Z-PATH 2016

COMPARISONS TO ATLAS

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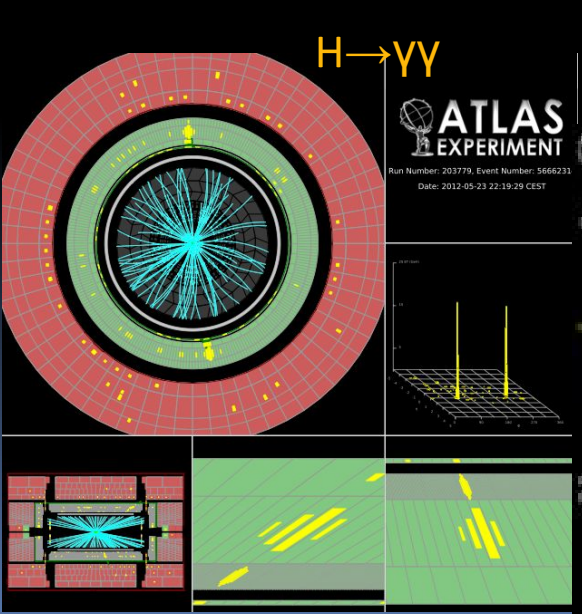
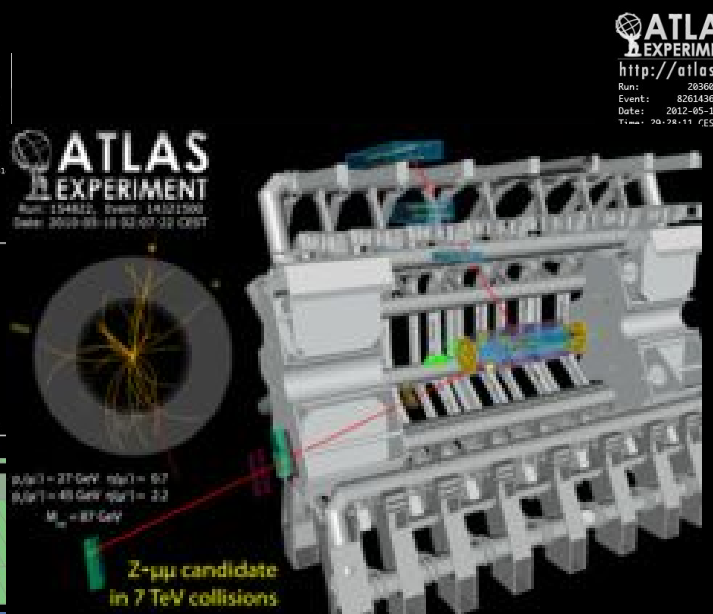
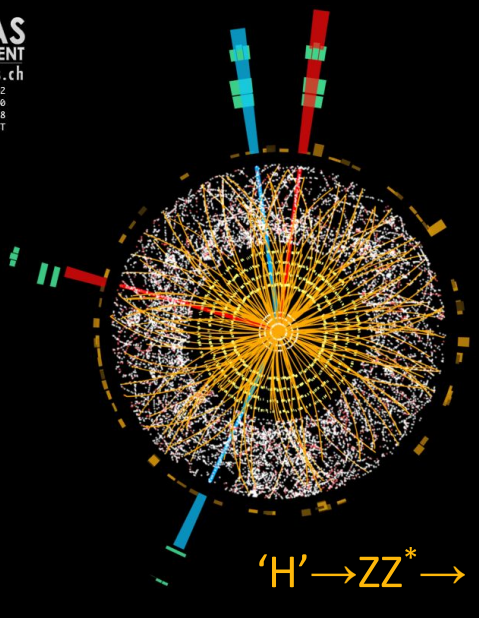
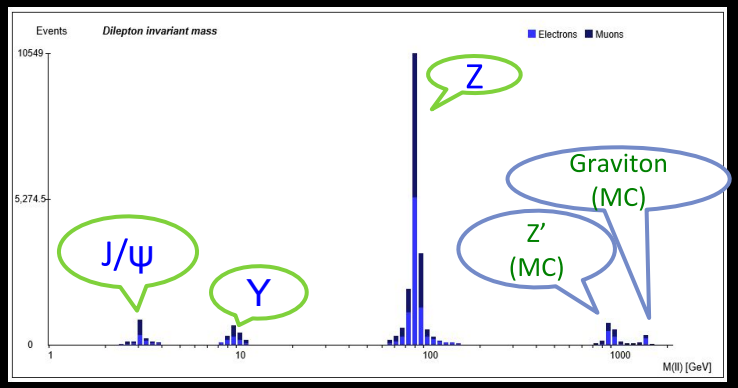


