

ATLAS Z-path

- ⊙ Students use simple techniques and tools to measure known particles and discover new ones
- ⊙ Z-path uses the invariant mass technique with the Z-boson as starting point

8 TeV ATLAS data analyzed by the students

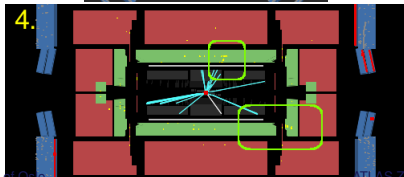
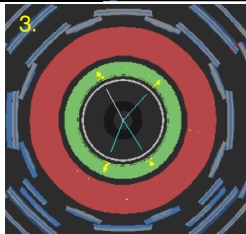
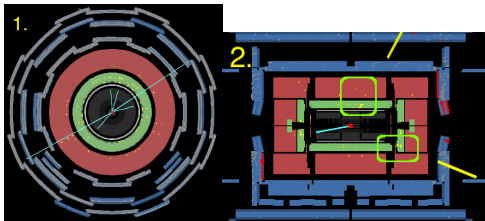
- ⊙ Di-leptons: 20 000 events
 - ⊙ $Z \rightarrow \ell^+ \ell^-$, $J/\Psi \rightarrow \ell^+ \ell^-$, $\Upsilon \rightarrow \ell^+ \ell^-$
- ⊙ Higgs $H \rightarrow \gamma\gamma$ candidates: 12 000 events (2 fb^{-1})
- ⊙ Higgs $H \rightarrow 4\ell$ candidates: 40 events (2 fb^{-1})
 - ⊙ $H \rightarrow 2 \times e^+ e^-$ $H \rightarrow 2 \times \mu^+ \mu^-$ $H \rightarrow e^+ e^- + \mu^+ \mu^-$
- ⊙ $Z' \rightarrow \ell^+ \ell^-$ di-lepton events: 2000 fully simulated events

All data selected using official (or close to official) ATLAS selection criteria.
Data produced in an xml-format to be visually analyzed in event-displays.

- ⊙ Each student (pair) analyzes 50 events
- ⊙ Uses [HYPATIA](#) event-display (based on ATLANTIS)

Identifying events

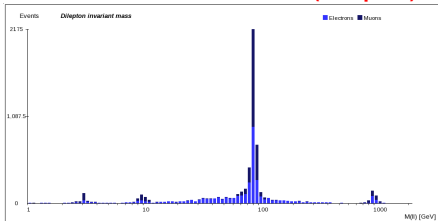
1. $\mu^+\mu^-$ or e^+e^- pair
 - J/Ψ , Υ , Z or Z' candidate
2. Di-photon event?
 - Higgs candidate!
3. Four "good" leptons?
 - Higgs $\rightarrow ZZ^*$ candidate!
4. Photons or electrons: photon conversions
 - Construct invariant mass of electron-pair - close to 0?
 - \rightarrow converted photon!
 - Cut on inner detector hits and momentum - do tracks disappear? \rightarrow converted photon.



Overview of results in OPlOT

- All students upload their results into the [OPlOT](#) web-interface
 - OPlOT php-based - developed in Oslo to ease submission, combination and discussion of results
- Results per institute and per day are automatically combined by OPlOT

Student Masterclass results (di-lepton):

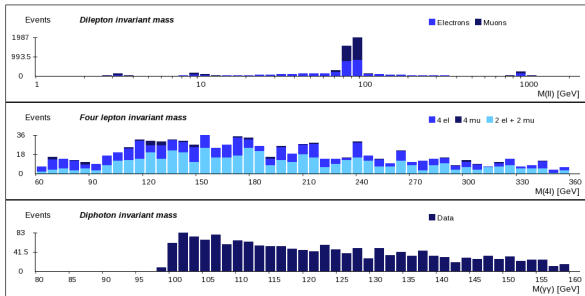


All results (di-lepton, 4-lepton and di-photon):

OPlOT – MasterClass – Combination for all institutes on 2015-03-14

Start Student Moderator Tutor Administrator

Monday, April 13th 2015 - 15:25:01 CEST



Plot type:

Dilepton statistics

	Electrons			
Region	R1	R2	R3	R4
Events	144	192	1494	145
Mean	3.00	9.63	89.75	994.34
Width	0.50	1.48	3.91	32.32

	Muons			
Region	R1	R2	R3	R4
Events	150	183	1839	149
Mean	3.08	9.90	90.52	990.89
Width	0.30	0.80	3.51	52.05

Number of events

	Student distribution	Expected
ll	6807	7800
4l	1172	40
γγ	1667	3600
Sum	9646	11440

The Z-path in the International Masterclasses 2015 and in the future

The Z-path in 2015

- ⊙ 86 different institutes, in total 100 Z-path events
- ⊙ in 24 countries
- ⊙ on 5 different continents
- ⊙ distributed on 19 days (between February 25th and April 1st)
- ⊙ video conferences with both CERN and Fermilab



The Z-path in the future

- ⊙ continue developing education material based on ATLAS data & results
- ⊙ prepare for possible new discoveries (Graviton, SUSY etc.) using similar final states
- ⊙ introduce more advanced looping over events after having studied 50 display events and set-up cuts and plot invariant mass and other variables
- ⊙ university projects at bachelor, master and Ph.D. levels based on open access ATLAS data, with possibilities to further develop the current tools and extend the ideas
- ⊙ take part in open access and preservation of data for education



Discover the Unknown