analytikjena

# contrAA® -
# A Revolution in Spectroscopy

**Basics and Applications of High-Resolution Continuum Source AAS**

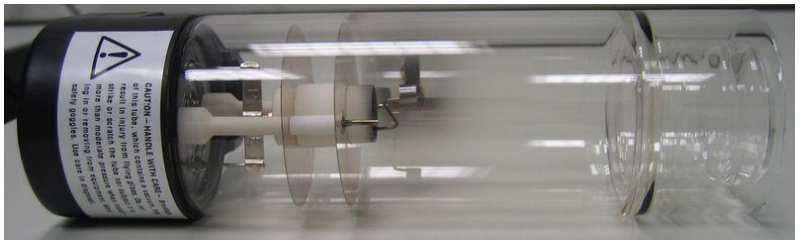
# Methods for element analysis

## AAS – a well established method for more than 50 years

- Simplicity
- Less interferences
- Robustness
- Low purchase cost
- Low operation cost

**BUT !!**

- Single element method
- Specific HCLs required
- Unprofitable for many elements
- Limitation in background correction

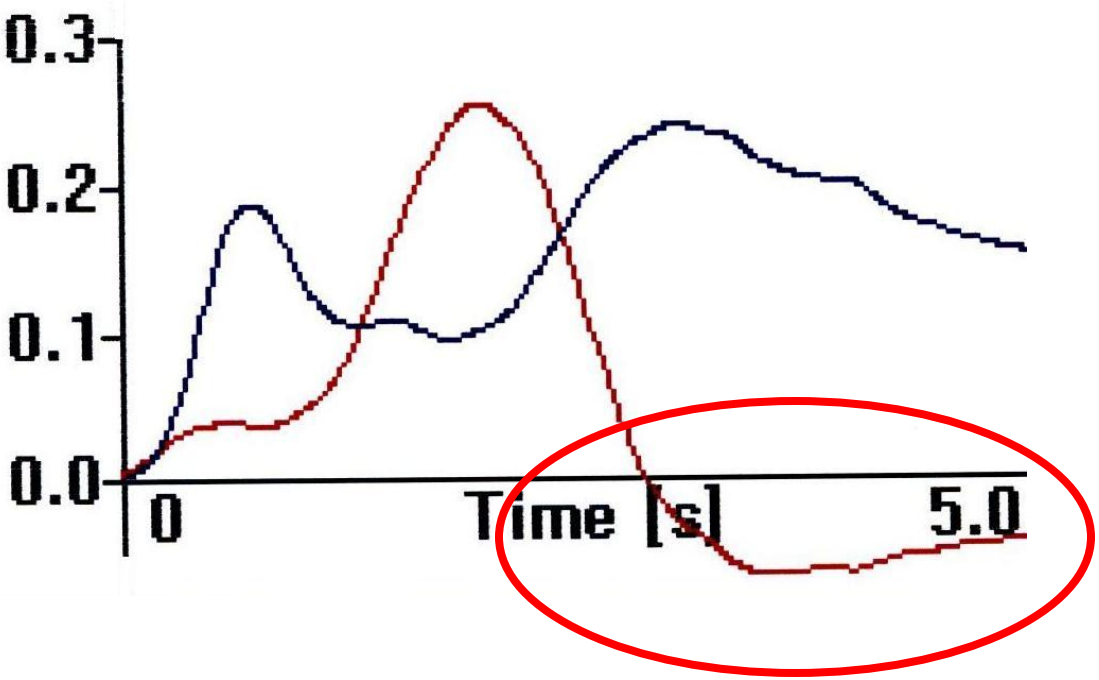


# New instrument development needs motivation


AAS goes multielement!

# New instrument development needs motivation

## We need more information!




In case of a spectral interference, we can see only the result, but not the reason – therefore the optimization of method parameters to avoid the spectral interferences is difficult.

# Key components of HR-CS AAS

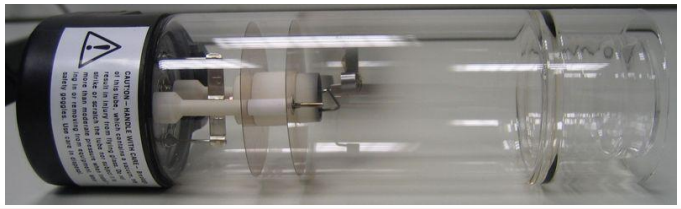
| HR-CS AAS | LS-AAS |
|---|---|
| **Radiation source** | |
| Xenon – short arc lamp | HCL, EDL, boosted HCL |
| **Atomizer** | |
| Identical atomizer for flame and graphite technique | |
| **Monochromator** | |
| High resolution >1:140000 | Low resolution |
| **Detector** | |
| CCD array detector | Single spot detector (PMT) |
| **Software** | |
| ASpectCS ® | WinAAS® |

