H->bb Overview and Aims

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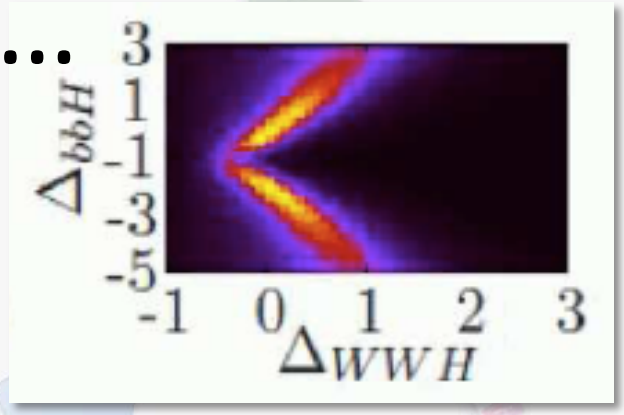
HSG5 Workshop at JINR, Dubna, 10 May 2011

The story so far…



- H->bb channel essential for Higgs searches
  - Essential to determine Higgs couplings: see Sven Heinemeyer's talk
  - Probes important mass region just above LEP limit
  - "Bumps" in other channels will need confirmation
  - Last H->bb results from boosted VH Monte Carlo study at 14TeV
  - Every channel helps!…
- H->bb activities for past few months:
  - Most effort has been into **WH->lvbb** analysis – aimed for Summer conferences
  - Both on un-boosted and boosted analyses
  - Other activities also important for now or for later: **ZH**, **ttH**, **VBF H->bb**
- A few people in several groups involved:
  - **Academia Sinica**: WH, ZH, cut-based analysis, pileup studies
  - **Argonne**: WH, cut-based analysis, muon reconstruction
  - **Edinburgh**: boosted WH, W+jets backgrounds
  - **Glasgow**: ttH, cut-based analysis, multivariate analysis
  - **LIP Lisbon**: WH, cut-based analysis, jet studies
  - **Liverpool/Birmingham**: WH, ZH, cut-based & multivariate analysis, b tagging
  - **LMU Munich**: WH cut-based analysis, QCD background, NLO MC validation
  - **UCL London:** boosted WH/ZH
  - **Victoria**: VBF H->bb, trigger studies
  - **Wisconsin**: WH, cut-based & multivariate analysis
  - … and more…

Un-boosted WH analysis

- Cut-flow comparison between various groups
- First done in rel.15, re-done to check migration to rel.16
- Analysis cuts established and almost final (see below)
- Several ongoing studies to finalize analysis selection:

Task	Obs	People
Trigger: study optimal trigger for the 2011 data. Bear in mind that single-lepton triggers will likely increase to pT thresholds of ≈20 GeV – i.e. analysis cuts will need to increase to ≈22 GeV; check also any sculpting, angular acceptance, etc	Does this need AODs? Enough info on WZ/top D3PDs? Sample A or sample T should have the foreseen menus Liaise with Gemma Wooden	
Muon reconstruction: investigate different options		Jinlong Zhang
Electron reconstruction: investigate alternatives	Inclusion/exclusion of cracks Inner detector cuts (B layer?)	
Pileup: what do we need to do with 2011 pileup	Reweighting method. Jet vertex fraction. Choice of vertex reconstruction	Jike Wang
Jet energy scale: investigate size of systematic uncertainty	Worry about b jets. Any way to improve di-jet mass resolution? Liaise with JetETmiss	Patricia Conde, Jose Maneira, Nuno Anjos
B tagging algorithms	Effect of each different choice on significance	Jinlong Zhang
Fast monitoring: implement WH baseline selection in online monitoring infrastructure	Example exists. Involves programming in Athena. Liaise with Fabien Tarrade.	Lianliang Ma
QCD background estimation from data		Michiel Sanders, Jonas Will
Wbb background estimation from data		
top background estimation from data		

WH analysis

- Analysis cuts almost frozen

- Additions & changes:
  - Number of jets/b-tagged jets:
    - Allowing >2 jets enhances tt background => **cut at N_{jet}==2**
  - Cut on $\Delta\phi(H,W) > 2.5$
    - Signal mostly back to back
  - B-tagger & working point:
    - Plan to use IPD3+SV1
    - Decide on working point
    - Interact with H.F.-tagging group
    - See talks by Andy and Paul later

