

SOES - 3101

Spark Optical Emission Spectrometer



EPCC / PRODUCTS / APPLICATION / SOFTWARE / ACCESSORIES / CONSUMABLES / SERVICES

Analytical Technologies Limited

An ISO 9001 Certified Company

www.analyticalgroup.net

▶▶ **Product Introduction**

Metal producing and fabricating plants require truly advanced elemental analysis at every step — from incoming materials to in-process testing to final inspection for outgoing quality. One analytical instrument measures up every time. With outstanding repeatability, reproducibility, and reliability, SOES 3101 is perhaps the industry's best-selling arc/spark optical emission spectrometry (OES) analyzer. Its fast, accurate, cost-effective measurements add certainty to critical supply chains.

Users get ultrafast information on changing process conditions. Also drastically reduced cost of ownership — with lower consumables, plus advanced diagnostics and easy maintenance to prevent expensive downtime. And this tenth-generation SOES 3101 responds to evolving plant requirements with a host of new improvements, as shown below.

▶▶ **FAST, SIMPLE STANDARDIZATION WITH ICAL 2.0**

Using conventional analyzers, standardization can take 30+ minutes, demand multiple samples, and require reruns whenever site conditions change. By contrast, in most cases ATL's proprietary iCAL 2.0 calibration logic needs only 5 minutes and a single sample per day. Plus it automatically compensates for most changes in environmental temperature or pressure. So SOES 3101 delivers outstanding stability, productivity, and savings, time after time.

▶▶ **NEW ANALYTICAL PERFORMANCE**

SOES 3101 features completely new factory calibrations, with extended calibration ranges and element selections; optimized source excitation parameters; and improved limits of detection (LODs). Example: for iron (Fe), aluminum (Al), and copper (Cu) matrices, the analyzer surpasses its already impressive performance with 30% to 40% better LODs.

▶▶ **NEW ARGON COST SAVINGS**

SOES 3101 models significantly decreased their consumption of expensive argon (Ar) gas. A brand-new feature now allows total shutdown of argon flow during standby, for periods configurable by the operator. Users save more consumables costs than ever!

▶▶ NEW EASE OF USE

SOES 3101 now provides routine, trouble-free analysis of 10 matrices, 65 methods, and 59 elements — via convenient controls for operation; easy access for use and maintenance; and enhanced software features such as quickcheck programs, virtual type standards, and spectrum scans.

▶▶ EASY-TO-USE SOFTWARE

Even for less experienced personnel, ATL's SPARK ANALYZER Pro software provides effortless operation. Favorites include application profiles tailored to preset user requirements; automatic program selection of sub-methods for given materials; spectra storage for later recalculations; multiple data export formats; and software-only upgrades for new lines, methods, or matrices.

Newest software highlights:

- Backup tool — for easy backups to network, other drives, etc.
- Virtual type standards — to improve accuracy by combining optimal element samples for type correction
- Extended grade library — for iron, aluminum, copper
- Quick-check programs — to identify & analyze main elements in under 12 seconds: for iron & aluminum materials, & now including analysis of copper
- Spectrum scan (optional) — to compare spectral lines of multiple samples in the same view
- Shift change protocol (optional) — to summarize all activities in a given shift: for handover to next operator, or QA optimization

▶▶ HARDWARE NOTE

The latest SOES 3101 eliminates a magnesium fluoride (MgF₂) window at the spark stand — saving costs and maintenance replacement efforts.

►► Instrumentation Features

Optical Systems Optic I:

- Wavelength range 120 nm – 235 nm
- Focal length 300 mm, Holographic grating with 3600 gr. / mm
- CMOS detectors

Optic II:

- Wavelength range 233 nm – 670 nm (optional -766 nm)
- Focal length 400 mm, Holographic grating 2400 gr. / mm
- CMOS detectors

The applicable and configured wavelength range is based on the customer's application requirements. Both optics are temperature stabilized and pressure compensated.

Plasma Generator:

The benefit of this full digitalization with high fidelity is the guarantee that the spark pulse created is the spark pulse desired, every time.

Precision is improved and so is the similarity of the generated spark signals (unit uniformity). With our off-line digital control, we ensure that each plasma generator delivers identical spark signals, with a negligible deviation between any two plasma generators.

Every plasma generator has a programmable output power waveform for application specific optimization.

Online drift correction and background correction:

- Permanent control of the peak position of each line and readjustment if needed (iCAL 2.0)
- Recalculation of the background signal wherever it is possible

Optimized Measurement Times:

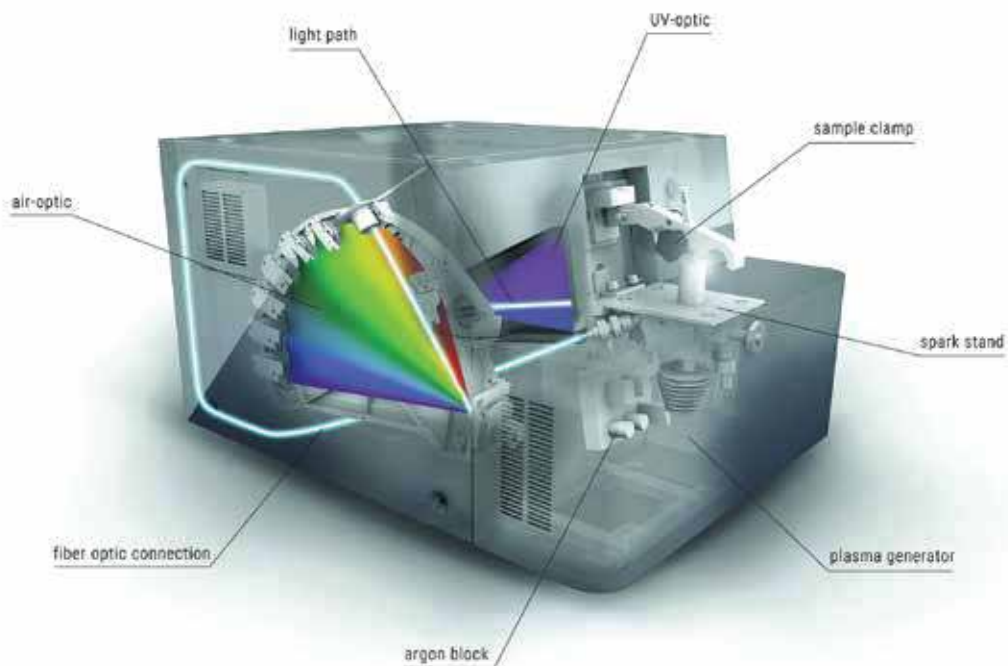
- Dynamic pre-burn time, reflecting the sample quality
- Minimized delay between measurement sequences
- Optimized number of excitation parameters including frequencies of up to 1000 Hz

Intelligent Calibration Logic (iCAL 2.0):

- Profile position control and standardization with only one sample

►► Accuracy of Analysis

It is the aim of modern OES spectrometers to greatly reduce the influence of the structure and composition (matrix) effects. The SOES 3101 combines traditional technologies like HEPS-High Energy Pre Spark to reach the stationary phase by “remelting” a small portion of the sample, resulting in a reduced structure effect.



