Helium Recovery in Diamond

Helium

Helium is generally found trapped under... **Helium** may be the 2nd most abundant element in the universe, but it is very rare on earth. The problem is that **helium's** average atomic velocity (remember, it exists as a monoatomic gas) is greater than the escape velocity needed to leave earth's atmosphere. 18 Jan 2016

Created in the earth crust by decay of Thorium & Uranium. Alpha particles emitted by decay (He Nuclei) are trapped by natural gas.

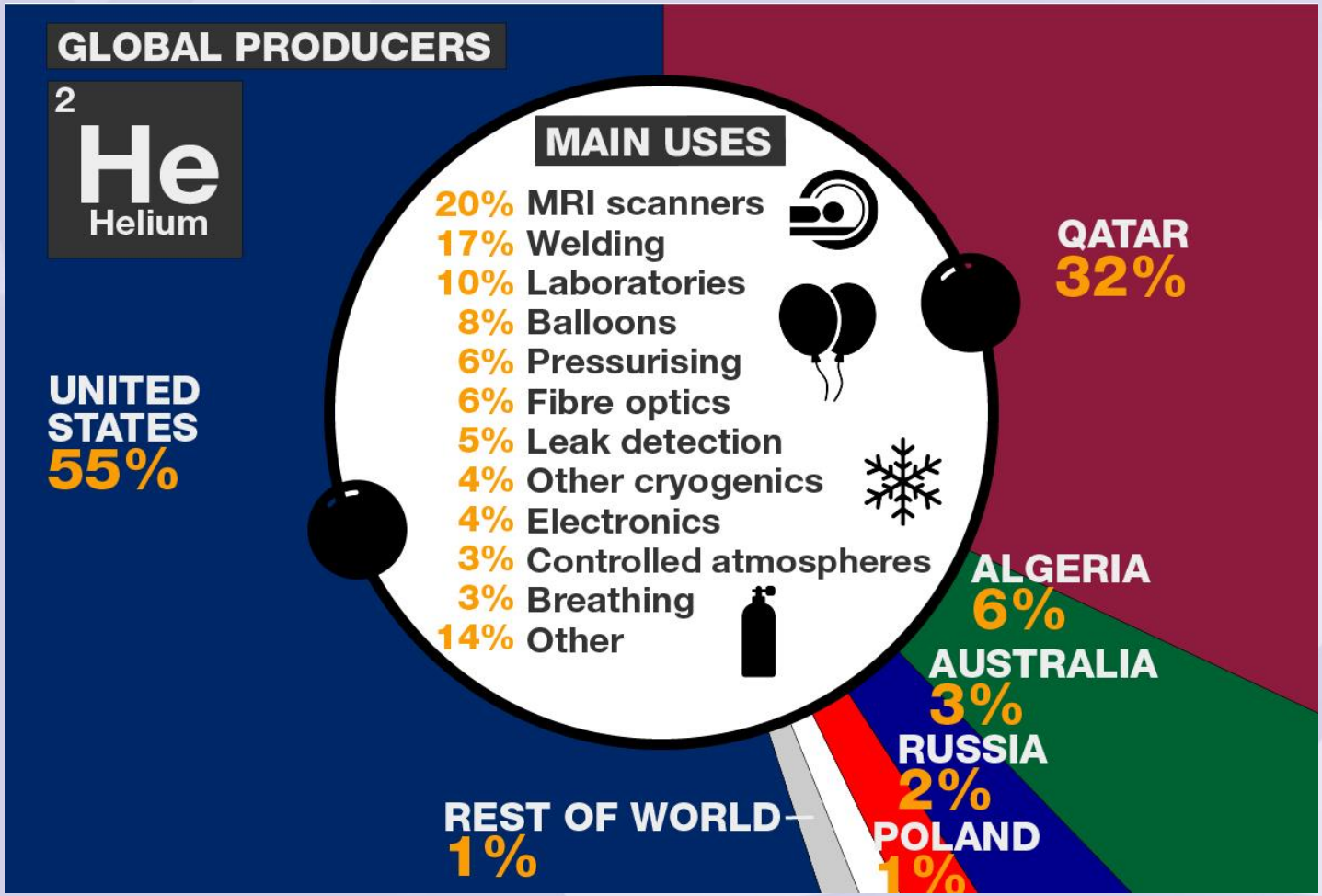
Helium makes up just 0.0005% of the atmosphere!

