AFTA WFIRST

Neil Gehrels and David Spergel

Astrophysics Subcommittee
February 14, 2013

WFIRST Activities

WFIRST

- 2010: WFIRST ranked 1st in large mission category by Astro2010
- 2011: Science Definition Team #1 formed to study WFIRST
- 2012: SDT #1 final report: arXiv 1208:4012

AFTA-WFIRST

- 2012 NASA announces receipt of two 2.4m telescopes (June)
- 2012 WFIRST-AFTA science conference at Princeton (September)
- 2012 SDT #2 formed to study 2.4m telescope for WFIRST science
  - working with Project team at Goddard and JPL

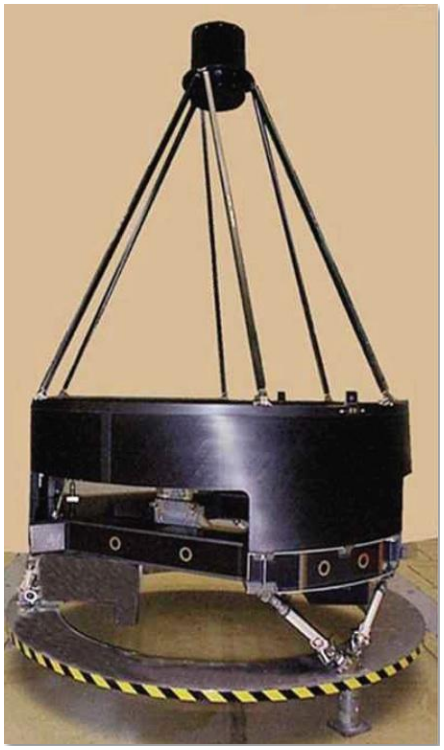
Program to package & characterize HgCdTe IR detectors (govt, industry, academia)

Science Definition Team #2

Neil Gehrels, GSFC Co-Chair
David Spergel, Princeton Co-Chair

James Breckinridge, Caltech
Megan Donahue, Michigan State Univ.
Alan Dressler, Carnegie Observatory
Chris Hirata, Caltech
Scott Gaudi, Ohio State Univ.
Thomas Greene, Ames
Olivier Guyon, Univ. Arizona
Jason Kalirai, STScI
Jeremy Kasdin, Princeton
Warren Moos, Johns Hopkins
Saul Perlmutter, UC Berkeley / LBNL
Marc Postman, STScI
Bernard Rauscher, GSFC
Jason Rhodes, JPL
Yun Wang, Univ. Oklahoma
David Weinberg, Ohio State U.

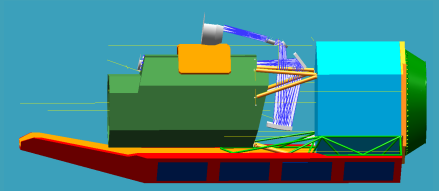
Wes Traub, JPL Ex-Officio
Rita Sambruna, NASA HQ Ex-Officio



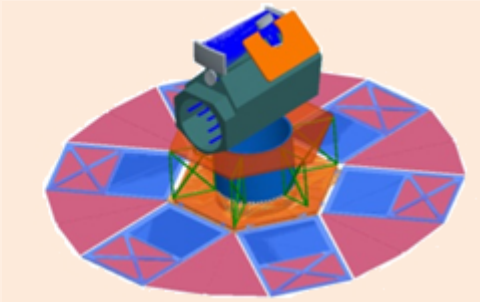
AFTA
Astrophysics Focused
Telescope Assets

