THE INVESTIGATION OF POLARIZED REFLECTIVITY PROPERTIES OF EXPLOSIVELY DRIVEN DENSE XENON PLASMA

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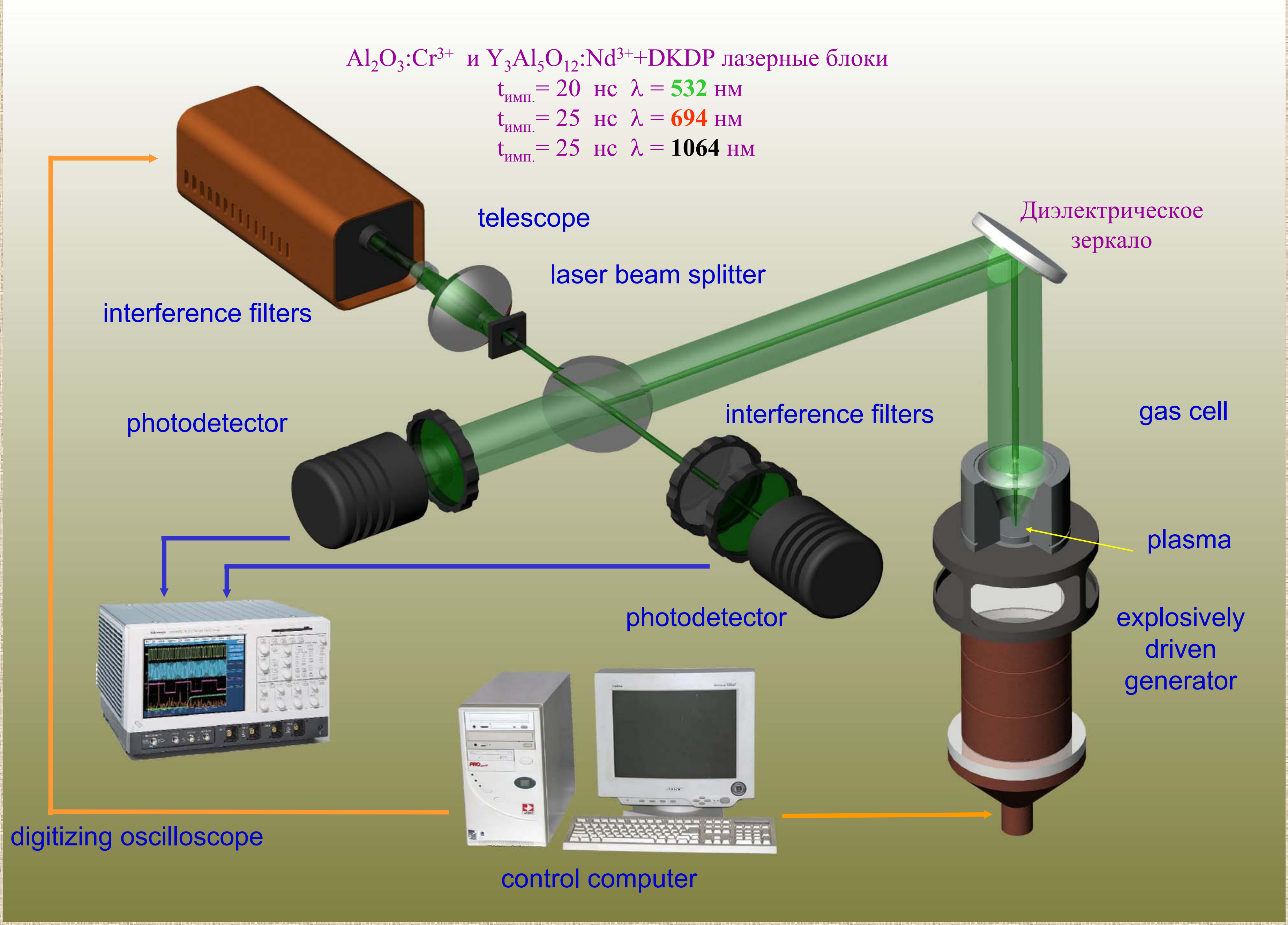
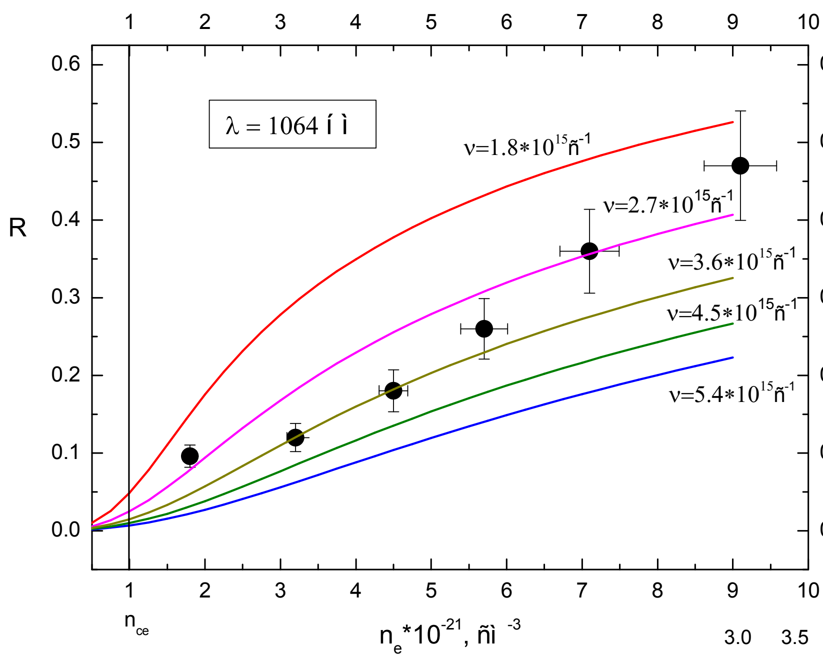
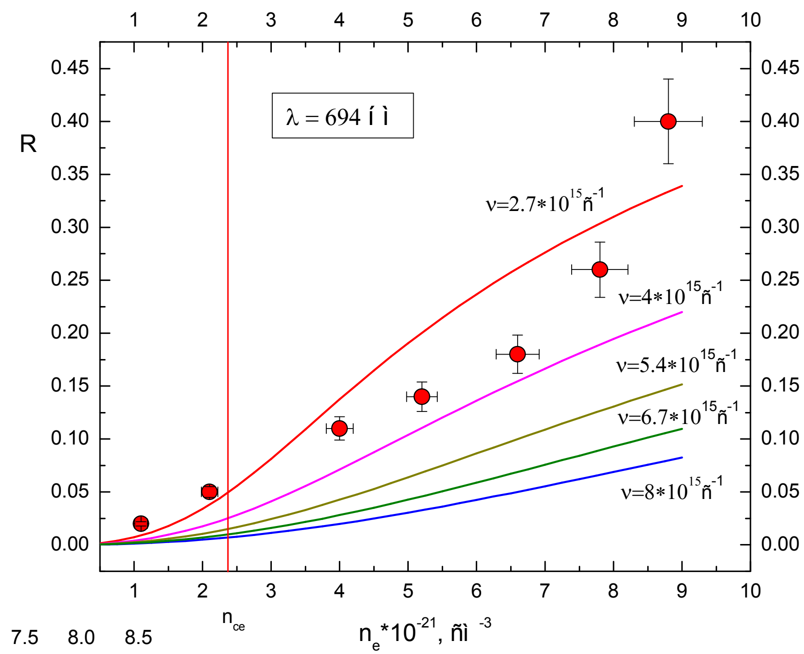
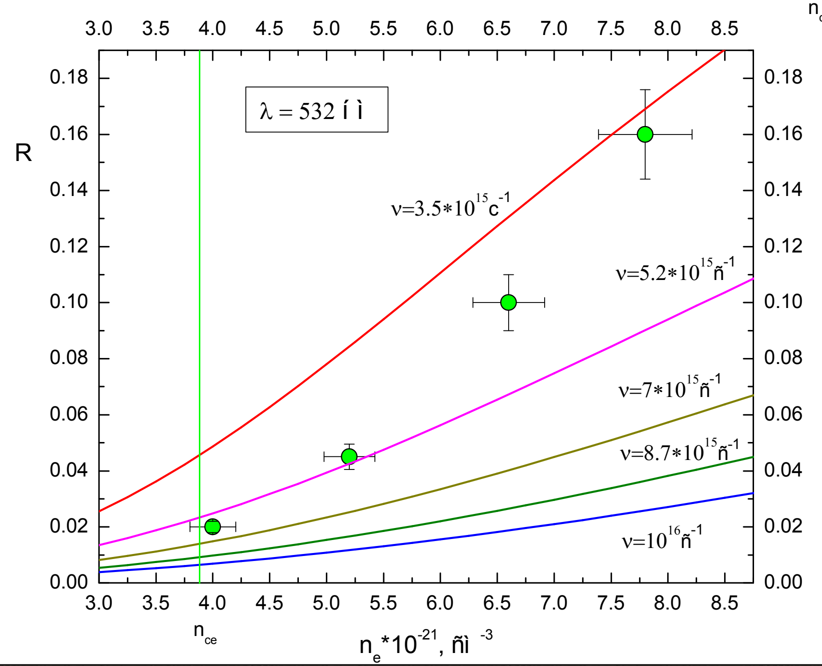
Optical probing of explosively driven dense plasma



