Physics of the ATLAS Z measurement

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What's new in 2015?

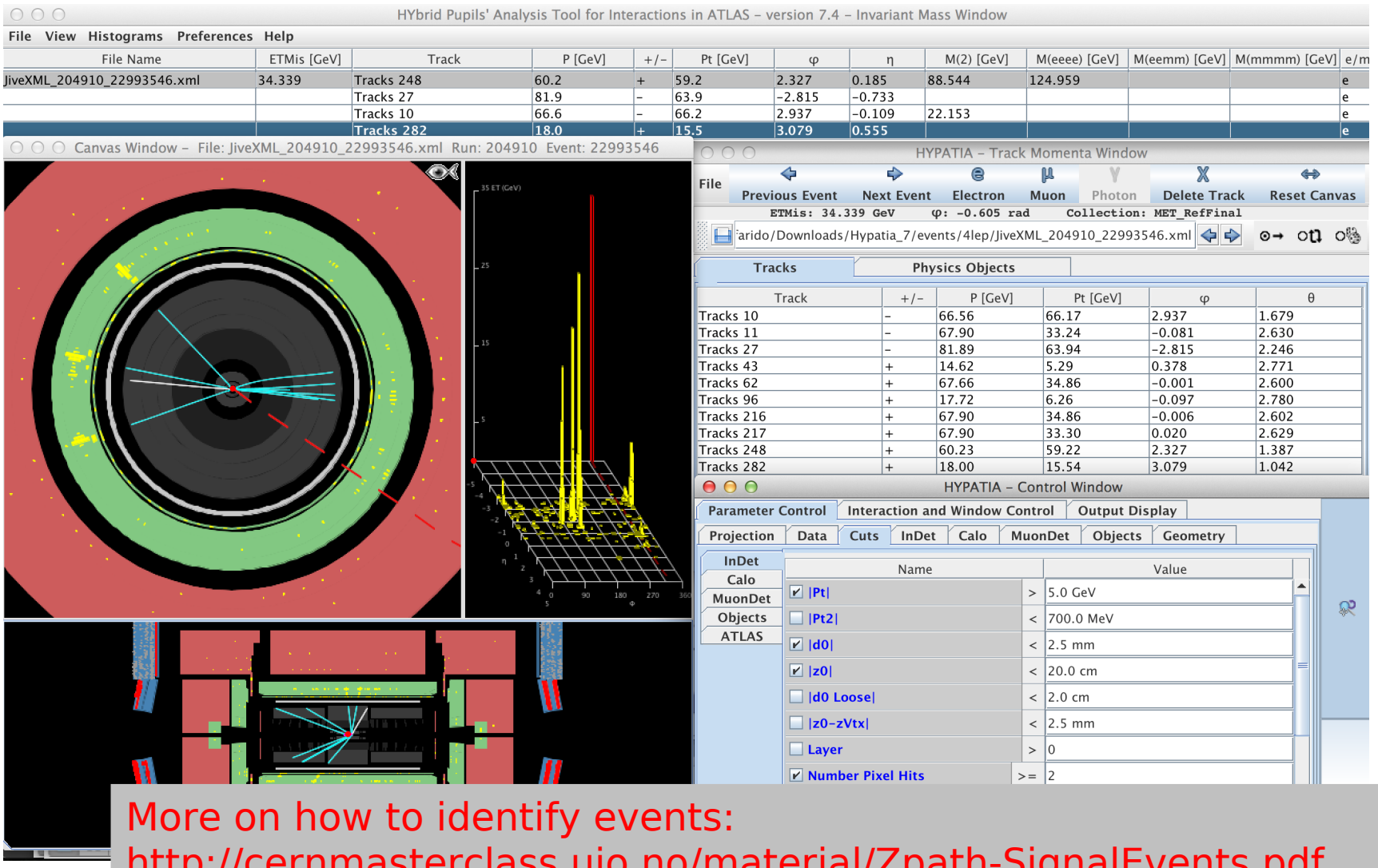
- Almost nothing
  - Some minor bug fixes in OploT
  - Removed some problematic muon events from the event sample

