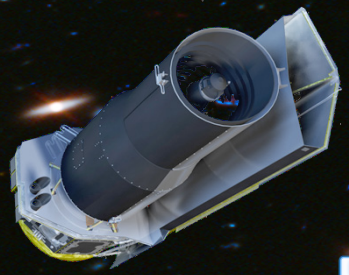
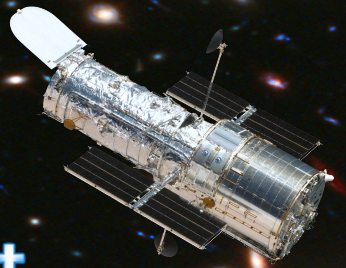
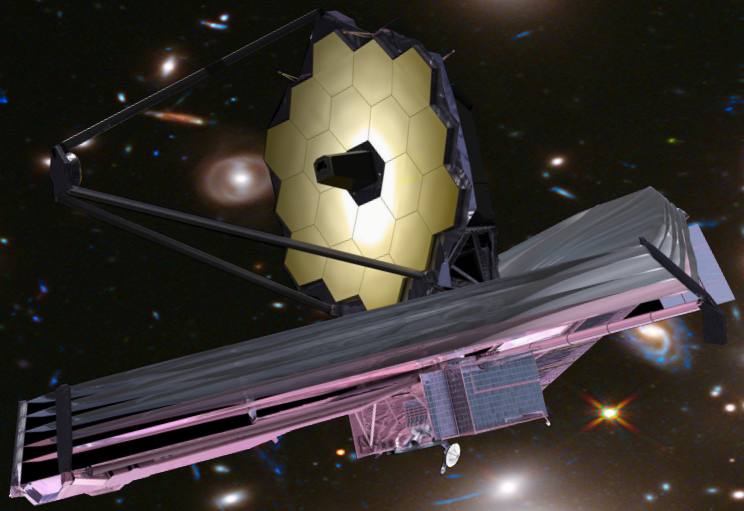




Preparing JWST observations at the Frontiers of the Universe



Nicolas Laporte

F. Bauer, D. Bina, F. Boone, I.Chillingarian, L. Infante, S. Kim, R. Pelló, I. Pérez-Fournon, and A. Streblyanska

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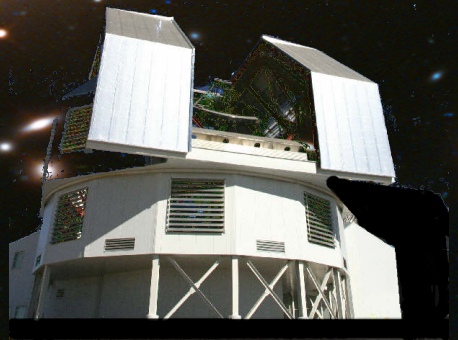
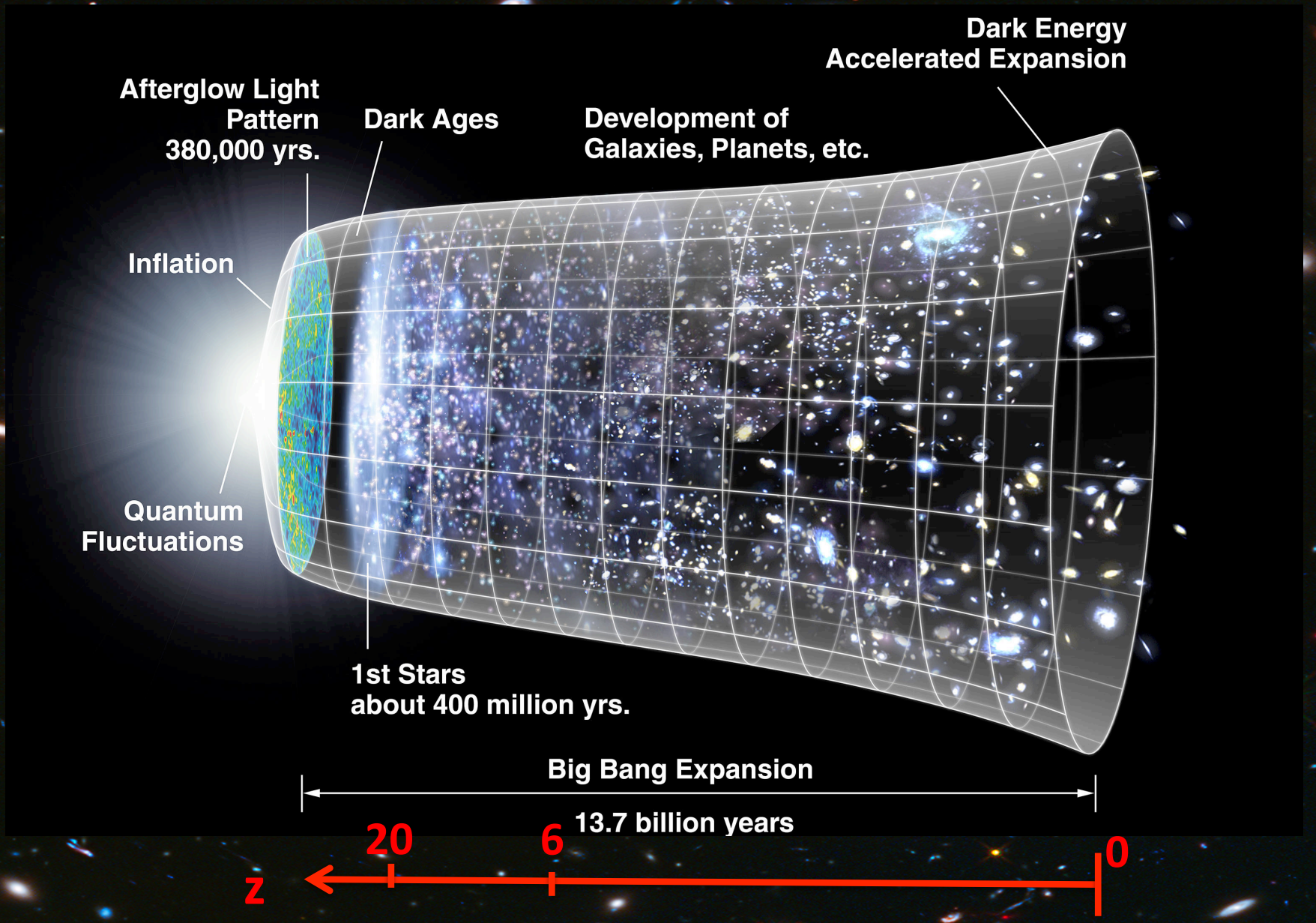
Journées SF2A – Mardi 2 Juin 2015



