Transiting Exoplanet WG Meeting

02/23/2017

Meeting Lead: Kevin Stevenson
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Topics for Today

- NIRSpec TSO CV3 presentation
  - Giovanna Giardino & Stephan Birkmann
- Simulated TSO data
- File sizes
- Background subtraction

NIRSpec TSO CV3 presentation

Simulated TSO Data

- Needed for DMS testing, pipeline validation, and data analysis tools testing
  - DMS, I&T, SSB, and INS all need data but may have different requirements
  - Coordination will go a long way
- Requested status report today
- Developing requirements
- Initial thoughts:
  - Short data set for quick tests and debugging
  - Long data set that needs to be broken down into multiple files
  - Realistic noise with cosmic ray hits
  - Transit with limb darkening and flat spectrum
  - Others recommendations?

File Sizes

- How do we package TSO observations for archive and distribution? Do we have one file per visit or multiple files?
  - If typical file size is >> 5 GB then we probably need multiple files
- What is the typical file size per instrument mode?
  - ~6 hour transit/eclipse of J~9 star
- What is the maximum file size per instrument mode?
  - 30 hour phase curve of very bright star
- Looking for ballpark estimates

Background Subtraction

- Need to define background subtraction in CALTSO3 pipeline for both imaging and spectroscopy
- Different instruments/modes likely to have different requirements
- Which method(s) work best for each instrument's TSO modes?
- Should BG subtraction be integrated into 1D spectral extraction?
  - Needed for optimal spectral extraction (Horne 1986)

TrEx WG Inputs - NIRSpec

1. (Simulated) TSO Data:
    a) No simulated data for TSOs available, but
    b) Real data from CV3 time series experiment exists and can be shared (see slides from Giovanna Giardino's presentation on 2/23)

2. Typical and maximum file sizes:
    - NIRSpec always uses subarrays (single output) for BOTS, therefore 10 μs per pixel data rate
    - Assuming 2 bytes per pixel (raw data) and ignoring resets, the data volumes are ~4 GB for the 6 hour transit, and ~20 GB for the 30 h phase curve for each detector
    - The above can be in a single file (one exposure)

TrEx WG Inputs – NIRSpec – continued

3. Background subtraction:
    - CV3 data suggest that a simple background subtraction (median of "out-of-trace" pixels per column) can be used to remove/suppress detector 1/f noise
    - See presentation by Giovanna Giardino's from 2/23

NIRCam transit operations

T Greene, J Fraine, E Schlawin, J Leisenring, J Stansberry

JWST Transit Group Telecon

23 February 2017

NIRCam transit operations 23 Feb 2017

- We obtained non-TSO spectra data during CV2 & CV3 & imaging TSO test data during CV3; delivered to STScI
- Jarron Leisenring is also simulating TSO data from synthetic NIRCam spectral images with simulated detector noise (using NIRCam's version of Bernie Raucher's HxRG noise generator)
  - t = 6.7 hr real time, Grism 0/R, K = 8 G2V star, F444W (3.9 – 5 μm), STRIPE mode, 70 RAPID groups, 2048 x 68 subarray, 1000 ints (18.4 GB)
- NIRCam TSO spectra background subtraction should be along columns (in spatial direction); do not cross stripe boundaries
- Imaging subtraction with an annulus?
- NIRCam STScI TSO POC should be Jonathan Fraine

NIRCam TSO File Sizes

- LW Grism spectroscopy requires using at least 1 HgCdTe SCA with either 4 outputs (STRIPE mode; bright targets; K < 5.5 or 6 mag) or 1 output (window mode; fainter targets)
- LW Grism + SW DHS spectroscopy requires 3 SCAs
    - Adopted TSO data acquisition strategy but science not approved for Cycle 1
    - Each SCA will store data in its own file if flight system is like CV2 / 3.
- #samples = #SCAs x outputs x #groups/(#groups +1) x exposure_time / 10 μsec
- Example 1: J=9 (J-K = 0.8), 6 hour transit observation in F322W2:
  - 4.3 GB per file (1 SCA); 13 GB for 3 files / SCAs (2 bytes / sample, uncompressed) (2048 x 64 subarray, 1 output, #groups = 17)
- Example 2: 55 Cnc e (K = 4.1 mag) 30 hr phase curve F444W:
  - 58 GB per file (1 SCA); 173 GB for 3 files / SCAs (#groups = 2, stripe mode, 2048 x 64)

NIRISS/SOSS TSO

- Simulated TSO data
  - 6 different exoplanet systems
    - Any phase curves?
  - Currently noise-free data, adding realistic noise
  - Data orientation and headers are pipeline compliant, can be calibrated through Level 2B
  - SUBSTRIP256 only, SUBSTRIP96 can be generated

