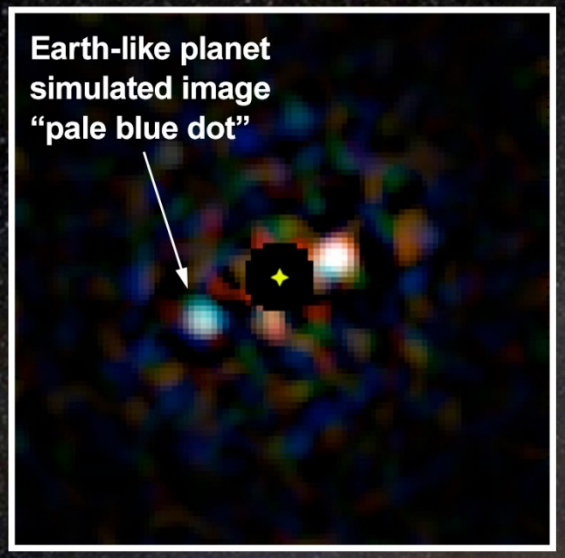

Ames Research Center

NASA

Space mission and instrument design to image the Habitable Zone of Alpha Centauri

αCenA

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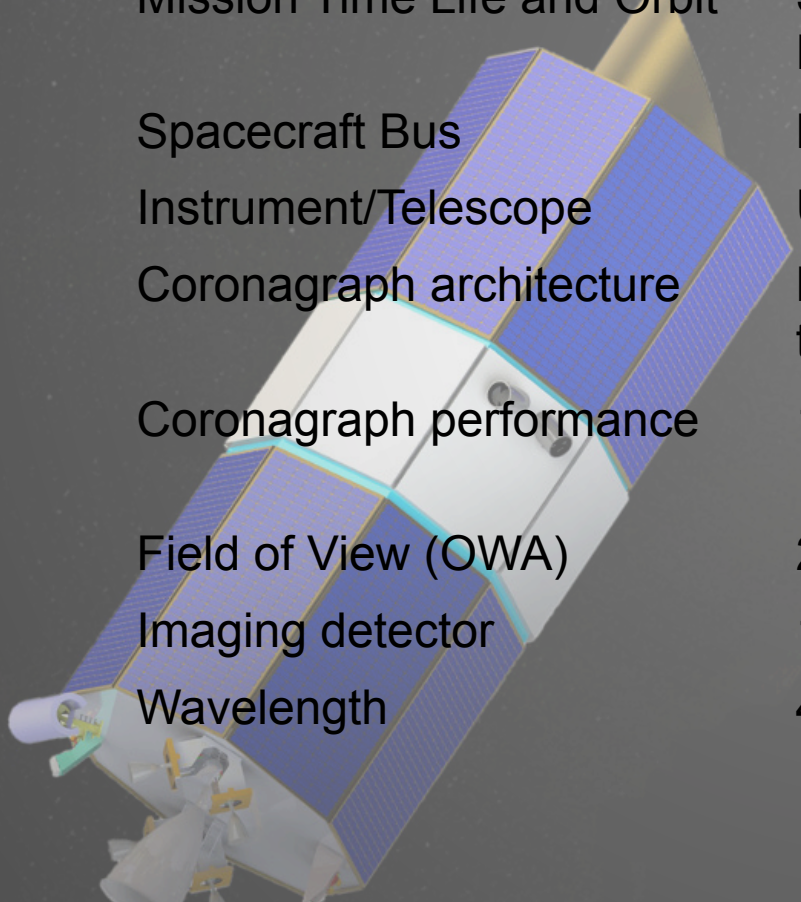
(Northrop Grumman Xinetics / Space systems Loral)

