



Summary

20 years of experience in planetary science and building space instrumentation. Participated in 6 space missions as part of the principal investigator's team. Lead scientist and grant owner for the FREN-D experiment. Experience in spacecraft operations, rover and orbiters. Lead for ground operations and data processing system. Project management for FREN-D instrument onboard ESA's ExoMars Trace Gas Orbiter (development, testing and integration, flight), ESA's PILOT-D instrument integration onboard LUNA-25 mission (interface control, testing and integration). Software engineer.

Work Experience

Space Research Institute, Moscow

(Leading research facility in Russia for planetary science and development of space instrumentation, 1000+ employees)

2016 – 2022: Senior Scientist

2012 – 2015: Project Leader

2003 – 2012: Software Developer

Education

2010: PhD in Physics and Mathematics

[Joint Institute for Nuclear Research, Dubna](#)

2005 – 2008: PhD course

[Space Research Institute, Moscow](#)

2000 – 2005: Master's in Software Engineering

[Moscow Tech. Uni. for Comm. and Informatics](#)

Projects

- **FREN-D**. Fine Resolution Epithermal Neutron Detector, ESA's ExoMars Trace Gas Orbiter.
- **LUNA-25**. Roscosmos' LUNA-25 mission.
- **PILOT-D**. ESA's camera for LUNA-25.
- **LEND**. Lunar Exploration Neutron Detector, NASA's Lunar Reconnaissance Orbiter.
- **DAN**. Dynamic Albedo of Neutrons, NASA's Curiosity Mars rover.
- **MGNS**. Mercury Gamma-ray and Neutron Spectrometer, ESA's BepiColombo.
- **HEND**. High Energy Neutron Detector, NASA's Mars Odyssey.
- **BTN-M1** and **M2**. Onboard Telescope for Neutrons instruments, the ISS.
- **ADRON-RM**. Passive neutron detector, ESA's ExoMars Rosalind Franklin rover.
- **ADRON-EM**. Active neutron detector, Roscosmos' ExoMars Kazachok lander.
- **ADRON-LR**. Active neutron detector, Roscosmos' LUNA-25.
- **NS-HEND**. Neutron Spectrometer – High Energy Neutron Detector, Roscosmos' Phobos-Grunt.

Skills

Management: MS Office, MS Project, Jira, Trello, Redmine. Team's workflow control. Software and hardware development life cycle. Project planning and execution. Technical and contractual documentation. Contractual work. Problem solving.

Science: data processing, data mining/manipulations, data visualization (graphs, maps, charts). Analysis, correlation, and comparison of different datasets. Achievement of publishable scientific results. Drafting of peer-reviewed paper texts, review process. Conferences abstracts. Peer review of science grants.

Technical: software development with C++/C/C#, Java, Python, IDL. Databases in MSSQL/Postgres/MySQL, software tools for data manipulation. Visualization tools (IDL, GMT). Windows and Linux advanced user and administrator. Website core technologies (JS, PHP, HTML, CSS) for user interfaces. Version control for code in Git, Bitbucket.

Publications

60 papers in peer-reviewed journals. **145 conference abstracts**.



Awards:

- 7 NASA Group Achievement Awards
- 2 ESA Awards
- K. E. Tsiolkovsky medal

Languages:

English – advanced
French – fluent
Russian – native

Personal Characteristics:

Result oriented · decision making · accountability · leadership without authority · quick learner · build and manage interpersonal relations · flexibility to adapt to change and cultural realities · confidence and commitment · pro-active · can-do attitude · open minded · trustworthy

Media appearances:

[ESA.int](#) · [Vesti24](#) · [Nauka TV](#) · [RTVI](#) · [NTV](#) and [many more](#).

Achievements

Project Management

- Lead development, testing and integration of the [FREND](#) instrument for ESA's TGO: workflow organization, spacecraft interfaces (mechanical, electrical, thermal, EMC) control, quality assurance, testing and validation planning and execution, physical calibration campaigns execution, contractual work.
- Delivered support for ESA's [PILOT-D](#) instrument integration onboard Roscosmos' LUNA-25 lander. Supervised and verified interface control documentation to match spacecraft requirements, point of contact for ESA and the Russian industry, supported ESA's testing campaign (control of test procedures and test reports), administered integration and testing onboard the spacecraft in Russia.

