update on Higgs mass benchmark analysis

Junping Tian (U. Tokyo)

ILD Analysis & Software Meeting, April 3, 2019

updates since benchmarking days II

- plot styles
- new understanding about jet angle resolution
- results for electron channel

reminder: Higgs mass benchmark analysis

- what performance to look at

  - final observable: Δm_H

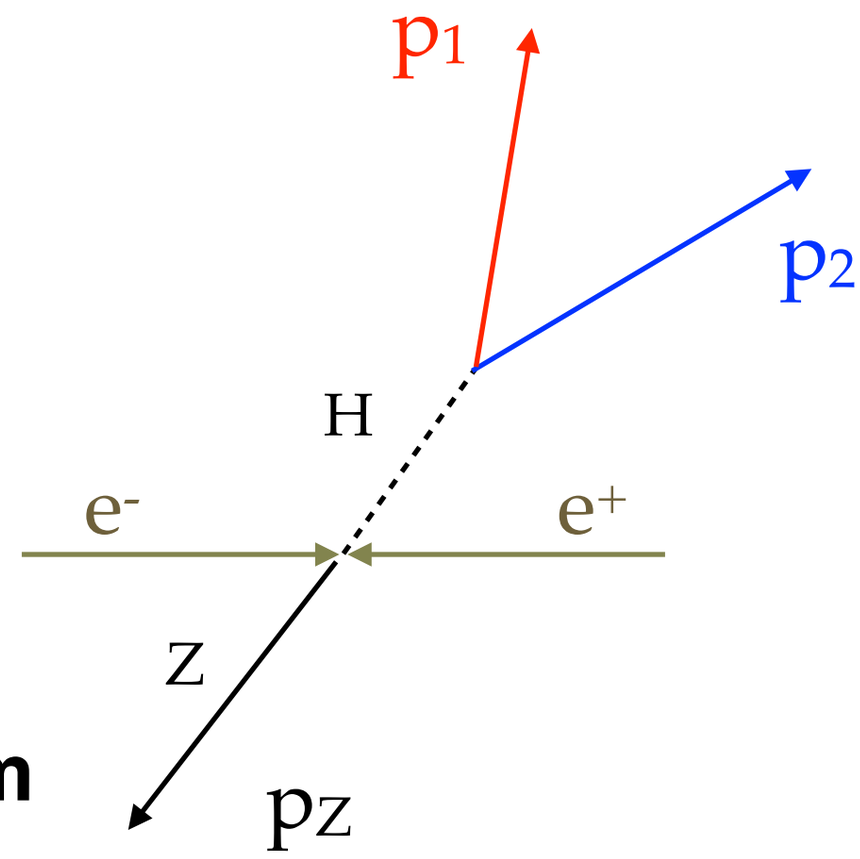
  - **intermediate**

    Z->ll: resolution on lepton momentum

    H->bb: resolution on jet-direction (ϕ,θ)

- basic: selection efficiencies

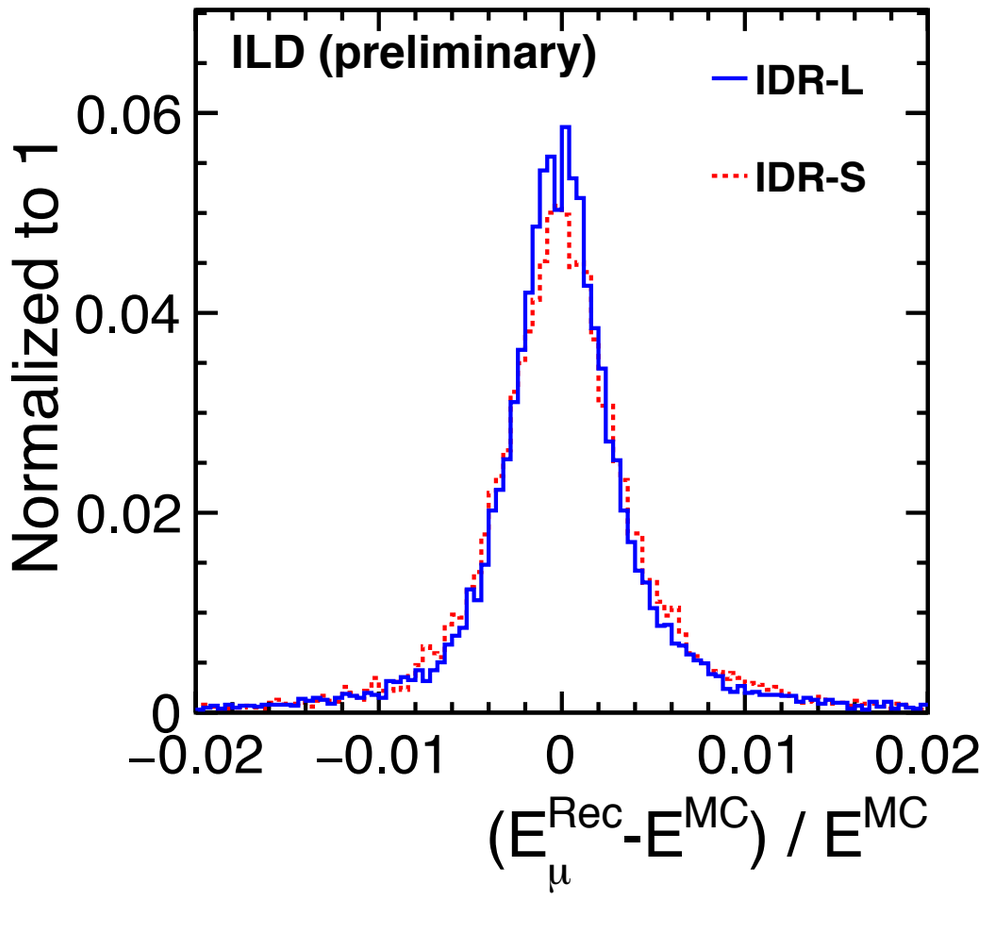
  Isolated Lepton Tagging, Flavor Tagging, etc.

