

FFAG for next Light Source

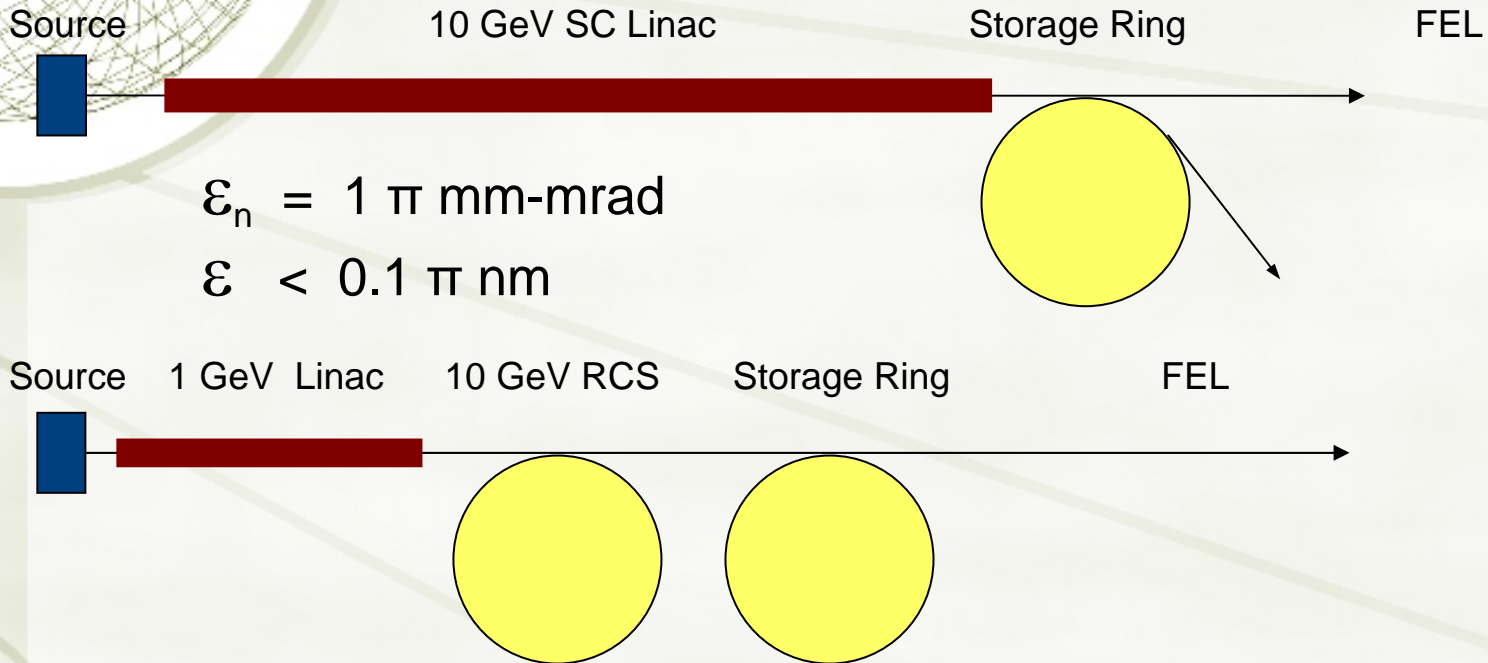
Alessandro G. Ruggiero

Semi-Annual FFAG-2006 Workshop

May 15 - 19, 2006

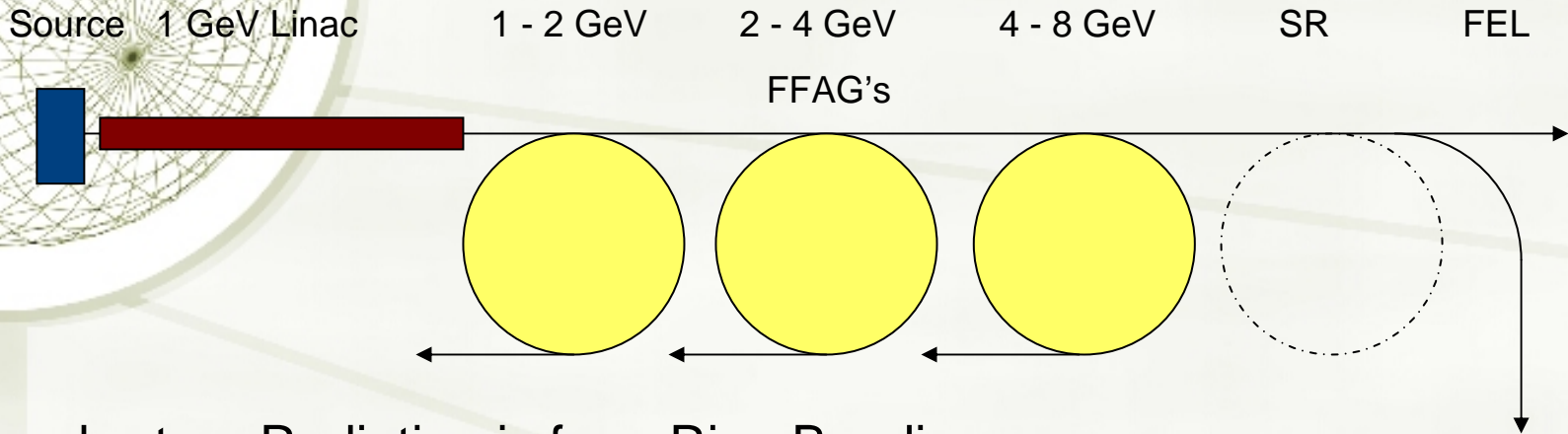
Components: 10 mA - 8 GeV

Brilliance --> Source + Lattice Properties



Damping Time + Quantum Fluctuation

FFAG Rings for Acceleration and Storage



Synchrotron Radiation is from Ring Bending.

Beam Brilliance is determined originally by the Source

The Ring Lattice can only decrease the Brilliance

