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Profile Monitor Additions to ISAC-OLIS

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Abstract: This report details the possible addition of two rotary profile monitors at the ISAC Offline Ion Source beamline, which would enhance beam diagnostic capabilities.

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1 Overview

In this note, I record the possibility of potentially adding two ISAC standard rotary position monitors[1] (RPMs) to the OLIS beamline, which is detailed in [2]. Importantly, the OLIS electrostatic optics are defined by two quadrupole triplets, arranged symmetrically about the 60° dipole.

The triplets are composed to two outer quadrupole assemblies which include a pair of grounded skimmer plates, used to define the electric field's effective length. The central quadrupole does not have its own skimmer, instead sharing that of its two neighbours. In the reports [3, 4], it is found that both the central triplet quadrupoles IOS:Q2 and IOS:Q5 are likely longitudinally misplaced following structural modifications.

2 New RPM at Quadrupole-5

From the beam optics standpoint, a new RPM can be inserted downstream of collimator 3B and IOS:Q4 by removing quadrupole IOS:Q5. The roughly 10 cm effective length quadrupole creates an opening in the lattice sufficient for an RPM insertion, shown in Figure 1. Considering skimmer plate placements for IOS:Q4 and Q6, free space generated by Q5 removal should be roughly 15cm.

Conveniently, use of MCAT for tuning of the OLIS optics leaves IOS:Q5 unpowered, instead relying upon the opposite polarity (Q4,Q6) pair. There are no changes to the tune at OLIS.

This monitor will enable imaging of the extant distribution beyond collimator 3B and crucially will allow for verification of the beam centroid in (x,y) nearly 1.5m upstream of IOS:RPM8.

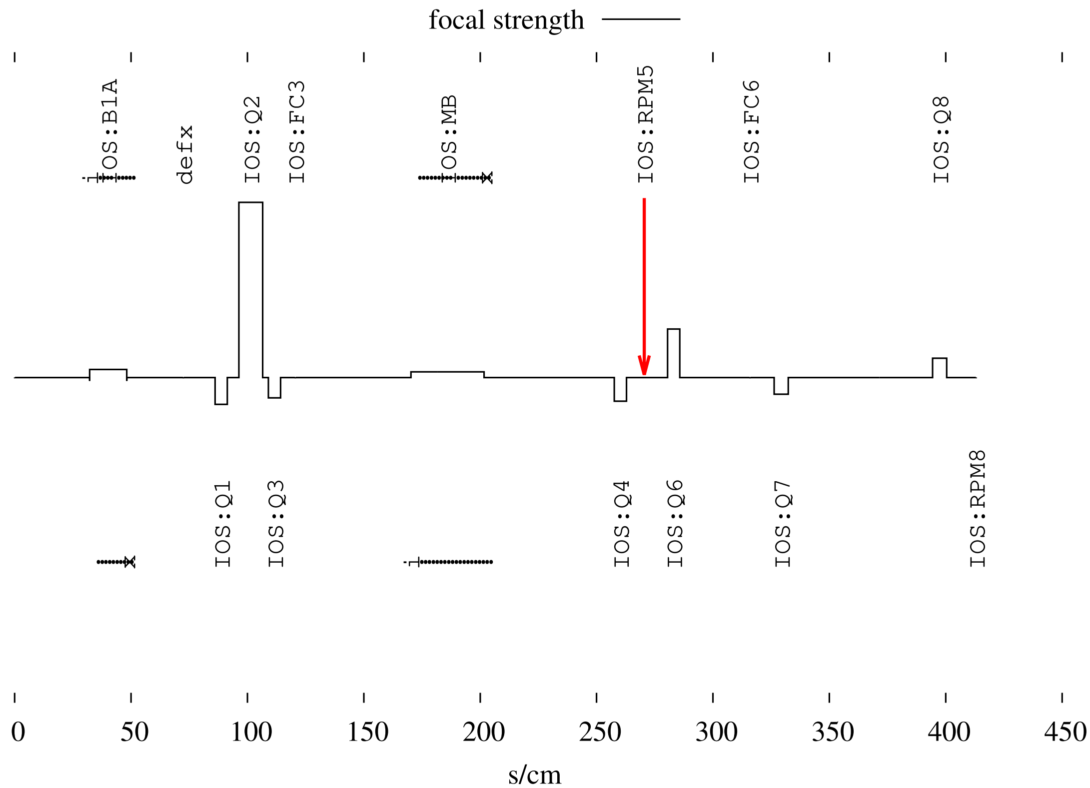

Figure 1: Layout of the original OLIS optics, shown from microwave source to IOS:RPM8. Quadrupole IOS:Q5 here has been removed and the red arrow indicates the location of a new profile monitor IOS:RPM5.