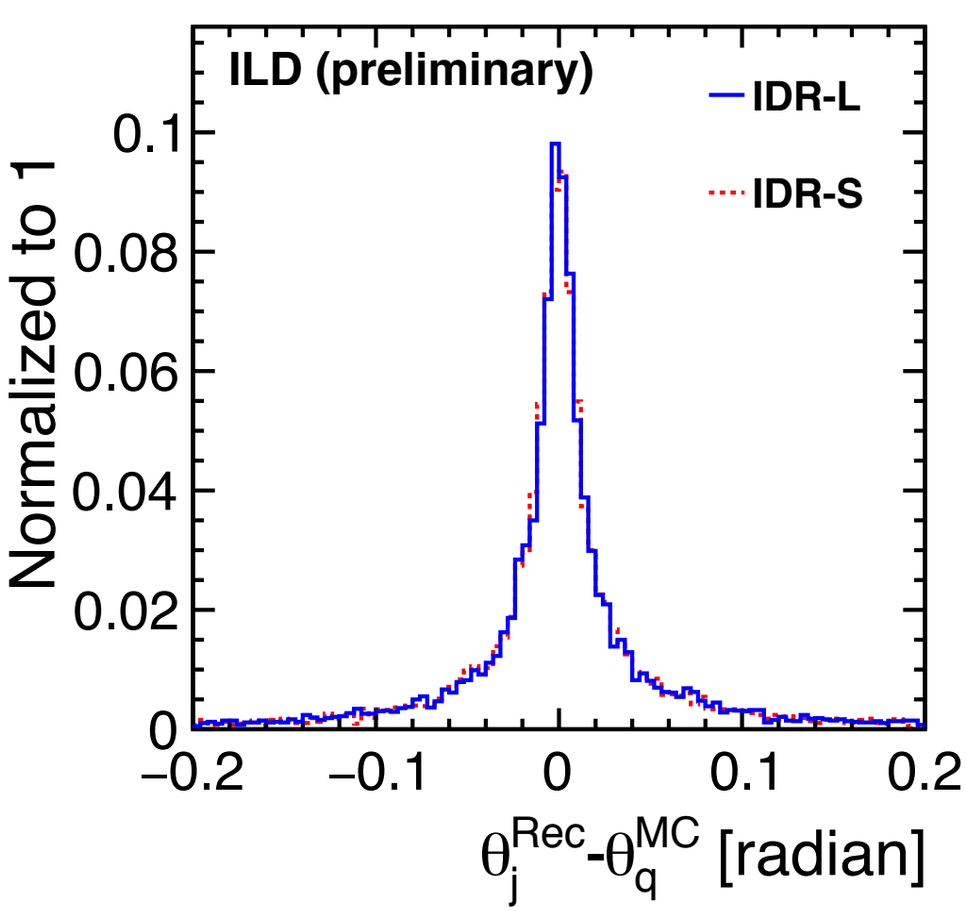


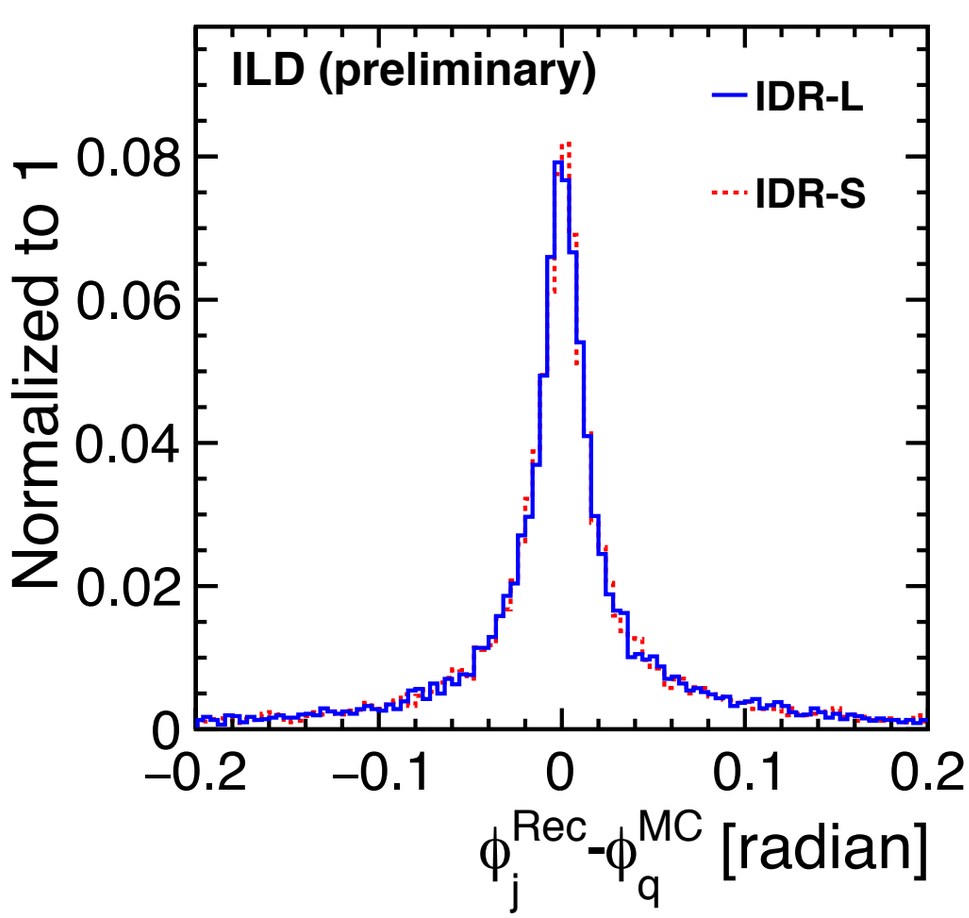
resolutions: conventional

$$e^+e^- \to \mu\mu H, H \to b\bar{b}$$

- j: reconstructed jet
- q: primary b-quark

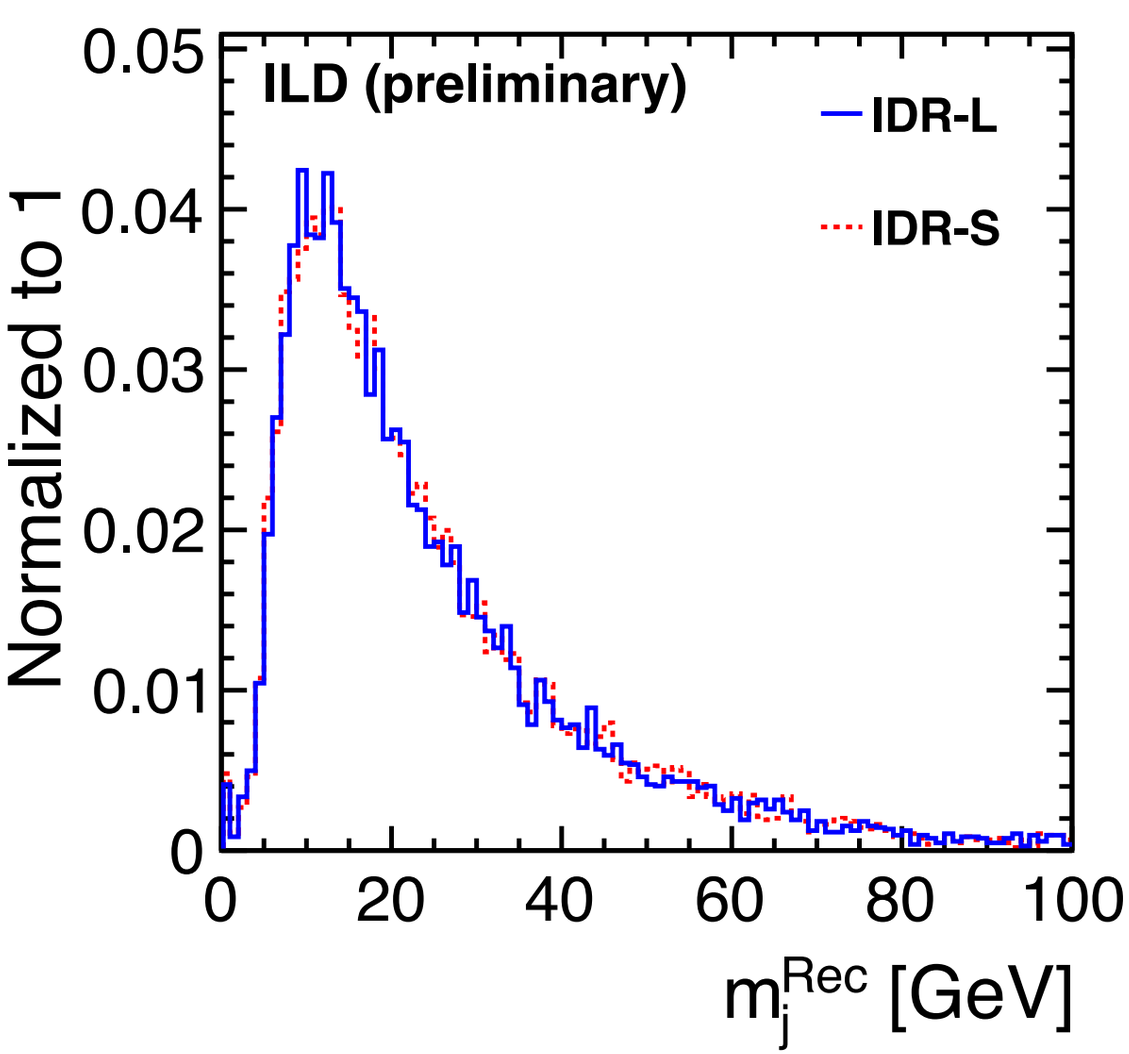


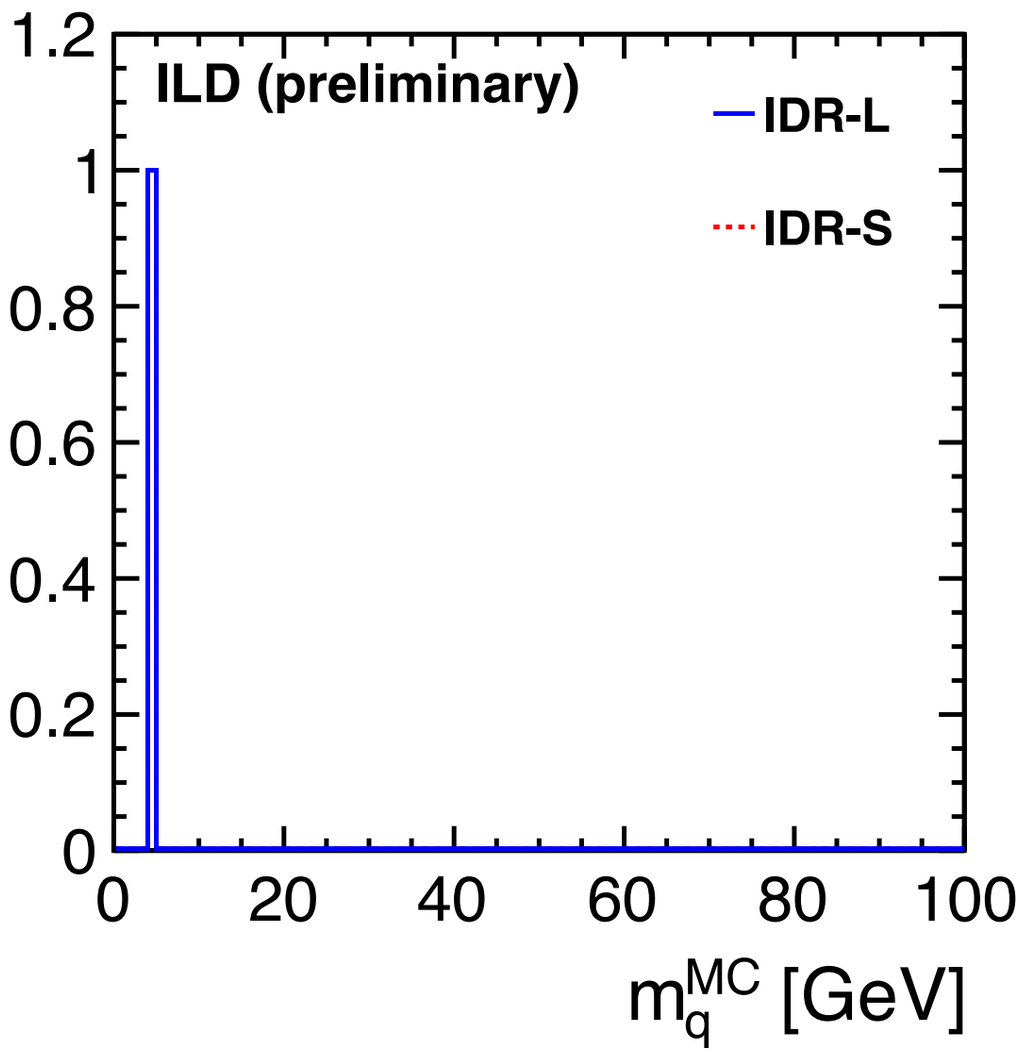




what MC truth should we compare to?

