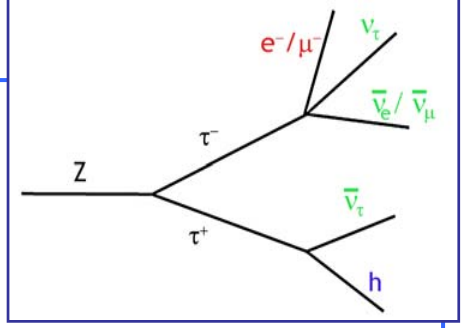
100 pb^{-1} data: in-situ EtMiss validation with **Z→ττ → lep-had evts**



Z → ττ → lepton-hadron analysis:

⇒ developed by Milano group: D. Cavalli, C. Pizio in close collaboration with Freiburg group.

⇒ First data in this channel can be used to:

- determine the **Tau scale** from the reconstruction of the visible mass (lept, τ–jet),
- determine the **EtMiss scale** from the reconstruction of the invariant ττ mass
- determine the **Tau-jet Identification Efficiency**
- measure the **cross-section**

⇒ Analysis at 10 TeV and L= 100pb^{-1}:

- Select Z→ ττ →lepton-hadron strict cuts applied to have low level of backgrounds
- Main backgrounds**: QCD, Wμν, Weν, Wτν, (tt, Zee, Zμμ)**
  - The QCD background can be very well suppressed optimising the lepton Isolation cuts
- **Estimate background in-situ using same sign events (SS events)**

  ⇒ signal events have opposite sign lepton and τ-jet (OS events)

Analysis Method

Two separated analysis ⇒ use the invariant mass to tune the EtMiss scale and the visible mass to tune the tau scale.

⇒ This analysis is now implemented in the Z/W Benchmark package

1. **Select max pT lepton in the event**
   p_T>10 GeV (15)
   Use single ele/μ trigger
2. **Basic cut flow:**
   - E_TMiss>20 GeV
     -mandatory for MET scale determination
     -helpful against QCD and Z→ll
   - Lept – E_TMiss Transverse Mass (m_T) < 30 (50) Gev
   - ΣE_T < 400GeV
3. **Invariant/Visible mass reconstruction:**
   use e/μ candidate and τ-jet candidates
4. **Second cut flow:**
   - 1. < Δφ (Lept – τ-jet) < 3.1 (2.8)
   - Invariant Mass ττ >0
5. **Separate OS evts from SS events**
   Signal: only OS evts,
   Backgds: OS and SS with similar probability→**background contribution can be estimated in-situ using SS events**
6. **Subtract SS from OS evts**
   A correction is needed for W background where OS/SS≈1.5
   → correction factor determined in situ (cfr. ATL-PHYS-INT-2009-005)
7. ⇒ **E_TMiss scale determination**
   from reconstruted invariant mass
   ⇒ **τ scale determination**
   from reconstructed visible mass

