THE MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION
MOSCOW STATE UNIVERSITY OF GEODESY AND CARTOGRAPHY (MIIGAIK)

MIIGAIK Extraterrestrial Laboratory

Geodesy and Cartography Support for Russian Planetary Missions:

The Moscow State University for Geodesy and Cartography (MIIGAiK)

J. Oberst [1)], V. Malinnikov, K. Shingareva, and the MExLab Team

1) Contact information:
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Juergen.Oberst@dlr.de

MIIGAiK = Moscow State University of Geodesy and Cartography

- 235 Years of History
- > 8500 Students
- > 600 Teaching Staff

The „Mega-Grant“

- Grant Competition Announcement („First Wave“): July 2010
- > 500 proposals submitted, winners announced: October 2010
- Joint proposal by Jürgen Oberst / MIIGAiK was selected, „Geodesy, Cartography, and Future Exploration of Planets and Satellites“

- Official Opening Celebration of Laboratory: September 20, 2011

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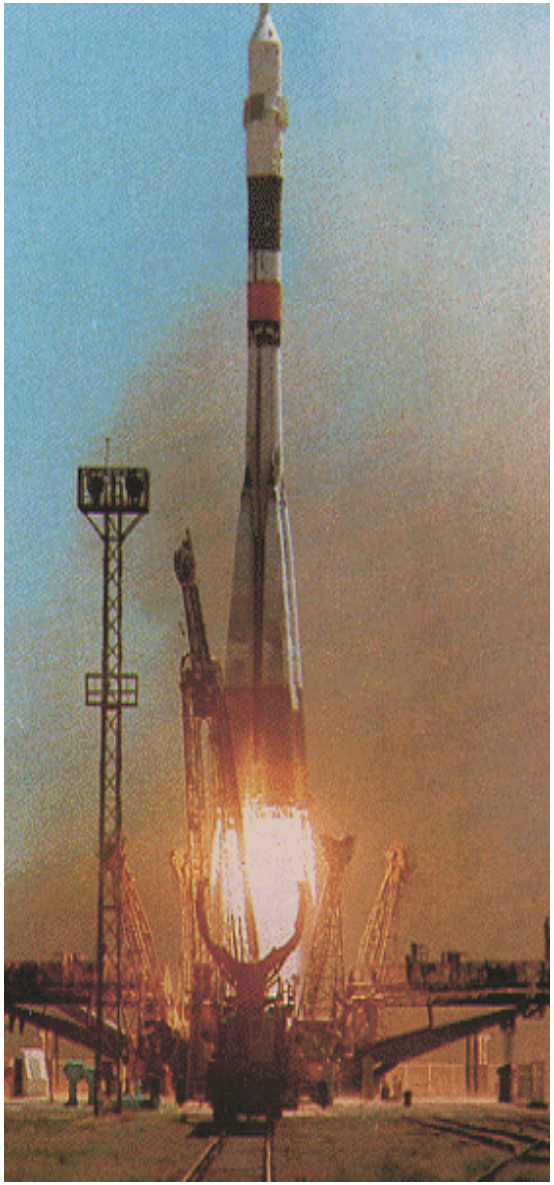
Objectives of the Project

- Develop infrastructure and knowledge for MIIGAiK to take a significant role in planning, execution, and analysis of data from future Russian as well as international planetary missions
- Develop modern work place and job opportunities which will attract young scientists and students to pursue careers in geodesy, cartography, and planetary science
- Train a young work force to support all future Russian space activities



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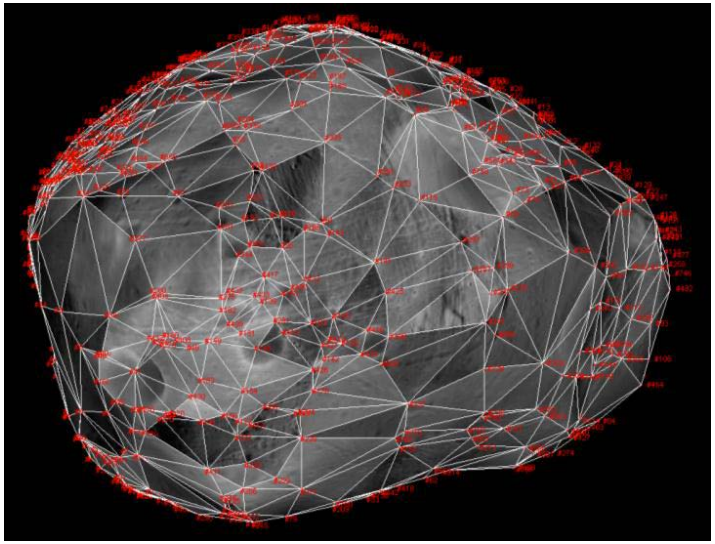
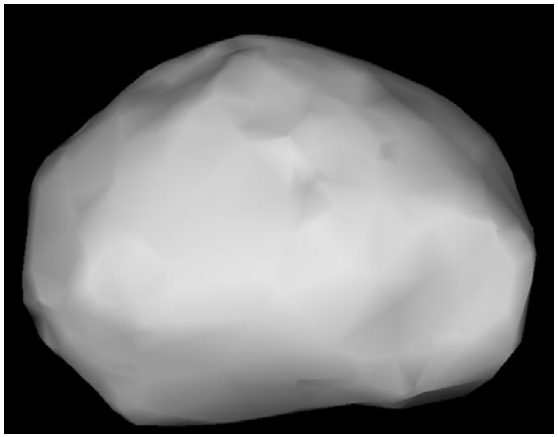
Phobos Size, Shape, and Rotation

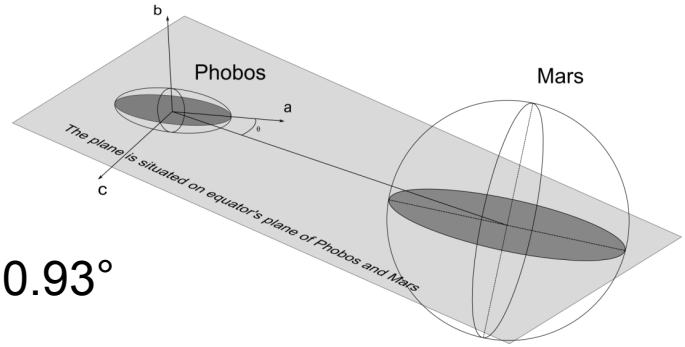
- Developed a new and independent control point network: made more than 20,000 point measurements in > 90 images, computed coordinates of > 800 control points
- New estimate of Phobos size, shape, and topography
- Phobos has ellipsoidal shape and moves in a slightly elliptic orbit close to Mars: forced librations. New estimates of Phobos libration parameters!
- Production of a new Phobos map





