

## Prospective Quantum-Optical Technologies for Satellite Navigation Challenges

**N. N. Kolachevsky**, *Corresponding Member of the Russian Academy of Sciences,  
Dr. Sci (Phys.-Math.), kolachevsky@lebedev.ru*

*P. N. Lebedev Physical Institute of Russian Academy of Sciences, Moscow 119991, Russian Federation*

**K. Yu. Khabarova**, *Cand. Sci (Phys.-Math.), kseniakhabarova@gmail.com*

*P. N. Lebedev Physical Institute of Russian Academy of Sciences, Moscow 119991, Russian Federation*

**I. V. Zalivako**, *zalikes@yandex.ru*

*P. N. Lebedev Physical Institute of Russian Academy of Sciences, Moscow 119991, Russian Federation*

**I. A. Semerikov**, *ilia179@mail.ru*

*P. N. Lebedev Physical Institute of Russian Academy of Sciences, Moscow 119991, Russian Federation*

**A. S. Borisenko**, *alexander.borisenko@yandex.ru*

*P. N. Lebedev Physical Institute of Russian Academy of Sciences, Moscow 119991, Russian Federation*

**I. V. Sherstov**, *i.sherstov@skoltech.ru*

*Skolkovo Institute of Science and Technology, Moscow 121205, Russian Federation*

**S. N. Bagaev**, *Member of the Russian Academy of Sciences, Dr. Sci (Phys.-Math.), bagayev@laser.nsc.ru  
Institute of Laser Physics, Russian Academy of Sciences, Novosibirsk 630090, Russian Federation*

**A. A. Lugovoy**, *lugovoy@laser.nsc.ru*

*Institute of Laser Physics, Russian Academy of Sciences, Novosibirsk 630090, Russian Federation*

**O.N. Prudnikov**, *Dr. Sci (Phys.-Math.), oleg.nsu@gmail.com*

*Institute of Laser Physics, Russian Academy of Sciences, Novosibirsk 630090, Russian Federation*

**A. V. Taichenachev**, *Corresponding Member of the Russian Academy of Sciences,  
Dr. Sci (Phys.-Math.), taich.alex@gmail.com*

*Institute of Laser Physics, Russian Academy of Sciences, Novosibirsk 630090, Russian Federation*

**S. V. Chepurov**, *Cand. Sci (Phys.-Math.), svc04@ngs.ru*

*Institute of Laser Physics, Russian Academy of Sciences, Novosibirsk 630090, Russian Federation*

**Abstract.** Accuracy of navigation and positioning provided by signals of global navigation satellite systems is largely determined by the frequency standards installed on board of satellites. In recent years, there has been a rapid development of new quantum-optical technologies using compact and frequency-stable laser systems, femtosecond frequency generators, ultracold atoms and ions. Optical methods of information reading and processing provided by atomic system were developed. This resulted in significant reduction of relative frequency instability of ground-based frequency standards down to 18th decimal digit. A number of successful European suborbital launches demonstrated a possibility of application of some of the technologies in the space segment. The paper provides a brief overview of the latest achievements in this field and possibility of its development in Russia.

**Keywords:** laser cooling, ultrastable atoms and ions, ion Paul trap, femtosecond optical frequency synthesizer, stabilized laser, optical clock