



S2 RANGER LE:

Analysis of Light Elements in
Cement, Slags and Feldspar

Welcome

Today's topics:

- S2 RANGER LE
 - Overview
 - XFlash® LE detector
 - Improved X-ray tube
- Analysis of Light Elements in Cement
 - Pressed pellets
 - Fusion beads
- Analysis of F and Na in Slags
- Analysis of Feldspar
- Summary
- Q & A



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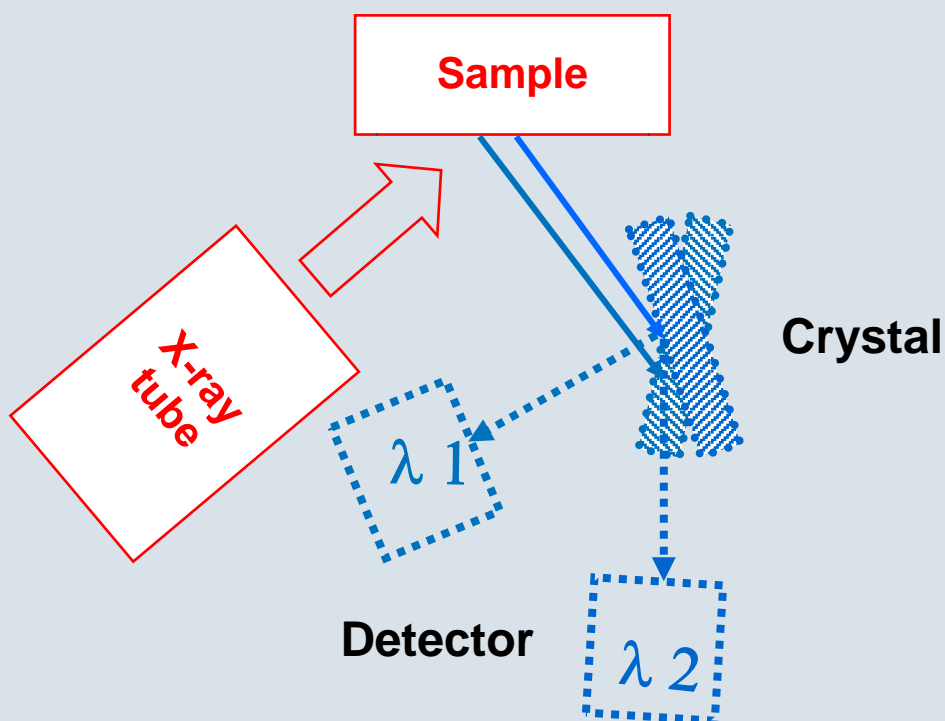
S2 RANGER LE



Overview

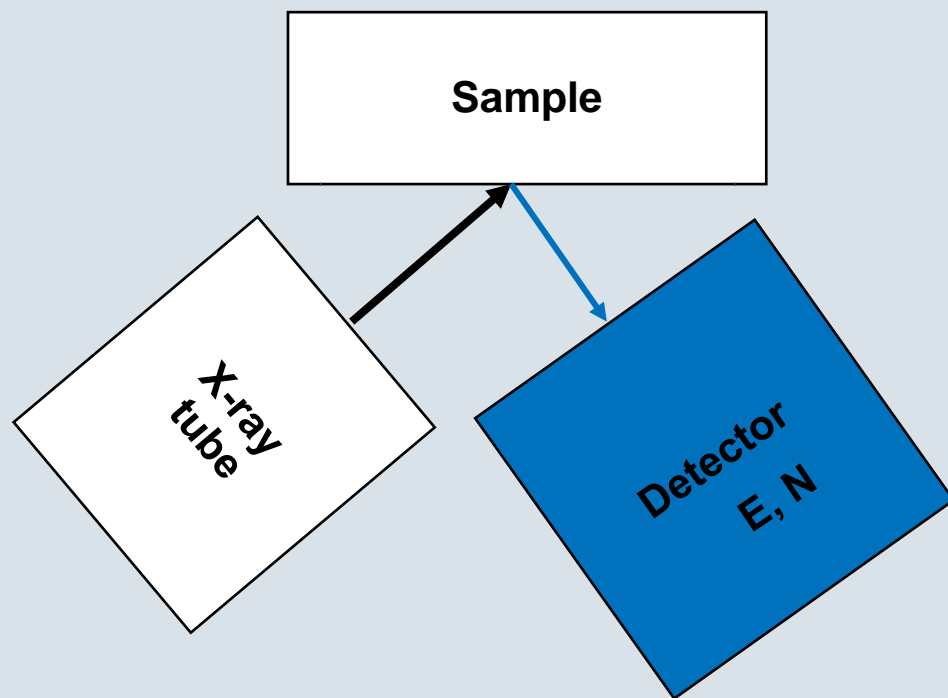
X-ray Fluorescence Analysis

Wavelength-dispersive XRF (WDX or WDXRF)



- An analyzer crystal separates the various wavelengths λ (energies)
- The detector records only the number, N , of X-ray photons at a given wavelength (energy)

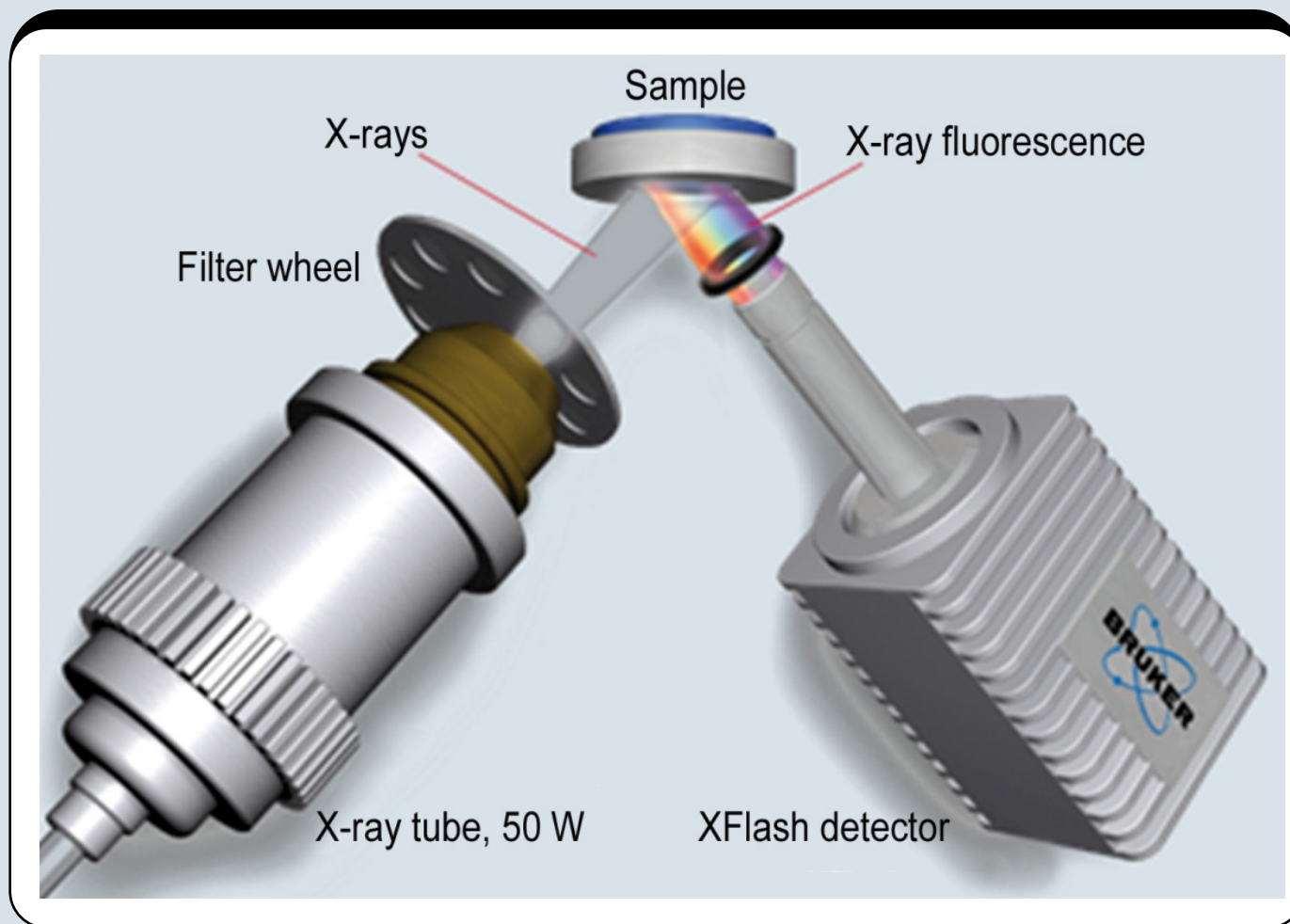
Energy-dispersive XRF (EDX or EDXRF)



The detector is used to record both:

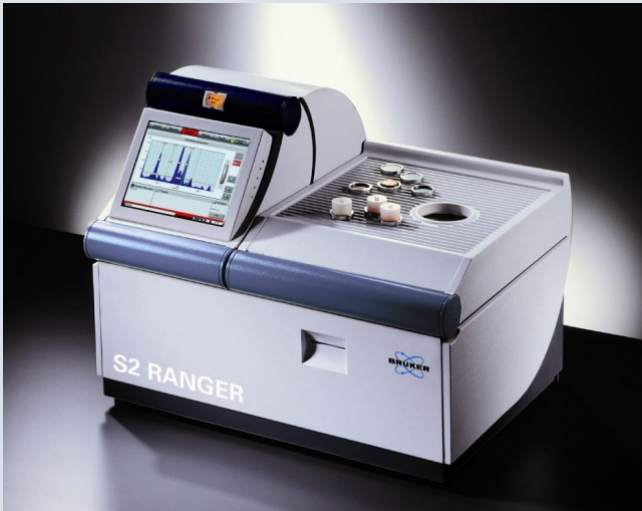
- the energy, E , and
- the number, N , of X-ray photons

Instrumentation – Closer Look



S2 RANGER

Hardware Advantages



- Minimum space requirements
- “All in one box” rugged system
- Single port connection
- Integrated Touchscreen
- Integrated PC & Printer
- Integrated vacuum pump
- Integrated sample changer (1 to 28)
- Direct excitation – high power (50W)
- XFlash[®] Silicon Drift Detector



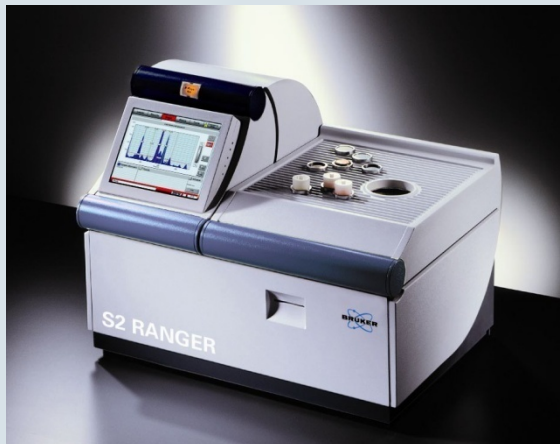
S2 RANGER

Flexible Sample Handling!



Automated System

Up to 28 different samples can be loaded



Manual System

Single sample position



S2 RANGER

EQUA ALL



- EQUA ALL is the unique standardless solution that enables you to obtain results without performing a calibration
- ELEMENT QUANTIFICATION for
 - ALL Elements from Na – U
 - ALL Ranges from ppm to 100%
 - ALL Materials (Oxides, Metals, Oils, etc...)
 - ALL Preparation (Pellets, Solids, Liquids, Powder, etc...)
- Installed on ALL S2 RANGERS
- NO Standards Needed!
- Uses a unique mathematical algorithm to calculate sample composition from a measured energy spectrum
- ~ 5 minutes for analysis
- Ability to customize your own Standardless Program

S2 RANGER

TouchControl™



Easier through intuitive touch screen operation

More convenient than ever based on an all-in-one instrument



S2 RANGER LE

50 W Power for Direct Excitation



- End window X-ray tube
 - Pd anode
 - Max power 50 W
 - Voltage 5-50 kV
 - Max current 2000 μ A
- 9-position filter changer for primary beam filters
- ➔ 50 W power fast and precise measurements
- ➔ High transmission window for enhanced light element excitation

S2 RANGER

XFlash[®] LE Silicon Drift Detector

- XFlash LE
 - 4th generation Silicon Drift Detector (SDD)
 - 10 mm² active area
- Unique light element performance
 - **High transmission window**
- Unique energy resolution
 - **129 eV FWHM**
 - @ Mn K α
 - @ 100,000 cps
- Unmatched count rates
 - up to 300,000 cps input count rate
 - up to 100,000 cps output count rate without resolution degradation
- Peltier cooled



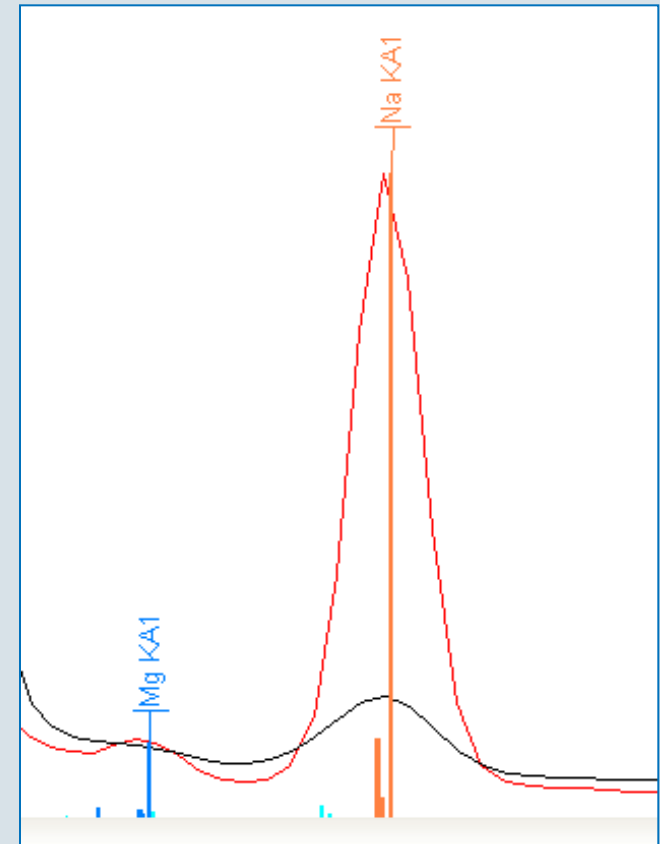
XFlash[®]
Technology

S2 RANGER

XFlash[®] LE



- More than 8 times sensitivity for Na (compared to standard SDD)
- More than 4 times sensitivity for Mg (compared to standard SDD)
- Lower background in the energy range up to 12.6 keV
- Better resolution in the energy range up to 12.6 keV



S2 RANGER with XFlash[®] LE

Advantages



- Enhanced sensitivity for light elements

Better detection limits for Na and Mg!

- Improved energy resolution

Better separation of neighboring peaks!

- Increased sensitivity

More counts and better statistics!

- Ability to measure higher count rates

Measure faster!