Z-path measurement

- each pair of students go through 50 collision events
- identify ll, 4l and $\gamma\gamma$ events and calculate invariant masses (in HYPATIA)
- resulting di-lepton invariant mass distribution is used to

  measure mass and width of Z^0 boson, J/Ψ and Υ mesons
  - look for new particles (Z' @ 1 TeV)
- di-photon and four lepton invariant mass distributions are used to
  - provide insight into the process of discovering the Higgs boson at the LHC

HYPATIA



More on how to identify events:
http://cernmasterclass.uio.no/material/Zpath-SignalEvents.pdf
http://cernmasterclass.uio.no/material/Zpath-Cuts.pdf

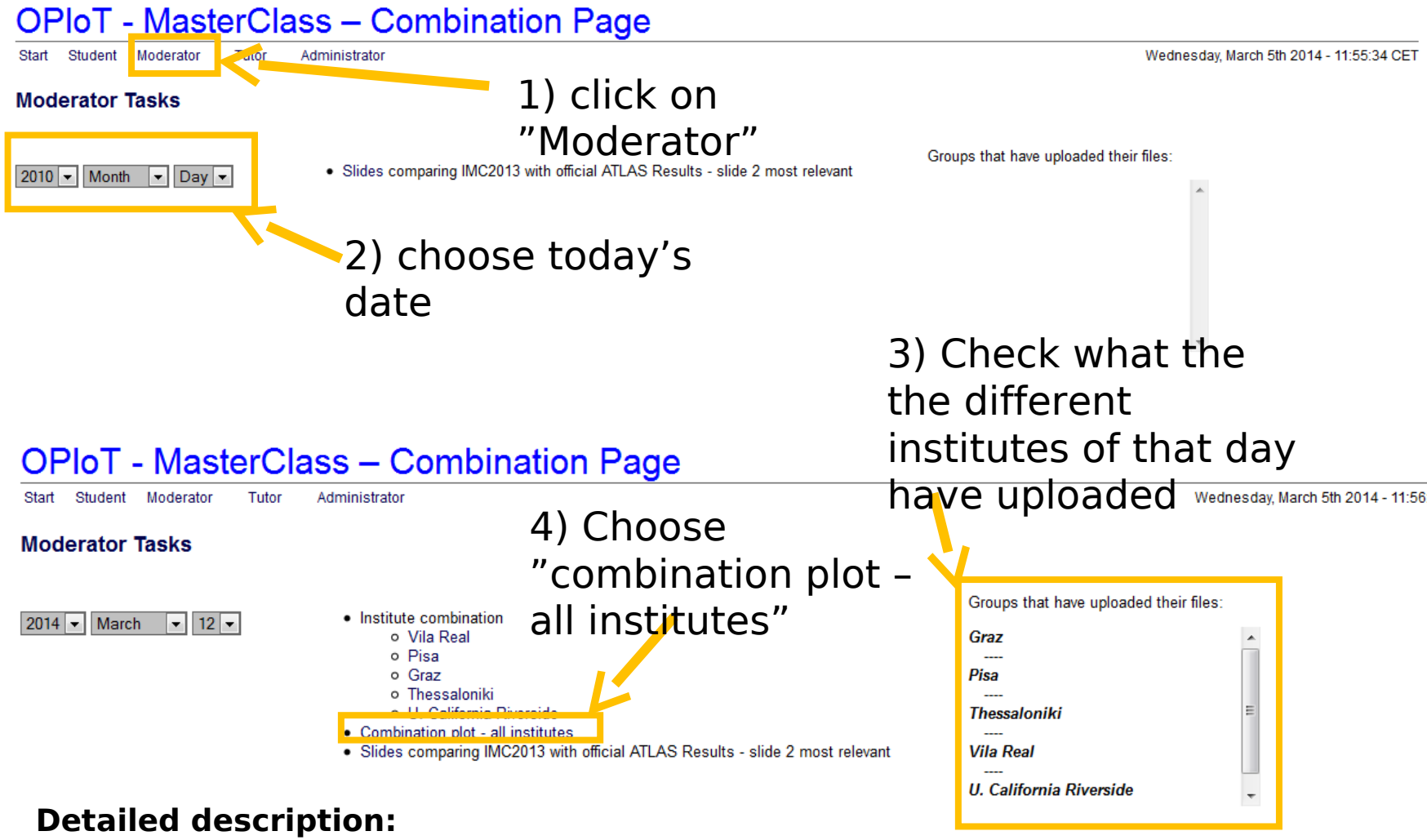
ATLAS Z-path data 2014

- Allowed to use 2 fb^{-1} for Higgs selections: $\gamma\gamma$ and 4l
  - Sequential run range 204769 – 206971
    - 2007pb^{-1} in period B12 – C6 from June – July 2012
- Moriond 2013 candidates list following official Higgs selections:
  - **40 h →** $l^+l^-l^+l^-$ candidates with 6 having an invariant mass in the range 120-130 GeV
    - evenly shared between e^+e^- $\mu^+\mu^-$, e^+e^- e^+e^- and $\mu^+\mu^-\mu^+\mu^-$
    - some events are replicated in the student's data sets
  - **11.100 h →** $\gamma\gamma$ candidates (4100 fully unconverted, 5400 mixed, 1800 double conversions)
    - data sets with double converted photons are not used unless there are exceptionally many students
- Same range as above for di-lepton selection
  - **18.500 Z, 1850 J/ψ, 1850Υ** events (modest fraction, still larger than Higgs)
    - 50% share between e^+e^- and $\mu^+\mu^-$
- MC events of **Z'** events (**1850**) mixed in the real data analyzed by students
  - 50% share between e^+e^- and $\mu^+\mu^-$
  - 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

- each institute is initially assigned 2 dataset packages with 20 datasets in each package.
- each dataset contains 50 events, for a group of two students to analyze.
  - this means that each institute has a default of 40 datasets available, which is enough to accommodate 80 students.
- Some further MC data is used in the online plotting tool, OPloT
  - to show expected di-photon and 4-lepton distribution at higher luminosities
- Data distributed as event mixtures in XML format available from
  - http://cernmasterclass.uio.no/datasets/ (password protected)
  - Accessible from: http://atlas.physicsmasterclasses.org/en/zpath_data.htm

