PDF4LHC Workshop
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Toward measurements of PDF observables at LHC
- **CMS Studies** -

Roberto Tenchini

INFN - Pisa

The LHC early phase

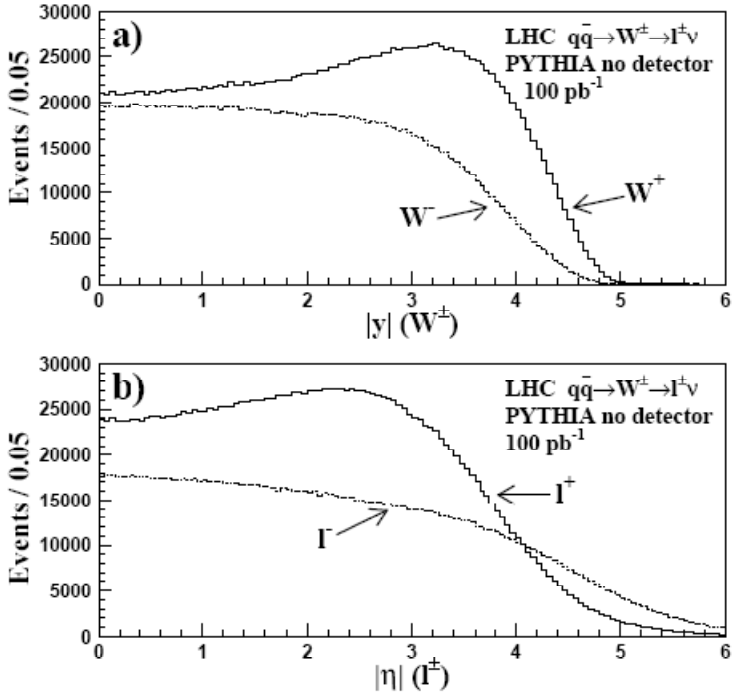
- Use early data to constraint the PDF making robust measurements
- For many observables statistics is not an issue, W charge asymmetry

