I.Tsukerman for ITEP Moscow group

EVO Russian ATLAS physics meeting, September 22, 2010

VBF H searches and jets at 7 TeV

Thanks to: R. Asfandiyarov, R. Brun, T. Carli, P. Gorbunov, M. Kaneda, B. Mellado,

A. Pilkington, K. Terashi, M. Warsinsky, Y. Wu, H. Yang

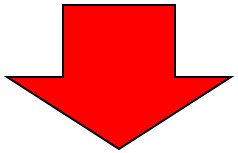
- **Motivation**
- **News from Higgs WG**
- **Jets in single minimum-bias events: preliminary**
- **Jets in ~3 pb^{-1} data with hard muon in final state: very preliminary**
- **Conclusion and plans**

Motivation

- **ITEP group MC studies of jets for VBF Higgs: 2006-2009**

  Four approved ATL-PHYS-INT notes related to tag jet properties and data reduction in signal and background events including low-luminosity pile-up
  Many plots and tables were included into CSC book (also H→WW PUB note)

- **ITEP group pilot study of jets/MET in 2.36 TeV real data: 2010**
  Presented at Jet/MET meeting on 10 March 2010, ESD→AANT analysis chain



- **Jets/MET in single minimum-bias and single lepton 7 TeV data**

- Basis to understand pile-up effects in real data (minimum-bias)
- Comparison with MC to check its prediction power
- Investigation of backgrounds to (VBF) H→WW→ll and H→ττ →ll

This analysis is based on Jet/MET and WW D3PD's

News from Higgs WG in 2010

- **H→WW PUB note about searches at 10 TeV: approved 09.06.2010**

  Prospects for Higgs boson searches using H→WW→ll νν decay mode for 10 TeV
  ATL-PHYS-PUB-2010-005, http://cdsweb.cern.ch/record/1270568

- **SM Higgs PUB note about sensitivity at 7 TeV: approved 16.07.2010**

  Sensitivity prospects for Higgs boson production at 7 TeV LHC running
  ATL-PHYS-PUB-2010-009, http://cdsweb.cern.ch/record/1278455

- **Two PUB notes about non-SM Higgs searches**

- **CONF notes about measurement of backgrounds to H production**

Data-driven BGR estimation of H→4 leptons: first tests with pp at 7TeV: October?
Measurement of W+jets→2l+MET rate as BGR to H→WW at 7 TeV : Approved
Data-driven BGR estimation of H→ττ → lh at 7 TeV: October?

Approved material to be included in my talk at IHEPLHC2010

Event selection of 7 TeV single minimum-bias data

- **Input data: 6.3M events (3M) from data (MC) jet/MET D3PD's**
  M. Kaneda's files, version 000025, runs 152221-152508
  Pile-up in data is checked to be negligible (a few permille probability for N_{vert} >1)
- **Stage 1: writing of compact NTuples in ROOT**
  Selection of some branches of variables related to jets and missing-E_T (MET)
- **Stage 2: Basic selection and analysis of events within ROOT**
  Fast algorithm based on TSelector class of ROOT; creation of histograms

- Luminosity blocks correspond to LHC "stable beams"

https://atlas.web.cern.ch/Atlas/GROUPS/DATAPREPARATION/DataSummary/run-summary.html

- At least one reconstructed vertex with N_{tracks} >4 and $|Z_{vert}|$<100mm
- L1_MBTS_1 trigger on (minimum-bias scintillators)
- Rejection of events with any "bad" and "ugly" jets
- Jet energy calibration: EM scale with factor; AntiKt4 Topo and Tower jets

Technical details about Jet/MET D3PD's: MC

1. Jet/MET D3PD's, MC with PARP(90)=0.16 parameter tuning

PARP(90)=0.16 instead of 0.25, to have better description of SumEt in forward region, details:

http://shimpei.web.cern.ch/shimpei/slides/SumETandUE.pdf

https://groups.cern.ch/group/hn-atlas-jet-etmiss-wg/Lists/Archive/DispForm.aspx?ID=3300

group10.perfjets.mc09_7TeV.115901.pythia_minbias_PARP90var.recon.ESD.e556_s766_s767_r1303_JetEtMissDPDModifier000025.v1_EXT0

2. Jet/MET D3PD's, MC w/o PARP tuning (only AntiKt4Topo), MC09 default:

https://twiki.cern.ch/twiki/bin/view/AtlasProtected/AvailableSampleWithJetEtMissDPDModifier000027
http://mkaneda.web.cern.ch/mkaneda/DPD/AvailableSampleWithJetEtMissDPDModifier000027/files.html

group10.perf-jets.mc09_7TeV.105001.pythia_minbias.recon.ESD.e517_s764_s767_r1302_JetEtMissDPDModifierSP000027.v4_EXT0

