

Electroweak Physics at the CMS Experiment at the LHC



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for the CMS Collaboration

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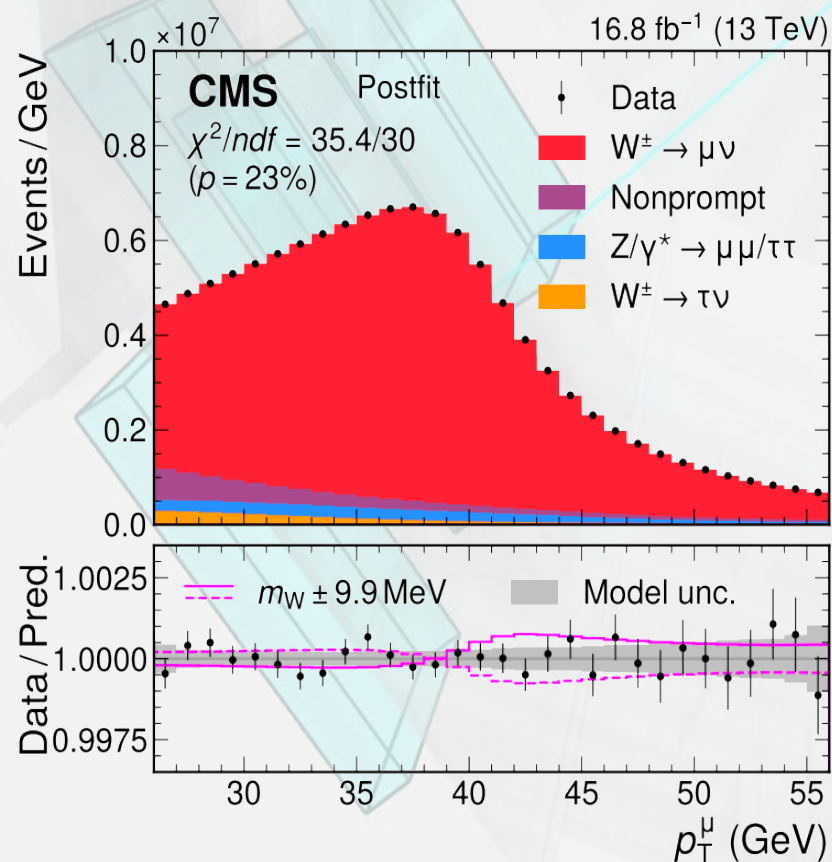
Session-conference "Physics of Fundamental Interactions" of RAS, dedicated to the 70th anniversary of V. A. Rubakov



Measurement of the W-boson mass at $\sqrt{s} = 13$ TeV



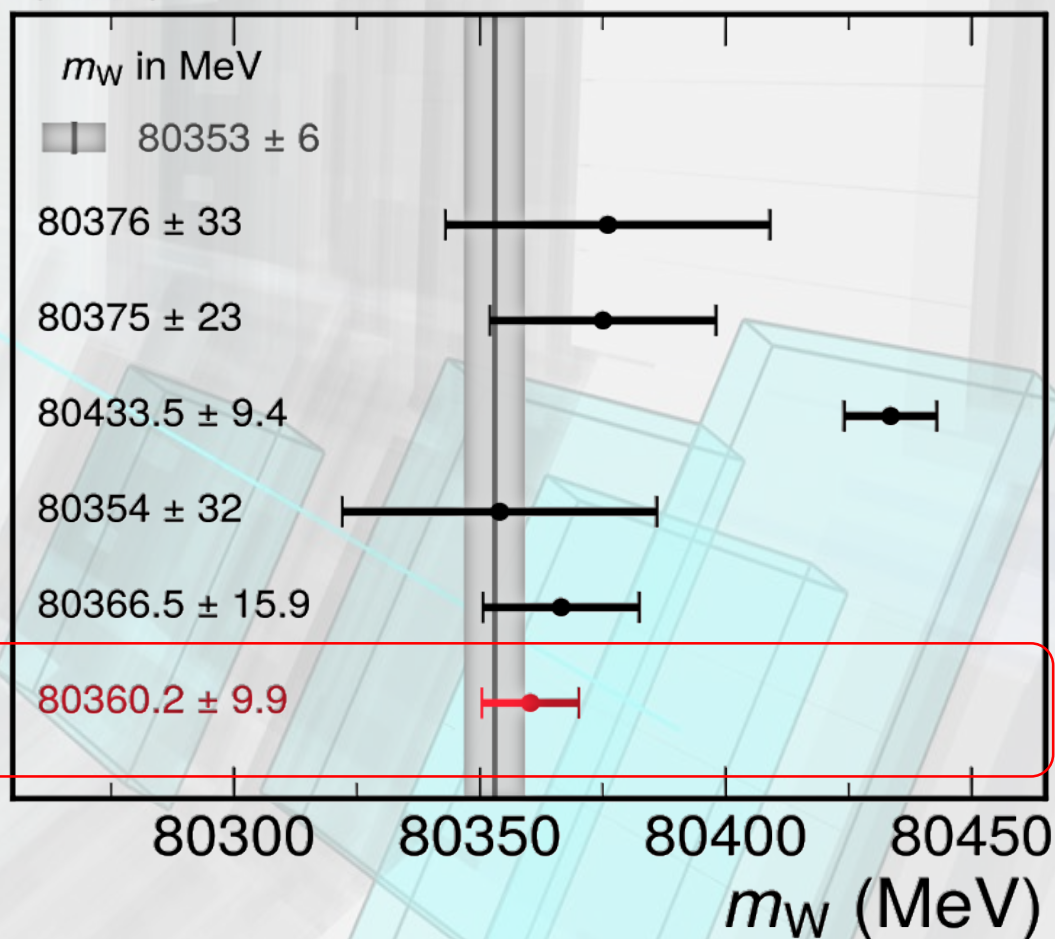
- The W-boson mass is obtained from fits of the reconstructed distributions of the muon transverse momentum and of the W boson transverse mass



