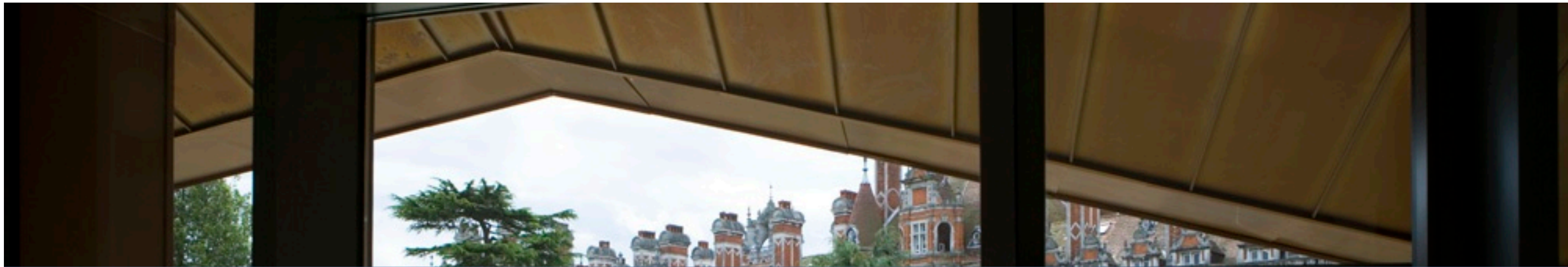


Top Quark Cross Section using Soft Muon Tagging

24 Juin 2011

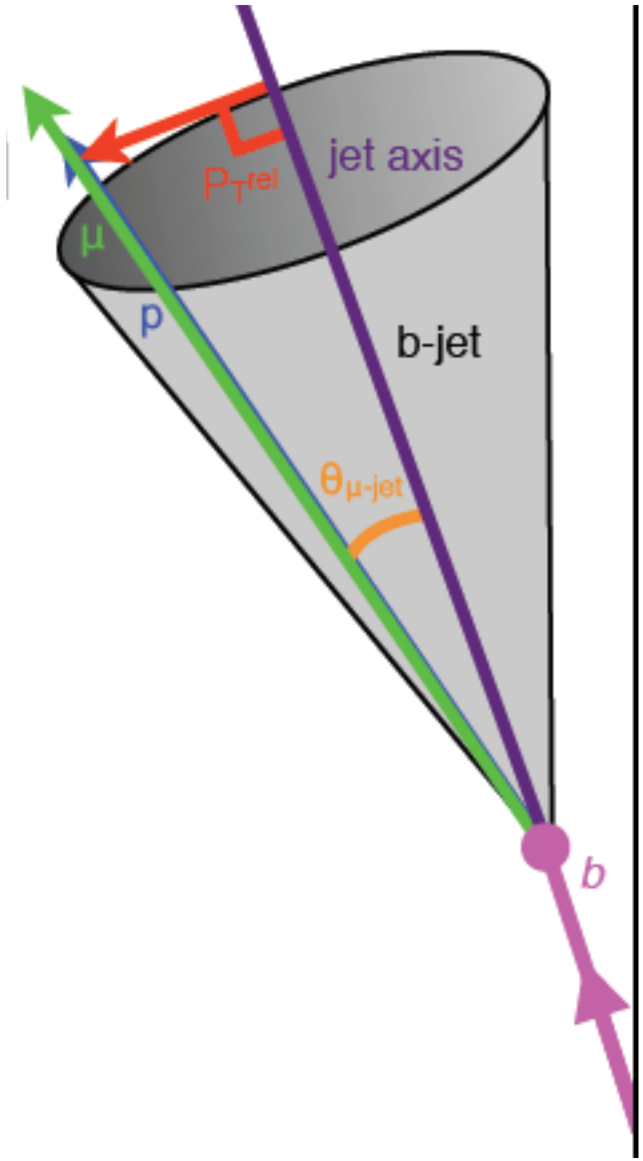
L.Cerrito, G. Salamanna, Giacomo Snidero, B. Cooper
V. Boisvert, R. Goncalo, M. Rose, J. Blanco

Queen Mary, University of London
Royal Holloway, University of London

London Top Group

Introduction

- Cross section in Semileptonic channel (e and μ) using Soft Muon Tagging
  - Complementary to lifetime based tagger analyses
    - Smaller efficiency due to BF
    - But similar Light Jet Rejection and less dependence on Si alignment (different systematics)
- SMT tagger used is NOT Ptrel one (available in AOD) it is based on MatchChi2 (soon available in AOD)
  - Same performance as Ptrel
  - Can use isolated muons for efficiency sample



SMT MatchChi2 (Ben)

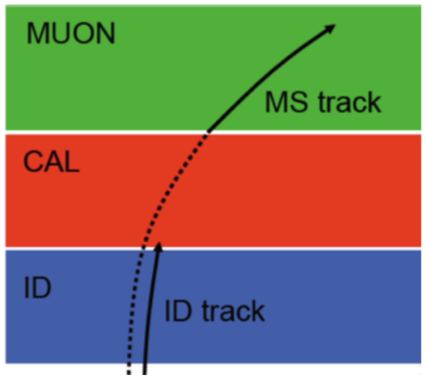
- SMT muon requirements:
  1. STACO muons
  2. $\Delta R(\text{jet}, \mu) < 0.5$
  3. $|d_0| < 4$ mm
  4. $p_T > 4$ GeV
  5. SMT μ != W μ
  6. "Is combined" with $\chi^2_{match}/DoF < 3.2$

same as p_T^{rel} SMT

Likelihood to separate HF and LF jets: χ^2_{match}/DoF provided by the muon reconstruction algorithm

- χ^2_{match} is the quality of the matching between the muon track from ID and MS. Built with five track params (η , φ , p_T , d_0, z_0) at the point of closest approach wrt the PV (perigee) weighted by covariance matrices.

$$\chi^2_{match} = (T_{MS} - T_{ID})^T (C_{ID} - C_{MS})^{-1} (T_{MS} - T_{ID})$$



- Performance studied by our group on MC: overall (including BR) tagging efficiency ~ 10%,

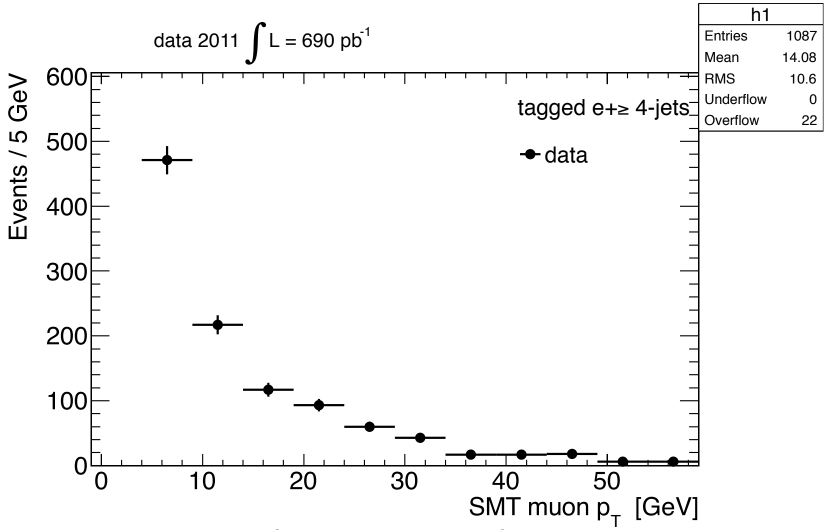
	p_T^{rel} – tagger		χ^2_{match} – tagger	
ε_b	p_T^{rel} – weight > X	LJR	χ^2_{match}/DoF < X	LJR
8%	3.7	790 ± 19	1.8	740 ± 17
9%	3.4	585 ± 12	2.3	595 ± 12
10%	3.14	430 ± 8	3.2	470 ± 9
11%	2.93	310 ± 5	6.0	330 ± 5

