

# **The Shuttle Mission**

## **Enabling Science & Exploration**

**HST 1<sup>st</sup> Servicing Mission**

**Life Sciences**

**Space & Microgravity Sciences**

**Joe Rothenberg**

**Scott M Smith**

**Howard Ross**

# ***HST 1st Servicing Mission History***

- **1960's – LST(HST) envisioned as a facility class observatory with servicing to maintain and improve scientific efficiency**
- **Shuttle enabled LST mission concept**
- **1970's Design formulation**
  - 15 year LST mission
  - 2 ½ yr upgrades 5 year ground return
  - Shuttle \$12M per flight @ 26 flights/year
- **1980's**
  - Decision 3 yr on-orbit upgrade/servicing of HST

# ***HST 1st Servicing Mission Prelaunch Environment***

- Keeping it sold through budget crisis
- Set stakeholders expectations for success
- Very optimistic about what it could/would do without talking about difficulty
- Did not conduct end-to-end optical performance test

***“Conscious expectation of the unexpected”***

# ***HST 1st Servicing Mission The Unexpected & Consequence***

## ***The Unexpected***

- Spherical aberration !
- Solar Array jitter !

## ***The Consequence***

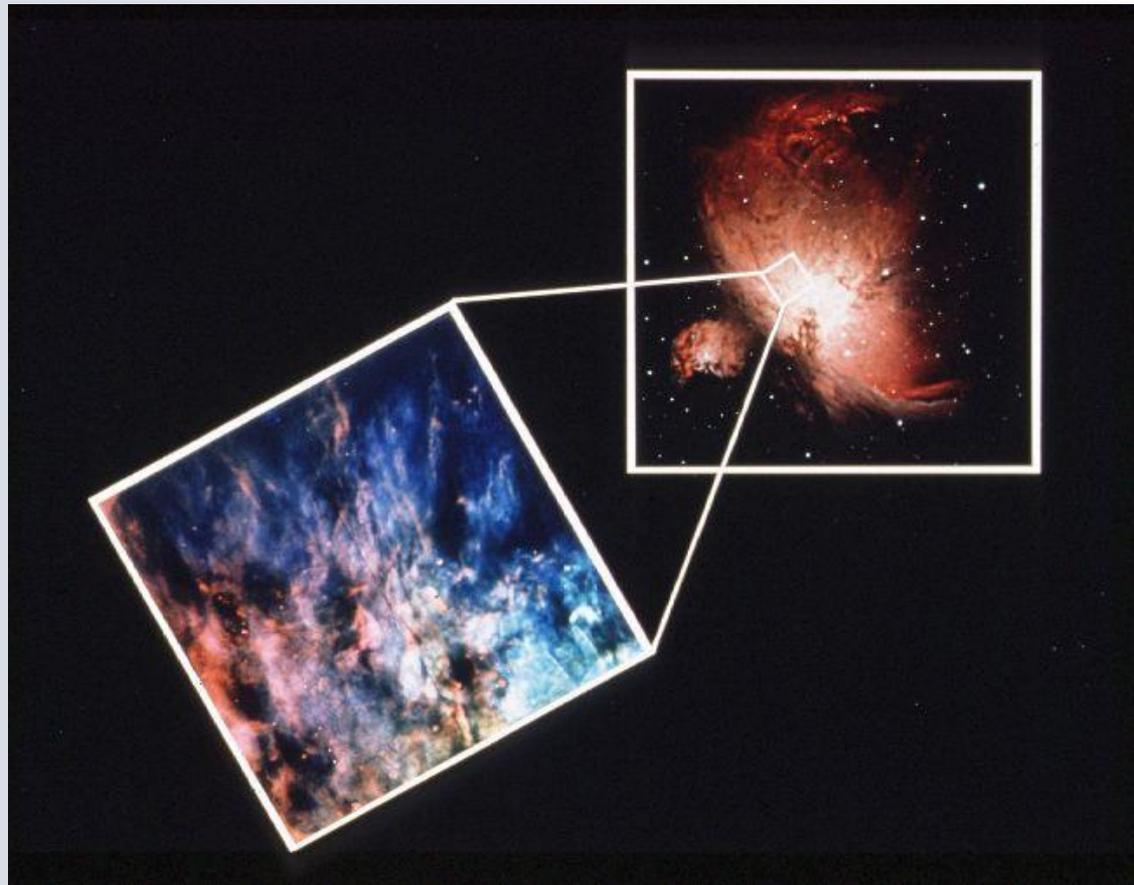
- Lost confidence in NASA
- I received a career changing assignment (Direction TBD)
- Shuttle was the key to enable restoring HST optical performance and NASA reputation

