# W mass & TGC study using Single-W process

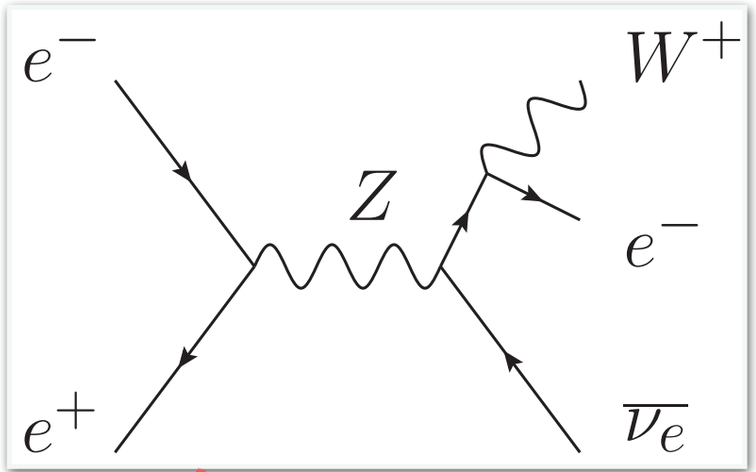
Shinshu University
K. Tsuchimoto

1st, November 2014 (39th General Meeting) :
—> Summary of my study

# Introduction

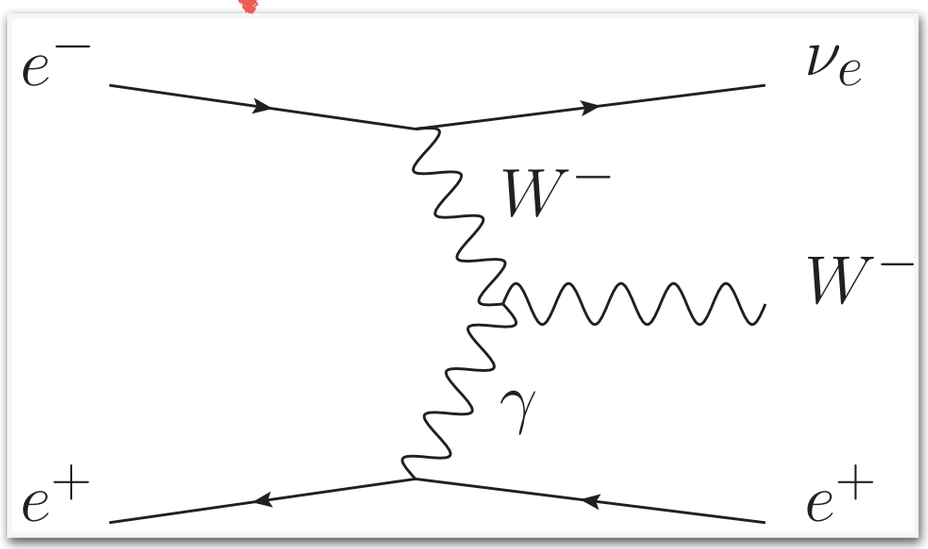
## Semi-leptonic single W process

/group/ilc/soft/samples/mc-dbd/ild/dst-merged/250-TDR_ws/4f_singleW_semileptonic/




=> 3 final state particles : e, ν, W

tunable with initial polarization on ILC




**Triple Gauge Couplings**

**W—>qq'(hadronic)**

final state : e, ν, q(jet), q'(jet)
2 jets => easier to recognize

directory measurable W mass via hadronic system

# Motivations

- There are 2 interesting physics motivations.
- Direct measurement of W boson mass with hadron modes
  - measuring $m_w$ to a few MeV uncertainty in W—>qq' decays
  - challenging requirements on JER and calibration
    - needs detector optimization
    - comparison of performance among different options of calorimeters (e.g., Si or Sc ECAL)
- Study of anomalous triple-gauge-boson couplings
  - mainly WWγ, WWZ couplings
  - these are signals of new physics beyond the SM

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- Direct measurement of W boson mass with hadron modes
  - measuring $m_W$ to a few MeV uncertainty in W—>qq' decays
  - challenging requirements on JER and calibration
  - needs modification on jet energy reconstruction
  - comparison of performance among different options of calorimeters (e.g., Si or Sc ECAL)

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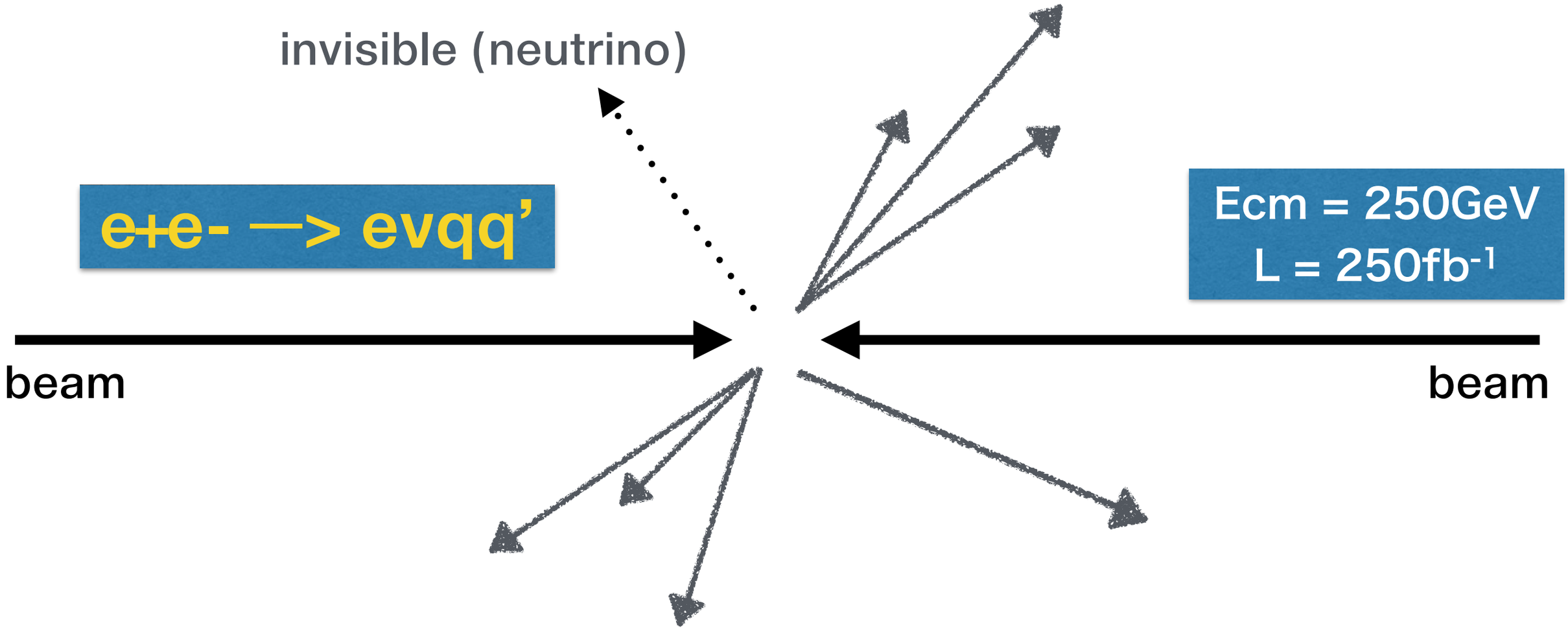
**I tried to reconstruct W mass with W—>qq(di-quark) jets**

# Reconstruction flow




1. **Require the only one isolated lepton (electron/positron)**
2. **Force remainder of PFOs into 2-jet with Durham algorithm**
3. **Invariant mass of di-jet should be equal to W mass**

# Isolated lepton finding

## with IsolatedLeptonFinder processor in MarlinReco

selection flow

Particle ID cut

Charged && ID with $E_{deposit}$ in ECAL/HCAL

Impact parameter cut

0 < Impact parameter < 0.01mm

Rectangular cut

$E_{track}$ > 15 GeV && $E_{cone}$ > 0 GeV (cosine of cone angle = 0.98)