13.09 X 11.72 X 9.48 km

Longitudinal forced libration amplitude of Phobos

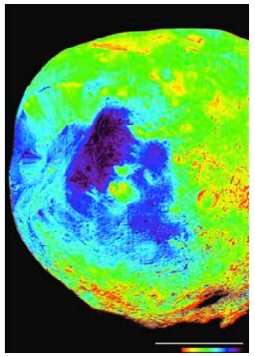


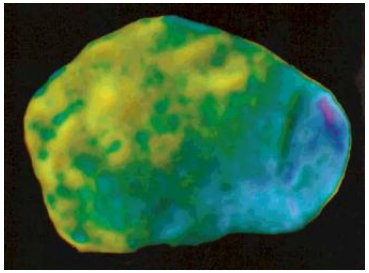
This study 1.09°±0.1°

Prediction from shape: 0.93°

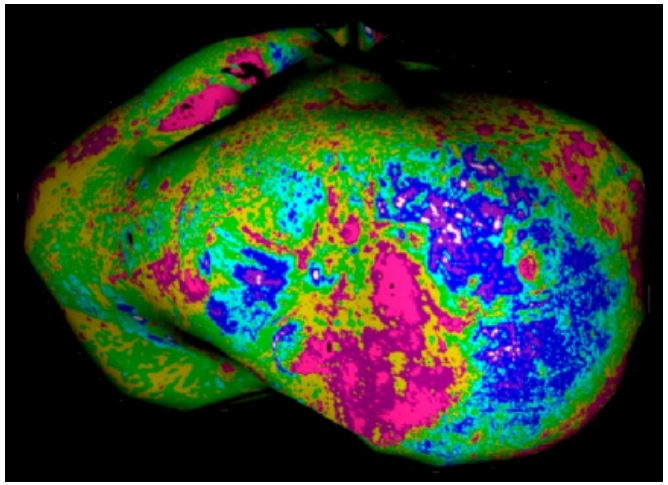
Spectrophotometric Analyses of Phobos Colors

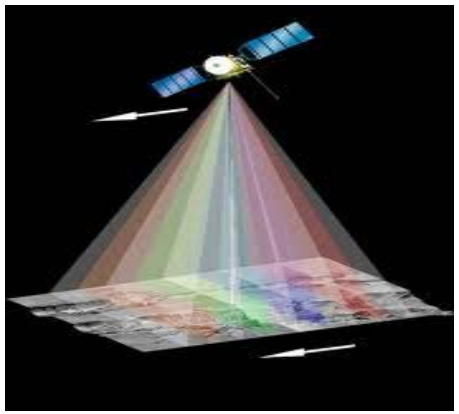
- Mars Express HRSC color images: more color channels and higher resolution than previous data. Cover parts of the Phobos far side
- Co-Registrations of color images; calibrations and photometric corrections
- Production of color ratios and identification of different terrain units





MRO Phobos-2





Mars Express /
MExLab data processing

Spectrophotometric Analyses of Phobos Colors

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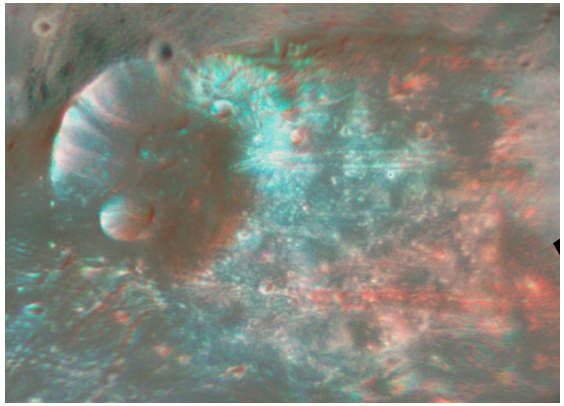
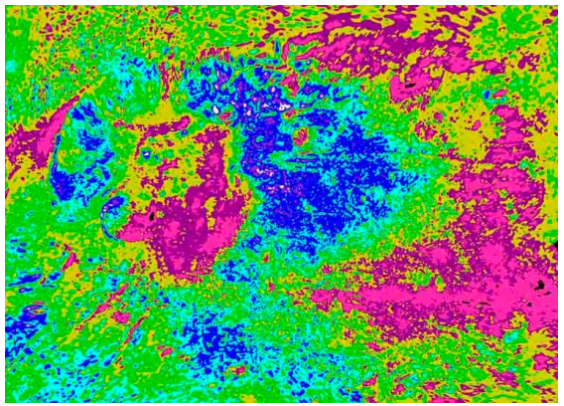
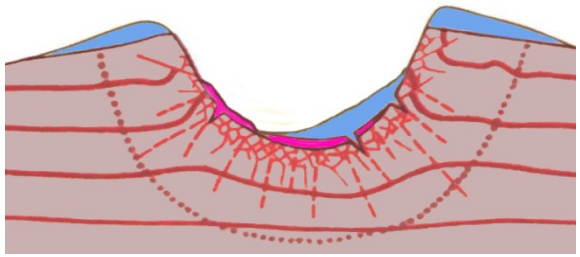
- Co-Registrations of color images; calibrations and photometric corrections
- Production of color ratios and identification of different terrain units
- Area distribution of units, e.g. near crater Stickney; interpretations



