W mass studies

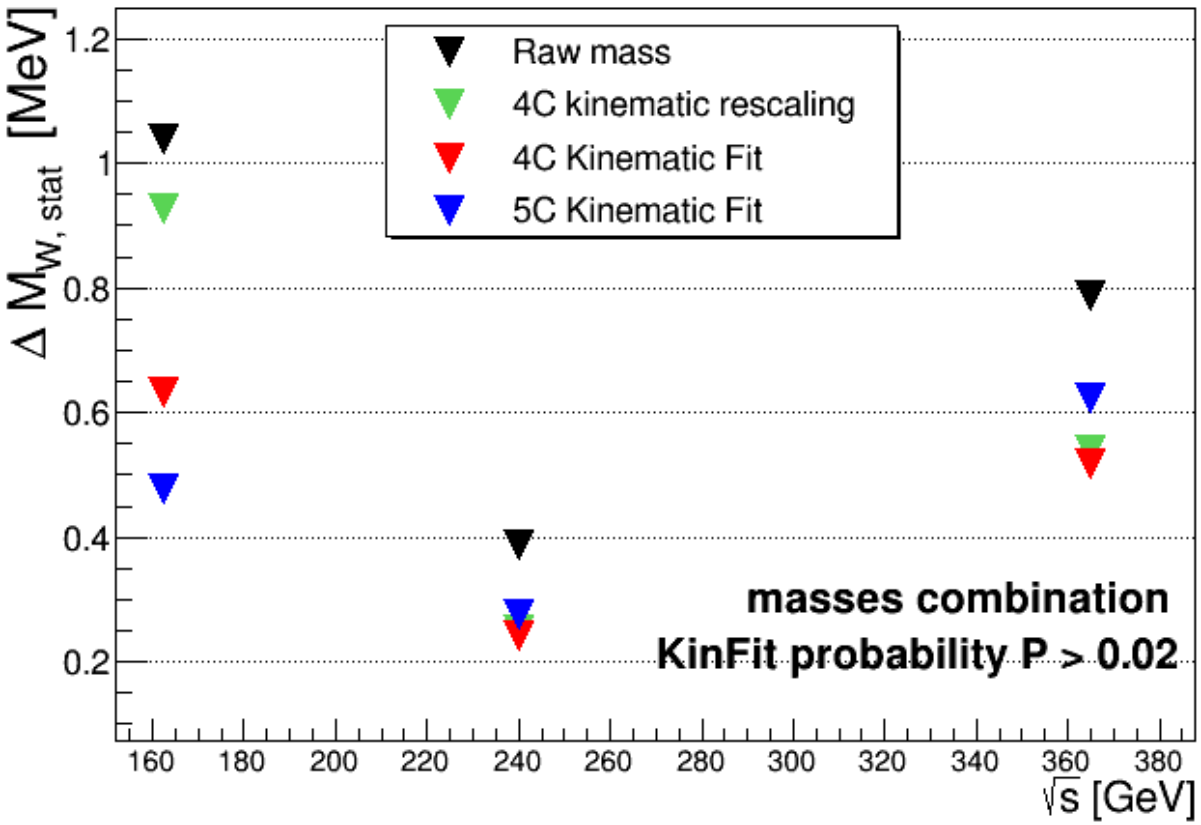
Hadronic and Semi-leptonic decays
WG1 & WG2 working meeting

Marina Béguin, Paolo Azzurri, Elizabeth Locci

October 9, 2018

Outline

Previously in the hadronic channel...



31/08/18 results

Statistical uncertainty variation with E_{CM} in the hadronic channel

To do :

- Covariance matrix
- ISR photons treatment
- Effect of colour reconnection treatment on statistical uncertainty.

Channel study

- Pythia8 simulation, 50000 events of $e^+e^- \rightarrow W^+W^- \rightarrow qqqq$ at 162.6 GeV, 240 GeV and 365 GeV ;
- Reconstruction with Heppy using the Silicon-Based detector ;
- 4 jets clustered with the Durham algorithm ;
- Events where at least one jet composed with only photons are rejected ;
- W mass reconstructions : raw mass, energy rescaling and kinematic fit 4C and 5C.

In the kinematic fit :

+ ISR photons treatment
+ Probability cut (> 0.02)

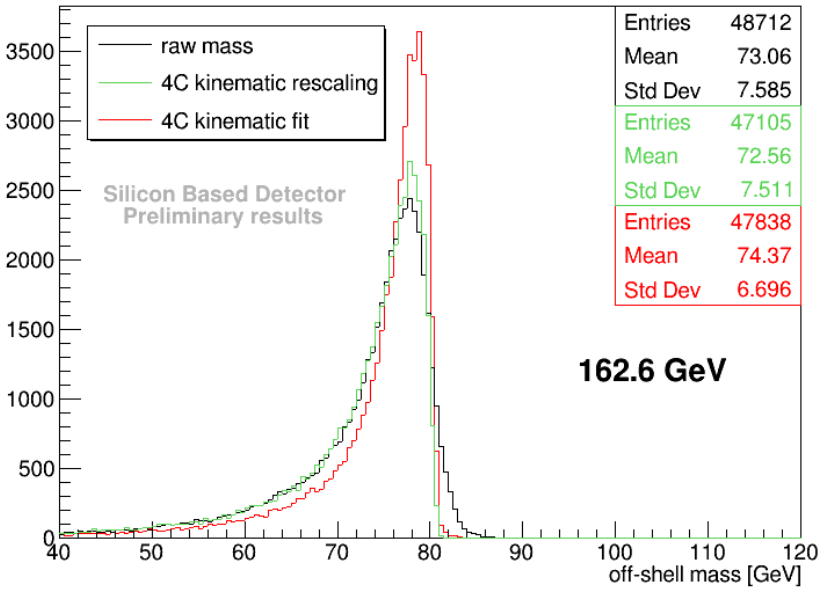
ISR photons treatment

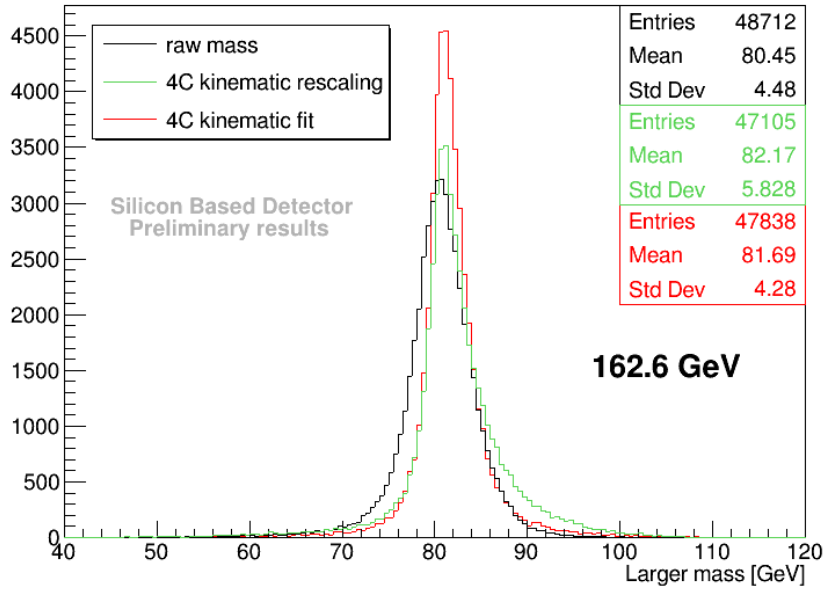
Event with ISR emissions is a problem for the fit constraints leading to a small fit probability (< 0.1) and reconstructed W masses in distributions tails. A solution is to introduce photons as fit object in kinematic fit.

