VANDELS

A deep VIMOS survey of the CANDELS UDS and CDFS fields

New ESO public VIMOS spectroscopy survey of the UDS and CDFS fields

R. McLure & L. Pentericci

VANDELS

New ESO public VIMOS spectroscopy survey of the UDS and CDFS fields

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80+ Co-Is
10 countries

VANDELS: motivation

Signed-off survey management plan in January 2015, first of four observing seasons runs from Aug 2015 – Jan 2016:

VANDELS: motivation

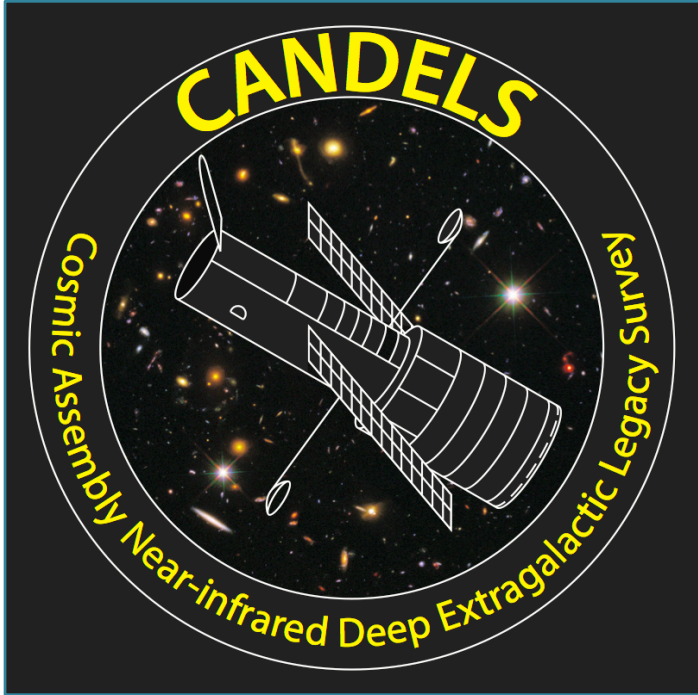Signed-off survey management plan in January 2015, first of four observing seasons runs from Aug 2015 – Jan 2016:

Survey completeness:

3%

VANDELS: motivation

Signed-off survey management plan in January 2015, first of four observing seasons runs from Aug 2015 – Jan 2016:

Proposal was focused on two key aspects:

⊙ Legacy value to astronomy community

⊙ Different science from previous VIMOS surveys (e.g. VVDS, zCOSMOS, VIPERS)

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Signed-off survey management plan in January 2015, first of four observing seasons runs from Aug 2015 – Jan 2016:

Proposal was focused on two key aspects:

⦿ Legacy value to astronomy community

⦿ Different science from previous VIMOS surveys (e.g. VVDS, zCOSMOS, VIPERS)

Four key elements of VANDELS:

⦿ Small area (0.2 sq. degrees), best available multi-wavelength data
⦿ Ultra-long integrations, minimum 20 hours per source (80 hour max)
⦿ Medium resolution spectra (MR grism)
⦿ Pre-selection biased to very high redshift (85% of targets at z>3)

VANDELS: survey fields

CANDELS
Cosmic Assembly Near-infrared Deep Extragalactic Legacy Survey

HST optical/near-IR imaging survey covering 0.2 square degrees split over 5 survey fields

COSMOS

EGS

GOODS-N

UDS

GOODS-S

VANDELS: survey fields

HST optical/near-IR imaging survey covering 0.2 square degrees split over 5 survey fields
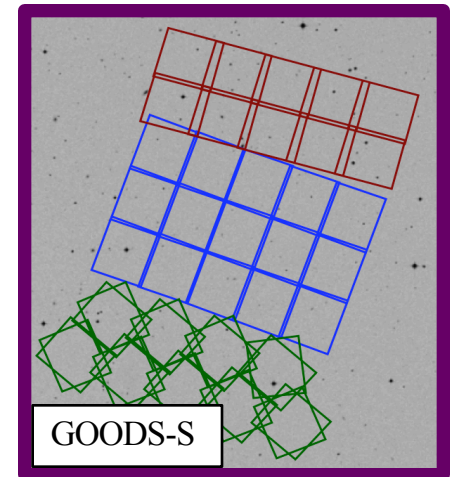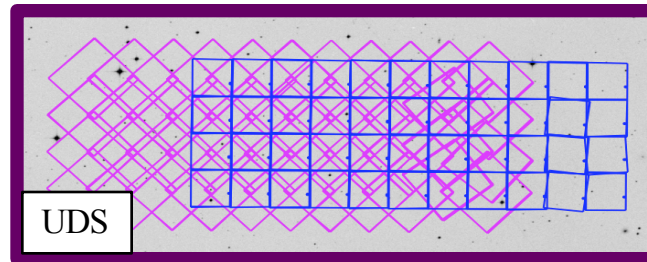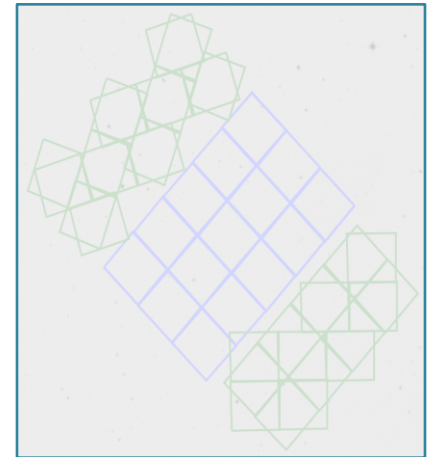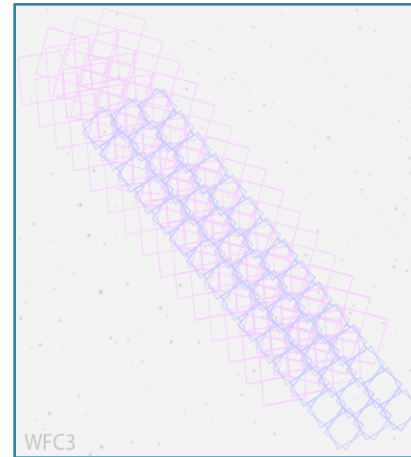
VANDELS targets the two southern CANDELS fields, exploiting unrivalled 15+ band (0.3μm-4.5μm) photometry and near-IR grism spectra (3D-HST)
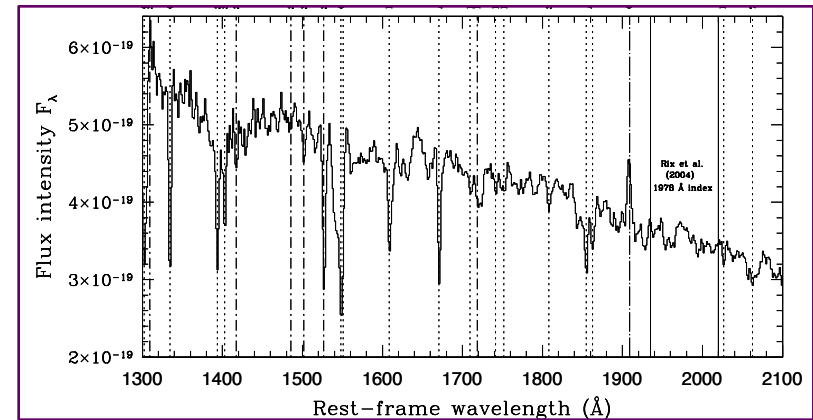
VANDELS: motivation

Primary Targets

- ⊙ Star-forming galaxies at 2.4<z<5.0 (H_{AB}<24)
- ⊙ Passive galaxies at 1.0<z<2.5 (H_{AB}<22.5)
- ⊙ Lyman-break galaxies at 3.0<z<7.0 (H_{AB}<27)

VANDELS: motivation

Primary Targets

- Star-forming galaxies at 2.4<z<5.0 (H_{AB}<24)
- Passive galaxies at 1.0<z<2.5 (H_{AB}<22.5)
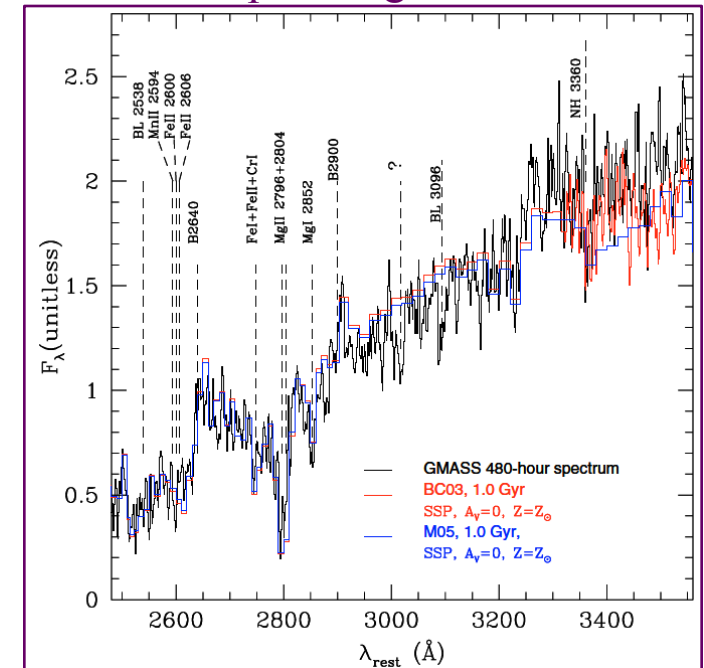- Lyman-break galaxies at 3.0<z<7.0 (H_{AB}<27)

Combine ultra-deep optical spectroscopy with near-IR grism spectroscopy and 0.3μm-4.5μm photometry to measure *physical* tracers of galaxy evolution: age, mass, dust, SFR, outflows, stellar metallicity….

