4l$ ratio compared to $tt\bar{t}$

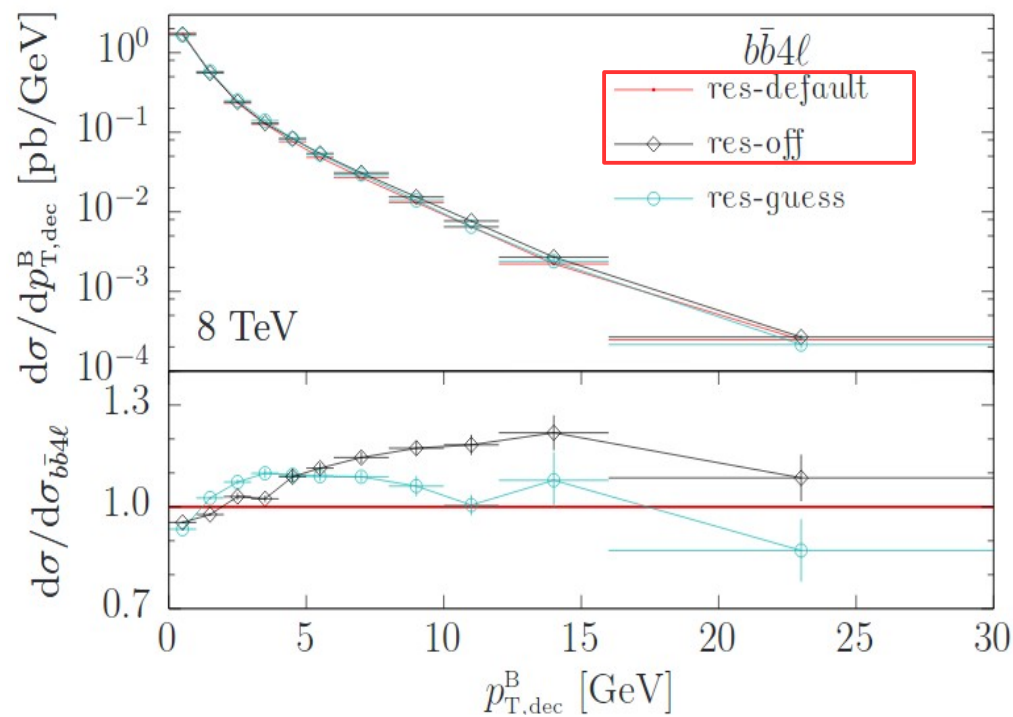
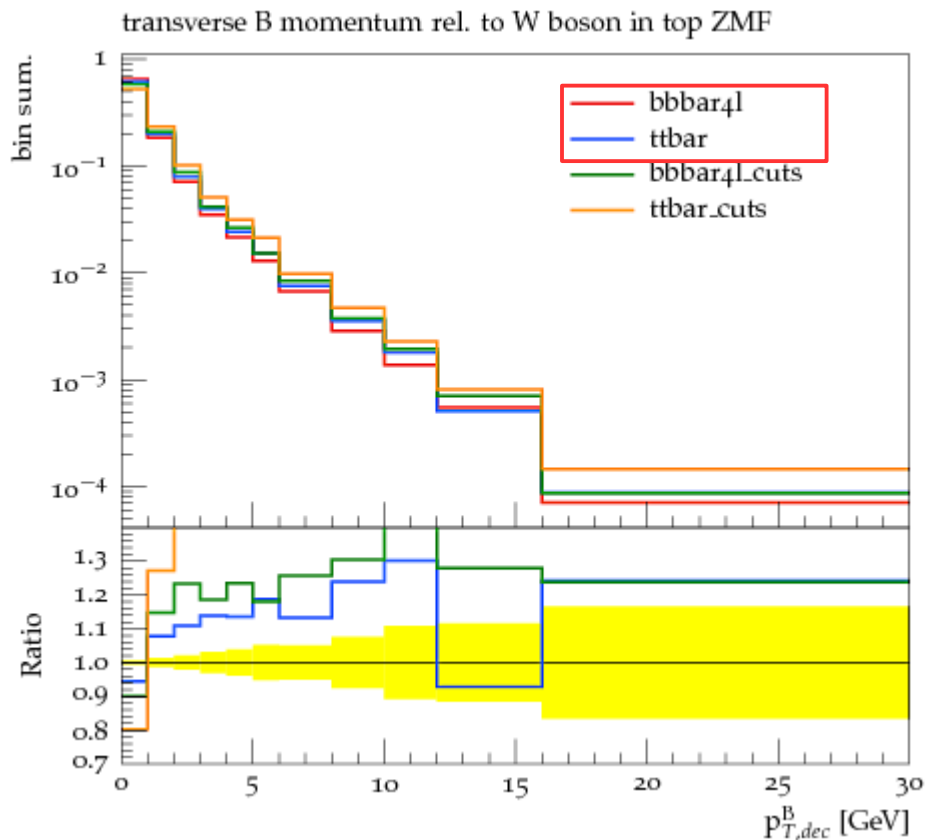


- ◆ invariant top quark mass:
 - combine bjet with corresponding lepton and neutrinos



- ◆ nice agreement of the line shape

- ◆ transverse projection of b hadron onto W boson, after boost in top ZMF



- ◆ good agreement between the ratio of bbbar_{4l} and ttbar compared to original publication



BACK-UP



- ◆ b from top:
 - consider the 2 jets that have one of the 2 leading b hadrons Ghost-associated
- ◆ W reconstruction:
 - combine lepton (no radiation, no dressing) with corresponding neutrino
- ◆ top:
 - combine bjet with corresponding W

- ◆ basic selection:
 - anti-kt 0.5 jets: $p_T > 30$ GeV, $|\eta| < 2.5$
 - b-tag: Ghost association with b hadrons
 - lepton: $p_T > 20$ GeV, $|\eta| < 2.5$
 - $p_T^{\text{miss}} > 20$ GeV (sum of neutrinos)

- ◆ note: event weights for now just +/-1