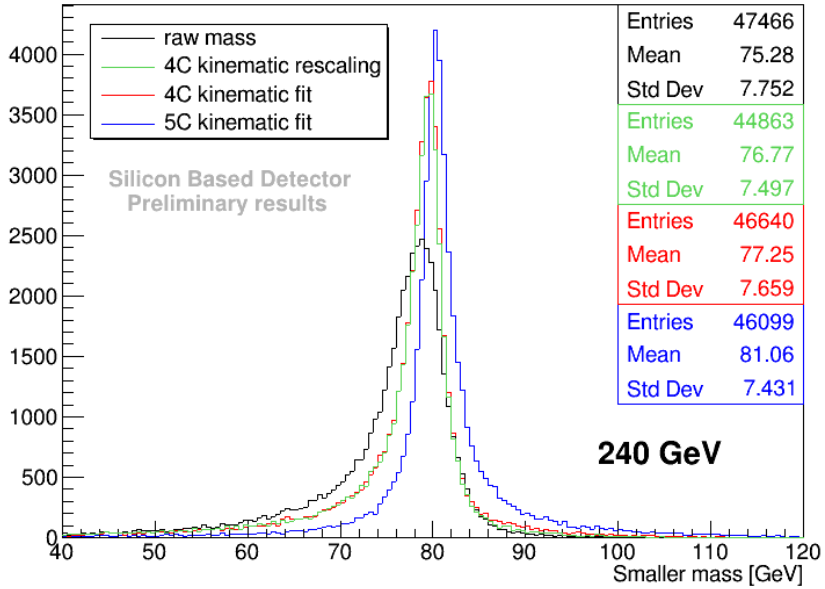
Principle : *arXiv:1006.0436*

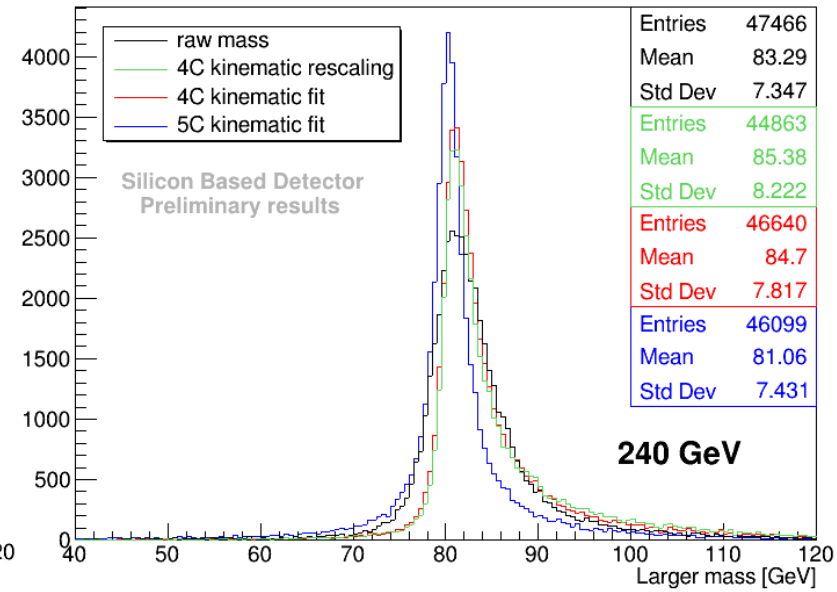
- Photons emitted along the beam axis (0, 0, $p_{z,\gamma}$, $E_{z,\gamma}$)
- Parametrization : p_z is not Gaussian (Power law) and cannot take part in the kinematic χ^2 fit (sum of Gaussian terms).
  $\rightarrow$ parametrization of the photon momentum $p_{z,\gamma} = p_{z,\gamma}(\eta)$ where η follows a Gaussian distribution with mean 0 and sigma 1.
- Additional contribution : $\chi^2 = \eta^2/\delta\eta^2 = \eta^2$

Reconstructions (1)

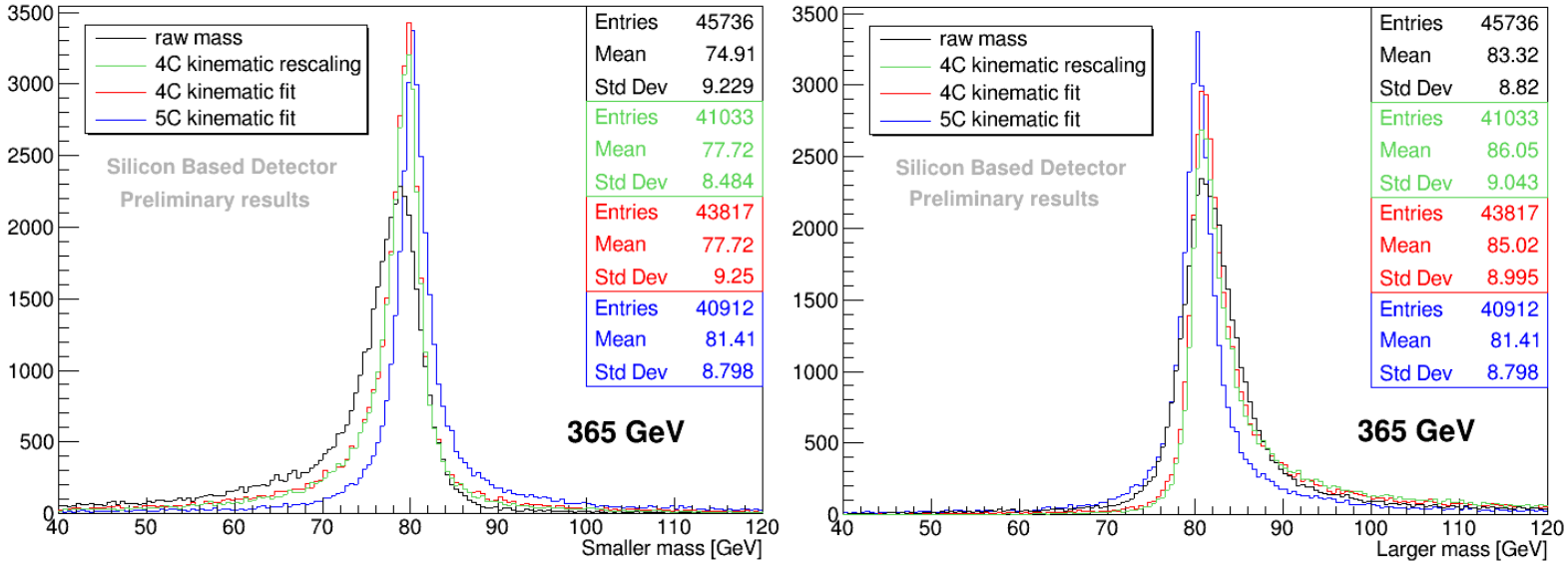






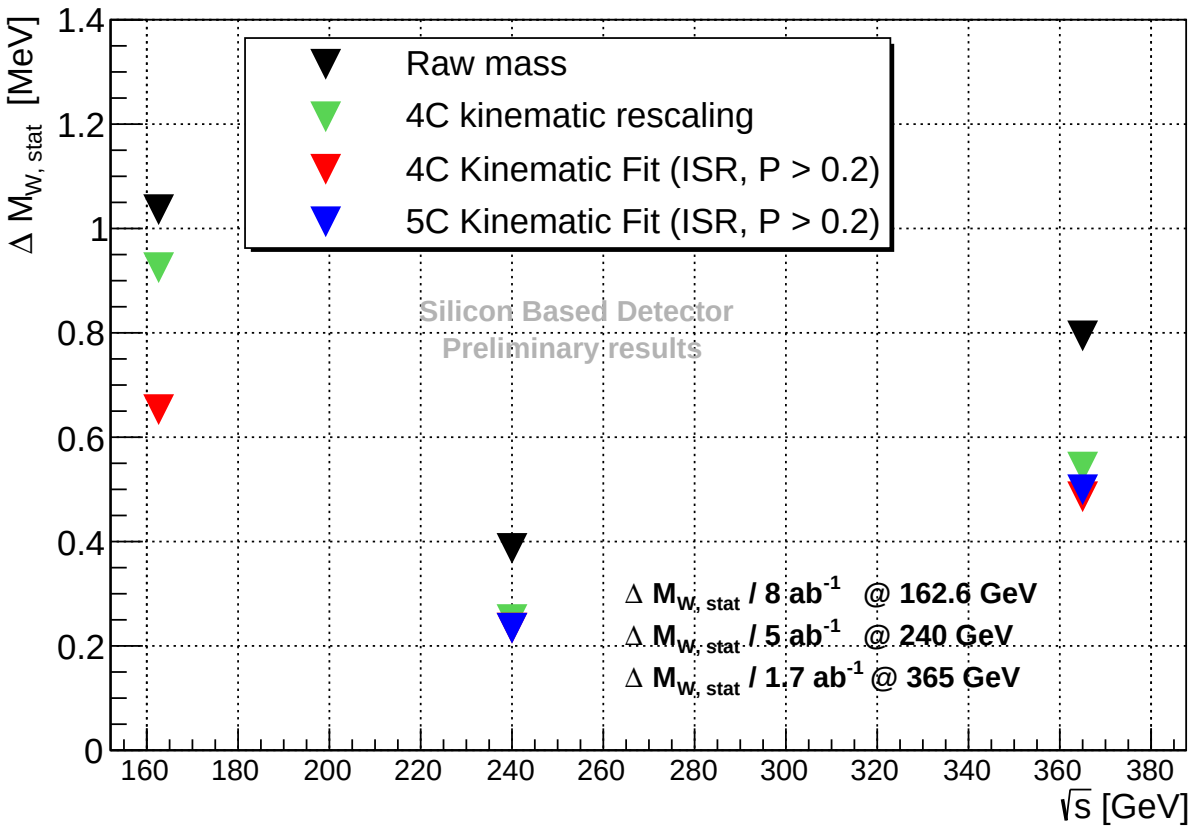


Reconstructions (2)



Best W mass reconstructions with the kinematic fit, 4C for 162.6 GeV and 5C for other energies.