Provide sufficient signal-to-noise and resolution to measure physical properties from *individual* spectra as well as stacks

Absorption line metallicities

UV+optical age constraints

VANDELS: motivation

Primary Targets

⊙ Star-forming galaxies at 2.4<z<5.0 (H_{AB}<24)
⊙ Passive galaxies at 1.0<z<2.5 (H_{AB}<22.5)
⊙ Lyman-break galaxies at 3.0<z<7.0 (H_{AB}<27)

Fundamental aim is to move beyond redshift measurement and extract *physical* information from the spectra
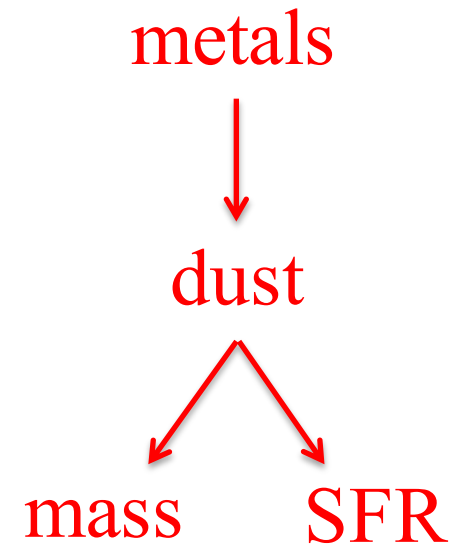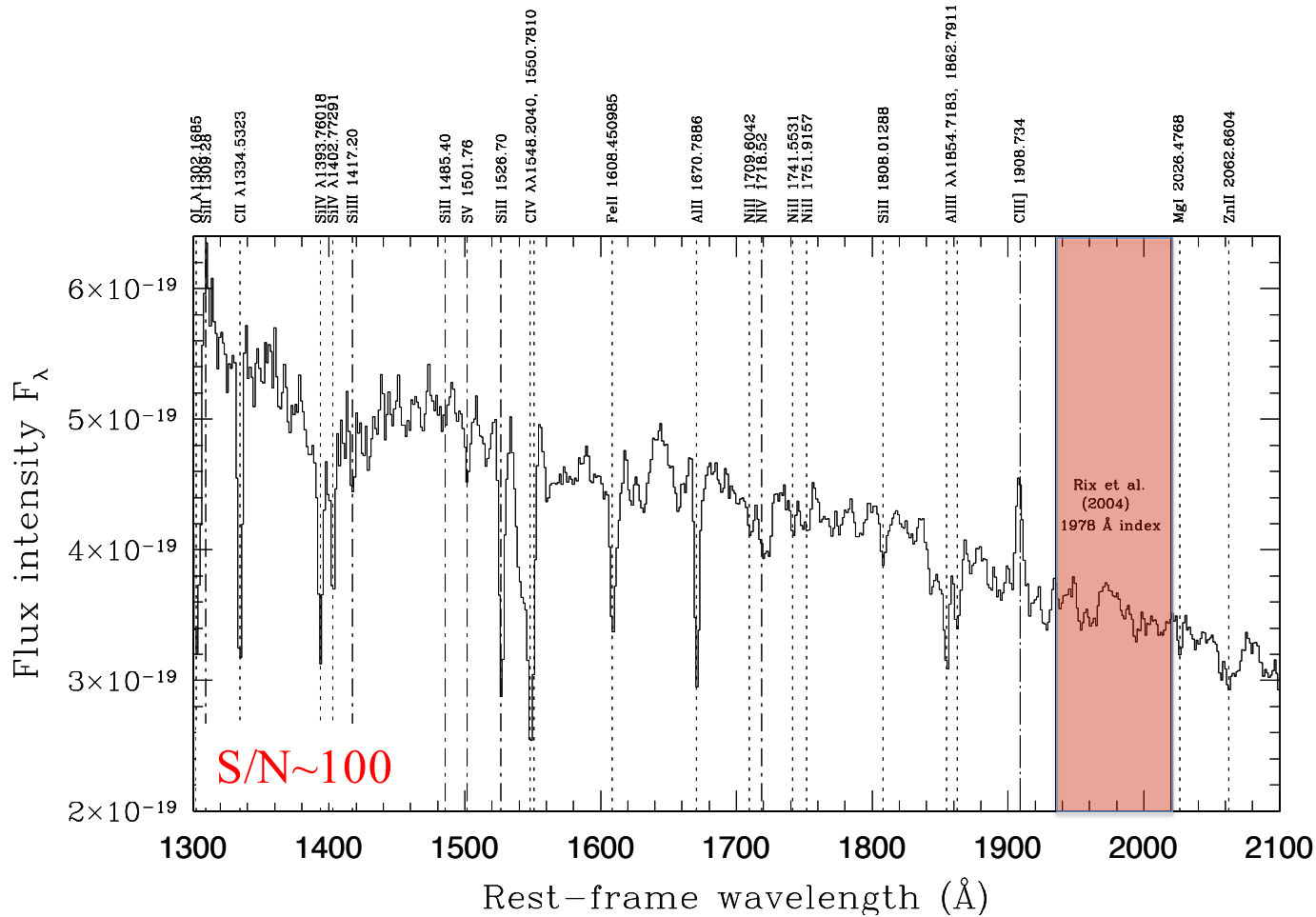
Absorption line metallicities
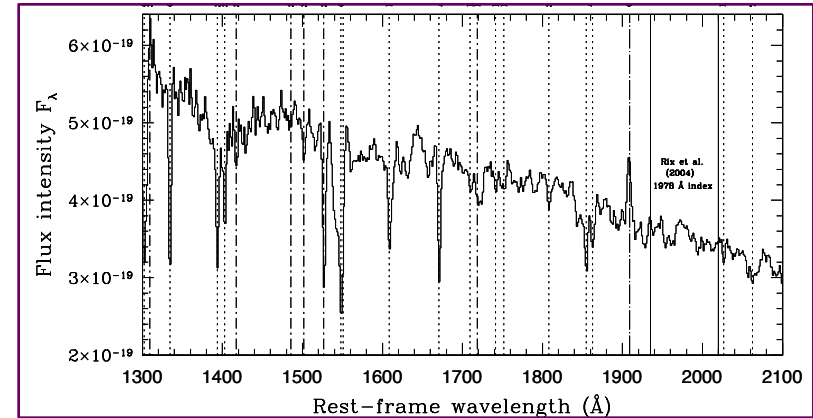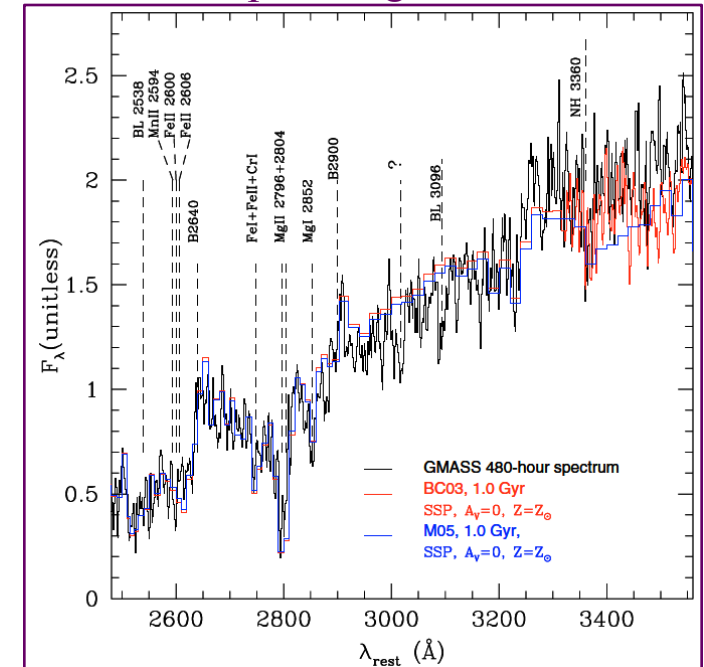
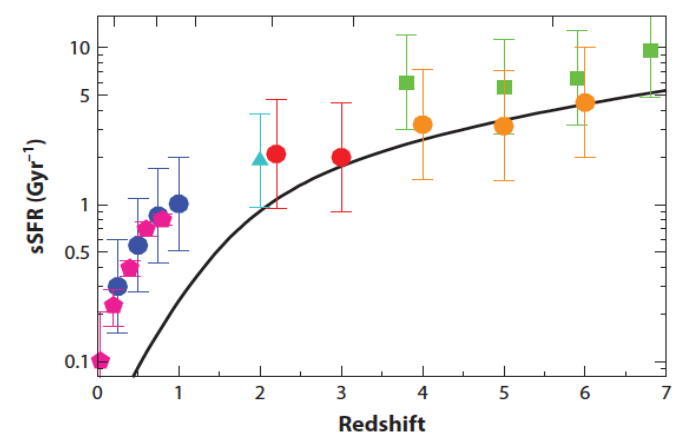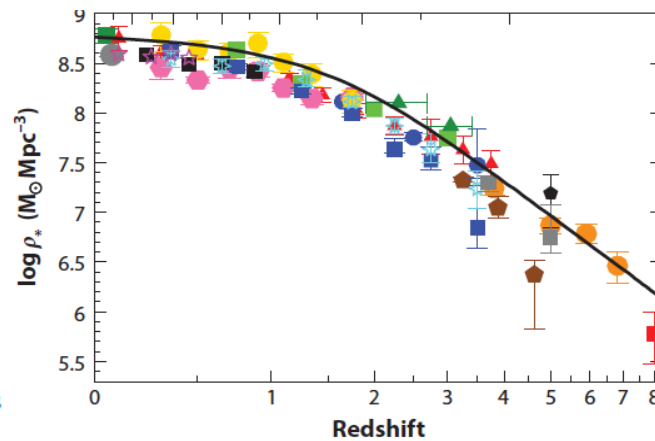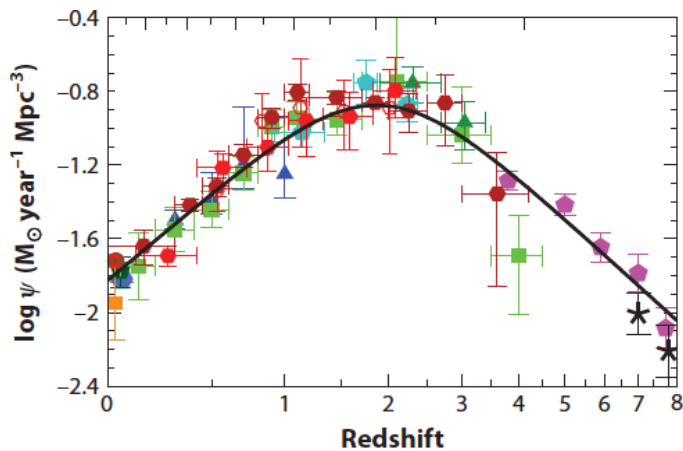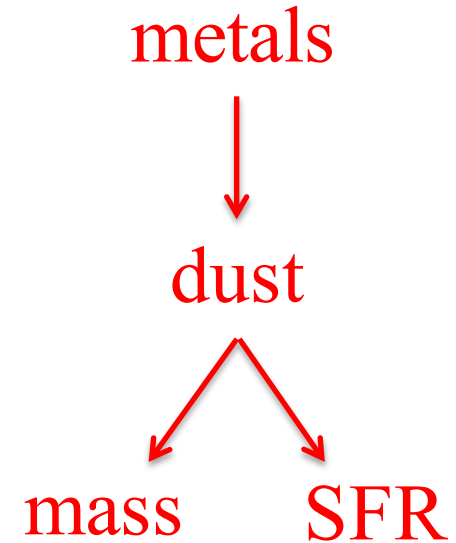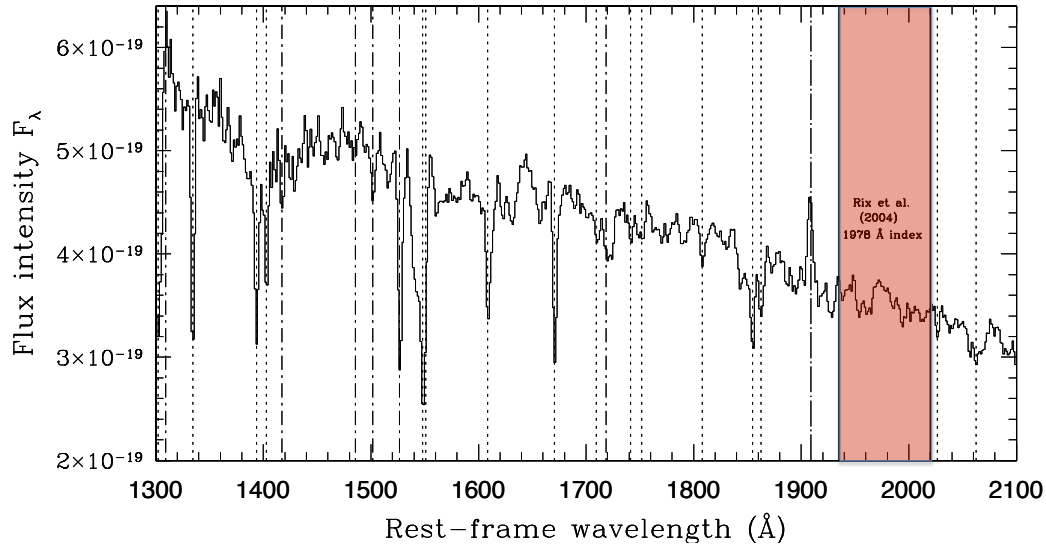**UV+optical age constraints**

