HST Science Products

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STUC meeting
May 13, 2016

“The Hubble mission continues to operate well, in no small part due to the proactive nature of STScI’s instrument and observatory monitoring and maintenance.” (STUC report)

HST Science Products

reference files

observing tools

Instrument Science Reports (ISRs)

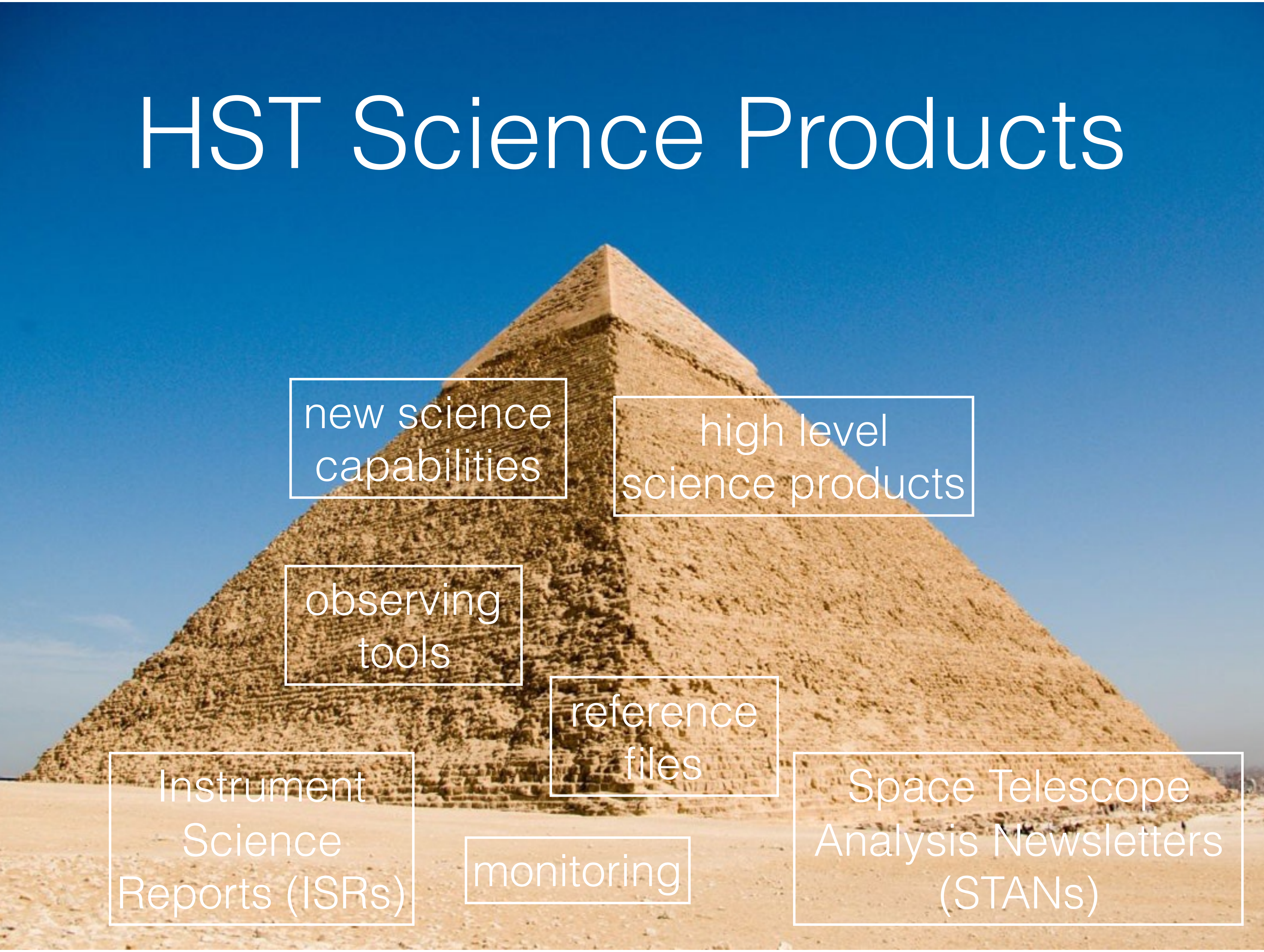
Space Telescope Analysis Newsletters (STANs)

new science capabilities

monitoring

high level science products

HST Science Products



The Cycle 23 Calibration Program Provides the Monitoring and Instrument Calibration Needed to Enable Science with HST

	External Orbits	Internal Orbits
ACS	33	936
COS	38	317
STIS	31	1388
WFC3	98	1619
Total orbits	**200**	**4260**

Science Products

Hubble Space Telescope
May 2016 STAN

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+--------------------------------------------------------------+
| STScI Analysis Newsletter (STAN)
| Cosmic Origins Spectrograph (COS)
| May 2016
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In this Newsletter we provide information about updates to the COS/FUV TDSTAB and DISPTAB reference files:

Contents:

- Updated COS/FUV Time Dependent Sensitivity Reference File (TDSTAB) Released
- Updated COS/FUV Wavelength Dispersion Solution Reference File (DISPTAB) Released

where the large scatter seen in the dark rate contributed to the large dark rate adopted. The scatter has now decreased substantially,