Escapes earths' atmosphere at a speed of 11.1 KM/s

Where does it come from?

- Much of the extraction in the United States and the world comes from underground gas fields between Amarillo, Texas, and Hugoton, Kansas.
- In 1925, the Federal Helium Reserve was created to stop export of He to others (this is why Germany had to fill their airships with Hydrogen).
- This one-of-kind system stores more than a third of the world's helium in crude form in the Cliffside gas field. The porous underground rock spanning portions of Texas, Oklahoma and Kansas holds gas like a sponge holds liquid, capped above by calcium anhydrite and on the sides by water.
- Found in other locations around the world in smaller amounts.

Where is it found and what is it used for.

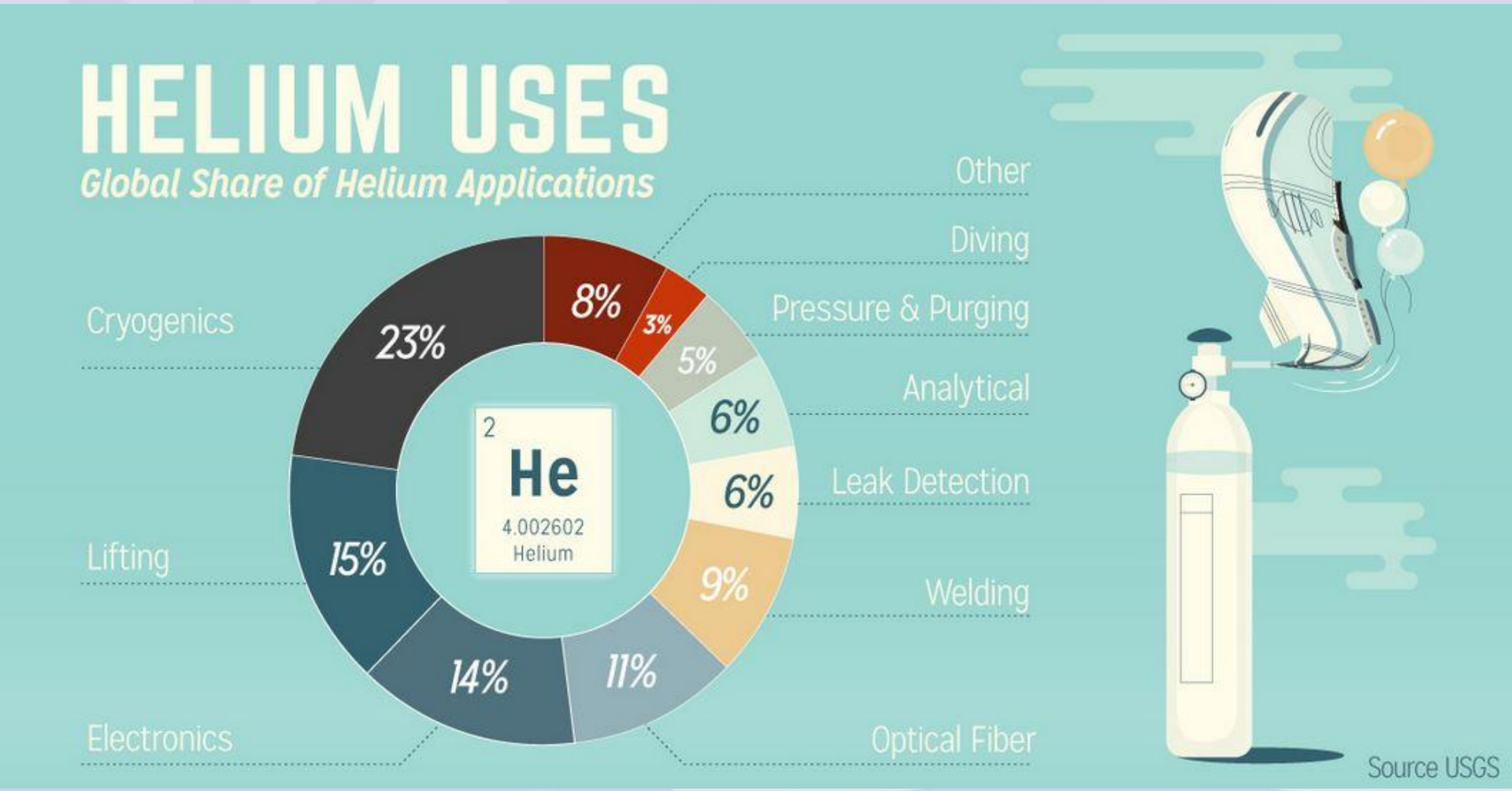


Why is it so useful?

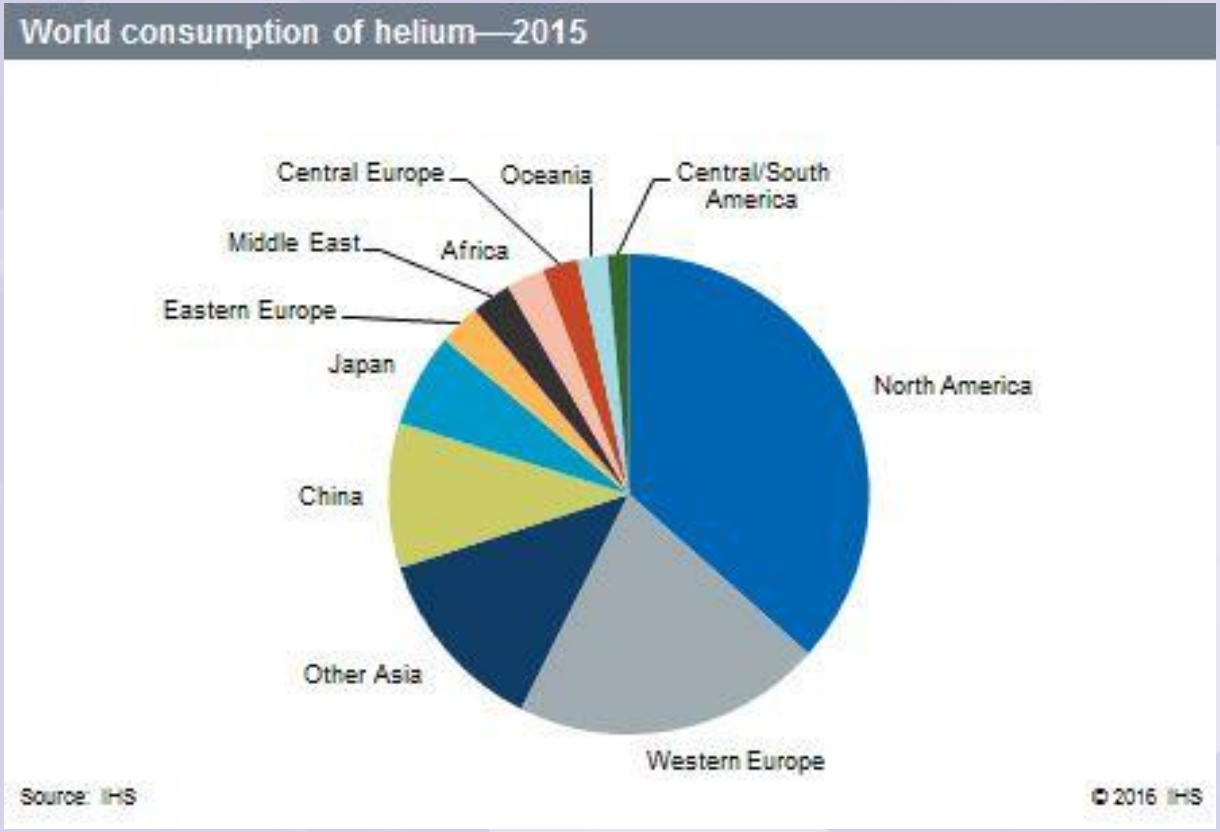
- Helium's modern applications come from the fact that it wants very little to do even with other helium atoms. This makes it very stable and very useful in the aerospace industry for guiding missiles, purging fuel lines and pressurizing tanks. It also keeps air bubbles out of fibre optics during manufacture.

