Distribution of Plasma Parameter upon Electrical Wire Explosion

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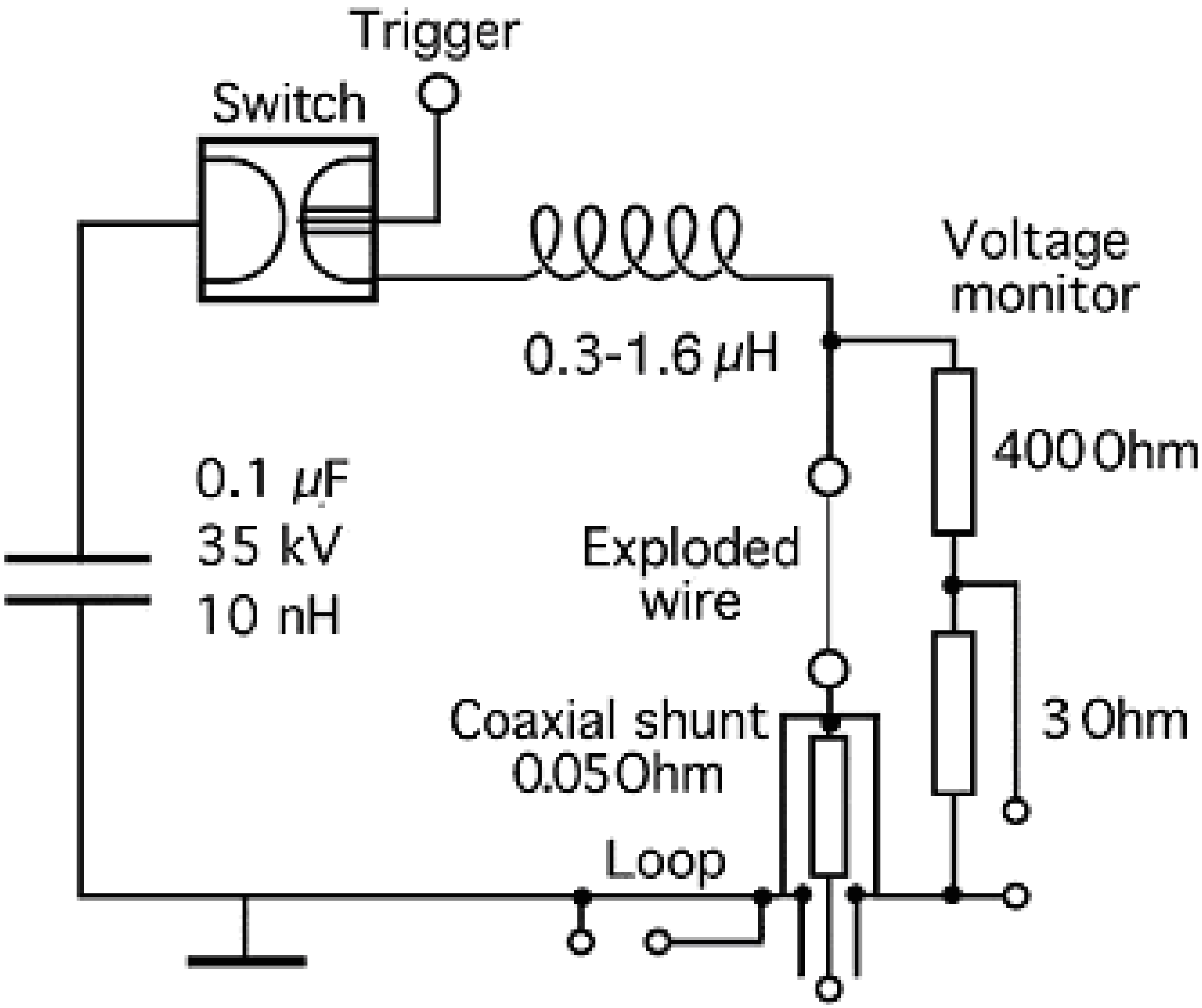
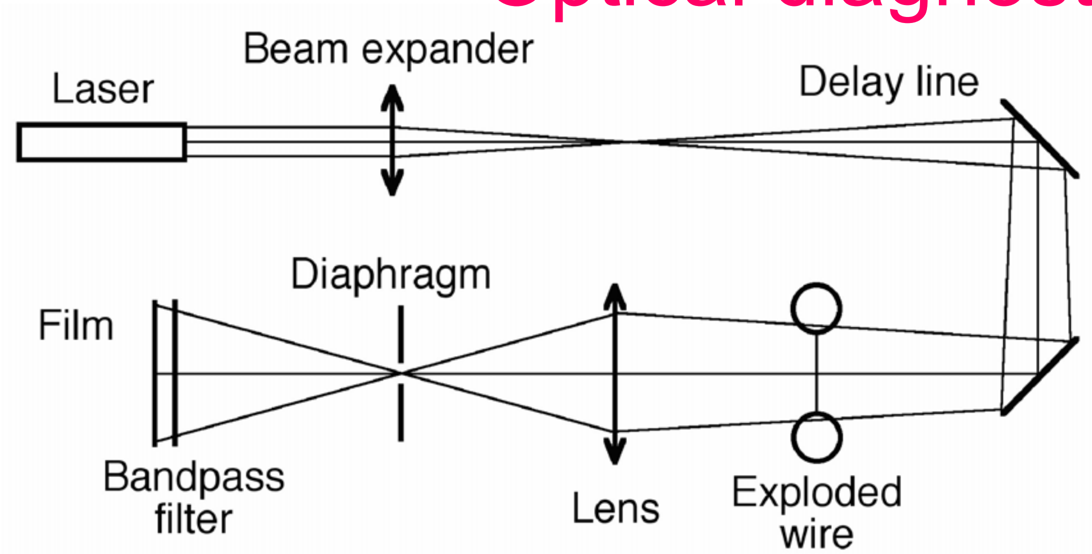
Experimental setup

(I_{max} ~ 10 kA, dI/dt ~ 50 A/ns)