Design Concepts

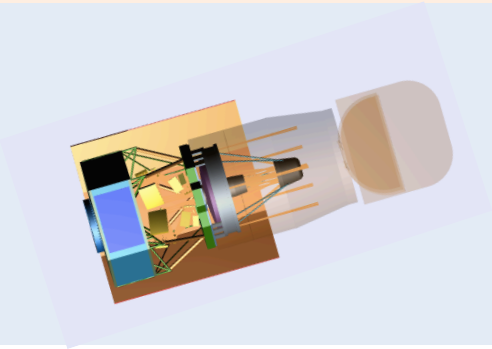
- **DRM1**
  - 1.3 meter off-axis telescope
  - Single channel payload
  - 5 year mission
  - Atlas V Launch Vehicle



- **DRM2**
  - 1.1 meter off-axis telescope
  - Single channel payload
  - 3 year mission
  - Falcon9 Launch Vehicle



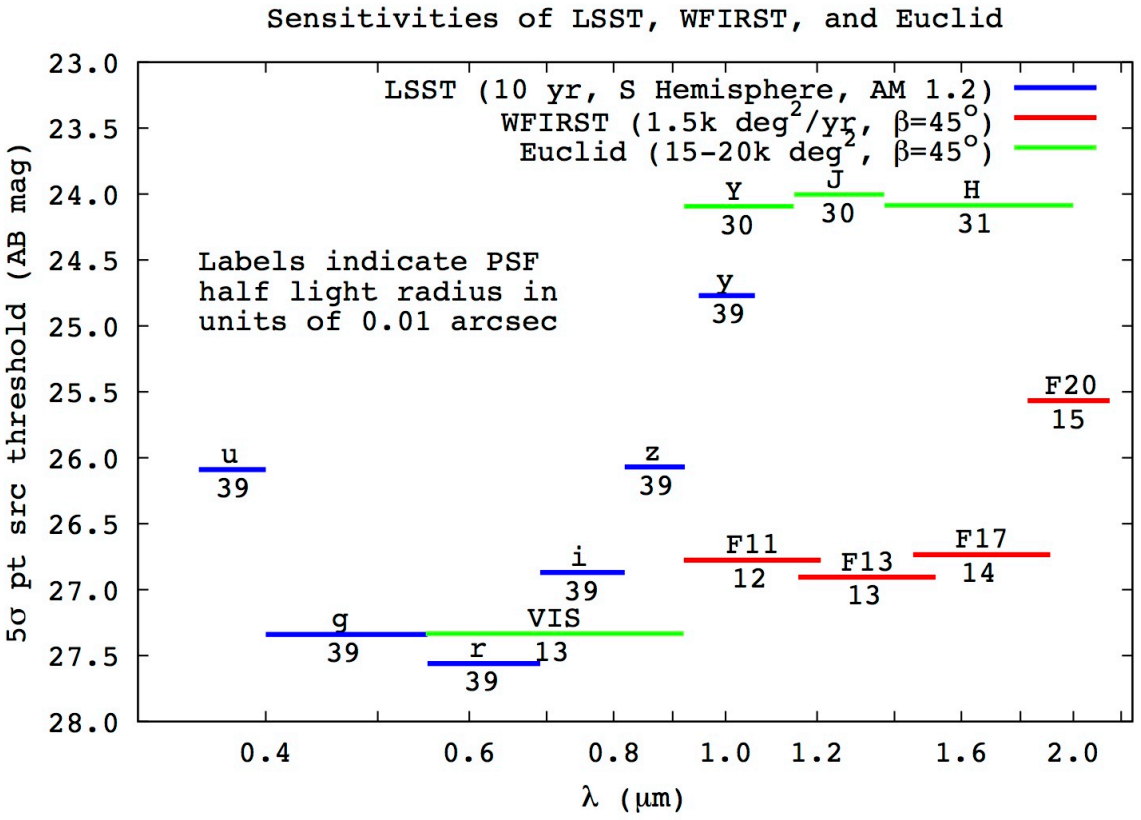
- **AFTA-WFIRST**
  - 2.4 meter on-axis telescope
  - 1-channel payload + coronagraph
  - 5 year mission
  - Falcon9 or Atlas V Launch Vehicle



