APPLICATION NOTE
LD20-05

MultiDetek2 gas chromatograph with PlasmaDetek2 & TCD detectors uses for the analysis of purity Xenon-Krypton-Neon

▲ MultiDetek2 ▲ PlasmaDetek2

The noble gases also called inert gases or rare gases have several characteristics that make them important and unique as: low reactivity, low thermal conductivity and high stability, among others. Being at very low concentration in the earth's atmosphere, it makes these gases very expensive to produce. The six naturally noble gases are Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr), Xenon (Xe) and the radioactive Radon (Rn).

The rarest gases of these are Xenon, Krypton and Neon making them very expensive to use for industrial applications.

NEON/KRYPTON/XENON MAJOR APPLICATIONS:

Aerospace: Xenon is used for the following aerospace applications: satellite programs, space travel, propulsion agent for spacecraft, satellite thruster and interplanetary probe.

Electronics: These rare gases, can be used in many electronics applications such as: excimer lasers, buffer gas used in lasers for semiconductor manufacturing, deep trench etching of DRAM integrated circuits, focused etch process, and plasma panel display.

Glass: Krypton is used as a filler in the production of double and triple-pane insulated windows. Major advantages of using krypton are reducing heat loss, increasing heat transfer resistance in the unit, and reducing levels of solar radiation. You can also increase the R-value or decrease the U-factor for window and door insulation with krypton, xenon and rare gas mixtures.

Lasers: Neon-based excimer lasers are utilized for etching silicon wafers, LASIK eye surgery, micro-machining organic materials, UV lithography in integrated circuit fabrication, micro drilling, He/Ne mixes for optical readers, and wafer dicing. Krypton gas lasers are also used during scientific research, to create white-light lasers and light shows.

Lighting: Krypton is used for bright white light and long lasting incandescent bulbs, as well as photographic lighting applications. Neon is used for lighting in signs. Stadiums, automotive HID, head lights, IMAX theaters, photography and other concentrated, bright-light applications rely on xenon to for their lighting needs.

LDETEK SOLUTION:

Measuring the purity of UHP Xenon, Krypton and Neon can be done with the MultiDetek2 analytical device. A combination of multiple columns, diaphragm valves and detectors all in one instrument are used to measure many different impurities to validate the purity of these UHP gases.

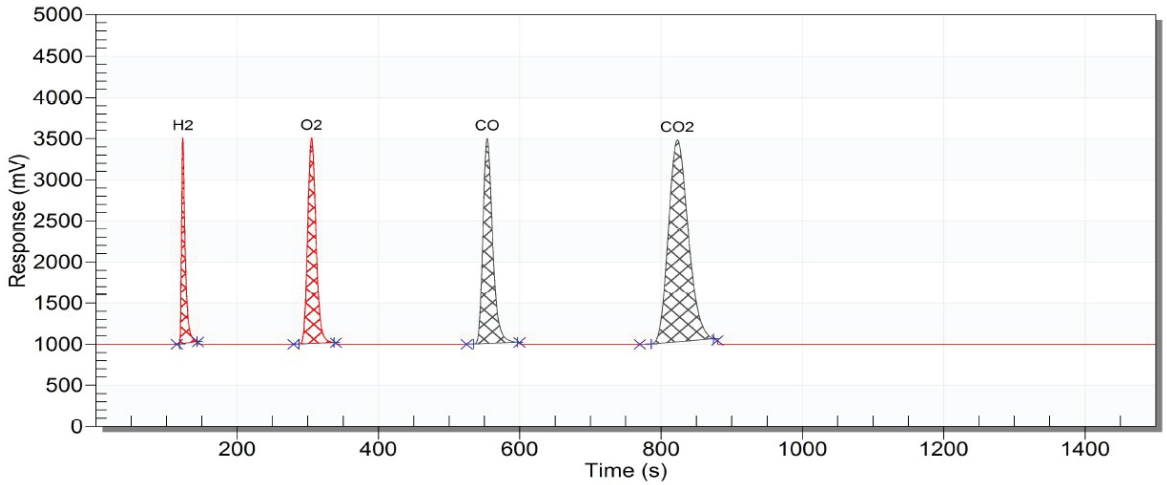
Our system uses the PlasmaDetek2 (PED) as detector to ensure good selectivity and sensitivity down to sub ppb level. The proper optic circuits are mounted on each of the PED installed in the instrument to optimize the selectivity for the impurity to analyse. Helium carrier gas is used here to ensure a limit of detection below 10ppb.

