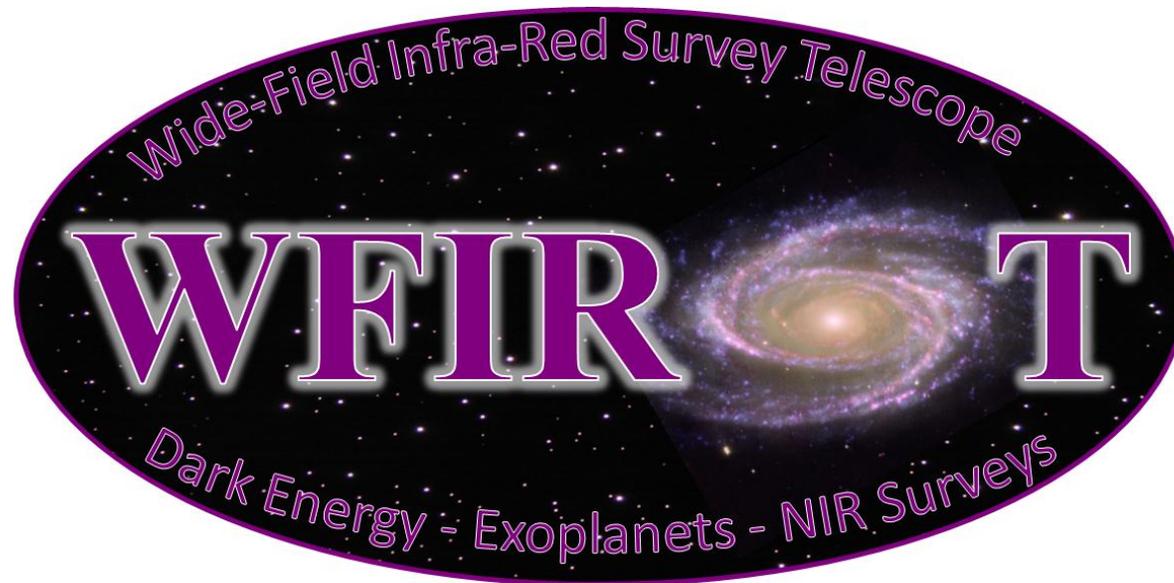


WFIR T

AFTA - Wide-Field Infrared Survey Telescope



Level-2 Requirements and Simulation Plans

Jeff Kruk

April 1, 2014

Level 2 Requirements

- Level-2 work has been on hold, but now resuming
- Draft document circulated in December will be greatly expanded.
- Brief Introduction for each measurement to be replaced by a detailed flowdown to the observation requirements, and the observation requirements will be followed by a flowdown to instrument requirements.
- Section on high-contrast imaging will be added
- Section on astrometry to be added?
 - Does not obviously flow from Level-1, but may be helpful for tracking purposes

Level-2 document structure

- Each science program will have sub-sections on:
 - Scientific objectives and requirements
 - Observation requirements
 - Operations concept
 - Instrument requirements
 - Archive dataset requirements
- Each sub-section of the document will contain:
 - Descriptive and reference material
 - Enumerated specific requirements
 - Traceability matrix to parent requirements
- Summary section at end combines all the instrument requirements
 - Traceability matrix to driving parent requirement

SNIa sample outline - 1

- Quantitative science measurement goals
 - Measure $D_L(z)$ over $0.3 < z < 1.7$ with TBD precision
 - Specify redshift bins, # SNe per redshift bin
 - Astrophysical uncertainties
 - Intrinsic variability
 - Extinction characterization and correction
 - Standardizability & SNIa demographics
 - Characterization of foreground MW extinction over survey area
- Reference Information
 - Observed SNIa rate per sq deg per Δz
 - Representative spectra
 - Representative light curves
 - etc

SN Ia sample outline - 2

- Observation Requirements
 - Survey area vs. redshift
 - Sampling cadence in rest frame
 - photometric accuracy for imaging data
 - Spectrophotometric accuracy for IFU
 - Wavelength (redshift) measurement accuracy
 - Measurement systematic uncertainties
 - Wavelength dependence of sensitivity
 - Temporal stability of sensitivity
 - Linearity, dynamic range,
 - Reassembling spectrum split among slices
 - Constructing 2-D background from host galaxy, & subtracting proper portion from SN spectra
 - Etc.

