(Second) Approval for JME-10-005

CMS MET Performance in Events Containing Electroweak Bosons from pp Collisions at $\sqrt{s} = 7$ TeV

Jim Alexander[1], Artur Apresyan[2], **Stefano Lacaprara**[3]

[1]Cornell, [2]CALTECH, [3]INFN Padova

31st CMS General Weekly Meeting
CERN, 25 August 2010

Outline

1. Introduction
   - Basic selection
   - Pile Up
2. $\not\!\!E_T$ in Photon + Jet Events
   - Goal and selection
   - Results
3. $\not\!\!E_T$ reconstruction in events with a W boson
   - q_T uncertanties
   - $W \rightarrow e\nu$
   - $W \rightarrow \mu\nu$
4. Conclusion

Introduction

Goal

Demonstrate the performance of various $\not\!\!E_T$ algorithms using events containing a W, Z, or high p_{T} photon

- The focus of this PAS is NOT to study/measure EWK bosons as such but to study MET reconstruction in those events
- Study and compare the performance of various MET algorithms in events with real MET (W), measure MET scale and resolution in events with γ/Z
- CaloMET (raw, TypeI/II corrected), TcMET, PfMET

Links:

- CADI http://cms.cern.ch/iCMS/analysisadmin/cadi?ancode=JME-10-005
- HN: https://hypernews.cern.ch/HyperNews/CMS/get/JME-10-005.html
- Twiki: https://twiki.cern.ch/twiki/bin/view/CMS/EwkMetComm
- Previous Approval (indico) - Pre-Approval (indico)

A Lighter PAS

Statistics

- As suggested at the first approval stay with "pre-ICHEP" integrated luminosity $\int \mathcal{L}dt \sim 200 - 250\,\mathrm{nb}^{-1}$.
- concentrate on PU issue and discrepancies on $\gamma + jet$.

New PAS

- $\not\!\!E_T$ in Photon + Jet Events
- $\not\!\!E_T$ reconstruction in events with a W
- POSTPONED WAITING FOR MORE DATA Performance of $\not\!\!E_T$ reconstruction in events with a Z boson
- DROP FOR THE TIME BEING
  - Effects of muon reconstruction uncertainties on $\not\!\!E_T$
  - $\not\!\!E_T$ significance
  - Estimating the $\not\!\!E_T$ distribution in $W \rightarrow e\nu$ events

Title and abstract

CMS MET Performance in Events Containing Electroweak Bosons from pp Collisions at $\sqrt{s} = 7$ TeV
JME-10-005

During the spring of 2010, the LHC delivered proton-proton collisions with a centre-of-mass energy of 7 TeV. In this note, we present results of studies of missing transverse energy, as measured by the CMS detector, in events containing W bosons or isolated, high transverse momentum photons. The performance of several different MET reconstruction algorithms is compared.

Editors: Artur Apresyan, Stefano Lacaprara, Jim Alexander (senior)
ARC: Fabio Cossutti (Trieste), Sharon Lee Hagopian (Florida-state), Paraskevas Sphicas [chair] (CERN)

Supporting Documents

Several supporting AN

- **AN-2010/118** CMS MET Performance in Events Containing Electroweak Bosons decaying into muons from pp Collisions at $\sqrt{s} = 7$ TeV (Padova)
- **AN-2010/131** Type-I and Type-II CaloMET performances in 7TeV data (Hamburg, TTU, Florida)
- **AN-2010/132** MET Scale Validation with Photon + Jet Events (Texas Tech Uni.)
- **AN-2010/176** Commissioning of the missing transverse energy in $W \to \mu\nu$ events for 12 nb^{-1} with the pp center-of-mass energy of $\sqrt{s} = 7$ TeV (Brown)
- **AN-2010/202** Missing transverse energy performances with electroweak bosons decaying into electrons in pp collisions at $\sqrt{s} = 7$ TeV (Saclay)

Changes since second Pre-approval

- Add Pile-up vs no Pile-up plots for key distribution (γ+jet response and resolution);
- Not for $W \rightarrow \ell\nu$: not statistically meaningful and overkill;
- Add number of events selected for each analysis;
- Update to 36x simulation for tc$\not{E}_T$;
- we use only Calo$\not{E}_T$ type II;
- Minor fix in plots style (no change in content) and in text;
- ...
- major comments and our replies in the backup sildes.

Basic Selection and Definition

Uniform Selection

- Vertex requirement, datasets, trigger selections (muon and electron)
- Electron and muon IDs following the VBTF recommendations (more on this later...)
- EGamma electrons are used in the studies of PFMET, in agreement with PF POG
- Latest/greatest ECAL/HCAL noise cleaning in re-reco used in the analysis

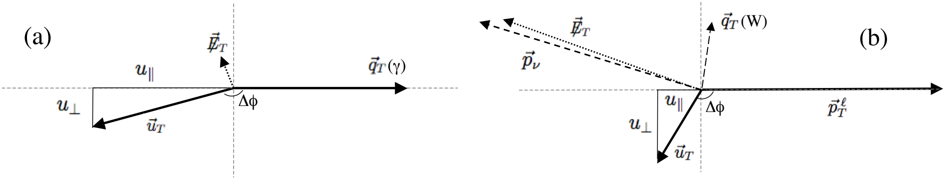
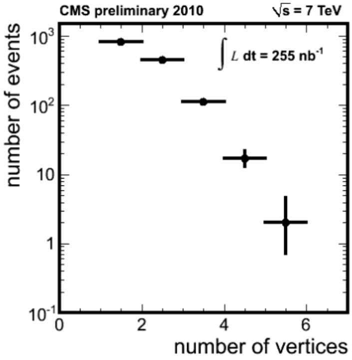


Figure: Kinematics: (a) Photon-Jet events; (b) *W* events.

PU Estimation and Treatments

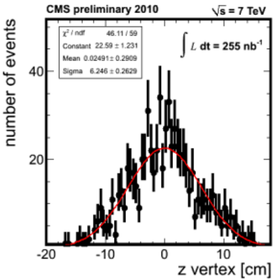
- MET related variables are sensitive to PU.
- Require just one Primary Vertex.
- MOTIVATION: start with simple (no PU) events and then eventually move to events with PU (not for this PAS)
- Estimate PU distribution by PV multiplicity: 60% 1 PV

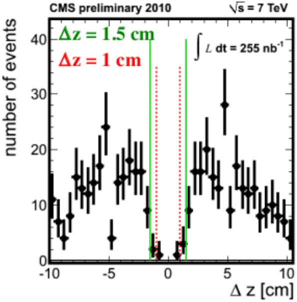


- Contamination from 2 not resolved PV estimated with toy MC (next slide)

Contamination from multiple PV

- Get z_{pv} distribution from data: $\sigma = 6.25 \pm 0.26$ cm





- Get minimal Δz for two PV to be resolved from data: $\Delta z = 1.5 \pm 0.5\,\text{cm}$
- Use Toy MC to estimate the $PV = 2$ contamination in $PV = 1$ sample: $7 \pm 2\%$. Negligible for $PV > 2$.
- scale the multi-PV distribution and subtract from the 1-vertex distribution

Outline

1. Introduction
   - Basic selection
   - Pile Up
2. $\not{E}_T$ in Photon + Jet Events
   - Goal and selection
   - Results
3. $\not{E}_T$ reconstruction in events with a W boson
   - q_T uncertanties
   - $W \rightarrow e\nu$
   - $W \rightarrow \mu\nu$
4. Conclusion

$\not\!\!E_T$ in Photon + Jet Events

Goal

- Events with no intrinsic $\not\!\!E_T$
- cross-section larger than that of Z
- *induce* $\not\!\!E_T$ by removing γ deposit in calo
- magnitude of *induced* $\not\!\!E_T$ well known.

- trigger HLT_PHOTON10_L1R
- Photon ID based on *loose* selections
  (see ``Photon reconstruction and identification at $\sqrt{s} = 7\,\text{TeV}$'', EGM-10-005.)

