Hubble Space Telescope Frontier Fields MidTerm Review

*Membership:

James Bullock (UC-Irvine) [Chair] ,

Mark Dickinson (NOAO),

Richard Ellis (Caltech),

Mariska Kriek (UC-Berkeley),

Sally Oey (U. Michigan),

Stella Seitz (Munich U. Obs),

S. Adam Stanford (UC-Davis),

Jason Tumlinson (STScI)

* My view of where we stand: what follows was not yet read by the committee, but I've done my best to provide a sense of our current consensus. Not yet final recommendation, want to make sure we've had time to reflect/consult.

FF program
(J. Lotz et al.)

6 strong-lensing clusters

+ **6** adjacent parallel fields

140 HST DD orbits per pointing

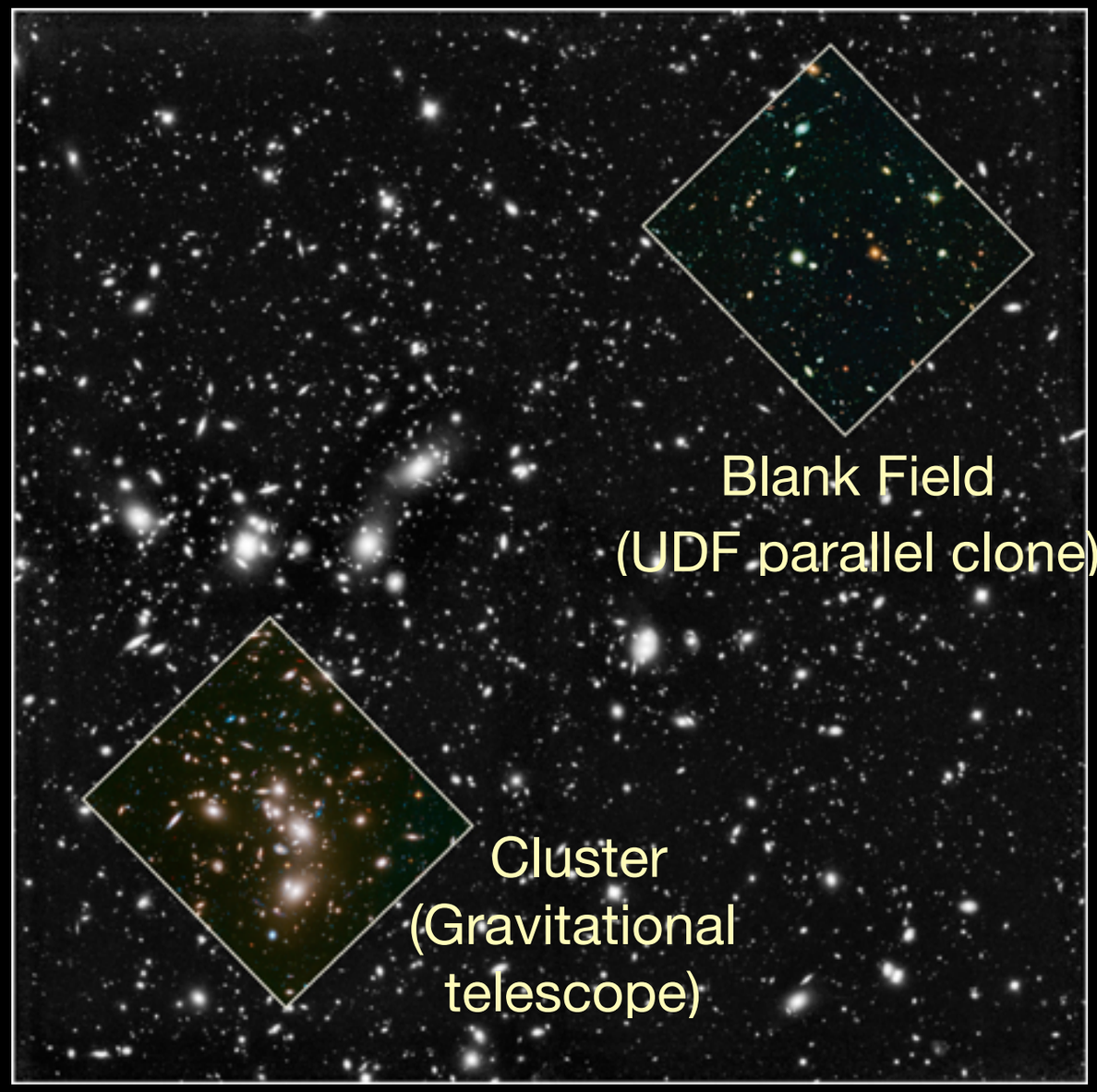
2 clusters per year x 3 years

→ **840** total orbits

