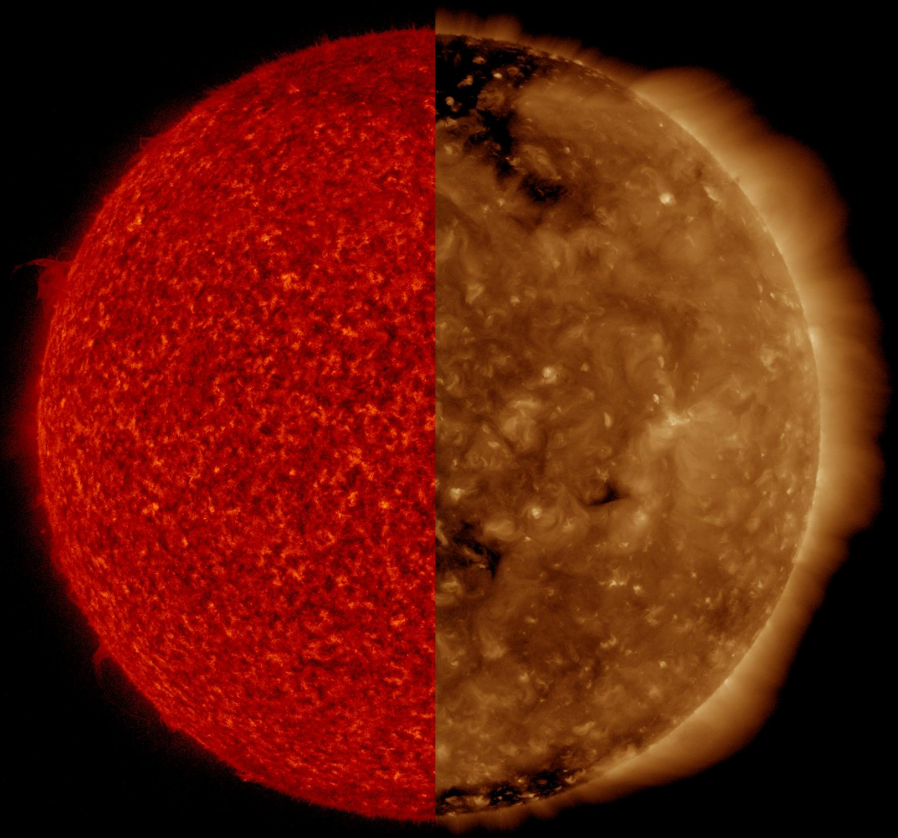
Future Program Implementation



For Solar Irradiance Data Continuity

Tom Patton et al. – Sun-Climate 2023

The Continuous Climate Data Record

1981 - 1989

1991 - 2003

2003 - 2020

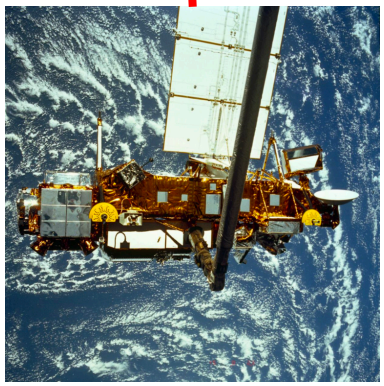
2013 - 2017

2017 – 2028

2025 - 2028

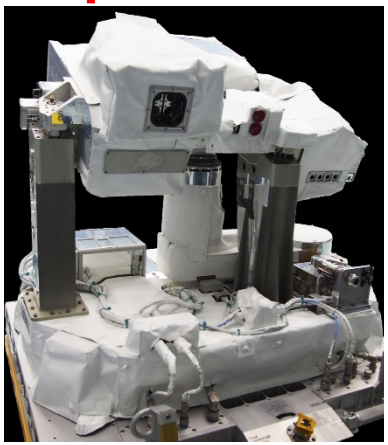
2028 - ?

What happens if there are potential gaps?
What is the plan after 2028?

