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# PDF Uncertainty Reduction for High-Mass Searches at the LHC using the ATLAS Detector

ePump Mini-Workshop  
7th October 2022

Daniel Hayden  
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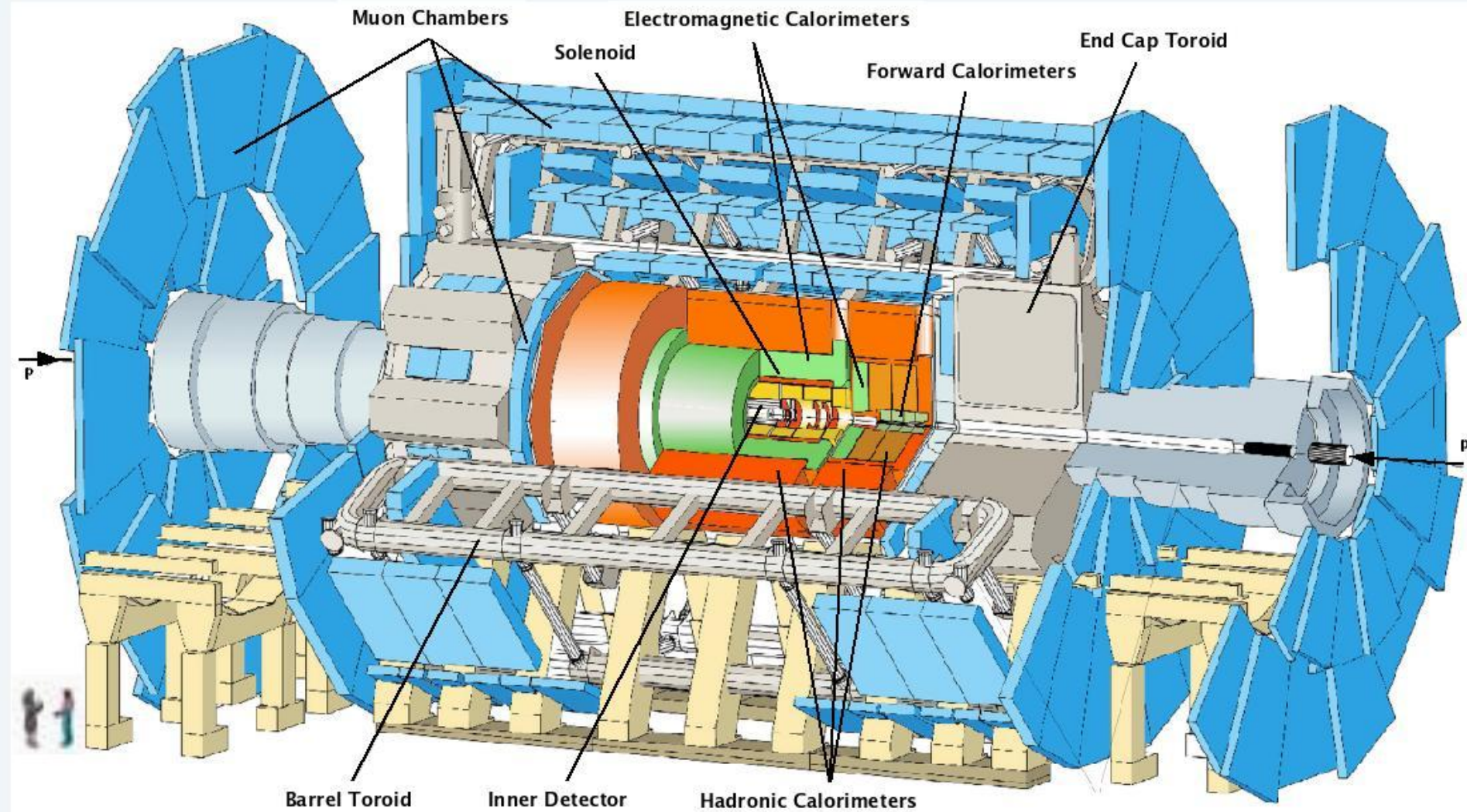


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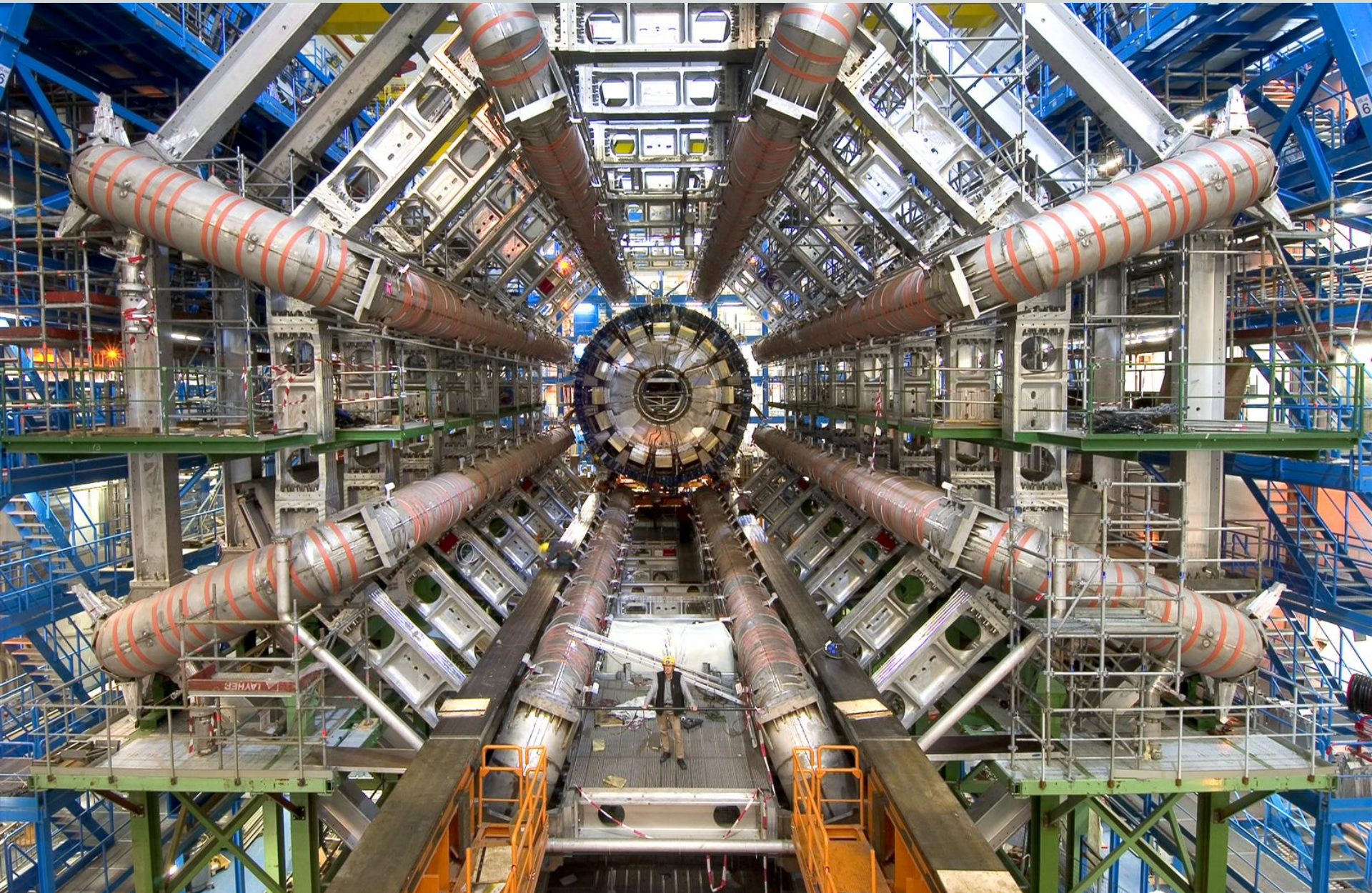


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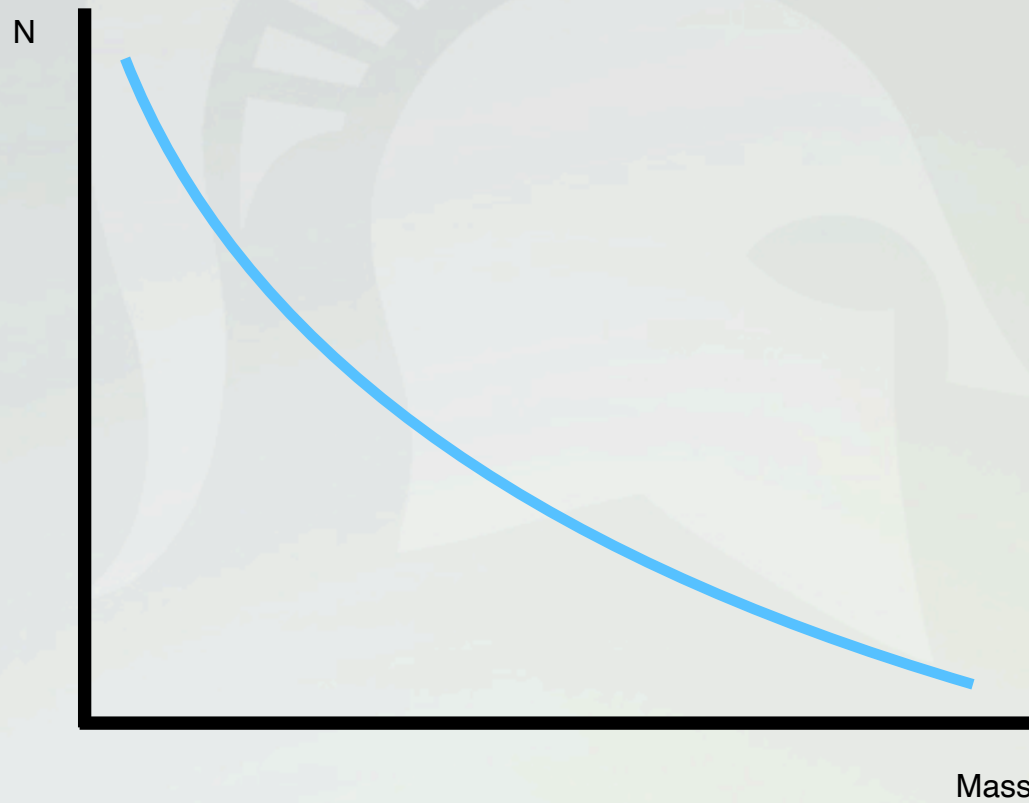
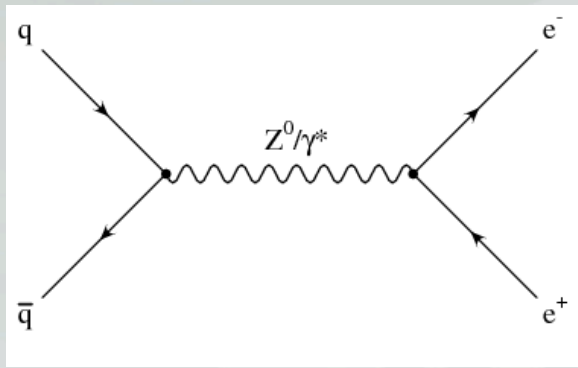


