EXPANDING
LABORATORY
PRODUCTIVITY
AND CAPABILITIES

FIAS

Flow Injection for Atomic Spectroscopy

Instrumental Technique

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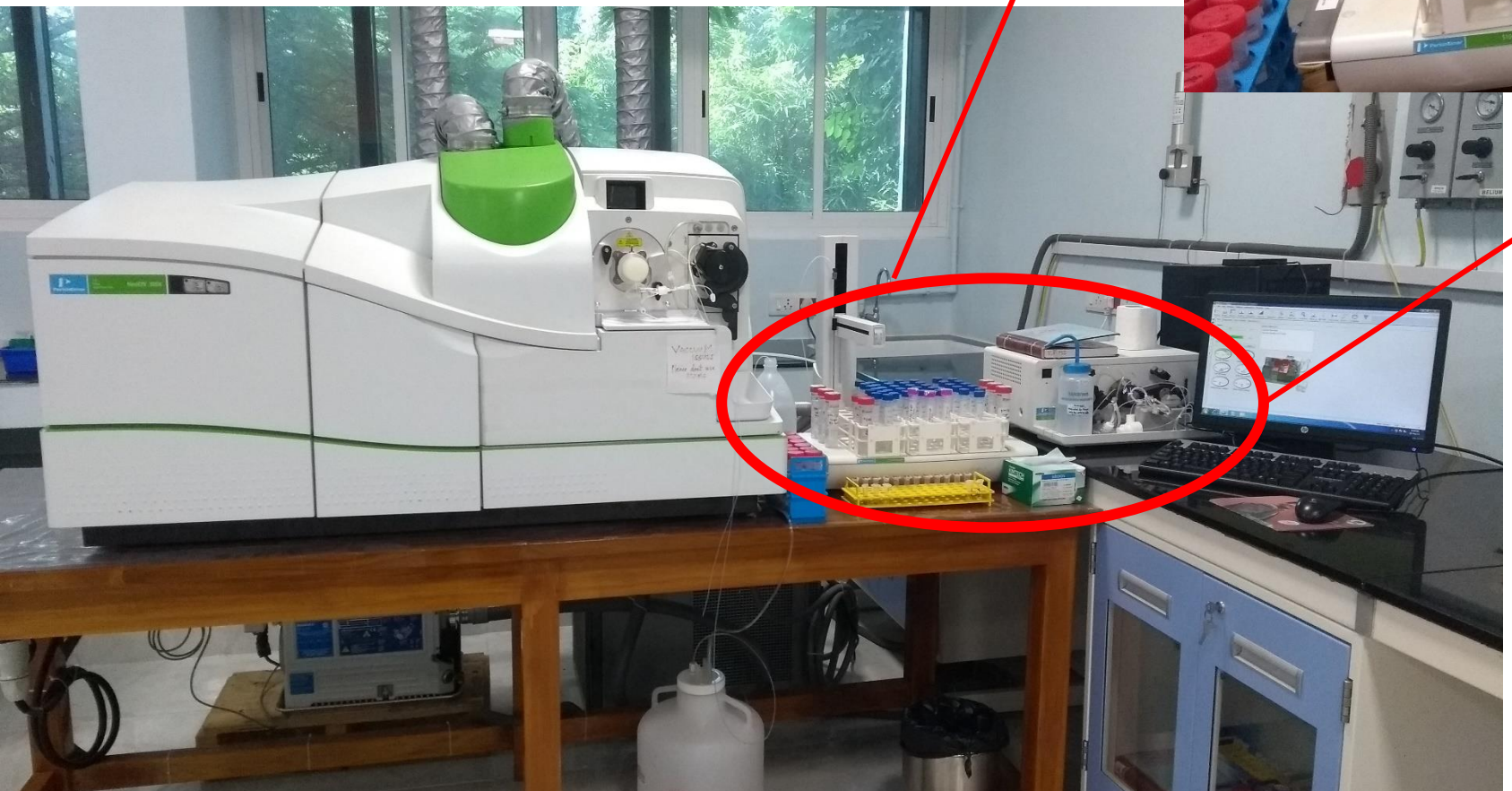
Inductively Coupled Plasma Mass Spectrometry (ICP-MS)



- S10 Autosampler
- Flow Injection System FIAS 400

Introduction Flow Injection System

- Flow injection analysis (FIA) is that type of continuous flow analysis that utilizes an analytical stream, unsegmented by air bubbles, into which highly reproducible volumes of sample are injected.
- Application of this principle to automatic analysis yields a fast, precise, accurate and extremely versatile system that is simple to operate.
- Unlike ambient standalone MS methods, FI-MS is specifically designed for the analysis of liquids, including raw or processed sample extracts.