αCenB

1 NASA Ames Research Center, 2 Subaru Observatory

Alpha Centauri Exoplanet Satellite (ACESat) Mission Overview

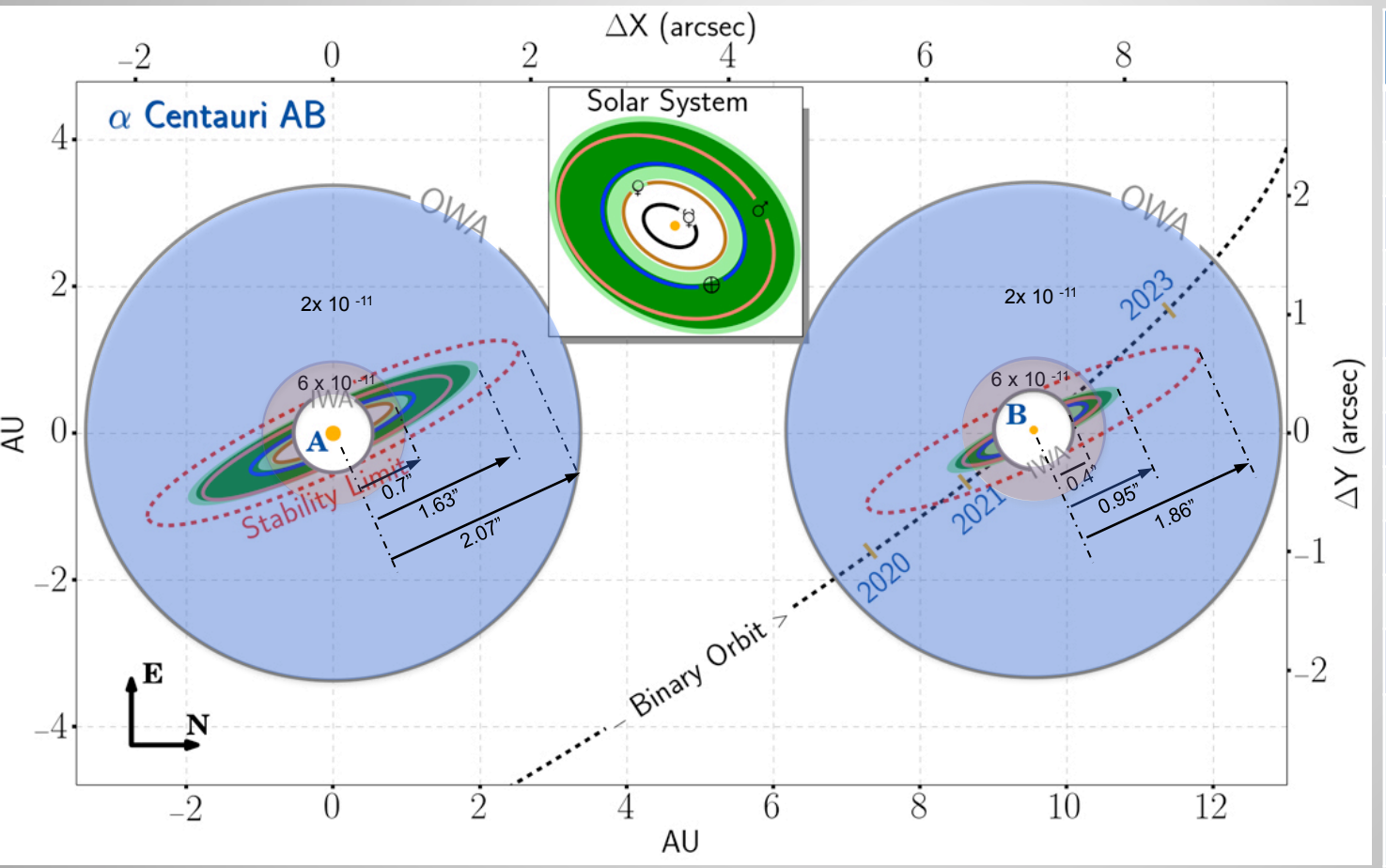
ACESat will directly image and characterize the planets and circumstellar debris disks of Alpha Centauri A & B, with the specific objective of identifying potentially habitable Earth-like planets.