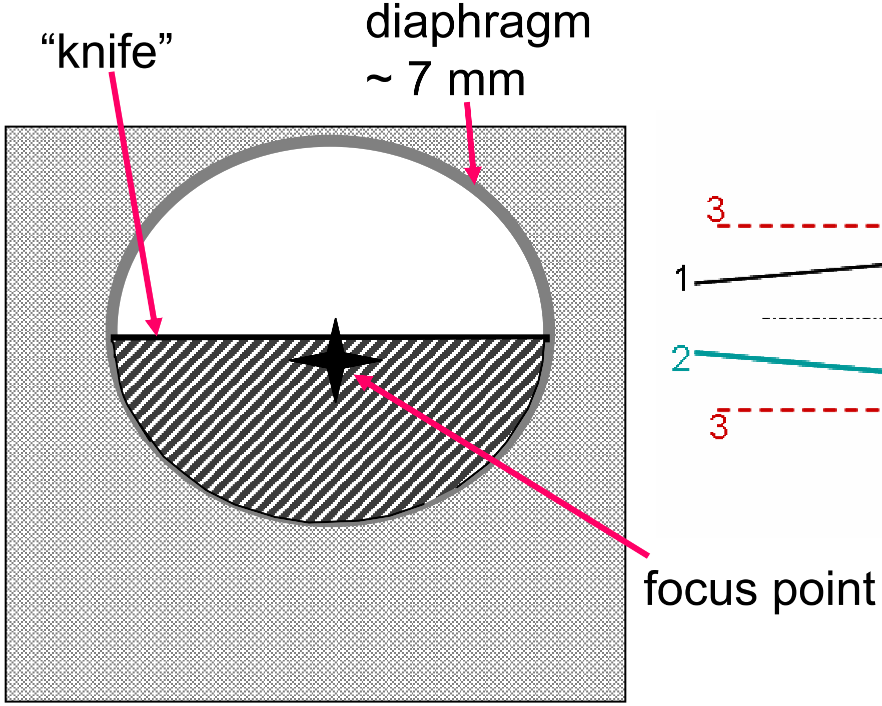


Optical diagnostics

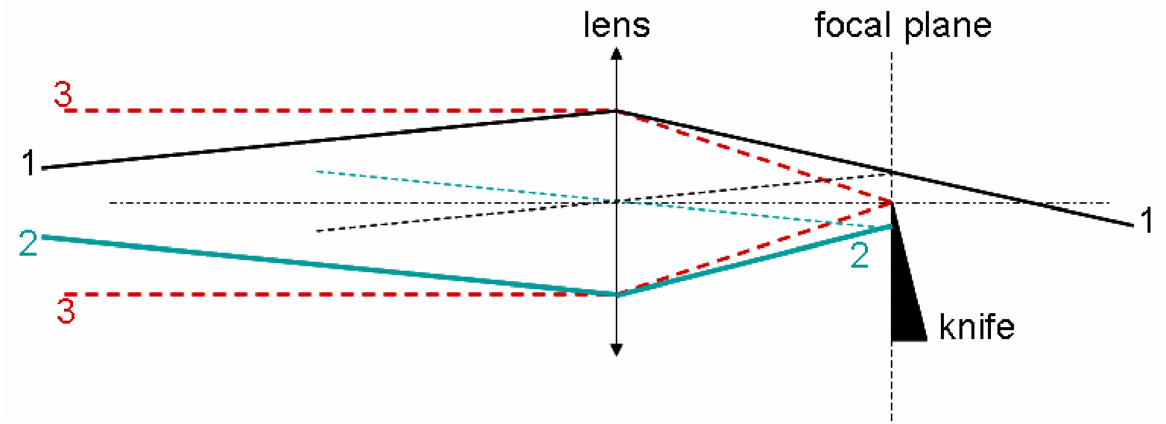


YAG:Nd^{+3} (λ = 532 nm, pulse duration 10 ns, energy 0.035 J)

Shadow imaging



Schlieren imaging



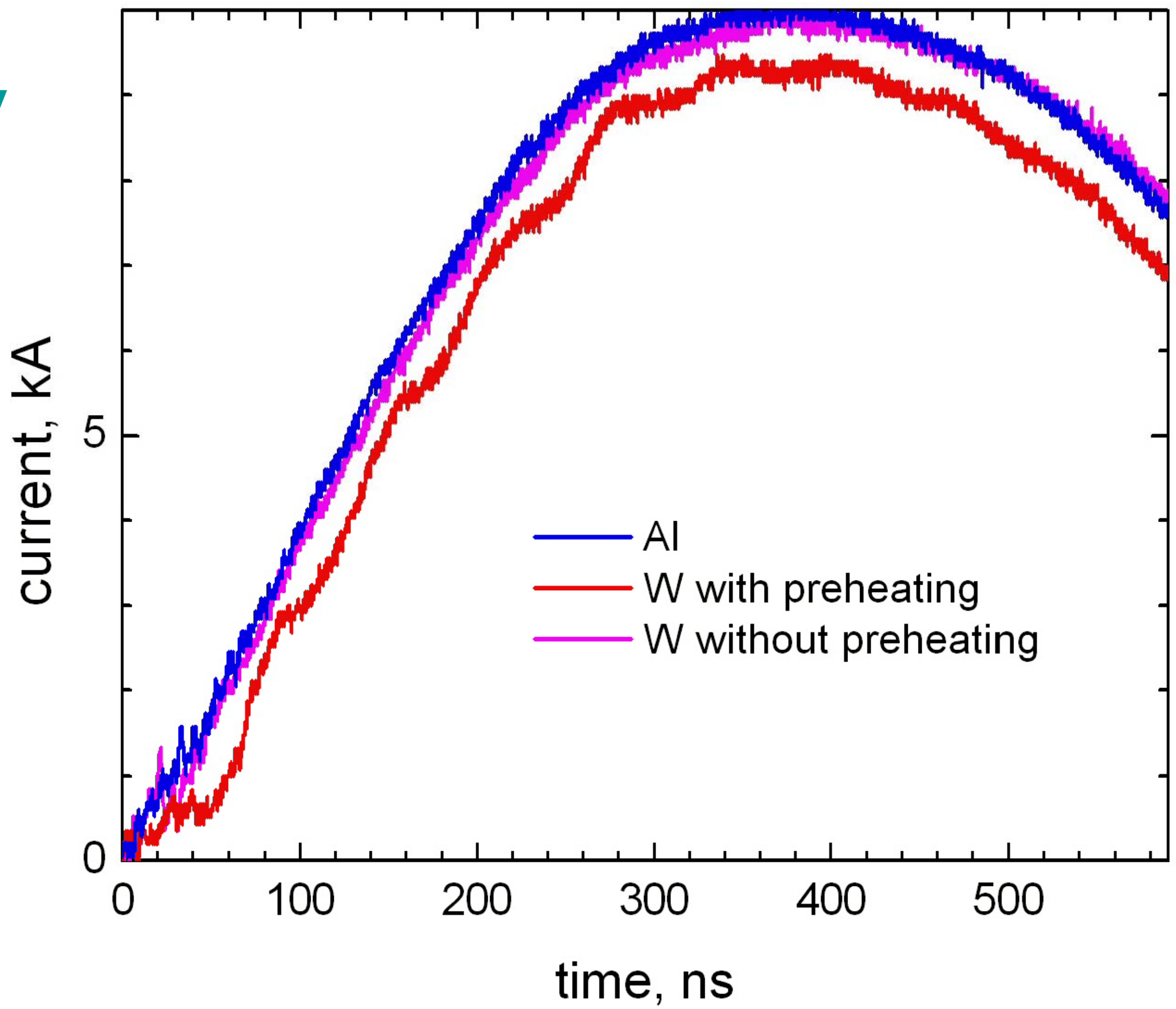
4-frame microchannel camera with 5-ns exposure duration, 10-ns interval between frames and maximum sensitivity in the ultraviolet range with photon’s energy > 10 eV

