IOTA electron lens parameters

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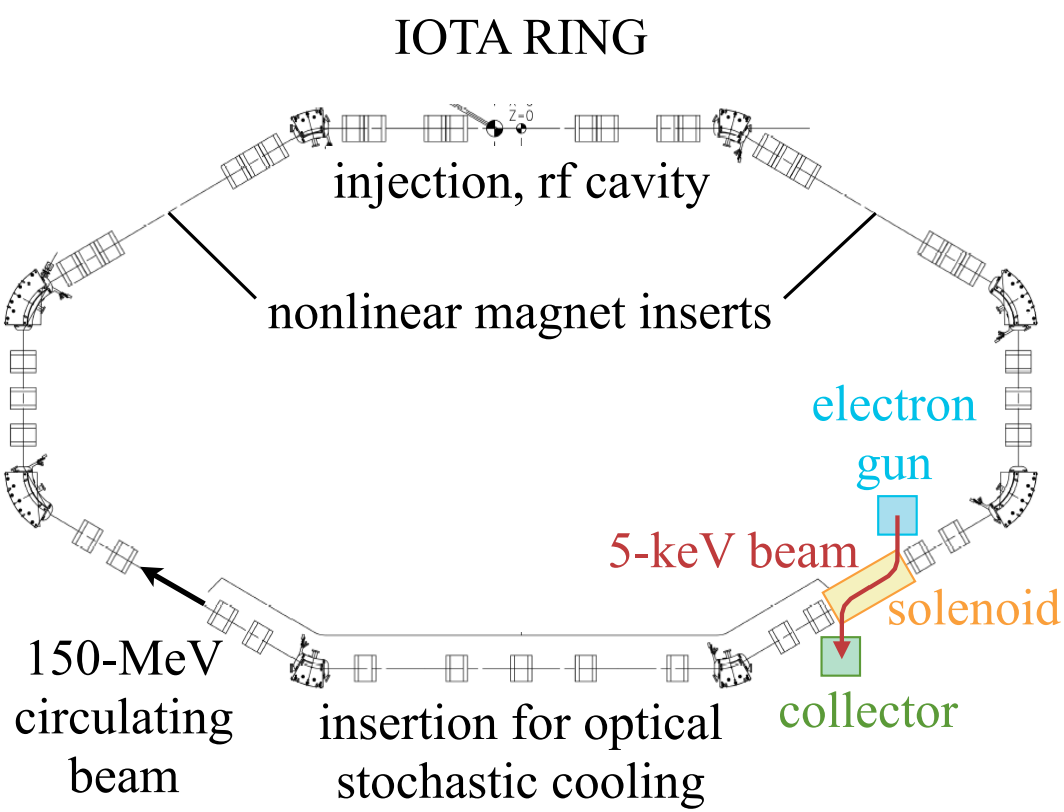
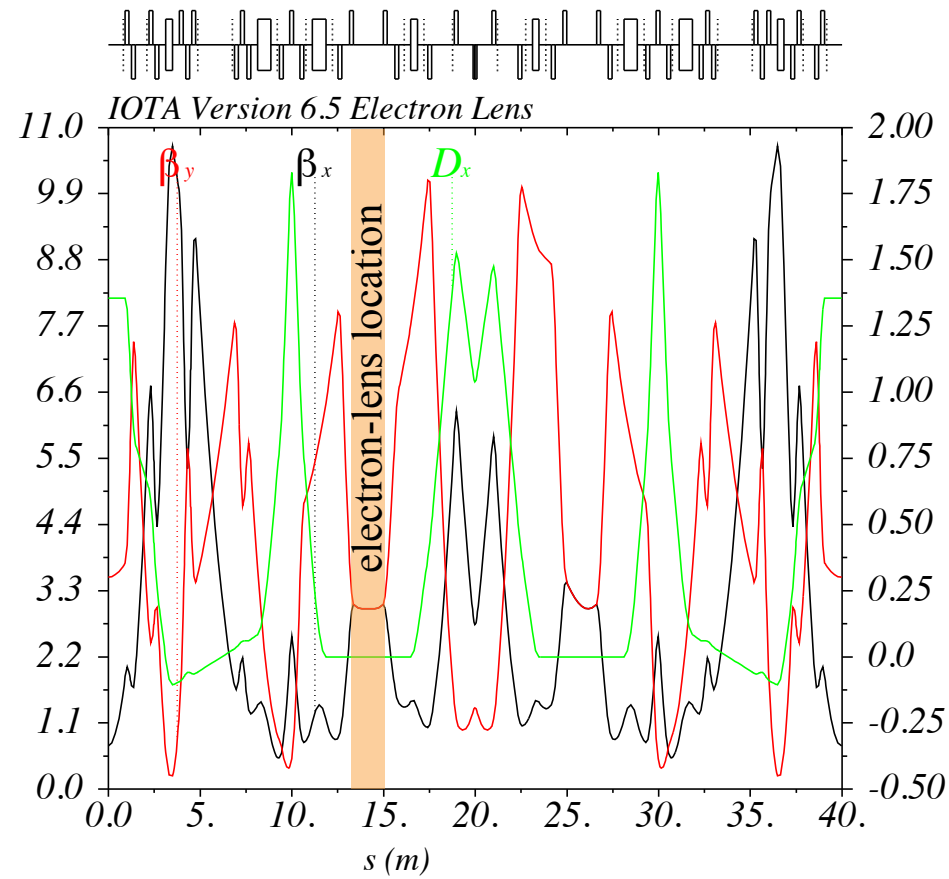
Electron lens in the IOTA ring





