MERCURY ANALYSIS
MADE EASY
AND AFFORDABLE

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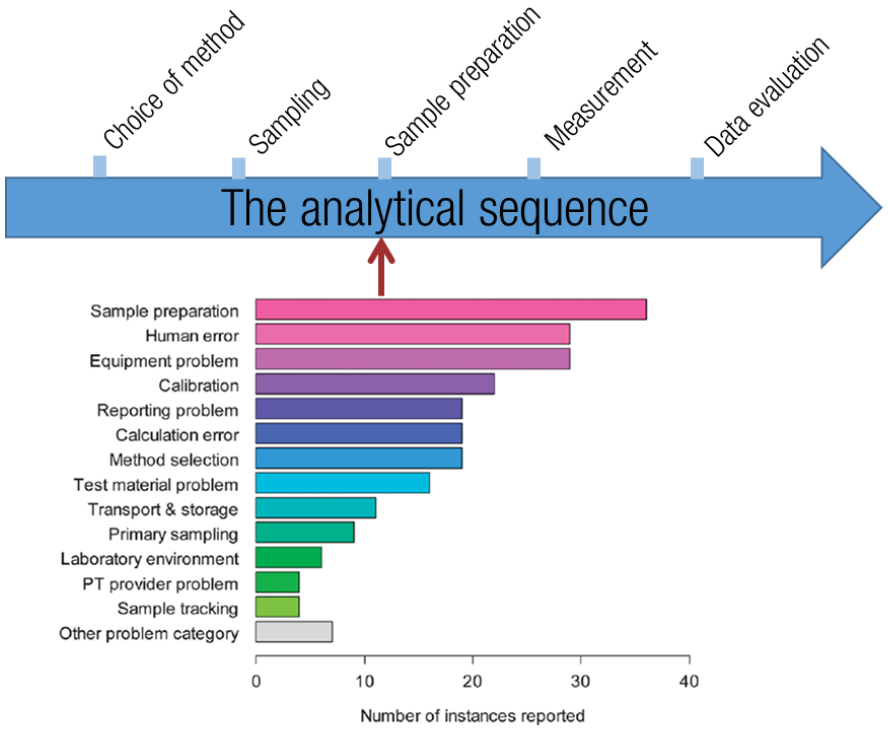
DMA-80 evo

Direct Mercury Analyser
March, 18th Lahti

CHALLENGES IN MERCURY ANALYSIS

- Sample preparation is the weak part of the analytical sequence
  - External contaminations
  - Incomplete digestion
  - Loss of volatile elements
  - Low purity of acids
- Increase time and cost per analysis



Analytical Methods, 5:2914–2915, 2013.

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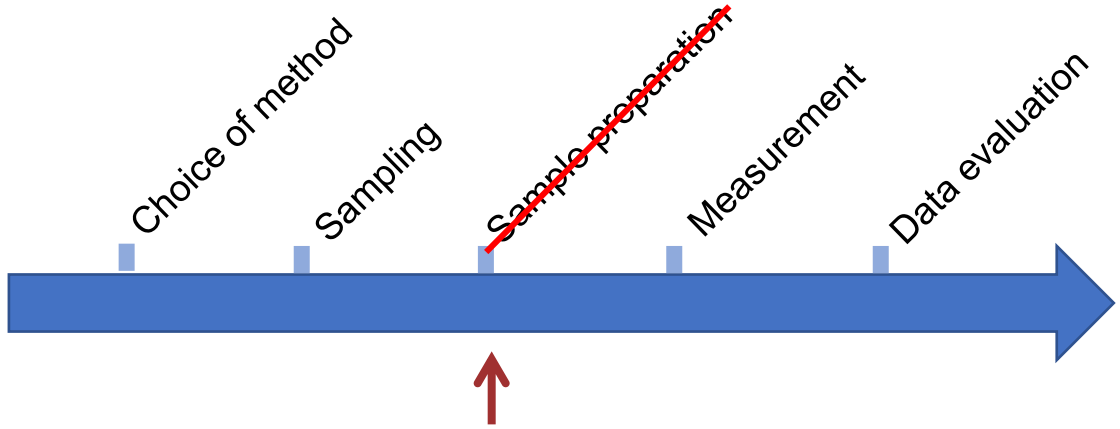
WHY DIRECT MERCURY ANALYSIS



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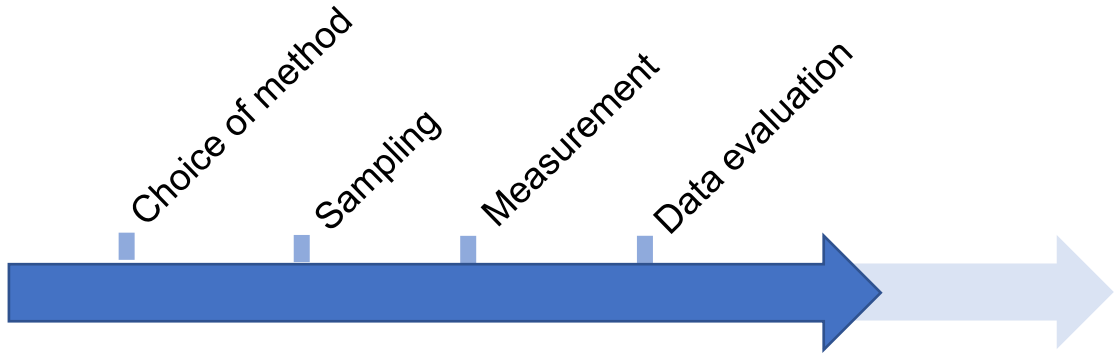
THE ANALYTICAL SEQUENCE WITH DMA-80 EVO



