

Studying the high redshift universe with NIRSpec on JWST

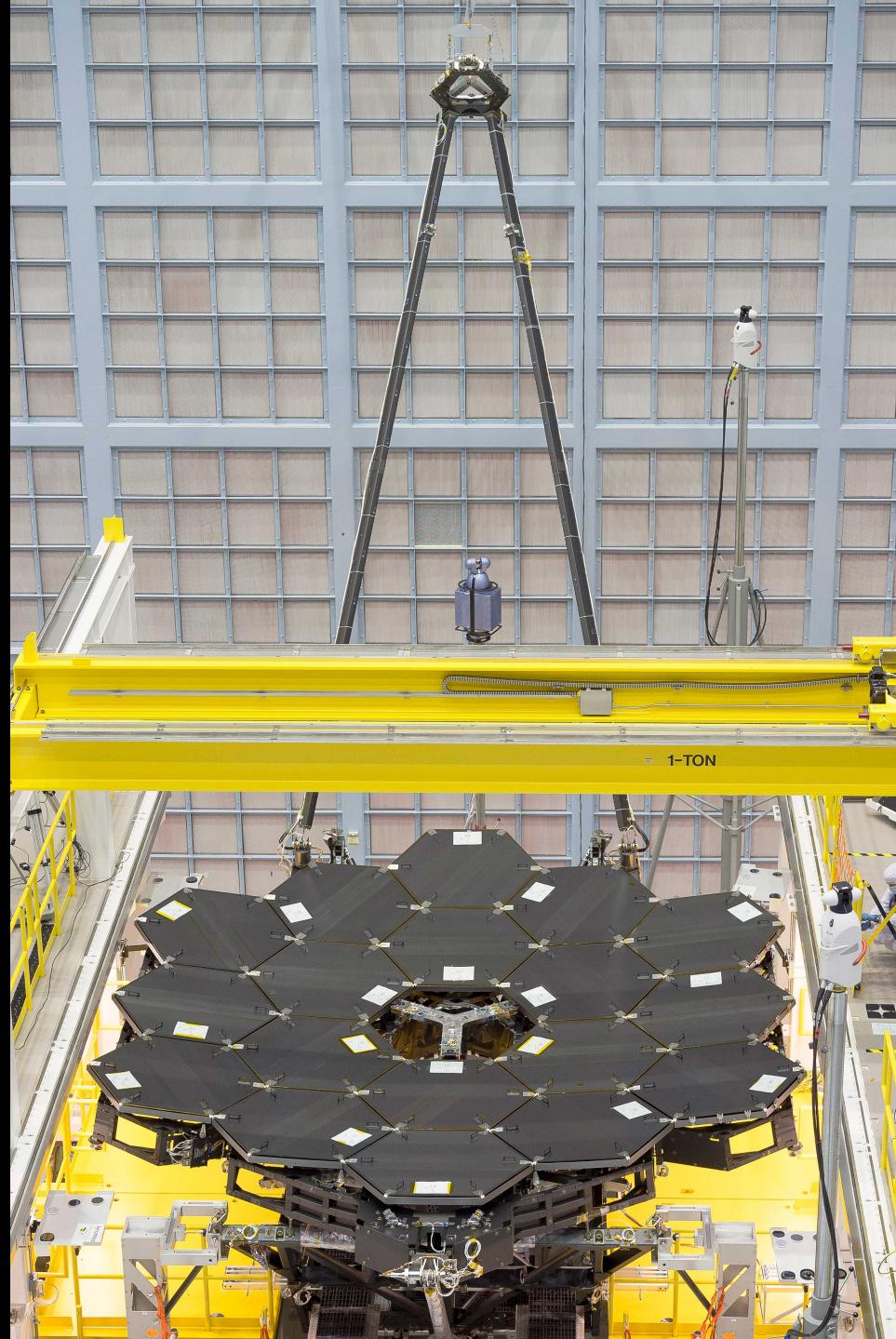
March 11 2016

M Franx & NIRSPEC Science Team

NIRSpec's GTO team

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B. Dorner [GTO team]	C. Willott [ESA SOT]
<u>P. Ferruit (project scientist)</u>	
M. Franx [IST]	