most effective

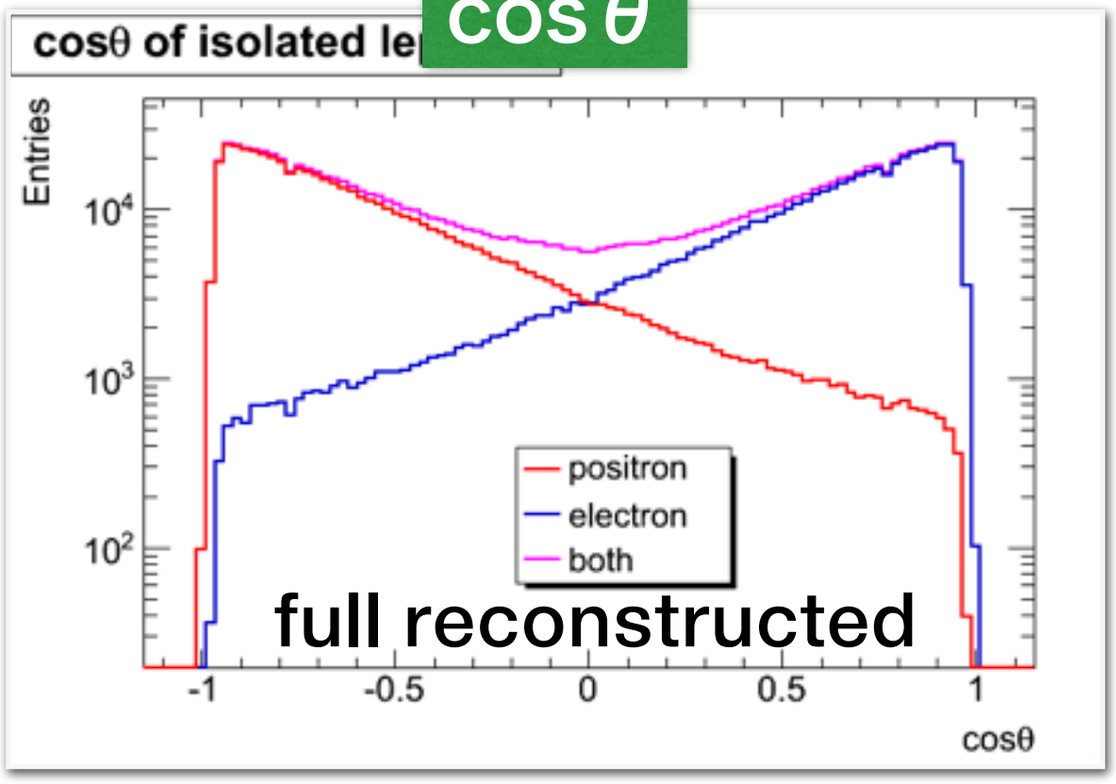
Polynomial cut

$E_{cone}$ < sqrt(20*$E_{track}$ - 300) GeV

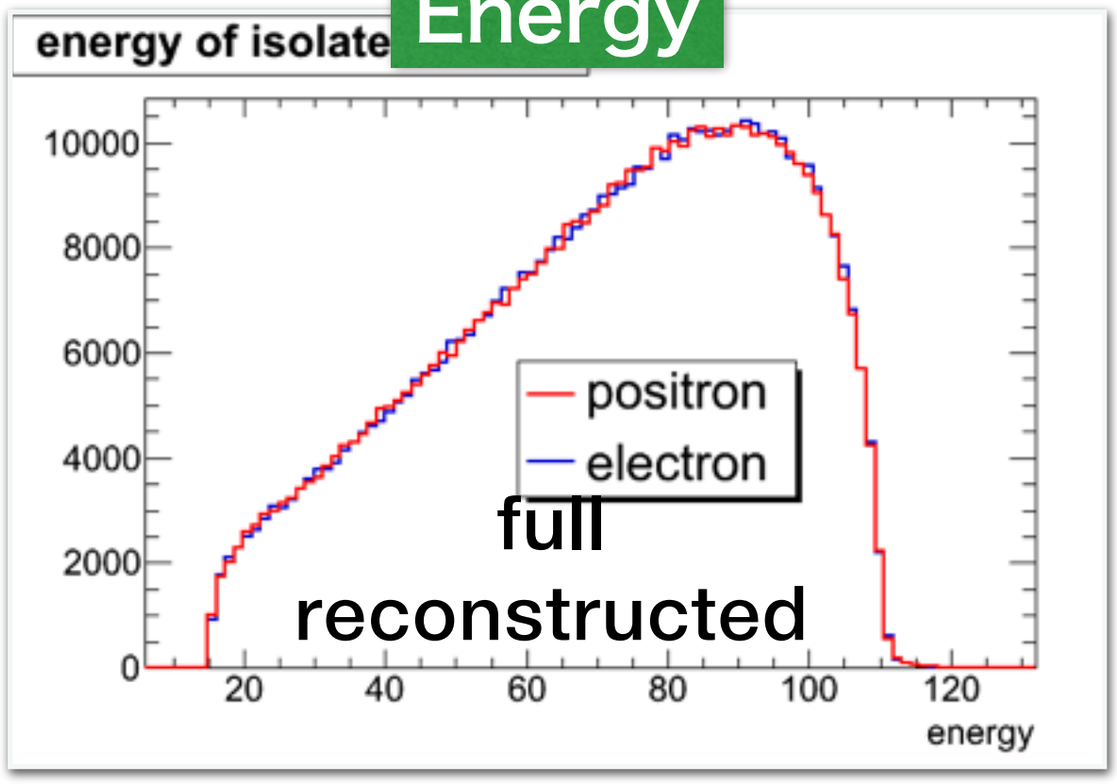
Isolated Lepton

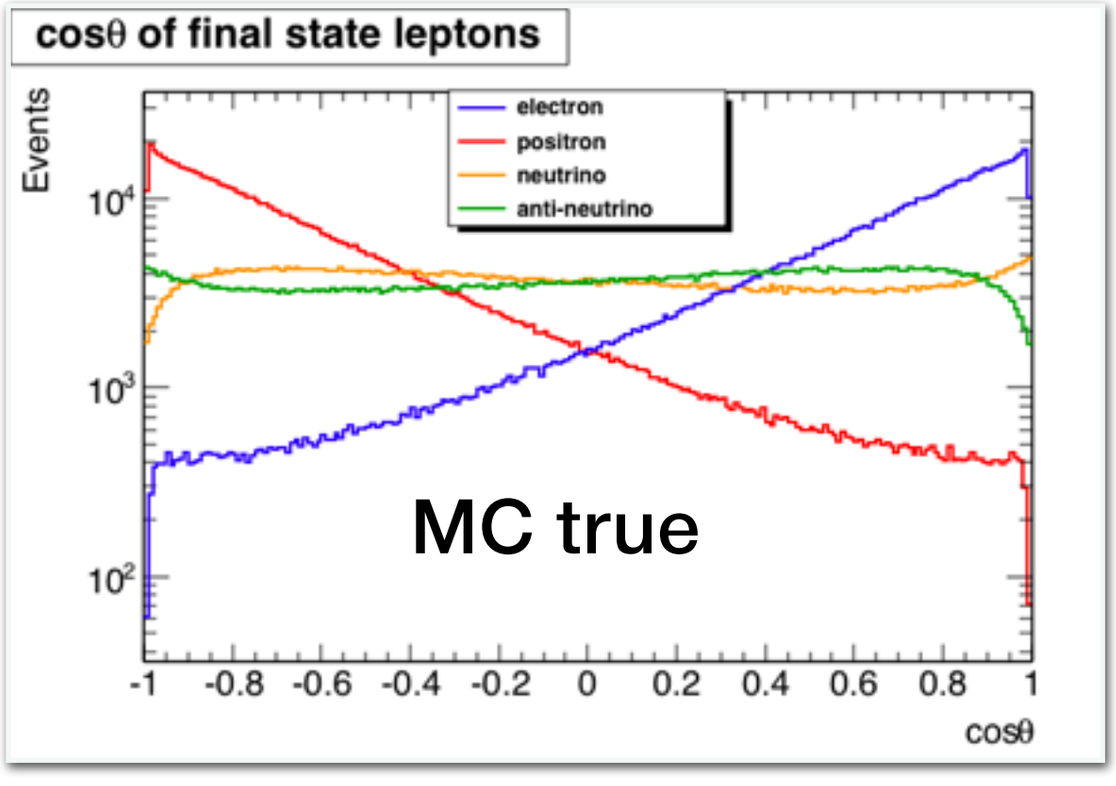
# Isolated lepton features

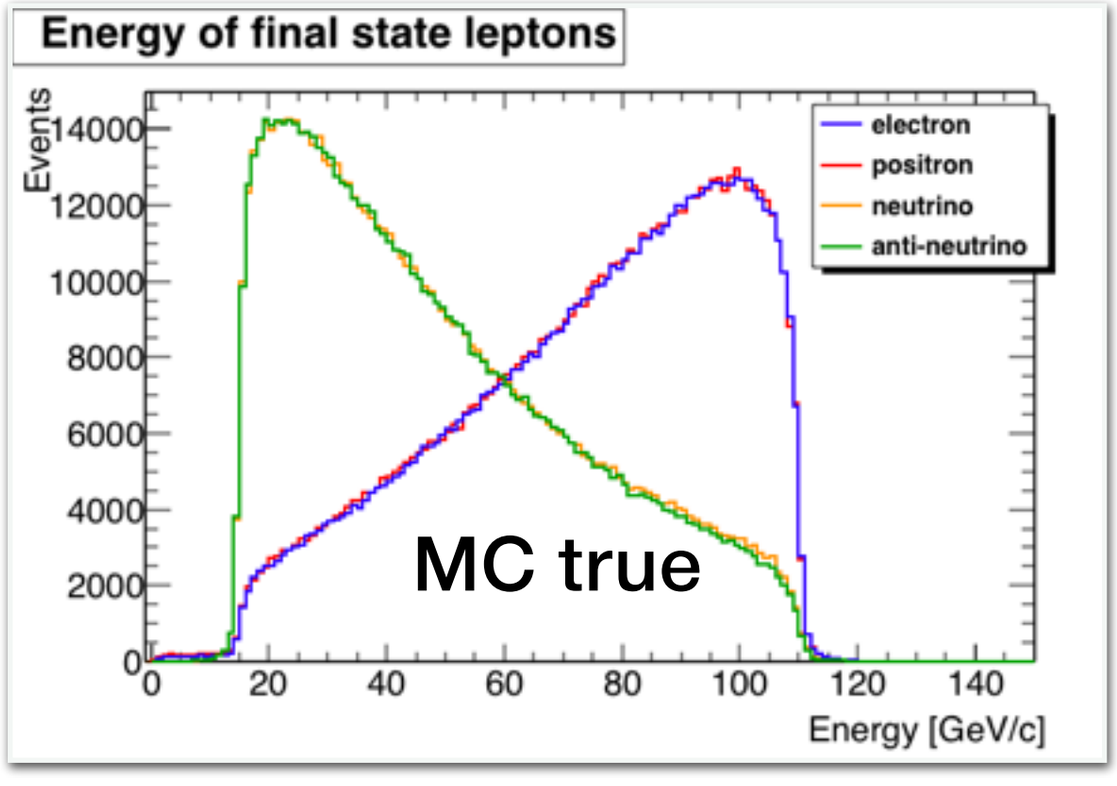
cos θ



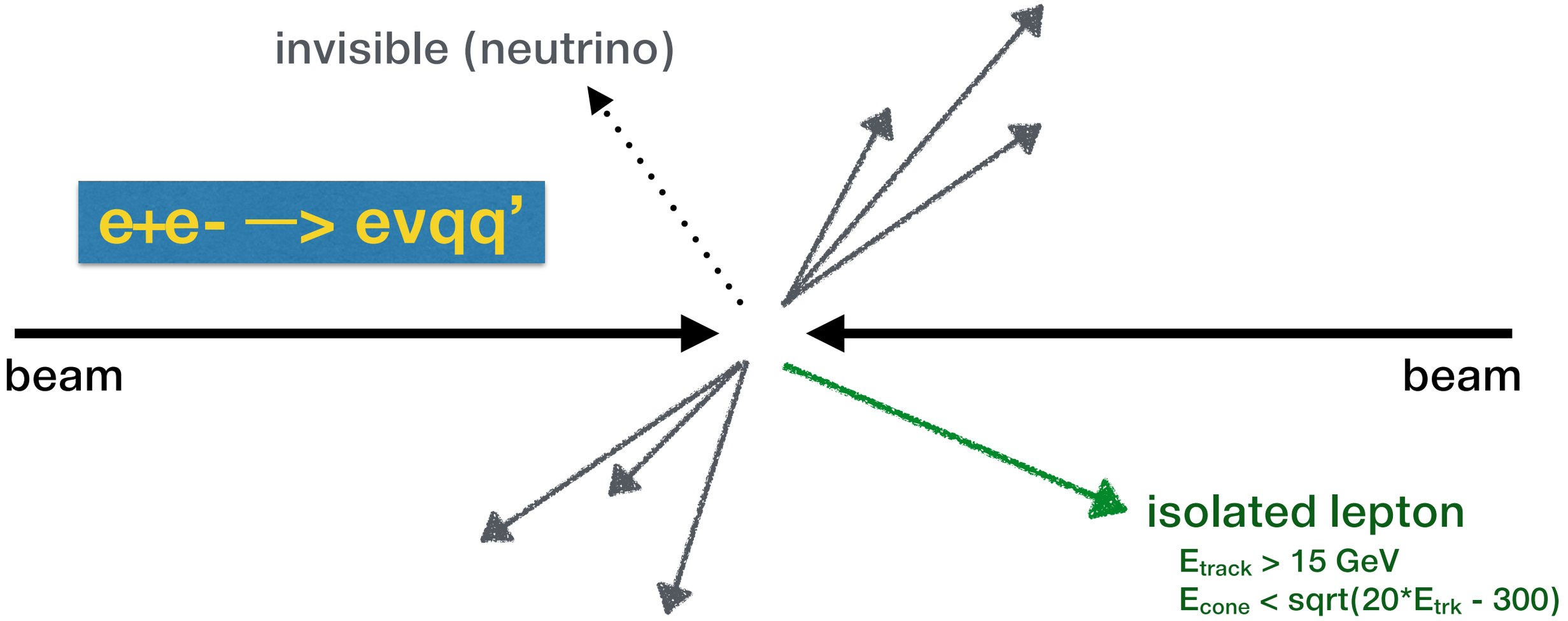

Energy



# Reconstruction flow

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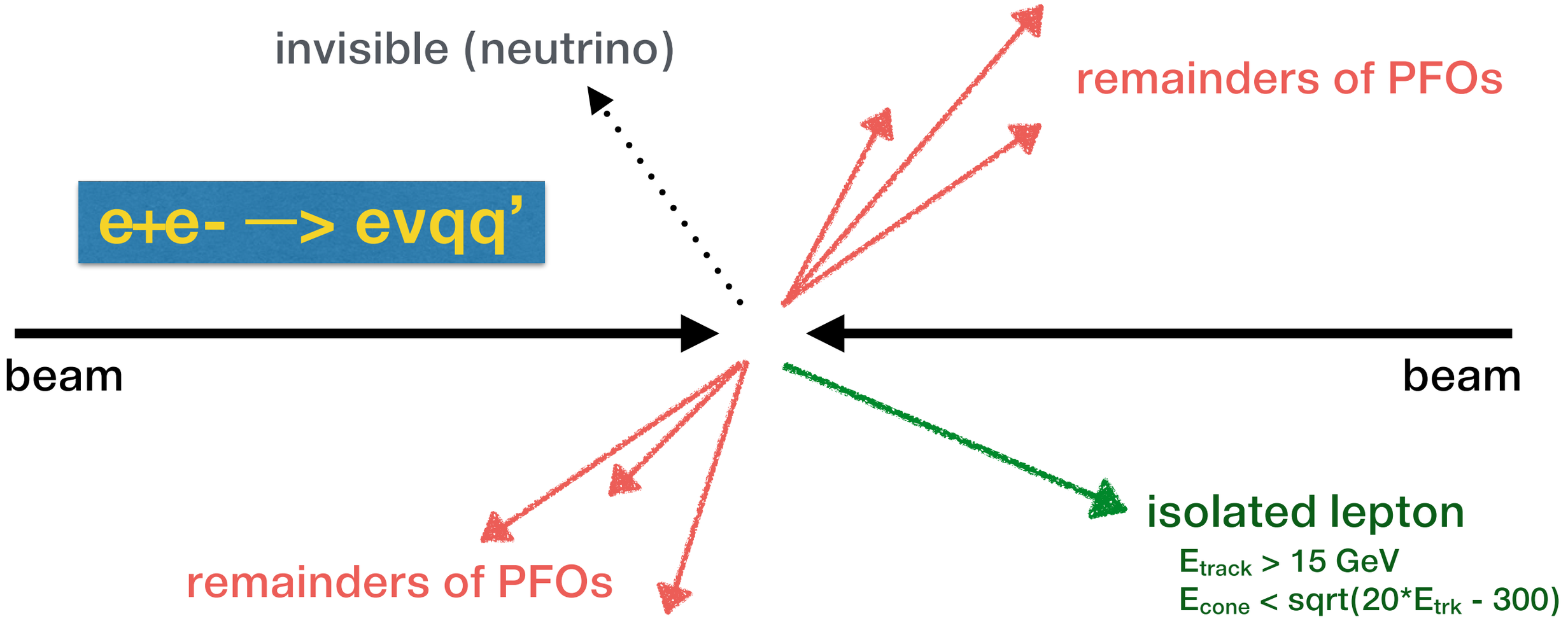


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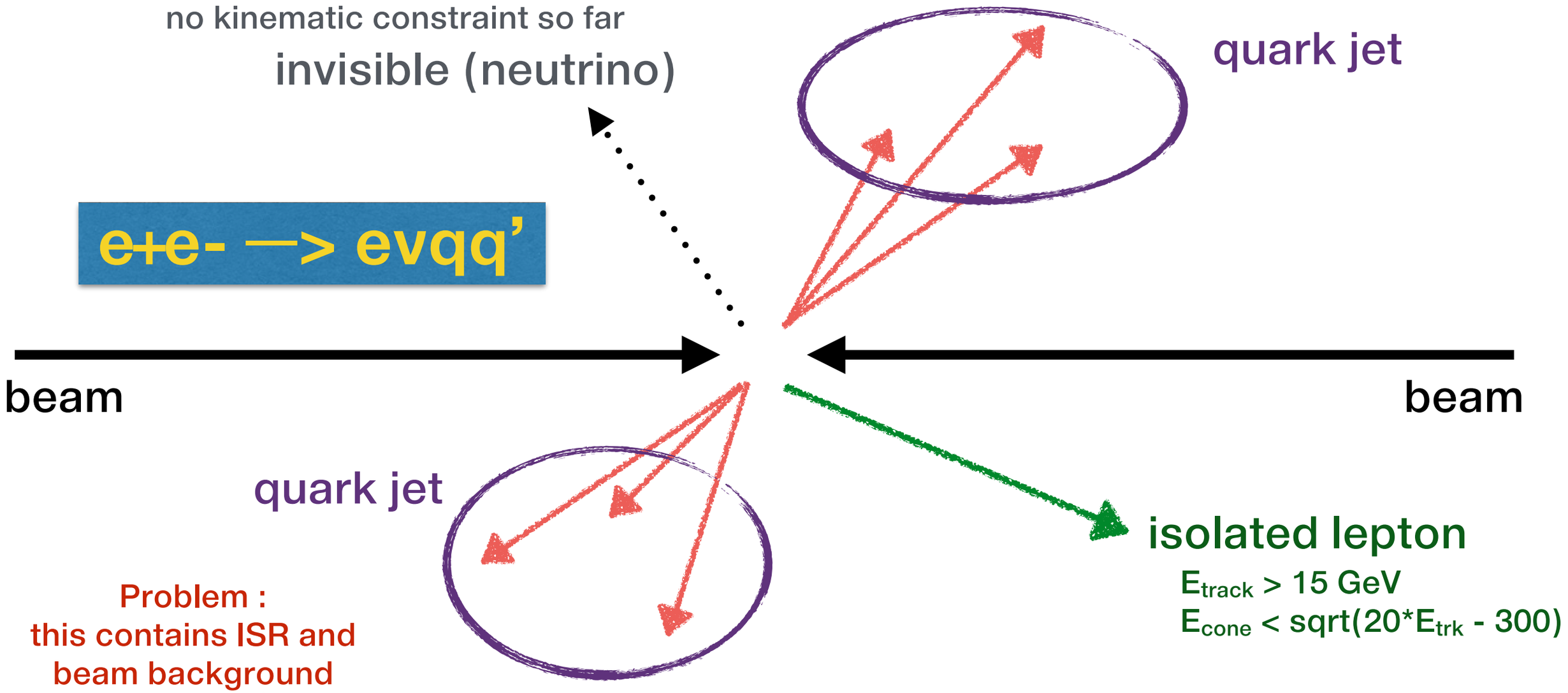