►► **Table 1: Calculation of detection limit (DL) according to DIN 32645:2008-11 with a confidence limit of 99.7% (3 sigma), recorded on a production series device**

Element	C	Si	Mn	P	S	Cr	Mo	Ni
Calibration range (%)	0.0008 - 4.7	0.0005 - 20	0.0005 - 29	0.0005 - 2.4	0.0005 - 0.43	0.0003 - 33	0.0004 - 9.5	0.0005 - 46
Detection Limit (ppm)	8	5	5	5	5	3	4	5

Element	Al	Co	Cu	Nb	Ti	V	W	Pb
Calibration range (%)	0.0005 - 8.7	0.0006 - 18	0.0002 - 8.1	0.0005 - 3	0.0002 - 3	0.0005 - 10	0.005 - 21	0.0008 - 0.38
Detection Limit (ppm)	5	6	2	5	2	5	50	8

Element	Sn	Mg	As	Zr	Bi	Ca	Ce	Sb
Calibration range (%)	0.0002 - 0.24	0.001 - 0.26	0.001 - 0.2	0.001 - 0.35	0.001 - 0.067	0.0001 - 0.013	0.001 - 0.17	0.001 - 0.24
Detection Limit (ppm)	2	10	10	10	10	1	10	10

Element	Se	Te	Ta	B	Zn	La	Ag	N
Calibration range (%)	0.0010 - 0.31	0.001 - 0.08	0.007 - 0.76	0.0001 - 2	0.0005 - 0.045	0.0003 - 0.42	0.00005 - 0.005	0.001 - 1.1
Detection Limit (ppm)	10	10	70	1	5	3	0.5	10

Element	Nd
Calibration range (%)	0.001 - 0.02
Detection Limit (ppm)	10

►► **Table 2: RN19/... Low-Alloy Steel**

Element	C	Si	Mn	P	S	Cr	Mo	Ni	Al	Co	Cu	Nb
1	0.916	1.08	1.57	0.109	0.123	3.11	1.03	3.17	0.577	1.79	0.458	0.467
2	0.905	1.07	1.58	0.108	0.114	3.12	1.02	3.17	0.579	1.79	0.462	0.462
3	0.905	1.08	1.57	0.108	0.121	3.11	1.02	3.17	0.579	1.78	0.461	0.459
4	0.918	1.07	1.57	0.108	0.113	3.12	1.03	3.17	0.580	1.79	0.463	0.459
5	0.901	1.07	1.57	0.109	0.119	3.12	1.03	3.17	0.575	1.79	0.462	0.458
6	0.907	1.07	1.57	0.108	0.112	3.11	1.02	3.17	0.576	1.79	0.462	0.455
7	0.917	1.08	1.57	0.108	0.118	3.11	1.02	3.17	0.575	1.78	0.46	0.461
<x>	0.91	1.07	1.57	0.108	0.117	3.11	1.02	3.17	0.577	1.79	0.461	0.460
SD	0.006 7	0.0026	0.0026	0.00057	0.0041	0.004 3	0.003 2	0.001	0.0019	0.003	0.0015	0.004
RSD (%rel.)	0.741	0.24	0.167	0.53	3.52	0.14	0.311	0.0318	0.338	0.169	0.315	0.86

Element	Ti	V	W	Pb	Sn	As	Zr	Bi	Ca	Ce	Sb	Se
1	0.12 3	0.505	0.528	0.0207	0.102	0.0781	0.0997	0.0076	<0.0001 0	0.0013	0.0662	<0.0010
2	0.12 2	0.500	0.524	0.0215	0.102	0.0767	0.0987	0.0080	<0.0001 0	0.0013	0.0663	<0.0010
3	0.12 1	0.504	0.530	0.0197	0.102	0.0767	0.0974	0.0070	<0.0001 0	0.0014	0.0663	<0.0010
4	0.12 1	0.503	0.526	0.0235	0.103	0.0771	0.0996	0.0088	<0.0001 0	0.0013	0.0668	<0.0010
5	0.12 2	0.501	0.526	0.0213	0.102	0.0776	0.0971	0.0077	<0.0001 0	0.0014	0.0666	<0.0010
6	0.12 1	0.502	0.530	0.0206	0.102	0.0768	0.0977	0.0075	<0.0001 0	0.0013	0.0670	<0.0010
7	0.12 2	0.503	0.533	0.0204	0.102	0.0772	0.0970	0.0074	<0.0001 0	0.0013	0.0667	<0.0010
<x>	0.12 2	0.503	0.528	0.0211	0.102	0.0772	0.0982	0.0077	<0.0001 0	0.0013	0.0666	<0.0010
SD	0.000 53	0.0017	0.0031	0.0012	0.0004 2	0.00053	0.0011	0.00057		0.00006	0.00031	
RSD (%rel.)	0.43 2	0.34	0.586	5.78	0.414	0.692	1.17				0.473	

Element	Te	Ta	B	Zn	La	Ag	N	Fe
1	0.0240	>0.210	0.0032	>0.0260	<0.0003 0	0.00095	0.0276	83.8
2	0.0246	>0.210	0.0032	>0.0260	<0.0003 0	0.00097	0.0261	83.8
3	0.0232	>0.210	0.0032	>0.0260	<0.0003 0	0.00095	0.0250	83.8
4	0.0235	>0.210	0.0032	>0.0260	<0.0003 0	0.00096	0.0252	83.8
5	0.0241	>0.210	0.0030	>0.0260	<0.0003 0	0.00096	0.0256	83.8
6	0.0237	>0.210	0.0031	>0.0260	<0.0003 0	0.00096	0.0257	83.8
7	0.0236	>0.210	0.0030	>0.0260	<0.0003 0	0.00094	0.0262	83.8
<x>	0.0238	>0.210	0.0031	>0.0260	<0.0003 0	0.00096	0.0259	83.8
SD	0.0004 6		0.00009			0.00000 9	0.00086	0.0169
RSD (%rel.)	1.94						3.31	0.0201