in collaboration with the NIRCAM team



SCHEDULE

2012		2013		2014		2015		2016		2017		2018											
J	U	J	F	M	A	M	J	A	S	O	N	D	J	F	M	A	M	J	A	S	O	N	D

OTE = Optical Telescope Element

OTIS = Optical Telescope + ISIM

k months of project funded critical path (mission pacing) schedule reserve

Spacecraft



Science Instruments

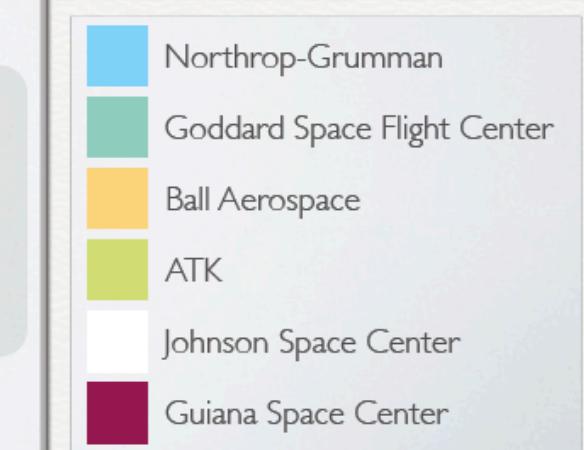
Segment Gear Motor replacement

Optical Telescope Element Fabrication and Testing

Faded areas are completed

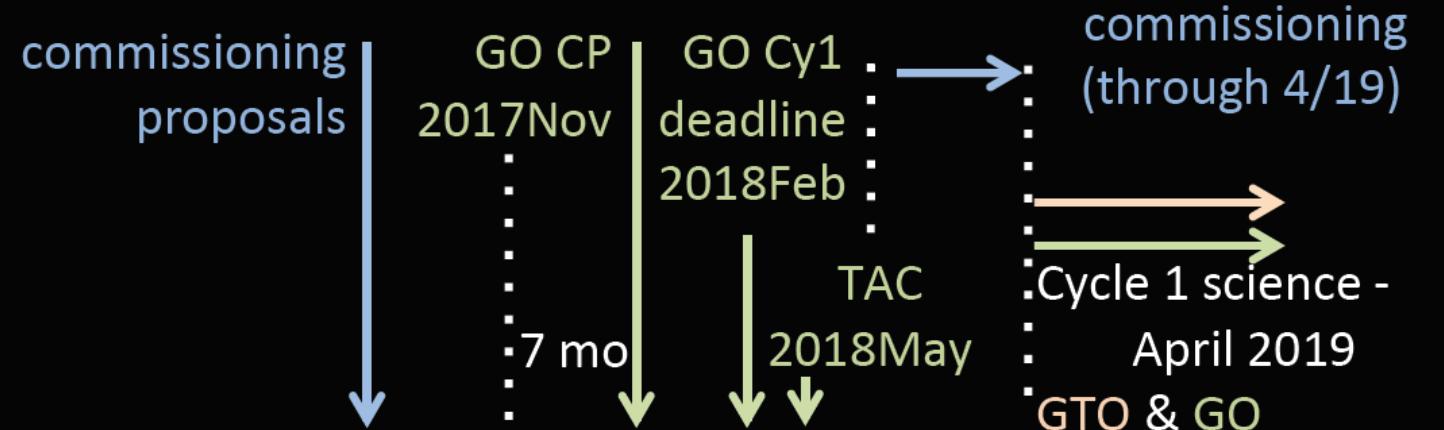
Telescope

6



JWST Science Planning Timeline

(draft schedule as of January 2015)



2015 2016 2017 2018 2019 2020 2021

You are here

GTO CP
2017Jan

GTO Proposal
deadline
2017Apr

ERS launch
deadline
2018Oct

Cycle 2
September - CP release
December – proposal
deadline
February 2020 – TAC
April 2020 – Cycle 2

