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Associated top Higgs search: with ttH (H→bb)

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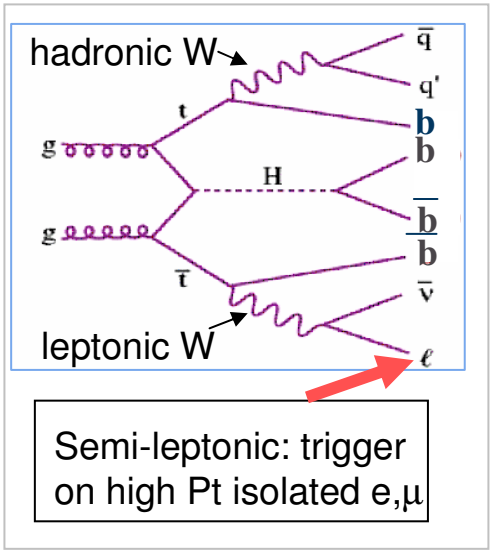
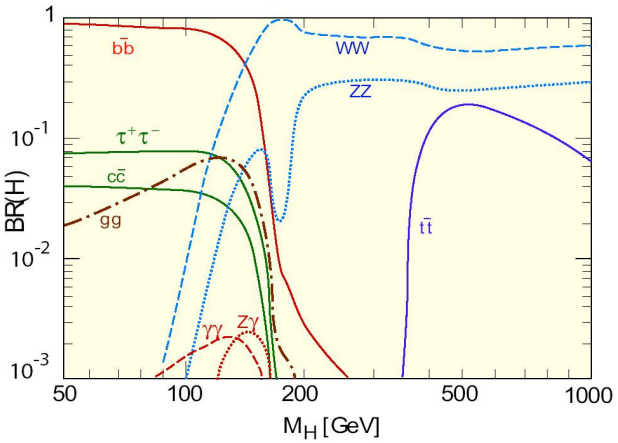
Introduction





- Putting the channel in context;
  - Steps to the channel:
    - ttbar, extra jets, b-tagging
  - Standard Semi-Leptonic trigger
    - High-Pt isolated lepton, *missing Et, Jets*
  - Attractive due to high BR(H→bb)
  - Extremely sensitive to b-tagging $(\varepsilon_b)^4$.
  - There are many ways to combine objects in the event

    → Large tails on mass reconstruction.
  - Mistagging, energy scales crucial.

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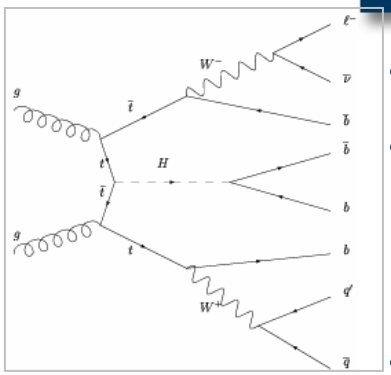
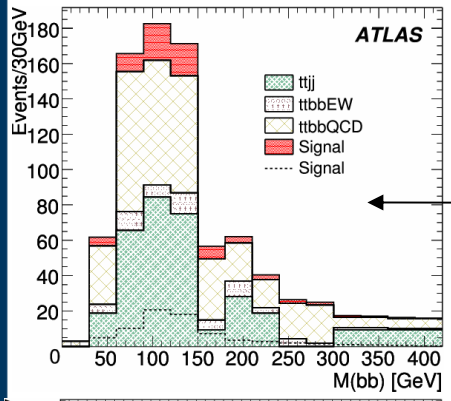
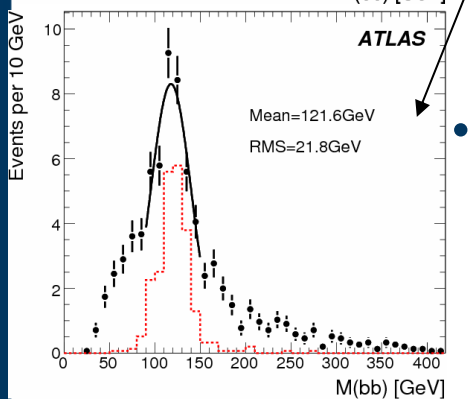
CSC note semi-leptonic ttH Hbb recap:







