



The Frontier Fields and Beyond

a sneak peek at JWST's universe

Jennifer Lotz, STScI

with Matt Mountain and the Frontier Fields Team

STUC meeting May 2014

HST Frontier Fields Implementation Team

STScI Core Implementation Team

PI - Jennifer Lotz

CoPI - Matt Mountain

Implementation Technical Lead - Norman Grogin

Denise Taylor, Patricia Royle,
David Adler, Ian Jordan, Alan Welty,
Bill Workman

Science Data Products Lead - Anton Koekemoer

Jennifer Mack, Jay Anderson,
Sara Ogaz, Roberto Avila,
Derek Hammer, Andy Fruchter,
Elizabeth Barker, Massimo Robberto,
Bryan Hilbert, Ray Lucas, Josh Sokol

Lensing Map Coordinator - Dan Coe

Anton Koekemoer, Elizabeth Barker,
Karen Levay, Scott Flemming

Web/Blog Master - Elizabeth Barker

Instrument Team Liasons -

John MacKenty, Norman Grogin, Linda Smith,
Janice Lee->Gabe Brammer

STScI Science Advisors:

Larry Bradley, Stefano Casertano
Harry Ferguson, Helmut Jenkner
Jason Tumlinson

External Science Advisors:

James Bullock, Mark Dickinson
Priyamvada Natarajan, Johan Richard
Adi Zitrin

Program Advisory Council:

Neill Reid, Ken Sembach, Bob Williams

OPO/Citizen Science team:

Carol Christian, Brandon Lawton, Alex Viana,
Tony Darnell, Hussein Jirdeh
Max Mutchler, Ray Villard, Donna Weaver

Spitzer Implementation Team:

Peter Capak, Jason Surace,
Lisa Stori-Lombardi

Admin Support - Ana-Maria Valenzulea



HST Frontier Fields: Goals

- ✦ enable awesome science (on a level playing field)
- ✦ engage the astronomy community in planning and follow-up
- ✦ engage the STScI staff
and use HFF as vehicle for improvement
- ✦ strengthen cross-observatory collaborations
- ✦ engage the broader community in astronomy,
HST and deep field science



Milestones Completed

Fall 2012: HDFI SWG presented a unanimous recommendation

Winter 2012: Frontier Fields announced in Cycle 21 call for proposals

All six clusters selected and announced

WFC3/IR F140W filter added to parallel field observations

Blank field positions announced

Spring 2013: ~35 Frontier Fields related proposal received for HST Cycle 21;
3 GO program and 7 archival/theory programs selected.

Public lensing map-makers selected through separate call

Summer 2013: **Phasells submitted for first 4 fields**

Data Pipeline testing: astrodrizzle, tweakreg, + self-calibration

Chandra GO programs awarded

Lensing maps delivered (8/30)



Milestones Completed

Fall 2013:

First Spitzer observations of Abell 2744 obtained 9/14/2013

Frontier Fields 'readiness review' 9/20/2013

Abell 2744 Lensing Map release by MAST/HLSP with interactive tool 10/16/2013

First HST Frontier Field observations - epoch 1 Abell 2744 10/25/2013

v0.5 data releases: 11/01; 11/08; 11/15; 11/22; 11/29

press release announcing Frontier Fields program 10/24/2013

Lensing Map release for all 6 clusters 11/27/2013

Winter 2014:

HST Epoch 1 Abell 2744 complete - 12/10/2013

v1.0 data release for Epoch 1 Abell 2744 - 12/16/2013

AAS poster session + press release - 1/7/2014

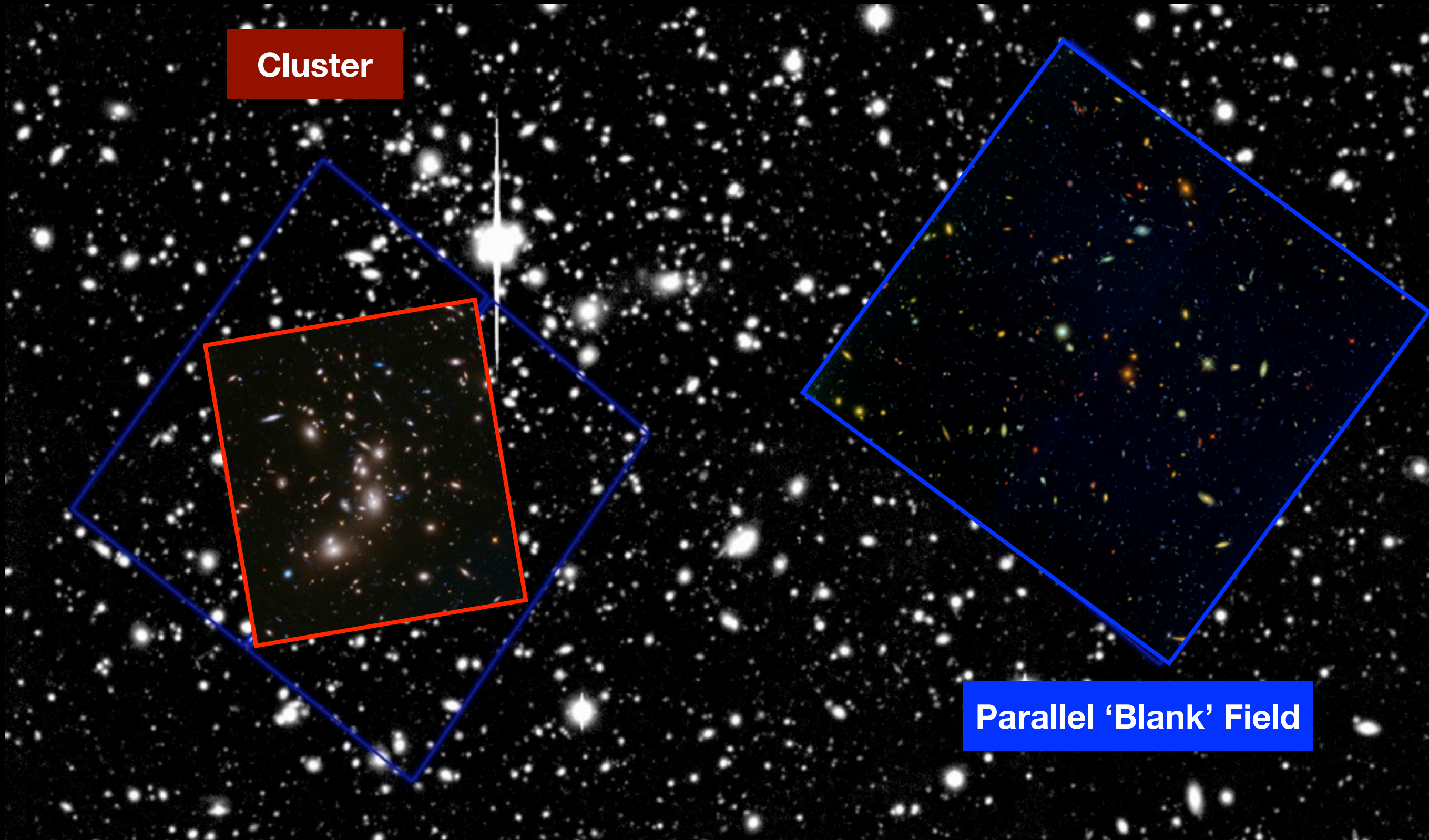
HST Epoch 1 MACSJ0416 begins - 1/4/2014

v0.5 data releases: 1/10; 1/17; 1/24; 1/31

v1.0 data release for HST Epoch 1 MACS0416 - 3/1/2014

Spitzer observations of Abell 2744 complete - 2/2014

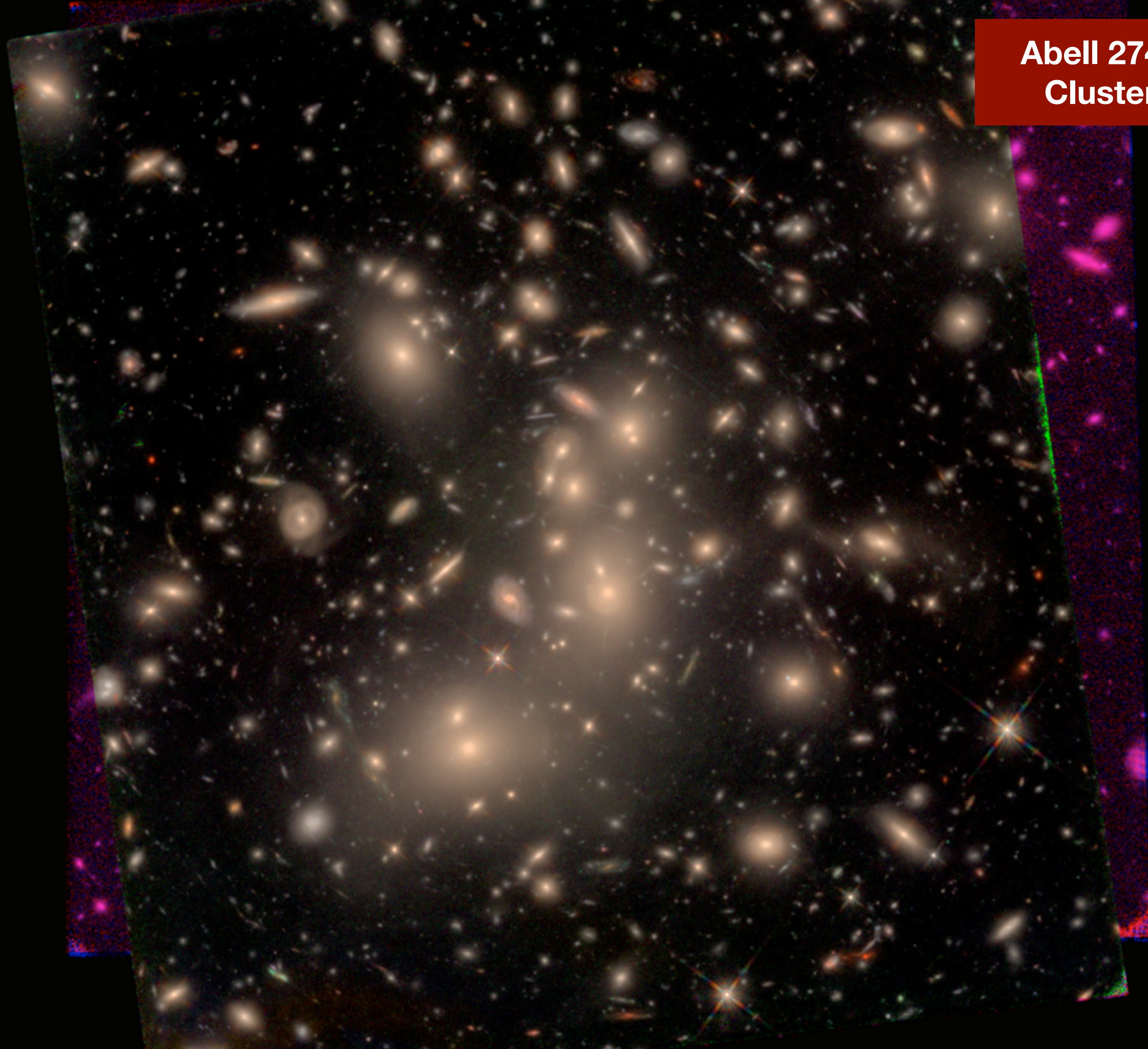
Abell 2744 - HST Epoch 1 completed Nov. 2013

