Characterization of Electron Cloud Properties Confined in a Gabor Space Charge Lens

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ECLOUD Workshop 2012

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

IAP

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Non Neutral Plasma Physics Group

Outline

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1. **Field of Research**
2. **Different Types of Space Charge Lenses at IAP**
3. **Diagnostics**
4. **Summary and Outlook**

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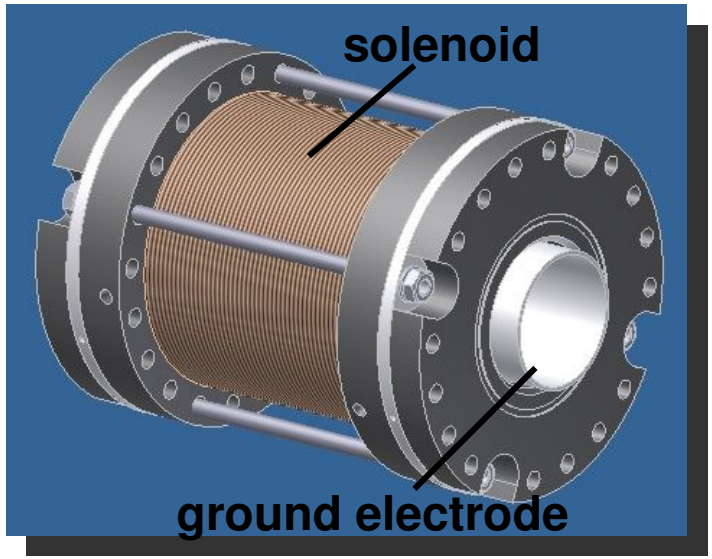
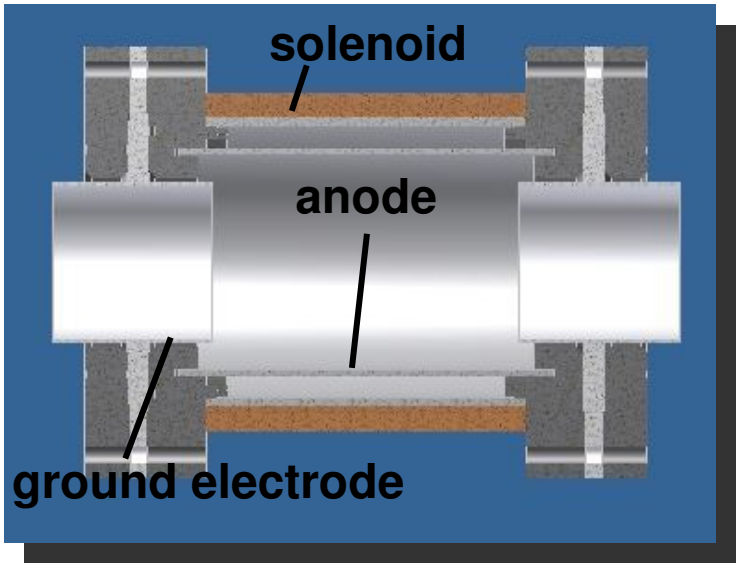
Field of Research





- focusing of ion beams
- determination of plasma parameters
- electron production and loss rates
- electron cloud dynamics

➡ **controlled and stably confined electron cloud**

Space Charge Lenses at IAP

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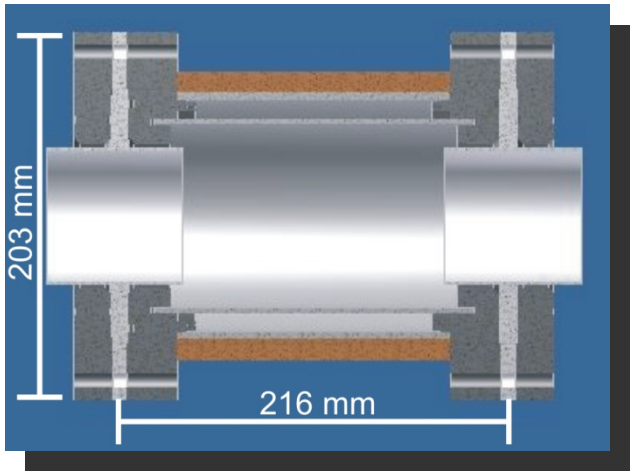

