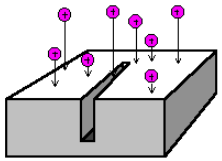
Northeastern University



Plasma Engineering Laboratory

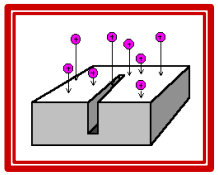
LOW-POWER mWAVE PLASMA SOURCE FOR MICROSYSTEMS

Felipe Iza and Jeffrey A. Hopwood

Northeastern University
Boston, MA
- USA -

ICOPS - Cheju, 2003

Outline



Device Description

- **Low-cost** gap-excited microwave plasma source
- **Low-power** device
- **Atmospheric pressure**

Probe Diagnostics

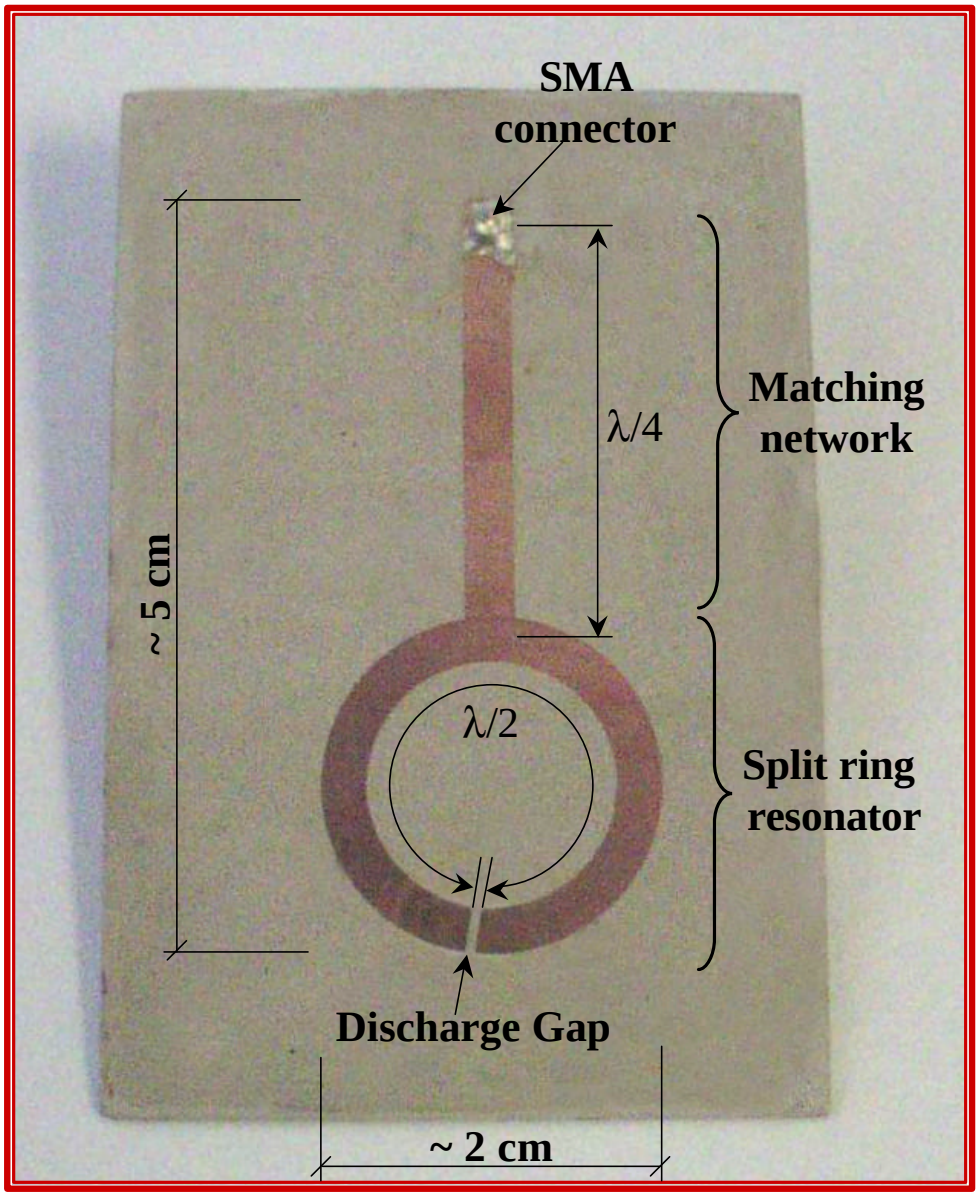
- **High-density** discharge
- Low sheath voltage

