



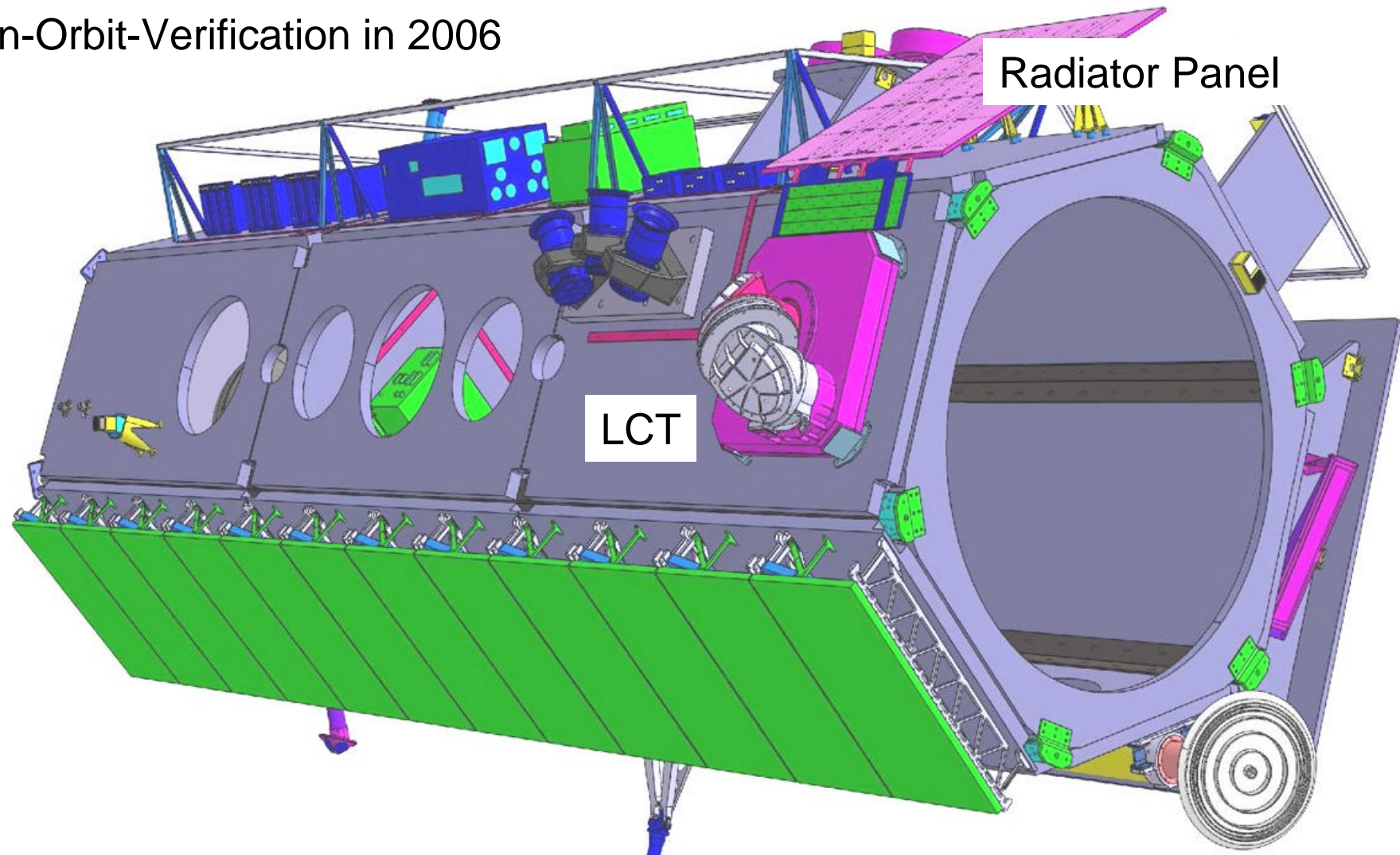
Fiber-optic Components for the Laser Communication Terminal on TerraSAR-X

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LEO-Terminal on TerraSAR Satellite

