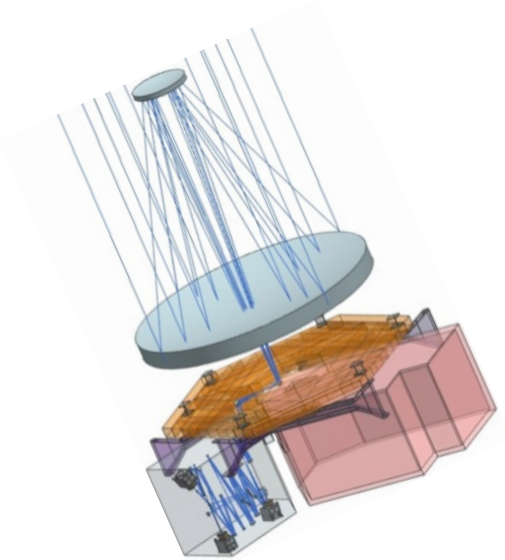
# Overview of WFIRST-AFTA Mission Capabilities

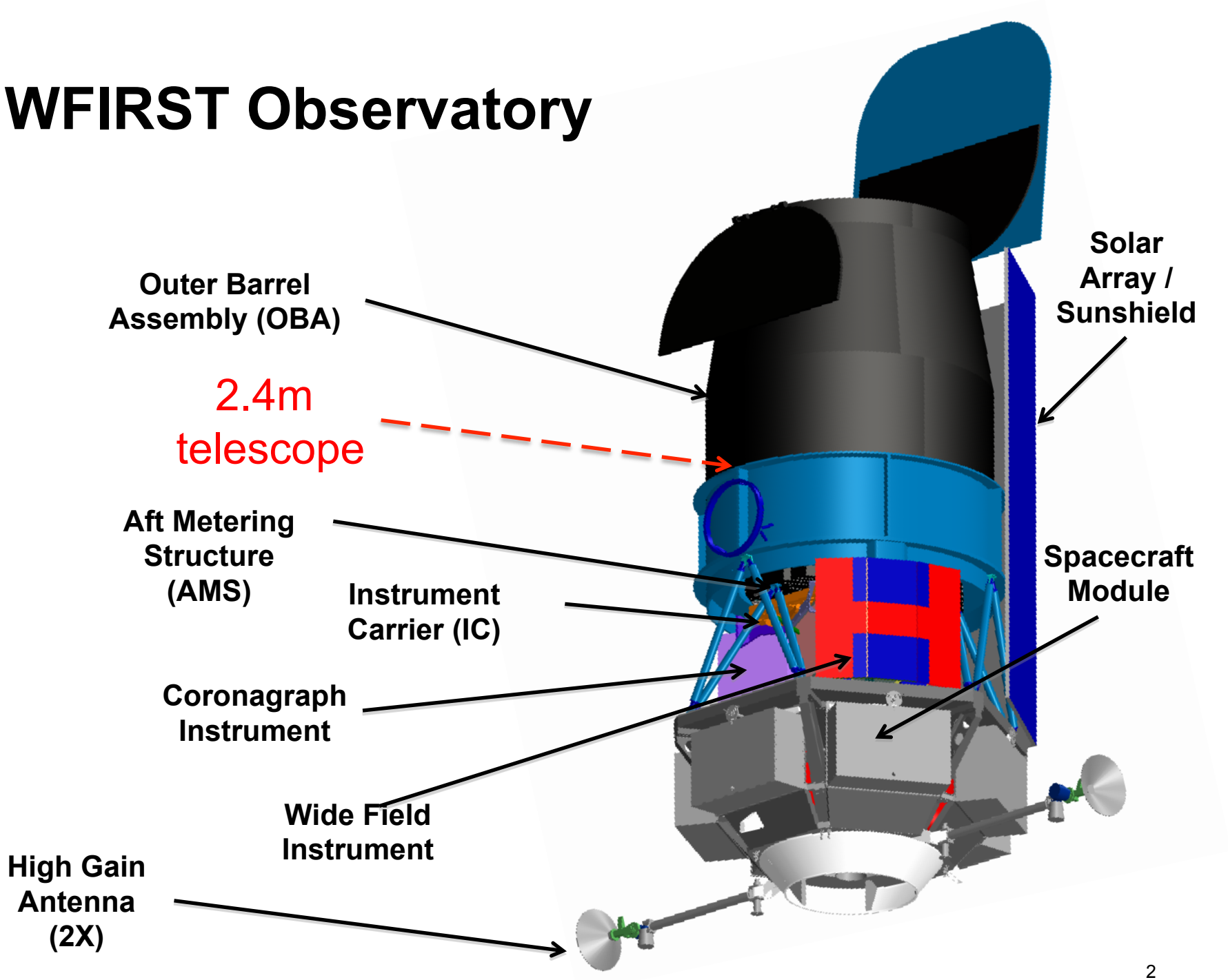
Neil Gehrels
WFIRST Project Scientist
(NASA-GSFC)