W mass statistical uncertainty - Full Luminosity



Note1 : at 162.6 GeV only the on-shell mass is considered.

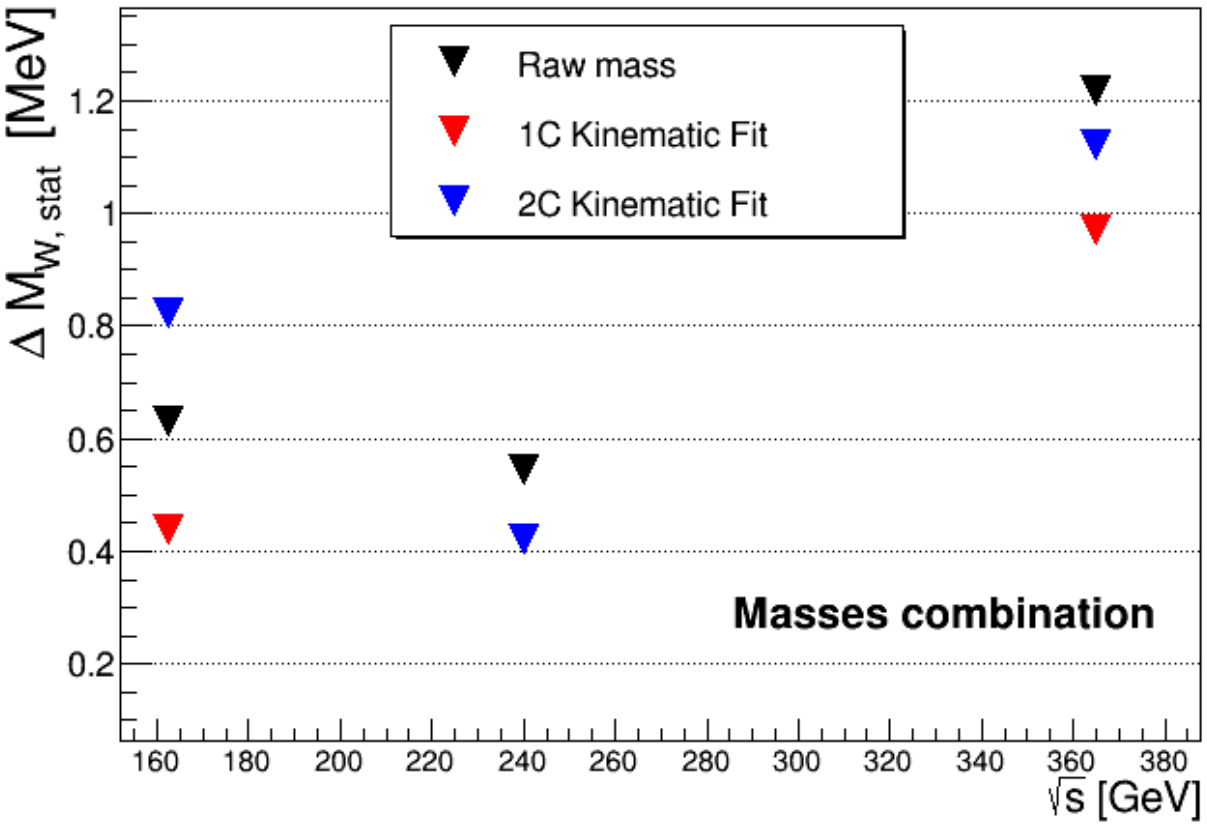
Note2 : there is no mass combination for the 5C fit.

Table: Statistical uncertainty with / without ISR treatment in kinematic fit

E_{CM} [GeV]	162.6	240	365
4C [MeV]	0.63 / 0.65	0.22 / 0.23	0.46 / 0.49
5C [MeV]		0.22 / 0.24	0.48 / 0.5

Outline

Previously in the semi-leptonic channel...



31/08/18 results

Statistical uncertainty variation with E_{CM} in the semi-leptonic channel

To do :

- Covariance matrix
- ISR photons treatment

Channel study

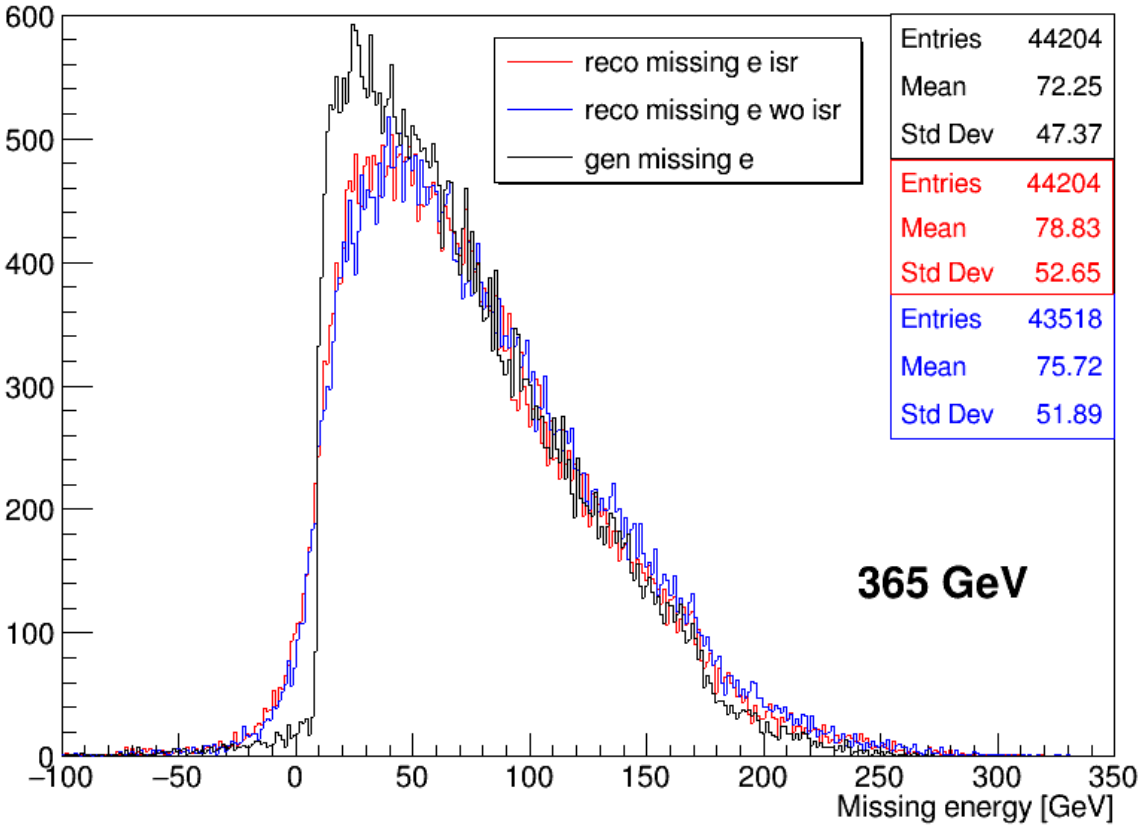
Only muon decays are considered.

- Pythia8 simulation, 50000 events of $e^+e^- \to W^+W^- \to qq\mu\nu$ at 162.6 GeV, 240 GeV and 365 GeV ;
- Reconstruction with Heppy using the Silicon-Based detector ;
- 2 jets clustered with the Durham algorithm ;
- FSR photons - lepton association : photon closer to the lepton track than any other object or the beam axis and at least 0.4 rad from any other track.
- W mass reconstructions : raw mass, kinematic fit 1C and 2C.

