Testing weights on $t\bar{t}$ events

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- Introduction
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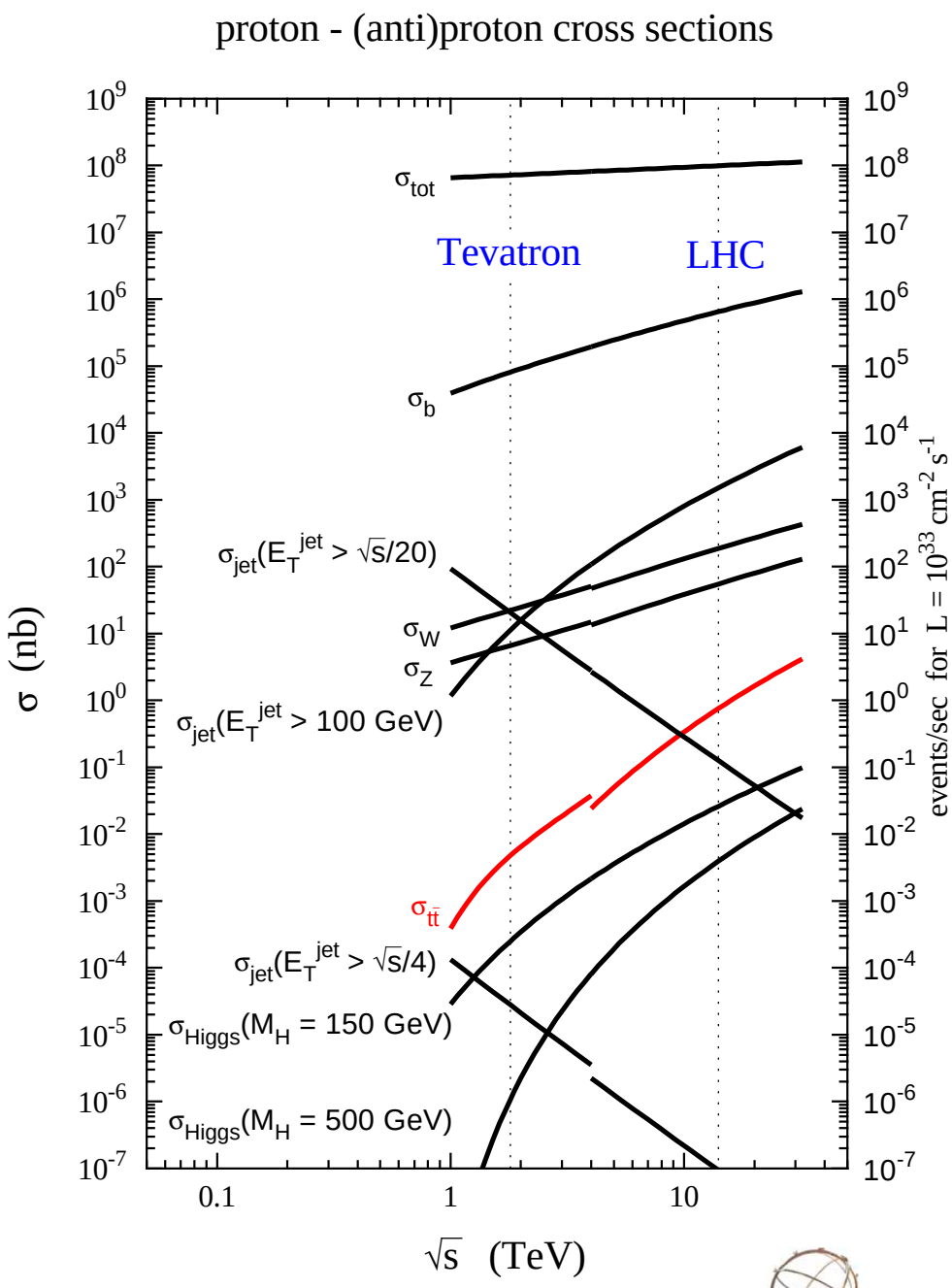
- $t\bar{t}$ analysis example job
- Results