2016-05-03	hst_0444.pmap	operational	New STIS CCD bias and dark reference files for
2016-05-02	hst_0443.pmap	archived	New biases and darks for STIS CCD data taken
2016-04-29	hst_0442.pmap	archived	These files are used in the dark current subtracti
2016-04-25	hst_0441.pmap	archived	New flash reference files for ACS full frame data
2016-04-20	hst_0440.pmap	archived	New dark reference files for ACS SBC data taker
2016-04-19	hst_0439.pmap	archived	These files are used in the dark current subtracti
2016-04-15	hst_0438.pmap	archived	New standard and cte-corrected darks.
2016-04-11	hst_0437.pmap	archived	New ACS WFC1-2K subarray bias.
2016-04-06	hst_0436.pmap	archived	The V2 and V3 reference positions were change
2016-04-01	hst_0435.pmap	archived	New reference files for ACS WFC data taken afte
2016-03-25	hst_0434.pmap	archived	New WCPTAB with updated XC range.
2016-03-17	hst_0433.pmap	archived	ACS WFC FLSHFILEs with SHUTRPOS set to A
2016-03-17	hst_0432.pmap	archived	New ACS WFC subarray biases.
2016-03-13	hst_0431.pmap	archived	New reference files for ACS WFC data taken afte
2016-03-08	hst_0430.pmap	archived	These files are used in the dark current subtracti
2016-02-29	hst_0429.pmap	archived	New ACS DRK, BIA, DKC after Dec. 16 2015.
2016-02-23	hst_0428.pmap	archived	Merging of the WFC3 branch context, along with
2016-02-11	hst_0424.pmap	archived	New ACS WFC1-1K subarray bias for data taken
2016-02-10	hst_0423.pmap	archived	Delivery of new STIS CCD bias and dark referen
2016-01-07	hst_0380.pmap	archived	New ACS WFC bias, dark, and cte-corrected dar
2015-12-22	hst_0379.pmap	archived	These post-flashed dark current files continue the
2015-12-01	hst_0378.pmap	archived	Redelivery of unchanged COS SPOTTAB rmap w
2015-11-24	hst_0377.pmap	archived	These post-flashed dark current files continue the
2015-11-23	hst_0376.pmap	archived	New gainsag holes have appeared on the detect modes and gsag_2015-10-27T10-24-18.392734_
2015-11-19	hst_0375.pmap	archived	New ACS bias, darks and cte corrected dark refe
2015-11-18	hst_0374.pmap	archived	New BIASFILE rmap which includes the new ape
2015-11-18	hst_0373.pmap	archived	New STIS CCD biases and darks.
2015-11-16	hst_0372.pmap	archived	Reactivating previous BPIXTAB. Current file has
2015-11-12	hst_0371.pmap	archived	Delivery of the new COS FUV GSAGTAB.
2015-11-10	hst_0368.pmap	archived	Reference file installation following 2015.2b insta
2015-11-03	hst_0366.pmap	archived	These post-flashed dark current files continue the support the new SPARS5 mode.

Science Products

STScI | SPACE TELESCOPE SCIENCE INSTITUTE

Instrument Science Report ACS 2016-02

SBC Internal Lamp P-flat Monitoring

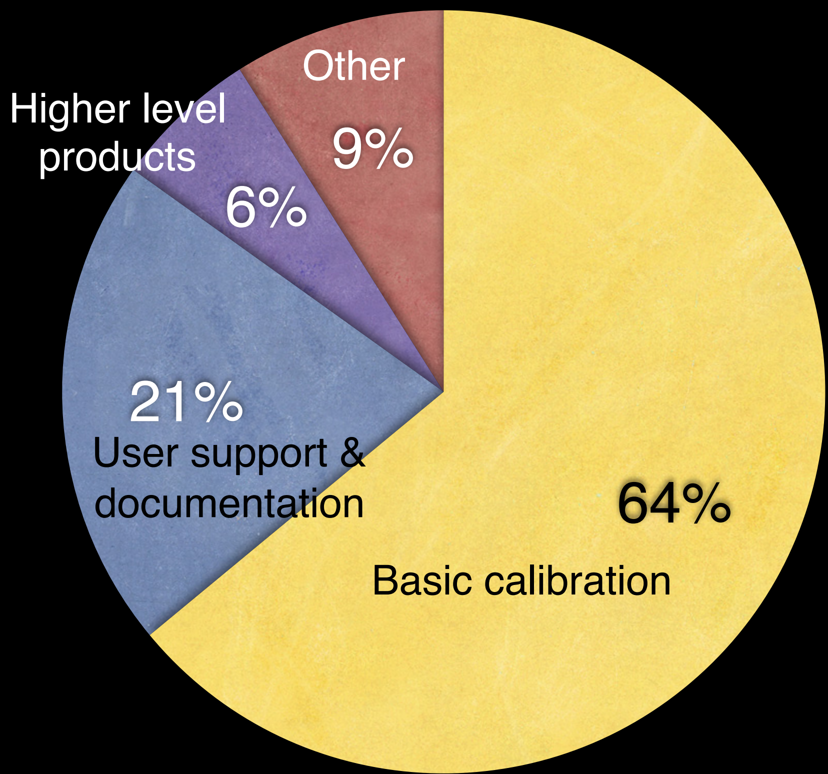
R.J. Avila, M. Chiaberge, R. Bohlin

March 25, 2016

January 6, 2016

16 November 2015

Basic Instrument Calibration is a Priority



FTEs in instrument teams devoted to basic calibration (yellow), user support & documentation (blue), higher level products (purple), other (management, institute service)

