ECAL studies & MET Commissioning

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Introduction

Physics analysis Aim : observation of ZZ diboson final states to study anomalous Triple Gauge couplings

Decay channel studied : ZZ ⟶ 2l2ν

⟶ Motivation : increase statistics { BR(ZZ->4l) = 0.36%
BR(ZZ->2l2ν) = 1.2 %

⟶ Good understanding the Missing Transverse Energy is required

Several ECAL studies (not necessary related to ZZ analysis) are also introduced.

Outline

Detector-related studies

ECAL Laser Monitoring study

ECAL Selective Readout study

⟶ Effects of Selective Readout on Jet/MET reconstruction

Physics analysis

MET Commissioning

ZZ ⟶ 2l2ν (not addressed here)

Conclusion and plans

ECAL Laser Monitoring

The ECAL Laser system is used to monitor the ECAL response variations (crystal transparency)

Procedure : Pulsing laser in each ECAL crystal and determine crystal response.

Reconstruction of laser pulse cannot be done by a weight method (time phase could change)

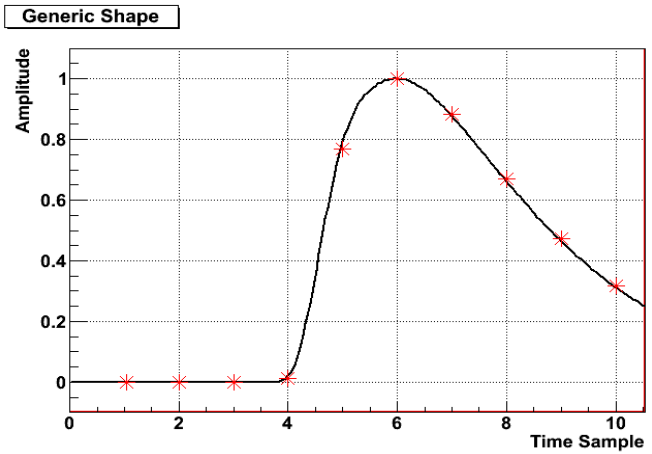
→ fit of the laser pulse shape

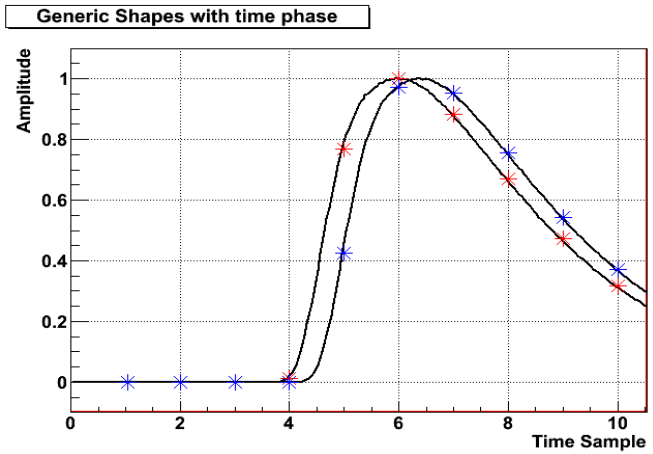
Currently fits parameters are computed with 40 MHz sampling data.

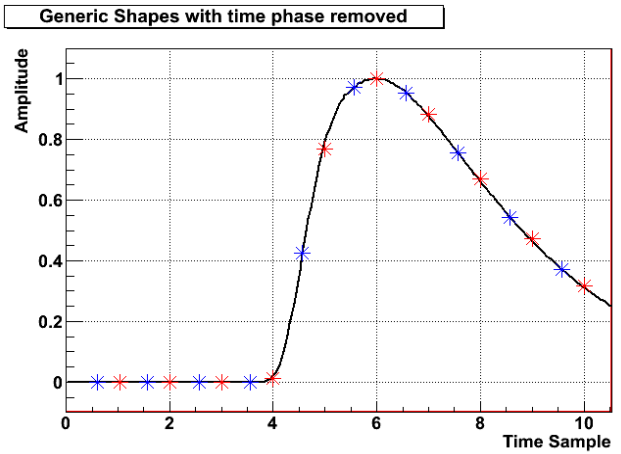
Ref : http://indico.cern.ch/getFile.py/access?contribId=2&resId=1&materialId=slides&confId=75541

Possible improvement : *Find a reliable parametrisation of laser pulse shape with a 1GHz sampling using dedicated data*

→ Oversample the laser shape by changing the laser phase of 1 ns in a 25 ns range







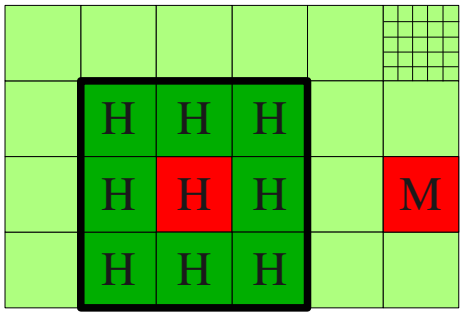
Study ongoing, results coming soon

The ECAL Selective Readout

Purpose

bring ECAL data-flow within allocated bandwidth (100kB/event) with minimal impact on physics performance

Selective Readout Processor (SR) : → Selects regions of high interest, using two thresholds : High Threshold (HT) and Low Threshold (LT)
These regions are fully read out.



High interest tower : Et > HT or neighbouring a tower with Et > HT
Full readout of 3x3 tower matrix

Middle interest tower : HT > Et > LT
Single tower considered as high interest , fully readout.

Low interest tower : Zero Suppression applied on each crystal of the tower

Zero Suppression (ZS) :

→ Applied on low interest towers (most of ECAL)

→ Channels with an amplitude below a given threshold are suppressed.

SR was designed to get optimal energy resolution on electrons and photons.

→ What is the possible influence of SR on other physics objects like jets or MET ?

