Higgs measurement in the four jets final state at a e+e- collider

Prepared by: Gaoyuan Wang (ATLAS)

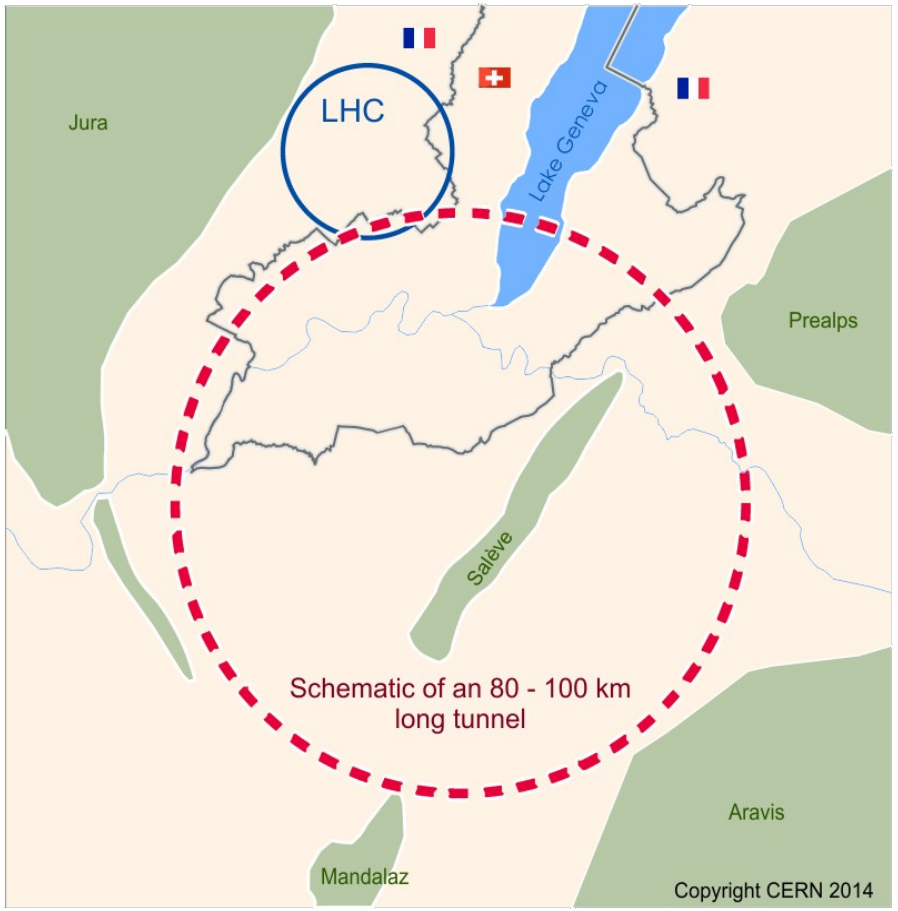
Supervisor: Jike Wang
Krisztian Peters

Outline

- e+e- Collider (FCC-ee, ILC) study
- Event sample generation – three tools
- Results and outlook

e+e- collider study

- FCC/ILC: High-luminosity, high-presicion e+e- collider.
- It could serve as a Higgs and Z factory.
- It enables Higgs precision measurement.
- We aim to study the Z(jj)H(bb) channel and the sensitivity depending on the detector parameters.