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DMA-80 EVO VS CV-AAS

Technique	DMA-80 evo	CV-AAS/ ICP
Sample preparation	Not required	Acid digestion
Wet chemistry	Not required	Yes, to eliminate interferences
Waste generation	Minimal	Yes
Sample type	Liquid, solid and gas	Aqueous
Sample size	Up to 500 mg sample	Up to 100 ml solution
Working range	Up to 1500 ng	Limited to low range
Running cost	Moderate	Elevated

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DMA-80 EVO ADVANTAGES

- Fast analysis
  - Rush samples
  - Evaluation of raw materials
  - Quick feedback to production
- High performance
  - High accuracy and precision
  - Wide working range
  - Official method compliance
- Ease of use
  - Direct mercury analysis in any sample (solid, liquid)
  - One calibration for all matrices

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DMA-80 EVO - INTRO

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DMA-80 CURRICULUM VITAE

- 25 years of experience in Direct Mercury Analysis
- 4000 systems installed worldwide
- Used in several applications:
  - Environmental
  - Power plant
  - Clinical/ biological
  - Cement
  - Food/ fish
  - Petroleum
  - Polymers

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CUSTOMER

The University of Helsinki is the oldest and largest university in Finland. It has repeatedly been ranked among world's top universities. The University's core focus is on research, teaching and valued support through community relations. By utilizing the power of science, the University has contributed to society, education, and welfare since 1640.

CHALLENGE

The main goal was to find a technique that would avoid contamination of wet chemistry samples pre-treatment before mercury analysis, and to eliminate chemicals and hazardous wastes.

SOLUTION

The DMA-80 was able to determine mercury quickly and easily, lowering operating costs. In addition, the superior performance of the DMA-80 was also a significant factor.

BACKGROUND

The Department of Environmental Science at University of Helsinki holds a high standard for environmental education and research. The research at this department focuses comprehensively on environmental changes caused by human activities. The research is aimed at finding solutions to environmental problems.

IMPLEMENTATION

The purpose of mercury analysis is mainly research, but it also has been used in some courses for teaching students. Samples analyzed are mostly sh, aquatic animals, plants, sediment, animal tissues, bird feathers, terrestrial plants, moss, mushrooms, and lichens. The DMA-80 Direct Mercury Analyzer from Milestone was purchased about 10 years ago and it has made Hg analysis faster, easier, with no use of chemicals or hazardous wastes.

Before the introduction of the DMA-80, the lab had the older Coleman MAS-50, which was a Cold Vapor AAS using $SnCl_2$ for reduction of Hg. It essentially hindered the lab's overall production as the analysts needed to prepare the samples in solution that was more expensive due to the use of chemicals and time.

They budgeted for the DMA-80 to be able to work faster and to avoid other wet chemistry sample treatment prior to analysis.

The DMA-80 is suitable for Hg concentrations of their samples. Their most common working range is about

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

"Our DMA-80 was purchased about 10 years ago, It made our Hg-analysis faster, easier and with no chemicals neither hazardous wastes."

