1970 - FIRST LASER RANGING IN CZECHOSLOVAKIA

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Abstract:

The first Czechoslovak laser ranging experiment was conducted on 1970. The setup and main characteristics of used instruments are presented. The conclusions of the experiment and transfer of experiences are mentioned.

Basic info:

Who ?

The authors of the first laser radar: Pavel Navara, Karel Hamal, Tomas Daricek, Antonin Novotny

Based on cooperation of following institutions:

- Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Department of Physical Electronics – laser of laboratory construction, detection package with photomultiplier, measurement time of flight, organization of experiment
- Research Institute of Geodesy, Topography and Cartography, Geodetic Observatory Pecny – SBG camera, their pointing to satellite
- Astronomical Institute of Czechoslovak Academy of Science – ephemerides of satellite, computing time at the Minsk 22 computer

Other collaborating organizations (from Czechoslovakia): Association for Chemical and Metallurgical Production, Usti nad Labem, Monokrystaly Turnov, Preciosa Turnov, Dioptra Turnov, Meopta Prerov, Mechanical workshop of Astronomical Institute CSAV

Where?

National Satellite Station Ondrejov/Skalka, Czech Republic (managed by Research Institute of Geodesy, Topography and Cartography)

When?

August – September 1970

What?

Distances from the station Skalka to the GEOS B geodetic satellite.

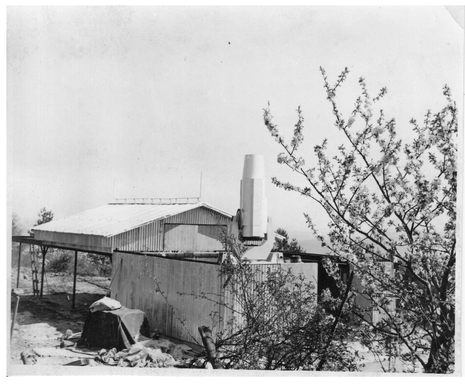


Fig 1: SBG camera during the installation in 1968
(photo made by V. Skoupy)

Mount:

- Satellitenbeobachtungsgerät (SBG) – camera for photographic observations of satellites, producer: Carl Zeiss Jena, Democratic Republic of Germany
- Installed at spring 1968 at National Satellite Station Ondrejov, Skalka, Czechoslovakia (Fig. 1)
- 4-axis mount: first, second and fourth axis manually controlled, third axis controlled by engine – rotation velocity around third axis controlled by previously prepared program for each pass
- initial pointing accuracy 1 deg, better accuracy achieved by small manual corrections performed by observer based on visual satellite monitoring in tracking telescope

Fig 2: SBG camera with laser head and collimator installed, laser power and cooling electronic on the right side

Transmit path:

Laser:

- Ruby laser – laboratory product of Faculty of Nuclear Science and Physical Engineering, Czech Technical University in Prague
- Two ruby rods 150 x 15 mm, both ends cut at Brewster angle, producer Association for Chemical and Metallurgical Production, Czechoslovakia
- Rods of oscillator and amplifier were placed in common focus of double elliptical pumping cavity
- Pumping by two xenon flashlamps
- Optical resonator: prism (R=100%) and BK7 plate (R=10%)
- Q-switching by rotating prism with rotation frequency 200 Hz
- Water cooling
- Simple arrangement, no precise adjustments need
- Connected with collimator on the SBG camera (Fig. 2)

Transmit telescope/collimator

- Galileo telescope with ratio 1:5

Parameters of laser pulse

- Wavelength 694,3 nm
- Length of pulse 18-23 ns
- Beam diameter after collimation 7,5 mm
- Repetition rate 0,08 Hz, period 12 sec (5 pulses per minute)
- Output energy 3-4,5 J
- Divergence at laser output 3 mrad
- Divergence after collimation 0,6-6 mrad

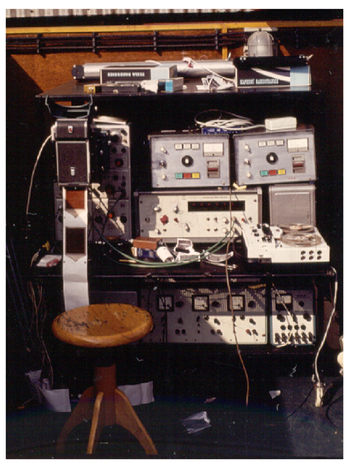


Fig 5: Detection electronic.
In the middle from left to right:
dual-beam oscilloscope
with photographic recording,
time interval counter,
magnetic tape recorder for voice recording

Receiving path:

Receiving telescope

- The SBG camera used
- Schmidt telescope with focal length 760 mm
- Input aperture diameter 420 mm (given by correction plate)
- Planar focal plane / originally used for location of photographic plates

Detection

- Detection package – modified photometer – was placed in focal plane (Fig. 3)
- Spatial filter – diaphragm
- Spectral filter with bandwidth 4 nm and transmission 45% from Meopta Prerov (CZ)
- Photomultiplier EMI 9558B – from EMI electronics, which was also for many years an internationally respected manufacturer of photomultipliers. This part of the business was transferred to Thorn as part of Thorn/EMI, then later became the independent concern Electron Tubes Ltd, now ET Enterprises Limited.

