Design of the New Storage Rings

P. Beller

Workshop on Atomic Physics Research at the Future GSI Facility

December 9 - 10, 2002

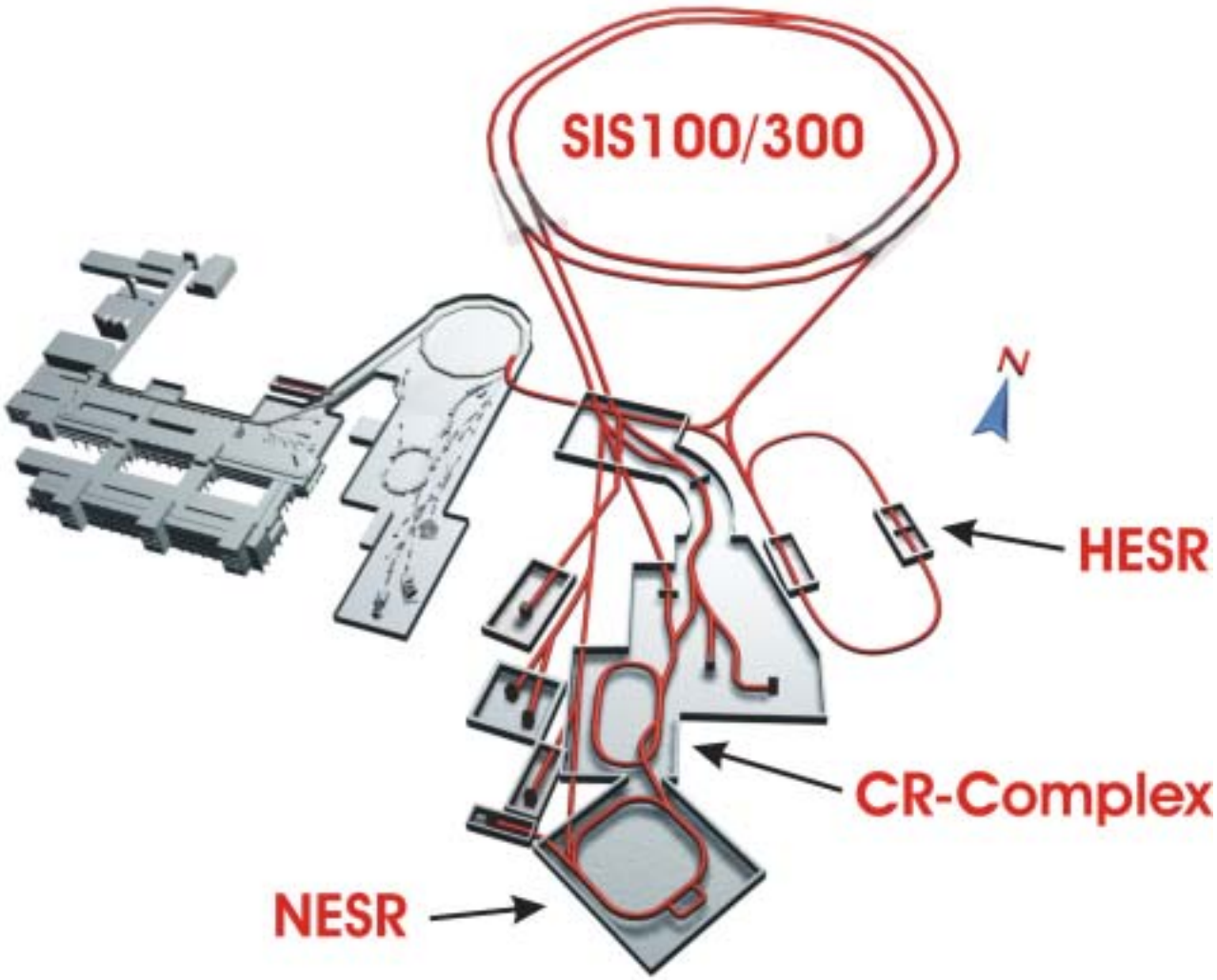
Physics at the New Storage Rings

a. Physics with Rare Isotope Beams
   - Stochastic Precooling
   - Electron Cooling
   - Fast Deceleration
   - In-Ring Experiments
   - Isochronous Mass Measurements

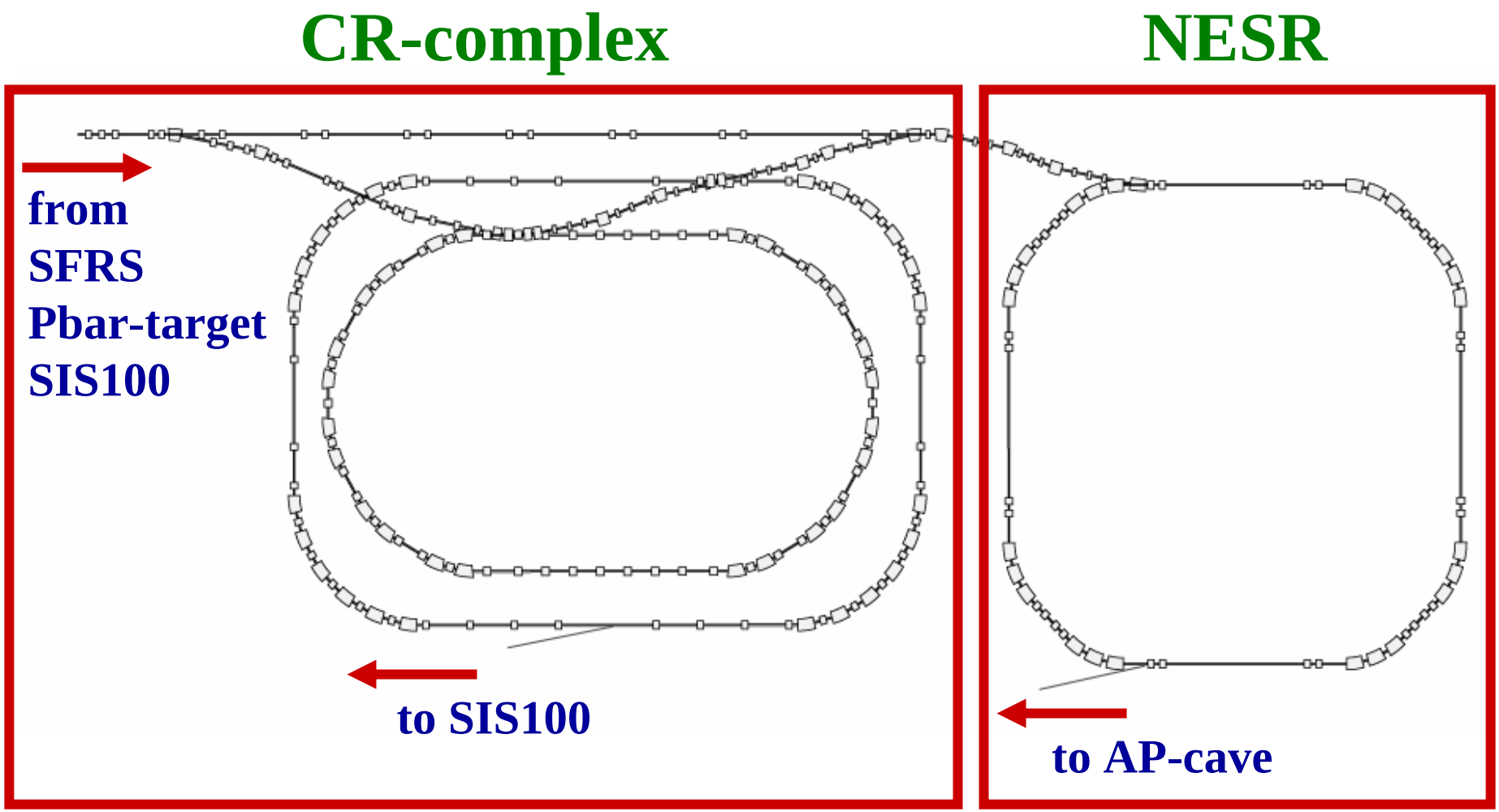
b. Antiproton Physics
   - Stochastic Precooling
   - Accumulation
   - In-Ring Experiments

c. Atomic Physics
   - Electron Cooling
   - Deceleration to Low Energies (< 100 MeV/u)
   - In-Ring Experiments
   - Fast/Slow Extraction to Cave