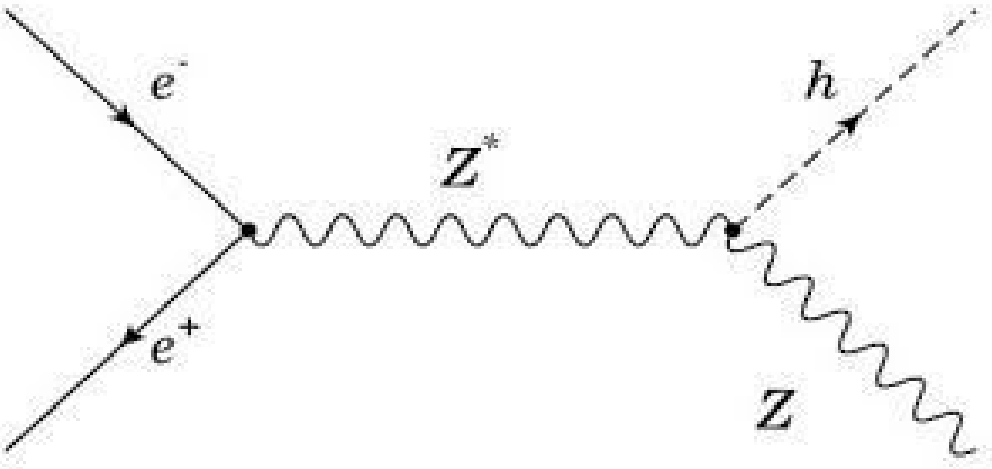
e+e- collider study

1. Sample the signal and background events.

2. Simulate the detector response.

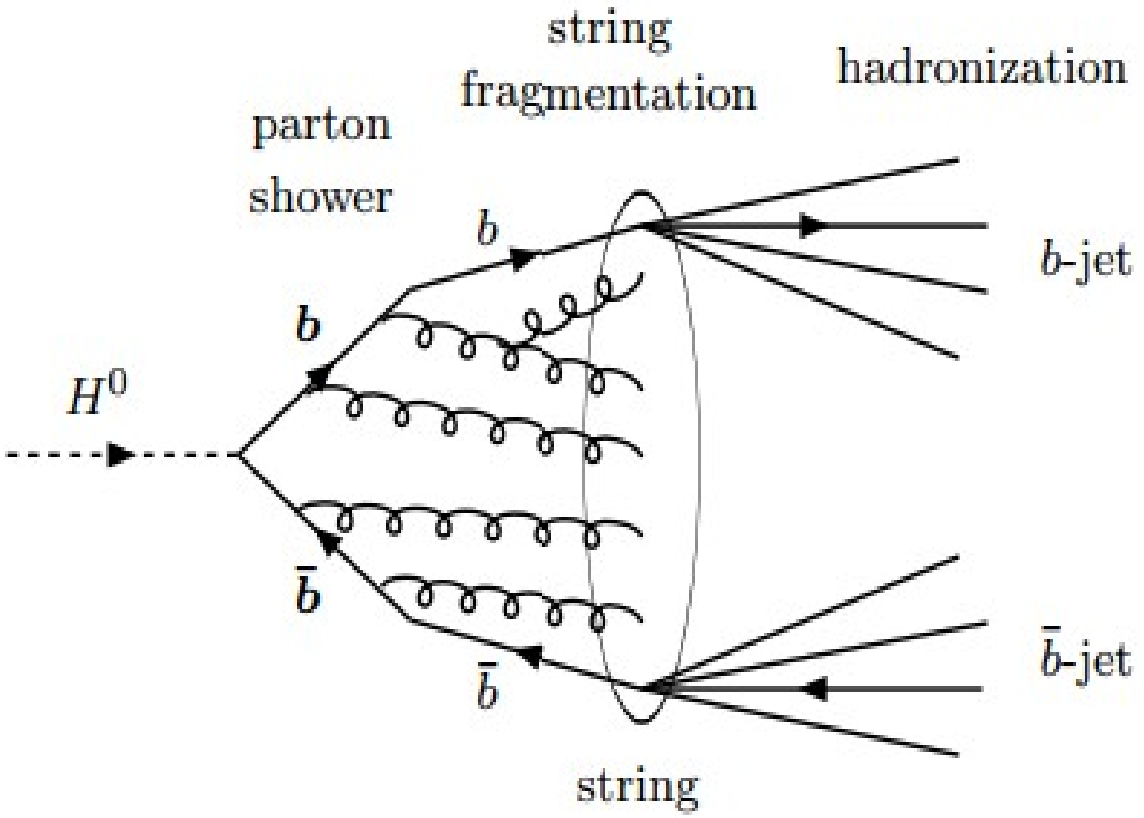
3. Study the reconstructed jets for signal and background.

