**Annex 2: Technical Specifications**

Name of the public contract: 3D Atom Probe Tomography – design, manufacture, and delivery of the system.

The Institute of Thermomechanics of the Czech Academy of Sciences intends to purchase the Local Electrode Atom Probe instrument to perform 3D Atom Probe Tomography (3D APT). High-sensitivity 3D APT instrument with nanoscale resolution (< 1nm) produces a 3D image showing the atomic structure and chemical composition of both microtip and wire geometry samples of metals, alloys, ceramics, semiconductors, oxides, minerals, and insulators.

* REQUIREMENT 1: The 3D APT instrument must be a stand-alone system capable of performing 3D Atom Probe Tomography, enabling both high-resolution 3D imaging of atomic structures and precise chemical composition measurements at the atomic scale, with a lateral resolution of about 0.3–0.5 nm and a depth resolution of about 0.1–0.3 nm.
* REQUIREMENT 2: The 3D APT instrument must be able to analyze both microtip and wire geometry samples of metals, alloys, ceramics, semiconductors, oxides, minerals, and insulators.
* REQUIREMENT 3: The 3D APT instrument must be brand new and non-used, fully functional, and of the latest generation. The instrument must fulfill all legal regulations on safety and health. The system must be fully CE compliant and must display an up-to-date CE marking, accompanied by a correct EC Declaration of Conformity as well as all required updated documentation.
* REQUIREMENT 4: The 3D Atom Probe Tomography system must include the Local Electrode Atom Probe Microscope (contains a Load-Lock chamber, Buffer/Storage chamber, Analysis chamber with cryo-cooled specimen stage, local electrode stage, specimen transfer components), Control Electronics Rack (contains the electronic components required to operate the 3D APT system), Facilities Unit (contains cryostat helium compressor, vacuum roughing pumps, laser water chiller), and PC workstation (data-acquisition, control and data analysis PC and desk).
* REQUIREMENT 5: The supplier must take full responsibility for the installation and commissioning of the equipment supplied within the price quoted. The supplier must cover all expenses associated with the installation. The supplier must specify necessary site requirements (electrical and non-electrical utilities, network requirements) for installing the 3D APT system. The supplier is required to ensure that the 3D APT instrument complies with the power supply standards EN 50160:2022 and ČSN EN 50160 ED.3 (330122). The Institute of Thermomechanics of the Czech Academy of Sciences will assist with making the necessary extensions and connections of the power, water, and gas supplies to the equipment (if needed).

**VACUUM SYSTEM**

**LOAD LOCK CHAMBER**

* REQUIREMENT 6: The load lock chamber must allow the introduction of up to 4 carousels, allowing the simultaneous introduction of local electrode pucks or more than 30 specimens, so that the specimens can be stored in the vacuum system with the location precisely recorded in the integrated database.

* REQUIREMENT 7: The pressure in the load lock chamber must be <1.0 x 10-5 Torr within 5 minutes of venting (all carousels have been removed from the load lock chamber prior to venting).

* REQUIREMENT 8: The pressure in the load lock chamber must be <1.0 x 10-6 Torr within 30 minutes of venting (all carousels have been removed from the load lock chamber prior to venting).

**INTERMEDIATE/ BUFFER/ STORAGE/ TRANSFER CHAMBER**

* REQUIREMENT 9: The pressure in the buffer chamber must be <1.0 x 10-8 Torr.
* REQUIREMENT 10: It must be possible to maintain samples and local electrodes under ultra-high vacuum (UHV) conditions prior to 3D analysis, allowing rapid sample transfer from the buffer chamber to the analysis chamber stage.
* REQUIREMENT 11: A fully integrated in-situ heated carousel is required to reduce pump-down times, increase sample throughput, and improve vacuum quality.

**ANALYSIS CHAMBER**

* REQUIREMENT 12: The pressure in the analysis chamber must be <1.0 x 10-10 Torr when the specimen temperature is maintained at 50K.

**THE VACUUM AND CRYOGENIC TRANSFER MODULE**

* REQUIREMENT 13: The Vacuum and Cryogenic Transfer Module (VCTM) must be included to allow the transfer of specimens between the 3D APT system and ancillary workstations while maintaining both ultra-high vacuum (UHV) and cryogenic conditions. The module must utilize a UHV-compatible portable chamber that is fully integrated into the 3D APT system via a docking station.

**SPECIMEN STAGE**

* REQUIREMENT 14: Accurate (sub-micron) automated 3D specimen movement and alignment of the specimen tip to the local electrode must be enabled.
* REQUIREMENT 15: The cryogenic temperature of the specimen must be adjustable in the range of 20-100K.

