



Weak Mixing Angle Pseudodata Studies

W. Barter

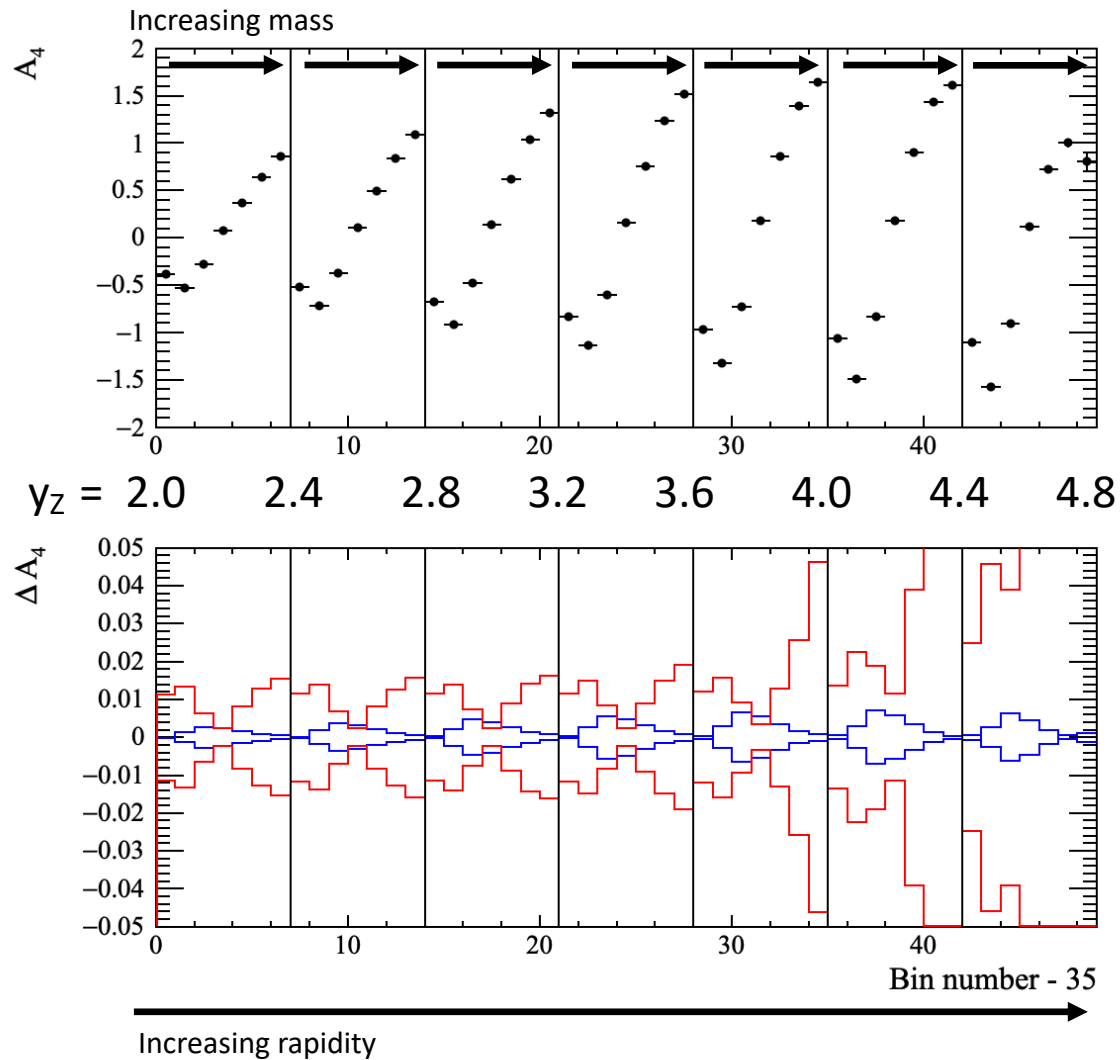
Imperial College London

30/04/20

Details

- Compare and combine pseudodata of measurements of A_4 (at Born level) at different experiments.
- Use a common framework for these studies:
 - POWHEG + Pythia8; LO EW, NLO(+PS) QCD
 - PDF: NNPDF31_nnlo_as_0118_hessian
 - Bins of width 0.4 in $|y|$
 - 7 bins in dimuon invariant mass: {50, 66, 76, 86, 96, 106, 116, 150 GeV}
- Since last time: sample size increased, extended comparison between experiments, LHCb pseudodata added.