- V. Low mass Higgs channel (<130 GeV) σ_{120}=99.6 fb
- Main backgrounds:
  - ttbb (QCD σ=2300 fb, EW σ=255 fb);
  - ttjj σ_{tt}=833,000fb σ_{ttjj}=110,000 fb
- CSC note has 3 analyses at MH=120 GeV:
  - cuts-based S/√B=1.82 (stat)
  - pairing likelihood S/√B=1.95 (stat)
  - constrained fit (cutting at $\mathcal{L}$sb=-4.2) S/√B=2.18 (stat)
  - Peak significance with no M_H window, cutting at $\mathcal{L}$sb=-4.4 Constrained fit S/√B=2.78(stat) i.e. Reducing mass window does not help when systematic errors not considered.
- Common preselection applied to all analyses
  - Trigger e25i, e60, mu20i, 1 Isolated high pt lepton,
  - 6 jets, 4 jets with b-weight>0

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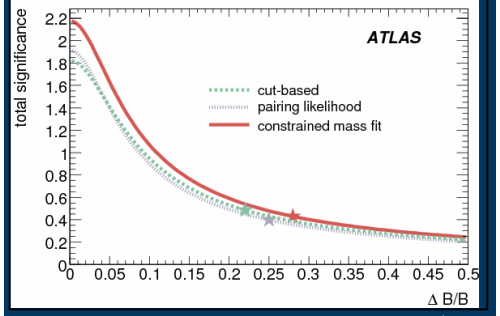
Problems ☹

- Low signal efficiency – "passing cuts", no truth (~2%)
- Low mass resolution of signal (combinatoric BG)
- Physics BGs peak in same place as signal: were statistically limited for CSC analysis.
- Pile-Up:
  - Lowers b-jet multiplicity. (10% fewer events having 4 b-jets, applies to background too!)
  - Broadens overall jet multplicity (more events with >8 and <4 jets.
  - Worsens mass resolution.
- Most important detector systematics:
  - b-tag eff. systematic
  - Jet energy scale systematic
  - Jet energy resolution systematic
  - Light jet rejection systematic

	Cut-based	Likelihood	Constrained fit
JES	5%	14%	8%
Jet resolution	7%	5.5%	14%
b-tagging efficiency	20%	20%	20%
Light jet rejection	5%	3%	10%
All contribution	22%	25%	28%

- Not all systematics included: BG norm.
  - For ttbar, the theoretical uncertainties associated with the NLO+NLL calculation are around 12%
  - With only 100pb^{-1} of data a direct measurement of the cross section for the semi-leptonic final state using *b*-tagging could be performed with a much smaller error.
  - To reap benefit from 'clever' analyses, needs TOTAL $\Delta B/B$ <5%

Impact of systematic uncertainties on significance Using $S/(\sqrt{B+\Delta B^2})$



Syst uncert. On BG

Markers at est. syst. uncert. On BG from detector systs (22,25,28%) for 3 analyses

