Radial RF Injectors for Improved Waste Stream Processing Progress Report
2Q FY18

Task 0 – Program Management
The funding documents have been received and signed at AFRL. We are working with our AFRL collaborators to ensure we can meet the desired scope of work in time remaining; we will inform our local program office and DOE as issues are encountered.

Task 1 – Beam Physics Design
We have downselected to the fundamental mode of a 350-MHz toroidal cavity, as it provides improved options for adding or subtracting beam flight tubes as required to meet the design goals of any given implementation of the radial RF gun.

We have explored the sensitivity of the cavity frequency to the number of beam tubes, and found it to be quite insensitive, as shown in Figure 1:

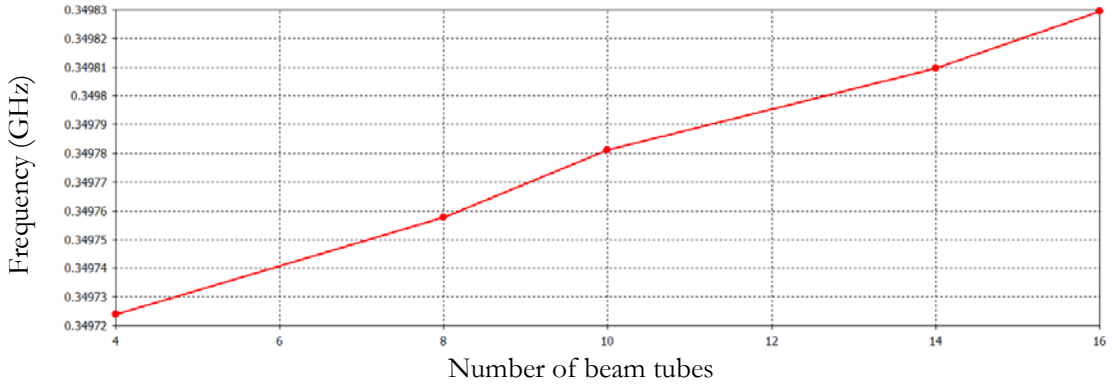

Figure 1: cavity frequency dependence with number of beam tubes.

This allows us to optimize the overall design for tradeoffs between the per-current beam tube and heat loss through the tube to the superconducting cavity.

We have essentially completed optimization on a two-toroid design, with the toroids independently powered and phased, including a reoptimization of the DC gun. This allows us to achieve essentially lossless beam transport from the cathode through the inner toroid's output beam tube, with energy gain in-line with requirements. Figure 2 shows the beam size, energy and energy spread as a function of radius; the beam starts 15 cm outside the outer edge of the outer toroid, 85 cm from the axis, and propagates inwards.

Task 2 – Engineering design and analysis
RF power coupler design
The physics design is now to the point where we can begin to design the RF system. The decision to decouple the radial cavities makes this task easier.

Other activities
We have prepared a paper and poster presentation for the 2018 International Particle Accelerator Conference; copies are attached.

We have submitted an invention disclosure on a novel method of gating beam generation from gridded thermionic cathodes, developed in part as a requirement to obtain short (relative to the RF period) electron

bunches so as to reduce the likelihood of beam loss within a superconducting cavity. The Laboratory is proceeding with filing a provisional patent.

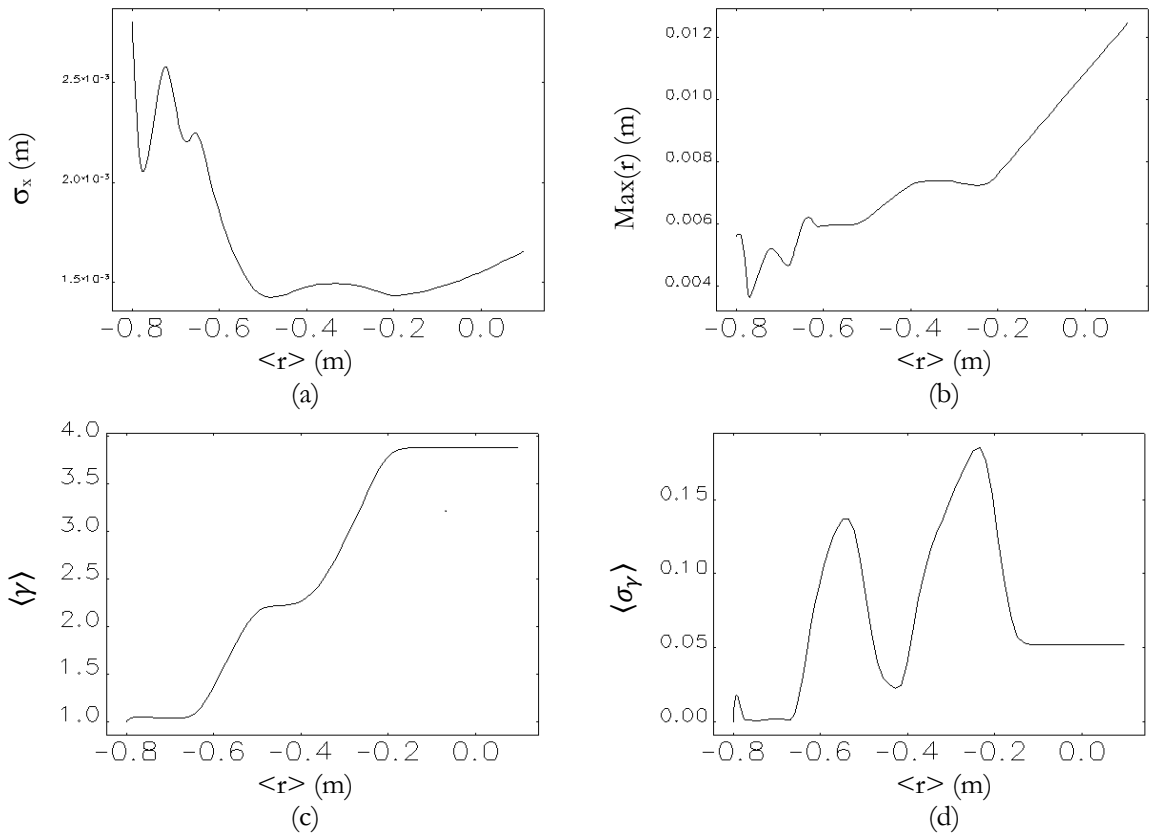

Figure 2: (a) rms and (b) envelope of the beam as a function of radius, and (c) mean and (d) RMS variation of the Lorentz parameter as a function of radius.