ETH Institute for
Particle Physics

$H \rightarrow WW \rightarrow 2\ell 2\nu$

Analysis Presentation

Daniel Meister

01/24/2013

Outline

1. **Introduction & Motivation**
2. **Analysis Description**
3. **Personal Contributions**
4. **Results**

Introduction & Motivation

- Search for the Higgs Boson

  $\rightarrow$ last “missing piece” of the Standard Model, theoretically predicted almost 50 years ago

  $\rightarrow$ evidence for the existence of scalar fields in nature

  $\rightarrow$ understand how symmetry breaking works for electroweak interaction

  $\rightarrow$ hints and/or exclusions of different models of BSM physics

- CMS/ATLAS discovered a boson with $m \approx 125$ GeV in 2012

  $\rightarrow$ http://arxiv.org/pdf/1207.7235.pdf

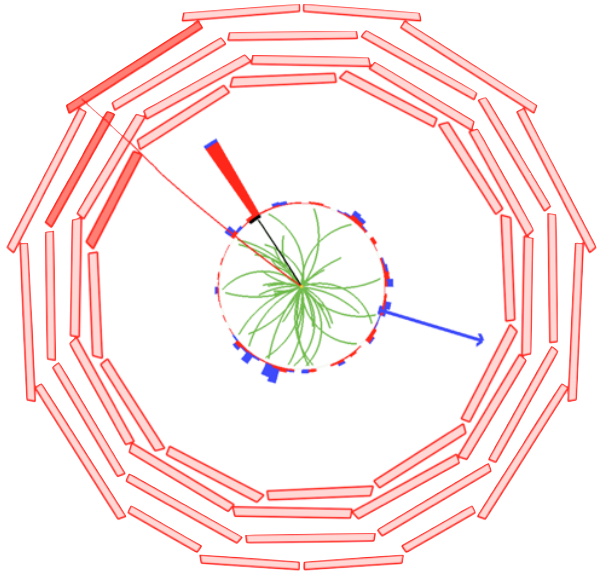
- Search in the $H \rightarrow WW$ channel

  $\rightarrow$ important channel e.g. to measure $\frac{H \rightarrow WW}{H \rightarrow ZZ}$ and properties

- Measurement of properties (mass / spin / parity)

  $\rightarrow$ is it really a SM Higgs?

Analysis Description



- HWW signal
  - Two high p_T leptons (e, μ)
  - Large missing E_T
  - No resonance peak
- Backgrounds

	Rejection	Estimation
W+jets	lepton ID/ISO	fake rate method
Z/γ^*	mass / missing E_T	"normalize" to Z-mass
tt/tW	jet bin / b-veto	b-tag efficiency
WZ/ZZ/Wγ	mass / m_T / no extra lepton	MC
WW	kinematic shape	normalize to high mass

- *Personal contribution:* Trigger efficiences

$\rightarrow$ triggers are not simulated so we need to correct MC samples

Analysis Description

ETH Institute for Particle Physics

Event Categories

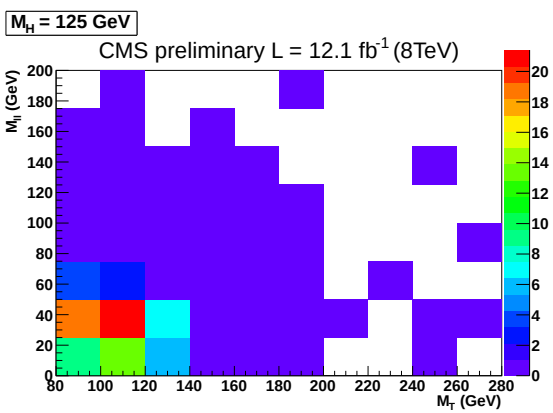
→ sensitive to different production modes / different dominating backgrounds

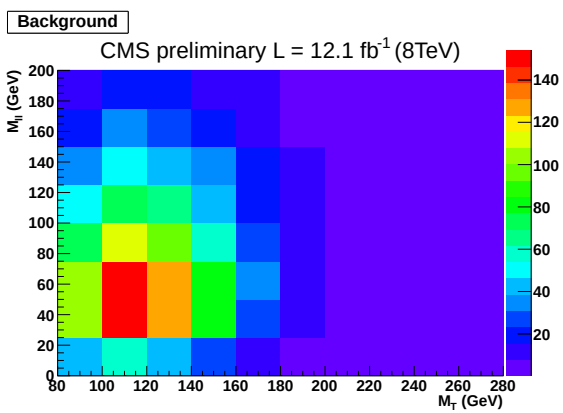
- Different lepton flavour pairs: **DF** ($e\mu$) and **SF** ($ee/\mu\mu$)
- Exclusive jet bins (**0**, **1**, and **2 jet**)