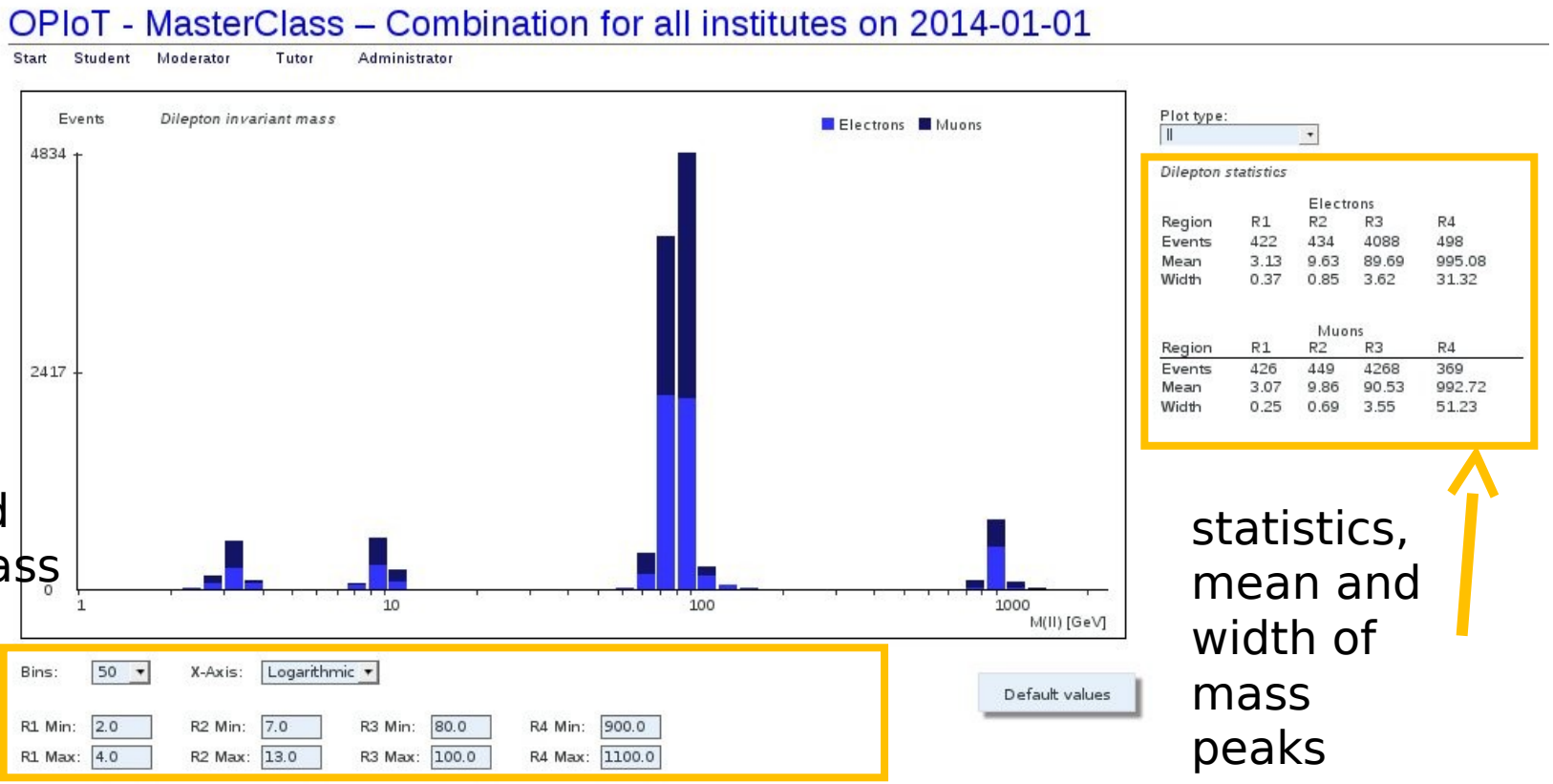
The plotting tool - OPloT



Detailed description:
http://cernmasterclass.uio.no/material/ModeratorInstructions-Zpath.pdf

Di-leptons

- Events corresponding to half of the available data in 2014 ($1fb^{-1}$) uploaded to OPloT
  - these are not analyzed by student, but rather ”perfect” distributions
  - might see more background in student’s results (especially low mass tail in Z-peak)