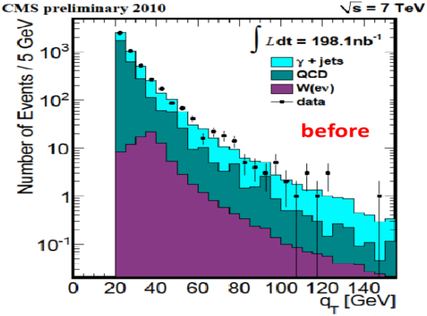
Analyzed Data Sample:

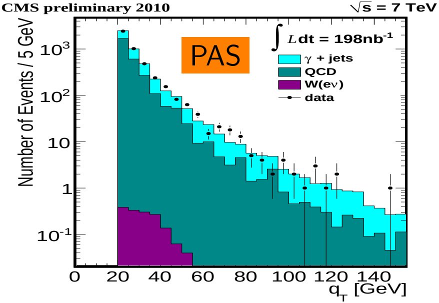
$\int \mathcal{L} dt = 198\,\text{nb}^{-1}$

Event selection:

- isolation:
  - ECAL energy deposit ($\Delta R < 0.4$) $E < 4.2 + 0.004 \times q_T$.
  - HCAL energy deposit ($\Delta R < 0.4$) $E < 2.2 + 0.001 \times q_T$.
  - N. tracks ($\Delta R < 0.4$) $N_{trk} < 3$.
  - $\Sigma_{(0.04<\Delta R<0.4)} p_{\mathrm{T}} < 2.0\,\mathrm{GeV} + 0.001 \times q_T$
- *e.m.* character:
  - Ratio HCAL/ECAL ($\Delta R < 0.15$) $R < 0.05$.
  - $R9 > 0.9 \times E^{\gamma}$
  - γ cluster major and minor 2^{nd} moments in $0.20 - 0.35$, $0.15 - 0.3$.
  - $\eta_{width} < 0.03$
- $q_T > 20$ and $|\eta| < 1.479$ (Barrel)
- Only 1 Primary Vertex (No PU) plus 2PV cleaning
- γ supercluster does not match pixel hits consistent with a track from the primary vertex ($W \rightarrow e\nu$ suppression)

Photon q_T and $W \to e\nu$ suppression





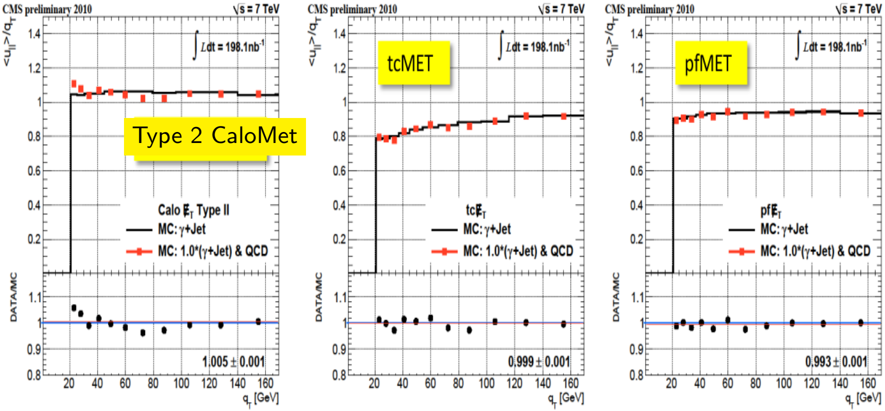
- significative amount of $W \to e\nu$ events pass standard γ loose ID
- strongly suppressed by pixel veto
- Cut on MC $\sim 2.9\%$:
  - $W \to e\nu$: $\sim 98\%$;
  - $\gamma + jet \sim 0.2\%$;
  - $QCD \sim 1.8\%$.
- On Data $\sim 4\%$

q_T distribution of events selected as photon-jet candidates.

- QCD di-jet contamination is dominated by $\pi^0 \to \gamma\gamma$ enriched jets.
- Still good for energy scale studies

Effect of di-jet contamination (NOT FOR PAS)

Shown response $(u_{\parallel}/q_T)$ for MC pure $\gamma + jet$ and $\gamma + jet$ & QCD di-jet



MC studies shows that QCD (di-jet) contamination give no bias in MET response

Recoil projections along the γ axis

Parallel component used to study $\not{E}_T$ scale and resolution PAS

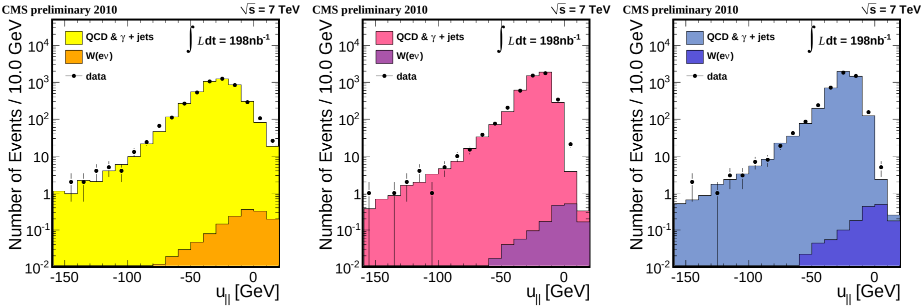
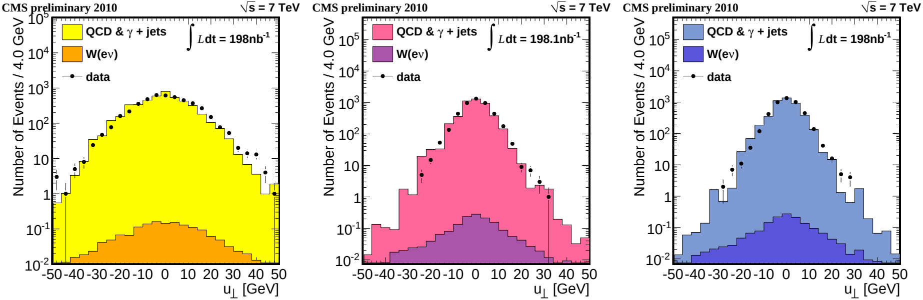


Figure: Decomposition of hadronic recoil into components parallel and perpendicular to photon probe. Upper row: $u_{||}$ distributions for (left to right) calo$\not{E}_T$, tc$\not{E}_T$, and pf$\not{E}_T$;

$W \rightarrow e\nu$ contamination strongly suppressed by pixel seed veto

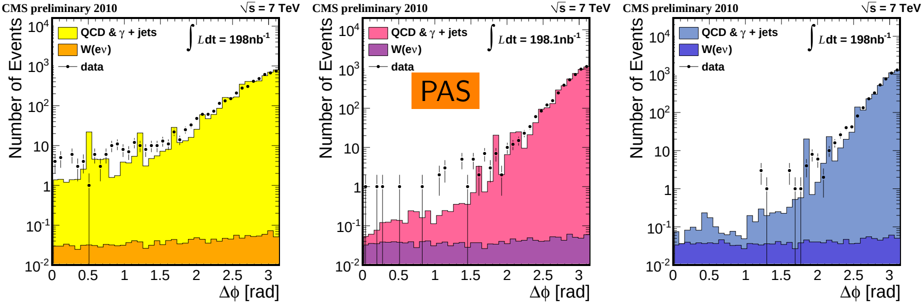
Recoil projections perpendicular to the γ axis

Perpendicular component used to study $\not\!\!E_T$ resolution due to calo noise, UE . . . PAS



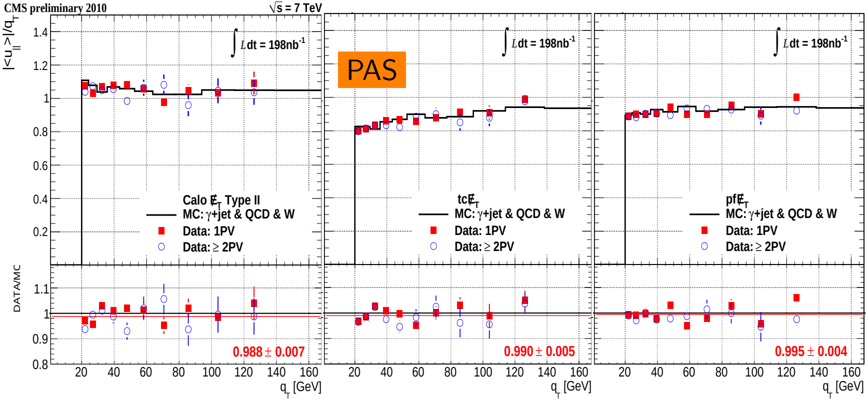
- PU affect the width of distribution See later
- 1 Primary vertex to select event with no PU
- NO PileUp in MC simulation

Angular correlation between $\vec{u}_T$ and q_T



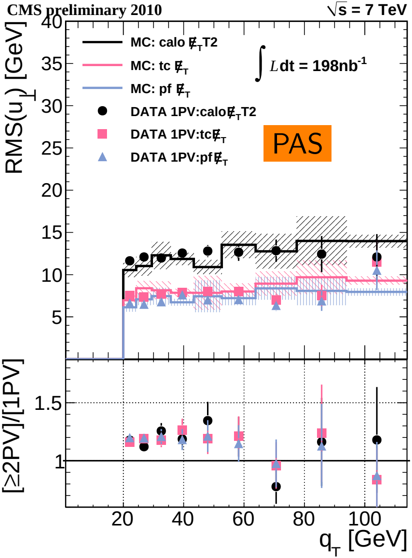
- $W \to e\nu$ is flat in $\Delta\phi$: large contribution at low $\Delta\phi$ if not suppressed (see last approval talk).
- Residual discrepancies at low $\Delta\phi$ is likely to be a resolution effect in the tail of the distribution;
  - Not present in pf$\not\!\!E_T$;
  - few % or few ‰ effect;
  - Does not affect results on response or resolution