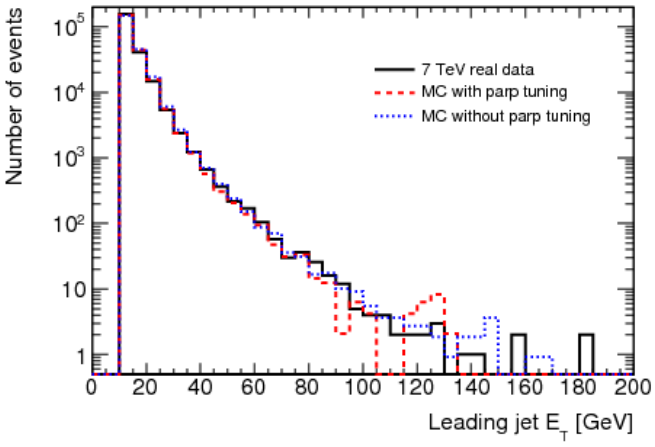
PARP(90) - is "power of energy rescaling term of the p_T(min) and p_T(0) parameters…" (hep-ph/0603175, page 354)

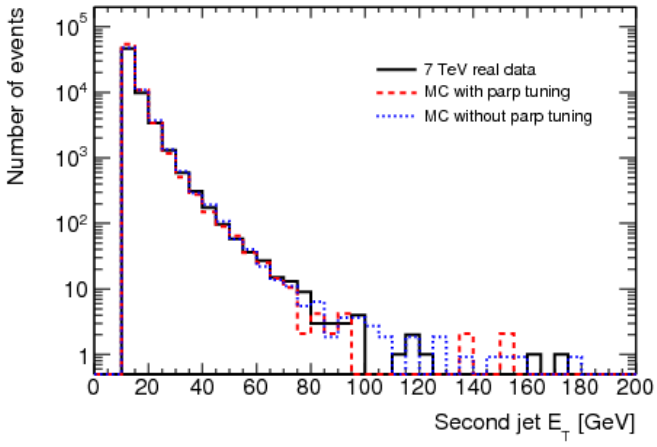
Note about MC normalization on plots:

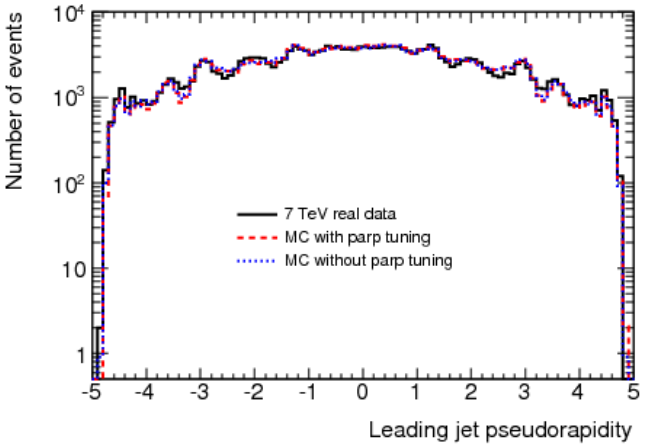
MC is normalized to have the same number of events as in data at given set of selection criteria

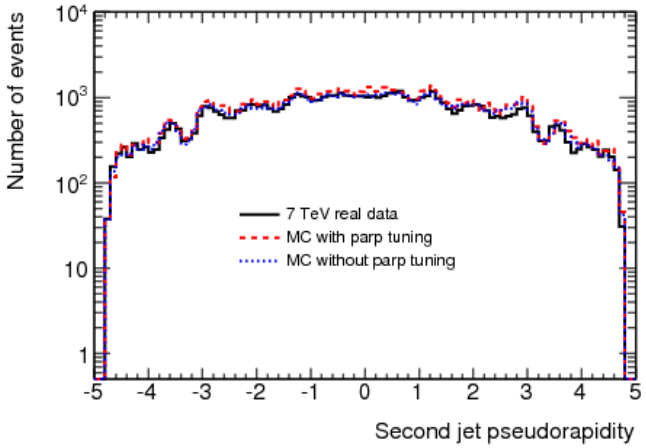
Leading and second AntiKt4Topo jet E_T and η