Quantum Fluctuation makes the Brilliance even smaller.

The goal is to minimize acceleration and storage time so that the Beam spends in FFAG's a period of time smaller than the Damping Time.

FFAG's have large Momentum and Betatron Acceptance. And are DC

FFAG Rings at Injection



FFAG

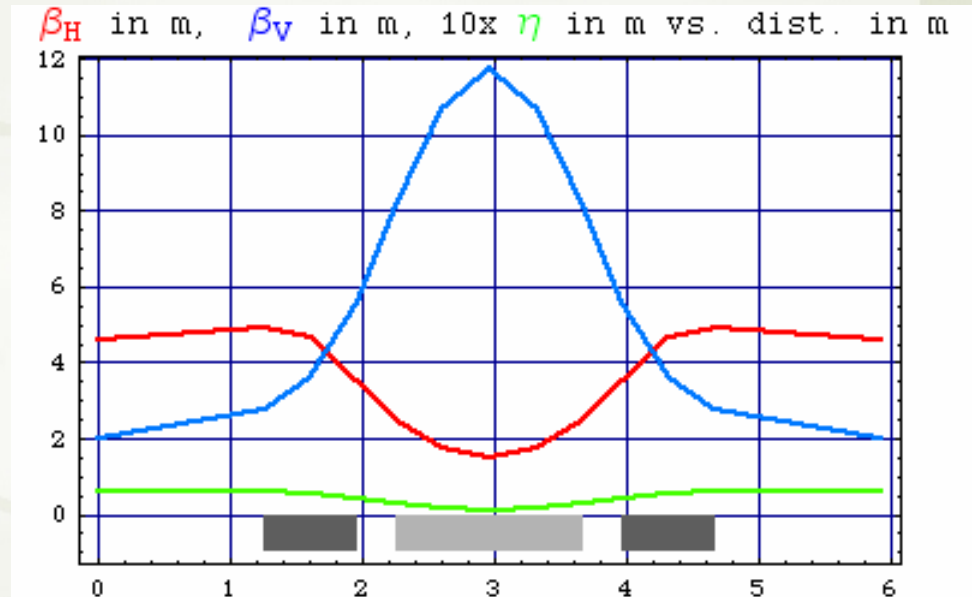
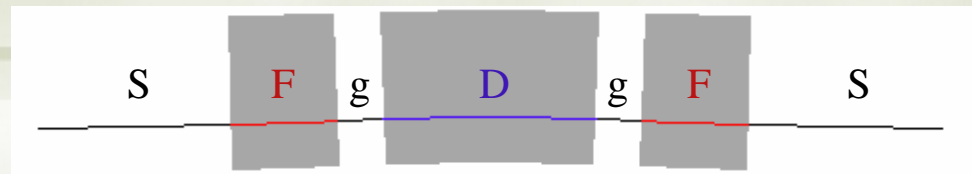
Circumference, m 807.091
 Periodicity 136
 Period Length, m 5.9345
 Long Drift S, m 2.5345
 Short Drift g, m 0.300

