

Explore the proton and search for the Higgs:  
Physics Discussion of the ATLAS W-path

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**International Masterclasses 2012 - Moderators orientation**

# Student's tasks 1

1. Explore the structure of the proton by counting the number of  $W^+$  and  $W^-$  events in  $W$  candidate events
  - Students identify  $W$  candidate events, decay products and (if possible) their electric charge, calculate ratio  $R_{\pm}$
  
2. Search for the Higgs in  $l^+ \nu l^- \nu + 0$  Jets final state
  - 210 Simulated  $WW \rightarrow l^+ \nu l^- \nu + 0$  Jets and 40  $H \rightarrow WW \rightarrow l^+ \nu l^- \nu + 0$  Jets were mixed with 5750 real data events
  - Students identify  $WW$  candidate events and measure the angle  $\Delta\phi_{ll}$

## Analysis on an ATLAS data sample



Group A: 0001-0050

Events		Tally Marks		Number of Events
Signal 1	$W \rightarrow e + \nu$	+		
		-		
	$W \rightarrow \mu + \nu$	+		
		-		
Signal 2	$WW \rightarrow l\nu + l\nu$	Event number	$\Delta\phi_{ll}$	
Background				

Comments/Event number(s) of strange or unclear events:



# Improvements with the data sample

data sample of  
6000 events

sub  
sample 1

sub  
sample 2

sub  
sample 6

split up  
into 6  
sub  
samples  
each of  
1000  
events

sub sample  $i$  (for MC 2012):

1000 events containing:

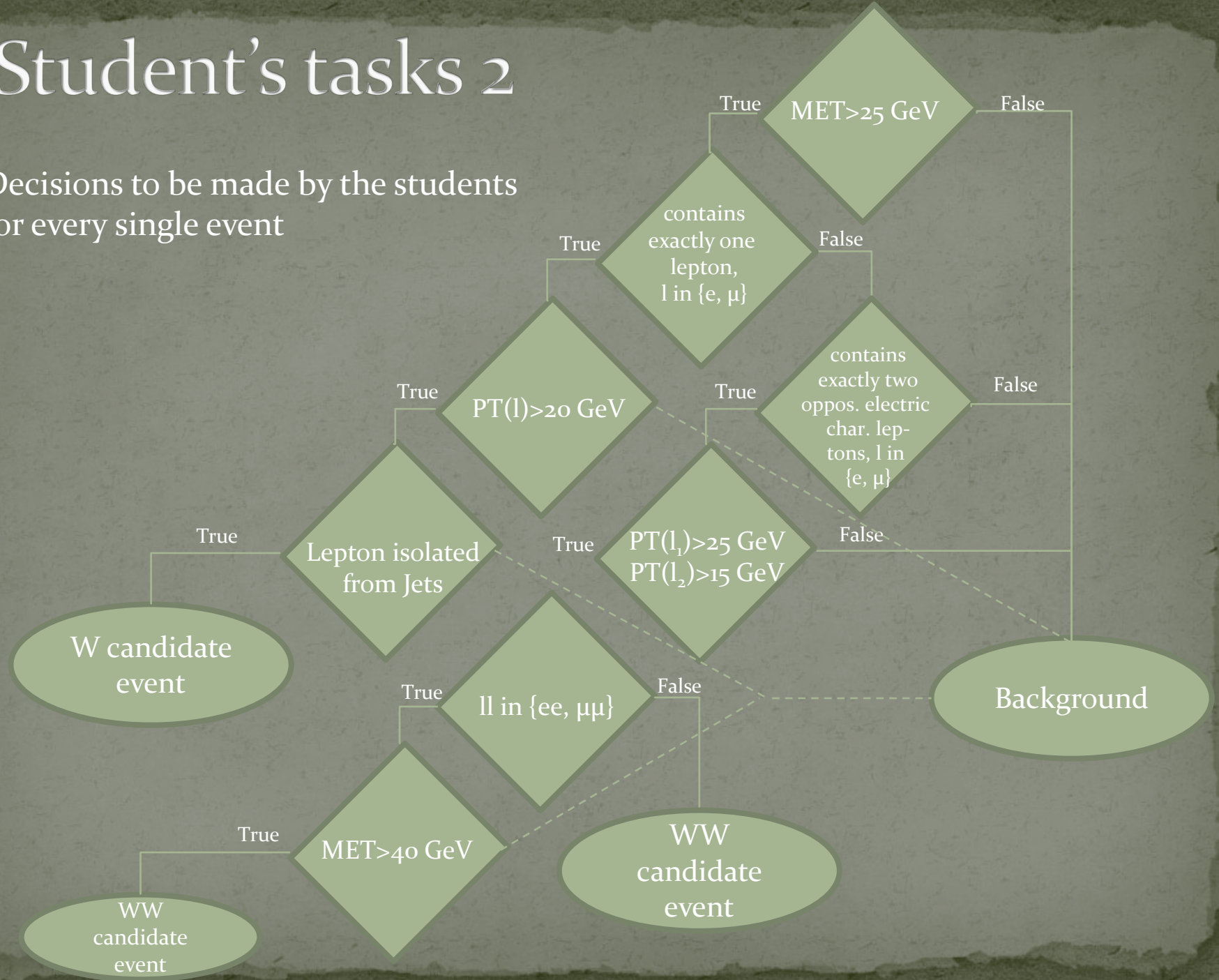
- $W$  candidate events ( $W \rightarrow l + \nu$ ;  $l \in \{e, \mu\}$ ) of real data
- Background events of real data
- $WW$  events ( $H \rightarrow WW \rightarrow ll + \nu\nu$ ;  $l \in \{e, \mu\}$ ) of simulated data

