Science Synergy between ASU and the Netherlands: Hubble, Webb and other (Future) Telescopes

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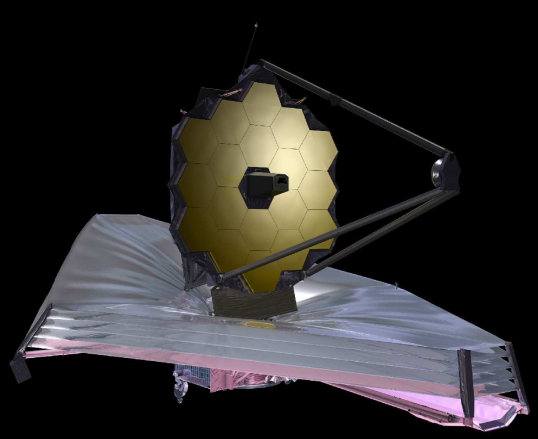
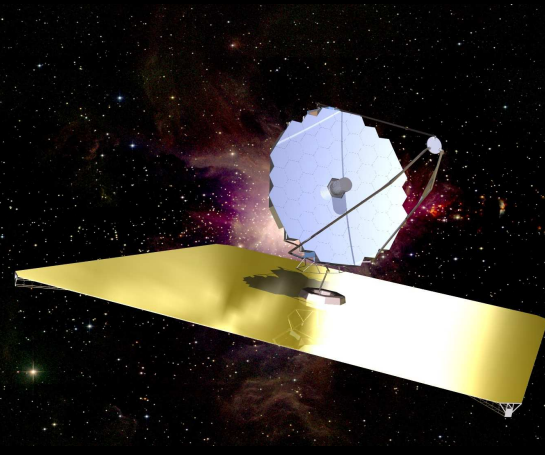




1973∼2020^{+}; 1996∼2031; 2000∼2050^{+} 2020∼2050^{+}?

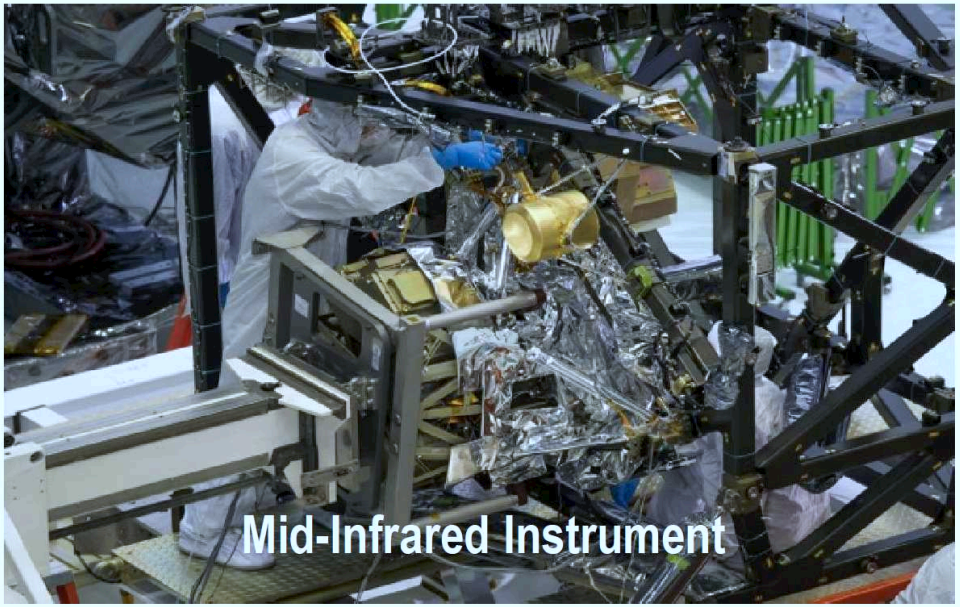
Focus charts for ASU meeting with Consulate of the Netherlands staff (ASU, Tempe, AZ);

