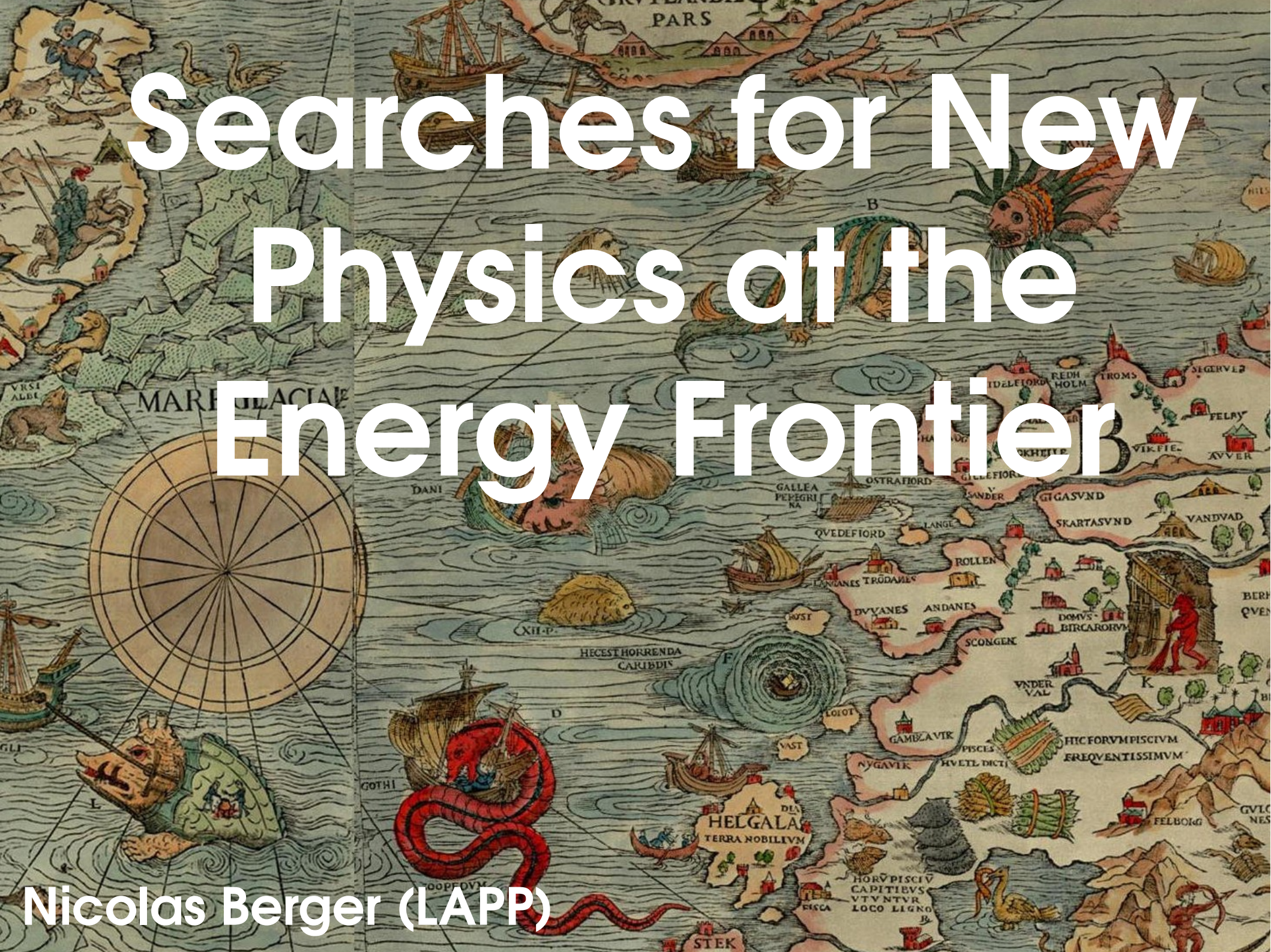
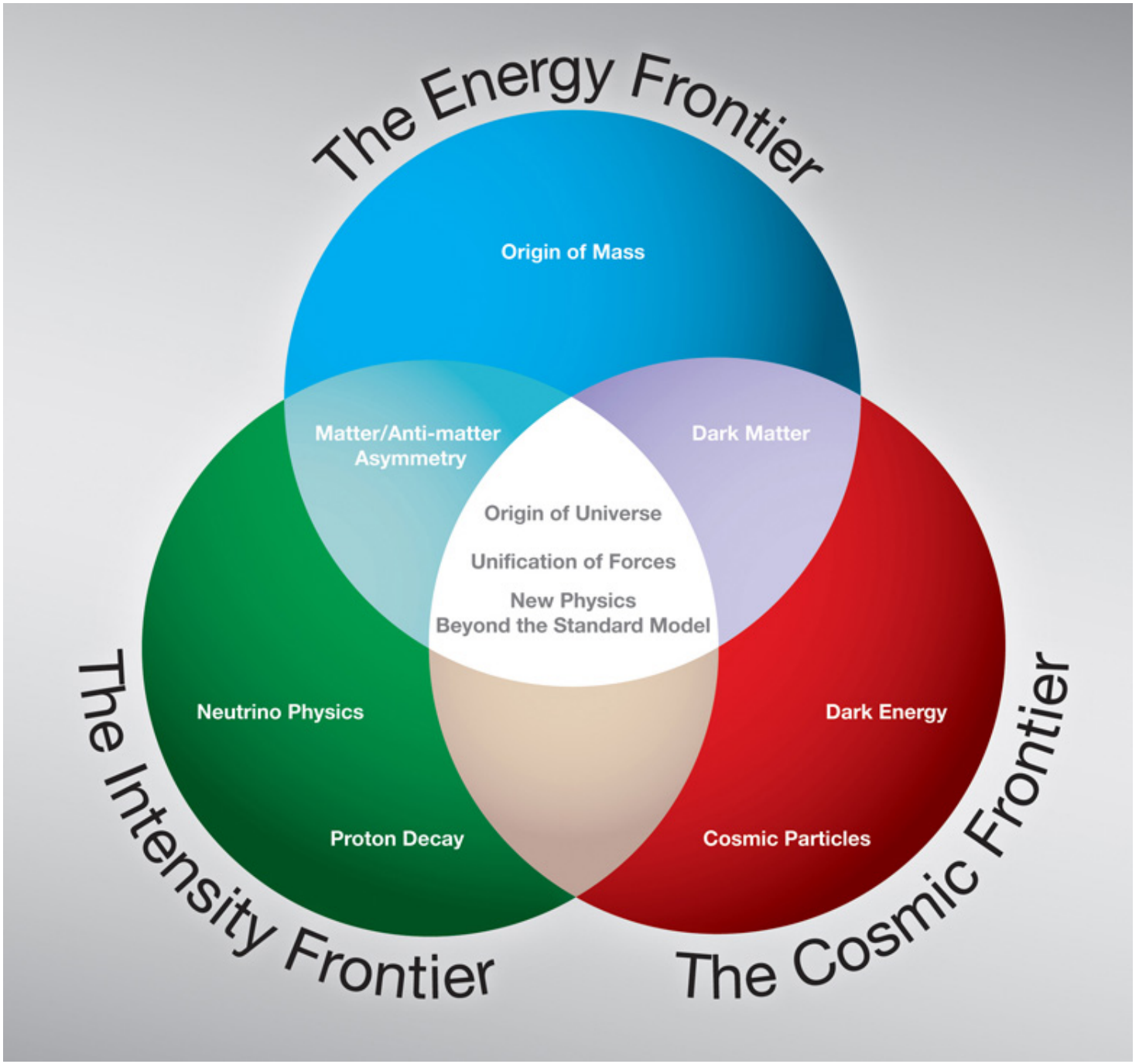


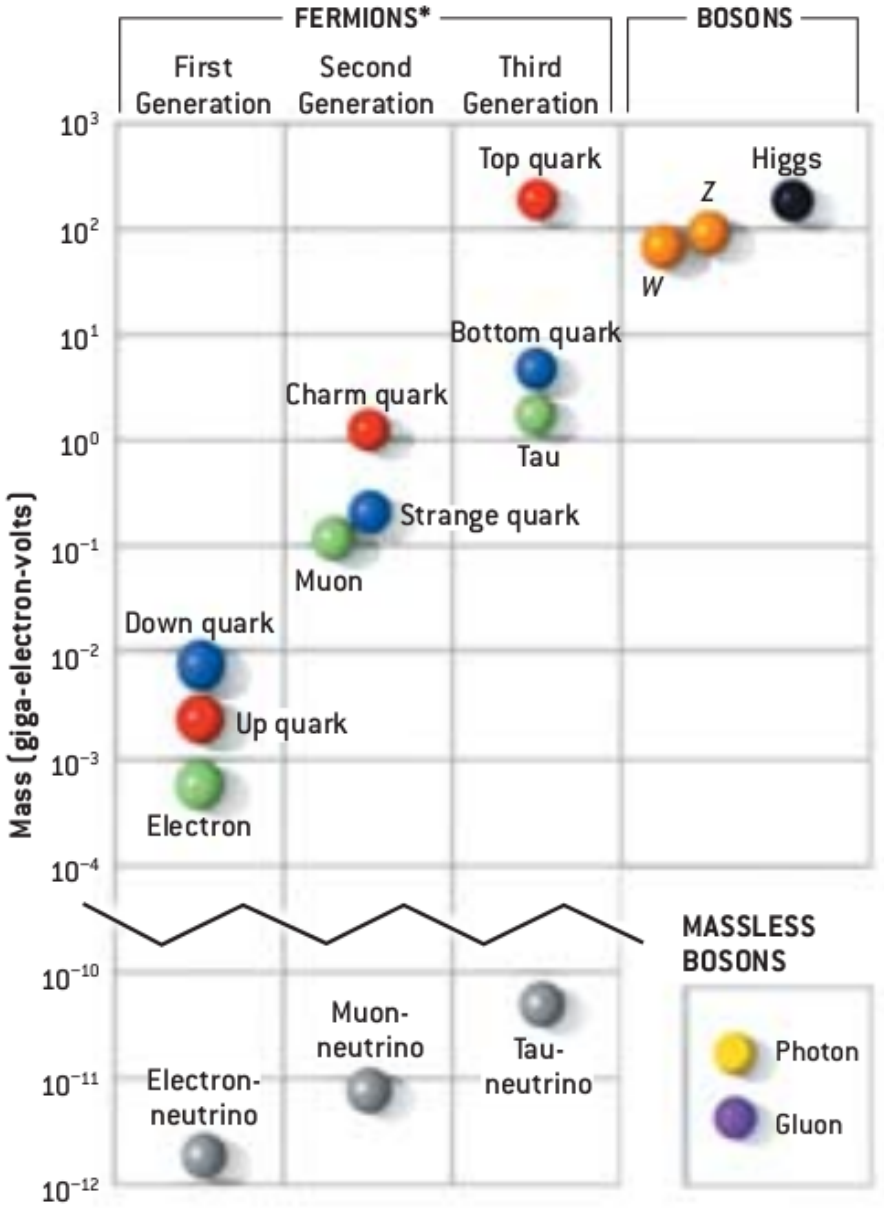
Searches for New Physics at the Energy Frontier

