Technical Overview

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Increasing Productivity and Reducing Costs With Fast Sequential Mode for Atomic Absorption Spectroscopy

Many labs have applications well suited to flame atomic absorption spectroscopy (FAAS), but are experiencing an increase in both sample loads and the number of elements to be determined. The Fast Sequential (FS) mode of Agilent's AA spectrometers offers high sample throughput and reduced cost of analysis, without the requirement of add-on accessories for the instrument. Fast Sequential mode offers:

- Increased productivity, compared to conventional FAAS, allowing more samples to be measured per hour e.g. 10 elements can be measured in a sample in under 2 minutes, consuming less than 10 mL of sample
- Reduced gas consumption, resulting in lower running costs
- Low sample volume consumption during analysis, resulting in less sample waste and reduced reagent and disposal costs
- Easy setup and fast method development

How Fast Sequential mode works

In conventional FAAS, a single element is determined each time a sample is aspirated. This means each sample must be aspirated multiple times to measure a range of elements. Typically, AA instruments have up to 8 lamp positions, some of which may be fitted with multi-elements lamps, so they can analyze a large number of elements. Even with a small number of samples, this is a process that consumes a lot of time and sample volume.

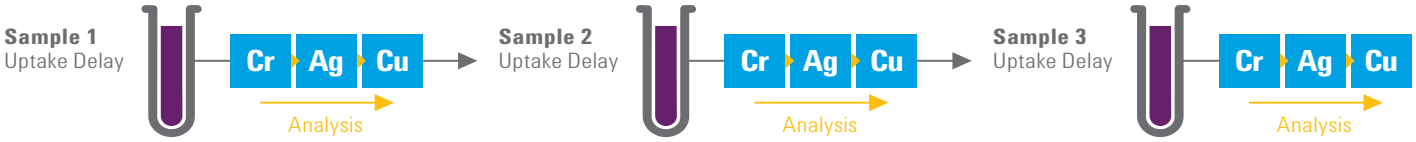
There are various strategies to speed up the analysis, such as the use of switching valve accessories to provide moderate speed improvements. However, these accessories come at extra expense, require extra consumables, and can be complicated to setup and operate. Unfortunately, they also still require each sample to be analyzed multiple times to determine all elements.

Fast Sequential mode is the default mode of operation for Agilent's 240FS and 280FS instruments, which can also be operated in conventional mode. Fast Sequential mode uses the high speed monochromator drive of the instruments to rapidly change between wavelengths for each element. To minimize warm-up delays, the Hollow Cathode Lamps are all turned on during analysis, and a high speed mirror drive quickly changes between the lamps, as required. The programmable gas control system instantaneously changes gas flows so each element can be analyzed under the optimal conditions.

The fundamental difference with Fast Sequential mode is that multiple elements are determined in a single aspiration of a sample. This greatly increases productivity, reduces running costs and minimizes the volume of sample consumed (which in turn reduces reagent and disposal costs). In FS mode, 10 elements can be measured in a sample in under 2 minutes, consuming less than 10 mL of sample.

Fast Sequential mode

Using Fast Sequential mode, samples are only aspirated once, with all elements being measured before the next sample is aspirated.



Conventional mode

Conventional AA determines only one element from each sample aspiration, so samples are analyzed time and time again during a multi-element sequence.