- To be discussed:
  - Background determination
  - Systematic uncertainties

Muon Selection	
finder	Staco
pT	> 20 GeV
|eta|	< 2.4
MCP quality cuts	yes
|Z0 wrt PV|	< 10mm
|d0 wrt PV|	< 1mm
isolation	pTtrk20/pT<0.1
Electron selection	
author	1 or 3
PID	RobusterTight
pTcluster	> 20 GeV
|eta|	< 2.47 excl. crack
isolation	etcone30<6GeV
|z0 wrt PV|	< 10mm
|d0 wrt PV|	d0signif < 10
vertex	
primary vertex	Nvtx>=1 & Ntrks>3
MET	
algorithm	METRefFinal
Jet selection	
finder	AntiKt4Topo
pT	> 25GeV
scale	EM+JES
|eta|	< 2.5
jet cleaning	Loose
Overlap removal	
jet-e	remove jet for dR<0.4
mu-jet	remove muon for dR<0.4
Event selection	
trigger	tbd
event cleaning	jet/ETmiss recommendation
lepton	exactly 1 lepton as defined above
MET	> 25GeV
b tag	>=2
Additional cuts	MT > 40 GeV
	ΔΦ(W,H) > X (? Under discussion)

Some recent results:

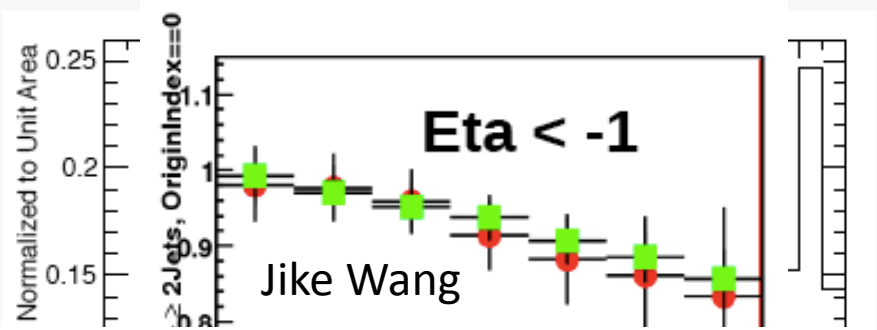
- Cut on $\Delta\phi(H,W) > 2.5$
  - Signal eff. 80%
  - tt eff. 42%