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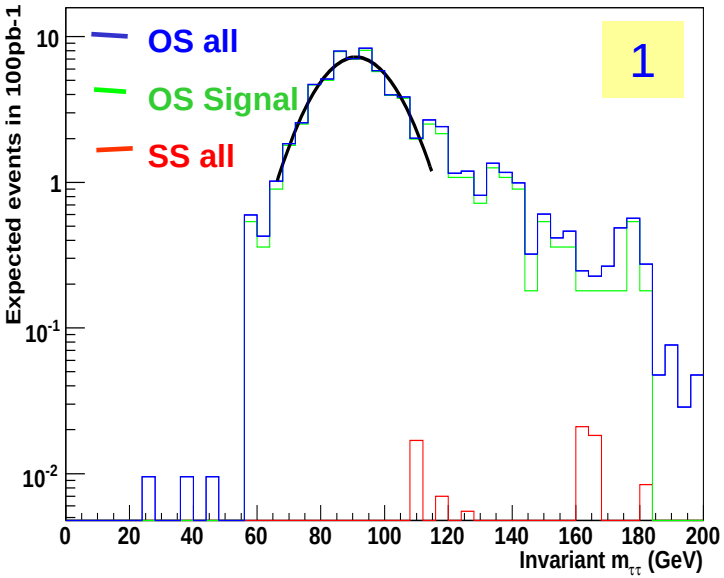
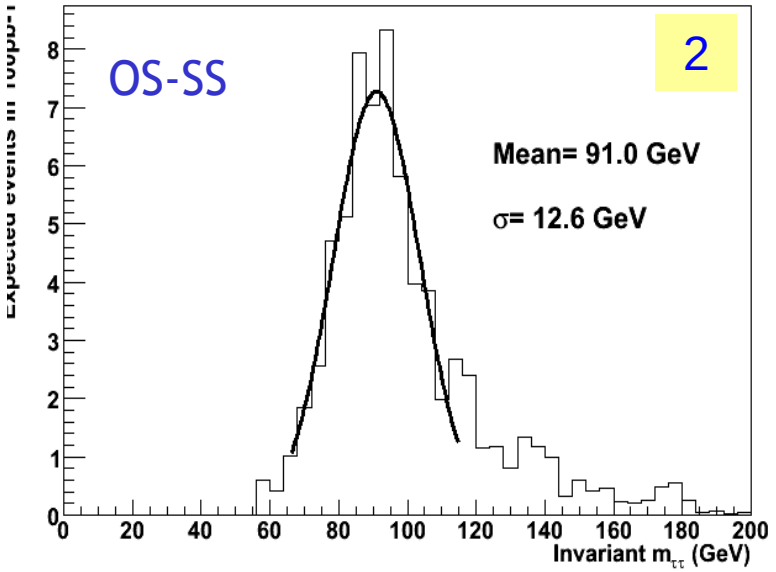
Z→ ττ: tune Missing ET Scale from invariant mττ





ττ invariant mass distributions:

1) OS (signal + background), SS (signal + background), NO QCD, OS Signal

2) OS – SS

In 100pb^{-1} ⇒ 200 Signal evts S/B=22

⇒S/B ~ 5 taking into account QCD background (still preliminar…)

