Resonance crossing and emittance growth

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Lattice

- 10 FODO cell without bends.
  - However, periodic boundary condition is imposed.
- Phase advance is about 90 deg. per cell.
- One inpulse gradient (or sextupole) error to excite harmonics.
  - Knob to control half (or third) integer resonance strength.
- No acceleration is included.

Method

- Tracking with independent variable of time (SIMPSONS).
- Linear change of all K1 simultaneously.
  - Slope can be variable.
- By single particle tracking
  - Phase space structure.
  - Time evolution of amplitude.
- By multi particle tracking
  - Define 68th particle amplitude out of 100 macro particles as 68% emittance.
  - Same for 90% emittance.

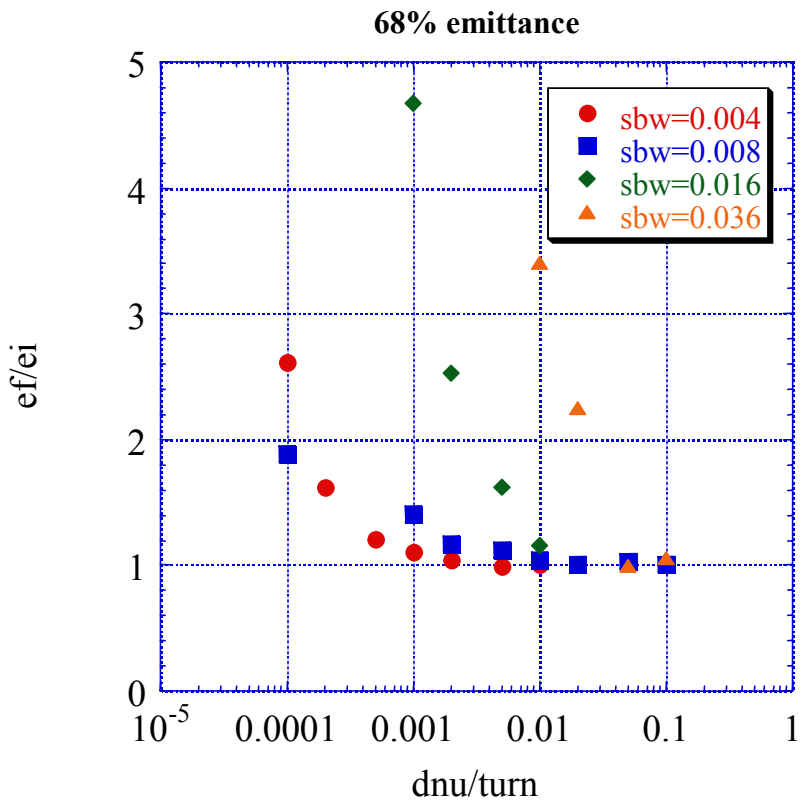
Half integer resonance

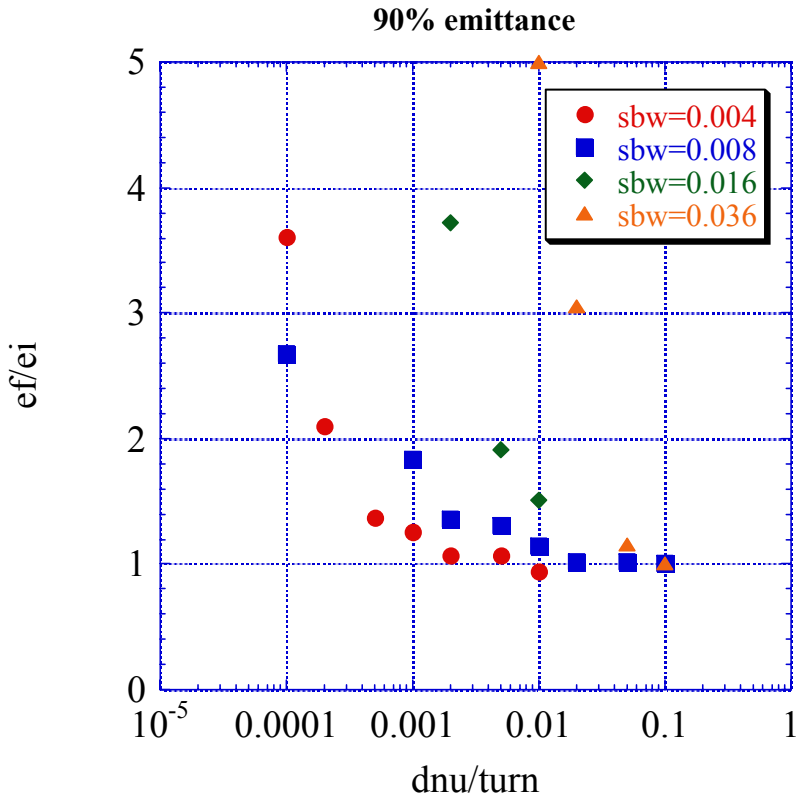
- Four different resonance width
  - sbw (stop band width)=0.004, 0.008, 0.016, 0.038
- Tune excursion
  - nux=2.37 to 2.55 linearly.
  - 2nux=5 is excited.
- Crossing rate (dnu/turn)
  - 0.0001/turn (slow) ~ 0.1/turn (fast)
- Horizontal only

