International Particle
Physics Outreach Group

International Masterclasses

ATLAS Z-Path Handbook

Introduction

Masterclass Ingredients

- Physicist
- Non-Physicist
- Real Data from an Experiment
- Tool to Visualise Data
- Method to Analyse Data
- Coffee

Goal of the ATLAS Z-Path Masterclass

- Identify collisions in ATLAS that are Z-boson candidates
- Calculate their invariant mass
- Plot them in a histogram, present, and compare

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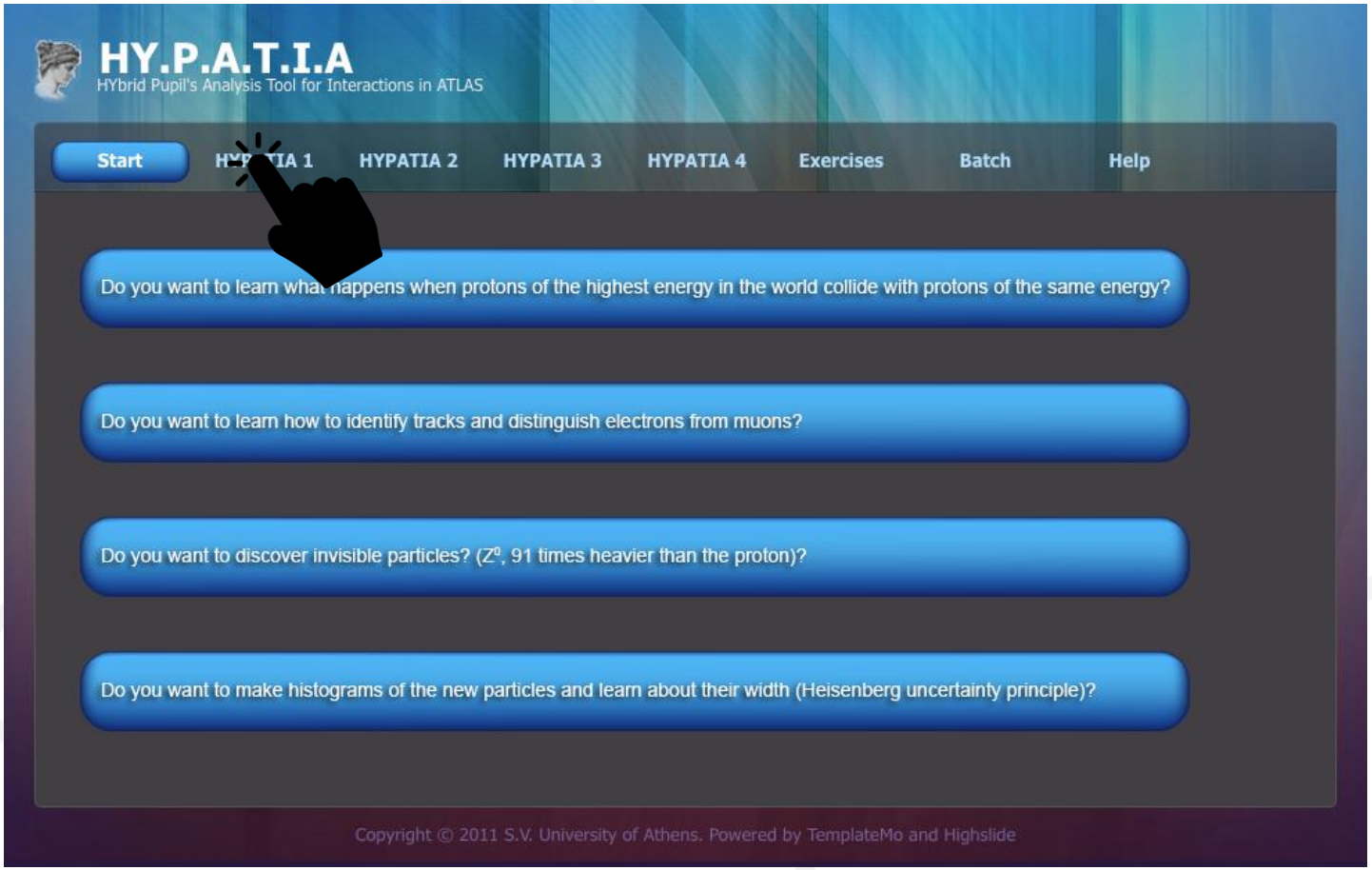
HYPATIA

http://hypatia.iasa.gr/en/index.html (or click on “ATLAS Z Path” in agenda)