SR Effects on Jets

Jet reconstruction : → Using both low interest and high interest ECAL towers

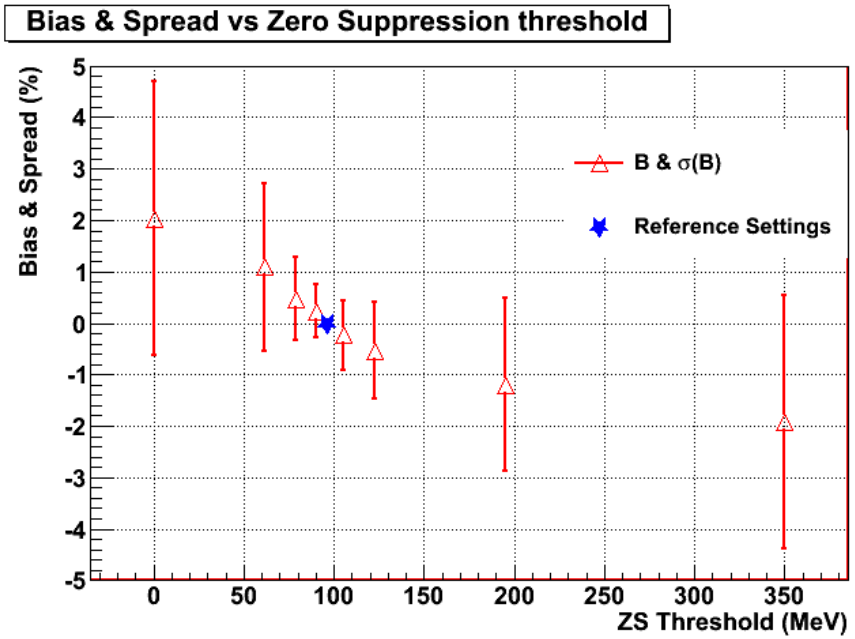
→ Remove ECAL electronic noise contribution by a cut on ECAL crystals

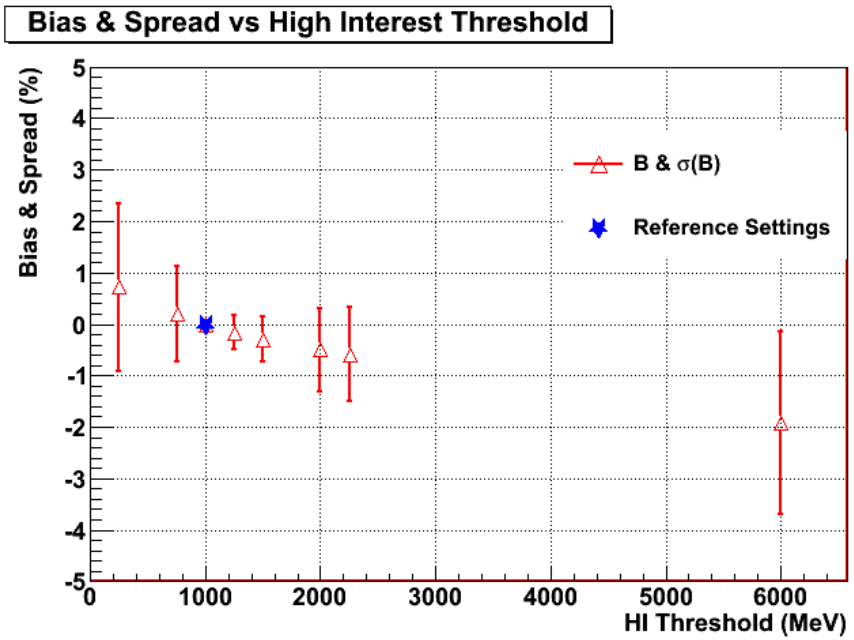
Currently : Jet ECAL noise threshold is lower than zero suppression threshold

→ Jet reconstruction depends on online Selective Readout settings ←

Effects of SR settings changes are studied in a simplified case (HT = LT, no middle interest towers, barrel only) using QCD events in a low luminosity scenario (~5 PU events luminosity) :

Comparison jet by jet of the raw energy E with that obtained with SR references settings → $B = \frac{E - E_{Ref}}{E_{Ref}}$





Small impact in a low luminosity scenario. Non negligible effects at high luminosity.
Could also have an impact on MET

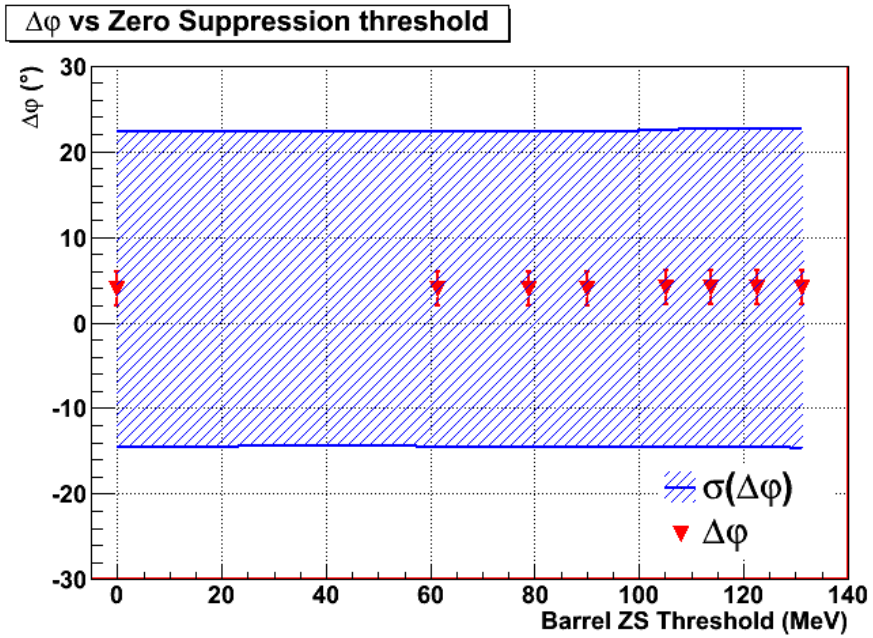
SR Effects on MET

Variations of Selective Readout settings may also affect the Missing Transverse Energy :

- Energy resolution
- MET φ direction

Comparison of raw CaloMET with GenMET in W → eν events.

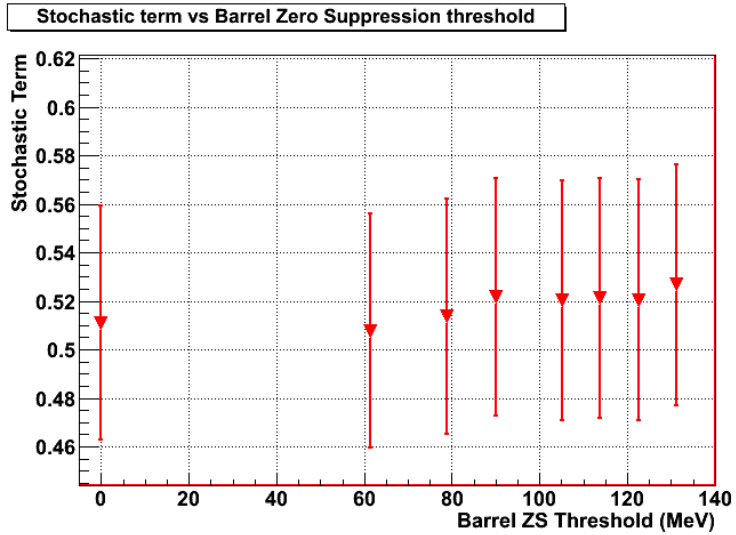
Δφ defined as $\varphi_{Calo} - \varphi_{Gen}$



Resolution $R = \frac{MET_{gen} - MET_{reco}}{MET_{gen}}$ as function of ΣEt

$$R = a\sqrt{\sum Et} + b$$

→ *Study of stochastic parameter a*



Constant bias in φ is due to the W charge asymmetry

Constant spread → no effects at low luminosity

Parameter *a* is consistent with errors on fit.

