Milli-Q®
Lab Water Solutions

Data Sheet

Ultrapure water tailored for trace elemental analyses

A wide array of laboratories around the world, ranging from semiconductor, energy and mining industries, to environmental, food safety and life science laboratories, are relying on trace elemental analyses. The sensitivity of the instruments used for these analyses is such that any contamination present in reagents might interfere with the analytical results. Specifically, water is used at many stages of the analytical process, and any contamination stemming from water may be carried throughout the analysis and compromise the results.

Milli-Q® IQ Element water purification and dispensing unit

The Milli-Q® IQ Element unit is specifically designed to answer the most stringent requirements of trace elemental analyses. When connected to a Milli-Q® IQ 7 series water purification system, the unit ensures that the ultrapure water delivered is free of ions, metals and particles.

The components of the Milli-Q® IQ Element unit have been carefully selected to not only remove contaminants, but also to safeguard against potential contaminations:

- The cartridge contains a combination of Jetpore® mixed-bed ion-exchange resin and innovative IQnano™ ion-exchange media to achieve ion removal down to trace levels
- The high-purity 0.1 µm Optimizer LW™ final filter ensures that no particles are released in the water
- The footswitch and the dispenser help prevent any risk of water contamination from the environment



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The life science business of Merck KGaA, Darmstadt, Germany operates as MilliporeSigma in the U.S. and Canada.

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Water quality

To assess the performance of the combination of the Milli-Q® IQ 7 series water purification systems with a Milli-Q® IQ Element unit, analyses by inductively coupled plasma mass spectrometry (ICP-MS) were performed in **two independent laboratories** (**Tables 1 and 2**). In both laboratories, a Milli-Q® IQ Element unit was connected to a Milli-Q® IQ 7005 system in a clean room, in order to minimize contamination due to the laboratory environment. The ultrapure water was collected after discarding at least 10 L of water, and the sampling bottles were rinsed several times with the water to be tested.

The results demonstrate that this water contains only extremely low levels of the elements tested and fulfills the most stringent purity requirements of modern ICP-MS instruments.

Table 1. ICP-MS analyses performed with high purity water obtained from a Milli-Q® IQ Element connected to a Milli-Q® IQ 7005 water purification system. Data obtained courtesy of **Agilent Technologies**, Tokyo, Japan.
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Isotope	Element	BEC (ng/L)	Sample (ng/L)	DL (ng/L)	Cell Mode
7	Lithium (Li)	0.04	< DL	0.04	[Cool NH_3]
11	Boron (B)	1.55	1.15	0.27	No gas
23	Sodium (Na)	0.56	0.68	0.11	[Cool NH_3]
24	Magnesium (Mg)	0.03	0.01	0.01	[Cool NH_3]
27	Aluminium (Al)	0.08	0.07	0.04	[Cool NH_3]
28	Silicon (Si)*	215.16	198.65	4.98	[H_2]
39	Potassium (K)	0.60	0.54	0.16	[Cool NH_3]
40	Calcium (Ca)	0.50	< DL	0.57	[Cool NH_3]
47	Titanium (Ti)	0.60	0.61	0.51	[O_2]
51	Vanadium (V)	0.03	0.03	0.01	[NH_3]
52	Chromium (Cr)	0.10	0.08	0.02	[Cool NH_3]
55	Manganese (Mn)	0.01	0.01	0.02	[Cool NH_3]
56	Iron (Fe)	0.66	< DL	0.50	[Cool NH_3]
59	Cobalt (Co)	0.00	< DL	0.01	[Cool NH_3]
60	Nickel (Ni)	0.03	< DL	0.16	[Cool NH_3]
63	Copper (Cu)	0.16	< DL	0.04	[Cool NH_3]
66	Zinc (Zn)	0.43	< DL	0.48	[NH_3 warm]
69	Gallium (Ga)	0.10	< DL	0.14	[Cool NH_3]
70	Germanium (Ge)	0.47	0.43	0.11	[H_2]
75	Arsenic (As)	0.03	0.06	0.04	[O_2]
85	Rubidium (Rb)	0.01	< DL	0.03	[Cool NH_3]
88	Strontium (Sr)	0.01	< DL	0.05	[Cool NH_3]
90	Zirconium (Zr)	0.04	< DL	0.09	[O_2]
95	Molybdenium (Mo)	0.07	< DL	0.10	[NH_3]
107	Silver (Ag)	0.50	0.55	0.17	[Cool NH_3]
111	Cadmium (Cd)	0.02	< DL	0.08	[NH_3 warm]
118	Tin (Sn)	0.71	0.64	0.60	[NH_3]
121	Antimony (Sb)	0.00	< DL	0.02	[NH_3]
133	Caesium (Cs)	0.00	0.01	0.00	[Cool NH_3]
138	Barium (Ba)	0.04	< DL	0.05	[NH_3]
182	Tungsten (W)	0.01	< DL	0.07	[H_2]
208	Lead (Pb)	0.09	< DL	0.08	[NH_3 warm]