Tools: Whizard->Pythia->Delphes



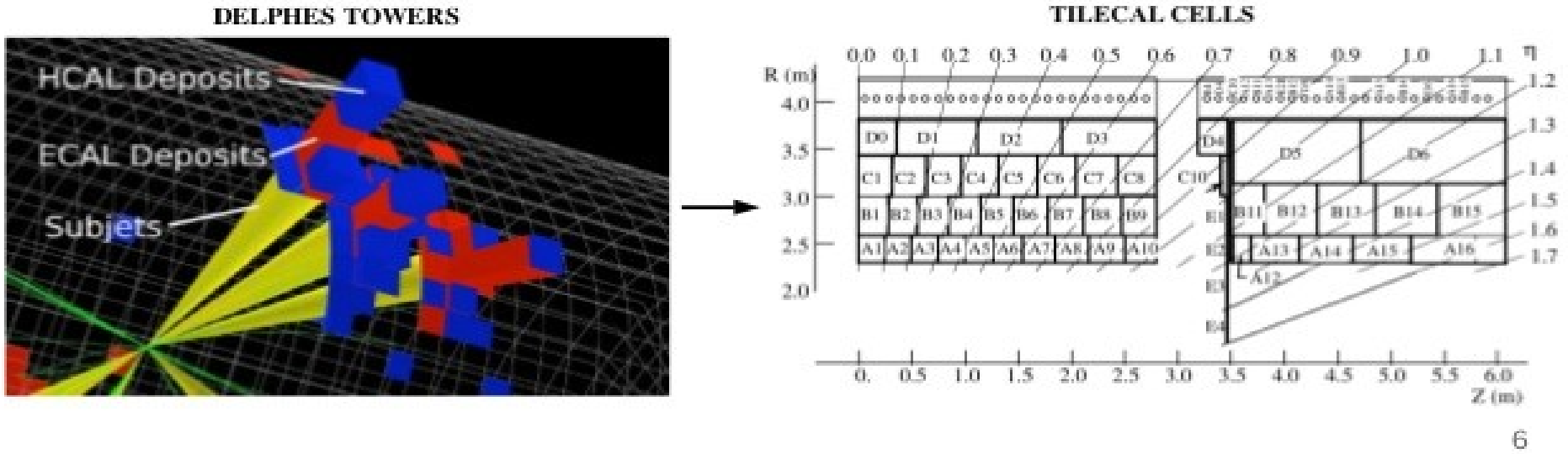
Efficient calculation of multi-particle scattering cross sections and simulation of event samples that can then be hadronized.

Tools: Whizard->Pythia->Delphes



PYTHIA is a program for the generation of high-energy physics events. It can simulate hard and soft interactions, parton distributions, initial- and final-state parton showers, multiparton interactions, fragmentation and decay.

Tools: Whizard->Pythia->Delphes



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Delphes performs a fast multipurpose detector response simulation. The simulation includes a tracking system, embedded into a magnetic field, calorimeters and a muon system.