Single particle behavior

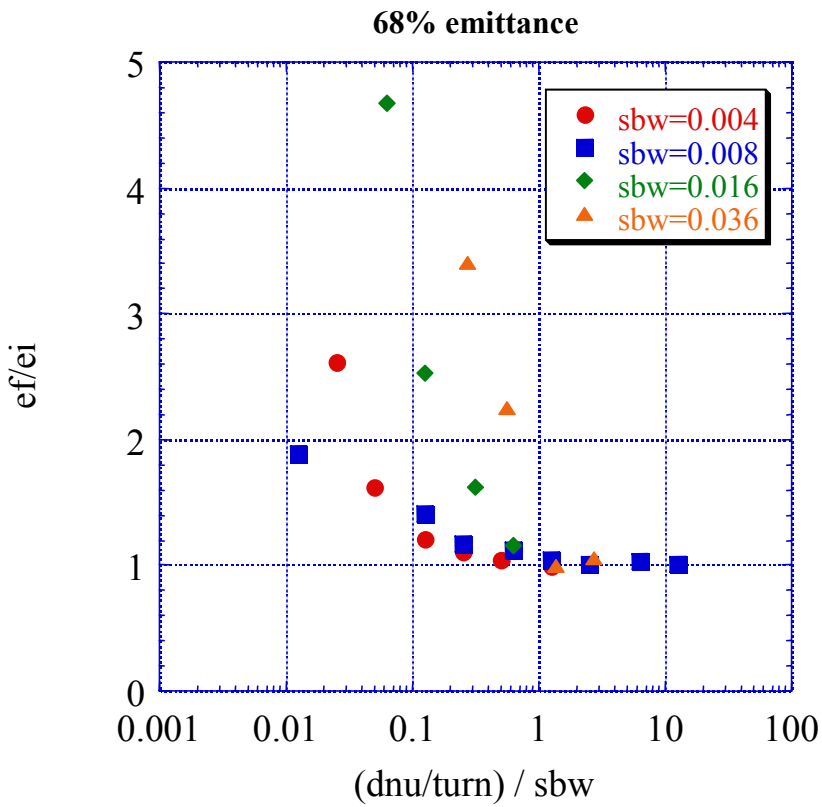
- Phase space (Poincare map)
- Evolution of ‘invariant’.
  - > see Mathematica notebook