►► Table 3: SUS5/... Cast Iron

Element	C	Si	Mn	P	S	Cr	Mo	Ni	Al	Co	Cu	Nb
1	3.78	2.04	0.618	0.0445	0.0131	0.0173	0.0017	1.05	0.0354	0.0023	0.0032	<0.0005
2	3.79	2.04	0.621	0.0447	0.0164	0.0173	0.0017	1.05	0.0360	0.0031	0.0032	<0.0005
3	3.78	2.03	0.619	0.0447	0.0169	0.0172	0.0016	1.05	0.0356	0.0032	0.0032	<0.0005
4	3.82	2.04	0.621	0.0448	0.0157	0.0173	0.0017	1.05	0.0358	0.0032	0.0032	<0.0005
5	3.78	2.03	0.620	0.0458	0.0180	0.0172	0.0016	1.05	0.0360	0.0030	0.0032	<0.0005
6	3.76	2.03	0.619	0.0438	0.0141	0.0174	0.0016	1.05	0.0355	0.0023	0.0031	<0.0005
7	3.79	2.03	0.620	0.0451	0.0148	0.0173	0.0016	1.05	0.0354	0.0028	0.0032	<0.0005
<x>	3.79	2.03	0.620	0.0448	0.0156	0.0173	0.0016	1.05	0.0357	0.0028	0.0032	<0.0005
SD	0.0156	0.0039	0.0012	0.00063	0.0017	0.00006	0.00006	0.00059	0.0002 5	0.00038	0.00004	
RSD (%rel.)	0.411	0.194	0.191	1.41	10.79	0.322		0.056	0.697			

Element	Ti	V	W	Pb	Sn	Mg	As	Zr	Bi	Ca	Ce	Sb
1	0.0093	0.50	<0.005 0	<0.000 8	0.075 2	0.0993	0.003 5	<0.001 00	0.0031	0.0001 3	0.0211	0.0158
2	0.0091	0.499	<0.005 0	<0.000 8	0.074 4	0.1010	0.003 6	<0.001 00	0.0034	0.0001 6	0.0226	0.0174
3	0.0091	0.499	<0.005 0	<0.000 8	0.074 8	0.0994	0.003 7	<0.001 00	0.0033	0.0001 4	0.0219	0.0175
4	0.0091	0.498	<0.005 0	<0.000 8	0.074 1	0.0973	0.003 4	<0.001 00	0.0033	0.0001 3	0.0218	0.0168
5	0.0091	0.492	<0.005 0	<0.000 8	0.075 1	0.1010	0.003 5	<0.001 00	0.0034	0.0001 5	0.0216	0.0178
6	0.0090	0.490	<0.005 0	<0.000 8	0.074 9	0.0959	0.003 0	<0.001 00	0.0034	0.0001 4	0.0215	0.0172
7	0.0090	0.491	<0.005 0	<0.000 8	0.074 9	0.0990	0.003 8	<0.001 00	0.0034	0.0001 6	0.0221	0.0184
<x>	0.0091	0.496	<0.005 0	<0.000 8	0.074 8	0.0990	0.003 5	<0.001 00	0.0033	0.0001 4	0.0218	0.0172
SD	0.0001	0.0043			0.0003 8	0.0019	0.0002 5		0.0000 9	0.0000 1	0.0004 7	0.0008 2
RSD (%rel.)	1.1	0.86			0.503	1.9					2.16	4.74

Element	Se	Te	B	Zn	La	N	Nd	Fe
1	<0.001 5	0.0041	<0.0001	0.0043	0.0067	0.0083	<0.0010 0	91.6
2	<0.001 5	0.0043	<0.0001	0.0044	0.0071	0.0076	<0.0010 0	91.6
3	<0.001 5	0.0041	<0.0001	0.0043	0.0066	0.0076	<0.0010 0	91.6
4	<0.001 5	0.0047	<0.0001	0.0044	0.0070	0.0096	<0.0010 0	91.6
5	<0.001 5	0.0035	<0.0001	0.0044	0.0064	0.0084	<0.0010 0	91.6
6	<0.001 5	0.0040	<0.0001	0.0045	0.0066	0.0088	<0.0010 0	91.7
7	<0.001 5	0.0041	<0.0001	0.0045	0.0065	0.0071	<0.0010 0	91.6
<x>	<0.001 5	0.0041	<0.0001	0.0044	0.0067	0.0082	<0.0010 0	91.6
SD		0.00037		0.00006	0.00028	0.00084		0.0227
RSD (%rel.)				1.47	4.11	10.21		0.0248

►► **Table 4: E/... Cr-Cr/Ni Steel**

Element	C	Si	Mn	P	S	Cr	Mo	Ni	Al	Co	Cu	Nb
1	0.0675	0.636	1.52	0.0026	<0.0005	14.80	1.23	25.67	0.222	0.0648	0.0174	0.0782
2	0.0698	0.643	1.52	0.0029	<0.0005	14.79	1.24	25.67	0.224	0.0648	0.0174	0.0785
3	0.0689	0.635	1.52	0.0029	<0.0005	14.82	1.24	25.62	0.222	0.0651	0.0176	0.0778
4	0.0638	0.637	1.52	0.0031	<0.0005	14.82	1.24	25.59	0.221	0.0652	0.0173	0.0779
5	0.0666	0.638	1.53	0.0030	<0.0005	14.79	1.23	25.63	0.222	0.0644	0.0174	0.0784
6	0.0651	0.637	1.52	0.0030	<0.0005	14.78	1.23	25.68	0.221	0.0648	0.0181	0.0770
7	0.0679	0.638	1.52	0.0033	<0.0005	14.81	1.24	25.62	0.222	0.0649	0.0175	0.0792
<x>	0.0671	0.638	1.52	0.0030	<0.0005	14.80	1.24	25.64	0.222	0.0649	0.0175	0.0781
SD	0.0021	0.0023	0.0031	0.0002		0.016	0.0039	0.0322	0.0011	0.00024	0.00027	0.00069
RSD (%rel.)	3.15	0.368	0.206			0.108	0.317	0.126	0.487	0.375	1.53	0.886

