Boosted Object Tagging with Wavelets

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Work in collaboration with
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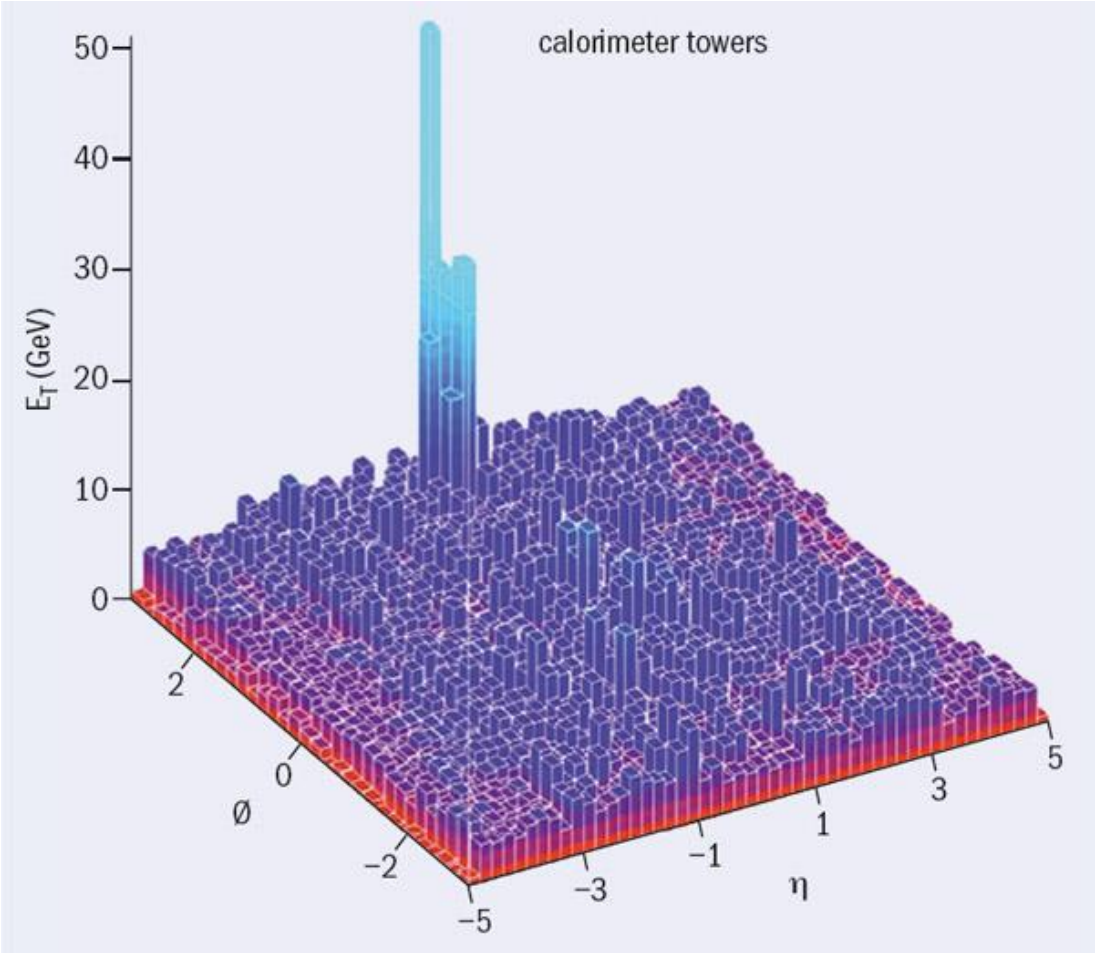
Boosted Particles

- Cleaning out signal from background is very hard for hadronic final states
  - How can we tell a hadronic top, higgs, or W/Z apart from multijets? In the high-Pt regime we get one hard jet for each of these.
- Distinguishing a hard heavy particle from QCD background can help us to see decays of new particles, e.g. heavy stops give us high energy tops.

