u c s b High Energy Physics

# WW progress report


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for

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# Introduction

- Recent WW analysis related presentations (all based on CSA07 samples):
  - DY study
  - Oli's WW report
  - Wjets study
  - JPT study
  - Top background study
- Now we are updating the analysis to new samples based on Summer/Fall 08 production.
- This presentation establishes the base line of the analysis and compares it with CSA07.

# Samples, X-sections etc

- Samples:
  - /TTJets-madgraph/Fall08_IDEAL_V9_v2/GEN-SIM-RECO (x-section: 317pb, k-factor: 1.3)
  - /WJets-madgraph/Fall08_IDEAL_V9_v1/GEN-SIM-RECO (x-section: 40nb, k-factor: 1.14)
  - /ZJets-madgraph/Fall08_IDEAL_V9_reco-v2/GEN-SIM-RECO (x-section: 3.7nb, k-factor: 1.14)
  - /WW_2l/Summer08_IDEAL_V9_v2/GEN-SIM-RECO (x-section: 4.8pb, k-factor: 1.65)
  - /ZZ_2l2n/Summer08_IDEAL_V9_v2/GEN-SIM-RECO (x-section: 0.32pb, k-factor: 1.47)
  - /WZ_3l/Summer08_IDEAL_V9_v2/GEN-SIM-RECO (x-section: 0.58pb, k-factor: 1.84)
  - /SingleTop_tWChannel/Summer08_IDEAL_V9_v1/GEN-SIM-RECO (x-section: 27.3pb, k-factor: 1.06)
- X-section numbers are extracted from generators.
- K-factors are derived from S.Tosi collection of NxLO x-sections:
  - http://www.ge.infn.it/~tosi/cms/topMC.html
- CSA07 predictions at 14TeV energy are scaled down to 10TeV using numbers from G. Ceballos
  - http://home.cern.ch/ceballos/xsec_14_10.pdf

**Integrated lumi (NxLO)**

| type | TTbar | W+0 jets | W+1jet | W+2jets | Z+jets |
|---|---|---|---|---|---|
| CSA07 | 2400/pb | 200/pb | ~1000/pb | ~1000/pb | 700/pb |
| 2008 | 2400/pb | 220/pb | 220/pb | 220/pb | 300/pb |

**Event count**

| type | TTbar | W+0 jets | W+1jet | W+2jets | Z+jets |
|---|---|---|---|---|---|
| CSA07 | 2M | 9M | 8M | 2.7M | 2.8M |
| 2008 | 1M | 10M | 2M | 0.6M | 1.3M |

# Muon selection

- Muon selection in CSA07:
  - global muons
  - Pt > 20 GeV
  - nTrkHits > 6
  - Chi2/nDoF(global fit) < 5
  - |d0| < 0.25 cm
  - Isolation: Pt/(Pt+SumCaloEt(dR=0.3)+SumTrkPt(dR=0.3)) > 0.92
- In 2_X_Y based data samples, content of the muon collection has changed. Instead of having fairly pure sample of global muons, we now have a merged collection of tracker, stand alone and global muons, which is designed for maximal reconstruction efficiency. Careful selection of muons is required.
- Following the muon ID note (blah), we set the following muon selection requirements for muons from Ws
  - global muons
  - Pt > 20 GeV
  - nTrkHits >= 11 (definition of number of hits has changed)
  - Chi2/nDoF(global fit) < 10
  - |d0| < 0.2 cm
  - Isolation: Pt/(Pt+SumCaloEt(dR=0.3)+SumTrkPt(dR=0.3)) > 0.92
- Isolation is extracted from the muon object itself and it's identical to PAT isolation