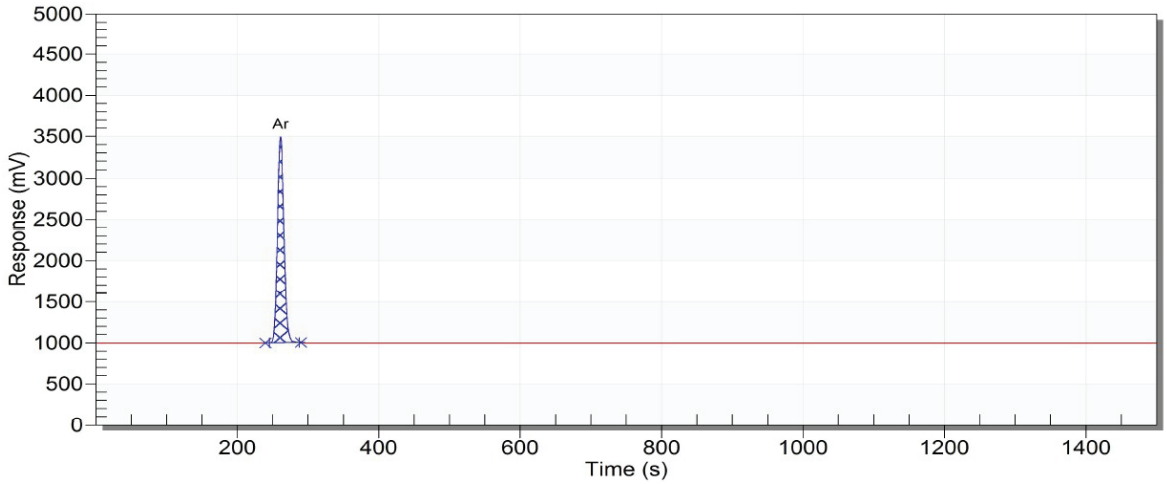
In the same instrument, our thermal conductivity detector (TCD) is mounted to measure the Helium impurity down to 1ppm concentration. The Argon carrier gas is required here to achieve the limit of detection.

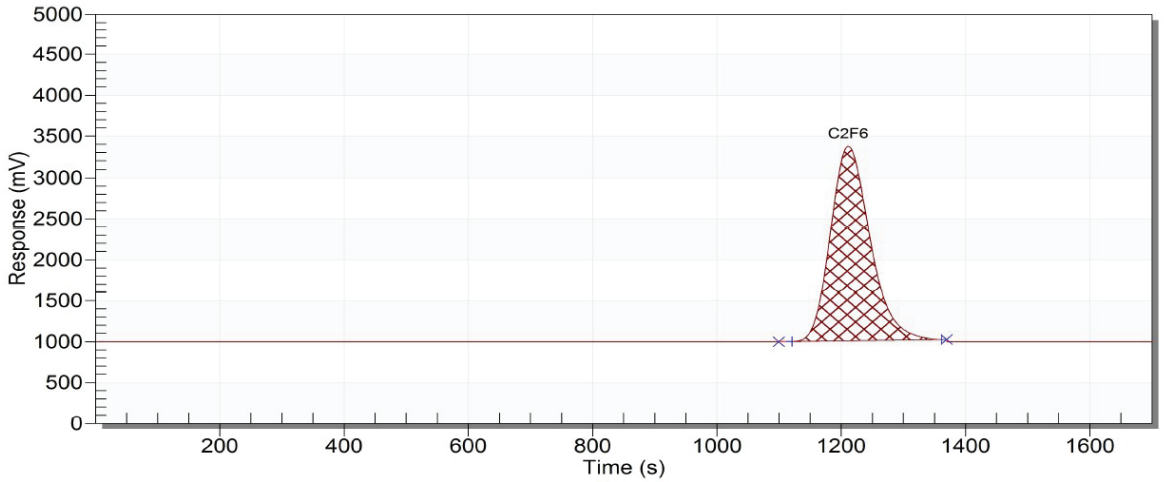
This application note will show the results of three different configurations of the MultiDetek2 instrument used for respectively measuring the purity of Xenon, Krypton and Neon. Different chromatograms show the response of every impurity to be analysed. The peak response obtained at a known concentration is then compared to the blank noise level to determinate the limit of detection obtained by our instruments.