# Radiation source

- **LS AAS**

**Hollow cathode lamp (HCL) line radiator**

Cathode contains the element to be analyzed



- **HR-CS AAS**

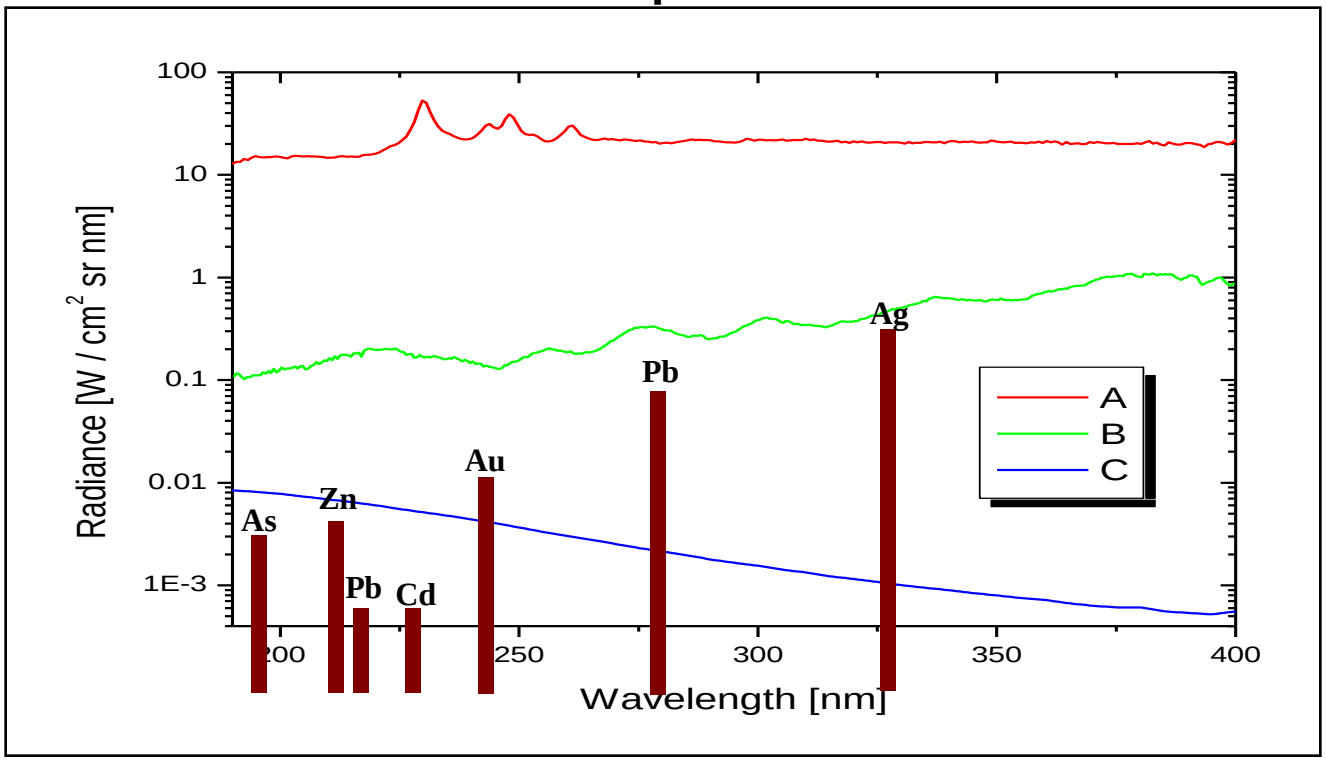
**Xenon short arc lamp continuum radiator**

Covers whole wave length range 185 – 900 nm

Determination of more than 67 elements with one lamp only

# Radiation source

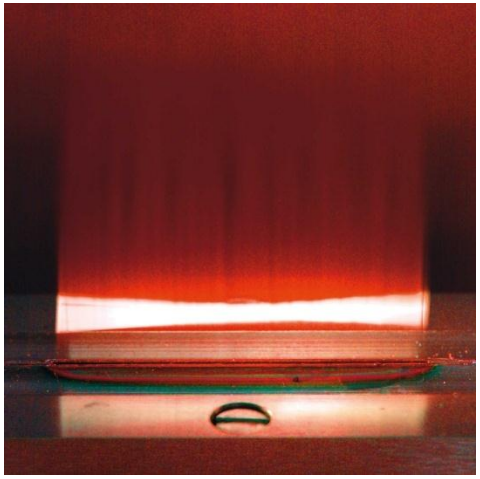
## Different radiation sources in comparison