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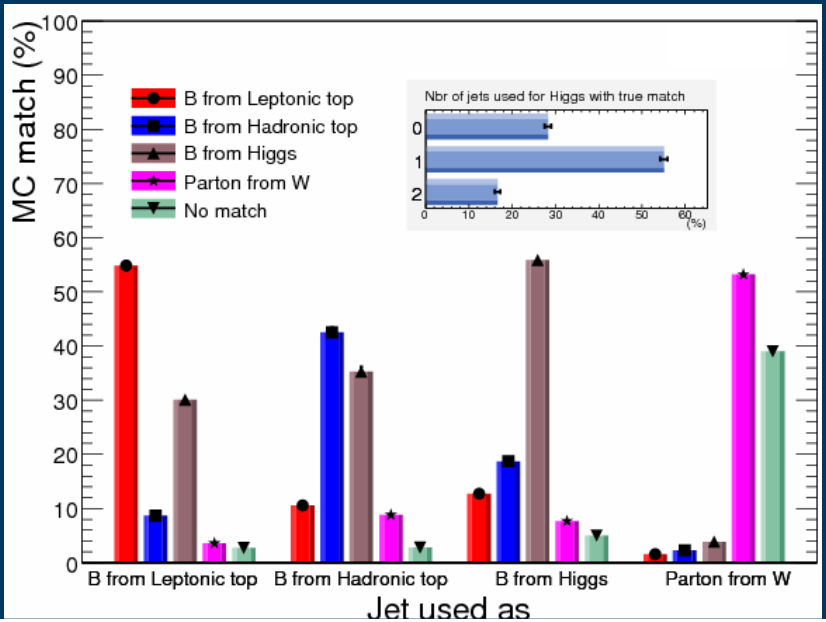
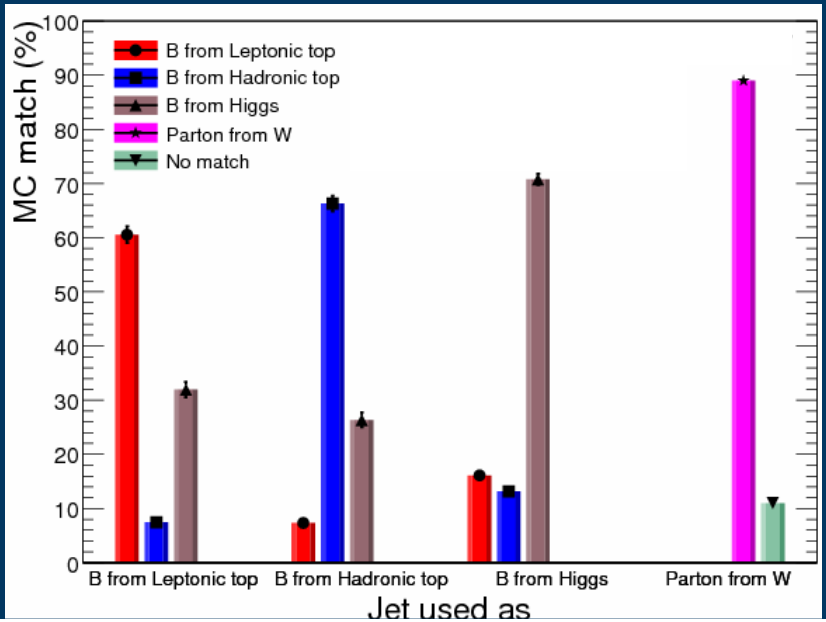
Combinatoric Background

- Almost 40% of hadronic W's have components not matched to ttH jets (ISR/FSR).
- Higgs b-Jets are very often wrongly included in top-quark reconstruction, even if the correct b-jets for the top-quarks are tagged as b-jets
- Even when b-tagging perfect, sizeable exchange of Higgs b-jets with top-quarks

Truth composition of reconstructed particles



When jets matched to b partons are b-tagged and relate to either a top-quark or the Higgs



