Wide Field Infrared Survey Telescope (WFIRST)

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WFIRST-AFTA Will Deliver Extraordinary Science

1. Frontiers of Knowledge

- Why is the universe accelerating?
- What is the dark matter?
- What are the properties of neutrinos?

2. Exoplanets

- How diverse are planetary systems?
- Do habitable worlds exist around other stars, and can we identify the telltale signs of life on an exoplanet?
- How do circumstellar disks evolve and form planetary systems?

3. Understanding our Origins

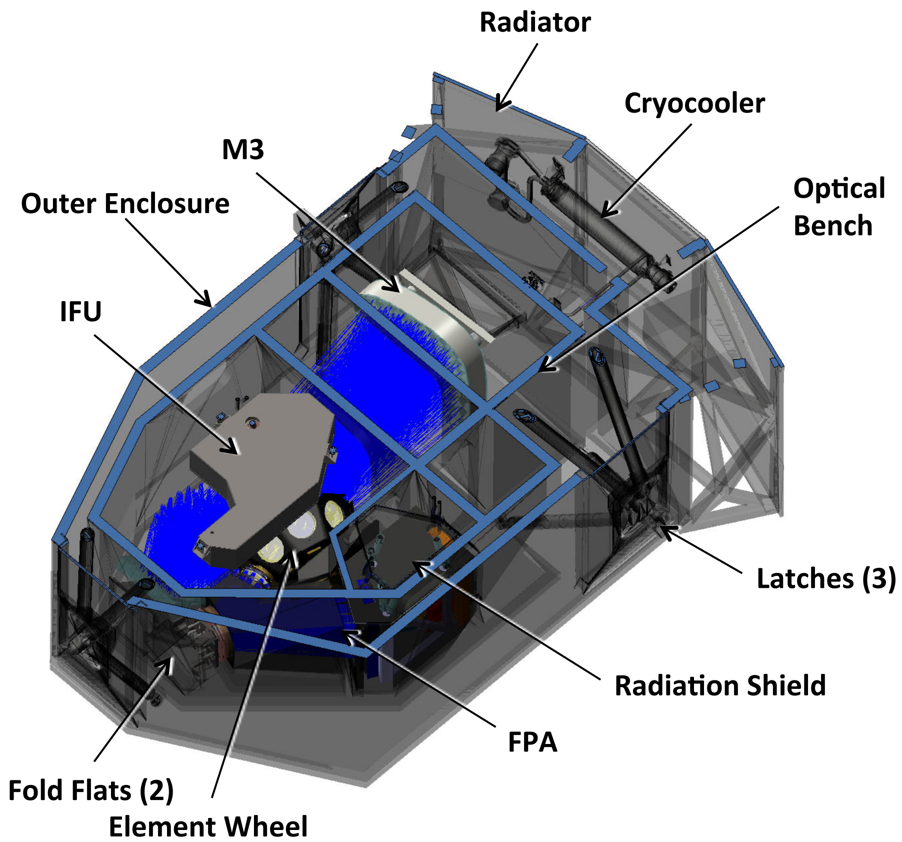
- How did the universe begin?
- What were the first objects to light up the universe, and when did they do it?
- How do cosmic structures form and evolve?
- What are the connections between dark and luminous matter?
- What is the fossil record of galaxy assembly from the first stars to the present?

