H->bb Weekly Meeting

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HSG5 H->bb Weekly Meeting, 9 March 2011

News! News! News!

- Bad samples:
  - MC10 Pythia-CTEQ66 QCD samples (IDs: 115216-115221) have been mistakenly run with the MC09c tune (i.e. LO* PDF) due to a bug – will be re-run
- Mainly for Eric…
  - New VBFNLO version will be out in next 2 months: http://www-itp.particle.uni-karlsruhe.de/~vbfnloweb/
- KinFitter – those considering a kinematic fit may be interested in this package:
  - Wiki: https://twiki.cern.ch/twiki/bin/viewauth/Atlas/KinFitter
  - ATLAS Note in CDS (ATL-COM-SOFT-2009-014): http://cdsweb.cern.ch/record/1206849?ln=en
- Next meeting of the LHC Higgs Cross Section H->bb subgroup booked for 17 March, 15:00 CET – see email from Chris Potter
  - More participants welcome, **especially experimentalists**

News! News! News!

- **Muon** CP group recommendations for release 16:
  - Reconstruction efficiency and isolation efficiency scale factors, momentum smearing functions
  - https://twiki.cern.ch/twiki/bin/view/AtlasProtected/MCPAnalysisGuidelinesRel16
- Jet/Etmiss recommendations for **jet cleaning** in release 16:
  - Medium jet cleaning should give similar rejection to rel 15 cleaning but with better efficiency
  - Tight jet cleaning should not be used – still under discussion
  - https://twiki.cern.ch/twiki/bin/view/AtlasProtected/HowToCleanJets#Bad_jets_rel16_data
- New!: Final **b-tagging calibrations** for release 16 based on full 2010 data:
  - https://twiki.cern.ch/twiki/bin/view/AtlasProtected/Analysis16
- e/gamma recommendations for **energy scale and resolution** in release 16:
  - https://twiki.cern.ch/twiki/bin/view/AtlasProtected/EnergyScaleResolutionRecommendations
  - And rescaler tool: https://twiki.cern.ch/twiki/bin/view/AtlasProtected/EnergyRescaler
- Standard Model **W/Z** group **baseline selection** for release 16:
  - See discussion in W/Z group Sharepoint
  - Also, finer points (and perhaps the not so fine) still being discussed

Future changes in W/Z baseline selection

To be studied and discussed

To be studied

Electron Selection
- Study various electron isolation criteria
- Study possibility to replace tight with medium +isolation for inclusive measurements

Muon Selection
- Effect of z0 and d0 cuts on the track selection
- Effect of new isolation cut on the inclusive measurements
- Staco / Muid ?

MET Definition
- Performance of MET_RefFinal_em and MET calculation of M.Boonekamp et.al. in VB+jets

Jet/Lepton Overlap removal
- Possibility to resolve jet reconstruction with nearby leptons
- Effect of lepton/jet overlap removal for large jet multiplicities
- Jet Unfolding: Compare unfolding w.r.t. pure truth container or to truth container when applying same lepton/jet/jet removal cuts

Jets:
- Calibration for jets in W/Z+jets events (flavor effects, this is multiplicity dependent)
- Close-by jets in W/Z+jets topology with more than 1 jet.
- Similar effects in B-jets

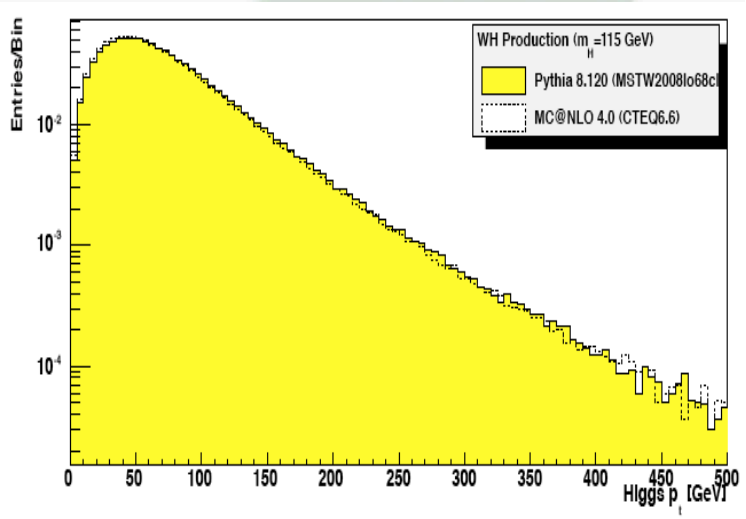
JVF Cut
- Study impact of new JVF Cut in rel.16
- Study Impact of Mc and data discrepancies
- Is it possible to correct for pile-up during unfolding?

