Spectroscopy with MIRI+NIRSPEC

DEEP GALAXY SURVEYS WITH JWST: FIRST LIGHT

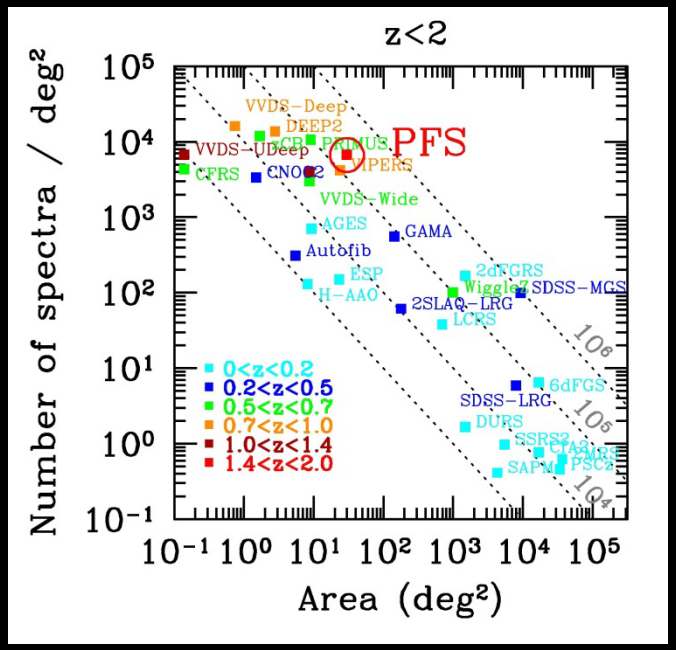
Content

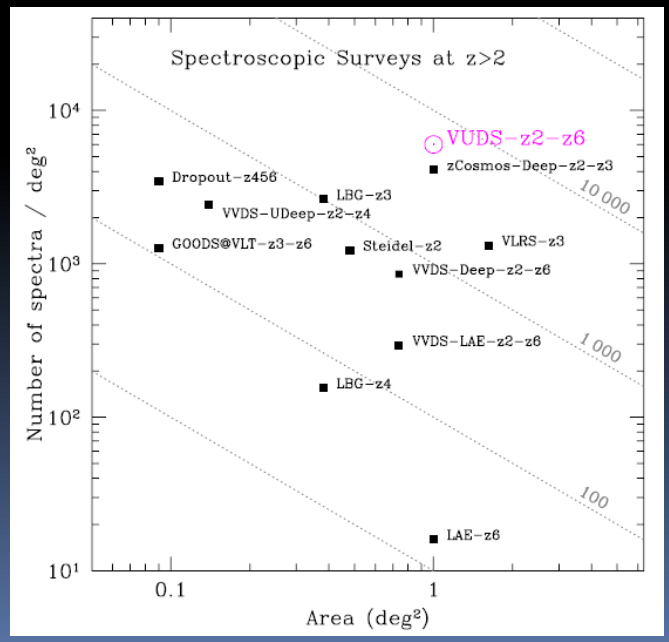
- Deep galaxy surveys: motivation
  - The key role of spectroscopy
- JWST: designed for deep surveys
- Finding objects in the epoch of reionisation
- Strategy
- Preparation in France: joining the international effort

Why deep spectroscopic surveys?

- The backbone of our global knowledge of the Universe
- The z_{spec} is a fundamental measurement
- Spectra provide important physical diagnostics
- Surveys = robust statistics
  - Need >10^4 galaxies
  - Cover large volumes (cosmic variance): degree scales