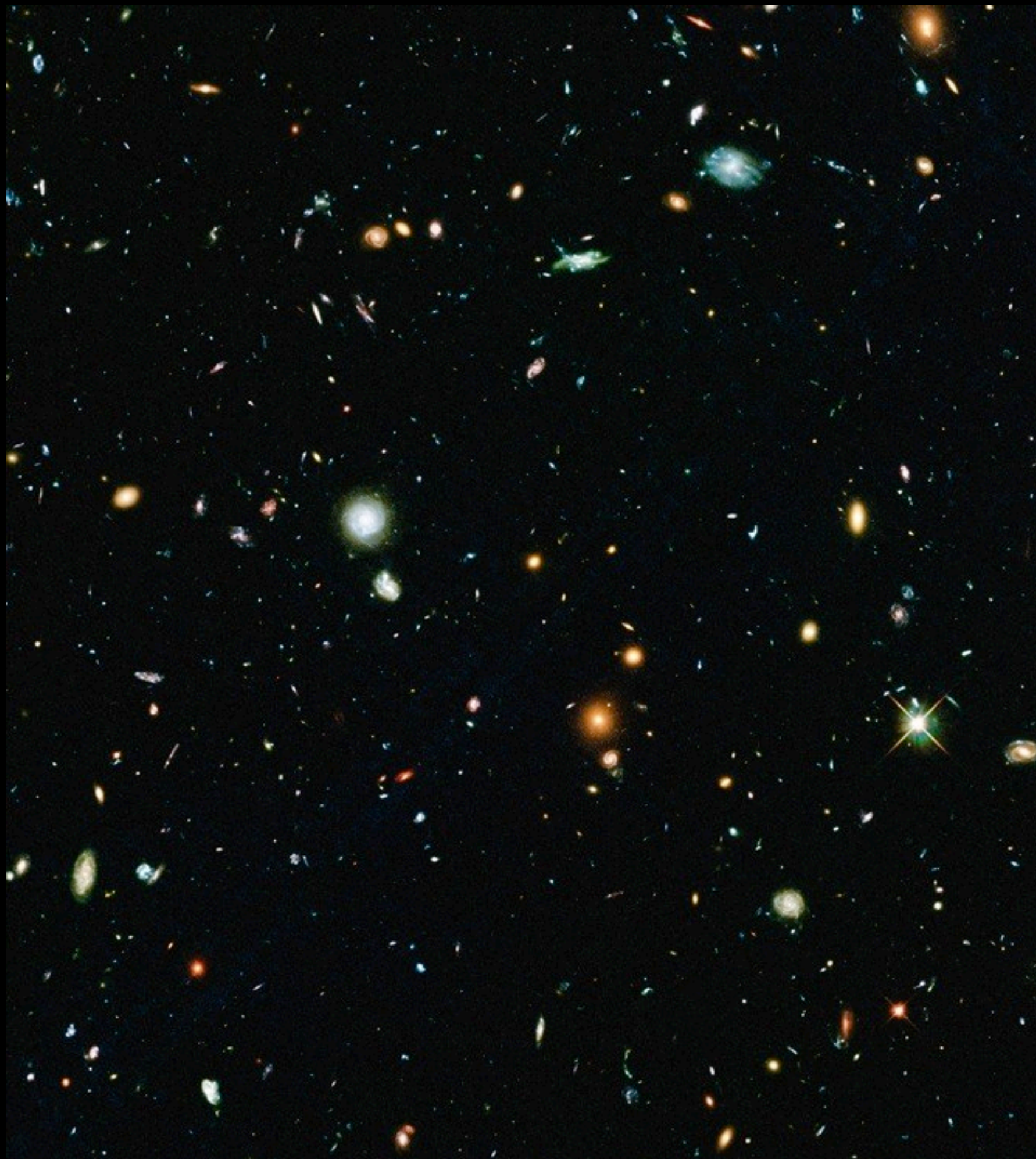


**Abell 2744
Cluster**



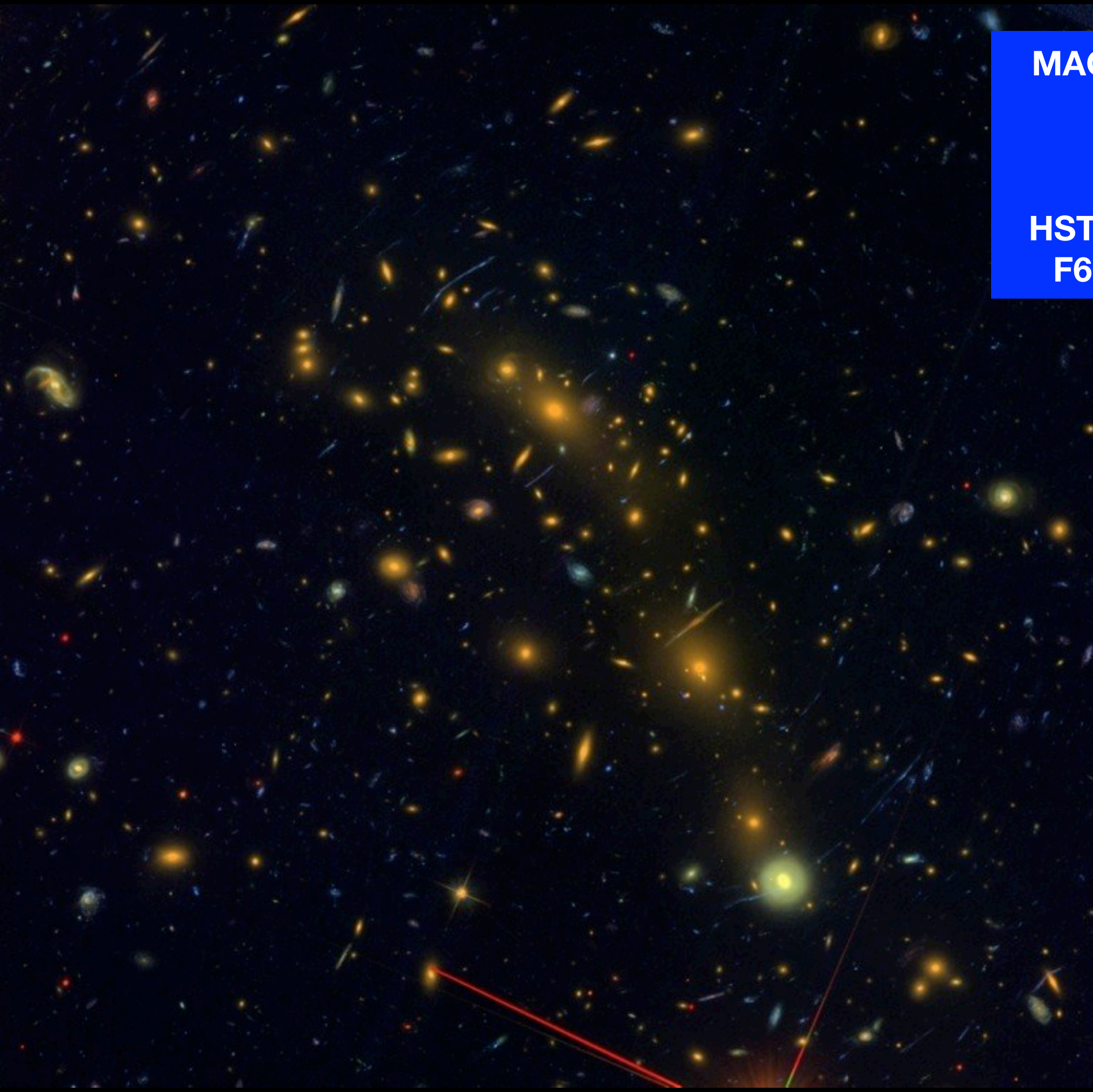
**Abell 2744
Cluster**





Abell 2744
Parallel 'Blank' Field
epoch 1

**HST ACS F435W/
F606W/F814W**



MACS0416+2403
Cluster
epoch 1

**HST ACS F435W/
F606W/F814W**

