Evolvable Space Telescope (EST)

Joint Exo-PAG and Co-PAG @ Seattle AAS meeting

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The problems

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- Funding profile spike
- Total and annual cost uncertainties'
- Maintain flow of science data
- 20-meter class telescopes
  - In one launch!

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JWST funding profile [illustration]

Time =>

Evolvable space telescope objectives

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Cultural Change

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2026 2036 2046

Modulate the large cost per year fluctuations

In-space replacement of instruments

Grow the performance with time

Schedule is dictated by budget realities,
science needs and technology advances

Steps to ~20-m: phase 1, 2, 3

Science Drivers [stage 1,2,3 =>~20m]

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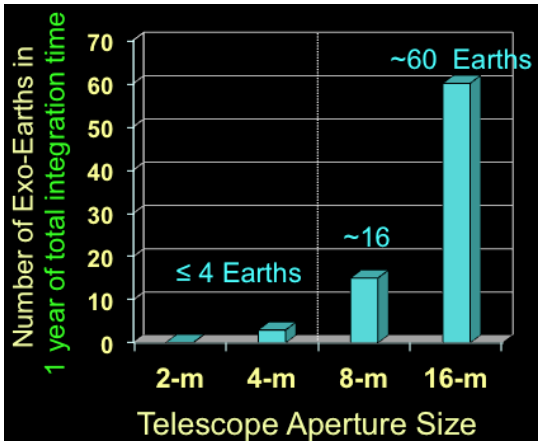
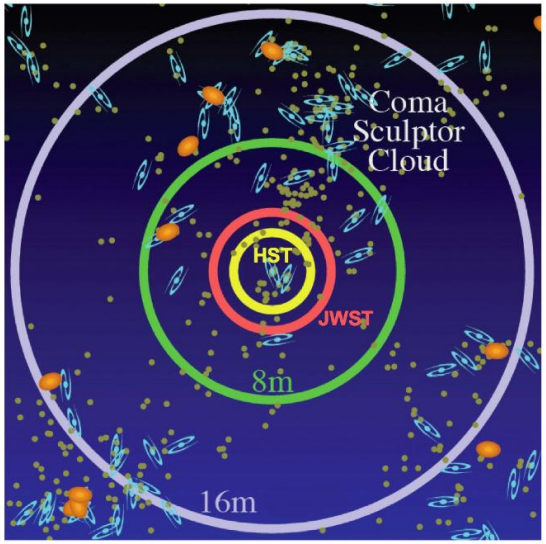
- Design concept based on science drivers from the ATLAST study*:
  - Exoplanet characterization and the discovery of life outside the solar system
  - Origin and evolution of the universe
  - Star formation and galaxy assembly
  - Distribution and nature of dark energy and dark matter
- Science objectives will evolve with each stage of EST deployment, ultimately achieving full ATLAST capability at Stage 3 with a 14 to 20 meter aperture
  - Stage 2 and 3 configurations may be enhanced by Stage 1 data
  - Enhancements will be expected for each stage's instruments
- Each stage, beginning with stage 1, designed to contribute significant science beyond then-current state-of-knowledge. **This is a *Fundamental Design Rule* for EST**



