Monitoring of optical properties of deep lake water

E.Ryabov, B Tarashchansky for the Baikal-GVD Collaboration

LOC Institutes and Organisations

We present the results of the one year monitoring of absorption and scattering lengths of light with wavelength 375–532 nm within the effective volume of the deep underwater neutrino telescope Baikal-GVD

BAIKAL5D(2020) construction

For in situ measurement of light scattering and absorption, the «BAIKAL-5D» instrument was developed. «BAIKAL-5D» was installed in the deployment area of the underwater neutrino telescope Baikal-GVD at a depth of 1250 m

1- hermetically sealed housing

with monochromator and electronics

2- point-like isotropic light source

3- receiver motion drive

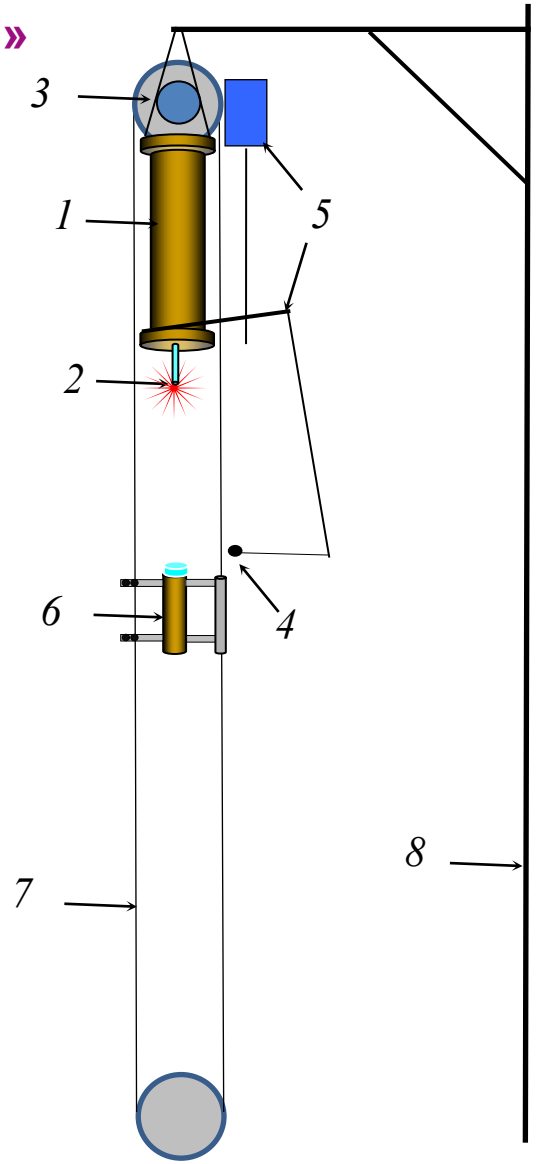
4- screen

5 – system of light source shading

6- wide angle light receiver

7- rope d=3mm

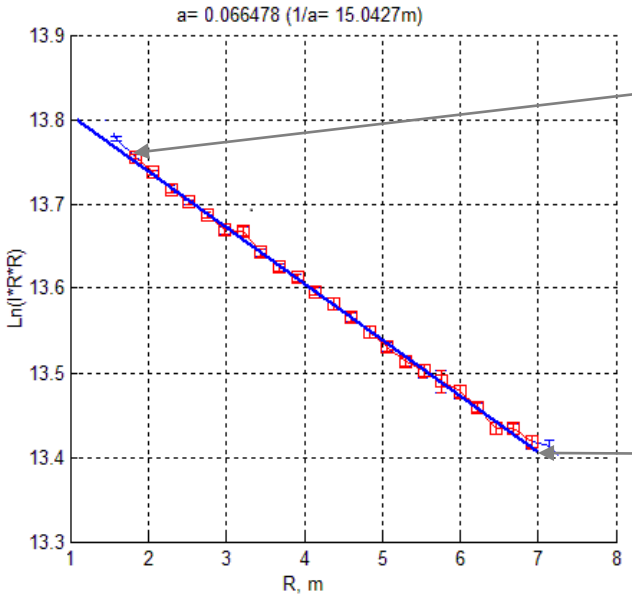
8- cable of string

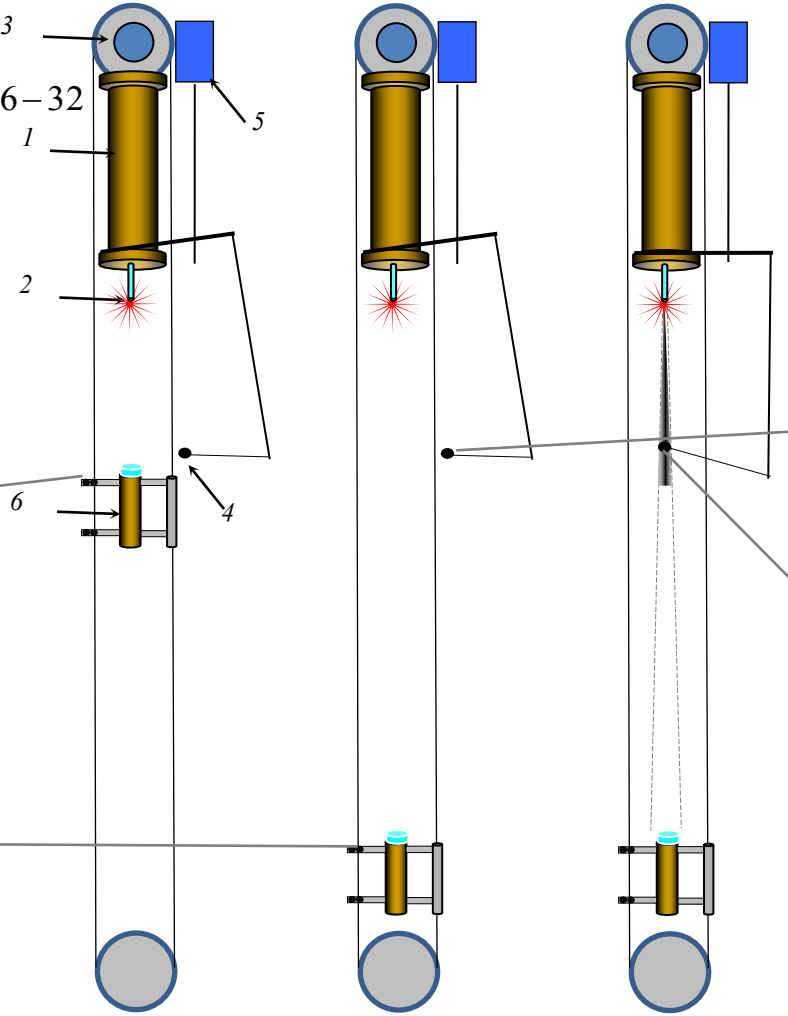


BAIKAL5D-the algorithm of measurement (2020 year)

Absorption [1]

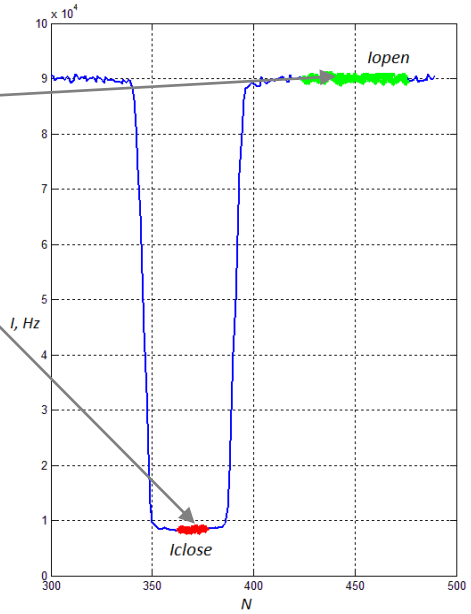
1. $\lambda = const$
2. $R_k = R_{\min} + \frac{R_{\max} - R_{\min}}{n} k, k = [0; n], n = 16 - 32$
3. $I_k = \frac{1}{m} \sum_{j=1}^{m} I_j(R_k)$
4. $\ln(I_k R_k^2) = -aR_k + const$
5. $a = a(\lambda) = 1 / L_a(\lambda)$





