ASTRODEEP

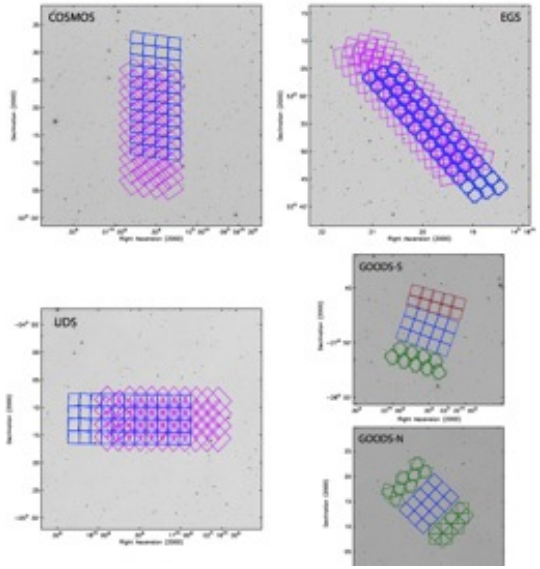
Unveiling the power of the deepest images of the Universe



CATALOGS
(WP4)

2 Analyze all data from public surveys in a coherent and well characterized way

This is a "production" WP.
Goal: to deliver high quality multi-wavelength catalogues extracted from our space and ground-based data.
These catalogues will be prepared using the algorithms developed in WP3.
We will also compute ancillary information like photometric redshifts, stellar masses, SFRs for all galaxies in the samples.



Most of the data have already been obtain in recent years
They are the result of a miscellanea of programs from several groups
All the data are public
The ASTRODEEP leaders (including US team) are involved in all these surveys -> we have direct access to data and analysis tools

Revised plan for data analysis

		GOODS North	EGS CANDELS	UDS	UDS CANDELS	COSMOS	COSMOS CANDELS	GOODS South	HUDFs	Frontier Fields
	Area Wave.	150'^{2}	150'^{2}	1^{o2}	150'^{2}	1^{o2}	150'^{2}	150'^{2}	15'^{2}	
ALMA	1.3 mm								0.15mJy	
HERSCHEL	500μm	9 mJy	12.8 mJy	13.4 mJy	13.4 mJy	9.5 mJy	9.5 mJy	9 mJy	9 mJy	
	350μm	7.2 mJy	8.9 mJy	9.3 mJy	9.3 mJy	6.6 mJy	6.6 mJy	7.2 mJy	7.2 mJy	
	250μm	5.7 mJy	10.7 mJy	11.2 mJy	11.2 mJy	8.0 mJy	8.0 mJy	5.7 mJy	5.7 mJy	
	160μm	2.7 mJy				11 mJy	11 mJy	2.4 mJy	2.4 mJy	
	100μm	1.1 mJy	3.7 mJy	4.0 mJy	4.0 mJy	5 mJy	5 mJy	0.8 mJy	0.8 mJy	
	70 μm							1.0 mJy	1.0 mJy	
Spitzer	70 μm	2.4 mJy	3.5 mJy	18 mJy	18 mJy	10 mJy	10 mJy	3.1 mJy	3.1 mJy	
	24 μm	21 mJy	50 mJy	230 mJy	230 mJy	60 mJy	60 mJy	20 mJy	20 mJy	
	16 μm	32 mJy						52 mJy	52 mJy	
	8 μm	1.7 mJy	4.8 mJy	10.2 mJy	10.2 mJy	17.3 mJy	17.3 mJy	1.7 mJy	1.7 mJy	
	5.8 μm	1.4 mJy	3.9 mJy	8.3 mJy	8.3 mJy	13.4 mJy	13.4 mJy	1.4 mJy	1.4 mJy	
	4.5 μm	0.2 mJy	0.6 mJy	1.2 mJy	1.2 mJy	2.0 mJy	2.0 mJy	0.2 mJy	0.2 mJy	26mag
	3.6 μm	0.1 mJy	0.3 mJy	0.6 mJy	0.6 mJy	1.1 mJy	1.1 mJy	0.1 mJy	0.1 mJy	26.6 mag
VLT/VISTA/ UKIDSS	2μm(K)	25.6	23.8	25.0	26.0	25.0	26.0	26.8	27.2	
HST-WFC3	1.6	27.8	26.7	---	26.7	---	26.7	27.8	29.9	
	1.4 (JW)								29.9	28.8
	1.2 μm(J)	27.8	26.7	---	26.7	---	26.7	27.8	29.9	28.8
	1 μm(Y)	28.0	---	---	---	---	---	28.0	30.0	28.8
VLT/VISTA	1μm(Y)	---	---	24.6	26.5	26.7	26.7	26.7	26.7	
HST-ACS	0.85μm(	27.6	---	---	---	---	---	27.6	29.4	28.8
	0.75	28.7	27.8	---	27.8	27.2	27.8	28.7	29.9	
	0.6	28.2	27.9	---	27.9	27.2	27.9	28.2	30.1	28.9
	0.45μm(B)	28.2	---	---	---	---	---	28.2	29.7	28.9
CFHT/VLT LBT	0.36μm(U)	28.2	27.0	27.5	27.5	27.7	27.7	28.0	28.0	
XMM	2-10 keV	1.5×10^{-15}	---	3×10^{-15}	3×10^{-15}	3×10^{-15}	3×10^{-15}	4×10^{-16}	4×10^{-16}	
XMM	5-10 keV	4×10^{-15}	---	1×10^{-14}	1×10^{-14}	1×10^{-14}	1×10^{-14}	7×10^{-16}	7×10^{-16}	
Chandra	0.5-2 keV	2×10^{-17}	5×10^{-17} erg cm^2 s^{-1}	---	---	2×10^{-16}	2×10^{-16}	1×10^{-17}	1×10^{-17}	

Revised plan for data analysis: a global plan to the end of the project

Where are we today?

Priority #1: Frontier Fields 1/2	(nearly) done
Priority #2: GOODS-S	in progress
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The HST Frontier Fields

New HST public survey
DDT extremely deep field program

HST and Spitzer multi-epoch (3 years) observations of six high-magnification clusters and nearby blank fields

- Studying distant galaxy populations ~10-100 times fainter than any previously observed
- Improve our statistical understanding of galaxies during the epoch of reionization
- Provide unprecedented measurements of the dark matter within massive clusters.

