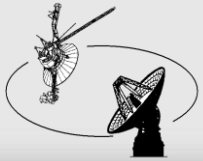

Omnidirectional Optical Communicator for Space Applications

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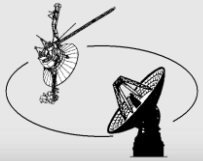
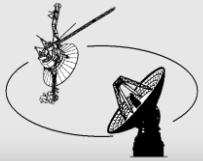
Jet Propulsion Laboratory, California Institute of Technology

Inter-Spacecraft Omnidirectional Optical Communicator (ISOC)



Outline

1. Description of ISOC
2. ISOC Design and Testing
3. Technology Demonstration Mission Concept
4. Conclusions



Acknowledgements

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  University of California – Irvine (UCI)

  Professor Ozdal Boyraz and his team

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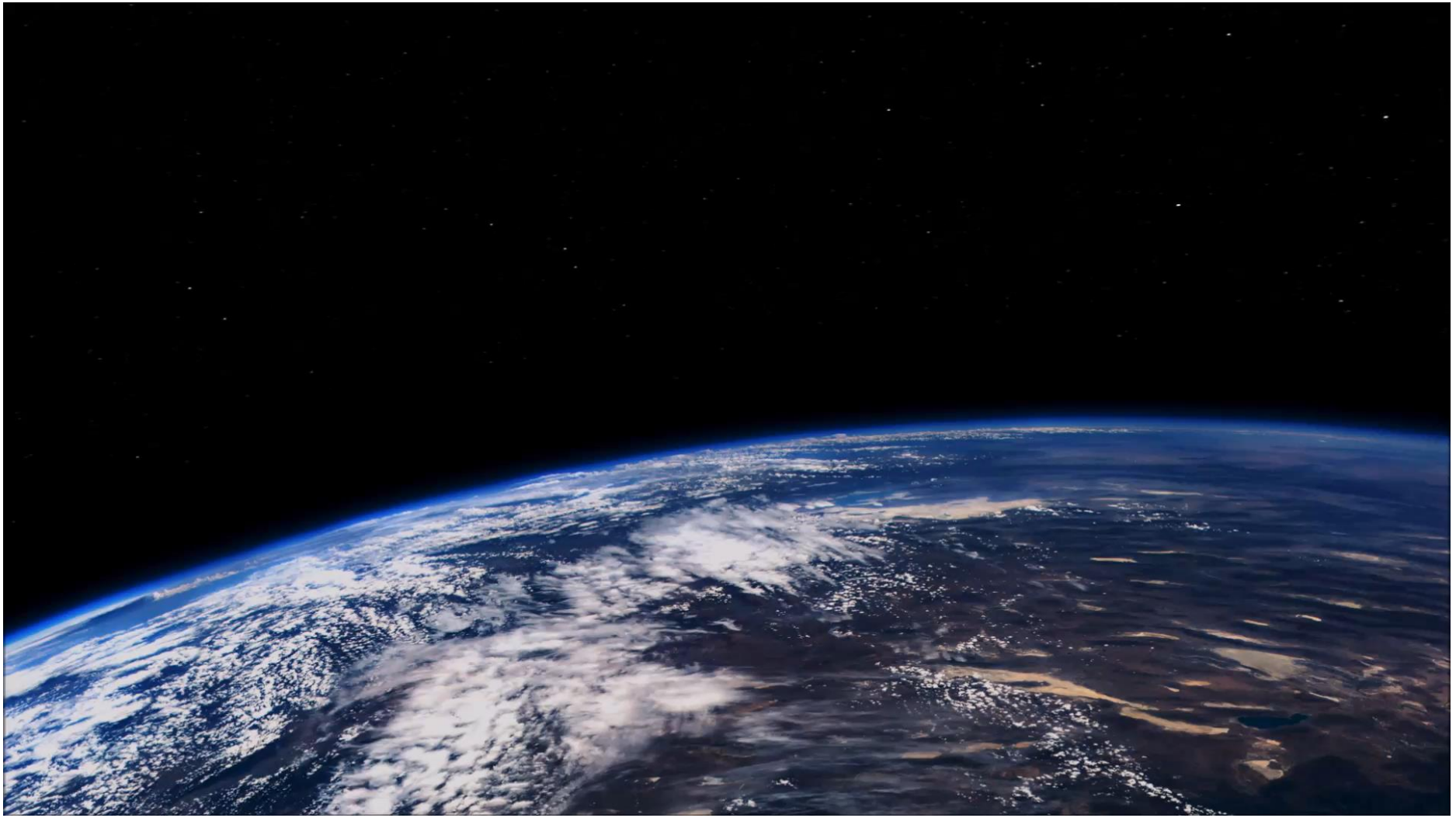
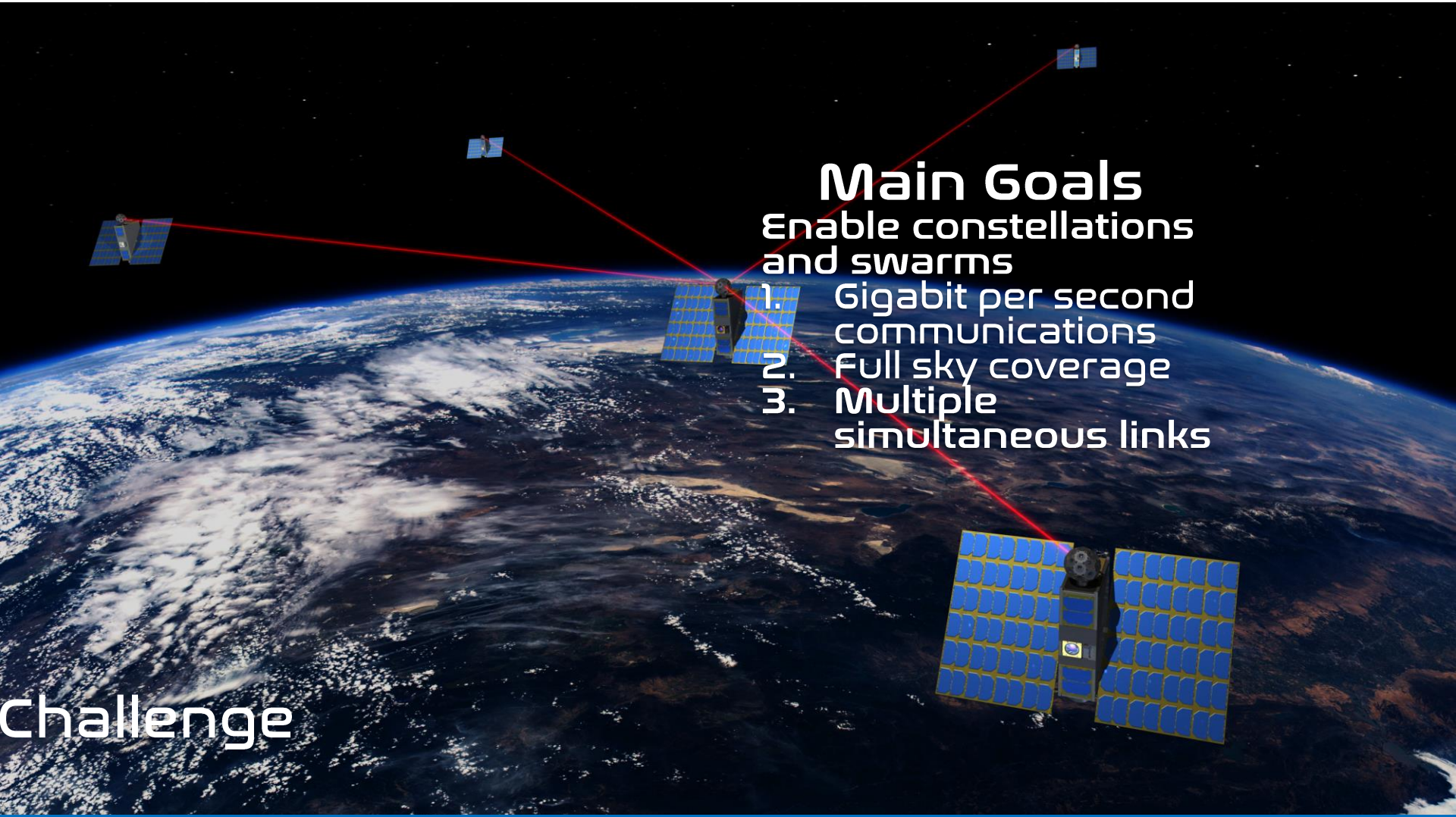
1. Description of ISOC