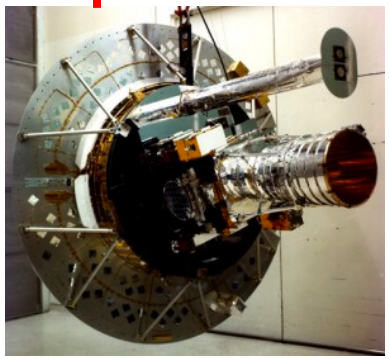


Upper Atmosphere Research Satellite
(UARS)

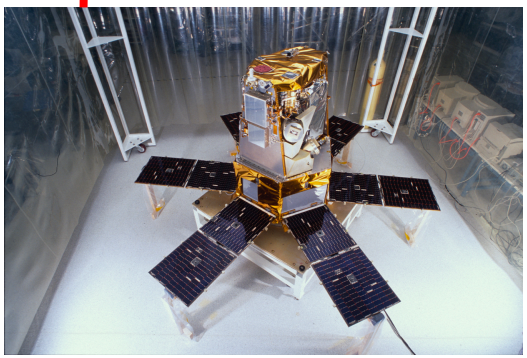
Total Solar Irradiance
Calibration Transfer Experiment
(TCTE)



Total & Spectral
Solar Irradiance Sensor
(TSIS-1)



Solar Mesosphere Explorer
(SME)



Solar Radiation and Climate Experiment
(SORCE)

(Operational Phase
Possible Extension)

The Continuous Climate Data Record

1981 - 1989

What happens if there are potential gaps?

2028?

2028 - ?

"For the next decade and beyond, the measurement imperatives include ... an emphasis on continuity so that gaps in observations that would preclude or impair scientific understanding and societal benefits are avoided."

2017 Earth Science Decadal Survey

"Long-term observations of the Sun's radiation on the Earth, total and spectrally resolved, … is critical to ensure that we can fully account for the effects of all natural variability when monitoring climate and the results of any mitigation strategies".

