Preliminary results on simulation of fast-ion instability at 3 km LBNL damping ring

21 April 2005

Pohang Accelerator Laboratory

Eun-San Kim

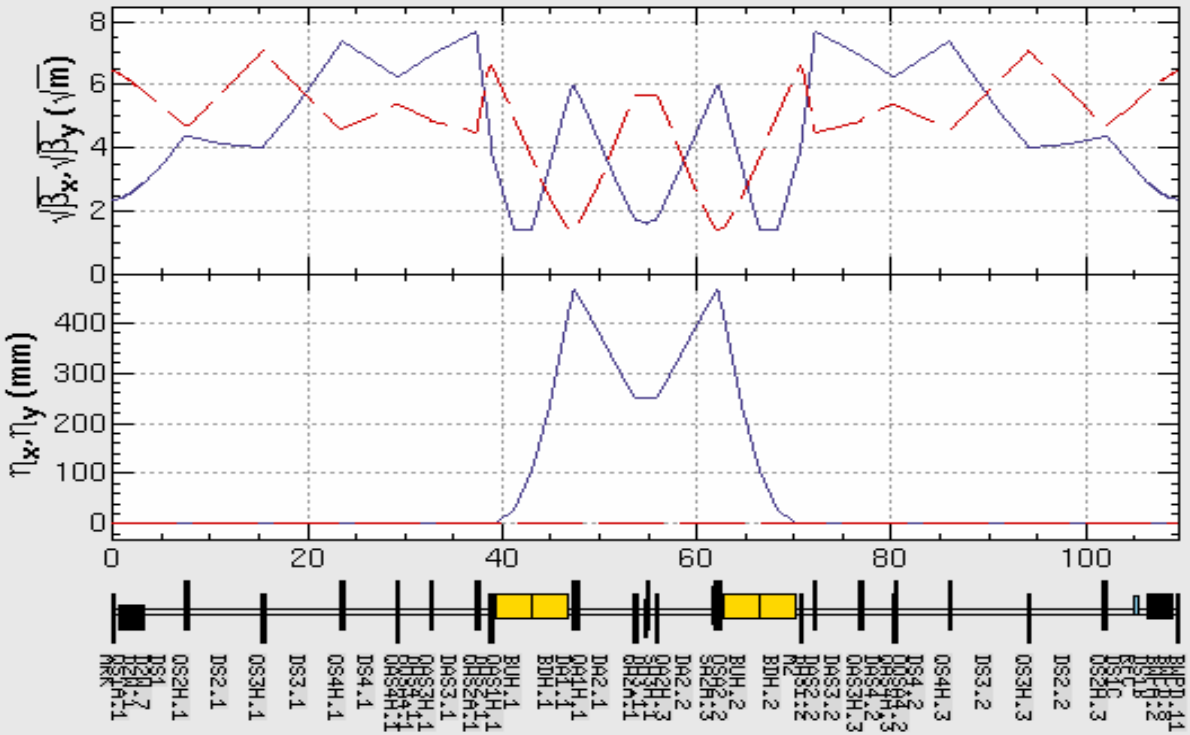
Main parameters of the damping ring

- Energy : 5 GeV
- Circumference : 3043 m
- RF voltage : 13.12 MV
- RF frequency : 650 MHz
- Harmonic number : 6598
- Natural emittance : 0.616 nm
- Horizontal/vertical damping time : 19 ms/19ms
- Longitudianl damping time : 9.5 ms
- Natural bunch length : 6 mm

Beam parameters

- **Particels per bunch : 2×10^{10}**
- **Number of bunches : 2820**
- **Bunch spacing : 3 ns**
- **Bunches per train : 94**
- **Bunches per gap : 16**
- **Number of bunch trains : 30**
- **Average current : 890 mA**
- **Ion density at bunch train : 1200/m**

One cell lattice for LBNL 3km damping ring (A. Wolski)



By SAD version

The lattice consists of 28 DBA cells.