Scientific context



Re-ionization of the Universe

From Alvarez et al. (2010)

- The first stars and galaxies produced UV photons that started to re-ionize the IGM.
- This process is first local, and then global via a percolation phenomenon.

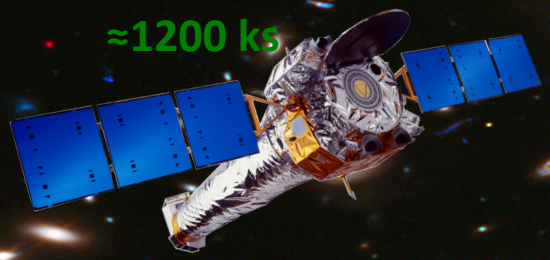
- Distant quasars observations show that the Universe is fully re-ionized at $z \approx 6$ (Fan et al. 2002)

- Are the first galaxies the only source responsible for the re-ionization ?

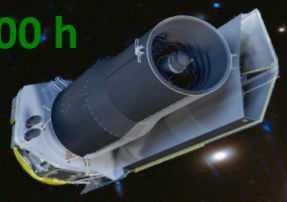
The last *Hubble* legacy program as a sneak peek of the *JWST*

FRONTIER FIELDS

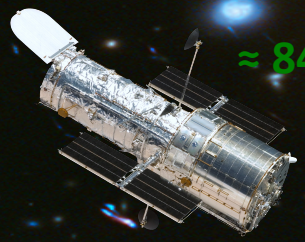
≈1200 ks

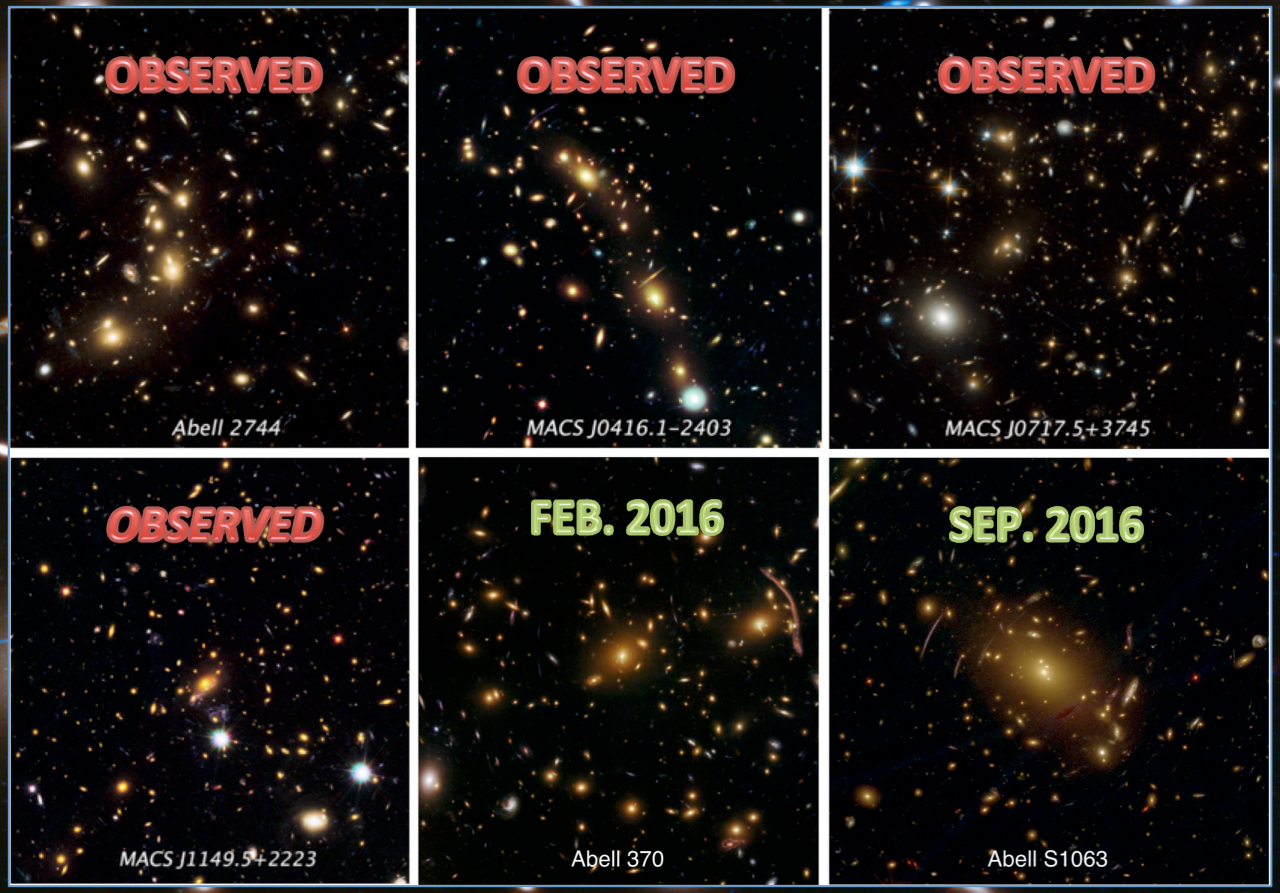


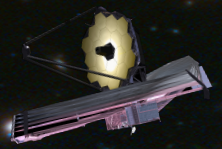
≈1000 h



≈ 840 orbits

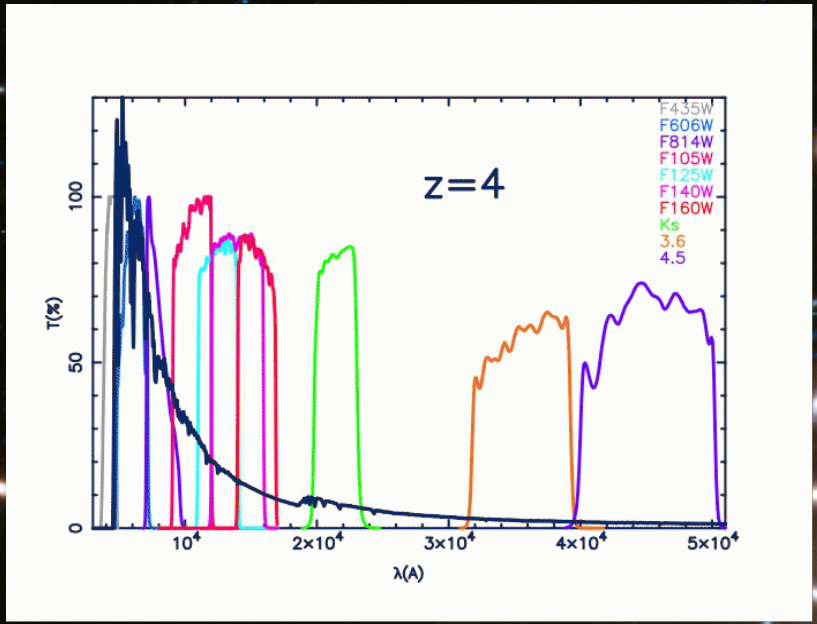




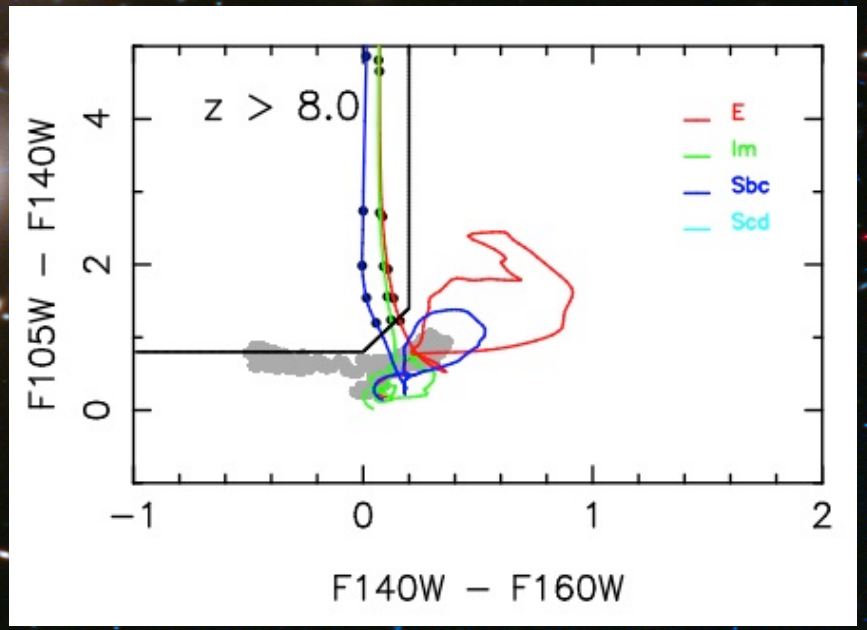


2h per pointing with NIRCAM at 1µm
instead of ≈20h with WFC3/HST

Search for z>6.5 in the 3 first HFFs



- The method generally used to select high-z objects is the Lyman Break technique (Steidel et al. 1996) combining :
  - non-detection in optical
  - color selection in NIR