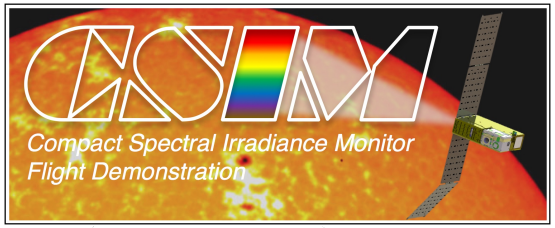
2022 NASA Strategic Plan

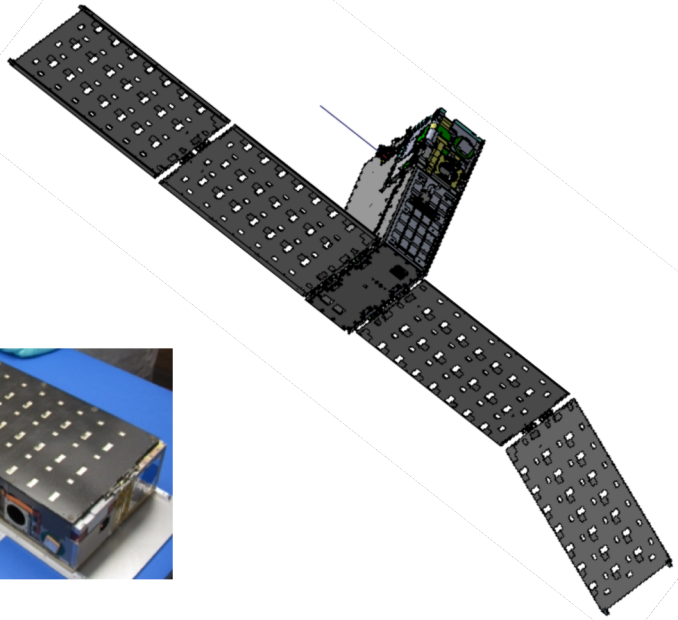
Sol

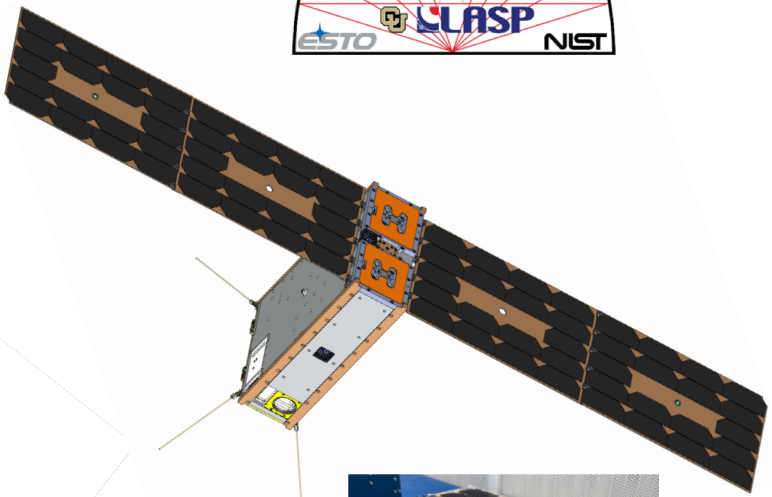
(SME)