4. Exoplanets: Stars + Galaxies

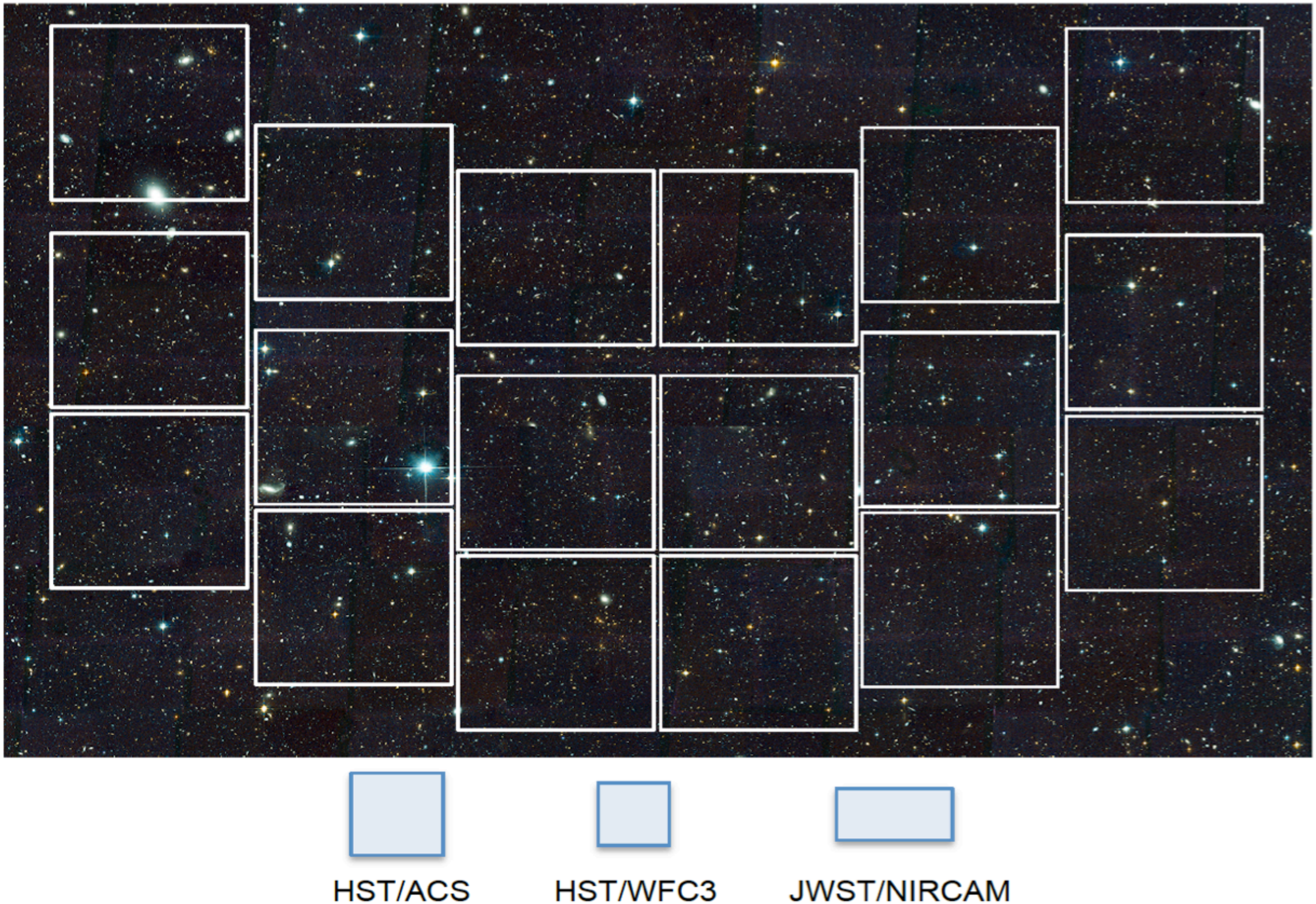
- What controls the mass-energy-chemical cycles within galaxies?
- How do the lives of massive stars end?
- What are the progenitors of Type Ia supernovae and how do they explode?

Wide Field Instrument

- 0.281 deg^2 (28 H4RG detectors (4k x 4k pixels per detector)
- GRS Spectroscopy (135-1.89) R=461 λ
- Filter wheel enables 6 filters from 0.76 to 2 microns, a grism, and a dark [ACTIVE DISCUSSION OF OPTIMAL FILTERS: SHOULD WE GO BLUE?]
- Integral Field Unit for slit spectroscopy (0.6-2.0 microns, R~100)