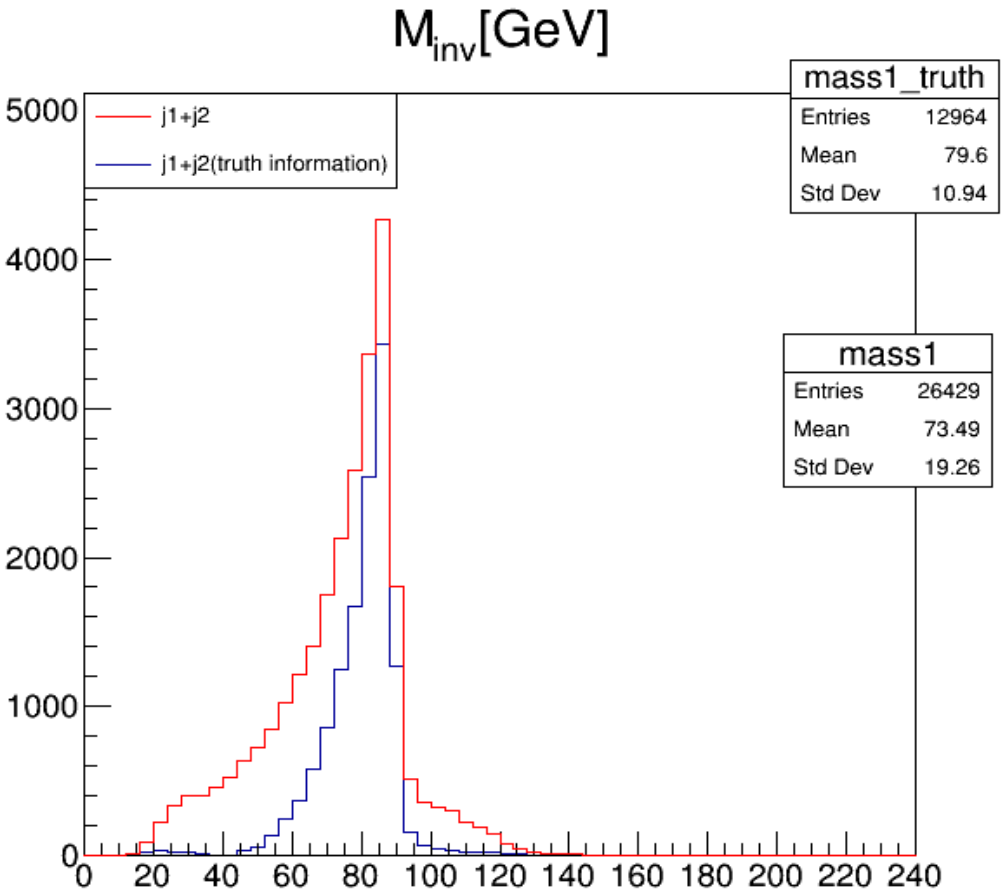
Tools: Whizard->Pythia->Delphes

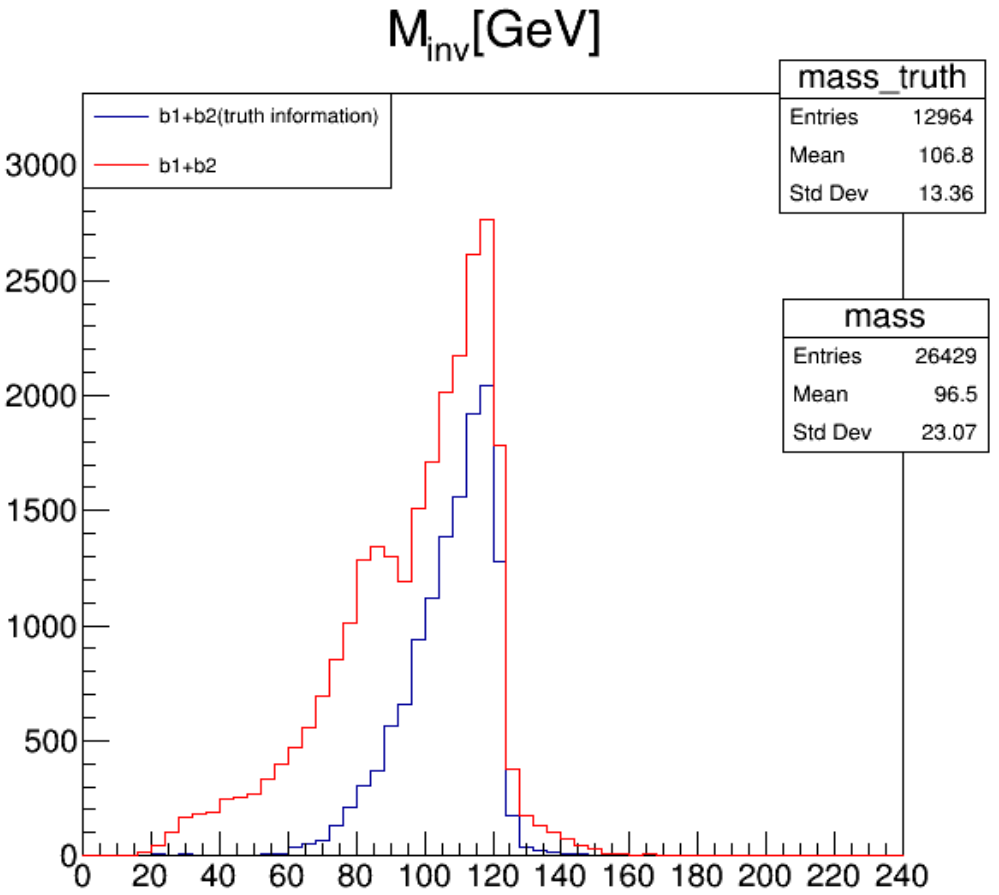
Detector parameters (ILD):

- Radius of the magnetic field coverage: 1.8m

  Magnetic field: Bz=3.5
- Charged Hadron Tracking Efficiency: For pt>0.1, |eta|<=2.4: 0.99
- Phi Bins : Ecal: 0.5 degree towers (5x5 mm^2), Hcal : 6 degree
- Eta Phi Bins: Ecal: 0.01 unit in eta up to eta = 2.5, Hcal: 0.5
- Ecal Resolution: For |eta| <= 2.5: sqrt(energy^2*0.01^2 + energy*0.15^2)
- Hcal Resolution: For |eta| <= 3.0: sqrt(energy^2*0.015^2 + energy*0.50^2)