Introduction

- The aim of this work is to study hadronic calibration by testing e.g. calibration weights on $t\bar{t}$ events
- $t\bar{t}$ events provide
  - jets
  - b-jets (Energy scale)
  - light flavour jets (invariant mass)
  - top mass (combined b-jet + 2 light jets)
- This is a good physics sample to study/understand the effects of the calorimeter calibration

$t\bar{t}$ *production: Total Cross Section*

- Total cross section for $t\bar{t}$-production is about a factor of 100 larger at LHC than at Tevatron
- $\sigma_{t\bar{t}}(14.0\,\text{TeV}) = 800\,\text{pb}$
- More than 8 million $t\bar{t}$ produced per year at low luminosity ($10^{33}\,\text{cm}^{-2}\,\text{s}^{-1}$)
- LHC will be a top factory



Golden plated: $t\bar{t} \rightarrow WWb\bar{b} \rightarrow (l\nu)(jj)b\bar{b}$

- Golden channel: here one W decays leptonically (e, μ) and the other W decays hadronically
  - Clean trigger from the isolated lepton
- The reconstruction starts with the W mass:
  - Different ways to pair the right jets to form the W
  - Jet energies calibrated using the m_W
- Important to tag the b-jets:
  - Reduces the background
  - Clean top quark samples
- Typical event selection:
  - Isolated lepton with $P_T > 20GeV$
  - $E_T^{miss} > 20GeV$
  - 4 jets with $E_T > 40GeV$
  - > 1 b-jet

$t\bar{t}$ *analysis:* 1st *step create ESDs and AODs I*

- The first step to study the effects of the hadronic calibration on $t\bar{t}$ events is to create ESDs and AODs:
- Set of ESDs/AODs created
  - Without local hadron calibration information
  - With local hadron calibration information
  - With the JetRec H1 weights
- To create ESDs and AODs I have followed the information given by Sven in his MPI talk
  http://cds.mppmu.mpg.de/cdsagenda/askArchive.php?base=agenda&categ=a0567&id=a0567s1t0/transparencies
- Release used to run the code: 11.0.41
- Data used: /castor/cern.ch/grid/atlas/datafiles/rome/digit/rome.004520.digit.ttbarWm/rome.004520.digit.ttbarWm._00001.pool.root.1
- Only 50 events

$t\bar{t}$ *analysis:* 1st *step create ESDs and AODs II*

- Our case:
  - Our original idea was to produce one ESD from digit files (it takes long time). Since the ESD contains all calo cells, we thought to use the ESD to re-reconstruct any higher calo reco object
  - Because some tracking problems, it is not possible to produce ESD from ESD
  - Now the strategy to test/evaluate/compute calibration constants is:
    - Produce several ESDs with various calibration options from digit files
    - Produce AODs from ESDs and run AOD analyses on the produced AODs

How to create ESDs with no calibration

- Set the lines in KtTopoJet_jobOptions.py as follow:

```
#        "JetTowerNoiseTool/DoNoise",
#        "JetPreClusterTool/PreClustering",
#        "JetMonitorTool/PreClusterMonitor",
#        "JetCellCalibratorTool/CellCalibrator",
KtTopoJets.KtFinder.RParameter = 0.1  # really means R^2 = 0.1
#KtTopoJets.KtFinder.RParameter = 1
#KtTopoJets.CellCalibrator.CellCalibratorName = "H1WeightToolAug04"
```

- Set in myTopOptions.py

```
doWriteAOD=False
doWriteTAG=False
doCBNT=False
PoolESDOutput="ESD.rome.004520.digit.ttbar.nocalib01.pool.root"
include ("RecExCommon/RecExCommon\_topOptions.py")
EventSelector.InputCollections = [ "rfio:/castor/cern.ch/grid/atlas/datafiles/r\
ome/digit/rome.004520.digit.ttbarWm/rome.004520.digit.ttbarWm._00001.pool.root.\
1" ]
```

