A first look at the ttH→γγ analysis: status and plans

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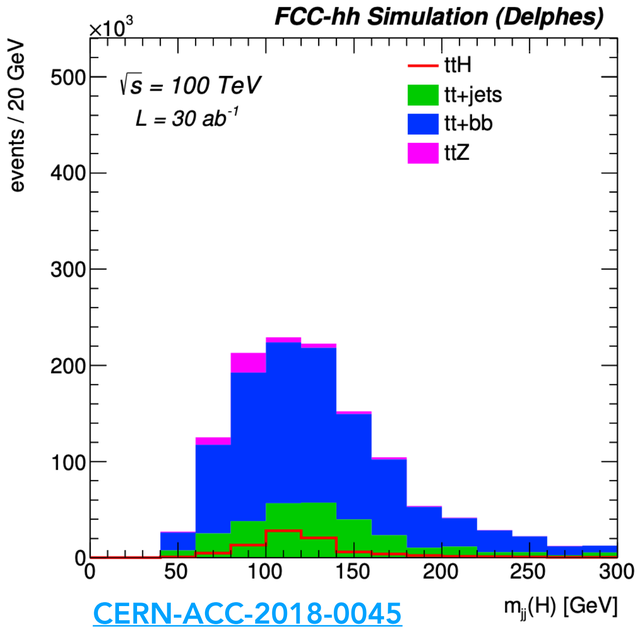
FCC-hh ESPP studies, meeting 5

Outline

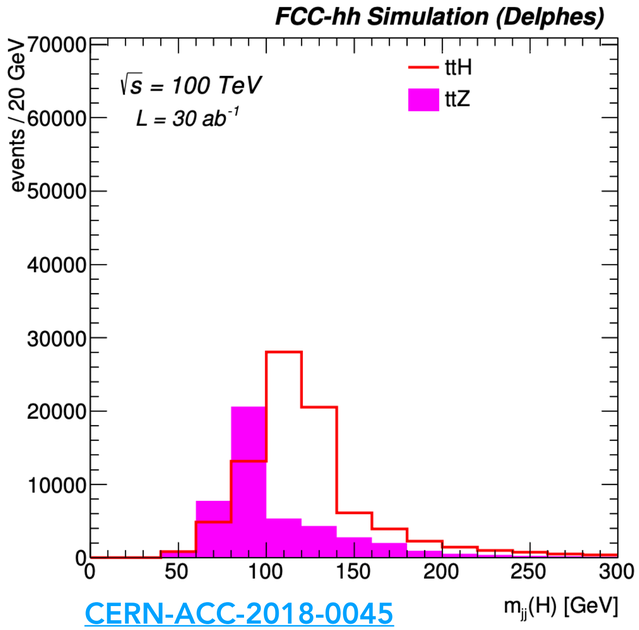
- The **ttH** production mode provides a **direct probe** to the **top quark Yukawa coupling** (= y_t).

  ttH→bb analysis covered in [CERN-ACC-2018-0045] for the European strategy update of 2019.

  FCC-hh scenario with pp collisions at $\sqrt{s}$ = 100 TeV, L = 30 ab^{-1}.



