Wrap-up concerning experimental pseudo-data

- **We have discussed at the previous two meetings how we could envisage to write a section as below which would really be useful as a concrete example of how the weak mixing angle measurements of the three experiments could be combined with a proper correlation treatment of all common theoretical uncertainties**

Wrap-up concerning experimental pseudo-data

- **We prepared some aspects of this more than a year ago!**
- **The bins discussed here are for producing numbers in terms of experimental observables for which pseudo-data is planned to be used**
- **Histograms from calculations have much finer binning (eg 1 GeV in m_{ll})**
- **Need to revise y_{ll} binning a bit to include LHCb and perhaps finer binning at high y_{ll}. Move to 11 bins from 0 to 4.4 for simplicity**
- **Adjust mass range to 61 to 151 GeV. Pole region defined as 81 to 101 GeV For |yll| > 2.4, use coarser binning of 10 GeV outside pole region.**

Binning:

- 18 bins in M_{ll} in the range 60 to 150 GeV (5 GeV width)
- 9 bins in $|\ y_{ll}\ |$ out to 3.6 (0.4 width)
- Binning in $\cos\theta^*$ and in dilepton p_T do not need to be standardized.

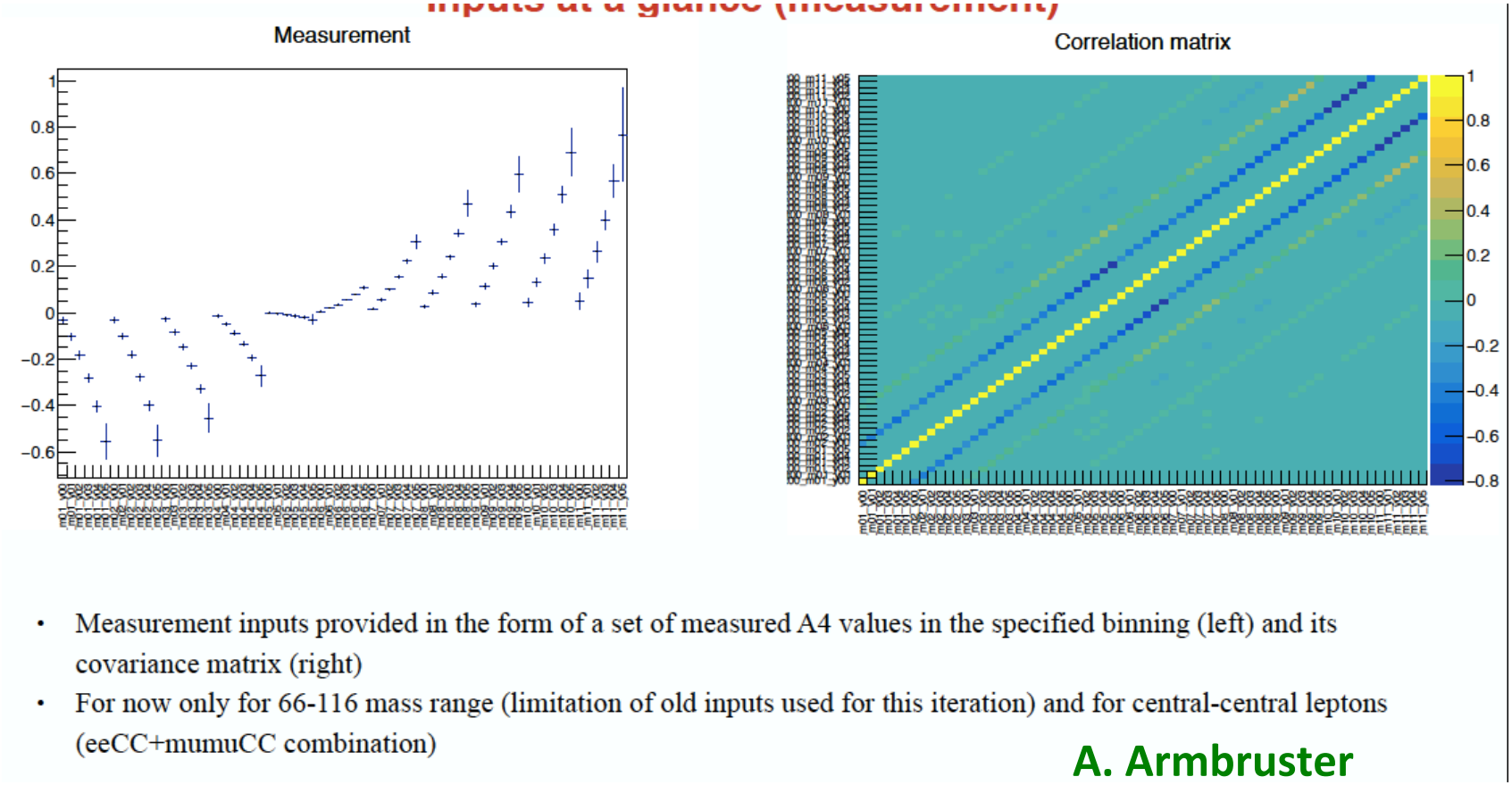
M. Schmitt

Standardized binning allows for direct compatibility tests among the experiments.

Also, improves connection to theory benchmark studies.

Wrap-up concerning experimental pseudo-data

- **ATLAS pseudo-data shown here correspond to a full-fledged pseudo-data analysis.**
- **A direct generator-level set of pseudo-data, "smeared to emulate detector effects" is also acceptable for these studies.**
- **ATLAS and CMS will produce also CF pairs overlapping in y with LHCb acceptance**

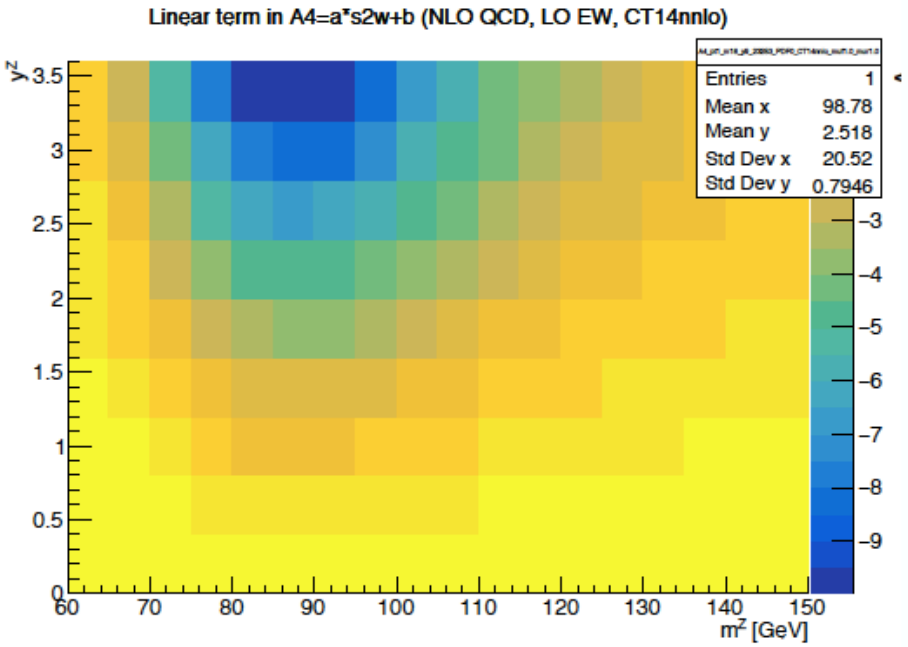


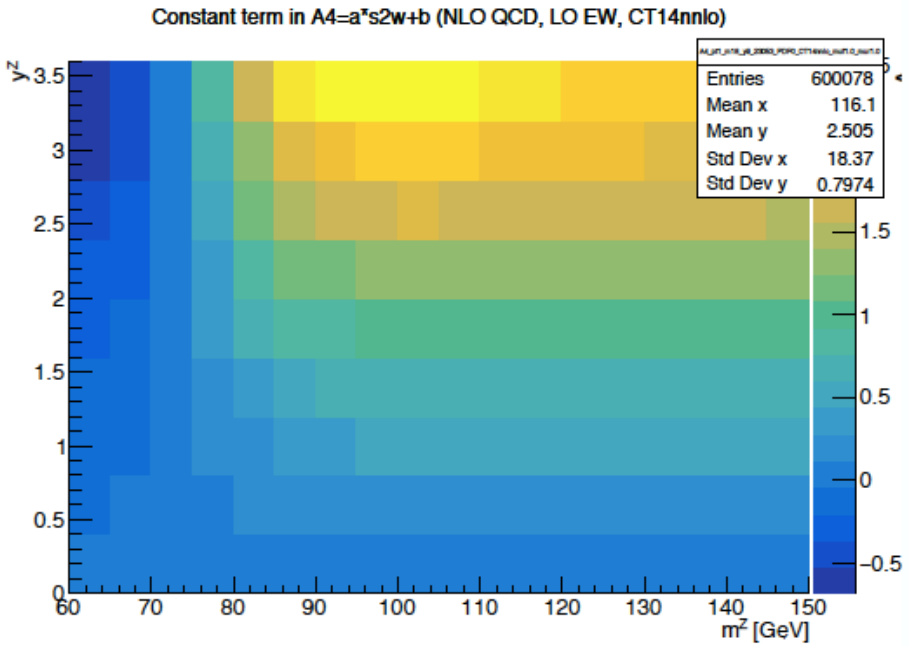
- Measurement inputs provided in the form of a set of measured A4 values in the specified binning (left) and its covariance matrix (right)
- For now only for 66-116 mass range (limitation of old inputs used for this iteration) and for central-central leptons (eeCC+mumuCC combination)