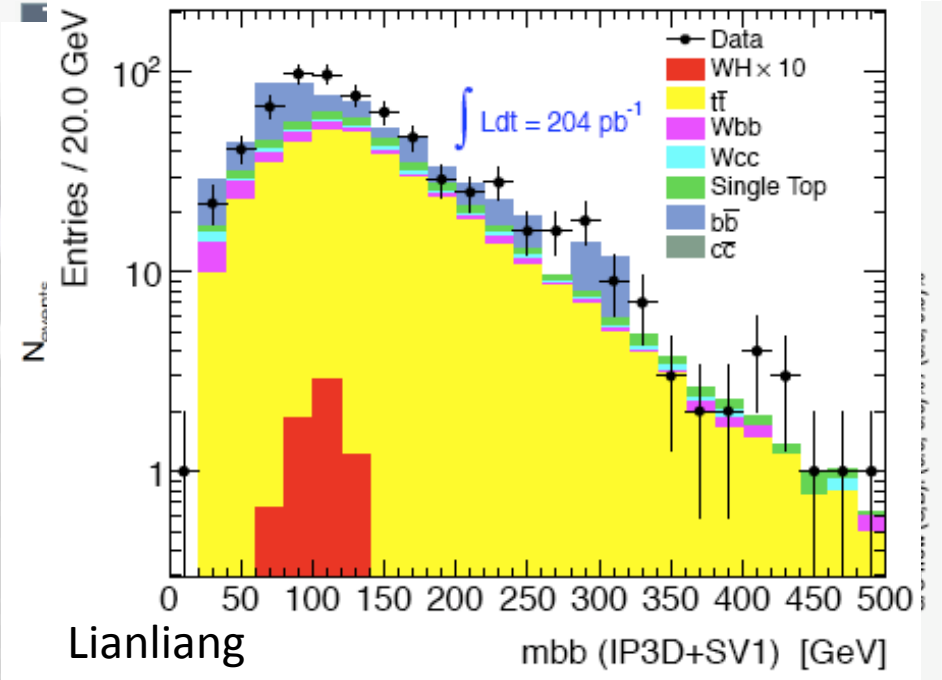
- Effect of JVF well described by MC

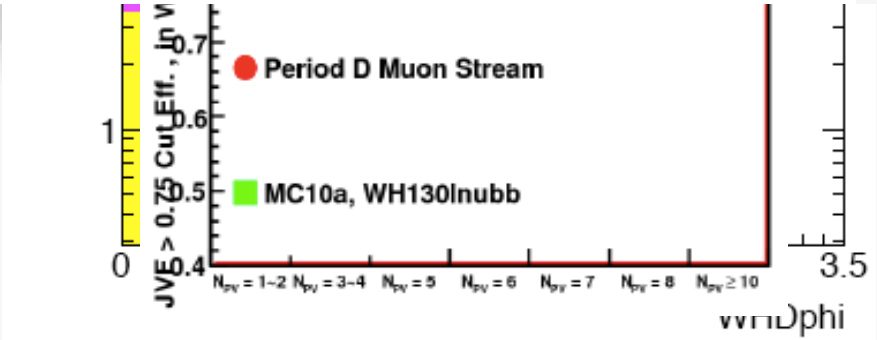
- Method being developed to determine QCD background

- Improvements from use of multivariate analysis

- 2011 data ($0.2fb^{-1}$) reasonably well described by MC
  - But need to control bb background