ACS: (70 orbits per position)			WFC3/IR: (70 orbits per position)		
Filter	Orbits	AB_mag	Filter	Orbits	AB_mag
F435W	18	28.8	F105W	24	28.9
F606W	10	28.8	F125W	12	28.6
F814W	42	29.1	F140W	10	28.6
			F160W	24	28.7



These data represent the new frontier of HST observations;
No other effort to release public catalogs

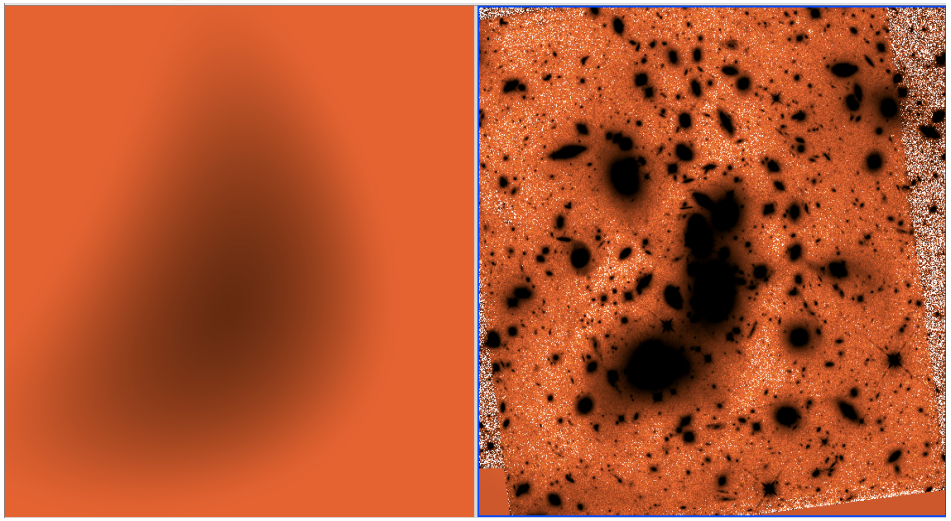
Quite challenging. Our (somewhat ambitious) goals are:

To extend the detection of even the faintest galaxies down into to the very central regions of the clusters, in order to exploit the full power of lensing magnification, beating as much as possible the contamination from cluster members;

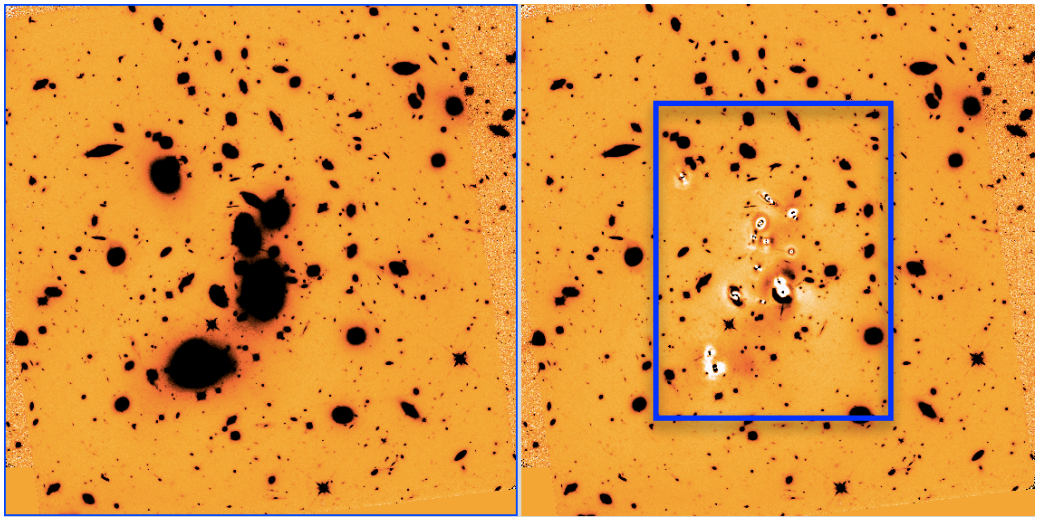
To obtain multiwavelength photometric catalogs in all available bands from UV to NIR, i.e. adding available ground-based and Spitzer data to the ACS and WFC3 images.

A

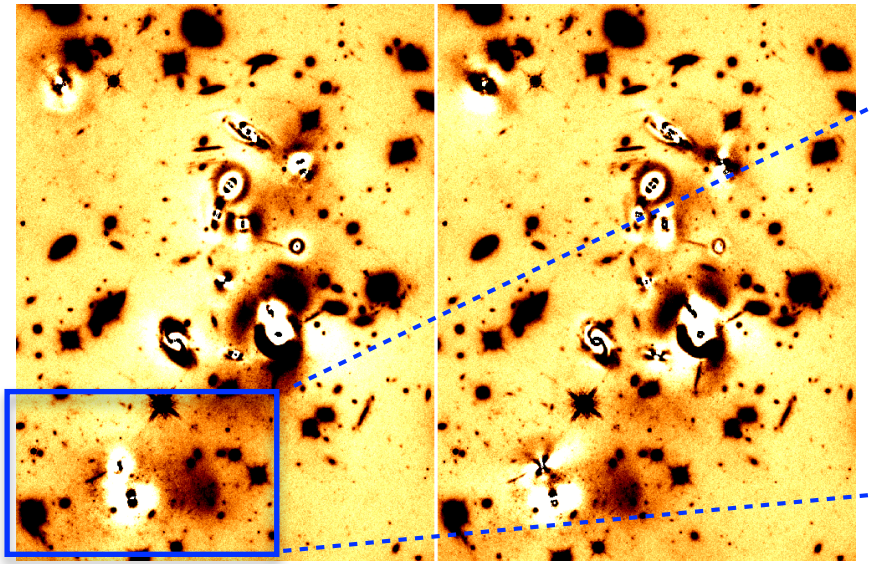
STEP1: Fit the ICL with Ferrer profiles using “masked” images



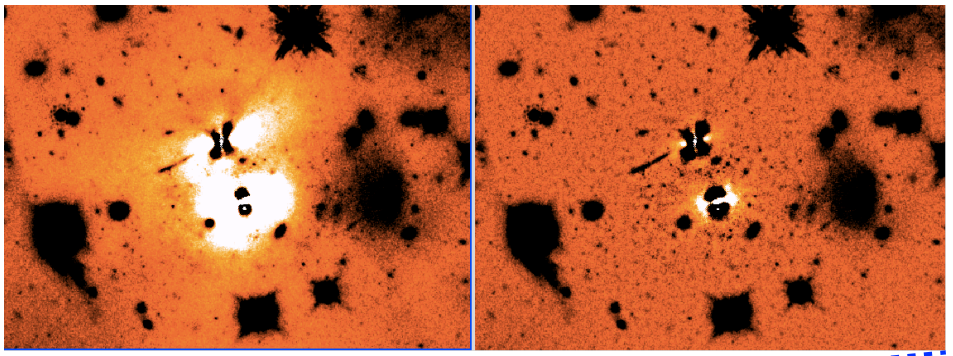
STEP 2: Fit of cluster bright galaxies with Galapagos on the ICL subtracted image