F-Sector Magnet

Length, L_F , m 0.700
 Bend Field, kG
 Gradient, kG/m

D-Sector Magnet

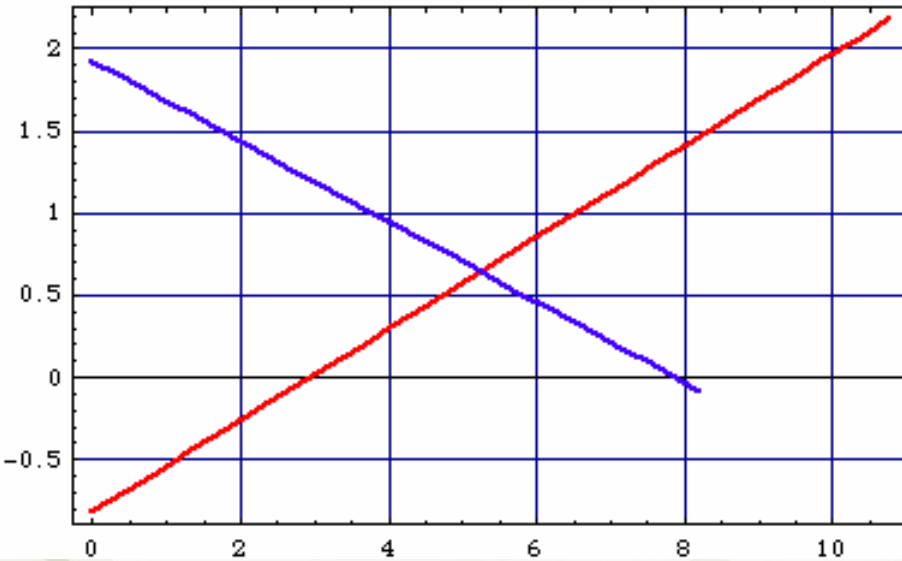
Length, L_D , m 1.400
 Bend Field, kG
 Gradient, kG/m



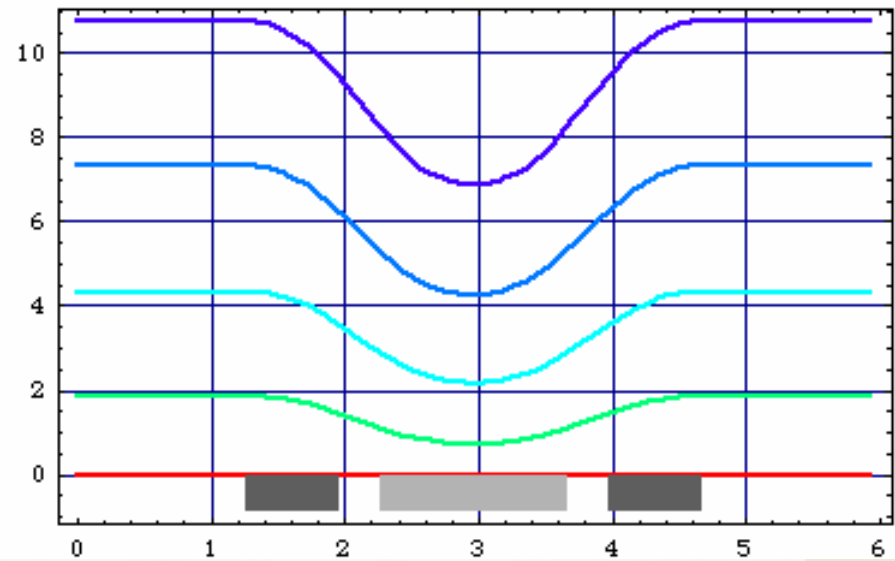
Phase Advance / Period, H / V	105° / 100°
Betatron Tunes H / V	39.76 / 37.75
Transition Energy, γ_T	-1105.5
Max β value, H / V, m	4.9 / 11.8
Max dispersion, η	6.0 cm
Chromaticity, H / V	-0.925 / 1.814