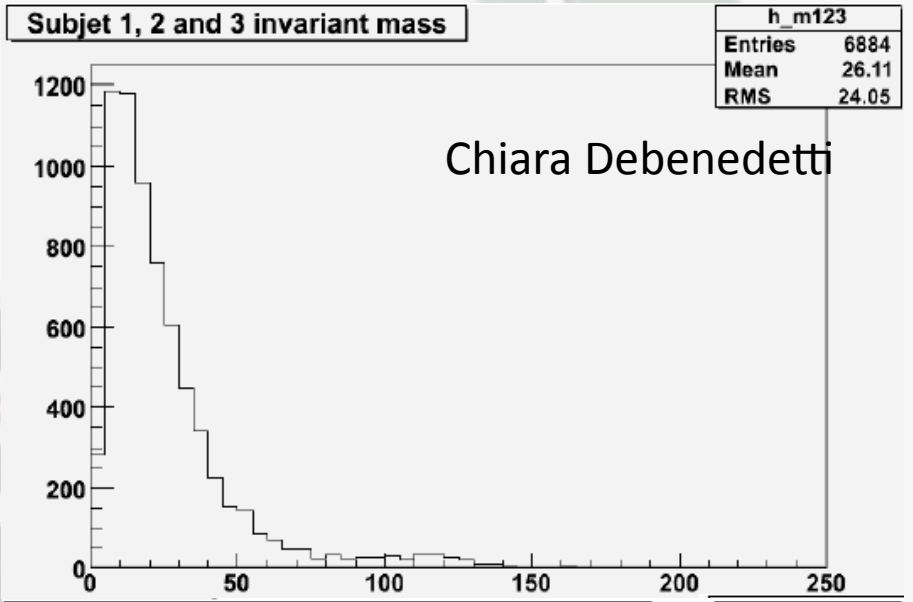


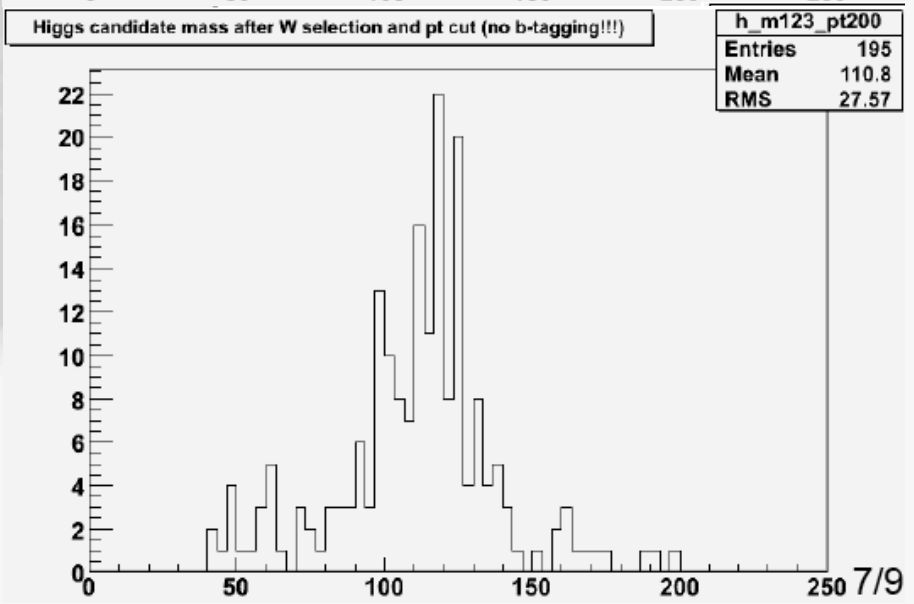




Boosted WH analysis

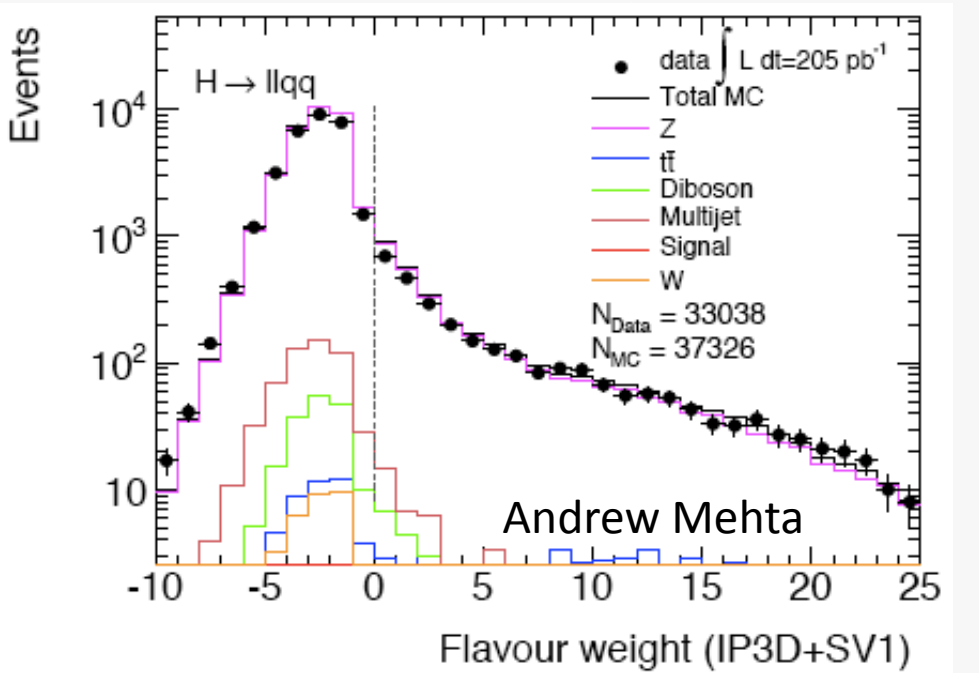
- Higher sensivity than un-boosted
  - With 1fb-1 should be able to reject ≈6xSM for low-mass Higgs versus ≈10 – 12xSM for WH/ZH (stat. only)
  - But relies on difficult techniques now being commissioned
  - Essential to dominate technique and extract results this year!
- Currently:
  - Optimizing cuts for 7TeV: 0.7% signal efficiency with 14 TeV cuts
  - Add b tagging to boosted jets
  - NLO WH->bb validation