ACS/ WFC3-IR in parallel

~**29th** ABmag in **7** bands

Brammer, VLT/Hawk-I K

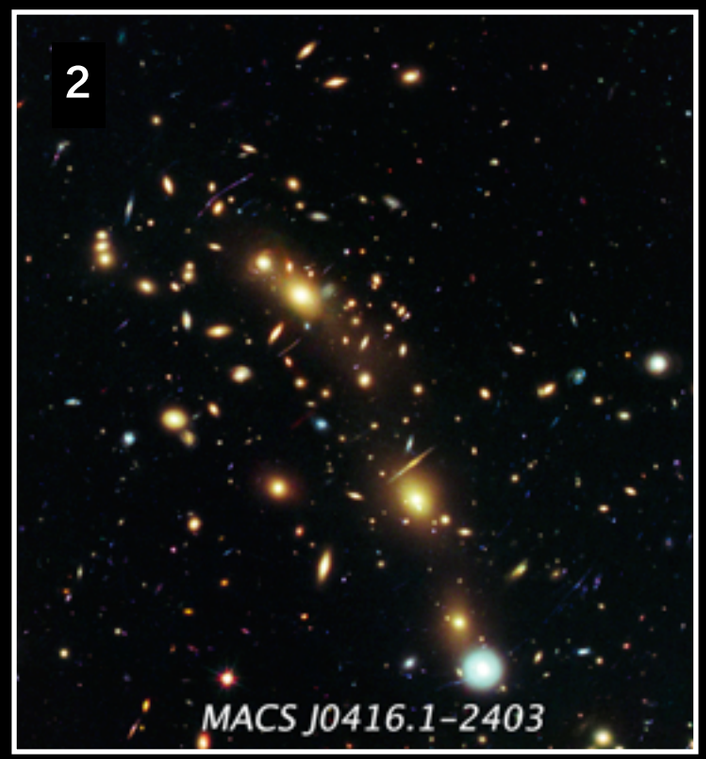


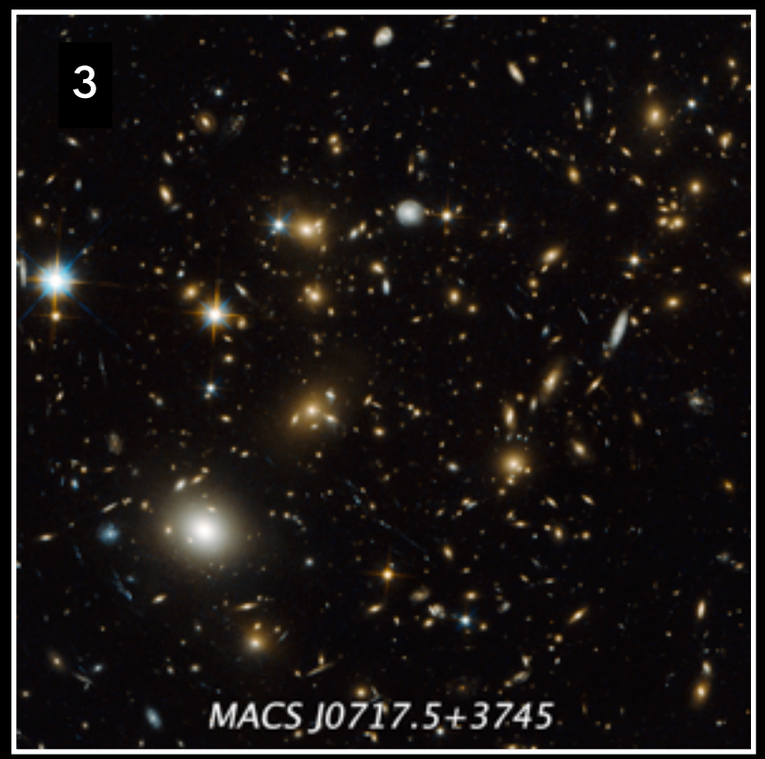
1000 hours Spitzer DD time for

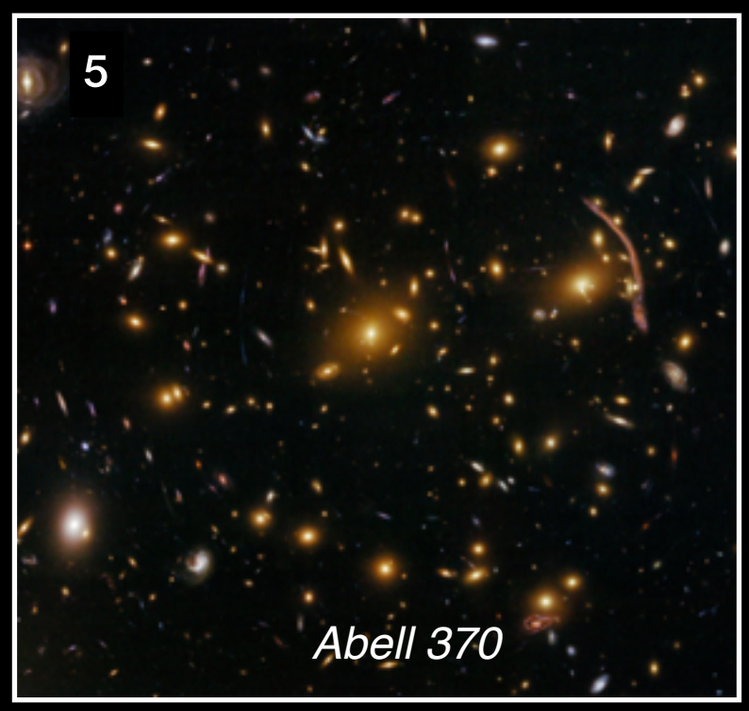
~**26.5** ABmag in IRAC 3.6, 4.5 μm

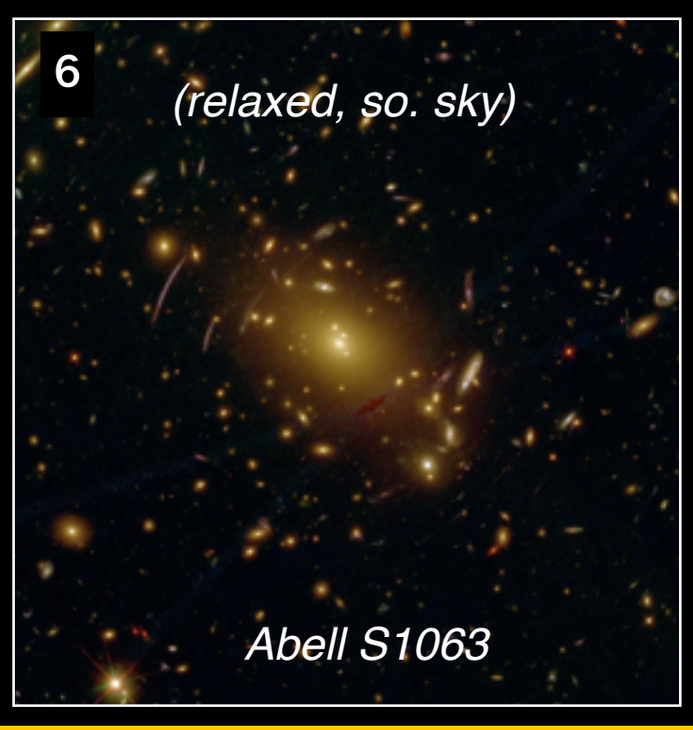
http://www.stsci.edu/hst/campaigns/frontier-fields/