$$\sigma(A) = \frac{1\text{-}A}{\sqrt{N}}$$

- Systematics (backgnd) must be controlled

$$A^{\text{observed}} = \text{purity} \times A$$

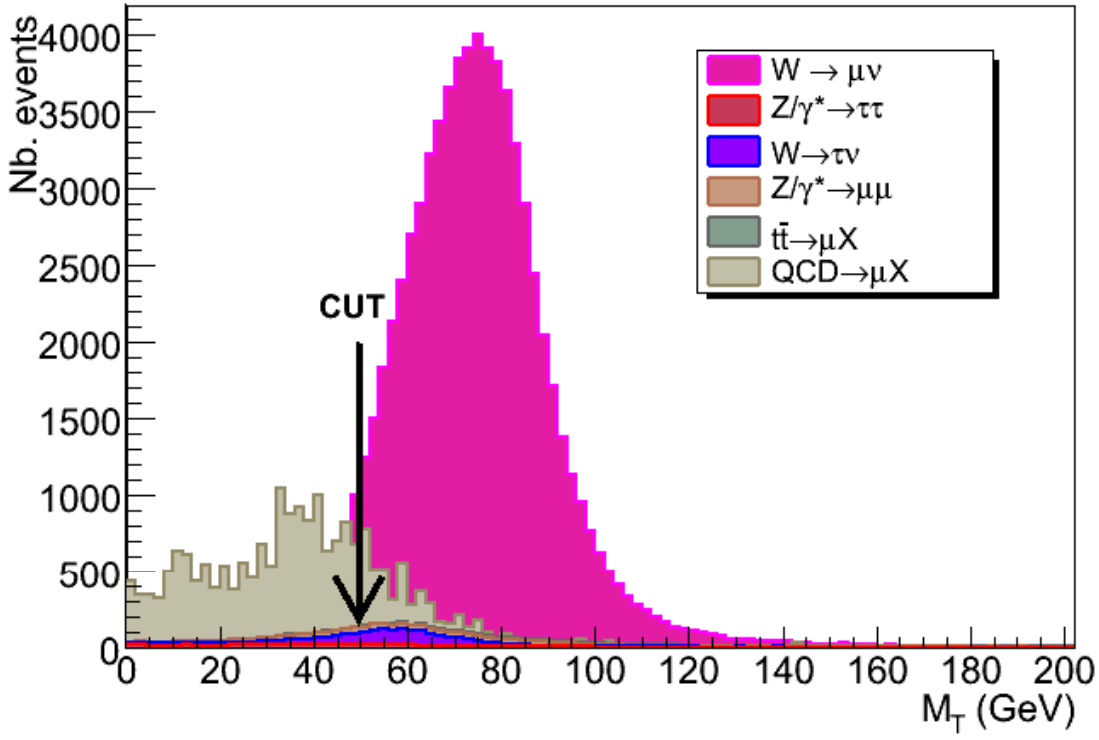
M. Dittmar et al. – 1997



The W transverse mass from muons

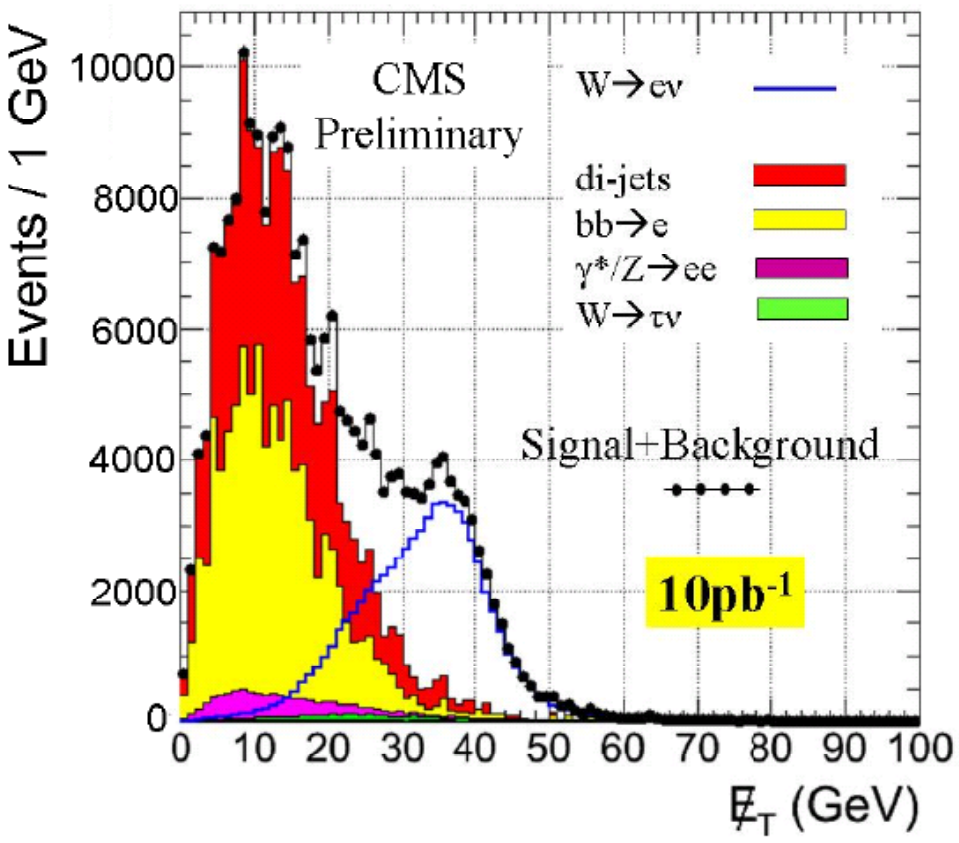
Combine measured muon and MET, full simulation with initial calibrations

Muons isolated, $p_T > 25$ GeV, $|\eta| < 2$



The Missing E_T from electrons

- Use simple electron id criteria (initial phase): matching of track to narrow shower in ECAL, cut on HCAL
- Require isolation, E_T> 20 GeV, |η|<2.5
- Bremmstrahlung: isolation for electrons is in an annular cone !

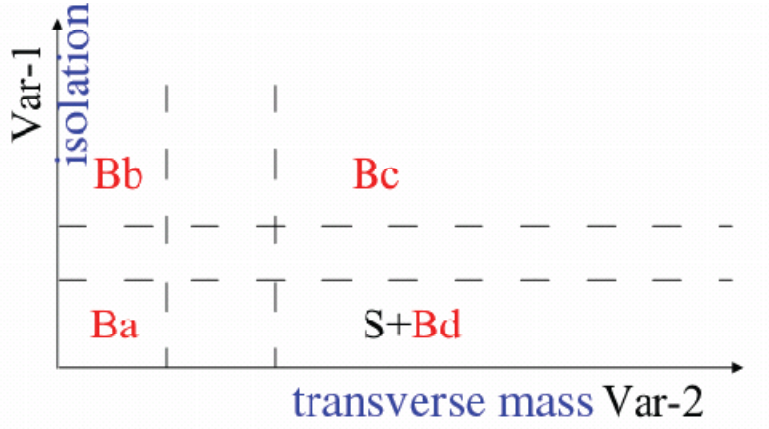


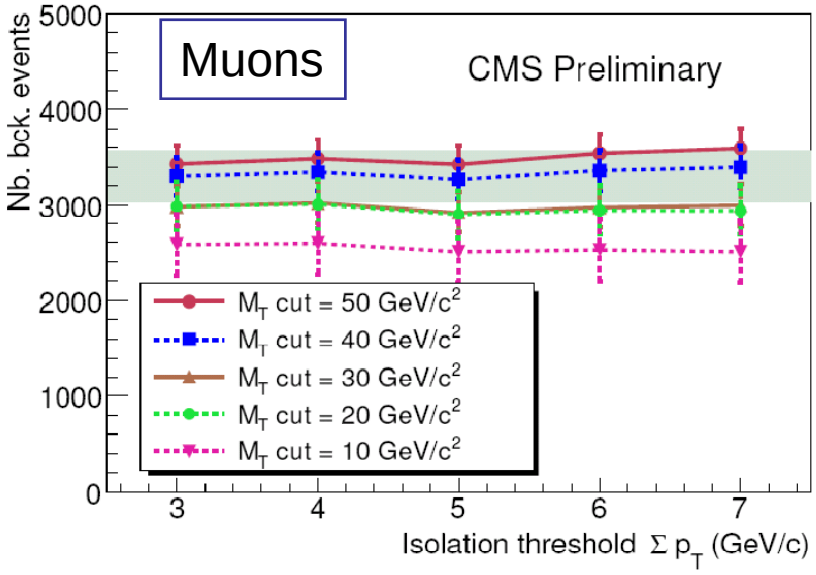
Data-driven background studies - matrix method -

