# CubeRRT: CubeSat Radiometer Radio Frequency Interference Technology Validation

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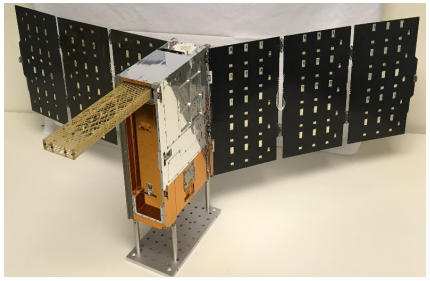
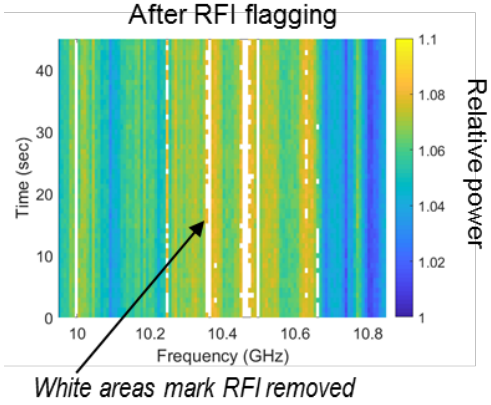
## Objective

- Demonstrate wideband radio frequency interference (RFI) mitigating backend technology for future spaceborne microwave radiometers operating at 6 to 40 GHz
  - Crucial to maintain US national capability for spaceborne radiometry and associated science goals
- Demonstrate real-time on-board RFI detection and mitigation in 1 GHz instantaneous bandwidth
  - Enable development of future low data-rate radiometer systems with RFI-mitigation capability
- Demonstrate operations in space to elevate real-time on-board RFI processing technology to TRL 7



CubeRRT 6U spacecraft with solar panels and payload antenna deployed




CubeRRT spectrogram on 9/5/2018 showing on-board RFI filtering that reduces downlink data volume by 99%

## Accomplishments

- Designed, implemented, and demonstrated an on-board real-time RFI processor capable of observing a 1 GHz instantaneous bandwidth combined with tunable 6-40 GHz radiometer front end and antenna subsystems
  - Through extensive pre-launch testing, RF electronics in a 2.5U, 2.5 kg package demonstrated NEDT performance of sub-kelvin level at less than10 GHz and remaining < 3 K up to 30 GHz. This technology received the US patent in May 2020.
  - On-board processor reduces 1 GHz input bandwidth into estimated power (brightness temperature) before and after RFI mitigation using 128 frequency channel kurtosis and cross-frequency detection algorithms, and it achieves SWaP (~ 0.25 U, 170 g, 10 W) and configurability which motivate adoption by future missions
  - 6-40 GHz tri-element tapered helix antenna subsystem achieves gains from 7 to 21 dBi in 0.25U, 116 g package
- System launched to the ISS on 5/21/18, deployed from the ISS on 7/13/18, and operated through 6/30/20
- Collected “first light” data on September 5, 2018 that validated RFI filtering algorithms; on-board processor has since operated successfully for more than 5400 hours in space, exceeding project goals and reaching TRL 7
- Demonstrated the reliability of COTS Xilinx Zynq-7100 FPGA and TI ADC08D1520 ADC by two years of space operations

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**$TRL_{in}$ = 5** **$TRL_{out}$ = 7**