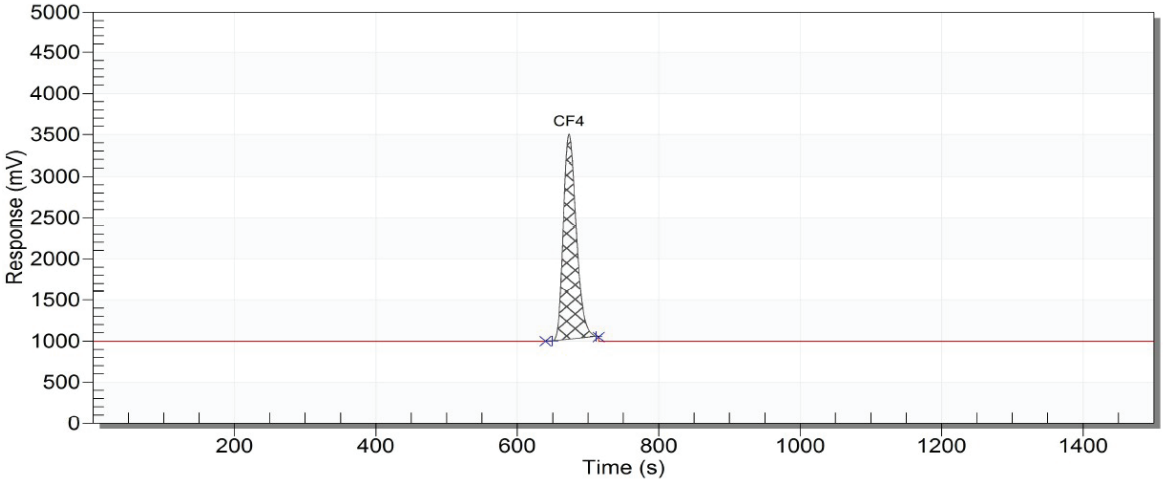
RESULTS FOR XENON GC:

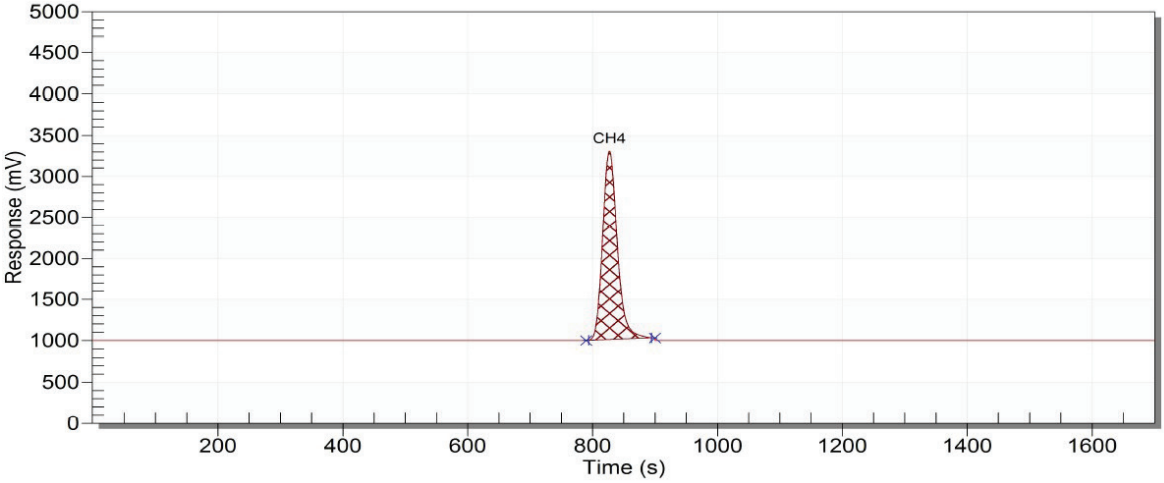
Chromatograms of trace ppm impurities H2-O2-CO-CO2-Ar-C2F6-CF4-CH4-Kr-N2-N2O-SF6 in UHP Xenon sample gas.