No influence of SR settings on MET resolution at low luminosity

MET Commissioning

Several channels are used to commission the Missing Transverse Energy

- W into leptons (separated channels for electrons and muons)
- Z into leptons (separated channels for electrons and muons / combination of both)

Understand different MET computations

CaloMET, Type-1 Corrected CaloMET, Track Corrected MET (tcMET), ParticleFlow MET

For each MET, several observables :

MET, Recoil, Angles, MET projections...

In examples following, the W → eν channel is considered

HLT Single electron 15 GeV line fired

Kinematic cuts : electron with pt > 30 GeV, in fiducial region

Lepton identified with POG criteria : Tight electron

Isolation — Track isolation
- → Using a full DR cone and removing only the electron track
- → Tracks contributing to isolation must be constrained at vertex
- Take into account electron bremsstrahlung for the signal
- Reject photon conversion from γ + jet background

+ ECAL/HCAL isolation

Z background rejection : no second electron with pt > 20 GeV

Results on Monte Carlo data

Datasets :
Summer09 @ 7TeV

W into electron for a 10 pb-1 integrated luminosity

	Cut value	W->eν	QCD	γ + jet	W->τν	Z->ee
# event	-	61530	56 M	2 M	78990	13000
HLT + Kinematic cut	Pt > 30 GeV, fiducial	29964	831000	5985	931	4724
Identification	Tight	25561	36855	3180	530	4071
Isolation	Isolated	20938	4978	1257	430	3365
Lepton veto # event selected	Pt > 20 GeV	20805	4822	1208	423	1077

→ S/B Ratio = 2.52 for a signal efficiency of ~69% in acceptance

Study of three observables : → MET & Transverse mass
→ MET projection on the lepton axis

Results shown for two METs : → Raw CaloMET
→ Particle Flow MET

MET & Transverse Mass spectra

Backgrounds (except W->τν) :

→ small MET expected

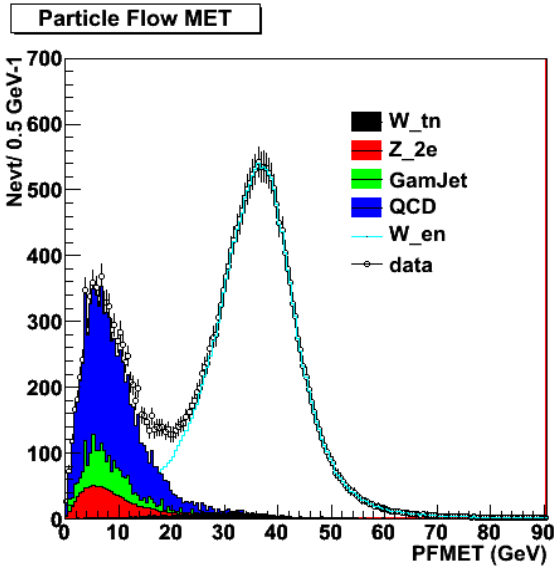
→ small transverse mass expected

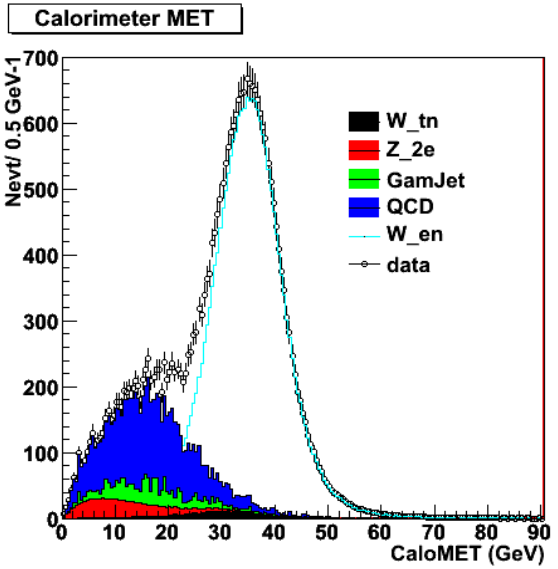
Calo MET : MET dominated by electron information (no complementary information as tracks, muons)

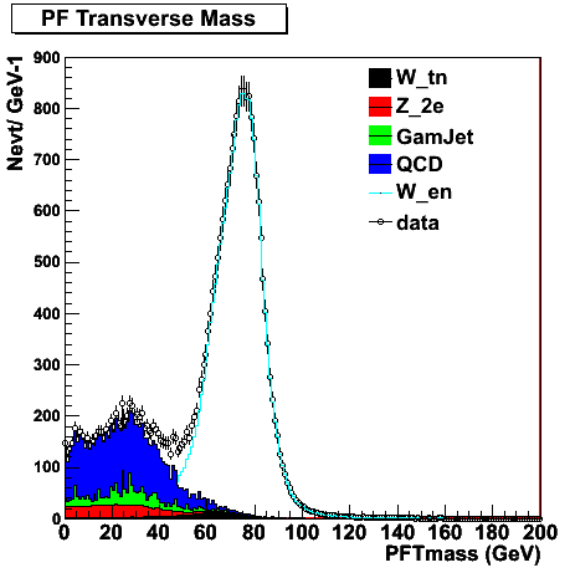
→ worse MET/ TMass reconstruction for QCD background

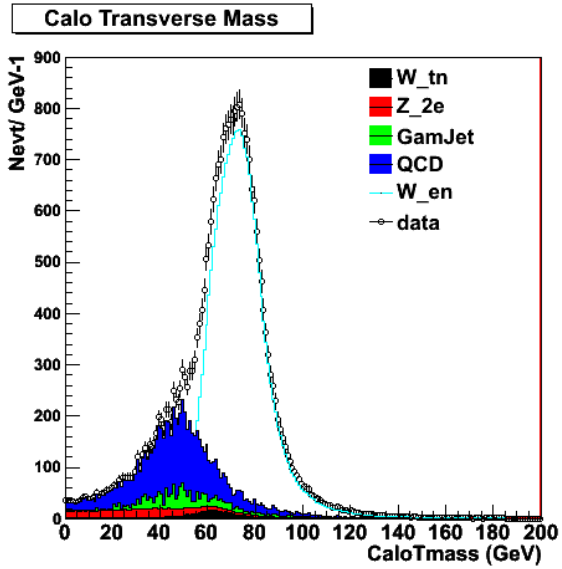
PF MET : take into account all event informations