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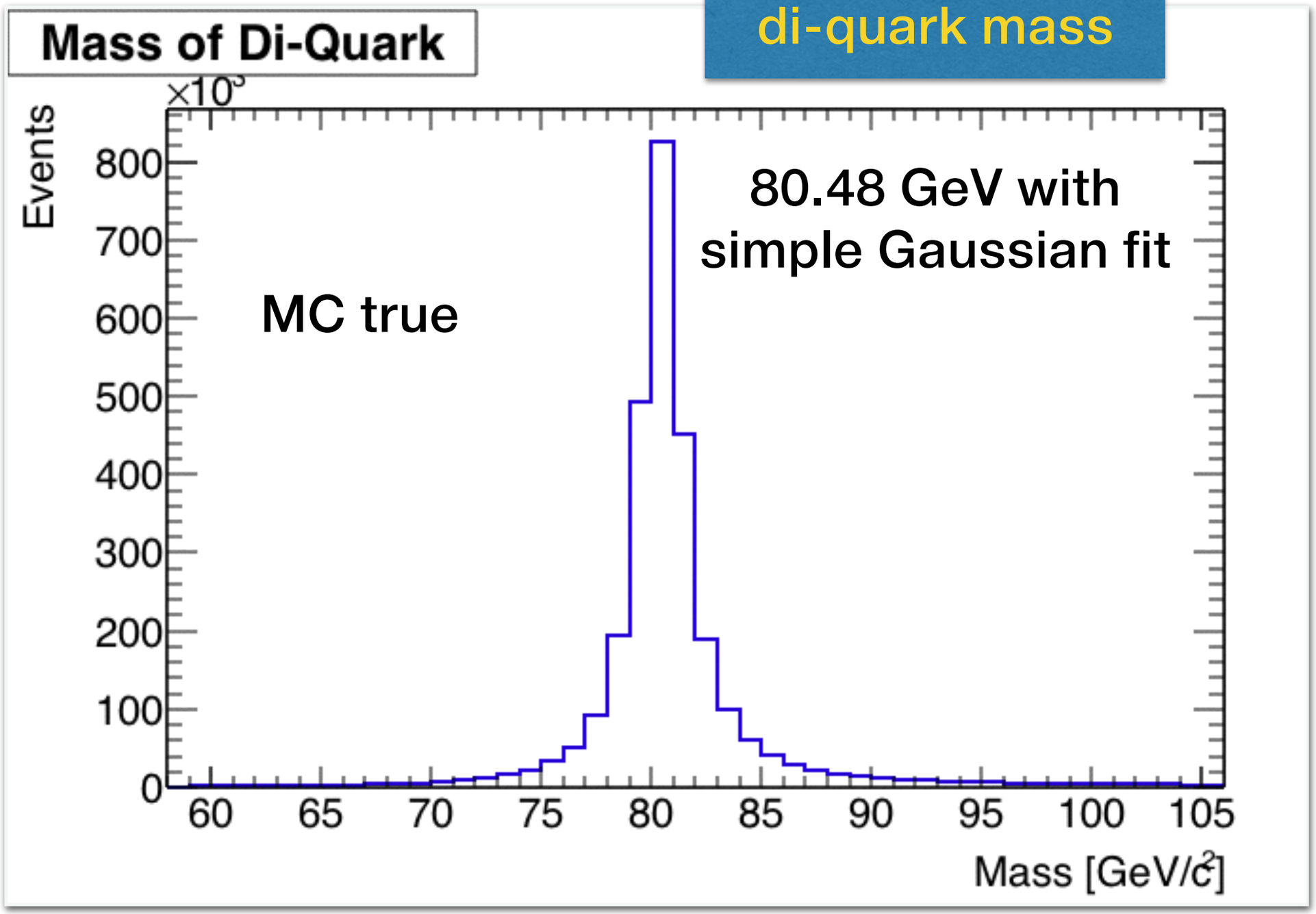
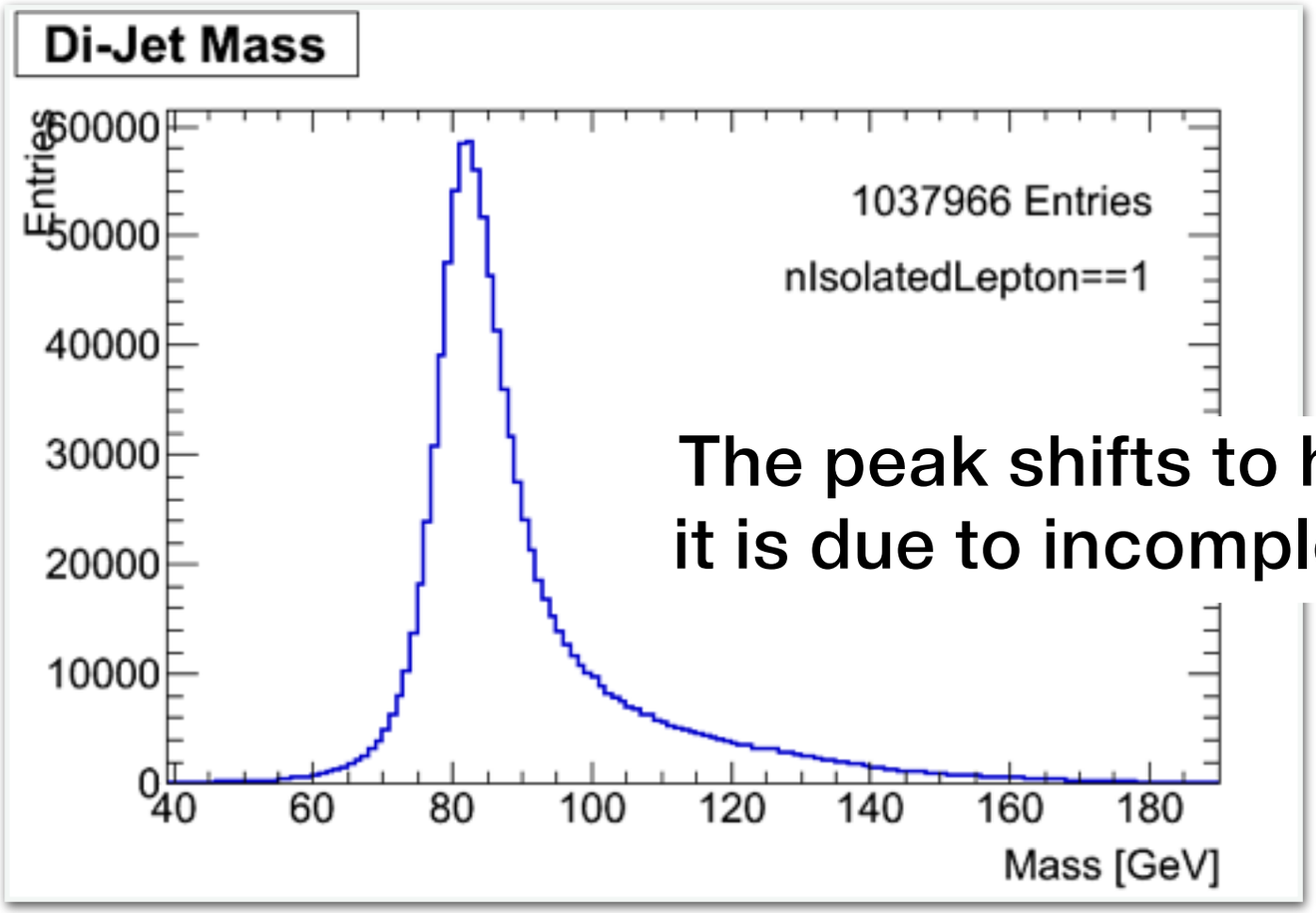
# MC analysis

Generator level di-quark mass



# W mass reconstruction




The peak shifts to high-energy side and has a tail, it is due to incomplete jet reconstruction strategy.

The reconstructed jets include many particles which are not wanted, e.g., ISR photons, or beam backgrounds.

**How can I exclude them? => better jet reconstruction**

# Unsolved issues

- Shifted W mass peak — it's due to →
- Exclusion ISR photon and beam background
- Separation between single-W and W-pair (both semi-leptonic)

- … and triple gauge coupling study with single-W

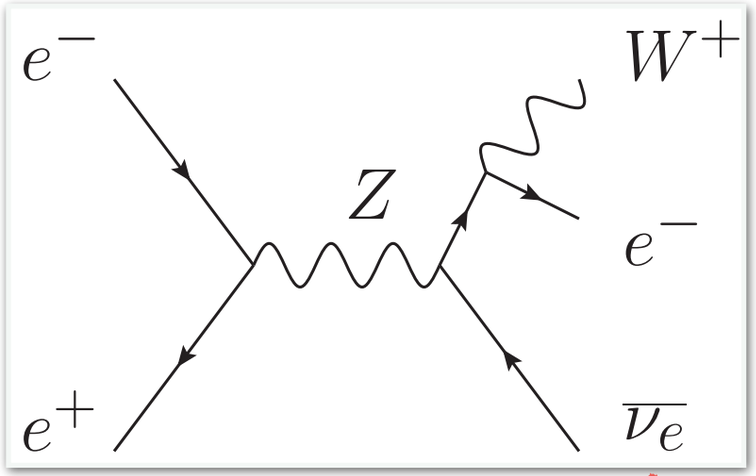
# Summary & Next

- I tried to reconstruct W mass with hadronic mode of semi-leptonic Single-W process(and also semi-leptonic W-pair events ).
  - but W mass was made a bit larger due to the jet clustering
    - => influence of ISR and beam backgrounds
      - some unnecessary particles are included in jets
- For the next, I'll try to improve jet clustering with optimized Durham $Y_{cut}$ value.
  - to separate the ISR photons
  - it needs y value scan and is necessary to evaluate the consistency

