

Detailed Technical specifications of IRMS after Pre-bid meeting in BSIP

Because isotope ratio mass spectrometry relies on achieving the highest precision possible for quantification of smallest signals of the minor isotopes in nature, modern IRMS requires the high sensitivity, the highest mass stability and the best isotope ratio linearity over the widest possible dynamic range in isotope ratios and sample size.

Must run at 8-10-kV for ultimate in sensitivity and best linearity

- must have minimum of $10^{12}\Omega$ resistors available for m/z 44,45,46 and $10^{13}\Omega$ implementation on cups 47,48,49 for CO₂ and 32, 33, 34 for O₂
- Must have two Faraday cups for the simultaneous collection of the continuous-flow hydrogen and deuterium ions at masses 2 and 3
- must have proven capability to build a 10 collector array; documentation required
- must have proven capability to measure Xe, Kr, Ar etc (specify masses needed)
- must have capability of integrating an extra collector to continuously monitor baseline
- must provide 3-10 publications in refereed journals supporting all modes of operation and all types of measurements requested, including clumped isotopes, $\delta^{18}\text{O}$ from Silicate samples and D/H of H₂ from GC or TCEA manufacturer must support ability to provide these capabilities by supplying 3-10 paper from the references scientific literature

SPECIFICATIONS AND EXPECTATIONS FOR AN AUTOMATED ISOTOPE RATIO MASS SPECTROMETER SPECIFICATION SET

1. Basic Mass spectrometer must have

- a. Source at 8,000-10,000 Volts (8 to 10-kV) accelerating potential for all masses from 2-170 amu
- b. System should be installed with a dual inlet system. The precision for Dual Inlet Analysis for various isotopologues should be specified with supporting documentation.
- c. Collector system should allow the measurement of CO₂ including clumped isotopes or CO₂, but must also allow measurement of N₂, O₂, N₂O, S etc.
- d. Specifically for clumped isotopes
 - must have capability of integrating an extra collector to continuously monitor baseline
 - must have no demonstrable background from 44-49
 - Must have proven capability of very low signal to noise ratio
 - Must have publications in refereed journals
- e. Mass Resolution >200 and Mass Resolving Power MRP > 900
- f. Abundance Sensitivity: The contribution of the mass 44 intensity to the intensity mass 45 is << 2 ppm
- g. Source must be highly sensitive and highly linear. Specifications for sensitivity, linearity and stability must be given specifically for continuous flow mode, and demonstration of compliance to specification must be computer
 - i. Sensitivity (via dual inlet): 600 molecules CO₂ per mass 44 ion at the collector in dual inlet mode or better

- ii. Sensitivity in continuous flow mode: 900 molecules CO₂ per mass 44 ion at the collector
 - iii. Ion Source Linearity: 0.02%/nA ion current (mass 44) at a sensitivity corresponding to 900 molecules/ion in the Continuous Flow mode or better
- h. Sample Consumption: 0.03 nmol/s for 1.5 V signal (5 nA) at mass 44 in the Dual Inlet mode; 0.047 nmol/s for 1.5 V signal (5 nA) at mass 44 in the Continuous Flow mode
 - i. Measurement channels must have resistors that are optimized for the natural abundance of each isotope, it must be possible to exchange out existing resistors for higher ohmic resistors for smaller samplers, including 10¹² and 10¹³ ohms.
- i. Construction and design of ion source and vacuum system must be such that memory is eliminated. To this end, the following design features should be included:
 - i. The ion source must have built in internal radiant heating of wetted surfaces in order to keep the water background at the lowest possible levels. Internal radiant heating eliminates almost all need for bakeout procedures, which can decrease the life expectancy of the vacuum sealing system.
 - ii. Needle valve inlet for continuous flow inlet systems should be resistively heated, to eliminate surface water that builds up when inlets are disconnected.
 - iii. The source must be pumped with a 2 stage turbomolecular pump with the highest possible compression ratio for H₂ and He.
 - iv. The entire system construction should conform to ultrahigh vacuum (UH V) design criteria, with only electropolished stainless steel components; all gaskets to be made of metal, preferably gold; and all components heatable either by resistance heating or by irradiation.
 - v. Bakeout of the source housing should not affect the lifetime or the functionality of the gaskets on the source housing.
- 6) Expectation: Decay of 2 V signal of ¹³C enriched CO₂ to < 100 ppm in <2 seconds
- j. Source must be self aligning, so that it can only be inserted in one way; there must not be any requirement for fiducial marks and there should be no mechanical tolerance for insertion in other than the correct position with the correct alignment. Procedure for removal and reinstallation of ion source must be specified in detail for evaluation.
 - 1) The source should be plug in, mounted directly to a flange for ease of access and ease of replacing filaments, with two screws and no possibility to allow incorrect positioning during installation.
- k. Must have Viscous gas flow from the dual inlet system with variable volume bellows for sample and reference gas (3 - 40 mL) with microvolume including two exchangeable cold fingers. Gas from changeover valve must enter source at ground potential, without requirement for ceramic tubing, to ensure memory free transfer of gas into the ion source.
 - l. The gas inlet at the changeover valve must be heated, to prevent this critical spot from being a possible source of memory.
- m. Ion source must have externally controlled variable conductivity

