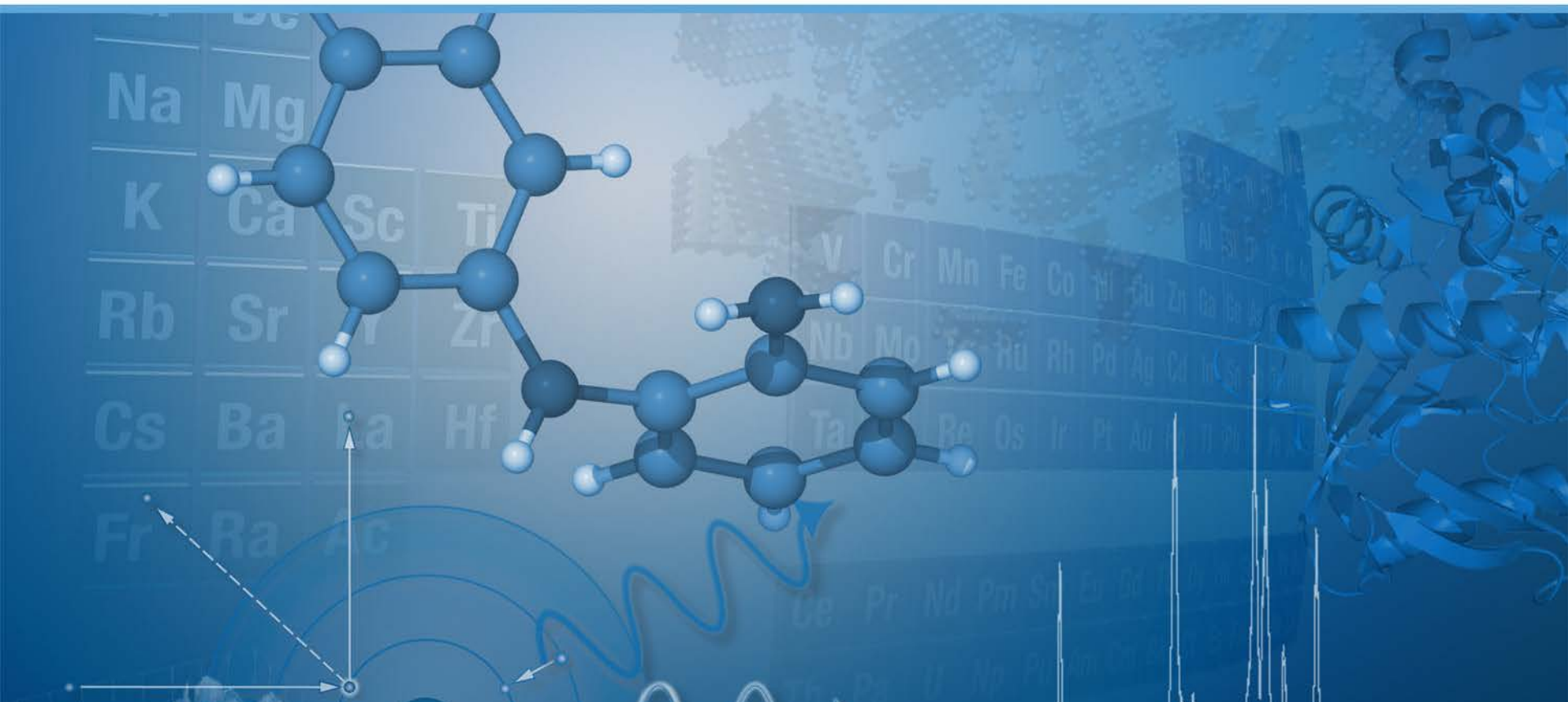


# WEBINAR: WDXRF for Petrochemical Analysis More Than a One-Trick Pony



# WDXRF for Petrochemical Analysis: More Than a One-Trick Pony



Arkady Buman  
Product Manager XRF  
North America

## Today's Topic

- Understanding the refinery process
- The value of WDXRF in process and quality control
- WDXRF
  - Analytical technology
  - Solutions for quantification
- Solutions for the refinery
  - Low sulphur analysis (ASTM D 2622)
- Bruker's WDXRF spectrometer S8 TIGER and its benefits
- Applications
  - Residual oil analysis
  - Lubricating oil
- Summary

# Today's Speakers

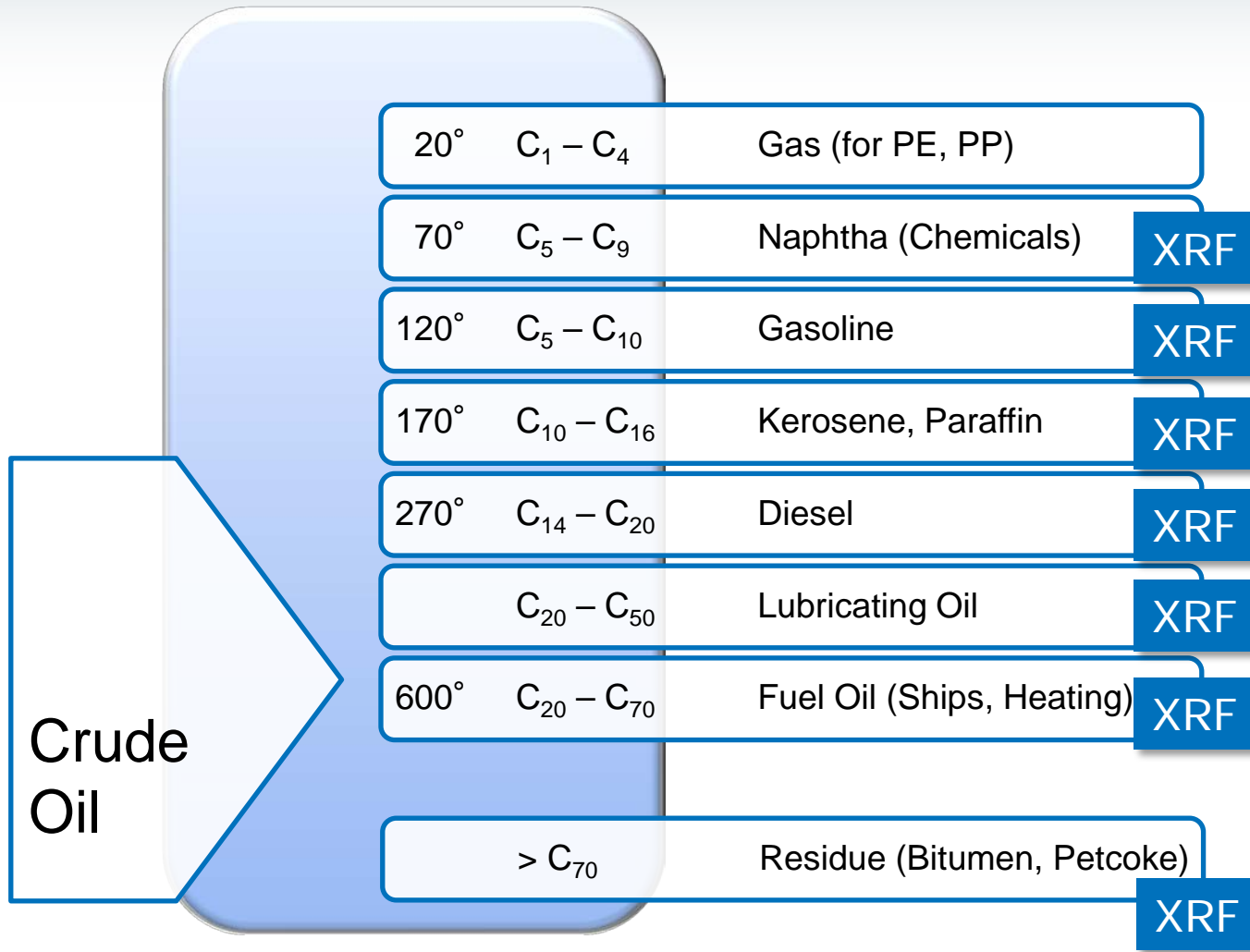


Dr. Kai Behrens,  
Global Product Manager  
XRF, Karlsruhe,  
Germany



Dan Pecard,  
Sr. Applications Scientist XRF,  
Madison, WI

# Understanding the refinery process Products



# Understanding the refinery process

## Product Mix – max. 197.000 tons crude oil/day

Fuels 90 %

- Gasoline 40%
- Diesel 23%
- Fuel Oil 15%
- Kerosene 10 %

ASTM  
D 2622

Non Fuels 5%

- Lubricants
- Bitumen
- Wax

ASTM  
D 6443

Fuel for the refining process 5%

Heat recycling

Loss to atmosphere 0.5%



## Audience Poll

- Please use your mouse to answer the question on the right of your screen:

Which analytical methods are you using for elemental analysis in your lab?