Mission Time Life and Orbit	SMEX-Class, 2-Years (>90% completeness), Earth trailing
Spacecraft Bus	LADEE Type, Secondary Payload to GTO
Instrument/Telescope	Unobstructed 45cm, Full Silicon Carbide
Coronagraph architecture	Baseline: PIAA Embedded on Secondary and tertiary telescope mirror. PIAACMC backup
Coronagraph performance	$1x10^{-8}$ raw $6x10^{-11}$ @ 0.4" (With ODI) $2x10^{-11}$ @ 0.7"
Field of View (OWA)	2.5" x 2.5"
Imaging detector	1k x 1k EMCCD 0.08"/px Sampling
Wavelength	400 to 700 nm, Dichroics 5 bands @ 10% each.

Scientific requirements

Goal: Image 0.5 to 2.0 R_e planets' equivalent brightness, in the HZ of aCen A&B during a 2 year mission

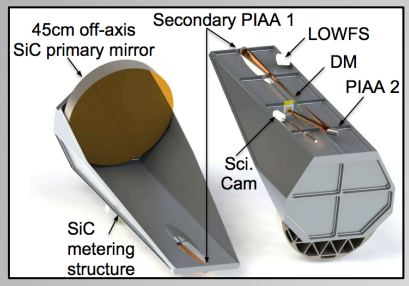


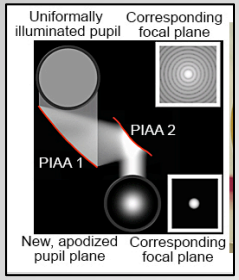
Contrs.	IWA	OWA
aCen B		
6x10^{-11}	***0.4"***	0.95"
6x10^{-11}	1.6λ/D	3.8λ/D
aCen A		
2x10^{-11}	***0.7"***	1.63"
2x10^{-11}	2.7λ/D	6.5λ/D
Stability limit (aCen A)		
2x10^{-11}		2.07"
2x10^{-11}		8.3λ/D
Sensitivity		
SNR=5	1.6 Days	
ODI Calibration	30 Days	

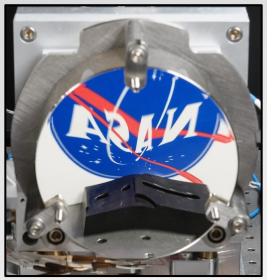
Credit: Billy Quarles, NASA Ames

Instrument Building blocks

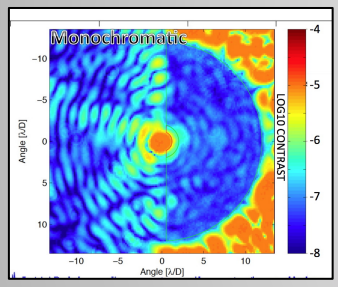
45 cm off-axis telescope with an **embedded** PIAA -> 10^{-5} (1.6 – 10λ/D)

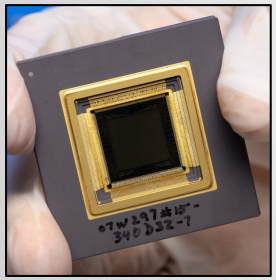


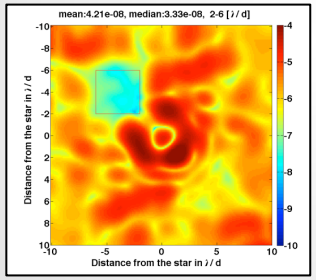




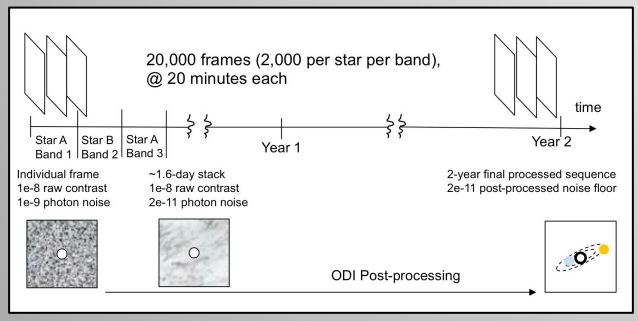
WFC (Multi-Star Wave Front Control) -> 10^{-8}