LHCb acceptance

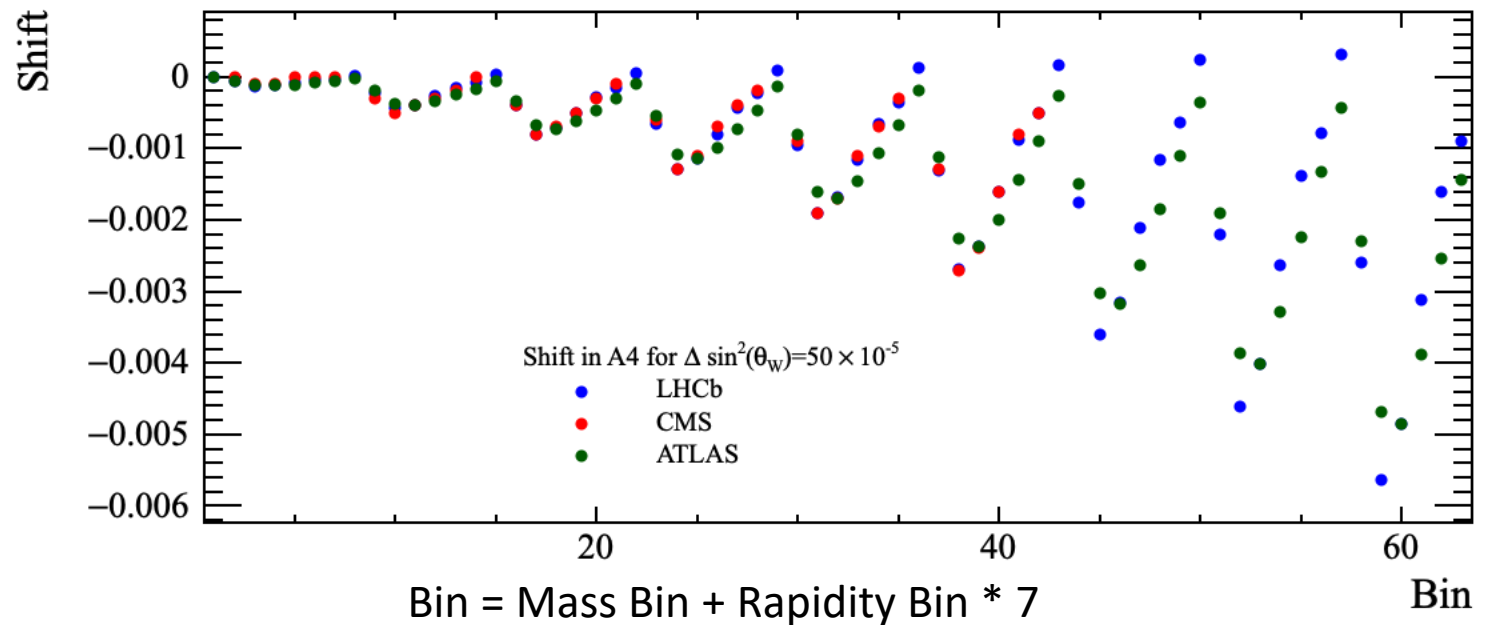
