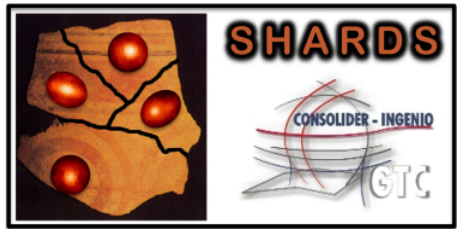


Workshop RIA, Valencia 29-30/03/2012
Deep galaxy surveys, large-scale structure, and dark energy
Spanish participation in future projects

Observatori Astronòmic

SHARDS: a big(-time) small(-field) survey

Antonio Cava

UCM SHARDS/CONSOLIDER postdoc

PI: Pablo G. Pérez-González

SHARDS core team: G. Barro, A. Cava, M. Balcells, N. Cardiel, J. Cenarro, J. Cepa, S. Charlot, A. Cimatti, C. Conselice, E. Daddi, J. Donley, D. Elbaz, I. Ferreras, J. Gallego, R. Gobat, R. Guzmán, A. Renzini, G. Rieke, J.M. Rodríguez-Espinosa, L. Tresse, I. Trujillo, V. Villar, J. Zamorano

END

SHARDS: Survey for High-z Absorption Red and Dead Sources

Main goal: spectro-photometric analysis of distant galaxies.

- ✓ Unbiased survey of passively evolving z>1 ETGs, with resolution (R=50) for detailed study
- ✓ Step forward from color (DRGs) or color-color (BzK) selection
- ✓ Data as good for detailed study as spectroscopy (galaxy-by-galaxy and going much fainter)
- ✓ ESO/GTC Large Program (PI: P.G. Pérez-González): 20 nights (180 hours), 2 GTC/OSIRIS pointings in GOODS-N, 25 filters (FWHM~15 - 17 nm) with GTC/Consolider Project grant
- ✓ Exposure times range from 4 to 30 ks
- ✓ Proposal requested detailed calibration, including imaging and spectroscopic observations: effect of sky variability, spatial variation of passband,…

SHARDS: current status

- ✓ Observations started in March 2010. GTC Staff very helpful and enthusiastic with our program. IP and co-I's participated in observations several times
- ✓ 110/147 OBs finished (16/25 filters)
- ✓ 136/184 hours finished (~75%). Data as good or even better than predicted by ETC! OSIRIS instrument responded very well Seeing <0.9".
- ✓ Complete OSIRIS/SHARDS pipeline developed (including absolute photometric calibration).
- ✓ SHARDS data already deeper than any other MB filters survey
- ✓ Very satisfactory science verification: measure emissions & absorption bands @ z=0-5
- ✓ Detailed stellar pop.'s modeling @z>1 underway

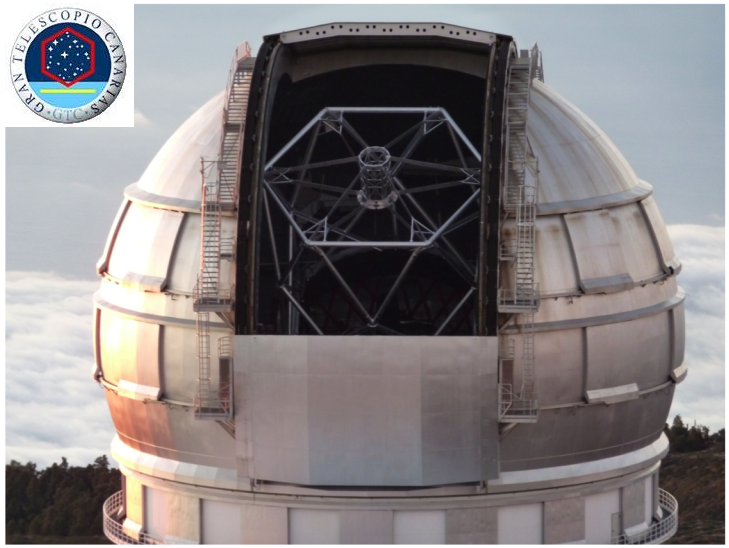
SHARDS: current status

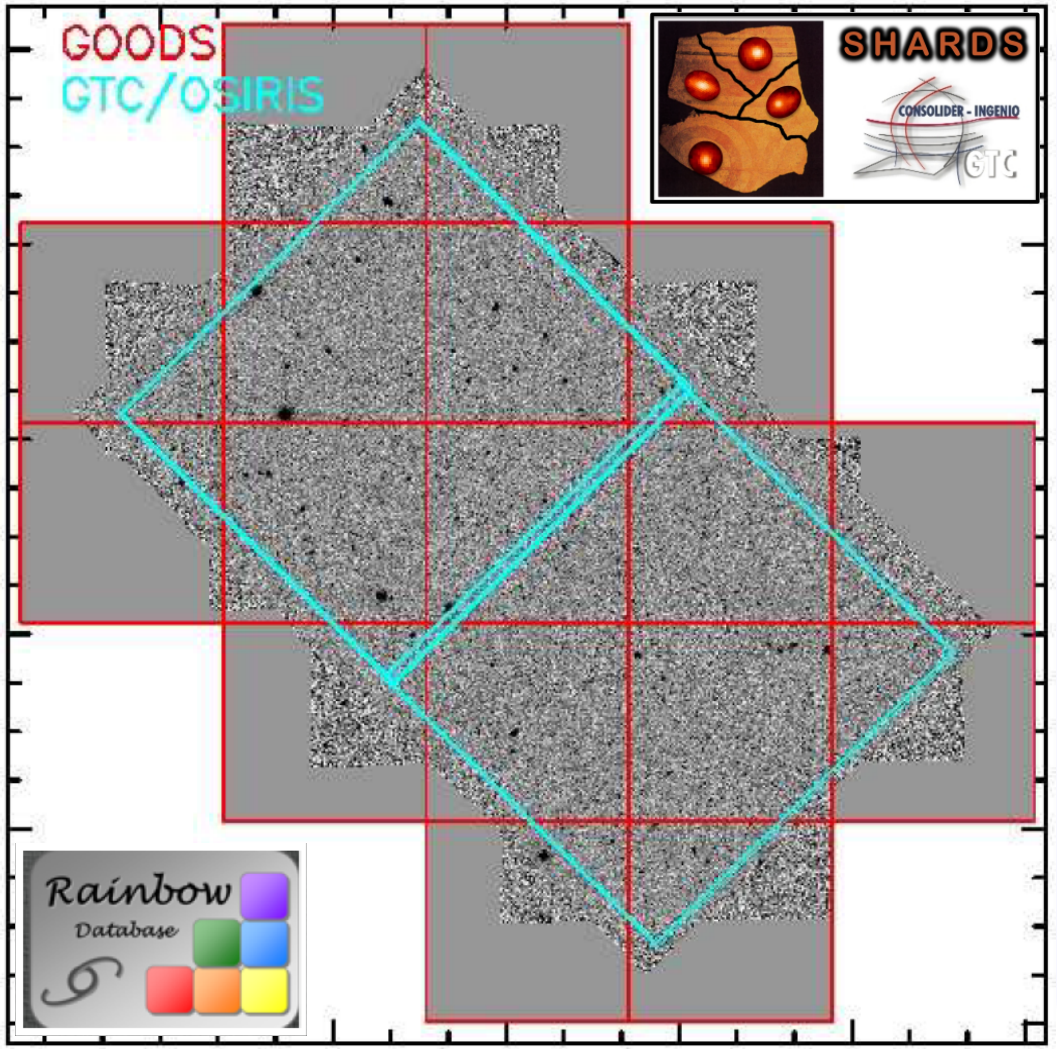
Filter #	Filter name	Central wavelength at AOI=10.5º (nm)	Width at AOI=10.5º (nm)	Exposure time (s)	Depth (AB mag)	Seeing (arcsec)	Transmission file
01	F500W17	500	15	3780	27.0	N/A	AOI=0º
02	F517W17	520	16	4445	27.0	N/A	AOI=0º
03	F534W17	536	17	4800	27.0	N/A	AOI=0º
04	F551W17	552	14	5190	27.0	N/A	AOI=0º
05	F568W17	569	14	5810	27.0	N/A	AOI=0º
06	F585W17	586	15	6125	27.0	N/A	AOI=0º
07	F602W17	603	16	7440	27.0	N/A	AOI=0º
08	F619W17	619	16	7920	27.0	N/A	AOI=0º
09	F636W17	636	16	9180	27.0	N/A	AOI=0º
10	F653W17	653	16	10440	27.0	N/A	AOI=0º
11	F670W17	668	16	4550	26.5	N/A	AOI=0º
12	F687W17	688	17	9270	26.5	N/A	AOI=0º
13	F704W17	704	18	6120	26.5	N/A	AOI=0º
14	F721W17	720	19	6600	26.5	N/A	AOI=0º
15	F738W17	738	15	7965	26.5	N/A	AOI=0º
16	F755W17	754	15	9000	26.5	N/A	AOI=0º
17	F772W17	771	16	9900	26.5	N/A	AOI=0º
18	F789W17	789	16	12250	26.5	N/A	AOI=0º
19	F806W17	806	16	14300	26.5	N/A	AOI=0º
20	F823W17	825	15	18540	26.5	N/A	AOI=0º
21	F840W17	840	16	21120	26.5	N/A	AOI=0º
22	F857W17	856	16	24240	26.5	N/A	AOI=0º
23	F883W35	880	34	16480	26.5	N/A	AOI=0º
24	F913W25	910	28	0 (OTELO)	26.5	N/A	AOI=0º
25	F941W33	941	34	32000	26.5	N/A	AOI=0º

SHARDS: observations

Some GOODS reasons to target the GOODS-N field:

- Extremely extended multi-wavelenght coverage: from X-rays to radio → *well sampled SEDs*
- very good spectroscopic coverage (necessary for photo-z calibration and specific flux calibration issues)
- observable from 10m class telescope, GTC, with OSIRIS instrument