SN Ia sample outline - 3

- Operations concept
 - Multi-tier 'layer cake' survey areas
 - Detection and preliminary photometric typing
 - Latency between initial observation & follow-up
 - Early spectrum for definitive typing
 - Scheduling of spectrophotometric follow-up (specify timing and depths of follow-ups)
 - SNIa light curve
 - Host galaxy at later date
 - Define dedicated calibration observations
 - Track time-dependent backgrounds
 - Etc.

SN Ia sample outline - 4

- Instrument Requirements
 - Filters required for imaging
 - Sensitivity in each band
 - Dynamic range
 - Spatial sampling for imaging
 - Spatial sampling & FOV for spectrograph
 - Bandpass of spectrograph
 - Resolution of spectrograph
 - Sensitivity of spectrograph
 - Field of regard
 - Etc. etc.

SN Ia sample outline - 5

- Archive Dataset Requirements
 - Raw and calibrated image data
 - Raw and calibrated IFU spectra
 - Host-subtracted light curves from images
 - Host-subtracted spectrophotometric time-series
 - Derived quantities:
 - Coordinates
 - Redshift
 - Extinction corrections
 - Rest-frame luminosity
 - Distance
 - Spectral features and associated sub-typing
 - Etc. etc.

Level-2 document structure

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HQ Program plan has summary versions of these

Requirements Analysis Status

- Initial flurry of comments in response to release of earlier draft
- Chris began draft of paper on WL PSF reqmts
- Considerable planning in past two months for work on microlensing, GRS, WL
- Coronagraph: majority of recent effort has gone into Level-1 and into the technology development plan, but flowdown to instrument requirements has been integral part of the downselect process

Upcoming Simulation Work

- Long-term:
 - Support top-down Level-2 requirements definition
 - Define measurement error budgets and observation concepts based on high-fidelity simulations
- Near-term:
 - Support bottoms-up development of error budgets
 - Set initial requirements on selected terms in error budgets to guide flight H/W development
 - Detectors: crosstalk, correlated noise, persistence, etc
 - Optics:
 - Limits on dispersion vs. wavelength
 - Continue study of characterizing PSF from science images
 - Etc.

Upcoming work: Microlensing

Scott, Dave, Rich,...

- Study extraction of microlensing system parameters with simulated WFIRST observations
 - Optimize observation scenarios
 - Optimize source extraction algorithms
- Study detector systematics, set requirements
- Develop next generation microlensing event simulator
- Study relative astrometry performance limits with real (HST/WFC3) and simulated data
- Improve predictions of event rates using HST images of bulge fields

Upcoming Work: Weak Lensing

Jason, Chris, ...

- Adapt GalSim to WFIRST (more on this tomorrow)
 - Collaboration with Rachel Mandelbaum
 - Can be used for point sources too, i.e. Bulge fields
- Study effects of detector systematics on galaxy shape measurements w/high-fidelity simulations
- Study process of stacking images obtained at different locations in FoV (different PSF, plate scale,...)
- Continue study of field diversity for monitoring PSF over time
- Photo-z calibration dataset requirements

Upcoming Work: GRS

Harry Teplitz, James Colbert, Jeff K, David Spergel,
JHU, STScI ...

- Study effects of stacking extracted spectra obtained at different points in FoV
 - different dispersion, different distortion, ...
 - Impacts on sensitivity, wavelength accuracy, ...
- Adapt aXe to WFIRST
- Study extraction window placement algorithms
- Set limits on dispersion as function of wavelength
- Reassess number of roll angles required
- Assess combination with CMB data

Upcoming work: SNIa

Saul, Charlie, Jeff K, ...

- Evaluate effects of slicer sampling of PSF
 - Losses at slice edges, as function of λ
- Evaluate host galaxy & sky contamination issues
 - Roll, zodi, stray light variation over lightcurve
 - Jitter sensitivity
- Detector effects:
 - correlated noise, reciprocity failure, persistence, non-linearity
 - Necessity for fine dithering?
- Dispersion requirements

Upcoming work: astrometry

David Spergel

- Assess astrometric performance for various WFIRST-AFTA observing scenarios

Upcoming Work: zodiacal & debris disks

Tom Greene, ...

- Simulate AFTA coronagraph images of zodiacal dust and debris disks
 - Prime and backup coronagraph architectures
 - Include instrumental noise and background sources
 - Model post-processed speckle noise
- Process with standard packages to extract disk properties & compare against inputs
- Repeat as coronagraph properties evolve

Upcoming work: common tasks

- Update galaxy catalogs & luminosity functions
- Update Galaxy catalogs/models
 - GSC-II & planned updates
 - VISTA VHS survey?
- Develop repository for reference information & simulation tools
- Maintain Science Requirements Document and update as results become available