

Primeval Universe WG

Cuby & Toft
WG leads

Work Packages :

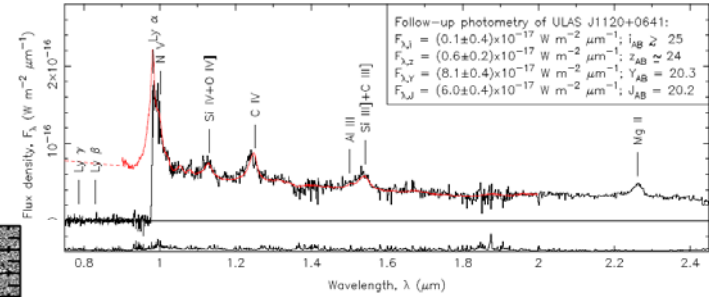
Survey Design (Capak & Dunlop), LBGs (McLure), QSOs (Mortlock, McMahon), IGM (Ferrara), CIRB (Kashlinksy), [lensing](#) (Cooray)

Content

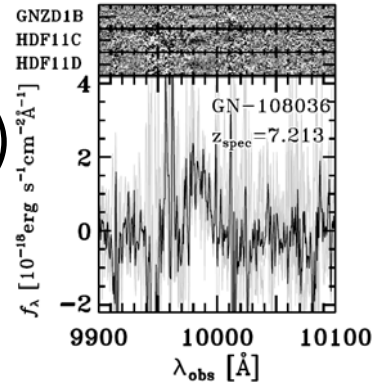
- Deep Fields
- Spectroscopic Surveys
- Synergies ELTs & JWST
- Simulations & cosmological codes

High-z Universe

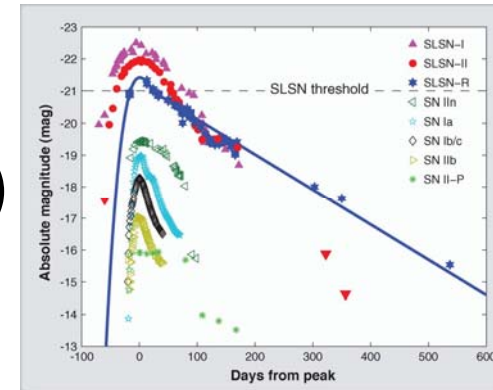
- High-z QSOs (from the Wide)



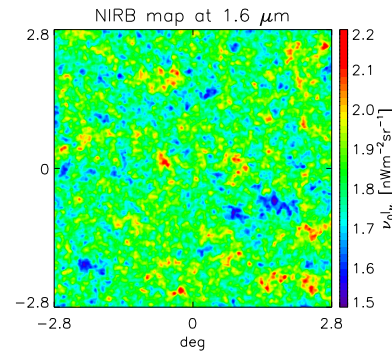
- High-z LBGs (from the Deep)



- High-z SuperLuminous SNe (from the Deep)



- CIB



- Role of lensing on number counts and search strategies

Deep Fields (1/7): time to chose

- Location of the Deep Fields has been discussed since the beginning of Euclid
- There were good reasons to wait
 - Spacecraft and payload designs needed to mature
 - The Reference Survey was required to better understand and evaluate the various options
 - Selection of fields from earlier projects (HSC, LSST)
- Time has now come to select the Euclid Deep Fields (EDFs) – 5 yr before launch
 - R. Scaramella indicates that he wants a meeting in the spring
 - We need additional time from ground based telescopes: we need to get organized now !

Deep Fields (2/7): NEP and SEP

- NEP and SEP_{off}* are mandatory fields for calibration
- These are good fields for CIB studies, but not for high-z objects
 - Multi-wavelength data are a must for proper selection and analysis of the high-z objects. In particular, Deep z-band data is extremely important for de-contamination from Brown Dwarfs
- Southern fields are preferable for most users : ESO / ALMA / LSST / SKA (pathfinders) for preparatory and follow-up observations
- That calibration forced the location of the Deep Fields to be at NEP and SEP is debatable, but let's not debate it here and make instead a compromise proposal

(*) SEP_{off} 7.5 degrees off SEP to avoid strong extinction and LMC

Deep Fields (3/7): NEP and SEP status

- Ref. survey: 20 sq. degrees x 40 visits (nominal depth) at NEP
- Ref. survey: 20 sq. degrees x 40 visits at SEP_{off}

- NEP has best near/mid-infrared degree-scale coverage with Akari / Herschel / Planck / Spitzer / WISE / Scuba2 / LOFAR, etc. data
- However, NEP has very limited optical coverage
- **New !** HSC and CFHT follow-up (PI Hasinger) u,g,r,i,z,y,J + NB
- Still not the preferred location for follow-up

- SEP_{off} also has Akari / Herschel, Spitzer etc. data + DES (+good follow-up capabilities !)

