Spectrum Instruments
a PerkinElmer company

# SP-AA 4500
# SP-AA 5000

## Atomic Absorption Spectrometer

Excellence in Measurement

Reliable · Accurate · Reasonable Price

# Atomic Absorption Spectrometer

SP-AA 4500 GRAPHITE FURNACE SYSTEM

SP-AA 5000 FLAME & GRAPHITE FURNACE SYSTEM

# Innovative Technologies

Spectrum Instruments is now your partner for atomic spectroscopy. Our AAS is productive, reliable and user-friendly. It improved the optical precision, linear range and background correction effectively. The SP-AA 4500 & 5000 are the external computer controlled AAS fitted with 8-lamp positions and automatic gas control.

## SP-AA 4500 is an Atomic Absorption Spectrometer for Graphite Furnace technique.

## SP-AA 5000 is an Atomic Absorption Spectrometer with international advance technologies for Flame & Graphite Furnace technique.

## Both models have two background correction technologies in one unit.

Spectrum Instruments developed PC information processing technology. Automatic measurement and straylight dynamic detected without any reference materials and any cost increment.

## Original Optical Noise Reduction

Spectrum Instruments develops optical noise reduction technology,which combines optical component UV enhancement technology. It improves instrument's optical performance, linear range and enhanced background correction.

## Lamp control ( Patent )

Spectrum Instruments develops interval lamp control technology.It makes normal hallow cathode lamps self-absorption back ground correction possible without the influence to instrument's stablity. Meanwhile, it will prolong working time of the lamp.
The cost of normal hallow cathode lamp is only about one-tenth of special lamp.

## Original "Hg lamp-reagent" gradient measurement

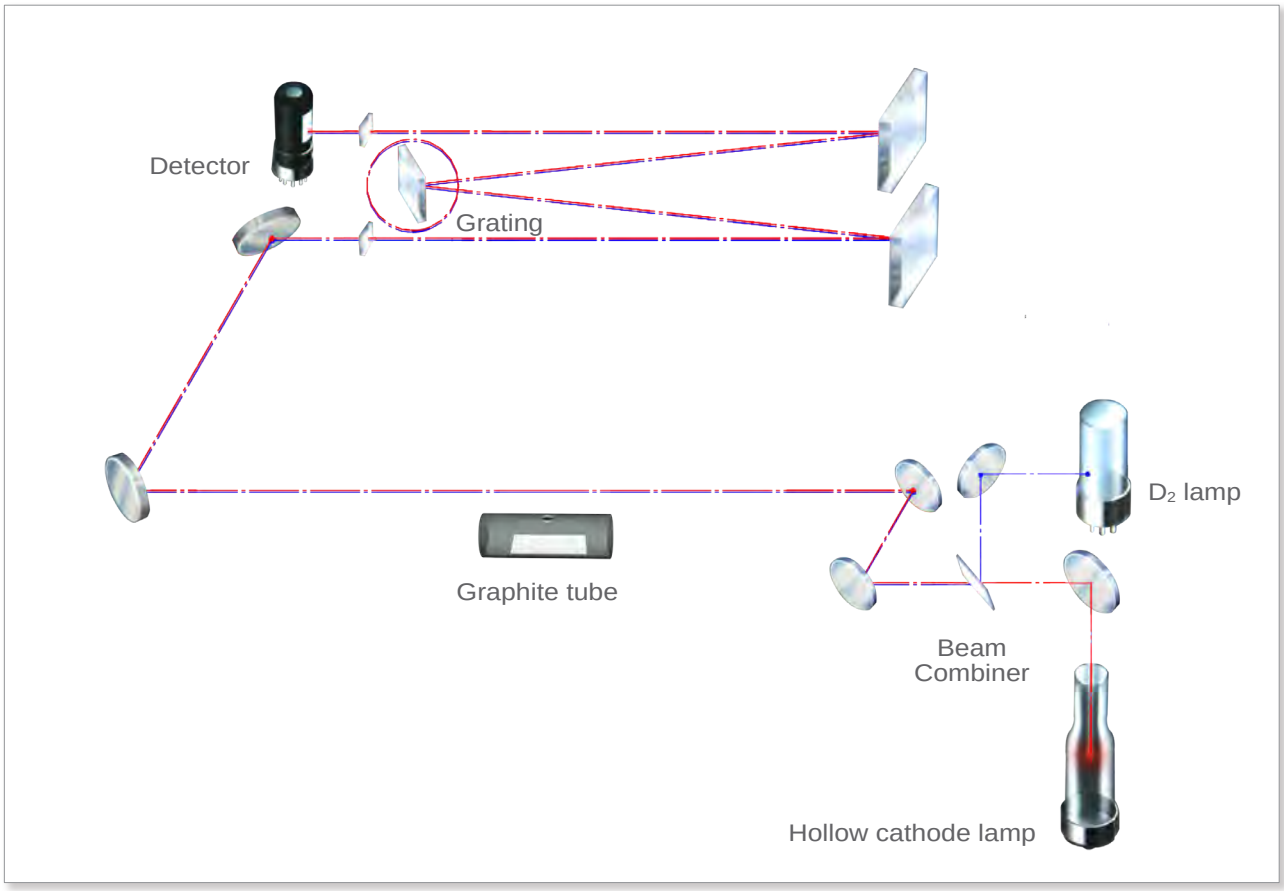
Spectrum Instruments develops "Hg lamp-reagent" gradient measurement technology. We establish an exact mathematical model to estimate "double beam linear and balance" specification. This technology provides a fast and economic method for instrument self testing system. It also establishes a brand new method to improve instrument's detection performance.

Numerous technological innovation and renewal such as fashion design, element lamp multi-dimensional automatic adjustment system, gas path electronics functional and modular design, No-adjustment $D_2$ lamp holder and so on.

