MEMORANDUM OF UNDERSTANDING BETWEEN THE NATIONAL RADIO ASTRONOMY OBSERVATORY AND THE NEUTRON STAR INTERIOR COMPOSITION EXPLORER

1. Purpose

In recognition of the importance of radio observations using the National Radio Astronomy Observatory (NRAO) facilities for certain science objectives of the Neutron Star Interior Composition Explorer (NICER) mission, as well as the relevance of NICER investigations to certain scientific programs conducted on NRAO facilities, this agreement aims to establish a reciprocal and cooperative arrangement in which observing time on NRAO telescopes and with NICER's X-ray telescope on the International Space Station (ISS) is made available for coordinated observations on a competitive basis. The science investigations that will be supported by this agreement are those that are enhanced by the combination of NICER observations with those using the radio facilities operated by the NRAO. The intent, in keeping with the missions of both NICER and the NRAO, is to maximize data availability and scientific return for the entire user community.

2. Background Description of the ISS NICER X-Ray Telescope

NICER, launched on 3 June 2017 aboard a SpaceX Falcon 9 rocket and was deployed for a primary mission duration of 18 months aboard the ISS. NICER utilizes X-ray (0.2–12 keV) "concentrator" optics and silicon-drift detectors, and offers GPS position and absolute time reference to better than 300 ns. NICER tolerates the ISS contamination and radiation environments, and provides high (> 65%) observing efficiency with safe-stow capability. Observing time, up to 8 Ms per year, is made available to scientists at U.S. and non-U.S. institutions to study a wide variety of astrophysical sources. Consistent with Explorer Program policy, exclusive-use data rights for NICER observations are available when justified through the NICER General Observer (GO) peer-reviewed proposal process.

3. Background Description of NRAO Radio Telescopes

The NRAO operates the Very Long Baseline Array (VLBA), a milliarcsecond-resolution continent---wide interferometer array; the Karl G. Jansky Very Large Array (VLA), an arcsecond---resolution centimeter---wave interferometer array; and the Robert C. Byrd Green Bank Telescope (GBT), a precise 100m single---aperture telescope. In addition, the NRAO is the North American Executive of the Atacama Large Millimeter/Submillimeter Array (ALMA). The present agreement covers the use of the GBT, VLBA, and VLA, with the potential of adding ALMA at a future date. The total amount of scientific observing time used on the operational NRAO telescopes ranges from 4500 to 6500 hours per year. The GBT, VLBA, and VLA are pointed telescopes generally allocated for PI proposals; their data proprietary period is 12 months, beginning at the time of the last observations associated with a proposal. NRAO accepts proposal submissions around February 1 and on August 1 annually. NRAO is funded by NSF as a research facility that operates state-of-the-art telescopes in an "open skies" mode for the entire astronomical community.

4. Scope and Purpose of Joint Program

This agreement commits observing time on NRAO telescopes for correlative observations of NICER sources, and observing time on NICER for correlative observations of NRAO sources. The available time will be awarded on a competitive basis and will be subject to approval by the NRAO Director and the NICER Principal Investigator (PI).

4.1 The scientific studies supported under this program are restricted to those that are enhanced by the combination of NICER observations with investigations that use the radio facilities operated by NRAO.

4.2 All standard observing restrictions for both observatories will apply to joint proposals under this program.

4.3 This program supports two distinct types of joint opportunities between NRAO and NICER, as described below.

5. Joint Proposals Opportunity: Access to NRAO Telescopes

By this agreement, NRAO permits the NICER GO Program to award NRAO observing time.

5.1 No more than 5% of the NRAO scientific observing time will be made available on NRAO's VLA, GBT, and VLBA, or up to 200-300 hours per year on each telescope. Allocation of time on ALMA is not covered by this agreement.

5.2 NICER will make funding available to successful U.S.-based investigators who request NRAO observing time through the NICER GO process.

5.3 Individual requests for 200 hours or more of time on NRAO telescopes will not be eligible for time, but may be eligible for funding via the "Correlative Observations" Opportunity (see item 9 below).