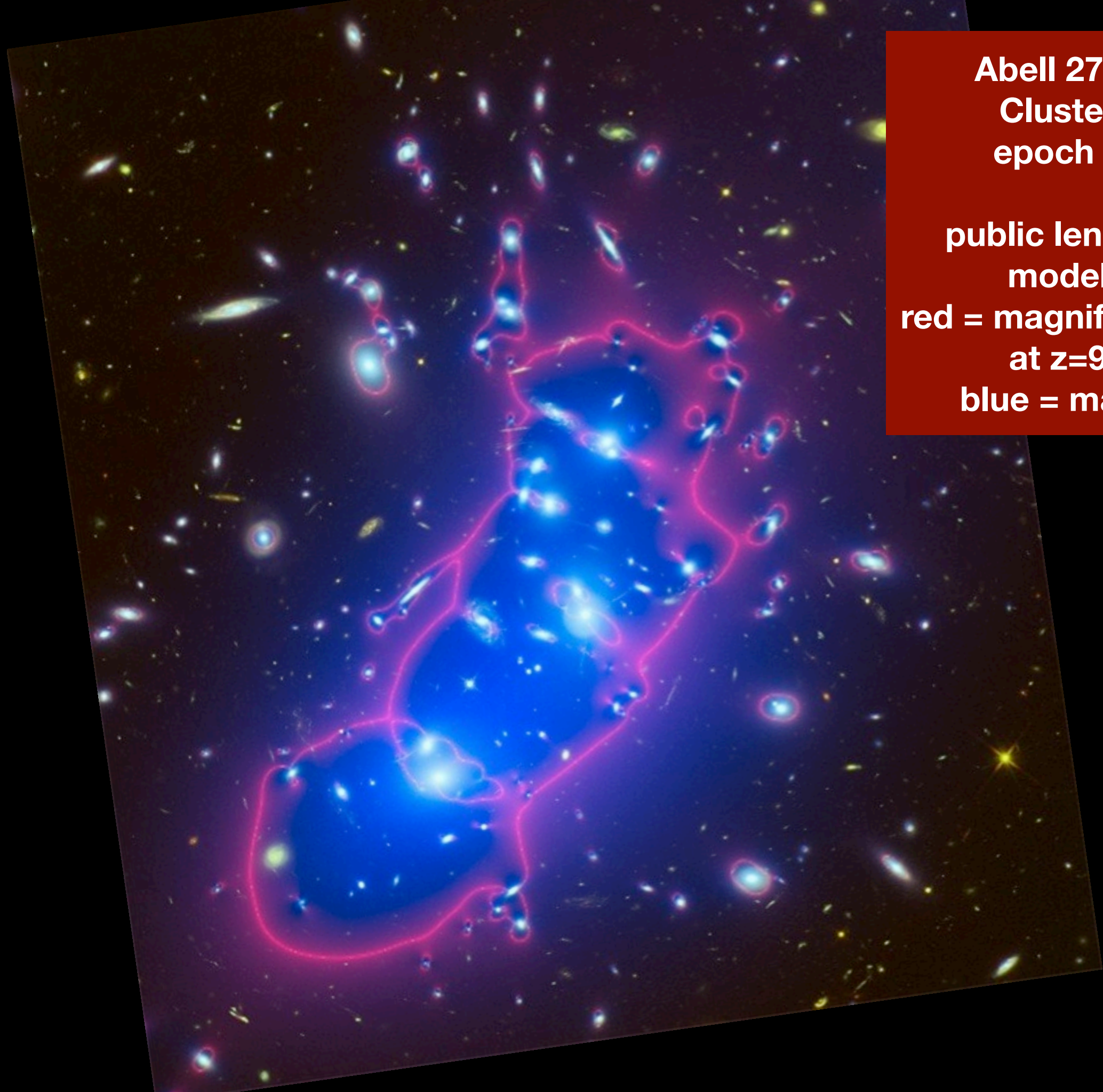


MACS0416+2403
Parallel “Blank” Field
epoch 1

HST WFC3/IR

**Abell 2744
Cluster
epoch 1**

**public lensing
model
red = magnification
at $z=9$
blue = mass**



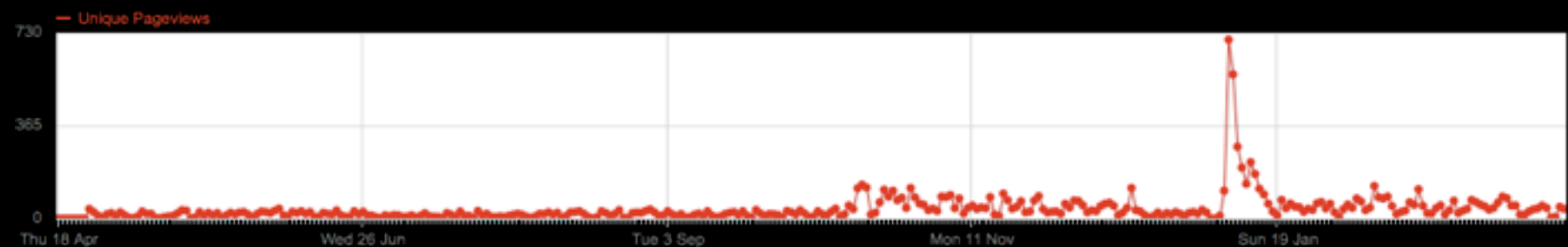