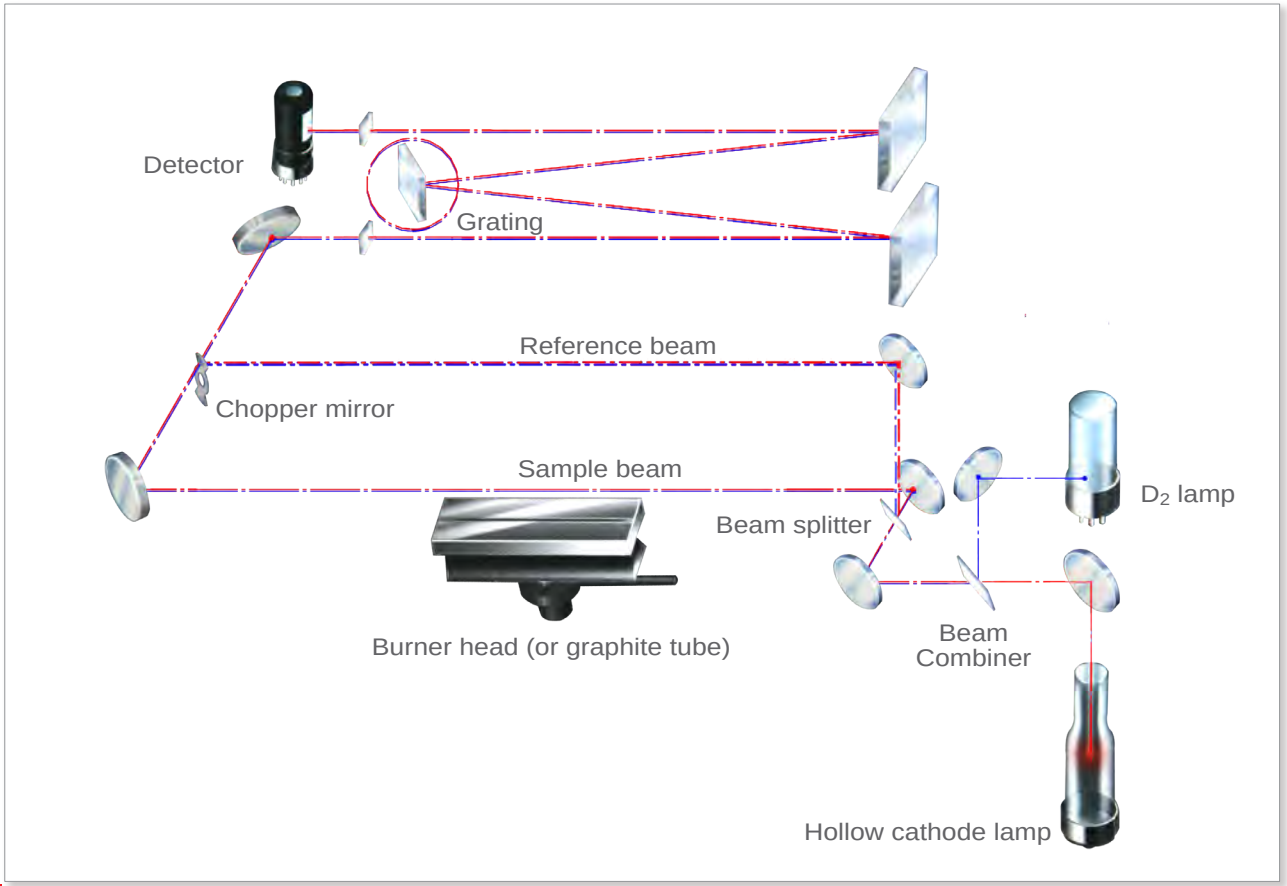
# Product model

SP-AA 4500 Graphite Furnace Atomic Absorption Spectrometer
SP-AA 5000 Flame & Graphite Furnace Atomic Absorption Spectrometer

## **Optical Diagram of SP-AA 4500 :** total reflection optical systems




## **Optical Diagram of SP-AA 5000 :** total reflection optical systems



# The combined advantages of two techniques

## Advantages of the Double-Beam System (for SP-AA 5000)

- Long-term stability.
- Automatic lamp drift compensation.

## Advantages of the Single-Beam System

- Highest light throughput.
- Less optics so no energy loss.
- High sensitivity.

## Outstanding Flame and Graphite furnace autosampler technology

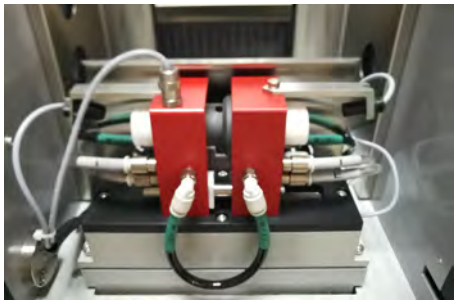
- The autosampler is easy to adjust and operate, stable running, no noise. It has a function of intelligent dilution in the system.
- One unit of autosampler can perform with flame and graphite furnace mode. The number of sample is 85 positions for flame mode and 87 positions for graphite furnace mode.

## Advance Dual Atomizer System (for SP-AA 5000)

- Combine two systems for flame and graphite furnace in one unit.

## Dual-Background Correction Functions

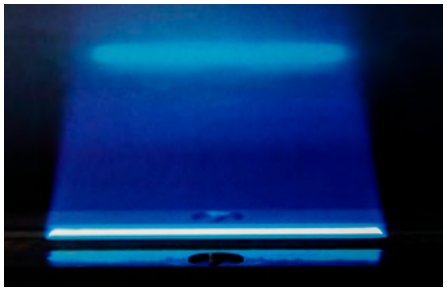
- The optimal background correction methods are installed as standard: self-absorption method (Smith-Hieftje) and deuterium lamp method ($D_2$ method).