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Viewing Events

HYPATIA 1

- Click through events
- Try zooming in/out
- What is missing E_T ?

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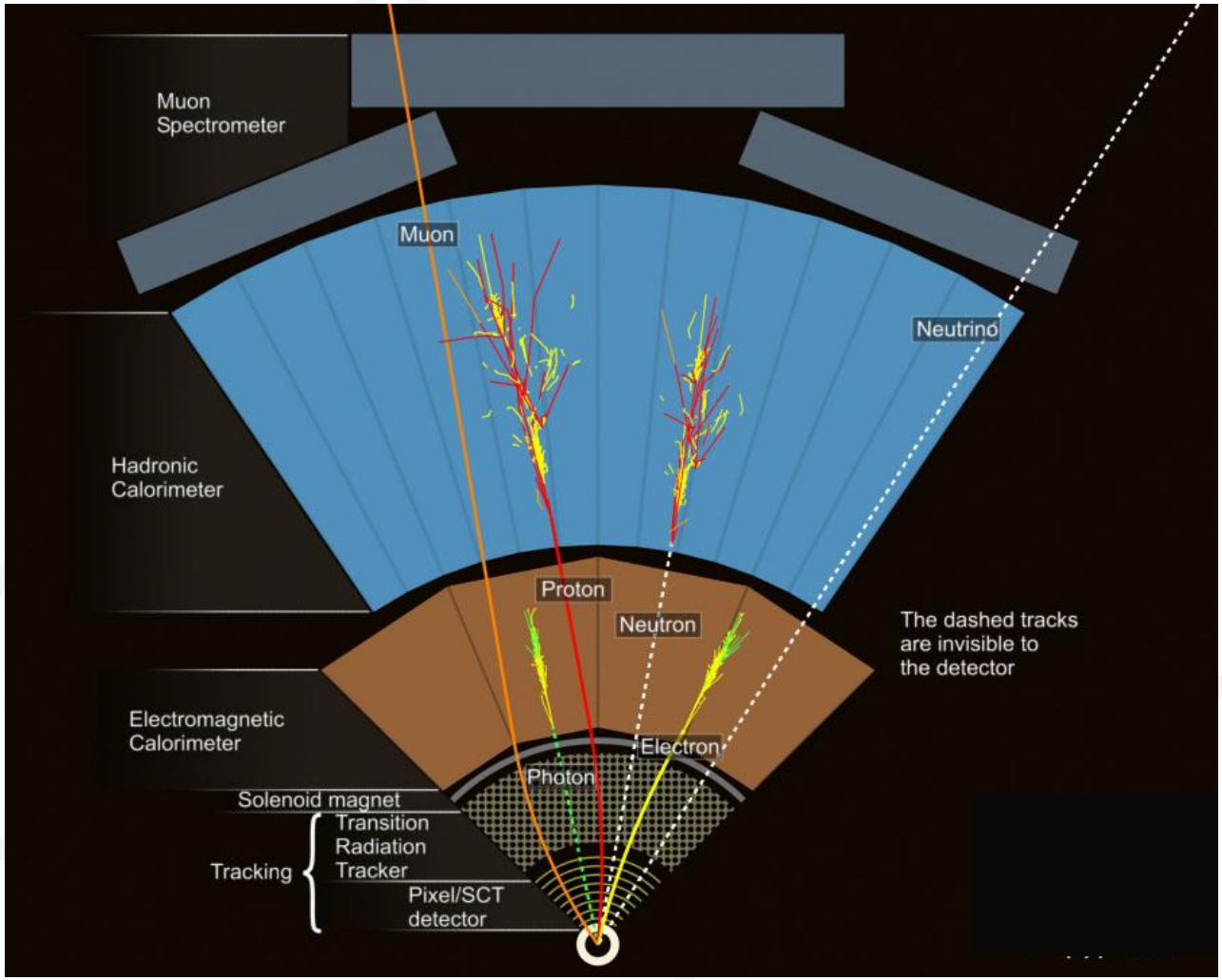
Particle ID in ATLAS



