

More
Machine Impedance and Instabilities
in the APS Storage Ring

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Storage Ring R&D Meeting

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PERFORMANCE ENHANCEMENTS RELATING TO COLLECTIVE EFFECTS

(in approx order of priority)

- Accurate impedance model !!
- Raise single bunch instability threshold (TMCI)
 - try increasing (double) dispersion in rf cavities
 - reduce effect of resistive wall impedance (reduce tune slope, $\Delta\nu/\Delta I$)
 - higher-conductivity small-gap vc's (surface coating)
 - even smaller $\beta_{x,y}$ at ID vc's
 - reduce ϵ_x with $+\Delta f_{rf}$
 - longer bunch? More δ_p ? (in principle)
 - bunch-by-bunch feedback system
 - Landau rf cavities (higher-harmonic)
- Raise single bunch accumulation limit
 - damp TMCI
 - longitudinal injection
 - remove 5-mm vc...
- Raise longitudinal single-bunch thresholds?

PROS/CONS

- Landau cavities
 - flexibility to lengthen OR shorten bunch
 - increase lifetime (e.g. 3x at ALS)
 - operating with Landau cavities tricky: longitudinal Robinson instabilities observed at ALS and Aladdin (sawtooth instability)
- Bunch-by-bunch feedback
 - can store single bunch current up to accumulation limit (probably raise that, too)
 - can also be used for SR bunch cleaning

SINGLE BUNCH MODEL NEEDED

- Recent studies with low emittance lattice give very different single-bunch horizontal instability characteristics (I_{TMC1} threshold & effect of V_{rf})
- We *don't have an impedance model* to reproduce results!!

| | 7.5 nm-rad | 3.9 nm-rad |
|----------------|----------------------|--------------------|
| ξ_x, ξ_y | $(3.5, 6.5) \pm 0.5$ | $(5, 6.5) \pm 0.5$ |

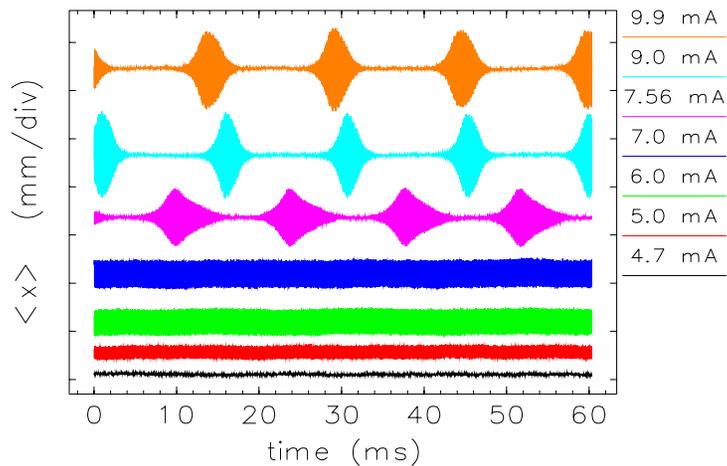
I_{TMC1} thresh (mA)

| | | |
|---------------|----------------------|-----------------------|
| 9.4 MV | 5.0 | 6.7 |
| 7.3 MV | 5.2 ($\Delta=5\%$) | 8.3 ($\Delta=25\%$) |

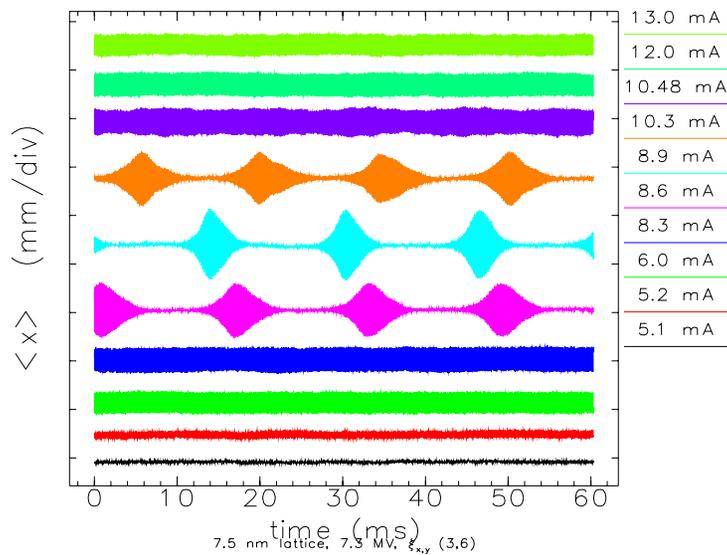
Single bunch accumulation limit (mA)

| # 5-mm ID vc | 0 | 1 | 2 | 2 |
|---------------|----|----|---|-----|
| 9.4 MV | 12 | 10 | 8 | 8.1 |
| 7.3 MV | 17 | 13 | – | 8.6 |

7.5 nm-rad

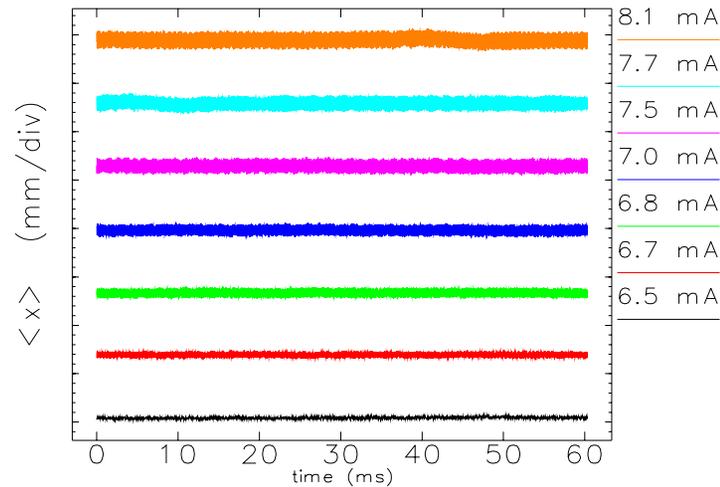


7.5 nm lattice, 9.4 MV, $\xi_{x,y}$ (3,6)

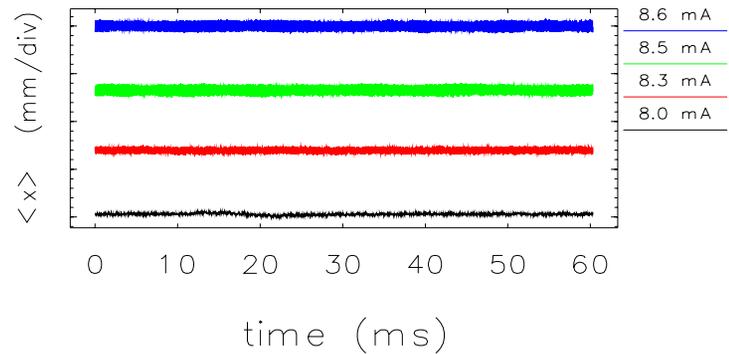


7.5 nm lattice, 7.3 MV, $\xi_{x,y}$ (3,6)

3.9 nm-rad



3.3 nm lattice, 9.5 MV, $\xi_{x,y}$ (4-5,6)



3.3 nm lattice, 7.3 MV, $\xi_{x,y}$ (4-5,6)