[arXiv:2412.13872](https://arxiv.org/abs/2412.13872)

Electroweak fit
 PRD 110 (2024) 030001
LEP combination
 Phys. Rep. 532 (2013) 119
D0
 PRL 108 (2012) 151804
CDF
 Science 376 (2022) 6589
LHCb
 JHEP 01 (2022) 036
ATLAS
 arXiv:2403.15085
CMS
 This work

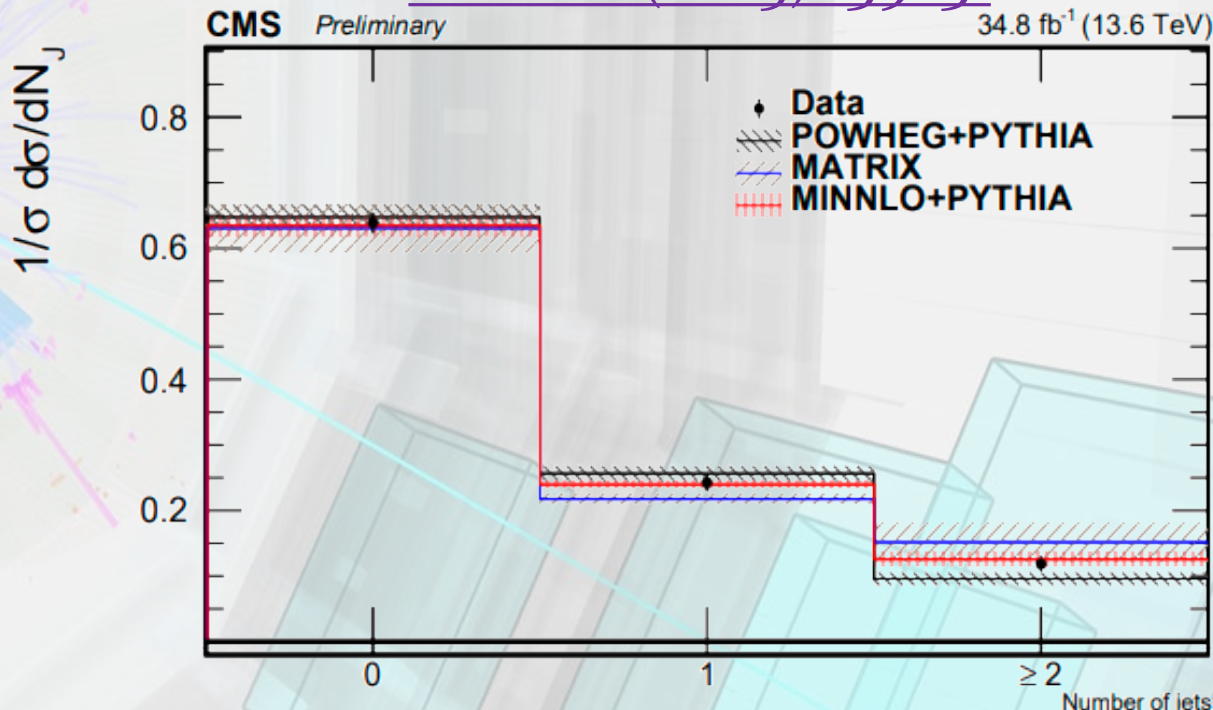
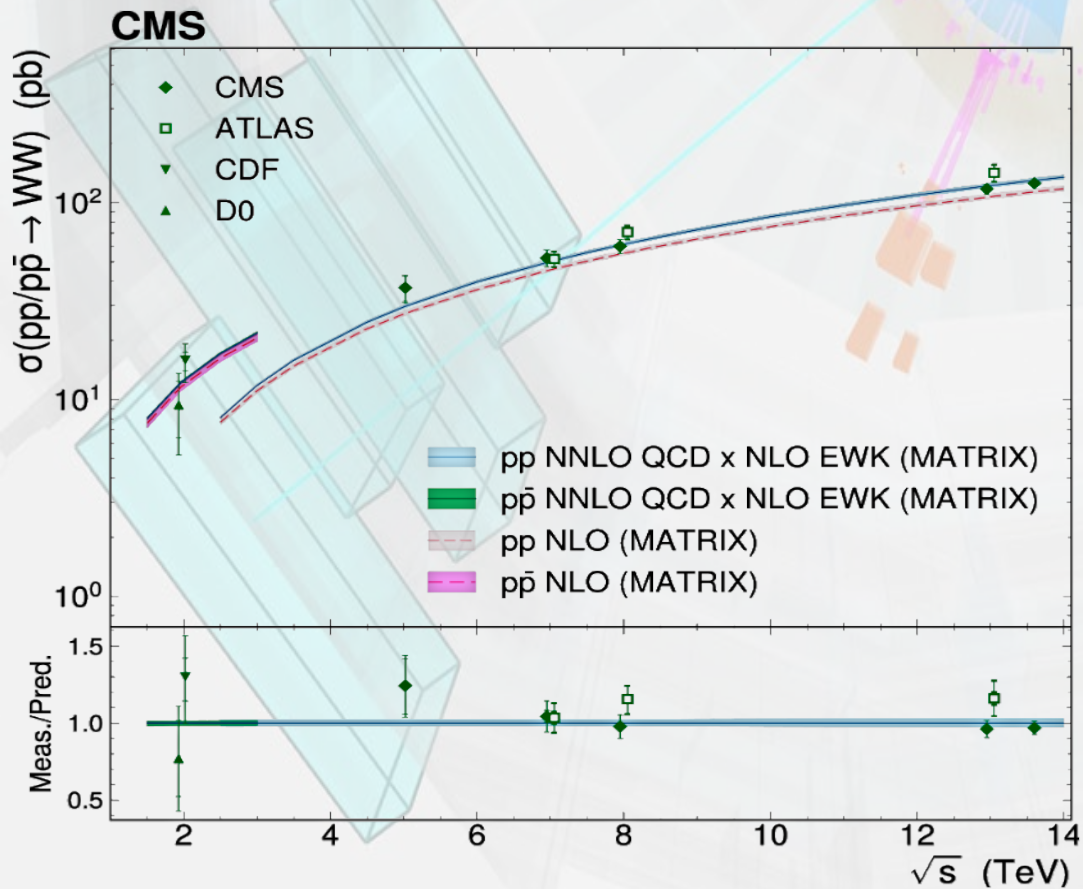
CMS



