2020-12-02 TSO WG Meeting notes

Date

02 Dec 2020

Attendees

- Nestor Espinoza
- Brian Brooks
- Nikolay Nikolov
- Unknown User (aroy)
- Diane Karakla
- Tony Keyes

Meeting agenda:

1. News & announcements.
2. Activities on each instrument branch.
3. Work distribution following the FY2021 work plan.
4. Closing remarks

Discussion items

Time	Item	Who	Notes
	1. News & announcements	Everyone	▪ Diane Karakla joins the TSO WG! A roundable introduction was made in order to allow everyone to introduce themselves.
20min	**2. Activities on each instrument branch**		
		Nestor Espinoza Unknown User (aroy)	**NIRISS activities**. No new activities other than CAP preparation — probable rehearsals happening within NIRISS on this end, in order to test our scripts and the overall CAP time-line, analyses and response times.
		Tony Keyes Unknown User (birkmann) Diane Karakla	**NIRSpec activities**. No new activities.
		Sarah Kendrew	**MIRI activities**. None reported as well internally.
		Nikolay Nikolov Brian Brooks	**NIRCam activities.** No new activities. However, within the IDT there has been some work on trying to get some new data from ground detectors, in order to check differences between GRISMR and GRISMC TSOs, and the improvement on 1/f noise correction. Basically, find that GRISMC data allows for a better correction, as initially reported on the NIRCam papers (see below). Also there is an ongoing TSO NIRCam data challenge. Website will be posted by Nikolay Nikolov here.
30min	**3. FY2021 work (full detail of the FY2021 here)**		
		Everyone	

- Nestor Espinoza gave a presentation summarizing the first of the two NIRCam papers on random and systematic error noise sources — the one focusing on **random** error noise sources. The main concern here is the so-called "1/f" noise, which is a random noise source introduced by the readout circuitry, and which is the random noise source that produces the largest variations in the data. It manifests itself as a time-varying, group-to-group (really frame-to-frame), flux variation on sets of pixels across an image. The NIRCam folks studied the effect in detail using a very long dark integration that contains 108 groups.

  The first question the NIRCam folks study in their paper is what are the main characteristics of this 1/f-noise component. To study this, considering this is a problem introduced by the readout, they studied this in the time-domain considering that reading each pixel takes around 10 micro-seconds (which they identify as a "time-cycle"), and that jumping from one row to the next takes around 120 micro-seconds. With this, one can create a time-series of the flux values of each pixel, and then study that time-series in the frequency-domain. This is how they make one of the key plots to understand the characteristics of this noise source, shown on Figure 4:

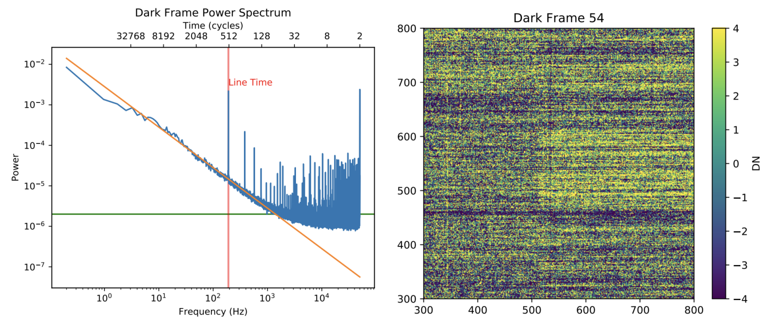

  Figure 4. *Left:* The average Lomb-Scargle periodogram from Amplifier 2's time series over 108 RAPID groups. The noise in the spectrum is close to a 1/f power law (orange line) from 10 to 1000 Hz. Above 1000 Hz, it is closer to white noise (green line) with spikes at specific frequencies. The top x-axis shows the inverse frequency as measured in number of clock cycles, which corresponds to the number of pixels read within a row. *Right:* This 1/f noise introduced in the readout circuit causes prominent correlated noise along the fast-read direction (horizontal) on a dark frame. The amplifier offsets have been removed, but the 1/f noise from these adjacent amplifiers (separated at X=512) shows different behavior.

  In this figure, the left-hand plot shows the power spectrum of the flux values considering these time-cycles. As can be seen, the power increases towards lower frequencies (larger time-scales) in a 1/f fashion (orange line). This means the process has a "long-memory", i.e., pixels very far away from each other (including pixels in different rows) have "memory" of each other's values. The power seems to hit a constant below about 100 time-cycles (i.e., 100 pixels or 0.001 seconds) — meaning pixels next to each other are more or less random within that time/length-scale. The "Line time" in the plot above is a peak that appears here due to the time it takes to jump from one row to the next (512 time-cycles/pixels). Note in the plot above there are two amplifiers "stitched" next to each other.

  The problem is particularly bad for NIRCam because these horizontal "strips" above go in the same direction as the wavelength direction. For NIRISS, NIRSpec and MIRI, the wavelength goes perpendicular to those strips, so it can be removed in general via "column-by-column" background substraction using non-illuminated pixels.

- Nestor Espinoza then motivates the first task to get done by the TSO WG members: figure out if the properties/removal techniques from the 1/f noise on each instrument/detector is similar to NIRCam. For example, NIRSpec has some subarrays which are really small (16 pixels), for which there might not be enough non-illuminated pixels to remove those 1/f stripes. Same goes for SUBSTRIP96 on NIRISS/SOSS — and for the smallest MIRI LRS subarrays. So, our goals here are to (a) check if this kind of analyses have been done for the other detectors, (b) figure out if they are understood well enough to properly remove them and (c) document what we know about 1/f on other instruments with TSO in mind.
- The very first task is to ask around in our instrument branches and check if there are dark frames in order to perform a similar analyses on each subarray/readout mode. These analyses might already be done — so we ought to ask in our instrument teams what's the status of this, and if power spectra like the one above has been quantified (i.e., are the time /length-scales the same for all detectors?).

- Once that's done, we need to perform analyses on them in order to document what we know and possible ways forward to account for this 1/f noise in extraction procedures: which subarray modes have enough non-illuminated pixels to remove these 1/f patterns? For those that don't have enough pixels, are there methods in place to perform spectral extraction accounting for that? Etc. This can have important consequences for the pipeline and for the TSO community in general, and as such the answers to these questions are high priority for our WG to figure out and document.

			▪ Presentation: TSOWG-Dec2-2020.key
5min	**5. Closing remarks of the meeting**		▪ Nestor Espinoza mentions tickets JSOCINT-302 - Jira project doesn't exist or you don't have permission to view it. and APT-92354 - Jira project doesn't exist or you don't have permission to view it. . Asks Nikolay Nikolov and Unknown User (aroy) to take a look at them — discussion holds important information for TSO observations in general.