# ***HST 1st Servicing Mission***

## ***The Plan to Fix HST***

- **Assemble Team, understand and validate problems**
  - Independent measurements and reviews
- **Develop Communicate and get by-in to Plan**
  - Independent review and assessment
  - Made stakeholders partners & communicated to them weekly
  - Targeted Dec 1 1993 for launch readiness
- **Understand what HST could do and maximize science**
  - Early Release Observations – amazing results
  - Routine science releases ASAP
- **Ensure follow-on Instruments were fully funded**
  - Don't eat the next generation

# ***HST 1<sup>st</sup> Servicing Mission Pre SM 1 Science Capability***



# ***HST 1st Servicing Mission***

## ***The Team***

- **GRC/GSFC/HQ/JPL/JSC/KSC/MSFC**
- **STSci**
- **ESA/CSA**
- **HST Instrument Teams**
- **US & European contractor community**

# ***HST 1st Servicing Mission Shuttle Program Challenges***

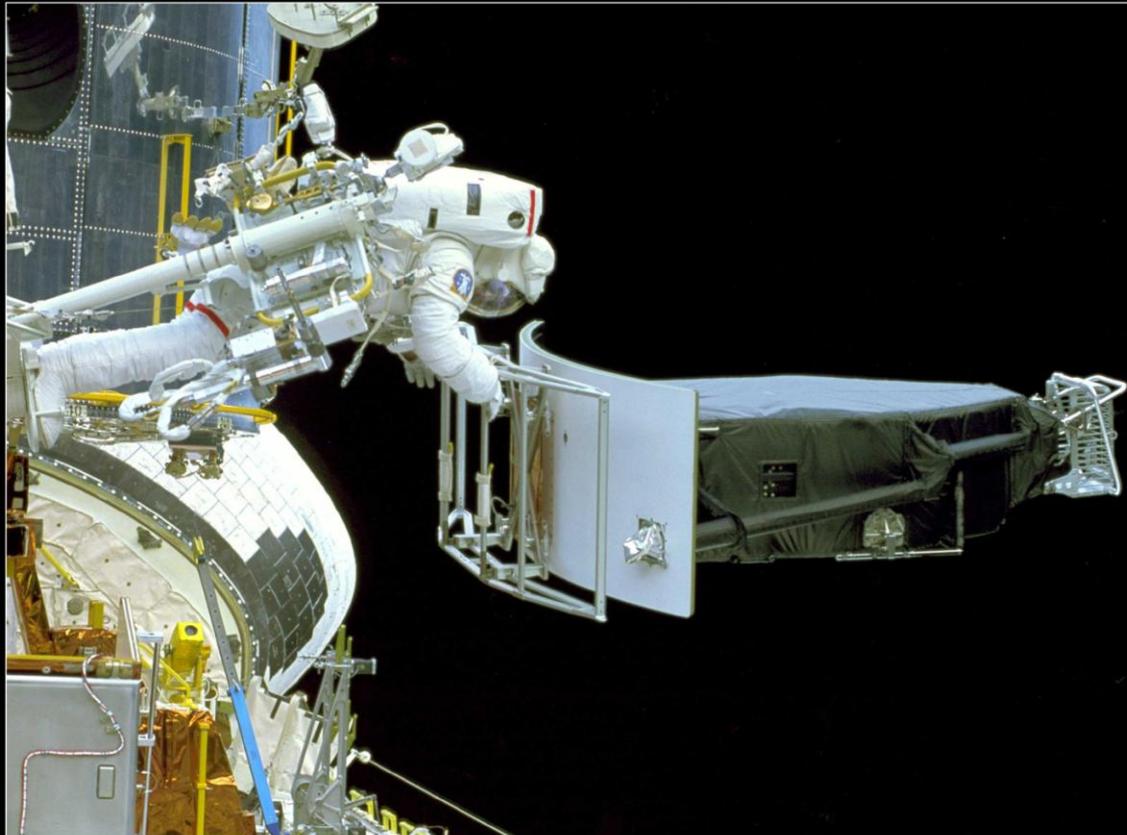
- Shuttle mission EVA typically 1 day
- Requirements grew from 2 to 8 hardware elements
- EVA's needed evolved from 1 to 4 days
- Crew historically assigned at L-1 year
- Understanding the mission complexity and having assigned crew earlier