Wide Field IR Telescope

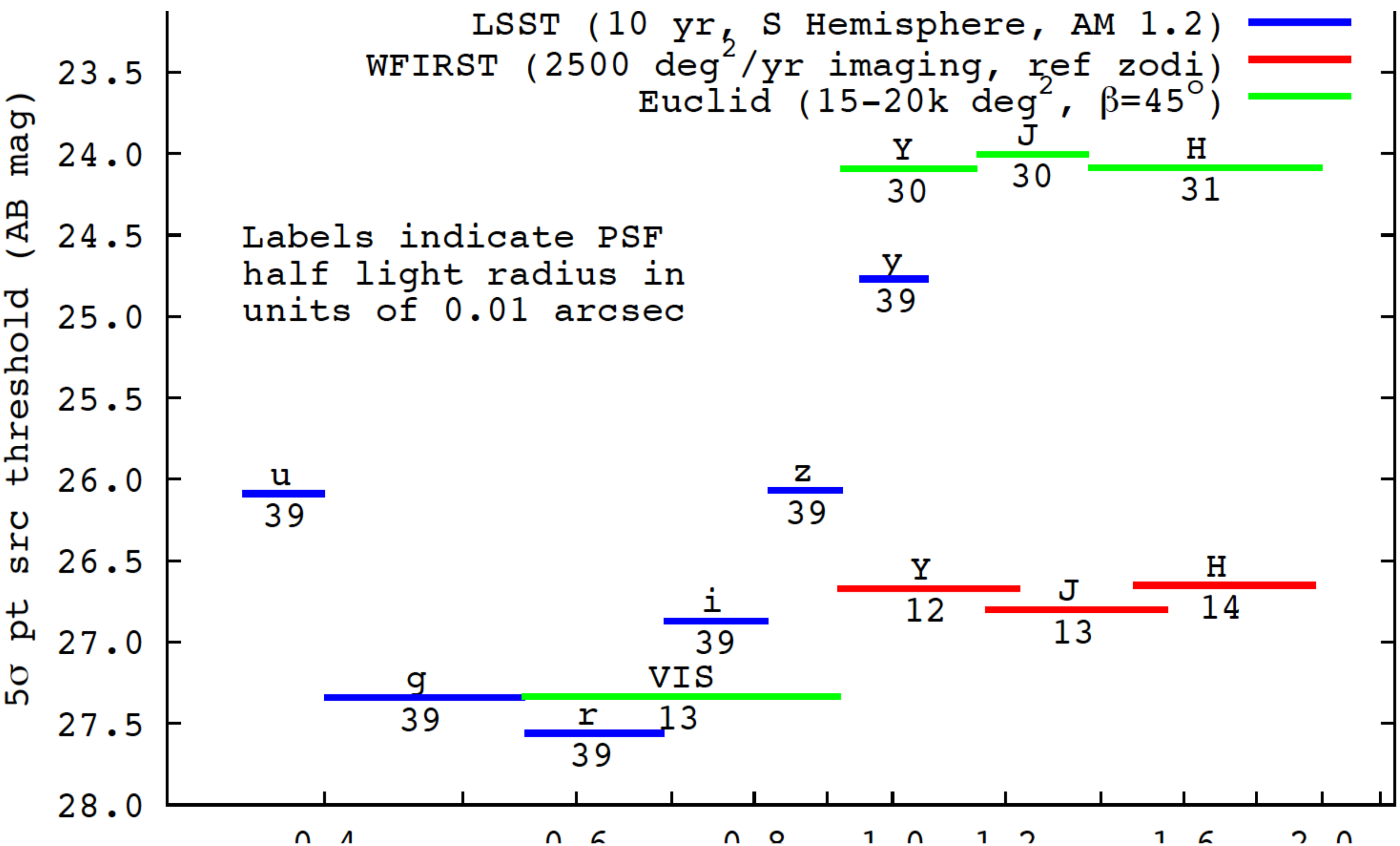


WFI Observing Modes

- High Latitude Survey: Optimized to study dark energy
  - 2227 deg^2 area YJHF184
    - 7 σ line flux of 1.2×10^{-16} $erg/cm^2/s$ (R=600)
    - 26.7 AB mag YJH (4-5 dithers at each of two roll angles/174 s integration)
  - SN surveys: 27.44/8.96/5.04 deg^2 with depths increasing to J=29.3/H=29.4
    - LSST deep drilling fields + Subaru fields

