Astrophysics Flagship Observatories

From observing distant galaxies to exploring exoplanets and their atmospheres, BAE Systems enables cutting-edge technology to expand our knowledge of the universe. As a major partner in each of NASA's Great Observatories, BAE Systems is continuing the legacy of pioneering astrophysics missions with the next generation of observatories, James Webb Space Telescope (Webb) and Nancy Grace Roman Space Telescope (Roman). As we look to the future, we are leveraging our rich heritage of groundbreaking astrophysics technology development to provide the stability and resolution needed to investigate planets across the cosmos using deep imaging and highly multiplexed spectroscopy to search for habitable worlds like ours.

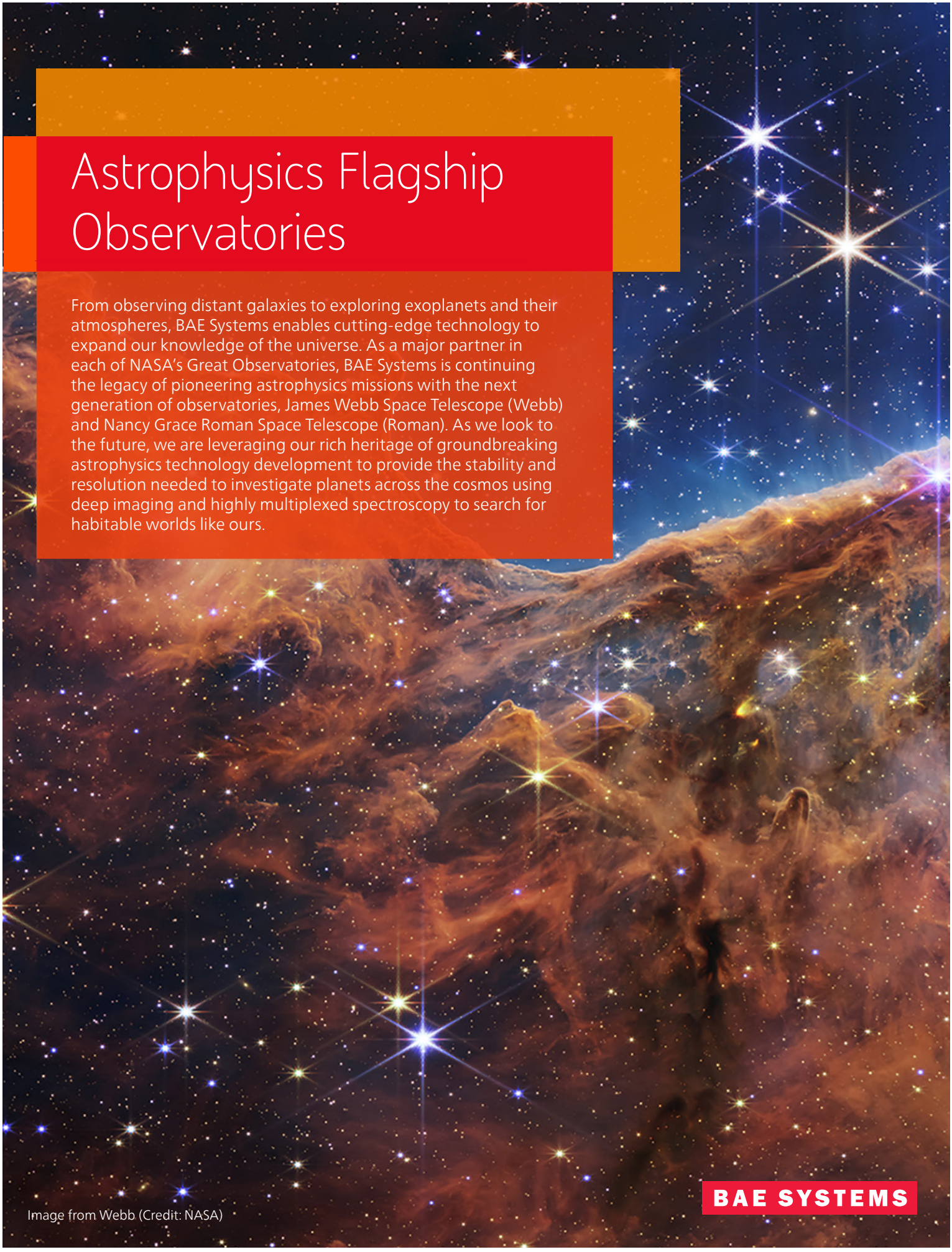


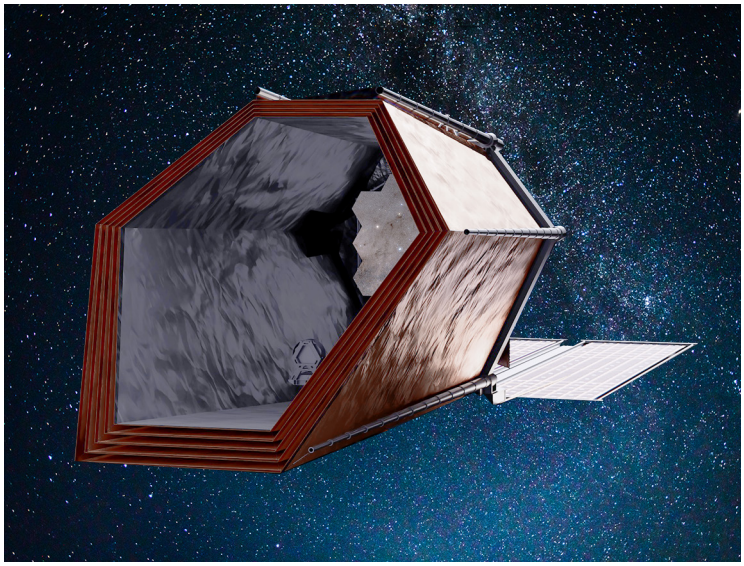
Image from Webb (Credit: NASA)

BAE SYSTEMS

Future Astrophysics Flagship: Habitable Worlds Observatory

Are we alone in the universe? A question that serves as the north star for NASA's Habitable Worlds Observatory (HWO). The HWO telescope is in the early stages of development and is focused on imaging earth-like planets orbiting other stars and searching them for signs of life. HWO would also provide a powerful lens to explore the stars, the planets of our solar system, galaxies, and the evolution of the universe with unprecedented sensitivity and resolution.

