Dynamically Controlling Image Integration Onboard The Star-Planet Activity Research CubeSat (SPARCS)

SmallSat Conference 2021

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ASU School of Earth and Space Exploration
Arizona State University

NASA

JPL Jet Propulsion Laboratory

The University of Arizona

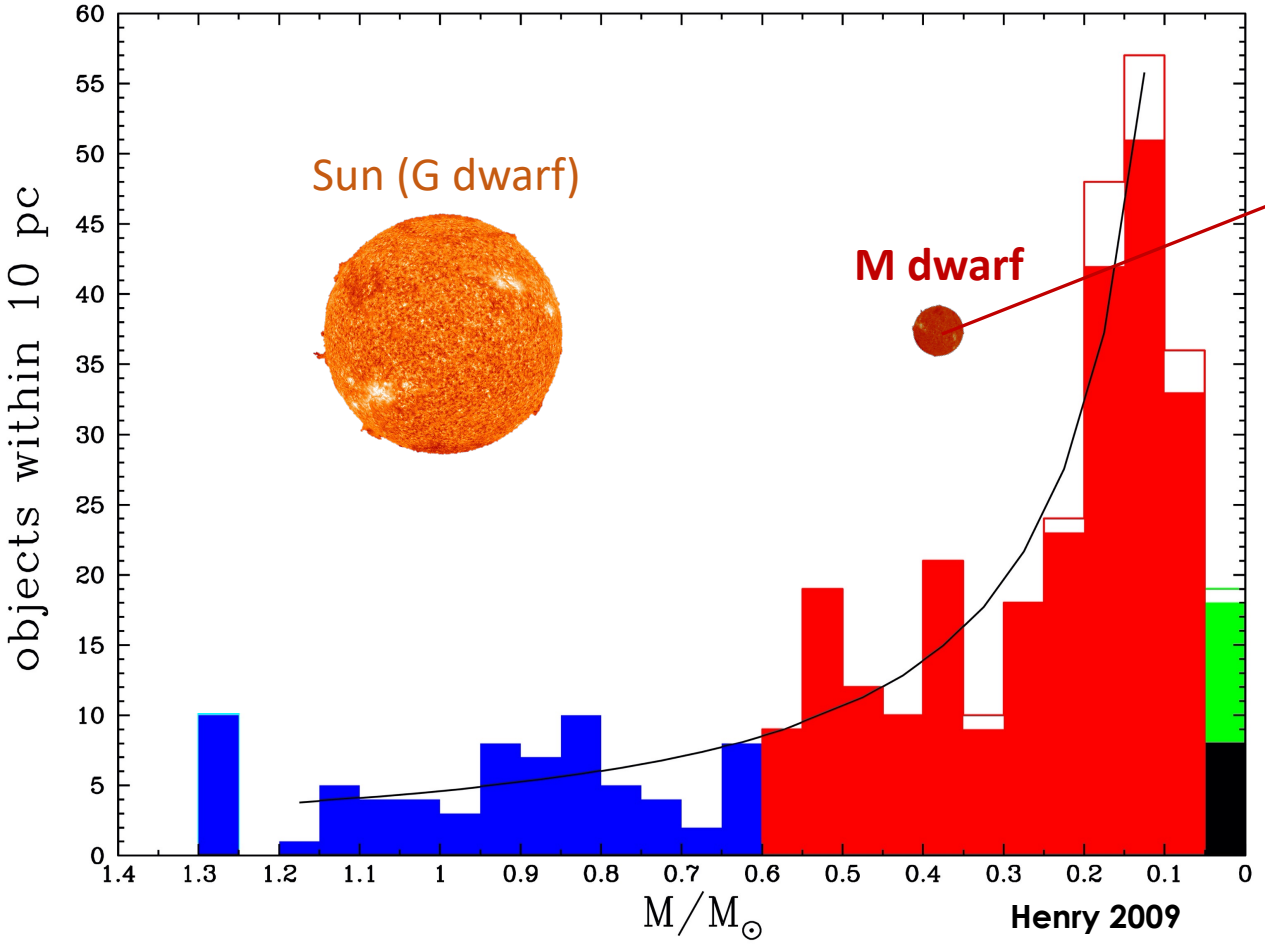
University of Washington

SwRI

MIT

Lowell Observatory

M Dwarfs: The Most Common Type of Stars



- 1.5 – 2.5 times cooler than the Sun
- 8% – 60% of the Sun both in radius and mass