⇒ QCD can be well suppressed optimizing the lepton isolation cut

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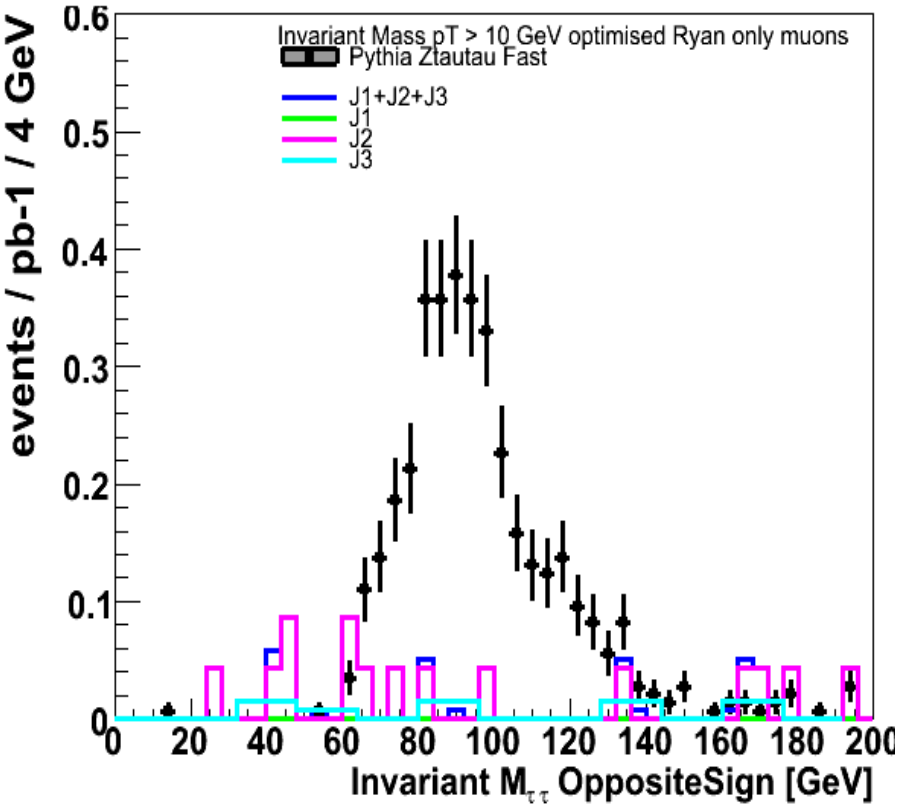
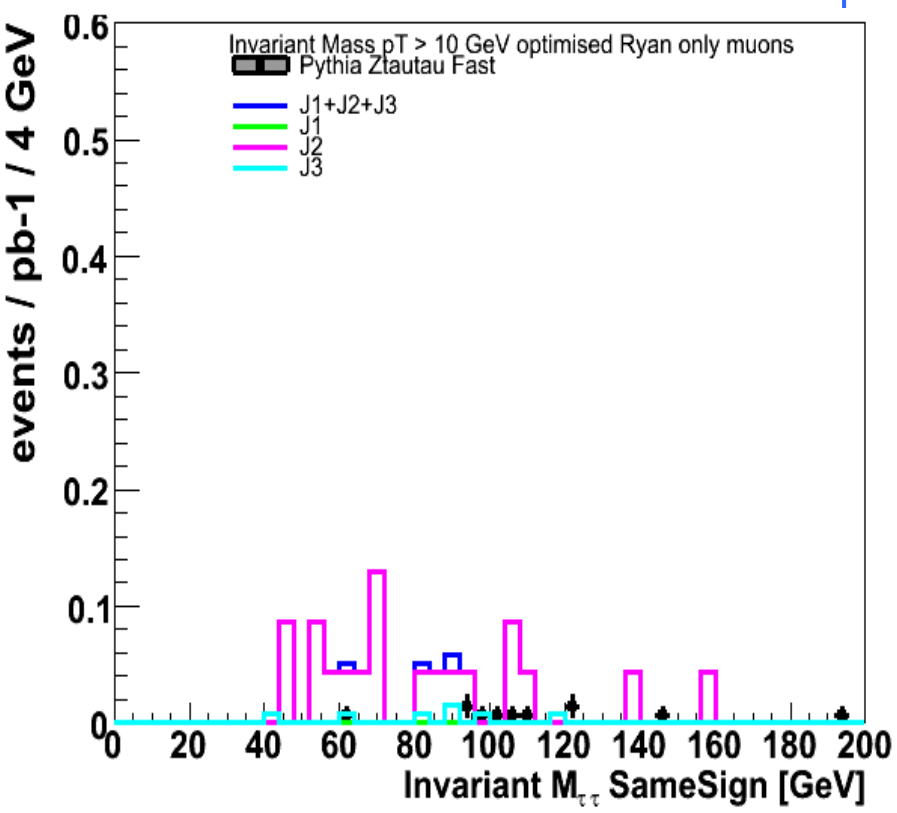
QCD background using very large statistics of AtlfastII events