E_T(lead), E_T(sec) >10 GeV, minimum-bias samples





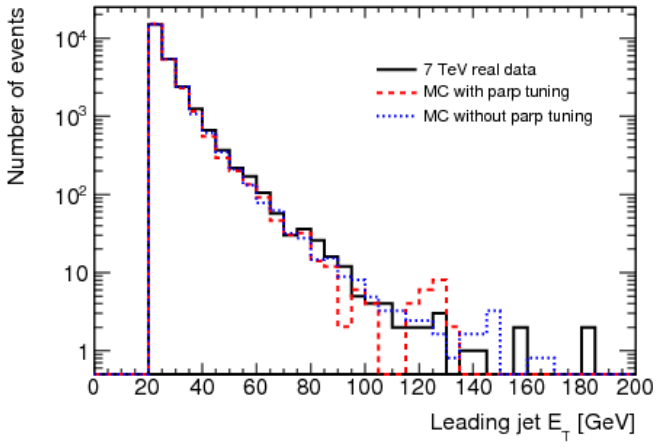


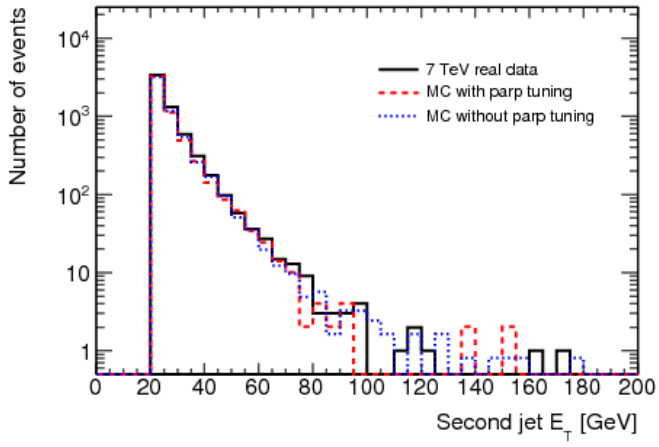


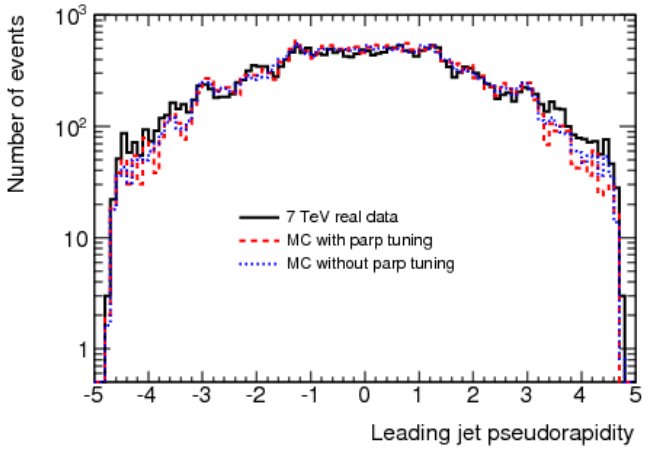
Both calorimeter cracks are clearly seen; data/MC: OK

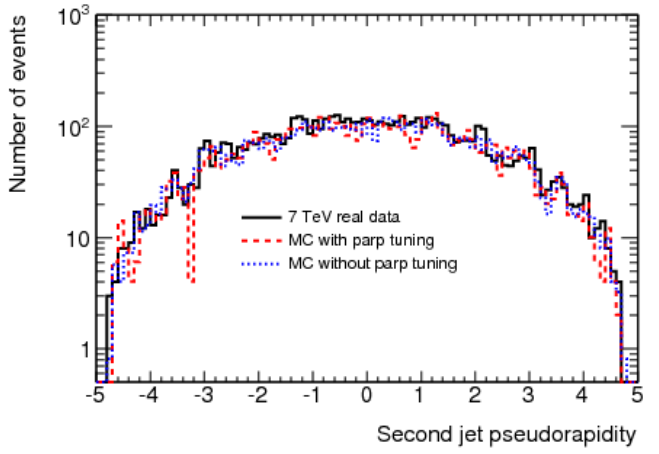
Leading and second AntiKt4Topo jet E_T and η