Description of ISOC: Inspiration

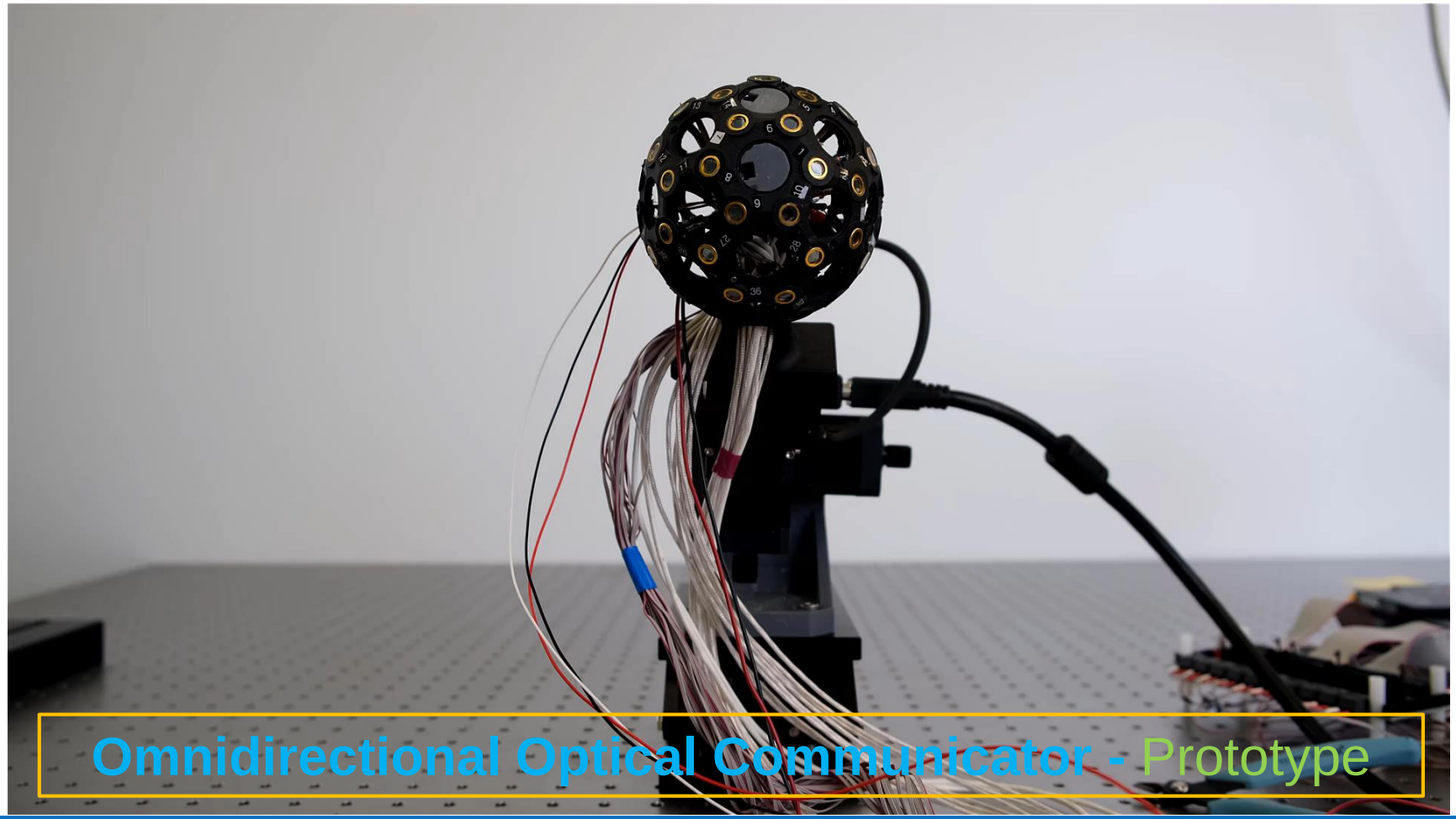
1. Description of ISOC



Description of ISOC: Challenge

1. Description of ISOC

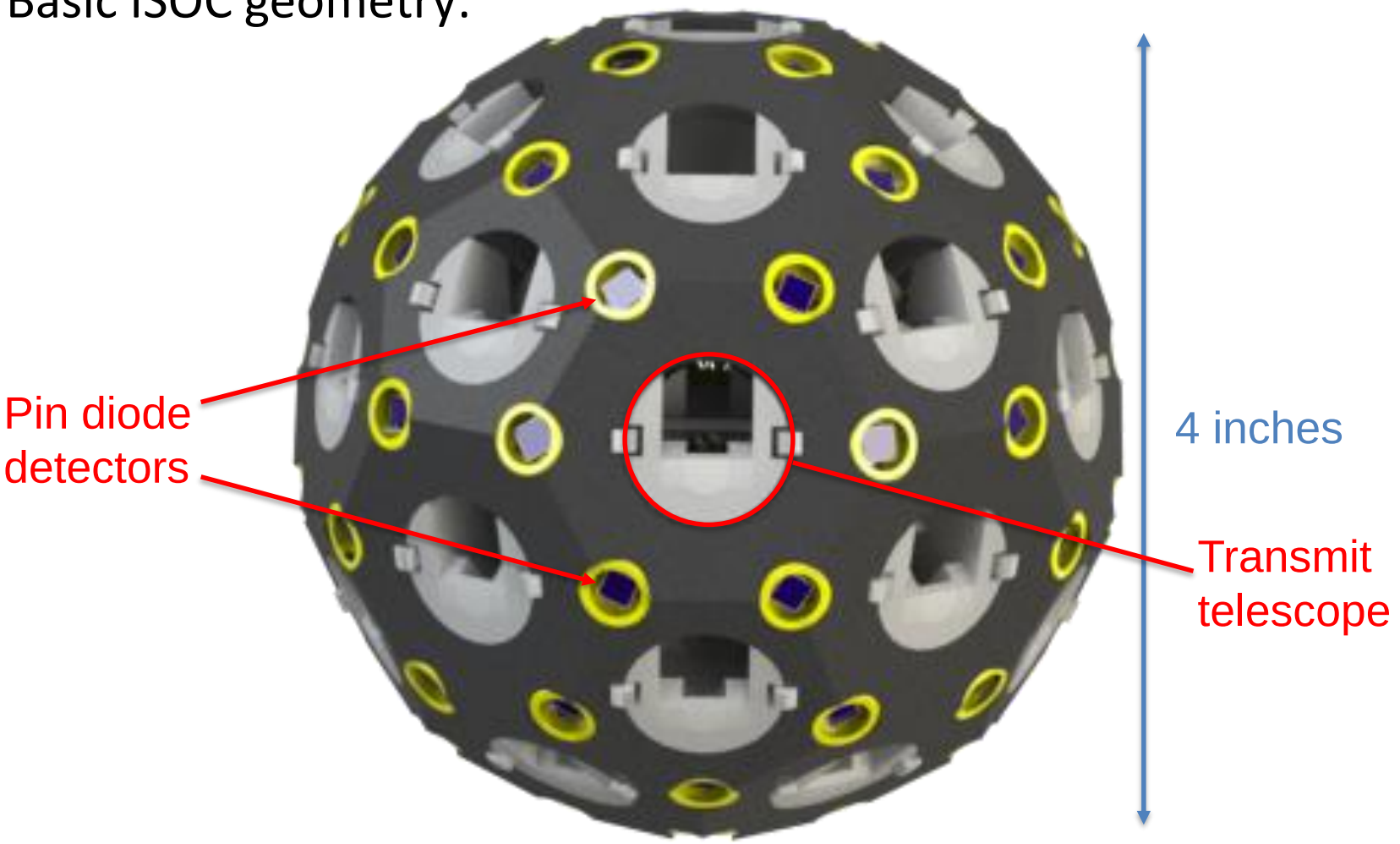
Let me introduce to you the ISOC:



Description of ISOC: ISOC Introduction

1. Description of ISOC

Basic ISOC geometry:

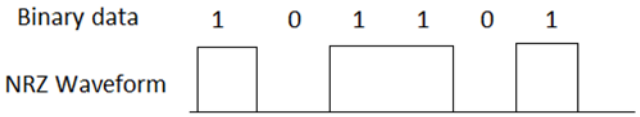


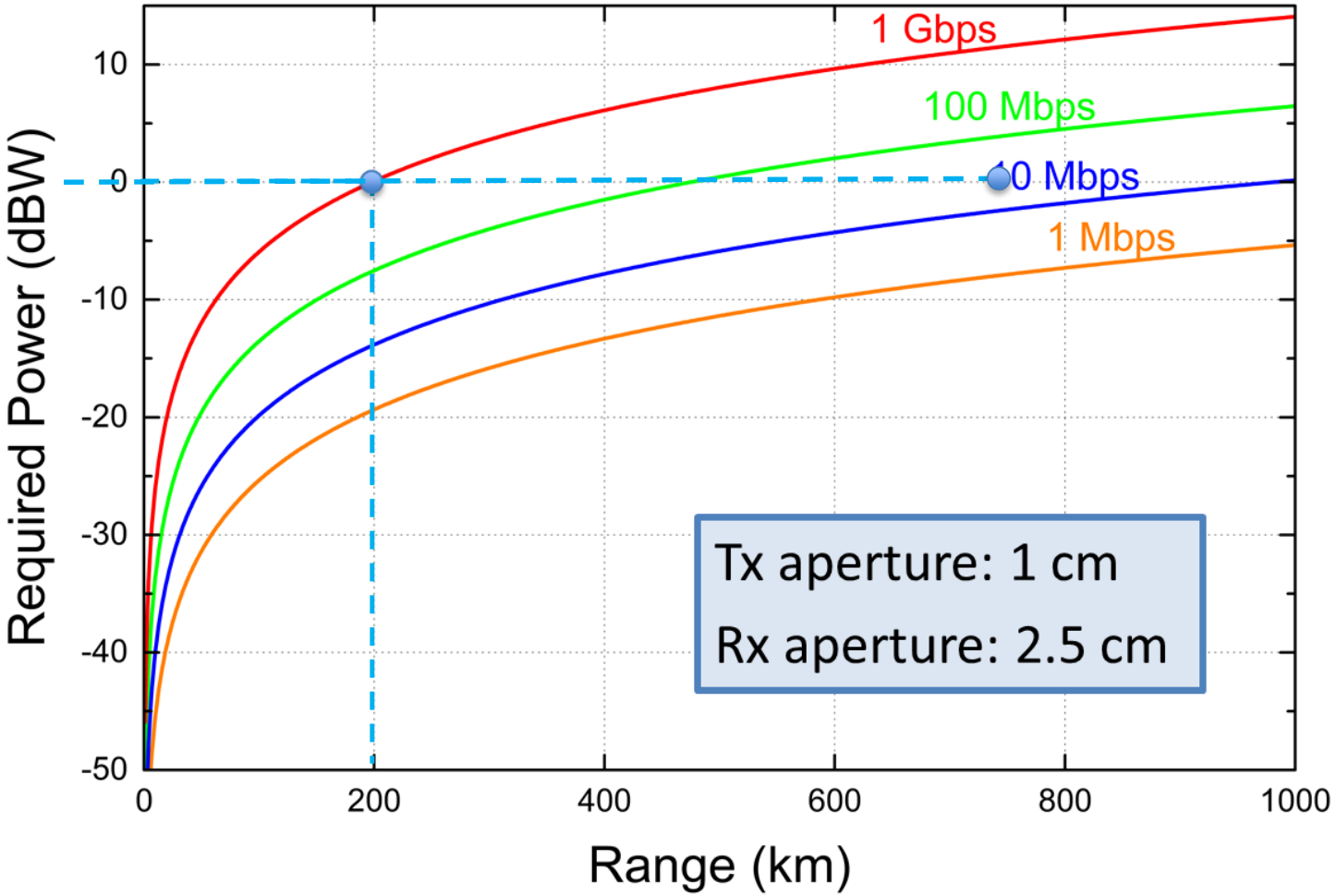
Description of ISOC: Basic ISOC geometry

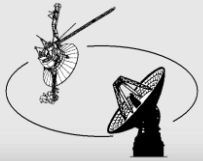
1. Description of ISOC

NRZ - OOK (On-Off Keying)

- Bandwidth (BW) = Bitrate (R_b)





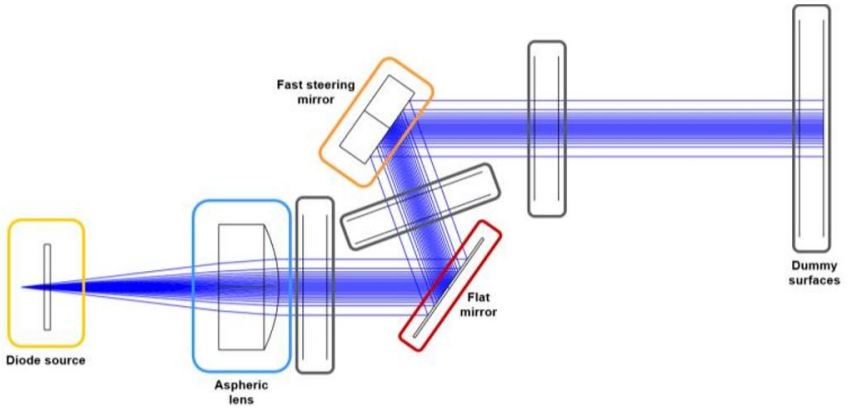


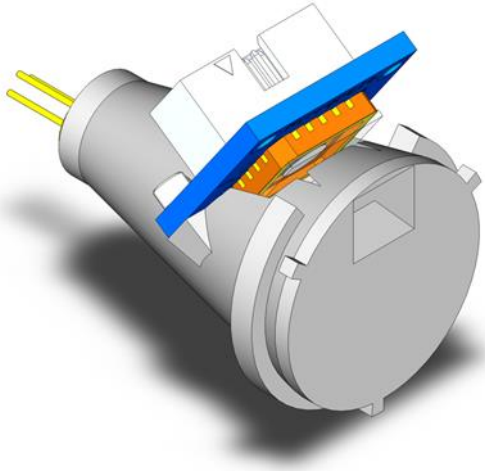
1. ISOC Design and Testing

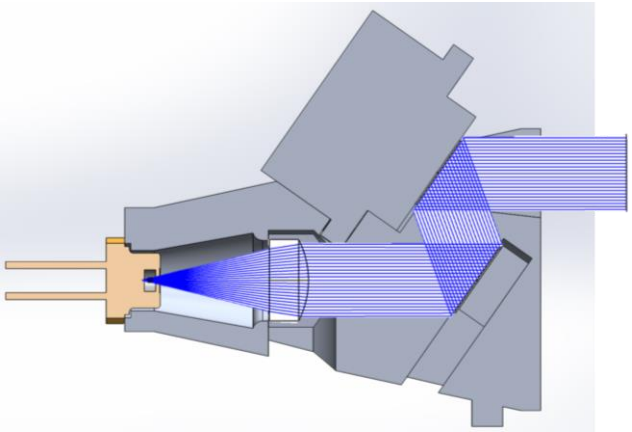
- Transmit telescopes
- Beam steering
- Angle-of-Arrival
- Data rate