Scattering

1. $\lambda = const$
2. $I_{close} = \langle I^j_{close} \rangle, I_{open} = \langle I^j_{open} \rangle$
3. $b = 1 / L_b = -\ln(1 - \frac{I_{close}}{I_{open}}) / R$ [2]

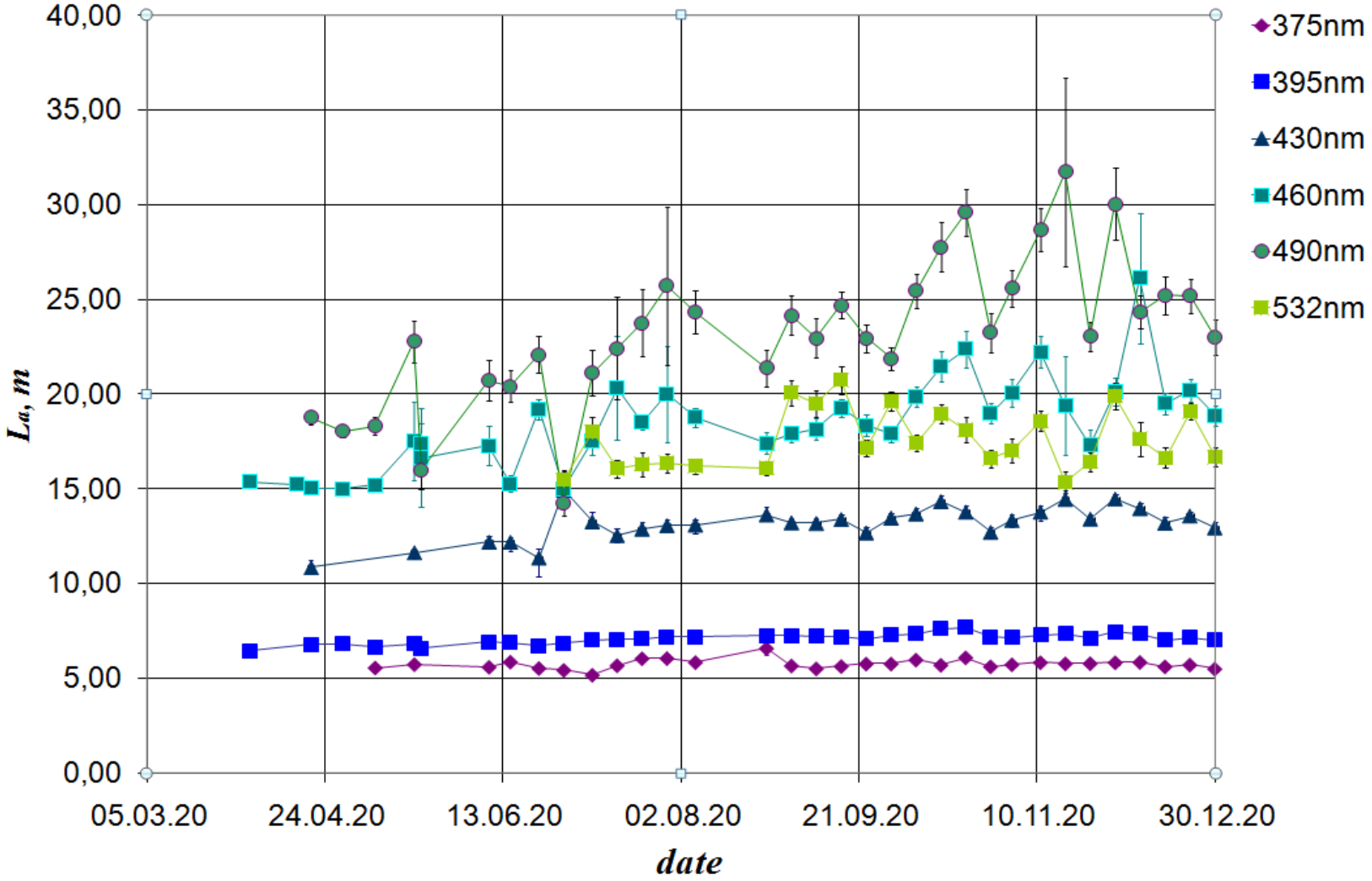


[1] Bauer, D., Brun-Cottan, J.C. \& Saliot, A. 1971.Cah. Oceanogr. V.23. N.9. P. 841-858.

