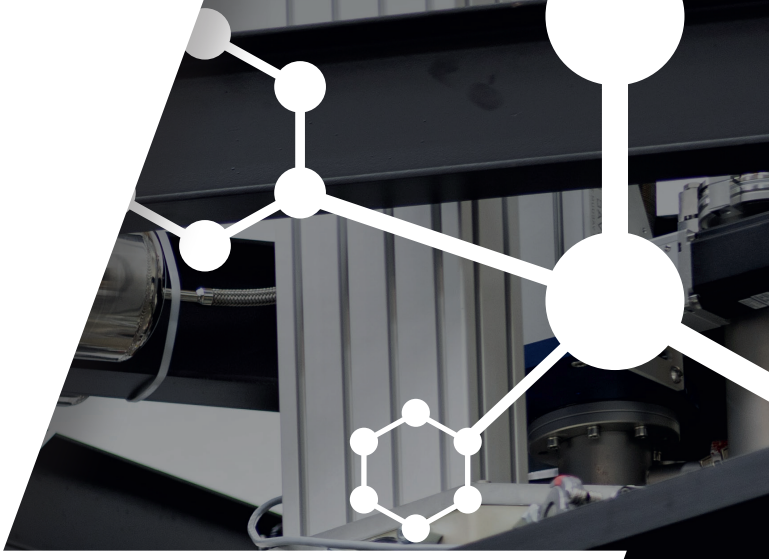
CryoConcept
an Air Liquide affiliate



Your key cryogenics partner for quantum computing and fundamental research

Your key cryogenics partner **for quantum computing and fundamental research**

CryoConcept's manufacturing site is located in Les Ulis, near Paris, France.

WHO ARE WE?

CryoConcept is a subsidiary of Air Liquide, a world leader in gases, technologies and services for Industry and Health. Originally a spin-off of IRAMIS CEA's SPEC laboratory, **CryoConcept designs and builds high-performance dilution refrigerator systems** for fundamental research and quantum computing, which are capable of reaching temperatures below 10mK.

As an industrial expert, Air Liquide fosters the industrialization of CryoConcept to further improve our systems' performance and reliability and meet growing demand for ultra-low-temperature cryogenics solutions.

More than 120 of our systems are currently in use worldwide in many fields, from research into nanoscience, dark matter, and condensed matter, to quantum physics and quantum computing.