FFAG-1 1 - 2 GeV

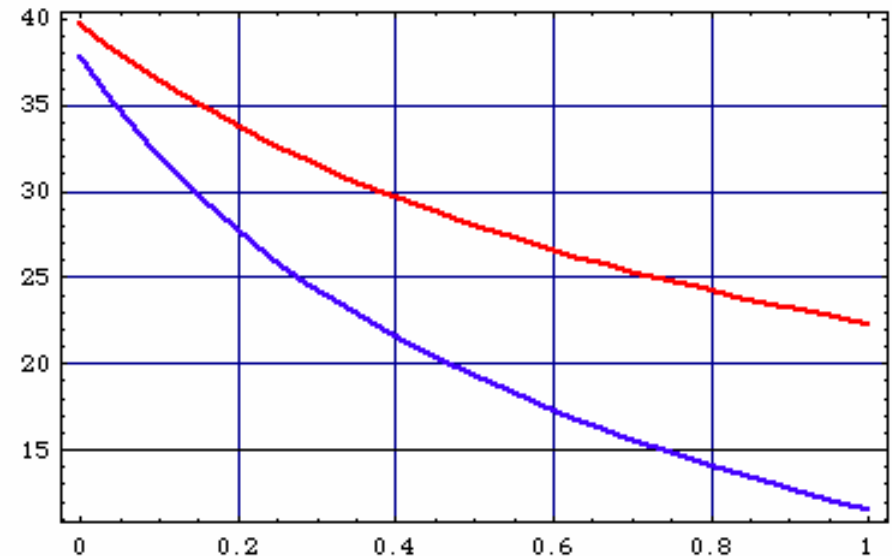
(Red) F-Sector (Blue) D-Sector



(Red) Injection (Blue) Ejection



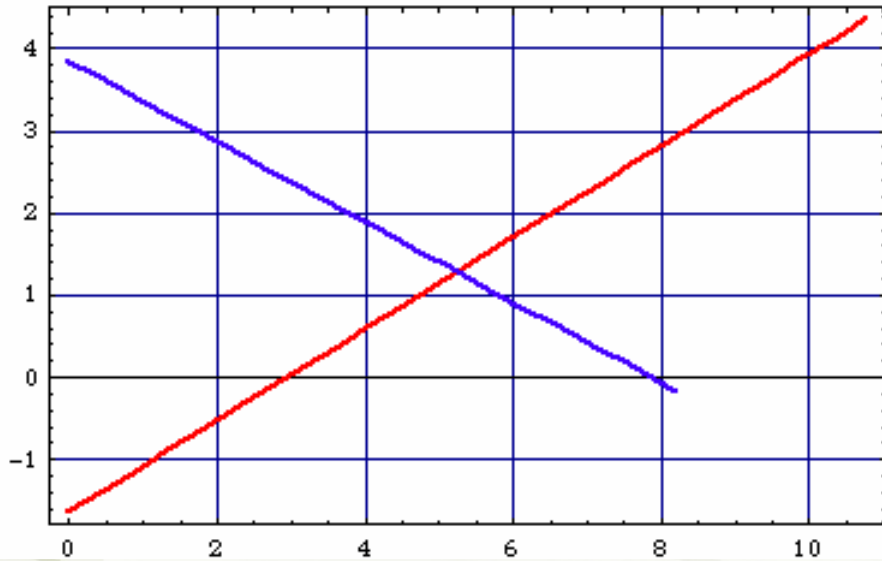
Betatron Tunes Q_H and Q_V versus δ



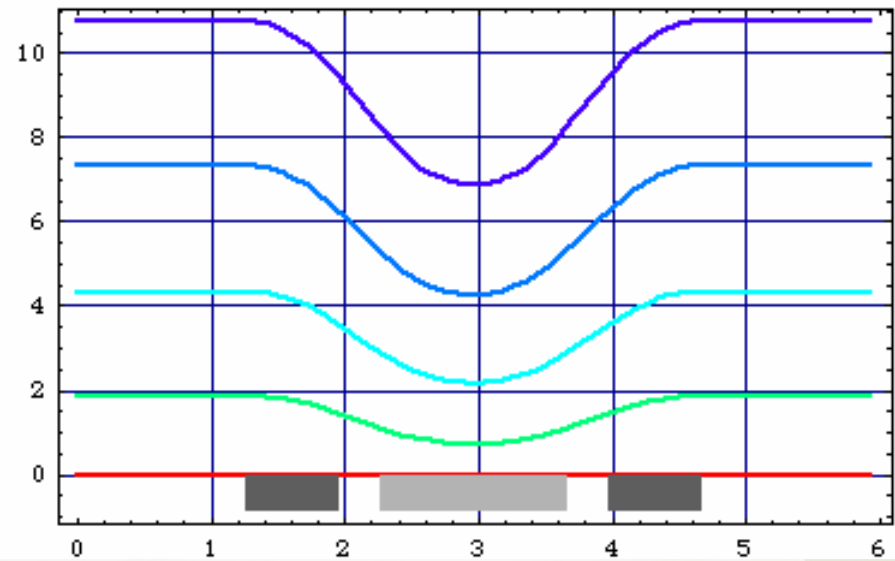
RF	201.2 MHz
h	542
Energy Gain	100 MeV/turn
Accel. Period	29.62 μ s
No. of Revol.	11
Damping Time	< 55,378 μ s
Energy Loss	< 0.118 MeV/turn