2. ELECTRONICS

- a) A large dynamic range for the continuous now IRMS system is required:
 - i) Specification: Linear amplifier range of the IRMS must be from 0-50 Volt, i.e. 0 - 167 nA
- b) Requirement: It must be possible to vary the value of the high ohmic resistor on any amplifier from the software

- c) Requirement: Each amplifier should have the option of having two resistors, to allow analysis of enriched samples or to allow the channel to be used for measurement of species with different isotopic abundances
 - d) Amplifiers must be in sealed and evacuated housing which is actively pumped, in order to reduce dark noise from ambient alpha radiation.
 - e) It must be possible to control the settings of the ion source from the software
- 3. DATA SYSTEM** For control of mass spectrometer, data acquisition, and data reduction
- a) Software must be capable of fully automated peak centering in all modes of operation, including all CF modes, and it should not be required to reset tuning tables when switching applications. Software must display both beam voltages and updated delta value of sample in real time. It must be possible to make decision to quit or continue based on delta output on screen
 - b) Requirement: System must be delivered with a suite of diagnostic tools in the software for automated monitoring and diagnosis of system parameters, specifically those tests that are made during in the final test of an instrument, including
 - i. absolute sensitivity
 - ii. relative sensitivity
 - iii. linearity, abundance sensitivity
 - iv. peak top stability (=magnet stability)
 - v. peak side stability (=high voltage power supply stability)
 - vi. VH~ converter stability
 - c) Parameters such as stability and linearity must be monitored and determined automatically during acquisition of samples
 - d) Software must allow full access to all raw data and processed data, full access to ion correction algorithms and intermediate data, and full access to raw data integrity and sample identity.
 - i) Software must contain documented routines for corrections of measured delta values for ¹⁷O isotopomers of CO₂. These routines should be assembled into a single module and should be applicable to measurements made on all sample preparation devices and all inlet systems. These routines must include ability to choose between "Craig correction", Santrock and Hayes (1988) approach, or the Assimow and Brenninkmeijer (2003) approach.
 - ii) IRMS software must contain documented routines for automated collecting and correcting time-shifted isotopomer peaks, corresponding to isotopically substituted molecules in the sample.
 - e) Access to easy batch reprocessing, manual peak and background definition including print-outs and data export
 - f) Automatic data storage must be possible on any external storage device.
 - g) Data must be archived in a data base which allows searching of all analyses for e.g., all analyses of a specific reference material, all analyses that are to be billed to a specific account, or all analyses run by a specific operator.
 - h) Data must be fully customisable and allow multiple exports of evaluated data to Excel and to use LIMS databases.
 - i) Software must provide landscape printouts and data transfer based on the raw data files without any reduction of data sets.
 - j) The spare parts must include at least 5 source filaments and other components which may be subjected to wear and tear for at least 5 years.

4. Dual Bellow Inlet System

- a) Change between dual inlet and continuous now operations should be controlled by a single mouse click. The switchover between inlet systems should be totally automatic, and there should be no requirement for loading of new software.
- b) Symmetrical dual variable volume metal bellows connected to the changeover valve via a set of crimped capillaries.
- c) Inlet system must allow, as an option, an automated reference refill device to allow automated replenishing of reference volume during extended runs
- d) Must have viscous gas flow from the dual inlet system with variable volume bellows for sample and reference gas (3 - 40 mL) with microvolume including two exchangeable cold fingers. Gas from changeover valve must enter source at ground potential, without requirement for ceramic tubing, to ensure memory free transfer of gas into the ion source.
- e) The gas inlet at the changeover valve must be heated, to prevent this critical spot from being a possible source of memory.
- f) The compression ratios of the sample and standard bellows should be identical to ensure that leak rates are the same from sample and reference reservoirs.
- g) Inlet system valves must be manually controllable through computer software using a mouse interface.
- h) The dual inlet system shall include an optional multiple inlet port for automated analysis of pure gases (H₂, CO₂, N₂, O₂).