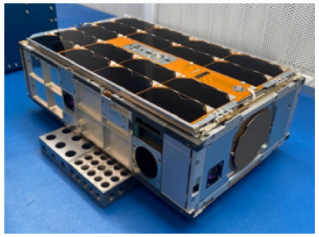
Possible Extension

The Next Generation of SI Measurement



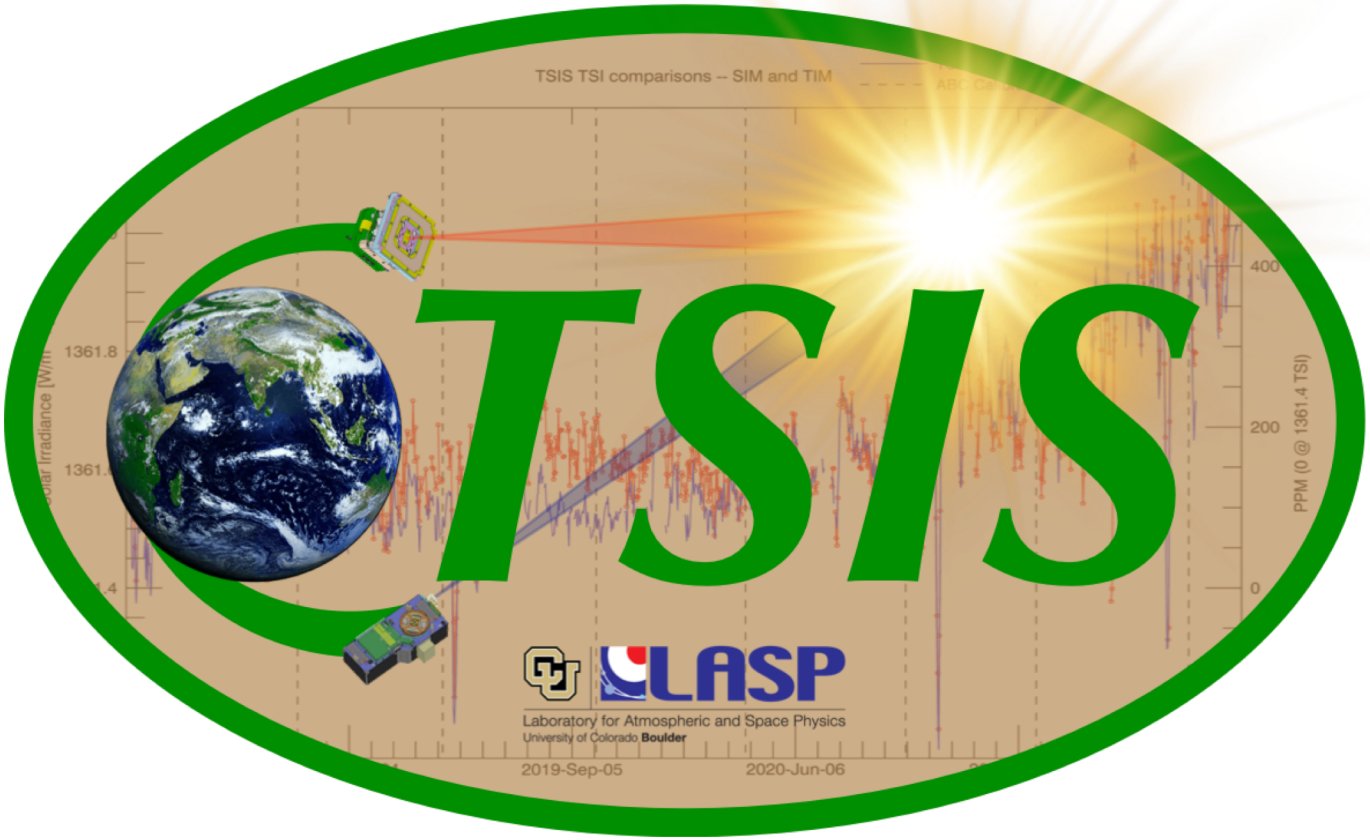






Instrument	Launch	Bus Size	Lifetime (planned / actual)	PI
CSIM	03-Dec-2018	6U	1 yr / 3.2 yr	Erik Richard
CTIM	02-Jul-2022	6U	1 yr / planned to Apr-2024	Dave Harber