Observing exoplanets in detail presents a unique set of challenges. BAE Systems enthusiastically lends evolving expertise and architecture, gained through programs like Hubble and Webb, as HWO pushes technological and architectural boundaries. Building off of two previous NASA awards, BAE Systems is conducting a research effort called the Ultra-stable Large Telescope Research and Analysis Program – Critical Technologies (ULTRA-CT). ULTRA-CT will focus on developing "ultra-stable" optical systems to support the observatory in capturing high-resolution images.



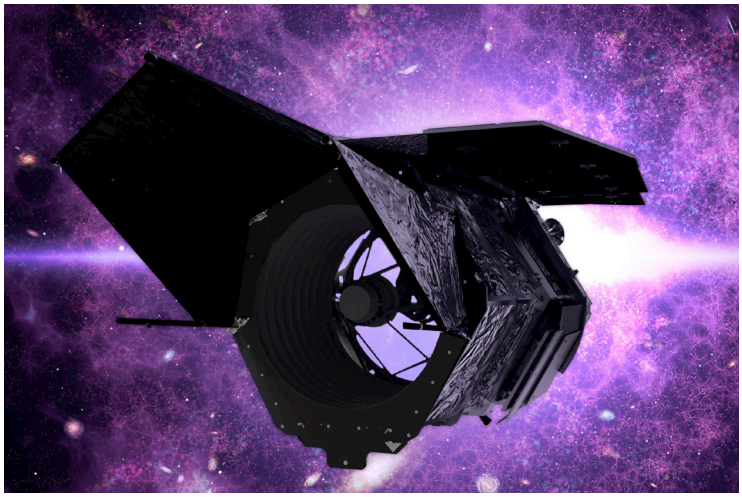
NASA's Habitable Worlds Observatory (HWO)

Current Astrophysics Flagship: The Nancy Roman Space Telescope

The Nancy Grace Roman Space Telescope, NASA's next flagship observatory, will enable advances in astrophysics by providing a large-scale survey capability in infrared wavelengths. The observatory is designed to capture data that will allow astronomers to answer high-priority scientific questions related to the evolution and fate of the universe and the abundance of planets in the universe.