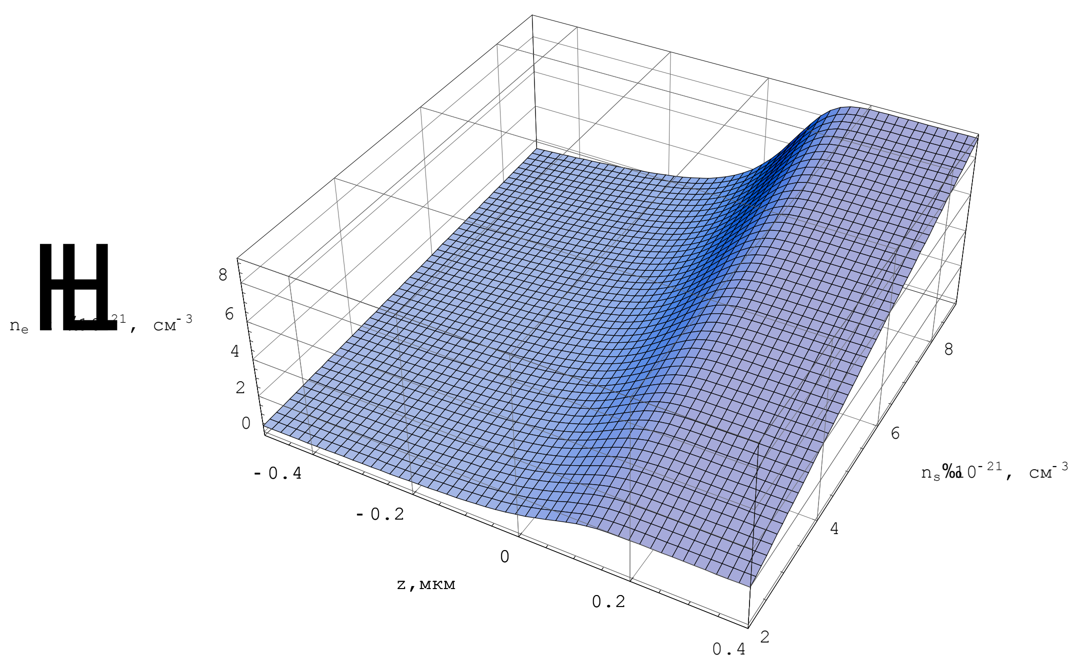
The reflectivity of shock-compressed dense xenon plasma for normal incidence.