FFAG-2 2 - 4 GeV

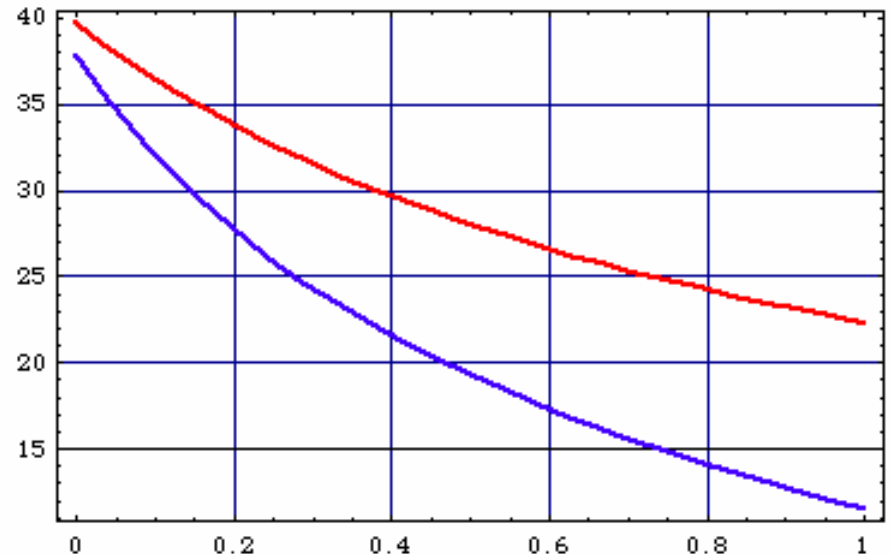
(Red) F-Sector (Blue) D-Sector



(Red) Injection (Blue) Ejection



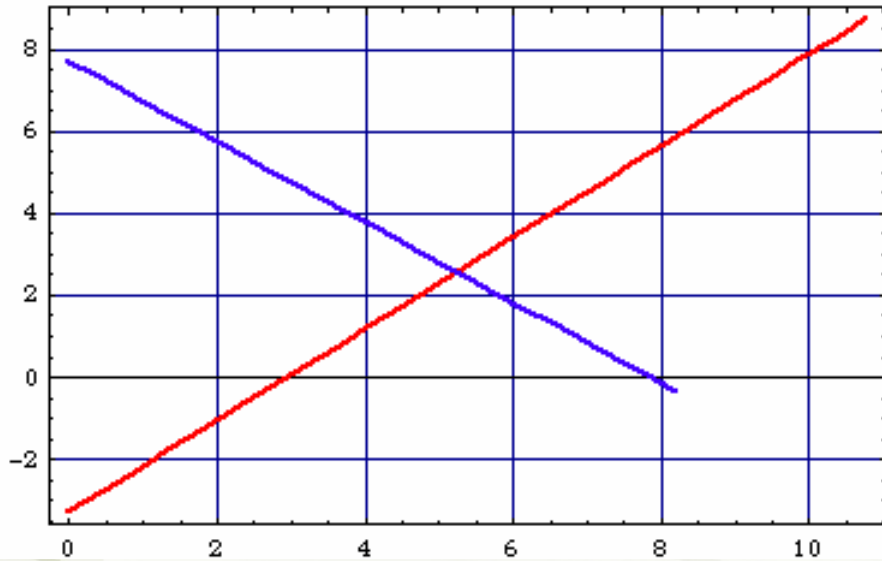
Betatron Tunes Q_H and Q_V versus δ



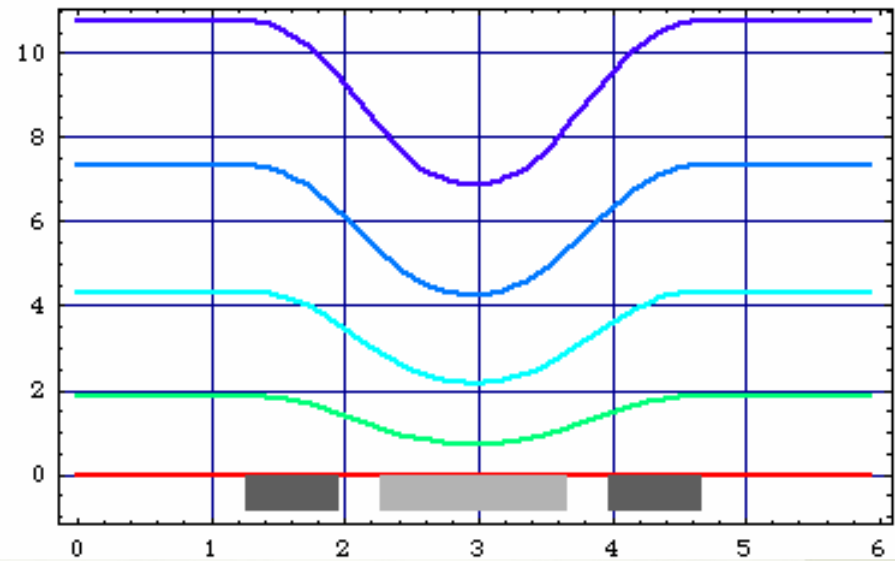
RF	201.2 MHz
h	542
Energy Gain	100 MeV/turn
Accel. Period	56.55 μ s
No. of Revol.	21
Damping Time	< 6,921 μ s
Energy Loss	< 1.697 MeV/turn

FFAG-3 4 - 8 GeV