- Improved stability

S2 RANGER with XFlash® LE

Key Applications



Cement



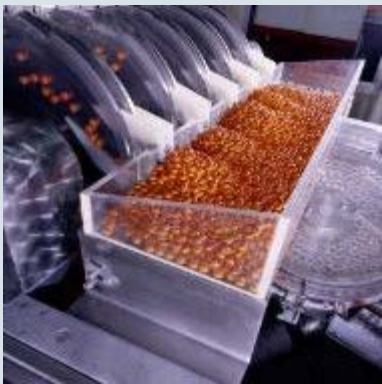
Slags



Minerals & Mining



Petrochemicals



Pharmaceuticals



Geology



Metals



Chemistry

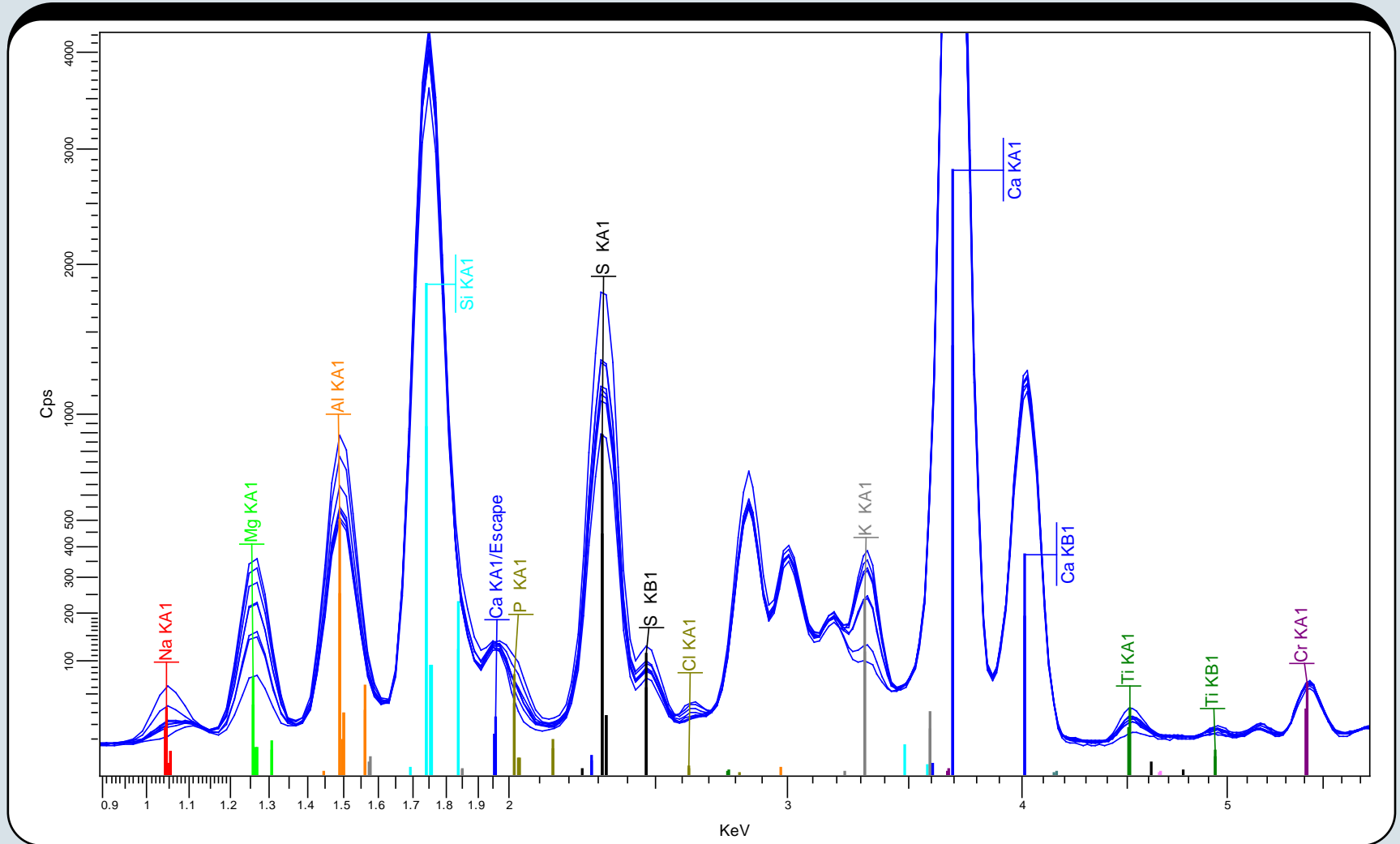


Analysis of Light Elements in Cement

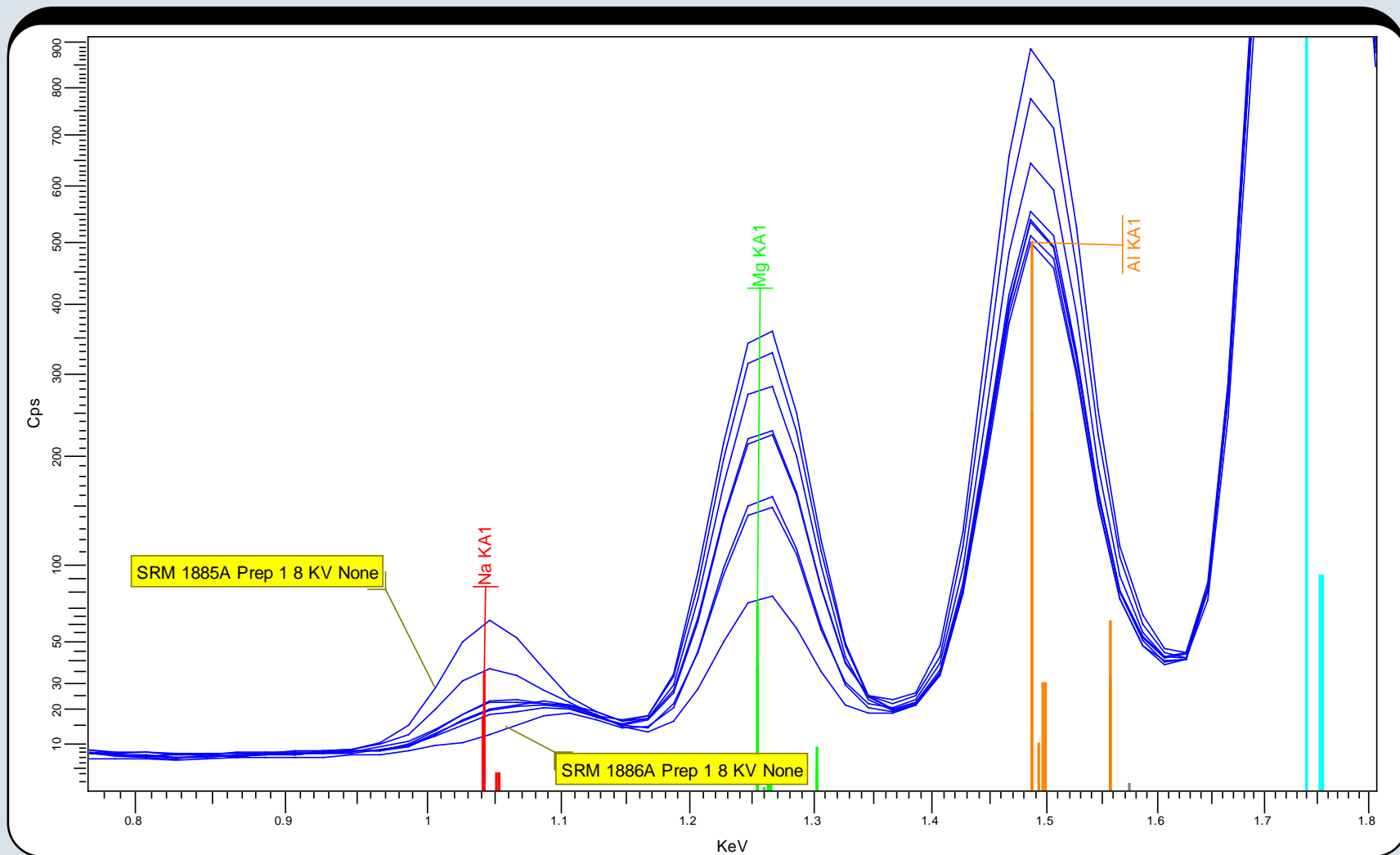
Measurement Method

- Measurement Region 1
 - 8 kV
 - No filter
 - 80 seconds
 - F - Ca
 - Measurement Region 2
 - 40 kV
 - 500 μm aluminum filter
 - 50 seconds
 - Ca - Sr
-
- Total analysis time: 3 minutes per sample!
 - Sample preparation: pressed powders

Cement Spectra – 8 kV

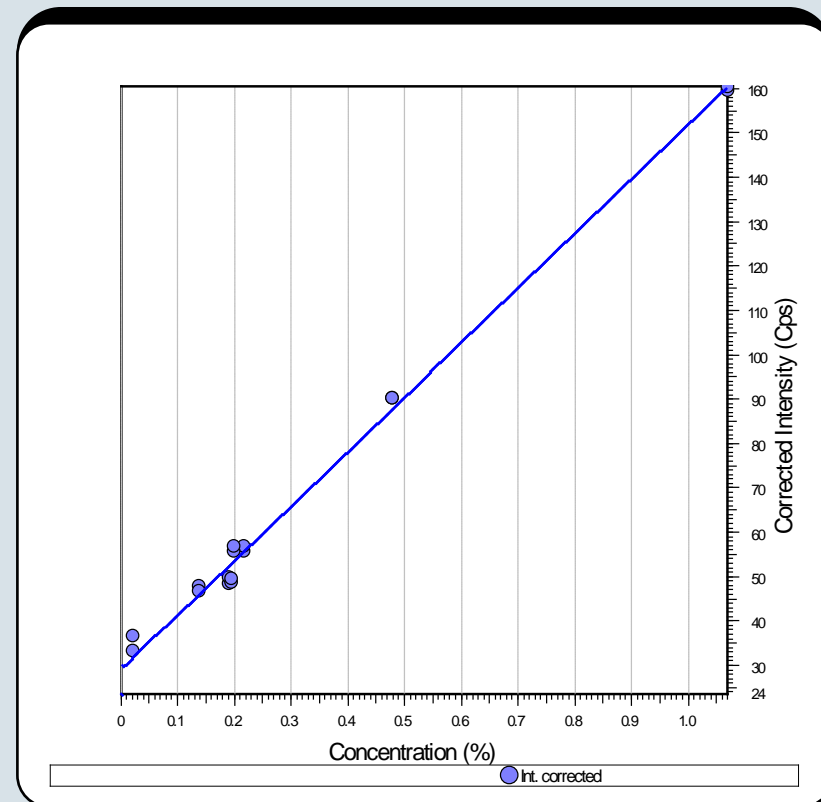


Cement Spectra – 8 kV



Calibration Data for Na₂O in Cement

- Abridged calibration data for line Na KA1/Cement
- S/N 5899, Mask: 30 mm, Mode: Vacuum, 8 kV, 1.15 mA, Filter: None
- Detector parameter 1: 600 parameter 2: 400
- Intensity evaluation: peak height
- Calibration data for compound Na₂O in original sample
- Absorption correction: Fixed alphas (empirically adjusted values)
- 16 standards from 0.02% to 1.07%
- Standard deviation: 0.0224%
- Squared correlation coefficient: 0.995102
- Alpha (Si): 17.8707 (Adjustable by regression)