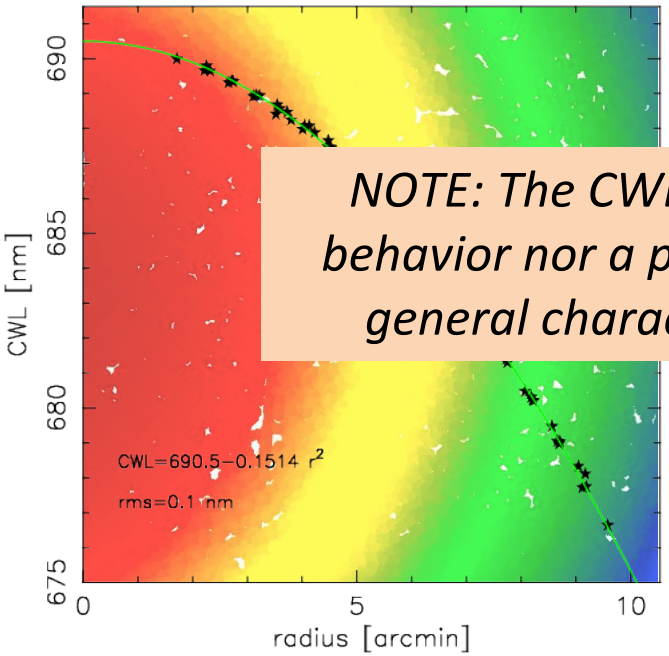


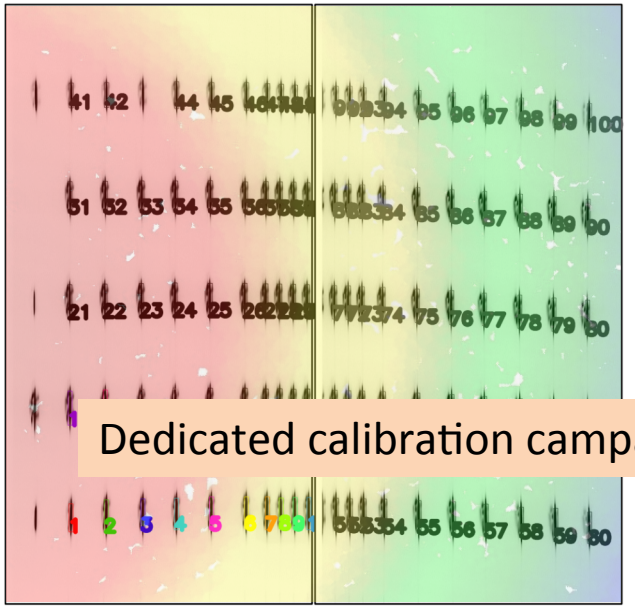


Spectral range	3650-10000 A
F.O.V.	7.8' x 8.5' (imaging; 7.8' x 7.8' unvignetted)
Plate Scale	0.125" (imaging and Spectroscopy)
Detector	2 x 2048 x 4096 Marconi CCD42-82 (with a 9.2" gap between them)
Pixel Size	15 µm/pix
Detector Quantum Efficiency (QE)	50% (400 nm), 90% (600 nm), 80% (800 nm), 40% (900 nm)
Image quality	EER80 < 0.15" (Imaging mode). Distortion < 2% in all the detector

SHARDS: calibrations

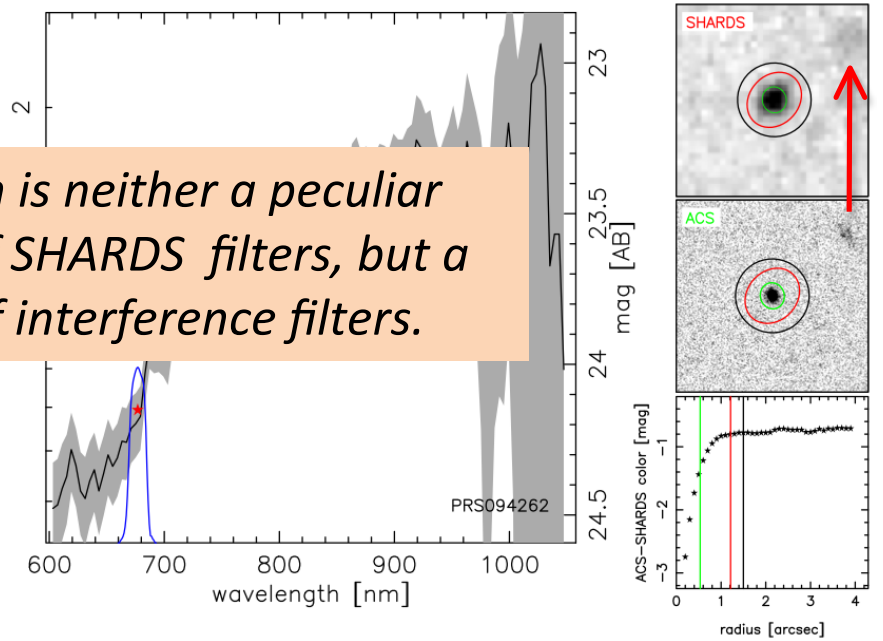
CWL vs FOV position

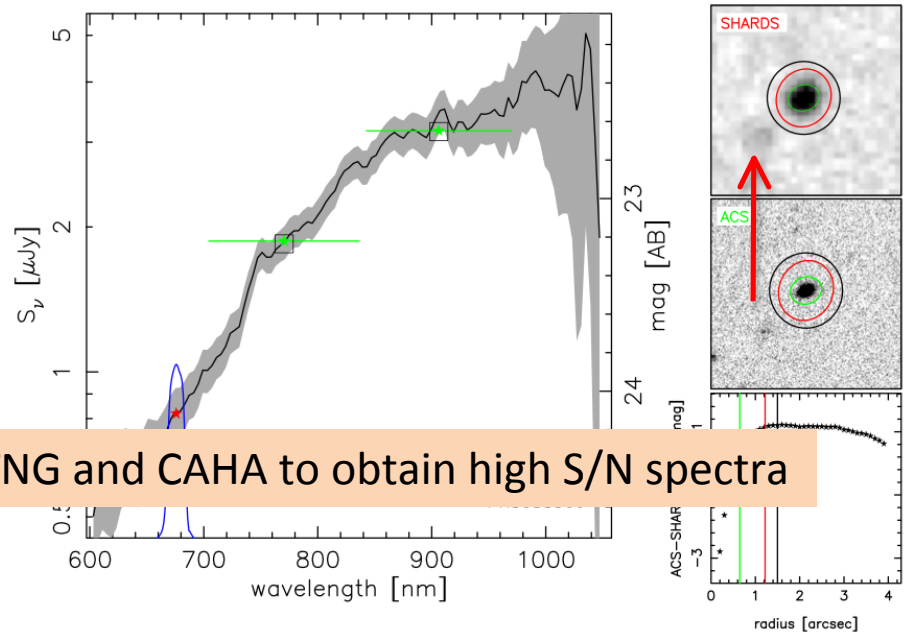




NOTE: The CWL variation is neither a peculiar behavior nor a problem of SHARDS filters, but a general characteristic of interference filters.

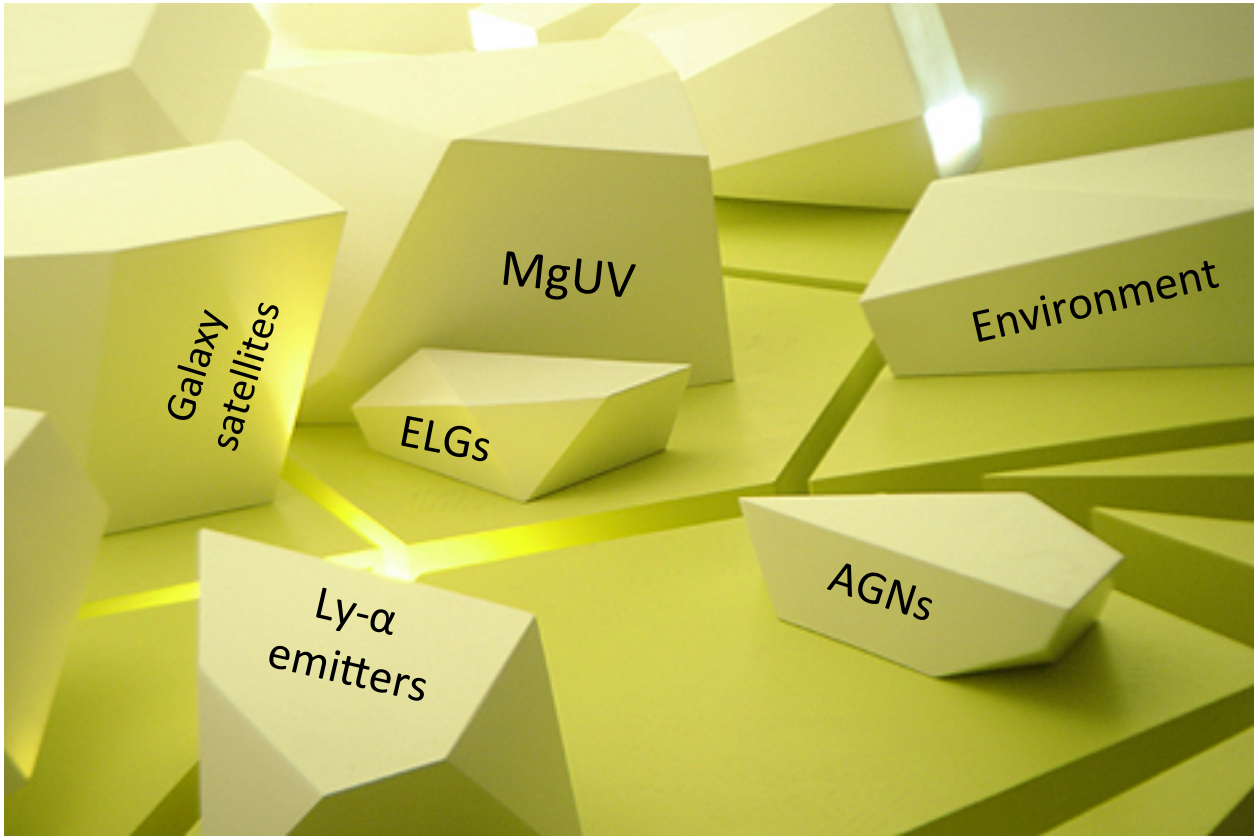
Flux calibration (HST grism spectra + TKRS/Models)