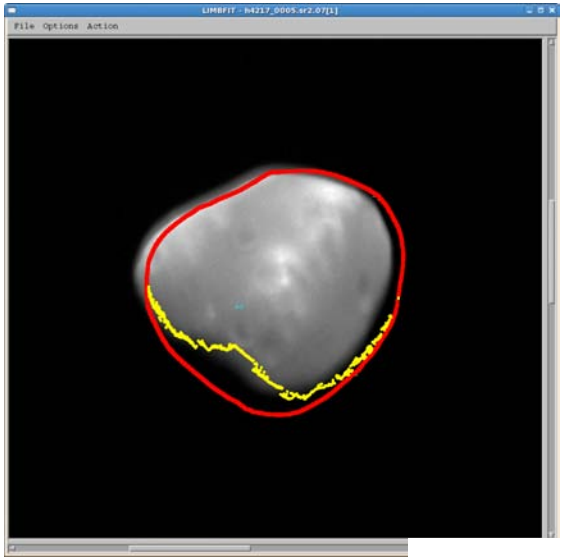




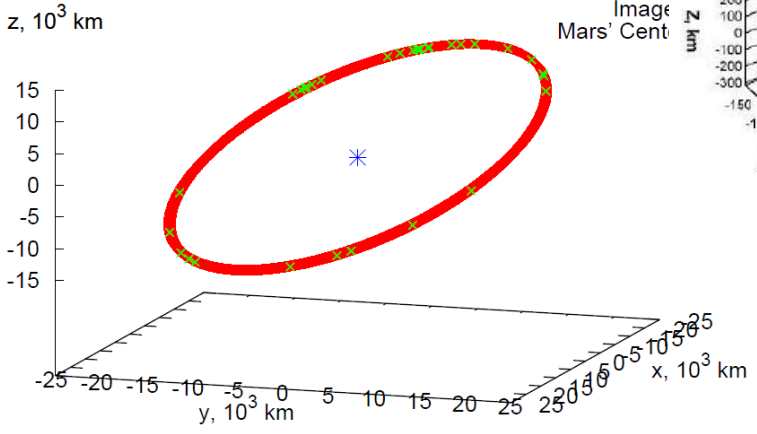
Phobos / Stickney crater

Astrometric Observations and Orbit Modeling

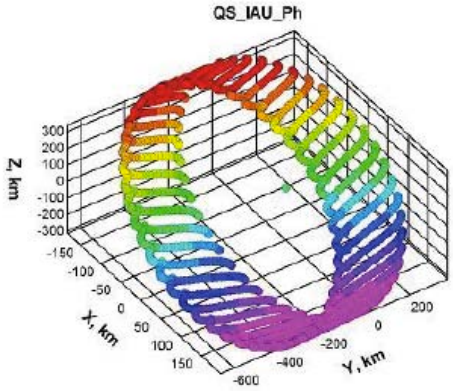
- Astrometric observations and measurements for Phobos and Deimos
- Orbital studies of natural and artificial satellites in complex gravity fields and under perturbations (radiation pressure, etc.)
- Simulation of meteoroid population and impacts on Phobos / Deimos
- Studies of formation and orbital evolution of Phobos dust torus



Deimos position measurement from HRSC image



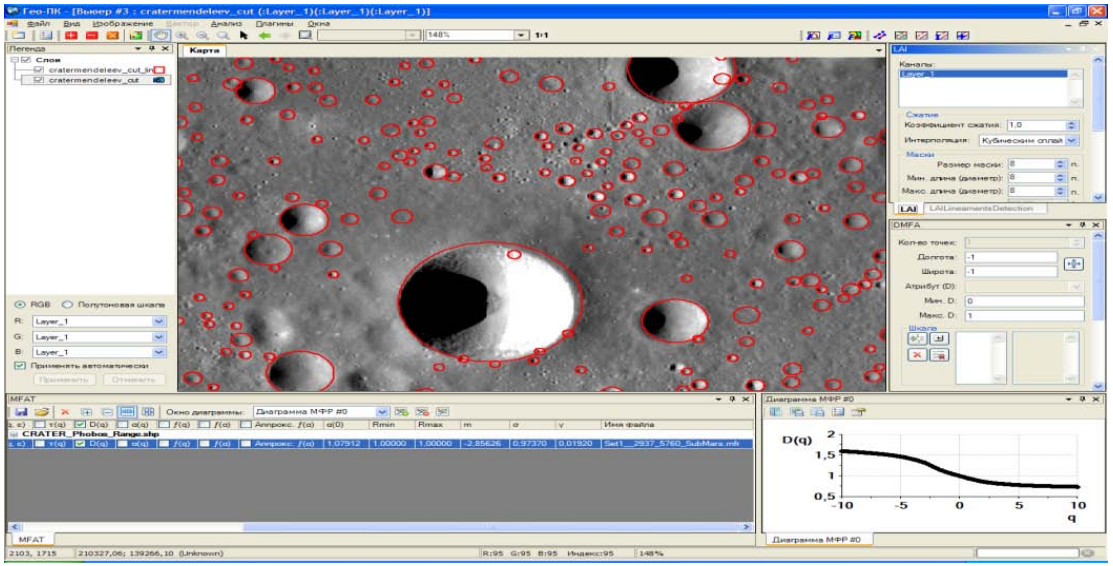
Deimos' orbit

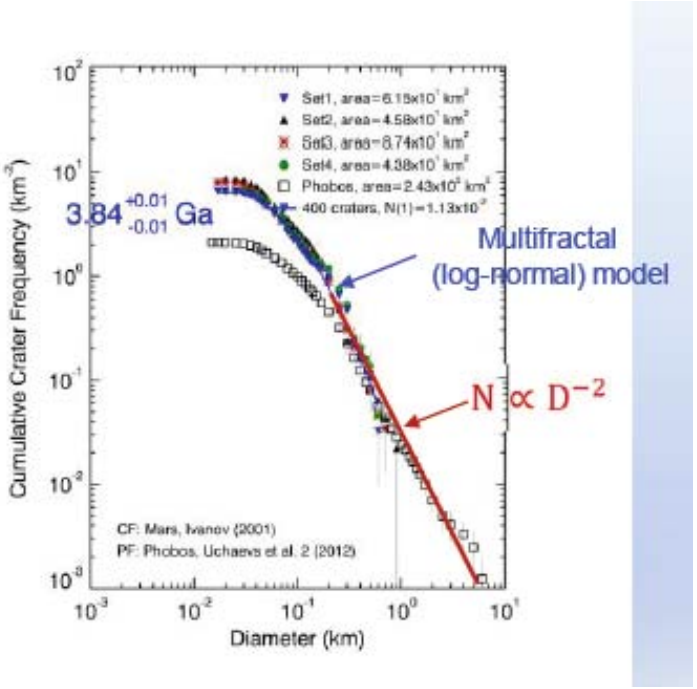


Spacecraft in Phobos quasi-orbit

Crater Statistics

- Developed texture-based crater detection algorithm based on „Circular Hough Transforms“
- Measurements of crater size-frequency distributions
- Surface age estimates using standard functions (Neukum, Ivanov, Hartmann, 2001)