Element	Ti	V	W	Pb	Sn	As	Zr	Bi	Ca	Ce	Sb	Se
1	2.04	0.262	<0.0070	0.0057	0.0012	<0.0010	0.0023	0.0049	0.00028	<0.00100	<0.0010	<0.0015
2	2.03	0.261	<0.0070	0.0056	0.0012	<0.0010	0.0024	0.0050	0.00060	<0.00100	<0.0010	<0.0015
3	2.03	0.259	<0.0070	0.0057	0.0012	<0.0010	0.0024	0.0050	0.00026	<0.00100	<0.0010	<0.0015
4	2.03	0.260	<0.0070	0.0057	0.0012	<0.0010	0.0024	0.0049	0.00026	<0.00100	<0.0010	<0.0015
5	2.05	0.261	<0.0070	0.0057	0.0012	<0.0010	0.0024	0.0050	0.00011	<0.00100	<0.0010	<0.0015
6	2.06	0.263	<0.0070	0.0056	0.0012	<0.0010	0.0024	0.0049	0.00012	<0.00100	<0.0010	<0.0015
7	2.05	0.259	<0.0070	0.0056	0.0013	<0.0010	0.0024	0.0049	0.00011	<0.00100	<0.0010	<0.0015
<x>	2.04	0.261	<0.0070	0.0057	0.0012	<0.0010	0.0024	0.0049	0.00023	<0.00100	<0.0010	<0.0015
SD	0.0114	0.0014		0.00005	0.00003		0.00003	0.00004	0.00018			
RSD (%rel.)	0.561	0.539		0.956								

Element	Ta	B	La	N	Fe
1	<0.007 0	0.0066	0.0011	<0.0010 0	53.3
2	<0.007 0	0.0067	0.0011	<0.0010 0	53.3
3	<0.007 0	0.0066	0.0011	<0.0010 0	53.3
4	<0.007 0	0.0066	0.0011	<0.0010 0	53.4
5	<0.007 0	0.0067	0.0011	<0.0010 0	53.3
6	<0.007 0	0.0067	0.0012	<0.0010 0	53.3
7	<0.007 0	0.0068	0.0011	<0.0010 0	53.3
<x>	<0.007 0	0.0067	0.0011	<0.0010 0	53.3
SD		0.0000 6	0.00003		0.0274
RSD (%rel.)		0.892			0.0513

►► **Table 5: RH18/... Highspeed Steel**

Element	C	Si	Mn	P	S	Cr	Mo	Ni	Al	Co	Cu	Ti
1	1.27	0.348	0.259	0.0136	0.0011	3.98	3.85	0.261	0.0138	10.02	0.0839	0.0113
2	1.27	0.349	0.259	0.0138	0.0012	3.99	3.88	0.261	0.0139	10.02	0.0835	0.0115
3	1.30	0.350	0.259	0.0147	0.0012	3.99	3.88	0.260	0.0139	9.99	0.0835	0.0116
4	1.27	0.349	0.259	0.0139	0.0010	4.00	3.86	0.261	0.0141	10.00	0.0837	0.0107
5	1.29	0.350	0.260	0.0140	0.0011	4.00	3.87	0.263	0.0141	9.97	0.0836	0.0116
6	1.29	0.353	0.261	0.0141	0.0013	4.00	3.89	0.264	0.0136	9.95	0.0836	0.0110
7	1.27	0.352	0.260	0.0138	0.0014	3.98	3.86	0.264	0.0136	9.97	0.0840	0.0108
<x>	1.28	0.350	0.259	0.0140	0.0012	3.99	3.87	0.262	0.0139	9.99	0.0837	0.0112
SD	0.0118	0.0019	0.00075	0.00035	0.00014	0.0092	0.015	0.0016	0.00022	0.0266	0.0002	0.00037
RSD (%rel.)	0.923	0.541	0.29	2.47	11.58	0.231	0.388	0.621	1.57	0.266	0.236	3.26

Element	V	W	Sn	As	N	Fe
1	2.92	9.27	0.0060	<0.0010 0	0.0247	67.7
2	2.94	9.43	0.0060	<0.0010 0	0.0231	67.5
3	2.97	9.41	0.0060	<0.0010 0	0.0248	67.4
4	2.91	9.39	0.0060	<0.0010 0	0.0241	67.5
5	2.97	9.37	0.0059	<0.0010 0	0.0259	67.5
6	2.95	9.39	0.0060	<0.0010 0	0.0268	67.5
7	2.91	9.28	0.0061	<0.0010 0	0.0268	67.7
<x>	2.94	9.36	0.0060	<0.0010 0	0.0252	67.5
SD	0.027 3	0.0626	0.00005		0.0014	0.102
RSD (%rel.)	0.93	0.668	0.813		5.44	0.151

►► **Table 6: BAS493/... Manganese Steel**

Element	C	Si	Mn	P	S	Cr	Mo	Ni	Al	Co	Cu	Nb
1	0.846	0.840	11.14	0.121	0.0102	0.273	0.959	3.08	0.0365	0.0099	0.0149	0.0040
2	0.848	0.849	11.12	0.123	0.0104	0.273	0.962	3.06	0.0371	0.0095	0.0149	0.0041
3	0.858	0.848	11.14	0.122	0.0103	0.272	0.964	3.08	0.0375	0.0090	0.0148	0.0041
4	0.855	0.849	11.19	0.124	0.0104	0.274	0.971	3.07	0.0363	0.0095	0.0149	0.0041
5	0.858	0.855	11.21	0.125	0.0105	0.275	0.975	3.06	0.0368	0.0099	0.0150	0.0039
6	0.847	0.846	11.18	0.122	0.0100	0.274	0.966	3.07	0.0370	0.0094	0.0149	0.0041
7	0.853	0.854	11.20	0.125	0.0105	0.276	0.976	3.06	0.0368	0.0100	0.0150	0.0040
<x>	0.852	0.849	11.17	0.123	0.0103	0.274	0.968	3.07	0.0369	0.0096	0.0149	0.0041
SD	0.0052	0.005	0.0323	0.0016	0.00018	0.0011	0.006 7	0.0084	0.00041	0.00034	0.00005	0.00007
RSD (%rel.)	0.606	0.585	0.289	1.26	1.79	0.405	0.696	0.275	1.11	3.57	0.348	