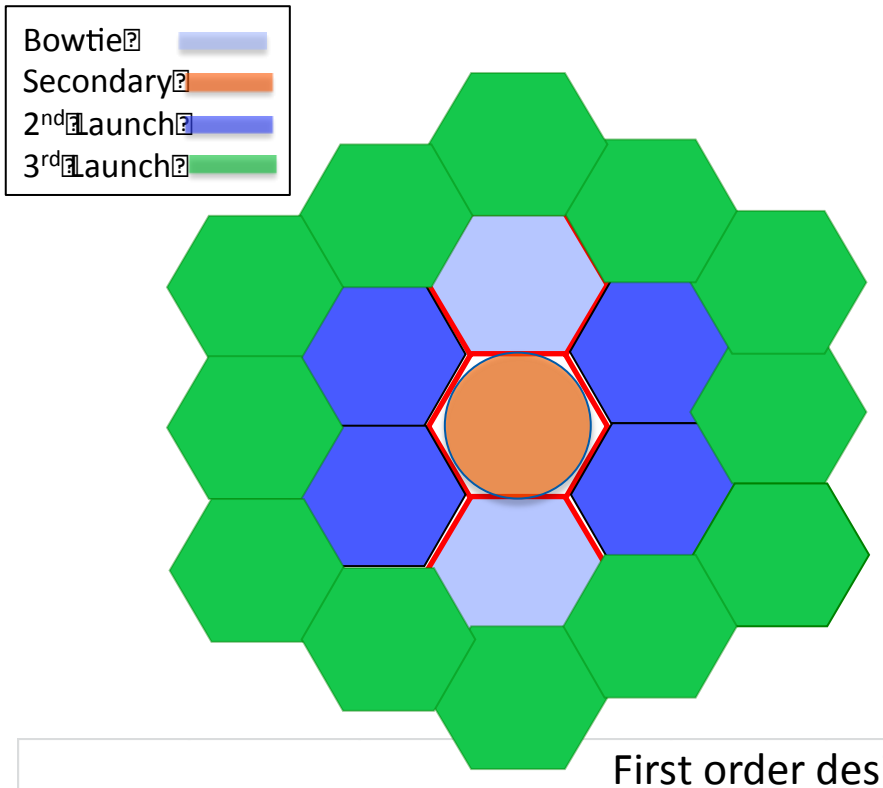
Number of Earth Spectra



Sun Detectable at S/N=5

* http://www.stsci.edu/institute/atlast/atlast-mission-concept-study

Primary mirror aperture grows with time



- 20-m Telescope assembled on-orbit in three stages:
  - Stage 1: Launch 2 mirror segments and secondary in ~4.5-m x 12-m off-axis "Bowtie" configuration fully functional observatory
  - Stage 2: Launch 4 mirror segments to complete 1st ring for 12-m on-axis Cassegrain observatory
  - Stage 3: Launch 12 mirror segments to add 2nd ring for 20-m on-axis Cassegrain observatory
- On-orbit servicing and instrument replacement on each visit
- Sunshield replaced on 2nd visit

First order design parameters

Hex Size (flat-flat) (meters)	Aperture Diagonal (meters)	Collecting Area (meters^2)	Number of Segments	Primary F/No.	Telescope Resolution[1] (mas)	Field of View[2] (arc-min)	Focal Plane plate scale (arcsec/mm)	Airy patterns in FP[3]	Number of Pixes in FP[4]
3.95	4.8 x 11.9	27.02	2	5.5 x 2.1	28 x 11	40 x 31	1.7 x 1.6	1.52E+08	6.08E+08
3.95	12.5	81.07	6	2.12	10.62	31.16	1.63	3.10E+10	1.24E+11
3.95	20.1	243.22	18	1.25	6.25	22.74	1.59	4.77E+10	1.91E+11

[1]Diffraction limited resolution at 500nm (1.22 l/D) in the yz plane

[2]FOV with 150 cm diameter hole at Prime Mirror

[3]Number of Airy diffraction patterns at the FP in the yz plan

[4]# of pixels in the 2-D detector at Nyquist based the yz plan

Candidate Telescope Configurations based on "mirror & mast"