E_T(lead), E_T(sec) >20 GeV, minimum-bias samples





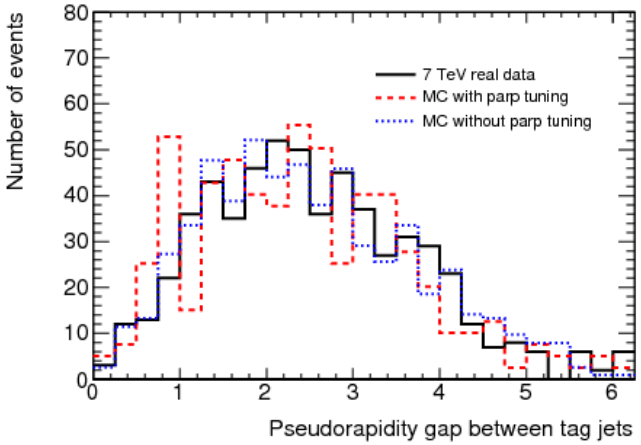


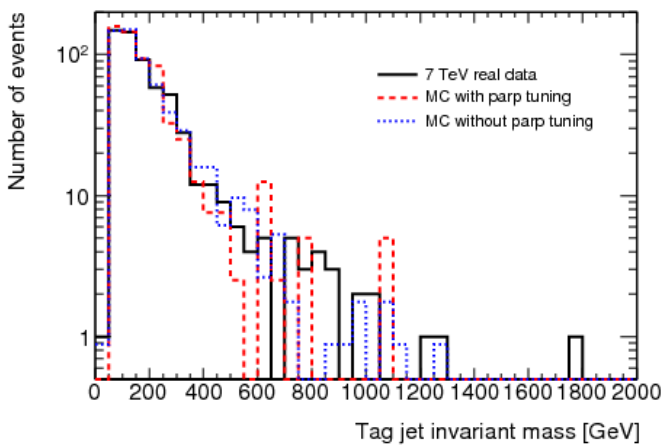


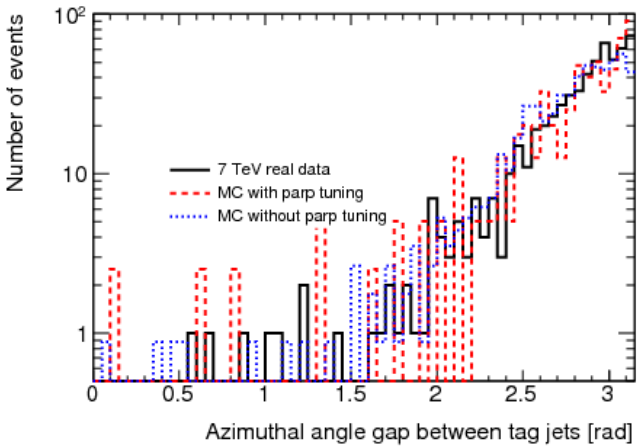
Data/MC: reasonable; for FW region default MC09 is better

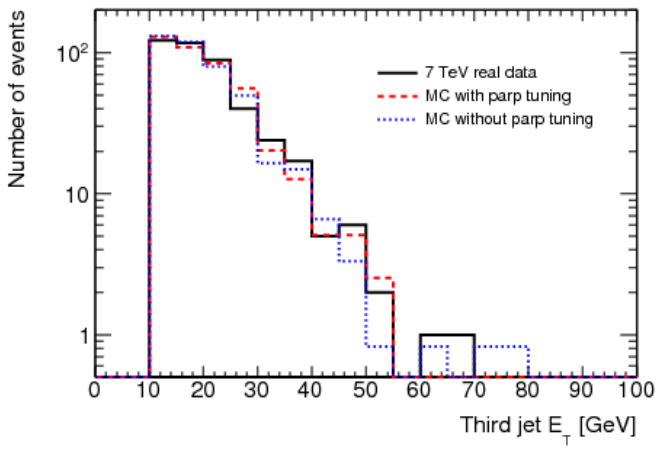
Correlation between "tag" jets; third jet E_T

E_T(lead)>40 GeV, E_T(sec) >20 GeV, |η(lead)| *|η(sec)|<0









Large Δη gap and high inv.mass are rare; data/MC: OK

Event selection of 7 TeV data with hard muon

- **Input data: 9M events from WW D3PD (Muons)**
  H. Yang's files, version 000402, ~3 pb^{-1} statistics, runs 160387-162882
  Lepton is required to have p_t >10 GeV and $|\eta|$<2.8
  Lepton can be staco muon or muid muon

- **Stage 1: writing of compact NTuples in ROOT – user "slimming"**
  Selection of branches of variables needed to study jets/MET in H production