Isolation cut for muons: EtCone30 <= 2 && NuCone40 < 1



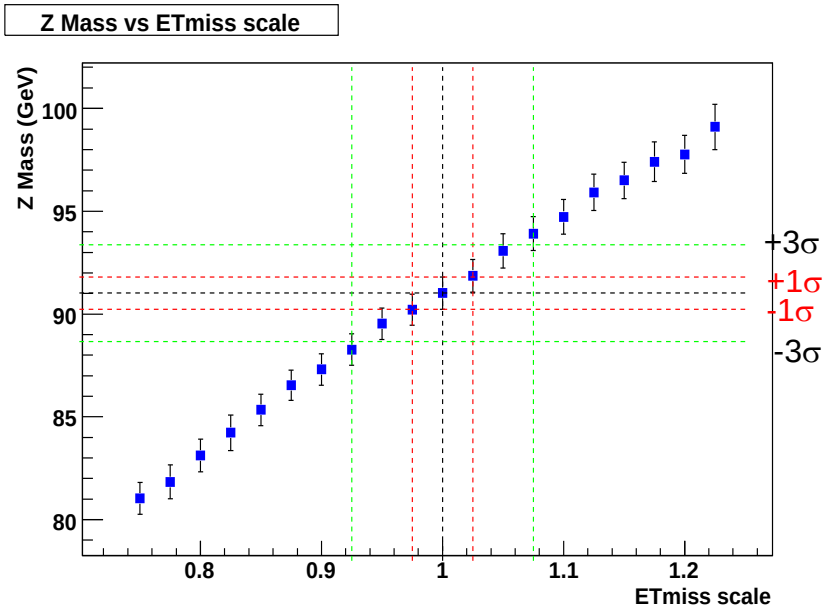


only muon channel

Z→ ττ: tune Missing ET Scale from invariant mττ

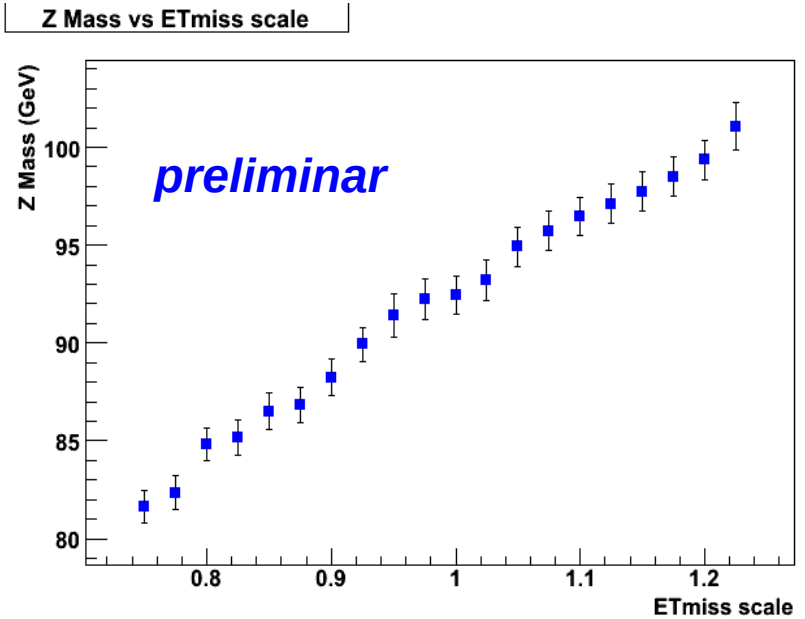
⇒ Determination of the EtMiss scale with invariant mττ :

- in 100 pb^{-1} invariant mττ mass reconstructed with an error of less then 1 GeV (0.8 GeV)
- taking into account only the statistical error the EtMiss scale could be determined with a precision of 3 %
- taking into account also systematic effects (subtraction of the SS events and the stability of the fit..) EtMiss scale could be determined with a precision of 8 %



Inv mass vs ETMiss Scale

OS Signal evts



OS-SS Signal+Backgd evts

(the one that we will have in real data !)

NO QCD included yet

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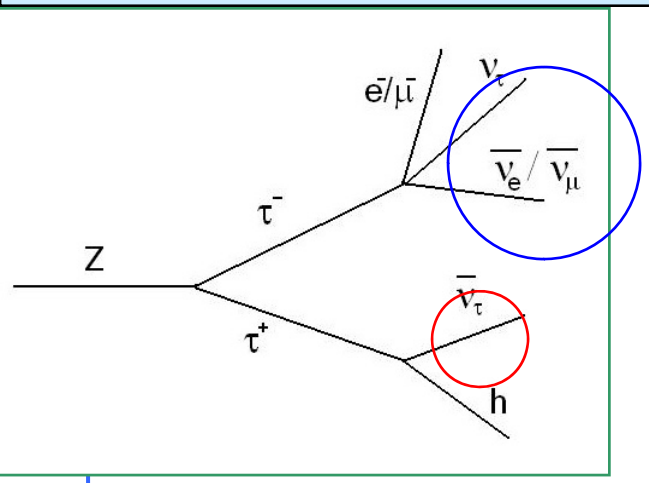
BACK-UP SLIDES

Invariant ττ Mass Reconstruction



$$m_{\tau\tau} = \sqrt{2(E_{lept} + E_{\nu 1})(E_{\tau\text{-jet}} + E_{\nu 2})(1 - \cos\theta)}$$

- $E_{lept}, E_{\tau\text{-jet}}$ = energies of visible τ decay products

θ = angle bet. the directions of visible decay products

- $E_{\nu 1}$, $E_{\nu 2}$ = energies of the two neutrinos systems

Assumptions:
- $m_\tau = 0$
- **collinearity**

The energies of the two neutrinos systems are obtained solving the system

Co

$$\begin{cases} \not{E}_x = (E_{\nu 1} * u_1)_x + (E_{\nu 2} * u_2)_x \\ \not{E}_y = (E_{\nu 1} * u_1)_y + (E_{\nu 2} * u_2)_y \end{cases}$$