$$e^+e^- \to \mu\mu H, H \to b\bar{b}$$

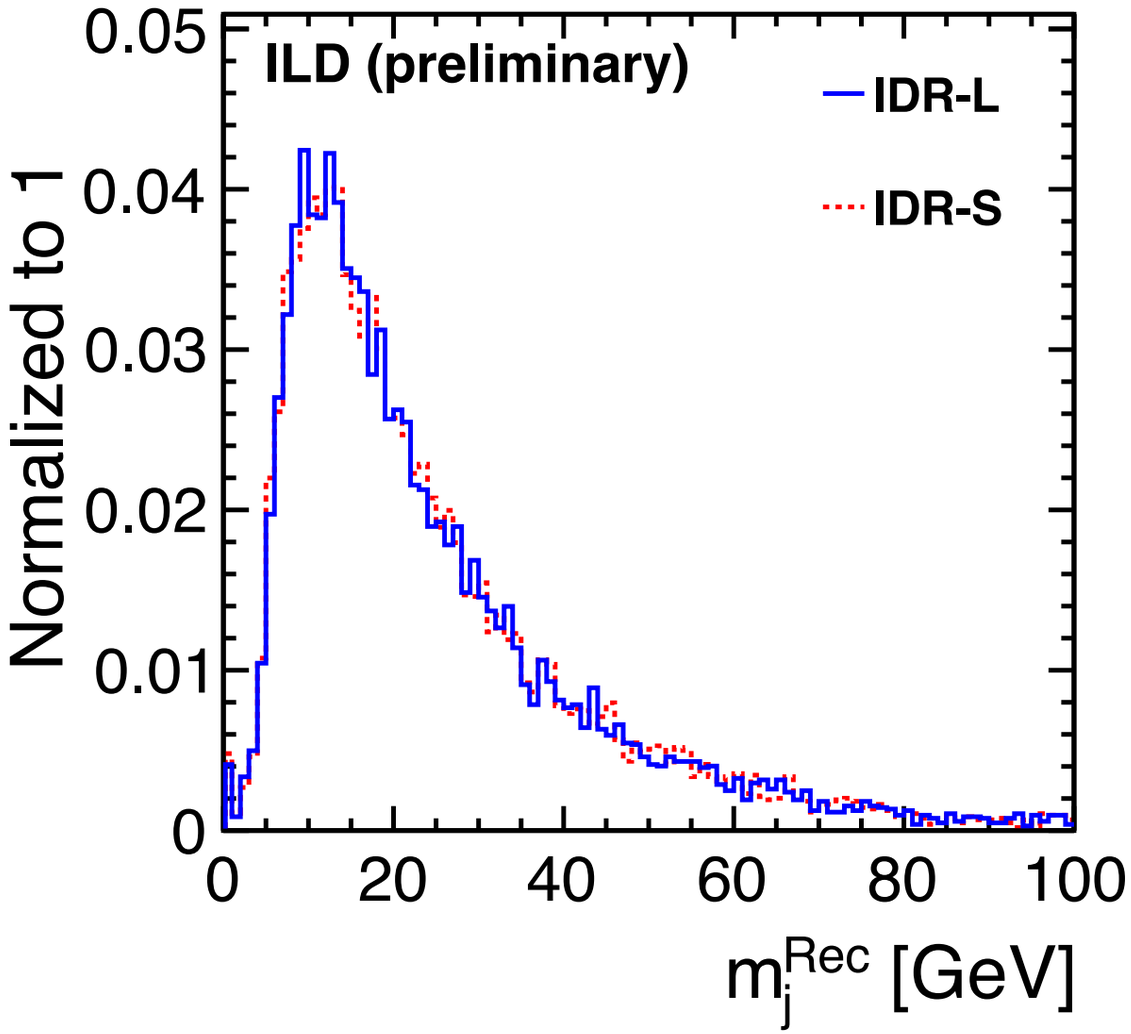


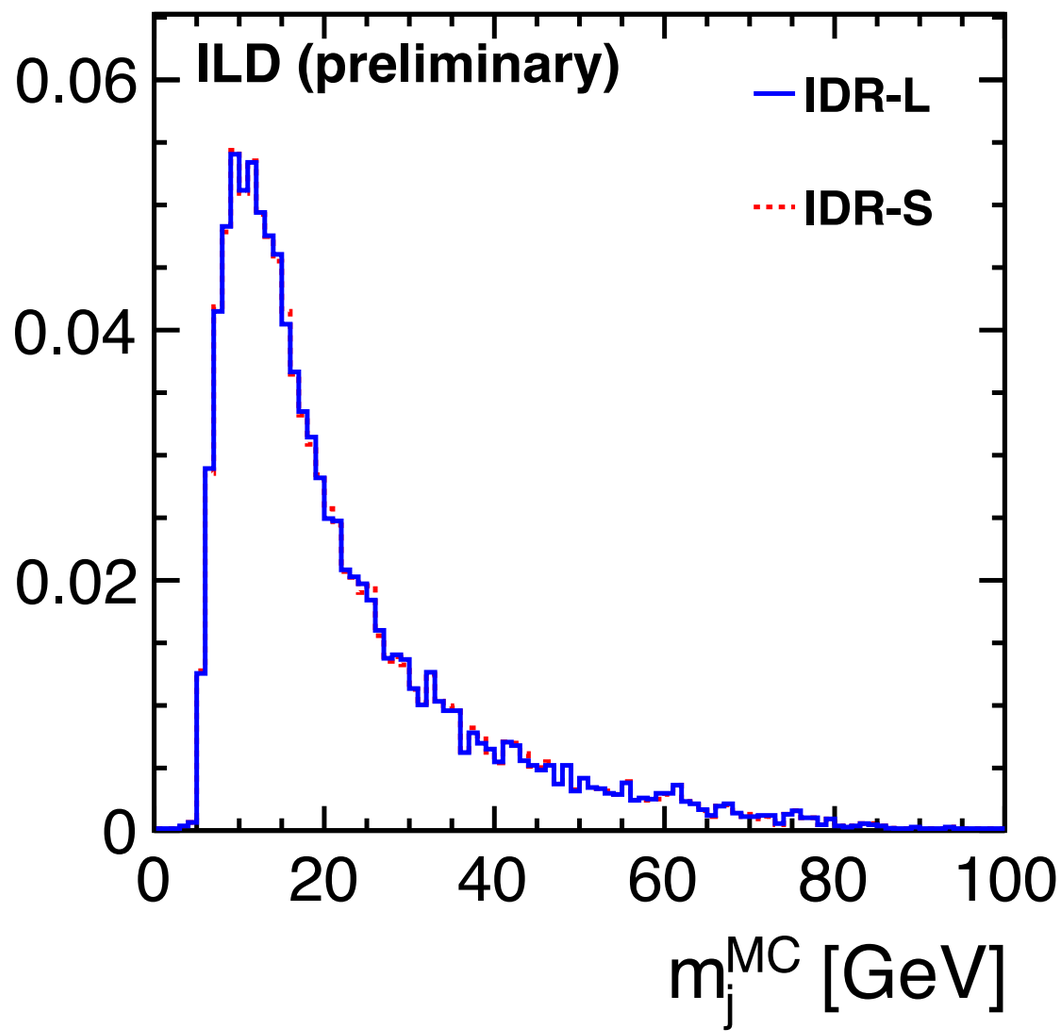


reconstructed jet mass is totally different with quark mass

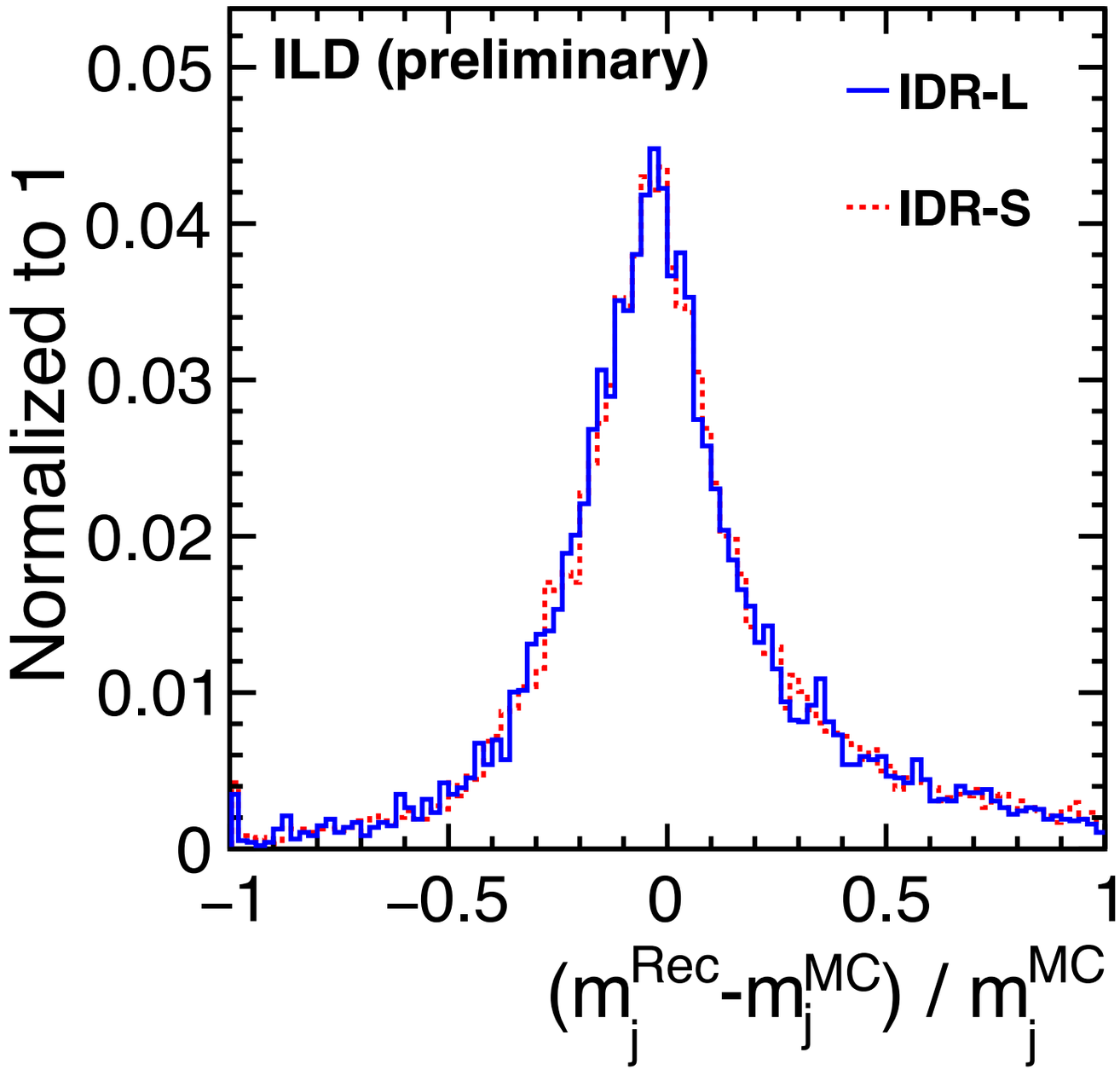
what MC truth should we compare to?

