

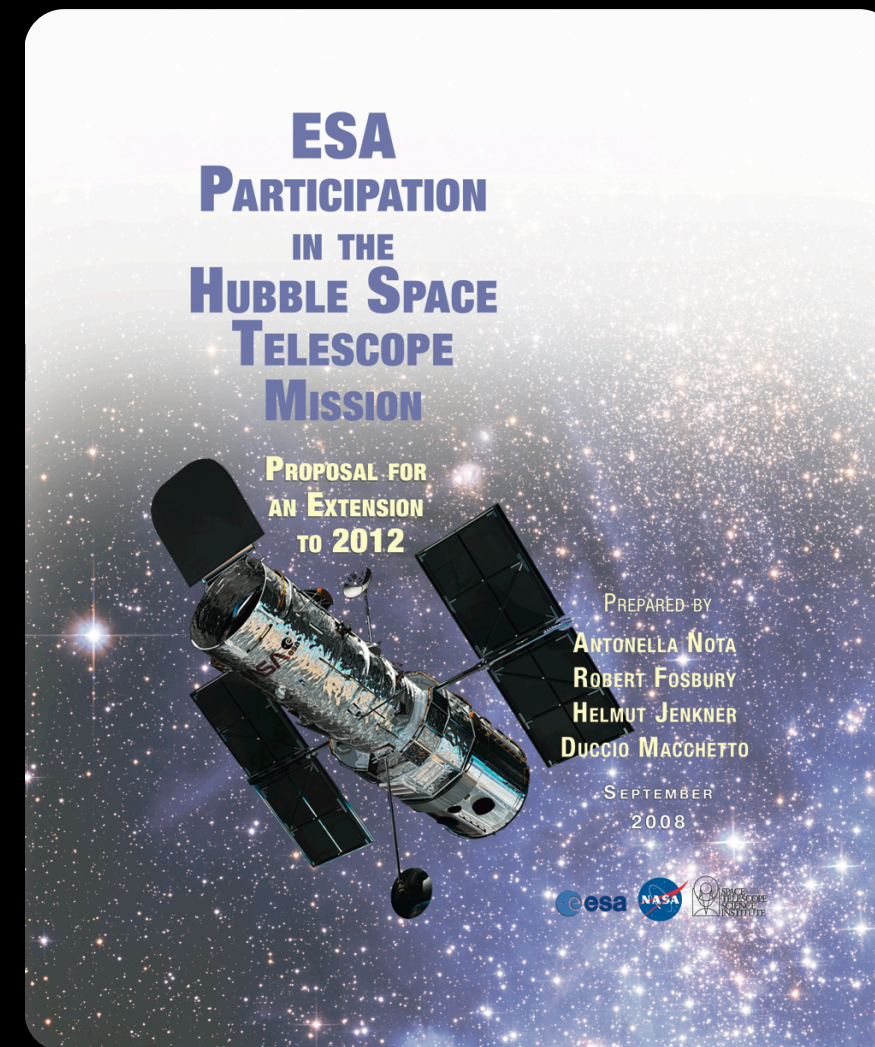
ESA Participation in the Hubble Space Telescope Mission

Proposal for an Extension to 2012

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STUC - November 14, 2008



- MOU between NASA and ESA for Hubble to expire in 2010
- ESA is operating several missions that are reaching end-of-life, and have high operational costs
- ESA holding review of missions, using existing advisory bodies:
 - Astronomy Working Group, Space Science Advisory Committee, Science Programme Committee



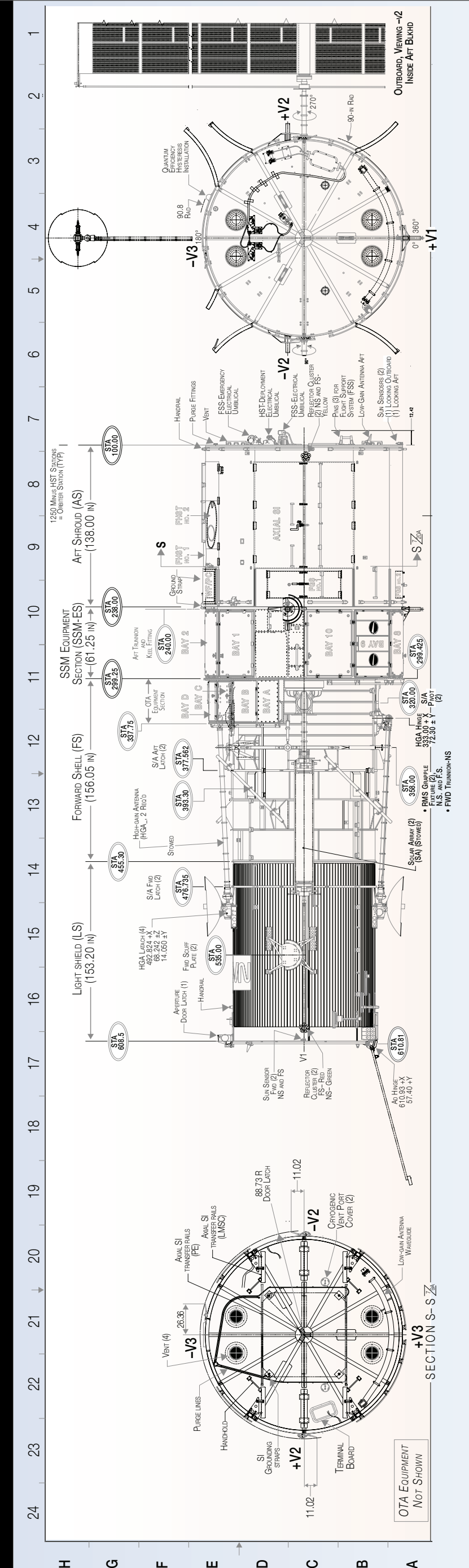
The Message

- Hubble has increased public awareness of astronomy worldwide
- ESA has been a major contributor to this success
- After SM4, Hubble will be at the peak of its scientific capabilities
- Hubble will make key contributions to the ESA Cosmic Vision themes
- We request to continue the European access to Hubble after 2010