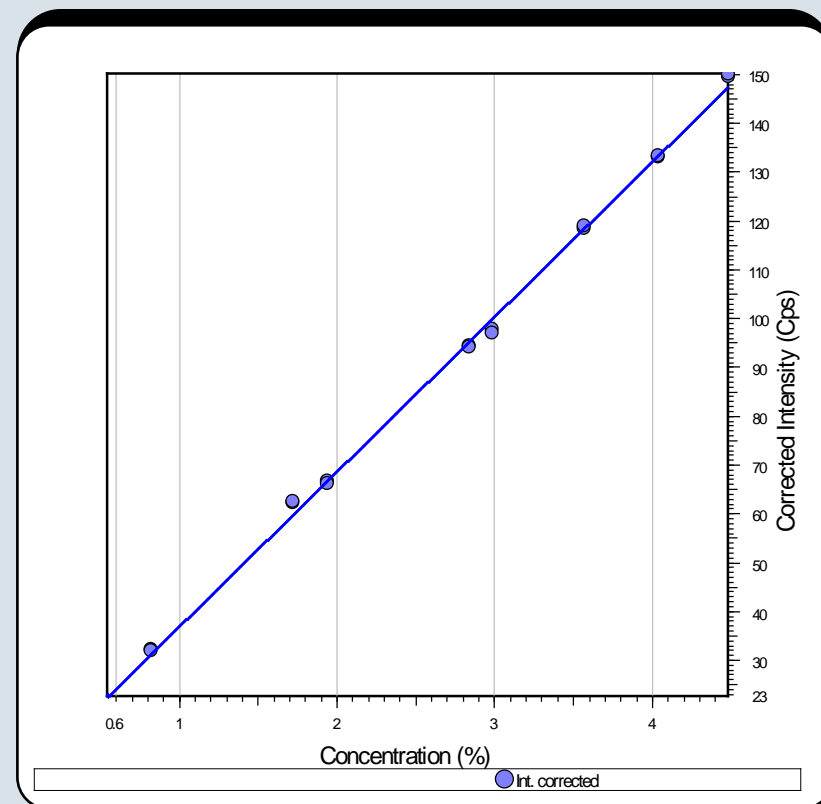


Calibration Data for Na₂O in Cement

Standard Name	Chem Conc (Weight %)	XRF Conc (Weight %)	Absolute Deviation	Gross Int (kcps)	LLD (PPM)
SRM 1880A Prep 1	0.190	0.166	-0.024	21.91	119.2
SRM 1880A Prep 2	0.190	0.154	-0.036	21.40	118.6
SRM 1881A Prep 1	0.199	0.222	0.023	23.26	127.5
SRM 1881A Prep 2	0.199	0.214	0.015	22.85	126.8
SRM 1884A Prep 1	0.216	0.222	0.006	23.88	118.2
SRM 1884A Prep 2	0.216	0.213	-0.003	23.64	119.0
SRM 1885A Prep 1	1.068	1.066	-0.002	55.93	113.3
SRM 1885A Prep 2	1.068	1.061	-0.008	55.84	113.8
SRM 1886A Prep 1	0.021	0.031	0.010	19.30	99.0
SRM 1886A Prep 2	0.021	0.058	0.037	20.60	99.1
SRM 1887A Prep 1	0.478	0.495	0.017	34.71	118.7
SRM 1887A Prep 2	0.478	0.495	0.017	34.69	118.6
SRM 1888B Prep 1	0.136	0.142	0.005	20.68	121.0
SRM 1888B Prep 2	0.136	0.150	0.013	20.92	120.8
SRM 1889A Prep 1	0.195	0.164	-0.031	22.74	112.0
SRM 1889A Prep 2	0.195	0.156	-0.039	22.41	111.7

Calibration Data for MgO in Cement

- Abridged calibration data for line Mg KA1/Cement
- S/N 5899, Mask: 30 mm, Mode: Vacuum, 8 kV , 1.15 mA, Filter: None
- Detector parameter 1: 600 parameter 2: 400
- Peak Channels[trapeze]: 1.158 - 1.364 keV
- Calibration data for compound MgO in original sample
- Absorption correction: Fixed alphas (empirically adjusted values)
- 16 standards from 0.81% to 4.48%
- Standard deviation: 0.0529%
- Squared correlation coefficient: 0.998056
- Alpha (Fe): 3.3278 (Adjustable by regression)



Calibration Data for MgO in Cement

Standard Name	Chem Conc (Weight %)	XRF Conc (Weight %)	Absolute Deviation	Gross Int (kcps)	LLD (PPM)
SRM 1880A Prep 1	1.720	1.795	0.075	67.33	104.4
SRM 1880A Prep 2	1.720	1.784	0.064	66.87	103.8
SRM 1881A Prep 1	2.981	2.876	-0.105	99.53	107.2
SRM 1881A Prep 2	2.981	2.901	-0.080	100.13	106.6
SRM 1884A Prep 1	4.475	4.547	0.072	149.82	103.6
SRM 1884A Prep 2	4.475	4.538	0.063	149.60	104.4
SRM 1885A Prep 1	4.033	4.027	-0.006	136.34	102.7
SRM 1885A Prep 2	4.033	4.016	-0.017	136.12	103.3
SRM 1886A Prep 1	1.932	1.909	-0.023	73.99	95.3
SRM 1886A Prep 2	1.932	1.923	-0.009	74.57	95.5
SRM 1887A Prep 1	2.835	2.791	-0.045	97.60	107.7
SRM 1887A Prep 2	2.835	2.793	-0.042	97.68	107.7
SRM 1888B Prep 1	3.562	3.574	0.012	119.76	104.4
SRM 1888B Prep 2	3.562	3.559	-0.004	119.26	104.2
SRM 1889A Prep 1	0.814	0.833	0.019	38.94	101.7
SRM 1889A Prep 2	0.814	0.838	0.024	39.04	101.3

Stability Data (n=10 of an unknown sample)

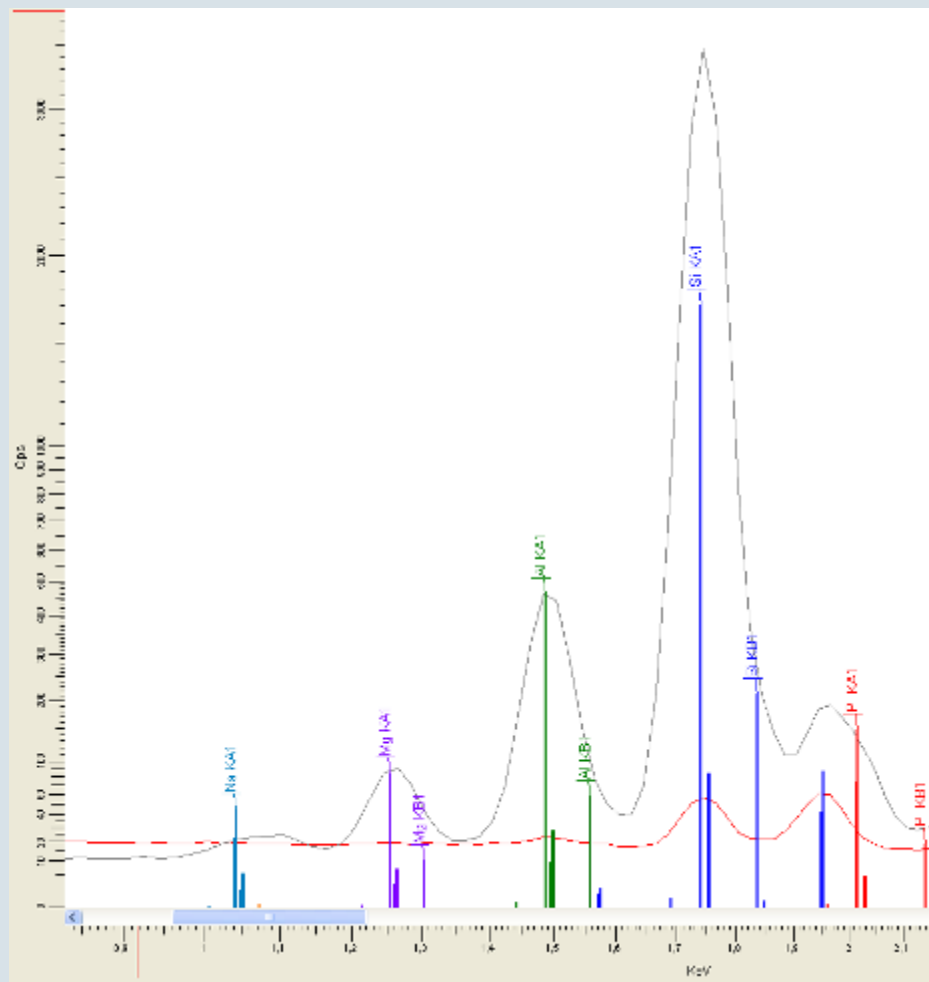


Stability Test	Na ₂ O (Weight %)	MgO (Weight %)	Al ₂ O ₃ (Weight %)	SiO ₂ (Weight %)	SO ₃ (Weight %)	K ₂ O (Weight %)	CaO (Weight %)	Fe ₂ O ₃ (Weight %)	Total (Weight %)
Rep 01	0.034	1.941	3.897	22.368	2.103	0.133	68.372	0.161	99.10
Rep 02	0.040	1.922	3.892	22.382	2.106	0.129	68.453	0.159	99.13
Rep 03	0.043	1.905	3.899	22.430	2.119	0.130	68.339	0.155	99.12
Rep 04	0.032	1.947	3.899	22.395	2.108	0.131	68.473	0.156	99.23
Rep 05	0.035	1.924	3.913	22.472	2.114	0.128	68.384	0.159	99.22
Rep 06	0.036	1.916	3.921	22.447	2.105	0.133	68.314	0.158	99.12
Rep 07	0.036	1.911	3.899	22.406	2.111	0.128	68.362	0.158	99.1
Rep 08	0.029	1.906	3.903	22.431	2.110	0.131	68.298	0.157	99.05
Rep 09	0.047	1.916	3.907	22.425	2.107	0.132	68.490	0.156	99.27
Rep 10	0.043	1.927	3.898	22.389	2.121	0.133	68.240	0.157	99.01