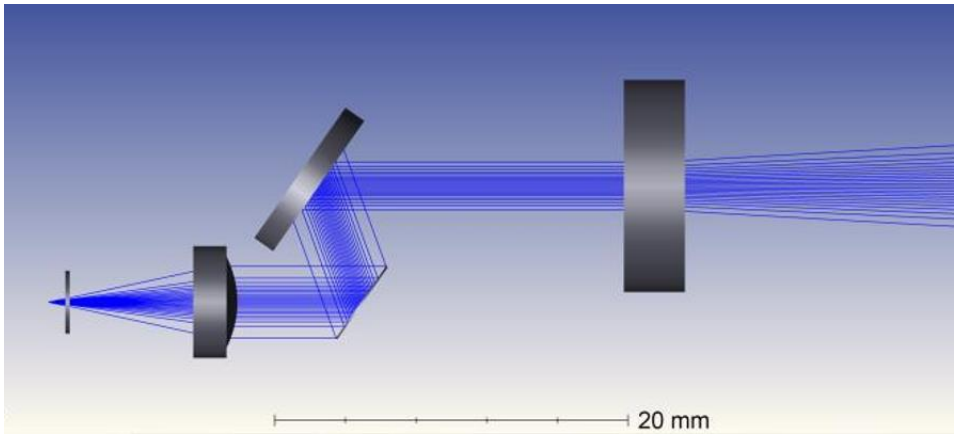
2. ISOC Design

ISOC Transmit Telescope - ZEMAX





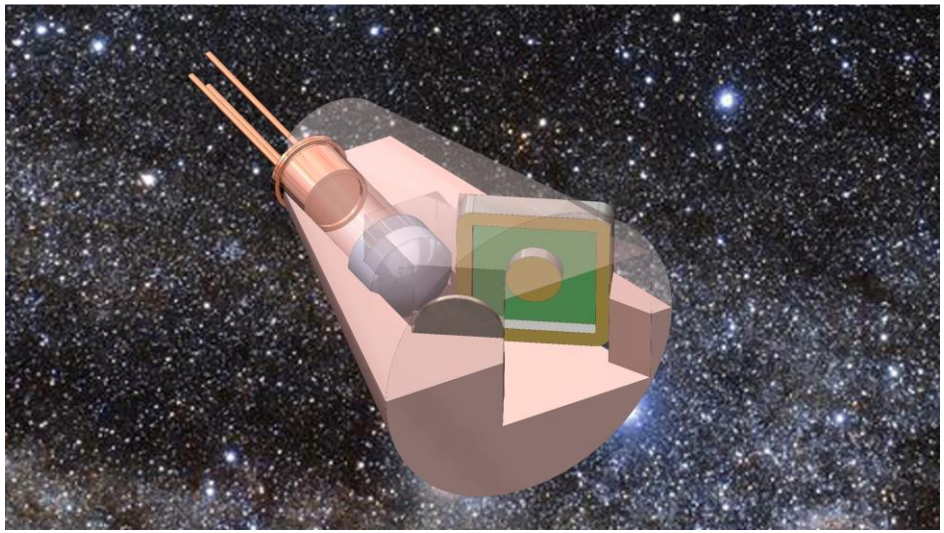


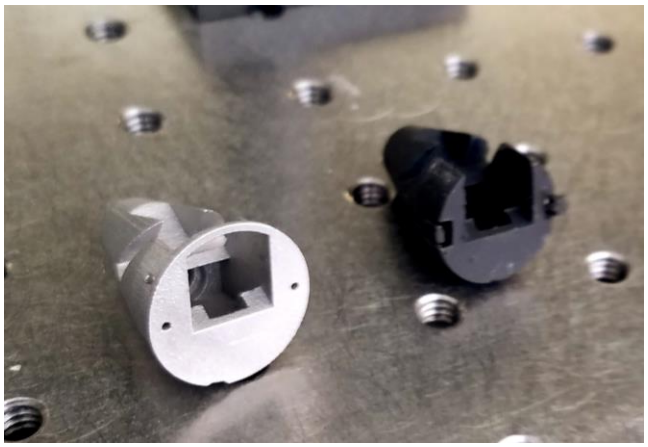


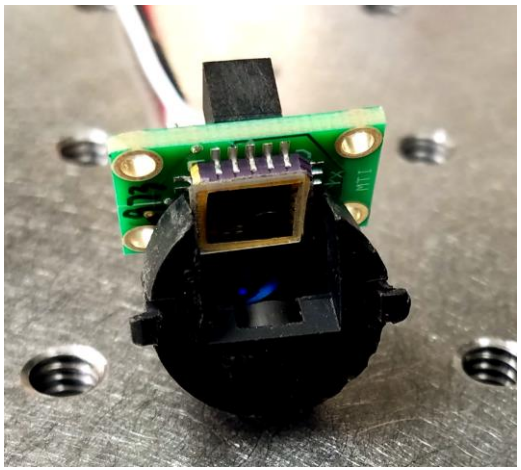
Description of ISOC: Transmit Telescope

2. ISOC Design

ISOC Transmit Telescope