# ***HST 1st Servicing Mission***

## ***HST Program Challenges***

- Major effort to understanding and replicating on-orbit configuration (***Most important decision we made***)
- Attracting quality staff to National embarrassment
- Keep Team focused on launch readiness
- 18 Independent Reviews
- Typical cost/technical/scheduled challenges

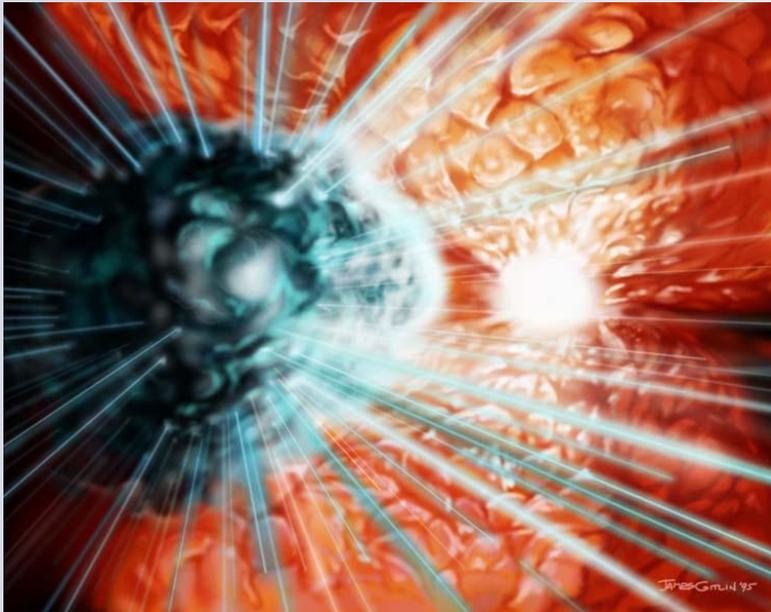
# ***HST 1st Servicing Mission Wide Field Camera Install***



A Second Look: Replacing the Wide Field and Planetary Camera

Image Credit: NASA, 1993

# ***HST 1st Servicing Mission Post SM 1 Images***



# ***HST 1st Servicing Mission***

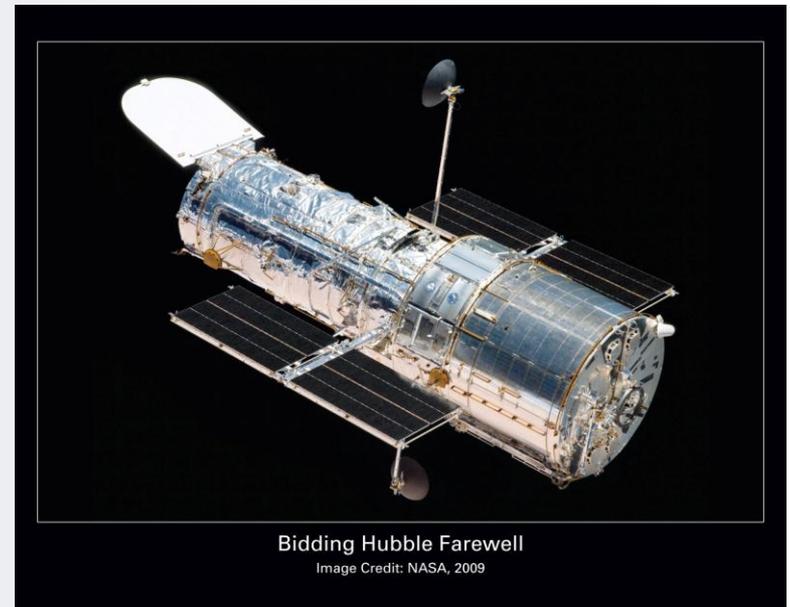
## ***Key lesson Learned***

- **Test as you plan to fly AKA test, test & retest**
  - Electrical fusing was found under sized
  - Initially trained with wrong replacement instrument configuration
  - Tool location on-board shuttle would not have worked
  
- **Review Teams can help**
  
- **Communications via “Top Ten” kept stakeholders on-board**
  
- **Simulations and training critical to success**
  - Closure of aft door
  - Configuration readiness for emergency Shuttle de-orbit
  