The Frontier Fields

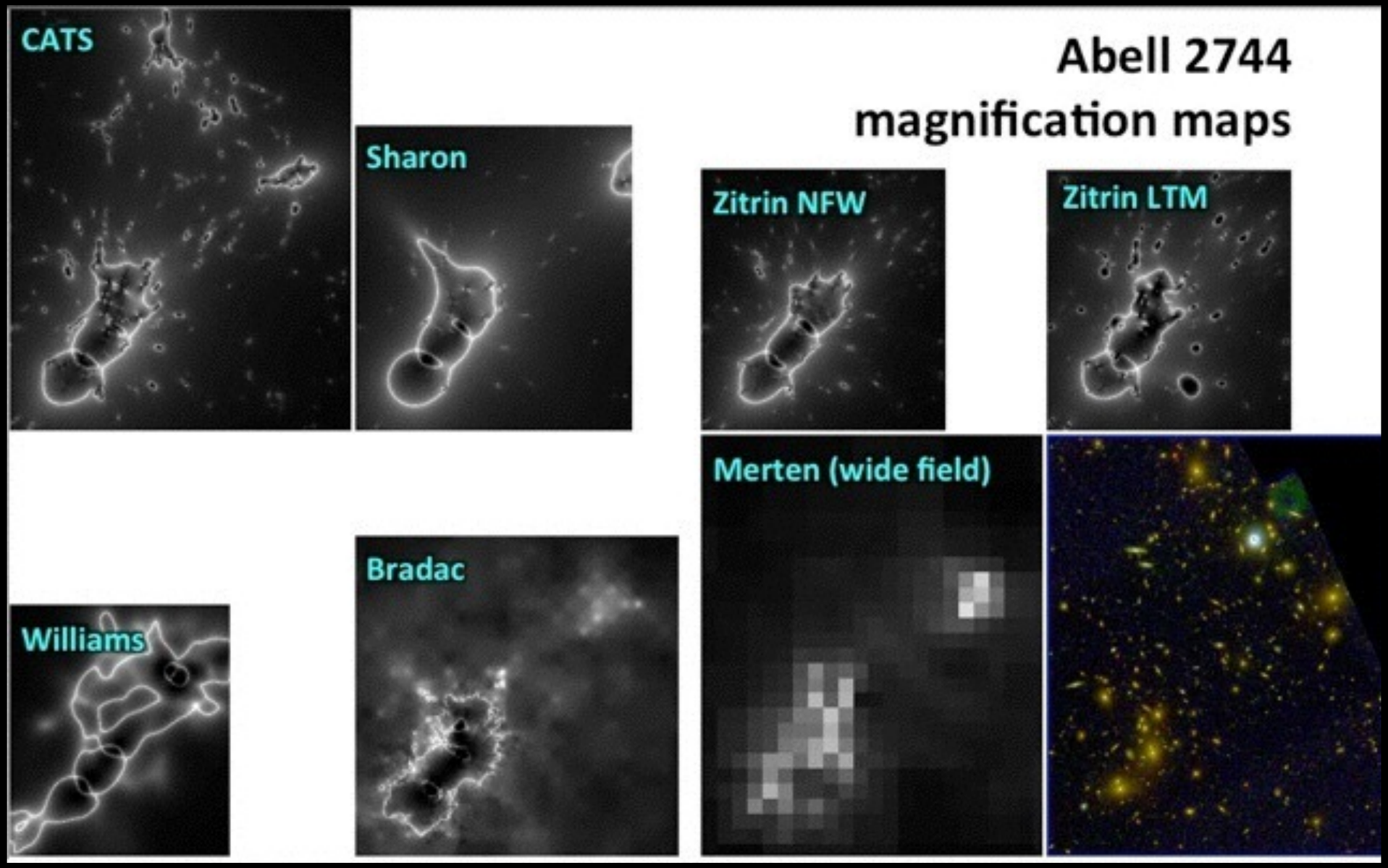








chosen based on known lensing strength, sky location, ancillary data

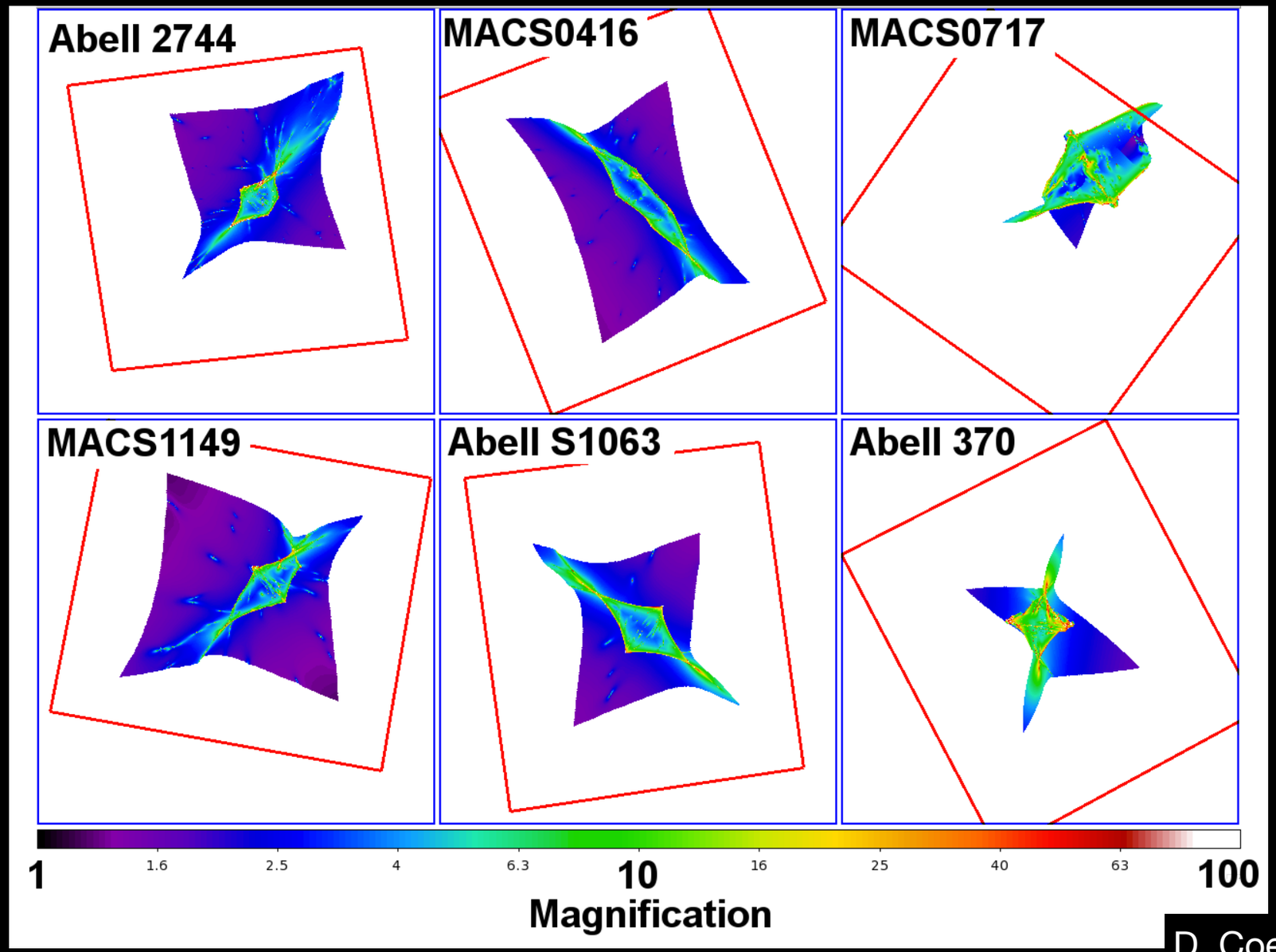


5 groups funded to make magnification maps for FF before 1st observations

(100s of arcs expected in FF data ⇒ tighter constraints on lensing models)

http://archive.stsci.edu/prepds/frontier/lensmodels/

why 6 clusters + parallel fields?