CERN-ACC-2018-0045



CERN-ACC-2018-0045

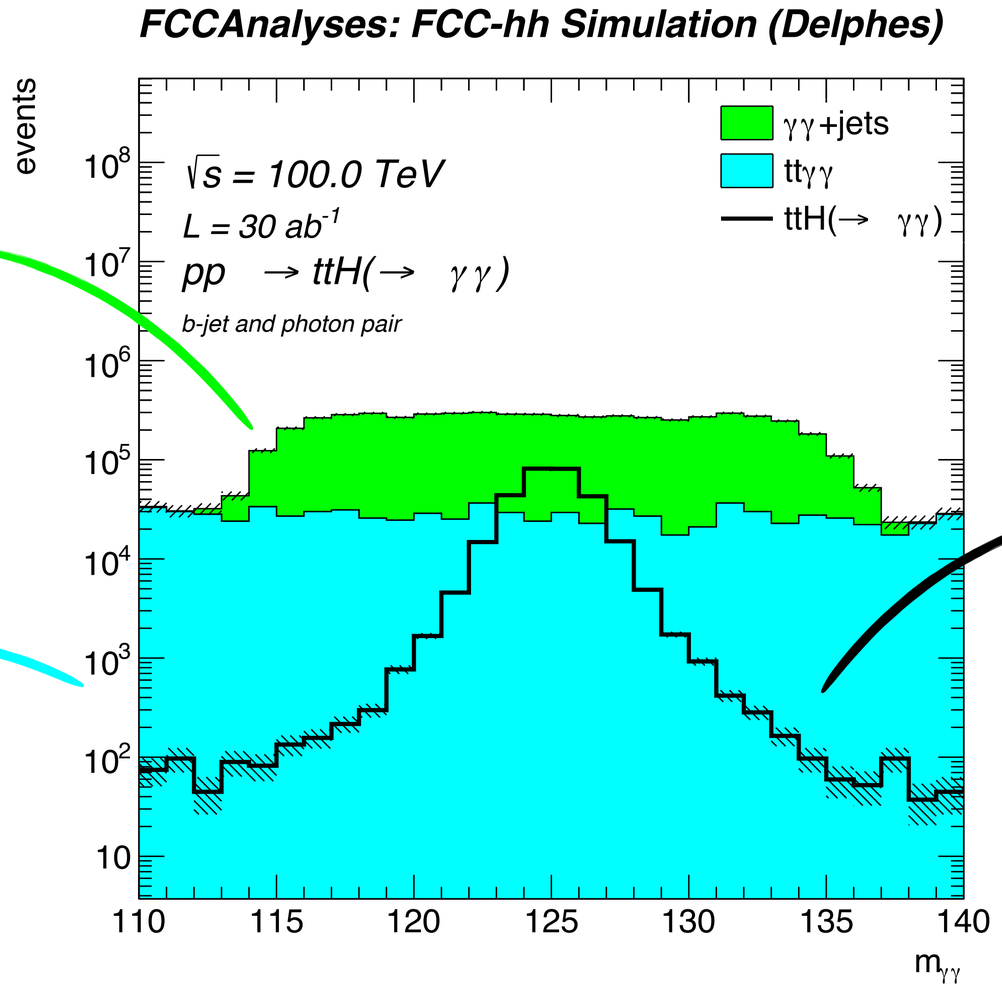
- Separating signal from backgrounds (= $t\bar{t}$ +jets) using jet substructure observables.
- Suppress background from fake b-jets by requiring ≥ 4 b-tagged jets.
- $\mathbf{m_{jj}(H)}$ = final discriminant.
- Parameter of interest = **N(ttH) / N(ttZ)**.
- $\delta y_t / y_t \approx$ 1%.

- We would like to target the **ttH production mode @ FCC-hh** at $\sqrt{s}$ = 84 TeV, adding the **diphoton decay** of the Higgs boson (= **ttH→γγ**).

The ttH→γγ analysis

γγ+jets background

ttγγ background



Signal ttH→γγ

- Very clean diphoton resonance around 125 GeV.
- Two b-jets from top quark decays.

- Samples generated by Birgit relying on MadGraph @ LO.
- Inclusive in top quark decay.

A first look at the analysis yields

Expected yields @ 30 ab^{-1}

	Signal ttH→γγ	Background γγ+jets	Background ttγγ
No cuts	2.28e+06	6.47e+08	8.56e+06
≥ 2 b-jets	1.38e+06	1.40e+07	4.15e+06
≥ 2 photons	3.08e+05	5.14e+06	6.59e+05
120 < $m_{\gamma\gamma}$ < 130 GeV	2.92e+05	2.54e+06	7.77e+04

- **Photon selection**: p_T > 30 GeV
- ***b*-jet selection**: p_T > 30 GeV, $|\eta|$ < 4.0, "Medium" b-tagging requirements.

Could reproduce results prepared by Birgit!

Caveat: MC samples available for $\sqrt{s}$ = 100 TeV, new samples at $\sqrt{s}$ = 84 TeV will be produced.

Summary & outlook

- We would like to explore the **ttH→γγ analysis @ FCC-hh** at $\sqrt{s}$ = 84 TeV.

  ➡ Following the **ttH→bb analysis** in CERN-ACC-2018-0045.

- We have just started to have a first look at the available signal and background samples, and try to gain confidence with the analysis setup.

- **What's next? A tentative timeline:**

  ➡ 1. Exploring discriminant variables for isolating **ttH→γγ signal** from the **non-resonant backgrounds**.

  2. Defining a **signal region**.

     ➡ Considering using a BDT to separate signal and backgrounds, splitting into leptonic and fully hadronic channels for the top quark decay, and splitting into $p_T(\gamma\gamma)$ bins (= proxy for $p_T(H)$).

  3. Fitting $m_{\gamma\gamma}$ as a final discriminant, to extract a measurement of the **ttH→γγ signal strength**.

  4. Showing the precision on $\mu(\mathbf{ttH} \to \gamma\gamma)$ at 30 ab^{-1} and documenting the analysis.