VANDELS: main science case

Primary science case is really focused on determining metallicity of star-forming galaxies at 2.4<z<5.5:

Halliday et al. (2008), stack of 75 GMASS galaxies at z~2

VANDELS: main science case

Primary science case is really focused on determining metallicity of star-forming galaxies at 2.4<z<5.5:

metals

↓

dust

↙ ↘

mass   SFR

Madau & Dickinson (2014)

VANDELS: main science case
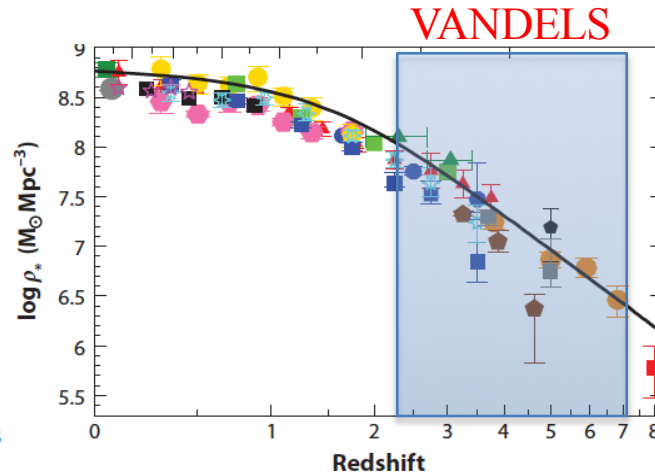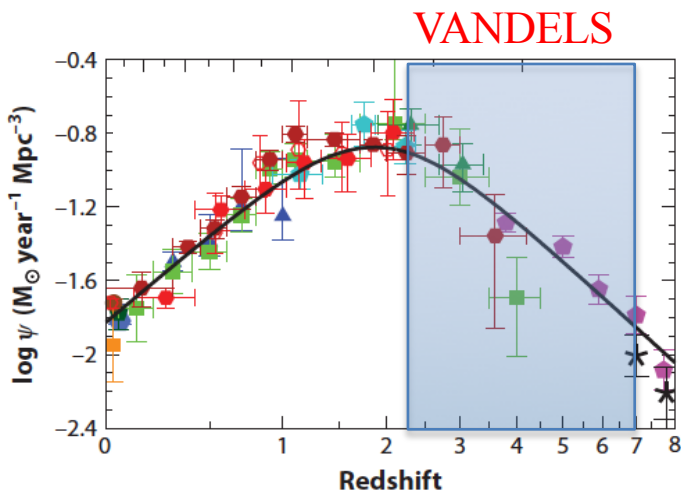
Primary science case is really focused on determining metallicity of star-forming galaxies at 2.4<z<5.5:

metals
↓
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↙ ↘
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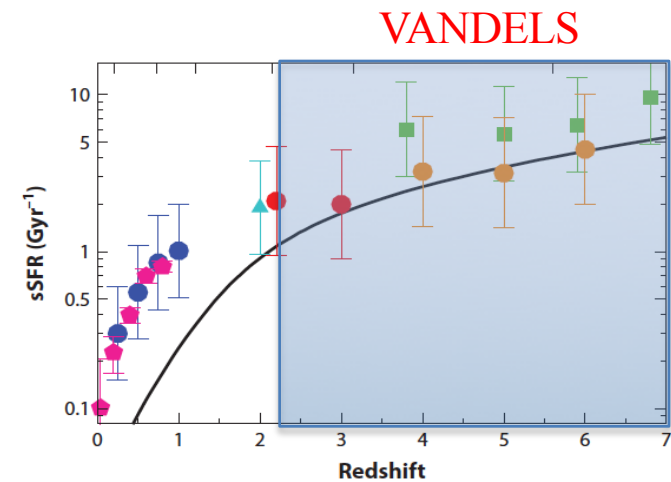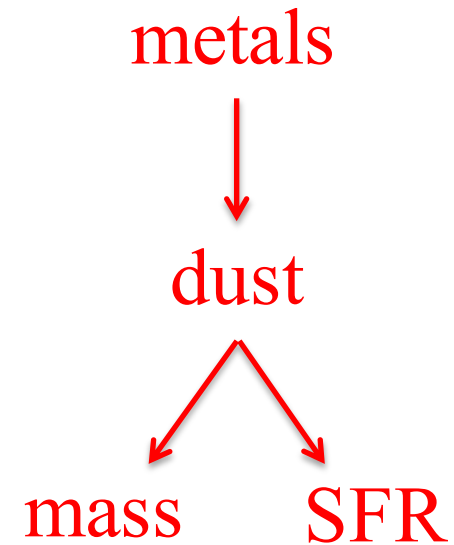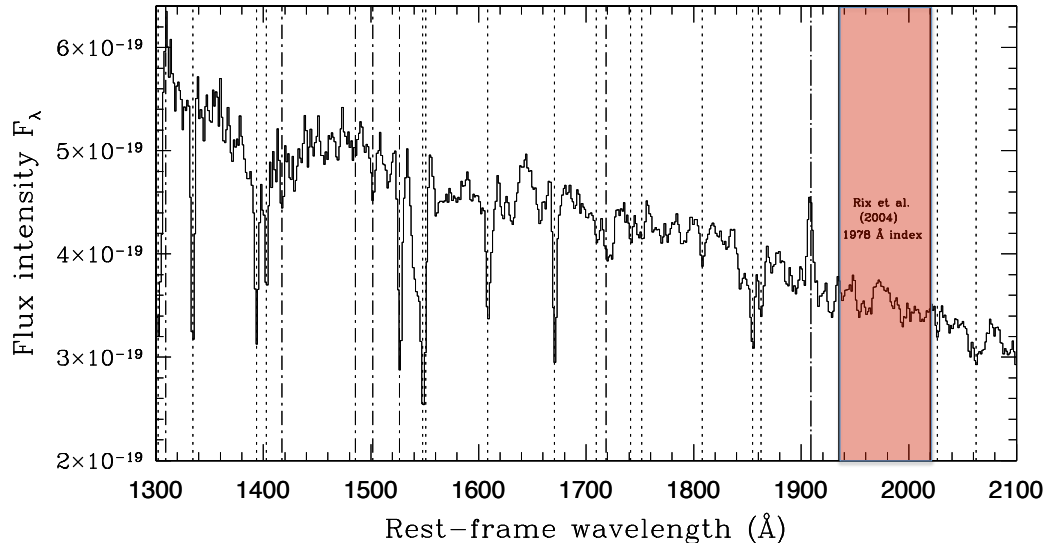
Madau & Dickinson (2014)

