Experiments using low energy ion beams

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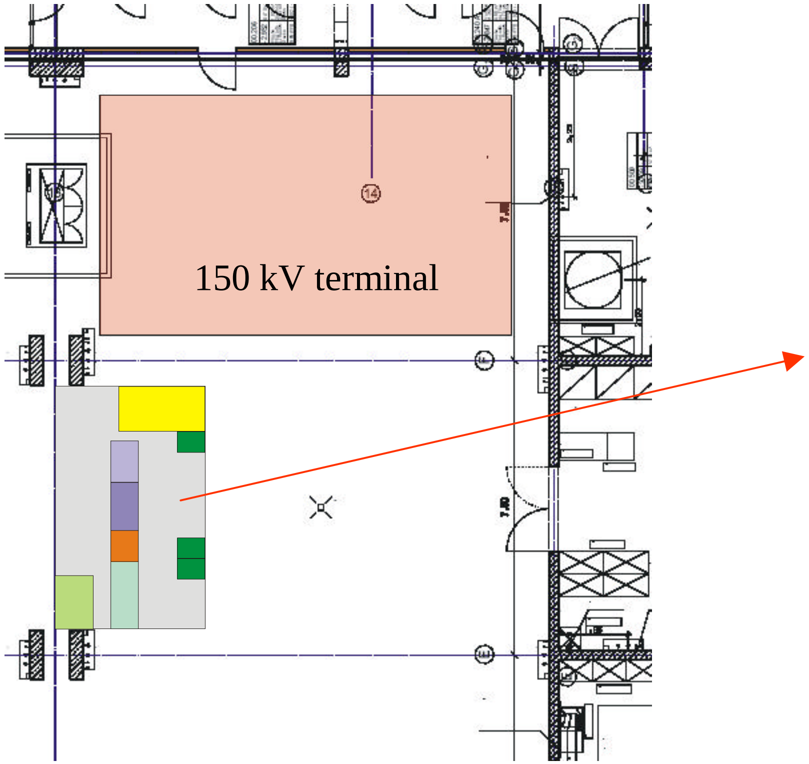
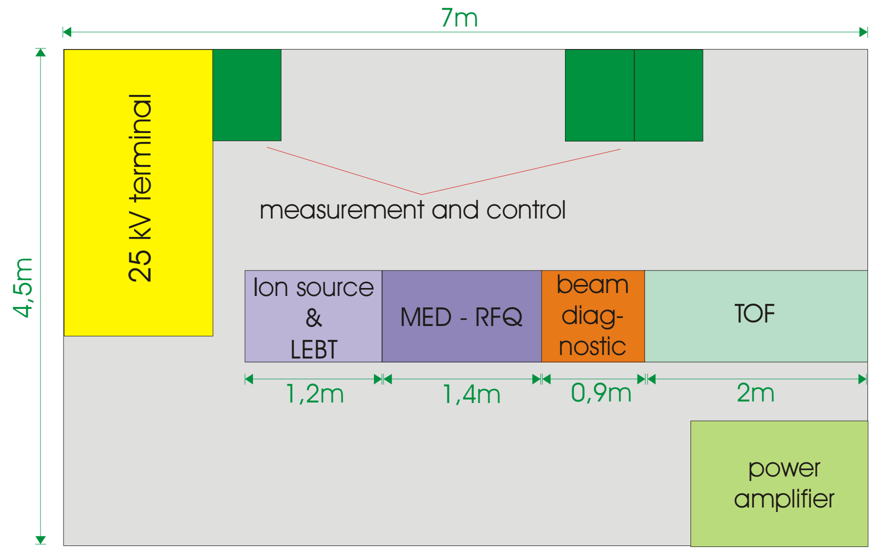
Overview

- test stand for the investigation of the MED – RFQ properties
- accelerator front end for several beam experiments
- small toroid for the investigation of ion beam drifts and instabilities