AAS

June 3, 2014

# WFIRST Observatory



# Observatory Capabilities

## Spacecraft

Telescope:
- 2.4m primary, 0.6m secondary
- 3rd mirror in WF instrument for TMA

Field of Regard:
- 54˚ - 126˚ w.r.t. sun
- 64% of sky

Downlink:
- Continuous 150 Mbps
- Ka-band to Ground Station

GEO orbit

Dry mass: 3900 kg

## Wide Field Instrument

Imaging 0.8 – 2.0 microns
0.28 FoV 0.11" pixel scale
6 filters
grism: 1.35 – 1.95 microns R~600

## IFU (in WFI)

0.6 – 2.0 microns
3" FoV 0.075" pixel scale R~100

## Coronagraph

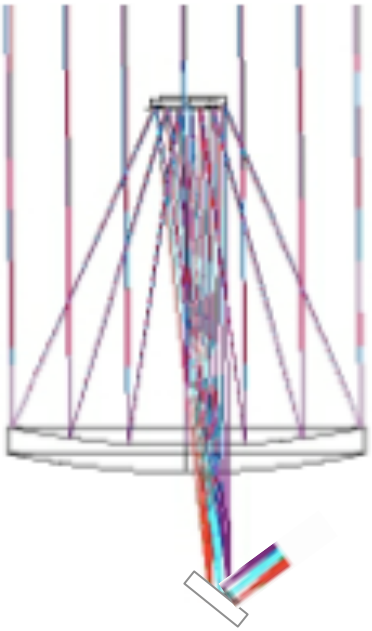
0.4 – 1.0 microns
2.5" FoV 0.017" pixel scale

## IFS (in coronagraph)

0.6 – 1.0 microns R~70

# TMA Telescope

- Three Mirror Anastigmatic
- Three powered (curved) mirrors
- 9 degrees of freedom from mirrors
  (curvature, conic constant, position for each)
- Allows control of 9 parameters
  (focal length, magnification of each mirror, astigmatism, coma, spherical aberration, field curvature)
- Much wider field than Ritchey-Chrétien
- Better image quality than Schmidt



