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Detailed Technical Specifications for Ion Chromatography Hyphenated with Inductively Coupled Plasma Mass Spectrometry (IC-ICP-MS):

Technical Specifications for procurement/installation of Ion Chromatography Hyphenated with Inductively Coupled Plasma Mass Spectrometry (IC-ICP-MS) at Sophisticated Analytical Instrument Facility (SAIF), IIT Bombay, India.

SAIF, IIT Bombay houses a variety of major analytical instruments. The main objectives of SAIF is to make sophisticated analytical instruments available to scientists and other users from academic institutes, R&D laboratories and industries to enable them to carry out measurements for R&D work. The department is planning to set up IC-ICPMS laboratory to measure abundances of element and isotopes in natural, environmental and biological samples along with anion and cations by conductivity detection. The Institute invites Sealed Tenders for the procurement, commissioning, standardization and calibration of the IC-ICPMS as per the technical specifications given below. (In the following text the IC-ICPMS stands for Ion Chromatography - Inductively Coupled Plasma Mass Spectrometry)

The system should be capable of accurately and precisely analyzing common, rare and toxic elements and trace elemental profiling of metals present at trace and ultra-trace level (% , ppm, ppb and ppt) in various type of environmental samples such as water, soil, sediments, sludge and waste extracts/digests, municipal and industrial solid wastes industrial, mining/metallurgy, natural water systems/hydrogeology, geology & soil science, biological/forensic, food, pharmaceutical samples organic solvents and Sea water. The system should have the capability to perform analysis from high concentration (%) to ultra-trace level (ppt) in a single run without any dilution. The system should have the capability to eliminate polyatomic and isobaric interferences, and acid matrices effectively and should analyze the sample precisely. The system should be easy to use and the vendor should be ready to give lifetime technical support. The vendors should demonstrate the performance of their system for a wide range of samples so as to meet the expectations of the IIT Bombay.

It should be possible to perform analysis using this instrument following the guidelines of International Food Safety Standards and Regulatory Agencies such as Codex, USFDA, and European Commission.

The system should be compatible with IC, HPLC and GC such that coupling with these instrument may be done at present or in future. Instrument interfacing with ICP MS is the responsibility of the ICP MS supplier

For a complete solution the following modules need to be provided.

Specifications of IC-ICP-MS

I. Ion Chromatography:

The system must be capable of simultaneously measuring cation & anion. The Ion Chromatography System should be nonmetallic PEEK based compatible for operation at all pH range and should allow simultaneous analysis of various anions and cations. It should provide flexibility for detection in complex sample matrices by Isocratic mode. Consumables and accessories should be quoted for the smooth operation of the system. The system should be able to perform suppressed conductivity applications. The software should be able to identify the various components such as pump and column automatically. The system components should have the following technical specifications.

II. Pump

Non-metallic PEEK based and compatible for all pH range as per the following specification. The pump housing must have two quaternary/ternary pumping systems in the same housing to allow simultaneous analysis.

Flow range	0.001 – 10 mL/min or better
Reproducibility/Accuracy of eluent flow	± 0.1% or better
Pulsation/Ripple	<1%
Flow precision	<0.1%
Pressure range	0 – 5000 PSI
Vacuum degasser	Built in

III. Column Housing

The housing should be able to identify the columns and set the optimal operating conditions for column operations.

IV. IC Columns

1. The column set quoted must be composed of a separator and precolumn packed with either the same column packing material or a compatible packing material. Column should be quoted for the following applications.
2. Rugged separation column for routine analysis
3. Columns for Cations like Cr, As, Se, Hg, Fe etc
4. Columns for Anions like F, Cl, NO₂, NO₃, PO₄, SO₄, Br, BrO₃, etc.
5. The columns should be suitable for the separation of monovalent and divalent cations as well as amines
6. IC Speciation kit (Cr, As, Hg, and Se) including separate & dedicated columns for each parameter & speciation standard.
7. The Columns must be suitable for interfacing using ICPMS

V. Injector

Two number of Dual position 6-Port injector valve with fast response time. The injector should be controlled through software.