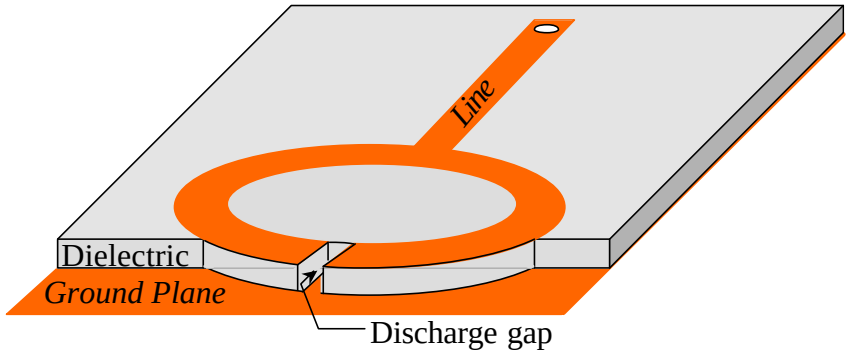
Spectrum Analisys

- Non-equilibrium, **low-temperature** discharge

Conclusions

Plasma Source Description





RT/Duroid 6010.8

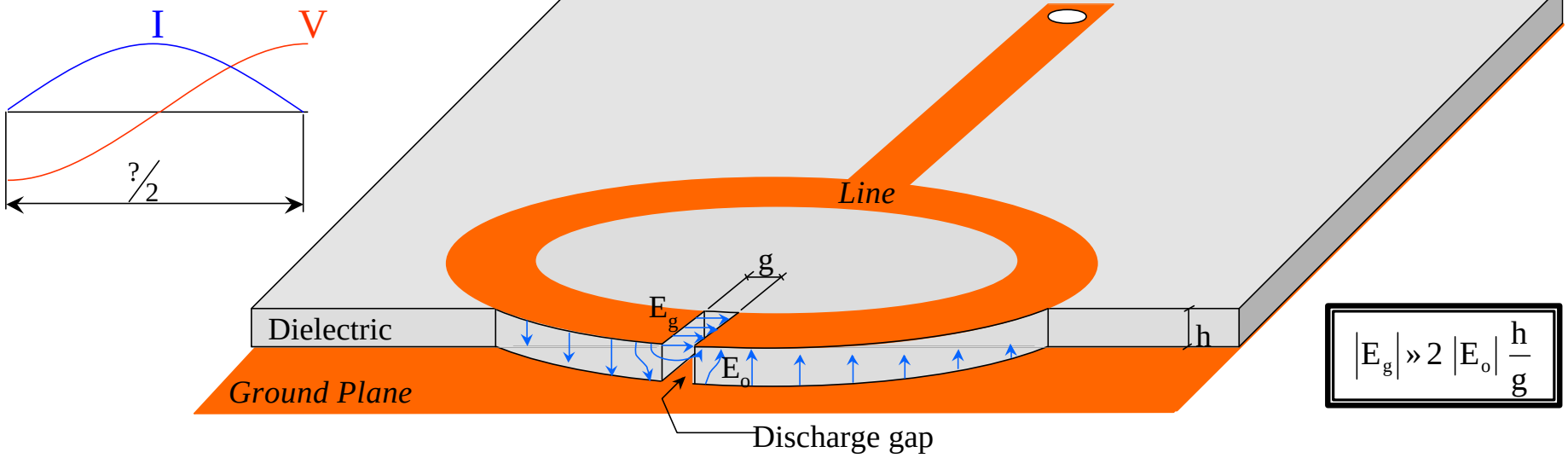
Dielectric: Ceramic reinforced teflon
Dielectric constant ε_r=10.8
Dielectric thickness: 635μm