$\not{E}_T$ Scale: $|u_{\parallel}|/q_T$



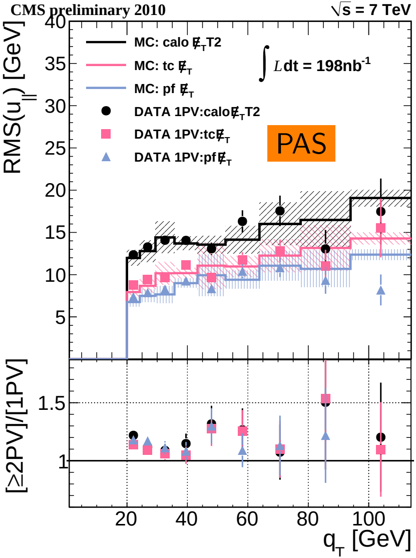
- JES correction for calo$\not{E}_T$ based on q/g jets. Response to q jets is ∼ 10% higher than g one. Direct γ have mostly q jet, so overcorrection is expected;
- Tc$\not{E}_T$ and pf$\not{E}_T$ are not corrected for JES, already in the algo;
- also shown $\geq 2PV$ distribution: response is not sensitive to Pile-UP **NEW**

Resolution (RMS) for $u_\perp$ vs q_T



- including uncertainties (statistical) from MC
- Resolution corrected for response curve
- NEW also shown ratio $\geq 2PV$ / $1PV$:
- resolution IS sensitive to PU
- Interesting to note that the PU effect is $\sim$ the same for all algos.
- Also $\sim$ independent ot q_T
- Measuring $\not\!\!E_T$ resolution in the data

Resolution (RMS) for $u_{\parallel}$ vs q_T



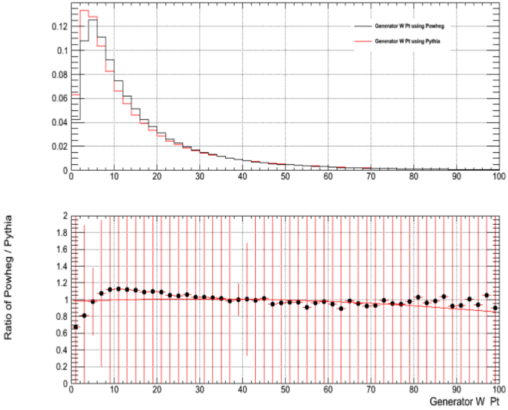
- including uncertainties (statistical) from MC
- Resolution corrected for response curve
  - measure RMS of $(u_{\parallel}/q_T)$ and then multiply by (average bin) q_T and scale correction
- also shown ratio $\geq 2PV$ / $1PV$: resolution IS sensitive to PU NEW
- Use of tracking information improves significantly the MET resolution

Outline

W q_T uncertainty

MC uncertainties for q_T

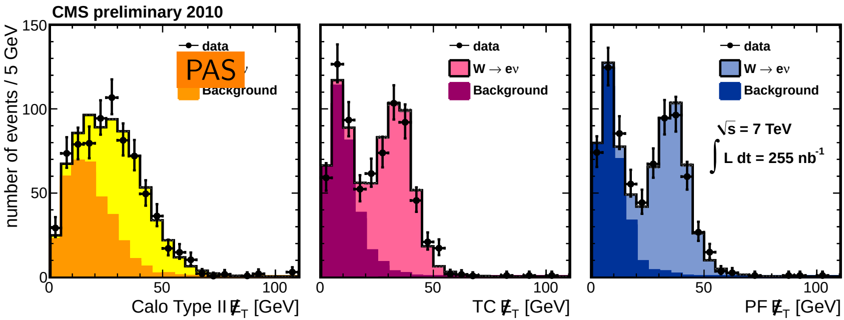
- Use standard PYTHIA and POWHEG
- Compare the two q_T distribution
- Use difference between original and reweigthed as systematic error, bin per bin.
- add this to error from PU contamination, as described before



$W \rightarrow e\nu$ selection

- Standard VBTF selection WP 80% no $\Delta\eta$ cut in endcap (EGamma prescription)
  - HLT $p_{\mathrm{T}}(e) > 10\,\mathrm{GeV}$
  - Electron id 80% efficiency.
  - $|\eta_e| < 2.5$ excluding $1.4442 < |\eta| < 1.56$
  - η dependent isolation on ECAL, HCAL and tracks AN-2010/133
  - No second electron $p_{\mathrm{T}} > 20\,\mathrm{GeV}$
- GSF filter + supercluster $p_{\mathrm{T}} > 25\,\mathrm{GeV}$ (VBTF is > 20)
- only 1 Primary vertex
- PU contamination cleaning
- Additional cuts to enrich $W \rightarrow e\nu$
  - $\not\!\!E_T > 25\,\mathrm{GeV}$
  - $M_{\mathrm{T}} > 50\,\mathrm{GeV}$
- POWHEG MC used
- QCD and EWK normalization by a fit on $\not\!\!E_T$ shape
- $\int \mathcal{L}dt = 255\,\mathrm{nb}^{-1}$, 461 events selected compatible with VBTF yield

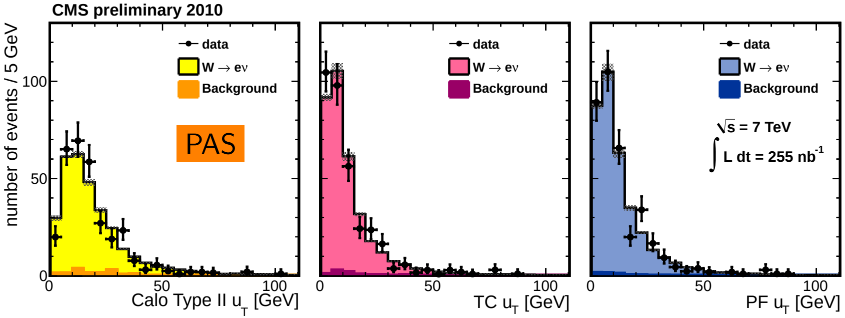
$\not\!\!E_T$ distribution in $W \to e\nu$ events



REMINDER: changes from previous PAS:

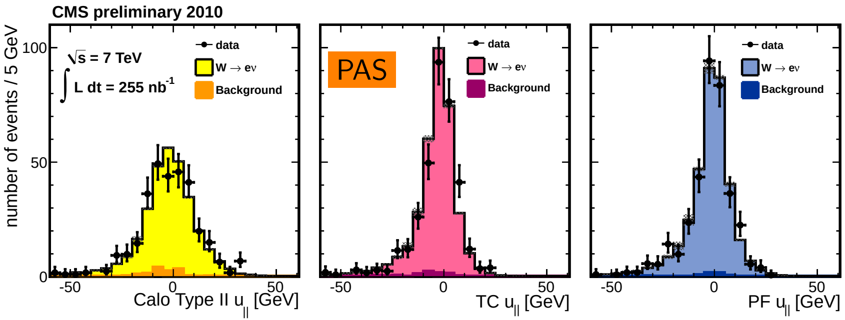
- $p_T(ele) > 25$ GeV (was 20)
- 1 primary vertex and PU cleaning
- NO $\not\!\!E_T$ cut in this plot
- use this distribution to normalize QCD and EWK in MC.

Recoil in $W \to e\nu$ events



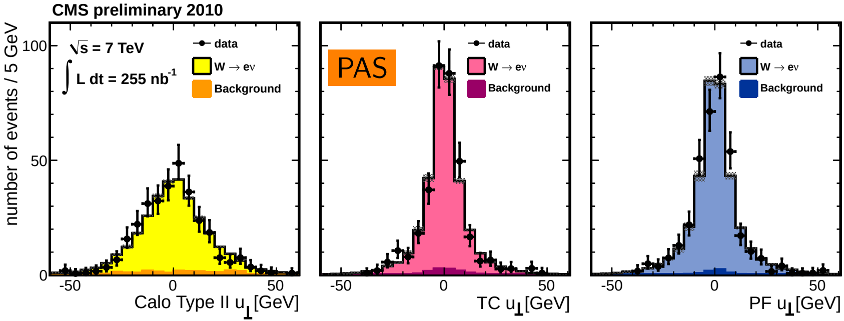
- agreement at low u_T much better due to Primary Vertex requirement and PU cleaning
- Uncertainties at low u_T dominated by q_T ones.