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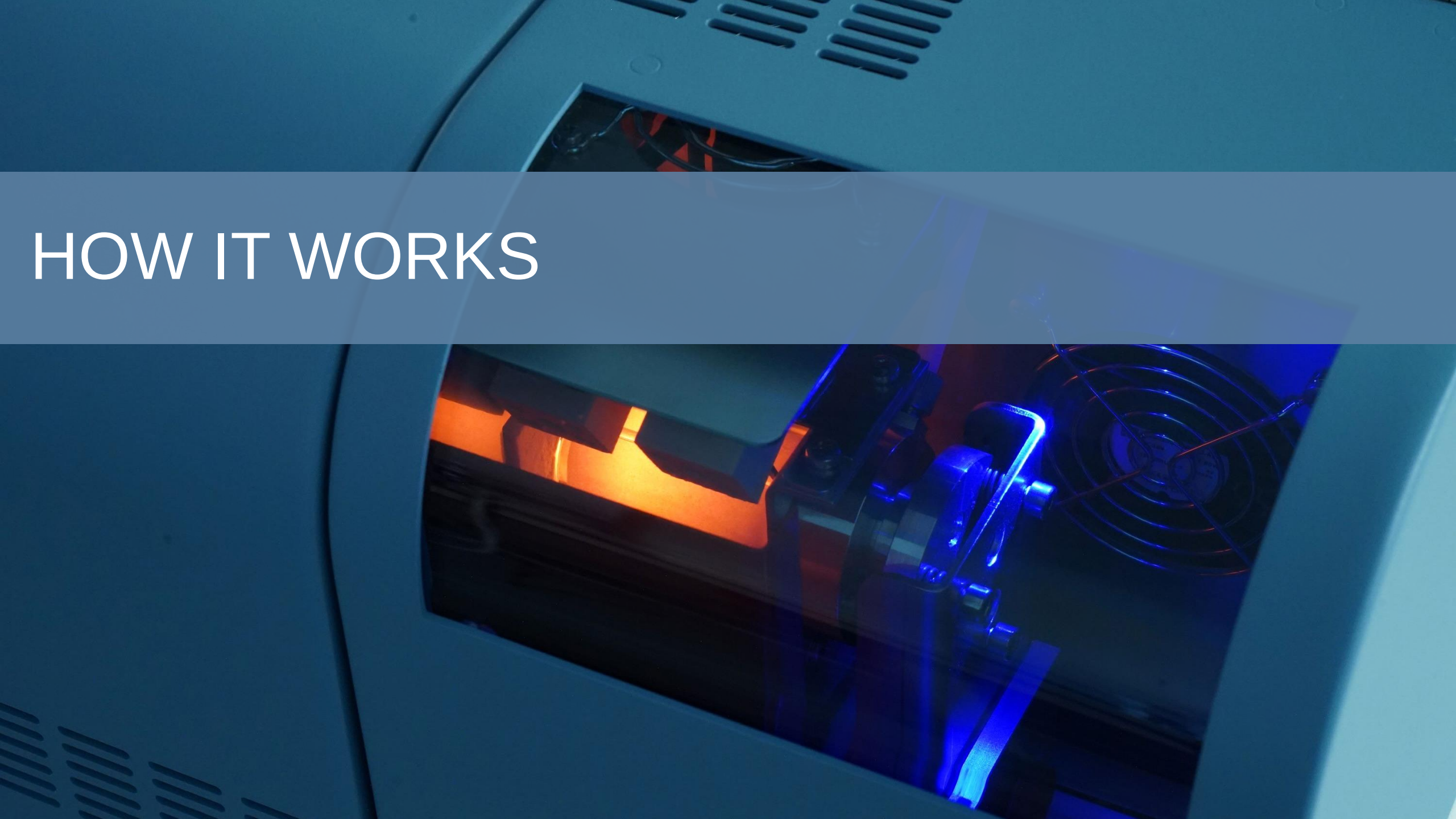
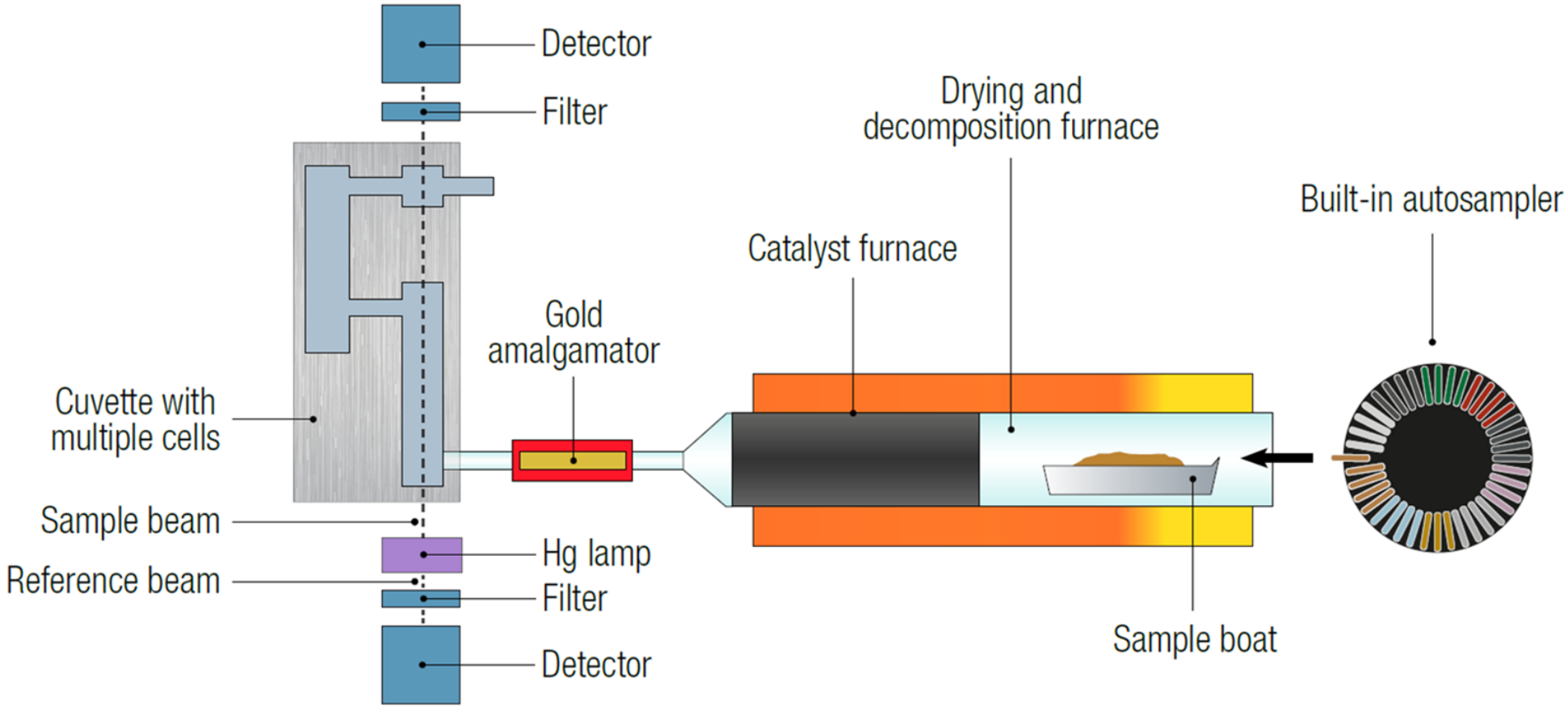
HOW IT WORKS