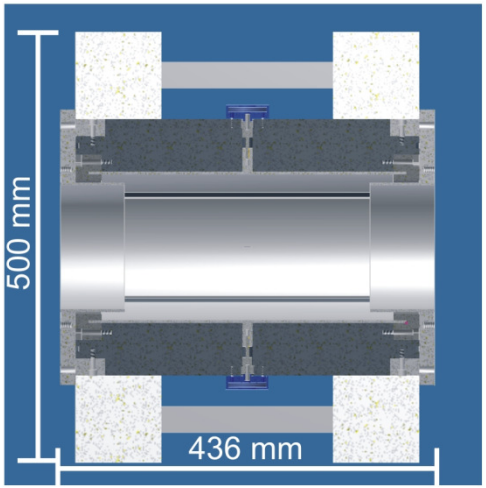

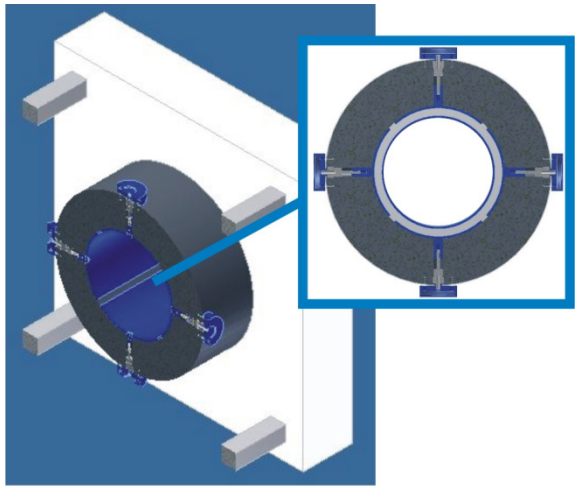

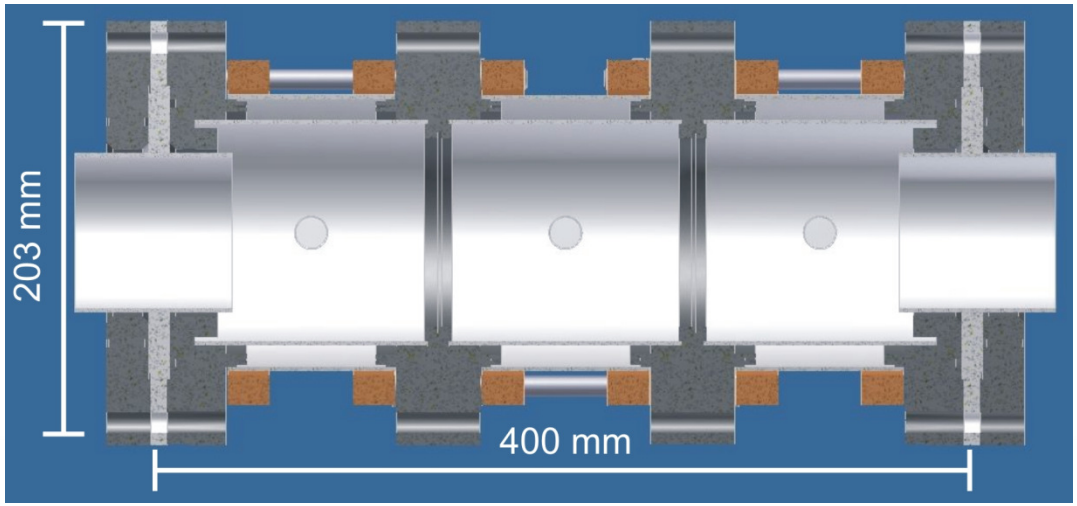

Electron Production

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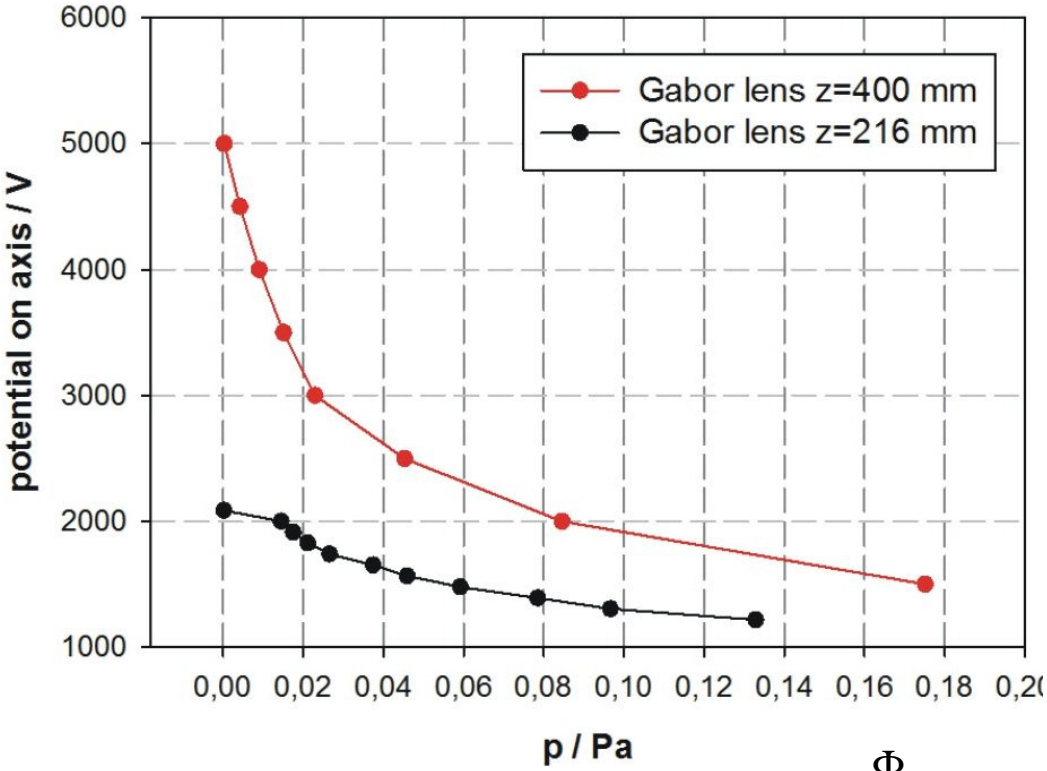
Nonneutral Plasma Ignition



$$\frac{\Phi_A}{B_z} = 1$$

Datei: Zündkurven

Results:

- higher probability of electrons produced at the edge
- filling times cannot be explained by particles interacting with residual gas alone