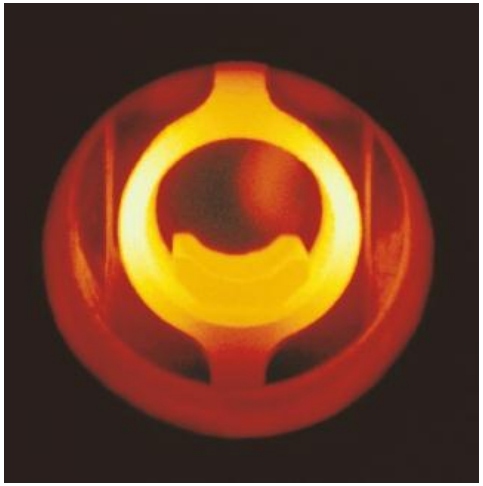

Source: „High-resolution continuum source AAS“ Welz,Becker-Roß,Florek,Heitmann

A Xenon-short arc lamp, XBO 301, 300 W, (GLE Berlin), „Hot - Spot“ - Mode
B Xenon lamp, L 2479, 300 W, (HAMAMATSU), diffuse mode
C D2 - Lamp, MDO 620, 30 W, (HERAEUS)

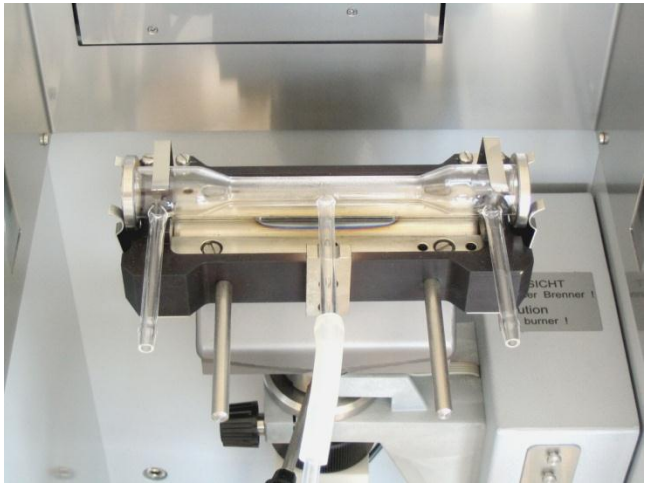
# Atomizer in HR-CS AAS



Flame atomizer

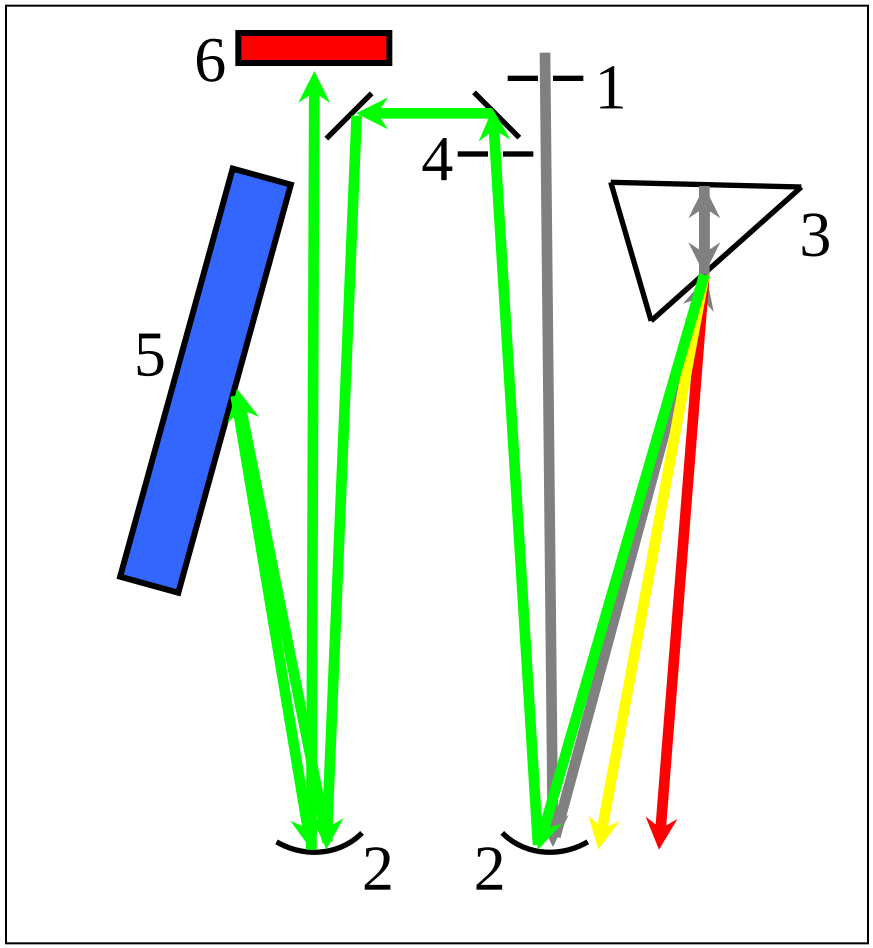


Graphite furnace atomizer



Quartz cell atomizer

# Double Echelle Monochromator




Source: ISAS Berlin

1: entrance slit (fixed)

2: off-axis parabolic mirror

3: prism in Littrow- position

4: intermediate slit (variable)