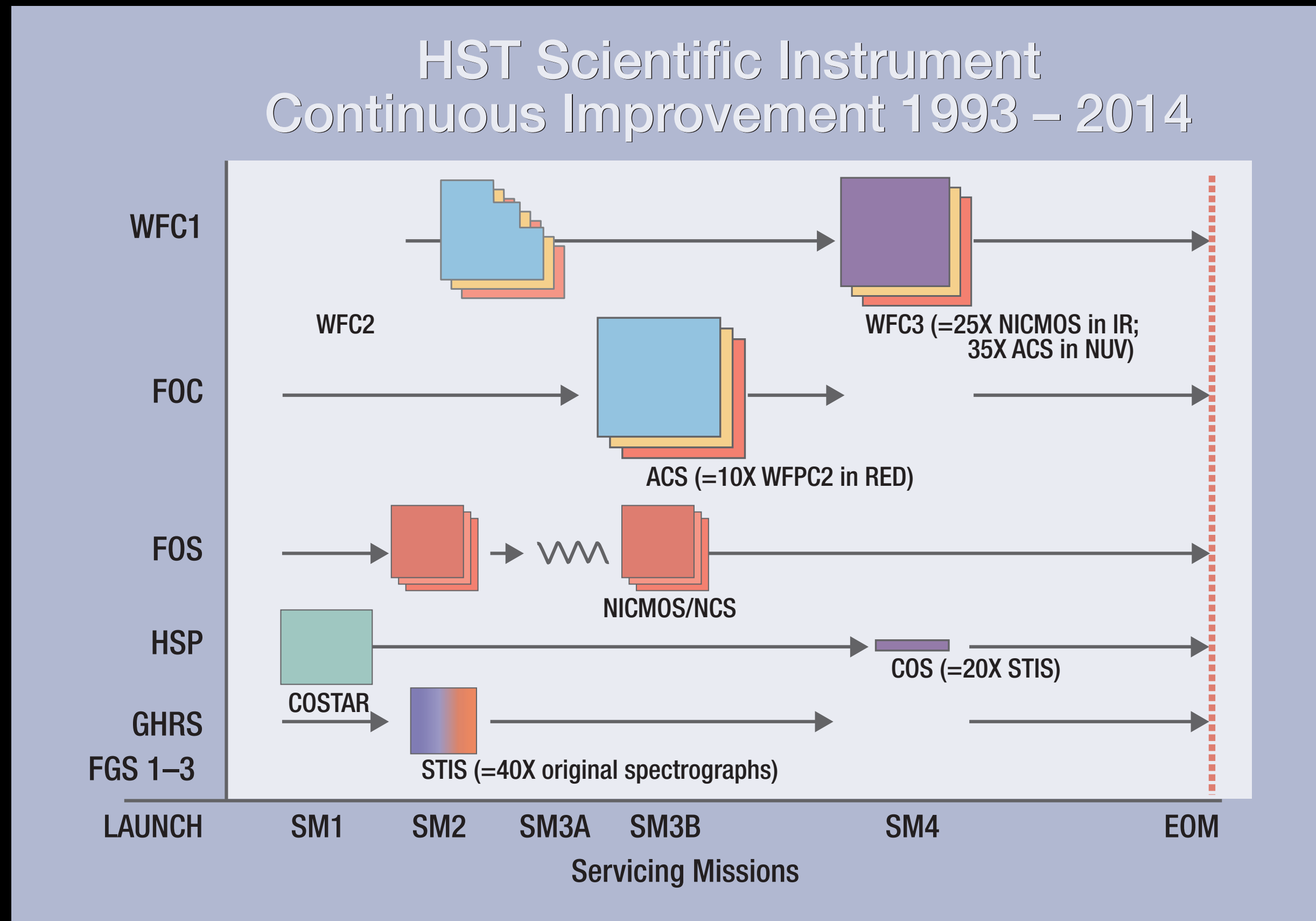


Hubble facts

- Hubble is a 2.4m telescope, optimised to observe from the UV (1200Å) to the Near-IR (2.4µm)
- Hubble was launched on April 24, 1990
- Hubble is a joint collaborative mission between ESA and NASA, regulated by a Memorandum of Understanding
- ESA contributes 15%, in terms of hardware and people (Faint Object Camera, 1st generation Solar Arrays, 15 scientists at STScI)
- European astronomers have guaranteed access to 15% of the observing time, over the lifetime of the mission
- MOU will expire in 2010, extension to be renegotiated
 - case here presented



Hubble is designed to be serviced by astronauts

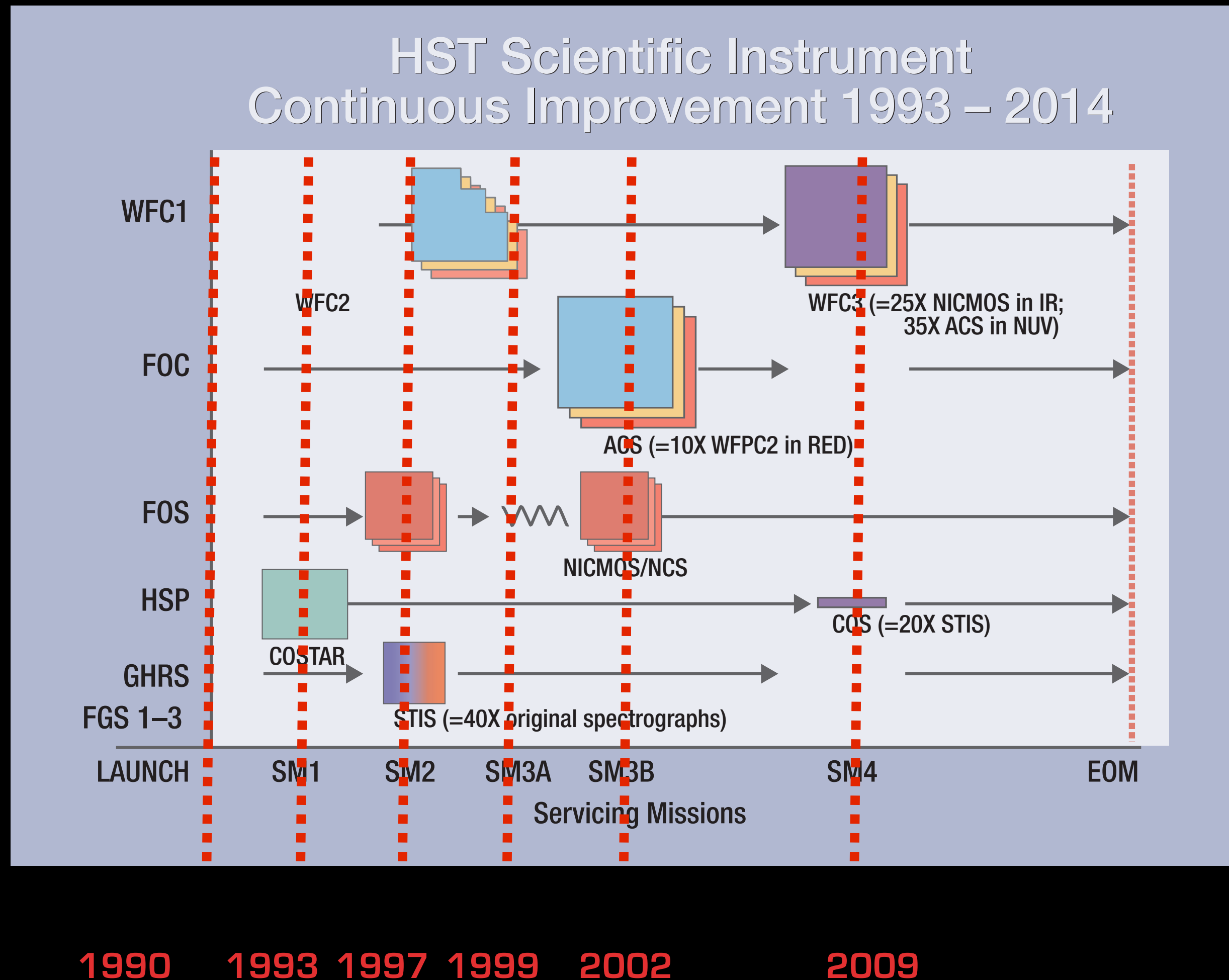


Hubble's unique

characteristics are:

- the diffraction limited imaging,
- the access to wide areas of the sky and to the UV domain,
- the deep dynamic range and high sensitivity,
- the low and stable observing platform (noise, point spread function).