VI. Auto Sampler

Auto sample should have 50 vial position of vial capacity of minimum 5 ml sample volume. Should have non –metallic flow path and should be completely controlled by software.

VII. Conductivity detector

Two number of conductivity detector for analysis of anions and cations. The detector should be microprocessor based with a Thermo-stated micro-flow cell conductivity block. The cell temperature

stability/accuracy <0.0010 °C is required. The user should be able to set the temperature of the conductivity block between 20 – 50 °C.

Cell volume	<1.0 µL
Range - Digital Analogue	0.01 – 15000 µs or more
Electronic noise	<0.1nS/cm at 1uS/cm level
Resolution	5 pS or better
Temperature coefficient or Linearity range	0-5% or better.
Baseline Noise	<0.2 nS/cm

VIII. ICP-MS with auto sampler and accessories

ICP-MS system for elemental analysis which is capable of delivering trace elemental profile of metals present at trace and ultra-trace level (% , ppm, ppb and ppt) in various type of samples. The system should be bench top model.

S. No.	Specifications	Requirements
1	Mass Range	4 - 260 amu or better
2	Scan Speed	3000 amu/sec or better
3	LC/GC/IC Interface	Shall have a provision to couple with HPLC /IC/GC for speciation studies
4	Auto sampler	Shall have fast, accurate and flexible sampling capacity. Capacity minimum 180 Vials of suitable capacity – 1000 nos, along with corrosion resistant components should be supplied.
5	Sample introduction	ICPMS should be quoted with glass concentric nebulizer, spray chambers, quartz torch for efficient matrix decomposition, sample ionization, and quartz injector. Suitable for use with aqueous, organic solvents and HF <u>Plasma Torch:</u> Full demountable torch with sample tube (ceramic / Sapphire injector) suitable for HF based solutions. <u>Nebulizer:</u> It must include a PFA nebulizer having high resistance to corrosive acids such as HF. <u>Spray Chambers:</u> 1. Quartz Spray chamber for high accuracy measurement provided with Peltier cooling and temperature controlled. 2. PFA Spray chamber for ultra-trace analysis and HF based solutions. <u>Peristaltic pump:</u> It should have high precision and should have a minimum of 3 channels provided with computer controlled variable flow-rate. User defined Peltier temperature setting should be provided in the range -5 to +20 °C or better. High Matrix Capability: System should be capable of doing analysis in percentage level, ppm, ppb and ppt level in single run. The system should be able to handle all type of samples ranging from clean water samples to high matrix samples with TDS ranging up to 20% or more with provision for direct aspiration without any need to dilute the sample.

		<p>Argon gas dilution accessory to aspirate >20% TDS samples should be included. The vendor has to quote all the required accessories to address high TDS samples.</p> <p>The sample Introduction system should have very low dead volume with low uptake rate (0.25 ml/min or better)so as to reduce the waste generation.</p> <p>The sample introduction system, torch & cones should be easily accessible. Cones should be made of nickel or platinum.</p>
6	Ion source RF Plasma	<p>Solid-state digital RF generator 27 MHz or higher, with variable power from 500 to 1600 W or better for automatic control of torch ignition, system warm up and shutdown.</p> <ol style="list-style-type: none"> 1. The source should be stable for varying sample matrix. 2. Single piece torch featuring quick dismount and remount fitting for easy maintenance. 3. 3-axis position shall be fully adjustable under computer control. 4. Auto shut down after completion of analysis. 5. Plasma gas control should have at least 4 active flow controllers for control plasma, auxiliary, makeup & carrier gases. 6. The plasma should be fully controlled through PC of horizontal, vertical and sampling depth for maximum sensitivity and minimum polyatomic interference. 7. Autotune facility / plasma view to optimize plasma conditions, lens and cell voltage, etc. for best ionization and sensitivity.
7	Plasma Mode	Shall have cold and hot Plasma modes (should be specified)
8	Mass flow controller	Electronic high efficient mass flow controller (specify) for controlling gas flow.
9	Interfaces	<p>Sampler, skimmer cones/extraction system should be easily mountable and demountable. The cones should be accessible without breaking vacuum for easy maintenance. Systems which can access the ion lenses without breaking vacuum will be preferred as it will reduce the instrument downtime after routine maintenance or services. Cones should have larger orifice (> 1 mm) to minimize clogging.</p> <p>Suitable water-cooled interface under vacuum and with standard high-performance Ni and Pt sampling and skimming cones. Lens/cons system outside the vacuum system is preferred to reduce downtime.</p> <p>4 sets of Nickel and 2 set of Platinum cone (skimmer and sampler cone) should be supplies extra.</p> <p>The ion optics and extraction system should provide high ion transmission across the entire mass range. Ion focusing should be capable of minimizing interface background (≤ 2 cps in no gas mode).</p> <p>Ion focusing system should be capable of removing all neutrals species and photons from the ion path without causing any damage to the optics. The system should be capable of minimizing interferences background.</p> <p>The system should have low maintenance components. The vendor should provide a maintenance chart for all the components that require frequent maintenance and should indicate</p>

