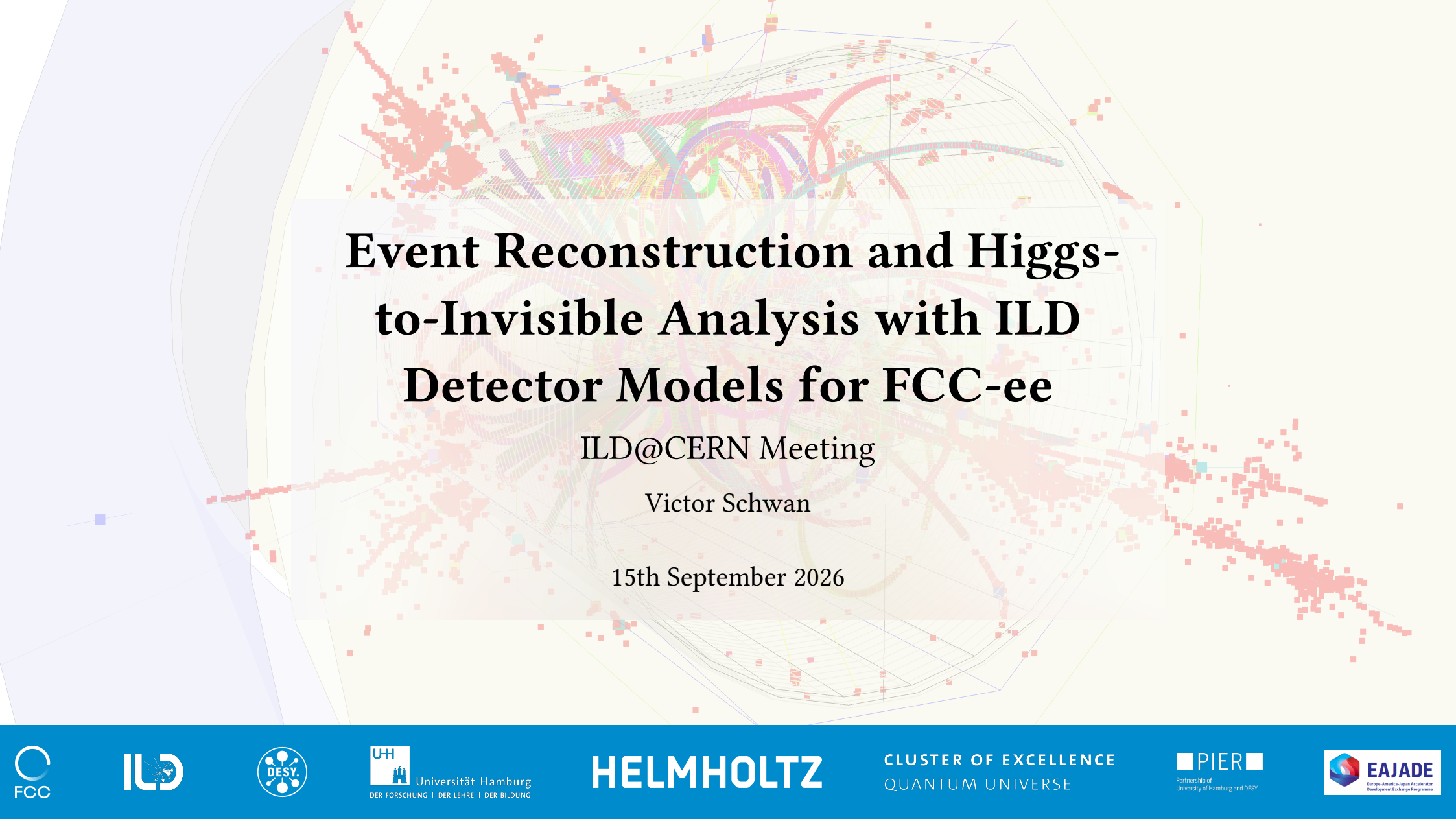




Event Reconstruction and Higgs-to-Invisible Analysis with ILD Detector Models for FCC-ee