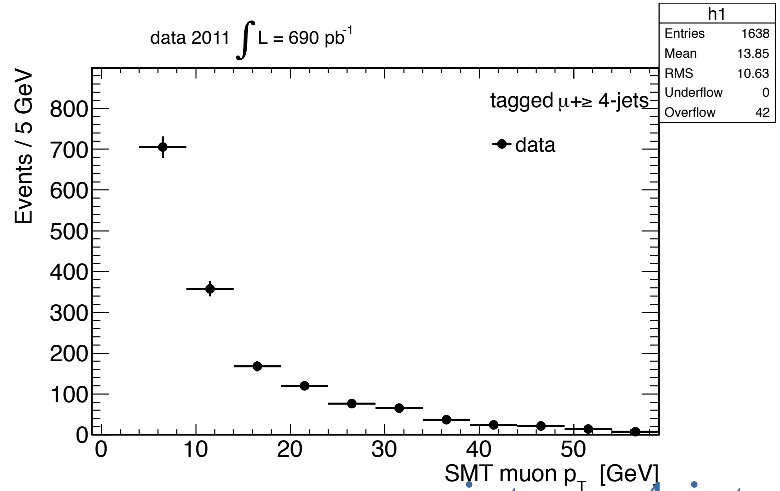
ATL-COM-PHYS-2010-335

Status Updates in ATLAS b-tagging group & Top b-tag liaison group

SMT: plots from data (egamma, Muon streams)(Giacomo)

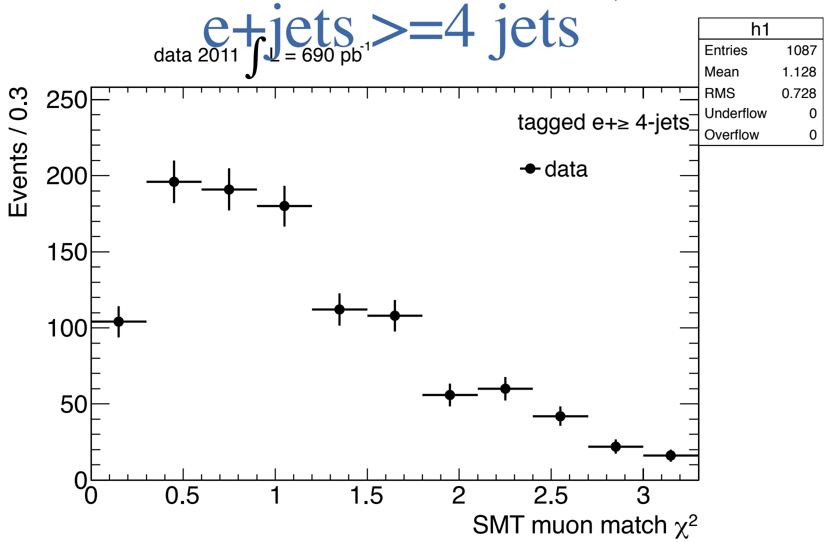
- See later for event selection, NO backd subtraction

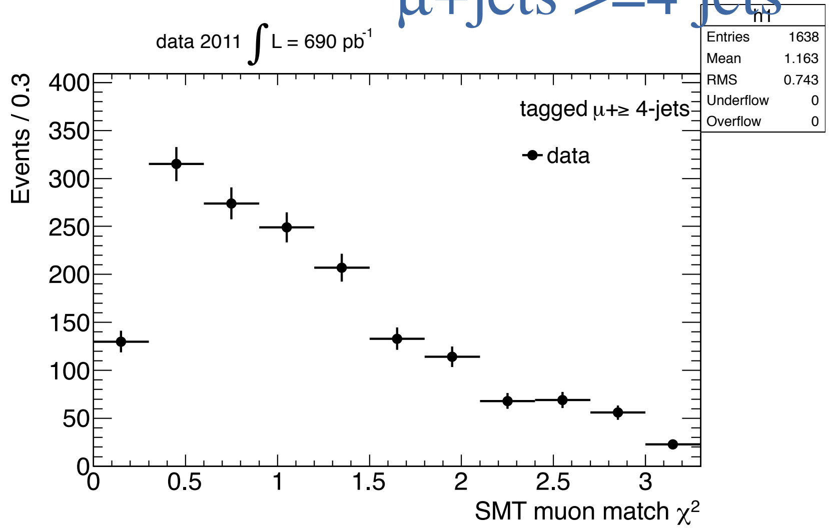




e+jets >=4 jets

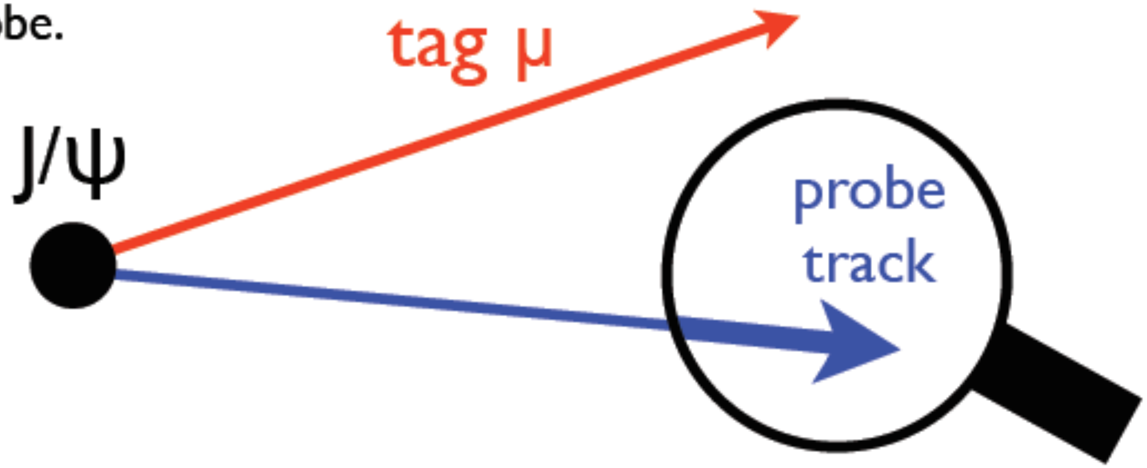
μ+jets >=4 jets





SMT MatchChi2: Efficiency (Matt)

- Efficiency in data can be found using samples of isolated muons, i.e. J/ψ, using Tag and Probe.