jet obtained with MC particles using same jet-clustering algorithm



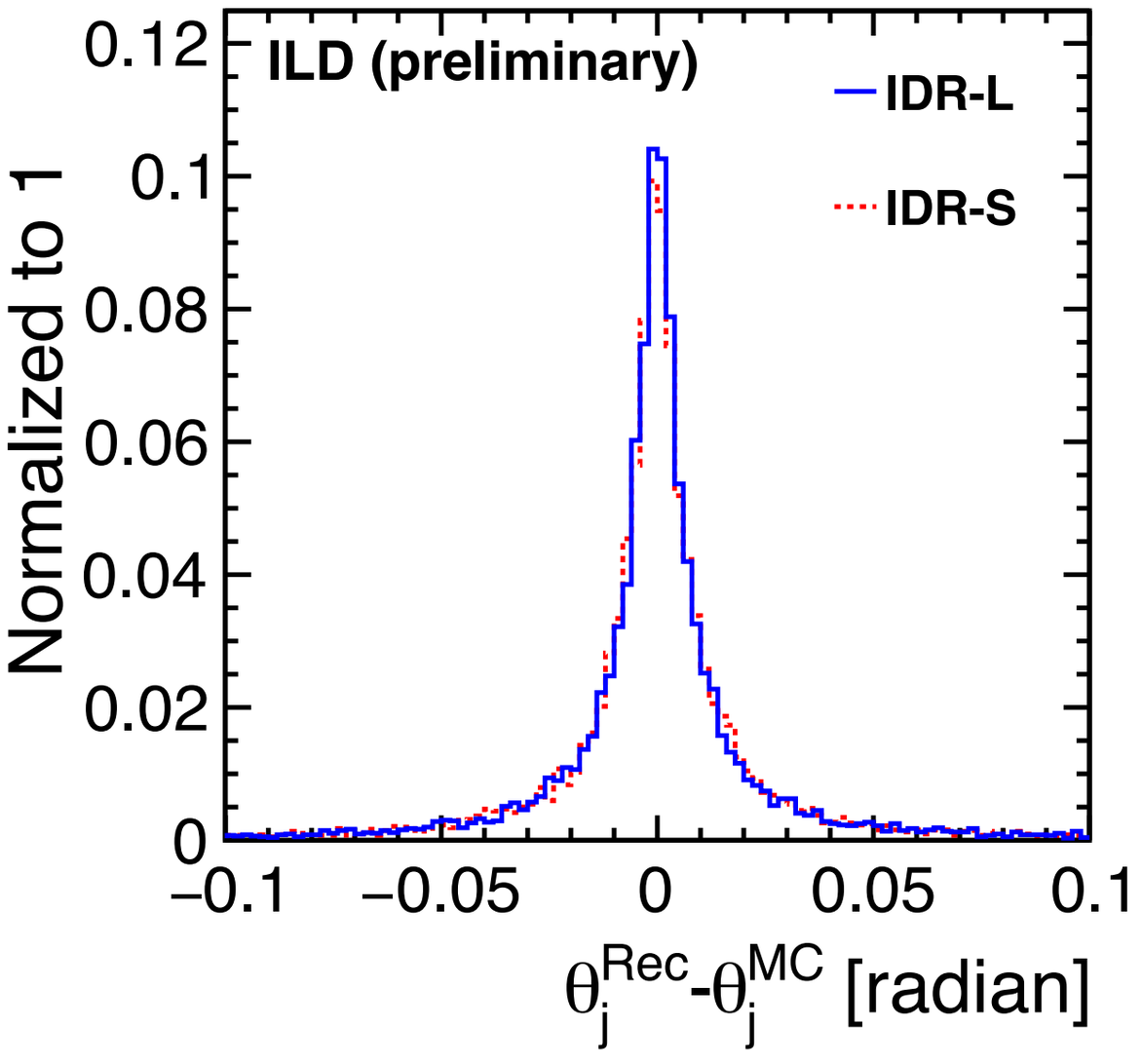


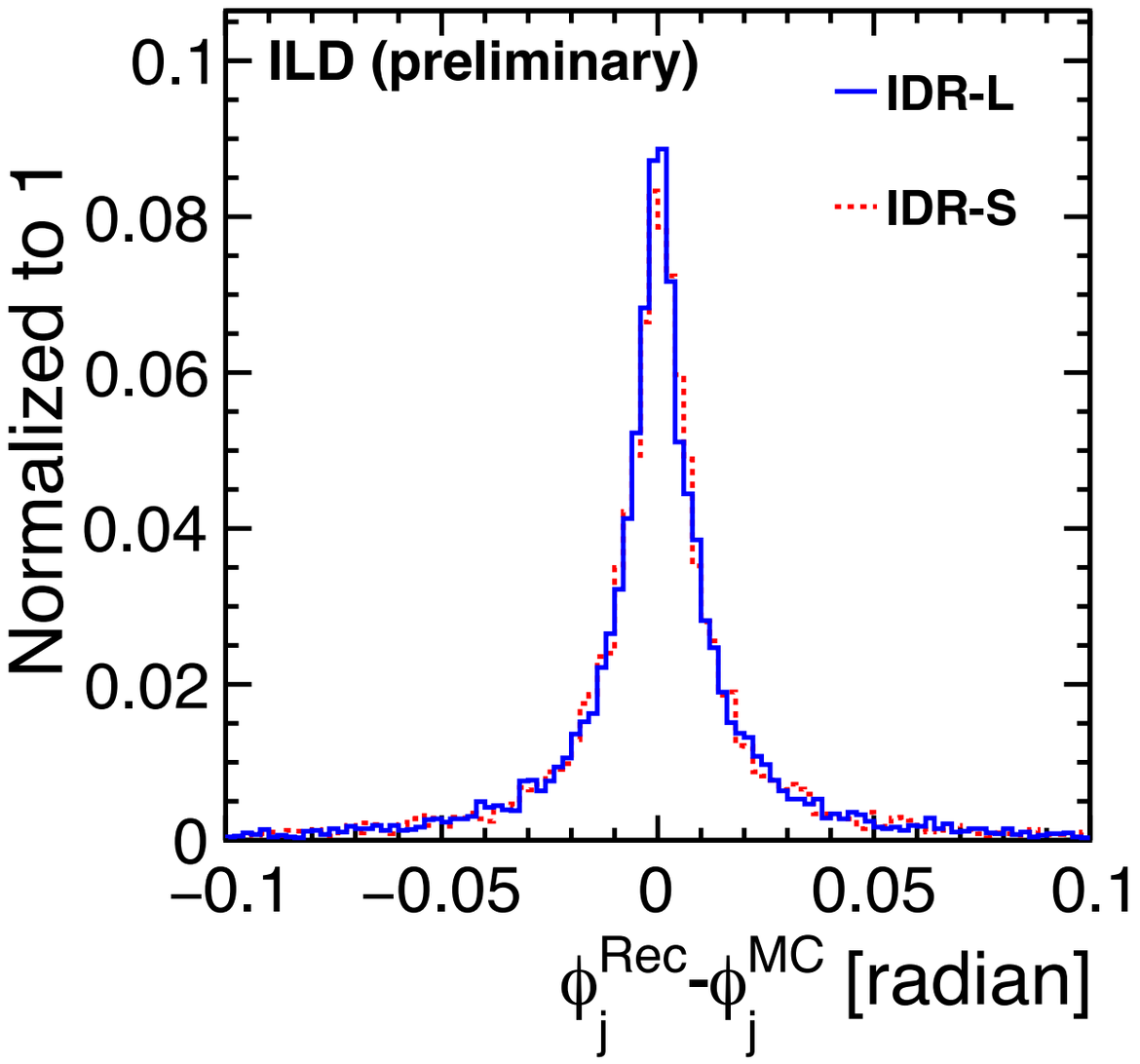
jet mass: reconstructed versus MC truth



the MC truth proposed earlier is a better one for comparison

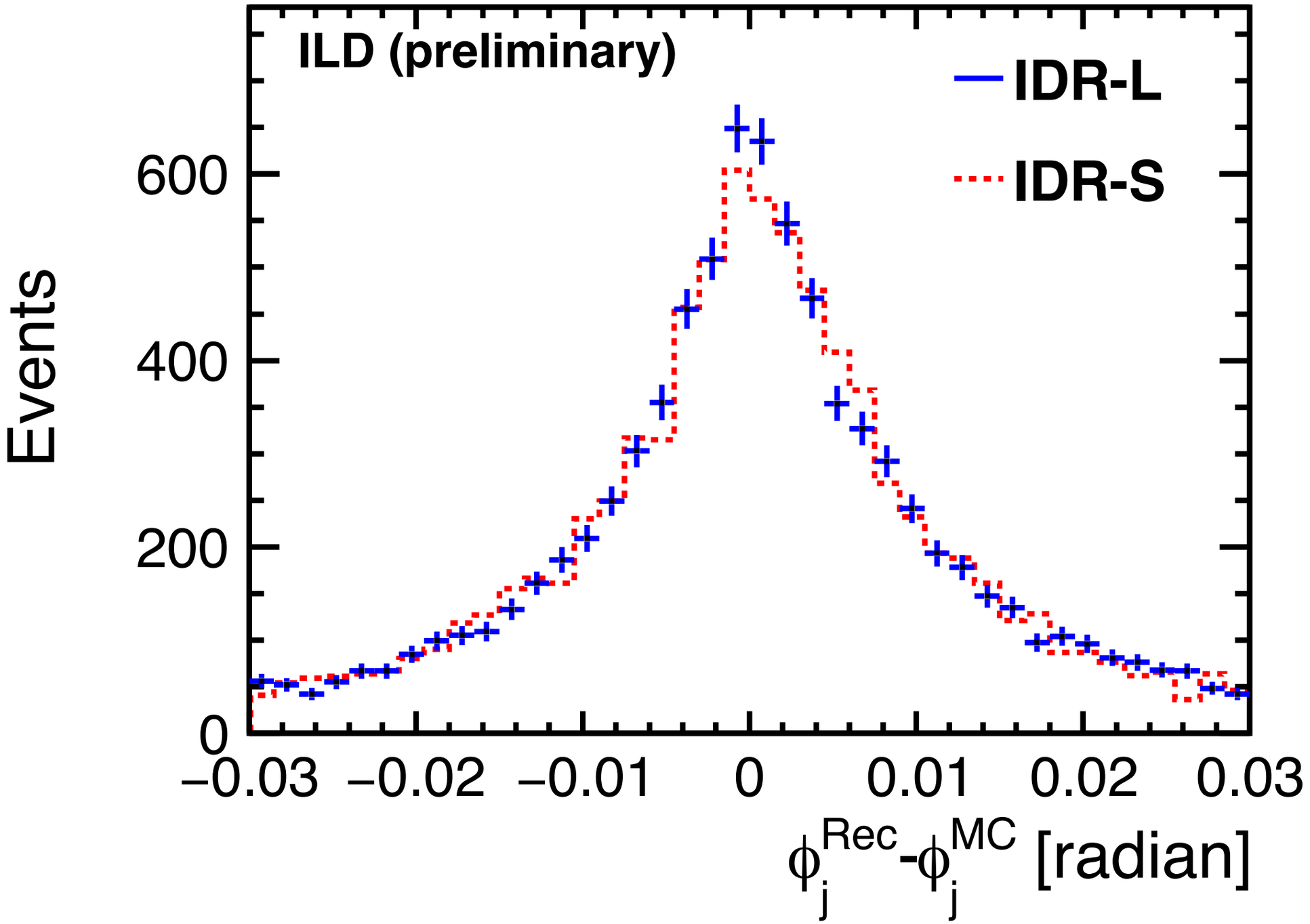
resolutions: with new proposal



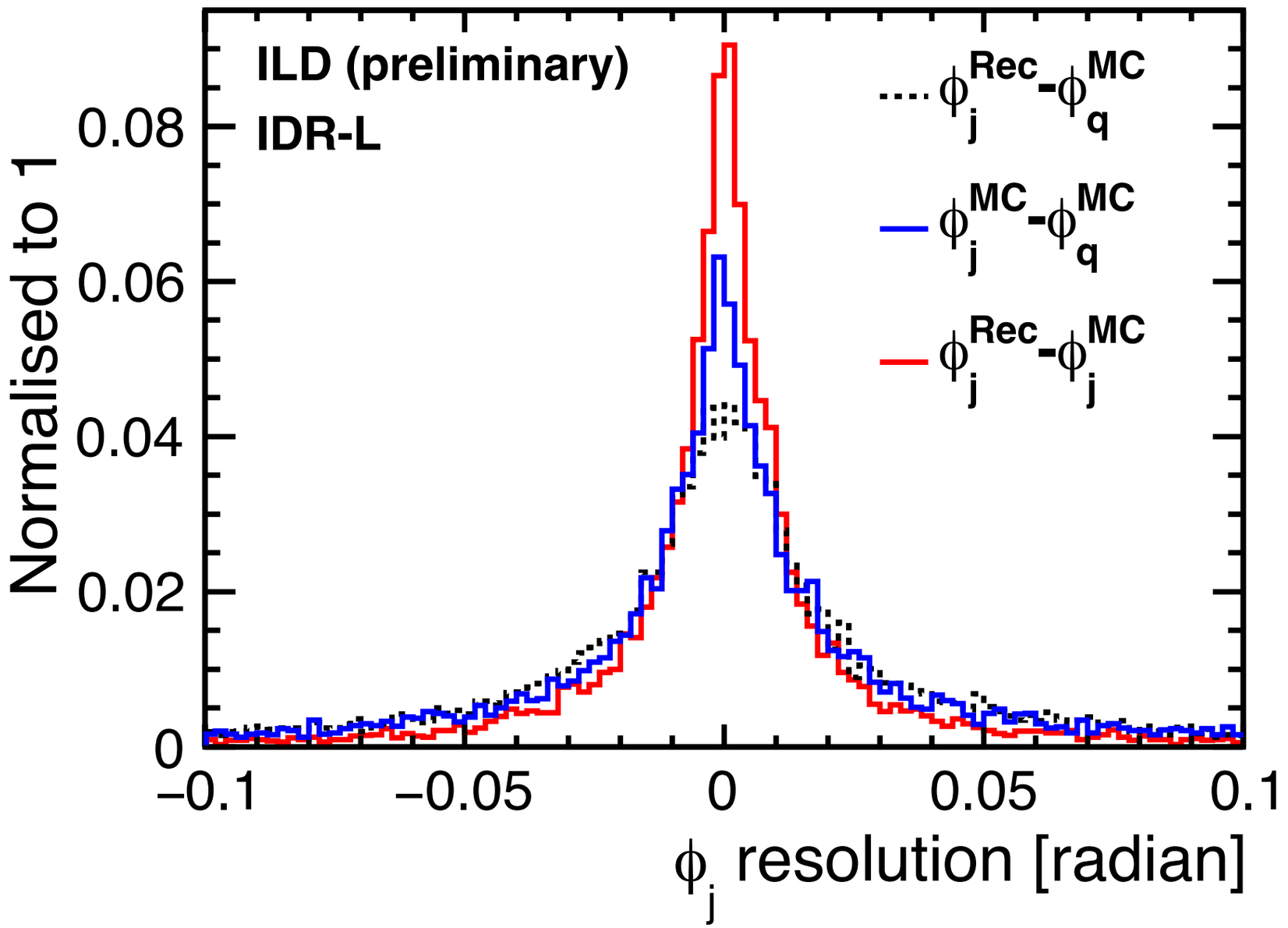


jet angle resolution: IDR-L seems slightly better than IDR-S