(Check all that apply):

- ICP-OES
- ICP-MS
- Flame AAS
- GF-AAS
- XRF
- TXRF
- Titration
- Others...



# Petrochemical applications

## Norms



Analytical norms define and govern:

- scope
- range
- accuracy
- precision
- for a given application and suitable tool.

The aim of norms is to make results comparable and traceable as basis for regulatory compliance.

Which technology can be used?  
ED or WDXRF?

# Standards and Applications of XRF for Automotive Fuels



## Sulfur in automotive fuels:

- [EN ISO 20884](#)  
Low range: 5 – 50 ppm  
High range: 50 – 500 ppm
- [ASTM D 2622](#)  
Low range: 5 – 50 ppm  
for gasoline, mineral oil

## Lead in automotive fuels:

- [DIN 13723](#)
- [ASTM D 5059](#)  
Low range: 1 - 30 ppm  
still relevant in developing countries



# Petrochemical Applications

## Norms for Petrochemistry



- Various norms are regulating the use of a specific analytical technique and tool for petrochemical applications:
- WDXRF is the most sensitive instrument of choice for the precise determination of sulfur in petrochemicals:

ASTM 2622 ISO 20884 ISO 14596	WDXRF	gasoline petroleum prod. fuels	ultra low detection limits ( $< 0.2$ ppm) highest precision

# S8 TIGER

## Superior Analytical Performance



# S8 TIGER WDXRF spectrometer series



The S8 TIGER<sup>(((</sup> WDXRF spectrometers are the latest models on the market with most modern technology!

Available in:  
three basic configurations:

- S8 TIGER 1K
- S8 TIGER 3K
- S8 TIGER 4K

# WDXRF spectrometer series: S8 TIGER 1K



Unique analytical performance with lowest cost-of-operation:

- Highest intensity in class
- No cooling water
- No compressed air
- Reduced helium consumption
- Economic:  
lowest cost of operation
- Smallest footprint (~ 0,8 m<sup>2</sup>)

# WDXRF spectrometer series: S8 TIGER 3K



Advanced analytical performance with clear benefits by design:

- Intensity like conventional 4 kW WDXRF
- 3 kW (60 kV, 150 mA)
- No compressed air
- Dust sealed spectrometer cabinet
- Smallest footprint (~0,8 m<sup>2</sup>)
- Reduced helium consumption
- Reduced cooling water consumption, independent from short fluctuations



# WDXRF spectrometer series: S8 TIGER 4K

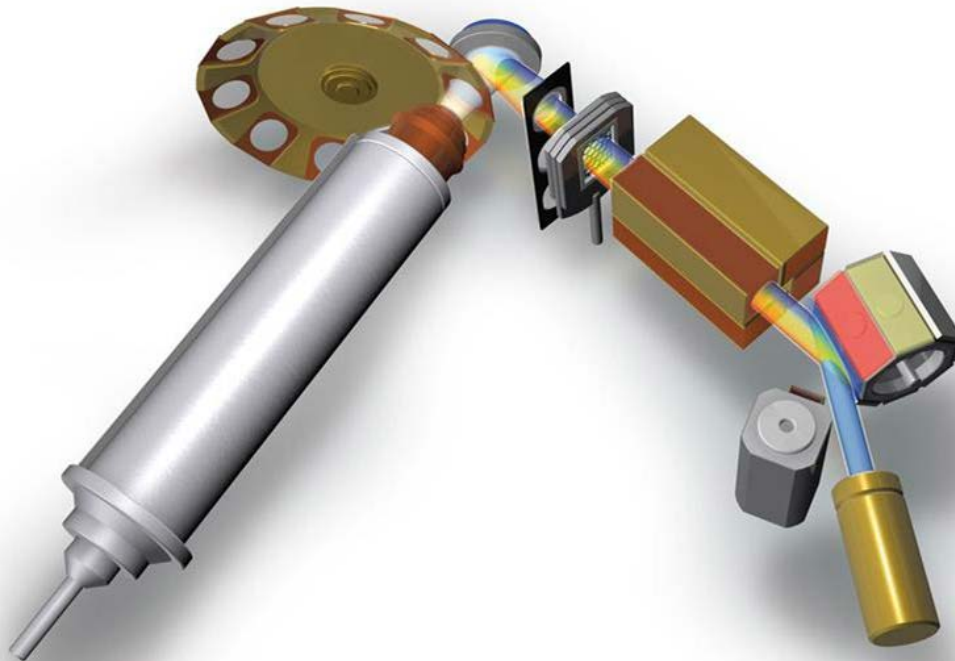


Superior analytical performance with clear benefits by design:

- Best in the market:
- max. 170mA - 4 kW for best light element analysis
- No compressed air
- Dust sealed spectrometer cabinet
- Smallest footprint (~0,8 m<sup>2</sup>)
- Reduced helium consumption
- Reduced cooling water consumption, independent from short fluctuations

# S8 TIGER

## Sequential WDXRF

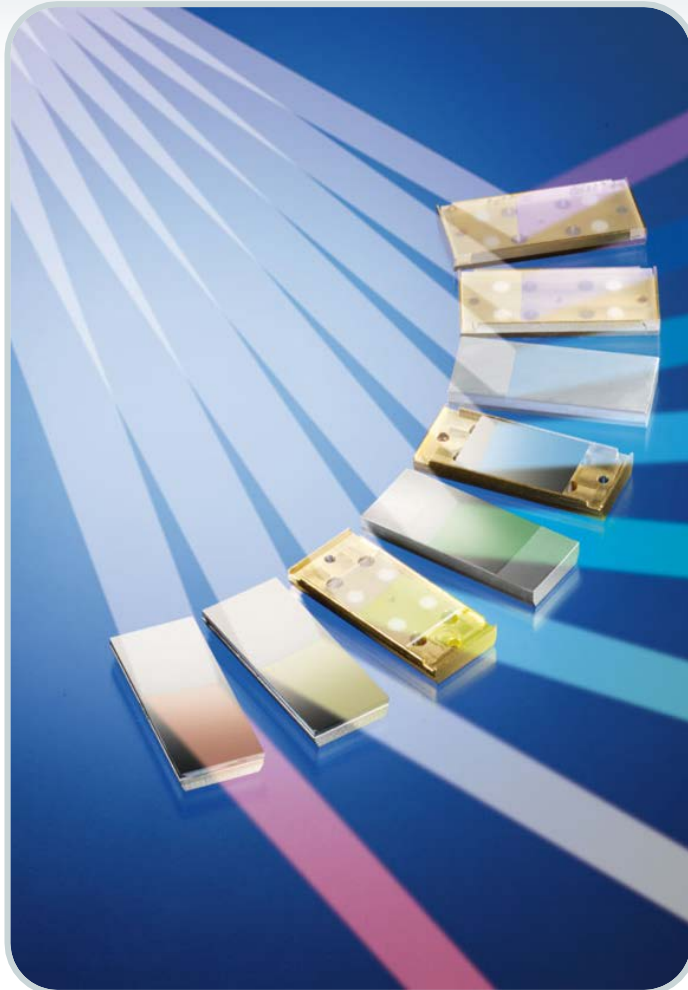


Analytical flexibility:

- 4 kW excitation  
20 – 60 kV
- 5 – 170 mA
- 10 beam filters
- 4 collimators
- 8 crystals
- 2 Detectors

# S8 TIGER

## Superior Analytical Performance



Unrivalled analytical flexibility:

- 10 position beam filter changer
- 4 position collimator changer  
(6 different divergence settings)
- 8 position crystal changer  
(15 different crystals)

Application optimized crystals:

- XS-CEM: long-term stable, temperature independent
- XS-GE-C: plus 40% intensity for P, plus 20% intensity for S
- XS-PET-C: plus 20 % intensity for Al
- XS-B: plus 100% intensity for B



# S8 TIGER

## Ultimate intensity



Curved analyzer crystal XS-GE-C

- Increased sensitivity for the elements P-Cl:
  - 20 % more intensity for S
  - 40 % more intensity for P
  - Improved resolution,
  - minimized line overlapping