Recoil along q_T in $W \to e\nu$ events



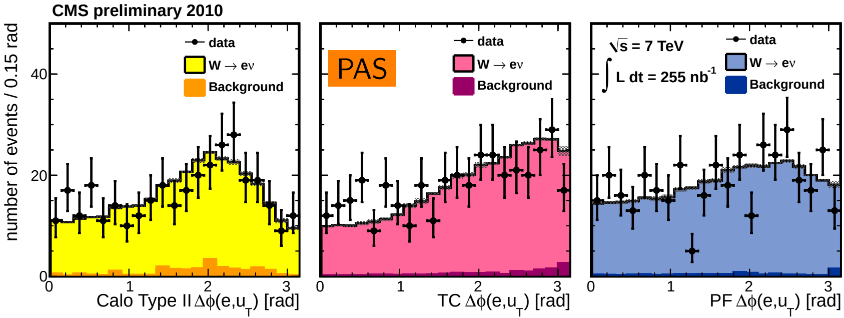
- Projection along $p_T(\ell)$, not q_T (unknown): correlation is good only for boosted W
- Asymmetry due to strict isolation cut on $W \to e\nu$: when $u_{||}$ is positive, electron and hadronic activities are in the same hemisphere, more likely that the electron is not isolated.
- Tail at low $u_{||}$: $W \to e\nu$ events with boosted W.

Recoil perpendicular to q_T in $W \to e\nu$ events



- Calo$\not\!\!E_T$ is clearly broader than TC and PF$\not\!\!E_T$;
- Still dominated by true $\not\!\!E_T$, width similar to that of $u_{\parallel}$.

$\Delta\phi$ recoil-lepton in $W \to e\nu$ events

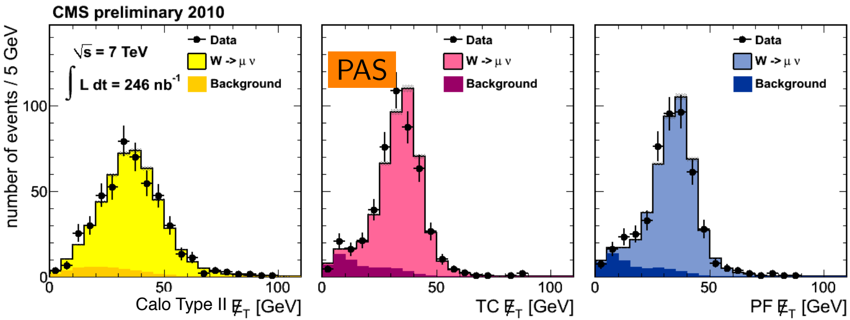


- Good agreement within statistical errors

$W \rightarrow \mu\nu$ selection

- Standard VBTF selection
  - HLT $p_{\mathrm{T}}(\mu) > 9$ GeV HLT_Mu9
  - Muon *Global* and *Tracker*
  - Tracker hits> 10, Pixel hits> 0; Muon hits> 0;
  - EM veto < 4 GeV; Hadronic veto < 6 GeV;
  - Relative combine isolation < 0.15
  - impact parapameter (beam spot) < 2 mm
  - Global fit $\chi^2 < 10$
  - $|\eta| < 2.1$
  - No second Muon $p_{\mathrm{T}} > 20$ GeV
- Muon $p_{\mathrm{T}} > 25$
- only 1 Primary vertex and PU contamination cleaning
- Additional cuts to enrich $W \rightarrow \mu\nu$
  - $\not\!\!E_T > 25$ GeV
  - $M_{\mathrm{T}} > 50$ GeV
- QCD and EWK normalization by a fit on $\not\!\!E_T$ shape
- $\int \mathcal{L}dt = 246\,\mathrm{nb}^{-1}$ 514 $W \rightarrow \mu\nu$ selected compatible with VBTF yield

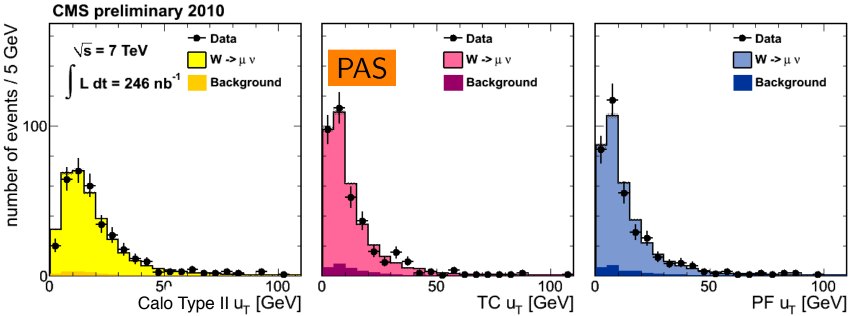
$\not\!\!E_T$ distribution in $W \to \mu\nu$ events



REMINDER: changes from previous PAS:

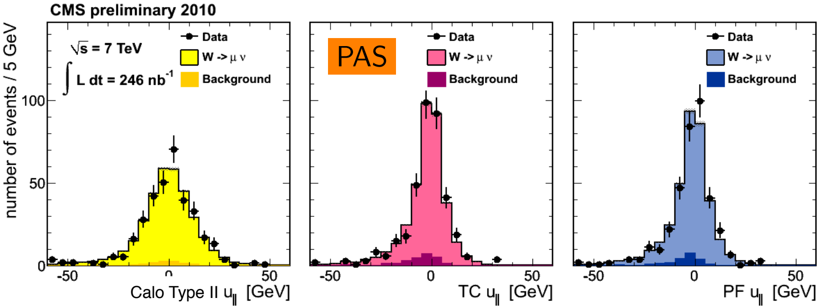
- $p_{\mathrm{T}}(\mu) > 25$ GeV (was 20)
- 1 primary vertex and PU cleaning
- NO $\not\!\!E_T$ cut in this plot
- use this distribution to normalize QCD and EWK in MC.

Recoil in $W \to \mu\nu$ events



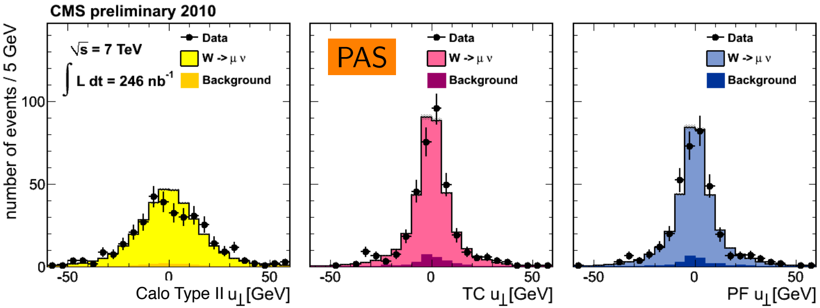
- Good agreement at low u_T thanks to PU contamination removal;

Recoil along q_T in $W \to \mu\nu$ events



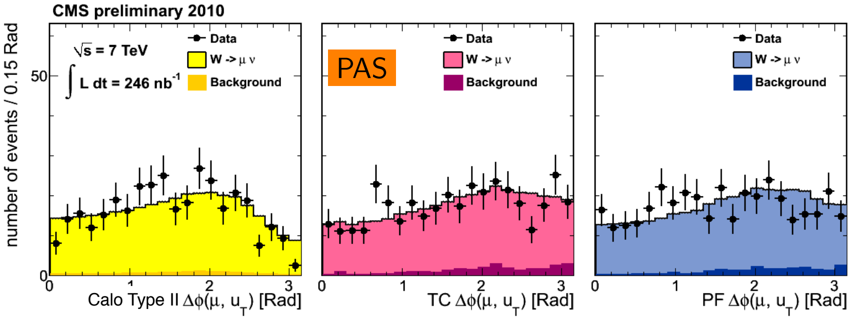
- Small/no asymmetries as compared to $W \to e\nu$ due to softer isolation cut.
- As for $W \to e\nu$, good correlation between $p_{\mathrm{T}}(\ell)$ and q_T only for boosted W

Recoil perpendicular to q_T in $W \to \mu\nu$ events



- Narrower distribution for TC and PF$\not{E}_T$

$\Delta\phi$ recoil-lepton in $W \to \mu\nu$ events



- Good agreement between data and MC

Outline

Conclusion

$\gamma + jet$

- Studies presented with $198\,\mathrm{nb}^{-1}$
- Analysis updated
  - considering $W \to e\nu$ contamination
  - introducing further cut (pixel seeds) to effectively reduce it
  - reducing PU effect by requiring just 1 Primary Vertex and multi-PV cleaning
- Data driven assessment of $\not\!\!E_T$ scale and resolution.
- PU effect visible in MET resolution but NOT in response NEW
- Good agreement data-MC seen

Conclusion/II

$W \to e\nu$ and $W \to \mu\nu$

- Studies presented with 255 and 246 nb^{-1} respectively
- Improvement wrt previous PAS
  - Stricter cuts to select purer W sample
  - Select events with just one Primary Vertex
  - Clean PU contamination in 1-vertex sample
- Uncertainties included:
  - q_T spectra using PYTHIA and POWHEG
  - from PU contamination
- Good agreement data-MC seen

Conclusion/III

PAS conclusion

- The performance of three $\not\!\!E_T$ algorithms have been examined with early data
- emphasis on the calibration scale and resolution of the $\not\!\!E_T$ response.
- Very good agreement between data and MC
- the improvement that results from the inclusion of charged particle tracking in jet reconstruction is visible and significant.
- The difference in performance is further confirmed in $\not\!\!E_T$ distributions of $W \to \ell\nu$ event samples which contain genuine $\not\!\!E_T$.