This system cannot be always solved→

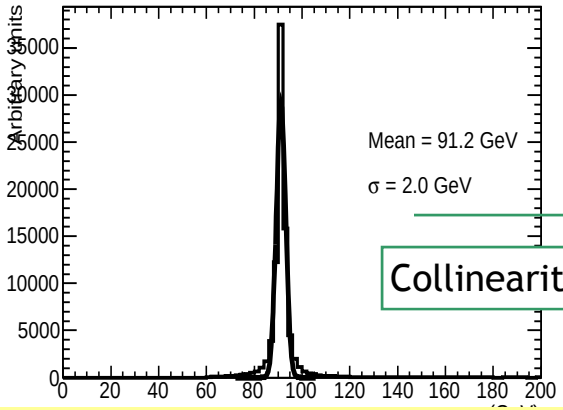
The invariant mass cannot be always calculated

- Determinant has to not be zero ($\sin\Delta\phi \neq 0$) → not back-to-bact lepton & τ-jet
- $E_{\nu 1}$, $E_{\nu 2}$ have to be > 0

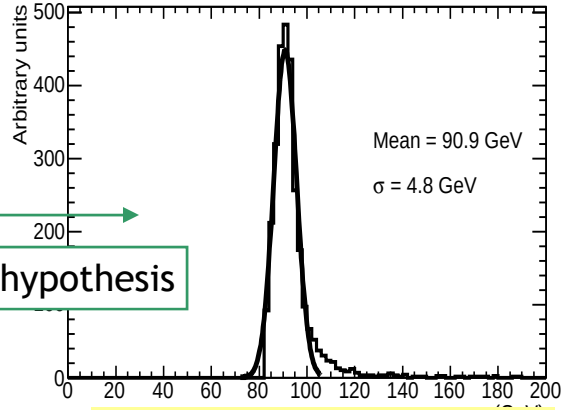
EtMiss Performance: Mass reconstruction

ττ invariant mass reconstruction

Generated m_Z

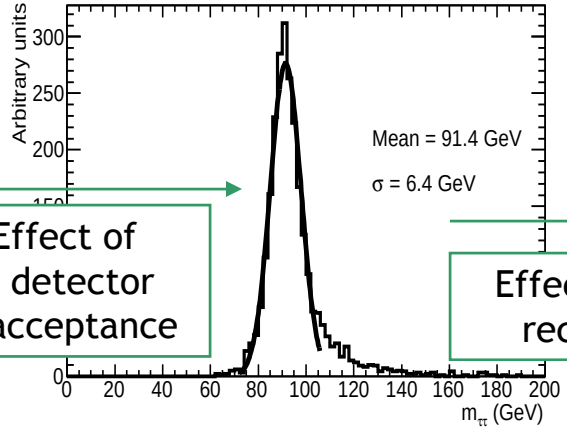


p.l. reconstructed $m_{\tau\tau}$



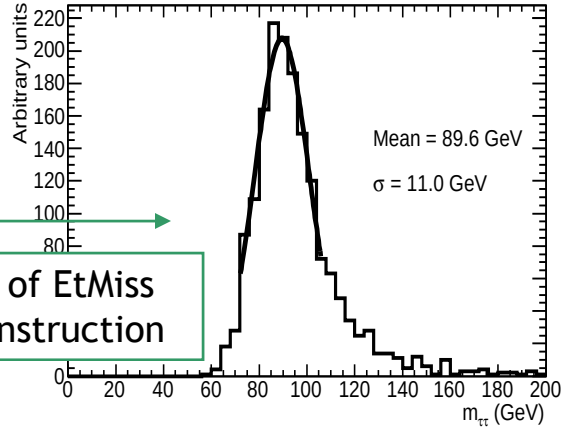
Collinearity hypothesis

ETMiss calc from particles in $|\eta|<5$)