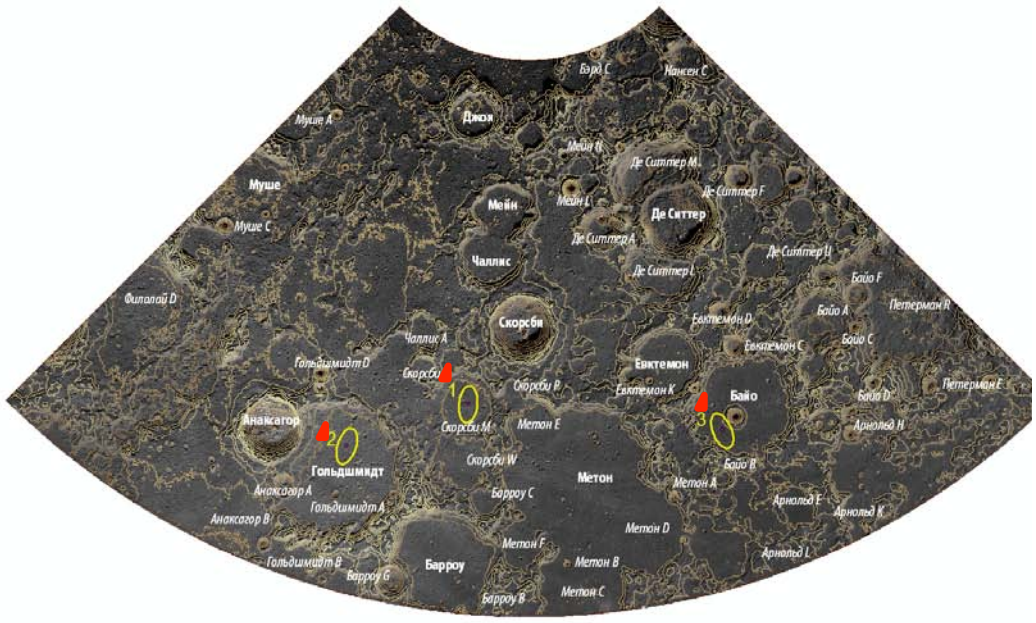




Mapping of Lunar Candidate Landing Sites

- Support upcoming Luna Glob and Luna Resurs missions
- Become familiar with Laser Altimeter and Camera Data from Kaguya and LRO (Lunar Reconnaissance Orbiter)
- Produce large image mosaics and topographic models from stereo images
- Derive various thematic maps (surface roughness, slopes), to assess landing site safety

Luna Resurs / Mitrofanov, 2010



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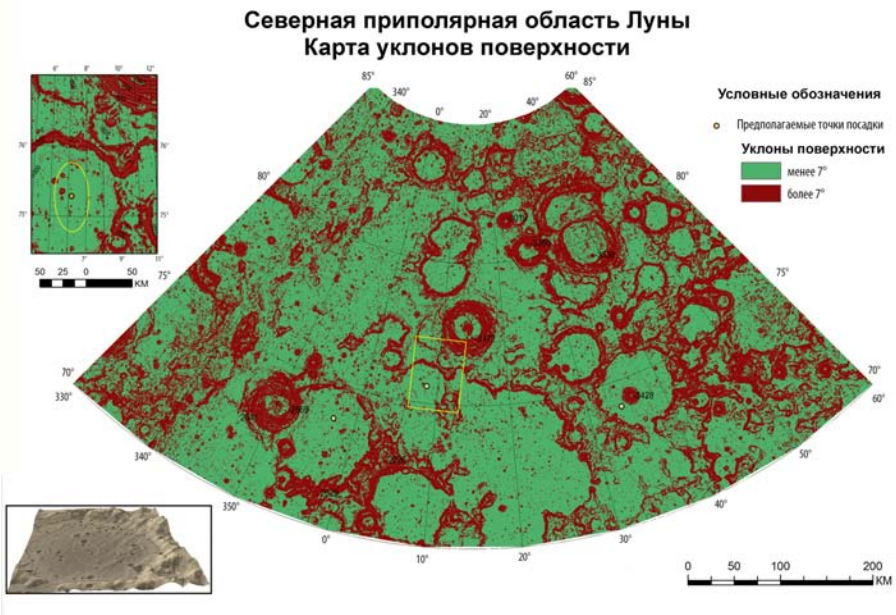
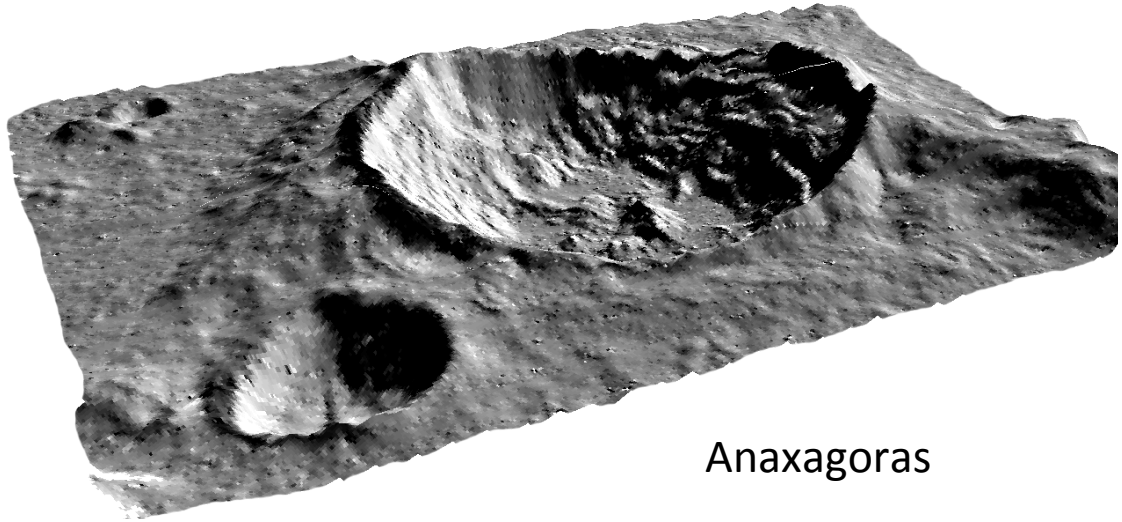
- Study horizon lines and illumination conditions at candidate landing sites