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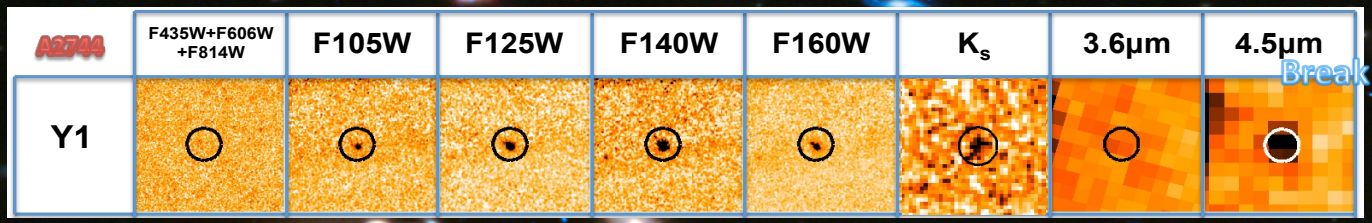
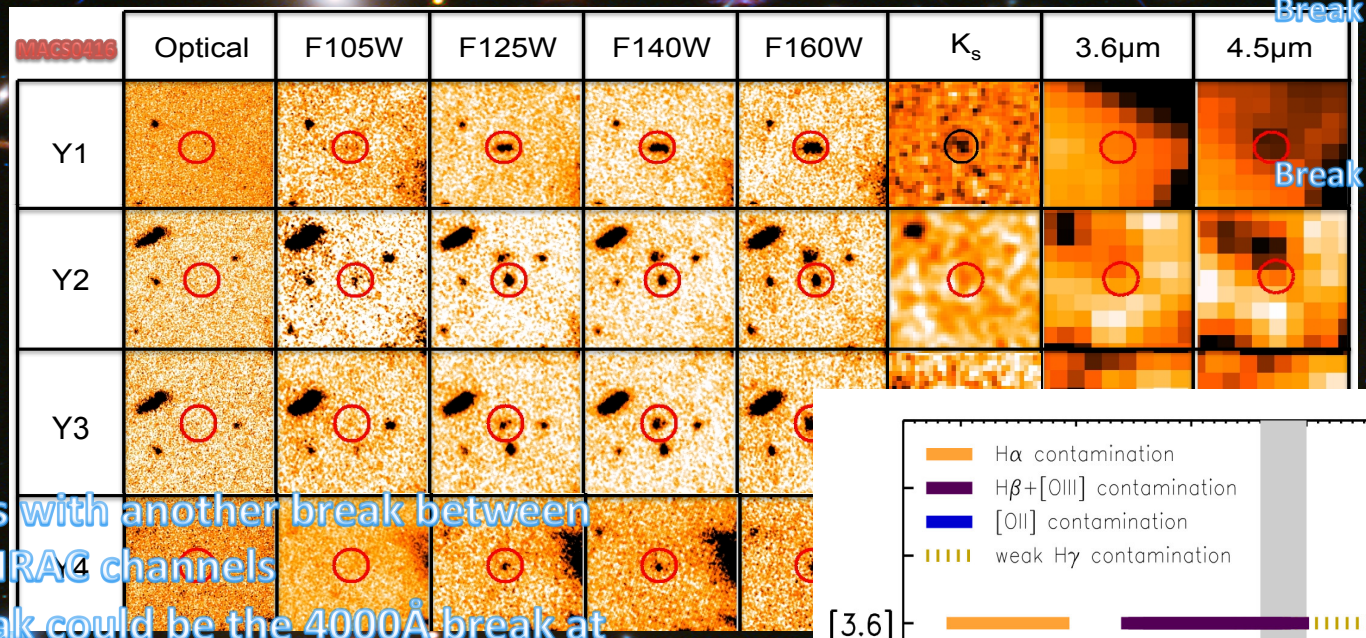
  - non-detection in optical
  - color selection in NIR