What do we see?



What do we see?

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Wavelets

- Wavelets are a kind of localized Fourier transform
- They are particularly good at edge detection
  - Used in Fermi collaboration to measure bubbles
- Can be used for image compression, washing out features smaller than some scale
  - A part of the JPEG 2000 compression standard

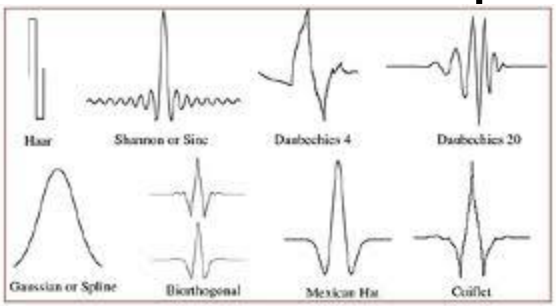
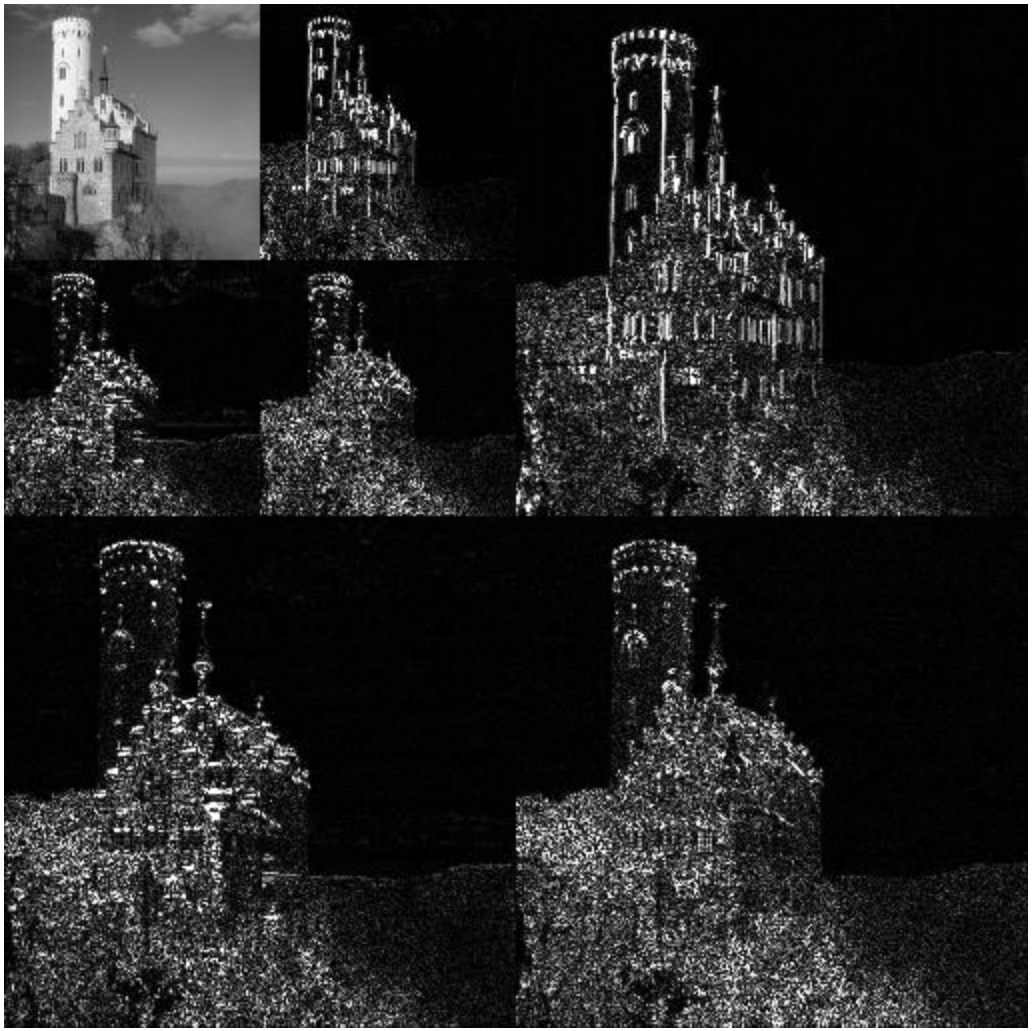


