

W mass in 4-jet channel

A Quick Review of Our Effort

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$e^+e^- \rightarrow WW \rightarrow qqqq$ at FCC-ee

Channel

Fully hadronic WW decay for now, we'll do semi-leptonic afterwards

\Rightarrow 4-jet final state, no missing energy

- Highest-BR WW channel ($\sim 46\%$)
- Fully constrained kinematics
- Sensitive to M_W , Γ_W , aTGC

Setup

- IDEA detector, Delphes fast-sim
- Winter2023 samples
- Energy scan:
 $\sqrt{s} = 160 \rightarrow 365$ GeV (7 points)

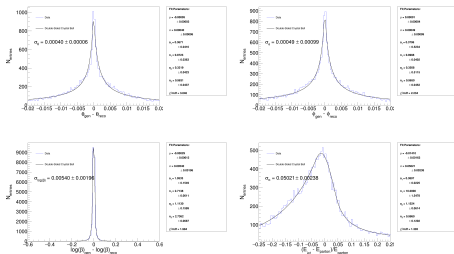
Two-stage analysis

Resolution study \rightarrow Kinematic fit

Step 1 — Jet Angular Resolution

- $ee\text{-}kt$, forced $N = 4$
- Gen vs. reco comparison
- Greedy ΔR matching (all 4 jets required)

Residuals fitted with Crystal Ball
to extract σ_θ , σ_ϕ , σ_x , σ_α
 \Rightarrow covariance matrix for fit



Work in progress — $\Delta\alpha$ under debugging

Step 2 — Kinematic Fit for M_W

- **4C fit:** 4-momentum conservation
- **5C fit:** adds $M_{W_1} = M_{W_2}$
- Minuit2 minimisation over 3 jet pairings \rightarrow best χ^2

Covariance matrix currently a diagonal placeholder — to be replaced by Step 1 output

Current Status

Angular resolution (Step 1)

- Pipeline running across all energy points
- Jet matching under active debugging — known issue in $\Delta\alpha$ residuals, likely from matching or parton energy calculation

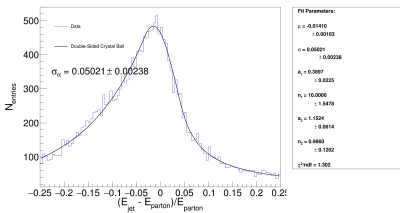
Kinematic fit (Step 2)

- Implementation complete
- 4C and 5C fits validated with placeholder covariance
- Pending: integration with realistic covariance from Step 1

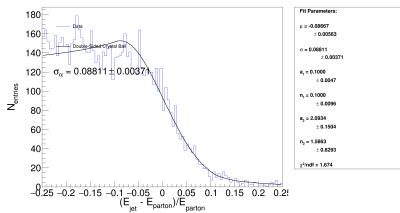
The two steps are ready to be connected once the angular resolution output is validated.

Current Problem

1 Jet:

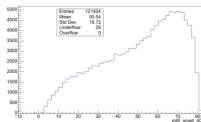


4 Jet:

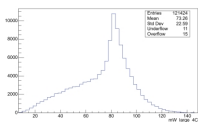


Kinematic Code Results

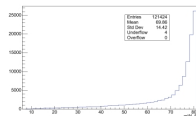
Our Implementation Results



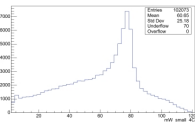
smaller dijet mass 160 MeV



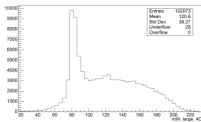
larger dijet mass 160 MeV



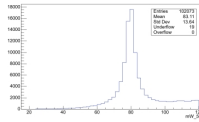
5C 160



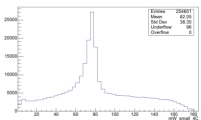
smaller dijet mass 240 MeV



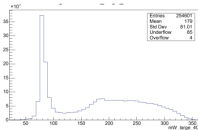
larger dijet mass 240 MeV



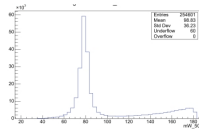
5C 240



smaller dijet mass 365 MeV



larger dijet mass 365 MeV



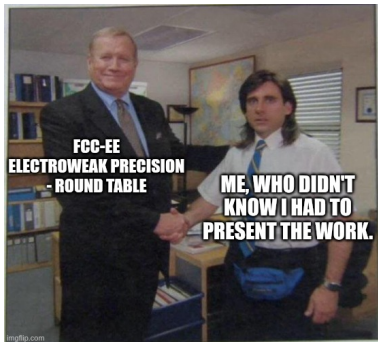
5C 360

Figure 1: The code output variables correspond directly to these reference plots.

Next Steps

1. **Fix $\Delta\alpha$ residuals in Step 1**
Isolate the source between jet matching and parton energy calculation
2. **Connect Step 1 \rightarrow Step 2**
Replace placeholder covariance with energy-dependent matrix from Step 1
3. **Improve \sqrt{s} treatment**
Event-by-event reconstruction or beam energy spread smearing
4. **Validate across full energy scan**
160 \rightarrow 365 GeV

Thank you for your
attention!





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