

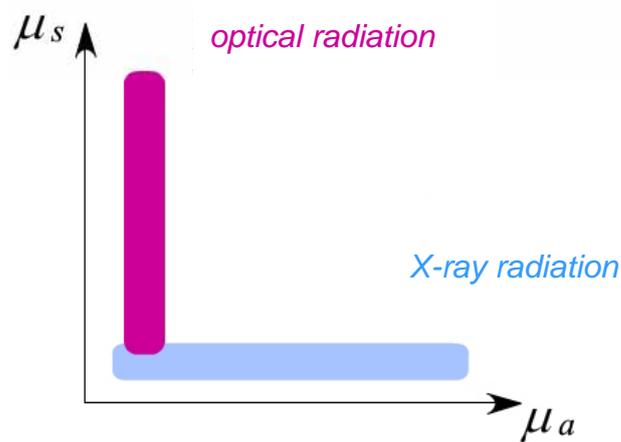
Moscow Institute of Electronic Technology  
(Technical University)

Ivan Pyanov

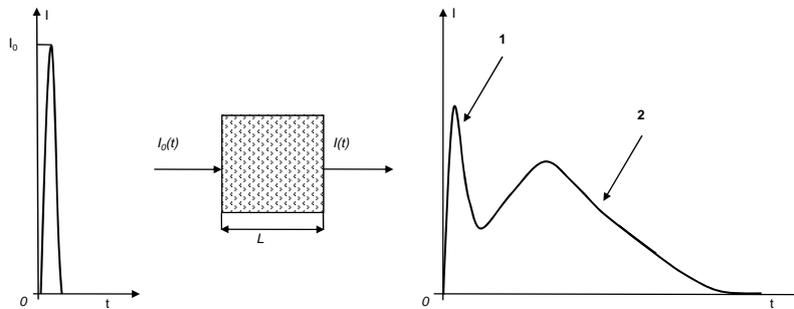
**The experimental separation  
of ballistic and scattered components  
in the temporal distribution of the ultrashort  
laser pulse passed through the turbid medium**

Moscow, 2009

2 Traditional and optical tomography



### 3 The temporal distribution of ultrashort laser pulse passed through the turbid medium



The ballistic (1) and scattered (2) photons

### 4 The mathematical apparatus based on nonstationary axial model of light propagation through the turbid medium

The formula for the radiant flux at time  $t$  at depth  $x$ :

$$F(t, x) = U_0 m v \delta(mvt - mx) \exp(-mx) + U_0 \eta(mvt - mx) \frac{v m_s x}{\sqrt{(vt)^2 - x^2}} I_1 \left( m_s \sqrt{(vt)^2 - x^2} \right) \exp(-mvt),$$

$v$  – the speed of light in the medium

$U_0$  – the energy of the initial pulse

$I_1(\bullet)$  – modified Bessel function of the 1-st kind of 1-st order

$\delta(\bullet)$  – Dirac delta function

$\eta(\bullet)$  – Heaviside function

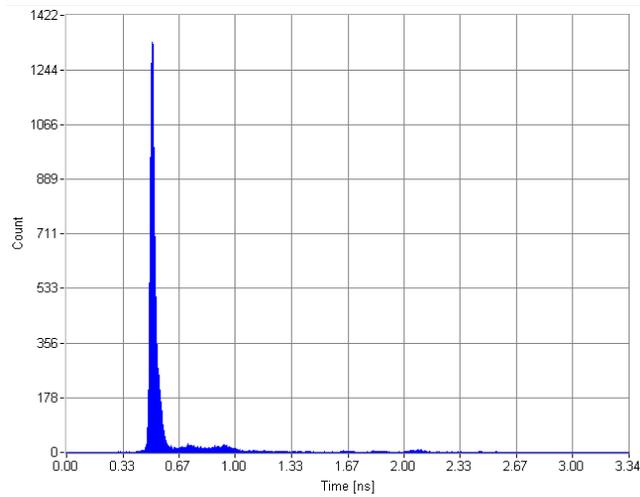
$m = m_a + m_s$  – the radiation extinction coefficient