HST Frontier Fields: Goals

✦ enable awesome science (on a level playing field)

HST FF data downloaded from >600 IPs (total)

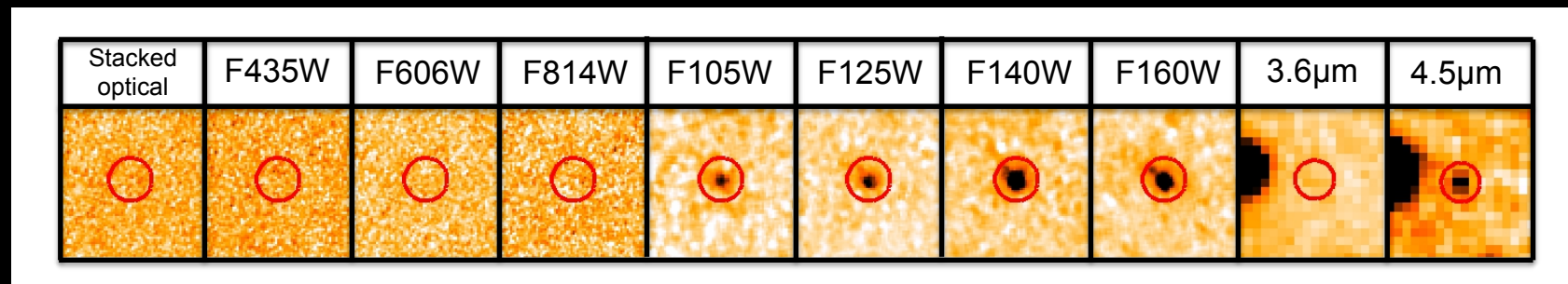
HST Lensing Model data downloaded from >200 IPs (total)
interactive lensing tool used >400 times