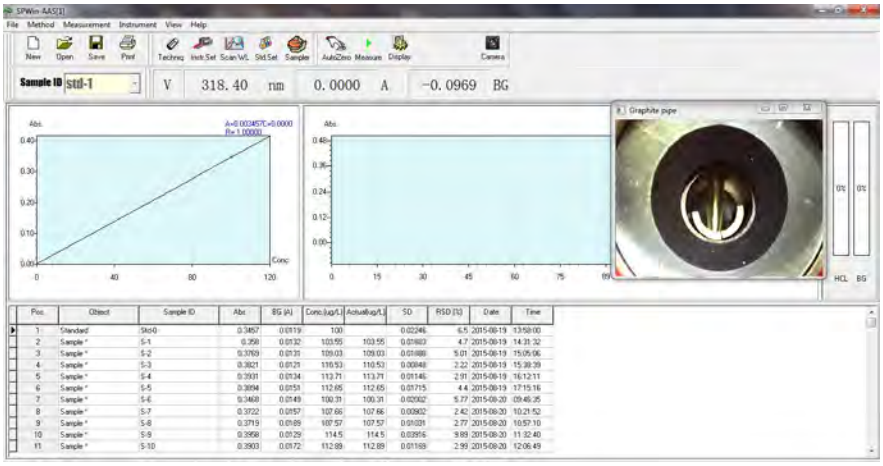
▲ Graphite Furnace head

▲ Graphite tube

▲ Scraper



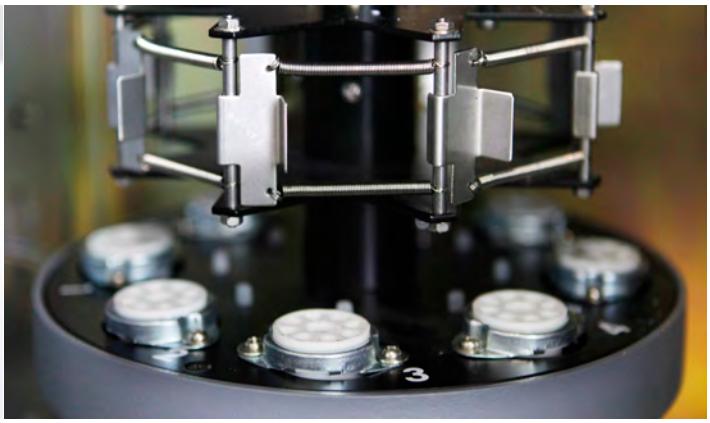
▲ Burner head




▲ Camera for Graphite tube

Atomic Absorption
Spectrometer

# The Main Features



## Reflection achromatic optical system :

SP-AA series Atomic Absorption Spectrometer using a large aperture of 355.8 and 345.6 mm focal length monochromator and 1800 lines/mm diffraction grating monochromator, total reflection optical systems, as well as aberration aspheric mirrors, the instrument has a high luminous flux, no color, excellent optical performance without chromatic aberration. Keep the measurement is accurate and reliable. Make the analysis is effective.

## Pioneering lamp turret position vertical structure :

8 lamps turret position vertical structure for maximum automatic changer.

## Automatic ignition for flame mode (for SP-AA 5000) :

The ignition of flame on the burner head is controlled from the software.

Good ability to resist atomizer optical radiation reasonable design.

## Autosampler for flame and graphite furnace :

One unit of autosampler can operate with flame and graphite furnace mode. The number of sample is 85 positions for flame mode and 87 positions for graphite furnace mode.

## Auto flame ignition and gas flow automatic setup (for SP-AA 5000) :

It is important to determine the optimal gas flow rate for the flame when using an organic solvent or after changing the burner height.

## Automatic burner height (for SP-AA 5000) :

The absorption sensitivity for flame analysis depends on the atomization position at the proper burner height .
Automatic burner cleaner for 50 mm. burner head (Option)

## Automatic slit selection :

The system can select the six slits for SP-AA 4500 and SP-AA 5000.

Powerful software and data process ability, humanistic operation interface and beautiful graphic output :

Fashion design, element lamp multi-dimensional automatic adjustment system, gas path, electronics functional and modular design, No-adjustment $D_2$ lamp holder numerous technological innovation and renewal.

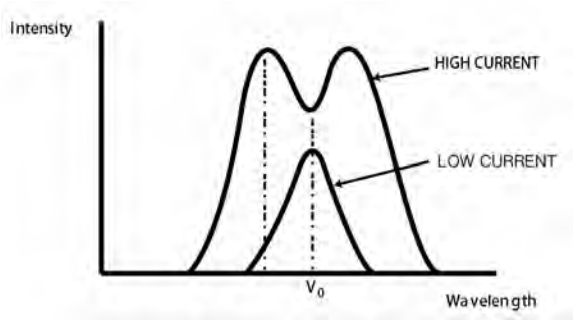
## Other automatic function :

- Full wavelength scan and peak seeking.
- Negative voltage and energy balance.
- Auto optical balance in $D_2$ lamp balance correction.
- Lamp current setting.
- Alarm and safety protection.

# Self-absorption background correction function

## 1.

Self-absorption background Correction (Smith-Hieftje).




## 2.

Comparison sheet of common background correction methods.

| Compare items | | $D_2$ lamp | Zeeman | | | Self-absorption |
|---|---|---|---|---|---|---|
| | | | Constant magnetic (Horizontal) | Alternate (Horizontal) | Alternate (Vertical) | |
| Device | Beam consistency | Bad | Good | Good | Good | Good |
| | Optics energy balance | Balance | Almost Balance | Almost Balance | Almost Balance | Imbalance |
| Property | Energy calculation | Loss | Big Loss | Big Loss | Small Loss | No Loss |
| | Wavelength correction range | UV Area (traditonal) | Full-Wavelength | Full-Wavelength | Full-Wavelength | Full-Wavelength |
| | Sensitive Loss | No | Big Loss | Loss | Loss | Few |
| | Baseline Stability | Not so good | Good | Good | Good | Better |
| | Background Correction 1A | Good | Good | Good | Good | Good |
| | Background Correction 2A | Bad | Good | Good | Good | Good |
| | Background Correction Structure | Not Allowed | Allowed | Allowed | Allowed | Allowed |
| | Spectrum Overlamping interference | Not Allowed | Partially | Partially | Partially | Same as Zeeman |
| | Curve flip | No | High | High | High | Very Low |

## 3.

Advantage of High performance self-absorption background correction.

Competing with Zeeman effect background correction, it is low cost, no loss of light due to polarizers, accurate correction for spectral interference and easy to use for various application.

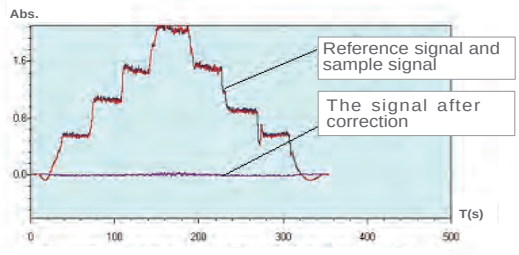
such as: Measurement of trace levels of zinc in iron solution.

| Interested Element | Analytical Line (nm) | Matrix Element | Absorption Line (nm) |
|---|---|---|---|
| Al | 309.28 | Mg | 309.30 |
| As | 193.76 | Fe | 193.73 |
| Ca | 422.67 | Fe | 422.64 |
| Cd | 228.80 | Ni | 228.84 |
| Cu | 324.75 | Fe | 324.73 |
| Mg | 285.21 | Fe | 285.18 |
| Ni | 232.00 | Fe | 232.04 |
| Pb | 217.00 | Fe | 216.95 |
| Sb | 217.58 | Fe | 217.55 |
| Se | 196.03 | Fe | 196.05 |
| Si | 251.61 | Fe | 251.69 |
| Zn | 213.856 | Fe | 213.8589 |

## 4.

**Spectrum Instruments SP-AA 4500 & 5000 break many technologies bottleneck:**

- Creating "multiple linearity and balance technique" adopted hardware and software combined method.
- Solving many problems by using self-absorption background correction.
- Dual signal (sample beam wide pulse and reference beam narrow pulse).
- Transmission/Absorption in wide linear range and dynamic balance.