Conductor: Copper
Conductor thickness: 9 μm

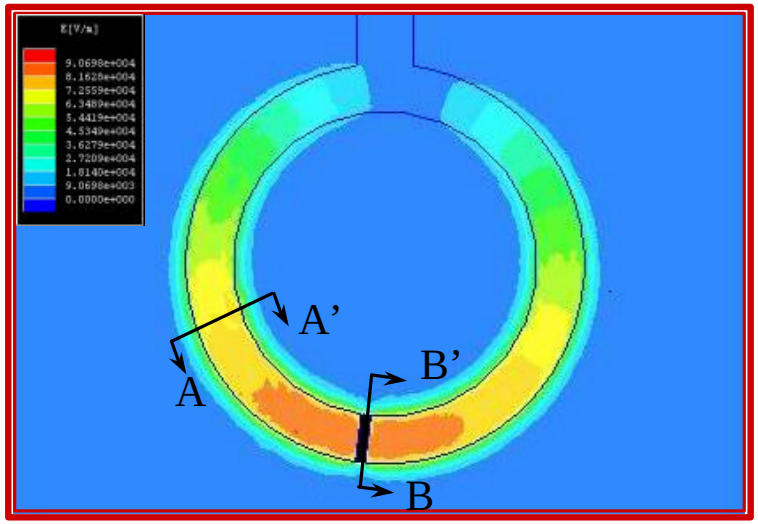
Operation Conditions

900 MHz
0.1 - 760 torr
0.150 - 3 W

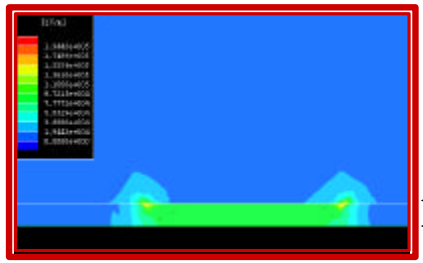
Principle of Operation



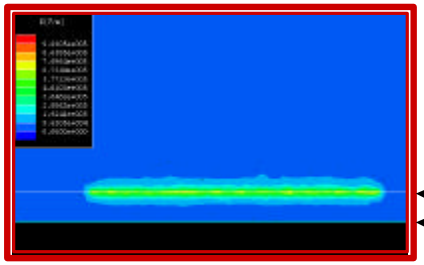
$$|E_g| \gg 2\,|E_o|\,\frac{h}{g}$$



Magnitude of the electric field |E|
Simulation using HFSS from Ansoft

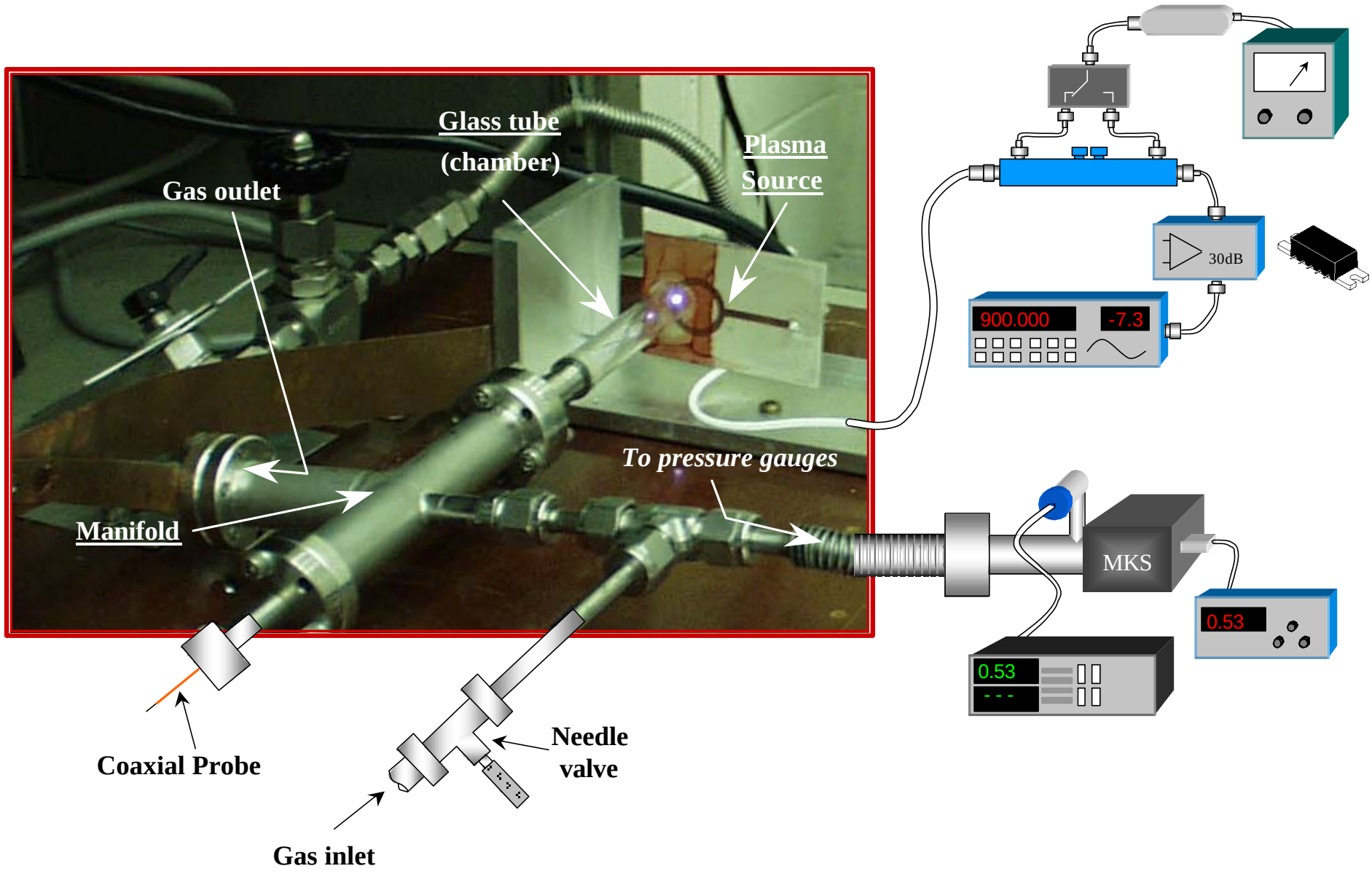


Section AA'