HST Frontier Field website visited by >585 visitors

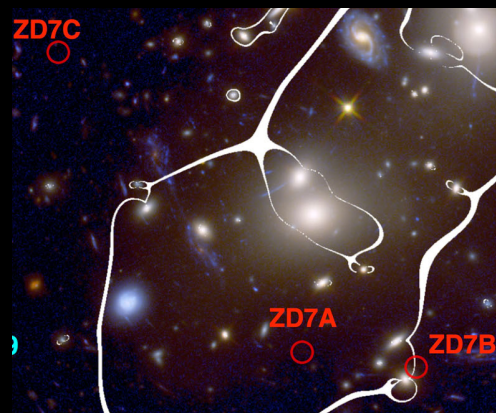
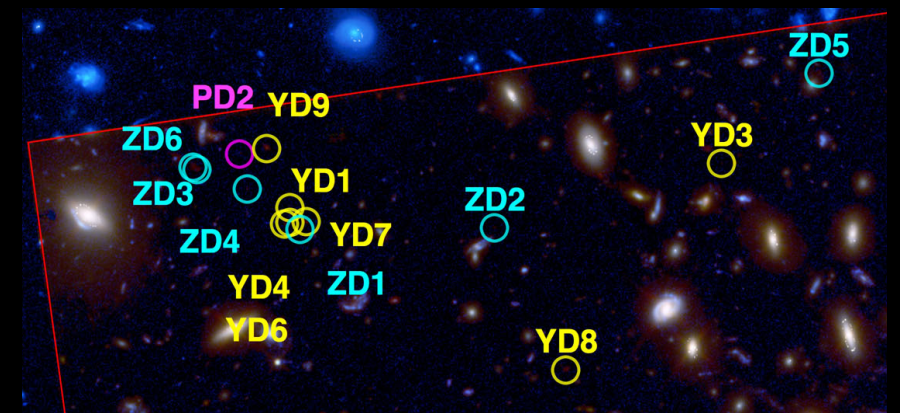


early days for science..

Early science (Abell 2744)



- $z \sim 8.2$ galaxy with strong $4.5 \mu\text{m}$ emission (rest-frame [OIII], $\text{H}\beta$)
- Laporte et al. 2014 (accepted).
- cluster of $z \sim 7-8$ galaxies?
- Atek et al. 2014, Zheng et al. 2014 (submitted)



- triply imaged $z \sim 7.5$ galaxy
- Zheng et al. 2014 (submitted)

- no $z > 9$ candidates? \Rightarrow sharp decline in cosmic SF ?
- Atek et al. 2014, Zheng et al. 2014 (submitted)



HST Frontier Fields: Goals

- ✦ engage the astronomy community in planning and follow-up

~35 Frontier Fields related proposal received for HST Cycle 21;
3 GO program and 7 archival/theory programs selected.

approved large Chandra, VLA programs;
VLT Hawk-I program K-band program; DEIMOS/Keck program,
multiple ALMA proposals; others??

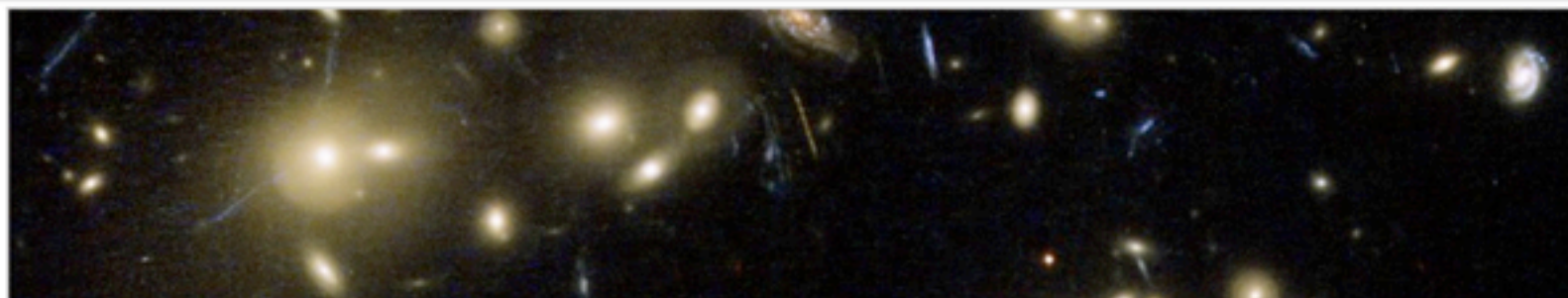
unprecedented coordination of 5 lensing groups for public maps;
work is continuing as they analyze simulated FF clusters

HST Cycle 22 response?

more ground-based spectroscopy needed?

updates to lensing maps with FF data?

Hubble Space Telescope Frontier Fields



[Home](#)
[HST Survey](#)
[FF Data](#)
[Lensing Models](#)
[EPO](#)
[Astronomer's Blog](#)
[Publications](#)
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This page is a clearing-house site for links to other public data on the Frontier Fields. If you have data you wish to share, please email frontierfields@stsci.edu. Please credit these data products appropriately -- see the links below.

Data Product	Abell 2744	MACS0416	MACS0717	MACS1149	Abell S1063	Abell 370
Hubble Frontier Fields J. Lotz, PI; M. Mountain, Co-PI ACS B, V, I; WFC3/IR Y, J, J+H, H	Images Models	Images Models	Images Models	Images Models	Images Models	Images Models
Spitzer Frontier Fields PI T. Soifer, P. Capak IRAC 3.6, 4.5 microns	Images	Images	Images	Images	Images	Images
Chandra Frontier Fields archival , C. Jones-Forman S. Murray (enter RA/Dec for Chandra archive search)	Images	Images	Images	Images	Images	Images
Subaru / Suprimecam CLASH team B, V, Rc, I, z	--	Images Catalogs	Images Catalogs	Images Catalogs	--	--
VLT / Hawk-I PI Marchesini, Brammer K	Viewer		--	--	--	--
Gemini / GeMS PI Carrasco, Levenson K		Raw Data enter Sci Prog: GS-2013B-DD-1	--	--	--	--
Spec. Redshifts (lensed galaxies for public lensing maps only)	Catalog Owers M., et al.	Catalog	Catalog	Catalog	Catalog	Catalog
Photometric Redshifts CLASH team	--	Catalog	Catalog	Catalog	Catalog	--