PRINCIPLE OF OPERATION



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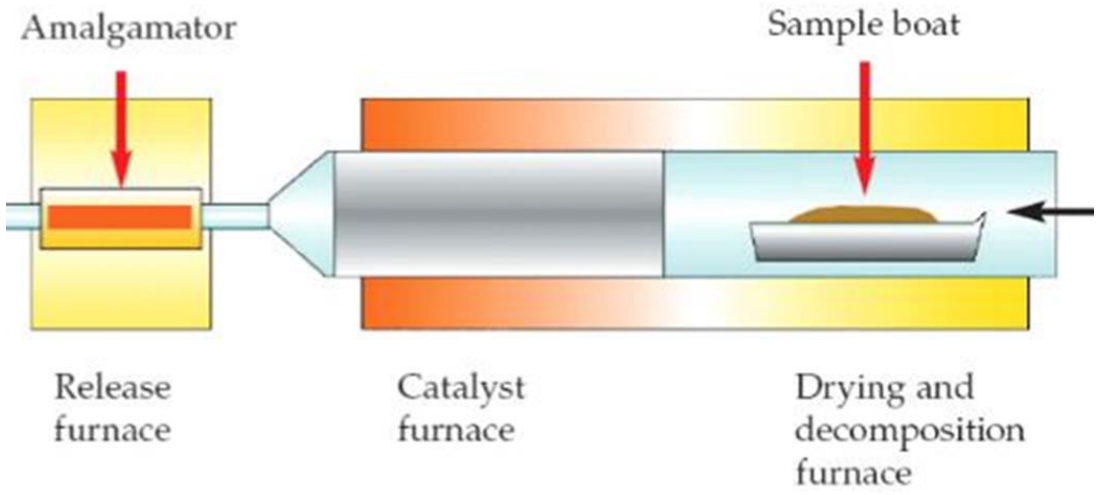
CATALYST TUBE AND AMALGAMATOR

Both fundamental components to ensure high quality and reliability in mercury analysis

- The catalyst has a double function
  - Reduces all Hg species to Hg0
  - Traps interferences
  - Removes halogens
- Selective amalgamator to catch Hg0
- Long lifetime and easy to replace
- Reliable performance batch after batch



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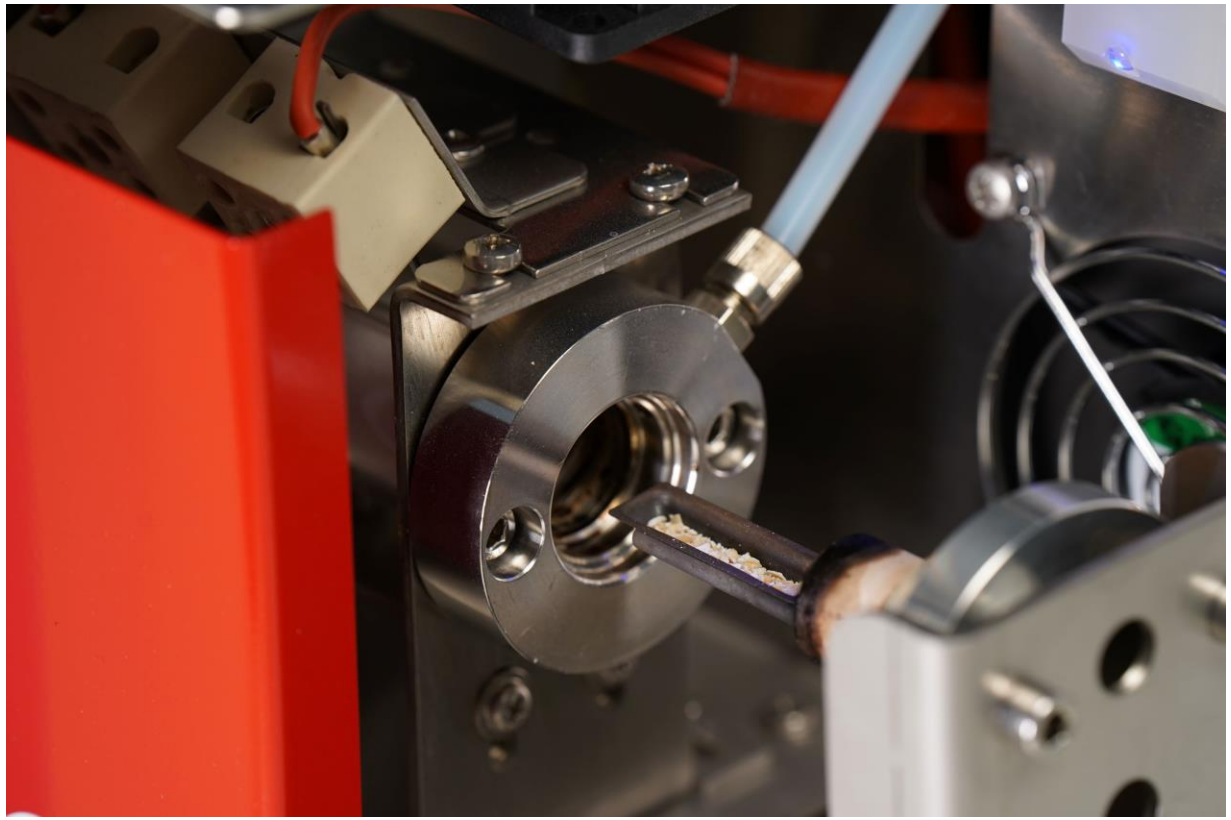
HEATING FURNACE

- Dries and decomposes the sample
- High decomposition temperature (selectable up to 850°C)
- Ensure complete Hg release even from challenging samples (geological, mining)



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FULL CONTROL OF SAMPLE DECOMPOSITION

- Direct temperature control of drying and decomposition processes
- Control of exothermic reactions (flammable samples)
- Enhance the catalyst lifetime, by controlling the decomposition of the sample