Objectives:

- determination of production rates

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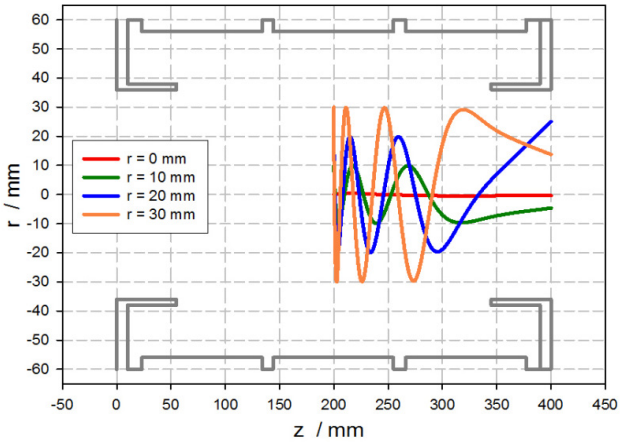
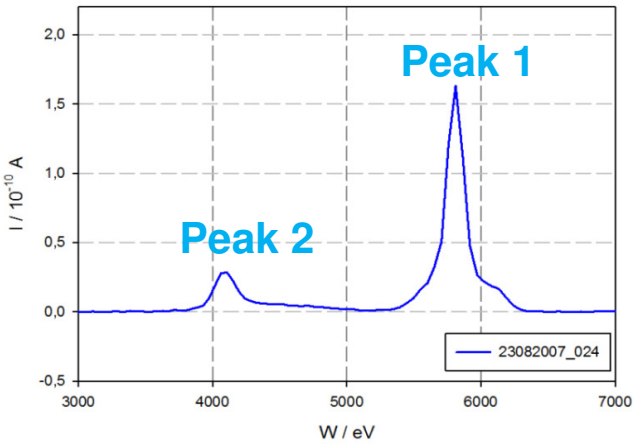
Electron Density Measurement

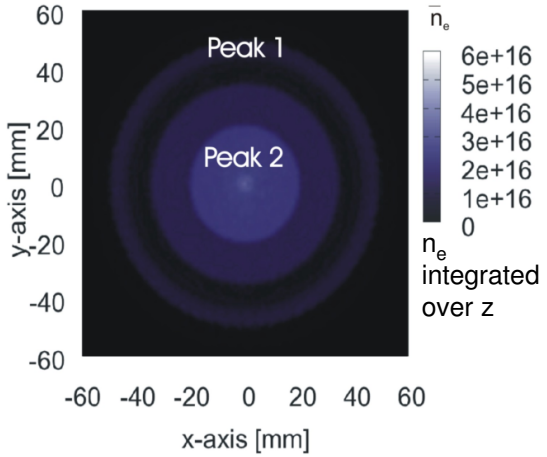
Trajectories of Emitted Residual Gas Ions



