Experimental Investigations on the High-Intensity Effects near the Half-Integer Resonance in the PSB

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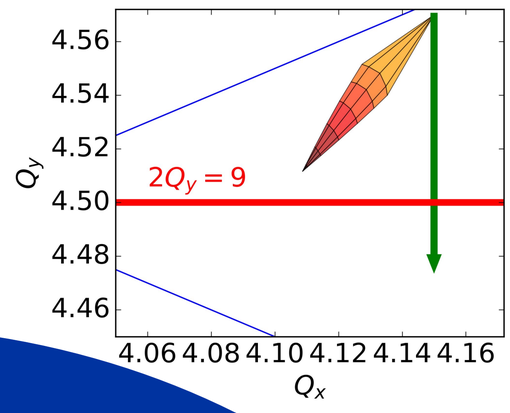
1. Experimental Setup

Dynamic crossing of half-integer resonance with **coasting** beam. Controlling **amplitude detuning** with space charge. Controlling **resonance strength** with quadrupole correctors.



Half-integer resonance crossing in PSB

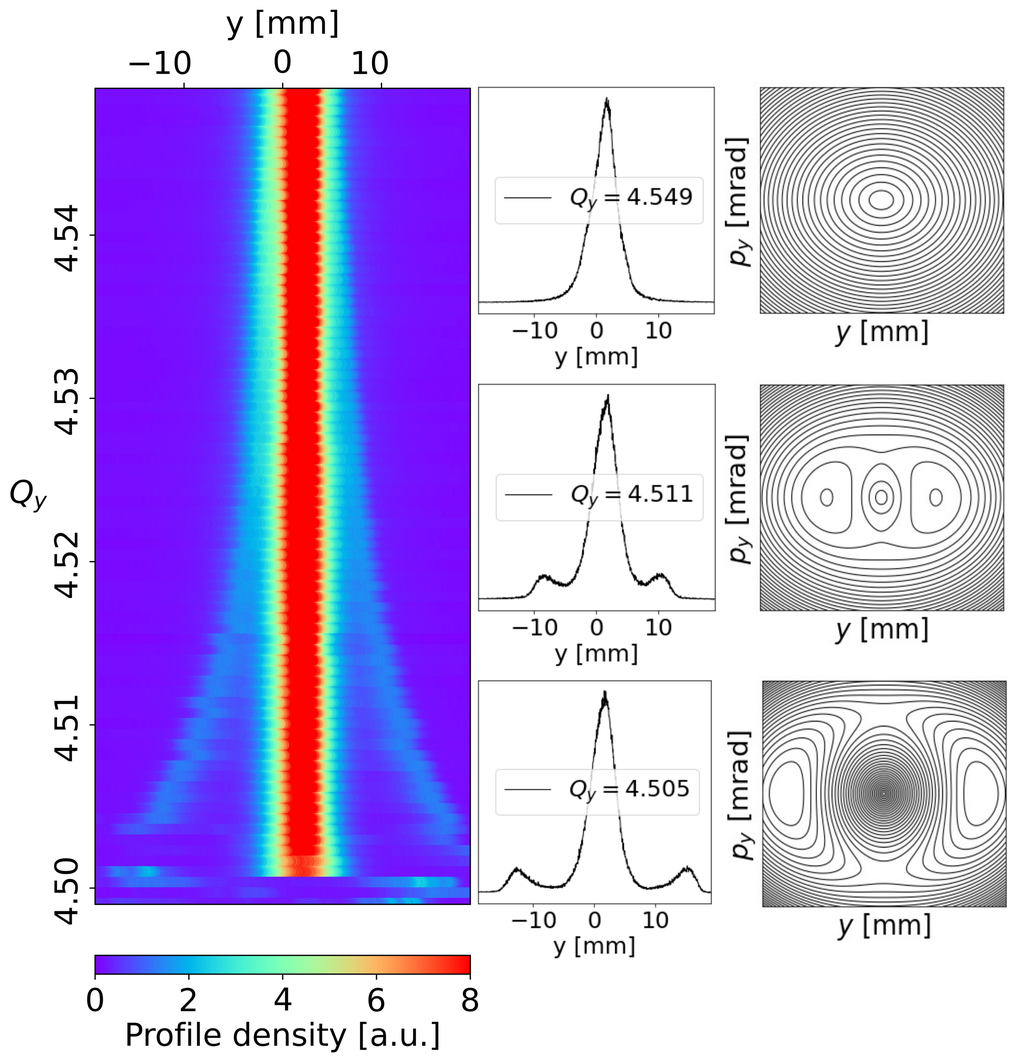
Objective is to increase beam brightness by mitigating emittance growth induced by integer resonances at $Q_{x,y} = 4$ due to large space charge tune spread.