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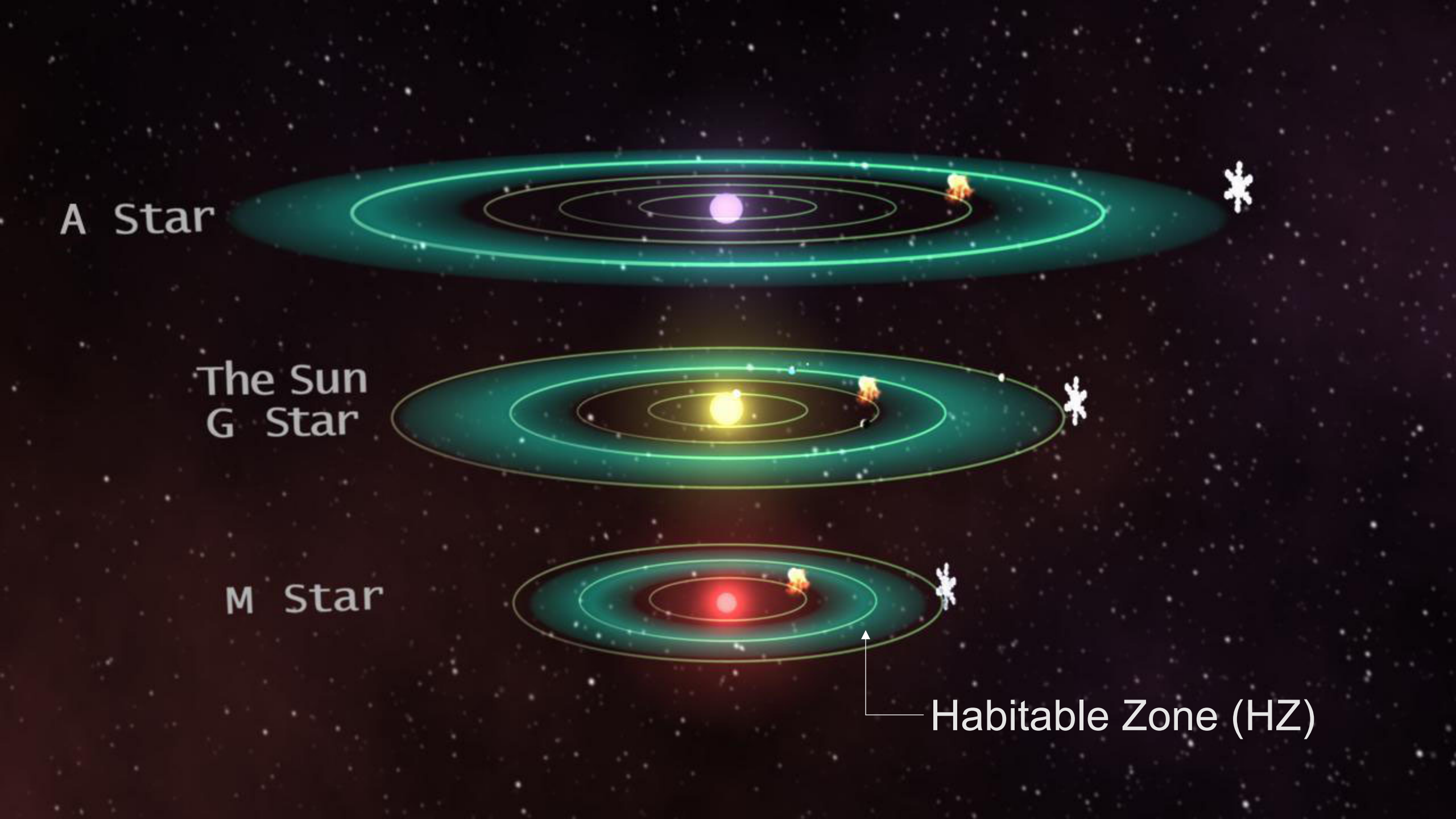
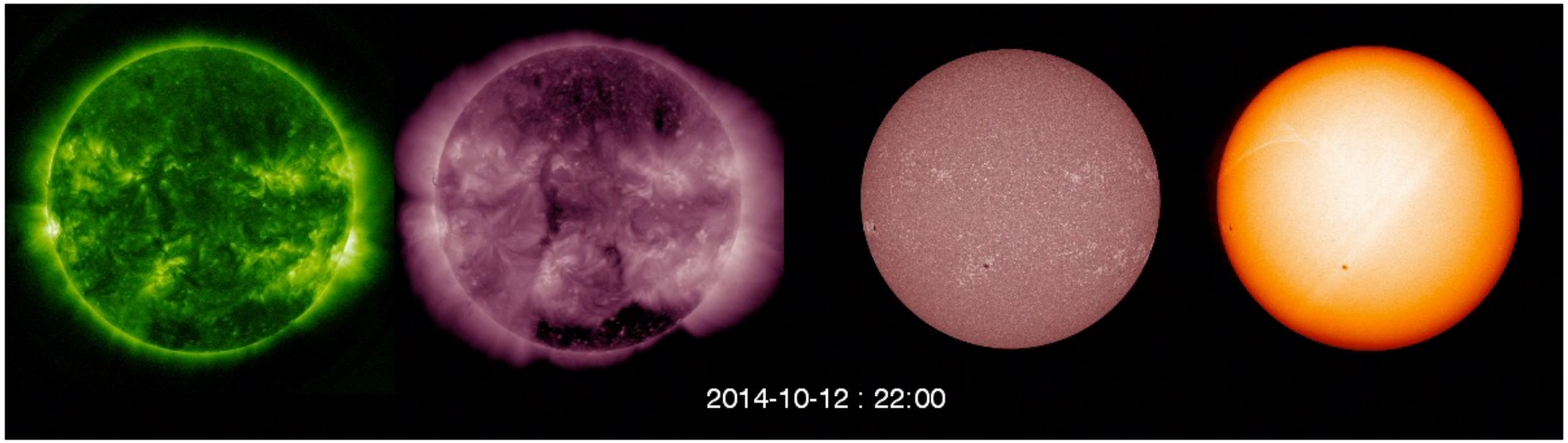

A Star
The Sun
G Star
M Star
Habitable Zone (HZ)

