LANSE Modernization Project at LANL


Abstract

In the framework of LANSE Accelerator Modernization Project (LAMP) preliminary research and evaluation of critical technology elements it was found that the proposed RFQ design had not been yet demonstrated experimentally worldwide. Such an RFQ should combine the ability of traditional light ion RFQs, and flexibility of acceleration pre-bunched beams, like RFQs for heavy ions.

Proposed RFQ should be able to accelerate beams with 35mA beam current and at the same time preserve pre-scribed macro-bunch time structure required by experiments. New algorithms for RFQ geometry generation have been proposed and optimization algorithms are being developed at LANL.

LAMP technology demonstration plans also include development of new set of electrodes for our RFQ test stand that will allow us to demonstrate the critical technology in laboratory experimental setup with low duty factor and low energy.

RFQ Beam Dynamics (BD) Algorithm

The most prominent Critical Technology Element in LAMP project is the RFQ with the set of requirements unprecedented in any other RFQ accelerator design worldwide. New specific design procedure and algorithm were developed to meet the RFQ geometry requirements. In this contribution the proposed procedure and main parts of the developed algorithm are presented, and the preliminary longitudinal beam dynamics (BD) results are discussed.

The major difference of the proposed RFQ, compared to existing high current light ions RFQs [3,4], is the requirement to start with the pre-bunched beam and pre-serve pre-existing time structure of the macro pulses or beam bunch trains in the RFQ and in the following DTL. At the same time, the beam ions and the beam halo formation requirements are usual for high beam current RFQs, and stricter compared to the heavy ion RFQs [5], that were designed to accelerate and shape the beam at lower RF frequency and lower velocities.

We started a very preliminary BD pre-design study in the pro-proposed RFQ. The first step in this study and algorithm development was done neglecting space charge effects (with only analytic estimates of those effects) and for longitudinal BD only. The Radial Matching Section (RMS), as well as the Transfer Cell (TC) at the beginning and at the end of the accelerating-focusing channel of the RFQ are not considered in simulations and will be included in the modeling at the following steps. The space charge effects will also be included in the simulations when the transverse BD will be fully included. All the formula used in this contribution are from [6], or immediately derived from them.

The requirement to accept in the RFQ pre-bunched beam dictates the significant change of the classical RFQ structure. So, the proposed RFQ does not have a Beam Shaper section, and the section of the Adiabatic (or Gentle) Buncher is significantly shortened.

The small modulation of electrodes is present in the very first cell of the RFQ (since we omitted RMS and TC sections).

RFQ geometry generation results:

- All curves except B-curve use left-side scale
- All curves except D_cell curve use left-side scale
- The longitudinal ($\mu_{oz}$ and $\mu_{z}$) and transverse ($\nu_{x}$ and $\nu_{y}$) phase advances estimates. Space charge dephased phase advances were estimated for 50 mA beam current
- Longitudinal BD simulation in the focusing channel geometry using code BEAMPATH [7]

LAMP Demo RFQ Test Stand

We have staged the LAMP technology demonstration as follows:

- Complete the first at the existing RFQ test stand and demonstrate the proton beam out of RFQ. For demonstration, the test stand can run at low duty fac-tor and with lower beam current.
- Develop modifications of the existing LEBT to include chopper and low frequency buncher. Develop new focusing structure and diagnostics for low energy RFQ beam.
- Develop an MEBT after the existing RFQ at 750-keV output beam. We can show chopping needed in the MEBT of the proposed scheme of the LAMP.
- Redesign the existing RFQ electrodes with a different vane profile that enables better capture of pre-bunched beam or short beam pulse. Important condition: the vane length should be the same as in the existing RFQ, so that only the vanes can be re-placed. The output beam energy can differ from the present design value, 750 keV.

References


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