ILD@CERN Meeting

Victor Schwan

15th September 2026

Detector Models

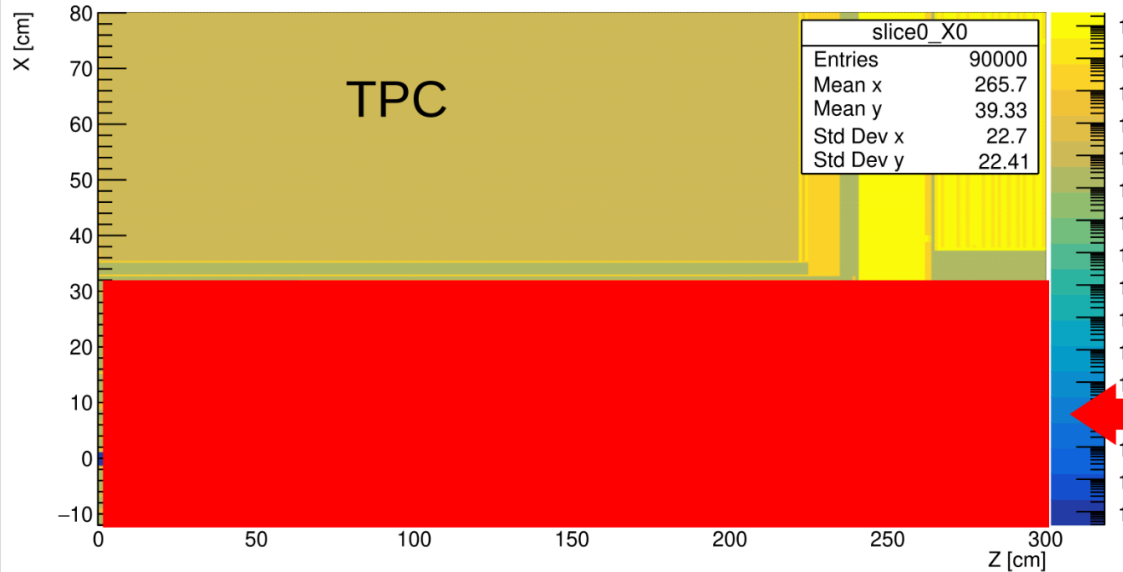
Reconstruction

Analysis

ILD@ILC

- ILC MDI
- Hybrid tracking layout

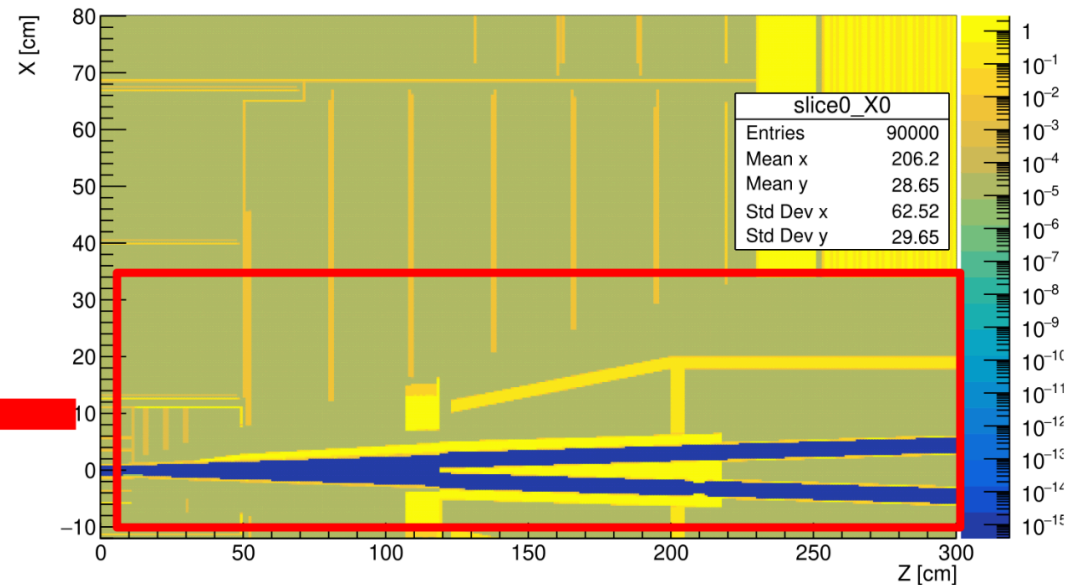
X0 Y= 0.010 [cm]



