ZHH analysis.

Status

Julie Munch Torndal
Di-Higgs analysis working meeting
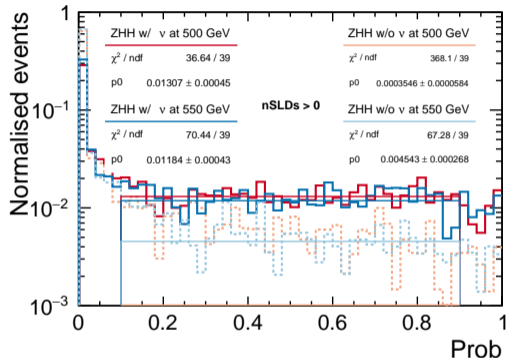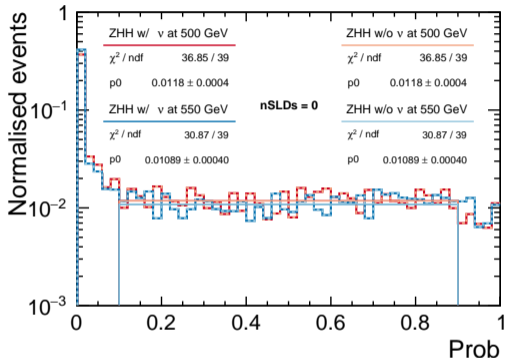**Dec 10, 2024**

TO DO

☑ neutrino correction works well in ZHH events in all (lepton, neutrino and hadron) channels
  - see ILD meeting for more details

☑ $Z \to$ invisible error analysis to resolve $Z \to \nu\nu$ versus ISR

☑ error flow and neutrino correction works for fast simulation (SGV) samples

☐ Higgs strahlung/WW fusion separation

☑ Neutrino Correction in ZHH events

- Errorflow ensures a flat probability distribution in central region for events without SLDs
- Neutrino correction recovers the flat probability distribution for events where SLDs are present
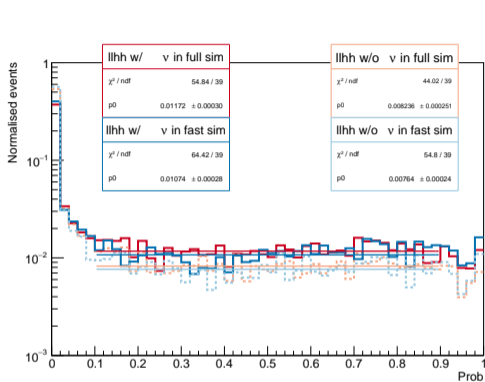
⊡⋅ Z → invisible error analysis
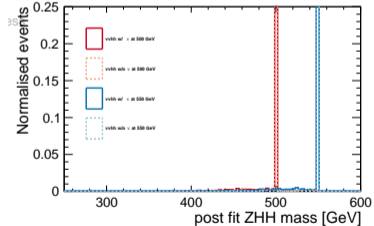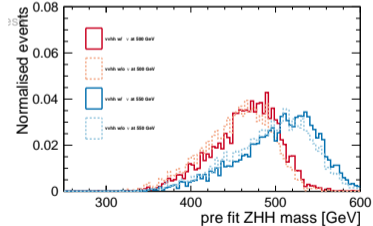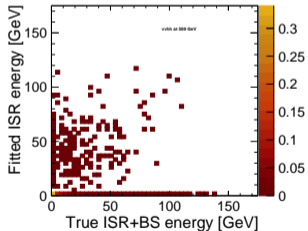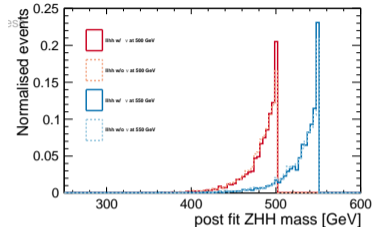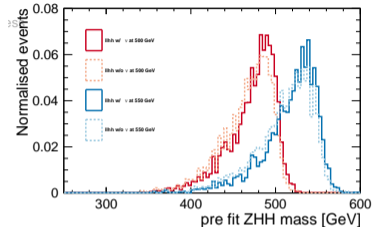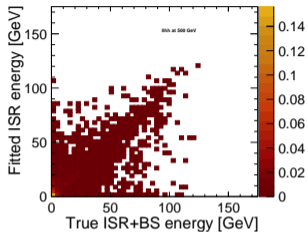
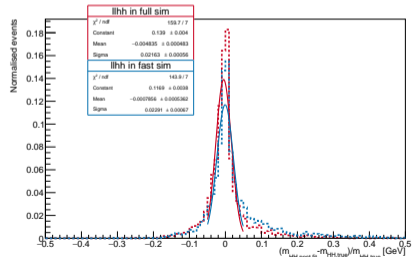- $Z \to \nu\nu$ handled with $Z \to$ inv fit object where fit prefers absorbing ISR/BS into $Z \to$ inv fit object

☑ Neutrino correction on SGV samples

- Very comparable fit performance between full and fast sim
  → testament to Errorflow and neutrino correction
- Some subtleties in kinematics and PFA confusion
- **No showstoppers here for fast sim analysis for ESSPU!**
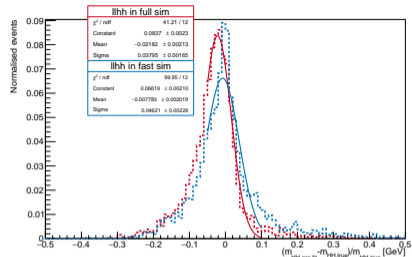
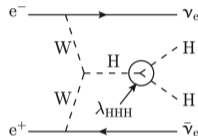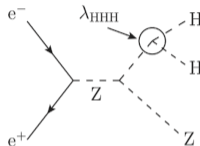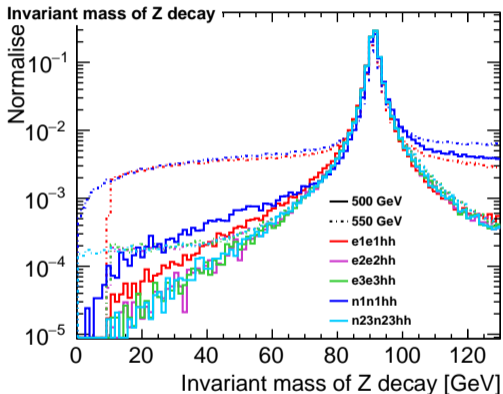# ☐ **Problem with LCFIPlus on SGV samples**

Question for Taikan

➤ The log is flooded by messages like

```
vertexline variance is negative: -0.020712
ref-point=(-1.895116,-0.537383,-4.409806)
pos=(-1.853984,-0.744632,-4.273220) at
t=0.349893
err=
[ 3.193223, -2.158618, -0.474140 ]
[ -2.158618, -0.022481, 0.999555 ]
[ -0.474140, 0.999555, -0.001849 ]
```

  – Triggered by LCFIPlus [here]*

  – Physics results so far still made sense, but...

    ▪ log files ca. 20x larger than the SLCIO file

    ▪ execution time?

  – For large production, this issue should be fixed

*https://github.com/lcfiplus/LCFIPlus/blob/39cf1736f3f05345dc67553bca0fcc0cf64be43e/src/geometry.cc#L1072

Higgs strahlung/WW fusion separation

Invariant mass of Z decay

- Contribution from WW fusion to ZHH final non-negligible @ 550 GeV
- Split $\nu_e \bar{\nu}_e HH$ channel into two channels by simple shape comparison on the Z-mass

Thank you.