work on data samples:

1. distinguish between  $W$  ( $W^+ \rightarrow e^+ + \nu$ ,  $W^- \rightarrow e^- + \nu$ ,  $W^+ \rightarrow \mu^+ + \nu$ ,  $W^- \rightarrow \mu^- + \nu$ ), Background and  $WW$
2. For  $WW$  events measure the angle between leptons in transversal plane
3. enter all values on the tally sheet

# Student's tasks 2

Decisions to be made by the students for every single event



# The essence 1

## 1. Report of measurement (15')

Each venue presents:

- measured ratio  $R_{\pm}$  of number of  $W^+$  to number of  $W^-$  events in  $W$  candidate events
- local histogram - distribution of  $\Delta\phi_{ll}$  (*angle between the two detectable leptons in transversal plane*) in  $WW$  candidate events

# The essence 2

## 2. Combination and discussion of measurement (10')

- Discuss development of  $R_{\pm}$  after combination and compare with current ATLAS measurement on the Editgrid [Online Spreadsheet](#)
- Discuss the meaning of that result
- Discuss development of histograms after combination on the following [websites](#) (Venues' histograms + Combined histogram)
- Discuss selection of events, pre-conditions for claiming a discovery, shape of the angular distribution (at this kind of level: *“By taking spin relations of the produced particles into account we expect to find the Higgs events mainly at angles less than 90 degrees while Standard Model WW events appear in the whole angle range in which they prefer to appear at angles greater than 90 degrees.”*) and current result of this search
- Discuss difficulties occurred during the measurement

Analysis 2012 - Online Spreadsheets - EditGrid - Windows Internet Explorer

http://www.editgrid.com/user/masterclass/Analysis\_2012

Convert Select

Favorites Suggested Sites Web Slice Gallery CERN Authentication (2) CERN Authen

International Master... International Master... Analysis 2012 - ... Doodle: Additional ...

### EditGrid

Spreadsheet / masterclass / Analysis 2012

File Edit View Format Insert Data Share Publish Collaborate Macro Help

Garamond 18 pt B / U

A2 =sum(B10:G10)

A	B	C	D	E	F	G	
1	N=	W → ... + v				Background	WW
2	357.0	positron	electron	antimuon	muon		number of events
3	place 1	46	37	38	26	60	3
4	place 2	0	0	0	0	0	0
5	place 3	0	0	0	0	0	0
6	place 4	0	0	0	0	0	0
7	place 5	12	21	33	4	53	24
8	place 6	0	0	0	0	0	0
9							
10	Sum	58.0	58.0	71.0	30.0	113.0	27.0
11	W+ & W-	number of W+	129.0	number of W-	88.0		
12	W+ / W-	1.47		±	0.20		
13							
14	Comparison with results of the ATLAS collaboration (from 2011):						
15	<i>Measurement of the W → lnu and Z/γ* → ll production cross sections in proton-proton collisions at sqrt(s) = 7 TeV with the ATLAS detector *)</i>						
16	<i>Search for the Standard Model Higgs boson in the H → WW(*) → lνlν decay mode using 1.7 fb<sup>-1</sup> of data collected with the ATLAS detector at sqrt(s) = 7 TeV **)</i>						
17	*) Authors: The ATLAS Collaboration (Submitted on 5 Dec 2011): <a href="http://arxiv.org/abs/1109.5141.pdf">http://arxiv.org/abs/1109.5141.pdf</a>						
18	**) Authors: The ATLAS Collaboration (24 Aug 2011): ATLAS-CONF-2011-134						
19		W → ... + v				Background	WW+0J cand.
20		positron	electron	antimuon	muon		

11.01.2012 / CERN / Maynoth / Copenhagen / Ferrara / place5 / place6 /

Done Read ✔ Writs ✔ login to join chat room.