HST Frontier Fields: Goals

- ✦ engage the STScI staff
and use HFF as vehicle for improvement

MAST: first theory models directly associated with HST data

astrodrizzle/tweakreg pipeline testing, scripts

ACS: calibration, bias destriping, self-cal, geometric distortion

WFC3: calibration (flats), variable sky, blobs,
persistence checking

scheduling: WFC3 scanned grism persistence time buffer

HST Frontier Fields: Goals

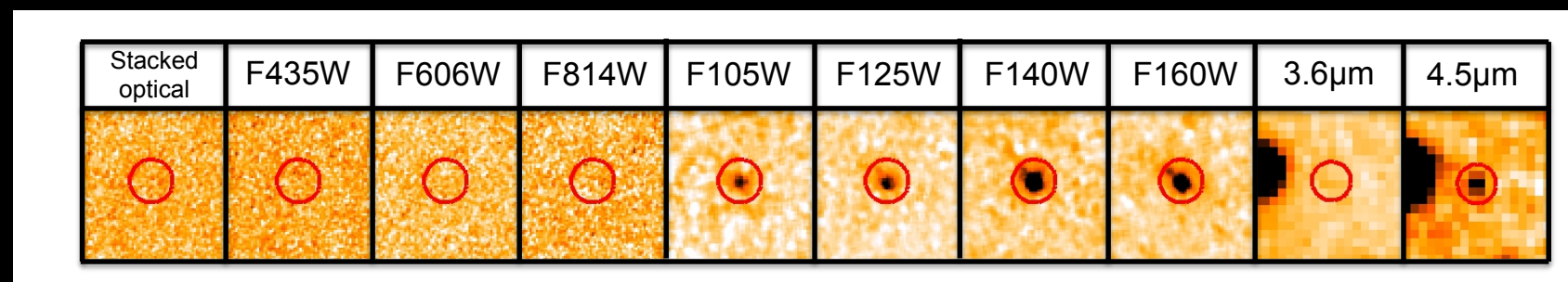
✦ strengthen cross-observatory collaborations

several joint Spitzer-HST press releases;

Gemini Observatory DD time for GEMS K-band
Abell 2744, MACS0416

-- discussion for more investment?

XMM? ALMA?



HST Frontier Fields: Goals

- ✦ engage the broader community in astronomy, HST and deep field science

JANUARY 8, 2014

The Washington Post

EZ RE

POLITICS & THE NATION

Capturing the cosmic dawn

Hubble and other telescopes find small, scattered galaxies with super-luminous blue stars

BY JOEL ACHENBACH

Two venerable space telescopes, the Hubble and the Spitzer, have teamed to study the very early universe, and here's what they see at the cosmic dawn: a wild and woolly party, with brilliant blue stars that aren't ready to settle down into anything so structured as a conventional spiral galaxy.

Instead, the early years of the universe featured a profusion of small, irregular, blobby galaxies that were popping with big, hot, super-luminous stars forming at a furious rate. Galaxies were colliding all over the place.

Ray Villard, a spokesman for the Space Telescope Science Institute, which conducts Hubble research for NASA, said it's like seeing the finale of a fireworks show, just that it's close to the beginning of time.

The new results and images of the early cosmos were released

Frontier Fields: Pushing the Limits of the Hubble Space Teles...