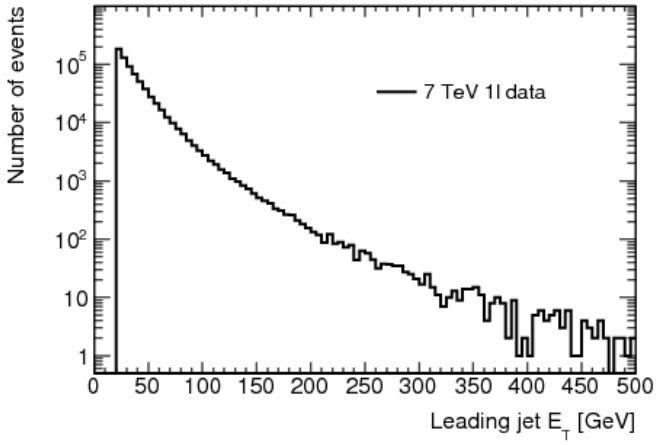
- **Stage 2: Basic selection and analysis of events within ROOT**
  Fast algorithm based on TSelector class of ROOT; creation of histograms

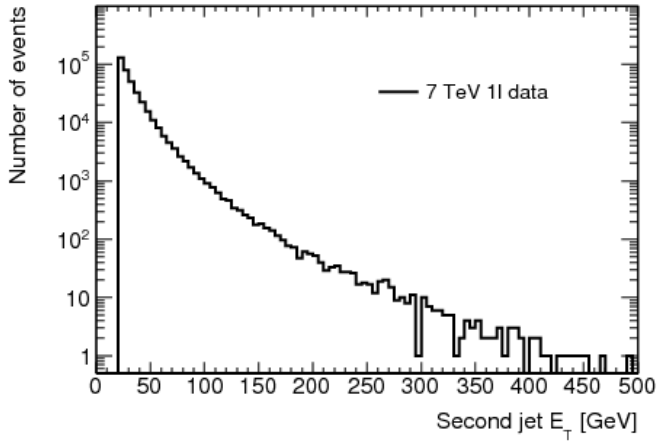
- HSG4 group selection of GRL (Koji's list, e-mail from Junichi 04.09.2010)
- At least one reconstructed vertex with N_{tracks} >3 and $|Z_{vert}|$<150mm
- L1_MU10 (for μ) trigger on
- Rejection of events with any "bad" and "ugly" jets
- Jet energy calibration: EM scale with factor; AntiKt4 (Topo and Tower) jets

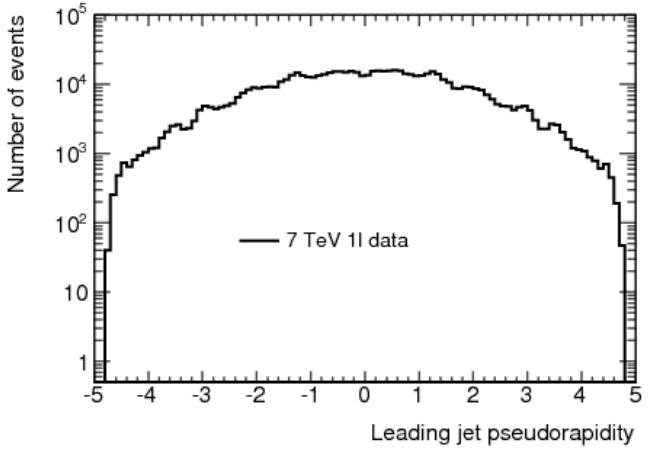
Recommendations from W/Z signature group for leptons to be implemented

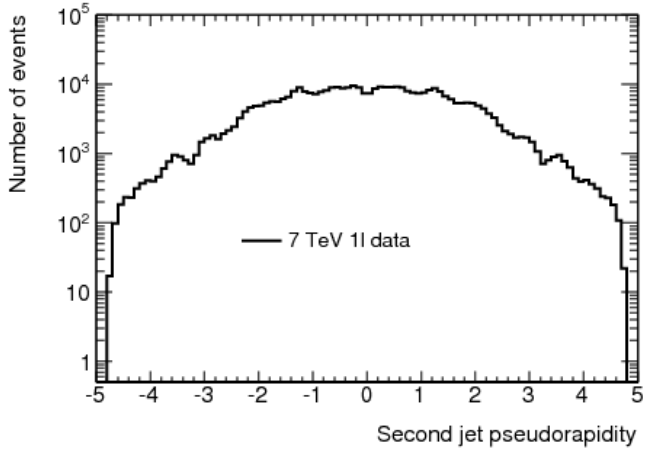
Leading and second AntiKt4Topo jet E_T and η