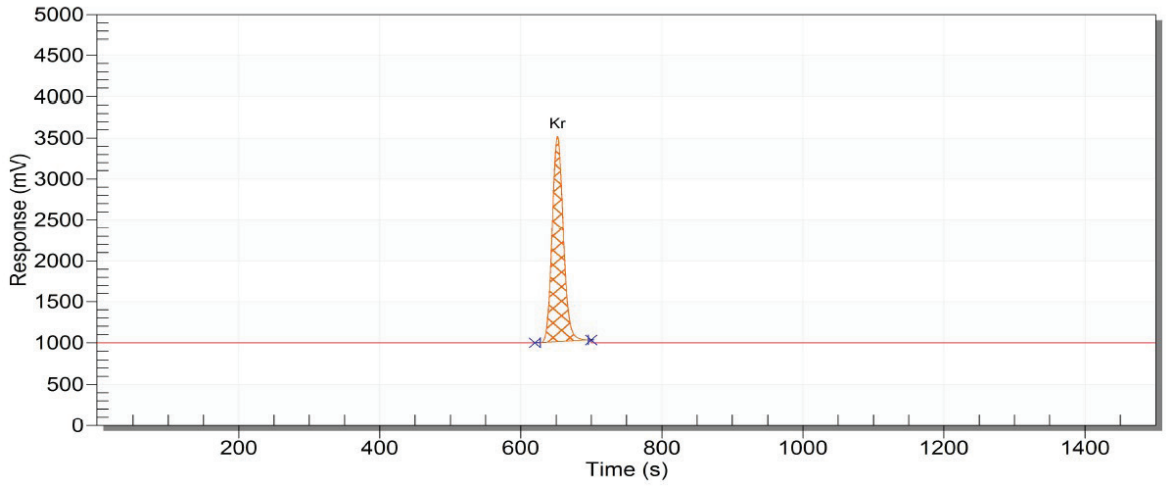





C2F6
Response (mV)
Time (s)


CF4
Response (mV)
Time (s)


CH4
Response (mV)
Time (s)


Kr
Response (mV)
Time (s)
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4000
3500
3000
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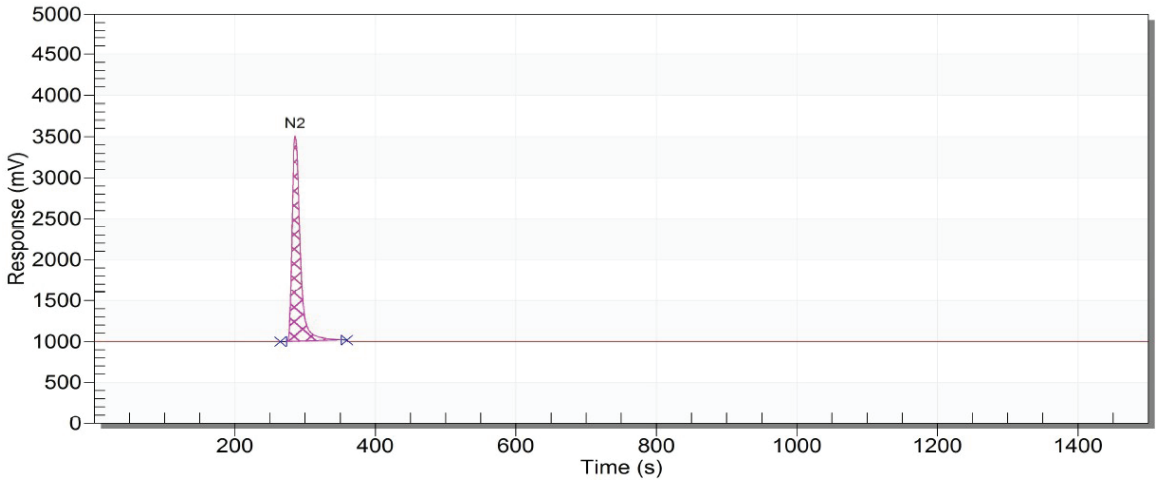
2000
1500
1000
500
0
200
400
600
800
1000
1200
1400