GTO Cy1
observations finalized
June 2017

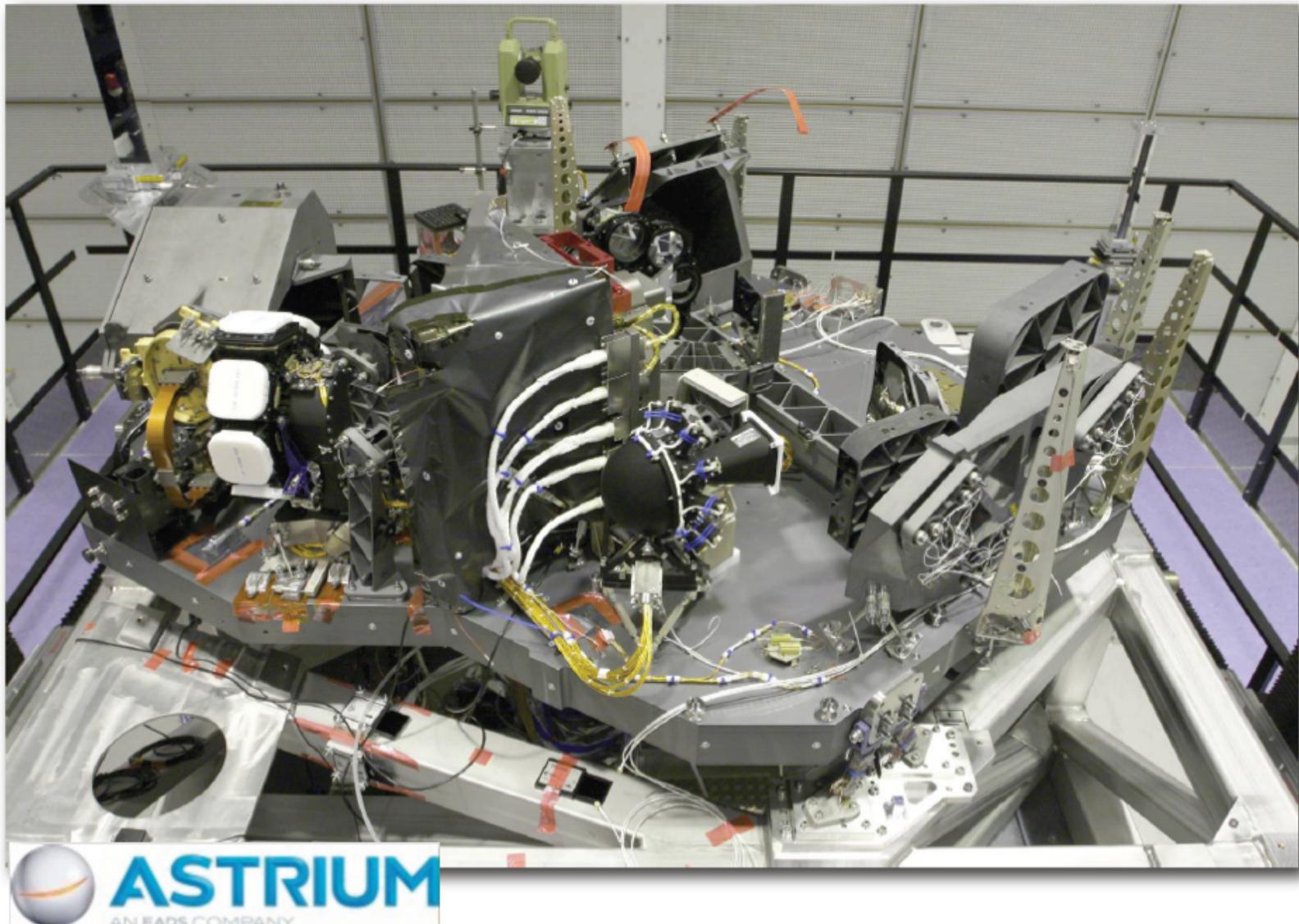
Meetings, Workshops

- 2015 oct ESTEC Exploring the Universe with JWST
- 2016 july **JWST@ROE**
- 2016 sept **Mastering the Science Instruments and the Observing Modes of JWST**, esac, madrid



James Webb Space Telescope

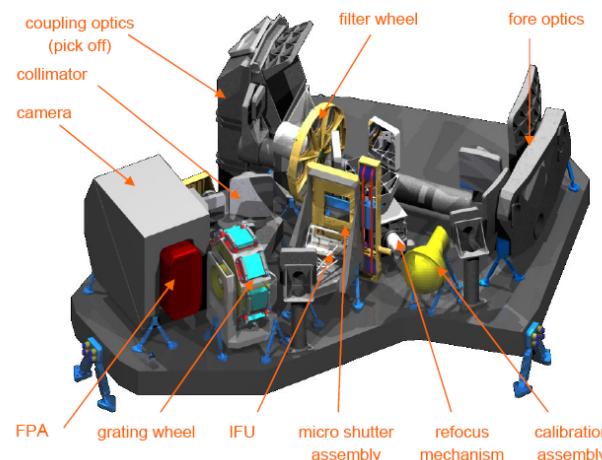
Assembled Flight Instrument



NIRSPEC: built by ESA (with Nasa). Instrument Scientist: Pierre Ferruit



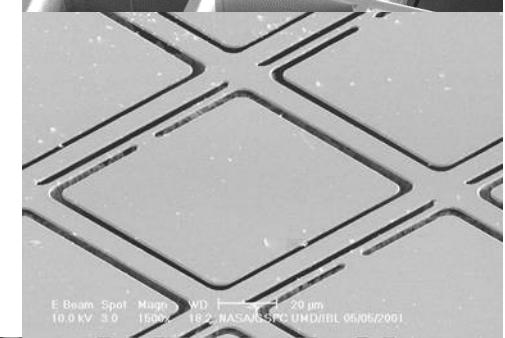
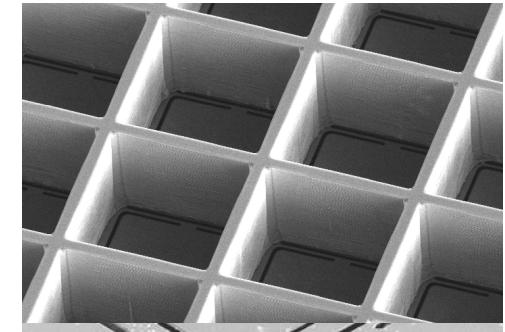
ESA instrument
Astrium prime contractor