HOME PAGE

W-PATH

Z-PATH

### Analysis

#### Combining results

After the measurement all the data will be combined. Therefore, you'll enter your measurement results into this [ONLINE SPREAD SHEET](#).

#### Instructions for the analysis

The histogram of the angular distribution from your venue can be obtained by choosing your venue from the drop down menu at the side menu of this website.

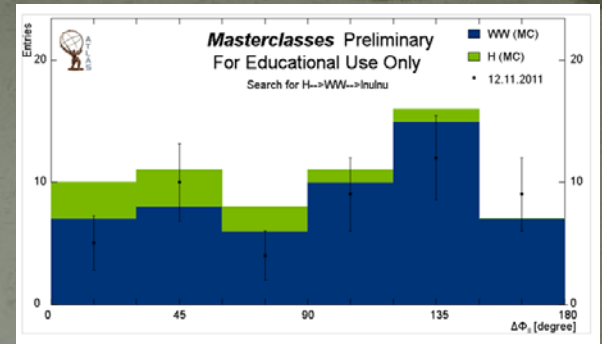
A Video Conference is taking place as closing event at the end of the day. There you'll come together with student groups from other cities and countries, which have also analyzed ATLAS data. Your results can be compared by using the Online Spread Sheet. Especially the measured angles of all WW candidate events are supposed to be combined in one single histogram. It will be discussed during the Video Conference.

### Content

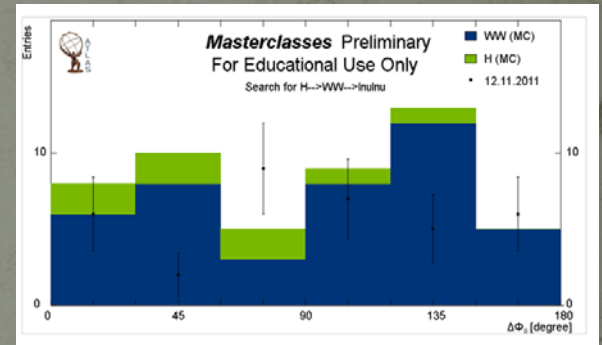
- AIMS/TASKS
- IDENTIFYING PARTICLES
- IDENTIFYING EVENTS
- MEASUREMENT

#### Analysis

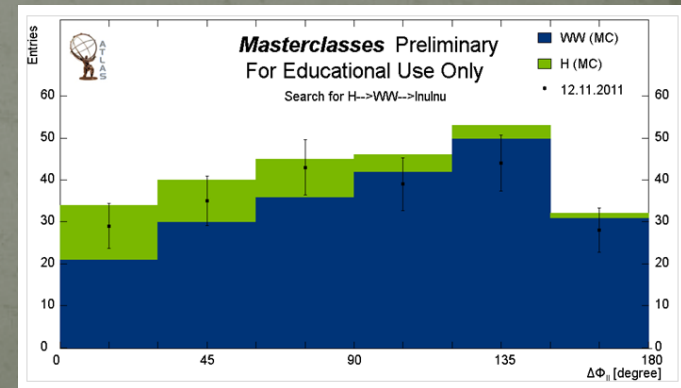
- Go to the histogram of your venue...
- Go to the histogram of your day.....



Histogram of venue 1



Histogram of venue 2



Combined Histogram of the day

Choose histograms of either venues or days  
From the drop-down menu



# Preparation/Support at the VC room

- Everything will be prepared for you: links to all necessary websites will be opened, spread sheets are hopefully filled by the students, histograms will be produced automatically
- You can fully concentrate on the moderation of the VC
- Summarizing sheet of paper will be in front of you:
  - Who is attending the VC? What to do? When to do? What do I need?
- Clock will be there
- And I will be there as well ;)

# Material

- [Masterclasses schedule](#)
- [Website](#) explaining the measurement
- [Online Spreadsheet](#) for discussion
- [Histogram Websites](#) for combination and discussion
- [ATLAS paper](#) (Springer Open Access article): Measurement of the  $W \rightarrow l\nu$  and  $Z/\gamma^* \rightarrow ll$  production cross sections in proton-proton collisions at  $\sqrt{s} = 7$  TeV with the ATLAS detector
- [ATLAS Conf Note](#) : Search for the Standard Model Higgs boson in the  $H \rightarrow WW \rightarrow ll\nu\nu$  decay mode using  $1.7 \text{ fb}^{-1}$  of data collected with the ATLAS detector at  $\sqrt{s}=7\text{TeV}$