$m_a$  – the radiation absorption coefficient

$m_s$  – the radiation scattering coefficient



## 7 The experimental temporal distribution of the initial laser pulse

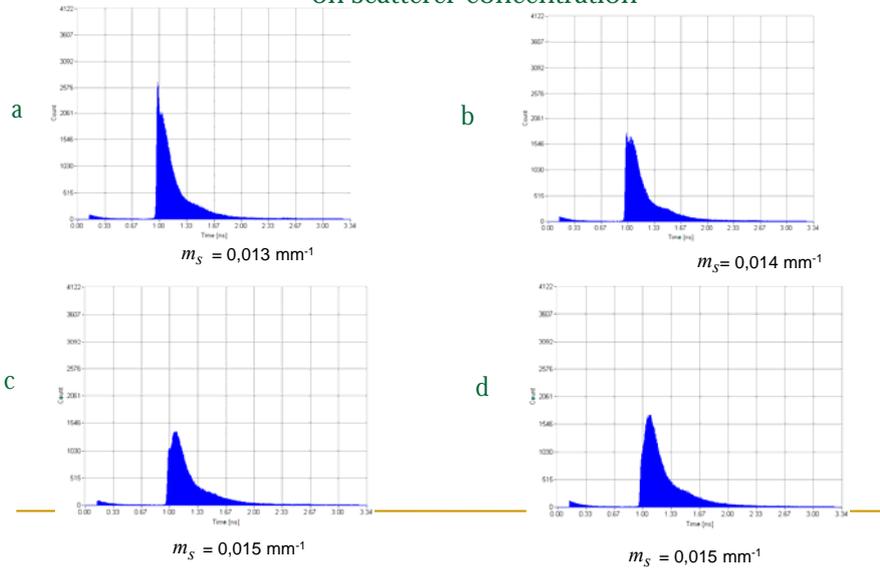


## 8 Test object – milk solution in water

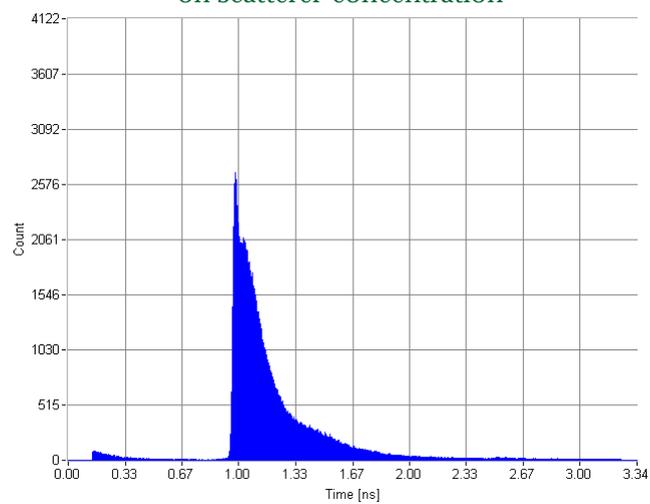


$$m_a = 0,003 \text{ mm}^{-1}, m_s = 0,015 \text{ mm}^{-1}$$

9 The bimodal temporal distribution of ultrashort laser pulses passed through the HSM in dependence on scatterer concentration