NRO's Gift to NASA and Astrophysics

- 2.4 meter telescope
  - High quality mirror and optical system
  - Easily used in a TMA design
    - Wide field of view
  - Well suited towards WFIRST mission concept
    - Higher spatial resolution enhances science capability
    - Larger collecting area enables more science in fixed time

Complementary to LSST,Euclid, and JWST

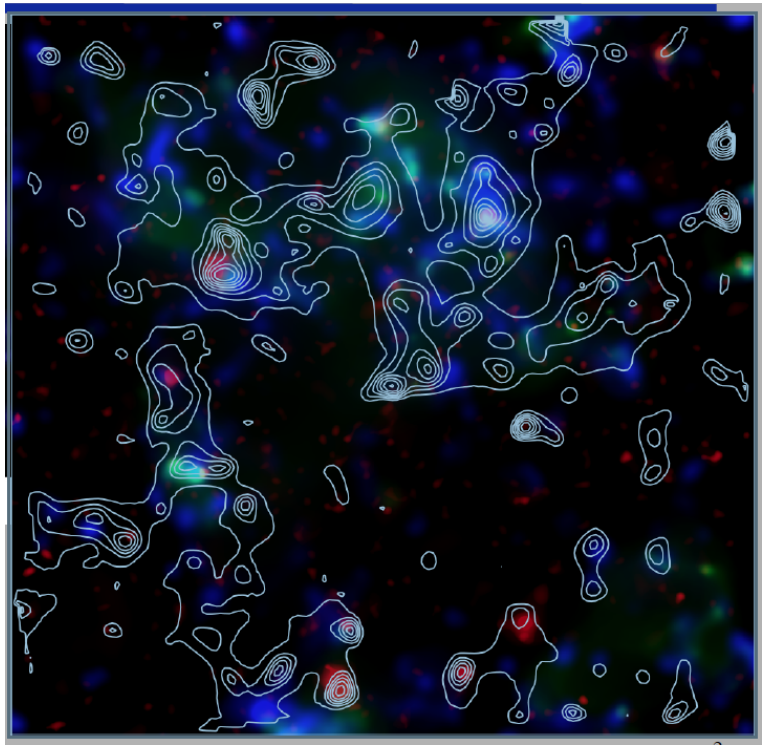


Multichroic View of Galaxies at ~0.1 as resolution

- Euclid at 0.6 microns
- WFIRST at 1.2 microns
- JWST at 3 microns

New Science Enabled by 2.4 m

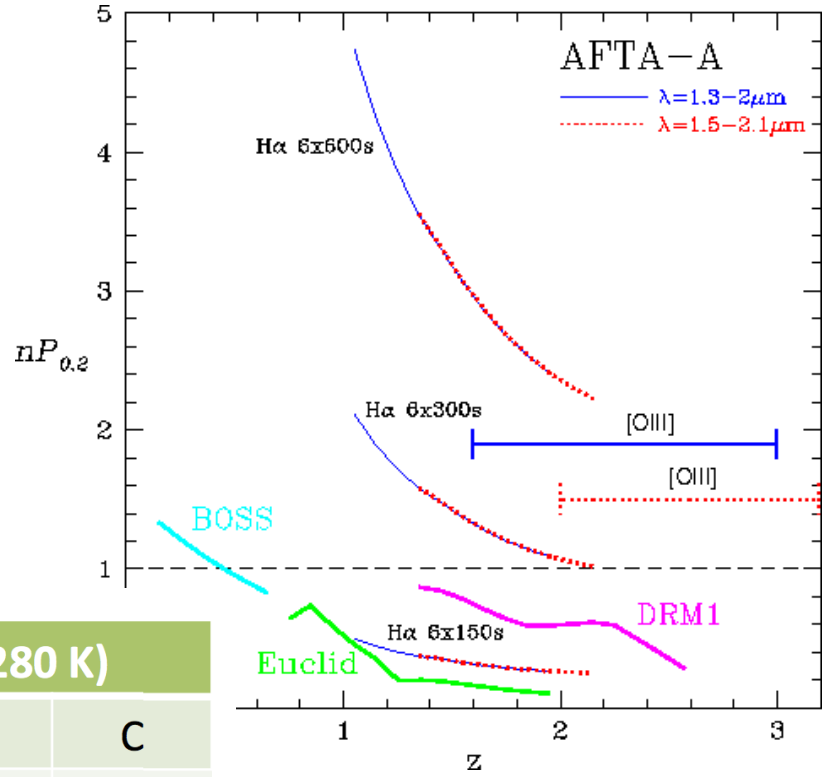
- Higher Resolution Galaxy Survey
  - More galaxies enables mapping large-scale distribution of dark matter
  - Detailed galaxy morphology enables detailed study of galaxy evolution (HST imaging with more than 100 x FOV)
  - *How Do Cosmic Structures Form and Evolve?*
    - "It is most important to obtain HST-like imaging to determine the morphologies, sizes, density profiles and substructure of dark matter, on scales from galaxies to clusters by means of weak and strong gravitational lensing, in lens samples at least an order-of-magnitude larger than currently available" (GCT, p97)