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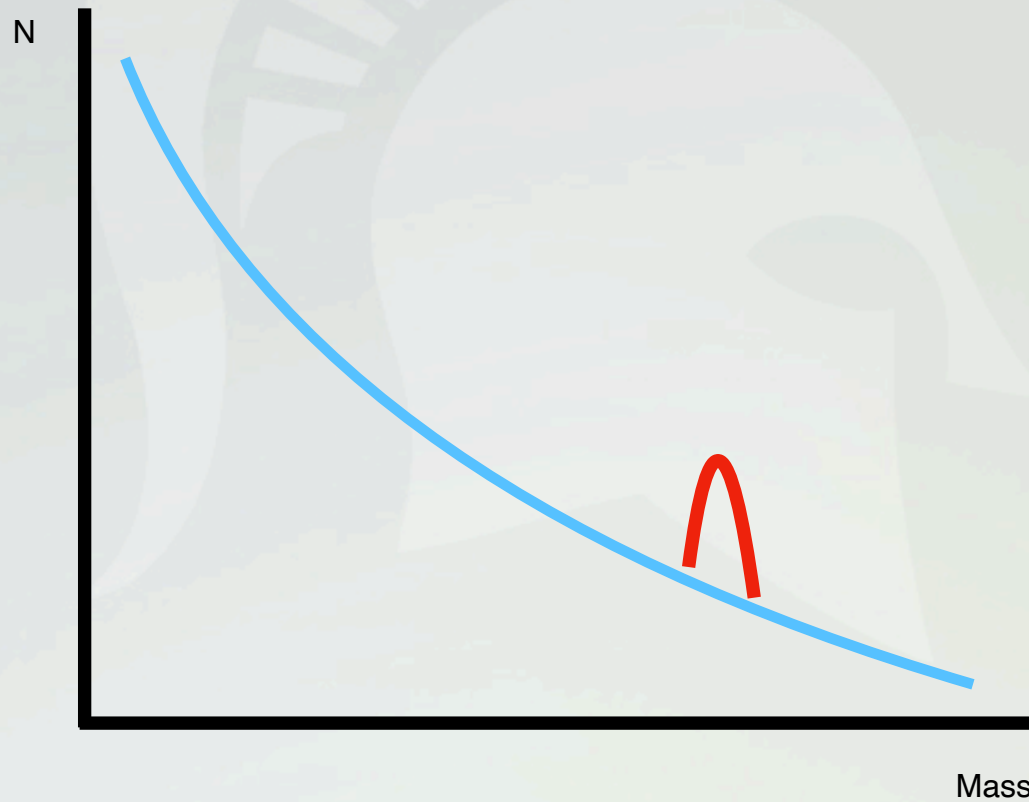
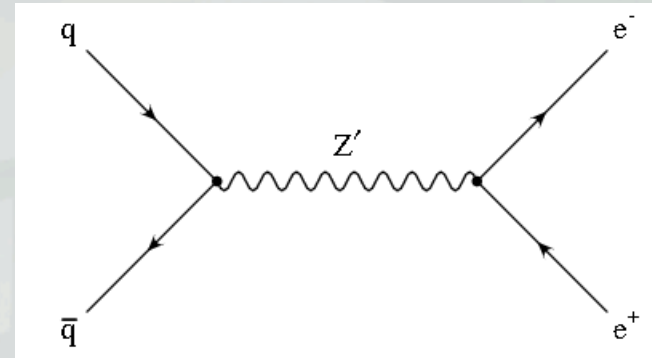
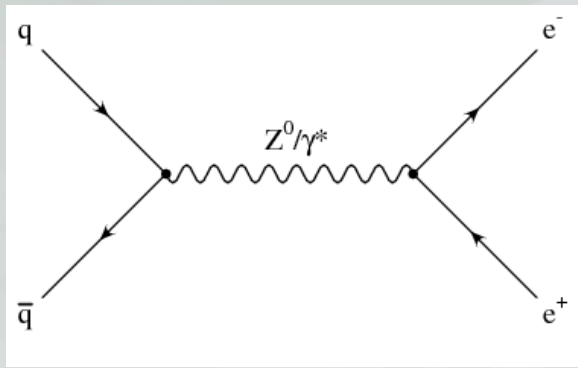




