Teledyne Leeman Labs

Prodigy Plus
High Dispersion Inductively Coupled Plasma Optical Emission Spectrometer

Bid Specifications

REV01112016

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Overview

This laboratory requires a fully automated high resolution simultaneous ICP-OES for trace element determinations in aqueous or organic materials.

General Instrument Specifications

The ICP-OES must include: an atmospheric pressure Ar ICP, a high-resolution simultaneous optical spectrometer and a state-of-the-art CMOS based array detection system. A computer and appropriate software must be provided for instrument control as well as, data acquisition, reduction, presentation, and storage. All proposals must include the ICP-OES, a data system (including printer) and any ancillary equipment needed to operate the ICP (e.g. circulators, chillers, air compressors, etc.).

The instrument must be capable of performing fully automated, unattended multi-element analysis with high precision and accuracy. By "fully automated" it is meant that the system supplied provide automation of all instrumental parameters. This must include: all gas flows, plasma power, autosampler control and automated shutdown.

New Equipment

The ICP-OES proposed must be a full production unit not a prototype, demonstration, used, or preproduction model.

Detailed Specifications

The ICP-OES system shall consist of, but not be limited to, the major functional units listed below. All associated electronic circuitry, software and hardware shall be interfaced to provide an integrated system for elemental analysis.

The vendor shall address each specification listed below, clearly stating whether or not the specification is met. Full supporting documentation is required where requested. Published literature values and/or citations, published specification sheets, instrument data output, and/or software screen displays may be used for these purposes.

I. Sample Introduction System.

a. Peristaltic pump - The sample introduction system shall include a built-in, computer-controlled, variable-speed peristaltic pump with 12 counter rotating rollers for pulse dampening and extended pump tubing lifetime. A minimum of 4 channels should be provided such that: sample may be pumped to the nebulizer, the spray chamber drain may be pumped, an internal standard may be added and automated sample dilution may be performed. The pump control system should incorporate an automated accelerated rinse feature and a standby mode to periodically rotate the peristaltic pump during periods when the instrument is not in operation (e.g. following an automatic shutdown at the end of a sample run).

b. Nebulizer - A concentric or grid nebulizer should be provided for high precision aerosol generation. Nebulizers for high solids, organic and HF samples must be available.

c. Spray Chamber - A low dead volume cyclonic spray chamber should be provided. Spray chambers for high solids, organic and HF samples must be available.

d. Ar Gas Flow Controls – All gas flows (coolant, aux, neb, purge, etc.) should be automated and should allow the user exceptional flexibility of gas flow control.

II. Inductively Coupled Plasma Source

a. ICP Torch – The plasma torch must be of a demountable design with various diameter injector bores available, capable of low flow operation. The quartz tubes for the coolant and auxiliary flow should be a single piece.
b. Frequency - The RF generator shall have an operating frequency of 40.68 MHz for improved sample penetration and reduced background.
c. Power - Output power should be user adjustable from 600 to 2000 Watts to provide maximum applications flexibility. The change interval shall be 10 W or less.
d. Automation - To facilitate operation by the novice operator, all aspects of the ICP source must be computer-controlled and automated. This must include at the minimum, gas flows, plasma power and plasma viewing position.
e. Safety - During normal operation, the instrument design must allow for unimpeded, yet safe viewing of the plasma such that the operator is never exposed to RF or UV emission.
    1. The ICP must be fully interlocked including gas flows, and interior access doors.
    2. The ICP system must be compliant with FCC regulations regarding RF emissions.

III. Plasma Viewing

a. Plasma Viewing Optics – It is preferred that the plasma viewing optics be composed of reflective components to eliminate chromatic aberrations (associated with refractive optics) and provide the optimum signal to background for all elements.
b. Dual Viewing Capability – The instrument proposed must be available in a dual view configuration for maximum analytical versatility. The instrument must allow the user to automatically optimize the plasma viewing position in each mode (i.e. axial or radial). Plasma viewing mode must be user selectable on wavelength-by-wavelength basis.
c. Automated Optimization of Plasma Viewing Position – The plasma viewing optics should allow the user to automatically scan the image of the ICP across the input slit to optimize the plasma viewing position. The user should be able to do this while optimizing on either signal-to-background or signal-to-noise for any wavelength between 165 and 1100nm. This must yield the highest S/B or S/N for each viewing mode.
d. In Laboratory Viewing Mode Upgrades – Preference will be given to systems that can be converted from dual view to radial-only should future analytical requirements necessitate such an upgrade (e.g. applications involving dedicated high dissolved solids analysis).

