Institute of Thermomechanics
Prague, Czech Republic

DEPARTMENT OF ELECTROPHYSICS

SYMMETRY DISTURBANCE AND ROTATIONAL INSTABILITIES IN A THERMAL PLASMA JET

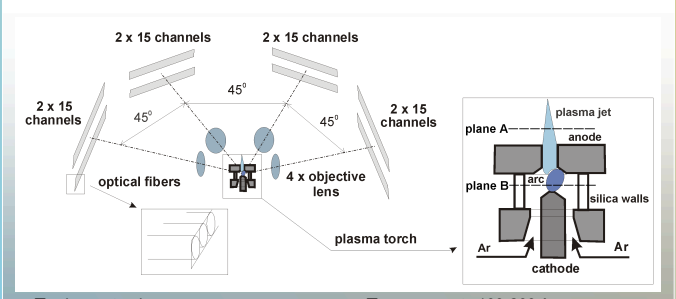
Z. Sekerešová, J. Hlína, J. Šonský

Institute of Thermomechanics AS CR, v. v. i., Dolejškova 5, 18200 Praha 8, Czech Republic

MOTIVATION

The aim of the work was to evaluate instabilities in a plasma jet using image analysis. Radiation distribution was reconstructed by inverse Radon transformation. We applied special methods to obtain parameters which described geometry of plasma cross-section radiation and compared with modulation of arc current. The results of this analysis show that the temporal developments are correlated.

EXPERIMENTAL ARRANGEMENT



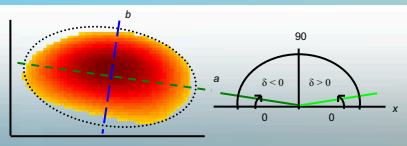
- plasma torch
  - arc - length about 5 mm
  - nozzle diameter 6 mm.
- arc currents 100-200 A
- argon flow rates 0.5 – 3 g/s.
- sampling rate 468 kHz/channel

DISTRIBUTIONS OF PLASMA RADIATION: MEASURED IN PLANE A - OUTSIDE AND PLANE B - INSIDE THE TORCH (THROUGH SILICA WALL).

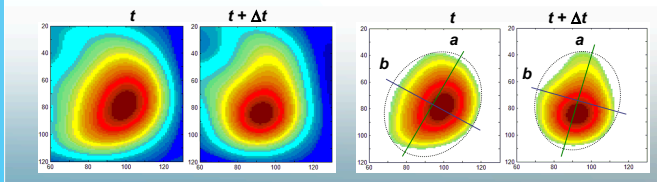
EVALUATION METHOD

The distributions of plasma radiation in the measurement planes were reconstructed using the inverse Radon transform. Characterization of plasma jet and arc cross-sections by ellipses enabled us to study these parameters: orientation δ - the angle between the fixed x–axis and the major axis of the circumscribed ellipse; and the deviation of tested planar profiles from the circular symmetry expressed by ellipticity - ratio *a*/*b*.

These two parameters were measured in two planes: inside plasma torch - through silica wall and outside - direct look at jet; and they were also measured at different argon flow rates i.e. 0.5, 0.7, 1.0, 1.2, 2.0, 2.5 and 3.0 g/s. Simultaneously with radiation arc current and voltage were measured.

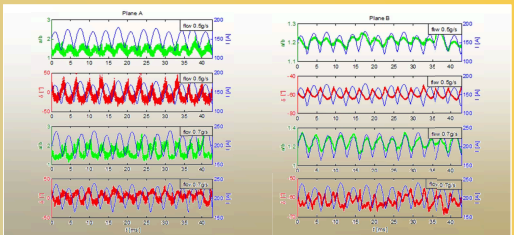


VISUAL REPRESENTATION OF MAJOR *a* AND MINOR *b* AXES OF THE ELLIPSE AND THE ANGLE δ BETWEEN THE FIXED x-AXIS AND THE MAJOR AXIS *a* OF THE CIRCUMSCRIBED ELLIPSE.

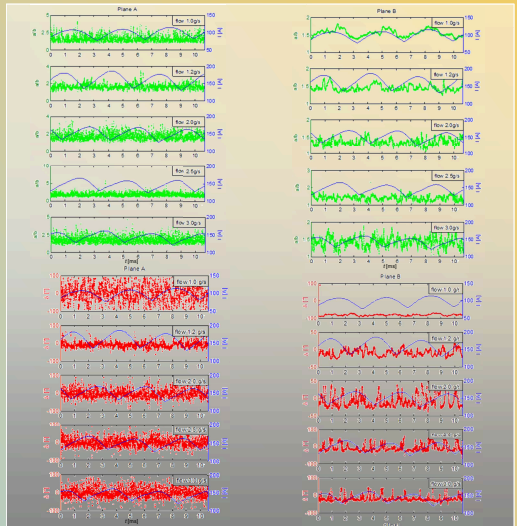


DISTRIBUTIONS OF PLASMA RADIATION IN THE PLANE A RECONSTRUCTED BY THE INVERSE RADON TRANSFORM IN TIME SEQUENCE, WITH AND WITHOUT BACKGROUND AND CIRCUMSCRIBED ELLIPSE WITH MAJOR *a* AND MINOR *b* AXES.

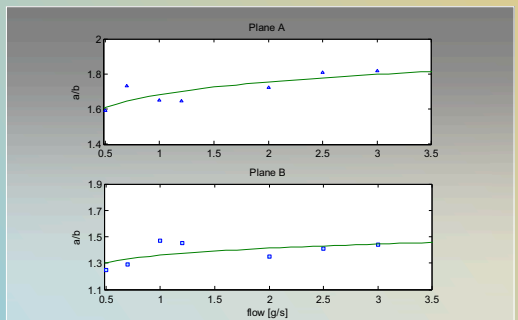
RESULTS



ELLIPTICITY AND ORIENTATION OF THE ELLIPSES APPROXIMATING PLASMA JET CROSS-SECTIONS FOR LOW GAS FLOW RATES (0.5; 0.7 g/s) AND TWO MEASURING LEVELS.



ELLIPTICITY AND ORIENTATION OF THE ELLIPSES APPROXIMATING PLASMA JET CROSS-SECTIONS FOR HIGH GAS FLOW RATES (1.0 UP TO 3.0 g/s) AND TWO MEASURING LEVELS.



COMPARISON OF DEPENDENCES OF RATIO *a*/*b* VERSUS FLOW RATE IN TWO PLANES OF DETECTION.

CONCLUSION

The delay and rate of changes of the studied parameters with respect to the arc current phase depend on the gas flow rate and position of recording arrays detecting the plasma radiation. Higher gas flow rates lead to stronger violations of the symmetry and fluctuations of the ellipticity in a larger range in the plane A - 5 mm above the plasma torch nozzle.

The same parameters describing the arc behaviour (in the plane B) show similar characteristics but give evidence about more stable behaviour of the arc.

Higher gas flow rates lead to irregular changes in symmetry and orientation in measuring plane A - direct view of plasma jet. In the measuring plane B - view through silica wall, there are strong fluctuations, but symmetry is much better than in plane A