- ✓ The obtained value is in a good agreement with the global EW fit and does not confirm CDF results
- ✓ Mass of W-boson was measured for the first time by CMS collaboration

Diboson + jets production:

- EW boson self-interaction check
- pQCD test
- Important background source for Higgs and BSM processes

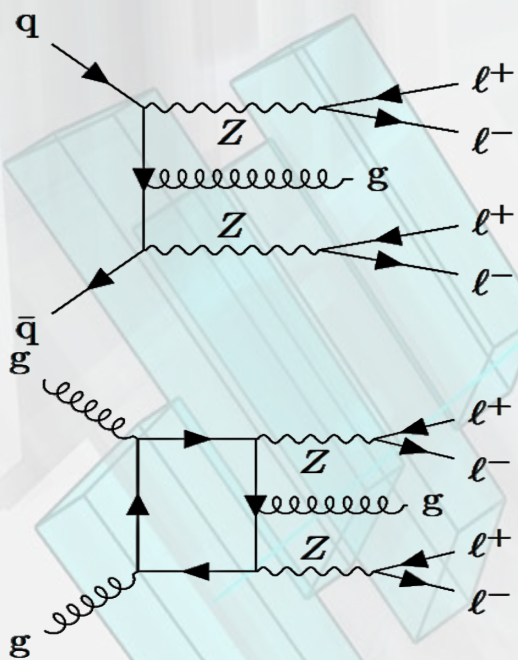


Observable	Expected	Observed
Cross section (fb)	812 ± 34(31, 15)	813 ± 35(32, 15)
0-jet fraction	0.648 ± 0.015(0.012, 0.009)	0.640 ± 0.016(0.013, 0.009)
1-jet fraction	0.256 ± 0.013(0.008, 0.010)	0.243 ± 0.013(0.009, 0.010)
≥ 2-jet fraction	0.096 ± 0.011(0.008, 0.008)	0.119 ± 0.011(0.008, 0.008)

- ✓ The $WW \rightarrow e^\pm \nu \mu^\mp \nu$ cross section was measured at new energy scale
- ✓ No significant deviations from the SM predictions were found

