

Status of Run-2 $\sin^2 \theta_{\text{eff}}^{\ell}$ pseudo-data studies and documentations in WG1

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On behalf of LHC-EW WG1

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- **Pseudo-data studies for Run-2 $\sin^2 \theta_{\text{eff}}^{\ell}$ measurement**
- **Status of WG1 documentation**
 - thanks to Daniel and Aram for providing slides!

Purpose of pseudo-data exercise

- **Preparatory step** towards combined Run-2 (and future) LHC measurements of $\sin^2 \theta_{\text{eff}}^\ell$
- **Each experiment measures unfolded $A_4(y, m)$**
 - no synchronization needed beyond this level
- **Common interpretation**
 - Same or equivalent “default” interpretation model
 - Consistent treatment of PDF and theory uncertainties
 - Common measurement bins
- **Exercise**
 - 1) Fits of pseudo-measurements from 3 experiments
 - each generate pseudo-data according to int-lumi, acceptances & effs
 - fit and share pseudo-measurements of $A_4(y, m)$
 - compatibility checks and combined extraction of $\sin^2 \theta_{\text{eff}}^\ell$
 - 2) Test latest theory developments in WG1
 - link between pseudo-data and theory benchmark exercises

- **Observable: Born-level $A_4(m, y)$**
 - 6 equal $y_{\ell\ell}$ bins with width of 0.4
 - 7 $m_{\ell\ell}$ bins: 52, 66, 76, 86, 96, 106, 116, 150
- (LO, NLO, NLO+HO) EW POWHEG + NLO QCD generated with POWHEG Z-EW + PYTHIA8 (+ PHOTOS)
- “ $\sin^2 \theta_{\text{eff}}^\ell$ -input scheme”: $(G_\mu, m_Z, \sin^2 \theta_{\text{eff}}^\ell)$ with $\sin^2 \theta_{\text{eff}}^\ell$: 0.23150 (± 0.00050)
- NNP31_nnlo_hessian_pdfas

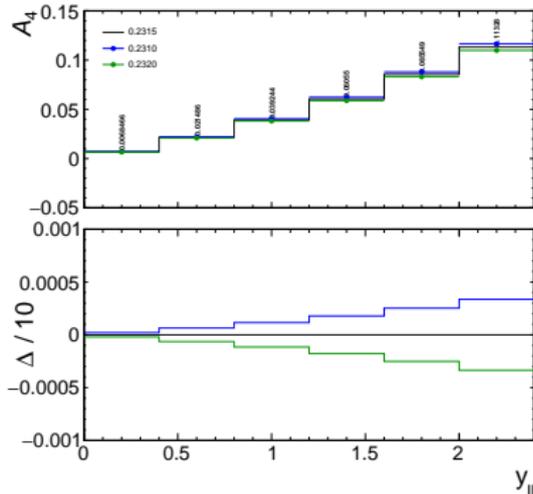
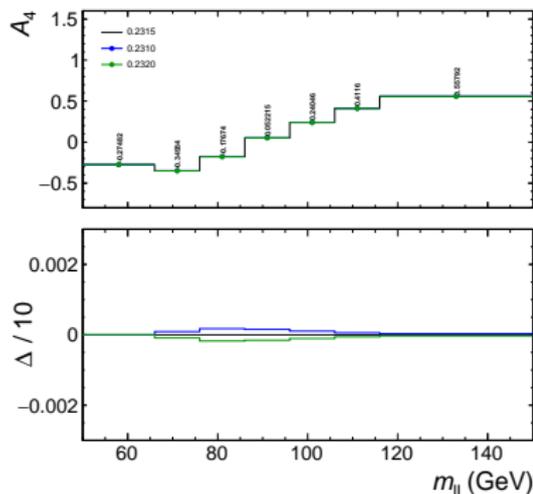
- 8 and 13 TeV
- Muon and electron channels
- Total of about 5B 8TeV and 10B 13TeV events in two channels