Element	Ti	V	Sn	N	Fe
1	0.0026	0.0243	0.0023	0.0251	82.6
2	0.0027	0.0244	0.0021	0.0260	82.6
3	0.0027	0.0243	0.0022	0.0263	82.6
4	0.0026	0.0246	0.0022	0.0270	82.5
5	0.0026	0.0248	0.0022	0.0270	82.5
6	0.0027	0.0246	0.0021	0.0263	82.6
7	0.0026	0.0249	0.0023	0.0273	82.5
<x>	0.0026	0.0246	0.0022	0.0264	82.6
SD	0.0000 3	0.0002 4	0.00007	0.00074	0.0456
RSD (%rel.)		0.989		2.8	0.0553

►► **Table 7: CRRM5/... Cr-Hard Cast**

Element	C	Si	Mn	P	S	Cr	Mo	Ni	Al	Cu	Ti	V	Fe
1	3.50	0.195	0.314	0.030 5	0.017 7	30.21	0.634	0.362	0.126	0.212	0.011	0.104	64.3
2	3.49	0.197	0.314	0.030 5	0.018 3	30.19	0.628	0.363	0.126	0.212	0.011	0.103	64.3
3	3.51	0.192	0.315	0.030 4	0.018 0	30.27	0.626	0.363	0.129	0.213	0.011	0.103	64.2
4	3.51	0.192	0.315	0.030 2	0.018 5	30.20	0.629	0.365	0.126	0.210	0.011	0.103	64.3
5	3.49	0.195	0.314	0.030 5	0.018 7	30.28	0.625	0.363	0.126	0.210	0.011	0.103	64.2
6	3.51	0.196	0.314	0.030 4	0.017 2	30.28	0.625	0.361	0.127	0.213	0.011	0.102	64.2
7	3.50	0.195	0.314	0.030 0	0.017 7	30.34	0.622	0.361	0.127	0.211	0.011	0.103	64.2
<x>	3.50	0.195	0.314	0.030 3	0.018 0	30.25	0.627	0.363	0.127	0.212	0.011	0.103	64.2
SD	0.00 68	0.002	0.000 51	0.000 2	0.0005 2	0.052 6	0.003 8	0.001 5	0.000 91	0.001 3	0.000 05	0.000 46	0.050 1
RSD (%rel.)	0.19 4	1.03	0.164	0.666	2.89	0.174	0.61	0.4	0.715	0.607	0.459	0.442	0.078

►► **Table 8: NIRM8/... Ni Resist**

Element	C	Si	Mn	P	S	Cr	Mo	Ni	Cu	Nb	Mg	Ce	Fe
1	1.44	5.36	1.62	0.086 8	0.012 4	2.78	0.765	34.99	0.229	0.015 7	0.039 2	0.012 6	52.6
2	1.43	5.35	1.63	0.086 1	0.011 1	2.77	0.766	35.00	0.229	0.015 5	0.035 8	0.013 1	52.7
3	1.44	5.39	1.63	0.086 7	0.011 4	2.79	0.769	34.96	0.229	0.015 7	0.036 2	0.013 1	52.6
4	1.43	5.32	1.64	0.086 2	0.010 6	2.78	0.765	35.00	0.230	0.015 5	0.036 8	0.013 9	52.7
5	1.44	5.35	1.64	0.088 0	0.012 4	2.79	0.768	34.90	0.230	0.015 5	0.036 7	0.014 0	52.7
6	1.44	5.37	1.64	0.087 3	0.011 2	2.78	0.762	34.96	0.229	0.015 9	0.037 4	0.013 6	52.7
7	1.43	5.35	1.64	0.087 1	0.010 9	2.79	0.765	34.93	0.229	0.015 6	0.037 0	0.013 2	52.7
<x>	1.44	5.36	1.64	0.086 9	0.011 4	2.78	0.766	34.96	0.229	0.015 6	0.037 0	0.013 3	52.7
SD	0.00 62	0.020 1	0.006 1	0.000 64	0.0007 3	0.006 8	0.002 1	0.038 1	0.000 33	0.000 12	0.001 1	0.000 48	0.027 7
RSD (%rel.)	0.42 9	0.375	0.373	0.741	6.34	0.245	0.28	0.109	0.142	0.78	2.95	3.58	0.052 6

►► **The Analysis of Aluminum and its Alloys**

►► **Table 1: Calculation of detection limit (DL) according to DIN 32645:2008-11 with a confidence limit of 99.7% (3 sigma), recorded on a production series device.**

Element	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn
Calibration range (%)	0.0005 - 36	0.0005 - 12	0.0001 - 53	0.0002 - 30	0.00005 - 11	0.0002 - 0.46	0.0003 - 4	0.0008 - 20
Detection Limit (ppm)	5	5	1	2	0.5	2	3	8

Element	Ti	Ag	As	B	Ba	Be	Bi	Ca
Calibration range (%)	0.0003 - 5.4	0.0001 - 1	0.001 - 0.011	0.0001 - 1.5	0.0001 - 0.006	0.00005 - 0.021	0.0005 - 0.71	0.0001 - 0.04
Detection Limit (ppm)	3	1	10	1	1	0.5	5	1

Element	Cd	Ce	Co	Ga	Hg	In	La	Li
Calibration range (%)	0.0001 - 0.33	0.001 - 0.046	0.0004 - 1.6	0.0001 - 0.11	0.0003 - 0.01	0.0003 - 0.1	0.0003 - 11	0.0001 - 8.2
Detection Limit (ppm)	1	10	4	1	3	3	3	1

Element	Mo	Na	P	Pb	Sb	Sn	Sr	Tl
Calibration range (%)	0.0003 - 0.12	0.0001 - 0.021	0.0008 - 0.017	0.0005 - 1.5	0.0015 - 0.55	0.0002 - 21	0.00005 - 11	0.0005 - 0.015
Detection Limit (ppm)	3	1	8	5	15	2	0.5	5

Element	V	Zr	Sc
Calibration range (%)	0.0005 - 0.11	0.0002 - 1.3	0.0002 - 0.4
Detection Limit (ppm)	5	2	2