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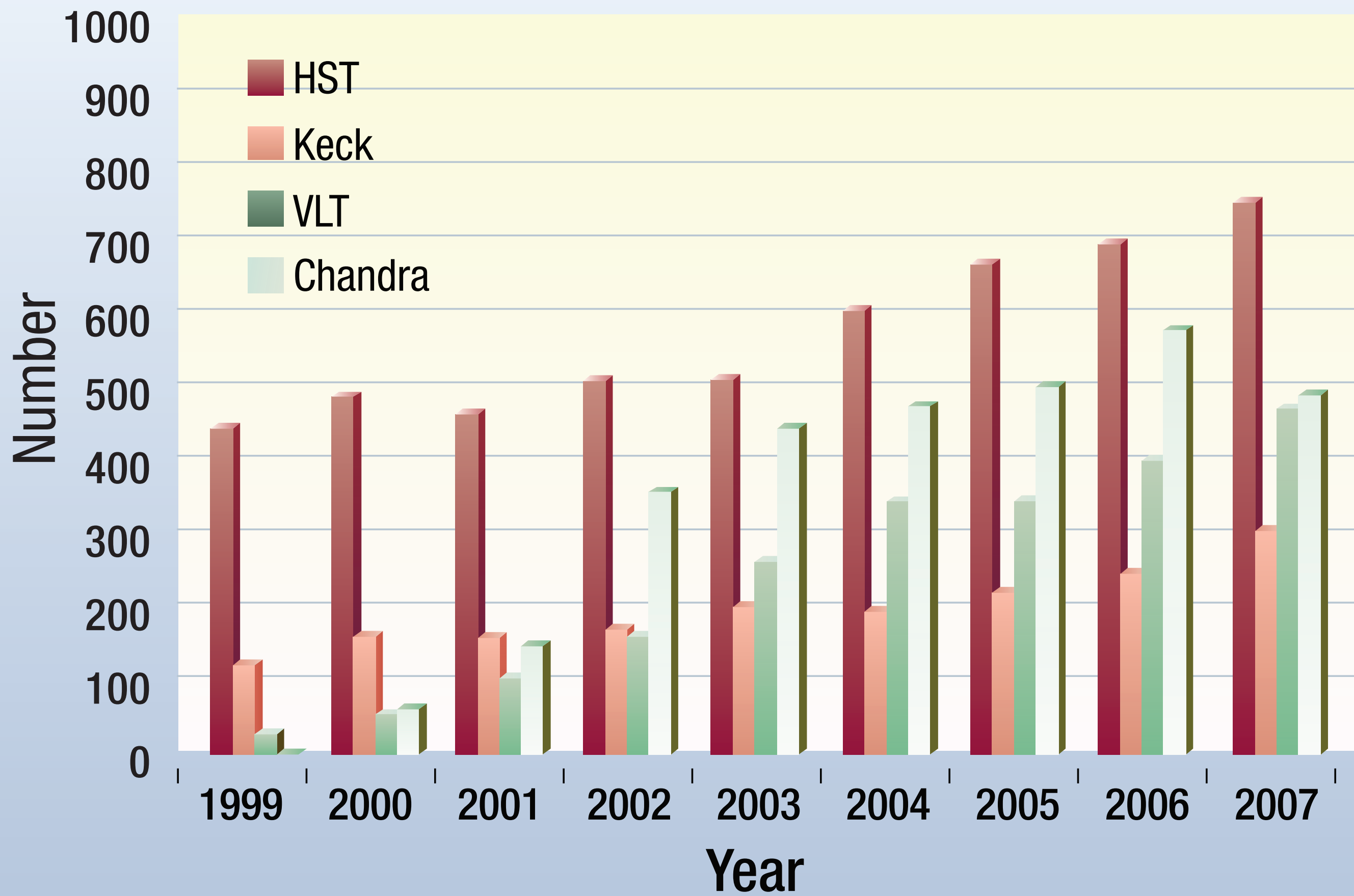


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Refereed publications per year