	Na ₂ O (Weight %)	MgO (Weight %)	Al ₂ O ₃ (Weight %)	SiO ₂ (Weight %)	SO ₃ (Weight %)	K ₂ O (Weight %)	CaO (Weight %)	Fe ₂ O ₃ (Weight %)	Total (Weight %)
Min	0.029	1.905	3.892	22.368	2.103	0.128	68.240	0.155	99.01
Max	0.047	1.947	3.921	22.472	2.121	0.133	68.490	0.161	99.27
Average	0.038	1.922	3.903	22.415	2.110	0.131	68.373	0.158	99.135
Std Dev	0.006	0.014	0.009	0.032	0.006	0.002	0.080	0.002	0.082
Rel Std Dev	14.940	0.726	0.221	0.143	0.283	1.521	0.118	1.127	0.083

S2 RANGER with XFlash® LE

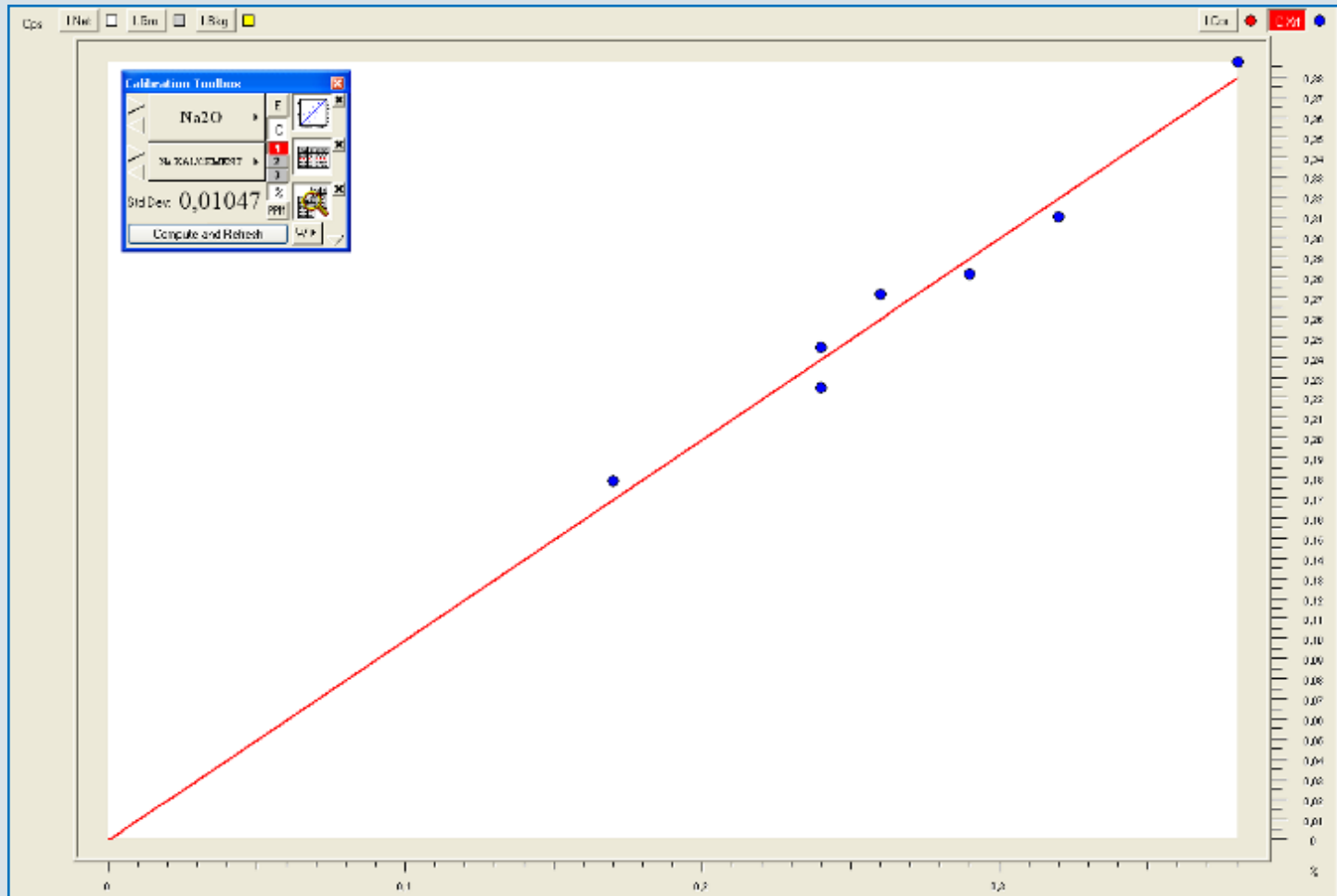
Spectrum: Cement as fused bead



- High sensitivity thanks to direct excitation and vacuum mode
- High resolution: clear separation of sodium and magnesium
- High dynamic range

S2 RANGER with XFlash LE

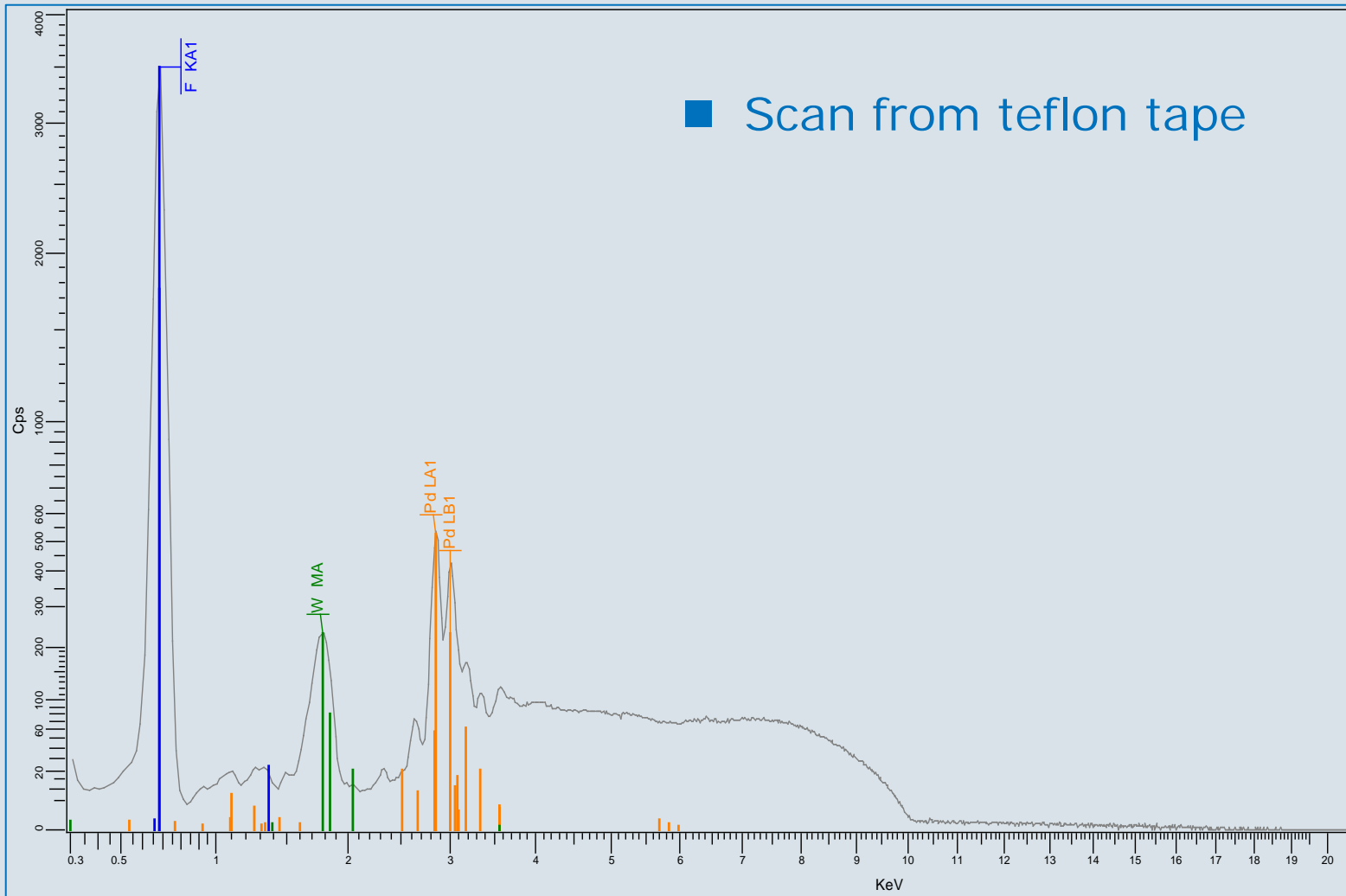
Cement – Calibration of Na in fused beads