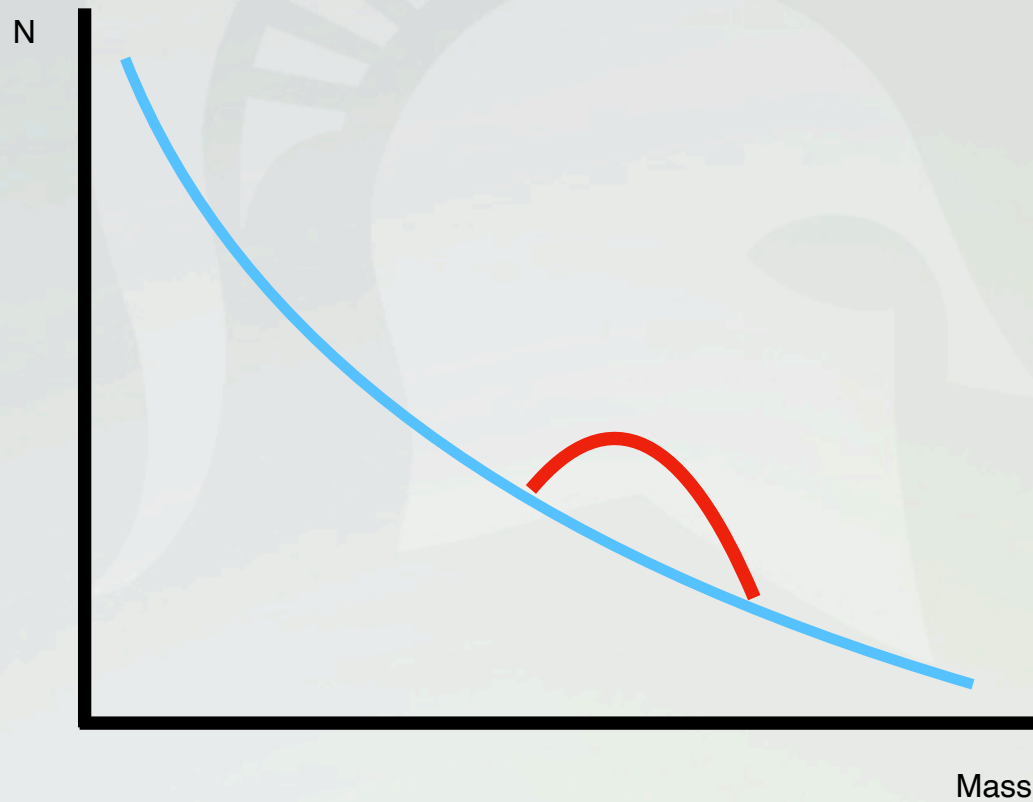
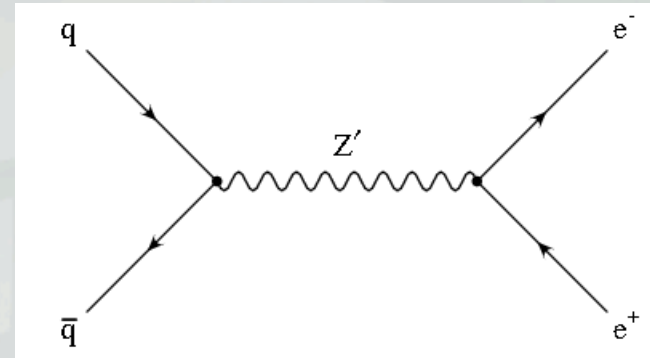
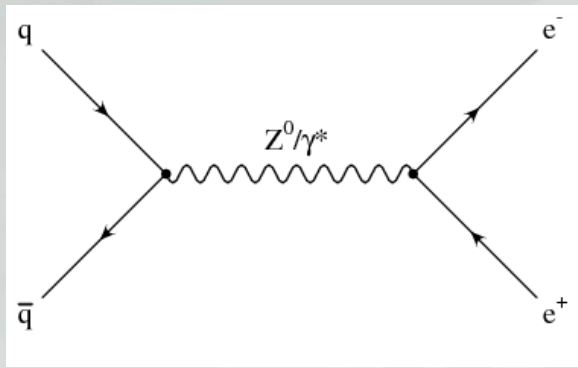
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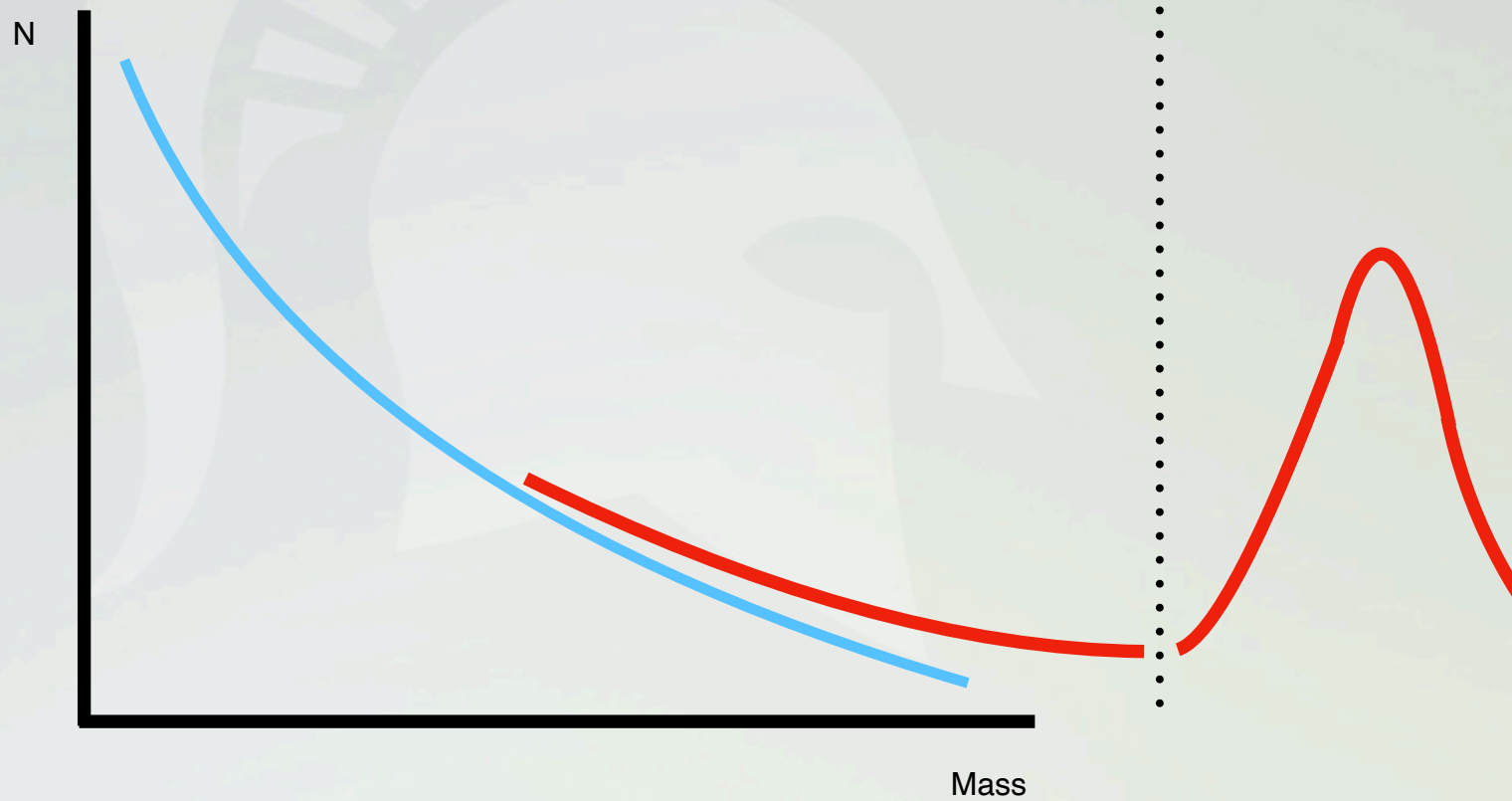
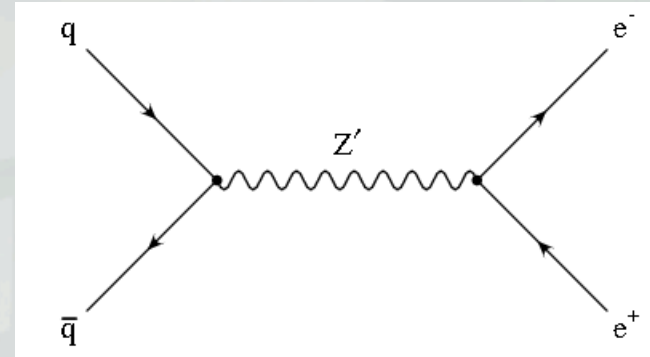
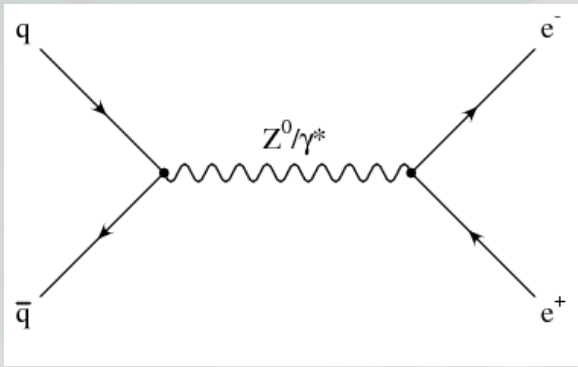
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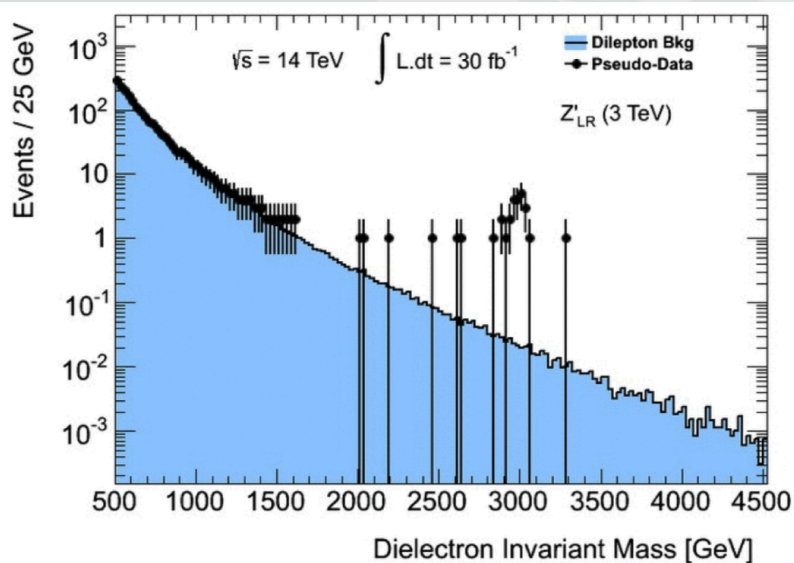
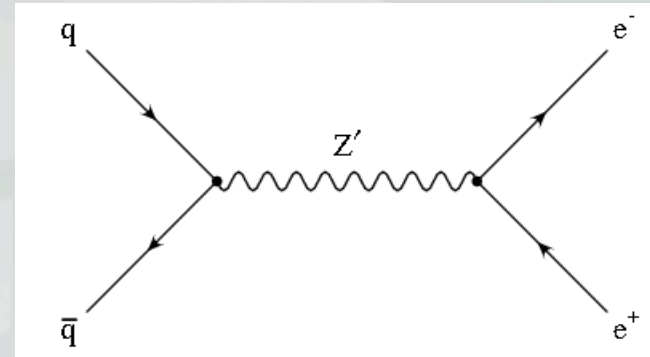
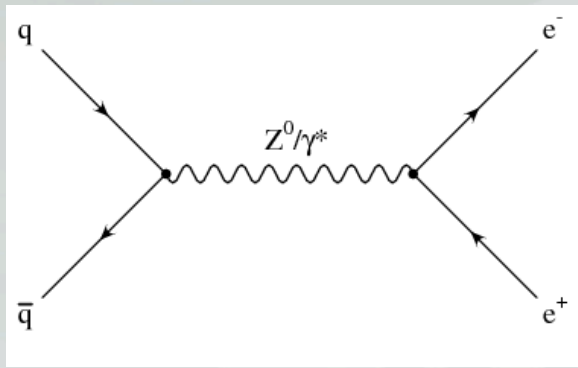


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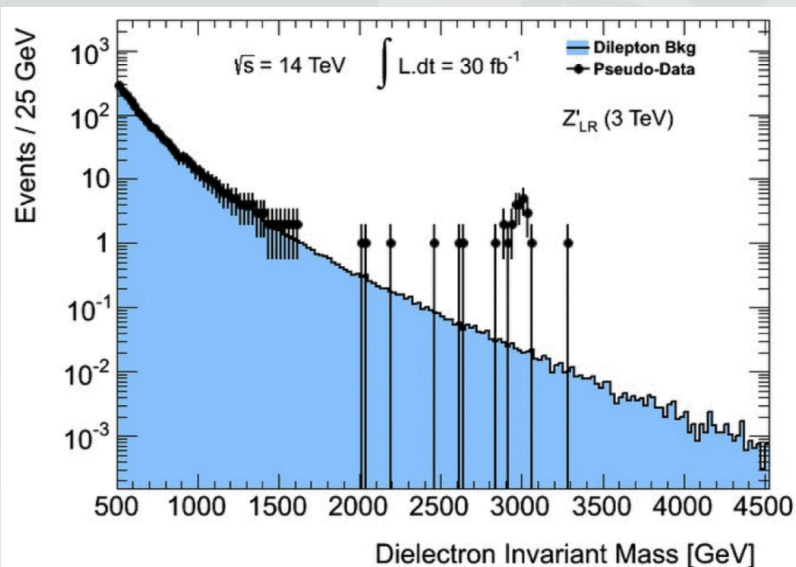
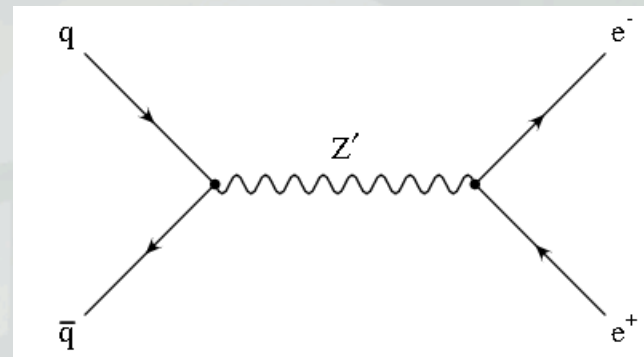
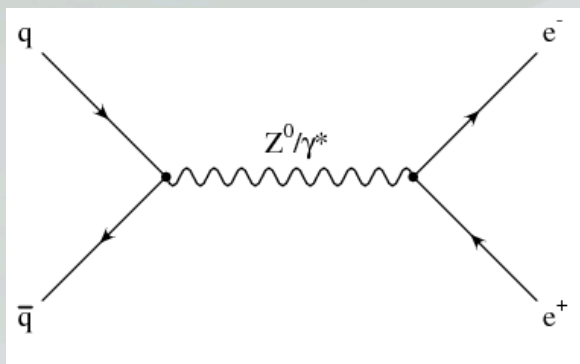


**Figure 1-1.** Dilepton backgrounds and the emerging signal for a LR  $Z'$  at 3 TeV for  $e^+e^-$  pairs after  $30 \text{ fb}^{-1}$ .