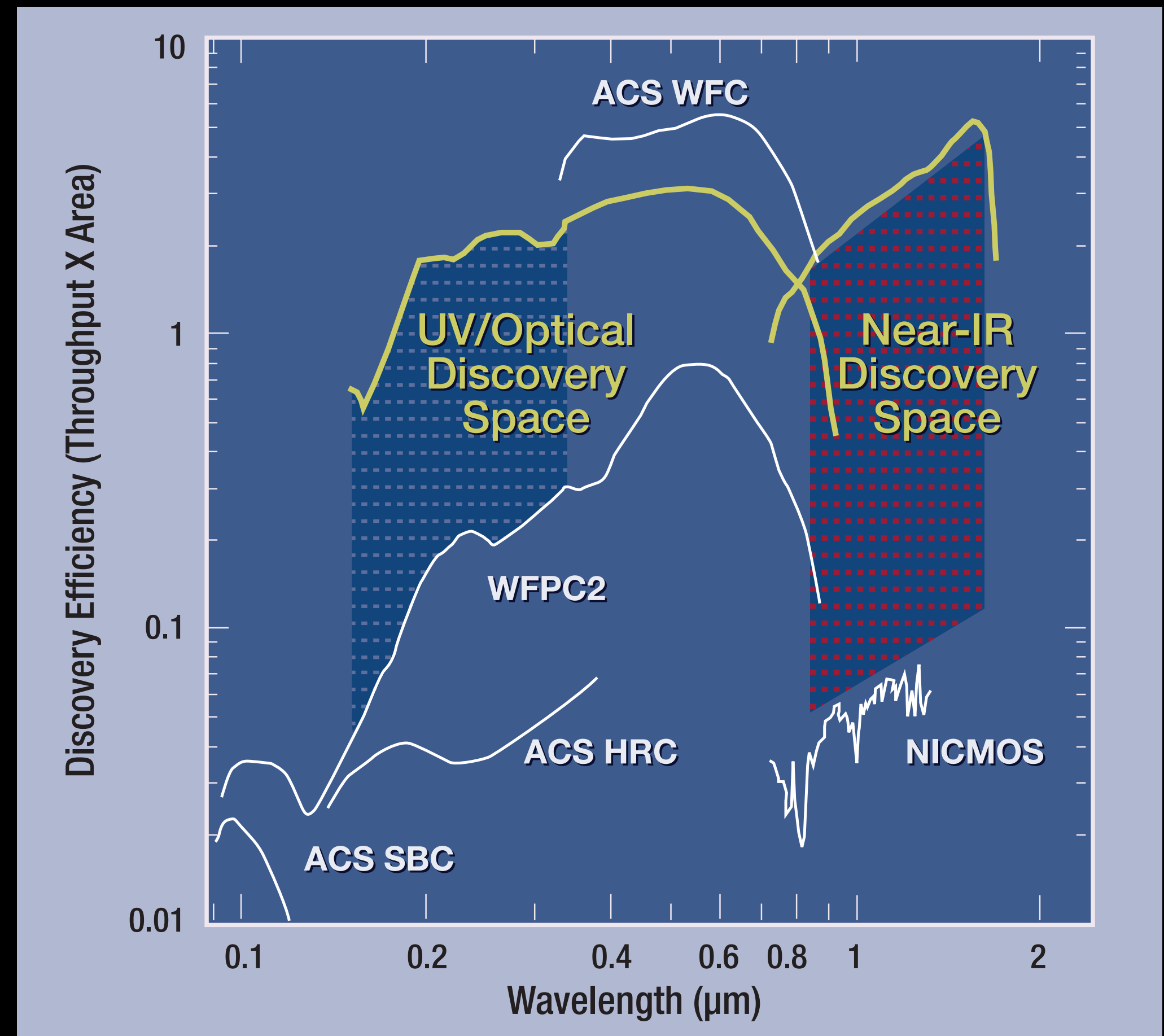




Hubble: expected scientific capabilities after SM4

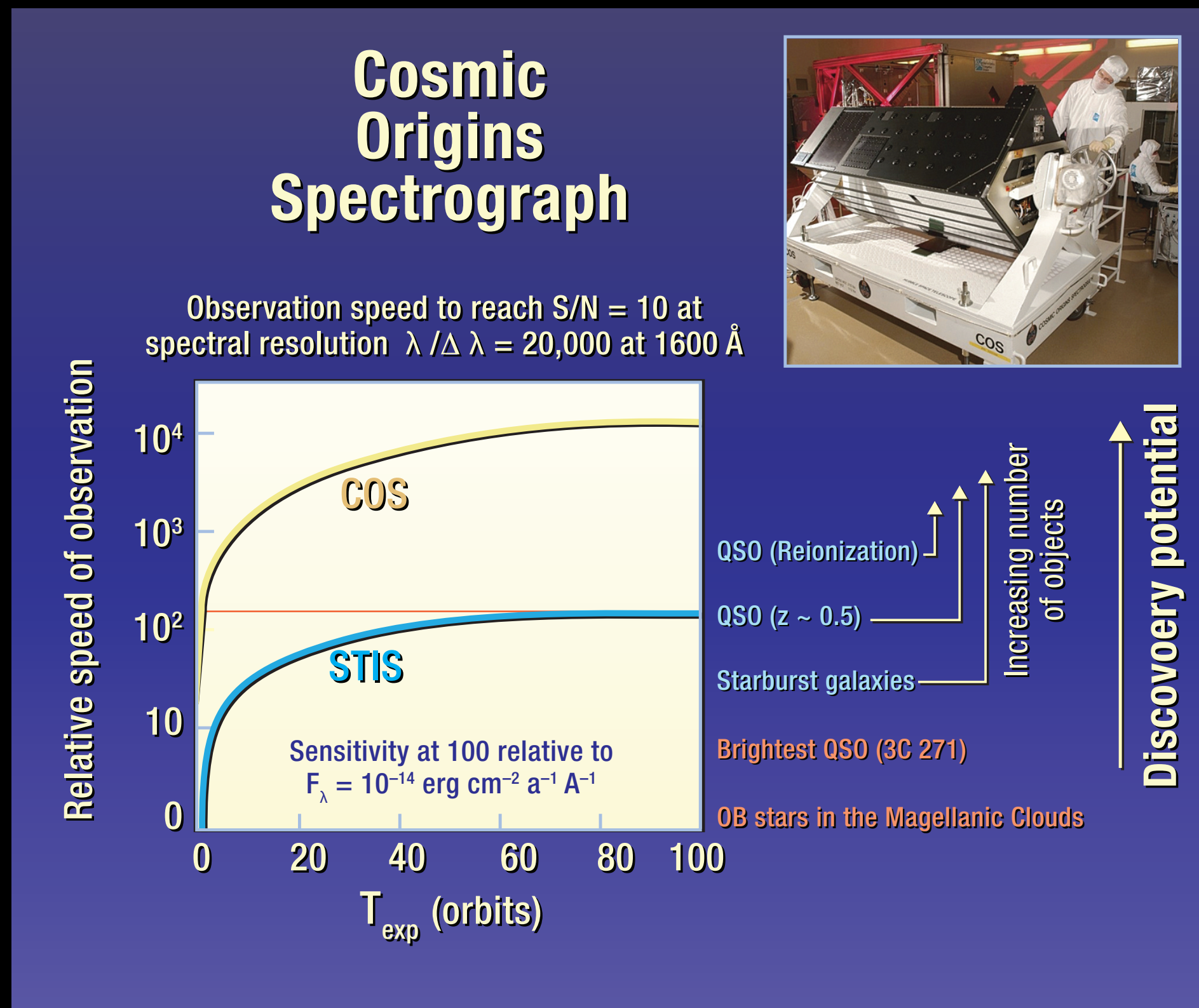
A new imager: Wide Field Camera 3

- WFC3 will offer panchromatic imaging capabilities from the UV (2000Å) to the IR (1.7μ)
- A UV-to-visible channel will image wavelengths from 2000Å - 1μ with a field of view of $162'' \times 162''$
- A large field ($123'' \times 136''$) IR channel will observe wavelengths from 900 to 1.7μ
- WFC3 will be very suited for identifying galaxies in the very early universe ($Z \sim 7-10$)



Discovery Efficiency = Throughput X Area

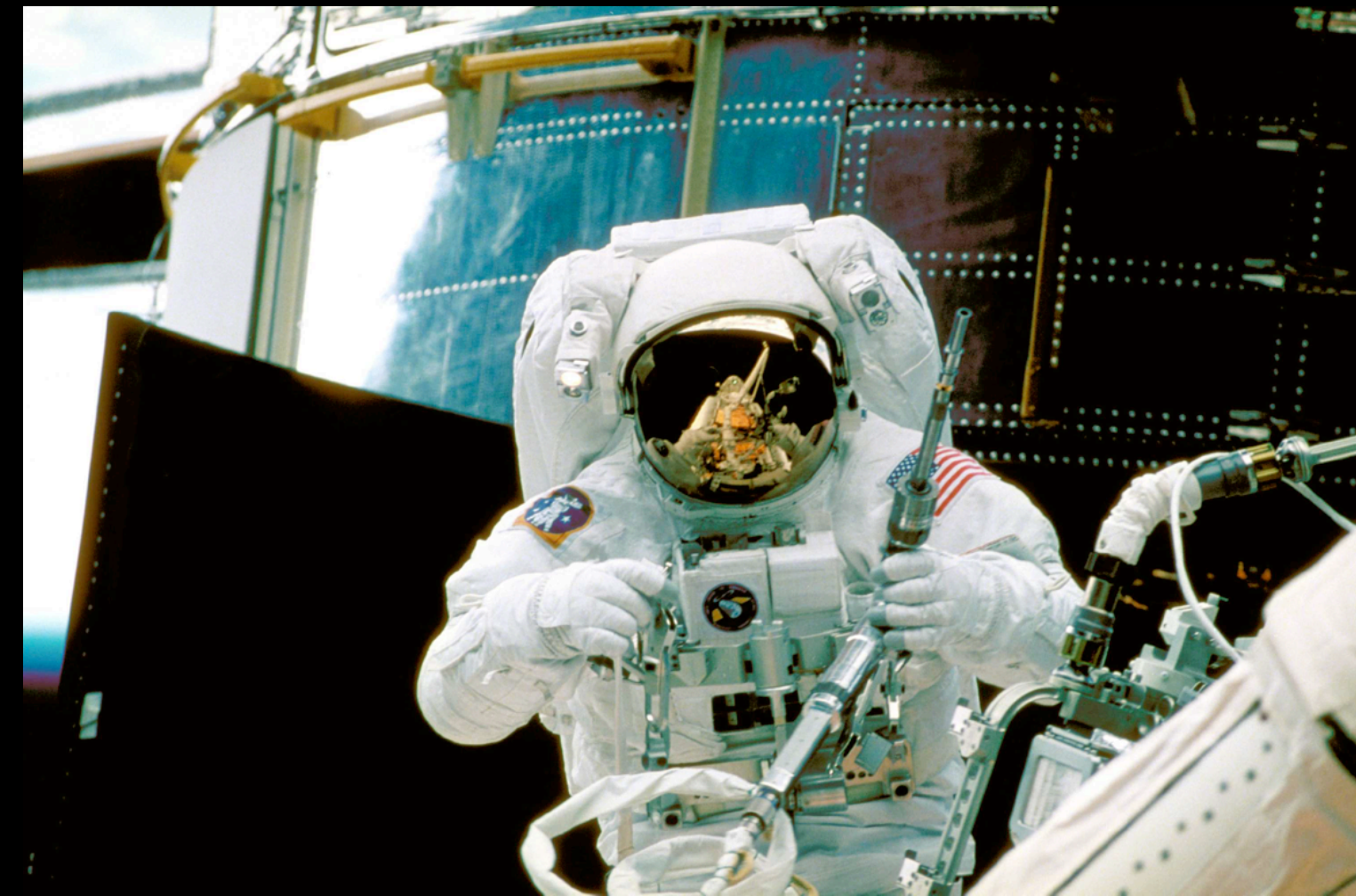
A new spectrograph: the Cosmic Origins Spectrograph