NASA selected BAE Systems to design and develop the Wide Field Instrument (WFI) Opto-Mechanical Assembly for the Roman mission. The Opto-Mechanical Assembly provides the stable structure and thermal environment that enables the WFI to meet performance. It includes the optical bench, thermal control system, precision mechanisms (based on the JWST primary mirror actuators), optics and electronics.

Slated to launch in the mid-2020s, Roman's large area surveys will provide scientists around the world, who will all have access to the observatory's data, with a treasure trove of information in a fraction of the observation time previously required.



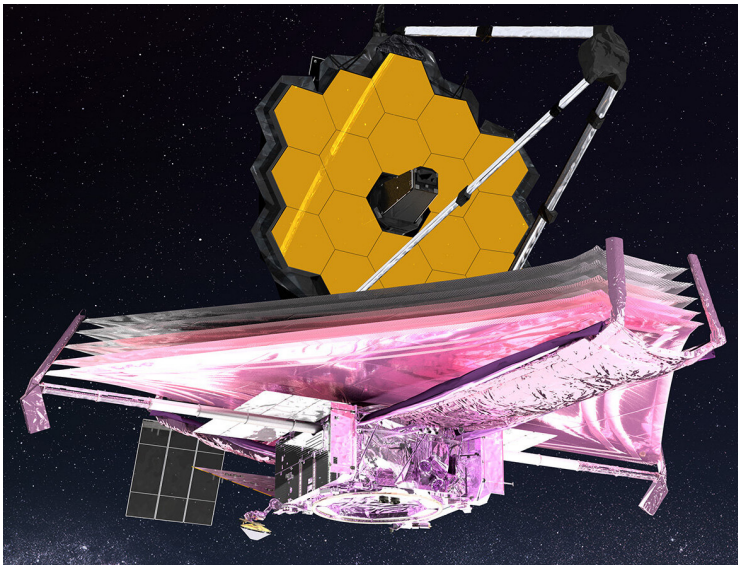
Roman Space Telescope rendering (Credit: NASA)

WFI radiators installed – prior to Thermal Vacuum Chamber (TVAC) testing

Current Astrophysics Flagship: James Webb Space Telescope

Webb is revolutionizing our understanding of the cosmos as it studies the earliest phases of our universe's history, from the first luminous glows after the Big Bang to the evolution of our own solar system. Webb successfully launched in December 2021.

BAE Systems was responsible for designing, building and testing the Optical Telescope Element for NASA's James Webb Space Telescope. This included the 18 gold-coated primary mirror segments and the secondary, tertiary and fold mirrors, as well as the mirror support structures, patented multi-stage actuators and drive electronics, all operating at cryogenic temperatures. BAE Systems also developed the wavefront sensing and control system, which measured and adjusted the position of the individual mirrors to an accuracy of tens of nanometers (a ten-thousandth of the width of a human hair!) so they act like a single, giant mirror.



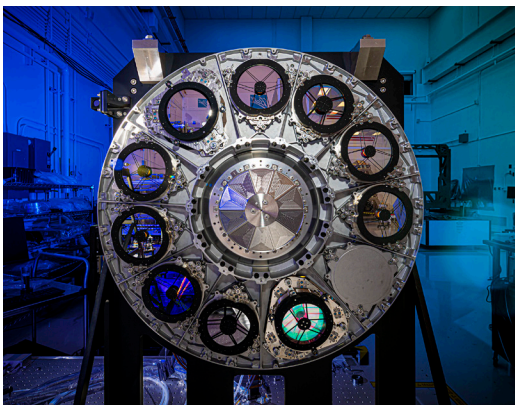
James Webb Space Telescope (Credit: NASA)

Webb Capabilities

- The world's largest and most powerful space telescope
- Webb offers unprecedented resolution and sensitivity from long-wavelength visible light to near-infrared and mid-infrared
- Detects objects up to 400 times fainter than can be observed by current ground-and space-based telescopes
- Webb observes distant galaxies over 13 billion light years away from us