Imagine a 2000 sq. degree version of the Cosmos dark matter map!

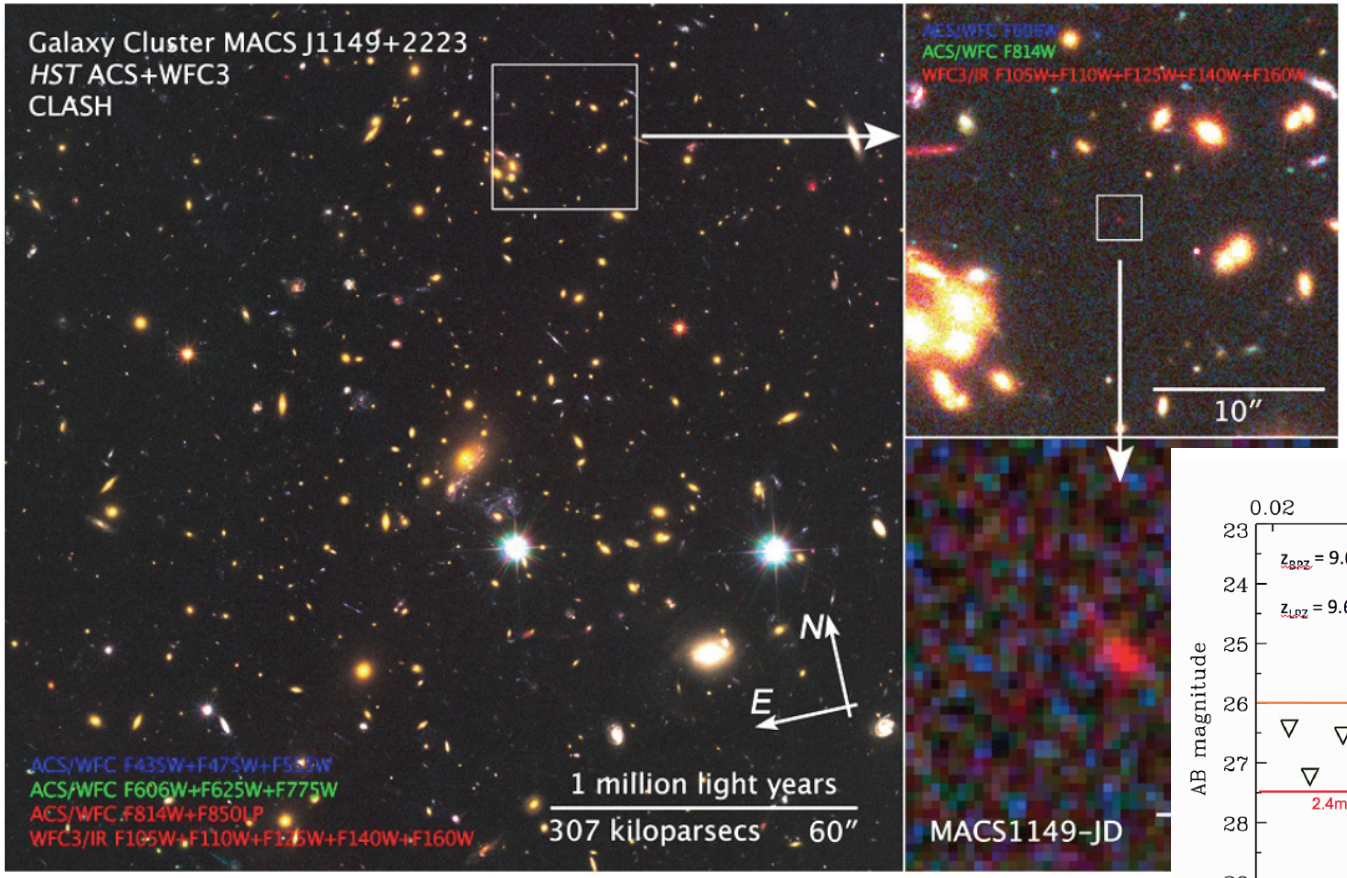
New Science II: Improved Dark Energy Measurements