→ *better precision*



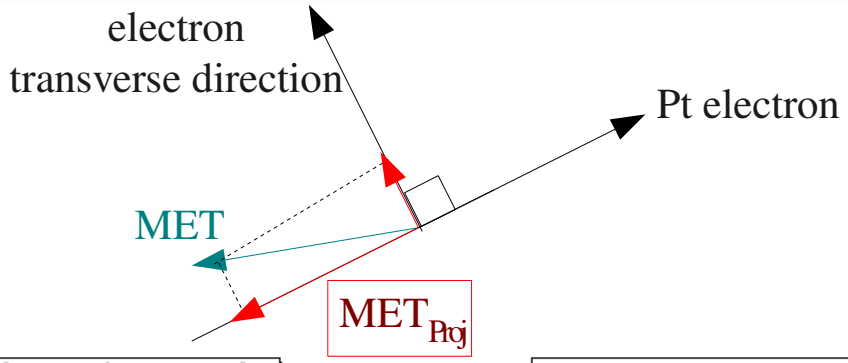






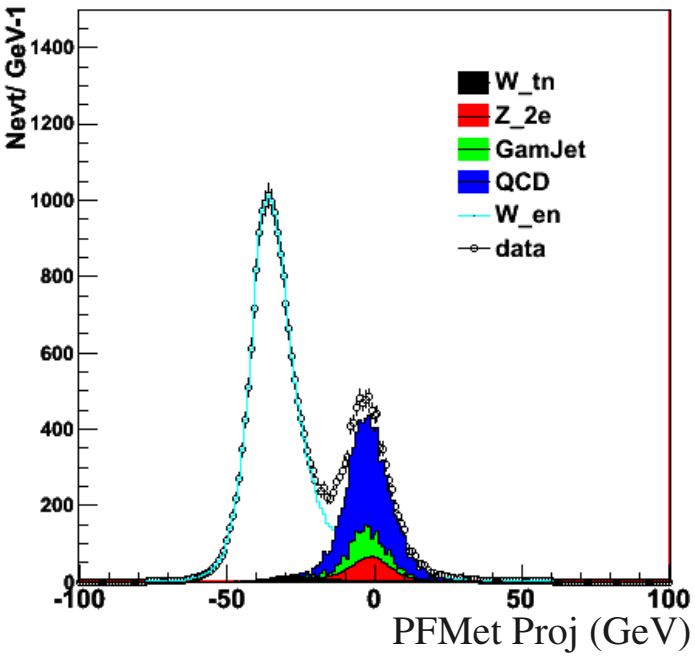
MET projection on electron axis

Definition :

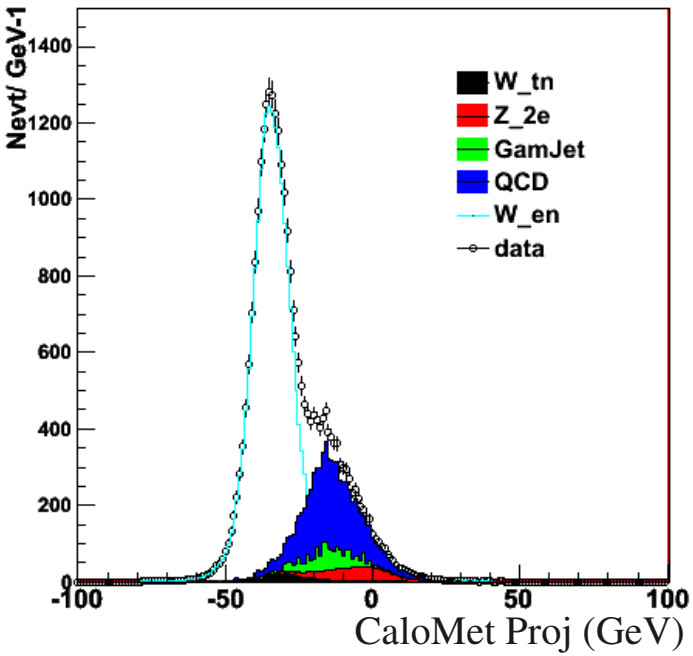


On background :
Expecting no correlation between electron direction and MET

PF MET projection on lepton axis



Calo MET projection on lepton axis



CaloMET completely correlated to the electron

CaloMET resolution on background worse than PFMET resolution

Conclusion

ZZ diboson final state study in dedicated channel ZZ → 2l2ν require a good understanding of Missing Transverse Energy.

Missing Et Commissioning :

- → Understand several MET computation and several observables
- → Data are coming → need a prompt feedback , many work to do !
- → PAS Note → Freeze of data around end of may
- → Ready for pre-approval in June

ECAL Selective Readout :

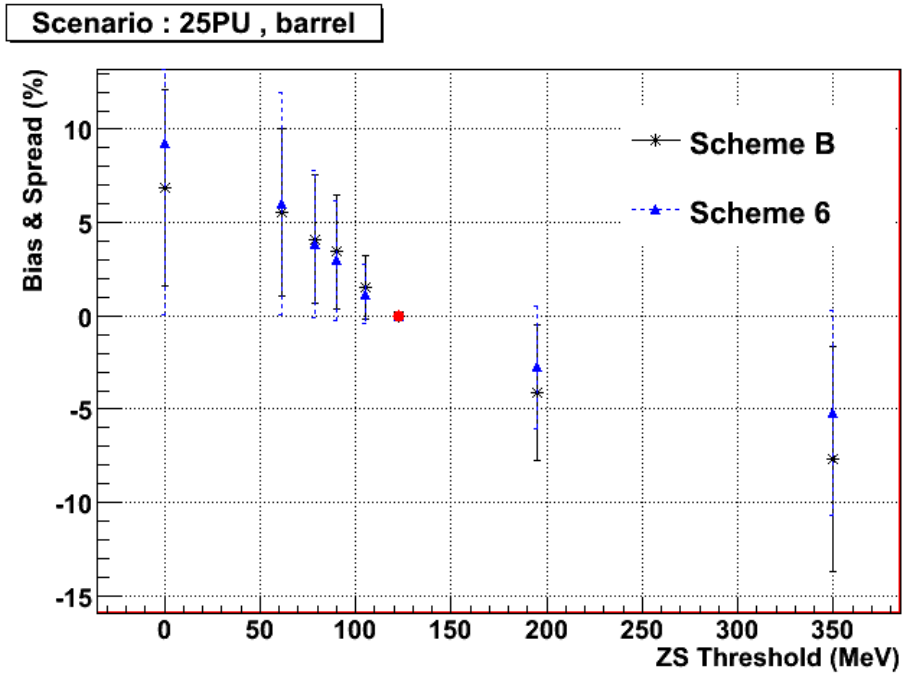
- → Checking SR settings variations has no significant impact on MET in startup conditions
- → More on jets but still negligible → Need to take care at higher luminosity