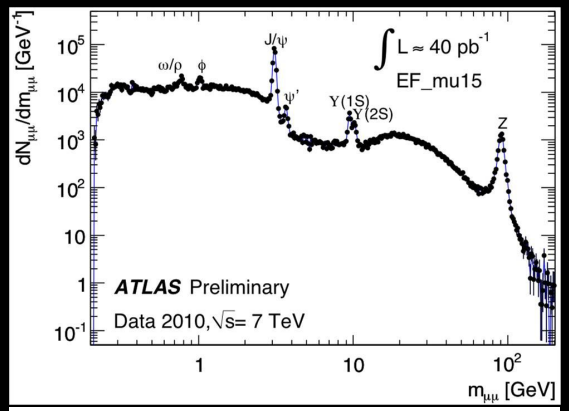


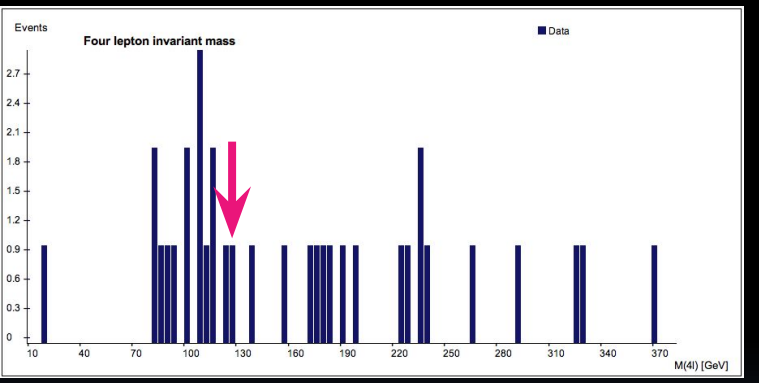


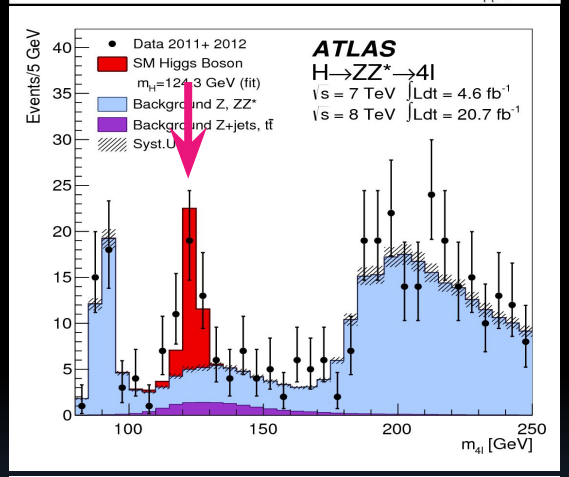
Invariant Mass – Overview of student results