VANDELS: main science case

Interesting secondary science case is detailed investigation of the descendents of high-z star-formers: passive galaxies at 1.0<z<2.5
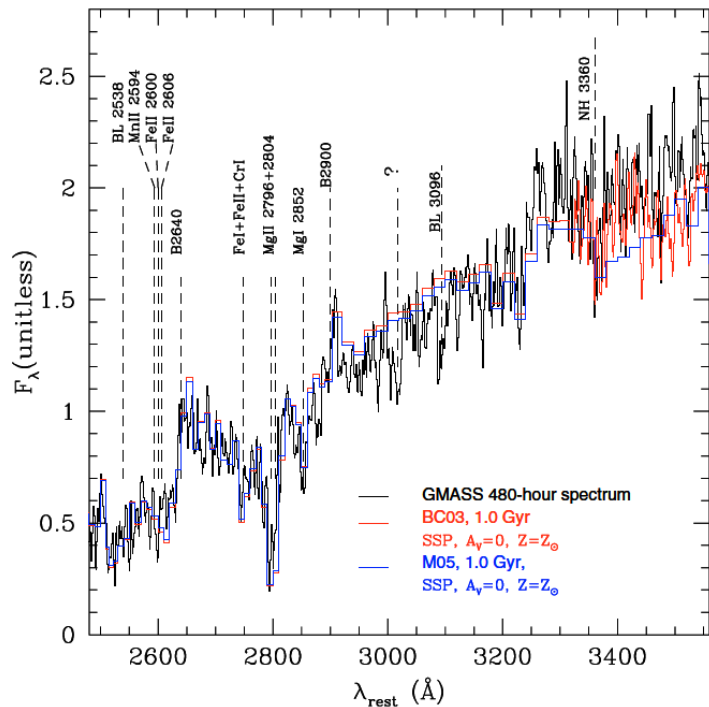
Cimatti et al. (2008)
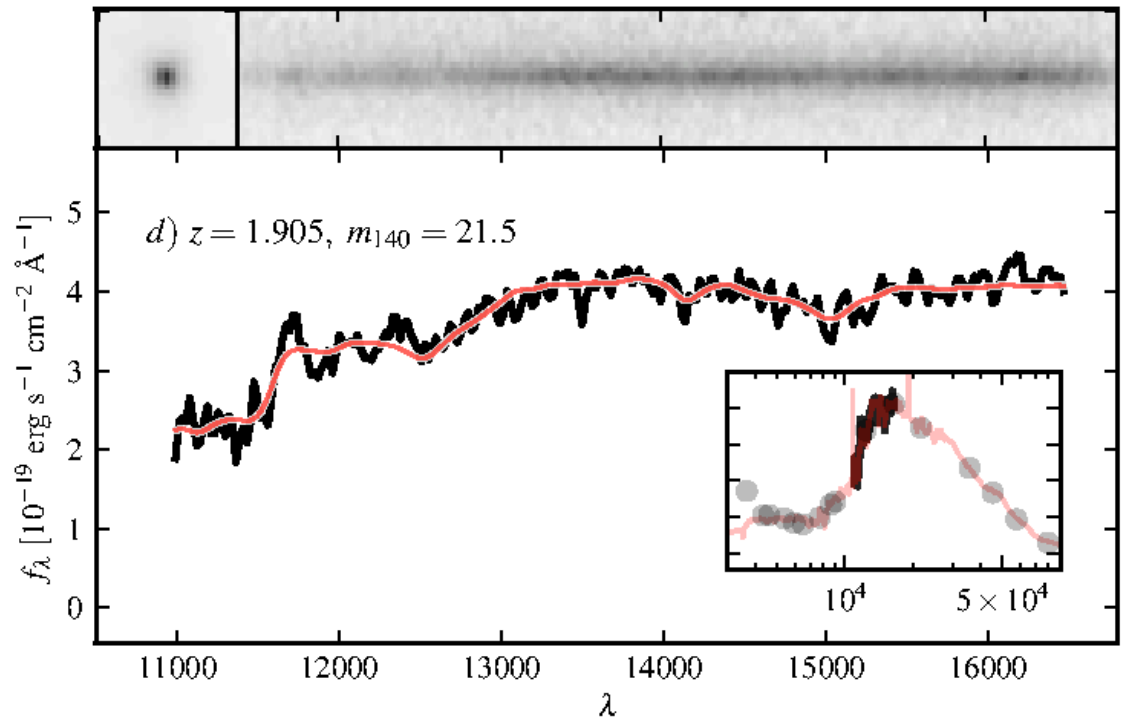
3D-HST (van Dokkum et al.)

⊙ Possible to constrain ages from UV breaks (2600/2800 Angs) from VANDELS and Balmer break from 3D-HST spectra

⊙ Full spectrophotometric fitting (photometry+spectra) offers prospect of delivering accurate stellar ages, masses and metallicities of massive quiescent galaxies at z~2

VANDELS: science case summary

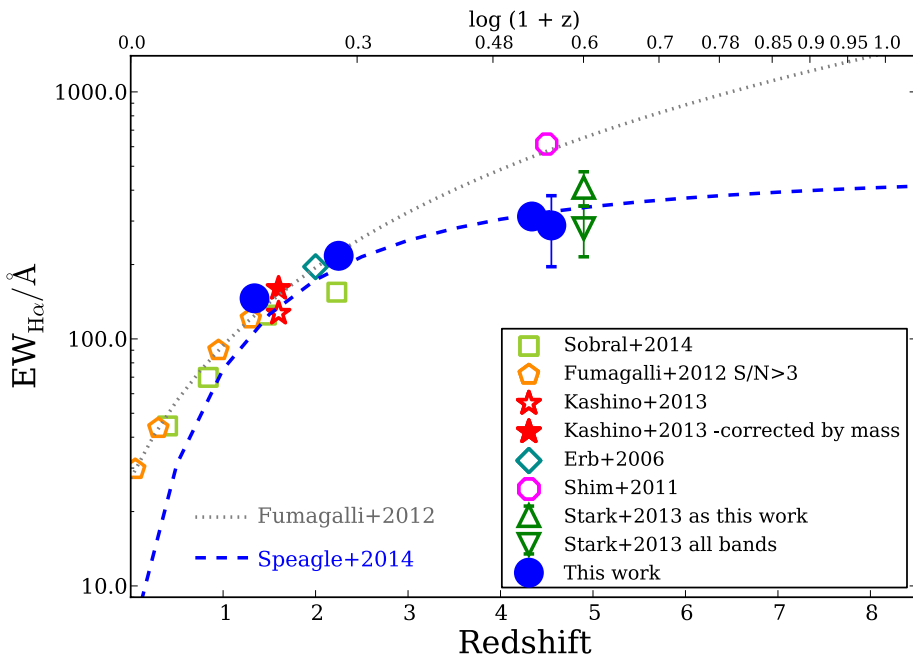- ⊙ Constraints on metallicity, dust, age of star-forming galaxies at z>2
- ⊙ Measurements of age, metallicity and stellar mass of quiescent galaxies 1<z<2.5
- ⊙ Outflow/inflow velocity measurements – feedback, build-up of mass-metallicity relation

Marmol-Queralto, McLure et al. (2015)

Hα equivalent width (EW) measured from SED-fitting of spectroscopically confirmed star-forming galaxies in CANDELS UDS+CDFS

Is Hα a decent proxy for sSFR?

VANDELS will provide 450+ spectroscopically confirmed galaxies in crucial redshift range

- ⊙ Quantify impact of nebular line emission at high redshift
- ⊙ Unbiased measurement of Lyα emitter fraction into epoch of reionization
- ⊙ Comparison with physical properties of AGN and Herschel sources

VANDELS: observations

CDFS: Pointings 1+2

CDFS: Pointings 3+4

UDS: Pointings 1+2

UDS: Pointings 3+4

VIMOS FOOTPRINT
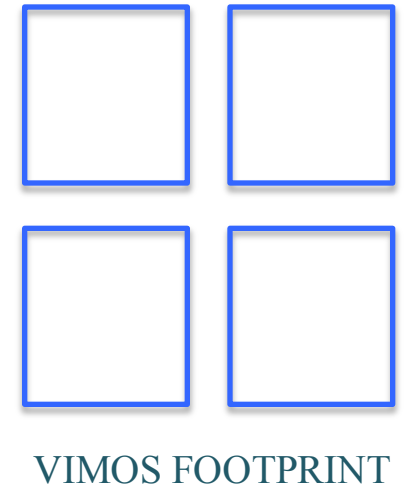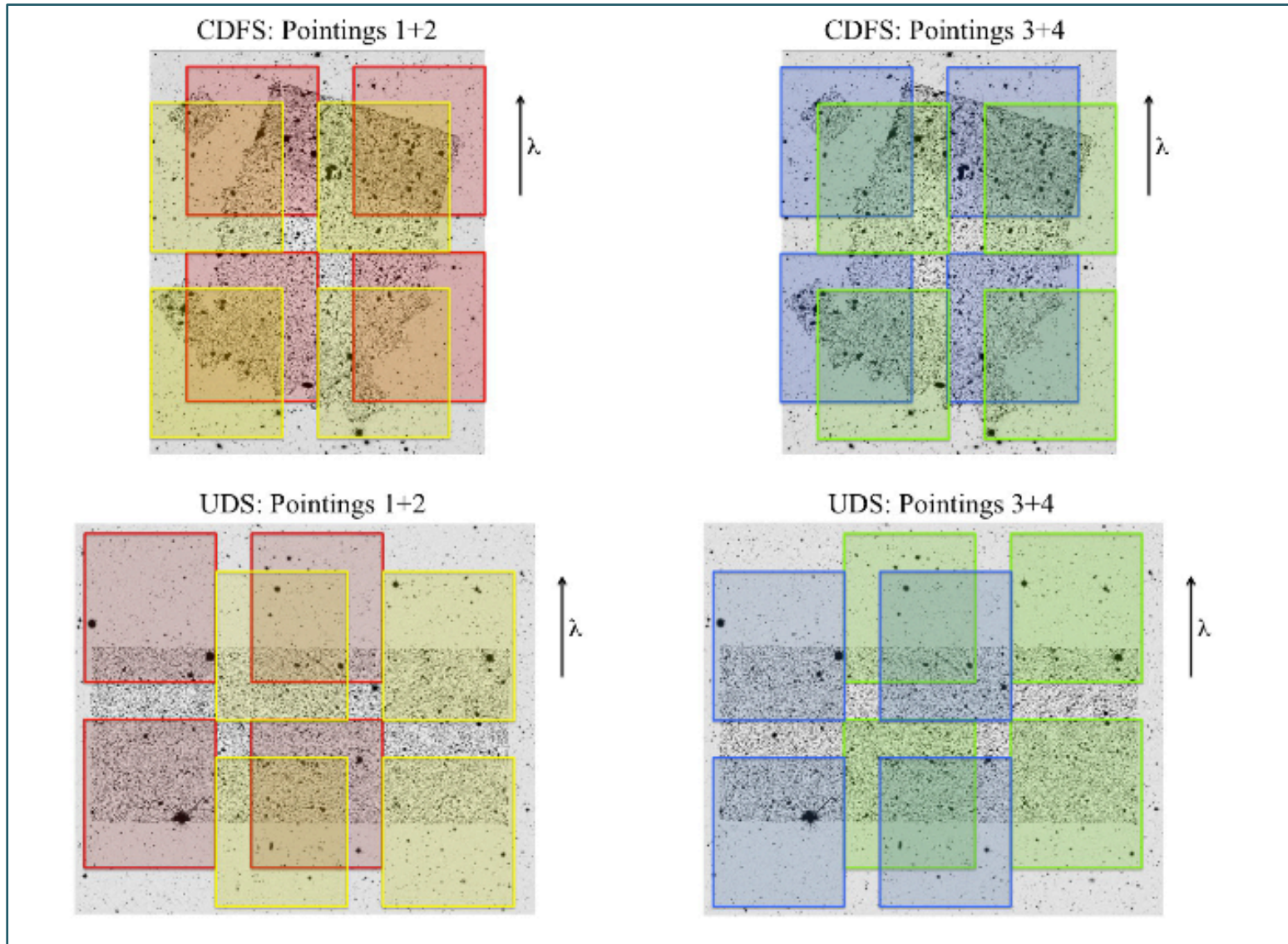
8 pointings in total, designed to cover HST imaging area