Soft X-ray Extreme UV Far UV Optical



NASA/SDO/J. Llama

But M dwarfs are much more active than the Sun…

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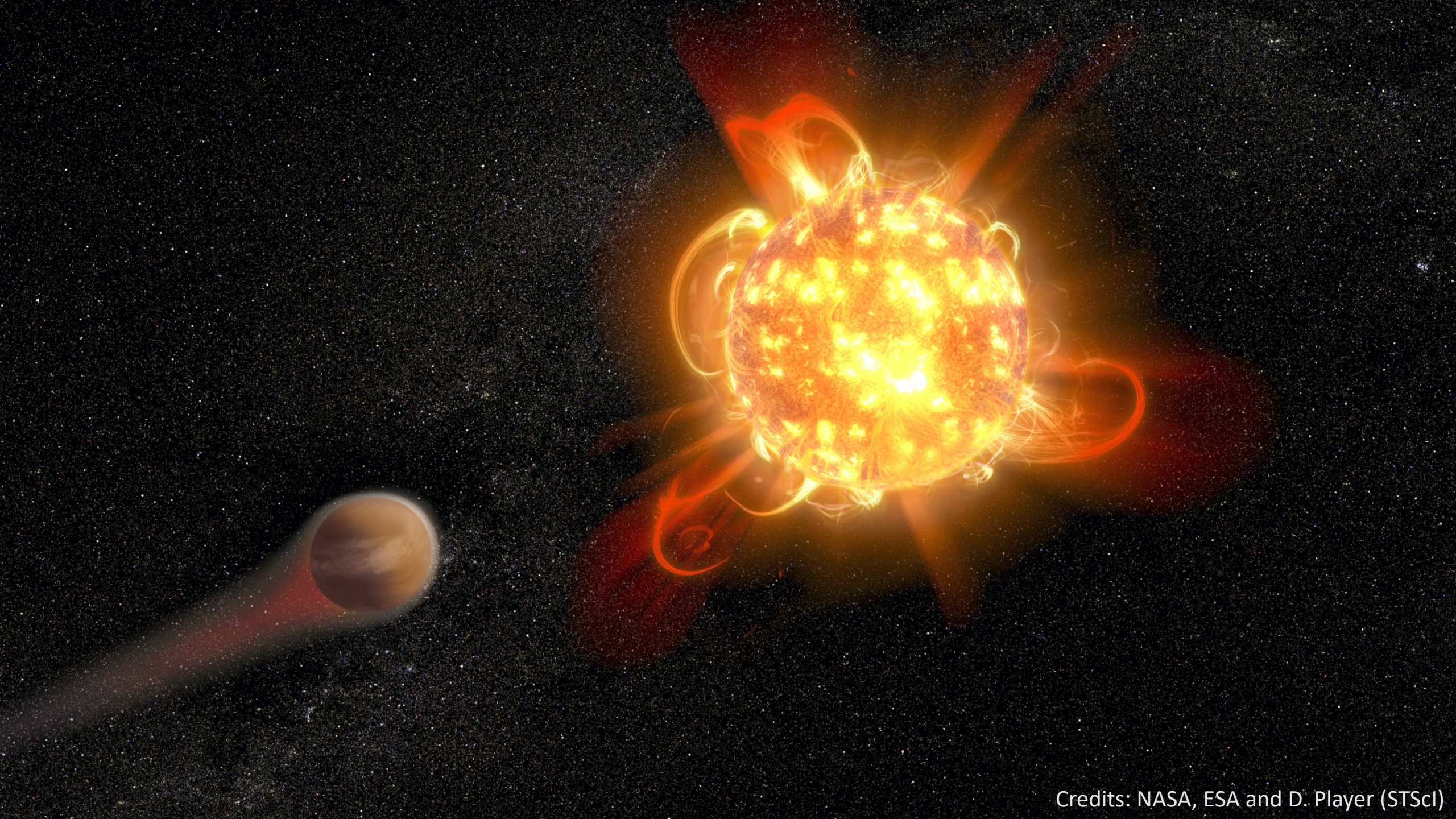
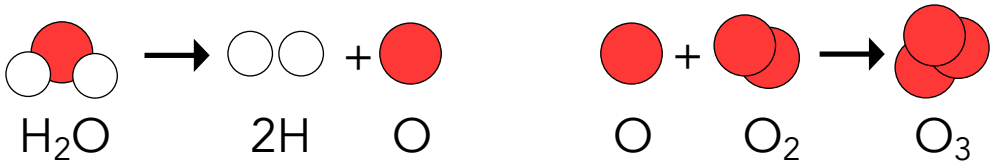
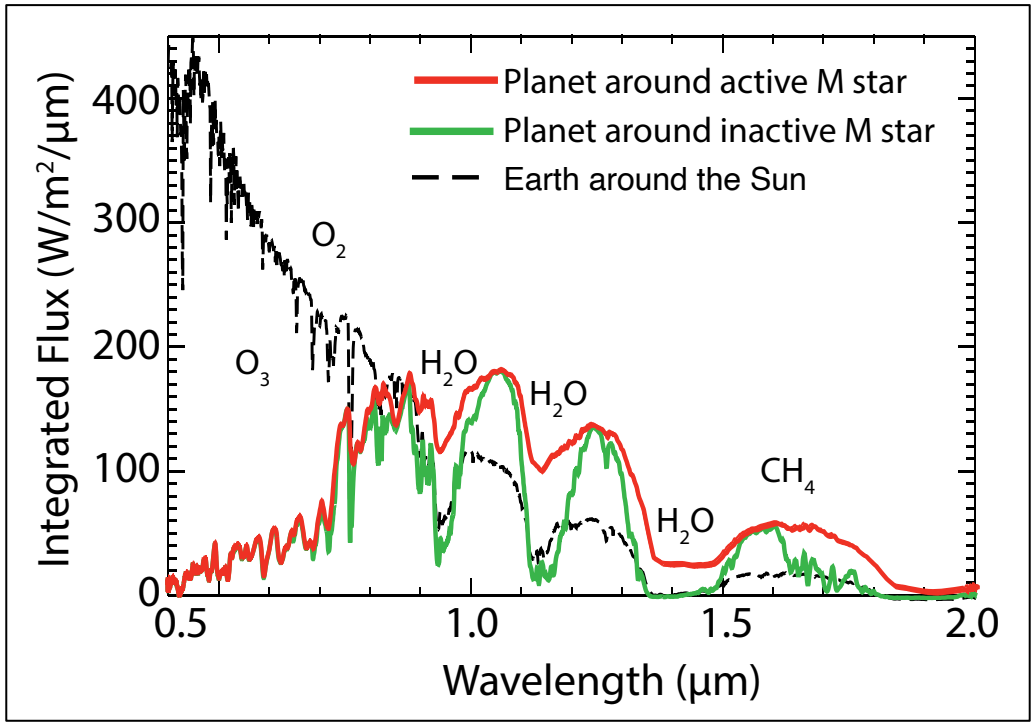