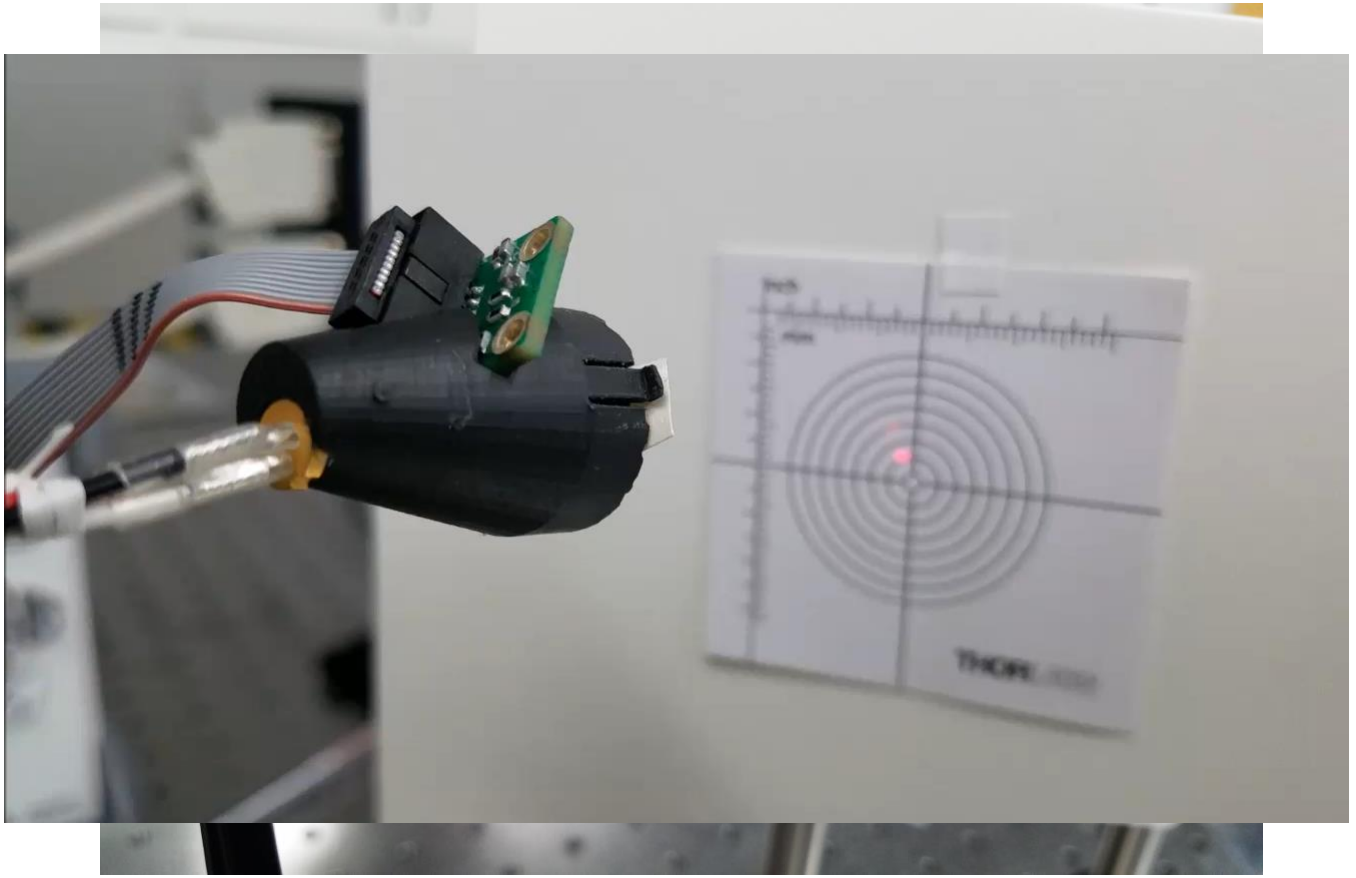




Omnidirectional Optical Communicator

2. ISOC Testing

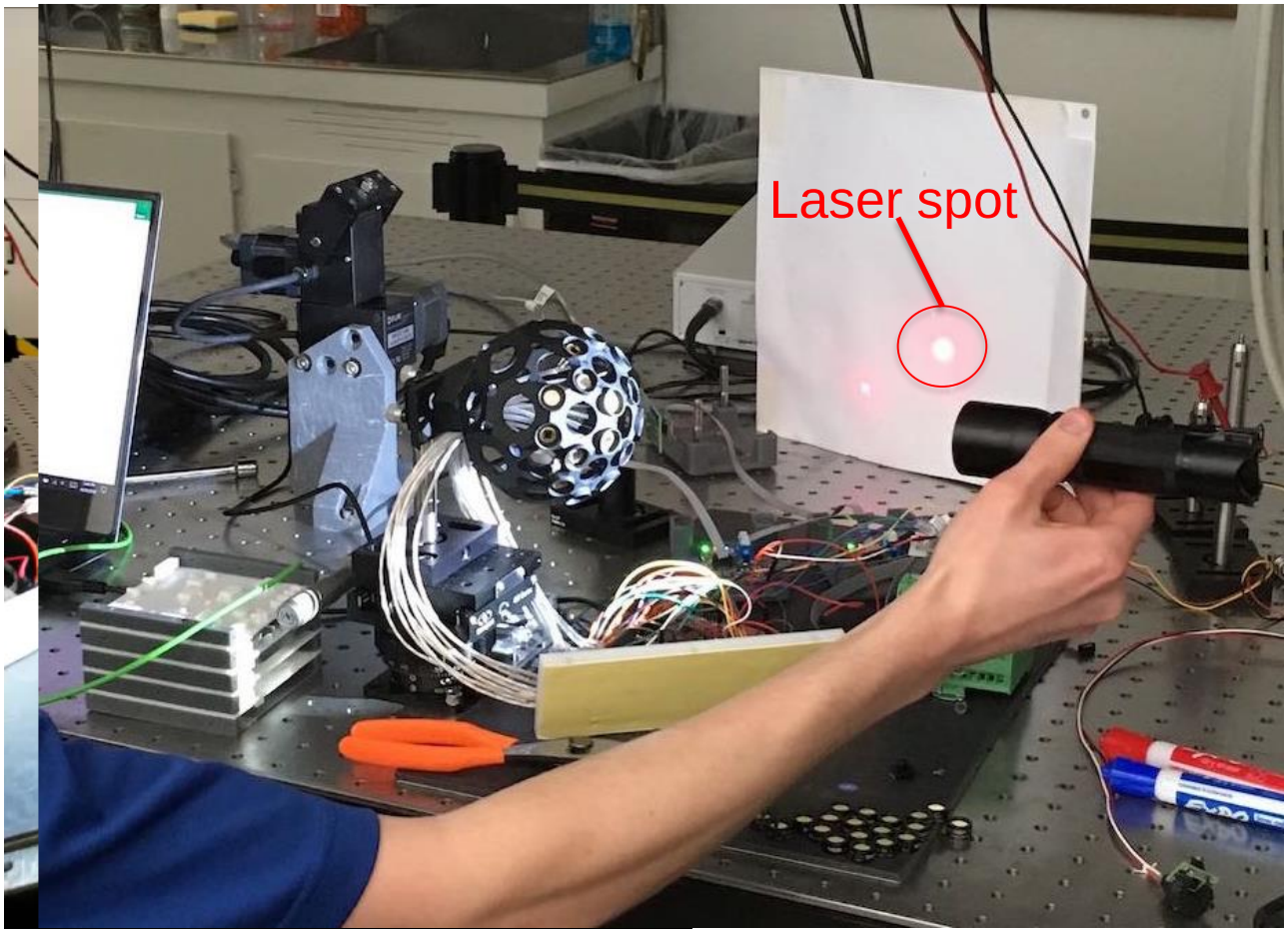
Miniature telescope testing



ISOC Telescope: Tx Telescope Testing

2. ISOC Testing

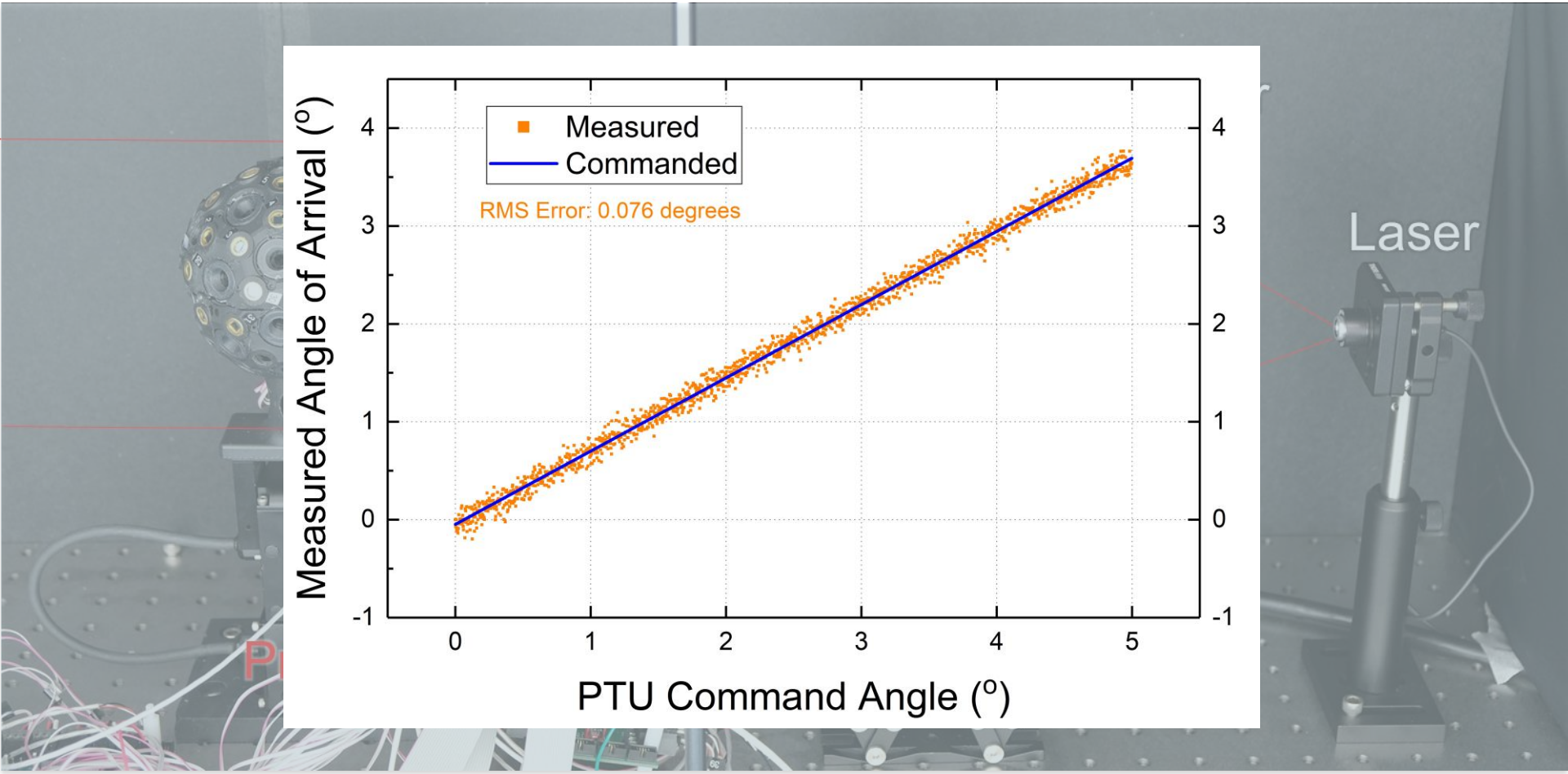
ISOC Angle-of-Arrival & Pointing testing