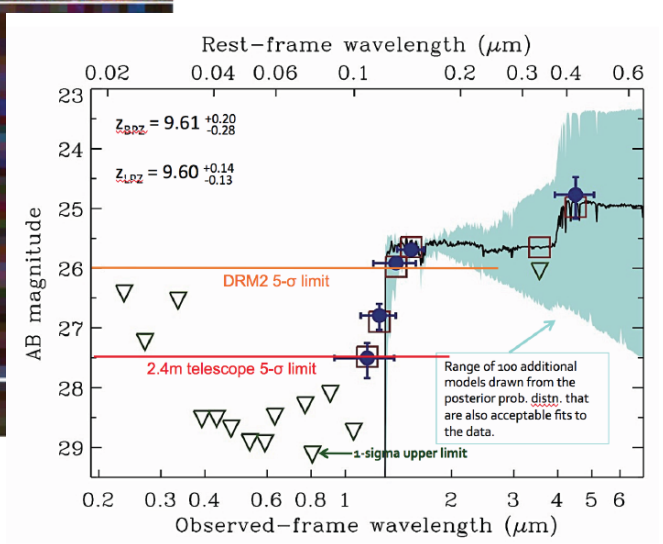
- Supernova
  - IFU improves SN info.
- BAO with OIII
- Strong Lensing



		DRM2	DRM1	DRM0 (280 K)		
Case				A	B	C
n_{eff} [gal / arcmin^2]	J	24	31	25	34	63
	H	27	33	31	46	62
	K or K_s	24	32	N/A	N/A	N/A
Time [days / 1k deg^2]		**126**	**131**	**88**	**118**	**195**