Since upon using 2 μm My filter any image didn’t been observed

ε < 180 eV thus T < 30 eV

Time dependences of current upon wire explosion in vacuum

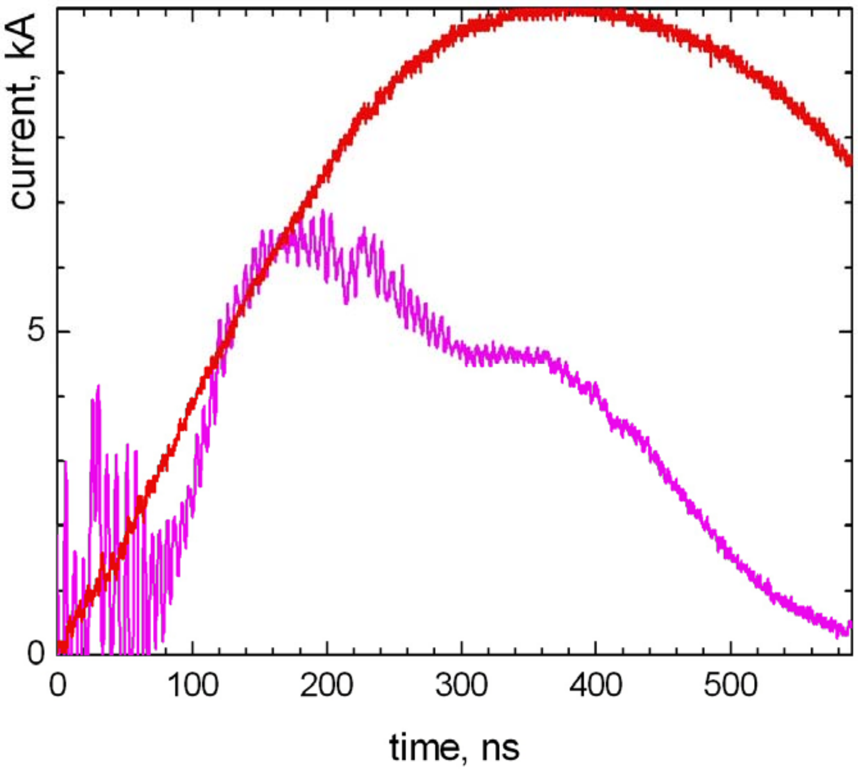
U_0 = 20 kV
l = 12 mm
d = 25 µm



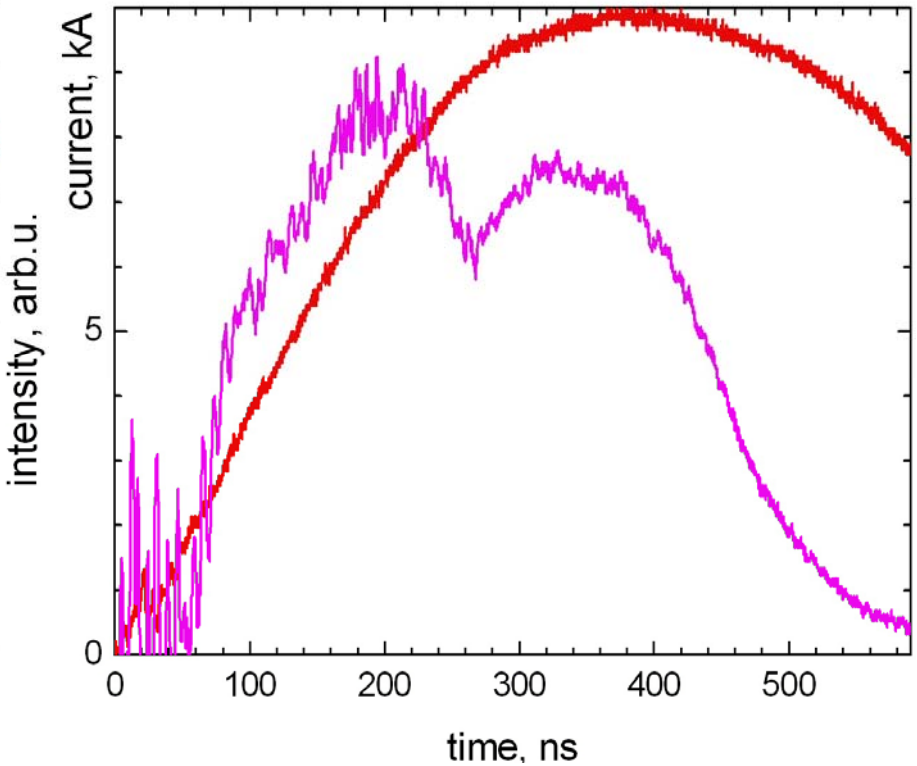
Time dependences of current and XRD signal upon wire explosion in vacuum

(U_0 = 20 kV, l = 12 mm, d = 25 μm)

