Technical Overview

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Synchronous Vertical Dual View (SVDV) for High Productivity and Low Cost of Ownership

Agilent 5900 SVDV ICP-OES

Maximize revenue potential

The Agilent 5900 Synchronous Vertical Dual View (SVDV) ICP-OES revolutionizes ICP-OES analysis with a series of operational, performance, and productivity improvements. It is designed for high sample throughput laboratories looking to run samples more efficiently, with the lowest possible cost-per-sample.

The 5900 SVDV ICP-OES includes unique Dichroic Spectral Combiner (DSC) technology that captures and combines axial and radial light from a vertical plasma in a single measurement covering the entire wavelength range. The 5900 also includes the high-speed Vista Chip II CCD detector and the integrated AVS 6/7 Advanced Valve System switching valve as standard. These three technologies combine to provide the fastest sample throughput and the lowest gas consumption per sample of any ICP-OES. Other features such as the vertical torch with axial viewing and Cooled Cone Interface (CCI) enable the 5900 to handle high salt

samples, volatile organic solvents, and corrosive sample matrices. With its ability to analyze multiple elements over a large linear dynamic range (LDR), the need for additional sample dilutions or multiple readings of the same sample is minimized, further improving sample throughput. The exceptional robustness of the 5900 SVDV ICP-OES ensures that fewer sample remeasurements are needed and instrument downtime is minimized.

What is Synchronous Vertical Dual View (SVDV)?

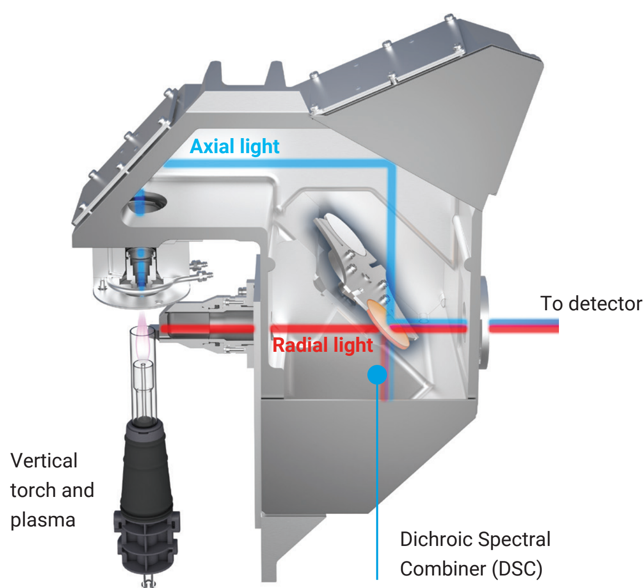

Figure 1. Schematic showing the emission from axial and radial plasma views synchronously converging onto the DSC. The combined emissions are then transmitted into the polychromator optics and to the detector.

Conventional dual view ICP-OES systems require the operator to set up a series of sequential measurements by selecting which elements are measured in axial mode, and which elements are measured in radial mode. Speed is compromised due to the need to measure radial and axial views sequentially. Most conventional dual view systems use a horizontal torch, rather than the more robust vertical torch orientation. Positioning a torch horizontally reduces torch lifetime and limits the matrix handling capability of the instrument. The vertical-torch design of the 5900 SVDV ICP-OES with DSC technology delivers accurate results in the quickest possible time compared to conventional dual view ICP-OES instruments.

With SVDV, the 5900 ICP-OES needs only a single measurement per sample. The pre-optics of the 5900 enable both axial light (emissions from the central channel of the plasma) and radial light (emissions from the side of the plasma) to converge to a single point.

When the DSC is placed at the convergence of both paths of emitted light, a combination of axial and radial emissions of light is synchronously directed into the optics of the 5900 ICP-OES (Figure 1). Reading both the axial and radial light at the same time significantly reduces sample-to-sample analysis time. It also ensures that the amount of argon consumed per sample is the lowest of any modern simultaneous ICP-OES.

In contrast, conventional 'simultaneous' dual view instruments are limited in the sample throughput they can achieve as they need to read axial and radial emissions sequentially. The user nominates which elements and wavelengths are to be read axially and which elements and wavelengths are to be read radially. Therefore, two discrete readings of the same sample are required. Depending on the design of the conventional simultaneous dual view instrument, it may be necessary to read the same sample up to four times for a complete analysis. Instrument performance is mandated for a benchmarked analysis like US EPA 200.7. But, using similar sample introduction components, the 5900 SVDV ICP-OES is typically more than twice as fast compared to conventional 'simultaneous' dual view systems.