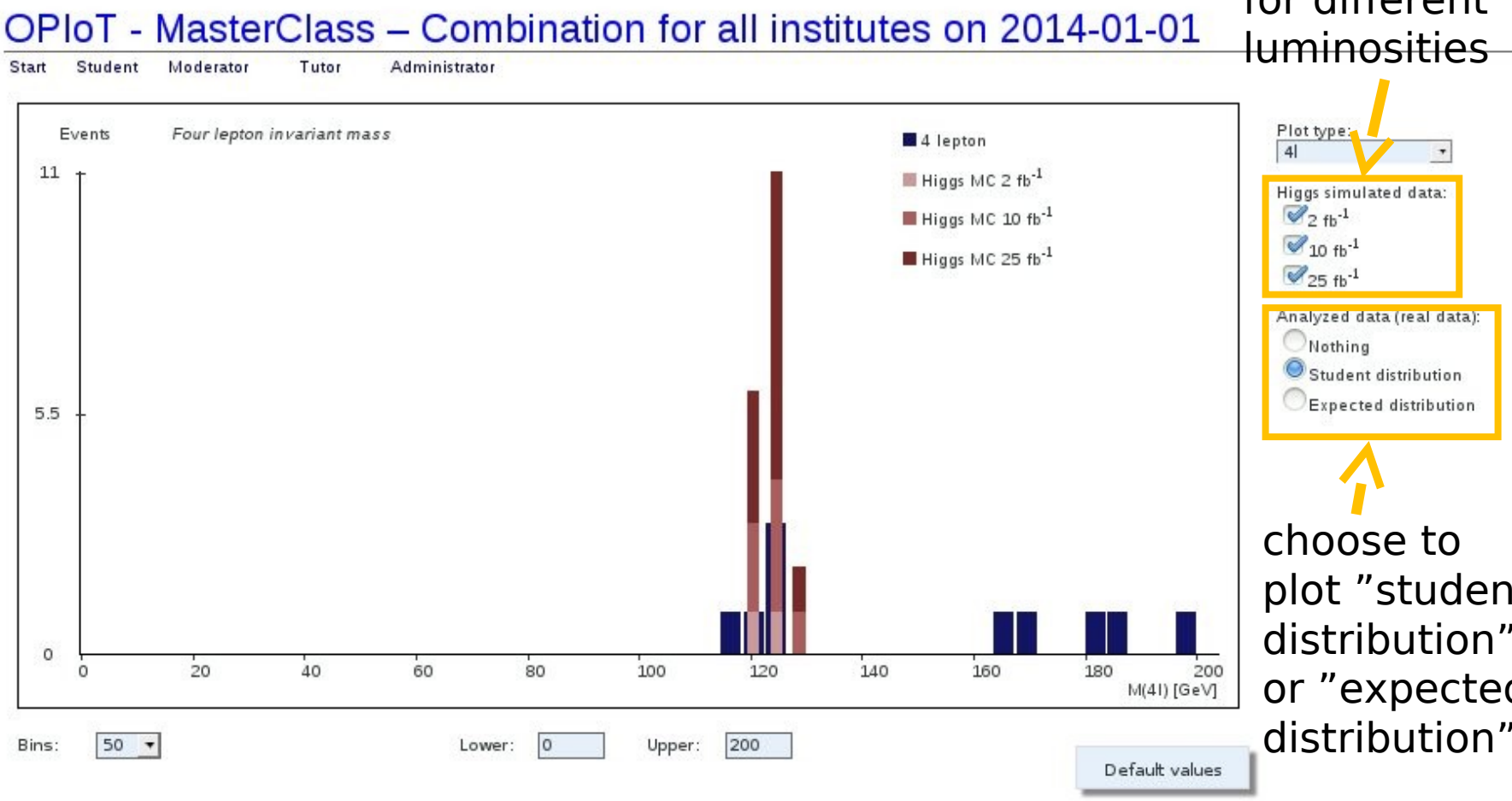


plotting options and defining mass ranges

statistics, mean and width of mass peaks

4 leptons

add simulated 4-lepton events for different luminosities