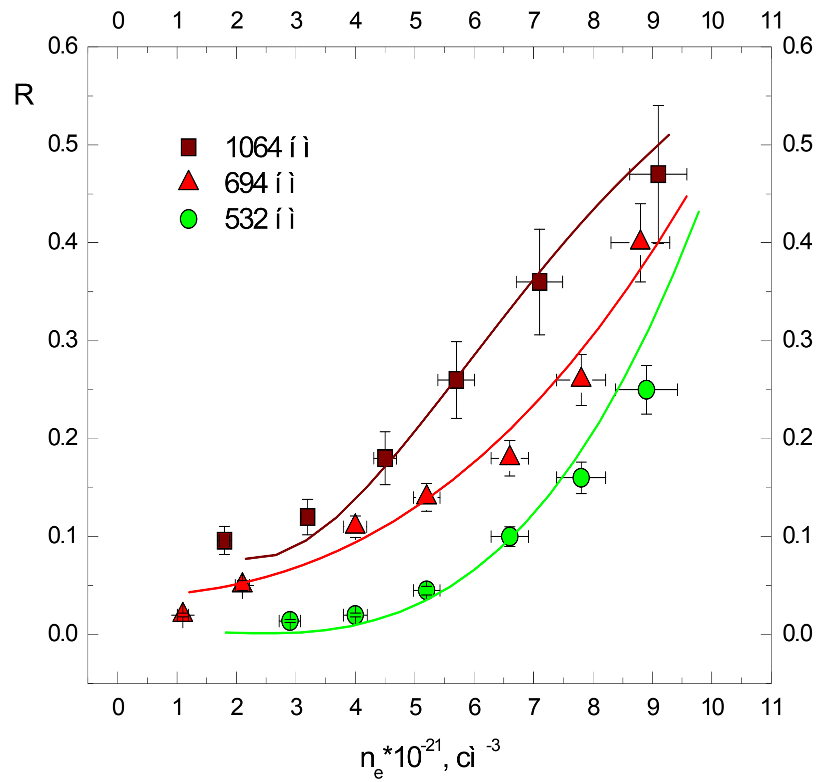






Simulation of electromagnetic wave propagation in explosively driven dense plasma.

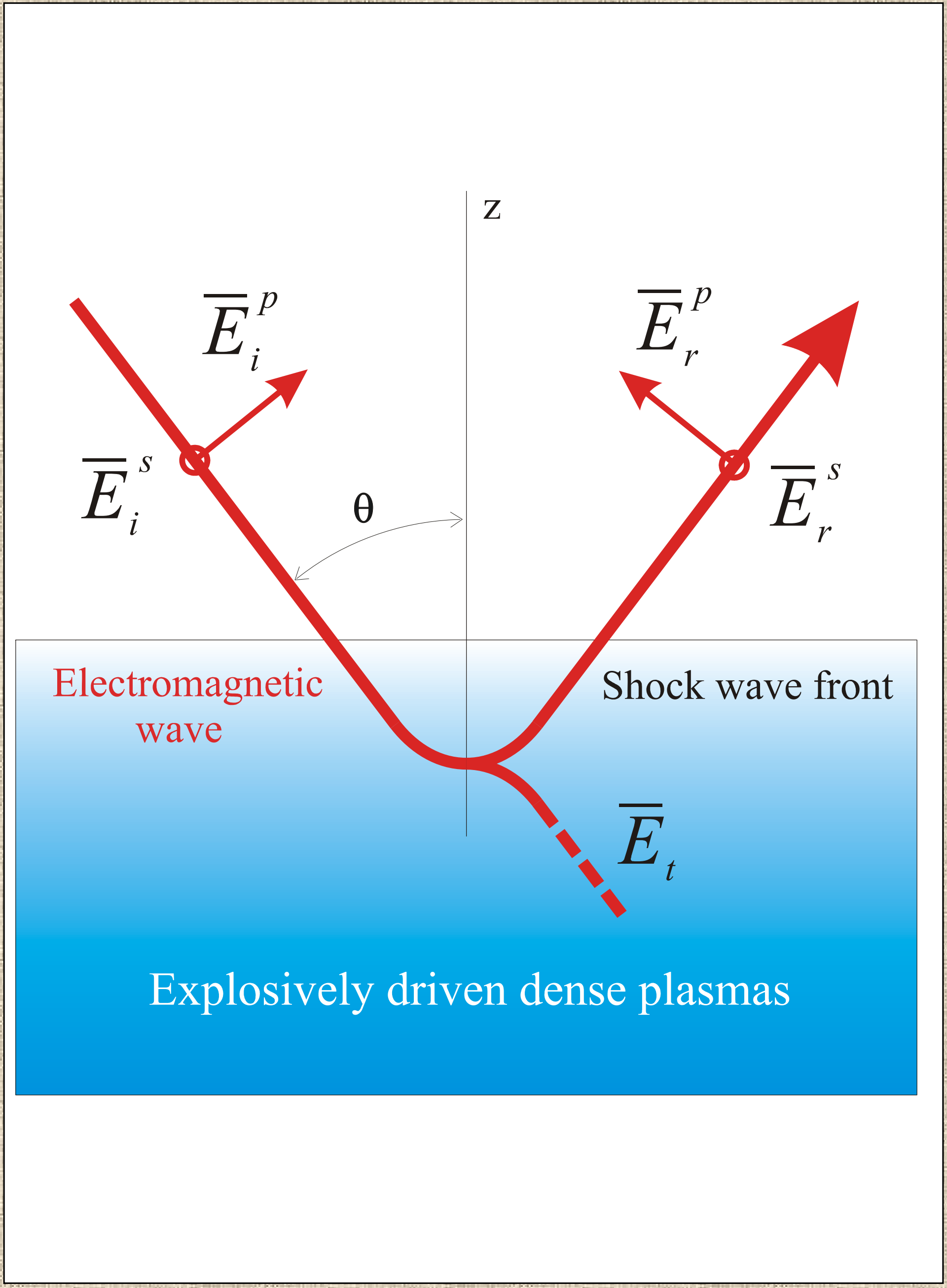




Electron density profile of dense plasma.