- Take two variables with discriminating power (e.g. isolation and M_T)
- Assume that the two are uncorrelated
- Compute bkg from

$$N_{QCD} = N_d = N_a \times \frac{N_c}{N_b}$$

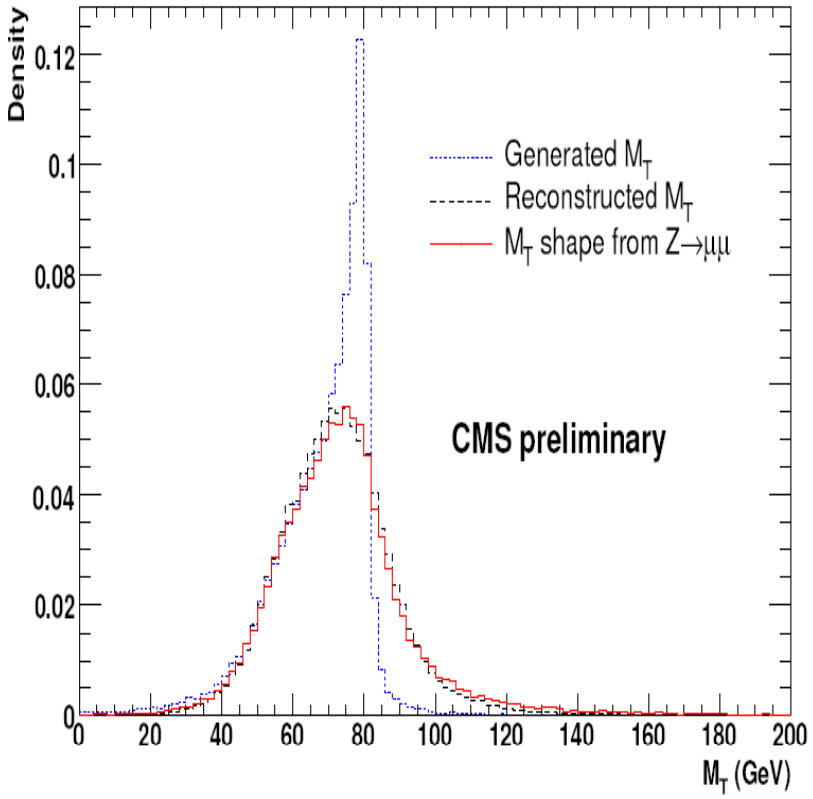
(Correct for small signal contamination in a,b,c)





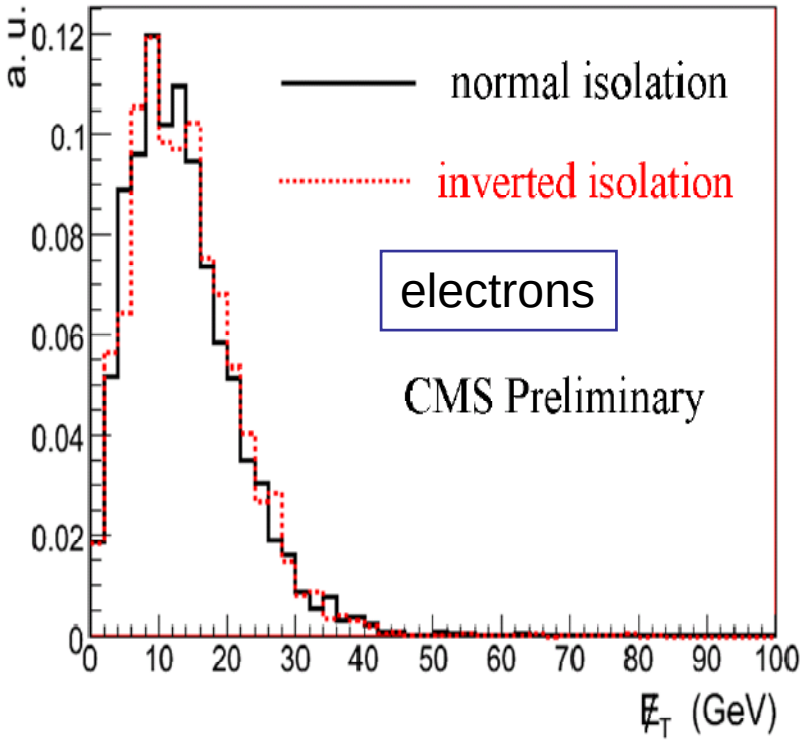
Data-driven background studies - template method -