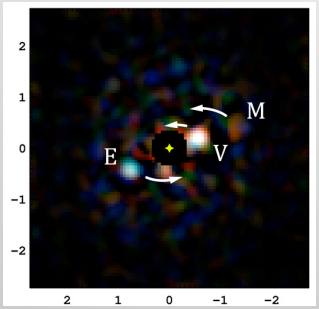


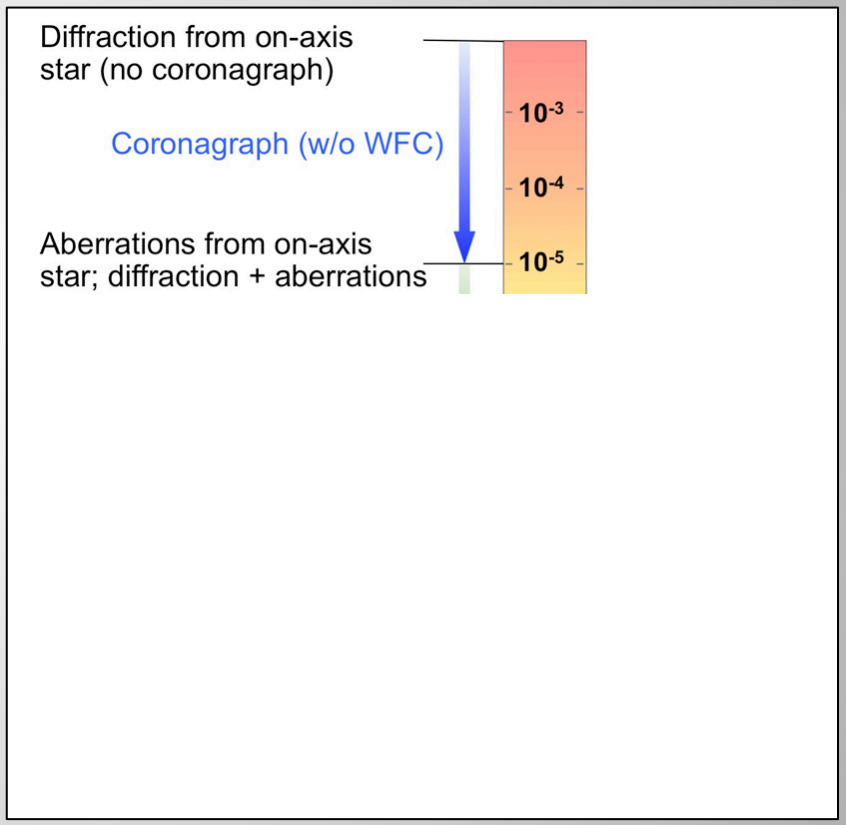




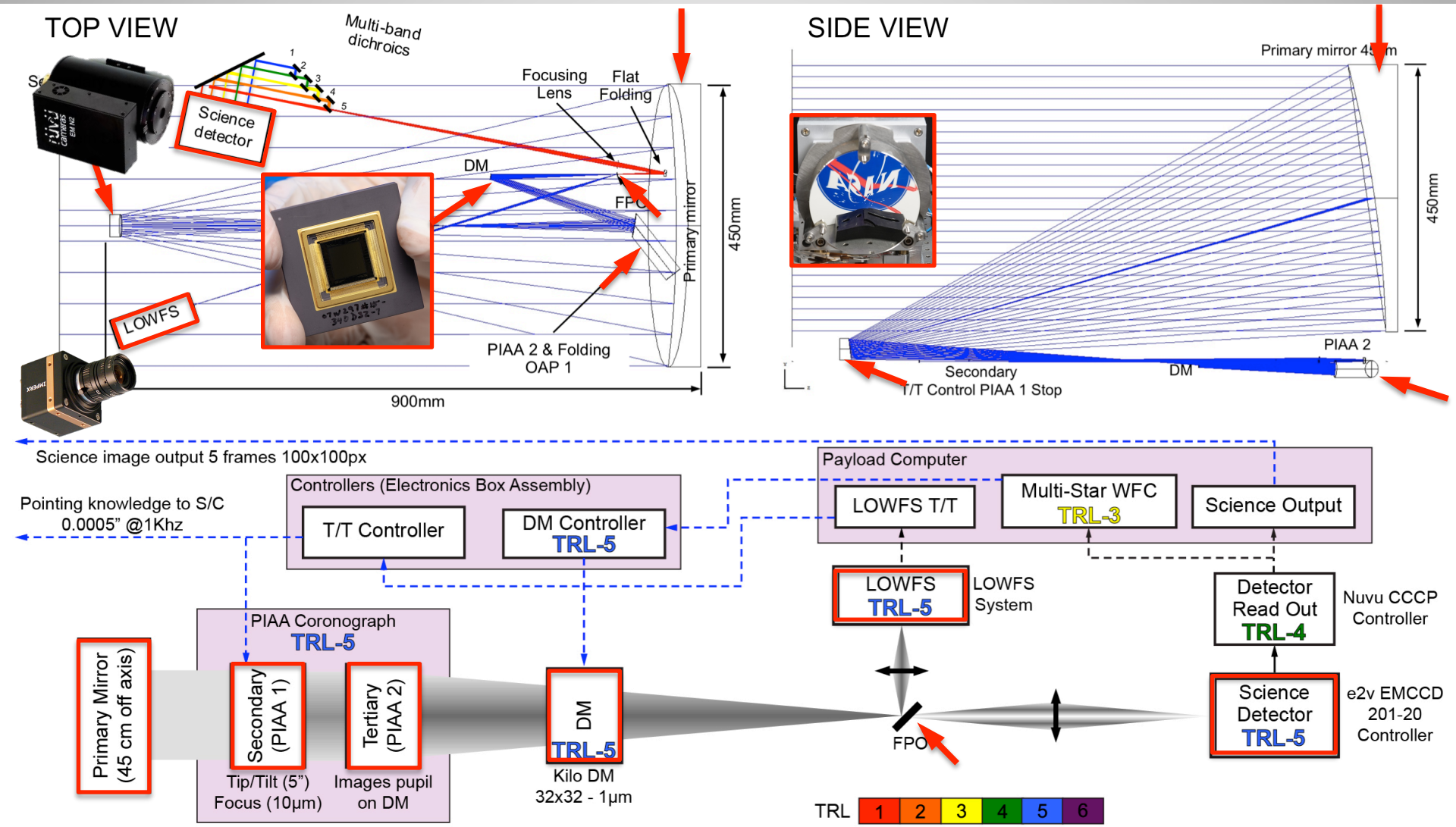
Continuous observation ODI -> 10^{-11}



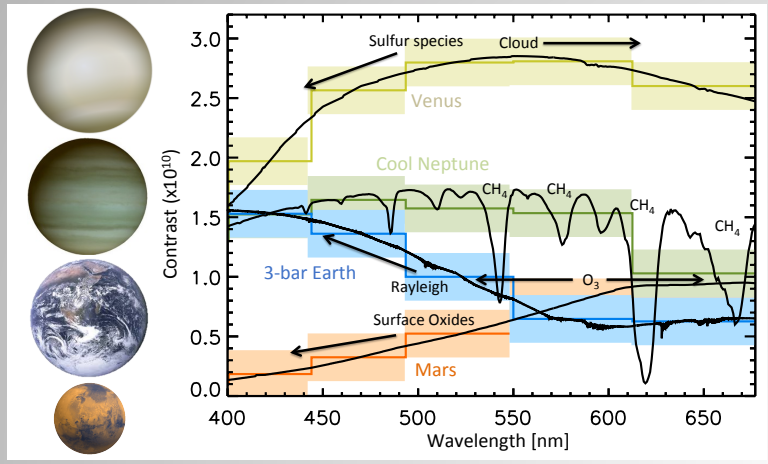