Simulation method (1)

- **Weak-Strong model** **- A**
  weak beam of ions is expressed by macroparticles.
  - **Only barycenter motion of strong electron beam is considered.**
- **No effect of magnetic field.**

  Interaction between a bunch and ions by Bassetti-Erskine formula. =30m hhh
- **One ionization point is considered in the ring.**
- **All bunches are initially set to zero displacement.**
- **New macro-ions are generated at the transverse position (x,x',y,y') of the bunch with a Gaussian distribution.**
- **Incoherent motions of ions can be obtained.**
- **Incoherent motions of electron beam can, such as emittance growth, cannot be computed.**

Simulation method (2)

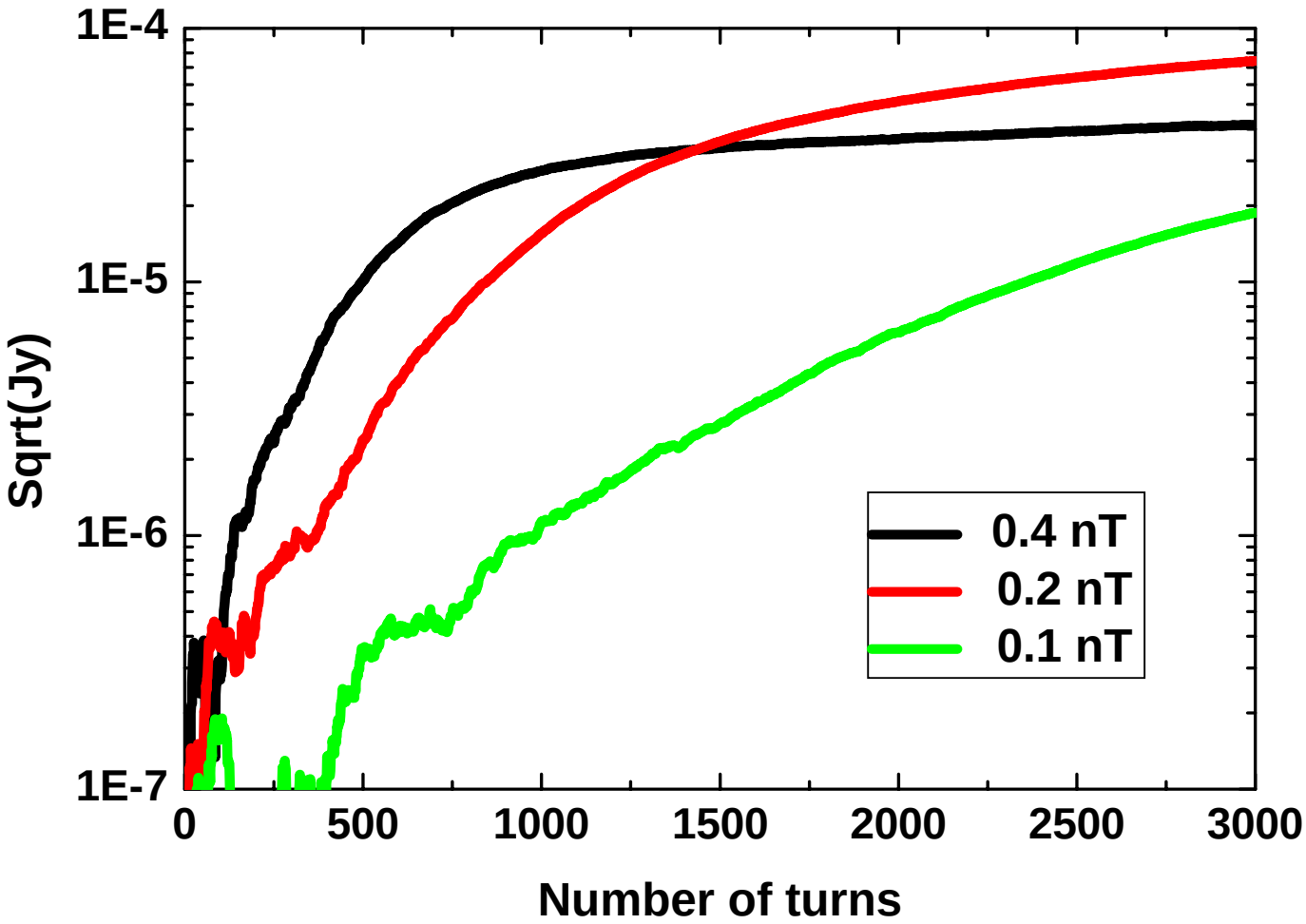
30 trains exist in the designed ring and harmonic number is 6598.