endless fight with statistics

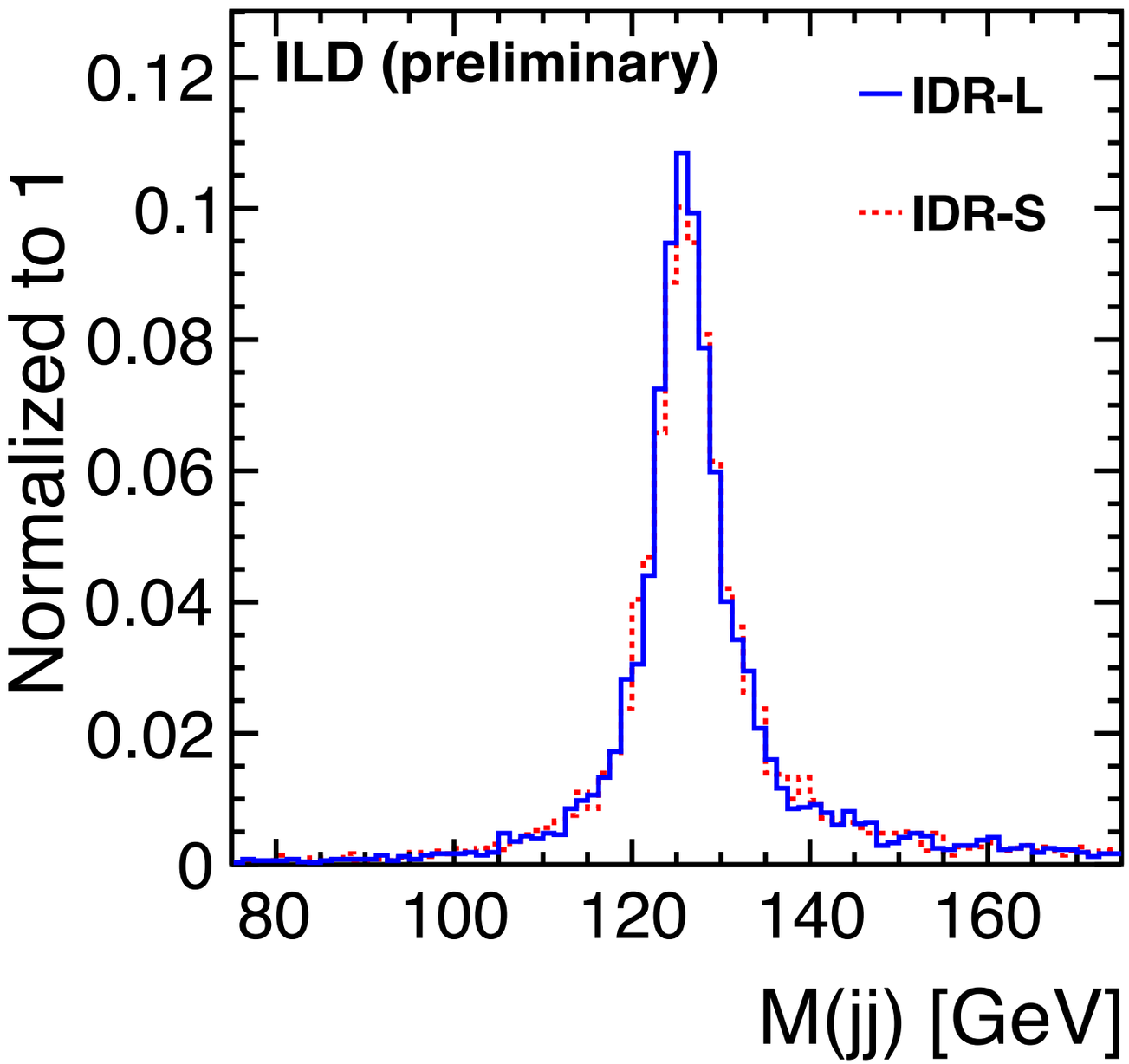


resolutions: why didn't see the difference before



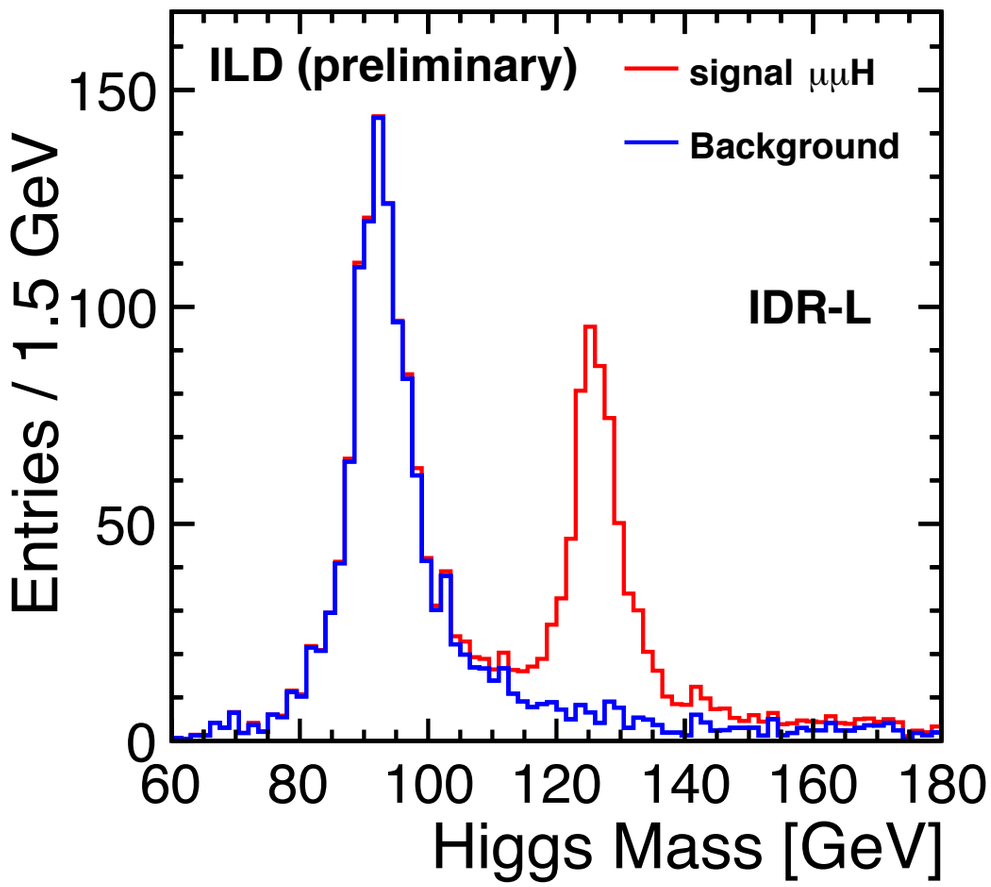
note the different color code

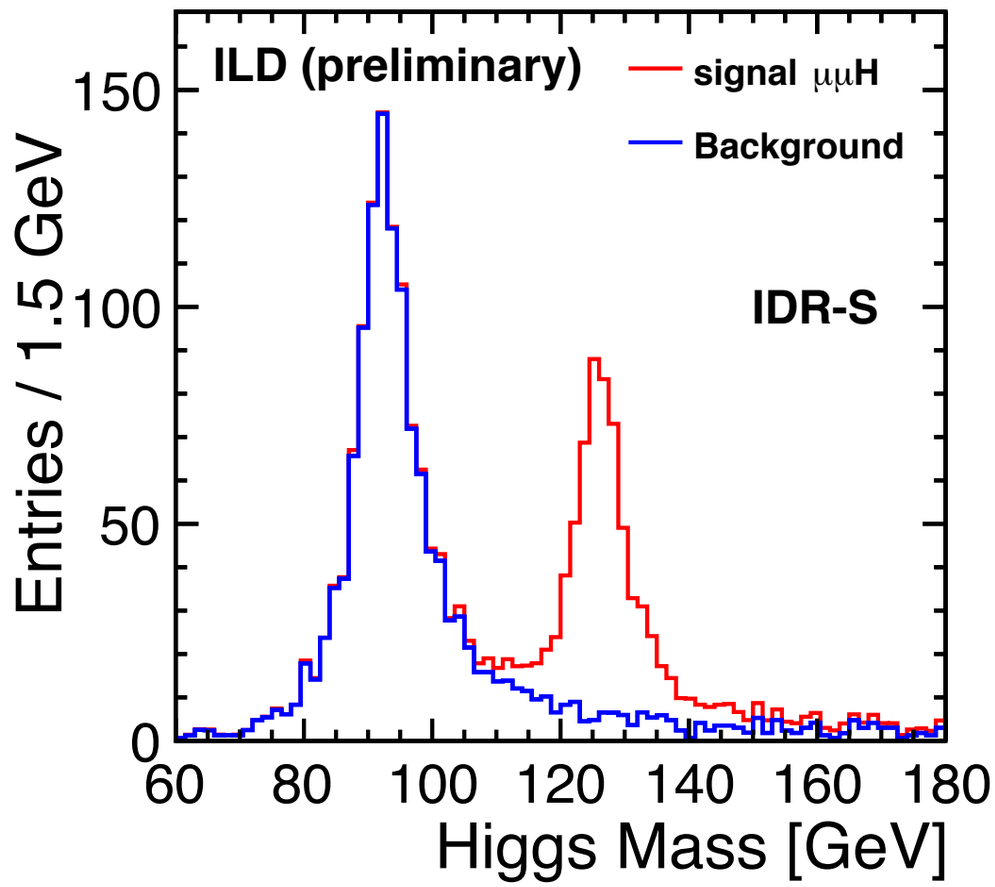
final observable: Higgs mass



final observable: Δm_H from full analysis

Preliminary $\sqrt{s} = 500$ GeV $e^+e^- \to \mu\mu H, H \to b\bar{b}$ $\int Ldt = 500$ fb^{-1}





