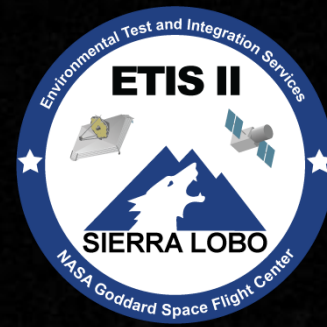




# *The “Very Cool” James Webb Space Telescope!*



*Peter J.B. Teague  
Sierra Lobo, Inc.*

*NASA Goddard Space Flight Center, Greenbelt, MD*



# *What is the JWST?*

- A large space-based observatory optimized for infrared wavelengths
- Program is a partnership between NASA, ESA, and CSA
- Program was originally called the Next Generation Space Telescope
- JWST will complement and extend the discoveries of the Hubble Space Telescope
- Twenty years in the making!

## *James E. Webb (1906-1992)*

- NASA's second administrator, James E. Webb, is best known for leading Apollo, a series of lunar exploration programs that landed the first humans on the Moon
- Webb also initiated a vigorous space science program that was responsible for more than 75 launches during his tenure, including America's first interplanetary explorers



# *Hubble Space Telescope (HST)*



- Launched by STS- 31, Discovery in 1990
- Size of a school bus, weighs >24,000 lbs
- Orbits the Earth at 570 km [340 mi.]
- Last upgrade mission: STS-125, Atlantis in 2009
- Mostly visible light-some IR and UV
- Still in service
- EOL expected 2020+