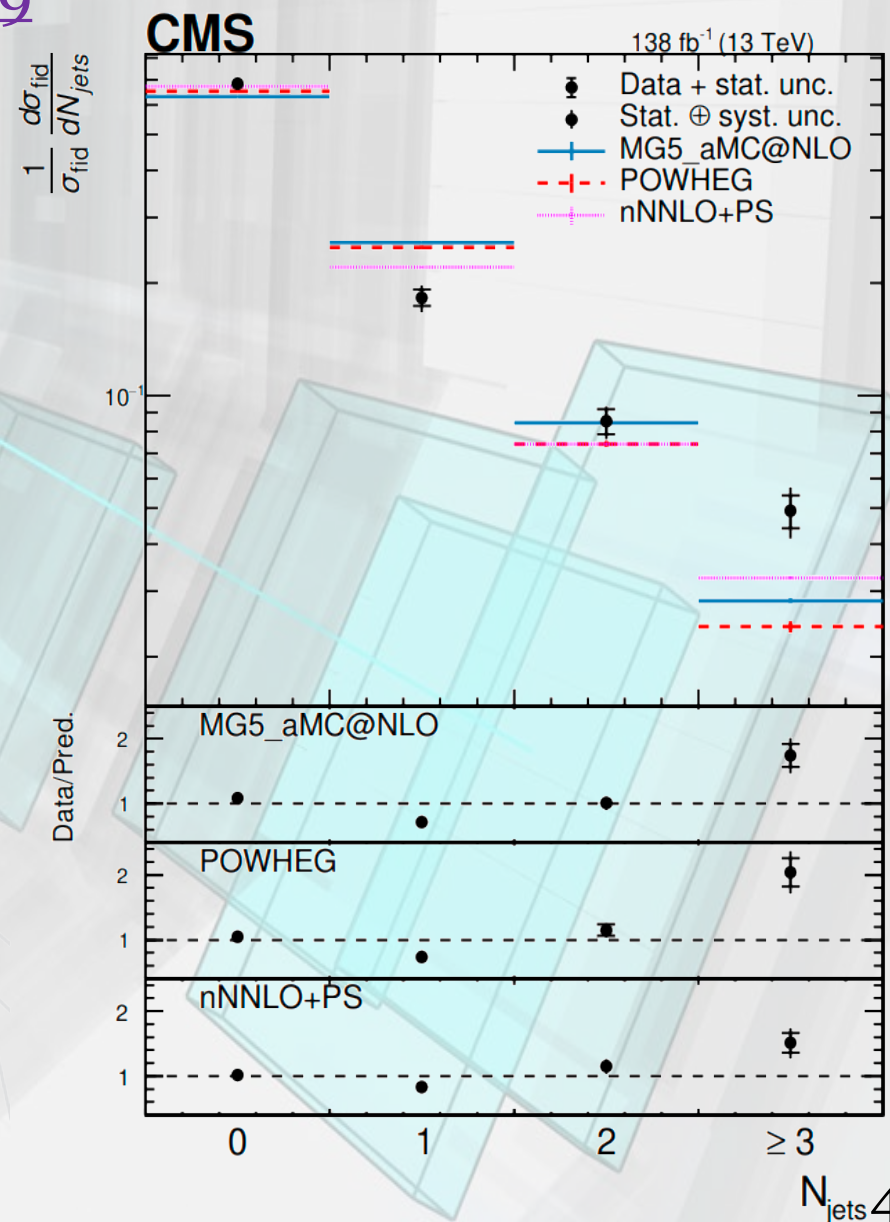
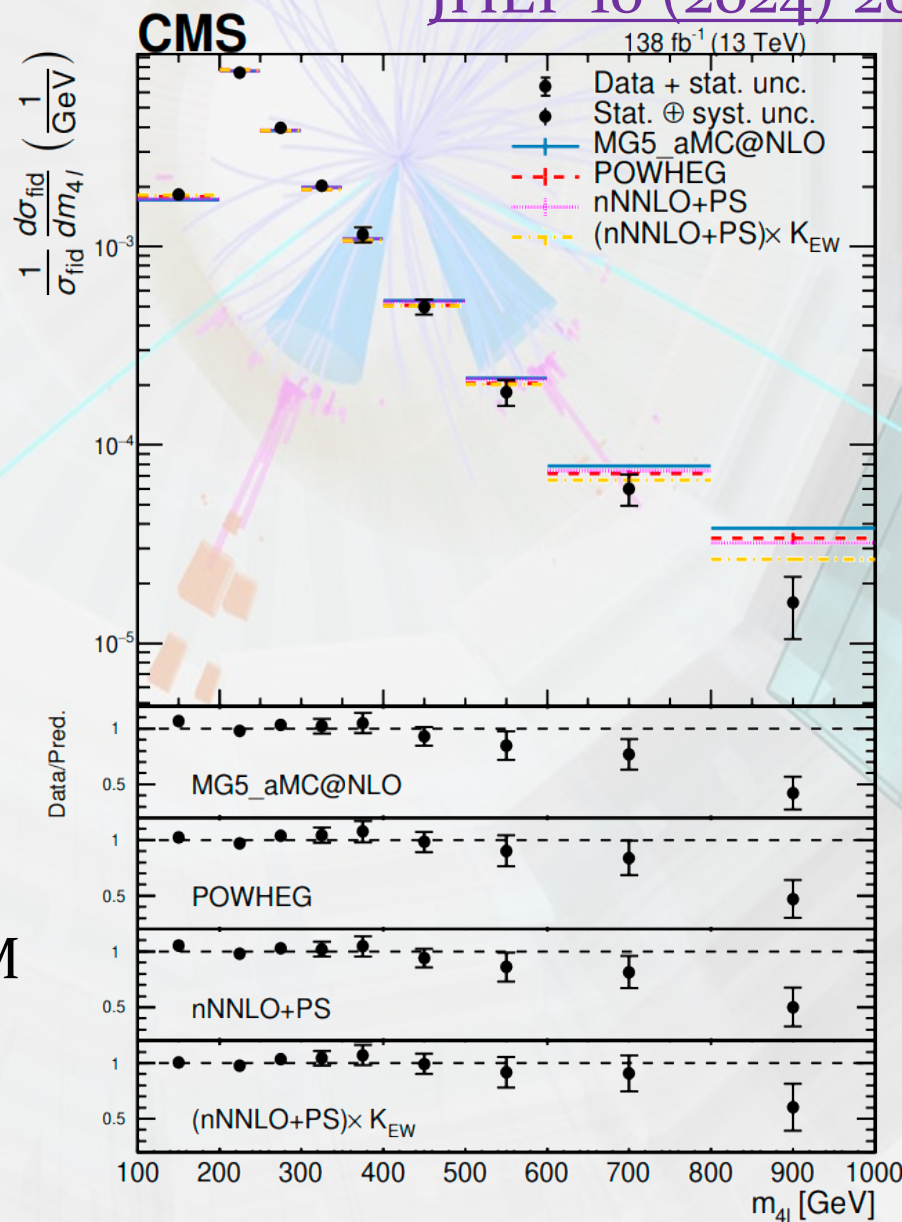
ZZ+jets cross section measurements

