CY2022 Energy Choice (revised 3/16/2021)
Jay Benesch

Summary

The draft schedule for CY2022 assumes 1050 MeV/linac. As the spreadsheets in https://jlabdoc.jlab.org/docushare/dsweb/View/Collection-49339 show, this may have a substantial fault rate if the improved vacuum procedures in the NL do not reduce the historical loss from an extended, controlled 300K dwell. Equally relevant is that Hall B wants polarization at fifth pass throughout the run while Hall A wants polarization at second, third and fourth pass. Three linac energies were explored with varying injector energies. A solution has been found with 1050 MeV/c injector gain and 1050 MeV/linac which has full polarization to B (and C), and P^2 at Hall A of 0.8 on passes 2 and 4 and 0.5 on pass 3. The draft schedule has been adjusted accordingly, extending the third pass run.

The values below were calculated using the application spinDoctor coded by Michele Joyce with physics input from Joe Grames and Yves Roblin.

Graphs

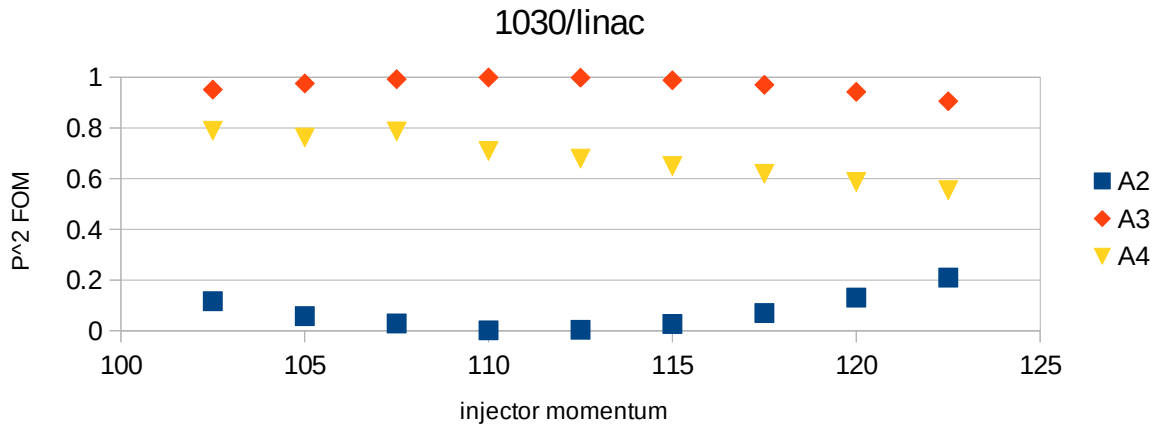

Figure 1. 1030/linac vs injector momentum. There is a good solution for Hall A passes 3 and 4 but no solution for pass 2. Hall B has optimum polarization throughout.

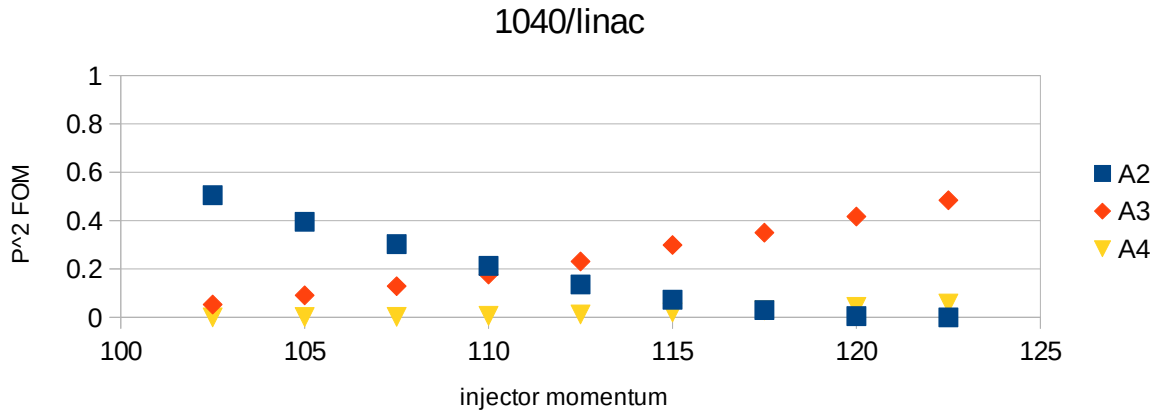

Figure 2. 1040/linac. No good solutions.

