

# Introduction: path towards publications and YR

- Possibly three+ publications will come out from the work done in the precision EW group:
  - Resummation benchmarking of  $p_{TW}$ ,  $p_{TZ}$  and  $p_{TW/Z}$
  - QED/EW corrections for precision EW measurements ( $s_2^{weff}$  and  $m_W$ )
  - PDF benchmarking
- YR report(s) will in general be more extensive in terms of topics than specific publications, but might be more concise concerning the work published in the sister publications by referring to them for details
- YR reports can include more material at the boundary between theory and experiment while obeying the publication rules of the experiments. Examples of such material are the ongoing pseudodata studies for the full run-2 LHC combination of the weak mixing angle measurement (see update by Aleko today)
- Aram and I will focus respectively on  $p_{TW/Z}$  benchmarking and QED/EW corrections as main editors and will ask some of you to help of course!
- Today brief reminder of current status of QED/EW paper draft (put mainly together by Elzbieta until now) plus some discussion of work remaining to be done.

# Introduction: path towards publications and YR

- 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.

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- Include available uncertainty tables from most precise measurements from ATLAS (preliminary) and CMS (published)
- Important note: as for pTW/Z paper, one appendix of ~ 5 pages will be reserved for each calculation to describe details, provide additional plots and numbers, etc ...

**Contribution from KKMC-hh already provided, thanks 😊**

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- Second part is devoted to the 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

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- Which theoretical uncertainties? See next slide

# Uncertainties for virtual corrections

- Which theoretical uncertainties need to be discussed and how should they be treated and combined for the interpretation of the weak mixing angle based on ATLAS/CMS/LHCb measurements in the future?  
This topic has been amply discussed in bits and pieces over the past few years but now we are ready hopefully to converge based on the most recent results from the different calculations.
- Recently, the choice of mass scheme has been brought up by Stefan (see his presentation in December and discussion introduced by Ayres today)
- The uncertainties related to the unknown higher-order corrections need to be assessed as a separate but maybe not unrelated item to the point above
- The parametric uncertainties depend on the choice of input parameters and have been studied in some detail already by Elzbieta for the various schemes and more recently by Fulvio/Alessandro for the  $s_2^{\text{weff}}$  scheme.
- The QCD dependence of the interpretation is another source of uncertainty. This has been shown by published work (Mustrahl frame) to be small and is even proven to be vanishingly small for a single gluon emission.
- What about mixed QCD/QED corrections?
- Anything else?

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- 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

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- Which theoretical uncertainties? See next slide

# Uncertainties for QED ISR/IFI corrections

- Which theoretical uncertainties need to be discussed and how should they be treated and combined for the interpretation of the weak mixing angle based on ATLAS/CMS/LHCb measurements in the future?
- Here the theoretical issues are of a different kind and have not been discussed much yet
- Is the choice of mass scheme also a source of uncertainty here? Most likely yes?
- The issue of multiple photon emissions and other higher order corrections of the IFI type should also be addressed.
- Photon induced processes?
- PDFs and the inclusion or not in them of the collinear photon effects
- What about mixed QCD/QED corrections?
- Anything else?

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- Fourth part is the key one to facilitate and harmonise (within reason) experimental measurements and combinations at the LHC using full run-2 data.
- Final numbers will be needed at 13 TeV energy

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# Introduction: path towards publications and YR ATLAS

ATLAS

- Table below needs further breakdown!!

Channel	$eeCC$	$\mu\mu CC$	$eeCF$	$eeCC + \mu\mu CC$	$eeCC + \mu\mu CC + eeCF$
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  $\sin^2 \theta_{\text{eff}}^\ell$  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).