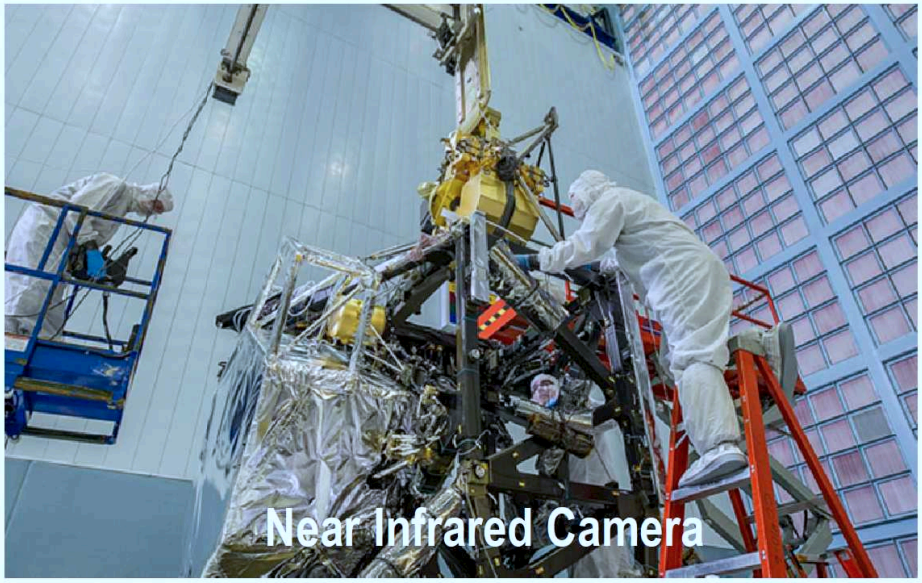
Wednesday Dec. 4, 2019. All presented materials are ITAR-cleared.

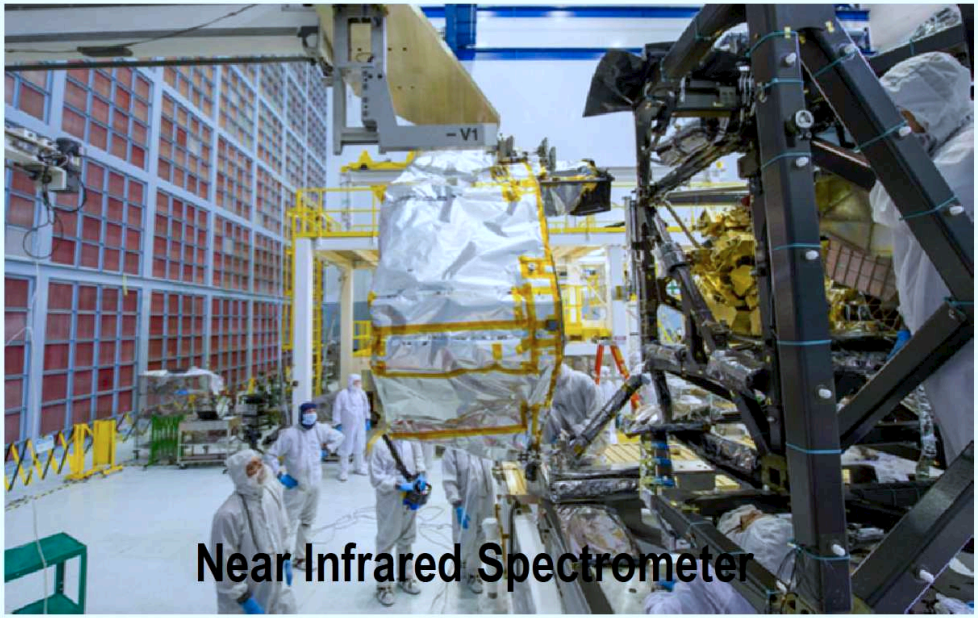
This talk: `http://www.asu.edu/clas/hst/www/jwst/jwsttalks/embassy19_ASU_NL_sciencesynergy.pdf`