DL, Detection Limit; BEC, Blank Equivalent Concentration
*Si is known to be difficult to measure by ICP-MS. When measured by GF-AAS, it was < DL (0.5 ppb).

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Experimental conditions (Table 1):

Reagents: Nitric acid: TAMAPURE AA-10 (Tama Chemicals Co. Ltd., Kanagawa, Japan)
DL and BEC: Obtained with water from Milli-Q® IQ Element and standard additions with 0.05% nitric acid.
Sample: Average of 6 values (3 samples measured twice each).

Instrument	Agilent 8900 ICP-QQQ
Nebulizer	MFN100
Torch	Quartz torch (2.5 mm id)
Cones	Platinum-tipped sampling, skimmer cones
Tuning modes	Cool NH_3 / NH_3 / NH_3 (warm) / O_2 / no gas / H_2
Acquisition mode	MS/MS
RF power (W)	630 (Cool NH_3), 1600 (NH_3, NH_3 warm, O_2, no gas, H_2)
Carrier gas (L/min)	0.7
Make-up gas (L/min)	0.7 (Cool NH_3 and NH_3), 0.85 (NH_3 warm), 0.7 (O_2, no gas, H_2)
Ext 1 (V)	–120
Ext 2 (V)	–10.5
Omega bias (V)	–80
Omega lens (V)	2.2 (Cool NH_3), 7.5 (NH_3, NH_3 warm, O_2, no gas, H_2)
Q1 entrance (V)	–7.5 (Cool NH_3), –6.5 (NH_3, NH_3 warm, O_2, no gas, H_2)
He flow (mL/min)	1 (Cool NH_3, NH_3, NH_3 warm), 0 (O_2, no gas, H_2)
NH_3 flow (mL/min)	15 (Cool NH_3, NH_3, NH_3 warm), 0 (O_2, no gas, H_2)
Axial acceleration (V)	1.5 (Cool NH_3, NH_3, NH_3 warm, O_2), 0 (no gas, H_2)
Energy discrimination (V)	–5 (Cool NH_3), –7 (NH_3, NH_3 warm, O_2), 4 (no gas), 0 (H_2)

Table 2. ICP-MS analyses performed with high purity water obtained from a Milli-Q® IQ Element connected to a Milli-Q® IQ 7005 water purification system. Data obtained courtesy of **UT2A**, Pau, France.