5. High Precision isotopic Analysis of Carbonates using DI System

- a) Specification:
Clumped Carbonate. $\delta^{13}\text{C}$ (‰) : ± 0.04 ; $\delta^{18}\text{O}$ (‰): ± 0.08 >20 $\mu\text{g CaCO}_3$.
- b) Must have linear response over range from sub-10 μg to more than 100 μg sample sizes.
 - i. The entire System must be thermostatically equilibrated to ensure that the errors due to temperature variations are nullified.
 - ii. Acid dosing valve should be of leak free design.

6. After Sales Support

- a) Atleast 3 (Three) Years manufacturer's guarantee on all supplied items including electronic parts.
- b) Vendor must have local isotope service organization in India, for which documentation is required, including full disclosure of names, locations, training, and years of experience.
- c) Availability of telephone support, including telephone numbers and email addresses, must be detailed. Information must allow contact to be made during bid evaluation, in order to evaluate the length or time and quality of response to technical personal or institute.

7. Terms and conditions

- a) Local service and consumable support at least for 5 years beyond the guarantee/warranty period
- b) Service support on call basis .
- c) Must have adequate number of similar installation in India (support with comprehensive list of users in India)
- d) May be called for Negotiations on short notice

Corrigendum for Technical specifications of ICP-OES after Pre-bid meeting in BSIP

A benchtop state-of-the-art Simultaneous - Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) for analysis of major, minor and trace elements in geological and environmental samples.

1. Vertical/horizontal plasma with dual view (axial and radial) or better capability. Plasma optimization should be through software interface with programmable power, start and shutdown of plasma.
2. The system should be with state-of-the-art solid state RF generator with 40/27 MHz frequency with stability better than 0.1%. Power output range should be 750-1500 Watts or better with increments of 10 Watts or better. Solid state RF generator with warm up time of 20 minutes or lower. The power output should be controlled through software. RF coil cooling unit may be inbuilt or external unit.
3. Spectrometer should cover full spectral range from 167-767 nm or wider to cover measurement of all elements. Instrument should be based on high dispersion Echelle based/ Paschen Runge optics based polychromator system, and spectral resolution of 0.008 nm at 200nm or better.
4. Built-in solid-state detector based on CCD/CID/CMOS technology covering entire wavelength range (167-767 nm or wider). Nature of detector purging gas and rate of gas consumption should be clearly mentioned. If Plasma tail management is required, the technology used must be clearly mentioned. The instrument must perform as a true simultaneous measurement technique with an advanced polychromator optical system. Must determine all elements simultaneously in a single run.
5. Plasma, Auxiliary and nebulizer gas flow should be variable with computer-controlled Mass Flow Controller / Volume Flow Controller. Gas consumption (including Plasma, auxiliary, nebulizer and purging) in terms of litre/minute per sample should be separately given. Plasma torch unit (torch, spray-chamber, nebulizer, etc.) must be easily detachable and mountable with the main instrument without the need for realignment. The accessories should include HF resistant assembly.
6. Compact auto-sampler which can accommodate more than 50 samples for automatic uninterrupted sample introduction.
7. Demonstrated in-run precision for a suit of elements should be less than 1.5% at ppm and ppb level in 3 hour long run. ICP should also demonstrate precision less than 3% RSD for all elements in high matrix/TDS conditions (20 % NaCl) in a 3 hour long run.
8. Instrument should be supplied along with computer with standard up-to-date windows-based software for the system control, operation, data acquisition and data reprocessing. It should have wavelength automatic selection, automatic generation of coexistent element information, Qualitative analysis, Quantitative analysis, can store data for entire wavelength range. All results and spectra during the run should be stored and retrievable for reprocessing

and reporting. Copy of the software should be provided separately for installation, if computer need to be changed in future. Wavelength library containing 25000 lines or more to be provided to cover the entire wavelength range. Software must be 21CFR part 11 compliant.

9. Installation, demonstration, and training for user on routine sample analysis should be done at BSIP. Precision of the measurements in ppb and ppm range should be within 2% which needs to be demonstrated during the installation of the equipment.

10. PC and laser printer should be included. (PC: i5 processor or better, HDD-2TB or more, RAM-8GB or better, 22-inch LED TFT monitor, or better, 64 bit).

11. Exhaust system, argon gas purification unit, air compressor, external chiller unit, and gas line (if any for operation) should be supplied and installed along with the instrument.