3 New RPM Upstream of Collimator 3A

Another new RPM can be added upstream of collimator 3A. The consideration here is slightly more involved, due to the nature of the beamline: Beams from any of the three sources are asymmetric about the OLIS dipole, starting from a round waist, meaning the (Q1,Q3) pair cannot be biased the same as (Q4,Q6). This is due to the need for a match condition at RPM8. Additionally, Q1 has reverse the polarity of IOS:Q6 in the original design, shown in Figure 1.

The polarity issue is trivially solved. The requirement of creating a narrow waist in x to transmit the 1 mm collimator requires modification of the lattice. Recalling that the longer Q2 does not possess its own skimmers, it is the ideal candidate for removal. However, this reduces the resolution of the separator and is illustrated in Figure 2, which shows (x,y) envelopes from the surface source up to the x-waist at the first collimator. The collimator beam size found to grow in size with compared to the original optics, increasing beam losses.

Recalling that a quadrupole's restoring force is proportional to beam size, the drift after Q1 introduces the undesirable effect of lessening Q3's strength in x. However, Q3 must set the y-envelope for transit through the OLIS dipole. This reduces the attainable x-waist at the entrance collimator: Pushing Q3 too hard will cause excessive y-divergence through the separator and downstream slit.

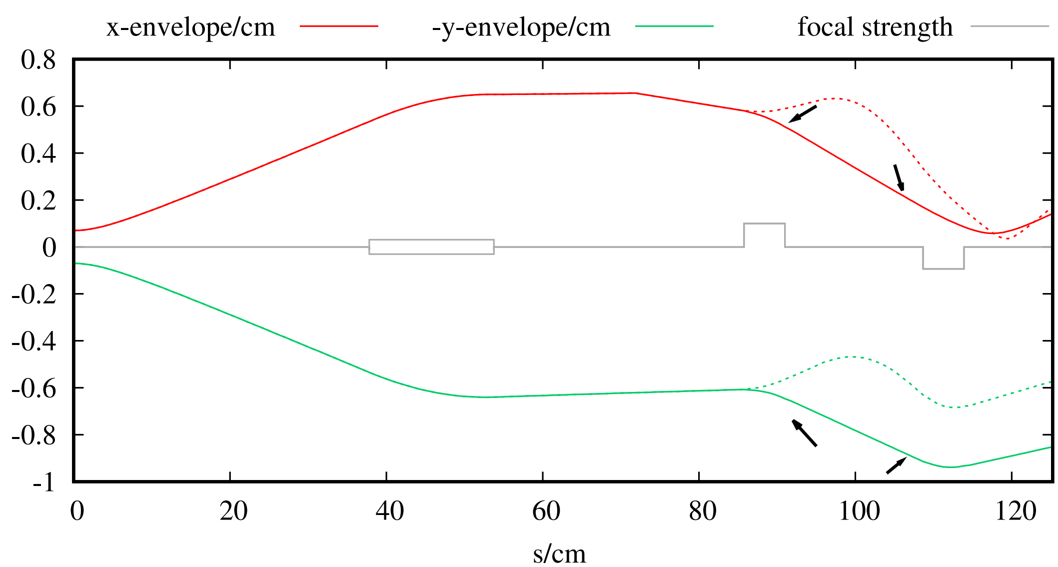

Figure 2: SIS beam with removal of IOS:Q2. **Dotted Lines:** Original tune using Q2. **Black arrows**: highlight decreasing x, increasing y without Q2, which causes an increase in the size at collimator 3A.

This issue is resolved by moving Q1 closer to Q3, shown in Figure 3. A new RPM0 is added upstream of Q1, providing information on beams exiting the 3-way bend[5], which precedes the quadrupole lattice, in addition to quantifying steerer lensing effects[6]. The new optics presented in this report does not cause any of the quadrupoles in OLIS to exceed their maximum power supply setpoints, for a 60keV beam tune: All existing power supplies can remain unchanged.

4 Summary

1. **Removal of IOS:Q5, already disused in operational tunes, opens up a drift space suitable for an RPM addition to the OLIS line, after the second collimator.**

2. **Removal of IOS:Q2 for an RPM insertion on its own reduces the ability to produce a narrow waist at the first OLIS collimator.**

3. **Moving IOS:Q1 to the centerpoint of the existing IOS:Q2 opens up space for an RPM while maintaining the ability to produce a horizontal waist at the first OLIS collimator.**

4. **The new optics presented herein is found to require at most 5.5kV on the OLIS quadrupoles for a 60keV energy. No quadrupoles power supply modifications are required.**