N2
Response (mV)
Time (s)
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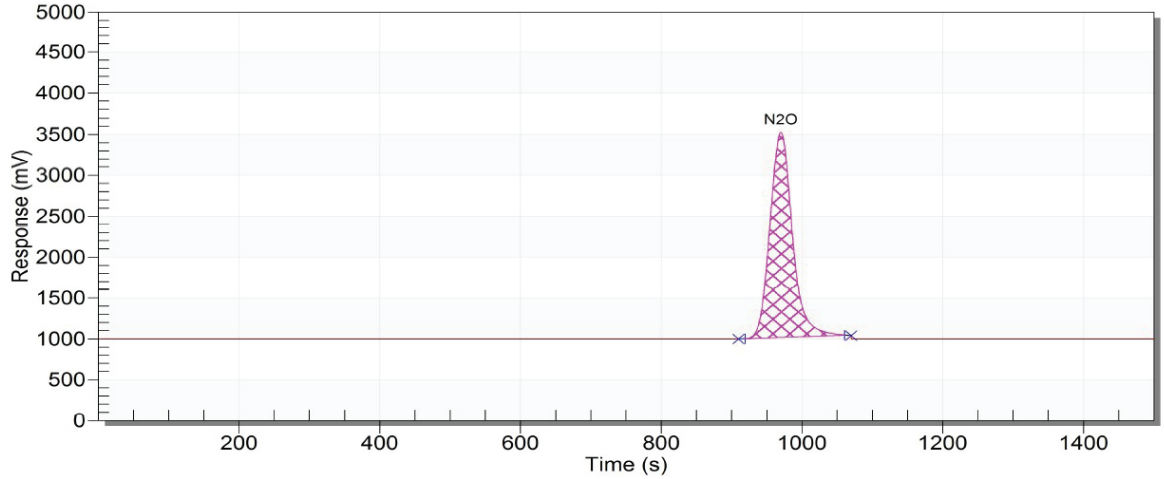
4000
3500
3000
2500
2000
1500
1000
500
0
200
400
600
800
1000
1200
1400


N2O
Response (mV)
Time (s)
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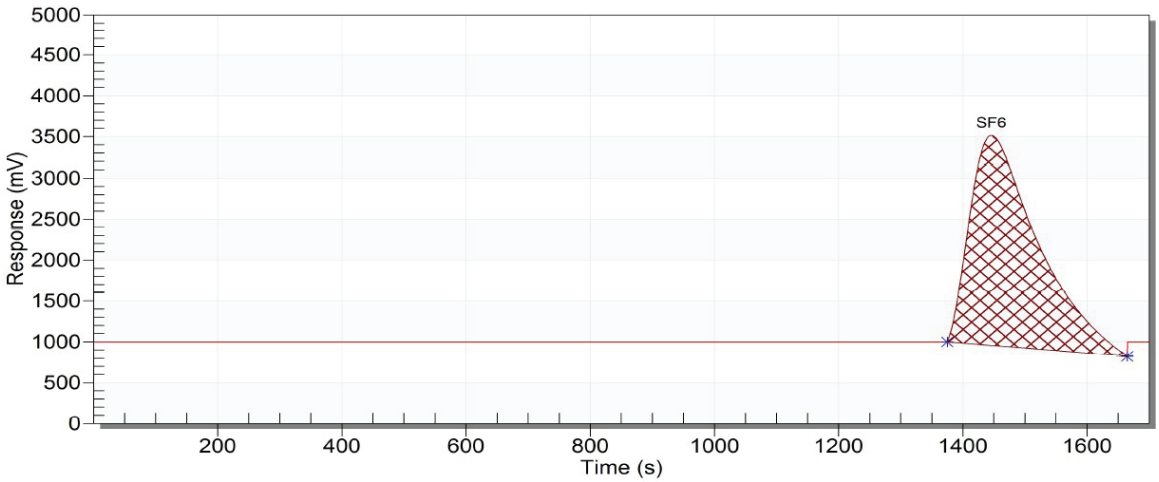
4500
4000
3500
3000
2500
2000
1500
1000
500
0
200
400
600
800
1000
1200
1400