ISOC Telescope: Telescope Testing

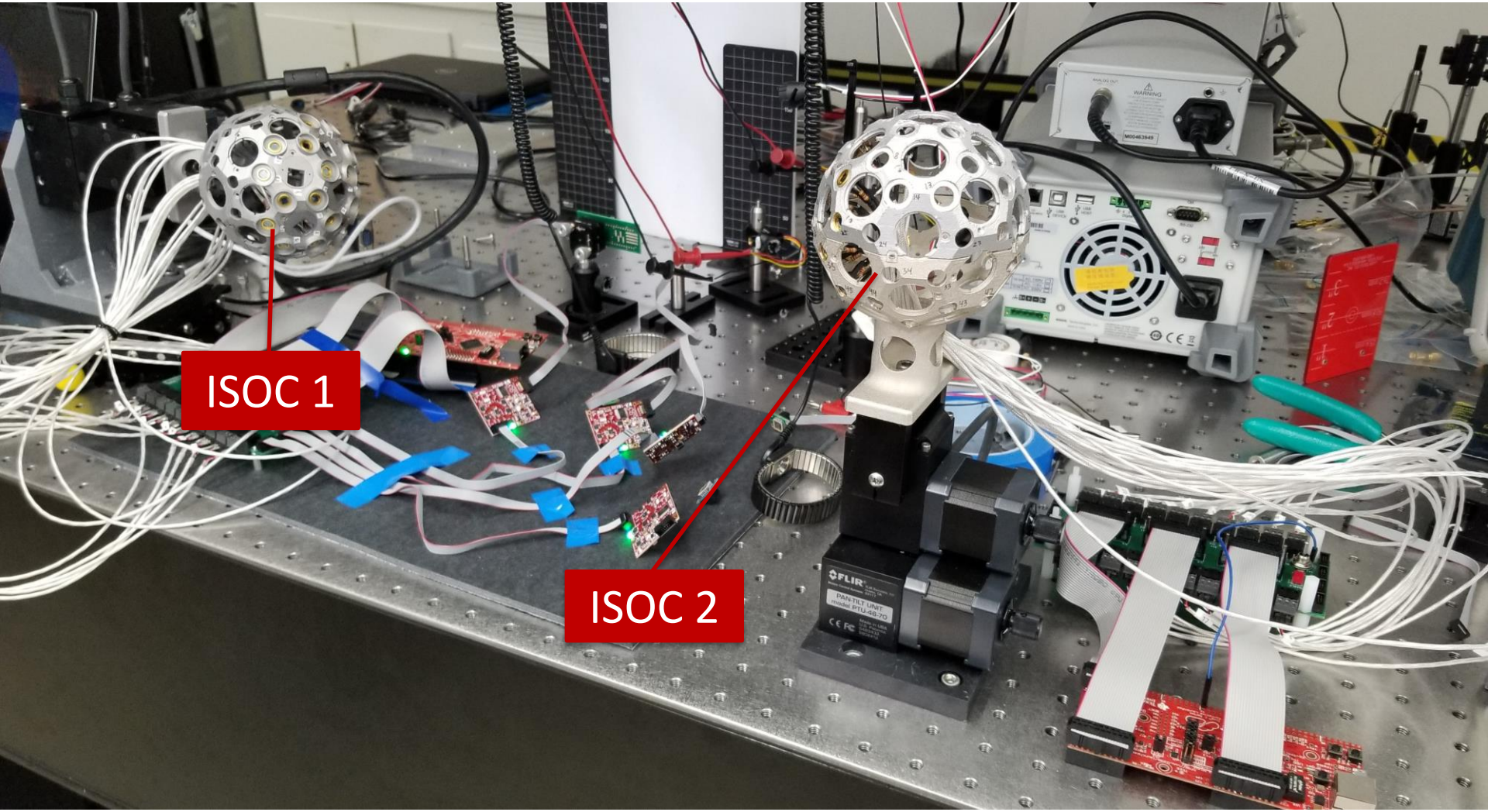
2. ISOC Testing

ISOC Angle-of-Arrival testing



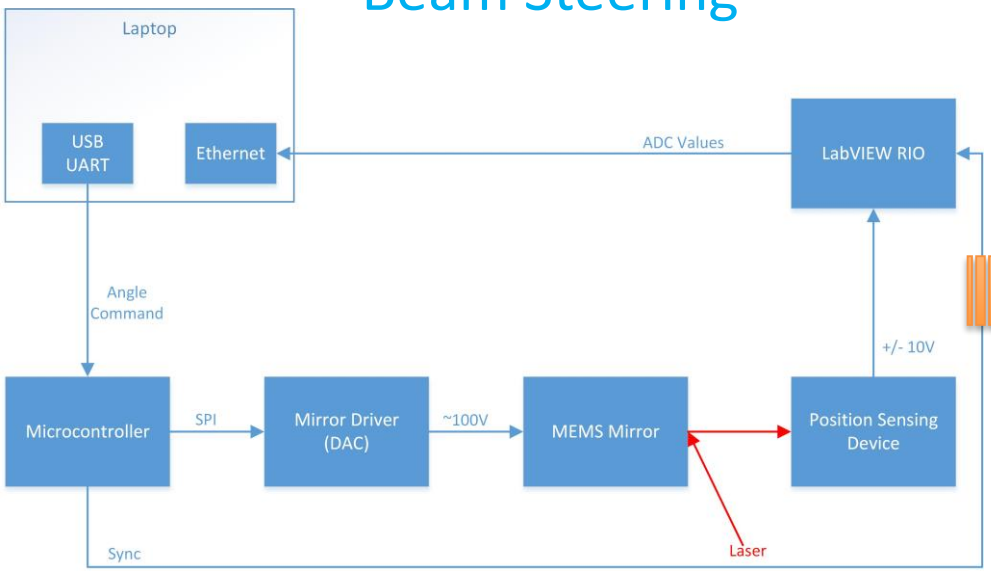
2. ISOC Testing

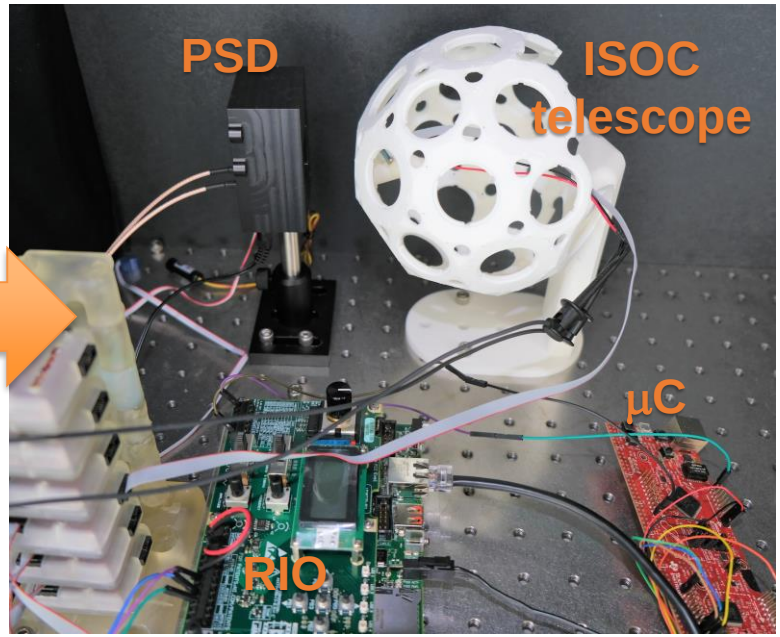
ISOCs under testing

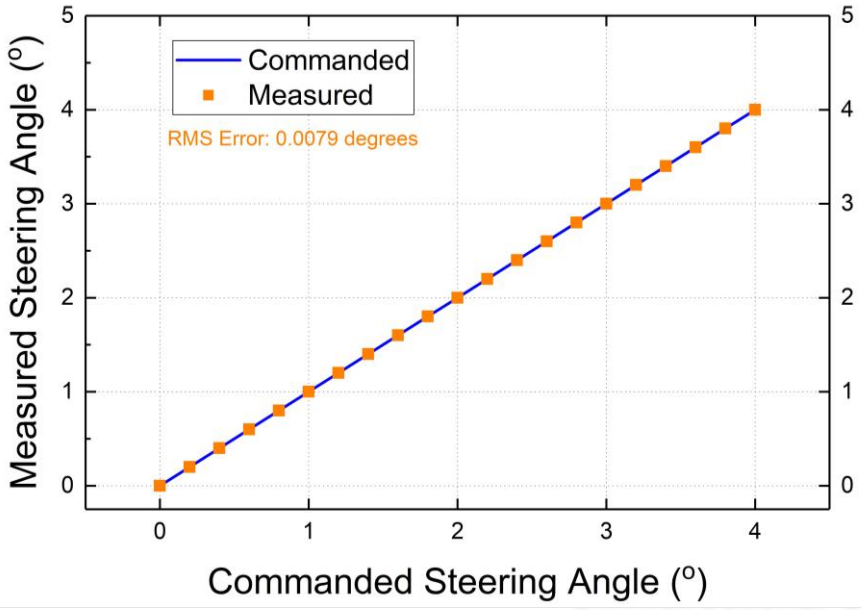


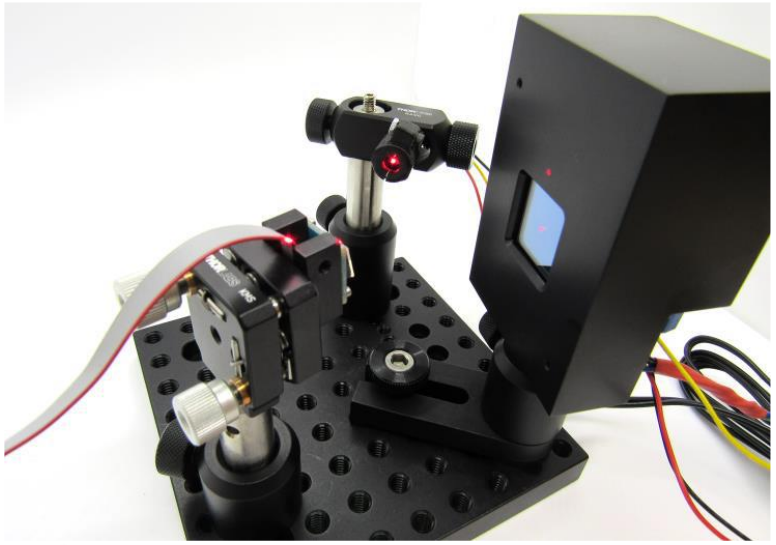
2. ISOC Testing

Beam Steering



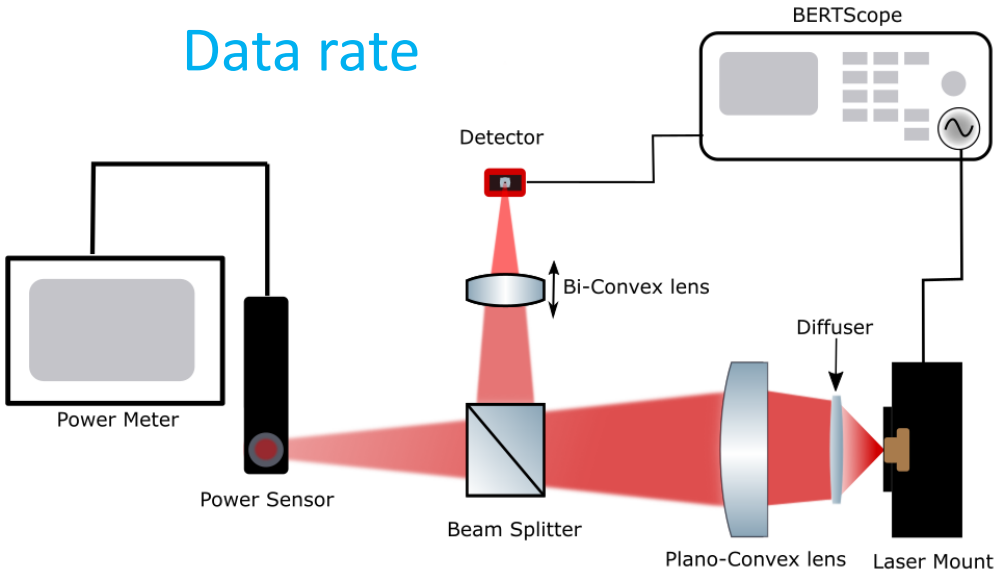


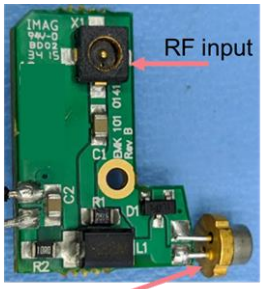