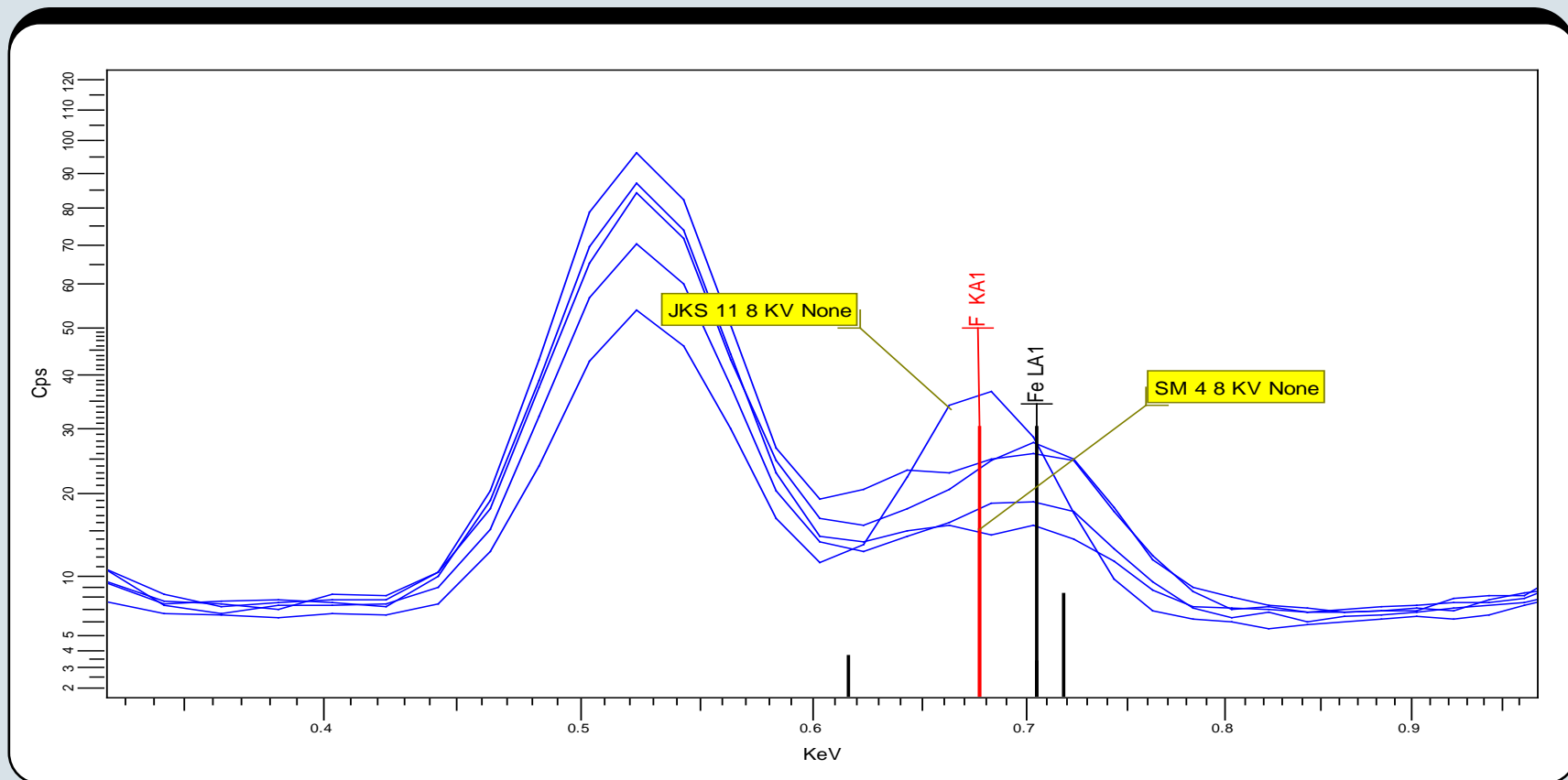


Analysis of Fluorine and Sodium in Slags

S2 RANGER with XFlash® LE Analysis of Fluorine



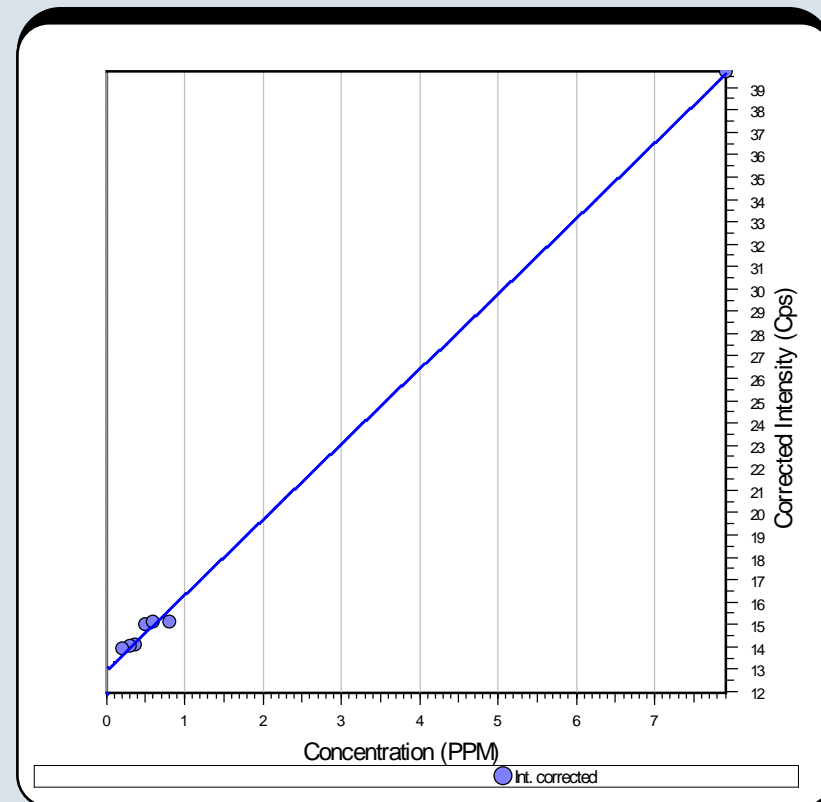
Fluorine Slag Spectra – 8 kV



- Note: Fe LA1 must be applied as a overlap correction for fluorine!

Calibration Data for F in Slag

- Abridged calibration data for line F KA1/Slag
- S/N 5401, Mask: 30 mm, Mode: Vacuum, 8 kV , 1.42 mA, Filter: None
- Detector parameter 1: 600 parameter 2: 400
- Peak Channels[trapeze]: 0.6222 - 0.8059 keV
- Calibration data for compound F in original sample
- Absorption correction: Fixed alphas (empirically adjusted values)
- Intensity model: raw peak intensity
- Minimization target: absolute error, 8 standards from 0.20 % to 7.90 %
- Standard deviation: 0.0872 %
- Squared correlation coefficient: 0.999043)
- *****Line overlap correction by Intensity (Fe KA1/LMF Slag) * (-0.002399) (Adjustable by regression)!!!!**



Calibration Data for F in Slag

Standard Name	Chem Conc (Weight %)	XRF Conc (Weight %)	Abs Dev (Weight %)	LLD (PPM)	Gross Int
SM 4	0.20	0.27	0.07	1983.6	12.40
SM 6	0.80	0.63	-0.17	1957.3	14.90
SM 7	0.60	0.63	0.03	2140.0	18.39
SM 5	0.30	0.31	0.01	1990.6	18.85
JKS 11	7.90	7.90	0.00	2836.4	23.62
SX 3921	0.50	0.60	0.10	2184.6	21.15
SX 3923	0.03	0.82	0.79	2350.1	24.06
SX 3924	0.36	0.33	-0.03	2616.6	30.35



Analysis of Feldspar

Industrial Minerals

Feldspars

Analytical requirements:

Alkali feldspars are a common raw material for ceramics and porcelain.