- File sizes
  - Transit/eclipse with SUBSTRIP256 = 2 GB
  - 48-hour phase curve with SUBSTRIP256 = 24 GB

- BG subtraction in CALTSO3
  - Recommend “column-by-column” (in the cross-dispersion direction)

Transiting exoplanet WG call 23 feb 2017 – MIRI input

MIRI TSO team:

J. Bouwman, T. Greene, G. Rieke, F. Lahuis, P.-O. Lagage, G. Wright, S. Scheithauer, D. Hines, O. Fox & S. Kendrew

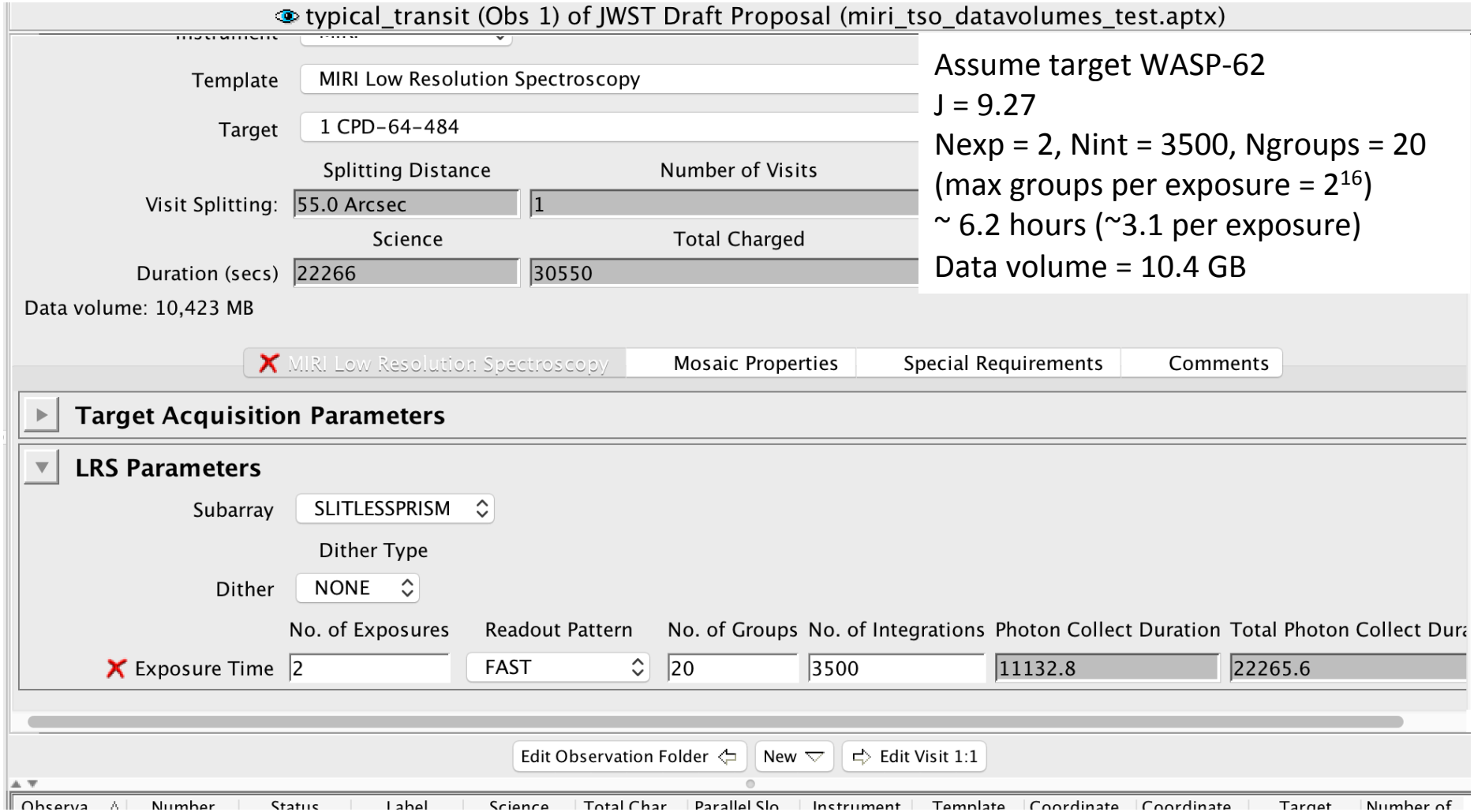
MIRI TSO pipeline testing

- Have MIRI LRS integrated into our MIRI Simulator (developed by the European Consortium) – includes slitless

- Currently testing slitless data with the pipeline (in Europe & at STScI)