5: Echelle- grating in Littrow-position

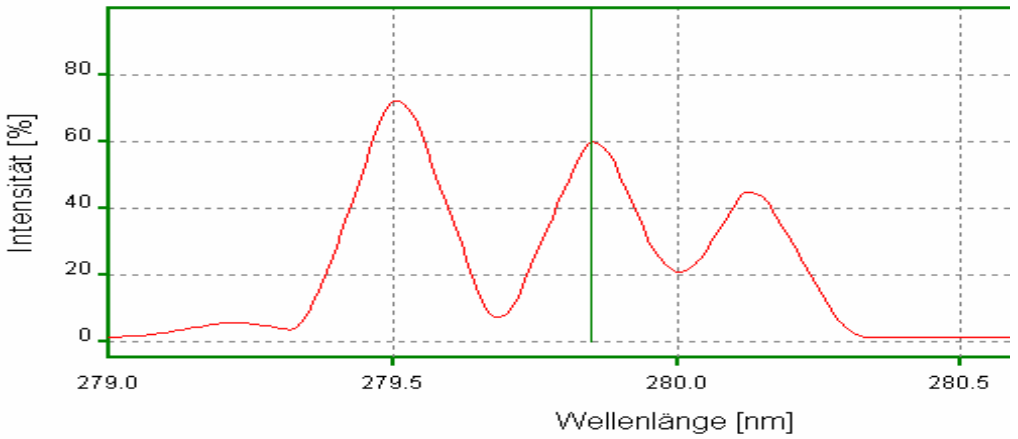
6: CCD – array detector

# Monochromator resolution LS AAS vs. HR-CS AAS

## LS AAS
## Emission scan

Mn – Triplet:

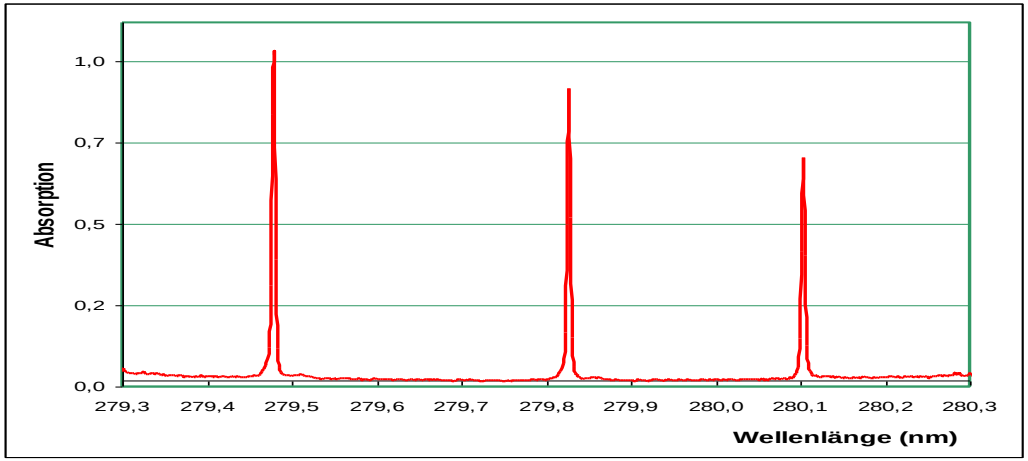
279, 4817 nm
279, 8269 nm
280, 1085 nm




## CS AAS
## Absorption spectrum

Resolution factor *1000*

better than LS AAS !!!