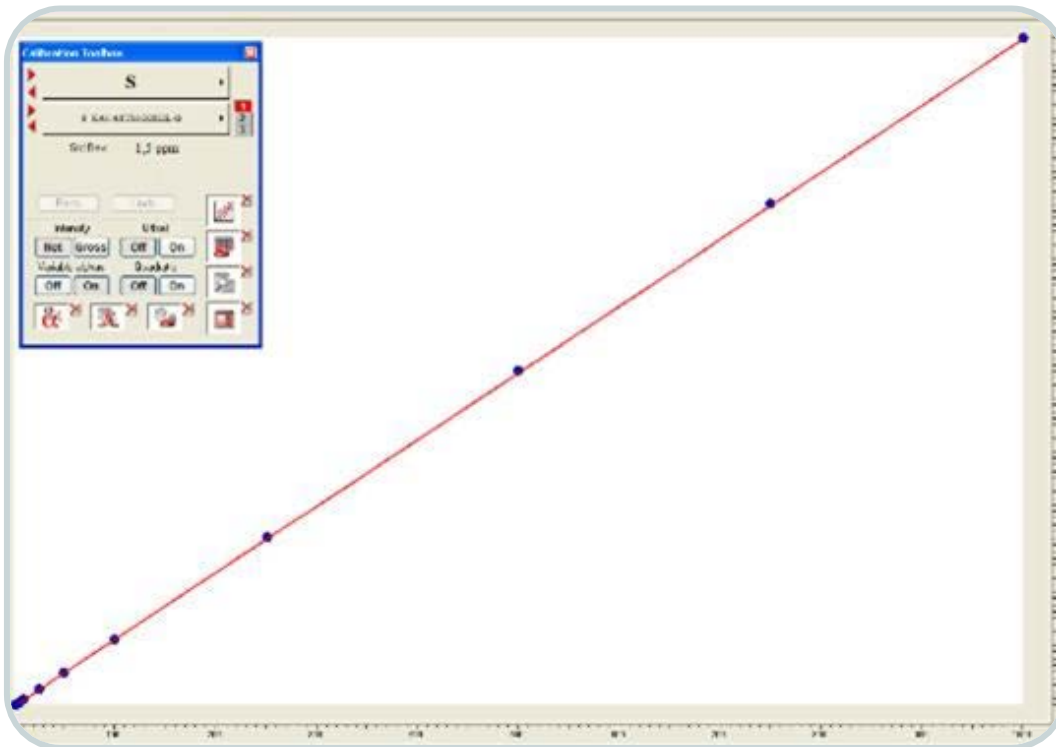


# PETRO-QUANT

## ASTM D 2622 – Low Sulfur in Gasoline



- Reduction of sulfur in fuels for cars, trucks and jets is a worldwide imperative to prevent SO<sub>x</sub> emission!
- Typical limit: < 10 ppm
- Analytical demands: Stay as close and accurate as possible to < 10 ppm



Concentration Range:

- 5 – 1000 ppm

Calibration Std. Dev:

- 1.5 ppm

Detection Limit:

- 0.4 ppm  
(3s, 30s)

# PETRO-QUANT

## ASTM D 2622 – Low Sulfur in Gasoline



Number of Repetitions	S (PPM)	Difference [ppm]
1	5.42	
2	5.12	0.30
3	5.17	0.05
4	5.31	0.14
5	5.78	0.47
...		...
18	5.34	0.40
19	5.53	0.19
20	5.67	0.14
21	5.56	0.11
Mean Value	5.51	
Abs. Std. Dev.	0.20	
Rel. Std. Dev.	3.70	

Repeatability for Sulfur:  
 Reference value  
 5.5 ppm  
 +/- 0.2 ppm

# PETRO-QUANT

## Solutions for the Petrochemical Industry



- Norm compliant to ASTM, EN, ISO, DIN
- Sulfur and lead in automotive fuels, lubricants
- Additives and stabilizers in oils, greases,...
- Wear metals to detect engine debris
- Impurities of catalysts in oils and polymers
- Additives in polymers and plastics
- Toxic elements according to RoHS/WEEE
- Pet coke / coal anodes
- Alternative fuels in cement production
- ...



# PETRO-QUANT



# PETRO-QUANT

## Unique Solutions For Petrochemicals



H																	He	
Li	Be											B	C	N	O	F	Ne	
Na	Mg											Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra	Ac																
			Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No			

Universal petrochemical calibration for up to 30 elements in hydrocarbon-based matrices– straight out of the box  
**NEW:** 4 additional elements: Co, As, Tl, Bi as additives and contaminants

# PETRO-QUANT

## Unique Solutions For Petrochemicals



### Universal Calibration for:

- Matrix: 95% or more hydrocarbons
- Elements: natural contaminants and technical additives
- Optimized sample prep for liquids & polymers
- Concentration ranges:
  - S, Cl: LLD to 5% (heavy fuels and metal working fluids)
  - Mg, P, S, Ca and Zn: up to several 1000 PPM (additives)
  - Ni, V and wear metals: max several 100 PPM (traces)

### Performance

- LLD's: few ppm's, typically less than 1PPM
- accuracy: few ppm
- precision: few ppm

# PETRO-QUANT

## Measurement Conditions



- The measurement conditions for PETRO-QUANT are specifically optimized for element concentrations down to trace levels (sub-ppm):
- Excitation: Rh anode to cover the whole element range  
S8 TIGER: 1000 W | 3000 W | 4000 W
- Filters: to optimize peak-to-background ratios  
Al: 12.5, 100, 200 or 500  $\mu\text{m}$ ; Cu: 200  $\mu\text{m}$
- Collimators: 0.23° , 0.46°
- Crystals: XS-55 (Na-Mg), PET (Al, Si), XS-Ge-C (P-Cl), LiF200 (K-Bi)
- Detectors: Proportional counter for light elements  
Scintillation counter for heavy elements
- Times: 20/6 | 16/4 | 12/4 s for peak/background measurements  
or automatically optimized for LLD 1 PPM



# PETRO-QUANT

## Ultimate Analytical Performance



Universal Calibration for petrochemicals based on SPECTRAplus:

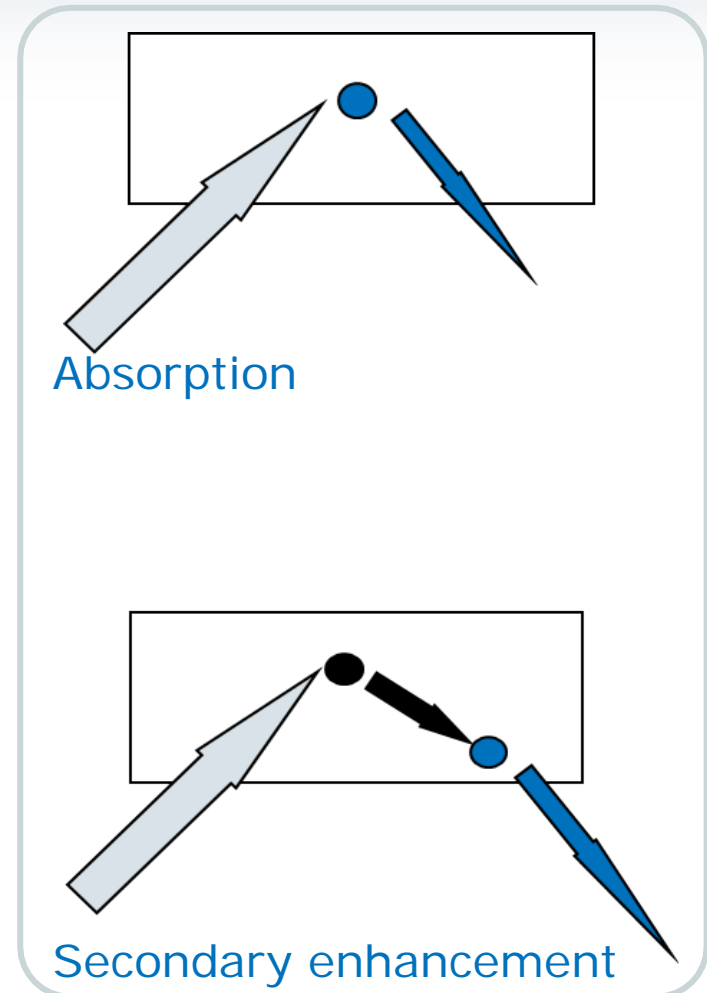
- Variable alpha (Fundamental Parameter) model for wide concentration ranges

