Statement of Work – HNX Spacecraft and Launch Services

1.0 GENERAL BACKGROUND

NASA will be procuring a low cost spacecraft to accommodate the Heavy Nuclei eXplorer (HNX) Instruments to form an Astrophysics Small Explorer (SMEX) Mission. NASA may also procure the launch services for this complete HNX mission. The mission is intended to investigate the origin and age of heavy cosmic-ray elements and determine the injection mechanism for cosmic-ray acceleration. In order to meet the mission requirements, the spacecraft needs to have a minimum 2 year on-orbit lifetime followed by a safe return of the payload/instrument to earth and instrument recovery for post mission processing.

2.0 HNX KEY SCIENCE OBJECTIVES

HNX will use two instruments to determine the origin of galactic cosmic rays, the enigmatic population of relativistic nuclei and electrons that fill interstellar space. These two instruments will take a direct sample of matter from the birthplace of heavy nuclei to the end of the periodic table. This data will be used to determine how cosmic accelerators work.

3.0 MISSION OVERVIEW

The HNX mission consists of two high-precision instruments which cover separate but overlapping ranges of the periodic table. A passive instrument will measure individual element abundances for elements with Z>70. This instrument must be returned to earth for post mission processing. An active electronic instrument delivers real time or near real time data during the mission with measurements of individual elemental abundances from Neon (Z=10) through Bi (Z=83) The two instruments must be accommodated on a single satellite that must be launched to low earth orbit. The orbit inclination must be between 51.6 and 90 °. The science is not highly dependent on the altitude, although in general, higher altitudes are preferred. HNX will be managed by the Goddard Space Flight Center in partnership with the chosen spacecraft provider who will expertly design, build, and test a highly reliable spacecraft using high-heritage subsystems and proven, well-tested engineering design. The Small Explorer missions will be classified as Category 3 missions (per NPR 7120.5E) with Class D payloads (per NPR 8705.4)

3.1 LAUNCH VEHICLE

Launch services may be purchased by NASA from the spacecraft provider, or can be provided by NASA if a suitable low cost NASA launch vehicle exists for the proposed spacecraft.

If a launch vehicle is proposed, the vendor must show heritage and previous launch success for the proposal launch vehicle. Launch loads and acoustic levels for the launch environment must be well known and shall be provided to NASA.

Historic and predicted ROM costs for launch of the proposed spacecraft on the proposed launch vehicle shall be provided in the response to this RFI.

3.2 LAUNCH MANIFEST

HNX intends to fly as a secondary payload to lower flight costs. The vendor must provide flight manifest possibilities with identified primary payloads and launch date options between August 2020 and December 2020. This SMEX mission is required to launch no later than 12/31/2020.

4.0 SPACECRAFT REQUIREMENTS

4.1 INSTRUMENT ACCOMMODATION

The spacecraft shall be able to accommodate the two planned HNX instruments. The passive instrument consists of glass tiles with a total surface area of approximately 21 m^2 and a total volume of 0.63 m^3. It will fly inside the pressurized portion of the spacecraft and is required to be safely returned to earth for post processing and data analysis. These tiles can be cut as necessary to cover internal capsule (spacecraft) surfaces, but cannot be stacked on top of each other. The active instrument occupies a volume of 2.27 x 1.25x 0.52 m tall. Although neither instrument has any direct viewing requirements, there cannot be any glass tiles between the 2 m^2 detector surface and the walls of the spacecraft. The current best estimate of the total mass for HNX (for both instruments with all peripheral hardware and harnesses) is 2500 kg. With desired contingency and margins, a total upmass and downmass capability of at least 3100 kg is desirable but not required at this time. The vendor's upmass and downmass capability shall be explicitly stated in the response to this RFI.

Existing spacecraft mechanical, electrical, software bus, communications, thermal, power, and other interfaces must be well defined and releasable immediately upon the execution of a contract or Partnership of Opportunity Document between NASA and the vendor. This includes, but is not limited to, the availability of mechanical drawings and interface control documentation.

Historic and predicted spacecraft accommodation costs shall be provided in the response to this RFI.

4.2 MECHANICAL INTERFACES

It is expected that the passive instrument glass tiles will be mounted directly to the inside walls of the pressurized capsule (spacecraft). The vendor response to this RFI shall include a description of possible mounting locations and surface area available. Mechanical structure will be provided by NASA to mount the active instrument to the capsule.

4.3 TEMPERATURE CONTROL

The vendor shall provide thermal control for the instruments inside the capsule (spacecraft). The passive instrument is a passive thermal design with maximum temperatures between -10 °C and +35 °C. The active instrument must be controlled by the spacecraft between -10 °C and +40 °C when operating. Non-operating temperatures for the active instrument are -20 °C to +50 °C. These temperatures assume that the instruments are maintained within a pressurized volume. Accommodation of the instruments within an unpressurized volume is not currently supported.

4.4 COMMAND AND DATA HANDLING

The spacecraft is required to provide data communications to the active instrument. The instrument is designed to provide data through an Ethernet interface. The maximum expected data rate, including margin, is 300 kbps during calibration mode.

4.5 POWER

The active instrument requires a nominal voltage of 28 VDC. The maximum power requirement (average) is 190 W. There is no credible peak power case.

4.6 INTEGRATION AND LAUNCH READINESS

The customer intends to deliver the instruments to the vendor for integration to the spacecraft beginning in February 2020. The spacecraft must be ready for launch no later than the end of December 2020.

4.7 OPERATING LIFETIME AND INSTRUMENT RETURN

The spacecraft shall be capable of operating on-orbit for a minimum of two years, followed by safe return to earth and fully intact instrument recovery. In the response to this RFI, the vendor shall name all past missions and/or payloads flown in LEO, their durations, dates, and whether they were concluded with a safe return to Earth. If a two year mission followed by a safe return to Earth has not yet been demonstrated, the vendor shall indicate when this requirement shall be met, the current schedule and how this development is being funded.

Landing loads for payload return must be known now and shall be submitted to NASA.

4.8 HERITAGE

The vendor must show heritage and previous launch success and safe return of payload to Earth for the pressurized capsule. Name the missions and/or payloads you have flown in LEO and their durations and safe return to Earth.

5.0 SAFETY AND MISSION ASSURANCE

Astrophysics Explorer missions are required to meet the requirements for safety, reliability, and mission assurance in the *Explorer Safety, Reliability, and Quality Assurance Requirements* document (see http://explorers.larc.nasa.gov/APSMEX/SMEX/programlibrary.html).

Acronym List

GSFC	Goddard Space Flight Center
LEO	Low Earth Orbit
NASA	The National Aeronautics and Space Administration
RFI	Request for Information
ROM	Rough Order of Magnitude
SMEX	Small Explorer
VDC	Volts Direct Current