- By knowing the shape of the signal, can extrapolate the QCD background from the region below the M_T (or MET) cut
- Parametrize the MET in the W sample from Z $\rightarrow \mu^+\mu^-$ data
- In the parametrization Z direction and p_T used
- In these methods distributions are reweighted by M_W/M_Z



Data-driven background studies - again on template method -

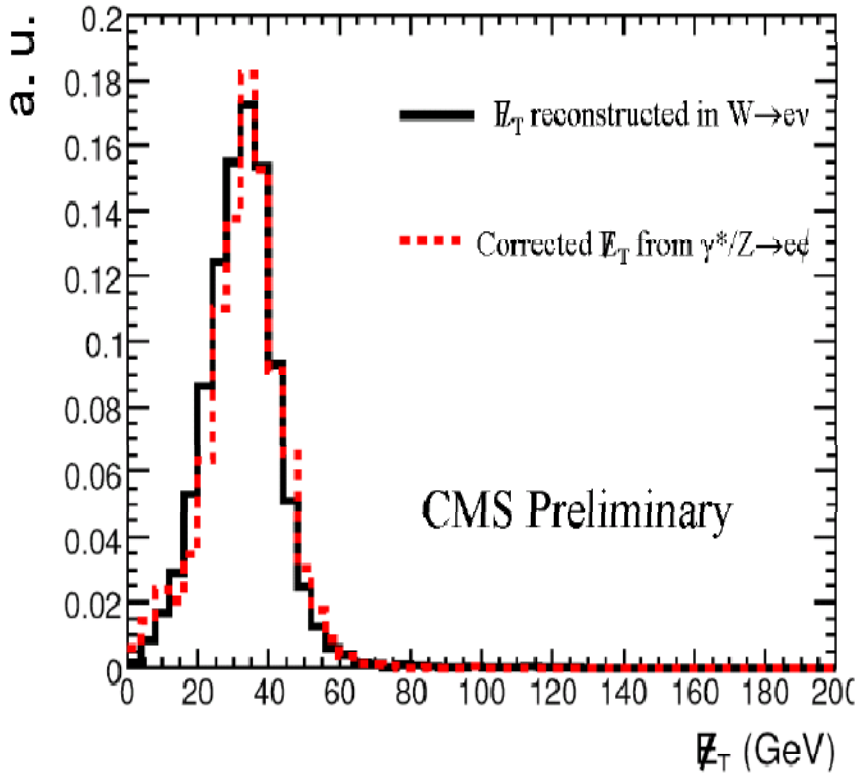
- Can invert isolation to get and enriched QCD sample.
- Check on the electron sample, MET from QCD di-jets seems not correlated