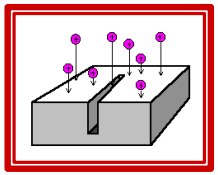


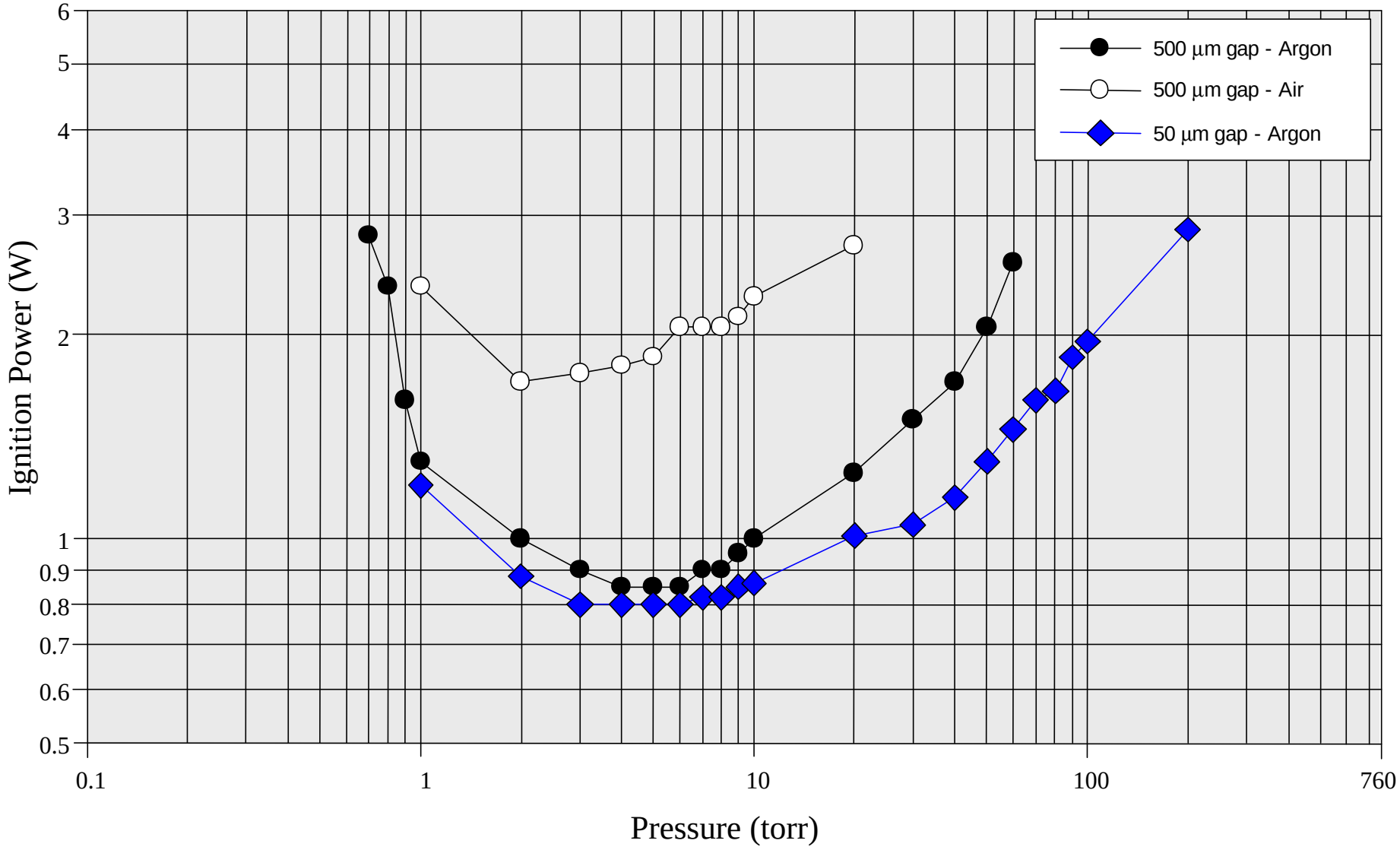
Section BB'

Experiment Set-up



Ignition Power & Gap engineering

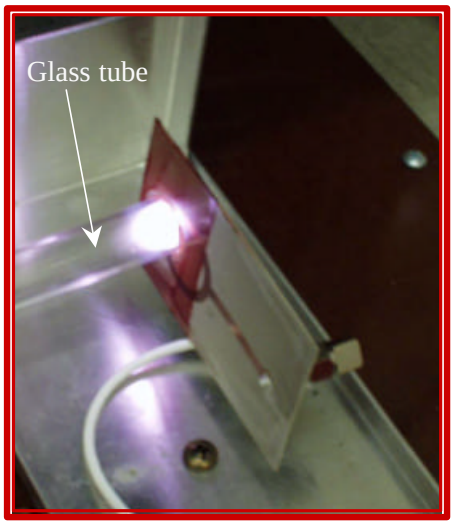


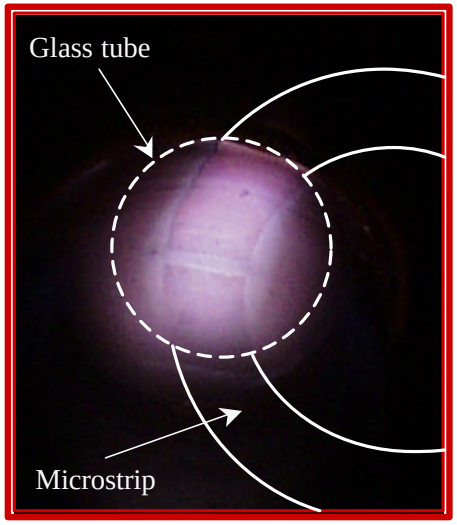


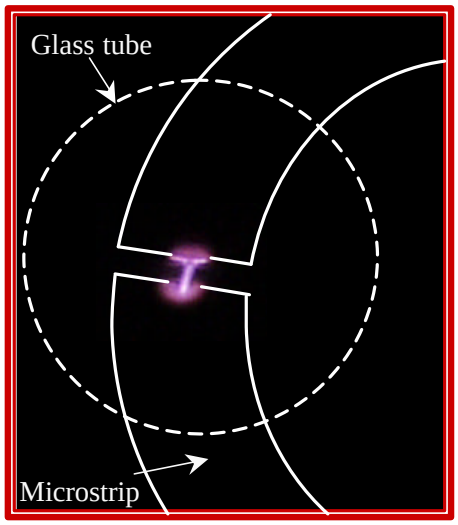
Pressure Range of Operation

Ar plasma @ 1W, 900 MHz

0.1 torr — 10 torr — 100 torr — 760 torr







Probe diagnostics:

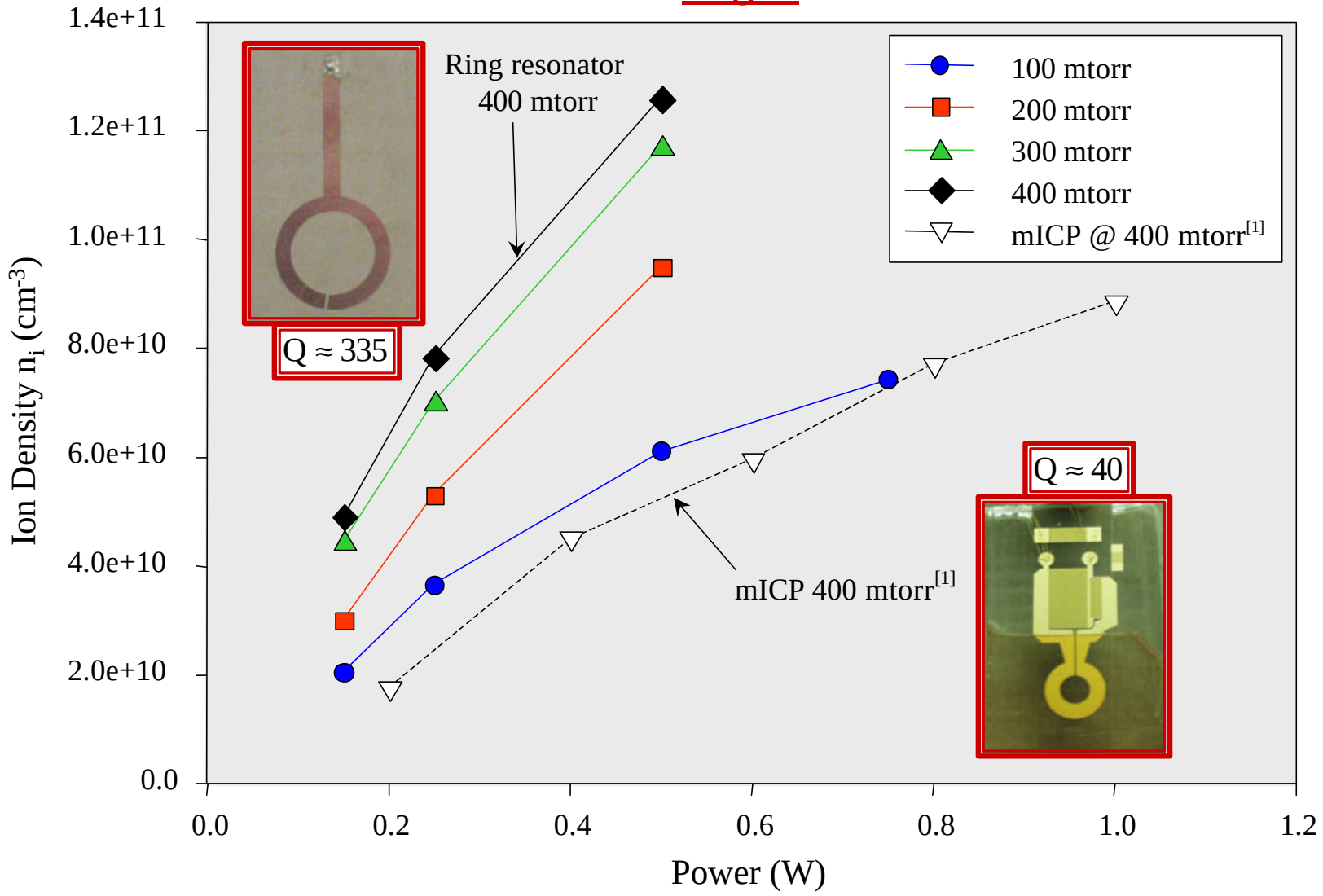
- Ion Density ~$10^{11}cm^{-3}$
- Floating Potential <5V

Spectroscopy:

- Trot = 400K
- Tvib = 0.7eV
- Texc = 0.32eV

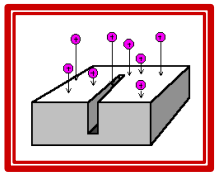
Probe diagnostics: Ion density

Argon

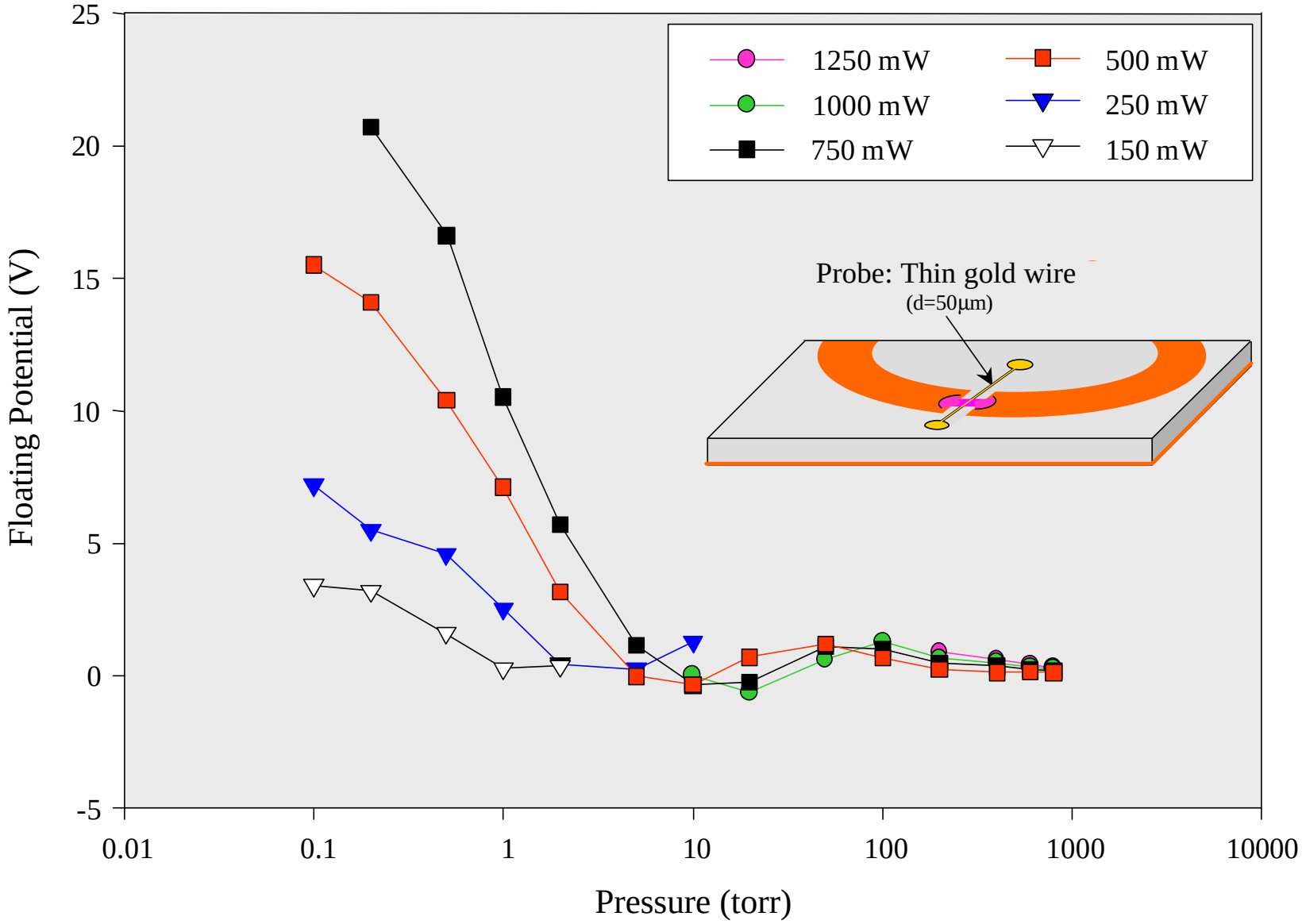


[1] Iza F. and Hopwood J., Plasma Sources Science and Technology, vol. 11, no. 3, pp. 229-235, August 2002

Probe diagnostics: Floating Potential



Argon



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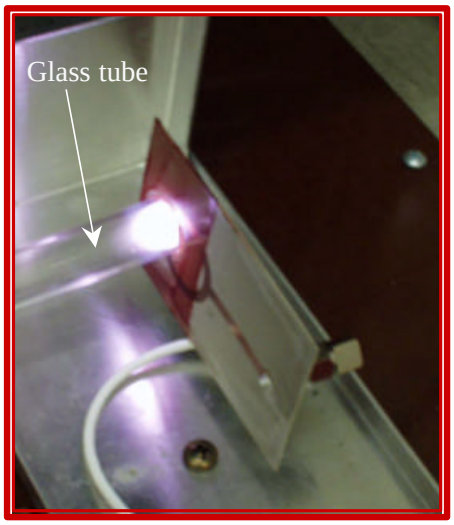

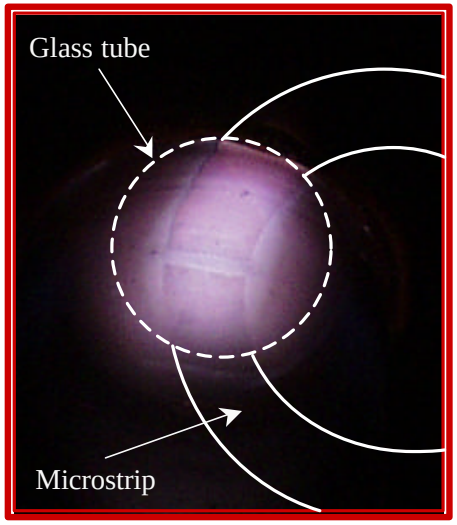

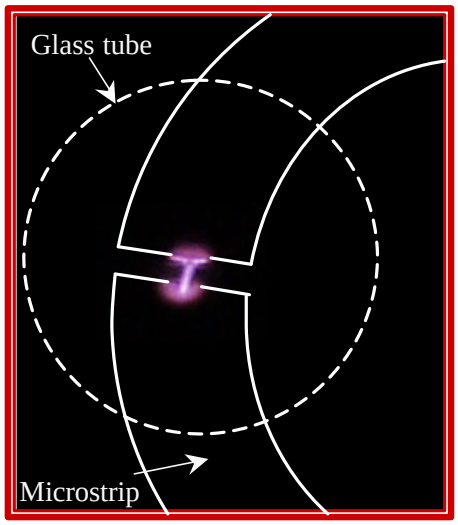

Probe diagnostics:

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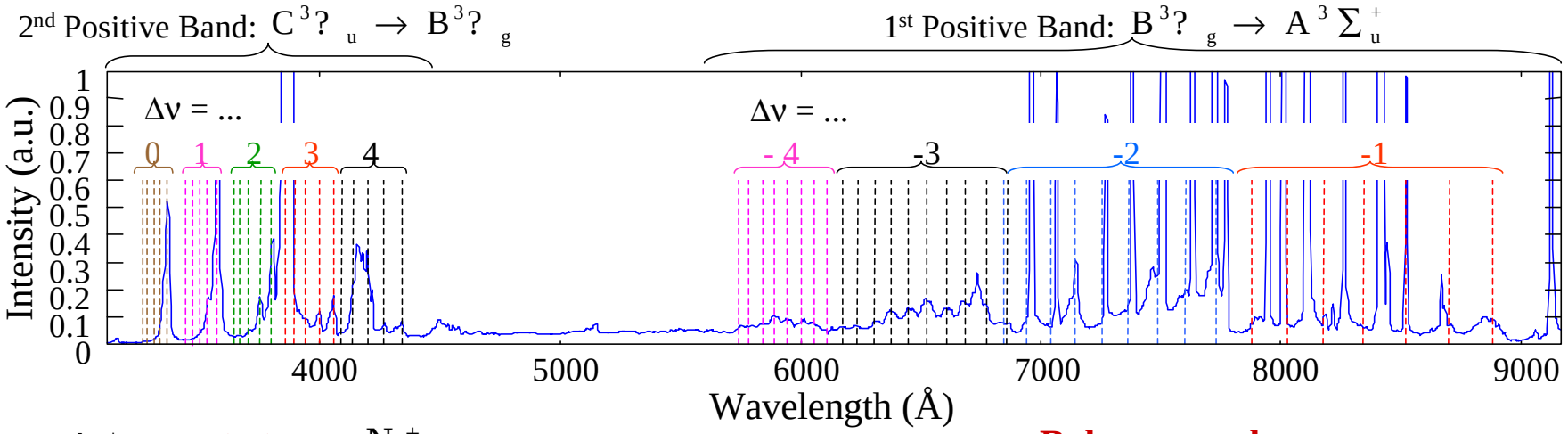
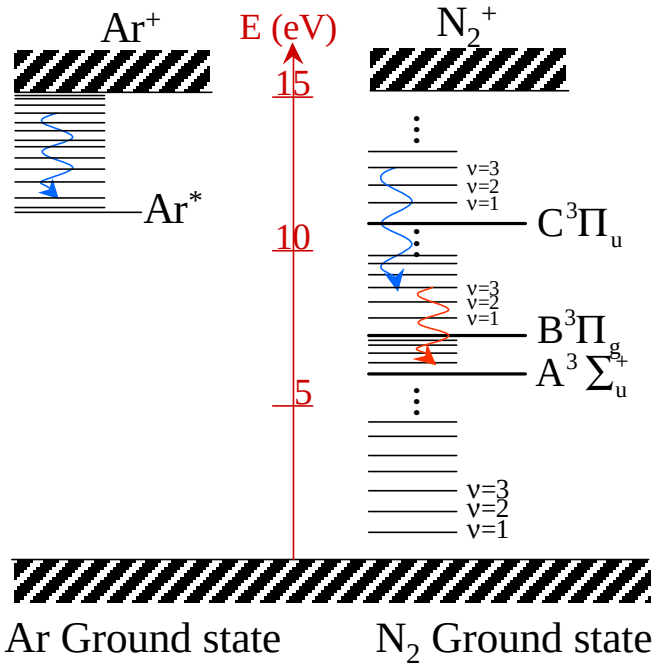
Spectroscopy:

- Trot = 400K
- Tvib = 0.7eV
- Texc = 0.32eV

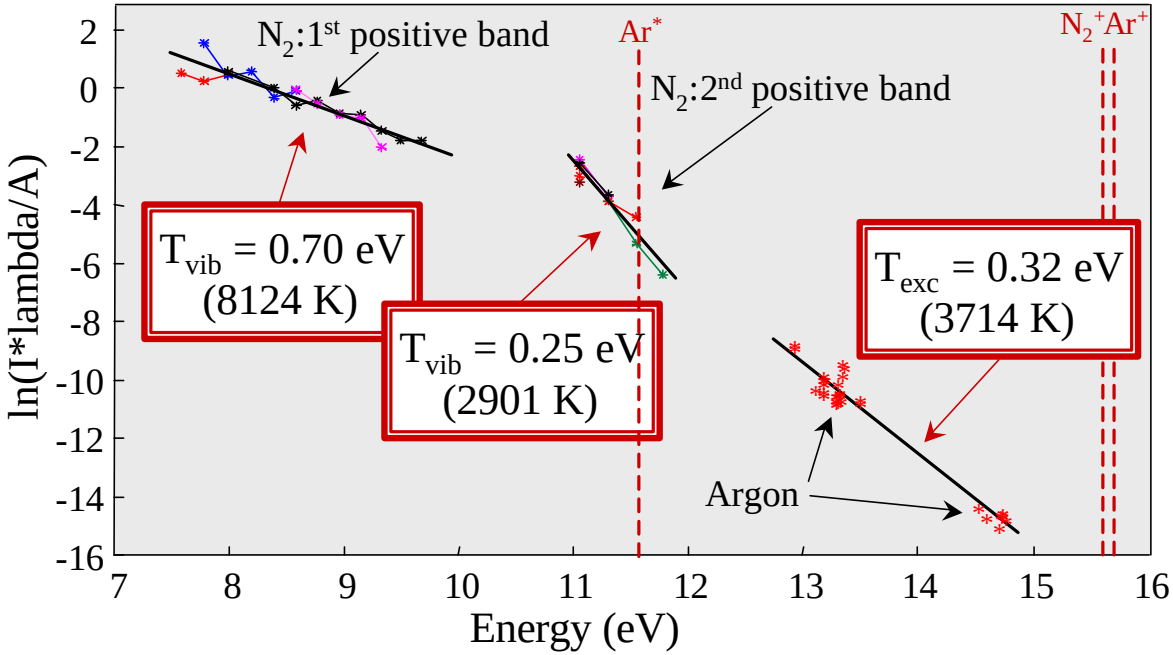
$T_{excitation}$ and $T_{vibrational}$ @760 torr

