Online retuning of ISAC linac beam with quadrupole scan tomography

O. Shelbaya, R. Baartman, P. Jung, O. Kester, S. Kiy, S.D. Rädel, T. Planche, Y.N. Rao, TRIUMF, Vancouver, Canada

Abstract
The method of tomographic reconstruction has been in use at TRIUMF and elsewhere for several years, allowing for the diagnostic extraction of elements of the beam matrix online. One of the more recent applications of the technique at TRIUMF-ISAC consists of using the measured density distribution as the input for a real-time tune re-computation. This technique is advantageous since it does not require installation of dedicated emittance meters but can instead be carried out with existing position monitors. Instead of requiring an operator to manually re-tune quadrupoles in a matching section, which can be time consuming, the method allows for a fast and reproducible means to precisely control the beam and can be proceduralized for use by operators tuning the machine.

Quadrupole Scanning on a Diagnostic
A quadrupole field (electric or magnetic) acting on an ellipsoidal particle distribution in position-momentum phase space is represented by a point-to-point transformation which is area preserving.

A downstream position-intensity diagnostic (RPM, Fig.1) is used to record the beam intensity distribution at a given quadrupole setting.

Retuning of ISAC-Linac beam
Quadrupole scans performed in the MEBT section [3] of the ISAC linac are used to extract the transverse distribution, without resorting to dedicated emittance meters.

This distribution is in turn fed into the envelope model of the machine, which is used to recompute the tune, whose computed settings are then loaded to the control system [4].

Since the quadrupole-drift transformation is known, so is its inverse. This connects the measured projections of the distribution to the a priori unknown phase space distribution, at the entrance of the quadrupole.

Conclusion
The method of quadrupole scan tomography provides the means to measure phase space distributions in the ISAC accelerator. This is not only an important tool for machine study, but also for beam investigations related to operation and beam delivery to experiments. This technique is now in use, along with other measurements, to develop model coupled accelerator tuning (MCAT), which aims to pair the use of an envelope code with on-line measurements.

Bibliography