MEMORANDUM OF UNDERSTANDING BETWEEN THE NATIONAL RADIO ASTRONOMY OBSERVATORY AND THE IMAGING X-RAY POLARIMETRY 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 Imaging X-ray Polarimetry Explorer (IXPE) mission, as well as the relevance of IXPE 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 on IXPE 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 IXPE observations with those using the radio facilities operated by the NRAO. The intent, in keeping with the missions of both IXPE and the NRAO, is to maximize data availability and scientific return for the entire user community.

2. Background Description of the IXPE Small Explorer Mission

IXPE was launched on 9 December 2021. IXPE opens a new window on the universe providing imaging X-ray polarimetry in the 2-8 keV band. The IXPE mission is now in a General Observer phase and observing time, up to 15 megaseconds 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 IXPE observations are available only when justified through the IXPE 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; the PI exclusive use period for the data 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 IXPE sources and observing time on IXPE 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 IXPE Principal Investigator (PI).

4.1) The scientific studies supported under this program are restricted to those that are enhanced by the combination of IXPE 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 IXPE, as described below.

5. Joint Proposals Opportunity: Access to NRAO Telescopes

By this agreement, NRAO permits the IXPE Mission 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. Individual requests for 200 hours or more of time on NRAO telescopes will not be eligible for time

5.2) Radio data acquired through the IXPE GO process will be available for the exclusive use of the proposers for the standard NRAO 12-month exclusive use period. Unless the users petition for an extension of the exclusive use period, the data will then become publicly available in the NRAO Archive.

5.3) The peer-reviewed IXPE GO proposal evaluation process will identify investigations with sufficient merit to be allocated IXPE observing time and funding. Those that request NRAO observations fall within the agreed-upon range of joint programs will be reviewed by NRAO for technical feasibility and by the IXPE proposal-evaluation process for the scientific merit of the NRAO observations. If the NRAO observations are judged to be scientifically compelling, technically feasible, and within the agreed-upon range of this joint program, then they will be be allocated NRAO observing time without additional review. NRAO reserves the right to reject any observation determined to be technically unfeasible for any reason.

6. Joint Proposals Opportunity: Access to IXPE Observations

By this agreement, the IXPE GO Program permits NRAO to award up to 300 ks of IXPE observing time per year. This award of time shall occur without further scientific review

by the IXPE 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 IXPE may be time-constrained, including coordinated and monitoring observations, and Targets of Opportunity, if full justification is included in the proposal. Up to one IXPE Target of Opportunity observation per year at medium or lower priority is permitted under this opportunity.

6.2) IXPE datasets generally have no exclusive use period and are released publicly via the HEASARC data archive within 14 days of the observations, consistent with IXPE's routine data-pipeline operations. However, proposers may request an exclusive use period of up to 6 months.

6.3) The peer-reviewed NRAO proposal-evaluation process will identify investigations with sufficient merit to be allocated observing time by NRAO. Those that request IXPE observations will be reviewed by IXPE for technical feasibility and by the NRAO proposal-evaluation process for the scientific merit of the IXPE observations. If the IXPE observations are judged to be scientifically compelling, technically feasible, and within the agreed-upon range of this joint program, then they will be allocated IXPE observing time without additional review. IXPE will reserves the right to reject any observation determined to be technically unfeasible for any reason.

6.4) Successful NRAO investigators may be eligible for IXPE GO funding. Subsequent to NRAO approval of observing time, proposals that include U.S.-based PIs or Co-Is will be invited to submit budget proposals to NASA. These proposals need to include a budget narrative describing in sufficient detail how the proposed funds will be used to analyze and interpret the awarded IXPE observations. NASA program personnel (as opposed to peer reviewers) will evaluate the cost proposals for cost reasonableness and compare the proposed cost to available funds.

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,
- to consult the IXPE GO webpage and the resources available there, and
- to contact the IXPE Helpdesk and/or the NRAO Helpdesk in case of questions.

9. Credits and Attributions

9.1) For results obtained using IXPE 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) IXPE attribution is required for all IXPE observations made under this program. Attribution for the observations and funding (if any) will be the same as for all other use of IXPE data products. “The Imaging X-ray Polarimetry Explorer (IXPE) is a joint US and Italian mission. The US contribution is supported by the National Aeronautics and Space Administration (NASA); the Italian contribution, by the Italian Space Agency (Agenzia Spaziale Italiana, ASI).”

10. Effective Date, Term, Termination, and Amendments

10.1) This agreement shall begin on 1 June 2024 or upon the date of its signing by both Parties, whichever is later, and will thereafter be subject to annual renewal by mutual agreement.

10.2) This agreement may be suspended by mutual agreement of the signatories in the event of a major equipment failure on the IXPE 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.

Dr. Anthony Beasley _____ Date

Director NRAO

Dr. Philip Kaaret _____ Date

IXPE Principal Investigator, NASA Marshall Space Flight Center

Dr. Hashima Hasan _____ Date

IXPE Program Scientist, NASA Headquarters

ADDENDUM TO THE

MEMORANDUM OF UNDERSTANDING BETWEEN THE NATIONAL RADIO ASTRONOMY OBSERVATORY AND THE IMAGING X-RAY POLARIMETRY EXPLORER

February 3, 2026

As of July 2025, calls for Imaging X-ray Polarimetry Explorer (IXPE) General Observer proposals are included as part of NASA's "Combined General Investigator General Observer Program." This Program funds only proposals with U.S.-based Principal Investigators (PIs). Therefore, U.S.-based Co-Investigators (Co-Is) on successful NRAO observing proposals with non U.S.-based PIs will no longer be invited to submit budget proposals to NASA.