WFIRST
WIDE-FIELD INFRARED SURVEY TELESCOPE
ASTROPHYSICS • DARK ENERGY • EXOPLANETS

High Latitude Survey



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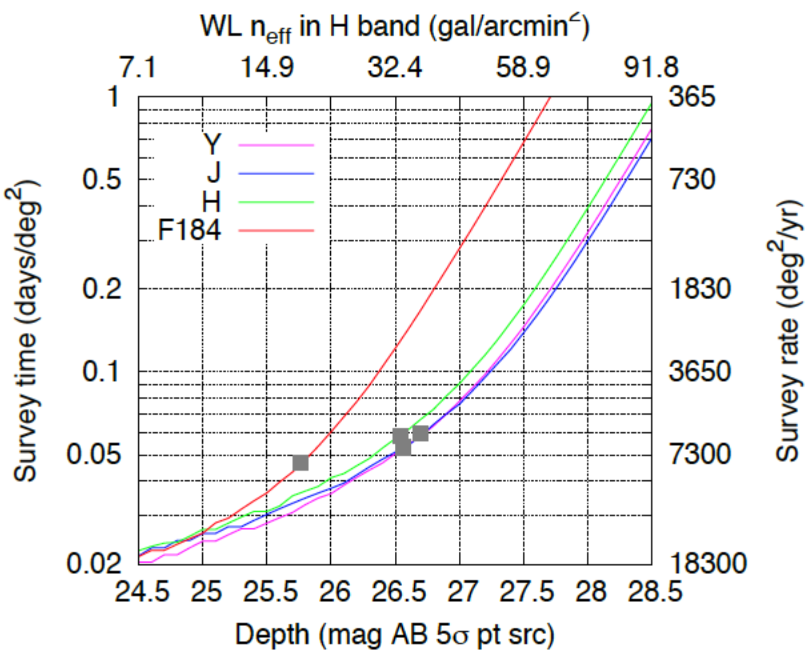


Figure 2-2: The survey time per unit area per filter, including overheads, for imaging surveys. The gray squares indicate the baseline HLS survey depth. The right hand axis marked in deg² covered per filter per year of observing time. The upper axis shows the effective weak lensing source density in H-band as function of depth.

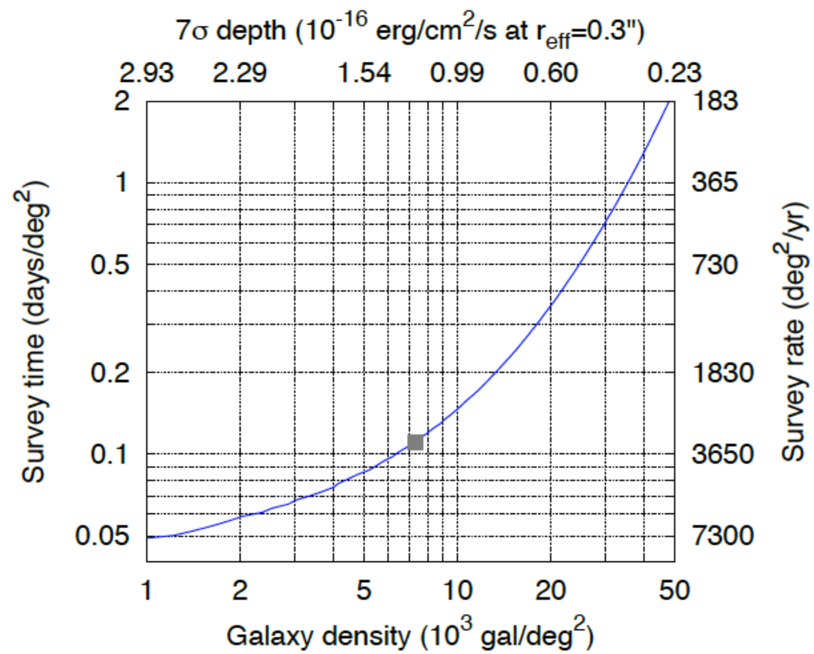
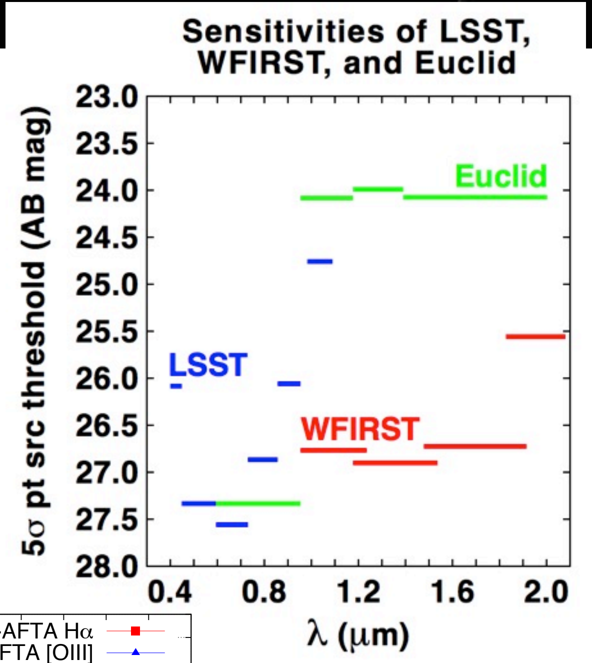


