

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

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by Konrad Jende

**International Masterclasses 2013 - Moderators orientation**

# Student's tasks 1

1. Explore the structure of the proton by counting the number of  $W^+$  and  $W^-$  events
  - Students identify  $W$  candidate events, decay products and (if possible) their electric charge, calculate ratio  $R_{\pm}$
  
2. Search for the Higgs in  $l^+ \nu l^- \nu + 0,1$  Jets final state
  - 693 real  $WW \rightarrow l^+ \nu l^- \nu + 0,1$  Jets were mixed with 5307 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  $i$ :

1000 events containing [first number for data samples 1-3, number in brackets for data sample 4-6]:

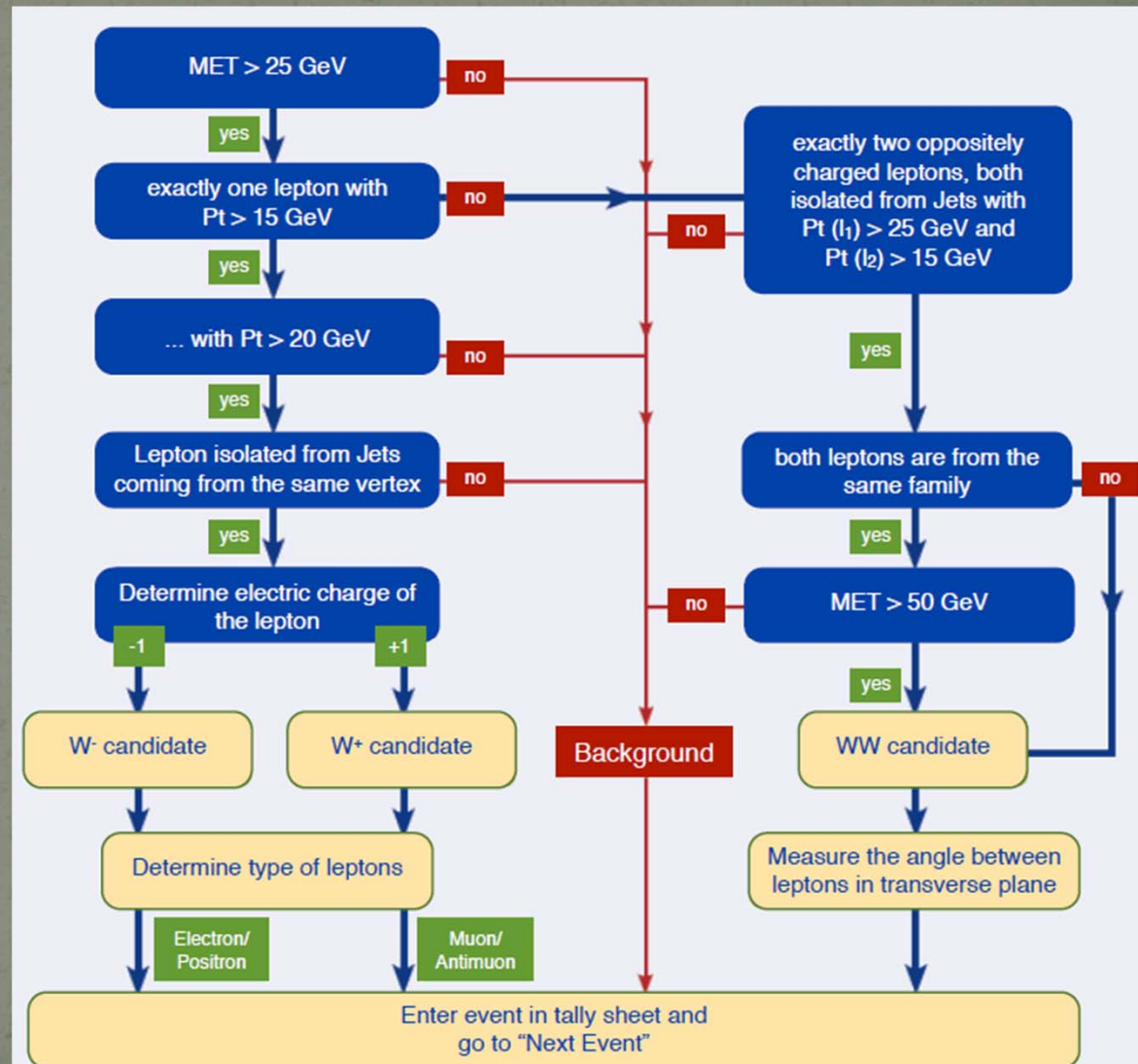
- 280 (310)  $W$  candidate events ( $W \rightarrow l+\nu$ ;  $l \in \{e, \mu\}$ ) of real data
- 560 (620) Background events of real data
- 160 (70)  $WW$  events ( $WW \rightarrow ll+\nu\nu$ ;  $l \in \{e, \mu\}$ )

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 transverse 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
- Number of events of found  $WW$  candidate events

The only thing you have to do is: Lead through the circulation and share the combined online spread sheet.

# The essence 2

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

- Go to the ATLAS [W-path analysis moderator website](#)
- Discuss development of  $R_{\pm}$  after combination and compare with current ATLAS measurement on the combined online spread sheet, which you will obtain by choosing the current date from the first drop-down menu on the moderator's website
- Discuss the meaning of that result
- Discuss development of combined histogram, which can be obtained by choosing the current date from the second drop-down menu
- Discuss selection of events, pre-conditions for claiming a discovery, shape of the angular distribution and current result of this search
- Discuss difficulties occurred during the measurement



# 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
- Moderator's website: [Link](#)
- [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  $\sqrt{s}=7\text{TeV}$