Prime TESAT

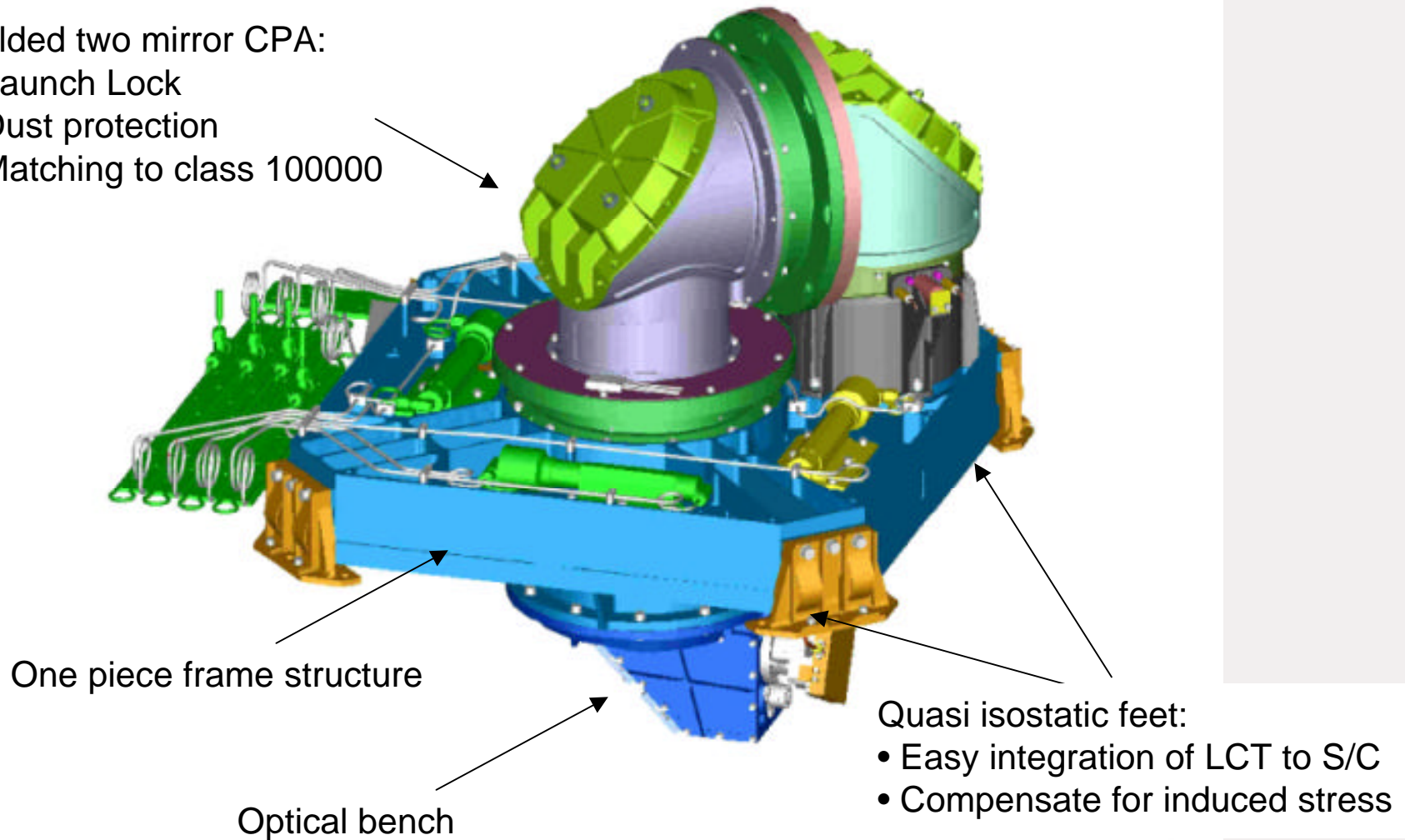
In-Orbit-Verification in 2006



Laser Communication Terminal Design

Folded two mirror CPA:

- Launch Lock
- Dust protection
- Matching to class 100000

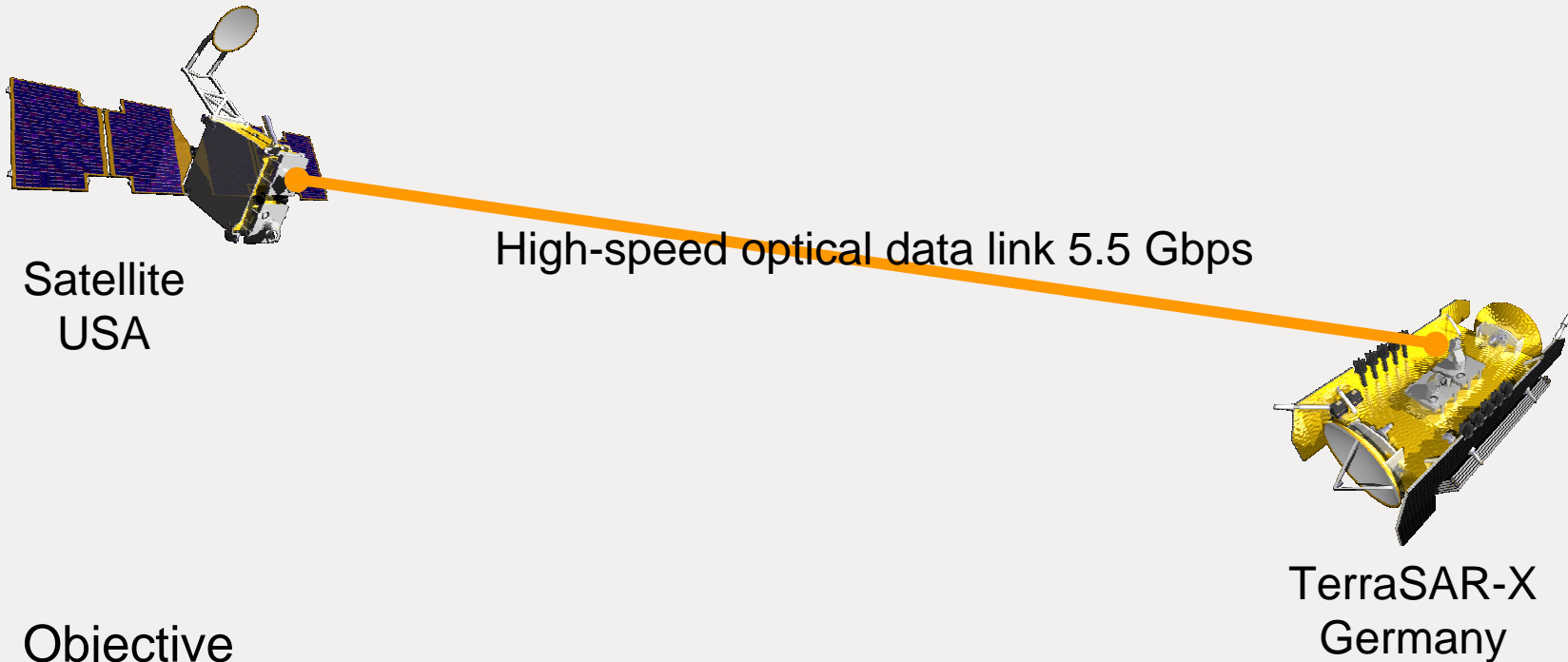


Status of Laser Communication Terminals

- **Laser Communication Terminals qualified in 2004**
 - **2 FMs in 2006; Integration started**
 - **In-Orbit-Verification, Satellite-to-Ground in 2006**
 - **In-Orbit-Verification, Satellite-to-Satellite in 2007**
- 
- A satellite is shown in space, oriented towards the viewer. It has two large, rectangular solar panels with a grid pattern, one on the left and one on the right. The satellite body is white with yellow accents. A large, white, oval-shaped antenna or terminal is visible on the right side of the satellite. The background is a dark blue space filled with numerous small white stars.