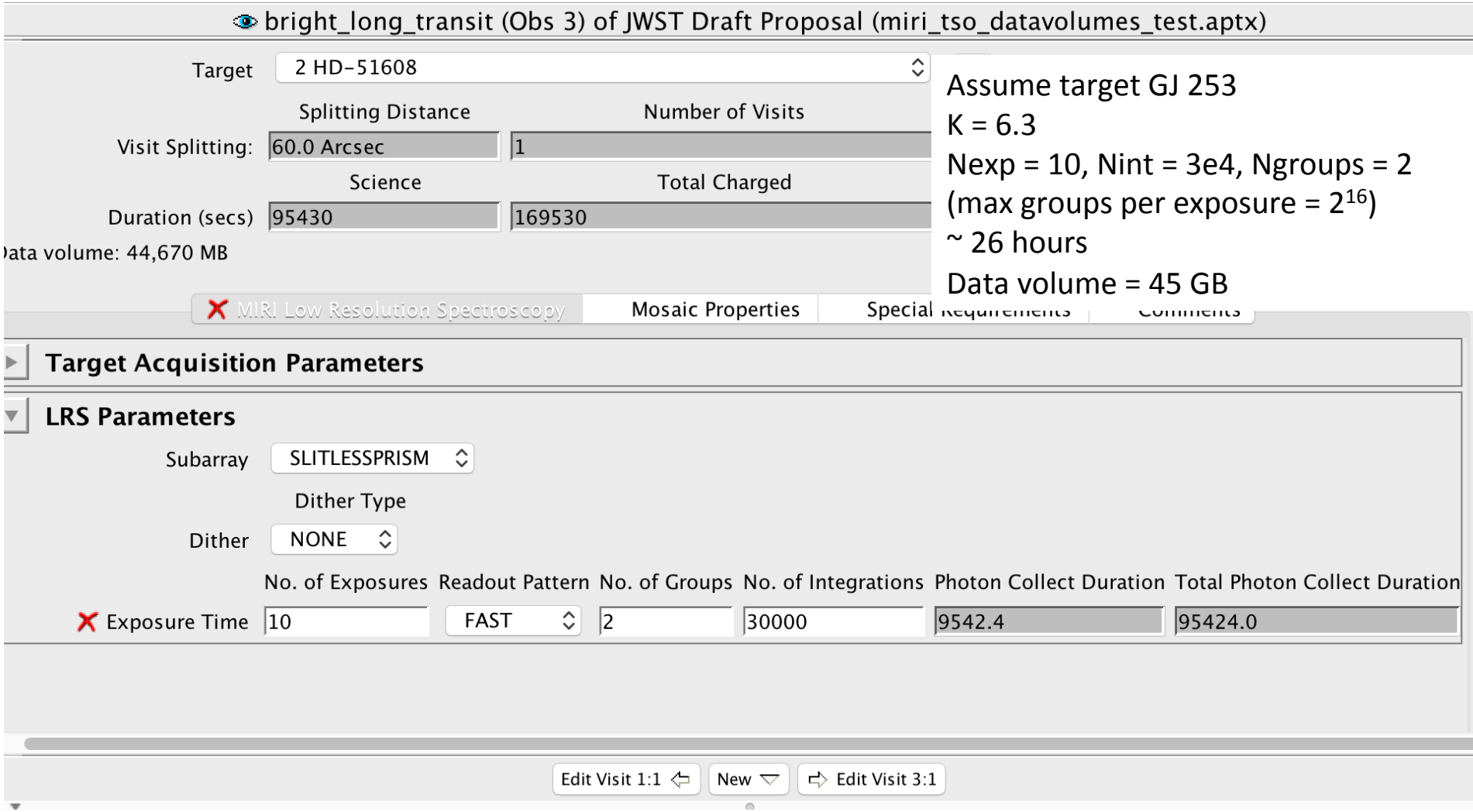
- Once have basics debugged (FITS keywords) will proceed to more systematic testing of algorithms @ STScI

Data volumes – J~9, 6 hr transit



Assume target WASP-62
J = 9.27
Nexp = 2, Nint = 3500, Ngroups = 20
(max groups per exposure = 2^{16})
~ 6.2 hours (~3.1 per exposure)
Data volume = 10.4 GB

Data volumes, bright target, long obs



Assume target GJ 253

K = 6.3

Nexp = 10, Nint = 3e4, Ngroups = 2

(max groups per exposure = 2^{16})

~ 26 hours

Data volume = 45 GB

Background subtraction

- Baseline of “no subtraction” may work for some observations
- Ongoing discussion amongst MIRI/TSO members but likely to need a combination of approaches:
  - Ability to take a dedicated off-source background exposure (before/after/before & after?) seems prudent
  - Need to measure the background throughout the transit observations in the pixels alongside the spectrum to detect temporal & spatial variations
  - Create a “master background” for LRS?