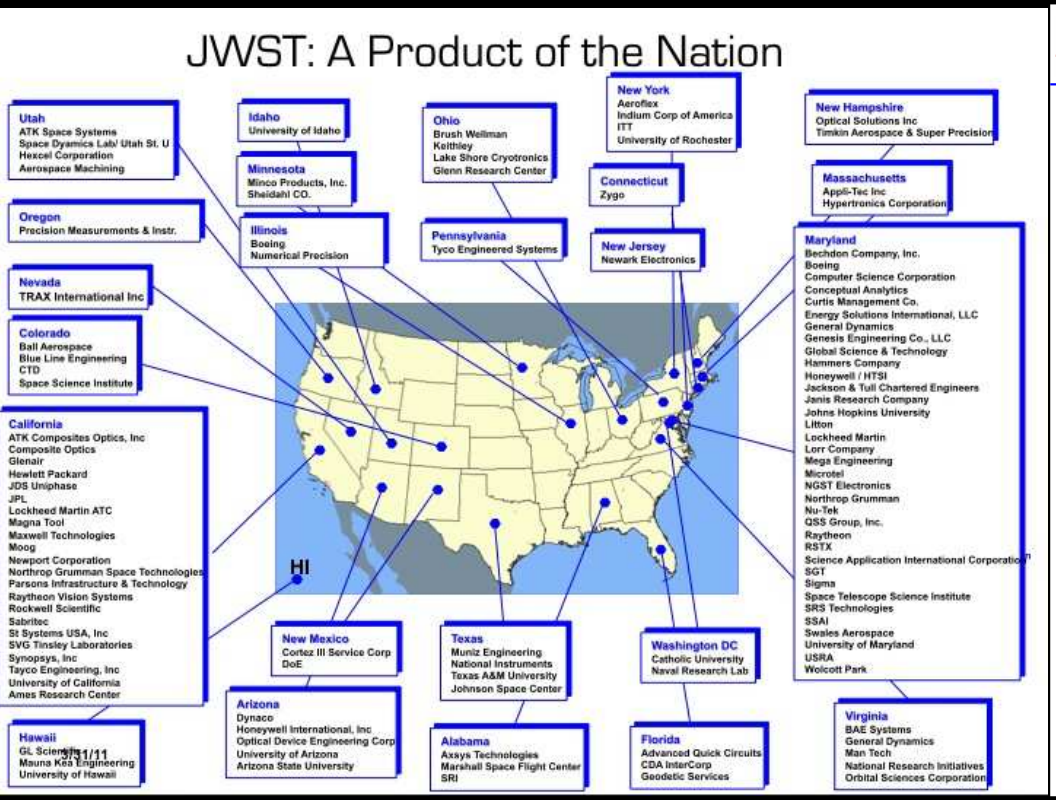
James Webb Space Telescope (JWST) tilted into the required position