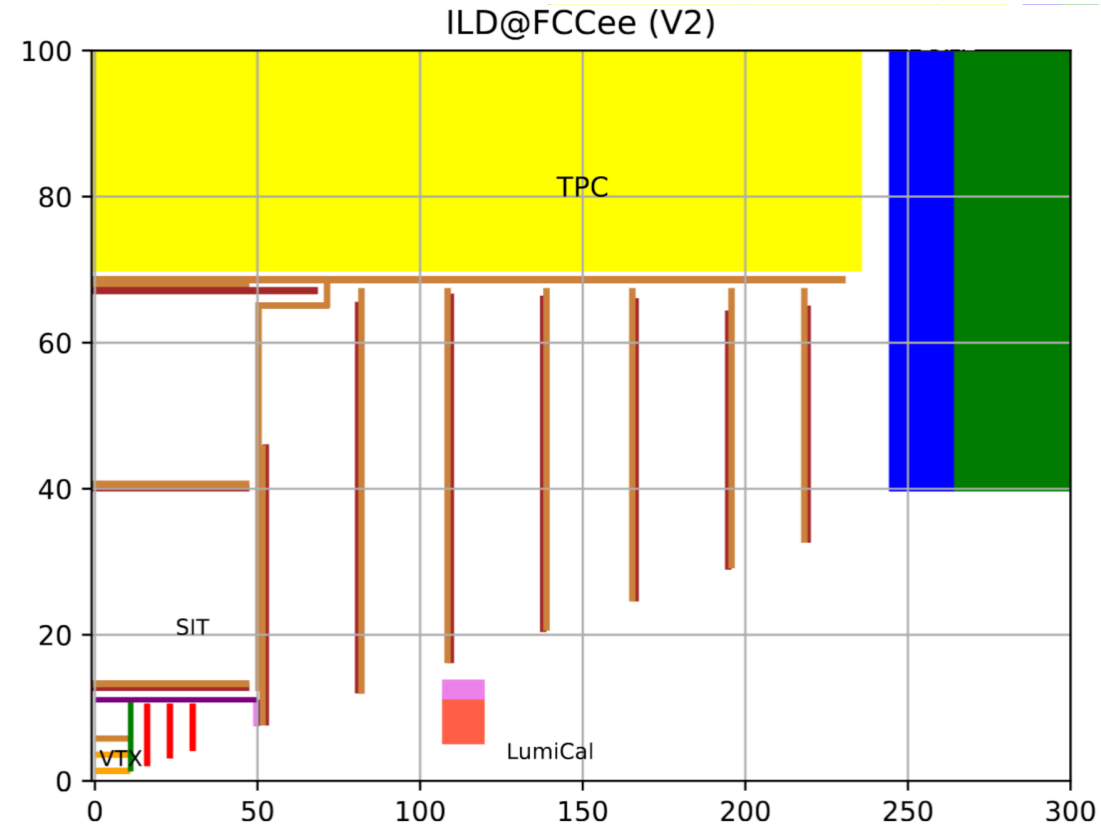
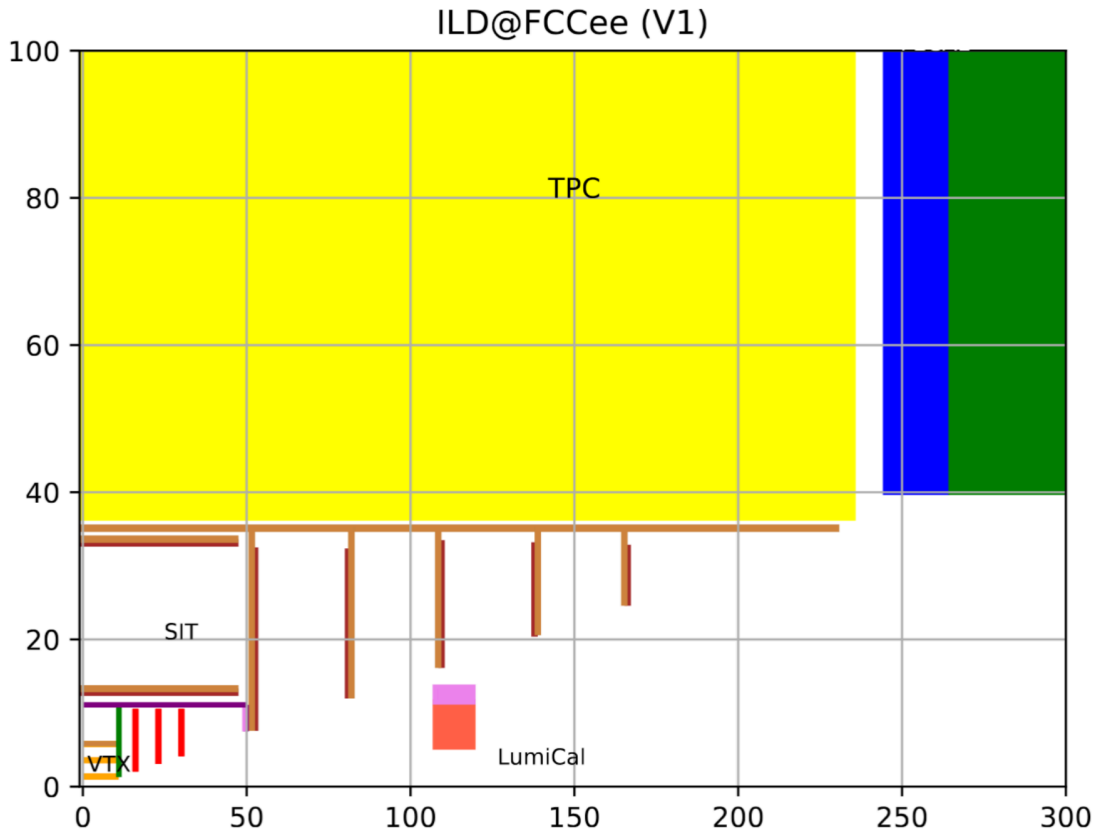
CLD@FCC

