High mass Drell-Yan measurement at the ATLAS experiment

and its phenomenological interpretation

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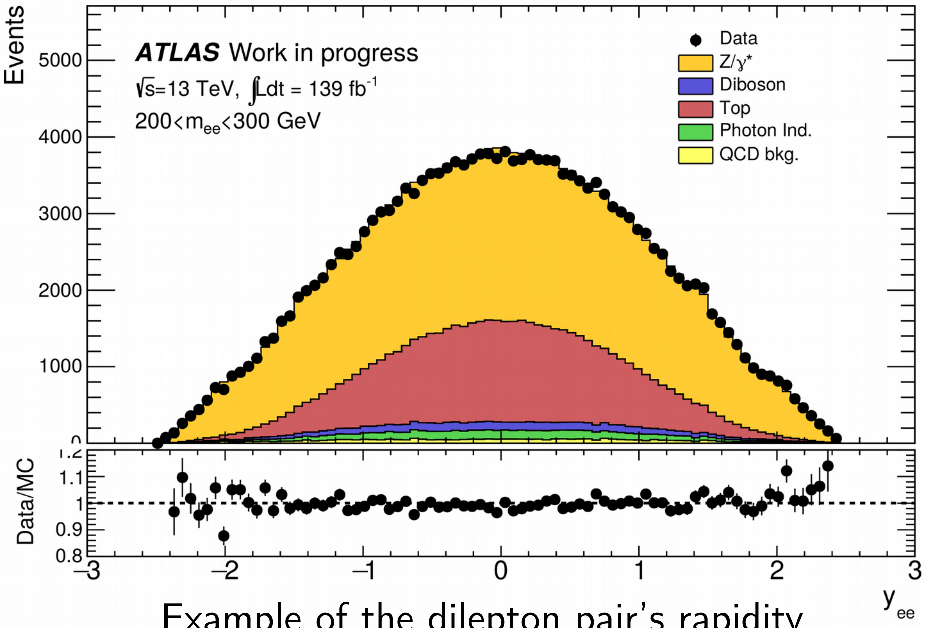
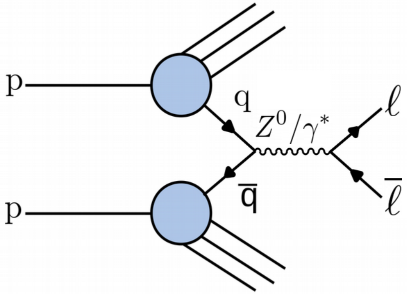
High-mass Drell Yan analysis

- The analysis aims to measure single ($d\sigma/dm_{ll}$) and double ($d^2\sigma/dm_{ll}d|y_{ll}|$) production cross sections of neutral-current DY at m_{ll}>116 GeV.
- DY measurements can be used to:
  - Set PDF constraints in wide Bjorken-X range.
  - EFT interpretations (see following slides).
- The results are corrected for detector efficiencies and unfolded to particle level.
- Measurement performed in the electron and muon channels, testing their compatibility (LFU) and providing the combination of their cross sections.



Example of the dilepton pair's rapidity measurement in the mass slice 200<m_{ee}<300 GeV.



The cross section can be extracted by measuring the number of data events recorded and subtracting the other SM backgrounds that decay into a dilepton pair.

High-mass Drell Yan: EFT interpretation

- SM precision measurements still leave room for potential BSM physics interpretations.
- An Effective Field Theory (EFT) approach can be used to set model-independent constraints on BSM physics:

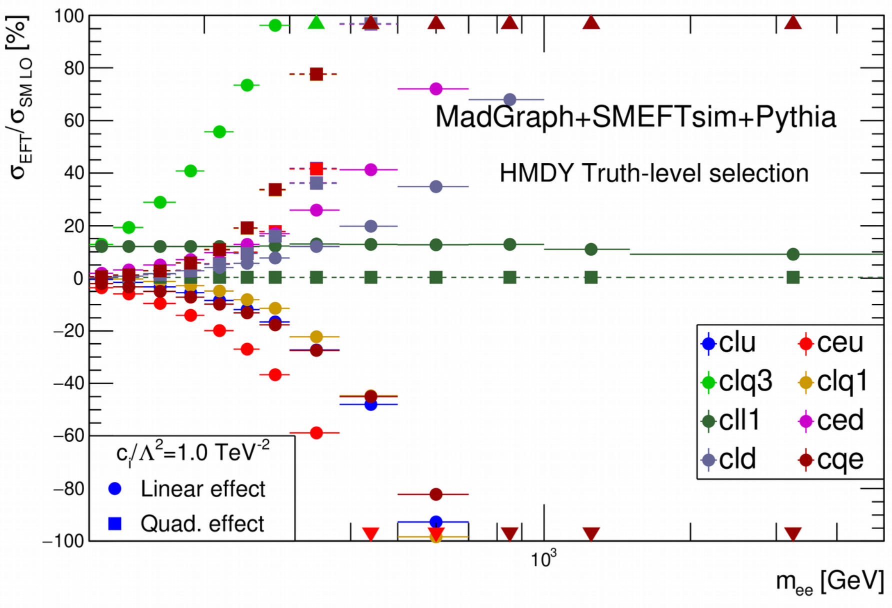
$$\mathcal{L}_{\mathrm{SMEFT}} = \mathcal{L}_{\mathrm{SM}} + \sum_{d>4} \mathcal{L}^{(d)} = \underbrace{\mathcal{L}_{\mathrm{SM}}}_{\text{SM}} + \underbrace{\sum_i \frac{c_i^{(d)}}{\Lambda^{d-4}} \mathcal{O}_i^{(d)}}_{\text{New physics}}$$

- SM is interpreted as the low-energy regime of a more general theory, where new physics is introduced by higher-dimensional operators (O_i) suppressed by the energy scale of the new physics (Λ).
- Each operator is associated to a coefficient c_i, which measures the impact of said operator.
- The impact of each operator on the SM amplitude splits in the interference with SM (linear), the pure EFT contribution (quadratic).

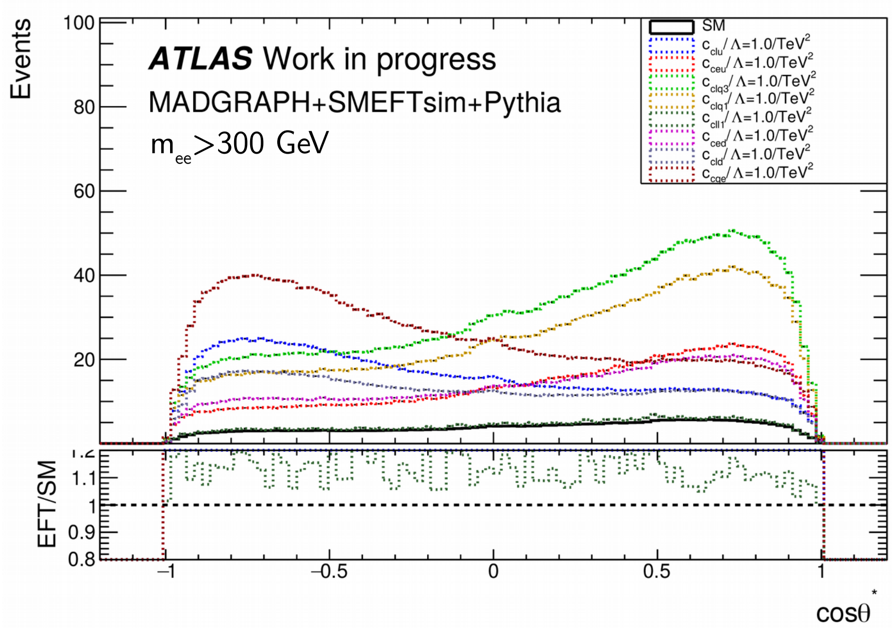
$$|\mathcal{A}_{\mathrm{SM}} + \sum_i c_i \mathcal{A}_i|^2 = |\mathcal{A}_{\mathrm{SM}}|^2 + \sum_i \underbrace{c_i 2\mathrm{Re}(\mathcal{A}_{\mathrm{SM}}^* \mathcal{A}_i)}_{\text{Linear}} + \sum_i \underbrace{c_i^2 |\mathcal{A}_i|^2}_{\text{Quadratic}}$$

High-mass Drell Yan: EFT interpretation

- EFT contributions are modelled using SMEFTsim: JHEP 12 (2017) 070
- New operators alter the cross section, increasing (decreasing) the total cross section when positively (negatively) interfering with the SM processes.



