

$H \rightarrow \tau\tau$ MEASUREMENTS IN ZH CHANNEL AT FCC-ee

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WORKFLOW 1.

- Since the last presentation in the FCC Higgs/top meeting, we migrated the analysis to the FCCAnalyses software:
 - produces the flat ntuples (stage 1 and stage 2),
 - applies cuts and builds histograms (stage final)
- We are currently running everything at ETP, after copying all the FCC samples we need
 - Aaron has written a batch submission for stage1
- We also have scripts to:
 - plot all the variables,
 - merge histograms,
 - write and submit datacards to Combine
- Main github repo is [here](#) (there are now two subdirectories for xsec and CP studies)

WORKFLOW 2.

- Using FCCAnalyses rather than Maria workflow allows us to have better control over the selection, variable definition, and event scaling
- We have imported Maria's tau reconstruction function, although we modified it to save all jets' tauID so we have a record for jets not associated with a valid tau decay (relevant for $Z \rightarrow qq$)
- All in all, we have all the elements in place to run (and re-run) the full xsec analysis in a straightforward and "fast" way

CROSS-SECTION ANALYSIS

■ We are differentiating final states:

■ $Z \rightarrow \ell\ell$

■ $Z \rightarrow bb, cc$ (heavy)

■ $Z \rightarrow uu, dd, ss$ (light)

■ $Z \rightarrow \nu\nu$

■ $\tau\tau \rightarrow \ell\ell$ ($\ell = e, \mu$)

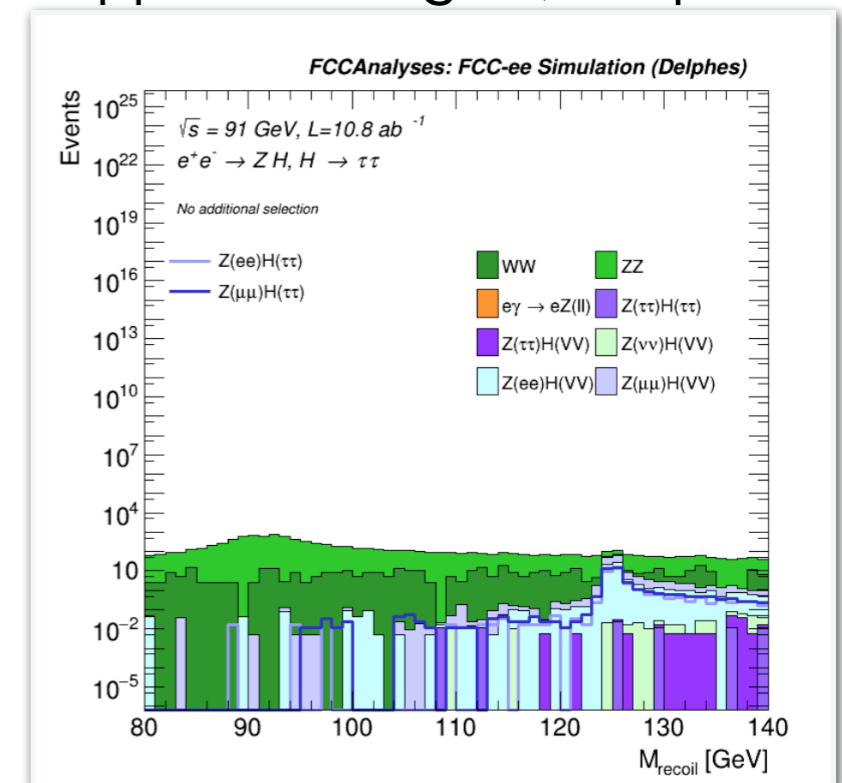
■ $\tau\tau \rightarrow \ell\tau_h$ ($\ell = e, \mu$)

■ $\tau\tau \rightarrow \tau_h\tau_h$

■ Basic selection asks for the final state to be reconstructed with the exact particles we want for each category and for the Z products and tauons to have opposite charges (except for $Z \rightarrow \nu\nu$ and $Z \rightarrow qq$)

■ Combine output on relative uncertainty for 4 lepton final state:

Best fit r: 0.999995 $-0.34681/+0.357183$ (68% CL)



- We have found the cause of the cross-section discrepancy between the signal being produced in Whizard or Madgraph
 - Madgraph SM has a lower Higgs width than Whizard (which uses the latest/correct value)
- Not an actual problem if we generate EFT samples as the model has the correct value
- Matteo will now proceed with EFT Htautau generation
- From the workflow point of view, most things only need to be slightly adapted,
 - there should be no need to change stage1,
 - CP sensitive variables need to be built in stage2 (we have some for gen level)

NEXT STEPS

- We are rerunning stage1 with the latest modifications
- Same for stage2, now including all categories (so far only did 4 lepton final state)
- We will then get preliminary results without further selection and then devise a strategy to get optimal selection on the kinematics of the events
- In the meantime, we have made a document in Overleaf to start writing the analysis note
 - We will already include the EFT sample discussion and see if we can make some progress in the CP measurement in time for ECFA
- If we have time, and people, and knowledge, we also want to implement Lars's ML tau reconstruction in FCCAnalyses and apply it to our study