Examples of good $z\approx8$ candidates

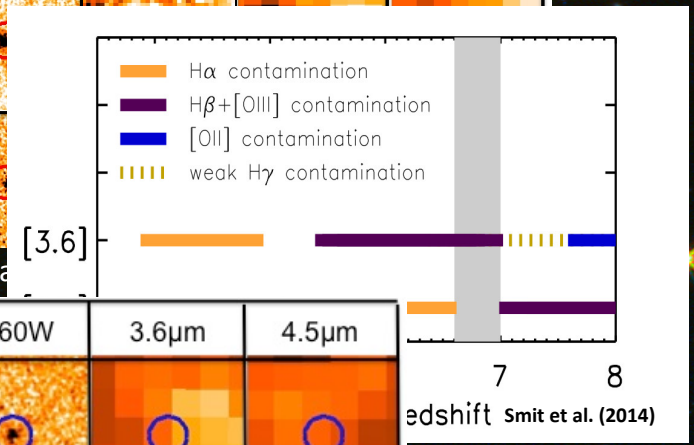


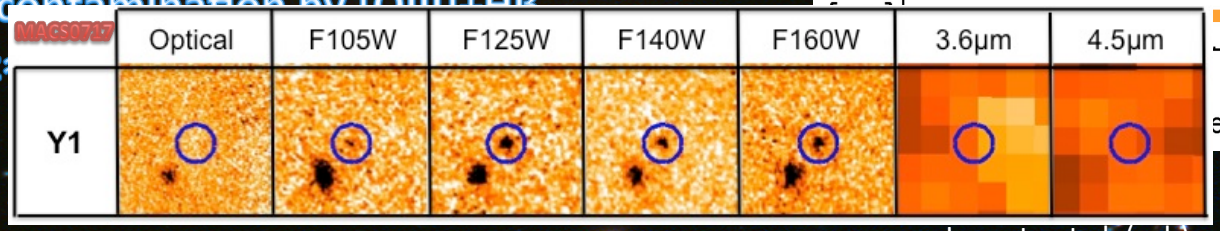
Atek et al. (2014), Coe et al. (2014), Ishigaki et al. (2014), Laporte et al. (2014), Zheng et al. (2014)



- 3 objects with another break between the two IRAC channels
- This break could be the 4000Å break at z≈8 or a contamination by [OIII]+Hβ lines at z

Infante et al. (sub), La





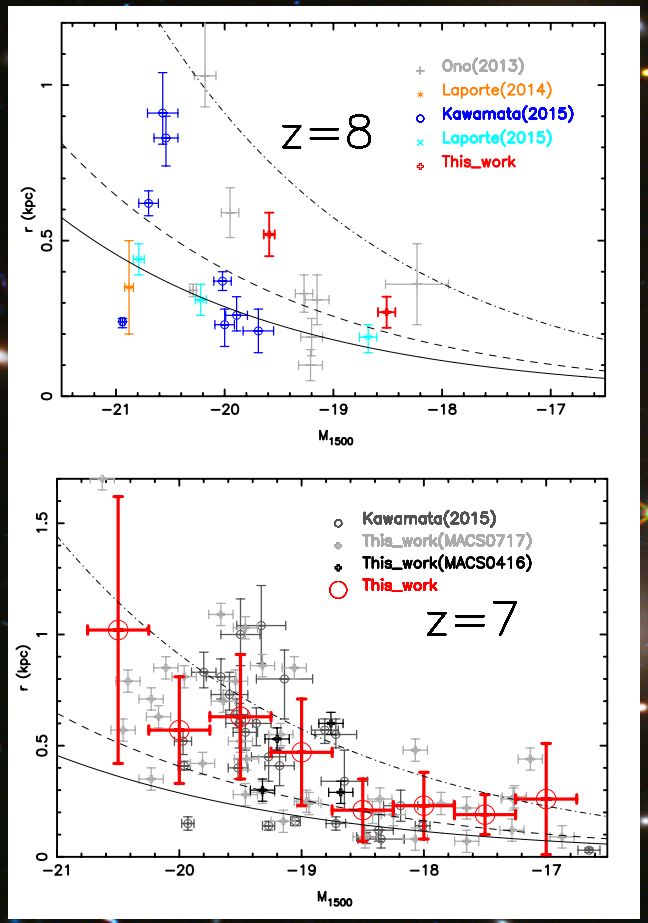
Laporte et al. (sub)

None of the z>7.5 LBG candidates selected on A2744 data has counterpart on ALMA map *(PI : F. Bauer)*

- Limit at 2σ = 0.10mJy
- Band 6 (211 – 275 GHz)
- SFR < 60 $M_{\odot}$/yr

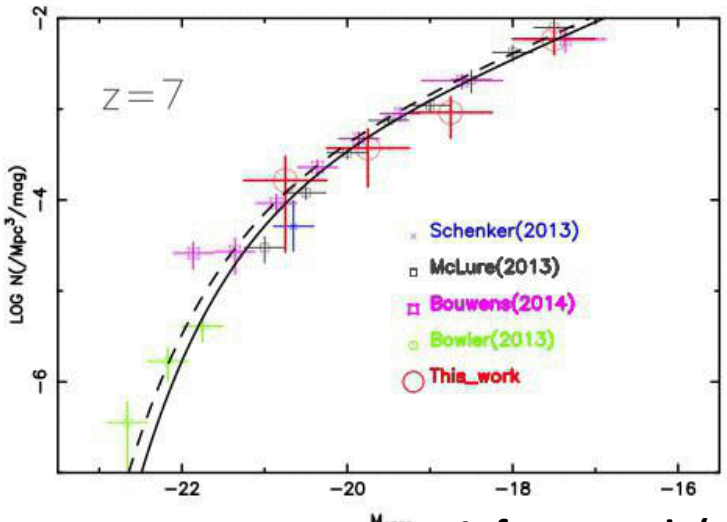
Physical properties

Size evolution of z>6.5 objects



Laporte et al. (sub)

UV Luminosity Function with 2 HFFs

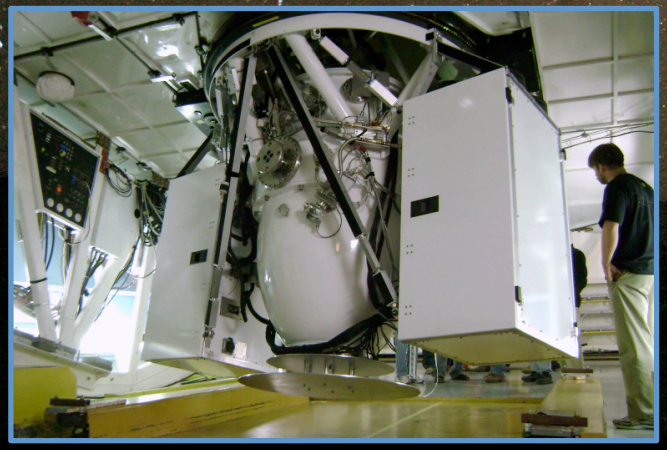


Infante et al. (sub)