Inter - Satellite - Link

Laserlink between German TerraSAR-Satellite and US-Satellite



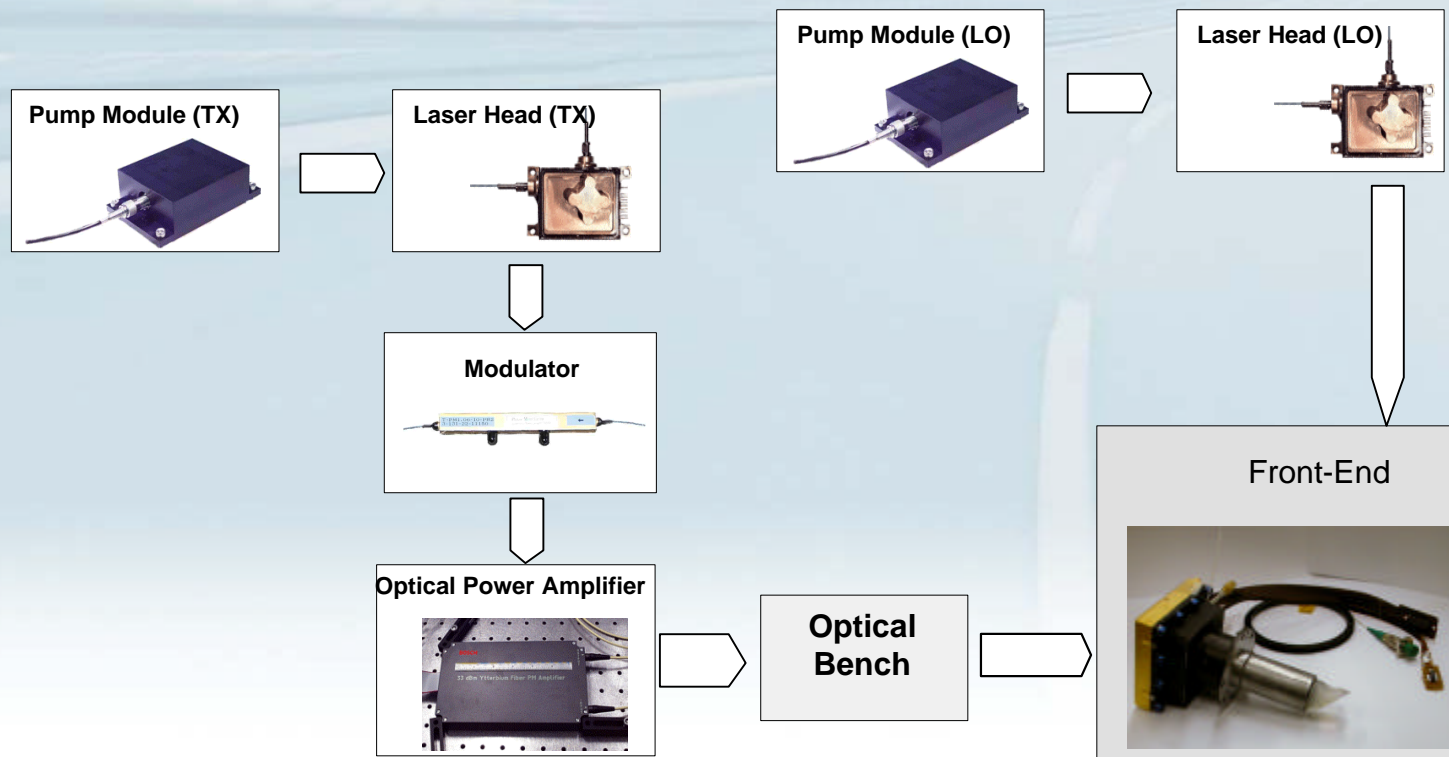
Objective

- LCT performance verification

Types of Fiber-optic Interconnections in LCTs

- **MM** for Nd-YAG Laser Pumping
 - Multi mode, step index, quartz-quartz fiber
 - Wavelength 808 nm
 - Optical power up to 5 W
 - **SM - PM** for Optical Signal Transmission
 - Single mode fiber, polarization maintaining
 - Wavelength 1064 nm
 - Optical power up to 1 W
- 
- A satellite is shown in space, with a large, glowing yellow laser beam emanating from its communications terminal. The satellite has several solar panels and a white body. The background is a starry space.