With vs. without truth-matching



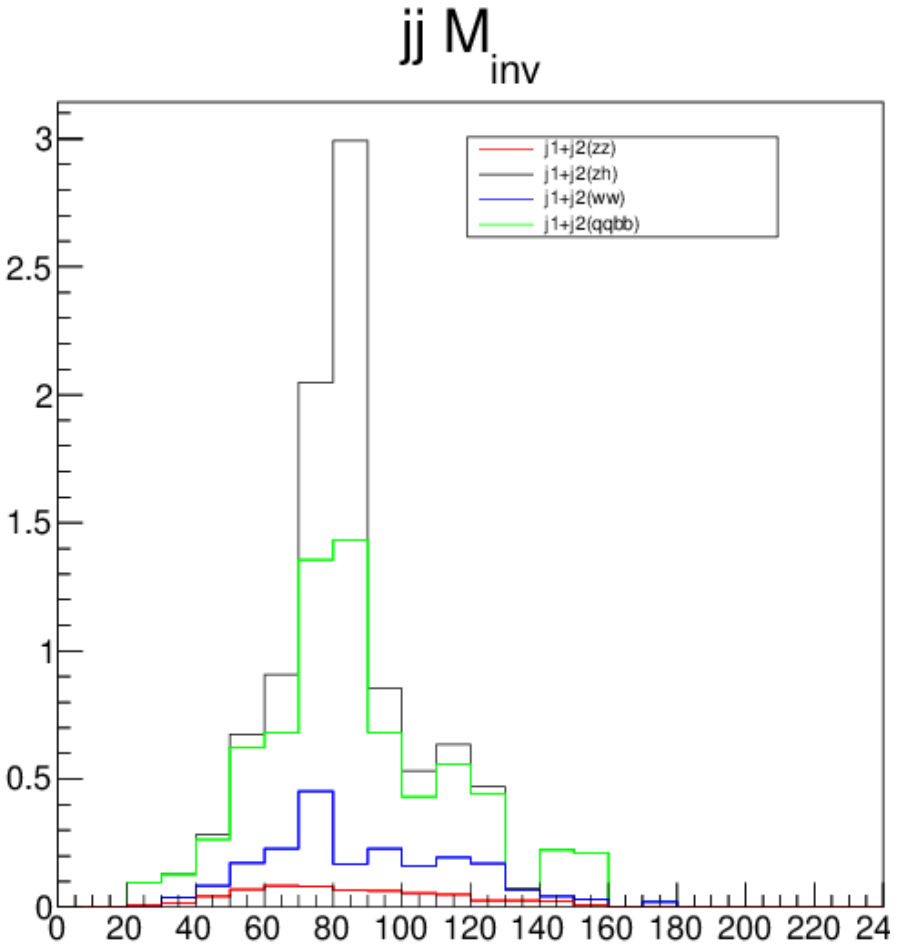


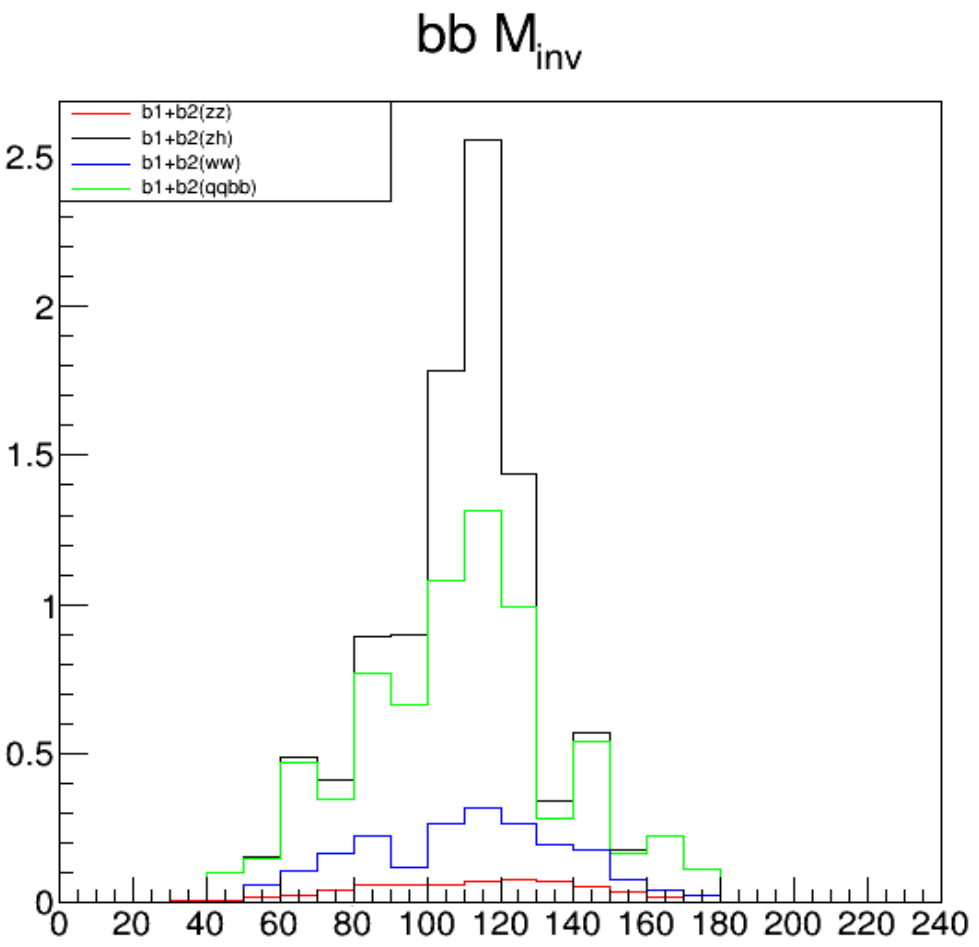
Delta R parameter: 0.5

Particles faking the signals:
b, tau...