# Back up

# semi-leptonic Single-W process

final state : e, ν, W

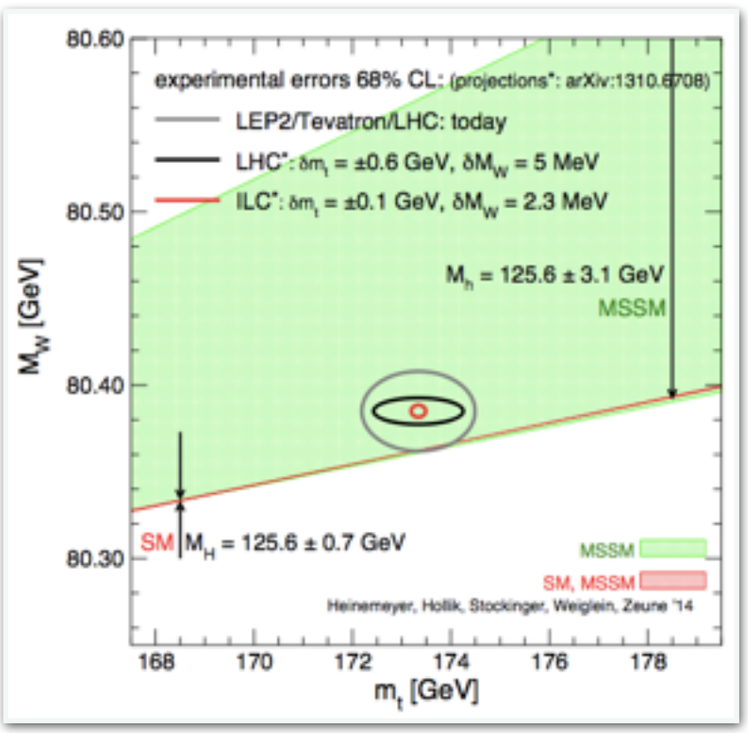



W —> q q'
very simple 2-jet event

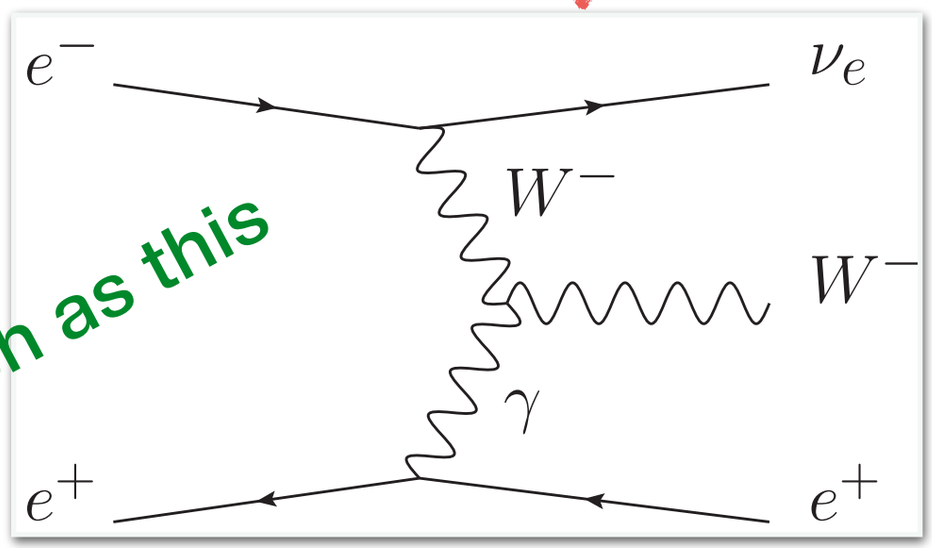
easy to recognize

direct measurement of $m_W$ via hadronic system

result of precise $m_W$ measurement can test the consistency of MSSM




tunable with initial polarization




such as this

anomalous gauge coupling

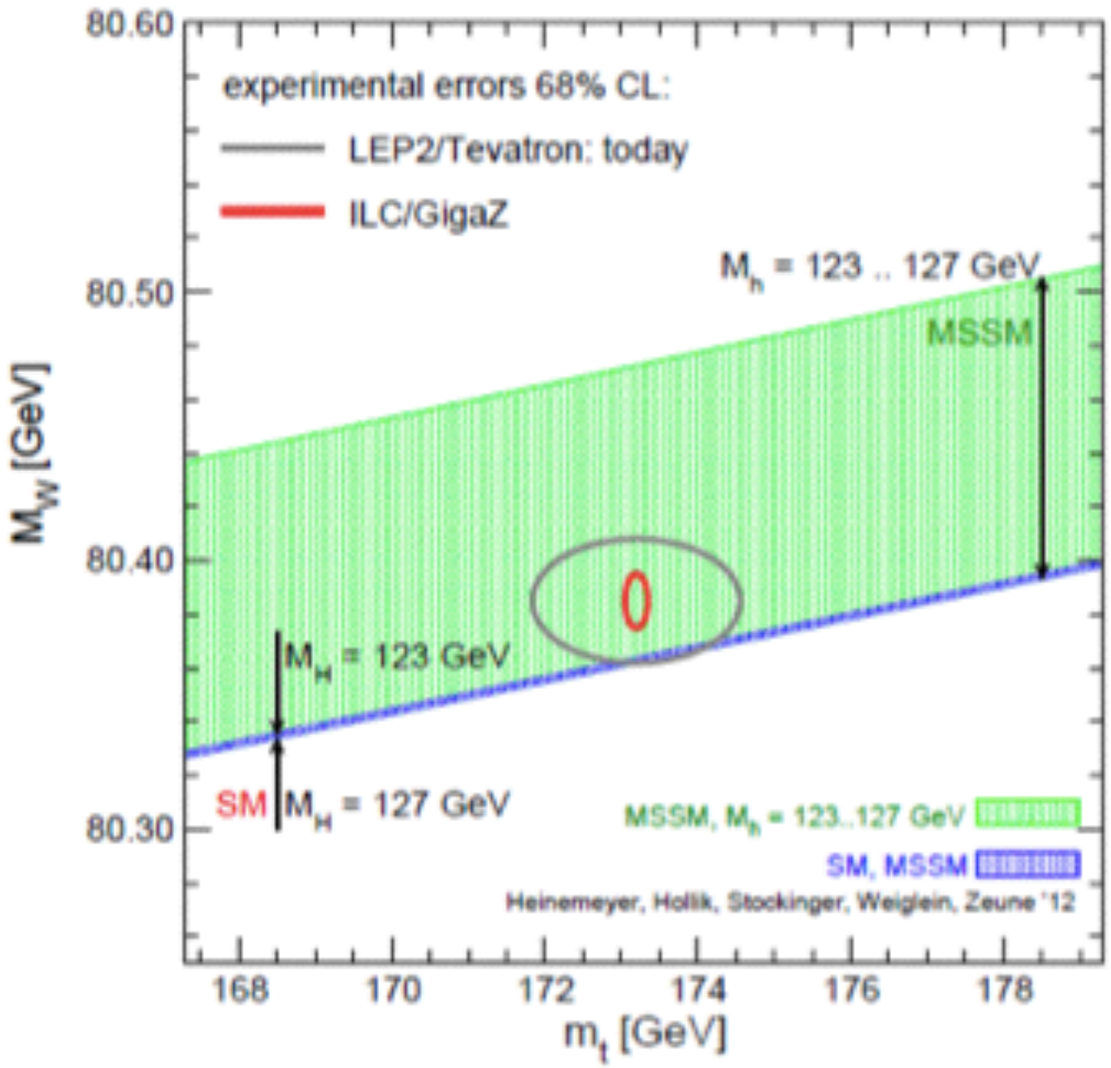
# Motivations

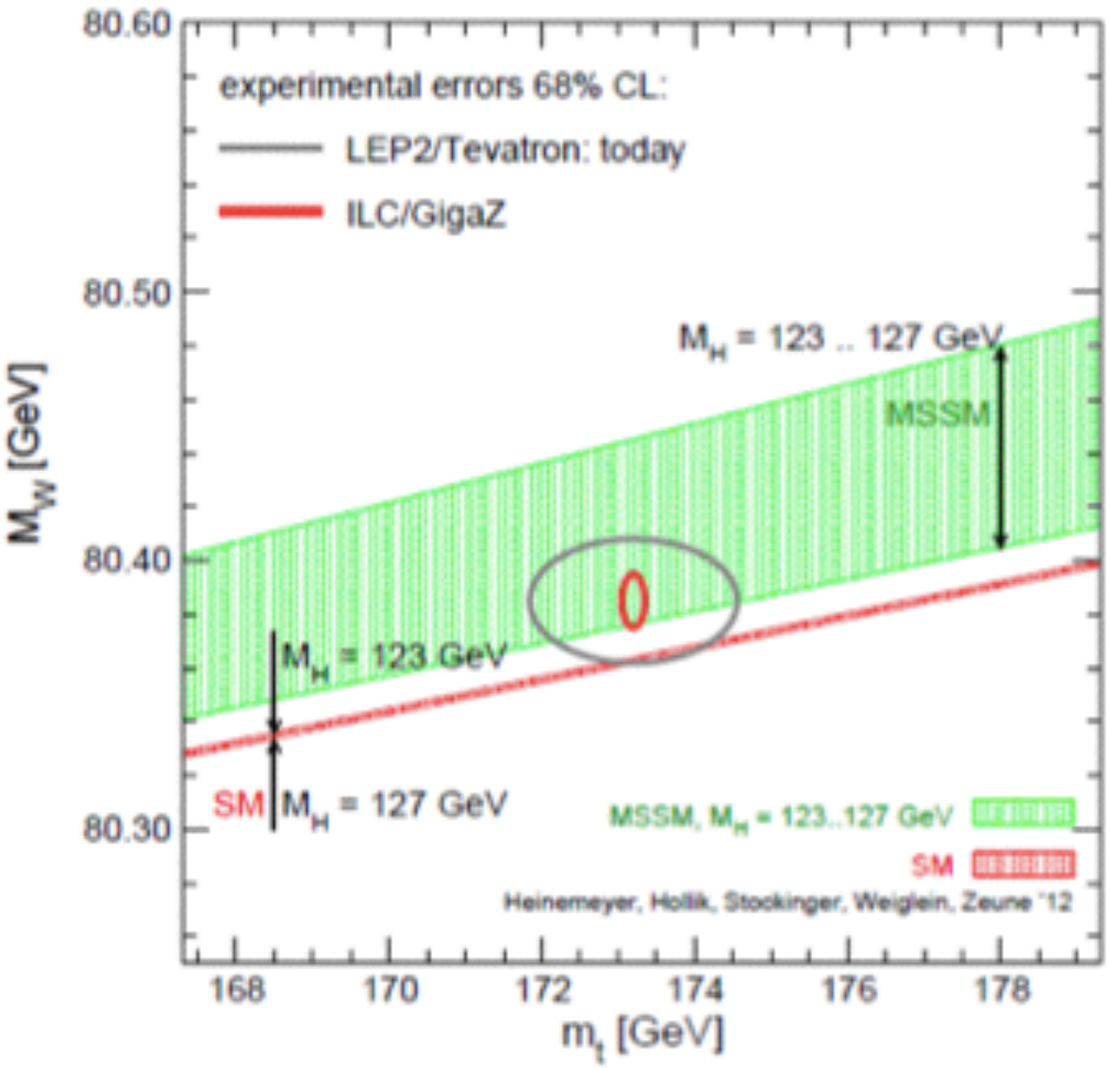
- Precise measurement of W boson mass
  - measuring $m_W$ to a few MeV in W—>qq' decays
    - challenging requirements on JER and calibration
      - needs detecter optimization
        - comparison of performance among different options of calorimeters (e.g., Si or Scintillator ECAL)

Now trying

- Study of anomalous triple-gauge-boson couplings
  - mainly WW$\gamma$ and WWZ couplings
  - signal of new physics beyond the SM

# Would mW to 2 MeV be interesting ?



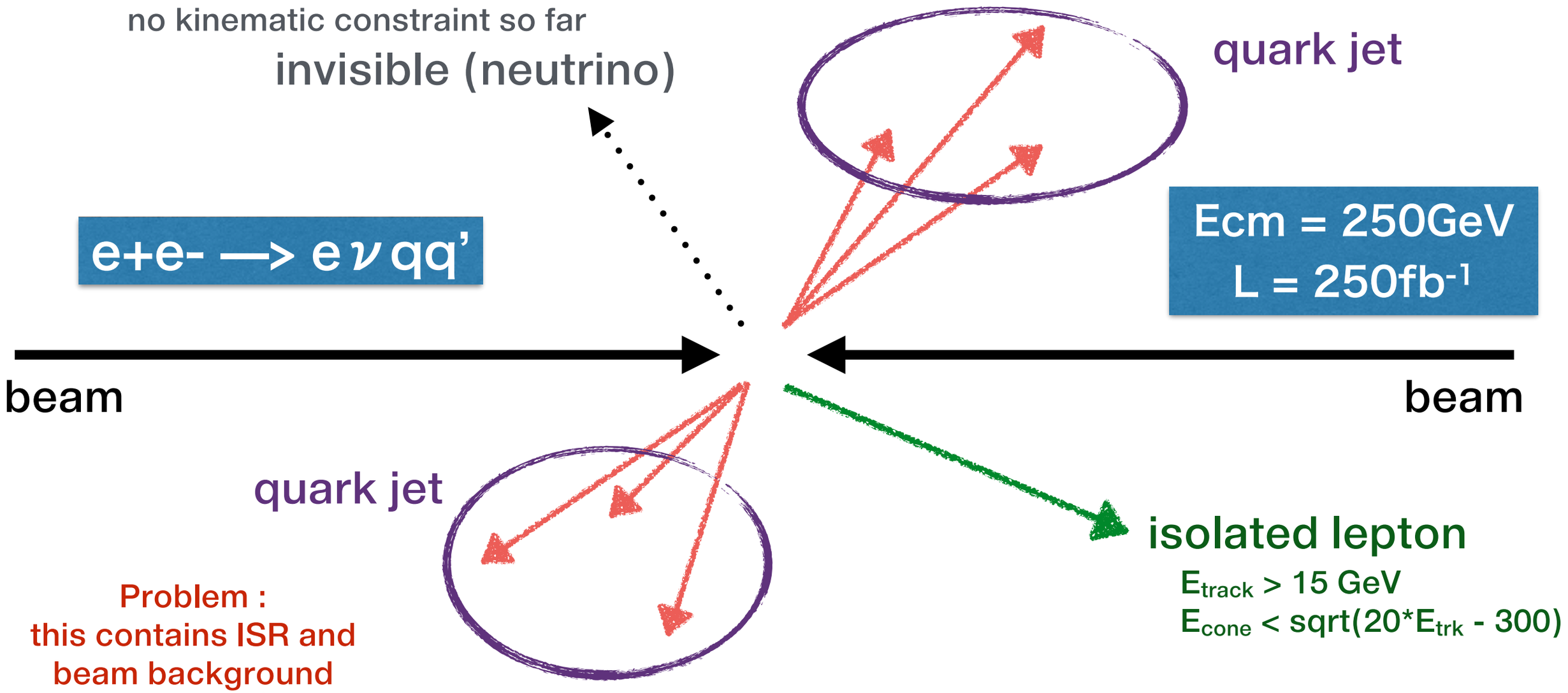

**Can test whether W and top masses are consistent with the SM Higgs mass or MSSM with either the 126 GeV object being the light (left plot) or heavy (right plot) CP even Higgs**

# My simulation conditions

**Simulation condition**

- $\sqrt{s}$ = 250 GeV, Luminosity : 250 $fb^{-1}$
- Beam polarization : (e-,e+) = (-0.8,+0.3)
- DBD-Samples : /group/ilc/soft/samples/mc-dbd/ild/dst-merged/250-TDR_ws/4f_singleW_semileptonic/
- Detector model : ILD_o1_v5
- ILC soft version : v01-17-05

