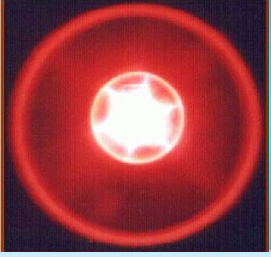


Reducing RF-power and x-ray load in ECRIS by metal-dielectric (MD) structures

L. Schachter¹⁾, K. E. Stiebing²⁾, S. Dobrescu¹⁾

1) National Institute for Physics and Nuclear Engineering, Bucharest- Romania

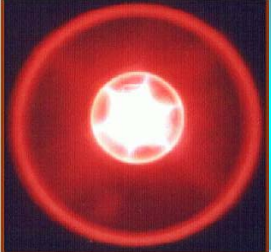
2) Institut für Kernphysik der J. W. Goethe Universität, Frankfurt/ Main- Germany



Starting points:

Metal dielectric structures (MD) installed in the plasma chamber of the Frankfurt 14 GHz ECRIS, have been used to significantly reduce the level of microwave power, necessary to extract ion intensities comparable to those extracted from the standard ECRIS (all stainless steel).

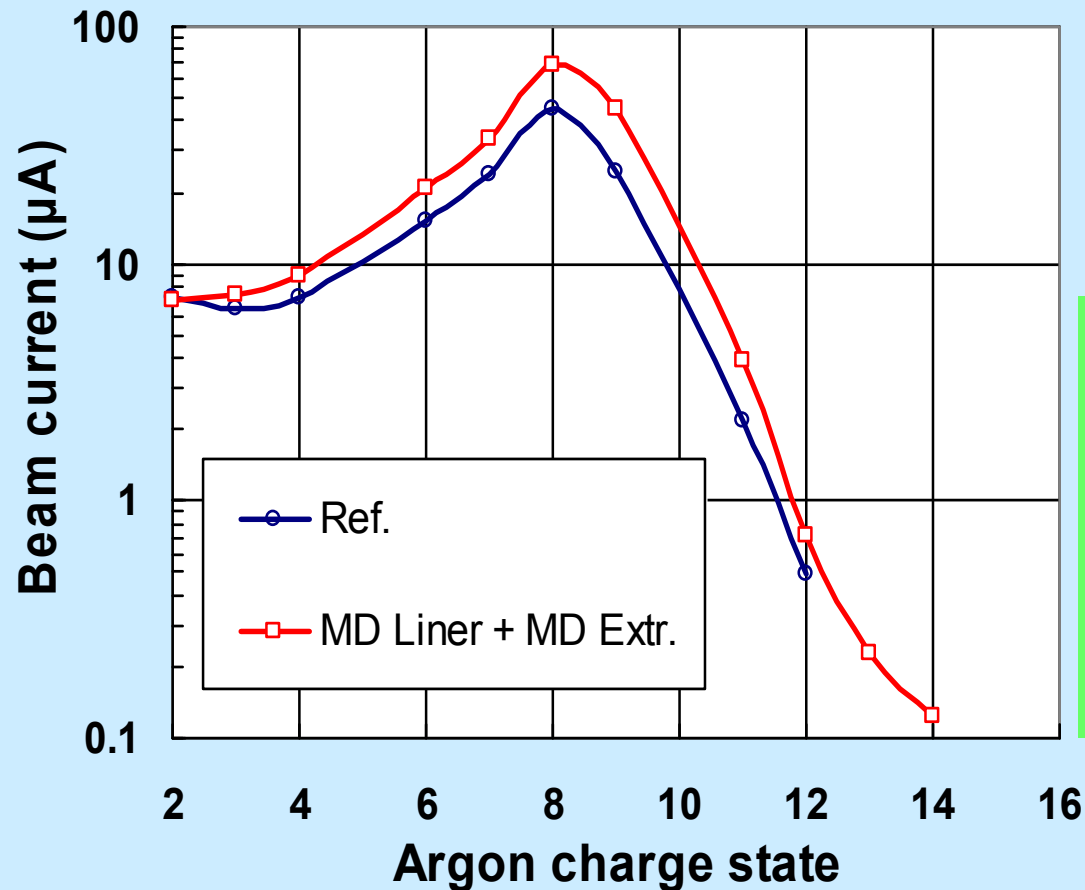
The measurements indicate that the RF power may be reduced by factors of 2-3, to obtain the same output of high argon charge states as in the standard source. This reduced level of microwave power also leads to a much lower load of Bremsstrahlung radiation from the source.



