Focus topic meeting "ttbar threshold"

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R. Franceschini, A. Irles J. de Blas (related focus topics), P. Azzi (liaison FCCee)

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Practical

The ECFA focus topics document is out:
https://arxiv.org/abs/2401.07564

Focus topics for the ECFA study on Higgs / Top / EW factories

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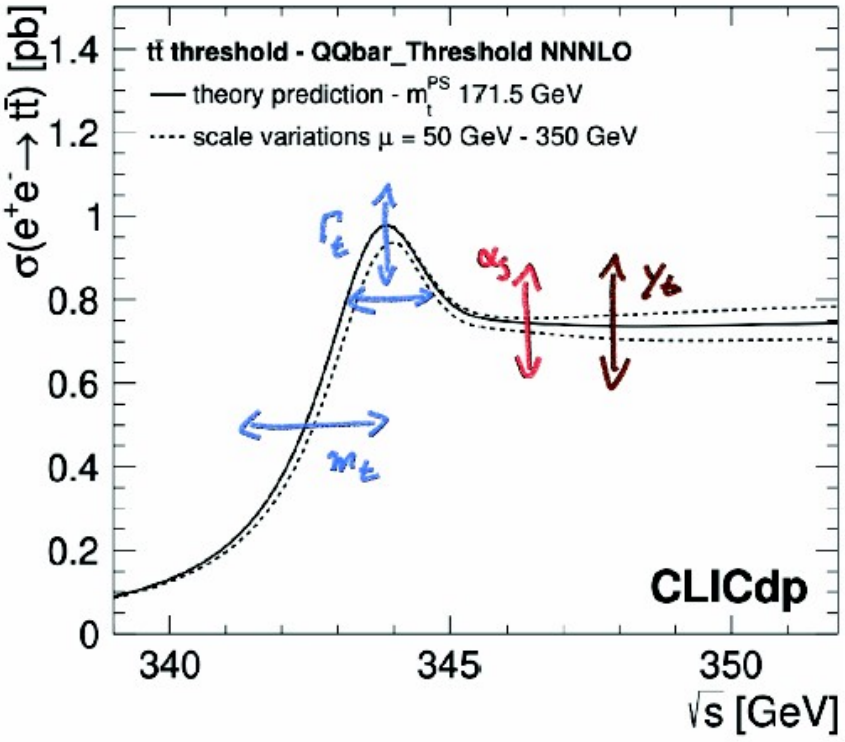
There is a mailing list for this group:
https://gitlab.in2p3.fr/ecfa-study/ECFA-HiggsTopEW-Factories/-/wikis/FocusTopics/TTthresh
Please, tell people to sign up if they want to join or follow this group

The $t\bar{t}$ threshold scan



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Scope of the study

Exp:

- Full-simulation study to revisit and harmonize experimental systematic uncertainties

Theo:

- Fully differential predictions at adequate precision (QQthreshold, F. Simon to perform fits)
- Specify procedure for comparison of data and theory (clarified last week)

Study width prospects in more detail (i.e. comparison LHC, interpretation in NP scenarios)

Embed top mass prospect in global EW fit environment (J. De Blas)

Find a way to make top Yukawa and strong coupling results more competitive

Theoretical and phenomenological targets

- Complete and harmonised assessment of systematic uncertainties on SM parameters extracted from the threshold scan.
- Degeneracies in a EFT analysis including only "one" energy point. How to disentangle effects combining with other (non-top-quark) measurements. Indirect constraints on top Yukawa.

MC samples needed

Basic samples available as listed in the Motivation Section, dedicated samples for threshold scan are needed.