Scientific Research

- Leading scientist for the [FREND](#) experiment.
- Conducted scientific data analysis to achieve publishable scientific results. Possess data visualization skills (data preparation, graphing, mapping). Put together scientific paper texts and handled journal peer review. Reported research results in scientific conferences with oral abstracts, public outreach events, lectures etc. Interfaced with the mission's international science team.
- Won, conducted, and concluded a Russian Science Foundation [grant](#) for research on [FREND](#) data.
- Provided science data archiving (to [NASA's PDS](#) and [ESA's PSA](#)), both on the science side (definition of data products and algorithms) and on the technical side (data retrieval/ingestion software).
- Profound knowledge of the Interactive Data Language ([IDL](#)), Generic Mapping Tools ([GMT](#)), [SPICE](#) library.
- Delivered peer reviews for scientific grants proposals and reports for the [Russian Science Foundation](#) and the [Federal Research Centre for Projects Evaluation and Consulting Services](#).

Technical Lead

- Supervised architecture and development of the [LUNA-25](#) science ground segment, a software system handling operations planning, sequencing, and real-time data processing. This system provides user interface to build and verify operational plans, considers operational constraints, ingests instrument sequences, and exports it to a format required by the spacecraft. Backend provides plans and sequences storage, mechanisms for validation and export, incoming data processing, distribution and quick visualization tools.
- Built technical requirements for the system and maintained traceability matrix. Drafted interface documentation to manage interaction with external spacecraft systems.
- Responsible for developer team workflow management, tasks review, testing/validation of the system.

Spacecraft Operations

- Conducted ground and flight operations of [HEND](#), [BTN-M1](#), [LEND](#), [DAN](#), [MGNS](#), [FREND](#) instruments.
- Developed, validated, and tested instruments' command sequences during scientific operations planning.
- Performed daily flight data receipt and technical analysis to monitor instruments' health and performance.
- Representative of [DAN](#) instrument in NASA's MSL ([Curiosity rover](#)) for daily operations together with the MSL science team: planning, sequencing, validation, data receipt and analysis.
- Technically led Roscosmos' [LUNA-25](#) science instruments operations: provided scientific and technical operational planning, interaction with instrument teams, development, testing and validation of complex ground and flight sequences. Created fault detection, isolation and recovery algorithms, onboard data management rules.

Software Development

- Delivered software for ground support equipment (GSE) in [BTN-M1](#) and [M2](#), [LEND](#), [DAN](#), [FREND](#), [MGNS](#) projects (embedded Linux environments). This software operates within a custom-built hardware, including low-level interactions with it. GSE mimics power and data interfaces of a spacecraft for the instrument, allowing control and data acquisition, and is used during development and testing phases.
- Created an architecture and implemented scientific databases for storage and handling of [BTN-M1](#), [LEND](#), [DAN](#), [FREND](#), [MGNS](#) data (MSSQL, Postgres, MySQL). These databases store low- and high-level data of the instruments, and some auxiliary data. Database architecture and user tools were designed to support full life cycle of instruments, starting from development and testing stage, and up to flight data handling. User tools allow ingestion of raw and auxiliary data into the database, its querying according to user's demands.
- Created data visualization software for [BTN-M1](#), [LEND](#), [DAN](#), [FREND](#), [MGNS](#) instruments for Windows environment, with files or database as inputs. The software performs low-level processing of the instrument data and provides visualization for quick-look analysis of the instrument's health and performance.

Scientific Interests

My main interest is in planetary science, specializing in remote sensing for hydrogen/water content in the upper regolith layer of a celestial body's by means of neutron flux measurements. I did most of the research on the hydrology of Mars and the Earth's Moon based on data from orbital and rover instruments. My expertise lies in creation of methods and models for neutron data processing and deconvolution, data mapping, regional analysis, cross-dataset correlation methods.