MED – RFQ test stand



floor plan of the experimental hall



principle layout of the MED-RFQ test stand

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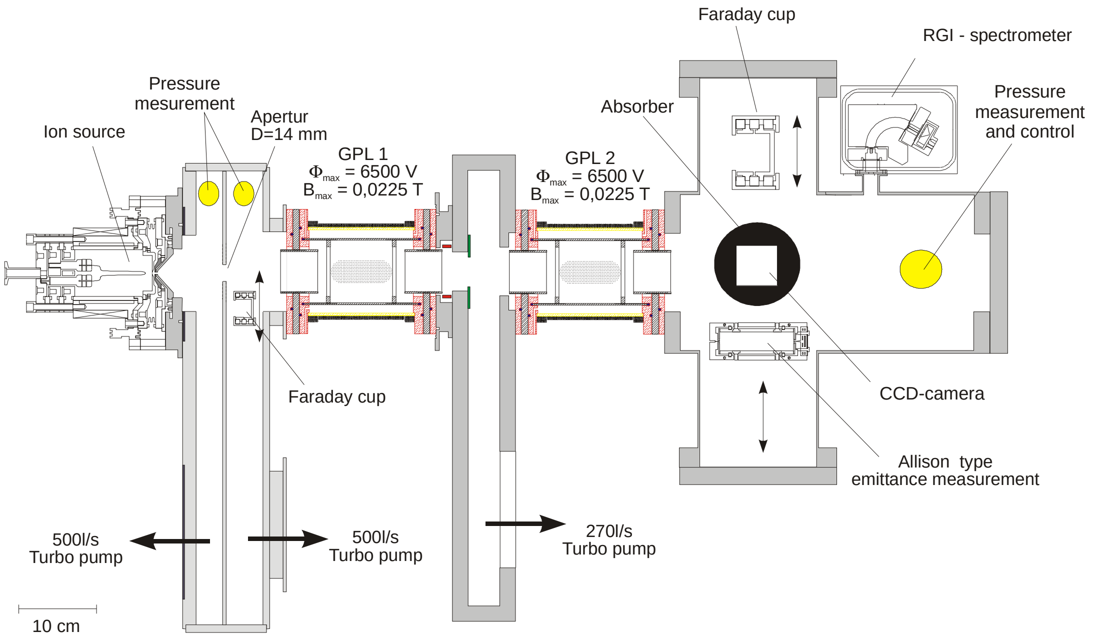
MED – RFQ test stand

Planned RFQ injection at the beginning of May



schematic drawing of the LEBT section

DC proton beam

W_{in} = 8 AkeV

r_{max} = 2 mm

r'_{max} = 60 mrad

I_{in} = 2 mA

Beam fractions delivered by the ion source!

