

The Shuttle Mission

Enabling Science & Exploration

HST 1st Servicing Mission

Life Sciences

Space & Microgravity Sciences

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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

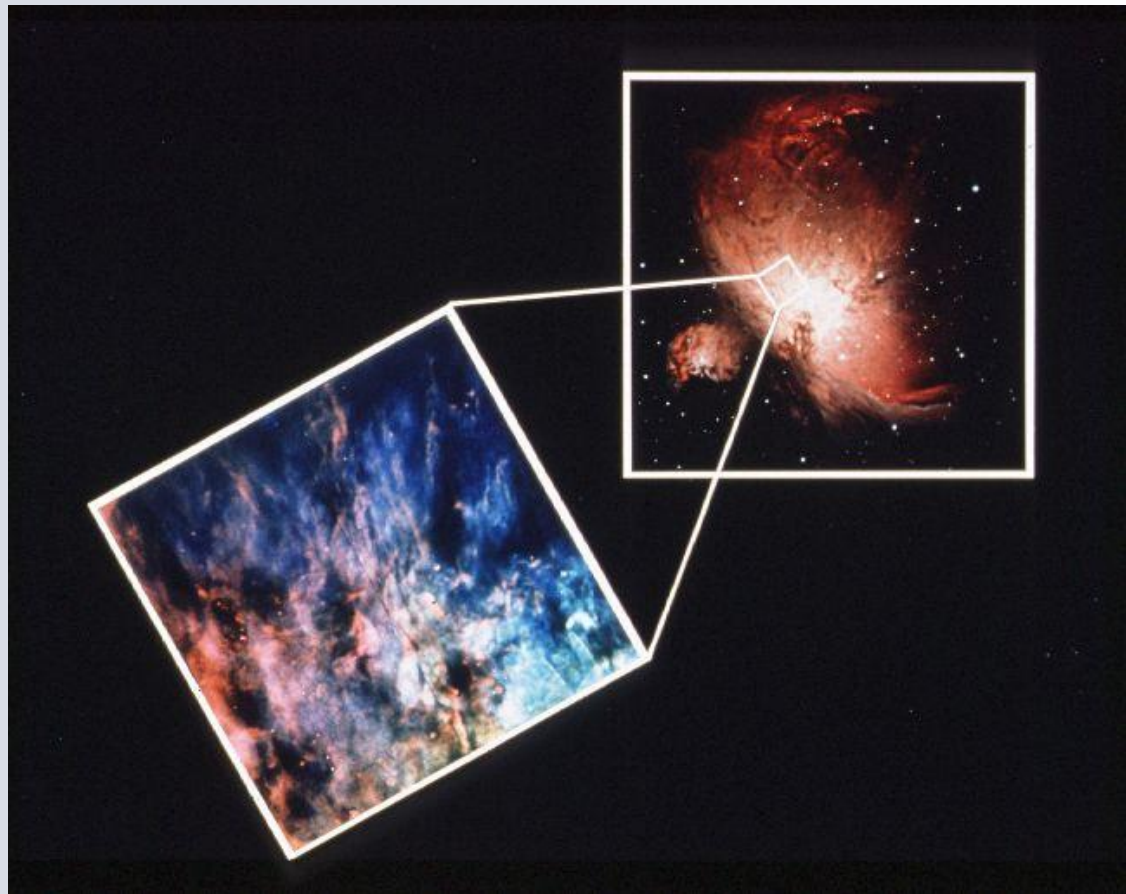
- Lost confidence in NASA
- I received a career changing assignment (Direction TBD)
- Shuttle was the key to enable restoring HST optical performance and NASA reputation

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 1st 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