Block Diagram of Fiber-optic Components



Laser Communications Terminals

High-Reliable Pump Modules for Nd:YAG Lasers

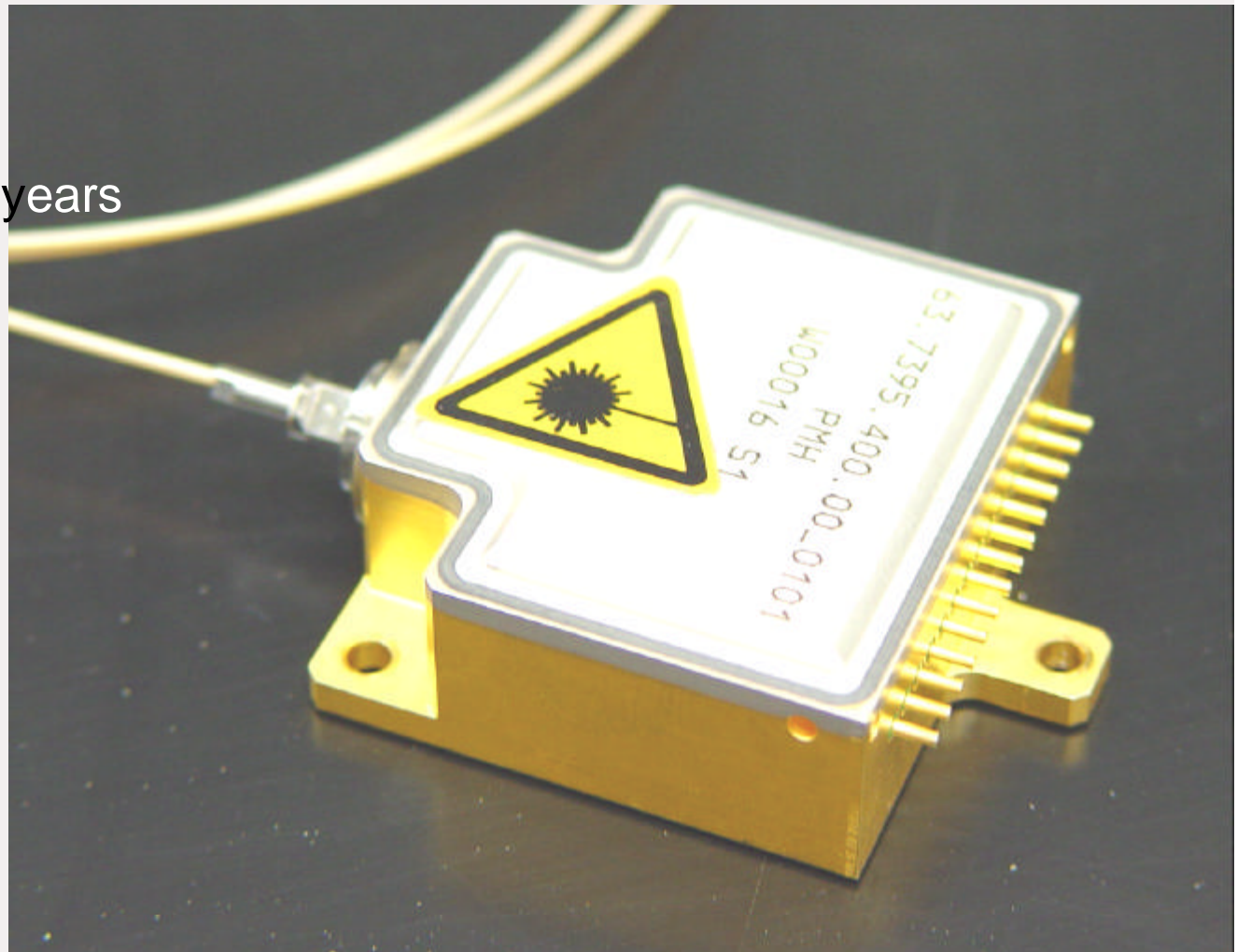
Hermetically sealed

Reliability

0.9999 in 10 years

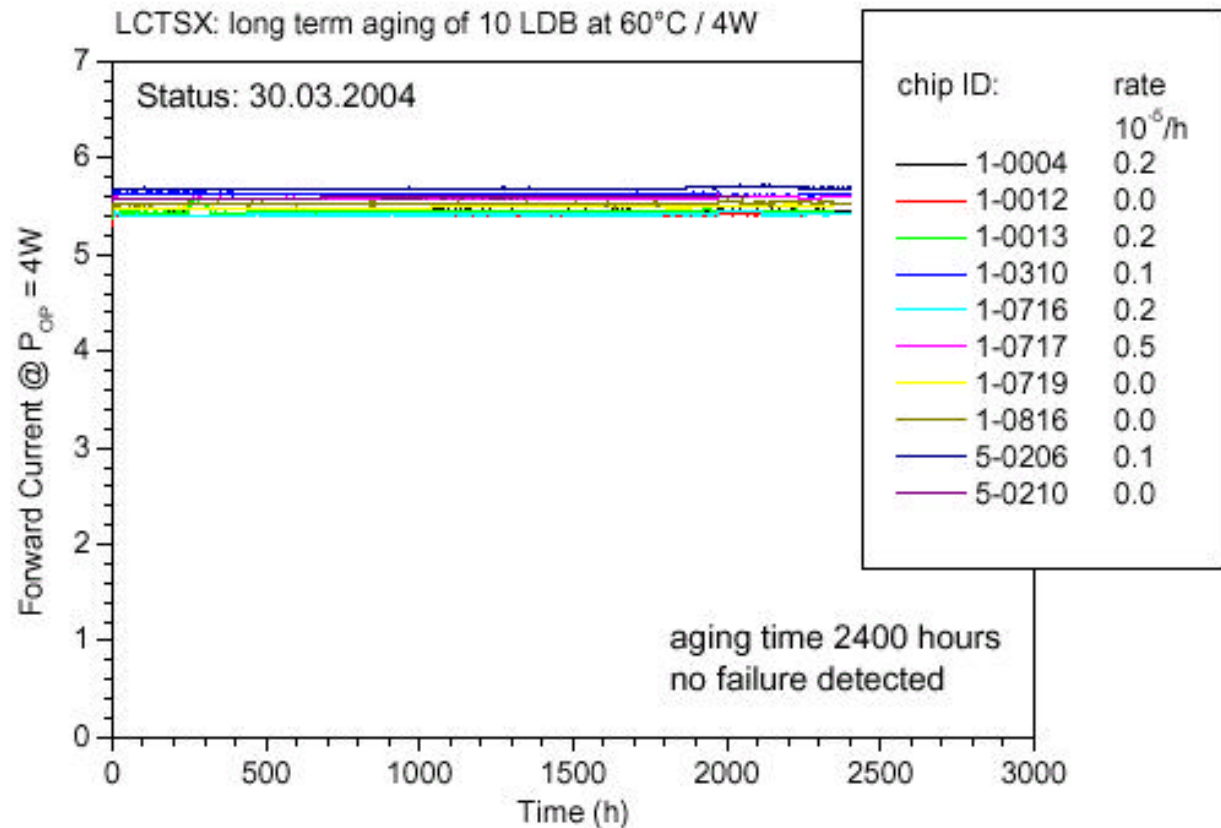
MTTF of laser diode

1.35 Mh



Laser Diode Bench Life Tests

- Various life tests based on the same laser technology performed since 1998
- 12 different test groups investigated
- Strongly accelerated test conditions