Al



W

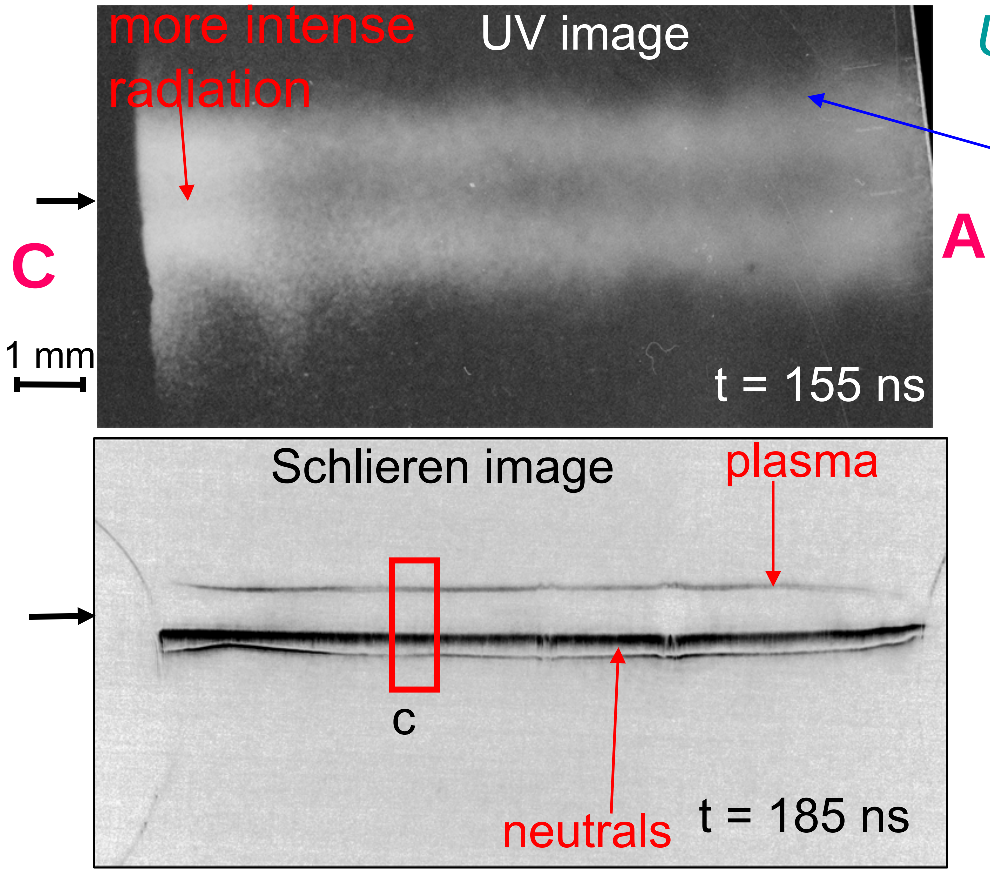


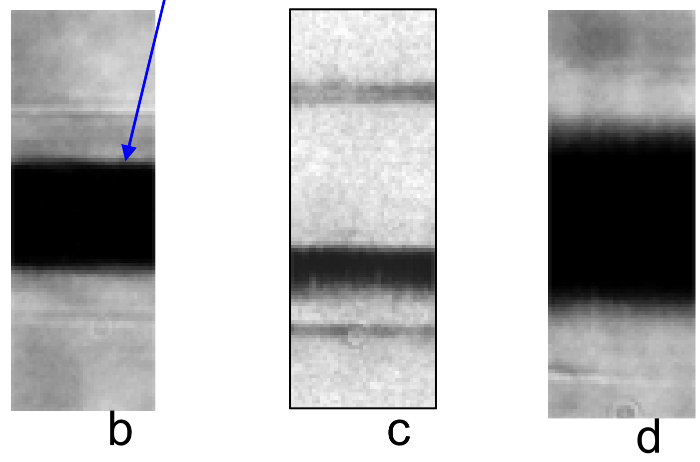
Explosion of Al wire in vacuum

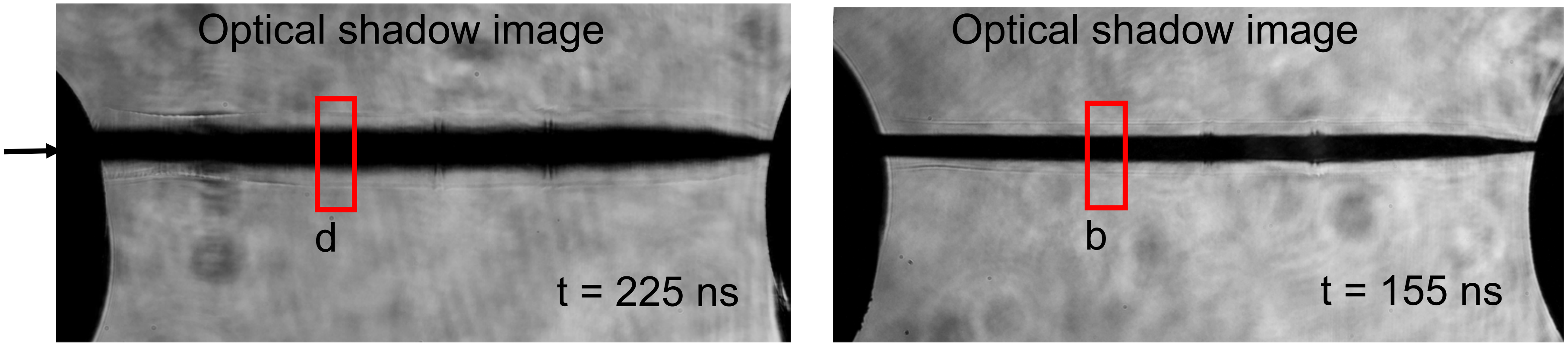
U_0 = 20 kV, l = 12 mm, d = 25 μm

d_{UV} ~ 1250 μm; V_{UV} ~ 3×10^6 cm/s

d_{core} ~ 720 μm; V_{core} ~ 3×10^5 cm/s