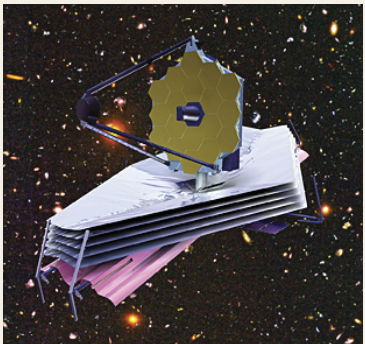
- COS is a high-throughput slitless UV spectrograph
- COS will be the most sensitive UV spectrograph ever flown on Hubble
 - COS is one order of magnitude more sensitive for point sources than STIS
- COS has been designed to characterise the Cosmic Web through UV spectroscopy
- COS will increase the number of available background QSOs by 100 times

Hubble: expected lifetime after SM4

- Repairs will be also be attempted to two instruments that have recently failed, the Advanced Camera for Surveys and the Space Telescope Imaging Spectrograph
- Servicing Hubble will provide for a lifetime extension. Several key components will be replaced:
 - All six batteries
 - A Fine Guidance Sensor
 - New outer blanket layers, to provide additional thermal protection
- AND... a replacement SI C & DH
- The expectation is that a fully successful SM4 will yield 7+ years of productive operations

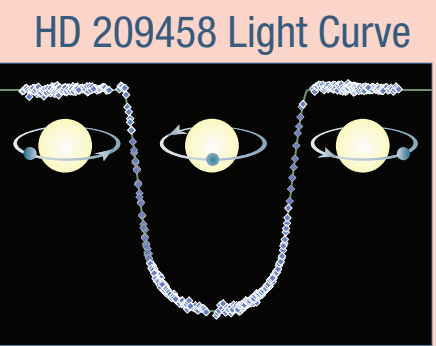


ESA
Cosmic
Vision

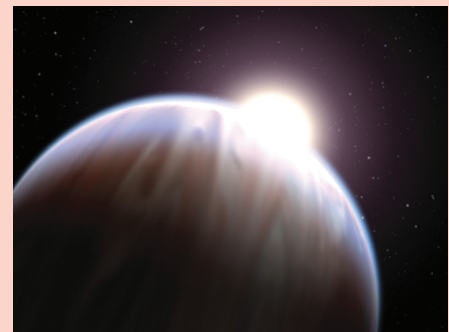


Planet formation
and emergence
of life

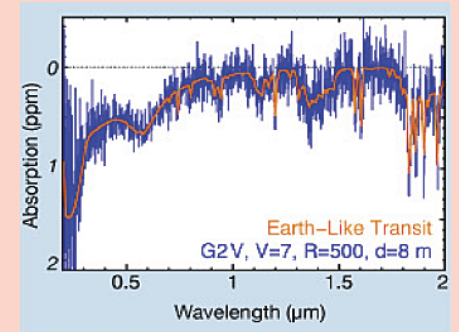
1 Jupiter
Transit



~20 Jupiter
Transits



Atmosphere of
Super-Earths



FUTURE...

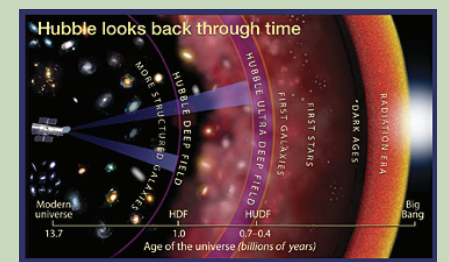
Are
we
alone?

How did the
Universe
originate?

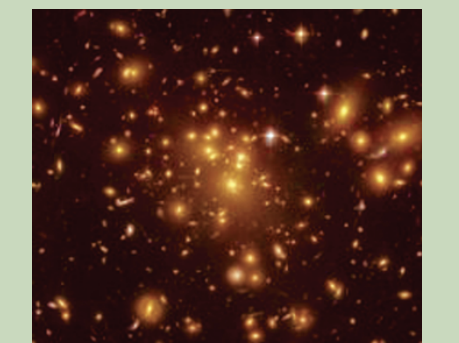
Normal Galaxies



Galaxies Responsible
for Reionization



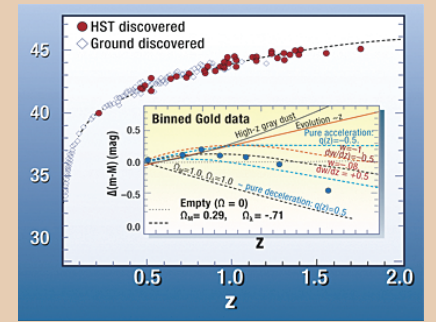
The First Galaxies



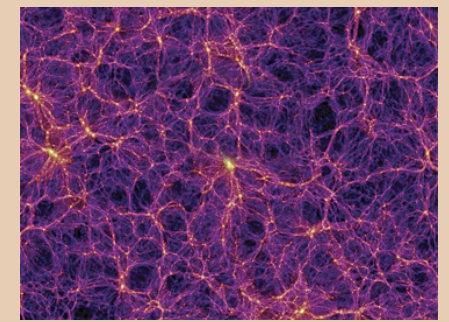
How do
galaxies
form?

What is the
Universe
made of?

Dark Energy



Characterization
of Cosmic Web



Tracing the
Chemical Evolution
of Galaxies

EUCLID?

What
is dark
energy?