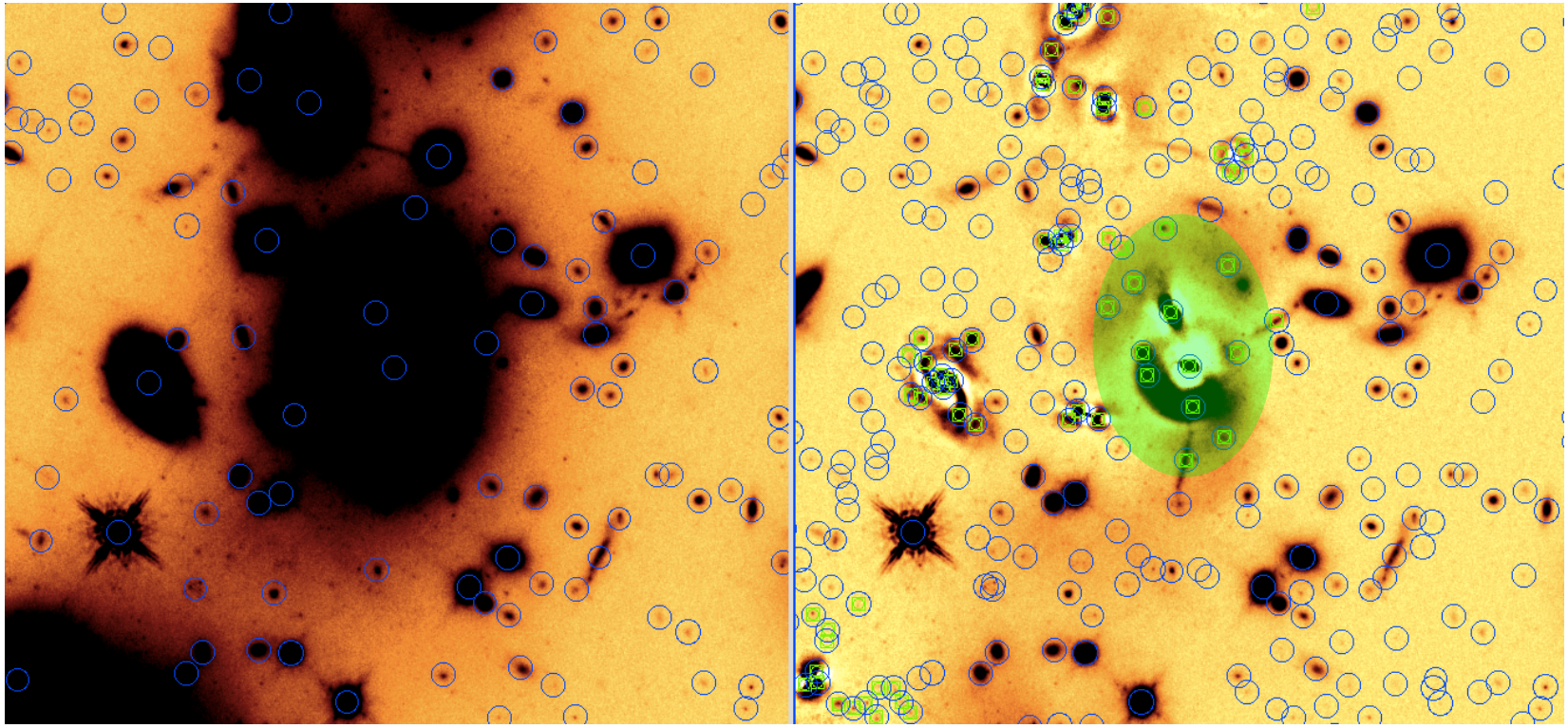
STEP 3: Iterative fit of ICL+ galaxies with GALFIT