Figure 2-3: The survey time per unit area for the grism spectroscopy required to observe a certain number density of Hα emitters at 7σ, at redshift z = 1.5. The corresponding flux limit for an r_{eff} = 0.3 arcsec source is marked on the upper axis. The gray square indicates the baseline strategy. The right axis is marked in number of deg² covered per year of observing time.

WFIRST-AFTA Dark Energy

Weak Lensing (2200 deg^2)

- High angular resolution
- Galaxy shapes in IR
- 380 million galaxies
- Photo-z redshifts
- 4 imaging filters

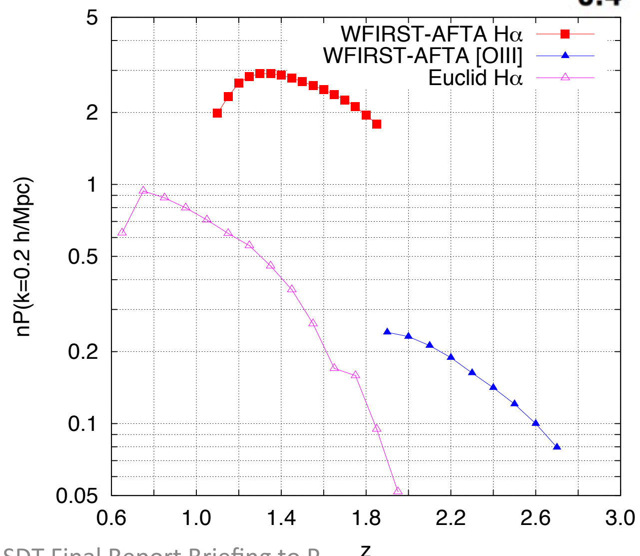


Supernovae

- High quality IFU spectra
- 5 day sampling of light curves
- 2700 SNe

Redshift survey (2200 deg^2)

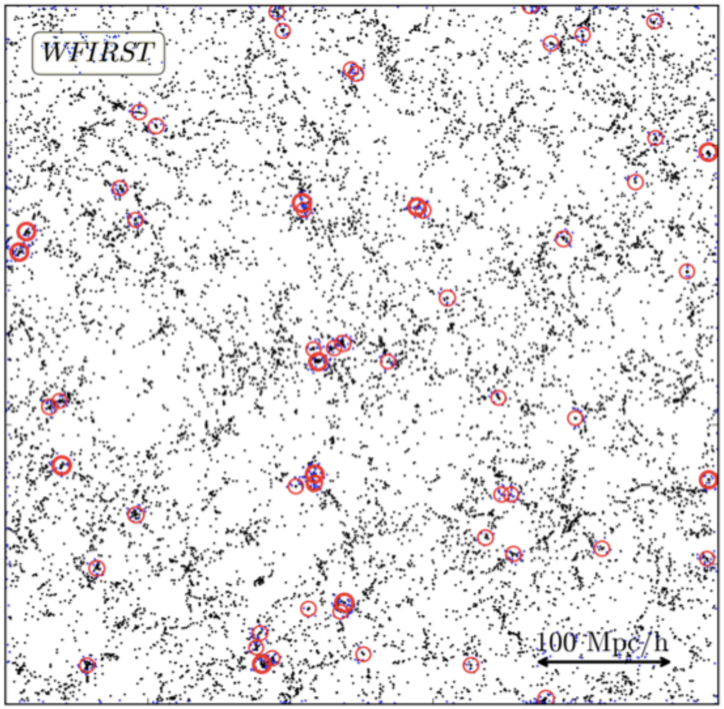
- BAO & Redshift Space Distortions
- High number density of galaxies
- 16 million galaxies