p ~ 10 %

H_2^+ ~ 60 %

H_3^+ ~ 30 %

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Accelerator front end

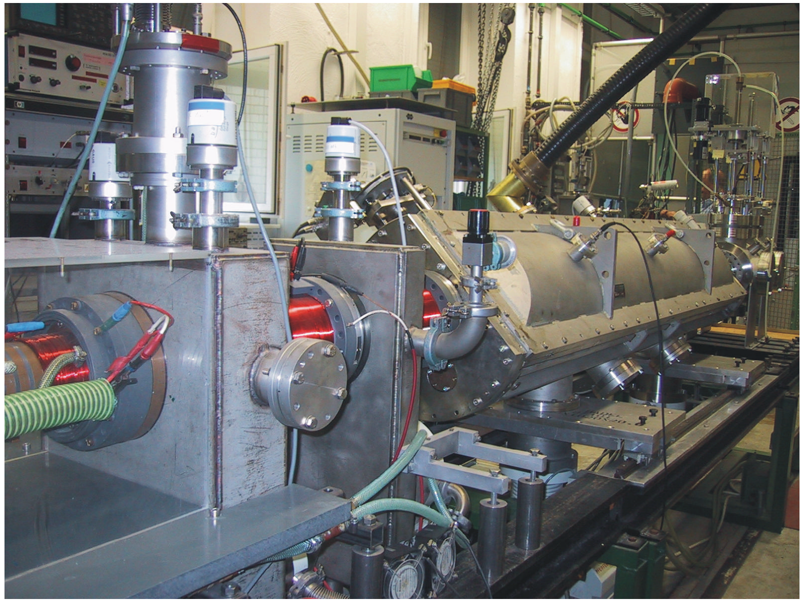
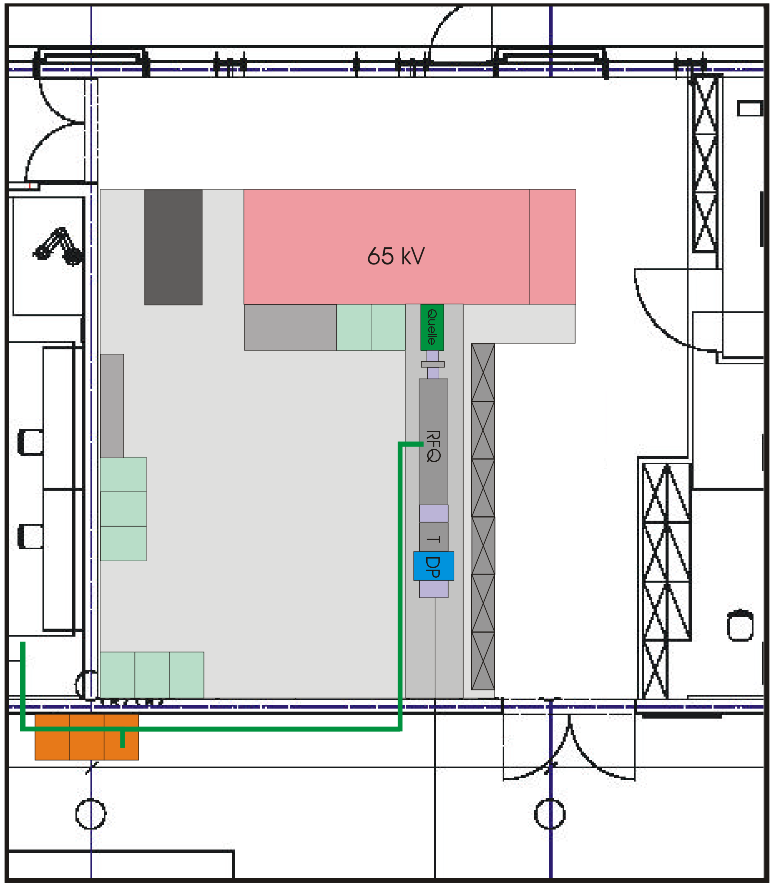