The reflectivity of shock-compressed dense xenon plasma for normal incidence.

Interaction of plasmas with polarized electromagnetic wave.



s-polarization

$$E_y = 0 \qquad E_z = 0 \qquad H_x = 0$$

$$E_x = E_0(z) e^{-i\omega(t - \frac{y \sin\theta}{c})}$$

$$E_0''(z) + \frac{\omega^2}{c^2}[\varepsilon(\omega, z) - \sin^2\theta] E_0(z) = 0$$

p-polarization

$$H_y = 0 \qquad H_z = 0 \qquad E_x = 0$$

$$H_x = H_0(z) e^{-i\omega(t - \frac{y \sin\theta}{c})}$$

$$H_0''(z) - H_0'(z)\{\log[\varepsilon(\omega, z)]\}' + \frac{\omega^2}{c^2}[\varepsilon(\omega, z) - \sin^2\theta] H_0(z) = 0$$

Dielectric function model for the integration of Maxwell equations

$$\sigma = a_0 T^{\frac{3}{2}} \left(1 + \frac{b_1}{\Theta^{\frac{3}{2}}}\right)\left[\ln(1 + A + B)D - C - \frac{b_2}{b_2 + \Gamma\Theta}\right]^{-1}$$

$$\Downarrow$$

$$\nu = \frac{\varepsilon_0 \omega_{pl}^2}{\sigma_{dc}}$$

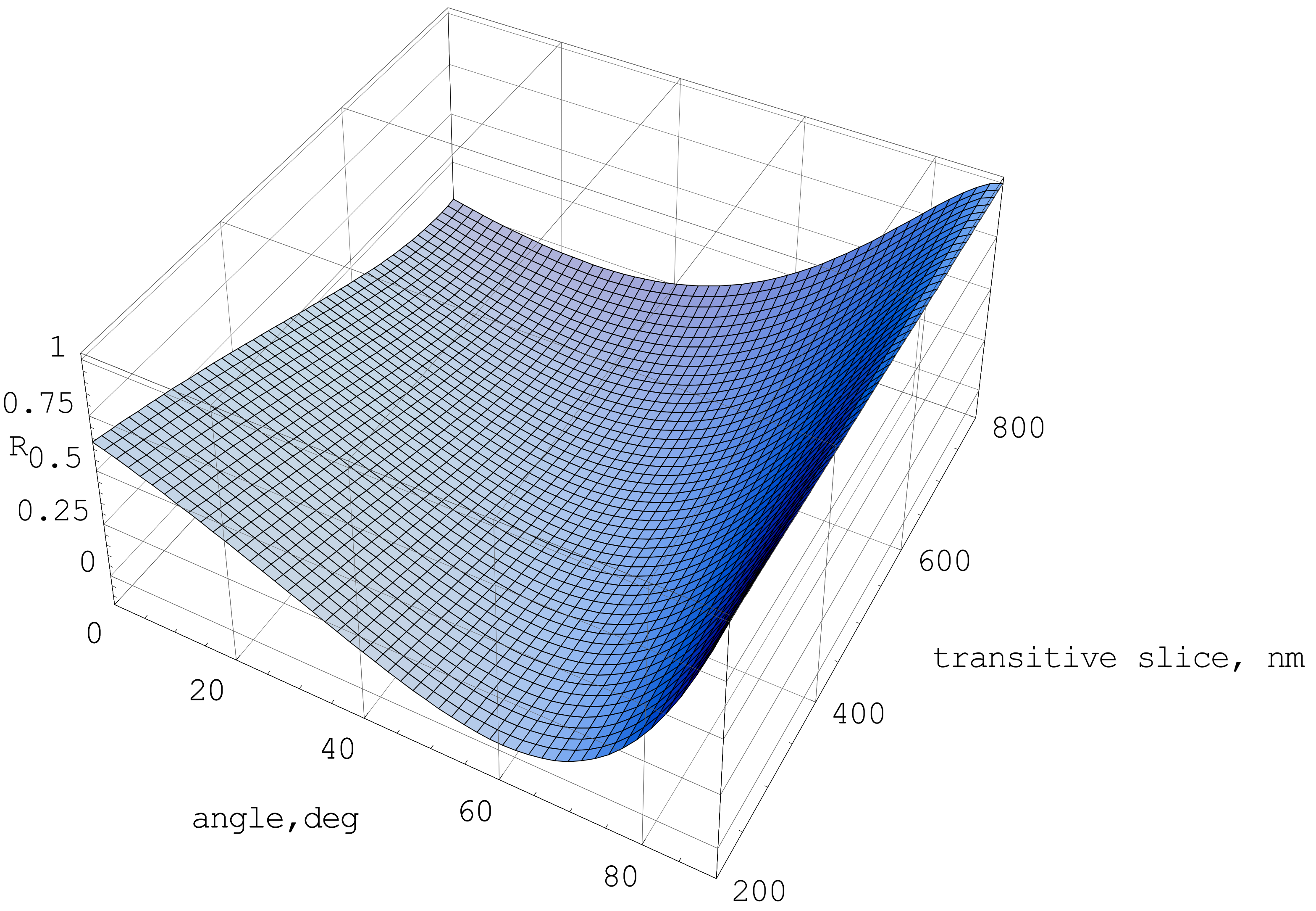
$$\Downarrow$$

$$\sigma(\omega) = \frac{\varepsilon_0 \omega_{pl}^2}{\nu - i\omega} \quad \Rightarrow \quad \varepsilon(\omega) = 1 + i\frac{\sigma(\omega)}{\varepsilon_0 \omega} \quad \Rightarrow \quad \frac{d^2 E(z)}{dz^2} + \frac{\omega^2}{c^2}\varepsilon(\omega, z)E(z) = 0$$