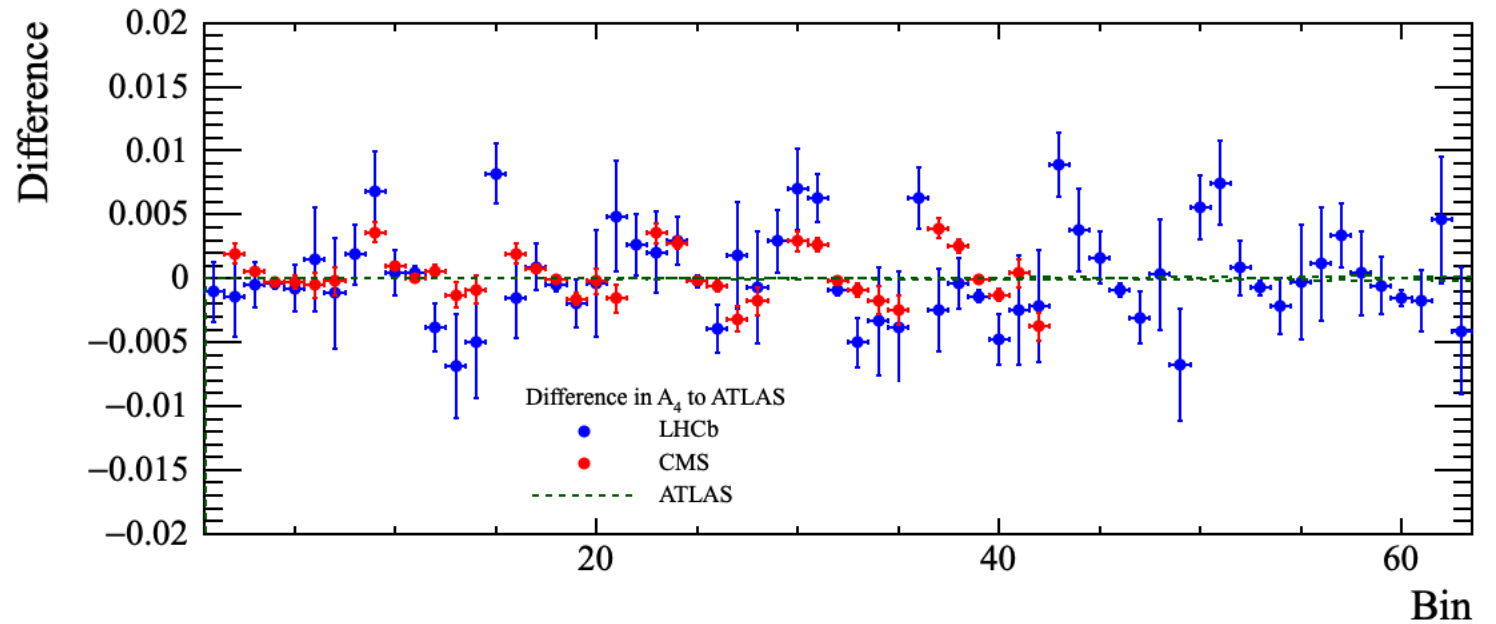