B-Jet Definition
- Study sensible definition of truth b-jet
- Study Calibration constants for b-tagging between 2.1 and 2.5 (get in contact with C. Weiser)

Study S/B ratio of Di-Boson analyses
- Loosen p_T cut on second lepton
- Use medium electron with/without isolation

To boost or not to boost…

- We expect a sizeable luminosity this year:
  - 0.6 fb^{-1} for PLHC in June; 1 fb^{-1} for EPS in July; 2 fb^{-1} for Lepton-Photon in August
- Need to get boosted VH analyses going again!
- Work is currently ongoing within the SM group – mainly on commissioning the jet substructure reconstruction
- Looking at a H spectrum in WH (by eye!):
  - ≈0.5 of the cross section above p_T^H = 100 GeV
  - ≈7.5% above p_T^H = 200 GeV



√s = 7 TeV	p_T^H > 0 GeV	p_T^H > 100 GeV	p_T^H > 200 GeV
Channels	σ x BR(e/μ) (fb) OR # events per fb^{-1}	σ x BR(e/μ) (fb) OR # events per fb^{-1}	σ x BR(e/μ) OR # events per fb^{-1}
WH->lνbb	150	75	11
ZH->llbb	29	14	2.2

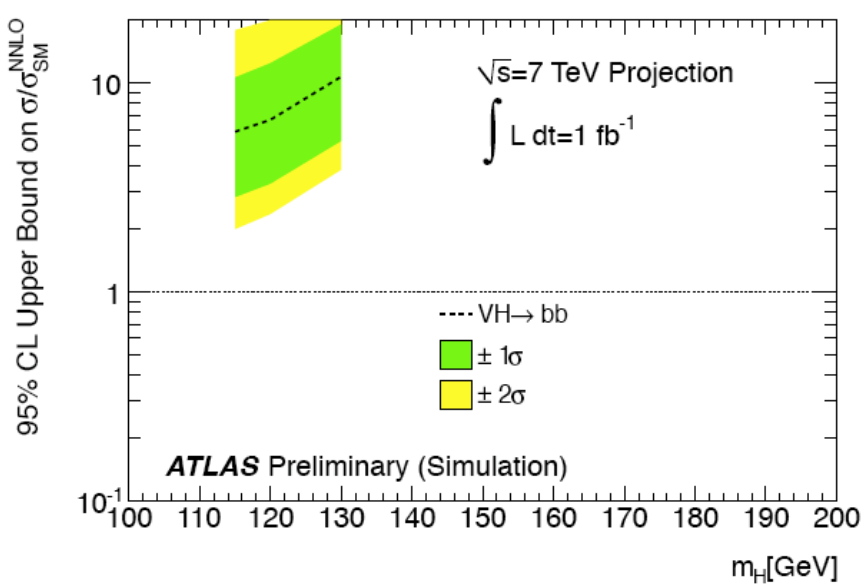
To boost or not to boost...

Un-boosted channel sensitivity:

- All we currently have at √s = 7 TeV are Lianliang's numbers from the 15/12/2010 H->bb meeting: http://indico.cern.ch/conferenceDisplay.py?confId=115169
- WH (e and μ channels) gives 56 x SM exclusion with 35 pb^{-1} at m_H = 120 GeV
- Includes 10% systematic uncertainty on signal and background and 11% on luminosity
- Assumes IP3D+SV1 will be usable for this analysis
- For 1 fb^{-1} this translates roughly as a factor 5 improvement, i.e. exclude ≈ 10 x SM

Boosted channel sensitivity:

- Exclude 6.7 x SM at m_H = 120 GeV with 1 fb^{-1} - see ATL_PHYS_PUB-2010-015
- Obtained by scaling 14 TeV numbers – room for optimization at √s = 7 TeV
- Analysis selects p_T^H > 200 GeV
- WH(W->lν) most promising, followed by ZH(Z->νν)



To boost or not to boost...