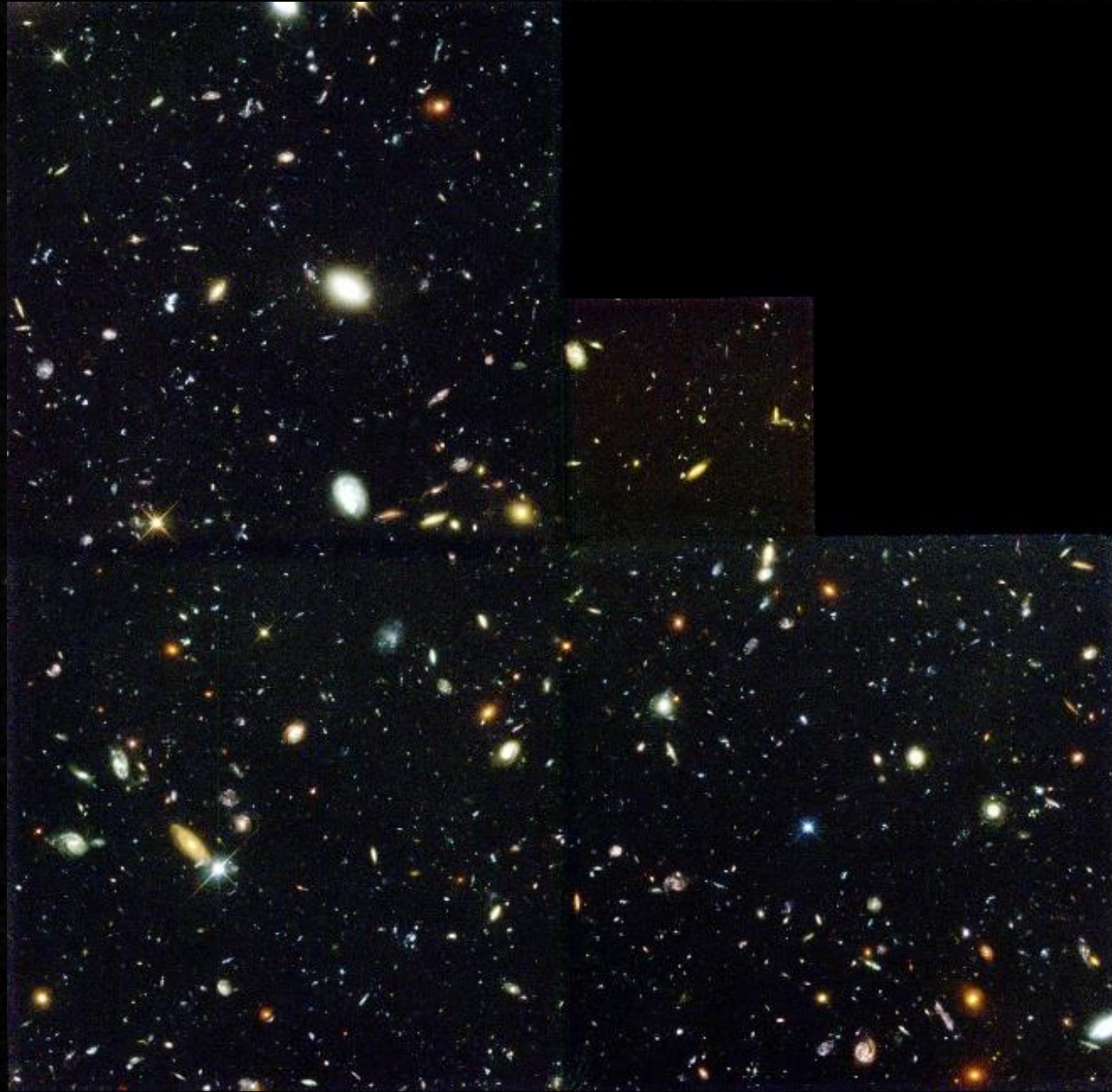
# *Hubble Deep Field*

In 1995, Robert Williams (Director, Space Telescope Science Institute) directed Hubble to stare at “nothing” for 100 hours.....just for fun.

The image is now known as the Hubble Deep Field.

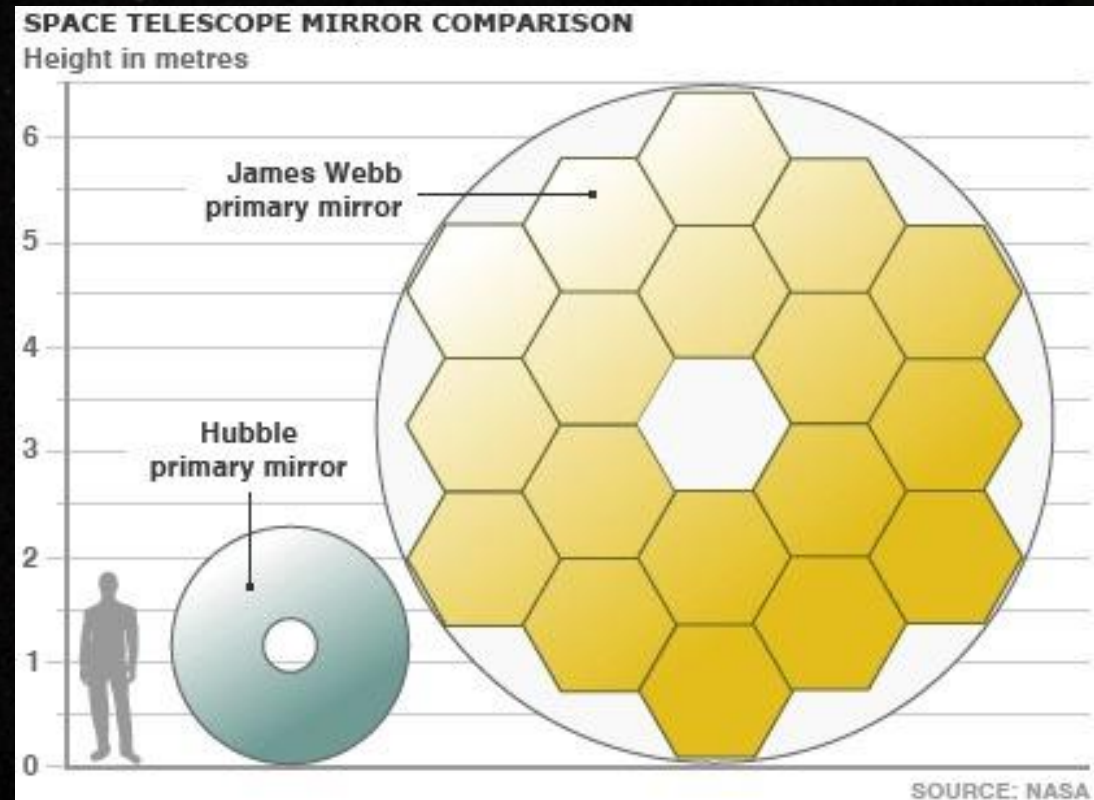
This is what he found.....