**LOCAL ELECTRODE**

* REQUIREMENT 16: The field of view up to 250 nanometers must be achievable.

**VOLTAGE MODE**

* REQUIREMENT 17: The ion field evaporation must be achievable using high-voltage pulses (voltage mode).
* REQUIREMENT 18: Maximum pulse rate for voltage mode must be at least 500 kHz.
* REQUIREMENT 19: The maximum DC voltage must be >13 kV.
* REQUIREMENT 20: The maximum voltage pulse must be > 2 kV.

**LASER MODE**

* REQUIREMENT 21: The ion field evaporation must be achievable using ultra-fast deep UV wavelength laser pulses (laser mode).
* REQUIREMENT 22: Maximum pulse rate for laser mode must be > 400 kHz.
* REQUIREMENT 23: The laser wavelength must be <300 nm and a laser spot size must be < 3 micrometers.

**VOLTAGE AND LASER MODE**

* REQUIREMENT 24: The ion field evaporation must be achievable using an operating mode that simultaneously applies both laser pulses and voltage pulses to the sample (voltage and laser mode).

* REQUIREMENT 25: The following acquisition parameters must be adjustable: The detection rate [ions/pulse] and the pulse rate [Hz] must be adjustable for voltage and laser mode acquisition. The laser pulse energy [nJ or pJ] must be adjustable for the laser mode and the pulse fraction [%] (the percentage of time the voltage is applied to the specimen during each cycle) for the voltage mode.
* REQUIREMENT 26: It must be allowed to pre-program acquisition parameter settings so that the parameters can be changed automatically during acquisition.
* REQUIREMENT 27: Mass resolution at FWHM (Full Width at Half Maximum for standard aluminium specimen) in both voltage and laser mode must be better than >1:900.
* REQUIREMENT 28: Mass resolution at FW0.1M (Full Width at 0.1 Maximum for standard aluminium sample) in both voltage and laser mode must be better than >1:400.
* REQUIREMENT 29: Mass resolution at FW0.01M (Full Width at 0.01 Maximum for standard aluminium sample) in both voltage and laser mode must be better than >1:200.

**DETECTION SYSTEM**

* REQUIREMENT 30: The detection system must be a position-sensitive single-atom detector with multi-hit capability and ionic detection efficiency >50%.
* REQUIREMENT 31: The detector must register the time it takes each ion to travel from the sample to the detection system, as well as its impact position.

**DATA ACQUISITION**

* REQUIREMENT 32: To ensure a constant evaporation rate (after the target detection rate has been achieved) the instrument must allow an automatic voltage control.
* REQUIREMENT 33: In laser mode, the system must automatically adjust laser pulse energy to maintain a constant field condition over the duration of the experiment.
* REQUIREMENT 34: The background noise present in 3D APT data taken from standard specimens and at standard acquisition conditions must be < 20 ppm/ns as an indication of good data quality (high signal-to-noise ratio).
* REQUIREMENT 35: The chemical sensitivity must be up to 10 parts per million.
* REQUIREMENT 36: The maximum data acquisition/collection rate must be 4M ions/minute.

**3D APT SOFTWARE**

* REQUIREMENT 37: At least five floating licenses of the latest version of a fully-network, multi-user, Windows-based software for 3D APT data management, visualization, and analysis must be provided. The required software features are the following: Data reconstruction into a 3D image and interactive 3D image rendering; Display and saving atom maps, mass spectra, compositions, isoconcentration surfaces, and arbitrary slices for selected atom types and selected regions of interest; Correlative analysis across complementary techniques, automated peak identification, scripting console, and third-party support.
* REQUIREMENT 38: The export of experimental data in ASCII format is required.
* REQUIREMENT 39: Unlimited and free software updates must be provided.
* REQUIREMENT 40: It must be possible to run, control, and service the 3D APT instrument remotely.

**INTEGRATED PLASMA CLEANER**

* REQUIREMENT 41: An automated plasma cleaner that enables the cleaning of specimens introduced into the vacuum system or the treatment of contaminated local electrodes must be fully integrated into the system.

**MANUAL ELECTROPOLISHER**

* REQUIREMENT 42: A Manual Electropolish Station without a Microscope is required for the production of sharp atom probe specimens. The item must include a power supply, chemical handling, and all accessories required to prepare high-quality atom probe specimens.

**ACCESSORY AND CONSUMABLES**

* REQUIREMENT 43: It must be provided a comprehensive list of accessories and consumables (replacement local electrodes and the micro-tip coupons used to mount specimens prepared using the focused ion-beam lift-out method) to fully enable application work including a wide variety of specimen preparation procedures. Key components required for FIB-based specimen preparation must be included.