Science
Mission Directorate

2018 Technology Demonstration Industry Day

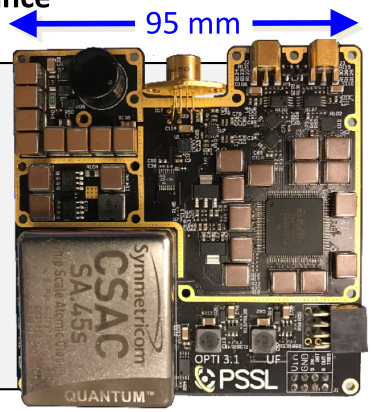
Technology
Demonstration MO

Technology Title: Optical Precision Time-transfer Instrument (OPTI)

Affiliation: University of Florida, Precision Space Systems Lab

Technology Description, Current Performance Metrics, and Performance Goals

- Compact, low power precision time transfer via exchange of nanosecond IR laser pulses
- 100 ps (3 cm) measured time-transfer accuracy
- Chip Scale Atomic Clock: 20 ns drift after 10^4 s
- Ground-to-space or space-to-space links
- Rx: < 5 W peak   Tx: < 15 W peak
- Volume: < 2U   Mass: < 2 kg
- Ground-to-LEO demo of OPTI: July 2018
- LEO-to-LEO demo with related tech: 2020



Current TRL

TRL 4

TRL By May 2021

TRL 6

Industry State of the Art Technology Performance

Radio frequency synchronization; high Size, Weight, Power (SWaP)

- GNSS: 3-10 nanoseconds
- TWSTFT: 1-2 nanoseconds

Laser-based synchronization

- Time-transfer by Laser link (T2L2): ~50 ps, 42 W, 5 kg
- ACES-ELT (future): < 25 ps, ISS payload

Technology Development Challenges to Meet TRL Goal

Making the technology rad hard

- Existing technology developed for short (< 1 yr) CubeSat missions in LEO
- For HPD missions, a radiation tolerant version may be needed
- For most components, rad tolerant parts can be found
    - One exception: Time-to-Digital Converter (TDC) that performs the precision time-stamping
    - Solution: The PSSL, with STMD support, has been developing TDCs and related functionalities in software on rad tolerant FPGAs

Precision beam pointing and acquisition still under development, currently TRL 4

Potential HPD Science Application (Optional)

- Synchronization of measurements made by swarms or constellations of microsatellites or CubeSats
- Example:
    - Particle detectors on a number of small satellites orbiting the Sun
    - Synchronization of the constellation to ~1 ns → relative arrival times of particles at each S/C + relative range between S/C
    - Enables 4D mapping (X, Y, Z, t) of solar activity

Contact Information

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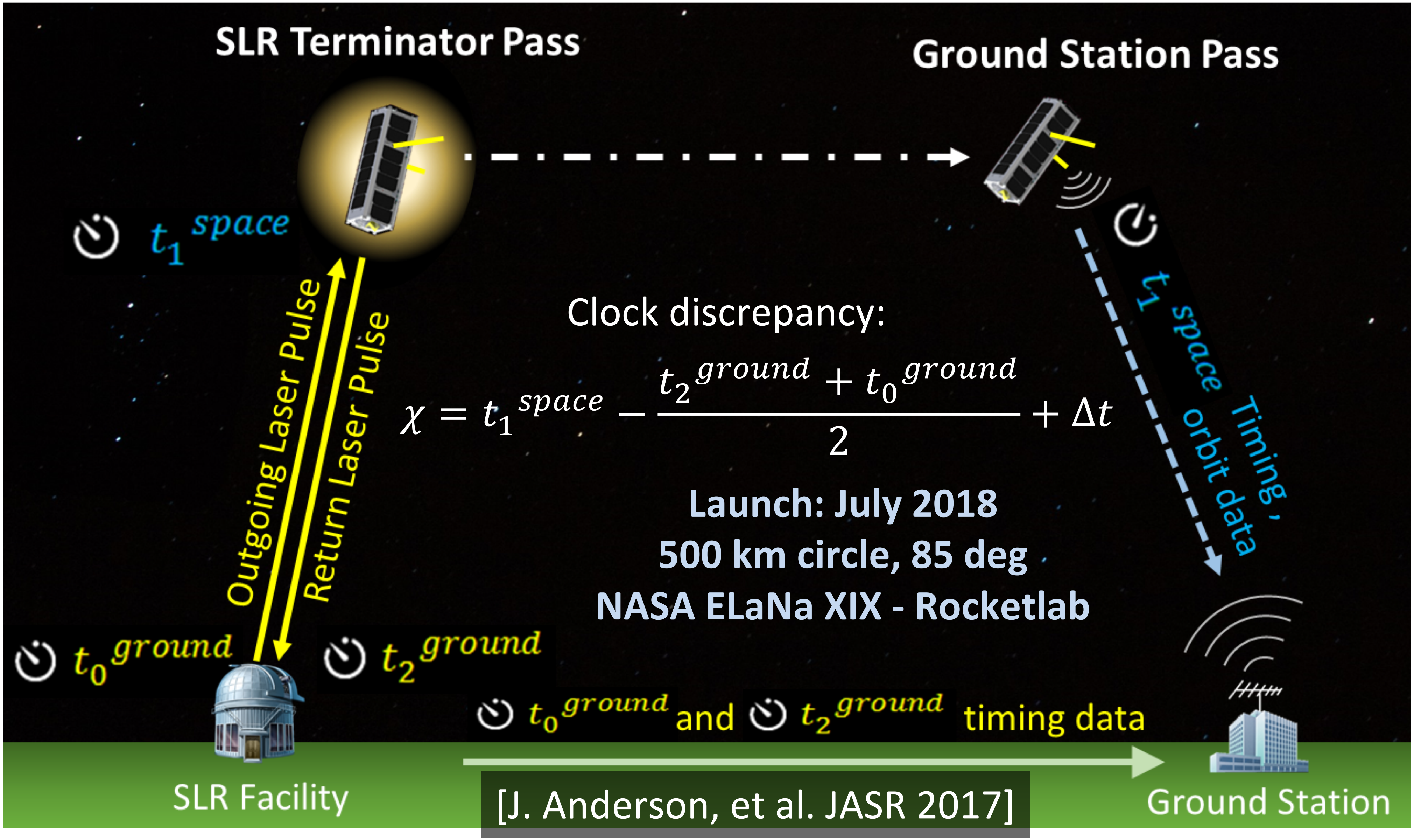
Additional Comments