Measurement time of flight (Fig. 4)

- Time interval counter Tesla BM455E (Czechoslovakia) with accuracy 1 µsec – it limited precision of results
- Dual beam oscilloscope
- Laser firing pulse starts the dual beam oscilloscope and also the time interval counter.
- Received pulse from photomultiplier stops the time interval counter and it draw second beam at oscilloscope.
- Time of laser firing was determined manually (by recording of voice on magnetic tape) (Fig. 5)

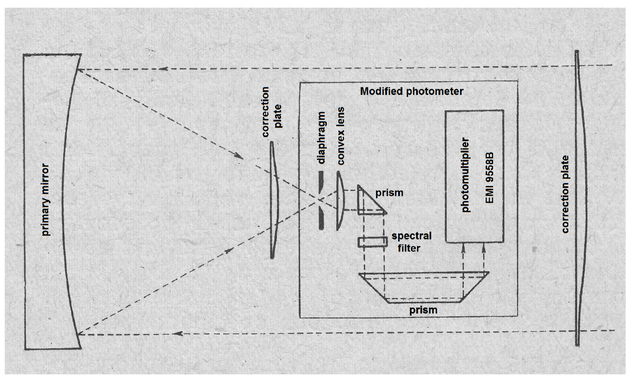


Fig 3: Scheme of detection package - modified photometer - installed in focal plane of SBG camera (from [3])

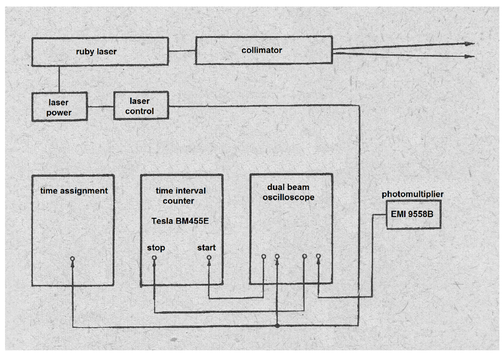
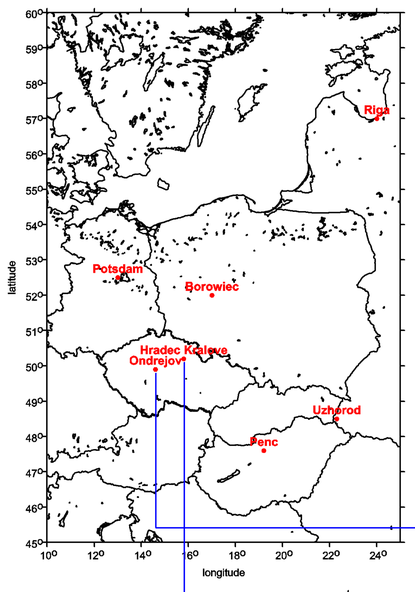


Fig 4: Signal scheme of experiment (from [3])

Conclusions from the experiment:

- Laser ranging experiment in Czechoslovakia was fourth in the world (after USA [5], France [6] and Japan [7])
- Distance to GEOS B satellite was measured – with precision 350 m (limited by time interval counter accuracy)
- Experiences with laser generator in the field condition was obtained
- Spectral filter meet needs for this application
- Tests with detection of clouds were used later for LIDAR construction
- Information about hazard of pulse laser beam at 5 km distance

Fig 7: SLR station at Hradec Kralove. 4-axis mount,
ruby laser (right),
receiving telescope (middle) with 45 cm aperture
(photo made by F. Hovorka)



The experiment gave fundaments for next steps:

The results from this first experiment were base for development of satellite laser radars in the Czechoslovakia – in the frame of INTERCOSMOS project.
The obtained experiences were used for building some parts for the SLR stations in the world for next 20 years:
Ondrejov, Czechoslovakia (now Czech Republic) (Fig. 6)
Hradec Kralove, Czechoslovakia (now Czech Republic) (Fig. 7)
Riga, Soviet Union (now Latvia)
Helwan, Egypt (Fig. 8 and 9)
Borowiec, Poland
Zvenigorod, Soviet Union (now Russia Federation)
Potsdam, Germany
Uzhorod, Soviet Union (now Ukraine)
Katzively, Crimea, Soviet Union (now Ukraine/Russia Federation)
Penc, Hungary
La Paz, Bolivia
Kavalur, India
Santiago de Cuba, Cuba (Fig. 10)
Quito, Ecuador
Nha Trang, Vietnam