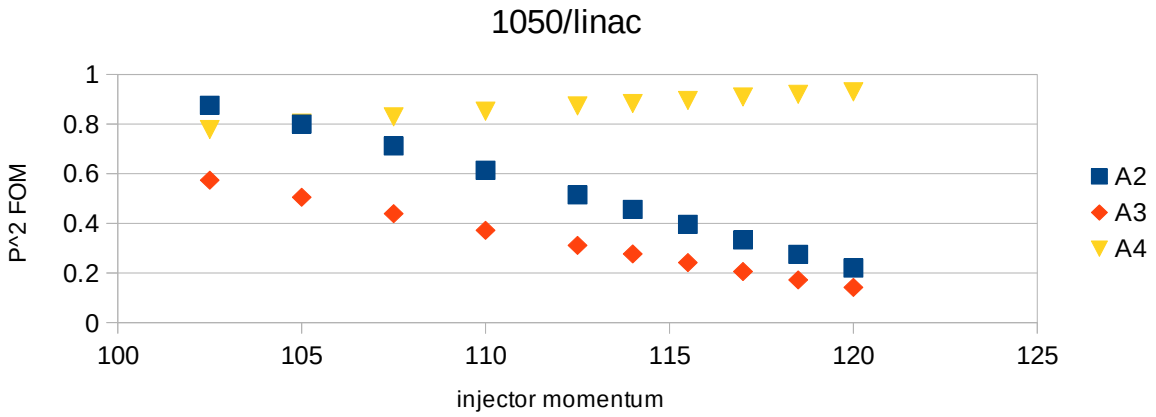

Figure 3. 105 MeV/injector has FOM 0.8 for passes 2 and 4 and 0.5 for pass 3. It follows that the pass 3 run needs to be extended to get data comparable in quality to passes 2 and 4. The collaboration may choose another injector energy given the differences in cross-sections; lowering both A2 and A3 to increase A4 seemed sub-optimal to the author.

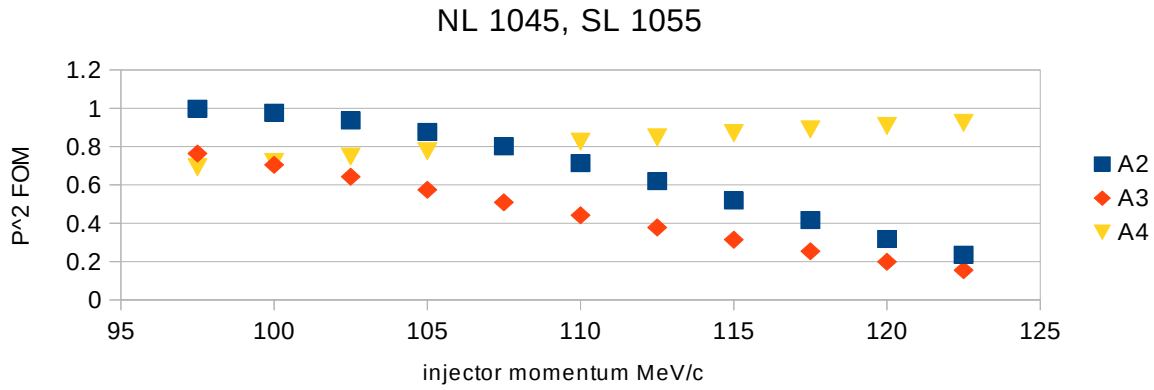

Figure 4. Mike Tiefenback's requested at the Beam Transport team meeting 3/16/21 that I explore a case with asymmetric linacs. I chose linac momentum gains with comparable fault rates per the spreadsheets of TN-20-033. I think the choice in Figure 3 of 105 MeV/c injector is preferable than the lowest point here, 20.4 MeV below nominal injector energy for NL at 1045 MeV/c. YMMV

Comments

After looking at the spreadsheets I prepared as CPP input (TN-20-033) I checked to see if there was a solution with lower linac energy in case the losses due to the extended period at 300K was as large as those seen historically. Unfortunately, the solution with 1050 MeV/linac seems the best, Fig. 3.