Effect of detector acceptance

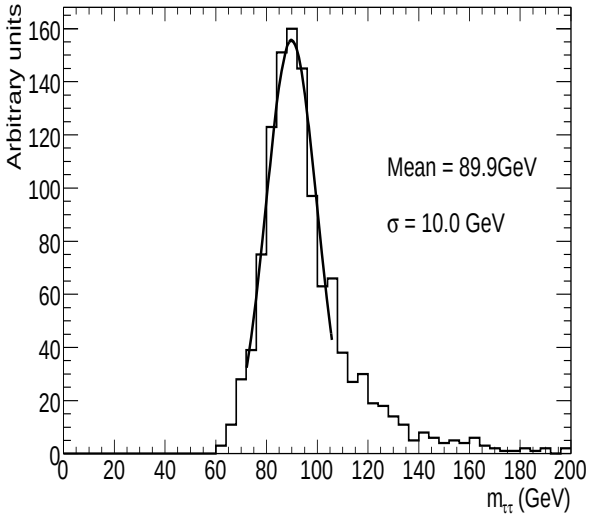
reconstructed ETMiss



Effect of EtMiss reconstruction

The reconstructed mττ is dominated by EtMiss measurement: EtMiss linearity and resolution crucial for ττ mass reconstruction

All reco quantities



$$\sigma(m\tau\tau) \div \frac{ETmiss}{|\sin(\Delta\phi)|}$$

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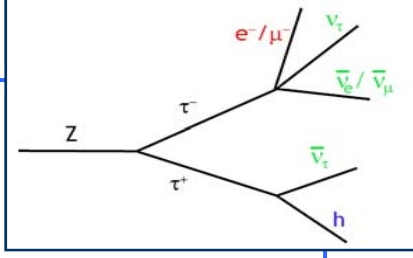
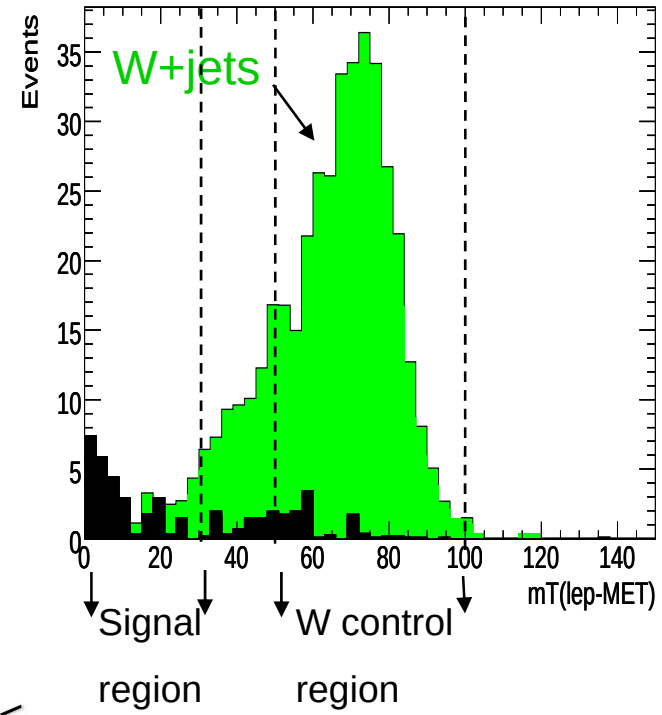
Subtraction of backgrounds in-situ using SS events



- Main backgrounds are QCD, W+jets:
  - QCD: same probability for OS and SS
  - W+jets: OS/SS=1.5

  in pp two production channels (qq'->SS/OS, qg->OS)



- Procedure to evaluate number of W OS evts:

Do not apply the $m_T^{lep\text{-}MET}$ cut

1) From $m_T^{lep\text{-}MET}$ distribution at the end of cuts :

   - Evaluate from data the number of W SS (N_{SS}^{CONT}) and OS events in the W control region (R_{SOS} = OS/SS):