image of the injector in the old experimental hall



floor plan of the new laboratory

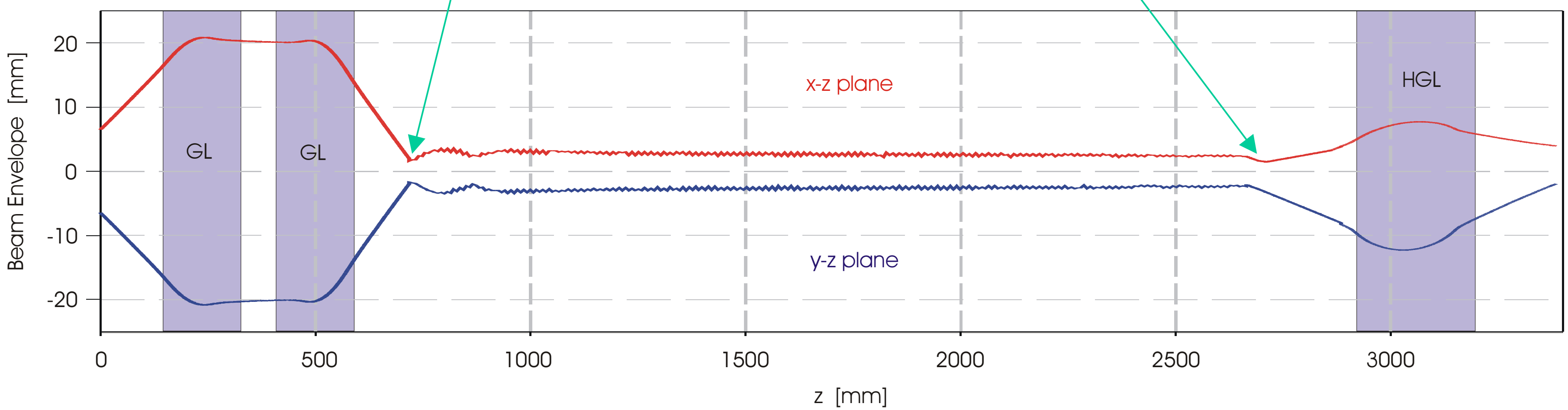
Accelerator front end

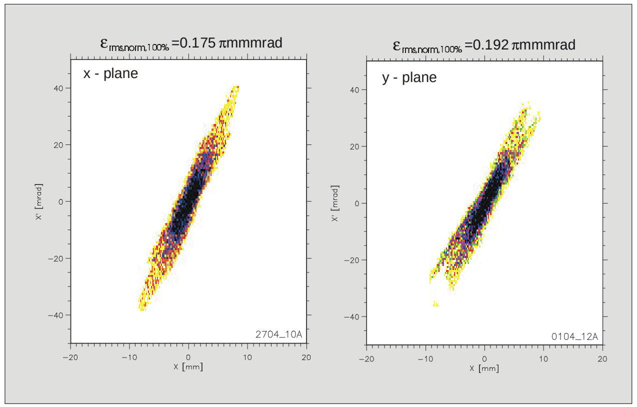
He^{+}, 14kev, 11 mA

RFQ entrance

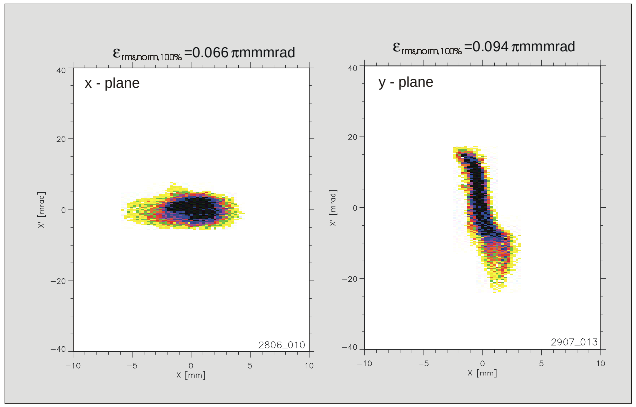
RFQ exit

He^{+}, 440 keV, 1.1 mA





lens off