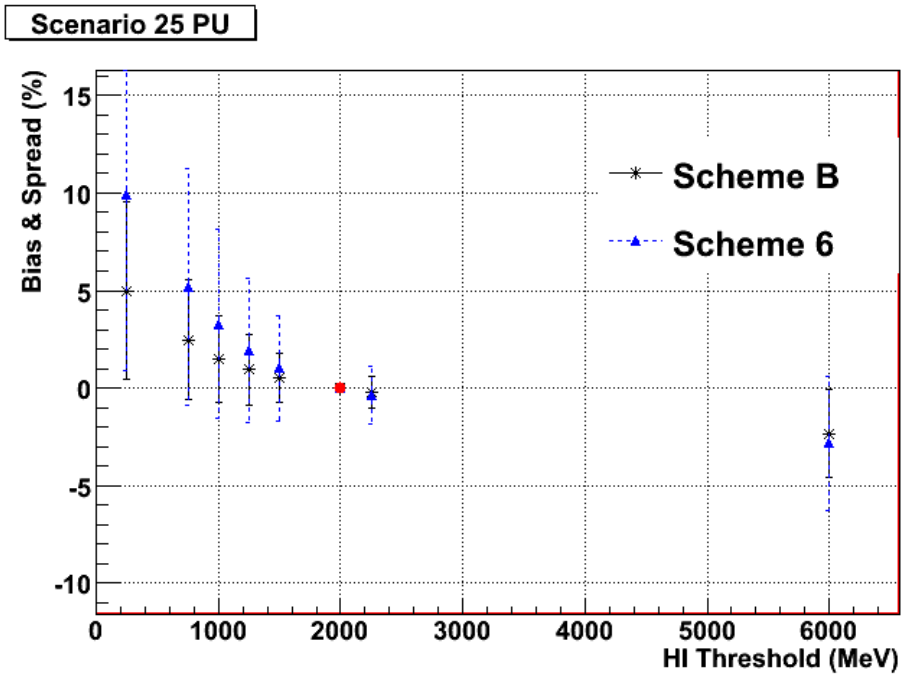
ECAL Laser Monitoring :

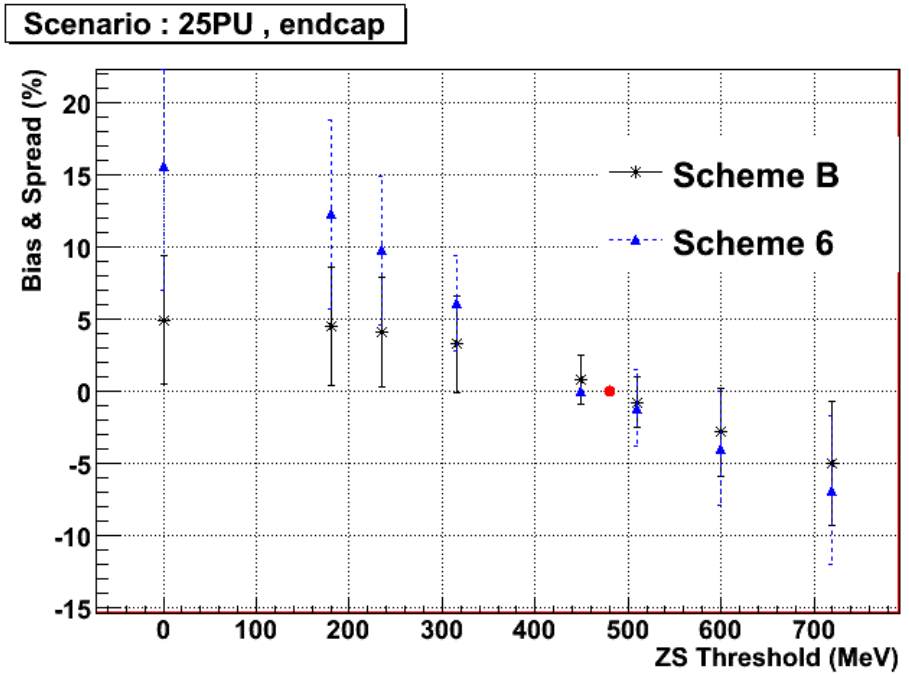
- → Use dedicated data to improve laser pulse shape parametrisation.
- → Expecting improvement of laser working conditions to monitor the ECAL response