↓ **for fast simulation**

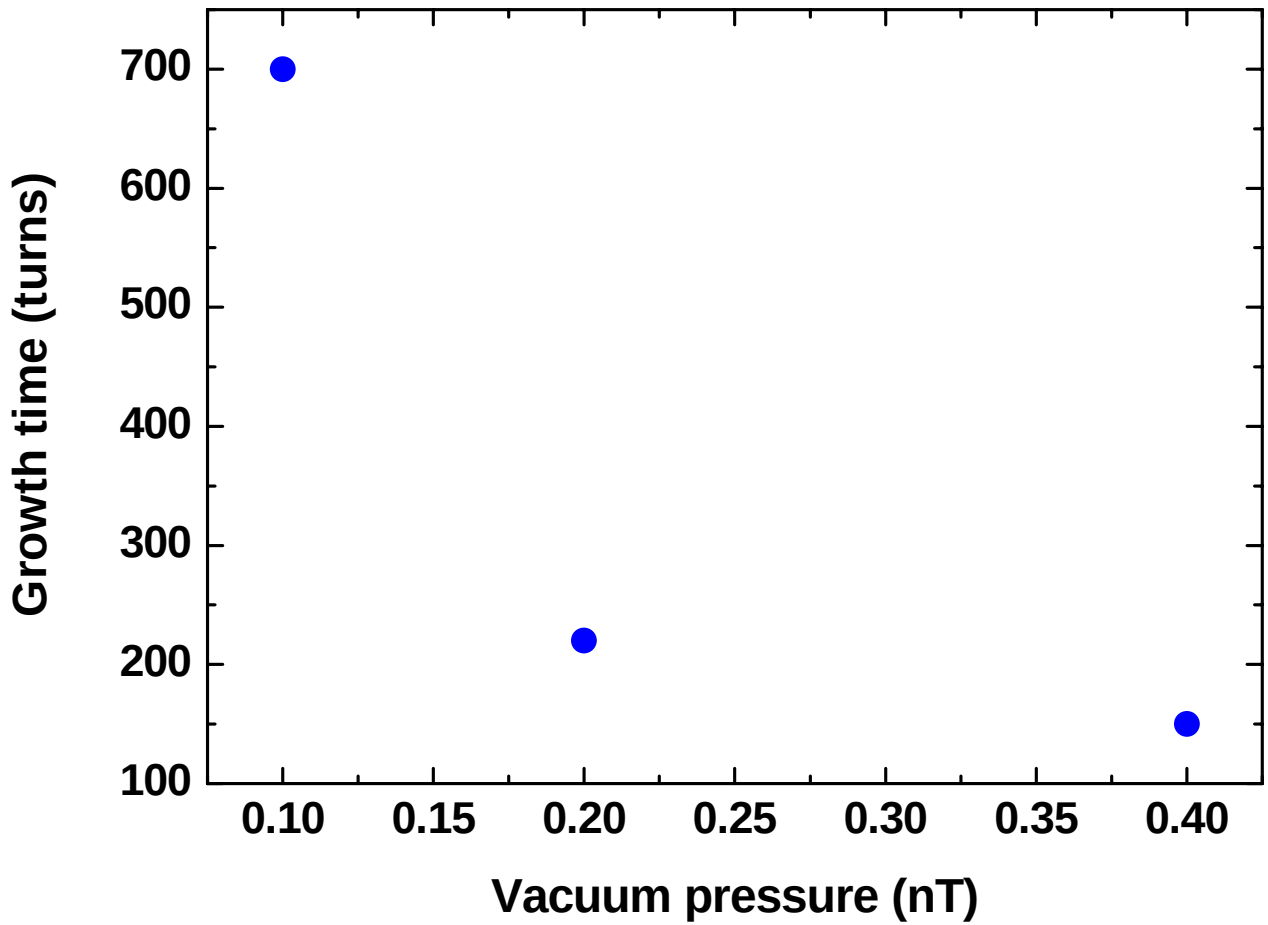
Only 1 train and harmonic number of 6598 / 30 are used in our simulation.

1 train includes 94 bunches and 16 empty buckets.