lens in operation

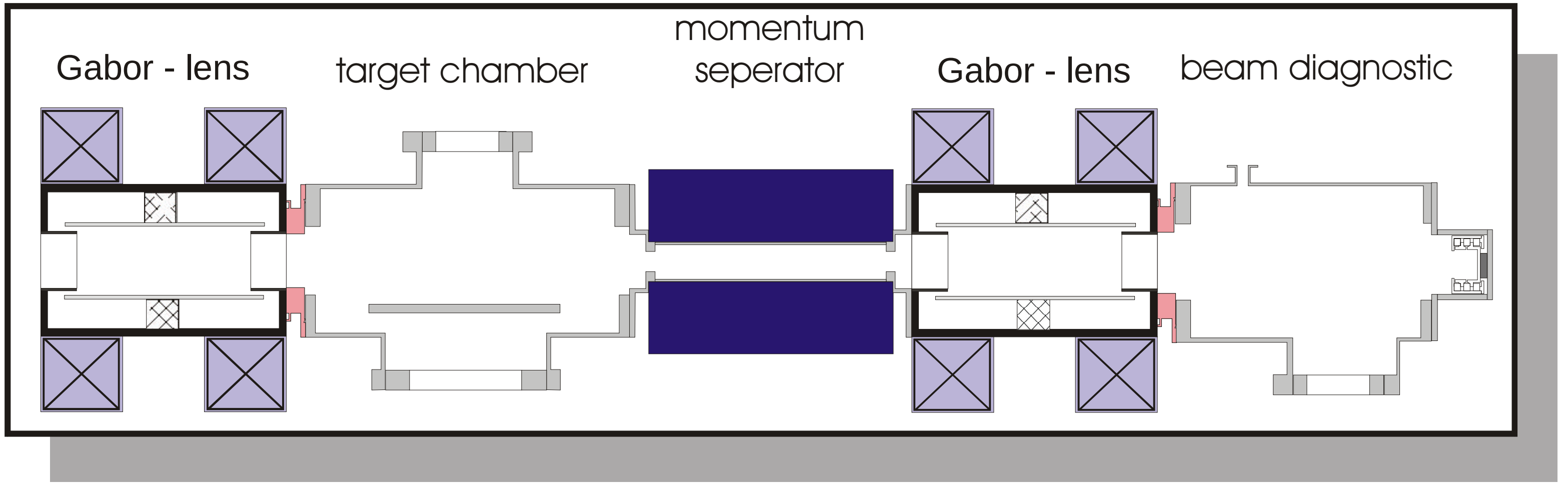
Accelerator front end

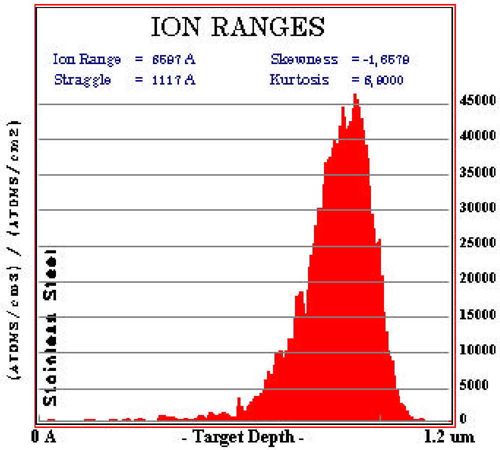
Motivation

- beam transport experiments using Gabor lenses
- beam - target & - plasma interaction (Prof. Jacoby)
- test stand for new accelerator structures (Prof. Schempp)
- advance lab course