Nicolas Berger (LAPP)

Ubi Sunt Dracones ?



The Energy Frontier

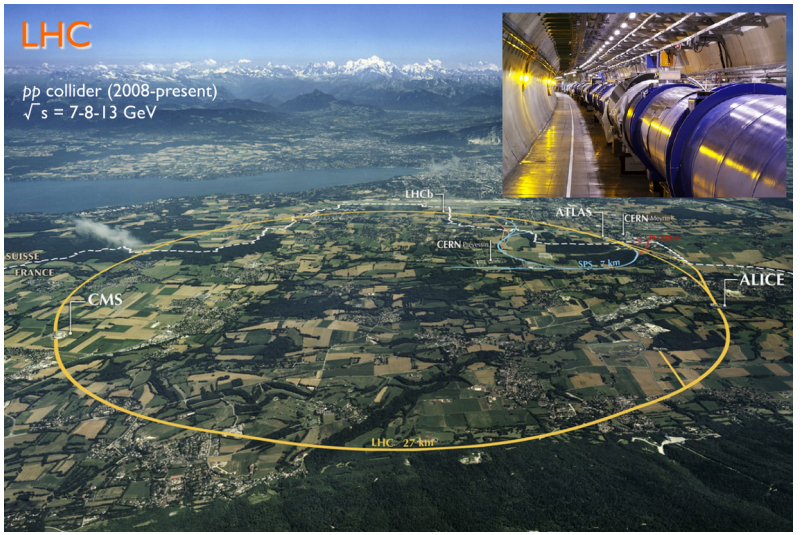


LEP
200 GeV

TeVatron
2 TeV

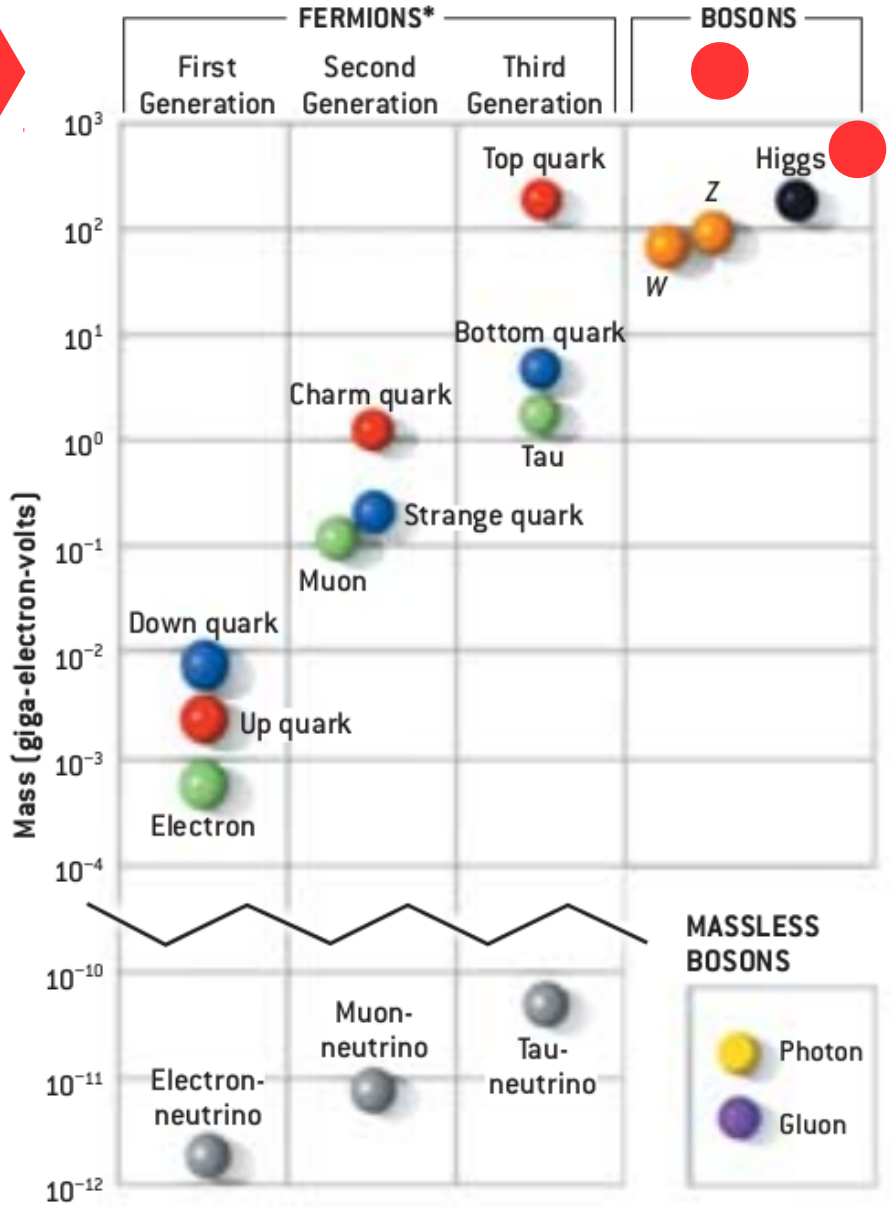
LHC
14 TeV

Need a high-energy collider to produce heavy particles



Expect new physics *at the TeV Scale*

The Energy Frontier



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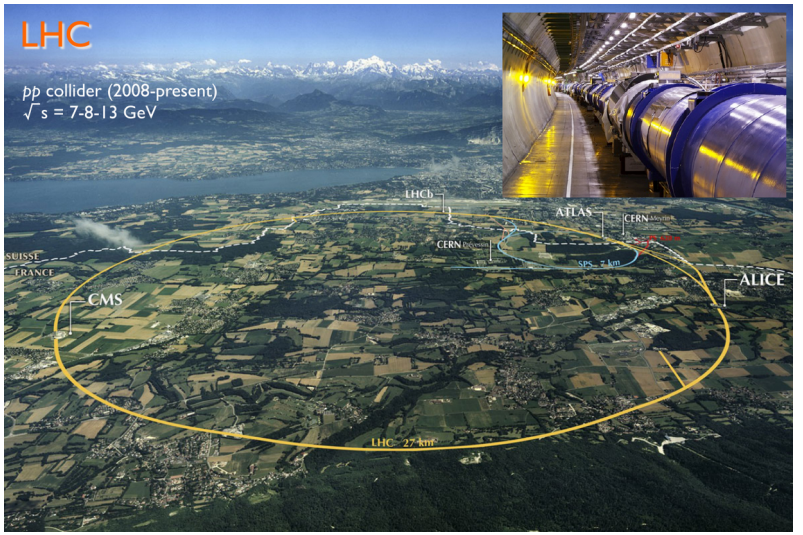