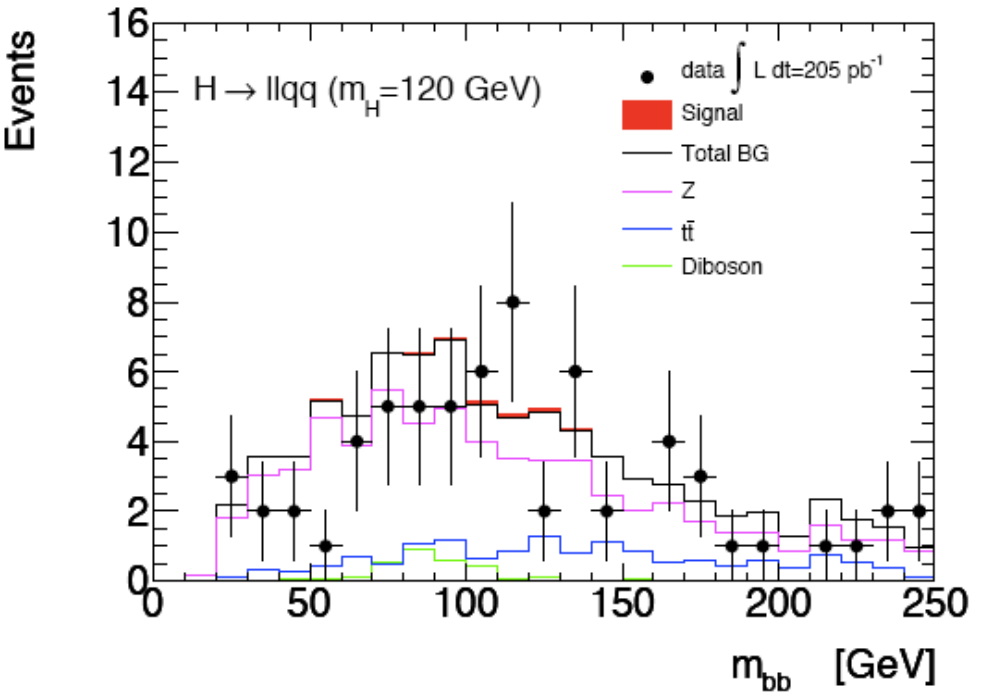




ZH analysis

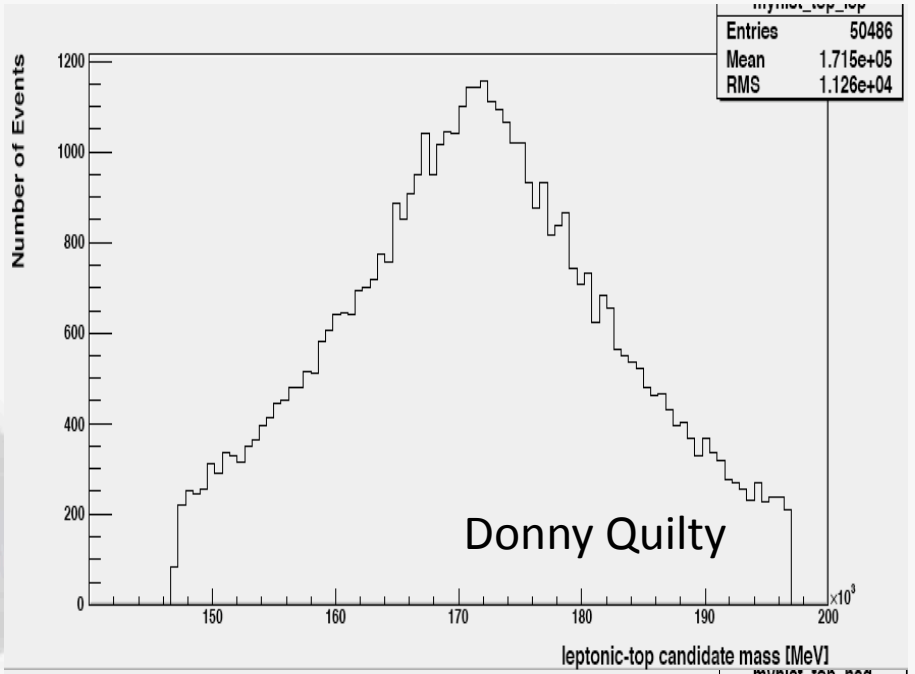
- Recently re-visited ZH analysis
- Applied heavy-Higgs H->ZZ analysis to low mass and 2011 data
- Reject 12xSM with 1fb^{-1}
  - Statistical errors only
  - May still be optimized
- Will try to include in Summer note