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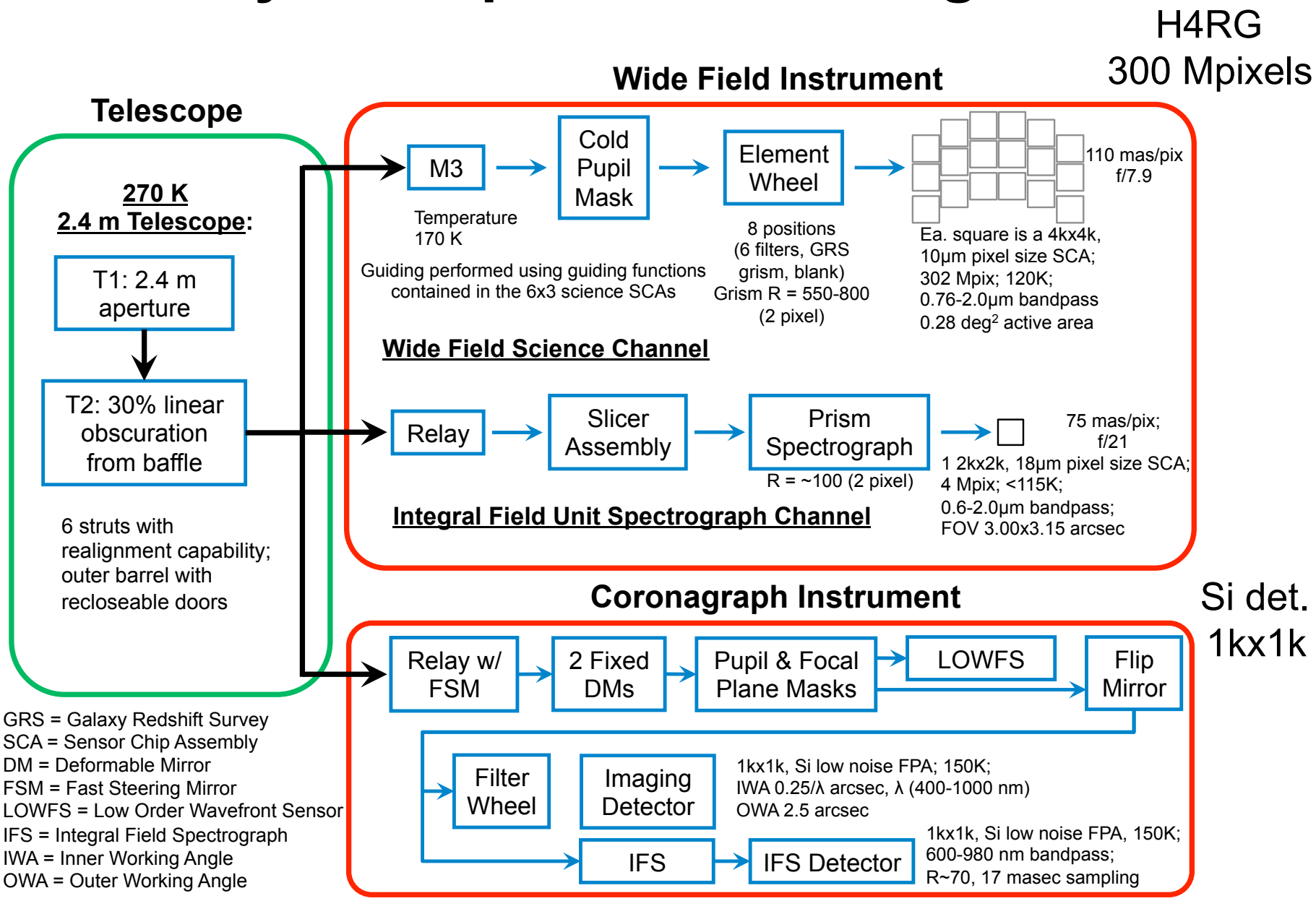
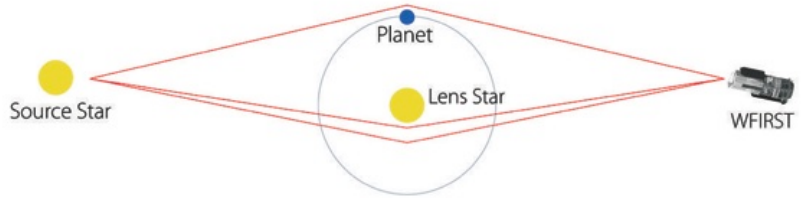
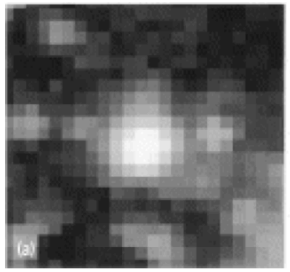
# Payload Optical Block Diagram