Expect new physics *at the TeV Scale*

New Particles

New Particles

New Particles

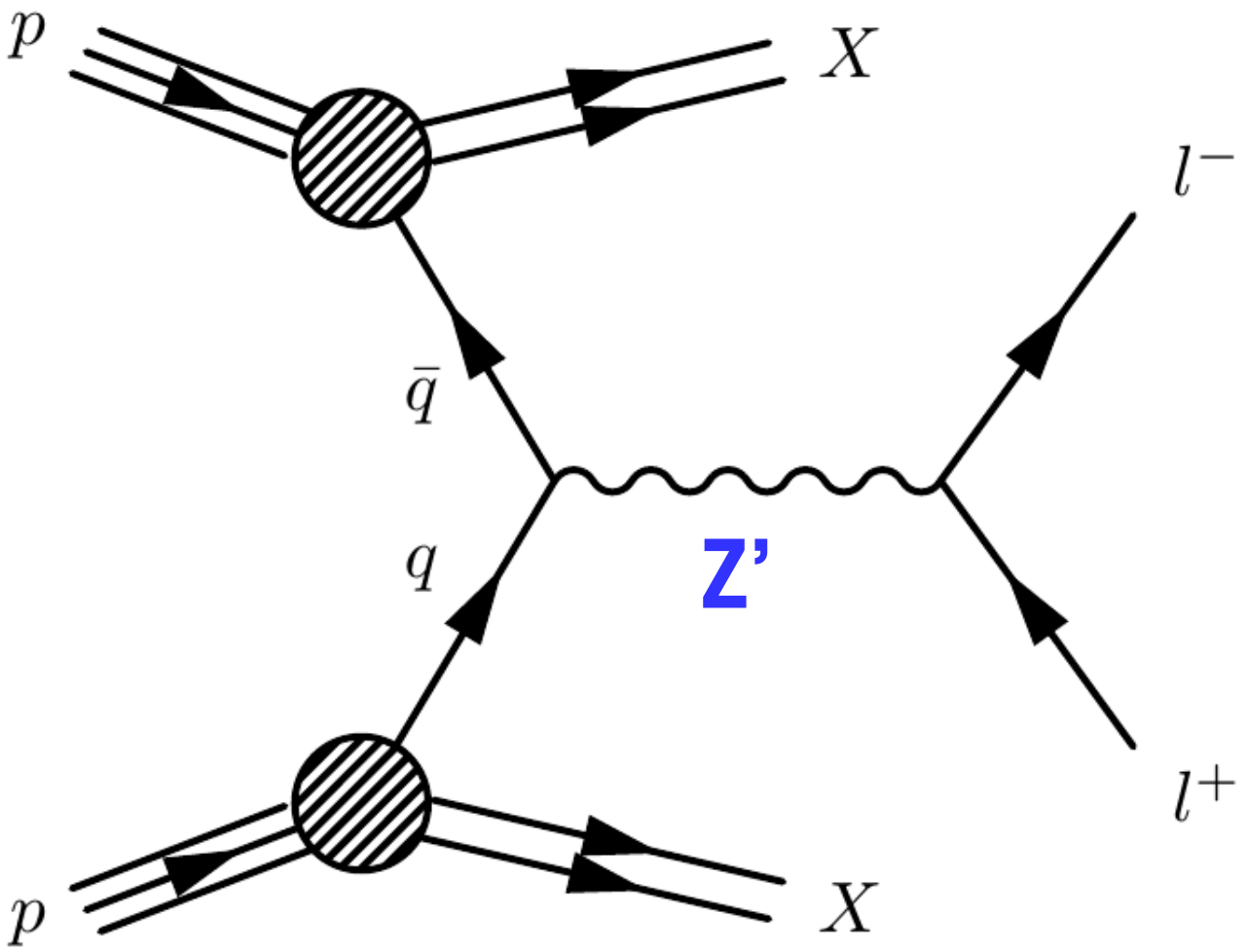
New Interactions

New Particles

New Interactions

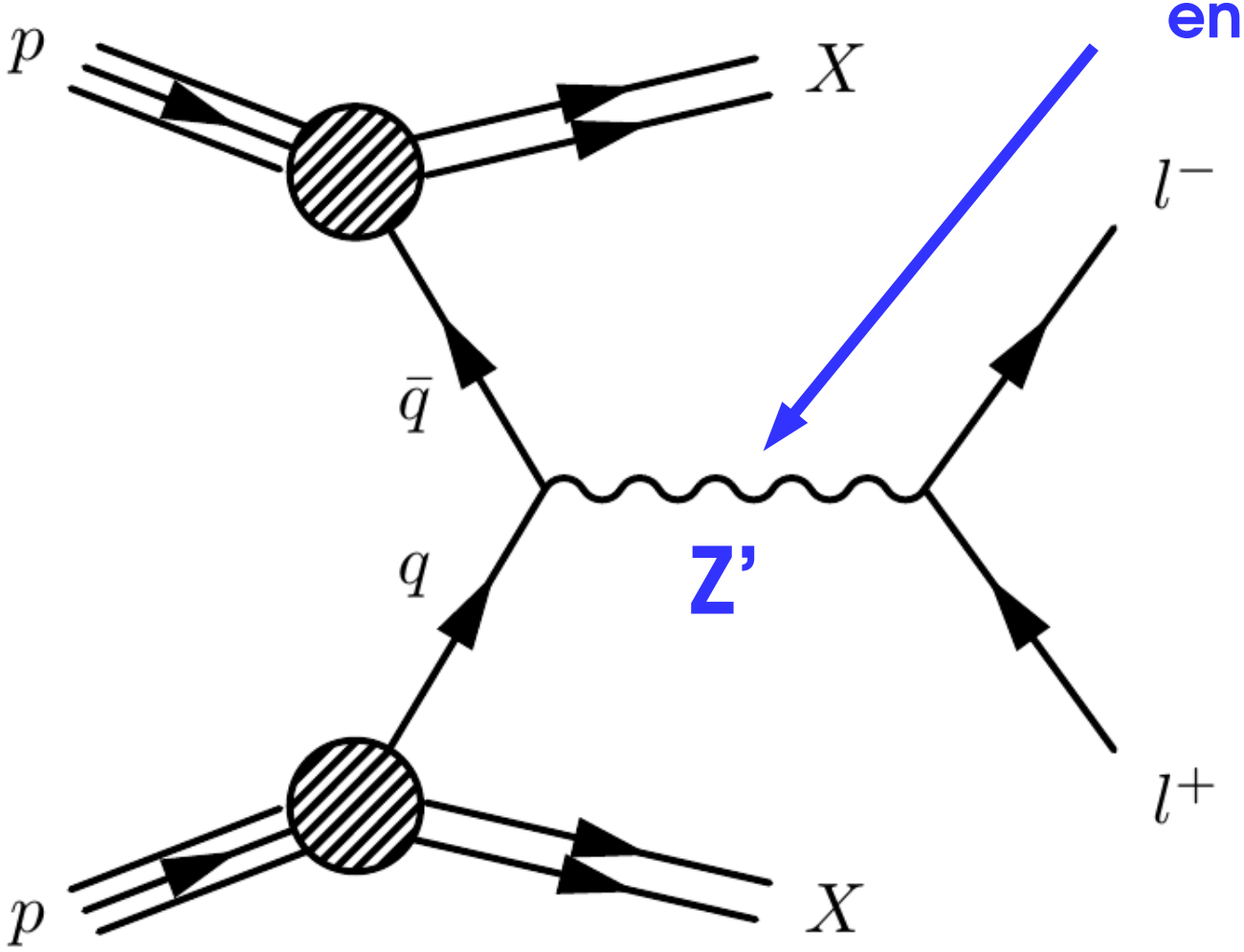
Extended Higgs Sector

New Vector Boson : Z'



New Vector Boson : Z'