<https://arxiv.org/abs/1308.5874>

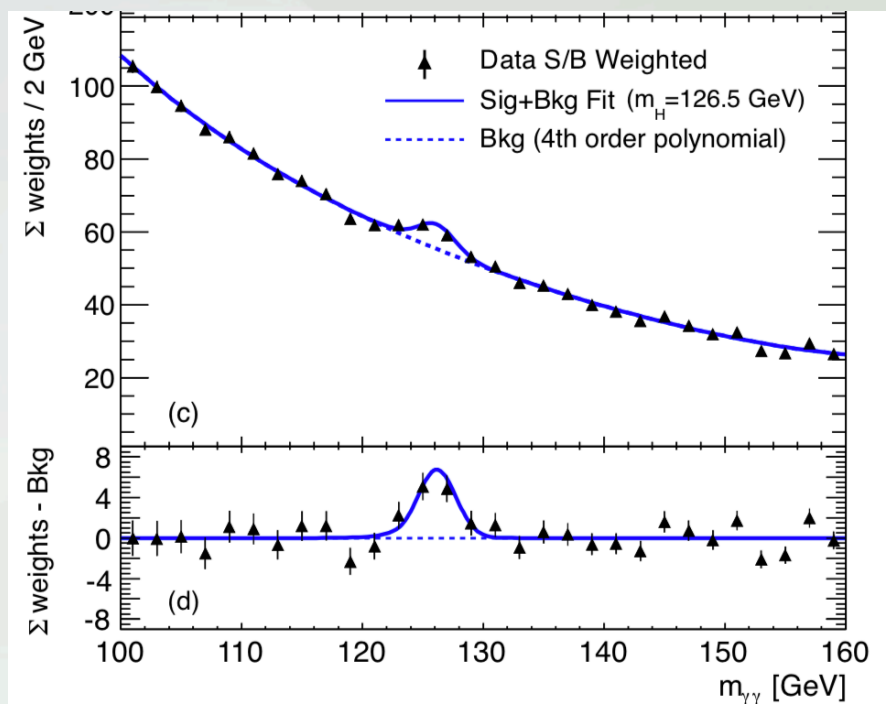
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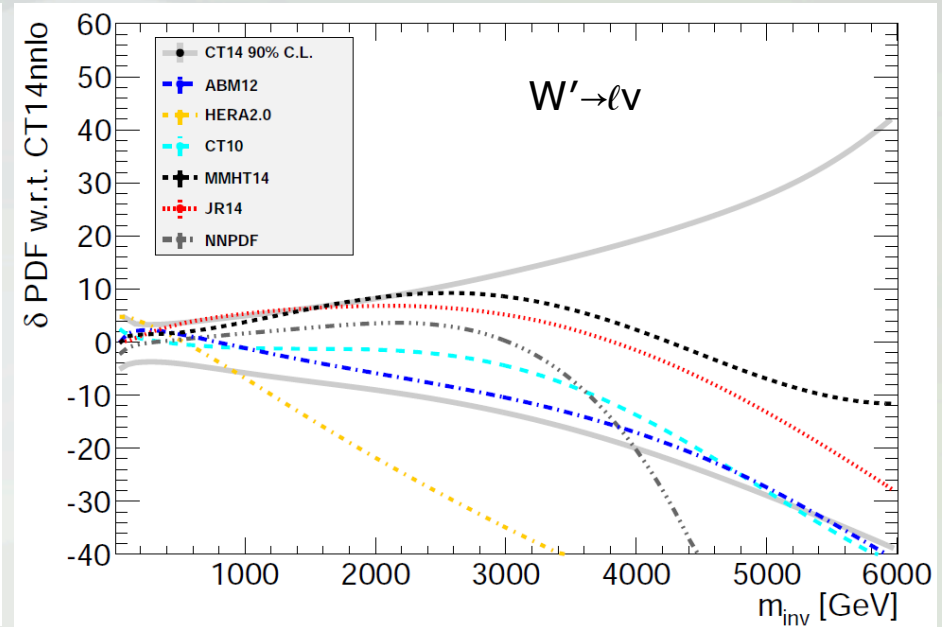
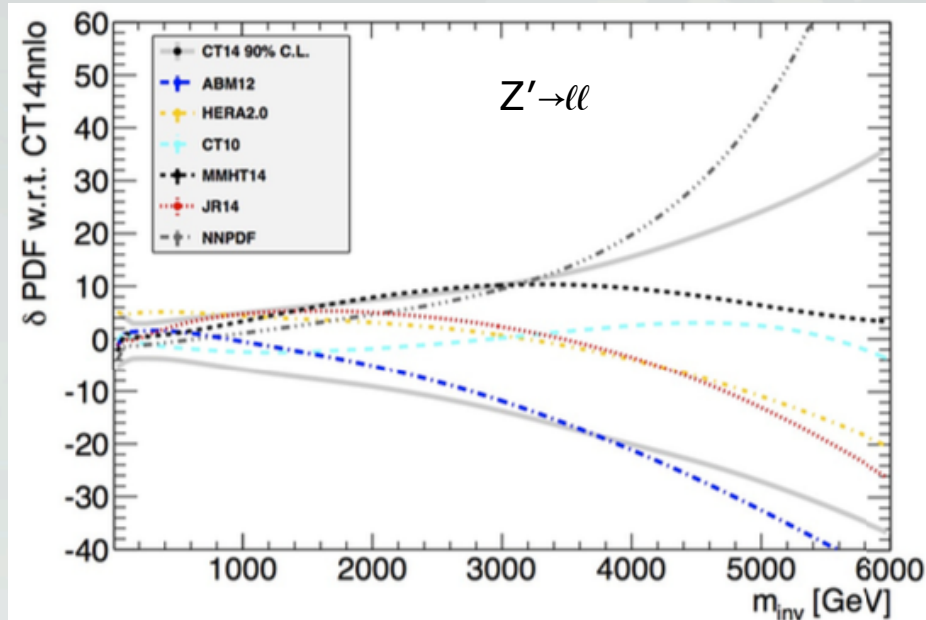


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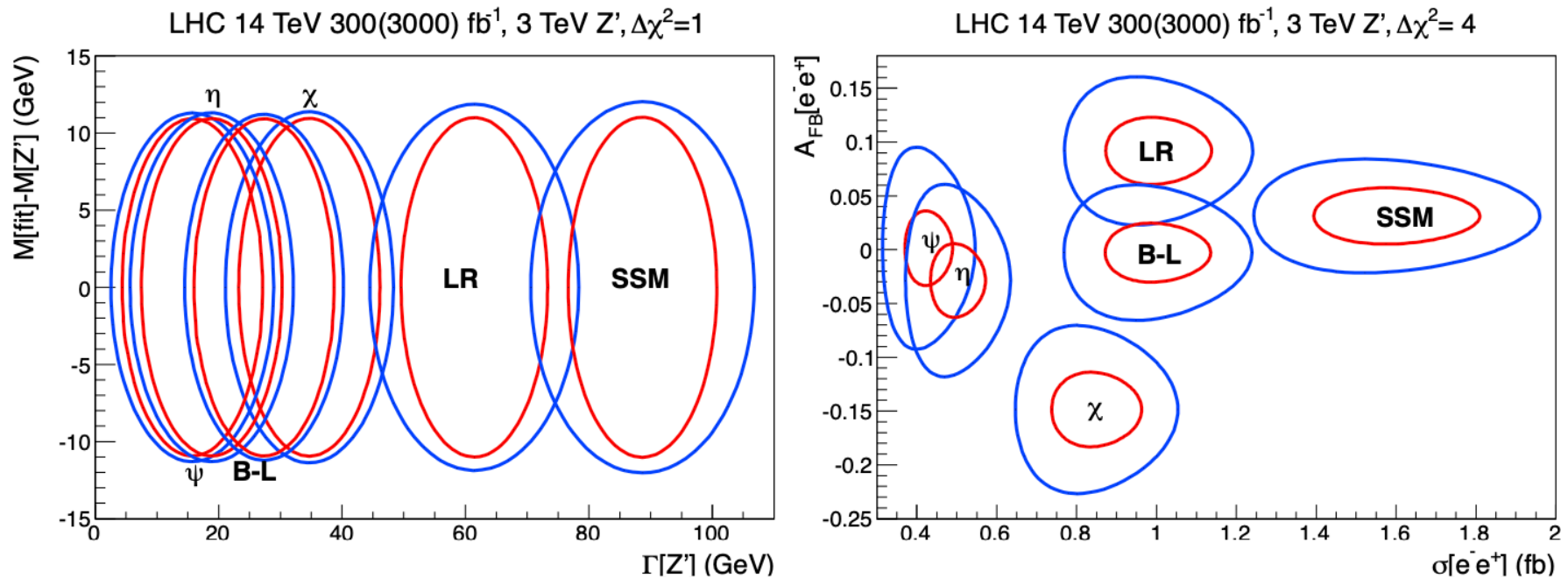


- (Above) PDF eigen-vector variation and PDF choice uncertainty (%)



