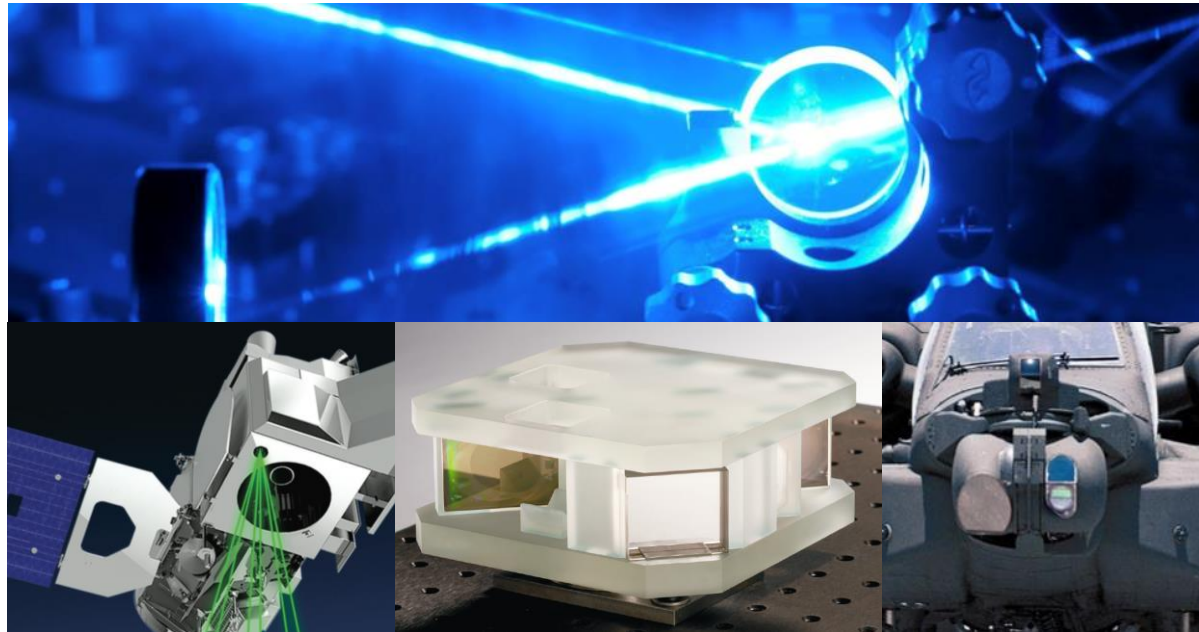




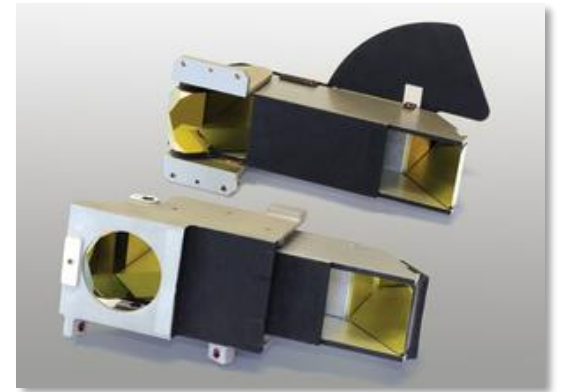
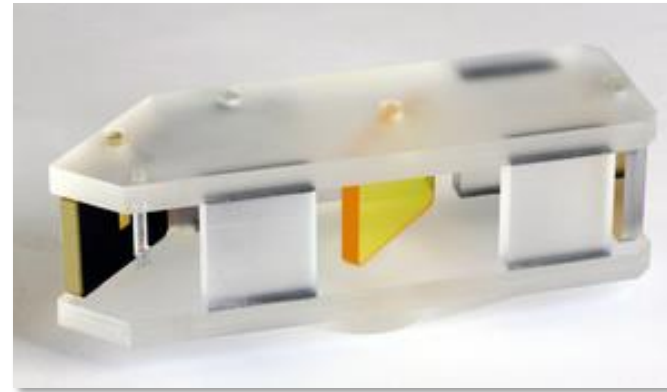
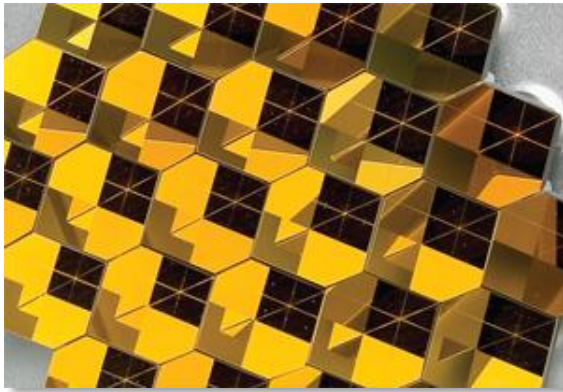
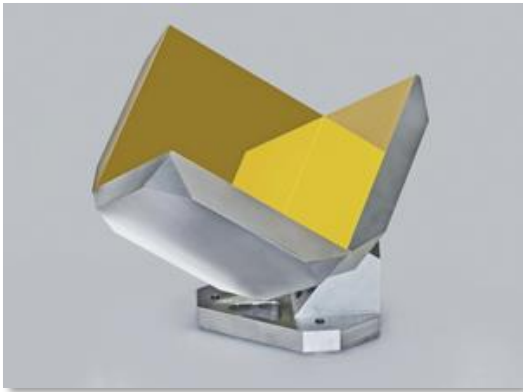
# Transforming Optical Structure Technology Through Innovative System Integration



Itai Vishnia CEO, PLX Inc.  
40 W. Jefryn Blvd. Deer Park, NY 11729, USA



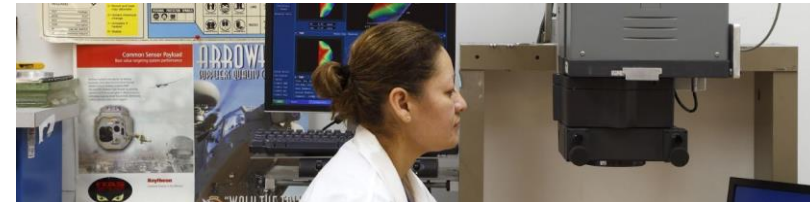
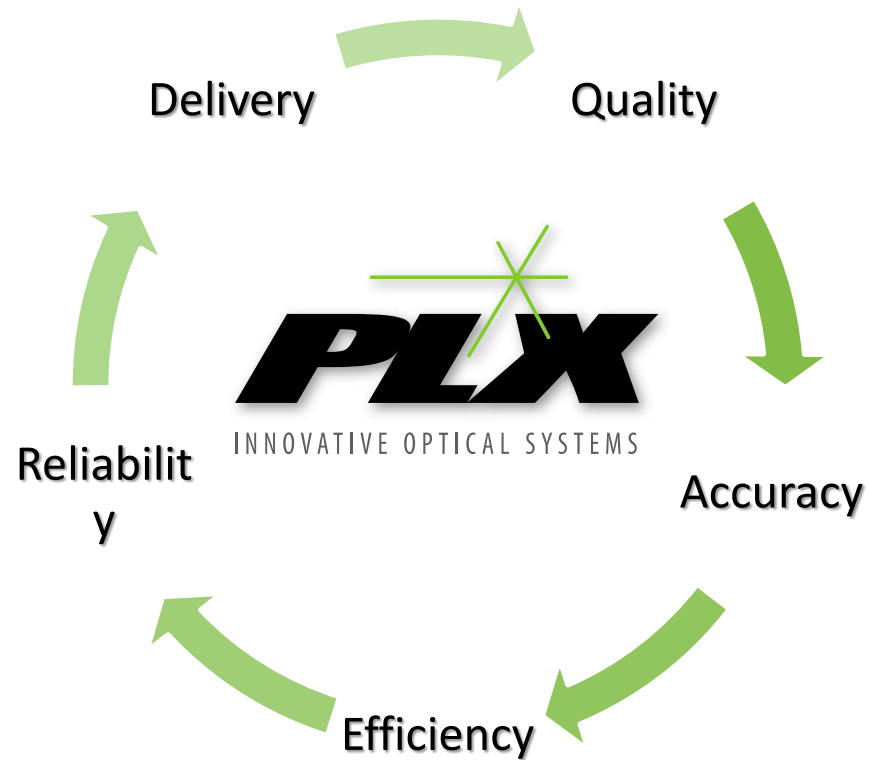
## Providing solutions that fit the demands of a new generation of optical requirements for the Defense, Aerospace and Commercial Industries