Needs high collision energy to produce



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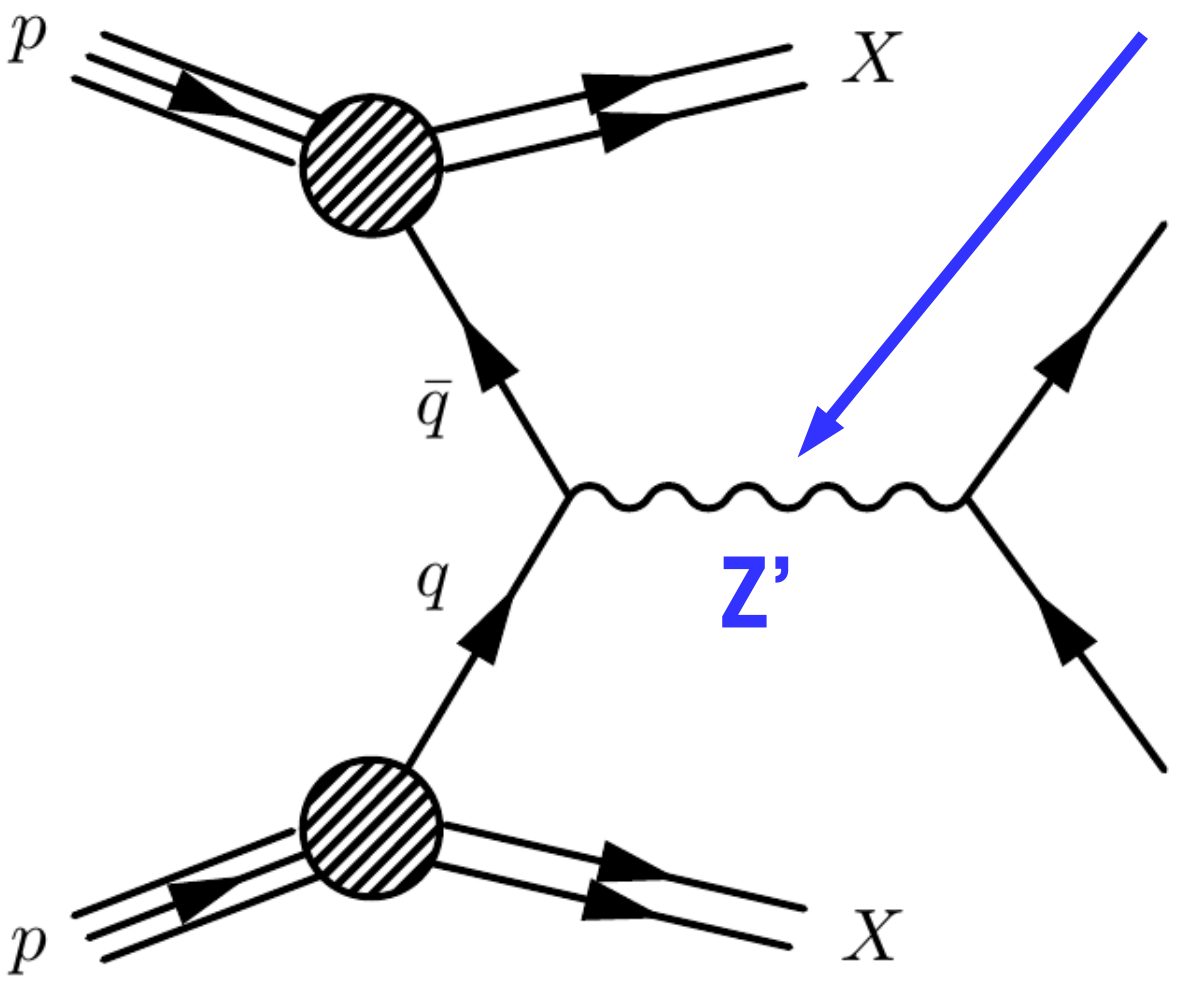
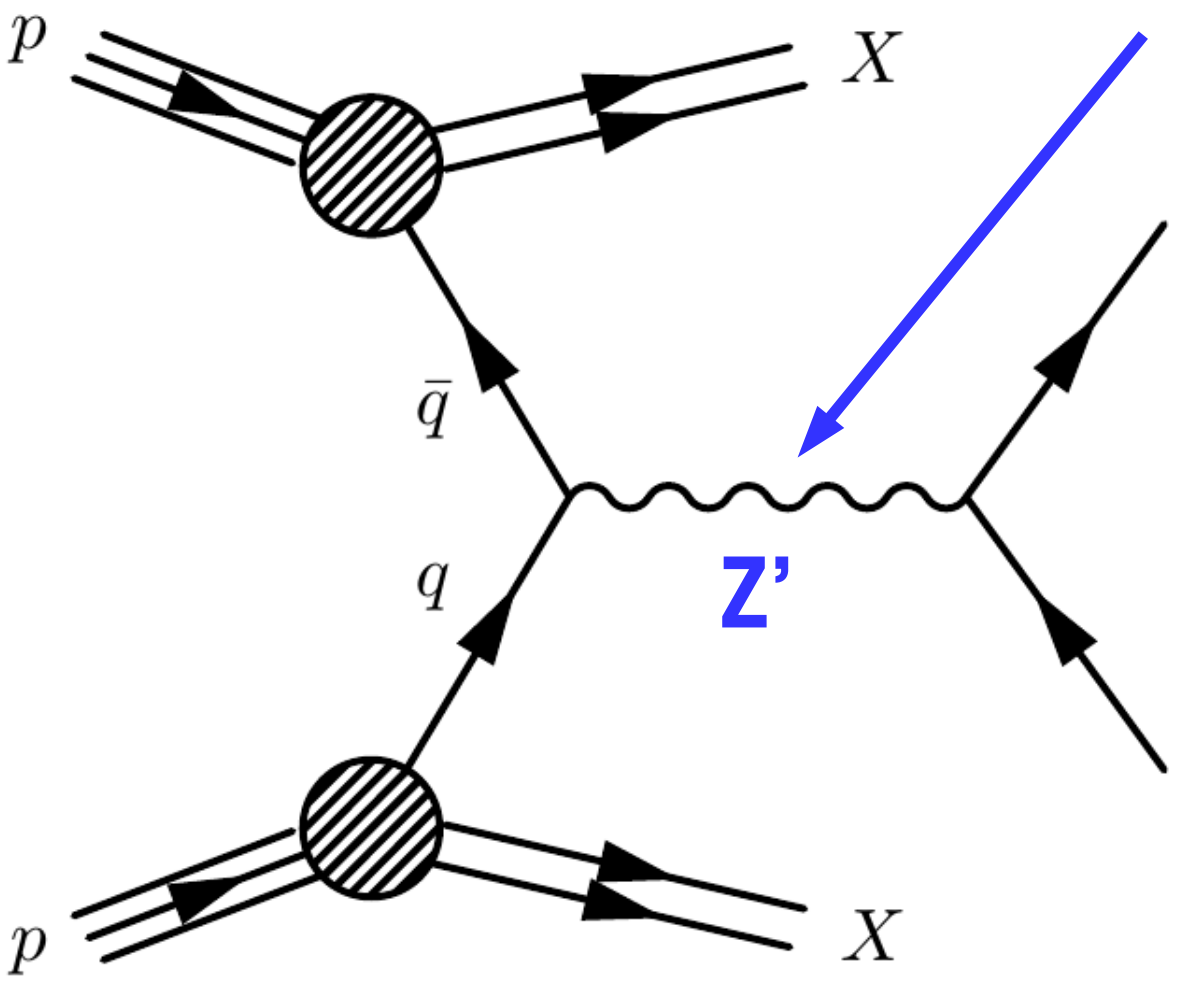


High Energy Leptons: e or μ

New Vector Boson : Z'



Needs high collision energy to produce

l^-

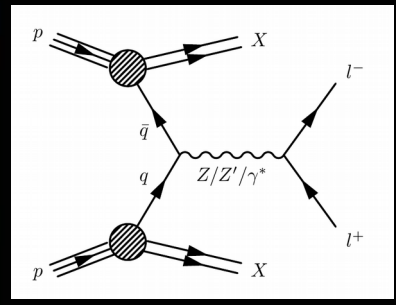
l^+

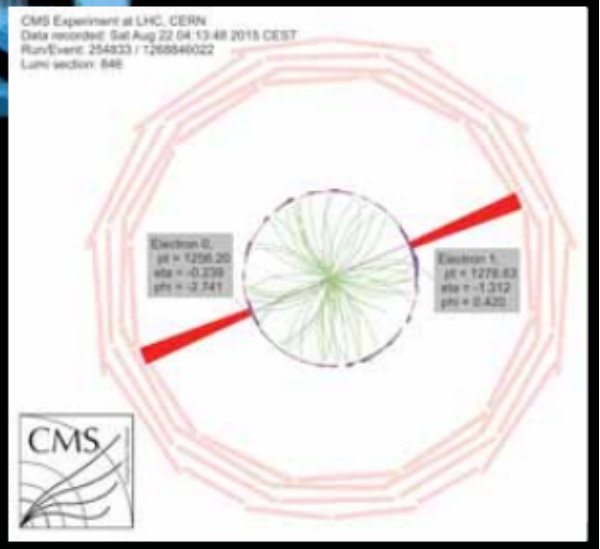
Reconstruct $M_{Z'}$ from Dilepton Invariant mass

$$M = \sqrt{\left(\sum E_i\right)^2 - \left(\sum \vec{p}_i\right)^2}$$

High Energy Leptons: e or μ

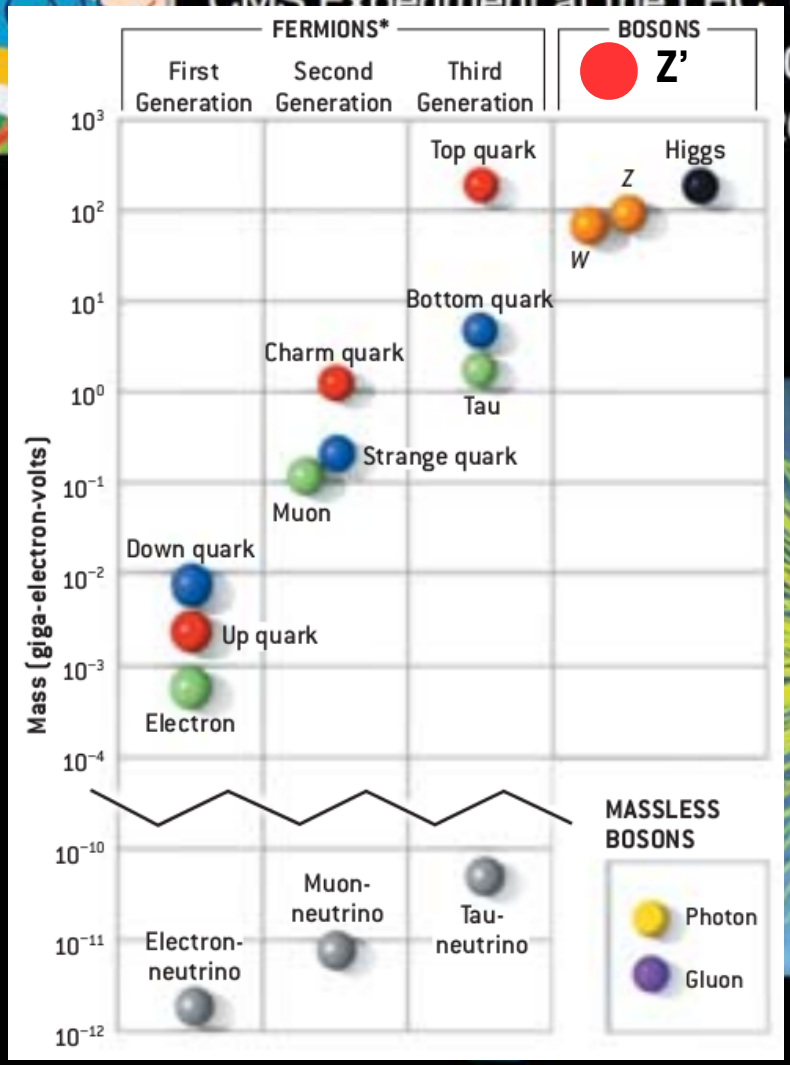
CMS Experiment at the LHC, CERN
Data recorded: 2015-Aug-22 02:13:48.861952 GMT
Run / Event / LS: 254833 / 1268846022 / 846

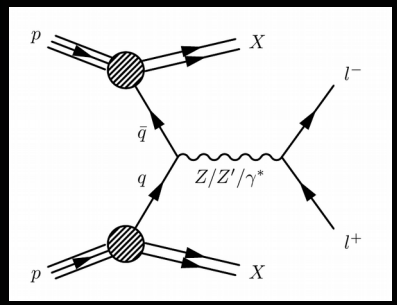


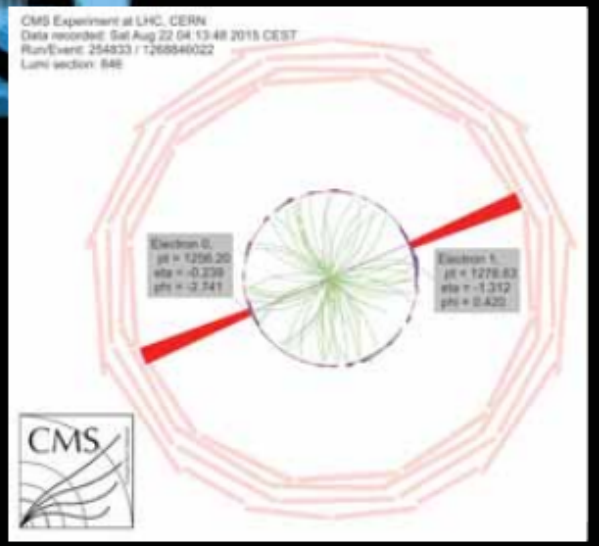


- Display of rare *colossal* e^+e^- candidate event with 2.9 TeV invariant mass
- Each electron candidate has 1.3 TeV E_T
- Back-to-back in ϕ

