

MSU-Facility of Rare Isotope Beams (FRIB)

Title: Development of phase-locked loop and low-level RF controller for high-Q superconducting resonant cavity for 644 MHz FRIB upgrade

Description: Ongoing Facility of Rare Isotope Beams (FRIB) will be a next-generation state-of-the-art ion beam accelerator for nuclear physics experiments and we are also doing R&D for the FRIB Upgrade, capable of improving the primary ion beam energy and, therefore, the beam power by almost a factor of two. A 644 MHz superconducting RF (SRF) resonant cavity and its subsystems are essential parts of the FRIB Upgrade. Since the bandwidth of this cavity is very narrow due to high Q, $\sim 10^{10}$ intrinsic Q and $\sim 10^8$ loaded Q, a phase-locked or self-excited loop is necessary to test and operate this cavity. Students of this program will participate in “development of low-level RF (LLRF) controller for 644 MHz FRIB upgrade SRF cavity tests”.

Detailed tasks will be as follows:

- 1) *Build a prototype of analog phase-locked/self-excited loop electronics using commercial off-the-shelf components (e.g. Mini-Circuits).*
- 2) *Test this circuit with a mock ~ 644 MHz cavity, built using coaxial waveguide components, at room temperature. Make modifications, as necessary.*
- 3) *Perform ADC/DAC analysis for 644 MHz digital LLRF controller. Determine if direct sampling is practical or if analog mixing is required. Identify and order components for Phase 2 using evaluation boards, if available, or modify existing FRIB circuit board designs. Some work may need to continue by FRIB sponsor.*

Contact: Peter Ostroumov, Ostroumov@frib.msu.edu