# PETRO-QUANT

## Calibrations and Matrix Corrections

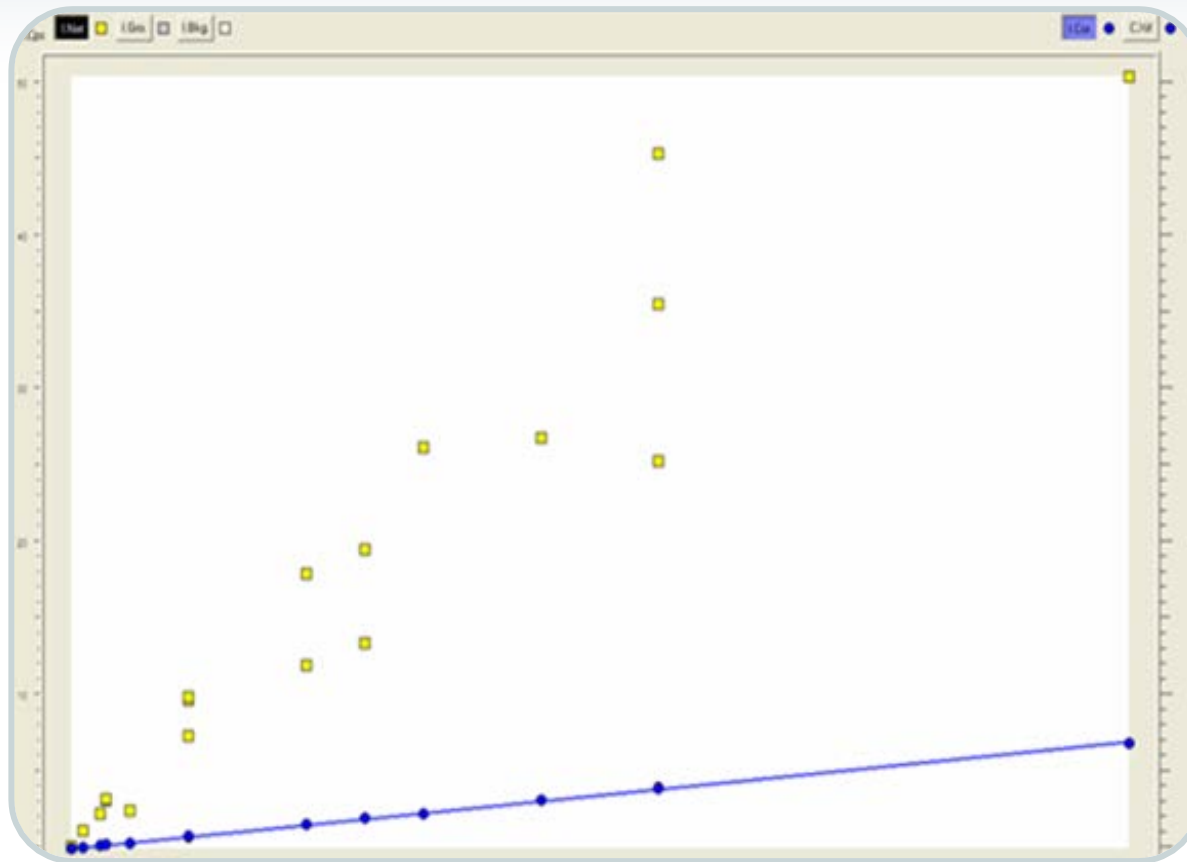


- XRF can analyze all different kinds of samples directly, therefore less sample preparation or treatment is involved.
- All elements inside will affect the fluorescence intensity from the analyzed element by absorption and secondary enhancement. Intensity is therefore strongly dependent on concentration.
- Only the powerful matrix correction method based on the variable  $\alpha$  model is able to handle the matrix effects in a globally efficient way, making the universal calibration valid over a wide concentration range. (available only with SPECTRA<sup>plus</sup>)



# PETRO-QUANT

Matrix Effect on V in Oil: 0 - 800  $\mu\text{g/g}$



■ Yellow squares  
Raw intensity changes as the concentration of different matrix elements changes

● Blue circles  
Straight calibration curve for a wide concentration range is achieved by the powerful variable  $\alpha$  matrix correction method.

# PETRO-QUANT

## Ultimate Analytical Performance



Universal Calibration for petrochemicals based on SPECTRAplus:

- Variable alpha (Fundamental Parameter) model for wide concentration ranges
- Automatic selection of best lines for high concentrations (S, Cl) and severe line overlaps (As, Tl, Pb, Bi)

# PETRO-QUANT

## Ultimate Analytical Performance



Universal Calibration for petrochemicals based on SPECTRAplus:

- Variable alpha (Fundamental Parameter) model for wide concentration ranges
- Automatic selection of best lines for high concentrations (S, Cl) and severe line overlaps (As, Tl, Pb, Bi)
- Aut-**O**-matic: Quantification of light matrix

# PETRO-QUANT

## Ultimate Analytical Performance



Aut-**O**-matic:

Quantification of light matrix

- Determining a Compound using Compton Ratio:
- Oxygen cannot be measured directly (absorption of its intensity by the cup foil)
- Determining of additional matrix compounds using Compton optimization
  
- In hydrocarbons as an example:
- The oil matrix (CH<sub>2</sub>) is determined by the balance to 100%,
- The oxygen content is determined by optimization of the Compton intensity

# PETRO-QUANT

## Ultimate Analytical Performance



Universal Calibration for petrochemicals based on SPECTRAplus:

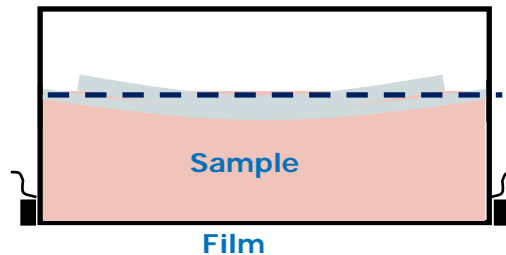
- Variable alpha (Fundamental Parameter) model for wide concentration ranges
- Automatic selection of best lines for high concentrations (S, Cl) and severe line overlaps (As, Tl, Pb, Bi)
- Aut-**O**-matic: Quantification of light matrix
- Geometric Correction of Wedge Effect
- Meniscus-Correction

# PETRO-QUANT

## Ultimate Analytical Performance



Liquid Sample Cell



### Geometric Correction of Wedge Effect and Meniscus-Correction

- Liquid samples often exhibit the meniscus effect: Top surface of the liquid is concave instead of flat.
- This will introduce errors in the calculation of the composition (wrong sample height)
- Meniscus Effect Correction for liquid samples:
- Insert size of the meniscus effect in the Application Wizard

Preparation: Liquid-Prep

Size

Area density:  g/cm<sup>2</sup>

Area:  cm<sup>2</sup>

Mass:  g

Diameter:  cm

Mass:  g

Thickness:  cm

Density:  g/cm<sup>3</sup>

Diameter Thickness Density

Diameter Thickness Mass

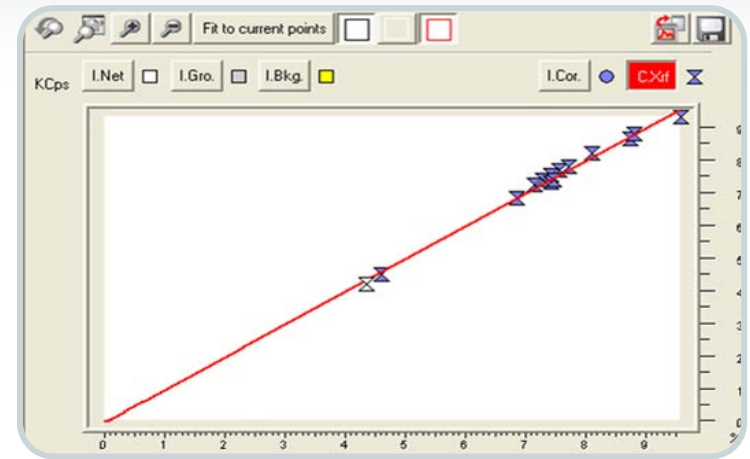
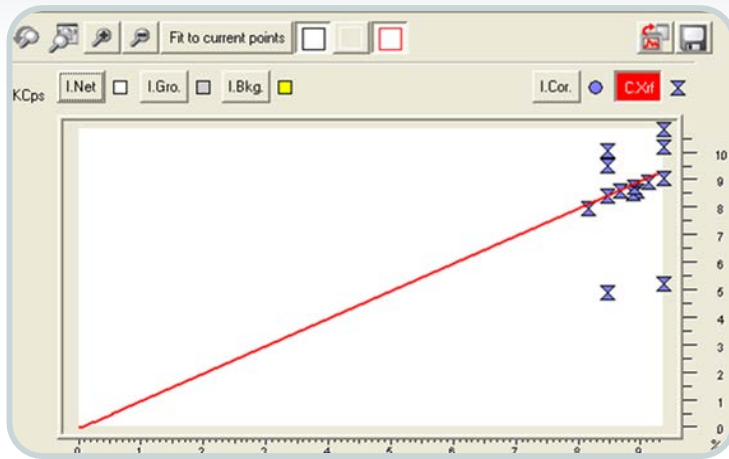
Diameter Mass Density