- Boosted VH Status and Plans:
  - Work ongoing in SM group on commissioning jet substructure technique
    - See Adam's presentation in last week's SM plenary: http://indico.cern.ch/getFile.py/access?contribId=0&resId=0&materialId=slides&confId=127720
    - Jet substructure note should be ready in 1-2 months
  - Work ongoing in parallel to provide b-tagging algorithm tuned for fat jet environment
  - Given infinite time, the plan would be to follow with measurements of g->bb and W/Z+bb with the substructure technique, and then VH(H->bb)
  - But we don't have infinite time! – need to put effort into optimizing the boosted VH analysis for 7 TeV
    - Edinburgh group has started on this – presentation next week – but more effort will be needed

To boost or not to boost…

- My view:
  - We need to have results for Summer conferences:
    - To improve the ATLAS sensitivity at low mass – follow the Tevatron mantra which says that “every channel counts”
    - Develop experience in the group on b tagging, WH reconstruction, setting limits and combining results – pave the way for later
    - Put H->bb on the map of useful channels
  - The un-boosted channels seem to be in a better position for this – remember only 2-3 months left, analysis should be ≈ frozen end of May
  - At the same time boosted VH has better sensitivity and must be our real goal for physics results in associated VH production this year
    - What could be shown from this channel in Summer?
  - How do we organize ourselves to achieve **both** goals?

- My proposal:
  - Split the work so that some people concentrate on un-boosted analysis and some on optimizing boosted analysis and on helping to commission jet substructure method
  - Get results out for Summer and move on fully to boosted analysis

Un-boosted WH Analysis – Next Steps

- After the effort with comparing cut flows, we're ready to start producing results!

- The roadmap is clear:
  1. Study optimal event selection
     - Proposal: start from W/Z group's baseline selection
     - Mostly the same as used in cut flow comparison with some differences:
     - STACO instead of Muid muons and some differences in jet cleaning
  2. Evaluate sources of systematic uncertainty
  3. Improve analyses
     - Find ways to reduce most important systematics
     - Multivariate methods?
  4. Accumulate statistics, write note, get results approved

- After this: merge efforts into boosted analysis for another set of public results before the end of the year