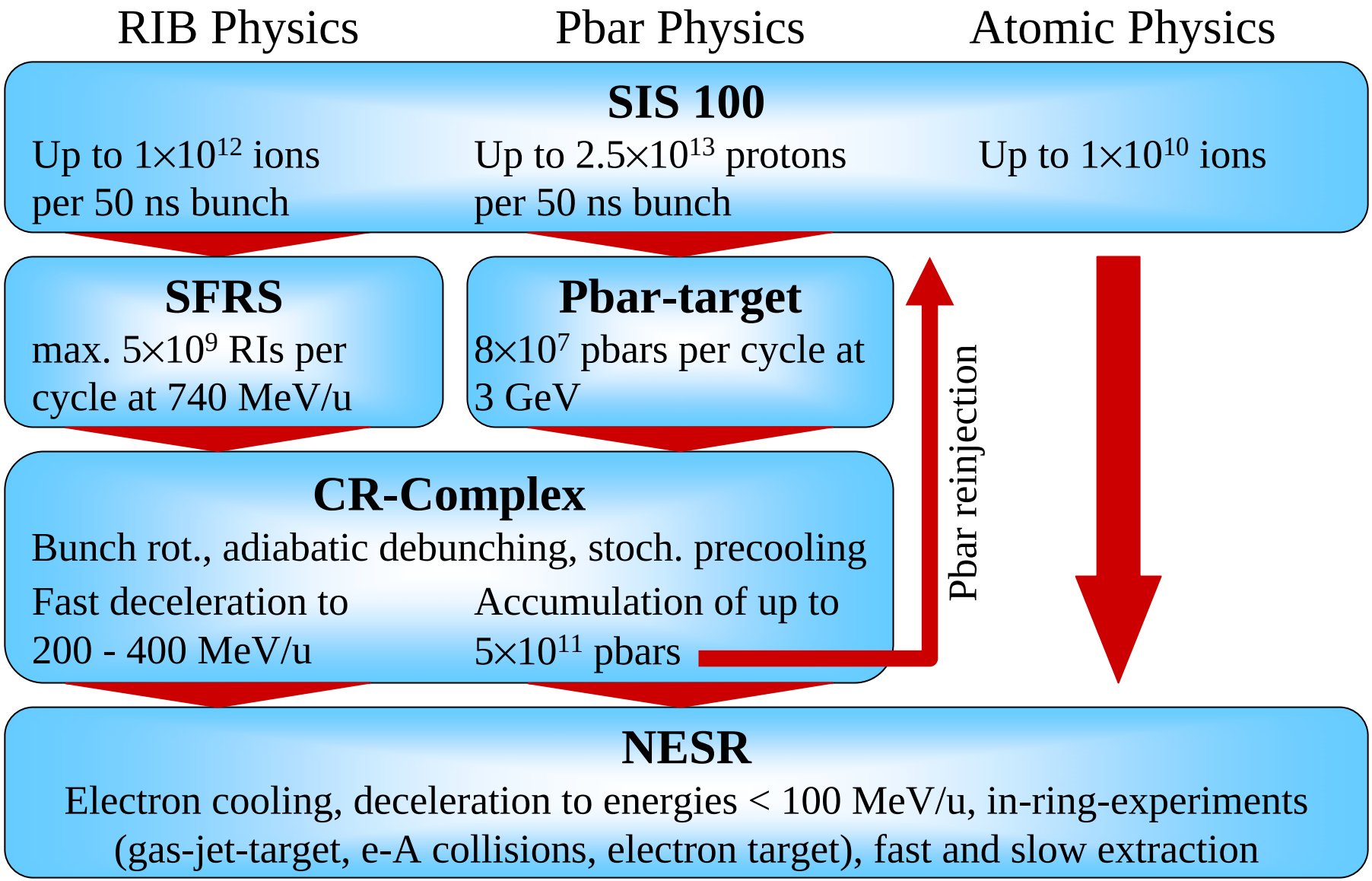
The Future Facility



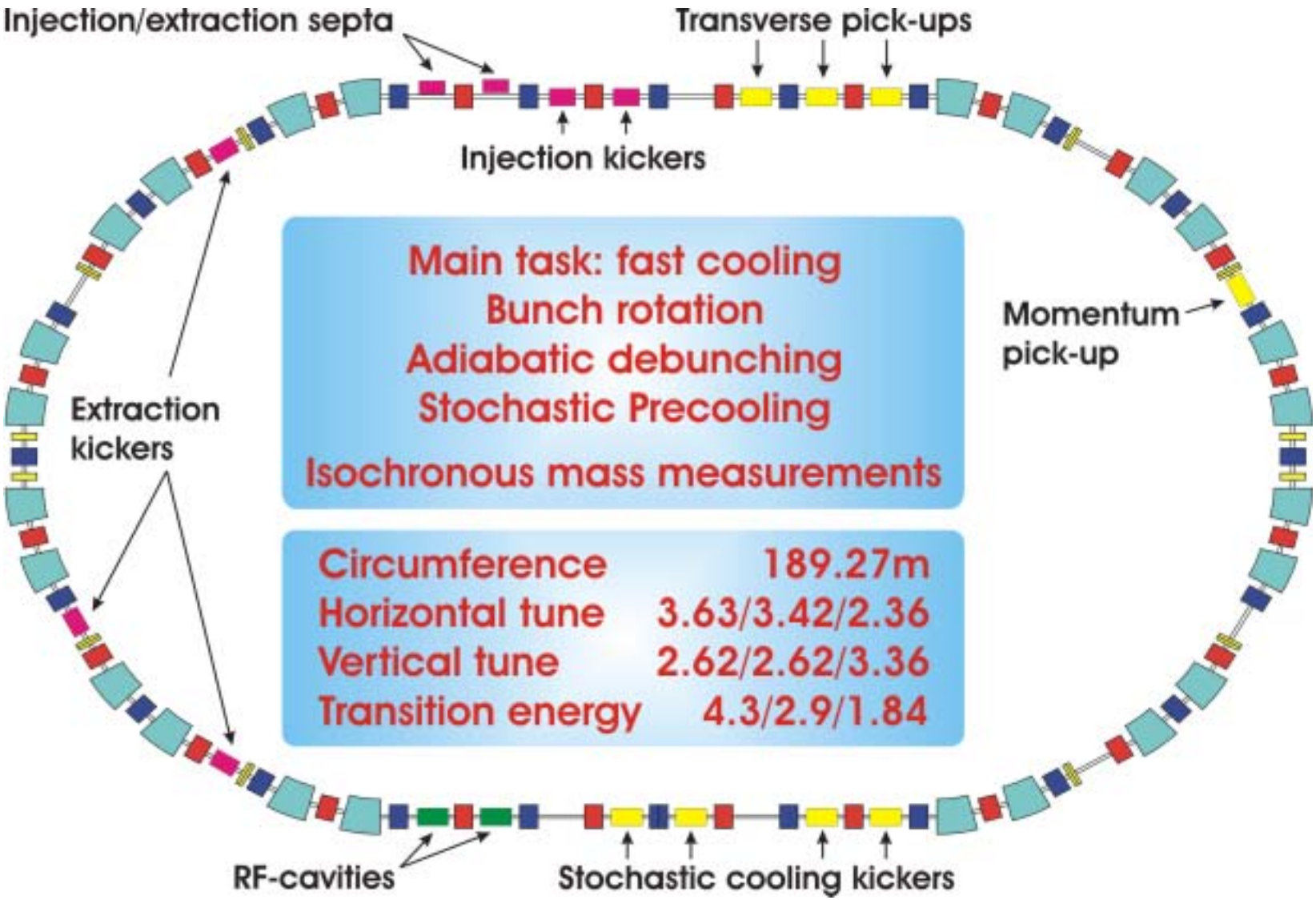
The Storage Rings



Operation Schemes

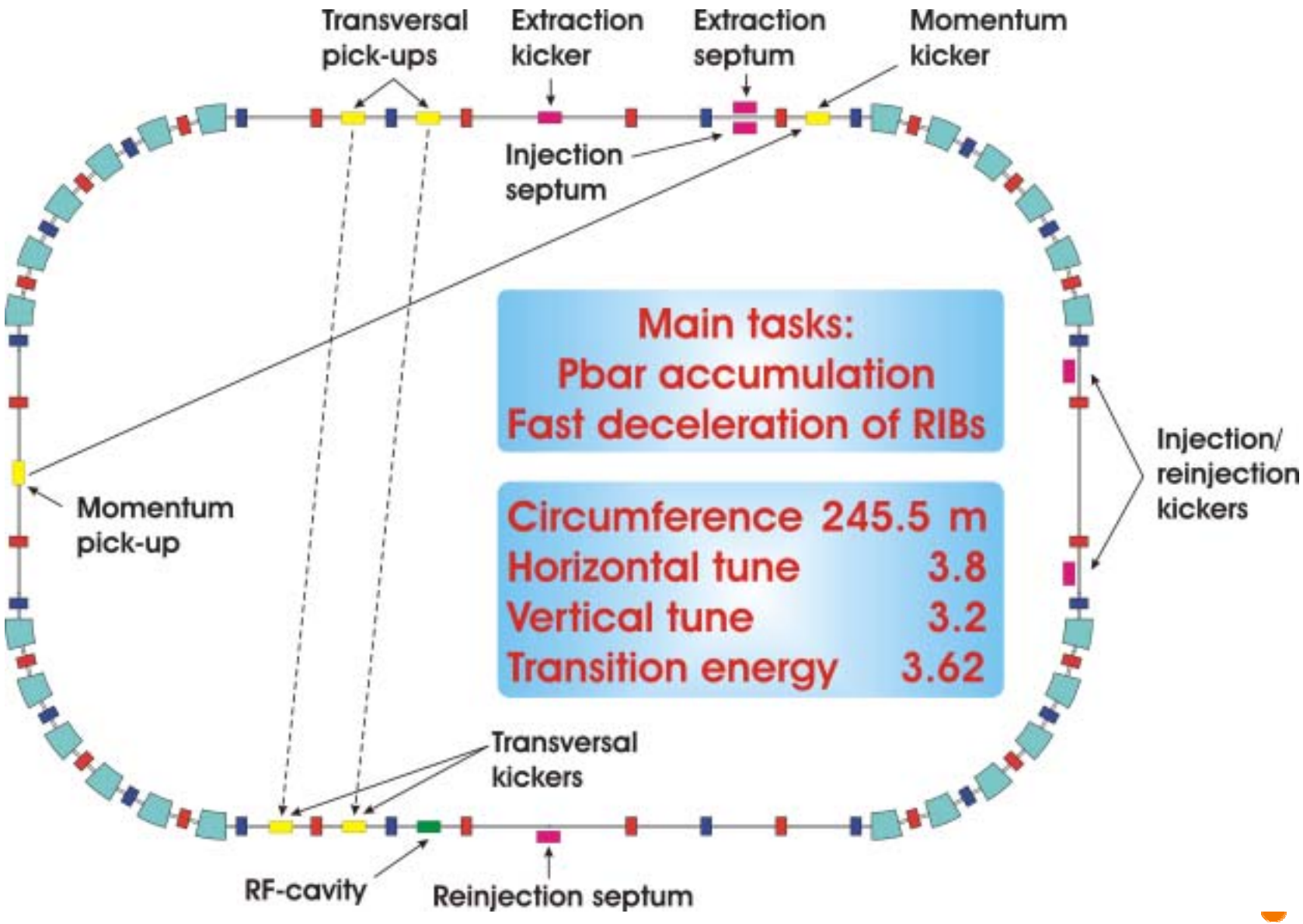


Layout of the CR Lattice

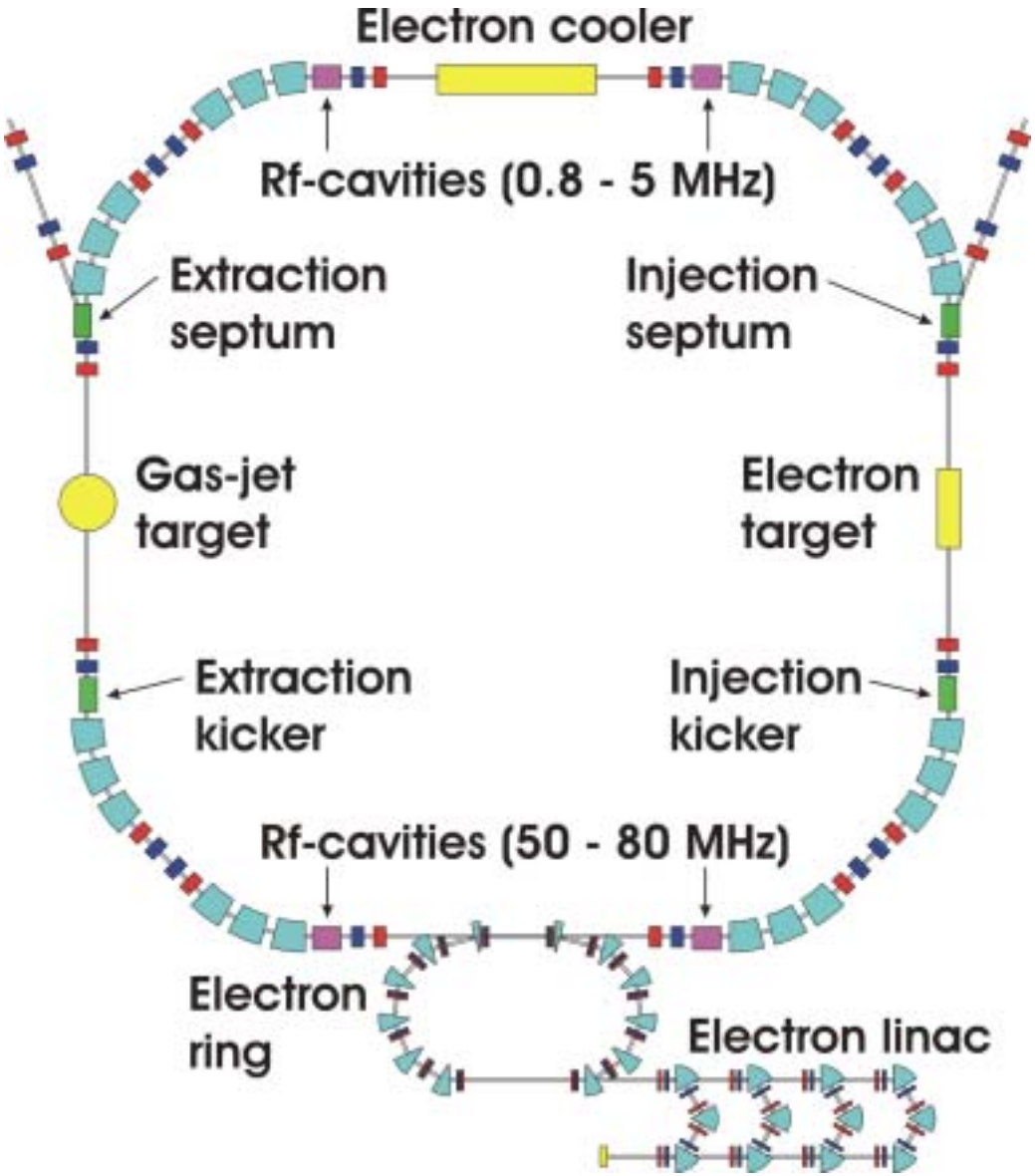


Lattice designed by A. Dolinskii

Layout of the AR Lattice



Layout of the NESR Lattice



Tasks

In-ring-experiments at