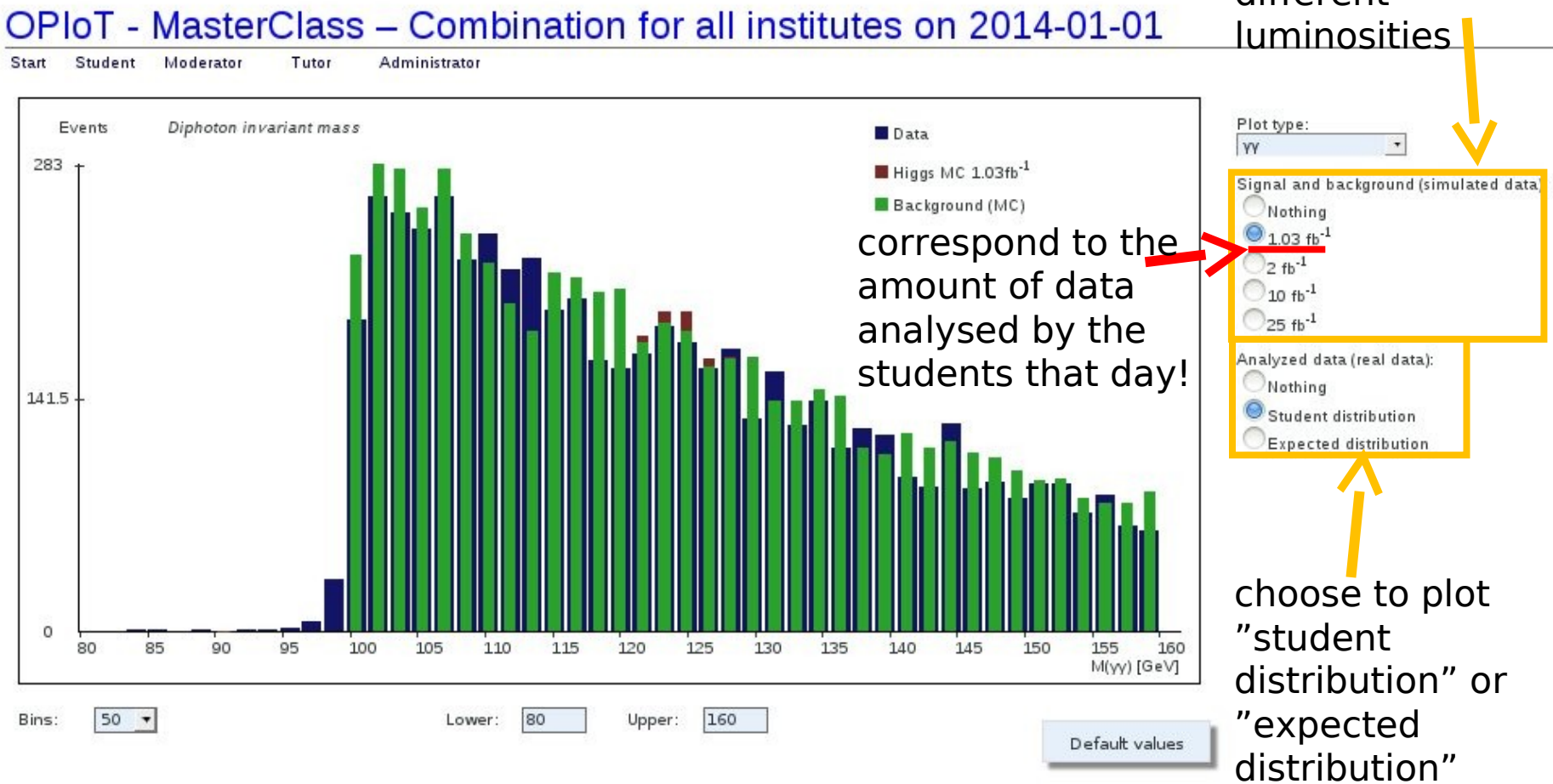


choose to plot ”student distribution” or ”expected distribution”

expected distribution: what to expect if all students had identified all the events correctly