In the kinematic fit :

+ No ISR treatment
+ Probability cut (> 0.02)

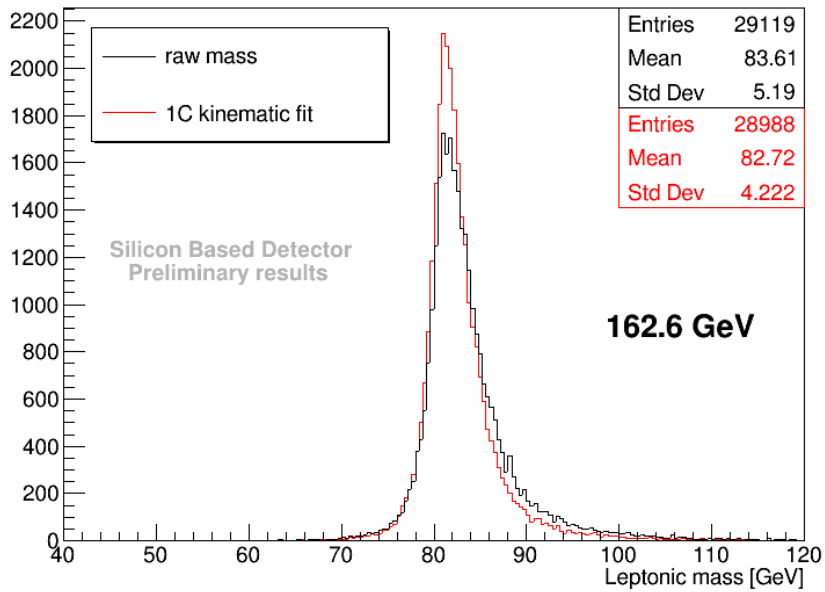
ISR photons treatment

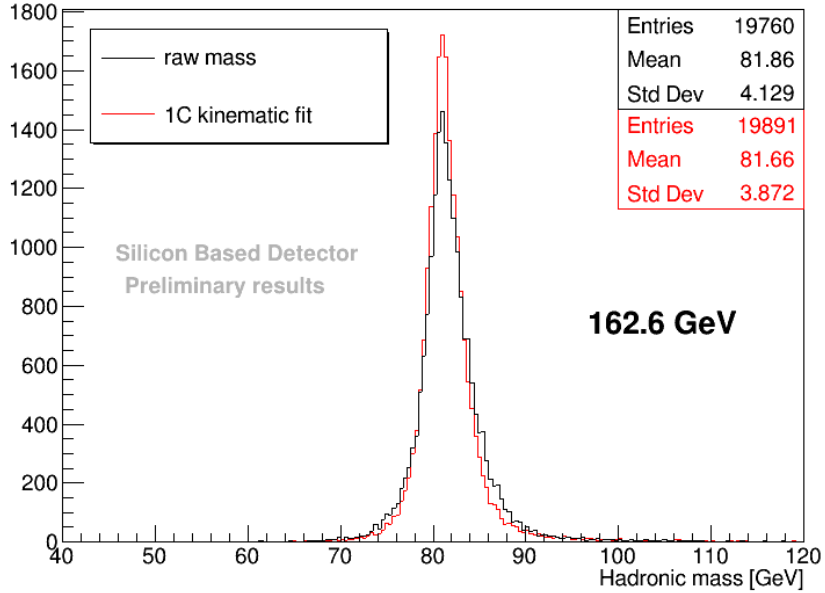


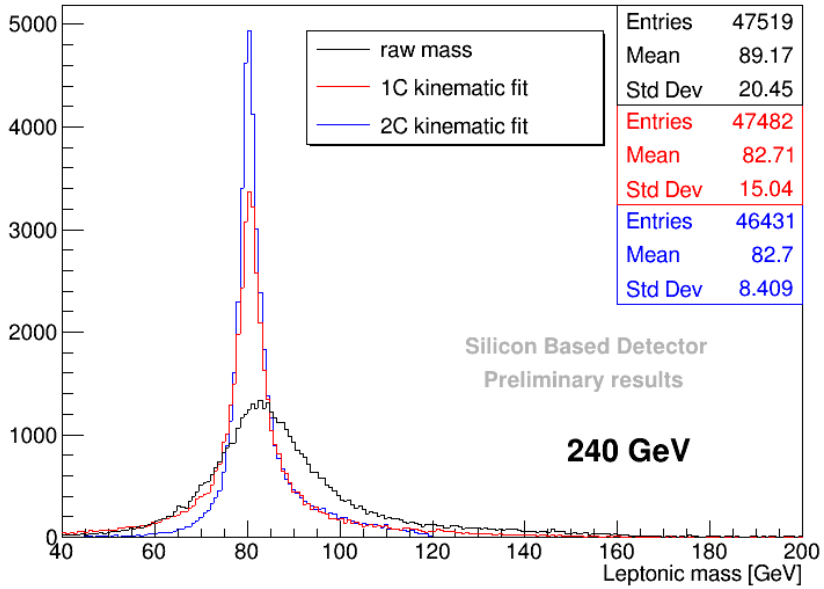
- Few ISR photons are reconstructed ;
- Missing energy reconstruction with and without ISR are almost identical ;
- ISR treatment in hadronic channel did not change a lot the statistical uncertainties ;

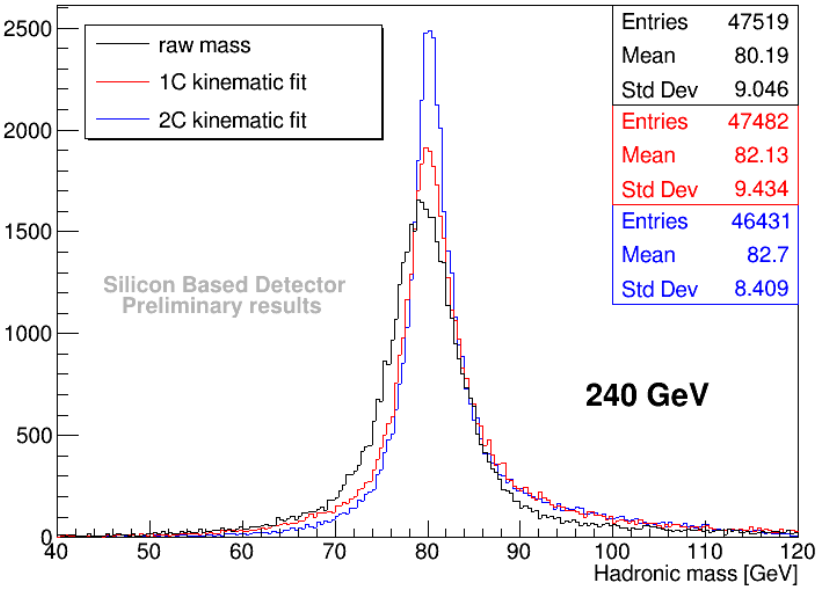
→ No ISR treatment in the semi-leptonic channel

Reconstructions (1)