E_T(lead), E_T(sec) >20 GeV , single muon data





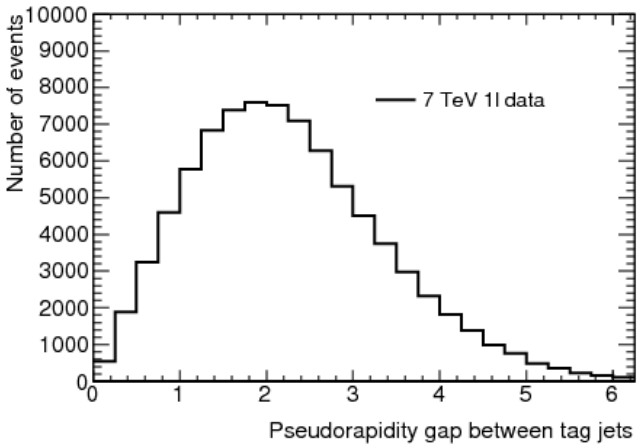


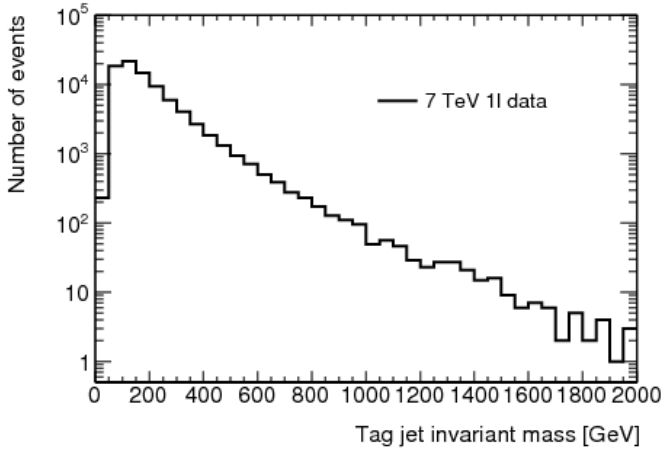


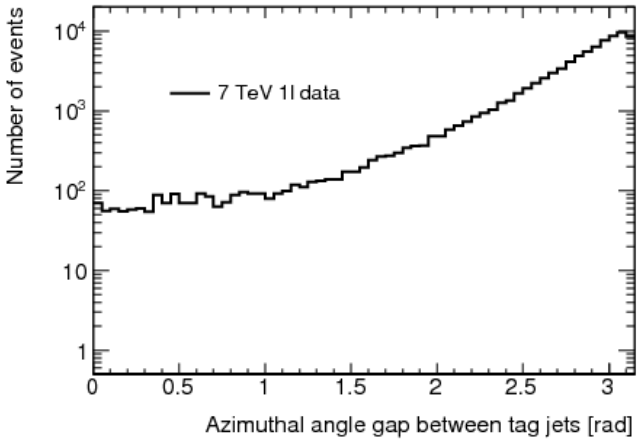
Both E_T and η–spectra for leading and second jet are similar

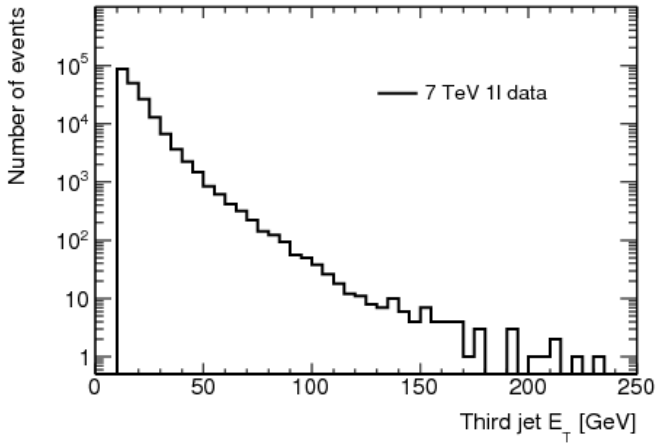
Correlation between "tag" jets and third jet E_T