Pos	t	T
1	00:00:30	200
2	00:00:30	200
3	00:01:00	650
4	00:01:00	650

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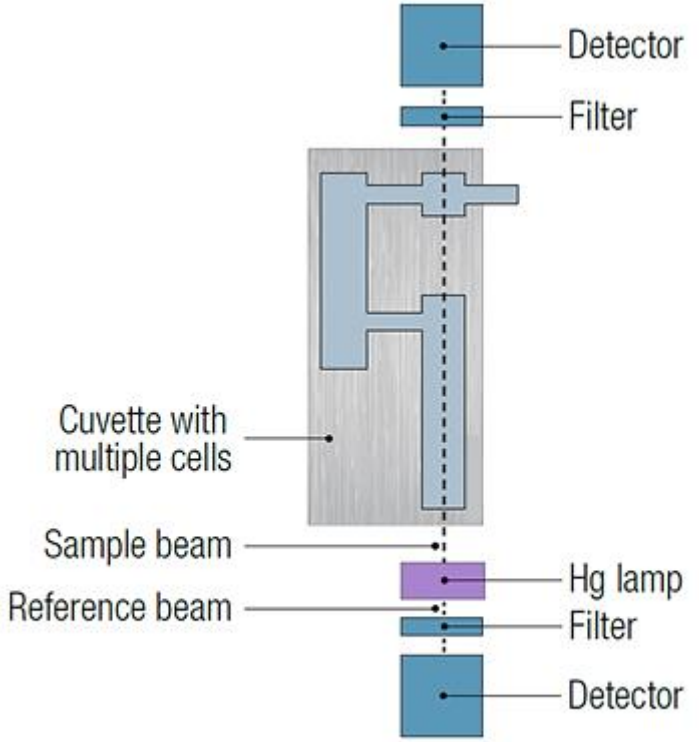
DMA-80 EVO - DOUBLE BEAM
TRICELL MODEL

- Superior signal stability
- Enhanced signal to noise ratio
- Better reproducibility
- Improved performance even at traces



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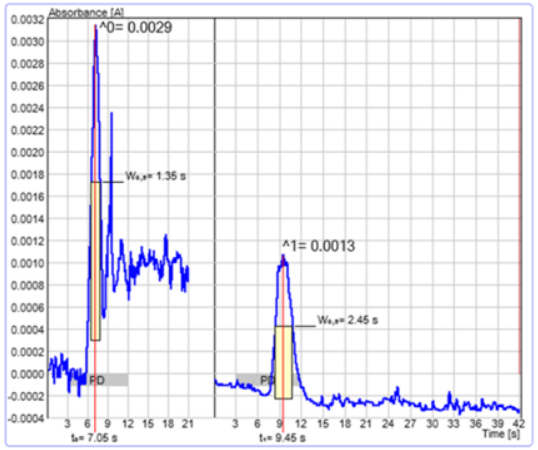
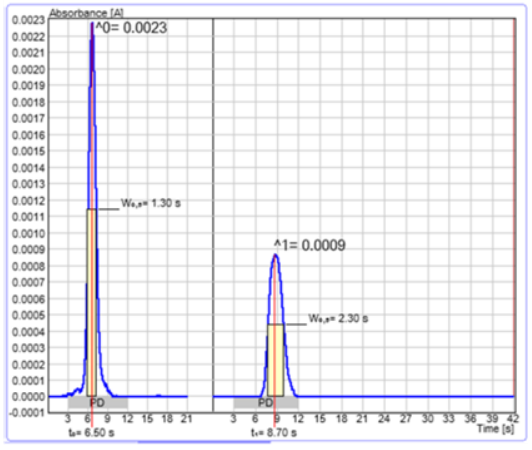
DMA-80 EVO - DOUBLE BEAM PERFORMANCE

TRICELL MODEL

- Detection Limit (DL)
  - 0,0003 ng
  - Excellent stability of the signal
- Low blanks level
- LOQ at 0,03 µg/Kg (vs the actual 0,1 µg/Kg)



30 ppt with single beam



30 ppt with double beam

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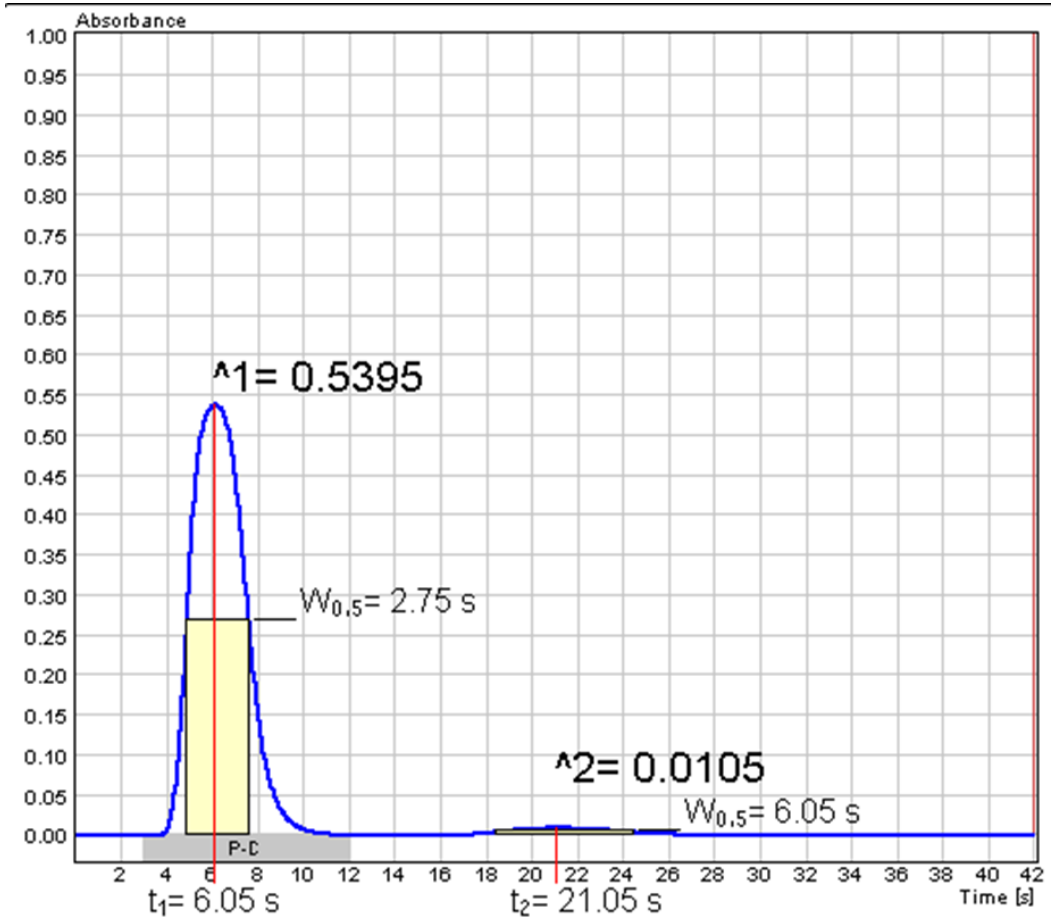
THE MERCURY MEASUREMENT