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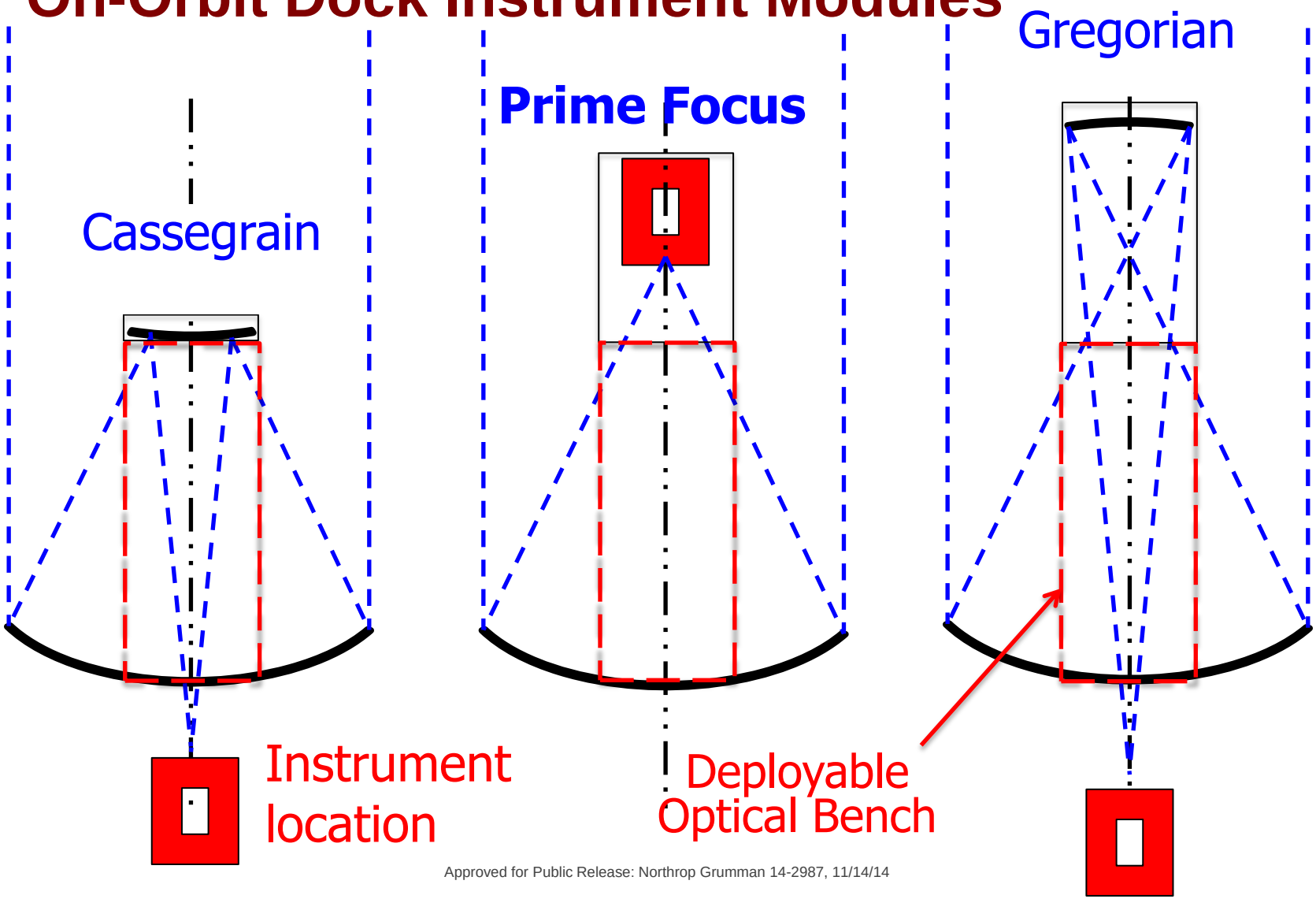
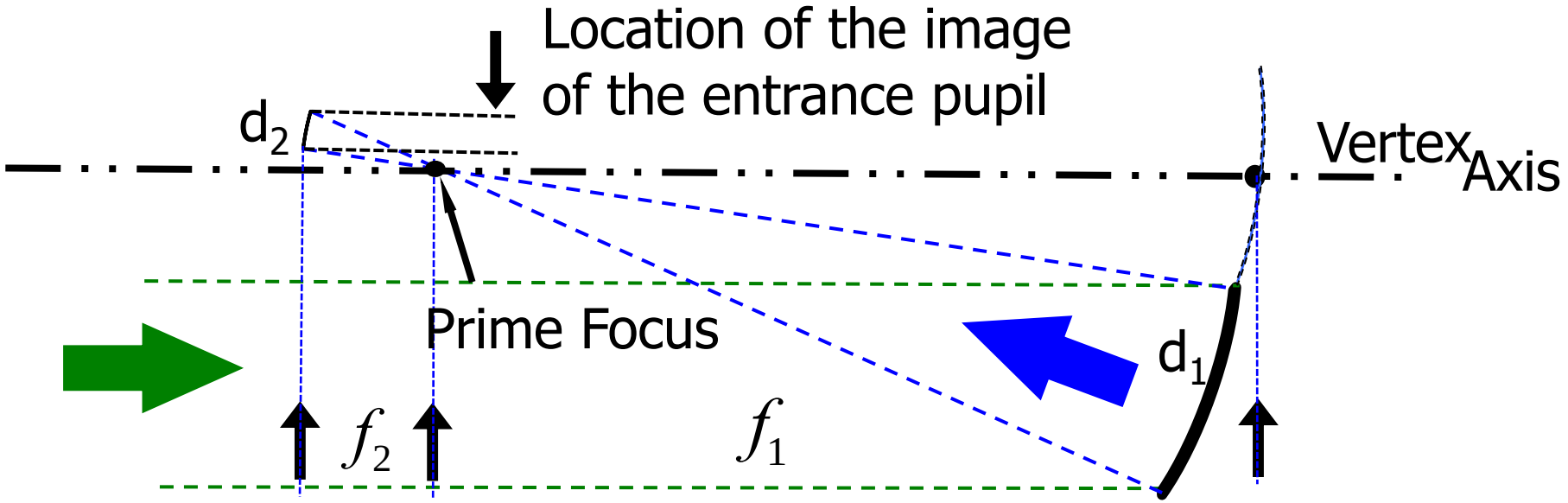
- **On-Orbit Dock Instrument Modules**