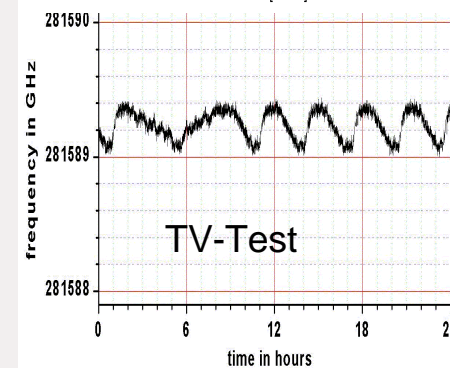
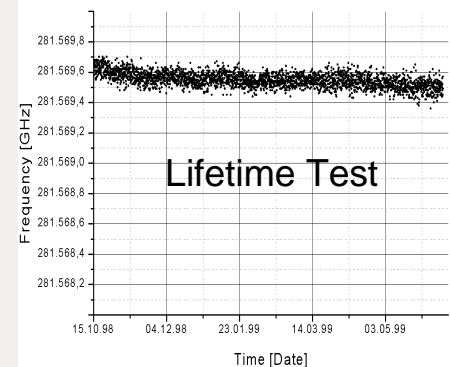
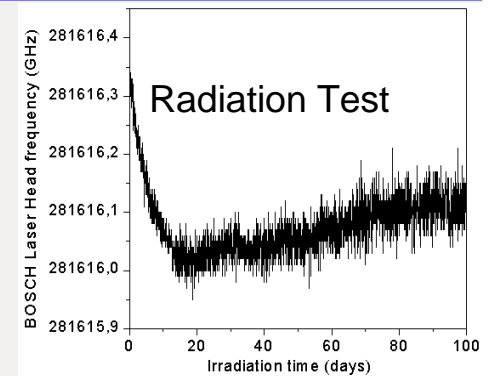
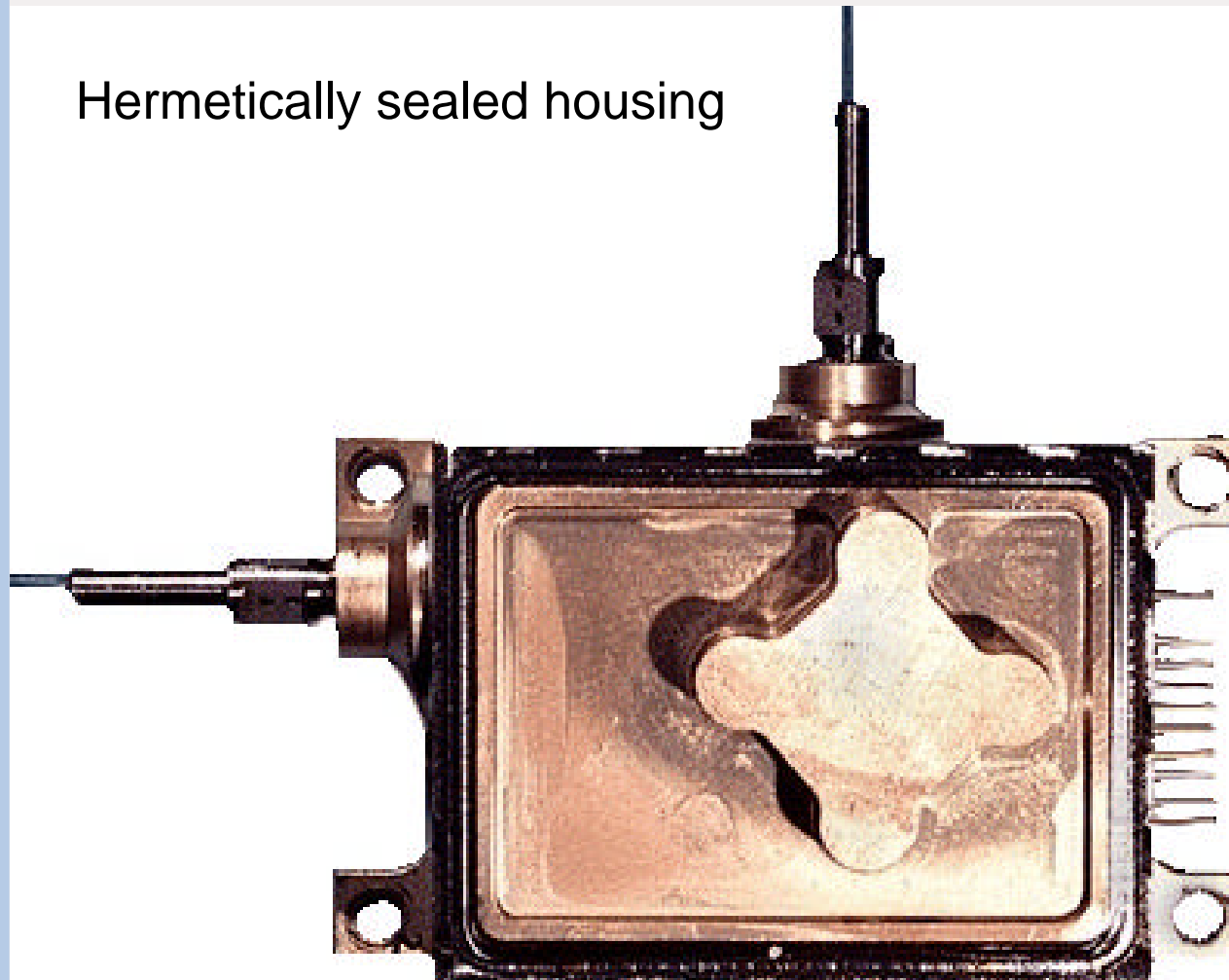