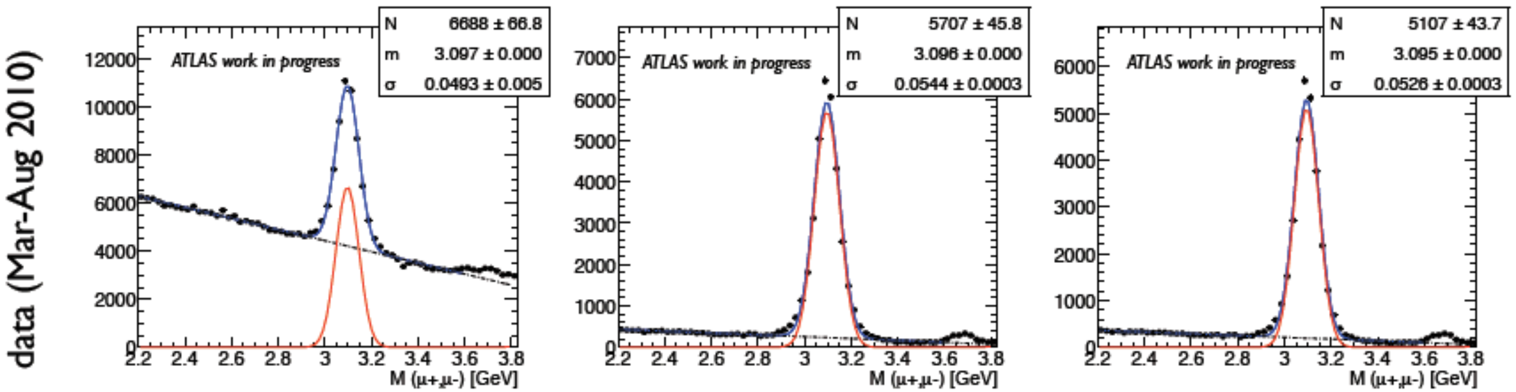
- tag is well defined muon, requiring a combined MS and ID track.
- probe is an ID track which has opposite sign to the tag, within $0.2 < \Delta R < 1.5$ of it, and passes a vertexing cut.
- A muonprobe meets the probe cuts, and is a combined MS and ID track

$$\varepsilon_{reco} = \frac{N_{T\&MP}}{N_{T\&P}}$$

$$\varepsilon_{\chi 2} = \frac{N_{\chi 2}}{N_{T\&MP}}$$

Status updates in Top b-tag liaison group & Combined Muon Performance group (low pT)

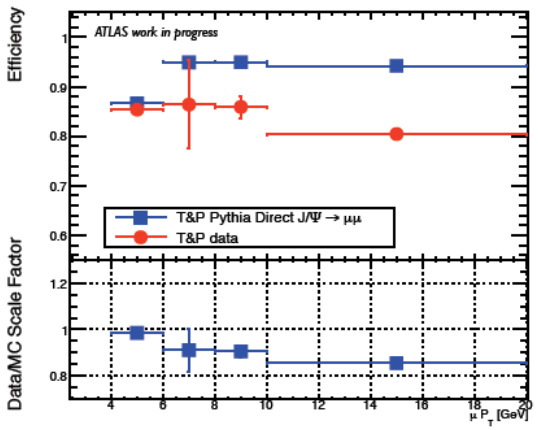
SMT MatchChi2: Efficiency (Matt)



$N_{T\&P}$ numerator of $\varepsilon_{\chi 2}$

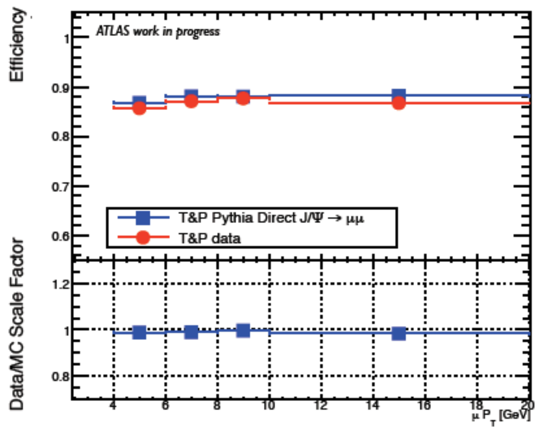
$N_{T\&MP}$ numerator of ε_{reco} & denominator of $\varepsilon_{\chi 2}$

$N_{\chi 2}$ numerator of $\varepsilon_{\chi 2}$



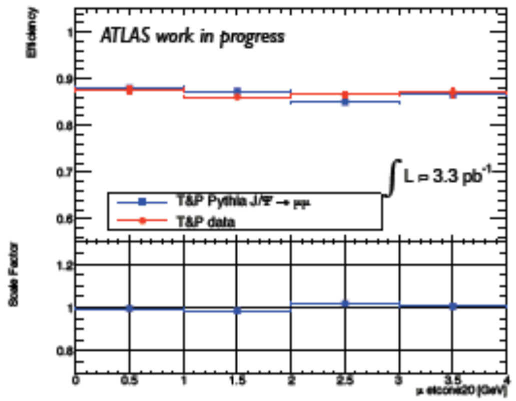
μ reconstruction

(discrepancy under investigation)

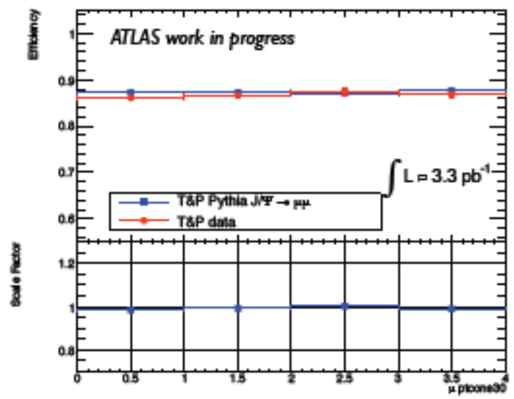


χ^2_{match}

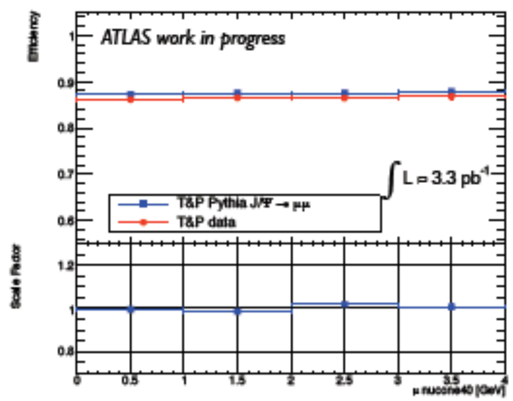
SMT MatchChi2: Efficiency (Matt)