The true measure of gas consumption is liters per sample. If the analysis time is halved, argon use will reduce by nearly 40%, even if the argon flow rate is 20% higher. Figure 2 shows how the consumption of argon changes with flow rate and measurement time for different sample sizes. Clearly argon flow rate is not equal to argon gas consumption. The 5900 SVDV ICP-OES and 5800 Vertical Dual View (VDV) ICP-OES include the same Freeform optical design and custom VistaChip II CCD detector. With this configuration, the 5900 SVDV ICP-OES consumes 30% less gas argon per sample compared to other 'conventional' dual view systems.

The DSC enables specific wavelengths of light to be reflected and transmitted into the echelle based polychromator. This selection allows the wavelengths of elements at trace levels to be measured axially, while the wavelengths of elements such as Na and K that are present at elevated concentrations are measured radially. Unwanted wavelengths of light are transmitted or reflected away, and do not enter the polychromator.

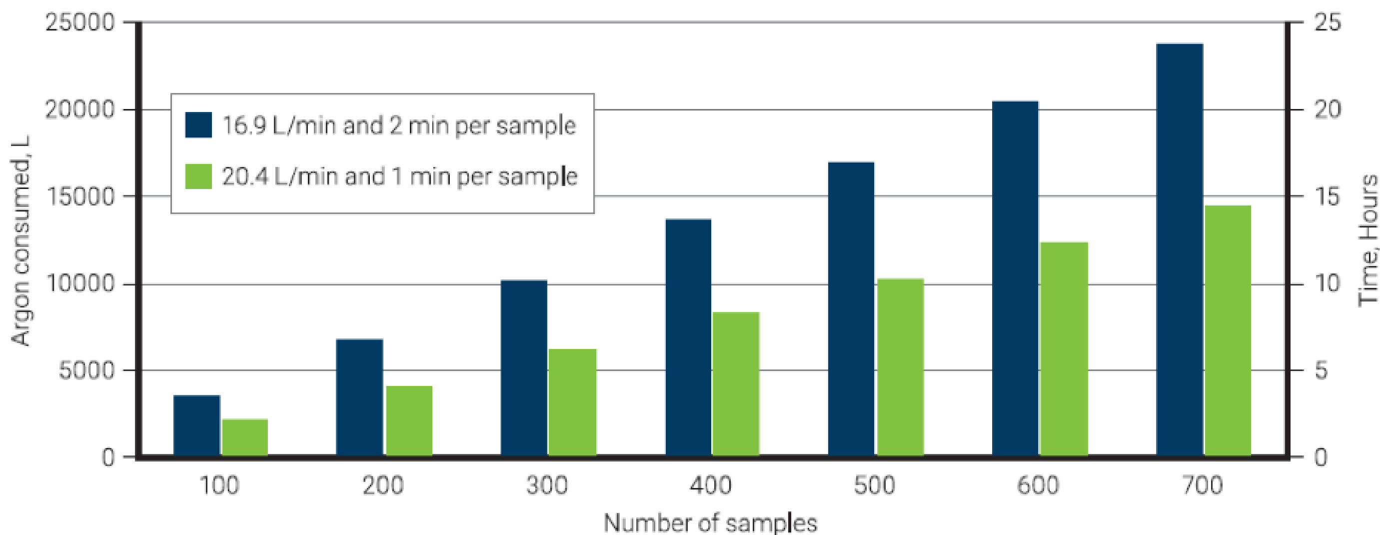

Figure 2. Changes to argon consumption (L) with flow rate (L/min) and measurement time for differing number of samples.

The 5900 SVDV ICP-OES with DSC is ideally suited to the analysis of environmental, food, and agriculture samples. These samples typically contain elements like Na and K at elevated ppm levels and elements such as As, Cd, Pb, and Se at trace ppb levels. All these elements can be analyzed in a single measurement using the 5900 SVDV ICP-OES.

Typical analytical performance

Linear dynamic range

The 5900 SVDV ICP-OES provides a wide LDR for Easily Ionized Elements (EIEs). Ionization interferences result from the presence of high concentrations of EIEs in samples, especially the common alkali elements, K and Na, and, to a lesser extent, the alkaline earth elements, Ca and Mg. These elements have low ionization energies and are easily ionized in the plasma. If these elements are present at sufficiently high concentrations, the electron density within the plasma is increased to a level where the atomization/ionization equilibrium of other elements is affected. The presence of EIEs in samples at increasingly higher concentrations causes enhancement or suppression of analyte emission signals, resulting in the reporting of either false high or false low element concentrations.

Dedicated radial view instruments generally avoid EIE interferences as the viewing height can be optimized to measure emissions in a part of the plasma where the alkali metals are less ionized. This approach minimizes the suppression or enhancement effect of ionization interferences.

Typically, conventional simultaneous dual view systems read EIE elements in radial view and trace elements in axial view. This technique takes two or more sequential measurements of the sample for a complete analysis of all elements.