Meniscus:  mm



# SPECTRA<sup>plus</sup> V2.2

## Geometric Correction ("Wedge-Effect")



- Example of Rh-Compton calibration in Oils without a Geometric Correction
- Example of Rh-Compton calibration in Oils with Geometric Correction applied
- Three new sample preparation options have been added to correct
  - Diameter - Thickness - Density
  - Diameter - Thickness - Mass
  - Diameter - Mass - Density

# PETRO-QUANT

## Ultimate Analytical Performance



Universal Calibration for petrochemicals based on SPECTRAplus:

- Variable alpha (Fundamental Parameter) model for wide concentration ranges
- Automatic selection of best lines for high concentrations (S, Cl) and severe line overlaps (As, Tl, Pb, Bi)
- Aut-**O**-matic: Quantification of light matrix
- Geometric Correction of Wedge Effect
- Meniscus-Correction
- Set for density measurement included

# PETRO-QUANT

## Norms available



- ASTM D6443 Ca, Cl, Cu, Mg, P, S and Zn in unused Lubricating Oils
- ASTM D2622 Low S in Mineral Oil
- ASTM D2622 Low S in Gasoline
- ASTM D2622 Low S in Diesel
- ASTM D2622 Medium S in Mineral Oil
- ASTM D2622 High S in Mineral Oil
- EN ISO 20884 Low S in automotive fuels
- EN ISO 20884 High S in automotive fuels
- EN ISO 14596 Low S contents in petroleum products
- EN ISO 14596 High S contents in petroleum products
- EN ISO 14597 V and Ni in Mineral Oil
- EN ISO 15597 Cl and Br in Mineral Oil
- DIN 13723 Pb in Gasoline
- DIN 51363 P in Lube Oils and Additives
- DIN 51391 Zn and Ca in Lube Oils
- DIN 51431 determination Mg in lubricants
- DIN51790 S, V, and Ni in Mineral Oil

# S8 TIGER

## PETRO-QUANT: Benefits



### PETRO-QUANT benefits for users:

- standardless trace analysis of a wide range of products and materials with outstanding precision and accuracy
- no calibration required by operators
- XRF expert knowledge not needed
- Time saving: several weeks calibration work saved
- Money saving: no expensive standards needed for calibration
- Quick start: routine analysis right from the beginning
- Simple: minimum operator training
  - analysis can be done by non-technical staff
- Expert system: easy generation of own calibrations using the optimized measurement conditions of the universal calibration

## Audience Poll

- Please use your mouse to answer the question on the right of your screen:

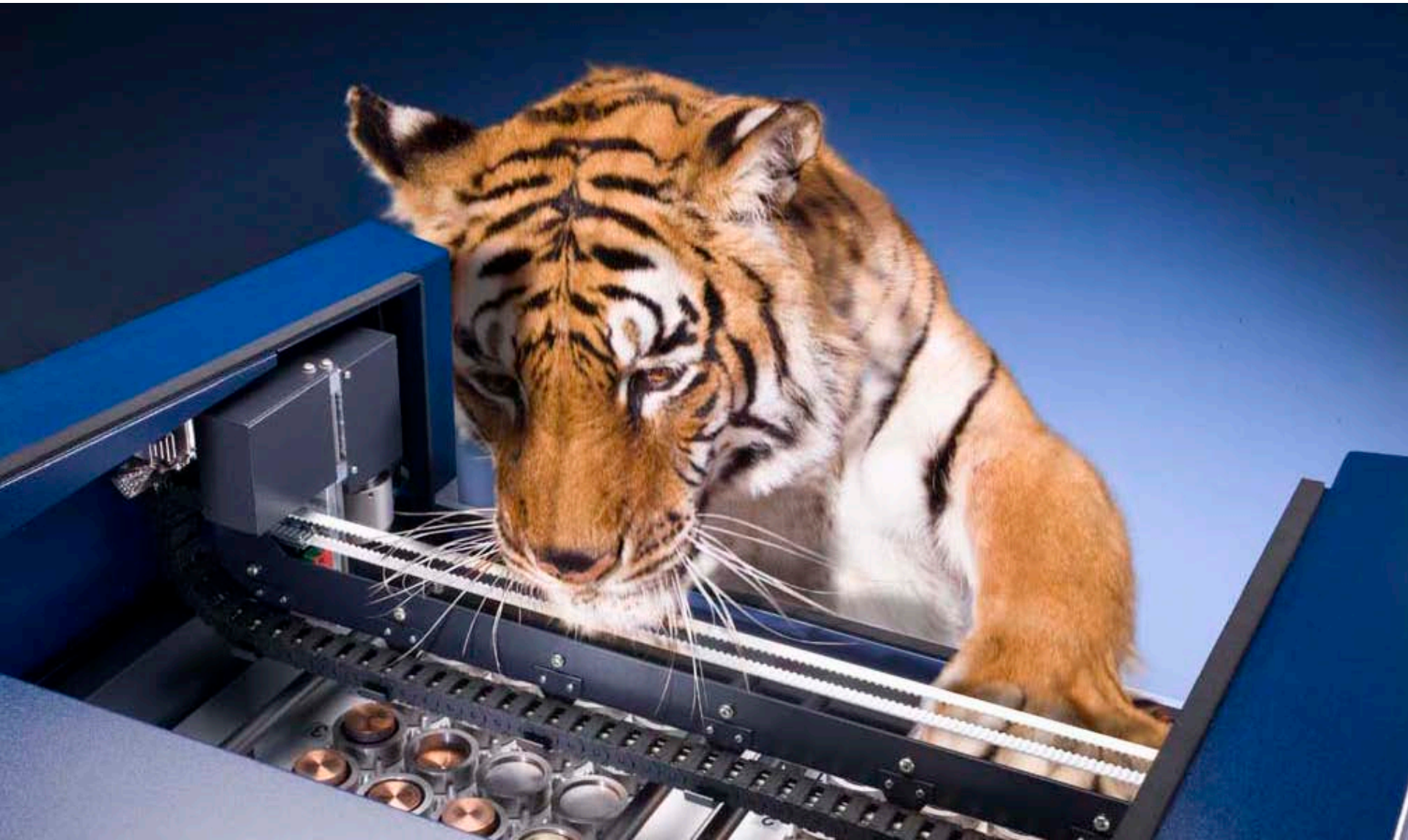
What applications are you running in daily routine?

(Check all that apply):

- S acc. ASTM D 2622
- S acc. ASTM D 4294
- S acc. ASTM D 7039
- Low sulfur by FTIR
- ICP
- Base oils / Lubricating oils
- Crude oil / Residual oil
- Waxes
- Catalysts
- Others...