Roman Capabilities

- Complimentary to Webb and Hubble
- Roman has more than 100 times the field of view than Hubble, enabling the observatory to conduct comprehensive and efficient surveys of the infrared sky
- Roman will capture equivalent quality images to Hubble with the Wide Field Instrument
- Scientists estimate Roman has the potential to examine a billion galaxies over the course of its mission
- Roman will complete the census of exoplanets started by Kepler through a technique known as microlensing

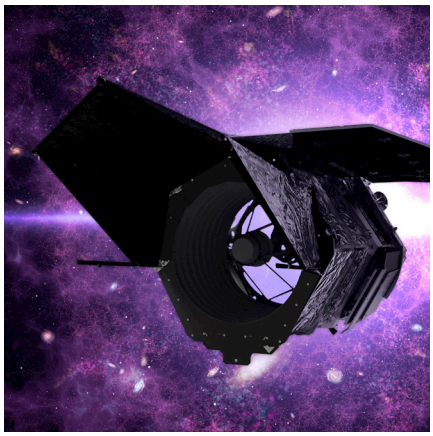


WFI element wheel installation

Webb team with assembled optical system

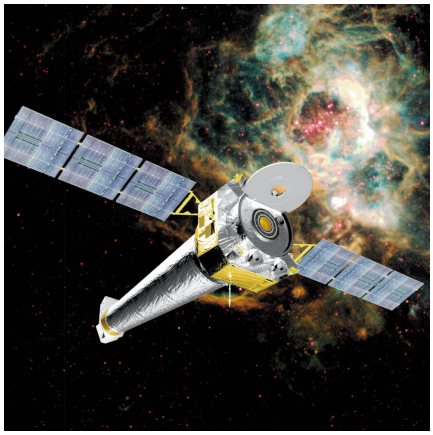
Great Observatories:

Spitzer – Launched in 2003



Using infrared detectors, Spitzer Space Telescope (Spitzer) captured celestial objects that were too dim, distant or cool to study with other astronomical techniques. BAE Systems built the Infrared Spectrograph (IRS) and the Multiband Imaging Photometer (MIPS), which were the most sensitive detectors ever flown on an infrared mission. Additionally, BAE Systems was responsible for the Cryogenic Telescope Assembly (CTA), which acted as the "eye" of Spitzer.

Chandra – Launched in 1999



NASA's flagship mission for X-ray astronomy, the Chandra X-Ray Observatory (Chandra) continues to advance our understanding of the structure and evolution of the universe by probing the origins of heavy elements and understanding the local physics of black holes. BAE Systems built the Aspect Camera, which points the observatory in the direction of its science targets, and the Science Instrument Module, which houses and controls the telescope's two focal planes.

Compton – Launched in 1991

The Compton Gamma Ray Observatory (Compton) used a combination of instruments to detect a range of high-energy radiation called gamma rays. BAE Systems built the Oriented Scintillation Spectrometer Experiment (OSSE) instrument and two fixed-head star trackers. OSSE completed the most comprehensive survey of the center of our Milky Way, discovering radiation is focused on the center of the galaxy.

Hubble – Launched in 1990

Hubble was the world's first large, space-based general telescope that revolutionized our understanding of the universe and sought to measure the Hubble Constant, a fundamental measure of the expansion of the universe, more accurately than ever before. BAE Systems contributions played a significant role in Hubble's success. Most notably, the Corrective Optics Space Telescope Axial Replacement (COSTAR) allowed Hubble to reveal the first crisp images of the cosmos. In addition, BAE Systems participated in every servicing mission, including developing innovative corrective hardware and astronaut tools for the in-space repairs of ACS and STIS during Servicing Mission 4. BAE Systems built all the scientific instruments listed below:

- Goddard High Resolution Spectrograph (GHRS)
- Corrective Optics Space Telescope Axial Replacement (COSTAR)
- Near Infrared Camera and Multi-Object Spectrograph (NICMOS) *
- Space Telescope Imaging Spectrograph (STIS) *
- Advanced Camera for Surveys (ACS) *
- Cosmic Origins Spectrograph (COS) *
- Wide Field Camera 3 (WFC3) *
- 2 star trackers, 5 major leave-behind equipment subsystems and more than 8 custom tools to support astronauts during servicing missions

** indicates the instrument is still on board Hubble today*

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