ATLAS – data for education

ATLAS W&Z

LHC Masterclasses 2014

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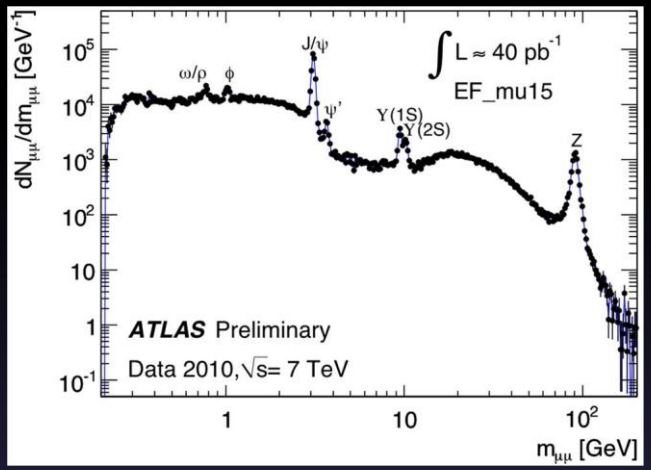
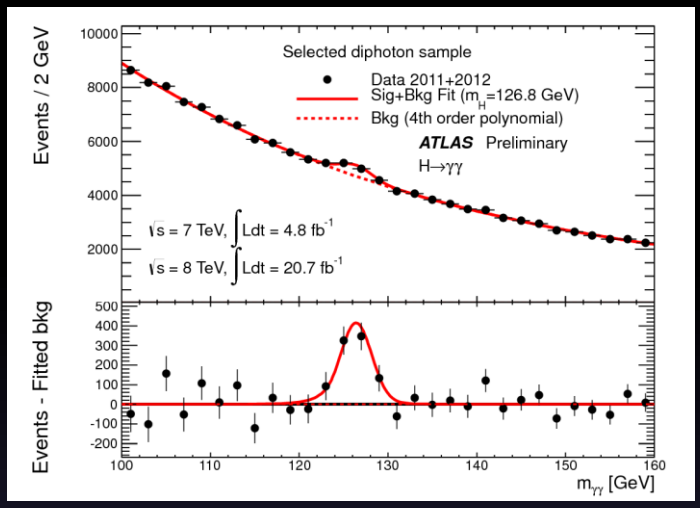
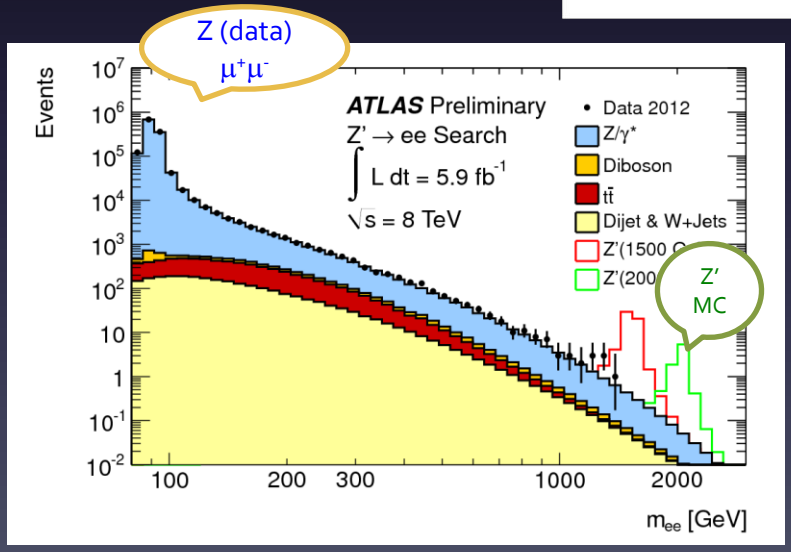
05.05.2014