etcone20



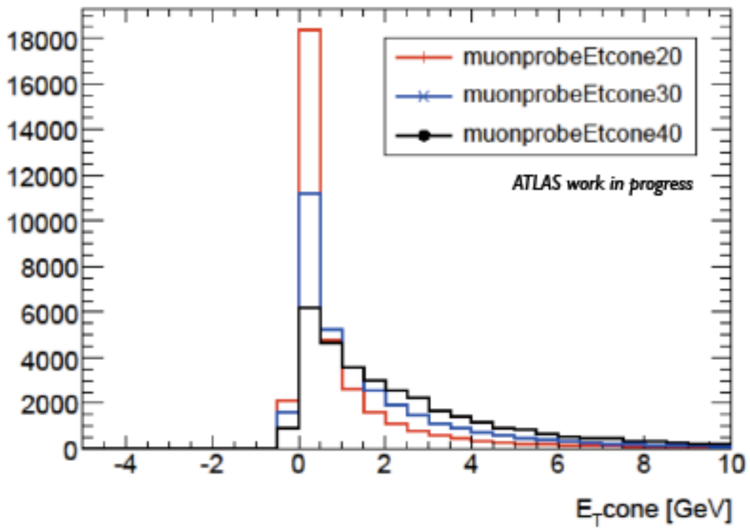
ptcone30



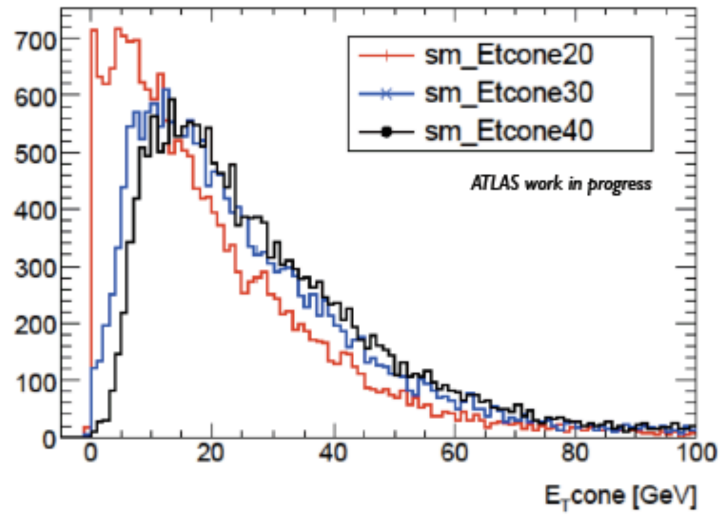
nucone40

Note the x-axis scale

J/Psi Data



Ttbar MC



SMT MatchChi2: Fake Rates/W+jets background (Giuseppe)

- 1. Get W+jets from Data-QCD-MC (signal and background) in 2 jet-bin, get Tag Rate (= Tag/Pretag) and scale for >=4 jet bin

$$W^{tagged-\geq 4jets} = W^{pretag-\geq 4jets} \cdot f^{\geq 4jets}_{tagged} \qquad f^{\geq 4jets}_{tagged} = f^{2jets}_{tagged} \cdot f^{corr}_{2\to\geq 4}$$

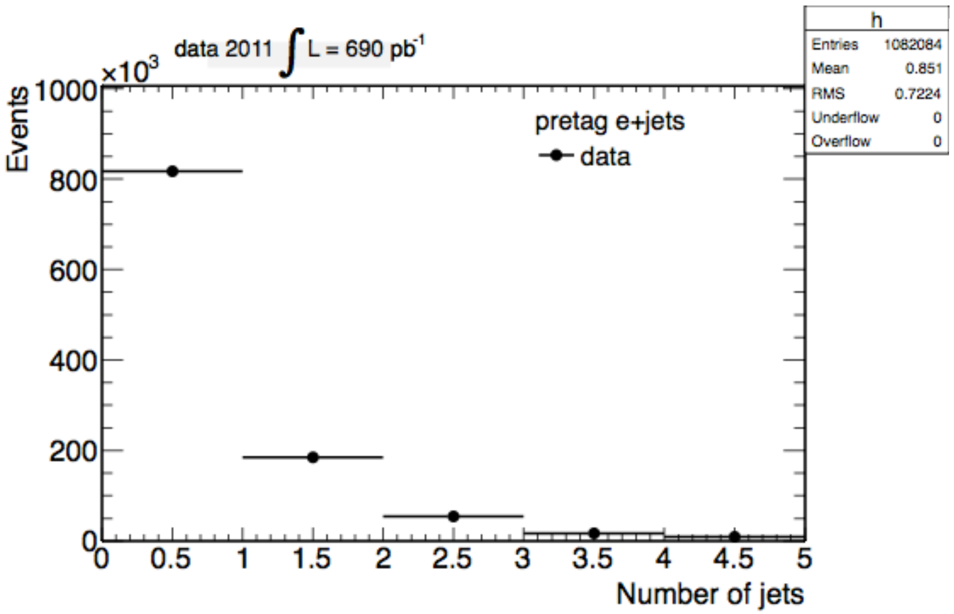
- 2. Get a per jet fake rate from multi-jets and γ+jets and veto SV0 (or use negative weights)
  - Gives you mostly W+LF
  - Then apply W+HF/W+LF from MC correction to get W+HF
- 3. Can also get per track fake rate using enriched data sample of π,K,p:
  - D*->Dπ→Kππ
  - Λ->Kp
  - Then need relative contribution of π,K,p in W+LF sample

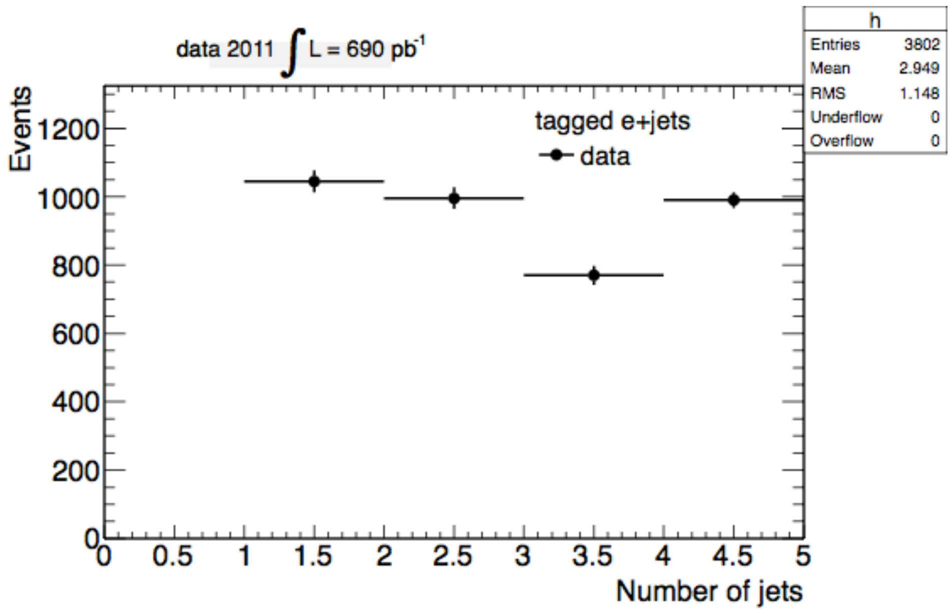
- Data11_7TeV AOD datasets:
  - Egamma and Muons streams
  - Periods: B, D, E1, F1-F3, G1-G5;
  - Integrated luminosity ≈ 690 pb-1
  - GRL: Top_GRL_G5.xml

- Top Group Event/Object selections:
  - details: https://twiki.cern.ch/twiki/bin/view/AtlasProtected/TopCommonObjects
  - code tested on ttbar cross-section event challenge, release: 16.6.3.5.1-TopPhys
  - Soon update to AtlasPhysics-16.6.6.2.2

Data Yields: e+jets (Giacomo)

