Readiness Review Questions for E906 11 February 2012

1. Can you please explain in a bit more detail your definition of duty factor and how you arrived at the requirement that it be >50% (with a goal of 80%)?

The duty factor is simply the <I>^2/<I^2> averaged over all RF buckets in a spill. We understand that because of injection and abort gaps in the accelerator bucket trains, 86% is the maximum duty factor is possible. The limits on the duty factor arise from two concerns: 1) random coincidences of single tracks fulfilling the trigger requirements on the 19 ns time scale and 2) random coincidences of tracks reducing the efficiency of track finding on the 200 ns time scale. The random coincidence rates increase as the instantaneous (bucket-by-bucket) luminosity squared. This implies that a 50% duty factor will produce 4 times more random events than a perfectly smooth extraction. By the simplest estimate of singles versus coincidence rates in our fast scintillators, the average duty factor in our better runs in 2012 was about 1%. Ideally, we would have measured the singles rate and the random coincidence rates in the commissioning run to test our Monte Carlo estimates based, primarily, on pion decays. We were never able to achieve sufficient quality beam to satisfactorily accomplish this in the commissioning run. However, the scalar rates in the scintillators agreed with our simulations to better than factors of 2. Based on background rate estimates done for our proposal, we expect approximately 100 random coincidences from pion decays for every real event with a perfect duty factor at 1013 protons per spill with a weak trigger cut on track transverse momentum. This would increase to 1 in 400 with a 50% duty factor (~400 events per second) and our data acquisition system was designed to easily handle this (100 microsecond dead time per event). We can increase the track transverse momentum cut in our trigger to reduce this farther with a trade-off in reducing acceptance for Drell-Yan events. With significantly lower duty factors, this will contribute substantially to the DAQ dead time and event complexity.

Another way to look at this is to consider the experience of the E866/NuSea experiment. The duty factor figure of better than 50% with a goal of 80% was based on the spill cuts that were made in the E866/NuSea experiment. A quick review of E866 kumac files and theses, these cuts varied between 25% and 50%. (The majority of the data had greater than 80% duty factor.) This cut depended on a variety of factors including the luminosity during the run. In SeaQuest, with the factor of 10 increase in proton beam intensity to a requested 2 x 1012 protons/s for a 5 second spill, the random rate was managed by shortening the target to dump distance and other optimizations. Our estimate, admittedly crude, based on studies was that the signal to noise rate would be comparable to E866 with similar duty factors.

Because the hit rate in the wire chambers increases as one moves horizontally away from the beam direction, the rate issues are worse with the new Station 1 drift chamber, which is larger in x compared to the old one. For the track finding, higher rates are mitigated by the smaller cell size and drift time in the new Station1 but the pattern recognition combinatorics will be worse due to the higher random rates.

1. Can you summarize your run plan for commissioning the detector once beam is available?  If there are beam intensity requirements (either upper or lower limits), please specify.  Do you have the necessary effort to complete this plan?  If not, what are your areas of need (in prioritized list) and what skill set is required (e.g. physicist, engineer, technician, student, pdoc, etc.

Beam Requirements: Initial beam tuning will be done with the lowest intensity possible simply to reduce activation in the target area, usually with single turn injection in the booster batch and one booster batch in the main injector. The AD requirement not to change the intensity of the linac injector for slow spill operation does set a lower limit on the RF bucket instantaneous luminosity that can be delivered to us when the test beam is running (~4.5 x1010/s). Once the beam is tuned we would like to commission with single turn injection in the booster and the combination of booster batches and bunches in the booster to fill the main injector as much as possible to get the maximum instantaneous duty factor. This should be about 2 x 1012 protons per spill. In the last run we saw clear variations in the beam intensity corresponding to different booster batches. To test for rate effects we will request occasional runs when the test beam is not in use that change the split to put a larger fraction of the beam on the test beam dump. We expect to commission the apparatus at this rate and then increase the turns of booster injection to the highest rate the trigger can handle up to 1 x 1013 protons per spill.

We presented our commissioning plan in the presentation. We are confident we have the necessary effort to complete this plan. We will need a few days of rigging support to install the new station 1 when it is completed.

1. Can you quantify the number of POT you need in order to produce your first publication?  How many to reach your target sensitivity?

The experiment requested a total of 5.2 x 1018 protons on target to reach our final sensitivity for both the hydrogen-deuterium and nuclear target measurements. The collaboration’s goal for first publication is to make a significant improvement over the E866/NuSea results for hydrogen-deuterium and the E772 results for nuclear targets. Depending on how one chooses to quantify “significant improvement,” this goal could be reached with between 0.3 x 1018 and 0.5 x 1018 protons on target (5-10% of final goal). The collaboration has a desire analyze these data quickly, to provide thesis data for a number of senior graduate students.