Highest-mass Run-1 events: 1.8 TeV (ee), 1.9 TeV (μμ)







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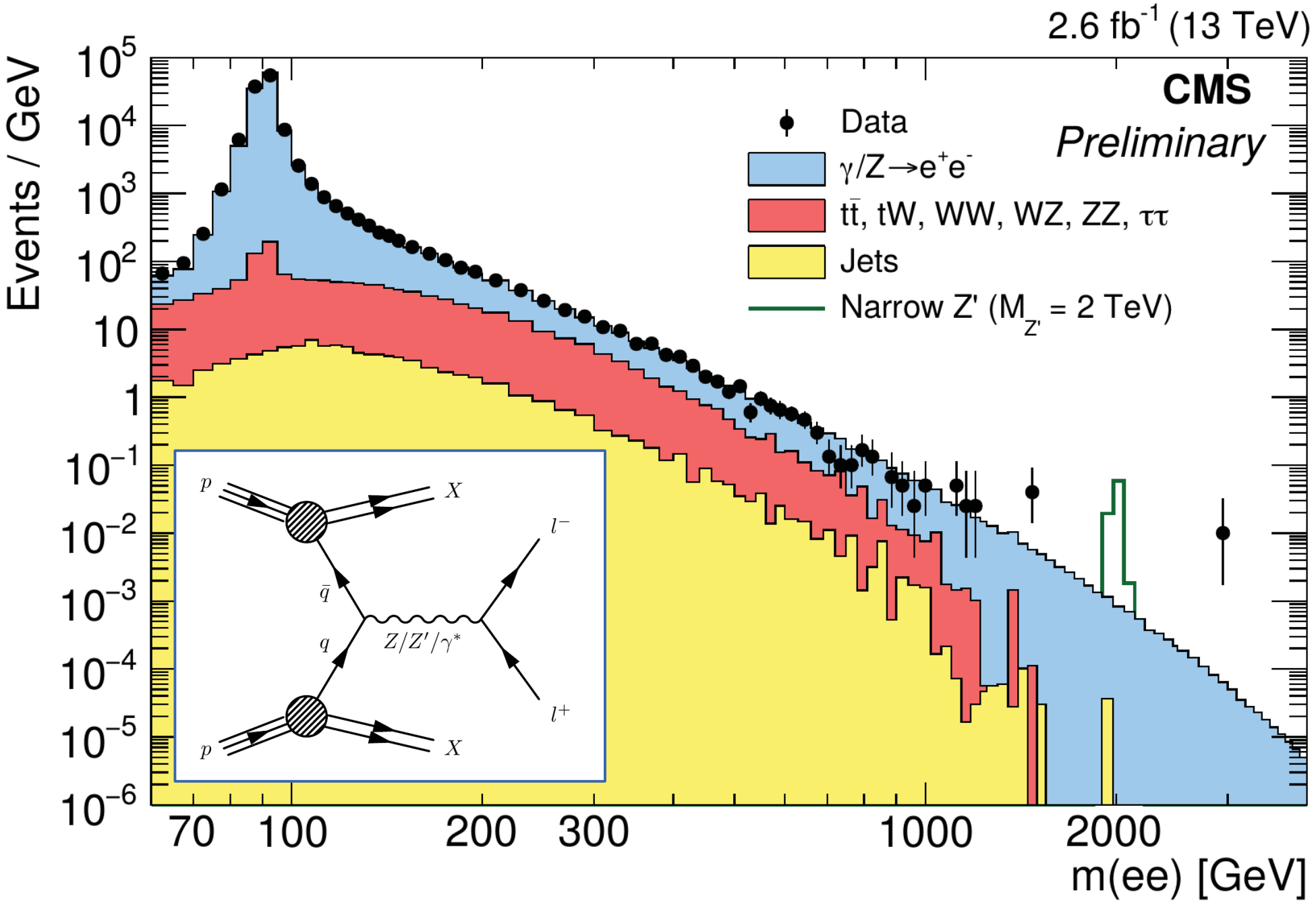
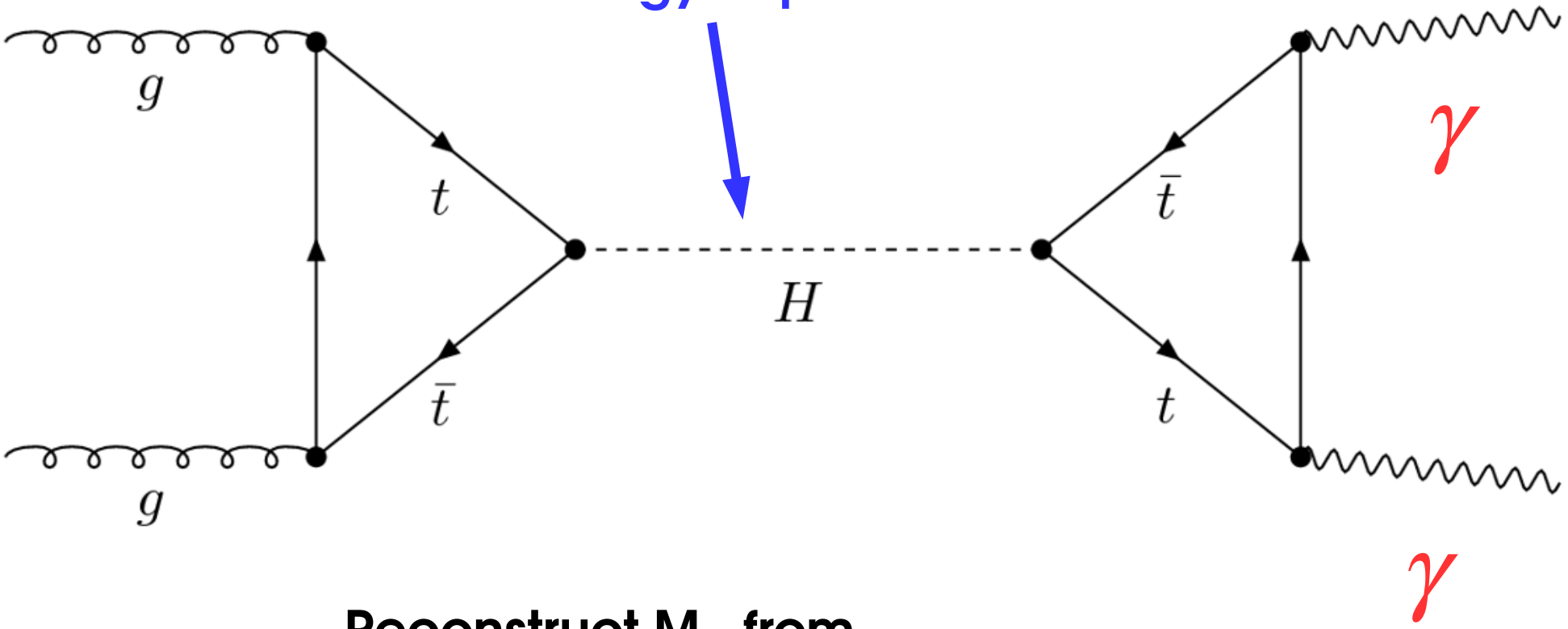
Invariant Mass Distribution



