Meeting Minutes

Charlie Kinsman

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1 Mu3e Meetings - Liverpool

1.1 13/10/22

Discussion of progress and trajectory. The aims are to initially register on all the relevant Mu3e channels. These include a Mattermost, Bitbucket and Indico account. Additionally, the Mu3e wiki sites both of the university and PSI. Start to focus background reading on the outer pixel layers and the tracking software. The current software is found on bitbucket and should be downloaded. Once this is completed this is where the focus should align, and start to get to grips with it by playing around with the software. In order to get to grips with the data, a knowledge of Root teetrees must be established. Finally, once the indico account is set up, start to attend the Mu3e physics and software meetings on Thursdays.

1.2 20/10/22

Many of the previous tasks are still in progress. The new focus is on the software. This should be focusing on the sensitivity and how that drops or rises with geometry.

1.3 3/11/22

The first point is to attend the analyser meetings on Fridays. Then start to focus on the vertex analysis. From this, a meeting with Nikos should be set up to go through the code written by Jason. This code should be taken on and adapted. Must speak to Joost about attending a Precision Muon workshop.

1.4 10/11/22

Discussed progress on my end, not too much had been done besides the beginning of testing of the code made by Jason. Discussion of my interpretation of the code against what it was actually achieving, and there was a fair amount of agreement. On top of this was the discussion of getting involved in hardware development, specifically doing the thermal tests and including temperature studies in the first year report.

1.5 17/11/22

A discussion was had on the progress made since last week. The first side came in looking at the general simulation and I discussed how I had started writing python scripts in order to inspect and handle the data in a fashion that was more familiar. This was fine, but the conclusion came in that the focus should be on editing files in root as this was far superior at handling data than numpy. By doing this, it would assure that a habit of using a slower system wasn't developed. Following from this a discussion of what would be done with the code of Jasons. This equated to looking into the code and making it more sophisticated. The final discussion covered the presentation that would be given at the next meeting. This included progress on both sides of the work.

1.6 24/11/22

The focus was on my presentation. The presentation itself focused on the work that had been done so far in developing my understanding of the general code and the development fork left by Jason. The general code focus was to get a general feel for the simulation and an understanding not only of the physics but also of the software and simulation. This was somewhat demonstrated but there were clear gaps in the knowledge. This was also true of the development code. It was therefore decided to present again the following week with more distributions.

1.7 8/12/22

Initially, I presented the progress and position I was in with the efficiency code. Initially discussing the distributions that had been pulled from the main code and the changes that had been made to them. These included the momentum and radius distributions, which previously (unbeknownst to me) were of the initial muons in the beam. This was fixed by using the Trirec output in combination with the vertex analysis output. The purpose of this was more to rectify the issues that were present in the previous presentation. This then moved to the dev branch left by Jason and the code written by Nikos. I showed some outputs that had been produced and explained their meaning, primarily to prove my own understanding. This then moved to the discussion of what to achieve next. I had my own suggestions which were to translate Nikos' code into c++ and fold this back into the dev branch of Jasons, so that the output of that piece of analysis are part of the general TFile produced by the code. I also proposed writing a TWIKI page or README file in order to make this code more approachable in the future and if it is folded into the master branch or used on the experiment. The direction proposed by the team was more focused on the code, initially analysing the discrepancy in efficiency, investigating the reason as to why there was unmatched tracks. Also producing 2D efficiency plots in reference to the z and phi windows. The final section of the meeting moved to the discussion of the recent update on Phase 2 of Mu3e and what this would equate to with Liverpools involvement.

1.8 15/12/22

Initially Sean presented his work on the code for the phase 2 simulation. Specifically on simulating an extra outer layer and working with the wider collaboration. I then presented my work on the efficiency studies and the direction it should go. More specifically comparing the outputs of the code from Nikos' code against the output of Jasons code. I presented what I thought was a comparison between the two and how this can be related to the truth cuts. It was decided a greater understanding of the tracking algorithm was needed and to add this into the presentation for next week. There was also a reminder that we need to fix the event display for the code.