# Reconstruction flow

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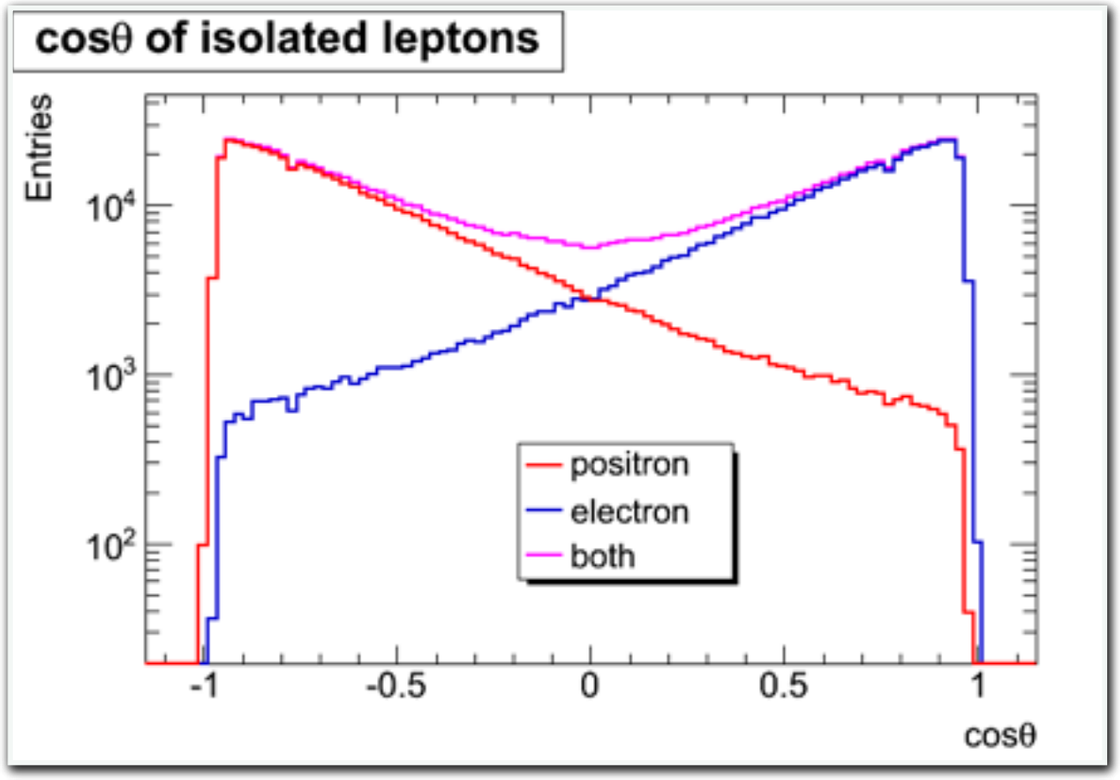
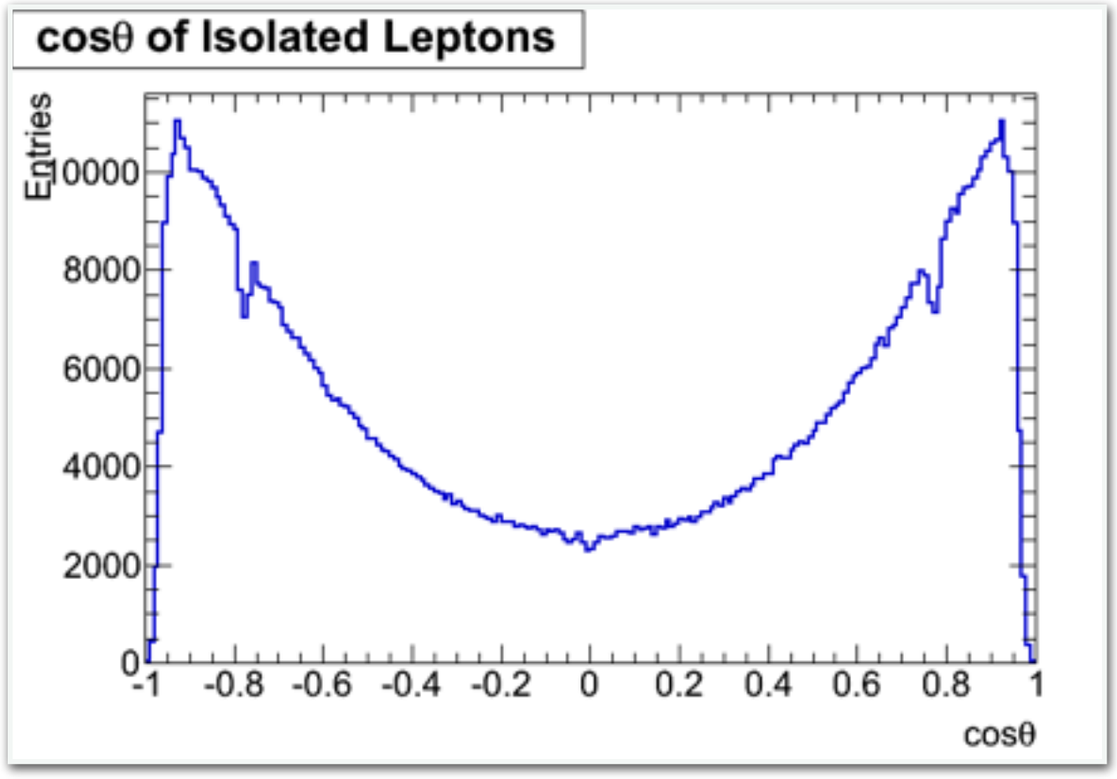
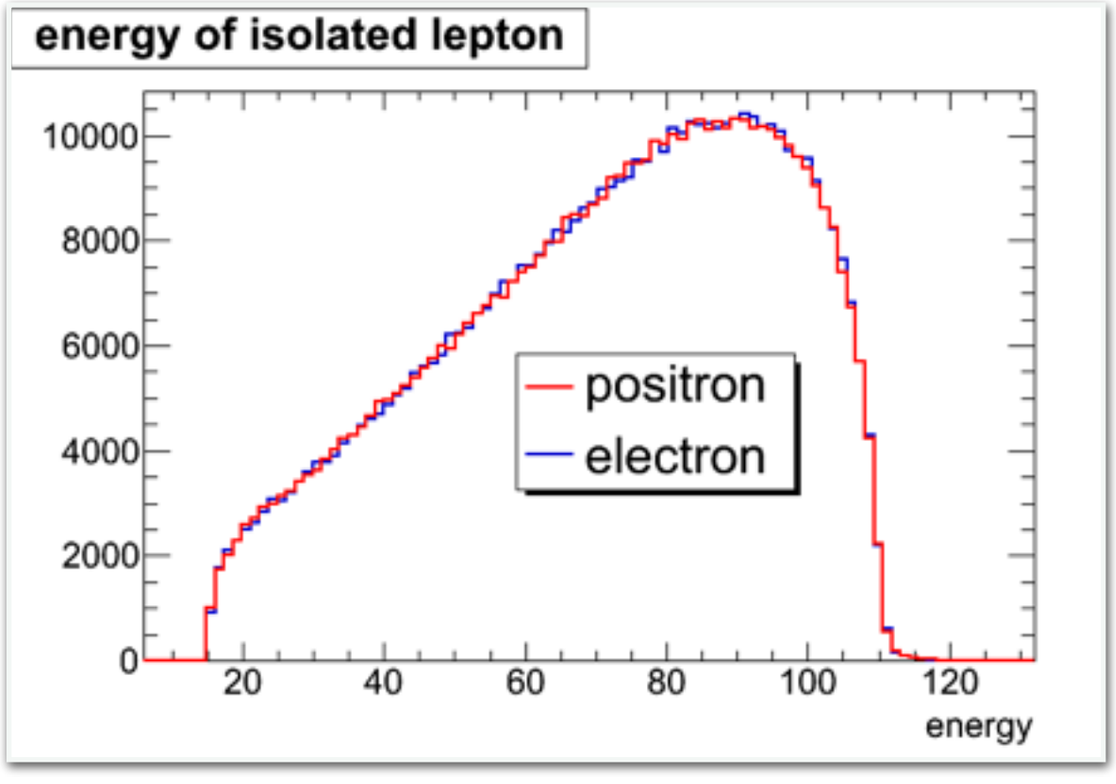
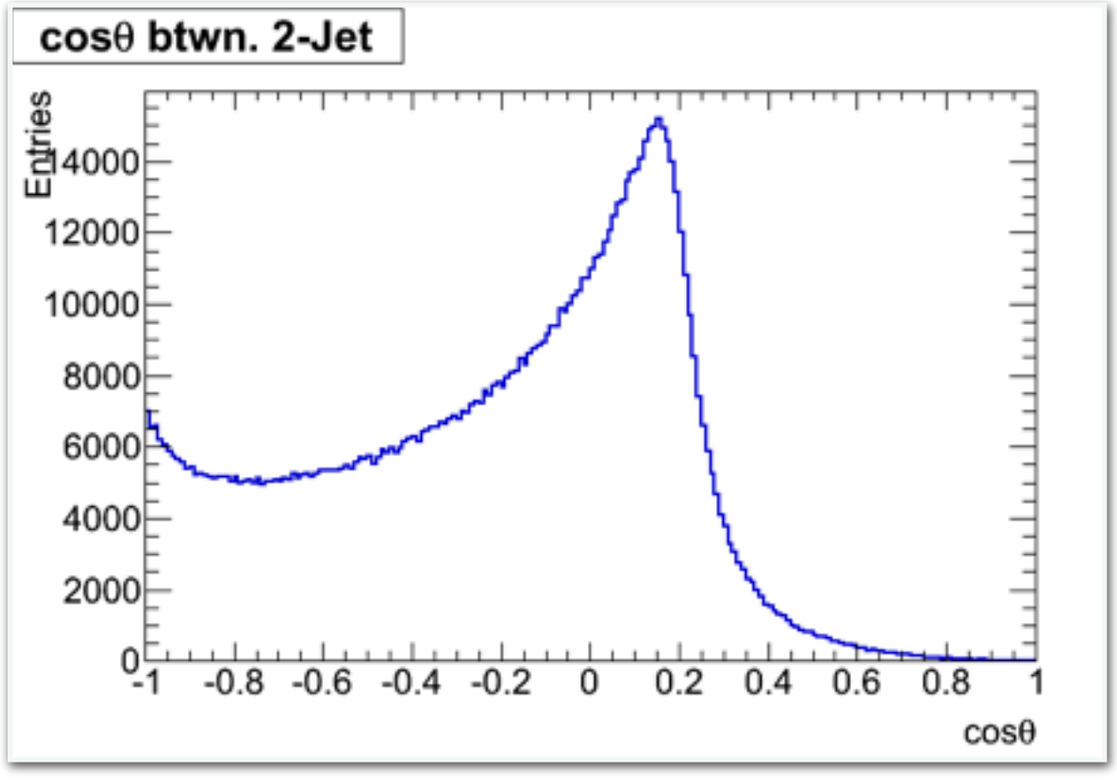
# Simulated plots 1

