

Status of TauPlusJets2012 Code

Catrin Bernius

Louisiana Tech University

OU HEP meeting

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Analysis Code Introduction

- **2012 Analysis code: TauPlusJets2012**

<https://svnweb.cern.ch/trac/atlasusr/browser/bernius/TauPlusJets2012>

- Instructions on how to set up code and how to run it can be found in the README file
 - Note: There are further README files in HplusChallenge/HplusChallenge/README-PhysicsClass, locations are noted in main README file
- If you are interested in contributing, send me an email!
 - Catrin.Bernius@cern.ch
- Presented update in $t\bar{t} \rightarrow \tau + X$ meeting last Tuesday (July, 31)
 - received many useful comments by Serban (thanks to Serban again!)
 - implemented most of these
 - additionally implemented some of the remaining WG recommendations

Changes described in detail on next slides!



Event selection (1) - preliminary

- Main analysis code is TNtupleAnalyzer.cxx/.h
 - runs on ntuples only!!
 - in HplusChallenge/Root
- Event loop:
 - C0: GRL
 - **C1: Trigger cut**
 - Working on trigger studies: A. Ha
 - Will choose tau+met trigger for n
 - C2: Primary vertex cut to check if it
 - Object Selection:
 - separate functions for Etmis, electron, muon, tau and jet selection
 - <https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/TopCommonObjects>
 - C3: LAr FEB problem: discard events with jets inside bad LAr region
 - C4: Jet cleaning cuts
 - Need to implement: reject event if LooseBadMinus jet in collection
 - C5: Lepton veto

Serban's concern: met cut of tau+met trigger is too high with xe55.
Need to look into other possibilities!!

→ Skimming of ntuples possible including all of the above cuts!!



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 - Will choose tau+met trigger for now

- C2: Primary vertex cut to check if it's D

- **Object Selection:**

- separate functions for Emiss, electron, muon, **tau** and jet selection
- <https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/TopCommonObjects>
- C3: LAr FEB problem: discard events with jets inside bad LAr region
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Quite a few comments
regarding the τ Object
selection (see later slides)

inating

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This is obsolete for 2012 data!!
You will still have to apply LAr quality
and cleaning cut, this is done with
larError flag in the electron selection!!

C3 is now purely the electron-muon
overlap cut!!

→ Skimming of ntuples possible including all of the above cuts!!



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- Event loop:
 - C0: GRL
 - C1: Trigger cut
 - Working on trigger studies: A. Hasib (Univ)
 - Will choose tau+met trigger for now
 - C2: Primary vertex cut to check if it's PriVtx
 - Object Selection:
 - separate functions for Etmis, electron, ...
 - <https://twiki.cern.ch/twiki/bin/view/AtlasProtected/TopCommonObjects>
 - C3: LAr FEB problem: discard events with jets inside bad LAr region
 - **C4: Jet cleaning cuts**
 - **Need to implement: reject event if LooseBadMinus jet in AntiKt4TopoEMJets collection**
 - C5: Lepton veto

This may be obsolete for analysis after TOP2012 deadline since moving to LCTopo jets!

JETS GENERALLY NEED SORTING OUT!!

→ Skimming of ntuples possible including all of the above cuts!!



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 - in HplusChallenge/Root
- Event loop:
 - C0: GRL
 - C1: Trigger cut
 - Working on trigger studies: A. Hasib (University of Oklahoma)
 - Will choose tau+met trigger for now
 - C2: Primary vertex cut to check if it's PriVtx or PileUp with > 4 tracks originating
 - Object Selection:
 - separate functions for Etmisss, electron, muon, tau and jet selection
 - <https://twiki.cern.ch/twiki/bin/view>
 - C3: LAr FEB problem: discard even
 - C4: Jet cleaning cuts
 - Need to implement: reject
 - **C5: Lepton veto**

Move to after skimming of ntuples to be able to do studies with leptons/taus!!

→ Skimming of ntuples possible including all of the above cuts!!