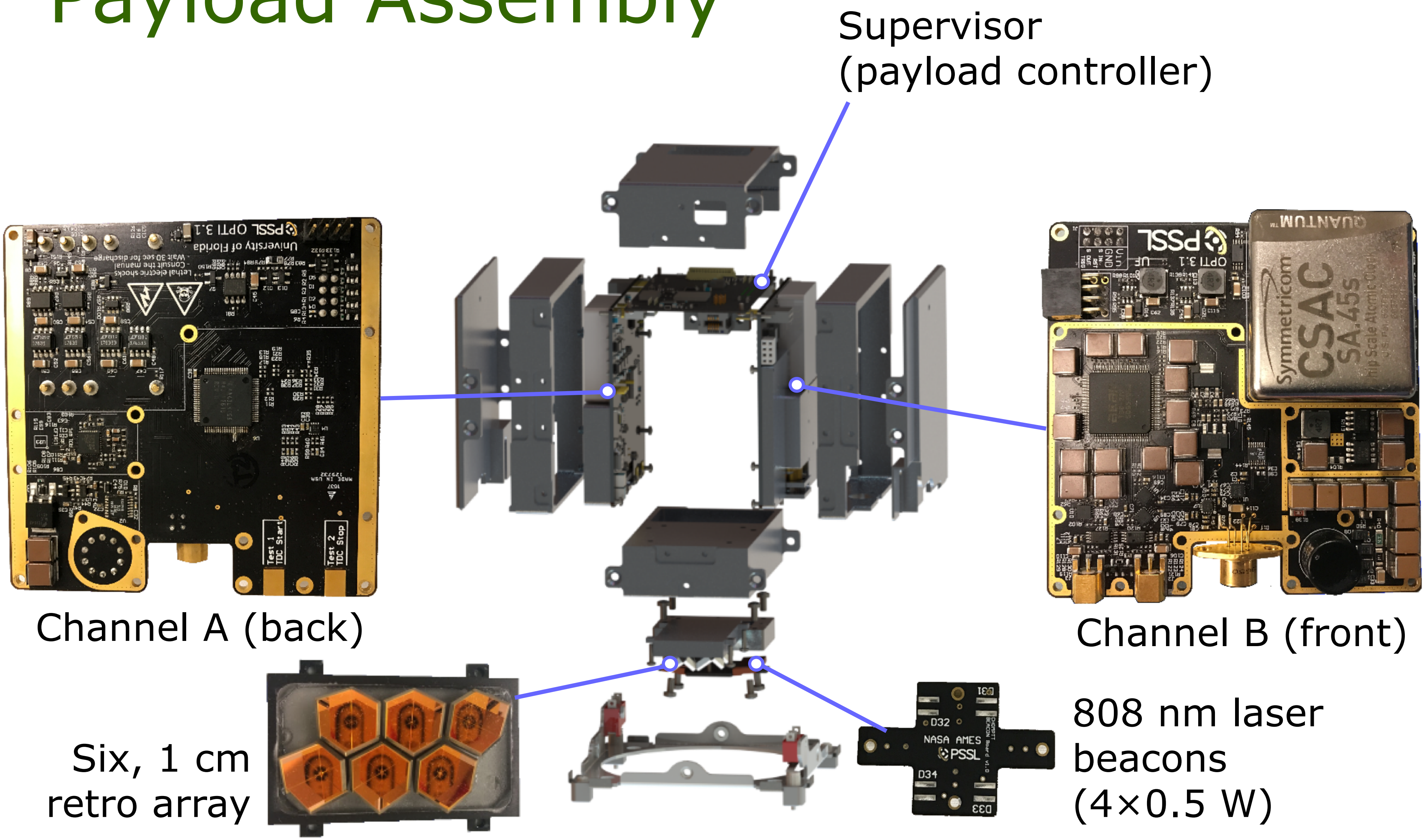
- Additional information on two CubeSat tech demonstration missions (CHOMPTT and CLICK) provided in back-up charts