Credits: NASA, ESA and D. Player (STScI)

M dwarf UV radiation/activity
→ Strong impact on the habitability of their planets

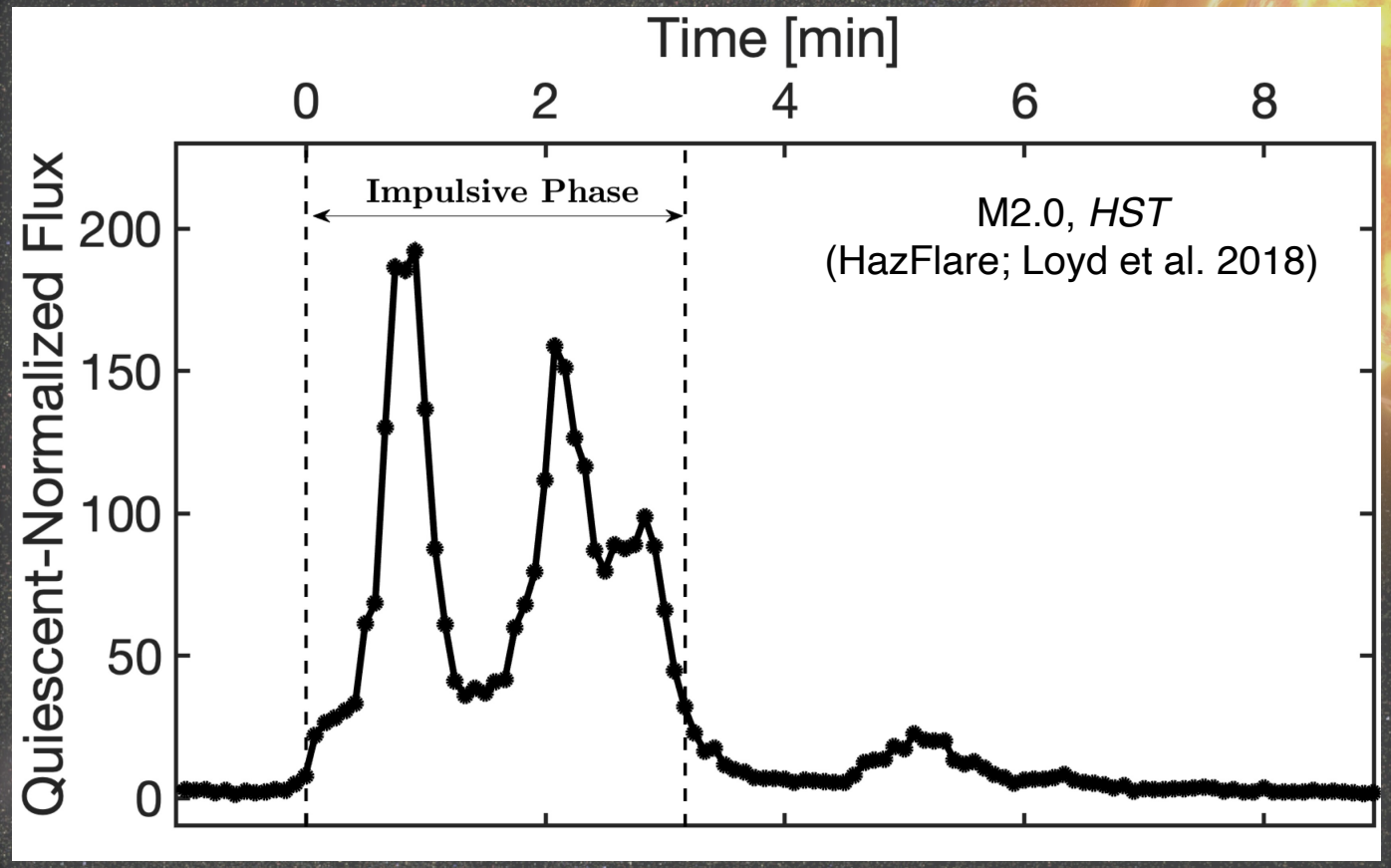


- Photodissociation of water molecules by far-UV (FUV) and near-UV (NUV)
- Atmospheric heating/escape by extreme-UV (EUV) photons



Adapted from Rugheimer et al. (2015)