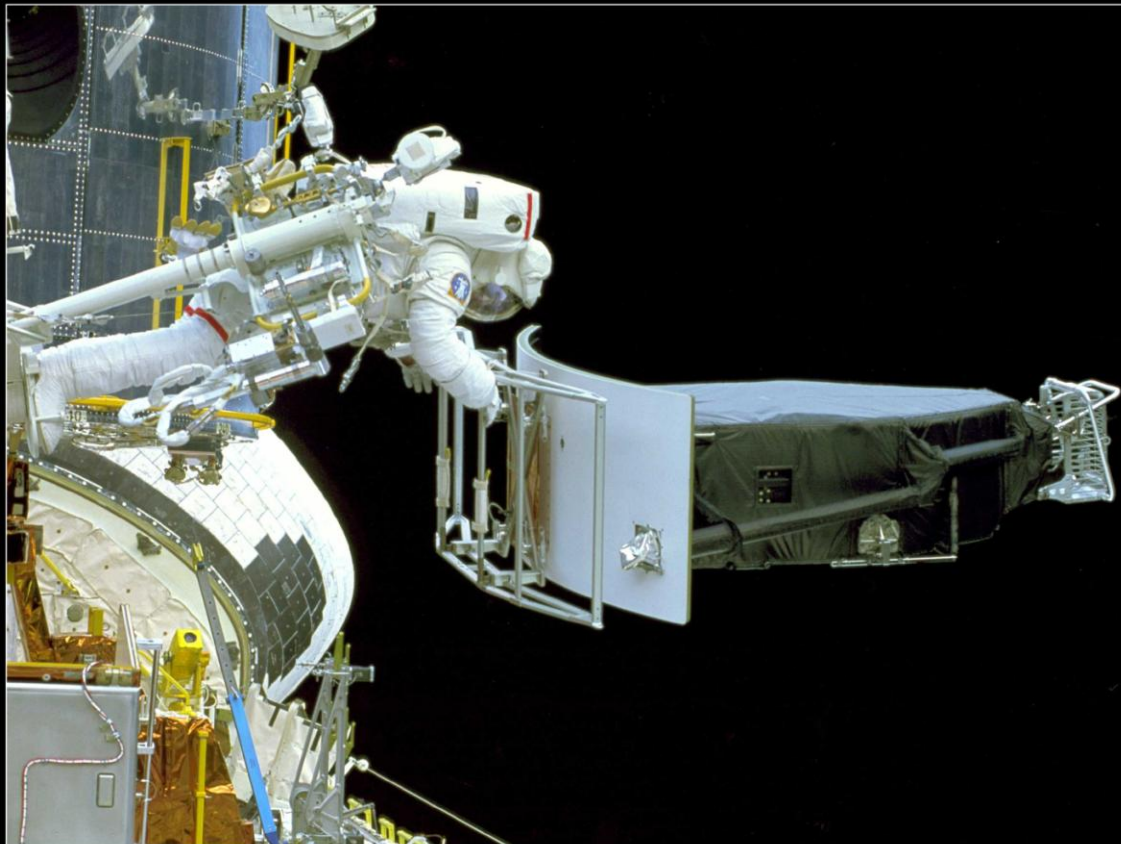
- Shuttle mission EVA typically 1 day
- Requirements grew from 2 to 8 hardware elements
- EVA's needed evolved from 1 to 4 days
- Crew historically assigned at L-1 year
- Understanding the mission complexity and having assigned crew earlier

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

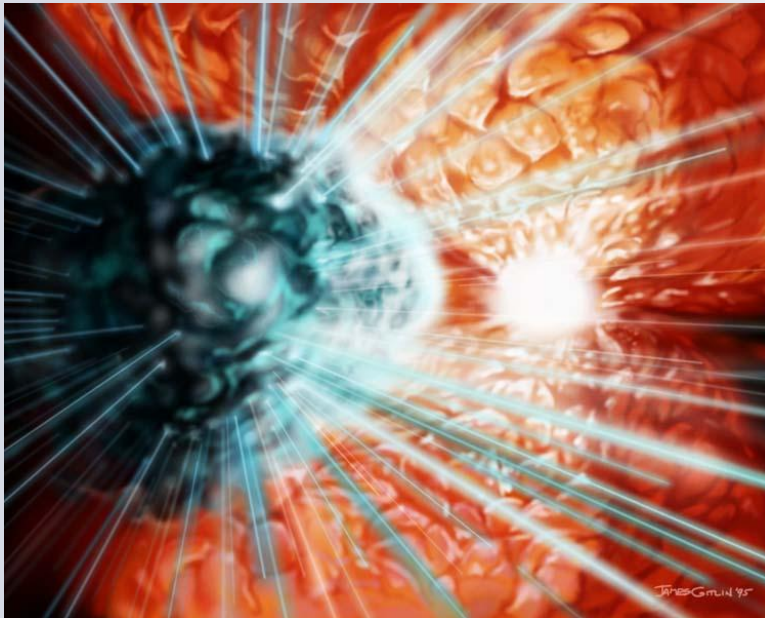
HST 1st Servicing Mission Wide Field Camera Install



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

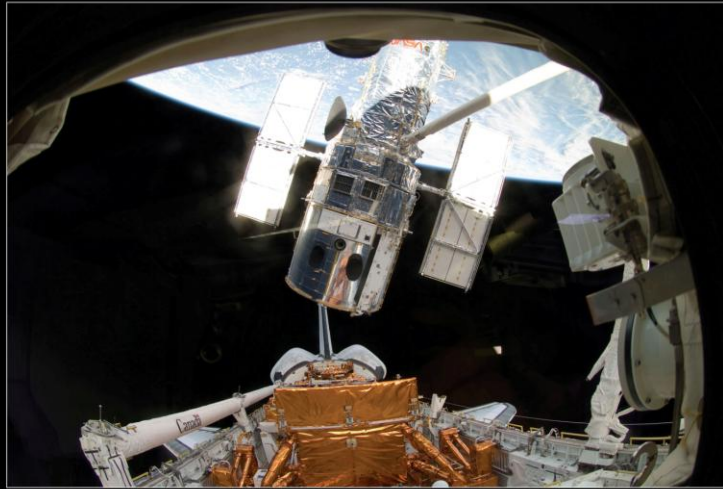
- **Test as you plan to fly AKA test, test & retest**
 - Electrical fusing was found under sized
 - Initially trained with wrong replacement instrument configuration
 - Tool location on-board shuttle would not have worked
- **Review Teams can help**
- **Communications via “Top Ten” kept stakeholders 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 5th Servicing Mission