Hubble
2.4m

Today

Hubble after SM4
2.4m

2010 – 2012

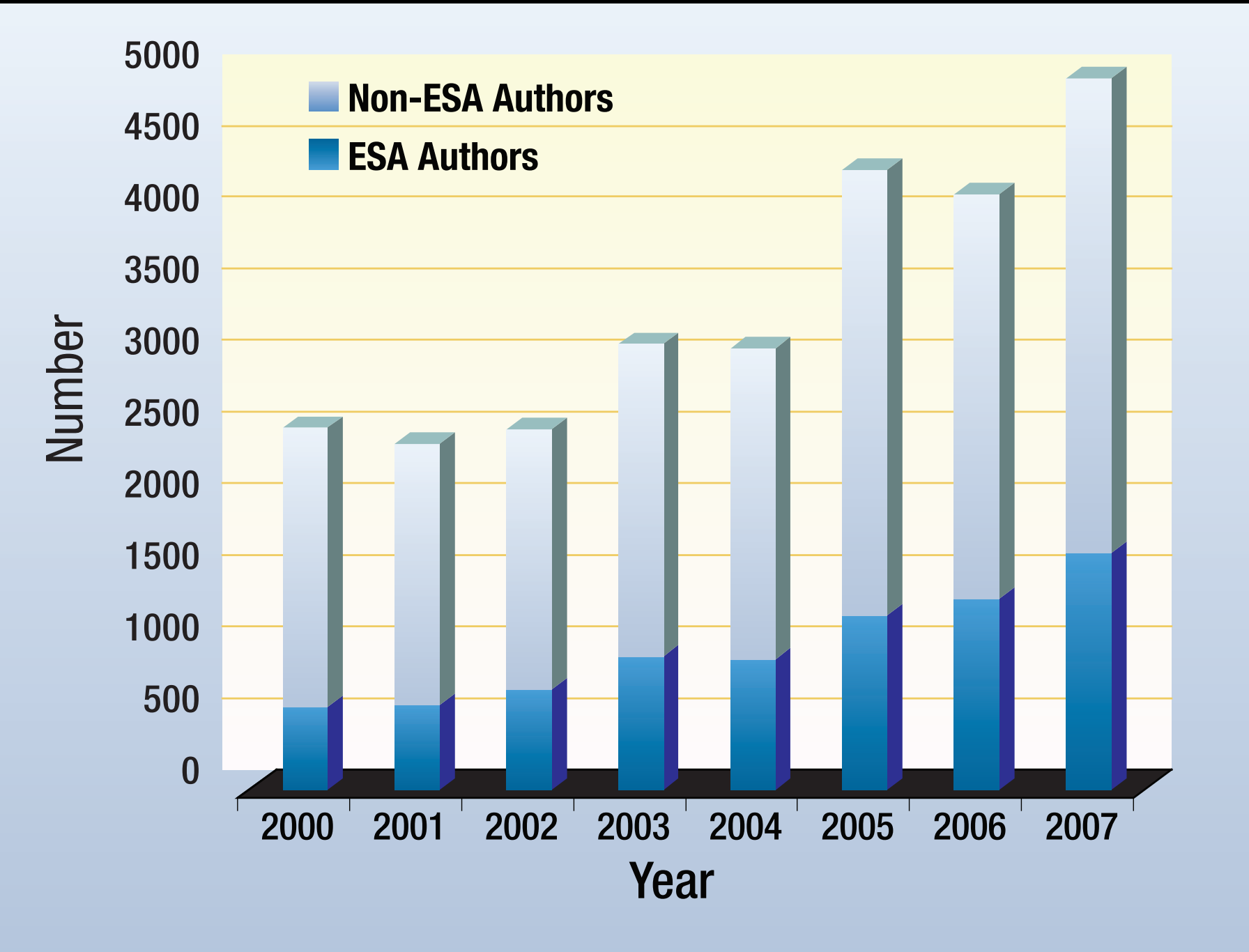
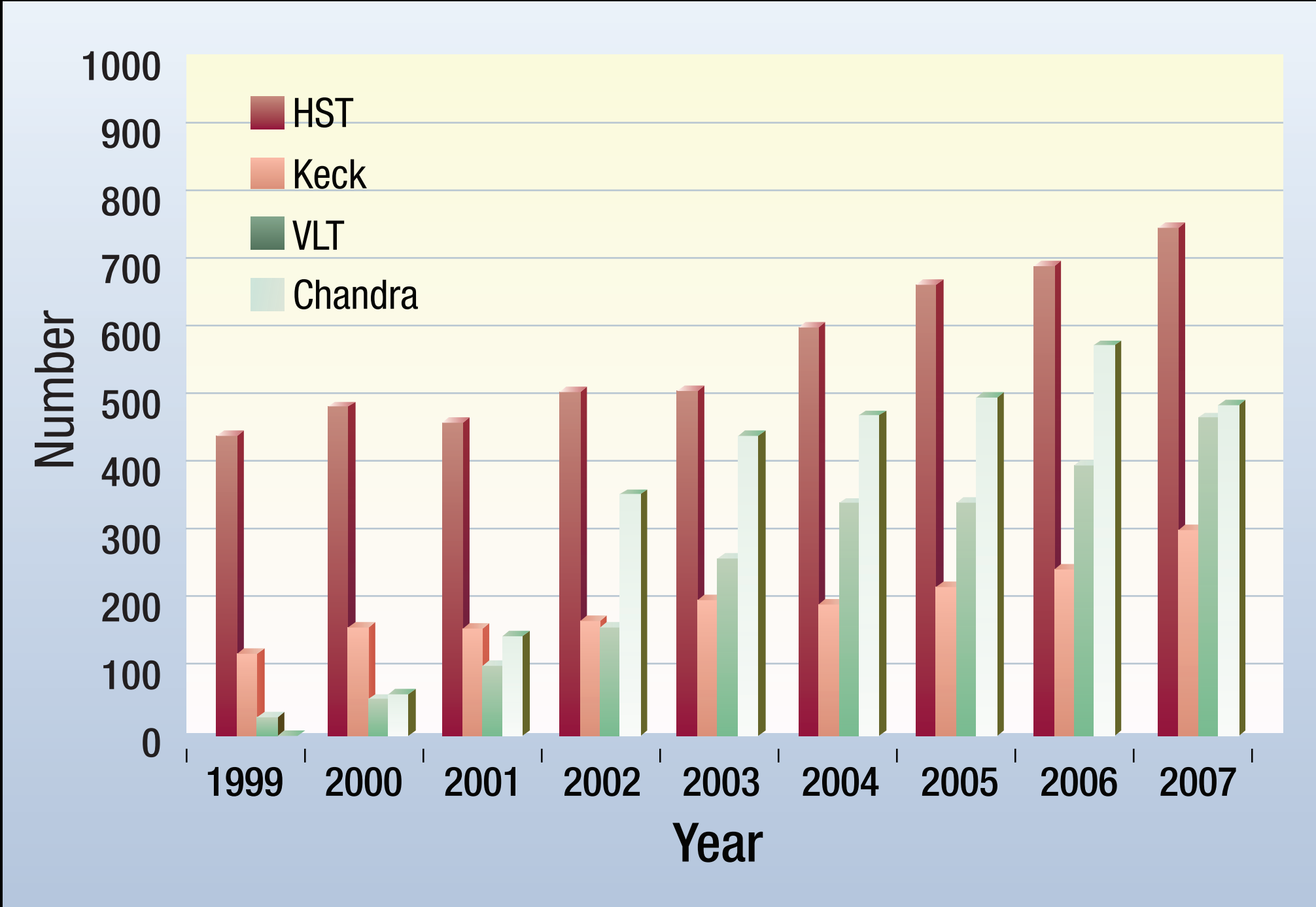
JWST
6m