- Thanks to HST data quality we can study the evolution of the size as a function of the luminosity at very high-z
- HFFs are improving the robustness of constraints we put on the faint-end of the LF up to z=10

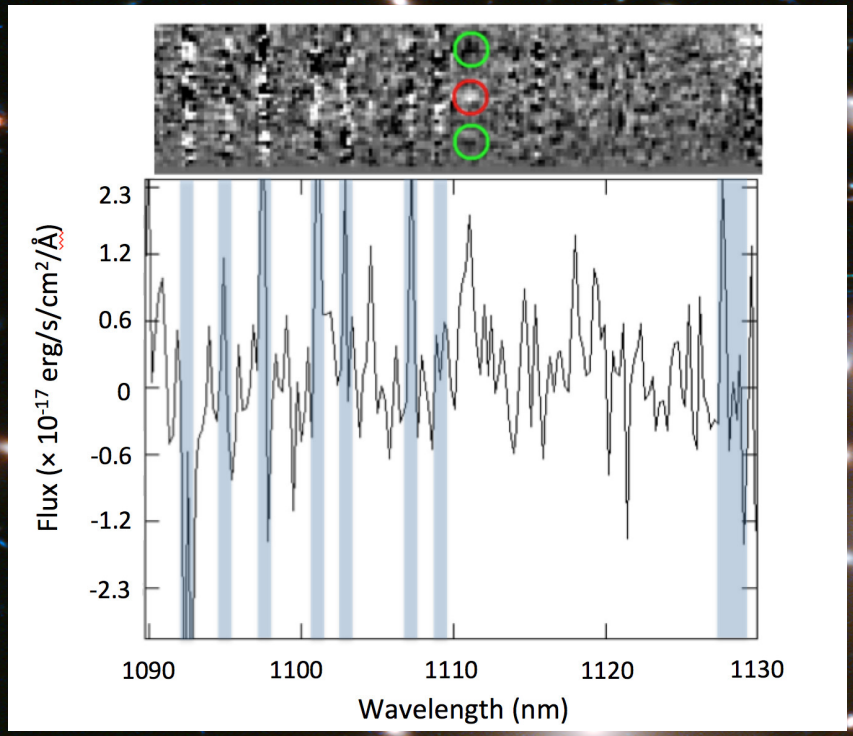
Spectroscopic follow-up

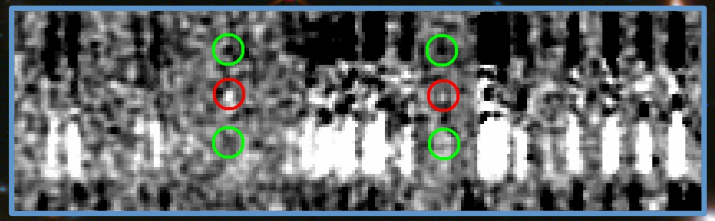
MMIRS / Clay
Grism : J Filter : zJ
R = 2400
Exposure time : 10h
Proposal : *CNTAC2014B-101*
(PI : F.E. Bauer)



31 objects
=> dozen at z>6.5
From 5th to 15th October 2014
Seeing : 0.4”

Preliminary results

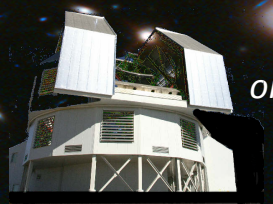




- **Expected at z≈8**
  ➔ [OIII] doublet at *z*=1.3
- Break between F814W and F125W > 3mag
- Object combining two stellar populations :
  (1) Young : responsible for lines
  (2) Old : responsible for large break

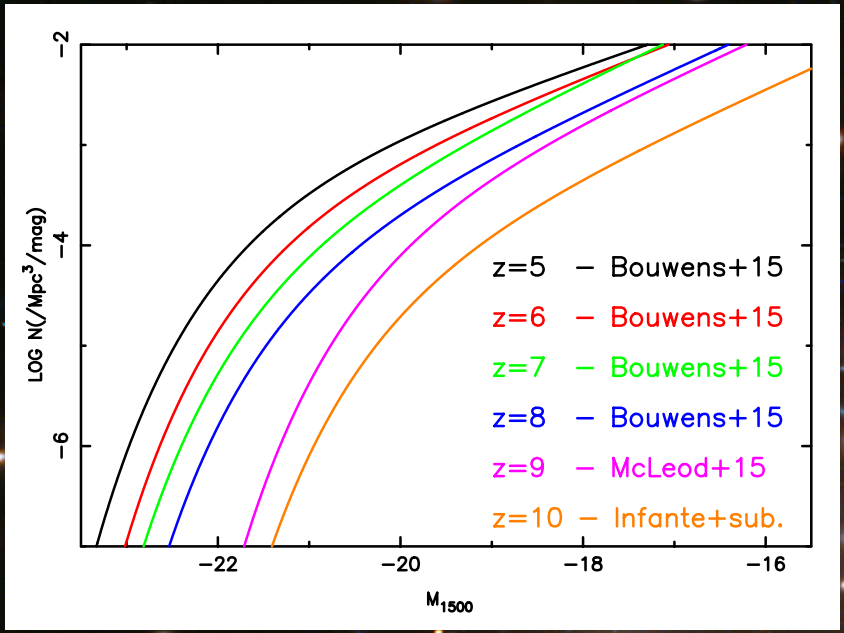
- **3σ line at λ=1111nm**
  ➔ If Lyα : *z*=8.34