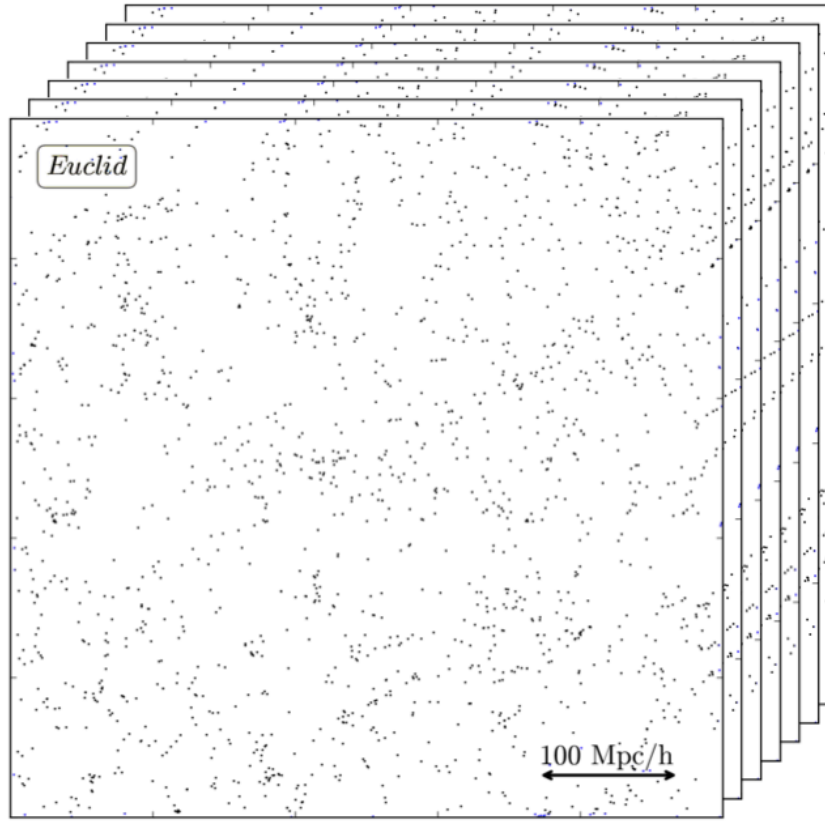


Detailed 3D Map of Large Scale Structure at z = 1-2

Large scale structure simulation showing 0.1% of the total WFIRST-AFTA Galaxy Redshift Survey Volume

$z = 1.5$

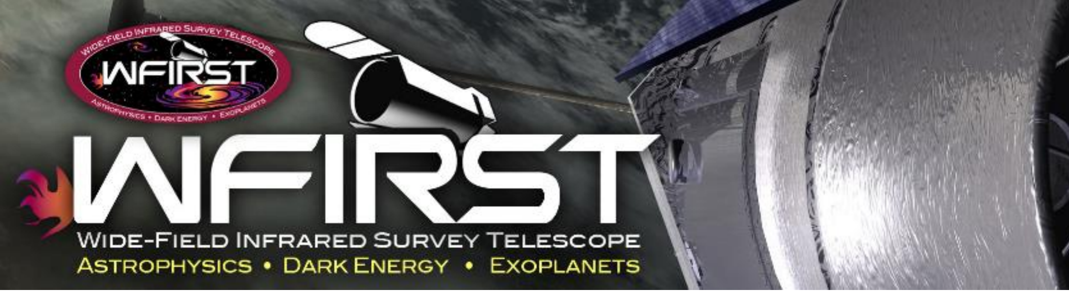




WFIRST
2,200 deg^2 @ 9 x 10^{-4} gal/Mpc^3

Euclid
15,000 deg^2 @ 1 x 10^{-4} gal/Mpc^3

Large scale structure simulations from 2015 SDT Report – courtesy of Ying Zu
Thin and thick red circles mark clusters with masses exceeding 5 x 10^{13} M_{Sun} and 10^{14} M_{Sun}, respectively