1.9 22/12/22

The meeting largely followed the same structure as last week. Sean presented his work on the extra outer layer and the updates he had about that. Specifically showing not only the geometry improvements, but also the work on the segments that could be gained from this so different 5, 6 or 10 hit segments for instance. This then moved to my presentation. My focus was to clarify my knowledge of the code and then present again my outputs so that they are explained with more clarity and correctness. I also told them of my document which displayed this knowledge with more clarity. It was then decided that I should continue with the efficiency plots after Christmas but also keep studying the code.

1.10 5/1/23

The meeting focused on the work that was produced up until Christmas and where that work was going now. Sean presented more slides on his work on the outer layer study. I did not have slides to present so I just discussed the position I was in. I initially discussed the document that I had been producing, specifically now that it was moving towards the side of the efficiency study how the document looked and how the plots that were associated with it looked. It was then decided that the event display should be fixed to allow for the debugging and analysis process to made easier. Plots

should be prepared and put into slides for next week. Finally, a school that focused on the hardware is occurring in the Easter in Warwick with details to be finalised later.

1.11 12/1/23

The meeting followed the same structure as last time, I presented work that had been completed and then Sean did. I presented the efficiency plots that had been produced and discussed where I wanted to go next. Sean then presented his work on the fifth layer for phase 2. There was a short discussion on phase 2 upgrades and considerations.

1.12 19/1/23

The meeting followed a similar structure to last week, I presented work that had been completed on the efficiency study and Sean presented what he had been completed on his phase 2 study. My work was less showing plots that had been produced and more showing code that had been written. This code was in aid of the fact that settings in the config files could not previously be edited in the command line making it impossible to iterate through a series of parameters. I presented this idea and showed the issue that it presented, mainly it produced a lot of data and therefore the piece of code I was using to collect and plot relevant parts of each file was breaking. I discussed briefly the code I was writing to sort through the files as they are written and discard them once the relevant information is collected. I also showed the issue I was having with the event display to discuss what the problems were.

1.13 26/1/23

Sean and I presented work that had been completed in the week. Sean presented what he had shown to the collaboration meeting on his phase 2 study. I showed some of the outputs I had got from the efficiency study. Primarily the plots focused on the comparison between reconstructed segments and the Monte Carlo tracks. I showed some of the outputs that had been collected regarding the comparison between the efficiency frames and the Monte Carlo tracks. I showed the code that had been written to collected both the efficiency frame and the nominal frame, as previously this was only collecting efficiency frames. I showed some of the plots that were being produced and discussed discrepancies that I had, primarily that there appears to be very little change between the two reconstruction modes. This is obviously an error and I discussed fixes to this issue.

2 Meetings with Helen

2.1 12/10/22

General meeting to introduce ourselves. Initially discussed a general overview of the research, particularly the balance of software and hardware. Initially a focus should be made not only on familiarising myself with the theory and software, but then following from this move to understanding the Mu3e software specifically. After this a brief discussion was had about the abstract that had to be submitted as a requirement of the UKRI funding source. A discussion of potential titles and themes for this abstract was had, followed by setting informal deadlines to make sure there was enough time to check and edit drafts.

2.2 7/11/22

The focus is the code written by Jason. Should go through his talks to get a full understanding the function of the code. A general overview is the tracking software and the vertex reconstruction efficiency. The first piece of code is a normal tracking pieces of software and assigning triplets with all the pixel layers. The second piece removes the first hit and attempts to assign triplets and therefore particle tracking. Using these two pieces of code, a comparison should be made of the reconstruction efficiency between the two pieces of code. This should be assessed by deciding if the correct missing pixel was identified. In parallel with this task, code should be written that could allow for the momentum and mass to be recovered.

2.3 16/11/22

Discussed the progress made since the last meeting. The initial focus was on the main software and what information/distributions have been extracted. Discussed the progress on PyRoot and what had initially been extracted, which included initial NTuples and outputting them into Numpy arrays. From this, values such as the momentum and particle mass are to be extracted. Helen is going to send some example C++ scripts that are to be practiced with. Moving on from this, a discussion was had on the progress made in understanding the code left by Jason. The complete aim is to adopt the code as my own. After an understanding of the code has been established, I should start to modify the code by accessing Jason's fork. I asked questions on the origin of the input files of the code and it was found to be in Jason's fork. The final task was to get the event plotter fixed on my computer. On the short term, a presentation should be prepared in order to present my progress to the Liverpool group the following day. A few initial plots that have been generated should be put in this presentation and explained in order for me to present my knowledge on the subject.