Particles faking the signals:
tau, gluon...

Inv. Mass signal + background





Major background: zz, ww and 4 jets.

Cut: 4 jet inv. Mass > 180GeV

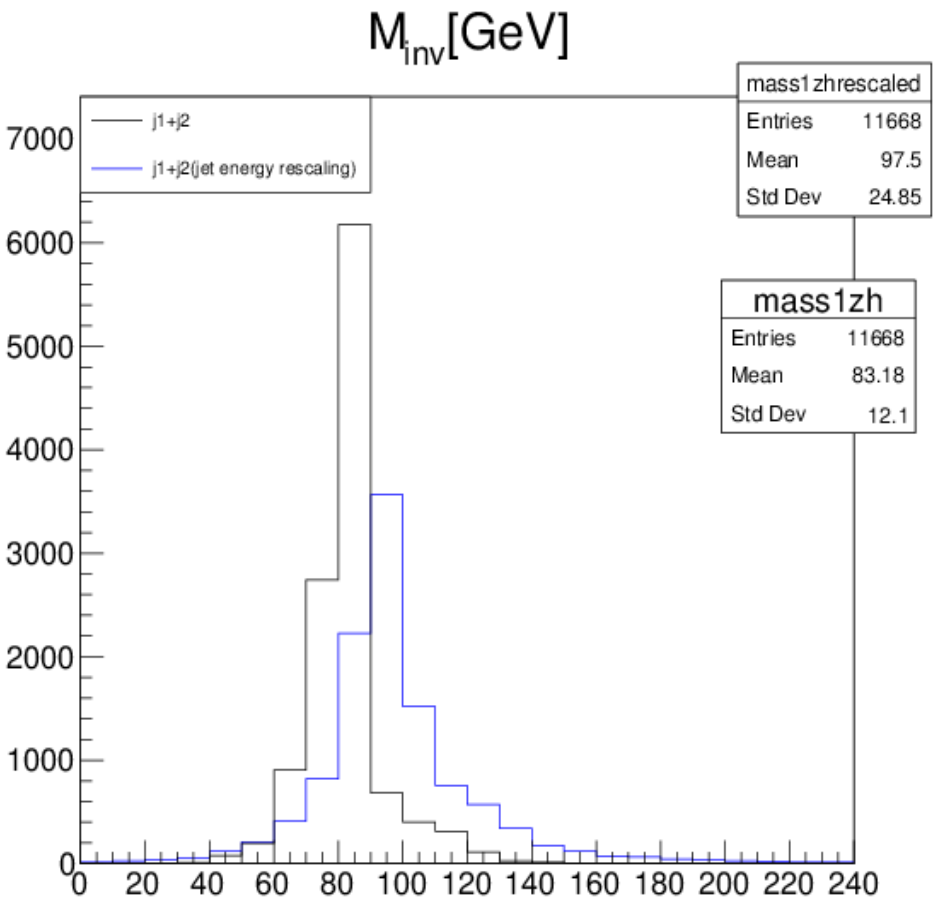
NCharge+NNeutral >=5, NCharge >=1

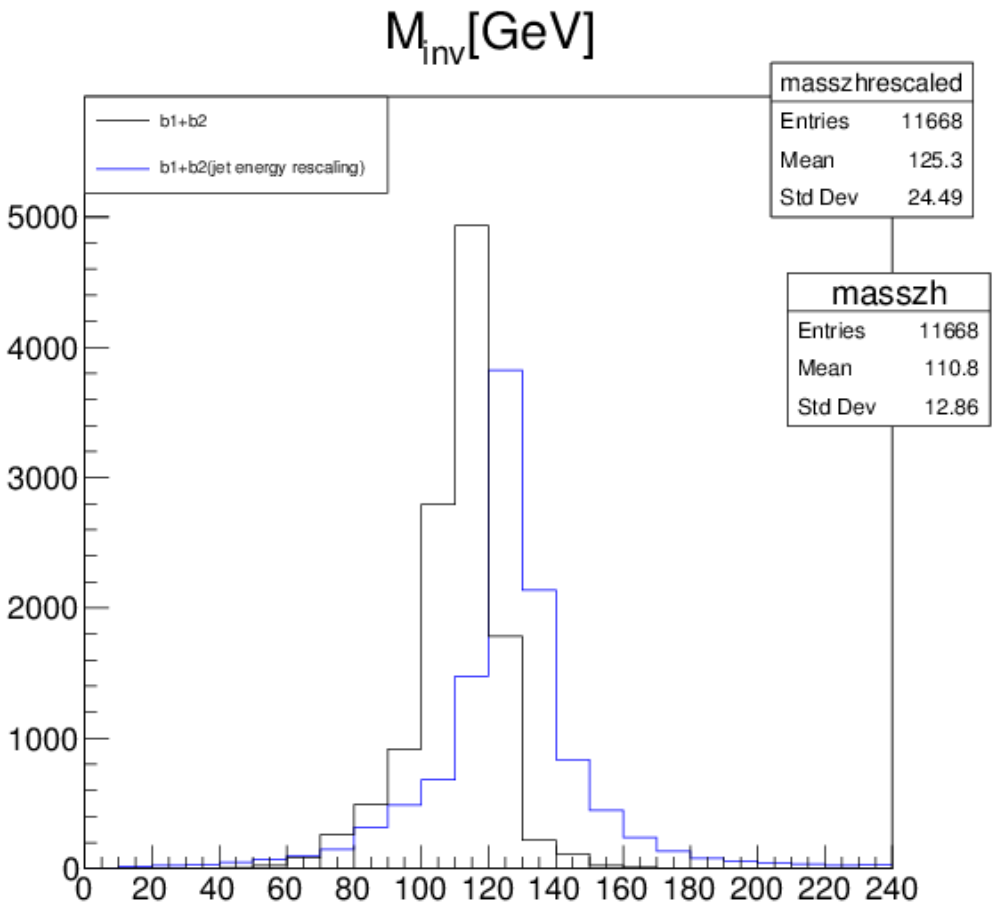
Rescaled jet energy

- Electrons are elementary particles: no pile-up collisions
- Final state has known energy and momentum (sqrt(s), 0,0,0)
- Jet directions (β_i = p_i/E_i) are well measured