►► **Table 2: 122/...** **Pure Aluminum**

Element	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ag	As	B
1	0.05 18	0.059 1	0.020 5	0.020 4	0.015 7	0.020 1	0.020 8	0.021 2	0.019 2	0.020 3	0.006 8	0.000 18
2	0.05 14	0.060 3	0.020 5	0.020 5	0.015 8	0.020 8	0.020 6	0.021 4	0.019 3	0.020 2	0.006 7	0.000 19
3	0.05 12	0.059 5	0.020 2	0.020 5	0.015 7	0.020 3	0.020 4	0.021 1	0.018 8	0.020 0	0.006 5	0.000 19
4	0.05 12	0.058 6	0.020 3	0.020 5	0.015 8	0.020 1	0.020 5	0.021 2	0.019 0	0.020 1	0.006 5	0.000 18
5	0.05 13	0.059 5	0.020 3	0.020 6	0.015 8	0.020 2	0.020 6	0.021 3	0.019 1	0.020 1	0.006 5	0.000 21
6	0.05 13	0.058 8	0.020 2	0.020 5	0.015 8	0.020 1	0.020 4	0.021 1	0.018 7	0.020 0	0.006 6	0.000 18
7	0.05 16	0.059 1	0.020 4	0.020 4	0.015 7	0.020 1	0.020 7	0.021 3	0.020 4	0.020 2	0.007 4	0.000 20
8	0.05 12	0.061 0	0.020 2	0.020 4	0.015 7	0.020 2	0.020 3	0.021 0	0.019 1	0.020 1	0.006 8	0.000 19
<x>	0.05 14	0.059 5	0.020 3	0.020 5	0.015 7	0.020 2	0.020 5	0.021 2	0.019 2	0.020 1	0.006 7	0.000 19
SD	0.00 021	0.000 79	0.000 13	0.000 06	0.000 06	0.000 24	0.000 2	0.000 12	0.000 53	0.000 08	0.000 3	
RSD (%rel.)	0.41 1	1.33	0.655	0.301	0.385	1.18	0.77	0.567	2.74	0.401	4.42	

Element	Ba	Be	Bi	Ca	Cd	Ce	Co	Ga	Hg	In	La	Li
1	0.00 35	0.000 49	0.007 5	0.000 23	0.005 2	0.011 9	0.015 4	0.025 6	0.007 6	0.014 4	0.021 1	0.000 38
2	0.00 35	0.000 49	0.007 6	0.000 20	0.005 0	0.012 2	0.015 6	0.025 5	0.007 7	0.014 5	0.021 1	0.000 36
3	0.00 35	0.000 49	0.007 5	0.000 22	0.005 0	0.011 8	0.015 2	0.025 2	0.007 6	0.014 1	0.020 8	0.000 39
4	0.00 35	0.000 49	0.007 5	0.000 23	0.005 0	0.011 8	0.015 3	0.025 4	0.007 6	0.014 3	0.020 9	0.000 40
5	0.00 35	0.000 49	0.007 5	0.000 23	0.005 0	0.011 9	0.015 3	0.025 4	0.007 5	0.014 3	0.020 9	0.000 38
6	0.00 34	0.000 49	0.007 4	0.000 21	0.005 1	0.011 7	0.015 2	0.025 2	0.007 8	0.014 2	0.020 7	0.000 37
7	0.00 35	0.000 49	0.007 5	0.000 23	0.005 1	0.012 0	0.015 4	0.025 5	0.007 6	0.014 3	0.021 1	0.000 37
8	0.00 35	0.000 48	0.007 5	0.000 19	0.005 1	0.011 5	0.015 1	0.025 4	0.007 6	0.014 0	0.020 7	0.000 37
<x>	0.00 35	0.000 49	0.007 5	0.000 22	0.005 1	0.011 9	0.015 3	0.025 4	0.007 6	0.014 3	0.020 9	0.000 38
SD	0.00 003		0.000 05		0.000 06	0.000 21	0.000 14	0.000 12	0.000 07	0.000 16	0.000 18	0.000 01
RSD (%rel.)			0.679		1.1	1.75	0.942	0.474	0.902	1.14	0.882	

Element	Mo	Na	P	Pb	Sb	Sn	Sr	Tl	V	Zr	Al
1	0.00 98	0.001 6	0.004 0	0.005 8	0.009 0	0.010 5	0.000 33	0.014 1	0.018 7	0.015 7	99.5
2	0.01 00	0.001 5	0.004 0	0.006 0	0.008 9	0.010 2	0.000 34	0.014 3	0.019 0	0.015 7	99.5
3	0.00 96	0.001 7	0.003 9	0.005 7	0.008 7	0.010 7	0.000 33	0.013 7	0.018 3	0.015 6	99.5
4	0.00 97	0.001 7	0.003 9	0.005 9	0.008 6	0.010 4	0.000 33	0.014 0	0.018 5	0.015 6	99.5
5	0.00 97	0.001 6	0.004 0	0.005 8	0.008 8	0.010 2	0.000 34	0.014 0	0.018 6	0.015 6	99.5
6	0.00 96	0.001 6	0.004 1	0.005 7	0.009 0	0.010 5	0.000 31	0.013 8	0.018 3	0.015 6	99.5
7	0.00 98	0.001 6	0.004 1	0.005 8	0.008 1	0.010 5	0.000 32	0.014 1	0.018 6	0.015 6	99.5
8	0.00 97	0.001 6	0.004 0	0.005 6	0.008 6	0.010 2	0.000 33	0.013 7	0.018 5	0.015 7	99.5
<x>	0.00 97	0.001 6	0.004 0	0.005 8	0.008 7	0.010 4	0.000 33	0.014 0	0.018 6	0.015 6	99.5
SD	0.00 015	0.000 04	0.000 08	0.000 13	0.000 28	0.000 18	0.000 009	0.000 21	0.000 22	0.000 06	0.003
RSD (%rel.)	1.51		2.06		3.24	1.78		1.49	1.17	0.381	0.003

►► **Table 3: 434/...** **Al/Si - Alloy**

Element	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ag	Be	Bi
1	12.9 8	0.328	1.73	0.197	1.41	0.099 7	1.49	0.123	0.119	<0.00 010	<0.00 005	0.001 4
2	13.0 1	0.326	1.75	0.197	1.41	0.100 0	1.50	0.122	0.118	<0.00 010	<0.00 005	0.001 5
3	13.0 2	0.328	1.73	0.197	1.41	0.099 9	1.50	0.122	0.119	<0.00 010	<0.00 005	0.001 4
4	13.0 3	0.33	1.72	0.197	1.40	0.100 0	1.49	0.122	0.120	<0.00 010	<0.00 005	0.001 5
5	13.0 0	0.331	1.72	0.196	1.40	0.099 9	1.49	0.121	0.119	<0.00 010	<0.00 005	0.001 4
6	13.0 1	0.327	1.74	0.197	1.41	0.099 7	1.49	0.122	0.120	<0.00 010	<0.00 005	0.001 5
7	13.0 6	0.327	1.74	0.197	1.41	0.100 0	1.50	0.122	0.119	<0.00 010	<0.00 005	0.001 5
8	13.0 7	0.327	1.75	0.197	1.41	0.099 9	1.50	0.122	0.119	<0.00 010	<0.00 005	0.001 5
<x>	13.0 2	0.328	1.73	0.197	1.41	0.099 9	1.49	0.122	0.119	<0.00 010	<0.00 005	0.001 5
SD	0.02 79	0.001 7	0.011	0.000 25	0.004 7	0.000 18	0.006 5	0.000 49	0.000 63			0.000 02
RSD (%rel.)	0.21 4	0.514	0.634	0.128	0.331	0.184	0.433	0.401	0.529			