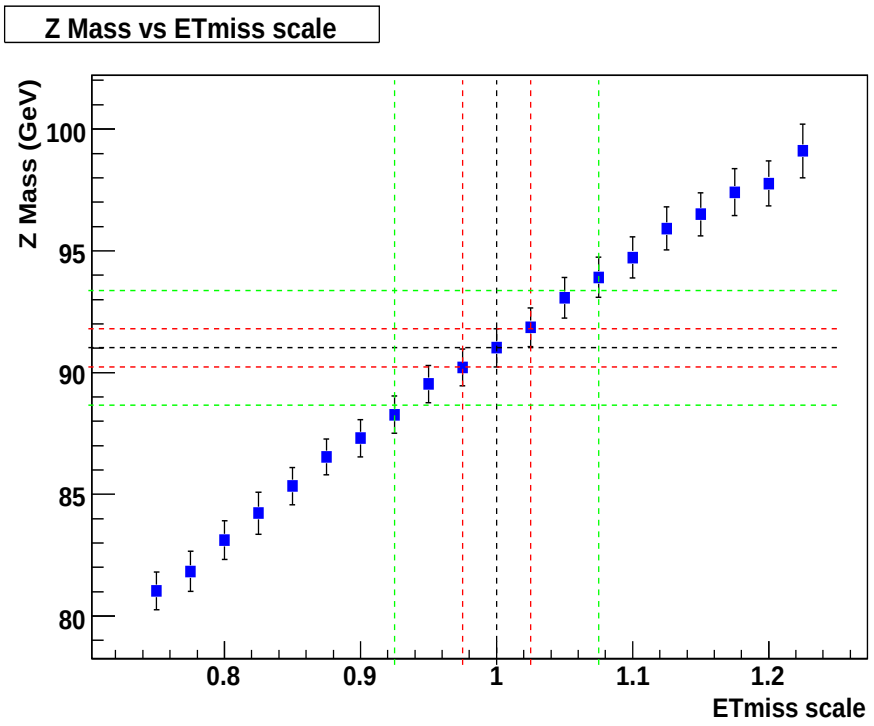
   $\Rightarrow$ for $50<m_T^{lep\text{-}MET}$ (GeV)<100 only W events are collected (other evts/W evts= 2.5%)

   $\Rightarrow$Get from MC the fraction of W evts with $m_T^{lep\text{-}MET} <$ 30 GeV in signal region respect to control (R_{CONT}= from MC)

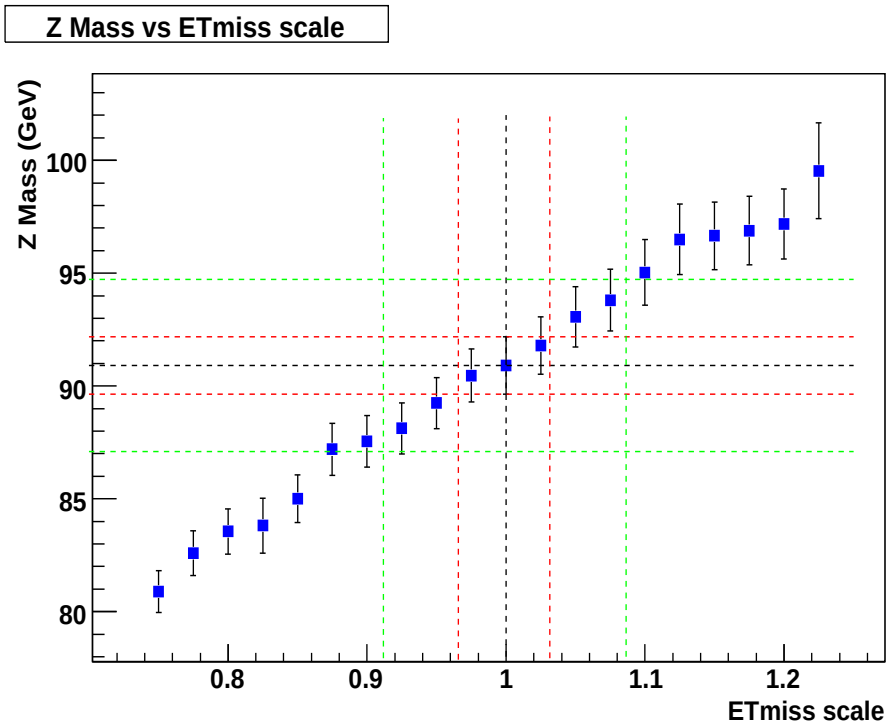
   →compare different MC…

3) Evaluate the number of W events OS expected in Signal region: $N_{OS}^{Signal\ region}=R_{CONT}*R_{SOS}*N_{SS}^{CONT}$

What can we do with 50pb-1 ?



100pb-1



50pb-1

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