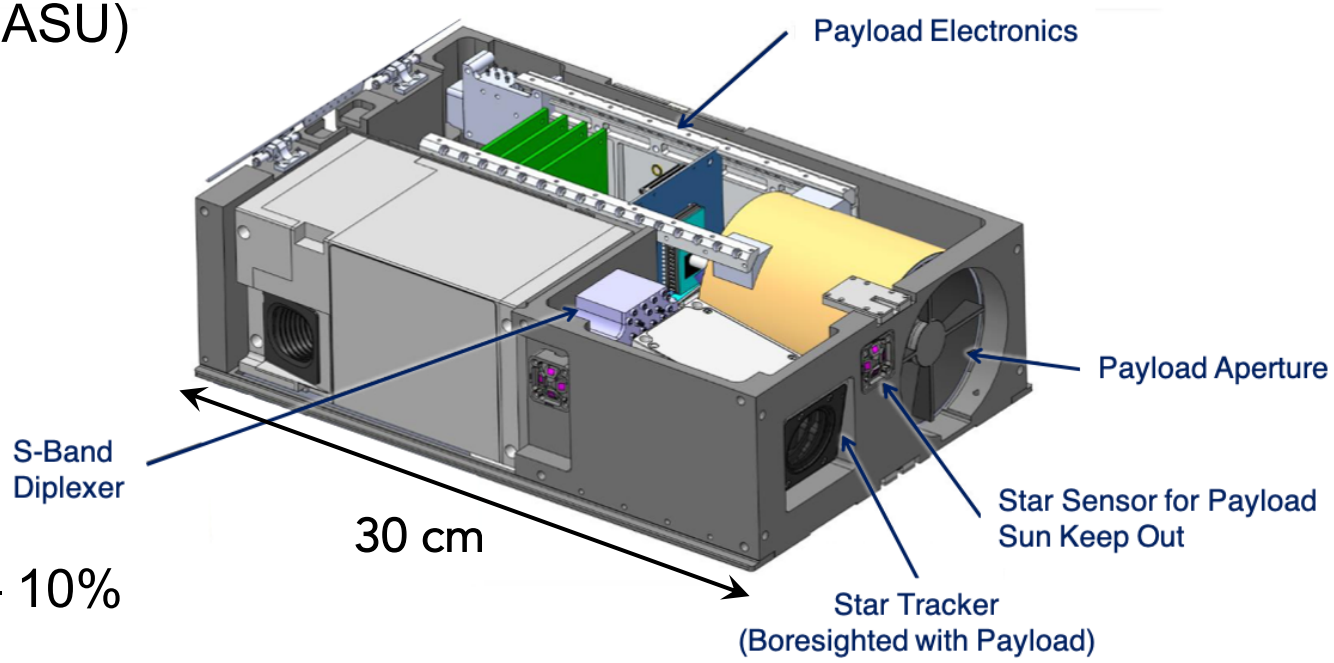
Need to study the flaring activity of M dwarfs in the UV to better understand the habitability of their planets



Credits: NASA, ESA and D. Player (STScI)

Star-Planet Activity Research CubeSat (SPARCS)

- PI: Prof. Evgenya Shkolnik (ASU)
- 6U CubeSat
- 9 cm telescope, FOV = 40’
- Camera with NUV and FUV CCDs
- Photometric precision: 1% – 10%
- Orbit: LEO, Sun-sync terminator
- Mission lifetime: ≥1 year
- NASA-funded, now 3 years into development phase



A space observatory dedicated to the photometric monitoring of M dwarf flaring activity in the UV.

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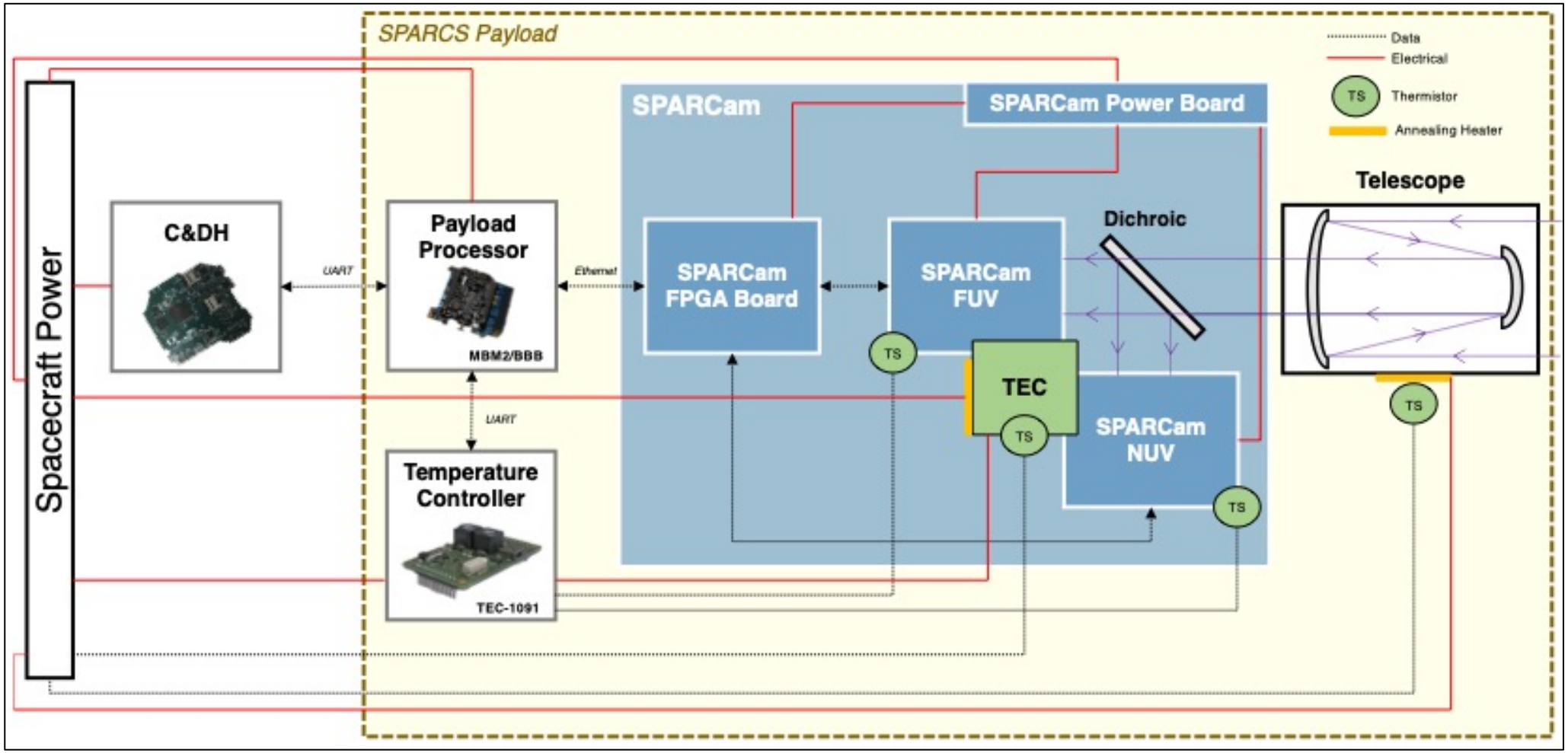
SPARCS Payload Architecture