Accelerator front end

beam - target & - plasma interaction



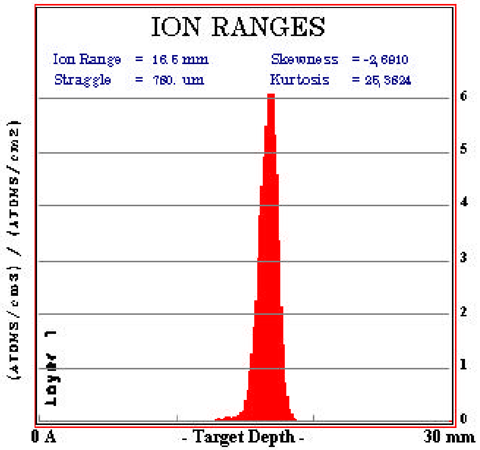


solid targets

440 keV He^{+} → stainless steel

gas targets

440 keV He^{+} → He 1 bar



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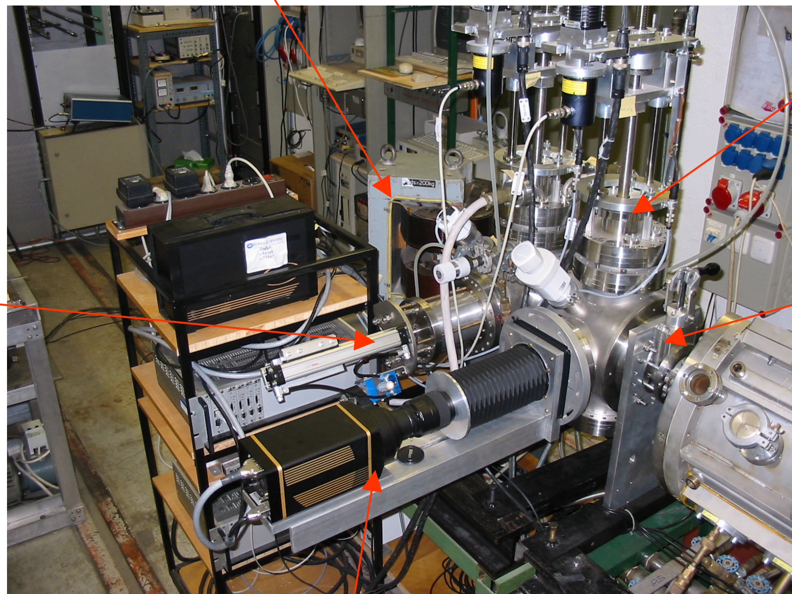
Accelerator front end

advance lab course in beam diagnostic



Test Toroid for Ion Beam Transport

Experimental setup

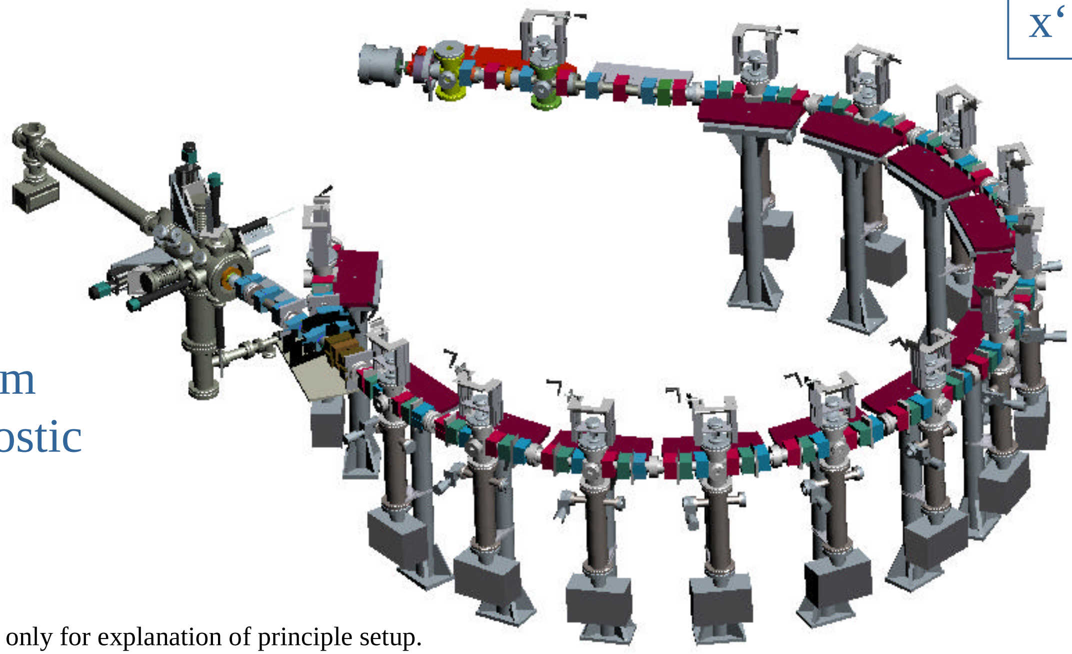
beam properties

W_b = 5 – 20keV

I = 1 – 15mA

x‘ = - 60 - + 60mrad

ion source & matching in section



beam diagnostic

12 solenoid segments 30°

Picture only for explanation of principle setup.

