ATLAS Live Muon Spectrometer Channel

ATLAS Live Muon Spectrometer Channel

James Stankowicz[1]

University of Florida[1]
Under the guidance of
Dr. Steve Goldfarb - University of Michigan

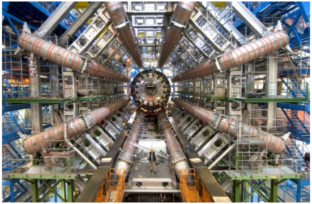
June 2009 - August 2009

Outline

Collaborative Tools

Overview

- Why Collaborative Tools are Necessary
  - The ATLAS Detector is big
  - 11 m radius containing over 12000 m^2 of suface area, and over 1,000,000 readout channels



Collaborative Tools

Overview

- Why Collaborative Tools are Necessary
    - The ATLAS Detector is big
    - 11 m radius containing over 12000 m^2 of suface area, and over 1,000,000 readout channels
    - The ATLAS Collaboration is bigger
    - 2500 Physicists from 169 institutes and 37 countries

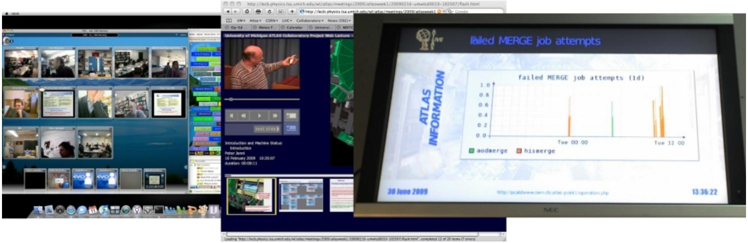
Collaborative Tools

Overview

- Why Collaborative Tools are Necessary
  - The ATLAS Detector is big
  - 11 m radius containing over 12000 m^2 of suface area, and over 1,000,000 readout channels
  - The ATLAS Collaboration is bigger
  - 2500 Physicists from 169 institutes and 37 countries
- What Collaborative Tools Do:
  - Connect people across vast distances
  - Keep collaborators up-to-date and involved

Collaborative Tools

Some Examples



Some Examples:

- Video Conferencing
- Webcasting and Archiving
- *Remote Monitoring*

ATLAS Live

Overview

- What Is ATLAS Live
- Targeting Audiences
- *Muon Spectrometer Channel*

ATLAS Live

What It Is

- Proposed project
  - All work is preliminary
- Collection of information channels
  - Television Channels
- Screens placed around CERN.
  - CERN - Main Auditorium
  - CMS - Building 40
  - ATLAS Live - Building 40

ATLAS Live

What It Is

- Proposed project
  - All work is preliminary
- Collection of information channels
  - Television Channels
- Screens placed around CERN.
  - CERN - Main Auditorium
  - CMS - Building 40
  - ATLAS Live - Building 40

ATLAS Live

What It Is

- Proposed project
  - All work is preliminary
- Collection of information channels
  - Television Channels
- Screens placed around CERN.
  - CERN - Main Auditorium
  - CMS - Building 40
  - ATLAS Live - Building 40

ATLAS Live

What It Is

- Proposed project
  - All work is preliminary
- Collection of information channels
  - Television Channels
- Screens placed around CERN.
  - CERN - Main Auditorium
  - CMS - Building 40
  - ATLAS Live - Building 40

ATLAS Live

Targeting An Audience

Leading Up To The Question:

- The Scala development software allows for robust channels
- Clearly good for general information and outreach
- Easy to interchange and share content between channels

ATLAS Live

Targeting An Audience

Leading Up To The Question:

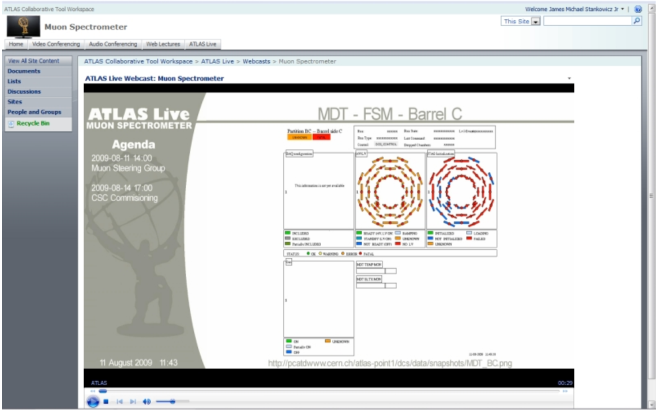
- The Scala development software allows for robust channels
- Clearly good for general information and outreach
- Easy to interchange and share content between channels