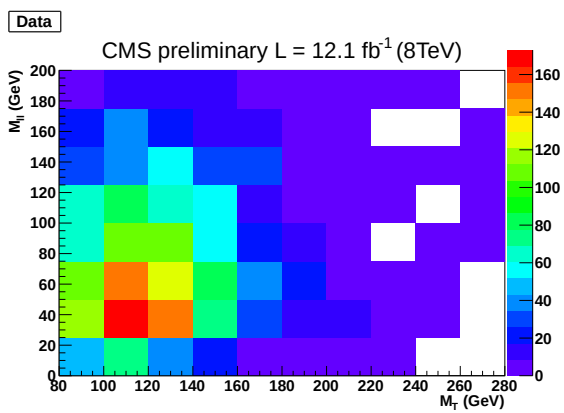
Analysis Approach

- Template fit to the kinematic distributions
- *Personal contribution:* Look at different mass variables

  → try to get better resolution for low Higgs masses



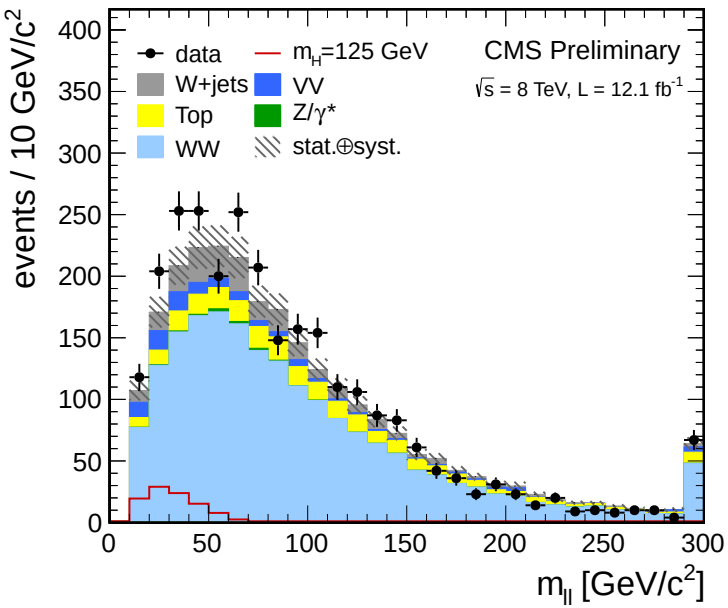




Data-Driven WW Estimate

ETH Institute for Particle Physics

For low-mass Higgs hypotheses ($m_H < 200\,\text{GeV}$)



- WW-dominated control region in $m_{\ell\ell} > 100\,\text{GeV}$
- Subtract contaminations from other backgrounds
- Extrapolate to signal region using ratio obtained from MC
- Good modelling of the kinematic distribution of WW process is crucial

- *Personal contribution:* WW Monte Carlo studies/validation

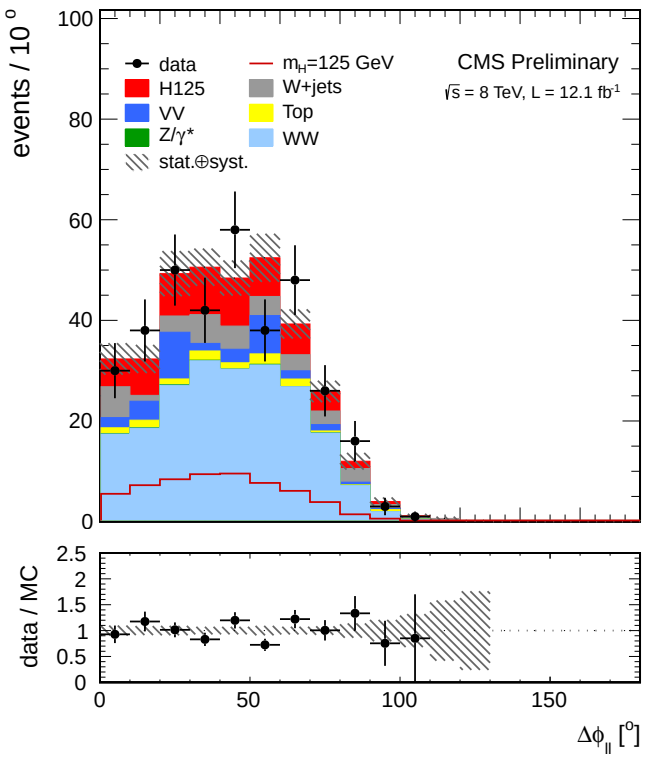
  $\rightarrow$ compare WW MC samples from different generators / parton showers