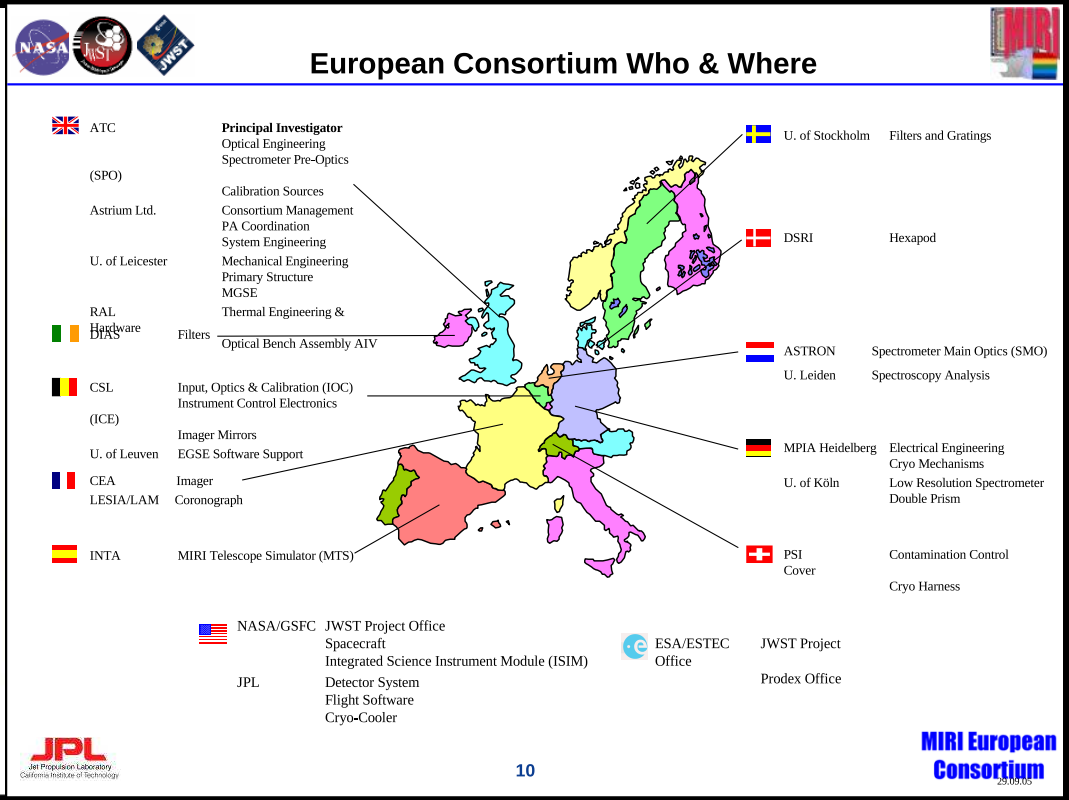
All Instruments Integrated











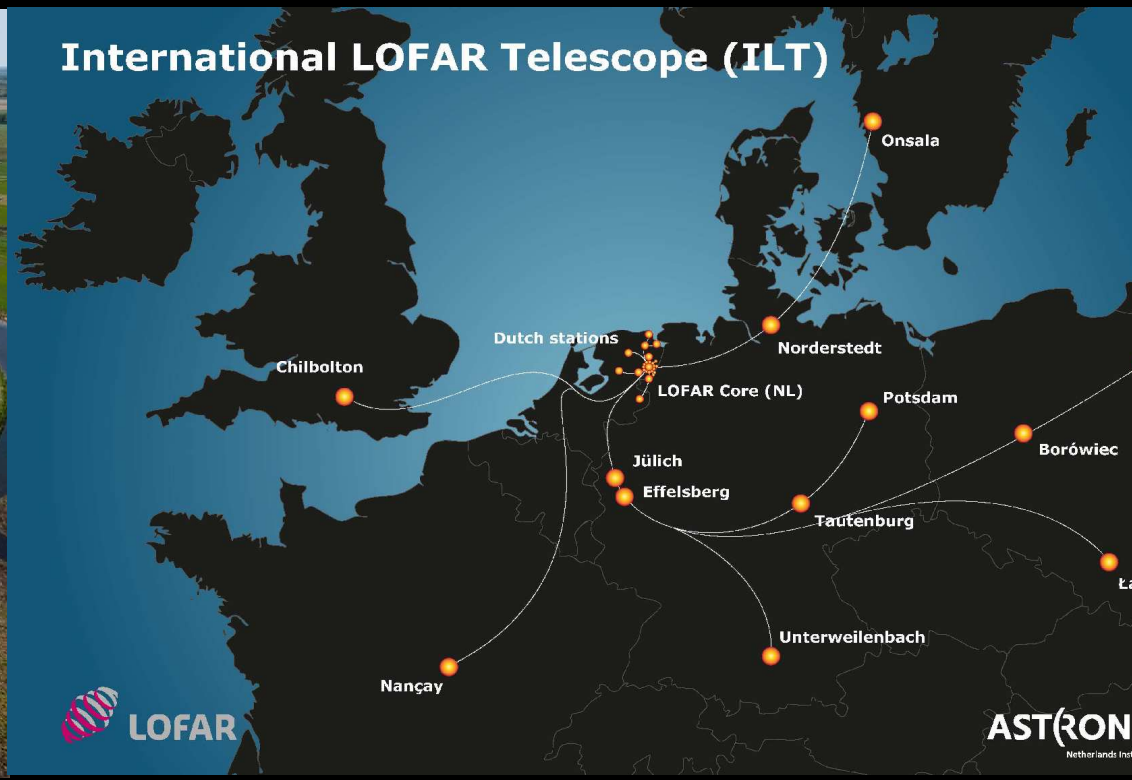
- JWST hardware made in 27 US States: $\gtrsim$99.5% of launch-mass finished.
- Ariane V Launch & NIRSpec provided by ESA; & MIRI by ESA & JPL.
- MIRI & NIRSpec by EU & ESA, major role for ESTEC & ASTRON.
- JWST Fine Guider Sensor + NIRISS provided by Canadian Space Agency.
- JWST NIRCam made by UofA and Lockheed.

28 August 2019: JWST Telescope integrated with Sunshield & Spacecraft!

(2) Role of the EU Very Large Telescope in HST & JWST science

The Very Large Telescope in Chile a powerful complement to HST and JWST.

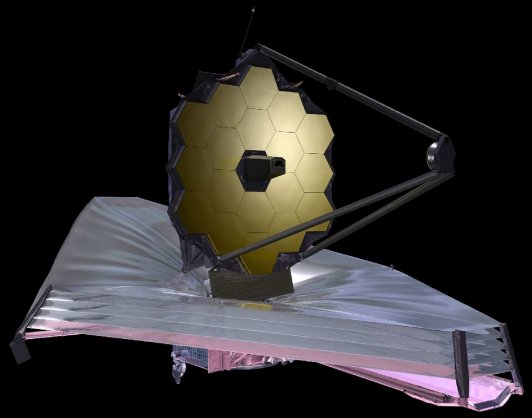
(3) Role of the Low-Frequency Array (LOFAR) in HST & JWST science