- The ZZ→4l+Jets differential cross section is measured with Run 2 statistics



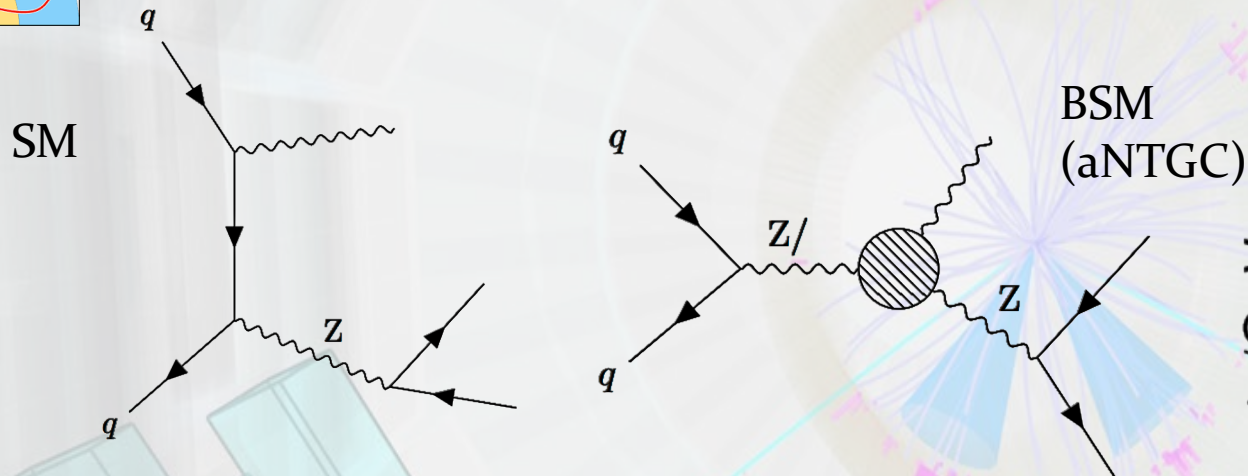
- Good agreement with SM in general, but some improvement of MC calculations is required