Major Papers

1. **A. V. Malakhov**, I. G. Mitrofanov, D. V. Golovin, M. L. Litvak, A. B. Sanin et. al. *High Resolution Map of Water in the Martian Regolith Observed by FREND Neutron Telescope Onboard ExoMars TGO*. [JGR Planets \(2022\)](#).
2. I. Mitrofanov, **A. Malakhov**, D. Golovin, M. Litvak, A. Sanin, H. Svedhem, L. Zelenyi et. al. *The evidence for unusually high hydrogen abundances in the central part of Valles Marineris on Mars*. [Icarus \(2022\)](#).
3. **A. V. Malakhov**, I. G. Mitrofanov, M. L. Litvak, A. B. Sanin, D. V. Golovin, M. V. Djachkova, S. Yu. Nikiforov, A. A. Anikin, D. I. Lisov, N. V. Lukyanov, M. I. Mokrousov, V. N. Shvetsov & G. N. Timoshenko. *Physical Calibrations of the FREND Instrument Installed Onboard TGO Martian Orbiter*. [Cosmic Research \(2022\)](#).
4. **A. V. Malakhov**, I. G. Mitrofanov, M. L. Litvak, A. B. Sanin, et. al. *Ice Permafrost "Oases" Close to Martian Equator: Planet Neutron Mapping Based on Data of FREND Instrument Onboard TGO Orbiter of Russian-European ExoMars Mission*. [Astronomy Letters \(2020\)](#).
5. I.G. Mitrofanov, A.B. Sanin, **A.V. Malakhov**, et. al. *Numerical modeling of mapping of Martian epithermal neutron emission: Applications to FREND investigation onboard ESA's Trace Gas Orbiter*. [NIMPA \(2022\)](#).
6. I. Mitrofanov, **A. Malakhov**, D. Golovin, A. Kozyrev, M. Litvak, M. Mokrousov, A. Sanin, V. Tretyakov,, L. M. Zelenyi, J. Semkova, T. Dachev, V. Shvetsov, G. Timoshenko, T. Tomilina, et. al. *Fine Resolution Epithermal Neutron Detector (FREND) Onboard the ExoMars Trace Gas Orbiter*. [Space Science Reviews \(2018\)](#).
7. I. G. Mitrofanov, A. B. Sanin, W. V. Boynton. G. Chin, J. B. Garvin, L. G. Evans, K. Harshman, M. L. Litvak, **A. V. Malakhov**, E. Mazarico, T. McClanahan, M. Mokrousov, G. A. Neumann, R. Sagdeev, V. Shevchenko, V. Shvetsov, D. E. Smith, R. Starr, V. I. Tretyakov, J. Trombka, D. Usikov, M. T. Zuber et. al. *Hydrogen Mapping of the Lunar South Pole Using the LRO Neutron Detector Experiment LEND*. [Science \(2010\)](#).
8. M. L. Litvak, I. G. Mitrofanov, A. Sanin, **A. Malakhov**, W. V. Boynton, G. Chin, G. Droege, L. G. Evans, J. Garvin, K. Harshman, T. P. McClanahan, M. I. Mokrousov, E. Mazarico, G. Neumann, R. Sagdeev, D. E. Smith, R. Starr, M. T. Zuber, et. al. *Global maps of lunar neutron fluxes from the LEND instrument*. [JGR Planets \(2012\)](#).
9. I.G. Mitrofanov, A.S. Kozyrev, A. Konovalov, M.L. Litvak, **A.V. Malakhov**, M.I. Mokrousov, A.B. Sanin, V.I. Tretyakov, Yu.I. Bobrovnikskij, T.M. Tomilina, A. Owens et. al. *The Mercury Gamma and Neutron Spectrometer (MGNS) on board the Planetary Orbiter of the BepiColombo mission*. [Planetary and Space Science \(2010\)](#).
10. C.G. Tate, J. Moersch, I. Mitrofanov, M. Litvak, P. Bellutta, W.V. Boynton, N. Cagle, B. Ehresmann, D. Golovin, C. Hardgrove, K. Harshman, D.M. Hassler, I. Jun, A.S. Kozyrev, D. Lisov, **A. Malakhov**, M. Mischna, S. Nikiforov, A.B. Sanin, R. Starr, A. Vostrukhin, C. Zeitlin et. al. *Mars Science Laboratory Dynamic Albedo of Neutrons passive mode data and results from sols 753 to 1292: Pahrump Hills to Naukluft Plateau*. [Icarus \(2019\)](#).
11. M.L. Litvak, I.G. Mitrofanov, Yu. N. Barmakov, A. Behar, A. Bitulev, Yu. Bobrovniksky, E.P. Bogolubov, W.V. Boynton, S.I. Bragin, S. Churin, A. Konovalov, A.S. Kozyrev, I.G. Kurdumov, A. Krylov, Yu.P. Kuznetsov, **A.V. Malakhov**, M.I. Mokrousov, A.B. Sanin, V.N. Shvetsov, G.A. Smirnov, G.N. Timoshenko, T.M. Tomilina, D.V. Tuvakin, V.I. Tretyakov, V.S. Troshin, A. Vostrukhin et. al. *The Dynamic Albedo of Neutrons (DAN) Experiment for NASA's 2009 Mars Science Laboratory*. [Astrobiology \(2008\)](#).
12. I.G. Mitrofanov, A.B. Sanin, D.V. Golovin, M.L. Litvak, A.S. Kozyrev, **A.V. Malakhov**, M.I. Mokrousov, V.I. Tretyakov, V.S. Troshin, V.V. Shevchenko, V.N. Shvetsov, A.R. Krylov, G.N. Timoshenko, Y.I. Bobrovniksky, T.M. Tomilina, R.Z. Sagdeev, G.N. Milikh, A. Bartels, G. Chin, S. Floyd, J. Garvin, J. Keller, T. McClanahan, J. Trombka, W. Boynton, K. Harshman, R. Starr, L. Evans et. al. *Experiment LEND of the NASA Lunar Reconnaissance Orbiter for High-Resolution Mapping of Neutron Emission of the Moon*. [Astrobiology \(2008\)](#).
13. M. L. Litvak, I. G. Mitrofanov, D. V. Golovin, A. S. Kozyrev, **A. V. Malakhov**, M. I. Mokrousov, A. B. Sanin, V. I. Tretyakov et. al. *Monitoring of the time and spatial distribution of neutron-flux spectral density outside the Russian segment of the International Space Station based on data from the BTN-Neutron space experiment*. [Cosmic Research \(2017\)](#).
14. I. Mitrofanov, M. Litvak, V. Tretyakov, M. Mokrousov, **A. Malakhov**, A. Vostrukhin. *Neutron components of radiation environment in the near-Earth and near-Mars space*. [Planetary and Space Research \(2009\)](#).