Example from currently running
“LCTSX” program

Laser Communications Terminals

Qualified Nd-YAG Ring-Laser (NPRO)

Hermetically sealed housing



Vibration Tests

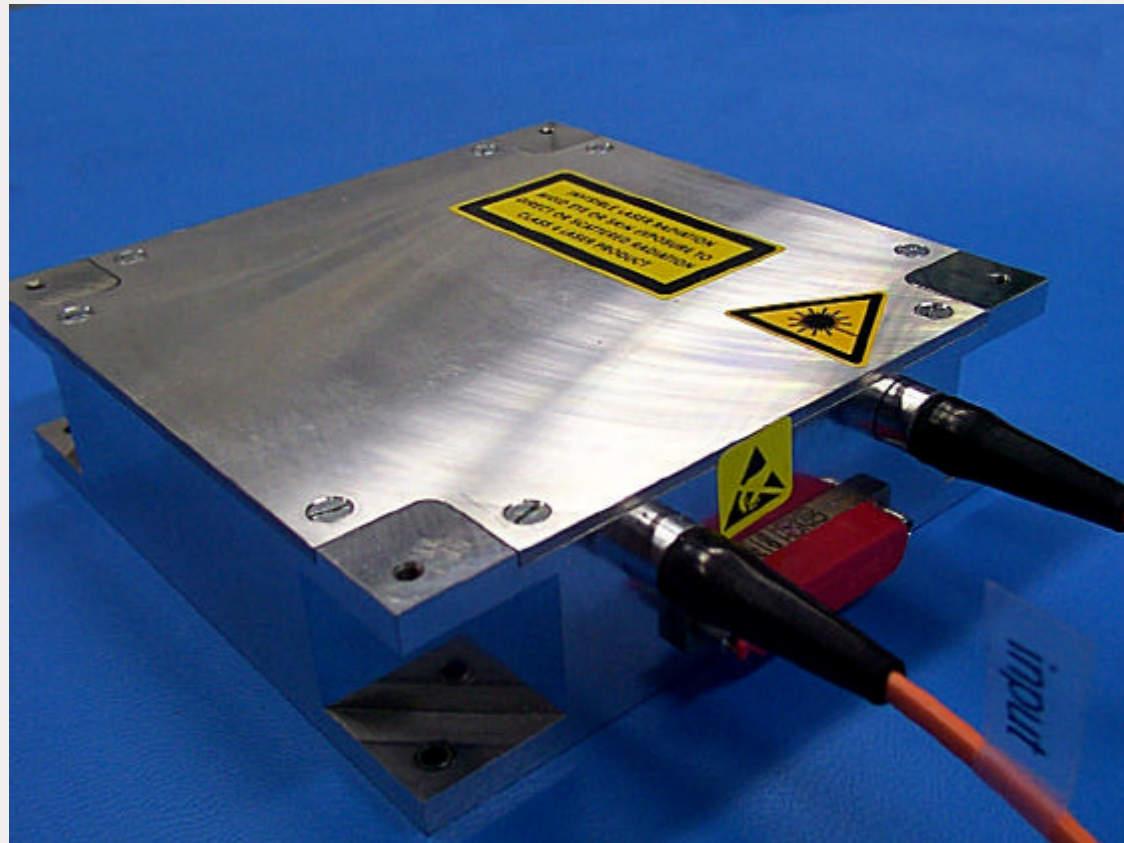
Electro-optical Modulator

- Sealed housing
- Orientated fiber to chip coupling
- Shock resistant



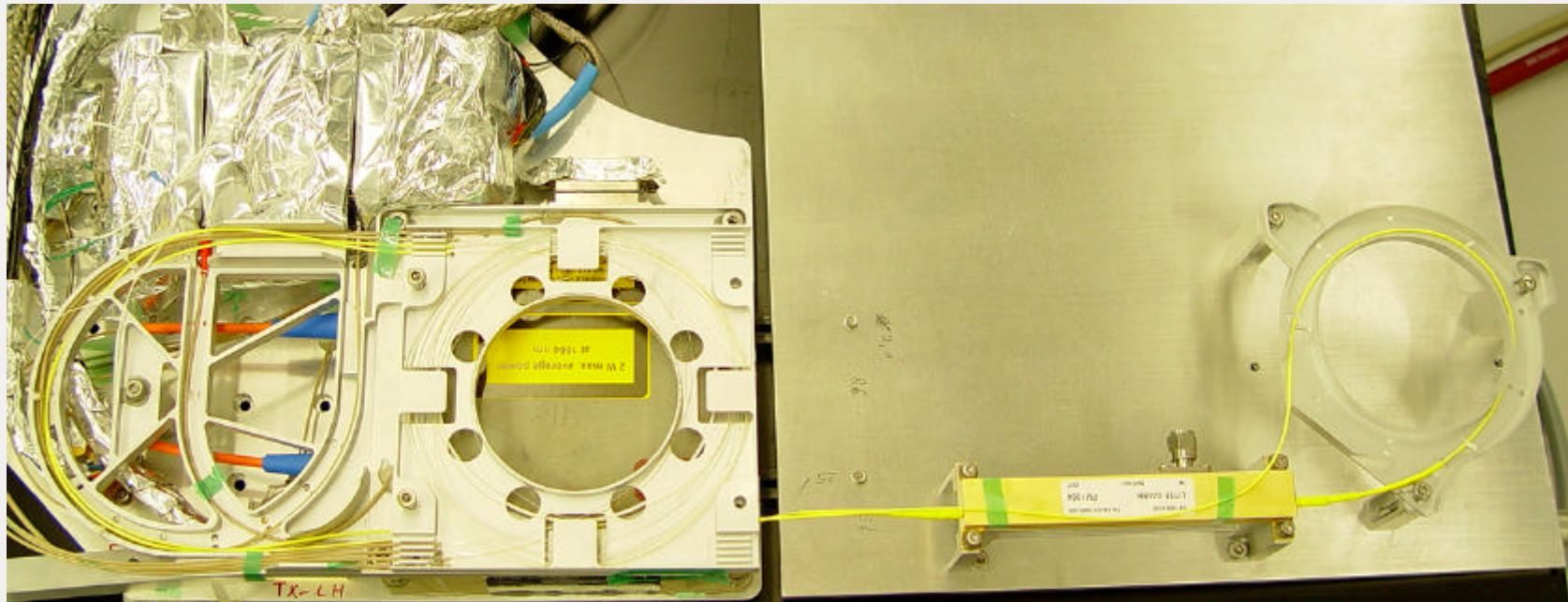
Optical Power Amplifier

- Polarization maintaining
- Radiation tolerant
- Optimized for single frequency input



Fiber Layout Verification in System Test Bed (STB)

- Fibers routed in dedicated fiber support
- Bare fiber protected by tubing
- Fibers connected by fusion splice
- Spare fiber stored in fiber boxes



Laser Communications Terminals



Data rate up to **8 Gbps**

- BPSK homodyne
- Spatial acquisition
- Tracking

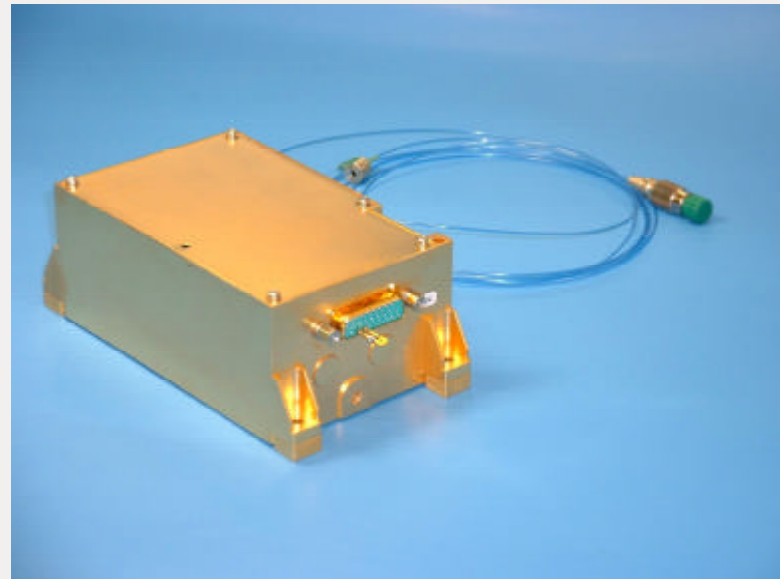
Laser sources for science and earth observation

Background

- Single frequency laser developed for coherent LCT
- Spin-off: Use of lasers in scientific / EO programmes
- Adaptation of electronics

Programs

- DWL BB shipped in September 2001
- GIFTS BB for NASA
shipped in May 2002
- SMART-2 BB
shipped in November 2002
- GIFTS FM qualification running, shipped in November 2004
- ALADIN FM going to be qualified
- SMART 2 kicked off



Laser Communications Terminals

Fiber-optic components suited for space application

- **SM-PM fibers can be handled**
- **Qualified fusion splicing process available**
- **Hermetically sealed lasers with fiber interface**
- **Modules qualified with environmental tests**
- **All components radiation resistant**
- **Technology for LCT established**