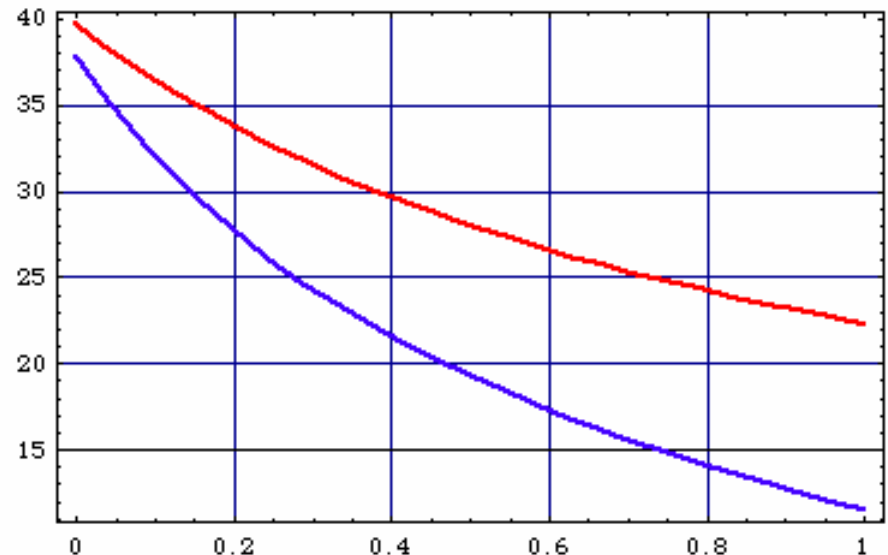
(Red) F-Sector (Blue) D-Sector



(Red) Injection (Blue) Ejection



Betatron Tunes Q_H and Q_V versus δ



RF	201.2 MHz
h	542
Energy Gain	300 MeV/turn
Accel. Period	37.70 μ s
No. of Revol.	14
Damping Time	< 865.1 μ s
Energy Loss	< 25.8 MeV/turn

FFAG-3 as Storage Ring at 8 GeV



Acceleration
40 μ s

Storage

460 μ s
(500 μ s)

Rep Rate 2 kHz

Duty Cycle 92%

Or use SR for 100% d.c.

