1 Analysis meeting summary, January 9th 2014

1.1 Present

V. Blackmore, D. Speirs, R. Bayes, A. Dobbs, J. Nugent, E. Santos, I. Taylor, C. Pidcott, M. Uchida, P. Hanlet, J. Cobb

Apologies from: A. Blondel, D. Orestano

1.2 Agenda Items

- Step IV.0 Preparation
  - Step IV.0 beam→MAUS (Nugent)
- Pion contamination in Step I (Orestano, c/o Nugent)
- Step V vs Step VI analysis plan (Speirs)
- AOB (All)
- Date of next meeting, January 23rd 2014, 3pm GMT

Tracker alignment effort, Step IV beam optimisation, and EMR analysis to be presented at next meeting.

1.3 Step IV.0 beam→MAUS (Nugent)

- MAUS code is approaching completion, and final checks are being made to ensure that MAUS can build G4BL properly.
- Finishing this segment by the end of January is still realistic, though depends on talking to D. Rajaram about a code review and integration into the MAUS trunk.
- When completed it will be the first step of a G4BL beam resource/library for future MAUS simulations .

1.4 Pion contamination in Step I (Orestano c/o Nugent, slides)

- J. Nugent was approached for G4BL simulations of the calibration beams used as part of the PID paper. These simulations are currently being worked through by D. Orestano.
- Data used in the PID paper was taken with the Decay Solenoid (DS) turned on and off (not by choice). The question arose as to whether template distributions with the DS "on" are applicable to data taken with the DS off.

- Slide 2 shows a series of plots from a simulation of run 3250 with the DS on (in red) and off (in black). The plots are (top) time-of-flight, (middle) y-position of a particle at the KL, and (bottom) x-position of a particle at the KL. The left plots are for muons, and the right for pions.

- There is a difference in position and time-of-flight of particles with the DS on and off.

- Slide 3: The template method relies only on the *energy* deposited in the KL, and the plots on this slide show no difference between the simulations with and without the DS.

- The conclusion is that it is OK to use the templates for identifying muon and pion distributions regardless of the state of the DS.

1.5 Step V vs. Step VI analysis plans (Speirs)

- Has built MAUS on the Strathclyde systems and all seems fine. The initial tests are working, and D. Speirs is working through the user manual

- Current understanding of the "Step V vs. Step VI" question relates to the Partial Return Yoke (PRY) fabrication. A choice will need to be made between Step V and Step VI, as both seems unlikely given the time needed to modify the PRY.

- Some of the difficulties of running Step V may be compounded by Step VI, e.g. the stochastic momentum loss and straggling within the absorbers introducing an uncertainty on the arrival time of the muons at the RF.

- Another question revolves around determining the TOF detector's scintillation response time, and whether or not this is a constant delay offset. Speirs has looked at some data sheets but found no information about a response time, recovery times were listed as around 1–2 ns.

- Question from V. Blackmore to I. Taylor: Does our knowledge of when a particle should arrive in the downstream section of the cooling channel affect the PID? In other words, is there a chance of mis-matching muons based on timing? Does it need any consideration as part of this study?

  - No, the chance of a mix-up between muons is extremely low. There will be an upstream PID, a downstream PID, and a combined PID using both upstream and downstream (that probably

won't be used for most analyses). Upstream PID uses the upstream tracker momentum, etc. PID will have to use information from the TOFs, but does not care about it for matching up arrival times between the upstream and downstream PID. The goal of the PID is that a change in momentum or direction of a particle (e.g. scattering) does not affect the eventual identification. A change in particle species should be observable, though.

- J. Cobb points out that we are measuring the efficiency of a black box, and that the upstream and downstream measurements are independent. The timing in the cavities is an interesting question, and we need to consider how well we can predict the time-of-arrival of a particle at the RF with realistic momentum errors.

  - J. Cobb also doesn't expect a difference in the (above) momentum/timing error between Steps V and VI as long as the RF phase is correct. A muon loses an "average" amount of energy in each absorber, ignoring the fact that the distributions have long tails, so the amount of energy will fluctuate by a few MeV. A muon entering with an *energy* of 240 MeV may exit with an energy of 230 MeV$\pm$2 MeV. If you extrapolate from the absorber to the cavity, the difference the $\pm$2 MeV maes to the arrival time is fairly small. Muons occupying the long tails of the distribution will lose a lot of energy and will be lost to us anyway.
  - The question for MICE is: How well can we get the phase of the muon at the first cavity.

- D. Speirs initial plan is to get to grips with MAUS by replicating some work by T. Carlisle. Cobb points out that Carlisle wasn't considering the RF in that simulation. When asked about alternatives, suggested work done by M. Rayner/V. Blackmore on simulating sections of the measured Step I beam through the Step IV/VI cooling channel (a possibility).

- Alternative suggestion by J. Cobb: Take a muon from a simulated beam upstream of TOF1 and figure out, using tracker reconstruction, how well its time can be predicted to the first cavity. Mostly an exercise in reconstruction errors.

  - A. Dobbs comments on track reconstruction in software: Ed (Santos?) has done a study where he measured the spread they get from the reconstruction and found it to be comfortably within the requirements for measuring cooling to 1%. MAUS contains the software needed to reconstruct tracks from MC.

  - J. Cobb wants to be able to run the MC on some set of tracks, reconstruct them, then find out how well the tracks were reconstructed by comparison with the truth.
  - A. Dobbs says that that the code needed to match up a MC truth and reconstructed track is in progress (but not in the latest version of MAUS), but it is difficult to do – you can't assign an ID to a MC event and carry that over to the tracker reconstruction, the reconstruction was designed to not rely on artificial IDs.

- The CAD-level geometry for Step V and VI is not in the Configuration Database. If detailed geometries are needed, R. Bayes should be informed and the process can get started.

- Legacy geometry files do exist in MAUS, and Speirs should use these to get started. It's unlikely that the CAD-level detailed geometries will add much to the questions that need answering first.

1.6 AOB (All)

- J. Nugent has uploaded three new beams from G4BL that use an elevated upstream section (i.e. around Q123→DS) using information from H. Nebrensky. These files have been uploaded to `ppewww.ph.gla.ac.uk/~jnugent/G4BL`

- V. Blackmore and J. Nugent to compare with non-elevated simulations and Step I beams. V. Blackmore to pass on Step I analysis code to J. Nugent before next meeting.

1.7 Date of next meeting

Next meeting: Thursday, 23rd January 2014 at 3pm GMT.