

Linac 200 MHz Power Systems Meeting Summary
Bob Webber – July 15, 2011

Meeting was held Wednesday, July 13, 2011

Attendees: Bob Webber, Ralph Pasquinelli, Bill Pellico, Fernanda Garcia, Howie Pfeffer, Dan Wolff, Trevor Butler, Johnathan Walters, Larry Allen

The purpose of the meeting was to discuss how we might get some momentum toward dealing with the 200 MHz Linac RF power system issues. Those issues, related to another 15 years of Linac operation, are:

- 1) The significant specialized maintenance and troubleshooting manpower required, even now, by the 40+ year old modulators
- 2) The already ~8 year-old obsolescence of the F1123 switch/series tubes in the modulator
- 3) The uncertainty about future availability of the 7835 RF power amplifier tube

Following considerable discussion, which began with the idea of replacing the full 200 MHz Linac with a 400 MHz Linac based on SNS design, five possible avenues to address the issues were identified, each of which with a different cost vs. risk balance.

1. Replace the full 200 MHz Linac, beam line and all, with a 400 MHz Linac based on SNS design
2. Replace the 7835-based 200 MHz power systems with Thales TH628 Diacrode-based 200 MHz systems, ala LANL plans
3. Replace the 7835-based 200 MHz power systems with klystron-based 200 MHz systems
4. Replace the present modulators with continued reliance on the 7835 RF tube
 - a. Pursue FNAL design of modulators that might also serve diacrode and/or klystron-based RF amplifiers as well as the 7835 RF amplifier (the possibility of incorporating a circulator between the amplifier and the Linac tanks might simplify new modulator design for the 7835-based RF system)
 - b. Pursue a new commercial design (Continental Electronics?) of modulator to serve the 7835 modulator
5. Make improvements to the existing modulators, without wholesale replacement, to eliminate the obsolete switch tube and other components that pose long-term maintenance issues.

On the surface, Option 1 appears to be the most risk-free, though perhaps the most costly option for reliable operation thorough 2025. It eliminates all risks inherent in the present 200 MHz Linac. Option 2 is similarly attractive, except it does not eliminate any risks associated with maintaining the present beam line components. LANL has done much development on this system, but it is still not ready for prime time nor has it been proven in an operational accelerator system. Option 3 offers that possibility of simplified modulator design and greater amplifier lifetime compared to a filament cathode and gridded tube amplifier. It retains the beam line components and presents the risks associated with a new klystron development. Options 4 and 5 are less attractive in that they do nothing to reduce the vulnerabilities associated with expecting another 15 years of support for the 7835 tube. Option 4a offers the possibility of a modulator design that would be directly applicable to another RF tube should that be necessary. Option 4b

probably requires the least amount of internal Fermilab effort. Option 5 eliminates the switch tube vulnerability and present modulator maintenance issues at probably the least cost. Note that Options 4b and 5 might be nearly technically identical.

It is apparent that to make a selection among the options that hopes to gain support by Laboratory Management and the funding agency, serious cost and schedule estimates need to be made for each. For a fair comparison, estimates for each option should include the full scope of design, procurement, installation, operational, and specific and prudent risk mitigation activities through 2025. Operational costs should include wall-plug power usage, tube rebuild/replacement costs, and maintenance effort over the life of the machine. The 'cost' to the Laboratory's ongoing physics program of accelerator shutdowns to implement each option must also be estimated.

Ralph offered to lead the cost estimate effort for the 400 MHz option, but will need the help of many different people and organizations, not all of whom were represented in the meeting. Leaders need to be identified for estimating the cost of the other options. Starting materials include records of current operating and maintenance costs, cost reports from SNS for their 400 MHz machine, cost reports on the LANL Diacrode system development, current Diacrode and 400 MHz klystron tube prices from Thales, and a one-year-old quotation from CPI for development and prototype of a suitable 200 MHz klystron. To further the base of quantifiable information, Fernanda will organize a small group to write a specification for a modulator that will support the 7835-based RF source for Fermilab. This is needed to obtain useful price estimates for either a commercial or internal design. Dan and Howie will complete work already begun to develop a conceptual engineering design and cost estimate for a modulator that might serve a variety of RF power tubes. Trevor, with Larry's help, will re-establish contact with Continental that was dropped at the end of 2010 when Larry retired from the Lab.

An early decision to contract with Continental or other commercial concern to do a design that can be reliably priced may be prudent.

We failed to establish a schedule for completing these tasks; that should be done at the next meeting. Another meeting of this group should be held again in early August to build and maintain some momentum.

Other relevant news:

John Lyles, who has done the LANL 200 MHz power system development around the Thales TH628 Diacrode tube, is expected to visit Fermilab and give a talk on his work on Sept 1-2, 2011.