Nonlinear integrable optics with electron lenses

Use the electromagnetic field generated by the electron distribution to provide the desired nonlinear field

1. Axially symmetric thin-lens kick (extended McMillan case)

current density $j(r) \propto \dfrac{1}{(r^2+a^2)^2}$

transverse kick $\theta(r) \propto \dfrac{r}{r^2+a^2}$

McMillan, UCRL-17795 (1967)
Danilov and Perevedentsev, PAC97

2. Axially symmetric time-independent Hamiltonian with thick lens

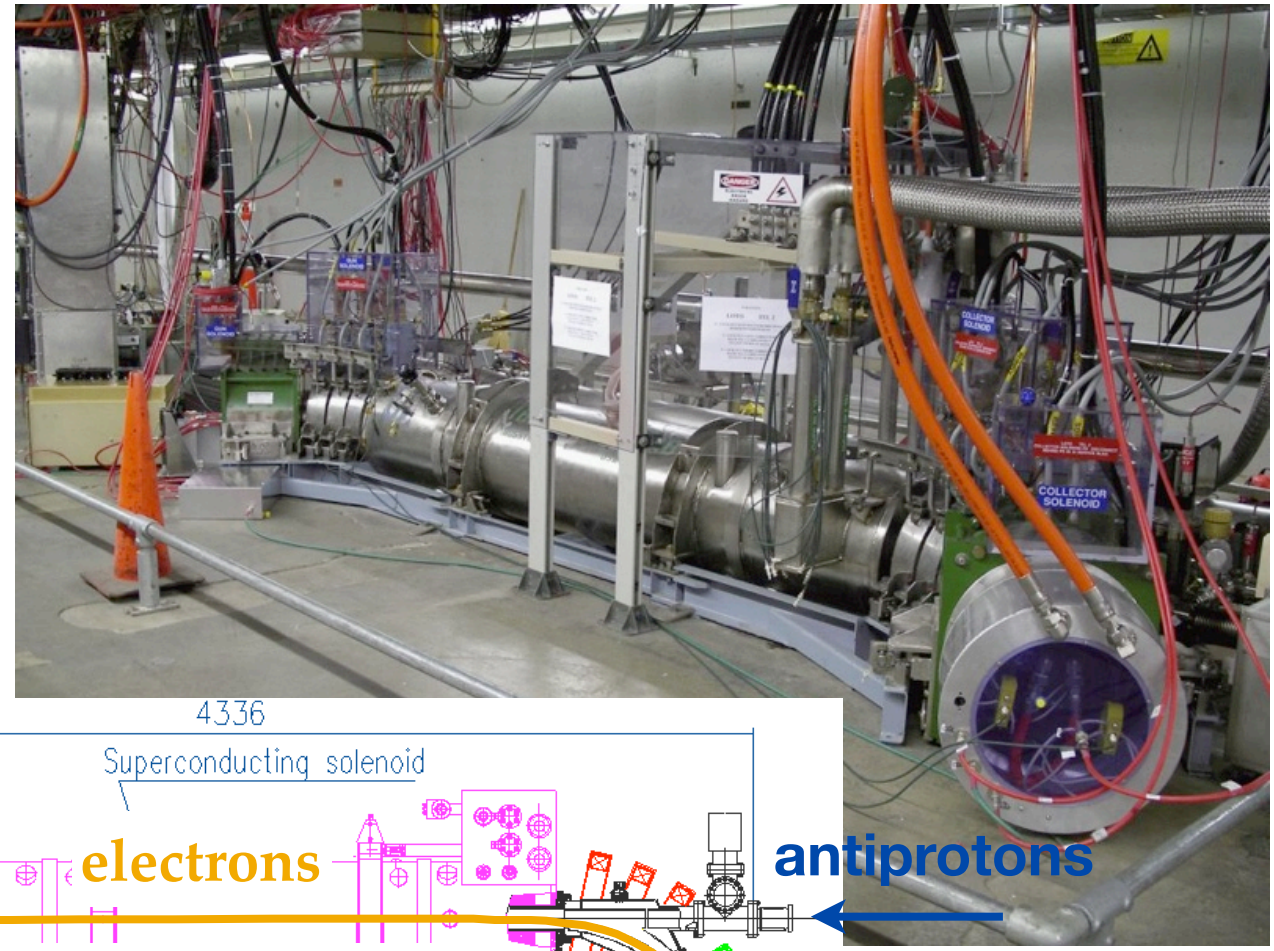
Any axially-symmetric current density distribution