The Questions:

- **How specific can the channel be?**
- **Can ATLAS Live assist with remote monitoring?**

ATLAS Live

The Muon Spectrometer Channel



https://espace.cern.ch/atlas-collaborative-tools/atlas-live/webcasts/MuonSpectrometer/default.aspx
mms://wmsuds01.cern.ch/atlaslive-test

Progress

Development

Development took place in the Scala InfoChannel 5 framework.
Scala consists of 3 components:

Progress

Development

Development took place in the Scala InfoChannel 5 framework.
Scala consists of 3 components:

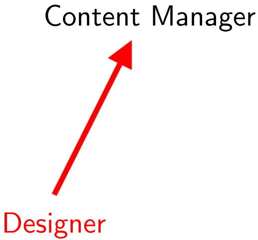
Content Manager

Content Manager - It's all in the name!!

Progress

Development

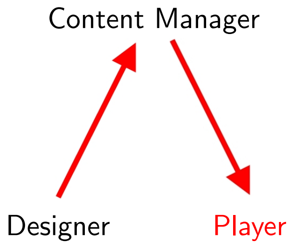
Development took place in the Scala InfoChannel 5 framework.
Scala consists of 3 components:



Content Manager - It's all in the name!!
Designer - Software and computer used to design content

Progress
Development

Development took place in the Scala InfoChannel 5 framework.
Scala consists of 3 components:



Content Manager - It's all in the name!!
Designer - Software and computer used to design content
Player - Software and computer used to display content

Progress

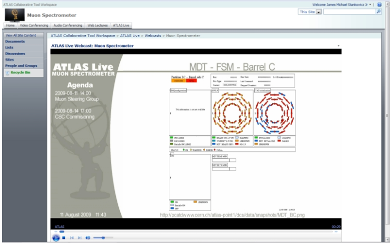
Channel Setup

- Commissioned development center (Designer and Player)

Progress

Channel Setup

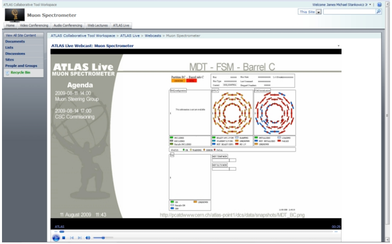
- Commissioned development center (Designer and Player)
- Created pilot Muon Spectrometer channel



Progress

Channel Setup

- Commissioned development center (Designer and Player)
- Created pilot Muon Spectrometer channel
- **Problem:** Each screen requires Scala software → $$$



Progress
Webcasting

- **Solution:** Encode and webcast the content displayed on one Player Screen.
- Computers become 'Players' by playing online content
- Automating webcasting required some creativity:
  - Player Computer automatically restarts at periodic intervals
  - Require Player to automatically webcast and start Player software after periodic reboots

Future Work

Future Content

- Disclaimer: Current Channel is *first* iteration!
  - Input and feedback from experts
  - Give the people what they want
- Scala is VERSATILE!
  - Show non-specific information (from ATLAS/LHC/etc...)
  - Show breaking news (webcasts/Higgs score/etc...)

Future Work

Future Content

- Disclaimer: Current Channel is *first* iteration!
  - Input and feedback from experts
  - Give the people what they want
- Scala is NOT THAT versatile
  - Pushing the limits ($\leftarrow$ typical physicist thing to do)
  - Capturing non-image data (html/agenda/etc...)