Heavy Higgs

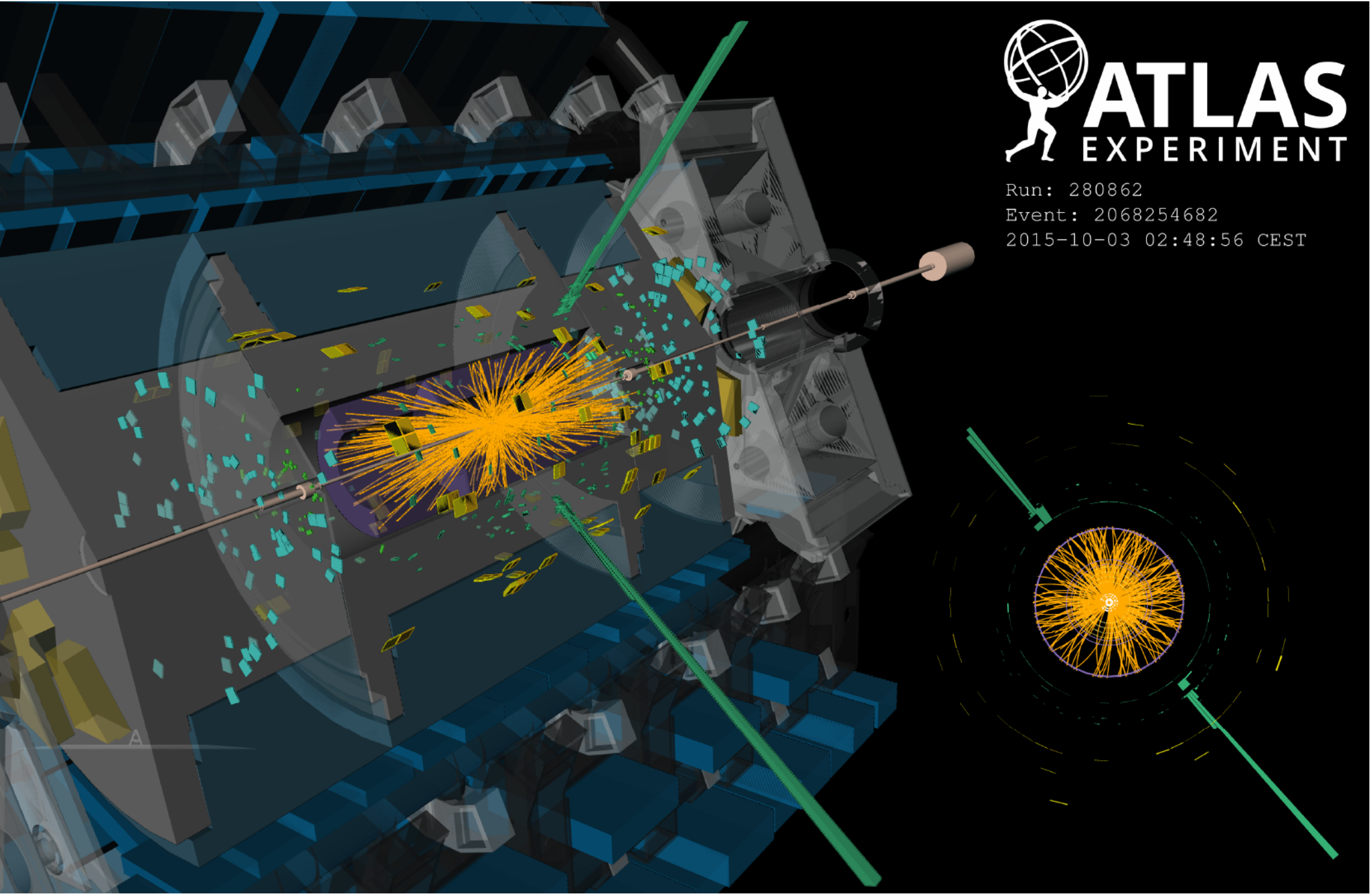
Needs high collision energy to produce



Reconstruct $M_{H'}$ from Diphoton Invariant mass

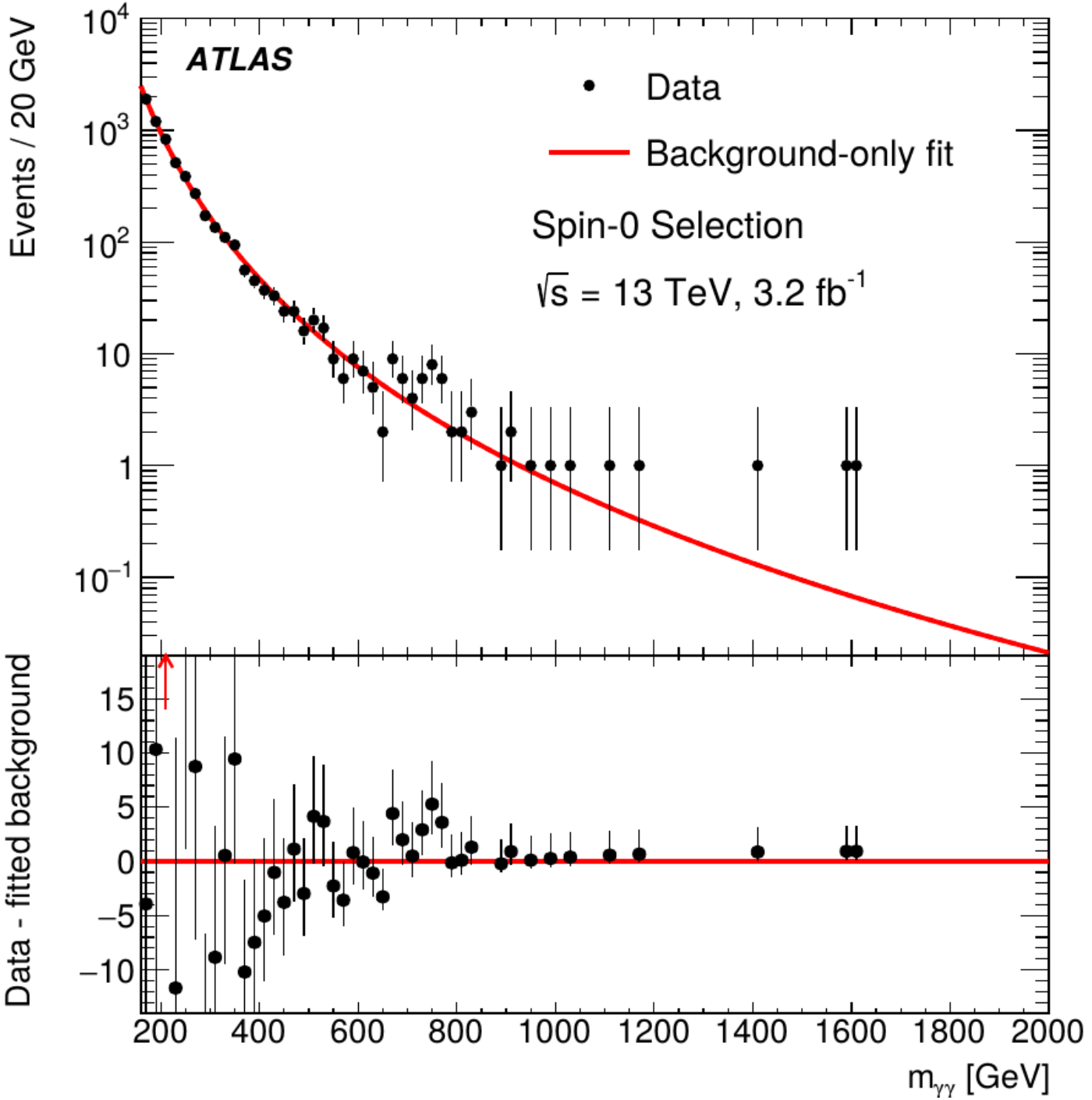
$$M = \sqrt{\left(\sum E_i\right)^2 - \left(\sum \vec{p}_i\right)^2}$$