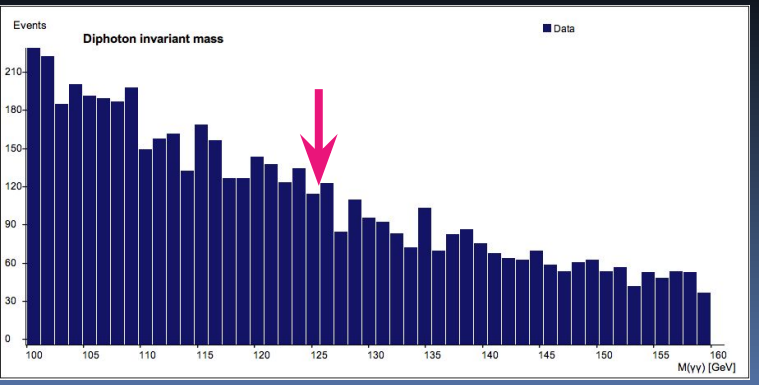
- You have mastered the Invariant Mass concept and applied the technique to:

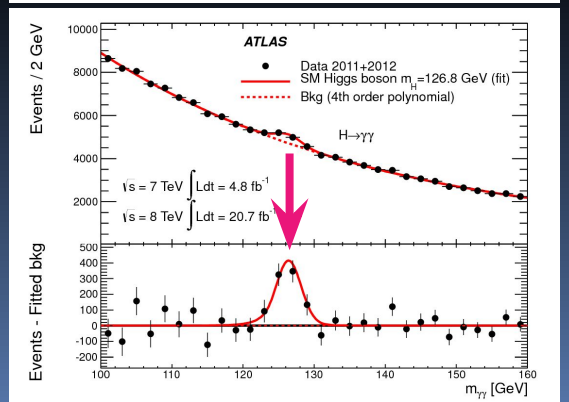






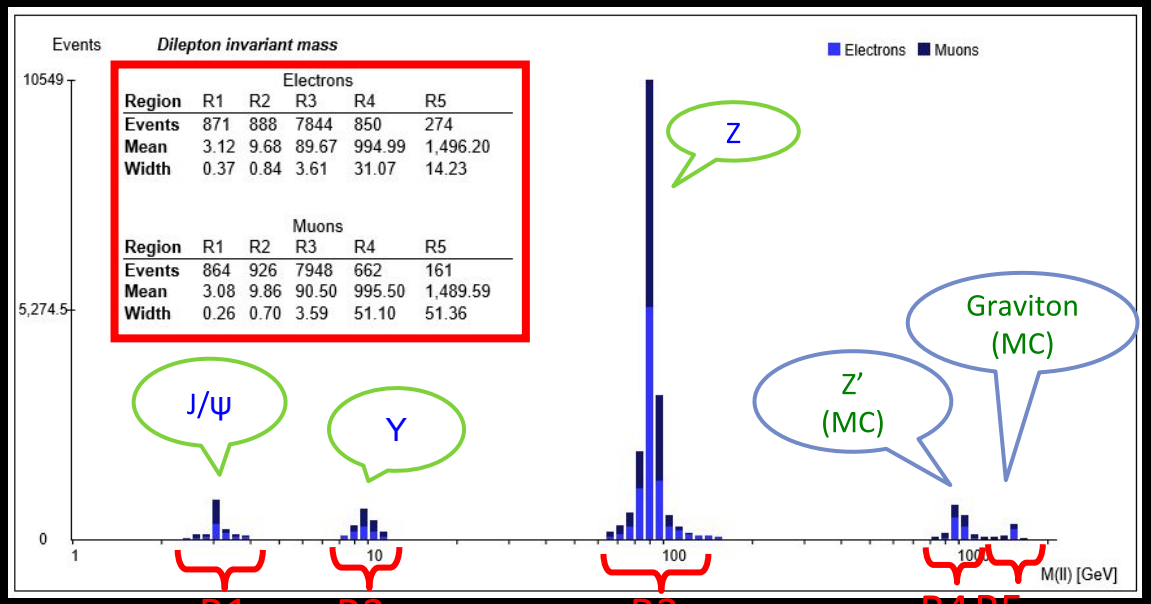






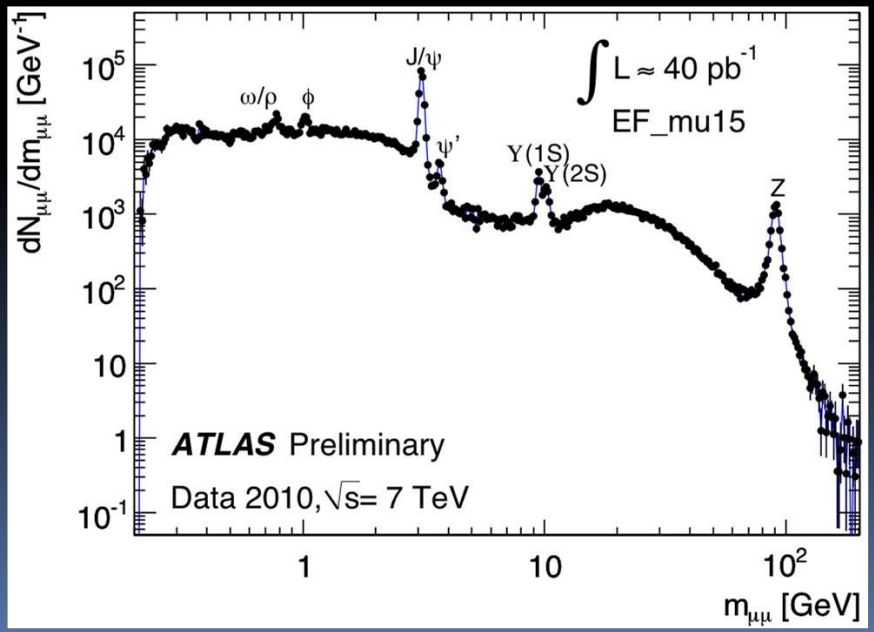
- Rediscover J/ψ, Υ, Z particles and measure their masses and decay widths
- Search for the Higgs boson (H) decaying to l^+l^- l^+l^- and γγ
- Search for new exotic particles (Z' and Graviton) that would decay into l^+l^-, 4 leptons and γγ