Future Work

Flash Encoding

- Present: WME
- Future: Flash Encoder

Future Work

Flash Encoding

- Present: WME
- The Good:
  - Easy screen capture
  - Automated encoding procedure (on startup)
  - CERN AVC has streaming procedure in place

- Future: Flash Encoder
- The Bad:
  - No simple screen capture
  - Possibly complicated automated startup
  - Requires servers to webcast

Future Work

Flash Encoding

- Present: WME
- The Good:
  - Easy screen capture
  - Automated encoding procedure (on startup)
  - CERN AVC has streaming procedure in place
- The Bad:
  - Some browsers/players won't properly display
  - Potential bandwidth issues

- Future: Flash Encoder
- The Good:
  - Universally playable/portable
  - Optimized for streaming webcasts
- The Bad:
  - No simple screen capture
  - Possibly complicated automated startup
  - Requires servers to webcast

Future Work

Other Issues

- Audio
  - Scala supports Audio
  - WME and Flash software support audio encoding
  - Should not be difficult, but is audio necessary/desired?
- Bandwidth
  - Encoding at 1000 kbps, online stream at 1119 kbps
  - How much can CERN support?
  - Trade resolution for bandwidth?
  - Will Flash use less bandwidth?

Summary

ATLAS Live Muon Spectrometer Channel

Q: Can ATLAS Live cater to specialized audiences?

- Obviously useful for general audiences and outreach
- Pilot channel for Muon Spectrometer experts

Summary

ATLAS Live Muon Spectrometer Channel

Q: Can ATLAS Live cater to specialized audiences?

- Obviously useful for general audiences and outreach
- Pilot channel for Muon Spectrometer experts

A: Yes!

- Scala is powerful and versatile enough
- Condenses up-to-date information into one place
- One component in remote shift-taking

Summary

ATLAS Live Muon Spectrometer Channel

Q: Can ATLAS Live cater to specialized audiences?

- Obviously useful for general audiences and outreach
- Pilot channel for Muon Spectrometer experts

A: Yes!

- Scala is powerful and versatile enough
- Condenses up-to-date information into one place
- One component in remote shift-taking

Other Points

- Framework for specialized channel in place
- Some work still to be done

Summary

ATLAS Live Muon Spectrometer Channel

Summary

ATLAS Live Muon Spectrometer Channel

Now let's go find the Higgs!

High Mass Higgs

High Mass Higgs Boson

James Stankowicz[1]

University of Florida[1]
Under the guidance of
Dr. Jonas Strandberg - University of Michigan

June 2009 - August 2009

Outline

Meet The Higgs

Existence

What is the Higgs?

Meet The Higgs

Existence

What is the Higgs?

- A particle!
- A boson! ($Spin = 0$)
- Undiscovered!

Meet The Higgs

Existence

What is the Higgs?

- A particle!
- A boson! ($Spin = 0$)
- Undiscovered!

Why should the Higgs exist?

Meet The Higgs

Existence

What is the Higgs?

- A particle!
- A boson! ($Spin = 0$)
- Undiscovered!

Why should the Higgs exist?

The standard model requires it:

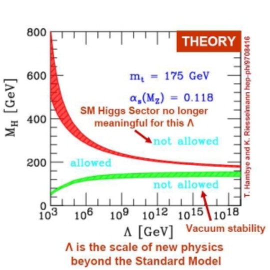
- Final quantum of Higgs field
  - The other quanta ($W^{\pm}$, Z^{0}) already observed
  - Results in massive particles in quantum field theory
- Electroweak symmetry breaking
  - Used to renormalize $W^{\pm}$ cross section calculations

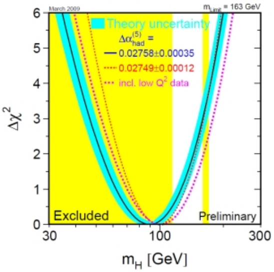
Meet The Higgs

Standard Model Higgs

Since 1960s:

- Sought at every collider (LEP/Tevatron/LHC(?)...)
- Observed lower mass limit: $114.4\ GeV < M_H$
- Tevatron-studied energies: $M_H \notin [160, 170]\ GeV$
- Most sensitive experimental region: $M_H \approx 170\ GeV$
- Theory favors: $200\ GeV > M_H \approx 90\ GeV$





Meet The Higgs

Standard Model Higgs

Since 1960s:

- Sought at every collider (LEP/Tevatron/LHC(?)...)
- Observed lower mass limit: $114.4\ GeV < M_H$
- Tevatron-studied energies: $M_H \notin [160, 170]\ GeV$
- Most sensitive experimental region: $M_H \approx 170\ GeV$
- Theory favors: $200\ GeV > M_H \approx 90\ GeV$

Presently:

- Most preparation for $M_H \approx 170\ GeV$
- Amount of Monte Carlo generated events:

Example background	$W^{\pm} + W^{\mp} \rightarrow e + \mu$	$\sim$ 50000 events
Signal ($M_H = 170\ GeV$)	$H \rightarrow e + \mu + \not{E}_T$	$\sim$ 35000 events
Signal ($M_H = 300\ GeV$)	$H \rightarrow e + \mu + \not{E}_T$	$\sim$ 4000 events

Finding The Higgs

Inside The Detector

When the LHC starts

It's like throwing two TVs at each other really fast and looking at what comes out to see how a TV works - Jiri Stehlik

Finding The Higgs

Inside The Detector

One collision:

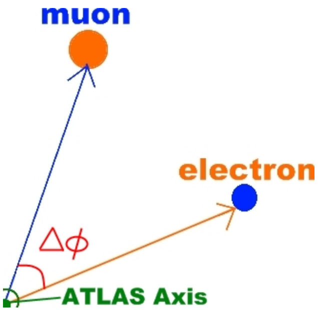
- Protons collide with anti-protons
- Mess of particles come out
- Outcome is *statistical*
- ATLAS tries to measure various properties
- i.e.: Particle identity, charge, $p^{\mu} = (E, \vec{p})$, $\Delta\phi$, ΔR, etc...

Finding The Higgs

Inside The Detector

One collision:

- Protons collide with anti-protons
- Mess of particles come out
- Outcome is *statistical*
- ATLAS tries to measure various properties
- i.e.: Particle identity, charge, $p^\mu = (E, \vec{p})$, $\Delta\phi$, ΔR, etc...



Finding The Higgs

Inside Root

Many millions of collisions every second:

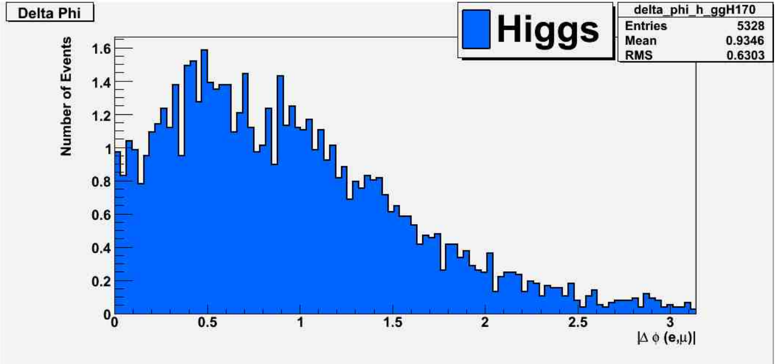
- Measure number of times each quantity takes a specific value
- i.e.: $\Delta\phi(e,\mu) = \pi$ happened 300 times, etc...

Finding The Higgs

Inside Root

Many millions of collisions every second:

- Measure number of times each quantity takes a specific value
- i.e.: $\Delta\phi(e,\mu) = \pi$ happened 300 times, etc...
- Use histograms and *statistics* to do physics!

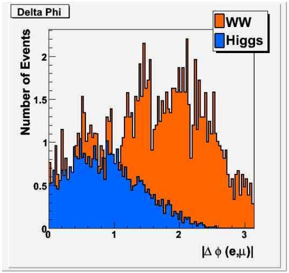


Finding The Higgs

Discovery

The Game:

- Pretend there is not a Higgs (only background = BG)
- Pretend there is a Higgs (only signal = SIG)

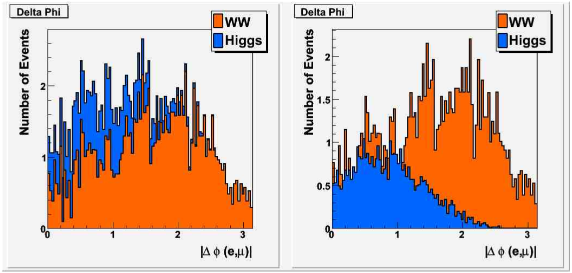


Finding The Higgs

Discovery

The Game:

- Pretend there is not a Higgs (only background = BG)
- Pretend there is a Higgs (only signal = SIG)
- Is SIG + BG *significantly different* from BG?