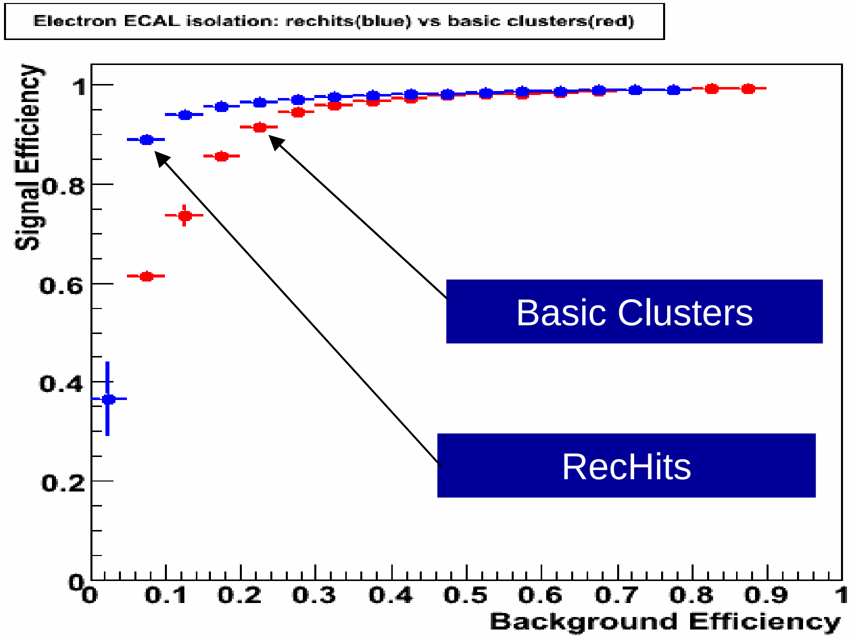
# Soft Muon selection

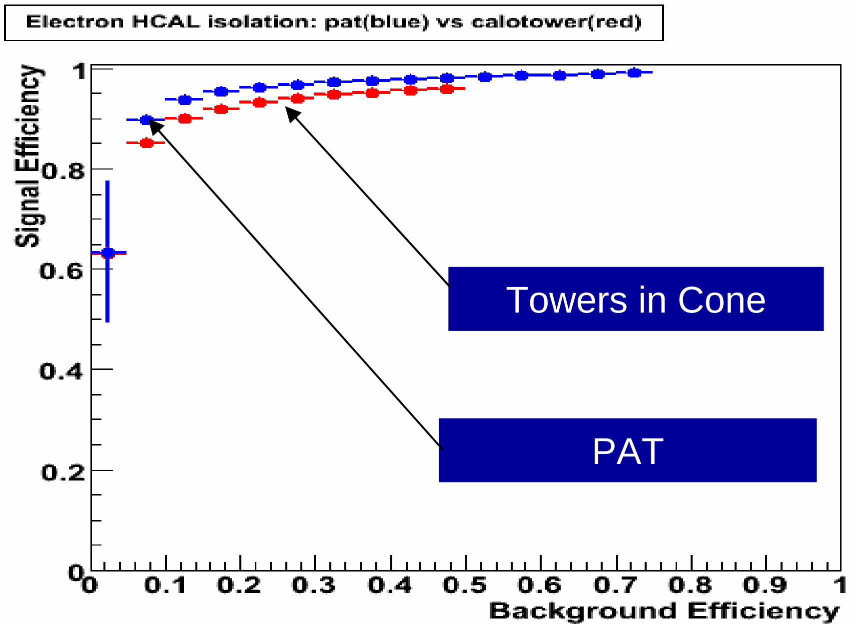
- In order to estimate the top background contribution after all selection cuts applied we rely on presence of soft muons from b-decays. The method itself was presented earlier.
- In CSA07 we used all global muons, which represented a fairly pure sample of muons.
- With new samples we have to find muon selection with good efficiency at low Pt and low mis-tag rate.
- Looking at muons from B-decays in TTbar: purity (P), tagging efficiency (Eff), effective tagging efficiency (Q=tag eff(1-2mistag_eff)^2):
  - All P: 64.6%, Eff: 29.8%, Q: 2.5%
  - AllGlobalMuons P: 87.3%, Eff: 27.1%, Q: 15.1%
  - TMLastStationOptimizedLowPtLoose P: 90.1%, Eff: 28.4%, Q: 18.3%
  - TMLastStationOptimizedLowPtTight P: 91.3%, Eff: 28.2%, Q: 19.2%
- Final selection:
  - Tracker muons with TMLastStationOptimizedLowPtTight ID
  - Pt > 3 GeV
  - nTrkHits >= 11
  - |d0| < 0.2 cm
- Tagging efficiency is a bit higher than what we had with CSA07 samples as expected.

# Electron selection

- In CSA07 we used Egamma POG recommended tight electron ID
- For new samples a few variables used in the selector have changed
  - SigmaEtaEta is replaced with SigmaIEtaIEta
  - H/E now has zero suppression and HCAL energy extraction procedure has changed significantly
  - Given that final version of the selector is not available yet, we changed a few cuts according to recommendations of Matteo Sani – EGamma expert responsible for the selection.
- Electron Isolation has changed.
  - For CSA07 analysis we computed calorimeter isolation following EGamma procedure for Jurassic Algorithm using the Basic Island Clusters as input for ECAL and CaloTowers for HCAL
  - Now we use official EGamma recommended isolation based on RecHits available via PAT