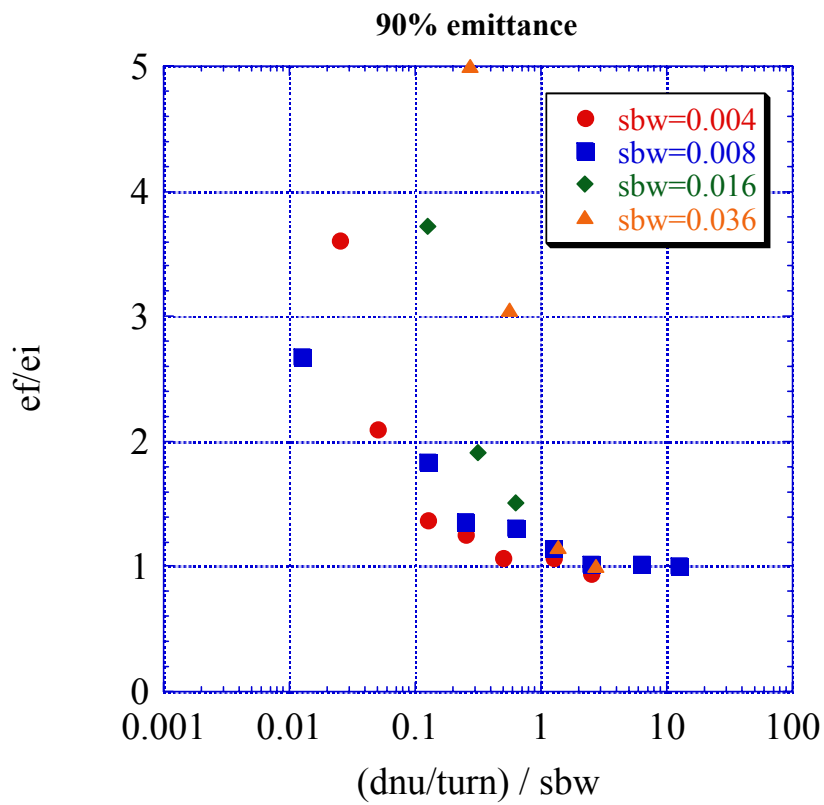
Emittance growth





Crossing speed is normalized



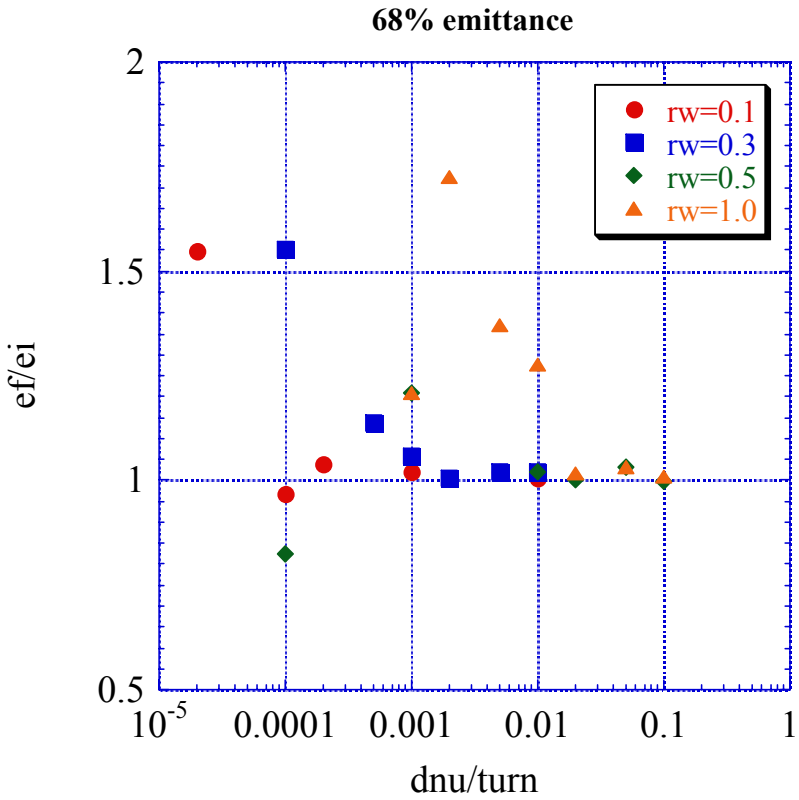


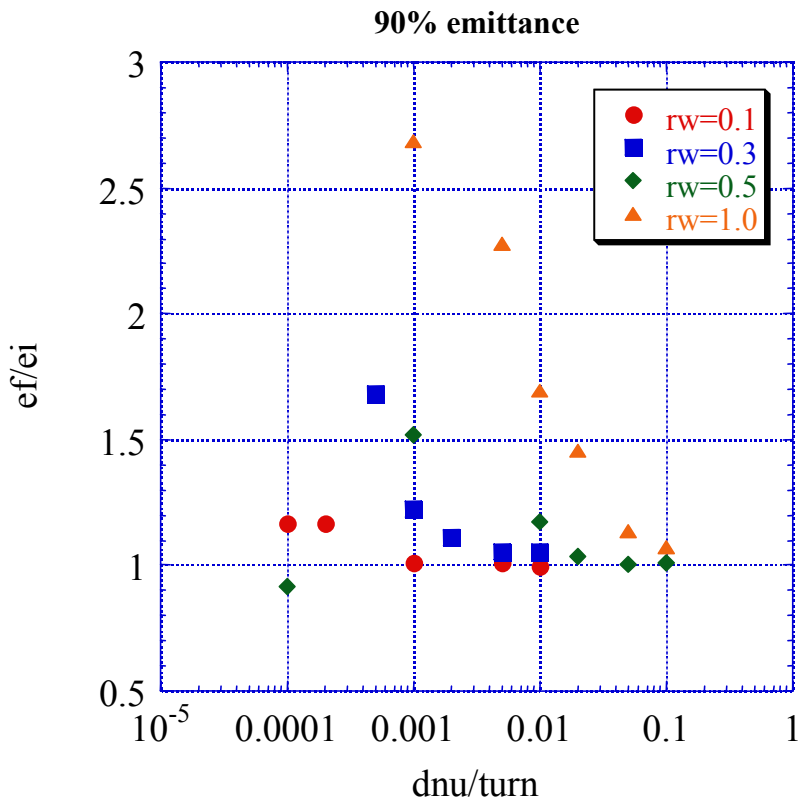
3rd integer resonance

- Four different sextupole strength
  - rw (relative width)=0.1, 0.3, 0.5, 1.0
- Tune excursion
  - nux=2.40 to 2.25 linearly.
  - 3nux=7 is excited.
- Crossing rate (dnu/turn)
  - 0.00002/turn (slow) ~ 0.1/turn (fast)
- Horizontal only