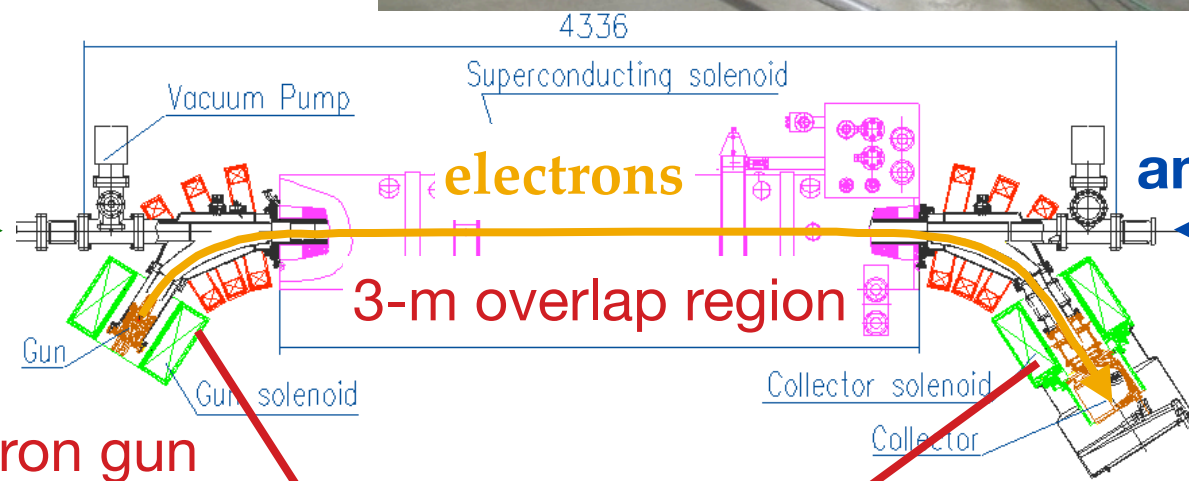
Solenoid provides

- focusing for the circulating beam, constant amplitude function
- magnetic confinement for low-energy beam