$\int Ldt = 4$ ab^{-1}

$P(e^-, e^+) = (-0.8, +0.3)$

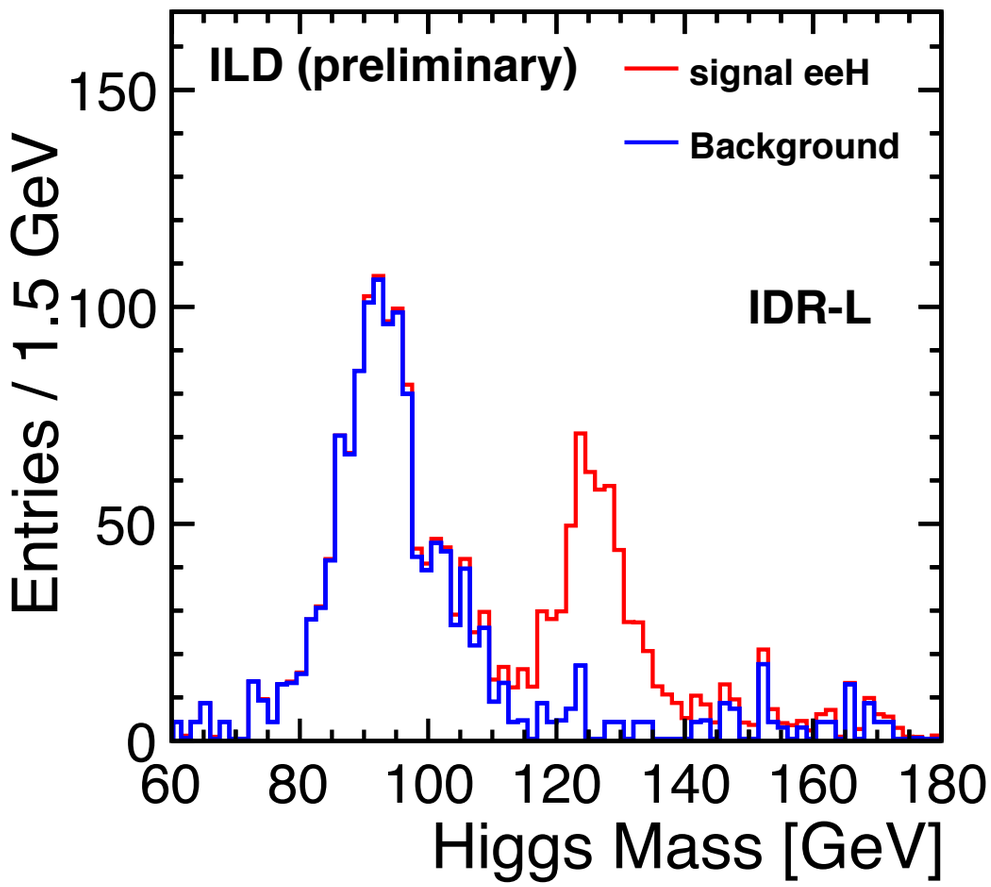
Large: Δm_H = 66 MeV

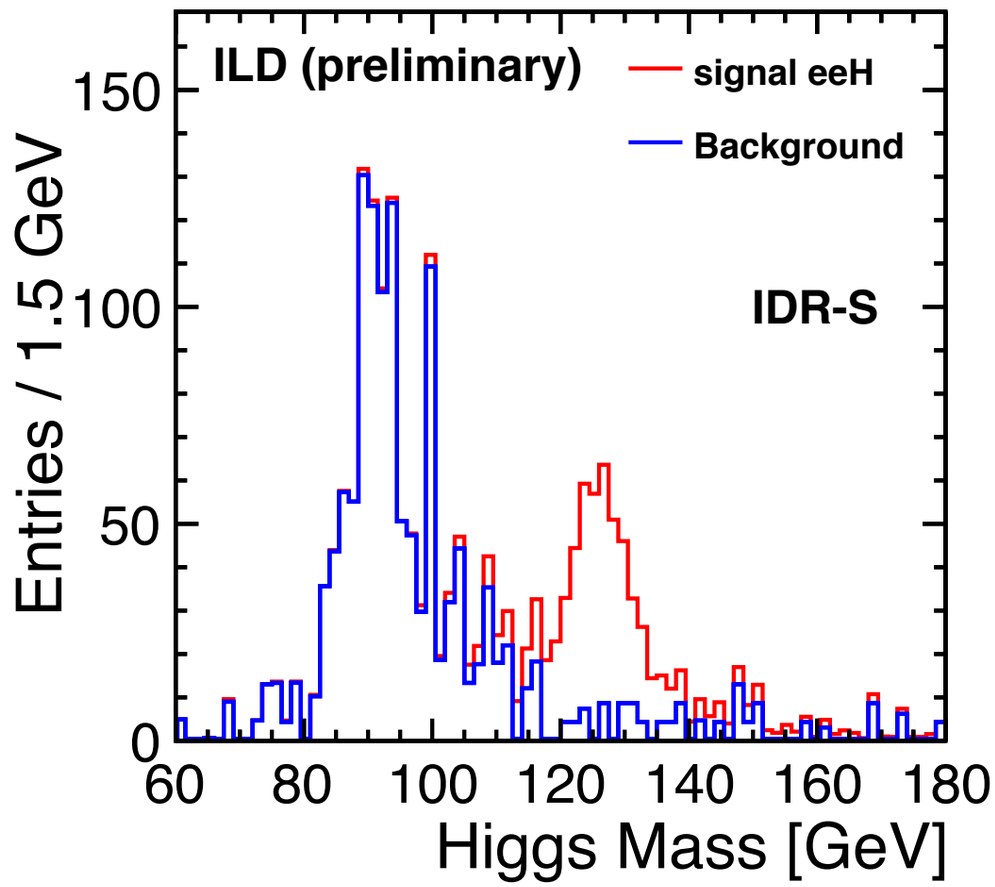
Small: Δm_H = 81 MeV

22% diff.

final observable: Δm_H from full analysis

Preliminary $\sqrt{s} = 500$ GeV $e^+e^- \to eeH, H \to b\bar{b}$ $\int Ldt = 500$ fb^{-1}





$\int Ldt = 4$ ab^{-1}

$P(e^-, e^+) = (-0.8, +0.3)$

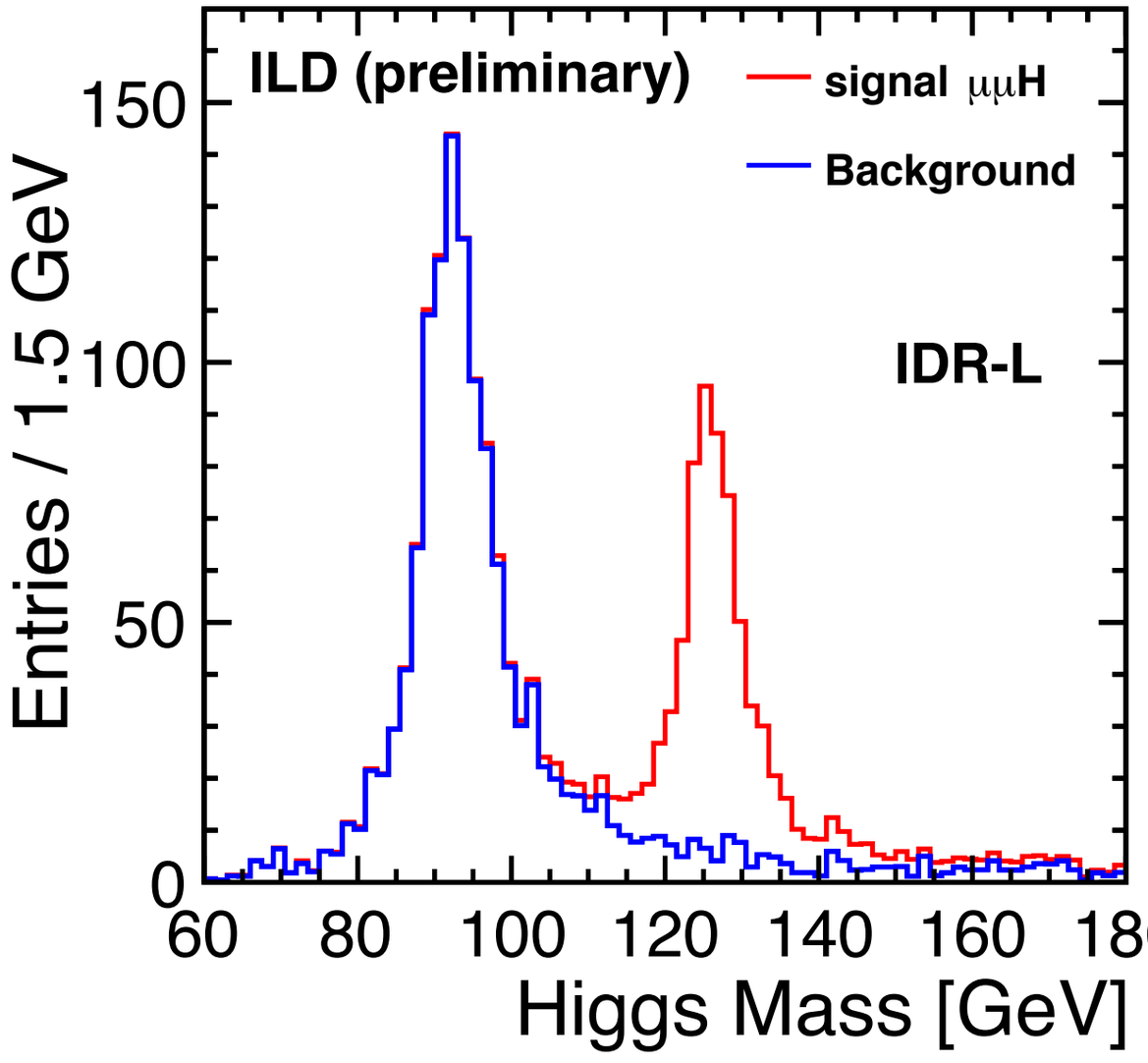
Large: Δm_H = 104 MeV

Small: Δm_H = 113 MeV

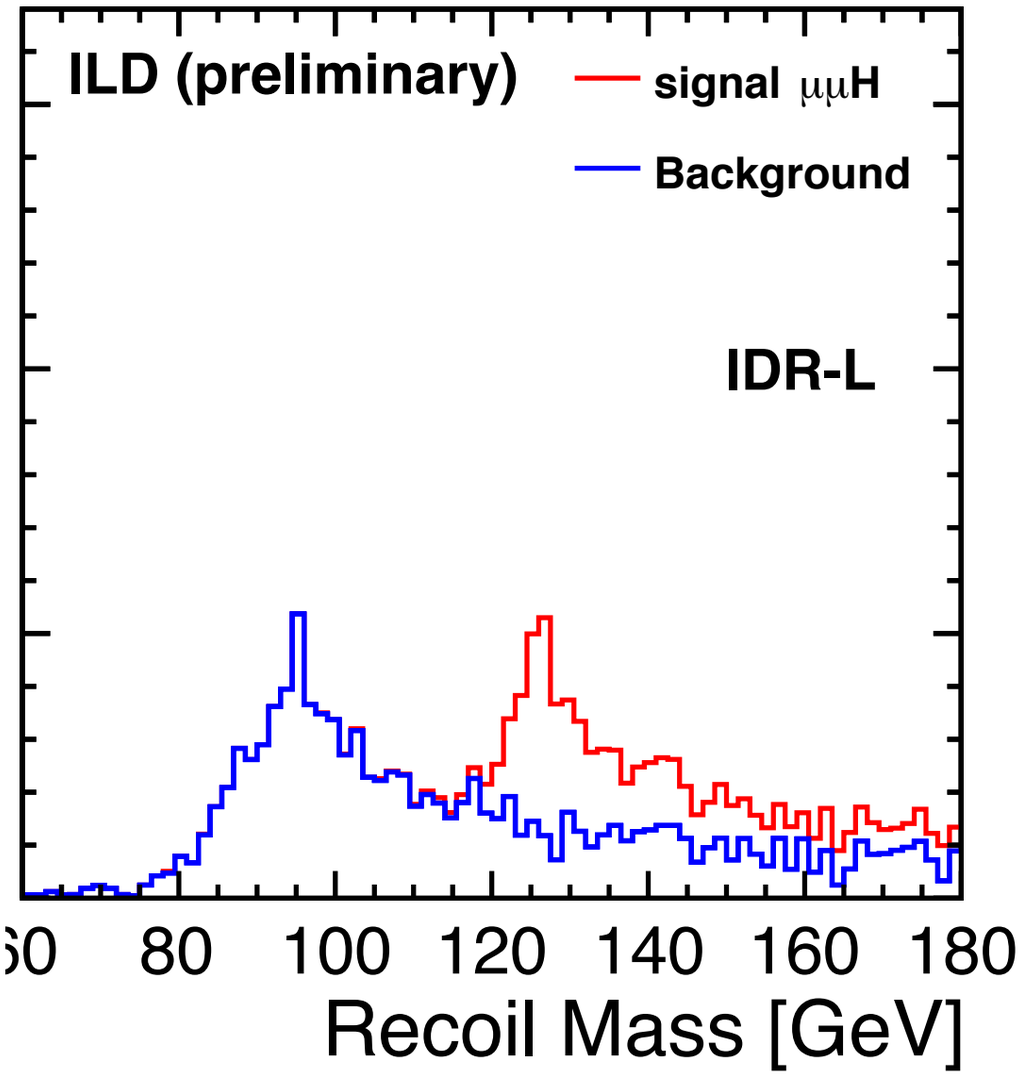
10% diff.