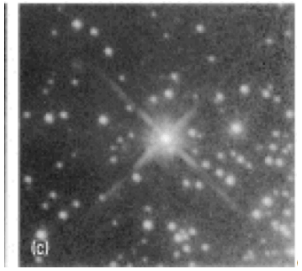


# Microlensing Capabilities




| Desires | WFIRST capability |
|---|---|
| Monitor dense star field | Galactic bulge, IR imaging<br>3 sq deg field |
| Adequate continuous time | 6 x 72 days = 1.2 years total |
| Long time baseline, astrometry | 6 years |
| Many exoplanet lensed events | 3000 exoplanets<br>300 Earth-mass<br>100's free floating |





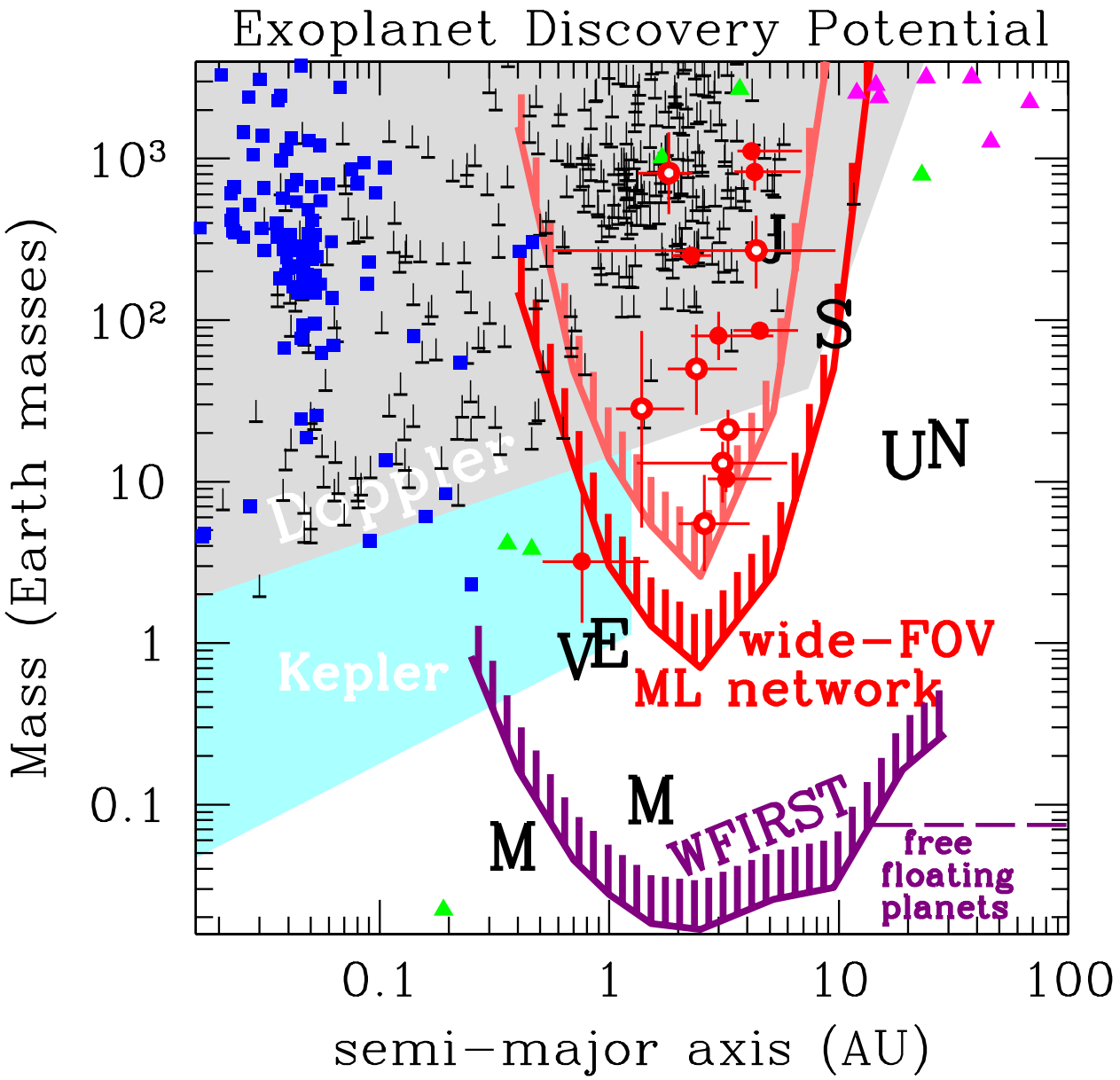
**WFIRST Benefits vs Ground**

Steady uninterrupted view for weeks at a time

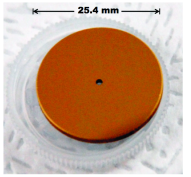
NIR coverage for reddened / obscured bulge region

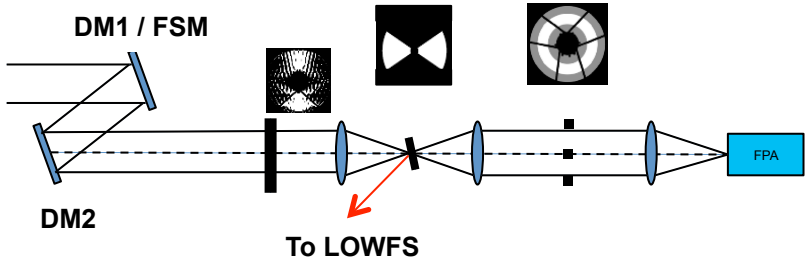
High angular resolution (~ 0.1" vs ≥1")

# Microlensing Capabilities



# Coronagraph Capabilities




## Desires

High contrast, image Jupiter exoplanets

Small inner working angle

Spectroscopy to characterize planets

Polarization to determine geometries

## WFIRST capability

$10^{-9}$ effective contrast

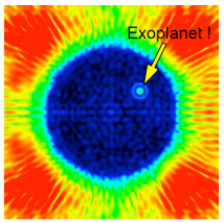
IWA ~ 100-200 milli-arcsec

R~70 (TBD)  600 – 950 nm

Polarization sensitivity

## WFIRST vs Ground & Space

| | | |
|---|---|---|
| WFIRST | $10^{-9}$ | 100-200 mas |
| HST | $10^{-4}$ | 200 mas |
| GPI | $10^{-6}$ | 100 mas |
| ELT | $10^{-7}$ | ~50 mas |