Results (November 2012)

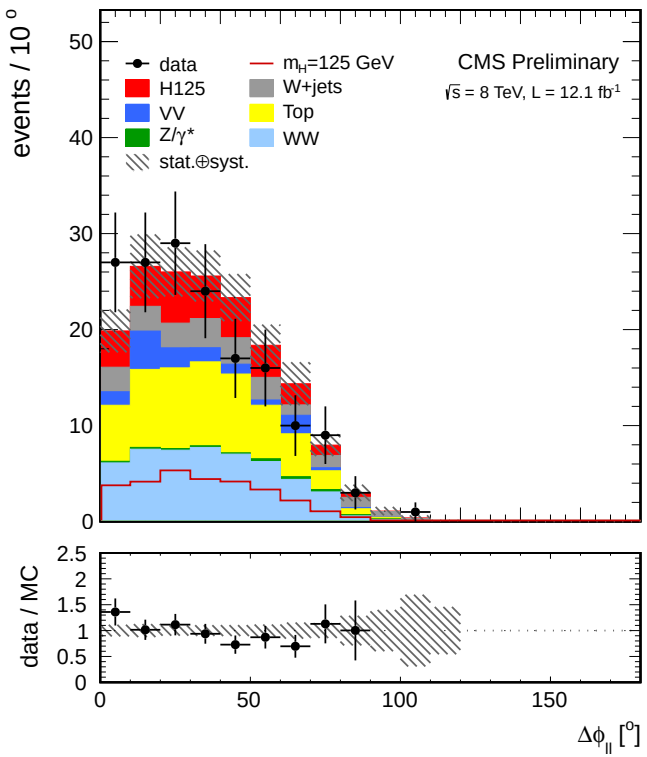
ETH Institute for Particle Physics

$\Delta\phi_{\ell\ell}$ – azimuthal angle difference between the two leptons

0-jet

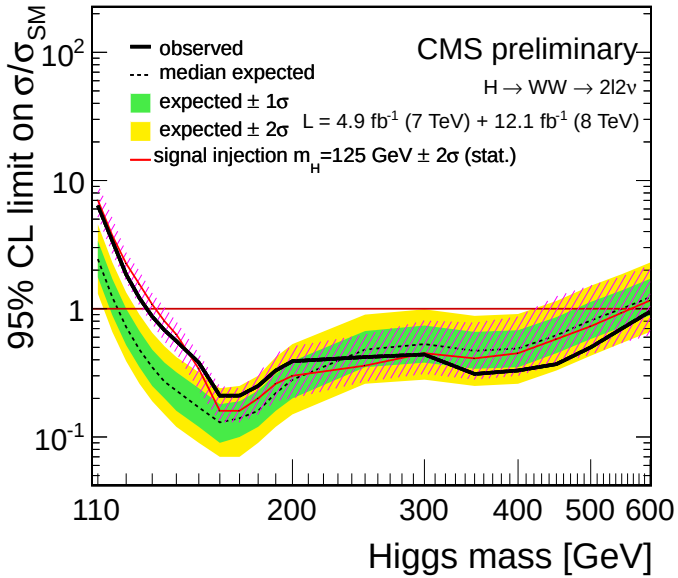


1-jet



More plots/numbers at: https://twiki.cern.ch/twiki/bin/view/CMSPublic/Hig12042TWiki

Results (November 2012)



- obs./exp. significance: $3.1\sigma/4.1\sigma$
- Best fit value $\frac{\sigma}{\sigma_{\mathrm{SM}}} = 0.74 \pm 0.25$