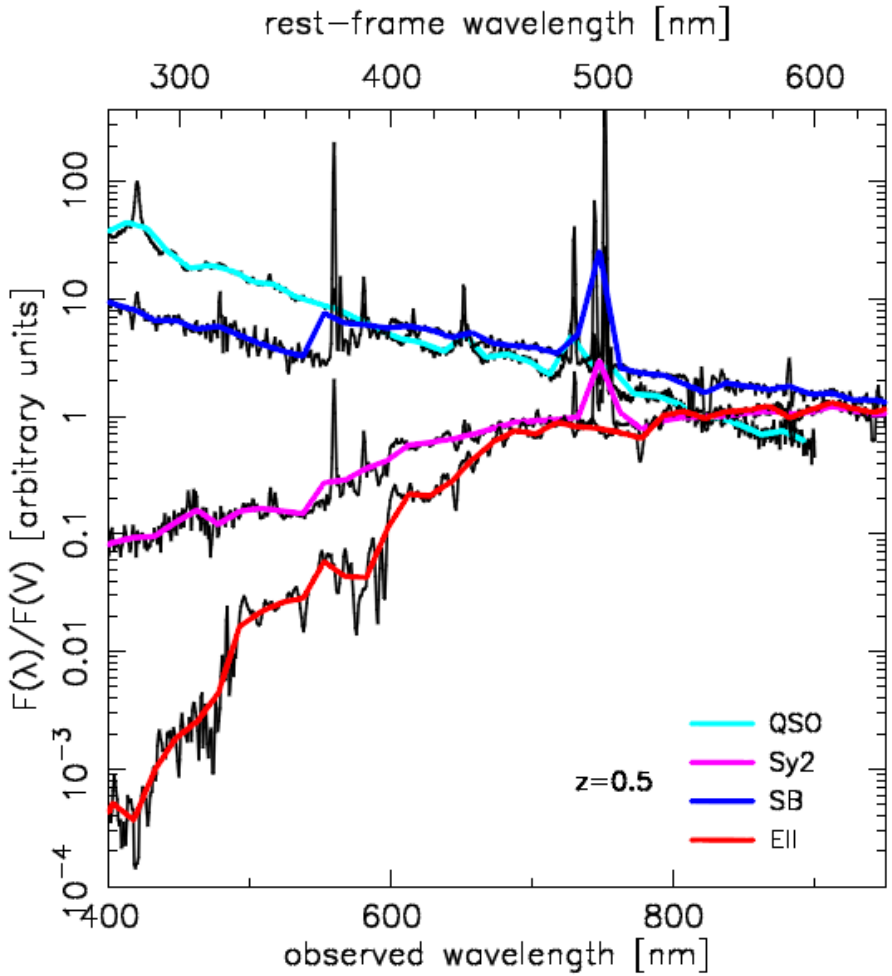
Dedicated calibration campaigns at TNG and CAHA to obtain high S/N spectra

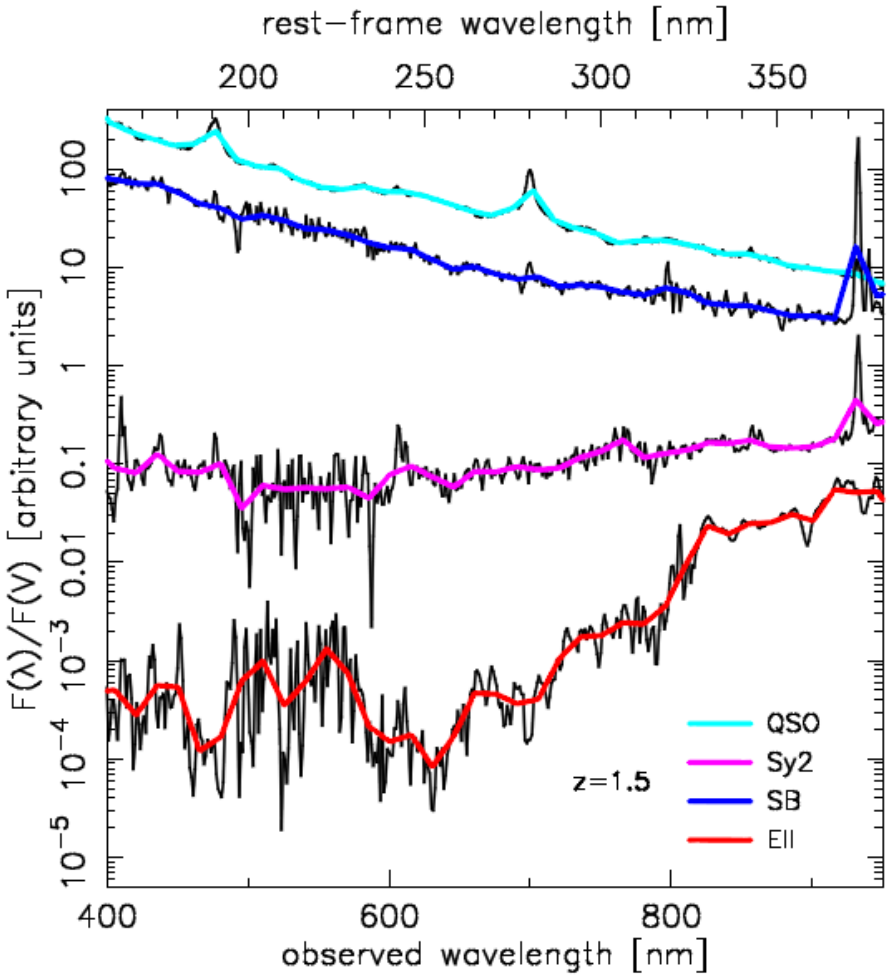
Shards of SHARDS



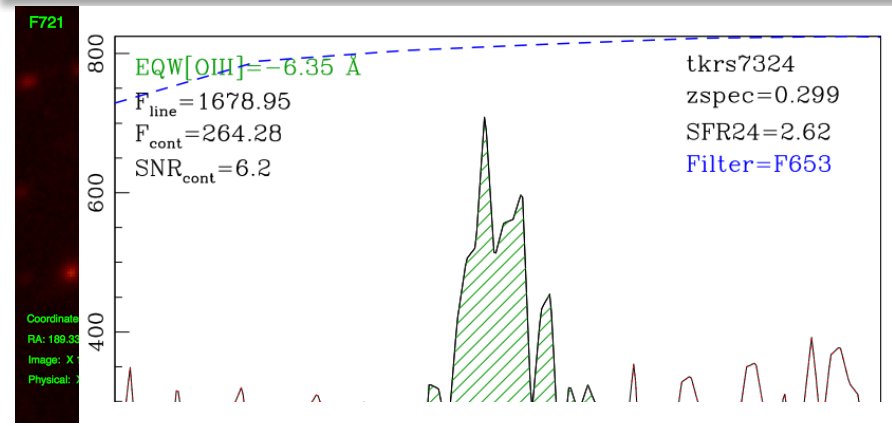
Shards of SHARDS - Science: ELGs

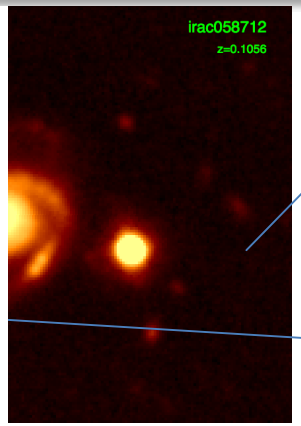
SHARDS was optimized for the study of R&D galaxies but ELGs were also within the goals of the survey