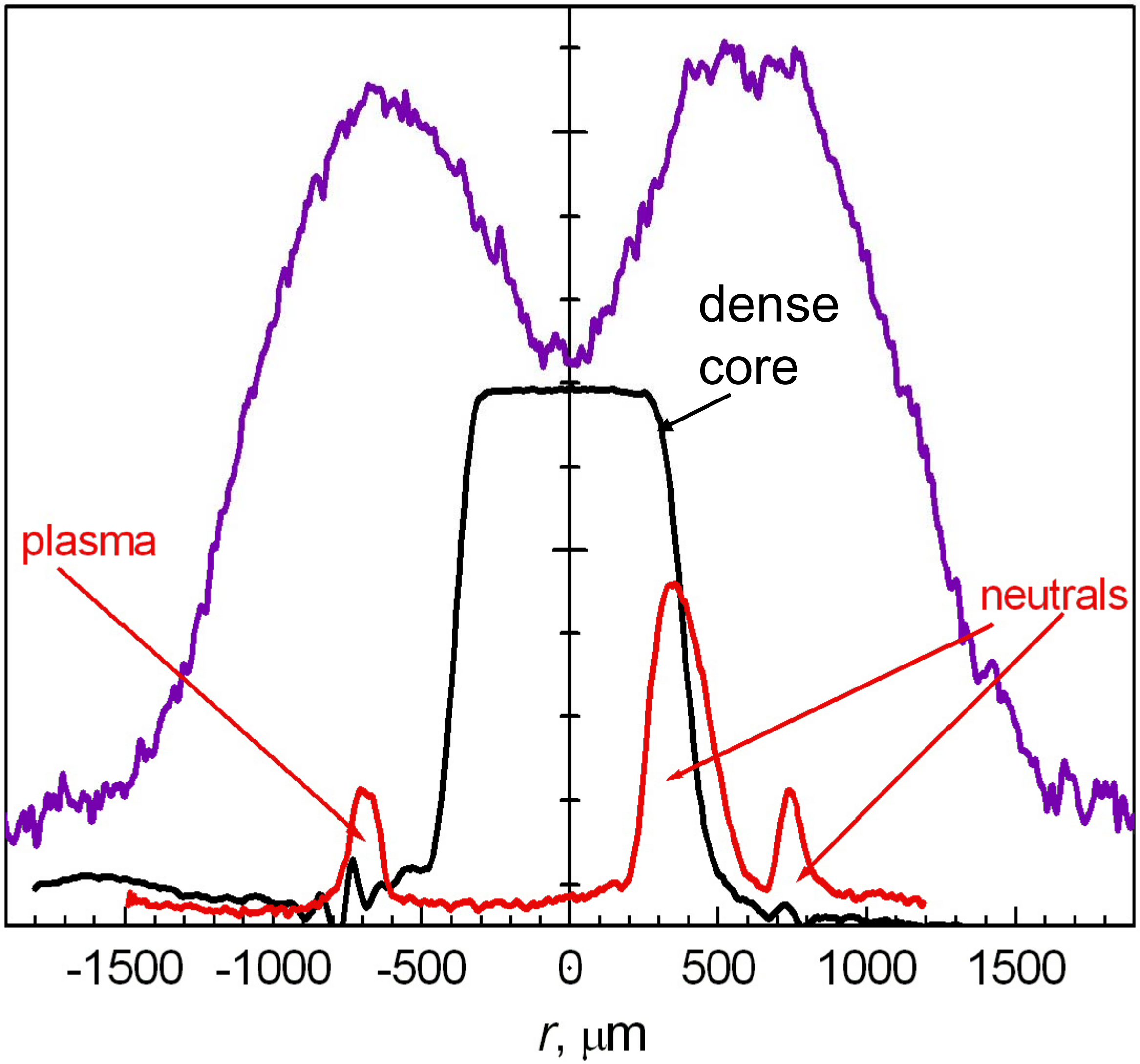




Densitograms of self radiation in UV range, shadow and schlieren- images

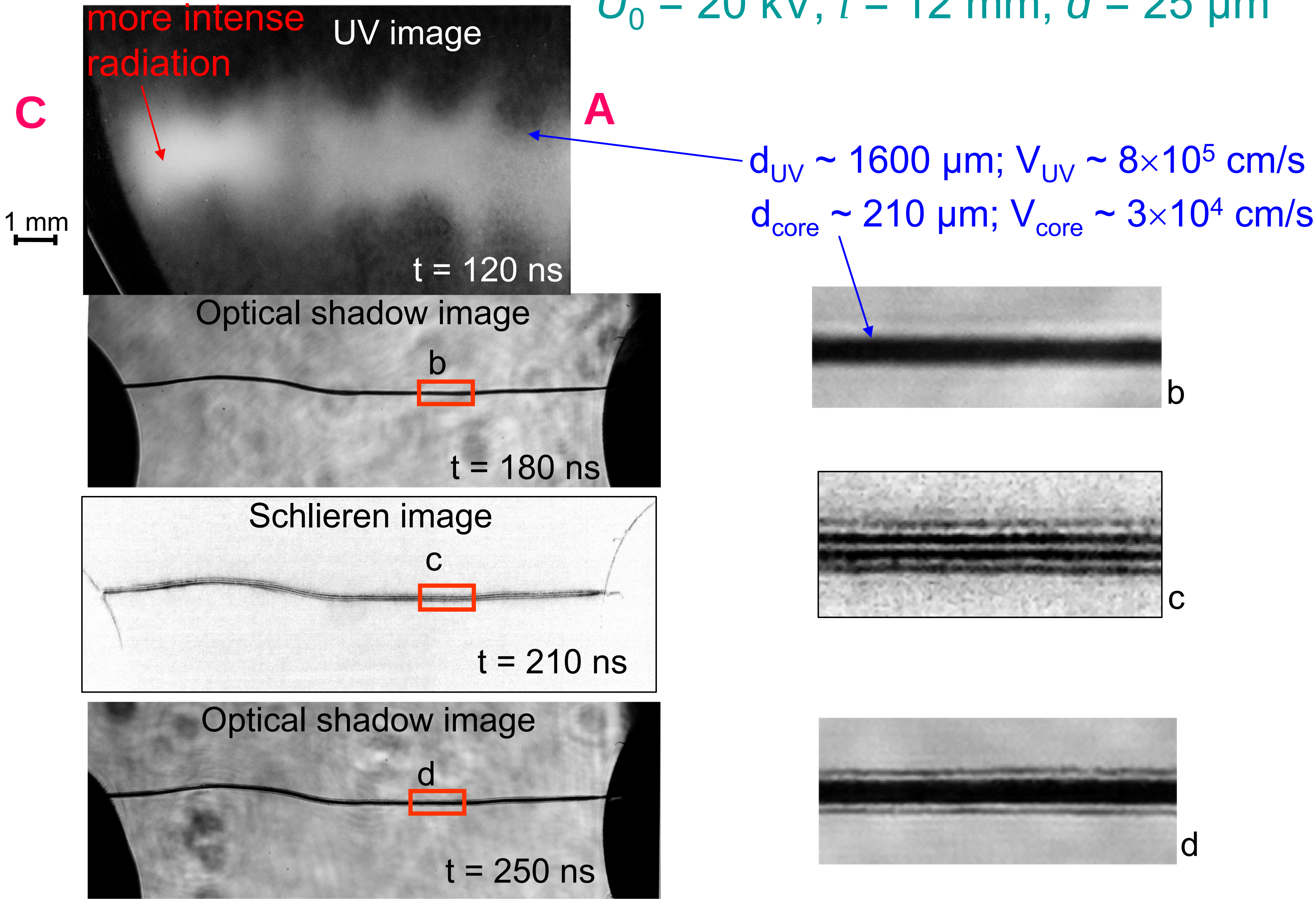
Al

U_0 = 20 kV
l = 12 mm
d = 25 μm



Explosion of W wire in vacuum

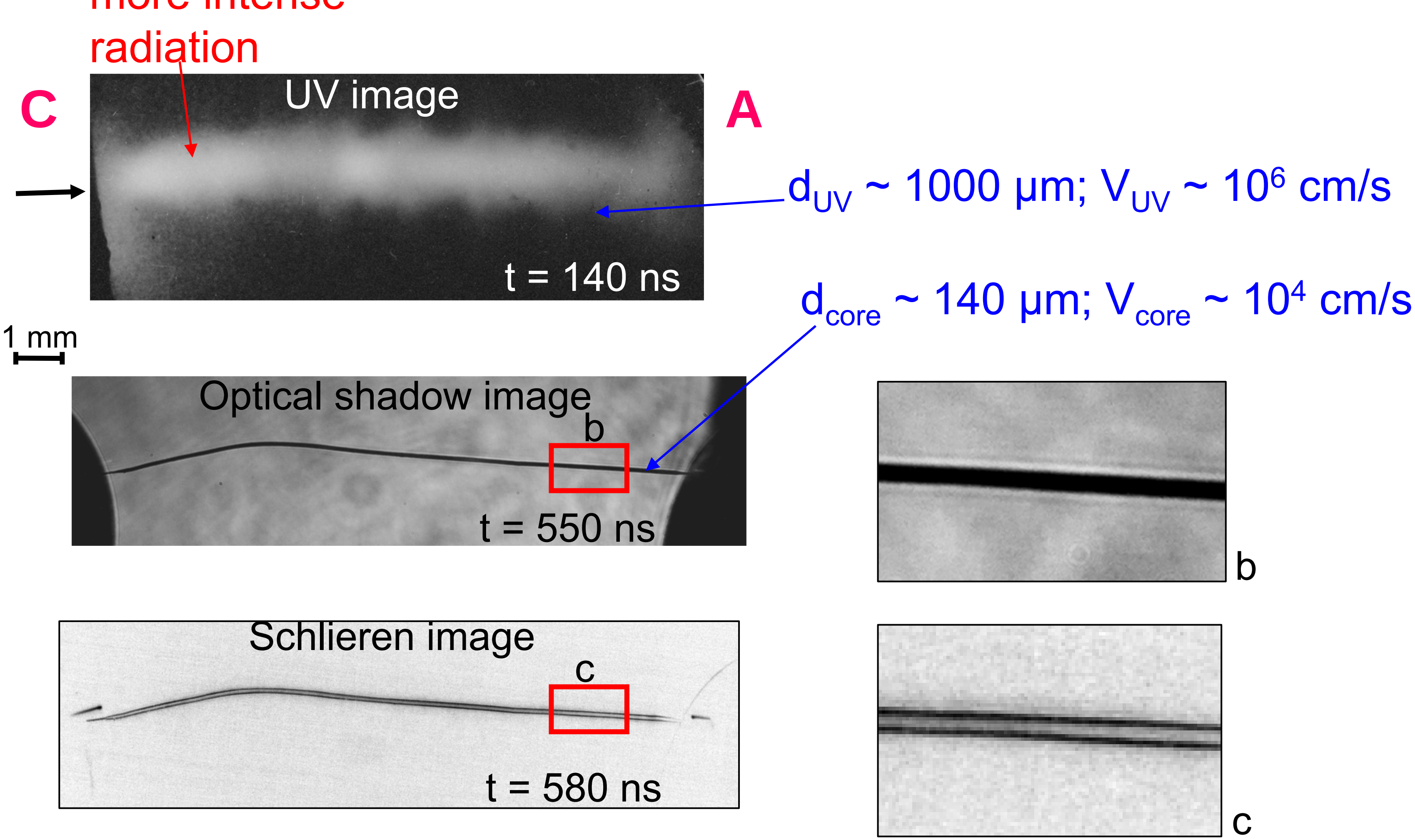