- … in a similar way as ATLAS did

Invariant mass M(l^+l^-): ATLAS vs. IMC students



- At the beginning of the LHC physics program, ATLAS rediscovered various standard model particles – J/ψ, Y, Z, etc. – before seeking new phenomena

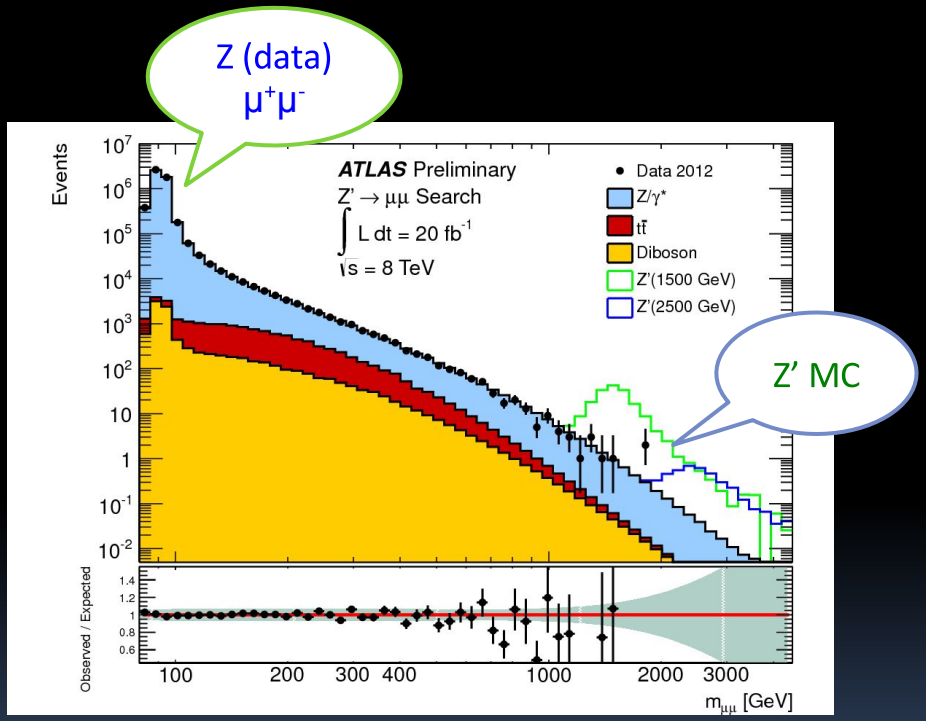
- You have found the J/ψ (~3GeV), Y (~10GeV), and Z (~91GeV) at the right masses!
- The Z' signal at 1 TeV and the Graviton at 1.5 TeV are Monte Carlo (MC) simulated
  - ATLAS searches for such exotic particles