Existing / on-going surveys

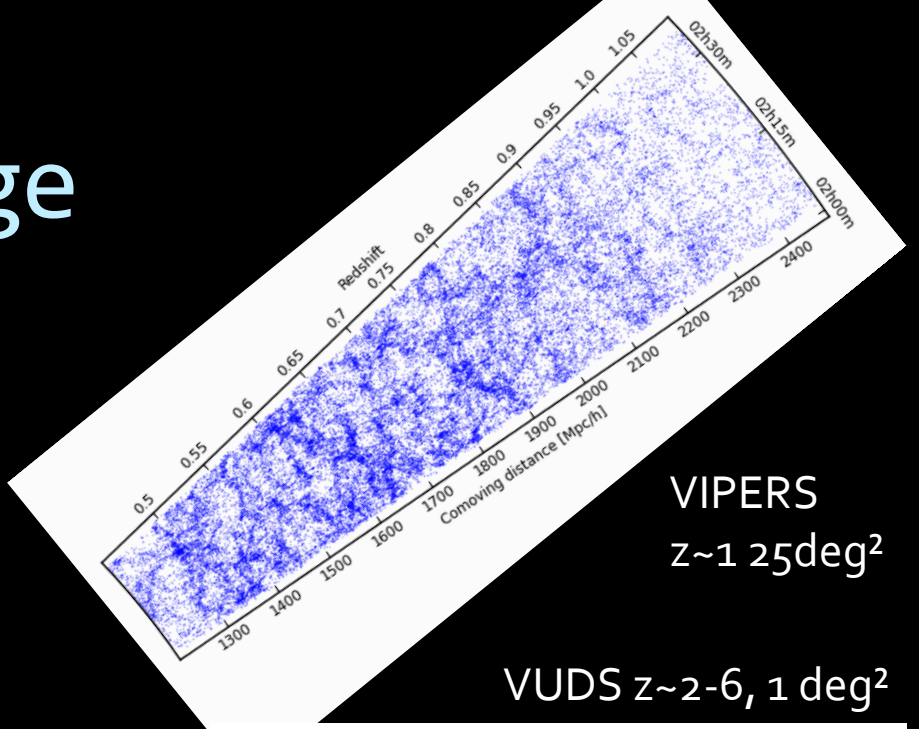




A strong heritage

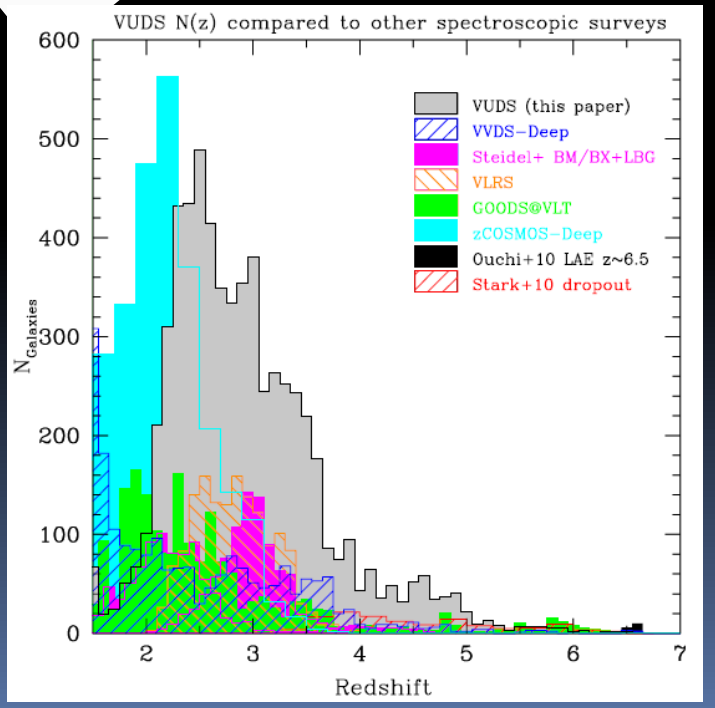
- Spectroscopic surveys have unlocked key progress
- Local universe: SDSS, 2DFGRS, GAMA,…
- 6-7 Gyr: VVDS, DEEP2, zCOSMOS, VIPERS,…
- 10-13 Gyr: LBG, GOODS-s, VUDS, VANDELS, MUSE…
- Upcoming: PFS, MOONS, DESI, Euclid, …