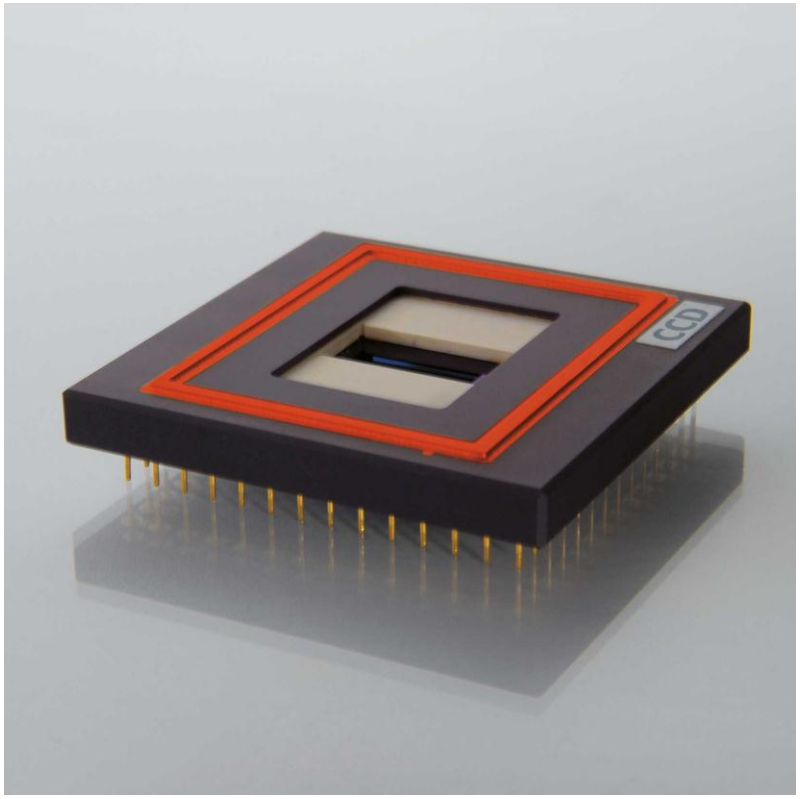


# Resolution – spectral interferences

| Analyt | Wavelength (nm) | Disturbing elements | Wavelength (nm) | λ-Difference (pm) |
|---|---|---|---|---|
| Se | 196.03 | Fe | 196.060 | 30 |
| As | 193.70 | Fe | 193.670 | 30 |
| Zn | 213.856 | Fe | 213.859 | 3 |
| Cd | 228.80 | As | 228.810 | 10 |
| | | Fe | 228.720 | 80 |
| Ni | 232.00 | Fe | 232.040 | 40 |
| Sn | 224.605 | Pb | 224.690 | 85 |
| | | Fe | 224.565 | 40 |
| Mn | 279.48 | Fe | 279.470 | 10 |
| Cu | 324.75 | Fe | 324.600 | 15 |
| Al | 396.15 | Fe | 396.110 | 40 |

# CCD Detector

## New detection technology




Detector “Pixels” are illuminated and read out simultaneously and independently.

200 Pixels are used analytically
200 independent detectors !

3 Pixels for AA measurement
- and the others???

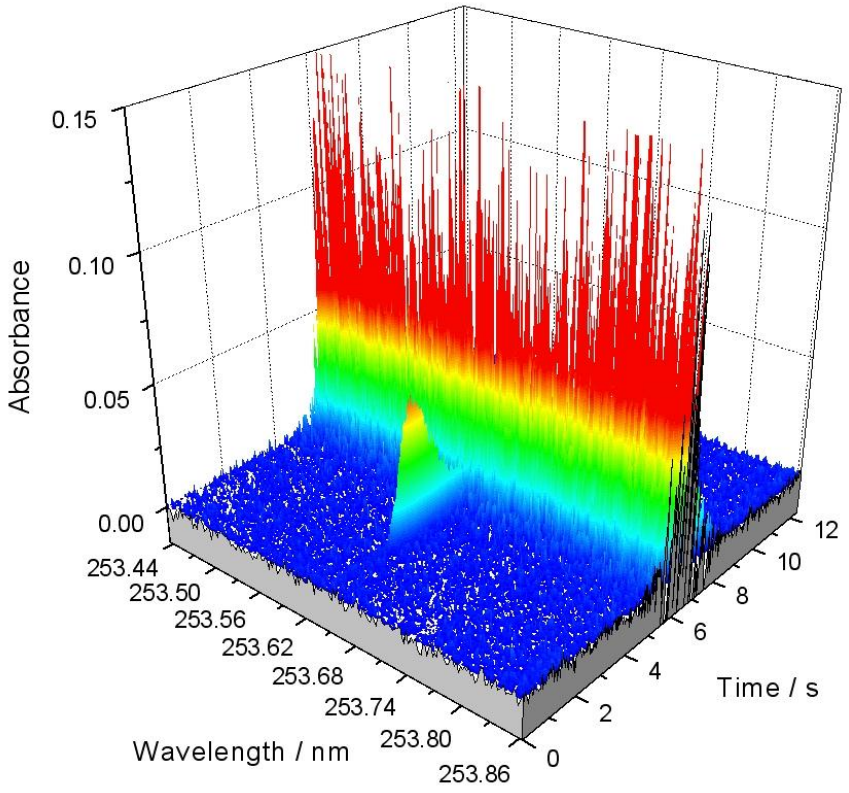
# Corrections

| Type of interference | LS-AAS | HR-CS AAS |
|---|---|---|
| Lamp intensity drift | Optical double beam sequential | Reference pixels simultaneous |
| Thermal emission | Lamp modulation sequential | Reference pixels simultaneous |
| Non specific absorption | BG correction sequential | Reference pixels reference spectrum simultaneous |