Backup

25 PU Luminosity Scenario



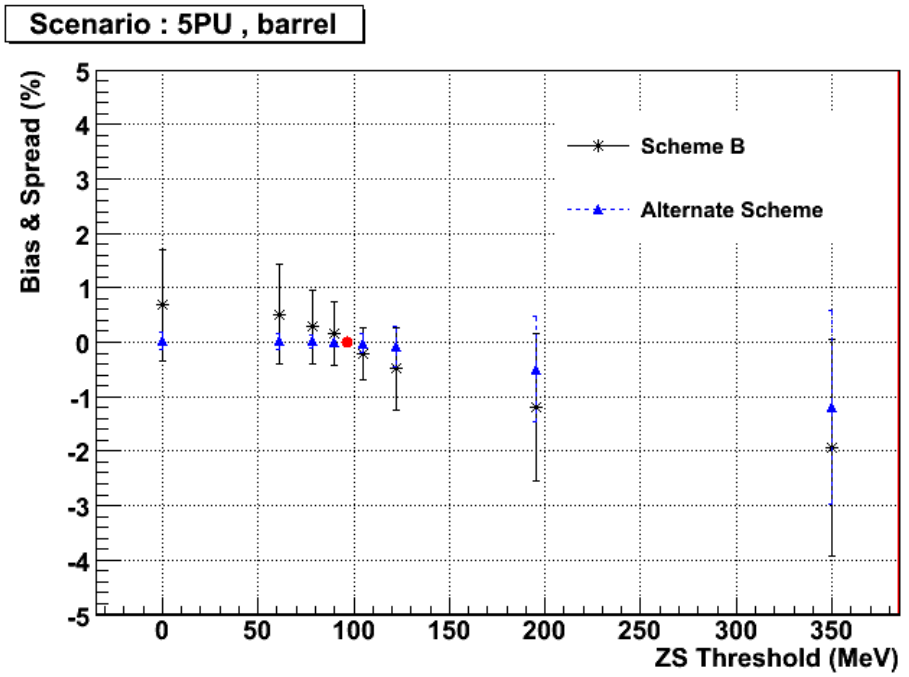


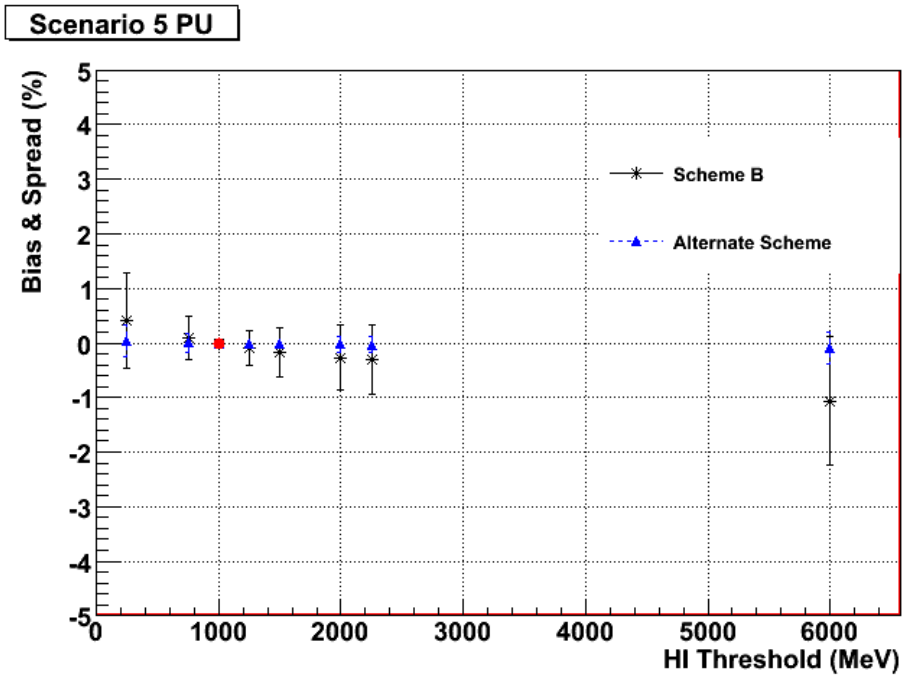


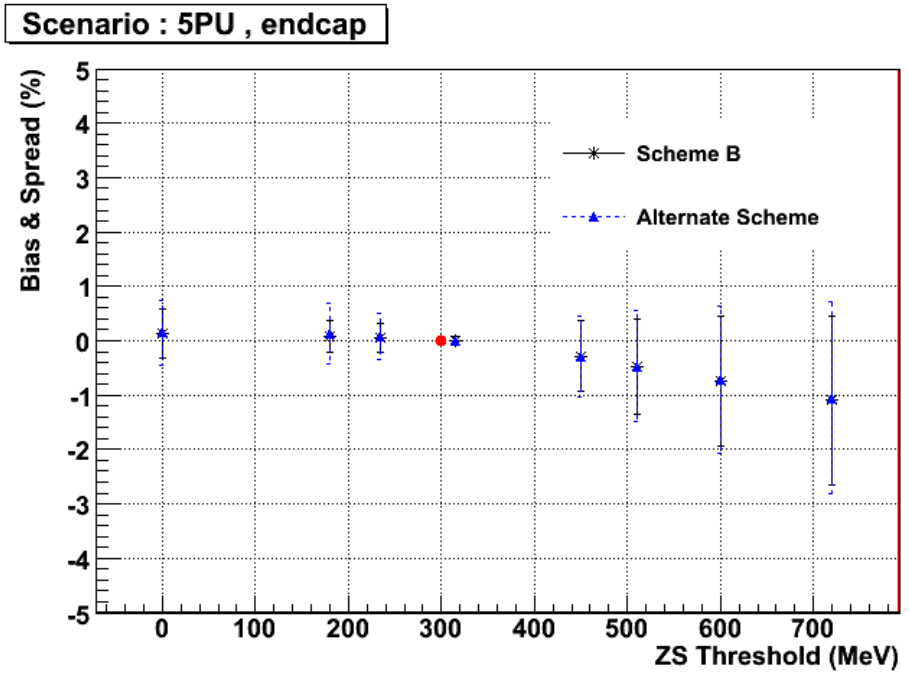
ZS threshold : Same (very few better) sensitivity using Scheme6 in barrel.
Deprecation of sensitivity in endcaps using Scheme6