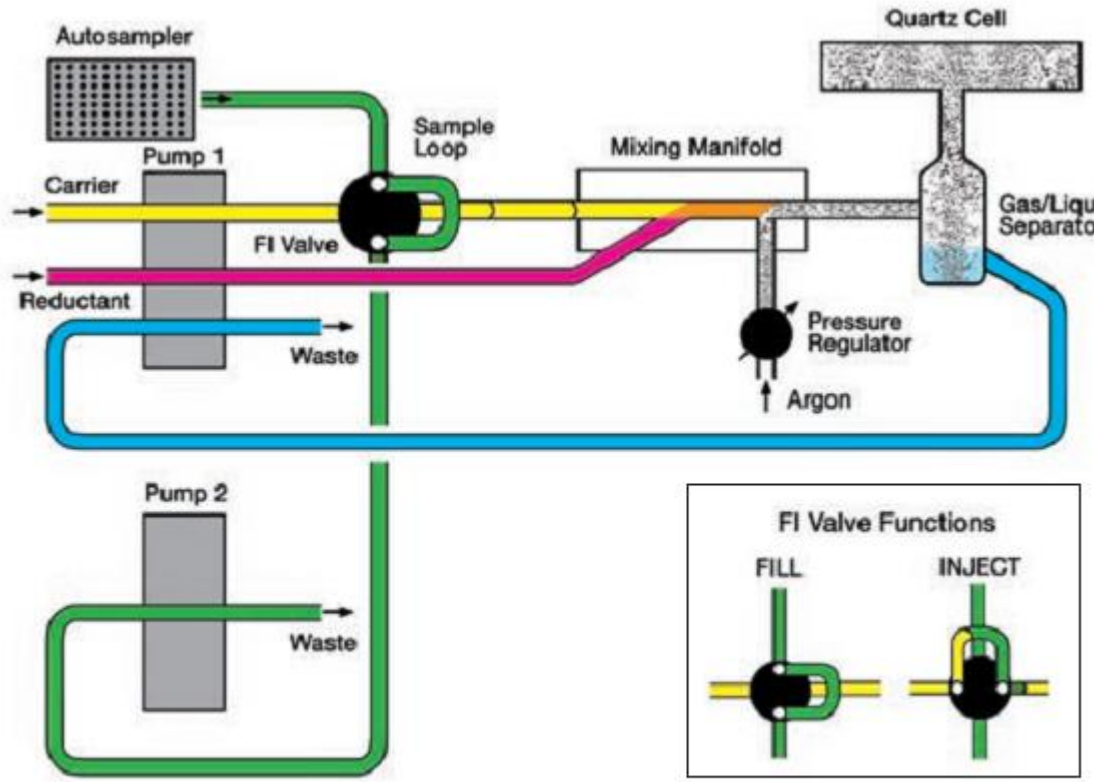


Figure 1. Schematic diagram of FIAS 400 system for automated hydride generation.

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HISTORY

- The concept of flow injection analysis received earliest attention from the electrochemists.
  - Nagy, Feher, and Pungor published their first of papers describing injection of a sample into a flowing stream of electrolyte in 1970. Their system involved passage of the sample carrier stream through a magnetically stirred mixing chamber followed by flow past a silicone-rubber-based graphite electrode. The resulting analytical readout was in the form of transient peaks.

- Subsequently, scientists from US and Denmark simultaneously modified the technique.
  - Their primary innovation was the use of flow-induced sample dispersion as the sample carrier stream was pumped through narrow bore tubing. This mechanism was used to effect controlled mixing of the sample with the stream as opposed to the gross mixing generated in the mechanically stirred chamber, thereby avoiding excessive sample dilution.
  - The Danish group developed the method using primarily instrumentation normally associated with segmented flow analyzers (SFA).

In the past, the presence of the air bubble in the analytical stream of a continuous flow system has been deemed necessary to effect three primary functions: (1) to limit sample dispersion; (2) to promote mixing of the sample with reagents by generating turbulent flow; and (3) to scrub the walls of the analytical conduits.
Further study has shown that, not only are all of these functions possible in the unsegmented stream, but also that the absence of the air bubble actually expands the capabilities of the analytical system.

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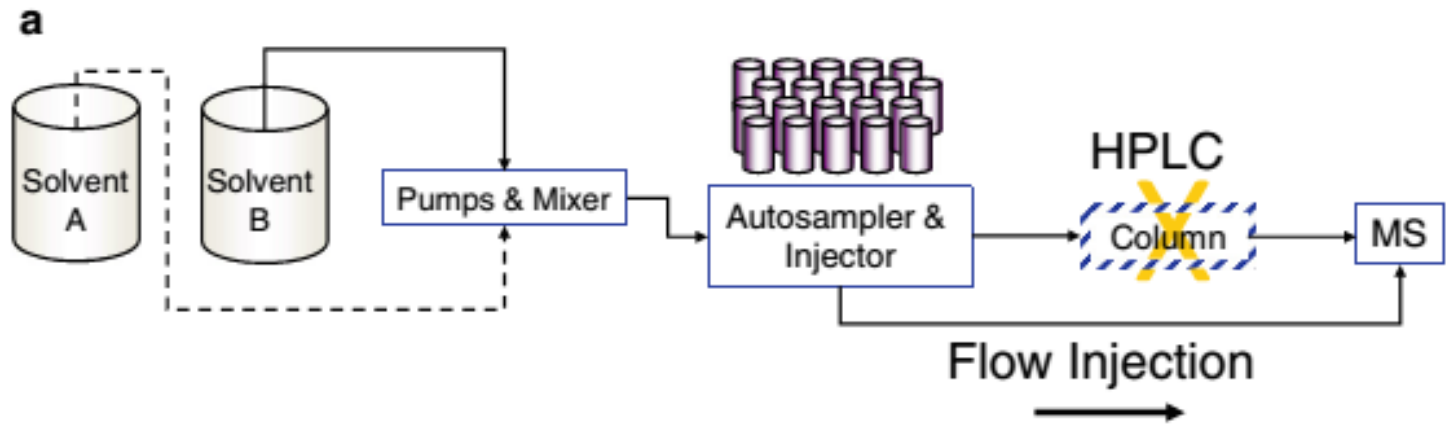