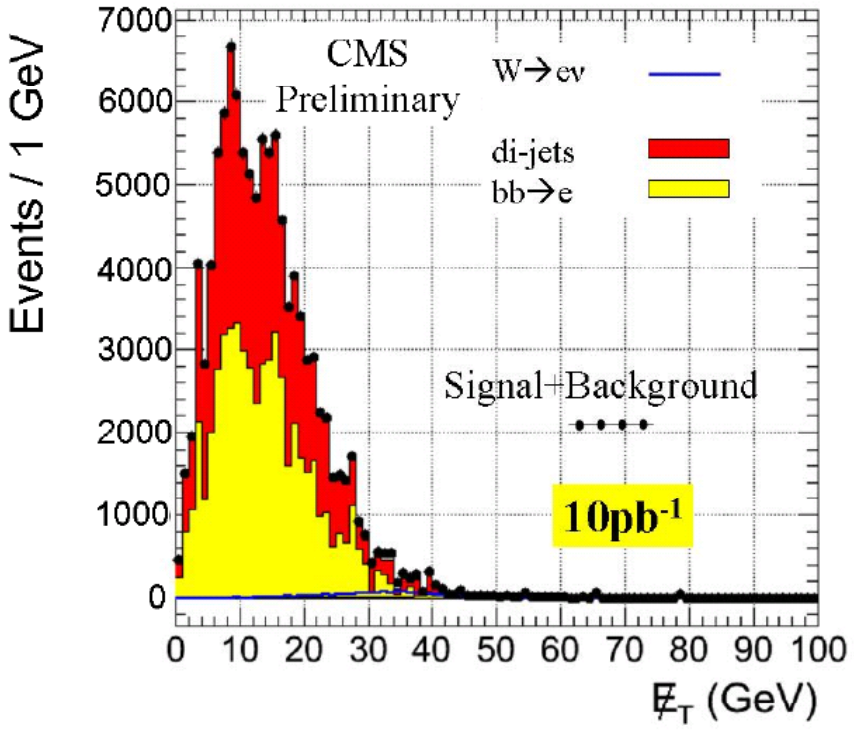
QCD di-jets

Data-driven background studies - template method (electrons) -

Shape of signal from Z → ee

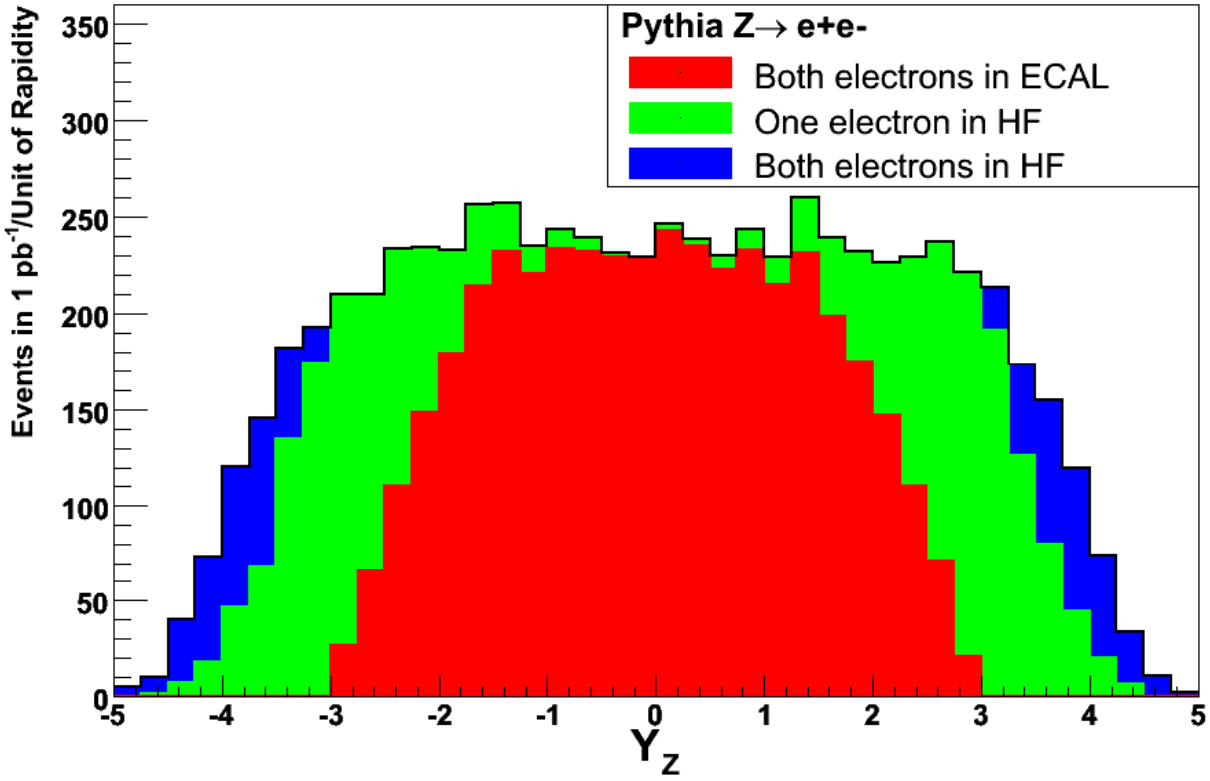


Single electrons with inverted isolation



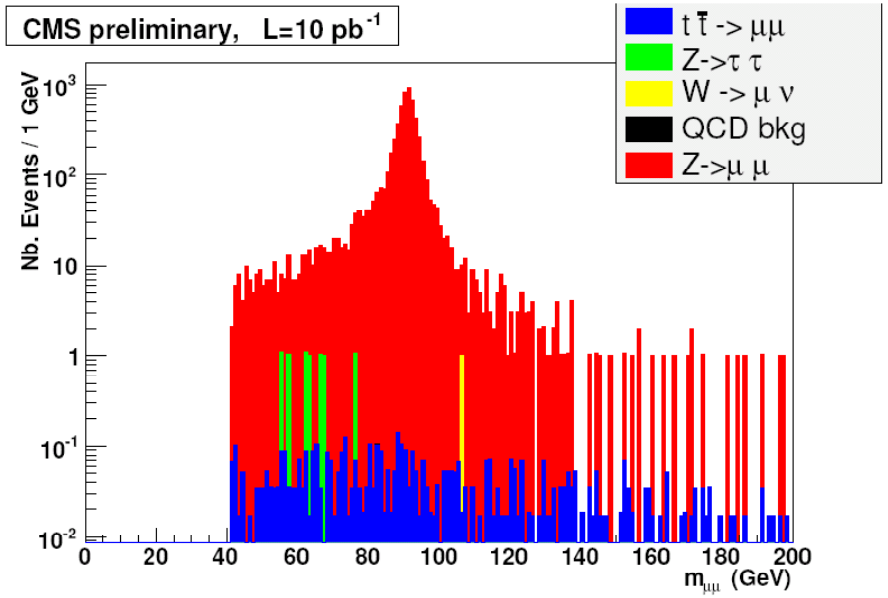
What about the efficiencies ?