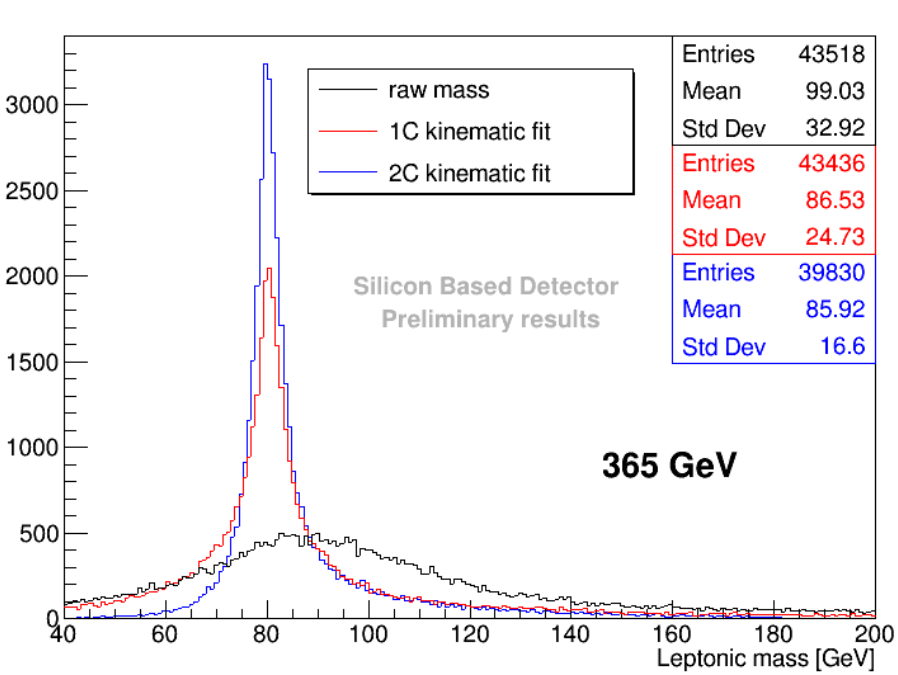


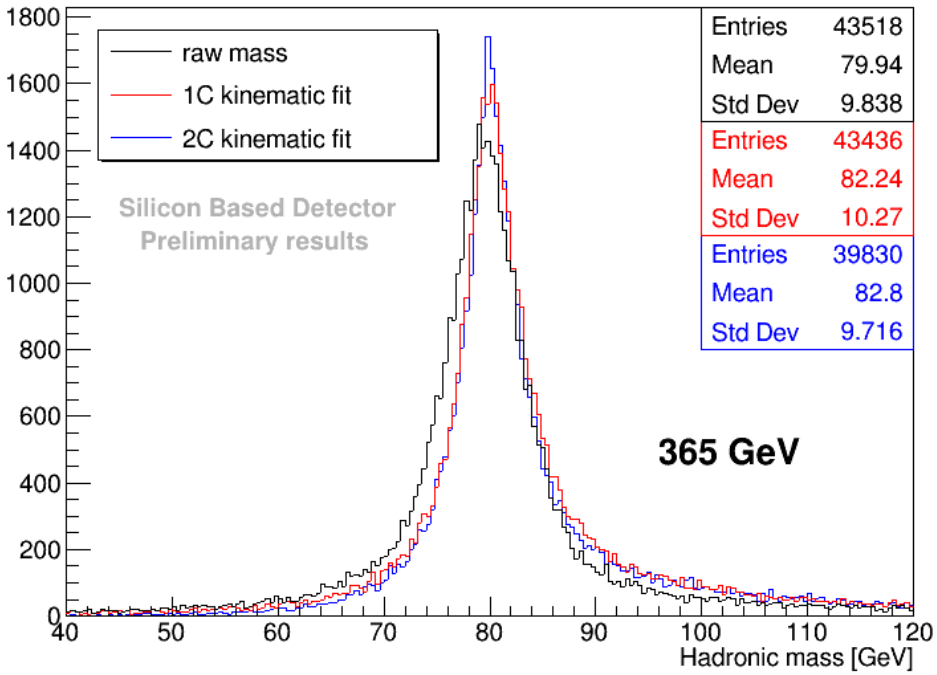






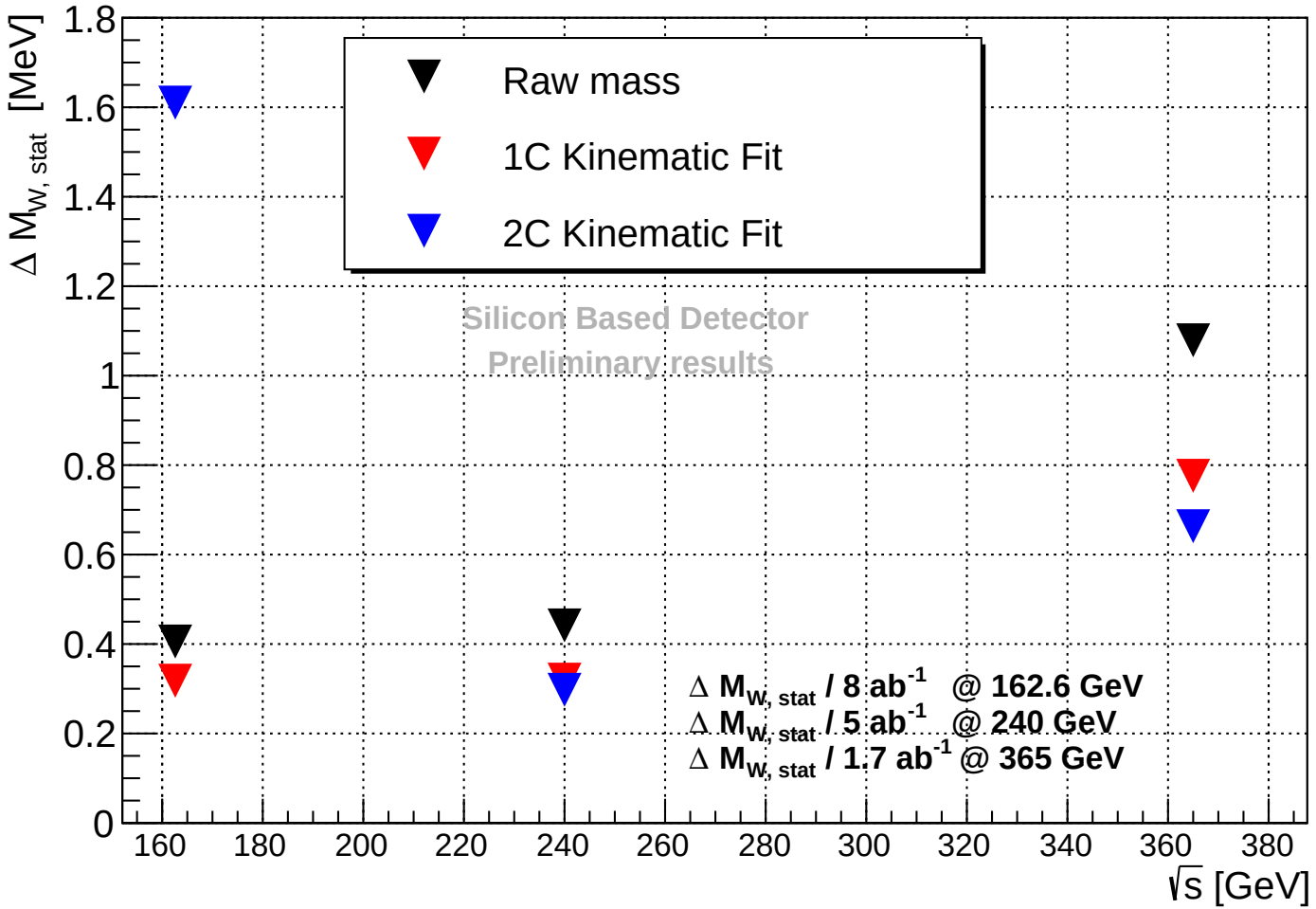
Reconstructions (2)





Best W mass reconstructions with the kinematic fit, 1C for 162.6 GeV and 2C for other energies.

W mass statistical uncertainties - Full Luminosity



Note1 : at 162.6 GeV only the on-shell mass is kept.
Note2 : there is no combination for the 2C fit.

Outline

CDR status

The majority of the work has been written in the CDR but important pieces are still to be added :

- Figures
- Conclusions in each channel
- Paragraph about what can be done to complete the study : background, cone opening angle to reduce CR systematic uncertainty in hadronic channel, Electron and Tau decay leptonic decay in the semi-leptonic channel...

Outline

Conclusion and Outlook

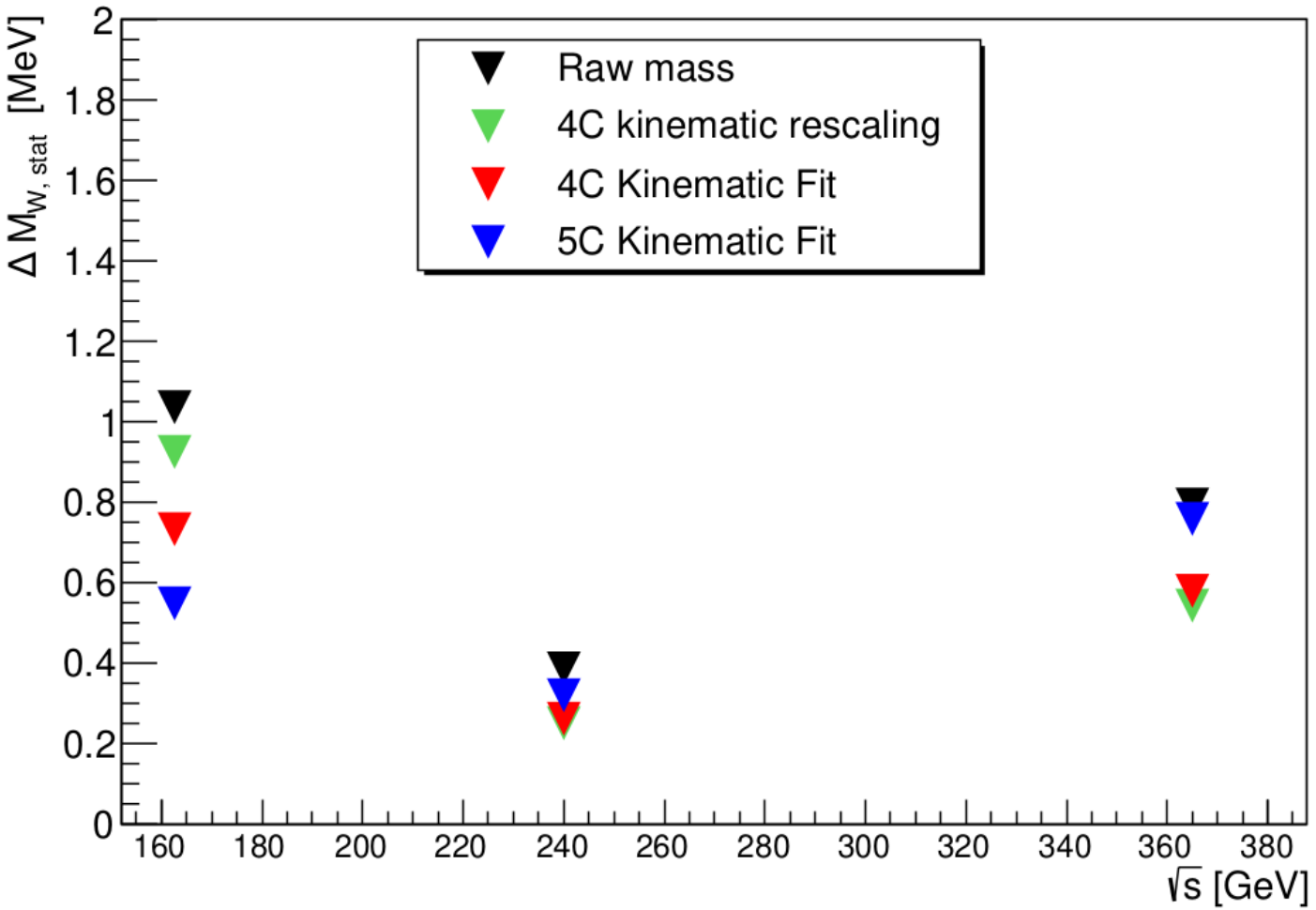
In both channels the study is almost done. Two remaining points and are under study :