S8 TIGER  
SampleCare™



# S8 TIGER SampleCare™

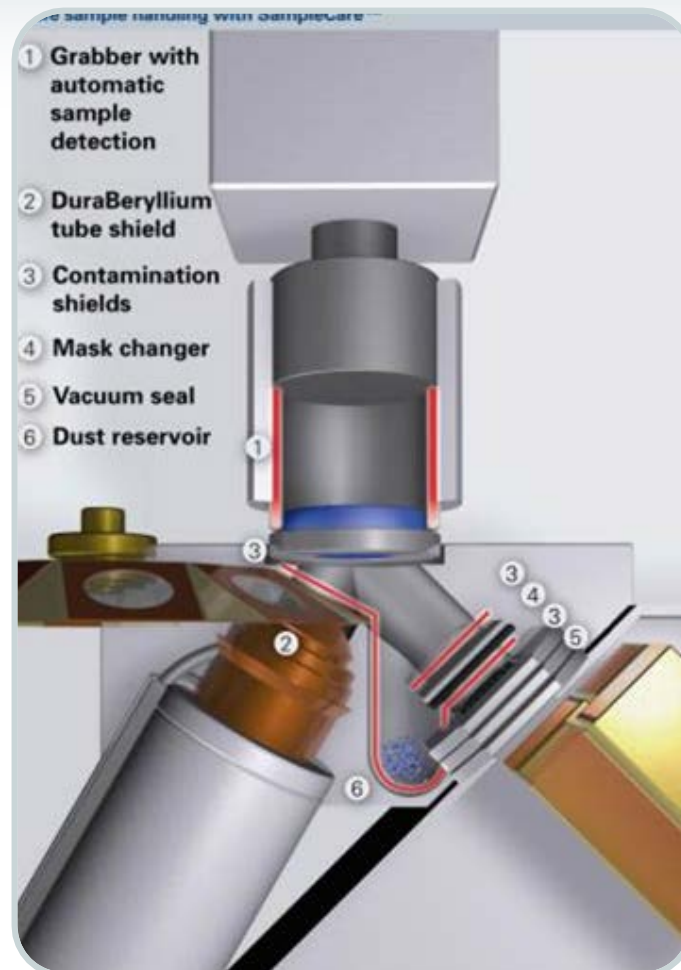


## Four Times Protection:

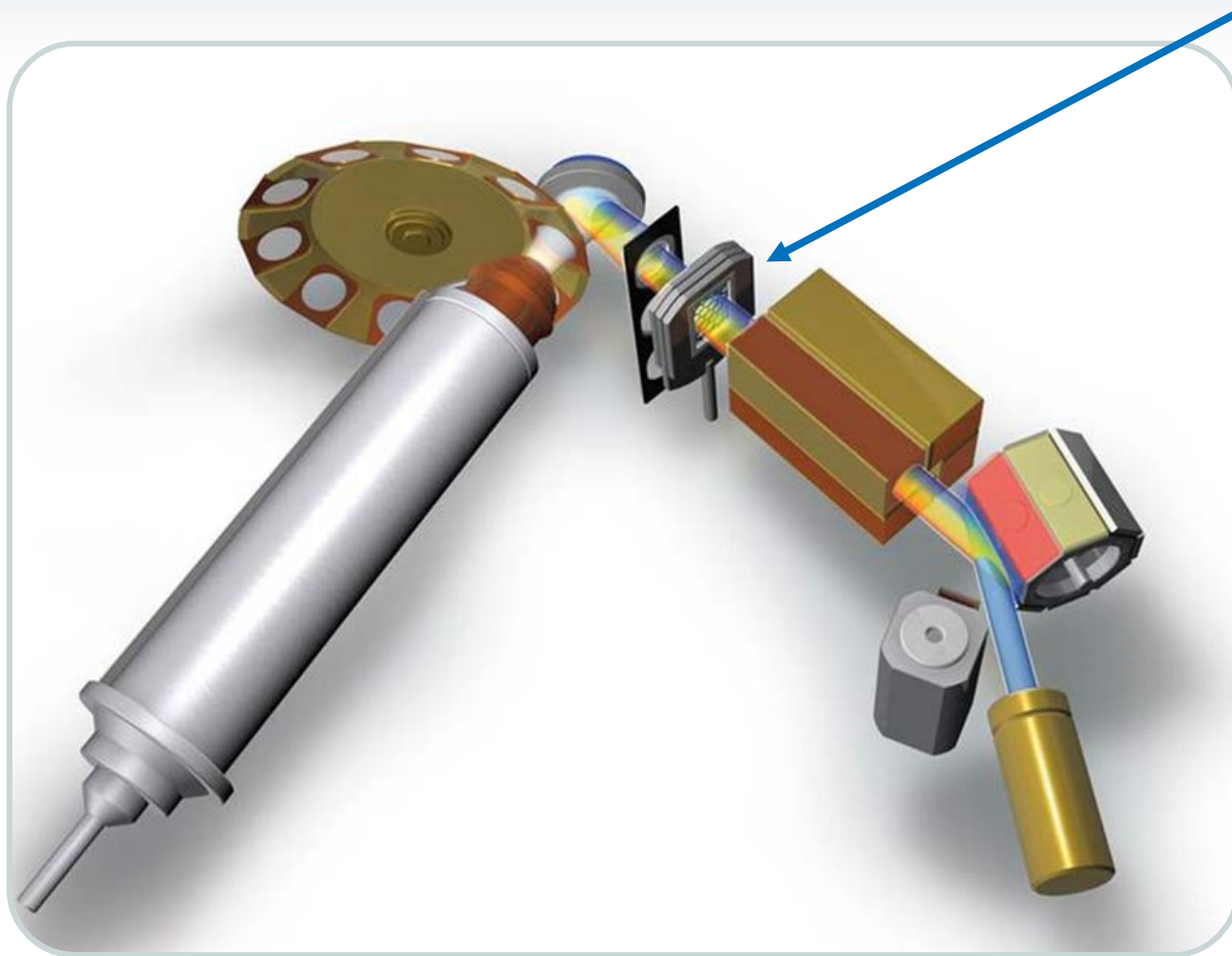
- Low maintenance cost and time, high instrument uptime due to unique protection during loading and unloading:
- Two contamination shields to protect tube window and goniometer
- Dust reservoir to collect sample particles and droplets

## Unique protection during measurements:

- Duraberyllium™ shield for tube window protection
- Unique Vacuum Seal with high transmission window for goniometer protection



# Vacuum Seal for safe analysis of liquid samples

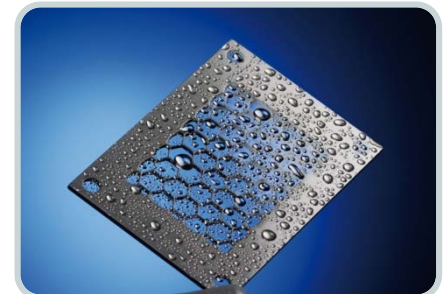




# Safe analysis of liquid samples: Vacuum Seal



- Vacuum seal protects spectrometer in case of sample cup leakage
- minimized helium flushed volume
- minimized pump-down times when changing from helium to vacuum mode
- minimized Helium consumption
- spectrometer chamber with all analytically relevant components (collimators, analyzer crystals, detectors) remain under stable vacuum for high stability

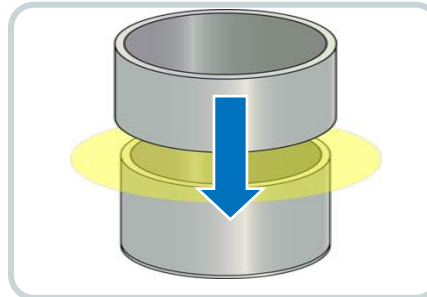


# Sample preparation

## Simple workflow



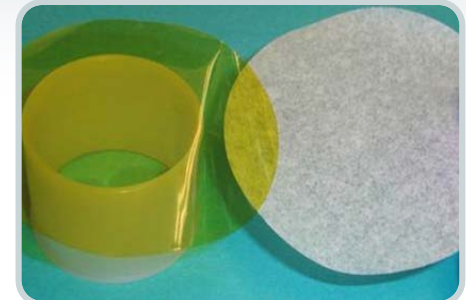
Three part liquid cup



2) Press down gently



4) Keep place clean



1) Place the foil on top



3) Sample cup is ready



5) Fill in sample

# More than a one trick pony Everything beside low sulphur in fuels



- The S8 TIGER WDXRF spectrometer not only analyses fuel sample for sulphur concentration but also allows to monitor:
  - Crude oil
  - Residual oil
  - Refinery products
    - Base oil, lubrication oil
    - Wear metals in oil
- Performance example shown on ASTM D 6443

# Standards and Applications of XRF for Lubricants



- EN ISO 14596 Low S
- EN ISO 14596 High S
- EN ISO 14597 V and Ni
- EN ISO 15597 Cl and Br
- DIN 51790 S, V and Ni
- DIN 51363 P
- DIN 51391 Zn and Ca
- DIN 51431 Mg
- ASTM D 6443 Ca, Cl, Cu, Mg, P, S and Zn

- A lubricant is a substance introduced between two moving surfaces to reduce the friction between them
  - improves efficiency and reducing wear
- It may also have the function of dissolving or transporting foreign particles and distributing heat.
- Typically lubricants contain 90% base oil (most often petroleum fractions, called mineral oils) and less than 10% additives.
- Additives deliver reduced friction and wear, increased viscosity, improved viscosity index, resistance to corrosion and oxidation, aging or contamination, etc.