- They are important for absolute measurements, as the Z rapidity differential cross section
- Segmentation in the forward calorimeter HF allows extended coverage in CMS

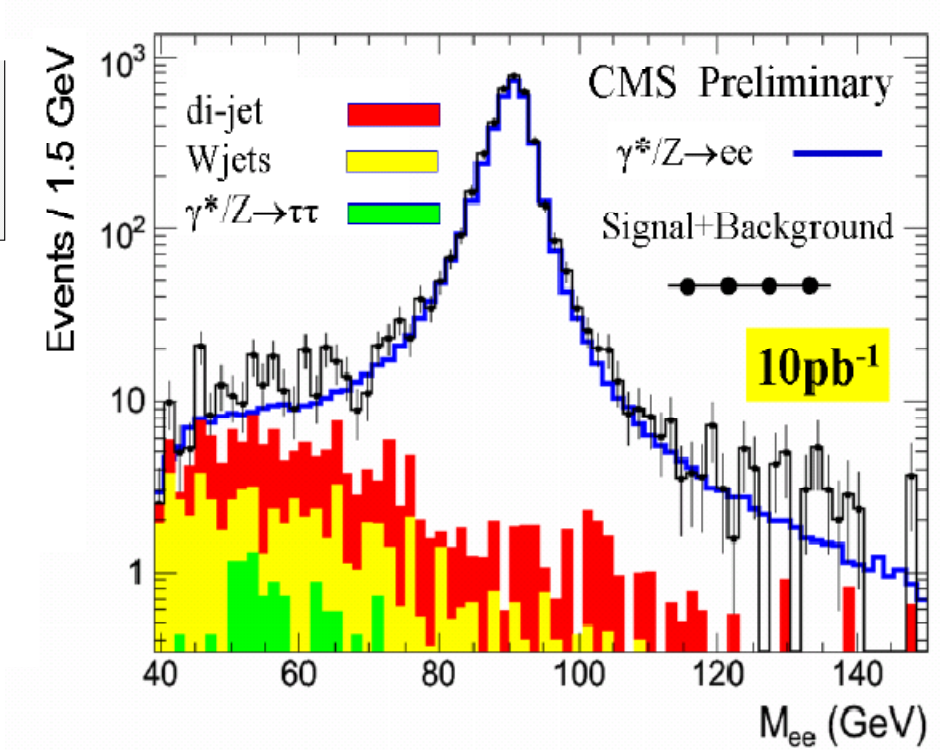


Efficiencies from the Z: double tag/single tag techniques

muons



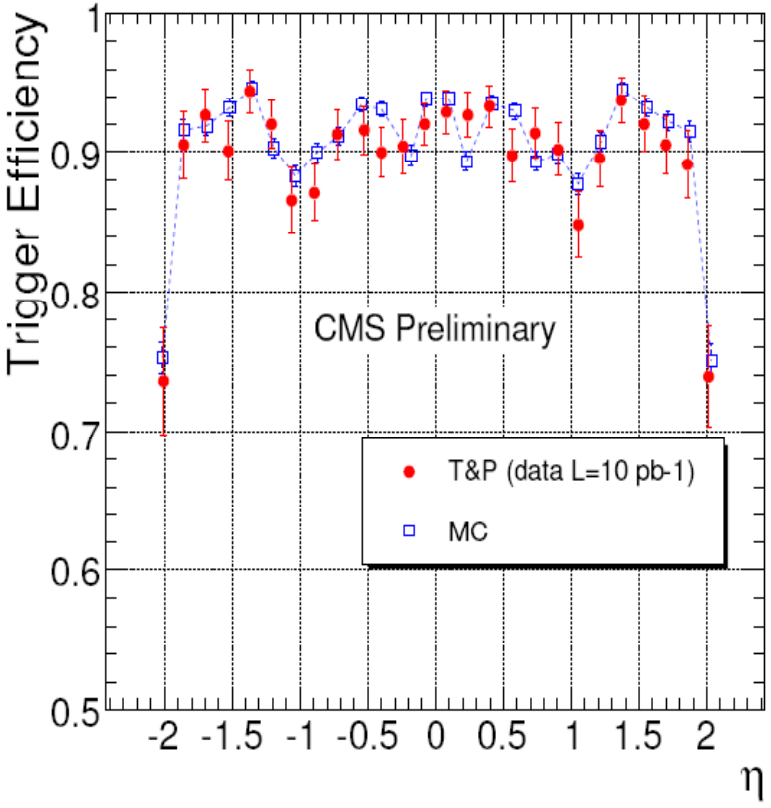
electrons



Can get easily pure samples at the Z

Efficiencies from tag&probe at the Z peak

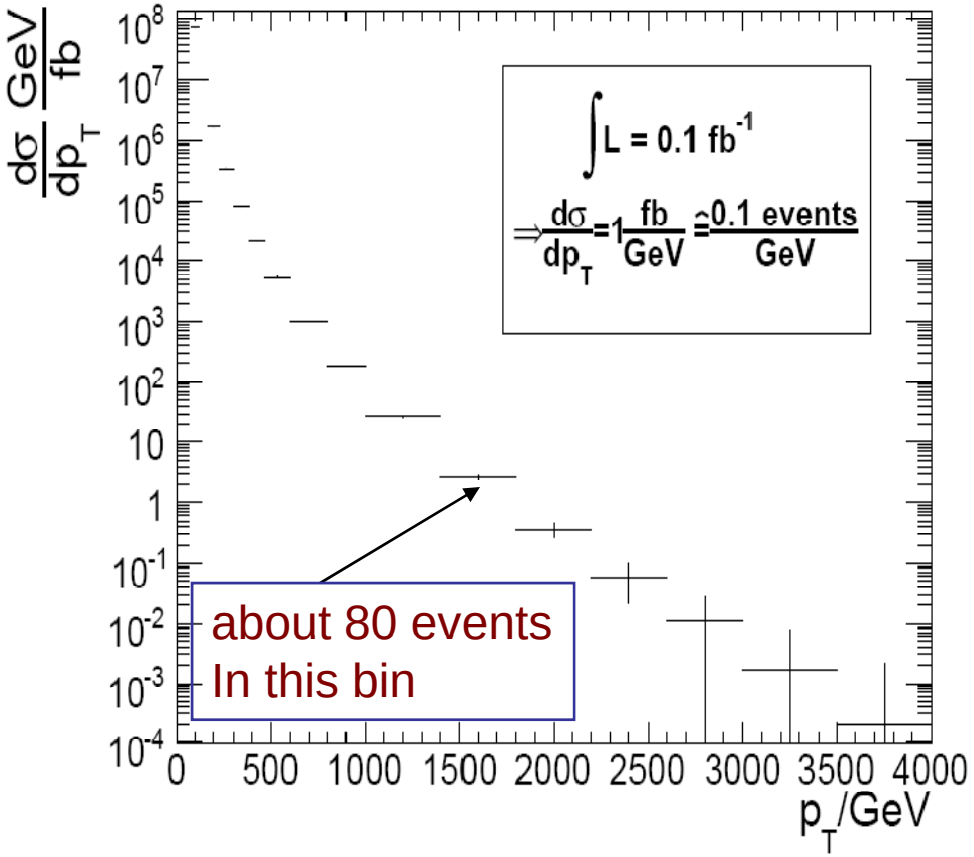
- One object, the tag, has strict criteria imposed on it to identify it.