- W width statistical uncertainty variation with E_{CM}. Templates method ($\Gamma_W \pm 100 MeV$) is also used.
- Effect of the cone applied on jets on the statistical uncertainty.

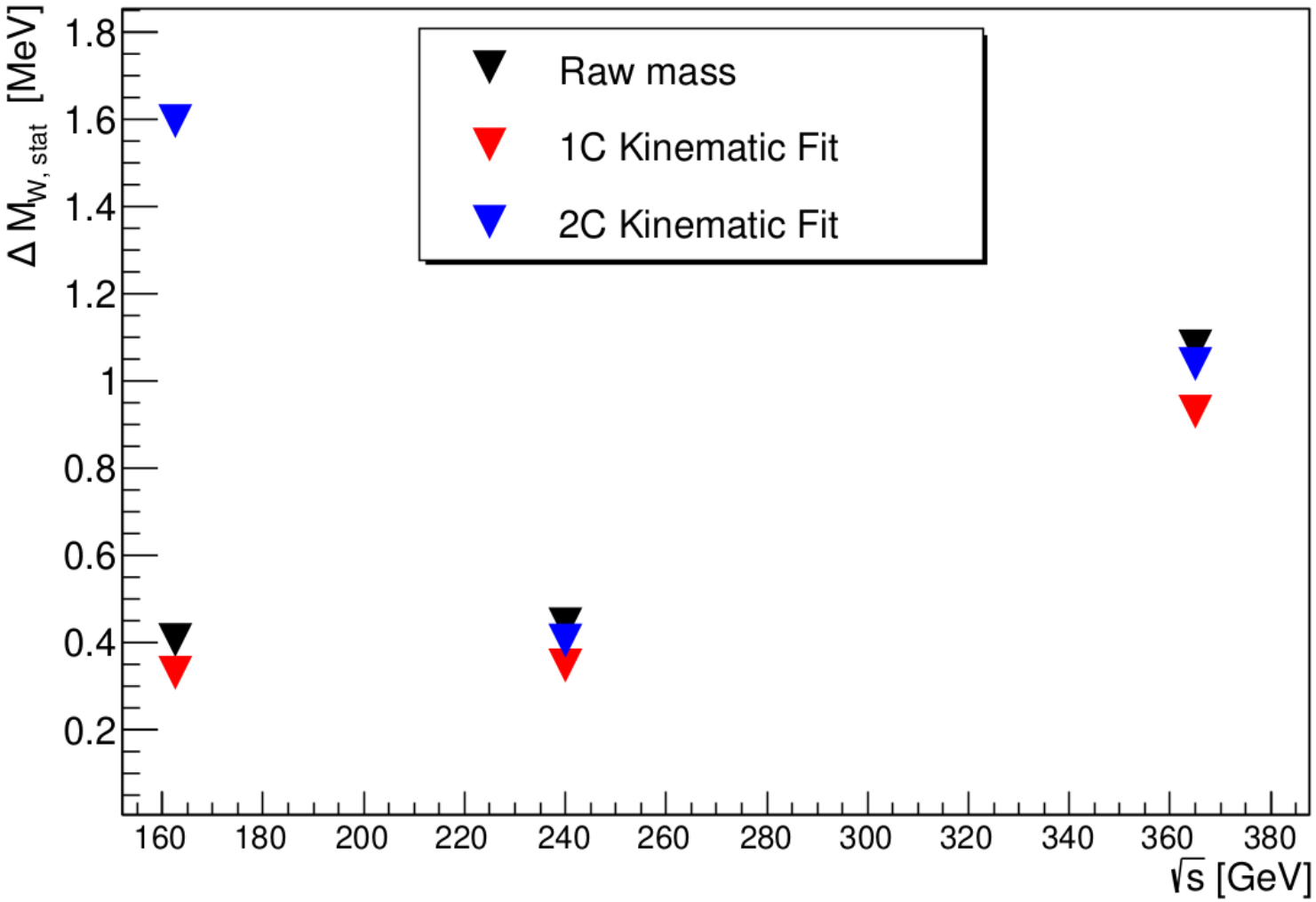
Thanks for your attention

BACK-UP

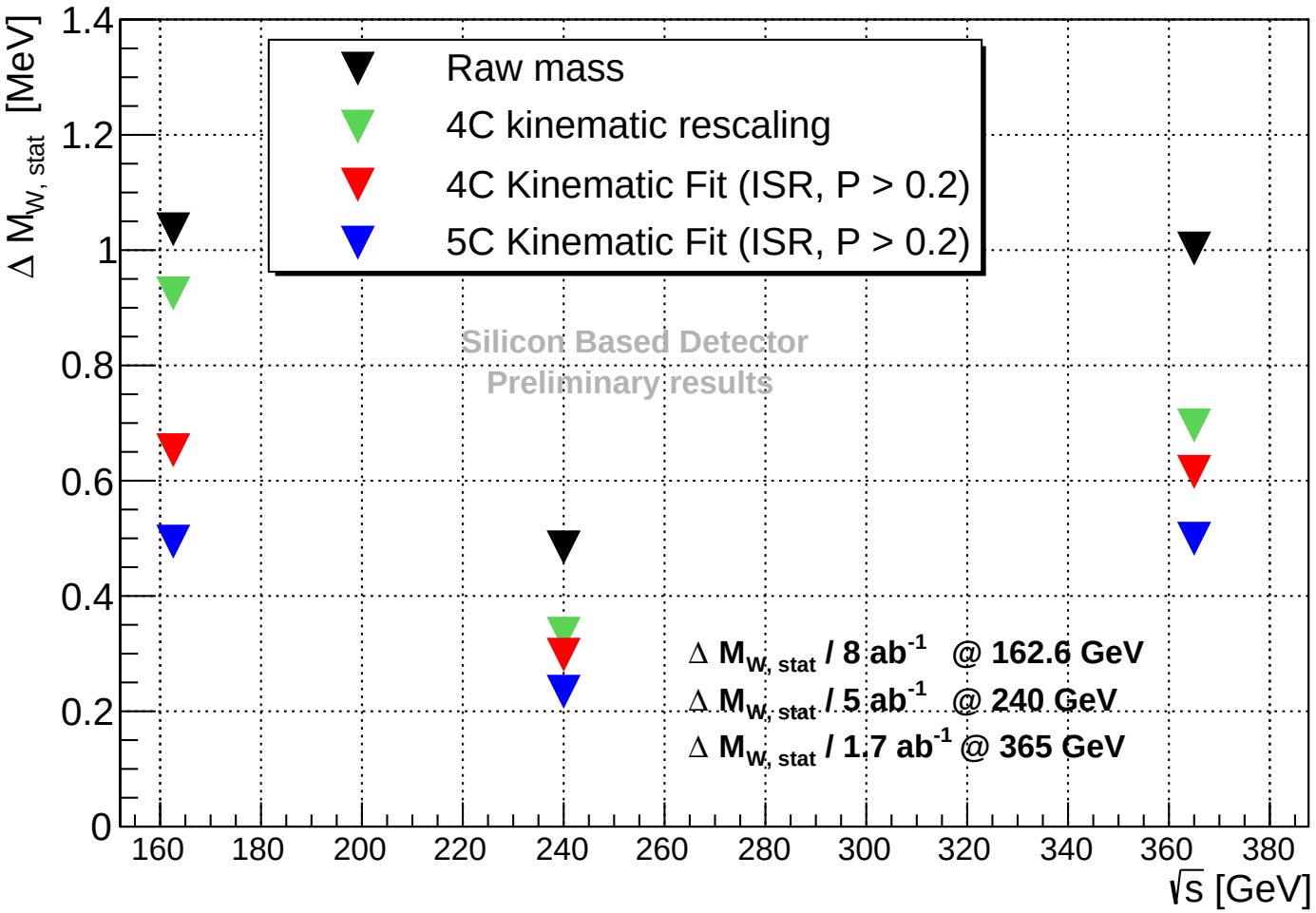
Hadronic - Statistical uncertainty without cut and without ISR Treatment