STEP 4: median Filter on residuals

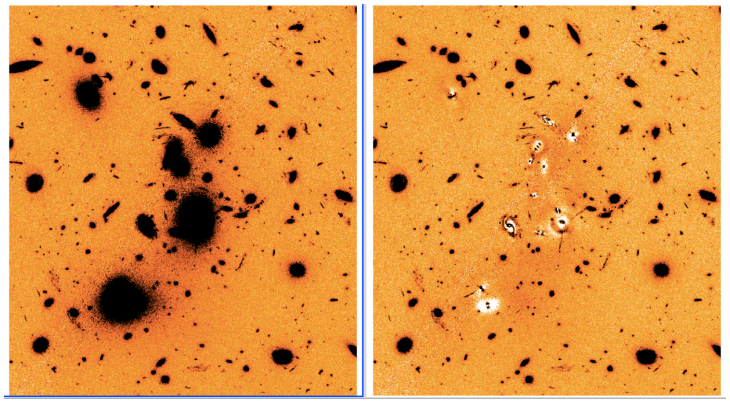


The H-band detection

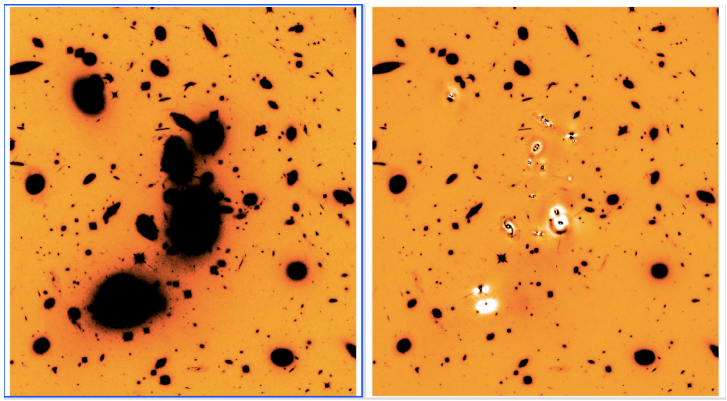


Other bands

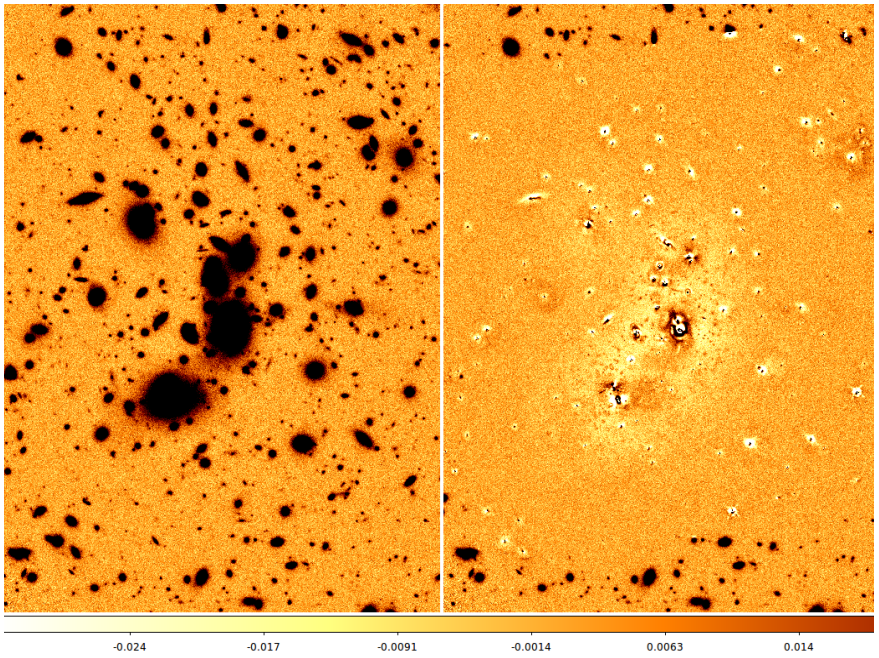
F606W



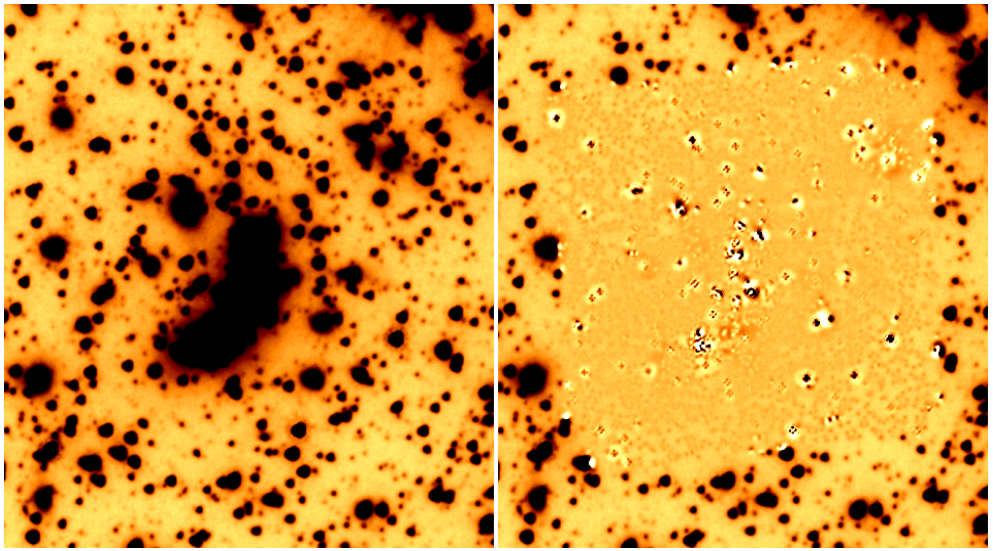
F105W



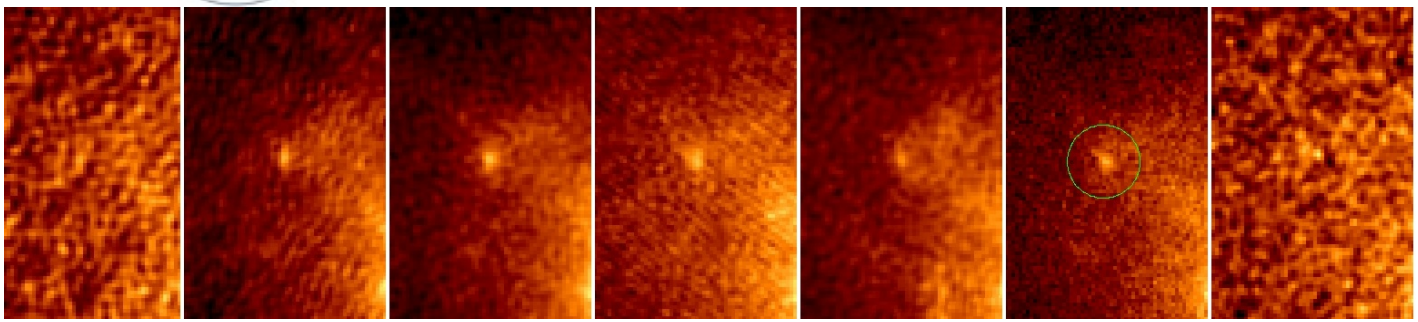
K - VLT

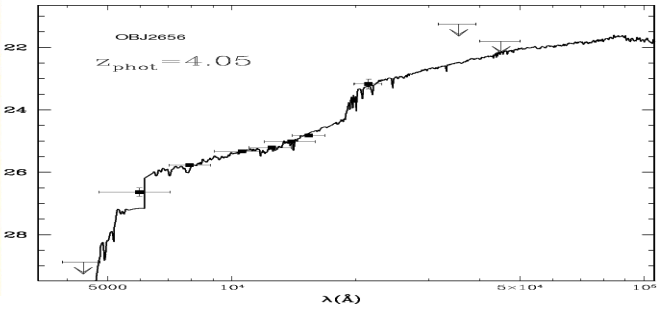


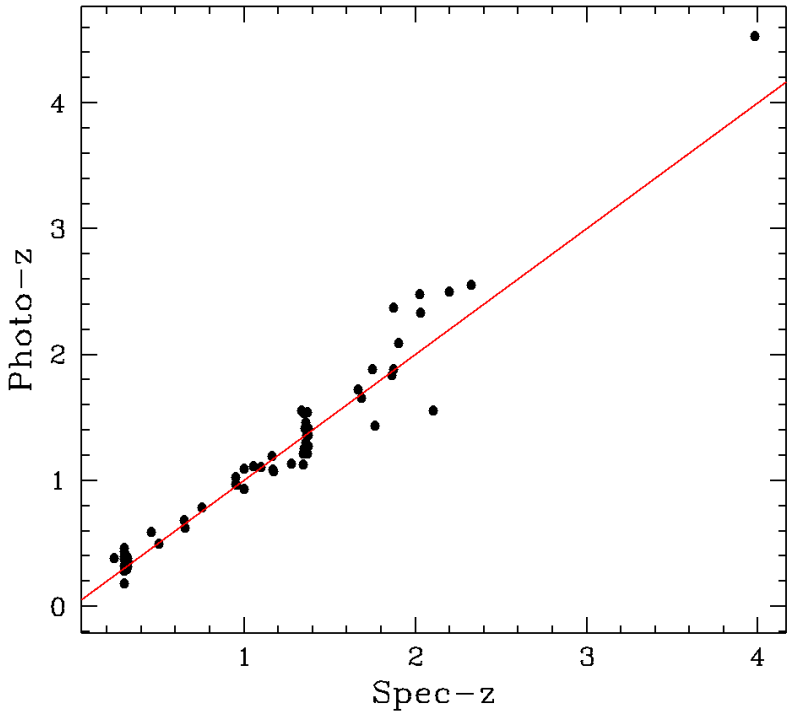
3.6-4.5µm Spitzer

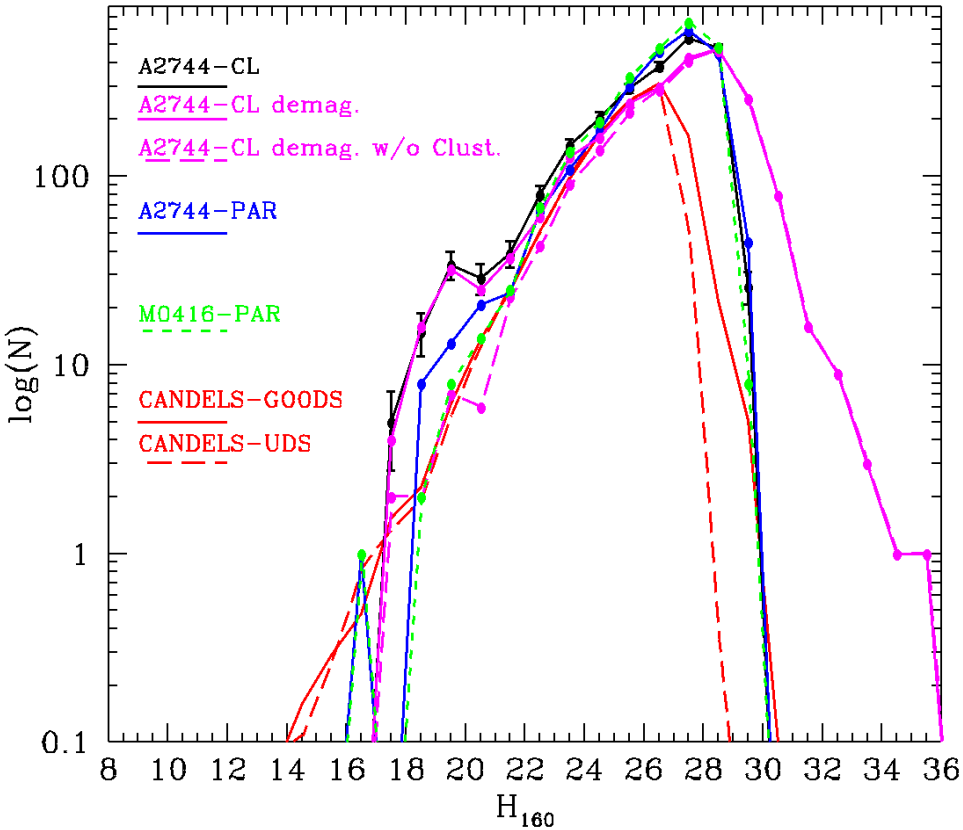


Results




OBJ2656
$z_{phot}=4.05$
λ(Å)