COS

λ calibration, FUV/LP4, C23 & C24 calibrations

STIS

automated monitoring, lamp monitoring, echelle blaze function, TDS, C23 & C24 calibrations

ACS

WFC CTE, WFC geometric distortion, SBC sensitivity/flatfields, PSF modelling

WFC3

UVIS bias, darks; IR dark, linearity monitors, C24 calibration, grism IR λ, flux calibration, photometric repeatability, focus monitoring

Priorities for higher level products are set by:

- ✓ free energy available after basic calibration, user support, documentation is covered
- ✓ concerns of user community for improvements to basic calibration, tools, monitoring
- ✓ resources required to implement higher level products
- ✓ enhancements to the legacy value of Hubble datasets
- ✓ discussions with the user community

High Level Science Products (HLSPs) are produced as the result of Large and Treasury Programs and are deliverables to MAST

HST Spectral Legacy Project

recommendation of working group formed after "Enhancing the Legacy of HST Spectroscopy" Workshop Nov. 15-16, 2012

The working group identified the following tasks as priorities for the next couple of years (from higher to lower priority)

- Make combined 1D spectral products available and create the pipeline to do it
- Visualization tools for spectra
- Search tool to select sources based on their classification
- Tool for feature identification and measurement (develop equivalent of source extractor for spectra)

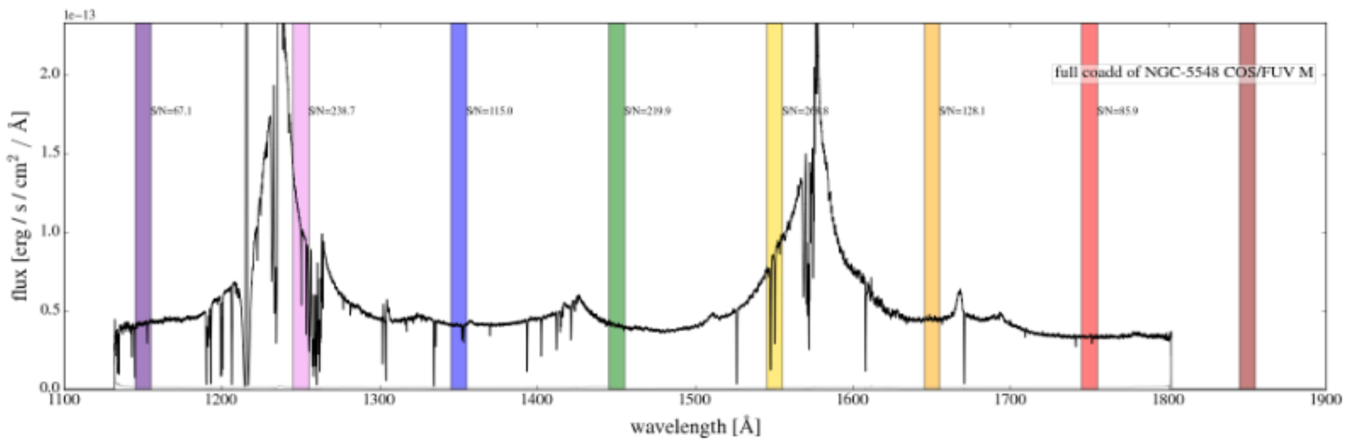
STUC Oct. 2013 K. Sembach presentation

STUC was briefed in Oct. 2013, Oct. 2014, Nov. 2015
resource level: ~1.5 FTE per year

HST Spectral Legacy Project

Enhances spectroscopic science return of Hubble archives

Welcome to the HST Spectral Legacy project.



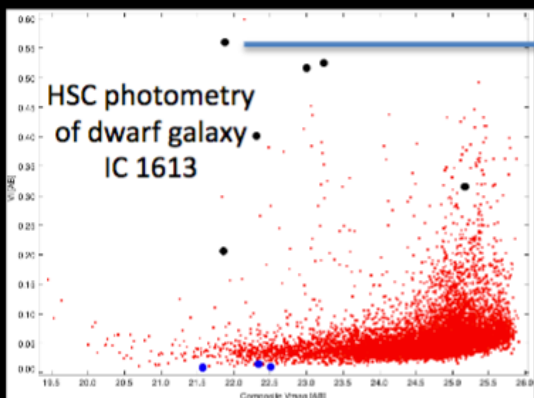
Coadd spectrum of NGC 5548, composed of 764 coadded exposures.