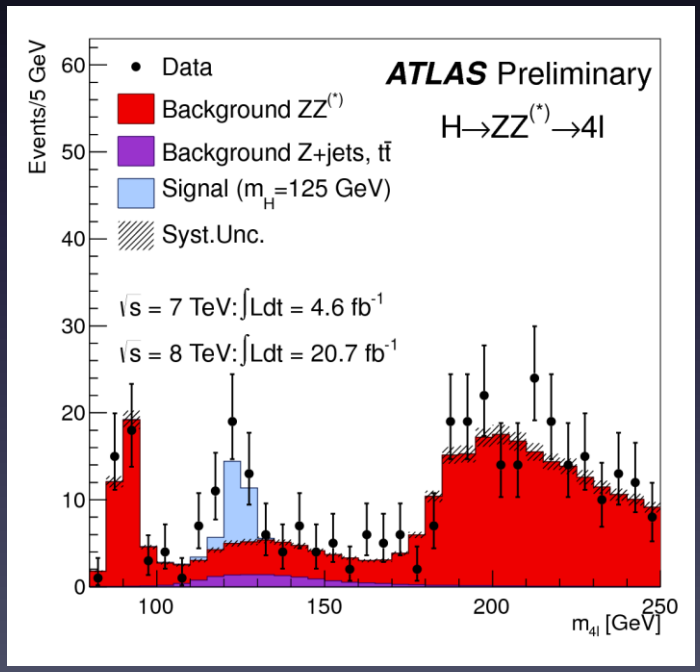
"Z-Path"

- Invariant mass technique
  - Measure mass of short-leaved particles
  - Discover new particles – Higgs
  - Search for exotic particles – Z' , …







