Homework for 10 ps TOF Proposal

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1. Please describe more fully the process how the Howard graduate student will develop the simulation of the RPC signal formation, who will supervise the student and what resources will be required.

The student would work with Prof. Marcus Alfred and Prof. James Lindesay of Howard University. They will both be able to commit 10% of their time on this project. The simulation of the detailed physics behind mRPC's is well advanced but is not yet completely perfect. Here are a couple of references, as an example:

http://www.sciencedirect.com/science/article/pii/S0168900203003371
http://conferences.fnal.gov/lhc2003/proceedings/williams/williams.pdf

Most of the codes are publicly available. We primarily will use HEED, to simulate primary electron generation, MAGBOLTZ, for avalanche development and getting the townsend and attachment coeff. One of the imperfect things is that MAGBOLTZ seems to get the Townsend coefficient wrong and it is not clear why. Garfield might be necessary as well.

Our plan is to use the above but to also get code from Crispin because at some point the space charge effects have to be put in, and Crispin has a way of simulating this, as well as the implementation of the above software. So we would not be starting from scratch. We would begin by reproducing some of the existing studies, and then once we are confident that we understand the code and that it produces reasonable results, we would like to start exploring the phase-space of possibilities – varying the gas mixture, gas types, seeing what happens if we use thinner glass or other materials, try thinner gaps, etc. From this we hope to at least have some guide to modifying the standard mRPC design, and also to understand if there is something not quite right with the simulations which might have been why Crispin got 16 ps when he expected 8.

2. Given existing manpower on the project and the limited resources available, please prioritize the funding request beyond the postdoc.

We would place highest priority on the ½ funded post-docs, since we really will need the manpower to do these studies. We think we have put forth an ambitious but feasible program, but only because we have enough manpower assigned. We essentially have 1 FTE post-doc on the MCP-PMT studies for two years, and 0.5 FTE on the mRPC studies for three years, which really isn't too much. Any loss of any of the post-docs will mean we will likely have to drop one of the studies that we intended. For the Howard University grad student, it might be possible that other funding could be found, so if it were really necessary to save on labor, we would prioritize that last.

For the materials, if we really needed to save, it would be best to drop the final system test with the Incom LAPPD tiles. From the studies with the Argonne LAPPD tiles, we'd probably have good enough assurance that the concepts on modifications to the standard LAPPD tiles work. It would still be important for us to communicate to Incom that there are users interested in these modifications, so that they design an industrial manufacturing process that will be flexible enough to accommodate our requested modifications to optimize for our application. We would prioritize this as the first study to be dropped.

We were asked during our presentation why pursue mRPC? The main reason is that it seems possible to improve to a level that becomes interesting (16 ps at mid-rapidity). The 24 gap version with small gaps was a big improvement from the Alice TOF. Since then development has stopped not because it couldn't be improved, but more because Crispin's interest went elsewhere. An mRPC TOF would be really very cheap, in case cost becomes a concern. It might also be useful in case the MCP-PMTs prove to have problems in the solenoidal field, which runs transverse to the pores. MCP-PMT development should also continue, since it promises better performance (at higher cost). Also, MCP-PMTs are photon sensitive and can therefore be used in many other applications (RICH, TOP/DIRC, EMCAL, etc). The mRPC only senses charged particles and is therefore limited to hadron PID.