2013 – 2018

Future Missions
... to 30m

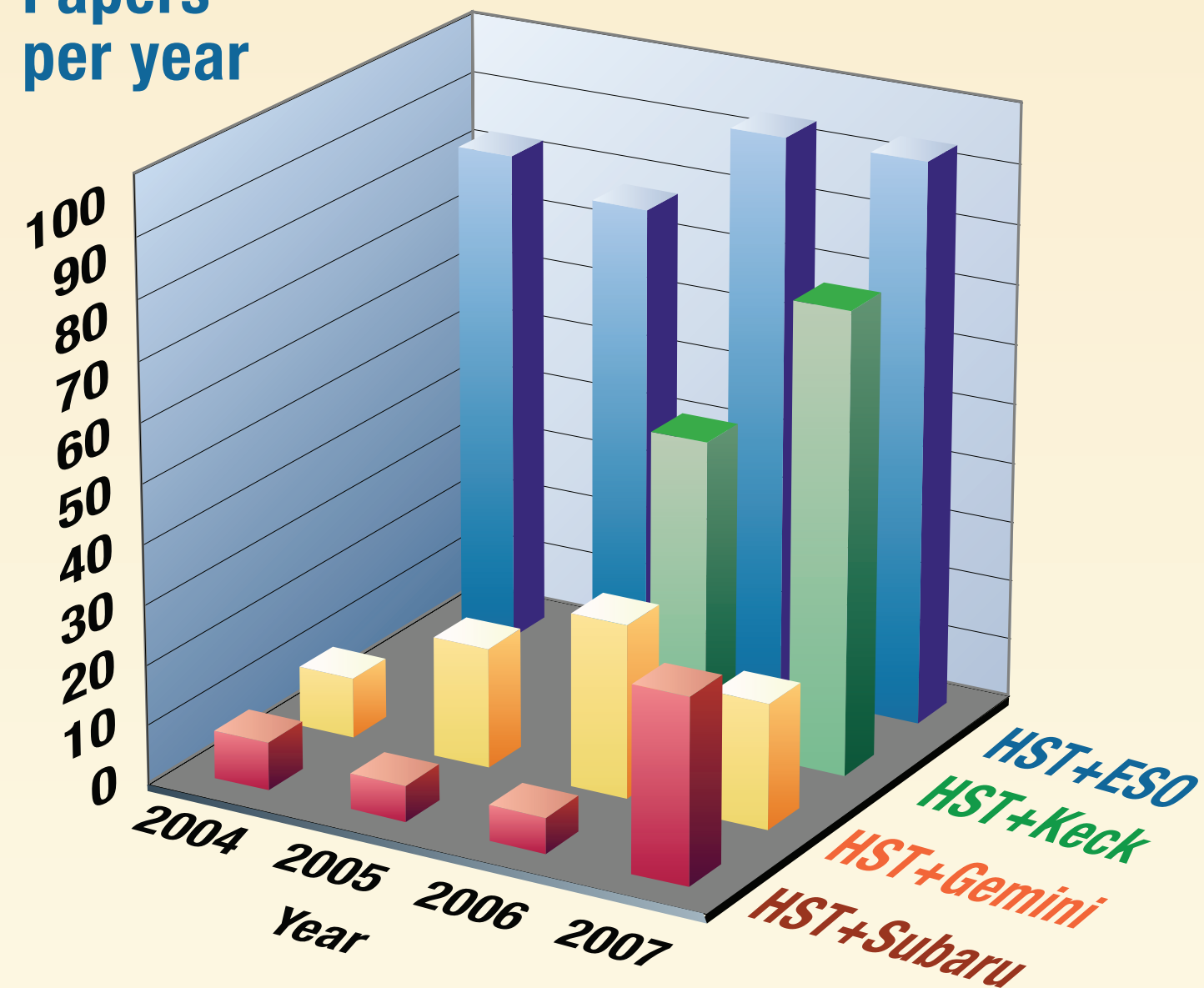
2020 – 2035

Number of refereed publications per year



28% of the authors are European

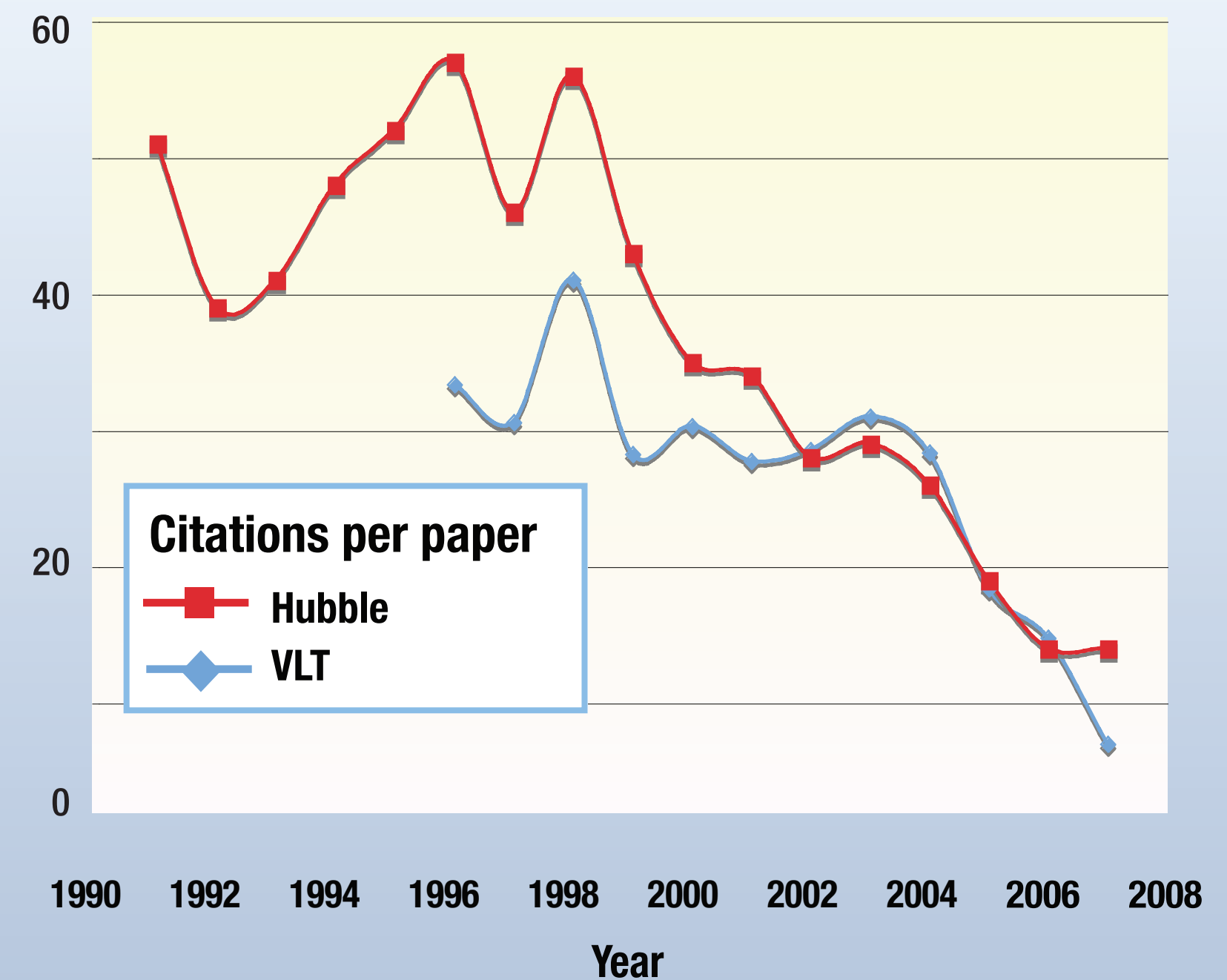
Papers
per year



Number of refereed publications based on data taken with Hubble AND one of the ground based observatories