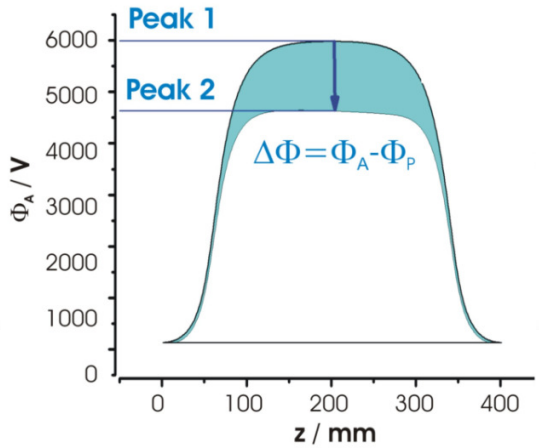
Detected Ion Energy Distribution



Locations of Production

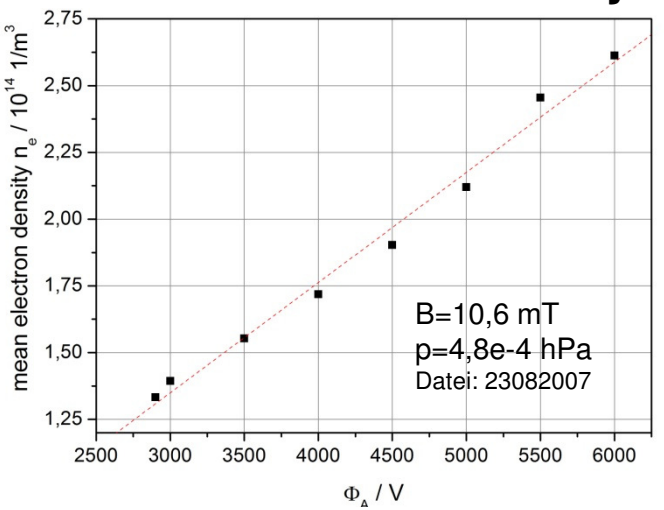


Potential Depression by Confined Electrons



$$n_e = \frac{4\varepsilon_0 \Delta\Phi_A}{er^2}$$

Mean Electron Density



Nonneutral Plasma Instabilities

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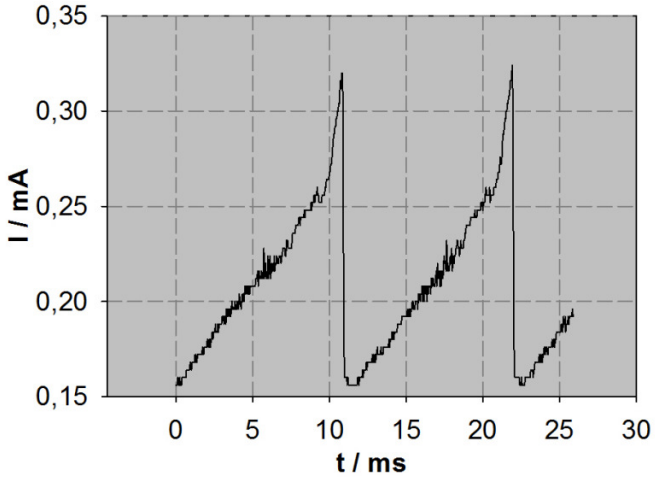
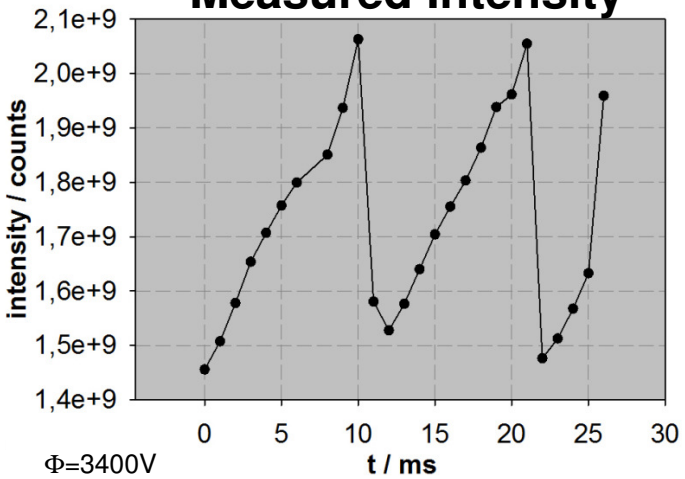
Measured Ion Current