$A_4(\sin^2 \theta_{\text{eff}}^\ell)$ at 8 TeV

- ΔA_4 for $\Delta \sin^2 \theta_{\text{eff}}^\ell = \pm 0.00050$

Left: $A_4(m_{\ell\ell})$ for $y_{\ell\ell} < 2.4$

Right: $A_4(y_{\ell\ell})$ for $86 < m_{\ell\ell} < 96$



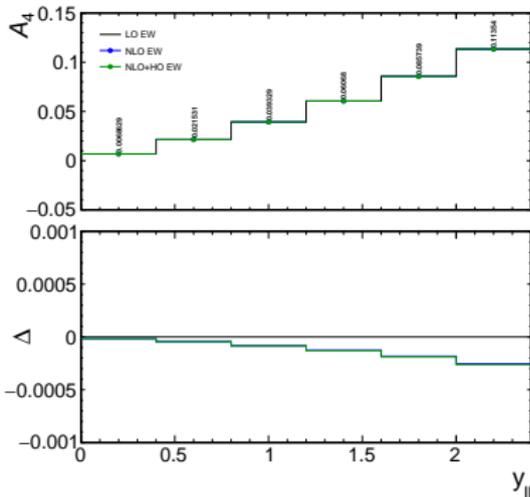
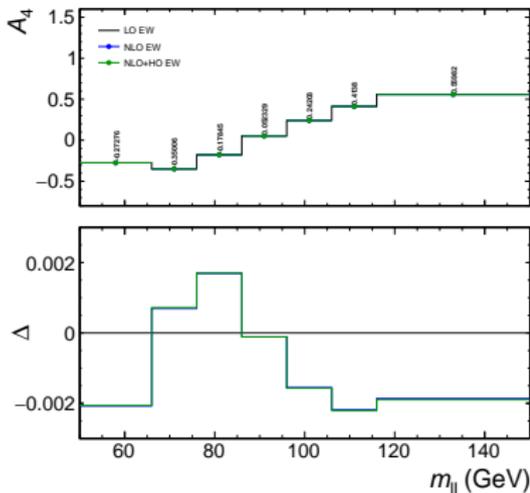
- Note $\Delta/10$ on y axis, reference for next two slides

A_4 at different EW orders at 8 TeV

- A_4 at LO, NLO, and NLO+HO

Left: $A_4(m_{\ell\ell})$ for $y_{\ell\ell} < 2.4$

Right: $A_4(y_{\ell\ell})$ for $86 < m_{\ell\ell} < 96$



- **In $\sin^2 \theta_{\text{eff}}^\ell$ input scheme:**

- Effective $\Delta \sin^2 \theta_{\text{eff}}^\ell$ for NLO-LO: < 0.00005

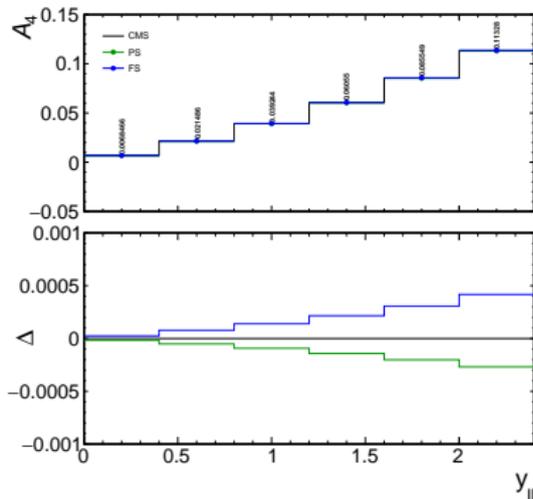
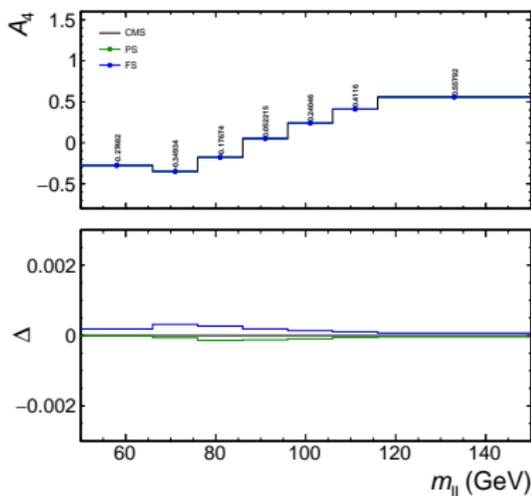
- Effective $\Delta \sin^2 \theta_{\text{eff}}^\ell$ for NLO+HO-NLO: negligible