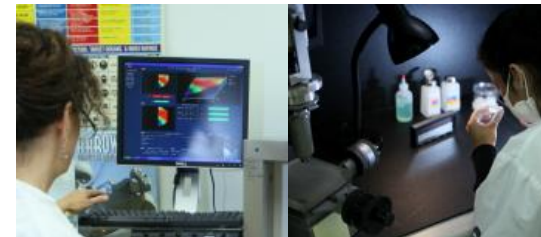
From a fabricator of precision lenses, prisms, mirrors and domes to a designer and manufacturer of high accuracy optical systems.



## Total in-house quality control and accountability



Our in-house manufacturing and environmental testing facilities, performance testing capabilities, and state-of-the-art optical analysis equipment provide total quality management and accountability.





## Production capabilities:

- ✦ CNC machines for glass fabrication.
- ✦ Four Blanchards.
- ✦ Four Surface Grinders.
- ✦ One 36" Grinder Table.

### Fabrication/ Machine Shop



- ✦ Optics with better than  $\lambda/20$  flatness.
- ✦ 30 grinding and polishing spindles.
- ✦ Two planetary polishing machines.

### Precision Optical Shop



- ✦ State-of-the-art work stations.
- ✦ Class 100 Clean Room.
- ✦ QC/QA Lab with Environmental Testing and Zeiss CMM.

### Assembly Labs/ Clean Room



- ✦ Metallic coatings, Anti-Reflective(AR) coatings, and dielectric mirror coatings.
- ✦ Coating for beam splitters, mirrors and metals.

### Coating Capabilities



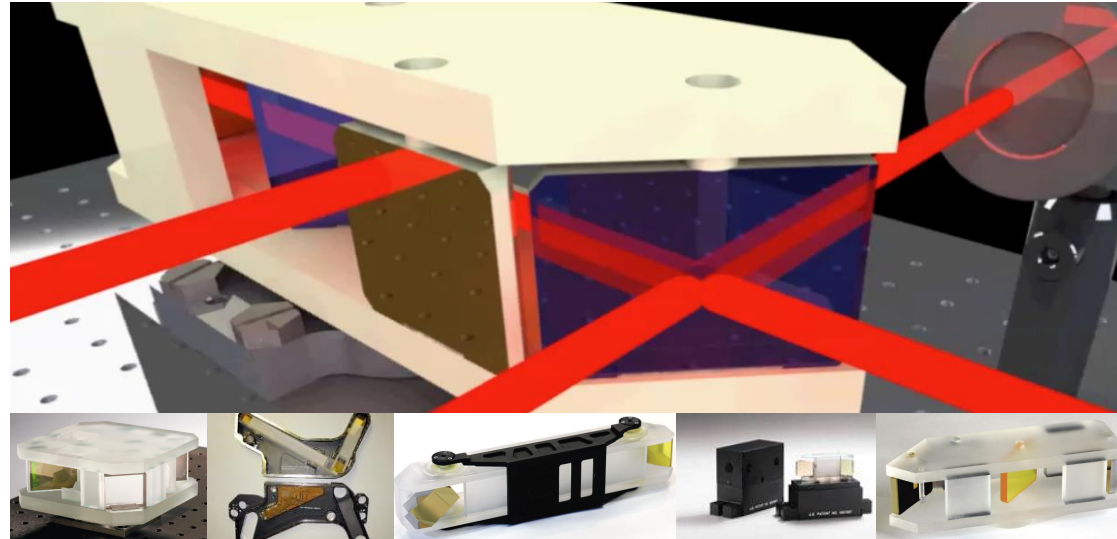


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# INTRODUCING M.O.S.T™

## Monolithic Optical Structure Technology

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## M.O.S.T.<sup>™</sup> Monolithic Optical Structure Technology

### Advantages with M.O.S.T Technology

- ✦ Combines all of the elements of a complex optical setup into single rugged monolithic unit.
- ✦ Superb optical stability, unsurpassed shock and vibration resistance.
- ✦ Sub-arc second accuracy between optical elements.
- ✦ Permanently aligned so you will never need to adjust it and also lasts indefinitely.

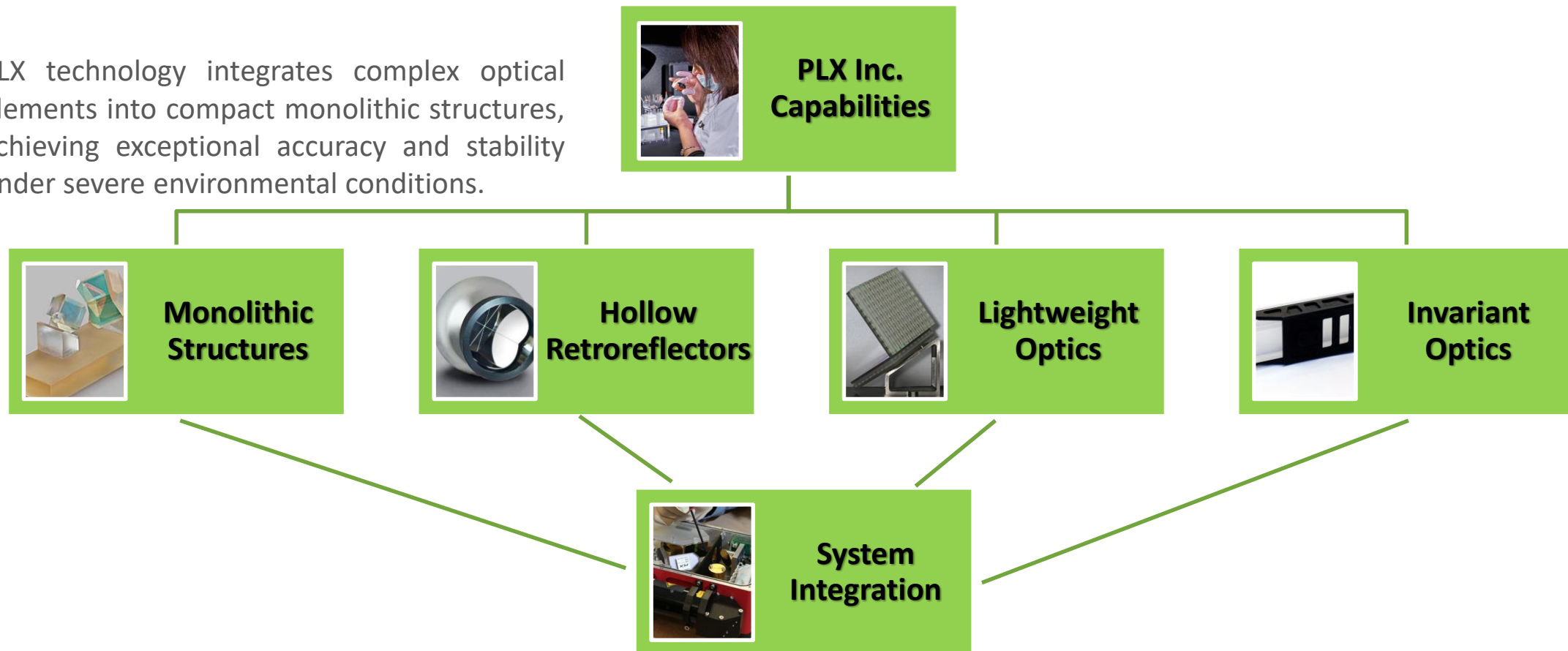


M.O.S.T. PROPERTIES	
FEATURES	SPECIFICATIONS
Glass Types Used	Typically fused Silica (SiO <sub>2</sub> ), low-expansion Borosilicate, ULE 7971, BK7 and ceramics
Lightweight Structure	Average glass density is 2.2 g/cm <sup>3</sup> (lighter than Aluminum)
Average Specific Stiffness	3.3x10 <sup>4</sup> N m/g (higher than Aluminum)
Uniform CTE	Coefficient of Thermal Expansion using fused Silica is 0.55 ppm/° K
Thermal Dependency	≥ 0.15% per degree
Oscillation Capability	≥ 1 KHz dependent upon the design and requirements