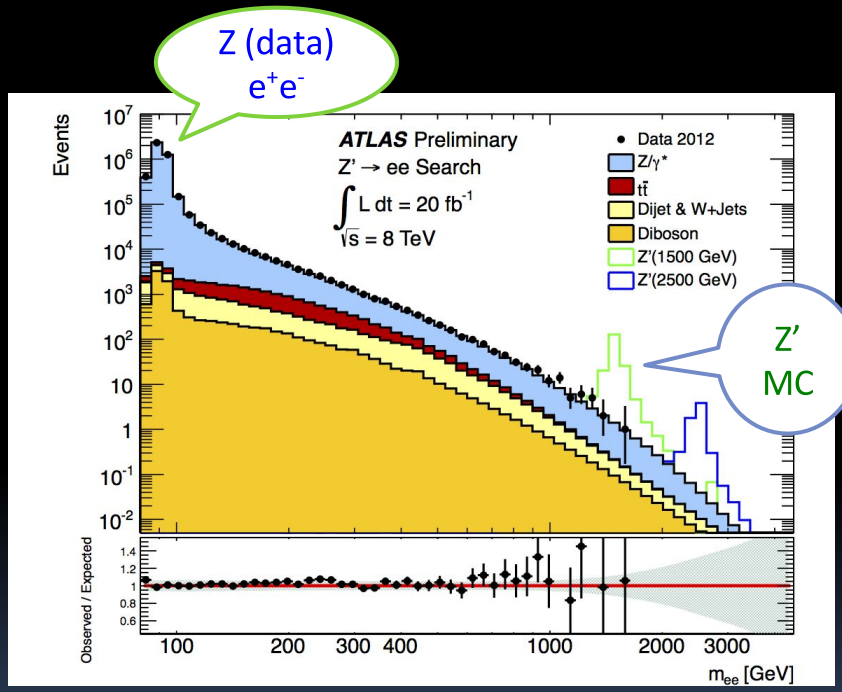


Invariant mass M(l^+l^-): ATLAS vs. IMC students

- Is there any New Physics out there? For example a new weak interaction mediated by a Z' boson?

- ATLAS status:
  - Z?: yes
  - Z'? No – not yet
    - Z' must be heavier than 2 - 2.5 GeV