Existing tools / examples

- ILD $t\bar{t}$ analysis https://github.com/ILDAnaSoft/ILDbench_QQbar

Contact & Further Information

- Gitlab wiki: https://gitlab.in2p3.fr/ecfa-study/ECFA-HiggsTopEW-Factories/-/wikis/FocusTopics/TTthresh
- Sign up for egroup: ECFA-WHF-FT-TTthres@cern.ch via http://simba3.web.cern.ch/simba3/SelfSubscription.aspx?groupName=ecfa-whf-ft-ttthres
- and/or email the conveners of ECFA WG1 GLOBal group: mailto:ecfa-whf-wg1-glob-conveners@cern.ch

Towards a standard sample

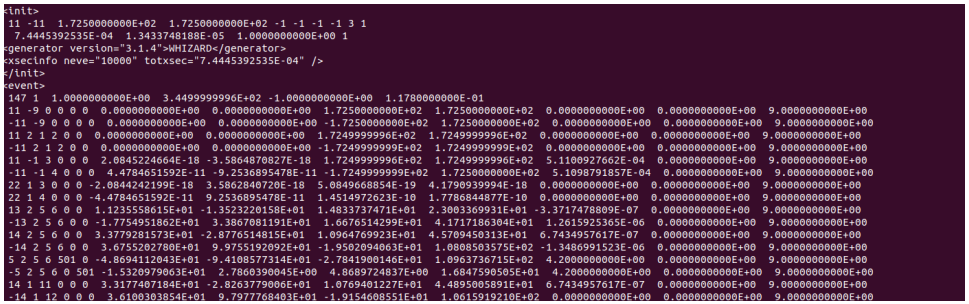
WHIZARD sample in preparation by M.V. (with help from J. Reuter, J. Tian)

e+e- → 6 fermions ($b\bar{b}$, 2 charged leptons, 2 neutrinos)

- Mostly e+e- → $t\bar{t}$ → WbWb, with all W decays
- Using SM_CKM (LO, no threshold enhancement, pole mass scheme)

With luminosity spectrum and ISR

- ILC 350, also FCCee is possible
- Generate (L,R),(R,L) + some (0,0)



Hadronization handled by Pythia (volunteers for Pythia variations?)

Example sample to get going shared in CERNBOX with Nadjieh/Zohreh and Matteo/Laura

Simulation requested in:

- ILD (full simulation, MC meeting 28/02),
- FCC (DELPHES?, meeting with Higgs/top conveners on Friday, March 1st), etc.

