Femtosecond Filament Plasma Channel Formation
And Decay Study By Transverse Optical
Interferometry.

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Abstract—Electron density dynamics in gases is studied from
ionization to hundreds of picoseconds after it by interferometry
method. Optical refractive index anisotropy, which precedes and
accompanies ionization, related with intense pulse propagation is
revealed.

Keywords—plasma channel; filamentation; femtosecond lasers

I. Introduction

Filamentation of femtosecond laser pulses provides many
interesting effects such as supercontinuum and terahertz
generation, formation of conducting plasma channels, etc.[1]
Dynamical balance between self-focusing and plasma
defocusing results in creation of a long plasma channel.
However, in recent works it is shown, that not only plasma
defocusing but also high order Kerr effect can saturate
intensity growth[2,3]. Thus, it is interesting to study the
moment of plasma channel formation to reveal role of both
mechanisms.

Another problem is the dynamics of plasma channel decay.
Here optical interferometry can be fruitful in the estimation of
electron density dynamics in the first nanoseconds where
plasma is still dense.

II. Experimental Study

We report results on decay of femtosecond filament
plasma channel. The results for air, nitrogen and argon under
atmospheric pressure conditions are obtained due to
interferometry method[4,5]. Investigation covers time scale
from the formation of the filament plasma channel to 150
picoseconds after it for air, N₂ and 600 picoseconds for Ar.
Patterns of phase shift due to plasma and corresponding
electron density patterns are obtained.

We also studied formation stage of the femtosecond
filament plasma channel. Optical refractive index anisotropy,
which precedes and accompanies ionization, related with
intense pulse propagation is revealed.

III. Results

The results show that electron density decreases faster in
N₂ than in air. Also they show that plasma channel in Ar exists
much longer and its decay is negligible on 150 ps time scale.

Fig 1. Phase distortion corresponding to a) plasma
channel; b) pulse propagation.

Optical refractive index anisotropy due to femtosecond
laser pulse propagation may be confirmation to high order
Kerr effect influence on plasma channel formation.

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