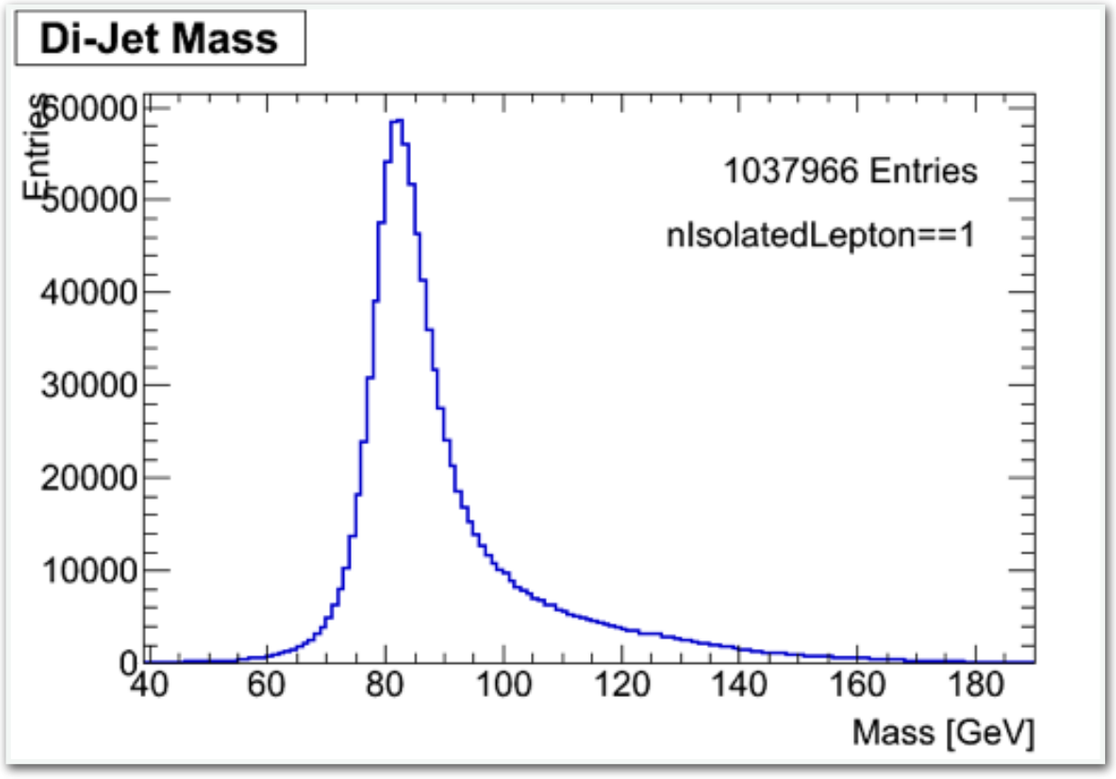


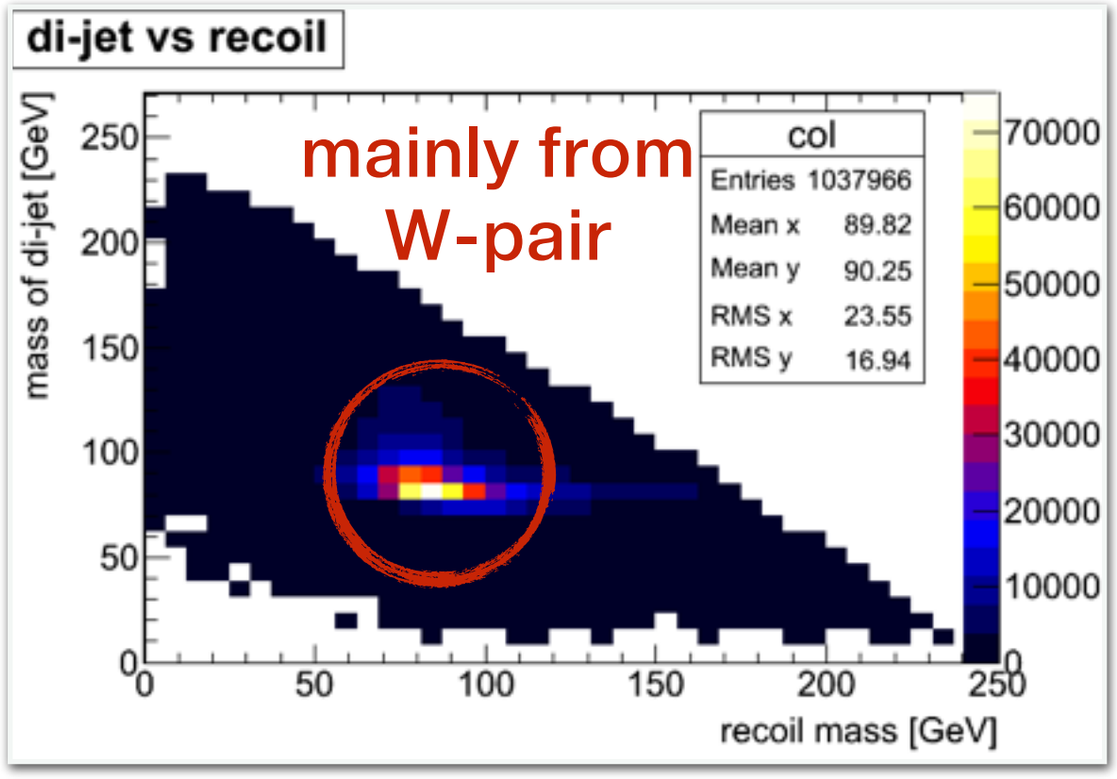



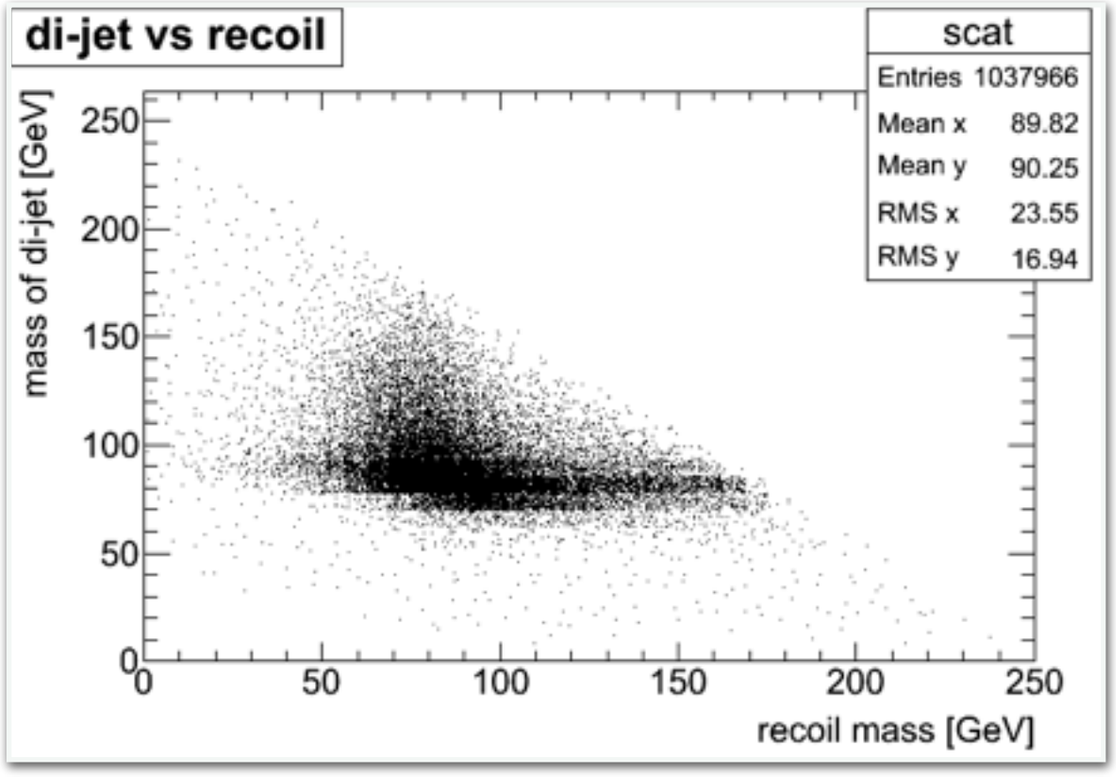



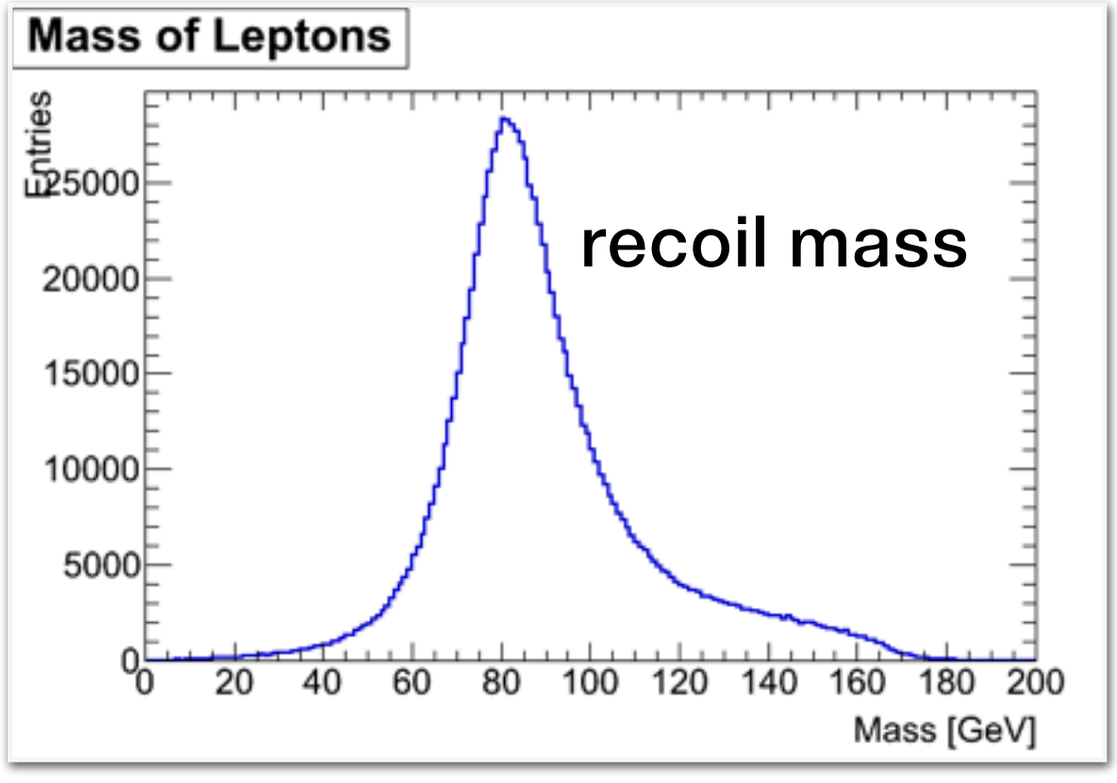



# Simulated plots 2

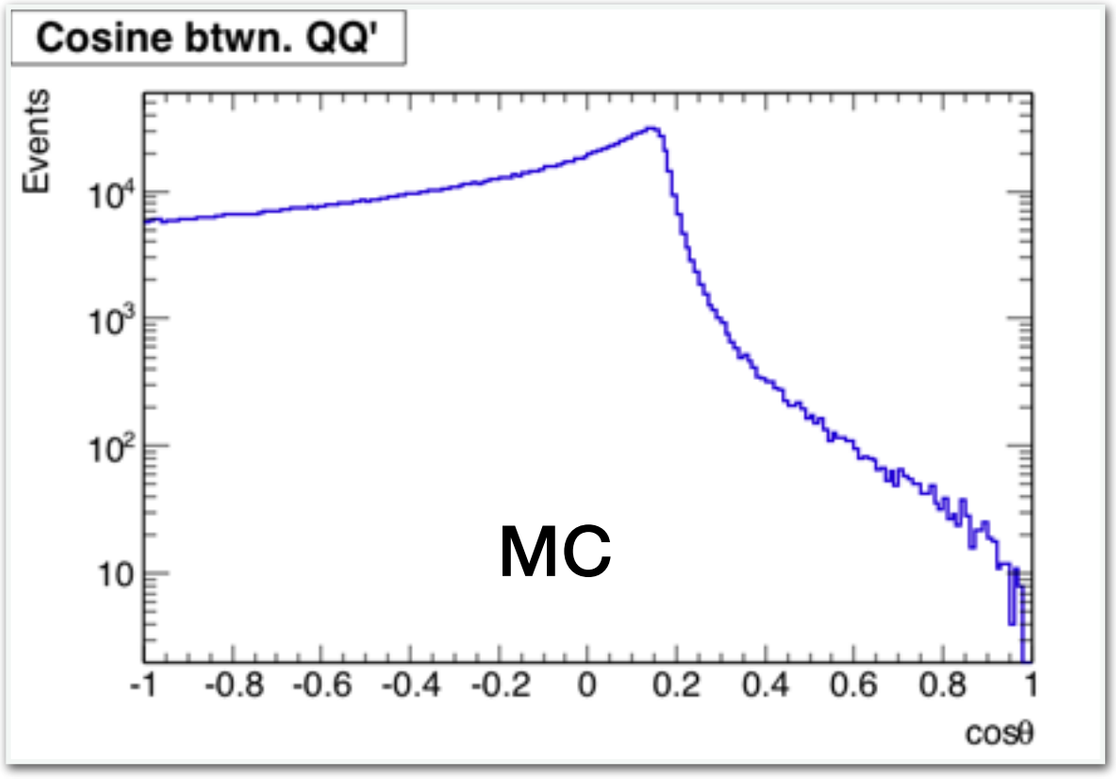


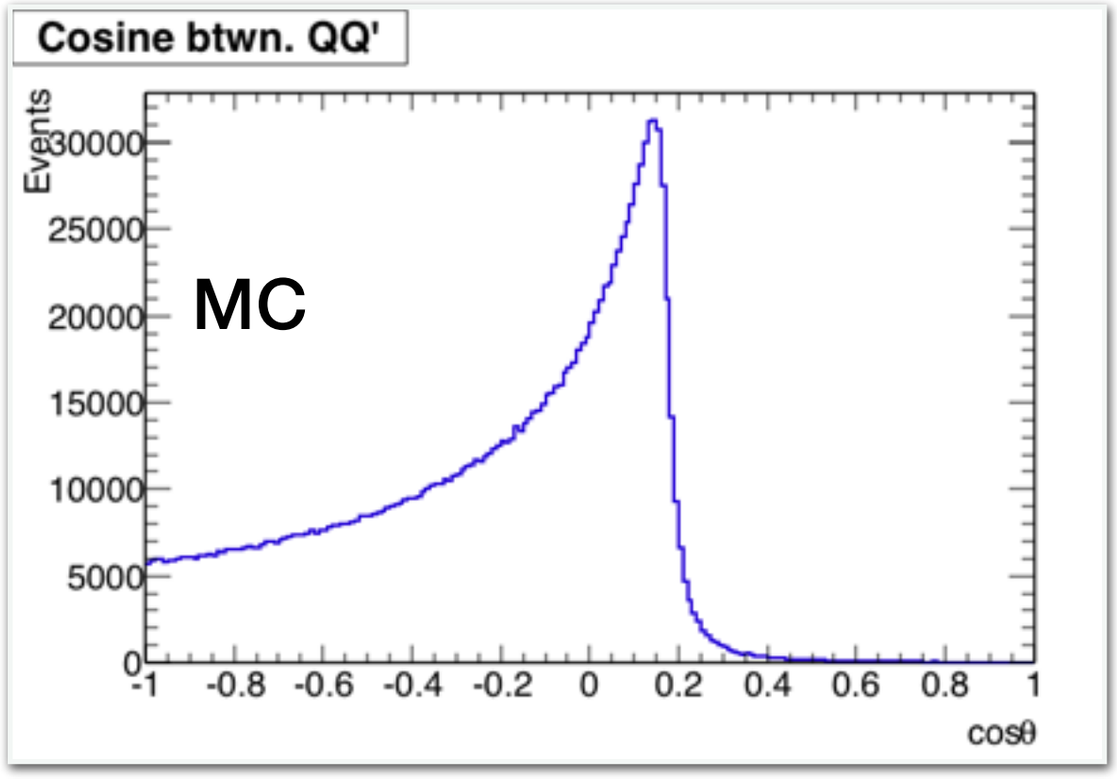



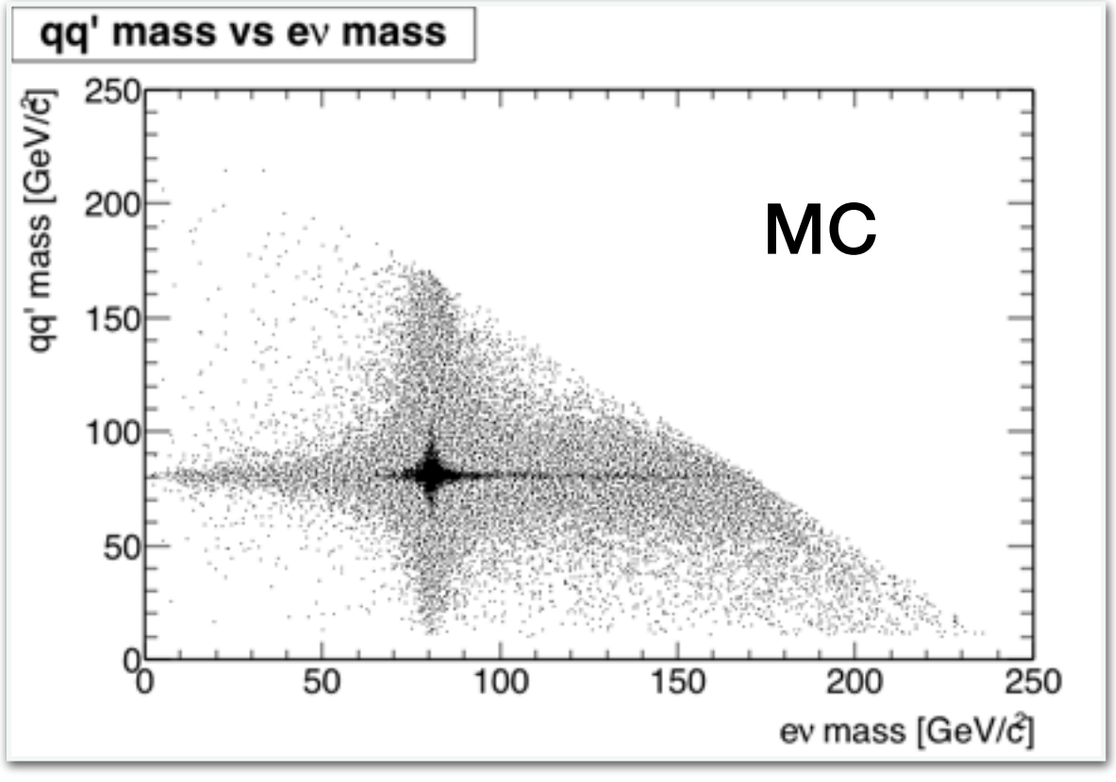