There were polarization variations during PREX and CREX due to the energy contributions of the Injector and North Linac varying within the fixed sum provided by the arc 1 energy lock. It follows that Ops and the Beam Transport Team must work to calibrate the injector chicane against the injector spectrometer and adjust the BL magnet map to ensure the two give the same answer. The injector energy lock uses the chicane comprised of the four Bls and the horizontal correctors within the chicane to adjust the last two cavities of 0L04 to fix energy. NB: there has been a discrepancy between spectrometer and chicane energy for more than two decades. We really need to make them commensurate.

Addendum

I sent the draft above to Edith Nissen, Yves Roblin and Mike Tiefenback for comment when I became concerned that the first spreader/recombiner (S/R) might not have enough angular acceptance to deal with the 13.5 MeV/c lower momentum exiting the injector and therefore the North Linac. Mike responded as follows. NB: I do not recall Mike suggesting supplemental correctors for the S/R. I remember coming up with the idea in a discussion about the cold startup procedure. I accept Mike's claim. I have designed such correctors, see TN-20-039. https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-227864/20-039.pdf The 1.5" ID by 30 cm long correctors are also needed for MOLLER so I've discussed having the drawings done this FY with Mike Bevins. The design can compensate for only 75% of the momentum error but that should be sufficient. Changing the coil forms from aluminum to copper and pressing cooling water tubes into the forms would allow for higher current without thermal concerns, perhaps sufficient to completely compensate. This is likely desirable for MOLLER as well as the corrector will be buried in lead there.

Mike's email:

Fri 3/5/2021 10:47 PM

I'm trying to understand what drives the 1.1% of which you speak. I think it's an arbitrary (polarization-motivated) alteration of the injector momentum vs. the "ideal" momentum for linac energy. Whatever the case, it is the variation of the arc dipole (S/R) set across the multiple passes that appears (to me) to matter. There is a two-parameter set of solutions, varying the first and second common dipoles, which one navigates to find the "best solution" by whatever criterion is important. Generally, this will be "to get the beam through the pipe."

One plays this same game particularly in asymmetric linac conditions, for which there is an interplay between the East and West arc S/R regions and injector momentum choice. As I understand (or not) the intent, you are varying the linac energy gain at constant injector energy to change the relative spin precession of the arcs to improve the simultaneous polarization performance at selected halls.

Your principal presently-available option to manage the multiple pass momentum offset (wrt design) is to alter the S/R dipole settings. Matching the low-pass trajectory better results in a mismatch for higher passes because the injector mismatch is washed out by the linac energy gain. This works at some level because the lower dispersion of the higher pass trajectory shrinks the actual dY offset. One should have room to harness the existing correctors to mitigate this yet more.

The next thing one can do, IF PRESSED, is to append magnets of the sort I have suggested to Jay to the lower pass beam pipe, either bucking or boosting the first common dipole bending field integral. This is a simple thing to accomplish, but again, one makes the physical addition only as required. There should be no problem in handling a 1% scale momentum discrepancy if I understand what is actually being considered.

Michael Tiefenback

From: Jay Benesch <benesch@jlab.org>
Sent: Friday, March 5, 2021 20:12
To: Michael Tiefenback <tiefen@jlab.org>; Yves Roblin <roblin@jlab.org>; Edith Nissen <nissen@jlab.org>
Subject: CY22 schedule

Attached find a draft TN written in response to a draft schedule Javier sent me to review. It just occurred to me that the 1.1% drop in energy at the end of the NL versus nominal 0.11284 injector ratio could be an issue. Opinions? Facts?