# *Hubble Deep Field*



# *JWST vs. HST*

- JWST is designed to look deeper into space to see the earliest stars and galaxies that formed in the Universe
- Will utilize a much larger primary mirror than Hubble
  - 2.7 times larger in diameter
  - 6 times the light-gathering power
- Infrared-optimized instruments with longer wavelength coverage and greatly improved sensitivity over Hubble



# *Size of the Webb*



- JWST will have a mass of approximately 6,500 kg, with a weight of 14,300 lbs on Earth (in orbit, everything is weightless), a little more than half the mass of Hubble. The largest structure of Webb will be its sunshield, which must be able to shield the deployed primary mirror and the tower that holds the secondary mirror. The sunshield is approximately the size of a tennis court!



# *JWST Primary Mirrors*

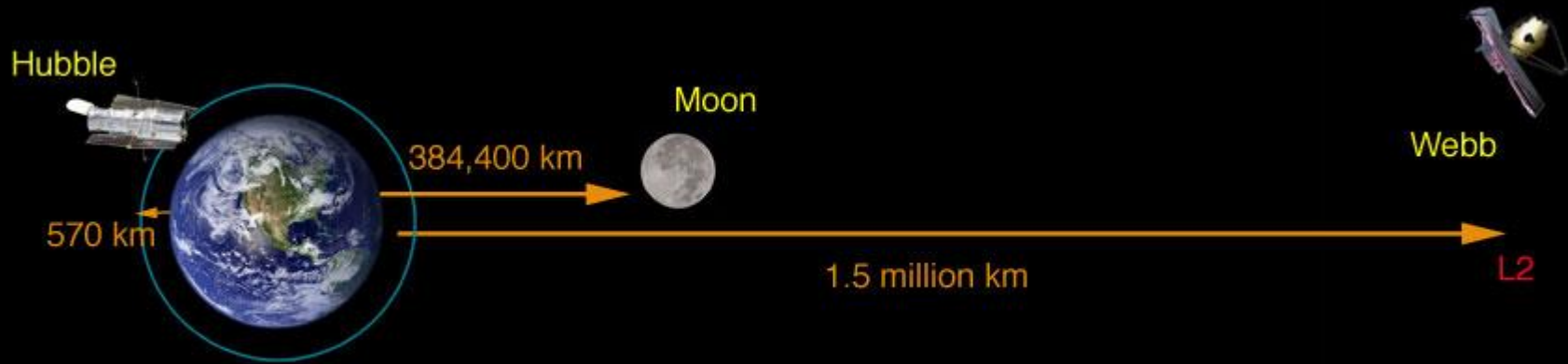
- 18 hexagonal segments individually steerable to focus as one 6.5m dia. mirror
- Cut from Beryllium- strong, lightweight metal having high thermal conductivity and high thermal stability
- Each mirror weighs only 20kg (plus another 20kg of steering and control hardware)
- Optical resolution: 0.1 arc-seconds
- Huge 25m<sup>2</sup> mirror surface covered in gold to better reflect IR!  
That is as much gold as .....