Event selection (2) - preliminary

- **C6: number of jets, jet vertex fraction cut to reduce pile-up**
- C7: τ cuts
 - exactly one τ , trigger match, pt cut
- C8: $E_{\text{tMiss}} > 65\text{GeV}$
 - C9: $E_{\text{tsum}} > 0$ (cut effective)
- C10: E_{tMiss} significance cut
- C11: transverse mass (τ , M_{T})
- C12: ≥ 1 b-tagged jet
- C13: mass (bjj) cut: 140 GeV

Jet selection needs sorting out in combination with jet object selection:

e.g.:

$|j_{\text{v}}f| > 0.5$ (in 2011: 0.75)

This is to be consistent with other groups and with b-tagging calibrations
(but found also contradictory information)



Event selection (2) - preliminary

- C6: number of jets, jet vertex fraction cut to reduce pile-up
- **C7: τ cuts**
 - **exactly one τ , trigger match, pt cut**
- C8: EtMiss $> 65\text{GeV}$
 - C9: Etsum > 0 (cut effectively not applied)
- C10: EtMiss significance cut
- C11: transverse mass ($\sqrt{s} - \text{MET}$) $> 50\text{GeV}$ cut
- C12: ≥ 1 b-tagged jet
- C13: mass (bjj) cut: 140 GeV

Serban's suggestion: REMOVE THIS CUT!!
Also, depending on which trigger is used, the trigger match is obsolete



Event selection (2) - preliminary

- C6: number of jets, jet vertex fraction cut to reduce pile-up
- C7: τ cuts
 - exactly one τ , trigger match, pt cut
- **C8: EtMiss > 65GeV**
 - C9: Etsum > 0 (cut effectively not applied)
- C10: EtMiss significance cut
- C11: transverse mass (τ , MET), 50GeV cut
- C12: ≥ 1 b-tagged jet
- C13: mass (bjj) cut: $140 \text{ GeV} < m(\text{bjj})$

Cut much too high, ideally do not cut on missing ET



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 - C9: $E_{\text{tsum}} > 0$ (cut effectively not applied)
- **C10: E_{tMiss} significance cut**
- C11: transverse mass (τ , MET) $> 50\text{GeV}$ cut
- C12: ≥ 1 b-tagged jet
- C13: mass (bjj) cut: $140\text{ GeV} < m(\text{bjj}) < 210\text{ GeV}$

Needs to be discussed!



Event selection (2) - preliminary

- C6: number of jets, jet vertex fraction cut to reduce pile-up
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 - exactly one τ , trigger match, pt cut
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- **C11: transverse mass (τ , MET) $> 50\text{GeV}$ cut**
- C12: ≥ 1 b-tagged jet
- C13: mass (bjj) cut: $140\text{ GeV} < m(\text{bjj}) < 210\text{ GeV}$

Ok to keep but 50 GeV too high,
recommendation is $\sim 30\text{ GeV}$



Event selection (2) - preliminary

- C6: number of jets, jet vertex fraction cut to reduce pile-up
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 - C9: $E_{\text{tsum}} > 0$ (cut effectively not applied)
- C10: E_{tMiss} significance cut
- C11: transverse mass (τ , MET) $> 50\text{GeV}$ cut
- **C12: ≥ 1 b-tagged jet**
- C13: mass (bjj) cut: $140\text{ GeV} < m(\text{bjj}) < 210\text{ GeV}$

Serban's suggestion: require 2 b-tagged jets

Will get higher systematic uncertainties but that might cancel out due to reduced background uncertainties!