Assumption: Technology required to be at TRL 5 by May 2021

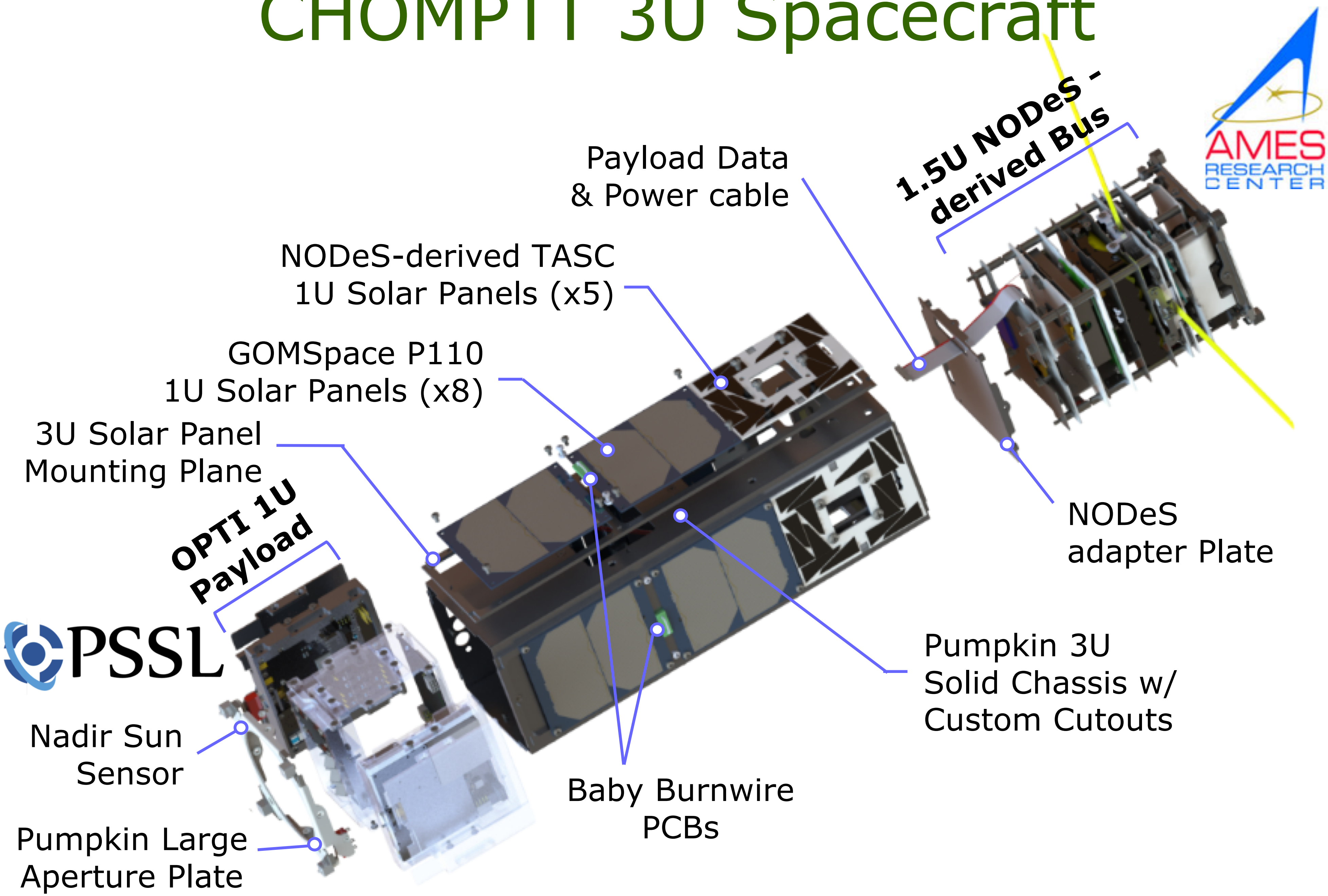
CHOMPTT CubeSat Mission Concept



OPTI Flight Payload Assembly



CHOMPTT 3U Spacecraft



CubeSat Laser Infrared CrosslinK (CLICK)