Backup

BACKUP

History

- pre-approval (with $\sim 12\,\mathrm{nb}^{-1}$) on June 28
- approval on July 9^{th} with $\sim 56\,\mathrm{nb}^{-1}$ NOT approved
  - While one has to congratulate all people involved for the fast production of the plots with the newly arrived data, we also saw that many questions have come up and issues need to be understood in the plots, which were not visible before.
  - more work has to go into the understanding of the new results, in particular for the gamma+jet sample.
  - ... Concentrate on the data which have been taken up to now.
  - ... it is clear that we start to see PU effects, thus certain plots should be done as a function of Nvtx ...
- Decision to skip ICHEP and concentrate on analysis for $\gamma + jet$ and PU issues.
- Second pre-approval on August, 9th
- Timescale for this 2^{nd} approval aims at PIC2010 (1-4 Sept)

Comments #1

Which is the size of PU effect??

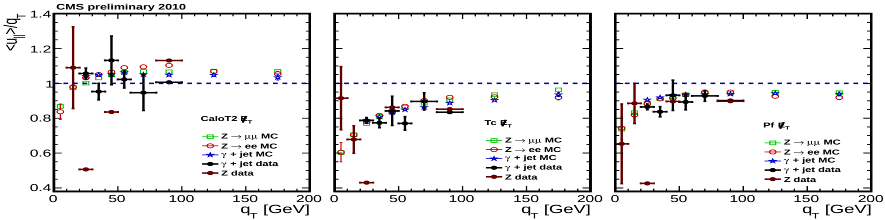
The current PAS tends to leave the reader hanging whether there is or is not an understanding of MET for EWK events with pile-up at the level of the ICHEP data sample since it explicitly only addresses events with 1PV (see statement on lines 20-23) . . . Nevertheless, I would propose that it is still beneficial to include the results from data alone so the reader can judge the size of the effect rather than not include anything.

Added plot comparing data w/ and w/o PU for γ+jet.
Not for W plots: overkill and statistically not very significant.

Comments #2

this analysis measures the response and resolution of the hadronic recoil. I think to call it a missing ET response measurement is a bit misleading because it doesn't transfer to other event topologies with missing ET

True: results does not work for $\not\!\!E_T$ in **all** event topologies, but are fine when $\not\!\!E_T$ is dominated by hadronic topologies. Keep the name. Example are Z events, not included in this PAS but will do in future one. Already shown that responses for $\gamma + jet$ and Z compared very well .



Comments #3

$\not\!\!E_T$ response misleading

It seems to me the resolution should be measured from RMS($u_{||}$-q_T) because the width of the $u_{||}$ spectrum may be driven by the width of the photon q_T bin rather than the recoil resolution

The resolutions of $u_{||}$ are calculated using $(u_{||}/q_T)$, binned in q_T. For a given bin we measure RMS of $(u_{||}/q_T)$ and then multiply this quantity by (average bin q_T) $\times$ (scale correction).
This allows to measure the MET resolutions corrected for the scale, measuring the 2^{nd} central moment, that is simply shifted to 1.0 instead of being at 0.

Comments #4

W Analysis Scope

The main point of the W analysis is to demonstrate the agreement of data and MC simulation. I do not think that you can measure the recoil response nor the resolution using W decays because you have nothing to calibrate the recoil against.

True. This section of the current PAS focuses on MET reconstruction in W events not response or resolution. Our W plots are mainly to demonstrate a good data/MC comparison and a simple comparison of performance of MET algos.
The response and resolution measurements using Z events were in the initial plan for this PAS, but due to the limited statistics, were dropped.

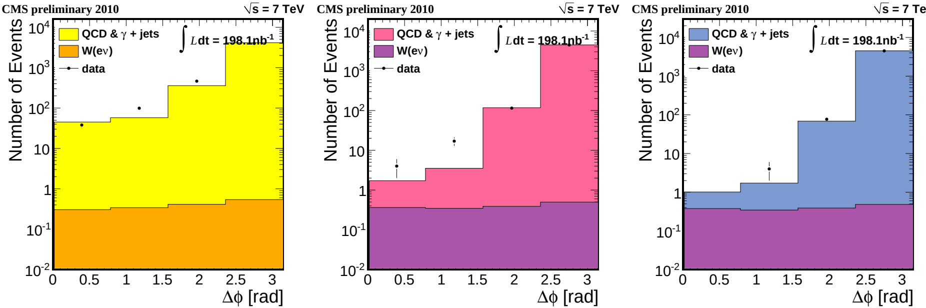
Comments #5

I think it is not clear that the widths of $u_{||}$ and $u_{\perp}$ are dominated by the recoil resolution. Both are projections of the recoil p_{T} on an axis that is only weakly correlated with the direction of the recoil p_{T}. The range of $u_{||}$ and $u_{\perp}$ is $-max(u_T)$ to $+max(u_T)$. So the recoil p_{T} distribution will affect the width of the $u_{||}$ and $u_{\perp}$ distributions.

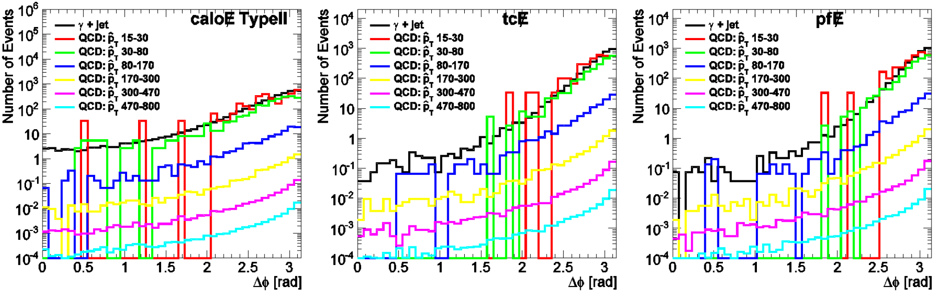
The RMS of either $u_{||}$ or $u_{\perp}$ will in general contain two pieces: a narrow core reflecting the basic hadronic resolution, and a wide (and in practice slightly asymmetric) component that includes the contamination from actual p_{T}. (this second component is $\in [-max(u_T), +max(u_T)]$)
It is true that we haven't really probed this issue very deeply, and consequently the text is carefully written to offer only a qualitative, not quantitative, interpretation of the plots. Nevertheless we feel the text offers some insight into the physical content of the plots, and for that reason should stay

Angular correlation γ jet: big bins

TypeII Calo$\not{E}_T$, TC$\not{E}_T$, PF$\not{E}_T$

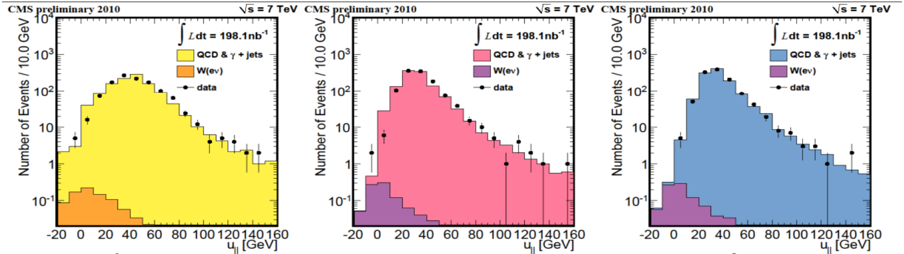


Angular correlation γ jet: statistics



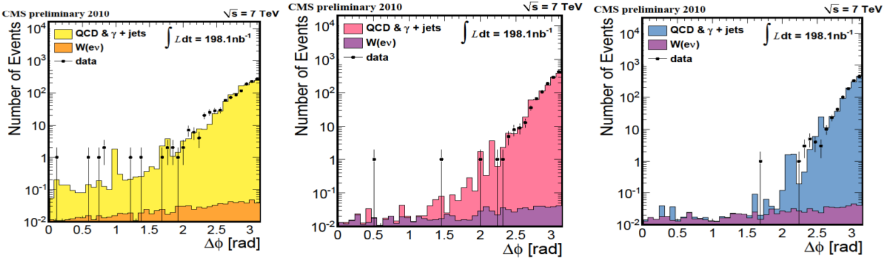
small/no statistics at low $\Delta\phi$ for low $\hat{p}_T$ bins for QCD di-jet events

$\gamma + jet$ angular correlation with $E_\gamma > 30$ GeV



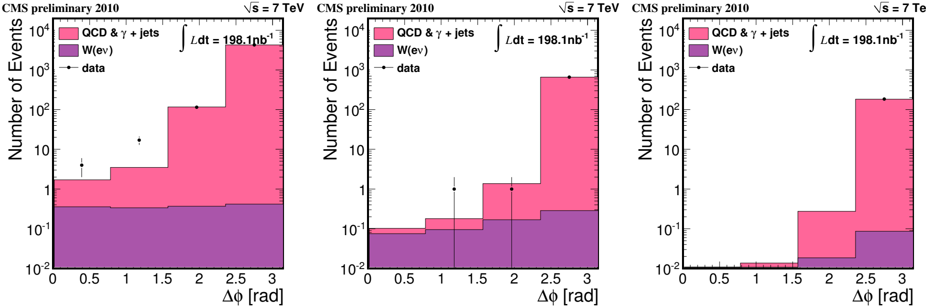
caloMET TypeII **tcMET** **pfMET**

After the "pixel seeds" cleaning . PT>30 cut is applied to enrich the sample with uncleaned W.
Main W contamination is expected at 30<PT<45. Instead somewhat better DATA/MC agreement