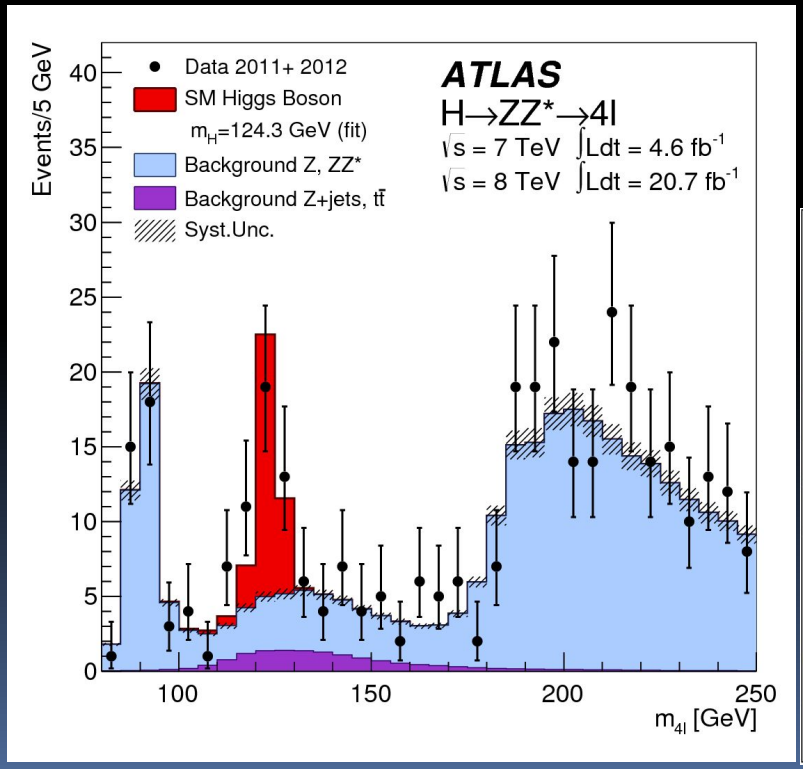


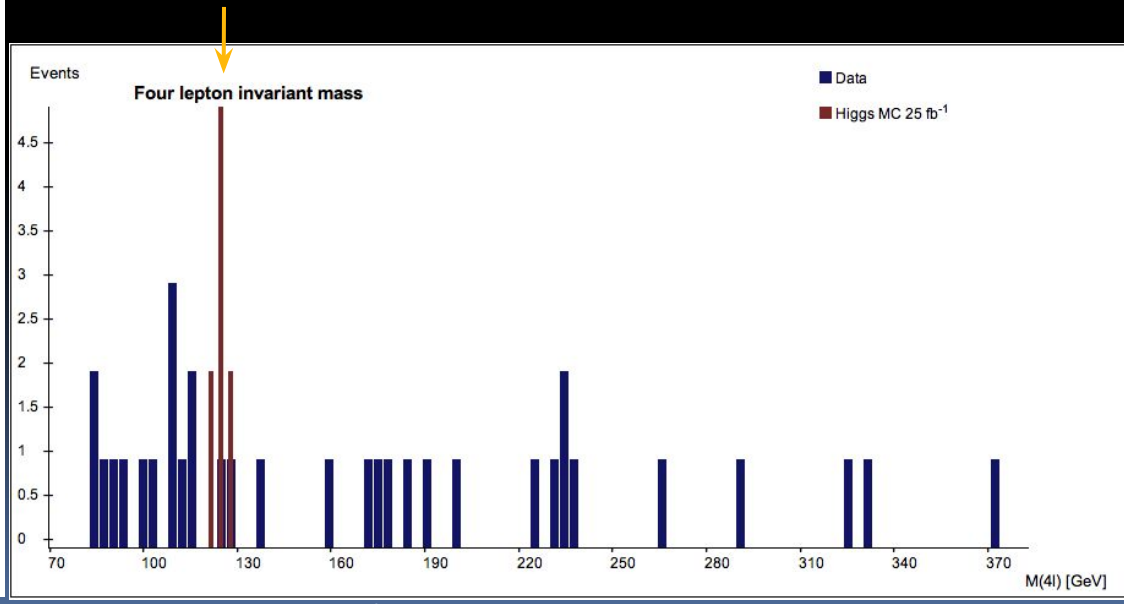
- With the Invariant Mass technique you could
  - Measure known particles
  - Look for new hypothetical particles – Z' or Gravitons, exactly like ATLAS does

Higgs search H → 4l
ATLAS vs. IMC Students

- ATLAS results
  - $H \rightarrow ZZ^* \rightarrow l^+l^-l^+l^-$
  - 25.3 fb^{-1}