MD in the plasma chamber:

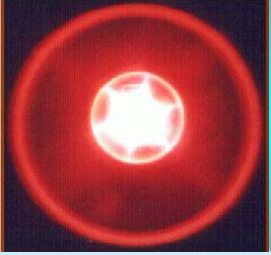
partial restoration of the plasma ambipolarity

→ *Increase of ion-confinement time*



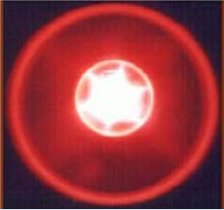
CSD for a plasma, optimized for the extraction of Ar-8⁺ ions

- All the charge states are enhanced between 30-90%
- Good enhancer of the medium charge states

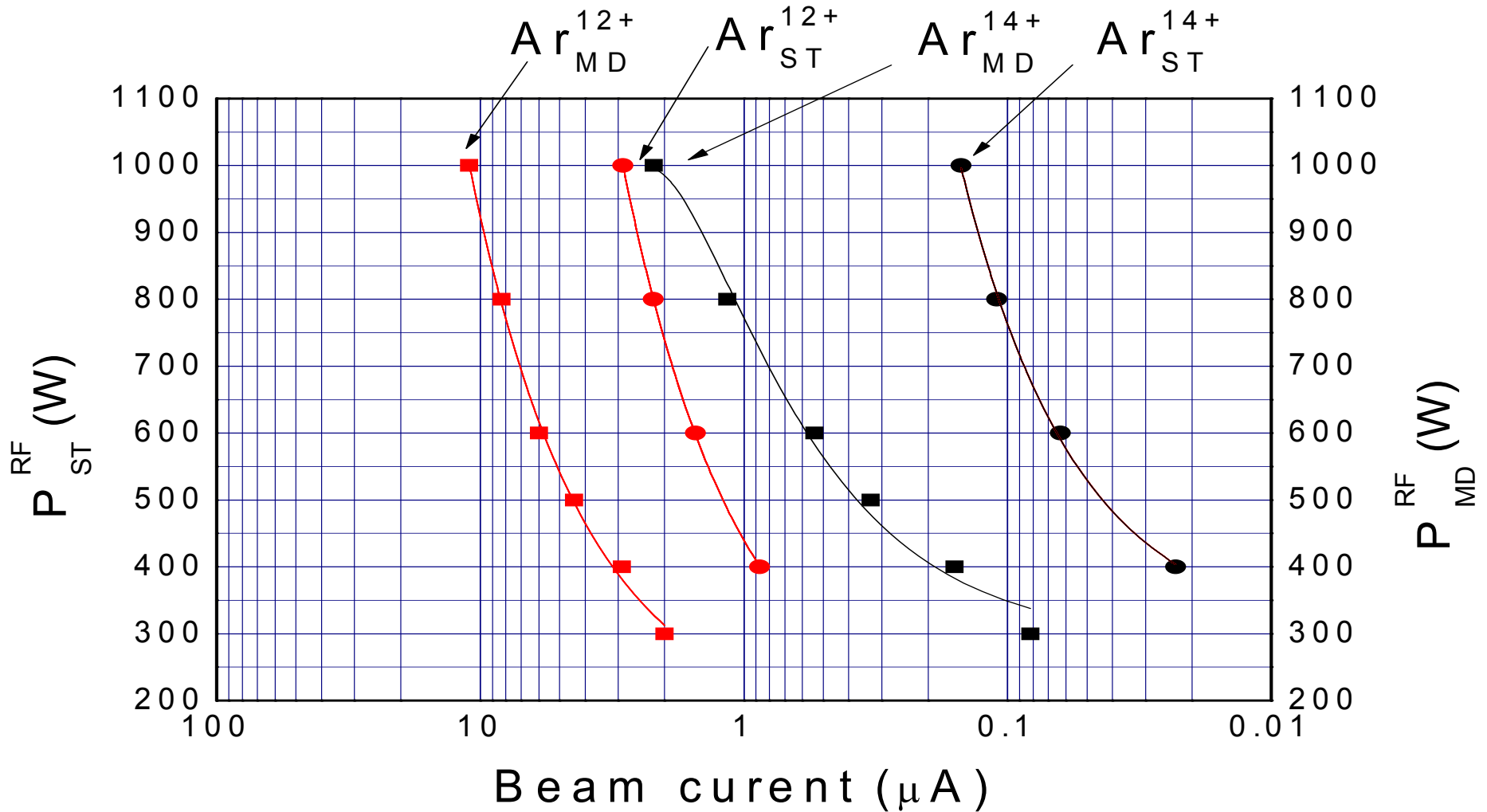


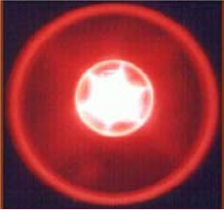
MD in the plasma chamber:

- **Increase of electron-density and temperature**
 - **Operation at lower pressure**
 - **Operation with reduced RF-power**
-
- **Increase of the HCS ion production**
 - **limiting plasma instabilities**
 - **minimize charge exchange processes and recombinations**
 - **RF power saving by a factor 2-3**
 - **reduced X-rays emission**