TC$\not{E}_T$: $\gamma + jet$ angular correlation at different q_T

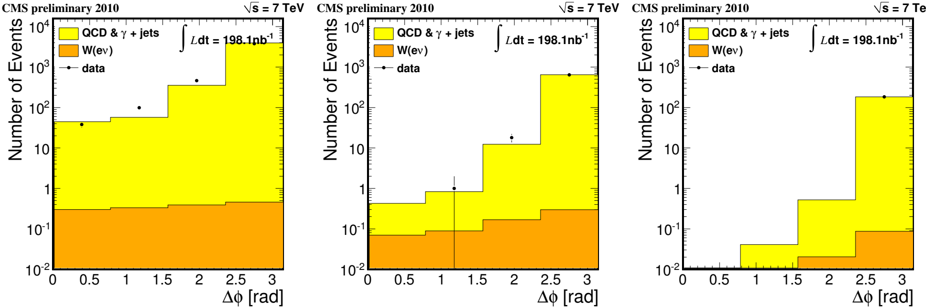
Left: $20 < q_T < 50$ GeV, Center: $35 < q_T < 100$ GeV, Right: $50 < q_T < 100$ GeV



Discrepancies is at low photon q_T

CaloII$\not\!\!E_T$: $\gamma + jet$ angular correlation at different q_T

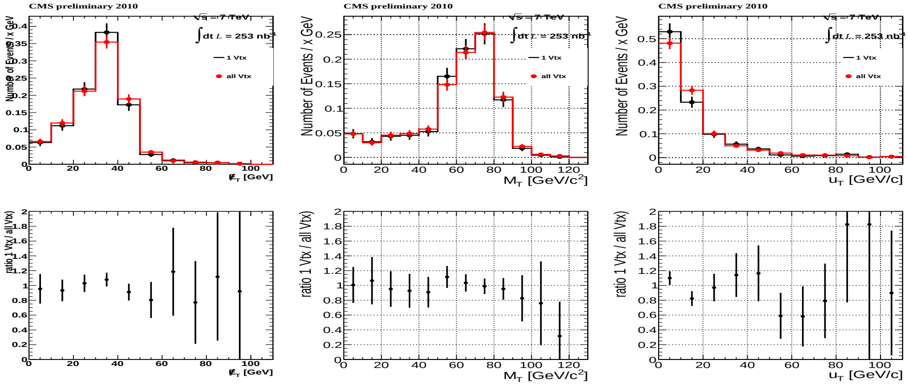
Left: $20 < q_T < 50$ GeV, Center: $35 < q_T < 100$ GeV, Right: $50 < q_T < 100$ GeV



Discrepancies is at low photon q_T

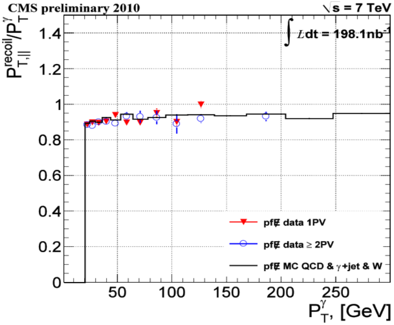
Any effect of PU in EWK studies?

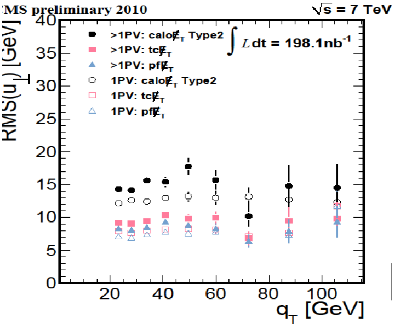
- Very limited effect of PU on M_{T} and $\not{E}_T$ distribution, on which the EWK analysis is based. Significant only for hadronic recoil
- Below: $\not{E}_T$ (l), M_{T} (c) and u_T (r) for $W \rightarrow \mu\nu$ case with Pf$\not{E}_T$



Any effect of PU in EWK studies? /II

- From $\gamma + jet$ analysis, no (or negligible) effect on MET scale from the PU.
- (limited) effect on $\not\!\!E_T$ resolution from PU
- will be needed for analysis such as W mass measurement (not in ICHEP EWK program)

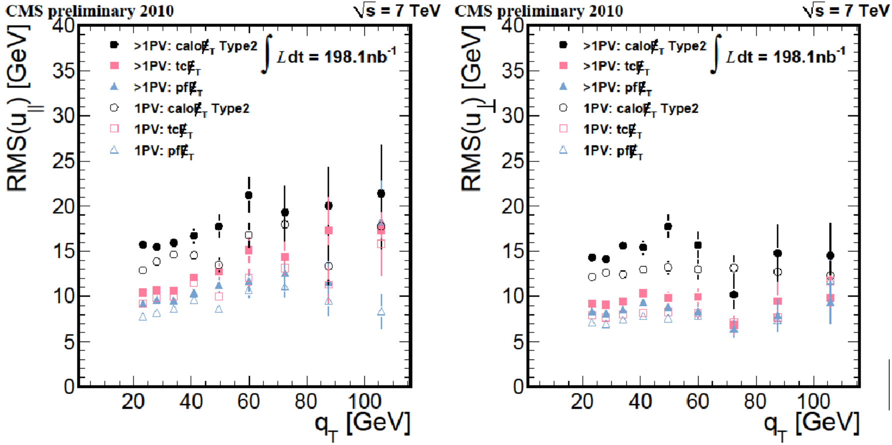




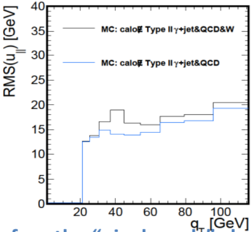
Effect of PU on resolution

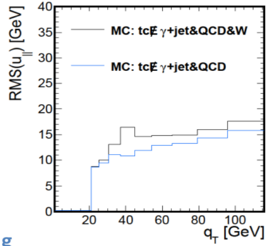
Resolution (RMS for $u_\perp$ and $u_\parallel$) as a function of q_T for events with 1 Primary Vertex and ≥ 2 PV for three different $\not{E}_T$ algos. Not for PAS