some fun

new method

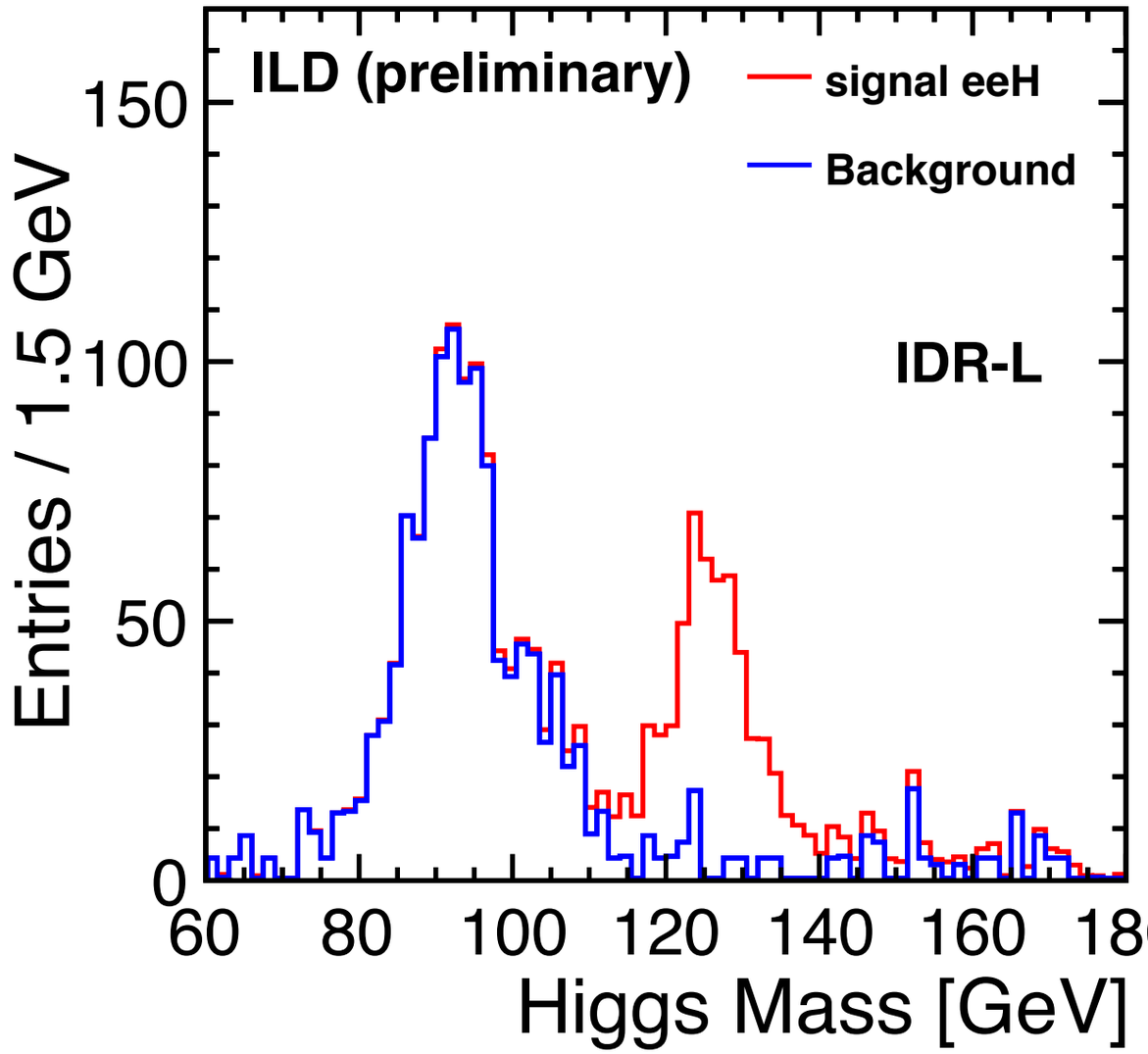


recoil method

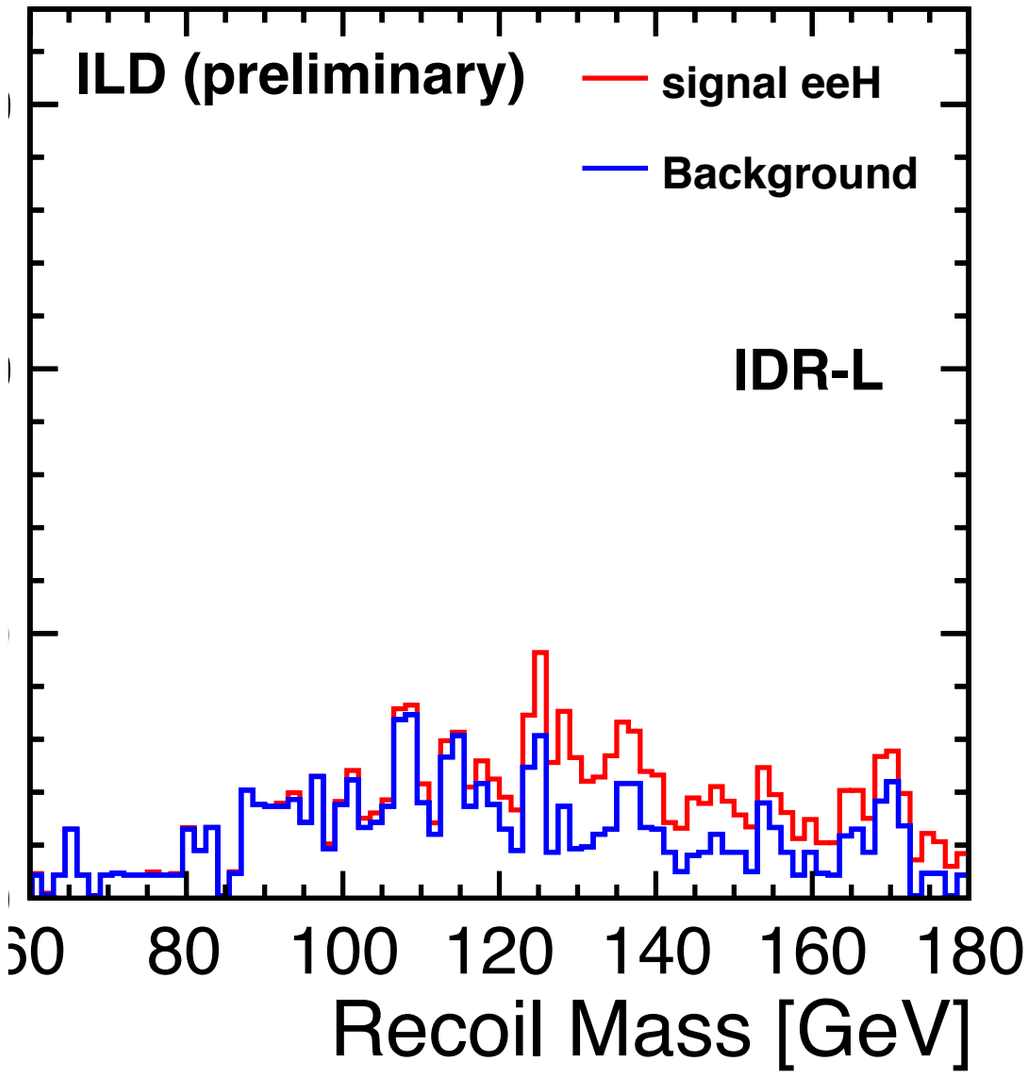


some fun

new method



recoil method

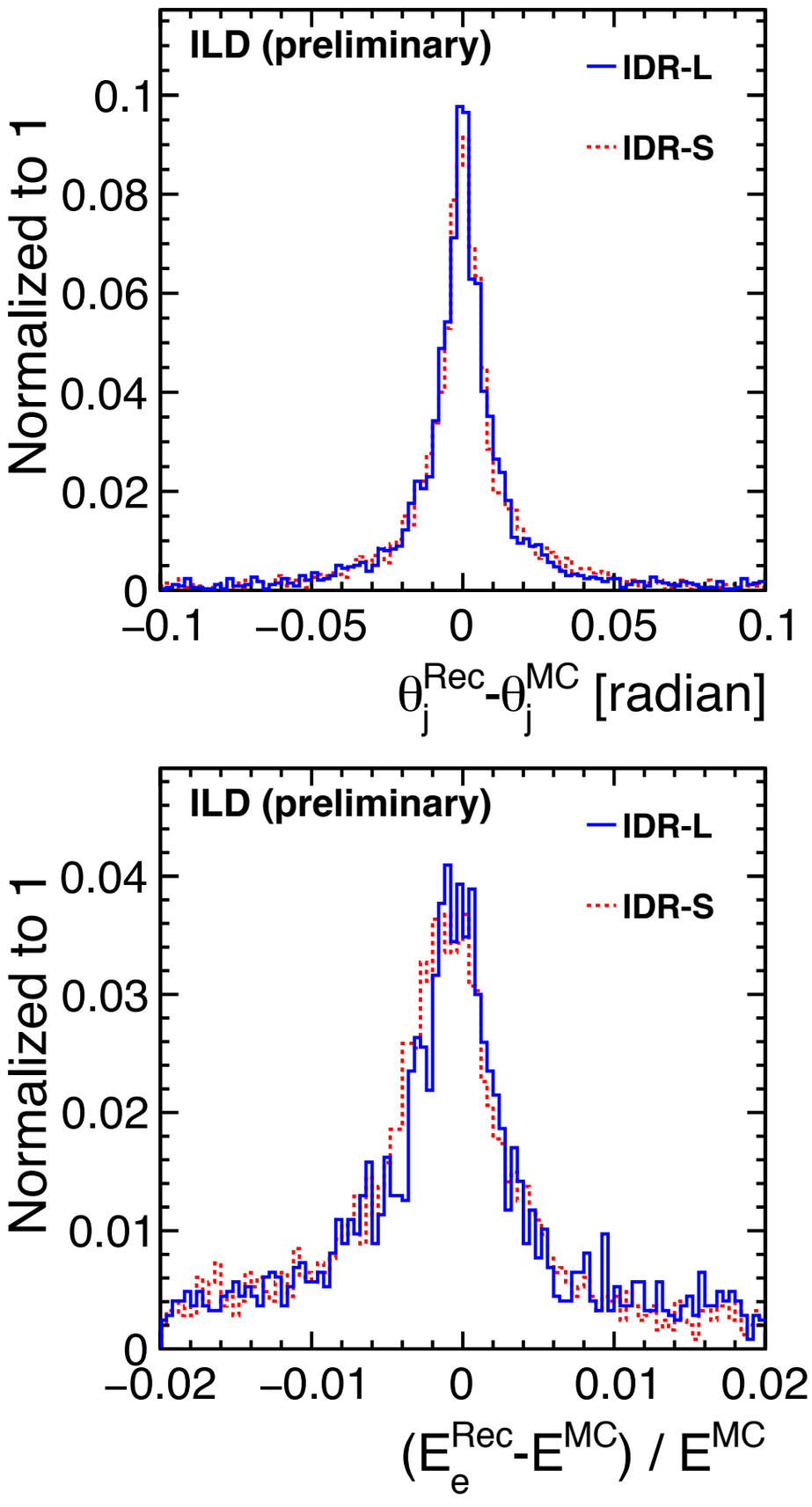


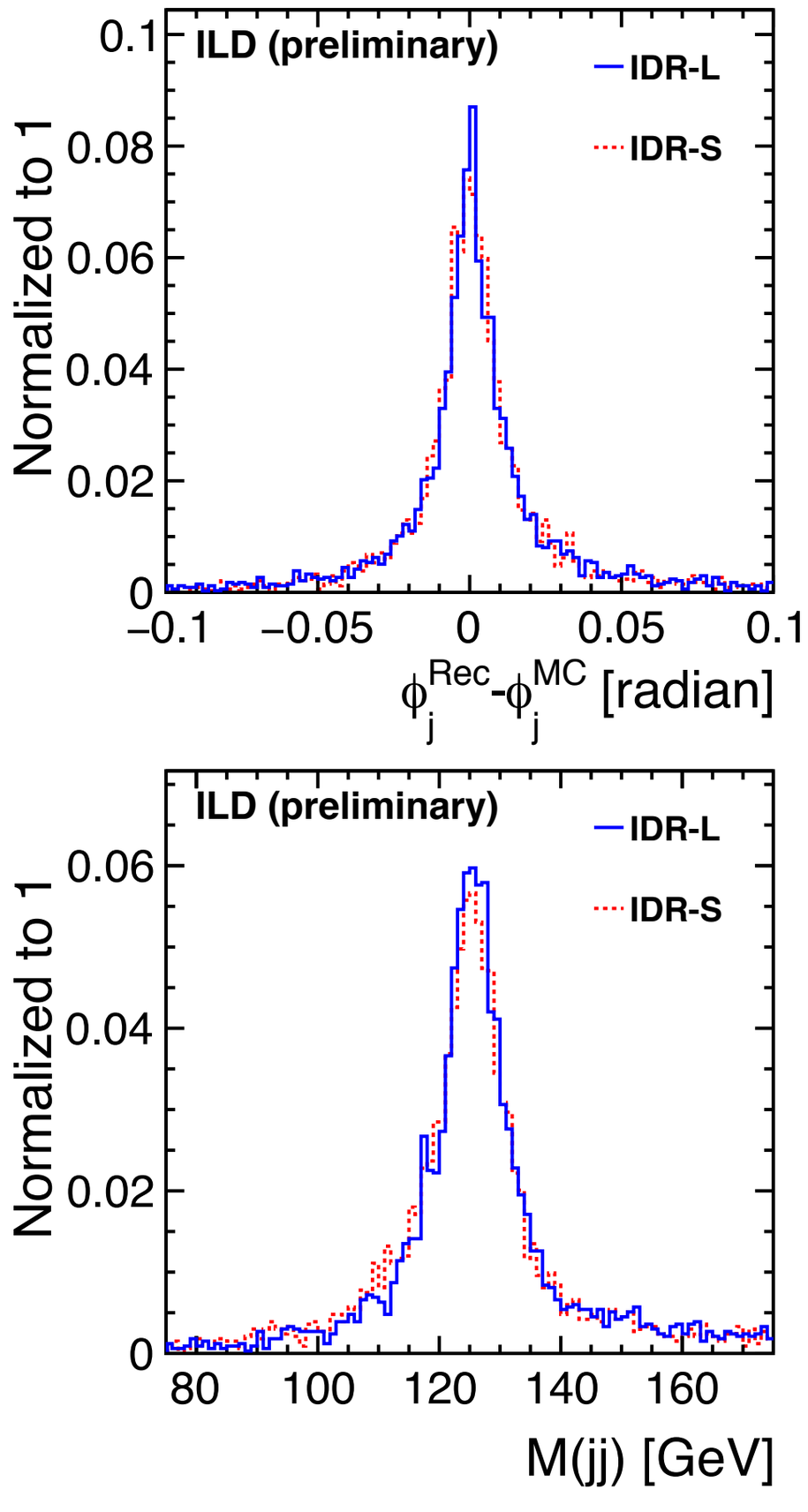
next step

- discuss with referee (F.Simon)
- complete ILD note
- update code in github
- refine plots if higher statistics would be available

backup

resolutions: $e^+e^- \to eeH, H \to b\bar{b}$



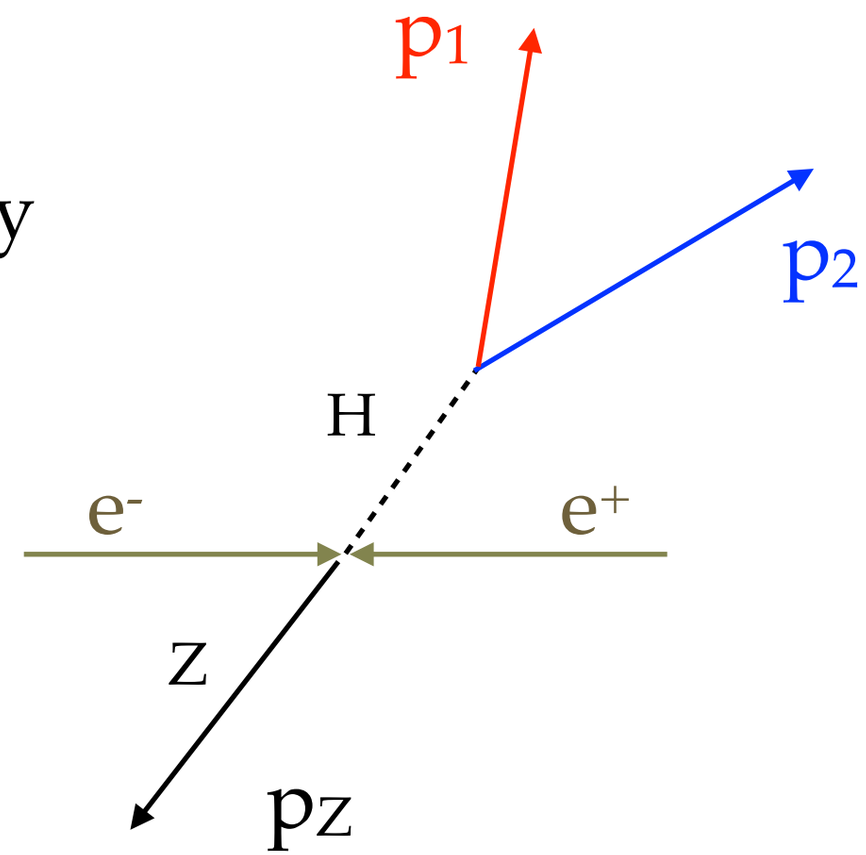


idea of a new method for measurement of m_H

(talk at LCWS17)

strategy

- require momentum balance only in transverse direction
- use measured jet direction, but not energy
- two constraints -> two unknown (p1, p2)



advantage