## Getting the M.O.S.T.<sup>™</sup> out of optical systems

PLX technology integrates complex optical elements into compact monolithic structures, achieving exceptional accuracy and stability under severe environmental conditions.

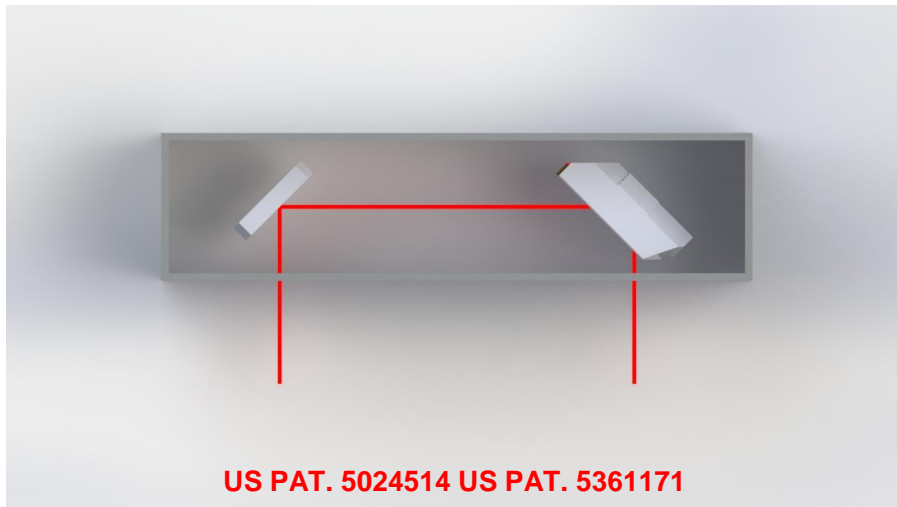




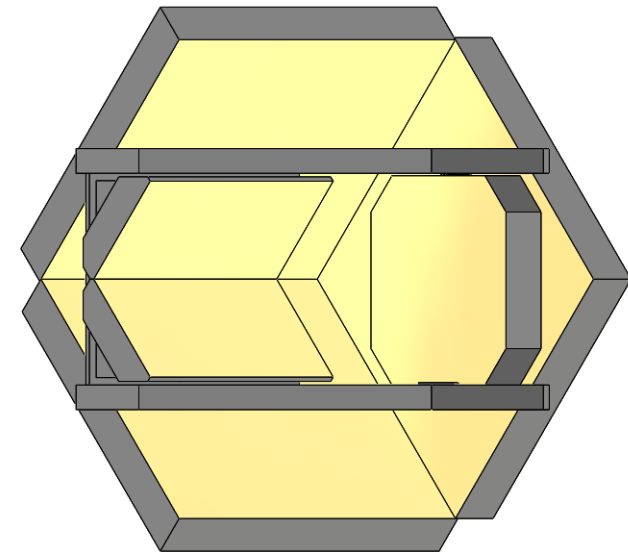


## Invariant Optics

- ✧ Since hollow retroreflectors are invariant systems, any M.O.S.T design that is configured similar to a Retroreflector will be invariant.
- ✧ A prime example of this is our Lateral Transfer Hollow Retroreflectors (LTHR).



LTHR – Ray Tracing



LTHR = Retroreflector



## PLX Inc. manufactures M.O.S.T. products and modules for integrators of systems on Military, Aerospace and Commercial platforms



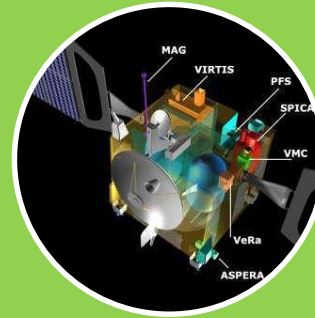
**EO/IR Fire Control**



**Common Sensor Platform**



**Mapping and Topography**



**Environmental and Atmospheric**



**Laser Tracker System**



**Laboratory Applications**



**Military Applications**

**Aerospace Applications**

**Commercial Applications**



## PLX M.O.S.T.<sup>TM</sup> Applications

**Laser Tracker**

**Laser Cavities**

**Spectroscopy**

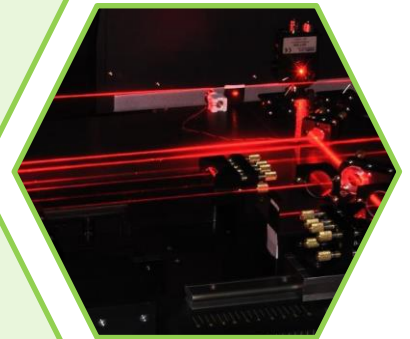
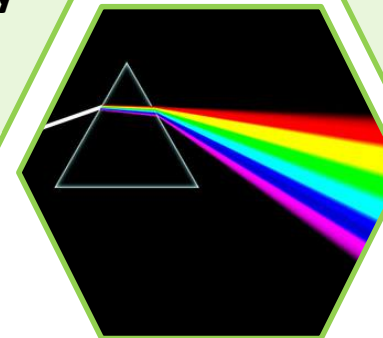
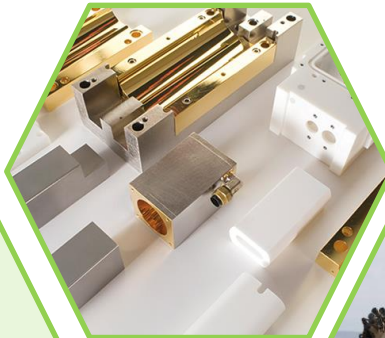
**Satellite Orientation**

**Free Space Optics (FSO)**

**Boresighting**

**LIDAR**

**Interferometry**





Collaborating  
with and  
serving some  
of the  
world's most  
influential  
companies



## DEFENSE



**LEONARDO DRS**

**LOCKHEED MARTIN**

**NORTHROP GRUMMAN**

**GENERAL DYNAMICS**

**Raytheon**

**BAE SYSTEMS**



## AEROSPACE



**esa**



Ball Aerospace  
& Technologies Corp.

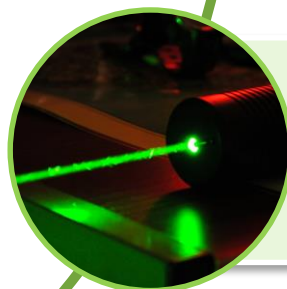
**AIRBUS**

**JPL**  
Jet Propulsion Laboratory

ThalesAlenia  
Space



**NEPTEC**



## COMMERCIAL



**BOEING**

**FARO**

**SPIRIT AEROSYSTEMS**

**+HUBBS**

OPTICAL TARGETING SPECIALTIES  
FOR METROLOGY SUPPORT SYSTEMS

## Case Study 1



# TES Spectrometer (2004)

Mission Status: **Completed**

- ✳ The **Tropospheric Emission Spectrometer (TES)** is one of four instruments aboard NASA's Aura Earth Spacecraft (formerly known as EOS-Chem 1.)
- ✳ The spectrometer's main operation is to study the chemistry and dynamics of the Earth's troposphere, the lowest level of Earth's atmosphere.
- ✳ PLX Inc. provided **high-accuracy** beryllium mirrors and retroreflectors that were instrumental to the success of the spectrometer.