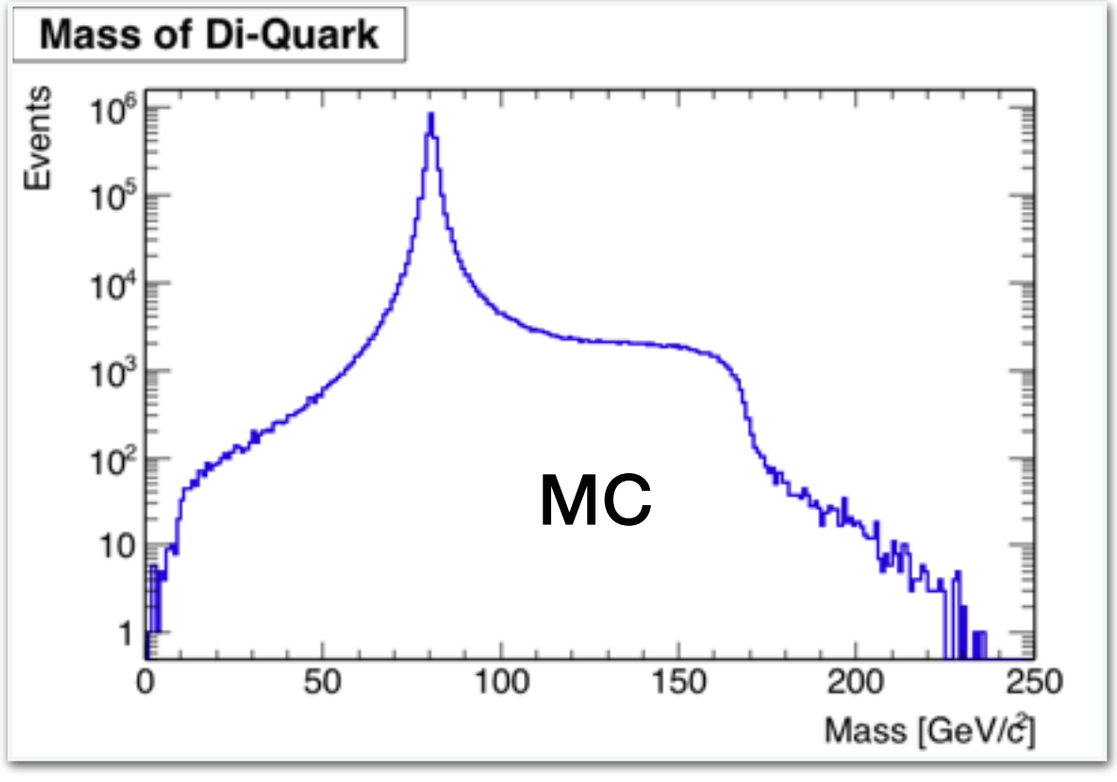



# MC di-quark plots

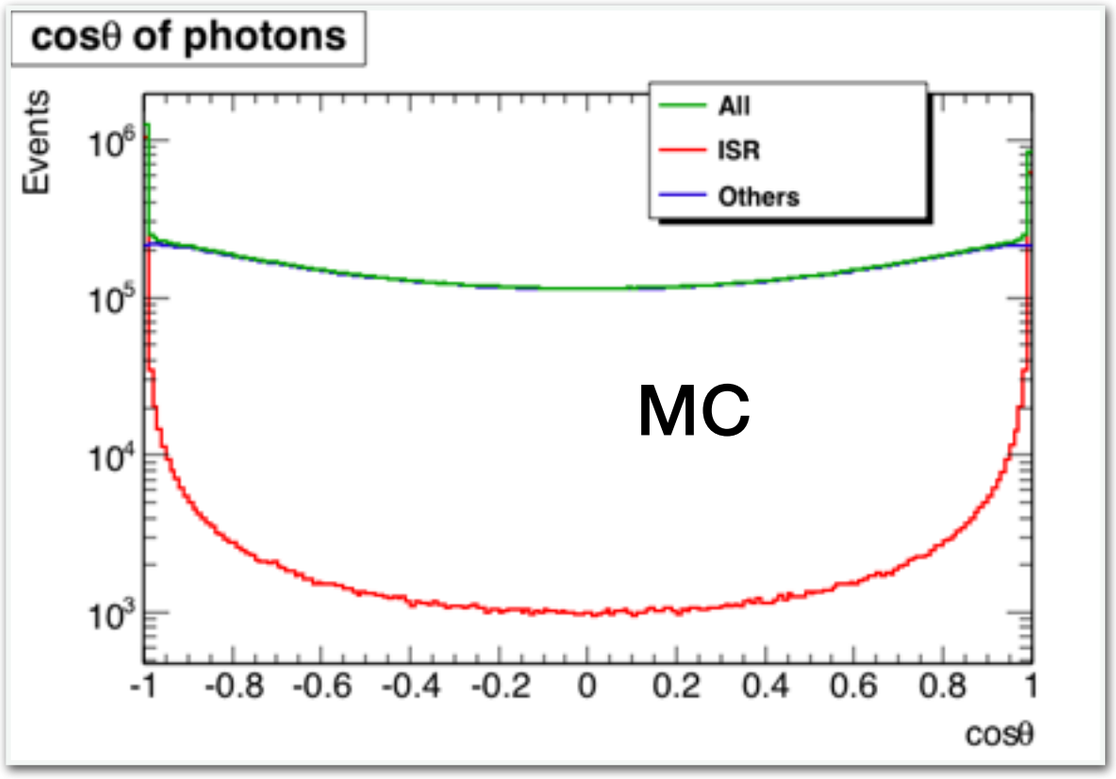


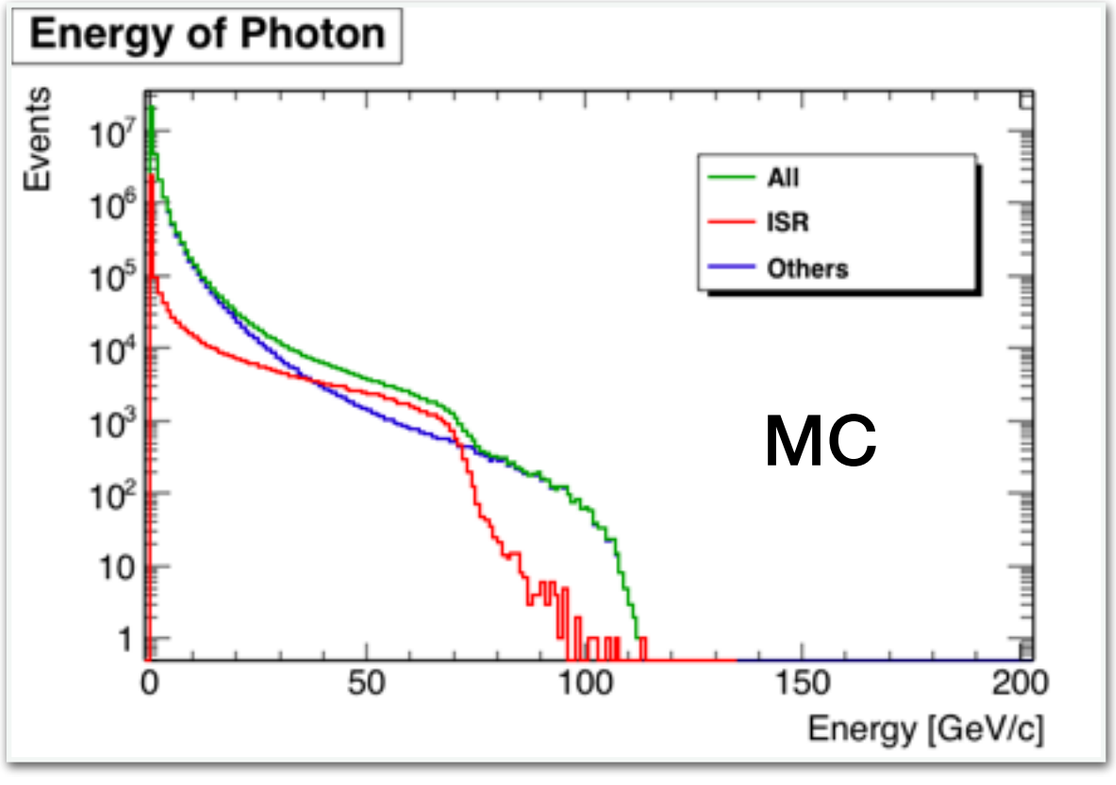



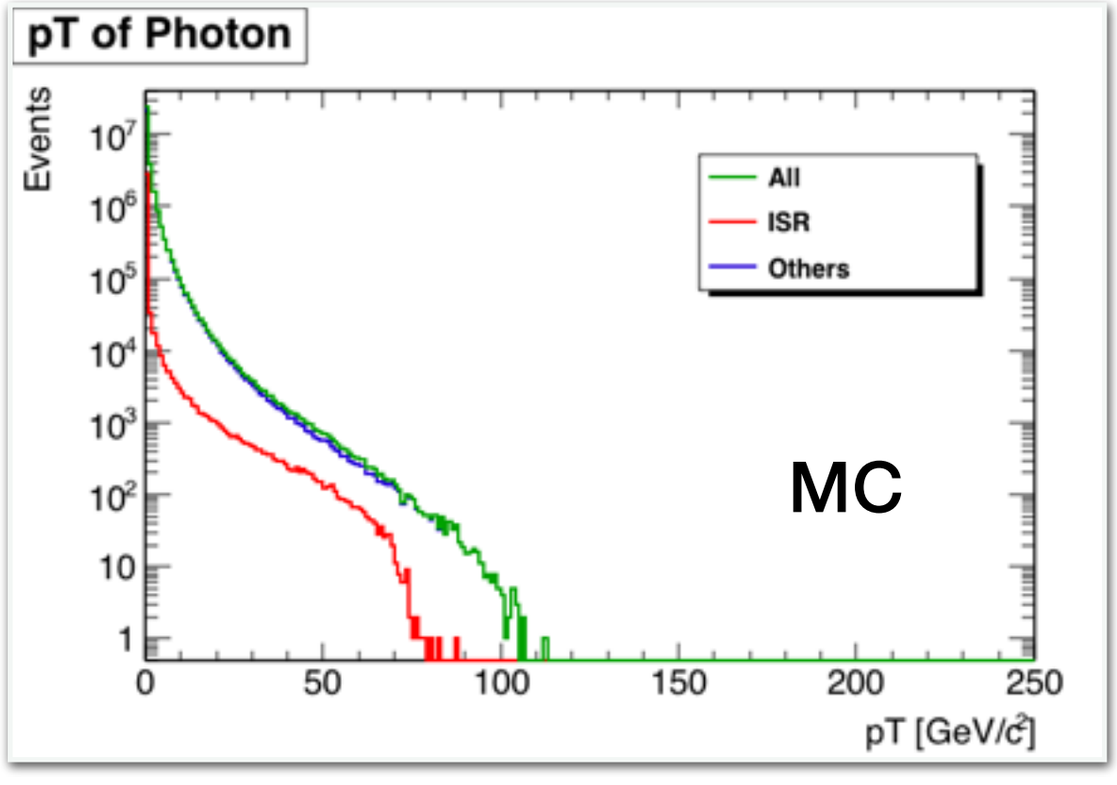



# MC ISR? plots

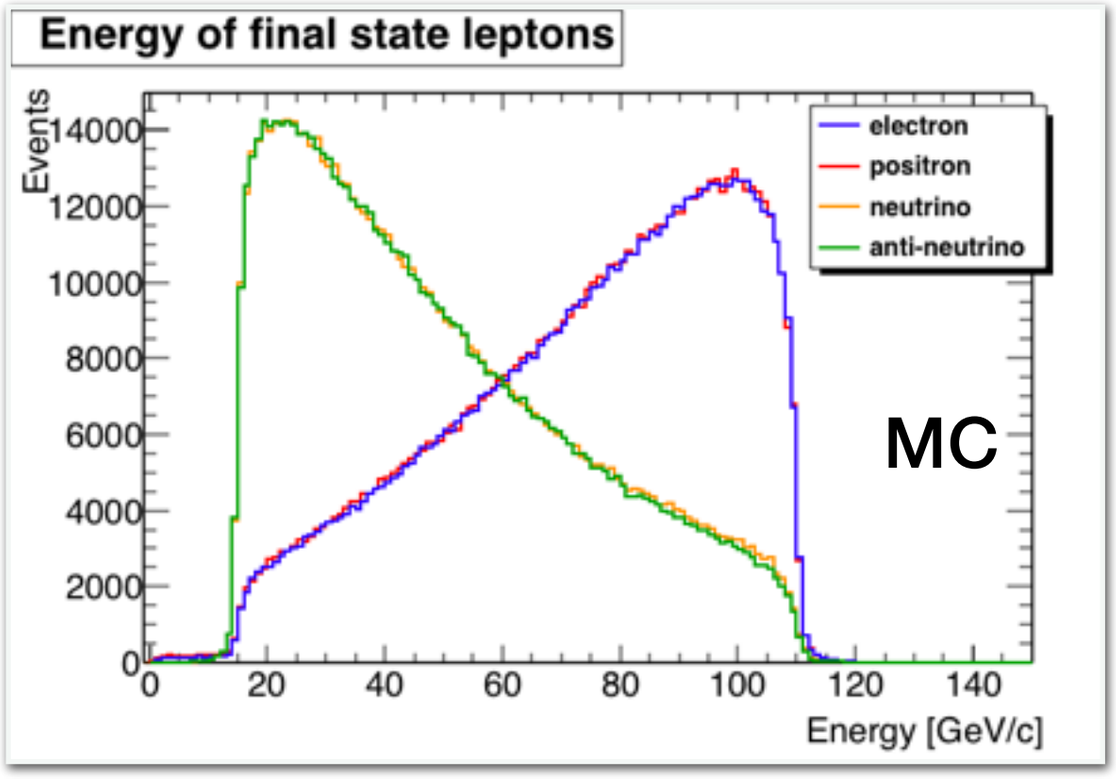


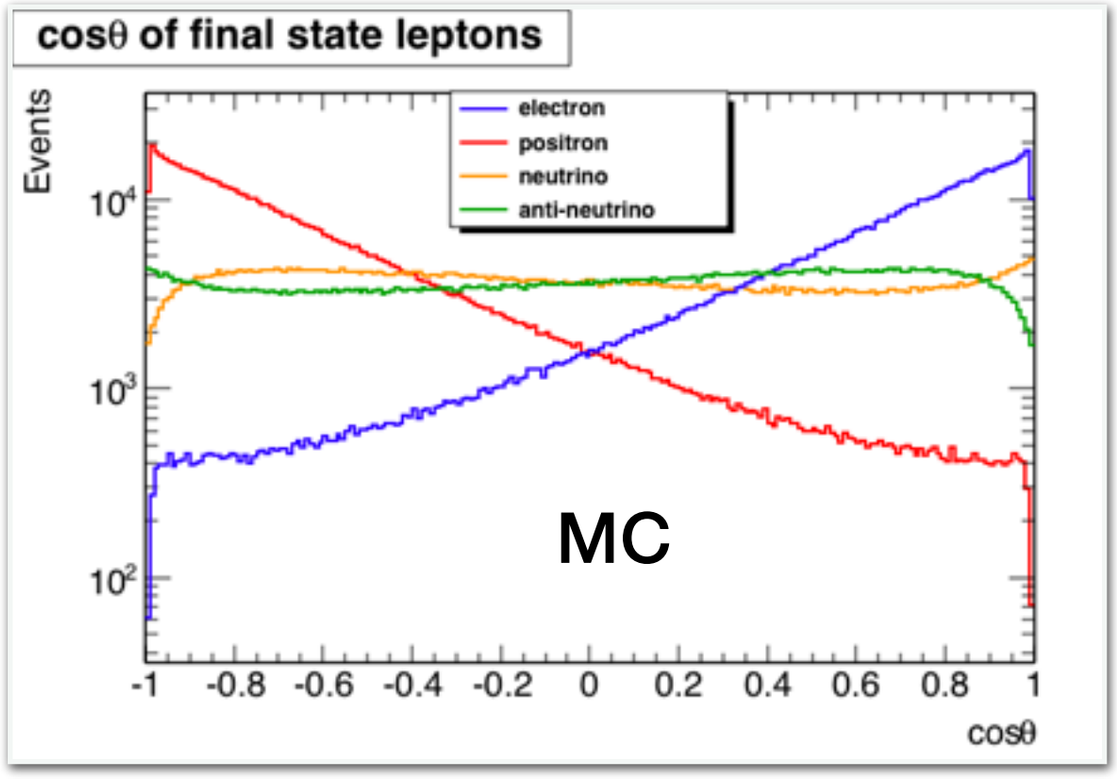

here ‘ISR’ means the photons which have no parents