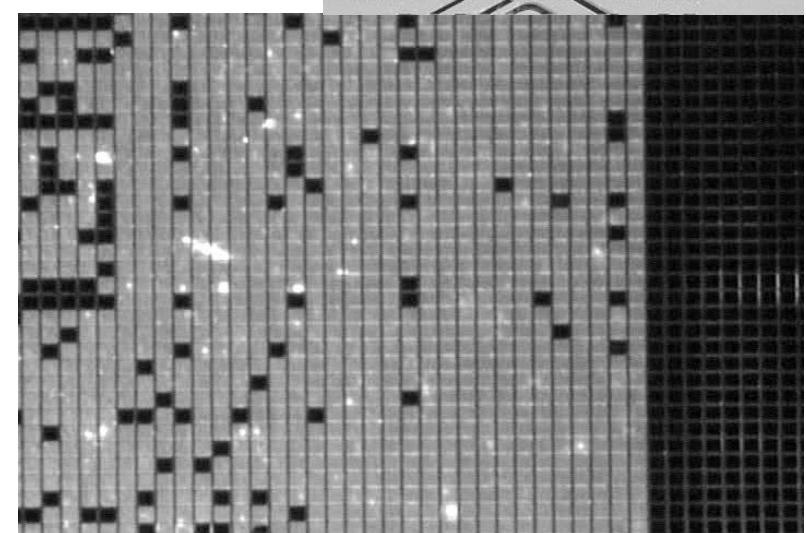
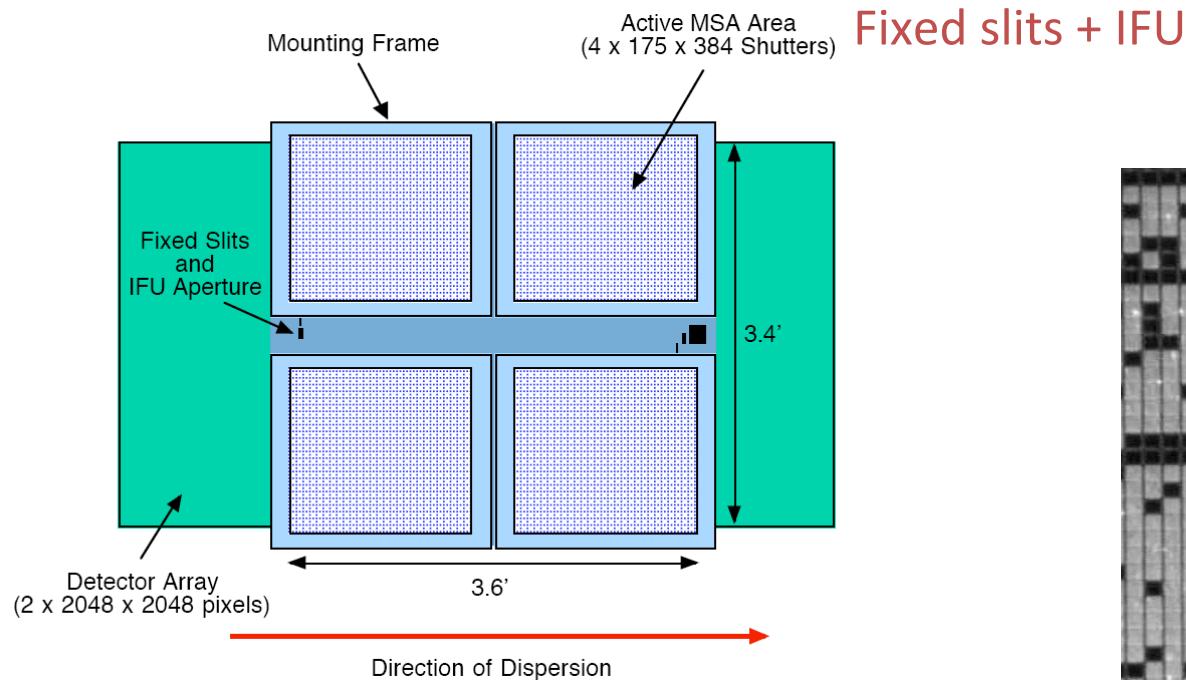
Near-Infrared Spectrograph



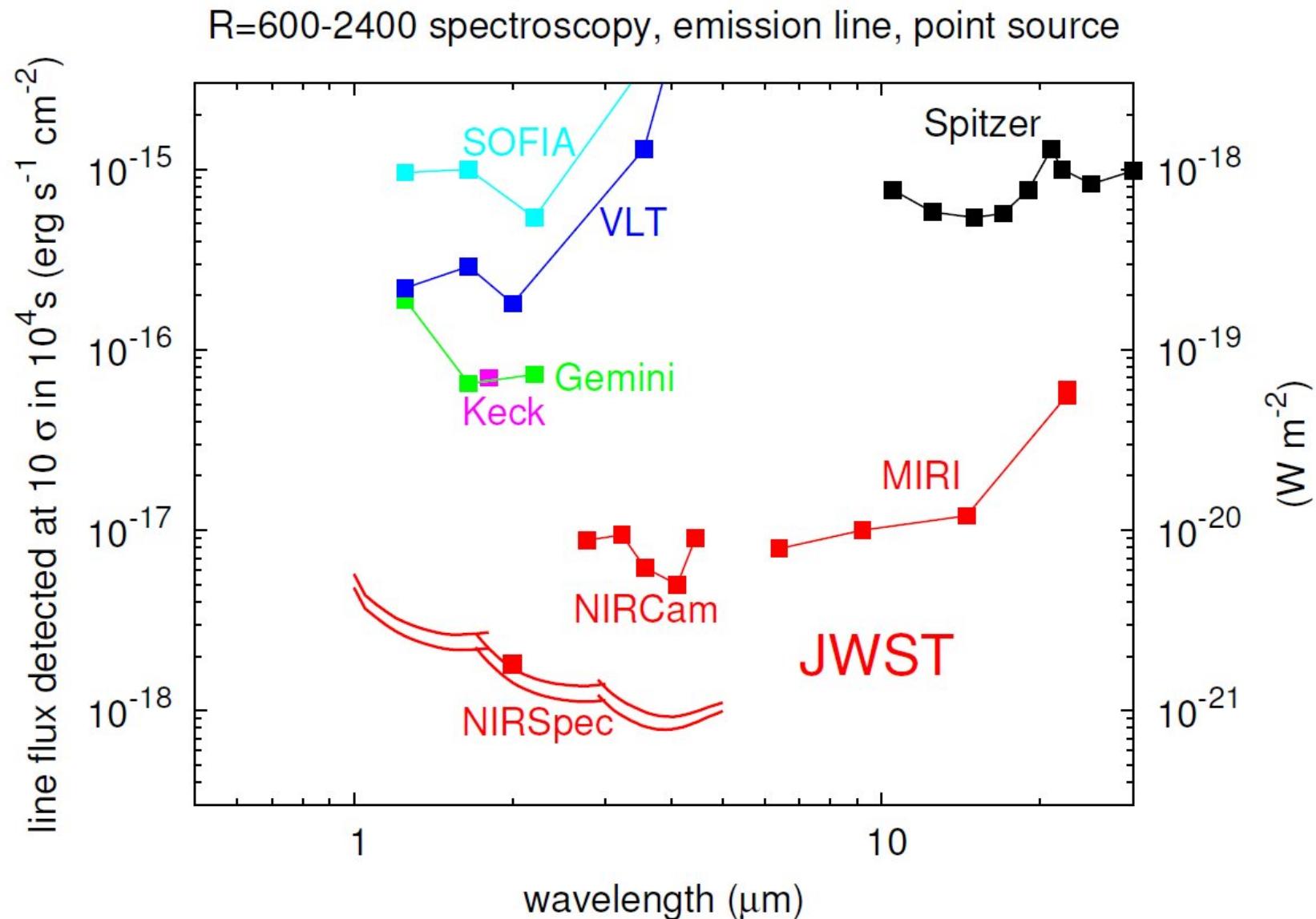
GSFC providing micro-shutters and detectors