Quality control (composition of major elements) and impurities (trace elements):

Na_2O – 10%, Al_2O_3 – 18%, SiO_2 – 70%

and trace elements:

Fe_2O_3 – 0.5%, TiO_2 – 0.05%



S2 RANGER with XFlash® LE Feldspars



Material group: Material:
 New standard material:

Display concentrations per: After validation, go to:

	Sum(%)	SiO2(%)	TiO2(%)	Al2O3(%)	Fe2O3(%)	Na2O(%)	K2O(%)	CaO(%)	MgO(%)	P2O5(%)	Ba(PPM)	Sr(PPM)	Zr(PPM)	Rb(PPM)	CO2(%)
2 CAS 11	99,76	66,900	0,020	17,600	0,300	2,910	10,600	0,470	0,130	0,030	T	T	T	T	0,800
2 CAS 13	99,77	72,000	0,340	15,700	0,130	8,280	0,650	1,140	0,030	0,030	T	T	T	T	1,470
70 a	99,99	67,100	0,010	17,900	0,075	2,550	11,800	0,110	T	T	179	T	T	274	0,400
BCS 375	99,93	67,100	0,380	19,800	0,120	10,400	0,790	0,890	0,047	T	T	64	T	48	0,394
BCS 375-1	100,05	69,260	0,313	17,890	0,291	8,890	1,470	0,780	0,180	0,226	95	101	79	52	0,720
BCS 376	99,90	67,100	T	17,700	0,100	2,830	11,200	0,540	0,034	T	T	55	T	368	0,351
CAS 8	99,99	67,150	0,030	18,630	0,110	3,530	10,600	0,220	0,020	T	T	T	T	T	-0,300
JF 1	99,61	66,640	0,005	17,990	0,080	3,540	10,070	0,920	0,006	0,009	1680	163	39	264	0,140
JF 2	99,67	65,200	0,004	18,430	0,060	2,460	13,110	0,090	0,003	0,002	320	193	7	222	0,240

Names: Automatic Unit:

Type "B" for Balance, "T" for Trace or use contextual menu.

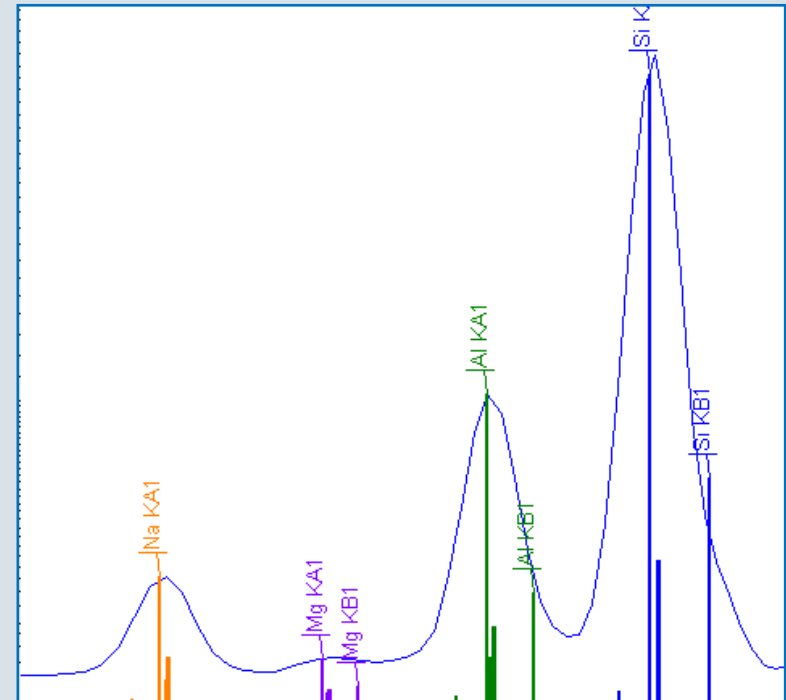
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- Selection of standard materials: SRM available
- Preparation as pressed pellets: simple, fast, cost efficient

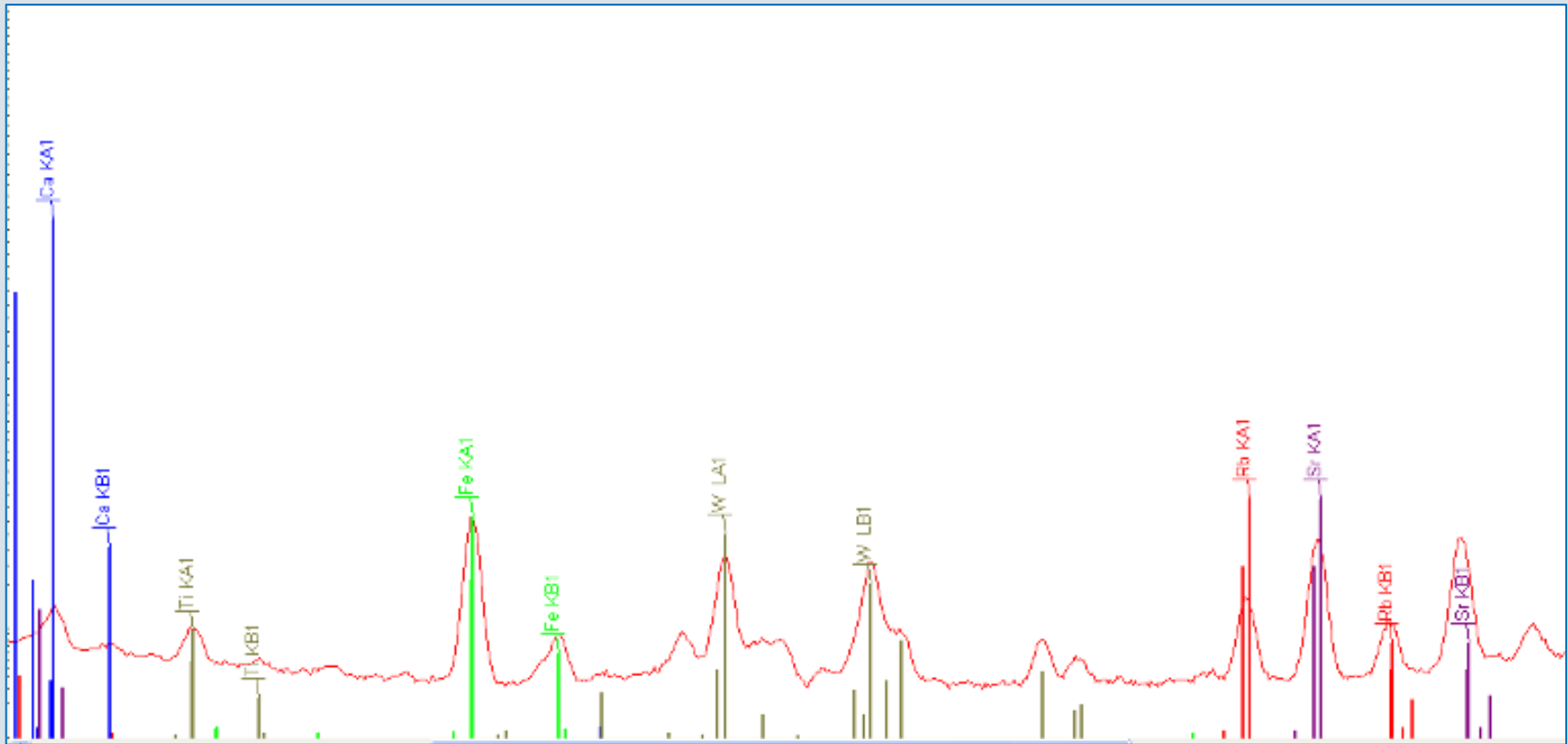
S2 RANGER with XFlash® LE Feldspars



- Best separation of light elements:
Clear identification from Na to P
- High sensitivity
- Direct excitation with 50 W
- Analysis in vacuum