Sample composition of Xenon and determination of the limit of detection:

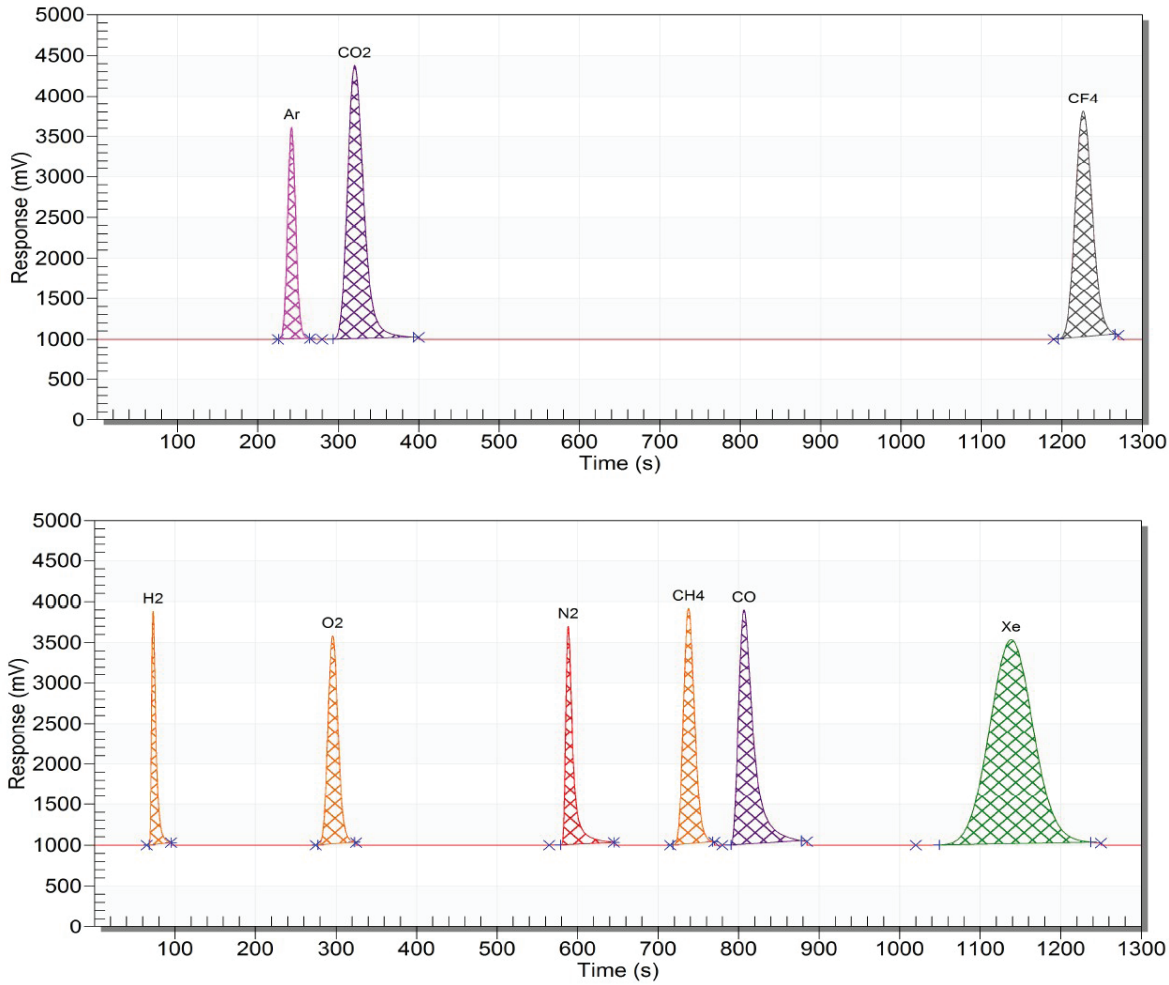
COMPONENT	CONCENTRATION (ppm)	PEAK HEIGHT (mV)	NOISE (mV)	LDL (3X NOISE) (ppb)
H2	11.00	2502	0.48	6.3
O2	11.00	2499	0.51	6.7
CO	11.00	2498	0.55	7.2
CO2	11.00	2487	0.55	7.3
Ar	8.90	2504	0.46	4.9
C2F6	10.00	2402	0.56	6.9
CF4	10.00	2382	0.56	7.0
CH4	10.00	2504	0.50	5.9
Kr	10.00	2506	0.54	6.5
N2	10.00	2504	0.45	5.4
N2O	10.00	2501	0.45	5.4
SF6	10.00	2500	0.70	8.4