The Next Generation of SI Measurement

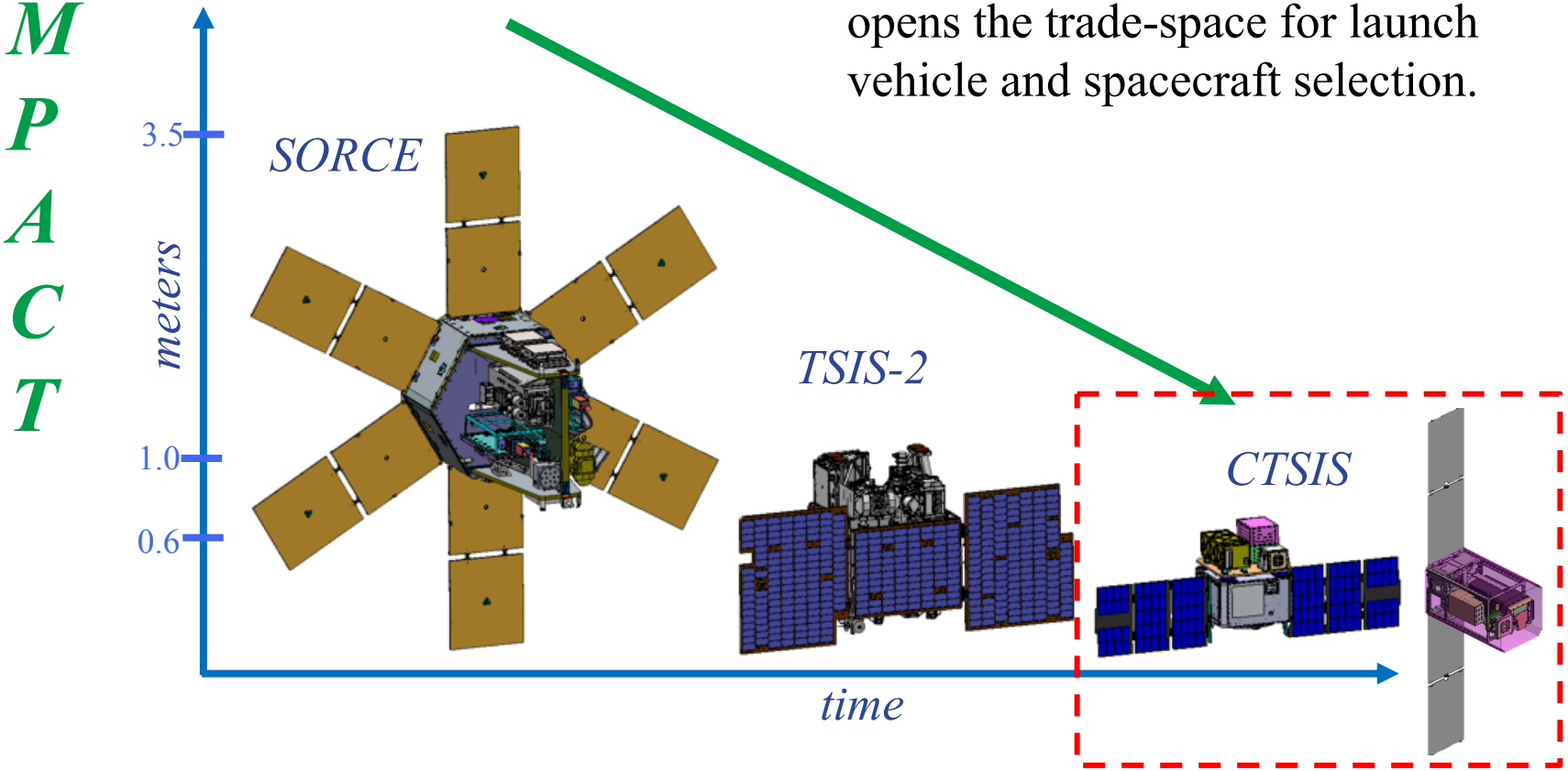


...but, what does the "C" in CTSIS mean?

What is CTSIS?

… can catch a ride

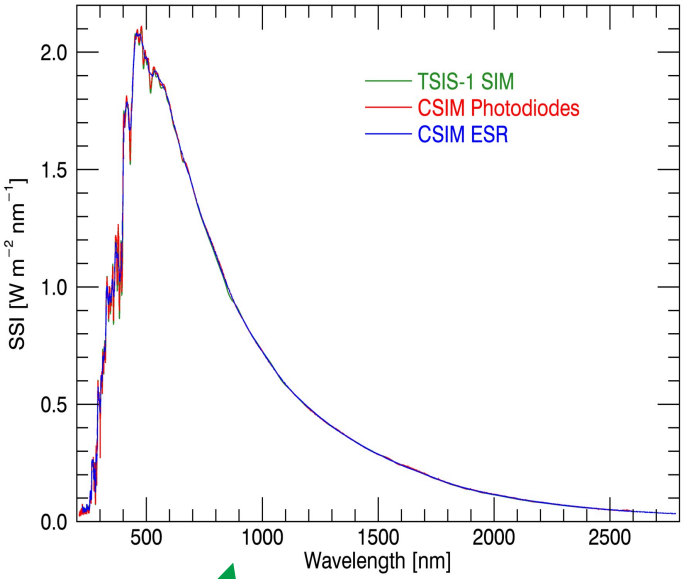
Reduced TSIS volume and mass opens the trade-space for launch vehicle and spacecraft selection.



What is CTSIS?

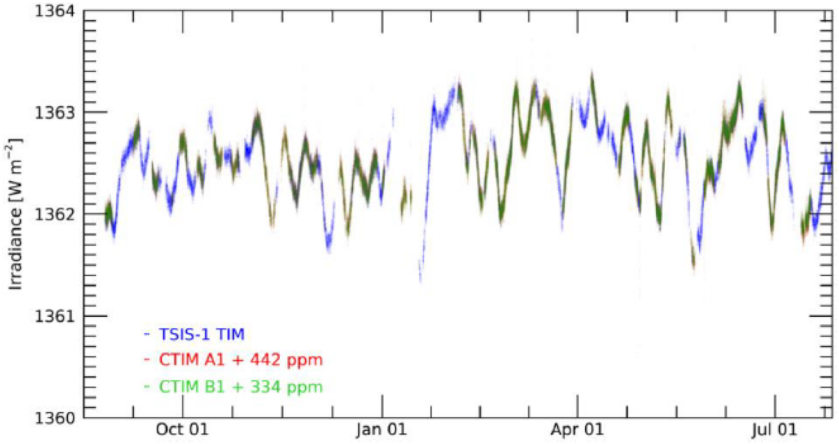
… can do the science

CONSISTENT



CSIM & TSIS-SIM have excellent (~0.5%) agreement between the nominal spectral range (300-2400 nm)

CTIM & TSIS-TIM also have excellent agreement, with only a 0.04% offset applied, and matches the observed Solar variability