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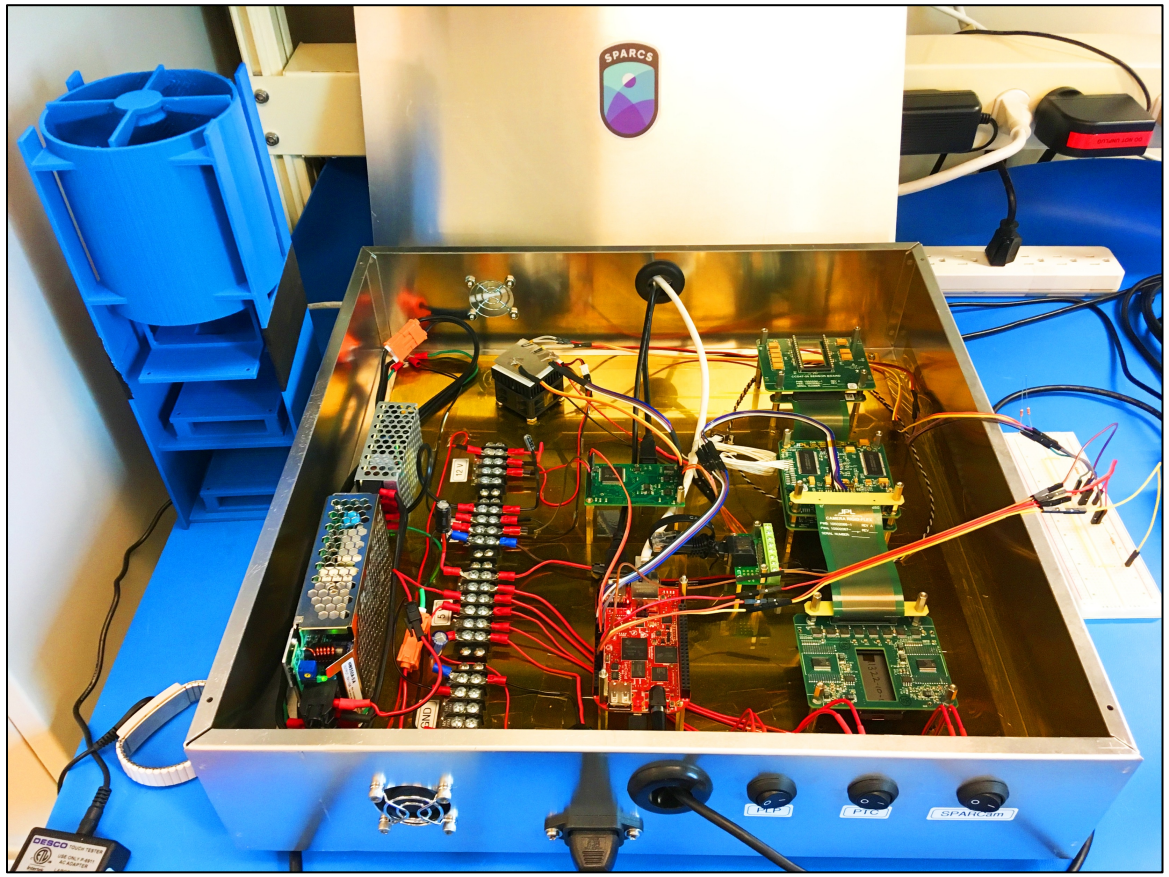
SPARCS Payload FlatSat

- Payload electronics functional testings
- Development of the fully Python-based payload processor software
  - Detector thermal control
  - Onboard data processing
  - Communications to/from C&DH



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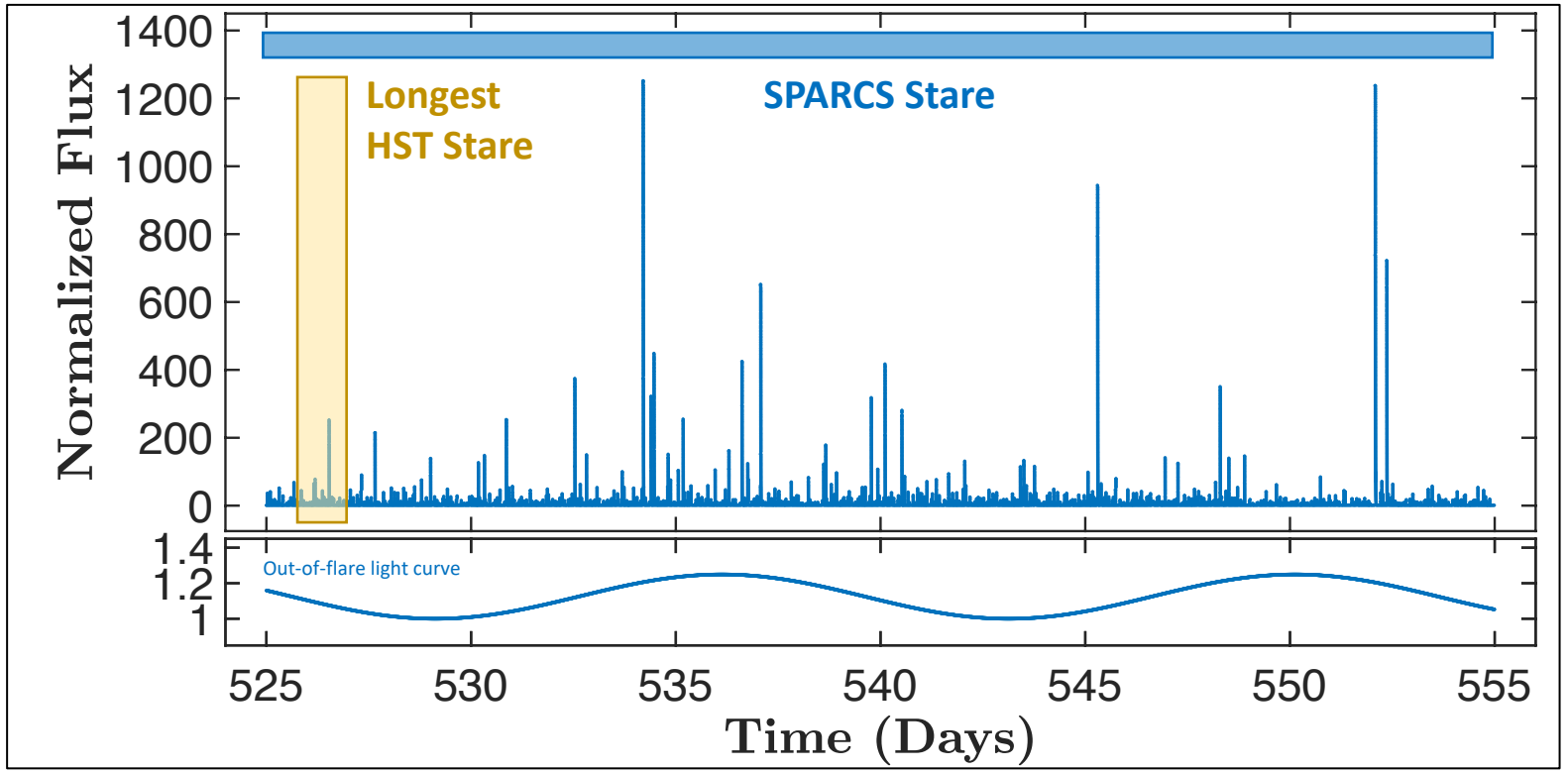
SPARCS Will Catch More High-Energy UV Flares