Isotope	Element	Sample (ng/L)	DL (ng/L)	Cell Mode
9	Beryllium (Be)	< DL	0.20	No Gas
11	Boron (B)	< DL	0.50	No Gas
40	Calcium (Ca)	< DL	0.29	H_2
45	Scandium (Sc)	0.59	0.53	H_2
70	Germanium (Ge)	< DL	0.10	H_2
71	Gallium (Ga)	< DL	0.13	No Gas
78	Selenium (Se)	< DL	0.57	H_2
88	Strontium (Sr)	< DL	0.02	No Gas
89	Yttrium (Y)	< DL	0.02	No Gas
90	Zirconium (Zr)	< DL	0.05	No Gas
93	Niobium (Nb)	< DL	0.03	No Gas
101	Ruthenium (Ru)	0.42	0.20	No Gas
103	Rhodium (Rh)	< DL	0.01	No Gas
105	Palladium (Pd)	< DL	0.34	No Gas
107	Silver (Ag)	0.40	0.15	No Gas
115	Indium (In)	< DL	0.01	No Gas
118	Tin (Sn)	< DL	0.15	No Gas
126	Tellerium (Te)	0.08	0.07	No Gas
139	Lanthanium (La)	< DL	0.02	No Gas
140	Cerium (Ce)	< DL	0.03	No Gas
141	Praseodymium (Pr)	< DL	0.02	No Gas
146	Neodenyum (Nd)	< DL	0.08	No Gas
147	Samarium (Sm)	< DL	0.13	No Gas
153	Europium (Eu)	< DL	0.04	No Gas
157	Gadolinium (Gd)	< DL	0.13	No Gas
159	Terbium (Tb)	< DL	0.02	No Gas
163	Dysprosium (Dy)	< DL	0.07	No Gas
165	Holmium (Ho)	< DL	0.02	No Gas
166	Erbium (Er)	< DL	0.11	No Gas

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Isotope	Element	Sample (ng/L)	DL (ng/L)	Cell Mode
169	Thulium (Tm)	< DL	0.03	No Gas
172	Ytterbium (Yb)	< DL	0.09	No Gas
175	Lutetium (Lu)	< DL	0.02	No Gas
178	Hafnium (Hf)	< DL	0.11	No Gas
181	Tantalum (Ta)	< DL	0.03	No Gas
185	Rhenium (Re)	< DL	0.09	No Gas
189	Osmium (Os)	< DL	0.14	No Gas
193	Iridium (Ir)	< DL	0.05	No Gas
195	Platinum (Pt)	0.18	0.16	No Gas
197	Gold (Au)	< DL	0.43	No Gas
202	Mercury (Hg)	5.1	1.52	No Gas
205	Thallium (Tl)	< DL	0.05	No Gas
209	Bismuth (Bi)	< DL	0.06	No Gas
232	Thorium (Th)	< DL	0.04	No Gas
238	Uranium (U)	< DL	0.04	No Gas

DL, Detection Limit

Experimental conditions (Table 2):

Reagents: Reagents were of Suprapur® analytical grade. Nitric acid: Ultrex® (J.T. Baker®, Avantor)
Sample: Average concentration in water from Milli-Q® IQ Element (10 measurements)

Instrument	Agilent AT 7900 ICP-MS
Nebulizer	PFA microflow nebulizer (200 µL/min) with PFA tubing and probe
Sample injection	Autoaspiration mode (without peristaltic pump)
Spray chamber	PFA Scott chamber
Torch / Injector	Quartz torch with removable injector (sapphire 2.5 mm)
Cones	Ni S-lens skimmer cone and Ni sampler cone
Lens	Lens-S type
Carrier gas	0.75 L/min
Make-up gas	0.50 L/min
Plasma gas	15 L/min
Plasma power	1500 W
Cell modes	No gas; H_2: Hydrogen reaction (5 mL/min)
Dwell time	1 sec
Sweeps	100
Replicate	5

Conclusion

Coupling a Milli-Q® IQ Element unit to a Milli-Q® IQ 7 series water purification system delivering ultrapure water produces ultrapure water suitable for trace and ultra-trace elemental analyses. This high-quality ultrapure water can be used for critical cleaning, for blanks, to dilute samples, or to prepare standard solutions for even the most sensitive ICP-MS or GF-AAS analyses.

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