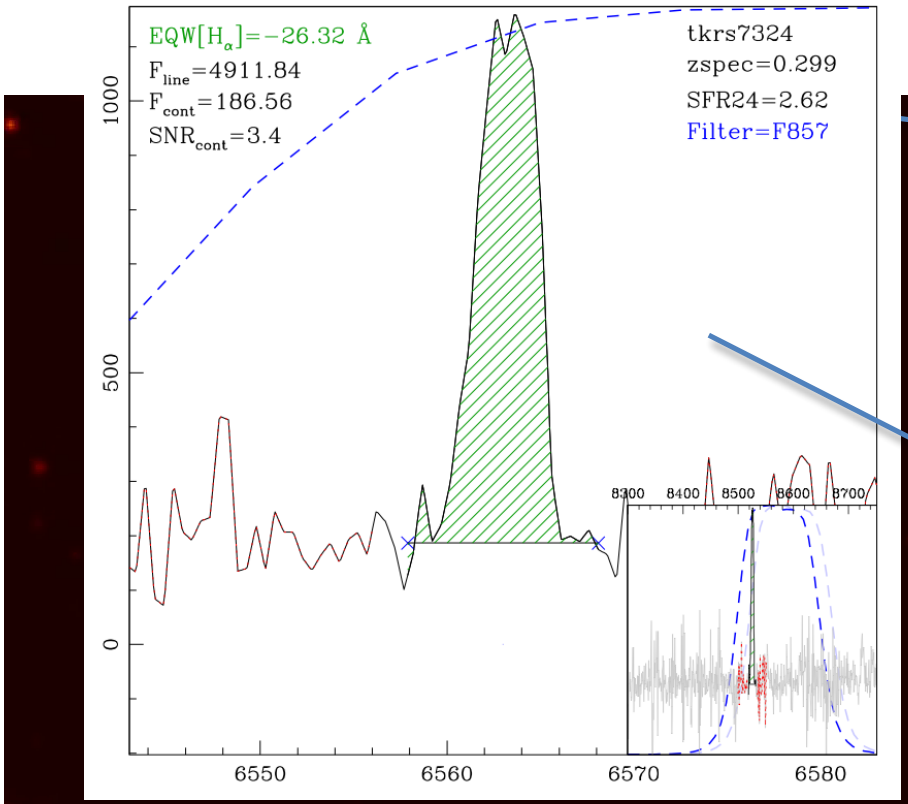
Shards of SHARDS - Science: ELGs

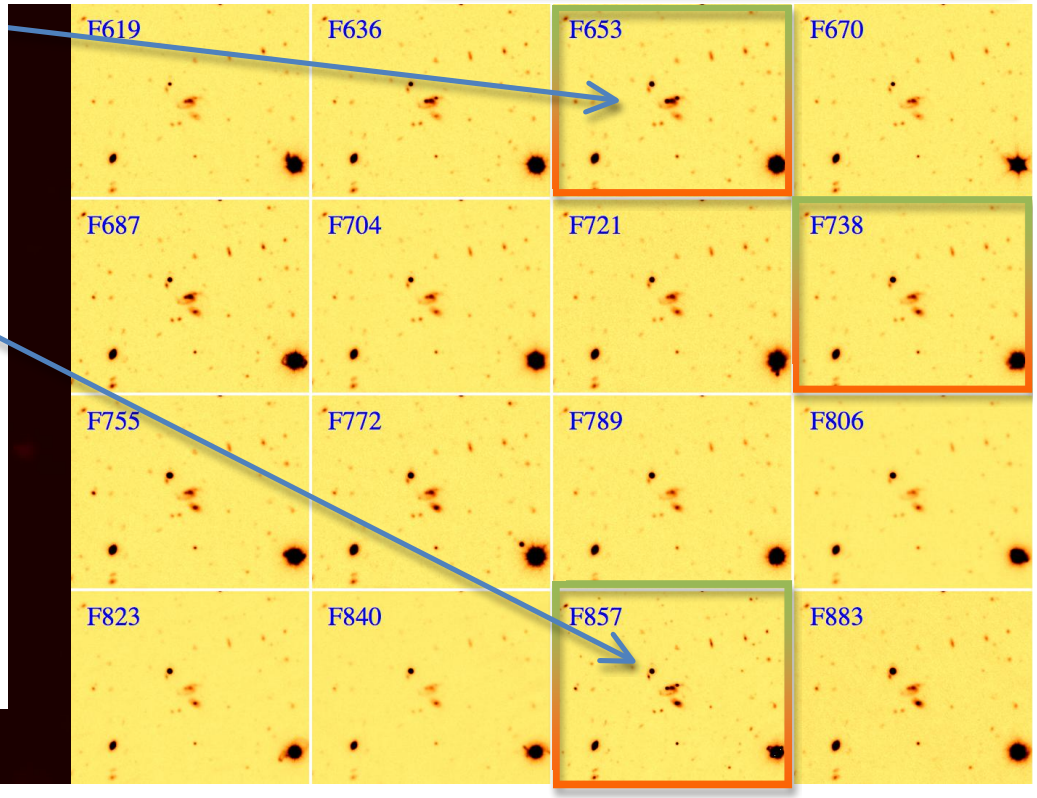




RAINBOWFICATION
directly in the images
Peak expected at F721

Ghost effects removal
and characterization
(started @IAC)



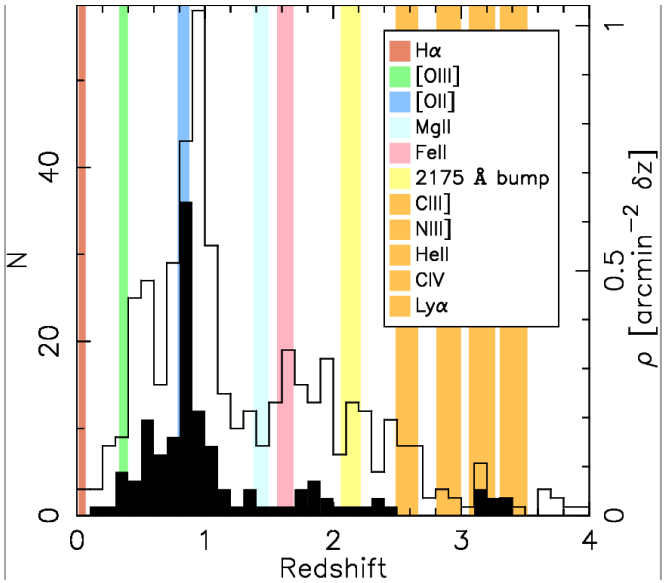


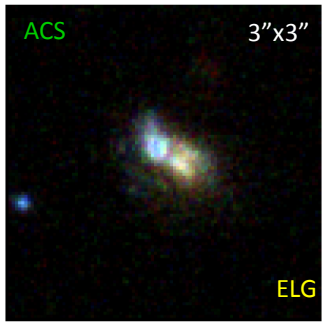
Shards of SHARDS - Science: ELGs

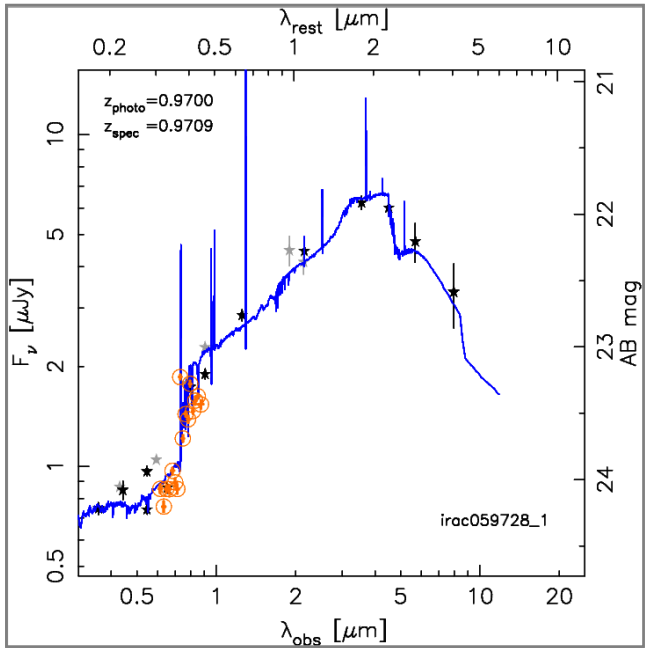
Selection of emission line galaxies through typical “trumpet” diagrams

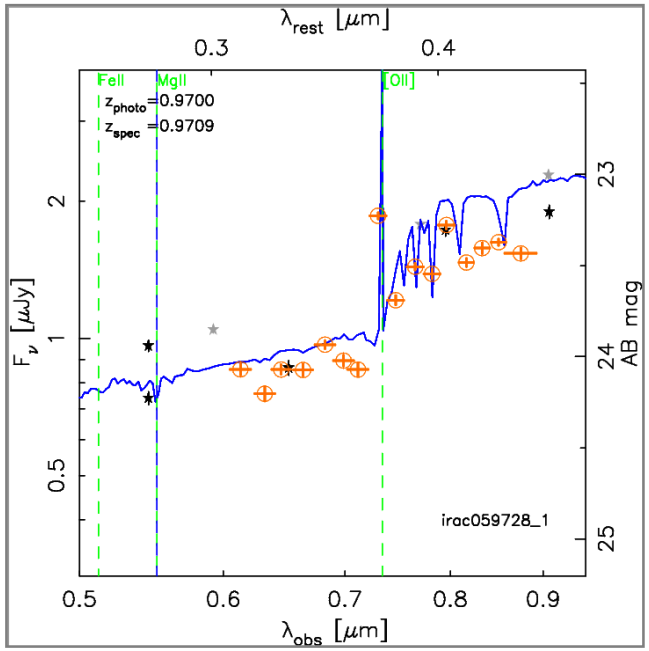
Spectroscopic limit mag~24

SHARDS expected to go down to mag~26.5-27 (using photo-z)