Simulated SPARCS light curve (DS Leo; M1V) based on Loyd et al. (2018)

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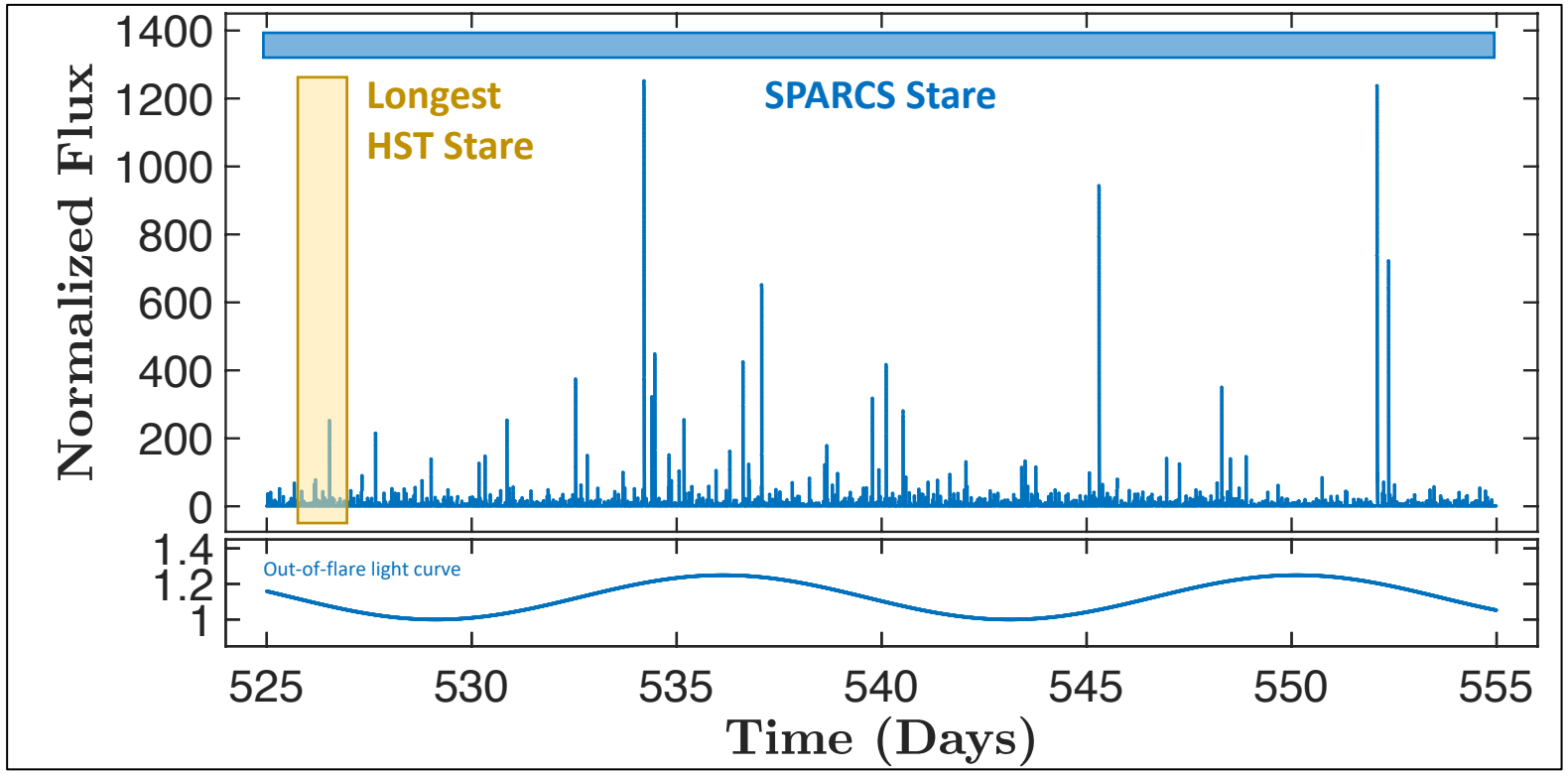
SPARCS Onboard Dynamic Image Exposure Control