Frontier Fields

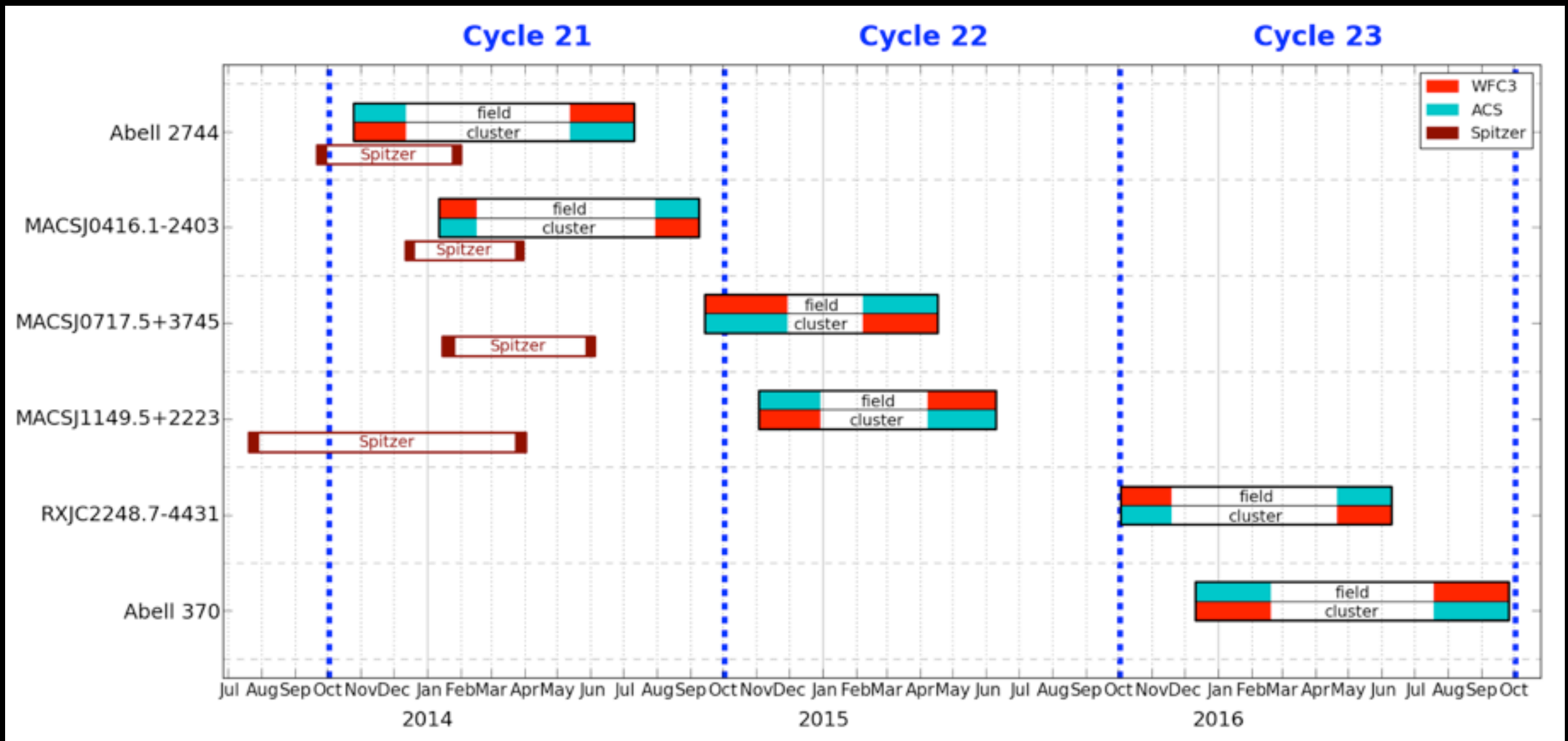
Pushing the limits of the Hubble Space Tel

Frontier Fields

285 likes · 406 talking about this

✓ Liked ✓ Following

the immediate future of the Frontier Fields



first two HST Frontier Fields complete August 2014
Spitzer Frontier Fields DD observations Sept 2013-June 2014
decision on HST Cycle 23 observations expected in Dec. 2014



Upcoming Milestones

- March 2014: HST Cycle 22 proposal deadline
- May 2014: Abell 2744 Epoch 2 observations start
- July 2014: Abell 2744 HST observations complete
full data release for Abell 2744 (v1.0 epoch 2; v2.0 for epoch 1)
- August 2014: Spitzer observations of 1st 4 clusters complete
- September 2014: MACSJ0416 HST observations complete
MACS0717 HST epoch 1 observations begin
full data release for MACS0416 (v1.0 epoch 2, v2.0 for epoch 1)
- November 2014: External committee to decide Year 3 convenes
MACS1149 HST epoch 1 observations begin
- December 2014: v1.0 data release for MACS0717 HST epoch 1
- January 2015: HST Cycle 23 call for proposals released
Winter AAS meeting
v1.0 data release for MACS1149 HST epoch 1



Upcoming Milestones

Spring 2014: contact external review committee members

Summer 2014: HST data pipeline script releases:
WFC3/IR time-variable sky

ACS self-calibration

Frontier Fields Survey Paper submitted

Frontier Fields HST Data Pipeline Paper submitted;
scripts/cookbook released.

Fall 2014: press release announcing complete data for 1st clusters?
convene external review (October/November)

HST Frontier Fields - Year 3?

external review in October/November 2014 (committee TBD)

Criteria for year 3 observations -

✦ *Are we making significant progress toward primary science goals?*

(1) probe galaxies $>10\times$ intrinsically fainter than any seen before, particularly those before and during reionization

(2) study the early formation histories of galaxies intrinsically faint enough to be the early progenitors of the Milky Way

(3) study highly-magnified high- z galaxies in detail: structures, colors, sizes and provide targets for spectroscopic followup

(4) provide a statistical picture of galaxy formation at early times

HST Frontier Fields - Year 3?

external review in October/November 2014 (committee TBD)

Criteria for year 3 observations -

- ✦ *Are we making significant progress toward primary science goals?*
- ✦ *Are the community science needs being met? (data releases, lensing maps, funding support ..)*
- ✦ *Ancillary science impacts (lensing models, cluster science ..)*
- ✦ *Synergistic activities (E/PO; improved data techniques; Spitzer)*



HST Frontier Fields: Goals

- ◆ **enable awesome science (on a level playing field)**
 - ⇒ continue to release HST data products in timely manner
 - ⇒ update lensing models
 - ⇒ publish survey + HST data pipeline papers
 - ⇒ fund FF science via HST archival proposals
- ◆ **engage the astronomy community in planning and follow-up**
 - ⇒ maintain + improve data clearing house page
 - ⇒ coordinate/support HST GO Cycle 21/22 FF programs (Treu, Siana, Rodney, ??)
- ◆ **engage the STScI staff and use HFF as vehicle for improvement**
 - ⇒ propagate HFF data pipeline efforts to HST system
 - ⇒ release HFF pipeline software & scripts
- ◆ **strengthen cross-observatory collaborations**
 - ⇒ continue to coordinate with Spitzer, especially on last 2 clusters
 - ⇒ talk to Gemini, ALMA, XMM
- ◆ **engage the broader community in astronomy, HST and deep field science**
 - ⇒ additional press releases as survey develops; encourage community releases
 - ⇒ Citizen Science project?