Next major step is JWST

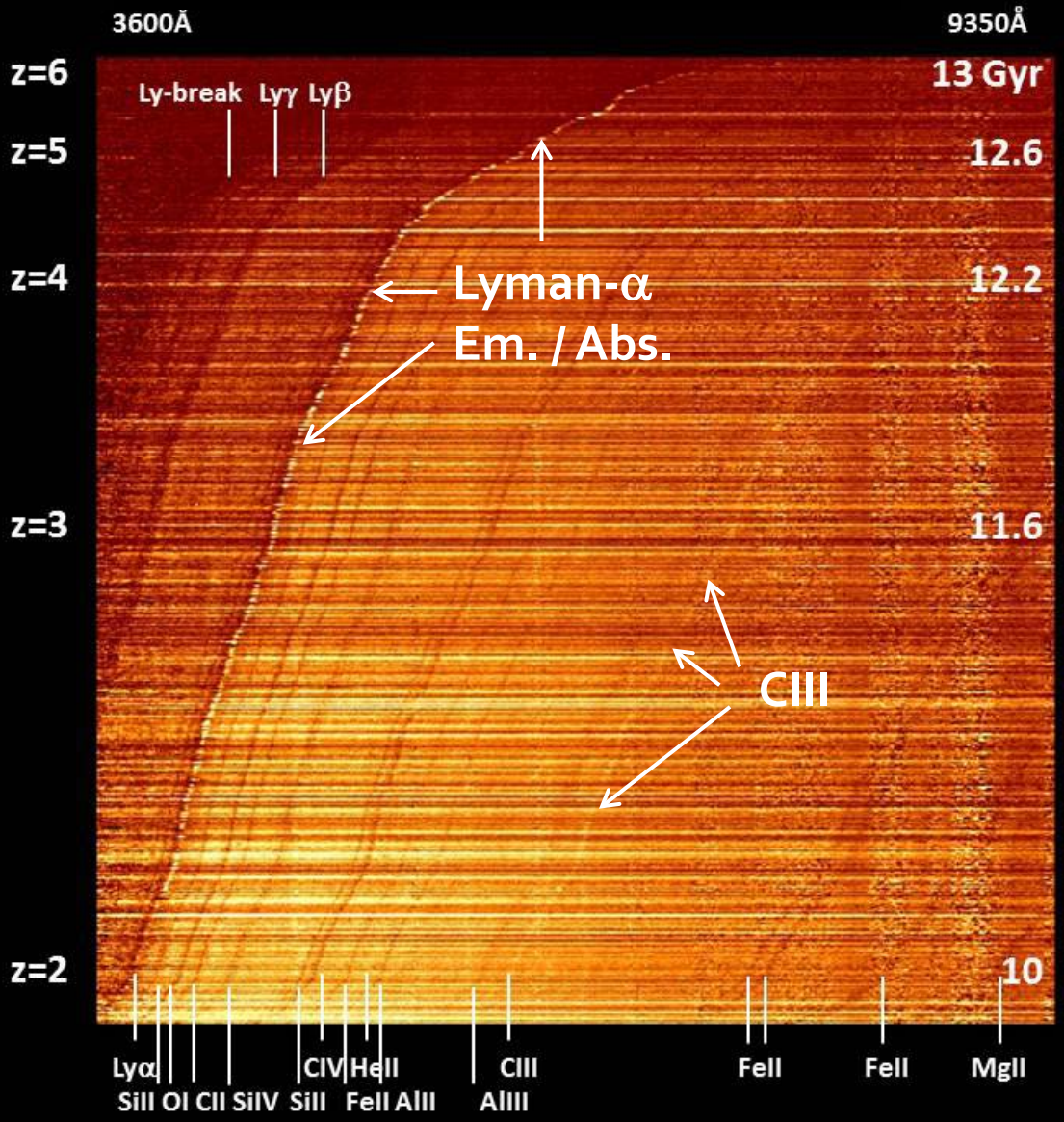


VIPERS
z~1 25deg²

VUDS z~2-6, 1 deg²

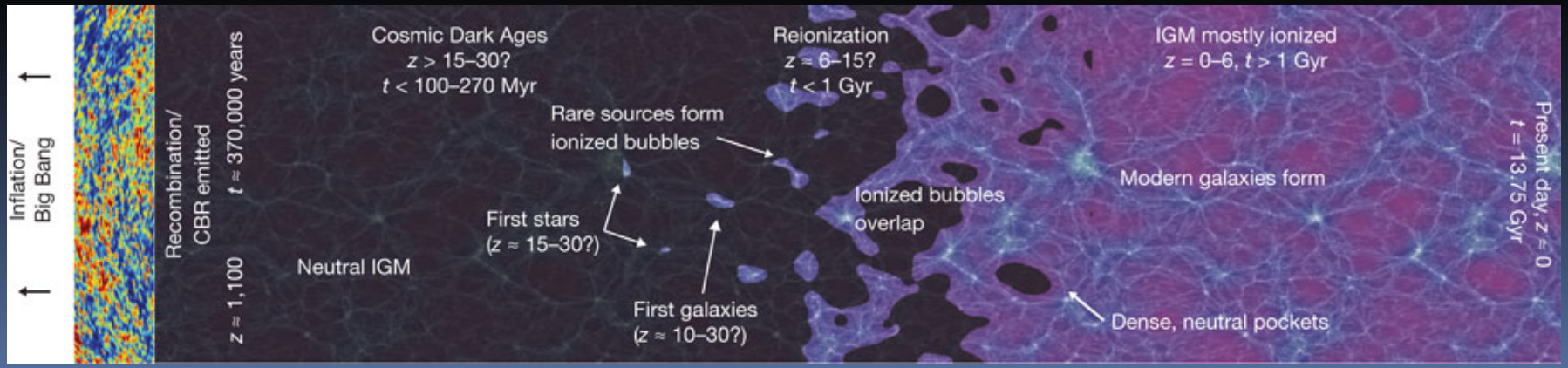


VIMOS Ultra Deep Survey (VUDS)
10000 galaxy spectra to z~6.5
1 image line = one spectrum



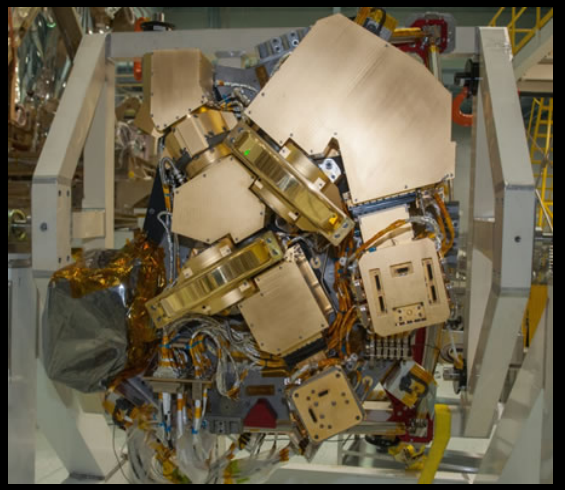
Why detect first light objects ?

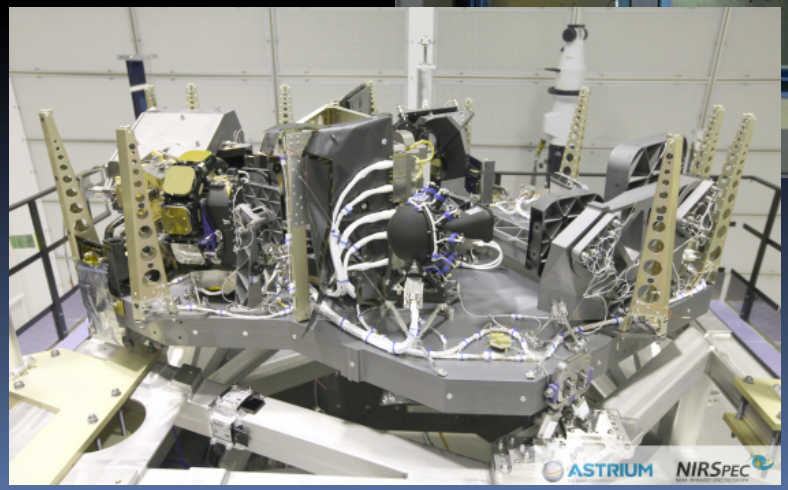
- Understand how re-ionization of the universe proceeded
  - What are the main sources responsible ?
  - When did it happen ?
- Study star formation at the beginning
- Study the early assembly of mass



JWST: designed for "first light"

- A primary goal of JWST: find and study first light objects in the Epoch of Reionisation
- Super-sensitive: 6.5m aperture + wide field + IR + space
  - NIRCAM – MIRI AB~33 in imaging
  - NIRSPEC - NIRISS: AB~31-32 in spectroscopy
- FOV: ~10 arcmin^2 per instrument