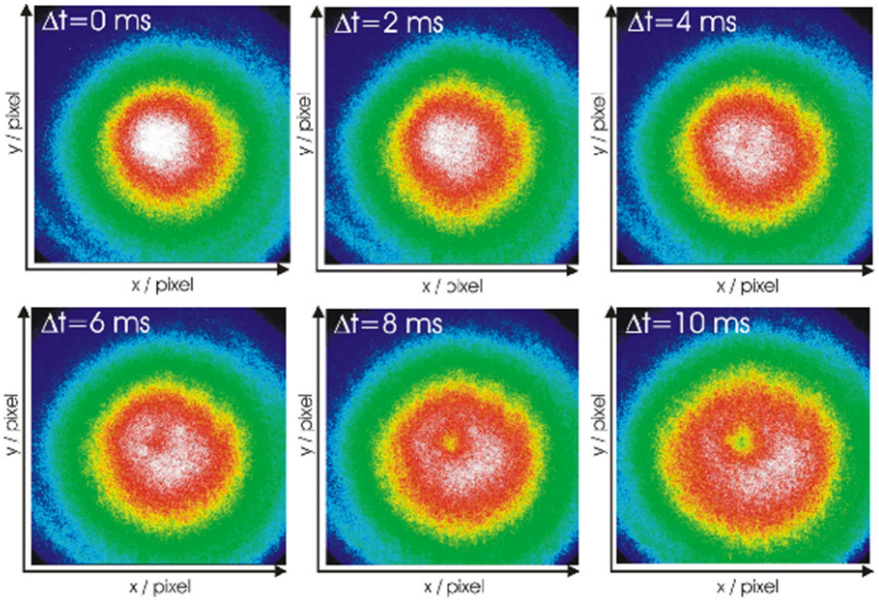


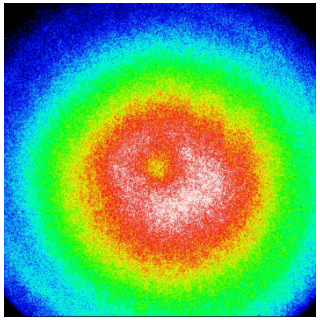
Measured Intensity



Φ=3400V
B=12 mT
p=7,9-4 hPa (He)
Datei: 18072011

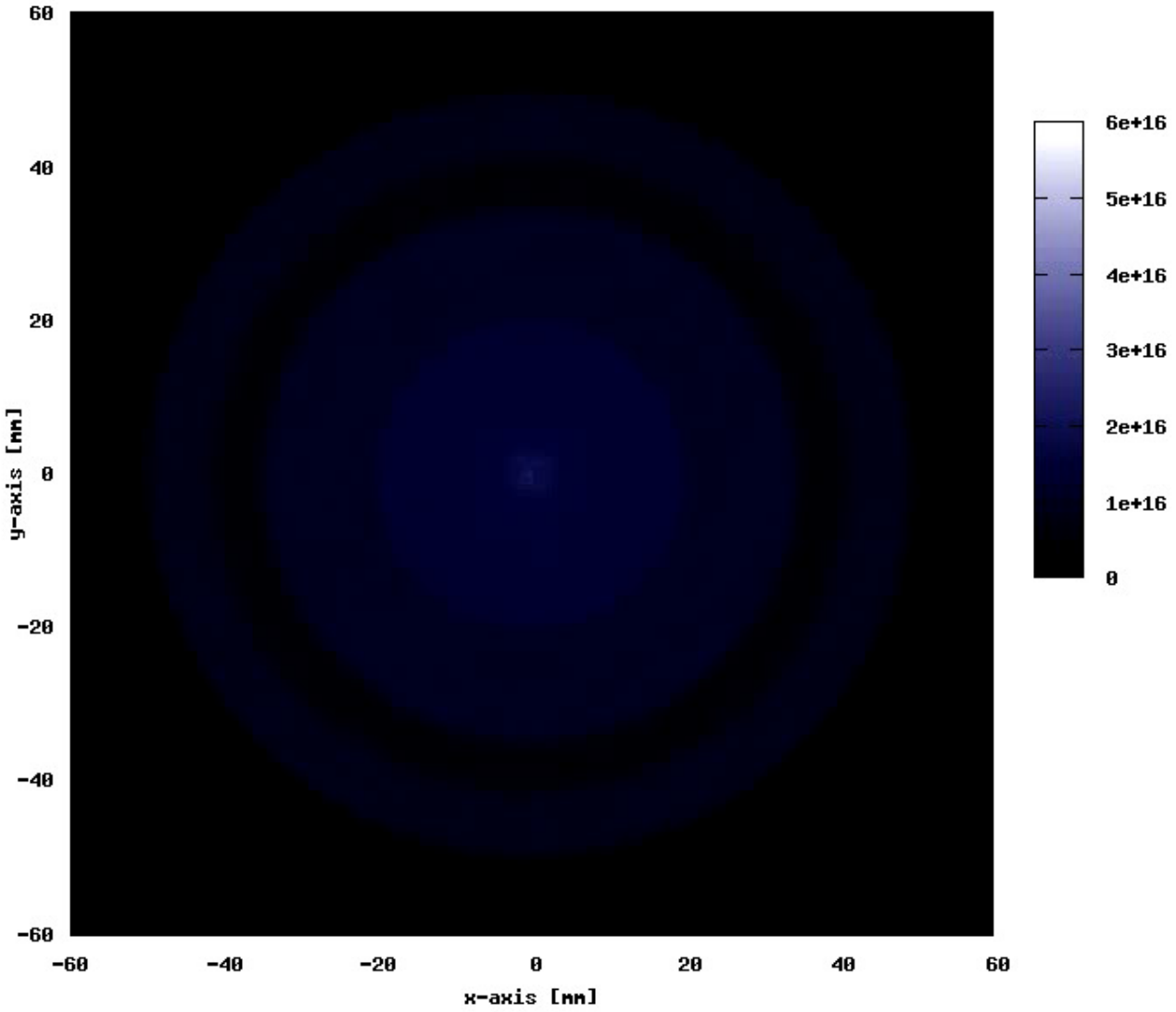
Time-resolved Measurement of an Instabilty





Simulation:

Arising instability seems to be a result of a difference in the local electron density distribution and the electron temperature in transverse and longitudinal direction.


60
40
20
0
-20
-40
-60
y-axis [mm]
-60
-40
-20
0
20
40
60
x-axis [mm]
6e+16
5e+16
4e+16
3e+16
2e+16
1e+16
0

Space Charge Lenses at IAP

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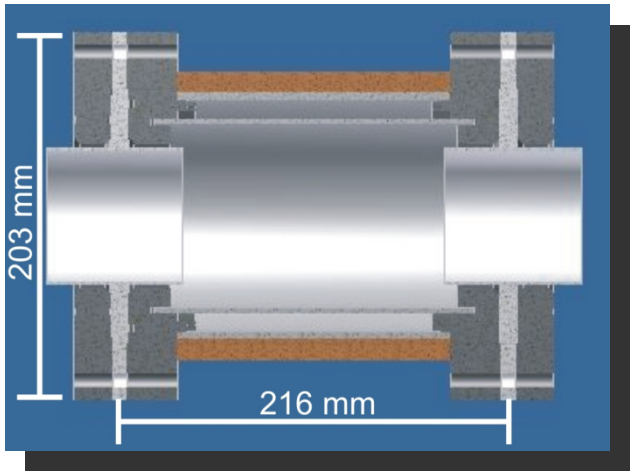