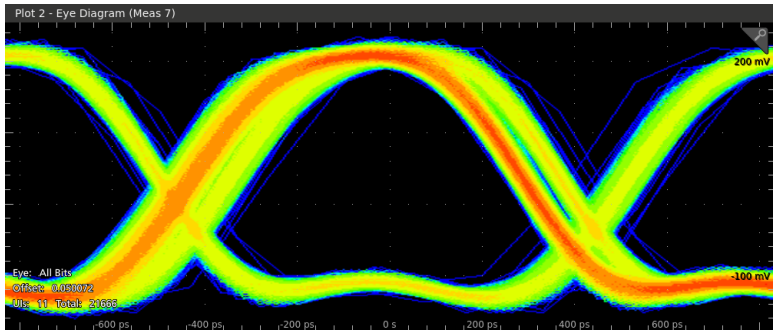


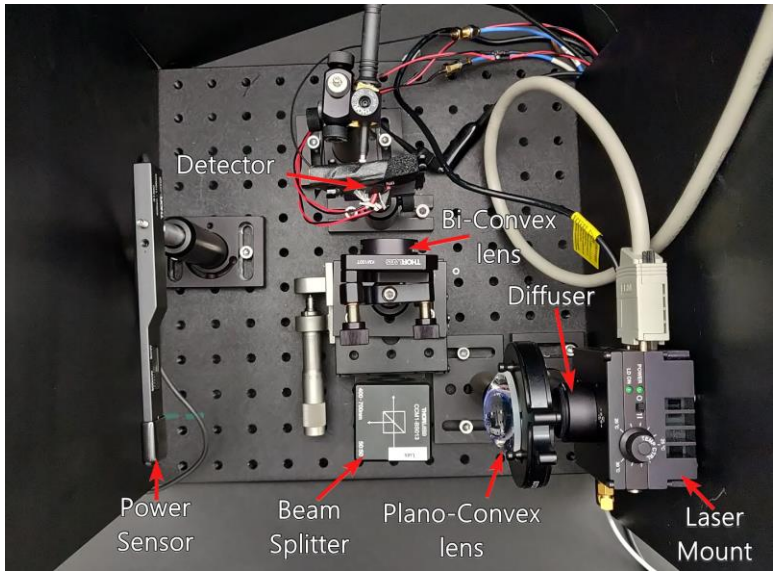
2. ISOC Testing

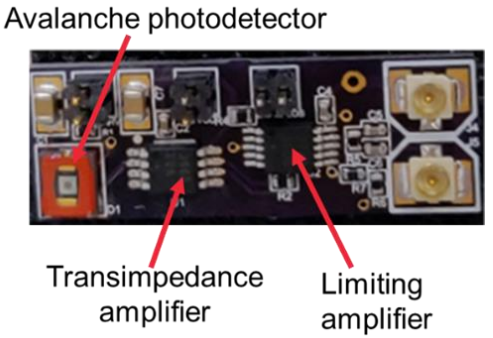
Data rate







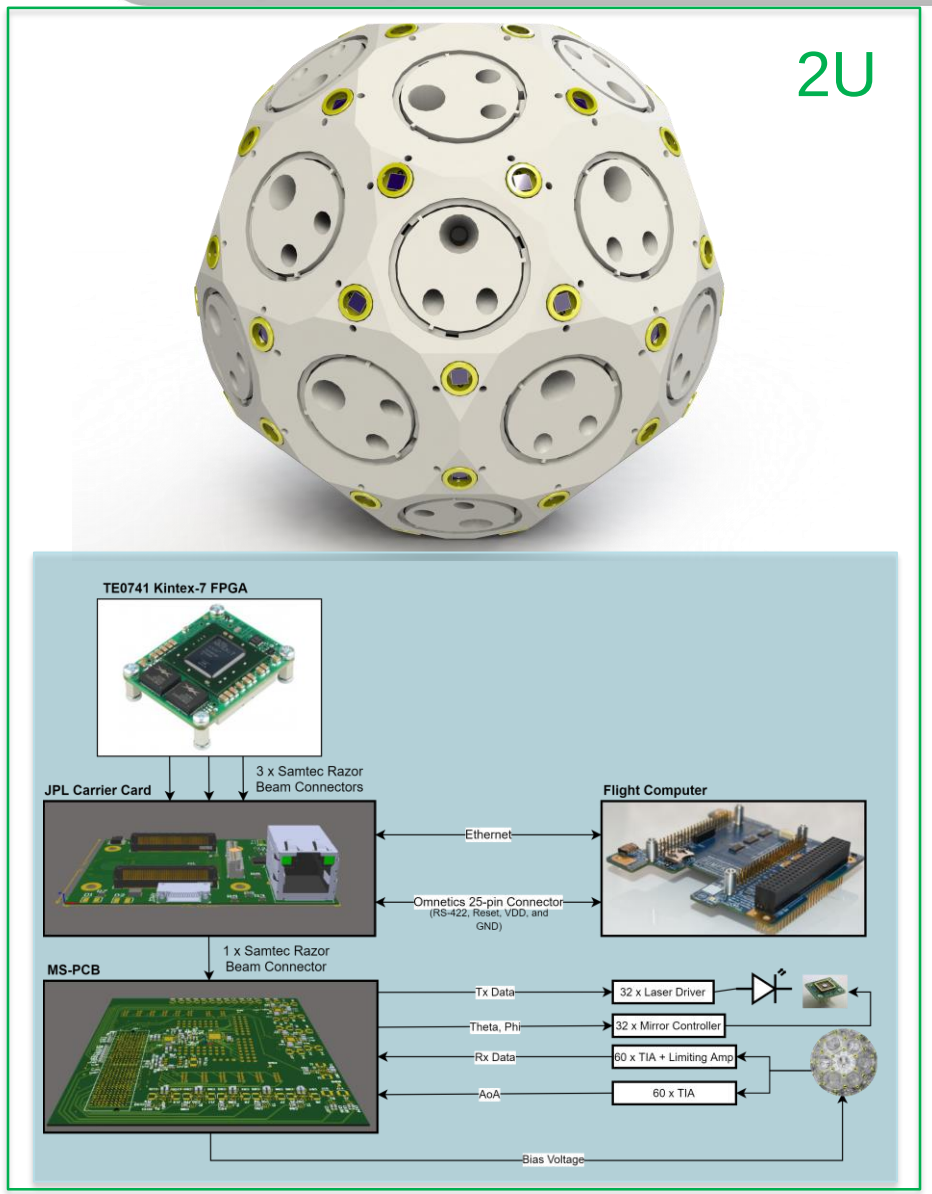




2. ISOC Testing

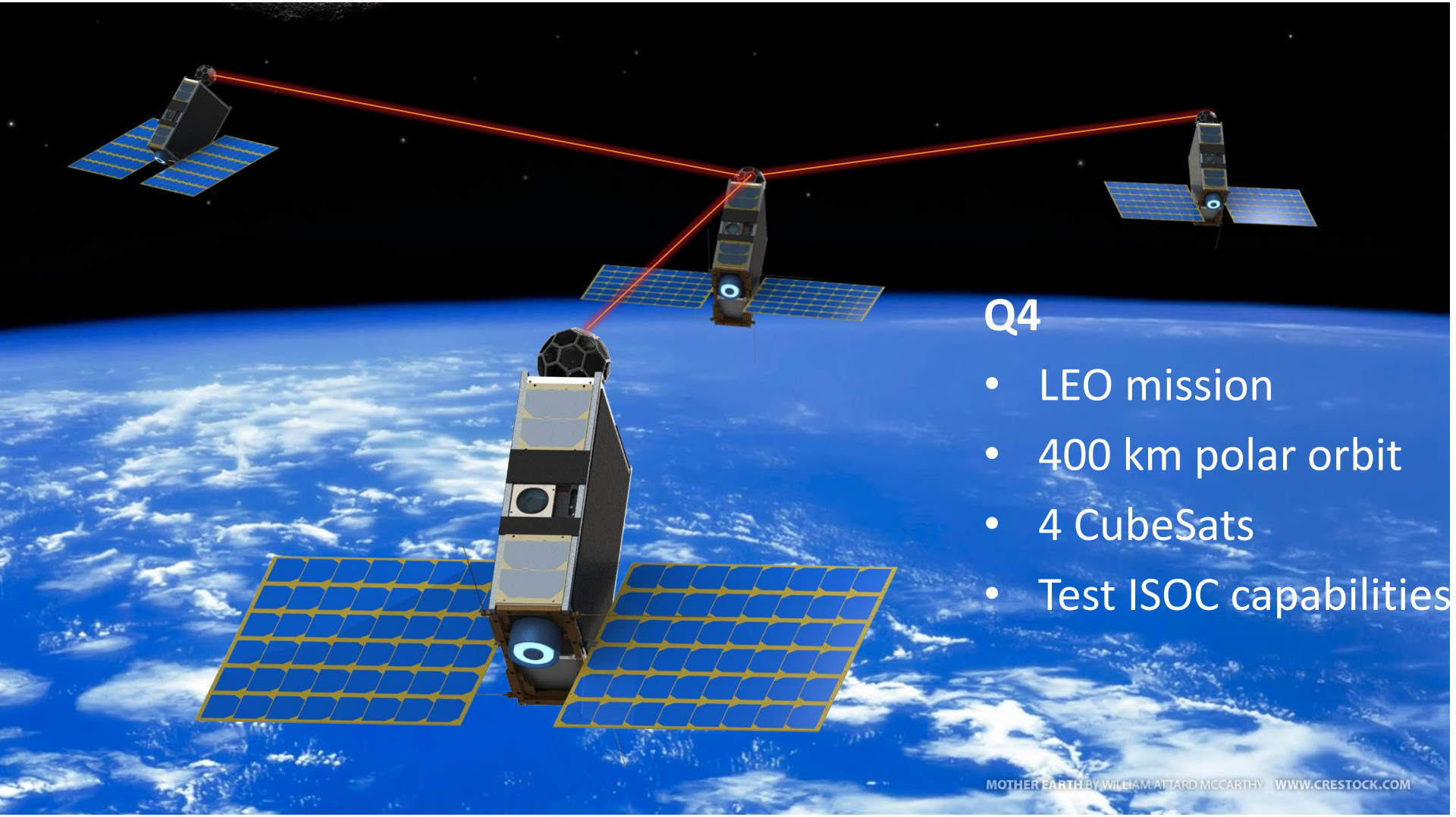
ISOC Flight Model

ISOC Parameters	
Parameter	**Value**
Wavelength	850 nm
Optical Tx Power (per laser)	1 W
Transmit diameter	0.5 cm
Receive diameter	1 cm
Data rate (≤200 km)	1 Gbps
Power Usage	15 W
Volume	2U
Mass	0.75 kg