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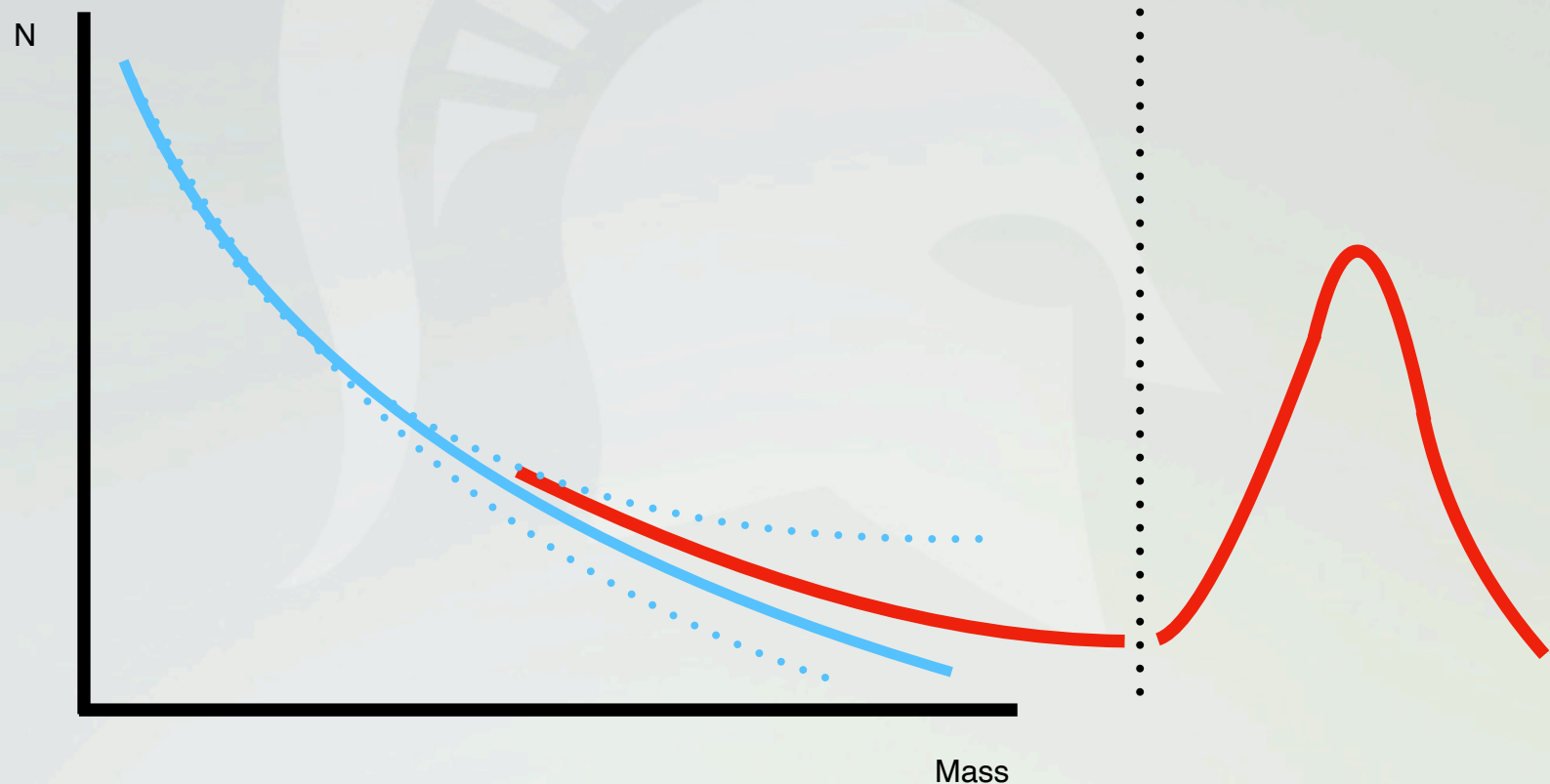


**Figure 2.** The results for  $pp \rightarrow Z' \rightarrow e^-e^+$  with dielectron invariant mass from 2.8 – 3.2 TeV. *Left panel:*  $\Delta\chi^2 = 1$  contours for the fitted width versus mass for the LHC at 300 fb<sup>-1</sup> and 3000 fb<sup>-1</sup>. *Right panel:*  $\Delta\chi^2 = 4$  contours of the simulated forward-backward asymmetry versus the cross section.