- Raw plots/No background subtraction

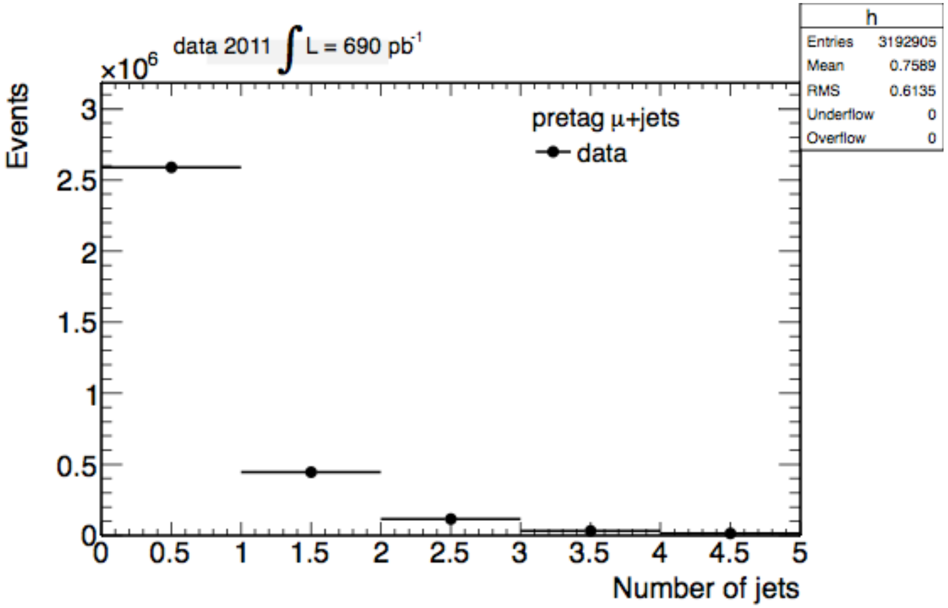


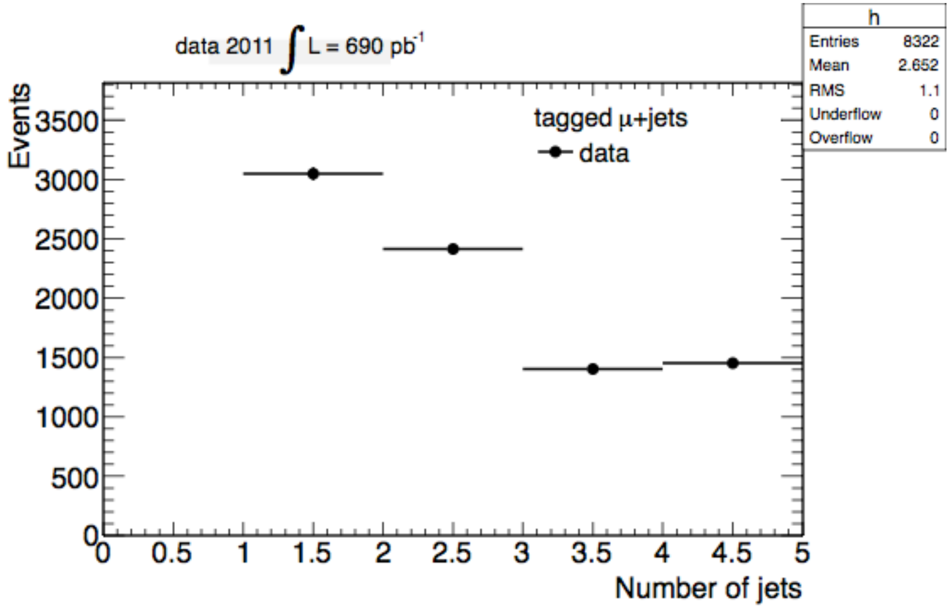


data e+jets					
	0-jet	1-jet	2-jet	3-jet	≥4-jet
pretag	817418	184460	54345	16794	9066
tagged	/	1045	996	770	990
tagged/pretag	/	0.567%	1.833%	4.585%	10.920%

Data plot: μ+jets (Giacomo)

- Raw plots/No background subtraction

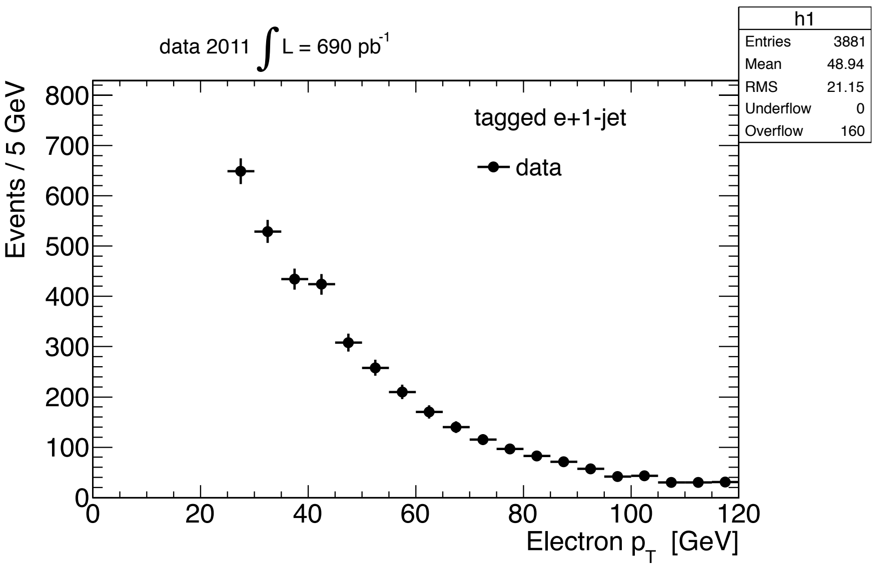


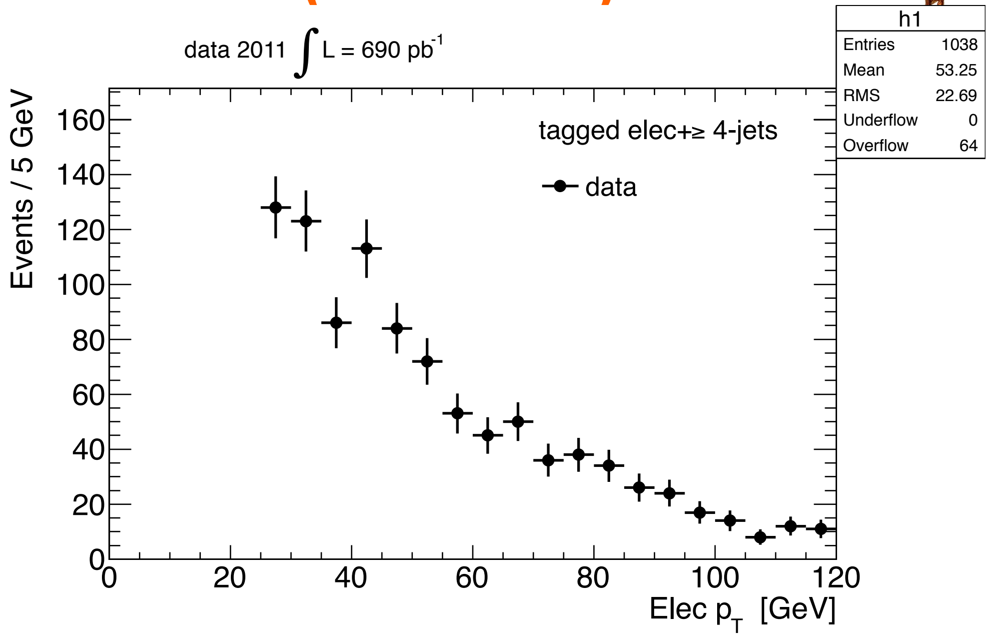


data μ+jets					
	0-jet	1-jet	2-jet	3-jet	≥4-jet
pretag	2.587E+06	4.439E+05	1.167E+05	30793	14235
tagged	/	3048	2416	1404	1453
tagged/pretag	/	0.687%	2.070%	4.559%	10.207%