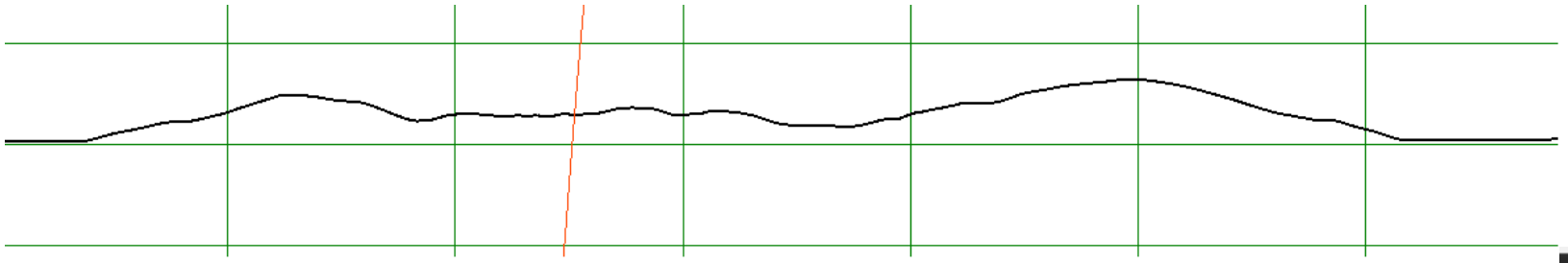




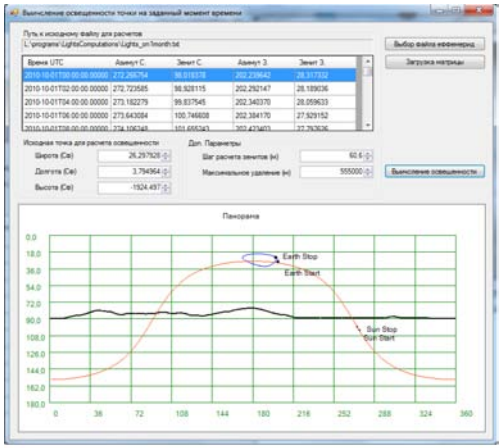
Anaxagoras

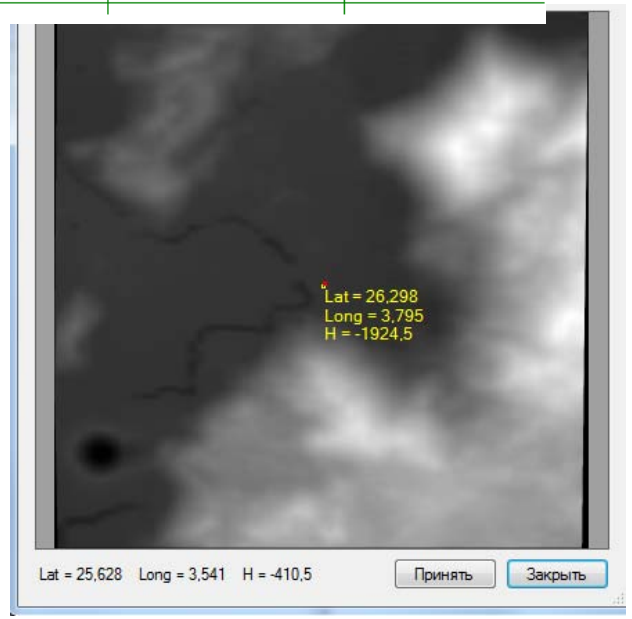
Mapping of Lunar Candidate Landing Sites

Горизонт лунной поверхности,
смоделированный ЭВМ-программой



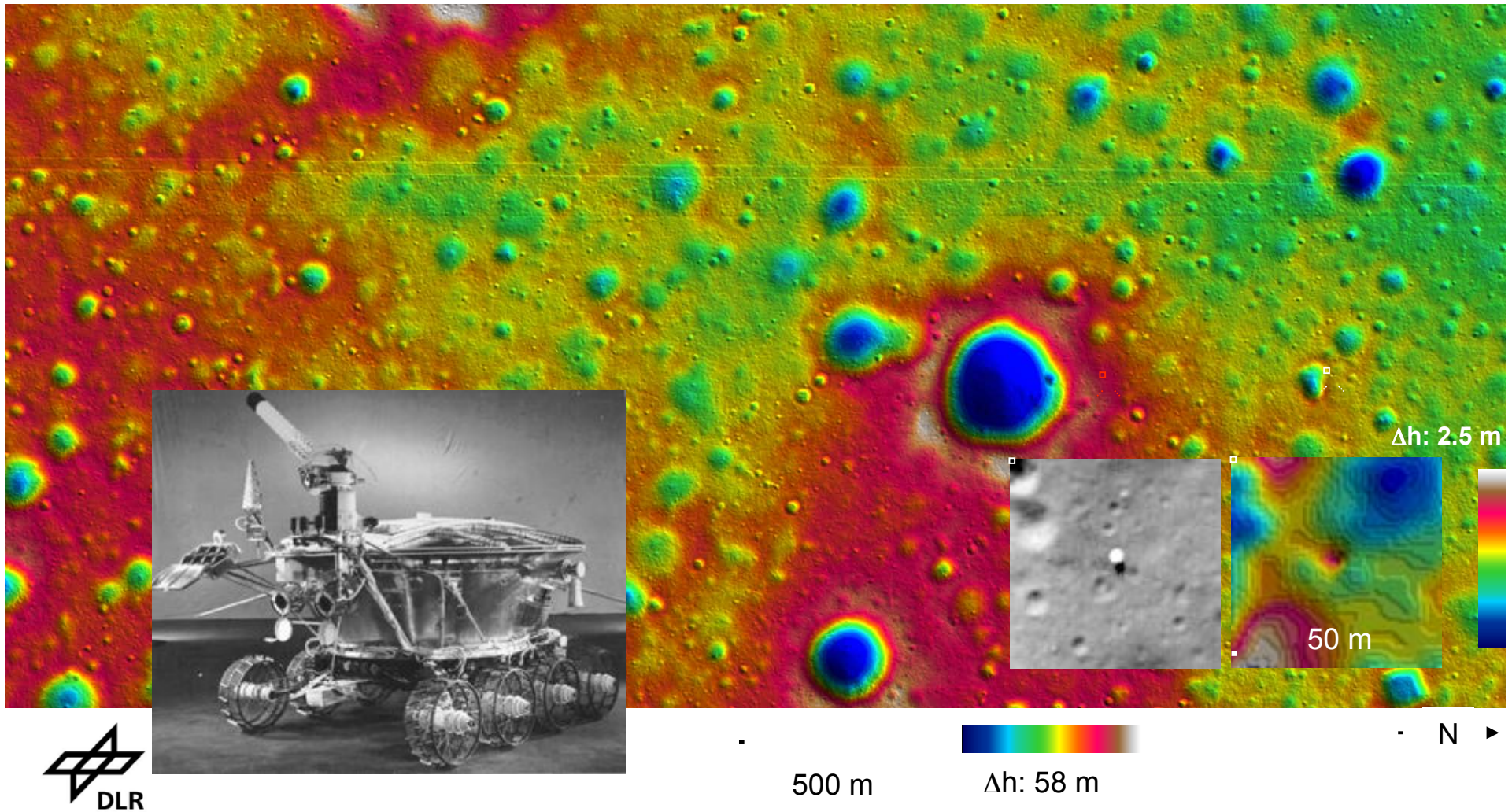
- Model horizon lines on basis of Digital Terrain Models (DTMs) at candidate landing sites
- and study illumination conditions during Lunar day