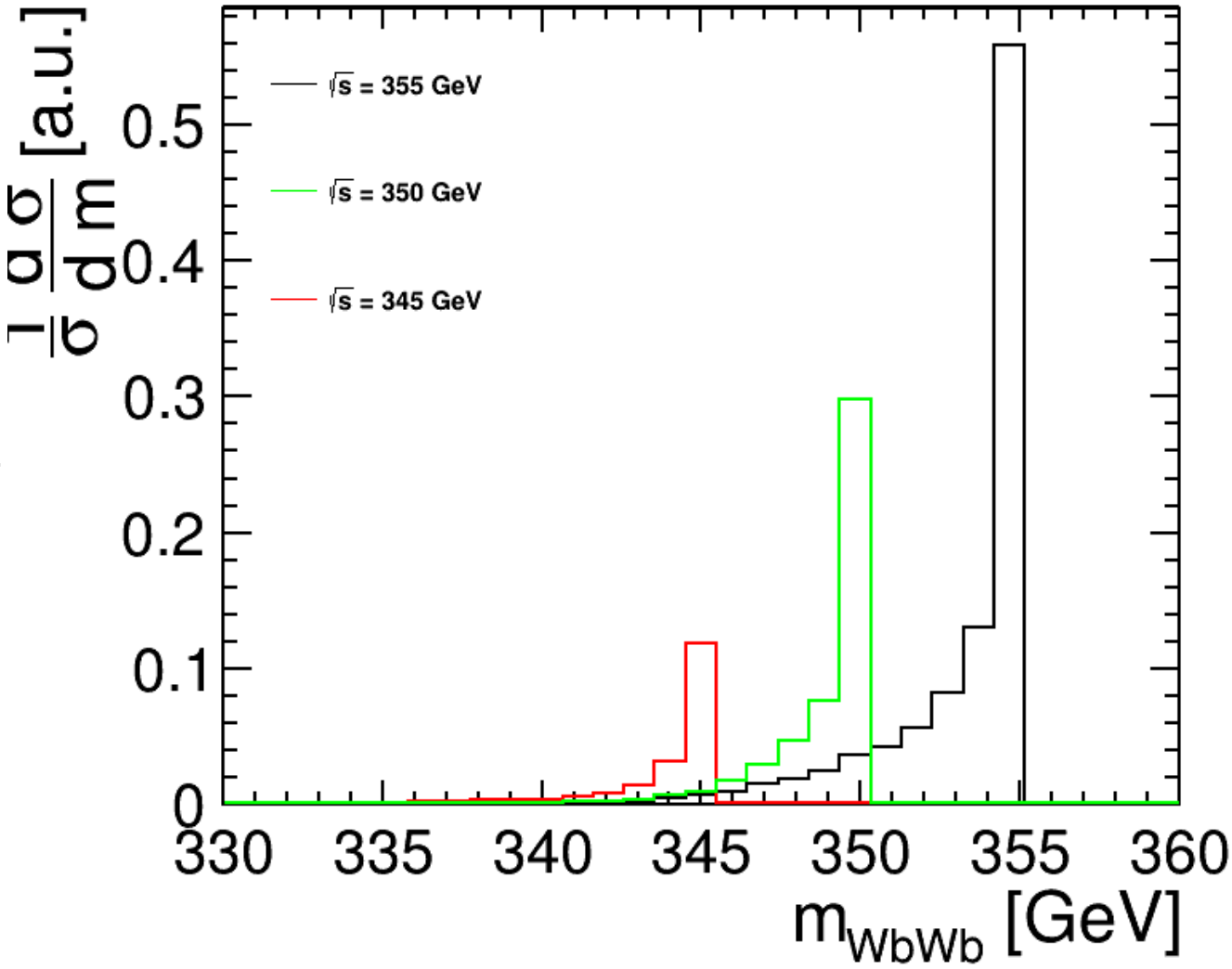
Threshold scan MC samples

ISR and luminosity spectrum lead to low-sqrt(s) tails

m_t^{pole} = 172.5 GeV
https://arxiv.org/abs/2402.08713

→

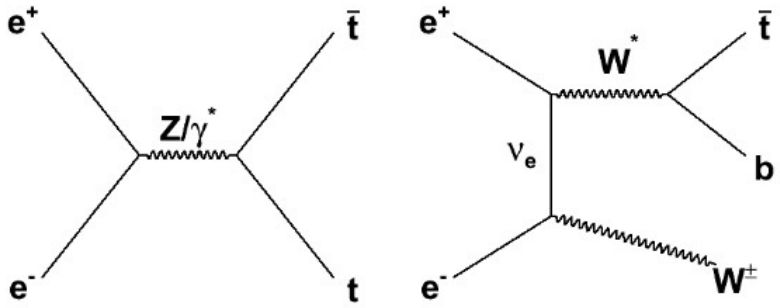
m_t^{PS} ~ 170.5 GeV
m_t^{1S} ~ 170.9 GeV



Signal vs. background

We need a working definition of **signal** and **background** between experiment and theory

Single top signal

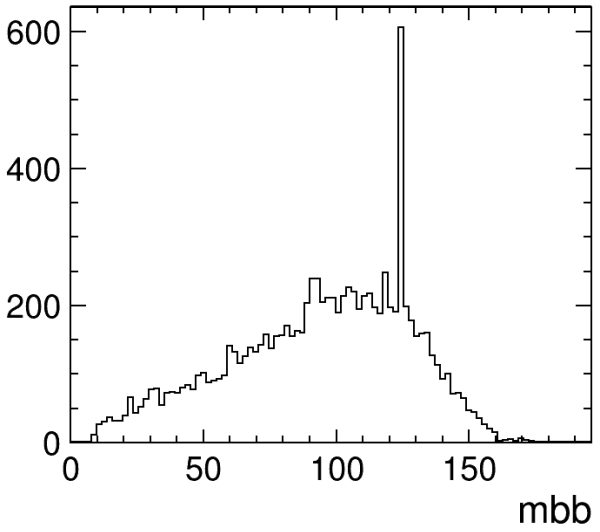


Backgrounds:

- 6f without b-jets (small if b-tagging is good)
- 2f & 4f backgrounds (rejected by requiring 2x #leptons + #jets = 6)
- **Higgs contamination, e+e- → ZH, Z → W+W-, H→bb**
  - is part of e+e- → WbWb, but not accounted for in calculations

Martin Beneke (last meeting):

- single top is included in the calculation and should be considered signal
- Higgs diagrams are not included and are a (small) reducible contamination that must be dealt with by experimentalists



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Experimental systematic uncertainties

Is the acceptance constant vs. sqrt(s) over the range of the threshold scan?