- FCC-ee MDI
- All-silicon tracking

X0 Y= 0.010 [cm]



- Ansatz:**
- 1) Remove everything inside of the TPC from ILD
 - 2) Replace with CLD subdetectors



Credit: Teresa Nunez Pardo de Vera

Detector Models

Reconstruction

Analysis

For physics studies with *ILD@FCC* we need to simulate and reconstruct hard scattering events:

1. Simulation of detector response
2. Event reconstruction based on detector response

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 1. Track finding & fitting
 2. Hit clustering in calorimeters
 3. Combination of above to reconstructed particles (Particle Flow)

For physics studies with *ILD@FCC* we need to simulate and reconstruct hard scattering events:

1. Simulation of detector response
2. Event reconstruction based on detector response
 1. **Track finding** & fitting
 2. Hit clustering in calorimeters
 3. Combination of above to reconstructed particles (Particle Flow)

1. Tracking is Frankensteinian: half ILD and half CLD subdetectors
 - Mix of standalone subdetector reco software
2. ILD's track reconstruction software is very much tailored to ILD@ILC
 - Especially the final combination of subdetector tracks
3. Different subdetector layout:
 - ILD: Many barrel detectors + one endcap system (FTD)
 - CLD: Each subsystem is divided into barrel and endcap
 - -> no clear mapping and easy exchange of subdetector names

I. Extrapolation of TPC tracks

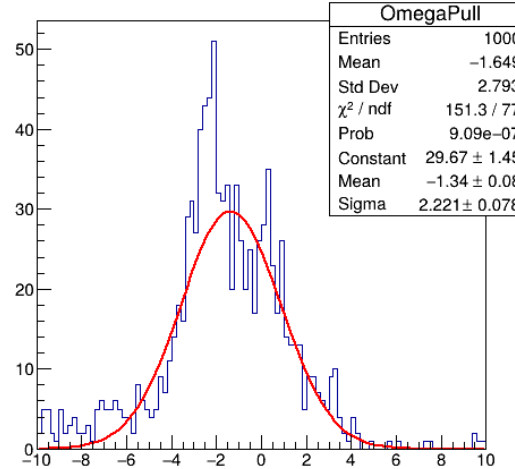
1. Extrapolate TPC track into silicon barrel detectors
2. Calculate expected intersection point layer-by-layer
3. Pick up hits if close enough to predicted intersection