$$\Uparrow$$

$$\nu^{ei}(\omega) = -i\frac{e^4 \beta^{\frac{3}{2}} n_e}{24\sqrt{2}\pi^{\frac{5}{2}} \varepsilon_0^2 m_e^{\frac{1}{2}}} \int_0^\infty dy \frac{y^3}{(\overline{n} + y^2)^2} \int_{-\infty}^{\infty} dx e^{-(\frac{x}{y} - y)^2} \frac{1 - e^{-4x}}{x(x - \varpi - i\eta)}$$

Angular dependence of p-polarized reflectivities vs extent of transitive slice.



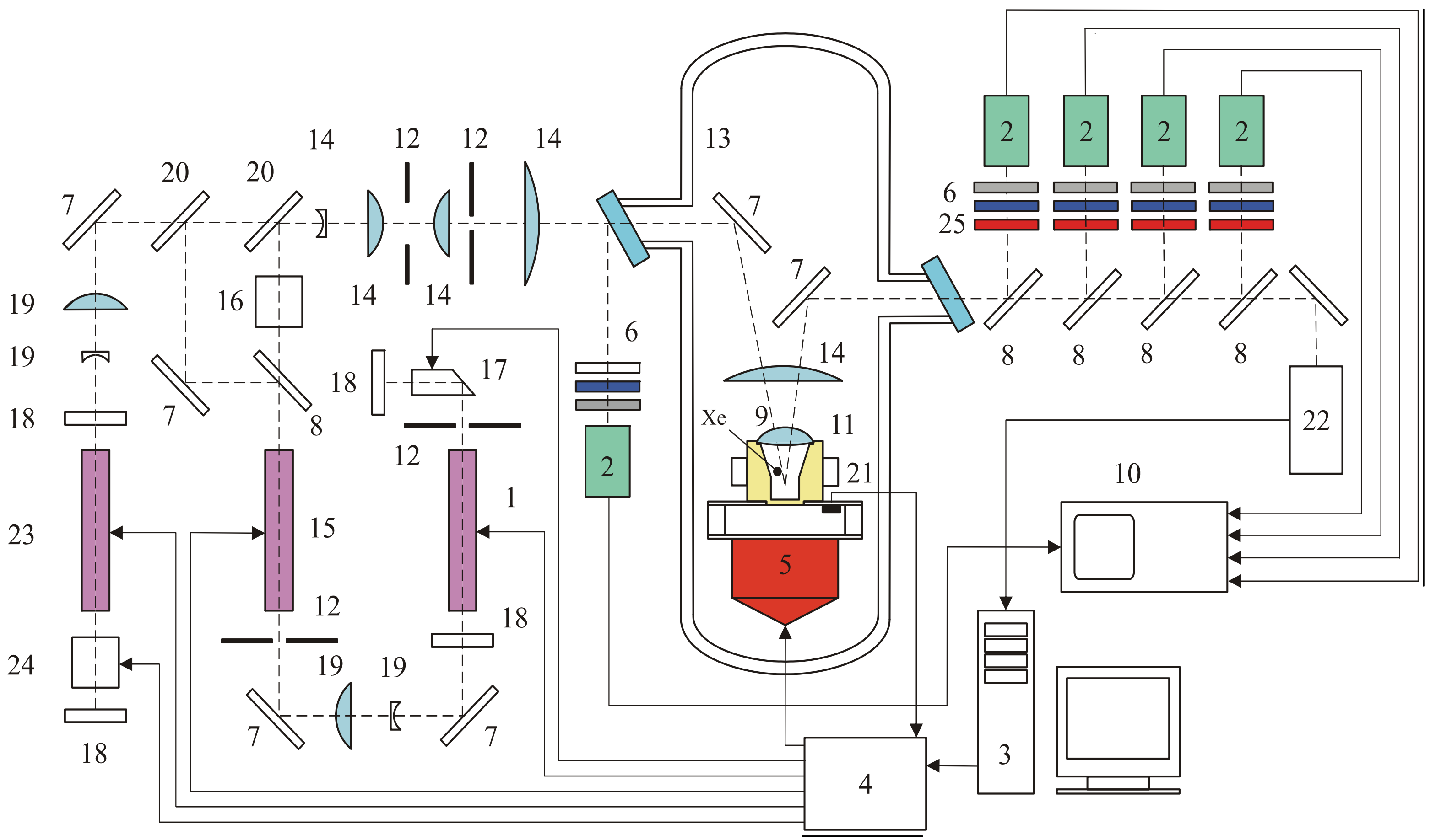
λ_{las}=1064nm

$n_e=7*10^{21}cm^{-3}$

T=30000 K

ρ_{pl}=2.7 g/cm^3

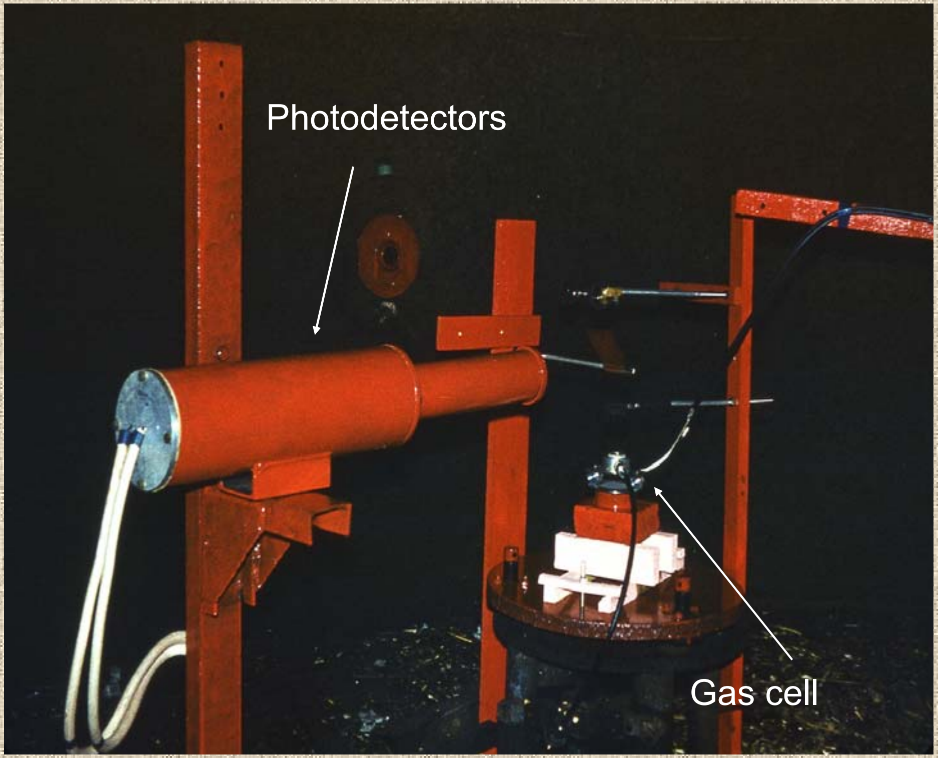
Optical probing of explosively driven dense plasma



Experimental setup.