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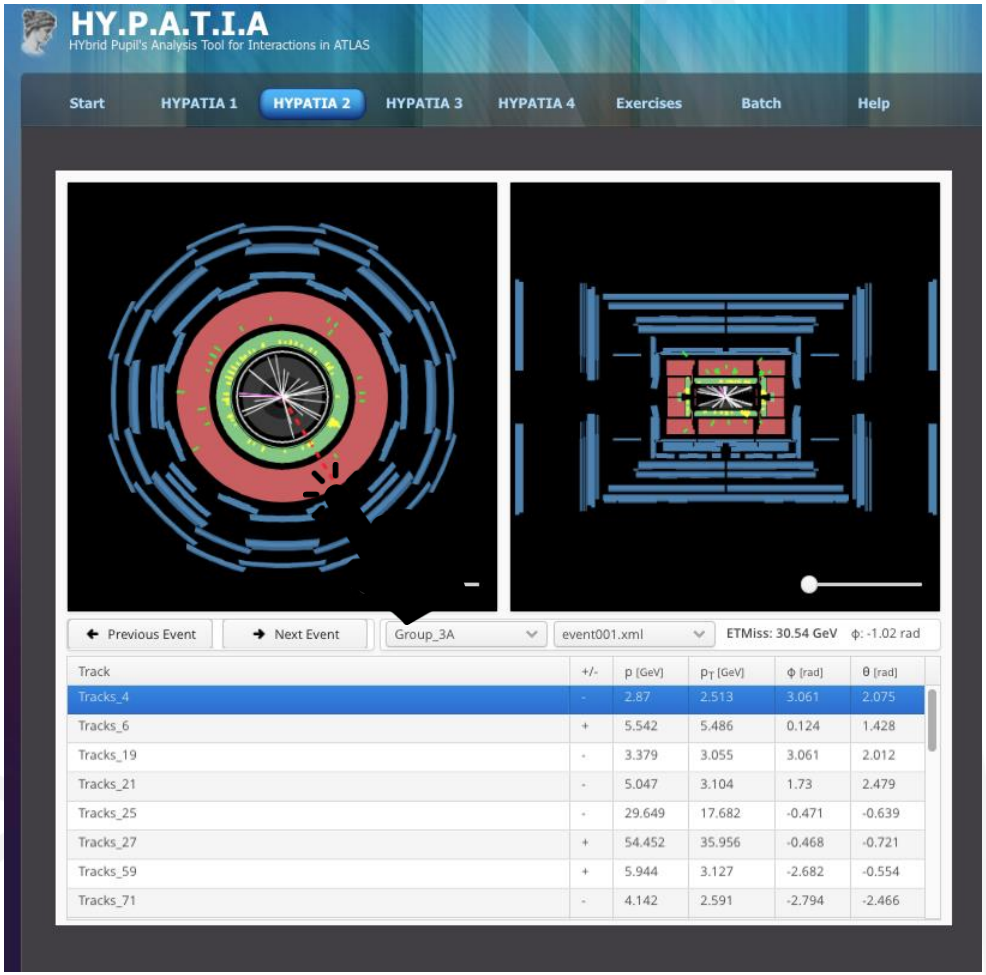
Particle Identification



HYPATIA 2

- Click through events
- Identify particles:
  - electrons / positrons
  - muons (+/-)
  - missing E_T
- Note the variables:
  - p = momentum
  - p_T = transverse momentum
  - ϕ = azimuthal angle
  - Θ = polar angle

