

## Qualification Service of the Laser Optics Test Center

“Sometimes there is no next time” – a failure of an optical component in an aerospace system can pose a serious threat to the success of the entire mission. Especially laser-induced damage and system degradation in high-power lasers for applications in aerospace must be prevented.

The Laser Optics Test Center at DLR Stuttgart performs extensive qualification procedures of optical laser components.

Our outstanding experience has been incorporated in projects with the European Space Agency (ESA), European companies and other research institutes. As an example, the Laser Optics Test Center has selected and qualified all relevant laser optics for the Atmospheric Laser Doppler LIDAR Instrument (ALADIN), which will be launched to space aboard the satellite ADM Aeolus, as part of ESA's Earth Explorer Missions. In this LIDAR system, a high-energy laser operating at ultraviolet wavelength, will be used to measure global wind profiles for improving weather forecast.

If you are planning projects involving any kind of laser optics in aerospace, we are your qualified partner. Measurements of laser-induced damage thresholds as well as studies on potential risks regarding molecular contamination are at the heart of our competence.



ADM Aeolus observation satellite (due for launch in 2018) that will be used for measuring global wind profiles. Image: ESA.

## DLR at a glance

The German Aerospace Center (DLR) is the national aeronautics and space research centre of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport, digitalisation and security is integrated into national and international cooperative ventures. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space programme. DLR is also the umbrella organisation for the nation's largest project management agency.

DLR has approximately 8000 employees at 20 locations in Germany: Cologne (headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Bremerhaven, Dresden, Goettingen, Hamburg, Jena, Juelich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Oldenburg, Stade, Stuttgart, Trauen, and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington D.C.

## Imprint

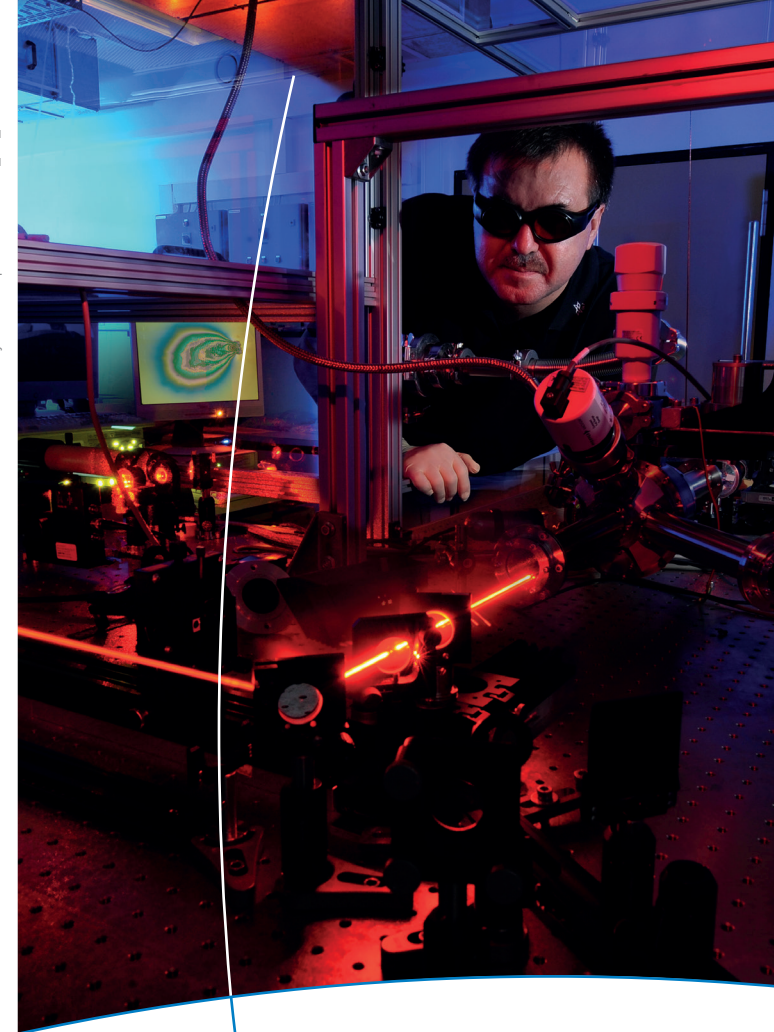
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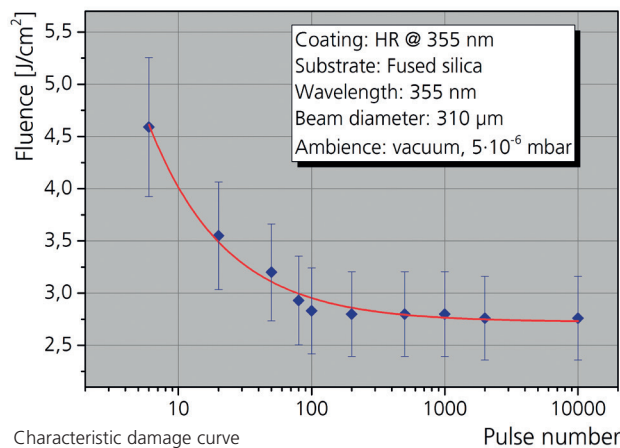
## Laser Optics Test Center for Aerospace Technologies