II. Track parameter-based merging

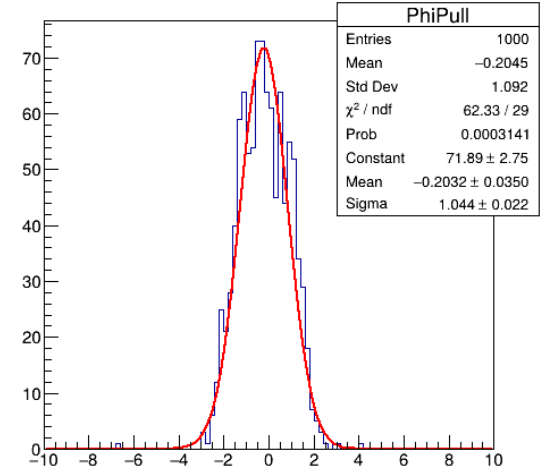
- If track params agree within thresholds -> Match!
- Geometry-agnostic!

- Revived ILDPerformance
- partially adapted to key4hep
- TPC-based extrapolation
- 1000 gun muons
- 50 GeV momentum
- shot at 85°

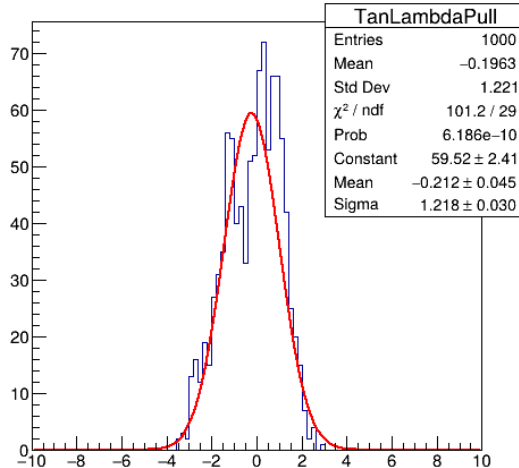
Omega pull



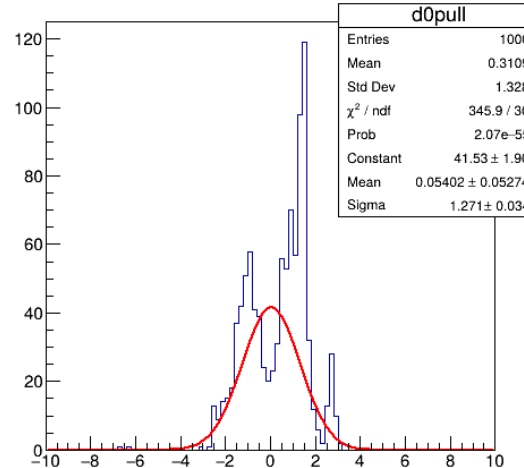
Phi pull



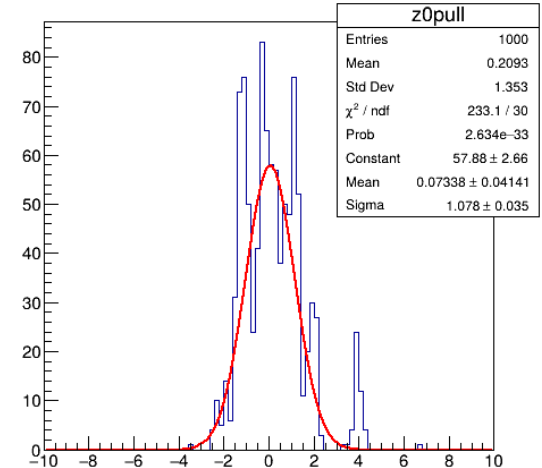
TanLambda



d0 pull



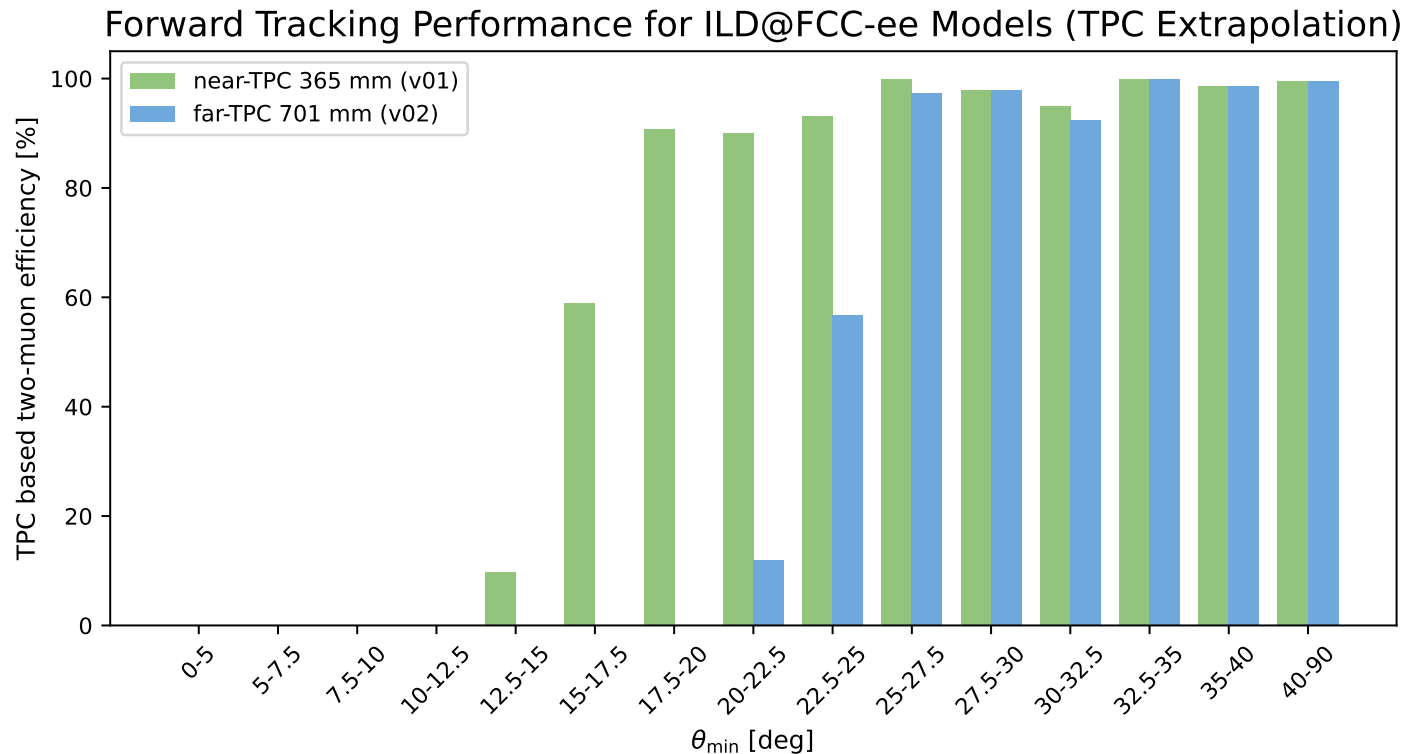
z0



- TPC-based extrapolation
- Two-muon efficiency vs minimal polar angle $\theta_{\min}$
- input sample:

$$ZH \rightarrow ZZZ^* \rightarrow 2\mu 4\nu$$

- 10 degree difference due to different inner radius of TPC which seeds track reconstruction



→ at the moment, use `ILD_FCCee_v01` for physics studies

Credit: Fatma Eysan Tekaslan

- First version of barrel track merging runs ✓
- Revived core functionalities of ILDPerformance ✓

Next steps:

- Scale up and submit jobs to grid ✗
- Compare & decide for one tracking approach ✗
- New processor to add very forward tracks to merged track collection ✗
- New processor to pick up envelope tracker (SET) hits ✗