5.4 Radio data acquired through the NICER GO process will be the property of the proposers for the standard NRAO 12-month proprietary period. Unless the users petition for an extension of the proprietary period, the data will then become publicly available in the NRAO Archive.

5.5 The peer-reviewed NICER GO proposal evaluation process will identify investigations with sufficient merit to be allocated NICER observing time and funding, and those that fall within the agreed-upon range of NRAO observing time will be allocated NRAO observing time without additional scientific review, if judged technically feasible. NRAO will perform feasibility checks on the proposed observations and reserves the right to reject any observation determined for any reason to be technically unfeasible or to jeopardize NRAO instrumentation. Such a rejection could jeopardize the entire proposed science investigation and influence the award of NICER observing time as well.

6. Joint Proposals Opportunity: Access to NICER Observations

By this agreement, the NICER GO Program permits NRAO to award up to 250 ks of NICER observing time per year. This award of time shall occur without further scientific review by the NICER mission, provided compelling justification is provided to NRAO that such observations substantially enhance the scientific reach of the proposed investigations.

6.1 Proposed observing time on NICER may be time-constrained, including coordinated and monitoring observations, and Targets of Opportunity, if full justification is included in the proposal. Note that proposed NICER observing time can include monitoring that precedes, follows, and/or (for TOOs) triggers NRAO observing time.

6.2 NICER datasets obtained under this agreement will not be proprietary to the PI and will be released publicly via the HEASARC data archive within 14 days of the observations, consistent with NICER's routine data-pipeline operations. No funds will be awarded from the NICER mission for such joint NRAO/NICER investigations.

6.3 The peer-reviewed NRAO proposal-evaluation process will identify investigations with sufficient merit to be allocated observing time by NRAO, and those that fall within the agreed-upon range of joint programs will be allocated NICER observing time without additional scientific review if they are judged technically feasible. NICER will perform feasibility checks on the proposed observations and reserves the right to reject any observation determined to be technically unfeasible for any reason. Such a rejection could jeopardize the entire proposed science investigation and influence the award of NRAO observing time as well.

7. Criteria for Award of Joint Observing

Observing time under this program will be awarded only to proposals that require use of both observatories to meet the primary science goals; the joint program shall not apply to usage of archival data. No NRAO time will be allocated without NICER time, and *vice versa*.

8. Establishing Technical Feasibility

Establishing technical feasibility is the responsibility of the proposing PI. To do so, proposers are strongly encouraged to:

- review the NRAO Call for Proposals
- consult the NICER Technical Handbook, or the NICER GO webpage
- contact the NICER Helpdesk and/or the NRAO Helpdesk in case of questions.

9. Credits and Attributions

9.1 For results obtained using NICER and NRAO facilities, proper attribution to NRAO facilities must be included in all publications, conference proceedings, posters, abstracts and talks and colloquia. Such attribution should read: "The National Radio Astronomy Observatory is a facility of the National Science Foundation operated under cooperative agreement by

Associated Universities, Inc."

9.2 NICER attribution is required for all NICER observations made under this program. Attribution for the observations and funding (if any) will be the same as for all other use of NICER data products.

10. Effective Date, Term, Termination, and Amendments

10.1 This agreement shall begin on 1 January 2023 or upon the date of its signing by both Parties, whichever is later, and will thereafter be subject to renewal by mutual agreement annually.

10.2 This agreement may be suspended by mutual agreement of the signatories in the event of a major equipment failure on the NICER spacecraft or in the case of a major event that renders NRAO infrastructure incapable of supporting antenna operations for an extended period of time. This agreement may be terminated by either signatory at any time by written notice.

10.3 This agreement may be amended, subject to the written agreement of both signatories or their designated representatives.

Digitally signed by Tony Beasley
Date: 2023.01.17 14:27:08 -05'00'

Dr. Anthony Beasley, Director _____ Date
NRAO

17 Jan 2023

Dr. Keith C. Gendreau , NICER PI _____ Date
NASA/GSFC