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Report of the Committee to Review of the Progress on the 700 kW FNAL Upgrade

A short follow-up review was held on September 11, 2015. The charge to the three person review committee was to assess Fermilab's response to a recommendation made at the January 21-23, 2015 review of Fermilab's plan to provide a reliable proton beam to the NovA target with the next two years.

The recommendation from that January review was:

> Fermilab should provide a plan, with a precise timeline and milestones, to establish 700 kW operations. The plan should include the identification of hardware and operational prerequisites needed to achieve the milestones and the plan should be updated as progress warrants. This plan also has to span all of the involved departments (Linac, Booster, RR/MI).

The September review committee was asked to determine whether Fermilab has an adequate plan for establishing 700 kW operations.

Findings:

- The committee was presented with a well-defined time line and set of milestones. This time line covers FY2015 and FY2016 up until the demonstration of 700kW in March 2016.
- All FY15 milestones have been successfully met, and Fermilab reports to be on schedule to meet the demonstration in March 2016.
- Operational reliability is a major emphasis of the ongoing PIP program.
- Fermilab believes that ongoing 700 kW operations in the RR/MI will likely not be possible due to unacceptable loss levels which will require RR collimators to resolve. There are plans for designing and building these collimators, but there are no associated milestones for this work. We were told the earliest installation date would be a shutdown in July 2016.
- Vacuum chamber misalignments in the Recycler Ring contribute to beam losses and are being addressed.
- The RF cavities in the booster have been upgraded steadily over that past several years. Some of the early repaired cavities have failed under full power running requiring rebuilding.
- The upgrade of the RF anode supplies will just be completed in the summer 2015 down.

Comments:

- Fermilab is to be congratulated, both on the creation of the plan, and the success thus far in carrying it out. The demonstrations of 521 kW for an hour, 15 Hz operation of the booster, and 6+6 slip stacking in the RR are truly impressive.
- Fermilab is to be commended for the ongoing emphasis on operational reliability. The focus of reliability in this review was on booster rf systems which will need to be operated routinely in a mode (15Hz) which is more demanding than in the past. Developments contributing to this emphasis are: new anode supplies (which also improve capacity), regular improvements to rf cavities and tuners through design work and lessons learned, the fabrication of additional rf

cavities to provide some redundancy, and the planned retention of effort to make repairs.

- A survey list of all the vacuum chamber misalignments in the recycler ring would be useful for an upgrade assessment and then develop a time phased plan for straightening those that are important.
- The observed failure rate of the repaired cavities and their subsequent repairs may continue for a while suggesting that budgets and technical staff should be provided for these repairs in the operational budget.
- Shielding assessment and loss mechanisms (and associated diagnostics) continue to be developed. Work needs to be done to address the operation at the intensities needed to support the full HEP program, and we encourage this ongoing effort.
- The charge question asked for a plan to address 700 kW operation to the NOvA target. The presentations at this review did address all of the issues associated with 700 kW operation, but the time line and milestones ended at the demonstration of this power level. The RR collimators are needed for regular operation to the NOvA target. These should be included in the regular updating of the requested plan.

Recommendations:

R1: Make a technical and financial plan to install the anticipated recycler ring collimators in summer 2016.

R2: Communicate with DOE OHEP a clear understanding of near term and final operational steady-state expectations for beam power delivery to the supported elements of the HEP program.

Answer to charge question:

Yes, Fermilab has an adequate plan addressing the establishment of 700 kW operations to the NovA target. This plan has been updated as requested and it does include all relevant departments. We continue to encourage Fermilab to use this plan and update it to address the ultimate achievement of routine 700kW operation to the target, and the delivery of the power needed to support the full Fermilab HEP program.