- After being released from the amalgamator, Hg flows through all cells (n°2 for the Dualcell)
- Height for both peaks is recorded
- Reading is done in every cell
- The system integrates the appropriate peak



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GREENER ANALYSIS

- No need to perform sample preparation
  - Avoid the use of concentrated acids
  - Reduced waste
  - Lower energy consumption
- No need to use gases
  - DMA-1 evo runs even with compressed air

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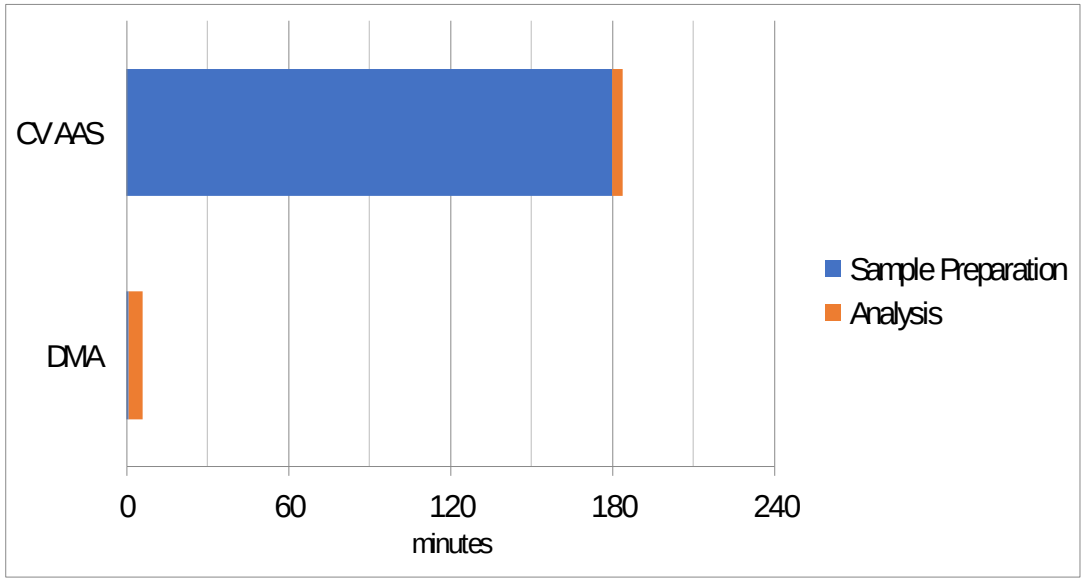
GREEN TECHNOLOGIES

EASE OF USE & PERFORMANCE

ANALYSIS TIME COMPARISON

- Over 90% time saving
  - No sample prep
  - Fast sample reprocessing
  - Less operator time



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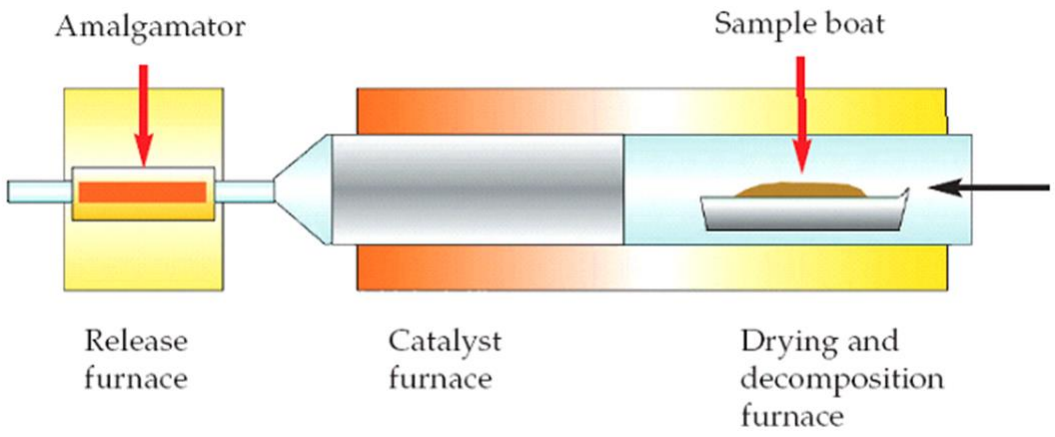
FAST ANALYSIS

- Great asset to:
  - Improve analysis workflow
  - Process rush samples
  - Evaluate raw materials
  - Provide quick feedback to production

6 min

NO METHOD DEVELOPMENT
ONE METHOD FOR VIRTUALLY ANY SAMPLE

- Drying
  - Water is evaporated from the samples (solid or liquid)
- Decomposition
  - Sample is heated and decomposed at high temperature
- Catalyst
  - Hg is converted into Hg^0
- Amalgamation
  - Hg is collected on gold-based amalgamator and then quickly released