<https://arxiv.org/abs/1308.2738>

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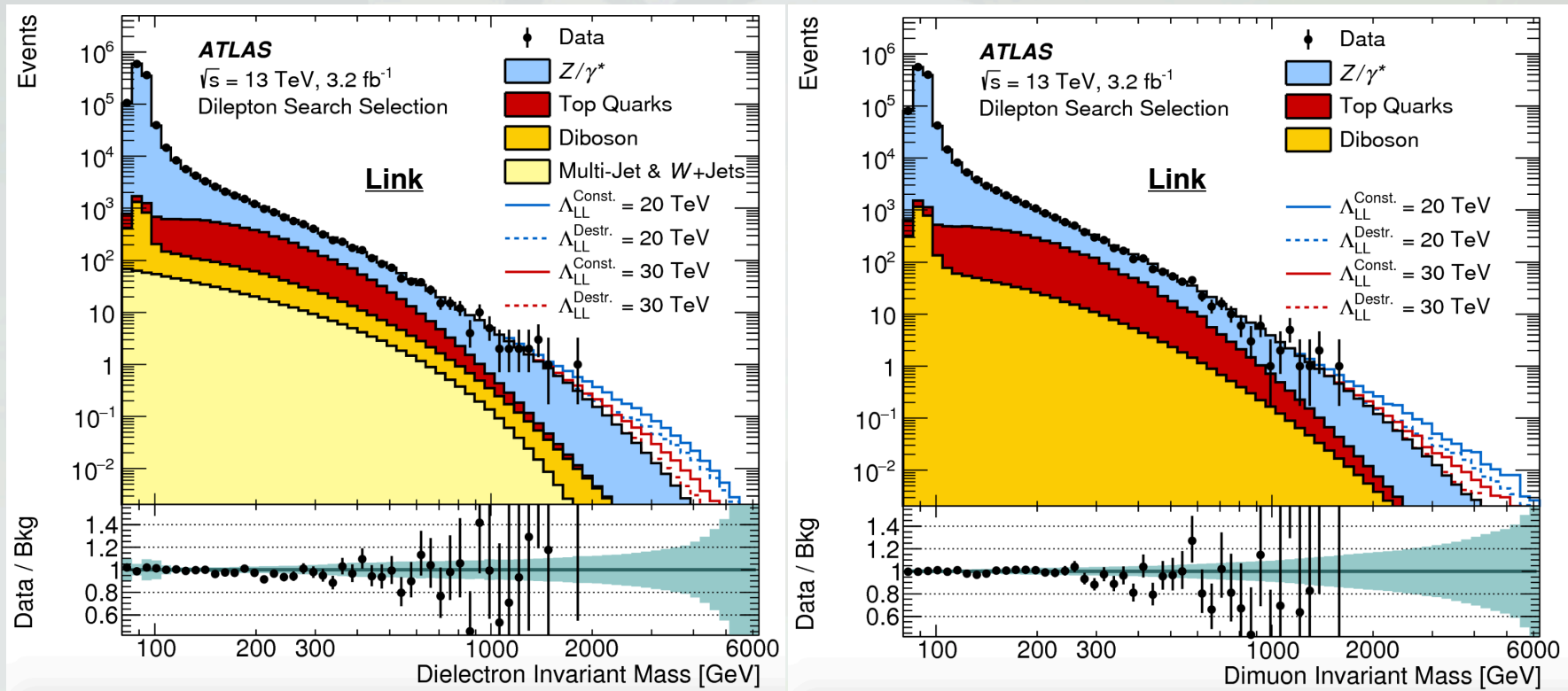
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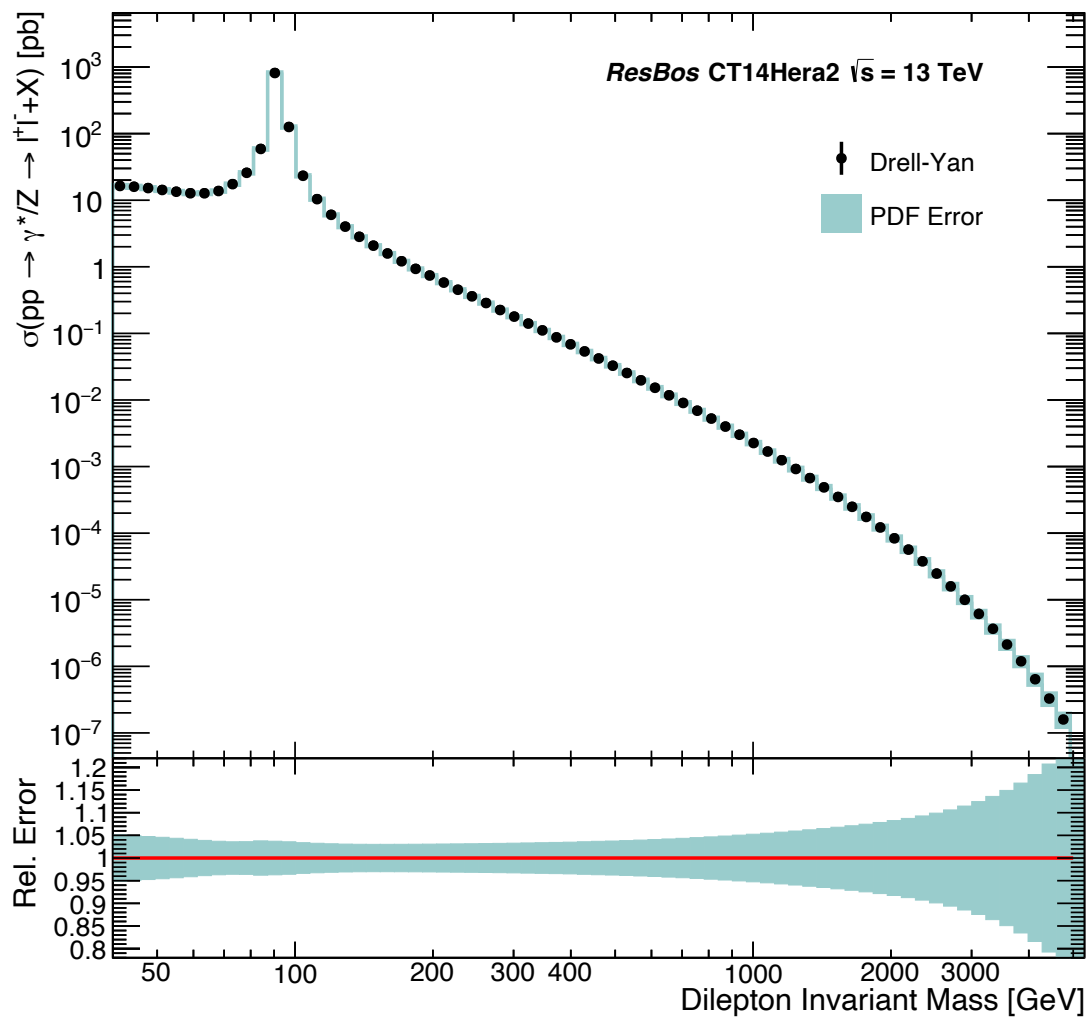
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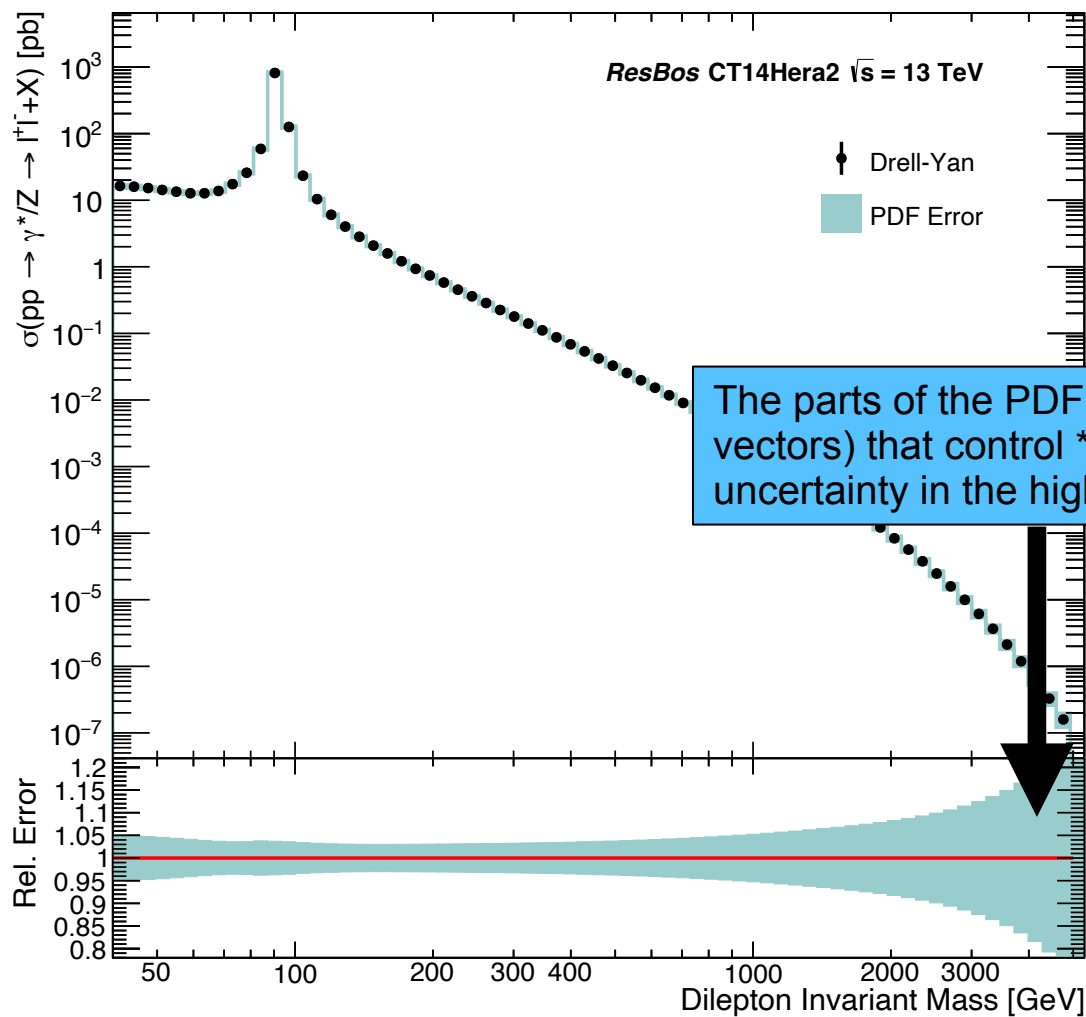
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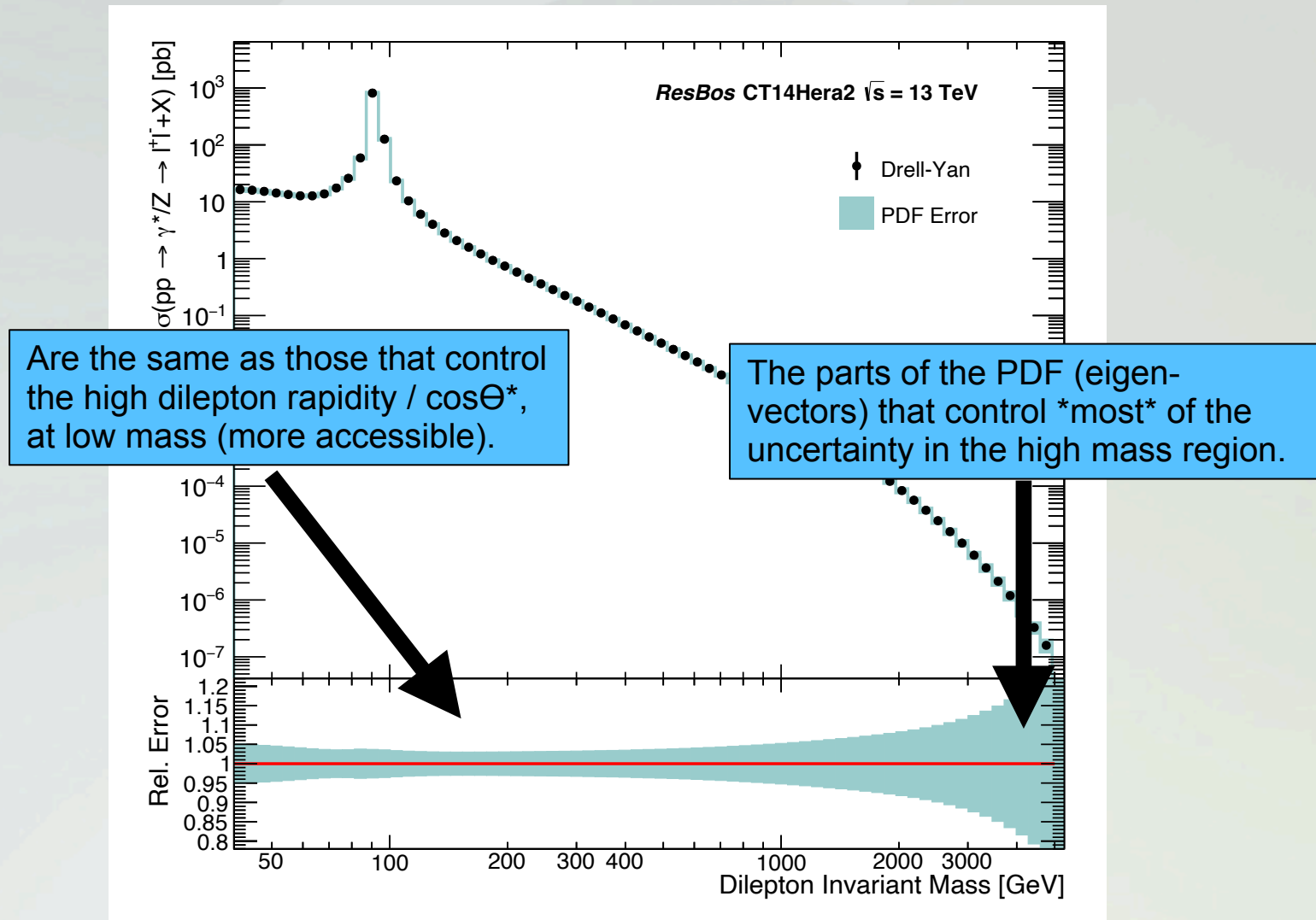