**A GOLF BALL!!**

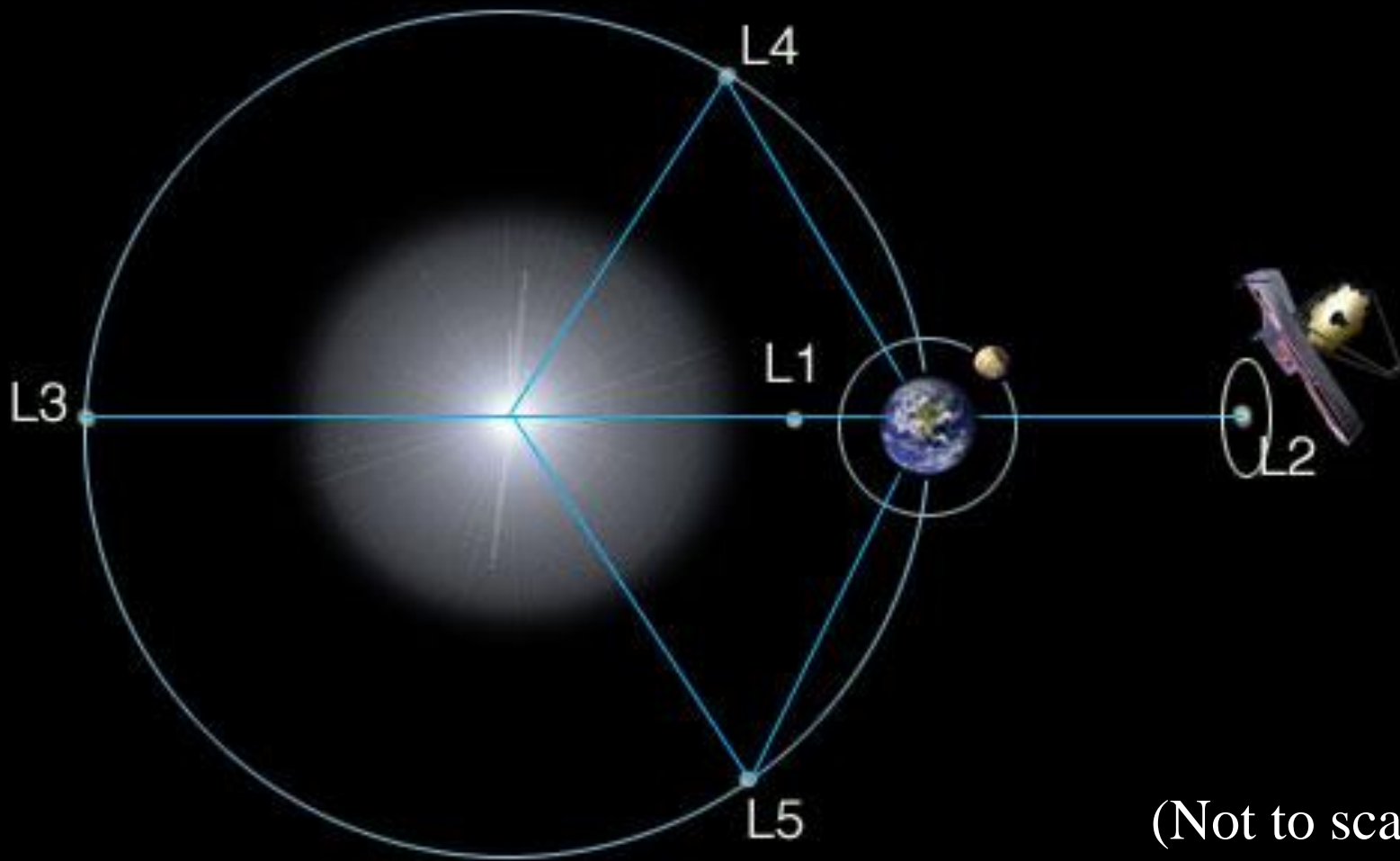
(Only about 46g...that's it!)