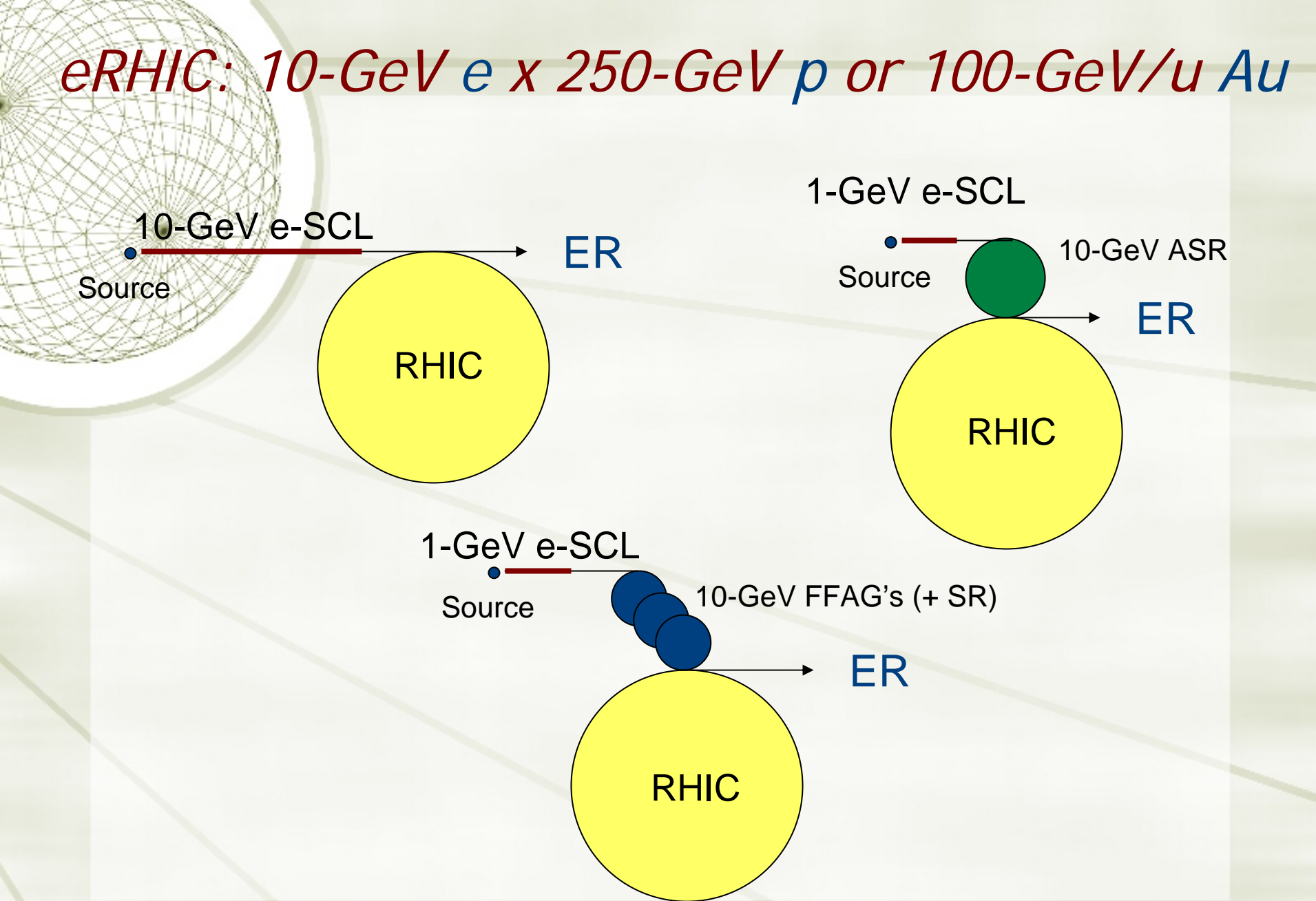
Energy Recovery

**That requires deceleration maybe in
the same FFAG rings**

The Storage Period 460 μ s is smaller than
Damping Time 870 μ s

No Quantum Fluctuation Effects !!

eRHIC: 10-GeV e x 250-GeV p or 100-GeV/u Au





Conclusions

Final Energy	8 GeV
Average Current	10 mA
Beam Power	80 MW
Power Loss during acceleration	8%
No Quantum Fluctuations	
Beam Brilliance at the Source preserved	
No Space Charge	
No Touscheck Lifetime	
FDF Triplet Lattice ideal for SR	
2.5 m Drifts for RF Cavities and Insertion Devices	
Very reasonable SRF system	