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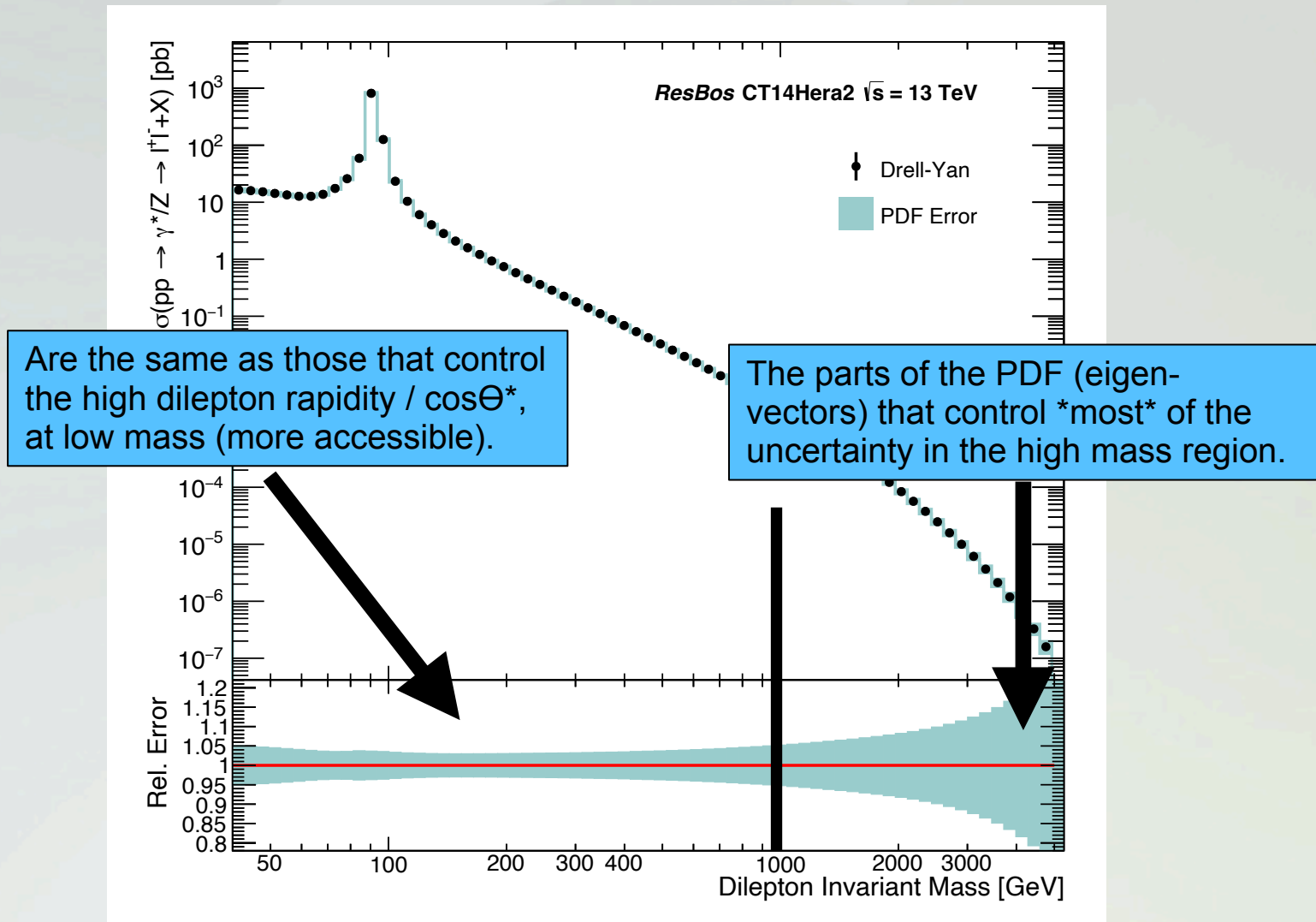
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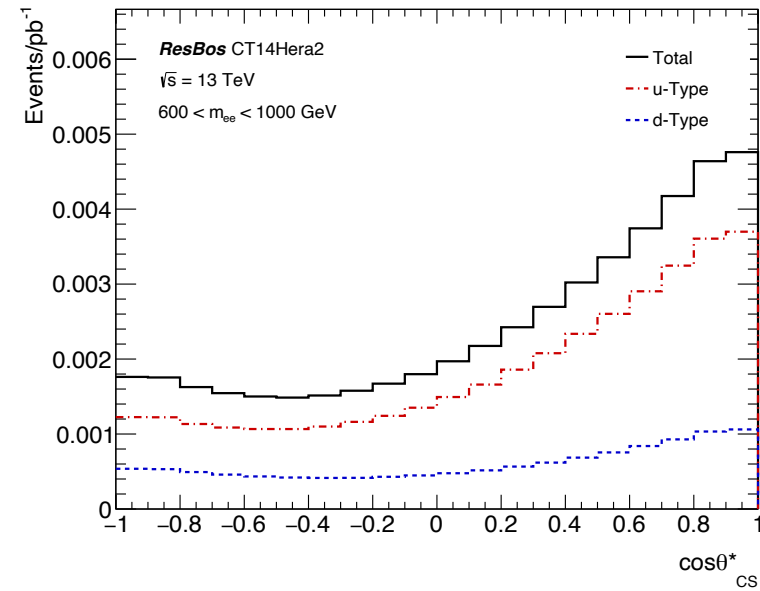
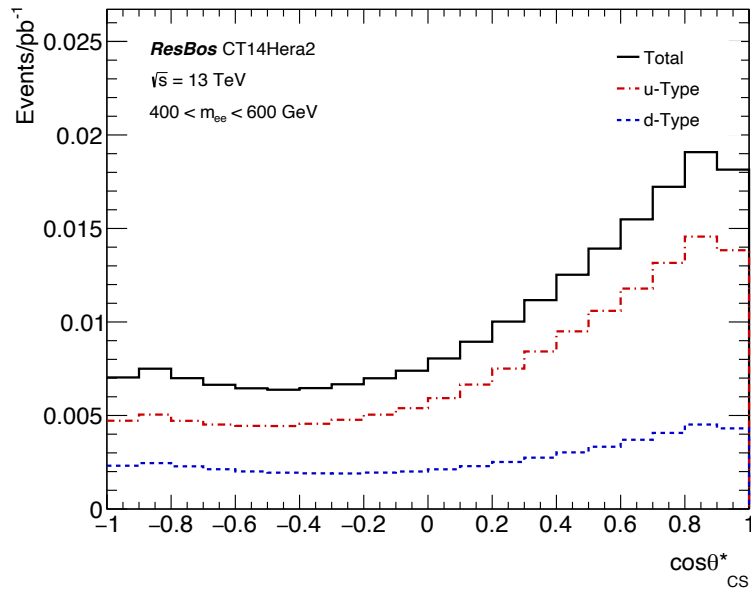
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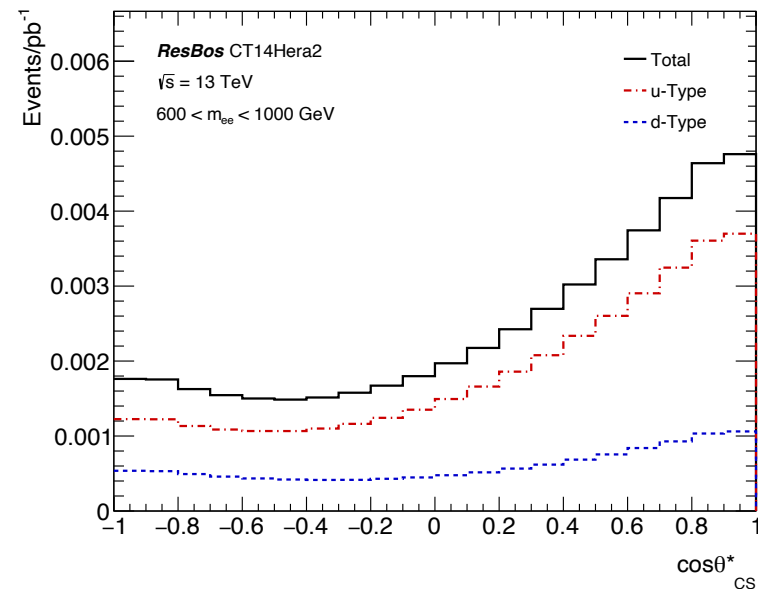
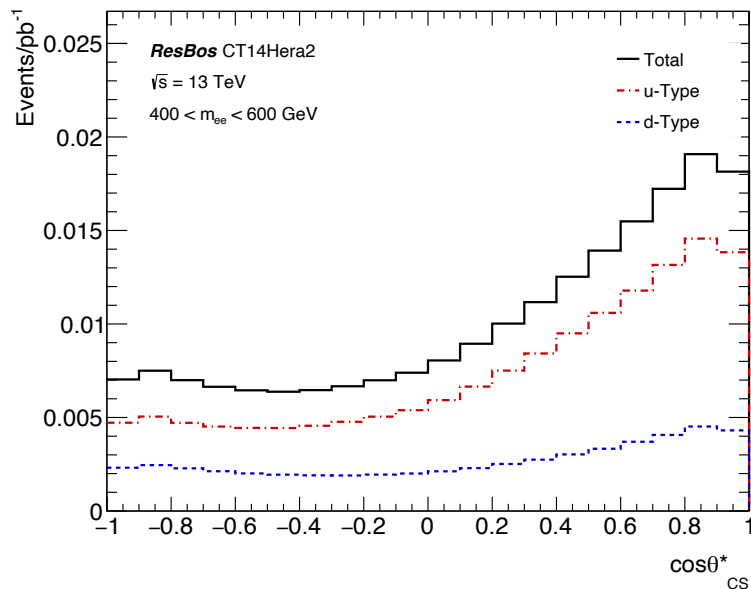




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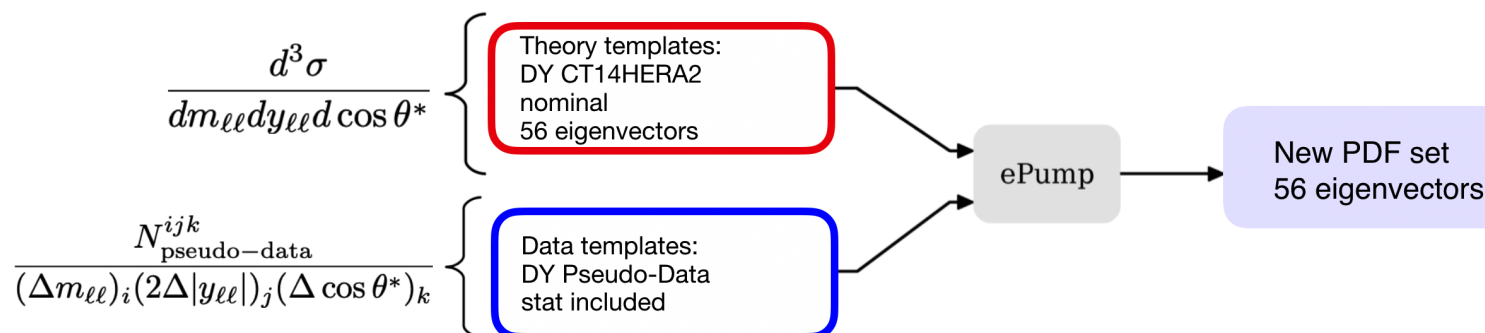
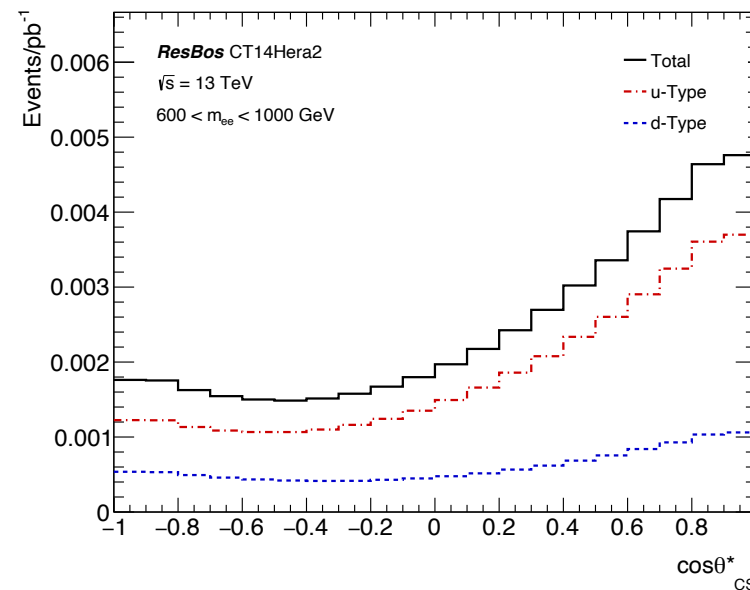
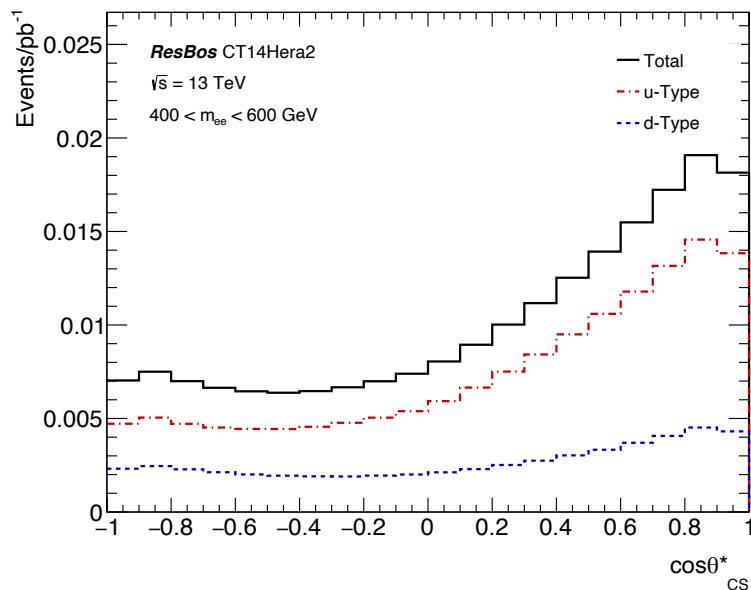