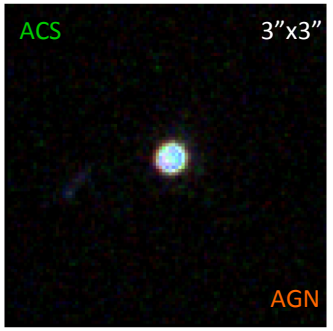


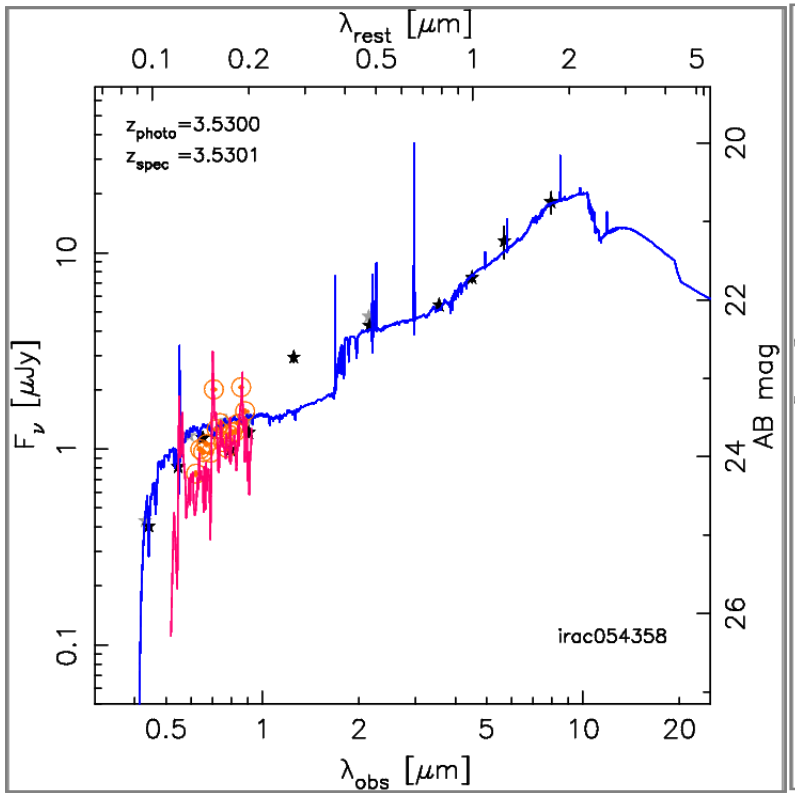


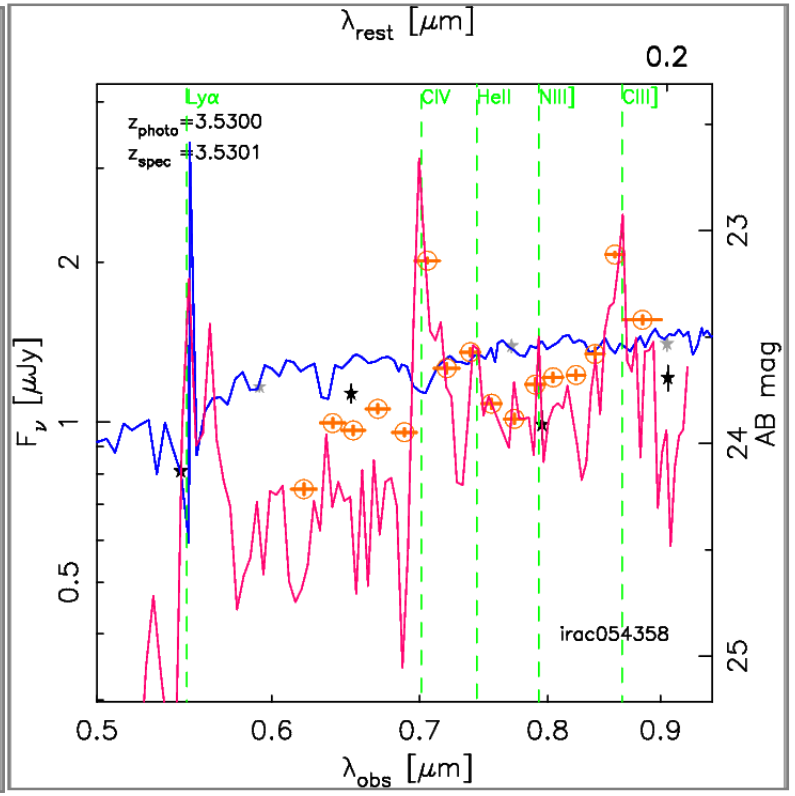


Shards of SHARDS – Science: AGNs

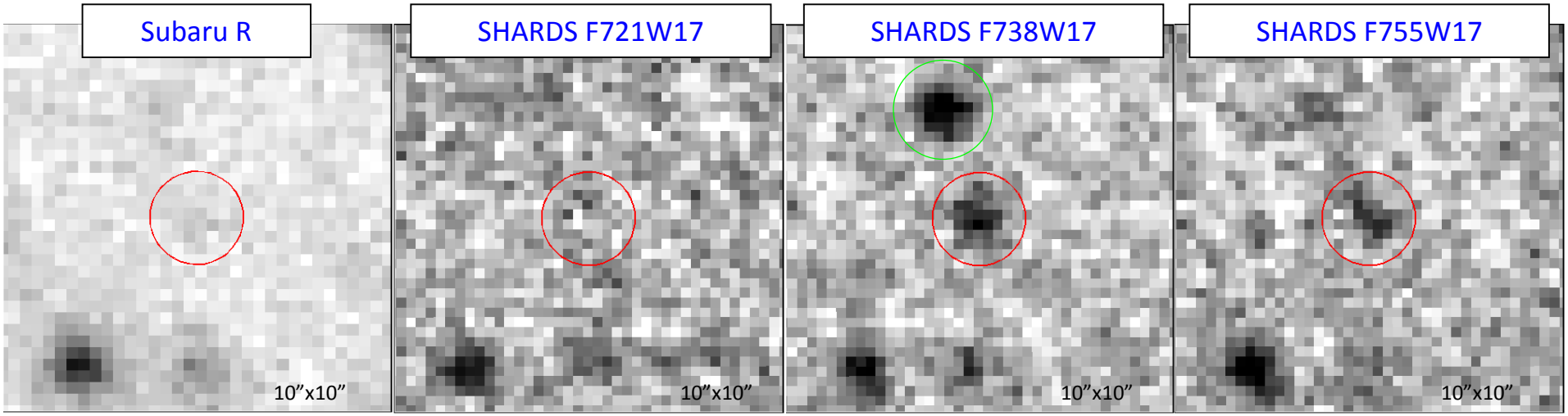
Strong emission lines from AGNs allow us to go at higher redshifts…



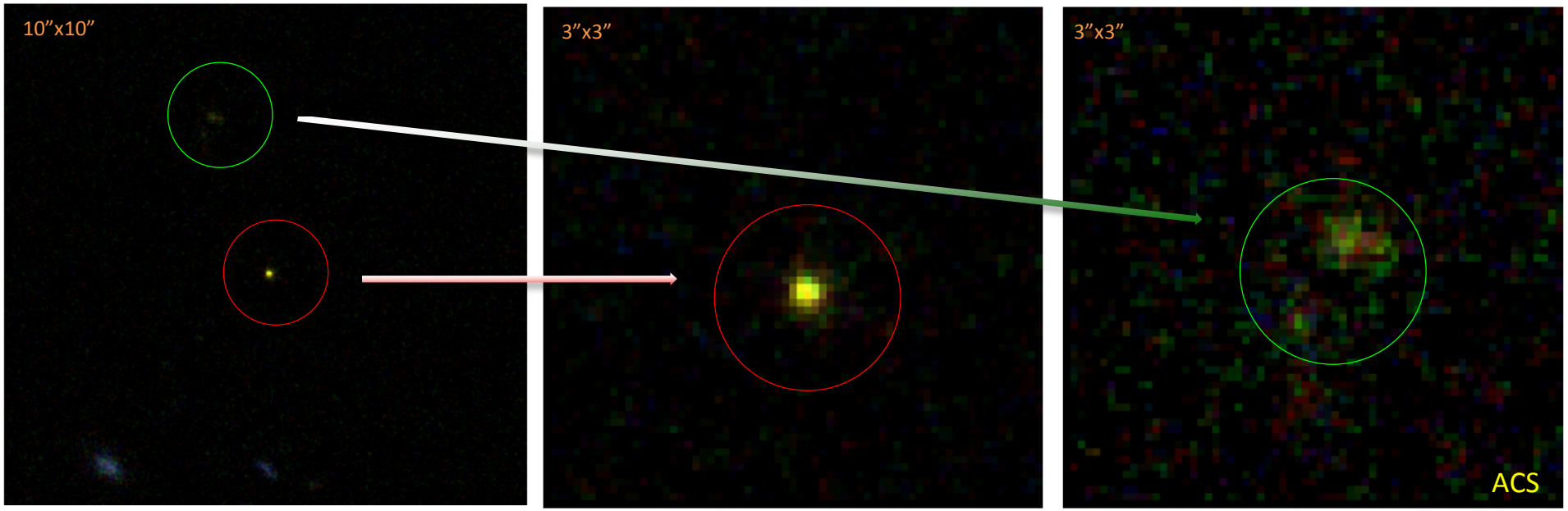




Shards of SHARDS - Science: LAEs at z~5



Credit: Rodríguez Espinosa et al., in prep. using 4 SHARDS bands



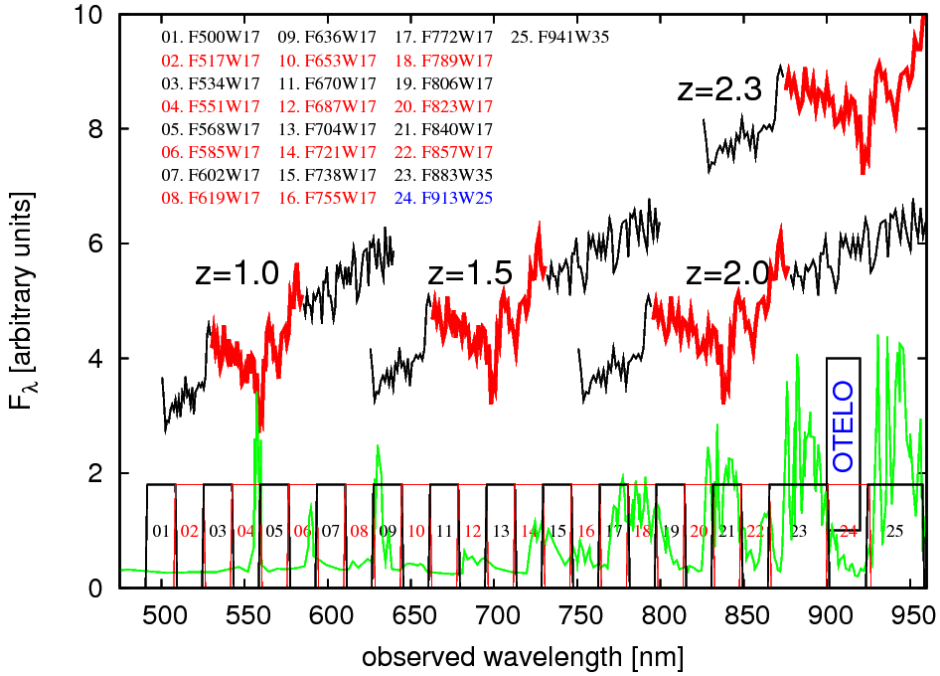
Shards of SHARDS - Science: absorption lines