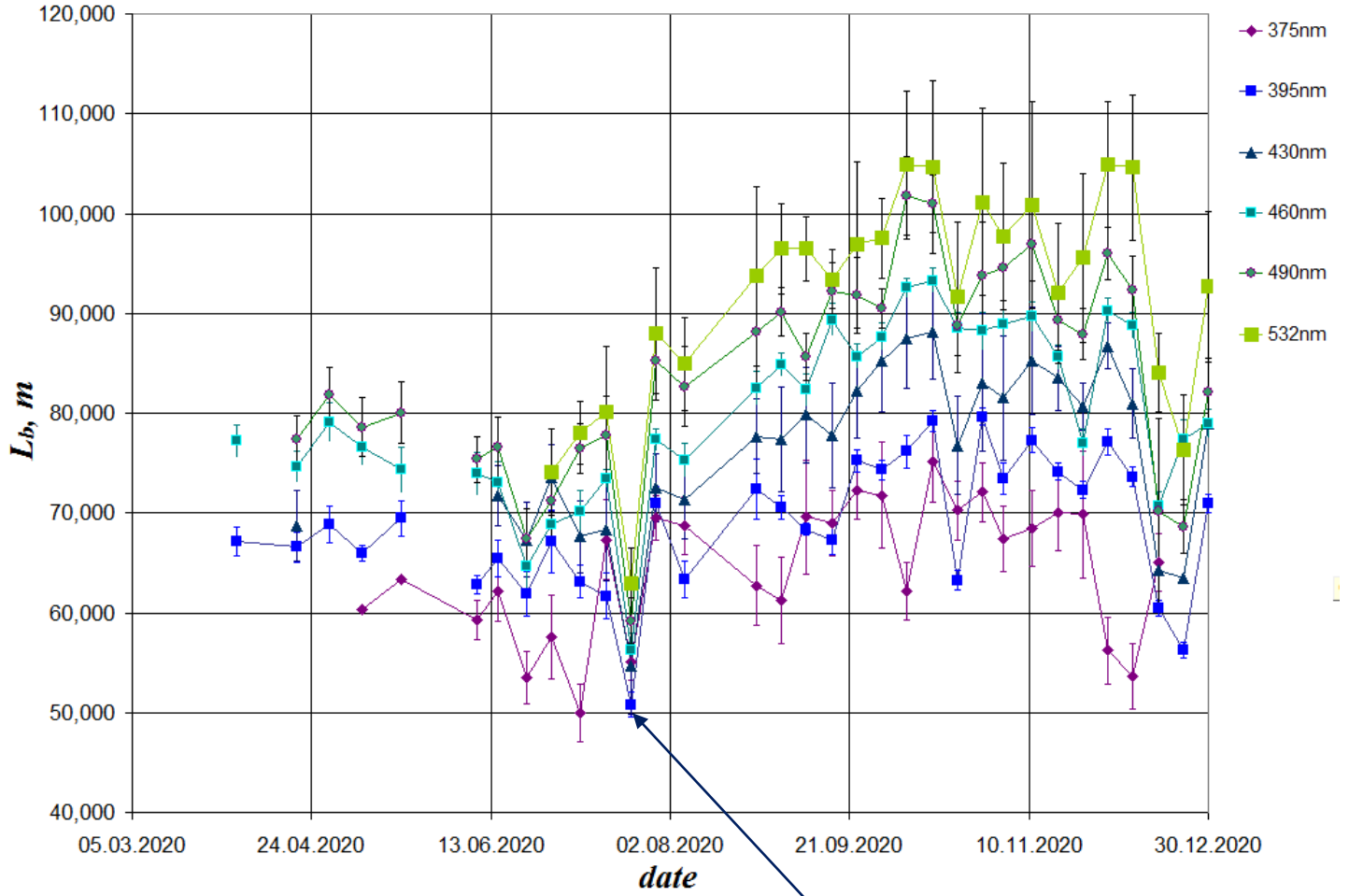
[2] A. Avrorin, et al., Asp-15—A stationary device for the measurement of the optical water properties at the NT200 neutrino telescope site, Nuclear Instruments &Methods In Physics Research A (2012), http://dx.doi.org/10.1016/j.nima.2012.06.035

Absorption length *La*

The scattering length and absorption length were measured regularly once a week at six wavelengths: 375nm, 395nm, 430nm, 460nm, 490nm, 532nm.