Self-absorption background correction (Cd 228.80 nm)

Flame background correction performance at 2.0A

Self-absorption background correction is more accurate than deuterium lamp ($D_2$) background correction.This is ideal for the quantitation of trace elements in matrix complex solution, such as bio-samples and metals.

Self-absorption background correction over the entire wavelength range from 185 nm to 900 nm.

No polarizer is used, measurements are possible with no light loss and high S/N ratio.

Due to the excellent self-absorption and $D_2$ lamp background correction ability,the molecular absorption and particle scattering are corrected and produce the accurate correction for spectral interference and some spectral overlap.

These technologies are appropriate to test trace elements in food,traditional chinese medicine,seawater,blood,biologicals high-salt solution, especially in the analysis of Cd,Pb,Cu,Zn.

# Excellent $D_2$ lamp background correction function

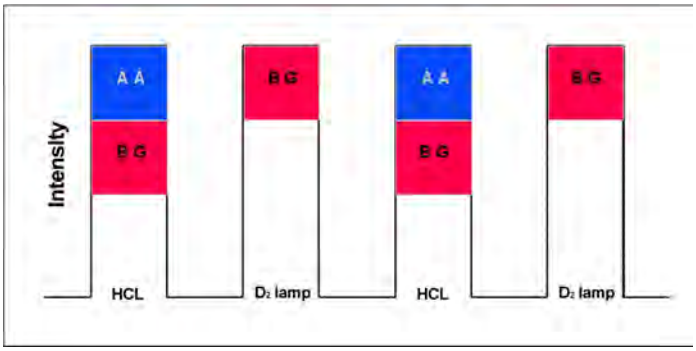
## Excellent $D_2$ lamp Background Correction Technology.

**Unique reflection optical system.**

Unique reflection optical system keeps the light transmission unique. It makes hollow cathode lamp beam and $D_2$ lamp beam through different wavelength in the best condition.
Hollow cathode lamp and $D_2$ lamp Beam optical balance technology extended application range of $D_2$ lamp background correction. It also realizes high ability of background correction.

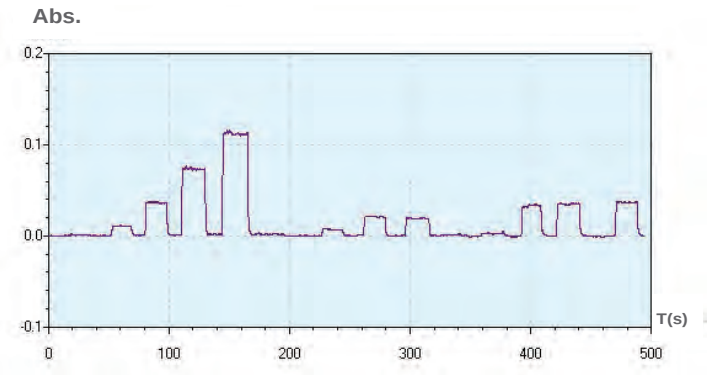
### Principle

The deuterium lamp method involves lighting the hollow cathode lamp and the deuterium lamp alternately at high speed. The light from $D_2$ lamp almost observes to wide-bandwidth molecular absorption as background absorption. While the light from the hollow cathode lamp can absorb the same bandwidth of the atomic absorption band and molecular absorption band, the total of the atomic absorption and the background absorption can be observed. With the deuterium lamp background correction method, light from both sources passes through the burner. The difference of absorbance is determined to conduct background correction.

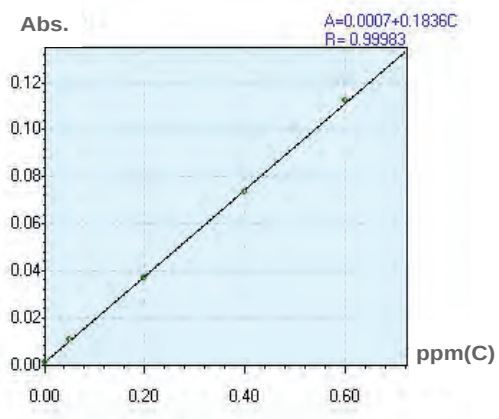



### Advantages:

- High-sensitive detection.
- Wavelength range of background correction could be extended to 500 nm.
- Simple and inexpensive.
- No sensitivity loss.
- Does not require a special primary light source.
- Powerful enough for most and graphite furnace application.



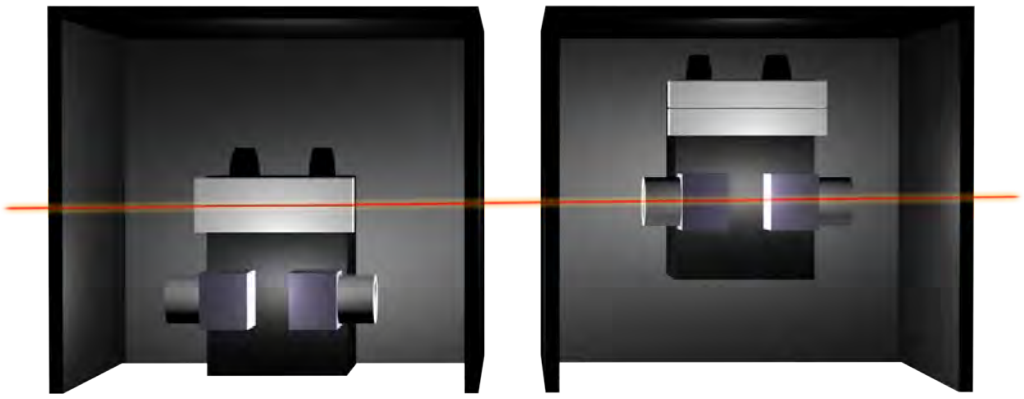

Cu Test Curve




Cu Standard Curve

# New Atomizer Smart Design For Easy Swicthing Between Flame and Graphite Furnace (for SP-AA 5000)

- The atomizer units (burner head and graphite furnace head) can be switched both manual operation and automatically by software operation. No need to disconnect pipes or wires.
- One autosampler can be used for both flame and graphite furnace measurements.