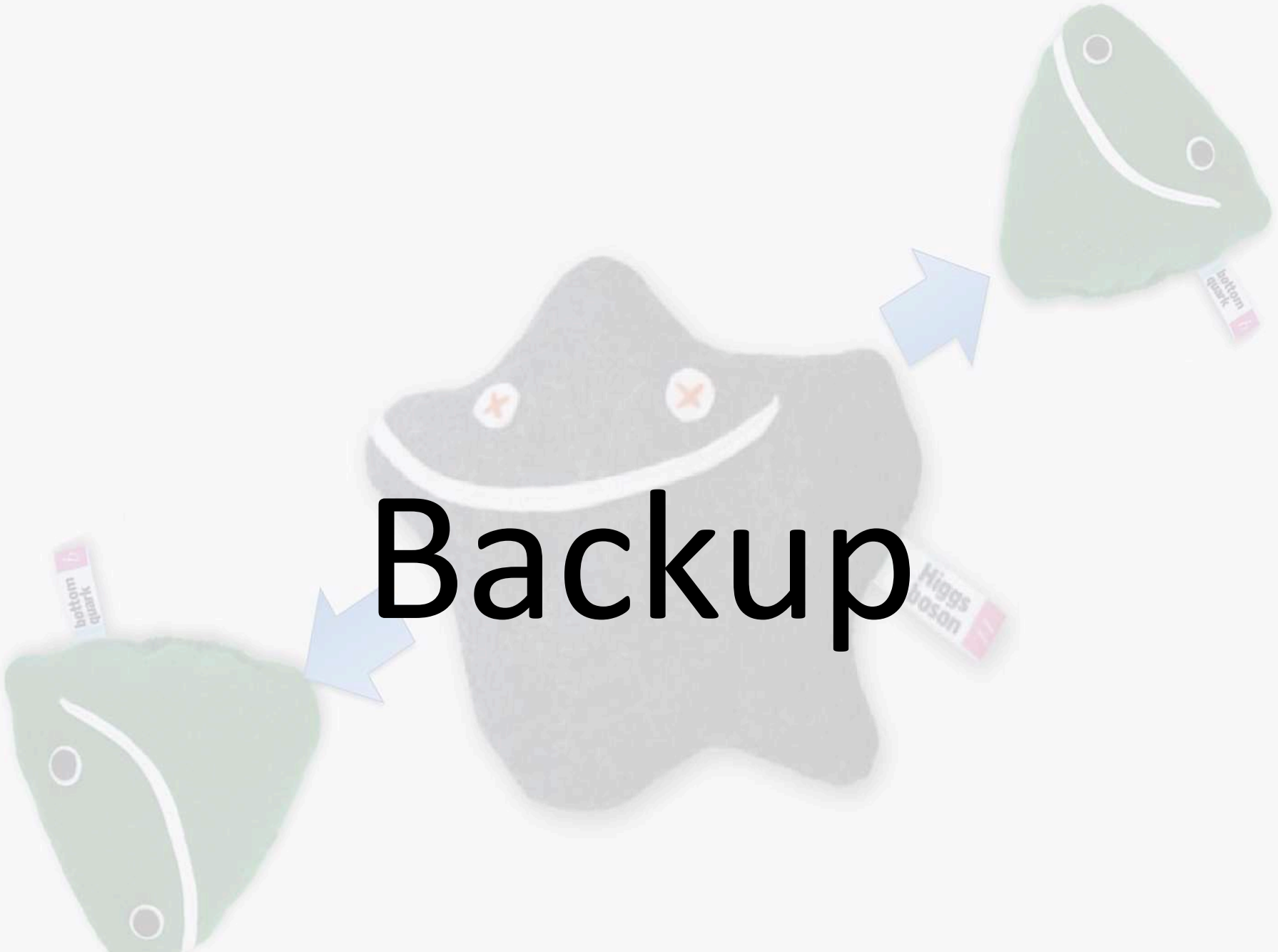
Other ongoing issues

- Fast monitoring
  - We are not a priority channel for this…
  - But should be ready to produce code for running in Tier0 once the analysis cuts are well defined and stable
  - The monitoring analysis cuts will be set in stone

- ttH:
  - Ongoing – see talk by Alistair today
  - Barcelona group ramping up on this channel

- VBF H->bb:
  - Ongoing – see talk by Eric today
  - Eric reassessing channel potential and working together with jet trigger to find good strategy

- Anything else?



Backup

Fast Monitoring

- Idea is to receive early warning when there is something interesting in the data
  - …better than getting a late warning from the other side of the ring ☺
  - Not to make plots of control regions – we have the regular monitoring for that
  - Not to do the analysis in real time – no final corrections, systematic uncertainties etc
    - Note that not seeing a signal does not mean it is not there, and vice versa!...
- Implications are that it should be **stable** and **robust** selection focusing on signal region

- Several open technical/organizational questions at the moment:
  - Where to run: Tier0, CAF or CERN Tier1
    - Other Tier1/2/3 would require too much bandwidth for AOD/D3PD/DAOD transfer
  - What data format:
  - D3PD:
    - Serious complications from D3PD versioning and stability - D3PDs not stable until long after data collection
    - D3PD size also a problem – would need to be produced from recent AODs as they are produced
    - Which D3PD – many different varieties and would require different analysis applications starting from different inputs
  - AOD:
    - Would need to implement analysis selection in Athena! (IWithin monitoring framework?)
    - Less versioning complications – could use stable Tier0 cache used for production
    - Could produce DAOD for selected events – would allow easy subsequent analysis, producing event displays etc

- When plans are more clear will need someone to implement/coordinate this for our group

Muon Channel Selection

Muon Object and MET Definition

- STACO Combined Muon
- Author=1 or 6
- MCP Quality Cuts for rel16
- MET Definition: MET_LocHadTopo
  - ex = MET_LocHadTopo_etx + MET_MuonBoy_etx - MET_RefMuonTrack_etx;
  - ey = MET_LocHadTopo_ety + MET_MuonBoy_ety - MET_RefMuonTrack_ety;
  - MET = sqrt(ex2+ey2);

Preselection

1. Vertex Cuts
   - $N_{vtx} \geq 1$ with $N_{tracks} \geq 3$
2. Jet Cleaning Cuts
   - Reject Events with ≥ 1 loose bad jet
   - Reject Events with ≥ 1 ugly jet
3. Muon PreSelection
   - ≥ 1 offline Muon with p_T>15 GeV
   - $|z_0^{wrtPV}| < 10$ mm for the 0^{th} vertex
4. Trigger
   - E4-G1 : EF_mu10_MG (seeded by L1_MU0)
   - G2-I1 (up to run 167576) : EF_mu13_MG (seeded by L1_MU0)
   - I1 (from run 167607) - I2 : EF_mu13_MG_tight (seeded by L1_MU10)

W → μν Selection

1. Preselection
2. One muon with
   - p_T >20GeV
   - $|\eta|$<2.4
   - Isolation $\Sigma p_{ID}^{Cone0.2}/p_T$ <0.1 (Tracks must come from selected vertex)
   - Veto Events with 2nd cb muon with p_T>20GeV
3. Missing Energy based on MET_LocHadTopo
   - E_T^{Miss} >25GeV
4. Transverse Mass
   - M_T >40GeV

Z → μμ Selection

1. Preselection
2. Two muons with the largest p_T which fulfill
   - p_T >20GeV
   - $|\eta|$<2.4
   - Isolation $\Sigma p_{ID}^{Cone0.2}/p_T$ <0.1 (Tracks must come from selected vertex)
3. Opposite Charge
4. Invariant Mass Cut
   - $66<m_{\mu\mu}<116$GeV

