1 Analysis meeting summary, January 23rd 2014

1.1 Present

V. Blackmore, C. Heidt, E. Santos, D. Rajaram, S. Ricciardi, J. Nugent, C. Pidcott, P. Hanlet, A. Dobbs, D. Orestano, C. Rogers, P. Soler, R. Bayes, M. Uchida

Apologies from: A. Blondel, J. Cobb, D. Speirs

1.2 Agenda Items

- Step I Wrap-up
  - Pion contamination in Step I (Orestano)
  - Elevated beam line G4BL comparisons (Nugent/Blackmore)
- Step IV.0 Preparation
  - Step IV.0 beam optimisation (Leonova/Pasternak)
  - Step IV.0 beam→MAUS (Nugent)
- Step IV
  - Reduced focus coil current study (Hanlet/Lagrange/Blackmore)
  - Step IV emittance study (Santos)
- AOB (All)
  - Updated MAUS documentation including tracker reconstruction
  - KL digitisation in MAUS for Monte Carlo
  - Parallel analysis session agenda for CM38
- Date of next meeting, February 6th 2014, 3pm GMT

Tracker alignment effort, Step V/VI analysis, and EMR analysis to be presented at next meeting.

1.3 Pion contamination in Step I (Orestano)

- An Editorial Board meeting took place on Wednesday 22nd January to discuss the issues affecting the analysis and how best to proceed towards publication.

  - Need to ensure that we can prove there is nothing wrong with the method we are applying. We will prove that by applying it to the Monte Carlo, initially with some smearing but ultimately with a full MAUS reconstruction. Try to reproduce what we have in the data, and show that the method can extract the pion contamination from the Monte Carlo.
  - Aim to have something to present at the Collaboration Meeting (CM38).

- Orestano has given the macro for generating profiles to Nugent. Nugent will generate Monte Carlo with G4Beamline and use the macro to create profiles. Then will do a side-by-side comparison between data and Monte Carlo. Nugent hopes to make some progress in using the macro before the next analysis meeting.

- Pidcott is looking for analysis tasks, and is willing to assist if helpful.

1.4 Elevated beam line G4BL comparisons (Nugent/Blackmore)

- Blackmore has not looked at Nugent's G4Beamline files yet (available at `ppewww.ph.gla.ac.uk/~jnugent/G4BL`), nor passed on analysis code to Nugent.

- Blackmore to do this before next meeting.

- Nugent encouraged to link to G4Beamline simulation results from the Analysis wiki, adding an entry on the main page (`http://micewww.pp.rl.ac.uk/projects/analysis/wiki`) with a brief description of the beams. This is a temporary solution until G4Beamline→MAUS "beam library" (see below) is online.

- Other analysis users are encouraged to look at these beam simulations.

1.5 Step IV.0 beam optimisation (Leonova)

- Trying to get a 60 cm diameter beam at the EMR location, for the Step IV.0 (no solenoid field) configuration using G4Beamline in Trace3D. However, both programs are producing errors and strange results.

- Leonova is currently using a G4Beamline version ("deck") last used by Ole Hanson. Nugent has since made improvements to the G4Beamline deck, and Leonova would like to see if that solves the errors. Nugent and Leonova to talk about this.

- Leonova has tried to run G4Beamline using settings used during the October EMR run (e.g. these) with low statistics, needs to try with higher statistics.

- Blackmore: Is there a central G4Beamline copy that everyone can use?
  - Nugent: No, but the G4Beamline→MAUS interface will be agreed on by everyone using G4Beamline (version controlled along with MAUS)
  - Nugent to put his G4BL deck on his launchpad G4BL branch
- Noted that Jaroslaw Pasternak is a good source of advice regarding the MICE upstream beam line and the cooling section (as Accelerator Integration Scientist)
- Advice is sought from an experienced G4Beamline user: **The "profile" command is the source of the errors**. Leonova thinks she can solve it (solutions should be sent to Leonova).
- Nugent suggests that if the problem is statistics and CPU power, he could offer a way to get larger samples/statistics done using the batch system at Glasgow or ScotGRID. Leonova could use the Fermilab supercomputer, but the learning curve for the middleware is steep. Nugent and Leonova to talk more on this.
- (Post-meeting) Cobb wonders if something like MAD-X or TURTLE might be more convenient to use in the early stages.

1.6 Step IV.0 beam→MAUS (Nugent)

- Work is underway to get the G4Beamline→MAUS code working on the MAUS test server at RAL. Rogers is helping Nugent to get it working. Once the code passes unit and build tests, it can be submitted for code review.
- Nugent intends to be done in the next few days and hand over the code for review before the next meeting.
- Rajaram states that once the code has passed the test server, he is happy to help with the code review and get it into MAUS after that point.

1.7 Reduced focus coil current study (Hanlet/Lagrange/ Blackmore

- Hanlet to join the analysis group mailing list
- Hanlet to talk to Ricciardi about the best Step IV geometry to use in MAUS

- Blackmore is repeating Rogers previous work with independent optics code, but that is still ongoing. Will then liase with Hanlet regarding Step IV geometry outcome.