99.9% Ar + 0.1% N_2 : 760 torr, 1.5 W



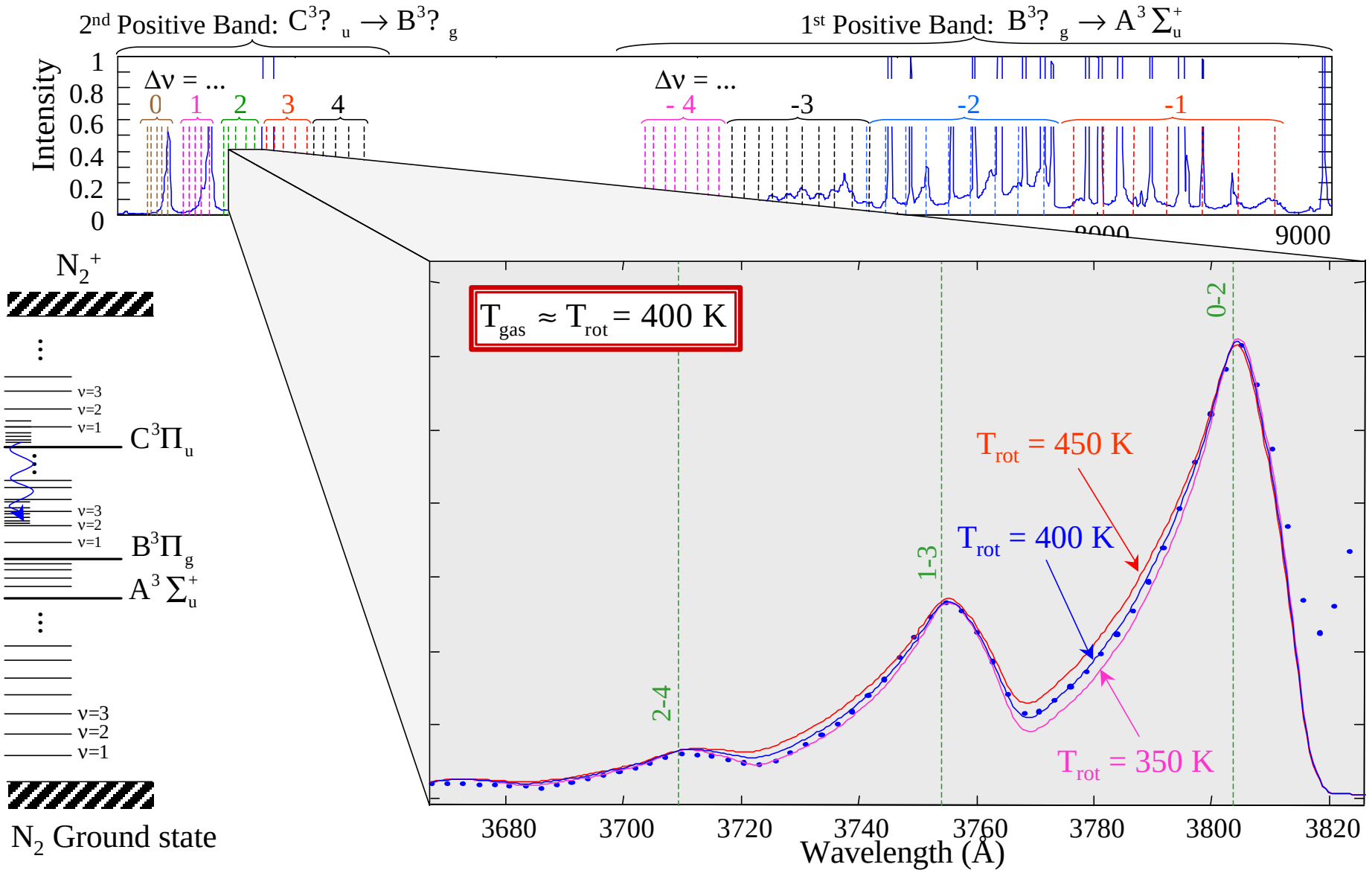


Boltzmann plot

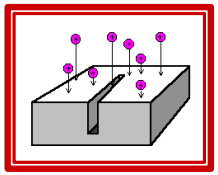


Rotational Temperature T_{rot} @760 torr

99.9% Ar + 0.1% N_2 : P=760 torr, 1.5 W



Conclusions



NEW DEVICE BASED ON A SPLIT-RING RESONATOR

- Low cost, robust and high-Q
- Low-Power
  - 0.5W Argon @ 760torr
- Wide pressure range operation
  - 0.1-760 torr

PORTABLE DEVICE

PROBE DIAGNOSTICS (LOW PRESSURE)

- High-density discharge
- Small sheath voltage at pressures > 3 torr

EFFICIENT AND DURABLE

SPECTRUM ANALISYS

- Non-thermal plasma
- 99.9% Ar +0.1%N_2, 760 torr, 1.5W
  - T_{exc}= 0.32eV (3714 K)
  - T_{vib}= 0.7eV (8124 K)
  - T_{rot}= 0.03eV (400K)

LOW-TEMP. APPLICATIONS

Acknowledgment

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