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# LASER COMMUNICATION EXPERIMENTS WITH ARTEMIS SATELLITE

**Abstract**

In November 2001, the European Space Agency (ESA) established the world-first inter-satellite laser communication link between the geostationary ARTEMIS satellite and the low Earth orbiting (LEO) SPOT-4 Earth observation satellite, demonstrating data rates of 50 Mbps. In 2006, the Japanese Space Agency launched the KIRARI (OICETS) LEO satellite with a compatible laser communication terminal and bidirectional laser communication links (50 Mbps and 2 Mbps) were successfully realized between KIRARI and ARTEMIS. ESA is now developing the European Data Relay Satellite (EDRS) system, which will use laser communication technology to transmit data between the Sentinel 1 and 2 satellites in LEO to two geostationary satellites (EDRS-A and EDRS-C) at data rates of 1800 Mbps. As the data handling capabilities of state-of-the-art telecommunication satellites in GEO increase so is the demand for the feeder-link bandwidth to be transmitted from ground. This is why there is an increasing interest in developing high bandwidth ground-to-space laser communication systems working through atmosphere. In 2002, the Main Astronomical Observatory (MAO) started the development of its own laser communication system for its 0.7m AZT-2 telescope, located in Kyiv, Ukraine. The work was supported by the National Space Agency of Ukraine and by ESA. MAO developed a highly accurate computerised tracking system for AZT-2 telescope and a compact laser communication package called LACES (Laser Atmosphere and Communication Experiments with Satellites). The LACES instrument includes a camera of the pointing and tracking subsystems, a receiver module, a laser transmitter module, a tip/tilt atmospheric turbulence compensation subsystem, a bit error rate tester module and other optical and electronic components. The principal subsystems are mounted on a platform, which is located at the Cassegrain focus of the AZT-2 telescope. All systems were tested with the laser communication payload on-board ARTEMIS and the data analysis was supported by the telemetry received from the ARTEMIS payload control centre in Redu (Belgium). Special attention was focused on the investigation of the impact of atmosphere turbulence on laser beam propagation, especially in cloudy conditions. A description of our telescope and ground based laser system as well as the experimental results will be presented.