▲ Flame measurement ▲ Graphite furnace measurement

## Longitudinal-heated graphite furnace :

Longitudinal-heated graphite furnace makes the improvement in accuracy. It minimizes many chemical interferences and matrix effects. It can programmable temperature up to 3000 $^{o}$C and the heating is 2000 $^{o}$C /s by software controlled.
Two independently controlled gas flows are used : external gas flow for protection of the graphite tube from the oxidation while heating and internal gas flow is used analytically to remove pretreatment step by-products and to control the sensitivity of an analysis. The internal gas flow can also be changed to an alternate gas, such as air or oxygen, to aid in sample decomposition.

## Minimize cost per analysis :

The cost of Longitudinal-heated graphite tube is cheaper when compare with the other techniques. You can choose between two types of tubes : platform type and wall type.

## STPF :

The "Stabilized Temperature Platform Furnace" (STPF) concept can reduce the spectral interferences. It improves the accruacy of the analytical data.

## Hydride System :

The Hydride system is a continuous flow technique for the determination of As, Se, Sb, Sn, Te, Bi and Hg at low microgram per liter (ppb) concentrations with electrothermal heating unit to heat the quartz cell. With the continuous flow mode, it guarantees convenient handling and precision as well as efficiency during the analysis of hydride-forming elements and mercury with the cold vapour technique.

▲ Hydride System

Atomic Absorption Spectrometer

# The Main Features

## Full operation SPWin-AAS software and QA/QC function

Neat and comprehensive information interface

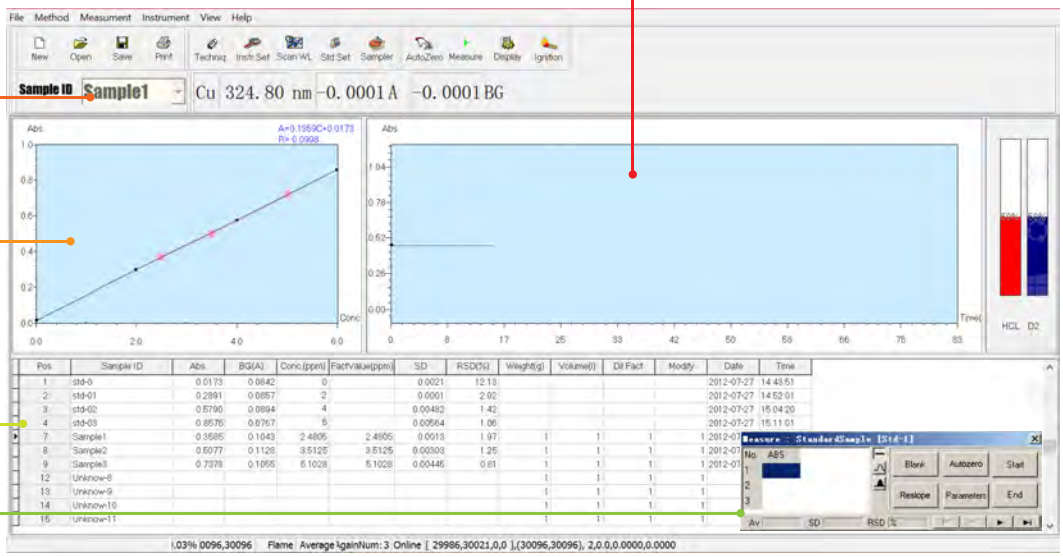
Flame real time status
Test process display

Sample No./Element name/
Wavelength and absorbance

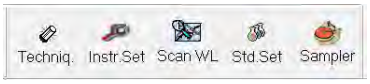
Standard Curve
Display curve equation
Related coefficient

Analysis result of elements
Sample No./Absorbance/
background signal
Calculated concertration of curve/
Actual concentration.

Test command
Press "Start" button,automatic
"Blank" & "correction" function

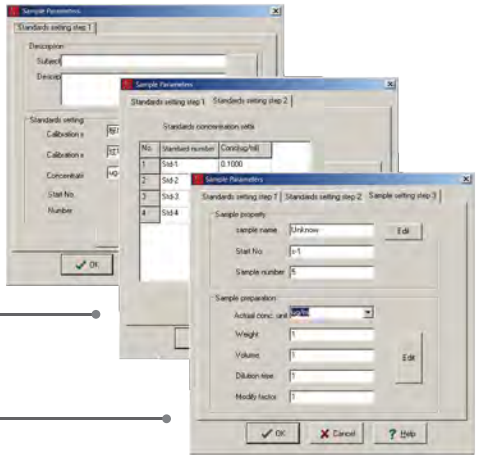



■ Sample setup guide
is easy to operate




1. Element: Sample setup

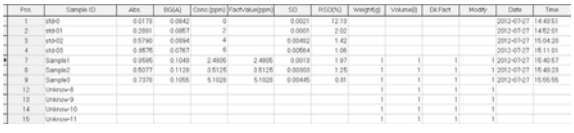
2. Standard sample information
Correction method, Correction equation,
Concentration unit, Standard sample start No.,
Quantity,Method description



3. Standard sample concentration setup

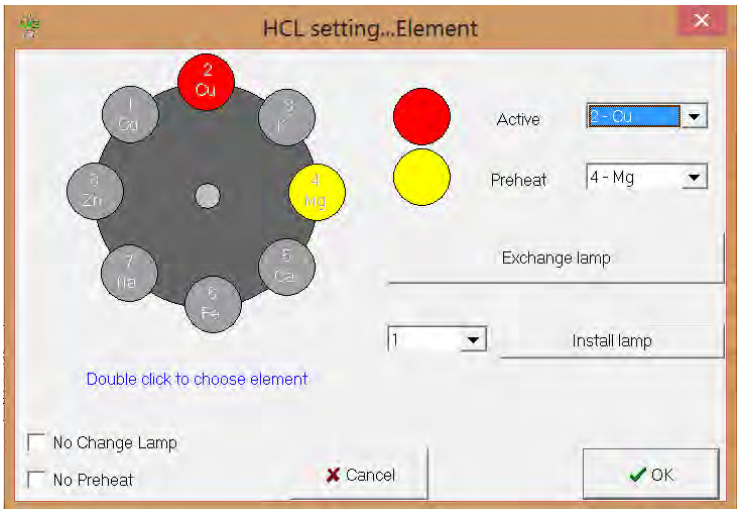
4. Sample property and configuration information