12. Quote should include UPS power back-up (for 30 minutes) supply and installation.

13. It should include additional set of essential spares (torch assembly, maintenance kit for demountable torch assembly, nebulizer, spray chamber, HF Sample introduction Kit, moisture trap, capillary tubes). Regulator and Argon gas cylinders (for 3 cylinders) should be supplied and installed.

14. Three years comprehensive warranty from the date of successful installation of the instrument in the institute. Machine downtime or delay in maintenance support (more than 15 days) during the warranty period should be accounted for extending the warranty period. Detailed AMC and CMC conditions should be furnished for consecutive five years after the warranty period. All spares/accessories required should carry part numbers from OEM with detailed scope. Declaration of availability of spares at least for ten years for the smooth running of the equipment from the date of installation must be submitted.

15. Single element Standards (with a shelf life of minimum two years from the date of supply) of 1000ppm in 100mL for at least 25 elements must be included. If an air compressor is used for operation of instrument, air compressor unit cost must be included. If nitrogen gas is needed for operation of the instrument, the bid must include (optional) high purity nitrogen gas generator. Operation and Service Manuals (both soft and hard copies) must be provided.

Corrigendum for Technical specifications of Fusion Bead Machine after Pre-bid meeting in BSIP

(A) Productivity:

3 samples at a time for sample throughput of minimum 10-12 fusions glass disks per hour or 24 borate solutions/hour

(B) Heating requirement:

1. Electrical / Gas heating.
2. Heating elements supporting up to 1200⁰ C for a great resistance.
3. Heating chamber temperature 1200⁰ C or more
4. There should be provision to monitor Temperature chamber stability.
5. In case of Gas based technology the burners should be auto calibrated so as to produce uniform heating for reproducible results
6. No Oxygen or Compressed Air should be required.
7. There should be a provision to monitor and display temperature inside the heating chamber.
8. The bead machine should not need any external cooling device like chiller.
9. For Gas based it should be spark ignition system for safe, reliable ignition.

(C) Electrical requirement:

1. Voltage: Should operate at standard Indian Voltage conditions 230-240V
2. Frequency: 50-60 Hz
3. External power supply

(D) Programmable Fusion Parameters: there should be provision to program following parameters to insure stable and reproducible glass disks.

1. Temperature
2. Time
3. Rate of heating
4. Crucible rocking speed
5. Cooling air flow
6. Possibility of agitation, rotation while inclined is a must for homogenous mixing of flux.

(E) Security features: The offered system must be equipped with following security features:

1. Integrated safety door
2. Emergency stop button
3. Can operate supervision free
4. Fully automated
5. The instrument should comply with International safety norms as per CE standard.

(F) Software and operation with following features: -

1. One touch operation
2. Touch screen
3. Windows based system
4. Should contains present programs
5. Possibility to create new fusion programs and modifies the present programs
6. Programmable pre-heat mode

7. Should be possible to connect to external PC
- (G) Three set of Pt Crucible and Casting Mould/Casting Dish should be provided. The Crucible should be of 95% Pt and 5% Au with a weight of minimum 30gms and volume of minimum 25ml. A Platinum-Gold Mould/Casting Dish of 40 mm diameter to match collimator mask of XRF with minimum weight of 35 gm should be offered.
- (H) Flux for Fusion Bead Preparation: Following Pre fused anhydrous beads with 99.99% purity, granulometry 100%, <50 micron sized beads, No dust, with water content <0.05% with Certificate of Analysis must be offered of premium make like Merck or equivalent. Quantity 10kG with wetting agent. The flux type should be suitable for fusion of rocks, sediments, ores and various earth science materials. Suitable additives such as Lithium Iodide e.t.c should be provided along with flux(2Kg).
- (I) 10 kg High-purity (99.98+%) pre-fused flux to prepare samples for XRF or ICP analysis. Composition : 100 % Lithium tetraborate. Properties: spherical vitreous beads, anhydrous and nonhygroscopic, homogeneous particles, no dust, controlled granulometry, high fluidity.
- (J) 10 kg High-purity (99.98+%) pre-fused flux to prepare samples for XRF or ICP analysis. Composition : 66.67% % Lithium Tetraborate, 32.83% Lithium Metaborate and 0.5% Lithium Bromide.. Properties: spherical vitreous beads, anhydrous and non-hygroscopic, homogeneous particles, no dust, controlled granulometry, high fluidity.
- (K) Hardware to use for ICP and AAS sample preparation inclusive of magnetic stirrer, beakers, Zirconium and Nickel crucibles sets with 6 lid sets, etc. should be included
- (L) Apart from above, please also quote one set of Platinum ware and flux for bead making in options with consumables etc.
- (M) Set of consumables and spares kit.
- (N) 15 KVA online UPS for proper functioning of bead machine
- (O) Warranty: 2 year warranty with optional 1 year extended warranty
- (P) Installation and training: Installation and training to be provided free of cost at site by application engineer or dedicated specialist
- (Q) A set of synthetic standards that will handle fused bead major element analysis of many of the elements required by the mining and mineral industries. Twenty multi- element synthetic standards to be delivered as powders. These synthetic standards should be able to cover a wide range of oxides and to be used for calibration and to verify inhouse standards for press powders pellets.

