

Round Table Discussion on Precision and Measurements

Goal: Trigger discussion on the subject focusing on the following

- Invite you to comment, giving your view on specific points
- Give suggestions for both TH and EXP (many have already been expressed during the meeting yesterday)
- Propose other points to discuss.
- Opportunity to raise any point you would like on Higgs measurements.

(I) Where are our current limitations?

(II) What should we measure?

Where are our current limitations?

	Best fit μ	Uncertainty				
		Total	Stat	Expt	Thbkd	Thsig
ATLAS + CMS (measured)	1.09	+0.11 -0.10	+0.07 -0.07	+0.04 -0.04	+0.03 -0.03	+0.07 -0.06
ATLAS + CMS (expected)		+0.11 -0.10	+0.07 -0.07	+0.04 -0.04	+0.03 -0.03	+0.07 -0.06
ATLAS (measured)	1.20	+0.15 -0.14	+0.10 -0.10	+0.06 -0.06	+0.04 -0.04	+0.08 -0.07
ATLAS (expected)		+0.14 -0.13	+0.10 -0.10	+0.06 -0.05	+0.04 -0.04	+0.07 -0.06
CMS (measured)	0.97	+0.14 -0.13	+0.09 -0.09	+0.05 -0.05	+0.04 -0.03	+0.07 -0.06
CMS (expected)		+0.14 -0.13	+0.09 -0.09	+0.05 -0.05	+0.04 -0.03	+0.08 -0.06

From Stefan's talk yesterday

TH signal systematics (ongoing efforts):

- Need to update to N3LO
- Need to update to new PDF uncertainties
- Non-negligible α_s (at this point)
- pT(H) (present in most measurements)

TH bkg systematics:

- WW
- V+jets
- Top pair production

- This is for the overall mu only many more specific measurements are statistically limited
- Overall things are in pretty good shape (with latest updates) for precision for run 2 $\sim 150 \text{ fb}^{-1}$
- Going beyond in precision: no low hanging fruits.

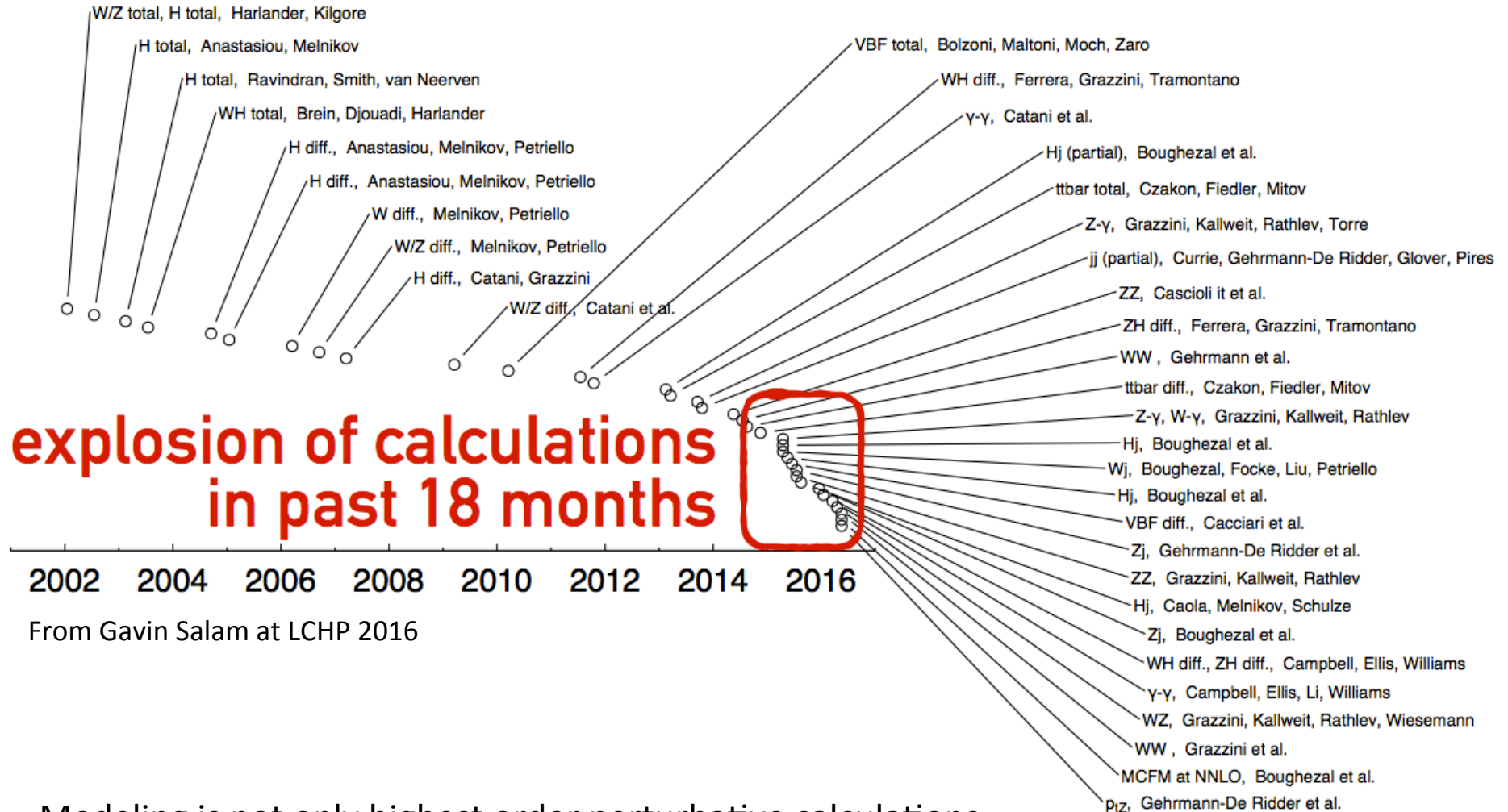
Where are our current limitations?