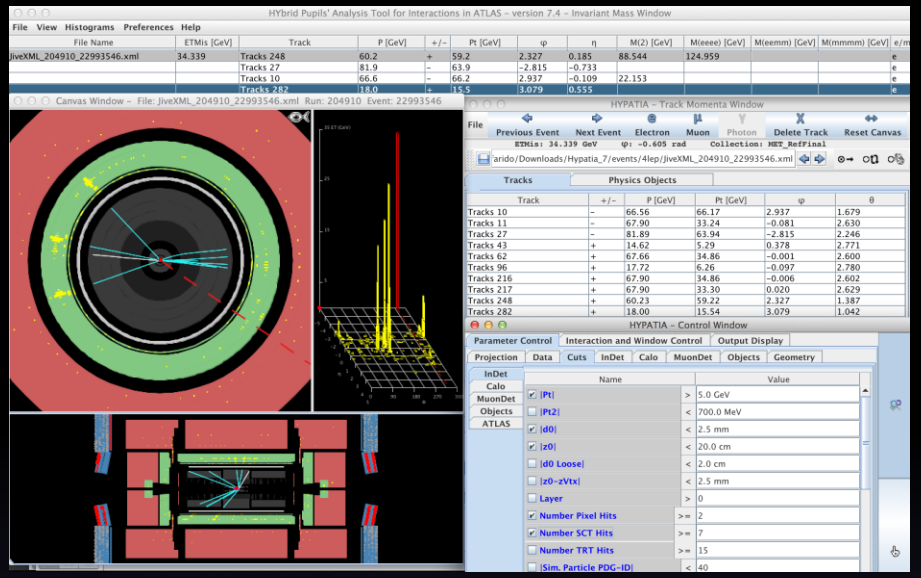


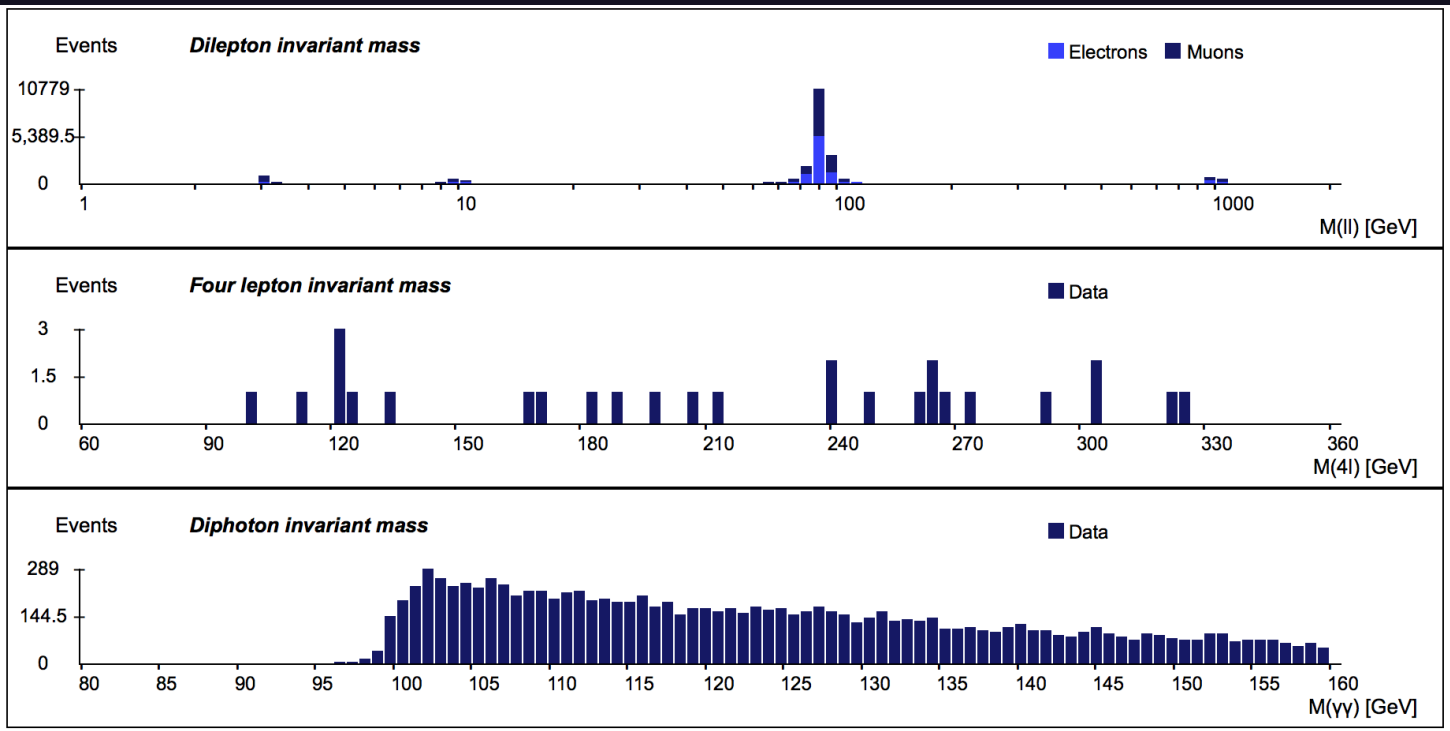
Z path Measurement, students

- identify ll, 4l, γγ events and calculate invariant masses

- Resulting two-lepton invariant mass distribution is used to measure Z^0 boson and J/ψ and Y mesons, look for new particles (Z' @ 1 TeV)

- Two photon and four lepton invariant mass distributions are used to provide insight into the process of discovering the Higgs boson at the LHC





Plot type:

ll+4l+γγ overview

Dilepton statistics

	Electrons			
Region	R1	R2	R3	R4
Events	844	827	7973	895
Mean	3.12	9.68	89.65	994.89
Width	0.37	0.84	3.63	30.73

	Muons			
Region	R1	R2	R3	R4
Events	880	867	8219	686
Mean	3.08	9.86	90.49	995.73
Width	0.26	0.68	3.57	50.73

