Monitoring of optical properties of deep lake water

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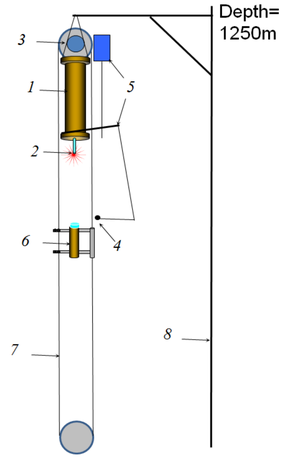
We present the results of the one year monitoring of absorption and scattering lengths of light with wavelength 375÷532nm within the effective volume deep of underwater neutrino telescope Baikal-GVD, which were measured by a device «BAIKAL-5D».

Device construction and measurement method. 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 and provided the ability to monitor the absorption and scattering of water in the period from April 2020 to January 2021.

1 BAIKAL5D(2020) construction

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



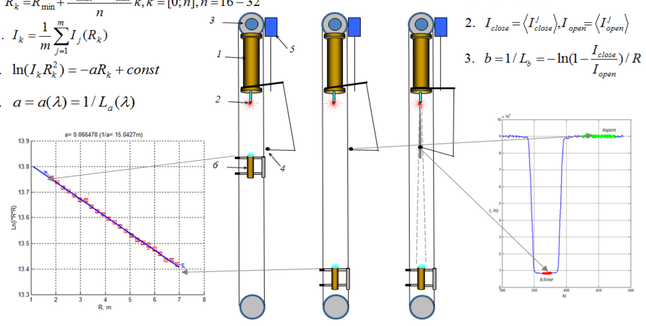
2 BAIKAL5D-the algorithm of measurement (2020 year)

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

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

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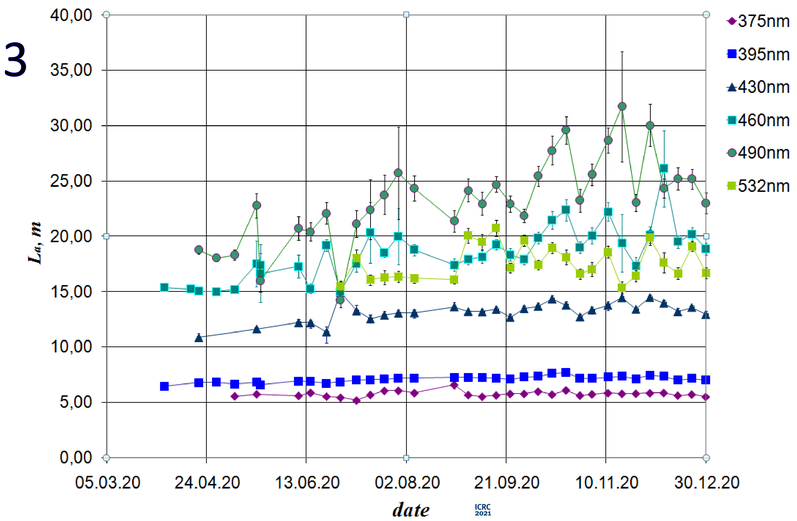

Time dependence of the absorption length during 2020.

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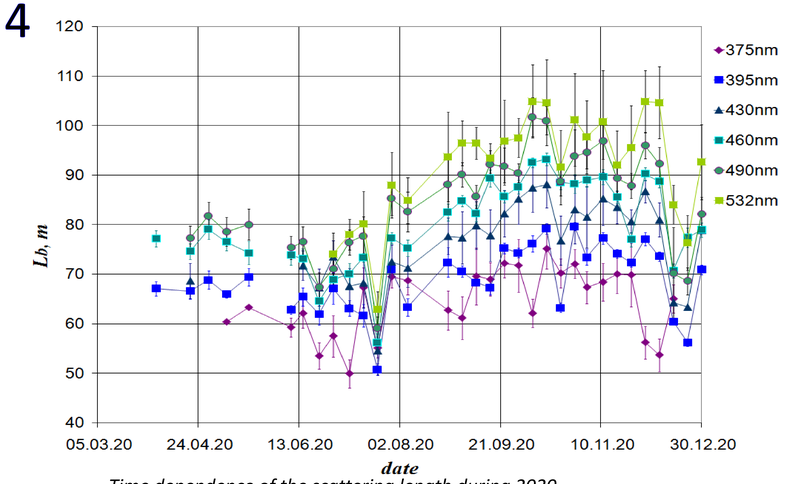

Time dependence of the scattering length during 2020.

Shot-time variations of absorption

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

08.01.2021-10.01.2021 - series of 45 measurements - variations of absorption coefficient **±10%** with period 15-16hour. The period of such variations matches with period of water current in the device installation location during November-January

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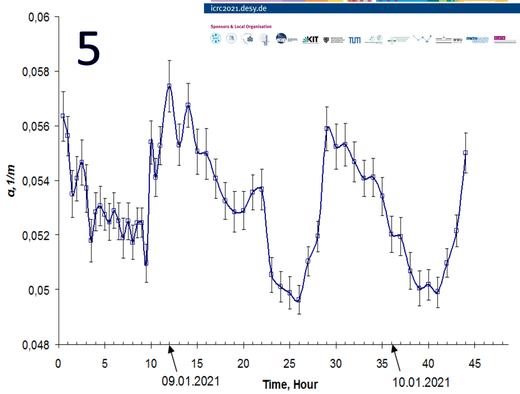

we believe, that such variations in the absorption coefficient can be associated with the movement of water volumes with different hydro-optical characteristics as a result of the November-January current on the level of the instrument installation

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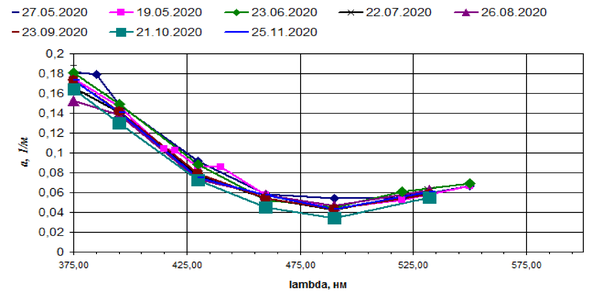
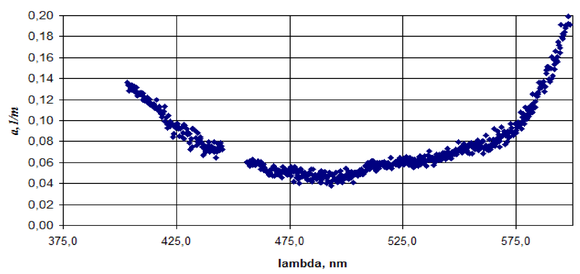


Absorption spectrum 2020, depth 1250m

Data comparison
2020 (BAIKAL5D №1)) and 2021 (BAIKAL5D №2) - the improved version of the device «BAIKAL-5D»



Absorption spectrum 05/05/21, depth 1180m

In 2020, we managed to implement continuous monitoring in situ of absorption and scattering lengths of light with wavelength 375÷532nm within the effective volume of the deep underwater neutrino telescope Baikal-GVD using the «BAIKAL-5D» device without performing maintenance and adjustment procedures for 9 months. The data obtained make it possible to estimate long-term and short-term changes in absorption and scattering. 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».

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