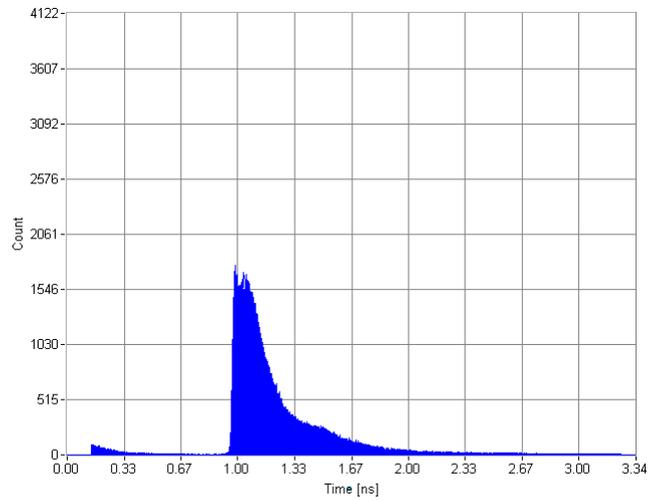


10 The bimodal temporal distribution of ultrashort laser pulses passed through the HSM in dependence on scatterer concentration



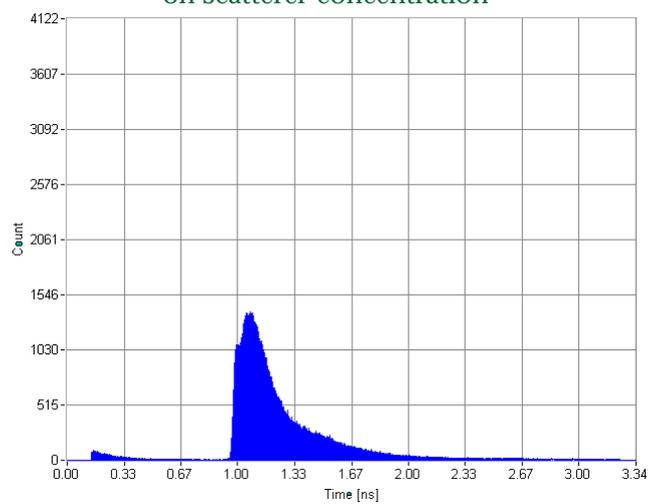
$$n = 1,5 \times 10^{-3}$$

1 The bimodal temporal distribution of ultrashort laser pulses passed through the HSM in dependence on scatterer concentration



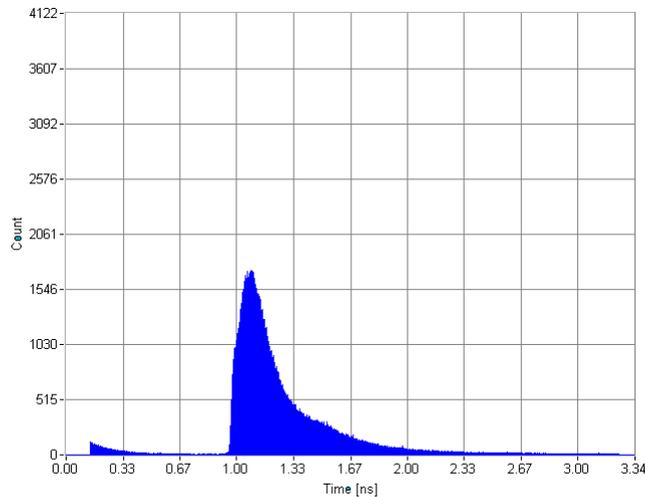
$$n = 1,54 \times 10^{-3}$$

2 The bimodal temporal distribution of ultrashort laser pulses passed through the HSM in dependence on scatterer concentration



$$n = 1,59 \times 10^{-3}$$

13 The bimodal temporal distribution of ultrashort laser pulses passed through the HSM in dependence on scatterer concentration



$$n = 1,63 \times 10^{-3}$$

14

## Conclusions

- The simultaneous observation of bimodal temporal distribution is complicated experimental task.
- The experimental setup was developed for bimodal temporal distribution receiving.
- The presented experimental setup has allowed to observe bimodal temporal distribution.
- The separation of ballistic and scattered components in the temporal distribution of the ultrashort laser pulse passed through the turbid medium was completed.

Thank you for your attention!