IV. Optical Spectrometer

a. Resolution – The optical spectrometer of the proposed instrument must provide a spectral resolution of 0.008nm at 200nm. Please specify the spectral resolution of the proposed system. Note, for array detector based system, please do not quote pixel resolution; quote only true spectral resolution (full width at half peak maximum is acceptable).
b. Wavelength Range – The wavelength range of the proposed system must include all wavelengths between 165 to 1100nm. There should be no gaps or holes in the spectrum in this wavelength range.

c. Spectral Image Quality – In order to maintain the best possible spectral resolution, the image quality of the spectrometer (i.e. focus of the image at the focal plane) should not degrade by more 20% anywhere in the spectrum. Please submit spectral scans for several wavelengths across the spectral region between 165 to 1100nm. For Echelle-based systems, please ensure that the extremities of the free spectral range are included (i.e. top and bottom of the spectrum, high and low wavelength extremes for several orders).

d. Focal Length – Because spectral image quality and scattered light intensity are a function of the focal length of the spectrometer, preference will be given to systems with a focal length in excess of 0.40 meters. Please state the focal length of the proposed system.

e. Thermostatic Control - Optical system should be temperature controlled to enhance stability. It is preferred that it be heated to a temperature that will consistently exceed the lab temperature (e.g. 35^{o}C). Cooling of the entire optical system is discouraged due to concerns about condensation.

f. Internal Wavelength Reference – The system proposed must have an internal emission source independent of the ICP (e.g. a Hg lamp, etc.) such that spectrometer validation can be performed.

g. Outgassing and UV Transmission - There should be no electronic components (or other materials known to outgas) within the optical spectrometer such that outgassing cannot interfere with light transmission or purge gas flow rates.

V. Detection System

a. Array Detection System – A state-of-the-art array CMOS detection system is required. The detector should be purposely designed for use with ICP-OES.

b. Detector Size – The solid-state device used should be as large as possible to accommodate the need for high dispersion and high spectral resolution. The entire spectrum of the optical spectrometer (from 165 to 1100nm) must fit on the detector in a single exposure with no holes or gaps in the spectrum. Please describe the detector in the proposed instrument.

c. Number of pixels - To better define analytical peaks and background correction positions, the detector should have a minimum of 3 million pixels.

d. Non-Destructive Readout (NDRO) – The detector must be capable of non -destructive readout using all pixels in the analytical subarray.

e. Contiguous Pixel Structure - The detection system proposed should have a contiguous pixel structure for wavelength selection flexibility, superior measurement precision, spectral diagnostic capability.

f. Simultaneous Background Correction and Internal Standardization – All wavelengths in an analytical method must receive identical integration times, regardless of the element's concentration. As such, the detection system proposed must be capable of simultaneous background correction and simultaneous internal standard measurement. By this, it is intended that the instrument acquire the on-peak analyte signals at the exact same time as it acquires background and internal standard signals. Further, this simultaneous measurement approach should hold true for the entire duration of the integration time used.

g. Data acquisition modes – The proposed detection system should be capable of:

    1. Simultaneous capture (i.e. digital "photograph") of the full spectrum in a single exposure. The instrument must have appropriate data handling/data display software to allow display and/or interrogation of the resulting spectrum. Spectral subtraction/addition capability is favorable. The resulting spectral information should be available for qualitative analysis of the elemental content of unknown samples.