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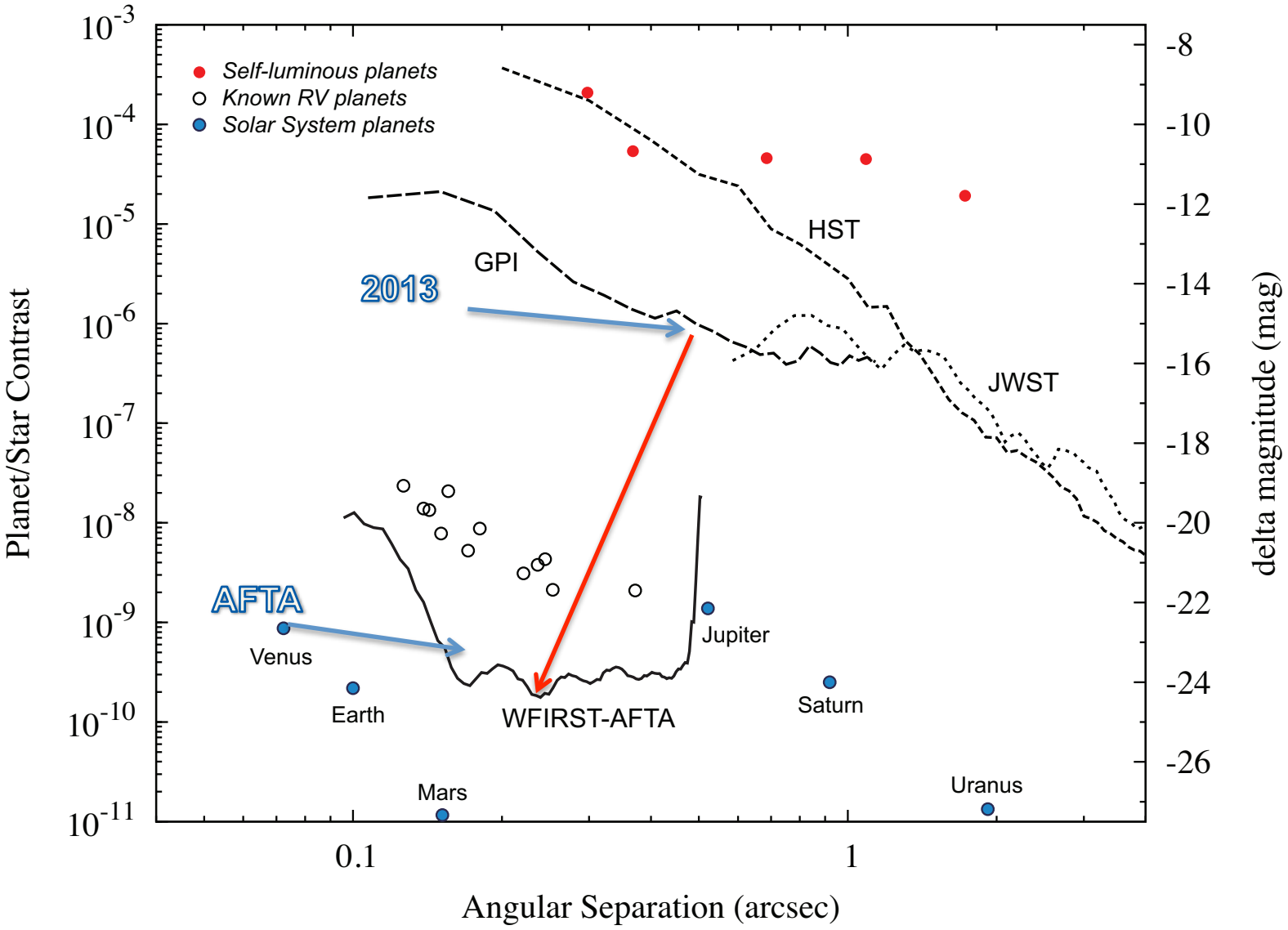