**Mission:** A main goal of the TES mission is to monitor ozone in the lowest layers of the atmosphere directly from space.

**Mission duration:** Aura satellite: Active  
TES: Elapsed – ~14 years

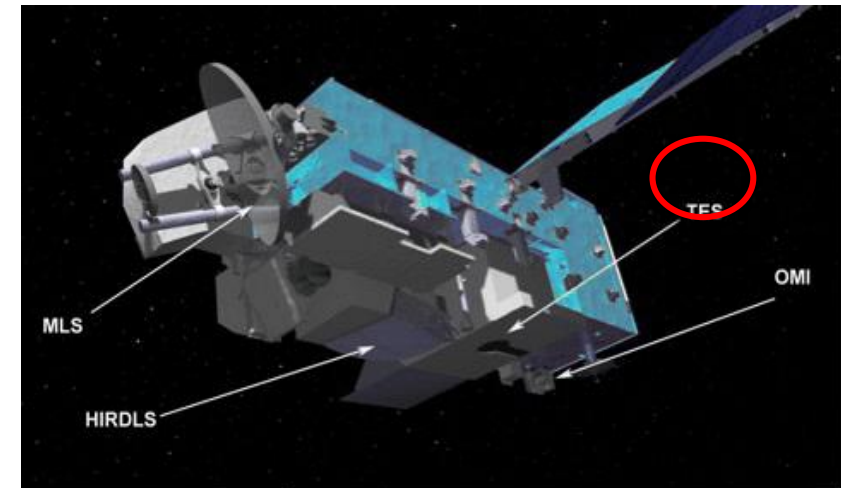


Image courtesy of SPARC



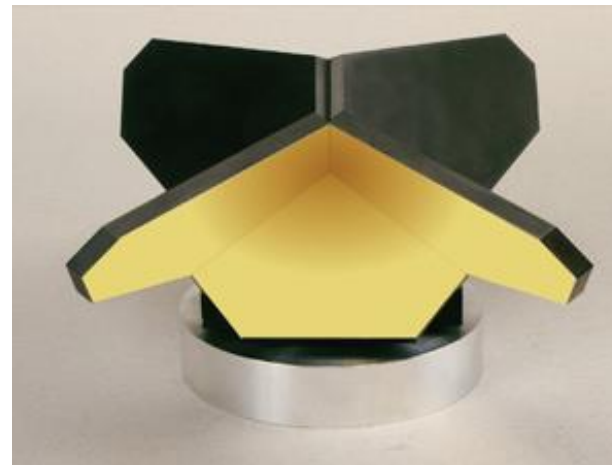
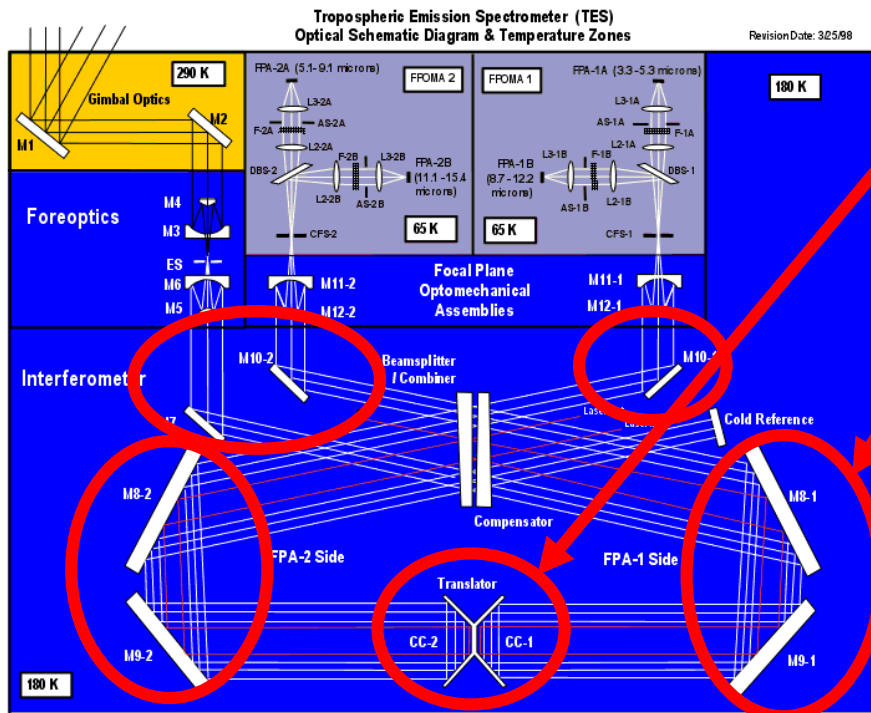
## Case Study 1



## TES Spectrometer (2004)

Mission Status: **Completed**

- ✧ TES is a high-resolution infrared-imaging FTIR spectrometer.
- ✧ The change in optical-path difference is achieved by back-to-back corner-cube reflectors (PLX Design) mounted on a translator mechanism.
- ✧ PLX Inc. also developed, designed and fabricated beryllium flat mirrors (M7 and M10) and roof mirrors (M8 and M9).



Beryllium Retroreflector by PLX

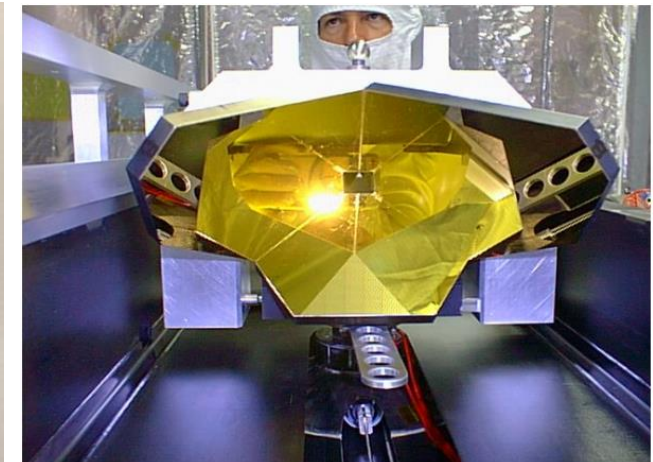


Image courtesy of NASA

## Case Study 2



## **Aerospace**



**Ball Aerospace  
& Technologies Corp.**

**Mission Status:** Active

The Alignment Monitoring and Control System (AMCS) is an alignment instrument for the Advanced Topographic Laser Altimeter System (ATLAS) aboard the **ICESat-2 satellite**.

PLX developed two Lateral Transfer Retroreflectors in conjunction with Ball Aerospace Technologies.