Photo−z
Spec−z


A2744−CL
A2744−CL demag.
A2744−CL demag. w/o Clust.
A2744−PAR
M0416−PAR
CANDELS−GOODS
CANDELS−UDS
log(N)
H_{160}

Status - as of today

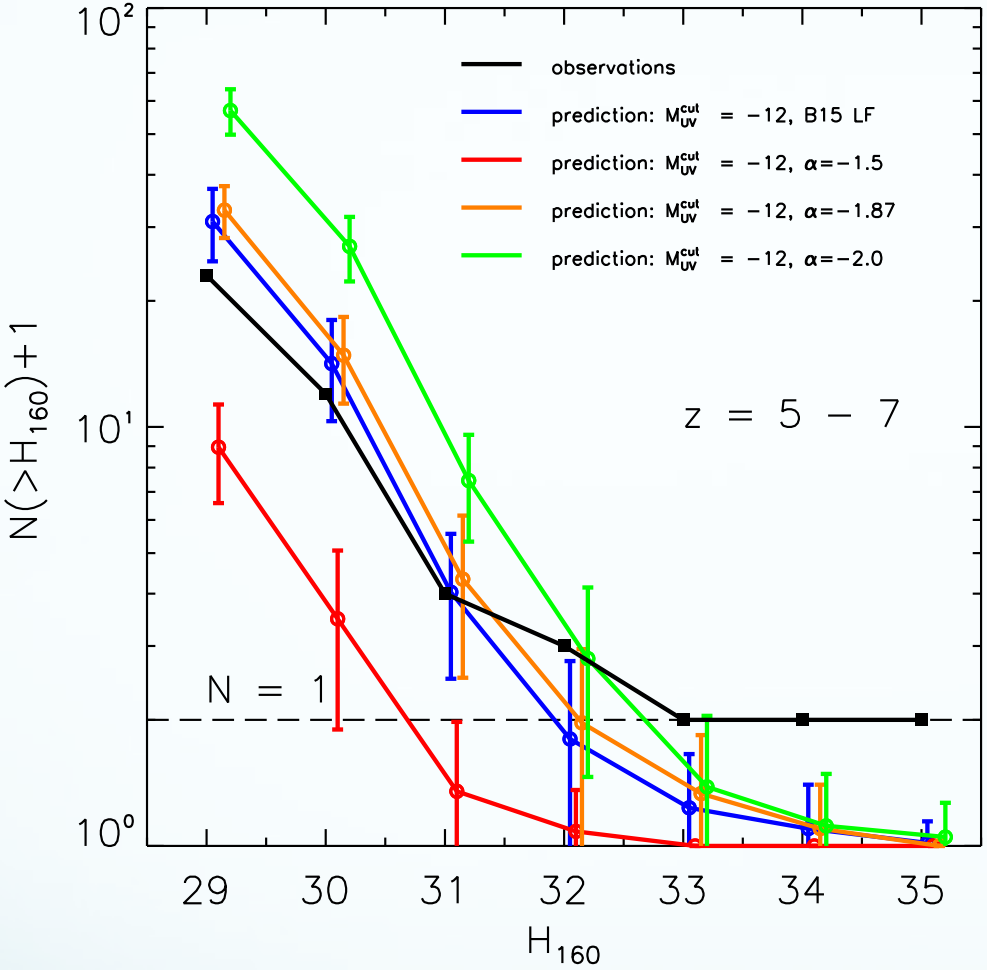
Abell2744

- ☑ Frontier Field #1 finished:
  7 HST bands +K-VLT + 2 Spitzer
- ☑ Parallel Field #1 finished:
  7 HST bands +K-VLT + 2 Spitzer

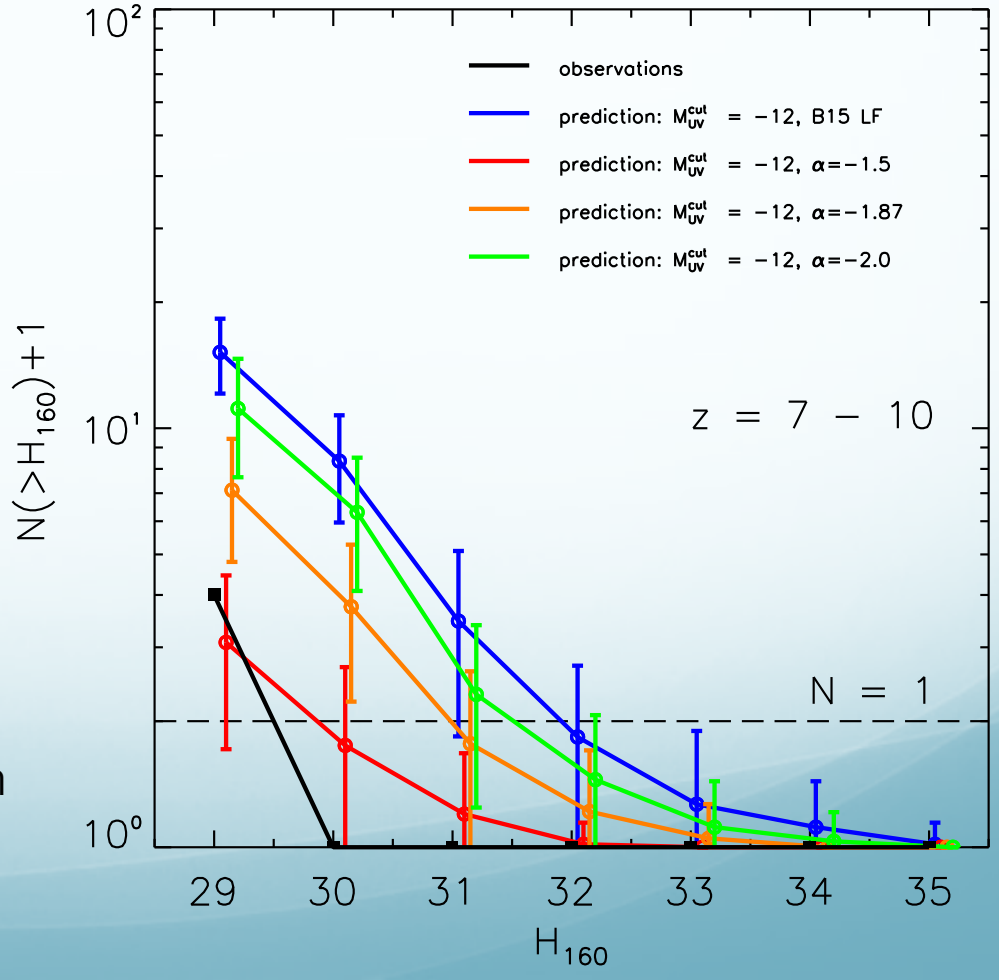
MACS0416

- ☐ Frontier Field #2 in progress:
  - ☑ 7 HST bands +K-VLT +
  - ☐ 2 Spitzer ongoing
- ☑ Parallel Field #2 finished:
  7 HST bands +K-VLT + 2 Spitzer

3 papers in preparation:
Merlin+ (technique)
Castellano+ (rest-frame properties)
?+ (High z galaxies)



At 5<z<7 the abundance of galaxies at H~33 follows the extrapolation of a Schechter LF: halos with mass ~1e9 M_Sun hold star formation



At z > 7 the LF slope might have a turn-over at faint magnitudes : the evolutionary trend (slope becoming flatter at decreasing z) impact first the faint galaxies at higher redshift (z > 7), then all galaxies are affected at lower redshifts (z~5).