JHEP 10 (2024) 209

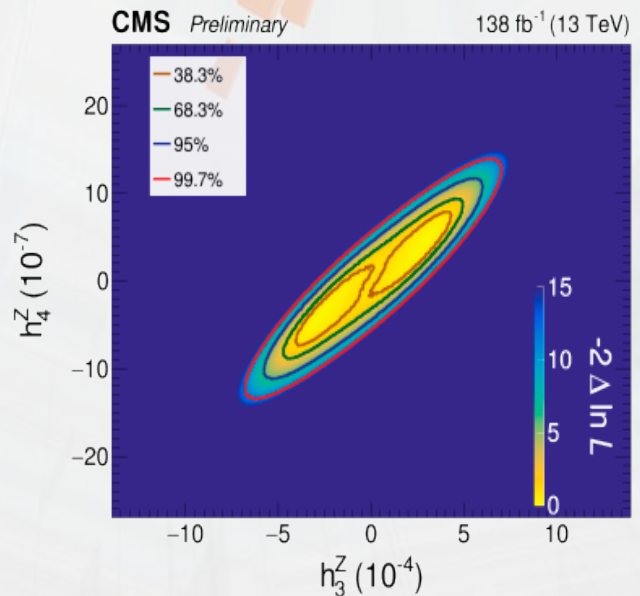
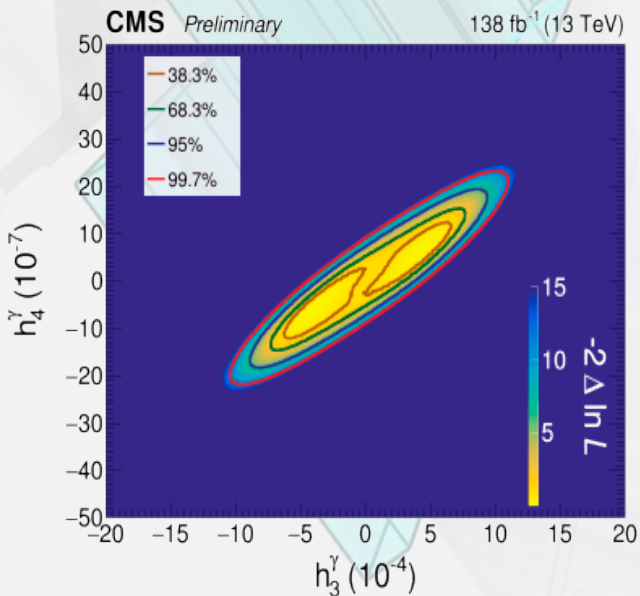
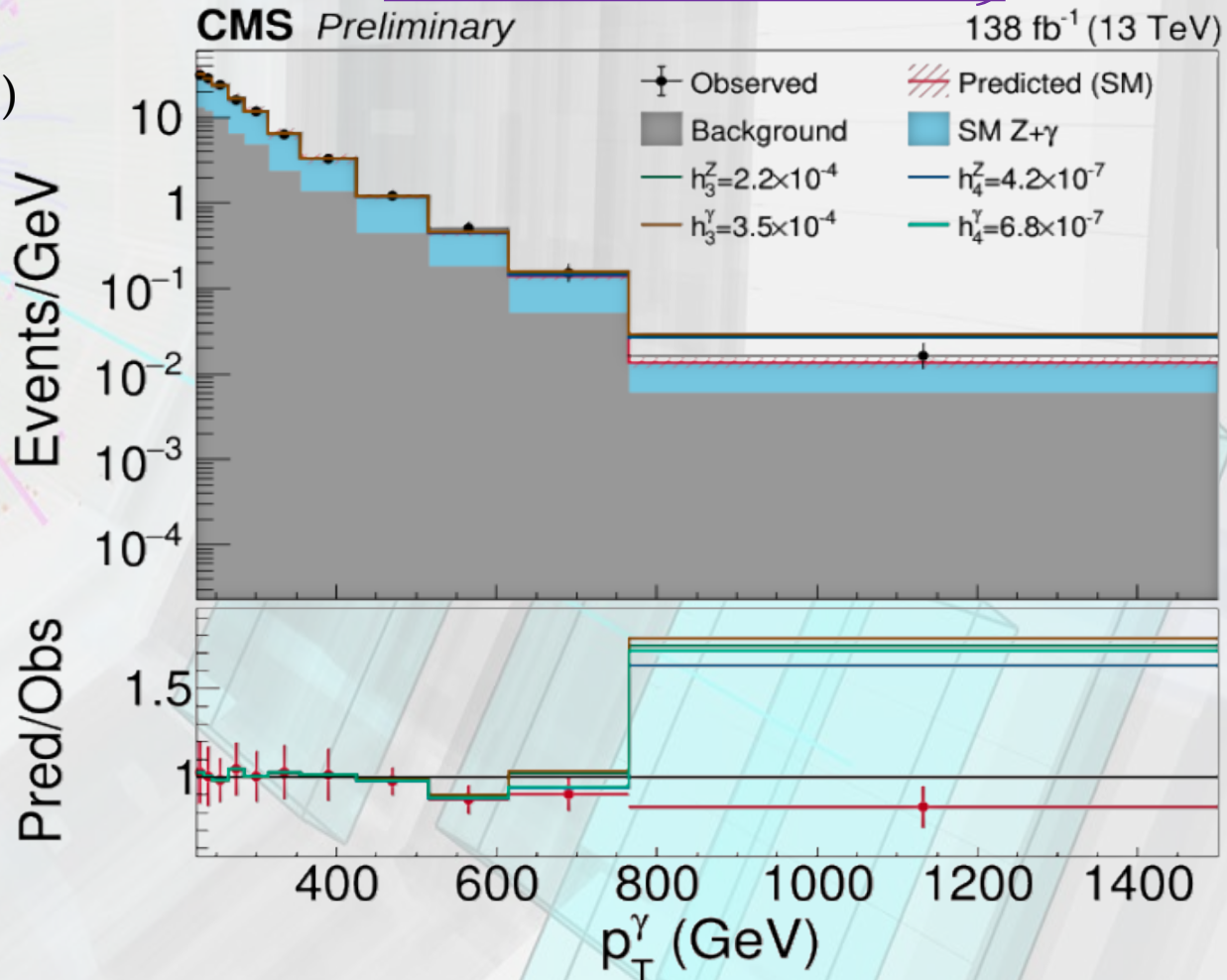


Search for Anomalous NTGC in $Z \rightarrow \nu\bar{\nu} + \gamma$

CMS-PAS-SMP-22-009

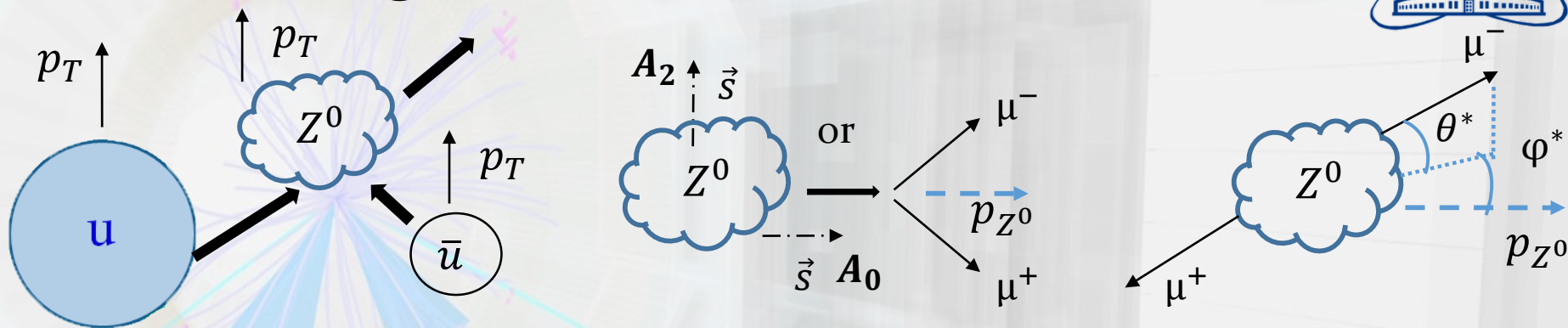
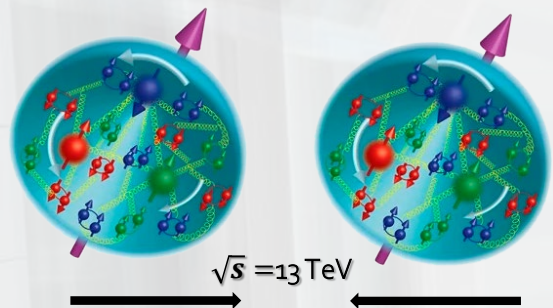