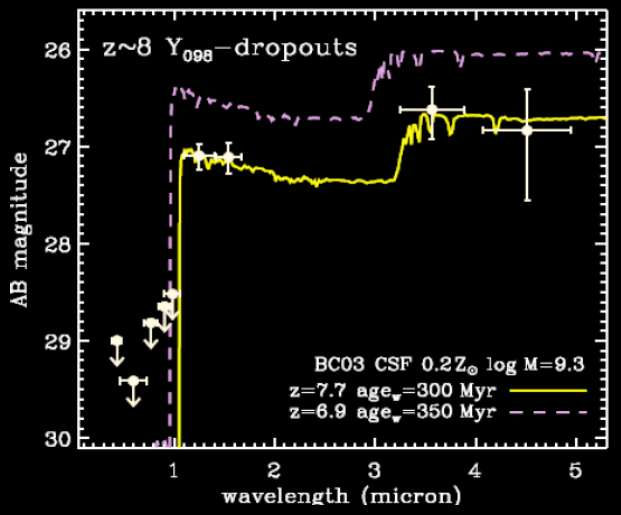




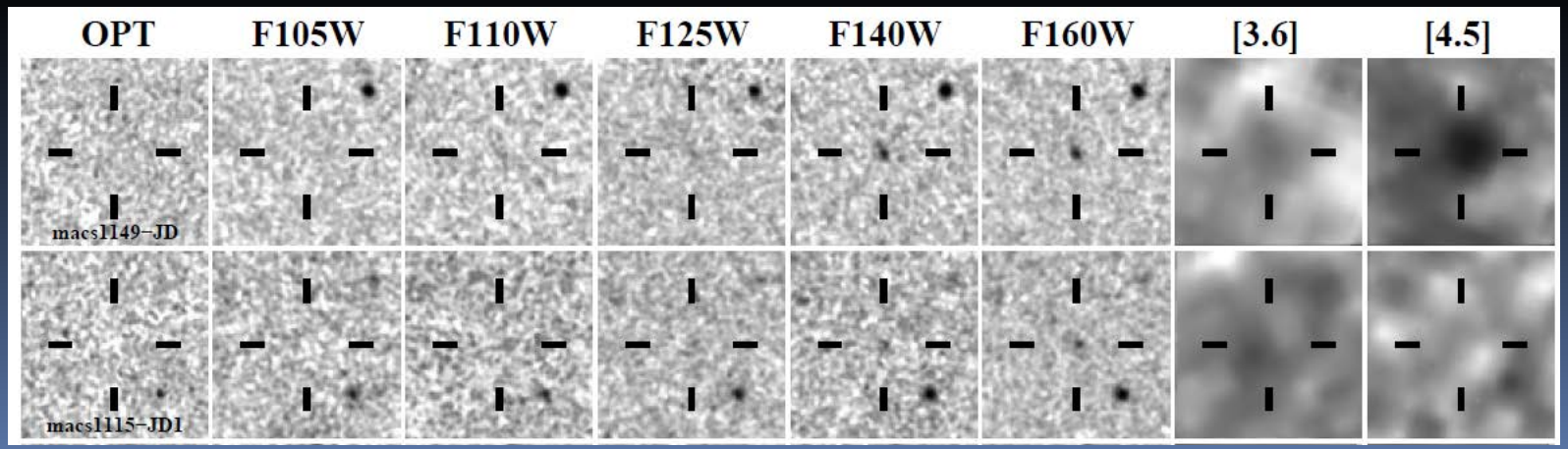
Find and study “first light” galaxies

- Need deep imaging to find candidates:
  - Lyman-α break (drop-out)
- Spectro follow-up
  - Find the redshift
- “First light” identified by the absence of “old” stars
  - MIRI imaging essential: stellar mass and age

Galaxy candidate at z~7.7 (Labbé et al. 2009)