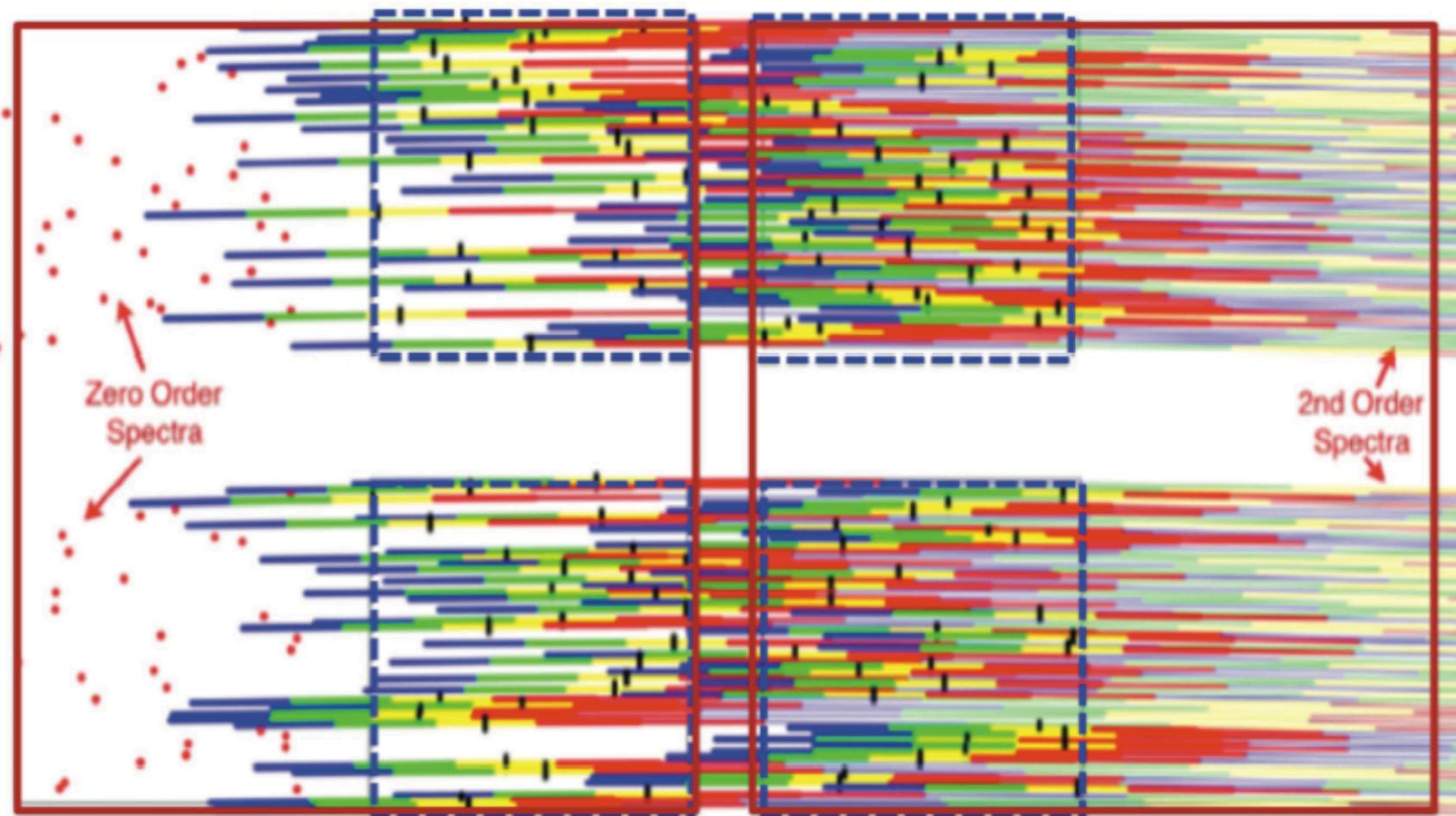
E Beam Spot Mag WD 20 μm
10.0 kV 3.0 1500x 18.2 NASA/GSFC/LBL 05/05/2001