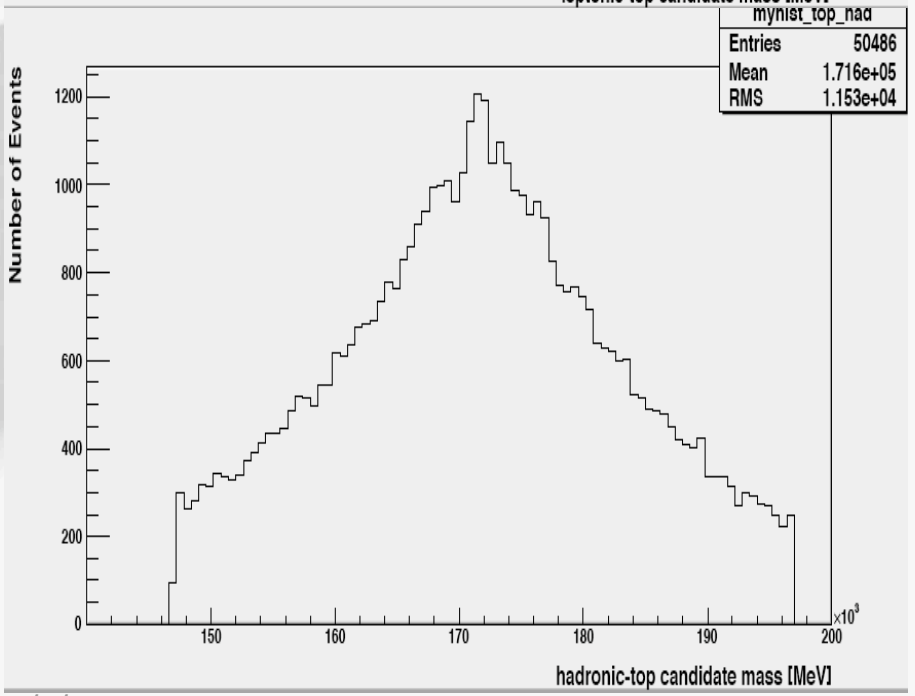




ttH analysis

- Some recent progress on this channel
- Cut-based and multivariate analyses ongoing
- Expecting more progress soon!