A. Armbruster

Finalising configurations to be run for publications and YR

- All experiments will use POWHEG+PYTHIA8 with Photos (?)
- Input value of effectie weak mixing angle?!
- ATLAS value is currently 0.23113, what about CMS and LHCb?
- Propose to use 0.231499 (see Powheg-EW new input scheme)





A. Armbruster

- From this set of predictions, one can produce interpretation curve A4 = a*s2w+b for each point in mass, rapidity
- Above shown for linear and constant term a, b for one EV

Path to Yellow Report

- **Fourth part is the key one to facilitate and harmonise (within reason) experimental measurements and combinations at the LHC using full run-2 data.**
- **Goal would be to arrive at finest possible breakdown of expected (mostly theoretical) uncertainties although correlated experimental uncertainties may be of interest too**

ATLAS

$m^{\ell\ell}$ (GeV)	70 – 80			80 – 100				100 – 125		
$\lvert y^{\ell\ell}\rvert$	0 – 0.8	0.8 – 1.6	1.6 – 2.5	0 – 0.8	0.8 – 1.6	1.6 – 2.5	2.5 – 3.6	0 – 0.8	0.8 – 1.6	1.6 – 2.5
Prediction (MMHT14)	−0.0870	−0.2907	−0.5970	0.0144	0.0471	0.0928	0.1464	0.1045	0.3444	0.6807
	Uncertainties			Uncertainties				Uncertainties		
Total	0.0176	0.0202	0.0404	0.0015	0.0015	0.0025	0.0044	0.0083	0.0098	0.0230
Stat.	0.0153	0.0164	0.0333	0.0013	0.0013	0.0021	0.0036	0.0072	0.0078	0.0188
Syst.	0.0087	0.0117	0.0229	0.0007	0.0008	0.0013	0.0025	0.0041	0.0060	0.0133
PDF (meas.)	0.0013	0.0049	0.0048	0.0001	0.0002	0.0004	0.0007	0.0007	0.0016	0.0043
p_{T}^{Z} modelling	0.0002	0.0004	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001	0.0002
Leptons	0.0023	0.0059	0.0118	0.0002	0.0001	0.0003	0.0007	0.0014	0.0037	0.0070
Background	0.0004	0.0011	0.0064	< 0.0001	< 0.0001	< 0.0001	0.0001	0.0004	0.0017	0.0031
MC stat.	0.0082	0.0088	0.0179	0.0007	0.0007	0.0012	0.0023	0.0038	0.0041	0.0100

Table 7: Expected measurement uncertainties in A_4 and their breakdown, based on MMHT14 pseudo-data. Also shown as a reference are the predictions for the central values using the MMHT14 PDF set, as obtained from Table 2.

Path to Yellow Report

- **Fourth part is the key one to facilitate and harmonise (within reason) experimental measurements and combinations at the LHC using full run-2 data.**
- **Goal would be to arrive at finest possible breakdown of expected (mostly theoretical) uncertainties although correlated experimental uncertainties may be of interest too**

CMS

Table 3: Summary of the theoretical uncertainties for the dimuon and dielectron channels, as discussed in the text.