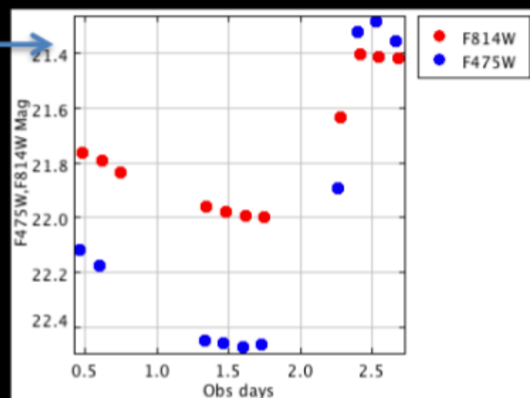
- Many science cases require all/most data on a given target
- HST Spectral Legacy project available March 7, 2016: spectroscopic equivalent of mosaics for images
  - combines all COS/FUV data on 1394 targets, 13121 exposures, 1722 coadded 1D spectra, 18 science-ready target samples, one-click downloads
  - Will expand to COS/NUV, STIS, legacy spectrographs

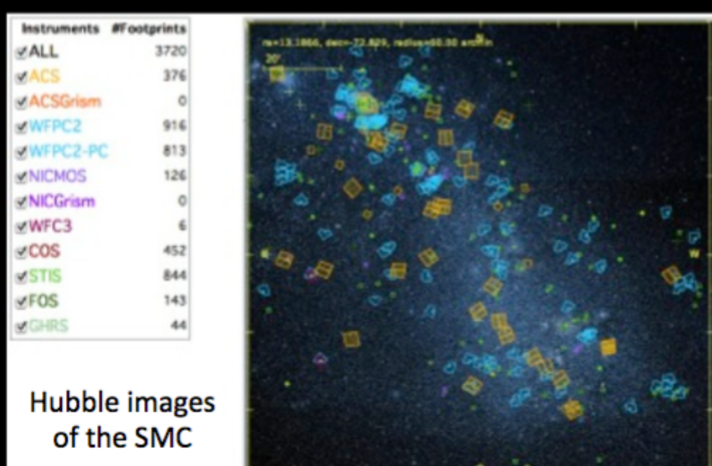
Hubble Source Catalog

Three Reasons to Build the Catalog

1. Time-variable phenomena – The HSC supports time-variable studies over a >20 year baseline.





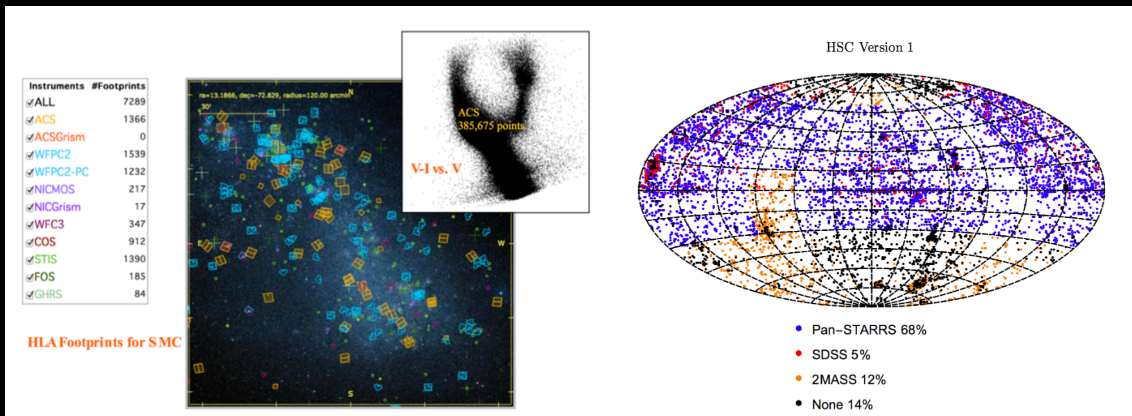


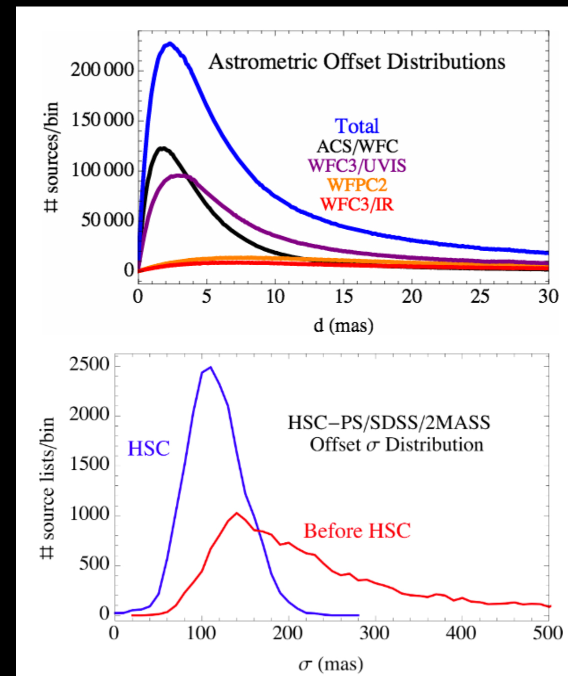
2. Mosaics – Accurate spatial offsets between observations are needed to build the HSC. These can then be used to make mosaics.

3. Very large datasets – Replicating what is available in the HSC in seconds would take most researchers weeks, months, or years to produce.