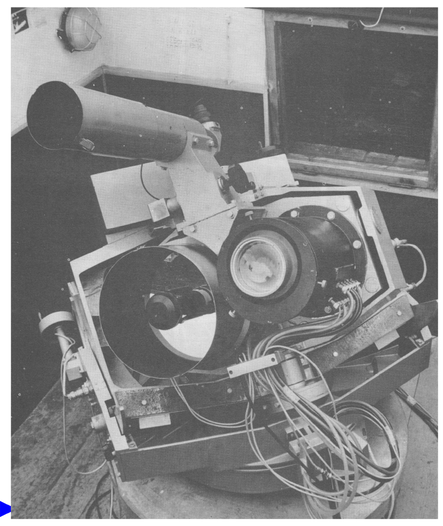
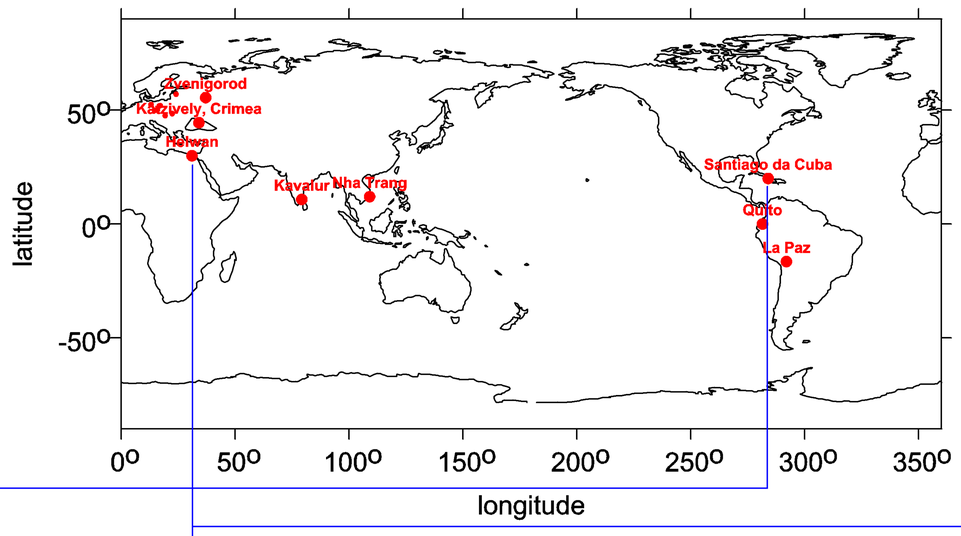


Fig 6: SLR station at Ondrejov (from 1972).
4-axis mount from University in Riga, ruby laser (right),
receiving telescope (left) with 32 cm aperture (from [8])



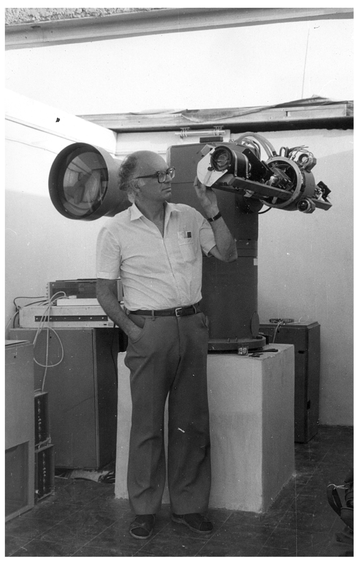


Fig 8: SLR station at Helwan on the beginning - with K. Hamal.
Alt-Azimuth mount, ruby laser head opened (right),
receiving telescope (left) with 40 cm aperture

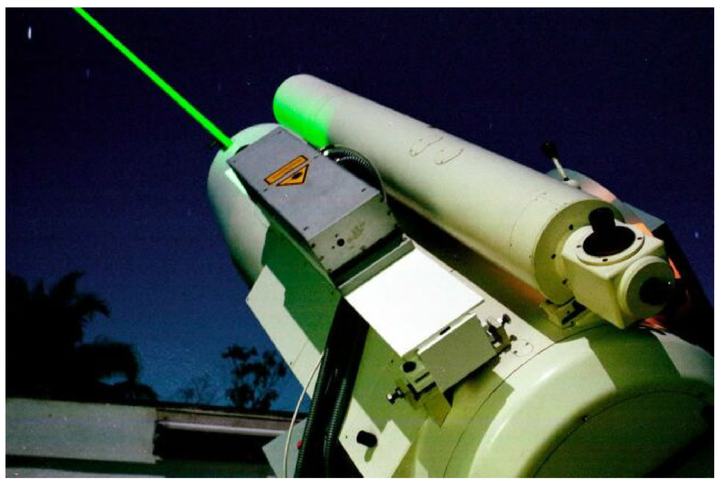


Fig 10: SLR station at Santiago de Cuba.
Nd:YAG laser head on SBG mount similar to this experiment

Fig 9: SLR station at Helwan in 90s - with local operator.
Nd:YAG laser beam with picosecond train of pulses,
goes through coude focus (photo made by J. Klokocnik)

Acknowledgements:

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