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## Minimizing space charge tune spread and increasing beam quality parameters with circular modes

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Space charge has been a limiting effect for low energy accelerators inducing emittance growth and tune spread. Tune shift and tune spread parameters are important for avoiding resonances, which limits intensity of the beam. Circular modes are round beams with intrinsic flatness that are generated through strong coupling, where intrinsic flatness can be transformed to real plane flatness through decoupling. It is understood that flat beams increase the quality parameters of a beam due to one of the plane emittances being smaller than the other plane since luminosity and beam brightness depend inversely on the beam emittances. We show that circular mode beams manifest smaller space charge tune spread compared to uncorrelated round beams, which allows better systematic control of operating point of the beam. Minimized tune spread allows flexible operating points on the tune map. We also dedicate current and intrinsic flatness ratio limits on circular modes, which increase quality parameters without detrimental effects on the emittance increase.

### Footnotes

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