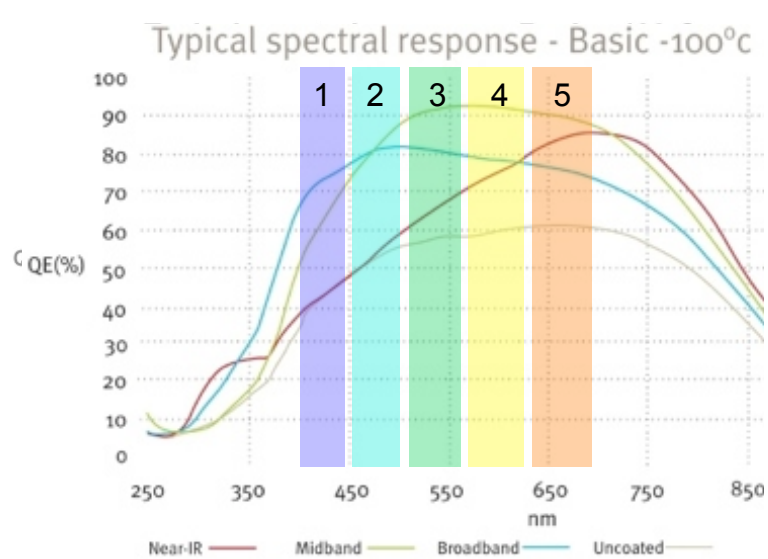
Optical and system design

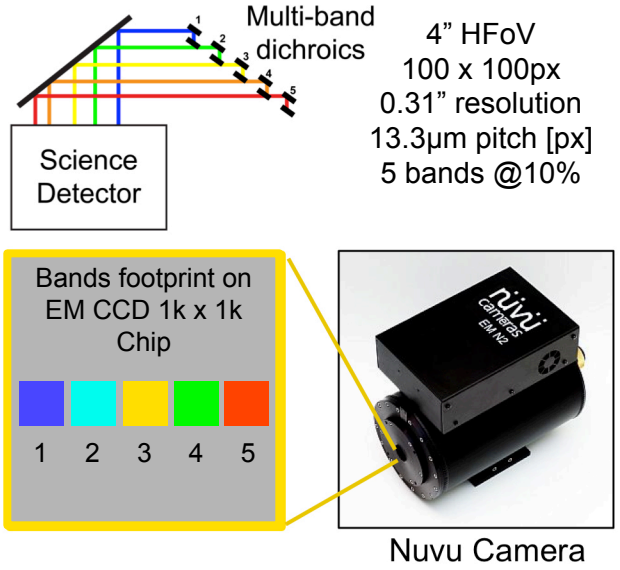


Multi-Spectral Imager



- Wavelength: **400 nm to 700 nm** (Contains 40% aCen A flux)
- **Five channels** of 10% bandwidth each.
- **SW (400nm):** Blue rayleigh scattering indicates **earth-like atmosphere**. (Const. coatings and QE)
- **LW (700): CH_4 absorption bands**. Limited by QE and WFC bandwidth.