Source: University of Maryland Electron Ring (UMER); http://www.ireap.umd.edu/ebte/ring/

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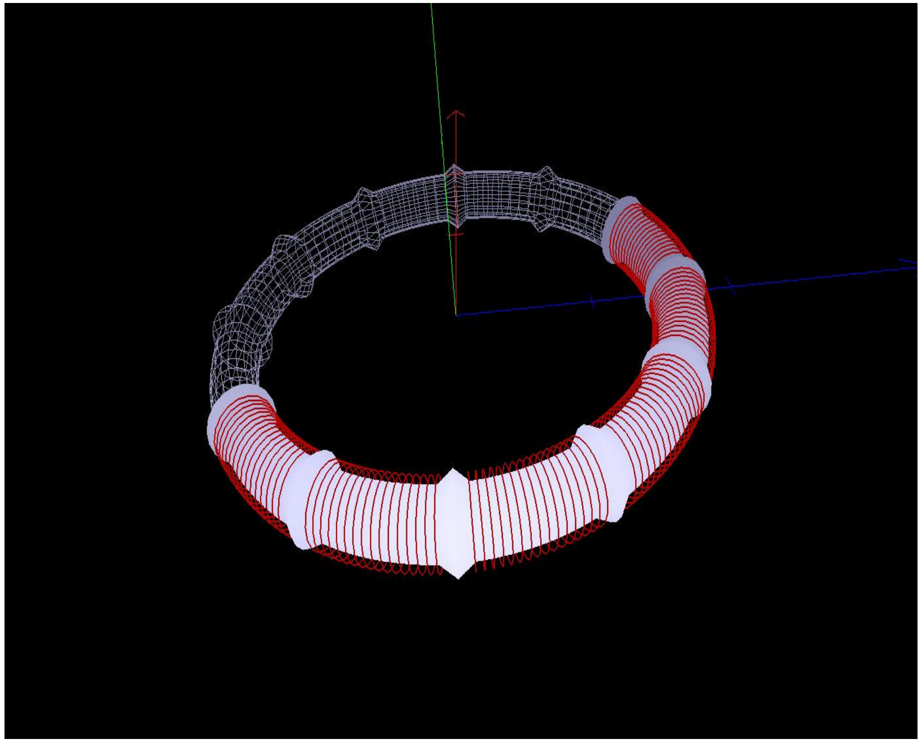
Test Toroid for Ion Beam Transport

Design study



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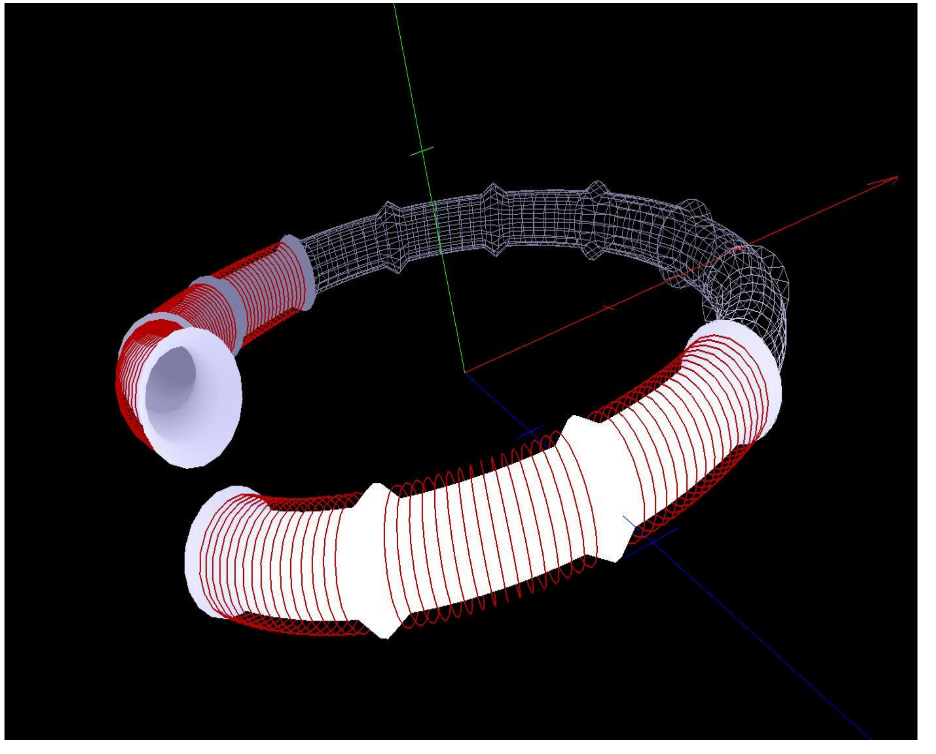
Test Toroid for Ion Beam Transport