Sensitivities - spectroscopy

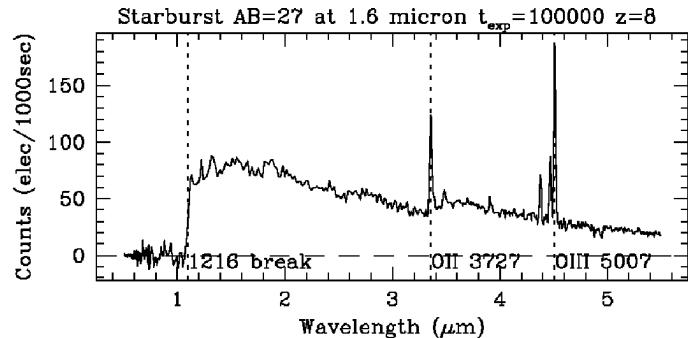


Spectra from NIRSpec

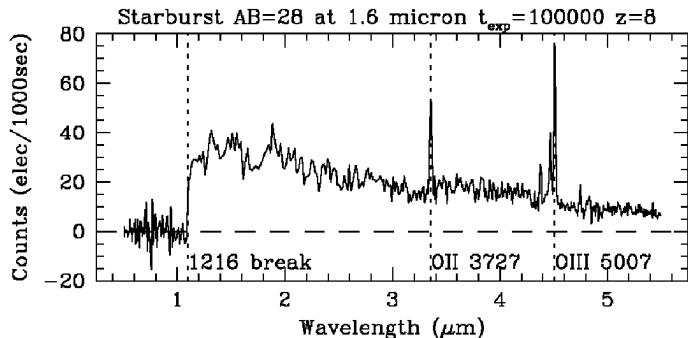


What NIRSPEC can do !

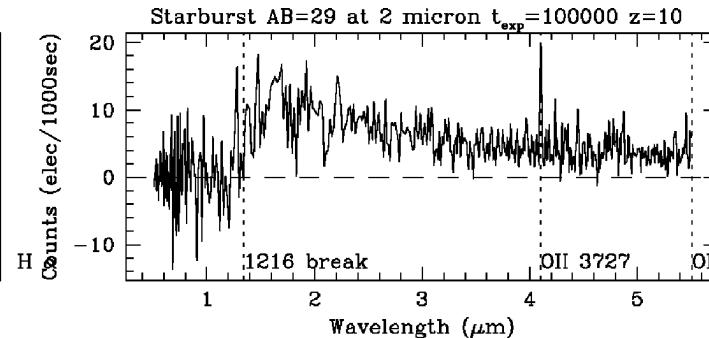
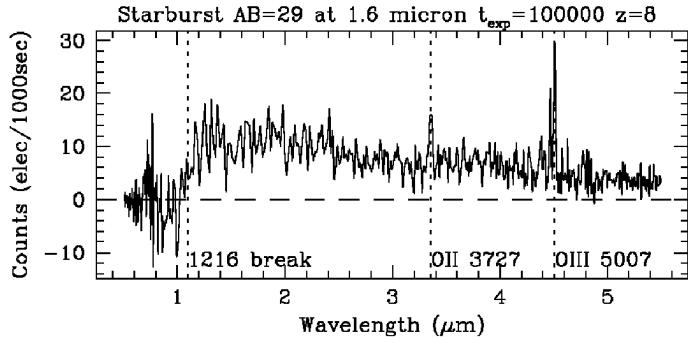
AB=27