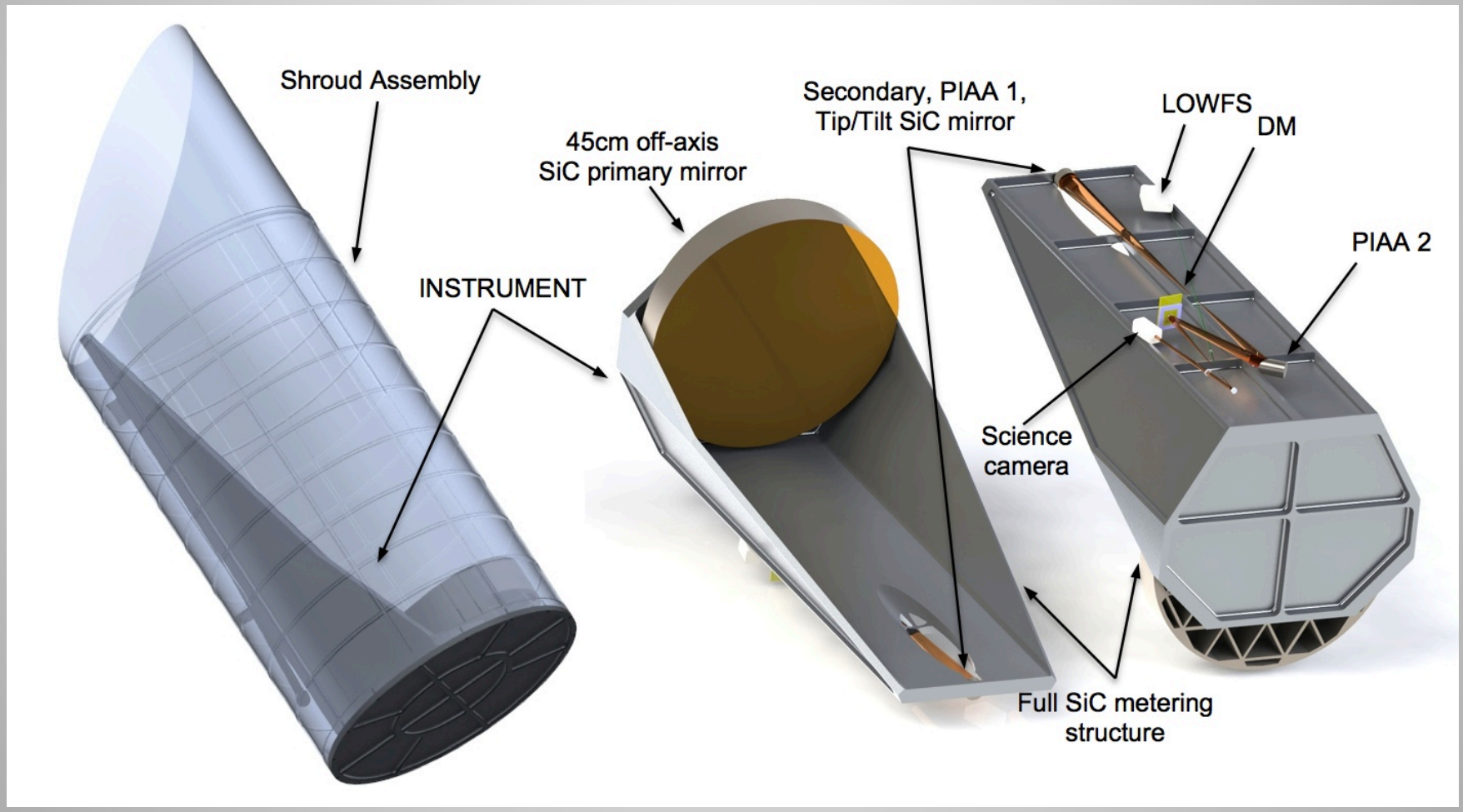




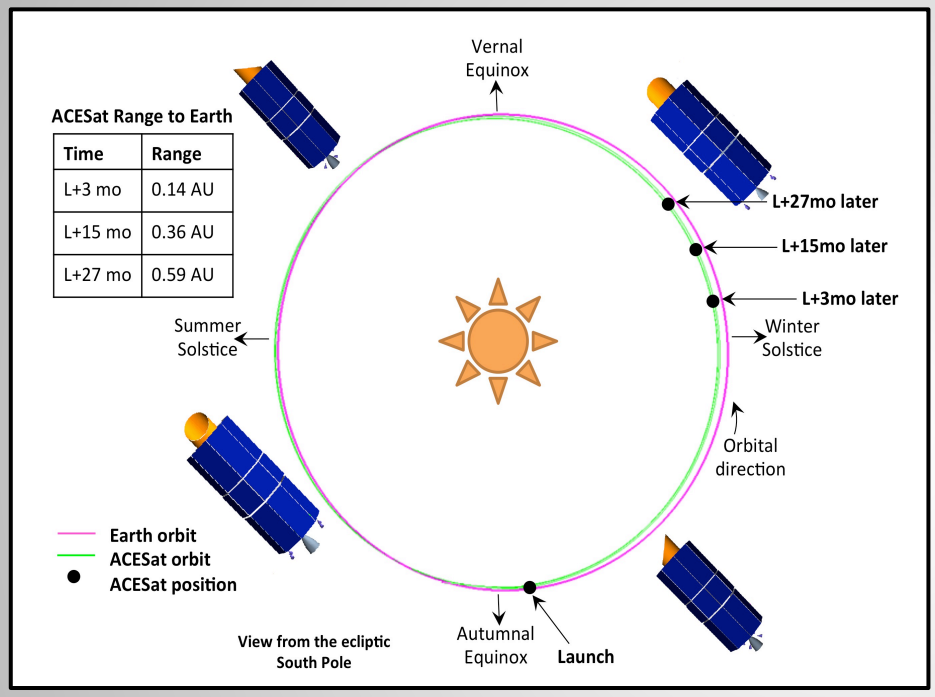
- E2v EMCCD 201-20 **almost zero RON**
- Short 10s exposure time to avoid cosmic rays