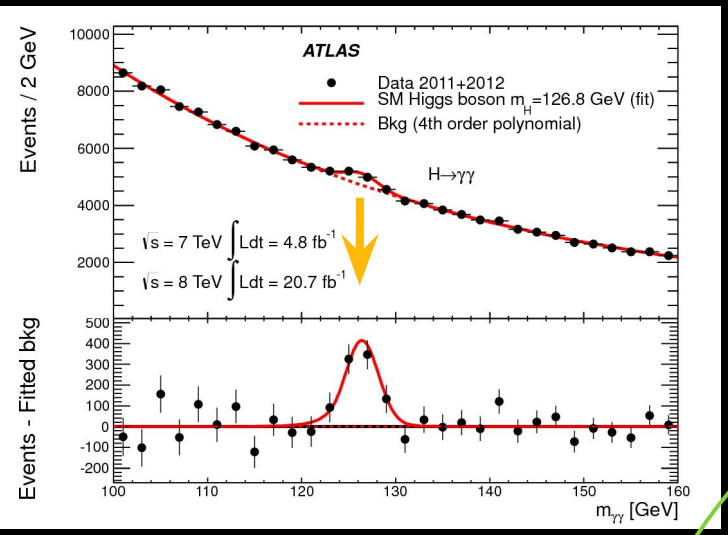
- You have searched for Higgs
  - $H \rightarrow l^+l^-l^+l^-$ with 2 fb^{-1}
- You have seen 2 candidates at ~125 GeV
  - 1 compatible with what ATLAS has observed
  - The other event corresponds to $ZJ/\psi \rightarrow 4l$
  - With 25 fb^{-1}, you would see ~10 events on top of very small background



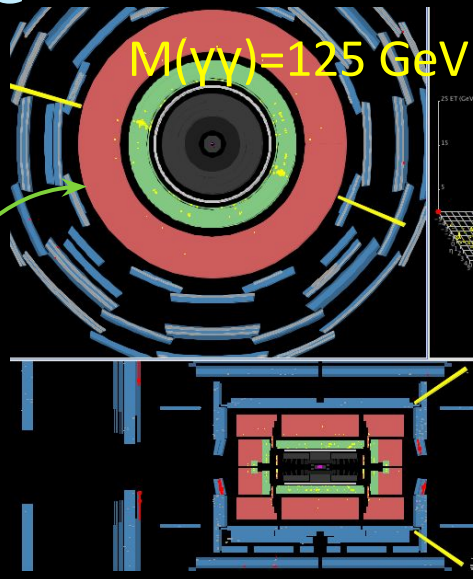


Higgs search H → γγ: ATLAS vs. IMC Students

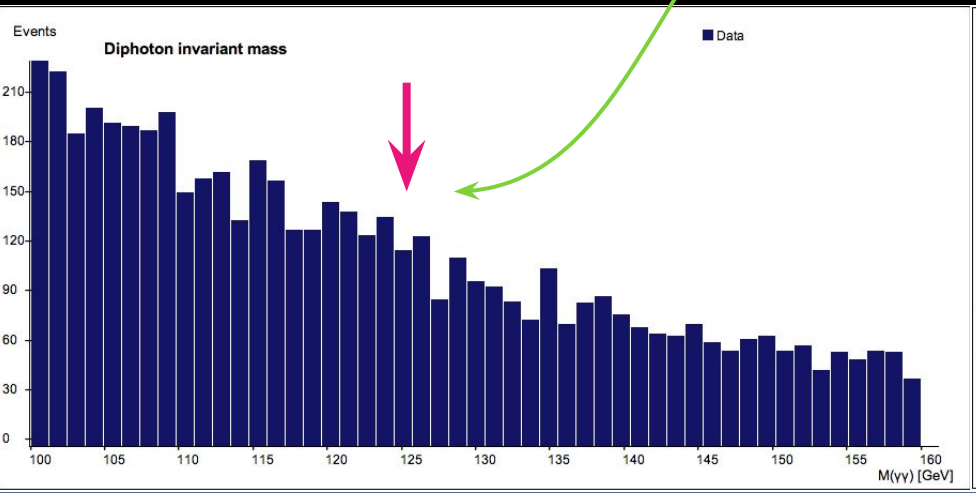
- ATLAS results: H → γγ
  - 25.5 fb^{-1} → clear signal