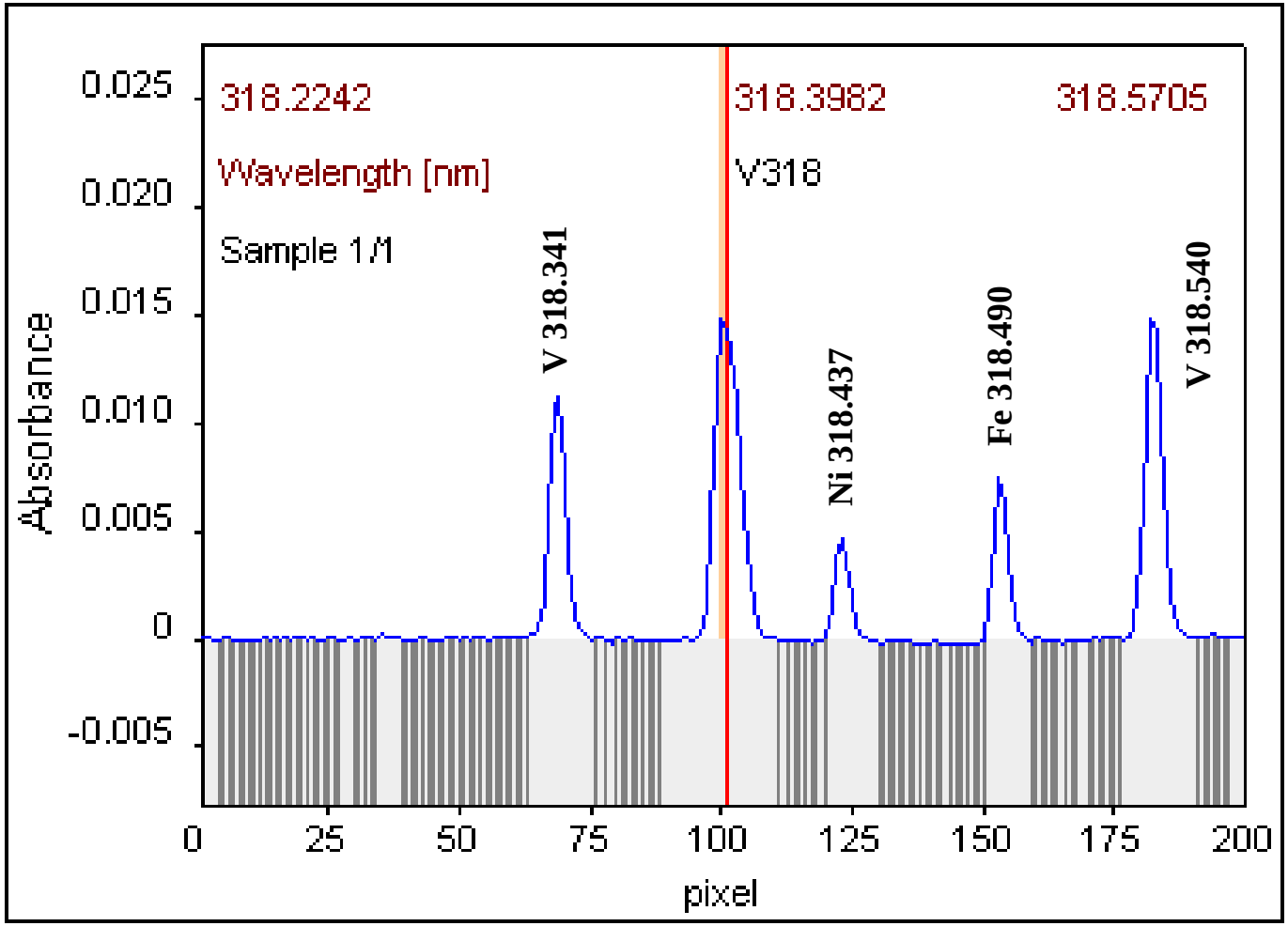
# Corrections

In HR-CS AAS we have a Third Dimension, i.e. we can see a lot more !

- We can see the spectral interference
- We can avoid the spectral interference
- And we have much better ways to correct for spectral interferences



