

Tuning characteristics of coaxial microwave plasma source operated with argon, nitrogen and methane at atmospheric pressure

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MOTIVATION

Development of microwave plasma source operated at high flow rates

APPLICATIONS

Gas processing:

production of hydrogen via hydrocarbons decomposition
hazardous gas treatment

TUNING CHARACTERISTICS

The tuning characteristics are defined as the dependence of the reflect coefficient P_R / P_I as a function of the normalized distance l / λ_g

P_I, P_R - incident and reflected power, measured directly by directional coupler

l - distance between the plasma axis and the movable short

λ_g - the wavelength in the WR 430 waveguide: 147.7 mm

MICROWAVE PLASMA SOURCE (MPS)

Gas flows:

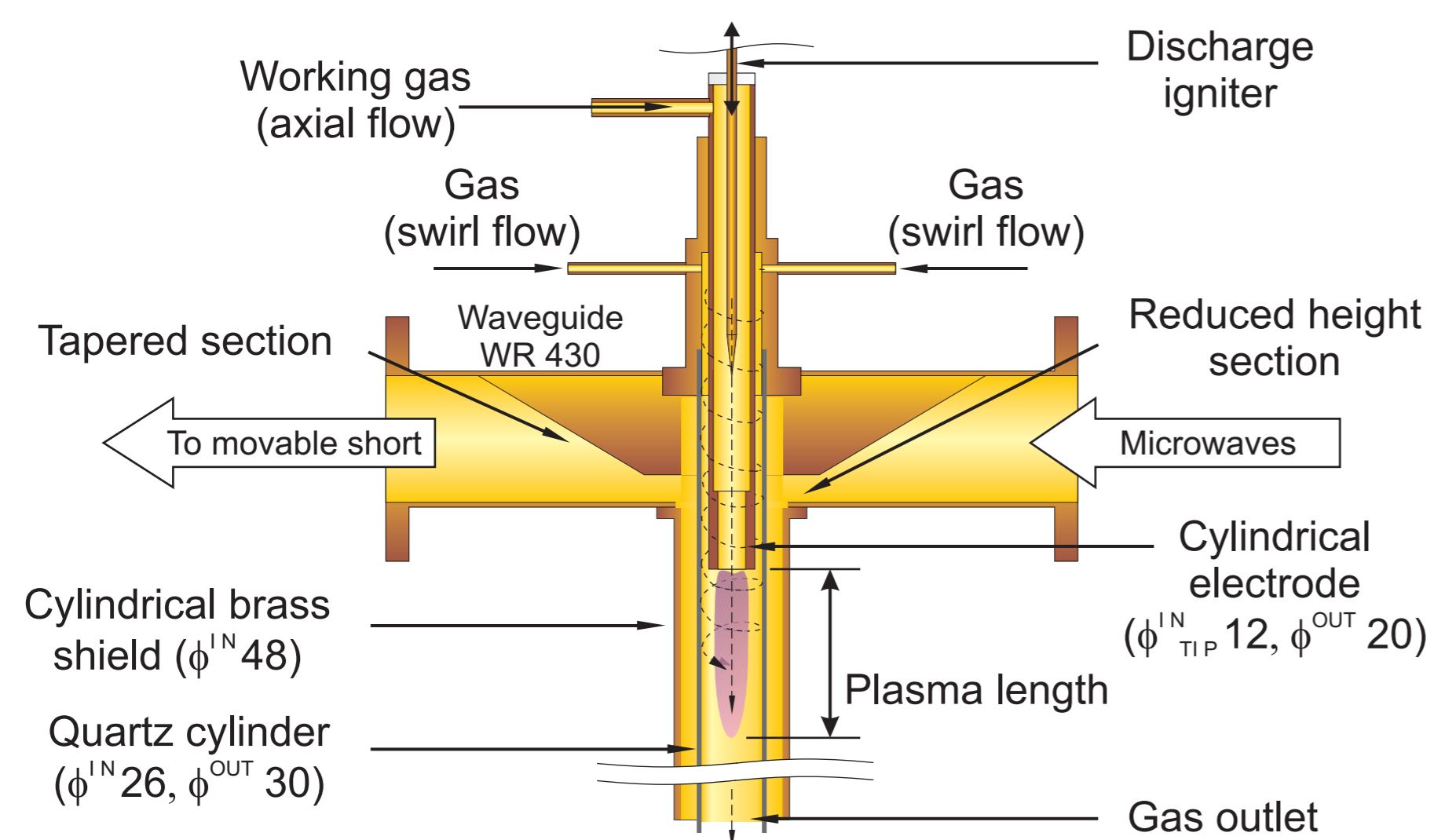
Swirl: 50 l/min (nitrogen)