1.8 Step IV emittance study (Santos, slides)

- Slide 2: Santos is liasing with Blackmore on a Step IV emittance study, including intermediate measurements with different configurations. The analysis uses only the tracker reconstruction. The resolution of the tracker has improved since MICE Note 90 and was presented at a previous analysis meeting.

- Slide 3: The resolution is better than a few percent for a wide range of momenta, and the situation as described in MICE Note 90 is worse than the current-day tracker.

- Slide 5: These slides just look at the "Step IV.0" configuration, which is Step IV without solenoid fields. In this scenario, the tracker can only measure the slopes of the straight tracks. If we want to look at P_x or P_y then we need to get P_z from the TOFs.

- Slide 6: A diagram with the quantities we want to look at. The tracker (green) and cooling channel (blue) are assumed to be aligned, and a straight track is shown corresponding to a muon traversing everything in the absence of a magnetic field. With this setup, we can look at multiple scattering by defining the angles before and after the cooling channel and we can also look at transmission.

- We look at multiple scattering as a function of the incident angle. If we histogram the scattered angles ($\Delta\theta_x$) then we will get a distribution whose mean we expect to be zero. Multiple scattering will have an impact on the width of this distribution (the Highland formula is used to predict this). Reconstruction effects may give a non-zero mean (which must be looked at), but the most interesting quantity is in the spread in the difference of angles.

- Slide 7/8: These are preliminary plots. The idea was to look at the different range of absorbers, in particular in these plots are lithium hydride and liquid hydrogen with the "no absorber" used as a benchmark. Slide 7 is what the tracker could measure (reconstructed tracks) and slide 8 compares the MC truth on the horizontal axis. The Highland formula says we expect the rms of the scattering angle to decrease as momentum increases, which is more-or-less what we see.

- Blackmore: Does the simulation include the absorber windows **and** the helium windows?

  - Santos: It does include the absorber windows, but would need to check the geometry file to see if the helium windows are included.
  - Ricciardi notes that the absorber geometry description is/has been updated by P. Snopok and is now quite different from what was included in the "legacy" MAUS geometries (i.e. those from G4MICE). R. Bayes is currently reviewing it, and the Step IV geometry will be released in one step rather than tiny pieces. Since the absorber geometry is so different, Santos may find himself having to re-run this analysis and compare.
  - Santos is not currently worried about the geometry being exactly correct. This is just a first look at the sort of analysis involved.

- Soler comments on the bump at around 200 MeV/c. Santos expects it to be an error, it shouldn't be there.

- Slide 9: The next step is to get the multiple scattering analysis polished and completed, though still needs to look at y. The tracker resolutions are different in x and y (slightly better in x). Then look at transmission, then turn on the solenoid fields and look at the change in emittance in Step IV.

- Blackmore asks if Uchida would find these simulations useful for the tracker alignment analysis, i.e. for seeing how much multiple scattering in the helium/absorber windows will affect the alignment.
  - Uchida says that the alignment analysis will be done as part of the tracker group, and since Santos is in the tracker group he is implicitely involved already. They'll look to see if there's any offset when you track from one tracker to the other.

- Rogers: The main problem when doing this multiple scattering study in no field is actually going to be the width of the detector. Does Santos look at the sensitivity to wide-angle scatters, say, compared to muScat?
  - Santos: The plots shown on slide 7 have error bars that are affected by the resolution of the detector. High-angle scatters are lost.
  - We need to highlight the fact that we don't get (measurable) large angle scatters in Step IV.0. Perhaps the analysis could be combined with the "field on" measurement, which will provide a larger range of angles.

- Soler: Is there any value in using just the Focus Coil field and not the Spectrometer Solenoid fields?

- The idea behind the no-field analysis is that its easiest done with straight tracks. If we had the FC field on, but the SS fields off, we would get straight tracks in the tracker, then some deviation from that in the FC field and absorber (lengthening its path length by an unknown amount) and then straight tracks at the downstream tracker. We would have less information at the trackers to be able to extrapolate a particles path (and scattered angle) back to the absorber.

1.9 AOB (All)

- Dobbs is in the process of updating the MAUS documentation to include more information on the tracker and reconstructing tracks with it. He welcomes comments and questions.
- Soler asks if there is any KL digitisation yet in MAUS (re: pion contamination in Step I).
  - Bayes says that there is a legacy geometry module for the KL that has sensitive detector volumes in it.
  - Rajaram confirms that there is no digitisation for the KL that handles Monte Carlo hits, the only digitisation is for real data.
- Soler asks about the agenda for the Collaboration Meeting (CM38)
  - Blackmore has been asked to come up with ≈1.5 days of parallel analysis session. A draft agenda has been sent to K. Long, and Rogers, but it needs refining.
  - **In principle, everyone who talks at the analysis meeting has been scheduled a (long) talk during the parallel session.**
  - The final parallel session agenda needs to be discussed with Rogers and S. Boyd (must be compatible with computing and operations sessions). Waiting to see Boyds draft agenda.

1.10 Date of next meeting

Next meeting: **Thursday, 6th Februar 2014 at 3pm GMT**. This is the last meeting before the CM, so we need to assess what we are able to present.