The primary features of the unsegmented stream

are:

- controllable sample dispersion;
- variable flow rates;
- baseline resolution between each sample;
- high sample throughput; and
- absence of any stabilization time.

- relatively inefficient ion sampling/transfer in ambient MS, while still achieving overall limits of detection.
- On the other hand, improvements in MS selectivity have allowed the avoidance of chromatography, while maintaining the practicality of instrumental analysis methods.

PRINCIPLE

2 main factors to monitor the precision of timing throughout the system:

❖ Injection port

The operation of the injection valve must be regulated to ensure injection of precise sample volumes.

❖ pumping mechanism

The residence time of the sample in the analytical conduits should ideally be identical for each sample, and the conditions to which the sample is exposed during processing should also be the same. Thus, the pump must be designed to generate reproducible flow rates to ensure precise sample residence times in the analytical manifold.

- The actual flow conditions obtained in FIA have been the subject of much investigation. While it was originally thought that turbulent flow is present, it was subsequently determined that FIA operates only in laminar flow regions.

- In reality, the flow conditions under which most FIA systems operate generate dispersion through both diffusion and convection.
- There is a critical set of flow conditions beyond which volume dispersion ceases to increase.
- It is radial rather than axial dispersion that contributes most significantly to sample dispersion in FIA systems.
- This type of dispersion, also called secondary flow, operates to move the fluid both toward and away from the tubing walls and thus serves as an efficient scrubbing mechanism.

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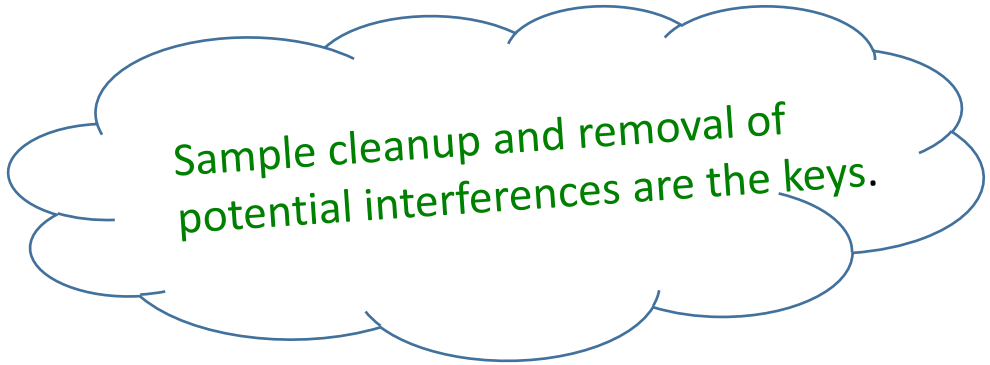
ADVANTAGES

- ✓ Higher tolerance for complex sample matrices
- ✓ Faster washout of high-concentration analytes
- ✓ Lower sample consumption
- ✓ Analyte preconcentration
- ✓ Closed system reduces contamination



LIMITATIONS

x. Very complex and dirty samples can be analyzed by diverting undesired portions of the HPLC effluent to waste and sending only chromatographic regions of interest to the mass spectrometer.

x. On the other hand, in FIA-MS, the entire sample injection band enters the mass spectrometer's atmospheric interface soon after the instrumental analysis run is started. This can lead to severe analyte signal suppression and the need of frequent cleaning of the ion source.

Thanks.

FIAS 100/400 Systems—Specifications

System Description	Automated flow injection system for use with Flame AA, cold-vapor and hydride-generation AA, graphite furnace AA, ICP-OES and ICP-MS systems. The FIAS 100 system is provided with 1 pump and the FIAS 400 systems are provided with 2 pumps.
System Control	Fully automated operation with computer-controlled spectrometer systems through control windows integrated into PerkinElmer instrument-control software.
Transport of Reagents	Stepper-motor driven peristaltic pump(s) with a maximum of 8 channels each for tubing with 0.13 to 3.18 mm inner diameter. Pump speed is selectable from 20 to 120 rpm.
Sampling and Flow Switching	FI switching valve with 5 ports and exchangeable sample loops. An optional 8-port valve is available for the FIAS 400MS system. All systems have exchangeable sample loops of various volumes.
Gas Supply	Carrier gas stream (argon) flow controlled from 40 to 250 mL/min by flow meter. Required inlet pressure: 320-400 kPa. Automatic switch-off after operating pauses of more than 10 min.