STUC May 2014 K. Sembach presentation

Hubble Source Catalog



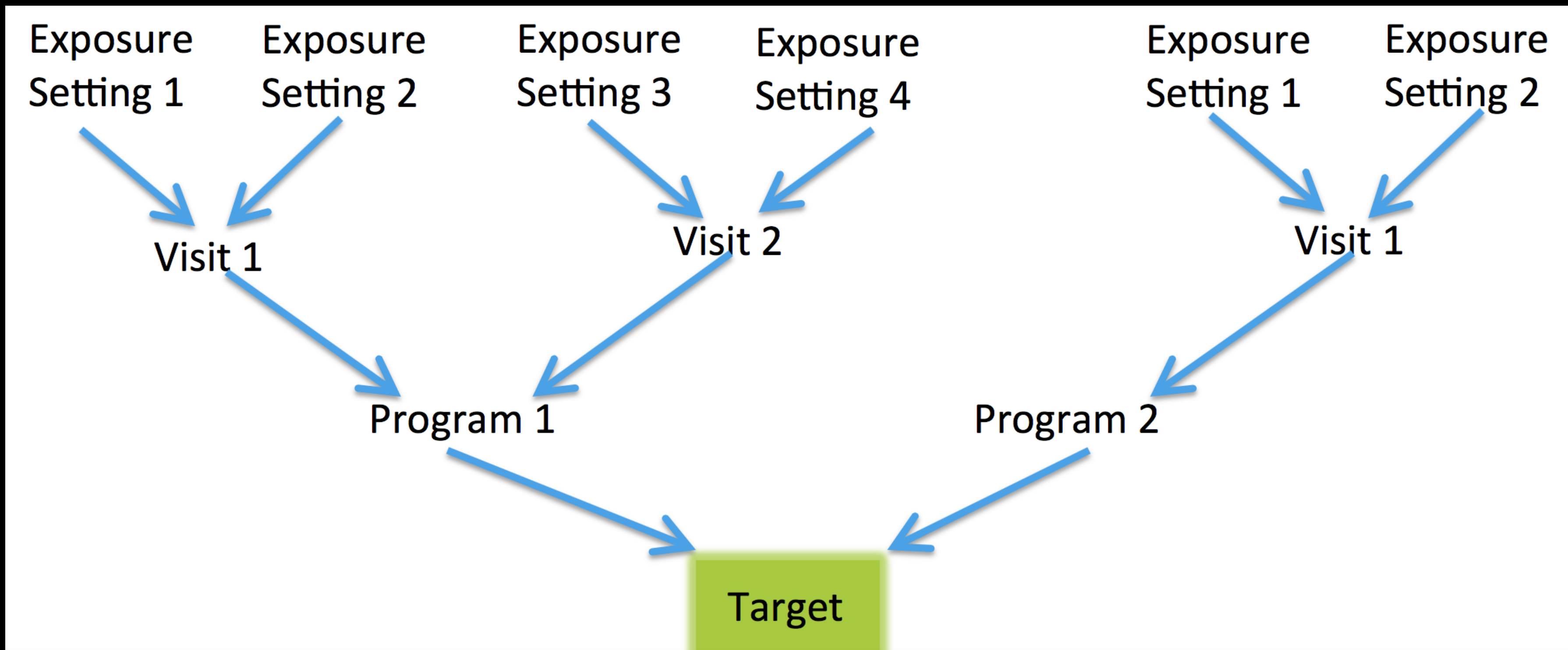


Whitmore et al. (2016)

STUC first briefed in April 2012
resource level: ~1.5 FTE effort per year

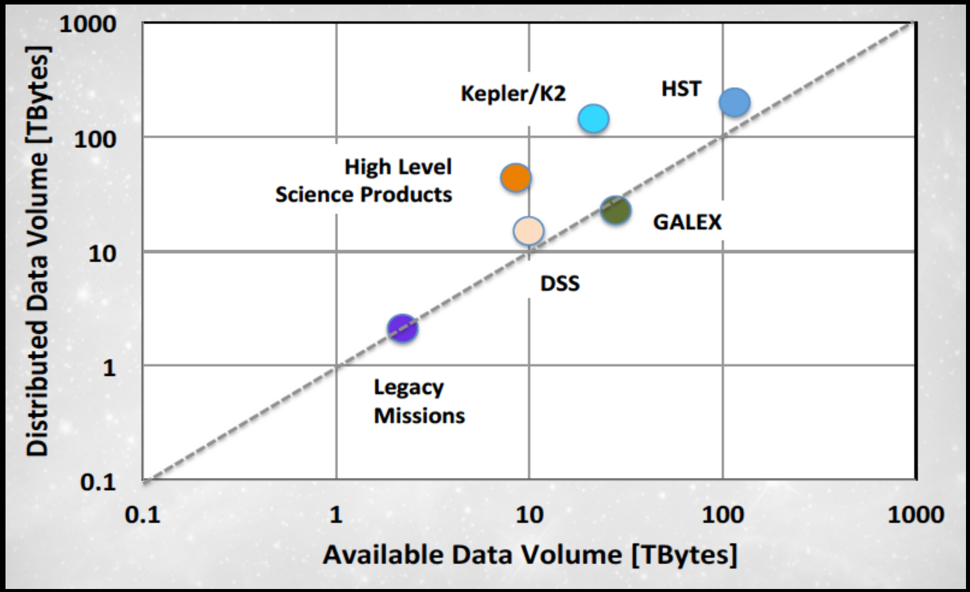
- Enables science from catalog of hundreds of millions of sources viewed by HST over its lifetime
- Version 1 released Feb. 2015: 80 million detections of 30 million sources from WFPC2, ACS/WFC, WFC3/IR, WFC3/UVIS
  - Mean photometric accuracy <0.1 mag; <0.02 mag for many sources
  - Relative astrometric residuals < 10 mas
  - Absolute astrometric offset <0.2”
- Version 2 release August 2016 includes new ACS data, version 3 (spring/summer 2017) new WFPC2 data, totaling 100 million sources
- Extensive cross matching with PanSTARRS & GAIA improves absolute astrometry to <0.01” with GAIA (currently <0.2” relative to PanSTARRS and 2MASS)
- Supports time-variable studies over a >20 year baseline ➔ Hubble Catalog of Variables
- Accurate spatial offsets between observations needed to build the HSC, can then be used to make mosaics
- Puts very large datasets in the hands of a wider community; increases the legacy value of the archival holdings