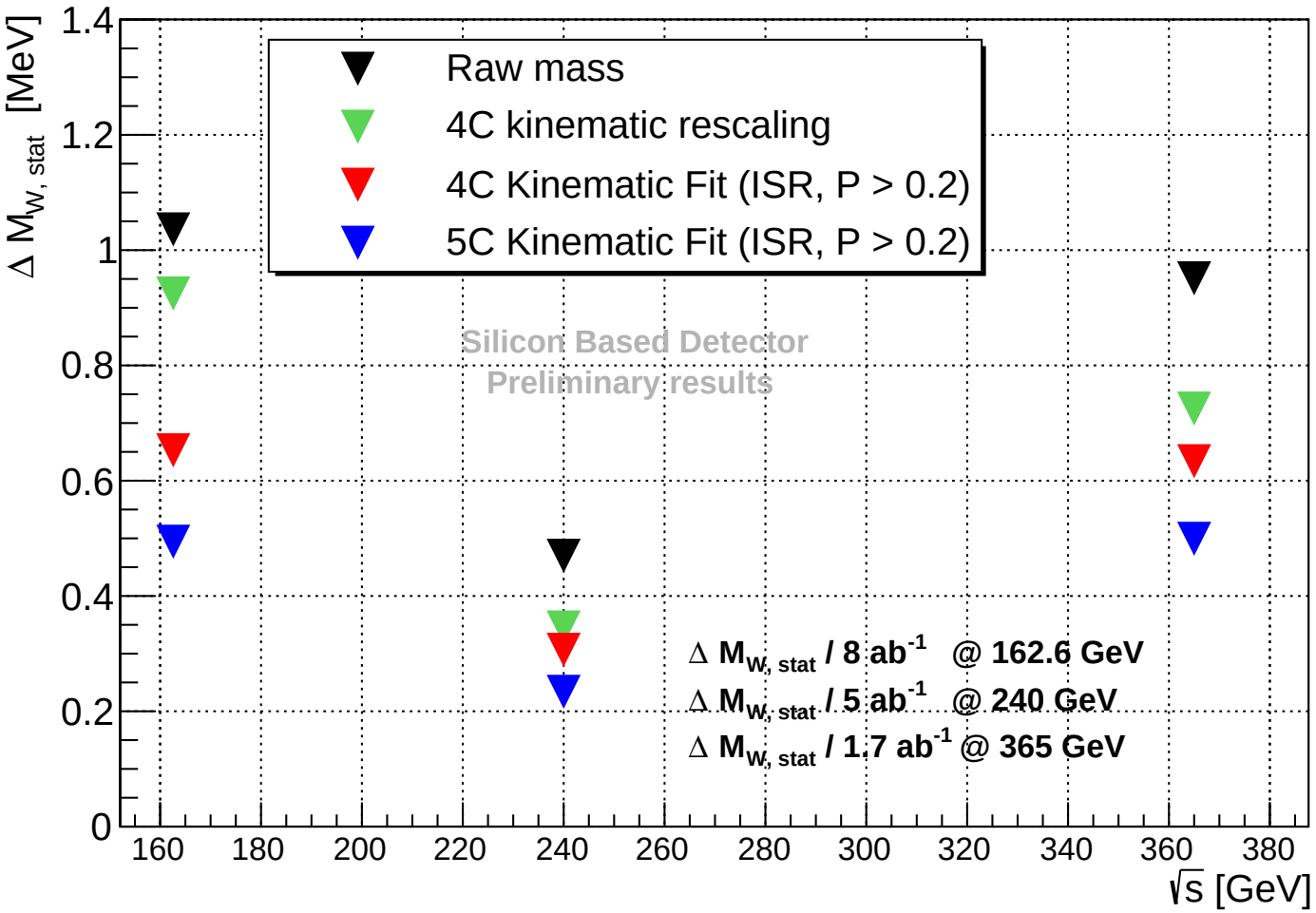
Semi-leptonic - Statistical uncertainty without cut and without ISR Treatment



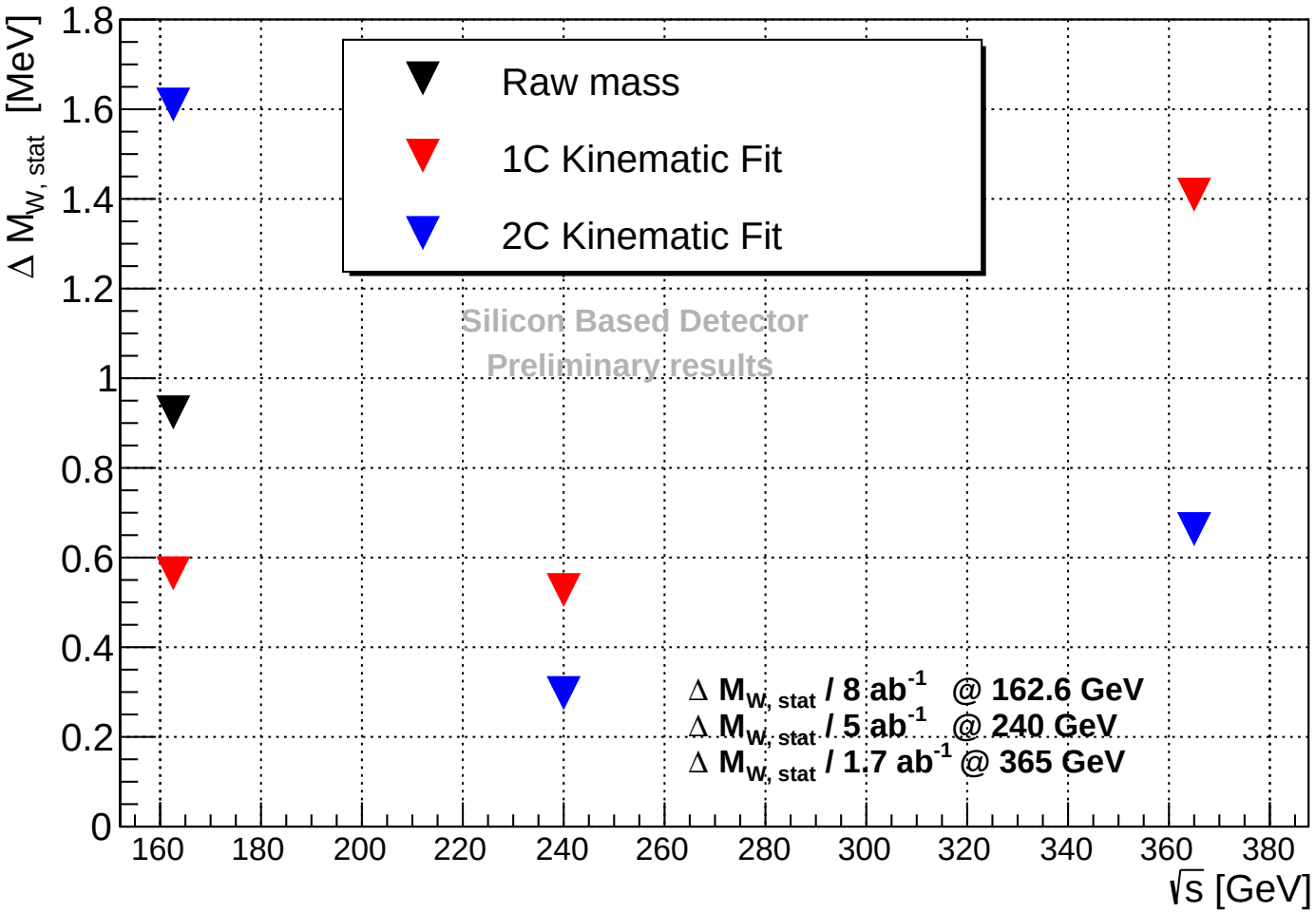
Hadronic - Statistical uncertainty smaller dijet mass