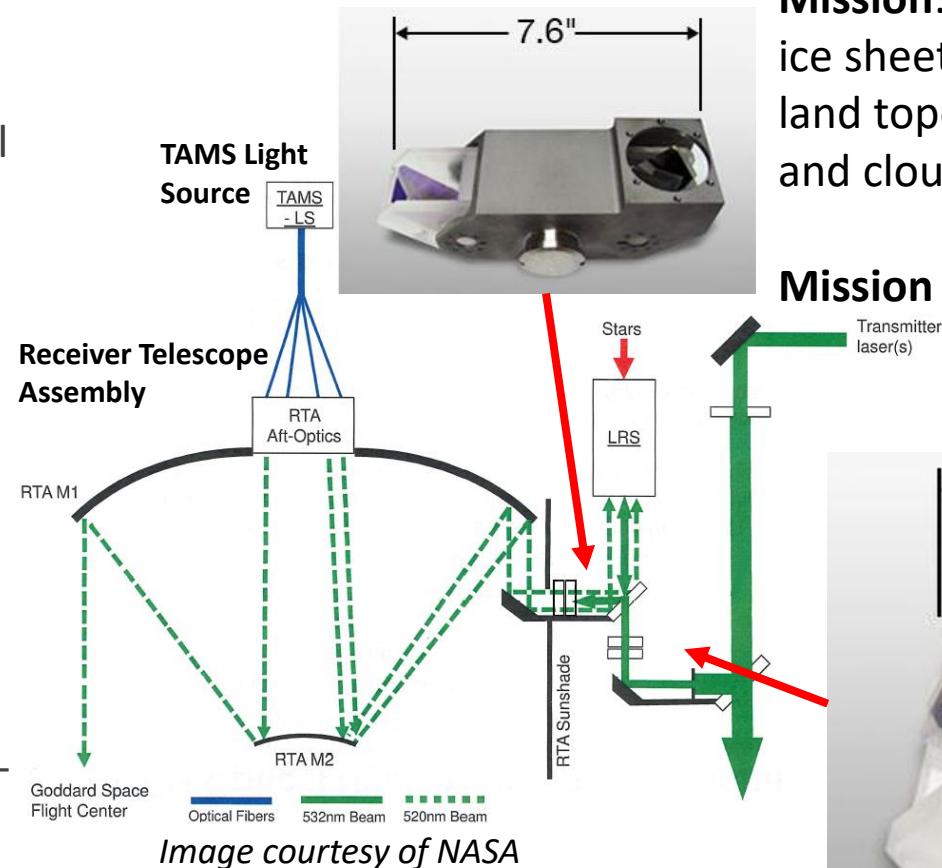
The retroreflectors are used to keep the laser and receiving telescope bore-sighted to each other during orbit.



# AMCS Alignment System (2018)

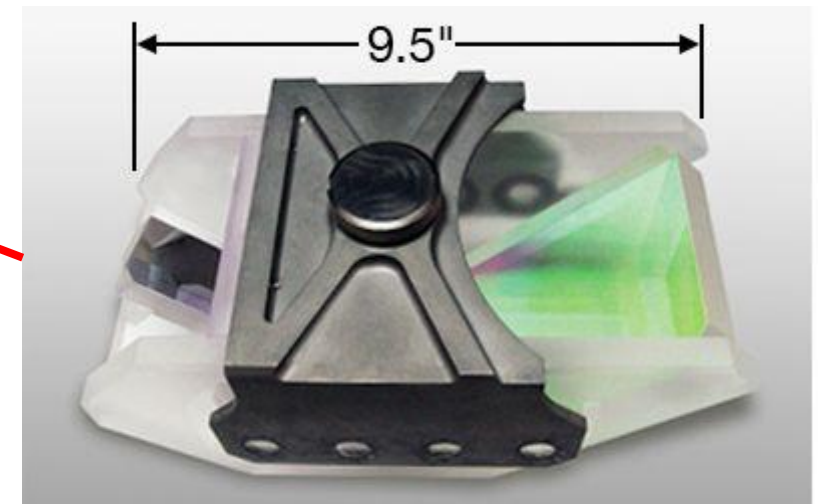
**Mission:** A satellite mission for measuring ice sheet elevation and sea ice thickness, land topography, vegetation characteristics, and clouds.

**Mission duration:** Planned – 3 years  
 Transmitter laser(s) Elapsed – 10 months



*Image courtesy of NASA*

**TAMS: Telescope Alignment Monitoring System**  
**LRS: Laser Reference System**







## Space Participation Timeline

**1975** – NASA's Apollo-Soyuz Mission.

**1985** – NASA's Discovery Shuttle Laser Test.

**1990** – Ball Aerospace's Relay Mirror Experiment.

**1990** – NASA's LACE Experiment.

**1997** – NASDA's Retroreflector in Space.

**2000** – NASA's Endeavor Shuttle Radar Mission.

**2002** – NASA's TES Spectrometer.

**2003** – CSA's ACE-FTS Spectrometer.

**2003** – ESA's PFS Spectrometer (Mars Express).

**2005** – ESA's PFS Spectrometer (Venus Express).

**2009** – Keldysh's Space Program.

**2015** – NASA's ICE, Cloud/Land Elevation Project.

**2016** – ESA's TIRVIM Spectrometer.

**2016** – NEPTec's CAMS Metrology System.

**2018** – Ball Aerospace's AMCS Alignment System.

**2021** – Future Project for an interferometer.



**esa**



Ball Aerospace  
& Technologies Corp.



ФГУП «Центр Келдыша»



ROSCOSMOS

**JPL**  
Jet Propulsion Laboratory

ThalesAlenia  
Space  
a Thales / Leonardo company



**AIRBUS**

**NEPTec**



## Case Study 3



## Boresighting

DefenseProgram Status: **Ongoing**

- ✦ PLX developed the Modernized Boresight Module in conjunction with Lockheed Martin.
- ✦ Operates with extreme stability, even under the harshest levels of vibration and shock.
- ✦ Designed to allow simultaneous viewing of multiple lines of sight. The module uses two LTHRs configured in a stable housing that provides one arc-second parallelism under the most adverse conditions.

**Arrowhead Targeting System**

Program started	2005
# of parts delivered	Over 1700



- ✦ Two custom Lateral Transfer Retroreflectors were designed in conjunction with Leonardo DRS and Raytheon.
- ✦ Provides long-range, lethal anti-armor and precision assault fires capabilities for US Army infantry.