Scattering length *La*

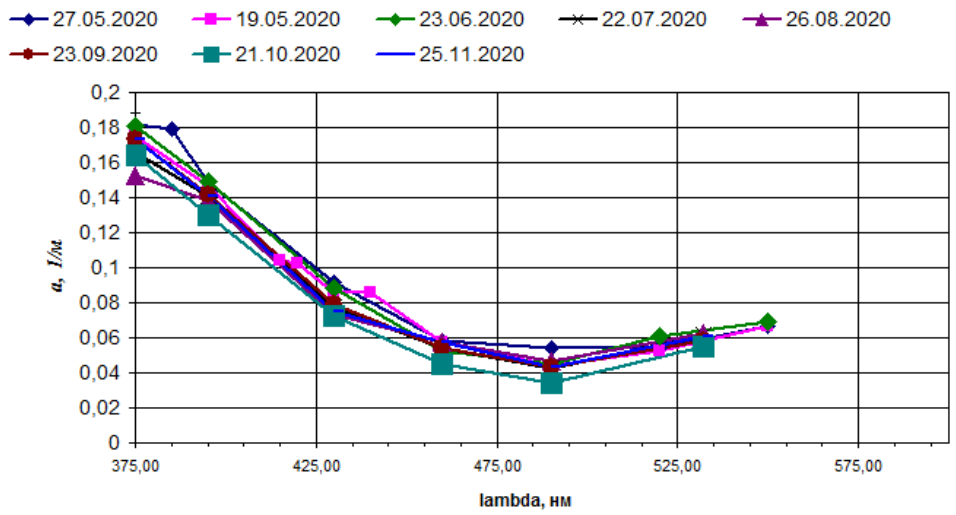


22.07.20- increasing the water glow by 5 times (estimated value)

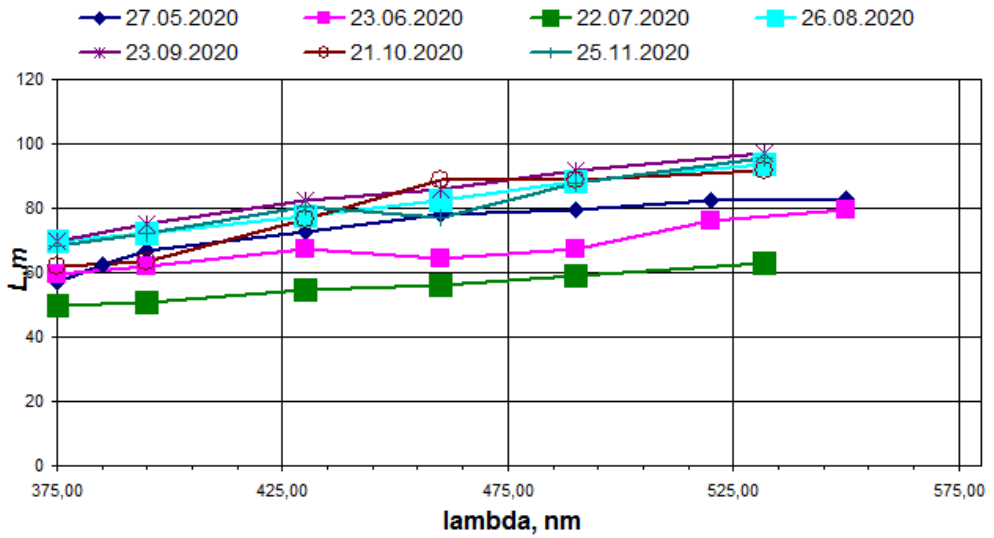
Absorption and scattering spectrum

The values of the absorption and scattering coefficients coincide with good accuracy with the previously obtained data and the 2021 measurements by «BAIKAL-5D» №2 - the improved version of the device «BAIKAL-5D»