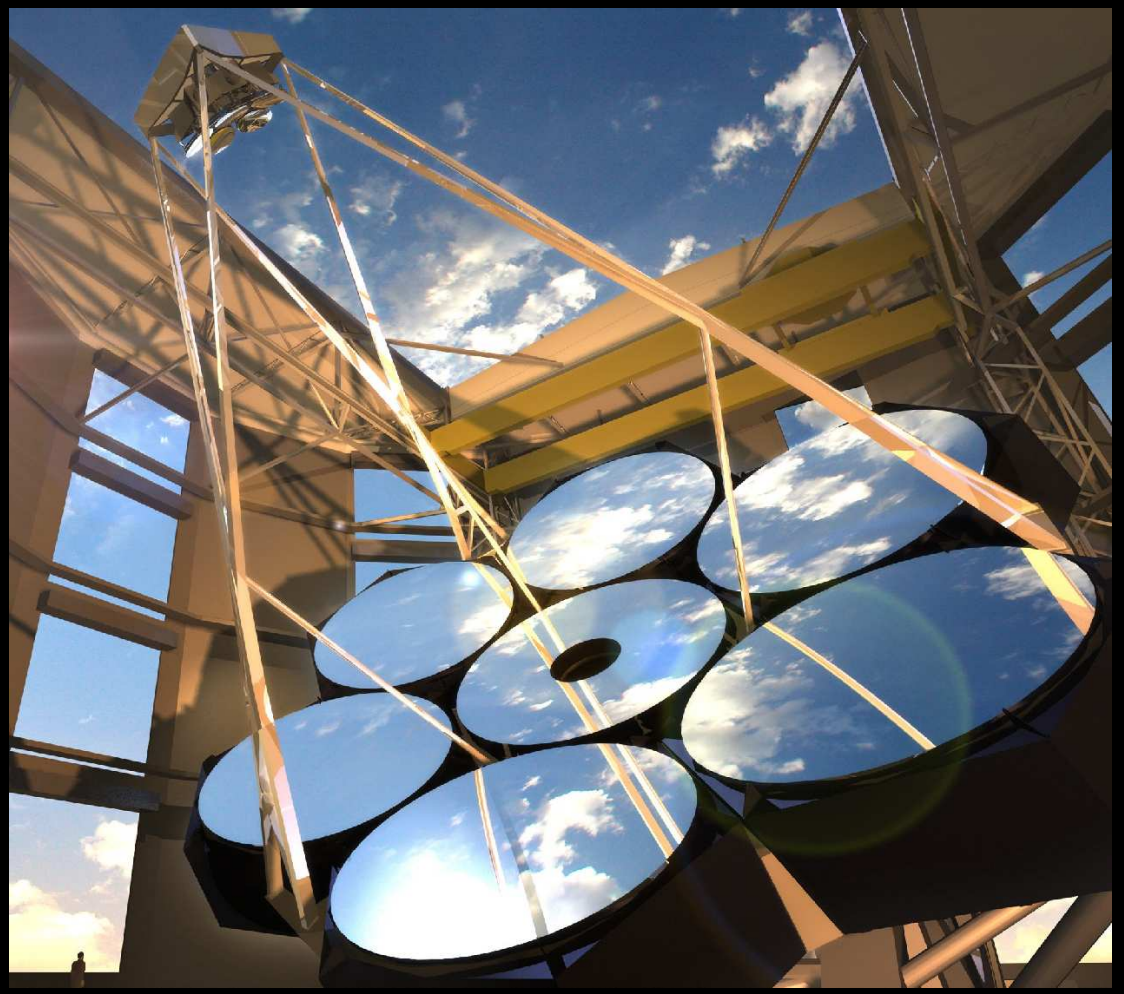


LOFAR in Drente and the EU a powerful complement to HST and JWST.