KEY FIGURES

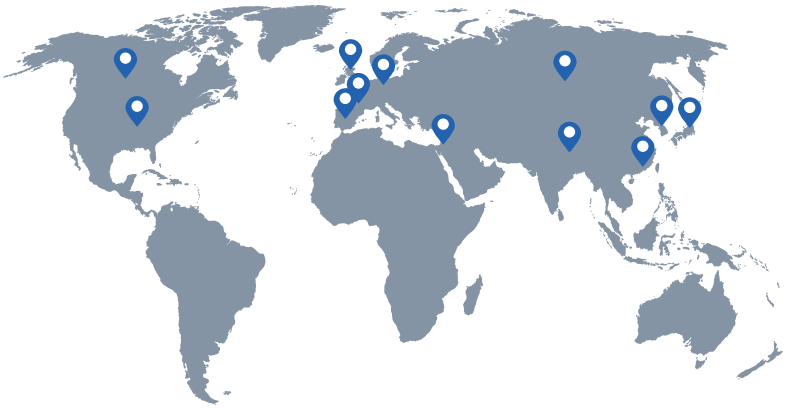
Founded in **2001**

Air Liquide affiliate since **2020**

18 employees

More than **120** dilution refrigerator systems in operation

<6 months manufacturing lead time*



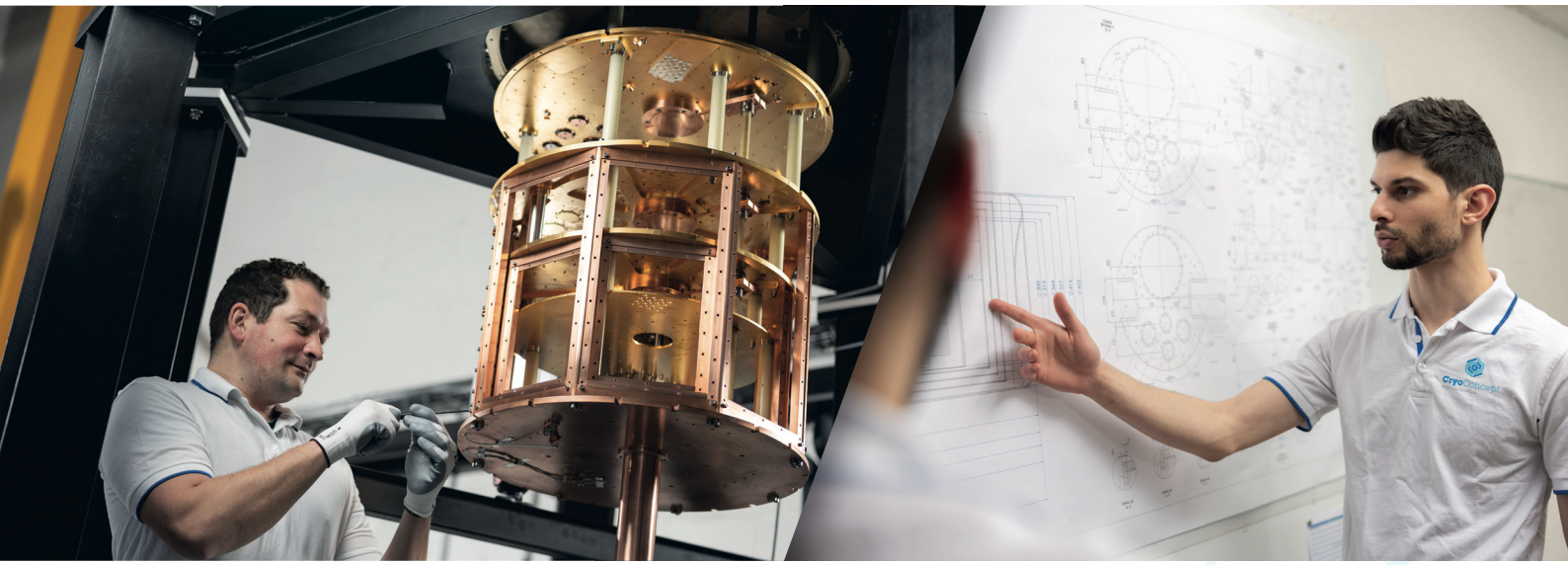
(*) Manufacturing lead time for standard system. If your system requires customization, the lead time will be adjusted.

A COMPLETE RANGE OF HIGH-PERFORMANCE DILUTION REFRIGERATOR SYSTEMS TO ANSWER YOUR SPECIFIC NEEDS

A key player in the field of ultra-low temperatures,
CryoConcept offers a full range of dilution refrigeration solutions.

HEXA-DRY range
cryogen-free dilution refrigerators

HEXA-WET range
liquid helium dilution refrigerators



Ultra-Quiet Technology™ by CryoConcept

With the ever-growing popularity of the **Hexa-DRY** range, and in order to meet the critical technical requirements of certain ultra-sensitive measurements, CryoConcept developed its **Ultra-Quiet Technology™ (UQT), which considerably reduces the vibrations of the whole cryostat in continuous mode.** Thanks to this technology, CryoConcept's HEXA-DRY UQT™ Bolometry dilution system is now the global benchmark for dark matter research. This optional technology also provides a highly stable environment for the measurement of quantum bits or condensed matter.

Customizable design for tailor-made solutions

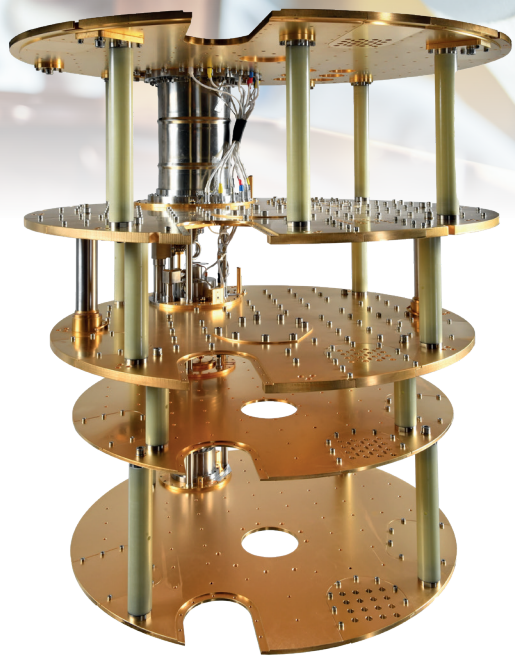
Our core system is standardized so that it can be implemented as a turnkey module in systems of virtually any size or power requirements. Our objective is to allow our users to create the conditions required for their experiments, including temperatures approaching absolute zero.
Our teams address the specific needs of each customer using a **holistic approach that combines consulting, design, installation and commissioning.**

QUANTUM COMPUTING

Quantum computing could be the next breakthrough in computer science. Instead of using bits that only have binary values of 0 or 1, quantum computers use the superposition principle of quantum objects to operate with quantum bits (qubits) that can have multiple values of 0 and 1 simultaneously, thus promising to solve problems that are currently intractable even for the world's largest supercomputers.