High Energy Photons

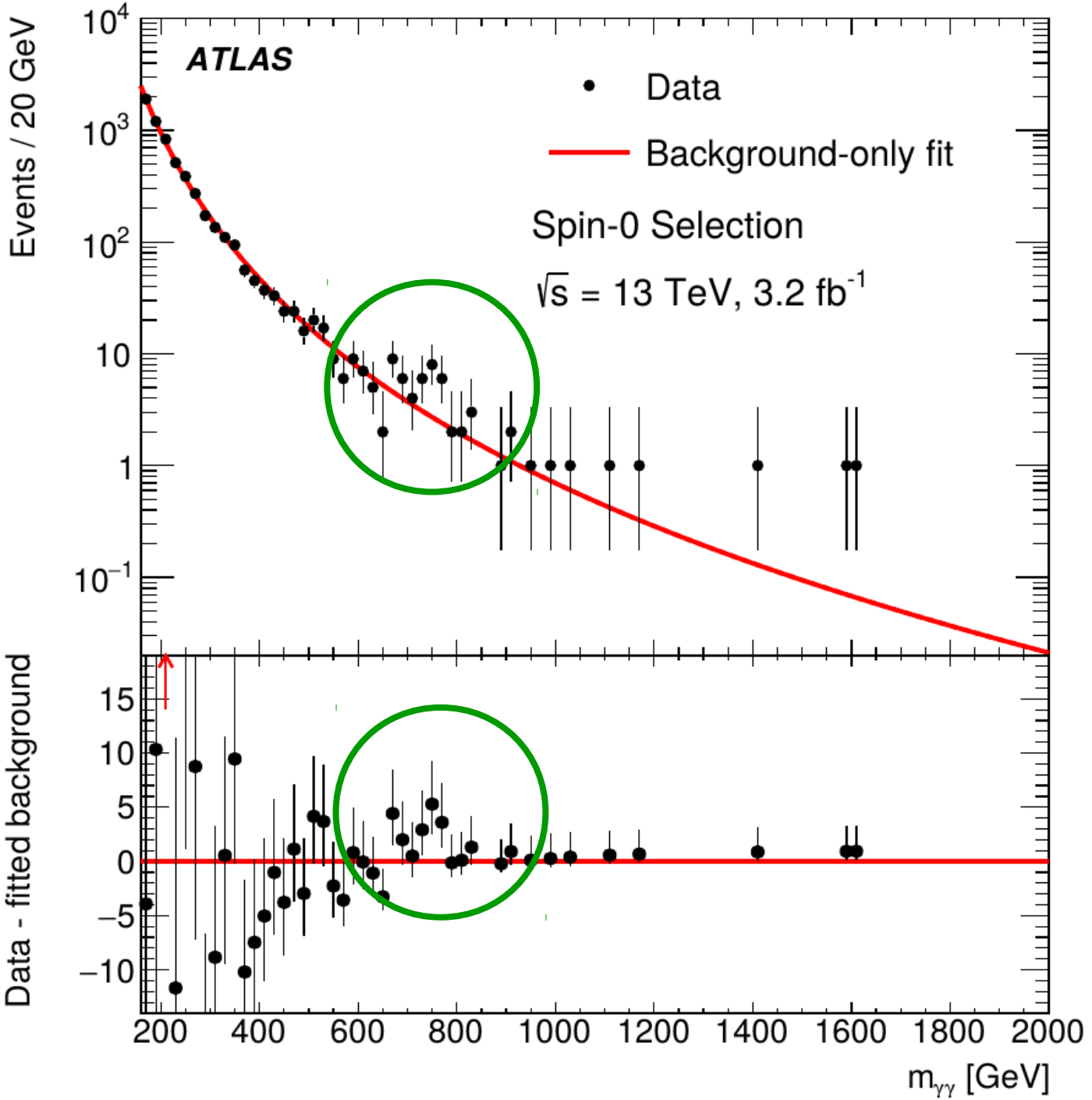


Invariant Mass $M_{\gamma\gamma}$ ~ 730 GeV

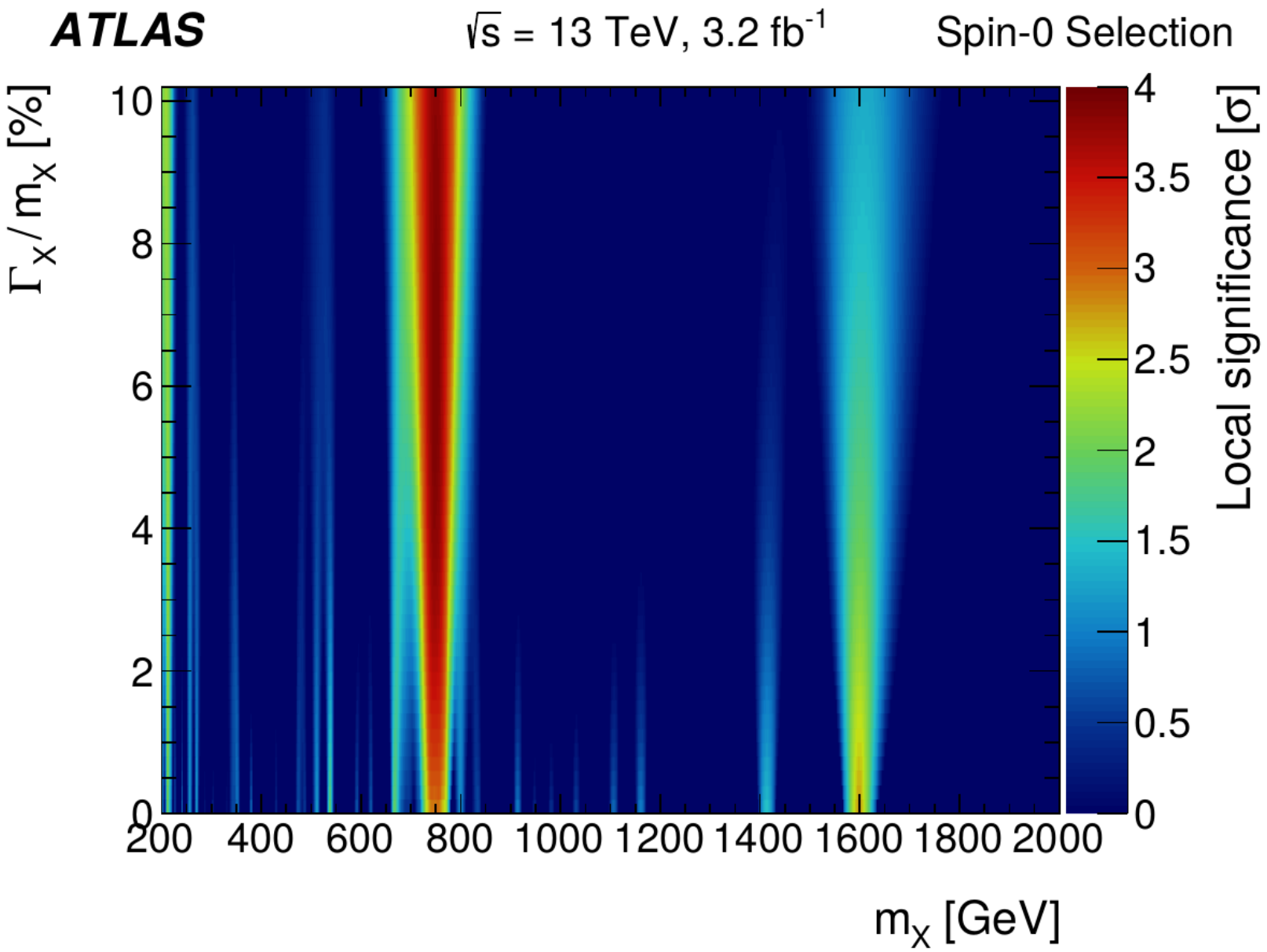
Invariant Mass Distribution



Invariant Mass Distribution



Significance



Probability for background to fluctuate up to here

0.003%

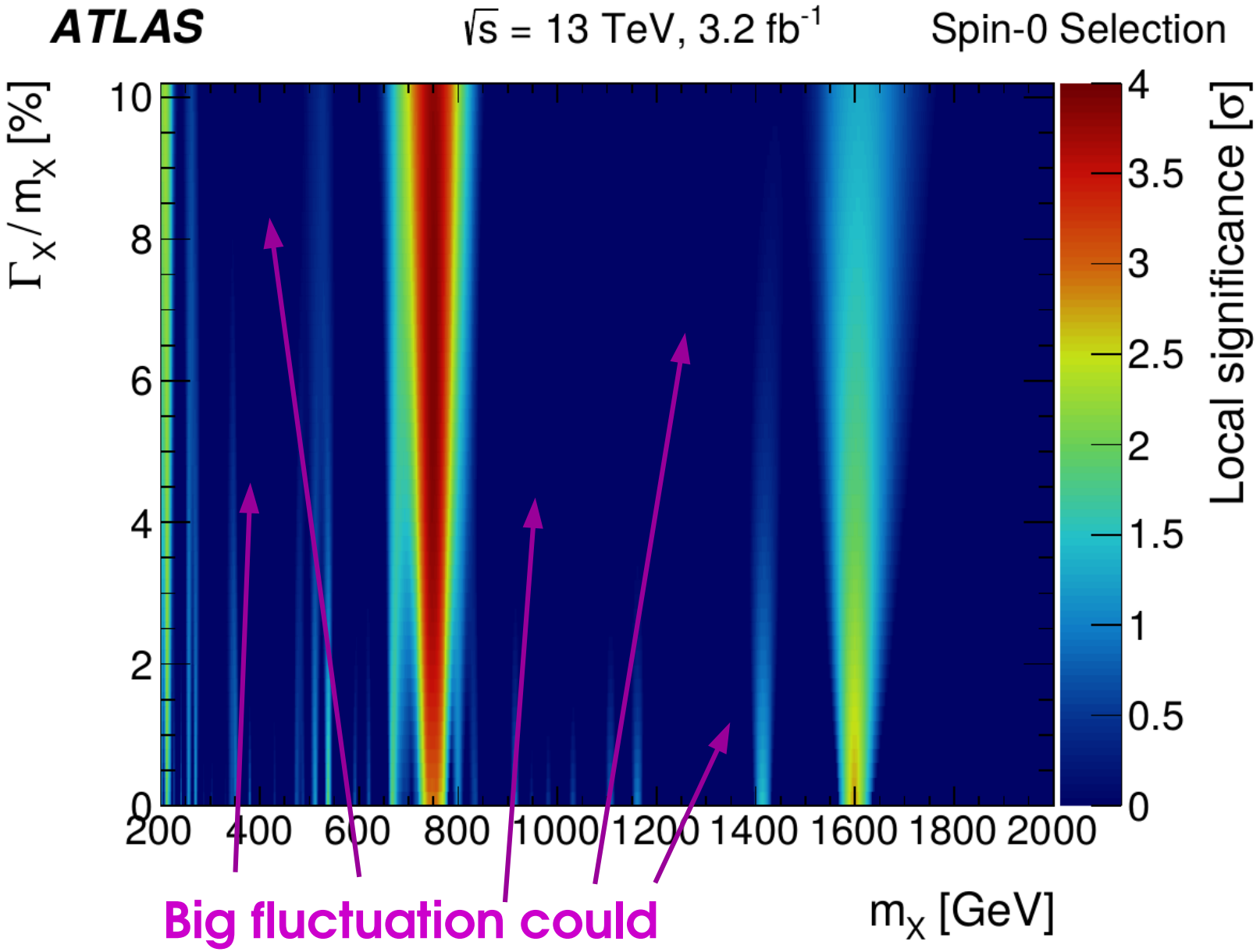
0.1%

2%

16%

Significance

Probability for background to fluctuate up to here



0.003%

0.1%

2%

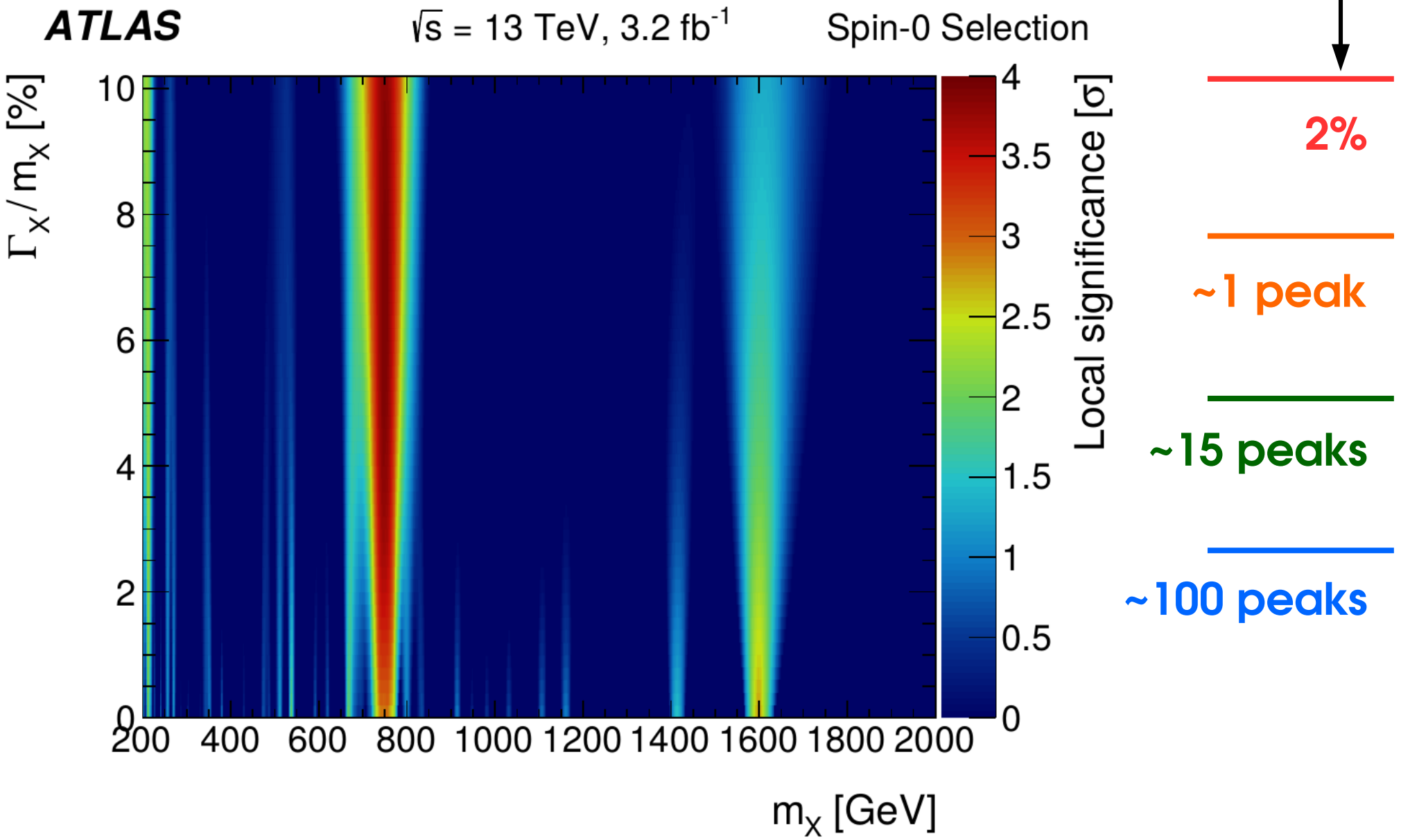
16%

Big fluctuation could have happened here

"Look Elsewhere" Effect