The Value of Combining Data



- Archive combines data: exposures within a visit
- High level science products for large/treasury programs typically deliver combined data and catalogs at the program level
- Clear advantages to providing uniform combination of data at the highest level, utilizing latest advances in calibration and processing, for science-ready data products
- This is the philosophy used by the HST Spectral Legacy Project, also useful for imaging

The Value of Combining Data



- High Level Science Products are downloaded ~10x more than HST(/HLA) relative to their data volume holdings on disk

- The current largest HLSPs constitute < 10% of the total science exposures to date in wide-field imaging (ACS/WFC, WFC3/IR, WFC3/UVIS); the remaining 90% are generally smaller programs, often obtained by teams too small (or too long ago) to deliver as HLSPs: still value

Anton Koekemoer slide

The Value of Combining Data: Supermosaics

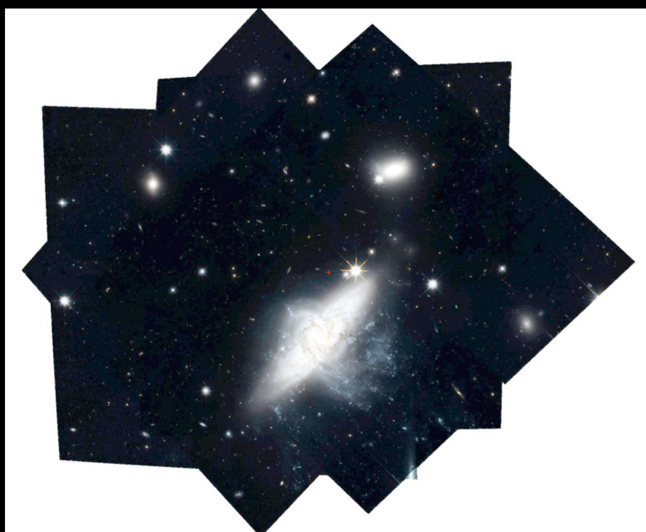
genesis of idea from A. Koekemoer's Nov. 2015 STUC presentation

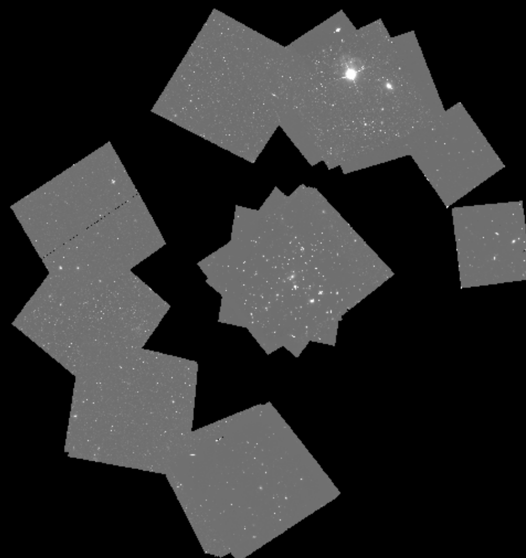
- Utilizes experience from Frontier Field processing in combining observations from current wide-field imagers
- Incorporates additional improvements in off-line processing such as:
  - ★ Mitigating persistence and time-variable sky in WFC3/IR data
  - ★ Improving low-level dark current residuals in ACS using self-cal
  - ★ Applying low-level sky background improvements that go beyond current reference file accuracy
- Images would be registered to same pixel grid and absolute astrometric reference frame on the sky
- Creates full-depth multi-filter mosaics, and associated ancillary products, on all fields that have been imaged by Hubble