The BSM processes (right) could visibly contribute to the $Z \rightarrow \nu\bar{\nu} + \gamma$ at high p_T^γ and p_T^{miss}



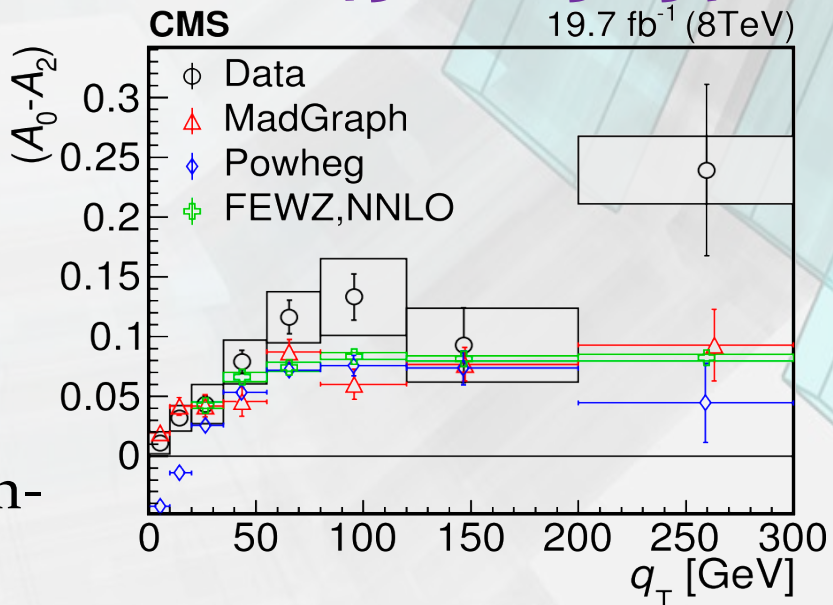
- ✓ No aNTGC contribution is found
- ✓ The most stringent limits on aNTGC are provided

Drell-Yan Angular Coefficients



$$\frac{d^2\sigma}{d\theta^*d\phi^*} \propto (1 + \cos^2\theta^*) + A_0 \frac{1}{2} (1 - 3\cos^2\theta^*) + A_1 \sin(2\theta^*) \cos\phi^* + A_2 \frac{1}{2} \sin^2\theta^* \cos(2\phi^*) + A_3 \sin\theta^* \cos\phi^* + A_4 \cos\theta^* + A_5 \sin^2\theta^* \sin(2\phi^*) + A_6 \sin(2\theta^*) \sin\phi^* + A_7 \sin\phi^* \sin\theta^*$$