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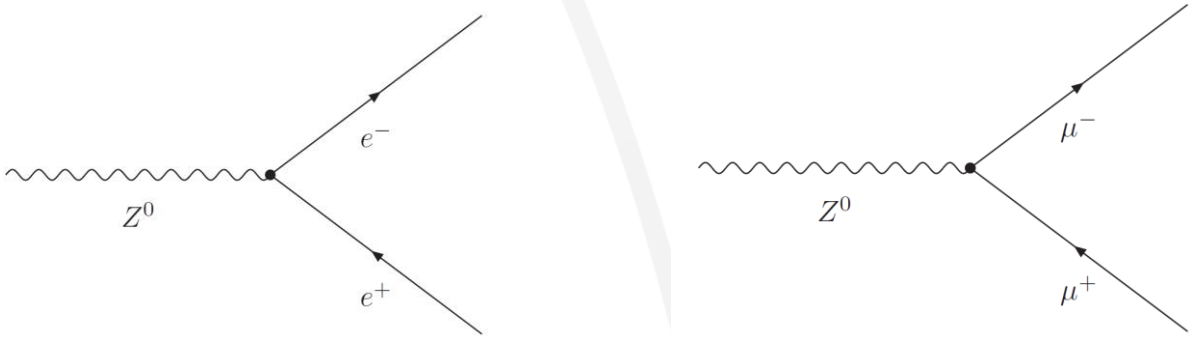
How to spot a Z boson

Z boson lifetime = 10^{-25} seconds

- We identify it by its decay products



Z boson mass = 91 GeV

- And by the mass reconstructed from the two leptons

$$m_X = \sqrt{2E_1E_2(1 - cos\theta)}$$

Expect lepton momenta to be similar to the Z mass

Mass Reconstruction

HYPATIA 3

- Click through events
- Click on tracks
- Make a p_T cut
  - What happens to the low momentum tracks?
- Add particle pairs
  - What are the reconstructed masses?
  - Try different combinations

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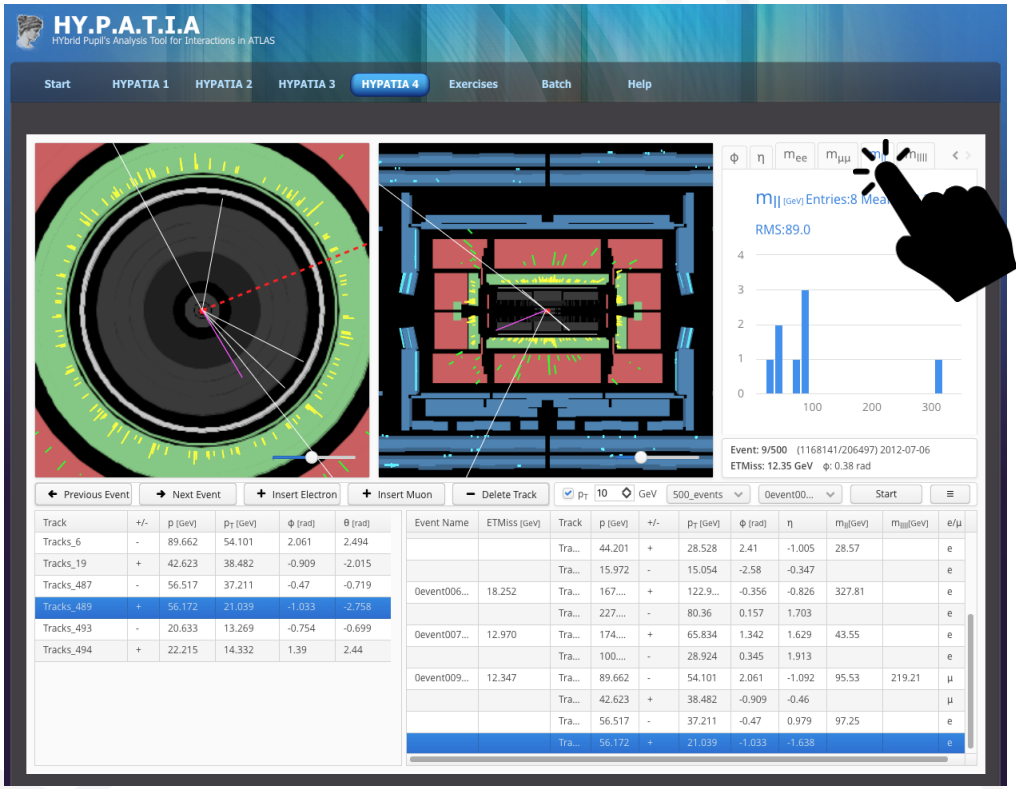
Data Analysis (Part I)