Axial: 50-200 l/min

(argon, nitrogen, methane)

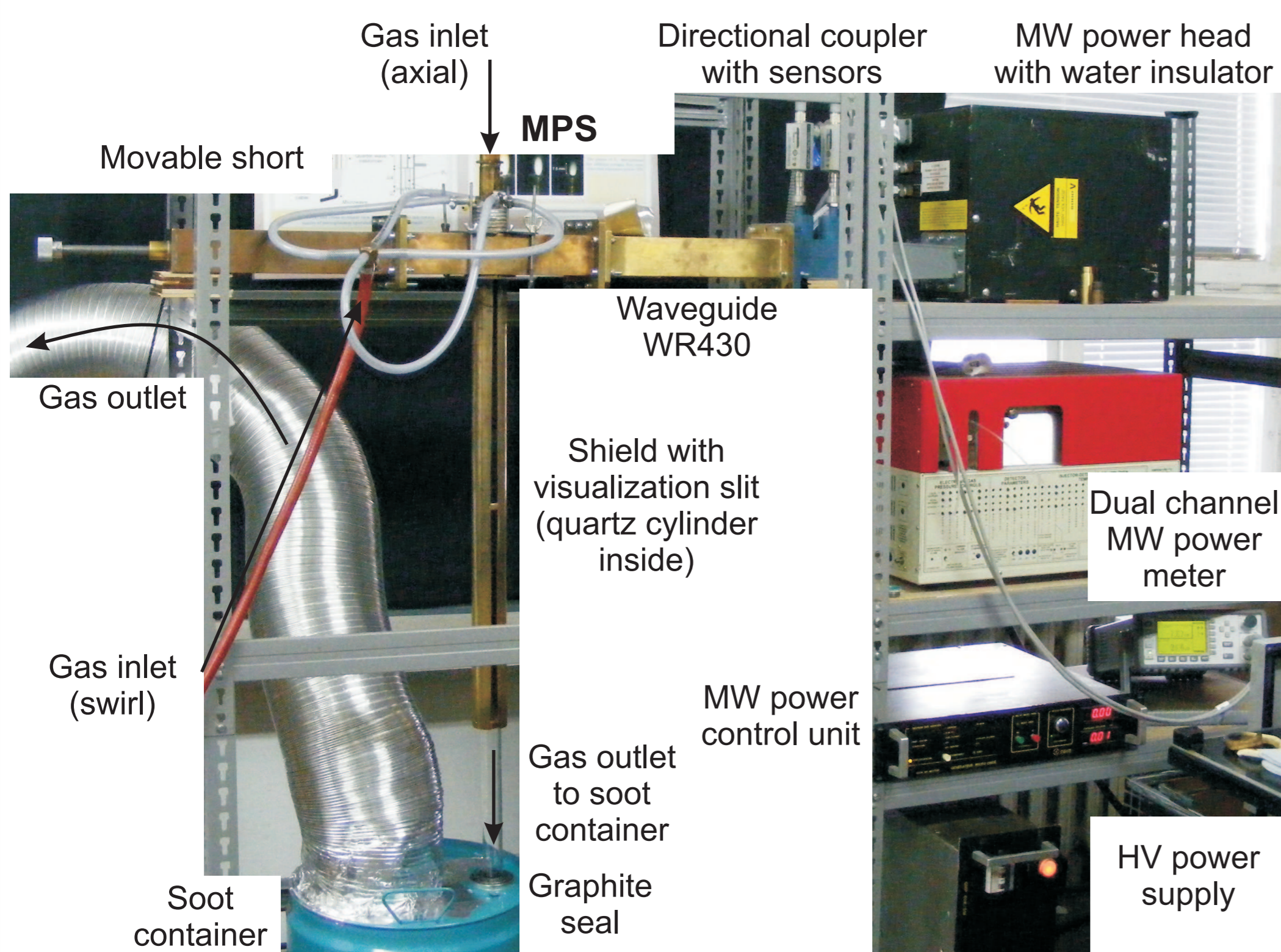
Microwave (2.45 GHz) powers:

600-5600 W



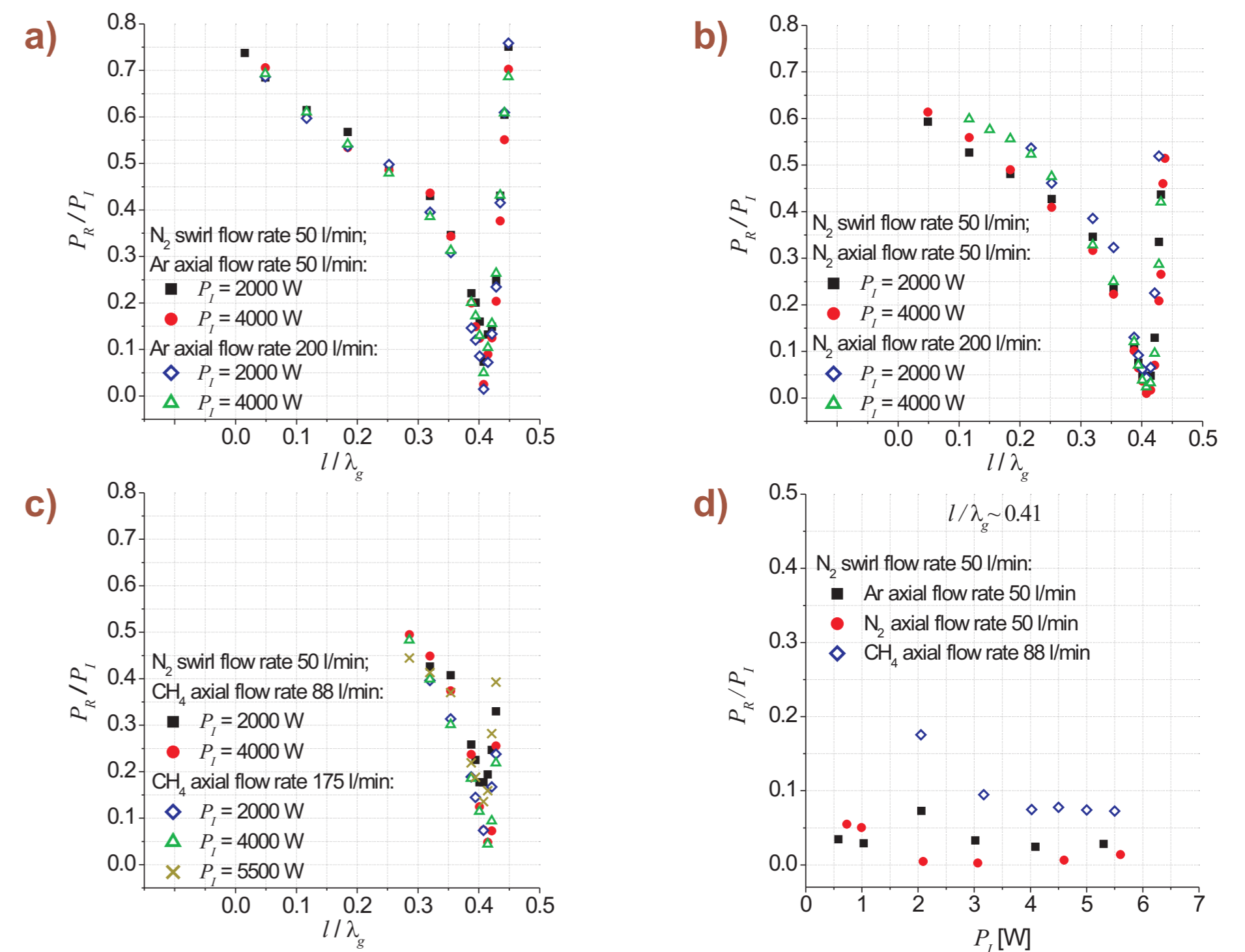
The sketch of coaxial MPS

EXPERIMENTAL SETUP

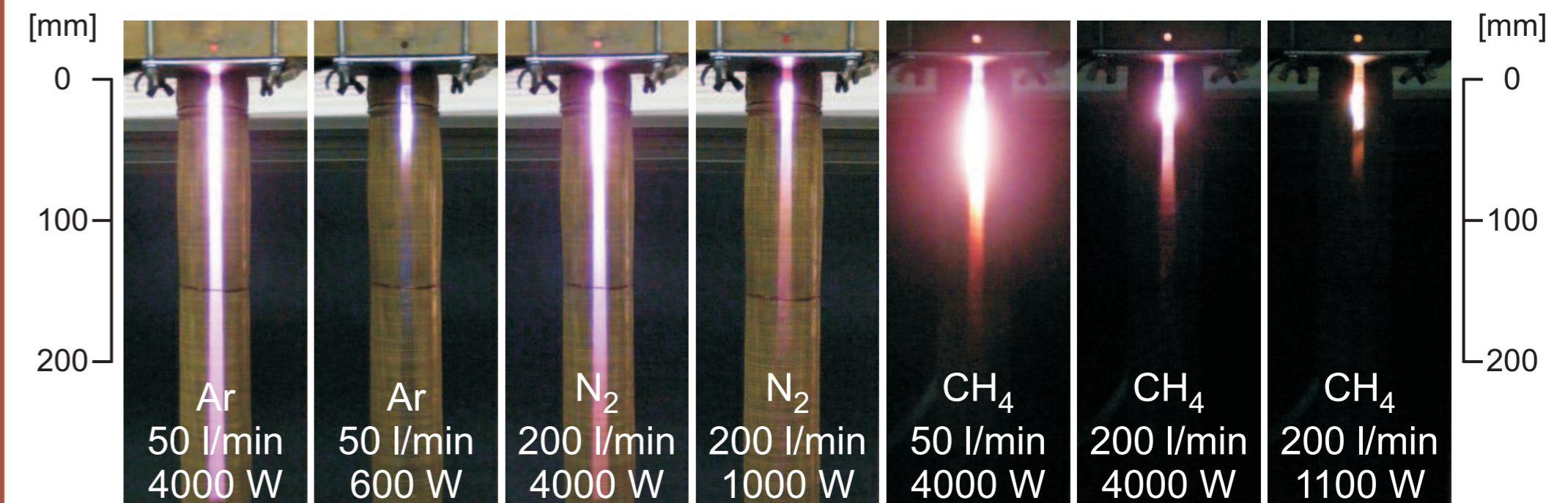


The experimental setup

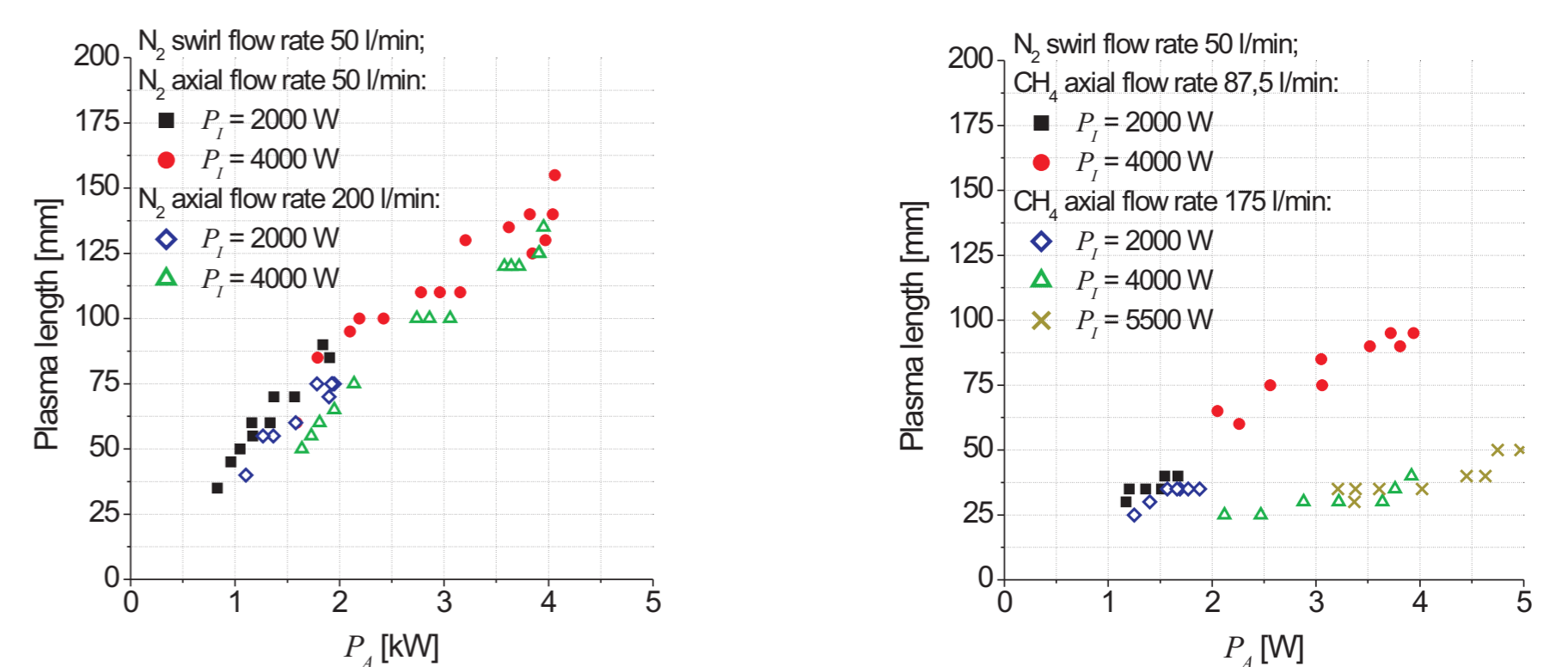
RESULTS



Normalized tuning characteristics of the coaxial MPS operated in argon (a), nitrogen (b) and methane (c) at atmospheric pressure and the fraction of the incident power reflected at the MPS input as a function of incident power for different axial gases at fixed position of movable plunger ($l / \lambda_g \sim 0.41$ (d), $\lambda_g - 147.7$ mm)



Microwave plasmas at different microwave absorbed powers P_A ($P_A = P_I - P_R$) and axial gas flow rates



The lengths of nitrogen (a) and methane (b) plasmas (measured from electrode) as a function of microwave absorbed power P_A ($P_A = P_I - P_R$) for different axial flow rates and incident microwave powers

SUMMARY

- Investigations of the tuning characteristics showed that at optimal positions of movable plunger, the use of argon, nitrogen and methane as the working gas caused, that 2%, 1% and 5% of the incident power was reflected, respectively. The tuning characteristics could be improved by further optimization.
- Stable operation at wide range of parameters, as well as good impedance matching allows the concluding that MPS can be very attractive tool for different gas processing at high flow rates. The MPS was successfully used for production of hydrogen via methane decomposition.