**Improved Bradley/Target Acquisition System (IBAS and ITAS)**

Program started	1995
# of parts delivered	Over 7100





## Case Study 4



# FTIR Spectroscopy



## Commercial

### FTIR

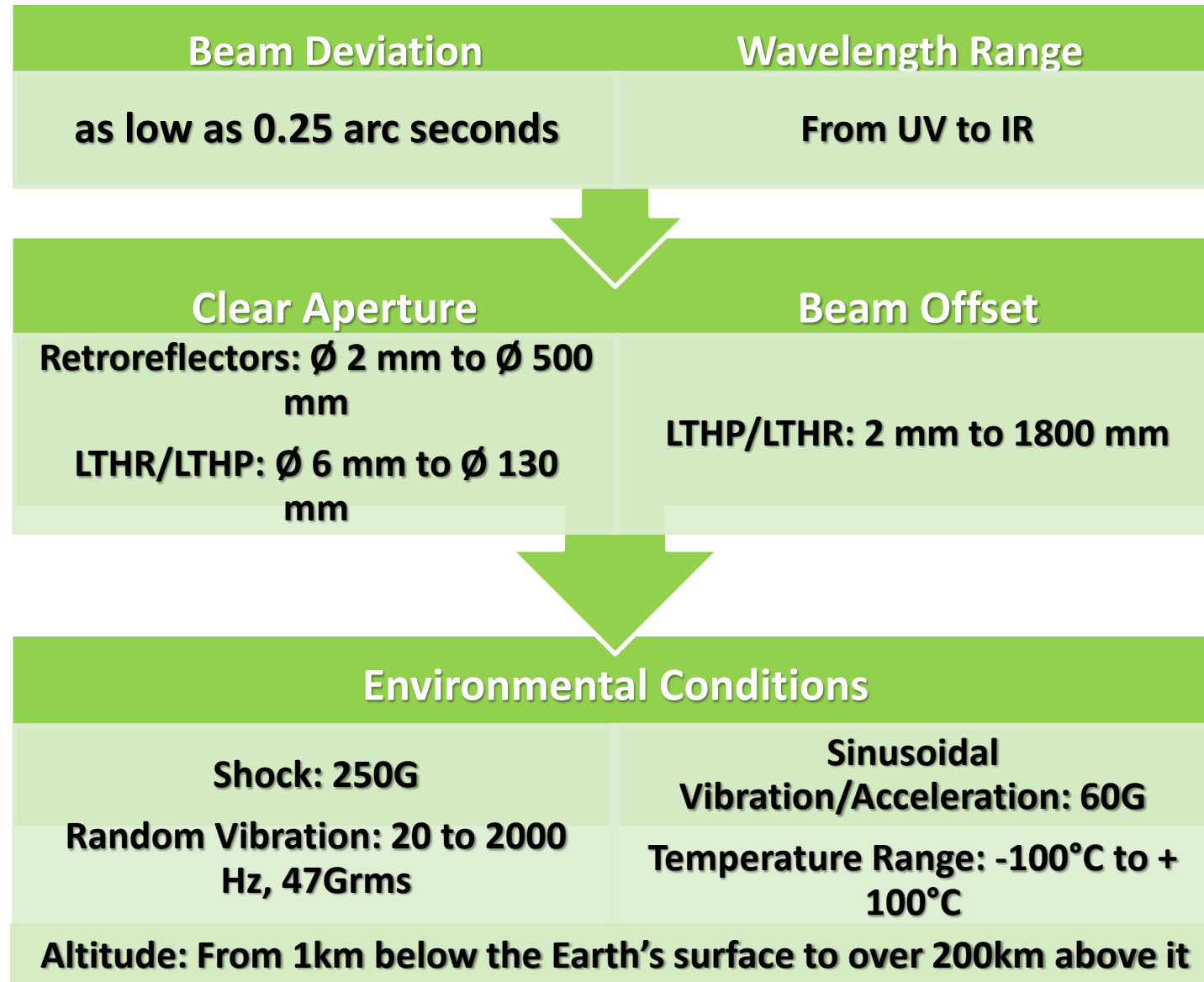
- ✧ PLX designed an ultra-stable platform for OEM incorporation into industrial analyzers. Several patented innovations achieved a new level of stability.
- ✧ The design also utilizes our moving cube-corner Retroreflector which is insensitive to tilt, and self-corrects any image displacement caused by shear motion.
- ✧ PLX also worked on the development of software, hardware and mechanics of the system.





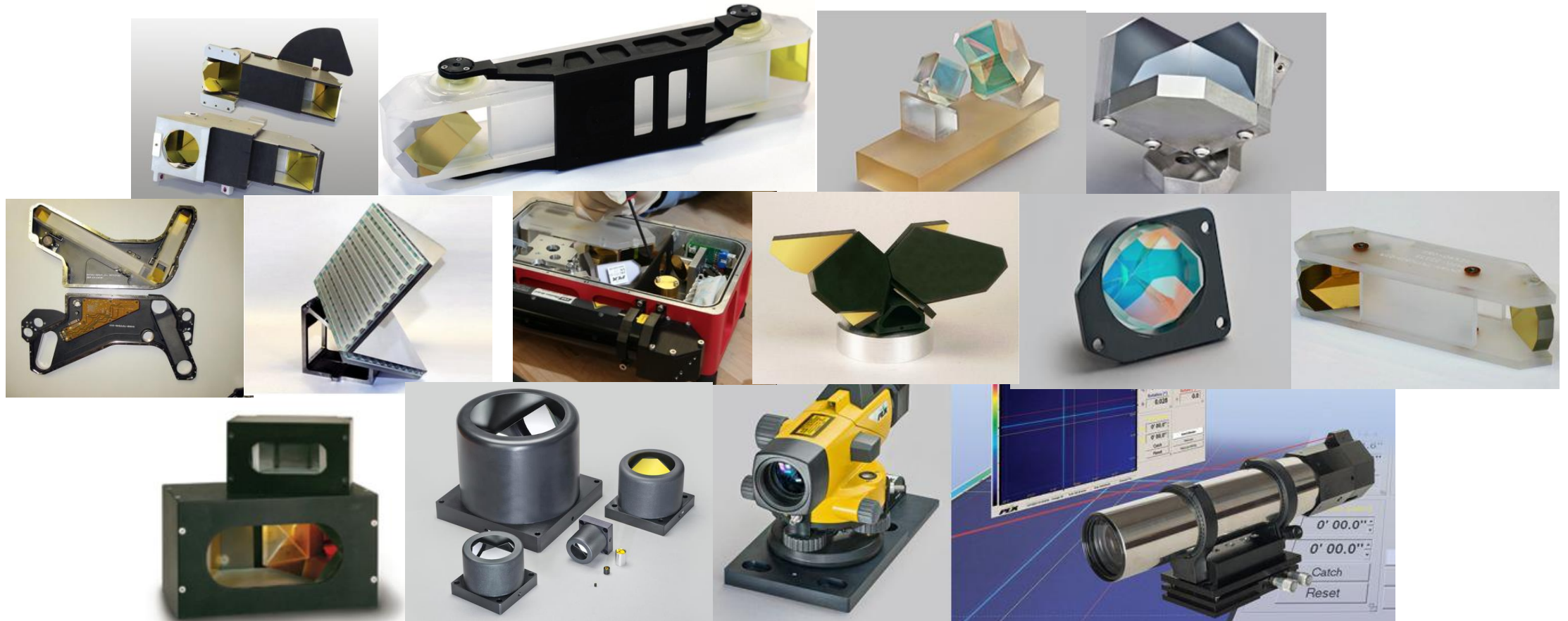


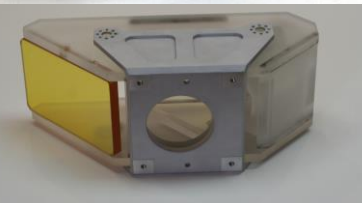
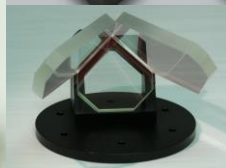
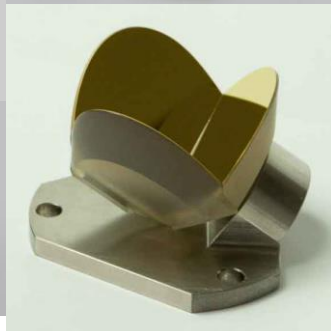
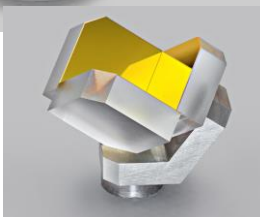
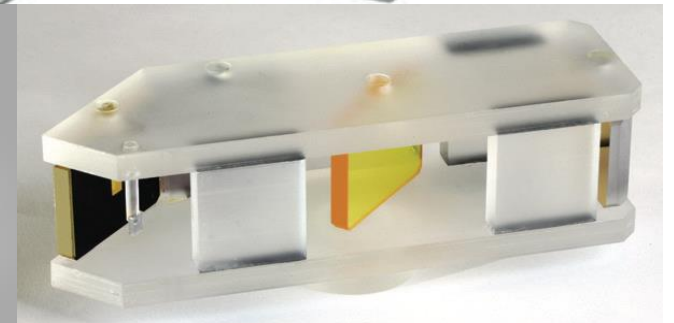
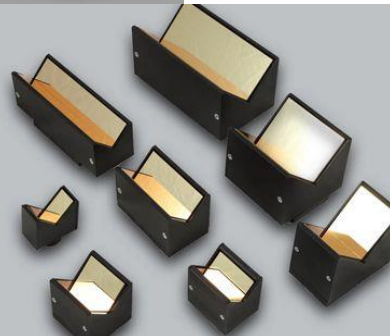
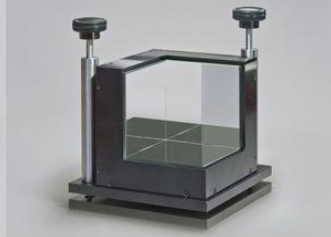
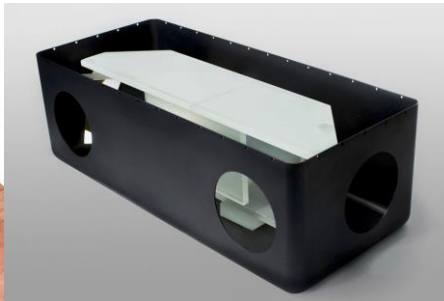
**PLX has delivered assemblies meeting the following performance:**