## Laser Optics Test Center

The Institute of Technical Physics at the DLR in Stuttgart is operating a qualification laboratory where the resistance of optical components against degradation and damage can be tested under high-power laser irradiation. These test procedures can also be carried out under space-like conditions in vacuum. Standardized damage threshold tests are performed, supplemented by raster scans to assess large component areas or long exposure lifetime testing. Another expertise is to investigate laser-induced molecular contaminations and effects of energetic radiation.

### Laser-Induced Damage Threshold Tests (LIDT)

Damage threshold tests are carried out in an application-oriented manner at common laser wavelengths in the infrared (1064 nm), visible (532 nm), and ultraviolet (355 nm, 266 nm) wavelength range using laser pulses of a few nanoseconds. These multipulse tests are performed according to ISO 21254 standard. Various types of optics with different coating designs (e.g. anti-reflective or high-reflective) can be fixed in the setup at different angles of incidence. In cooperation with external partners we also have the capability of testing effects of proton- or  $\gamma$ -radiation.

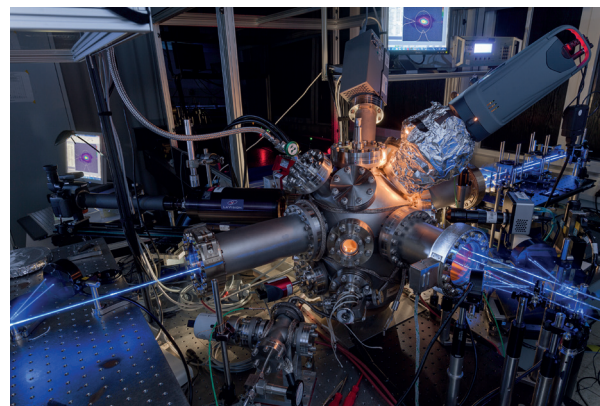


LIDT tests are performed under ambient conditions or, as an option, under gas atmosphere or in vacuum. Long term operations of space laser systems with a mission duration of several years lead to very stringent requirements of precision and longevity of utilized optical components, which can be tested in accelerated aging experiments.

### Laser-Induced Molecular Contamination (LIMC)

Operation of space laser systems can be strongly affected by laser-induced molecular contamination. For that reason, several missions failed. Laser-induced contaminations come from outgassing volatile materials like glues, adhesives, isolation materials or electronic boards. The outgassed molecules can be cracked by interaction with laser radiation and the residuals are deposited on the optics. This occurs especially in case of intensive radiation in the shortwave spectrum (VIS/UV).

Usually, laser-induced contamination mainly appears in laser systems which are operated in vacuum, however, it can also be a risk for hermetically sealed systems. To mitigate this risk, fundamental research is necessary to investigate the formation and growth of laser-induced depositions. The Laser Optics Test Center runs several ultra-high vacuum chambers to



## Harsh environments

Nowadays, laser systems are increasingly used in air- and spacecraft platforms. The operation in harsh environments enhances the risk of damage and system failure. Ultra-high vacuum, energetic radiation, hydrocarbon contaminants, atomic oxygen, high-speed exposure to aerosols under rapidly changing temperatures are, among other effects, very challenging for the performance of optical coatings, surfaces and components.

perform research as well as screening tests of critical materials. An ISO document (ISO TR 20811) was developed to provide a reference test procedure for LIMC.

### Microscopic Characterization of Surface Damages

For visualizing and characterizing molecular contaminations as well as damages on laser optics, we use a combination of different microscopic and spectroscopic techniques. These include Nomarski microscopy, white-light interference microscopy, scanning electron microscopy, atomic force microscopy, Fourier-transform infrared spectroscopy and energy dispersive X-ray spectroscopy.