Modeling parameter	Muons	Electrons
Dilepton p_T reweighting	0.00003	0.00003
μ_R and μ_F scales	0.00011	0.00013
POWHEG MINLO Z+j *vs.* Z at NLO	0.00009	0.00009
FSR model (PHOTOS *vs.* PYTHIA 8)	0.00003	0.00005
Underlying event	0.00003	0.00004
Electroweak $\sin^2\theta^{\ell}_{\text{eff}}$ *vs.* $\sin^2\theta^{\text{u,d}}_{\text{eff}}$	0.00001	0.00001
Total	0.00015	0.00017

Path to Yellow Report

ATLAS

- **Table below needs further breakdown!!**

Channel	ee_{CC}	$\mu\mu_{CC}$	ee_{CF}	$ee_{CC} + \mu\mu_{CC}$	$ee_{CC} + \mu\mu_{CC} + ee_{CF}$
Total	65	59	42	48	34
Stat.	47	39	29	30	21
Syst.	45	44	31	37	27
	Uncertainties in measurements				
PDF (meas.)	7	7	7	7	4
p_T^Z modelling	< 1	< 1	1	< 1	< 1
Lepton scale	5	4	6	3	3
Lepton resolution	3	1	3	1	2
Lepton efficiency	1	1	1	1	1
Electron charge misidentification	< 1	0	< 1	< 1	< 1
Muon sagitta bias	0	4	0	2	1
Background	1	1	1	1	1
MC. stat.	25	22	18	16	12
	Uncertainties in predictions				
PDF (predictions)	36	37	21	32	22
QCD scales	5	5	9	4	6
EW corrections	3	3	3	3	3

Table 8: Expected measurement uncertainties in $\sin^2\theta^{\ell}_{\text{eff}}$ and their breakdown, based on MMHT14 pseudo-data. The values are given in units of 10^{-5}, assuming an effective value of $\sin^2\theta_W = 0.23152$. The uncertainties are broken down separately for those arising from the A_4 measurements and from the predictions. The PDF uncertainties are treated as uncorrelated between the A_4 measurements and the predictions (see text).

Finalising configurations to be run for publications and YR

- **If we don't have any progress on the inputs from CMS and LHCb over the next few months, then one of the most useful sections of the YR for the experiments will be either descoped to an ATLAS-only exercise, which would be highly undesirable and unwelcome, or worse will be omitted completely.**

- **Since the full run-2 measurements from the experiments are still in the distant future, one might use the WG beyond the YR to complete this exercise, but this would be a shame in my opinion.**

- **Of course, some people in the WG might argue that after all this brings the QED/EW part of the YR to the same level as the pTW/Z part (for which it is really out of scope to assess the impact of all the theoretical work done on the W mass measurement itself, see the discussion two days ago in the dedicated meeting on this topic).**

Finalising configurations to be run for publications and YR

- What about the lepton definition and the consistency between the virtual EW corrections on one side and the IFI/ISR corrections on the other?
- In the initial discussions, we had agreed to do the following:
  - For the virtual corrections, use Born leptons only since these are computed in a correct way without any QED radiation (the LEP Ansatz!).
  - For the IFI/ISR/FSR corrections, use bare muons only because there is no additional dependence on a dressing algorithm and because the muon mass is large enough that the calculations remain numerically "safe" compared to electrons.
  - Do we agree to stick to the above? I certainly hope so!
- Additional points which require some discussion:

Back-up slides

Path to Yellow Report

- **We believe working on the overall YR together is quite important from now on because the interplay between experiment and theory is the key to a useful report which in our minds has the goal of laying out a possible strategy (not necessarily unique!) of how experiments would publish their full run-2 results and how they would this be optimally ready for an overall LHC combination once all the individual results (and interpretations) are out.**

- **The prospects look good that this future LHC combination could have very similar precision to the overall LEP/SLC result ($16\ 10^{-5}$)**

- **However, achieving that will surely require work beyond what will be in a YR published in summer 2020 (eg PDF uncertainty)**

- **So the YR will be a guideline showing what we can strive towards and work will surely continue beyond it on all fronts, but based on a, hopefully sound, written document vetted by the whole community.**

Path to Yellow Report

- **First part focuses on setting the context: LEP/SLD briefly with the best references available today, using also similar work done in the context of FCC_ee studies, and then hadron colliders with the Tevatron and early LHC measurements.**

Contents

- **Include available uncertainty tables from most precise measurements from ATLAS (preliminary) and CMS (published)**

Path to Yellow Report

- **Second part is devoted to so-called virtual EW corrections.**
- **It contains current status of calculations with tables and plots from available results based on Dizet, Powheg-EW and MC-SANC**

Path to Yellow Report

- **Third part is devoted to so-called QED ISR and IFI and also to the impact of photon-induced processes which belongs here.**
- **At this point PDFs come in, and comparisons are done**
  a) without including photon-induced processes at all and using standard PDFs and
  b) including photon-induced processes but using PDFs matched to LUXQED