		consumables that require frequent replacement.								
10	Vacuum system	<p>A robust high efficiency vacuum system with 3 or more vacuum stage and minimum maintenance and utility with low noise level.</p> <p>The pumps should be acoustic free system.</p> <p>Safety mechanism against power failure. (should be specified).</p> <p>Vacuum oil for refilling should be provided.</p>								
11	Quadrupole	<p>The quadrupole mass filter should be stable and should provide a resolution of 0.4 amu or better.</p> <p>The analyzer quadrupole must have the ability to discretely control the resolution of selected mass regions dynamically, without affecting the overall nominal resolution of the system for non-“custom-controlled” mass region.</p> <p>The Mass range should be from 4 - 260 amu or better to allow the analysis of radioactive elements & actinides.</p> <p>The Dwell time should be better than 0.1 ms (in both pulse count and analog modes) for fastest settling.</p> <p>Quadrupole material: Made of molybdenum/SS or better for a very low coefficient of thermal expansion.</p> <p>Scan speed >3000 amu/s</p> <p>The analyser must have the ability to discretely control the resolution of selected mass regions dynamically without affecting the overall nominal resolution of the system.</p> <p>Quadrupole driven by digital RF generator (2 MHz or higher)</p> <p>Quadrupole with High Mass and Low mass cut- off feature</p> <p>Quadrupole supply and replacement should be included in the warranty</p>								
12	Resolution & Stability	<p>0.4 amu or better</p> <p>ICPMS system should have good stability and good performance, bidders should enclose copy of their qualification stability test as proof.</p> <p>Mass stability of + 0.05 amu over 8 hrs or better</p> <p>Short term stability 3% RSD or better over 10 min</p> <p>Long term stability 3% RSD or better over 120 min</p> <p>Short term and long term Mass stability (should be specified)</p>								
13	Gas control	System should have dedicated MFC devices to control plasma, auxiliary, nebulizer, reaction gas and collision gas.								
14	Sensitivity	<p>Sensitivity should be adequate for analyzing from ppt level to high ppm levels without dilution.</p> <p>Specify the sensitivity for at least 3 mass levels</p> <table border="1" data-bbox="615 1688 1395 1873"> <thead> <tr> <th>Level/Element</th> <th>cps/mg/l</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> </tr> </tbody> </table> <p>Specify IDL @ n=10, multi element, integration time -5s.</p>	Level/Element	cps/mg/l						
Level/Element	cps/mg/l									
15	Background Equivalent Concentration.	Background equivalent concentration should be less than 1 cps (the exact value should be Specified)								