3. Technology Demonstration Mission

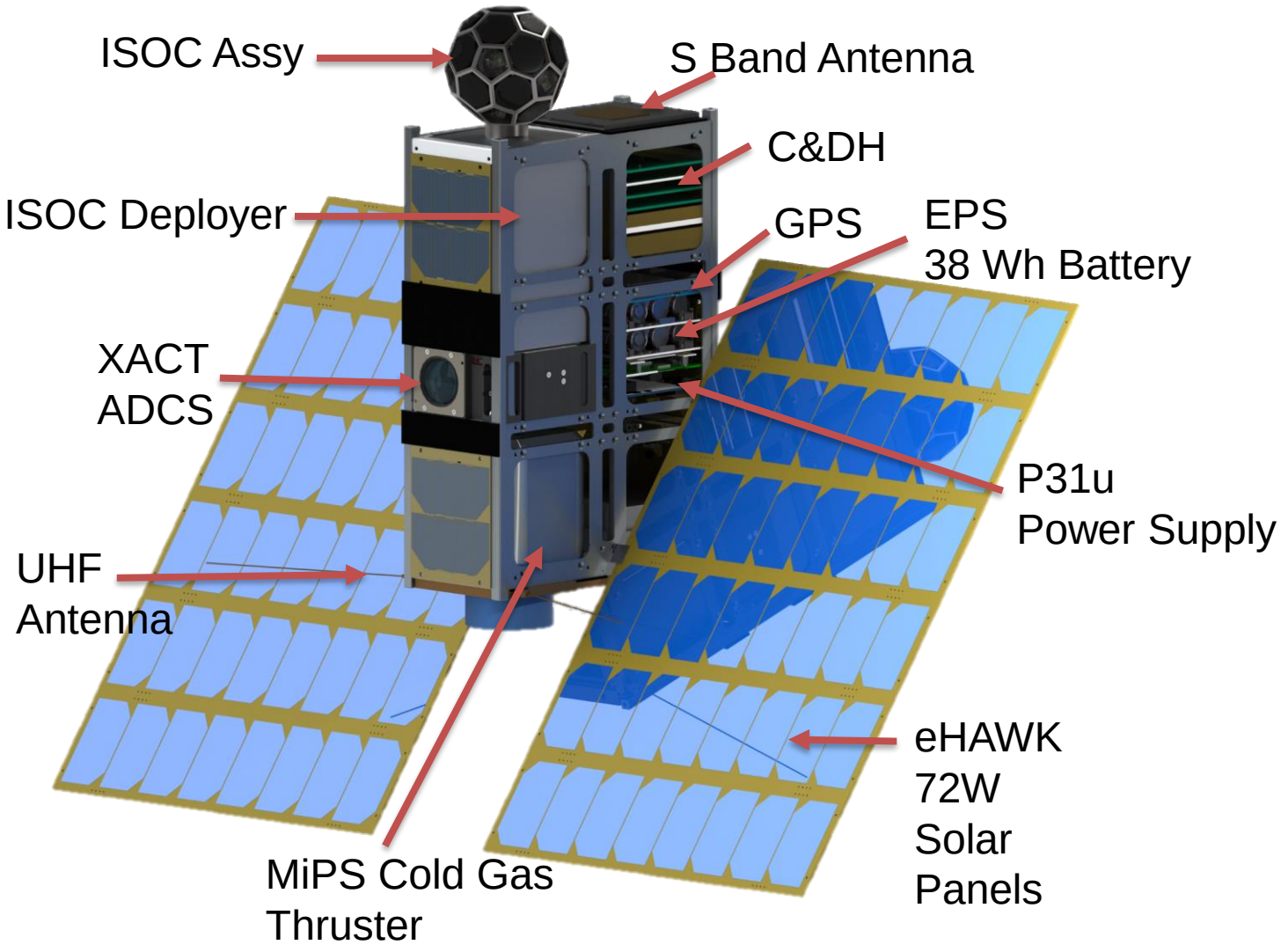
Q4



Q4

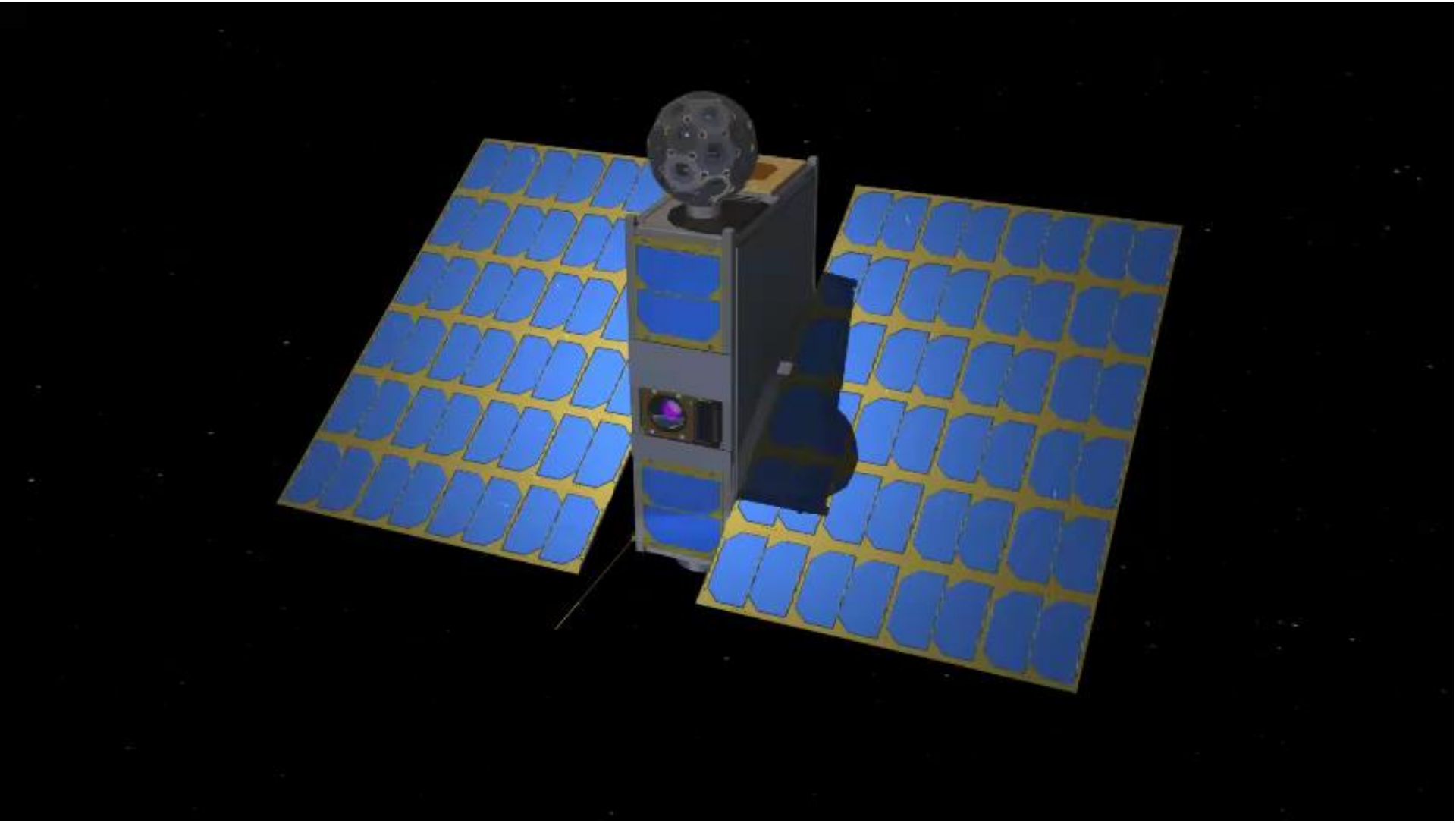
- LEO mission
- 400 km polar orbit
- 4 CubeSats
- Test ISOC capabilities

3. Technology Demonstration Mission



Omnidirectional Optical Communicator

3. Technology Demonstration Mission



Omnidirectional Optical Communicator

3. Technology Demonstration Mission

Orbital Dynamics

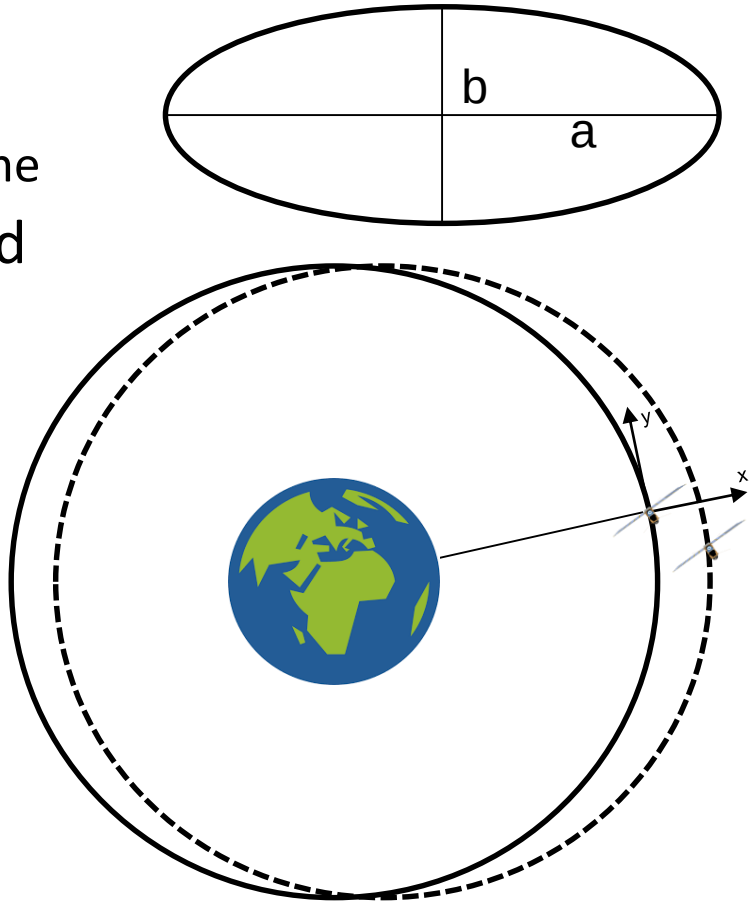
- Clohessey-Wiltshire Equations
  - Describe chaser motion in target frame
- Same semi-major axis, same period
  - Relative motion is repetitive

$$\ddot{x} - 2n\dot{y} - 3n^2x = f_x$$

$$\ddot{y} + 2n\dot{x} = f_y$$

$$\ddot{z} + n^2z = f_z$$

$$n = \sqrt{\frac{\mu}{a^3}}$$



3. Technology Demonstration Mission

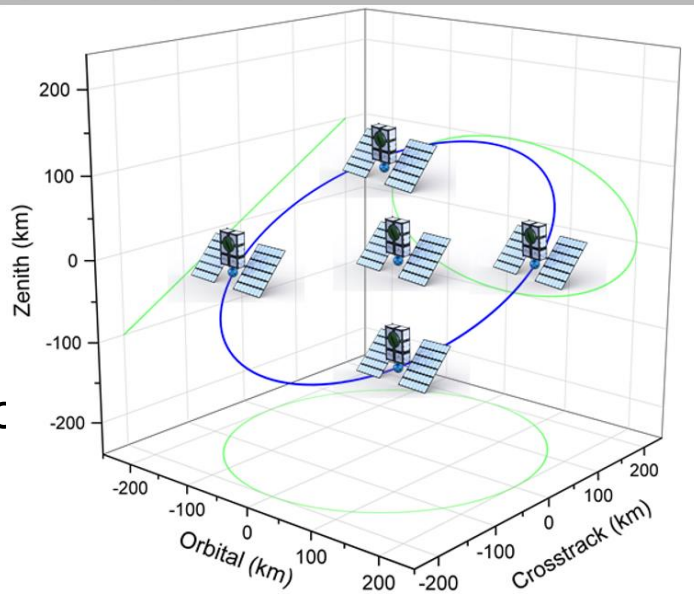
Orbital Dynamics

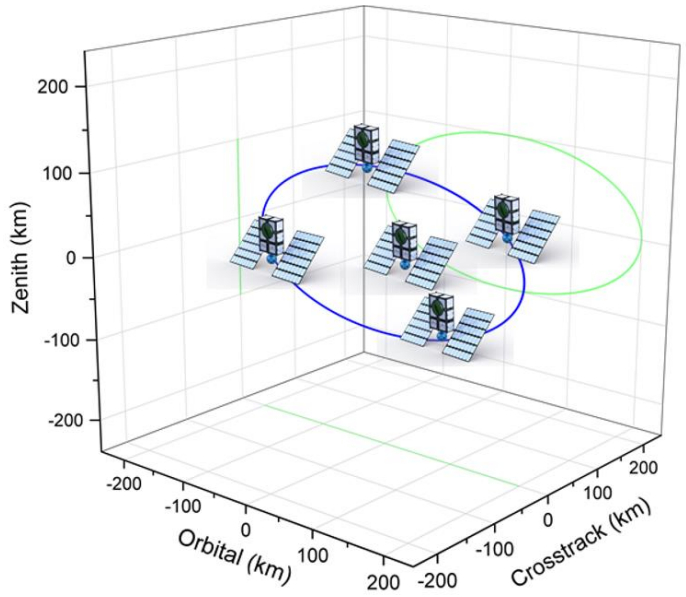
Possible Configurations

- Homogenous Analytical Solutic

$$x = A_x cos(nt + \alpha)$$
$$y = -2A_x sin(nt + \alpha) + y_{off}$$
$$z = A_z cos(nt + \beta)$$