New Science III: Strong Lensing

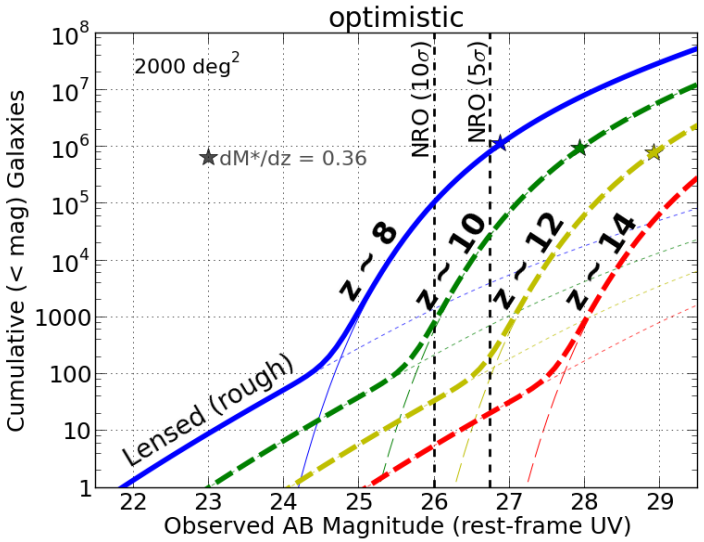


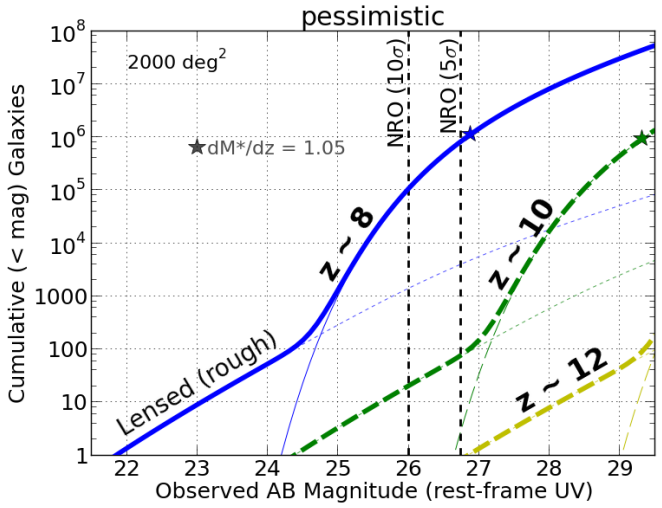


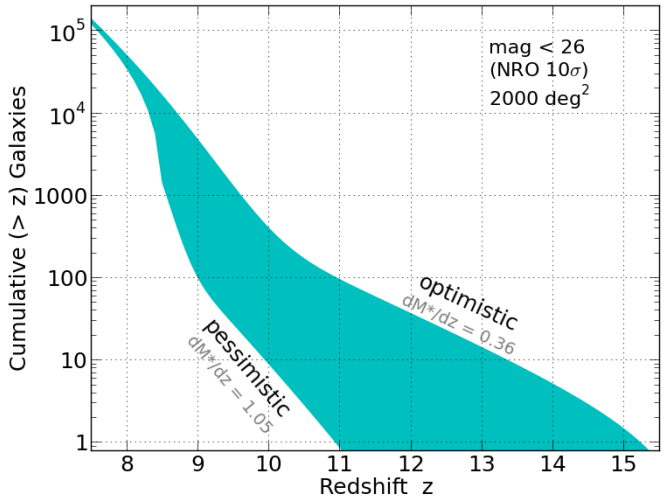
CLASH Survey across 2600 sq. deg

New Science IV: JWST Target Finder

- Deeper HLS (mag 26 (10 σ) rather than 25) enables the detection of large number of high z target galaxies for JWST