	(BEC)	
16	Background ratio	1cps or less (the exact value should be specified)
17	Oxide ratio	CeO/Ce (%) - 2% or better (the exact value should be specified)
18	Doubly charged ratio	Ba ²⁺ /B ⁺ - 3% or better (the exact value should be specified)
19	Isotope ratio precision Ag ¹⁰⁷ /Ag ¹⁰⁹	0.1% RSD or better (the exact value should be specified)
20	Cell Technology	<p>System should be provided with a suitable technology to remove polyatomic & Isobaric Interferences.</p> <p>The system should have all the three modes of operation: Standard, collision (using inert gases such as helium) and reaction mode for trace level detection and for effective removal of interferences from complex sample matrix.</p> <p>ICPMS system having dedicated gas channels for inert gas and reaction gas pure/mixture for trace level detection and for effective removal of interferences from complex sample matrix.</p> <p>The system should be capable of performing mass shift mode/proton shift mode or equivalent technology and the vendor should attach appropriate application note to demonstrate the technology. The system should be very effective in removing unwanted polyatomic interferences formed due to free atoms.</p> <p>The gas switching time & stabilization time of the collision and reaction cell from no gas to inert and/ or reaction gas is to be specified and should be demonstrated during technical evaluation.</p> <p>The reaction/collision cell system must work at low & high mass cut off facility to take out freshly formed poly atomic interferences.</p>
21	Dynamic range	9 orders of magnitude or better
22	Detector	<p>1.The ion detector should be simultaneous discrete dynode electron multiplier and should allow element concentration calibration over a full 9 orders magnitude of dynamic range in a single scan using both analog and pulse ion counting mode.</p> <p>2.The data acquisition rate should be 2000 amu/sec or more. ICPMS should have high data acquisition rate to address Nano particle applications.</p> <p>3. Life time (should be specified)</p> <p>4. Detector should be replaced free of cost during warranty period</p>
23	Standard solution traceable to NIST	<p>100 ml of 1000 ppm ICP MS Standard solutions NIST traceable certified reference solutions for Al, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cu, Fe, Ga, Zn, Tl, Te, Sr, Se, K, Li, Mg, Mn, Na, Ni, Pb, As, Hg, Mo, P, Y, Ag, Au, S, Si, Sc, In, Cs, Rb, Sb, Zr, Sn, Ti, V, W, V, Pd, and Gd Multielement standard solution is preferred. When multielement standard solution is not available, single element standard solution should be provided.</p> <p>Internal standard and instrument baseline control standards should be provided</p>
24	Torch and Nebuliser	Shall provide additional number (2 nos each) compatible torch and nebuliser (2 nos each) Mini Torch is not acceptable.

25	Gas Generator/Gas cylinders	Suitable gas generator /cylinders (two for each) with suitable regulators for each type of gases/gas mixtures. Necessary gas purification system and gas switching manifold should be included
26	Ar gas consumption (Litre/min)	The recommended flow rate for standard and high TDS application should be specified.
27	Computer platform	Suitable branded computer (HP /DELL) i5/i7 processor with minimum 12 GB RAM Memory , Intel chipset, 1 TB HDD, DVD-RW, additional LAN port, 23” LED monitor with suitable original latest windows based 32/64 bit operating system, with MS Office. (With Original CD) and LaserJet printer.
28	Quantification software System/Software	<p>The Vendor should quote IQ/OQ/PQ for the ICPMS system LIMS compatibility Software for batch analysis.</p> <p>Perpetual software updates should be provided free of charge as and when available.</p> <p>Windows-based latest version of software with perpetual license capable of controlling all aspects of Mass Spectrometer, having following features:</p> <p>software that guides users through the method and sequence development, and method templates for the rapid development of commonly used methods.</p> <p>On-line help with quick steps to reference the entire instrument user manual</p> <p>Software must have inbuilt methods available for routine samples to enable fast turnaround time after installation and commissioning.</p> <p>The software should also have facilities for exporting data to excel or equivalent spreadsheets for easy processing.</p> <p>Quantitative analysis including external calibration, internal calibrations, a method of standard additions, isotope ratios and isotope dilutions and semi-quantitative analysis should be possible.</p> <p>Calibration for multi-element external calibration, a method of standard additions, and isotope ratios.</p> <p>Reprocessing of stored data should be possible without re-running samples for changes in calibration points, internal standard points or curve fit mode.</p> <p>Editable auto-sampler rack and tube positions</p> <p>Fully automated instrument initialization (start-up) routine, including instrument stabilization time, plasma X/Y position adjustment, mass calibration, and quadrupole resolution</p> <p>Simultaneous real-time graphical display of signal as full mass scan, segments of the mass scan, and signal response vs time for multiple isotopes or ratios.</p> <p>Software should have Remote diagnostics and LAN connectivity.</p> <p>Up-gradation of software should be given free of cost as and when the new extension version are released by the manufacturer/vendor at no additional cost during the period of</p>

