Folks,

The one big piece of negative feedback that we got from the Seattle meeting was that almost no one was happy with the table of Higgs coupling accuracies shown by the Higgs group. This table did not reflect the current status of the Higgs group's very substantial work. It was basically a compilation of numbers that the group had collected from the advocates of various facilities. The level of analysis that had gone into the estimates and the methodology used to produce the numbers was very non-uniform. Nevertheless, it is an example of what we do not want to do at Snowmass. Many people, advocating for a wide range of machines, told me that the table of projected Higgs coupling accuracies will be a key output of Snowmass. We need to think carefully about how this should be done.

I would like to make a proposal for the presentation of Higgs couplings in the Snowmass Higgs group report. I think that it is reasonable to put this on the table for discussion:

1. For each of the major machines under consideration, we should report numbers that, in our judgement, represent expectations for the fraction errors on potentially observable quantities: signal strengths for reactions, e.g., $gg \to h \to \gamma\gamma$, cross sections where these are actually directly measureable, e.g. $\sigma(e^+e^- \to Zh)$ observed using Z recoil, and ratios of branching ratios, e.g. $BR(h \to \gamma\gamma)/BR(h \to ZZ^*)$. A list of numbers should be presented for which it is reasonable to *ignore correlations*. Then it is possible to use this list of numbers to perform fits to the various couplings, allowing comparison of different machine options, and to perform fits to new physics models.
2. These numbers should then be passed through a 9-parameter fit similar to the one used in my paper on Higgs couplings arXiv:1207.2516, so that Higgs coupling accuracies can be generated for a table with a uniform methodology.

I would now like to discuss these items in turn:

Item #1 :

The biggest problem here is that the two LHC collaborations have taken different approaches to these numbers. ATLAS has given public estimates, but they are conservative, especially for 3000 fb^{-1}. Some estimates – in particular, those for the very important observables with $h \to b\bar{b}$ – are not included. CMS has not presented its input numbers, only the result of a 6-parameter fit done by Markus Klute. There are two sets of output numbers, one more conservative (though less so than ATLAS, also reflecting the fact that CMS is ahead (at least in public) on $h \to \tau\tau$ and $h \to b\bar{b}$.

After some discussion with Jianming and Eric Feng last weekend about the public ATLAS estimates, I wrote Table 1, which is probably not yet completely correct but at least is not stupid. The measurements in the table can be considered as approximately uncorrelated for Snowmass purposes. My proposal is to adjust the numbers in the Scenario 2 column to bring the 6-parameter fit done by Markus into rough agreement with his values. I apologize that I have not completed that yet.

For ILC, the measurement accuracies on input values are given in the ILC TDR. (The reason that these numbers are given is that I insisted on it.) The ILC proponents will describe a more optimistic scenario with higher luminosity, their version of Scenario 2. I would like to see us present both sets of numbers.

For CLIC, I believe there is a parallel set of numbers available, though I do not have it in hand.

For TLEP, I collected these numbers with the help of Blondel and Janot and presented them (as of January) in my presentation to the Princeton Higgs workshop.

For Muon Collider, most of the relevant input values are given in their white paper.

So I think it is possible to collect information that could reasonably be put in a summary table.

Item #2:

I think it is important that all number in our final Higgs summary table be produced with a uniform methodology. I also think it is important that they allow the widest freedom in the fit, since there are theoretical models that tweak each individual Higgs coupling. Also, for most colliders, the fact that we cannot directly measure the Higgs width is a limitation that must be overcome through a wide suite of accurate measurements. My proposal satisfies these requirements.

Thanks for listening.

Michael

July 11, 2013

Observable	300	3000	3000-Scenario 2
$\sigma(gg) \cdot BR(\gamma\gamma)$	$0.07 \oplus 0.12$	$0.04 \oplus 0.12$	$0.02 \oplus 0.06$
$\sigma(WW) \cdot BR(\gamma\gamma)$	$0.31 \oplus 0.11$	$0.11 \oplus 0.11$	$0.10 \oplus 0.06$
$BR(\gamma\gamma)/BR(ZZ)$	0.10	0.03	0.03
$\sigma(gg) \cdot BR(WW)$	$0.25 \oplus 0.13$	$0.25 \oplus 0.13$	$0.08 \oplus 0.07$
$\sigma(WW) \cdot BR(WW)$	$0.66 \oplus 0.11$	$0.57 \oplus 0.11$	$0.21 \oplus 0.06$
$\sigma(Wh) \cdot BR(\gamma\gamma)$	$0.67 \oplus 0.10$	$0.26 \oplus 0.10$	$0.21 \oplus 0.05$
$\sigma(gg) \cdot BR(\tau^+\tau^-)$	$0.11 \oplus 0.13$	$0.10 \oplus 0.13$	$0.03 \oplus 0.07$
$\sigma(WW) \cdot BR(\tau^+\tau^-)$	$0.15 \oplus 0.10$	$0.13 \oplus 0.11$	$0.05 \oplus 0.05$
$\sigma(Wh) \cdot BR(b\bar{b})$	$0.18 \oplus 0.14$	$0.15 \oplus 0.14$	$0.06 \oplus 0.05$
$\sigma(t\bar{t}h) \cdot BR(\gamma\gamma)$	$0.54 \oplus 0.10$	$0.18 \oplus 0.09$	$0.17 \oplus 0.05$
$\sigma(gg) \cdot BR(\mu\mu)$	$0.50 \oplus 0.14$	$0.17 \oplus 0.12$	$0.16 \oplus 0.07$
$\sigma(t\bar{t}h) \cdot BR(b\bar{b})$	$0.25 \oplus 0.20$	$0.20 \oplus 0.20$	$0.08 \oplus 0.10$
$\sigma(WW) \cdot BR(invis)$	$0.20 \oplus 0.24$	$0.18 \oplus 0.24$	$0.06 \oplus 0.12$

Table 1: Suggested set of LHC input data for Snowmass fitting. The errors in this table are supposed to be taken as uncorrelated. The listed contributions are experimental plus theoretical error in extracting the values, to be added in quadrature.