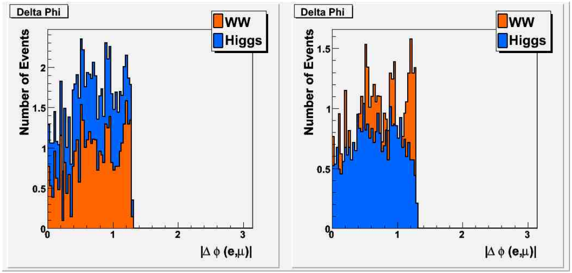


Finding The Higgs

Discovery

The Game:

- Pretend there is not a Higgs (only background = BG)
- Pretend there is a Higgs (only signal = SIG)
- Is SIG + BG *significantly different* from BG?
- Hint: Try to increase *difference* by making cuts on data



Finding The Higgs

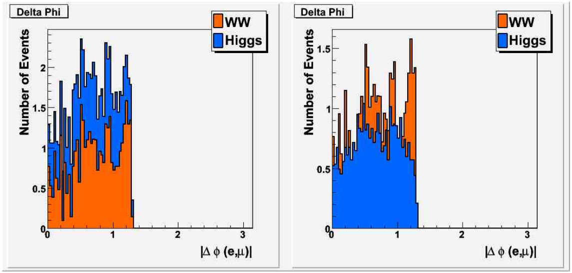
Discovery

The Game:

- Pretend there is not a Higgs (only background = BG)
- Pretend there is a Higgs (only signal = SIG)
- Is SIG + BG *significantly different* from BG?
- Hint: Try to increase *difference* by making cuts on data
- Quantify *significant difference* with standard deviation (σ)

$$\sigma \approx \frac{\int (SIG)\, d\xi}{\left(\int (BG)\, d\xi\right)^{1/2}}$$

Discovery: $\sigma \geq 5$



High and Low

Low Mass Cuts

$M_H \approx 170\ GeV$ - most studied

$$H \rightarrow W + W \rightarrow e + \mu + \nu_e + \nu_\mu = e + \mu + \not{E}_T$$

Preselection cuts:

- Pass triggers
- $\Delta R(e, \mu) \geq 0.3$
- μ, e properties
- $M_{e,\mu} \geq 15\ GeV$
- $\not{E}_T \geq 30\ GeV$
- $M_T \geq 30\ GeV$

Secondary cuts:

- Number of jets $= 0$
- $p_{T;e,\mu} \geq 30\ GeV$
- $\Delta\phi(e, \mu) \geq 1.3$

High and Low

Low Mass Cuts

$M_H \approx 170\ GeV$ - most studied

$$H \rightarrow W + W \rightarrow e + \mu + \nu_e + \nu_\mu = e + \mu + \not{E}_T$$

Preselection cuts:

- Pass triggers
- $\Delta R(e, \mu) \geq 0.3$
- μ, e properties
- $M_{e,\mu} \geq 15\ GeV$
- $\not{E}_T \geq 30\ GeV$
- $M_T \geq 30\ GeV$

Secondary cuts:

- Number of jets $= 0$
- $p_{T;e,\mu} \geq 30\ GeV$
- $\Delta\phi(e, \mu) \geq 1.3$

High and Low

High Mass Cuts

$M_H \geq 220\ GeV$ - here studied

$$H \rightarrow W + W \rightarrow e + \mu + \nu_e + \nu_\mu = e + \mu + \not{E}_T$$

Preselection cuts:

- Pass triggers
- $\Delta R(e, \mu) \geq 0.3$
- μ, e properties
- $M_{e,\mu} \geq 15\ GeV$
- $\not{E}_T \geq 30\ GeV$
- $M_T \geq 30\ GeV$

Secondary cuts:

- Number of jets $= 0$
- $p_{T;e,\mu} \geq 30\ GeV$
- $\Delta\phi(e, \mu) \geq 1.3$

High and Low

High Mass Cuts

$M_H \geq 220\ GeV$ - here studied

$$H \rightarrow W + W \rightarrow e + \mu + \nu_e + \nu_\mu = e + \mu + \not{E}_T$$

Preselection cuts:

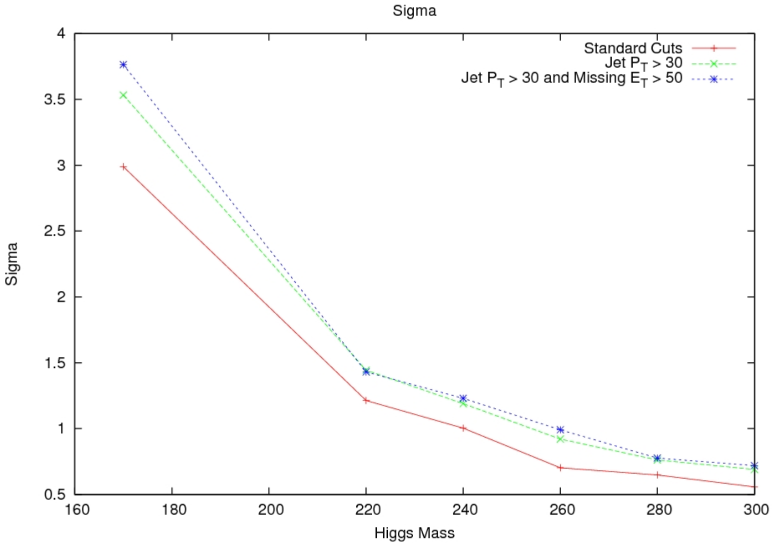
- Pass triggers
- $\Delta R(e,\mu) \geq 0.3$
- μ, e properties - $\uparrow \vec{p}_{e,\mu}$
- $M_{e,\mu} \geq 15\ GeV$
- $\not{E}_T \geq 50\ GeV$
- $M_T \geq 30\ GeV$

Secondary cuts:

- Number of jets $= 0$ - $\uparrow \vec{p}_{jet}$
- $p_{T;e,\mu} \geq 30\ GeV$
- $\Delta\phi(e,\mu) \geq 1.3$

High and Low

High Mass Cuts



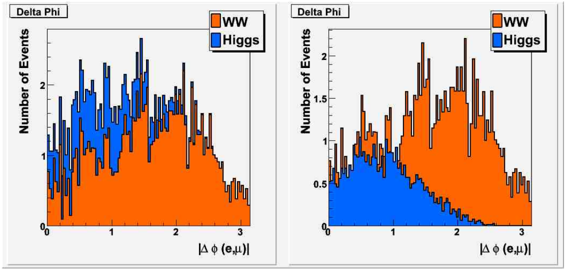
High and Low

$\Delta\phi$ Cut

Losing $\Delta\phi$ Cut

- Higgs is a spin 0 boson
- For $M_H \approx 170\ GeV$, $|\Delta\phi(e,\mu)|$ should be small
- For $W + W \rightarrow e + \mu$, $|\Delta\phi(e,\mu)|$ need not be small
- Cut on $|\Delta\phi(e,\mu)| < 1.5$

M_H (GeV)	Standard Deviations Before $\Delta\phi$	After $\Delta\phi$
170	3.699	4.839
220	1.389	1.068
240	1.176	0.643
260	0.938	0.354
280	0.770	0.215
300	0.710	0.140

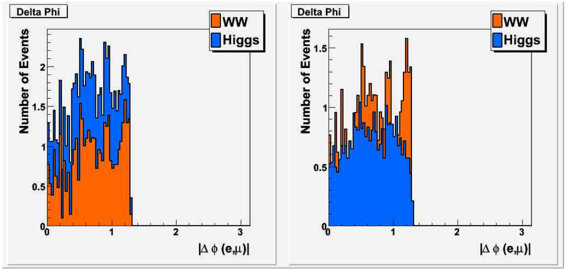


High and Low
$\Delta\phi$ Cut

Losing $\Delta\phi$ Cut

- Higgs is a spin 0 boson
- For $M_H \approx 170\ GeV$, $|\Delta\phi(e,\mu)|$ should be small
- For $W + W \rightarrow e + \mu, |\Delta\phi(e,\mu)|$ need not be small
- Cut on $|\Delta\phi(e,\mu)| < 1.5$