5.New form establish automatically after completed



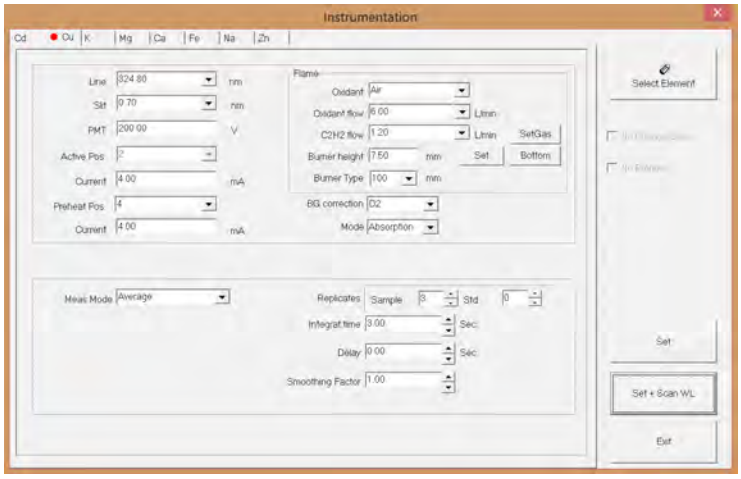
## ■ Test condition and calculation setup, Instrument automatically control.

1.



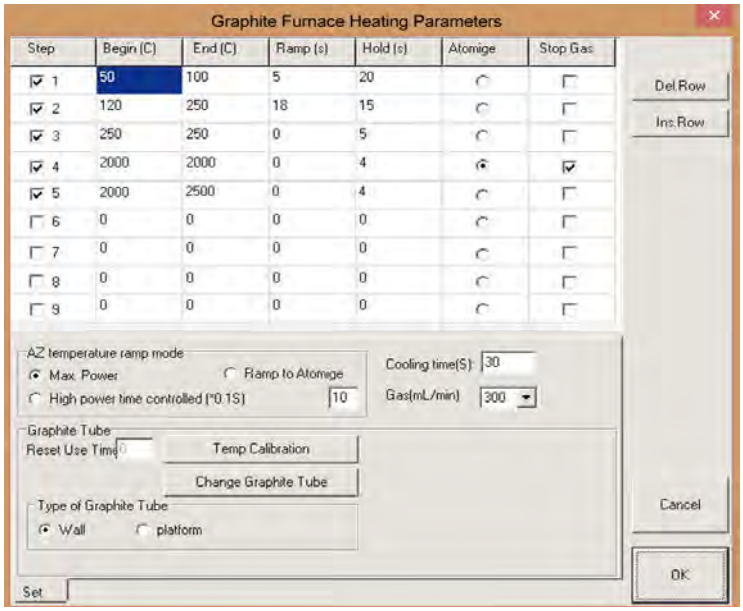

Element lamp setup
Element lamp property
Element lamp position

2.




Default value of every element (recommended)

3.




Temperature condition setup(recommended)

# Fields of Application/Industry:

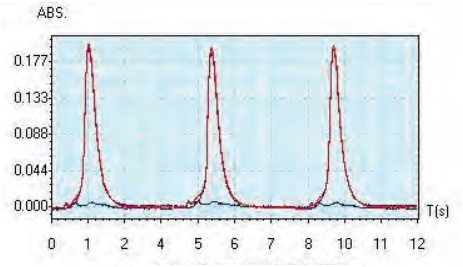
- Chemistry / Polymer Industry
- Clinical Chemistry / Medicine/
- Hygiene / Health Care
- Cosmetics
- Electronics
- Energy
- Environment / Water / Waste
- Food / Agriculture
- Geology / Mining
- Material Analysis
- Metallurgy / Galvanization
- Pharmacy
- Refineries / Petrochemistry
- Semi-Conductor Technology
- Others




# Example of application case

### 1. Soil analysis

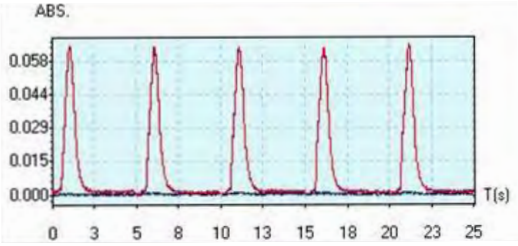
Test content of Pb in soil sample




Pb Atomization Graphic of soil sample

### 2. Food analysis

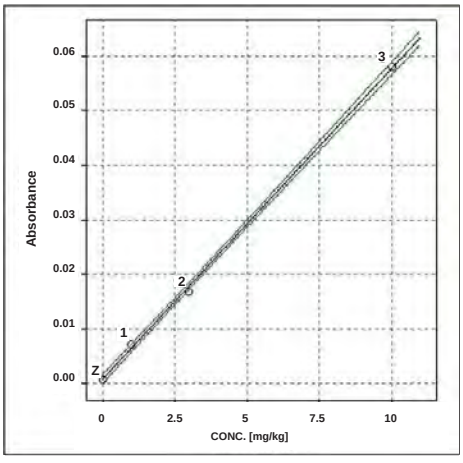
Graphite Furnace test content of Cd in tea leaf sample.



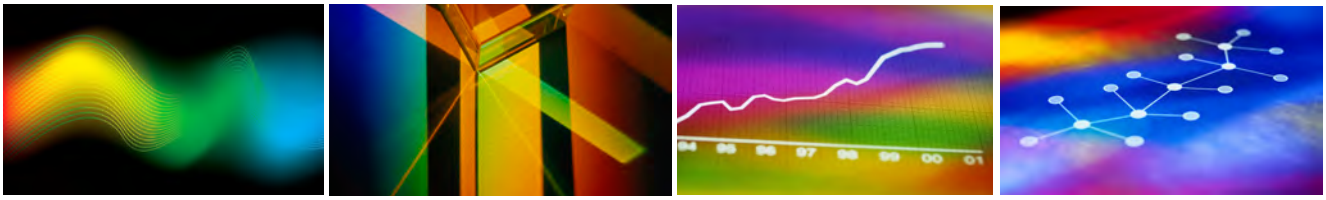

Cd Atomization Graphic of Tea leaf sample

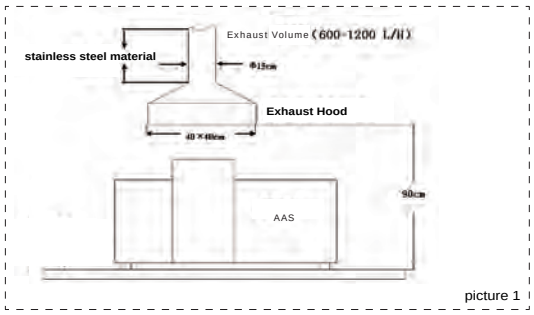
### 3. Petroleum analysis

Determination of Al in motor oil by flame mode. Al calibration standards have been prepared in a solution containing 20 g oil and 35 g IMBK. The calibration standards have been prepared using fresh motor oil (clean oil).