E_T(lead)>40 GeV, E_T(sec) >20 GeV, |η(lead)| *|η(sec)|<0



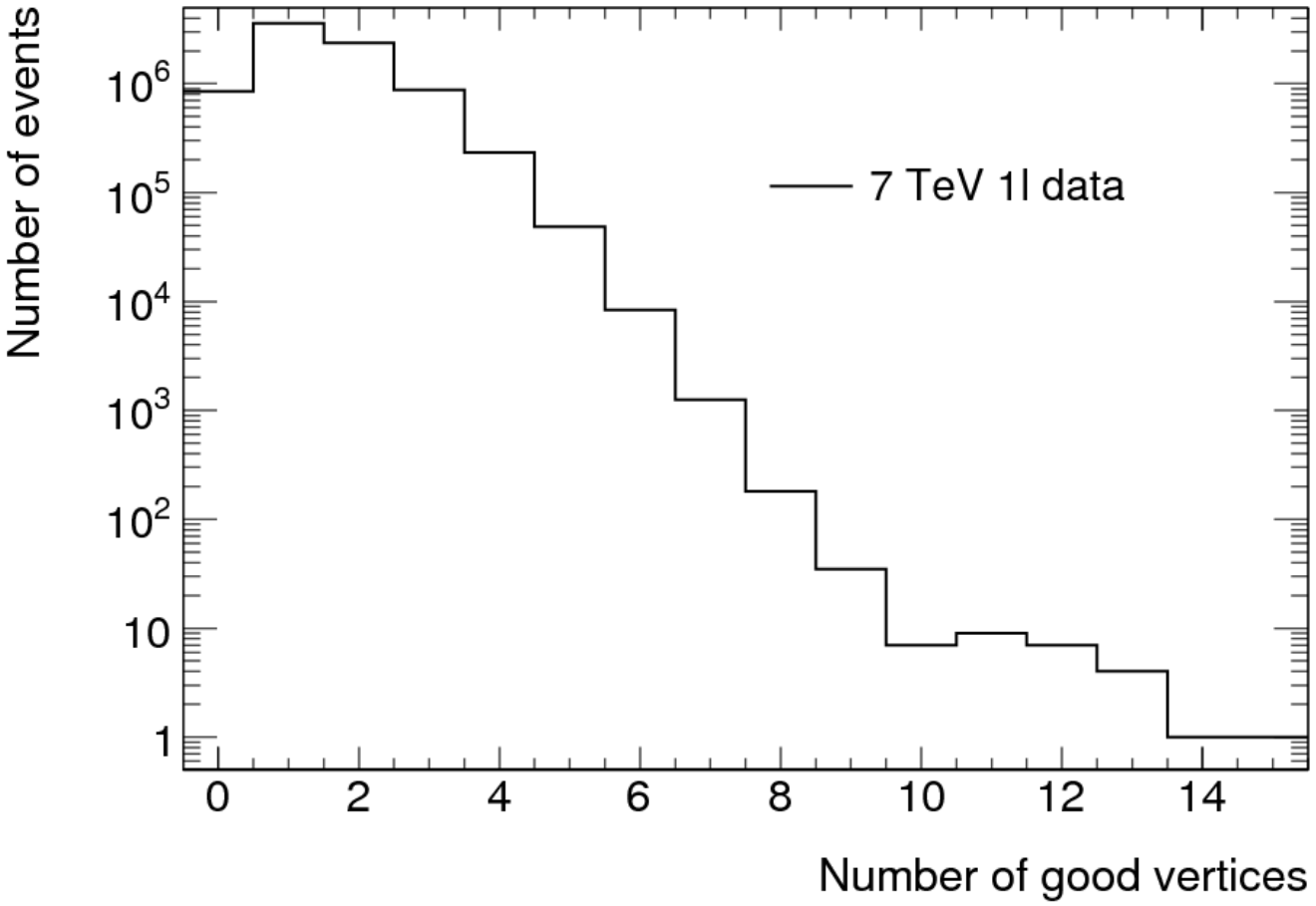






At 3 pb^{-1} statistics is already ok to study VBF jets!

Number of good vertices in 1μ events: pile-up



Pile-up is already significant right now!

Data reductions for jets in 1μ vs N_{vert}: preliminary

Relative efficiency (%)	1 vertex akt4topo	2 vertices akt4topo	3 vertices akt4topo	>3 vertices akt4topo
HSG4 GRL selection	100	100	100	100
Good vertex selection	44.8	29.8	11.1	3.6
L1_MU10 trigger on	36.6	39.1	40.8	42.7
Standard jet cleaning	98.7	98.0	97.1	95.4
E_T (lead)>40 GeV	8.1	8.3	8.5	8.7
E_T (sec)>20 GeV	88.6	89.1	89.3	90.5
η(lead)*η(sec) <0	43.1	42.6	42.5	42.2
Δη (lead, sec)>3.8	9.5	10.2	10.2	10.2
M(lead,sec)>500GeV	31.8	33.2	32.8	30.0

Small increase of selection efficiency due to pile-up

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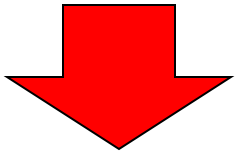
Conclusion and short-term plans