(4) Future: Next generation 20–40 m ground-based telescopes and ATLAST

True relative size: Hubble, James Webb, & Giant Magellan Telescope



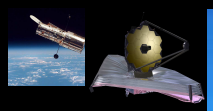


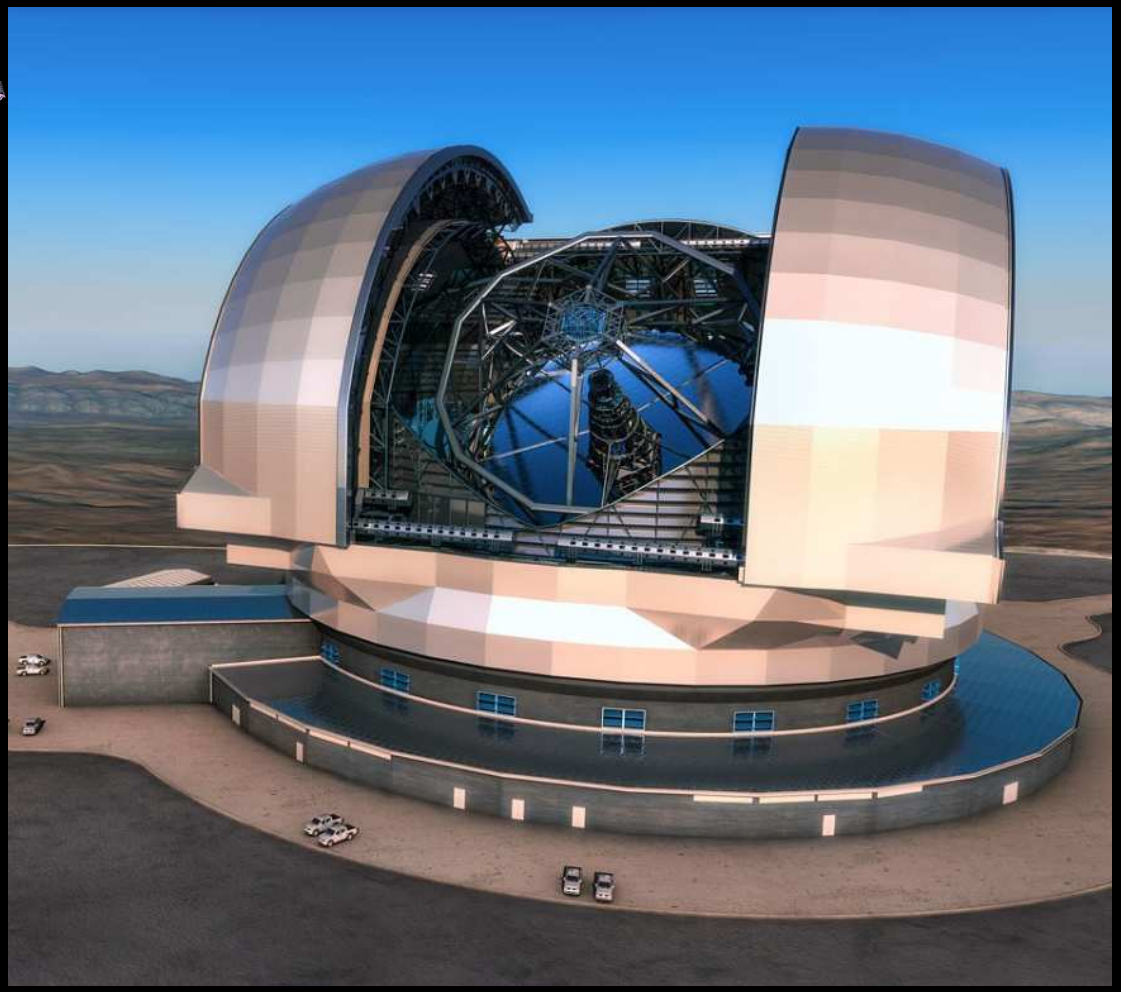
(1973∼2020^{+}); (1996∼2031); (2000∼2050^{+}).

- JWST has superbly dark sky & sensitivity, and stable images.
- GMT has 4×higher Res (AO), high-Res spectra, long-term time-domain.