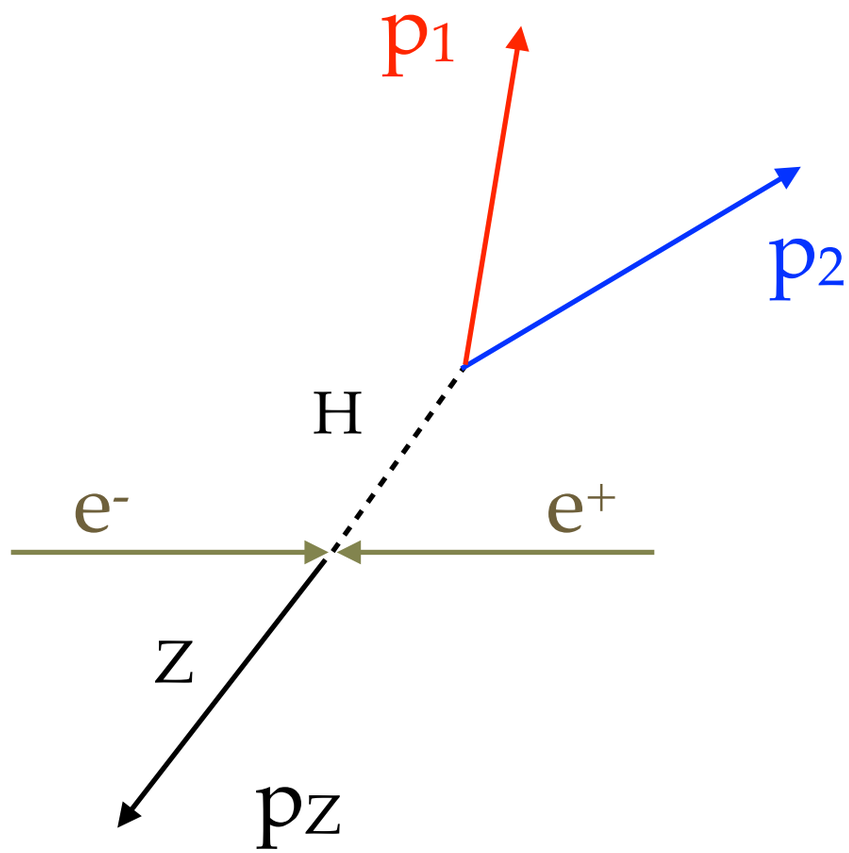
- insensitive to beam energy
- insensitive to beamstrahlung/ISR
- insensitive to (b)-jet energy (scale & resolution)

analytic results

$$p_1 \sin\theta_1 \cos\phi_1 + p_2 \sin\theta_2 \cos\phi_2 = p_x$$

$$p_1 \sin\theta_1 \sin\phi_1 + p_2 \sin\theta_2 \sin\phi_2 = p_y$$

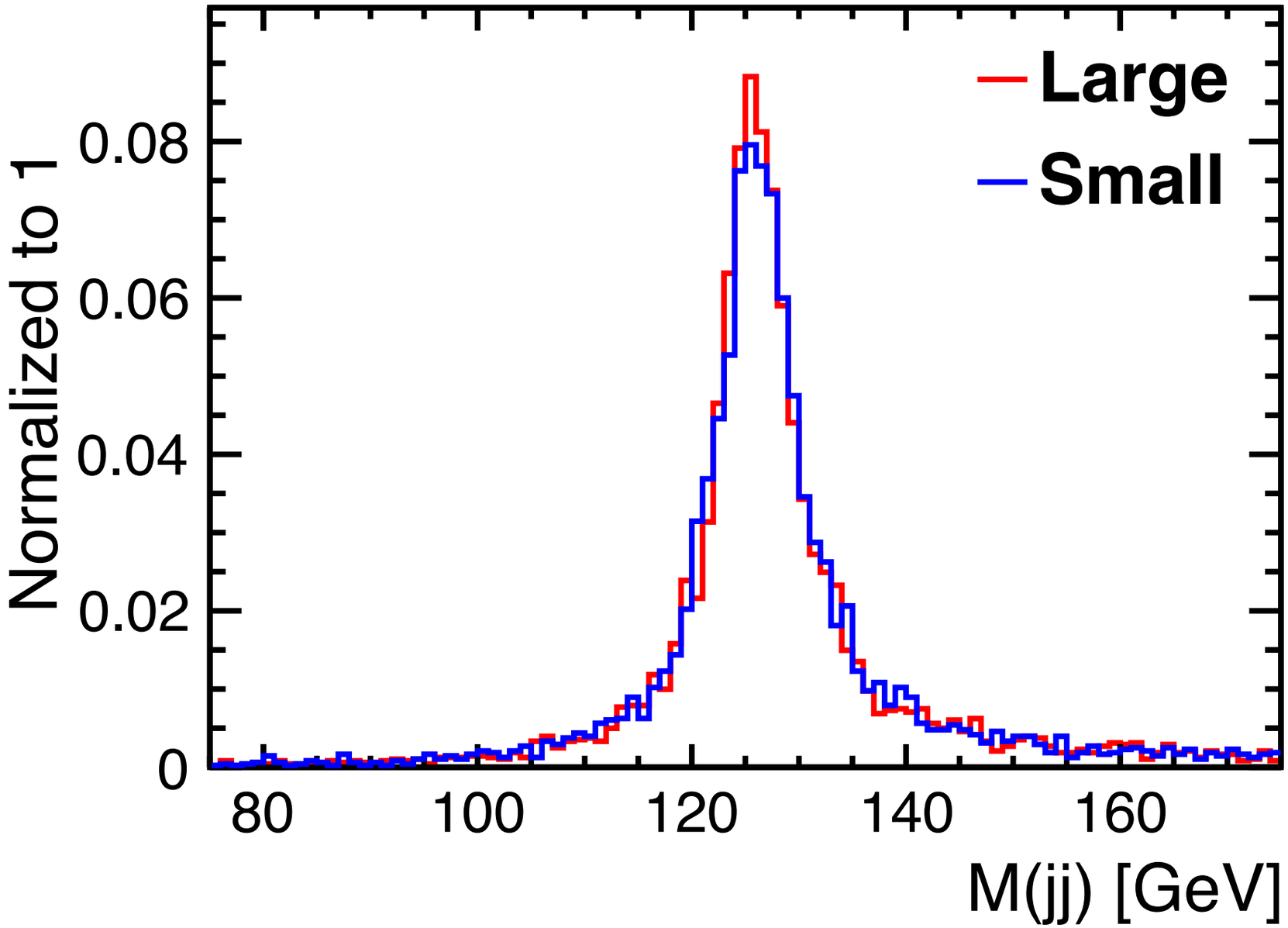
(px, py: measured from p_Z)



$$\boxed{\begin{pmatrix} p_1 \\ p_2 \end{pmatrix} = \frac{p_t}{\sin\phi} \begin{pmatrix} \frac{\sin(\phi - \phi_2)}{\sin\theta_1} \\ \frac{\sin(\phi_1 - \phi)}{\sin\theta_2} \end{pmatrix}}$$

$$\phi = \phi_1 - \phi_2 \qquad p_t = \sqrt{p_x^2 + p_y^2}$$

final: Higgs mass (new method)



σ~3.2 GeV

σ~3.7 GeV

(core part: [120, 130] GeV)