Candidates from Bouwens et al. 2014



A strategy with JWST

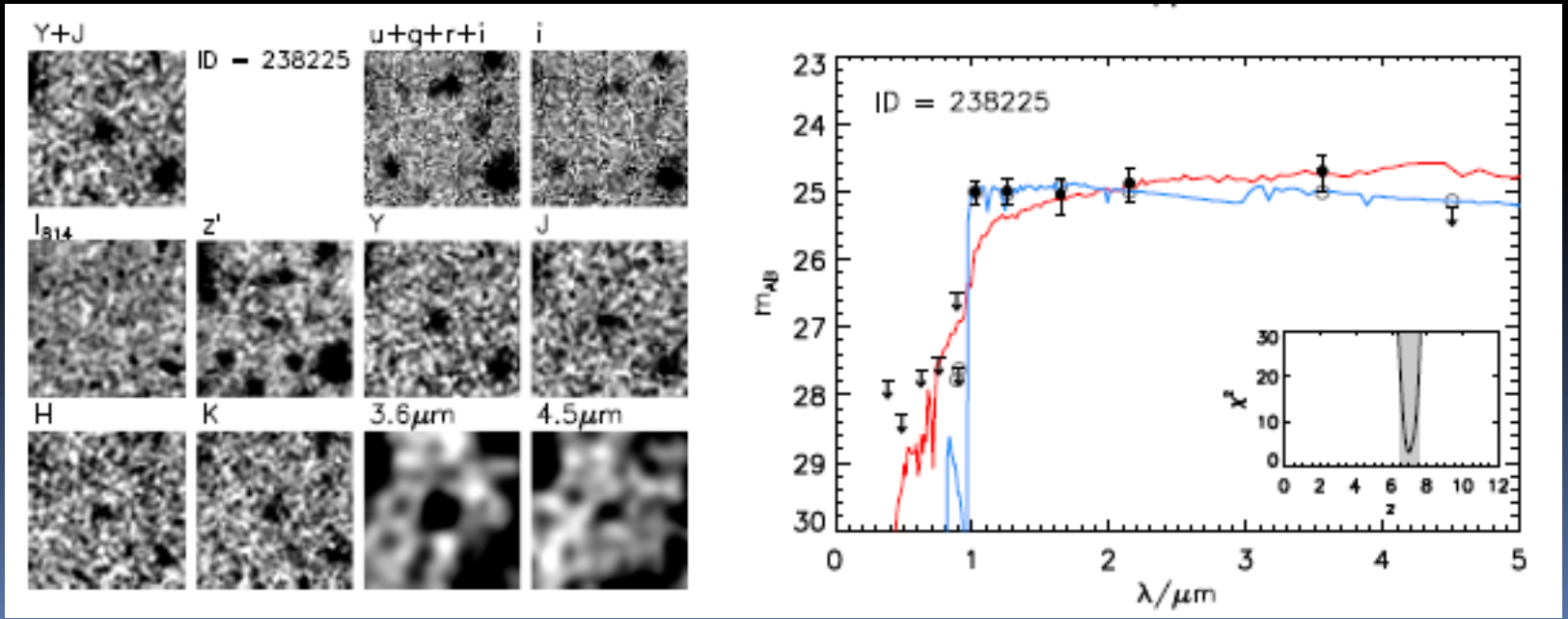
How do you build a survey logic for jWST ?

- The classical route
  - Deep multi-band photometry
  - (smart) target selection
  - Wide field spectroscopic survey: the fundamentals of statistics
  - High spatial / spectral resolution follow-up
- JWST is a short mission: 5 years
- Major surveys will (must) be launched early on
- Likely to follow similar path as for HDF / COSMOS / CANDELS / FF: paving the parameter space volume/depth

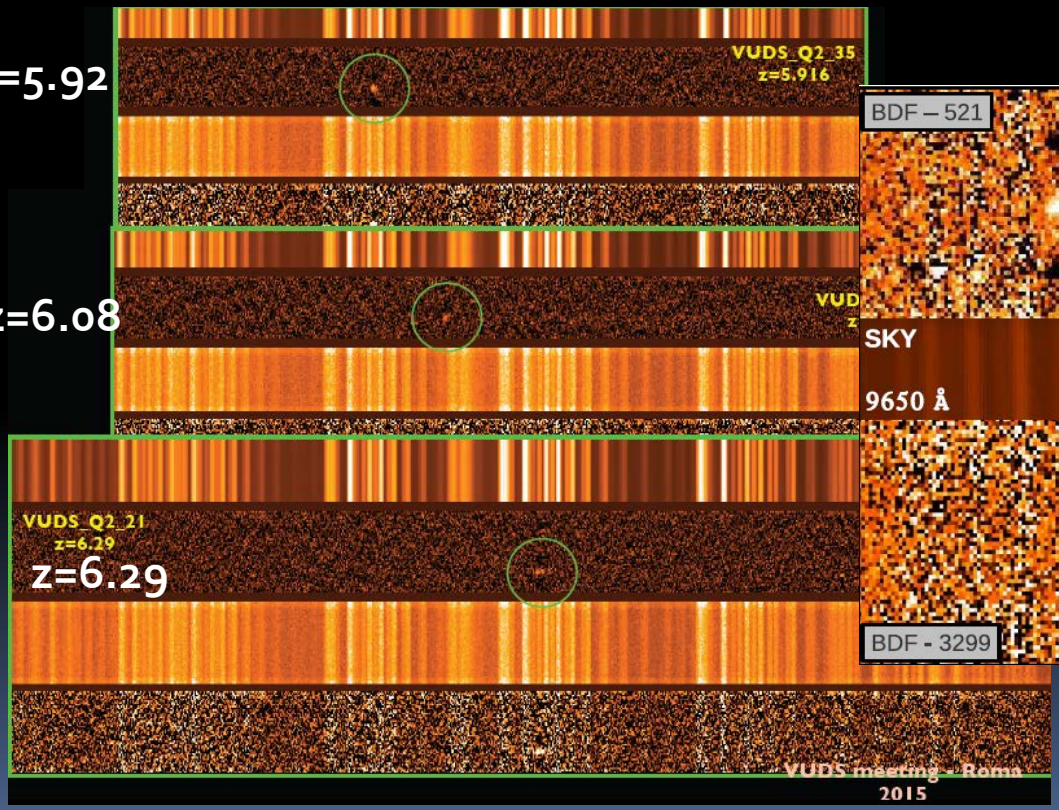
Large samples of candidates from photometry before JWST