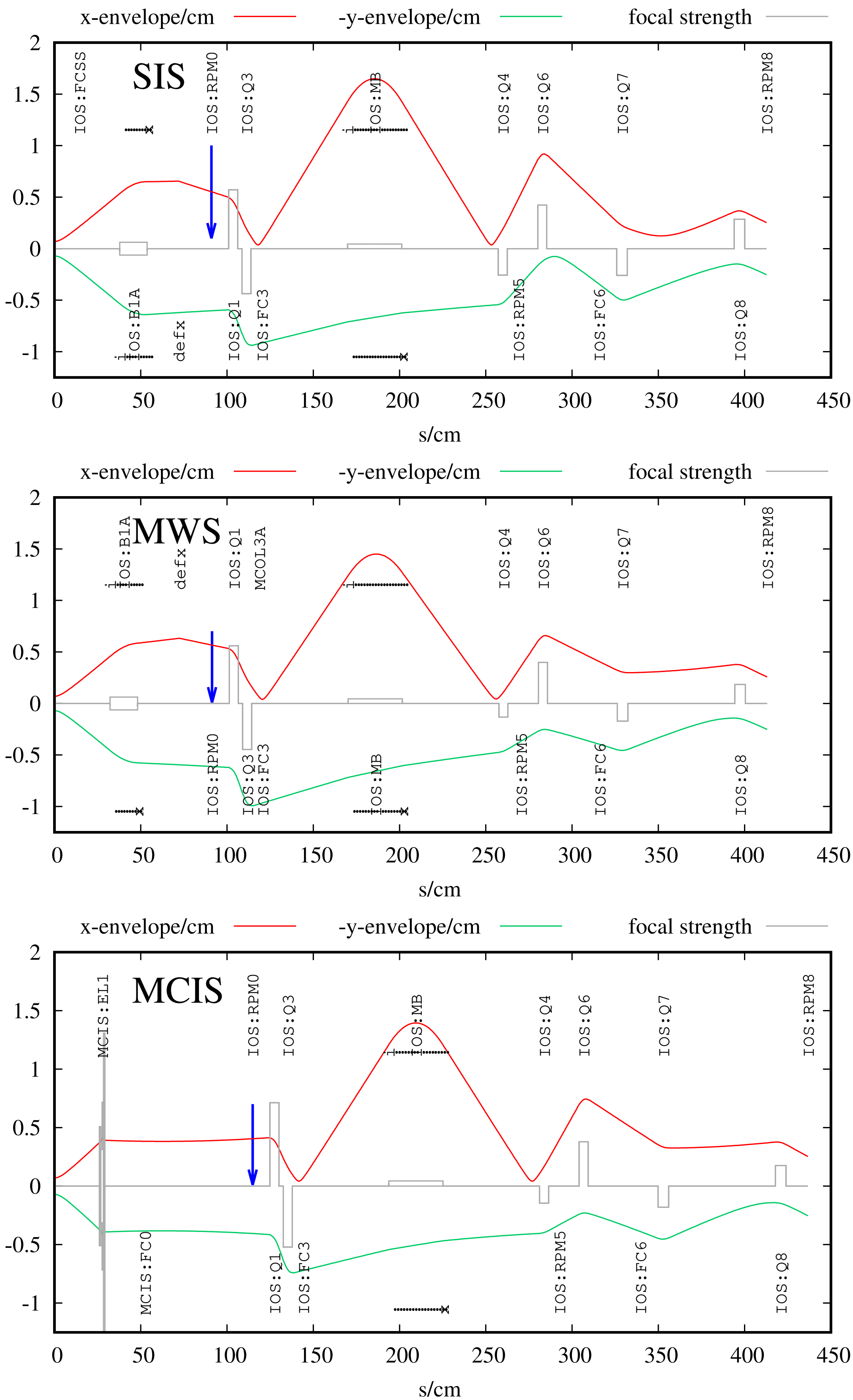

Figure 3: A blue arrow indicated the location for a new IOS:RPM0, moving Q1 and Q3 and removing IOS:Q2, enabling use of a 1mm collimator.

5 Acknowledgements

Thanks to Rick Baartman, Chris Charles, Friedhelm Ames, Joseph Adegun, Spencer Kiy and Thomas Planche for useful discussions. Thanks to RIB operators for feedback on OLIS tuning.

References

[1] Olivier Shelbaya, Richard Baartman, Paul Jung, Oliver Kester, Spencer Kiy, Thomas Planche, Yi-Nong Rao, and SD Rädel. On-Line Retuning of ISAC Linac Beam with Quadrupole Scan Tomography. In *Int. Particle Accelerator Conf.(IPAC'21), Campinas, SP, Brazil*, 2021.

[2] Olivier Shelbaya. OLIS to RFQ Beam Transport and Acceleration in TRANSOPTR. Technical Report TRI-BN-20-13, TRIUMF, 2020.

[3] Olivier Shelbaya. Anomalous Operational OLIS Tunes. Technical Report TRI-BN-19-20, TRIUMF, 2019.

[4] Olivier Shelbaya. Report On OLIS Quadrupoles 5 and 7 . Technical Report TRI-BN-22-12, TRIUMF, 2022.

[5] Olivier Shelbaya. OLIS Maintenance Summary by Oli S. Technical Report TRI-BN-20-04, TRIUMF, 2020.

[6] Olivier Shelbaya. A Record of OLIS Steerer Lensing. Technical Report TRI-BN-24-05, TRIUMF, 2024.