Questions and answers - Josh Bendavid Lecture 1

The following questions were submitted through Google Form. Some / all may have been answered in the Q&A session already. Nevertheless, we request our lecturers to provide written answers here for the benefit of those who could not attend that session. Thank you!

Page 14. You mentioned that light loss can be as much as 98%. Does it plateau out at this value or can it get worse if you run longer before an opportunity for recovering? It also looks like the recovery is not back to full performance. Some recover to ~20%. Is this an issue before the calorimeter can be replaced?

It can get worse as running continues, and some of the damage is permanent, ie no recovery even with an indefinite period of zero/low radiation exposure. The transparency loss does lead to a performance degradation for electrons/photons/jets/missing energy since the mitigation is to multiply by 1/transparency in software, which also increases the noise and necessitates a correspond increase in hit and cluster thresholds. Nevertheless the degradation is expected to be tolerable up to the end of Run 3 (after which the full endcap, ie everything with |eta|>1.5 will be replaced)

Slide 17. Just out of curiosity, what made the displacement of the beam pipe? And, did it make any impact on the experiment?

The displacement of the beam-pipe with respect to the pixel detector was actually caused by an imprecise mechanical placement of the pixel detector during its initial installation. The impact on the experiment was minimal, but the procedure/precision for placement of the pixel detector was improved for Run 2. As the luminosity increases the centering of the pixel detector with respect to the beam becomes more important in order to avoid issues with uneven radiation dose as a function of phi.

Page 20 and following on tag and probe. Do we look for efficiencies, corrections etc, separately for pi+ and pi-? After all, the detector may be not fully symmetric to charge. If so, what is the level of efficiency difference between + and - particles?

Yes efficiencies are checked and if necessary measured separately for positive and negative charged electrons and muons. The main source of differences in this respect are alignment effects (related to the direction of curvature in the magnetic field) rather than the small differences in interactions with the material (due to the fact that the detector is made of matter rather than anti-matter). Efficiencies can vary up to the percent level in some particular cases and this difference and the associated systematic uncertainties are of particular importance for charge asymmetry measurements where the overall efficiency cancels out.

Slide 33. could you explain what the bottom left plot represents in simple terms?

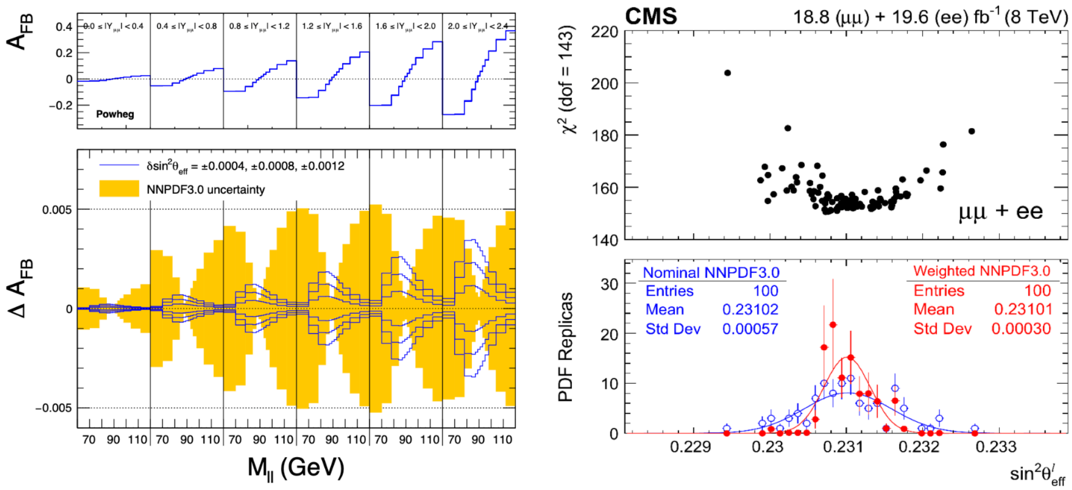
This plot is an “unrolled” plot, where the top panel shows the two dimensional dependence of the forward-backward asymmetry AFB as a function of dilepton mass and (absolute) rapidity. Each sub-region shows the dilepton mass distribution within one bin of dilepton rapidity. The bottom panel shows the relative sensitivity of each bin in this two-dimensional space to variations of the weak mixing angle (blue lines) and of the parton distribution functions (ie the distribution of the momenta of quarks and gluons inside the proton).

Slide not specified. How do you measure or determine the (reconstruction?) efficiency when it comes to jets? I.e. how do you get uncertainties on the energy etc?

Since jets are a collection of a number of different particles, the probability of missing or not reconstructing the jet entirely is usually very small, and the most relevant question is the calibration of the jet energy and its uncertainties. The jet energy scale is typically calibrated in data using a combination of momentum “balancing” in di-jet, photon+jet and Z+jet events. Hadronic W decays in ttbar events may also be used to improve the calibration. Aside from statistical uncertainties from the calibration samples, systematic uncertainties may be assessed related to e.g. differences in response between jets originating from different quark flavours, different hadronization models in the Monte Carlo, etc.

In-situ PDF constraints: Weak Mixing Angle Case

- CMS and ATLAS weak mixing angle measurements exploit in-situ constraints to reduce PDF uncertainties with Bayesian reweighting of Monte Carlo replicas/profiling of nuisance parameters associated with Hessian representation (numerically equivalent in the Gaussian limit)



Eur. Phys. J. C (2018) 78: 701 (CMS)

Slide 34. When you profile the pdfs in the weak mixing angle measurement, how much are they allowed to vary? Have you tried other ranges and what was the result?

In this particular case the PDFs are allowed to vary within their “prefit” uncertainty, ie within the uncertainty which has been provided as part of the PDF fit itself. Other ranges have been tested e.g. in the context of the updated ATLAS mW measurement (see slide 7 of part 2 of the lecture slides)