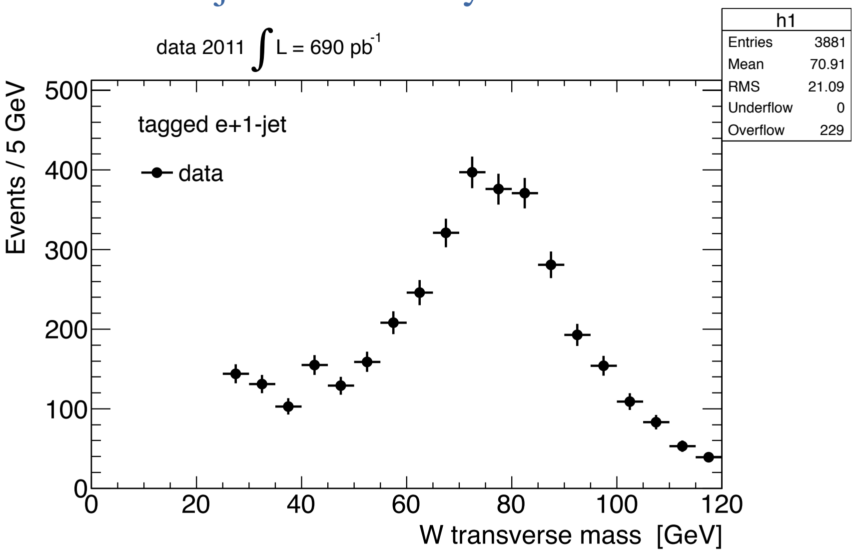
Data Plots: e+jets

(Giacomo)