Significance

Probability for background to fluctuate up to here SOMEWHERE



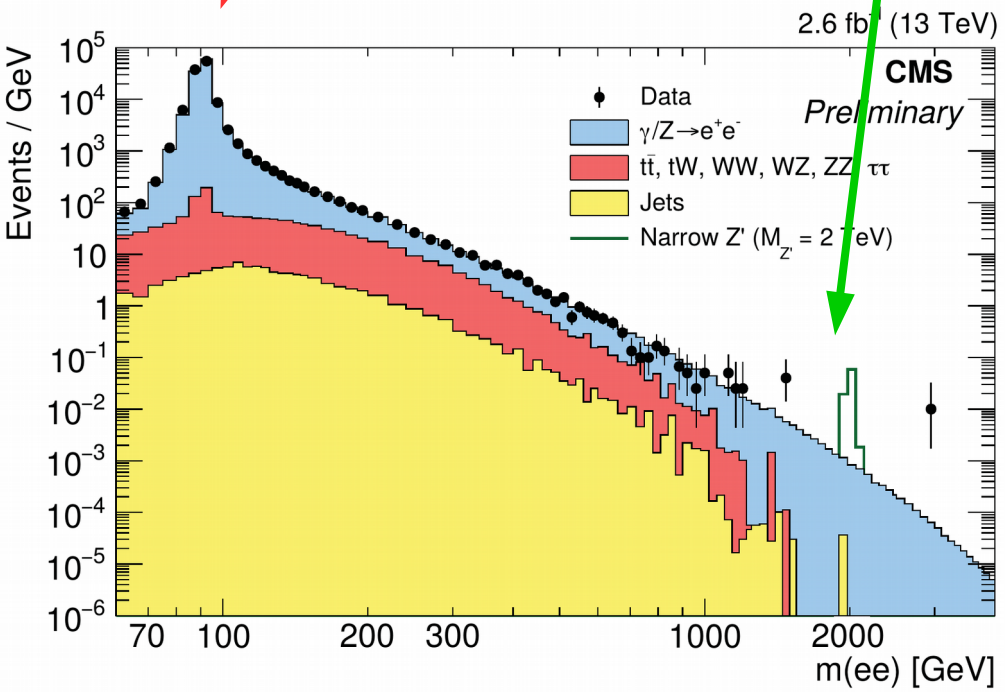
Future

Energy is important …

…. But lots of data is also **very** important

Lots of events here

We want some here too



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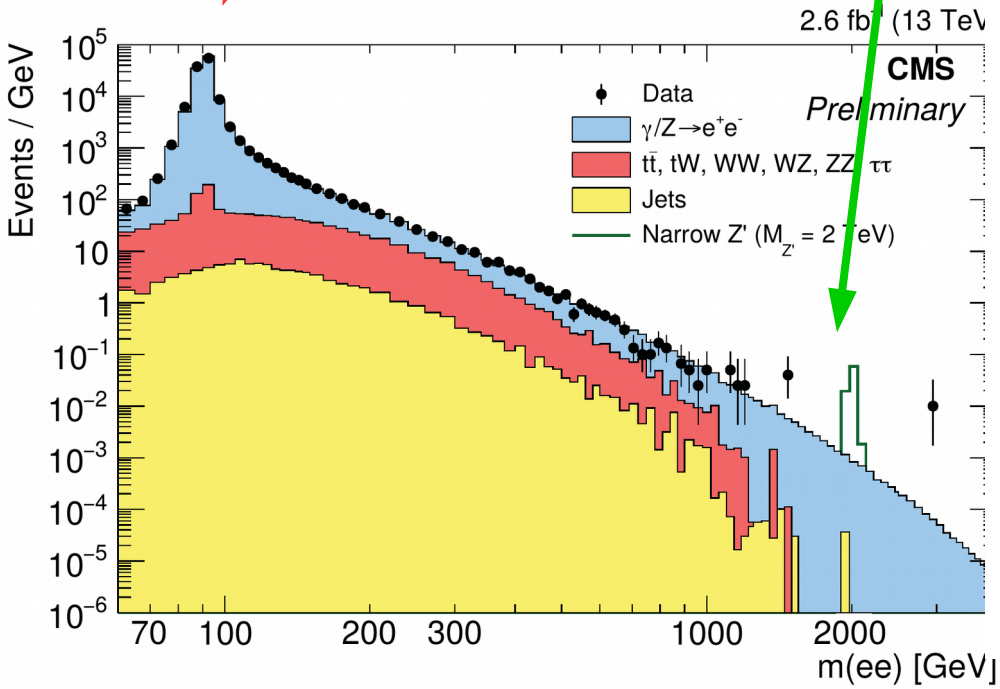

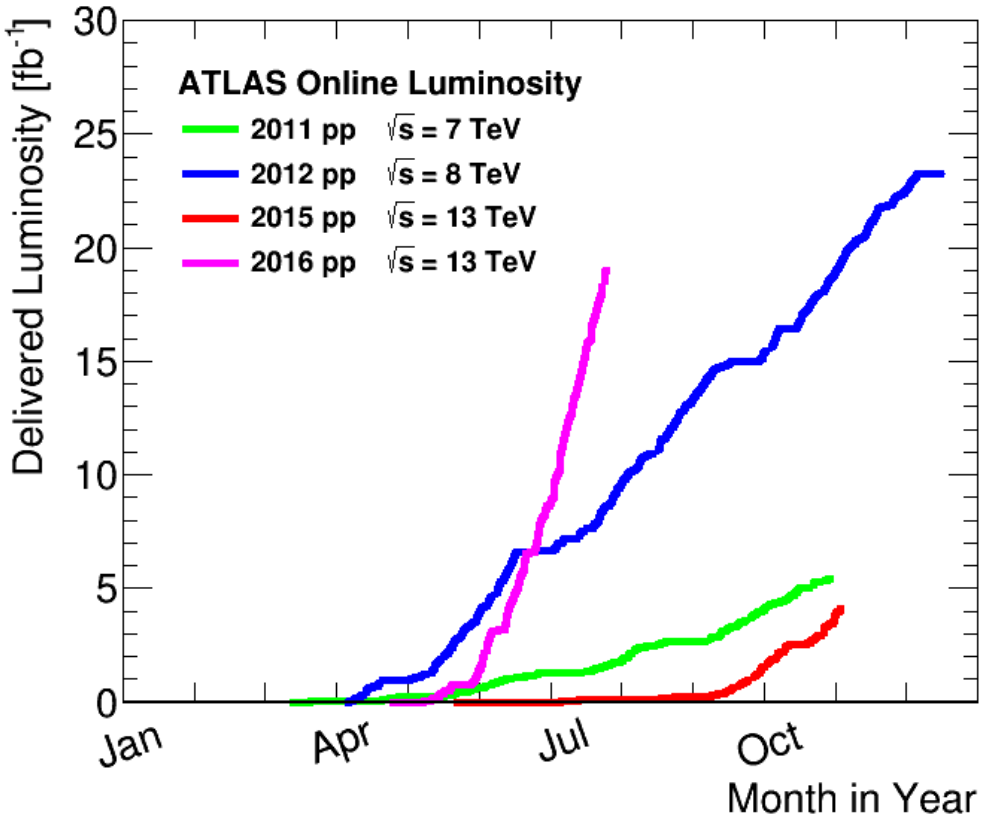

Future

Energy is important …

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LHC Ultimate Goal:

3000 fb^{-1}

Lots of events here

We want some here too