# PETRO-QUANT

## ASTM D 6443: Lubricating Oils



Analysis of Additives in Lubricants:

- Turn-key solution, norm compliant
- Ultimate high precision allows accurate blending
- Cost savings: expensive additives saved

	Mg	P	S	Cl	Ca	Cu	Zn
Cal. Range [ppm]	2000	1500	7500	1500	5000	500	1500
Detection Limit [ppm, 3 $\sigma$ , 100s]	1,7	0,7	6,6	1,9	1	0,5	0,3
Repeatability [21 times]							
Mean value [ppm]	740	500	2780	510	1960	199	500
Abs. Std. Dev. [ppm]	10	4	15	2	3	0,7	4,7
Precision [%]	1,42	0,86	0,54	0,42	0,18	0,35	0,95

# PETRO-QUANT

## Routine Operation as Easy as 1-2-3



- Liquid samples

1. weigh the liquid into a cup
2. select the measurement method and start the measurement

The screenshot shows a software window titled "\_Routine-He". It contains a table with the following columns: "Pos", "Sample", "Method", and "Type". The first row is selected, showing "1A1" in the "Pos" column, "PetroSample" in the "Sample" column, and "Liquid" in the "Type" column. The "Method" column is open to a dropdown menu. The menu items are: "ASTM D2622 high", "ASTM D2622 low", "DIN51363", "DIN51391 Ca", "DIN51391 Zn", "DIN51431", "ISO14596 high", "ISO14596 low", "ISO20884 high", "ISO20884 low", and "Oilquant2". The "Oilquant2" option is highlighted in dark blue and circled with a blue oval.

Pos	Sample	Method	Type
1A1	PetroSample		Liquid
1A2		ASTM D2622 high	
1A3		ASTM D2622 low	
1B1		DIN51363	
1B2		DIN51391 Ca	
1B3		DIN51391 Zn	
1C1		DIN51431	
1C2		ISO14596 high	
1C3		ISO14596 low	
1C4		ISO20884 high	
1D1		ISO20884 low	
1D2		Oilquant2	
1D3			
1D4			
1E1			
1E2			

# PETRO-QUANT

## Routine Operation as Easy as 1-2-3



- Liquid samples
3. get results!

The screenshot shows a software window titled "Results Monitor - [OilQuant : ]". The window has a menu bar with "File", "Edit", "View", "Tools", "Window", and "Help". Below the menu bar is a toolbar with various icons for file operations and analysis. The main area contains a table with the following data:

Sampl\	Date	CalibrationMethod	S (%)	Cl (PPM)	K (PPM)	Br (PPM)	Zr (PPM)	Sb (PPM)	CH2 (%)
Lot090204-WM6_30	05.10.2004 12:32:06	oilquant2-ppm	0.003735	32	27	29.9	30.6	28	100.0

# PETRO-QUANT

Let's Make a Method for Racing. . .



- Remove elements from method to customize the application for exact requirement for speed and accuracy

Example: Control of engine oils for wear metals in motor development as well as tests on the course

Test for modern alloy elements to the:

- lowest ppm level
  - short analysis time ( $\leq 10\text{min}$ )
  - highest precision ( $\leq 1\text{ ppm}$ ), esp. for Mg, Al, Si ( $\leq 2\text{ ppm}$ )
- PETRO-QUANT systems were used successfully for engine development and optimization by several car manufacturers





# PETRO-QUANT

## Wear Metal Debris – Speed, Speed, Speed



Sample	Mg (ppm)	Al (ppm)	Si (ppm)	P (ppm)	Ca (ppm)	Ti (ppm)	V (ppm)	Cr (ppm)	Mn (ppm)
1	12.5	8.9	7.6	8.8	12.1	9.2	10.3	10.7	10.6
2	11.2	6.7	8.4	8.9	10.1	10.6	10.4	10.9	10.3
3	10.5	8.0	10.0	9.1	10.7	10.0	11.8	10.1	10.0
4	10.1	5.8	5.8	10.1	9.6	10.6	10.2	11.0	10.4
5	12.5	8.0	11.3	8.7	9.6	11.1	9.9	10.5	9.9
6	8.9	7.5	9.0	9.2	10.4	9.5	10.1	9.0	10.2
7	11.8	9.9	10.6	9.4	11.9	10.7	10.1	10.0	11.1
8	7.3	9.0	11.0	8.7	11.2	10.4	10.6	10.6	10.1
9	9.7	7.2	8.1	10.1	12.5	10.8	10.3	10.5	10.5
10	10.2	7.3	8.5	10.8	10.4	10.8	10.3	10.0	10.2
11	10.6	8.5	5.9	8.9	11.1	9.8	10.3	10.0	9.9
12	8.4	8.3	6.5	9.3	12.5	10.4	11.2	10.3	10.1
Mean	10.3	7.9	8.6	9.3	11.0	10.3	10.5	10.3	10.3
Std. Dev.	1.6	1.1	1.9	0.7	1.0	0.6	0.5	0.5	0.3
Max	12.5	9.9	11.3	10.8	12.5	11.1	11.8	11.0	11.1
Min	7.3	5.8	5.8	8.7	9.6	9.2	9.9	9.0	9.9
Range	5.2	4.1	5.5	2.1	2.9	1.9	1.9	2.0	1.2

**10-Minute Analysis for  
16 elements!**

# PETRO-QUANT

## Wear Metal Debris – Speed, Speed, Speed



Sample	Fe (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	Mo (ppm)	Sn (ppm)	Pb (ppm)
1	10.5	11.0	10.2	9.9	9.8	9.8	9.1
2	9.7	9.9	10.0	9.9	9.3	11.8	9.8
3	9.4	10.2	9.9	9.8	9.6	10.5	9.4
4	11.0	10.1	10.1	9.9	9.3	8.2	9.7
5	9.3	11.0	10.3	9.6	9.7	6.6	10.1
6	10.2	10.2	10.1	9.7	8.3	9.8	9.8
7	9.6	10.5	10.0	9.8	8.9	10.5	10.1
8	10.2	10.2	10.2	10.1	8.5	14.0	9.9
9	9.6	9.9	10.5	10.1	9.9	9.4	9.6
10	9.7	10.2	10.1	10.4	9.1	11.0	9.5
11	9.1	10.5	10.3	9.9	10.0	9.4	9.7
12	10.4	10.3	10.4	9.9	9.8	10.0	10.0
<b>Mean</b>	<b>9.9</b>	<b>10.3</b>	<b>10.2</b>	<b>9.9</b>	<b>9.4</b>	<b>10.1</b>	<b>9.7</b>
<b>Std Dev</b>	<b>0.6</b>	<b>0.4</b>	<b>0.2</b>	<b>0.2</b>	<b>0.6</b>	<b>1.8</b>	<b>0.3</b>
<b>Max</b>	<b>11.0</b>	<b>11.0</b>	<b>10.5</b>	<b>10.4</b>	<b>10.0</b>	<b>14.0</b>	<b>10.1</b>
<b>Min</b>	<b>9.1</b>	<b>9.9</b>	<b>9.9</b>	<b>9.6</b>	<b>8.3</b>	<b>6.6</b>	<b>9.1</b>
<b>Range</b>	<b>1.9</b>	<b>1.1</b>	<b>0.6</b>	<b>0.8</b>	<b>1.7</b>	<b>7.4</b>	

**10-Minute Analysis for  
16 elements!**

# Use Conditions to Create Your Own Calibrations



- Easy generation of own calibrations by using the optimized measurement conditions of the universal calibration
  - No setup scans or PHA's needed
  - Select elements, measure standards, calibrate, validate, done
  - No additional drift correction samples required
  - Saves lots of time

Material group:  Material:

Compound list:

Name	Formula	Z	Order
Aluminum	Al	13	3
Antimony	Sb	51	24
Barium	Ba	56	25
Bromine	Br	35	18
Cadmium	Cd	48	22
Calcium	Ca	20	9
Chlorine	Cl	17	7
Chromium	Cr	24	12
Copper	Cu	29	16
Iron	Fe	26	14
Lead	Pb	82	26