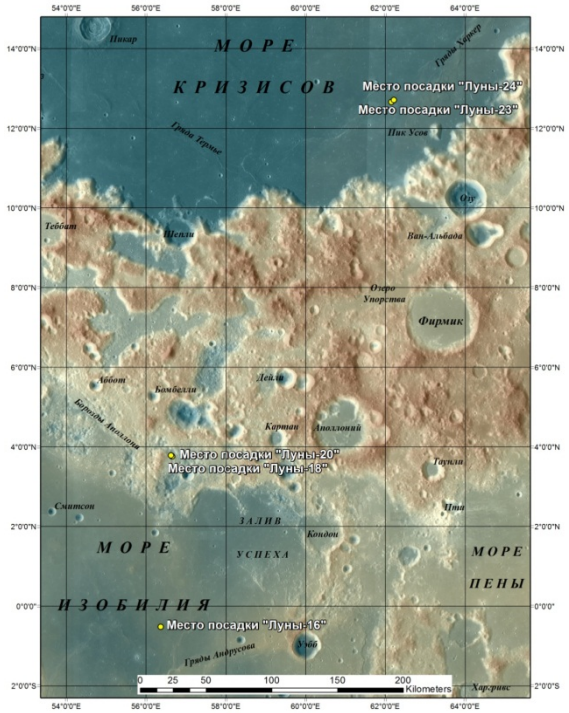
Recovery of Historic USSR Lunar Mission Data

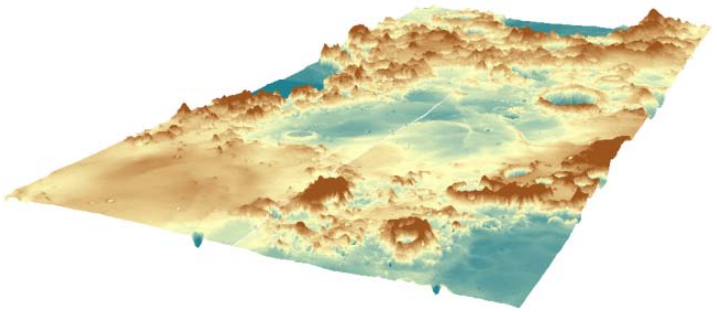
- Computed topographic maps of Lunokhod-1 and -2 activity areas using LRO stereo images; identified and mapped the rover traverses in images

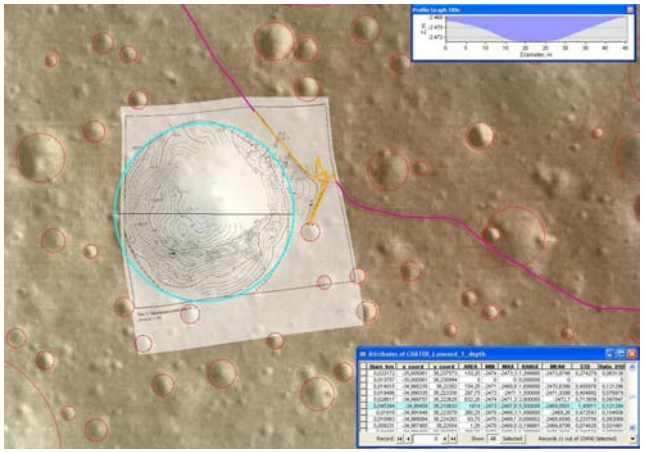


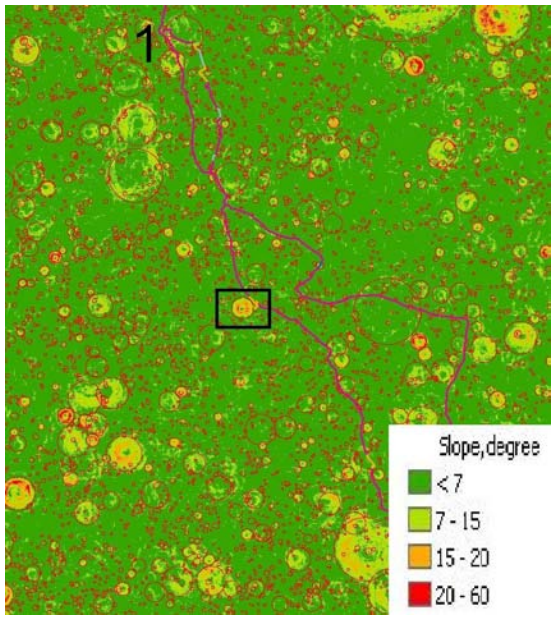
Recovery of Historic USSR Lunar Mission Data

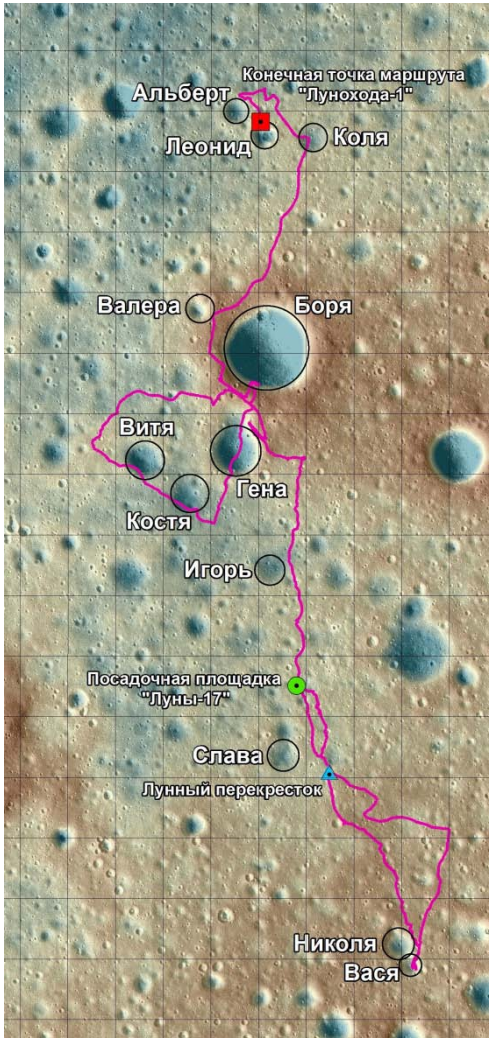
- Identified and mapped the rover traverses in 3-D; produced various thematic maps











Work Structure

Developed group structure with defined levels of work responsibilties:

- Cartography and Mapping (Dr. Irina Karachevtseva)
- Multispectral Image Processing and Mathematical Analysis (Prof. Alexander Grechishev)
- Geodesy and Photogrammetry (Prof. Jürgen Oberst)
- Navigation and Dynamics (Dr. Valery Lupovka)
- Information Systems and Support (Dr. Feodor Shkurov)
- Management (Mikhail Semenov)