- Enforce total energy and momentum conservation

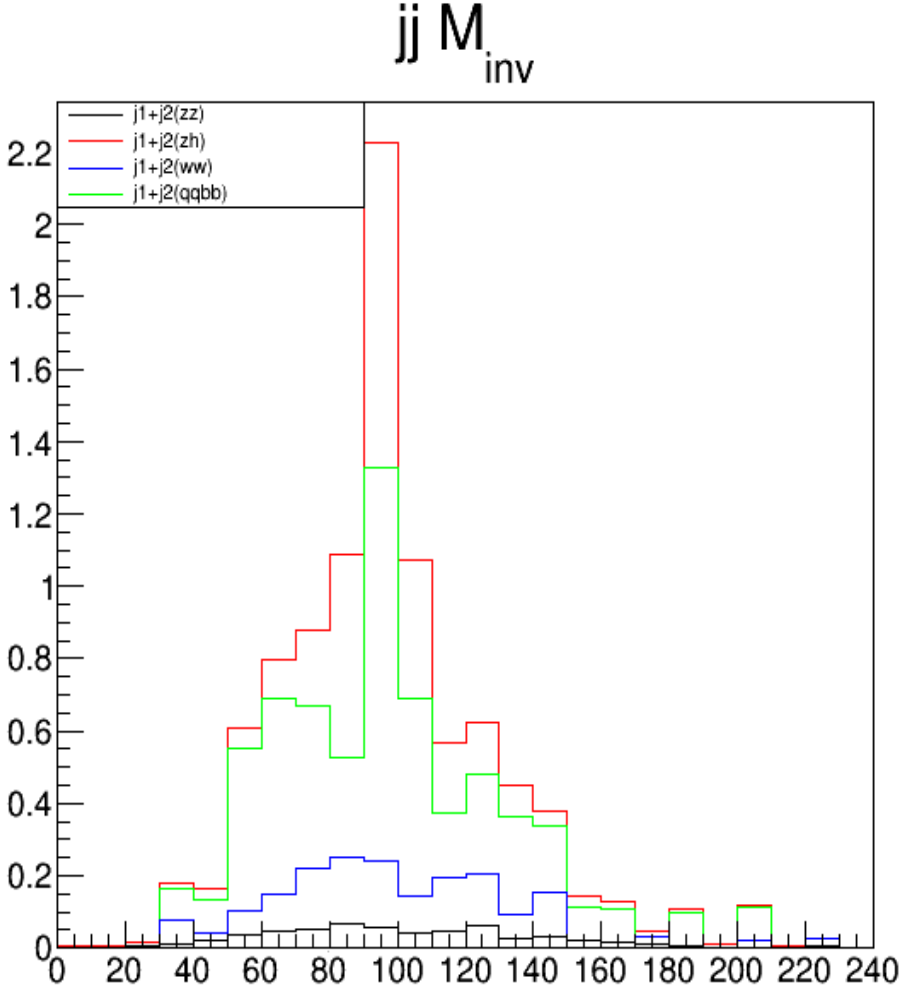
$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ \beta_1^x & \beta_2^x & \beta_3^x & \beta_4^x \\ \beta_1^y & \beta_2^y & \beta_3^y & \beta_4^y \\ \beta_1^z & \beta_2^z & \beta_3^z & \beta_4^z \end{bmatrix} \begin{bmatrix} E_1 \\ E_2 \\ E_3 \\ E_4 \end{bmatrix} = \begin{bmatrix} \sqrt{s} \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