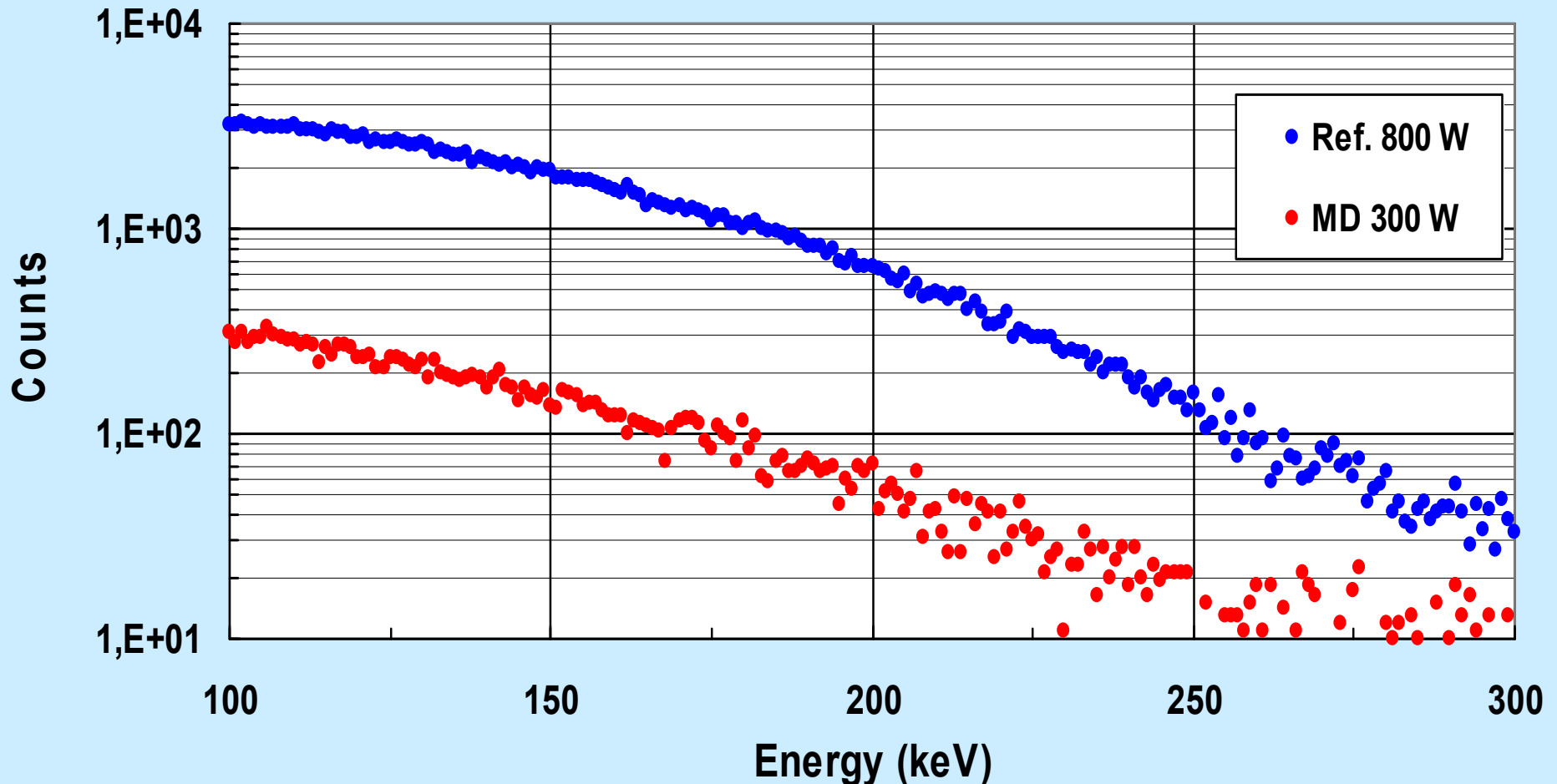


Saving RF-power by MD:

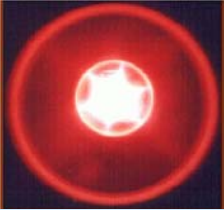




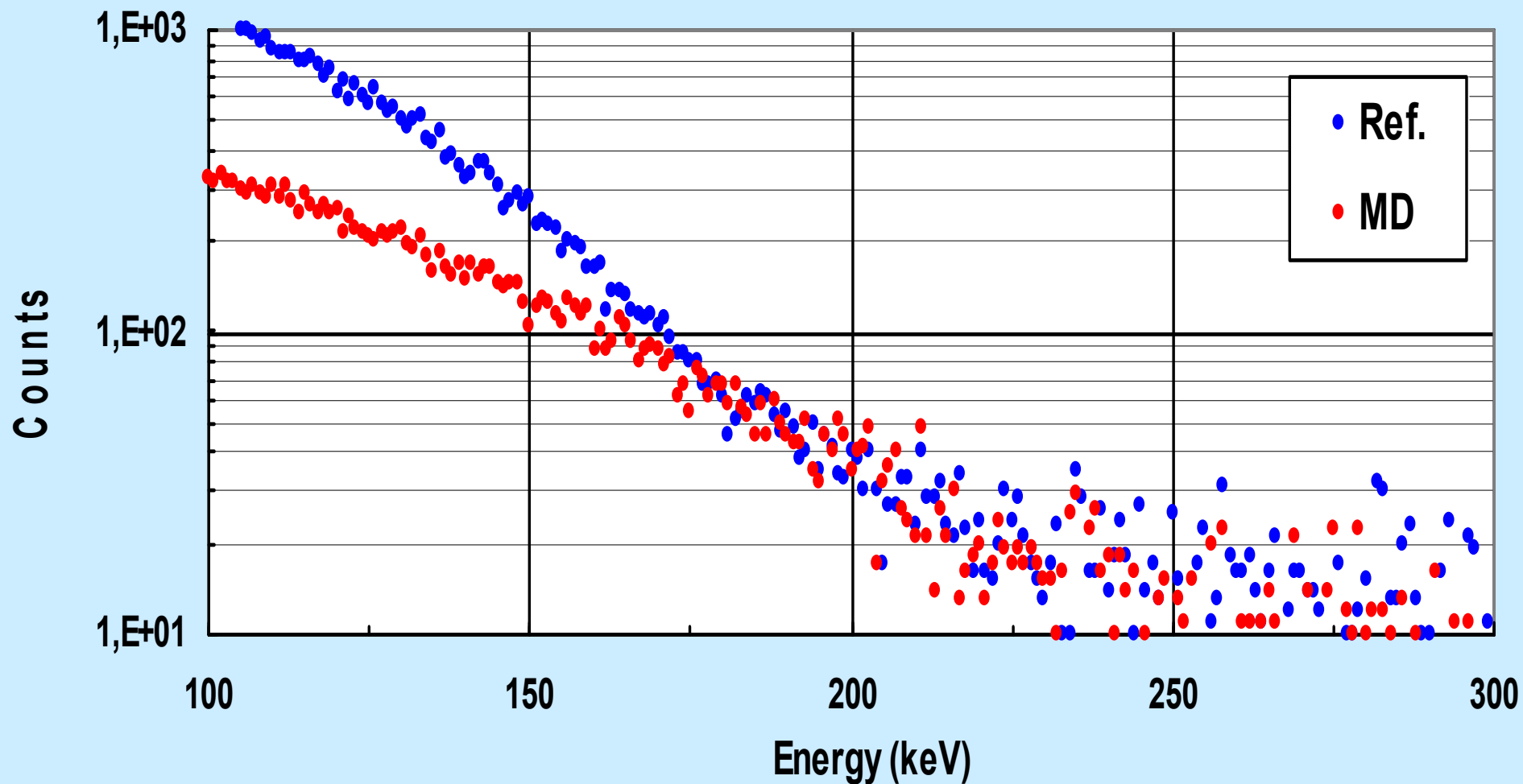
IF you don't like x-ray emission!



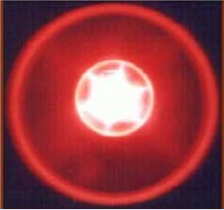
X-ray emission is reduced by a factor 10 for the source equipped with MD structures as compared to the „standard“ (all stainless steel) source.
(The source has been optimized for the extraction of Ar-12⁺ ions)