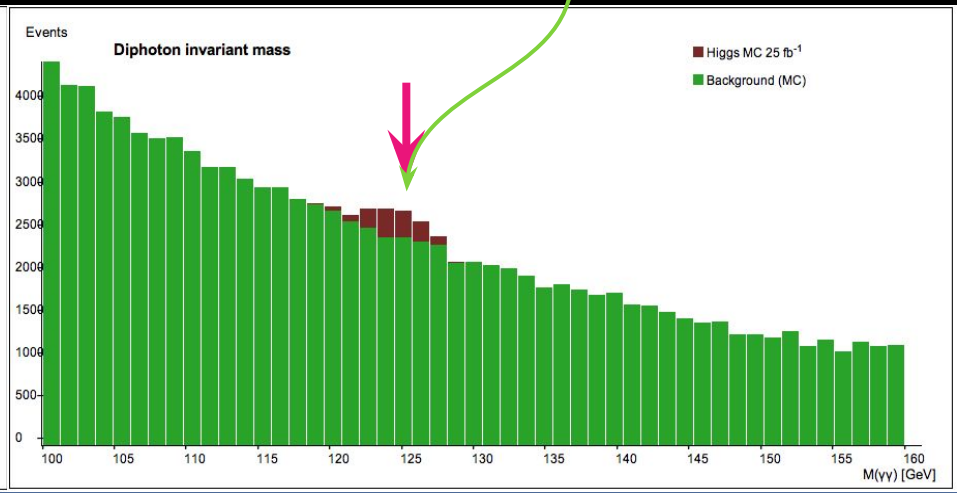


- You have searched for Higgs
  - H → γγ with 2 fb^{-1}
- You have several candidates at ~125 GeV
  - You don't have enough statistics to reproduce the ATLAS result

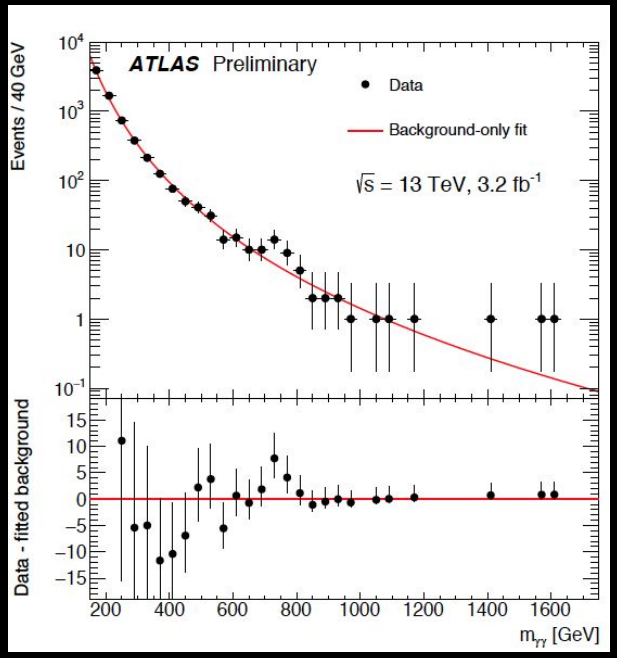


- With 25 fb^{-1}, you would clearly observe a signal on top of a large background.





New particle / New physics?



- Spin-0 (Higgs-like)?
  - decays to di-photons, ZZ, WW, di-leptons (suppressed for electron and muon)
- Spin-1 (Z/Z'-like)
  - decays to di-leptons, not to di-photons, ZZ, WW
- Spin-2 (Graviton-like)
  - decays to di-photons, di-leptons, ZZ, WW