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3rd order resonance at RHIC injection

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1 Beam decay close to the 3rd order resonances at injection

Experimental measurements of the beam decay of the Blue beam were carried out at two working points close to the 3rd order resonance [1]:

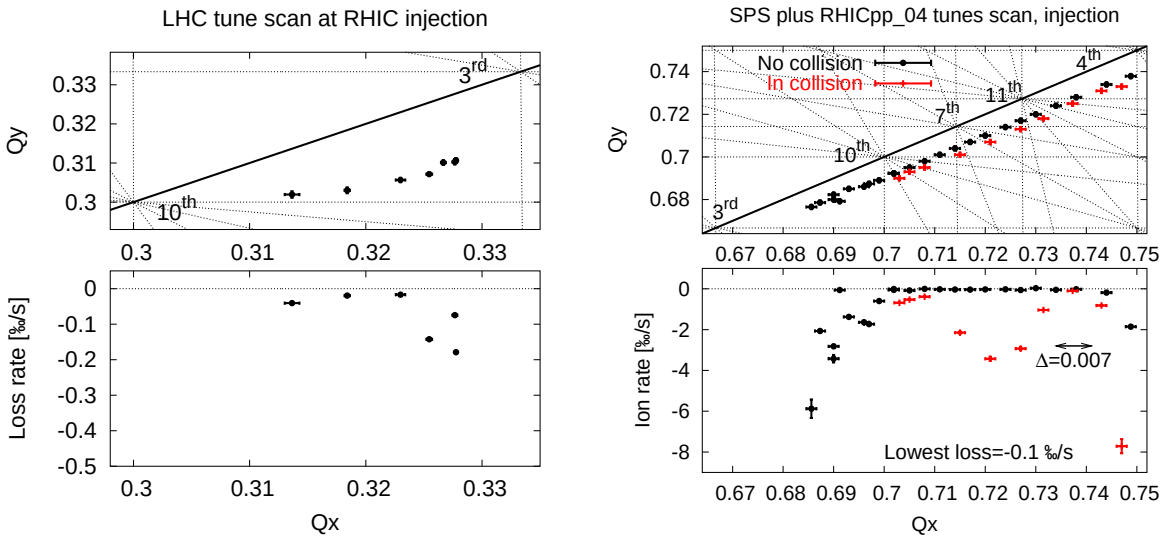

Figure 1: Tune scans in the Blue ring.

The fact that the beam lifetime was good at the LHC working point implies that the horizontal sextupolar resonance (3,0) cannot limit operation. On the other hand the vertical resonance (0,3) is seen in the SPS working point as a real limitation for machine operation. This resonance is driven by skew sextupoles and higher order multipoles. Nevertheless models including skew sextupoles at the interaction regions and at the dipoles do not predict such a large impact on beam stability.

2 Measurements of amplitude detuning and resonance terms

Measurements of the amplitude detuning were carried out in the Blue ring at injection, figure 2. Both horizontal and vertical amplitude detuning are negative, i.e. particles with larger amplitude have lower tunes. This amplitude detuning can only deteriorate the beam lifetime in the SPS working point (below the diagonal) since the tunes are above the resonance (0,3).

Figure 3 shows a measurement of the resonance (3,0) using an AC dipole and compared to the model [2]. The good agreement between them confirms that the horizontal resonance (3,0) does not threat operations.

3 Possible remedies

There are two options that would allow operation at the SPS working point:

1. Compensate the resonance (0,3) by minimizing spectral lines using skew sextupolar correctors.
2. Avoid the vertical resonance (0,3) by moving the tunes above the diagonal and use octupoles to introduce a positive amplitude detuning, see table 1.

Both options should in principle work. The second has the advantage of requiring shorter time than the first one.

dQx	383.73	-292.33	139.95	-90.79	octf-nodisp
dQy	-281.2	330.4	-109.96	119.85	octd-nodisp

Table 1: Amplitude detuning introduced by the arc octupoles [3].

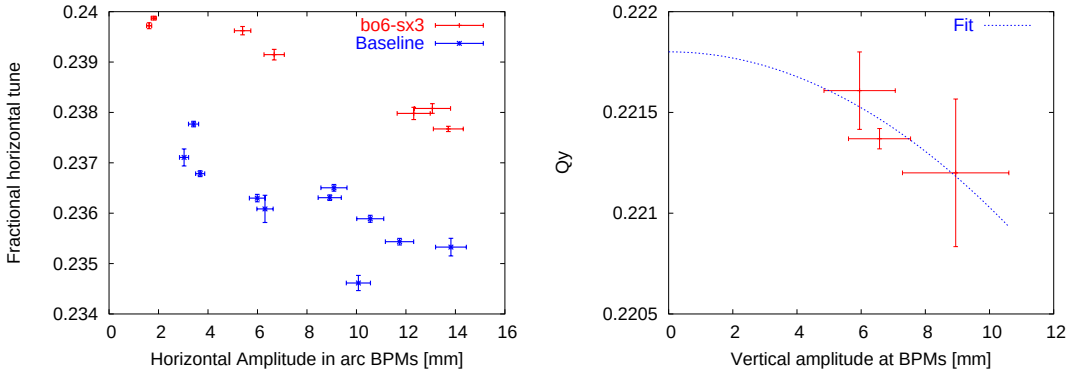

Figure 2: Horizontal and vertical amplitude detuning measurements at injection for the Blue ring.

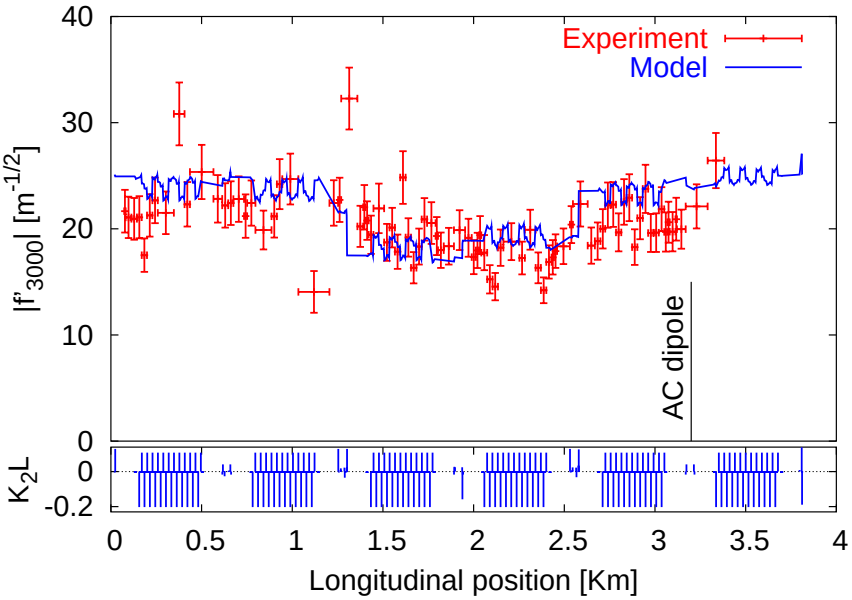

Figure 3: Measurement of f'_{3000} with an AC dipole for the Yellow ring with working point (0.31,0.22).

References

[1] R. Tomás et al. "Quest for a new working point in RHIC", EPAC 2004.

[2] R. Tomás et al. "Measurement of multipole strenghts from RHIC BPM data", EPAC 2004.

[3] Steven Tepikian, private communication, 2004.