EFT contribution with respect to the SM cross section in each given bin.

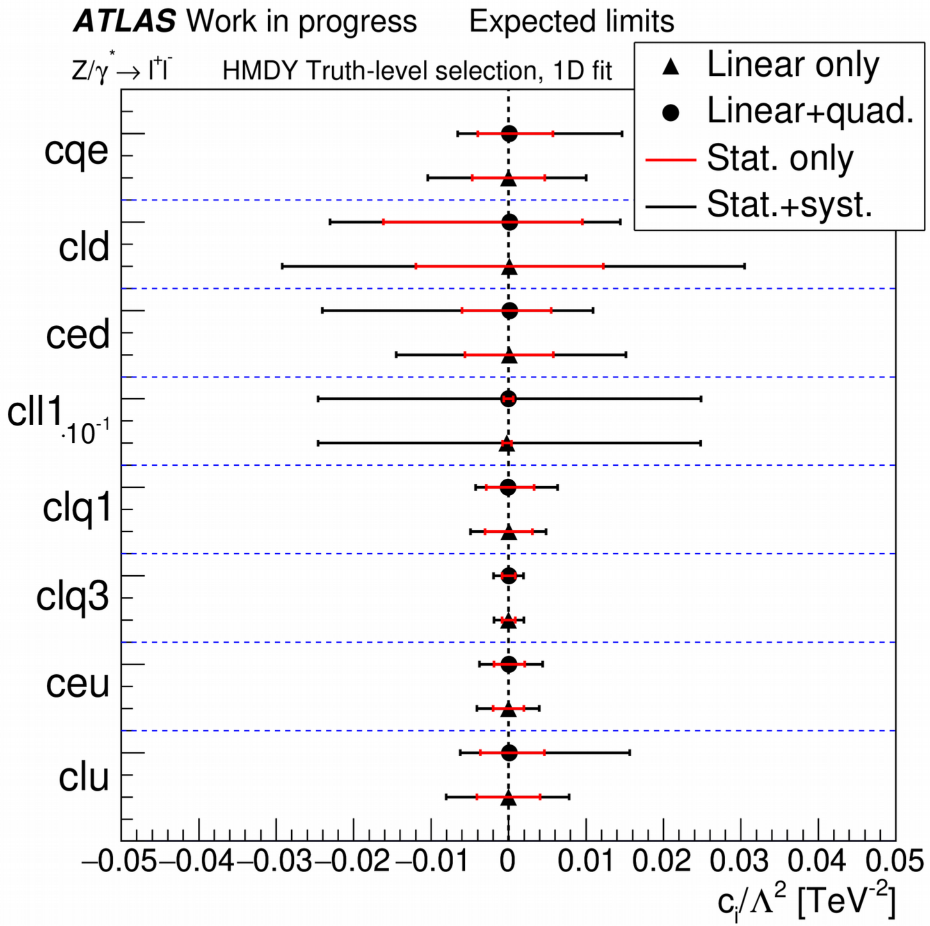


- Angular variables offer a lot of potential for EFT fits in neutral-current Drell-Yan.
- Left: each operator not only increases the SM cross section, but shifts the distribution in different directions.

Drell Yan analyses: HMDY EFT interpretation

- Dimension 6 operators are considered. SM flavour assumptions are also taken to reduce the number of operators (>2500→93 parameters)
- Limits are set on the c_i/Λ^2, both give a handle on the operator's impact and we cannot disentangle them.
- Limits shown use 1D ($d\sigma/dm_{ll}$) pseudo-data using the expected statistical and systematic uncertainties → Expected limits
- The combination of electron and muon decay channels allows for improved limits.
- Neutral-current DY offers the potential for leading constraints on 4-fermion operators.

Individual limits, one operator considered at a time



Conclusion

- The Run 2 ATLAS dataset contains wealth of data taken at energies never reached before, a good place to look for BSM phenomena.
- Precision Standard Model measurements on-going, aiming to provide crucial inputs for a wide variety of studies.
- This still leaves room for BSM interpretations, such as Effective Field Theories. We aim to set leading constraints on some dim-6 operators, with opportunities to further improve our limits:
  - 2D fits, angular variables improve our sensitivity.
  - Combination with other ATLAS measurements (diboson, top, Higgs...) in a global EFT fit.

Thanks for your attention!