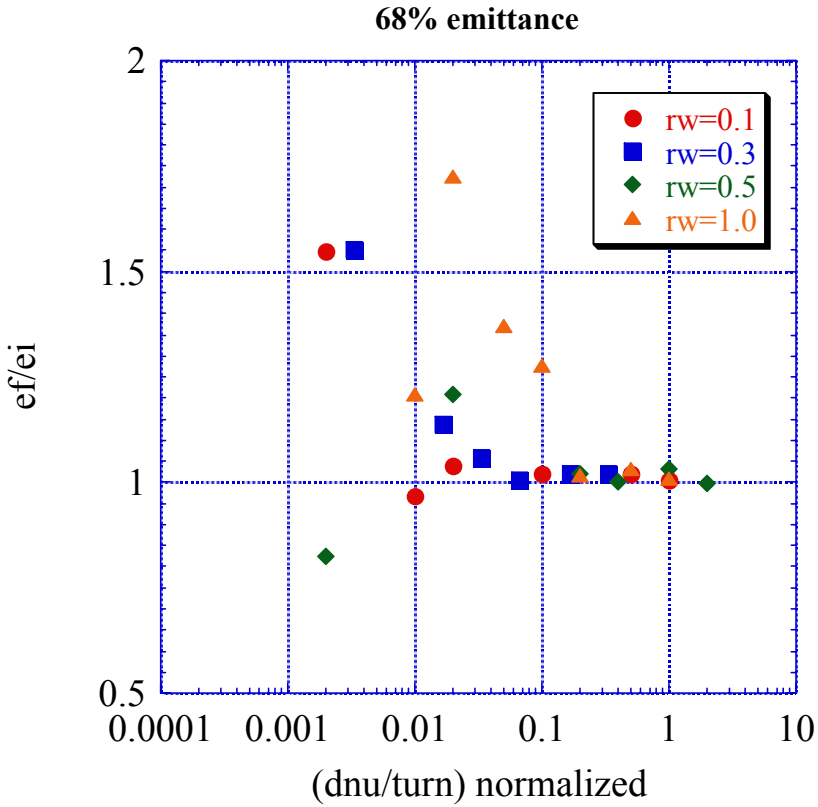
(with particle loss, emittance can be decreased.)

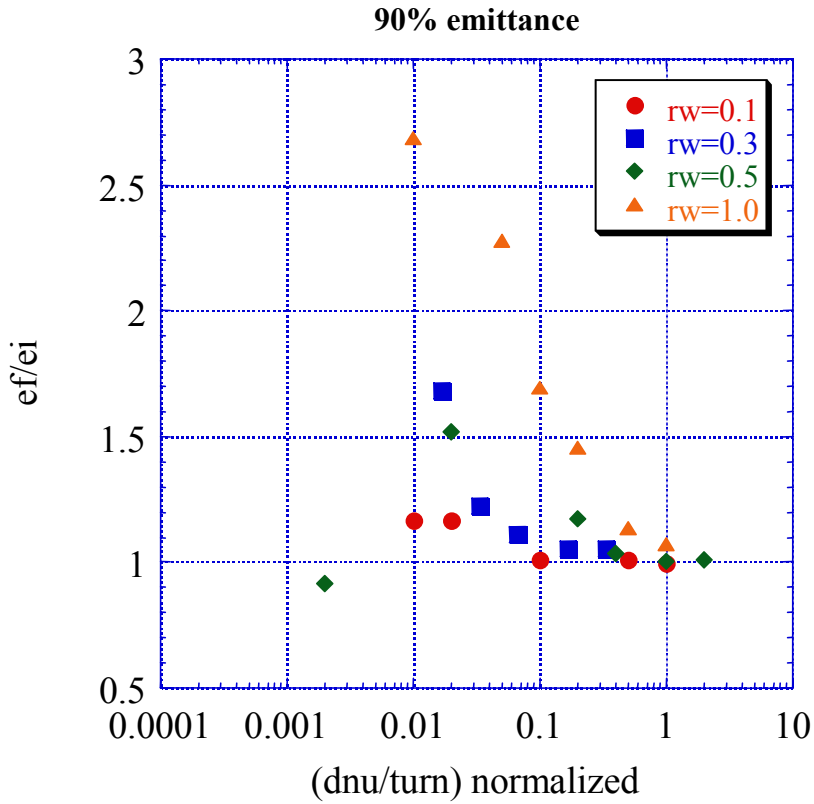
Emittance growth





Crossing speed is normalized





conclusion

- In half-integer crossing, almost no growth is observed when dnu/turn > resonance width.
- When dnu/turn < resonance width, growth becomes larger with wider resonance width.

- Similar in 3rd-integer crossing, but no clear dependence on the resonance strength.