Outlook

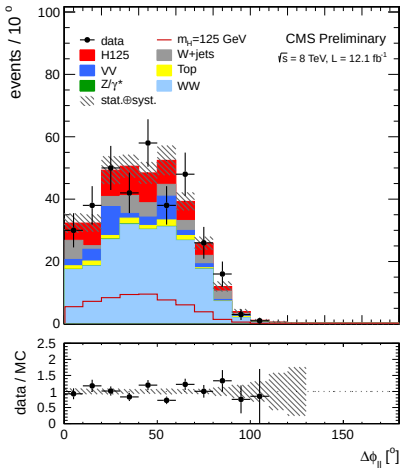
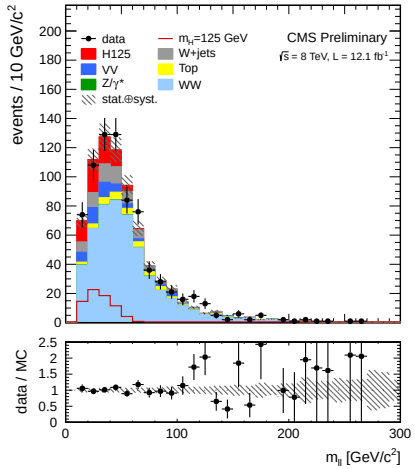
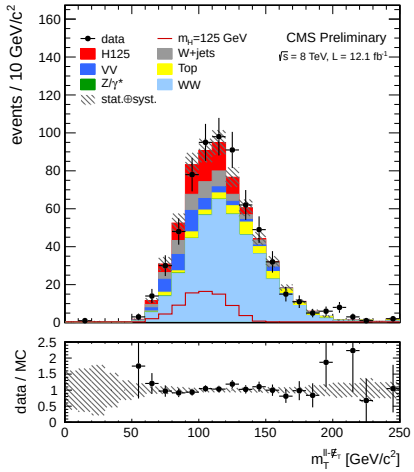
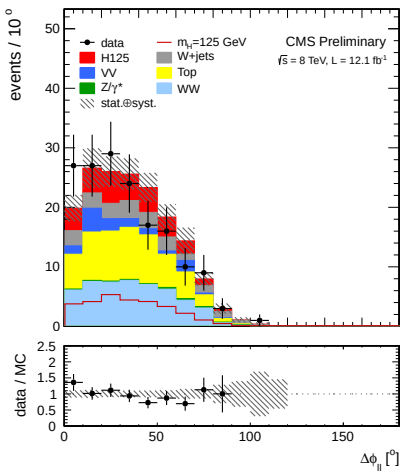
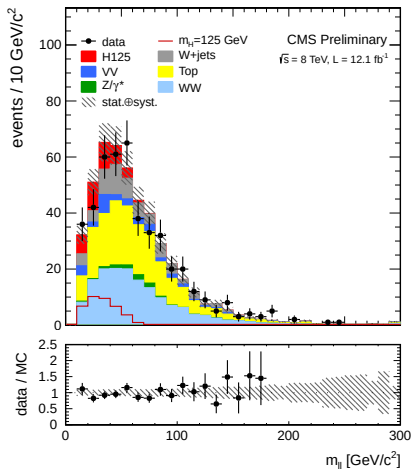
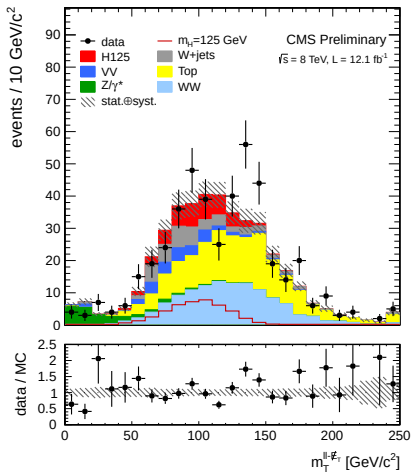
- Improved analysis with more data
- Measurement of properties (spin/parity)

More plots/numbers at: https://twiki.cern.ch/twiki/bin/view/CMSPublic/Hig12042TWiki

Backup

Results (November 2012)