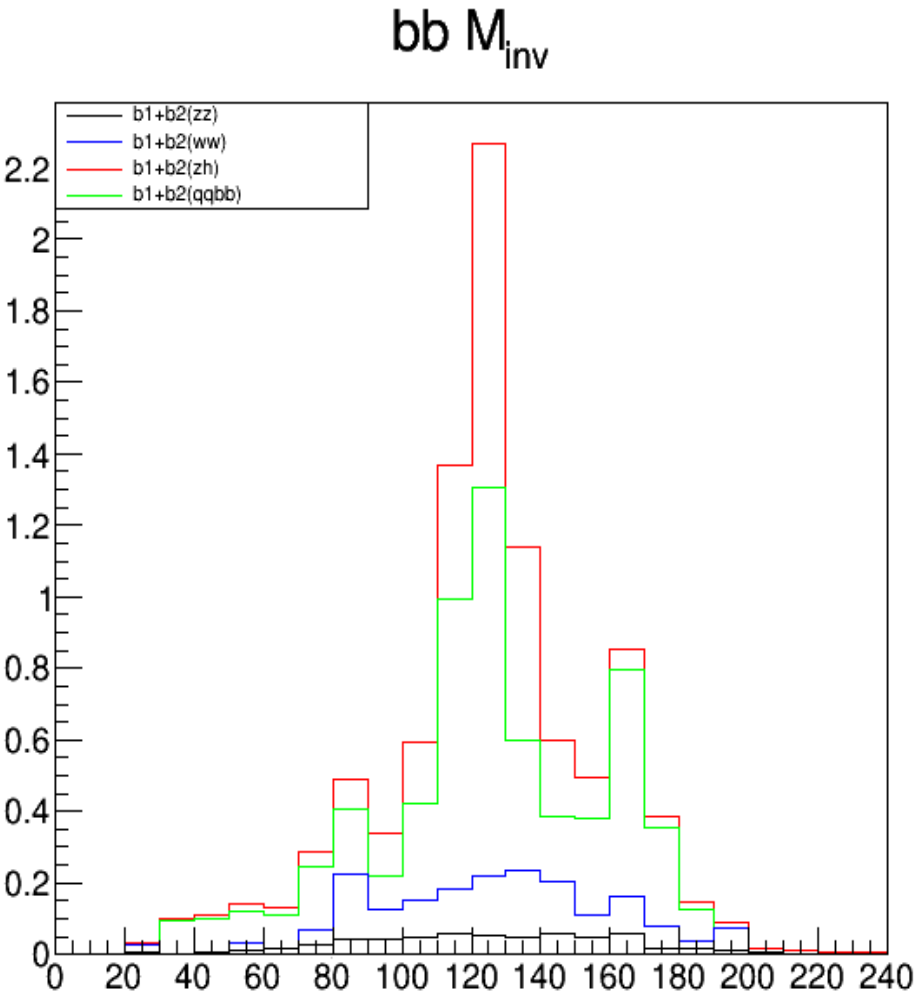
Rescaled jet energy





Inv. Mass with rescaled jet energy





Major background: zz, ww and 4 jets.

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Conclusion

- Fast event generation and detector simulation using WHIZARD, PYTHIA and DELPHES.
- Particles fake the signal.
- Important backgrounds.
- Inv. Mass with rescaled jet energy.

- Tune the DELPHES card parameters for FCC/ILC design study.

[1]. Cards provided by the DELPHES collaboration

[2]. FCCee website:http://tlep.web.cern.ch/

[3]. P. Azzi, C. Bernet, C. Botta, P. Janot, M. Klute, P. Lenzi, L. Malgeri and M. Zanetti,“Prospective Studies for LEP3 with the CMS Detector,"arXiv:1208.1662 [hep-ex].

[4]. ILC website: https://www.linearcollider.org/ILC

[5]. Patrick Janot, Lecture note: Physics at Future Colliders, 28-29 July 2016

[6]. WHIZARD website: https://whizard.hepforge.org/

[7]. PYTHIA website: http://home.thep.lu.se/~torbjorn/Pythia.html

[8]. DELPHES website: https://cp3.irmp.ucl.ac.be/projects/delphes