Figure 1

Note: other LDL could be obtained with different injection volume and chromatographic condition

RESULTS FOR KRYPTON GC:

Chromatograms of trace ppm impurities Ar-CO2-CF4-H2-O2-N2-CH4-CO-Xe in UHP Krypton sample gas



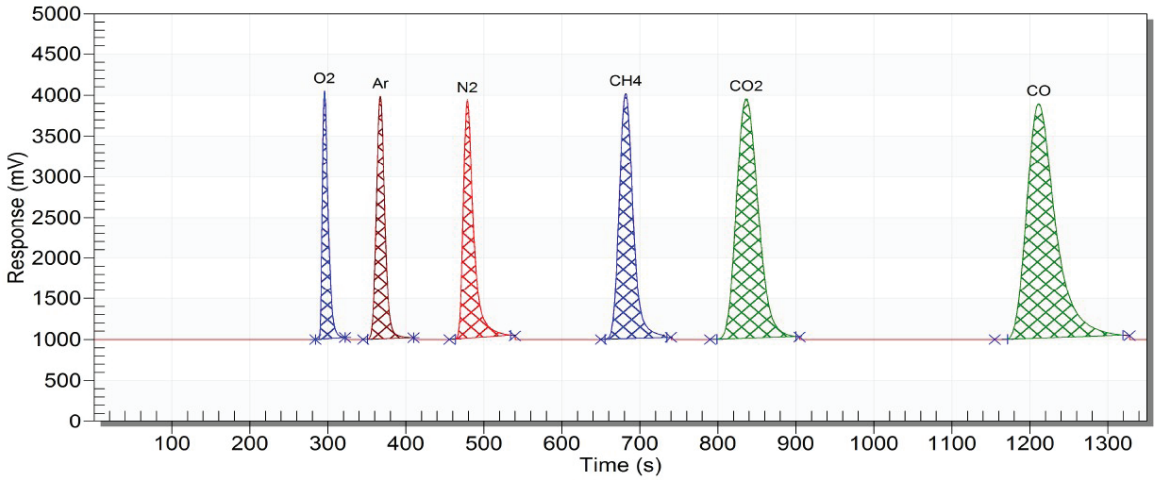
Sample composition of Krypton and determination of the limit of detection:

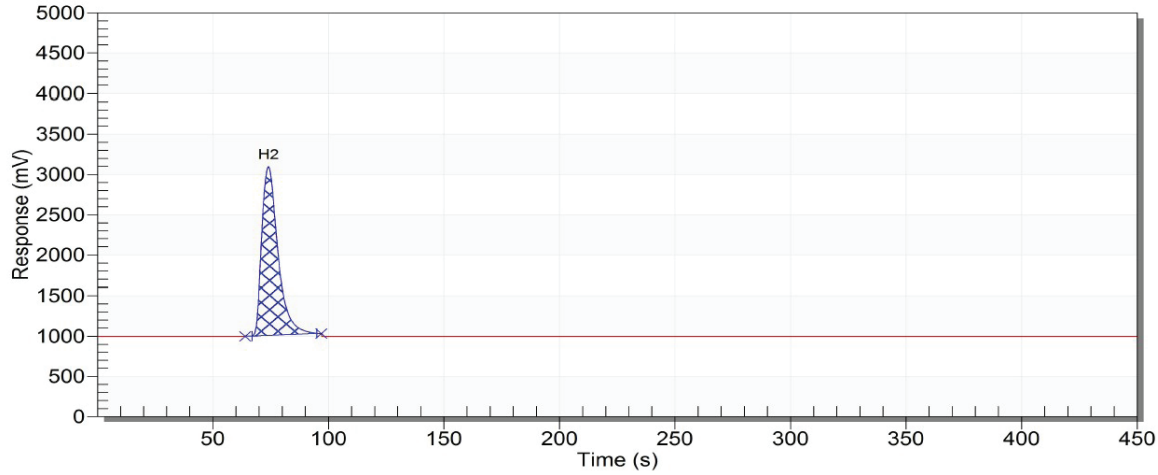
COMPONENT	CONCENTRATION (ppm)	PEAK HEIGHT (mV)	NOISE (mV)	LDL (3X NOISE) (ppb)
Ar	8.90	2606	0.46	4.7
CO2	10.10	3377	0.55	4.9
CF4	10.00	2802	0.56	6.0
H2	9.50	2981	0.49	4.7
O2	8.50	2599	0.51	5.0
N2	9.10	2750	0.46	4.6
CH4	9.80	2955	0.52	5.2
CO	9.50	2952	0.55	5.3
Xe	10.00	2523	0.60	7.1