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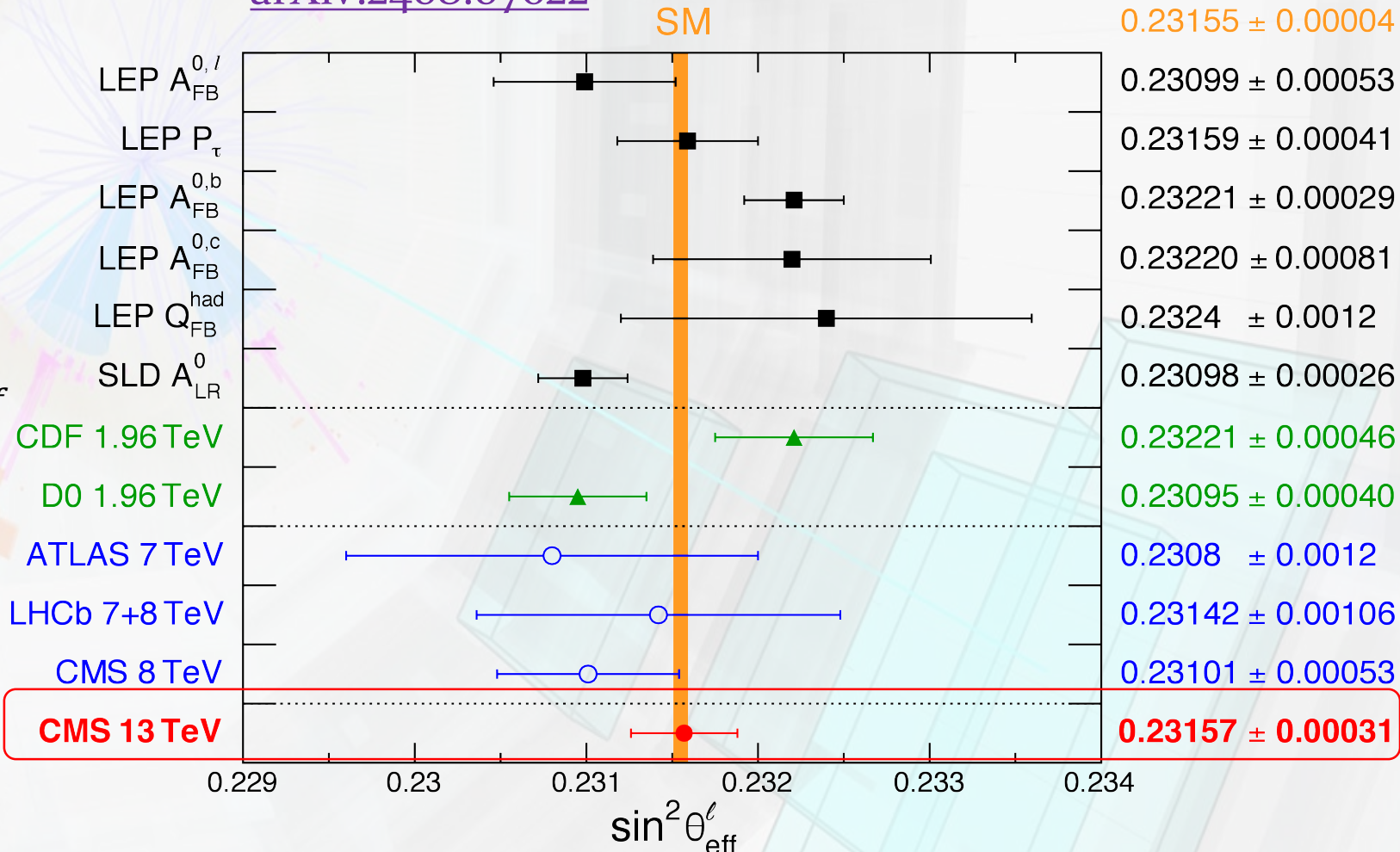
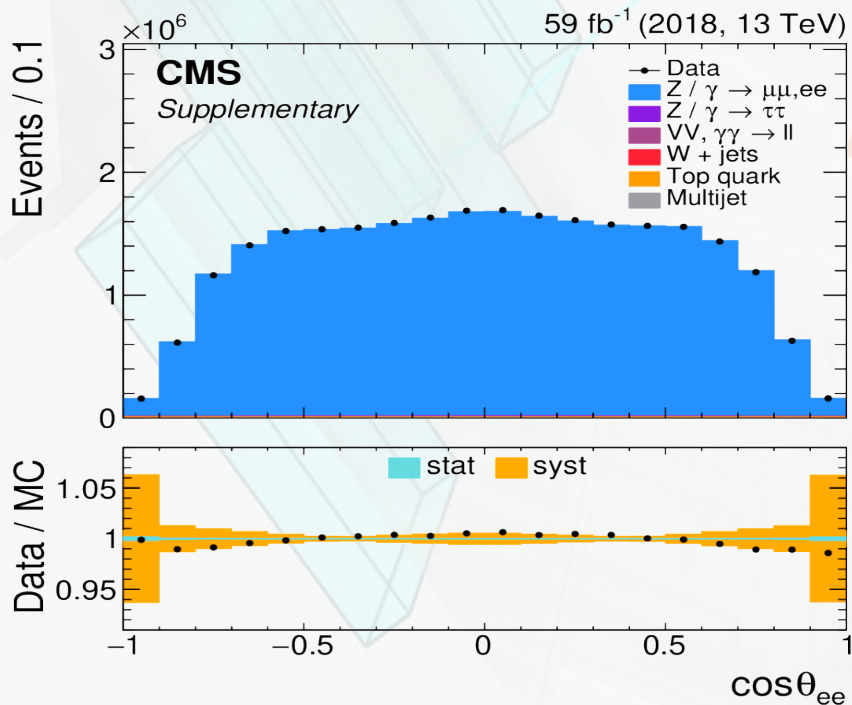
- ✓ Five angular coefficients were measured at 8 TeV
- ✓ Good agreement with SM model predictions
- ✓ A_i measurement at $\sqrt{s}=13$ TeV is also done and awaiting publication

- All A_i depends on PDF
- A_i are functions of p_T^{ll} , y^{ll}
- At LO only A_4 (A_{FB}) is non-zero at $p_T^{ll} \rightarrow 0$
- $A_0 - A_2$ related to the Z-boson polarization
- $A_0 = A_2$ at LO QCD (Lum-Tung relation) but it is violated at higher orders
- $A_5 - A_7$ define the contribution of T-odd asymmetries and may appear non-zero in processes at NNLO QCD

A_{FB} and $\sin^2 \theta_{eff}^l$ Measurement at $\sqrt{s} = 13$ TeV

[arXiv:2408.07622](https://arxiv.org/abs/2408.07622)

- A_4 ($\frac{3}{8} A_{FB}$) is sensitive to V-A structure of the couplings in parity violation terms
- Only A_4 ($\frac{3}{8} A_{FB}$) is non-zero at LO QCD at small p_T^Z
- A_{FB} was used to extracting $\sin^2 \theta_{eff}^l$ value by CMS collaboration



- ✓ Good agreement with previous measurements and global SM fit
- ✓ The most precise measurement at hadron collider

Conclusions

CMS shows an excellent performance to detect different signals and produced many EWK measurements at different energies:

- ✓ Precision measurements of inclusive W and Z production cross section with large statistic
- ✓ Detailed studies of differential cross sections and many observables, like asymmetries and angular coefficients, etc.
- ✓ Study of WW and ZZ production associated with jets
- ✓ All CMS measurements are so far in agreement with theoretical predictions from the Standard model and each other. No new physics is observed.

CMS Standard Models Physics Results:

<https://cms-results.web.cern.ch/cms-results/public-results/publications/SMP/index.html>