Element	Ca	Cd	Co	Ga	Hg	Li	Na	P	Pb	Sb	Sn	Sr
1	0.01 39	<0.00 010	0.001 9	0.007 2	<0.00 03	<0.00 010	0.007 5	<0.00 08	0.007 4	<0.00 15	0.006 3	0.027 7
2	0.01 40	<0.00 010	0.002 0	0.007 2	<0.00 03	<0.00 010	0.007 6	<0.00 08	0.007 2	<0.00 15	0.006 6	0.027 0
3	0.01 40	<0.00 010	0.001 9	0.007 2	<0.00 03	<0.00 010	0.007 4	<0.00 08	0.007 2	<0.00 15	0.006 3	0.027 1
4	0.01 38	<0.00 010	0.001 9	0.007 2	<0.00 03	<0.00 010	0.007 5	<0.00 08	0.007 2	<0.00 15	0.006 3	0.027 8
5	0.01 38	<0.00 010	0.001 9	0.007 2	<0.00 03	<0.00 010	0.007 4	<0.00 08	0.007 3	<0.00 15	0.006 5	0.027 7
6	0.01 40	<0.00 010	0.002 0	0.007 3	<0.00 03	<0.00 010	0.007 3	<0.00 08	0.007 2	<0.00 15	0.006 5	0.027 7
7	0.01 40	<0.00 010	0.001 9	0.007 2	<0.00 03	<0.00 010	0.007 6	<0.00 08	0.007 3	<0.00 15	0.006 4	0.027 4
8	0.01 39	<0.00 010	0.001 9	0.007 3	<0.00 03	<0.00 010	0.007 6	<0.00 08	0.007 3	<0.00 15	0.006 3	0.027 7
<x>	0.01 39	<0.00 010	0.001 9	0.007 2	<0.00 03	<0.00 010	0.007 5	<0.00 08	0.007 3	<0.00 15	0.006 4	0.027 5
SD	0.00 01		0.000 03	0.000 03			0.000 09		0.000 05		0.000 11	0.000 31
RSD (%rel.)	0.68 4											1.12

Element	V	Zr	Al
1	0.01 35	0.010 3	81.4
2	0.01 33	0.010 3	81.4
3	0.01 34	0.010 2	81.4
4	0.01 33	0.010 3	81.4
5	0.01 33	0.010 3	81.4
6	0.01 32	0.010 2	81.4
7	0.01 33	0.010 3	81.3
8	0.01 34	0.010 2	81.3
<x>	0.01 33	0.010 3	81.4
SD	0.00 008	0.000 04	0.040 4
RSD (%rel.)	0.62 1	0.363	0.049 7

►► **Table 4: 271/...** **Al/Cu - Alloy**

Element	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ag	Be	Bi
1	0.1 92	0.307	4.50	0.204	0.089 6	0.012 3	2.07	0.013 0	0.153	<0.0 001	<0.0 0005	<0.0 005
2	0.1 91	0.306	4.45	0.204	0.093 5	0.012 3	2.06	0.013 1	0.154	<0.0 001	<0.0 0005	<0.0 005
3	0.1 90	0.304	4.45	0.204	0.091 6	0.012 4	2.04	0.013 2	0.162	<0.0 001	<0.0 0005	<0.0 005
4	0.1 92	0.311	4.50	0.205	0.092 8	0.012 3	2.08	0.012 9	0.150	<0.0 001	<0.0 0005	<0.0 005
5	0.1 90	0.305	4.44	0.204	0.087 3	0.012 3	2.04	0.012 9	0.164	<0.0 001	<0.0 0005	<0.0 005
6	0.1 90	0.306	4.44	0.204	0.093 8	0.012 2	2.06	0.012 7	0.160	<0.0 001	<0.0 0005	<0.0 005
7	0.1 91	0.307	4.47	0.205	0.092 6	0.012 2	2.09	0.012 8	0.158	<0.0 001	<0.0 0005	<0.0 005
8	0.1 92	0.310	4.50	0.204	0.093 8	0.012 2	2.09	0.012 8	0.152	<0.0 001	<0.0 0005	<0.0 005
<x>	0.1 91	0.307	4.47	0.204	0.091 9	0.012 3	2.07	0.012 9	0.156	<0.0 001	<0.0 0005	<0.0 005
SD	0.0 009 7	0.002 4	0.026 1	0.000 44	0.002 3	0.000 05	0.018 8	0.000 16	0.005			
RSD (%rel.)	0.5 09	0.77	0.585	0.217	2.51	0.435	0.912	1.23	3.17			

