

Technical Specifications for the procurement of Inductively Coupled Plasma Mass Spectrometer (ICP-MS)

Preamble

An Inductively Coupled Plasma Mass Spectrometer (Quadrupole ICP-MS) is proposed to be procured for routine analysis of the following:

1. Selected major and trace elements including REE and PGE (2-260 amu) abundances, in geological (silicates), environmental and biological material, in solution-mode with detection limits down to parts per trillion (ppt) level.
2. Provision for in-situ selected major and trace elements (2-260 amu) analysis of materials (minerals, glasses, ceramics, metals, alloys etc.) with detection limits down to parts per trillion (ppt) level.
3. Provision for in-situ U-Pb isotopic analysis of zircon, monazite, apatite and titanates in conjunction with a Laser Ablation Microprobe (LAM).

General Specifications

The ICP-MS instrument under procurement should be capable of integration with a Laser Ablation Microprobe for the aforesaid objectives. Detailed specifications are as follows:

1. Basic Design:

- (i) The system should be a space saving, compact bench-top model that can fit into allocated space of 6' x 6' lab space with all the sub-systems and accessories.
- (ii) All stainless steel, corrosion-resistant exteriors.
- (iii) Open architecture design for sample introduction system for ease of operation in switching between LAM, GC/LC/IC etc.

2. Sample Introduction System:

Sample Introduction System should be capable of easy switching between Liquid system and Laser Ablation System with the following additional capabilities.

- a. Nebulisers:** The following types of nebulisers shall be quoted separately and clearly stating whether it is **part of the standard equipment** or as an **optional item**.
 - (i) MicroMist Glass concentric nebulizer.
 - (ii) Cross/Micro flow/PFA nebulizer for HF medium.
 - (iii) Direct Inject nebulizer.
 - (iv) Meinhard nebulizer.
- b. Spray Chambers:** The following types of Peltier-Cooled Spray Chambers should be quoted separately and clearly stating whether it is **part of the standard equipment** or as an **optional item**.
 - (i) Quartz Scott-type.
 - (ii) PFA Spray chamber for HF medium.
 - (iii) Standard cyclonic type suitable for different kind of samples.

c. Peristaltic Pump:

- (i) 3-4 Channel, At least 10-roller pump with precise computer controlled pumping of the sample, internal standards and spray chamber drain.
- (ii) Should be close to the spray chamber for faster rinse, sample uptake/out and minimum transfer line volume.

d. Injectors:

- (i) Alumina/quartz/PFA injectors suitable for HF medium and other sample environments.

3. Plasma Ion Source

a. Plasma Gas Control:

Should have a minimum of four Active Mass Flow Controllers (AMFC) for Control plasma, auxillary, makeup and Carrier Gases. Consideration will be given for a system with an additional fifth AMFC for additional carrier gas flow which could be used for future upgradation of the system.

b. Torch:

- (i) One piece glass/quartz torch with a minimum diameter of 2.5 mm for efficient matrix decomposition and sample ionization. System should be capable of using a demountable torch with platinum/sapphire injector.

c. Computer control of the torch.

- (i) Torch movement should allow for complete computer-control and auto tunable in x-y-z directions with independent movements in the three directions.
- (ii) Provision for Auto-alignment of the torch after routine maintenance with a reproducibility better than 0.1 mm in x-y-z directions.
- (ii) Option of "Manual override" provision for the above mentioned movements should also be available.

d. Plasma RF Generator.

- (i) All solid state, digitally driven 27 MHz RF and with a range of 1300-1500 Watts generator for efficient and superior ionization.

e. Shield Torch Mechanism

- (i) Shield Torch mechanism capable of reducing the plasma ion energy spread and provide for efficient cool plasma operations.

4. Ion Extraction Interface

a. Sample Cones and Skimmer Cones

- (i) Sample and skimmer cones of high purity Ni should be easily mountable and dismountable.
- (ii) Scope of supply of standard and optional Nickel/Platinum cones should be clearly specified.

5. Ion Optics and Focusing Systems

a. Extraction Lenses

- (i) Should be capable of minimizing interface background.
- (ii) Lens configuration should provide a flat mass response with the best low mass transmission.

- (iii) Should be dual mode extraction system (conventional and soft-extraction).

b. Off-axis Lens System

- (i) System must have an off-axis lens system to the ion lens.
- (ii) Ion lenses should be outside the high vacuum region for easy maintenance.

6. Vacuum System.

- (i) Single floor mounted remotely located rotary pump that reduces noise level in the room.
- (ii) For intermediate and analyzer stages, vacuum system should be supported by turbo molecular pumps for cleaner and faster vacuum.

7. Provision for Reaction Cell

- (i) Instrument should have a provision to port as He Collision/Reaction Cell. Results of analysis of specific elements with interferences by these methods should be attached.
- (ii) Separate AMFCs for Reaction cell gases.