- Change RecExCommon_topOptions.py to not include H1WeightToolG4

```
        thisAlg.ParticleJetBuilderTool.CellCalibratorName=" "
#        thisAlg.ParticleJetBuilderTool.CellCalibratorName="H1WeightToolG4"
```

- Run: athena.py myTopOptions.py
- This create ESD with no calibration

How to create ESDs with local hadron calibration

- Set the lines in KtTopoJet_jobOptions.py as follow:

```
#        "JetTowerNoiseTool/DoNoise",
#        "JetPreClusterTool/PreClustering",
#        "JetMonitorTool/PreClusterMonitor",
#        "JetCellCalibratorTool/CellCalibrator",
KtTopoJets.KtFinder.RParameter = 0.1  # really means R^2 = 0.1
#KtTopoJets.KtFinder.RParameter = 1
#KtTopoJets.CellCalibrator.CellCalibratorName = "H1WeightToolAug04"
```

- Set in myTopOptions.py

```
doWriteAOD=False
doWriteTAG=False
doCBNT=False
PoolESDOutput="ESD.rome.004520.digit.ttbar.calib01.pool.root"
include ("RecExCommon/RecExCommon\_topOptions.py")
include ("CaloClusterCorrection/CaloTopoLocalCalib_jobOptions.py")
EventSelector.InputCollections = [ "rfio:/castor/cern.ch/grid/atlas/datafiles/r\
ome/digit/rome.004520.digit.ttbarWm/rome.004520.digit.ttbarWm._00001.pool.root.\
1" ]
```

- Change RecExCommon_topOptions.py to not include H1WeightToolG4

```
        thisAlg.ParticleJetBuilderTool.CellCalibratorName=" "
#        thisAlg.ParticleJetBuilderTool.CellCalibratorName="H1WeightToolG4"
```

- Run: athena.py myTopOptions.py
- This create ESD with local hadron calibration

How to create ESDs with JetRec H1 weights

- Set the lines in KtTopoJet_jobOptions.py as follow:

```
#        "JetTowerNoiseTool/DoNoise",
#        "JetPreClusterTool/PreClustering",
#        "JetMonitorTool/PreClusterMonitor",
        "JetCellCalibratorTool/CellCalibrator",
KtTopoJets.KtFinder.RParameter = 0.1  # really means R^2 = 0.1
#KtTopoJets.KtFinder.RParameter = 1
KtTopoJets.CellCalibrator.CellCalibratorName = "H1WeightToolAug04"
```

- Set in myTopOptions.py

```
doWriteAOD=False
doWriteTAG=False
doCBNT=False
PoolESDOutput="ESD.rome.004520.digit.ttbar.nocalib01H1w.pool.root"
include ("RecExCommon/RecExCommon\_topOptions.py")
EventSelector.InputCollections = [ "rfio:/castor/cern.ch/grid/atlas/datafiles/r\
ome/digit/rome.004520.digit.ttbarWm/rome.004520.digit.ttbarWm._00001.pool.root.\
1" ]
```

- Change RecExCommon_topOptions.py to include H1WeightToolG4

```
thisAlg.ParticleJetBuilderTool.CellCalibratorName="H1WeightToolG4"
```

- Run athena.py myTopOptions.py
- This create ESD with JetRec H1 weights

How to create AODs with no calibration

- Set in myTopOptions.py

```
doWriteESD=False
doWriteAOD=True
readESD=True
doWriteTAG=False
doCBNT=False
PoolAODOutput="AOD.rome.004520.digit.ttbar.nocalib01.pool.root"
include ("RecExCommon/RecExCommon_flags.py")
include ("RecExCommon/RecExCommon\_topOptions.py")
EventSelector.InputCollections = [ "rfio:/castor/cern.ch/user/t/teresab/ESD.rome
.004520.digit.ttbar.nocalib01.pool.root"]
```

- The RecExCommon_topOptions.py is like the ESD's
- Run: athena.py myTopOptions.py
- This create AODs with no calibration