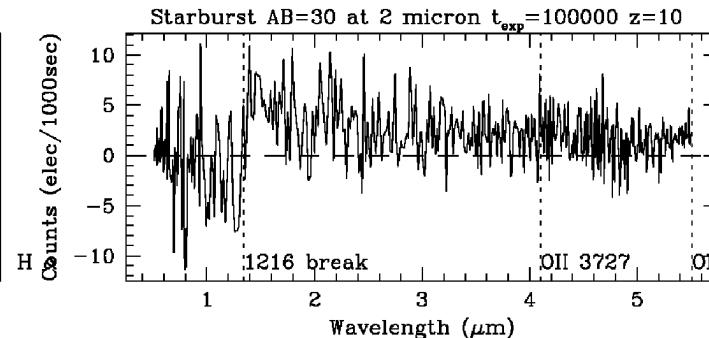
AB=28



AB=29



AB=29



AB=30

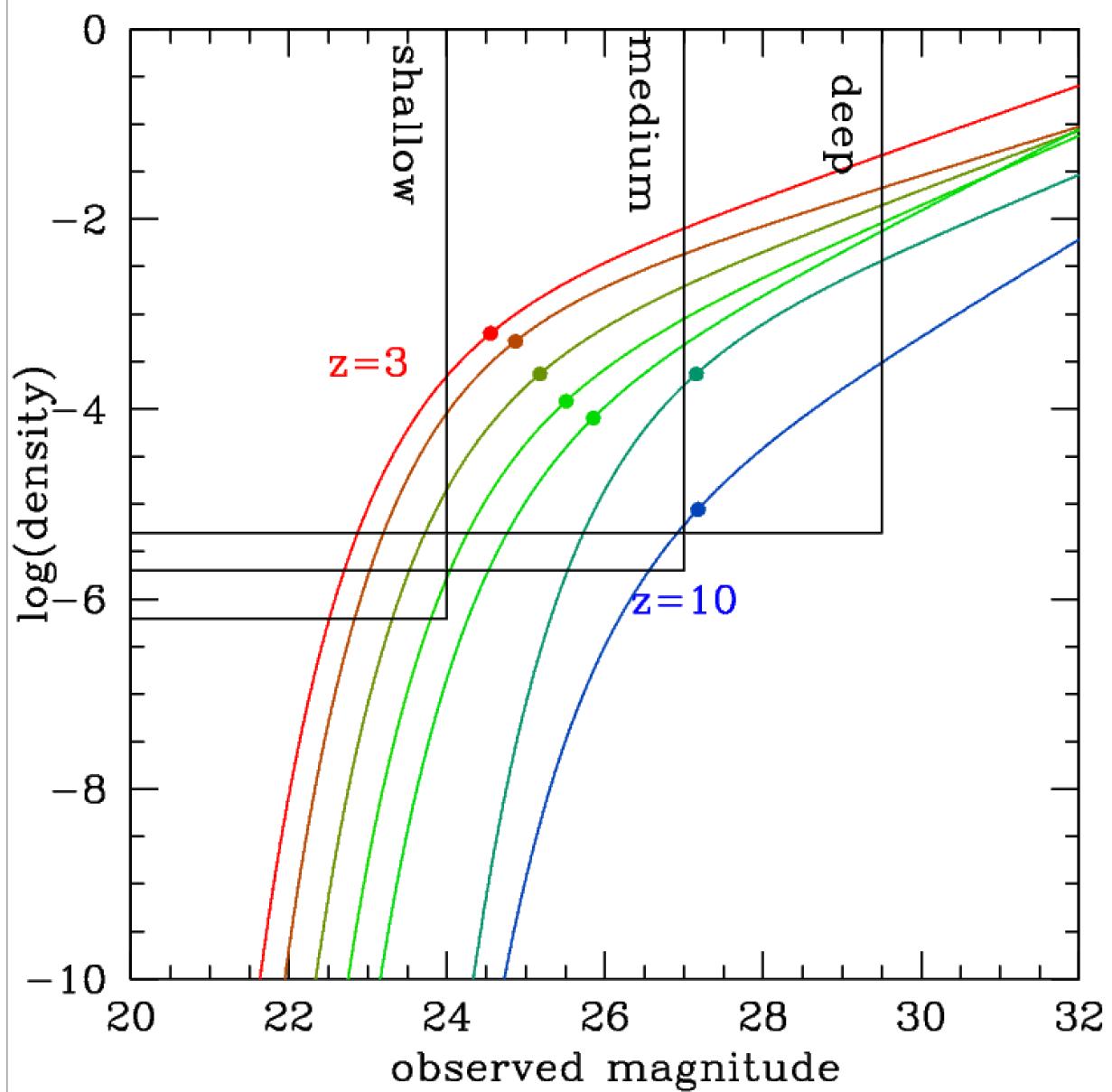
Derive redshifts, stellar masses, stellar ages, gas ionization and metallicities, star formation rates, kinematics, pop III stars, Ly- α LF to $z=10$, etc.

Overall NIRSpec GTO Galaxy Assembly Plan

- a MSA wedding cake survey at R=100 and R=1000
 - 1) Deep, 20-30 sq arcmin, 1-5 μm , 40-45% of the time, AB \leq 29-30, 2 $< z <$ 14, with NIRCAM team
 - 2) Medium, 100 sq arcmin, 1-5 μm , 40-45% of the time, AB \leq 27-28, 2 $< z <$ 14 , with NIRCAM team
 - 3) Shallow, 400 sq arcmin, 2-5 μm , 10-20% of the time, AB \leq 25-26, 7000+ spectra, 2 $< z <$ 4 (4 $< z <$ 14)
- ≈500 hours

