Marumi Kado – Lecture 1 Questions

Questions marked in green were answered during the Q&A session. Original questions listed without correction for grammar/spelling. Where a slide number was given it is shown.

Q1 (slide 8): What does condensate mean here?

Q2 (slide 10): Is the Higgs decay width the leading order value or does it include NLO EW correction? Also the BRs in the plot.

Q3 (slide 28): For a high-pT b-jet coming from a heavy BSM Higgs, what b-tagging efficiency can we expect at the LHC?

Q4 (slide 36): Could you explain what is going on in the dsigma_fid/d(costheta*) plot on the right? How do we interpret it?

Of course! This went a bit fast, sorry! To explain the interpretation of the plot on the right you should first look at the plot on the left. This plot shows how different the cos theta* distribution looks like for different spin hypotheses of the observed boson. What this plot shows you is the relative difference that you can expect in different parts of the differential distribution between the hypotheses. Now looking at the right plot, you still see the spin 0 hypothesis prediction (from the program HRes including a small part from VBF, VH and ttH production) and on top of it the data! Now this is what is used to discriminate between the two hypotheses.

Q5 (H->4l): Why do the gg->ZZ and Z+X backgrounds not also have a peak at the W mass?

To have a peak at the W mass would require that the neutrino be "seen" as one of the leptons. In this case four leptons are reconstructed so the W which would produce one visible charged lepton will not produce a peak. The peak you see at the Z mass is due to the decay of the Z boson to four leptons which you can picture as a Z boson with the emission of an off shell photon yielding two additional leptons.

Q5 (slide 40): Is s/b ~ 30 for this single event, or for all the events in the 4 muon channel?

This is a very approximate estimate is for events in the ttH category of the 4-lepton channel, not all 4 muon events. The s/b will depend on how strongly requirements to select ttH are imposed. A higher s/b is achievable but it will be at the cost of a lower statistics!

Q6 (slide 46): What does "t" stand for in pT,t on the plot?

Good question and this should have been explained in the slide! It is the transverse momentum with respect to the thrust axis defined as:

$t = (\vec{p}T_{\gamma 1} - \vec{p}T_{\gamma 2})/|\vec{p}T_{\gamma 1} - \vec{p}T_{\gamma 2}|$

For more details see:
https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PAPERS/HIGG-2013-08/

Q7: How do you decide where to make the cuts for the STXS method?

Q8: What have we learned so far from the STXS measurements?

STXS measurements in first approximation are differential measurements with a pinch of interpretation, as several processes at the truth level are considered in the fit. What these show is that even when stretching the reach of measurements in regions of phase space where measurements could be sensitive to physics beyond the Standard Model, no significant deviation is seen!

Q9 (slide 49): Does STXS provide more information/insights than analysing all the events without any categorisation?

Yes it surely does! It is essentially a differential measurement (with a subtle difference w.r.t. to a fully fiducial differential measurement). STXS explore the production of the Higgs boson in very different regions of phase space, some which could be sensitive to physics beyond the Standard Model. Also an important point of STXS is that these can be easily interpreted in terms of Standard Model effective field theory.

Q10 (slide 54): What's the difference between unfolding variable measurement verses using the STXS categories?

Very good and subtle point! It can be argued that fitting STXSs is effectively an unfolding. The difference mostly is in the definition of the fiducial volume. In a fully fiducial cross section measurement, the goal is to have measurements that are as much as possible independent of the production processes. This requires that the efficiency in the fiducial volume be roughly the same for any production process (not an easy thing).
This is one fundamental difference between fiducial and STXS fits, as in the STXS fit several cross sections will be measured simultaneously in a given phase space which will result in some degree of correlation/degeneracy that relies on your TH prediction (all this will be in the correlation matrix but not necessarily trivial to disentangle). The goal of the traditional unfolding and fully fiducial cross section is that it focuses on the experimental effects only.

Q11: Could you please clarify in basic terms what pile-up means and what leads to pile-up? Thank you.