Confirmations on-going with :
- X-Shooter/VLT (July 2015)
- FLAMINGOS2/Gemini (Sep. 2015)



10h with MMIRS
only ≈15mn with NIRSPEC/JWST
and up to 5μm

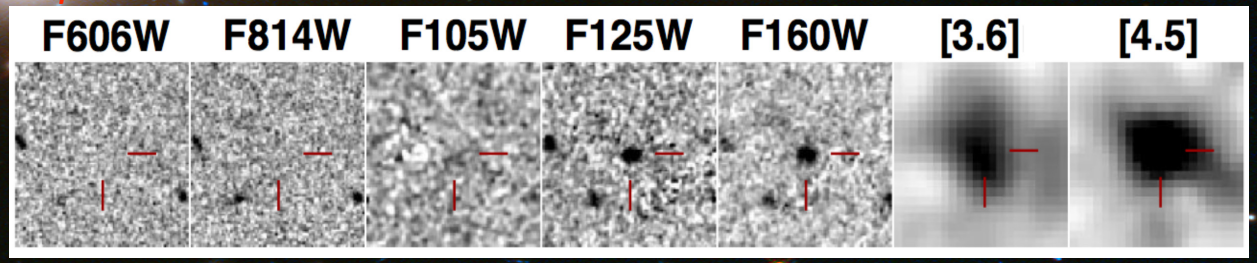
State of the art
before the arrival of the JWST



- The most distant galaxy confirmed by spectroscopy is at z=7.73 (Oesch 2015)
- The most distant object is found at z≈11 (LBG selection – Coe et al. 2013)

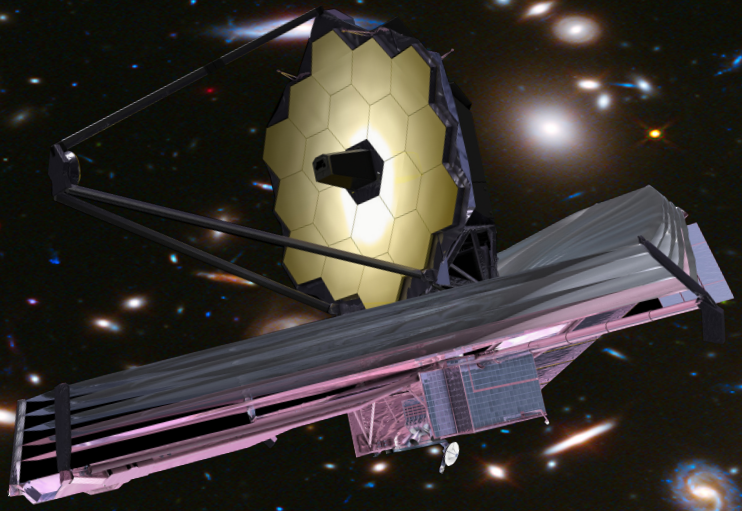
- The shape of the UV Luminosity Function is well known up to z≈7-8
- Beyond z≈7-8 they are few robust candidates that is not enough to draw a conclusion on the shape of the LF.

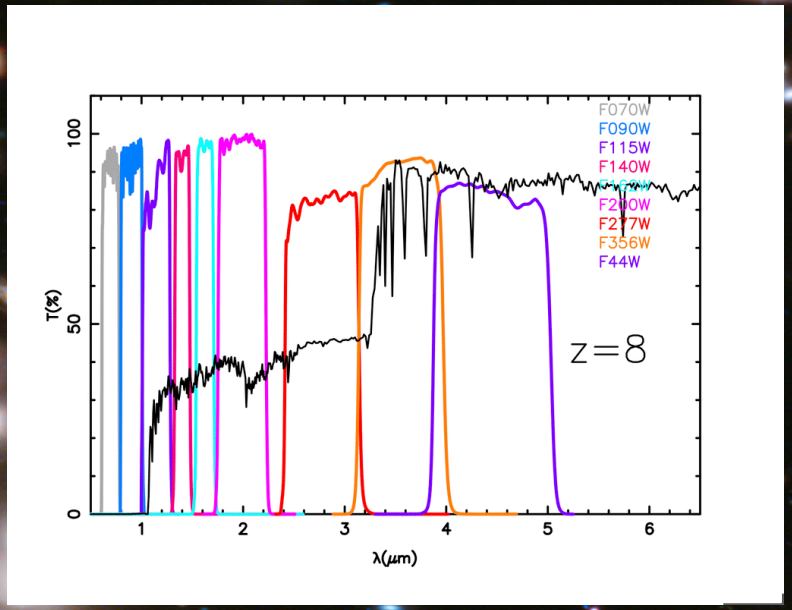
$z_{spec} = 7.73$



Oesch et al. (2015)