- A_4 determined with fit to generator level data (leptons in 4π).
- Bins in mass and rapidity; shift from weak mixing angle in blue ($\pm 50 \times 10^{-5}$); uncertainty from PDFs in red.
- Excellent agreement between Hessian and MC PDF replica (not shown) uncertainties.
- Binning scheme here:

$$\text{Bin} = \text{Mass Bin} + \text{Rapidity Bin} * 7$$

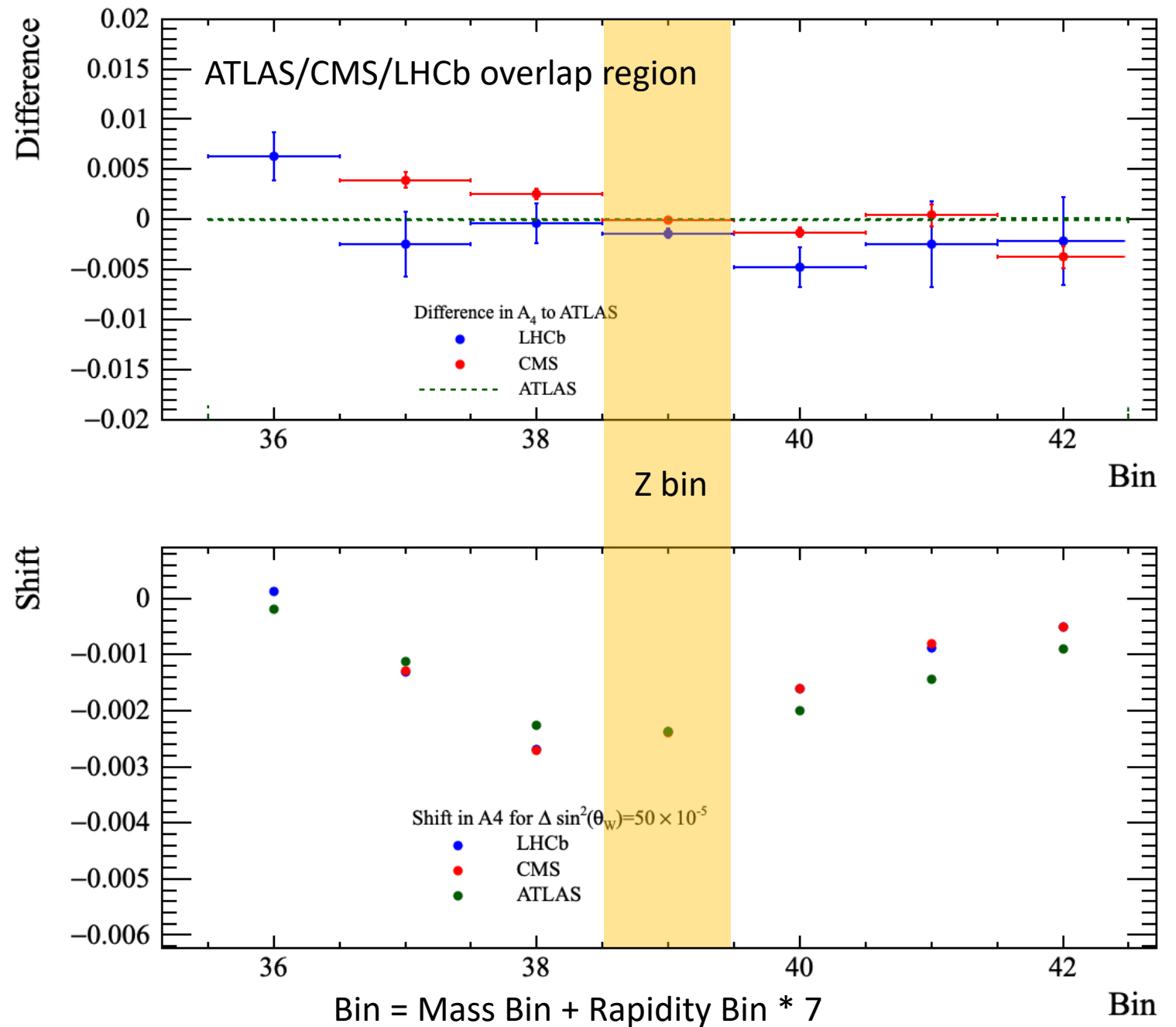
Validation

- ATLAS, CMS, LHCb all produce A_4 predictions, and we see excellent agreement on the Z peak.
- We also agree very well on the Z on the shift in A_4 induced by a shift in the weak mixing angle.
- Plot excludes lowest mass CMS bin.



Validation

- ATLAS, CMS, LHCb all produce A_4 predictions, and we see excellent agreement on the Z peak.
- We also agree very well on the Z on the shift in A_4 induced by a shift in the weak mixing angle.
- Plot excludes lowest mass CMS bin.