- The probe is another object with looser criteria to meet.
- The Z resonance links tag-and-probe, ensuring a pure sample.
- Caveat: correlations.
  - Need to prove that works on full simulation
  - Better factorizing the cause of inefficiencies, study one by one
- Requires (small) bkg subtraction



Inclusive Jet cross-section (CMS)

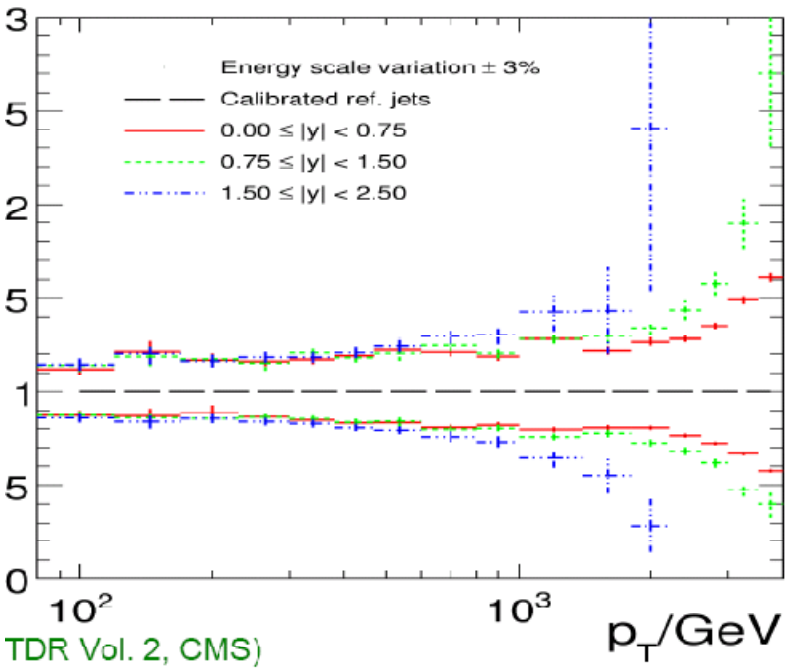
•We will have quickly a measurement of the Jet cross section with good statistical precision…