GOODS-South

A unique field: target of the deepest observations from all telescopes and satellite;
Public catalog already exist but they are inhomogeneous and often obtained with inconsistent and non-optimal procedure.

Our aim: to process all the data with our consistent and advanced techniques.
The resulting data base (from Herschel to X-ray wavelengths) would be a long-standing result from ASTRODEEP.

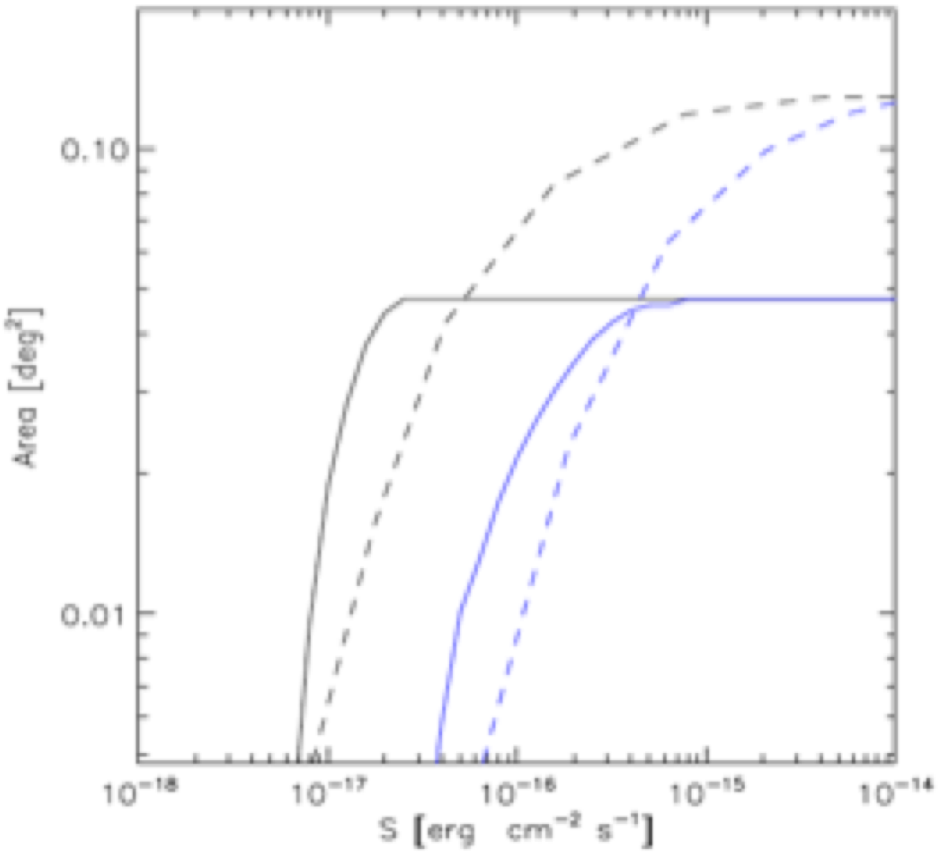
This is really ASTRODEEP *manifesto*: this is what ASTRODEEP was made for.

GOODS-South

ASTRODEEP added values

- X-ray 4Ms Chandra
  - Exploits the prior knowledge of objects in HST images
  - Increased sensitivity at fainter fluxes (1.5x more objects);
  - Pathfinder for exploitation of 7Ms survey
- HST/ground-based/Spitzer bands
  - New photometry (T-PHOT better than TFIT)
  - K-selected objects
  - New photometric bands (Intermediate bands)
  - Deeper Spitzer images
- Herschel Images
  - First catalog on HST priors
  - New procedure for image preparation (in coll. with ESA)
  - ASTRODEEP recipe for optimal deblending
  - Improved detection of 500μm sources

- X-ray 4Ms Chandra



Thanks to prior photometry, we go deeper than blind search surveys

Cappelluti+, in prep

New photometry (T-PHOT better than TFIT)

