1 Analysis meeting summary, March 13th 2014

1.1 Present

V. Blackmore, J. Nugent, D. Speirs, R. Bayes, A. Dobbs, J-B. Baptiste, C. Pidcott, S. Middleton, M. Leonova, D. Rajaram, J. Cobb, C. Hunt, P. Hanlet

Apologies from: D. Orestano, M. Uchida, C. Rogers, J. Pasternak

1.2 Agenda Items

- Step I Wrap-up
  - Pion contamination in Step I (Orestano)
- Step IV.0 Preparation
  - Tracker reconstruction (Dobbs)
  - PID: "The Celeste Effect" (Pidcott/Dobbs)
- Step IV Preparation
  - Reduced focus coil current study (Lagrange)
- Step V vs Step VI
  - "Criteria for a successful experiment at Step ..." (Blackmore)
  - Progress towards simulation of Step V and VI (Speirs)
- Polarisation in MICE (Middleton)
- AOB (All)
- Date of next meeting, March 27th 2014, 3pm GMT

1.3 List of actions

- **Nugent**: Show first impressions of MAUS+KL simulations, compared to G4BL, at next meeting.
- **Nugent**: Pass on number used for the angle of the upstream quadrupoles in the elevated G4BL simulations to Nebrensky.
- **Dobbs**: Flag poor Kalman fits for low-p_t particles – to be interpreted by global reconstruction
- **Dobbs**: Check particle flags in positron simulations to see if they're primary or secondary particles in the trackers.

- **Dobbs**: Make truth momentum histogram for all positrons that enter the trackers.

- **Dobbs**: Check if momentum reconstruction fails for *just* positrons at low p_t or if it does similarly for muons also.

- **Dobbs**: Check if analytical calculation of number of helical turns in the tracker field compares well with the reconstructed number of turns in the tracker field.

- **Lagrange**: Present plots and comparison between "perfect" and "reduced current" Step IV geometries for reconstructed tracks at the next meeting.

- **Blackmore**: Circulate operational table of Step V and VI for comments.

- **Nebrensky**: Find out the difference between polyethlene and the "borated plastic" used for the proton absorber, then pass this information on to Nugent for use in G4BL simulations.

1.4 Pion contamination in Step I (Orestano)

- KL digitisation code is now on bzr. Nugent has checked out code and started simulations with MAUS+KL digitisation.

- Aim for a first comparison of simulations at the next meeting.

1.5 Tracker reconstruction and the "Celeste Effect" (Dobbs/Pidcott)

- Following on from the CM, tracker reconstruction works well except for at low p_t. Dobbs is thinking about what can be done to make it better.

- "Celeste effect": A tracker recon anomaly seen by Pidcott at the CM, whereby some particles had a reconstructed momentum greater than expected from their time-of-flight between TOF0 and TOF1, causing a secondary "shadow" distribution (see Global PID talk at CM38). This was partially resolved for muon and pion studies, but still exists as a problem for positron simulations.

- Outputting the momenta of a scifi track point sometimes results in a case where the reconstruction gives a momenta up to the GeV level.

  - Dobbs says that its very clear that it's the low p_t particles causing the reconstruction severe difficulty. A good fraction of the fits don't look good and have poor Kalman fit values at low p_t.

- **Question**: Do we care about positrons? The pion and muon reconstruction seems fine, only positrons being struggled with. We don't want positrons to look like muons or pions, but that should be clear from looking at their time-of-flight.
  - The majority of the positrons don't get to tracker 2.
  - Cobb: Is there anything in the tracker reconstruction that knows about the mass of the particle? If not, it should work as well with positrons as pions and muons. What distribution is being simulated, and is it the same distribution in (p_x, p_y, p_z) for each species?
  - Pidcott: Distribution starts at TOF0 with no (p_x, p_y), but particles develop transverse momentum as they go down the channel.10 positrons per spill, final reconstructed momenta came from Kalman fits.
  - Positrons may be hitting something and showering – Event view has been attached to the agenda, but its unclear how particles are colour-coded.
  - Reconstructed spill picture shows that 5 of 10 positrons made it to tracker1, and only 1 of 10 made it to tracker 2 (which is typical). Red line is a straight line fit rather than a curved fit.
  - Can determine charge of positron from track – if showering is happening, it would generate equal numbers of positives and negatives. Dobbs to check particle flags to determine if tracks are due to primary or secondary particles.
  - Dobbs to make histogram of truth momenta of all positrons that enter the tracker.
  - Dobbs will flag poor Kalman fitted particles, so that we're warned about poor reconstruction.
  - Up to global reconstruction to tie together reconstructed tracks in the tracker with the time-of-flight from the TOFs.