# Background correction and resolution

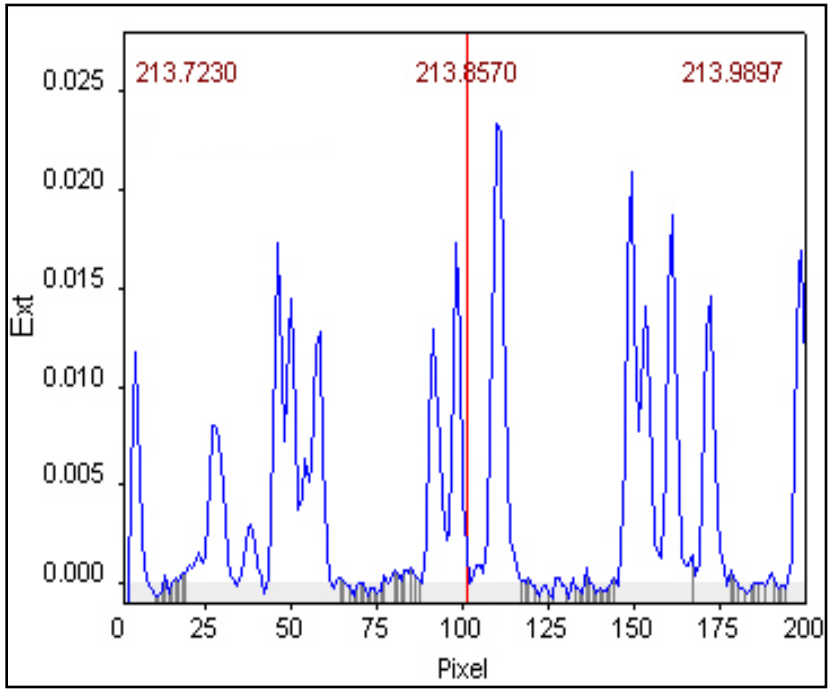


# Corrections of discontinuous events

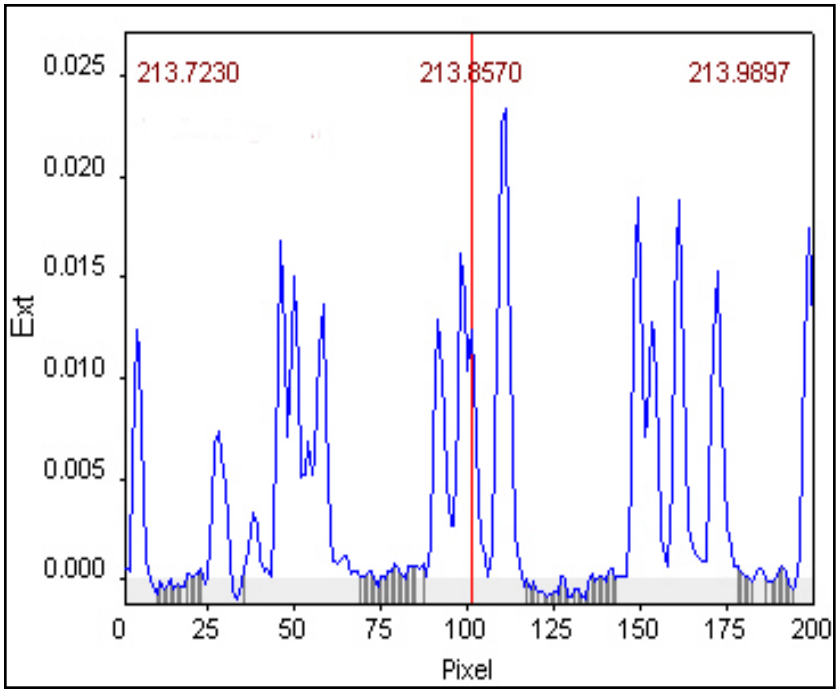
## Diatomic molecules with rotational fine structure

- OH, NO, CN are natural constituents of flame gases
- NO, PO, SiO, CS etc. might be generated in the presence of high matrix concentration
- Neither the D2 nor the Smith-Hieftje system can correct for this background,
- the Zeeman system can only correct if the background is not affected by the magnetic field !
- In HR-CS AAS we can measure and store a reference spectrum that can be subtracted from the sample spectrum using a least-squares algorithm