Richard 2023

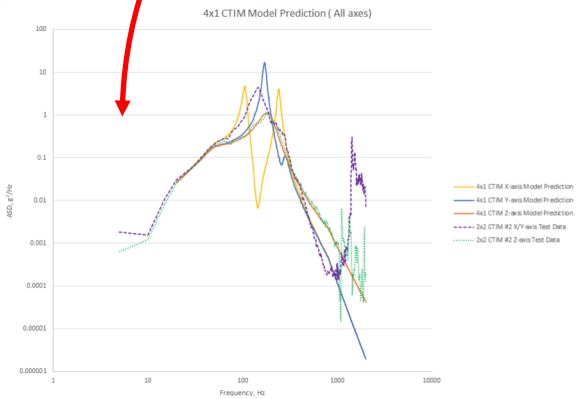
Harber 2023

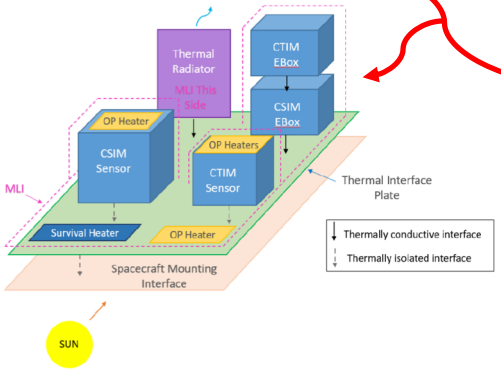
What is CTSIS?

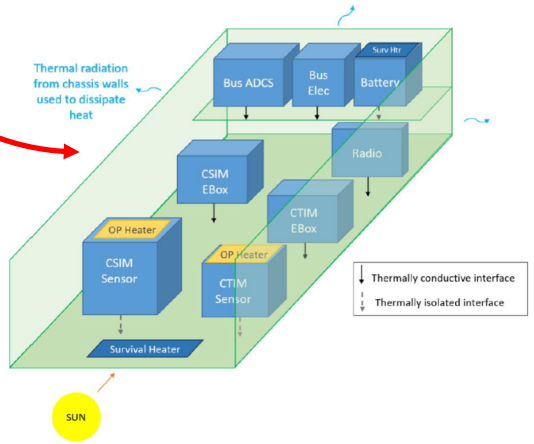
… technology is ready

A P A B L E

- CSIM and CTIM have executed science on-orbit for 5 years combined as demonstration flights, far exceeding the nominal 1 year lifetime for cubesats
- Minimal changes (EEE parts, reliability, SIM channels) support even longer-duration science data acquisition
- A CTSIS implementation has the appropriate environmental resiliency
  - Through correlated structural models
  - Through thermal design similarities







What is CTSIS?

OVERAGE

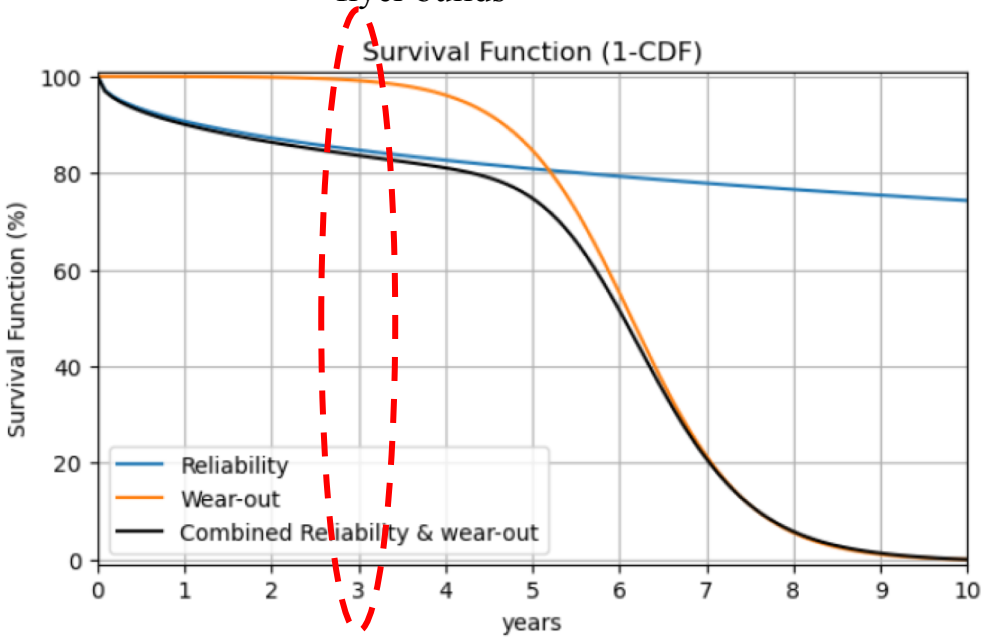
- Utilization of a planned + launch on need mission architecture
  - "responsive" mission planning, as opposed to rigid planning w/ canonical large, free-flyer builds
- That means
  - On-orbit redundancy (2 CTSIS flying at all times)
  - a replacement unit is ready to go in case an on-orbit unit fails
  - Planned "age out"

What is CTSIS?