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    - LSST deep drilling fields + Subaru fields
- Bulge Survey: Optimized for exoplanet discussion
  - 6 season of 72 days
  - 10 contiguous field (2.8 degrees) each observed every 15 minutes in W149 and once every
  - 52 seconds in W149 (33000 epochs) and 290 seconds in Z087 (7000)
  - Fields are “confusion-limited”
  - Potential for high precision astrometry (50-700 mas/epoch) and seismology
    - 2.6 billion photons from a H=19.6 mag star!

WFIRST and Exoplanets

Microlensing will enable the detection of additional objects from the size of Mars to 30,000 times the mass of our Sun

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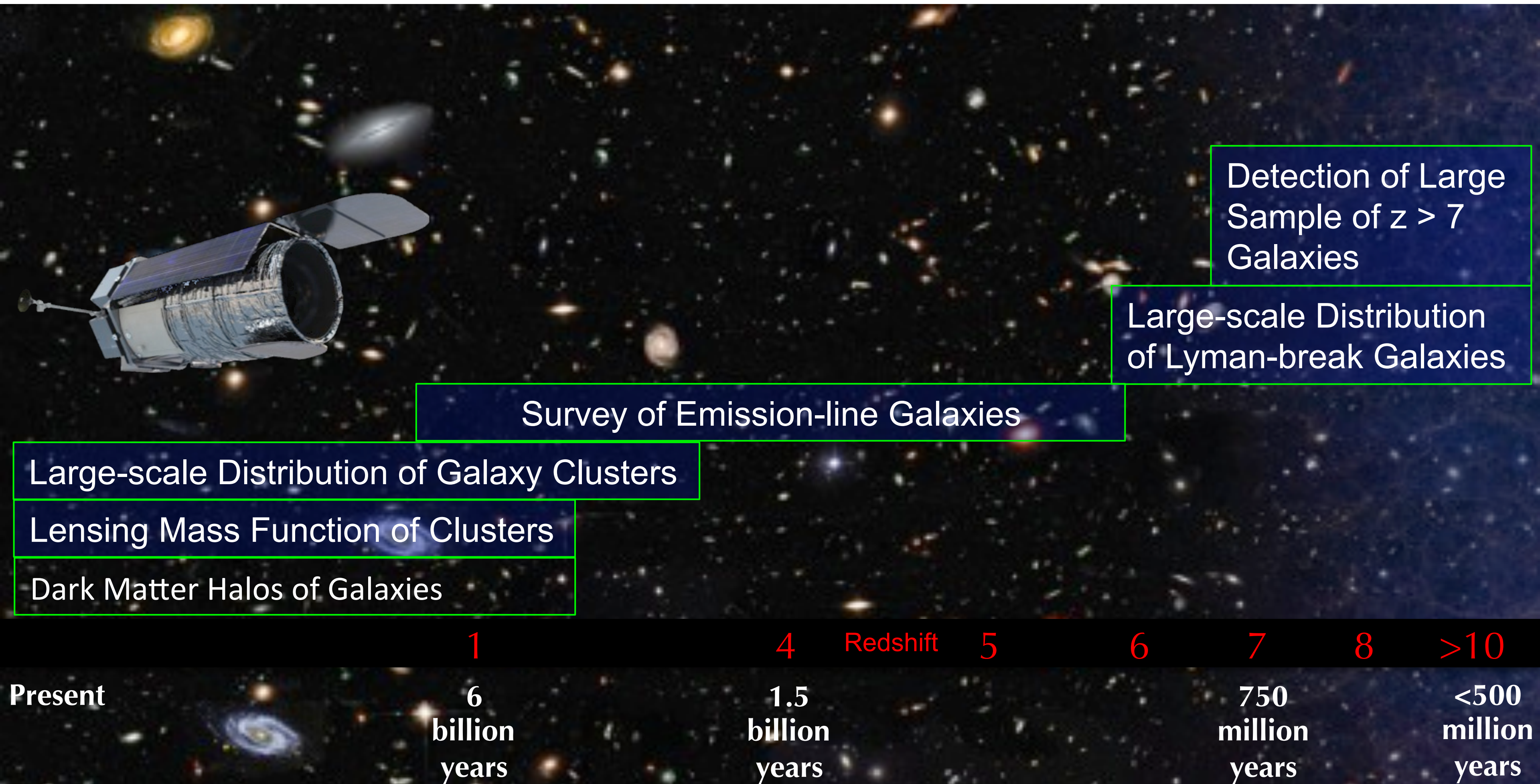
- GO Observations
  - Treasury vs. Modest Programs
  - Wide vs. Deep (Galactic surveys/Real big UDF)