M_H (GeV)	Standard Deviations Before $\Delta\phi$	After $\Delta\phi$
170	3.699	4.839
220	1.389	1.068
240	1.176	0.643
260	0.938	0.354
280	0.770	0.215
300	0.710	0.140



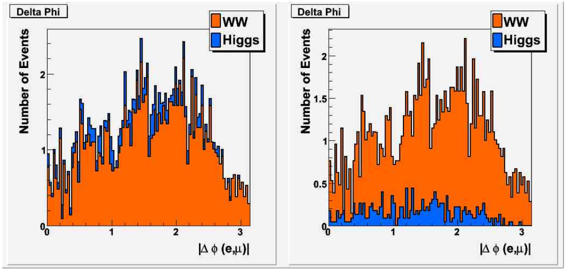
High and Low

$\Delta\phi$ Cut

Losing $\Delta\phi$ Cut

- Higgs is a spin 0 boson
- For $M_H > 170\ GeV$, $|\Delta\phi(e,\mu)|$ has no trend
- For $W + W \rightarrow e + \mu$, $|\Delta\phi(e,\mu)|$ need not be small
- Cut on $|\Delta\phi(e,\mu)| < 1.5$ no longer effective

M_H (GeV)	Standard Deviations Before $\Delta\phi$	After $\Delta\phi$
170	3.699	4.839
220	1.389	1.068
240	1.176	0.643
260	0.938	0.354
280	0.770	0.215
300	0.710	0.140



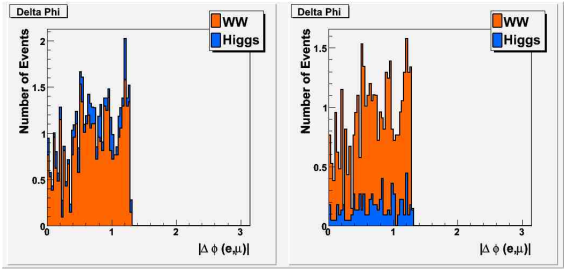
High and Low

$\Delta\phi$ Cut

Losing $\Delta\phi$ Cut

- Higgs is a spin 0 boson
- For $M_H > 170\ GeV$, $|\Delta\phi(e,\mu)|$ has no trend
- For $W + W \rightarrow e + \mu$, $|\Delta\phi(e,\mu)|$ need not be small
- Cut on $|\Delta\phi(e,\mu)| < 1.5$ no longer effective

M_H (GeV)	Standard Deviations Before $\Delta\phi$	Standard Deviations After $\Delta\phi$
170	3.699	4.839
220	1.389	1.068
240	1.176	0.643
260	0.938	0.354
280	0.770	0.215
300	0.710	0.140



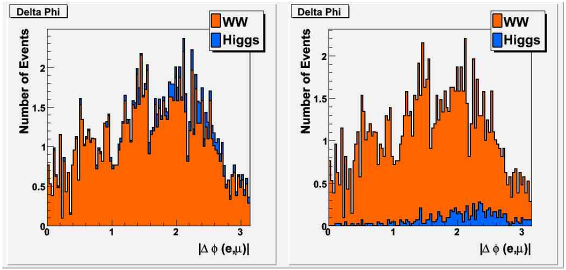
High and Low

$\Delta\phi$ Cut

Losing $\Delta\phi$ Cut

- Higgs is a spin 0 boson
- For $M_H > 170\ GeV$, $|\Delta\phi(e,\mu)|$ has no trend
- For $W + W \rightarrow e + \mu$, $|\Delta\phi(e,\mu)|$ need not be small
- Cut on $|\Delta\phi(e,\mu)| < 1.5$ no longer effective

M_H (GeV)	Standard Deviations Before $\Delta\phi$	After $\Delta\phi$
170	3.699	4.839
220	1.389	1.068
240	1.176	0.643
260	0.938	0.354
280	0.770	0.215
300	0.710	0.140