Electron Channel Selection

Electron Object and MET Definition

- use v16 OTX check and only using final map for run 167521
- use simple combination of E of the cluster and η and ϕ from the track (unless the track has <4 SCT +Pixel hits)
- η-cuts should be performed with cluster coordinates for OTX, $|\eta|<2.47$, crack removal
  - More Details under: https://twiki.cern.ch/twiki/bin/view/AtlasProtected/ElectronsEnergyDirection
- MET Definition: MET_LocHadTopo
  - To be corrected for energy scaling/smearing

Preselection

1. Vertex Cuts
- $N_{vtx} \geq 1$ with $N_{tracks} \geq 3$

2. Jet Cleaning Cuts
- Reject Events with ≥ 1 loose bad jet
- Reject Events with ≥ 1 ugly jet

3. Electron PreSelection
- ≥ 1 offline electron with p_T>15 GeV with egammaPID::Medium_WithTrackMatch

4. Trigger
- Period ABCDE1-E3 (up to and including run 160879) : L1_EM14
- Period E4-I2: Trigger EF_e15_medium

W → eν Selection

1. Preselection
2. One electron with
- egammaPID::Tight_WithTrackMatch
- Author 1 or 3
- p_T >20GeV
- $|\eta|<2.47$ excl. $1.37 < |\eta| < 1.52$
- Veto Events with 2nd medium electron with p_T>20GeV and electron isolation: 4 GeV on corrected E_T^{cone20}

3. Missing Energy based on MET_LocHadTopo
- E_T^{Miss} >25GeV

4. Transverse Mass
- M_T >40GeV

Z → ee Selection

1. Preselection
2. Two electrons with the largest p_T which fulfill
- Author 1 or 3
- egammaPID::Medium_WithTrackMatch
- p_T >20GeV
- $|\eta|<2.47$ excl. $1.37 < |\eta| < 1.52$

3. Opposite Charge
4. Invariant Mass Cut
- $66<m_{ee}<116$GeV

Tight Selection and Jet Definition

1. Additional Tight Selection for W/Z+jets

- Electrons: Require additional relative Isolation (on corrected isolation energy):

  $E_T^{cone20,Corrected}/P_T^{ele} < 0.2$

  - Note: cut value need to be adjusted
  - this is not yet in the WZ-D3PDs but can be calculated via el_Etcone20
    - https://svnweb.cern.ch/trac/atlasusr/browser/mfiascar/WjetsD3PDskimming/trunk/IsoCorrection.cxx
    - https://svnweb.cern.ch/trac/atlasusr/browser/mfiascar/WjetsD3PDskimming/trunk/IsoCorrection.h
    - float El_Etcone20_pt_corrected = isoTool.correctElectronIsolation (m_el_eta->at(i), m_el_pt->at(i), m_el_Etcone20->at(i));
- $|d_0^{wrtPV}| < 0.1$mm
- W-Channel: Reject events with second lepton
  - Isolated, medium electron with p_T>20GeV
  - Combined muon with p_T>20GeV
- Currently no JVF Cut

2. Overlap Removal

- Lepton/Jet Overlap removal
  - Remove closest jet to a well reconstructed W/Z decay lepton if this jet is closer than ΔR<0.2
  - Remove event if jet with $p_T \geq 20$ GeV is closer than 0.6 to signal lepton
- Jet-Isolation
  - Apply no Jet Isolation, but apply uncertainties from jet/etmiss group for close-by jets

4. Jet Selection

- Collection: AntiKt jets build from topoclusters
  - Size: results from various jet sizes: 0.4 and 0.6 (add more as calibration get available)
  - Priority: 0.4 Cone Size
- Scale Definition: Use EM+JES jets with offset, and beam spot corrections until GCW and LCW get available
- Remove Jets (which are no signal leptons) with $p_T \geq 20$ GeV and
  - Medium Bad Jets Definition (= tight+ in rel15)
  - Negative Energy
- Jet threshold: Jets are considered if $p_T \geq 30$ (Baseline) and 20 GeV (Optional after careful studies)
  - both cuts should be applied through out the full analysis. Keep in mind that the 20GeV might only be doable for the 2010 data
- Rapidity Rage: $|y| < 4.5$

5. B-Jet Selection

- Collection: AntiKt jets build from topoclusters with cone-size 0.4
- Scale Definition: Use EM+JES jets with offset, and beam spot corrections
- $P_T \geq 30$ GeV (Baseline) and $P_T \geq 20$ GeV
- $|\eta| < 2.1$
- SV0 tagger: Cut at 5.85 in r16
- use BTagging Calibration Tool to reweight MC using SF provided by b-tagging group