Short answer: modeling (of signal and background)

- ZZ:
 - TH (Normalization and pTH)
- $\gamma\gamma$:
 - TH (Normalization and pTH)
 - Background systematic uncertainties (parameterizations)
 - Energy resolution (ATLAS case)
- WW:
 - TH (Normalization, jet bins)
 - WW irreducible background
 - Top pair production
 - Jet Energy Scale
 - Fake backgrounds
- $\tau\tau$:
 - TH (Normalizations, pTH and jet bins)
 - VBF specific (tag and veto efficiencies)
 - VBF specific (UE and PS)
 - Embedding, TES...
- bb:
 - TH (pTH for the VH production)
 - V+jets modelling
 - tt modelling
 - B-tagging
- ttH:
 - TH (Normalization)
 - tt+HF (bb)
 - Fakes (ML)
 - Light-rejection (bb)

Other channels, $\mu\mu$, cc, etc...

The Year of NNLO and N³LO



- Modeling is not only highest order perturbative calculations...
- Improving our signal and background MC modeling is also crucial
- Experimental input also very important.

Points for Discussion

Measurements

- Improved fiducial definitions (not necessarily for the a given analysis sensitivity but also to probe and improve modeling)
- Propose more exclusive measurements (on and off shell)?
e.g. Fabrizio this morning: boosted Higgs in bb?
- New observables (on and off shell)
- Differential cross sections.
e.g. from Veronica's talk.
- Common ATLAS and CMS fiducial (and XS bins) definitions
- Propose relevant ratios (channels, COM energy, etc...)
- Standard model processes to measure in specific phase space regions to improve modeling.
- Profiling paradigm: should all NPs be profiled?

Keep interacting effectively:

- Wish list from EXP for predictions
- Wish list from TH for measurements
- Communicate efficiently: HEPdata and rivet routines

Points for Discussion

Sample questions:

- Which ratios are interesting (Michael)? Ratios to standard processes?
- Fiducial: Gino on 4l fiducial definition, Veronica on the use of MVAs precluding fiducial definitions
- Missing uncertainties: to account for non factorization? To account for possible non standard couplings? How to estimate UE and PS uncertainties accurately?
- MC: which MC to choose for the signal? For the backgrounds? Full NNLO MC?
- ...

What should we measure?

- Wilson coef., POs, Template XS, simply fiducial/differential
- Which WCs are measureable?
- Do we have the tools to measure WCs and POs?
- Which choice is most sensitive to NP?

Discussion (I)

General discussion on fiducial and differential cross sections and how to minimize sensitivity to TH systematic uncertainties.

- **Gino Isidori**: emphasized the the importance of well defined fiducial volumes, concerted possibly among experiments for useful comparison with theory prediction. Gino pointed out the importance of having fiducial volumes closer to the reconstruction level selections in order to minimize the effect of the variation of the efficiencies with different models.
- **Veronica Sanz**: pointed out the importance of simple fiducial regions and the problem of defining them when MVA analyses are involved.
- **Giacinto Piacquadio**: also pointed out that model dependence could sneak in also through the background estimates (not only efficiency variations).
- **MK²** : For the time being no significant deviations are seen so the focus can still be on the reducing efficiency variations a priori. Then if specific models predict variations in the background estimates through e.g. control regions, then sufficient input on the background estimates should be provided (or a model dependent analysis should be done).
- **Frank Krauss**: emphasized the importance of HEP Data which is currently not sufficiently widely used in particular in search analyses.

Discussion (II)

- **Gianpiero Passarino:** Should uncertainties related to the narrow width approximation or the missing parameterization of modifiers framework accounting for higher order corrections be included? Problem is the model dependence of these variations cannot be done in a general way.
- **Michael Peskin:** In the measurement of the ratios of cross sections and the ratios of branching ratios, these observables minimize the dependence on the TH systematic uncertainty. It was hoped that from these observables all other coupling modifiers could be retrieved but it has been found to be non straightforward. These measurements are done from a combination of channels and where not specific measurements of ratios of fiducial cross sections aimed explicitly at minimizing specific systematic uncertainties.
- **Su Dong:** Emphasized the importance of thinking of specific fiducial cross section ratios specifically aimed at more precise measurements that minimize sensitivity to theory or modeling systematic uncertainties.
- **Reisaburo Tanaka:** noted the importance of further improving TH predictions and the timescale of these predictions, emphasizing the slightly longer timescale for publications with the full Run 2 dataset (150 fb^{-1}).

Discussion (III)

General discussion on what to measure: Wilson coefficients from EFTs, Pseudo Observables, Simplified template cross sections, fiducial cross sections?

- **Giampiero Passarino:** Which Wilson coefficients can be measured?
- **Gino Isidori:** Parameters of the Lagrangian are in general not measured strongly advocating defining Pseudo Observables. Gino gave the example of the kappa framework as being a good set of pseudo observables.
- **Chris Hays and MK²:** Will in any case measure all of the above, as has already been done, as a proper measurement of the Wilson coefficients should require a complete machinery including all correlations of e.g. systematic uncertainties in differential distributions. Measurements in SILH have already been done using the di-photon channel.
- **Gianpiero Passarino:** pragmatically what are the available tools to perform measurements of Wilson coefficients?

The question of the choice of basis for the EFT approach was not discussed. There was no time to further discuss this question which is also at the center of the LHC Higgs cross section working group. Certainly a question for further debates.