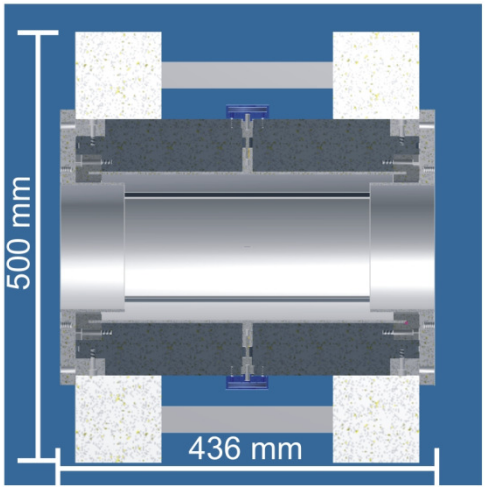

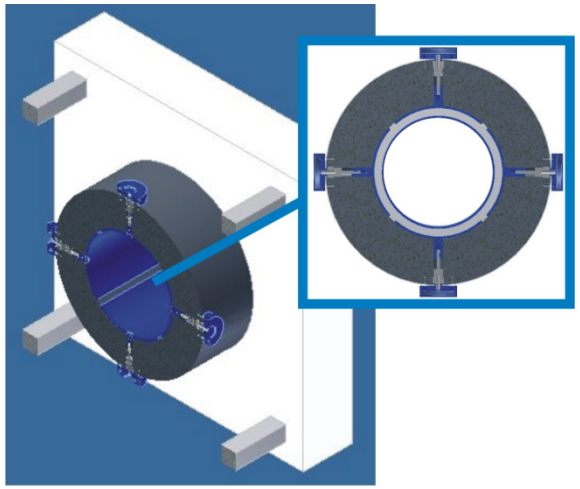

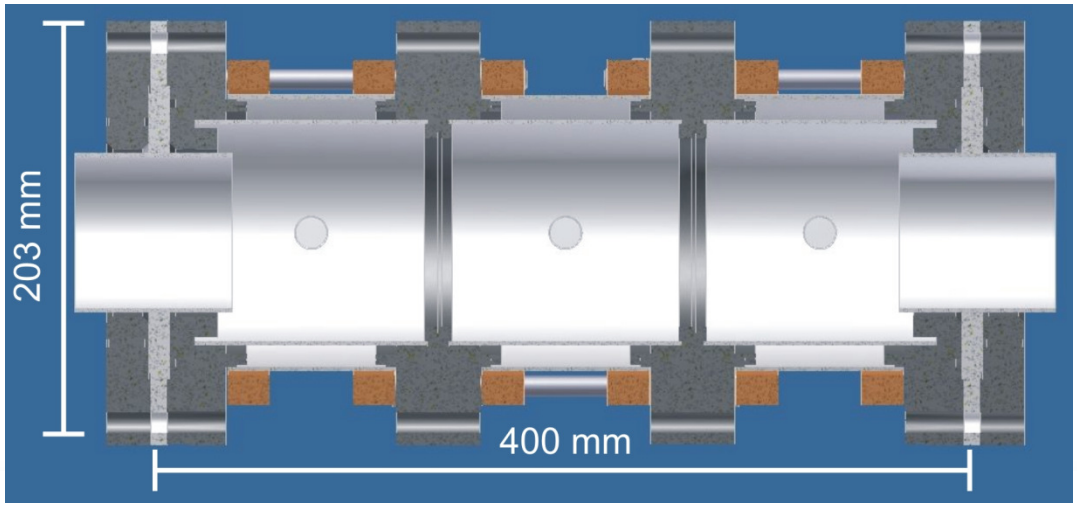

Electron Losses

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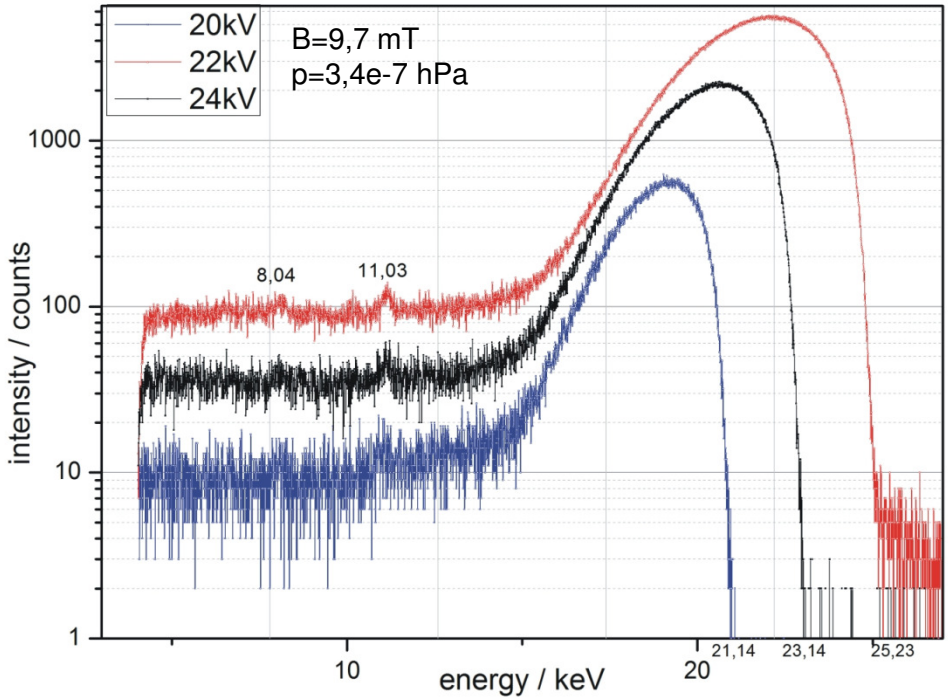
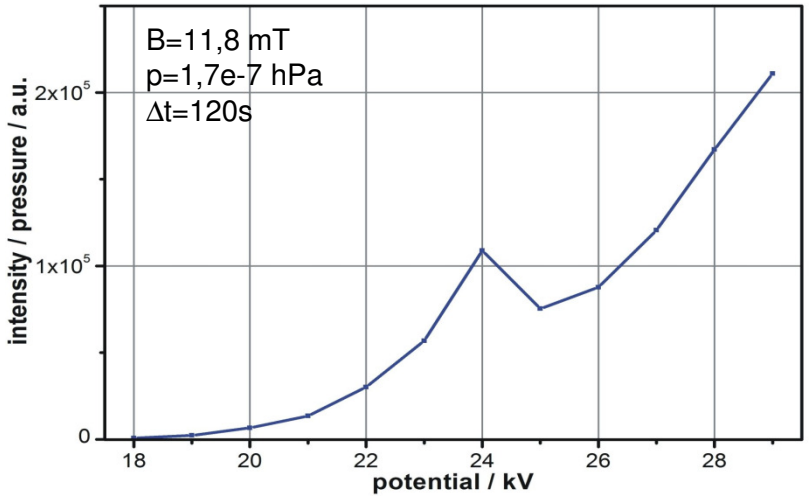
Emitted Bremsstrahlung Spectra