After the Frontier Fields : *the crucial role of the JWST*

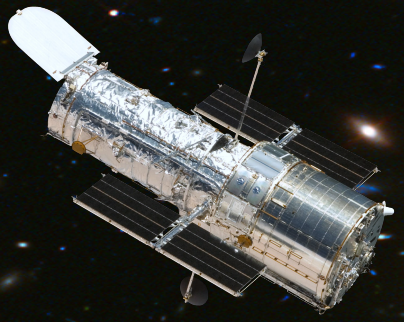




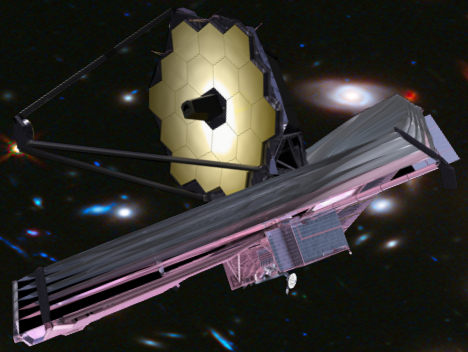
- The JWST will detect the 4000Å break up to $z \approx 12$, and thus improve the constrain on the stellar mass.
- **JWST will reach 30AB mag at ≈5σ in F356W and F444W in ≈20h**

- The detection of two clear breaks in SED of high-z candidates would strongly reduced the low-z hypothesis
- **We absolutely need to observe the 6 Frontier Fields with NIRCAM JWST at long wavelength to get a complete picture of the faintest z>8 candidates (redshift, stellar mass, …)**

Summary



FRONTIER FIELDS



Same Exposure Time
&
6 clusters and parallel fields

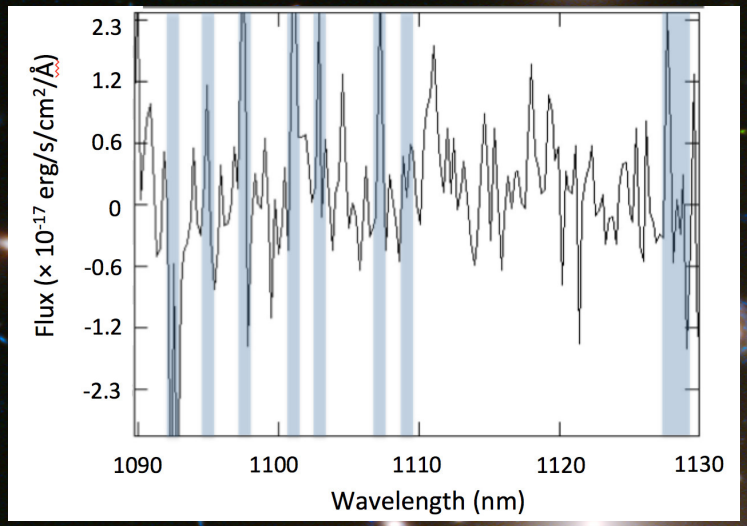
5sigma depth : 29.0 AB mag
N(z=8) ≈ 100
N(z=9) ≈ 50
N(z=10) ≈ 20
N(z=11) ≈10
N(z=12) ≈1

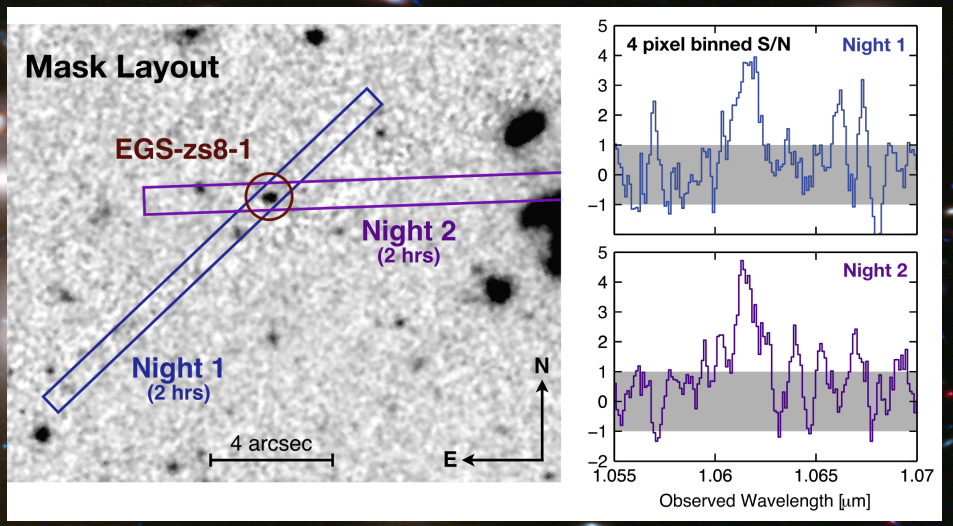
5sigma depth : 30.5 AB mag
N(z=8) ≈ 500
N(z=9) ≈ 300
N(z=10) ≈ 150
N(z=11) ≈ 80
N(z=12) ≈ 40

➔ **To increase the number of first galaxies known, a legacy program such as the FF should be initiated with the JWST**

➔ **The Frontier Fields clusters should be re-observed with JWST to constrain the SED of high-z candidates selected on HST images**

The shape of Ly-α





Oesch et al. 2015