VANDELS: observations
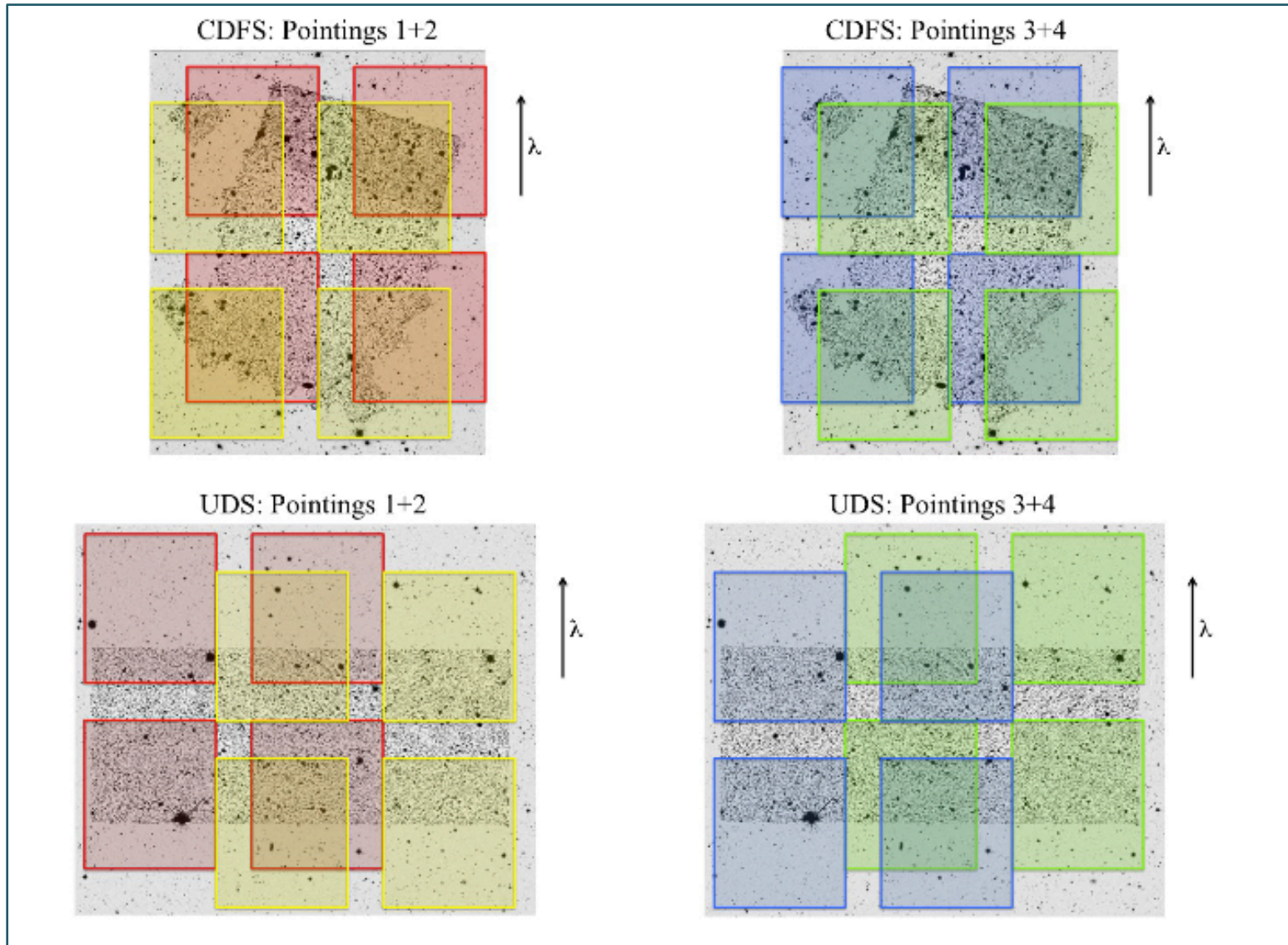
Each pointing targeted four times, for 20 hours each:
bright targets get 20 hours, faint targets get 80 hours

VANDELS: photo-z pre-selection

VANDELS exploits the multi-wavelength photometry in UDS and CDFS to do uniquely robust photometric redshift pre-selection….
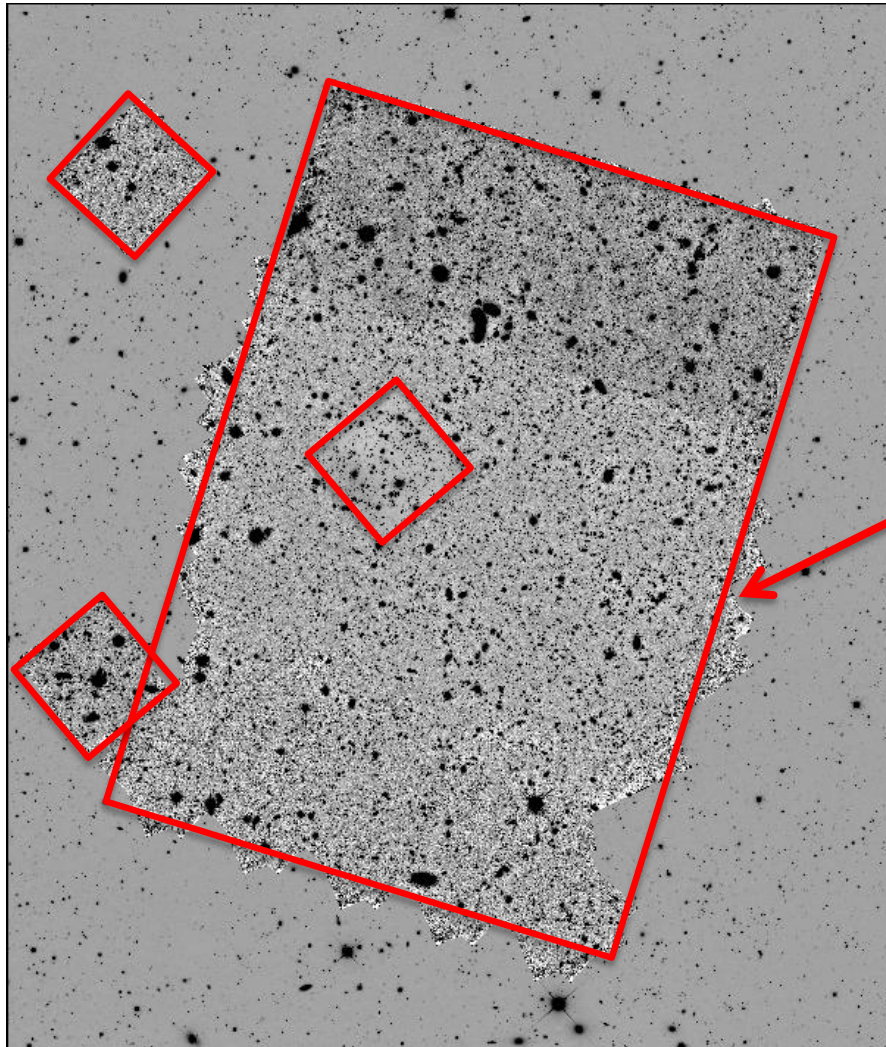
VANDELS: photo-z pre-selection

VANDELS exploits the multi-wavelength photometry in UDS and CDFS to do uniquely robust photometric redshift pre-selection….

VANDELS CDFS FIELD

In area covered by CANDELS HST imaging use the Guo et al. (2013) TFIT catalogues featuring aperture matched, 14-band photometry 0.3-4.5μm

VANDELS: photo-z pre-selection

VANDELS exploits the multi-wavelength photometry in UDS and CDFS to do uniquely robust photometric redshift pre-selection….

VANDELS CDFS FIELD

For extended CDFS region, Edinburgh VANDELS catalogue, utilizing a combination of 16-band photometry:

VIMOS U+R imaging
GEMS HST imaging in V_{606} and z_{850}
Subaru medium band imaging (7 bands)
J+K imaging from TENIS survey on CFHT
Y+H imaging from VISTA VIDEO survey
IRAC "supermap" of all CDFS Spitzer programmes