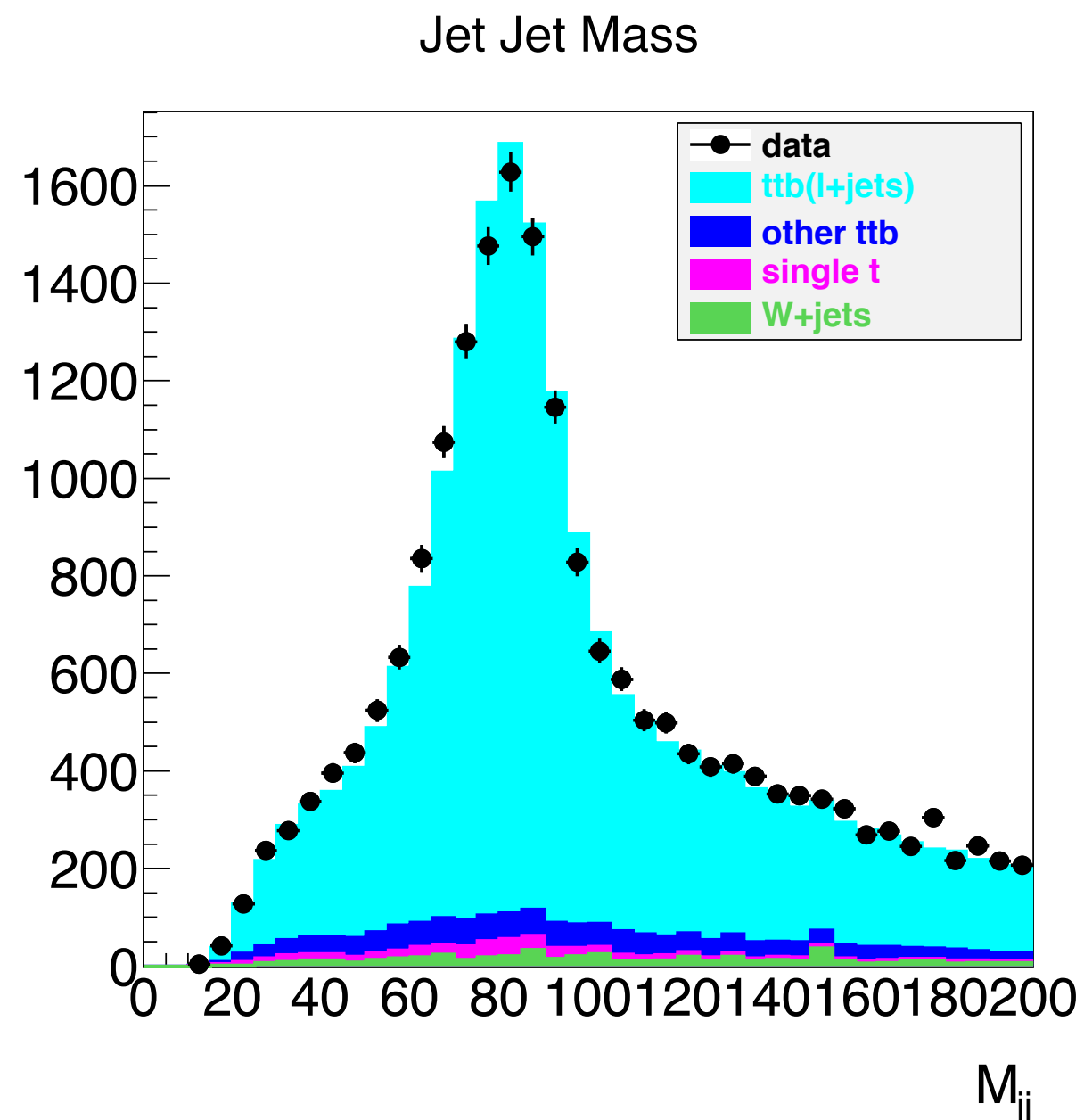