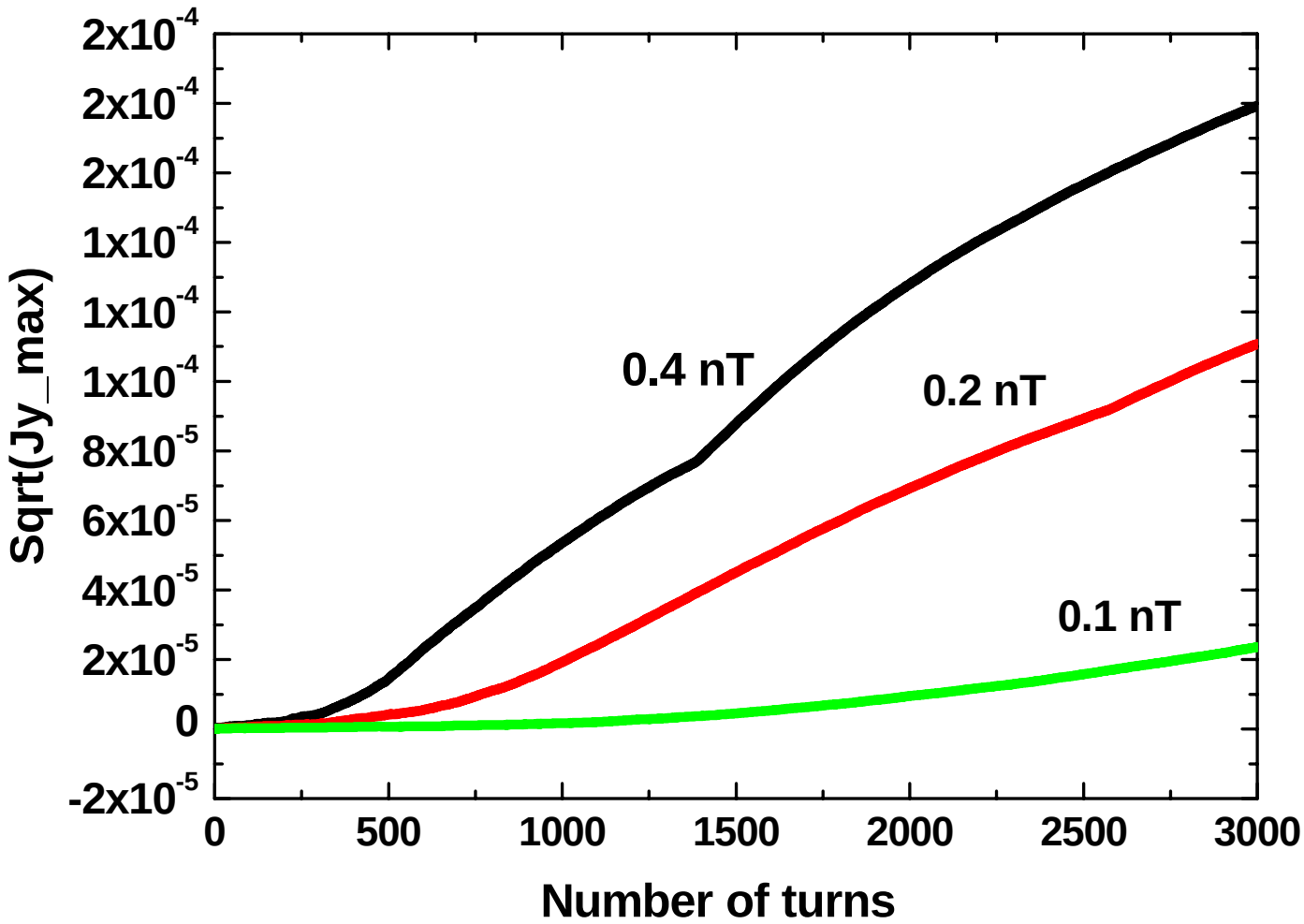
Amplitude of last (94th) bunch in train



Exponential growth time vs vacuum pressure



Maximum amplitude of the bunches



Summary

- We performed weak-strong simulations to show aspects of fast-ion instability in the 3 km LBNL DR.
- Preliminary results show that we need to consider bunch by bunch feedback system to suppress the beam instability in the vacuum pressure of 0.1 nT.
- Further simulations need to be performed and strong-strong simulation will be also performed to predict blow-up of beam emittance.