1—$Y_3Al_5O_{12}$:Nd^{3+} laser, 2—multichannel photodetector, 3—control computer, 4—high-speed control block, 5—explosively driven generator, 6—interference filters, 7—mirror, 8—laser beam splitter, 9—axicon, 10—digitizing oscilloscope, 11—gas cell, 12—diaphragm, 13—explosive chamber, 14—lens, 15—Y_3Al_5O12:Nd^{3+} three-pass amplifier, 16—KTP crystal, 17—electro-optical DKDP shutter, 18—laser mirror, 19— telescope, 20—mirror, 21—gas cell thermostat, 22—spectroscope, 23—Al_2O_3 :Cr^{3+} laser, 24—electro-optical DKDP shutter, 25-polarizer

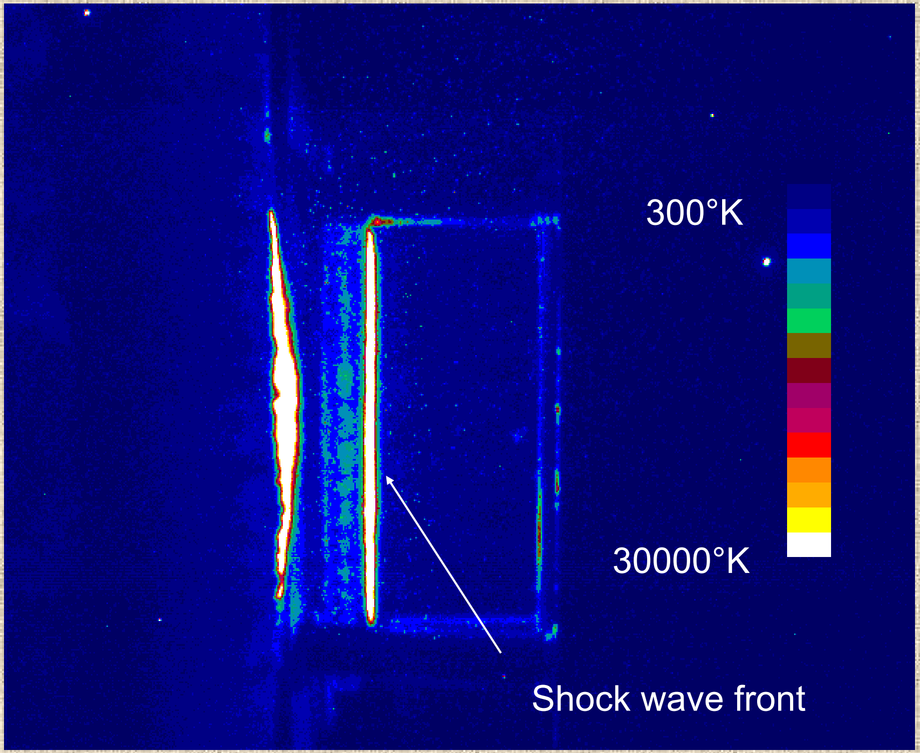
The probe pulsed laser system.

Investigation of explosively driven dense plasma using low intensity electromagnetic waves.