U_0 = 20 kV, l = 12 mm, d = 25 μm



Explosion of W wire in vacuum

U_0 = 20 kV, l = 12 mm, d = 25 μm

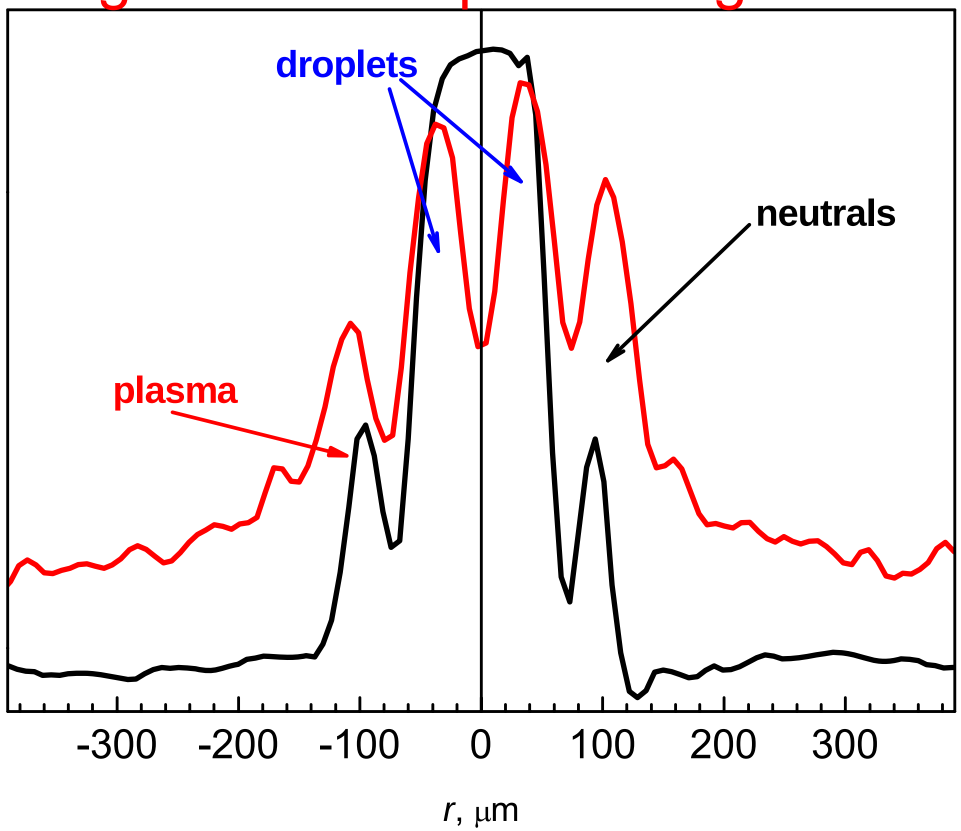
Regime with preheating



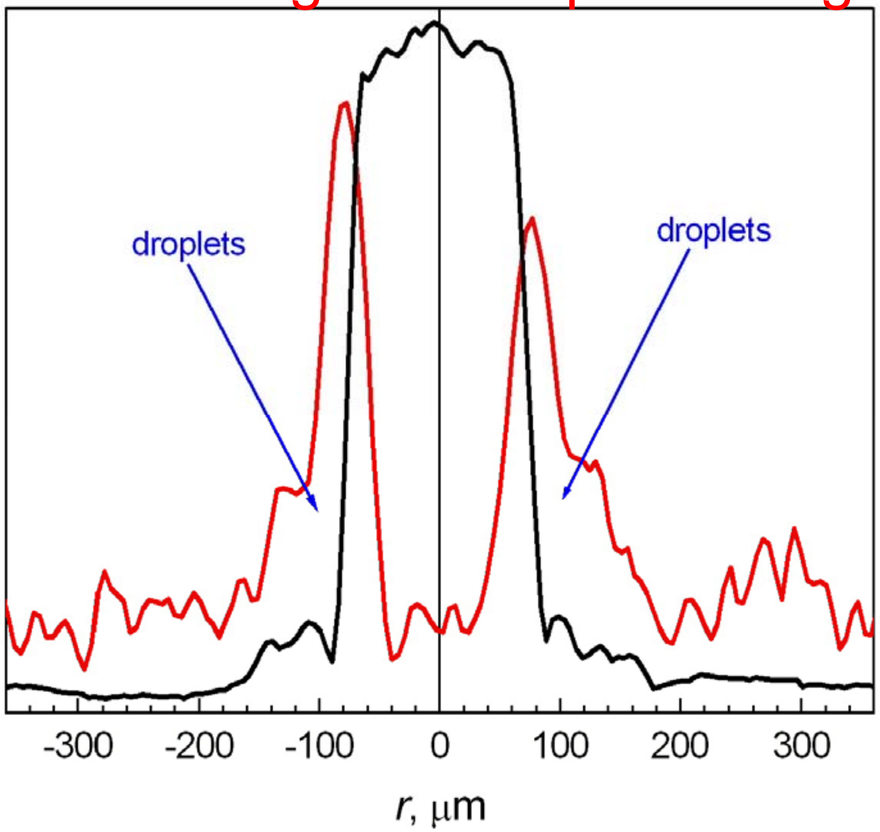
Densitograms of shadow and schlieren images upon explosion of W wire

