



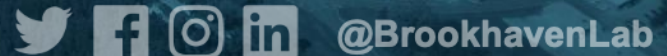
RHIC Accelerator Physics EXperiment (APEX) Program – FY 2024

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# Verification of RHIC Octupoles Limitations

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# Proposal: RHIC Octupoles Limitations

*Goal*      Scan RHIC octupoles to the maximum allowable by power supplies to find the maximum operational octupole current before practical dynamic aperture reduction.

*Benefits*      The Landau damping offered by octupole magnets is a passive mechanism to mitigate collective effects from impedance and electron cloud and unstable head-tail modes.

Understanding of the RHIC octupoles performance limitations will inform the decisions on proper mitigation mechanisms for collective effects in the EIC HSR.

*Results*      Report in APEX weekly meeting and the EIC Design Report.

# Description

## *Machine and beam setup*

### **Proton beam in store with about 6 nominal charge bunches**

- Landau damping is single-bunch effect → no need for fully populated beam
- DA measurement involves controlled beam loss
- Reduced beam current → reduced beam loss

### **Beam energies: 24 and 255 GeV**

- DA limitations by octupoles are more severe for 24 GeV beam

### **Several tune pairs, including $Q_x, Q_y = (0.28, 0.21)$ [BBQ]**

- EIC HSR fractional tunes at injection

## *Method*

### **Scan octupole current to max. available from power supplies while monitoring beam loss [BLM; IPM; DCCT, WCM]**

- Octupole designed to operate at 25-33% of their quench limit (198 A), wire layers bench tested to +/-100 A.
- Operating current is +/-50.6 A. Power supplies are bipolar. Sets of octupoles are powered in series. [RHIC Configuration Manual, pp. 58-59; EIC-ADD-TN-077] Current leads might be a limitation. [F. Micolon]

## *Further studies*

### **Repeat at different radial shifts**

- RHIC APEX Radial Shift, POC: G. Robert-Demolaize

# Resources

<i>Team</i>	M. Blaskiewicz, V. Ptitsyn, S. Verdu-Andres, MCR crew
<i>Spokesperson(s)</i>	S. Verdu-Andres
<i>Time</i>	4 hours, a second try might be needed
<i>Data analysis</i>	In-situ and offline
<i>Applications</i>	Regular control room applications
<i>Instrumentation</i>	BBQ IPM BLM DCCT, WCM

# Detuning coefficient ranges

S. Peggs et al., EIC-ADD-TN-077 (2023): <https://www.osti.gov/servlets/purl/2205642>

Tune  $Q$  varies with particle amplitude  $a$ :

$$\begin{aligned} Q_x(J_x, J_y) &= Q_{x0} + \kappa_{xx}J_x + \kappa_{xy}J_y \\ Q_y(J_x, J_y) &= Q_{y0} + \kappa_{xy}J_x + \kappa_{yy}J_y \end{aligned} \quad x=(2J\beta)^{1/2}\cos(\psi)$$

Accel.	Energy & optics	Octupole count	Octupole sums			Detuning coefficient ranges		
			$\sum \beta_x^2$ $10^6\text{m}^2$	$\sum \beta_x\beta_y$ $10^6\text{m}^2$	$\sum \beta_y^2$ $10^6\text{m}^2$	$\kappa_{xx}$ $10^3\text{m}^{-1}$	$-\kappa_{xy}$ $10^3\text{m}^{-1}$	$\kappa_{yy}$ $10^3\text{m}^{-1}$
RHIC	injection	90	0.106	0.047	0.103	$\pm 94.9$	$\pm 84.2$	$\pm 92.3$
	storage		0.115	0.050	0.108	$\pm 9.3$	$\pm 8.1$	$\pm 8.8$
HSR	injection	137	0.200	0.116	0.321	$\pm 179.1$	$\pm 207.8$	$\pm 287.5$
	storage		0.243	0.148	0.362	$\pm 19.7$	$\pm 24.0$	$\pm 29.4$

Table 3: RHIC and HSR detuning coefficient ranges. The HSR injection and storage optics are hi-n-inj-101723-proton.bmad and hi-n/275-10-collision/hsr.bmad, with the layout git#17e7f5e69c010f93d5be9cf027e71bec2495beed. The RHIC optics are derived from the Au23-100GeV-e0 lattices.