# Electron selection II




- Plots show
  - Signal: electrons with Pt>20 from WW passed robust el ID
  - Background: electrons with Pt>20 from Wjets failed robust ID
- Final electron selection:
  - pixel matched gsf electron
  - Pt > 20 GeV
  - |d0| < 0.025 cm
  - Tight Electron ID (Egamma POG)
  - Isolation: Pt/(Pt+SumTrkCaloPt(dR=0.3)) > 0.92
  - muon veto (dR=0.1)

# Jet Veto

- JPT – jets corrected for track average response in the calorimeter
- CaloJet and TrkJet Veto @ 15 GeV
  - WW = 397, Top = 100
- JPT @ 25 GeV
  - WW = 405, top = 85
- JPT @ 20 GeV – need tighter cuts too keep top background lower
  - WW = 361, Top = 40
- Plot is missing

# CSA07 vs WW2009

## CSA07 predictions at 10TeV

To scale down CSA07 estimates we used the expected drop in cross-section.

| | DY ee | DY mumu | DY tautau | ttbar | Wjets | WZ | ZZ | WW | TW |
|---|---|---|---|---|---|---|---|---|---|
| ee | 1.4 ± 1.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 7.5 ± 1.2 | 2.8 ± 1.4 | 1.5 ± 0.4 | 1.4 ± 0.3 | 40.1 ± 2.0 | 2.9 ± 0.4 |
| mumu | 0.0 ± 0.0 | 7.6 ± 2.8 | 0.6 ± 0.6 | 14.3 ± 1.7 | 0.7 ± 0.7 | 2.2 ± 0.4 | 1.1 ± 0.3 | 58.0 ± 2.4 | 5.0 ± 0.6 |
| emu | 0.0 ± 0.0 | 1.5 ± 1.1 | 14.9 ± 3.8 | 30.2 ± 2.4 | 27.5 ± 6.3 | 5.1 ± 0.7 | 0.2 ± 0.1 | 225.8 ± 4.7 | 13.5 ± 0.9 |
| total | 1.4 ± 1.0 | 9.1 ± 3.0 | 15.5 ± 3.8 | 51.9 ± 3.2 | 31.0 ± 6.5 | 8.9 ± 0.9 | 2.7 ± 0.4 | 323.9 ± 5.7 | 21.4 ± 1.2 |