Using the DSC on the 5900 SVDV ICP-OES, EIEs can be measured radially while trace elements are being measured axially—all in a single reading. This simple but effective method eliminates ionization interferences for elements like Na and K, while enabling trace elements like As, Se, Cd, and Pb to be determined at the same time, with no time penalty. The DCS ensures low argon consumption per sample, accurate results, and wide LDR for EIEs (Figure 3).

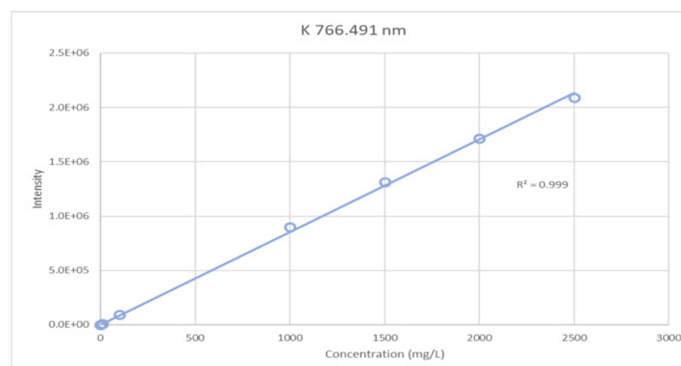

Figure 3. Linear dynamic range for K 766.491 nm from 0.1 to 2500 mg/L using the 5900 SVDV ICP-OES.

A recent study demonstrates the LDR of EIEs using the 5900 SVDV ICP-OES for Certified Reference Material (CRM) MP-A Trace Elements in Milk Powder (High Purity Standards, USA). The data shows very good high concentration recovery of Na and K and excellent recoveries of trace level analytes from a single analysis. A summary of the experimental results is shown in Table 1.

Table 1. Recovery of major and minor elements in CRM-MP-A , after microwave acid digestion.

Element and Wavelength (nm)	Certified Value (mg/kg)	Measured (mg/kg)	Recovery (%)
K 766.491	16650	17600	95
Na 588.995	4276	4340	99
Fe 238.204	2.28	2.1	108
Cu 324.754	0.52	0.52	101
Mn 257.610	0.2	0.2	109
Zn 202.548	40.8	42	97

Future-proof with flexible modes of operation

For maximum flexibility and application coverage, the 5900 SVDV ICP-OES with DSC technology can operate in four different modes (note that all configurations and operational modes use a robust vertical torch). The mode selector (Figure 4) positions the relevant optical component (DSC, mirror/hole, hole, or mirror) into the light path to enable the following operational modes:

1. Synchronous Vertical Dual View (SVDV): Mode selector = DSC, enables synchronous axial and radial view measurements
2. Vertical Dual View (VDV): Mode selector = Mirror/'Hole', enables sequential axial and radial view measurements
3. Dedicated Radial View (RV): Mode selector = 'Hole', enables radial view measurements only
4. Dedicated Axial View (AV): Mode selector = Mirror, enables axial view measurements only

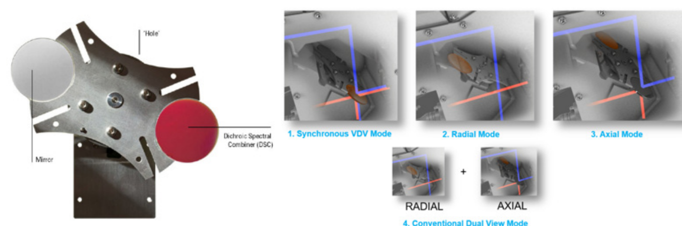

Figure 4. The mode selector (left) that enables the four modes of operation (right) on the 5900 ICP-OES.

Using a vertical torch with end-on (axial) and side-on (radial) pre-optics enables high TDS samples to be analyzed, while achieving ppb level sensitivity. This inherent robust capability and flexibility of the 5900 SVDV ICP-OES ensure that any future analysis requirements are covered in the one instrument. Simply select the best configuration for your application.

Conclusion

The Agilent 5900 SVDV ICP-OES with DSC is a productive, high-performance instrument with a low cost per analysis. The DSC allows the 5900 SVDV ICP-OES to run axial and radial view analysis in a single measurement. This effective technology results in fast analysis times and reduced argon gas consumption, plus higher precision, as all wavelengths are measured in one reading.

The vertical torch orientation used in the 5900 SVDV provides a high level of robustness allowing analysts to measure complex samples—from high %TDS samples to volatile organic solvents—with good long-term stability. With the flexibility of operation in four different models, the 5900 SVDV ICP-OES allows laboratories to future-proof their application-requirements to handle more-varied samples, develop new methods, or meet changing legislation.

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