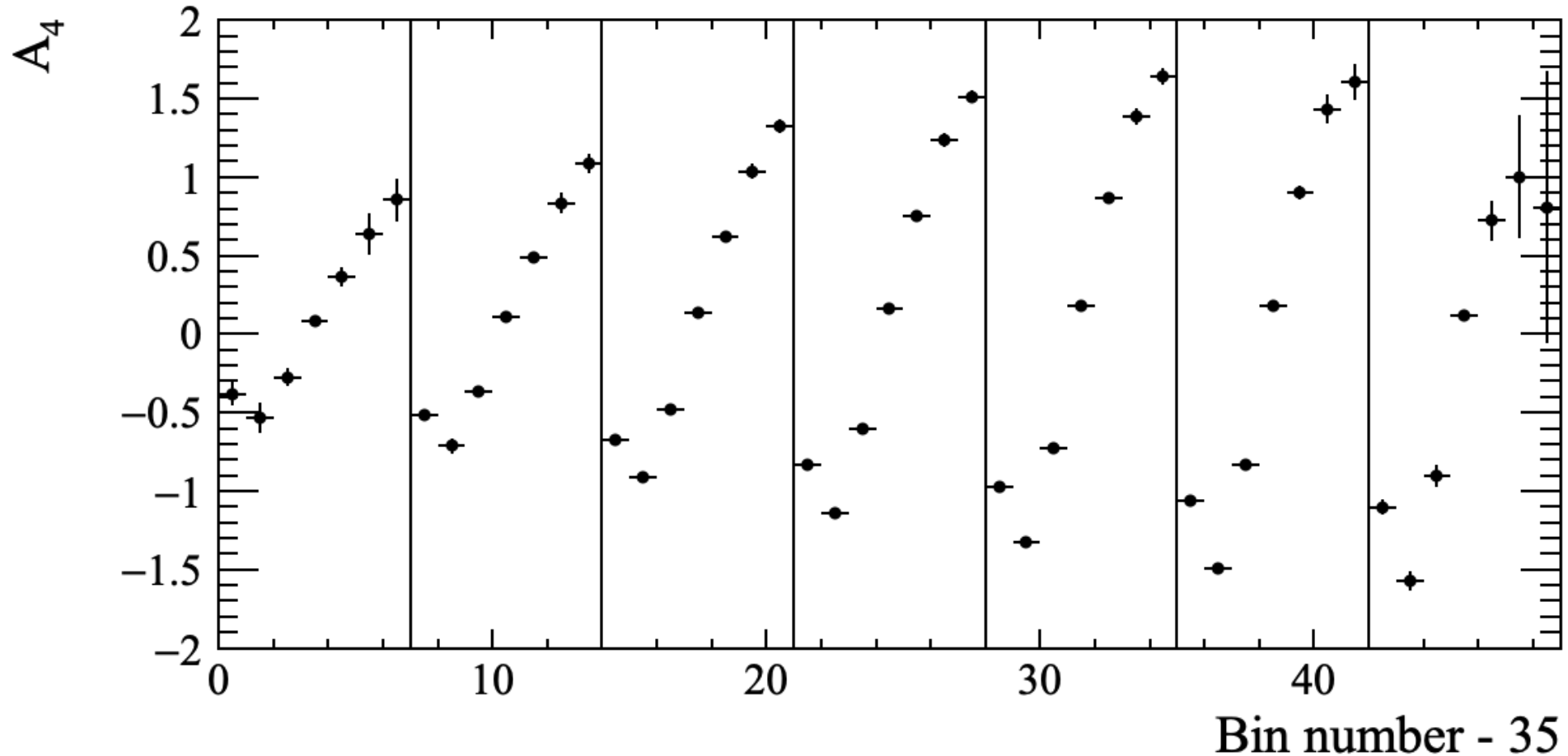


LHCb pseudodata

- Consider events within LHCb acceptance:
 - Kinematic selection defined by previous analyses and current plans for weak mixing angle measurement.
 - Consider $2 < y_z < 4.8$.
- Study performed at generator level (no smearing).
- Normalise expected yields to those found in $\sqrt{s} = 13$ TeV cross-section analysis, scaled by full Run II integrated luminosity (6/fb) – so include effects of detection efficiency $\neq 100\%$.
- Expect roughly 1M events in LHCb acceptance in Run II dataset.
- Fit $\cos \theta$ distribution for $A_4(m, y)$.

LHCb pseudodata

Statistical uncertainties shown are those expected in the analysis, given the size of the LHCb dataset.



LHCb pseudodata

- Extract favoured value of weak mixing angle from pseudodata.
- For Run II, LHCb expects Stat Unc: 31×10^{-5} ; PDF Unc (not profiled): 21×10^{-5}
 - Asimov and Poisson-fluctuated sets agree; improvement on statistical uncertainty from an A_{FB} measurement of roughly 20%.
 - Low dilution in forward region means (relatively) small PDF uncertainty, profiling less advantageous.
 - Eigenvector with largest contribution to uncertainty is eigenvector 29 – Aleko's study showed profiling had biggest impact on this eigenvector.
- LHCb Run III (using LHCb upgrade) should reduce this statistical uncertainty by a factor 2.
- Will upload data to `/afs/cern.ch/user/w/wbarter/public/ForEWWG/` in next few days.