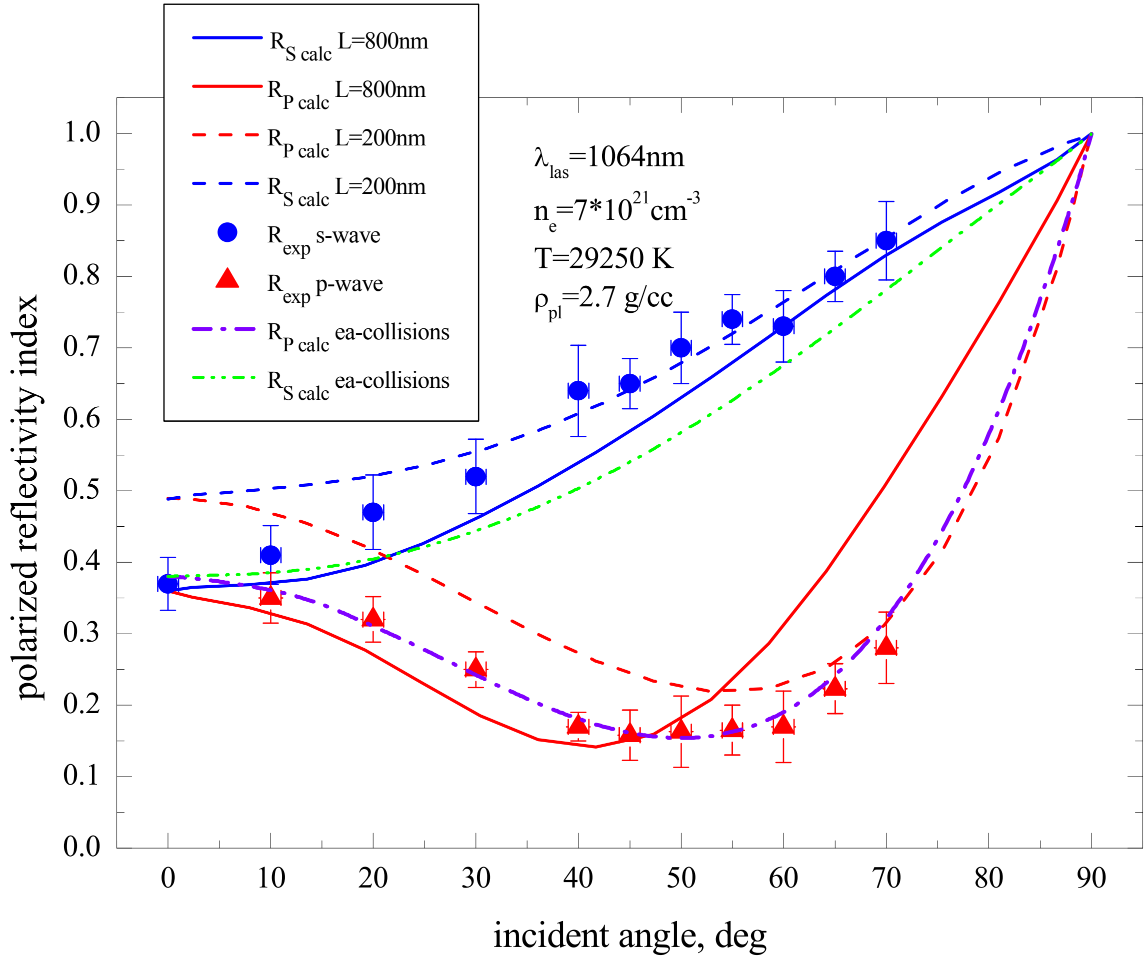


Investigation of polarized reflectivities of explosively driven dense plasma

Shock wave propagation

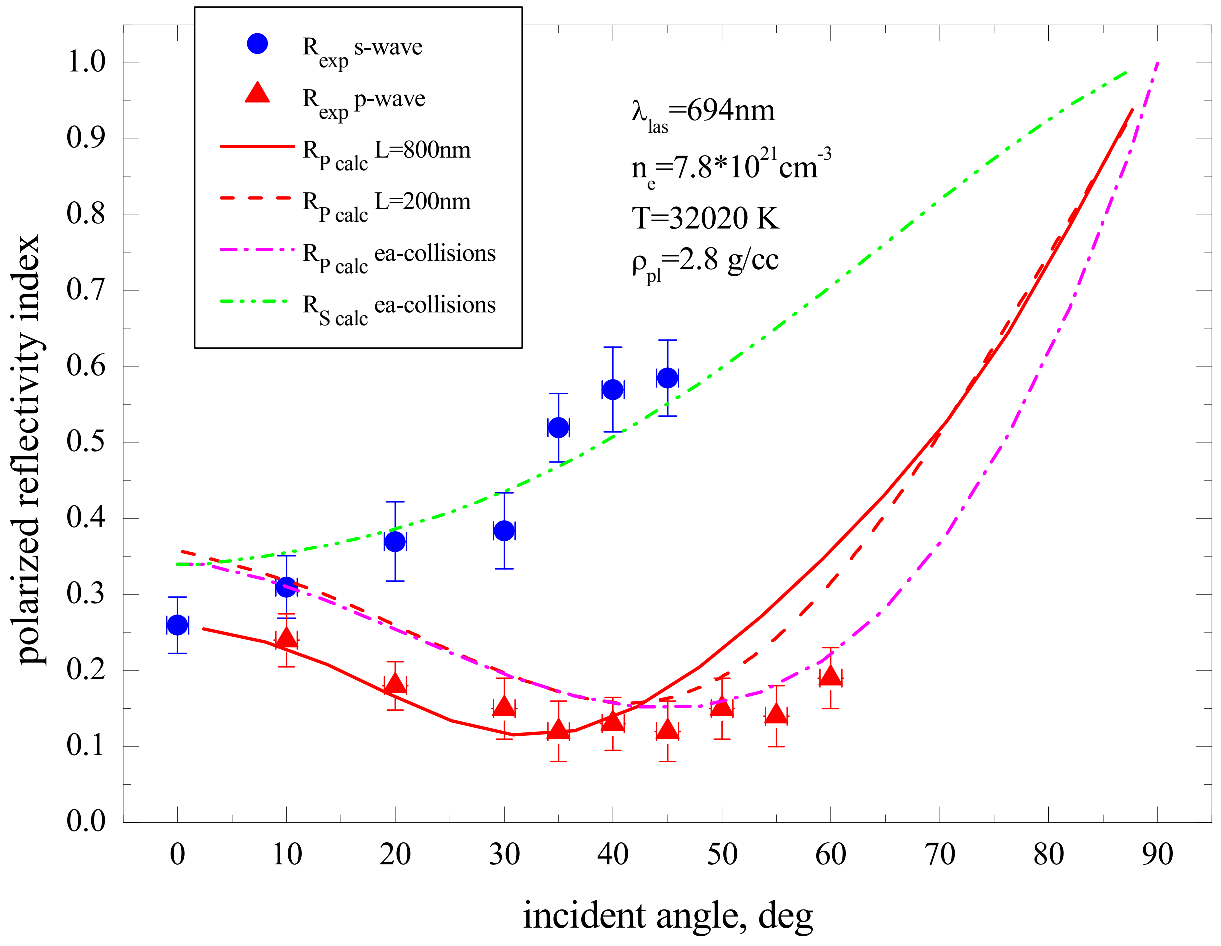


Dense plasma angular dependence of s- and p-polarized reflectivities. Λ=1064nm



Solid and dashed curves are calculation for 200nm and 800 nm transitive layer.

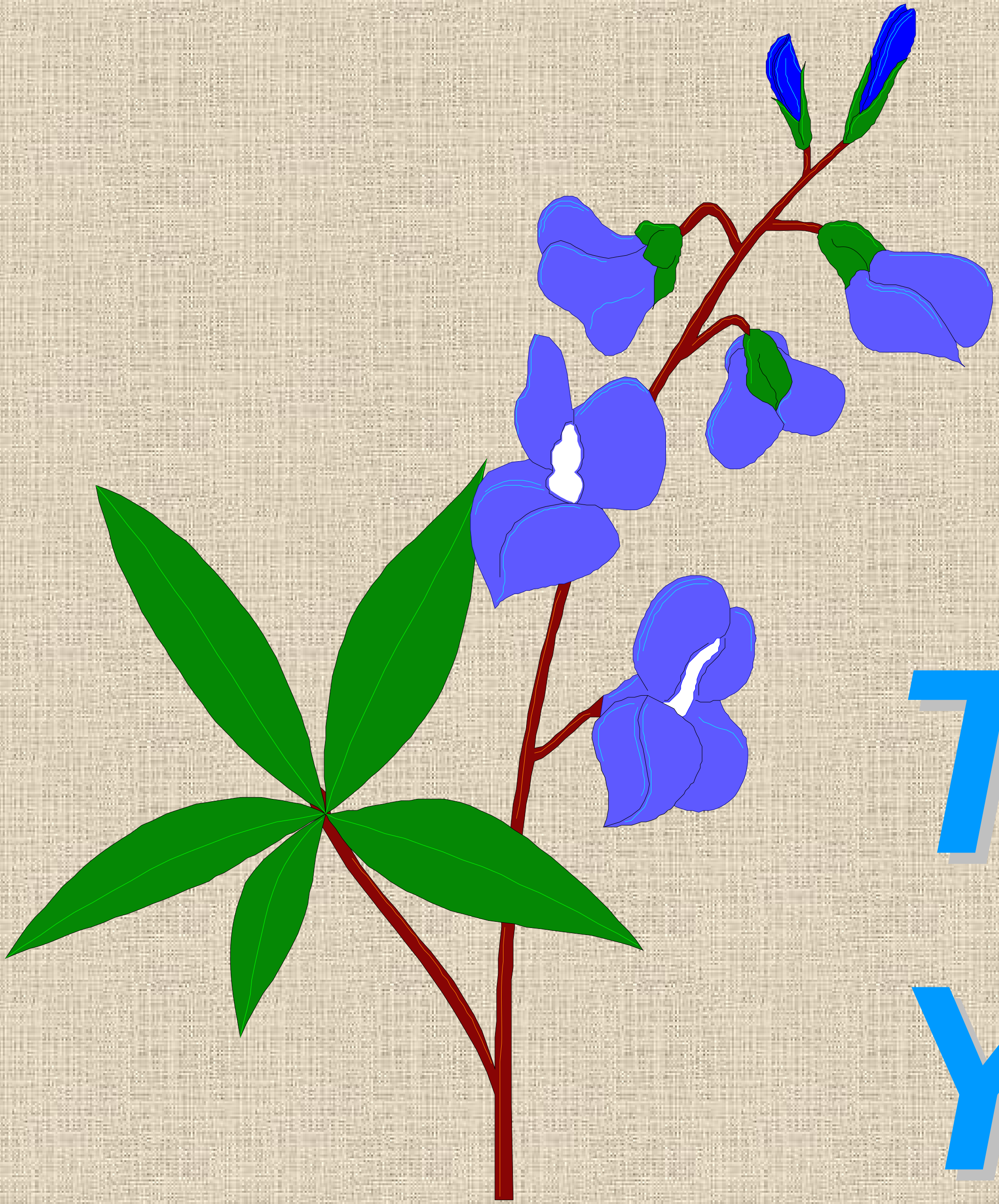
Dense plasma angular dependence of s- and p-polarized reflectivities. Λ=694nm



Solid and dashed curves are calculation for 200nm and 800 nm transitive layer.

Conclusions

- The results of the new experiments on polarized reflectivities of explosively driven dense xenon plasma are presented. The study of polarized reflectivity properties of the plasma was accomplished with plasma density ρ = 2.7 g/cm^3, pressures up to P ~ 18 GPa and temperatures up to T ~ $3 \cdot 10^4$ K under conditions with strong Coulomb interaction (the nonideality parameter up to Γ ~ 2.0).
- The integration of Maxwell equations has been based on an interpolation formula for dc conductivity, obtained from a systematic quantum statistical treatment of different limiting cases.
- To interpret correctly the results of reflectivity measurements it is necessary to know parameters of a transitive plasma layer. Angular dependence of s - and p-polarized reflectivities at several wavelengths can be used in the integration of corresponding Maxwell equations to construct the spatial profile of the density of charge carriers.



Thank You.....!