- R. Scaramella is trying to implement *an additional* EDFS 10 sq. degrees field at Dec = -35 deg. Not a known field

Table 1. HEROES specifications

Instrument (1)	Filter (2)	Redshift Range (3)	Exposure/pixel (mins) (4)	5σ mag (5)
HSC SUBARU	g	...	10	26.5
	r	...	10	26.1
	i	...	15	25.7
	z	...	20	25.1
	y	...	20	24.4
	8140	5.67-5.75	10	24.1
	9210	6.53-6.62	20	24.0
WIRCAM CFHT	J	...	5	22.1
MEGAPRIME CFHT	U	...	20	25.5

Magnitudes are 5σ $2''$ diameter AB. The redshift ranges are for the high redshift Lyman α searches. The exposure times are total but will consist of at least 4 stepped sub-exposures to reject cosmic rays and to cover chip boundaries. Readout times are short compared with the individual exposures. The g, r, i, z, y imaging and the narrow band exposures will be carried out with Hyper Suprime-Cam, and comprises 100 fields allowing for field overlap. The J band exposures on CFHT require 1100 pointings and the U exposures 140 pointings

Deep Fields (4/7): conclusions on NEP and SEP

- NEP OK for CIB, possibly OK for high-z objects, not best location for follow-up in general, and certainly not OK for follow-up for most Europeans
 - SEP_{off} : less data than NEP, no HSC/CFHT but VST/VISTA/LSST (?), better follow-up capabilities...
 - Additional EDFS 10 sq. degrees suggested by R. Scaramella does not seem optimal. No data, would require extensive preparatory observations.
- compromise solution would be a mix of NEP, SEP_{off} and equatorial Deep Fields (HSC and LSST)

Deep Fields (5/7): number of visits

- Nominal number of visits at NEP and SEP_{off} for the Deep is 40 over 40 sq. degrees (80 pointings). That is: **3200** visits in total (**4000** including the EDFs proposed by R. Scaramella)
- 12 visits are required for calibration at NEP and SEP_{off} . Assuming we are not interested to go deeper and free to go elsewhere, we could have 2240 visits i.e. 28 degrees at nominal depth (AB=26, 5σ , point source)
- Pb: zodiacal light level higher at the (celestial) equator. Say x 2.5
- Ignoring overheads, visibility and other issues, but including zodi level, we could therefore have ~ 10 -15 sq. degrees at the celestial equator at the nominal depth as part of the nominal Deep Survey allocation with only 12 visits at NEP and SEP_{off}

Deep Fields (6/7): a possible compromise proposal

- 20 sq. degrees at nominal depth (40 visits) in one only of NEP and SEP_{off} and 12 visits only in the other
- 20 sq. degrees on 2 equatorial fields (COSMOS and XMM-LSS)
- Total: 6,000 visits, i.e. ~ 1.5 x current reference survey – 4 additional months. Change of requirements.
- Caveat: would require ~ 2 x 10-day continuous observations for each field every year (4 x 10-day blocks / yr)
- Further possible trade-offs:
 - Reduce even further the number of visits at NEP or SEP_{off}
 - Reduce coverage on equatorial fields

Deep Fields (7/7): equatorial HSC and LSST Deep Fields

COSMOS						
	Area sq. deg	g 5 σ , 2''	r 5 σ , 2''	i 5 σ , 2''	z 5 σ , 2''	y 5 σ , 2''
HSC	7.2	27.5	27.1	26.8	26.3	25.3
LSST	9.5		28			

XMM-LSS						
	Area sq. deg	g 5 σ , 2''	r 5 σ , 2''	i 5 σ , 2''	z 5 σ , 2''	y 5 σ , 2''
HSC	5.3	27.5	27.1	26.8	26.3	25.3
LSST	9.5		28			

- HSC data will be available when Euclid starts

Spectroscopic Surveys

- No clear needs / requirements identified at the moment
- If HSC equatorial fields are retained, it will be important to liaise with PFS/SuMIRe that will cover these fields starting ~ 2020
 - Coordination TBD

Synergies JWST / ELTs

- JWST
 - Synergy with CIB (Deep Field)
 - Follow-up of high-z objects is critical to the science case (SEDs up to 15 mic, spectroscopy).
 - But 3-yr overlap with Euclid (minimum JWST lifetime) -> reach depth before coverage on the Deep
- Definition of key / legacy / projects in preparation / discussion for TMT and E-ELT. Contribution from our WG expected. E.g.:
 - LBG follow-up at high spatial resolution and low/moderate spectral res.(MICADO, HARMONI @ E-ELT)
 - QSO follow-up at high spatial and high spectral resolutions (HARMONI, HIRES @ E-ELT)

Cosmological codes

High-z re-ionization codes include Ly α radiative transfer, at different scales for different science cases: CIB, LAE clustering, QSO Ly α spectroscopy, etc.

In the next months we will review our requirements:

- what simulations need to be done
- what physics should be included
- what codes do we have available
- how to benchmark/compare them
- what supercomputing resources might be needed

We welcome information and feedback on policies for contributed / private codes

We will also review our requirements on image simulations

- Particular attention to peculiar populations contaminating the selection of high-z QSOs and Galaxies: brown dwarfs, red galaxies