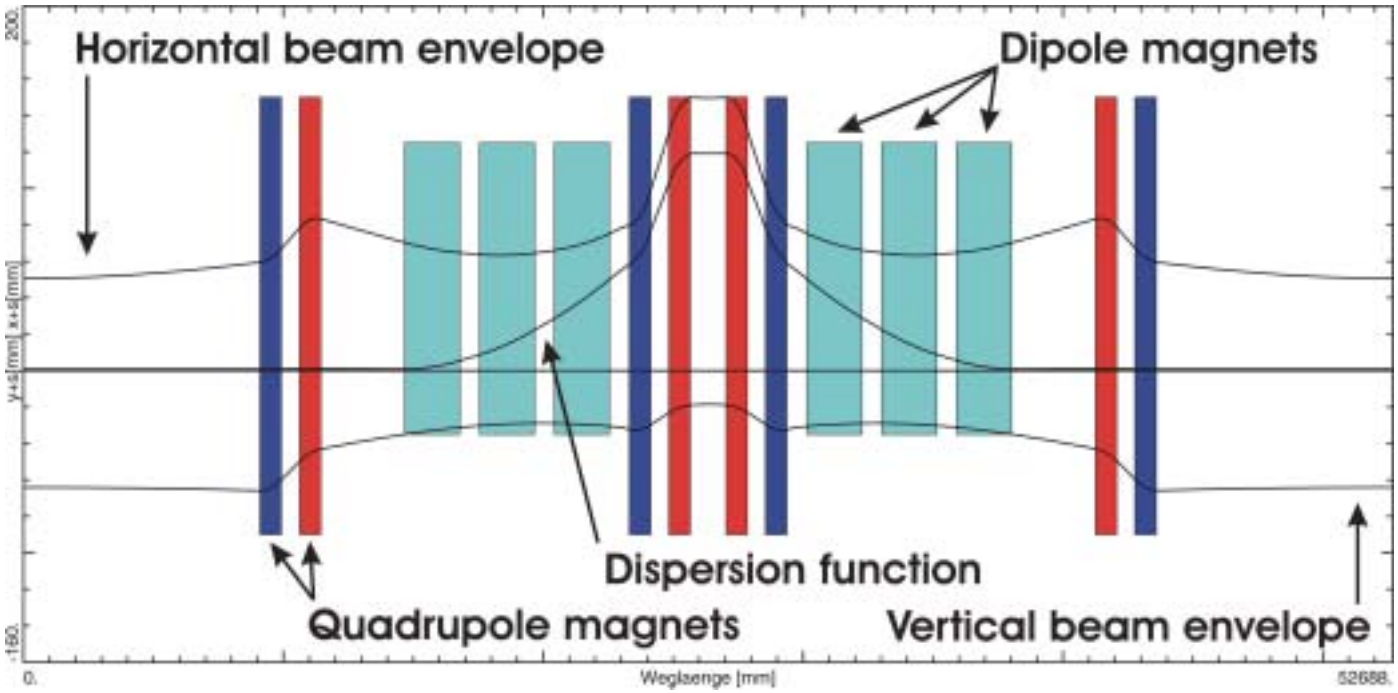
- Gas-jet-target
- Electron target
- Electron ring

Deceleration to energies < 100 MeV/u

Parameters of the NESR Lattice

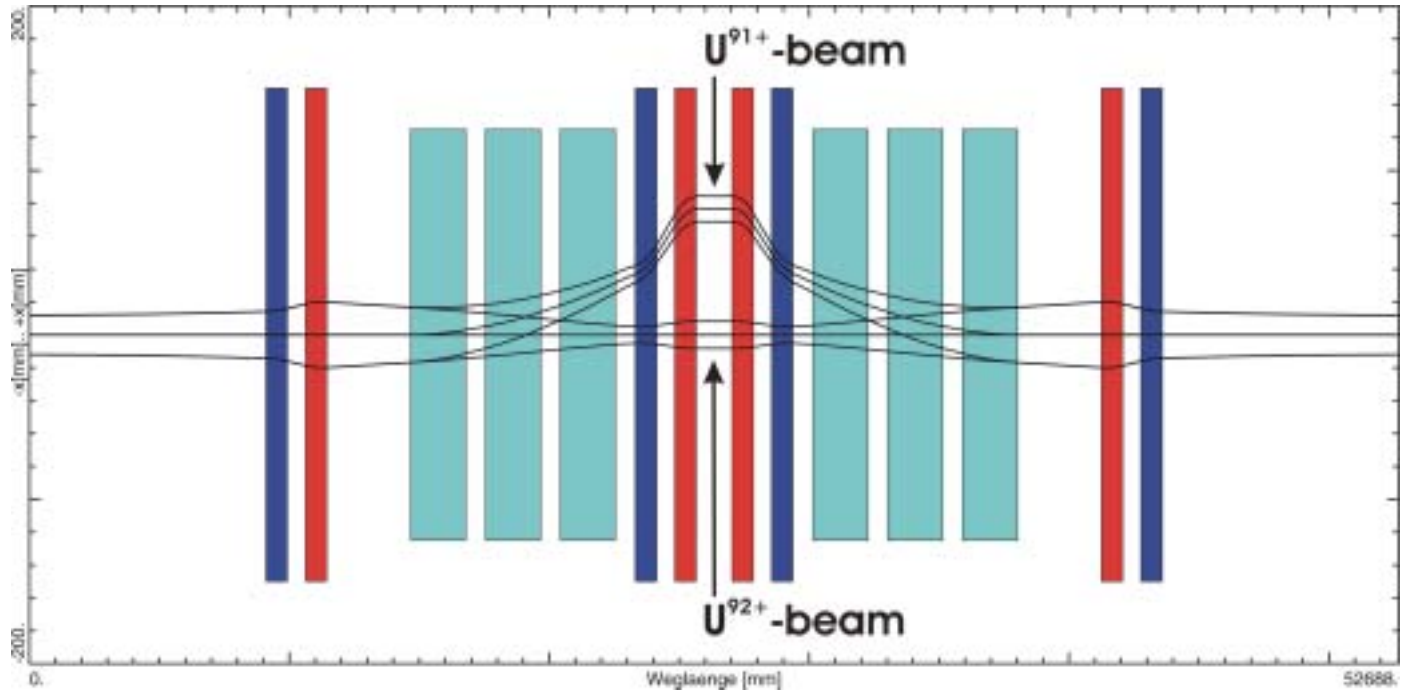
Circumference [m]	210.75
Maximum bending power [Tm]	13
Max. energy for U^{92+} [MeV/u]	840
Dipole magnets	
Number of dipole magnets	24
Maximum dipole field [T]	1.6
Bending angle [degrees]	15
Bending radius [m]	8.125
Quadrupole magnets	
Number of quadrupole magnets	32
Effective length [m]	0.8
Maximum quadrupole gradient [T/m]	6.51

Beam Envelopes and Dispersion Function



Horizontal/vertical acceptance [mm mrad]	160/100
Momentum acceptance [%]	±1.75
Horizontal/vertical tune	3.2
Transition energy	5.64
Natural horizontal/vertical chromaticity	-4.8/-4.6