2. Quantitative multielement analysis as is typically performed in ICP-OES.

IV. Analytical Performance

The vendor shall demonstrate the following specifications under a single set of operating conditions (without the need for re-optimization). Please use multi-element solutions in 1% HNO_3.

a. Resolution – demonstrate a spectral resolution of 0.008nm or better by providing a scan (and the raw pixel intensities) associated with the thallium doublet at 190nm. Note, the instrument must produce the equivalent (or superior) resolution during routine multielement analysis.
b. Spectral Image Quality – In order to maintain the best possible spectral resolution, the image quality of the spectrometer (i.e. focus of the image at the focal plane) should not degrade by more 20% anywhere in the spectrum. Please submit spectral scans (and raw pixel data) for several wavelengths across the spectral region between 165 to 1100nm. For Echelle-based systems, please ensure that the extremities of the free spectral range are included (i.e. top and bottom of the spectrum, high and low wavelength extremes for several orders).
c. Wavelength Range – demonstrate that the system proposed provides continuous coverage of the wavelength range from 165 to 1100nm by providing a full spectral display that includes Al at 167nm, Ba at 455nm and K at 777nm.
d. Stability.

    i. Short term stability - shall be demonstrated using a multi-element solution of 10 ppm to be better than 1% RSD without internal standardization over a 10 minute period.
    ii. Long term stability - shall be demonstrated using a multi-element solution of 10 ppm to be better than 2% RSD without internal standardization over a 8 hour period.
    iii. Wavelength Stability – overlay scans at approximately 30 minute intervals from the above long-term stability test as an indication of the wavelength stability of the system. Please do this for 3 elements of widely varying wavelength (e.g. As 189, Ba 455, K 777).

VII. Operating Software

a. System Security:
    1. The operating software should employ the Windows™ 7 security features to protect acquired data.
    2. Login and logout capability should be built into the operating software to ensure only qualified operators use the system and that their actions on the system are traceable.
    3. Software should provide multiple permission levels which the system administrator may assign to individuals based on their qualifications.

b. Calibration:
    1. The operating software should provide linear and non-linear calibration algorithms.
    2. The software must provide weighting to increase the significance of low concentration standards.
    3. Calibrations must be displayed graphically with all standards readings provided in tabular form. In this way possible outliers can be identified and excluded from the displayed calibration fit without needing to re-run standards.

4. Entry of user-defined acceptance criteria or calibration correlation at the start of an automated sequence is required so that time and samples are not lost when the calibration fit is unacceptable.

c. Quality Control:
   1. The software must provide for quality controls including check standards, recovery checks, and duplicates.
   2. In automated operation when the quality controls are run may be pre-defined based on frequency or absolute location. In this way, repetitive checks can be programmed quickly while one-time checks may be located at the operator’s discretion.

d. Data Integrity:
   1. All readings must be stored to the system database automatically and removal of records cannot be permitted.
   2. An audit trail must provide a permanent history of active operators and instrument conditions, available for review upon request. In this way, calculated results can be fully reconstructed from the instrument raw data as required by 21 CFR 11 and CHROMERR regulations.
   3. The calculations for each instrument reading of average intensity, background correction, internal standardization, conversion to concentration, and inclusion of applied correction factors must be displayed upon request. In this way software validation of automatic calculations may be verified.

VIII. Laboratory Constraints

a. Due to laboratory space limitations, a bench top system is necessary.
b. Instrument input power requirements must be single phase 195-245 V, 30 amp, and/or accessory 115 volt 15 amp supplies

IX. Accessories.

The vendor shall provide the following accessories as option for purchase immediately or at a future date: Autosampler, Organic Sample Introduction System, HF Resistant Sample Introduction and Hydride Generation System.

X. Consumables.

The vendor shall supply a complete set of glassware and pump tubing for immediate operation. The vendor shall also supply pricing information for consumables packages consisting of, but not limited to, a spare ICP torch, spray chamber, nebulizer, o-rings, gaskets, etc.

XI. Warranty and Installation.

The vendor shall provide at least one-year parts and labor warranty.

XII. Training.

a. During the instrument installation and acceptance process, the vendor shall provide one day of on-site training. Training will include routine maintenance, ICP-OES setup and optimization, hardware and software operation.

XIII. Service.

Vendor shall provide extended service contract information including: details of service contract available, target response times, and pricing. A factory certified service engineer thoroughly trained in ICP-OES technology shall provide service.

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