## An infinite amount of applications





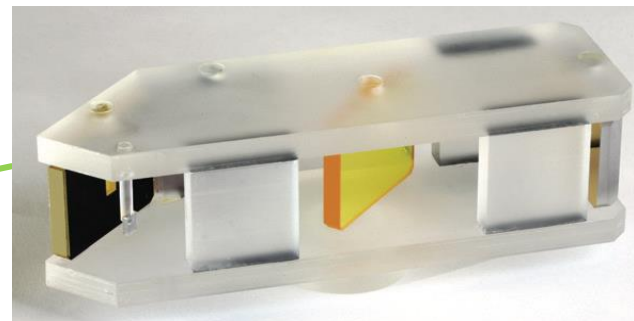
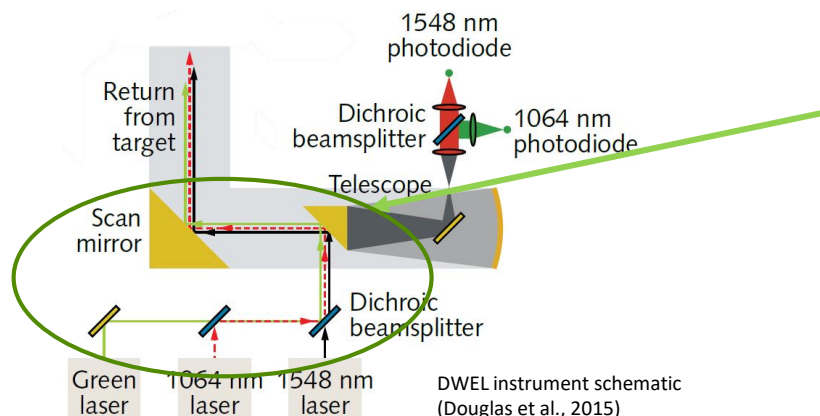




## Future Applications

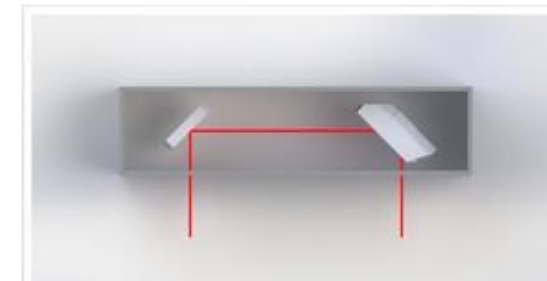
### LiDAR – Light Detection And Ranging

- ✦ ABI Research forecasts more than 69 million automotive LiDAR sensor will ship in 2026.
- ✦ The Dual-Wavelength Echidna Lidar (DWEL) collects simultaneous scans of forests with two lasers at different wavelengths.
- ✦ LiDAR system for Airborne measurement of clouds and aerosols.



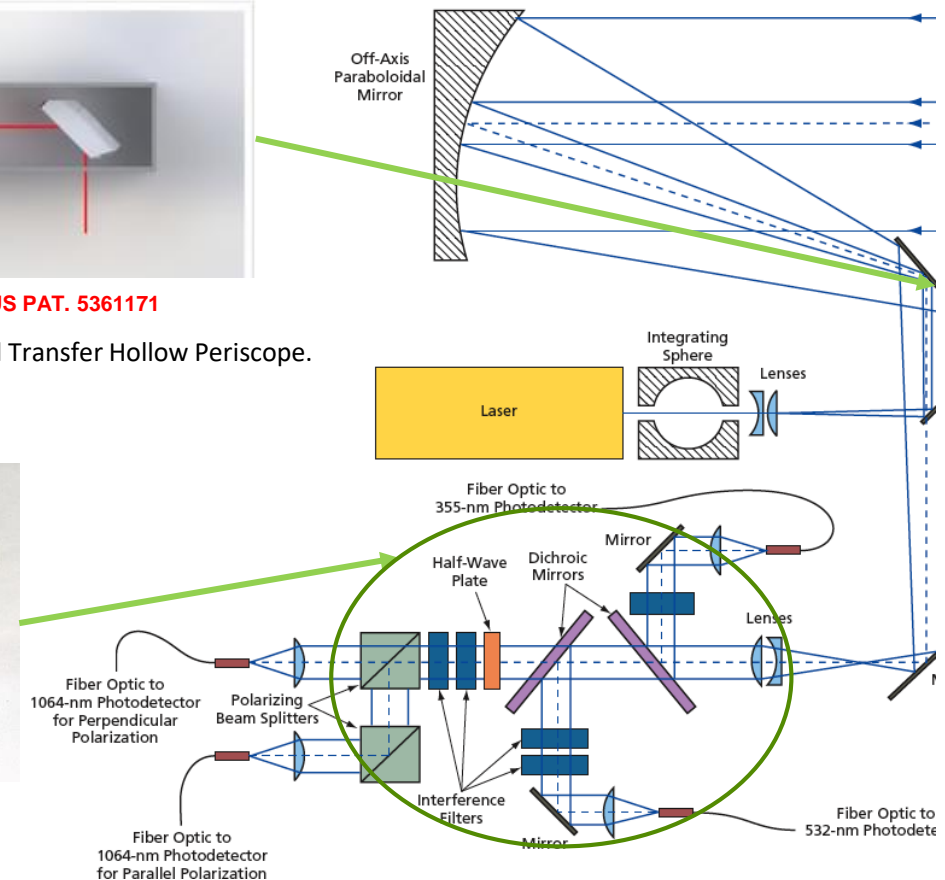
US PAT. 6752503 US PAT. 6141101 US PAT. 5949543

An Example of PLX's M.O.S.T Product.



US PAT. 5024514 US PAT. 5361171

An Example of PLX's Lateral Transfer Hollow Periscope.



Simplified Optical layout of Airborne LiDAR System (Matthew McGill et al.)



## Free-Space Optical Communication (FSO)



# Future Applications

- ✧ PLX is currently in development of a custom MEMS Retroreflector in conjunction with Boston Micromachines.
- ✧ The Modulating Retroreflector (MRR) system has been demonstrated to provide continuous asymmetric free space optical communication at data rates up to 200 Kbps using a binary modulation scheme.