How to create AODs with local hadron calibration

- Set in myTopOptions.py

```
doCaloTopoCluster = True
doWriteESD=False
doWriteAOD=True
readESD=True
doWriteTAG=False
doCBNT=False
PoolAODOutput="AOD.rome.004520.digit.ttbar.calib01.pool.root"
include ("RecExCommon/RecExCommon_flags.py")
include ("RecExCommon/RecExCommon\_topOptions.py")
EventSelector.InputCollections = [ "rfio:/castor/cern.ch/user/t/teresab/ESD.rom\
e.004520.digit.ttbar.calib01.pool.root"]
```

- The RecExCommon_topOptions.py is like the ESD's with local hadron calibration
- Run: athena.py myTopOptions.py
- This create AODs with local hadron calibration

How to create AODs with JetRec H1 weights

- Set in myTopOptions.py

```
doWriteAOD=False
doWriteTAG=False
doCBNT=False
PoolESDOutput=PoolAODOutput="AOD.rome.004520.digit.ttbar.nocalib01H1w.pool.root"
include ("RecExCommon/RecExCommon_flags.py")
include ("RecExCommon/RecExCommon\_topOptions.py")
EventSelector.InputCollections = [ "rfio:/castor/cern.ch/user/t/teresab/ESD.rome
.004520.digit.ttbar.nocalibH1w.pool.root"]
```

- Set the RecExCommon_topOptions.py like in the ESD case with the JetRec H1 weights
- Run: athena.py myTopOptions.py
- This create AOD with JetRec H1 weights

$t\bar{t}$ *analysis job example I*

- To start running a $t\bar{t}$ analysis, I have used the $t\bar{t}$ job example in: 11.0.41/PhysicsAnalysis/AnalysisCommon/AnalysisExamples/AnalysisExamples-00-11-05
- This $t\bar{t}$ example demonstrates a $g\,g \rightarrow l\nu b\,jj\,b$ reconstruction
- I have used the default ttbarExample_jobOptions.py given in 11.0.41/PhysicsAnalysis/AnalysisCommon/AnalysisExamples/AnalysisExamples-00-11-05/share
- I have changed KtTower with KtTopo for the $t\bar{t}$ analysis

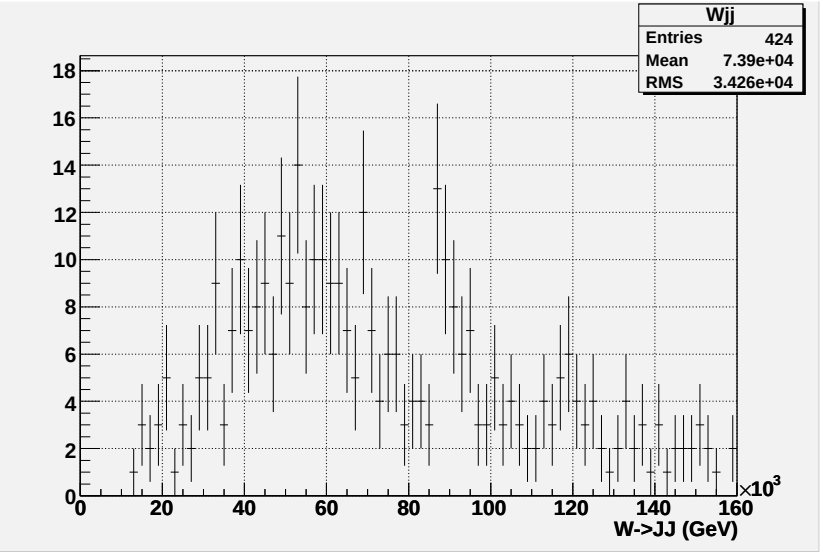
$t\bar{t}$ *analysis job example II*

- Basic cuts used in the $t\bar{t}$ code (see ttbarExample_jobOptions.py):