Figure 8
Examples of types of wavelets

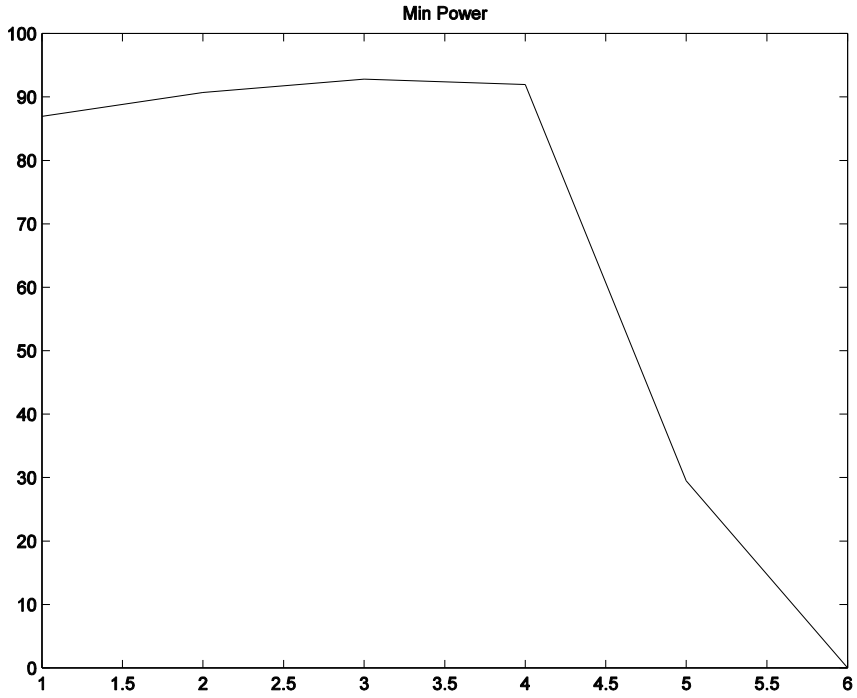
Edge Detection

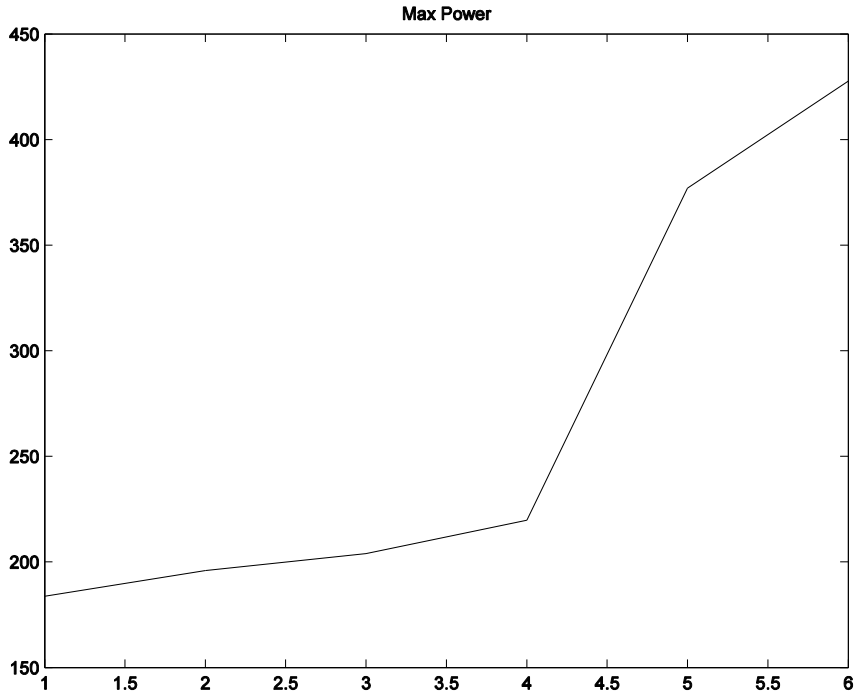


Regions of Interest

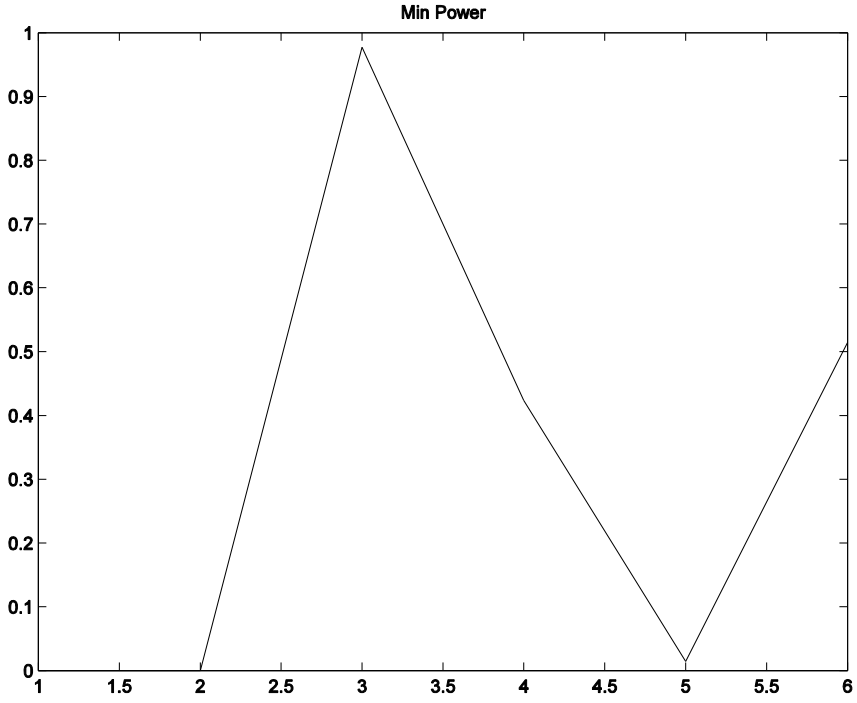
- Averaging over an entire calorimeter loses the position-sensitivity of wavelets
- We use a standard jet algorithm (C-A jets) and use the jet's direction to identify a cell of interest
- We now consider all possible wavelets that include that cell and find the highest and lowest wavelet coefficients at a given size

