# Prospects of laser retroreflector arrays in GLONASS

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Reflection characteristics of retroreflector systems define energy balance of laser ranging in great degree. GLONASS satellites have one-axis attitude and because of that, taking into account velocity aberration, there is a need to provide ring-shaped distribution of intensity in the far field of reflected light with angular radius of ≈5.3". There are several ways of solving this problem.

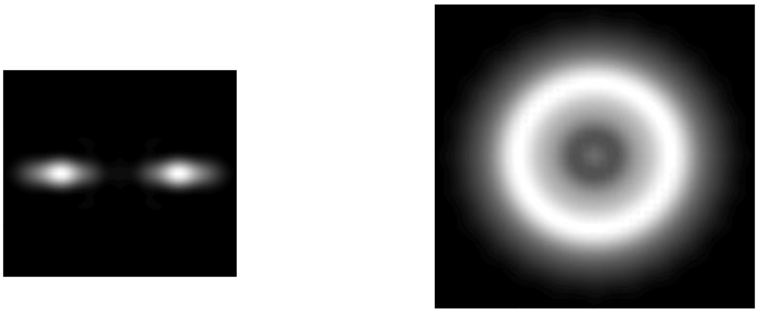
Corner cube reflector (CCR) with uncoated sides, as we know, forms a diffraction pattern of six peripheral spots and one central spot. To form quasi ring-shaped pattern, CCRs are rotated by certain angle relative to each other during assembly of CCR array. As a result, diffraction pattern of retroreflector array is a ring with a bright central maximum containing up to 30% of reflected light energy. This part of energy is always lost, due to velocity aberration.

Another way of creating a ring-like pattern, developed in RPC PSI, is to cover sides of a CCR with special interference coating [1] which provides a zero shift of phase of orthogonal components of electric vector in reflection from each side of a CCR (fig. 1). In this case, a ring with optimal angular radius and maximum intensity is formed, allowing to increase an effective reflective area by about 50%.

*a* *b*

**Fig.1 Far field diffraction patterns (FFDP) of reflected light from a single CCR with interference coating (*a*) and from retroreflector array (*b*)**

Disadvantage of both approaches is that CCR array has non-zero “signature”, i.e. it elongates reflected laser pulse with oblique incidence of light. A more perspective way, first of all for navigation satellites, can be in use of CCR with one of dihedral angles changed by a certain angle (2.4" in case of GLONASS), and with metal or special interference coating on its sides. In this case, diffraction pattern looks like two spots at the angular distance of about 11" (fig. 2a). If several CCRs are turned and assembled into an array, the diffraction pattern is shown in fig. 2b; to form a narrow intensity ring one has to use larger size of CCRs.



*a* *b*

**Fig.2. FFDP of reflected light from a single “two-spot” CCR (*a*) and retroreflector array (*b*)**

The retroreflector array can consist of 30 – 36 larger size CCR placed as a ring, the cross-section can reach up to $200 \cdot 10^6$ $m^2$.

As we know, during reflection of a laser pulse from multi-element retroreflector arrays the signal length and its envelope are changed as the signal is a combination of single-electron pulses. In that respect, an advantage of the retroreflector system composed from “two-spot” CCRs, in addition to increased cross-section, is defined by the fact that reflected signal is formed but just few CCRs are located in opposite sides of the ring at a considerable distance from each other. With inclined positions of CCR, this allows to determine retroreflector array’s center more accurately and to reduce uncertainty of measurements reference to the satellite center of gravity.

Thus, new technical and technological solutions in the area of development of retroreflector systems allow a significant increase of the retroreflector array cross-section of navigation satellites without decreasing laser ranging accuracy.

## List of references

1. M.A.Sadovnikov, A.L.Sokolov, V.D. Shargorodskiy. Analysis of the equivalent surface scattering of corner cube reflectors with the faces of different coating// The success of modern electronics. 2009. № 8.
2. M.A.Sadovnikov, A.L.Sokolov. Spatial polarization structure of radiation formed by a retroreflector with nonmetalized faces. Optics and spectroscopy. V. 107. No. 2. P. 201 – 206 (2009)
3. A.L.Sokolov, V.V. Murashkin. Diffraction polarization optical elements with radial symmetry. Optics and spectroscopy. V. 111. No. 6. P. 859 – 865 (2011)