technische universität dortmund

Funded by
DFG Deutsche Forschungsgemeinschaft
German Research Foundation

UNIVERSITÉ Clermont Auvergne

Bi-weekly updates

Lars Röhrig

April 6, 2022

Department of Physics, TU Dortmund University
Laboratoire de Physique, Clermont-Ferrand

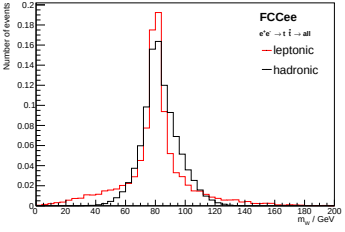
Object reconstruction

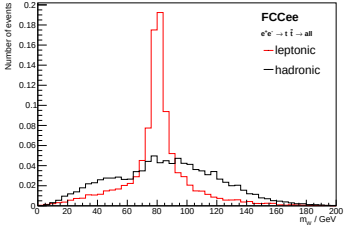
- Object reconstruction for semileptonic channel: $e^+e^- \to t\bar{t} \to \ell\nu bq\bar{q}\bar{b}$
  → Signature: 1 lepton (either electron or muon) + MET + 4 jets (2 b-tagged)
- Jet clustering motivated by talk from J.M. Torndal:
  1. $k_\perp$-algorithm provided by `FastJet`
  2. Jet clustering performed with all reconstructed particles
  3. Requiring exactly 4 jets and 80% b-tag

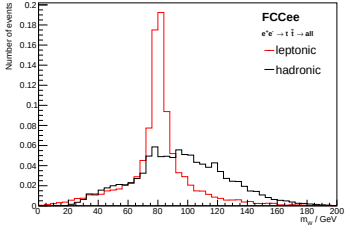
```
# select jets
.Alias("Jet3", "Jet#3.index")

.Define("pseudo_jets",              "JetClusteringUtils::set_pseudoJets_xyzm(RP_px, RP_py, RP_pz, RP_mass)")
# arguments in clustering_jade(a, b, c, d, e):
# a: Jet cone radius R = 0.5
# b: Clustering
    # 0 -> inclusive clustering
    # 1 -> exclusive clustering with dcut
    # 2 -> exclusive clustering to exactly njets
    # 3 -> exclusive clustering up to exactly njets
    # 4 -> exclusive clustering with ycut
# c: Cut-value depending on clustering
# d: Ordering of returned jets
    # 0 -> sorted by pt
    # 1 -> sorted by E
# e: Recombination scheme
# .Define("FCCAnalysesJets_jade",     "JetClustering::clustering_jade(0.5, 2, 4, 0, 10)(pseudo_jets)")
.Define("FCCAnalysesJets_jade",      "JetClustering::clustering_ee_kt(2, 4, 0, 10)(pseudo_jets)")

# .Define("jets_jade",                "JetClusteringUtils::get_pseudoJets(FCCAnalysesJets_jade)")
.Define("jets_jade",                 "JetClusteringUtils::get_pseudoJets(FCCAnalysesJets_jade)")
```

Object reconstruction — W boson

- Two reconstructed W bosons from $W \to \ell + \nu$ (leptonic) and $W \to q + \bar{q}$ (hadronic)
- Leptonic reconstruction works well, hadronic reconstruction challenging
- Flavor assignment based on MC truth (as far as I understand) → choose b and c tag based on WP?
- Tried several hadronic W reconstructions:
  1. Build all 4 jets without b-tag information and calculate the jet pair with $\min(|m_{jj} - m_W|)$
  2. Build 2 b-tagged jets, 2 nb-tagged jets and calculate m_{jj}^{nb}
  3. Build 2 b-tagged jets, 2 nb-tagged jets and calculate m_{jj}^{nb} when $\text{flavor}(j_1) \neq \text{flavor}(j_2)$





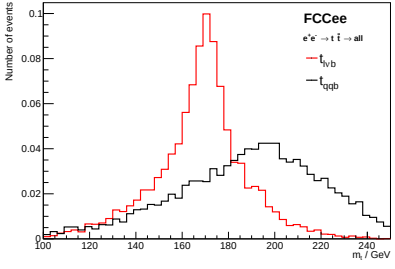


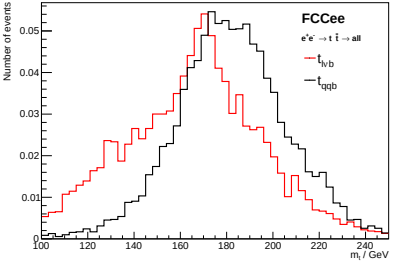
Object reconstruction — t-quark

- Use the reconstructed W bosons to further combine with a b-tagged jet
- b-jet matching similar to W bosons: $\mathbf{min}(|m_{\ell\nu j_b} - m_t|)$ and $\mathbf{min}(|m_{jjj_b} - m_t|)$
- But: heavily depends on which channel is favored, here: W boson flavor-constrained

```
t_lvb0 = (met + reco_lepton + bjet0).M()
t_lvb1 = (met + reco_lepton + bjet1).M()

t_qqb0 = (jet0 + jet1 + bjet0).M()
t_qqb1 = (jet0 + jet1 + bjet1).M()

# match b jet to W boson
if abs(t_lvb0 - m_t) < abs(t_lvb1 - m_t):
    h_RECO_t_lvb.Fill(t_lvb0)
    h_RECO_t_qqb.Fill(t_qqb1)
elif abs(t_lvb0 - m_t) > abs(t_lvb1 - m_t):
    h_RECO_t_lvb.Fill(t_lvb1)
    h_RECO_t_qqb.Fill(t_qqb0)
```

```
t_lvb0 = (met + reco_lepton + bjet0).M()
t_lvb1 = (met + reco_lepton + bjet1).M()

t_qqb0 = (jet0 + jet1 + bjet0).M()
t_qqb1 = (jet0 + jet1 + bjet1).M()

# match b jet to W boson
if abs(t_qqb0 - m_t) < abs(t_qqb1 - m_t):
    h_RECO_t_lvb.Fill(t_lvb1)
    h_RECO_t_qqb.Fill(t_qqb0)
elif abs(t_qqb0 - m_t) > abs(t_qqb1 - m_t):
    h_RECO_t_lvb.Fill(t_lvb0)
    h_RECO_t_qqb.Fill(t_qqb1)
```





- Leptonic reconstruction of W boson works well
- Hadronic reconstruction of W boson quite challenging (should be the focus on now)
  → Jet clustering + matching and b tagging correctly?
  → Other object definitions required?