•… however, the Jet Energy Scale is a concern …



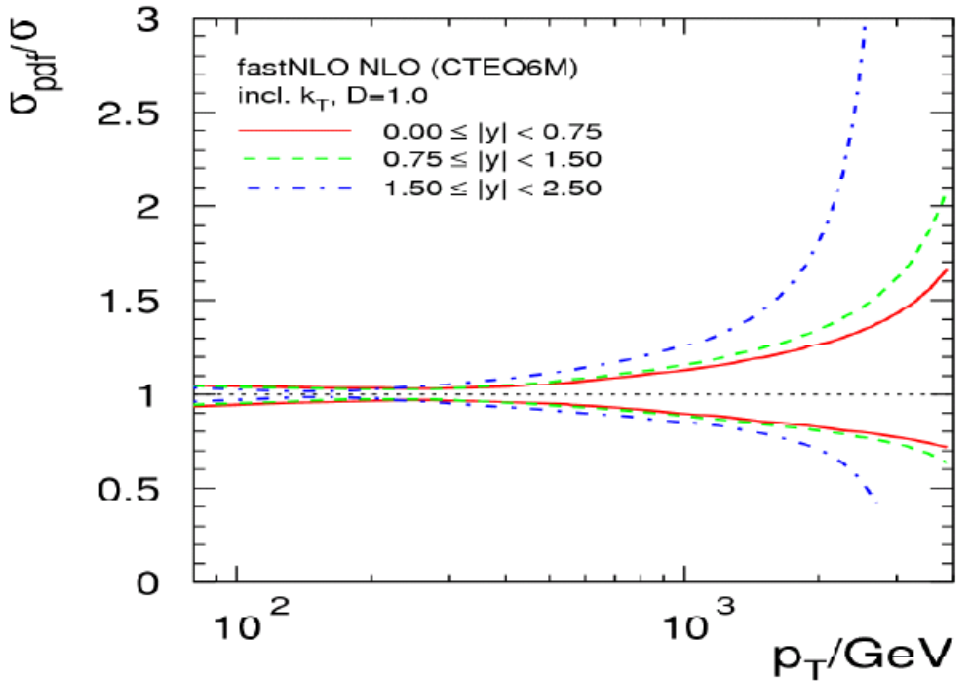
The issue : Jet Energy Scale

Variation of JES (±3%)



TDR Vol. 2, CMS)

PDFs (CTEQ6.1) in NLO



… long way before arriving at 3% in JES … expect to start at ~ 10%

gamma+jet

- One of the issues: trigger thresholds
- Studies ongoing on optimization and use of prescale factors for $E_T(\gamma)< 80$ GeV

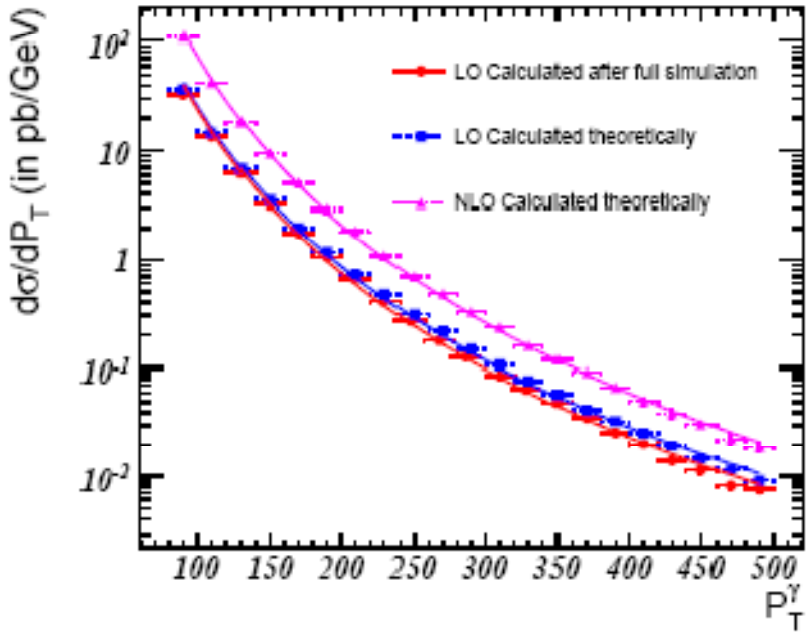
Trigger	Threshold (GeV)	QCD [Hz]	Wenu [Hz]	Zee [Hz]	gamma jet [Hz]
Single Electron	26	12.6 +- 6.7	9.7 -- 0.2	1.2 +- 0.02	-
Double Electron	12,12	0.1 +- 0.06	-	1.0 +- 0.02	-
Relaxed Double Electron	19	0.3 +- 0.1	-	1.0 +- 0.02	-
Single Photon	80	1.1 +- 0.2	-	-	2.0 +- 0.1
Double Photon	30, 20	1.3 +- 0.8	-	-	0. 3 +- 0.02
Relaxed Double Photon	30, 20	0.9 +- 0.6	-	-	0.3 +- 0.02

Table from the CMS PTDR, Lumi=2X10^{33}, for illustration only

gamma+jet

- Analysis: here the photon helps for the energy scale ~ 1%
- Cross section uncertainty dominated by knowledge of luminosity (but could normalize on the Z)
- Other effects (trigger, selections) should be a few percent
- Promising channel, studies ongoing

CMS-NOTE-2007/004



Other channels

- Started work on Z+jet, potentially very clean channel for gluon PDFs
- Preliminary work on strange-quark PDF done for the LHC workshop of 2000 (s g → W c channel; charm tagging from semileptonic decay to muon) plan to restart it

Conclusions

- Several studies on data driven methods to make robust assessment of W,Z observables.
- Studies on specific W,Z observables (W charge asym, Z rapidity) recently started.
- Studies on other channels (using jets, gammas, etc.) ongoing
- CMS very interested in devising a common LHC strategy to constraint the PDFs from observables measured at 14 TeV