- Re-discovered that the LHC is a very good: up - anti-up quark collider!
- A careful selection of data at low mass (where no signal is expected) could be used to constrain the high-mass PDF uncertainties.

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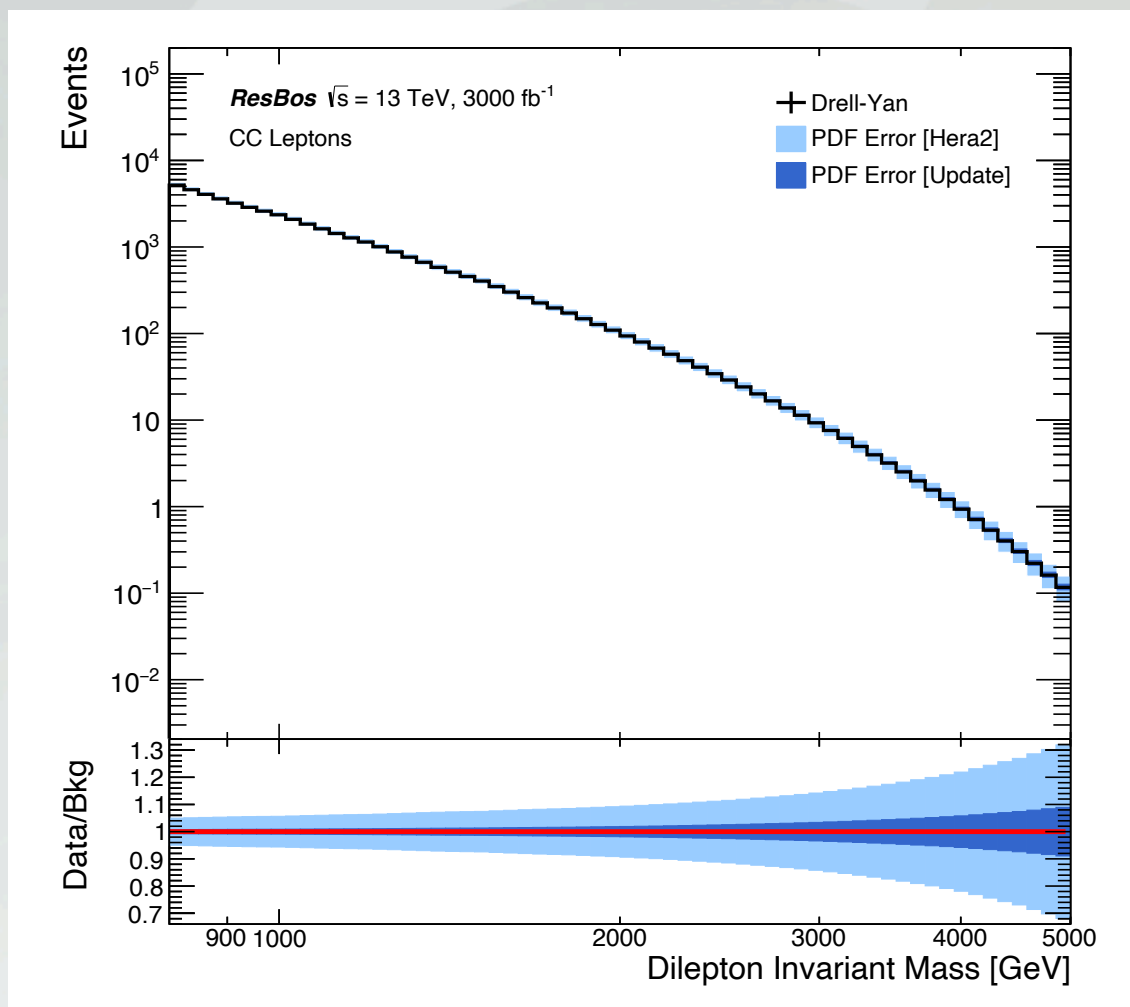
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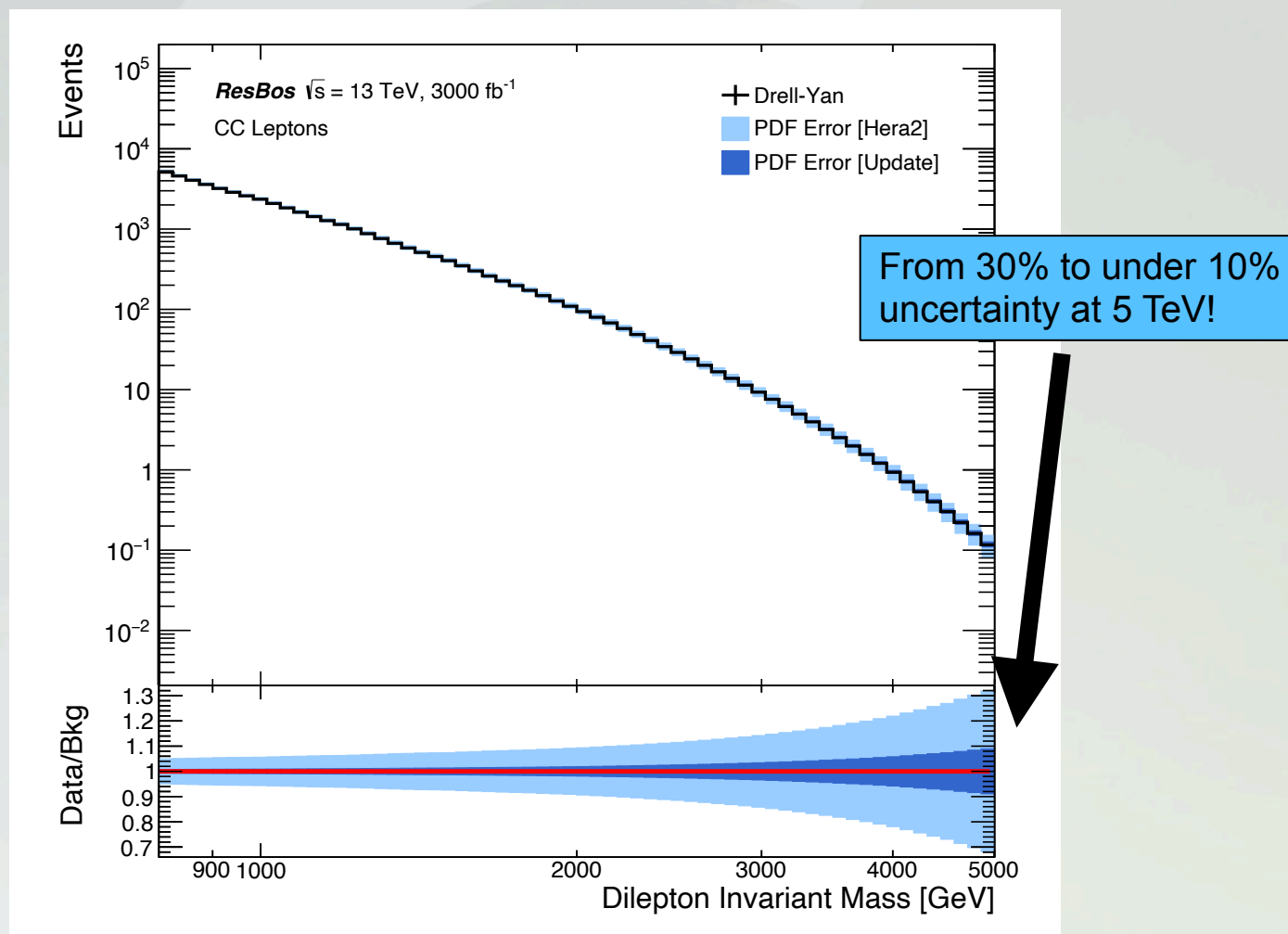




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## Some Remaining Questions

- This was a study using Neutral-Current Drell-Yan, what about Charge-Current?
  - Yao has been working on this over the last few months!
  - Appears that the  $W^+/W^-$  indeed has something further to add.
- For the non-resonant searches: at what level of theory uncertainty or integrated luminosity from the LHC do we lose sensitivity completely?
  - Starting to look into this now (grads can get involved too!)
  - Once we establish the above, how much does this theory uncertainty reduction method help? What happens if you push the reduction even further?