U_0 = 20 kV, l = 12 mm, d = 25 μm

Regime without preheating



Regime with preheating



Parameters of material

Al

160 ns –

d_{core} ~ 720 μm

v_{core} ~ 2.5×10^5 cm/s

n ~ 7×10^{19} cm^{-3}

T ~ 9×10^3 K

(T_{cr}~ 8×10^3 K)

160 ns –

d_{UV} ~ 1200 μm

v_{UV} ~ 2.5×10^6 cm/s

ε_{UV} < 180 eV

W

260 ns –

d_{core} ~ 130 μm

v_{core} ~ 2×10^4 cm/s

n ~7×10^{21} cm^{-3}

T ~ 8×10^3 K

(T_{cr}~ 14×10^3 K)

110 ns –

d_{UV} ~ 2000 μm

v_{UV} ~ 10^6 cm/s

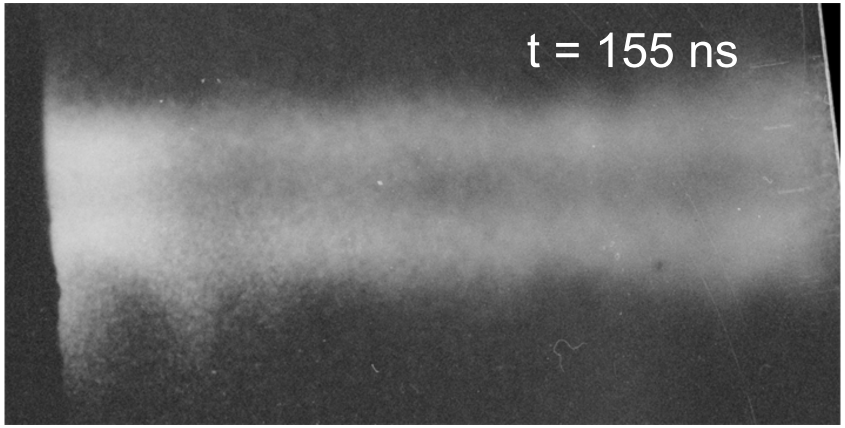
ε_{UV} < 180 eV

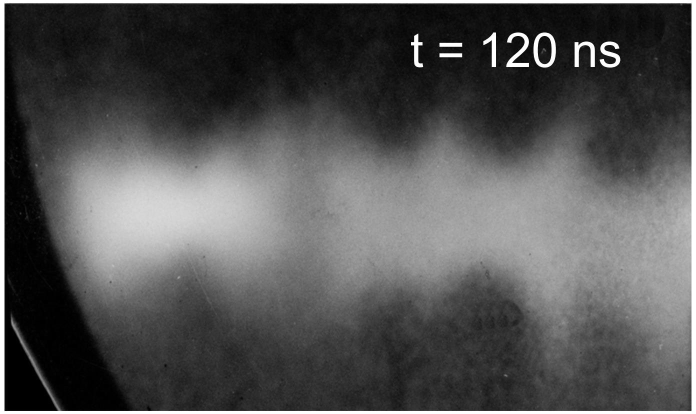
Comparison of images of regions radiating in ultraviolet range