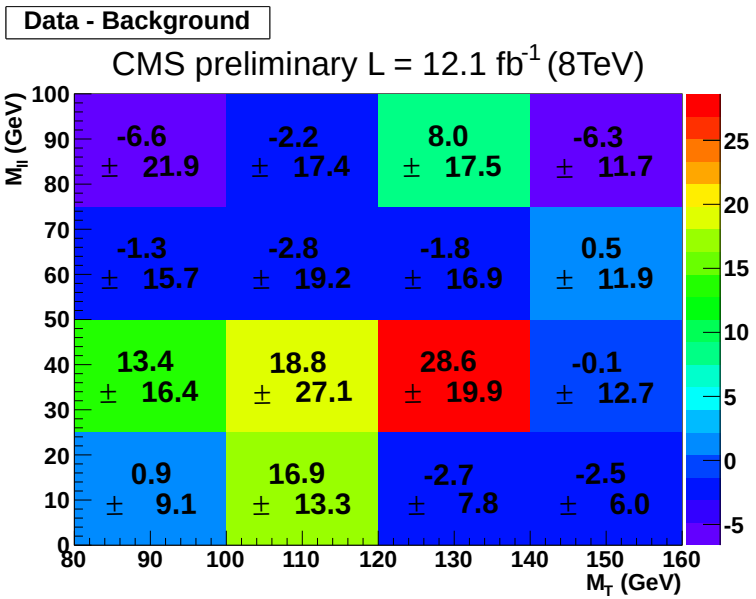
ETH Institute for Particle Physics

	$\Delta\phi_{\ell\ell}$	$m_{\ell\ell}$	m_T
0-jet			
1-jet			

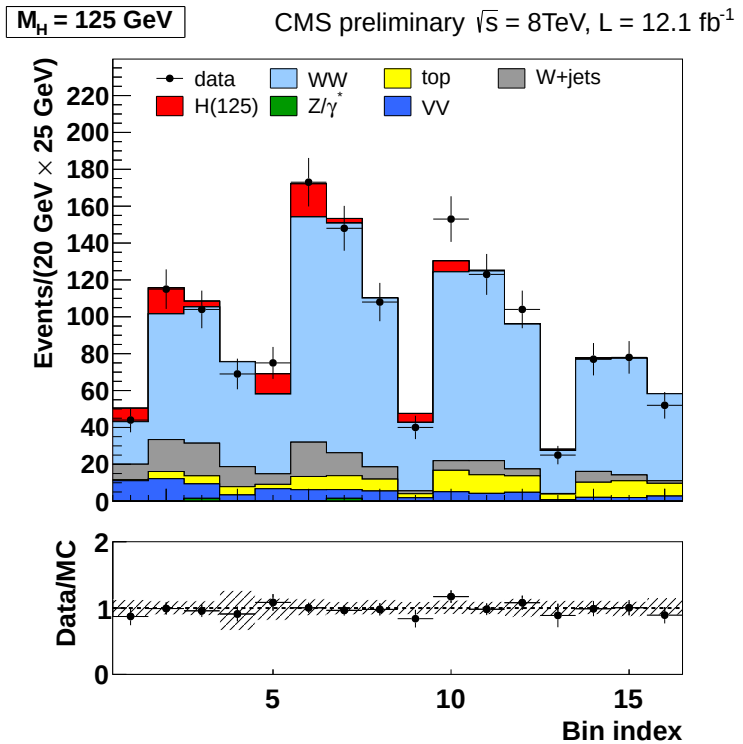
Results (November 2012)

$e\mu$ channel – 0-jet bin

data – background after S+B fit

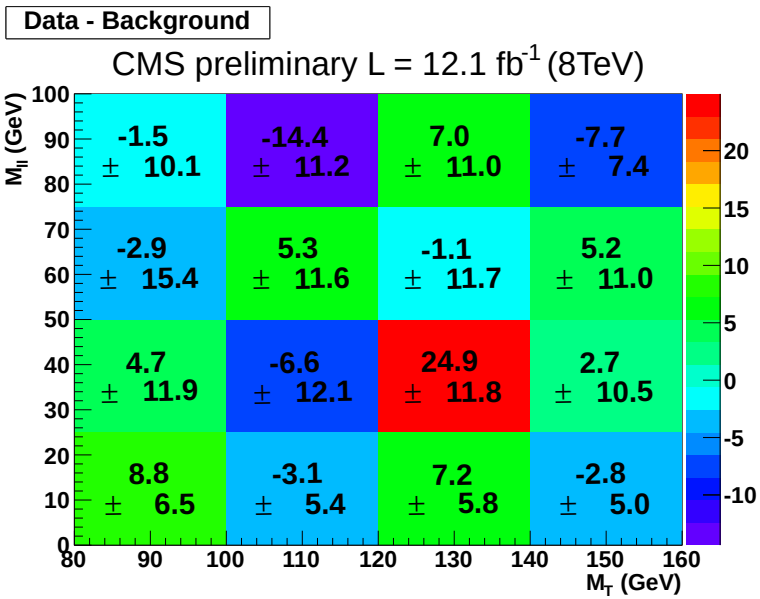


unrolled histogram after S+B fit



$e\mu$ channel – 1-jet bin

data – background after S+B fit



unrolled histogram after S+B fit