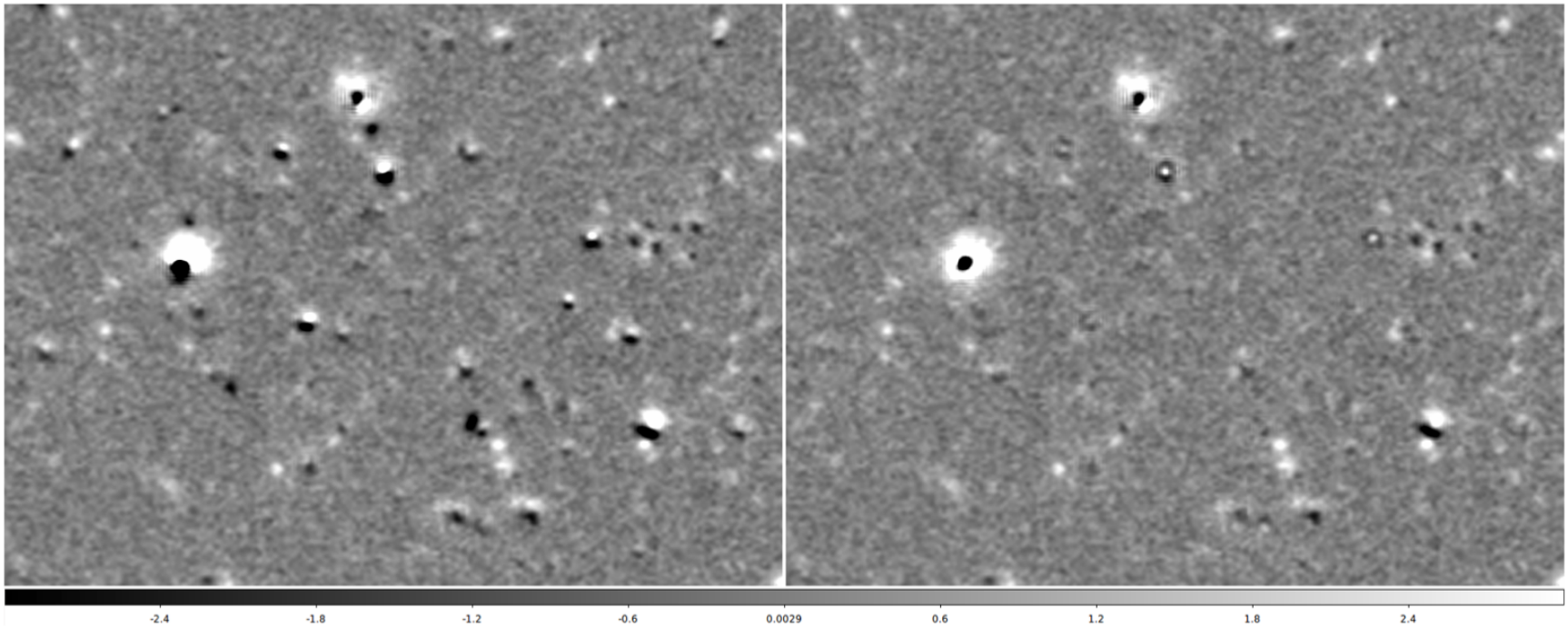
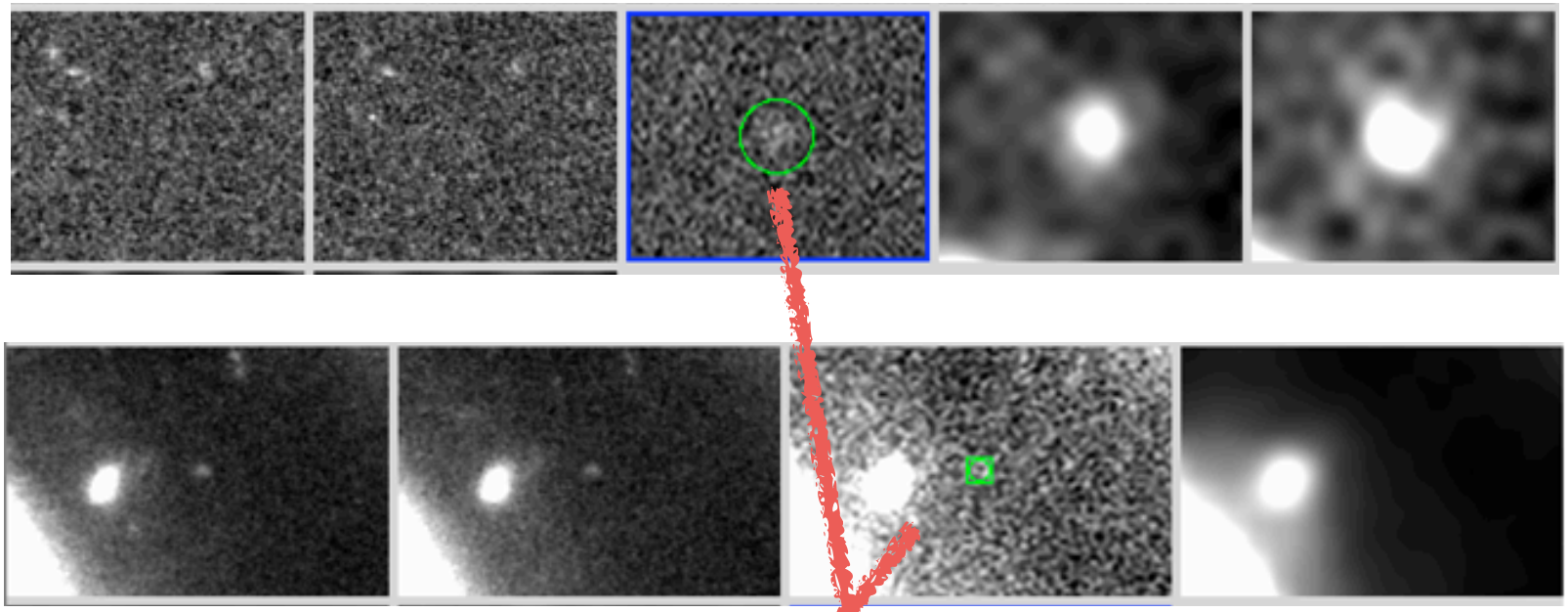
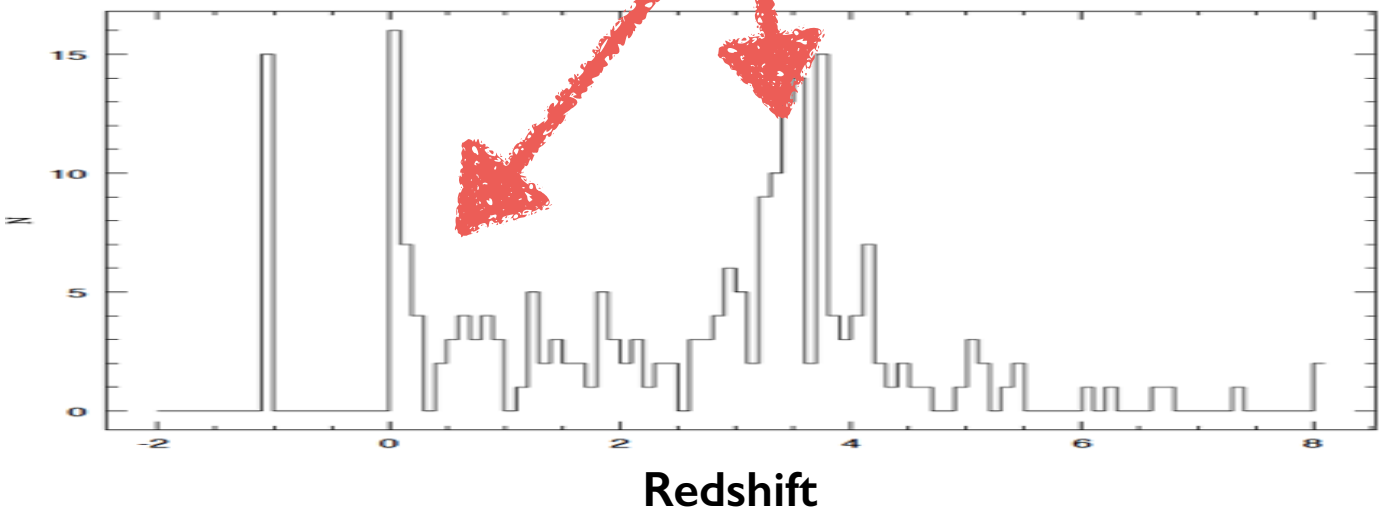


Figure 3 UDS I band TFIT vs. T-PHOT comparison. The panel on the left shows a small patch of the "official" CANDELS residual image obtained using TFIT. The residual image of the same regions is showed in the right panel, this time obtained using T-PHOT with "cells-on-objects" method and improved local kernel registration. Note the disappearance of many spurious black spots