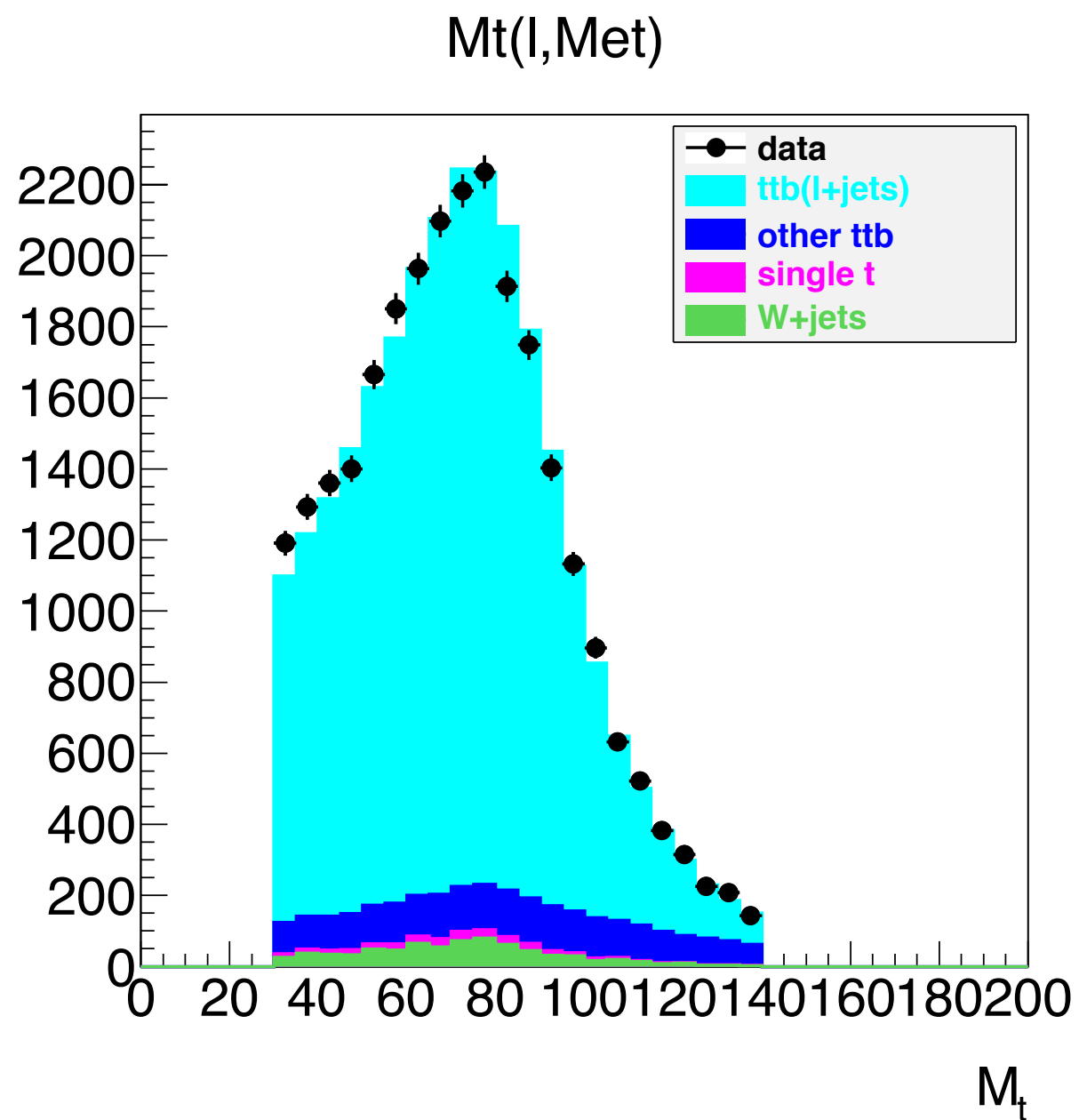
Event selection (2) - preliminary