(4) Future: Next generation 20–40 m ground-based telescopes and ATLAST

True relative size: Hubble, James Webb, & EU Extremely Large Telescope

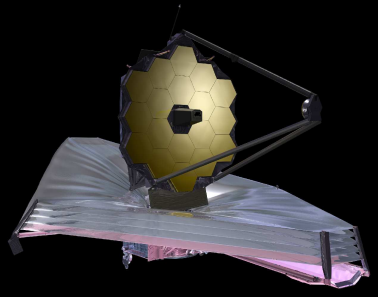


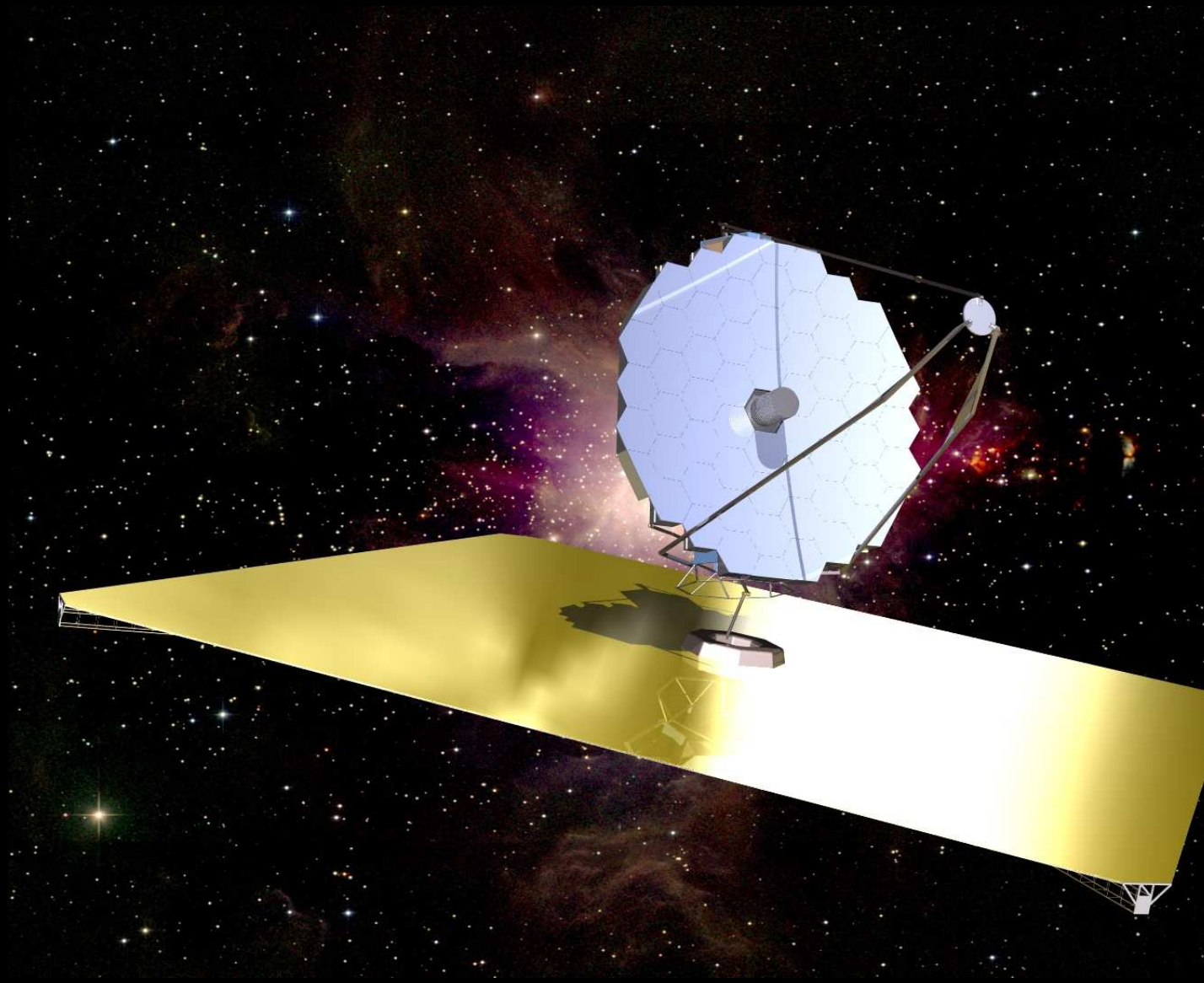


(1973∼2020^{+}); (1996∼2031); (2000∼2050^{+}).

- JWST has superbly dark sky & sensitivity, and stable images.
- E-ELT has 6×higher Res (AO), high-Res spectra, long-term time-domain.

True relative size: Hubble, James Webb, and ATLAST ...





(1973∼2020^{+}); (1996∼2031); (2020∼2050^{+}?).

Like HST will have done for ∼50 yrs, & JWST for ∼30 yrs, ATLAST can provide powerful US-EU/NL synergy for decades to come.