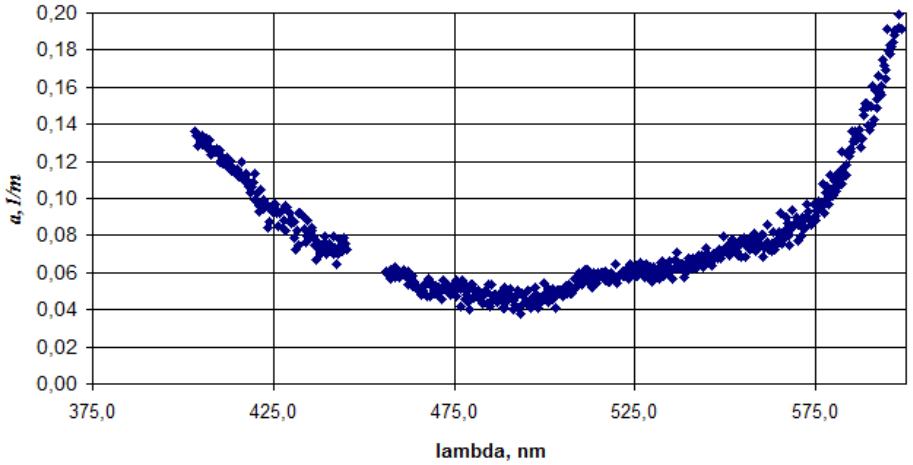
Absorption spectrum 2020, depth 1250m



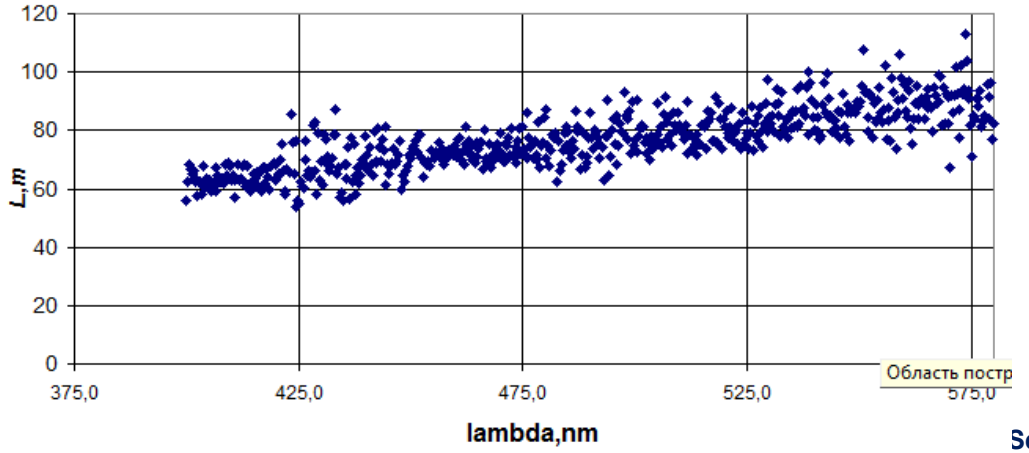
Scattering spectrum 2020, depth 1250m



Absorption spectrum 05/05/2021, depth 1180m



Scattering spectrum 05/05/2021, depth 1180m



Shot-time variations of absorption

2020 year - measurements once a week for 6 wavelength of light.