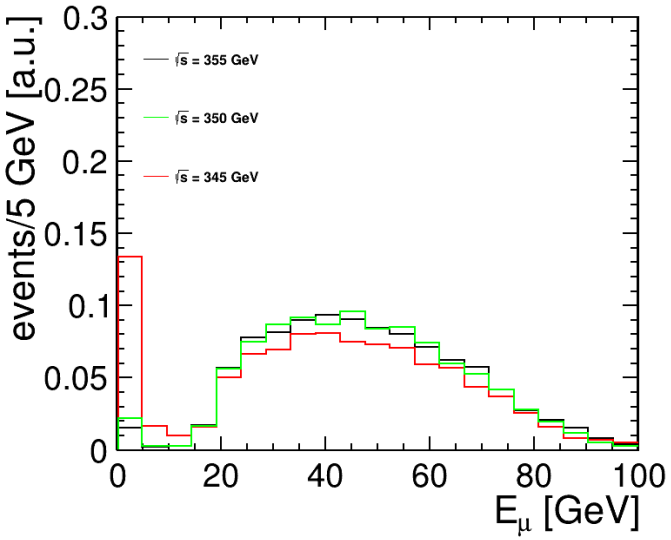
- Realistic selection requires one/two b-tags and isolated leptons, with “near-complete polar angle coverage” (https://arxiv.org/pdf/1307.8102.pdf + CLIC 380 https://arxiv.org/pdf/1807.02441.pdf)

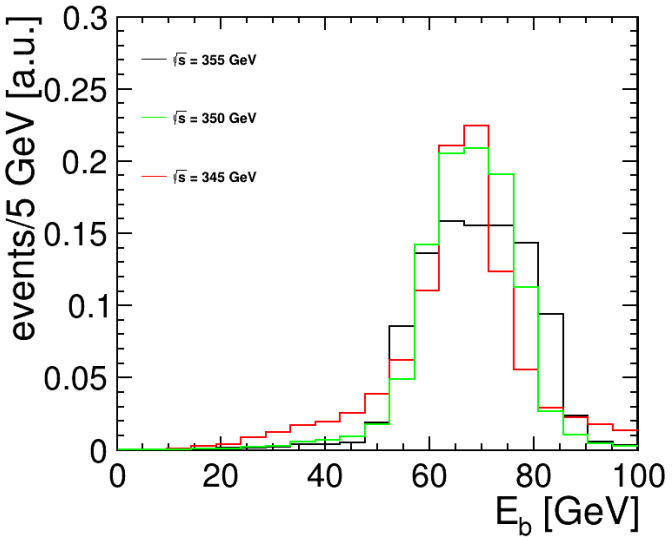
Is the b-tagging efficiency constant? Or can we calibrate it in-situ?

- Double-tag method, ATLAS (https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/TOPQ-2023-21/), LEP (https://arxiv.org/abs/hep-ex/0509008), or ILD (https://arxiv.org/pdf/2306.11413.pdf)

No reconstruction?

- Required by measurement of A_{FB}, but not needed (or desirable) for cross section





Summary

Threshold scan signal MC samples are in development:
- WHIZARD six-fermion (with single top, Higgs, etc.) pure leading order in pole mass scheme → example samples available
- Samples with more advanced model, including threshold enhancement, could be produced in the future

Volunteers to analyze these will present their plans today

Plenty of related activities are still looking for personpower

Practical:

Will use official mailing list from now on

Regular meetings on Wednesday afternoon (17:00 CERN time)