HI threshold : Sensitivity increased using Scheme6

5 PU Luminosity Scenario



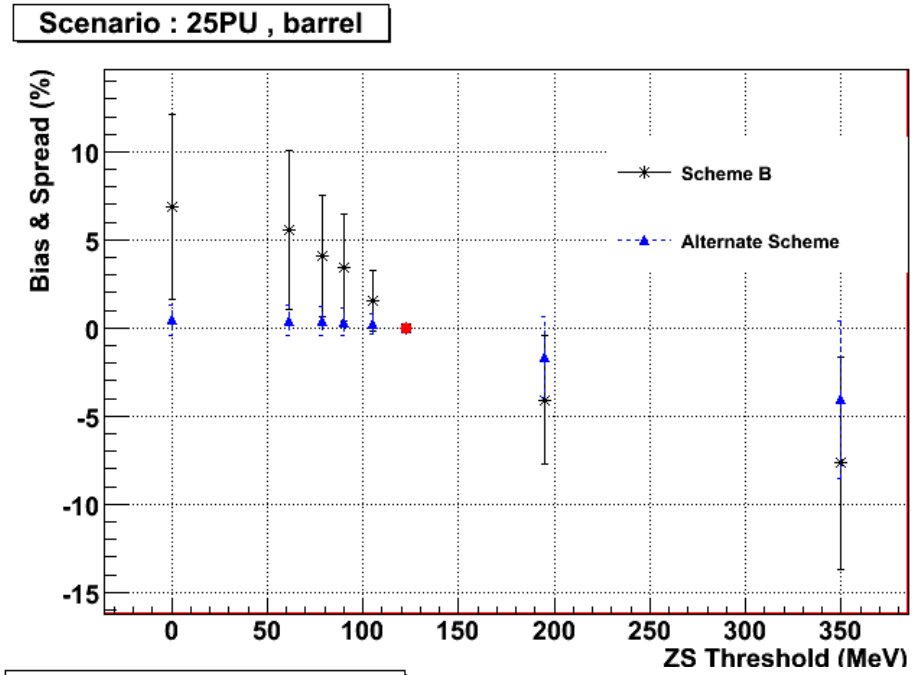


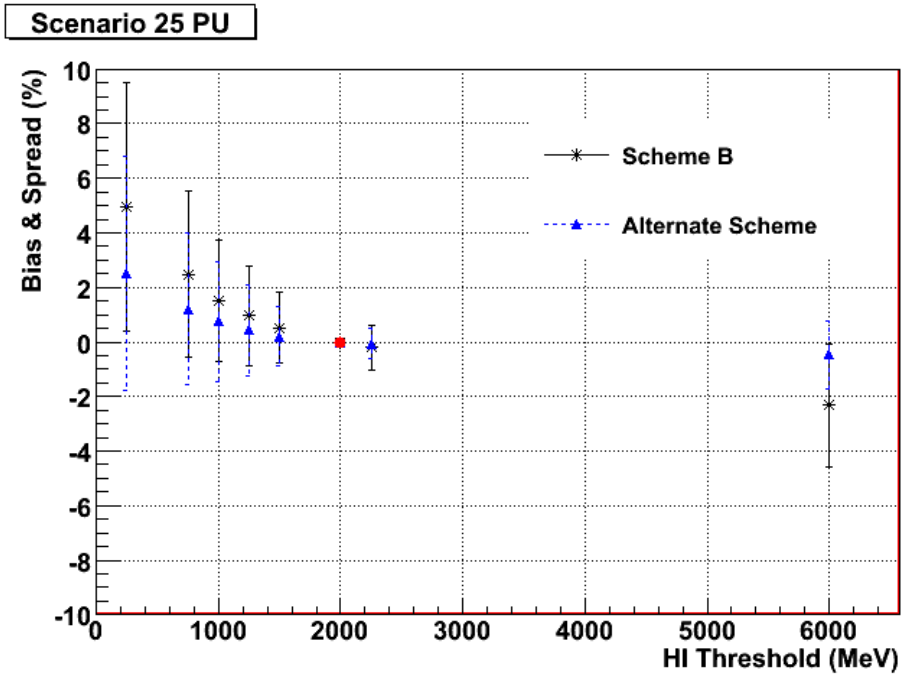


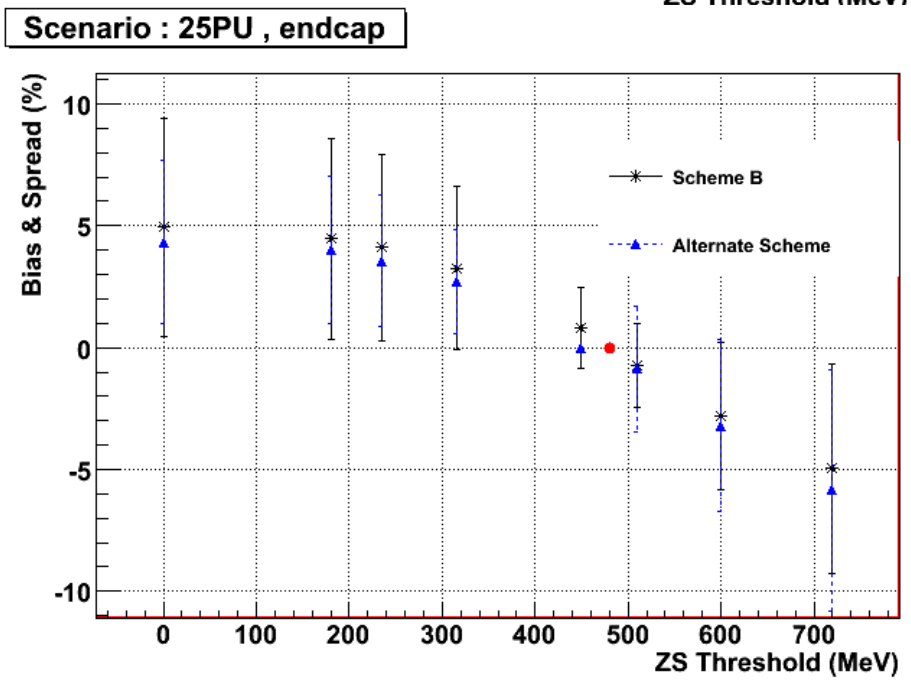
Using a higher crystal threshold :

- Provides an insensitivity of jet reconstruction to a possible change of HI threshold.
- Provides an insensitivity of jet reconstruction to a possible change of ZS threshold until 80-85% of the crystal threshold value.

25 PU Luminosity Scenario







In this 25PU example, endcap threshold is not high enough to make the reconstruction insensitive to possible ZS setting changes in endcap.

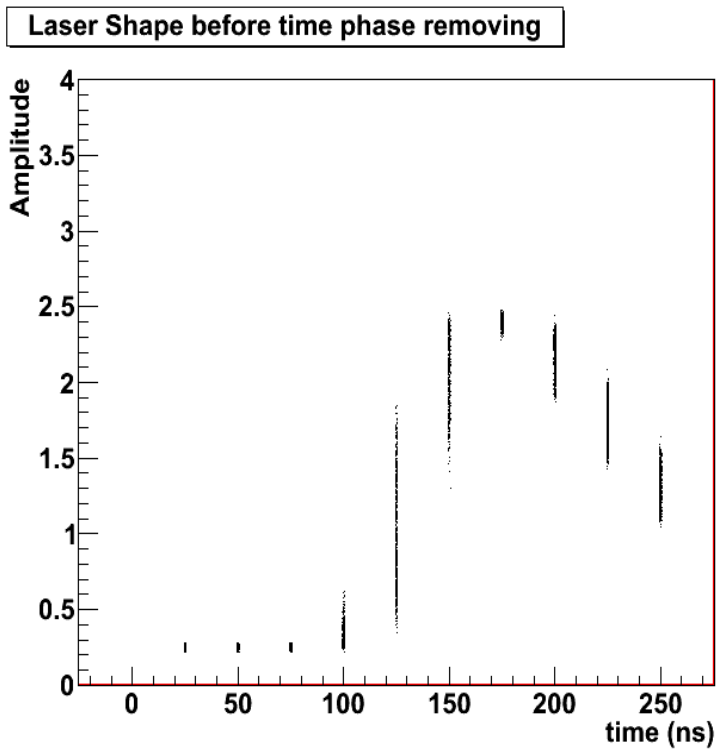
→ *Imply a sensitivity to HI threshold*

Barrel stays insensitive in a 25 PU lumi scenario to ZS threshold.

