

# FCC-hh physics and performance meeting- 20/2/2025 Introduction

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# Introduction and news

- Work underway towards dedicated FCC-hh submissions for ESPPU- as discussed in previous FCC-hh general meeting on February 10th: <https://indico.cern.ch/event/1506555/>.
- As a reminder:
  - We would like all groups/teams anticipating results that will be ready for inclusion by 31st March deadline to present ideally in the P+P meeting but otherwise in the FCC-hh general meeting so we can review/understand the results.
- Next meetings scheduled for:
  - 6th of March, 4PM CERN Time- <https://indico.cern.ch/event/1506572/>
    - We already have several teams pencilled in for this meeting- please could you confirm by next Thursday (27th February if you intend to make a presentation), in case we need to plan an additional overflow meeting.

# Reminder: Sample production

- Started new production tag (fcc\_v07) for official Delphes samples for 2025 results
  - Using latest key4hep release including finally a fix for previously persistent memory/crash issues, as well as fix for the jet matching (amongst others)
  - Highest priority samples are the ones for  $b\bar{b}yy$  and  $H \rightarrow \mu\mu$  analysis, they are completed at 100 TeV, and in progress at other energies
- LHE generation of the highest priority key analysis samples (single Higgs) at alternative energies nearly completed, expanding to broader scope
- [Link to spreadsheet tracking production status](#)
- In case of further requests please get in touch a.s.a.p.

# Summary + outlook

- Many ideas and ongoing analyses, still lots of work to do!
  - Need to really streamline & focus efforts for the key deliverables by end of March
    - Make sure the analyses in advanced state are documented in time!
    - If your analysis will proceed on a longer timescale but could converge by the open symposium- get in touch so we can understand how to help.
  - Please cross-check your teams status against the slides (in the backup) that we presented at the last FCC-hh meeting- let us know if anything has changed.
- Thanks for your time and efforts, and reach out if there are things we can help with.



Backup- status presented in last  
FCC-hh meeting

# Status & plans: Definite deliverables

- New baseline: [running scenario at 84 TeV](#), [Delphes card II for detector performance](#)
    - Common note describing the Delphes detector parameterization configurations (“cards”) planned for all analyses documents to reference, updated w.r.t. 2019 studies (Michele, Birgit)
    - Additional points: energies of 72, ~100 and 120 TeV | Idealistic Delphes card I
    - Luminosity scenarios to be agreed on? Full scan, few key points? For now: 30 ab<sup>-1</sup>
  - Analyses in advanced stage, definitely planned for **31st of March deadline**:
    - Higgs self-coupling in  $\bar{b}b\gamma\gamma$  (Angela, Paola, Birgit) - all energies, both Delphes cards
    - Single Higgs ratios - minimum  $H \rightarrow \mu\mu / H \rightarrow 4\mu$  - (Birgit, Michele) - all energies, both Delphes cards
    - Higgs self-coupling in  $\bar{b}bll + E_T^{miss}$  (Birgit, Kerstin, Elisabetta) - @ 100 TeV, Delphes card II only
    - VBS  $WW$  (Chilufya, Marc-Andre et al) - @ 100, 27 and 50 TeV, older Delphes card
- All (planned) as stand-alone notes that can be referenced by the FCC-hh summary note

# Status & plans: Probable deliverables

- New baseline: [running scenario at 84 TeV](#), [Delphes card II for detector performance](#)
  - Common detector performance/Delphes configuration note (Michele, Birgit)
  - Additional points: energies of 72, ~100 and 120 TeV | Idealistic Delphes card I
  - Luminosity scenarios to be agreed on? Full scan, few key points? For now: 30 ab<sup>-1</sup>
- Analyses in earlier stage, but committed to first results for **31st of March deadline**:
  - First result of Top-Yukawa coupling in  $\bar{t}tH(\gamma\gamma)$  standalone (Elena, Stefano, Birgit) - likely only at 84 TeV, with card II for first iteration, ratio analysis potentially on a longer timeline
  - VBF  $HWW$  lineshape analysis (Elliot) - currently working on 100 TeV, switch to 84 TeV possible?, card II for first iteration
  - Differential distributions of  $\bar{t}t$ ,  $\bar{t}tV$ ,  $VV$  processes as input to global fits (Michele, Birgit, Elliot?) - important results, timeline a bit critical, ideally @ all energies, as first iteration only 100 TeV?

# Status & plans: Longer timeline

- Further analyses + updates/expansions of results possible on the longer timeline, for the symposium in Venice **end of June** :
  - Adding missing channels, energy scenarios and/or detector performance benchmarks to the key analyses where needed
  - Ratio analysis of  $\bar{t}tH(\gamma\gamma)$  /  $\bar{t}tZ(ee)$ , combination of  $\bar{t}tH(\gamma\gamma)$  and  $\bar{b}b\gamma\gamma$  for 2D  $\kappa_t$  vs  $\kappa_\lambda$  scans
  - Higgs width from off-shell VBF  $H \rightarrow WW$  (Robin, Birgit) - first round of tester samples @ 100 TeV in production, Delphes card II, detailed analysis strategy (incl. energy points) to be defined
  - Re-interpretation of  $\bar{b}b\gamma\gamma$  di-Higgs results as resonant narrow resonance scan (Angela, Birgit) - at least 84 TeV, ideally all energies + both Delphes cards



# Status & plans: Timeline unclear

- Ongoing analyses / important results with timelines that are still (somewhat) unclear:
  - $\bar{b}b\tau\tau$  (Monica, Jordy, et al): Advanced re-analysis of the channel involving new ML techniques, main bottleneck background sample statistics under discussion, currently @ 100 TeV, old Delphes card - ideally update at least to new production, include 84 TeV - probable to have at least an initial result for March deadline, full-scale results and combination with  $\bar{b}b\gamma\gamma$  on June timeline possible?
  - $\bar{t}tH(bb) / \bar{t}tZ(bb)$  2019 ratio analyses that would be valuable to redo at alternative energies, but currently uncovered - shares a lot of base samples with other analyses, possible on June timeline, perhaps earlier if started soon?
  - Triple Higgs/quartic coupling (James, Holly, Tom): Just started on sample production
  - CPV HVV couplings (Sarah, Andy, Sinead, Aidan, Christophe, Julia + masters students): investigating sensitivity to CPV couplings through measurements of CP-odd observables- using private samples- update in P+P meeting planned soon.
- Is there anything missing we'd like to study further by the open symposium (e.g. BSM analyses)?