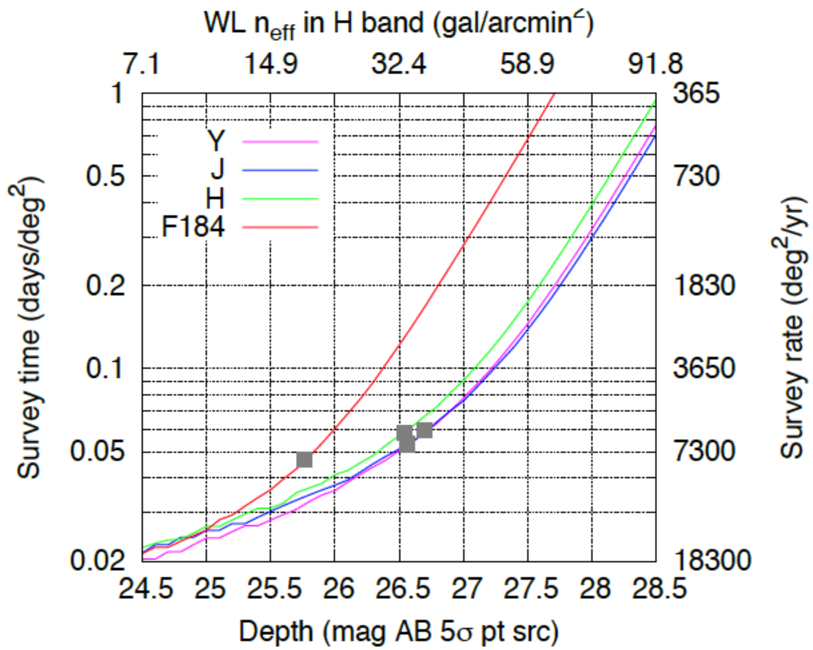
WFIRST-AFTA: A Unique Probe of Cosmic Structure Formation History

Using Observations from the High-Latitude Survey and GO Programs



Going Deep

- Deep Supernovae Fields
  - Optimize overlap with LSST/HSC+PFS
    - Multi-wavelength studies
    - Target finders for JWST + ELTs
  - Early Science Fields (particularly for JWST)
- Bulge Fields
- GO Observations:
  - 25% of observing time (more in extended operations)
  - Ultradeep fields of J=30 AB!
  - Treasury versus small proposals
- GI Programs
  - No proprietary period for imaging and spectroscopy



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Is Happening!

- Currently in Phase A (until mid-2017)
- Launch planned for mid-2020s (In-guide budget has a 2025 launch)
  - Earlier launch (2024) would lower mission cost and increase overlap with JWST
- How can you get involved?
  - Science Investigation Teams
    - Olivier Doré Weak lensing and galaxy redshift survey
    - Saul Perlmutter Supernovae
    - Ryan Foley Supernovae
    - Scott Gaudi Microlensing
    - Bruce Macintosh Coronagraphy
    - Margaret Turnbull Coronagraphy
    - Jason Kalirai GO science, Milky Way
    - James Rhoads GO science, cosmic dawn
    - Brant Robertson GO science, galaxy formation & evolution
    - Alexander Szalay GI science, archival research
    - Benjamin Williams GO science, nearby galaxies
  - Conferences
  - Think about how you will use WFIRST for your science and make sure that you and the telescope are ready!