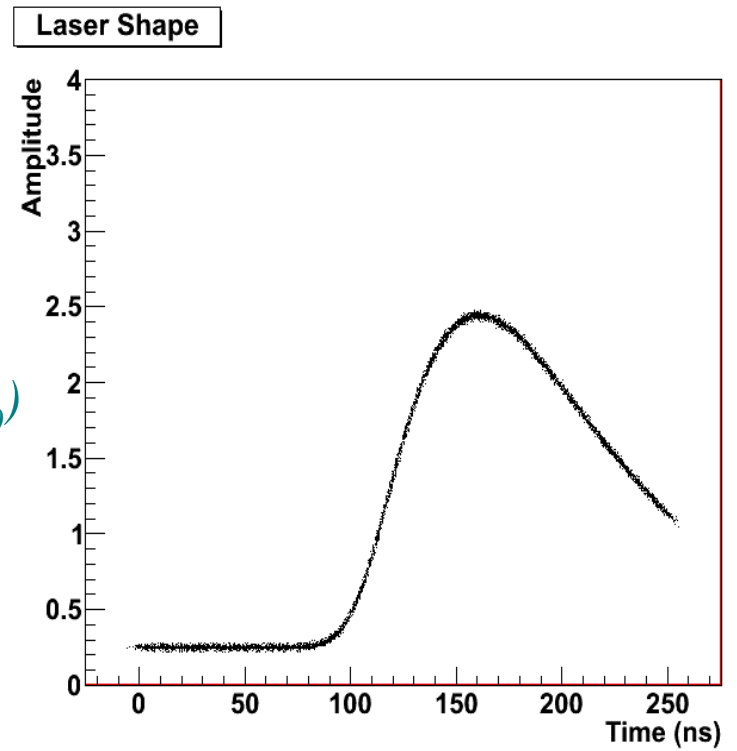
Time Phase Removing

Step 2 : Remove time phase shift for each event on APD samples
Using all pulses, reconstruct the complete shape

Taking all events of one laser sequence

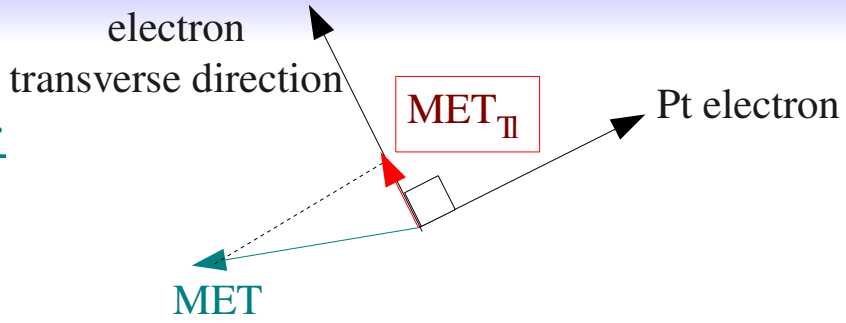


Using Matacq time t
and
removing time phase (t-t_0)
on ~600 pulses



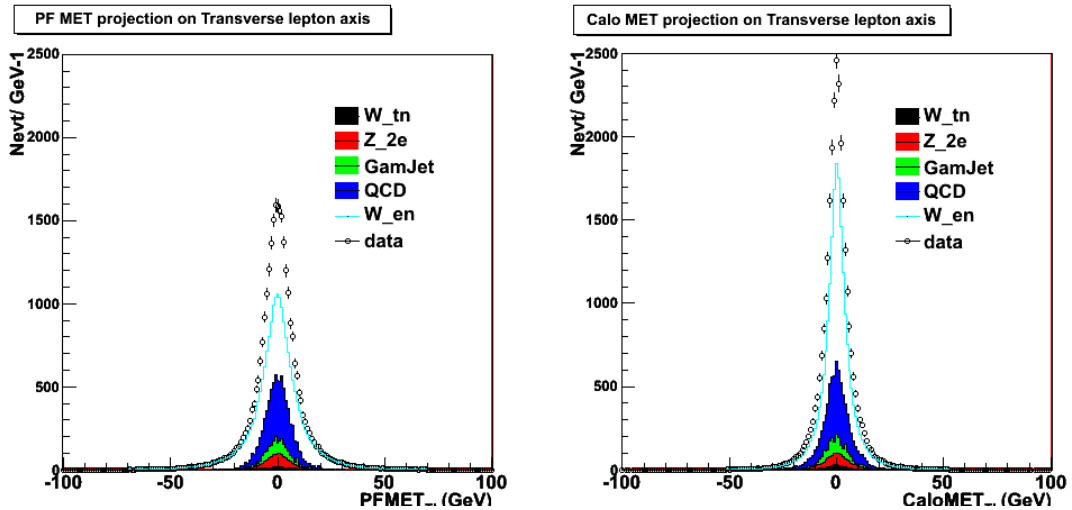
Transverse lepton MET projection

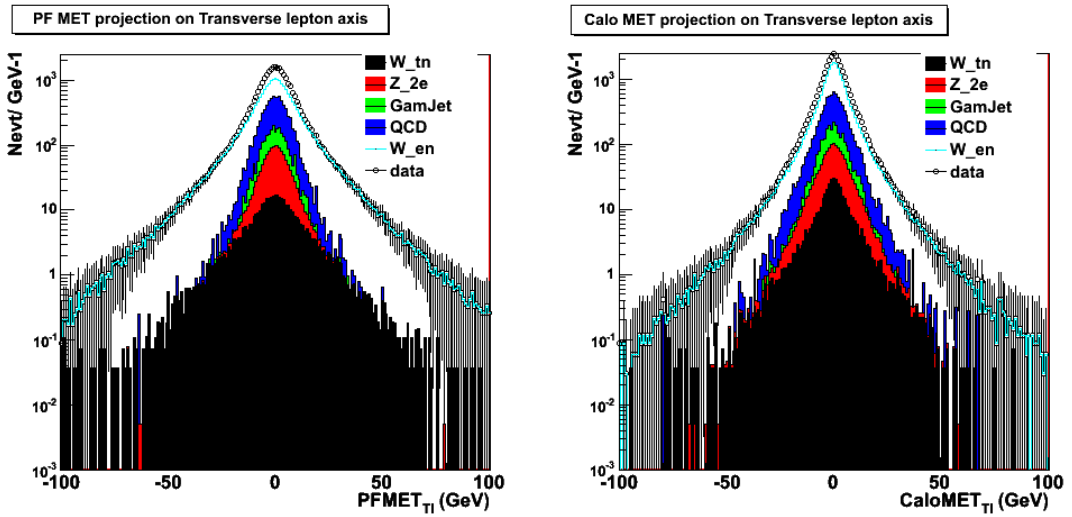
Definition :



Expecting : Zero centered distributions

MET values smaller for background
- → Small transverse component
- → Background spread smaller than signal spread





On Signal :

CaloMET more correlated with electron direction
- → Smaller transverse contribution
- → Tighter distribution