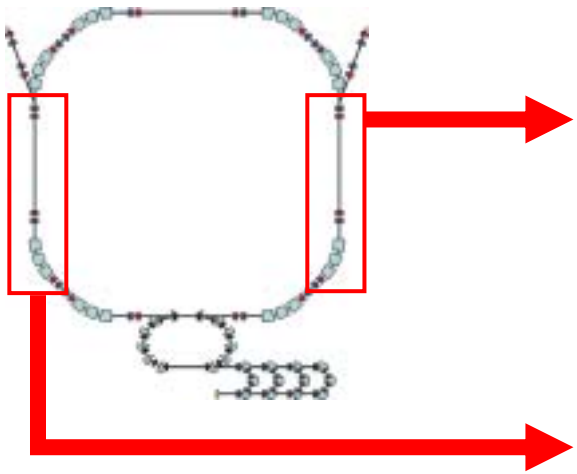
Separation of Two Uranium Charge States

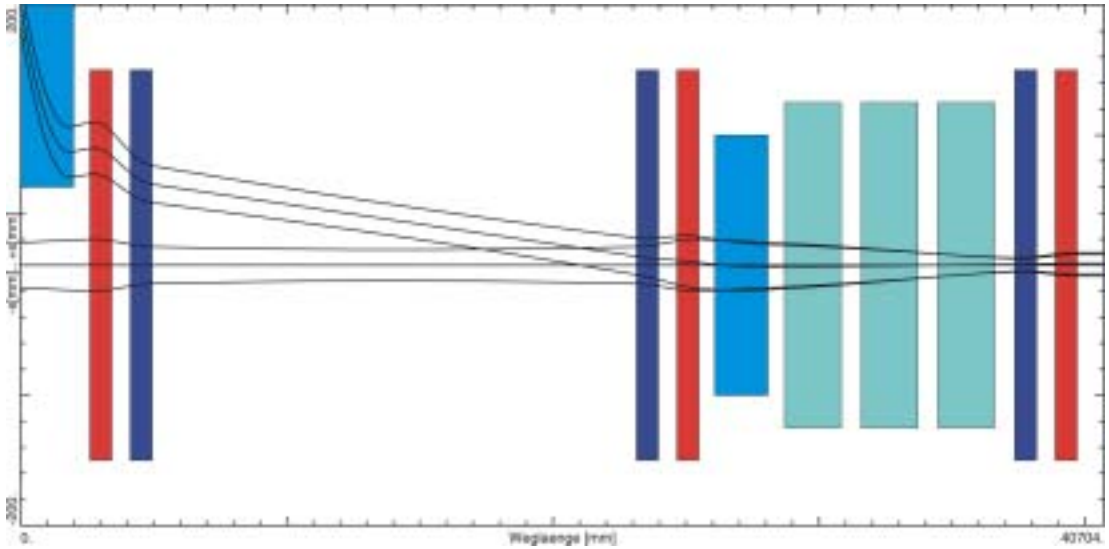


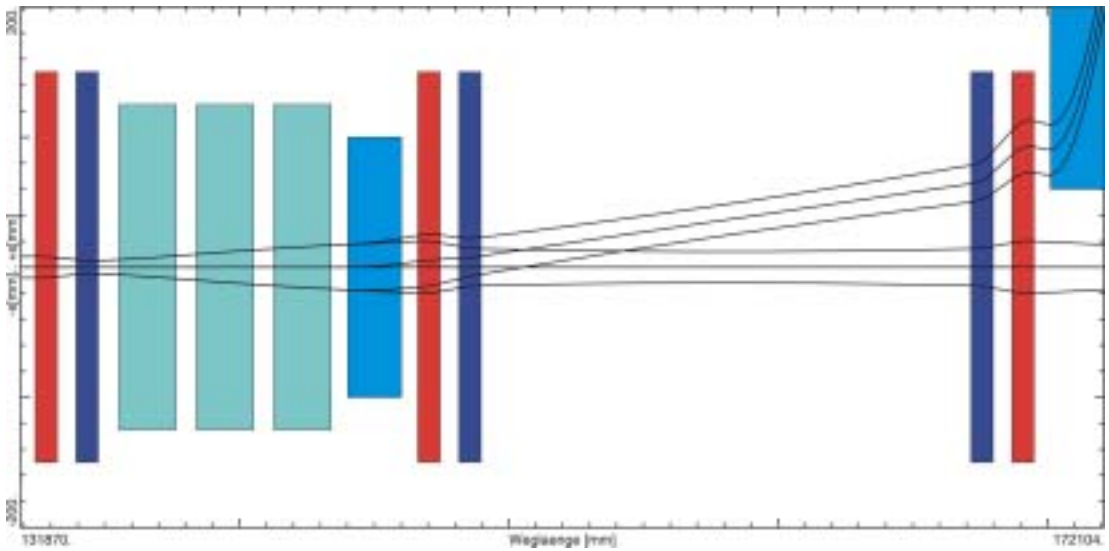
Maximum dispersion [m]	7.24
Horizontal beta function in the arc [m]	6.72
Separation of U^{92+}/ U^{91+} (ε = 0.1 mm mrad) [mm]	79
Separation of U^{92+}/ U^{91+} (ε = 10 mm mrad) [mm]	63