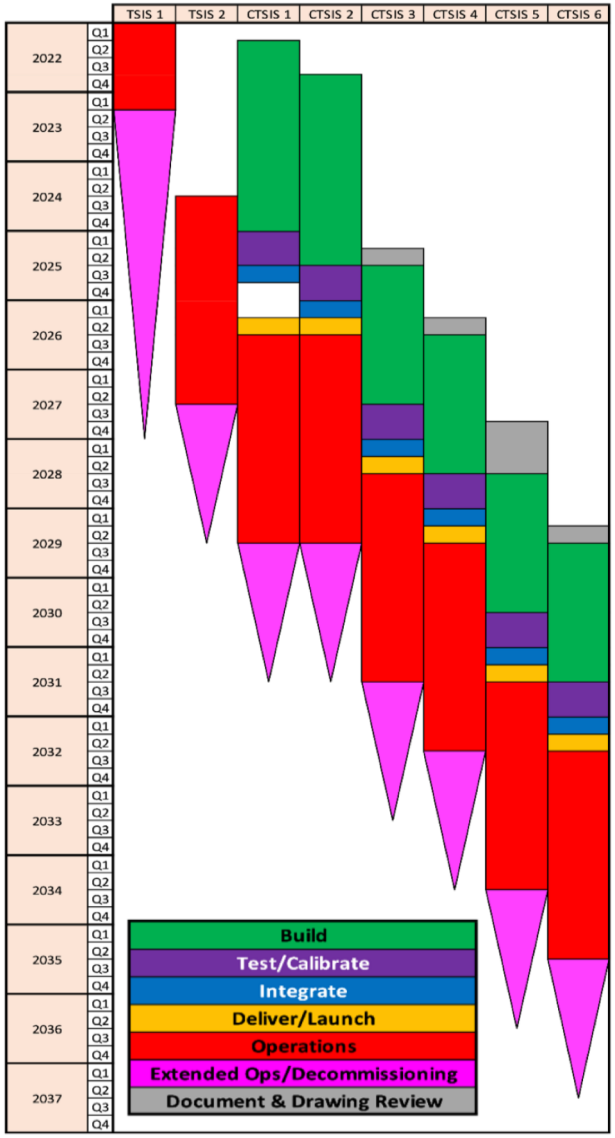
… will reduce risk

O V E R A G E

- Utilization of a planned + launch on need mission architecture
  - "responsive" mission planning, as opposed to rigid planning w/ canonical large, free-flyer builds