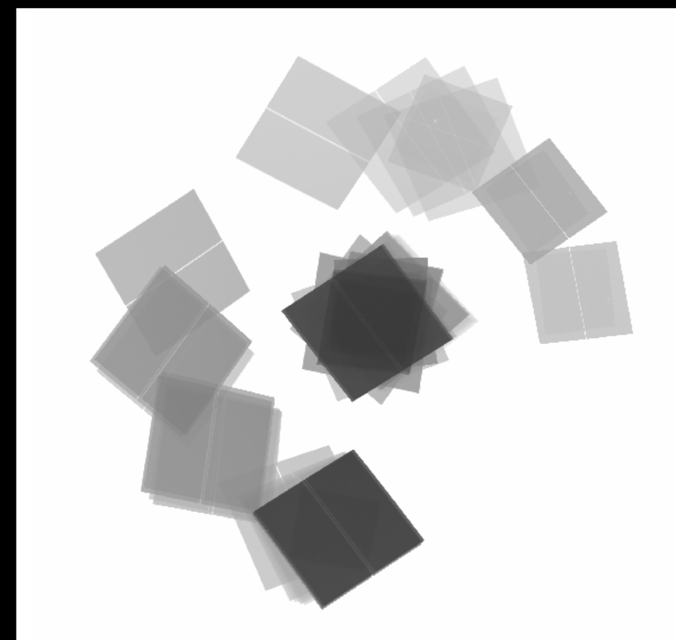
resource estimate: 0.6 FTE

Anton Koekemoer slide

The Value of Combining Data: Supermosaics







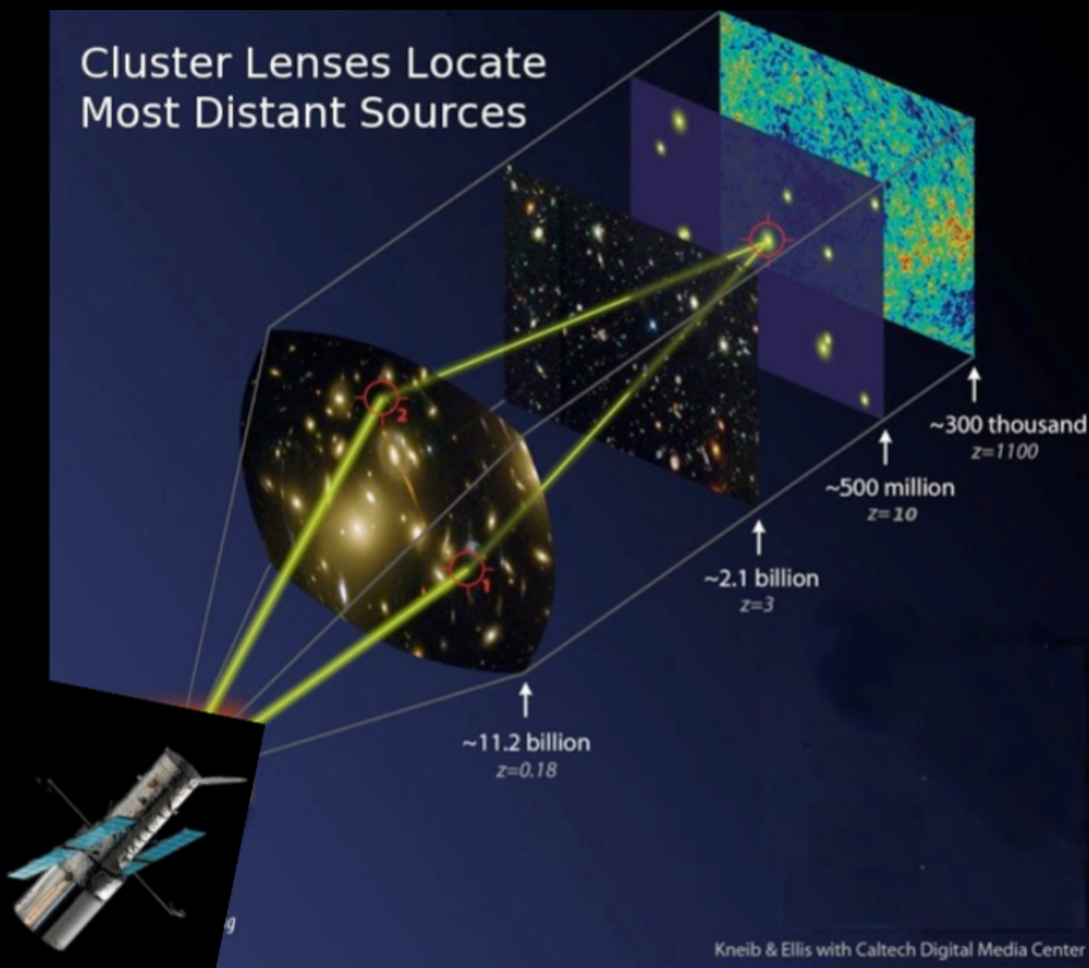
MACS J1149.5+2223: Instruments, filters, and exposure times (units of ks; total 1,009 ks)

Instr.	WFC3/UVIS							ACS									WFC3/IR					
Filter	225	275	336	350	390	606	814	435	475	555	606	625	775	814	850	105	110	125	140	160	164
Exp/ks	4	26	24	5	2	5	15	114	2	5	74	2	6	230	22	141	2	94	58	172	6

