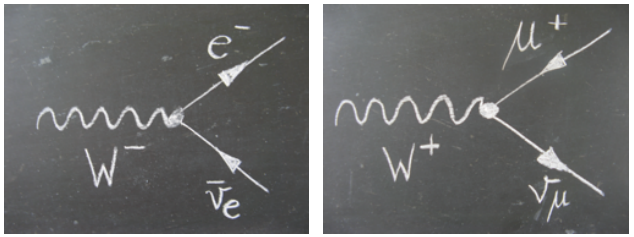
A. Aims of the exercise



1) Check the quark structure of the proton

- **Recognize and *count* W → l+ν decays**

+

$W^+ \rightarrow e^+ + \nu_e \rightarrow e^+ + ET_{manquante}$

$W^- \rightarrow e^- + \bar{\nu}_e \rightarrow e^- + ET_{manquante}$

$W^+ \rightarrow \mu^+ + \nu_\mu \rightarrow \mu^+ + ET_{manquante}$

-

$W^- \rightarrow \mu^- + \bar{\nu}_\mu \rightarrow \mu^- + ET_{manquante}$

- **Measure the ratio W^+/W^-**

In a proton-proton collision, will we produce more W^+ or W^- ?

With which proportion of W^+ and W^- ?

What do we learn from this ?

2) Looking for the Higgs boson ($H \rightarrow W^+ + W^-$)

- **Identify events with 2 W :**

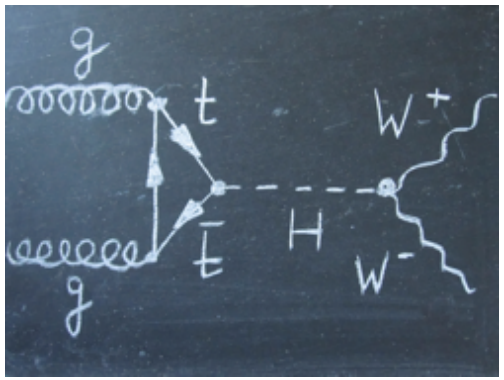
$W^+W^- \rightarrow e^+ + \nu_e + e^- + \bar{\nu}_e \rightarrow e^+ + e^- + ET_{manquante}$

$W^+W^- \rightarrow e^+ + \nu_e + \mu^- + \bar{\nu}_\mu \rightarrow e^+ + \mu^- + ET_{manquante}$

$W^+W^- \rightarrow \mu^+ + \nu_\mu + e^- + \bar{\nu}_e \rightarrow \mu^+ + e^- + ET_{manquante}$

$W^+W^- \rightarrow \mu^+ + \nu_\mu + \mu^- + \bar{\nu}_\mu \rightarrow \mu^+ + \mu^- + ET_{manquante}$

- ***Measure the angle* between the two charged leptons(e/μ)**
- **Observe the distribution of this angle**



This angle is different if the two W come from a Higgs boson or from another process.

B. Starting

1. Open the software

Top-left : `Applications ▶ Autre ▶ ATLAS W path`

2. Loading data

1 click for opening data
2 click to go back to the home folder
3 open the following file :

a) First, all together, a training exercise :

Masterclasses-XX/W-path/events/exercise2-2014.zip

STOP We do the training together

b) Then, alone, you analyse your own dataset :