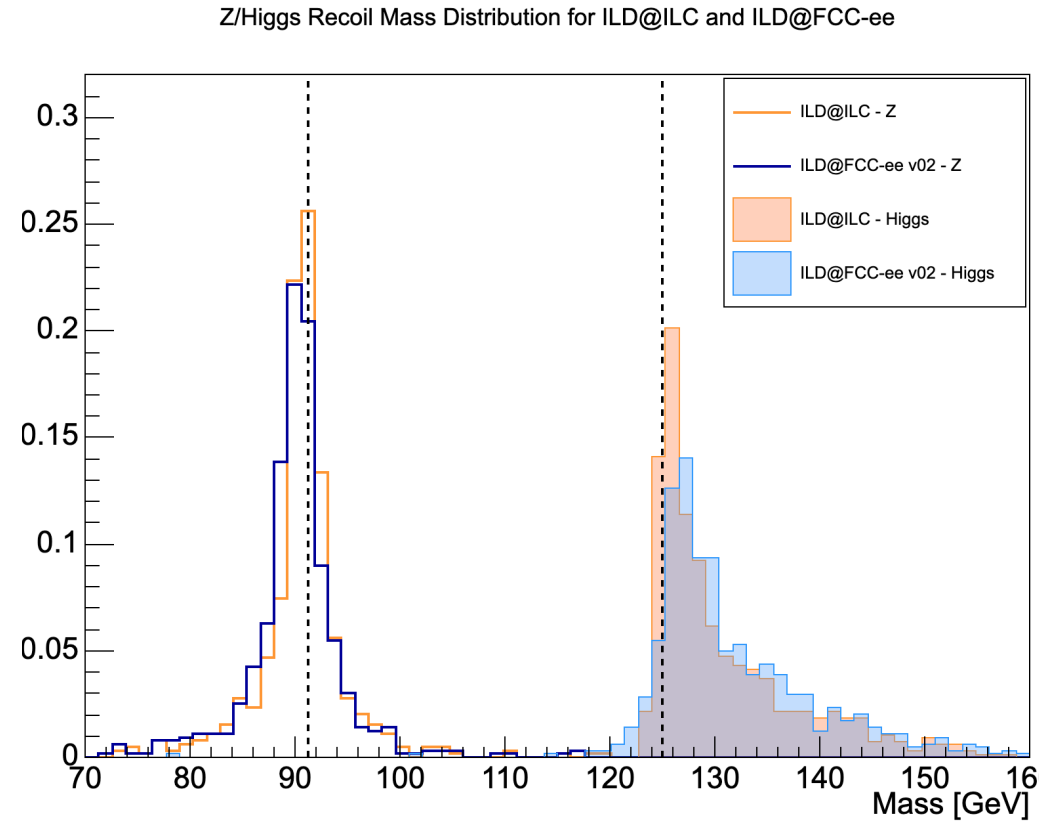
Detector Models

Reconstruction

Analysis

- Higgs to invisible analysis with ILD@FCC
- Signal process: $H \rightarrow ZZ^* \rightarrow 4\nu + \text{BSM}$
- Dominant backgrounds known from previous H->Inv analyses
 - *SiD@ILC* (Chris Potter et al., 2022)
 - *ILD@ILC* (Yu Kato et al., 2020)
 - $e^+e^- \rightarrow ZZ \rightarrow \mu\mu\nu\nu$
 - $e^+e^- \rightarrow WW \rightarrow \mu\nu\mu\nu$
- Collaboration on software framework
 - Simulation and reconstruction book-keeping based on diHiggs *ILD@LCF* analysis
 - Gaudi-based reconstruction and high-level analysis in collaboration with Teresa
 - Extra scalar analysis

- FIRST, VERY PRELIMINARY RESULT of full Gaudi-based reconstruction!!!!
- Recoil mass against $\mu^+\mu^-$ pair from Z
- Disclaimers:
 - For both det mods inputs generated with ILC beam spectrum
 - Events with muons in the very forward region (outside of TPC's acceptance) exclude for both detector models
 - Different B-field strength (ILC: 3.5 T vs FCC: 2 T) explains different peak resolutions



Credit: Fatma Eysan Tekaslan

- Two *ILD@FCC* detector models available
- Track reconstruction with TPC and CLD-inner silicon key challenge
 - Two approaches for track merging in the barrel region are implemented
- Core functionalities of ILD's tracking benchmarking tool revived
- Higgs-to-Invisible analysis:
 - First shot by summer student
 - *Serves as integrated test of the reconstruction chain*
 - Successful!!!!!!

Thank you for your attention!



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