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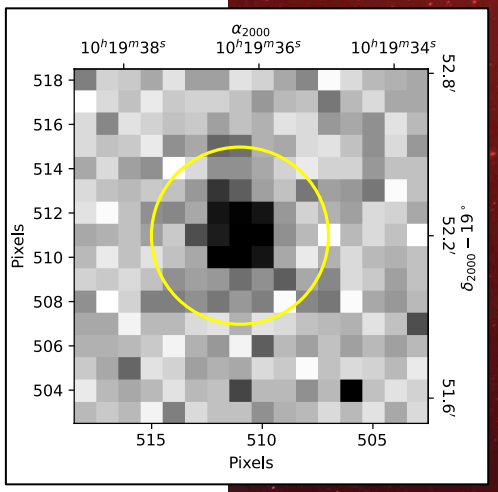

Need to automatically reduce exposure times upon flare detection → Near-real time onboard image processing (image reduction, cosmic ray & bad pixel cleaning)

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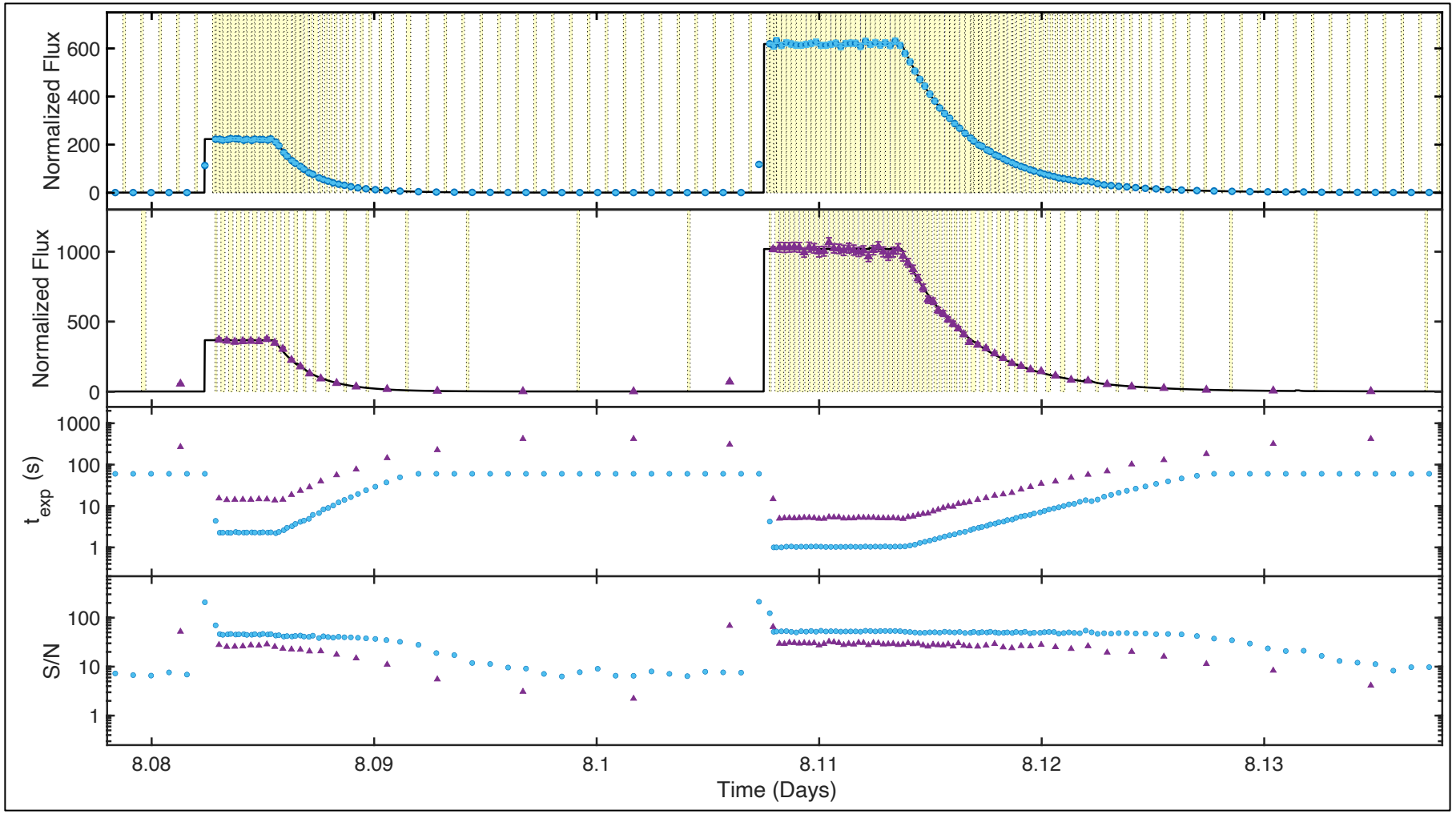

NUV channel

FUV channel

Ramiaramanantsoa et al. (PASP submitted)

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The Interdisciplinary SPARCS Team

Principal Investigator
Evgenya Shkolnik (ASU)

Systems Engineer
Daniel Jacobs (ASU)

Payload Scientist
David Ardila (JPL)

CubeSat Telescope and I&T
Paul Scowen (ASU)
Matt Beasley (SWRI)
Mary Knapp (MIT)

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Varoujan Gorjian (JPL)
Joe Llama (Lowell)
Victoria Meadows (UW)
Mark Swain (JPL)
Robert Zellem (JPL)

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April Jewell (JPL)

Operations/Software
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Tahina Ramiaramanantsoa (ASU)

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