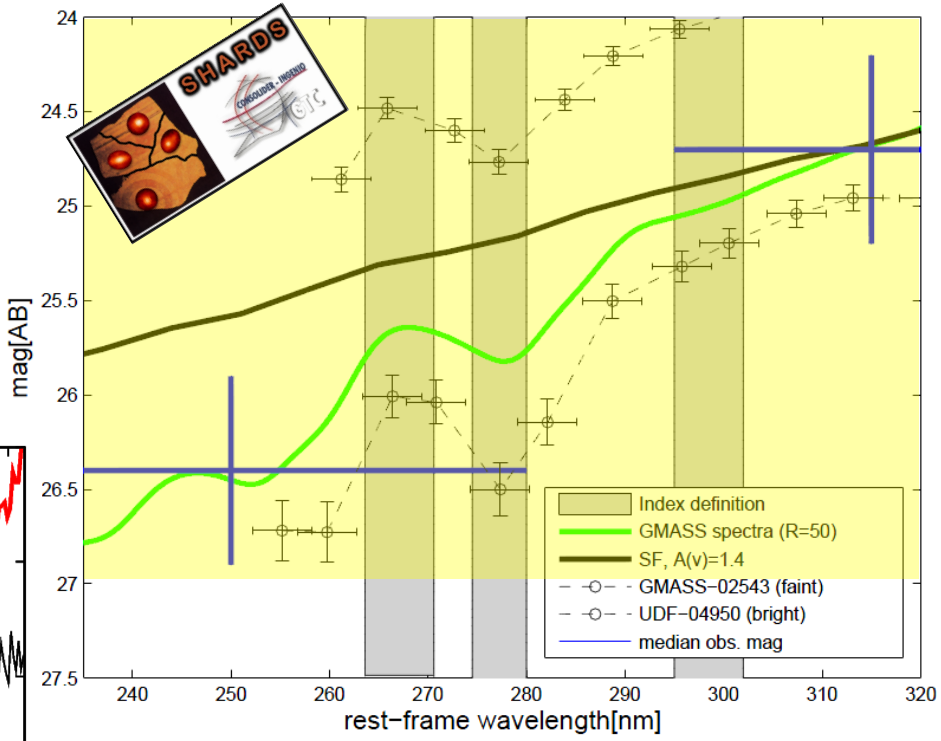
SHARDS was optimized for the study of R&D galaxies, especially by using the MgUV spectral index (λ~2800Å).

-The GMASS stacked spectrum of 13 quiescent ETGs in GOODS-S at a resolution R = 50 (green)

- expected rest-frame SEDs in the SHARDS filters for the faintest and the brightest passive galaxy (dashed lines) drawn from the GMASS (Cimatti et al. 2008) and the UDF sample (Daddi et al. 2005a)

- Typical SFG can be easily identified due to the lack of features

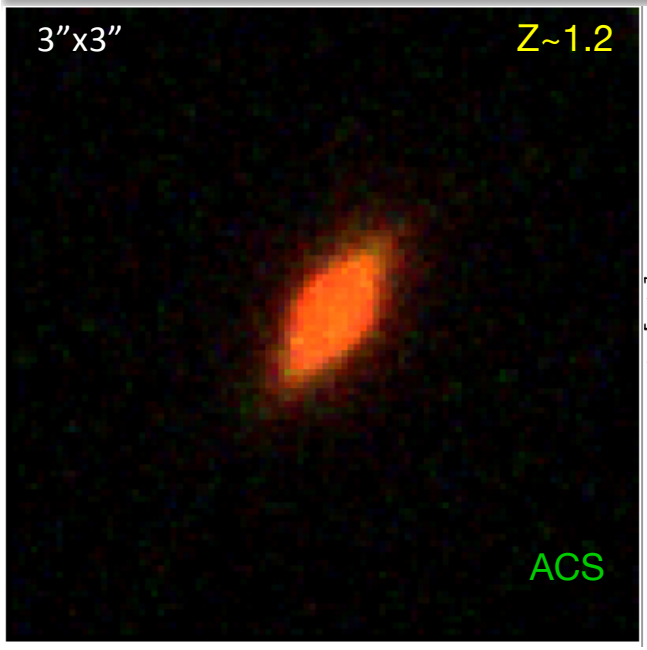


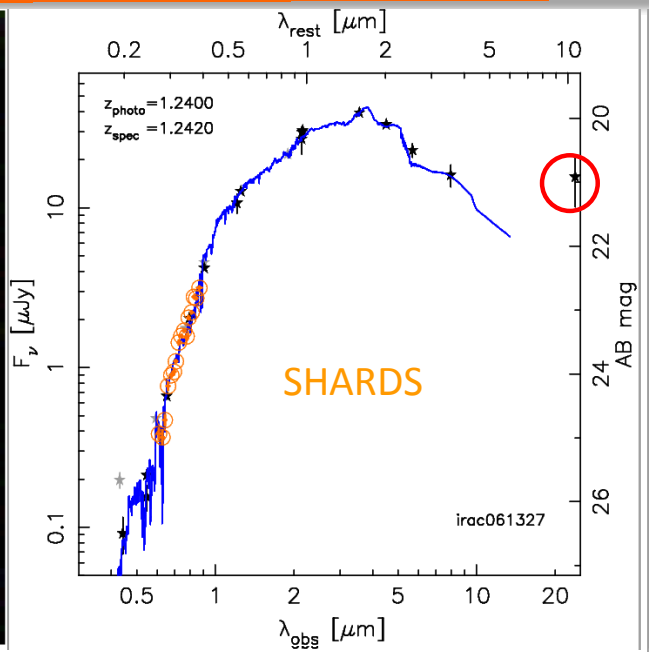


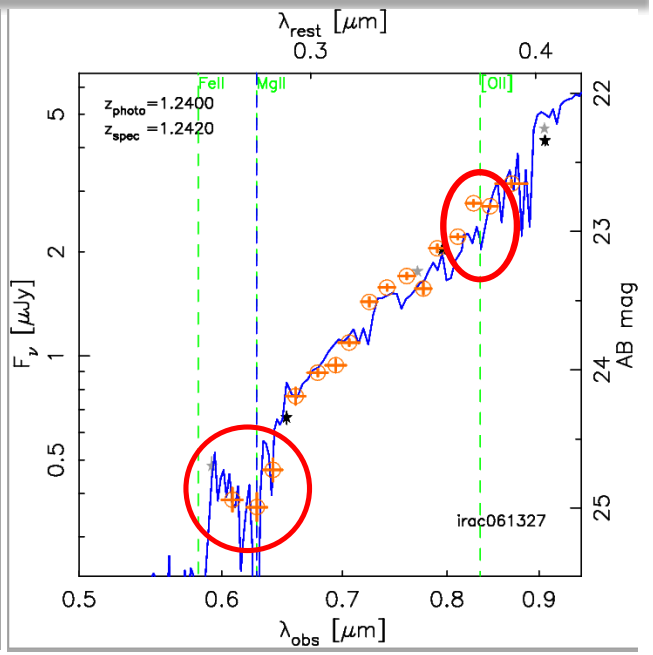
- Using the full set of SHARDS filters, we will be able to probe the prominent absorption feature placed at λ=2650–2950Å, distinctive of passively evolving galaxies with a resolution R~50.

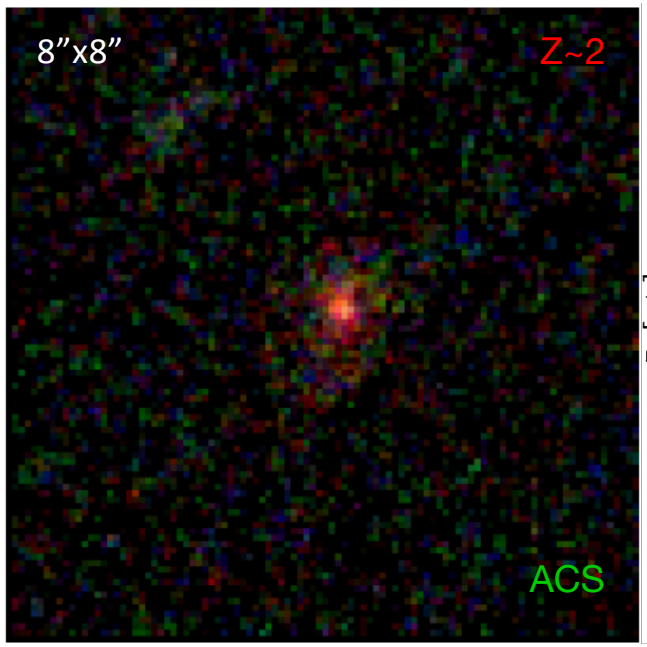
- The detection of this feature will allow us to obtain an estimate of the age of the last star formation burst, jointly with the galaxy redshift, with an accuracy better than z=0.02.