Prime focus layout for one segment



- One reflection to the prime focus
  - 1st Coronagraph Mask and/or
  - UV spectrograph entrance slit
- Two reflections to the first A/O mirror
  - (Maximize transmittance)
- Enables low instrument polarization

Bow-Tie Prime focus Phase 1

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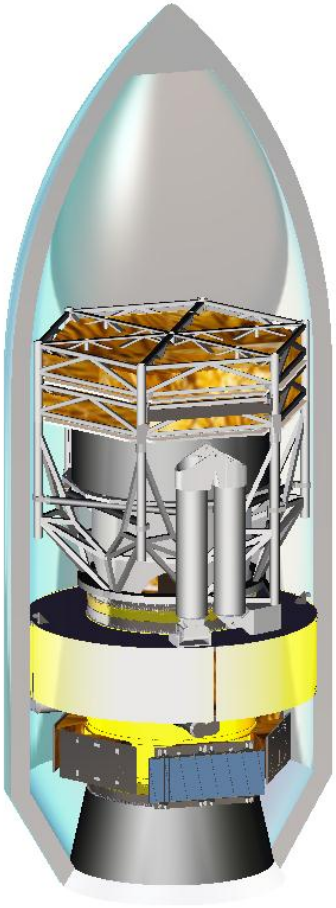
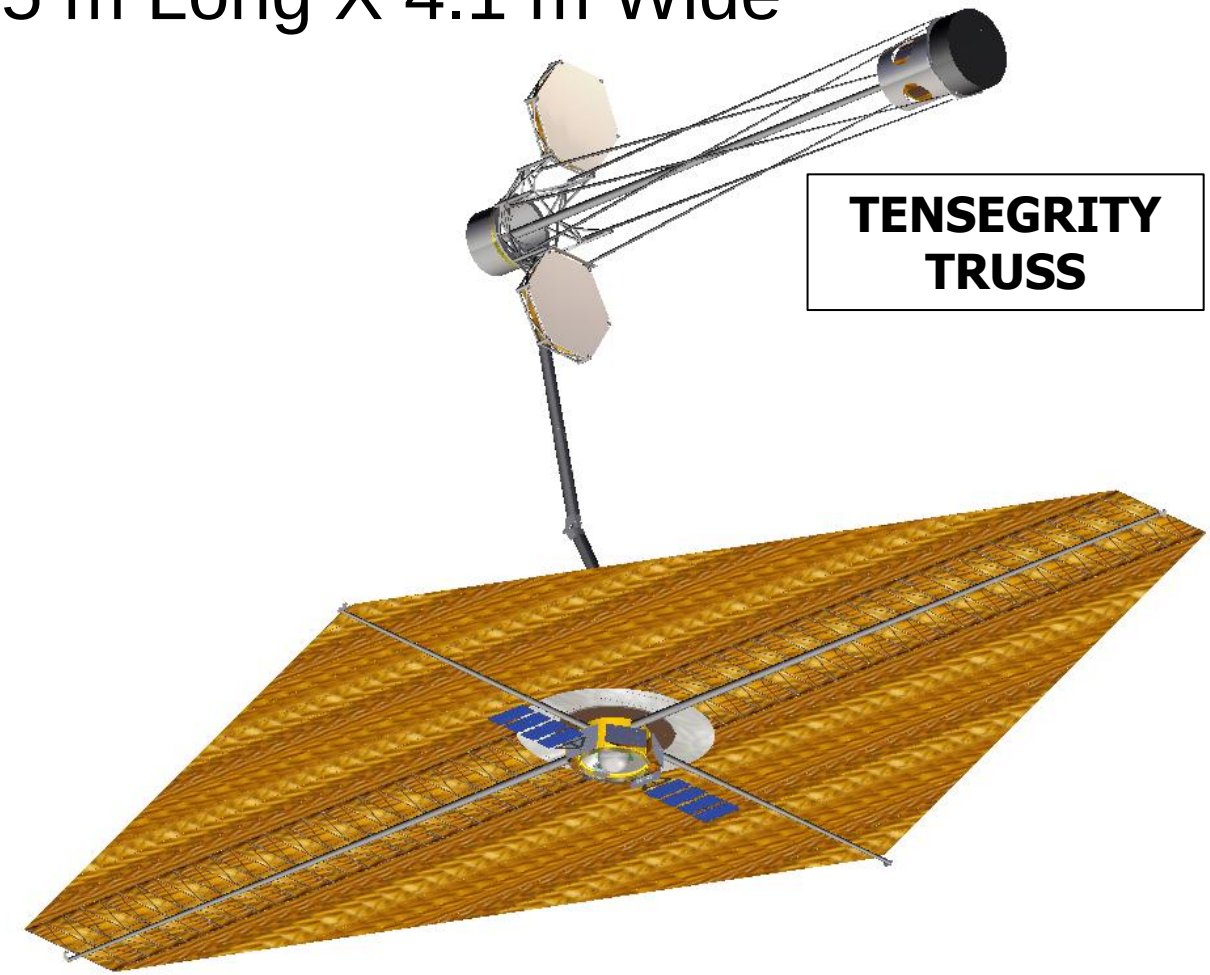
- Two 3.9 m (Flat to Flat) Hex Segments
- Aperture 11.75 m Long X 4.1 m Wide





TENSEGRITY TRUSS

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Backup Charts

Top Level Requirements

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- Are we alone? How did we get here? These 2 fundamental questions can be addressed with a large UVOIR space telescope, with:
  - Large aperture (10 to ≥16 meters)
  - Starlight suppression to enable exoplanet observations (10^{-10} contrast)
  - UV to NIR wavelength coverage (100 to 2400 nm)
  - Diffraction-limited optical quality (12 to ≤ 8 mas at 500 nm, ≥80% Strehl)

Parameter	Requirement	Goal	Notes
Telescope Aperture	> 10 m	> 16 m	> ATLAST concept
Stage 1	Bow-tie	4 x 12 m	Two hexagonal segments
Stage 2	Filled Aperture	12 m	Eighteen hexagonal segments
Stage 3	Filled Aperture	20 m	Twelve hexagonal segments
Wavelength	100-2400 nm	90-8000 nm	UVOIR, MIR under evaluation
Field of View	5 to 8 arcmin	30 arcmin	Wide field VNIR imaging
Diffraction Limit	500 nm	250 nm	Enhanced UV/Optical resolution
Primary Segment Size	2.4 m	3.93 m	flat to flat
Primary Mirror Temp	< 200 K	150 K	Minimize heater power
Design Lifetime	15 years	>30 years	On-orbit assembly and servicing