Design study



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Test Toroid for Ion Beam Transport

Motivation

- space charge compensation in torodial beam transport
- investigation of beam drift effects
- investigation of beam instabilities
- experimental study of beam injection
- evaluation of numerical simulation with experimental results

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Test Toroid for Ion Beam Transport

Investigation of ion beam drifts

$$v_{drift} = \frac{F \times B}{qB^2}$$

centrifugal force

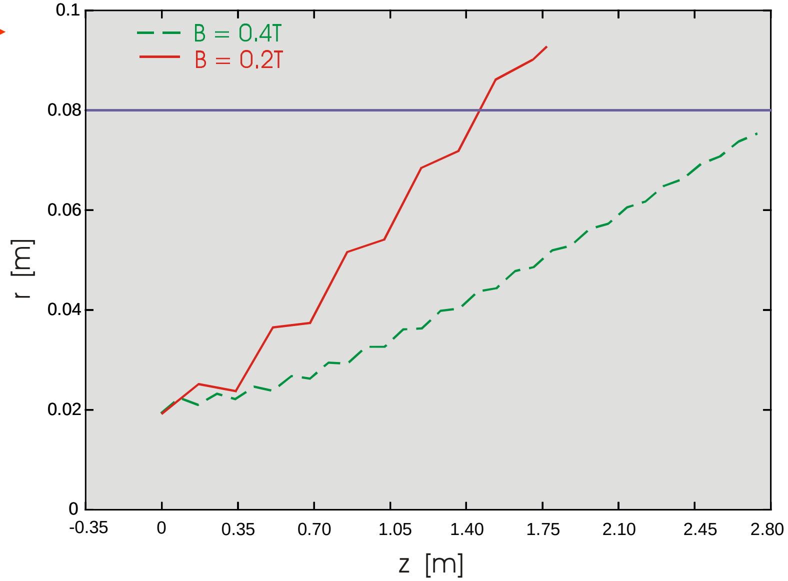
$$v_{\perp} = \frac{mv_{\parallel}^2}{qB^2} \frac{R_c \times B}{R_c^2}$$

electrostatic forces

$$v_{\perp} = \frac{E \times B}{B^2}$$

inhomogeneous torodiale magnetic field

$$v_{\nabla B} = \pm \frac{1}{2} v_{\perp} r_L \frac{B \times \nabla B}{B^2}$$



beam envelope as a function of z for two different B_z

Test Toroid for Ion Beam Transport

Collective Instabilities in Intense Charged Particle Beams

One-Component Beams

- Electrostatic Harris instability
- Electromagnetic Weibel instability

Propagation Through Background Electrons

- Electron-ion two-stream (Electron Cloud) instability

Propagation Through Background Plasma

- Resistive hose instability
- Multispecies Weibel instability
- Multispecies two-stream instability

Conclusion

test stand for MED – RFQ

RFQ measurements at the beginning of May

accelerator front end

reconstruction and upgrade of the old facility

test toroid

low scale experiments for high current storage ring

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