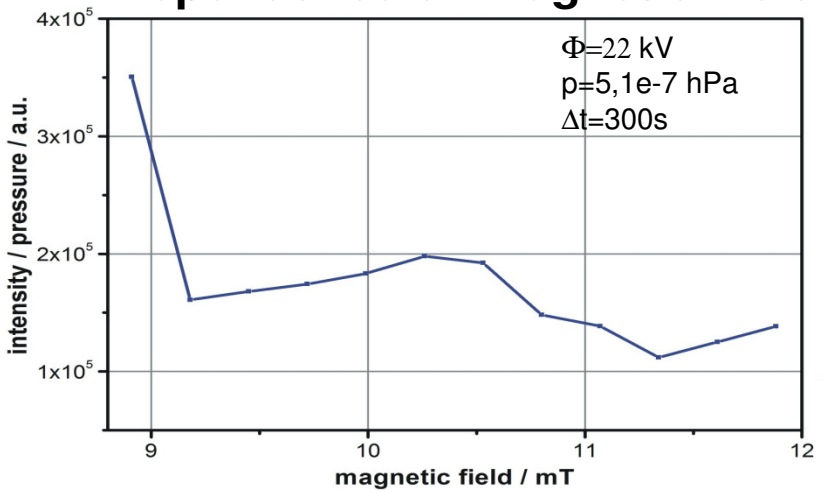
Objectives:

- study of loss channels
- determination of loss rates

Dependence on Anode Potential



Dependence on Magnetic Field



Temperature Measurement

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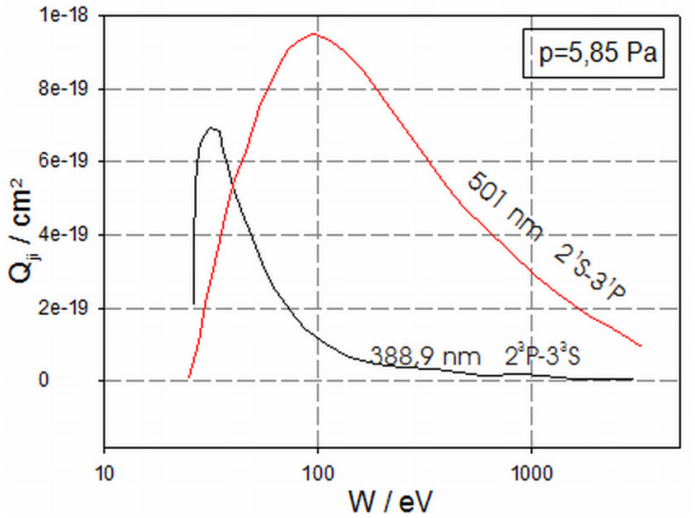
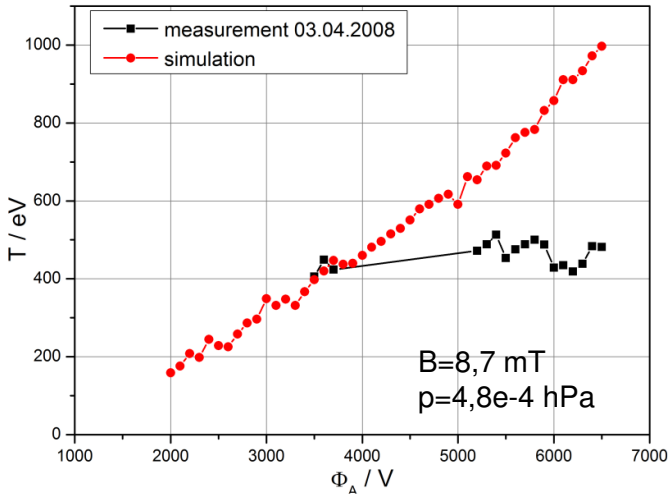
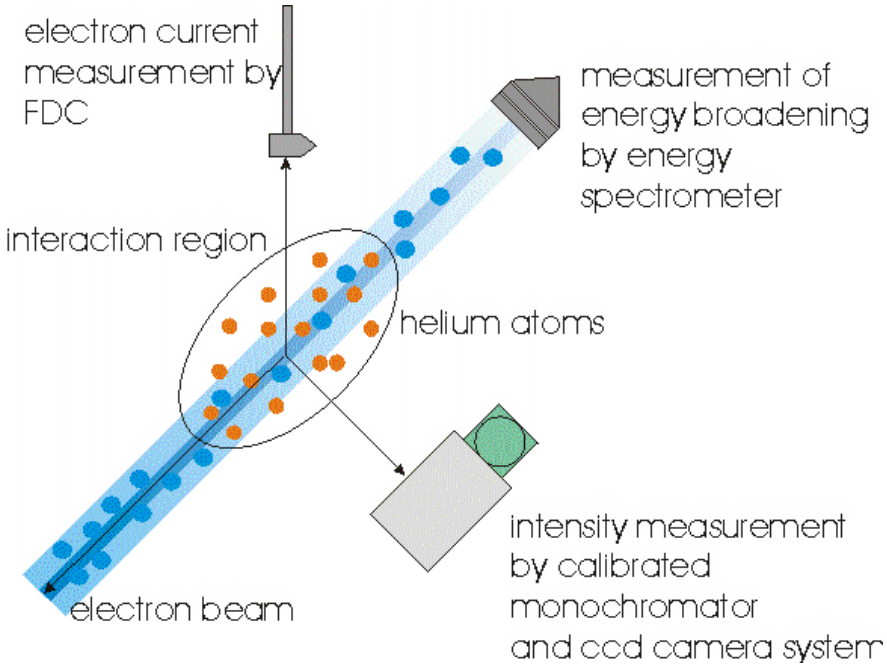
Ratio of Emission Cross Sections