HYPATIA 4

- Select m_{ll} tab upper-right
- Apply p_T cut
- Select 500_events data
  - Group A starts at 0event001
  - Group B starts at 3event001
- Make a p_T cut
  - What happens to the low momentum tracks?
- Add particle pairs
  - Note reconstructed masses
  - See Next Slide

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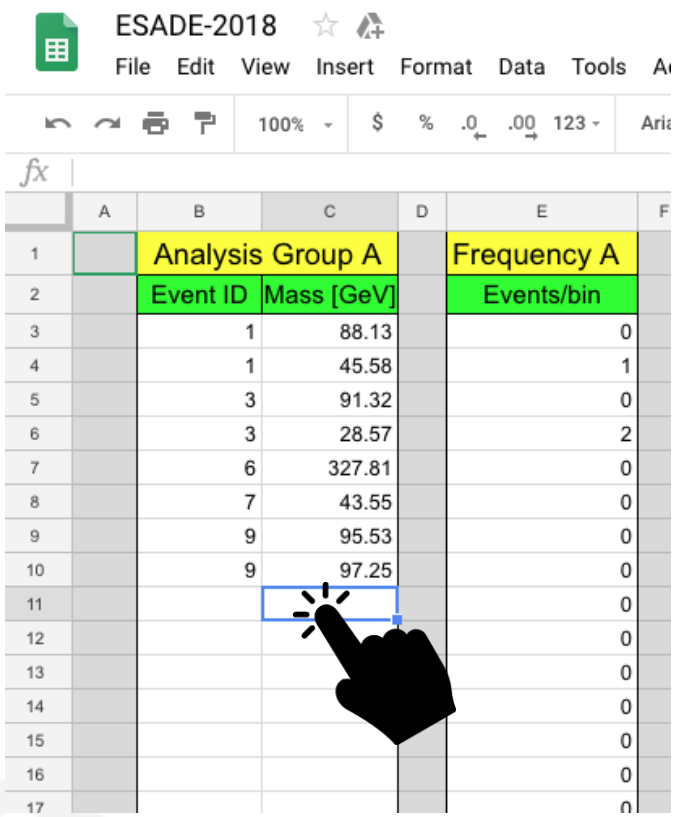
Data Analysis (Part II)



	A	B	C	D	E
1		Analysis Group A			Frequency A
2		Event ID	Mass [GeV]		Events/bin
3		1	88.13		0
4		1	45.58		1
5		3	91.32		0
6		3	28.57		2
7		6	327.81		0
8		7	43.55		0
9		9	95.53		0
10		9	97.25		0
11					0
12					0
13					0
14					0
15					0
16					0
17					0

Google Sheet

- Enter Event ID
  - Example: 6/500 (enter 6)
- Enter masses of pairs
- Gather Data
  - 150 events for each group
- Take screen captures of typical and interesting events
  - Typical = expected Z boson
  - Interesting = other
- Make mass histogram
  - From Google sheets

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The Presentation

Introduction

- About the Experiment
- About the Search

Data Analysis

- Describe the Method
- Describe the Results
- Show typical and interesting event displays

Results

- Present Mass Histogram
- Point out any peculiarities (if any)
- Describe next steps