Element	Ca	Cd	Co	Ga	Li	P	Pb	Sb	Sn	V	Zr	Al
1	<0 .0 00 10	<0 .0 00 10	0.20 9	0.01 06	<0.0 001	<0.0 008	0.0 021	0.3 89	0.00 17	0.01 45	0.10 4	91. 7
2	<0 .0 00 10	<0 .0 00 10	0.20 7	0.01 06	<0.0 001	<0.0 008	0.0 020	0.3 91	0.00 18	0.01 45	0.10 4	91. 7
3	<0 .0 00 10	<0 .0 00 10	0.20 5	0.01 07	<0.0 001	<0.0 008	0.0 020	0.3 84	0.00 18	0.01 47	0.10 5	91. 8
4	<0 .0 00 10	<0 .0 00 10	0.20 9	0.01 05	<0.0 001	<0.0 008	0.0 021	0.3 84	0.00 17	0.01 43	0.10 3	91. 7
5	<0 .0 00 10	<0 .0 00 10	0.20 7	0.01 07	<0.0 001	<0.0 008	0.0 021	0.3 77	0.00 17	0.01 49	0.10 5	91. 8
6	<0 .0 00 10	<0 .0 00 10	0.20 8	0.01 07	<0.0 001	<0.0 008	0.0 020	0.3 94	0.00 18	0.01 47	0.10 4	91. 8
7	<0 .0 00 10	<0 .0 00 10	0.21 0	0.01 06	<0.0 001	<0.0 008	0.0 021	0.3 86	0.00 18	0.01 46	0.10 4	91. 7
8	<0 .0 00 10	<0 .0 00 10	0.20 8	0.01 05	<0.0 001	<0.0 008	0.0 021	0.3 86	0.00 18	0.01 45	0.10 4	91. 7
<x>	<0 .0 00 10	<0 .0 00 10	0.20 8	0.01 06	<0.0 001	<0.0 008	0.0 02	0.3 86	0.00 18	0.01 46	0.10 4	91. 7
SD			0.00 16	0.00 01	<0.0 001		0.00 004	0.0 053	0.00 004	0.00 019	0.00 058	0.0 439
RSD (%rel.)			0.78 6	0.92 6	<0.0 001		1.79	1.3 6	2.04	1.3	0.55 8	0.0 478

►► **Table 5: 5182/... Al/Mg - Alloy**

Element	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Be	Bi	Ca
1	0. 1 5 8	0.194	0.049 0	0.3 52	4.5 4	0.031 1	0.019 3	0.042 9	0.028 2	<0.0 0005	0.002 3	<0.0 0010
2	0. 1 5 6	0.196	0.048 7	0.3 52	4.5 4	0.031 2	0.019 0	0.042 5	0.029 0	<0.0 0005	0.002 4	<0.0 0010
3	0. 1 5 5	0.193	0.048 3	0.3 51	4.5 3	0.031 0	0.019 2	0.042 5	0.028 8	<0.0 0005	0.002 4	<0.0 0010
4	0. 1 5 8	0.193	0.049 3	0.3 50	4.5 2	0.031 0	0.019 1	0.043 1	0.028 8	<0.0 0005	0.002 4	<0.0 0010
5	0. 1 5 5	0.192	0.048 4	0.3 52	4.5 1	0.031 1	0.019 0	0.042 5	0.029 3	<0.0 0005	0.002 4	<0.0 0010
6	0. 1 5 4	0.196	0.048 4	0.3 52	4.5 1	0.031 2	0.018 9	0.042 3	0.029 1	<0.0 0005	0.002 4	<0.0 0010
7	0. 1 5 4	0.197	0.048 3	0.3 52	4.5 2	0.031 2	0.019 0	0.042 4	0.029 0	<0.0 0005	0.002 3	<0.0 0010
8	0. 1 5 3	0.193	0.048 4	0.3 51	4.5 4	0.030 9	0.018 8	0.042 5	0.028 8	<0.0 0005	0.002 4	<0.0 0010
<x>	0. 1 5 5	0.194	0.048 6	0.3 52	4.5 3	0.031 1	0.019	0.042 6	0.028 9	<0.0 0005	0.002 4	<0.0 0010
SD	0. 0 0 1 7	0.001 7	0.000 37	0.00 056	0.01 25	0.000 1	0.000 14	0.000 28	0.000 32		0.000 02	
RSD (%rel.)	1. 1	0.869	0.753	0.16	0.2 77	0.322	0.757	0.654	1.1			

►► **Table 6: 3432/... Al/Zn - Alloy**

Element	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Be	Ca	Ga
1	1.82	0.793	4.20	0.419	0.256	0.006 6	0.309	5.01	0.059 5	<0.00 005	0.000 38	0.011 7
2	1.83	0.783	4.25	0.415	0.254	0.005 9	0.308	5.01	0.060 1	<0.00 005	0.000 40	0.011 8
3	1.82	0.772	4.22	0.414	0.254	0.005 8	0.307	5.01	0.060 3	<0.00 005	0.000 37	0.011 9
4	1.82	0.782	4.22	0.417	0.256	0.005 9	0.306	5.02	0.060 3	<0.00 005	0.000 36	0.011 8
5	1.83	0.777	4.26	0.414	0.256	0.005 8	0.308	5.02	0.060 5	<0.00 005	0.000 35	0.011 9
6	1.83	0.784	4.24	0.418	0.258	0.005 9	0.309	5.02	0.060 5	<0.00 005	0.000 36	0.011 9
7	1.82	0.786	4.24	0.415	0.256	0.005 9	0.308	5.03	0.060 6	<0.00 005	0.000 36	0.011 8
8	1.83	0.771	4.24	0.414	0.258	0.005 9	0.310	5.06	0.060 7	<0.00 005	0.000 35	0.011 9
<x>	1.82	0.781	4.23	0.416	0.256	0.006 0	0.308	5.02	0.060 3	<0.00 005	0.000 37	0.011 8
SD	0.00 39	0.007 3	0.019 4	0.001 9	0.001 5	0.000 27	0.001 2	0.016 3	0.000 38			0.000 06
RSD (%rel.)	0.21 6	0.94	0.458	0.451	0.598		0.395	0.324	0.629			0.506

Element	Li	P	Pb	Sn	Sr	V	Zr	Al
1	<0.00010	<0.0008	0.198	0.0983	<0.0005	<0.0050	0.0017	86.8
2	<0.00010	<0.0008	0.200	0.0961	<0.0005	<0.0050	0.0017	86.8
3	<0.00010	<0.0008	0.202	0.0962	<0.0005	<0.0050	0.0017	86.8
4	<0.00010	<0.0008	0.199	0.0950	<0.0005	<0.0050	0.0016	86.8
5	<0.00010	<0.0008	0.201	0.0960	<0.0005	<0.0050	0.0017	86.8
6	<0.00010	<0.0008	0.202	0.0966	<0.0005	<0.0050	0.0017	86.8
7	<0.00010	<0.0008	0.199	0.0969	<0.0005	<0.0050	0.0017	86.8
8	<0.00010	<0.0008	0.201	0.0965	<0.0005	<0.0050	0.0017	86.7
<x>	<0.00010	<0.0008	0.200	0.0965	<0.0005	<0.0050	0.0017	86.8
SD			0.0016	0.00092				0.0293
RSD (%rel.)			0.824	0.953				0.0338

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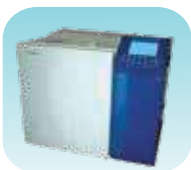
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