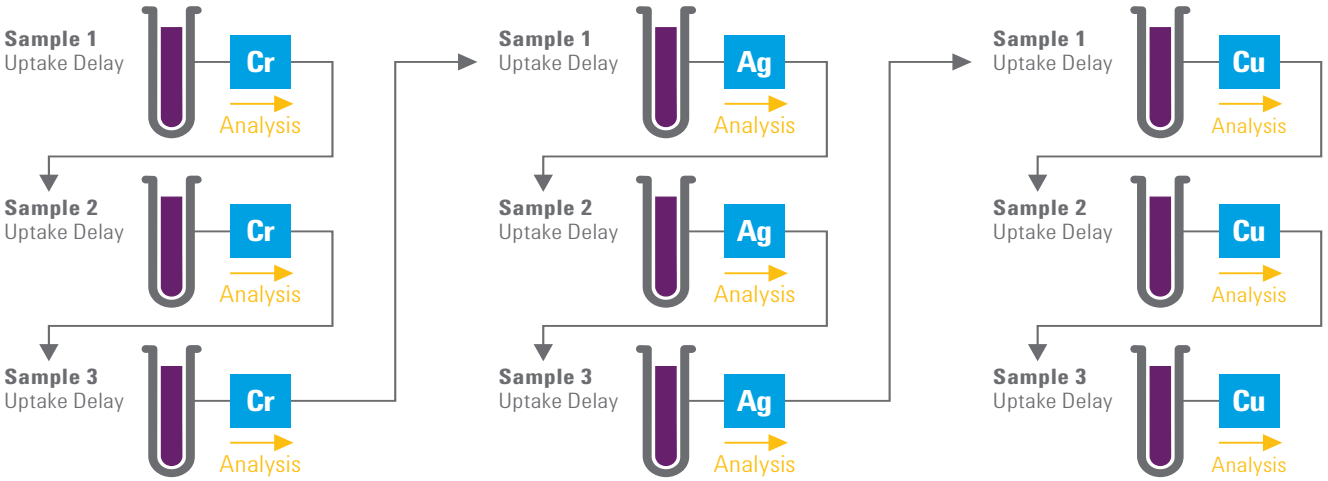


Figure 1. A comparison of Fast Sequential mode and Conventional mode for AA analysis.

In addition to Fast Sequential mode, Agilent's PROMT acquisition can be used to further accelerate the analysis. It integrates the signal until either the desired precision is achieved or the user-defined measurement time has elapsed.

Reduce gas consumption and analysis time by over 60%

To demonstrate how much time can be saved in Fast Sequential mode, an analysis of nine elements (Cr, Ag, Cu, Mn, Fe, Co, Ni, Pb, and Mg) in 20 samples was performed three different ways:

- in conventional FAAS mode;
- in Fast Sequential mode; and
- in Fast Sequential mode with PROMT acquisition.

The analysis was performed with an SPS 4 autosampler, included a Cal Zero and three standards, and included a 5 second rinse every 10 samples.

With the instrument setup to run as a conventional flame instrument, all samples for the first element were measured, and then the process was repeated for the subsequent 8 elements. The method used 3 integrations of 3 seconds for each element, for a total analysis time of 95 minutes.

The instrument was then setup to run exactly the same method in Fast Sequential mode. The instrument measured multiple elements in each solution from a single aspiration. The total analysis time was reduced to 52 minutes.

Finally, the instrument was setup in Fast Sequential mode with PROMT acquisition. The instrument measured multiple elements in each solution, then continued to the next one. The precision limit was 0.5% and the maximum measurement time was set to 5 seconds. Using Fast Sequential mode and PROMT, the total analysis time was reduced to just 36 minutes.

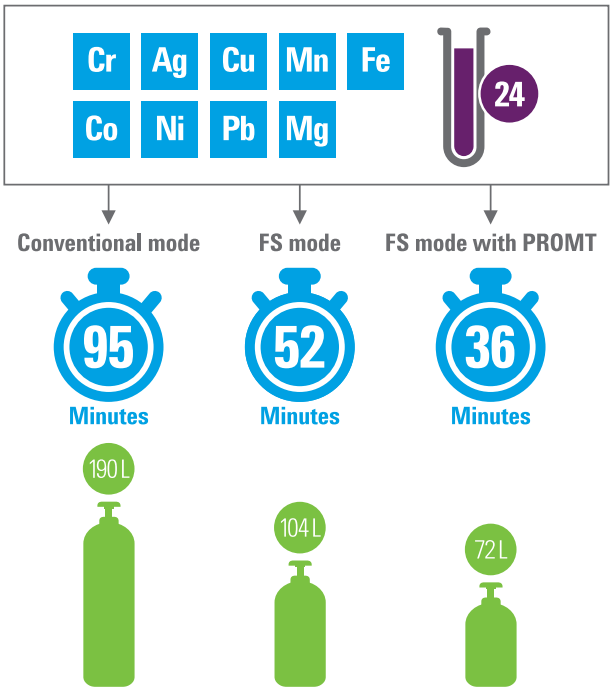


Figure 2. Comparison analyses of 20 samples containing 9 elements. A Cal Zero and three standards were used and a 5 second rinse was performed every 10 samples

Each analysis used 2 L/min of acetylene, resulting in 190 L of acetylene being consumed in conventional mode for the analysis of 24 samples, including calibration standards. This was reduced by 62% to just 72 L in FS mode with PROMT.

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