The Integral Field Unit
Spectrograph for WFIRST

David R. Law (STScI)
Klaus Pontoppidan, David Rubin
• Optical+NIR image slicer IFU
• Wavelength coverage 0.4 – 2.0 microns, R ~ 100 from compound prism
• 21 slices at 0.15” or 0.30” per slice, 1-2 pixels per slice
• Critically sampled: 2 pixels per spectral resolution element (FWHM), H2RG
• 3.00” x 3.15” or 6.00” x 6.30” FOV

All subject to change
• JWST will be supported by a new exposure time calculator.

• It is called Pandeia – after the Greek goddess of brightness.

• As part of the original concept, Pandeia was developed by the JWST project as a multi-mission product.

• Pandeia is 100% data-driven. A new observatory can be implemented by modifying a well-defined set of reference data.

• In development by a large team since 2012. WFIRST reps: Klaus Pontoppidan, Tim Pickering
Pandeia Operational Concept

- Focus on calculating accurate signal-to-noise ratios of astronomical observables.
- Detailed scene creation for broad science cases
  - extra-galactic, galactic, stellar, etc.
- Full three-dimensional model
  - two spatial, one wavelength
- Detailed detector models with focus of IR CMOS types
  - including the HAWAII 2RG/4RG family
- Rapid parameter space exploration.
- Includes support for
  - Imaging, slitless spectroscopy, IFU spectroscopy, coronagraphy and more.
- Full version-controlled and documented development piggy-backing on the JWST ETC project
Example of a Pandeia/WFIRST calculation for one of the potential IFU designs (designs can be revised in seconds).

- Galaxy + point source (point source normalized to 2.2 μJy at 0.556 micron).
- 0.15” pixels, 1 pixel per slice, 3” slice length.

- IFU development coordinated with K. Pontoppidan, D. Law, D. Rubin, J. Kruk and S. Perlmutter
- IFU implementation benchmarked against multiple simulation tools
- Reference data aligned with the latest official version of the WFIRST data
Cross-calibration of Pandeia IFU simulations

Test 1: High SNR blackbody
Test 2: Medium SNR $z=0.5$ SN
Test 3: Dithered 2-exposure $z=0.5$ SN
Test 4: Low SNR $z=1.5$ SN

Three simulation tools for cross-comparison
Pandeia: Developed for JWST, extended to WFIRST
D. Law: Developed for SDSS, extended to WFIRST
D. Rubin: Developed for SNIFS, extended to WFIRST

WFIRST IFU
IFU noise contribution and limiting performance

Relative noise contributions (Test3 simulation case)

Estimated limiting point source sensitivities: 5σ in 1 hour, medium zodiacal background.

PSF-matched aperture extraction.
Baseline survey characteristics (from 2015 SDT report); see Foley talk, Rubin poster for details

IFU avoids K-corrections, better subtraction of host galaxy light, no slit losses

Simulate IFU observations of supernova plus host galaxy
Select a host galaxy from SDSS IFU library

Library of ~ 2000 nearby galaxies
SDSS Input Galaxy: MANGA 12-129618 (CGCG 161-122)

WFIRST Science Symposium Pasadena, February 2016
Redshift to $z = 0.5$, add a supernova

Input supernova spectrum: Hsiao Ia template
Simulate WFIRST observations and data cube construction

4 dithered exposures, 1hr total integration time

Wavelength slice of reconstructed IFU data cube near 1.0 microns

Recovered SN spectrum after subtracting host galaxy for a SN far from/near galaxy center (black/red)

(see also poster by David Rubin)
Current specifications driven by the supernova program

Other possible GO programs (from SDT report):
• Resolved stellar populations at high redshifts?
• Spectroscopic redshifts to calibrate photo-z?
• Exoplanet transit spectroscopy?
• Your idea here

Are there any other interesting use cases that should be considered during development? Increase FOV? Wavelength range?
• First release (WFI imaging) of Pandeia-WFIRST now live
  – Webpage and information: http://www.stsci.edu/wfirst/software/Pandeia

• Ongoing Development
  – Add support and documentation for IFU calculations to the notebook GUI
  – Notebooks with example IFU calculations
  – Technical report on IFU simulations and sensitivities
  – Work with SIT to converge on final design specifications
IFU group has been having bi-weekly telecons since ~ April 2015, including STScI, IPAC, LBNL, GSFC, Pitt

Working group wiki page at IPAC:
https://staffwiki.ipac.caltech.edu/WFIRST_Science_Support/IFU_Simulations
(telecon minutes, reference files, early simulation results)

Formal IFU WG now formed (co-chairs Perlmutter and Law)
Contact us to get involved (dlaw@stsci.edu)