- **Probability to have full VBF H signature in single MB is $<10^{-5}$**
  However in ~1% cases there is a jet with E_T >20 GeV
  Numbers are expected to be larger in summer-autumn ATLAS data due to pile-up
- **Agreement data/MC for jets in single MB**
- **At 3 pb^{-1} 1l statistics is already good to study jet tagging/veto**

Talks presented at Jet/MET, HSG3 and HSG4 WG meetings

- **More plots with jet kinematics; inclusion of MET**
- **Analysis of 2l-D3PD'; more 1l statistics; exclusion of jets from e**
- **Data/MC comparison for 1l and 2l data; pile-up effect**



Material to be included into future HWG CONF note about VBF

Backup slides

Technical details about event selection
(recommendations from Jet/MET WG)

```
if((*vxp_nTracks)[i]>=5&&TMath::Abs((*vxp_z)[i])<100)
```

At least one vertex with such condition

```
if((*jet_antikt4h1tower_isGood)[jetakt4l]==0||(*jet_antikt4h1tower_isGood)[jetakt4l]==1)
```

Event with any “bad” (0) or “ugly” (1) jets was rejected

```
jetakt4topoe=(*jet_antikt4h1topo_emscale_E)[jetakt4lt]*(*jet_antikt4h1topo_EMJES)[jetakt4lt];
jetakt4topopt=(*jet_antikt4h1topo_emscale_pt)[jetakt4lt]*(*jet_antikt4h1topo_EMJES)[jetakt4lt];
jetakt4topoeta=(*jet_antikt4h1topo_emscale_eta)[jetakt4lt];
jetakt4topophi=(*jet_antikt4h1topo_emscale_phi)[jetakt4lt];
jetakt4topomass=(*jet_antikt4h1topo_emscale_m)[jetakt4lt]*(*jet_antikt4h1topo_EMJES)[jetakt4lt];
```

Calculation of jet kinematics

Note: jet variable names are slightly different at WW and Jet/MET D3PD’s!

Technical details about Jet/MET D3PD's: data

Not "slimmed" Jet/MET D3PD's

group10.perf-jets.data10_7TeV.00152221.physics_MinBias.recon.ESD.r1297_JetEtMissDPDModifier000025.v1_EXT0
group10.perf-jets.data10_7TeV.00152345.physics_MinBias.recon.ESD.r1297_JetEtMissDPDModifier000025.v1_EXT0
group10.perf-jets.data10_7TeV.00152409.physics_MinBias.recon.ESD.r1297_JetEtMissDPDModifier000025.v1_EXT0
group10.perf-jets.data10_7TeV.00152441.physics_MinBias.recon.ESD.r1297_JetEtMissDPDModifier000025.v1_EXT0
group10.perf-jets.data10_7TeV.00152508.physics_MinBias.recon.ESD.r1297_JetEtMissDPDModifier000025.v1_EXT0

Not all files were used for this analysis

"Slimmed" Jet/MET D3PD's

user.terashi.JetXsecConfNote.v1.group10.perf-jets.data10_7TeV.00152166.physics_MinBias.recon.ESD.r1297_JetEtMissDPDModifier000025.v1_EXT0
user.terashi.JetXsecConfNote.v1.group10.perf-jets.data10_7TeV.00152214.physics_MinBias.recon.ESD.r1297_JetEtMissDPDModifier000025.v1_EXT0
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Technical details about WW D3PD's-1

https://twiki.cern.ch/twiki/bin/view/AtlasProtected/WWWZMCSamples

user10.HaijunYang.data10_7TeV.00160387.physics_Egamma.merge.AOD.f280_m568.D3PD_v15.6.10.4_tag-00-04-02
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user10.HaijunYang.data10_7TeV.00161118.physics_Egamma.merge.AOD.f282_m573.D3PD_v15.6.10.4_tag-00-04-02
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user10.HaijunYang.data10_7TeV.00161520.physics_Egamma.merge.AOD.f283_m578.D3PD_v15.6.10.4_tag-00-04-02
user10.HaijunYang.data10_7TeV.00161520.physics_Muons.merge.AOD.f283_m578.D3PD_v15.6.10.4_tag-00-04-02-
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Technical details about WW D3PD's-2

https://twiki.cern.ch/twiki/bin/view/AtlasProtected/WWWZMCSamples

user10.HaijunYang.data10_7TeV.00162347.physics_Egamma.merge.AOD.f287_m588.D3PD_v15.6.10.4_tag-00-04-02
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