(R) Set of CRMs with full traceability of following elements as per the following range should be provided. All CRM's (minimum 5 gm each) should be used to make fused bead locally to be supplied.

Sl. No.	Elements	Range (%)
1.	Fe ₂ O ₃	5 – 82
2.	SiO ₂	0.2 – 80
3.	CaO	0.01 - 80
4.	MnO ₂	0.02 – 75
5.	Al ₂ O ₃	0.1 – 75
6.	TiO ₂	0.01 - 40
7.	MgO	0.02 – 70
8.	P ₂ O ₅	0.005 – 35
9.	SO ₃	0.005 – 50
10.	Cr ₂ O ₃	0.1 – 10
11.	NiO	0.01 - 10
12.	ZnO	0.01 - 10
13.	BaO	0.01 - 40
14.	V ₂ O ₅	0.01 – 10
15.	Na ₂ O	0.01 -55
16.	K ₂ O	0.01 -40
17.	CuO	0.01-8
18.	SrO	0.01-20
19.	ZrO ₂	.01-40
20.	PbO	0.01-10

Relative accuracy of above mentioned elements of concentration from .01 to 1 % should be \pm 5%, 1% to 10 % should be \pm 2% and above 10 % to 80% the relative accuracy should \pm 1%, and 80% and above relative accuracy should be 0.5%.

**Corrigendum for Technical specifications of FTIR spectrometer with Microscope after
Pre-bid meeting in BSIP**

FTIR specification

Wavelength Range	: 4000–600 cm ⁻¹ with moisture resistant long durable ZnSe Optics (with ZnSe beamsplitter).
Wavenumber Accuracy	: 1.5 cm ⁻¹ or better
Wavenumber reproducibility	: 0.005 cm ⁻¹ or better
Spectral Resolution :	< 2cm ⁻¹
Peak to peak noise	: 30,000: 1 or better
apodization. Source	: Mid IR source, user friendly with 5 years free replacement warranty
Reference Laser	: Solid state laser with 10 years warranty.
Interferometer	: permanently aligned with minimum 10 years warranty
Detector	: Linear DLaTGS/ DTGS Detector
Optics	: Completely sealed and desiccated optics with life indicator
Software	: Suitable software for Spectral collection, Quantitative analysis, baseline correction, smoothing, derivitization, spectral deconvolution, library search etc. Windows 10 operated
Accessories	: 1) Hydraulic press kit with 13 pellet holder and die. Kit should also accompany with Agate, Mortar and Spectroscopy quality KBr powder. 2) Diamond ATR accessory should be quoted for analysis of corrosive and reactive solids, liquids, resins, powders, gels etc Libraries of 10,000 compounds including pharma, polymer etc. 3) Suitable branded computer and printer.
Installation and Familiarization	: At lab by dedicated engineers

Microscope Specification

Spectral Range	: 600 – 4000 cm-1
Modes of operation	: Reflection, ATR, and transmission
Micro ATR	: Clip on diamond ATR to cover entire spectral during microscopy
Field of View	: 1900um using visible camera, with resolution 5 mega pixel.
Sampling Accessories	: Diamond Compression cell and sample preparation kit including coated mirrors, needles, forceps, roller knife, gold coated mirrors and ir reflection mirrors (Kevley, 25 numbers)
Microscope stage	: 1x 3 inch travel XY stage with coarse/fine focus and condenser focus.
Software	: Windows 10 operated software for For both visualization and collection of Visible image and IR spectrum.
Minimum working distance	: 1/3” , with coarse/fine Z stage alignment. IR image masks :Variable from 60 micron to 2000 micron
Warranty	: 3 years +2 years optional extended warranty
UPS	: 15Kva online UPS to be provided along with instrument.