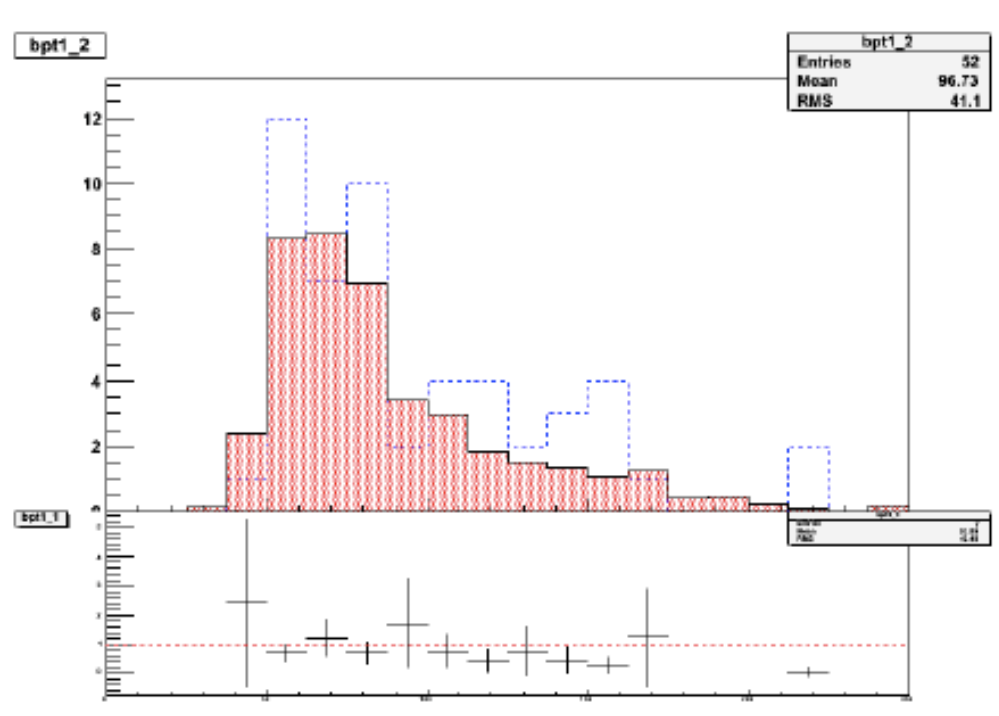


VBF H->bb analysis

- Difficult channel
- Challenging trigger
  - Working with jet trigger experts
  - Short- to medium-term solution found (up to ≈2E33)
  - HLT 2b + L1 jets

- Rough estimation gives similar event numbers to all-hadronic VBF H->$\tau_h\tau_h$

- Testing data-driven background determination method:
  - Get bb background from ratio of single- to double-b tagged events in control region



CONF note for EPS-HEP 2011

- Editors: Paul Thompson, Andrew Mehta, Patricia Conde-Muiño
- Title: "*Searches for a Higgs boson decaying to a b-quark pair with the ATLAS detector at the LHC*"
- Tight time scale:
  - First **INT** note draft should be ready on 10 June
  - To be finished by the end of the month
  - Data frozen for EPS on 22 June – expect final calibrations etc
  - **CONF** note circulated early July to be approved before conference
  - Conference starts 21 July
- Notes:
  - Need this material for **H->bb poster** accepted at EPS-HEP
  - Could re-use the existing CDS number (ATL-COM-PHYS-2010-929)
  - SVN area for note https://svn.cern.ch/reps/atlasgrp/Physics/Higgs/HSG5/data_7TeV/ATL_COM_PHYS_2010_929/trunk/

H->bb poster for EPS-HEP

H->bb searches with the ATLAS detector at the LHC

The H -> bb channel is extremely important for the observation of a Higgs boson signal at the LHC. In the Standard Model, this channel would provide a significant contribution to the Higgs boson search in the low mass region, where this decay mode constitutes the dominant Higgs decay channel. Due to the enormous jet production cross-section at the LHC, the search must target channels where the Higgs boson is produced in association with a weak boson, a pair of top quarks, or jets separated by a rapidity gap. It also requires complex techniques to reconstruct the signal and separate it from an overwhelmingly large background. We present the status of Higgs searches in the H->bb channel currently being performed within ATLAS.

- The poster abstract was accepted by the conference
- Will be presented by Patricia (random selection among list of volunteers)

Today's agenda

Thursday 19 May 2011

09:00 - 10:40 **H->bb**

Convener: Christopher Collins-Tooth (University of Glasgow)

- 09:00 **Hbb: Overview and Aims** *20'*
  Speaker: Ricardo Jose Morais Silva Goncalo (Royal Holloway)
- 09:20 **WH Update from LIP** *20'*
  Speaker: Dr. Patricia Conde Muíño (LIP-Lisbon)
- 09:40 **WH analysis update** *20'*
  Speaker: Dr. Paul Thompson (University of Birmingham)
- 10:00 **WH Cut-based Analysis with 2011 Data** *20'*
  Speakers: Dr. Lianliang Ma (University of Wisconsin (Madison)), Dr. Lianliang Ma
  Lashkar Kashif (University of Wisconsin-Madison)
- 10:20 **Boosted analysis/Jet Substructure** *15'*
  Speaker: Adam Davison (University College London)
  Material: **Slides**
- 10:35 **Edinburgh Boosted WH status** *05'*
  Speaker: Wahid Bhimji (University of Edinburgh)