# Corrections of discontinuous events

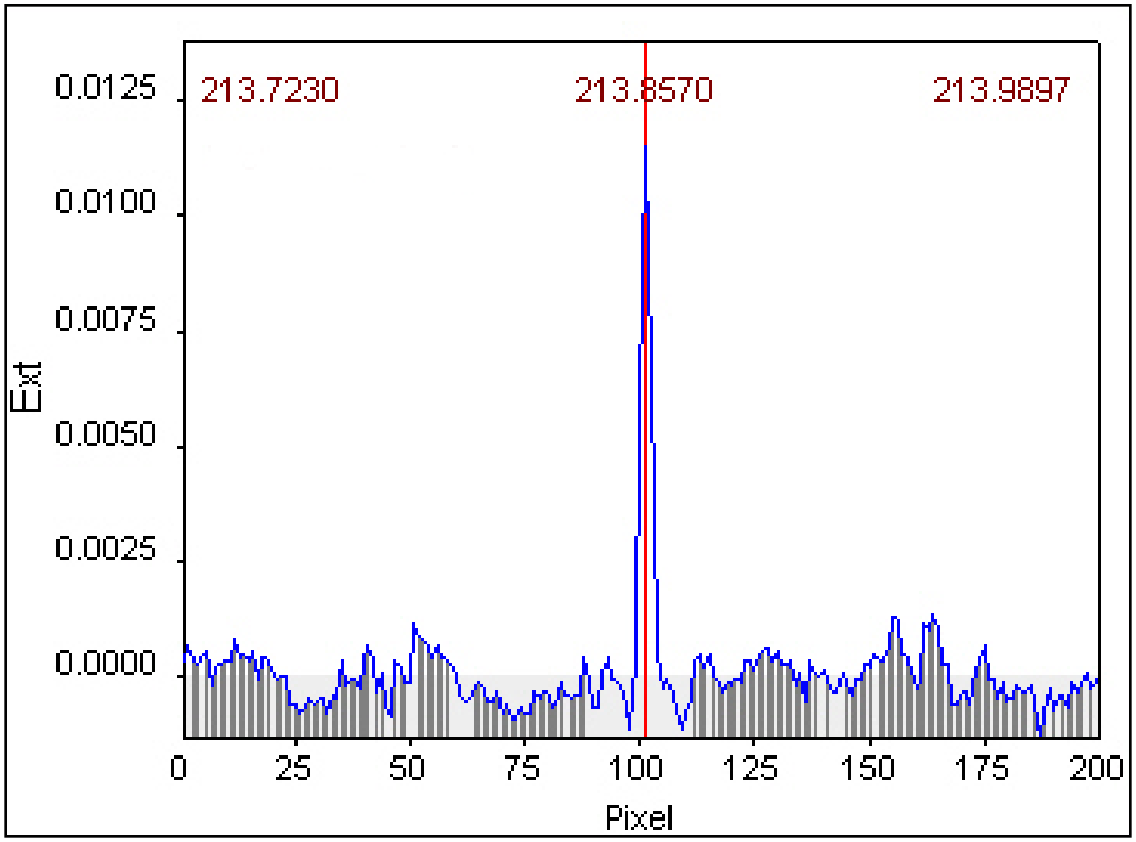



Matrix: 3% $HNO_3$




0,01 mg/L Zn in 3% $HNO_3$

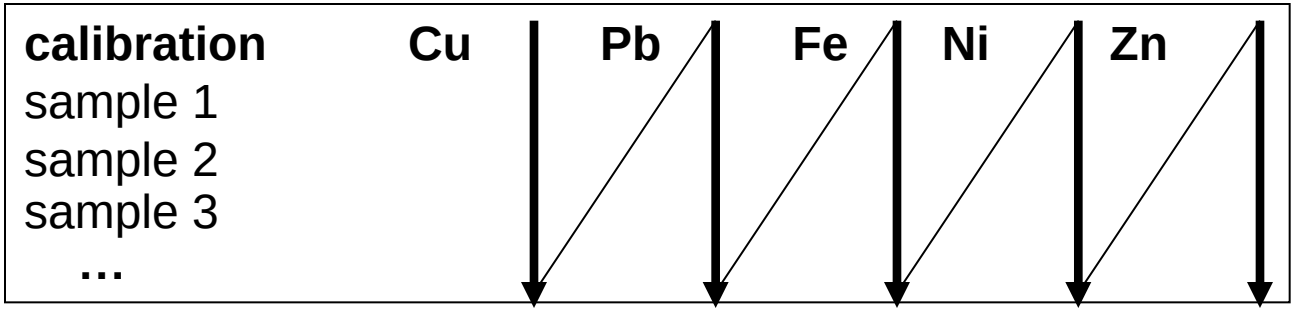
# Corrections of discontinuous events




Corrected spectrum

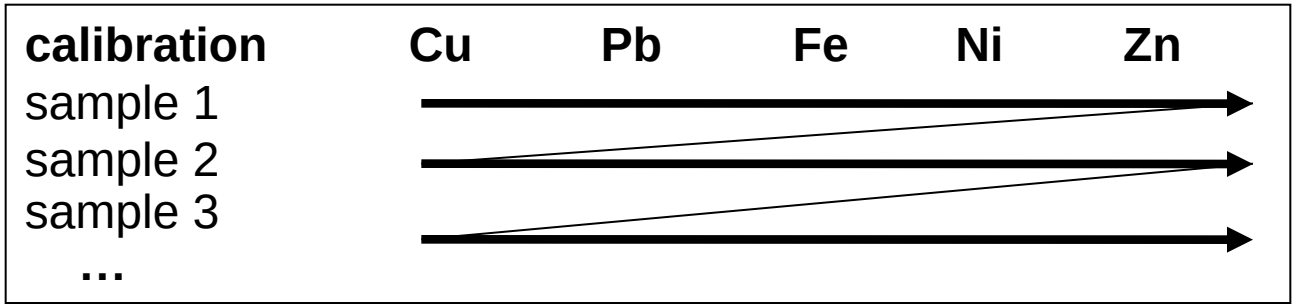
# Multi-element analysis

## Single element method




**LS AAS**

## Sequential multi element method

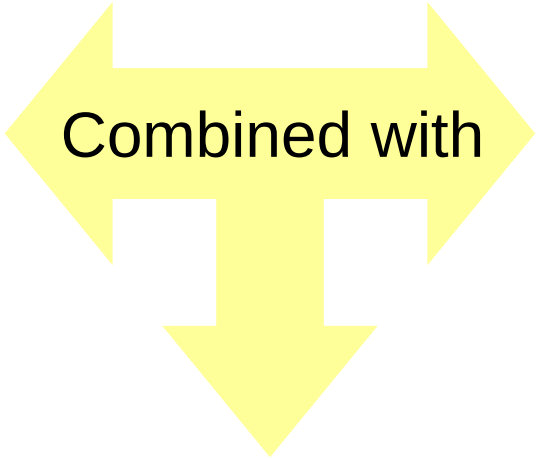



**CS AAS**

# Conclusion

Simplicity,
Less interferences,
Durability

of AAS




Speed,
Flexibility
Information

of ICP

Continuum Source
Atomic Absorption Spectrometry

**Closing the gap between AAS and ICP**

# Quality is the difference

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Thank you for your attention!