Nagaitsev and Valishev

Tevatron electron lens (TEL-2)





protons

electrons

antiprotons

3-m overlap region

collector

5-kV, 1-A electron gun
thermionic cathode
200-ns rise time

conventional solenoids
0.1–0.4 T

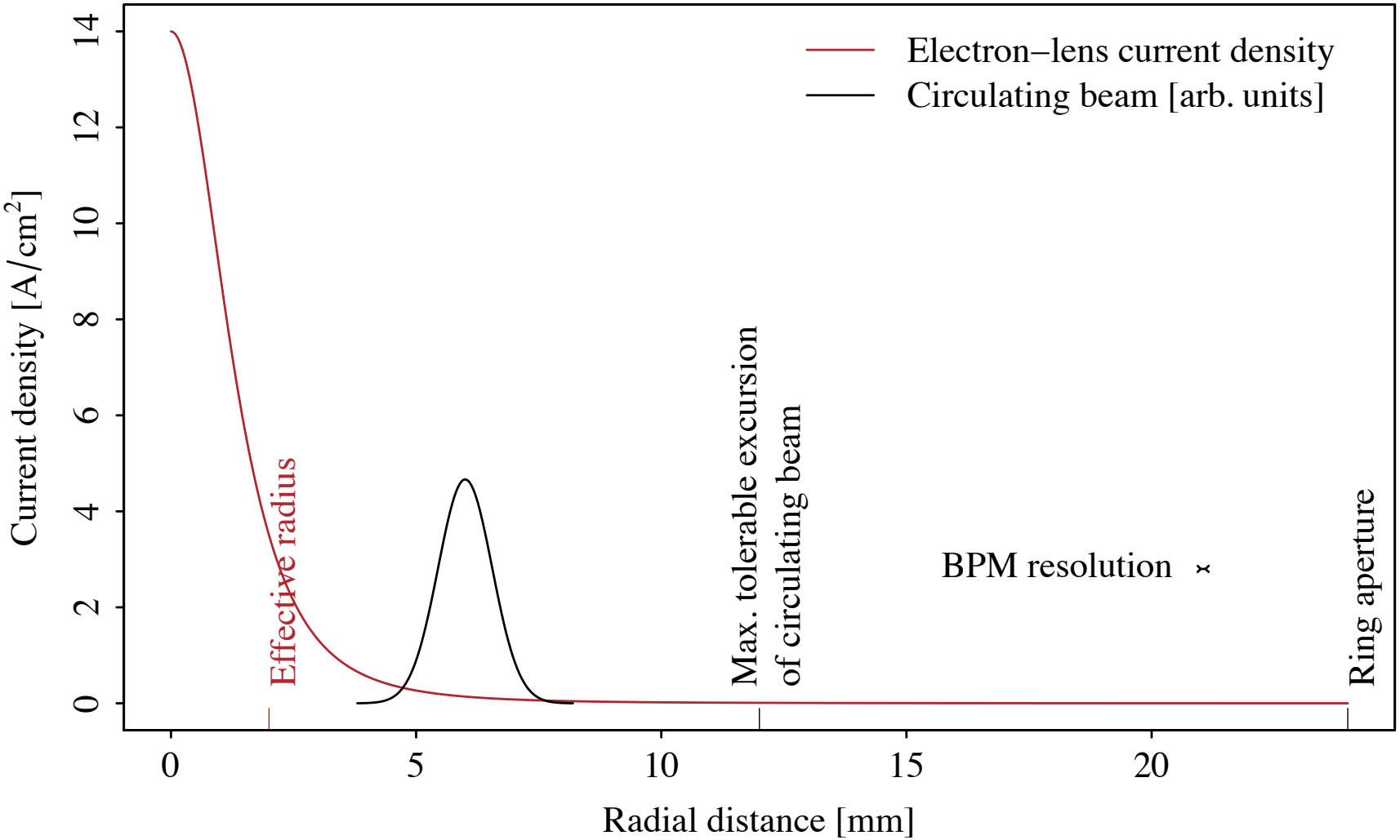
Preliminary design parameters

Amplitude function	3 m
Circulating beam size (rms)	0.55 mm
Main solenoid length	1 m
Main solenoid field	0.33 T (0.5 T max)
Gun/collector solenoids	0.1 T (0.4 T max)
Cathode-anode voltage	5 kV (10 kV max)
Beam current	1.7 A
Max. current density in overlap region	14 A/cm^2
Effective radius in overlap region	2 mm
Max. radius in overlap region	12 mm
Effective radius at cathode	3.6 mm
Max. radius at cathode	22 mm

