HINS "Six-Cavity Test" Goals Statement

Bob Webber

October 28, 2009

Beams Document 2986-v2, High Intensity Neutrino Source R&D Program Goals Statement, specifically defines the goals of the Fermilab HINS program. The second of the four stated goals is:

- Demonstrate the use of high power RF vector modulators to control multiple RF cavities driven by a single high power klystron for acceleration of a non-relativistic beam

The HINS "Six-Cavity Test" is an intermediate configuration of the front-end of the HINS Linac for achieving this particular goal in a period that precedes the availability of cryogenics required by superconducting solenoid magnets in the baseline HINS design.

The "Six-Cavity Test" configuration consists of the HINS ion source and 2.5 MeV RFQ followed by a beam line comprising six HINS room-temperature RF cavities with individual vector modulators, quadrupoles for transverse focusing, beam diagnostics devices, and a beam absorber. The single HINS 325 MHz Toshiba E3740A-Fermi klystron provides RF power for the RFQ and all six cavities.

Achieving the following specific goals shall define successful completion of the HINS "Six-Cavity Test":

1. Transportation of nominal 2.5 MeV beam from the RFQ to the diagnostics line at ≥5mA beam current with an efficiency ≥ 80% with no RF power in the six cavities.
2. Simultaneous operation of the RFQ and six cavities, without beam, at nominal RF power levels with individual amplitude and phase control feedback loops incorporating vector modulators on each of the six cavities (and optionally the RFQ). The target regulation precision is 1% amplitude and 1 degree phase for all six cavities throughout a one-millisecond pulse.
3. Transportation of nominal 2.5 MeV beam from the RFQ to the diagnostics line at ≥5mA beam current with an efficiency ≥ 80% with the six cavities adjusted to provide longitudinal focusing and minimal acceleration.
4. Measurement of the beam energy downstream of the six cavities using time-of-flight techniques with the conditions of item 3 above. Beam energy measurement objective is absolute accuracy better than 5% and resolution better than 25 keV.
5. Acceleration of beam at ≥5mA beam current up to ~3 MeV, as measured by time-of-flight, through the six cavities while operating with amplitude and phase control feedback loops incorporating vector modulators.
6. Optimization and quantitative measurement of final beam energy stability, pulse-to-pulse and within a one-millisecond beam pulse, with the conditions of item 5 above.
7. Quantitative measurement of the vector modulator loop dynamic response by modulating and measuring beam energy within a one-millisecond beam pulse.