A variety of technologies can be used to create quantum computers, and most of them (Josephson, CMOS, etc.) involve very low temperatures (below 1 Kelvin). In that case, dilution refrigerators are needed to keep the qubits cool. The equipment required for quantum computers takes up a lot of space. To offset this constraint, **we designed our HEXA-DRY product range to be as compact as possible, to optimize the amount of space available for experiments.**

To continue to increase the number of qubits, CryoConcept works hand-in-hand with Air Liquide to couple helium liquefiers with dilution refrigerators and reach 4 Kelvin, which is critical for this application. Our design office and customization capacity enable us to address the needs of a wide array of qubit technologies and platforms. **Moreover, our experience in producing reliable systems with extremely long service lives enables us to address the availability requirements of future quantum computing platforms.** As such, CryoConcept is involved in several notable initiatives of the French Quantum Plan ("*Plan Quantique*").



HEXA-DRY:
A RANGE OF **COMPACT, CRYOGEN-FREE DILUTION REFRIGERATORS WITH LOW VIBRATION LEVELS**

KEY BENEFITS

Unique non-mechanical contact exchange technology:

- Low vibration level.
- Dynamic exchange rate and unlimited service life.
- Quick removal of the pulse tube in case of maintenance.

Customization:

- High-level collaboration with each customer to design the best system for their experiment, needs and requirements.
- Plates can be changed quickly at any time to allow for several experimental set-ups.

CHARACTERISTICS:
HEXA-DRY SIZE XL

	GUARANTEED	EXPECTED
Base temperature	10mK	9mK
Cooling power @20mK	10µW	12µW
Cooling power @100mK (Dynamic)	350µW	400µW
Cooling power @100mK (Performance)	450µW	500µW

TECHNICAL SPECIFICATIONS:
HEXA-DRY SIZE XL

Design	Hexagonal 300K top flange allowing easier access
Mixing-Chamber plate diameter	Ø500mm
Sample space	Ø523mm x 300mm
Available ports	12 ISO-K DN63 ports on the side, 4 KF50 ports, and 3 ports ISO-K DN63 on the top
Quantity of He3	18 liters

BOLOMETRY

Bolometers are detectors that work by converting the energy of incident radiation into heat to raise the temperature of a body fitted with a thermometer. Many conditions must be met for a bolometer to work correctly in a dilution refrigerator, the most important of which is a low vibration level.

Our proprietary Ultra-Quiet Technology™, which is used on the HEXA-DRY dilution refrigerator, proved that by offering the lowest level of vibration on the market in continuous operation (<40nm RMSD* in the z-direction in the 1Hz-1kHz range), we can significantly increase measurement accuracy.

Bolometers are also highly sensitive to radiation. **To avoid any contamination of our systems' measurements, we use archeological copper and lead.** Both materials are necessary to manufacture the Outer Vacuum Chamber (OVC), the lead shield assembly and the shields. CryoConcept has developed expertise in handling and manufacturing all these materials.

Our HEXA-DRY Bolometry dilution refrigerator with Ultra-Quiet Technology™ meets all these requirements. It was designed to operate continuously for long periods (more than 1 year) while being operated fully remotely. Today, we are a leader in this segment of the cryogenic market thanks to our expertise in materials and minimizing vibration levels for bolometry experiments.

HEXA-DRY BOLOMETRY: A RANGE OF CRYOGEN-FREE DILUTION REFRIGERATORS WITH LOW VIBRATION LEVELS AND LONG SERVICE LIFE THANKS TO OUR ULTRA-QUIET TECHNOLOGY™

KEY BENEFITS

- Established expertise in low-radioactivity material.
- Low vibration level.
- Dynamic exchange rate and unlimited service life.
- Quick removal of the pulse tube in case of maintenance.