— I’m not sure about this

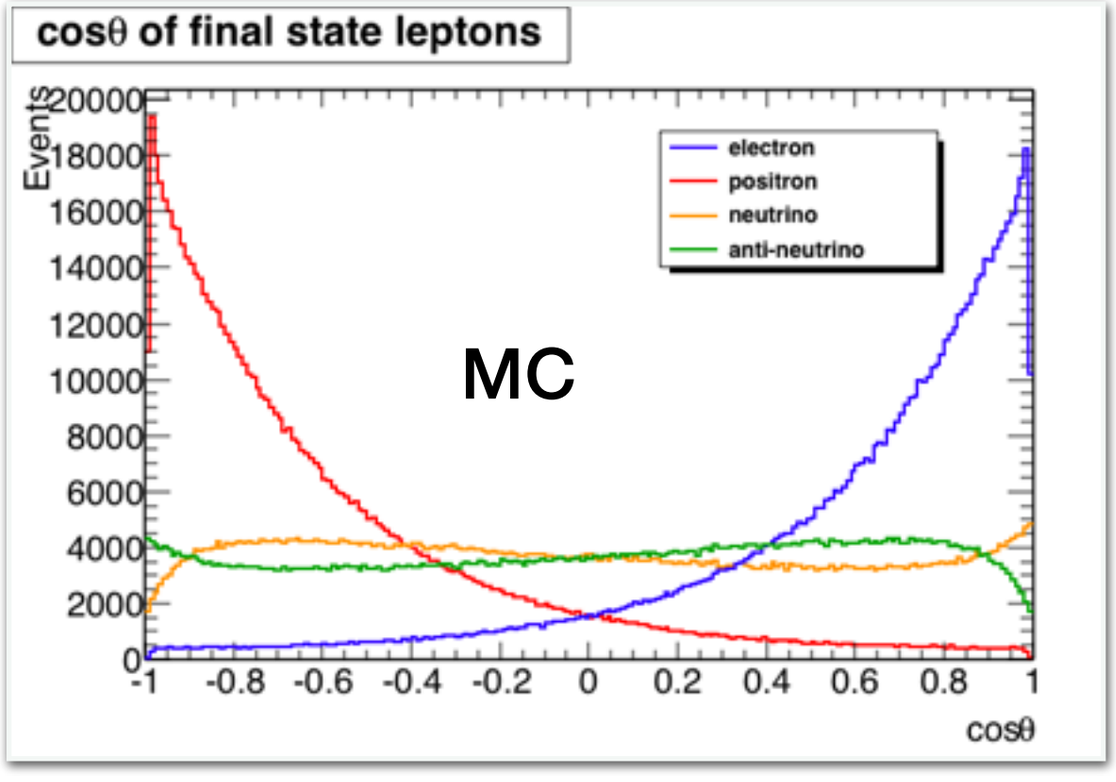


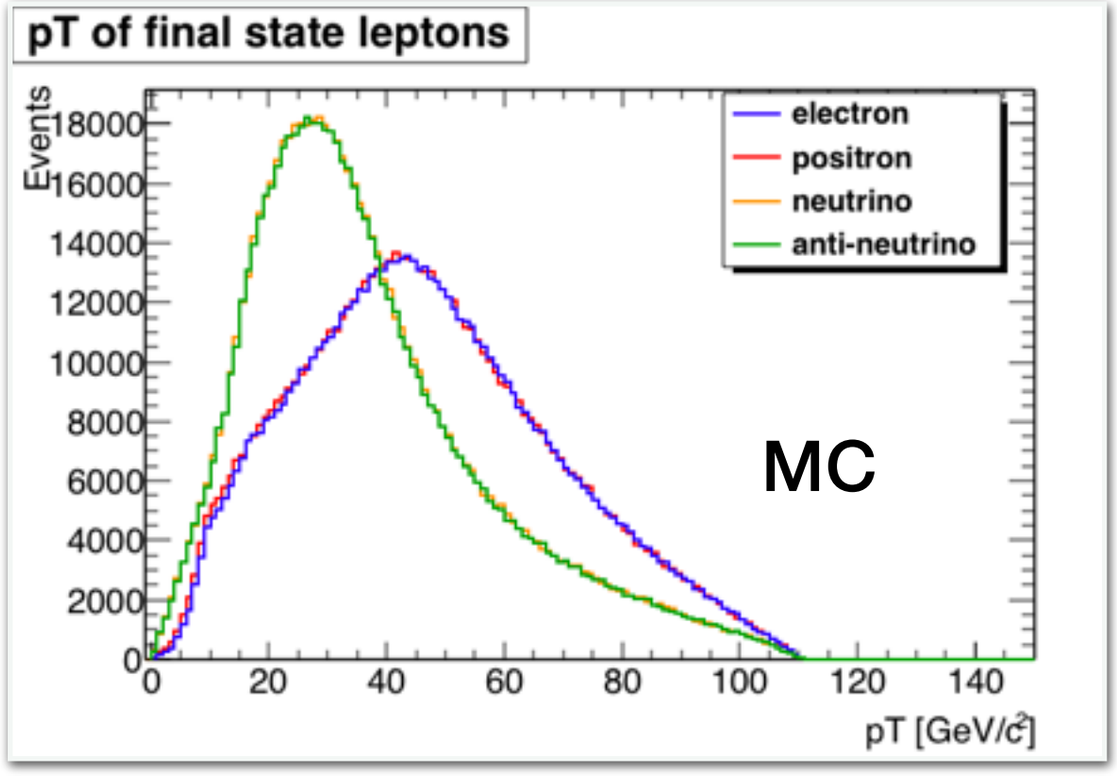



# MC leptons plots

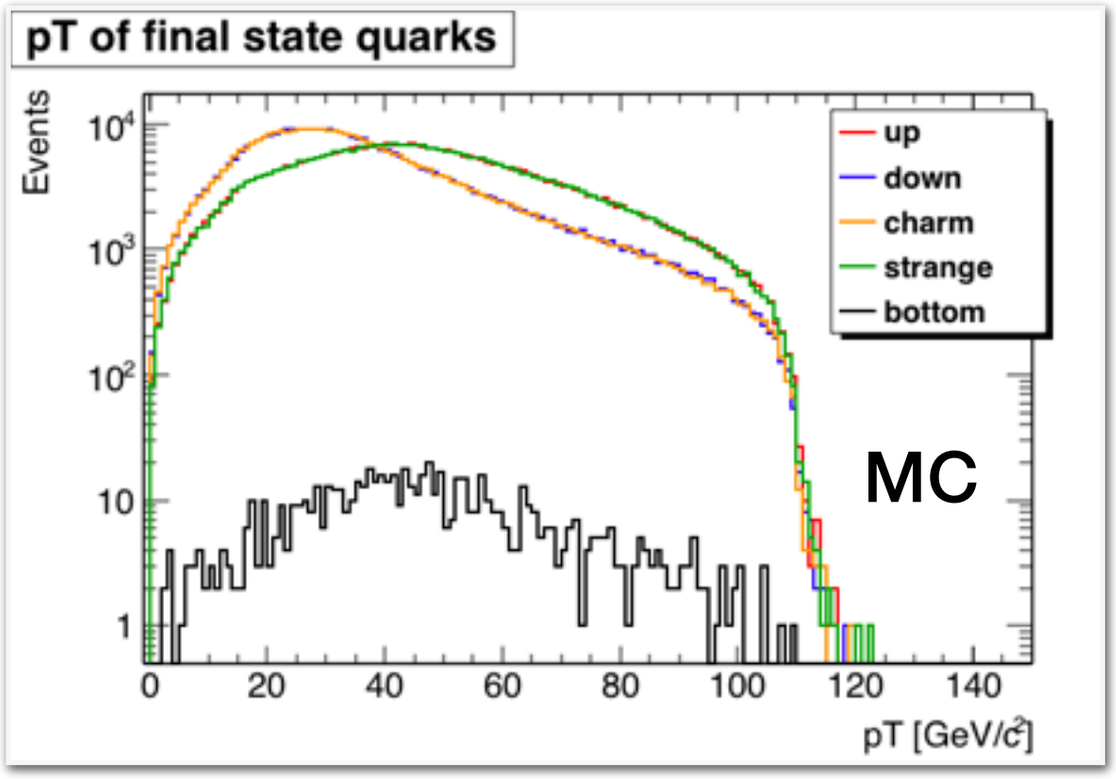


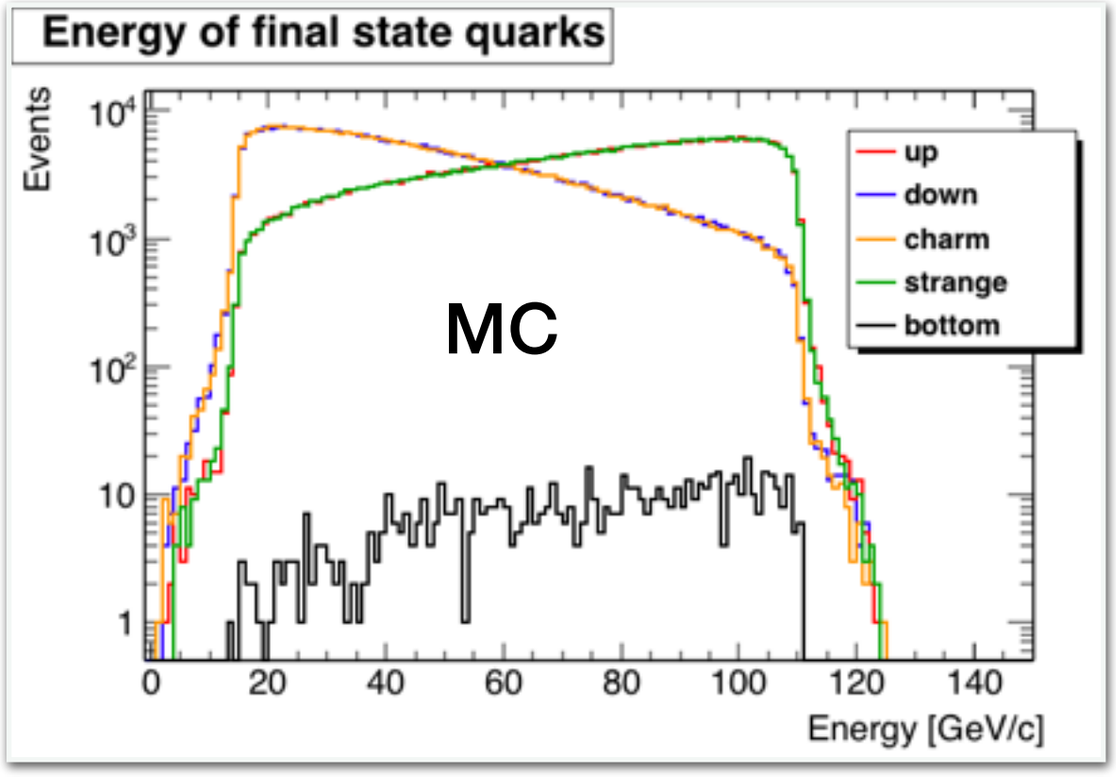



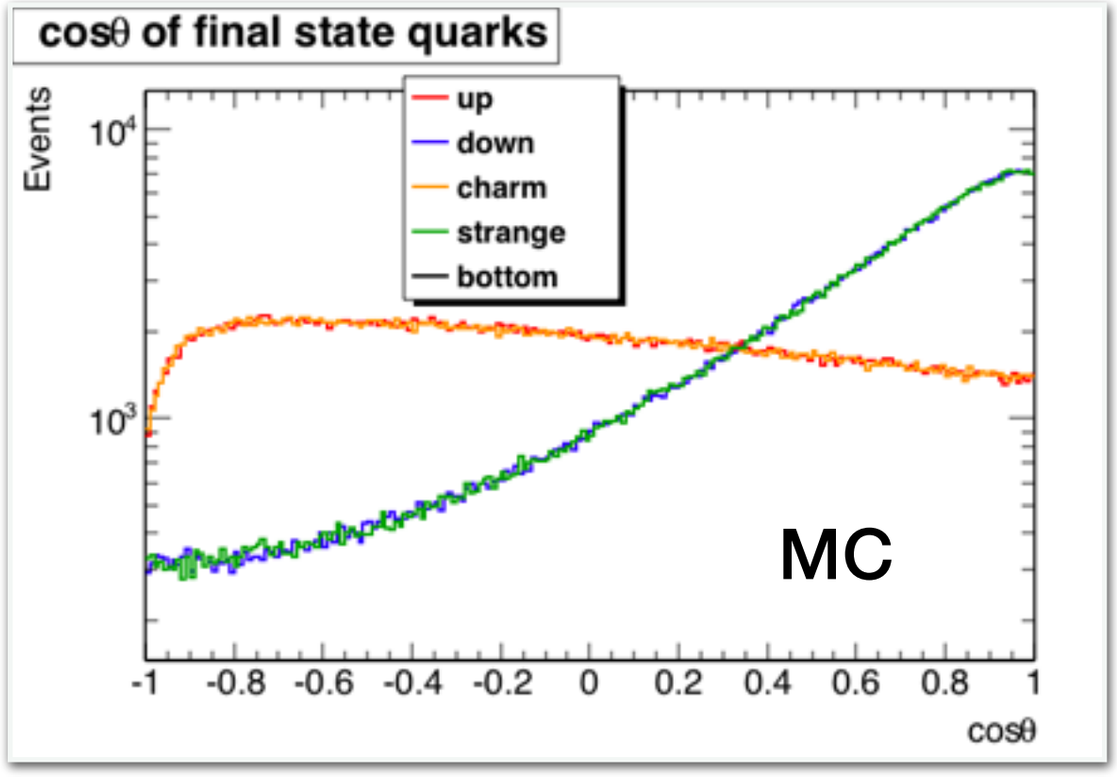



# MC quarks plots



# MC anti-quarks plots