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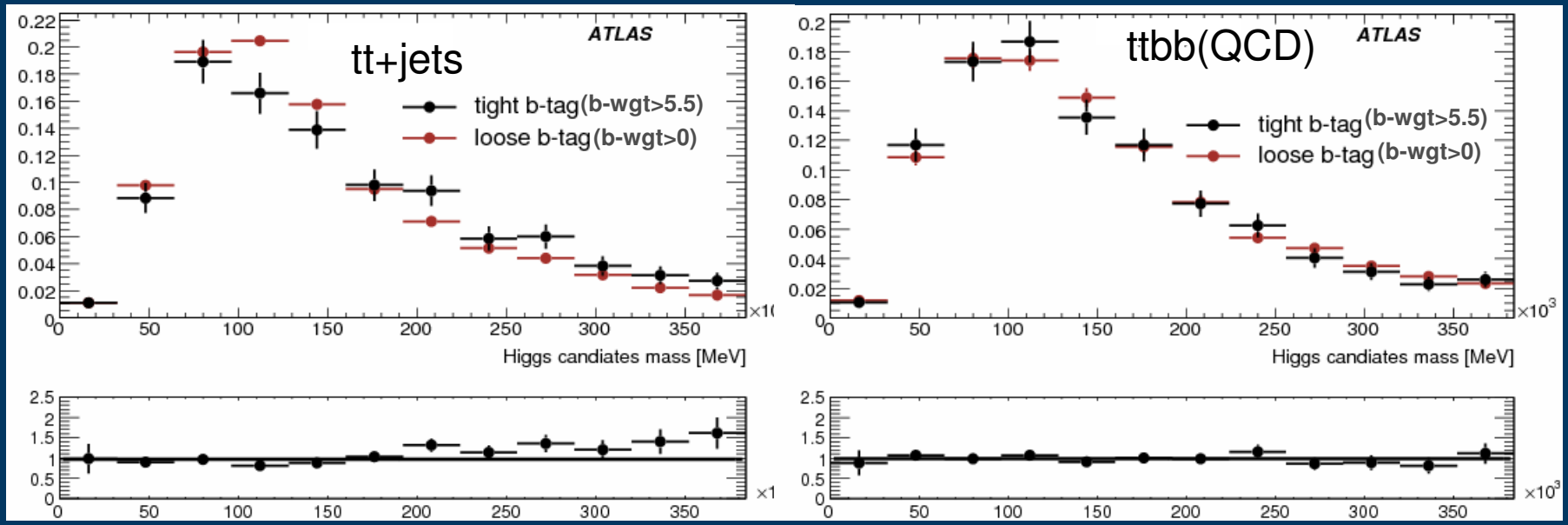
Shape Analysis

- Must develop methods to measure background from data (& relative ttjj/ttbb cont.).
- Higgs boson candidate mass spectrum depends **weakly** on b-tagging working point for individual samples.
- BUT relative contribution made up by ttbb/ttjj depends on the strength of the btag cut applied.



- Use MC ttjj/ttbb fraction & data to normalise at loose working pt. (b-tag weight>0, where there is <1%signal)
- Use MC jet flavour composition and ratio of b,c,light efficiencies at 'medium' & 'loose' working points to assess predictive performance of shape and norm. at medium point.
- Allows extrapolation to 'tight' (>5.5) working point, where there is a higher proportion of signal.
- Further correction possible in 'tight' distribution by looking at signal depleted region of mass spectrum.

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CSC Note missed:

- Fully hadronic, fully leptonic final states.
  - Samples produced, some analysis done, statistically limited.. Could use Atlfast-II.
- Neural Net (people looking now)
  - Possibly other methods to improve combinatorics as well? – Hadronic W? Assoc. b-jets to top/Higgs?
- Only rudimentary shape analysis so far.
  - Need to measure backgrounds from data.
- Use newer generators:
  - Spin correlations now in MC@NLO v3.31

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Where do we go from here?

- We'd like to keep our Physics group going, many people in the group feel that the group should be in charge of the development of a common analysis and that should continue with more or less the same organization we had for the CSC effort.
- Others think that at least up to the first fb-1 we should act as a sub-group of the Top Working group.
- Everybody shares the feeling that we are soon moving towards a concrete interaction with the Top group during early data taking.
- First stage may be in deciding the contents of the D1PD??
- Undoubtedly, we should share a common procedure and algorithms for reconstructing the tops