Telescope Hardware

- Full SiC 45cm, Off-axis telescope, L/25 max end-to-end WFE (Total 45Kg mass)
- Active thermal control to maintain 10˚C operation with 0.1˚C PV stability
- 0.5mas RMS stability LOWFS (Demonstrated for CAT III EXCEDE Lockheed Martin)



Mission operations

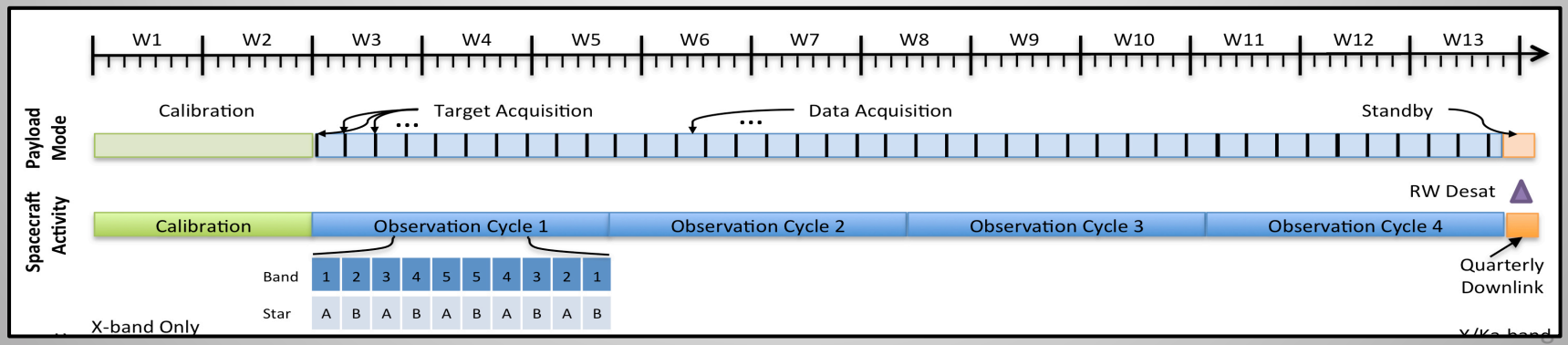


High stability pointing spacecraft

Unperturbed observation per quarter, 1.6 days/band/star

Quarterly operations:

- **DSN Downlink** and reaction wheels desaturation and quarter end.
- **90˚ Roll** to keep sunshield in position
- **Calibration** per quarter (Speckle MSWC, LOWFS).



αCEN A

αCEN B

Conclusion

1) We developed an instrument design to achieve the science goals

2) We developed a mission concept that satisfies instrument stability requirements

3) We are advancing key technologies (PIAA, DM, WFC, Post-processing) for ACESat and other direct imaging missions (AFTA-C, EXO-C, EXCEDE)

Questions?

Image credit: Juan Nabzo, Jan 5th 2015, Chilean Patagonia