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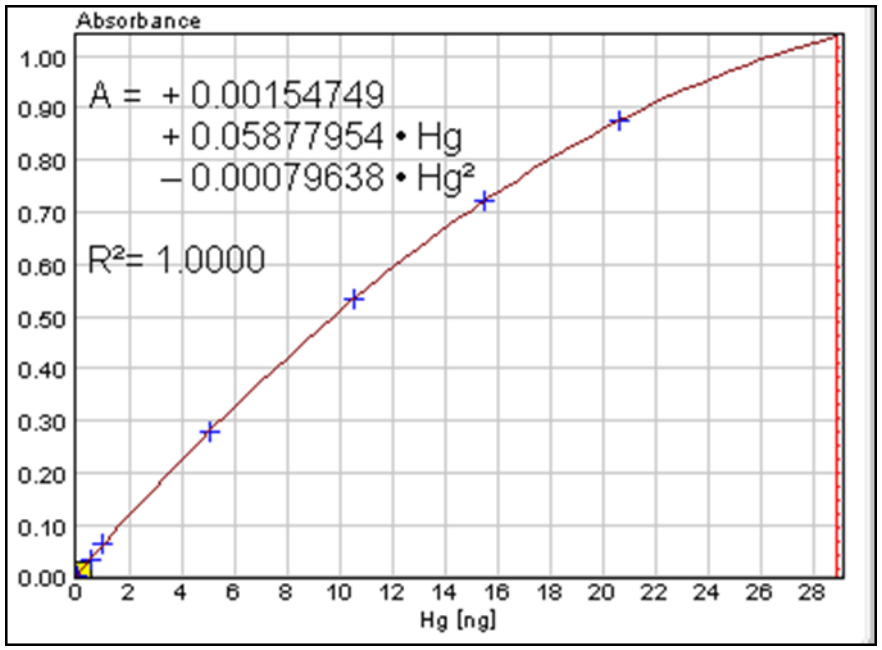
ONE CALIBRATION FOR ALL MATRICES

- Same calibration for all matrices
- Software automatically distributes calibration based on ng of mercury present in the samples
- Long lasting calibration
- Calibrates with inexpensive liquid standards

Direct Analyzers



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ONE CALIBRATION FOR ALL MATRICES

Certified material	Certified (µg/Kg)	DMA-80 evo (µg/Kg)
NIST 1568a Rice Flour	5,8 ± 0,5	5,9 ± 0,2
BCR-150 Skim Milk Powder	7,7 – 11,1	9,2 ± 0,2
NIST 1630a Coal	93,8 ± 3,7	93,4 ± 2,4
NIST 1633b Fly Ash	141 ± 19	149 ± 2
BCR-61 Aquatic Plant	210 – 250	221 ± 3
GSD-10 Stream Sediment	280 ± 40	270 ± 15
BCR-422 Cod Muscle	543 – 575	558 ± 8
IAEA-086 Human Hair	534 - 612	574 ± 12
NIST 2711 Soil	6250 ± 190	6240 ± 70
BCR-680 Polyethylene	24,3 – 26,3 mg/Kg	25,8 ± 0,5 mg/Kg

OFFICIAL METHODS COMPLIANCE

- US EPA 7473
  - Total mercury in solid and solutions
- ASTM D-6722-01
  - Total mercury in coal and coal combustion
- ASTM D-7623-10
  - Total mercury in crude oil

HIGH ACCURACY AND PRECISION

Sample	Concentration DMA-1 *evo* (mg/kg)	Certified (mg/kg)
NIST 1633b	0.142	0.14 ± 0.02
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NIST 1633b	0.139	0.14 ± 0.02
NIST 1633b	0.135	0.14 ± 0.02
NIST 1633b	0.140	0.14 ± 0.02

NIST 1633b, Constituent Elements in Coal Fly Ash Certified Material
RSD: 2.06% - Mean: 0.139 mg/Kg - SD: 0.028

Sample	Concentration DMA-1 *evo* (mg/kg)	Certified (mg/kg)
BCR 277R	0.125	0.128 ± 0.017
BCR 277R	0.122	0.128 ± 0.017
BCR 277R	0.123	0.128 ± 0.017
BCR 277R	0.127	0.128 ± 0.017
BCR 277R	0.127	0.128 ± 0.017

BCR 277R, Estuarine Sediment Certified Material
RSD: 1.83% - Mean: 0.124 mg/Kg - SD: 0.0023

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SUITABLE FOR A WIDE RANGE OF SAMPLES

Environmental

Food/Fish

Power plant/Coal

Cement/Mining

Clinical/Biological

Petrochemical

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DMA-80 EVO - USER INTERFACE

- Available with dedicated terminal or PC
- Software incorporates the most advanced features to ensure:
  - Data reliability
  - Compliance with regulations
  - High productivity
  - Simplify analysis report

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21 CFR PART 11 COMPLIANCE

- Auto-save function
- History trail organized by field
  - All
  - System
  - Access
  - Errors
  - Application
- Expiring date signature
- New access level
  - Manager