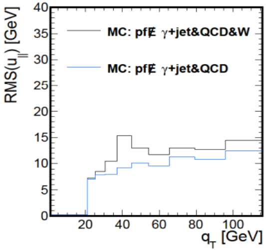
Data after $W \to e\nu$ pixel veto



Effect of pixel cleaning on Resolution



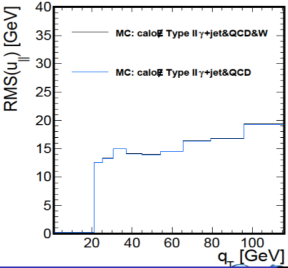


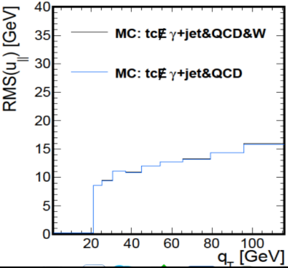


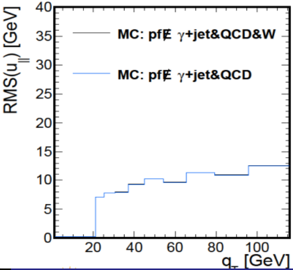
Before the "pixel seeds" cleaning

caloMET TypeII | **tcMET** | **pfMET**

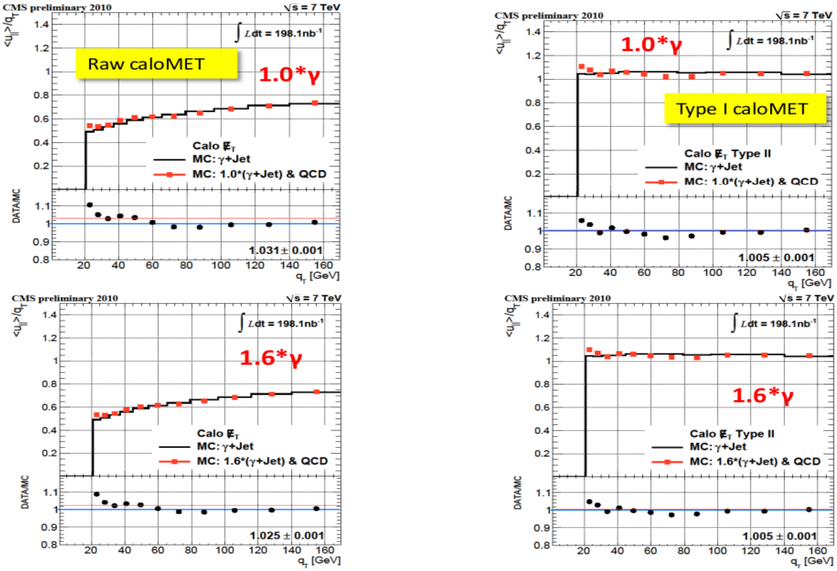
After the "pixel seeds" cleaning

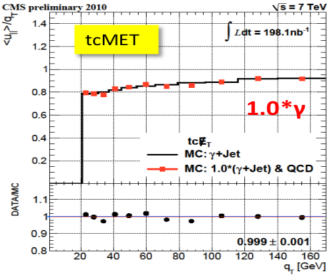


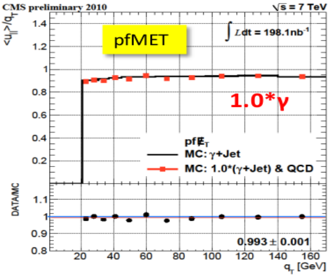


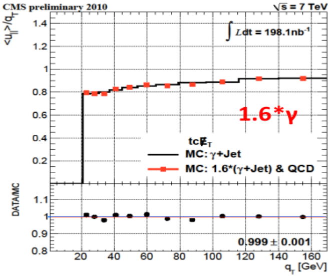


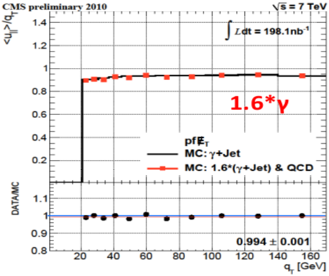
Effect of QCD contamination on Resolution



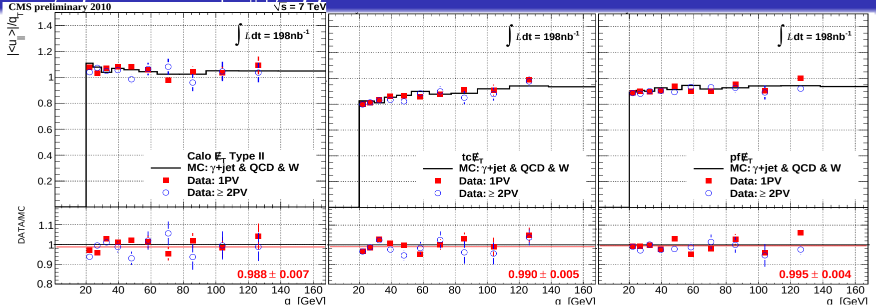

CMS preliminary 2010
√s = 7 TeV
∫ L dt = 198.1nb^-1
tcMET
1.0*γ
tcE̸T
MC: γ+Jet
MC: 1.0*(γ+Jet) & QCD
<u∥>/qT
DATA/MC
0.999 ± 0.001
qT [GeV]

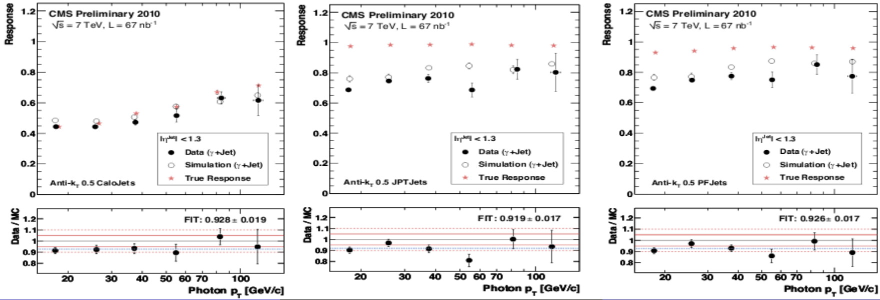

CMS preliminary 2010
√s = 7 TeV
∫ L dt = 198.1nb^-1
pfMET
1.0*γ
pfE̸T
MC: γ+Jet
MC: 1.0*(γ+Jet) & QCD
<u∥>/qT
DATA/MC
0.993 ± 0.001
qT [GeV]


CMS preliminary 2010
√s = 7 TeV
∫ L dt = 198.1nb^-1
1.6*γ
tcE̸T
MC: γ+Jet
MC: 1.6*(γ+Jet) & QCD
<u∥>/qT
DATA/MC
0.999 ± 0.001
qT [GeV]

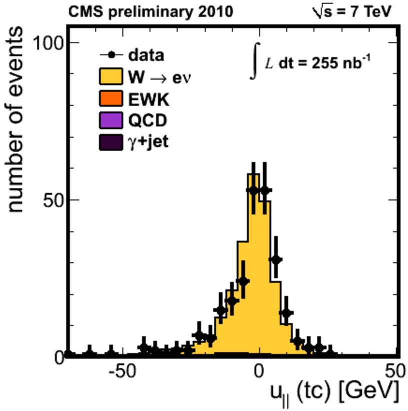

CMS preliminary 2010
√s = 7 TeV
∫ L dt = 198.1nb^-1
1.6*γ
pfE̸T
MC: γ+Jet
MC: 1.6*(γ+Jet) & QCD
<u∥>/qT
DATA/MC
0.994 ± 0.001
qT [GeV]

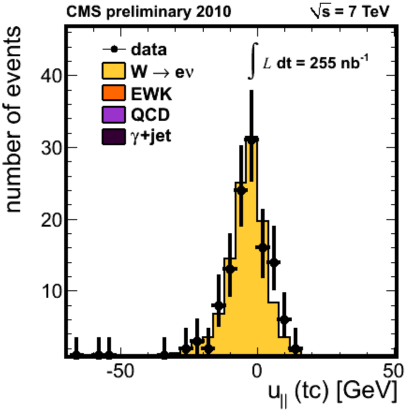
$\not{E}_T$ Scale: $|u_{\parallel}|/q_T$ vs JME-003





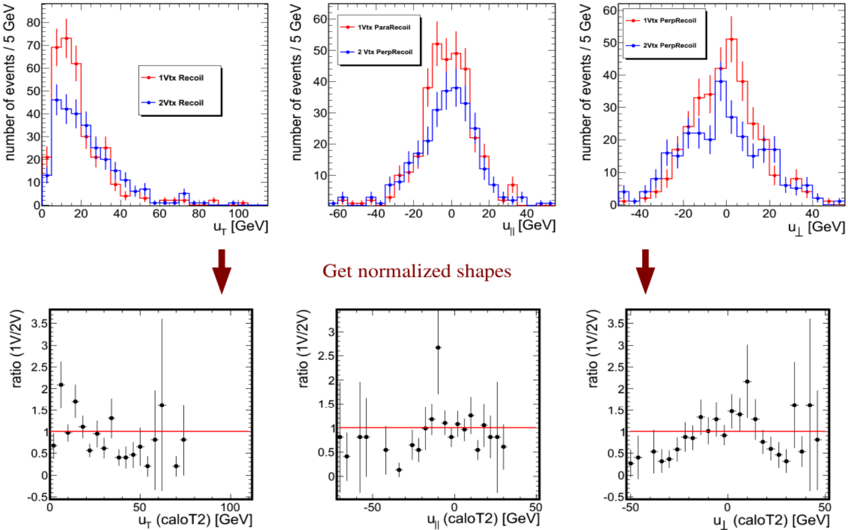
$u_{\parallel}$ Barrel vs Endcap for TcMet



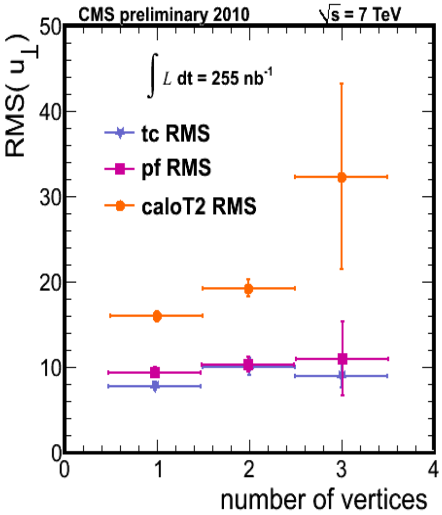


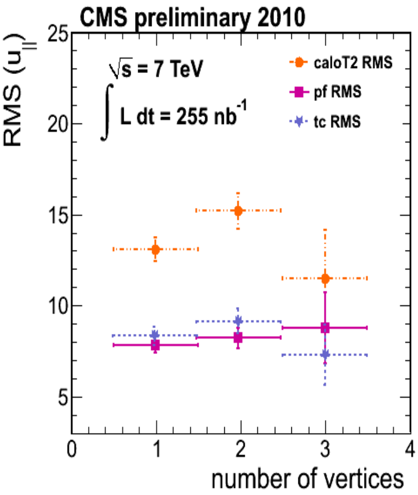
Effect of PU contamination on Recoil $W \rightarrow e\nu$