Work Structure

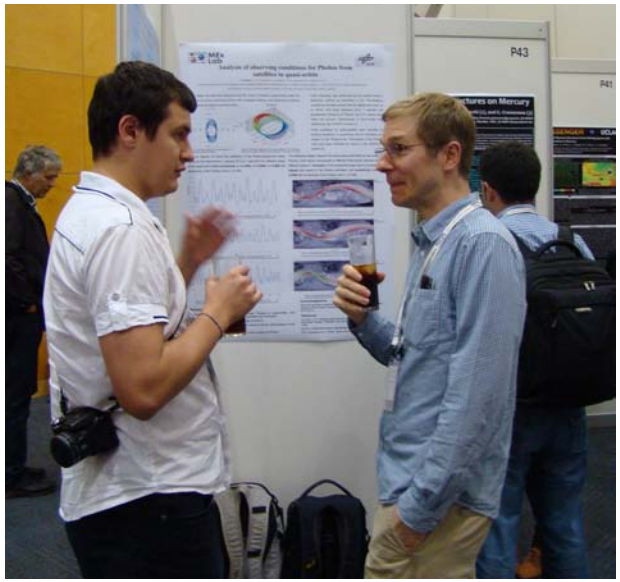
- Education and support for young students at Master level
  - 12 Master theses covering various planetary science topics completed
- Developed student Ph.D. program:
  - well-defined project and thesis work
  - sufficient funding for students to work full-time (no side jobs...)
  - foreign language training and research visits in foreign countries
  - currently: 8 Ph.D. students

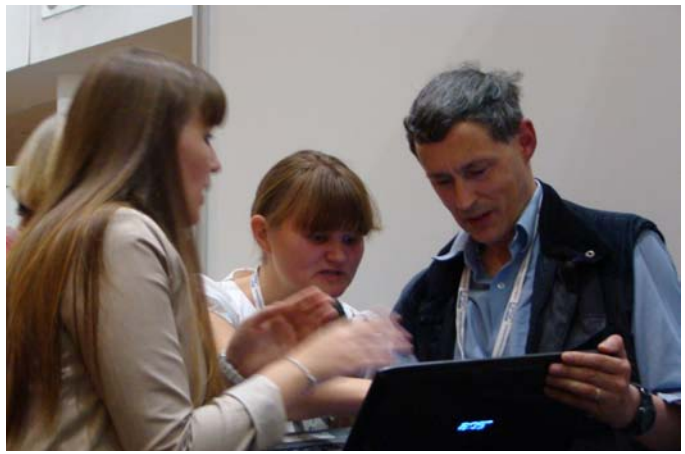
Student Exchanges

- > 30 visits of MIGAiK students in Berlin and vice versa (6-10 days)
- > 5 long-term research visits (2-3 months)

International Networking / Cooperations

- MExLab organized Europlanet- and ISPRS (International Society for Photogrammetry Cartography) workshops
- International Summer School at MIIGAiK, 2012
- Conference contributions (2M-S2, 2M-S3, Astrokazan 2011, LPSC, EGU, EPSC)
- MEXLab scientists involved in ESA Cosmic Vision proposal teams (JUICE, GETEMME, Marco Polo, etc.)
- Joint publications in international journals
- MIIGAiK submitted 12 (!) EPSC abstracts, 2012





isprs
information from imagery

Europlanet Research Infrastructure
A European Research Infrastructure for Planetary Science

Future Plans – Funding from Third Parties

- Helmholtz Joint Research Groups (German-Russian Bilateral Research Project)
- European Union (EU) FP7 funding, one project currently in negotiation phase („PROVIDE“), more proposals being prepared
- Grants, Ministry of Education and Science of the Russian Federation
- RFFI grants
- Work agreements with IKI (Luna Glob – landing site studies)

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ИКИ

RFBR RUSSIAN FOUNDATION FOR BASIC RESEARCH

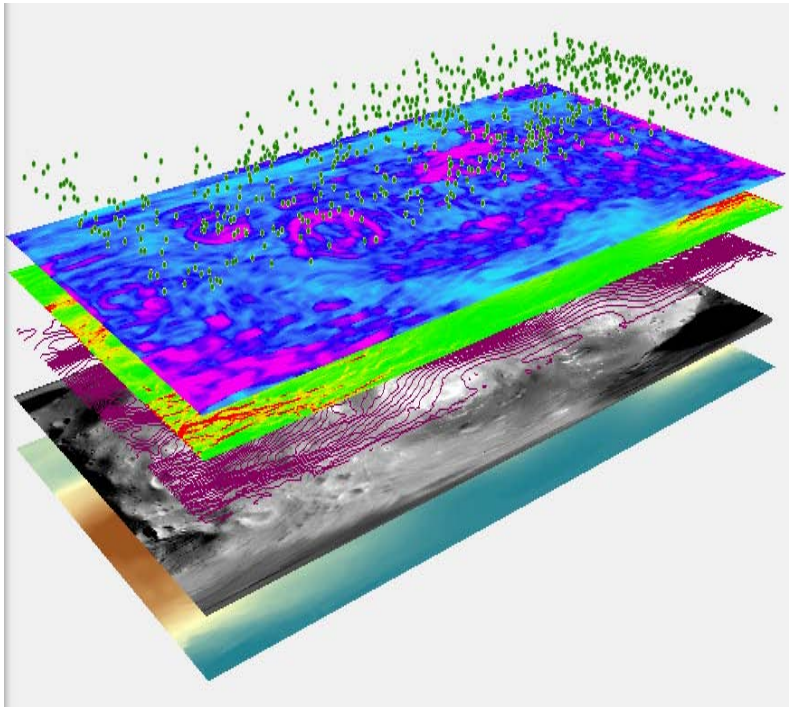
HELMHOLTZ GEMEINSCHAFT

Future Plans

- Develop roving platform, approx. 50 kg
- Modular, can be carried, assembled, and operated by team of 2
- Built-in stereo panoramic camera, navigation system, and computing power
- Tool for experimental software development (terrain reconstruction, autonomous navigation, etc.) and education
- Rover is flexible to carry additional instruments; International cooperations foreseen