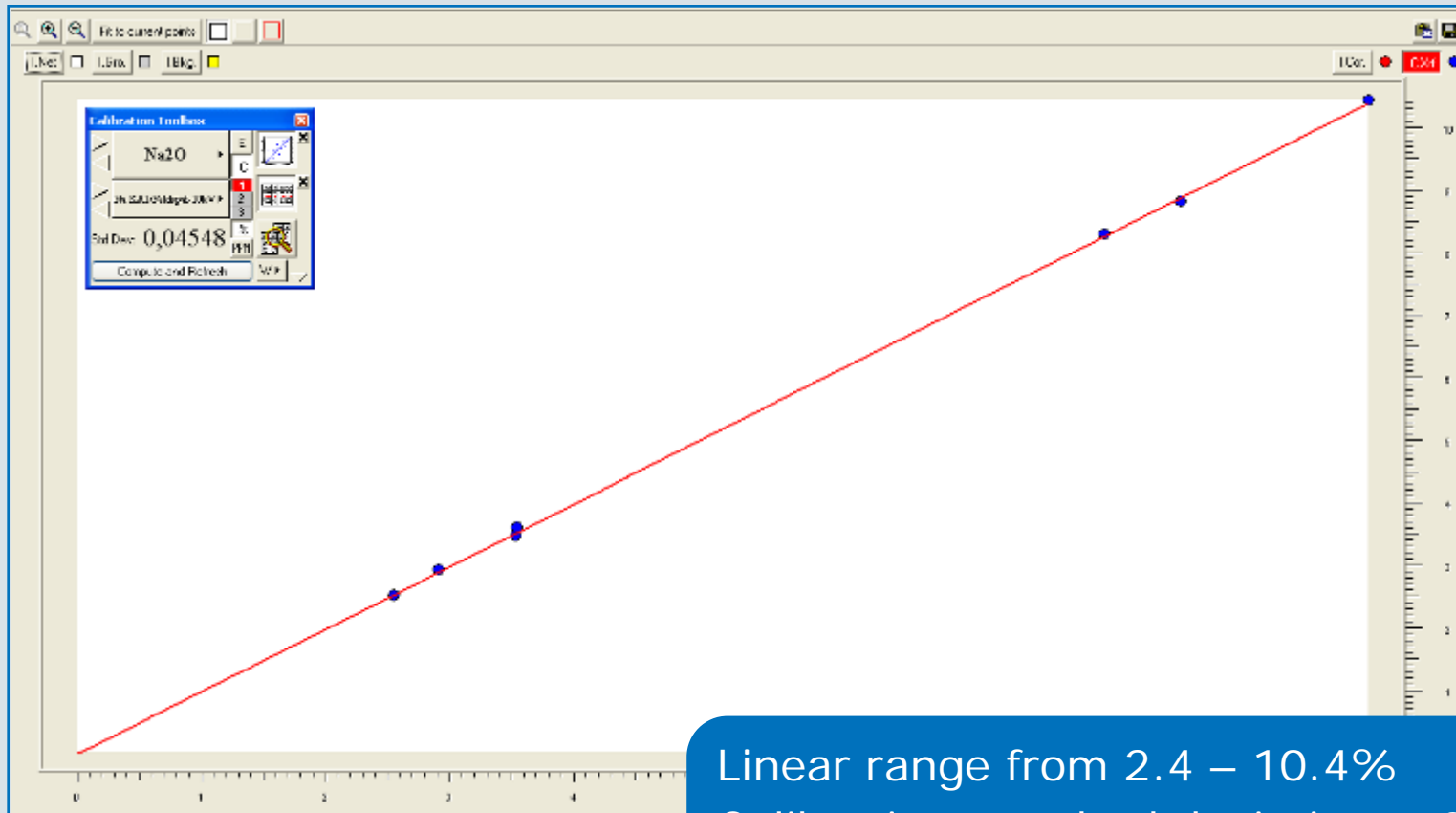


S2 RANGER with XFlash® LE Feldspars



- Best separation for trace elements, no severe line overlap
- Elements of interest: Ca, Mn, Fe, Sr

S2 RANGER with XFlash[®] LE Feldspars



Linear range from 2.4 – 10.4%
Calibration standard deviation < 0.05%
Detection Limit: 200 ppm

S2 RANGER with XFlash[®] LE Feldspars



Repetitions	Na ₂ O (%)	MgO (%)	Al ₂ O ₃ (%)	SiO ₂ (%)	P ₂ O ₅ (%)	K ₂ O (%)	CaO (%)	TiO ₂ (%)	Fe ₂ O ₃ (%)	Ba (ppm)	Sr (ppm)	Zr (ppm)	Rb (ppm)
1	8,82	0,20	18,36	69,40	0,23	1,52	0,83	0,31	0,29	86	103	74	54
2	8,88	0,19	18,35	69,42	0,23	1,49	0,80	0,31	0,29	80	100	73	53
3	8,84	0,19	18,34	69,41	0,23	1,51	0,85	0,31	0,29	63	102	78	54
4	8,88	0,20	18,34	69,36	0,23	1,52	0,84	0,32	0,29	93	103	75	55
5	8,87	0,21	18,31	69,37	0,24	1,55	0,83	0,32	0,29	74	103	74	55
6	8,87	0,19	18,35	69,37	0,23	1,52	0,83	0,32	0,29	90	102	73	54
7	8,84	0,18	18,37	69,45	0,22	1,50	0,81	0,31	0,29	69	104	74	55
8	8,86	0,19	18,32	69,44	0,23	1,51	0,82	0,31	0,29	80	101	79	54
9	8,88	0,19	18,37	69,33	0,24	1,53	0,84	0,31	0,29	69	101	75	55
10	8,84	0,21	18,35	69,39	0,24	1,53	0,81	0,31	0,29	79	102	81	54
Mean Values	8,86	0,20	18,35	69,39	0,23	1,52	0,83	0,31	0,29	78	102	76	54
Abs. Std Dev.	0,02	0,008	0,019	0,038	0,005	0,017	0,014	0,003	0,001	9	1	3	1
Rel. Std. Dev.	0,23%	4,15%	0,11%	0,05%	2,35%	1,09%	1,75%	0,92%	0,40%	12,12%	0,99%	3,70%	1,26%

S2 RANGER with XFlash[®] LE Feldspars

Results:

Na ₂ O:	8.86 +/- 0.23 %
MgO:	0.20 +/- 0.008 %
Al ₂ O ₃ :	18.35 +/- 0.02 %
SiO ₂ :	69.39 +/- 0.038 %
P ₂ O ₅ :	0.23 +/- 0.005 %
K ₂ O:	1.52 +/- 0.017 %
CaO:	0.83 +/- 0.014 %
Fe ₂ O ₃ :	2.37 +/- 0.02 %



Accurate control of the composition and impurities of mined Feldspars with the S2 RANGER with XFlash LE

S2 RANGER with XFlash[®] LE

The optimum choice

For all applications with requirements for light element analysis:

- Cement
- Industrial Minerals
- Blast Furnace Slags
- Petrochemicals
- Mg in Lubricants
- Food and Cosmetics
- Etc...



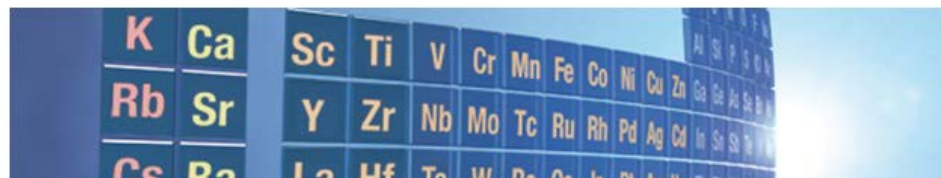
S2 RANGER with XFlash® LE For More Information



For S2 RANGER XRF lab reports, visit www.bruker-axs.com/lab_reports_xrf.html

- *[XRF 103 S2 RANGER with XFlash LE and GEO-QUANT M - Analysis of Gypsum and Carbonate Rocks.pdf](#)*
- *[XRF 82 S2 RANGER - Fast Analysis of MgO and Main Components in Limestone.pdf](#)*
- *[XRF 81 S2 RANGER - Rapid Analysis of the Main Components in Cement.pdf](#)*

For more Bruker XRF webinars, visit www.bruker-axs.com/webinars_xrf.html



XRF Webinars – Live and On-Demand

Webinar	Content
Dec 15, 2011 Applications of EDXRF Light Element Analysis to Cement, Slag and Limestone	Attend this live half-hour webinar to learn how the S2 RANGER LE solves challenges with the analysis of light elements F - Cl in materials such as cement, slag and limestone. Register now
Jun 22, 2011 µ-XRF – Fast and Sensitive Spatially Resolved Elemental Analysis	This webinar introduces Bruker's M4 TORNADO and its applications. The M4 TORNADO µ-XRF spectrometer features the latest technology for fast, highly sensitive and nondestructive elemental analysis. View recording of session I View recording of session II
May 18, 2011 Rare Earth Element Prospecting and Production	Learn how "Indiana Jones" analytical X-ray methods give you the elemental and mineralogical composition information you need in the quest, extraction, recovery and processing of rare earth elements (REEs). View recording Download slides

Q & A

Please **type** any questions you may have for our speakers in the **Q&A panel** and click **Send**.



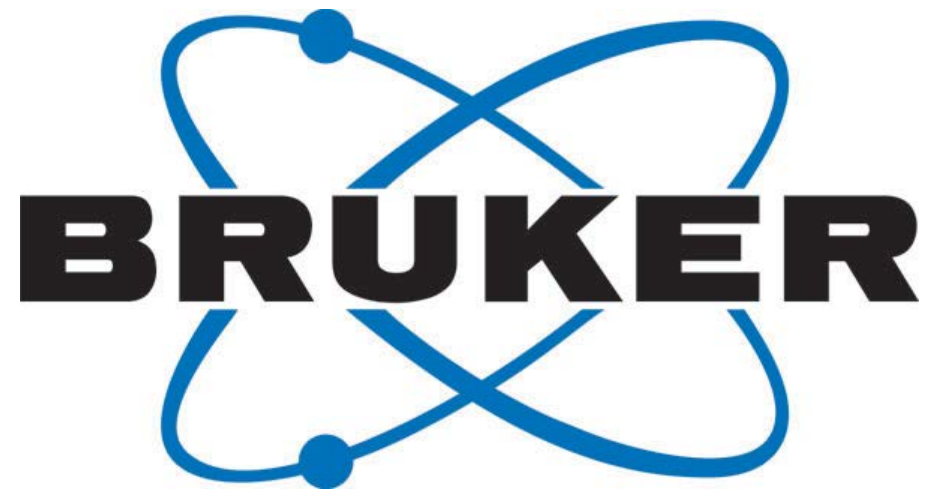
Cement



Slags



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