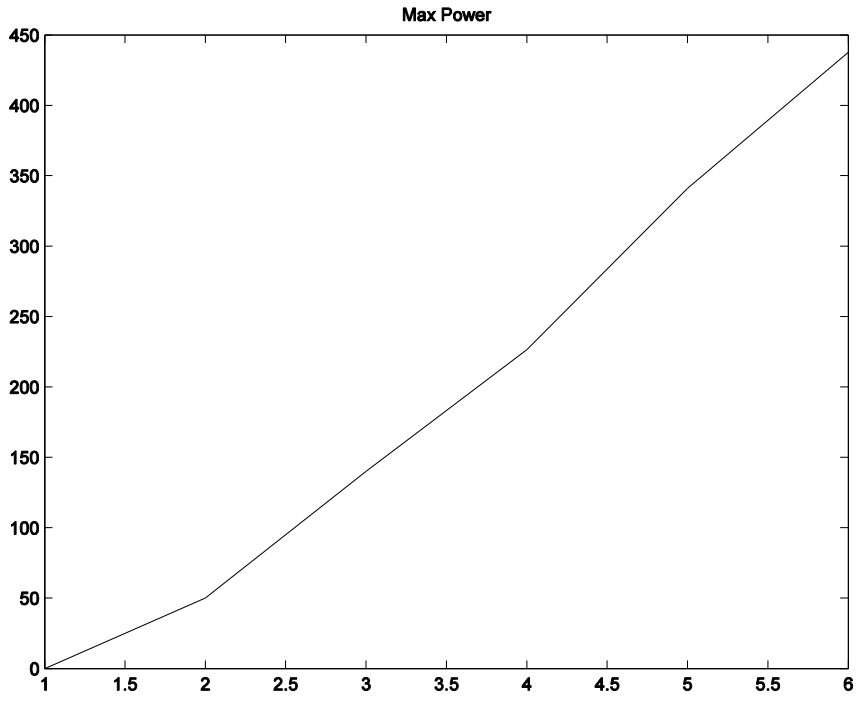
Typical QCD Jet





Typical W Boson



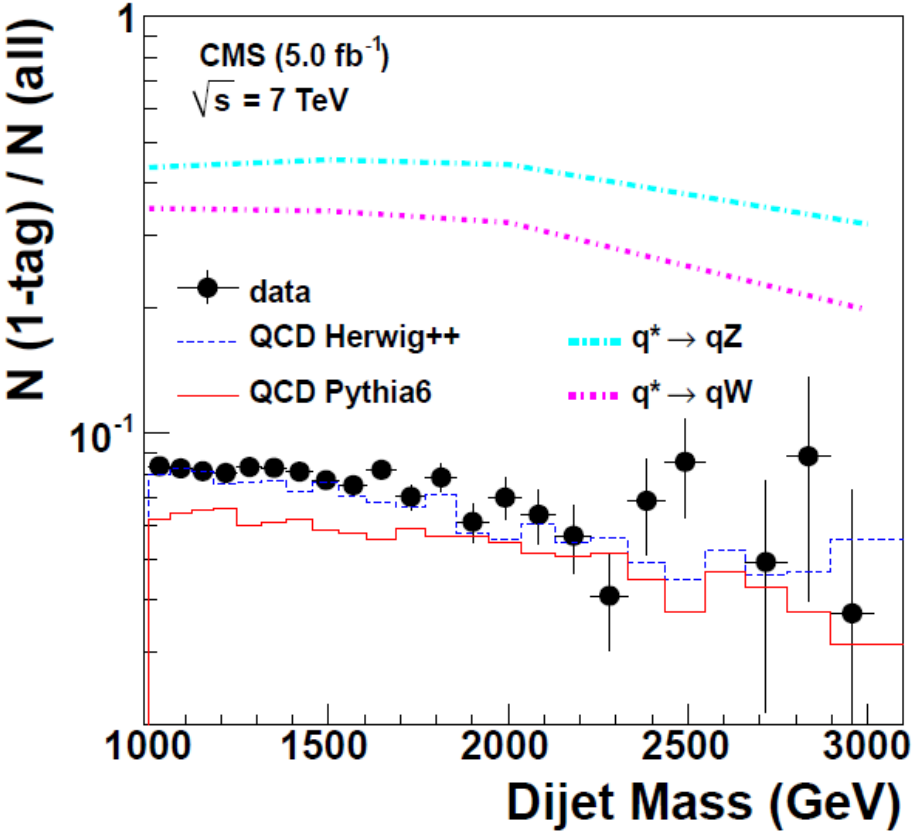


Tagging Cuts

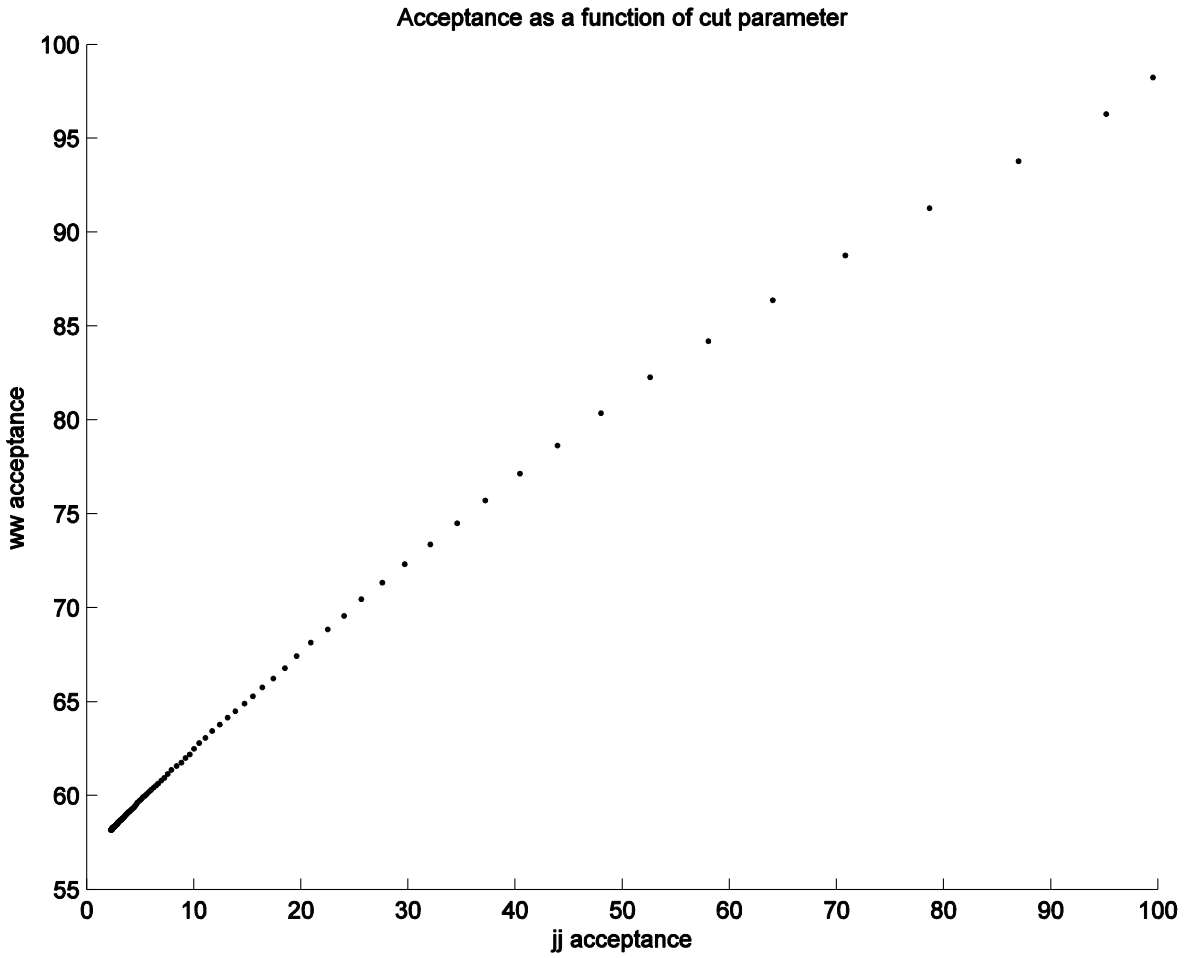
- All of our cuts are based ONLY on the wavelet transform
  - No jet mass cuts, mass drops, or other current techniques
- Anything which has very small max power in the smallest wavelet is called a W boson
- Anything which has large concavity in (max-min)/(max+min) is a W boson