Di-photons

add simulated di-photon events and Higgs signal for different luminosities



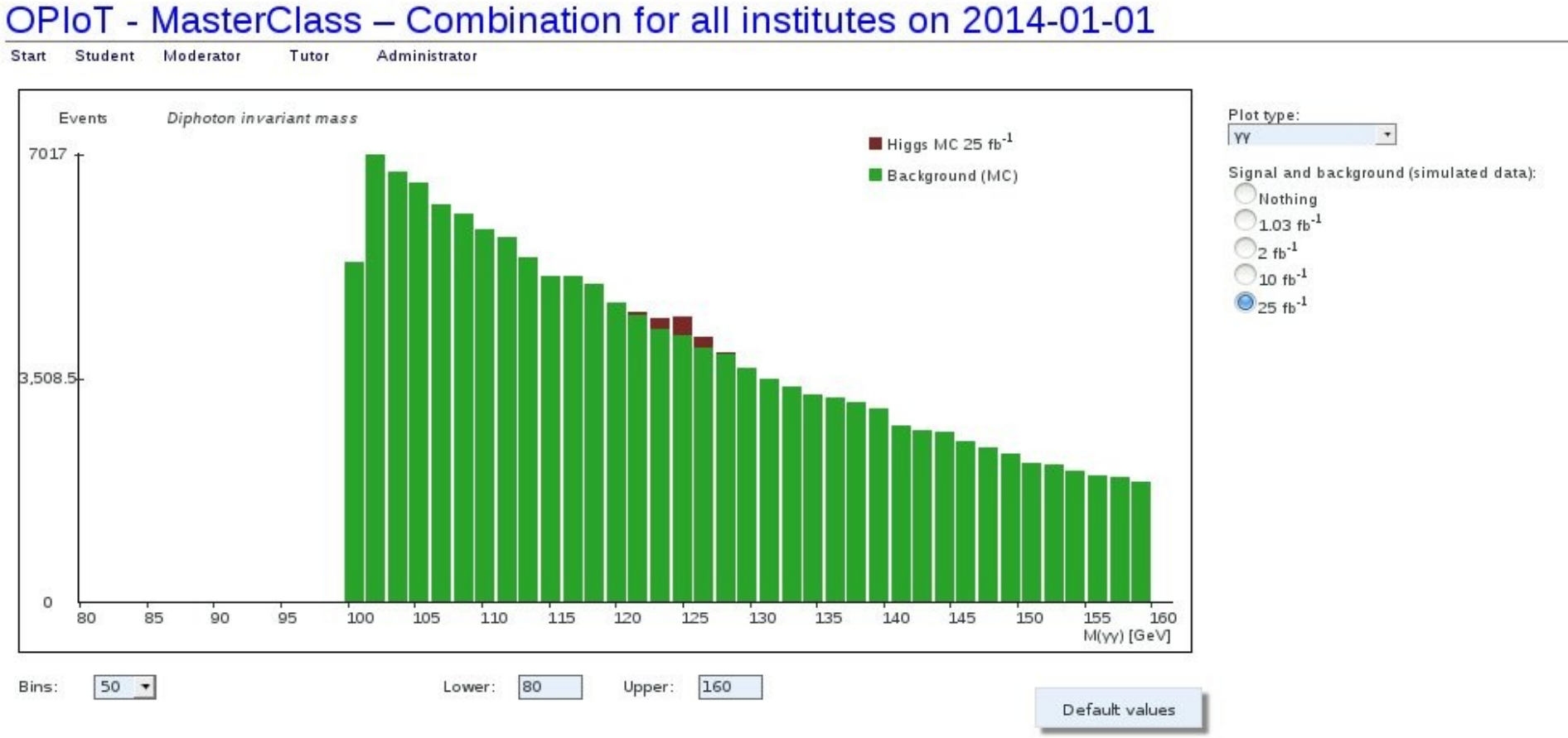
correspond to the amount of data analysed by the students that day!

choose to plot ”student distribution” or ”expected distribution”

expected dist.: what to expect if all students had identified all the events correctly

Di-photons

- Can also show only simulated data with the full ATLAS luminosity (25 fb^{-1})
  - to illustrate that we need more data than we have at the IMC to discover Higgs!



More information

- Detailed description for moderators:
  - http://cernmasterclass.uio.no/material/ModeratorInstructions-Zpath.pdf
    - Section 8: Keywords for discussion
- Slides to compare student's result with official ATLAS results
  - http://cernmasterclass.uio.no/material/Zpath-ATLAS.pdf
- Identifying events with HYPATIA
  - http://cernmasterclass.uio.no/material/Zpath-Cuts.pdf
  - http://cernmasterclass.uio.no/material/Zpath-SignalEvents.pdf
- Instructions for institutes:
  - http://cernmasterclass.uio.no/material/InstituteInstructions-Zpath.pdf
- Instruction for students (cheat sheet):
  - http://cernmasterclass.uio.no/material/cheat-sheet_en.pdf
- If there are any questions do not hesitate to contact us:
  - epf-mc@fys.uio.no