A4 for different schemes at 8 TeV

- Complex-Mass (CMS), Pole (PS), & Factorization (FS) schemes

Left: $A_4(m_{\ell\ell})$ for $y_{\ell\ell} < 2.4$

Right: $A_4(y_{\ell\ell})$ for $86 < m_{\ell\ell} < 96$



- In $\sin^2 \theta_{\text{eff}}^\ell$ input scheme:

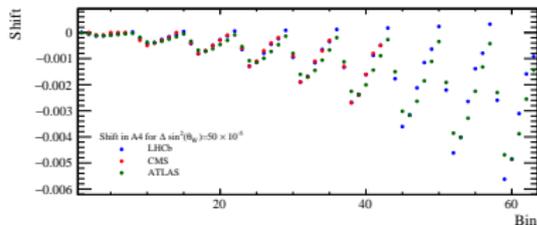
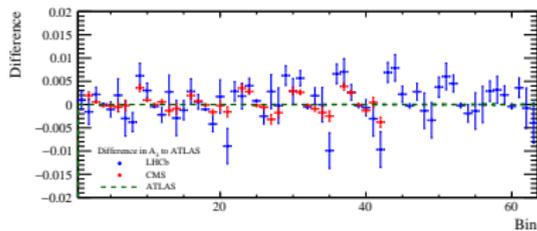
- Effective $\Delta \sin^2 \theta_{\text{eff}}^\ell$ for CMS-PS: < 0.00005

Status and plans for pseudo-data studies

- We have first A4 predictions and pseudo-measurements

Discrepancies in central predictions may be ok for this round of pseudo-data study, depending on the scope

- First estimates of individual stat+pdf errors (no combined fit)



- **For combination need to use common / equivalent tools:**
 - Default QCD+EW interpretation model & $A4(y, m; \sin^2 \theta_{\text{eff}}^{\ell})$ templates
 - EWK and QED uncertainties (good progress here)
 - PDF uncertainties (some studies and discussions started)
 - QCD uncertainties (no studies so far)

Since already three years, the group plans to produce a few publications, signed by the people who did the work (almost exclusively theorists)

1) $p_T^{Z/W}$ resummation:

This will be most likely limited to the case of the Z boson although the real goal of all this work is an understanding of how to port the uncertainties from the Z boson to the W boson

- Exercise never done before
- Results from several calculations basically completed

2) QED/EW effects at the Z pole for $\sin^2 \theta_{\text{eff}}^\ell$ measurement

Also exercise never done before (for specific asymmetry observable, including breakdown of gauge-invariant contributions between QED ISR, FSR and IFI)

- Results from several calculations basically completed

Since already three years, the group plans to produce a few publications, signed by the people who did the work (almost exclusively theorists)

3) PDF correlations:

Very much needed for precision measurements and combinations

- Exercise never done before
- Results soon for first iteration with one global PDF group
- Full study extends surely beyond this cycle of WG

- Finally, CERN report will collate somehow the three publications and incorporate a summary of work done using pseudodata from ATLAS/CMS/LHCb in view of future $\sin^2 \theta_{\text{eff}}^{\ell}$ measurement combinations
 - Will provide important guidelines for individual measurements
 - Should perhaps also include summary of work on m_W combination

Resummed predictions of the transverse momentum distribution of Drell–Yan lepton pairs in proton-proton collisions at the LHC

Insert your name and institutional address*

**World*

Abstract

Placeholder

Keywords: Drell–Yan, Resummation, LHC

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Editors of different sections are identified:

- Global editor: Aram Apyan
- Sections 2-3: Luca Rottoli, Frank Tackmann
- Section 4: Valerio Bertone, Thomas Cridge
- Section 7: Giuseppe Bozzi, Ignazio Scimemi

- Appendices: All the contributing groups
(~5 pages discussing the specifics of each calculations.
Figures supporting the results in the main body can also
be included here for each group.)

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Editors of different sections are identified:

- Global editors: D. Froidevaux, F. Piccinini
- General introduction: S. Dittmaier, A. Freitas
- Virtual corrections: F. Piccinini, E. Richter-Was
- QED corrections : S. Bondarenko, L. Kalinovskaya, S. Yost
- Photon-induced processes : S. Bondarenko, A. Vicini

- Appendices: All the contributing groups
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be included here for each group.)

- A lot of progress and work done in benchmarking exercises
- Next: start documenting descriptions and completed work
 - skeletons are prepared and editors are assigned
- Thank you to everyone contributing to these studies!