

March 2024 Report of the NICER User's Group

The NICER User's Group (NUG) received an update from the NICER mission team on Tuesday, March 5 and convened to discuss the update and respond to the mission team on Friday, March 15. This report summarizes the outcome of the NUG's discussion and includes our responses to requests from the team.

The NUG would especially like to commend the mission team on receiving approval for an astronaut repair of the optical light leak - this is a major accomplishment that will be pivotal for the mission's successful continuance, and the NUG is highly appreciative of the efforts by the mission team!

GO Program

The NUG is pleased to learn that NICER outpaces all other ISS experiments in terms of peer-reviewed publications, and believes this to be a reflection of the GO program in many ways. The NUG is happy to learn that additional funding is available if a graduate student is involved in the project.

The NUG notes that the GO program still receives less funding per proposal than some other X-ray missions that have significantly less data reduction overhead, and hopes that in the future, the GO amount per proposal can be increased as the mission budget allows.

Joint NICER-IXPE Workshop

The NUG is excited about the possibility of a NICER workshop this summer, and have several recommendations regarding its content and format:

- We suggest that the workshop include some sessions that are specific *only* to NICER reduction, and not focus solely on the joint use of IXPE-NICER data. The NUG believes that there are many, many users who would benefit from a step-by-step approach to NICER reduction, and that involvement with the IXPE component should be optional for attendees (and vice versa, for IXPE-only folks).
- We note that the workshop would be maximally helpful if it contained material to train new users on writing NICER proposals, since the Call for Proposals is typically announced in late summer. For example, IXPE and XRISM have recently held pre-proposal workshops with tools to simulate their datasets; this would be extremely helpful for NICER.
- We request that the workshop explicitly include use of the new SCORPEON background model, especially with a soft source for which it is relevant.

- We request that the workshop provides examples of how to handle calibrations under the optical leak conditions.
- Although past workshops have posted videos, we **strongly** suggest that the workshop generates a comprehensive, step-by-step, text-based walkthrough of how to go from an email saying your NICER data has been obtained, to a spectrum (i.e., where to download data, which Analysis Threads to follow in which order, and so forth).

Data Analysis Threads and Reduction Help

The NUG commends the NICER helpdesk as one of the best across all NASA missions in terms of response time and helpfulness. This is a major benefit to students as well as veteran users, and this has definitely been noticed and appreciated!

The NUG is very happy with the new proliferation of analysis threads that address a wide variety of reduction situations, and is grateful to the mission team for the attention paid to developing this resource, which is vital to the open use of NICER data and to student access. We note a few things for potential continued improvement:

- Some information available online regarding data analysis is outdated. The NICER cookbook on SciServer does not include information about how to use the SCORPEON background model and background light curve analysis. Some Data Analysis Threads do not state which version of the software they are relevant to, and some warn the reader that they are outdated, but still come up as default when searched. We suggest that outdated threads be placed in a different location or that each thread explicitly state which pipeline version they are meant to work for, and to clearly state when the thread was last updated. Likewise, links to PDFs of previous NICER workshops should warn readers that some of the analysis steps have been updated since that workshop.
- Similar to the above suggestion about the workshop output, we request a step-by-step walkthrough of NICER reduction of an actual target with the order of the threads explicitly laid out. Many users have reported confusion about what order the threads appear in, and do not know how to get their data ready for any given thread.
- The NUG notes that people feel that some help tickets have been passed back and forth between SciServer and NICER, without clarity about who can help solve the problem. Although this may not be within the NICER mission team's purview, long-term, it would be nice if there was a "one-stop shop" where one can submit a help ticket for AWS, NICER, HEASoft, SciServer, etc, and then a clearinghouse which shunts it to the right team for an answer.

Software Updates

The NUG is thrilled with the new SCORPEON update, and reports that it provides excellent calibration to faint and soft sources. This is a huge improvement over static background models and we are very pleased with it, and express our gratitude to its developers for making it available. The NUG strongly feels that this will increase the number of viable targets for NICER and will open up the science to new classes of objects.

The NUG also commends the NICER team on their very fast response to the optical light leak, including giving recommendations on how to handle calibrations and what observations are most affected, and the newest releases take it automatically into account, which is extremely helpful for new users and people using the data jointly with other missions.

The NUG has a few suggestions regarding the software:

- The SCORPEON light curve subtraction has time bins of 32 seconds, which is quite large for science cases that require very rapid timing. We realize that this will be computationally expensive, but it is important to be able to use SCORPEON for fast-timing like estimating ms periodicities. If SCORPEON is infeasible at these timescales, we request some recipes and recommendations from the mission on how best to mitigate background in fast-timing applications. We note also that detection of some bursts requires background lightcurve information at finer than 32-second time bins.
- While the current nicerl2 has defaults for particle loading vs. optical background (over/under thresholds), which are tunable, and there are some threads that make recommendations, these have to be sought out very specifically. It would be useful to have a discussion in the workshop documents or in the requested step-by-step walkthrough on what kind of artifacts and flares are expected from bad removal of these effects, and how to spot them.
- Many papers have been published using the old static background models, and it is unclear how much the science would change if SCORPEON were applied instead. The NUG notes that studies such as [Partington et al. \(2023\)](#), which compares NICER background models, are particularly important and should be supported.

Senior Review

The NUG is willing and eager to help with NICER's upcoming Senior Review case, which will be evaluated in early 2025. In this section, we respond to the NICER team's request to brainstorm ideas about how to enhance this case:

- NICER's large effective area, rapid ToO response, and flexible timing capabilities (extremely rapid cadence as well as daily monitoring) makes NICER a unique and

powerful player in fulfilling NASA's Time Domain and Multi-messenger (TDAMM) goals.

- Being on the ISS and having a joint program with MAXI via OHMAN is extremely important, as NICER can slew to MAXI's transients faster and detect them with greater sensitivity than Swift-XRT across a significant spectral energy range.
- NICER was not meant to be a high-resolution spectrometer, but it has been able to outperform many instruments in this arena, including detailed spectral follow-up of transients. This has led to unique insights that were not possible in the past, as Chandra and XMM cannot monitor individual outbursts with anywhere near the necessary cadence. The capability for detailed follow-up of transients is especially relevant in the context of near-future multi-wavelength time domain sky surveys such as Rubin/LSST and MeerKAT.
- NICER's spectral capabilities are perhaps not well enough advertised - it is better than Swift-XRT and has a higher effective area between 0.5 and 4 keV than XMM-Newton; most new users do not realize that they can get high quality spectral monitoring or even just individual spectra from NICER.
- It should be stressed in the review that this is not just a neutron star instrument, and has, like the enormously successful Swift, moved on to a vast number of science applications (AGN coronae, jets, stellar winds, recurrent novae, comets...). The NUG suggests that the senior review team gather data on the increase in number of proposals from different science areas across NICER's cycles to emphasize this point.
- Regarding DEI aspects of the review, the NUG recommends collecting statistics on how many papers were published by first-time PIs, students, or members from underrepresented groups.
- Regarding DEI and the size of the served community, the NUG recommends collecting information on the countries of residence of leading NICER paper authors and NICER PIs, to show the global reach of the mission. The NUG believes that in many countries, NICER is used as the premier instrument for transients and rapid timing.

The NUG plans to meet again late this year, and is hopeful that this meeting can occur after the scheduled astronaut repair, so that we can react to the instrument's most recent status and provide more timely information for the Senior Review.

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