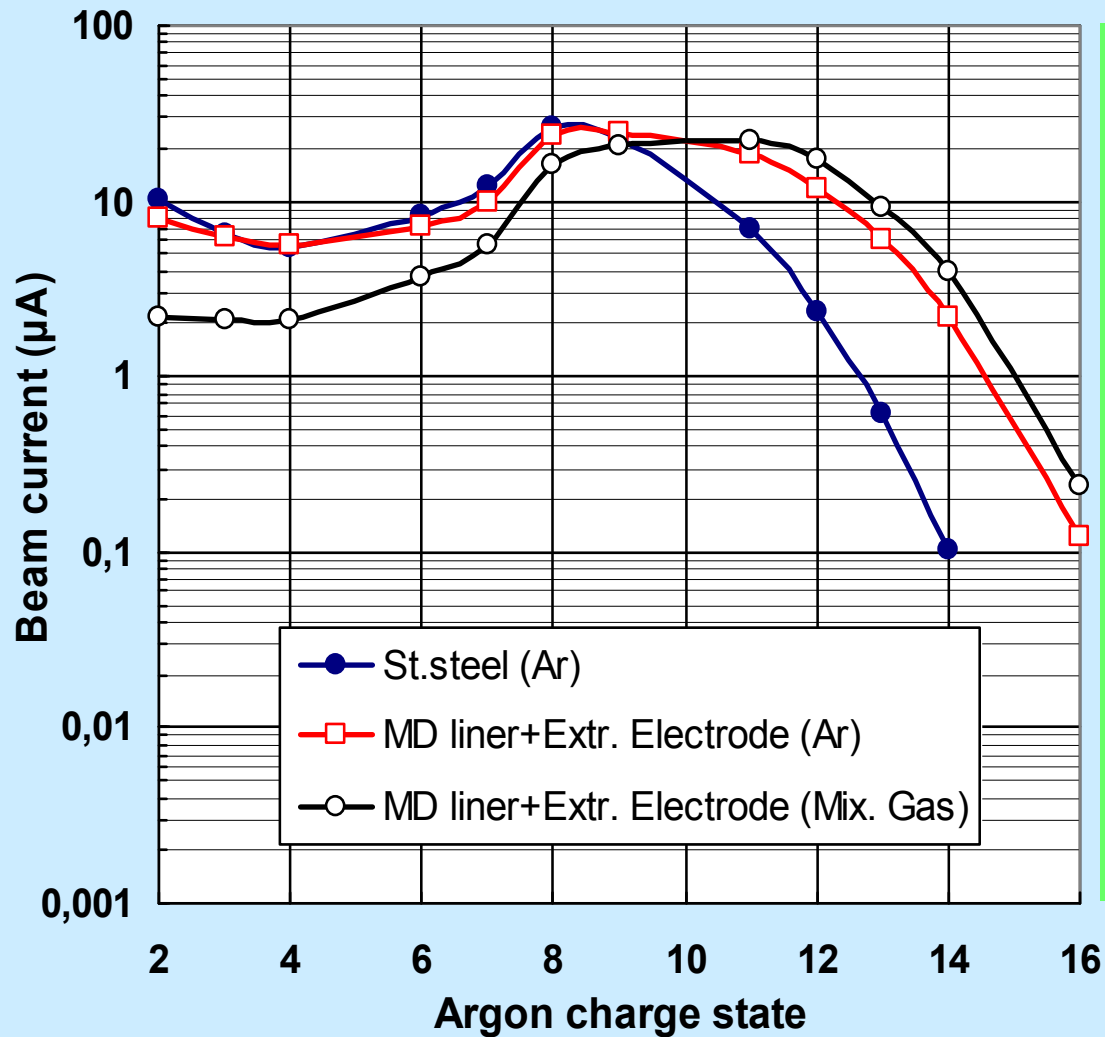
X-ray spectra at 800 W RF Power for the standard source and the source equipped with MD- structures



The source has been optimized for the extraction of Ar-8⁺ ions



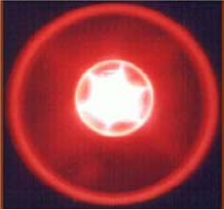
MD versus gas-mixing



MD liner+ MD extraction electrode inserted in the plasma chamber :

