

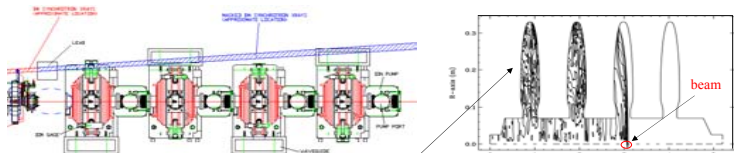


Abstract : One of long-term goals in operating the APS storage ring is raising the single bunch current limit. We take a three-step approach in order to accomplish this goal:

1. Obtain detailed knowledge of the impedance in the ring → **Impedance Database**
2. Explain and reproduce the phenomena observed in the ring via simulation → **Experiment vs. Simulation**
3. Propose and implement specific methods to increase the single bunch current → **Longitudinal Injection**

I. IMPEDANCE DATABASE

Impedance Elements



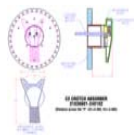
Wakefield generated by the interaction by the beam and rf-cavities



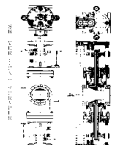
ID Chamber



Flag Chamber



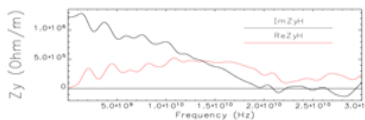
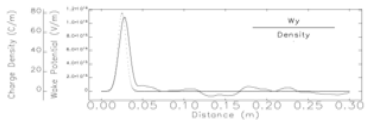
Synchrotron Radiation Absorber



Beam Scraper

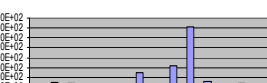
- The APS Storage ring has many Impedance Elements
- The impedance elements generate the “wakefield” behind the beam
- Definition
 1. Wakepotential: integrated effect of wakefield
 2. Impedance: fourier transform of wakepotential
- Wakepotential/Impedance limits total current stored in the ring
- We study the impedance induced collective phenomena via experiment, simulation, and theory.

Total Impedance



Impedance Database developed for the APS storage ring provides detailed knowledge of wakepotential and impedance in the ring; this work greatly extends the existing **Impedance Budget**.

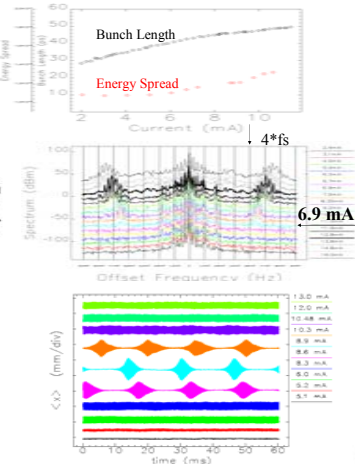
Vertical Impedance (kOhm/m)



Breakdown of Impedance Database is **Impedance Budget**; its value represents the DC impedance of each element; it shows that **insertion device chambers** are the dominant source of vertical impedance in the ring.

II. Experiment vs. Simulation

Experiments

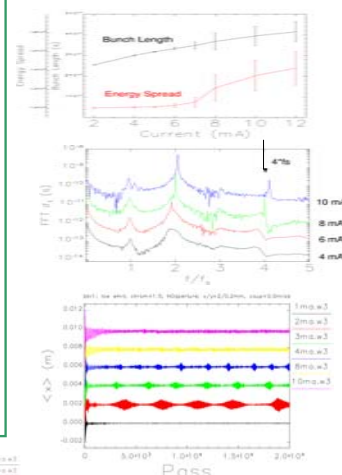


Experimental data provided by Y. Chae, L. Emery, K. Harkay, A. Lumpkin, J. Song, B. Yang.

Comparisons

- Vertical Tune Slope: good agreement with V. Sajaev's tune shift measurement by orbit response method developed for the APS storage ring
- Bunch length and energy spread: good agreement
- Bunch spectrum of microwave instability: good agreement
- Response of kicked beam: good agreement in beam centroid and tune spectrum
- Response of kicked beam: comparison of beam size in progress
- Horizontal saw-tooth instability: qualitatively good agreement showing stable to bursting to steady state increasing the current

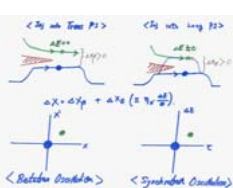
Simulations



If horizontal saw-tooth instability is not cured, it will increase the horizontal emittance; turn-by-turn beam size variation in saw-tooth instability simulation is shown in the figure.

III. Longitudinal Injection

Longitudinal Injection Scheme

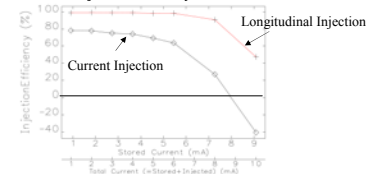


Longitudinal Injection Scheme

Proposals to Increase Single Bunch Current Limit

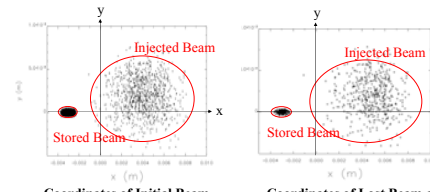
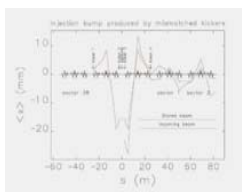
- Reduce the impedance
- Implement feedback system
- Negative momentum compaction lattice
- Longitudinal Injection
- More

Injection Efficiency vs. Current



Injection Efficiency Improved in simulation !

Current Injection Scheme



Coordinates of Initial Beam

Coordinates of Lost Beam at

- ➔ Reduce the Beam Loss
- ➔ Reduce the Separation
- ➔ Longitudinal Injection