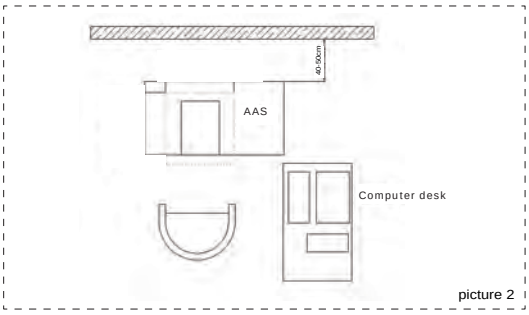



Determination of Al in motor oil

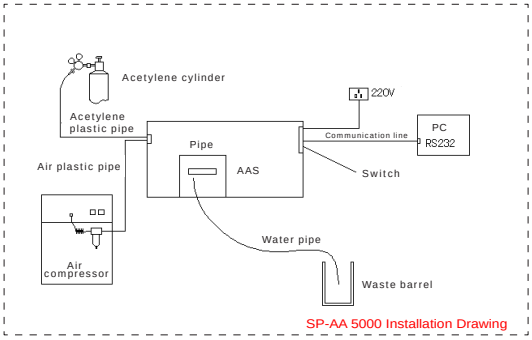




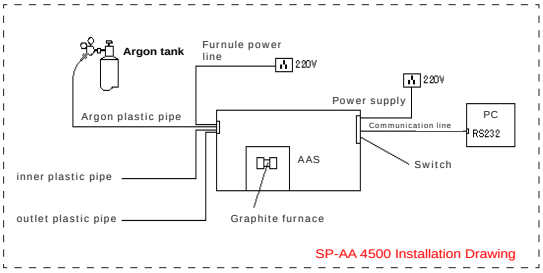
picture 1



picture 2



SP-AA 5000 Installation Drawing



SP-AA 4500 Installation Drawing

## 1. Exhaust Equipment

Exhaust equipment is required in the laboratory.The exhaust air rate should adsorb the big newspaper. If the exhaust air rate is too high, it will affect the stability of the flame. On the contrary, if the exhaust air rate is too low, the harmful gas will not be exhausted.
( Refer to picture 1 )

## 2. Laboratory Cabinet

Laboratory cabinet is required to be consisted and stable. The table top should be smooth. The distance between the instrument and the wall is required about 40-50cm. It will be convenient for installation and maintenance.
( Refer to picture 2 )

## 3. Power Requirement

### 3.1 SP-AA 5000 Flame:

Power requirement: 220 V (±10%), 50/60 Hz
Power ≥ 220 V×10A, 1 KVA exchange purification of electronic power supply is required.
A separated earthing cable if possible.

### 3.2 SP-AA 4500 & 5000 Graphite Furnace:

Power requirement: 220 V (±10%), 50/60 Hz
Power ≥ 220V×30A, 15 KVA exchange purification of electronic power supply is required.
A separated earthing cable is required and earth resistance≤4Ω.

## 4. Gas Supply Configuration

### 4.1 Flame:

A bottle of high purity Acetylene ≥ 99.5% (instrument grade) is required. Output pressure of Acetylene gauge: approximately 0.8-1.6 kgf/cm$^2$ (0.08-0.16 MPa or 12-22 psi). Technical grade Acetylene is not allowed.
A bottle of high purity Nitrous Oxide ≥ 99.5% (instrument grade) if need. Output pressure of Nitrous Oxide gauge: approximately 4-6 kgf/cm$^2$ (0.4-0.6 MPa or 56-85 psi).
Compressed air, oil free, output pressure gauge: approximately 4-6 kgf/cm$^2$ (0.4-0.6 MPa or 56-85 psi).

### 4.2 Graphite furnace:

A bottle of ultra high purity Argon(99.998%)or high purity Argon(99.995%)is required.Output pressure of Argon relief value: approximately 2.5 kgf/cm$^2$ (0.25 MPa or 35 psi). Cooling water is required.

### 4.3 Hydride:

A bottle of ultra high purity Argon(99.998%)or high purity Argon(99.995%)is required.Output pressure of Argon relief value: approximately 2.5 kgf/cm$^2$ (0.25 MPa or 35 psi).

## Innovation Technologies

Spectrum Instruments improve the optical precision, linear range and background correction effectively. SP-AA 4500 is an external computer controlled AAS equipped with 8-lamp positions and automatic gas control.