Fields: HST, NIRCAM deep and medium fields

- 4) R=3000 IFU spectroscopy of extended objects
 - ≈300 hours



Overall Goals

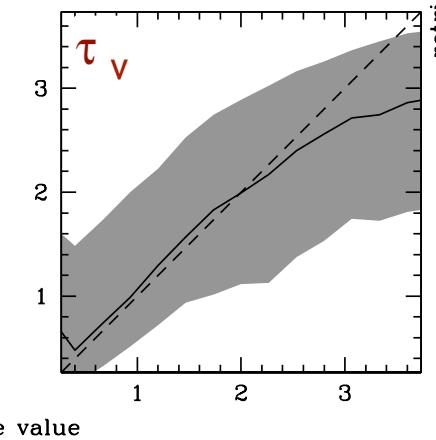
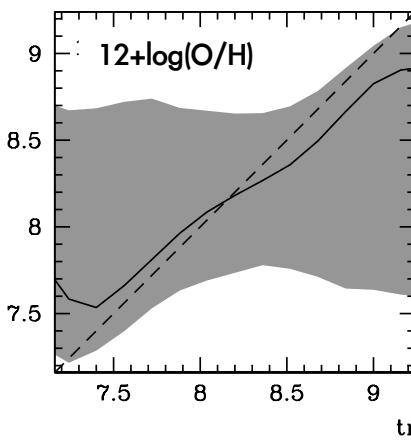
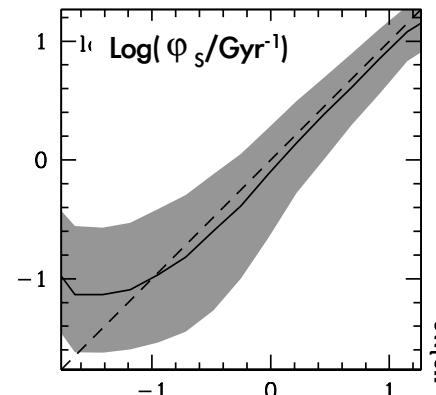
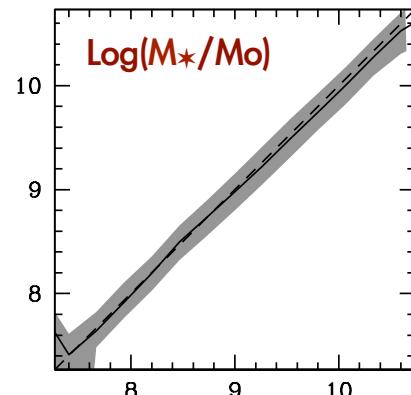
- Obtain accurate spectroscopy from $z=15$ to $z=2$ – the era of first light to the peak in SFR, AGN growth, and the onset of the red sequence
- Go > 5 magnitudes fainter at $1-5 \mu\text{m}$ than possible now – sample an entirely new domain.
- Science questions
 - what are the earliest galaxies/stellar populations (pop 3, etc) ?
 - what caused reionization, what is escape fraction ?
 - what are the stellar masses, metallicities, SFRs, ages, etc ?
 - How do star formation rates and stellar masses evolve ?
 - how do galaxies assemble ?
 - how is star formation regulated ?
 - how does AGN growth relate to galaxy growth ?
 - what is the role of environment ?
 - what is the relation between galaxies and their halos ?
 - what feedback processes can we observe ?

Retrievability of galaxy physical parameters

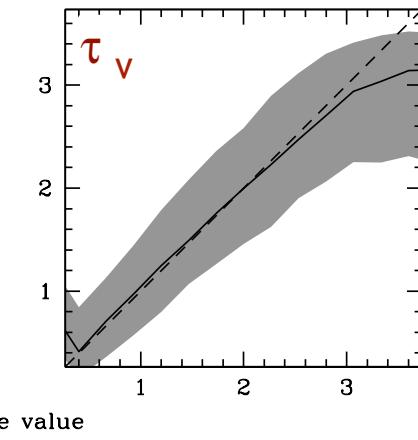
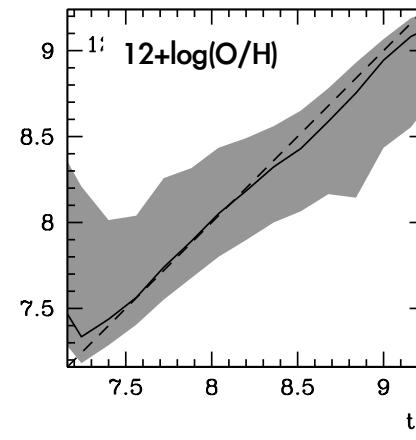
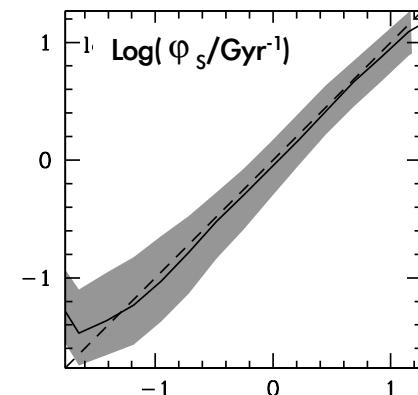
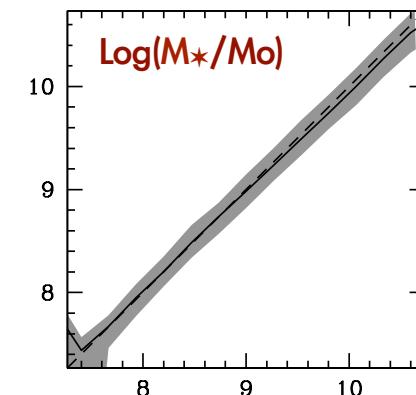
Global results for 10,000 pseudo-observed galaxies (wide range of true parameters)

R=100, S/N=5/pixel

averaged retrieved PDF



R=1000, S/N=5/pixel



See also presentation by Chevallard

true parameter value

(Pacifici et al. 2012)

One Key Result

Census of the universe to z=14

- Select galaxies in the red (4.4μ) -
 - rest frame optical to $z=11$ - get dusty, “old”, or low star formation galaxies to $z=9$
- Consistent stellar masses and ages
(get rid of those emission lines !)
- Consistent star formation rates from Balmer lines
- Evidence for Pop III or AGN, or other “special effects” ?

Summary

- JWST is well on track for launch in 2018
- NIRSPEC will allow detailed spectroscopy of the reionization era
- First proposals due mid 2017
- Be ambitious. Proposals can combine NIRCAM imaging + Nirspec follow-up
- First simulated data planned for ESAC meeting
- More information: presentations from 2015 Estec meeting, jwst.stsci.edu, jwst.esa.int
- Full ETC early 2017 @ stsci.edu