VANDELS: photo-z pre-selection

VANDELS exploits the multi-wavelength photometry in UDS and CDFS to do uniquely robust photometric redshift pre-selection….
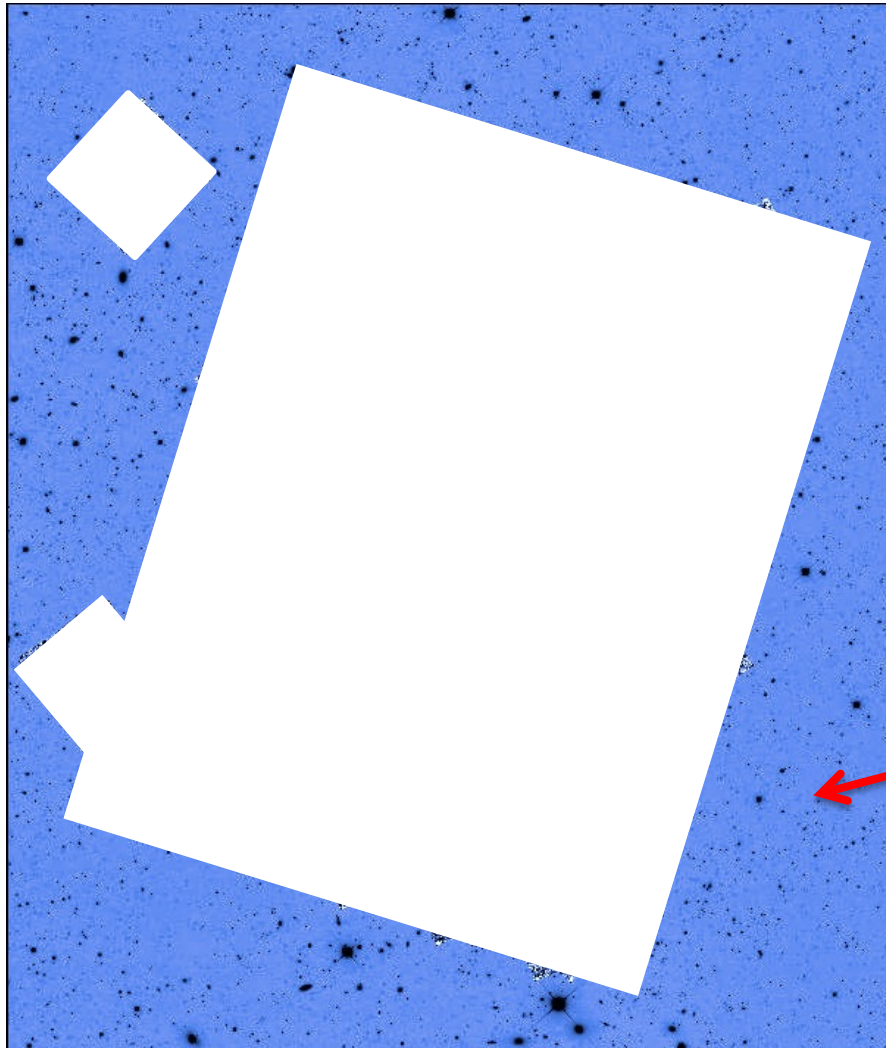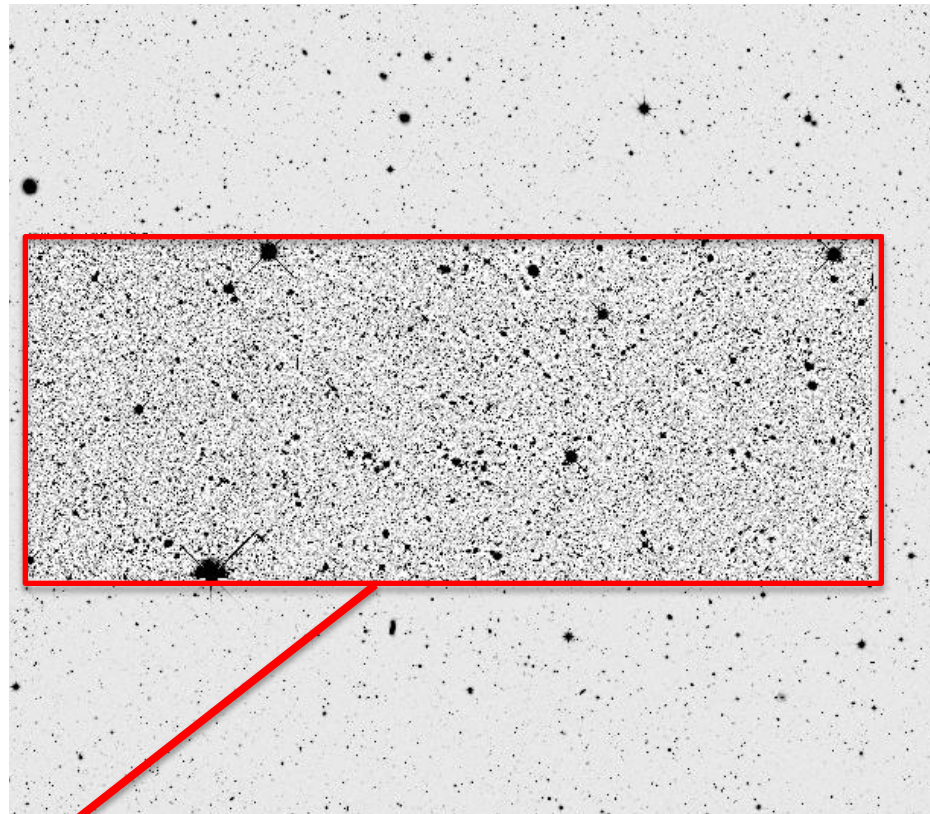

VANDELS UDS FIELD

Within CANDELS HST region, exploit Galametz et al. (2013) TFIT catalogue, which features 15-band aperture matched photometry covering 0.3-4.5μm

VANDELS: photo-z pre-selection

VANDELS exploits the multi-wavelength photometry in UDS and CDFS to do uniquely robust photometric redshift pre-selection….

VANDELS UDS FIELD

Within extended UDS region, Edinburgh VANDELS catalogue using 13-band photometry:
CFHT U-band, Subaru $BVRizz_{nb}$, VIDEO Y-band, JHK from UKIDSS UDS, IRAC from SEDS

VANDELS: photo-z pre-selection

VANDELS exploits the multi-wavelength photometry in UDS and CDFS to do uniquely robust photometric redshift pre-selection….
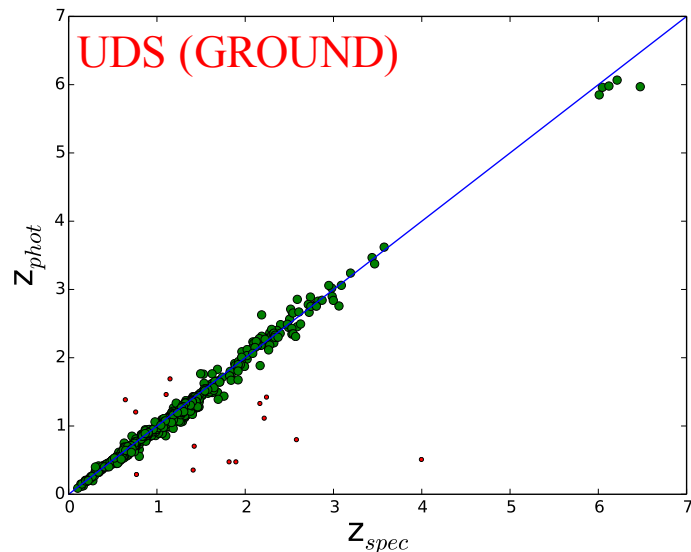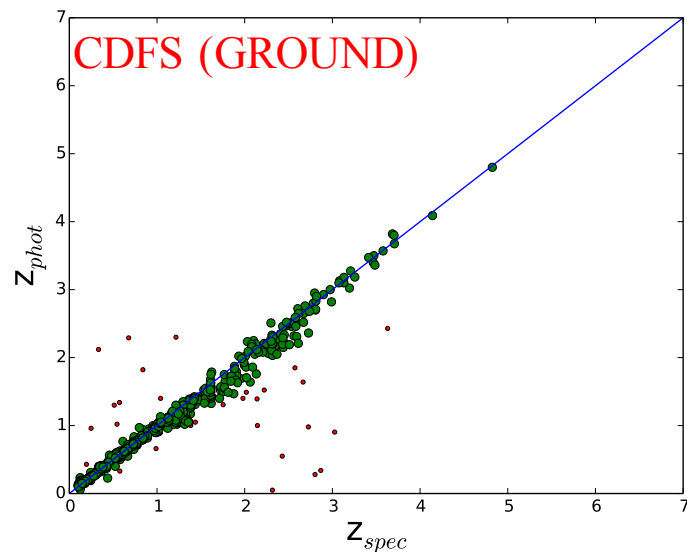

HST regions:
Official CANDELS photo-z catalogues (Dahlen et al. 2013)

WIDE regions:
❖ Photo-z results based on new ground-based multi-wavelength photometry catalogues

❖ 14 independent photo-z runs (11 individuals)
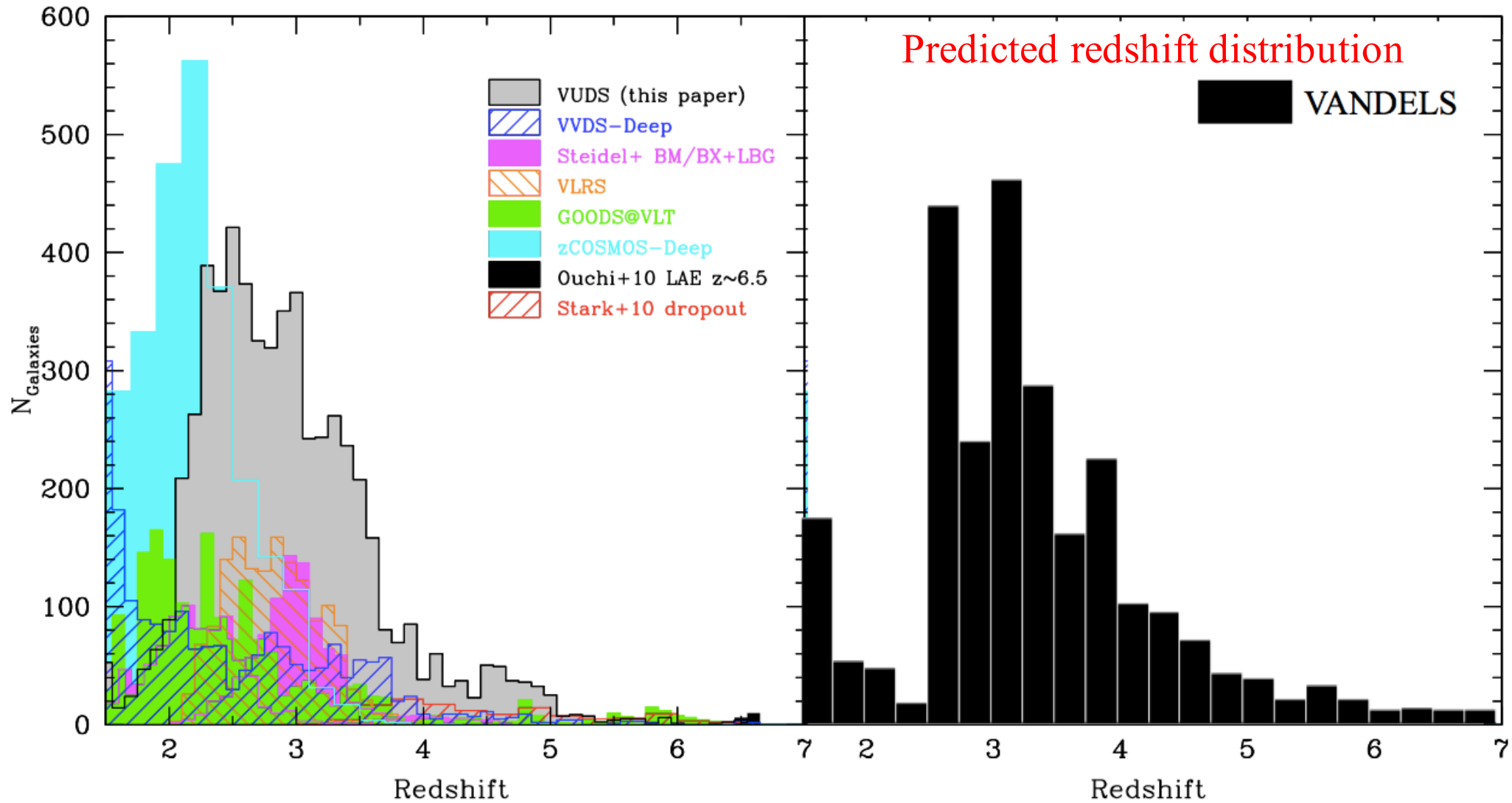
❖ median photo-z results comparable with HST results