SP-AA 4500 Performance Specification

| System Design | |
|---|---|
| Optical system | Developed optical noise reduction technology, which combined optical component UV enhancement technology. It improved instrument's optical performance, linear range and enhanced background correction. |
| Monochromator | Czerny-Turner type with 2 focal lengths at 355.8 and 345.6 mm, automated wavelength selection and slit selection. |
| Wavelength range | 180-900 nm |
| Grating | Holographic grating with 1800 lines/mm |
| Wavelength repeatability | ±0.1 nm |
| Wavelength accuracy | ±0.3 nm |
| Dectection limited | Cd ≤1.0 pg |
| Slits | Automated slit selection 0.1; 0.2; 0.4; 0.7; 1.4; 2.0 nm |
| Detector | Wide range UV sensitive photomultiplier tube |
| Lamp | Automated 8-lamp turret with independent lamp power supply for each lamp and two heating circuits for preheating lamp operation. Non-coded lamp and coded lamp can be used for analysis. |
| Background Correction | Deuterium (D2) Background Correction and Self-absorption Background Correction. |
| **Graphite furnace System** | |
| Heating System | Integrated computer-controlled Longitudinal Heated Graphite Furnace. |
| Function | Analytical furnace program up to 9 steps can be set up. |
| Temperature | Programmable temperature up to 3000 °C in 1 °C increment. |
| Heating Rate | Maximum linear heating rate is 2000 °C/s under software control. |
| Ramp time & Holding time | 1s～255s |
| Gas Flow | Choice of two inert gases with computer-controlled flows. Separate control of inert gas stream is Argon for internal and external gas flow. The external gas flow is 1 L/min and internal gas flow in the graphite tube can be adjusted to 250 mL/min. |
| Cooling System | A closed circuit optimized to save time, water and provide stable condition. Water temperature during operation is approx. 38 °C. |
| Autosampler for Graphite | Injection volumes from 1 to 50 µL in increments of 1 µL are user selectable. Automatic dilutions and additions of three different modifiers are available. Corrosion resistant sample tray holds 87 positions. |
| Safety Functions | Warning will function when cooling water flow failure, gas pressure over, Furnace temperature too high, Graphite tube broken. |
| Hydride System | The Hydride system is a continuous flow technique for the determination of As, Se, Sb, Sn, Te, Bi and Hg at low microgram per liter (ppb) concentration with electrothermal heating unit ( 600-950°C ) to heat the quartz cell. The Hg will be determined with the cold vapour technique. The system has the gas flow control including two peristaltic pumps for supply the reagent, acid and samples solution. |
| **Other information** | |
| Software | SPWinAA Software Package |
| Weight | 120kg |
| Dimensions (W x D x H) | 800 mm x 800 mm x 575 mm |
| Environmental Requirements | 10 °C up to 35 °C Rel. humidity max. 85 % |
| Power Requirements | 110 / 220V±10%, 50/60Hz |

SP-AA 5000 Performance Specification

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|---|---|
| **System Design** | |
| Optical system | Dual Optics combined for single beam and double beam mode. True Double Beam developed optical noise reduction technology, which combined optical component UV enhancement technology. It improved instrument's optical performance, linear range and enhanced background correction. Measurement modes of atomic absorption and atomic emission are available. |
| Monochromator | Czerny-Turner type with 2 focal lengths at 355.8 and 345.6 mm, automated wavelength selection and slit selection. The monochromator provides a true double beam operation. |
| Wavelength range | 180-900 nm |
| Grating | Holographic grating with 1800 lines/mm |
| Wavelength accuracy | ±0.3 nm |
| Sensitivity (Cu) | approx. 0.8A at 5 ppm, RSD≤0.5% |
| Slits | Automated slit selection 0.1; 0.2; 0.4; 0.7; 1.4; 2.0 nm |
| Detector | Wide range UV sensitive photomultiplier tube |
| Lamp | Automated 8-lamp turret with independent lamp power supply for each lamp and two heating circuits for preheating lamp operation. Non-coded lamp and coded lamp can be used. |
| Background Correction | Deuterium (D2) Background Correction and Self-absorption Background Correction. |
| **Flame System** | |
| Burner-Nebulizer-System | All-titanium 100mm and 50mm burners are available:-100mm burner for air / acetylene operation, 50mm burner for both air / acetylene and nitrous oxide /acetylene operation. Adjustable nebulizer with internal Platinum / Iridium capillary, PEEK Nozzle and fixed ceramic impact bead are supplied as standard. SP-AA 5000 features automated setting of burner height for each elements. |
| Spray Chamber | The PPS (Polyphenylene Sulfide) spray chamber is used for both aqueous and organic solution. |
| Gas Controls | Programmable gas control features software-controlled gas flows with automatic setting of gas flows for each element. |
| Safety Functions | Interlocked safety system prevents selection of the nitrous oxide flame if the nitrous oxide burner is not fitted. Sensor controls for protection to use the incorrect burner head and check the siphon system. To ensure correct operating fuel gas and oxidant pressures are maintained also to check the flow rate. In case of the system power failure, safety interlocks will shut down the gases automatically. |
| Hydride System | The Hydride system is a continuous flow technique for the determination of As, Se,Sb, Sn, Te, Bi and Hg at low microgram per liter (ppb) concentration with electrothermal heating unit ( 600-950°C ) to heat the quartz cell. The Hg will be determined with the cold vapour technique. The system has the gas flow control including two peristaltic pumps for supply the reagent, acid and samples solution. |
| Autosampler for Flame | Corrosion resistant sample tray is consist of 85 positions. Integral peristaltic pump with speed control provides on-demand rinsing of the probe, eliminating carryover. |
| **Graphite furnace System** | |
| Heating System | Integrated computer-controlled Longitudinal Heated Graphite Furnace. |
| Function | Analytical furnace programs up to 9 steps can be set up. |
| Temperature | Programmable temperature up to 3000 °C in 1 °C increment. Maximum linear heating rate is 2000 °C/s under software control. |
| Gas Flow | Choice of two inert gases with computer-controlled flows. Separate control of inert gas stream is Argon for internal and external gas flow. The external gas flow is 1 L/min and internal gas flow in the graphite tube is 100ml/min and 200ml/min. |
| Cooling System | A closed circuit optimized to save time, water and provide stable condition. Water temperature during operation is approx. 38 °C. |
| Autosampler for Graphite | Injection volumes from 1 to 50 µL in increments of 1 µL are user selectable. Automatic dilutions and additions of three different modifiers are available. Corrosion resistant sample tray holds 87 positions. |
| Safety Functions | Warning will function when cooling water flow failure, gas pressure over, Furnace temperature too high, Graphite tube broken. |
| Camera for Graphite tube | This camera provides a full-color image monitoring for observation of the sample injection by autosampler or manual injection. It is also able to observe the sample drying in Graphite tube. |
| **Other information** | |
| Software | SPWinAA Software Package |
| Weight | 150kg |
| Dimensions (W x D x H) | 800 mm x 800 mm x 575 mm |
| Environmental Requirements | 10 °C up to 35 °C Rel. humidity max. 85 % |
| Power Requirements | 110 / 220V±10%, 50/60Hz |


PerkinElmer Thailand
290 Soi 17, Rama 9 Road, Bangkapi, Huay Kwang,
Bangkok 10310, Thailand
Contact: +6623197901
Email: sales.thailand@perkinelmer.com

PerkinElmer Malaysia
#2.01 Level 2, Wisma Academy Lot 4A, Jalan 19/1 Petaling Jaya
Selangor 46300 Malaysia
Contact: +60379491118
Email: Malaysia.Sales@perkinelmer.com

PerkinElmer Singapore
2, Tukang Innovation Grove, #04-01, JTC MedTech Hub,
Singapore 618305
Contact: +6568681662
Email: sgsales@perkinelmer.com