		warranty.
29	Uninterrupted Power Supply(UPS)	True online UPS of suitable capacity with power factor correction and harmonic distortion (< 5 % THD ;< 3% Single Harmonic), Three phase input and 440V for the smooth running of ICP-MS with tubular battery (Brand- Panasonic/ Exide /Ameron) with back up of 45 min. (Brand APC/Emerson/Numeric).
30	External Accessories	Exhaust system with flexible metallic bellows and required accessories, drain and waste drum.
31	Spares/ Consumables	The system should have low maintenance components. Vendors have to give a maintenance chart for all the components that require frequent maintenance and also include consumables needed for maintenance. Consumables for running 5000 samples should be included in the bid.
32	Training	Maintenance and application training for two persons at factory site must be provided for SAIF, IIT Bombay staff, free of cost. Additional onsite Application/Maintenance training should be provided after installation.
33	Compliance Certificate	A compliance certificate duly signed by the OEM/Bidder against all the specifications, with a Yes or No for each specification.

TERMS & CONDITIONS:

1	Model and year of introduction of the instrument & incoterms	Shall be mentioned in the tender along with original brochures /catalogue. Though the specifications given are of basic and general in nature. Bidder should quote price door to door delivery duty paid. IIT Bombay would provide the exemption certificates as applicable.
2	Place of installation	At SAIF IIT Bombay
3	Warranty	<ol style="list-style-type: none"> 1. 3 years comprehensive warranty from the date of completion of installation for the complete system including replacement of instruments and parts, spares, consumables, accessories and labour charges. 2. Complete set of spares and consumables as stand by shall be provided/made available along with the equipment or from time to time during the period of warranty. 3. The repair/servicing and periodic IPV (Instrument Performance Verification) of the equipment with traceable standards have to be carried out by the manufacturer/supplier free of cost during the entire warranty period or extended warranty period irrespective any number of repairs / services. 4. Definite time schedule for servicing of equipment, time required for attending break-downs, etc shall be indicated in the terms & conditions for warranty. 5. Shall provide good after sale service/technical support and should be capable of attending on short notice. At least 2 preventive maintenance visits and unlimited breakdown calls by the service/application support engineer is to be provided during the warranty period, every year. 6. The manufacture / supplier shall give a warranty certificate.

		7. Supply of spares and services should be guaranteed for 10 years from the date of installation.
4	After sales service	Shall provide for annual maintenance contract / after sales service contract after the warranty period.
5	Training of personnel	Basic/required training (not less than five days) and troubleshooting training to be imparted to the satisfaction of laboratory officials
6	Specification sheets	Detailed specification sheet(s) highlighting all the technical and other specifications must be attached.
7	Users List	Complete list of users in India for the equipment (inclusive of the quoted model) along with certificates/testimonials from the customers shall be enclosed.
8	Instrument Performance Verification (IPV) (IQ, OQ & PQ)	As per the specified standards applicable with documents
9	Installation Check out specification.	Shall be provided by the supplier.
10	Performance	Three/four samples will be given to vendor to check the performance of the equipment during the course of technical evaluation. Sample should be analyzed using the system model quoted by the vendor in this bidding process. Sample performance will be the part of technical evaluation and within stipulated time vendor should give the test result.