10:40 - 11:10 Coffee

11:10 - 11:30 **H->bb**

- 11:10 **WH analysis Update Munich** *20'*
  Speakers: Jonas Zacharias Will (Ludwig-Maximilians-Univ. Muenchen-Unknown-Ur
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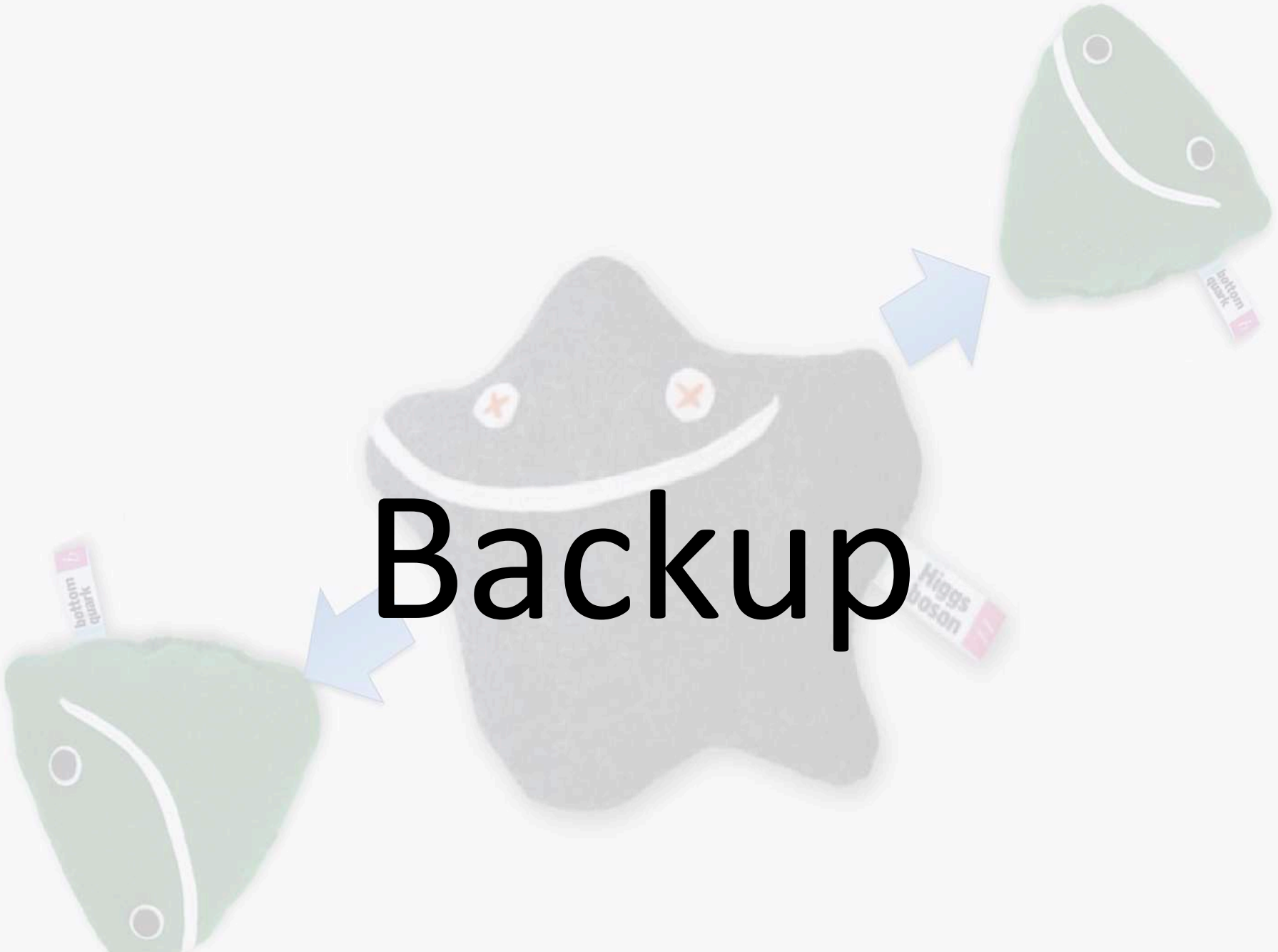
11:30 - 13:00 Discussion: Goals for H->bb Summer Conferences



Backup

The Grand Plan