HOW TO TRY AND IMPROVE THE MACHINE / COMPLEX PERFORMANCE WHEN LIMITED BY SPACE CHARGE?

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- ◆ **-1) 2 extreme cases**
  - ▪ **Small beam in the vacuum chamber**
  - ▪ **Large beam in the vacuum chamber**
- ◆ **0) There is "no space charge limit" => 4 parameters are important**
  - ▪ **Space charge tune spread**
  - ▪ **Time spent with this tune spread**
  - ▪ **Allowed % of transverse beam emittance blow-up**
  - ▪ **Allowed % of beam loss**

- 1) **Keep constant or reduce bunch brightness N_b / ε (limit given by smallest beam size) => Optimization of the filling scheme (e.g. longitudinal bunch merging to double the brightness at higher energies but then less bunches, etc.)**

- 2) **Increase the bunch length or flatten the bunch profile (to reduce the peak intensity)**

- 3) **Increase the dispersion (to increase the beam size but keeping the small emittance)**

- 4) **Decrease the machine radius**

- 5) **Increase the beam energy**

- 6) **Reduce the time spent with the largest tune spread (e.g. inject with a Bdot)**

- 7) **Better injection process: painting (Liouville), H^- (> Liouville), etc.**

- 8) **Optimize the lattice (smoothness, effect of super-periodicity, etc.)**

- 9) **Resonances compensation => What about SC-induced resonances?**

- 10) **Find the best working point in the tune diagram (for the allowed % of beam loss and transverse emittance growth) => Both integer (Montague resonance, resonances less excited, etc.) and non-integer part**

- 11) **If unavoidable beam losses => Localize them on collimators**

- 12) **If transverse emittance blow-up => Cooling afterwards?**

- 13) **Use circular modes (limit given by largest beam size)**

- 14) **Inductive insert to compensate the longitudinal space charge**

- 15) **Transverse space charge compensation schemes as discussed for beam-beam (but distributed vs. localized)?**

- 16) **Interplay with other mechanisms (imped., e-cloud, beam-beam, cooling, etc.) / incoherent-coherent => SC can be beneficial (Landau damping, longer decoherence time, no TMCI, etc.)**

- 17) **Others?**