Full Publication Lists



astrophysics
data system

60 papers in peer-reviewed journals
145 conference abstracts

Media Appearances

10.11.2022	Znanie Russia	Lecture on the neutron detectors for exploration of Mars
22.04.2022	Pravda.ru	Commentary on the Russian Lunar programme
14.04.2022	Zaryadye Park	Lecture on the FREND instrument results
15.12.2021	ESA.int	FREND's discovery of possible water ice in Valles Marineris
22.09.2021	YouTube	Educational video on neutron detectors for planetary science
20.02.2021	Vesti24	Commentary on the Perseverance rover landing
19.02.2021	M24	Commentary on the Perseverance rover landing
19.02.2021	M24	Second commentary on the Perseverance rover landing
25.07.2021	Nauka TV	Question of Science: Man on Mars
06.10.2020	Saint-Petersburg	Commentary on the exploration of Mars
04.10.2019	YouTube	Lecture on the search for water on Mars at IKI
30.11.2018	TVC	Commentary on the BepiColombo mission
20.11.2018	RTVI	Commentary on the Russian Lunar programme
19.10.2016	NTV	Commentary on the ExoMars' Schiaparelli landing
19.10.2016	Zvezda	Commentary on the ExoMars' TGO instruments
12.04.2016	Pravda.ru	Interview on the ExoMars mission
16.03.2016	Roscosmos TV	Short film on the ExoMars programme
01.12.2015	YouTube	Lecture in the Cosmonautics Museum on the ExoMars mission
27.09.2015	Roscosmos TV	FREND experiment description
21.01.2015	Roscosmos TV	Commentary on the FREND experiment
10.08.2014	Vesti24	Commentary on the HEND and FREND experiments

Awards

- 2010 – NASA Group Achievement Award to the Lunar Reconnaissance Orbiter Team
- 2011 – NASA Group Achievement Award to LRO Mission Operations Team
- 2011 – NASA Group Achievement Award to the Lunar Reconnaissance Orbiter Exploration
- 2013 – NASA Group Achievement Award to MSL DAN Instrument Development and Science Team
- 2013 – NASA Exceptional Achievement Award to the LRO Science Mission Team
- 2015 – NASA Group Achievement Award to MSL Prime Mission Science and Operations Team
- 2016 – ESA Award in recognition of outstanding contribution to the ExoMars 2016 mission
- 2016 – K. E. Tsiolkovsky Medal of Russian Federation of Cosmonautics
- 2017 – NASA Group Achievement Award to MSL Extended Mission-1 Science and Operations Team
- 2018 – ESA Award in recognition of outstanding contribution made to the BepiColombo mission
- 2019 – Star City Administration Award for participation in "Gagarin's Lesson" event