The LEP Electroweak Working Group (lepewwg) example

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Motivation

- This COST Action unites theorists, phenomenologists and experimental physicists from different messengers.
- Continued discussions on how to integrate the work of these communities to improve in our analysis and understanding of the data for constraining/detecting Quantum Gravity effects.
- In particular, discussions on experimental data property, data access, data sharing, and specifically between experiments/observatories and theorists/phenomenologists.
- In this context, I'd share my experience with the LEP Electroweak Working Group (lepewwg), a very successful initiative that may provide useful ideas.

In memoriam



Agnieszka Jacholkowska

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	Measurement	Fit	$ O^{\text{meas}} - O^{\text{fit}} / \sigma^{\text{meas}}$
$\Delta \alpha_{\rm had}^{(5)}({\rm m_Z})$	0.02750 ± 0.00033	0.02759	
m _z [GeV]	91.1875 ± 0.0021	91.1874	
Γ _z [GeV]	2.4952 ± 0.0023	2.4959	-
$\sigma_{\sf had}^{\sf 0}\left[{\sf nb} ight]$	41.540 ± 0.037	41.478	
R _I	20.767 ± 0.025	20.742	
A ^{0,I}	0.01714 ± 0.00095	0.01645	
A _I (P _r)	0.1465 ± 0.0032	0.1481	-
R _b	0.21629 ± 0.00066	0.21579	
R _c	0.1721 ± 0.0030	0.1723	• • • • • •
A ^{0,b}	0.0992 ± 0.0016	0.1038	
A ^{0,c}	0.0707 ± 0.0035	0.0742	
A _b	0.923 ± 0.020	0.935	
A _c	0.670 ± 0.027	0.668	•
A _I (SLD)	0.1513 ± 0.0021	0.1481	
$sin^2 \theta_{eff}^{lept}(Q_{fb})$	0.2324 ± 0.0012	0.2314	
m _w [GeV]	80.385 ± 0.015	80.377	-
Γ _w [GeV]	2.085 ± 0.042	2.092	•
m _t [GeV]	173.20 ± 0.90	173.26	
March 2012			0 1 2 3



Initially

- Each experiment analysing, presenting and publishing independently its own data.
- Each experiment using their preferred theoretical model/framework for the analysis.
- Data for each observable presented with four different measurements (one per experiment) and combination left for the audience...
- Blind combination obviously wrong due to complexity of role of systematic effects and of non-negligible correlation matrices.

Dawn of the LEP Electroweak Working group

- After about one year of operation, the Spokespersons of the 4 LEP experiments proposed to create a coordination group to properly combine the data and produce correct LEP results.
- I was appointed by Jack Steinberger (Nobel Prize) to seed that group on behalf the Aleph Experiment.
- The **lepewwg** started with 8 members (4*2 exp. reps.)
- For each measurement the systematics were scrutinised in detail to split those that were common (E_{cm}, Lumi, Th. uncertainties,...) from those that were experiment specific.
- Also techniques to combine complex covariance matrices were developed.

Evolution of the LEP Electroweak Working group

⇒ we felt that, from the experimental point of view the measurements were properly combined.

BUT

- Since the measurements were reaching high precision, and the calculations for the extraction of the quantum corrections were rather complex, the focus shifted to the proper theoretical interpretation of the measurements
- ⇒ theorists/phenomenologist for the codes/frameworks used by the experiments were integrated in the **lepewwg**

Impact of the LEP Electroweak Working group

\Rightarrow Great success !

- Theorists/phenomenologists could understand the meaning and the complexities of the measurements and tune their theoretical codes/approaches to cope with them.
- Experimentalists could understand the right interpretations of their measurements, the theoretical uncertainties and the right language to fit the data to extract properly the quantum corrections.

Result of the LEP Electroweak Working group

Model adapted immediately for all LEP measurements/constraints

- Heavy flavours (Agnieszka), QCD, Susy searches, Other searches,...
- Concepts/techniques proven to work (Monte Carlo) not only to combine measurements but also to properly combine constraints.
- All LEP results benefited enormously from the **lepewwg** experience, and it was extended to include also measurements/data/constraints from other experiments beyond LEP.

Access of the theorist/phenomenologists to the LEP data

- In the **lepewwg** theorists/phenomenologists were participating, as any other group member, in the understanding of the proper combination and interpretation of the data.
- They had access to the experimental data already properly elaborated and combined by the experimentalists, but not to the "raw" data.

Access of the theorist/phenomenologists to the LEP data

- Some theorists/phenomenologists that wanted a more direct access to the data, decided to join the experiments as members.
- This came with full-rights but also with some duties.
- Those theorists/phenomenologists could test with complete freedom their own new models/ideas on the "raw" data of that experiment.
- In the mid term, some of these new ideas/approaches escalated to the **lepewwg** and became the standard.

In our case:

- For VHE gamma rays, Agniezska (HESS) and I (MAGIC) proposed to start a LIV Working Group following the concept of the **lepewwg** (~2015). Quickly VERITAS joined in.
- This initiative was officialised and backed up with an MoU signed by the Spokespersons of the 3 observatories.
- The LIV Working Group has been let by Agnieszka, later by Julien and now by Tomislav.
- So far, no theorists/phenomenologists have been group members, though some have been invited to specific meetings to help in the clarification of theoretical issues.
- By now a publication with stress on the combination method developed using Monte Carlo, and now heading to a publication using real data.

Future possibilities ?.

- As a part of the COST Action outcome, maybe the creation of an expanded LIV Working Group integrating different messengers at the experimental level. Needed ?.
- As a part of the COST Action outcome, maybe the integration of theorist/phenomenologists in the LIV Working Group on a regular basis, as happened in the **lepewwg** and following that model.
- Theorists/phenomenologists wanting a more direct access to the raw data can anytime apply to current observatories/experiments. In MAGIC we've got theorists as full members has duty implications) but also as associates (no duties but access to data and authorship limited to specific fields).

Beyond LIV

- In VHE Gamma Ray Astronomy often observation significance for many sources at the limit => poor lightcurves and spectra.
- Data from H, M and V could be combined for observations of the same sources => larger significance, reduction of systematics, more meaningful lightcurves and spectra.
- Caveat: combination from variable sources requires concurrent observations or source variation/evolution models.
- Done already for a few specific sources with coordinated concurrent observations, but could be developed as a general strategy, à la LIV Working Group.
- Unfortunately non-optimal relation between HESS, MAGIC and VERITAS have hampered this initiative.

Outlook

- Beyond whether the COST Action will be extended or not, maybe the right time to work out, as an outcome, the future of this effort uniting theorists, phenomenologists and experimental physicists from different messengers.
- An enlarged LIV Working Group, including all messengers and theorists/phenomenologist and with a concept similar to that of the lepewwg, could be a very important initiative for the future.
- If we want to go to that venue, now is the right moment to head in that direction and agree on how to proceed.

Thanks !