- C6: number of jets, jet vertex fraction cut to reduce pile-up
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- C12: ≥ 1 b-tagged jet
- **C13: mass (bjj) cut: $140\text{ GeV} < m(\text{bjj}) < 210\text{ GeV}$**

Serban sent a few plots from lepton + jets with mass distributions:
good mass resolutions



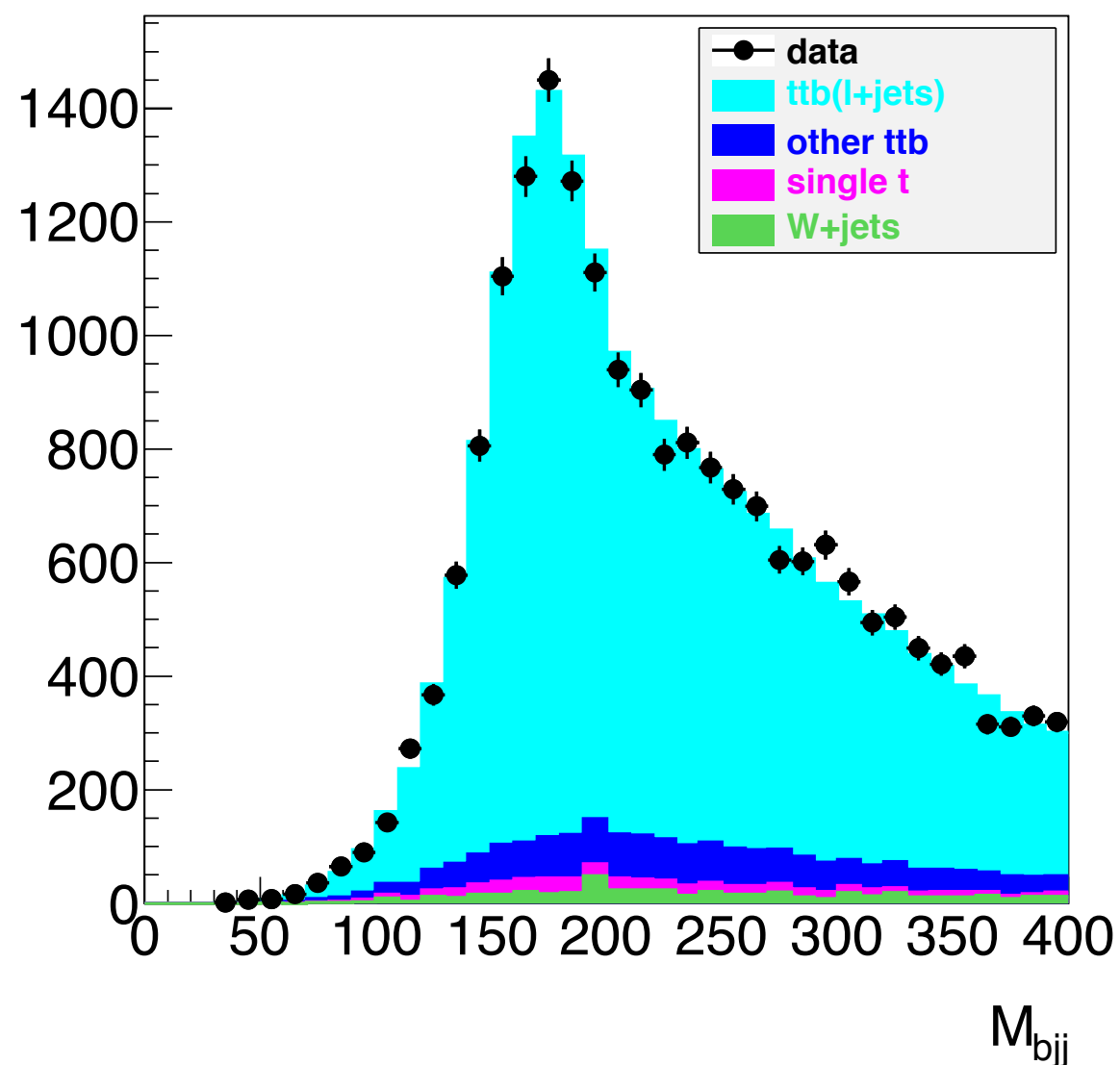
Mass distributions - lep + jets



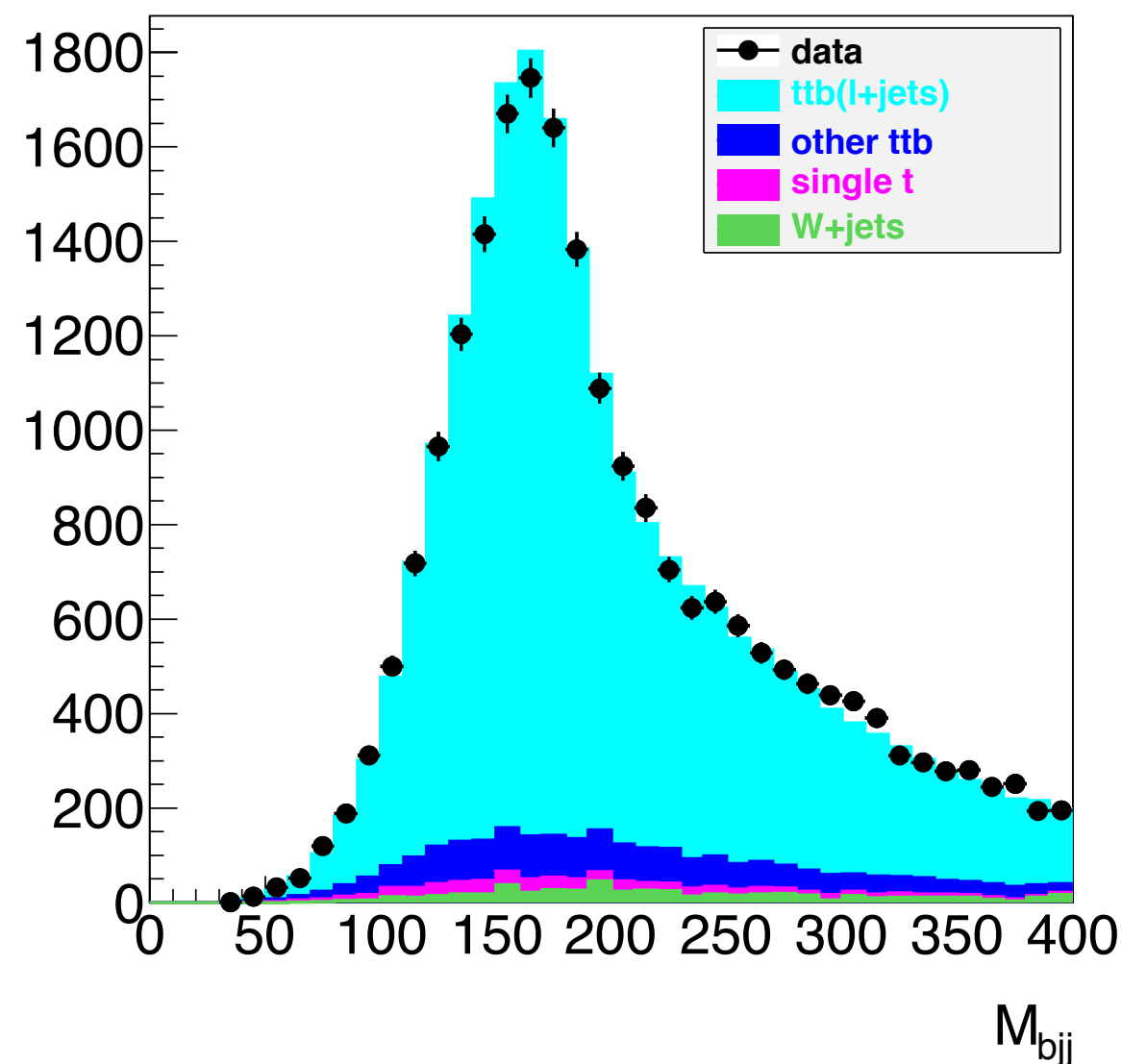


Mass distributions - lep + jets

b1 Jet Jet Mass



b2 Jet Jet Mass





Event selection - new cutflow!!