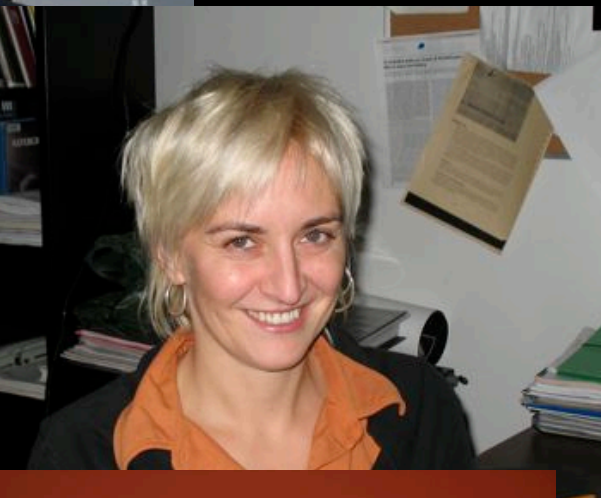
Number of refereed publications in the literature that are based on data taken with Hubble and

For papers at least 5 yr old, the average citation/paper is 43



ESA's contribution to Hubble

- ESA contributes 15 scientists to STScI Hubble science operations
 - 30% of the total # of scientists supporting Hubble,
 - mostly deployed in instrument calibration and user support
- ESA maintains and supports some remaining Hubble hardware - Solar Array Drive Mechanism and Electronics

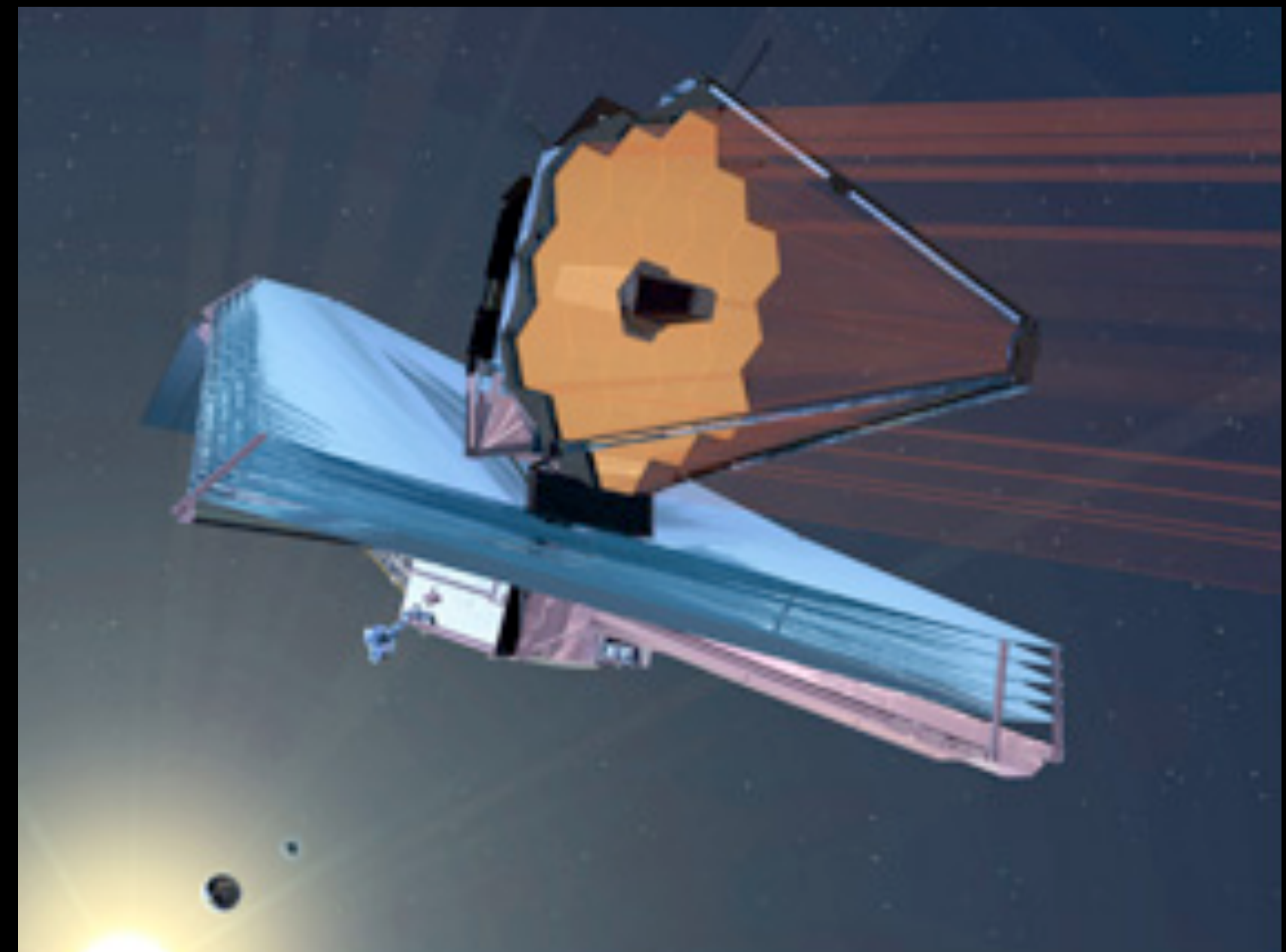


ESA's benefits from Hubble

- The European community has guaranteed access to a minimum of 15% observing time on Hubble
- The European community's scientific interests are represented in the User Group (STUC), in the Time Allocation Committee (TAC) but also in the STScI oversight bodies (STIC)
- Approximately 200 European astronomers have served on the TAC
- More than 60 European astronomers were employed by ESA at STScI: most returned to Europe, bringing know-how and scientific connections to their European institutions
- More than 200 European students and visitors have spent time doing research at STScI.

The productive collaboration on Hubble

- has established ESA as a reliable and trustworthy partner to NASA
- has set the foundations for the partnership with NASA on JWST and possibly on future missions



Hubble: the cost of the extension

3.4 M Euro/yr are requested to continue ESA's involvement in the HST Mission:

- maintain 15 people (ESA staff and contractors) at STScI
- maintain and support the remaining hardware on Hubble: Solar Array Drive Mechanism, and the Solar Array Drive Electronics
- The Space Telescope Coordinating Facility will close in 2010.

The investment is modest for a very high scientific return - namely:

- 0.75 KEuro per Hubble orbit
- 5.5 KEuro per published paper in 2007

- Astronomy Working Group met in Estec on October 15-16
 - Hubble ranked #1 mission
- Space Science Advisory Committee met in Spain on October 28
 - Hubble is one of the top three missions ESA will continue supporting