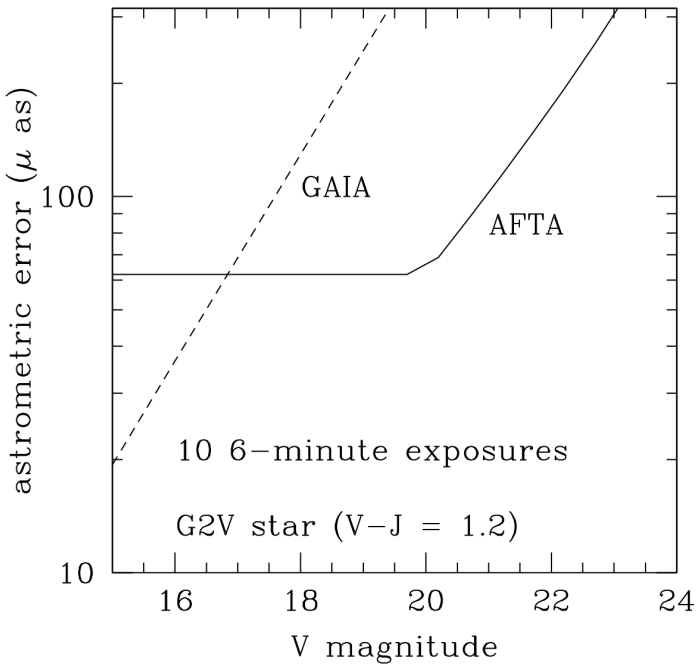






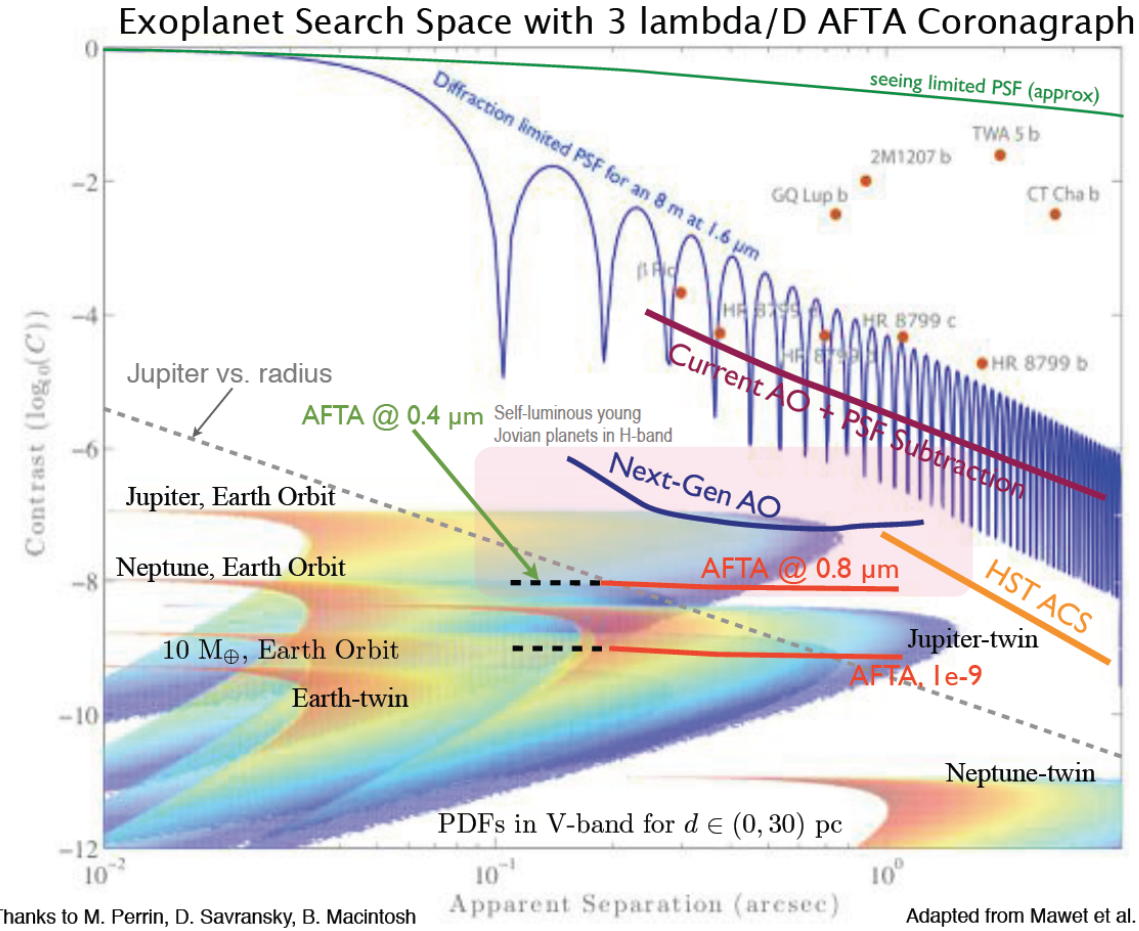
New Science (V): Astrometry and Dark Matter