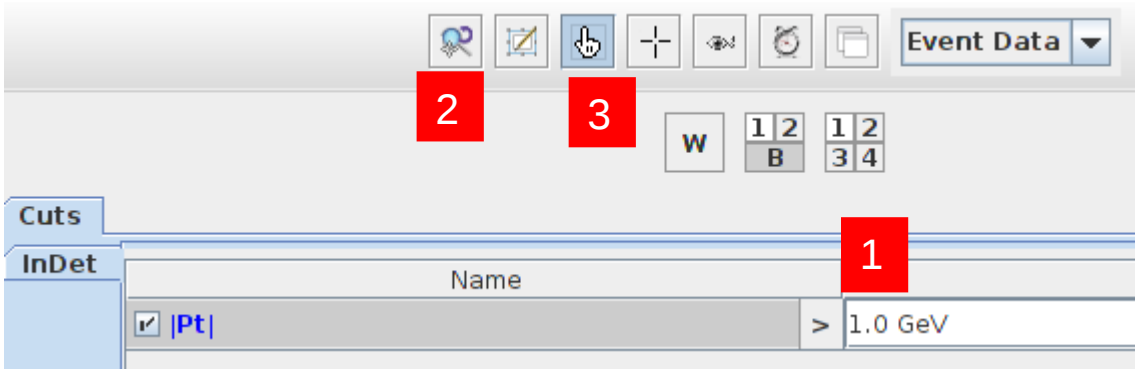
Masterclasses-XX/W-path/events/XY.zip

Group number

Username: lt-master-00 password: wsY7GeNG

Data sample:	Signal 1	
1A	$W \to \nu + \cdots$	$W \to \nu$
Event #	e^+	e^- μ^+

3. Cuts and tools

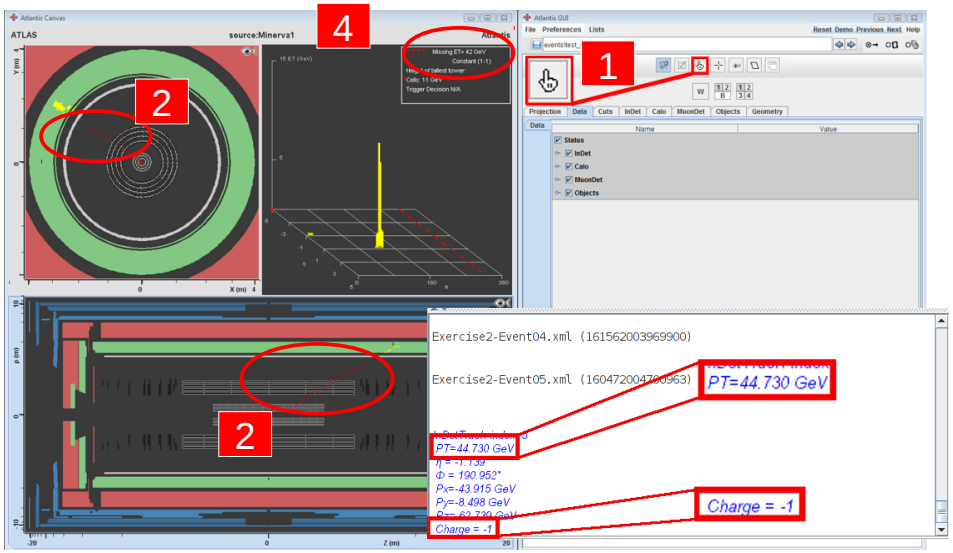


Cuts (select what to see on the graphical interface)
1 modify the cut on Pt (5 or 10 GeV)
Tools : sélectionner l'outil de
2 zoom/rotation
3 selection

- Zoom in : towards the detector's inside
- Zoom out : to the exterior
- Translation : press « m » then 2
- **Angle measurement** : press « p » while selecting the two tracks with 3

C. Selection

1 lepton : e+, e-, μ+ ou μ-
2 leptons : e+e-, e+μ-, e-μ+, μ+μ-



Charged leptons : e, μ

1 Click on the hand

2 Select the track corresponding to the lepton

3 Read PT and charge

Isolated lepton : no other track around it (beware of the projections ! ». The isolation value is given in the informations.

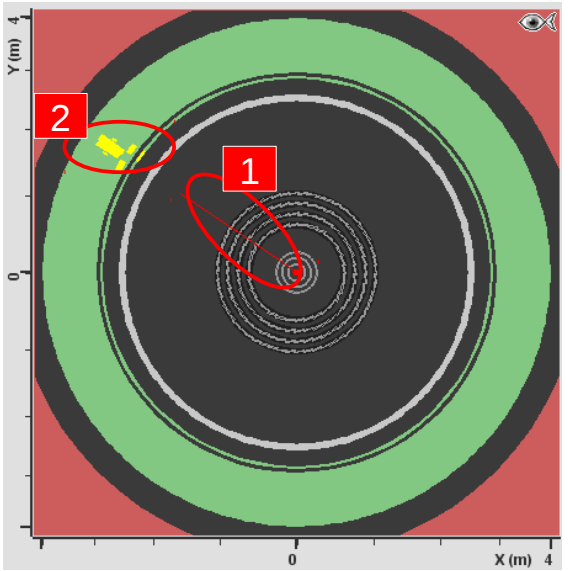
Missing transverse energy

4 Read « Missing ET »

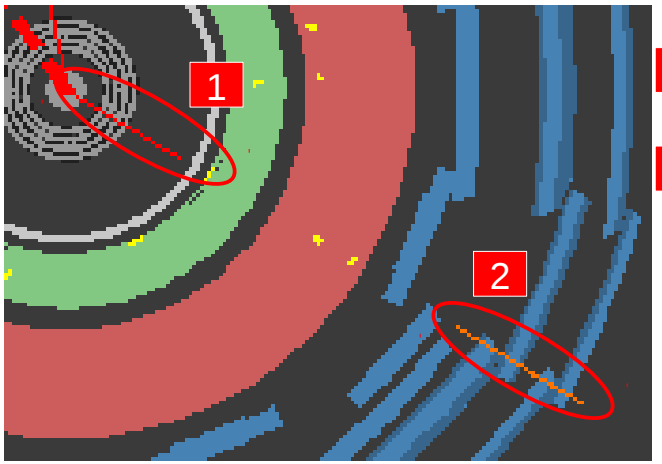
Recognize an electron/positron

1 Track

2 Energy in the EM calorimeter



Recognize a muon/antimuon



1 Track

2 That continues in the muon system

D. Results

1. <u>Fill in the counting spreadsheet</u>

Data sample: 1A		Signal 1				Signal 2		Back-ground	Comment
		$W \to \nu + \cdots$		$W \to \nu + \cdots$		$WW \to l\nu l\nu$	$\Delta\Phi_{ll}$		
	Event #	e^+	e^-	μ^+	μ^-				
	1								
	2								

Put a cross in the corresponding event

Rite the angle (in degree) for WW events

Don't forget the background !

⚠ Une seule marque par ligne !

2. <u>Once you finished the 50 events</u>

- Sum each column

	49								
	50								
Number of Events:									

- The sum of all columns has to be 50 .....
- Open the browser (top-left : `Applications ▶ Autre ▶ ATLAS Firefox W-path`)
- You should be on : `http://goo.gl/qXc99h`

i. Take the correct table depending on your group number

ii. Fill in the numbers and angles

Groupes 00-19 (9X) | Groupes 20-39 (10X)

0	Positron e+	Electron e-	Antimuon μ+	Muon μ-	Bruit de fond	WW
A						
B						