Audit trail tacking in full compliance with 21 CFR part 11

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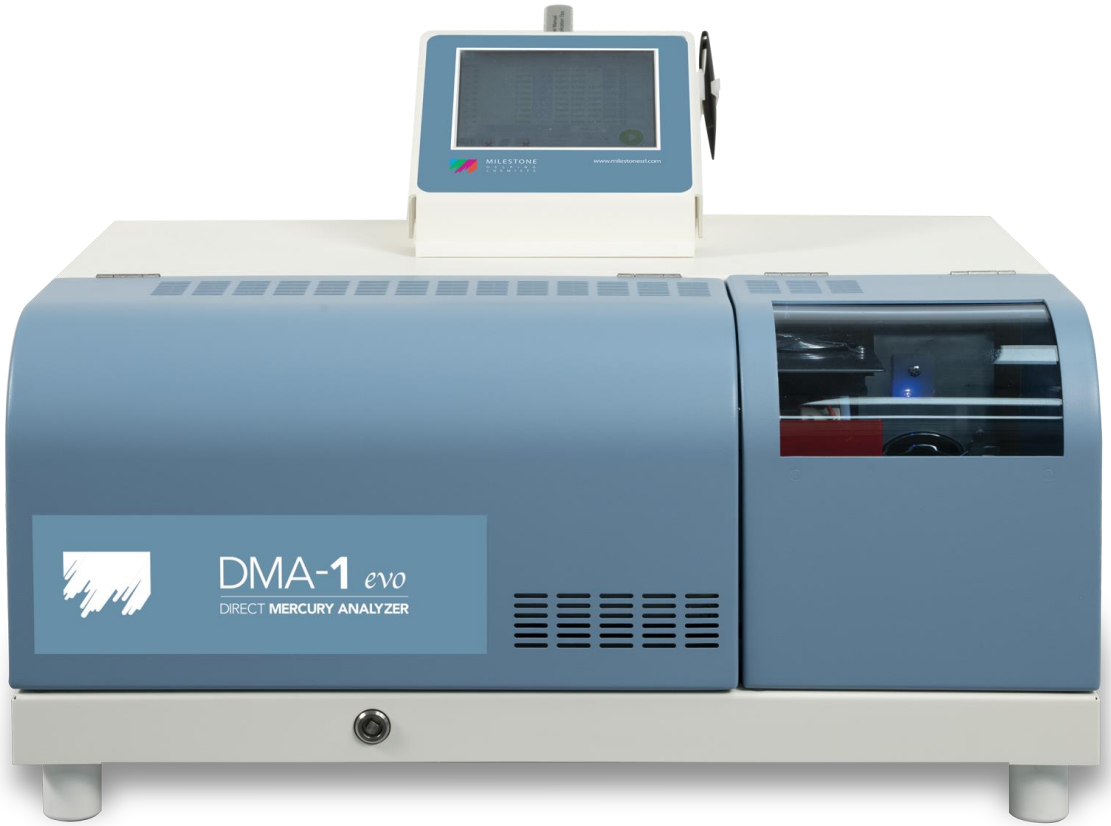
DMA-1 EVO



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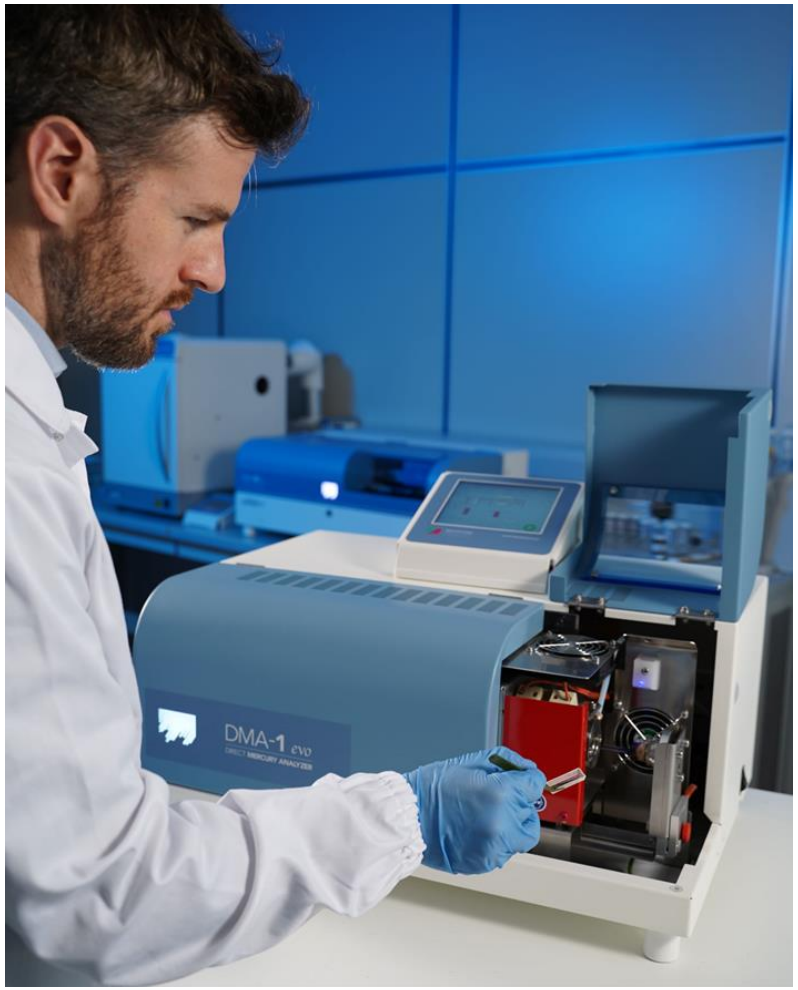
COMPACT AND AFFORDABLE

DMA-1 EVO ADVANTAGES

- High performance
- Ease of use
- Fast analysis
- Affordable and cost-effective
- Compact



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COMPACT AND AFFORDABLE

- Limited bench space
  - Integrated user interface
- Suitable for
  - Onsite testing
  - Mobile labs
- Low initial investment
- Low running cost

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DMA-80 EVO AIR COMPRESSOR

- Lower running cost
- Reliability and low maintenance
- Great performance
- High safety and better working conditions

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COST-EFFECTIVE ANALYSIS

- No reagents are required
  - Avoid the use of concentrated acid (often ultra pure)
- No sample preparation required
- Strong reduction of wastes
- Less operator time

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THANK YOU