- Track reconstruction is poor for low p_t particles, but is it as bad for muons as it seems to be for positrons (since the method has no dependency on mass, they should give equivalent results). Dobbs to check this.

- Can calculate the number of helical turns a particle will take in the tracker if we know its true momentum. Can compare this the reconstructed number of turns – Dobbs to check this.

- Nebrensky: Possible that we're just at the edge of what it's possible to do with the tracker. There's always going to be poor performance at low momenta, we need to understand what the limits are. Dobbs says that this is possible, the lower resolution of the tracker in p_t is 5 MeV – Dobbs to look at the spectrum of positrons to verify.

1.6 Reduced focus coil current study (Lagrange)

- C. Hunt working on the basics of a "perfect baseline" Step IV geometry simulation. Lagrange is checking all is according to MICE notes. Then make a simulation using the reconstruction routines to compare what we can measure with a perfect Step IV and with the reduced FC current geometries.

- Want to run a full simulation to see where we're at, and then place with the matching currents to achieve a periodic beta function and see the effect on the maximum momentum spread the reduced current FC can accept.

- Care should be taken to stick to *either* the "as designed" coil geometries *or* the "as built" coil geometries (as simulation uses current density, so coil geometry matters).

- Bayes: The configuration database has the "as built" geometry, defined from D2 onwards. It's very close to being declared "official", and it would be good to use it eventually.

- Cobb: Can do a perfectly good study as long as a self-consistent set of coils are used. Consider T. Carlisle's thesis and the self-consistent set of coils and currents there.

- Long: Need a set of plots and a comparison between "perfect" and "reduced current" analysis for *reconstructed* particles by the end of the month.

- We can always improve on the reduced current settings chosen for this comparison, but must start making a comparison somewhere.

1.7 "Criteria for a successful experiment at Step ..." (Blackmore/Speirs)

- Blackmore will distribute a "table of configurations" for running Step V and VI. Asks that people think about what physics we could learn from each configuration.

- Motivation is to inform a decision between Step V and VI based on physics. For example, does Step VI give us access to extra lattices that are of interest to NF or μ-collider studies?

- Long: We need to put away our prejudice and work on the relative benefits of Steps V and VI and, within reason, imagine that we could modify Step V in some way if necessary to do something like Step VI (without actually doing Step VI)

1.8 Progress towards simulation of Step V and VI (Speirs)

- Based on feedback from the CM, starting out by simulating "perfect" baseline Step V and VI configurations with MC truth and comparing the emittance reduction between the two. Repeat with reconstructed tracks and compare recon with truth. Finally, compare emittance reduction between Step V and VI using reconstructed tracks.

- Currently have baseline Step V and VI lattice with absorbers in place ready to simulate. Speirs is working through some diagnostics and hopes to have example plots at the next meeting.

- Has been looking for examples of configurations to simulate in, in particular C. Rogers MICE Note 434. Will look at table to be circulated by Blackmore.

- Long: Speirs nominated as the best person to write a section for MPB report on the Step V/VI decision path. We (Blackmore/Long) need to put together a direction of travel (i.e. the table mentioned previously), but for Speirs to write about the status of the analysis and the proposed plan. – agreed to be Speirs.

1.9 Polarisation in MICE (Middleton)

- A more complete presentation of this work will happen at the next meeting.

- Working on polarisation measurements in MAUS, with the main aim being to see if we can tell the difference between forwards and backwards polarised muon decays by looking at the decay electron energy spectrum in the EMR (just the EMR, no other detectors).

- Currently have simulated a simple beam with forward and backward polarised muons passing through a block of plastic, then looking at the decay electrons inside the block.

1.10 AOB (All)

- Nebrensky: Question for Nugent about elevated beam line simulation. Nugent has taken geometry info that Nebrensky passed on and put it into the G4BL deck he was using. Nebrensky wondering what Nugent took as the upstream quadrupole angle, the number on the drawing is very difficult to read. Nugent did decipher something and wrote it down, will pass it on to Nebrensky.

- Nebrensky: The magnetic field/coil positions inside the Decay Solenoid is going to remain a mystery. Took a look whilst it was open for repairs, but measurements weren't helpful due to the amount of MLI – couldn't see where the coils were.

- Nebrensky: Dipole field discrepancy study should be removed from analysis agenda – mentioned at CM, but can't mechanically make a good measurement due to the layout of D1 and the radiation levels around it. Deemed to not be a big problem, since we'll measure the momentum of our particles (would be a minor improvement on our efficiency).

- Nugent: The proton absorber in G4BL is made of polyethylene, but the real beam stop is "borated plastic". What is the actual *difference* between these materials. Nebrensky comments that it might be the same material used as sheathing over the beamstop and will find out.

1.11 Date of next meeting (All)

- Date OK, no objections.