0.25 nonlinear tune spread

BPM resolution, beam size, dynamic range of phase-space reconstruction

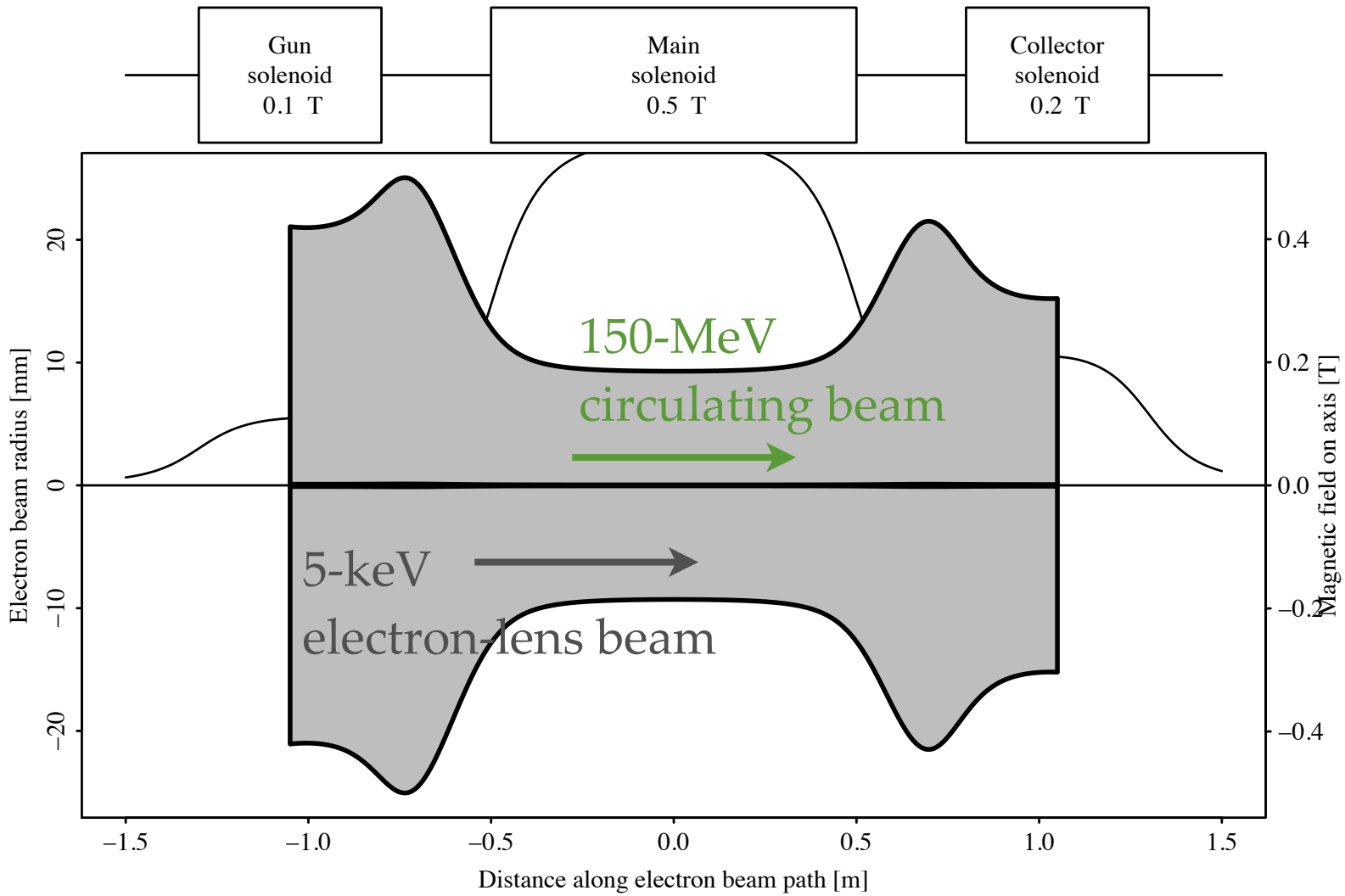
Constraints on beam size design



small betatron amplitude: maximum detuning

large betatron amplitude: negligible detuning

Magnetic configuration and compression



Summary

Trying to reuse TEL-2 gun and collector solenoids (0.1-0.4 T)

New resistive solenoid needed: 1 m long, 50 mm aperture, 0.5 T

New bend coils and vacuum chamber

Open questions:

- tolerances and space-charge evolution of current-density profile
- pulsing pattern to mitigate large instantaneous beam power
  - 2 A x 5 kV = 10 kW