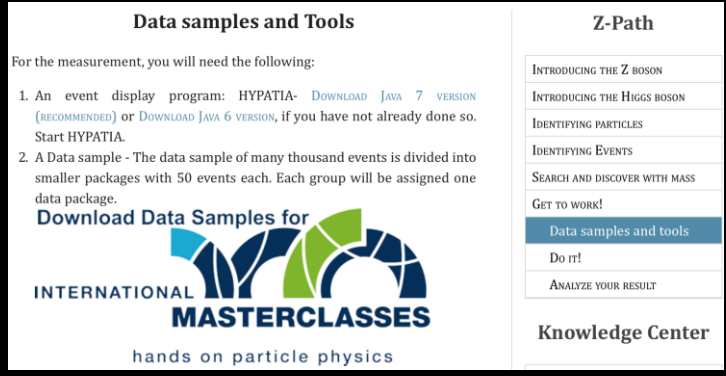
Number of events

	Student distribution	Expected
ll	24292	130
4l	32	10
γγ	11163	60
Sum	35487	200

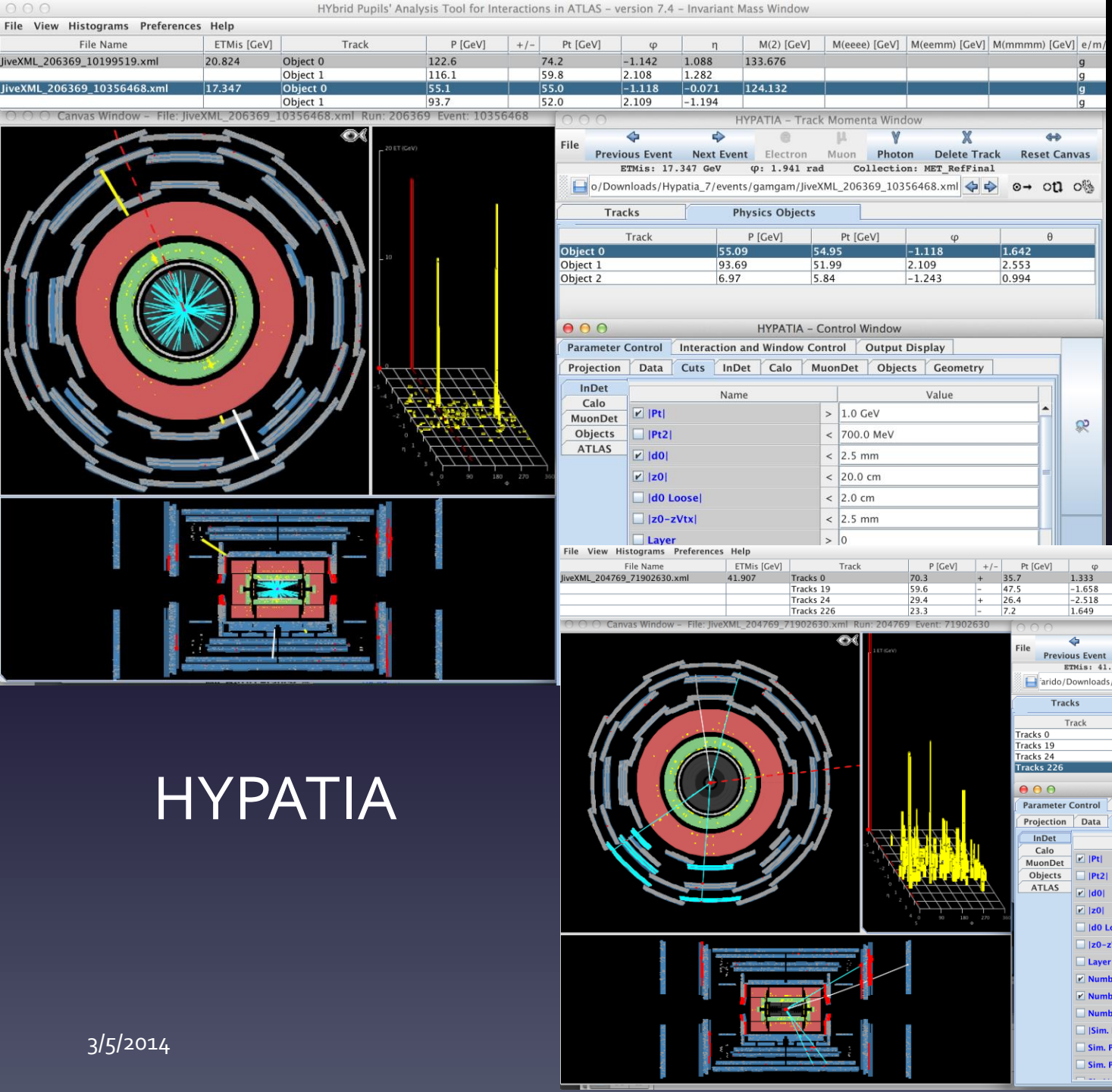
ATLAS Z-path data 2014

- Allowed to use 2/fb for Higgs selections: $\gamma\gamma$, 4l
  - Sequential run range 204769 - 206971, 2007 /pb , periods B12 – C6, June – July 2012
- Moriond 2013 candidates list following official Higgs selections
  - 40 H → $l^+l^-l^+l^-$ candidates with 6 are in the range 120-130 GeV
  - 11 100 H → $\gamma\gamma$ candidates (4100 fully unconverted, 5400 mixed, 1800 double conversions)
- Same range as above for di-lepton selection from same run range above
  - 18500 Z, 1850 J/ψ, 1850Υ events (modest fraction, still larger than Higgs)
- MC event displays of Z' events (1850) mixed in real data analyzed by students
  - mc12_8TeV.158020.Pythia8_AU2MSTW2008LO_Zprime_ee_SSM1000.recon.ESD.e1242_s1469_s1470_r3542/
  - mc12_8TeV.158026.Pythia8_AU2MSTW2008LO_Zprime_mumu_SSM1000.recon.ESD.e1242_s1469_s1470_r3542/
- In total 37 000 events

ATLAS Z-path data 2014



- Data distributed as event mixtures in XML format
  - Password protected http://cernmasterclass.uio.no/datasets/
  - Accessible from http://atlas.physicsmasterclasses.org/en/zpath_data.htm
  - Read through HYPATIA Event Display
- Di-lepton resonances: $l^+l^- = e^+e^-, \mu^+\mu^-$ ATLAS W&Z
  - 50% Z 5% J/ψ 5% Υ 5% Z'
- Higgs
  - 30% $H \rightarrow \gamma\gamma$ (20% unconverted, 10% converted) 5% $H \rightarrow l^+l^-l^+l^-$ (replicated in student datasets)
- 37 directories of 20 (A-T) datasets → 50 events analyzed by 2 students
- Some further MC data is used in the online plotting tool OPIoT, but only invariant mass distributions are used from these samples