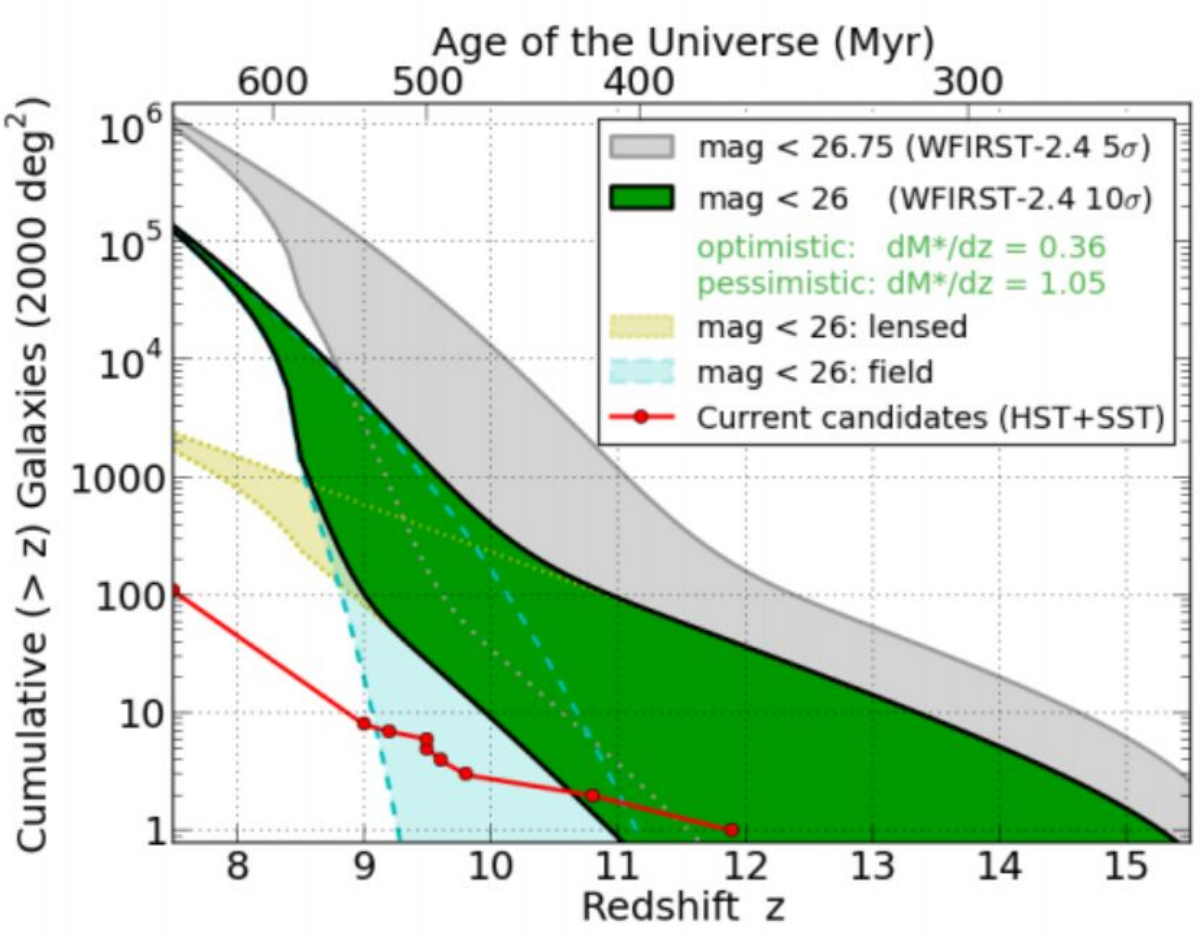
# GO Capabilities

| Attributes | WFIRST capability |
|---|---|
| Imaging survey | J ~ 27AB over 2400 sq deg |
| | J ~ 29AB over 3 sq deg deep fields |
| Multi-filter photometry | Filters: z, Y, J, H, Ks, W (wide) |
| Slitless spectroscopy | 0.28 sq deg, R~600 |
| Slit multi-field spectroscopy | IFU, R~70 |
| Number of SN Ia SNe | $2 \times 10^3$ to z~1.7 |
| Number galaxies with spectra | $2 \times 10^7$ |
| Number galaxies with shapes | $4 \times 10^8$ |
| Number of galaxies detected | few x $10^9$ |
| Number of massive clusters | $4 \times 10^5$ |
| Time domain astronomy | supernovae – slit spectroscopy in 5 days |
| | lensed exoplanets – few hours to 1 day |
| | transient response in few hours (goal) |