# *JWST vs. HST*

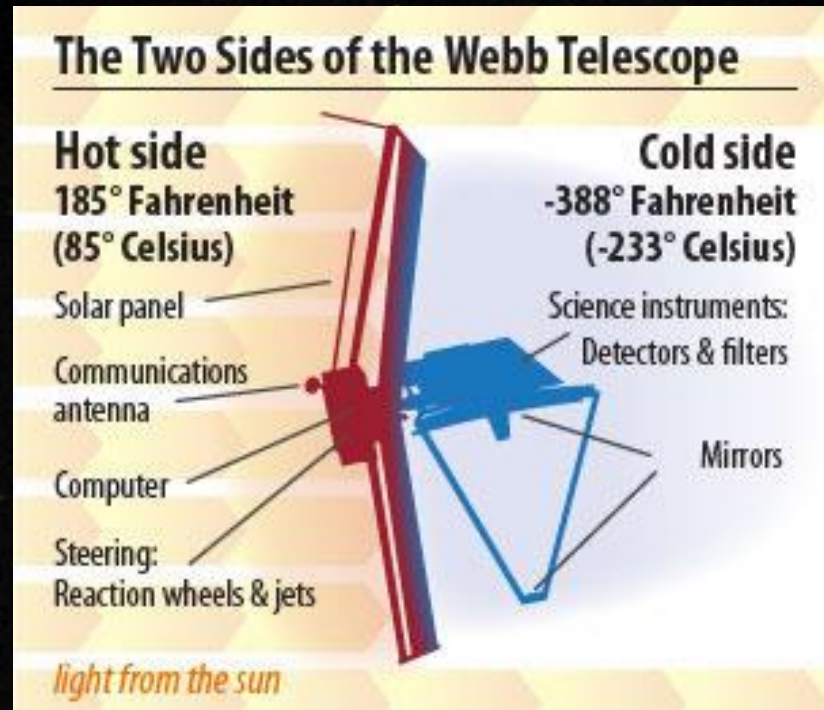


- JWST will operate much farther from Earth, maintaining its extremely cold operating temperature, stable pointing, and higher observing efficiency than the Earth-orbiting Hubble
- It will orbit the Sun along with the Earth

# *JWST at “L2” Lagrange Point*



# Very Cool!



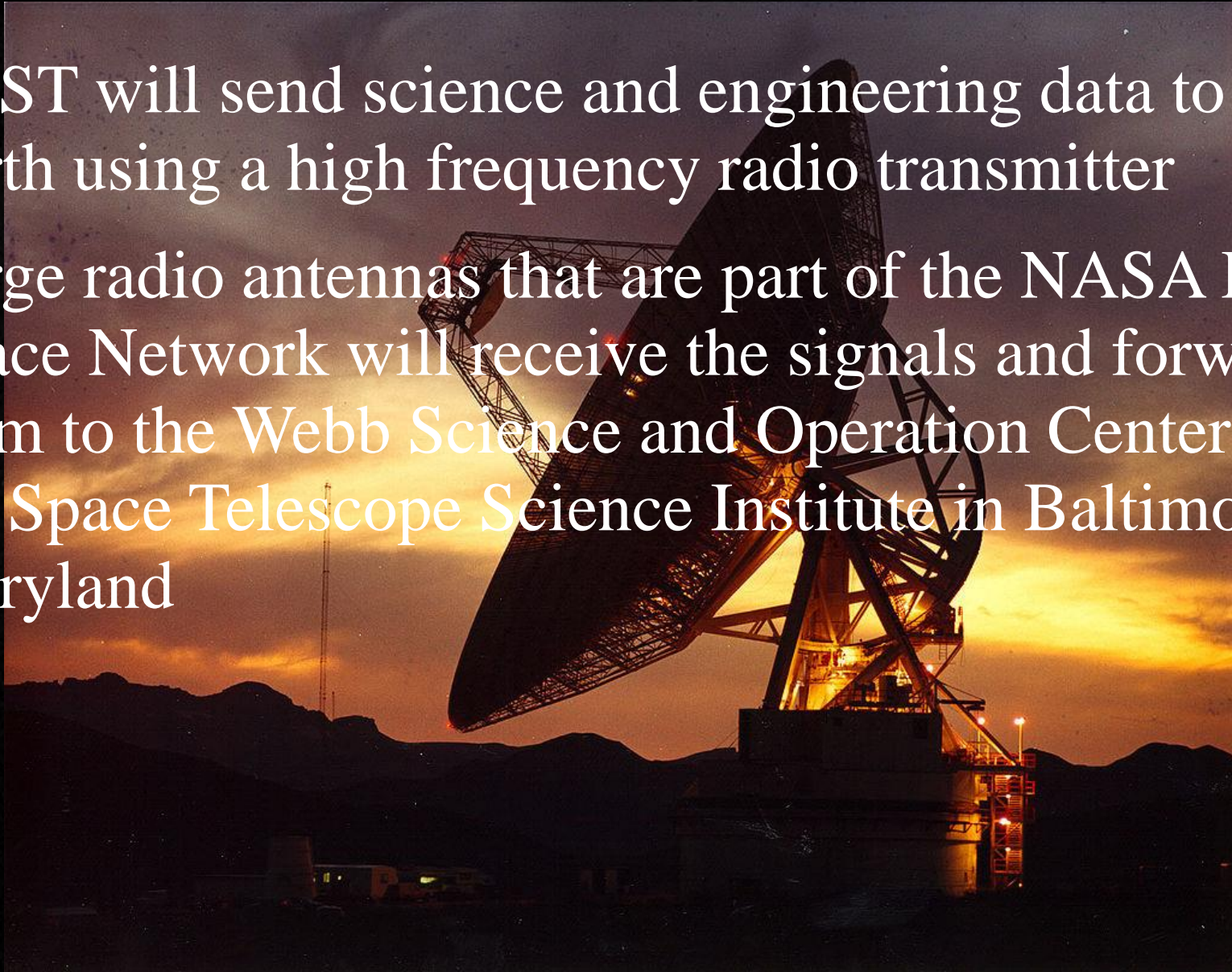
- **HOT SIDE:** The side of the telescope facing the Sun and Earth
- **COLD SIDE:** The primary mirror side facing its target including mirrors, filters, and science instruments. This side must operate under  $50^{\circ}\text{K}$  in order to be sensitive enough to detect/record very distant IR sources