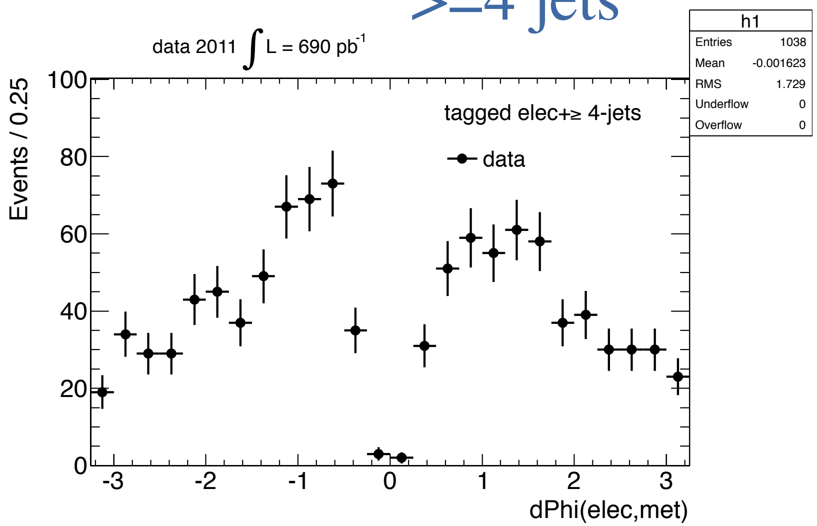




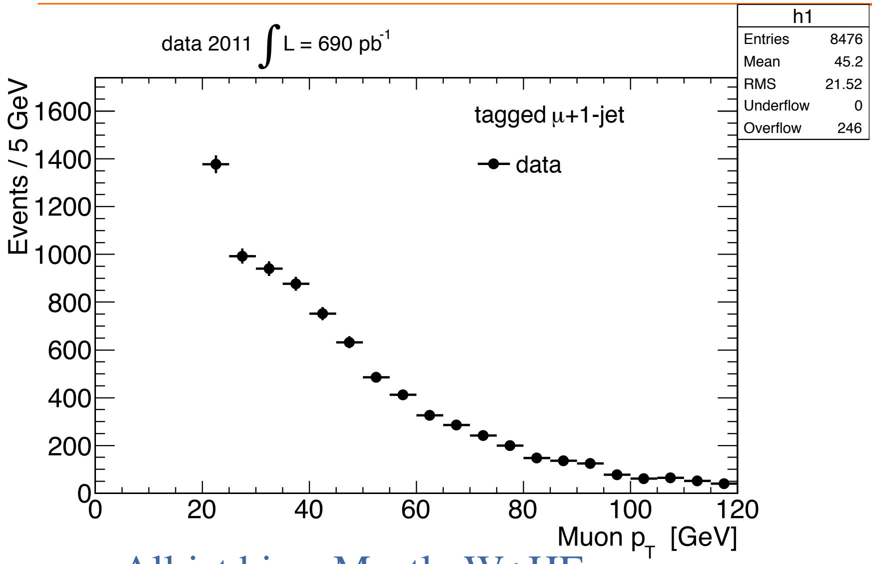
All jet bins: Mostly W+HF



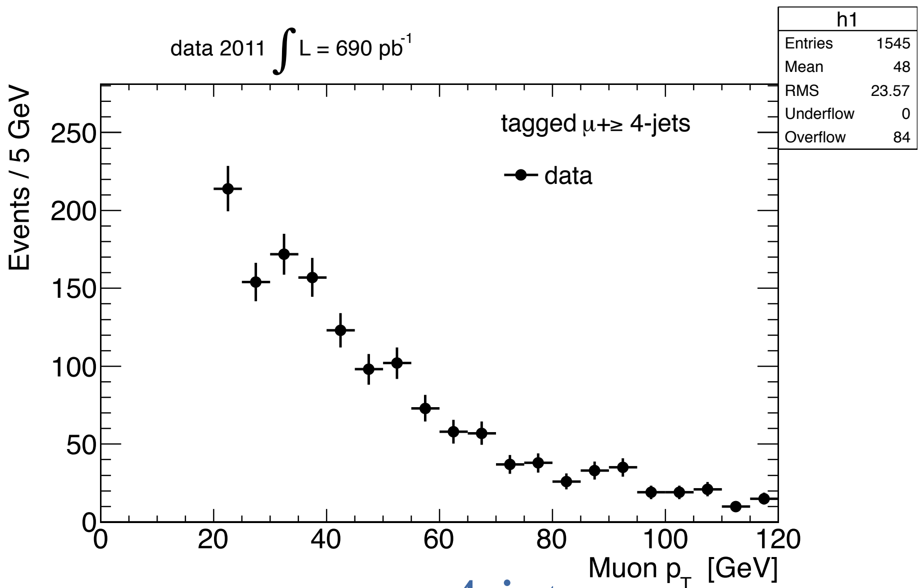
>=4 jets



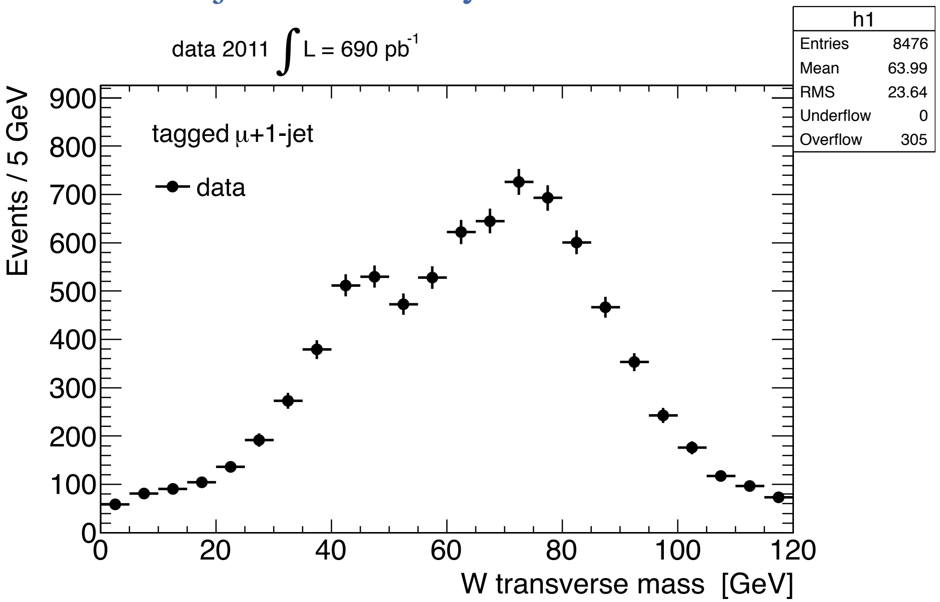
Data Plots: μ+jets (Giacomo)

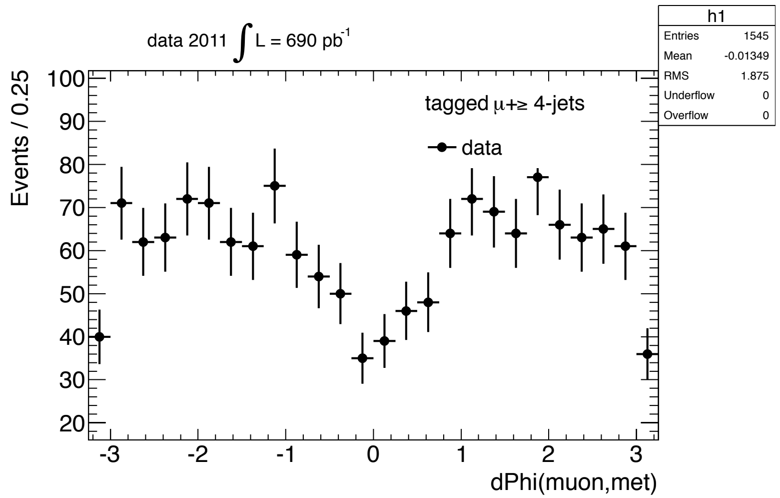


All jet bins: Mostly W+HF



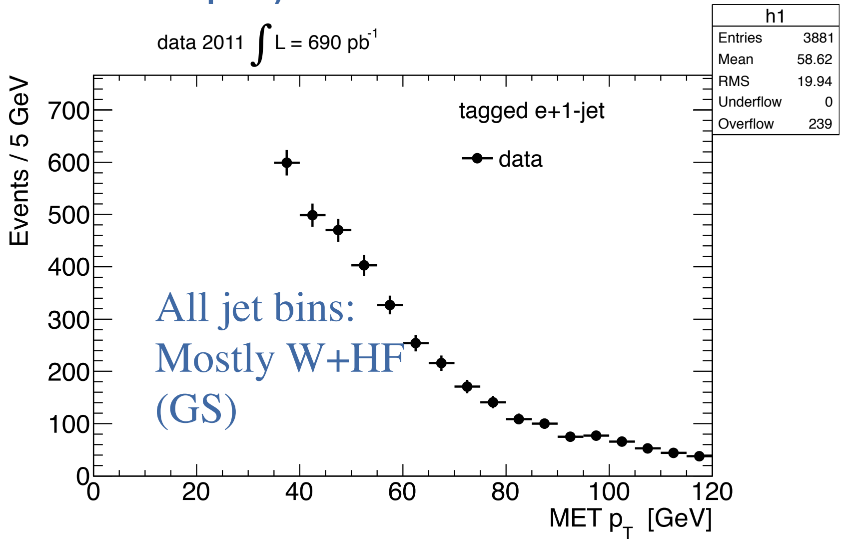
>=4 jets

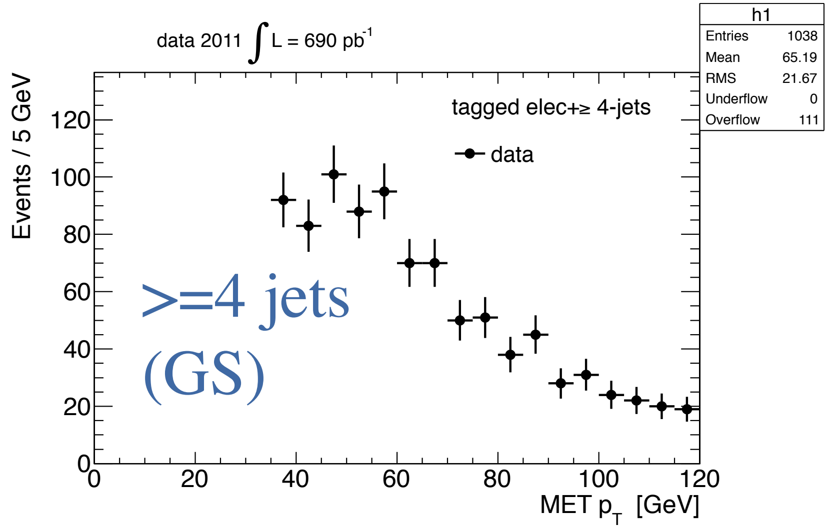




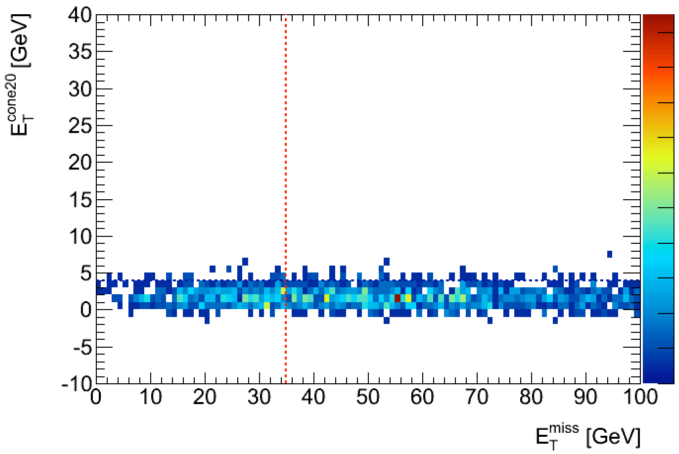
QCD backgrounds: e+jets (Jacob)