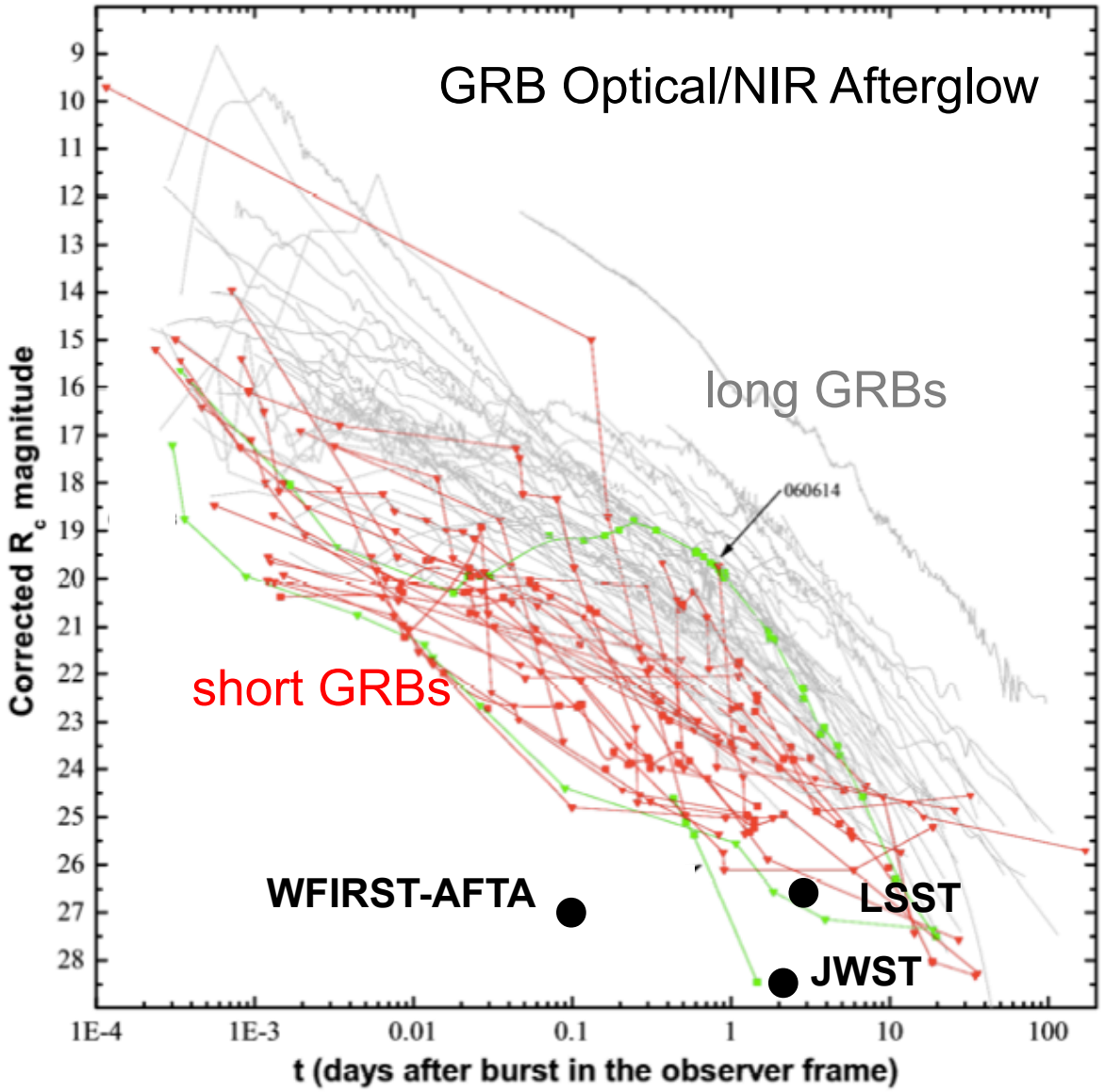
*** Coronagraph also available for GO observations

# High Redshift Galaxy Luminosity Function

WFIRST's High Latitude Survey will yield up to 2 orders of magnitude more high redshift galaxies than currently known



# Response to Transients




NS-NS mergers produce GWs & GRBs

EM afterglows are bright, but short-lived

Kann+ '08

# Status

- SDT study underway with project team.  Final report due '15
- "New start" in FY16 of FY17.
- Science teams and possibly hardware teams to be selected competitively in about 2 years.
- Use of donated telescope and addition of coronagraph have increased the interest in WFIRST:.
  - $66M add by Congress.  Used for pre-Phase A risk reduction & schedule advancement
  - Funding ramps up in FY18, capturing the JWST funding "wedge" for astrophysics
- Cost with coronagraph is $2.1 - 2.4B depending on launcher
- Launch date is 2023 to 2024

# Conclusions

- WFIRST-AFTA with 2.4m telescope has capabilities that are orders of magnitude better than current instruments
- Microlensing observations
  - NIR from space
  - More sensitive and less confused than ground measurements.
  - 3000 exoplanet detections
- Coronagraph is enabled by larger mirror.
  - Optical measurements in controlled instrument from space
  - $10^{-9}$ contrast and 100-200 mas IWA
  - significant improvement compared to space and ground
- WFIRST-AFTA is gaining momentum in funding and community support. Need to work hard on coronagraph development, keeping it "in the box"