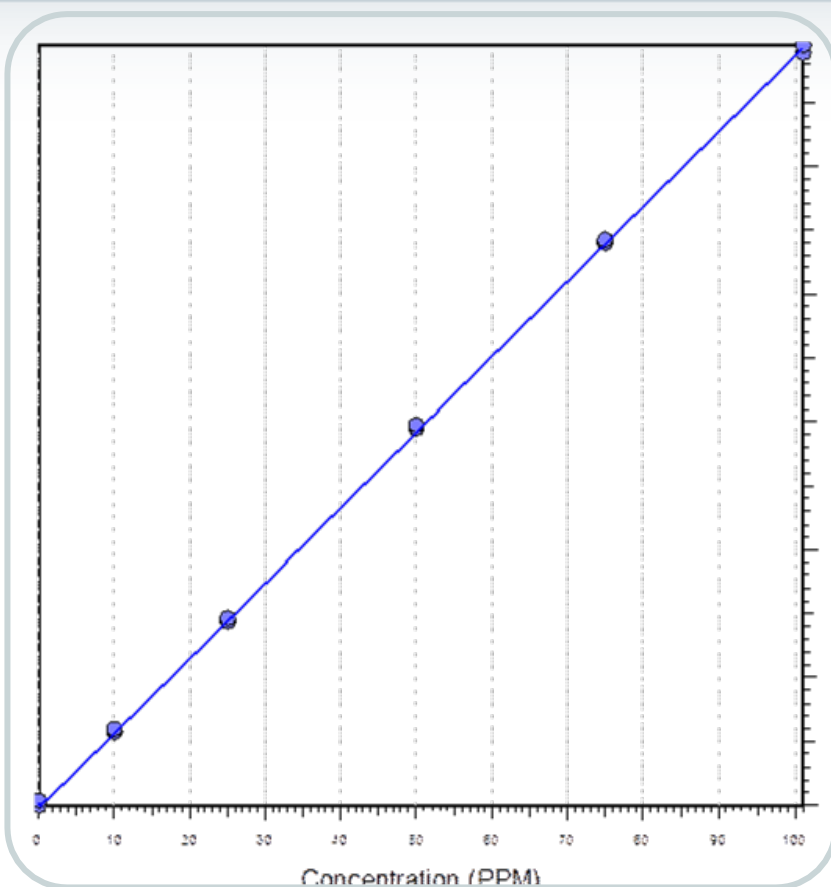
# Crude oil Residual oil



- Crude oil and residual oil analysis requires the accurate and precise determination of traces
  - Very light elements such as Na
  - Hazardous elements such as Pb and As
  - Impurities from production
- Sample preparation is simply: Fill the oil in a liquid cup, prepared with 4  $\mu\text{m}$  Prolene foil
- heavy oils are slightly heated to increase the viscosity
- PETRO-QUANT or the short customized method is used to run the sample



# Residual Oil Detection Limits



Element	Cal. Dev. [ppm]	LOD [ppm]
Si	0.3	0.2
Al	0.2	0.6
Fe	0.2	0.2
V	0.3	0.2
Ni	0.2	0.2
Cu	0.1	0.2
Pb	0.4	0.4
As K $\alpha$	0.2	0.1
As K $\beta$	0.4	0.5

# Residual Oil Precision



Sample	As (PPM)	Si (PPM)	S (%)
Std 5 Prep 1	10,20	52,00	2,02
Std 5 Prep 2	9,90	51,90	2,00
Std 5 Prep 3	9,90	50,50	2,01
Std 5 Prep 4	9,70	51,60	2,00
Std 5 Prep 5	10,30	51,90	2,01
Min	9,700	50,50	2,00
Max	10,30	52,00	2,00

- Accurate analysis of hazardous elements in trace levels
- Quick and repeatable sample preparation
- High precision at major and trace concentration level

# S8 TIGER

## Instrumental Advantages



Vacuum-Seal (high transmission window)

- Safe liquid analysis
- Reduced helium consumption
- Better precision (goniometer always in vacuum)
- Fast switch between liquid and solid samples

Low temperature tube head

- Keeps samples cold
- Less evaporation, more reliability

Duraberyllium™ tube window shield

- Keeps tube window clean, protective coating

Direct loading, no turret design

- No internal movement for reliability

Two helium modes

- Reduced helium pressure for oils
- Atm. helium pressure for fuels

# PETRO-QUANT with S8 TIGER

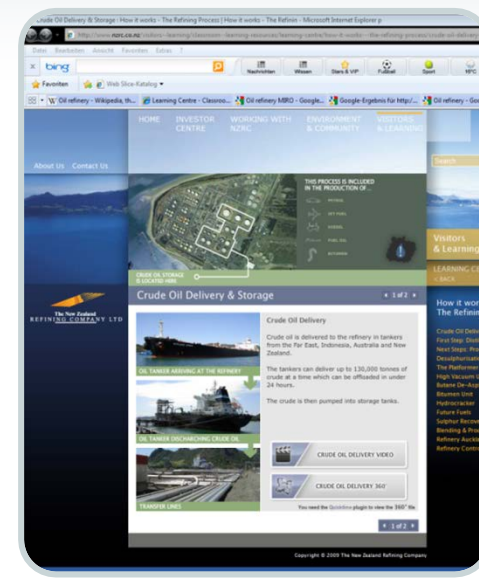
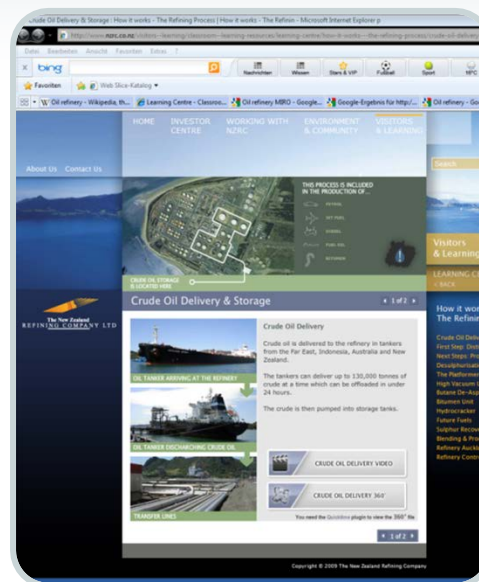
## Benefits for the Petrochemical Industry



- Cost savings due to reduced helium consumption
- Unique vacuum seal requires only the flushing of the sample chamber
- Ambient pressure applies only for volatile liquids
- Reduced helium pressure for oils and lubricants
- High instrument uptime
- Unique instrument protection due to the vacuum seal
- Reliable liquid analysis
- No cup leakage due to effective tube head cooling
- Best accuracy and precision
- Unique vacuum seal keeps the spectrometer chamber always under vacuum



# Knowledge Base Web resources



- Information: <http://www.bruker.com>
- Learning: [http://en.wikipedia.org/wiki/Oil\\_refinery](http://en.wikipedia.org/wiki/Oil_refinery)
- Learning: <http://www.nzrc.co.nz/visitors--learning/classroom--learning-resources/learning-centre.aspx>
- List of refineries: [http://en.wikipedia.org/wiki/List\\_of\\_oil\\_refineries](http://en.wikipedia.org/wiki/List_of_oil_refineries)

# S8 TIGER Ready-To-Analyze Solutions



GEO-QUANT T



GEO-QUANT M



METAL-QUANT



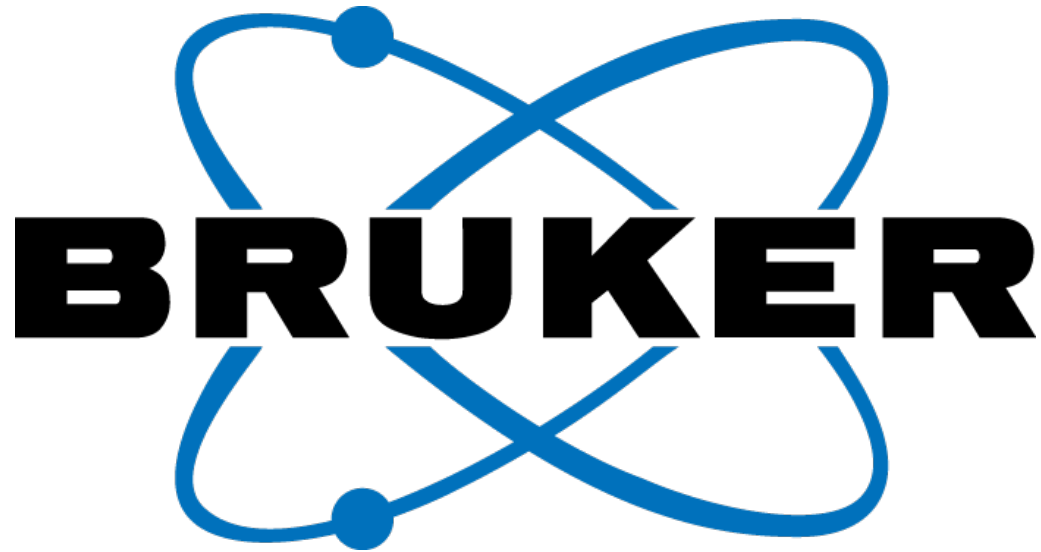
CEMENT-QUANT



PETRO-QUANT



RoHS-QUANT



Innovation with Integrity