Injection and Extraction Scheme

Septum magnet	
Length [m]	2
Deflection angle [mrad]	134

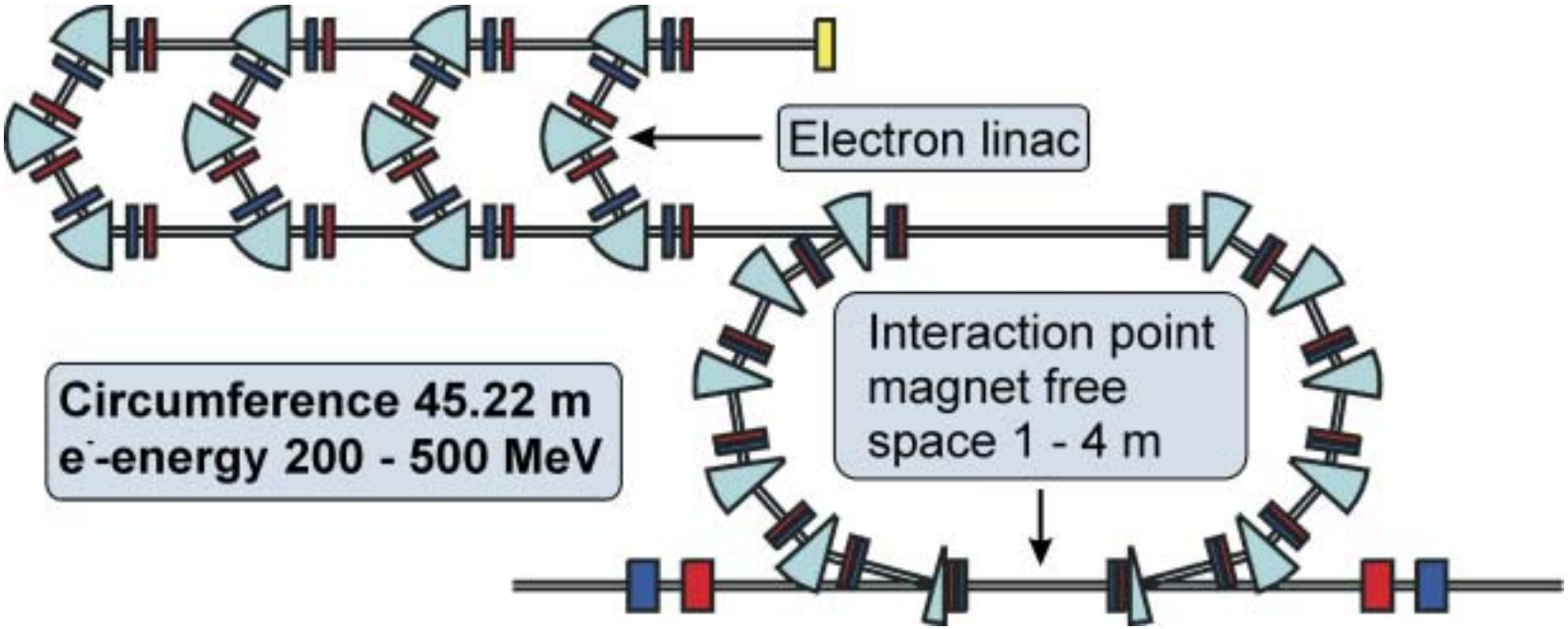






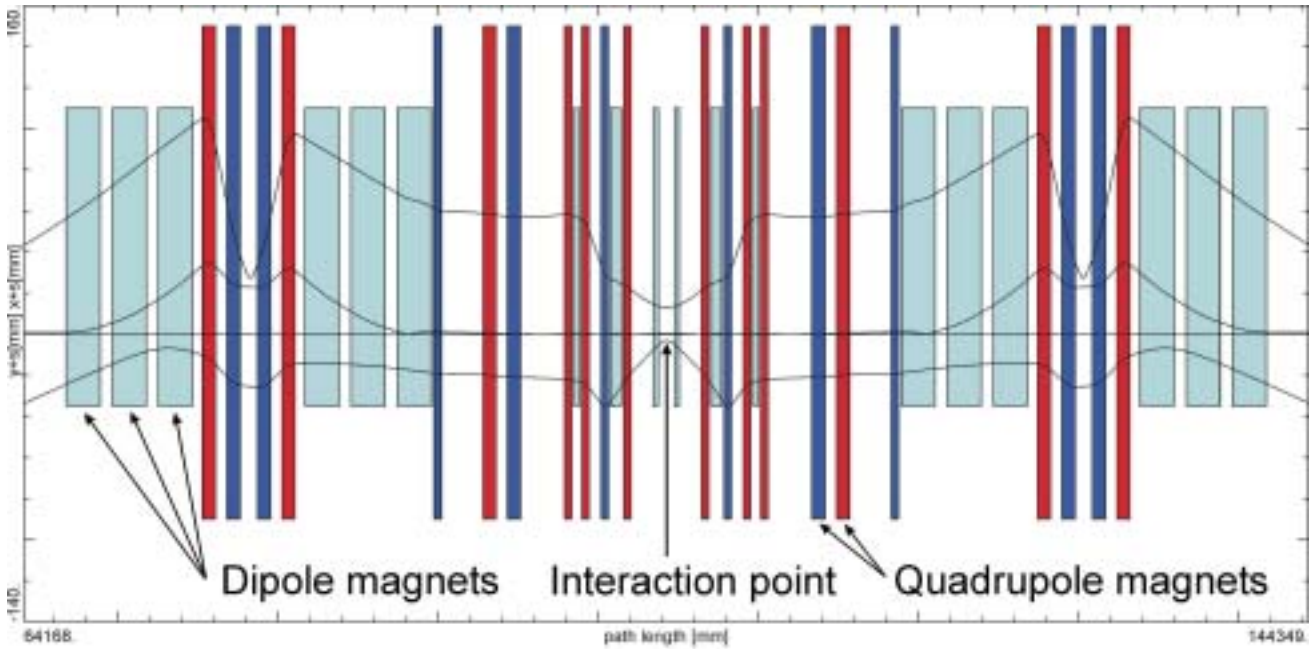
Kicker magnet	
Length [m]	2
Deflection angle [mrad]	2.6

The Electron Ring



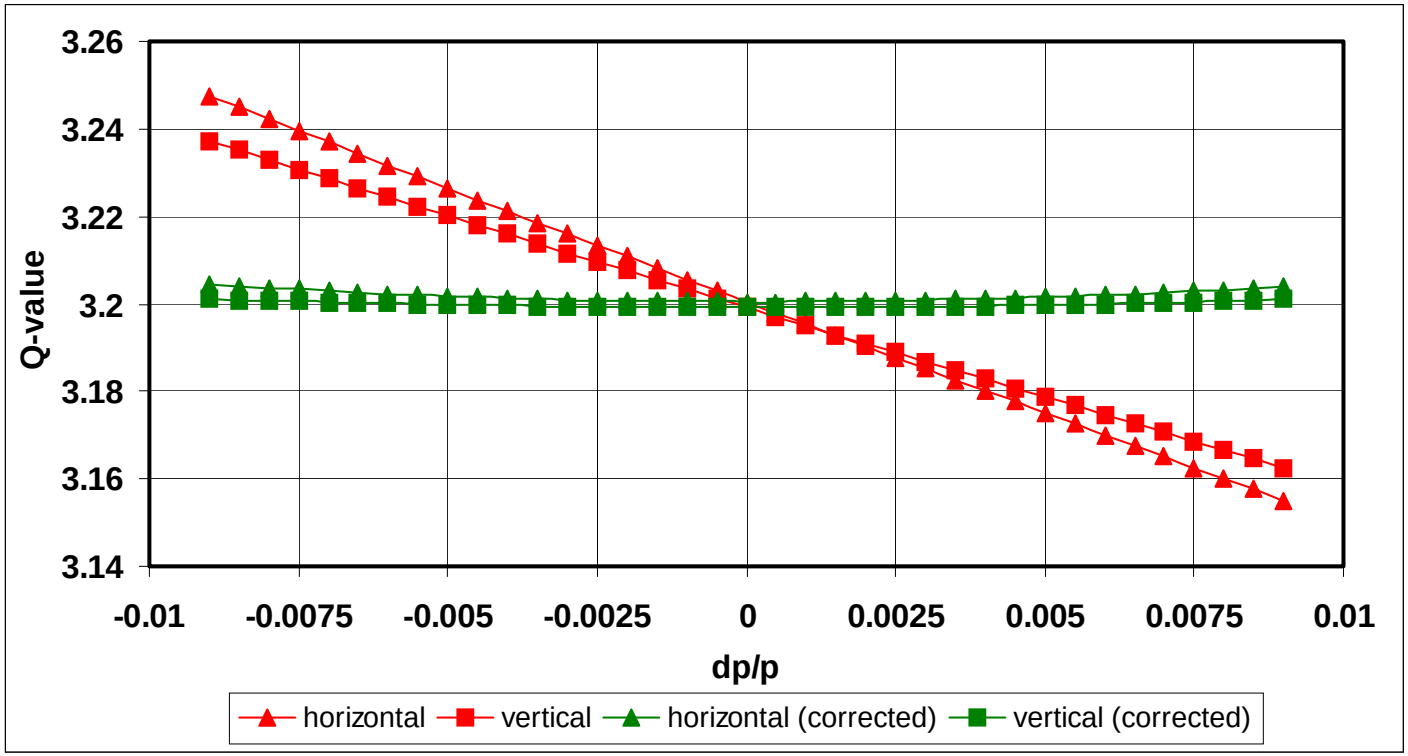
Horizontal/vertical emittance [mm mrad]	0.05
Momentum spread [%]	± 0.018
Horizontal tune	3.8
Vertical tune	2.8
Luminosity [cm^{-2} s^{-1}]	~ 1×10^{28}

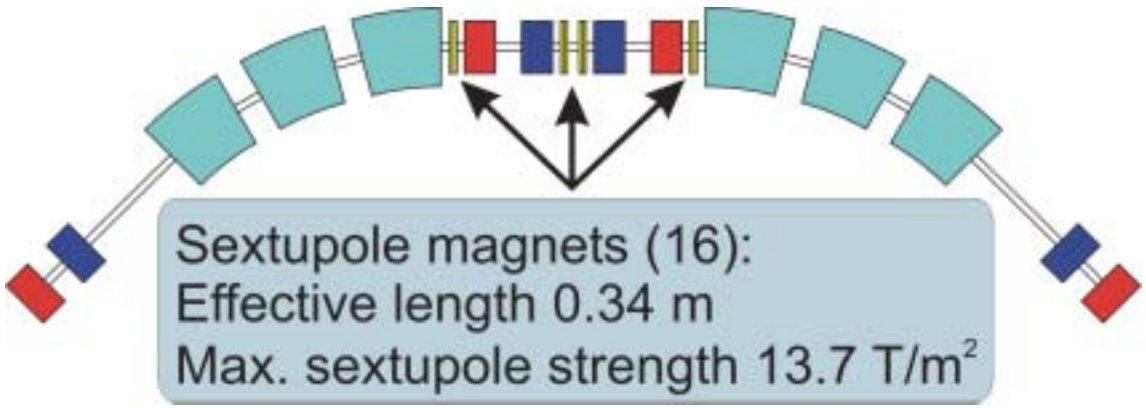
The Electron-Nucleus-Interaction Region



Length of magnet free space [m]	1
Horizontal beta function at IP [m]	1.5
Vertical beta function at IP [m]	0.15
Horizontal electron beam size [µm]	270
Vertical electron beam size [µm]	87