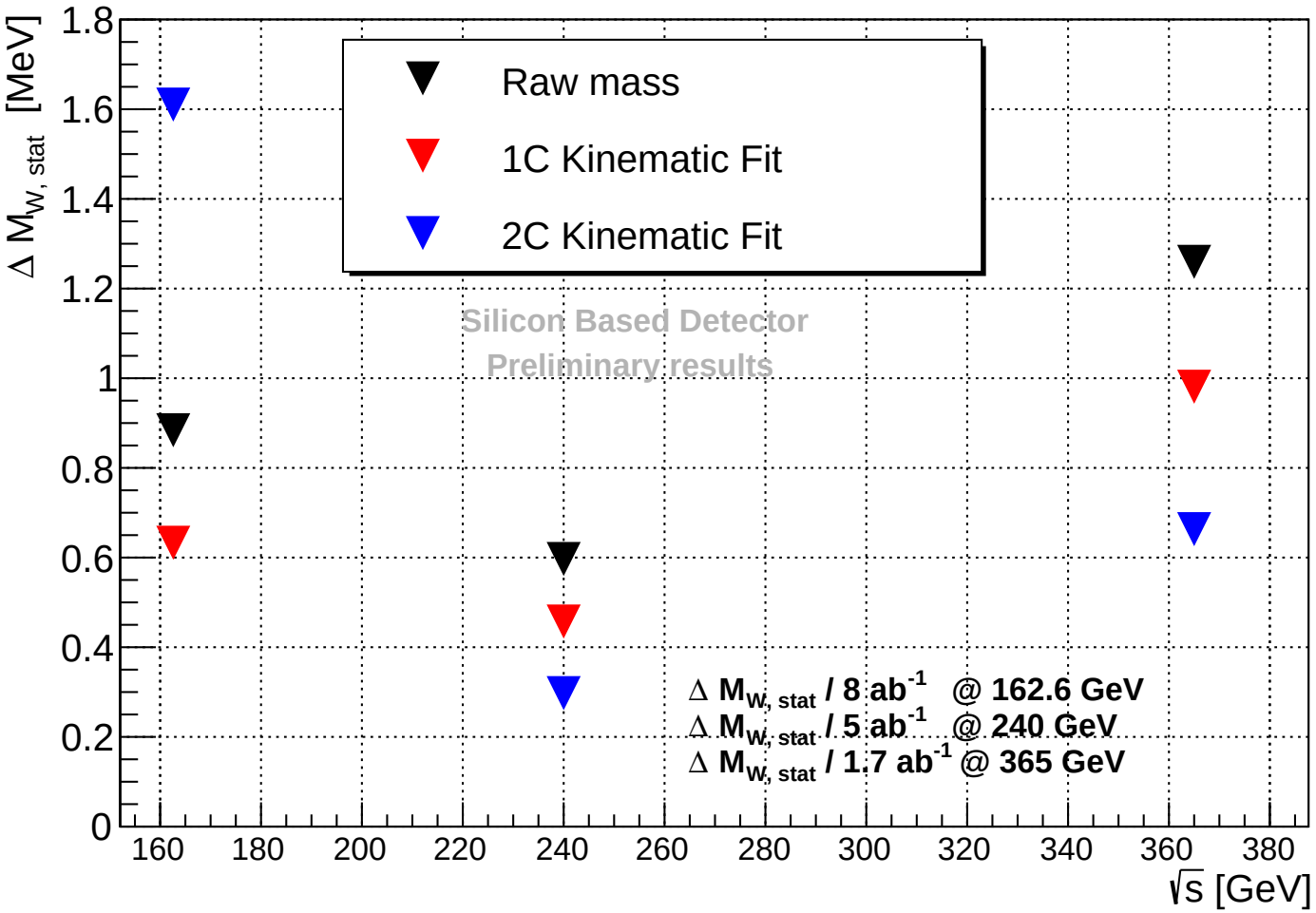
Hadronic - Statistical uncertainty larger dijet mass



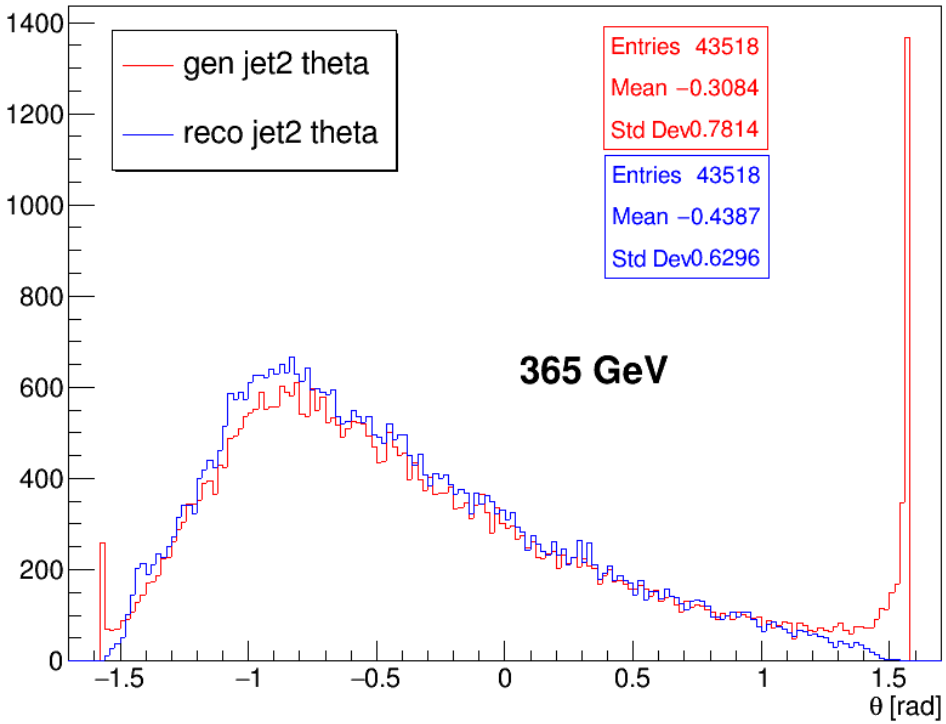
Semi-leptonic - Statistical uncertainty leptonic mass

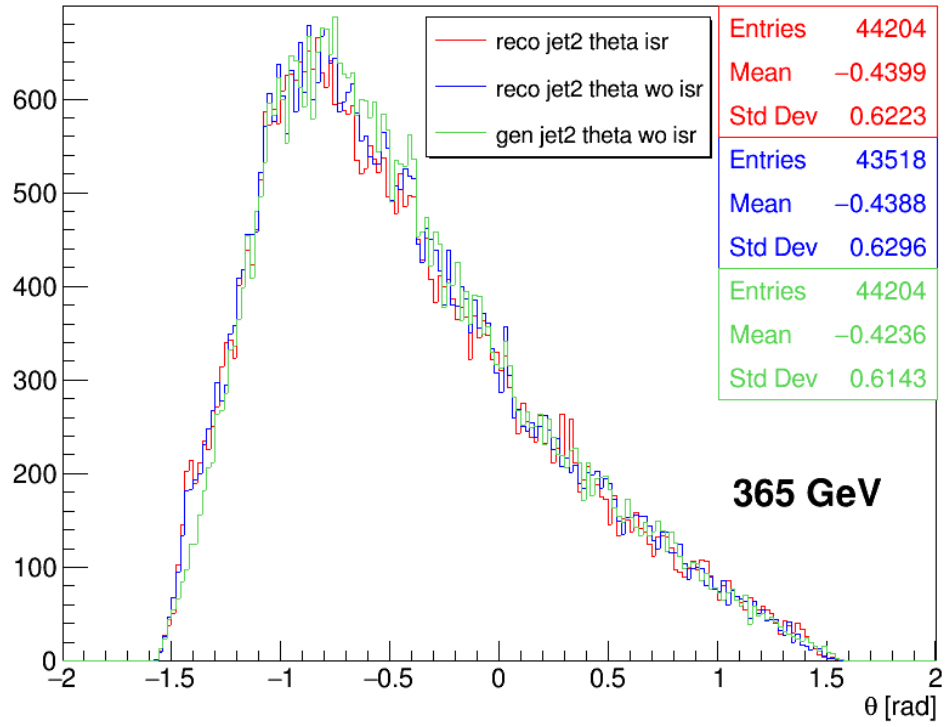


Hadronic - Statistical uncertainty hadronic mass



Why there was a difference with/wo ISR at genLevel(1) ?





Why there was a difference with/wo ISR at genLevel(2) ?