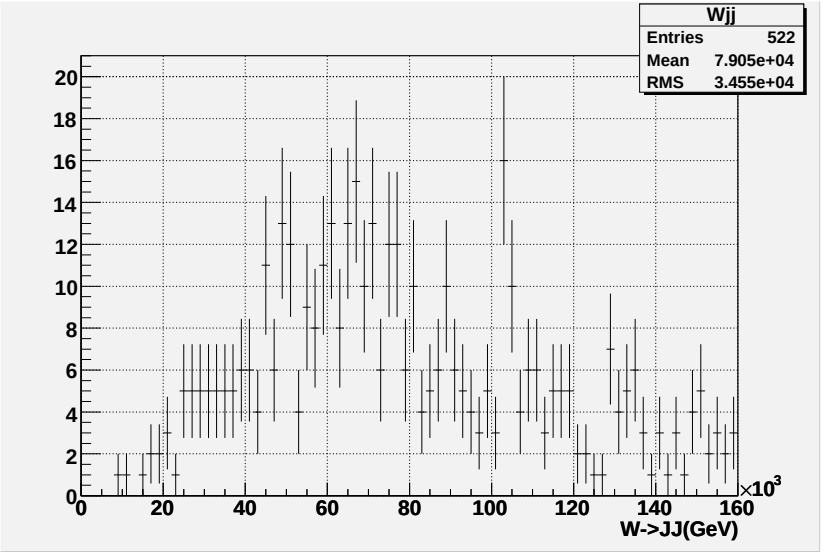
```
# Author: Ketevi A. Assamagan
# BNL, July 16, 2004
# job options for ttbar -> jjb lnub analysis example
...
# User analysis steering algorithm
# Missing ET calibration options: "Raw" = uncalibrated, "H1" or "Region"
theApp.TopAlg                += [ "ttbar" ]
ttbar                         = Algorithm( "ttbar" )
ttbar.PreSelectedElectrons    = "MyPreSelectedElectrons"
ttbar.PreSelectedMuons        = "MyPreSelectedMuons"
ttbar.PreSelectedBJets        = "MyPreSelectedBJets"
ttbar.PreSelectedJets         = "MyPreSelectedParticleJets"
ttbar.OutputLevel             = ERROR
ttbar.MissingEtObject         = "MET_Final"
ttbar.MissingEtCut            = 18.0*GeV
ttbar.EventWeight             = 1.0
ttbar.DeltaMjj                = 25.0*GeV
ttbar.HistDirectoryName       = "ttbar"

# The AOD input file
EventSelector.InputCollections = [
   "/afs/cern.ch/user/k/ketevi/w0/aod/ttbar/dc2.003026.A0_top.g4dig807.aod870._00001.pool.root"
```

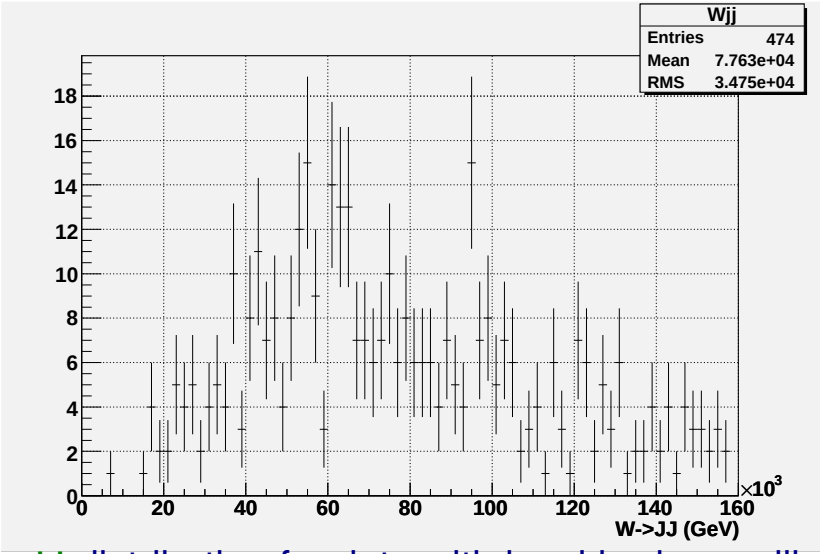
A first look at the W → JJ distribution



W → JJ distribution for not calibrated data



W → JJ distribution for data with JetRec H1 weights



W → JJ distribution for data with local hadron calibration (no DM corr.)