$$\sigma_{MAD}=0.015$$

outlier fraction $< 2\%$

Realistic aim is for $<10\%$ redshift interlopers
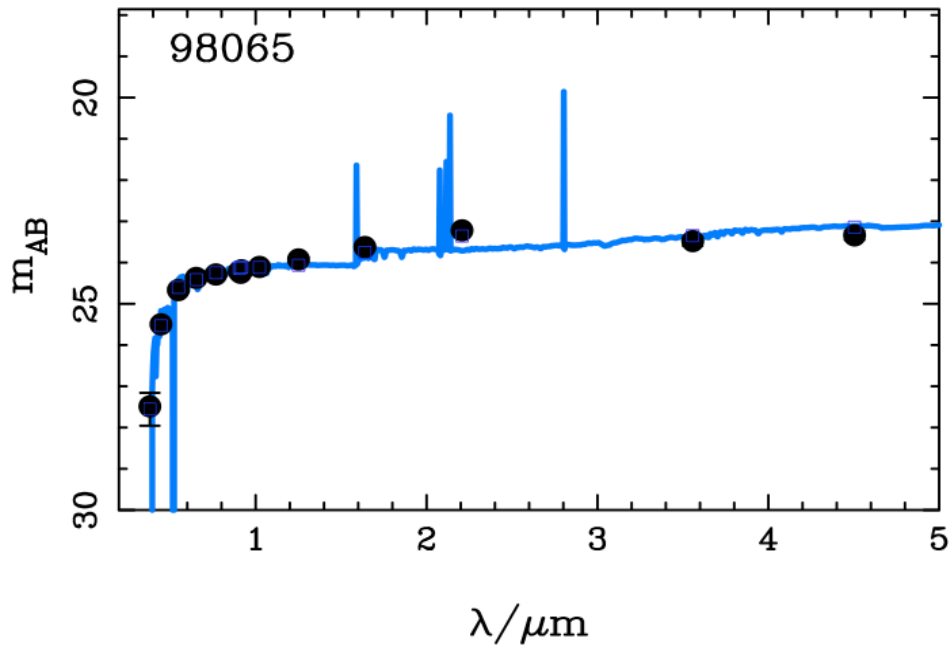
VANDELS: photo-z pre-selection

Le Fèvre et al (2015)

VANDELS: test observations

Allocated two observing runs in Nov/Dec 2014 to test mask preparation and observing strategy. Obtained ~10 hours of integration in both UDS and CDFS on two masks.

Example 2D spectra from UDS mask:

FIELD: UDS (EXTENDED AREA)
ID: 98065
CLASS: 2.4<z<5.5 SF
z_{phot} = 3.27
z_{spec} = 3.24

SF at z=3.24

VANDELS: test observations

Allocated two observing runs in Nov/Dec 2014 to test mask preparation and observing strategy. Obtained ~10 hours of integration in both UDS and CDFS on two masks.

Example 2D spectra from UDS mask:

FIELD: UDS (EXTENDED AREA)
ID: 99159
CLASS: High-z AGN
$z_{phot} = 3.81$
$z_{spec} = 3.97$

Type 1 AGN at z=3.97

VANDELS: test observations

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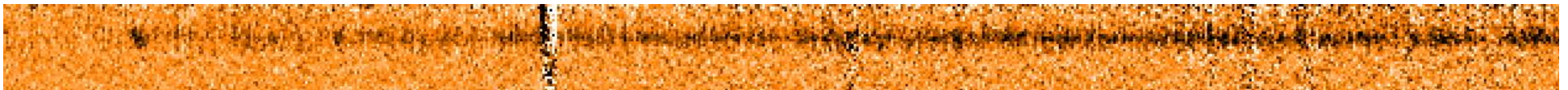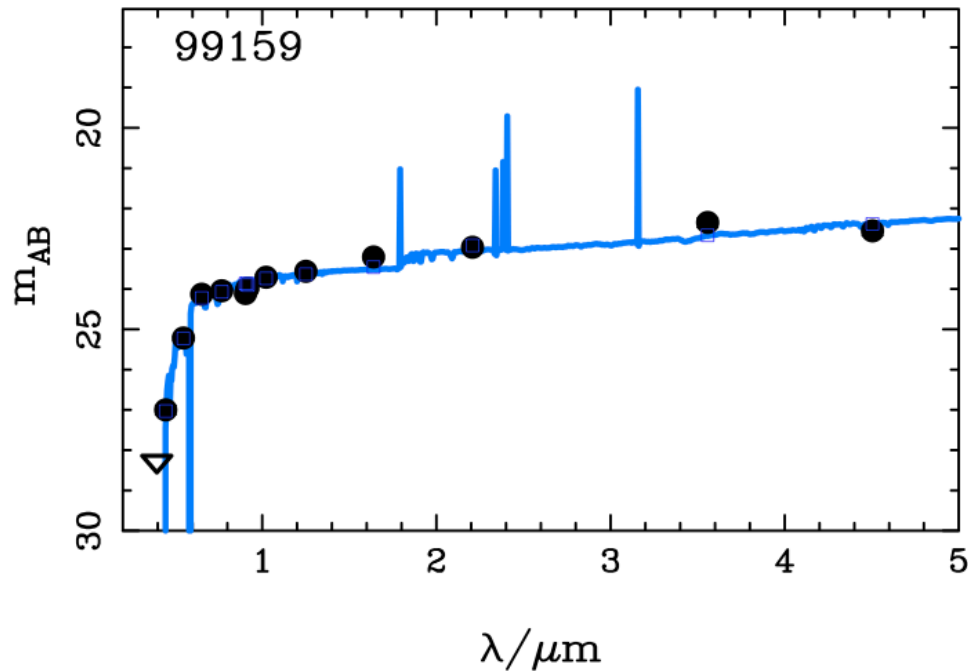
Example 2D spectra from UDS mask:

FIELD: UDS (CANDELS AREA)
ID: 2113
CLASS: $3.0 < z < 7.0$ LBG
$z_{phot} = 3.94$
$z_{spec} = 4.03$

LAE at z=4.03

VANDELS: test observations

Allocated two observing runs in Nov/Dec 2014 to test mask preparation and observing strategy. Obtained ~10 hours of integration in both UDS and CDFS on two masks.
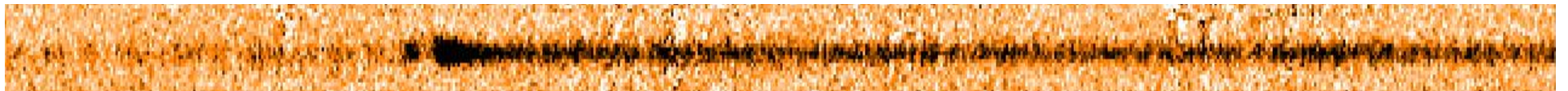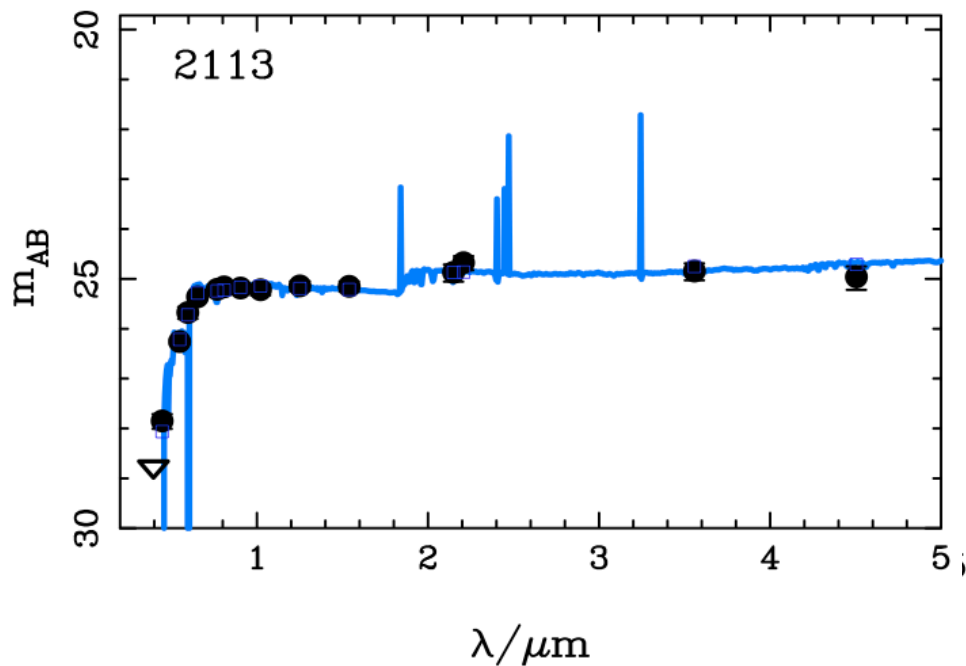
Example 2D spectra from UDS mask:

FIELD: UDS (CANDELS AREA)
ID: 4689
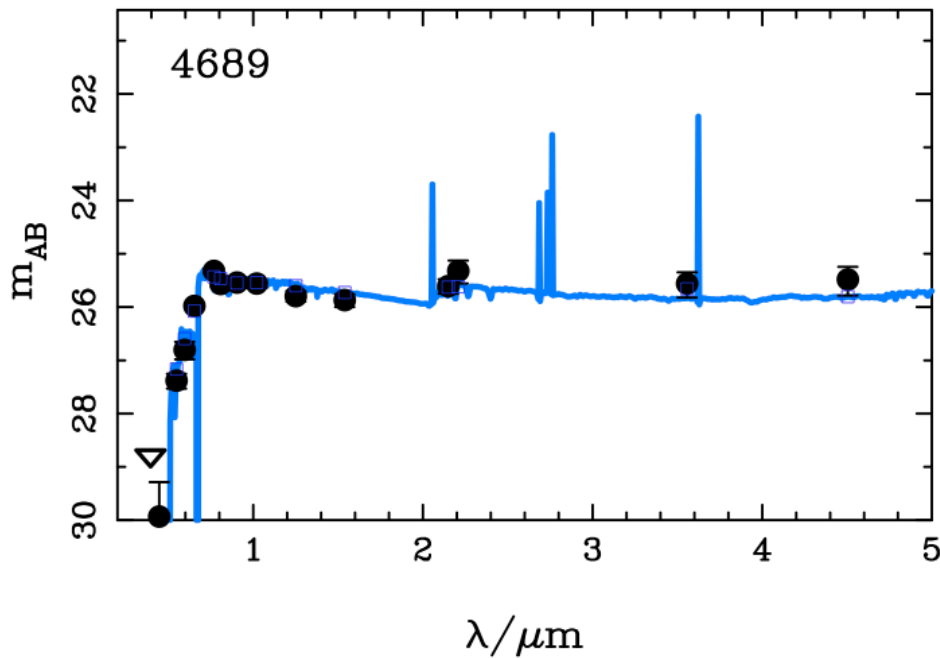CLASS: $3.0<z<7.0$ LBG
$z_{phot} = 4.52$
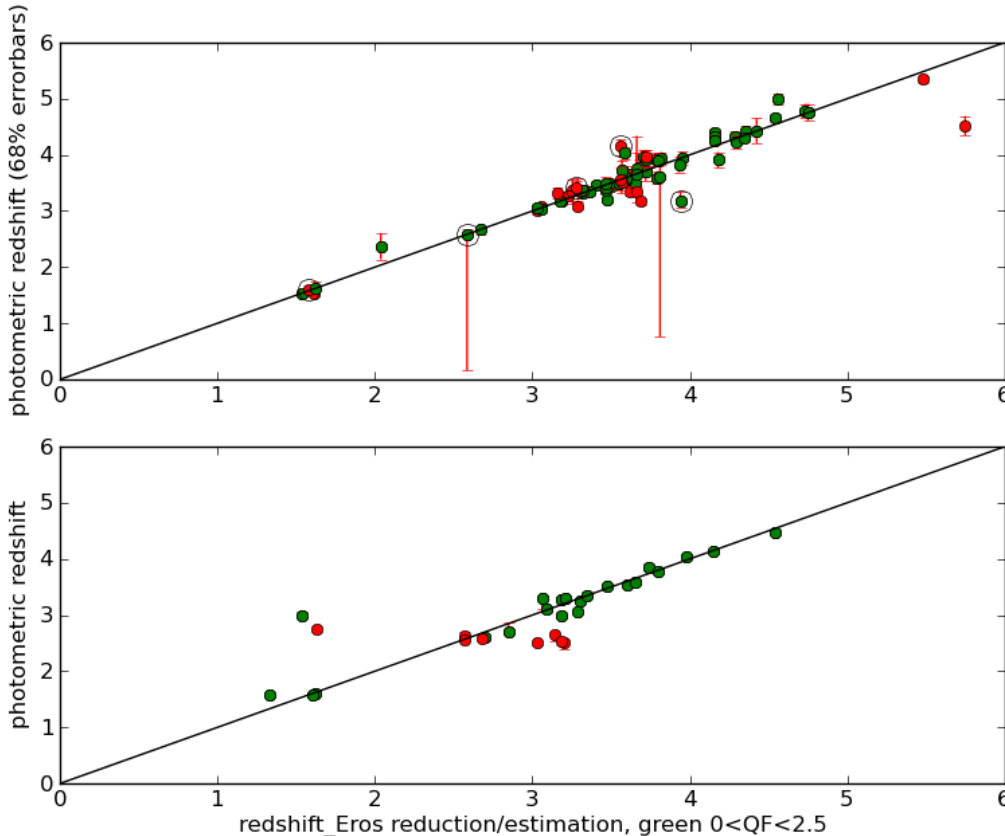$z_{spec} = 4.62$

LAE at z=4.62

VANDELS: test observations

Allocated two observing runs in Nov/Dec 2014 to test mask preparation and observing strategy. Obtained ~10 hours of integration in both UDS and CDFS on two masks.

z_{spec}-z_{phot} comparison from test mask in CDFS:

Green = high quality redshift

Red = low quality redshift

Target selection appears to be working well…

VANDELS: schedule

VANDELS has been allocated 912 hours of visitor mode observations, to be carried out in four observing seasons (Aug-Dec) during 2015-2018. All raw data are immediately public on ESO archive, and reduced data will be released ~9 months after observations.

Provisional Data Release Schedule:

Data release	Date	No. of completed spectra			No. of partially complete spectra			Total
		20-hrs	40-hrs	80-hrs	40-hrs(50%)	80-hrs(25%)	80-hrs(50%)	
DR1	Sept 2016	160	160	0	320	320	160	1120
DR2	Sept 2017	320	480	160	320	320	160	1760
DR3	Sept 2018	480	960	320	0	0	320	2080
DR4	Sept 2019	640	1280	640	0	0	0	2560

Data Reduction:

Data reduction is being carried out in Milan, by the team responsible for reducing VIMOS data obtained in VVDS, zCOSMOS, VIPERS and VUDS surveys

VANDELS: synergy with MOONS spectrograph
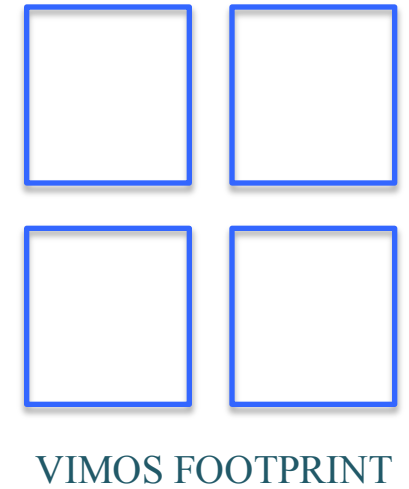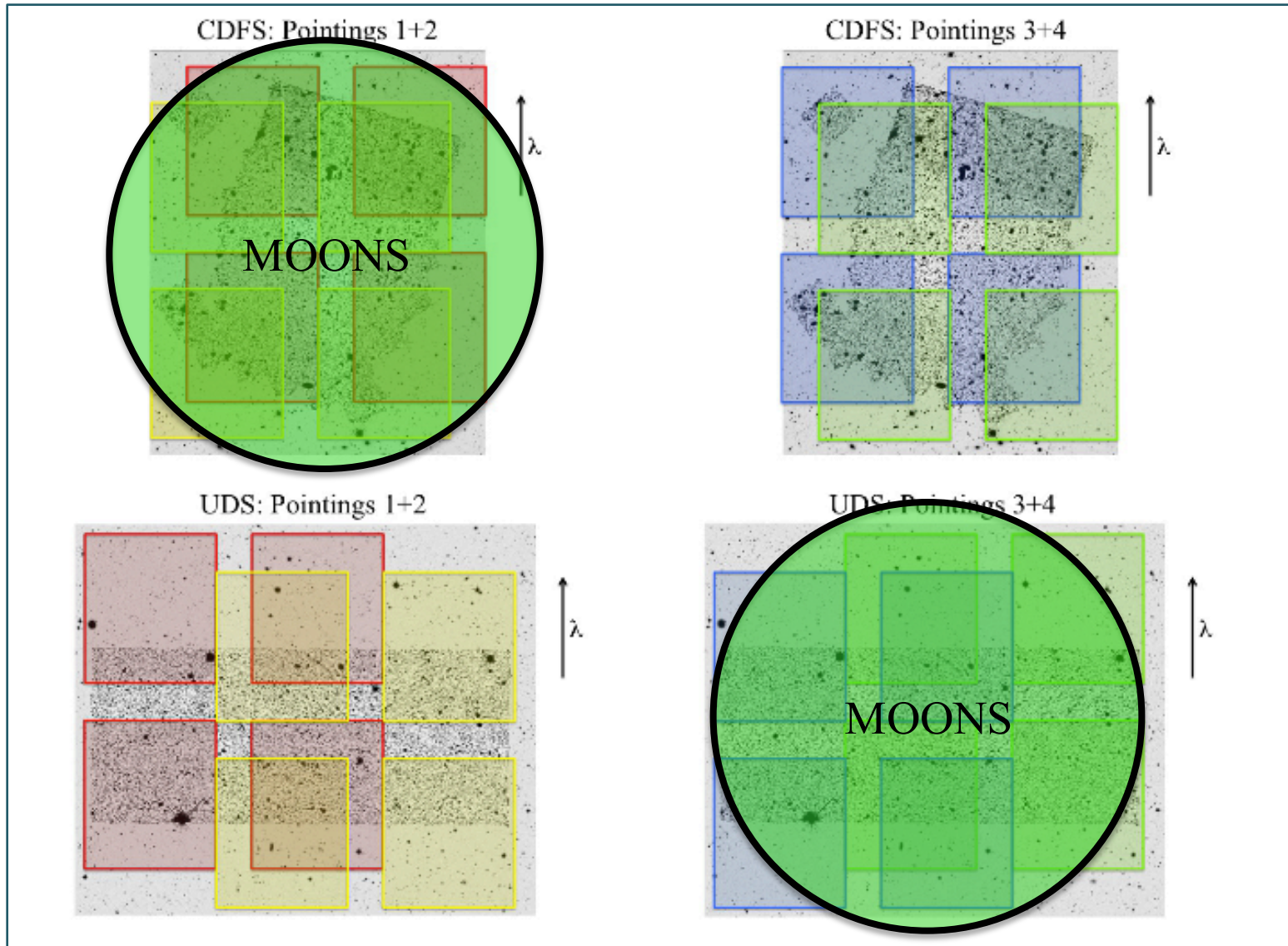
VANDELS with provide 2000+ targets for MOONS ultra-deep survey
(0.4-1.8μm coverage)

Summary

- ⊙ 912 hours of VIMOS visitor time: 2015-2018
- ⊙ 20-80 hour integrations focused on z>3 star-forming galaxies
- ⊙ Science goals: ages, masses, metallicities and outflows at high-z
- ⊙ Raw data immediately public
- ⊙ Reduced data released ~9 months after observations taken
- ⊙ Full details can be found at: vandels.inaf.it

VANDELS

A deep VIMOS survey of the CANDELS UDS and CDFS fields

New ESO public VIMOS spectroscopy survey of the UDS and CDFS fields