## *How long will the mission last?*

- Mission lifetime of at least 5-1/2 years, goal of >10 years
- JWST will carry fuel for a 10-year lifetime
- The project will perform mission assurance testing to guarantee 5 years of scientific operations starting at the end of the 6 month commissioning period

# *Communications*

- JWST will send science and engineering data to Earth using a high frequency radio transmitter
- Large radio antennas that are part of the NASA Deep Space Network will receive the signals and forward them to the Webb Science and Operation Center at the Space Telescope Science Institute in Baltimore, Maryland



# *How far will JWST look?*

- One of the main goals of the telescope is to detect some of the very first star formations in the Universe
- At those redshifts, the Universe was only one or two percent of its current age
- The Universe is now 13.7B years old, and these redshifts correspond to 100 to 250 million years after the Big Bang
- The light from the first galaxies has travelled for about 13.5B years

# *The SSDIF Cleanroom at Goddard*

- *SSDIF: Spacecraft Systems Development and Integration Facility*
- One of the largest cleanrooms in the world!
- 125 ft. L x 100 ft. W x 9 stories tall...  
...1.3 Million Cubic Feet!
- 40 ft tall x 25 ft wide overhead door
- Two 35-ton overhead cranes
- Nearly 1 Million CFM of unidirectional horizontal airflow is created with over 1,600 HEPA filters on north wall and a perforated return plenum on south wall
- Bank of carbon prefilters also filter out molecular contaminants
- Certified to Class 7 per ISO 14644-1 [FS209E Class 10,000]