- C0: GRL
- C1: Trigger cut
 - **needs to be decided on!**
- C2: Primary vertex cut to check if it's PriVtx or PileUp with > 4 tracks originating
Object Selection (see more on later slides, no event rejection)
- C3: electron - muon overlap
- C4: Jet cleaning cuts

→ *Skimming of ntuples possible after C0-C4!*

- C5: Lepton veto
- C6: number of jets, jet vertex fraction cut to reduce pile-up
- C7: 1st set of τ cuts:
 - $p_T > 20\text{GeV}$, $|\eta| < 2.3$, 1 prong taus
- C8: leptonic W mass cut: $30\text{GeV} < m_T(\tau, \text{MET}) < 140\text{ GeV}$ cut
- C9: ≥ 2 b-tagged jet
- C10: hadronic top mass cut: $140\text{ GeV} < m(bjj) < 210\text{ GeV}$
- C11: 2nd set of τ cuts
 - tau_muonVeto, tau_EleBDTMedium, tauLhTight



Object Selections - Updates

- τ object selection
- Jet updates
- Problem with MET tool in current D3PDs



TauSelection - reminder

- So far in code: HSG6 τ object selection
 - https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/HSG6Winter2012#Object_Selection

tau jets			
author	calo-seeded (author == 1 or 3)		
alg	tau_tauLlhTight	No need to rerun TauID; BDT will be investigated	
pT>	20 GeV		
abs(eta)<	2.3		
no. of tracks	1 OR 3	TopD3PD: tau_numTrack	
tau_muonVeto==0	Muon veto	0 if it passes the veto	
tau_EleBDTMedium==0 NEW	e veto	0 if it passes the veto	

- electron overlap removal ($\Delta R < 0.2$)
- muon overlap removal ($\Delta R < 0.2$)



TauSelection - NEW

- Following suggestions from Serban:
 - In Object selection:
 - 1- or 3-prong τ s
 - τ author is 1 or 3
 - τ - electron removal ($\Delta R < 0.2$)
 - τ - muon removal ($\Delta R < 0.2$)
 - using all muons, also soft muons
 - event veto scale factor calculation (need to check if still necessary)
 - filling vector
- All other cuts have been moved to cut flow:
 - C7: $p_T > 20\text{GeV}$, $|\eta| < 2.3$, 1 prong taus
 - C11: tau_muonVeto, tau_EleBDTMedium, tauLlhTight



JetSelection

- Updates:
 - Moved all jets to AntiKt4LCTopoJets ($\text{jet}_* \rightarrow \text{jet_AntiKt4LCTopoJets}_*$)
 - same done for MET vector (not sure if all correct)
 - no re-calibration necessary
- Needs to be done:
 - check on JVF cut and JVF SF



TOPMETVector - recent finding

- Email from Alison Lister, Aug, 1
 - in current D3PDs:
 - electron componets of MET are all exactly zero
 - MET thinks that there are 0 electrons, meaning all electrons will enter the MET as jets
 - electrons are not ignored, the are just in a different term
 - electrons with $pt > 25\text{GeV}$ will enter the MET at EM+JES scale instead of the EM scale
 - Will cause a degradation in the MET resolution
 - same in data and MC
 - assigning a larger uncertainty to MET
 - need to watch out when propagating uncertainties to MET
- Not going to be fixed in time for TOP2012



Summary & Outlook

- **Summary:**

- Current version of code in svn
 - Latest changes in TauPlusJets2012 trunk (tagged as TauPlusJets2012-00-00-10)
- compiling but not tested it yet on MC12/data ntuples yet
- ntuples from are mostly ready now!

