Oct 2021

NICER
Neutron star Interior Composition ExploreR

NICER NUG Response
Keith Gendreau on behalf of NICER Team

Introduction

- The NICER project is grateful for the NICER Users Group's inaugural report, and thanks NUG members for the thoughtful effort that went into producing it.

- The report makes a number of prioritized recommendations for improving NICER's interactions and interfaces with its users; we respond to these recommendations in the following pages.

- Overall, we find the NUG's recommendations to be well motivated and worth pursuing in principle; indeed, some of them have already been addressed but not communicated very well by the project.

- As resources allow (bearing in mind that NICER is a very small project within Astrophysics at NASA), we look forward to pursuing the remaining prioritized recommendations on a best-effort basis, in continued consultation with the NUG.

Calibration

"Calibration: investigate the deviation of the best-fitting Crab model below 1 keV. Perform a systematic study and comparison of the ISM abundances and edge shapes needed to fit NICER data with those from high-resolution instruments."

- The NICER team is proud of its calibration products, but there is always room to improve. We will endeavor to make improvements along the lines of the NUG request, as resources allow.

Calibration Specifics (1)

- Translate conference and workshop presentations into published calibration documentation
  - The NICER team has already published new calibration notes and calibration best-practices documentation on its website, and will continue to improve these products. Specific examples include:
    - Screening criteria
    - Astrophysical & instrumental systematic features to be aware of
- A comprehensive and systematic study of the effects of the interstellar medium (ISM) with comparison to grating data
  - Such a project—to identify and reduce NICER, XMM, and Chandra data and perform calibration-grade cross-calibration analyses—is extremely resource intensive. The NICER team would look to coordinate with the NUG to move such a project forward.

Calibration Specifics (2)

- Concern about the Crab-driven calibration below 1 keV (~40% differences with XMM grating)
  - The comparison between Crab data from NICER and a particular XMM grating observation (Kaastra et al. 2009) is indeed concerning at first glance. A difference in the "power-law index slope" performance of the response of just a few hundredths may explain this difference. We will continue to investigate.
- Unexplained residuals in the 1.5–2.5 keV range
  - As the NICER team has previously noted, we have received little feedback on this and similar issues from the observing community. We welcome collaboration with NUG members to identify specific observations, especially those jointly performed with other facilities, that would enable a focused diagnosis.
  - In response to the request that NICER offer users a feedback form, we point out that this is already available through the HEASARC Helpdesk functionality.
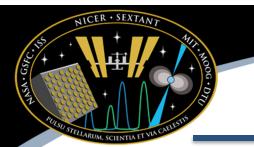
Calibration Specifics (3)

- Encourage cross-calibration
  - NICER has indeed performed several cross-calibration observations, coordinated via the IACHEC (K. Forster/NuSTAR as lead); typically, there are 1–2 opportunities per year. Some of these datasets have been thoroughly analyzed (e.g., Crab, 3C 273), but others require additional care and dedicated attention. For example, some targets are extended or have extensive dust halos, complicating the analysis given NICER's unique optics. The NICER team will focus on exploiting all cross-calibration observations more productively.
- Request for systematic error column in spectral files
  - This is a reasonable request, and the NICER team will attempt to accommodate it in the next software release.

Analysis Threads

"Analysis threads: develop start-to-finish walk-through analysis threads to go from unfiltered event files to background-subtracted spectra, light curves and power spectra"

- Since receipt of the NUG report, the NICER team has published 12 new analysis threads and updated nearly all previously existing threads with new information.

- It is a reasonable request to create higher-level analysis threads, and our goal will be to produce these for the next NICER software release.

Background

"Background: adopt a single background model as the 'default' that provides the most reliable starting point for analysis."

- Having a choice for modeling background is not new (e.g., RXTE PCA had two background models to choose from, "faint" and "bright")

- Adoption of a single "default" background model could be counterproductive, depriving users of the differing strengths of dissimilar models and potentially hindering innovation.

- To facilitate the use and comparison of existing models, the NICER team will focus on making them available to the community as an integrated part of NICER software releases, so that they are standardized and easier to download, configure, and use.

- Selecting between models could be easily accomplished by setting a "switch" in the `extractor/xselect` software so the user can check and compare multiple models in a straightforward way.

- As we, and the community, gain experience with the existing models (currently "3C50" and "space-weather"), it may well be possible to recommend one as a reliable starting point for most datasets.

GO Program

"GO program: introduce a 'Key Projects' category to encourage the proposal of large, high impact projects requiring significant observing time"

- Adding a new category will add complexity in order to solve a problem that may not actually exist.
  - The proposal selection process for NICER does not disincentivize projects with significant observing time requests.
  - Nevertheless, we now recognize that there may be a perception that topical review panels are constrained in the amount of total time they can recommend. In practice, that is not the case: time is not allocated per panel. Rather, a balance of projects is selected across panels until the total available time is reached.
- The NICER mission will work to improve awareness of this fact:
  - We are exploring ways to add clarification to the AO and will update the proposal webpages to explain that large projects are welcome.
  - We will add instruction to the reviewers to advise them that large time requests have been encouraged by the mission.

Other NUG Issues

- *"Data distribution: have a publicly available quick-look data website for fast access to data from new transients"*
  - We are developing implementation plans for delivery of quick-look data to the archive.
- *"Data delivery and analysis tools: deliver quick-look data products / [single high-level pipeline]"*
  - We recognize the broad utility of easily accessible "Level 3" data products such as lightcurves and spectra. We note that past and present missions have made such high-level products available through large-scale reprocessing of archived datasets, after calibration, background, and other necessary inputs have reached a mature and stable state. NICER is nearly there, and development of a Level 3 pipeline should be possible in the near future.
- *Light curve page for all NICER targets*
  - In principle, this would represent a subset of the Level 3 effort described above, but with the complication of near-real-time updates to lightcurves. A concern here is that the majority of NICER's time is spent observing Guest Observer targets, most of which are granted exclusive-use periods. We welcome the NUG's thoughts on how the competing priorities of GO exclusive use vs. public display of near-real-time data should be balanced.