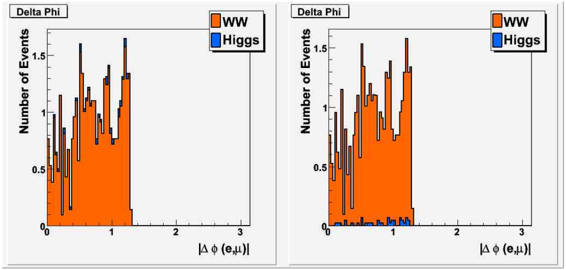


High and Low
$\Delta\phi$ Cut

Losing $\Delta\phi$ Cut

- Higgs is a spin 0 boson
- For $M_H > 170\ GeV$, $|\Delta\phi(e,\mu)|$ has no trend
- For $W + W \rightarrow e + \mu, |\Delta\phi(e,\mu)|$ need not be small
- Cut on $|\Delta\phi(e,\mu)| < 1.5$ no longer effective

M_H (GeV)	Standard Deviations Before $\Delta\phi$	After $\Delta\phi$
170	3.699	4.839
220	1.389	1.068
240	1.176	0.643
260	0.938	0.354
280	0.770	0.215
300	0.710	0.140



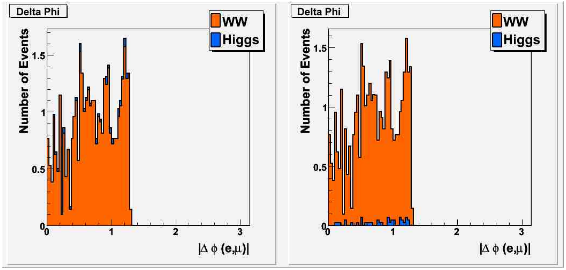
High and Low

$\Delta\phi$ Cut

Losing $\Delta\phi$ Cut

- Higgs is a spin 0 boson
- For $M_H > 170\ GeV$, $|\Delta\phi(e,\mu)|$ has no trend
- For $W + W \rightarrow e + \mu, |\Delta\phi(e,\mu)|$ need not be small
- Cut on $|\Delta\phi(e,\mu)| < 1.5$ no longer effective

M_H (GeV)	Standard Deviations Before $\Delta\phi$	After $\Delta\phi$
170	3.699	4.839
220	1.389	1.068
240	1.176	0.643
260	0.938	0.354
280	0.770	0.215
300	0.710	0.140



Summary

High Mass Higgs

Q: How will the current search criteria do if $M_H > 170\ GeV$?

- Theoretically most favored $M_H \approx 90\ GeV$ experimentally invalidated
- Most efforts focused around 170 GeV
- Murphy's Law - Anything that can go wrong will

Summary

High Mass Higgs

Q: How will the current search criteria do if $M_H > 170\ GeV$?

- Theoretically most favored $M_H \approx 90\ GeV$ experimentally invalidated
- Most efforts focused around 170 GeV
- Murphy's Law - Anything that can go wrong will

A: Not that well!

- Not much Monte Carlo data
- Most powerful cut ($\Delta\phi(e, \mu)$) counterproductive for $M_H \geq 220\ GeV$

Summary

High Mass Higgs

Q: How will the current search criteria do if $M_H > 170\ GeV$?

- Theoretically most favored $M_H \approx 90\ GeV$ experimentally invalidated
- Most efforts focused around 170 GeV
- Murphy's Law - Anything that can go wrong will

A: Not that well!

- Not much Monte Carlo data
- Most powerful cut $(\Delta\phi(e, \mu))$ counterproductive for $M_H \geq 220\ GeV$

Other Points:

- Changed some cuts to increase σ
- Made but did not analyze other parameters

Summary

High Mass Higgs

Summary

High Mass Higgs

FIN!

Acknowledgments

Thanks to pretty much everyone:

- All the Univeristy of Michigan people:
  - Dr. Steve Goldfarb
  - Dr. Jonas Strandberg
  - Dr. Jean Krisch
  - Dr. Homer Neal
  - Jeremy Herr
  - The others not on here
- The other REU students - it was fun!