Per Perumal et al 2021

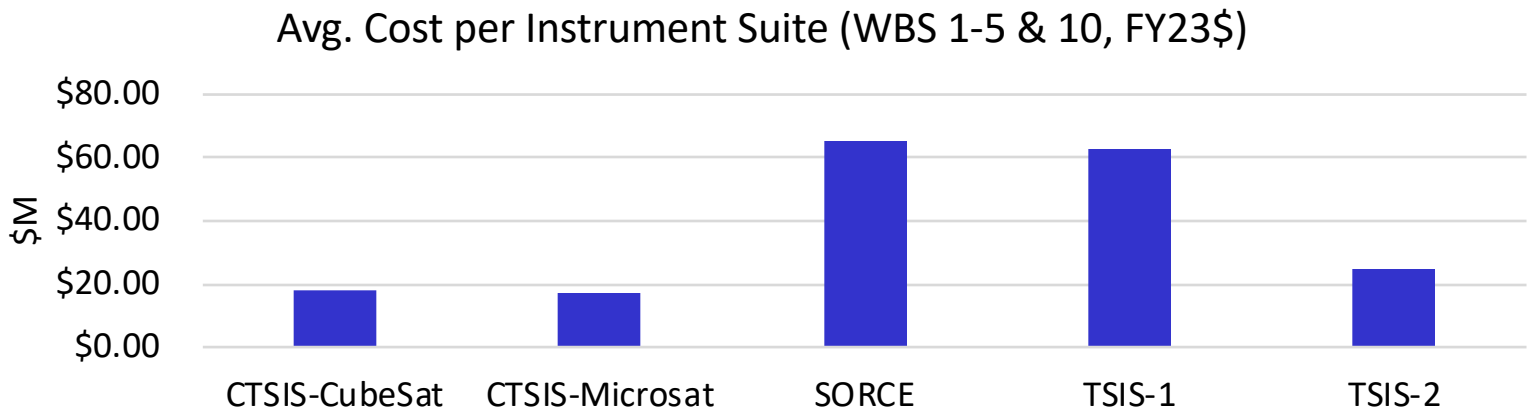


What is CTSIS?

… is affordable

COST-EFFICIENT

Architecture	Cost (FY23$)	Reserve Applied	CTSIS Instrument Program Cost
CTSIS-CubeSat	$167,506,408.33	$58,627,242.91	$226,133,651.24
CTSIS-MicroSat	$158,101,068.50	$39,525,267.13	$197,626,335.63
Architecture	**Cost (RY$)**	**Reserve Applied**	**CTSIS Instrument Program Cost**
CTSIS-CubeSat	$197,329,437.25	$69,065,303.04	$266,394,740.29
CTSIS-MicroSat	$187,302,948.14	$46,825,737.03	$234,128,685.17



What is CTSIS?

… can maintain the solar-climate data record!

1981 - 1989

1991 - 2003

2003 - 2020

2013 - 2017

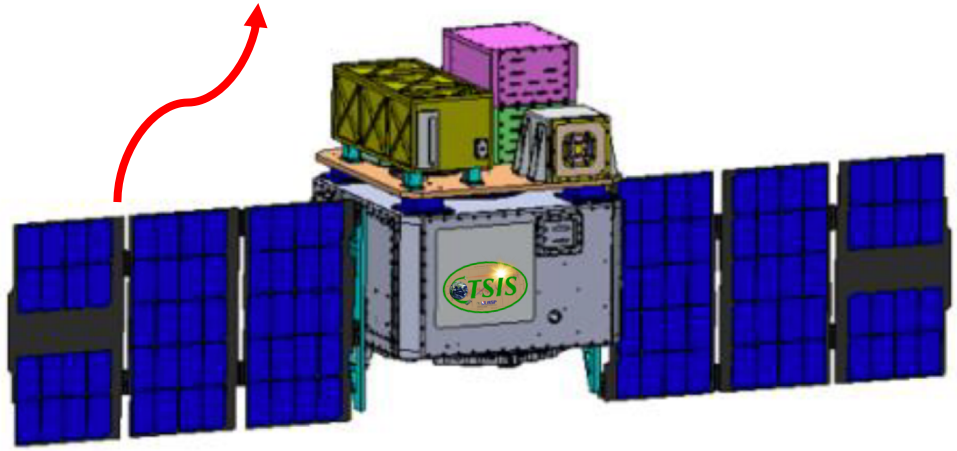
2017 – 2028

2025 - 2028

2028 - ?

2028 – 2038 … and Beyond!

NTINUITY



Special thanks - CTSIS Study Team

- Principal Investigator: Dave Harber
- Instrument Engineering: Alexandra Curtin
- Instrument Engineering: Dave Crotser
- Structural Engineering: Kevin McWilliams
- Thermal Engineering: Melanie Fisher
- Mechanical Engineering: Cody Wong
- Mechanical Engineering: Max Fowle
- Science Data Systems: Stephane Beland
- Business Analyst: Ian Karanovich
- Administrative Support: Kelly Boden
- Science team: Peter Pilewskie, Erik Richard, Ed Thiemann, Tom Woods
- Systems Engineering: Allison Russert
- Funding Organization: Earth Science Technology Office

Questions


TSIS TSI comparisons -- SIM and TIM
1361.8
400
200
0
PPM (0 @ 1361.4 TSI)
2019-Sep-05
2020-Jun-06
TSIS
LASP
Laboratory for Atmospheric and Space Physics
University of Colorado Boulder