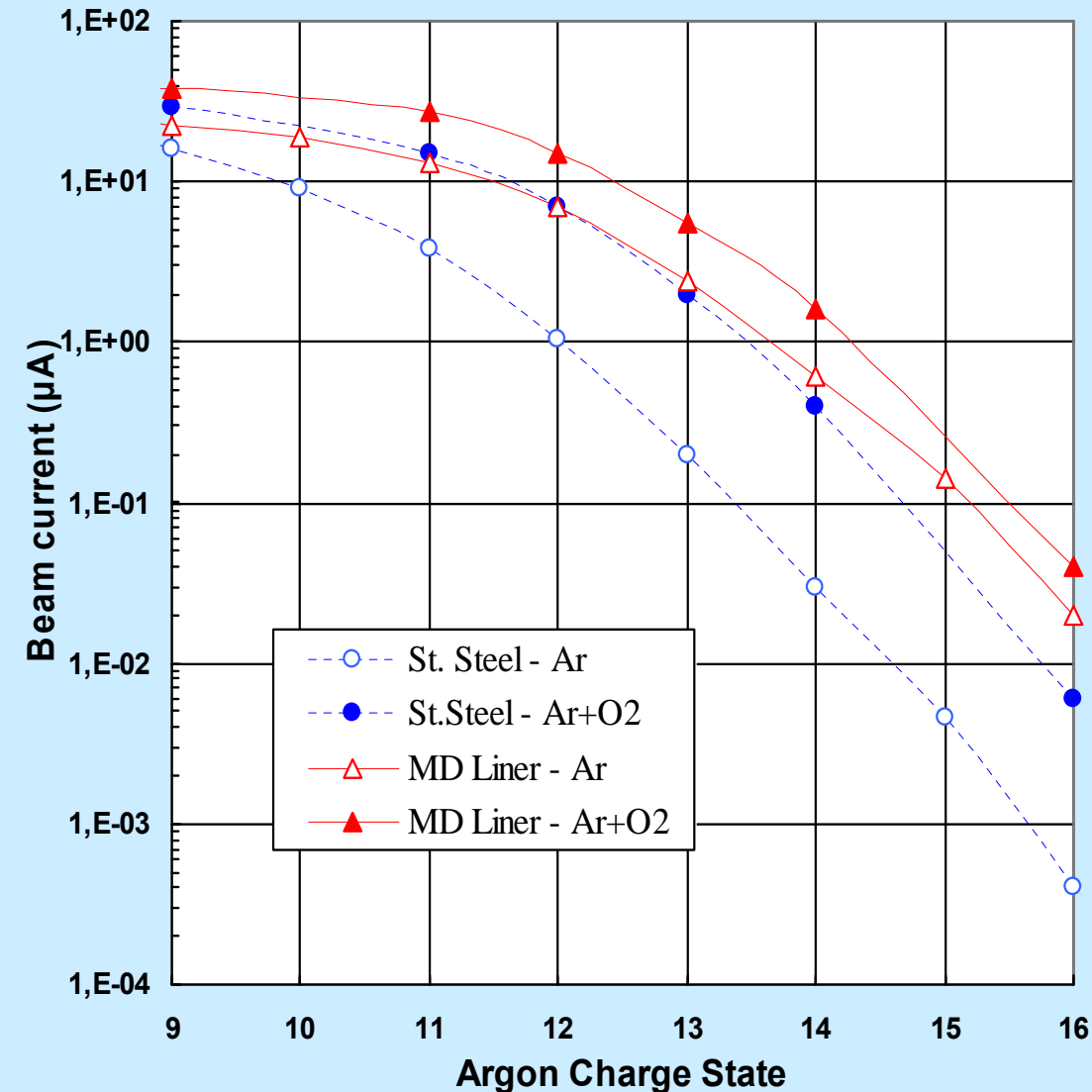
→ *Much stronger effect with MD*

- extracted currents of Ar-14⁺ ions are increased by a factor of **7** compared to the standard mode of operation.
- gas mixing in the presence of MD increased the performance by another factor of ≤ 2
- negligible content of support gases (e.g. O₂)



MD versus gas-mixing

INTRINSIC EFFECTS

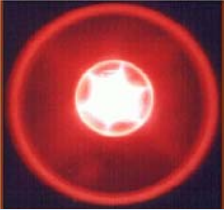


MD liner inserted in the
plasma chamber
L. Schachter, et al.;
Rev. Sci. Instr. 71, Vol. 2, p.918, (2000)

$$I_{(\text{MD, Ar})} / I_{(\text{st.st. Ar+O}_2)} = 3.3$$

for Ar¹⁶⁺

*MD intrinsic effect is 3 times
stronger than the gas mixing
effect for very high charge
states*



CONCLUSION

*MD liner +
MD extraction
electrode in the
plasma chamber*

- **Significantly stronger production of high charge state ions**

• Saves RF power

- **Significant lower X-rays emission**

• Reduced ECRIS design restrictions