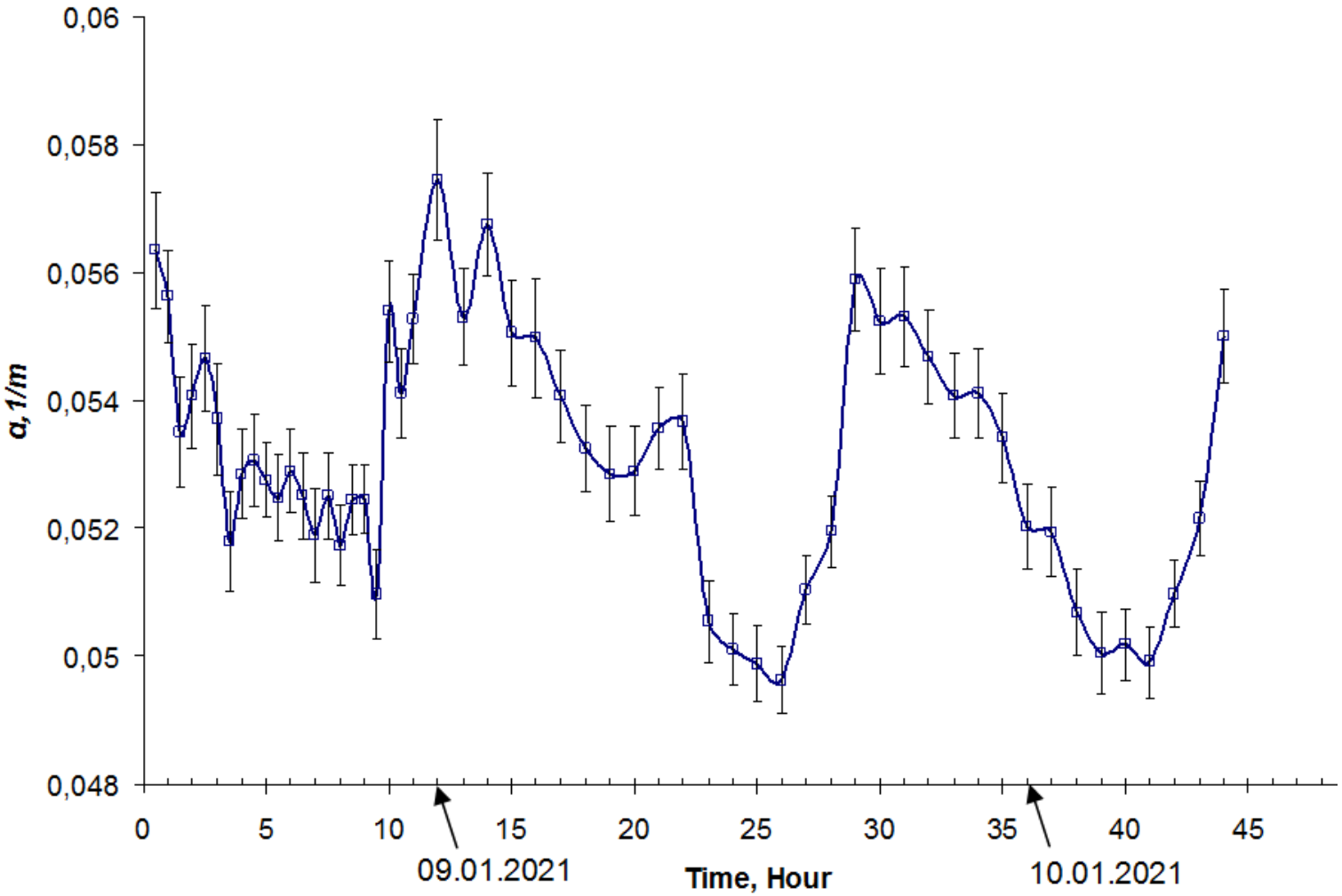
21.04.2020, 08.10.2020 -a series of 10 measurements every hour for 460 nm – variation of absorption coefficient ±3%~measurement error.

08.01.2021-10.01.2021 - a series of 45 measurements - variations of absorption coefficient ±10% with period 15-16hour:

-for every measurement we have good linear approximation $\ln(I_k R_k^2) = -aR_k + const$

-the period of such variations matches with period of water current in the device installation location during November-January

-Storm in period 05.01.2021-12.01.2021



We believe, that such variations in the absorption coefficient can be associated with the movement of water volumes with different hydro-optical characteristics as a result of the November-January current on the level of the instrument installation

Conclusion

In 2020, we managed to implement continuous monitoring in situ of absorption and scattering lengths of light within the effective volume of the deep underwater neutrino telescope Baikal-GVD. The data obtained make it possible to estimate long-term and short-term changes in absorption and scattering.

Thank you for your attention