Current Tagging Performance

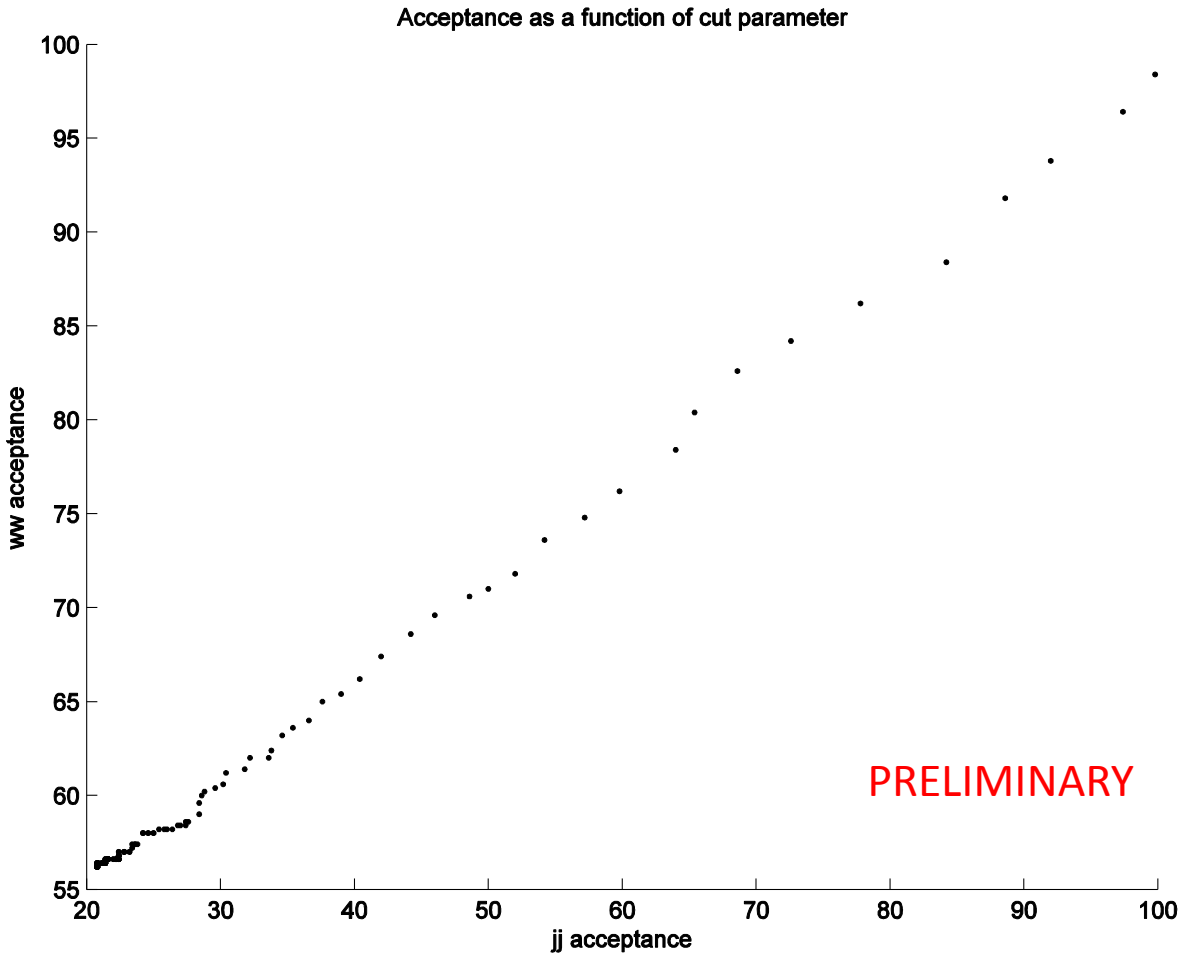
- Current study for Wj resonances in a highly boosted regime
- For a W acceptance of ~35% they have a jet mistag rate of ~8-10%
  - CMS arxiv/1212.1910