# *The SSDIF Cleanroom at Goddard*

Return Plenum

Overhead door



HEPA Filters

Airflow

# *JWST in the SSDIF*



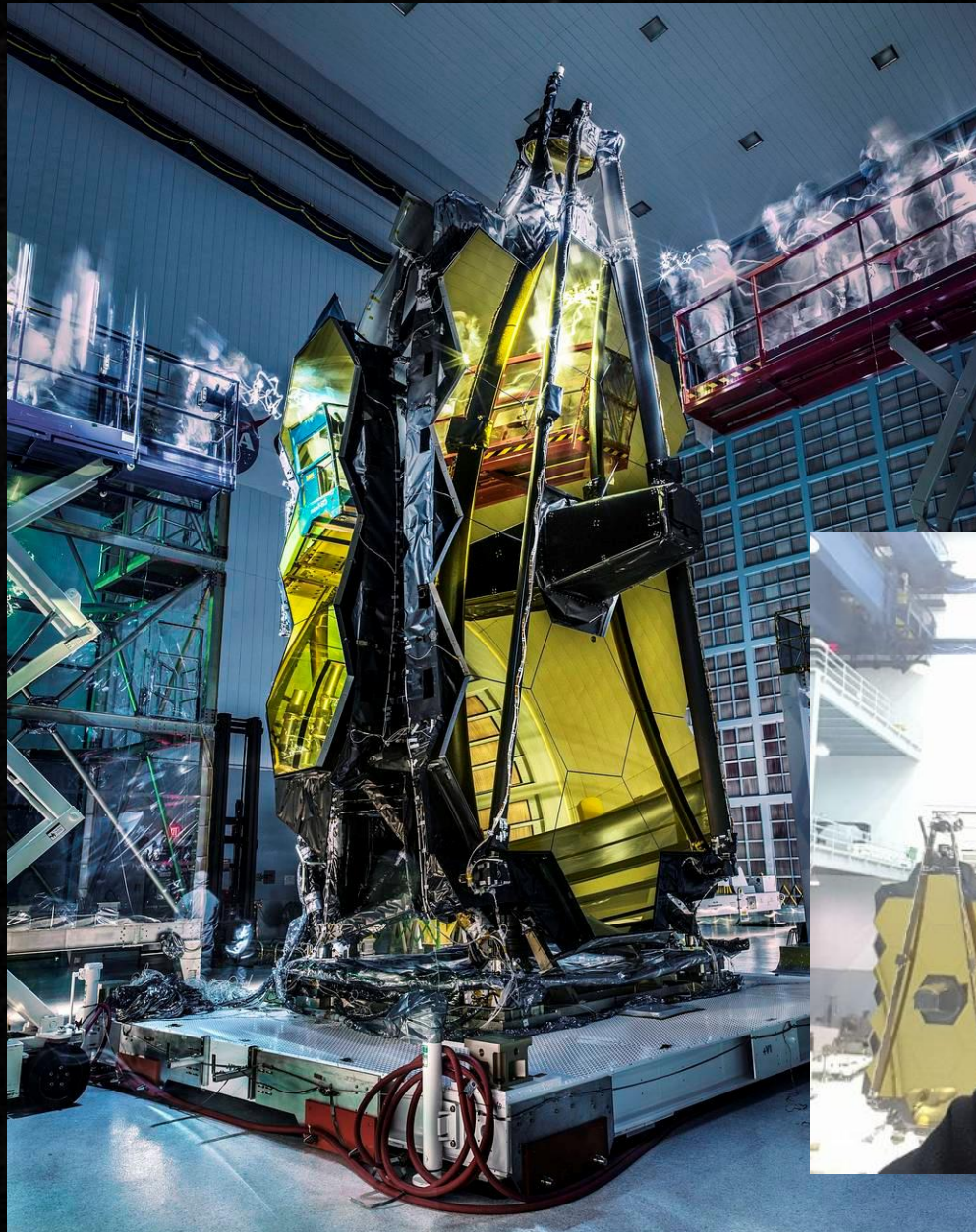
# *Lights Out Inspection*



# *Ghostly Inspections*



# *Ghostly Inspections*



# *Testing at NASA GSFC*



- Unit is shown covered in a 40 ft. tall portable cleanroom tent while outside the SSDIF cleanroom
- Telescope was vibrate tested on a custom vibration table and also subjected to acoustical testing to simulate vibration at launch

# *How Did We Ship It?*

- Telescope was shipped in a custom shipping container, a “cleanroom on wheels” called the STTARS container (Space Telescope Transporter for Air, Road, & Sea)



# *Transport by Air Force C-5A Galaxy*

- STTARS container was designed to just fit inside an Air Force C-5A Galaxy!