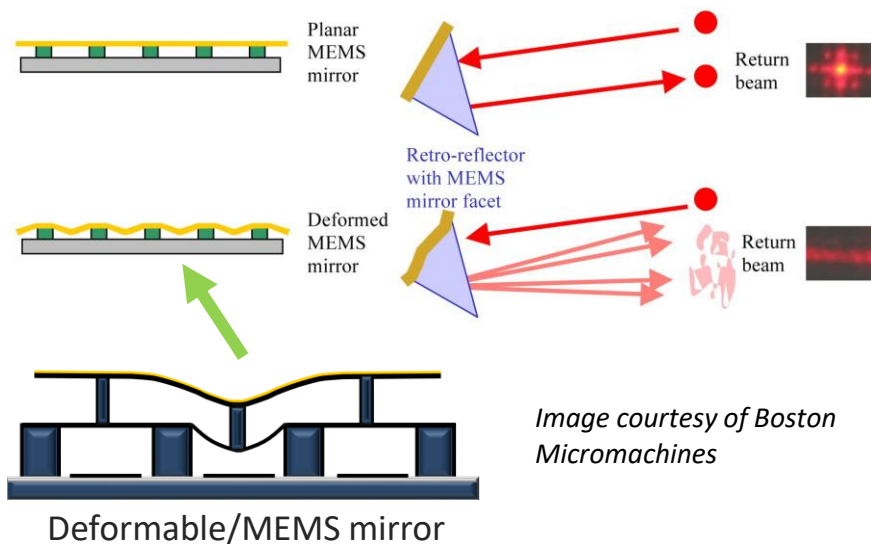
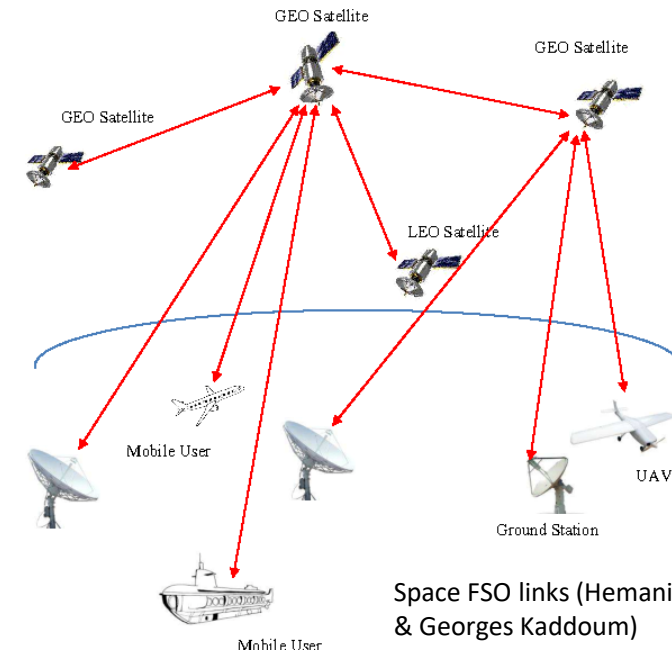


Image courtesy of Boston Micromachines



A Boston Micromachines MMR with PLX Retroreflector

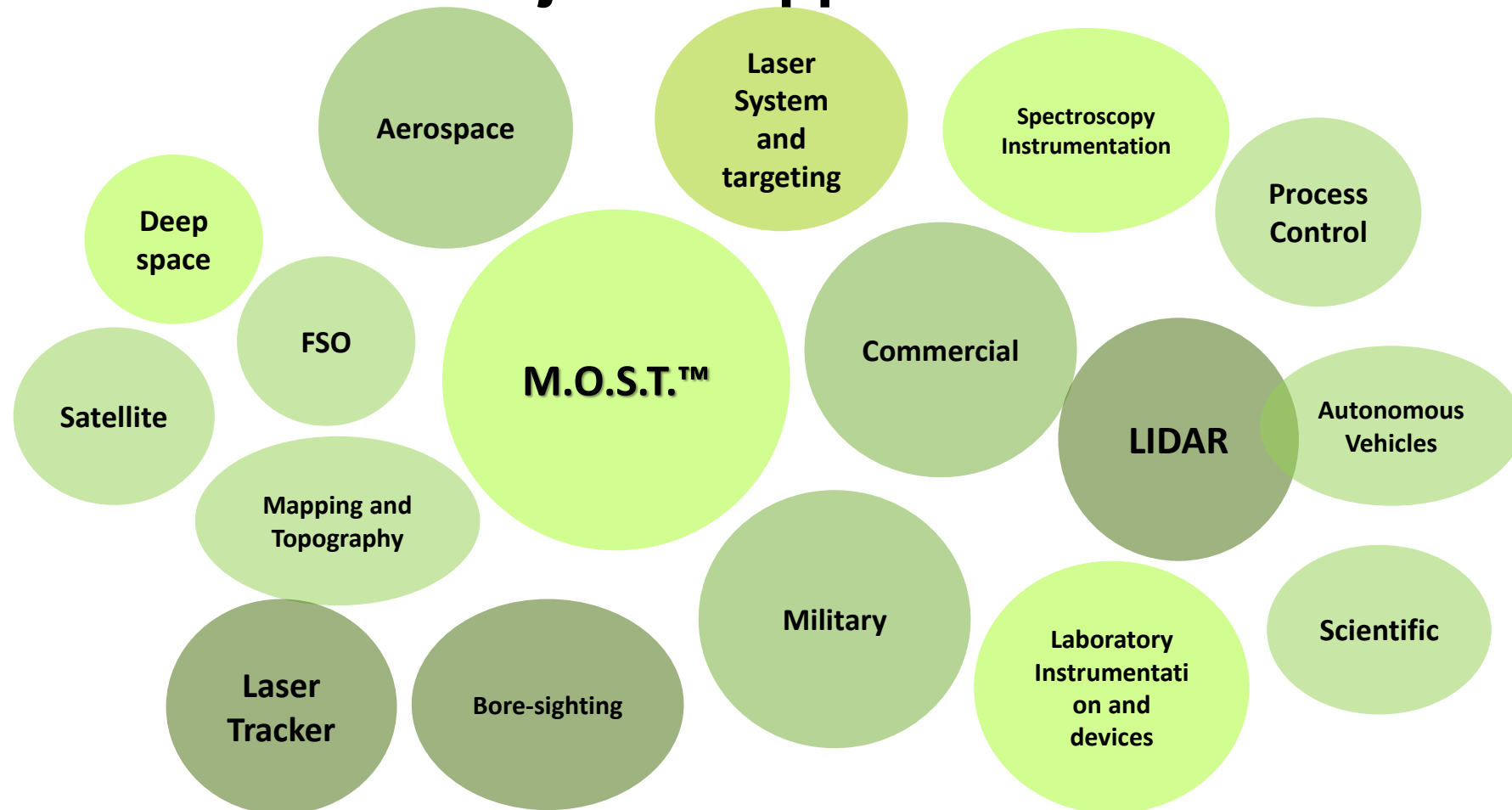


Space FSO links (Hemani Kaushal & Georges Kaddoum)

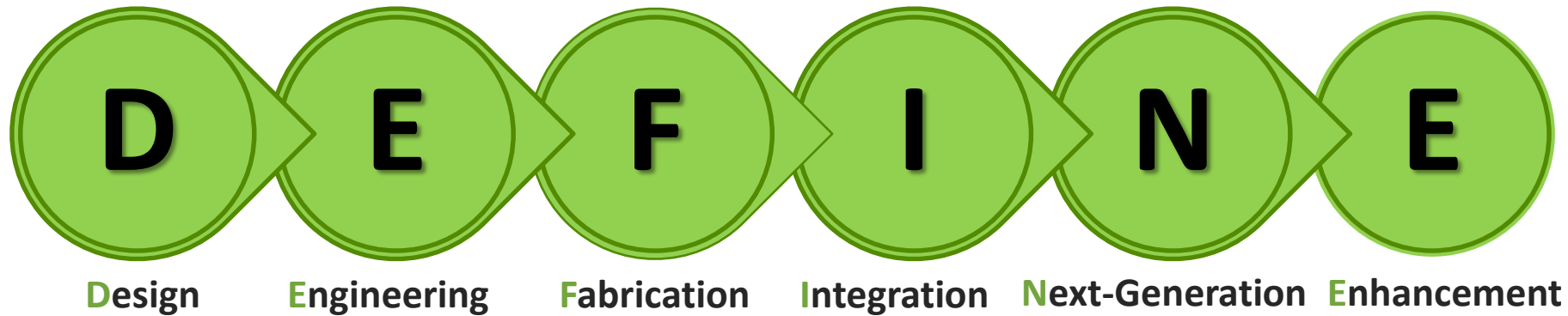
- ✧ Ground-to-satellite (satellite-to-ground) links
- ✧ inter-satellite links
- ✧ deep space links



## Projects / Applications







**DEFINE** your requirements and we will utilize  
and adapt our technology to meet your needs

Thank You!  
Itai Vishnia  
iv@plxinc.com

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