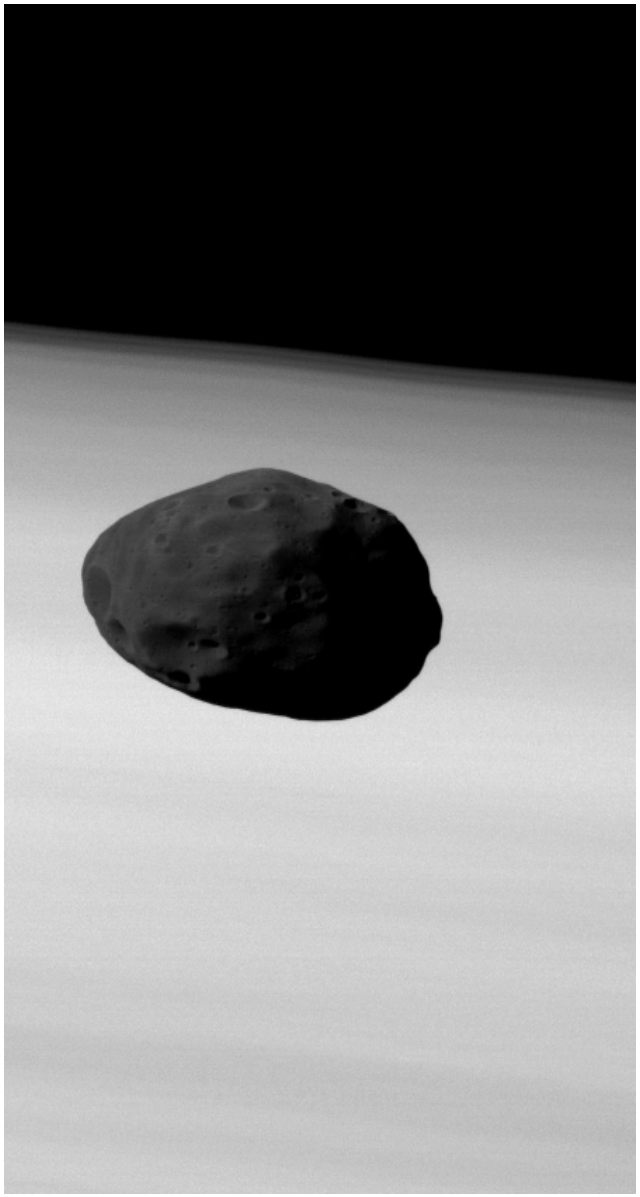
Rover development at MIIGAiK. Work status, last week --

Future Plans



- Continued support and for upcoming Lunar Lander missions !
- Support and preparations for ExoMars
- Geodesy and cartography of Outer Planet Satellites to support cooperations with ESA‘s JUICE mission

Future Plans



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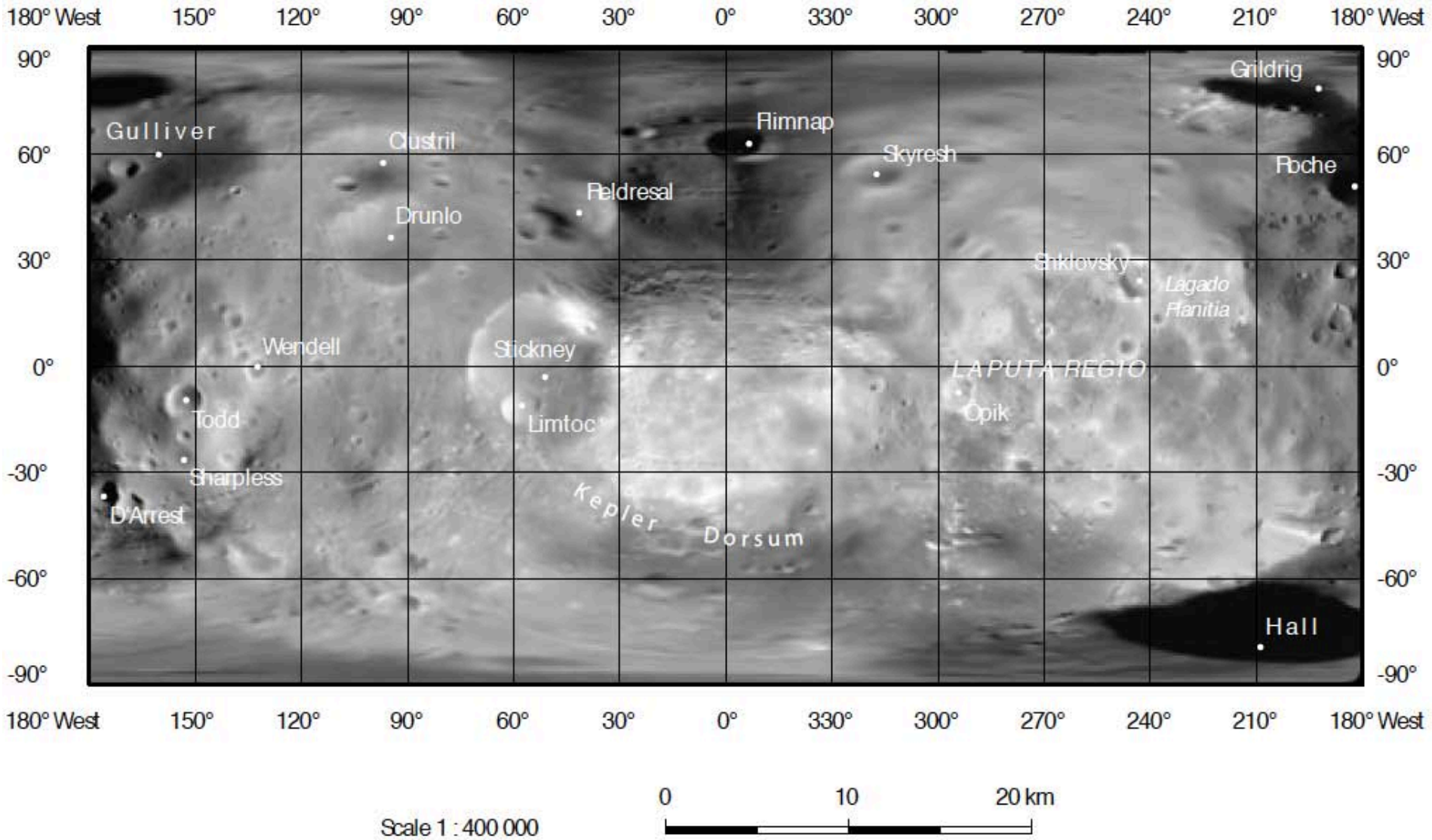
- Support and preparations for ExoMars
- Geodesy and cartography of Outer Planet Satellites to support cooperations with ESA‘s JUICE mission
- Publication of a Phobos Book
  - Signed agreement with Planetary Space Science
  - Guest Editors: J. Oberst, T. Duxbury, A. Zakharov
  - 21 first-authors have committed

Спасибо за внимание!!!



Map in cooperation with DLR, Marita Wählisch