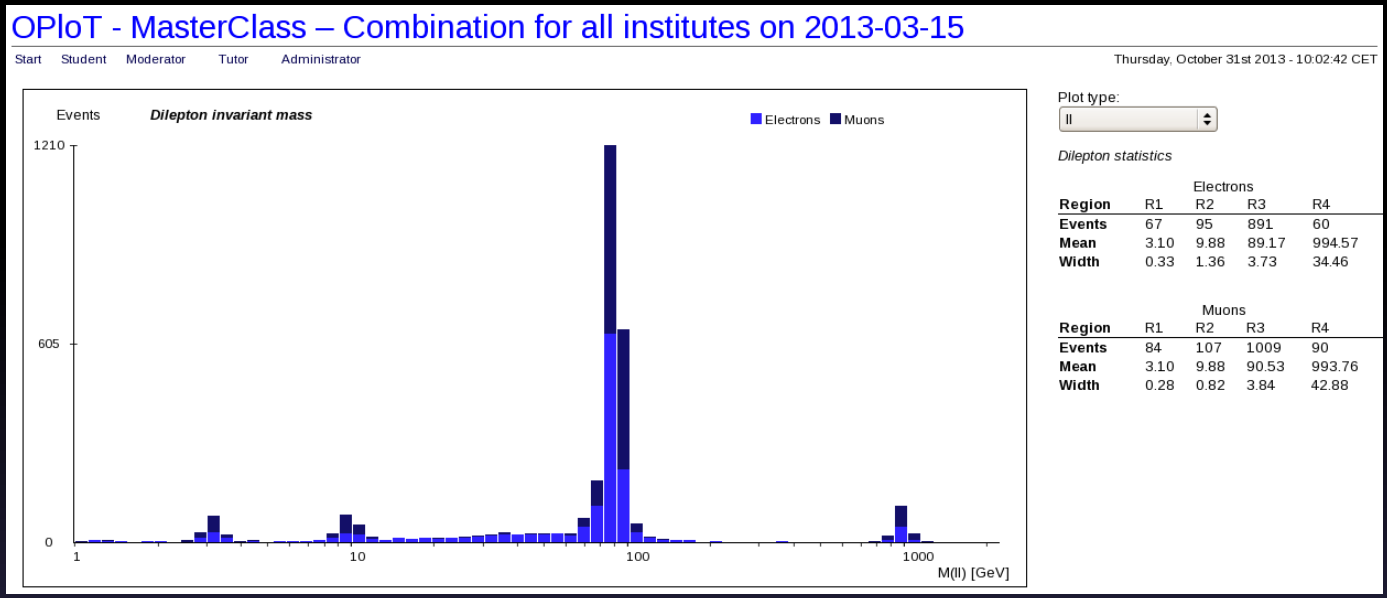


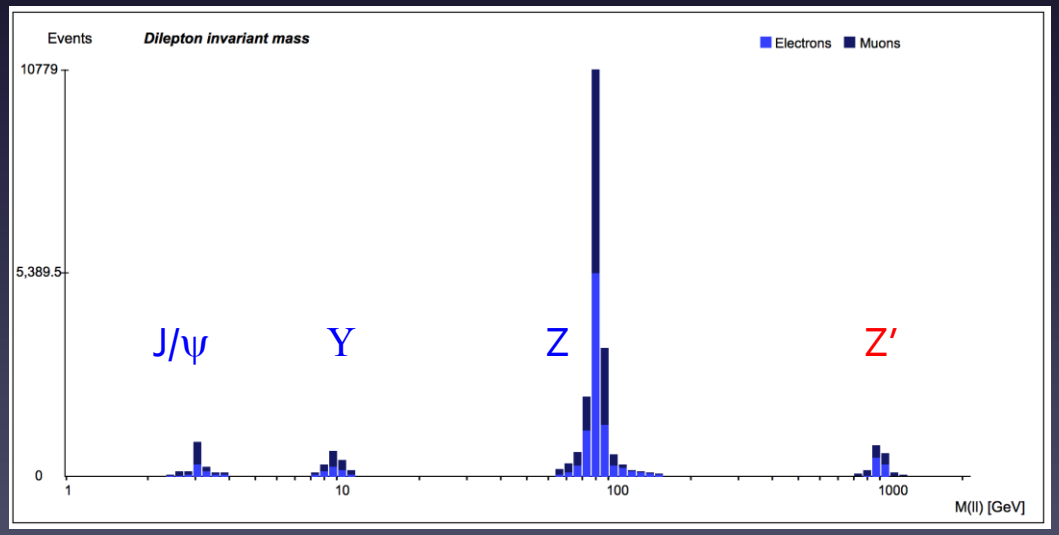
HYPATIA

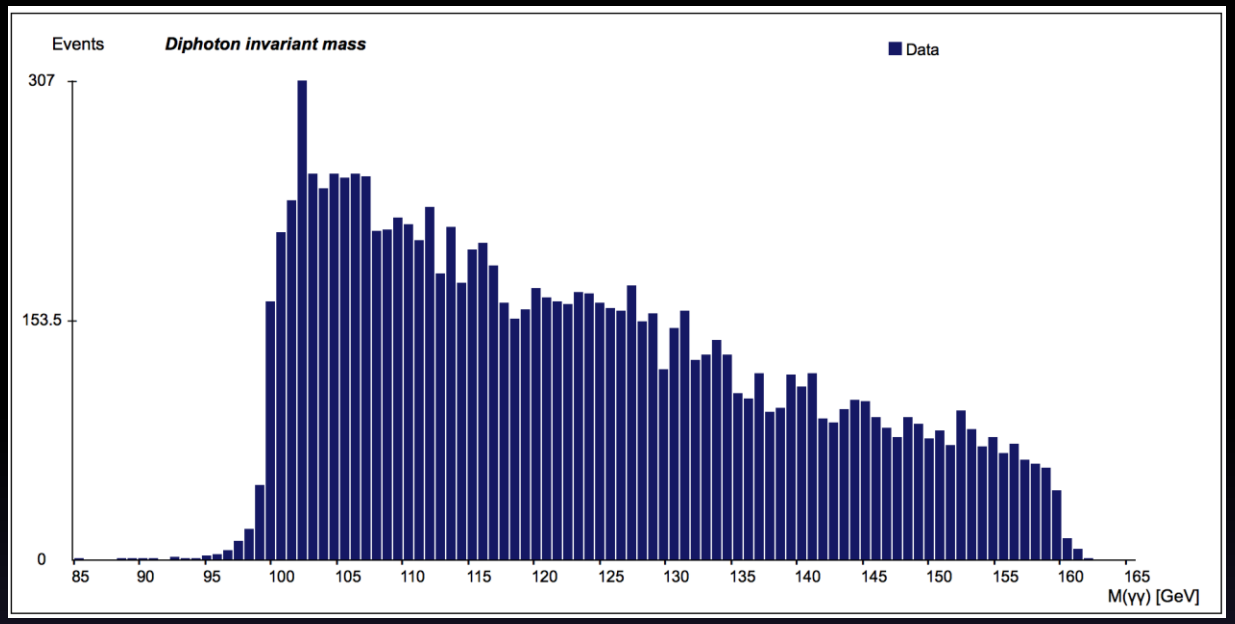
3/5/2014

MC2014 – di-leptons

- Full statistics ~ 24050 events, 8 TeV
  - Measured by students in 2013 (7 TeV, 9000 events) →
  - Some misidentified events, especially for electrons
  - Otherwise all particles found at right masses, including Z' surprise
- Expected 2014 ~2.5X more statistics →

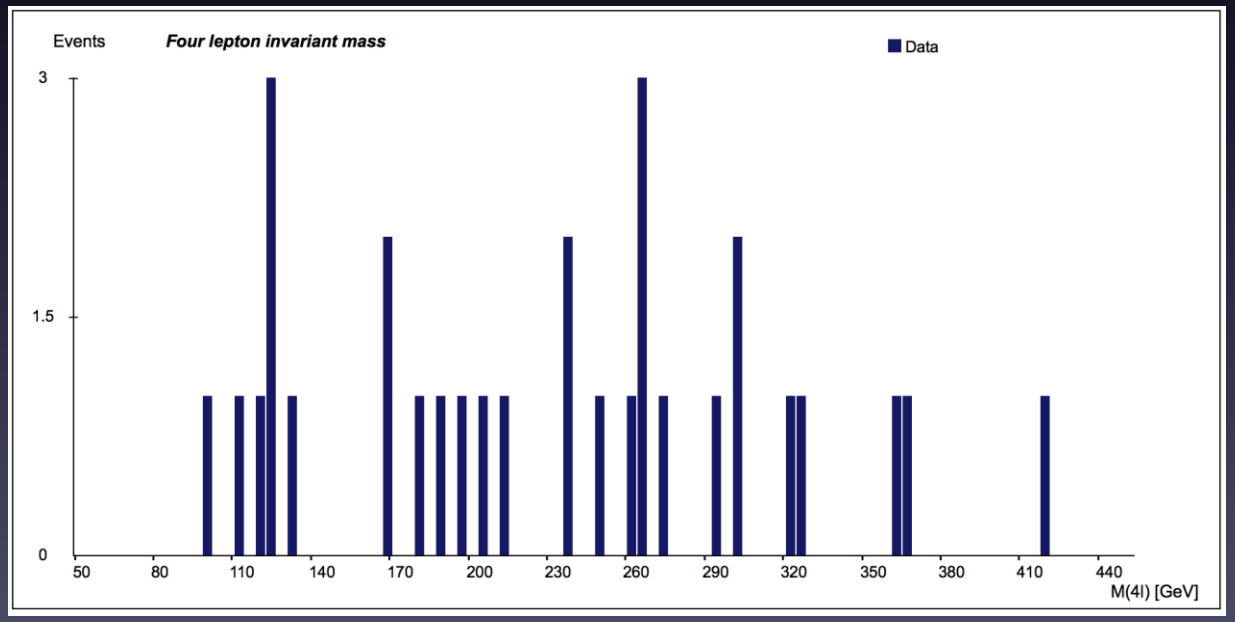






2 fb^{-1}

$H \rightarrow \gamma\gamma$



$H \rightarrow ZZ^* \rightarrow 4l$

Future plans

- 2013 (for 2014 the trend continues)
  - ATLAS Z: 70 institutes
  - ATLAS W: 55 institutes
  - CMS: 55 institutes
  - ALICE: 10 institutes
  - LHCB starting in 2014
- Continue developing education material based on ATLAS data & results
  - Zpath: Prepare for possible discoveries (Graviton, SUSY, …) using similar final states
  - Zpath: Introduce looping over XML events AFTER having studied 50 display events, set-up cuts and plot invariant mass and other variables
- Use of material beyond IPPOG master classes – password protection
  - On-demand events at schools, …
  - Student Projects at physics institutes, …