Anton Koekemoer slide

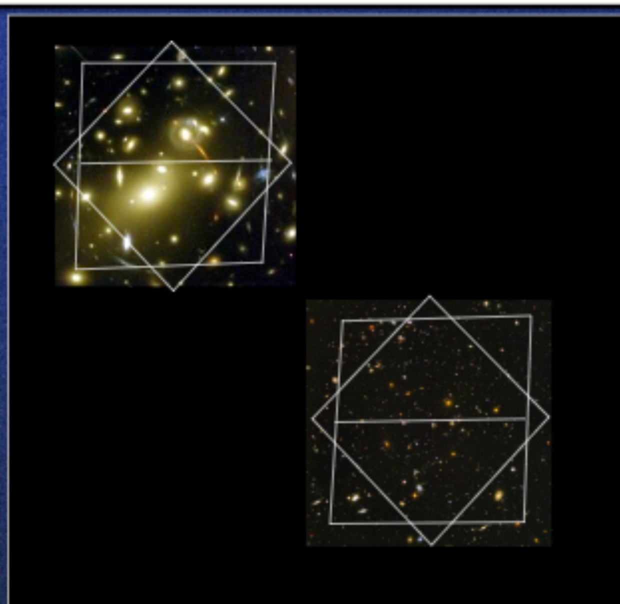
Hubble Frontier Fields

STUC first informed about Ultra Deep Fields Observing Initiative in April 2012



Hubble Frontier Fields

Hubble Deep Field Initiative (HDFI)



James Bullock (UC-Irvine) [Chair]
Mark Dickinson (NOAO)
Steven Finkelstein (UT Austin)
Adriano Fontana (INAF, Rome)
Ann Hornschemeier Cardiff (GSFC)
Jennifer Lotz (STScI)
Priya Natarajan (Yale)
Alexandra Pope (U. Mass)
Brant Robertson (Arizona)
Brian Siana (UC-Riverside)
Jason Tumlinson (STScI)
Michael Wood-Vasey (Pittsburgh)

The Committee was charged by the STScI Director to:

- Solicit input from the astronomical community in defining the science goals and recommendations.
- Define the science case and a set of science goals for a new set of ultra-deep imaging fields with sensitivity depths comparable to those of the HUDF and HUDF-09 infrared follow-up. Provide an assessment of the urgency of pursuing this science.
- Assess the prospects for near-field science that can be achieved with these deep-field observations.
- Recommend the number of fields, location, filters, and depths that should be obtained to meet the science goals.

STUC Nov. 2012 K. Sembach presentation

Hubble Frontier Fields

HDFI: Background and Process

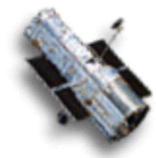
- STScI solicited community input (pro/con) on the idea of devoting time to a new deep field initiative ("Deep Fields Beyond the HUDF")
  - Responses were due August 31, 2012
- Committee reviewed and discussed 32 white papers submitted by the community
- Considered a broad set of topics
  - Deep blank fields
  - Fields lensed by foreground clusters
  - Grism observations
  - Deep fields in parallel with COS spectroscopy
  - Synergy with JWST and other observatories, E/PO, implementation strategies, etc…

The committee presented a unanimous recommendation to the Director.

STUC Nov. 2012 K. Sembach presentation

Hubble Frontier Fields

HDFI: Proposed Next Steps



Implementation

- Convene "HDFI Implementation Team"
- Final selection of clusters based on science priorities from panel and practical considerations
- Define the actual observing program, coordinate with other observatories (Spitzer in particular), create observing specification, and build long range scheduling plan

Community Engagement

- Announce initiative to the community if Matt approves
- Establish website for regular updates and reference
- Issue guidance on program so GOs can propose to supplement or analyze these data in C21.
- Engage lensing experts to support the broader community with high-quality, user-friendly lensing maps, and support their maintenance.
- Upcoming lensing workshop at STScI (April 2013).

STUC Nov. 2012 K. Sembach presentation

Hubble Frontier Fields

A Model for Community Science Planning and Implementation

<u>HDFI Science Working Group</u>
- review white papers; collect community input
- set science goals, strategy
- set obs. requirements (number of targets, depth, ..)
- science advisory group

<u>Astronomy Community</u>
- write white papers
- informal input to target selection, obs. plan
- related HST GO/archival/theory programs
- funded + unfunded lensing models
- ancillary programs (ALMA, Chandra, VLT, ...)
- review committees (STUC, TAC, mid-term)
- **analyze public data with public models; do science!**

<u>STScI Implementation Team</u>
- observational planning (target choice, detailed design, scheduling)
- data pipeline + calibration (multiple versions/releases; improved calibration)
- lensing model funding + coordination
- data & model releases
- cross-observatory coordination (Spitzer; Gemini)
- ancillary data clearinghouse
- communication with community (blog, email list, public talks, formal reviews)

Jennifer Lotz slide

Hubble Frontier Fields

Broader impacts for the community

- astrodrizzle/drizpac testing by HFF data pipeline team
- improved ACS bias striping algorithms
- developed ACS “self-calibration” of CTE effects in dark
- testing of WFC3/IR “blob” mask, sky flats
- WFC3/IR variable sky ramp fitting algorithm
- testing WFC3/IR bright sky avoidance observing strategy
- better scheduling buffers for severe WFC3/IR persistence events
- first set of theoretical models in MAST directly linked to HST data
- improved ACS astrometry solution
- new ACS sky flats; improved approach to ACS darks

+experience benefits wider cross section of archive (e.g. supermosaic initiative)
2 FTEs spread across 8-9 people

Jennifer Lotz slide