- **Setting success expectations important**

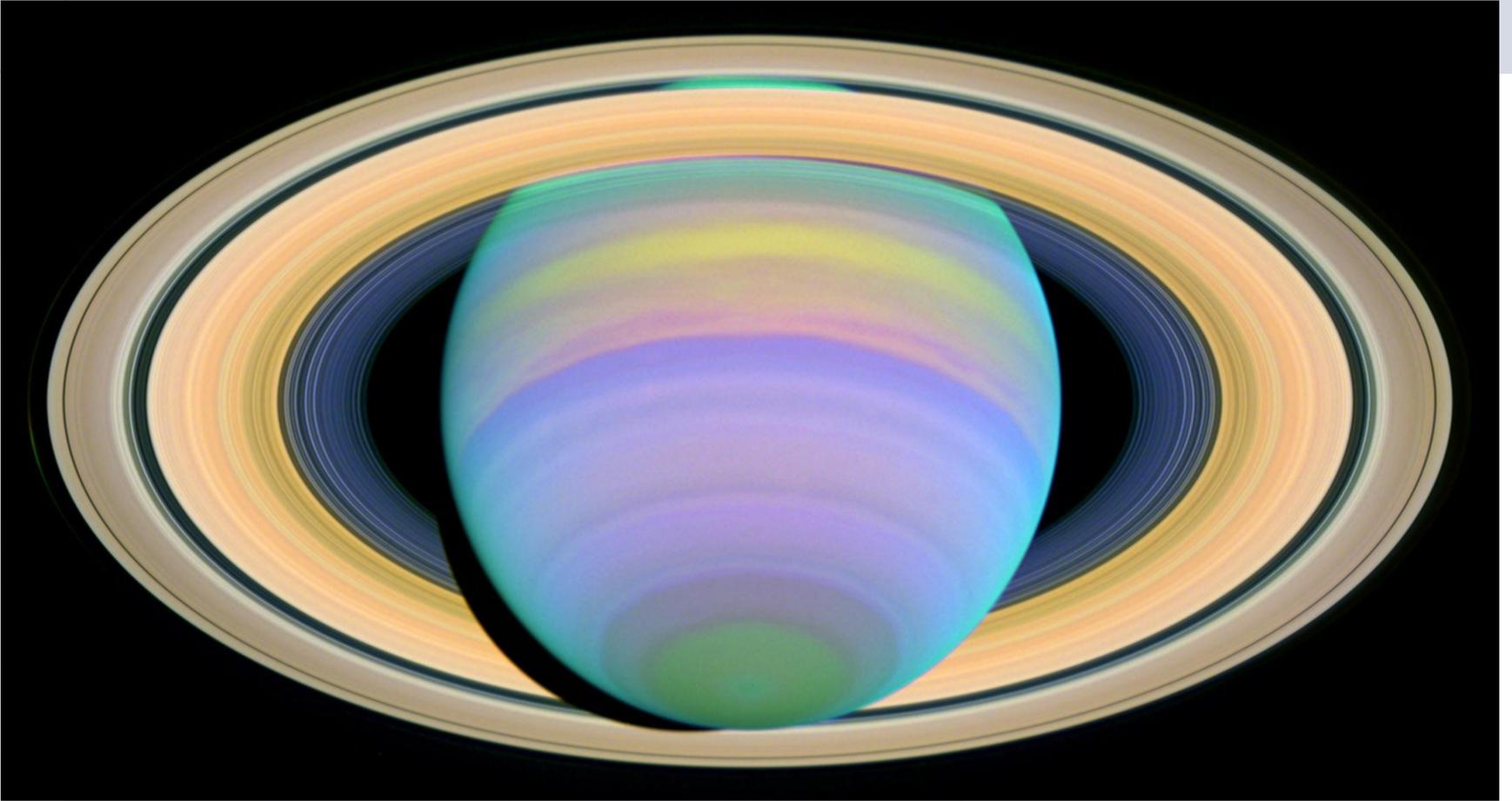
# ***HST 1st Servicing Mission Concluding Remarks***

- Shuttle critical to the initial mission concept, optical performance recovery and in particular the scientific success of HST
- After 5 servicing missions
  - HST scientific return is 1000 more efficient than launch configuration
  - Current life expectancy is >25 years
- If you are asked to take on the number 1 priority for your organization – DO IT!

# ***HST 5<sup>th</sup> Servicing Mission*** ***Final Servicing Mission***



# Saturn



# Jupiter and Io



# Hubble Ultra Deep Field Survey