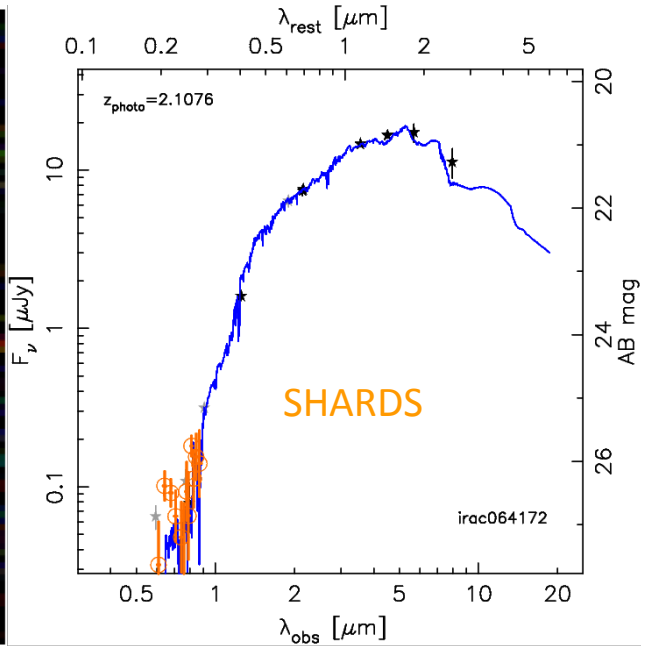
Shards of SHARDS - Science: absorption lines

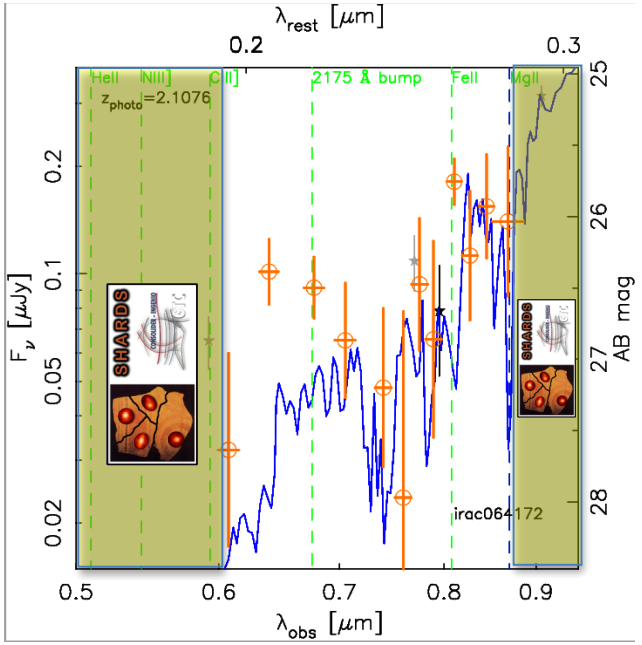








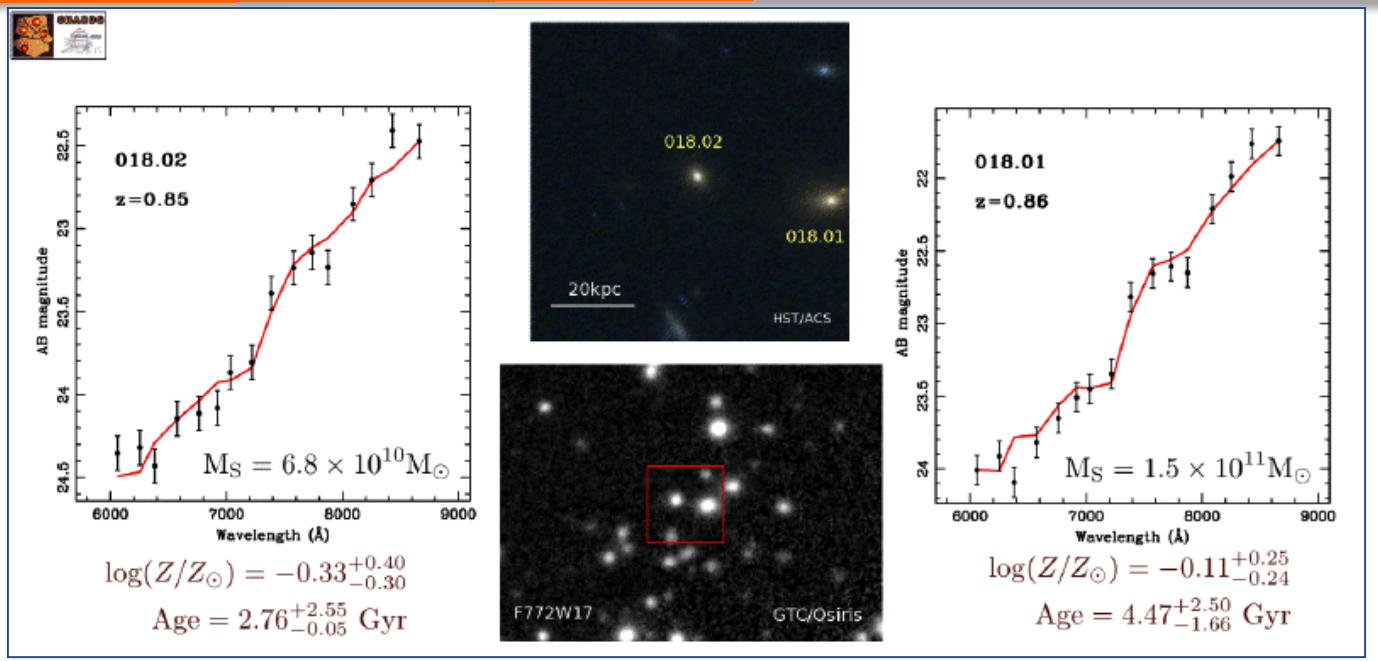


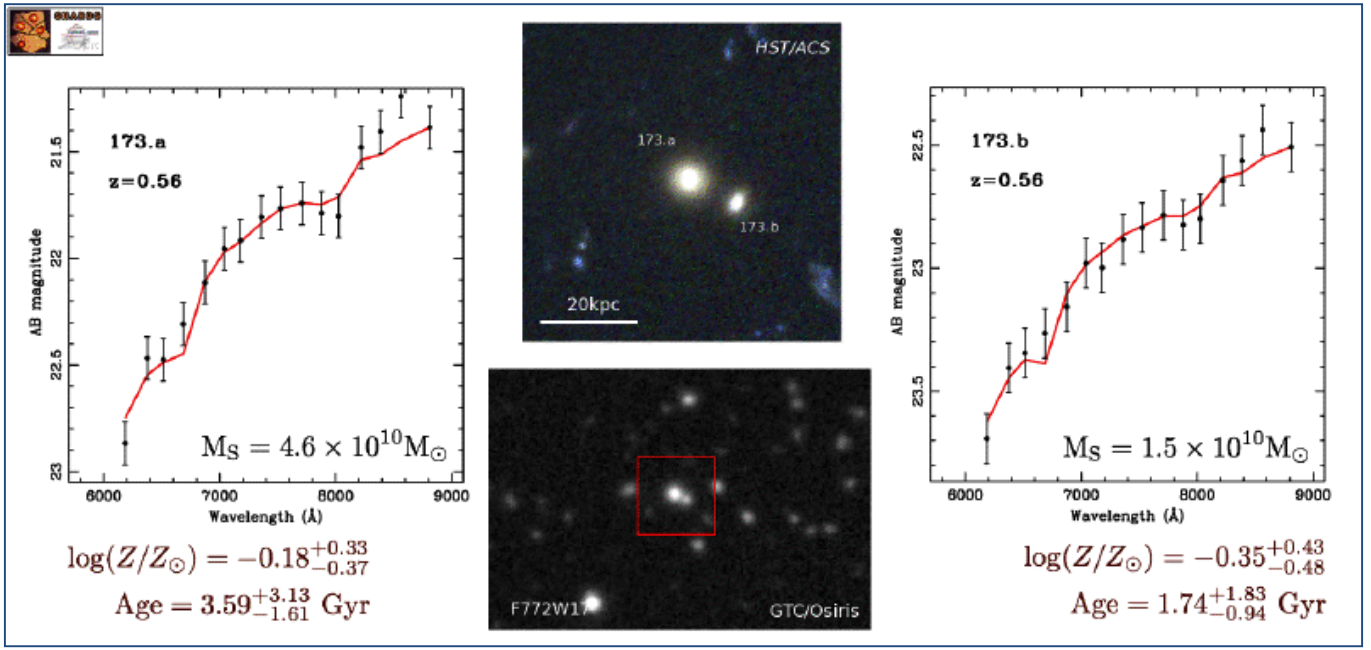


Shards of SHARDS - Science: galaxy satellites

Testing the minor merger scenario

Continuous accretion of minor satellites create the outer envelopes and enlarge the size of the galaxies