Pileup effects on caloT2 recoil variables (data only)

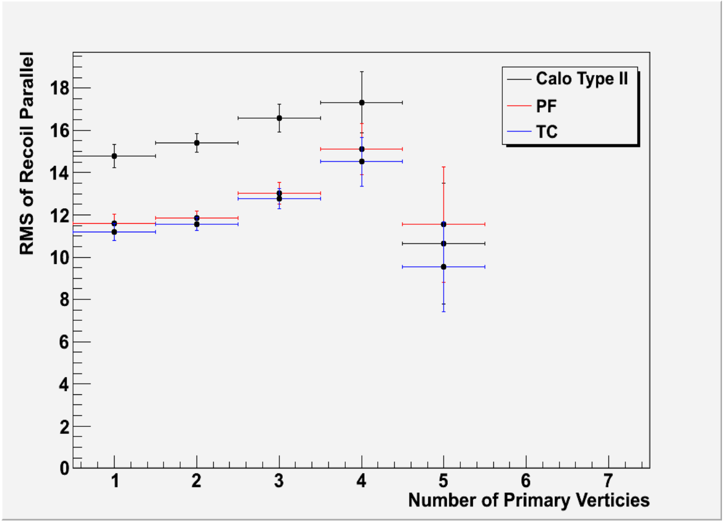


Any effect of PU in EWK studies? $W \to e\nu$

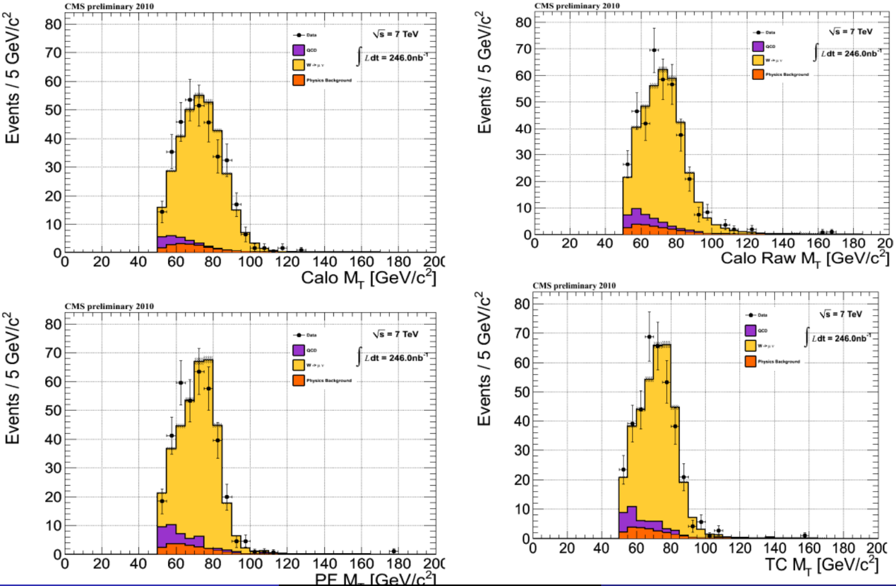




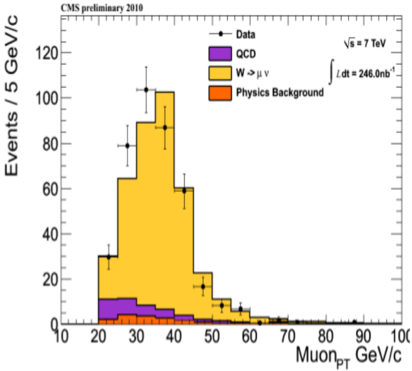
Any effect of PU in EWK studies? $W \to \mu\nu$

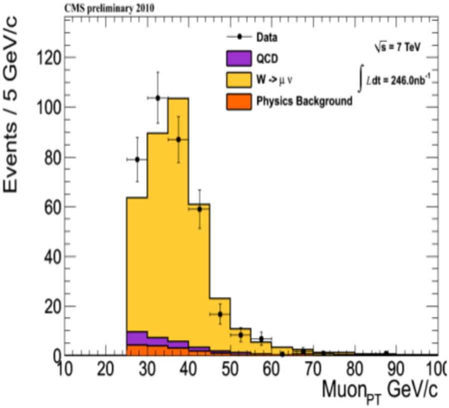


MT distribution for $W \to \mu\nu$



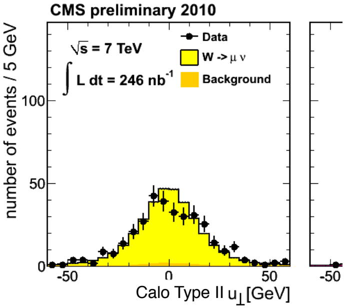
Muon p_T distribution for $W \to \mu\nu$

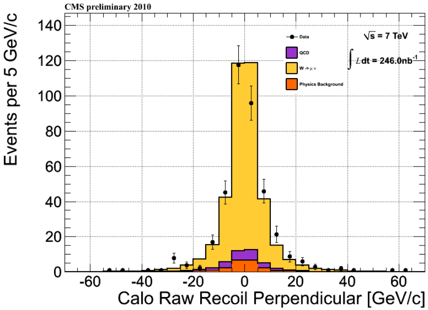




For 20 and 25 p_T cut
Note: different QCD/EWK normalization for MC from MET distribution

Recoil perpendicular to q_T in $W \to \mu\nu$ events





W yield comparison

$W \to e\nu$

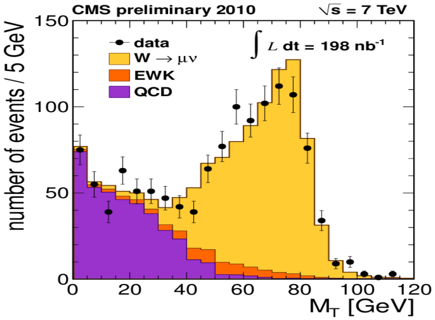
- With 246 nb^{-1} we have 999 $W \to e\nu$ candidates (background subtracted), any # of Primary Vertices
- Rescaling to 198 nb^{-1} (VBTF $\int \mathcal{L}dt$) gives: 804 $W \to e\nu$
- to be compared with 799.7 ± 30 $W \to e\nu$ candidates reported by VBTF PAS

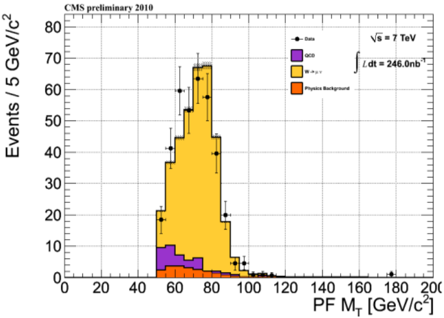
$W \to \mu\nu$

- With 255 nb^{-1} we have 1090 $W \to \mu\nu$ candidates (background subtracted), any # of Primary Vertices
- Rescaling to 198 nb^{-1} (VBTF $\int \mathcal{L}dt$) gives: 839 $W \to \mu\nu$
- to be compared with 818.7 ± 27 $W \to \mu\nu$ candidates reported by VBTF PAS

Comparison with EWK PAS at ICHEP M_{T} $W \to \mu\nu$

Left EWK PAS , Right Current analysis

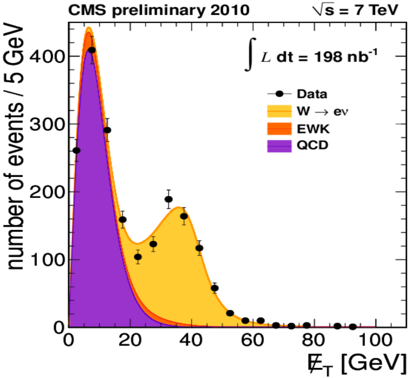


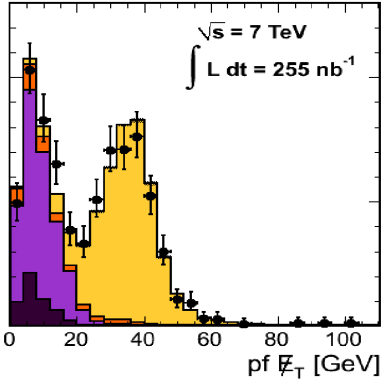


- $p_{\mathrm{T}} > 25$ GeV (VBTF is > 20)
- $\not{E}_T > 25$ GeV (VBTF no cut)
- only 1 Primary vertex
- Shown only fot $M_{\mathrm{T}} > 50$
- Plot NOT for current PAS!

Comparison with EWK PAS at ICHEP $\not\!\!E_T$ $W \to e\nu$

Left EWK PAS $\not\!\!E_T$, Right current work $\not\!\!E_T$





- $p_{\mathrm{T}} > 25\,\mathrm{GeV}$ (VBTF is > 20)
- only 1 Primary vertex