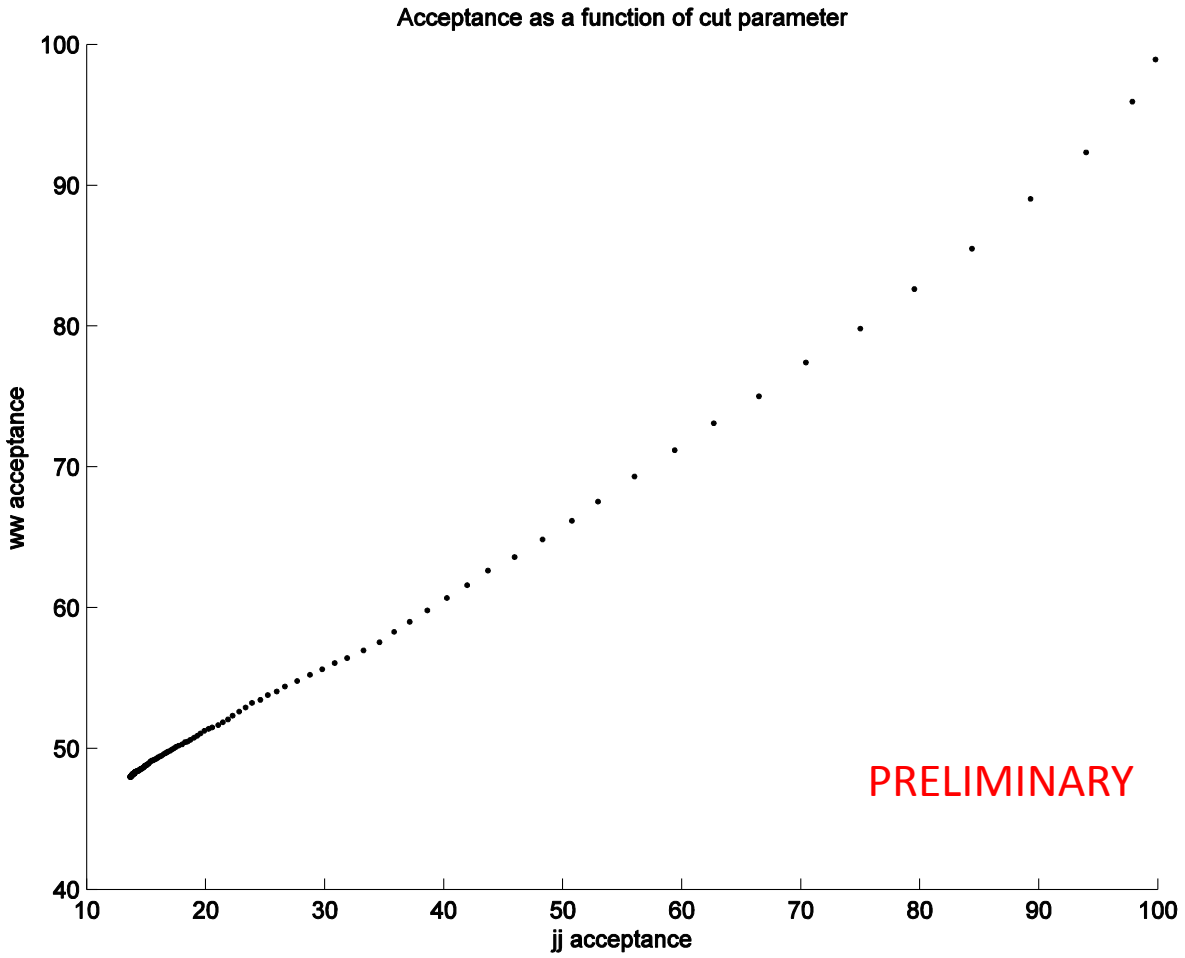
Acceptance – Lepton Collider



Acceptance – More Boosted Object



Acceptance - Hadronic Environment



Conclusions

- Wavelets offer competitive tagging performance as compared to existing tools
- This approach is independent from the many current taggers which ‘deconstruct’ a jet algorithm
  - We hope it can provide complementary information, study is ongoing