D. Coe et al, 2014

high-redshift volumes probed by strong lensing is small

Science Goals: High-z

- probe galaxies 10-50x intrinsically fainter than any seen before, particularly those before and during reionization
- study the early formation histories of galaxies intrinsically faint enough to be the early progenitors of the Milky Way
- study highly-magnified high-z galaxies in detail: structures, colors, sizes and provide targets for spectroscopic followup
- provide a statistical picture of galaxy formation at early times

Science Goals: Lower-z

- deep and high-spatial resolution studies of z~1-4 galaxies, (UV escape fraction, sub-kpc structures and star-formation)
- map out dark matter and substructure in clusters
- study cluster galaxies, dwarfs, intracluster light in clusters
- search for (lensed) SN, transients in distant universe

…

Early science - year 1

- ADS - 41 articles (39 refereed) with "Frontier Field" in abstract since 2012 (> 50% use FF data or lensing maps)

- HST - 14 funded Cycle 21, 22 programs with "Frontier Fields" in abstract (3 GO - Treu, Siana, Rodney)

- Chandra, ALMA, VLA, VLT Hawk-I, MUSE, Gemini GEMS AO, Keck ancillary observing campaigns underway

- 3 Frontier Fields workshops planned for 2014-2015

  Yale Frontier Fields Workshop, Nov 2014

  Sesto, Italy, Feb 2015 " Science from the Frontier Fields"

  IAU Focus Meeting, August 2015 "The Frontier Fields: Transforming our Understanding of Cluster and Galaxy Evolution"

Our Charge

- Is Frontier Fields program is addressing scientific goals outlined by Hubble Deep Fields Working Group?

- Are Frontier Fields data of a quality sufficient to advance deep field science?

- Has STScI been a responsible steward of the Frontier Fields program

- Should remaining two Frontier Fields observations be done (280 orbits total)?

- Can you recommend improvements that will maximize the science return?

Our Charge

- Is Frontier Fields program is addressing scientific goals outlined by Hubble Deep Fields Working Group?

  Yes - as well as can be determined at this early stage

- Are Frontier Fields data of a quality sufficient to advance deep field science?

  Yes

- Has STScI been a responsible steward of the Frontier Fields program

  Yes (!)

- Should remaining two Frontier Fields observations be done (280 orbits total)?

  - Initial poll of committee: **unanimous "Yes"**

- Can you recommend improvements that will maximize the science return?

  - Ongoing coordinated lens map efforts

Oct 14-15

Presentations by:		
	Jennifer Lotz	Frontier Fields overview
	Anton Koekemoer	HST Data Releases & Pipeline
	Dan Coe	FF Public Lensing Models
	Tommaso Treu	GLASS
	Steve Rodney	Supernovae in the Frontier Fields
	Steve Finkelstein	Blank Fields, high-z sources
	Rachael Livermore	Cluster Fields, high-z sources
	Brian Siana	UV imaging of Frontier Fields
	Adi Zitrin	High-redshift galaxies/ Lens models
	Marusa Bradac	Lens models/Spitzer results
	Peter Capac	Spitzer FF Data

Prior to the meeting we solicited feedback from:

- Rychard Bouwens, Tom Broadhurst, Yohan Richard, Brant Robertson, Rogier Windhorst

Overall Impression of *Committee

Still too early to know ultimate impact of FF, but…

Execution has been impressive.
J. Lotz et al. doing GREAT job; big team, hard problem
- Excellent calibration/distribution of data

A lot of excitement in the community
FF off to a quick start; lensing effort v. well received

High-z detections roughly as expected (no bad surprises)
- cluster fields more complex than blank but we knew this going in

Refereed publications in STScI Librarian's Database

Program	Age [yr]	N_papers	h	Papers/year
CANDELS	4	158	34	40
HFF	1	37	8	37
UDF09 Illingworth	5	91	43	18
CLASH	4	45	19	11
UDF12 Ellis	2	20	13	10
PHAT	4	28	8	7

➡Quick start. No red flags here.