Final Servicing Mission



Lifting Hubble from Atlantis' Cargo Bay

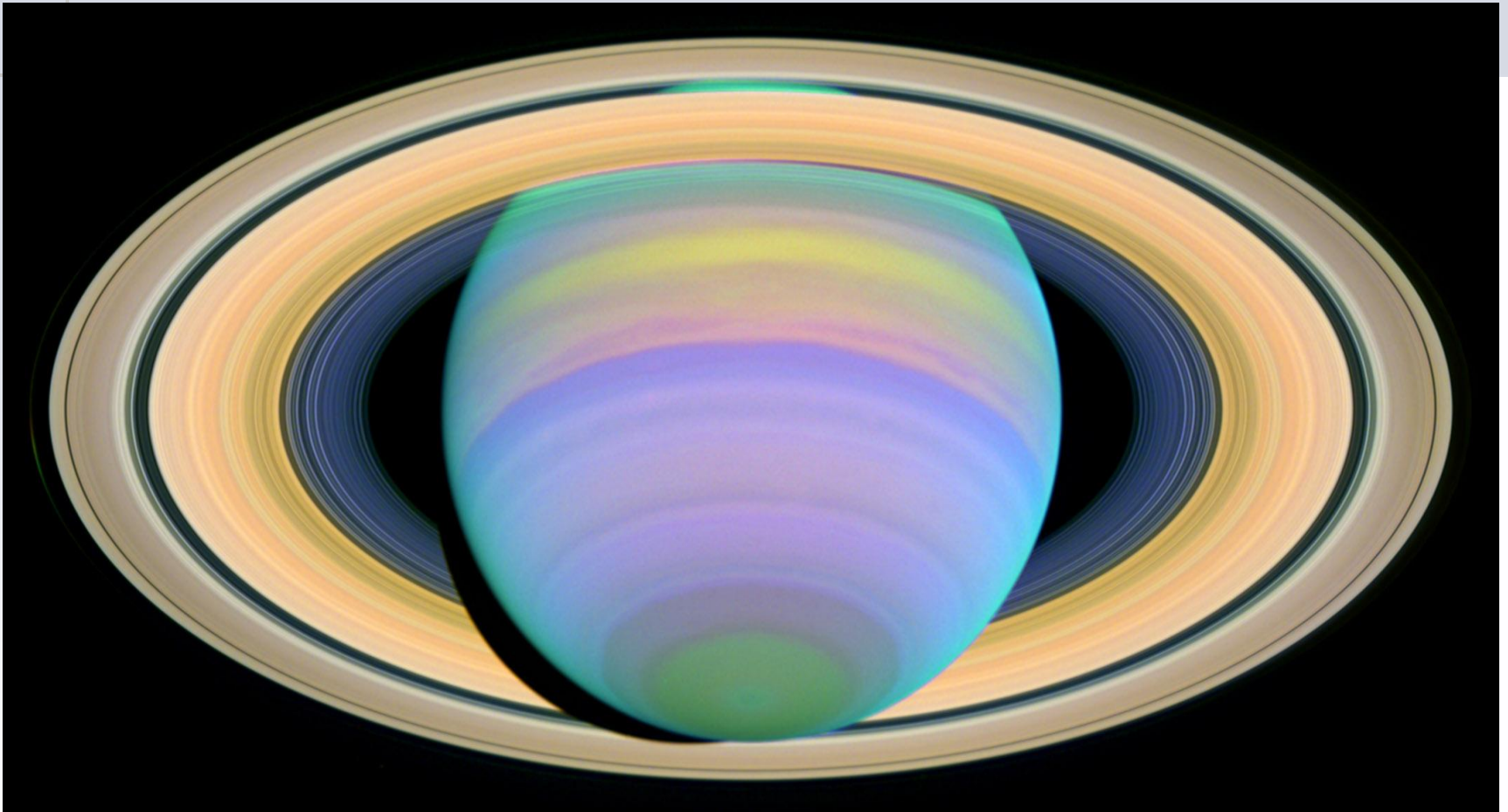
Image Credit: NASA, 2009



Bidding Hubble Farewell

Image Credit: NASA, 2009

Saturn



Jupiter and Io



Hubble Ultra Deep Field Survey