- **Next steps:**

- Study event selection but move on quickly from there
- Work on systematics and background estimation

If you are interested in contributing, please contact me!!
Catrin.Bernius@cern.ch

BACKUP





Twiki pages

- **Top RootCore package versions for 8TeV analyses:**
 - <https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/TopRootCoreRelease>
- **Systematic uncertainties:**
 - <https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/TopSystematicUncertainties>
- **Top Common Scales**
 - <https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/TopCommonScales>
- **Top Common Objects:**
 - <https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/TopCommonObjects>
- **2012 GRL**
 - <https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/TopGRLs>



ElectronSelection (1)

- Electron Object selection function:
 - set larVetoEle variable for electron lar hole rejection in cut flow
 - electron quality cuts: el_tightPP, el_author, el_0Q
- option to set the electron energy rescaling & smearing
 - new function combining electron energy rescaling (data) and smearing (MC)
`float el_E_corrected()`, returning corrected electron energy
→ avoid having the rescaling code twice (in electron loop and MET loop)
- afterwards calculating the correct electron energy and direction for pix&sct and basically TRT standalone tracks
- etiso correction (no changes made here)
- eta & Et cut
- electron muon overlap (electron-jet overlap done in JET LOOP)
 - Bill's version contains two of them → should be checked!!
- then filling of the vectors



ElectronSelection (2)

- Corrections/Scaling:
 - updated packages and descriptions (egammaAnalysisUtils-00-03-24)

<https://twiki.cern.ch/twiki/bin/view/Main/PhotonPlusMetSusy2012>

Electron related			
Energy & direction	yes	yes	Code snippet on D3PDs...  Reference
Energy scale	yes	no	Use egammaAnalysisUtils-00-03-24 <pre>EnergyRescaler er; er.useDefaultCalibConstants("2012"); new_E = scale.applyEnergyCorrectionMeV (e_cl_eta, e_cl_phi, e_E, e_Et, SYST_FLAG, "ELECTRON"); //energies in MeV</pre> SYST_FLAG is 0=NOMINAL, 1=ERR_DOWN, 2=ERR_UP (one sigma variations). Reference
Energy resolution	no	yes	Use egammaAnalysisUtils-00-03-24 <pre>EnergyRescaler er; er.useDefaultCalibConstants("2012"); smear.SetRandomSeed (EventNumber + 1001 * iele); double smearedEnergy = oldEnergy * er.getSmearingCorrectionMeV(cl_eta, oldEnergy, SYST_FLAG, CT_FLAG);</pre> iele is the index of the electron within its collection (before any selections). SYST_FLAG is 0 for nominal scale, 1 or 2 for 1-sigma variations. CT_FLAG should be false for all MC12 physics samples (produced with zero constant term for the LAr EM resolution). Reference

Electron selection up-to-date!!



MuonSelection

<https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/MCPAnalysisGuidelinesData2012>

- **Changes made compared to 2011**

- Number of pixel hits+number of crossed dead pixel sensors > 0 (was 1 in 2011).
- Number of SCT hits+number of crossed dead SCT sensors > 4 (was 5 in 2011).
- A successful TRT extension where expected (i.e. in the eta acceptance of the TRT). An unsuccessful extension corresponds to either no TRT hit associated, or a set of TRT hits associated as outliers. The technical recommendation is therefore:
 - Let $n_{\text{TRT}}^{\text{hits}}$ denote the number of TRT hits on the muon track, $n_{\text{TRT}}^{\text{outliers}}$ the number of TRT outliers on the muon track, and $n := n_{\text{TRT}}^{\text{hits}} + n_{\text{TRT}}^{\text{outliers}}$
 - Case 1: $0.1 < |\eta| < 1.9$. Require $n > 5$ and $n_{\text{TRT}}^{\text{outliers}} < 0.9 n$.
 - Case 2: $|\eta| \leq 0.1$ or $|\eta| \geq 1.9$. If $n > 5$, then require $n_{\text{TRT}}^{\text{outliers}} < 0.9 n$.

This is now implemented in the code!!
Muons Selection up-to-date!!