8. Quadrupole Mass Analyzer

a. Quadrupole

- (i) Quadrupole rods preferably of “True hyperbolic” cross section for better peak shape and resolution.

b. RF Generator

- (i) Fully digital RF generator.
- (ii) Minimum of 2.5 MHz for best abundance sensitivity with:
 - Mass Range: 2-260 amu
 - Abundance Sensitivity: 5×10^{-7} or lower.
- (iii) Detection limits: The detection limit must be < 1 ppt for all masses. The quote should provide certificate of analysis, showing detection limits, of representative low, medium and high mass elements, with methodology.
- (iv) Oxide ratio represented by CeO/Ce: < 2%
- (v) Doubly charged ions represented by Ba⁺/Ba²⁺ : < 3%

9. Mean background of the system should be less than 1 cps at 220 amu in pulse counting mode.

10. Ion Detector Assembly

- (i) Discrete dynode electron multiplier type detectors that can operate in simultaneous dual-mode.
- (ii) Minimum of 9 orders of linear dynamic range, with background noise of <0.5 cps.
- (iii) High speed analog mode for transient signals.
- (iv) Dwell time of minimum 100 microseconds (in both pulse count and analog modes).
- (v) Working concentration range of the detectors should be from the detection limit to 500 ppm or more with a maximum of >1000 ppm in He-gas mode

without any adjustments of settings such as resolution, detector voltage etc.

11. Computer System and Software for System Control, Data Acquisition and Analysis.

- (i) Branded (DELL/IBM/COMPAQ) Intel at least Core i3 Processor with a minimum of 3.2 GHz Processor speed, 6 GB RAM, 500 GB HDD, CD/DVD RW with a separate graphics card that can support multiple displays with preloaded Windows 7 OS.
- (ii) Software package should work on a Microsoft Windows 7 Professional Platform.
- (vi) Software package should be comprehensive to handle the following basic options:
 - Acquisition in full spectrum, peak hopping and time resolved modes.
 - Data analysis that is supported using isotope ratios, isotope dilution, external and standard calibrations with or without internal standards.
 - Should support semi-quantitative analysis with rapid screening of unknowns.
 - Data archival and retrieval functions.
 - Auto-tuning of the instrument from a cold start.
 - Data Reporting and Macro Programming of customized analysis routines.
 - System diagnostics software.

(Two identical computer systems one with a second license of the software should be supplied – for On-line analytical work and Off-line Data Processing).

12. Additional Software

- (i) ‘Glitter’ or an equivalent time-resolved analysis software trace element and U-Pb isotopic analysis should be quoted as part of the main package. The software should be complete with routine for common Pb corrections.

13. Operational Requirements:

a) System should be capable of working with the following power and environmental requirements:

- (i) Single Phase, 220-240 V, 50 ± 5 Hz power supply.
- (ii) Temperatures in the range of 18 to 30 degrees Centigrade.
- (iii) Operational Humidity (non-condensing) of upto 80%.

b) Separate quote for a 20KVA Uninterrupted Power Supply (UPS) system with 60 min backup, of a standard make, may be given, as it is part of operational requirement.

14. Manuals-Circuit Diagrams: A complete set of operation-maintenance modules and circuit diagrams should be provided in hard copy as well as on CD along with the instrument.

15. Miscellaneous:

a. **Onsite testing and performance demonstration of the following upon installation:**

- (i) Demonstration of short term and long term stability for mass range from Li to U with desired stability with <0.5% RSD for two hour measurements

using 10 ppb solutions in the standard operation mode of the instrument. Standard solutions should be supplied by the vendor towards this.

(ii) Demonstration of overall analytical reproducibility for about 30 trace elements including REE and PGE, Zr, Ti, Ta, W, Nb, Hf and Se in multi element solutions and international rock standards (in solution mode). Desired analytical precision should be <5% RSD for the elements. All the solution standards to be supplied by the vendor.

TERMS AND CONDITIONS

- 1. Warranty & Maintenance:** The warranty of the equipment should be specified in detail which should indicate period, cost etc. Warranty for the instrument, support sub-systems and the computer systems from the date of satisfactory installation of the instrument. Response should be 'with-in 48 hours' after lodging a warranty call for troubleshooting. Machine down-time during warranty period should be allowed for extended warranty.
Separate quote for annual comprehensive maintenance of the instrument and subsystems including spares parts as and when required for five years post warranty may be given.
- 2. Routine Consumable components for the first three years of operation:** Routine consumable components shall be supplied with the instrument for the first three years of the operation of the instrument.
- 3. Training:** Post-installation, application related training for two personnel at the factory site in operation, maintenance and application, after a period of exposure time on the instrument.
- 4. Accessories:** A comprehensive list of accessories with catalogue/part number and cost should be provided.
- 5. List of Users in India:** A complete list of Indian Users and the systems that are being handled shall be provided with the name and address of the contact person against each user institute.
- 6.** Vendor must have India-based service organization, for which detailed documentation is required, including full disclosure of names, locations, training, and years of experience.
- 7.** Vendor must have local parts stocking, for which documentation is required.
- 8.** Availability of telephone support, including telephone numbers and email addresses, must be detailed.