CHARACTERISTICS: HEXA-DRY BOLOMETRY SIZE M

	GUARANTEED	EXPECTED
Base temperature	10mK	9mK
Cooling power @20mK	10µW	12µW
Cooling power @100mK (Dynamic)	350µW	400µW
Cooling power @100mK (Performance)	450µW	500µW

TECHNICAL SPECIFICATIONS: HEXA-DRY BOLOMETRY SIZE M

Design	Hexagonal 300K top flange allowing easier access
Mixing-Chamber plate diameter	Ø300mm
Sample space	Ø313mm x 300mm
Available ports	3xDN50 and 6xDN63 (with 1 Line-Of-Sight Access)
Quantity of He3	18 liters

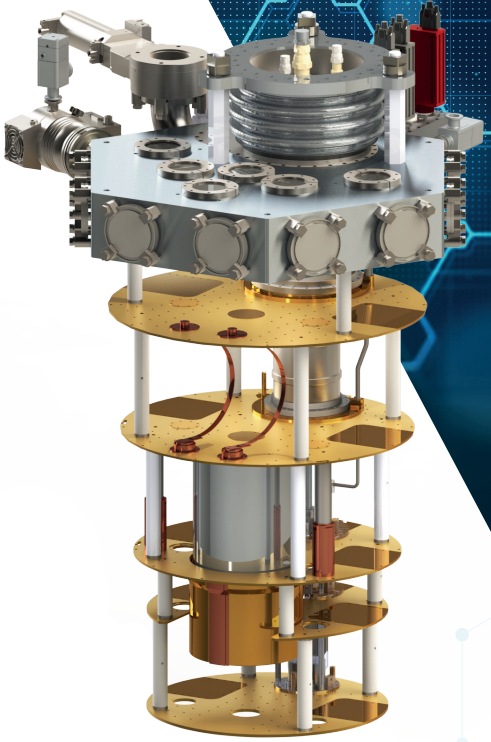
(*) Root-mean-square deviation (RMSD) is a measure of the average distance between atoms.

CONDENSED MATTER

Condensed matter physics is one of the most active fields of contemporary physics because of the diversity of systems and phenomena available for study. It is the study of systems with many constituent parts that have strong interactions between each other. Low temperatures and strong magnetic fields are typically used to reveal the astonishing properties of matter such as the fractional quantum Hall effect.

To address the specific needs of these applications, we have designed our systems so that the magnets are parallel with the dilution unit, meaning the system is **very compact and cools down fast.** Our Ultra-Quiet Technology™, installed on our HEXA-DRY equipment, also enables us to reduce the noise of such experiments.

HEXA-DRY 14T: A RANGE OF COMPACT, HIGH-CAPACITY, CRYOGEN-FREE DILUTION REFRIGERATORS WITH OUR ULTRA-QUIET TECHNOLOGY™



KEY BENEFITS

Magnets up to 14T mounted parallel with the dilution unit:

- Compact outside.
- Large inside.
- Quick to cool down.

CHARACTERISTICS:
HEXA-DRY BOLOMETRY SIZE L

	GUARANTEED	EXPECTED
Base temperature	10mK	9mK
Cooling power @20mK	10µW	12µW
Cooling power @100mK (Dynamic)	350µW	400µW
Cooling power @100mK (Performance)	450µW	500µW

TECHNICAL SPECIFICATIONS:
HEXA-DRY BOLOMETRY SIZE L 14T MAGNET

Design	The magnet is located in parallel of the dilution unit at 4K
Mixing-Chamber plate diameter	Ø400mm
Sample space	Ø423mm x 300mm
Available ports	12 ISO-K DN63 ports on the side, 4 KF50 ports and 3 ISO-K DN63 ports on the top
Quantity of He3	18 liters
14 Tesla Magnet	Solenoid configuration - Superconducting magnet Bore 52mm

CRYOCONCEPT TECHNICAL SUPPORT

CryoConcept supports you throughout your system's lifecycle:

Installation and commissioning:

From on-site tests to installation in your laboratory, CryoConcept provides in-person assistance and user training.

Maintenance and technical assistance:

An after-sales service with diagnostics and support by telephone (response in less than 24 hours) and email (response in less than 3 days). If necessary, CryoConcept can also provide on-site support.

Spare parts:

If necessary, spare parts can also be supplied or exchanged (depending on the warranty status).

Upgrade:

Please contact us if you need to upgrade your system to meet specific new needs.

CRYOCONCEPT AFTER-SALES SERVICE

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CryoConcept
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CryoConcept is a French company located near Paris, with about 20 employees, that designs and builds cryogenics systems for quantum computing and fundamental research. CryoConcept is a subsidiary of Air Liquide, a world leader in gases, technologies and services for Industry and Health, which is present in 75 countries with approximately 66,400 employees. The Group places sustainability at the heart of its strategy, aiming for a comprehensive performance both financial and non financial. It serves more than 3.8 million customers and patients and its revenue amounted to more than 23 billion euros in 2021.