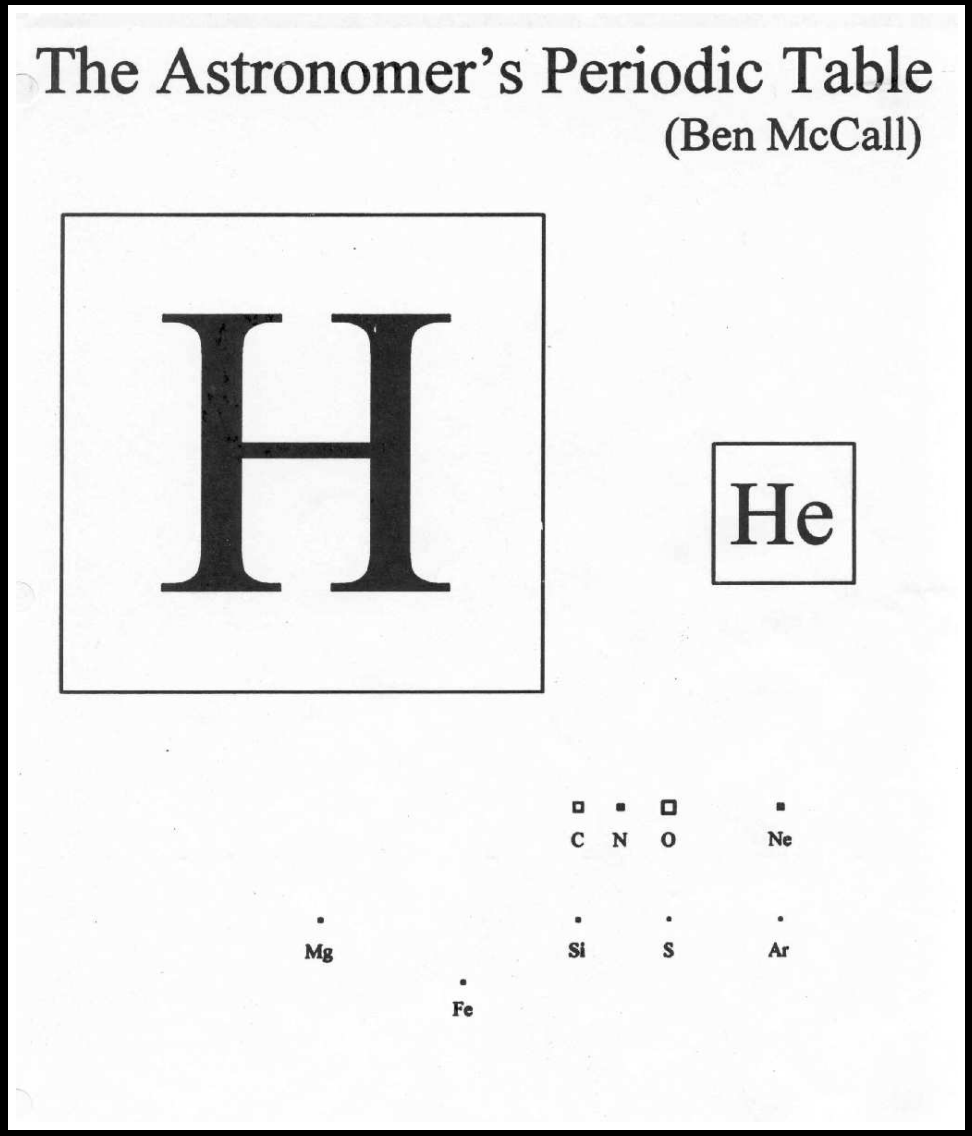
The real Periodic System

(1) Hydrogen & Helium only chemical elements made in the Big Bang.

(2) All heavier elements made inside (massive) stars.

(3) Late stages of stellar evolution and Supernova explosions distribute these throughout the universe.

(4) Planets and people literally made from stardust!



[The real Periodic Table with cosmic abundance included!]

- (5) This requires the worlds largest supercomputers to model.
- (6) powerful potential synergy between AZ(Intel etc.)/ASU and NL/Univ. v. Amsterdam $\Longrightarrow$ Opportunities for exchange students & industry!

(5) Summary and Conclusions

(1) Hubble has revolutionized astronomy in the last few decades.

- The ESO VLT played a critical complementary role in this.

(2) JWST will open the next frontier in 2021. JWST is designed to:

- Map the epoch of First Light and the first stars (0.3 Byrs).
- Galaxy Assembly and Supermassive Blackhole growth from the start.
- Characterize the atmospheres of Earth-like exoplanets.
- LOFAR and E-ELT play a critical complementary role in this.

(3) JWST will have a major impact on astrophysics next decade:

- Infrared sequel to HST in 2021; train the next generation researchers.
- Provide and outline technology for future space missions (ATLAST).
- Define the next frontier to explore: the Cosmic Dark Ages.

$\Longrightarrow$ All this offers new opportunities for US/ASU–EU/NL collaborations.

SPARE CHARTS

- References and other sources of material shown:

http://www.asu.edu/clas/hst/www/jwst/ [Talk, Movie, Java-tool]

http://www.asu.edu/clas/hst/www/ahah/ [Hubble at Hyperspeed Java–tool]

http://www.asu.edu/clas/hst/www/jwst/clickonHUDF/ [Clickable HUDF map]

http://www.jwst.nasa.gov/ & http://www.stsci.edu/jwst/

http://ircamera.as.arizona.edu/nircam/

http://ircamera.as.arizona.edu/MIRI/

http://www.stsci.edu/jwst/instruments/nirspec/

http://www.stsci.edu/jwst/instruments/fgs

Gardner, J. P., et al. 2006, Space Science Reviews, 123, 485–606

Mather, J., & Stockman, H. 2000, Proc. SPIE Vol. 4013, 2

Windhorst, R., et al. 2008, Advances in Space Research, 41, 1965

Windhorst, R., et al., 2011, ApJS, 193, 27 (astro-ph/1005.2776).

Some of our ASU grad students do important outreach events:

Annual Girl Scout Stargazing at the White House South lawn (July 2015).

ASU student Amber Straughn (right; now at NASA GSFC working for Nobel Laureate Dr. John Mather) informs the Obama's about NASA.