Temperature Measurement



Measurement Scheme



Optical Emission Cross Section:

$$Q_{ji} = \frac{\Phi_{ji}}{I/e \cdot n_0}$$

$$\Phi_{ji} = \frac{photons}{t \cdot \Delta x} = \frac{I_{ji}}{t \cdot \Delta x}$$

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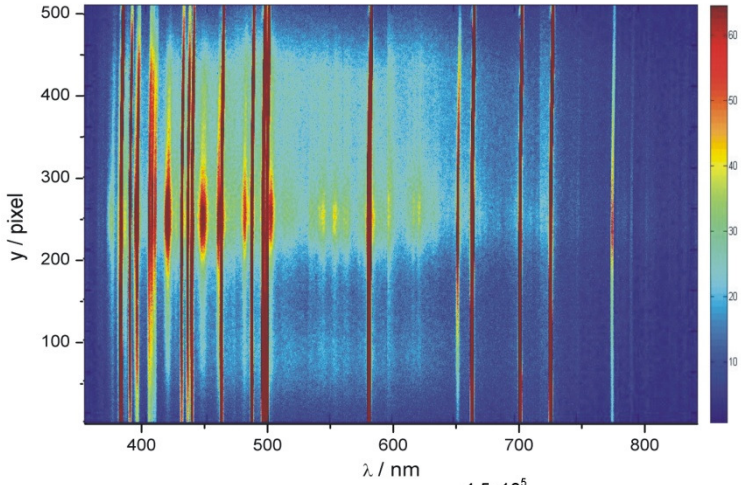
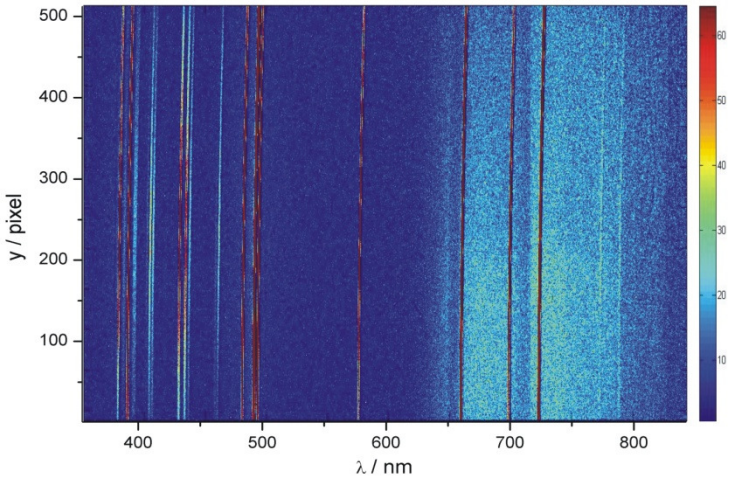
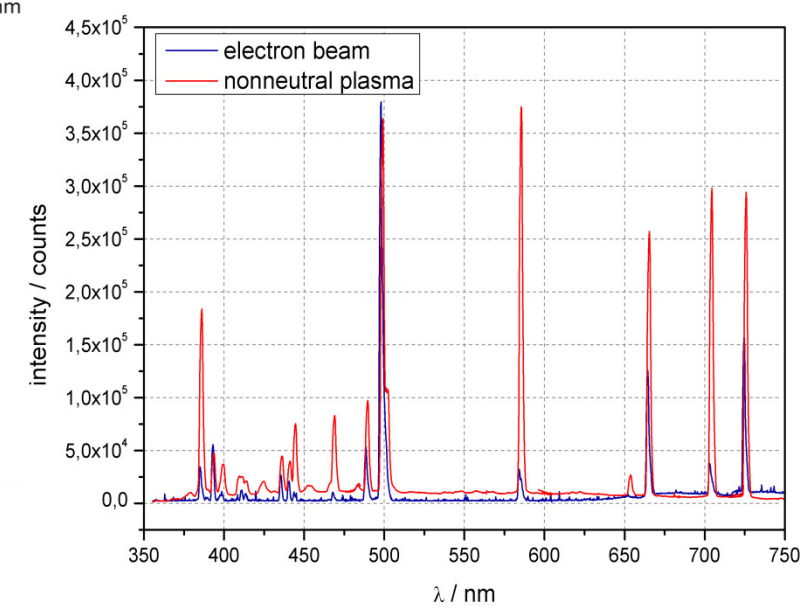
Comparison of Spectra

Nonneutral Plasma



Electron Beam





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Summary and Outlook

- different diagnostic techniques have been presented
- electron production and loss rates as well as the related electron temperature still need to be determined
- implementation of these effects into numerical models
- study of the interaction between ion beam and electron column

Thank you for your attention!