- X,Y motion coupled
- Z motion free



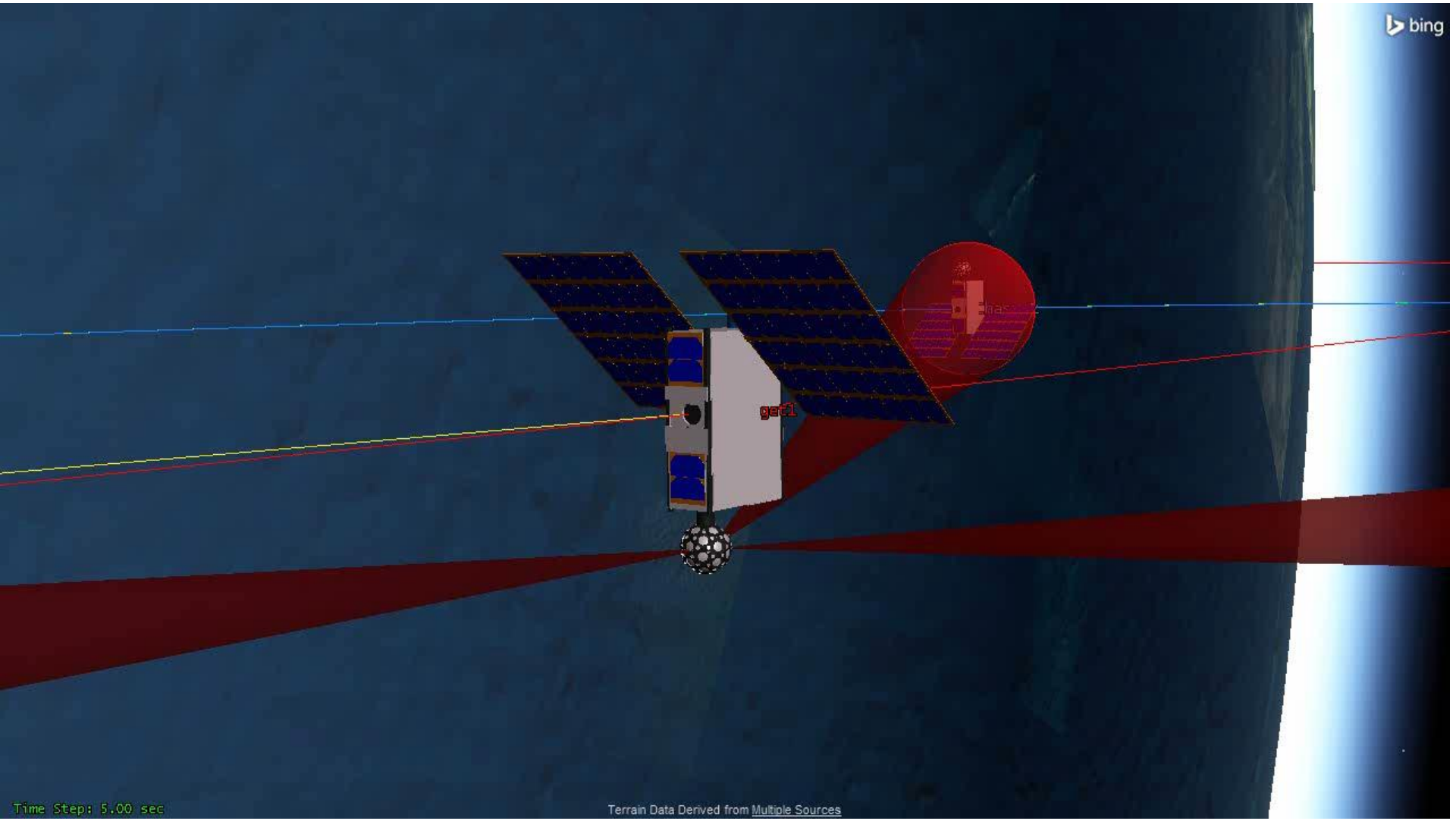


3. Technology Demonstration Mission

Chosen Configuration

3. Technology Demonstration Mission

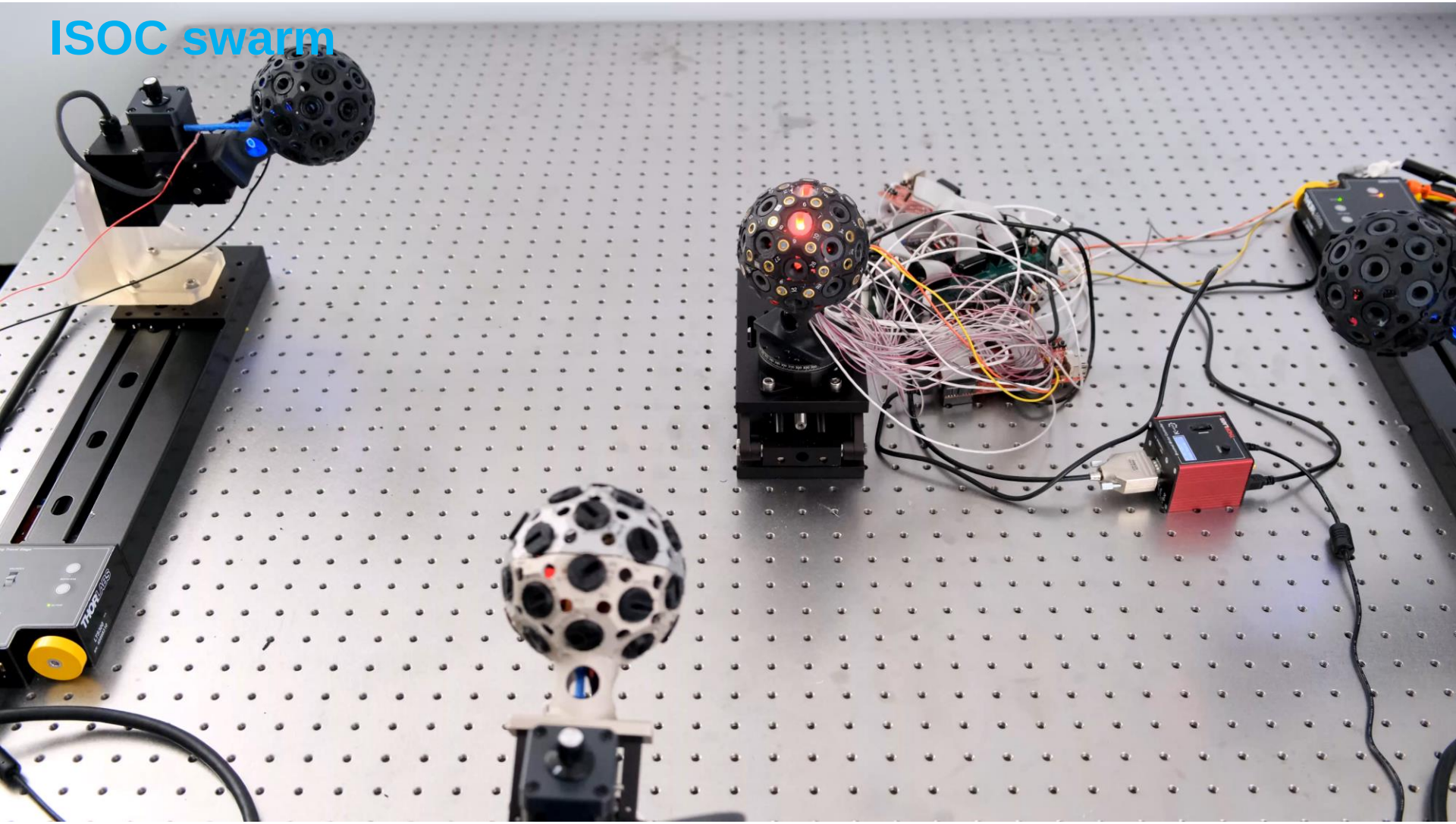
Chosen Configuration



Omnidirectional Optical Communicator

3. Technology Demonstration Mission

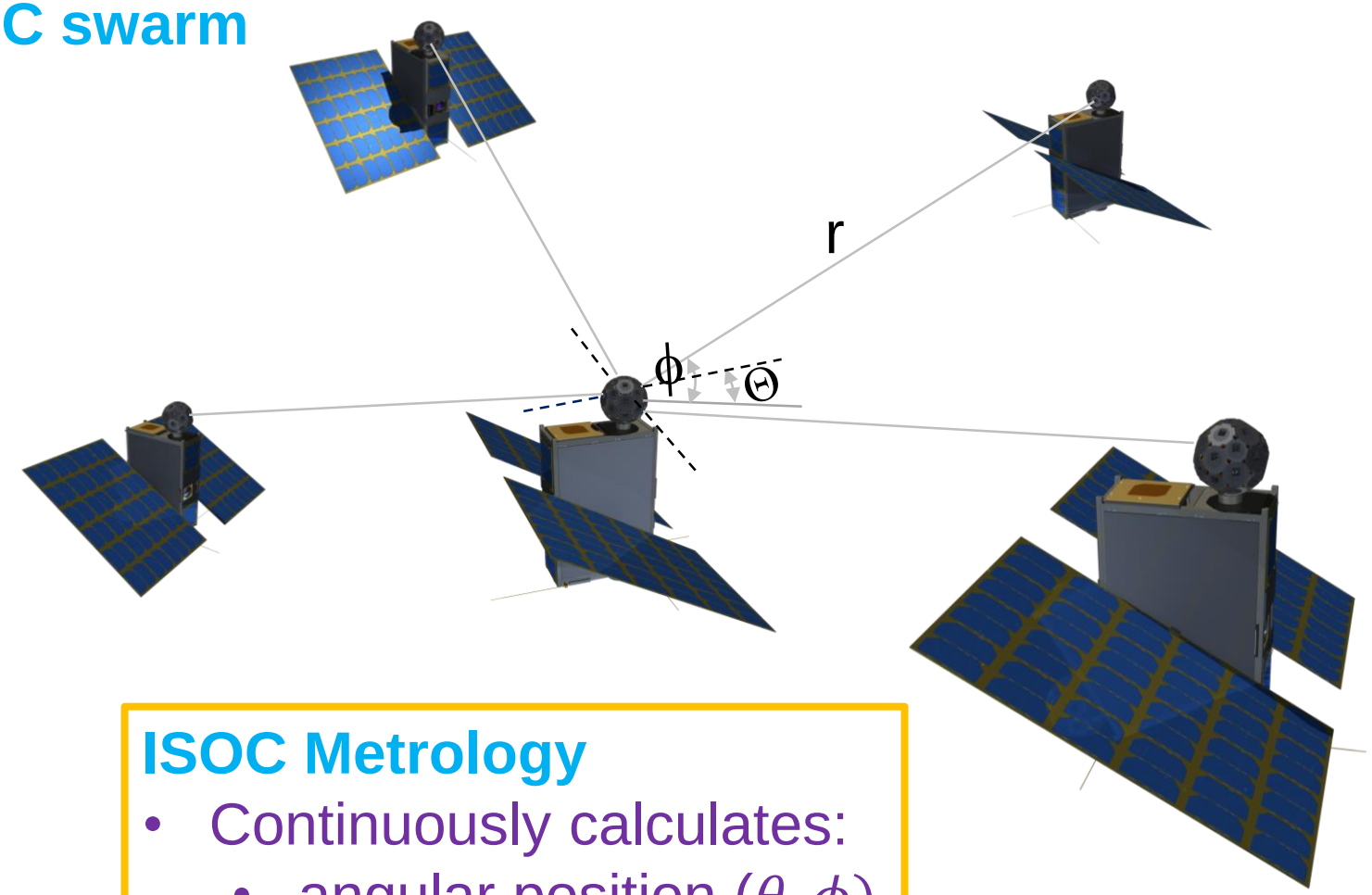
ISOC swarm



Swarm emulator using automated platforms

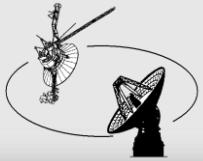
3. Technology Demonstration Mission

ISOC swarm



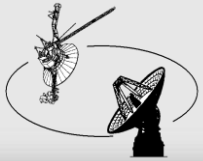
ISOC Metrology

- Continuously calculates:
  - angular position (θ, ϕ)
  - distance (r)



4. Conclusions

- A novel Omnidirectional Optical Communicator has been presented
- We presented design considerations and preliminary results of the ISOC testing
- We also discussed Q4 - a technology demonstration mission for the ISOC
- The ISOC is a potential enabler for future swarm and constellation missions



Thank You

Questions?