K-selected objects
+
IRAC-selected objects





Wang+ in prep
Boutsia+, in prep

Herschel Improved mosaics

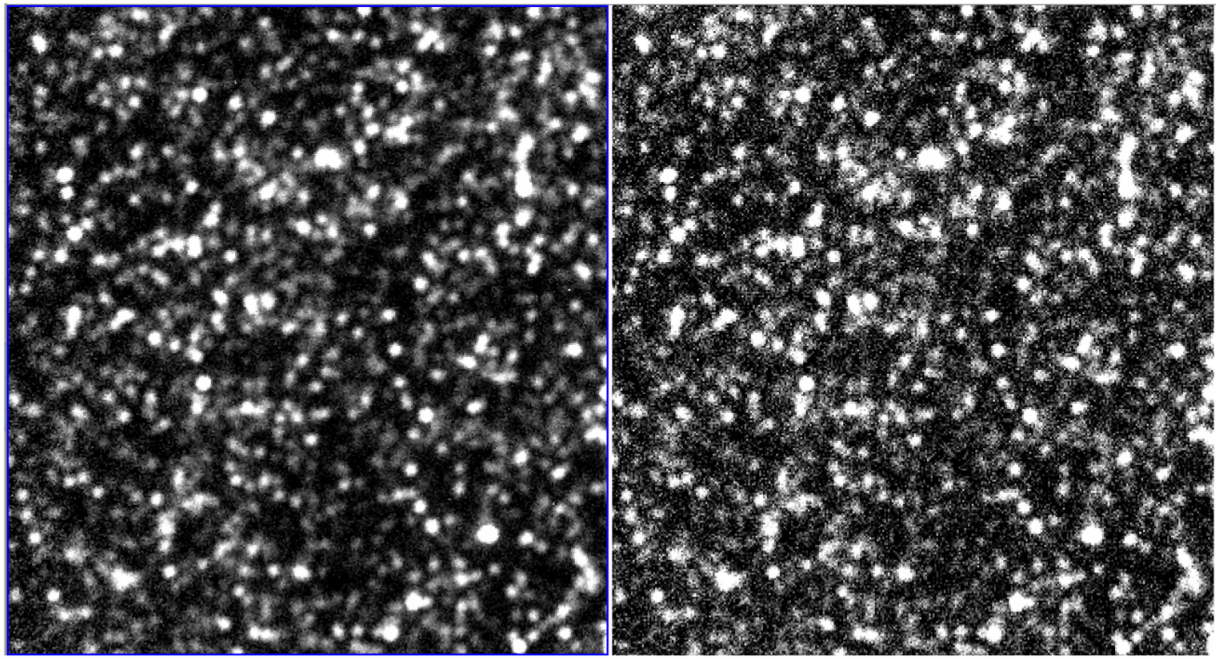


Figure 18 : SPIRE image at 250μm from the new analysis of the combined ultradeep dataset (left) vs the shallower image used from the reduction of the previous public data release (right).

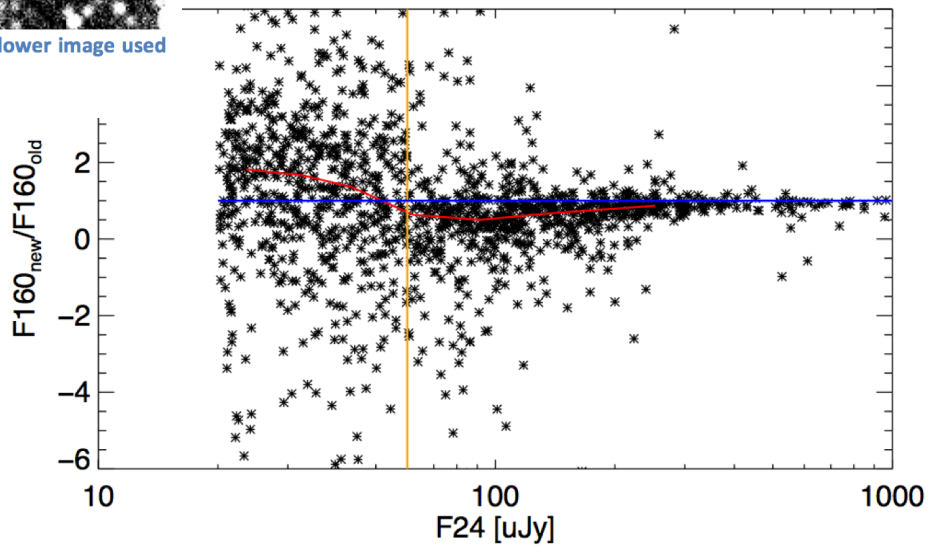


Figure 16 : comparison of the F160 new (unimap) vs old (HIPE) values.

Revised plan for data analysis: a global plan to the end of the project

Where are we today?

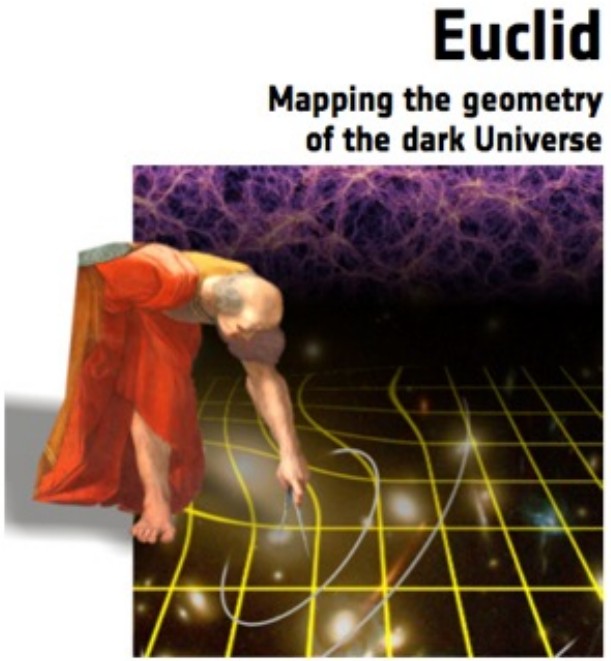
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5 To establish the know-how for the future space missions, most notably EUCLID.

Euclid is the next ESA space mission.
It will survey half of the sky to investigate the nature of dark matter and dark energy.

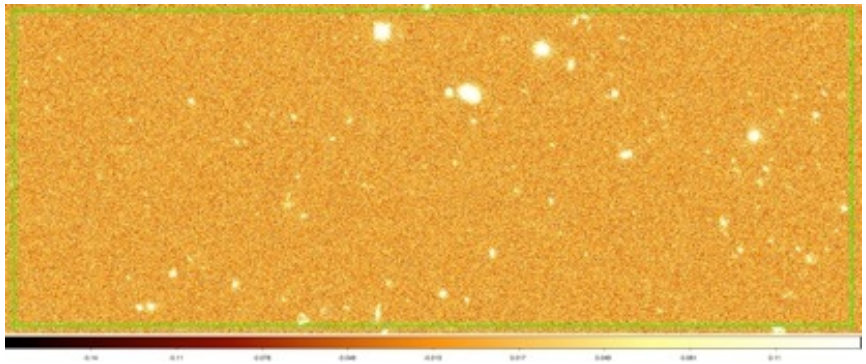
Its deep observations are a 10000x scaled version of the ASTRODEEP data.

Our goal is to use the ASTRODEEP data to simulate the Euclid deep surveys and to test our analysis software on the huge dataset expected from Euclid



IMAGING

Our GENCAT tool is able to simulate galaxy catalogs in all Euclid bands;
We have modified SkyMaker in order to simulate the 0.7deg x 0.7 deg images from Euclid
We're ready to start simulations for the photometric accuracy on the deep imaging survey.



SPECTROSCOPY

Preliminary work on de-confusion of deep spectra done by V. Bruce
F. Cullen will start working around summer 2015

A REVISED CATALOG OF CHANDRA 4MS SURVEY

- Computed a new catalog of X-ray sources in the 4Ms Chandra image-
- Exploits the prior knowledge of objects in HST images
- Increased sensitivity at fainter fluxes (1.5X more objects);
- Pathfinder for exploitation of 7Ms survey
- Originated within ASTRODEEP (byproduct of D3.1)