- We like Met vs Iso ABCD method as a cross check (systematic uncertainty)
- Number will come from MET shape fit & extrapolation (using anti-electron sample)



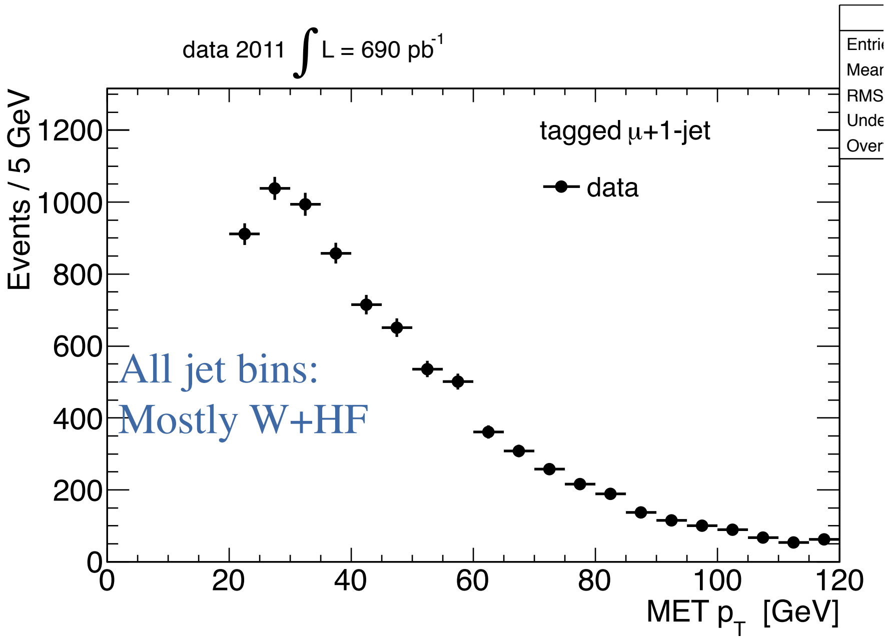


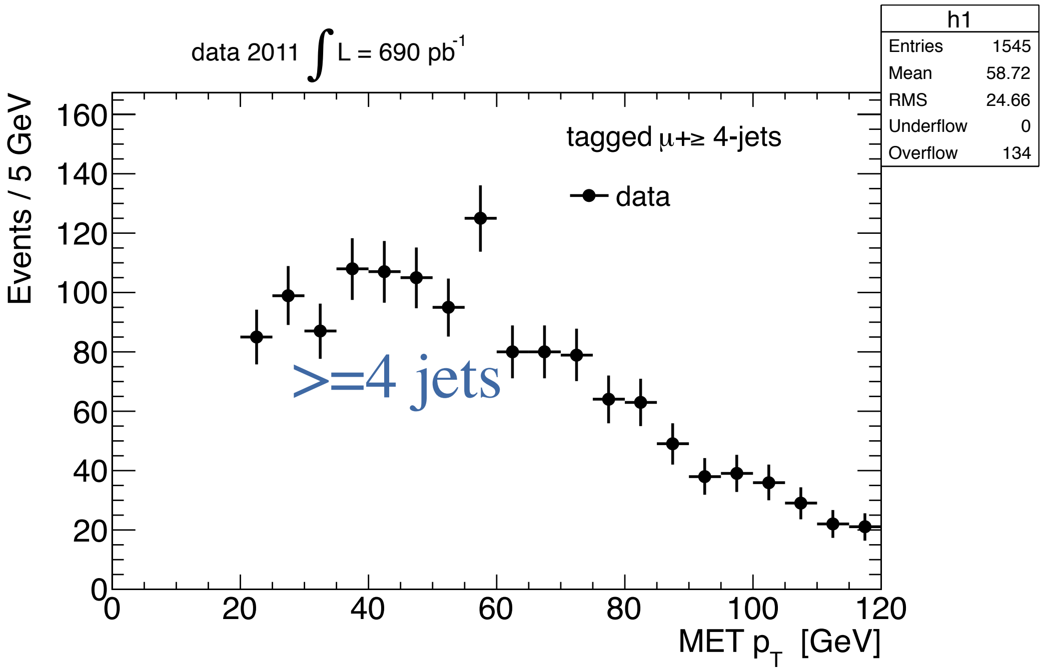
>=4 jet bin ttbar MC, all event selection pretag (some isolation seems to be in) →



QCD background: μ+jets (Giacomo)

- We like Met vs Iso ABCD method as a cross check (systematic uncertainty)
- Number will come from Matrix Method

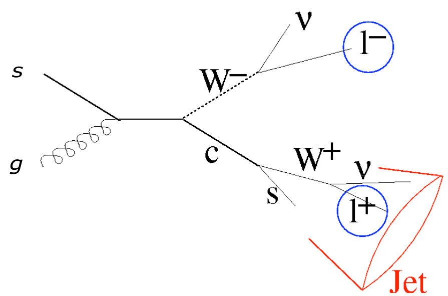




Conlusions

- SMT algorithm is final and gives good performance
  – Efficiency & fake rates are ongoing
- Analysis follows official event selection (except for tag requirement obviously)
  – Now upgrading to 16.6.6.2.2
- QCD backgrounds have started
- W+jets backgrounds have started (fake rates)
- Having the charge of the soft muon is useful to correlate to charge of b(c) quark!
  – Also working on W+c cross section analysis

$$\sigma_{Wc} \times \mathrm{BR}(W \to \ell \nu) = \frac{N_{\mathrm{tot}}^{\mathrm{OS-SS}} - N_{\mathrm{bkg}}^{\mathrm{OS-SS}}}{Acc \int L\mathrm{dt}},$$



(1+2) jet tagged	electron	muon
OS-SS	701	2364
OS+SS	2041	5464
(OS-SS)/(OS+SS)	0.343	0.433

Conclusions

- Not using Top D3PD (not right variables and too big)
- For 16.6.3.5.1: used our own Athena ZZtop code (Ricardo) as an ntuple maker (Top dAOD->ntuple on local disks)
- For 16.6.6.2.2: use ZZtop to skim Top dAOD (AOD->AOD)
  - Hard skim relying on TopCommonInputs so outputs fit on local disks
  - Different skims for backgd studies and systematics, but easy to choose selection cuts in skims (at jobO level!)
- Then use ZZtop as athena analysis code directly (AOD->plots) or as ntuple maker (AOD->ntuple)
- So PLEASE:
  - Don't assume everyone is using Top D3PD!
  - Continue skimming AOD to Top dAOD
  - Continue supporting TopCommonInputs
    - May be we can help with maintaining this

DPD ©

DPDs Rock!

Backups

$$
\begin{aligned}
N^{OS} &\approx N^{OS}_{sgn} + N^{OS}_{bkg} \\
N^{SS} &\approx N^{SS}_{bkg} \qquad (N^{SS}_{sgn} \approx 0) \\
N^{SS}_{bkg} &\approx N^{OS}_{bkg} \\
\Longrightarrow \quad N^{OS-SS} &\approx N_{sgn}
\end{aligned}
$$