- From large ground-based IR surveys: ULTRAVISTA, UDS, …
- From HST WFC3 surveys: CANDELS
- From the deepest Spitzer surveys: SPLASH+
- Need to sample the massive population as well as small building bricks

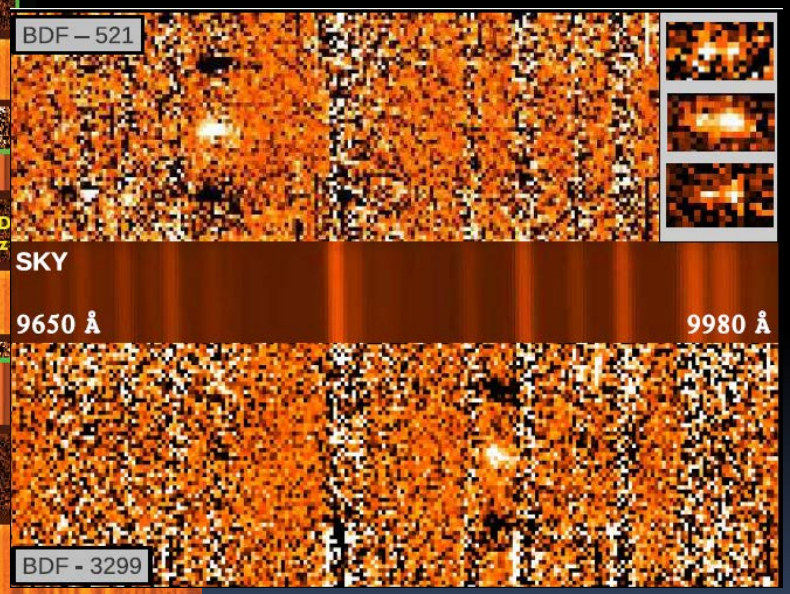
ULTRAVISTA: Bowler et al. 2014



Significant existing spec-z samples before JWST

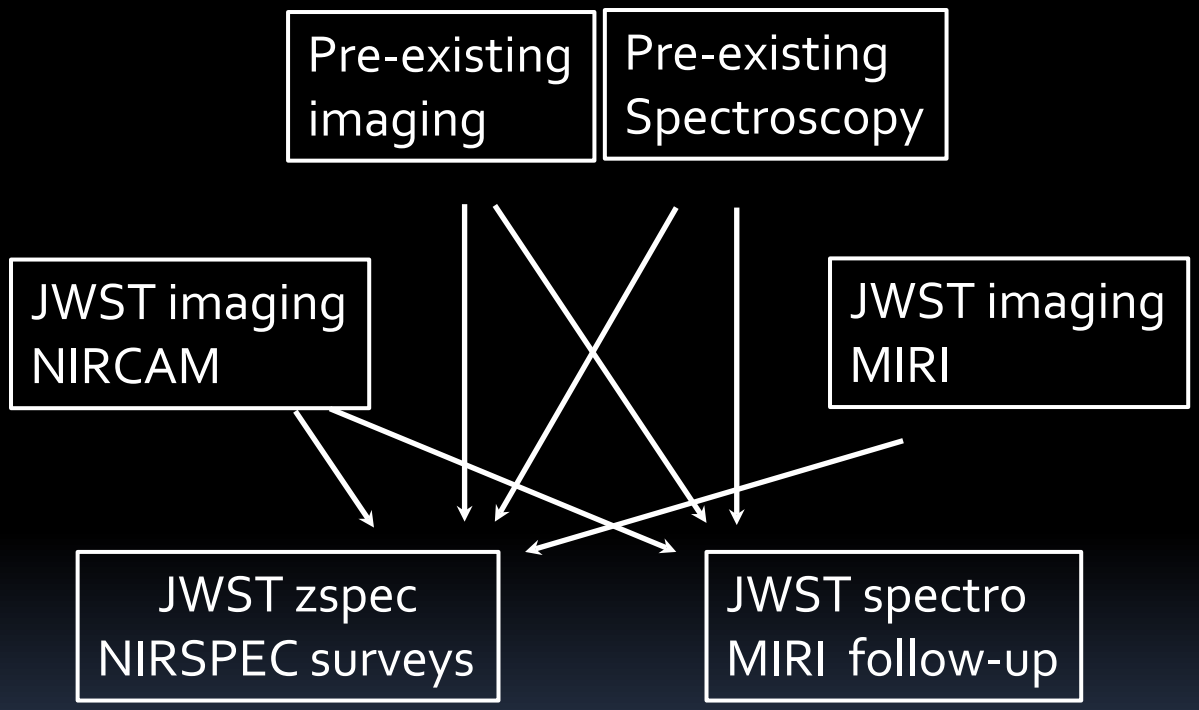


VUDS, in prep.



Vanzella+2011

A likely picture for “first light” surveys with JWST



- Degree scales
- 10000 objects
- AB~31-33
- z>6

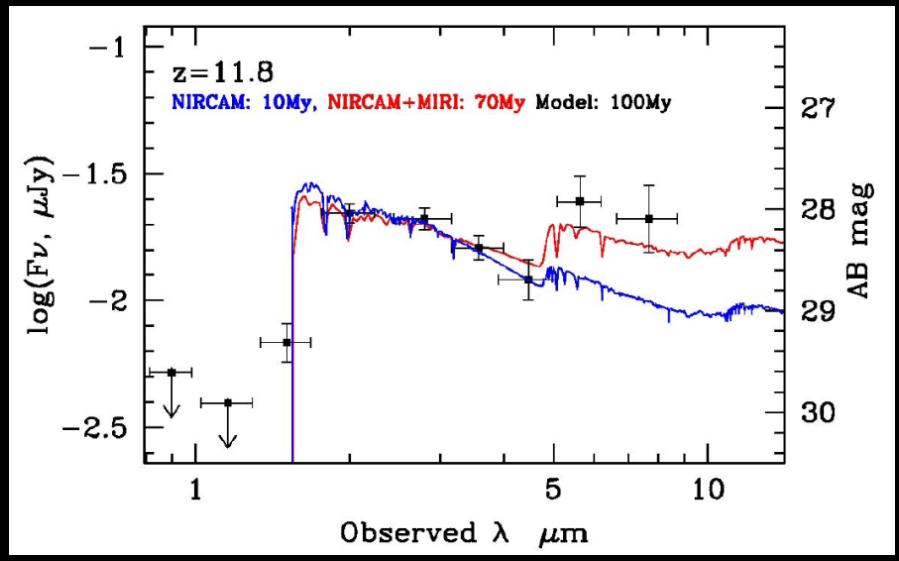
The main survey fields will be targeted: COSMOS, GOODS/CANDELS, XMM-LSS-D1/UDS

MIRI Deep Fields Survey

- Based on MIRI GTO
- Aim for 1st light objects z>7
- ~100h
- ~10 MIRI fields
  - TBD: field vs. clusters
- F560W and F770W

- Used as seed for open Large Program

Simulations (w/ O. Ilbert)



Legitimate french participation to JWST first light surveys

- Based on expertise: know-how
  - On past imaging and spectroscopic surveys
  - From participation in JWST instrumentation
  - Connexion with large international collaborations (COSMOS, VUDS, CANDELS, …)
- Based on resources: FTEs, software
  - Spectra extraction
  - Redshift measurements
  - Physical parameters measurements
- National commitment: Services d'Observation and expertise centers