Chromaticity Correction

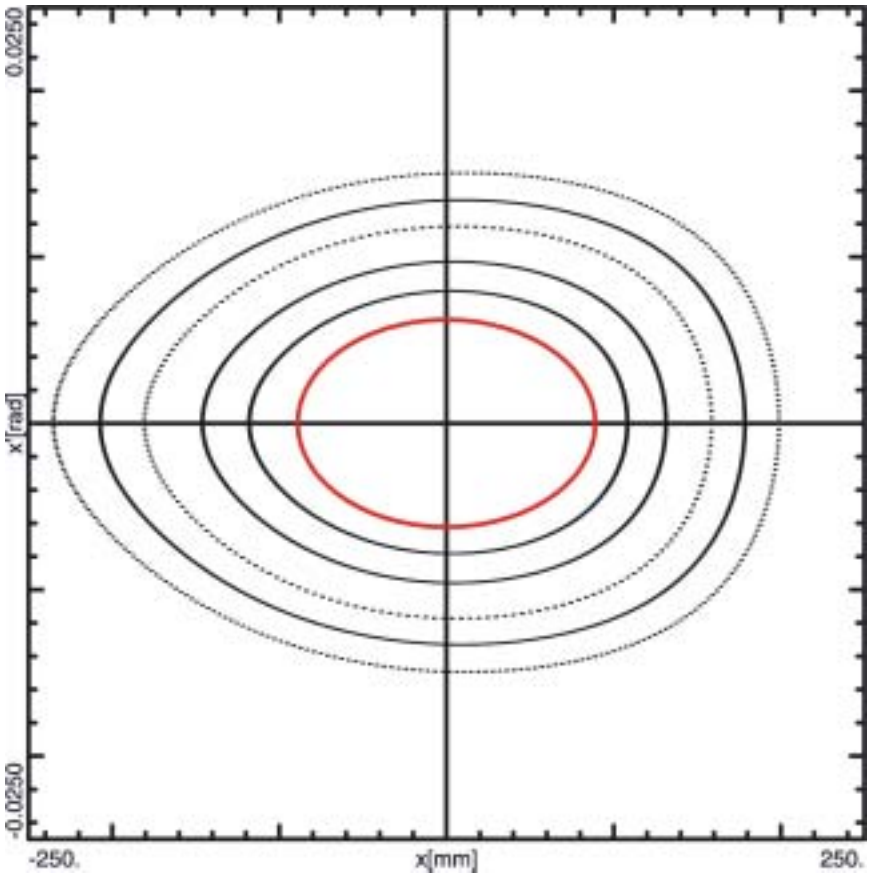


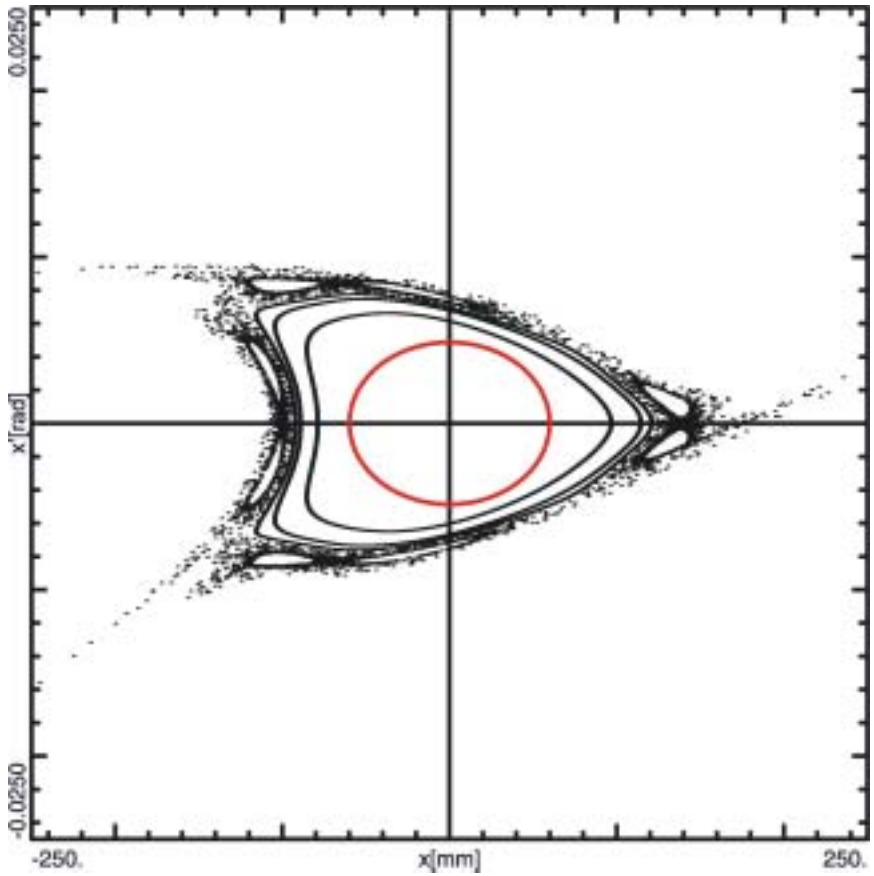


Dynamic Aperture Calculation

Geometric xx' acceptance (drawn in red) for dp/p = 0

Normal operation a ≈ 500 mm mrad Collider mode a ≈ 300 mm mrad



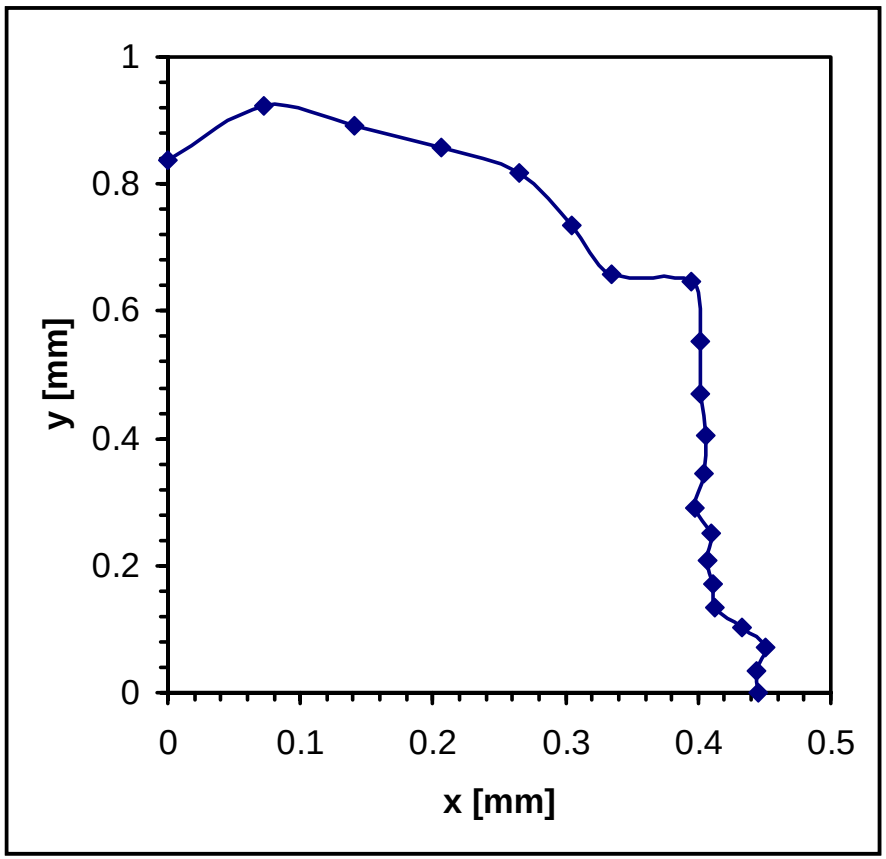


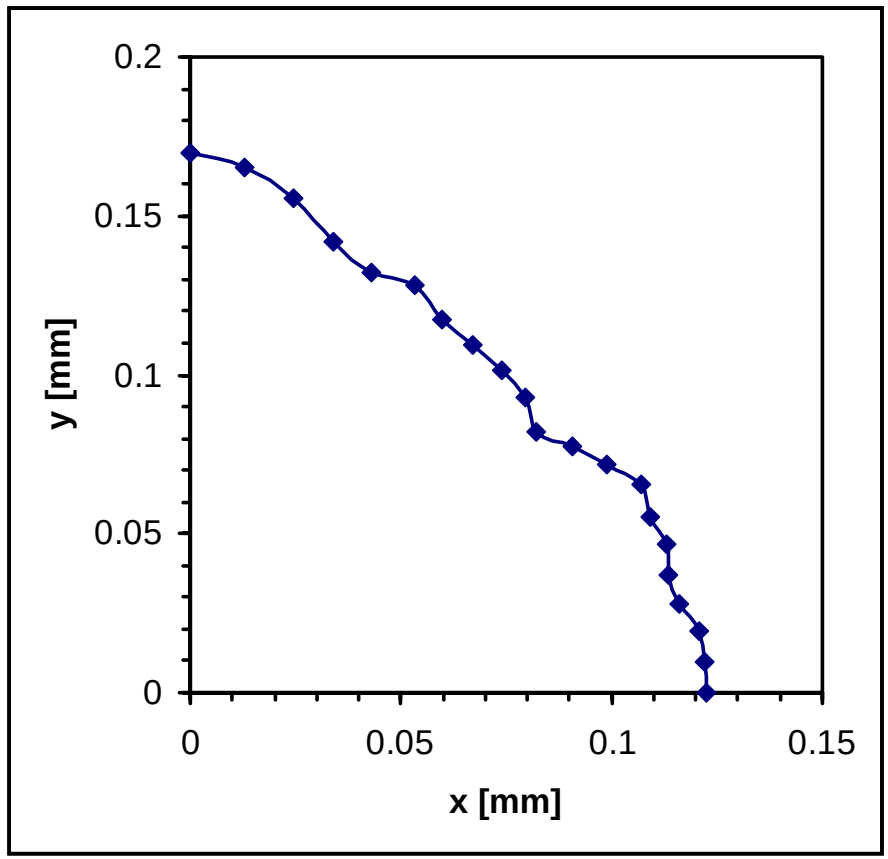
Only sextupole components are included.

Dynamic Aperture Calculation

Geometric xx' acceptance (drawn in red) for dp/p = 0

Normal operation a ≈ 500 mm mrad Collider mode a ≈ 300 mm mrad

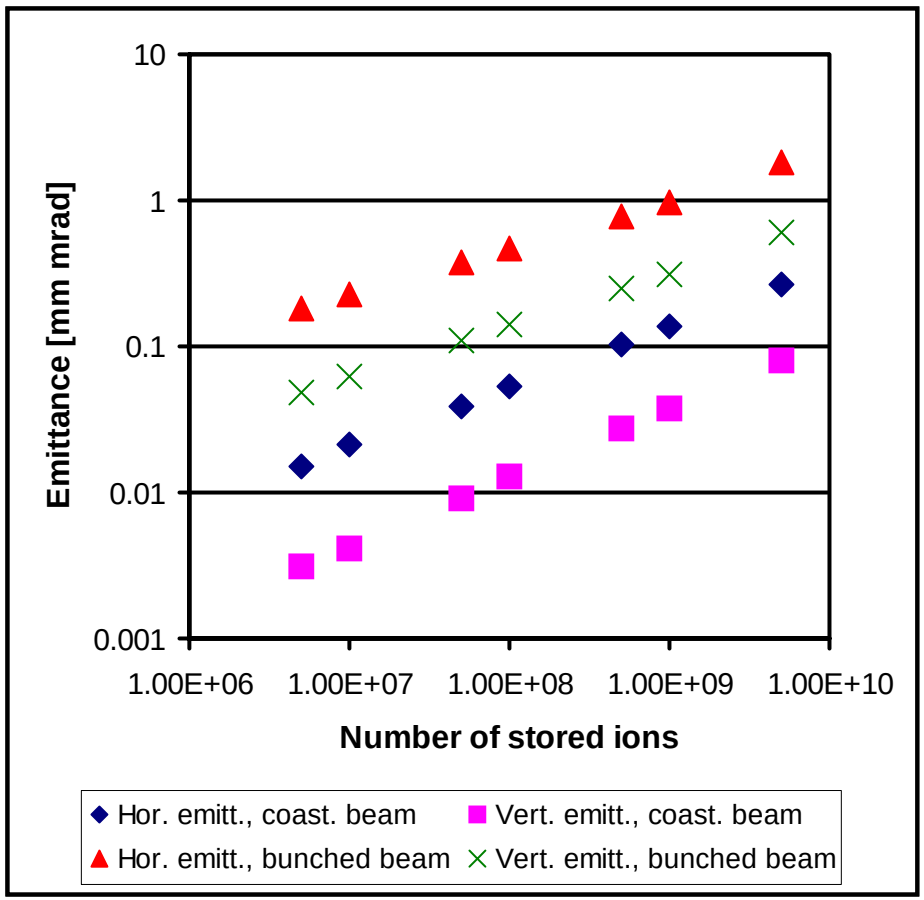


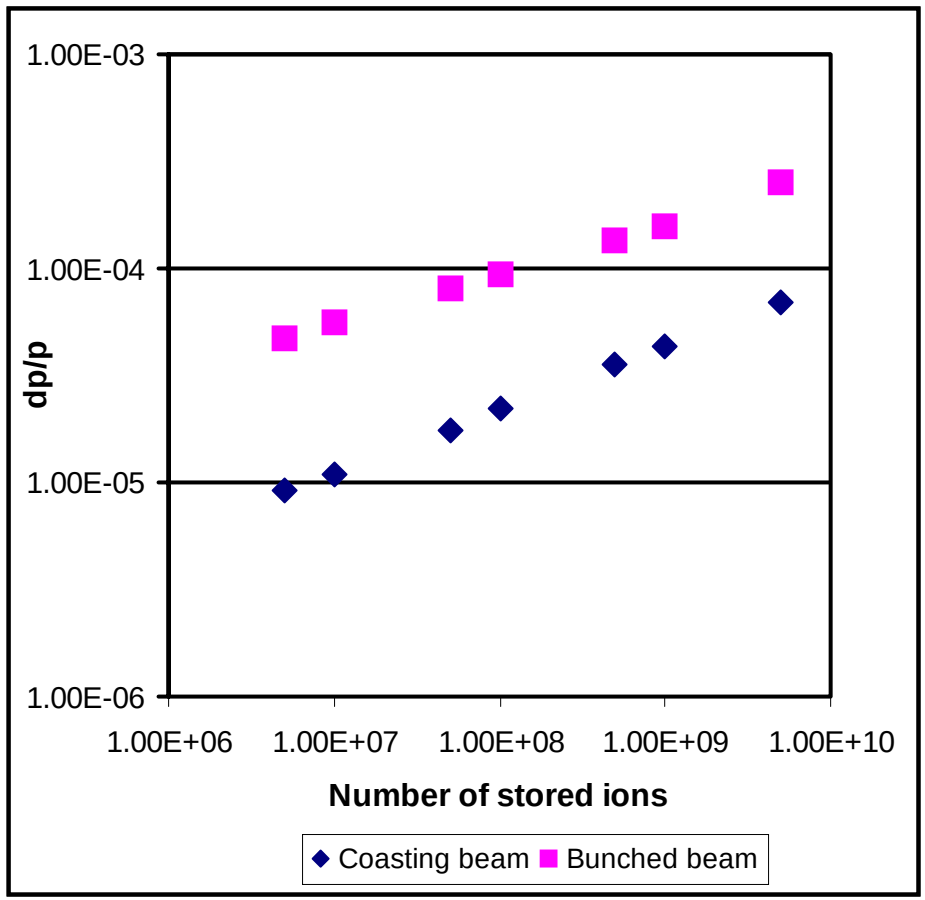


Only sextupole components are included.

Equilibrium Beam Parameters

Non-magnetized electron cooling, electron current 1 A
U^{92+}-beam at 740 MeV/u, bunch length ≈ 0.1 m





Calculations by G. Trubnikov

Work to Be Done

a. Final Lattice Layout
   - Higher Order Corrections
   - Dynamic Aperture Calculations

b. Completion of Ring Design
   - Magnet Design
   - Beam Diagnostics

c. Beam Dynamics Calculations
   - Cooling Times
   - Equilibrium Beam Parameters, including target

d. R & D
   - Electron Cooler for Energies up to 450 keV
   - Stochastic Cooling Systems
   - Rf-Systems

... and much more, depending on experimentalists requirements ...