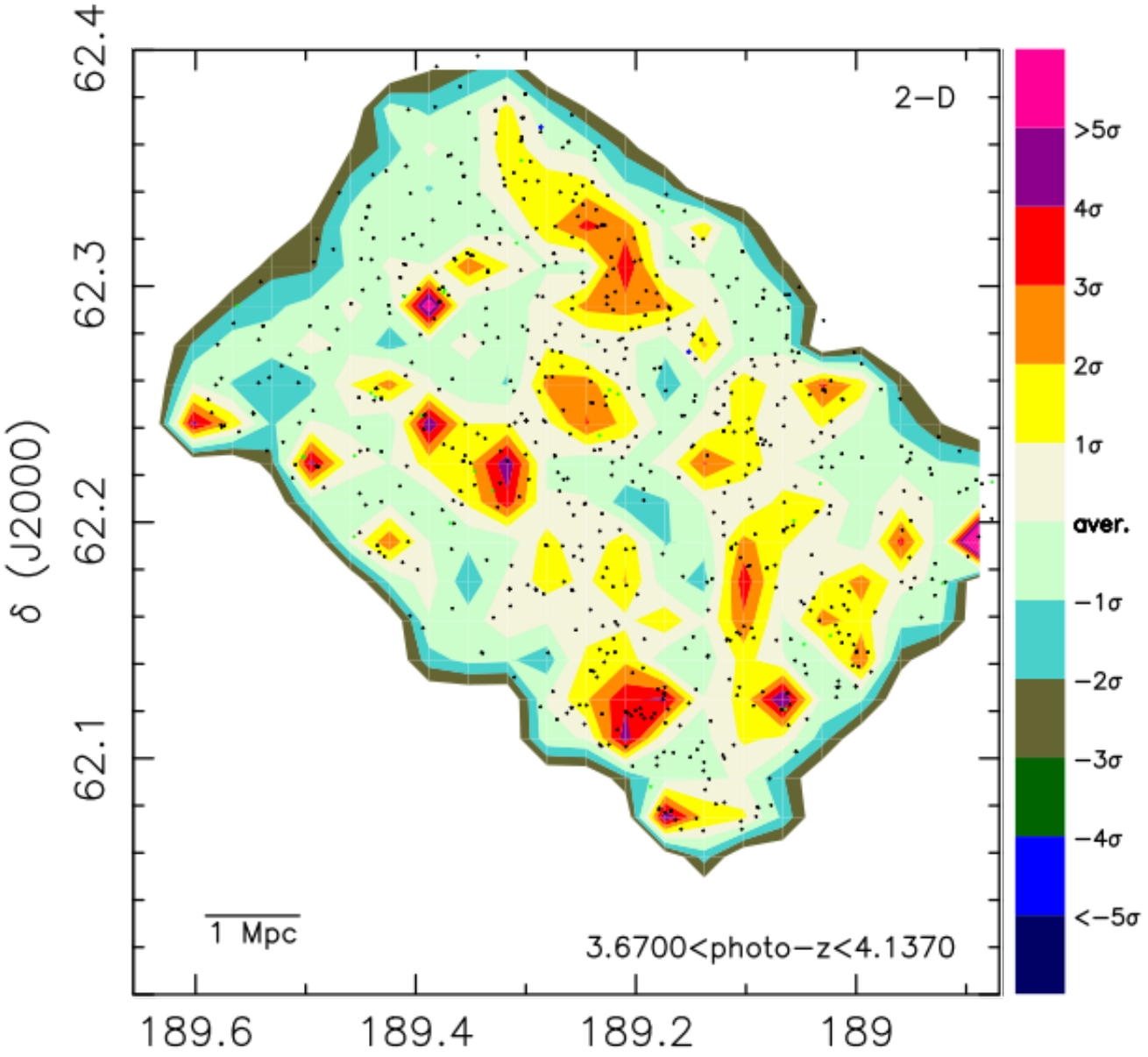




Credit: Ferreras, Trujillo et al. (2012; in prep.)

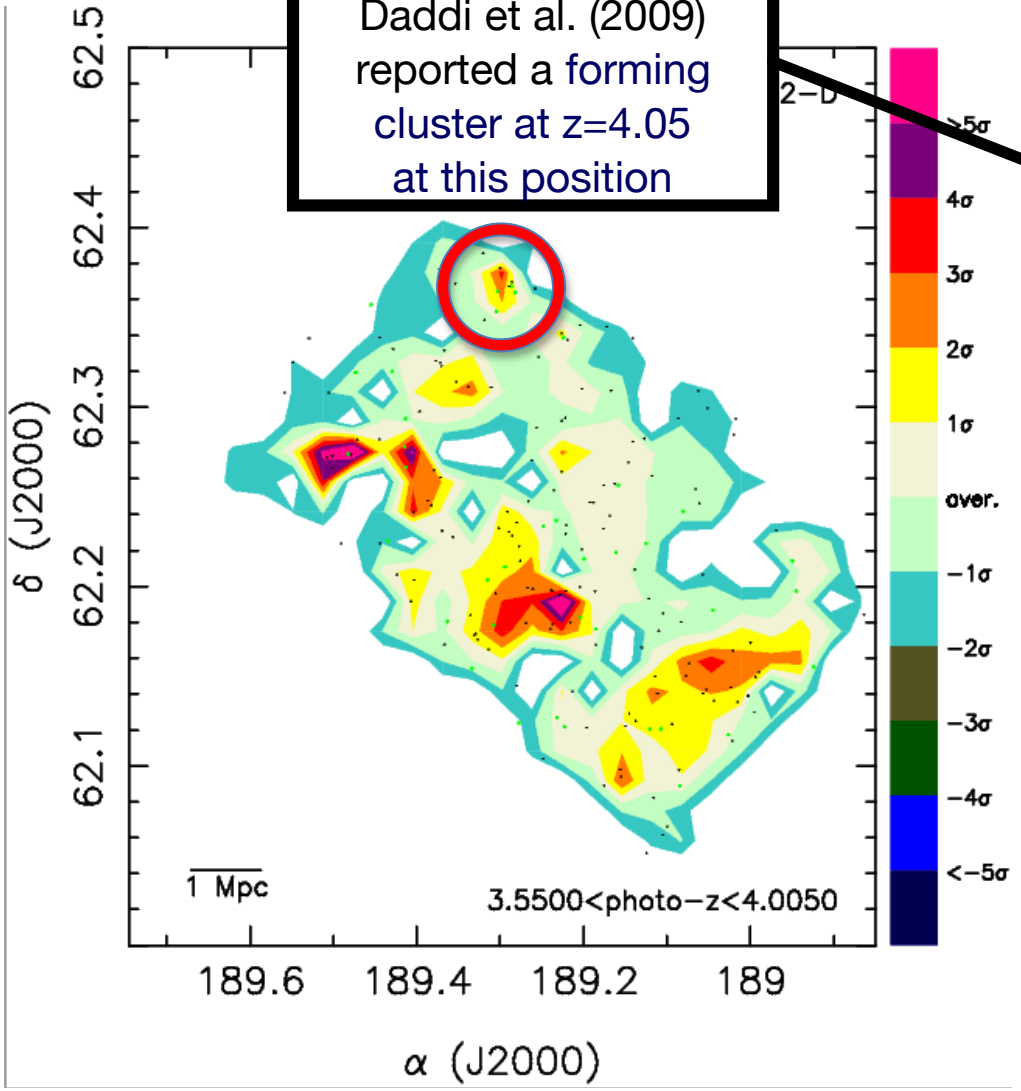
Shards of SHARDS - Science: environment

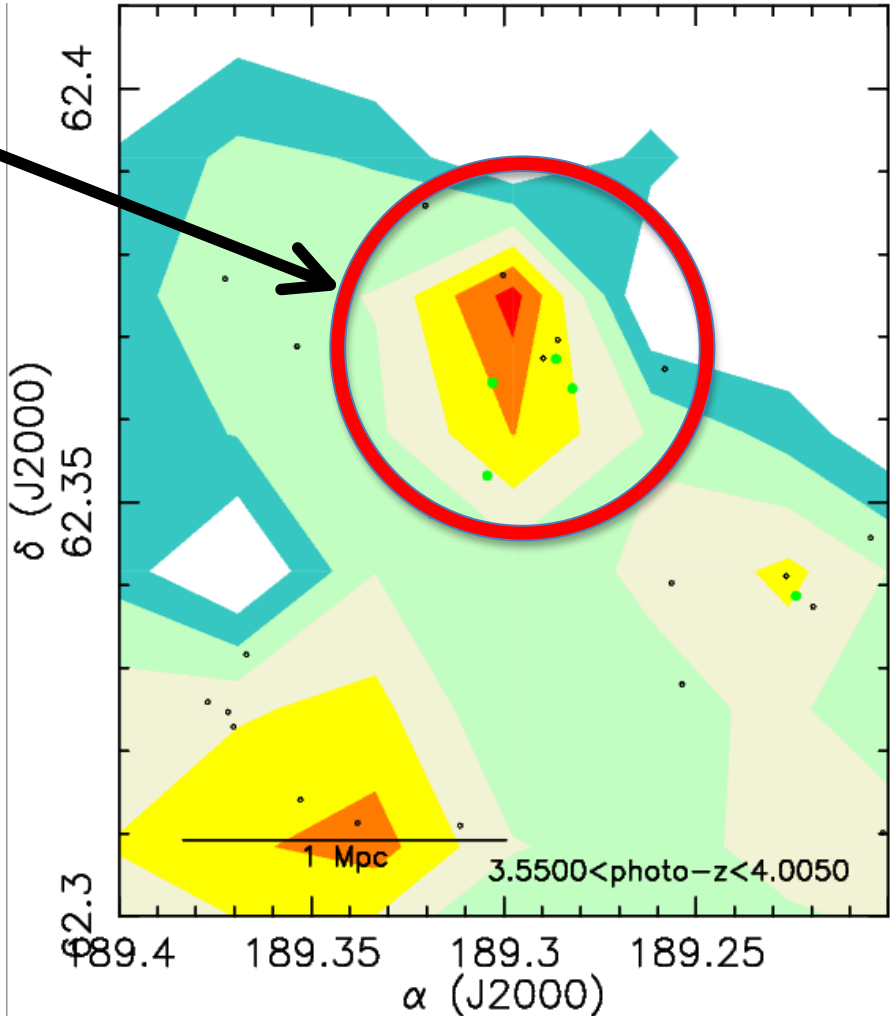
We expect to obtain high quality photometric redshifts (delta(z)/(1 + z)<0.02) for all sources in the GOODS-N field at z<1 and I<26 (more than 10,000 galaxies).



Shards of SHARDS - Science: overdensities

Literature comparison:
Daddi et al. (2009)
reported a forming
cluster at z=4.05
at this position





END

SHARDS vs Large Surveys : a synergy is possible

We all (probably) agree that:

- Small-field ultra-deep surveys must be considered complementary (NOT alternatives) to large-field shallower surveys, both in objectives and methods

- Large-field surveys are indispensable for statistical studies of extreme and rare objects, LSS studies, high-precision cosmology.

...small is beautiful!

Ultra-deep small field surveys are needed and fundamental for galaxy formation studies (high-z) that rely on multi-wavelength ultra deep photometry for detailed SED fitting and stellar population studies. Downsizing, quenching,…

LSS/clustering is out of the reachable goals for small field deep surveys, BUT overdensities at high redshift can be identified and protoclustering investigated only with deep enough data.

Last but not least for SHARDS:

Workbench to JPAS/PAU-like surveys

Spanish leaded survey

SHARDS – Data releases

Release	Date	Notes
DR0	04/2012	First internal data release including maps and catalogs for pointing1
DR1	2013A	Full internal data release:maps and first merged catalogs
DR2	2013B	Updated catalogs
pDR1	2013B	Subset of maps and first catalogs
pDR2	2014B	Full public data release: maps and catalogs
pDR3	2015	Extended data release: ancillary data, basic properties (redshifts, masses, …) and derived stellar population parameters

-Data releases through the Rainbow database in VO format.

- VO-compliant analysis tools (enhancements in utilities such as the Rainbow Navigator web interface).