PRELIMINARY

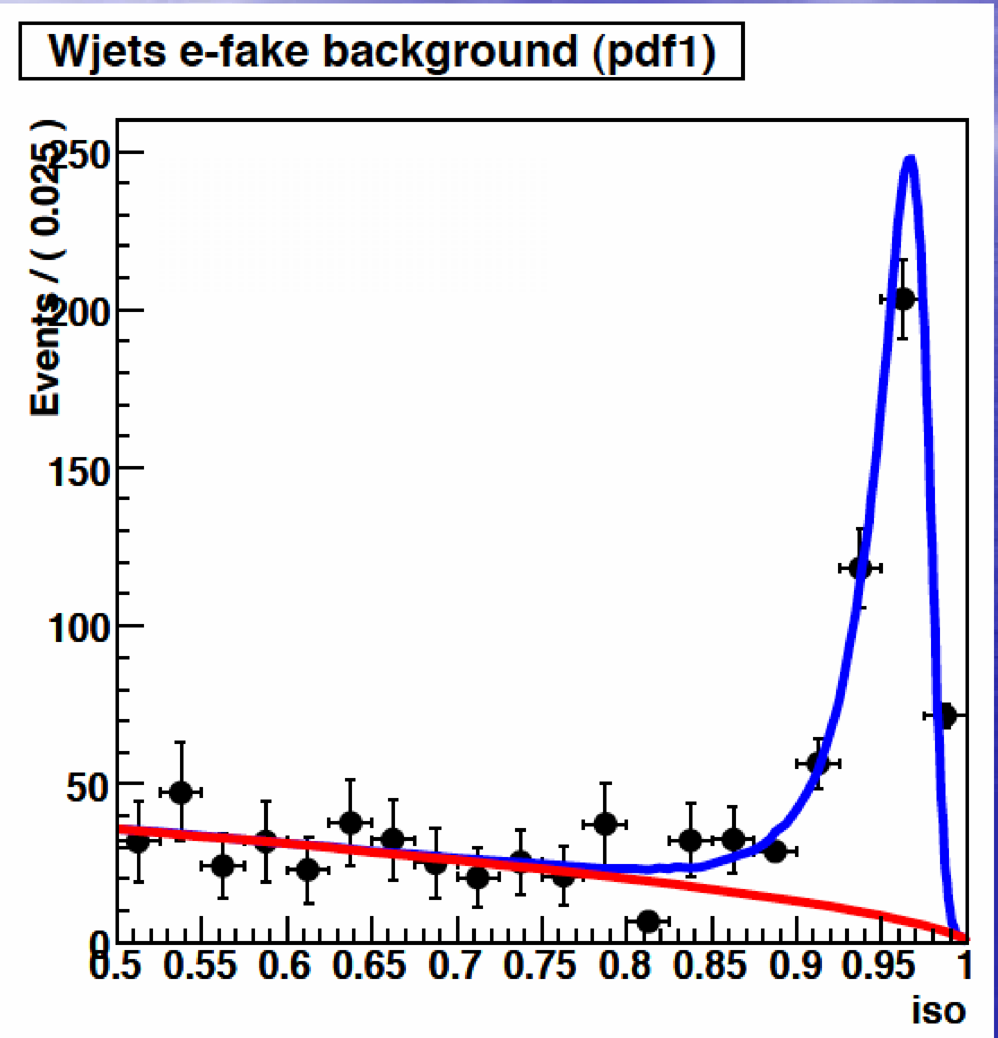
## Reference results

V01-02-06 samples.

| | DY ee | DY mumu | DY tautau | ttbar | Wjets | WZ | ZZ | WW | TW |
|---|---|---|---|---|---|---|---|---|---|
| ee | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 4.4 ± 1.4 | 0.0 ± 0.0 | 0.8 ± 0.1 | 1.1 ± 0.1 | 42.1 ± 2.7 | 2.7 ± 0.8 |
| mumu | 0.0 ± 0.0 | 0.0 ± 0.0 | 0.0 ± 0.0 | 7.5 ± 1.8 | 0.0 ± 0.0 | 2.3 ± 0.2 | 1.7 ± 0.1 | 70.5 ± 3.5 | 4.0 ± 0.9 |
| em | 0.0 ± 0.0 | 0.0 ± 0.0 | 6.7 ± 4.7 | 20.8 ± 3.0 | 51.8 ± 16.4 | 6.3 ± 0.3 | 0.1 ± 0.0 | 257.6 ± 6.7 | 12.9 ± 1.6 |
| total | 0.0 ± 0.0 | 0.0 ± 0.0 | 6.7 ± 4.7 | 32.7 ± 3.8 | 51.8 ± 16.4 | 9.4 ± 0.3 | 2.9 ± 0.1 | 370.2 ± 8.0 | 19.6 ± 2.0 |

- Wjets background is slightly higher than expected, but statistical errors are large
- WW signal yield is up by 15%.
- Top background is lower by 35% (better jet veto)
- All other numbers are fully consistent with expectations.

# New method of Wjets background estimation




- Isolation is main discriminating variable for jets induced fakes.
- Shape of the background distribution can be either extracted from QCD samples or fitted from data if enough statistics is available.
- All major sources of background have isolated leptons and their background distribution shape can be extracted from Z events from data.
- Both electron and muon contributions can be estimated with this method
- Having two different methods of background estimation, gives confidence to the results

# Plans

- Currently we are finalizing background estimations.
- A few ways to improve background suppression are under investigation
- Plan to have a first draft of the note in 2 weeks
- Complete analysis update by next multi-boson meeting on March $12^{th}$.
- Go for pre-approval after that.

# Conclusion

- Event selection is updated for new data samples
- Jet veto is improved by using JPT jets (calo jets correct for tracks)
- CSA07 results scaled to 10TeV are consistent with preliminary results on new samples.
- New method of W+jets background estimation based on isolation sideband extrapolation is developed.
- Analysis is actively converging and we are aiming for pre-approval in March.

# Back Slides

# Event Selection UPDATE ME

- Muon selection: global muons
  - Pt > 20 GeV
  - nTrkHits > 6
  - Chi2/nDoF(global fit) < 5
  - |d0| < 0.25 cm
  - Isolation: Pt/(Pt+SumCaloEt(dR=0.3)+SumTrkPt(dR=0.3)) > 0.92
- Electron selection: pixel matched gsf
  - Pt > 20 GeV
  - |d0| < 0.025 cm
  - Tight Electron ID (Egamma POG)
  - Isolation: Pt/(Pt+SumTrkPt(dR=0.3)) > 0.92
  - muon veto (dR=0.1)
- Jets selection
  - Uncorrected Et > 15 GeV
  - |eta| < 3.0
  - don't count jets within dR=0.4 from electrons
- MET selection
  - MET(corrected for muon) > 20 GeV
  - pMET(DYtautau suppression) > 20 GeV
- Candidate selection:
  - opposite charge electron-muon pair
- Z-veto:
  - no ee or mumu pairs in the event with mass in [76,106] GeV. One lepton can be non-isolated