- Astrometry
  - Higher resolution and improved collecting area enables AFTA/WFIRST to achieve same astrometric accuracy 10 times faster than DRM1
  - Trace substructure in globular cluster tidal tails: test whether dark matter is warm dark matter
  - *GAN 4: What are the connections between dark and luminous matter?*
    - *Using local universe as dark matter laboratory*
    - *What is the baryon-dark matter connection at low galaxy masses?*
    - *How much Low-Mass Substructure Exists Locally*
  - *GAN DA: Astrometry as a General Area of Discovery Potential*



New Science VI: Coronagraphy

- 2.4 m large enough to enable imaging of planets around nearby stars. Aiming to achieve 1e-9 contrast.
- Still under study



Thanks to M. Perrin, D. Savransky, B. Macintosh

Adapted from Mawet et al. 2012

Rich GO Science

Planetary Bodies

A Full Portrait of the Kuiper Belt, including Size Distributions, Colors and Binarity
Free-floating Planets in the Solar Neighborhood
Exoplanet Spectroscopy with WFIRST
Extending Open Cluster and Star Forming Region IMFs to the Planetary Mass Regime
WFIRST: Additional Planet Finding Capabilities - Astrometry
WFIRST: Additional Planet Finding Capabilities - Transits

Stellar Astrophysics

Stellar and Substellar Populations in Galactic Star Forming Regions
Identifying the Coldest Brown Dwarfs
Stellar Fossils in the Milky Way
The Infrared Color-Magnitude Relation
Finding the Closest Young Stars
The Most Distant Star-Forming Regions in the Milky Way
Super-resolution Imaging of Low-mass Stars with Kernel-phase & Precision Wavefront Calibration with Eigen-phase

Galactic Astrophysics and the Local Volume

Proper Motions and Parallaxes of Disk and Bulge Stars
Quasars as a Reference Frame for Proper Motion Studies
The Detection of the Elusive Stellar Counterpart of the Magellanic Stream
Near-field Cosmology: Finding the Faintest Milky Way Satellites
Dissecting Nearby Galaxies
Substructure Around Galaxies Within 50 Mpc
Resolved Stellar Populations in Nearby Galaxies
Deep Surface Photometry of Galaxies and Galaxy Clusters

Extragalactic Astrophysics

Galaxy Structure and Morphology
Strong Lensing
Searching for Extreme Shock-dominated Galaxy Systems from $1 < z < 2$
Mapping the Distribution of Matter in Galaxy Clusters
Merging Clusters of Galaxies
Group-Scale Lenses: Unexplored Territory
The Evolution of Massive Galaxies: the Formation and Morphologies of Red Sequence Galaxies
Finding and Weighing Distant, High Mass Clusters of Galaxies
Probing the Epoch of Reionization with Lyman-Alpha Emitters
Obscured Quasars
The Faint End of the Quasar Luminosity Function
Strongly Lensed Quasars
High-Redshift Quasars and Reionization
Characterizing the sources responsible for Reionization
Finding the First Cosmic Explosions With WFIRST

General

Synergy Between LSST and WFIRST
The Shapes of Galaxy Haloes from Gravitational Flexion
WFIRST and IRSA: Synergy between All-Sky IR Surveys

Study Schedule

- SDT Meetings
  - Nov 19-20, 2012 GSFC
  - Jan 10-12, 2013 JPL / Caltech
  - Mar 18-19, 2013 GSFC
  - plus weekly telecons
- Report due April 30, 2013
- Independent cost estimate by end April
- AAS evening public session held at Long Beach AAS