Why continue?

- Original charge made a good case for 6 clusters + 6 blank fields. Nothing indicates reasoning was flawed.

  - Lensing volumes are SMALL. Cosmic Variance BIG.

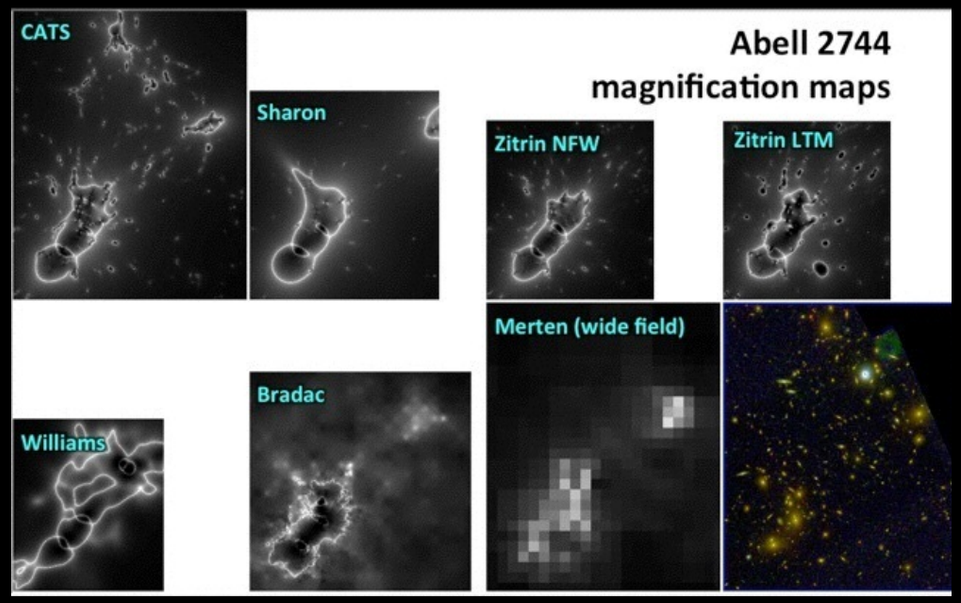
- We are “rolling the dice” from lens to lens. Two more rolls

- Continue to open up new legacy fields in the sky for follow-up; fields for JWST depth

- Momentum built. People are preparing for these clusters. Need to get it done.

Our Charge

- Can you recommend improvements to existing program that will maximize science return?



Lens maps:

- impressive start
- concerns linger
- problems can be overcome

The good:

- Various maps yield consistent “global” results for high-z populations: LF’s, ionizing photons, etc.
- Many people using maps, even outside HST (e.g. ALMA)

The bad:

- Maps don’t agree in detail; matters for individual galaxies
  - Need to figure out why groups don’t agree
  - Need coordinated tests against simulations
- As constraints/maps get better, playing field no longer level

Suggestions to maximize science return?

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Update / improve lens maps

Suggestions to maximize science return?

- Calls for coordinated lens models should be ongoing.
  - Need re-level playing field for non-lensers
  - New maps for first 2 FF clusters should happen soon
    - Include updated redshifts, ancillary constraints

- Promote more urgent simulation comparisons
    - could ask groups to provide maps of a simulation mock to illustrate accuracy as part of same call
    - could consider sponsoring a workshop

- Details of the call should be worked out in consultation with experts. Upcoming Yale workshop great opportunity.

What else to maximize science return?

ICL maps in clusters would be useful
- aid in understanding high-z sources

ultimately would be nice to have vetted "standard" galaxy catalogs (spitzer + HST)

Might consider using upcoming workshops to issue a "Call to Arms" to the community:

- Give us ICL maps & catalogs and we will act as a storehouse
- We will help you coordinate some community activity here

Summary

- Is Frontier Fields program is addressing scientific goals outlined by Hubble Deep Fields Working Group?

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  Yes

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