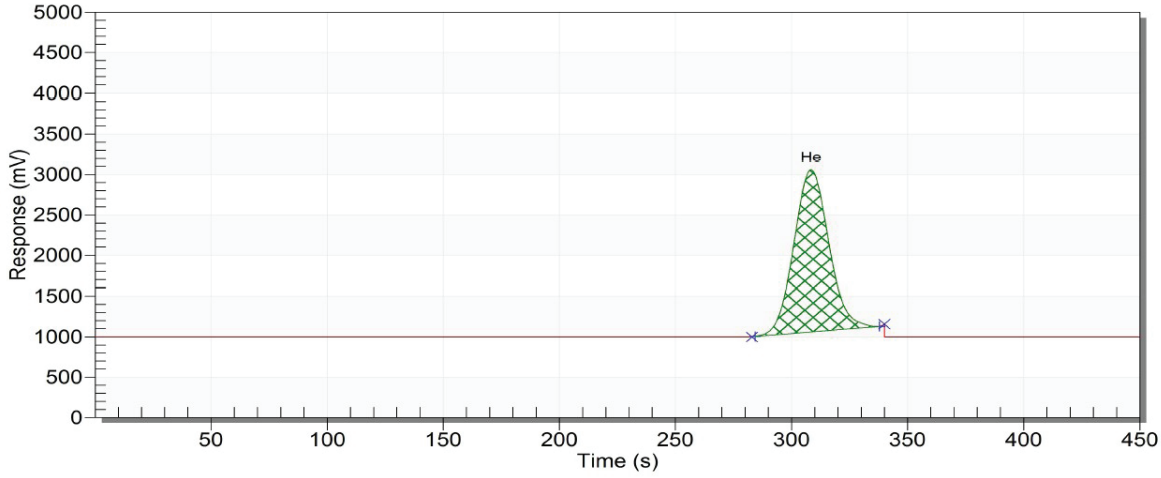
Figure 2 Note: other LDL could be obtained with different injection volume and chromatographic condition

RESULTS FOR NEON GC:

Chromatograms of trace ppm impurities O2-Ar-N2-CH4-CO2-CO-H2-He in UHP Neon sample gas







Sample composition of Neon and determination of the limit of detection:

COMPONENT	CONCENTRATION (ppm)	PEAK HEIGHT (mV)	NOISE (mV)	LDL (3X NOISE) (ppb)
O2	53.30	3098	0.21	10.8
Ar	50.00	3005	0.17	8.4
N2	49.50	2967	0.20	10.0
CH4	48.30	3021	0.25	12.0
CO2	44.80	2991	0.31	13.9
CO	48.20	2901	0.31	15.5
H2	50.00	2101	0.14	10.0
He (TCD)	50.00	2109	15	1066 (1.06ppm)

Figure 3

Note: other LDL could be obtained with different injection volume and chromatographic condition

CONCLUSION:

The MultiDetek2 gas chromatograph uses with the PlasmaDetek2 and the thermal conductivity detector (TCD) together in the same instrument allows to measure multiple impurities in sub ppb along with detecting He impurity down to 1ppm concentration. The system is rackmount and compact. It also offers a full remote control and the proper industrial communication protocol.

LDetek

Where innovation leads to success

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