# *Next Stop: Johnson Space Center*

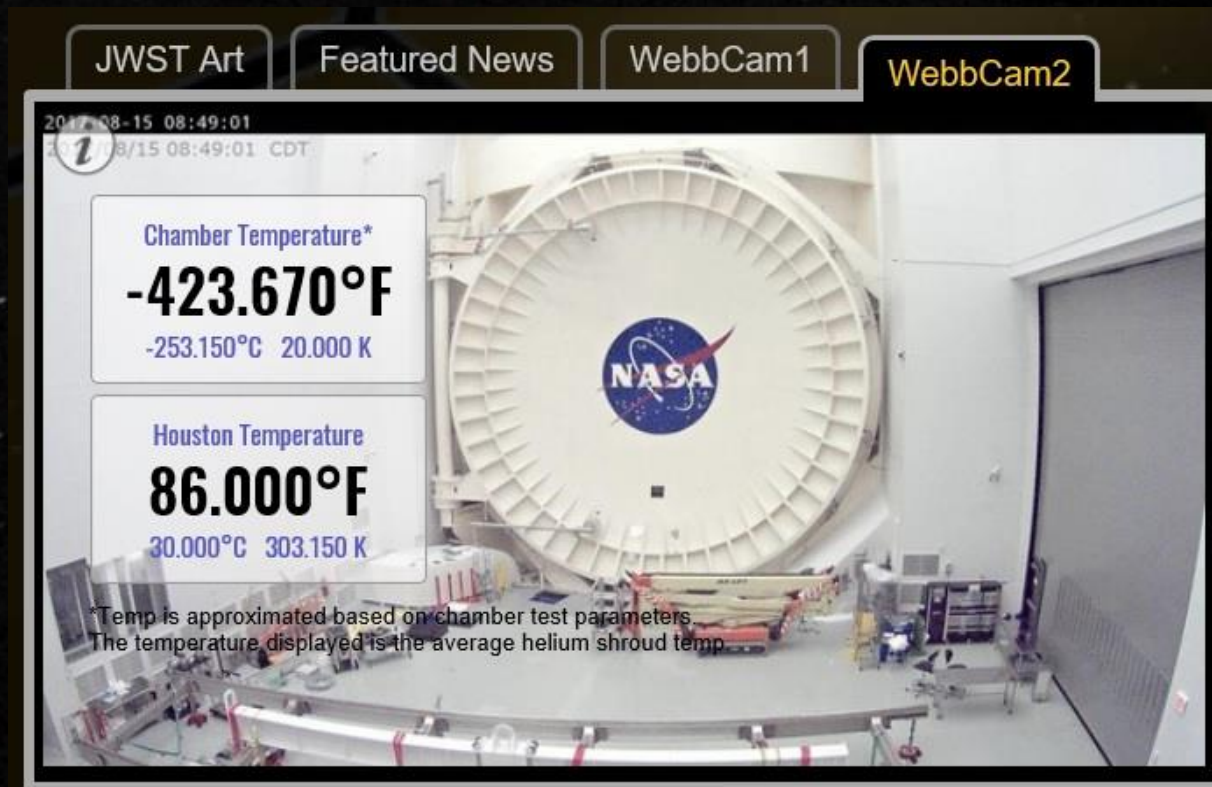
- Chamber A at JSC is the only TVAC chamber in the world large enough to hold the telescope!



Just the chamber door alone is 40 ft. in diameter  
and weighs 40 tons!

# *Next Stop: Johnson Space Center*

- The giant door was closed in July for 100 days of space simulation



Hurricane Harvey caused some minor delays in the testing but power was never lost

# *Next Stop: Northrop Grumman*

- Sunshield, Spacecraft bus, and other miscellaneous items will be added



- Sunshield, the size of a tennis court, has FIVE layers to protect the cold side from all heat sources, including the Sun
- Since telescope will now be too large to ship “Next Day Air”, system must ship by boat to launch site

Credit: Northrop Grumman Corp.

# *Launch in 2018-2019*

- After spending time at Northrop Grumman in CA for final Integration & Test, JWST will be transported by boat to The Spaceport in French Guiana, South America, near the equator
- JWST will be launched on an Ariane 5 rocket
- Launch date:  
NET Spring 2019



*What do we expect to discover  
with JWST?*

Discoveries we didn't expect !

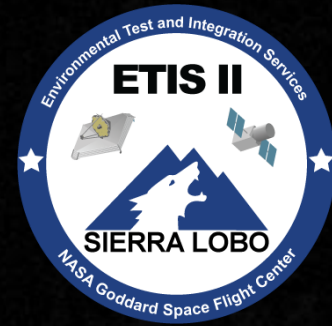


# *Resources*

- More information on JWST:  
[jwst.nasa.gov](http://jwst.nasa.gov)
- JWST Live webcam:  
[jwst.nasa.gov/webcam.html](http://jwst.nasa.gov/webcam.html)



# Questions??



*Peter J.B. Teague*  
*Sierra Lobo, Inc.*  
*NASA Goddard Space Flight Center, Greenbelt, MD*