Idea is to inject above the half-integer resonance $2Q_y = 9$ (i.e. far from the integer resonances) without having beam degradation.

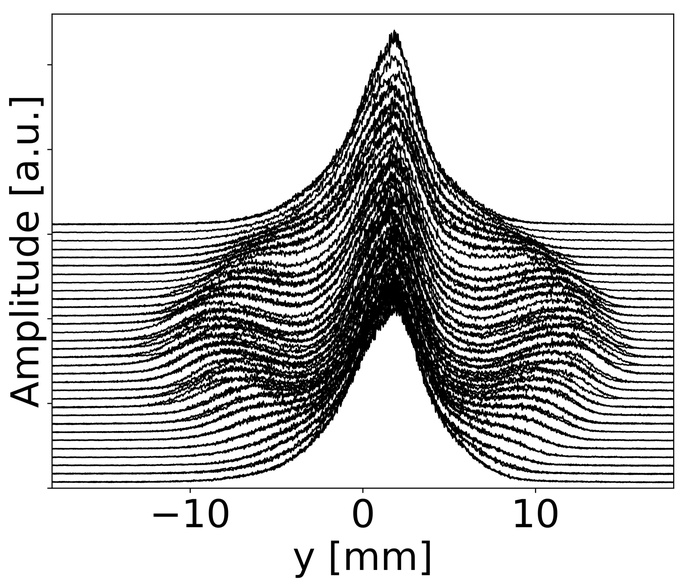
Studies to experimentally characterize the effects of space charge when dynamically crossing the half-integer resonance.

2. Particle trapping occurs during the half-integer resonance crossing with coasting beam under strong space charge:

- For $Q_y > 4.54$: beam is far from resonance → linear phase space → Gaussian vertical beam profiles.
- For $4.52 < Q_y < 4.54$: particles from beam core (largest detuning) interact with half-integer → amplitude detuning creates stable resonance islands near the center → islands appear in measured vertical profiles as two beamlets.
- For $Q_y > 4.52$: tune ramp continues → resonance islands (along with trapped particles) move outwards → beamlets separate from beam core and hit machine aperture.

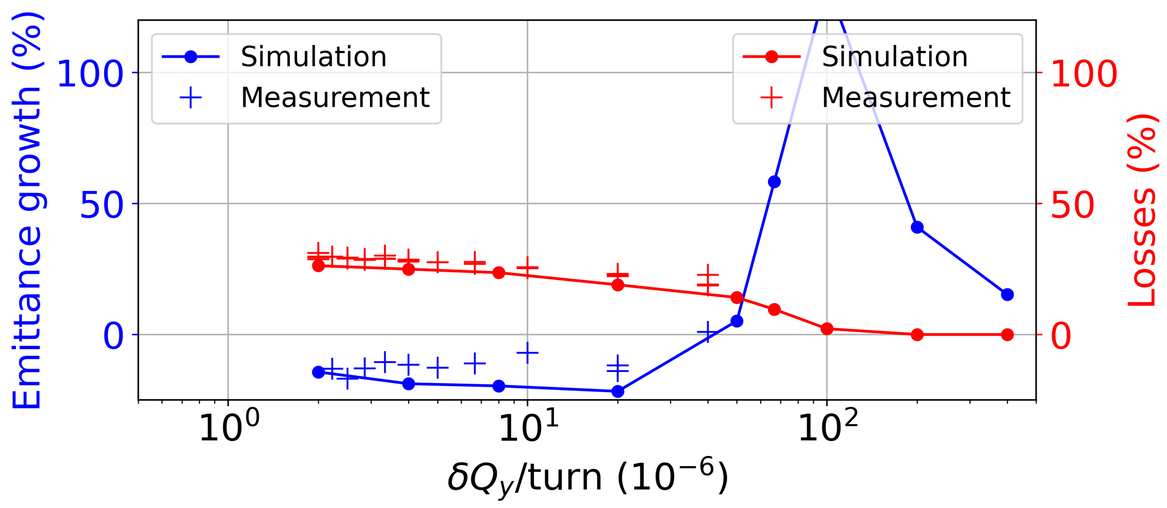


3. Phase space rotation Two families of quadrupole correctors create orthogonal driving terms to excite the half-integer resonance. By **rotating the excitation driving term**, the island structure in the phase space, at a fixed distance from the resonance, rotates. This rotation is seen in the measured vertical profiles.



4. Changing the crossing speed leads to different effects. After fully crossing the half-integer resonance:

- Slow crossing: **beam loss** (high probability of particle trapping)
- Fast crossing: **emittance blow-up** (small probability of trapping and higher of scattering)



5. Operationally beams have higher intensity and are bunched → effects from periodic resonance crossing are expected to dominate → subject of future studies.

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