Al

W

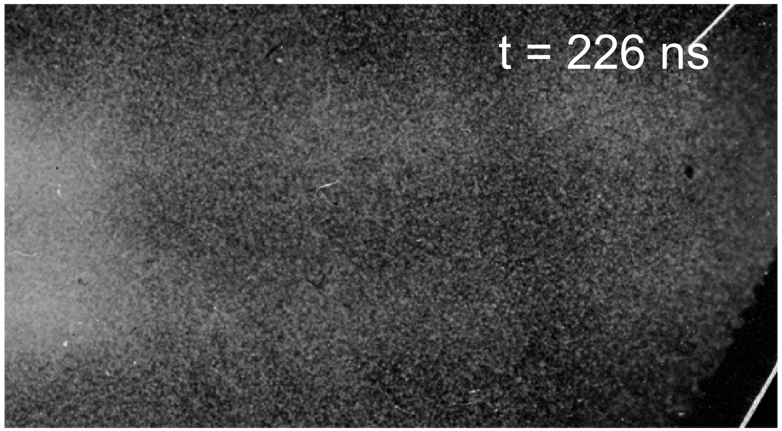
400 μm Pinhole diameter

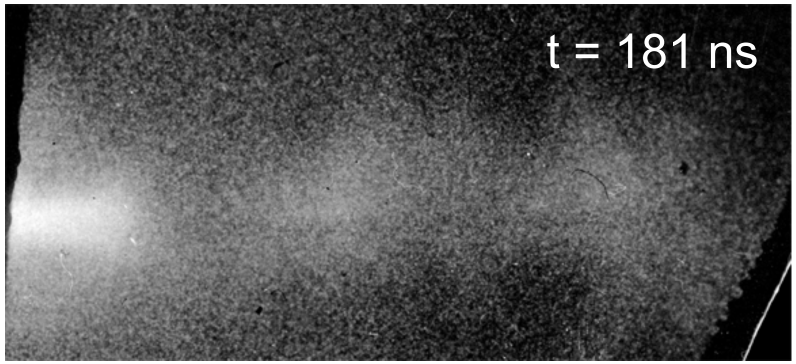




200 μm Pinhole diameter

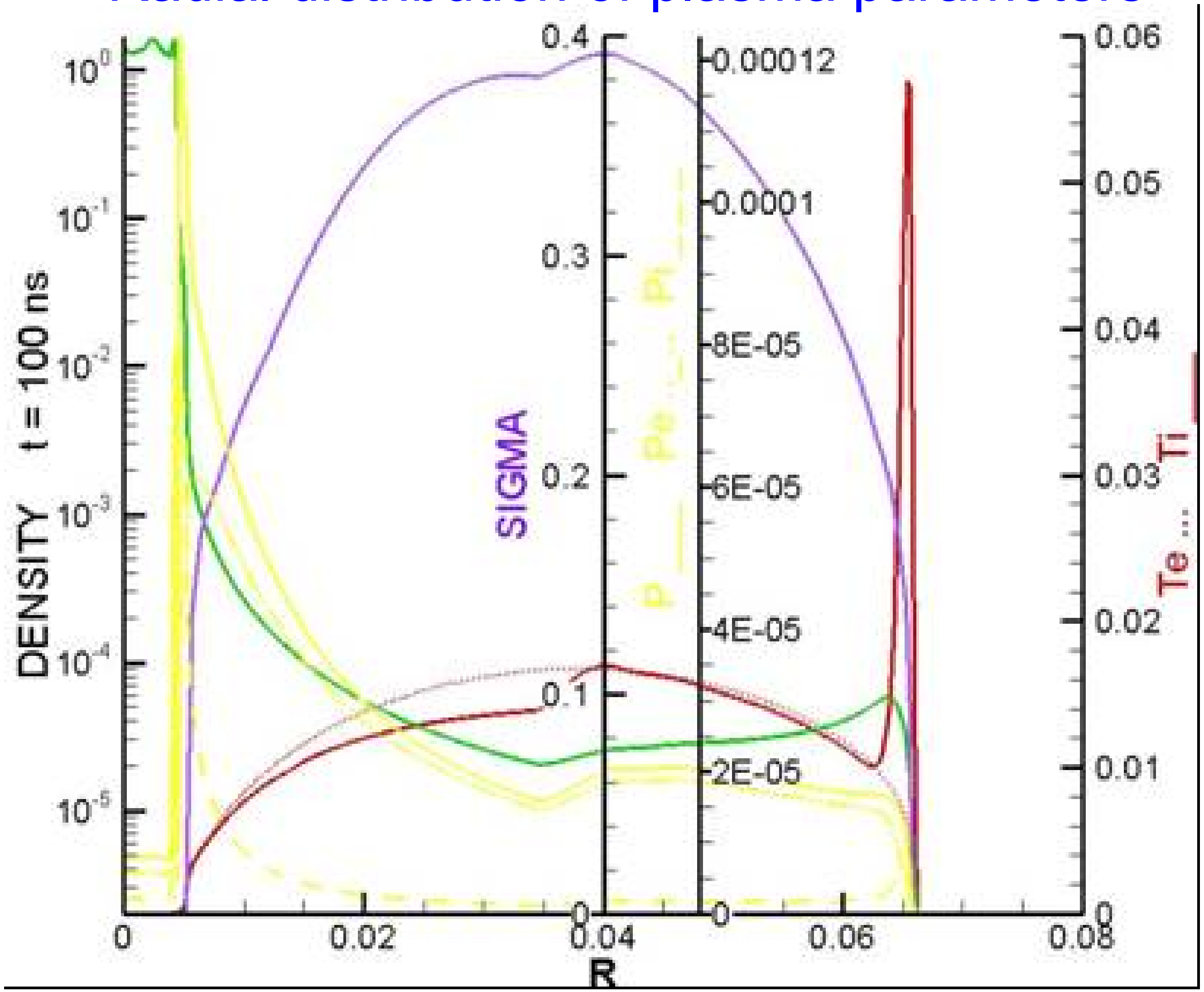
1 mm





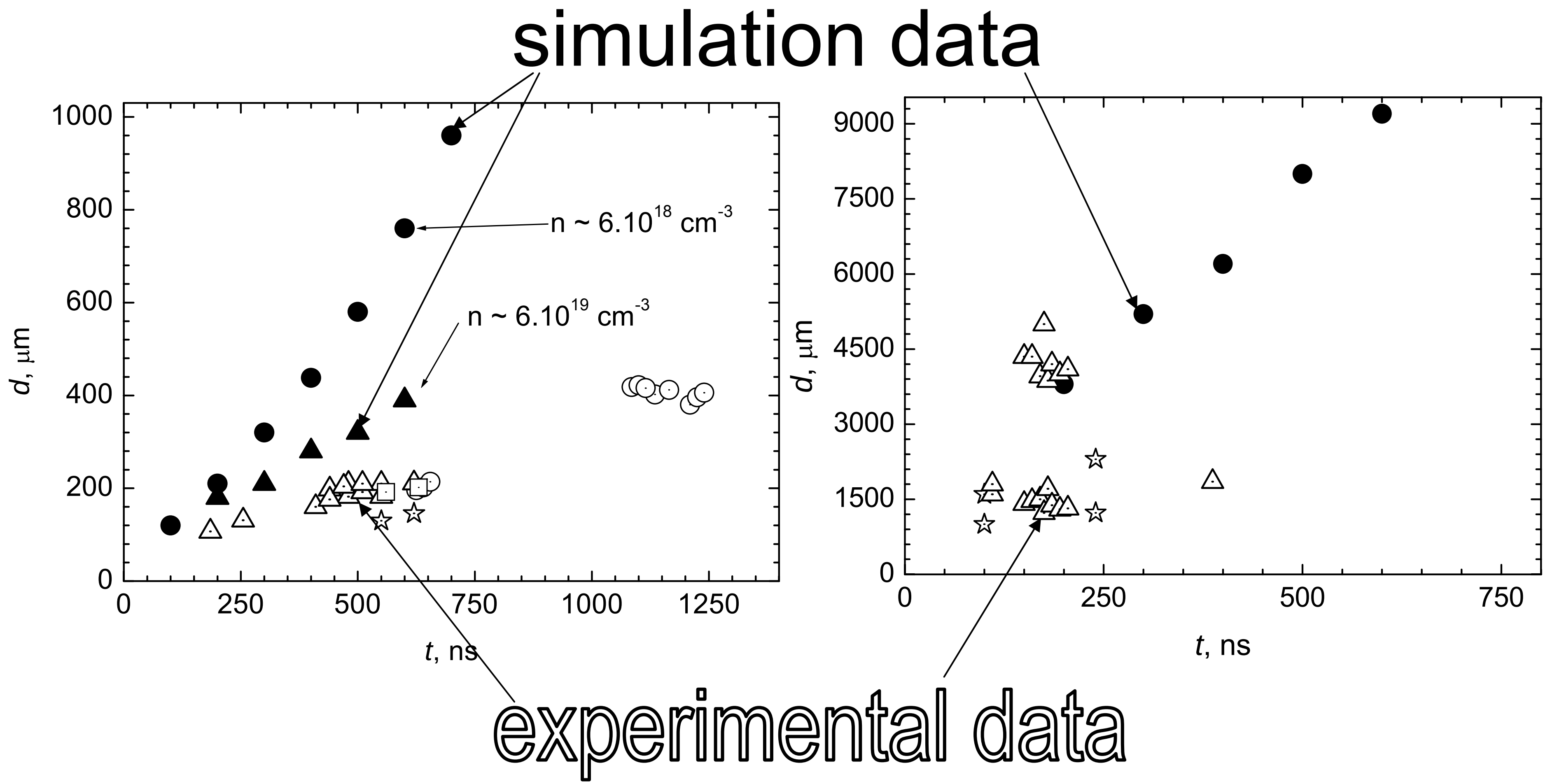
Simulation results

Radial distribution of plasma parameters



numerical code: V.A. Gasilov, A.Yu. Krukovskii, 1990

Comparison of experimental and simulation data for explosion of 25-μm W wire in vacuum



CONCLUSIONS

- there are different scenarios of breakdown development upon wire explosion;
- size of the region radiated in UV range (current-conducting) noticeably exceeds the size of the region occupied by the dense products under wire explosion in vacuum;
- experimental evidence of influence of light matter contaminating wire surface and some of the adsorbed gases on breakdown process was obtained;
- instabilities develop in the radiative region;
- more intense UV radiation was observed in the near-cathode region.

Thank you for your attention