2.4 21/11/22

Briefly discussed the progress of the presentation. Showed the general layout of the presentation and which was met with approval. The main focus of the discussion was on Jason's code and the general focus of that. Initially, the discussion was more general, in that the presentation should be made so that I express my understanding, not only in the code but the physics that the code represents. The conversation then moved from the presentation to the code itself. Initially focusing on the code given by Nikos and interpreting that to the code written by Jason. I gave my understanding of the code, which was that the code is not achieving anything computationally but is interpreting the efficiency root file. The second piece of code takes the outputted .npy files and produces some .png plots. These pieces of code should be adapted, not only to be more readable to me but also to make my own and focus on plots that are more relevant to me. The final discussion was the physical interpretation of the efficiency code written by Jason. The focus initially was on the distinction between hit efficiency and reconstruction efficiency. This lead to discussing how one informs the other and how that can affect the measurement. The sum of the conversation was that investigation, not only into the code but also the physics of the situation. The code should investigate the efficiency of each ladder and assess the threshold of the efficiency of each ladder, with respect to it's importance, and whether the tracking algorithm can account for an hit efficiency drop or it is a more serious problem. Ideas for this should be included in the presentation.

2.5 5/12/22

Continued the discussion on what the code left behind by Jason and the pyroot code given by Nikos. The focus was on the development of this code and molding it into my own code and taking it passed the current version. After discussing how the current version was acquired (basically by copying and pasting from his personal directory), it was decided it would be more helpful if it was cloned from the bitbucket. After this the presentation that was to be given on Thursday was discussed, specifically sending through the plots to prove understanding before presentation. Each slide should include very specific information about file sources and the maths that has been done for each distribution.

2.6 15/12/22

Continued and clarified the information that was passed in the team meeting earlier in the day. Discussed the steps that were to be taken over the next few days, in particular, what information should be pulled from the simulations. The first focus should be looking at the matched and unmatched tracks and not making unnecessary jumps. So looking not only at the matching algorithms and how they match tracks, but also the tracking algorithm and seeing how the output of this compares to the truth tracks. This should be added into the presentation for next week.

2.7 20/12/22

Discussed the document that had been produced and where it should go. I suggested to have this as a running document, such that this can be used as a reference point for myself and potentially

others. The document appeared to make sense and aesthetically was good to look at. We then moved onto questions I might have about terms or areas that I had found. These were to be added into the document and highlighted in red and also added into the presentation. Moving from this, we discussed the presentation on Thursday. I should present work that has been completed last week. This isn't necessarily an extension on the plots produced, but possibly reproducing the plots from last week with more clarity. Specifically, put definitions of equations used. This means, if an efficiency is called, the equation that was used should be explicitly stated. Also, if I use a term that is one of my own, I should explicitly define this as well. We agreed to meet again at the same time tomorrow to go through the presentation, so a draft needs to be ready for 3.

2.8 12/01/23

Continuing on from the meeting that was had earlier in the week, the main focus was on fixing the event display. I initially showed the presentation that was to be given at the next meeting, it was received well with a few changes to be added in. After these changes were discussed and we had discussed the next steps to be taken with regards to the efficiency code, we moved to the event display. I discussed the errors that had been thrown up both on the main branch and the development branch. We attempted a few fixes and then came up with a plan to fix it.

2.9 26/01/23

The main focus was on the event display and ideas for fixes we had. The main idea was updating the branch which had not been touched since Jason left it in September. We walked through some steps that were to be taken in order to successfully clone and merge the branches on gitbucket. It was decided that the the main focus should be to get to grips with git commands and update my own fork.

3 Mu3e Physics and Software Meetings

3.1 15/11/22

I gave a brief introduction to the group initially about myself, followed by a brief overview of my current work and it's progress. This was a very brief initial discussion.