- Those small atoms and very weak attractive forces between them result in the lowest boiling point of the permanent gases, making it fantastic at cooling things to extremely low temperatures, Liquid helium is used to cool superconducting magnets to just above absolute zero in applications ranging from magnetic resonance imaging (MRI) machines to the Large Hadron Collider.

Helium – what's it used for?

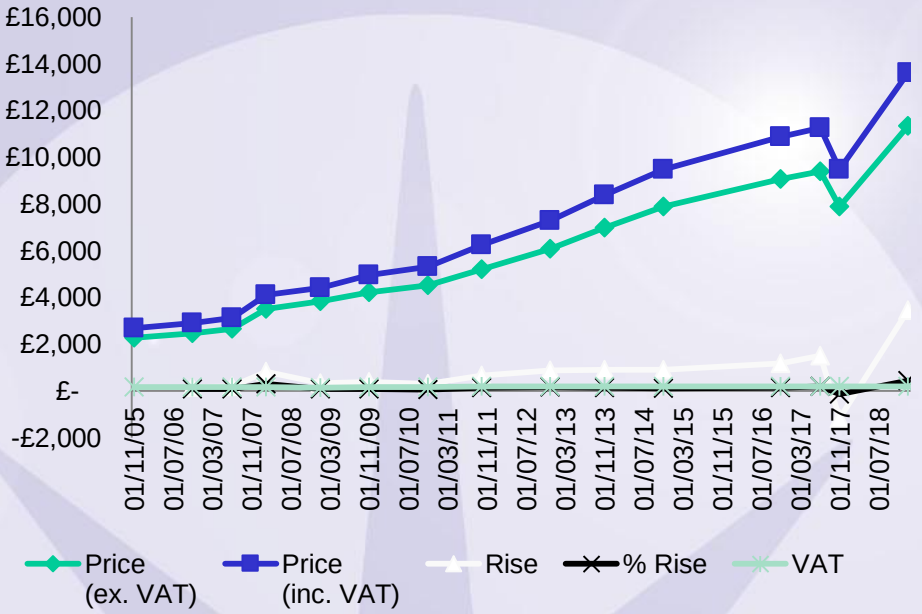


Who uses the most??



Over the last 10 years the cost of helium has ballooned.

Date	Price (ex. VAT)	Price (inc. VAT)	Rise	% Rise	VAT
01/11/05	£ 2.290	£ 2.69			17.5%
01/11/06	£ 2.470	£ 2.90	£ 0.180	8%	17.5%
01/07/07	£ 2.670	£ 3.14	£ 0.200	8%	17.5%
01/02/08	£ 3.500	£ 4.11	£ 0.830	31%	17.5%
01/01/09	£ 3.850	£ 4.43	£ 0.350	10%	15%
01/11/09	£ 4.230	£ 4.97	£ 0.380	10%	17.5%
01/11/10	£ 4.530	£ 5.32	£ 0.300	7%	17.5%
01/10/11	£ 5.200	£ 6.24	£ 0.670	15%	20%
01/12/12	£ 6.080	£ 7.30	£ 0.880	17%	20%
01/11/13	£ 6.980	£ 8.38	£ 0.900	15%	20%
01/11/14	£ 7.890	£ 9.47	£ 0.910	13%	20%
01/11/16	£ 9.070	£ 10.88	£ 1.180	15%	20%
01/07/17	£ 9.390	£ 11.27	£ 1.500	19%	20%
30/11/17	£ 7.890	£ 9.47	-£ 1.180	-13%	20%
01/01/19	£ 11.340	£ 13.608	£ 3.450	44%	20%



07/11/2019

Should we just be releasing this precious resource into the atmosphere??

- Recovering helium becomes more and more sensible as the price increases (currently £11+ ltr).
- We use 30,000 litres a year of which much is eventually lost.
- However normally you only want the nice clean stuff! Much of what you can recover is contaminated.
- Recovery system cost £700K approx.

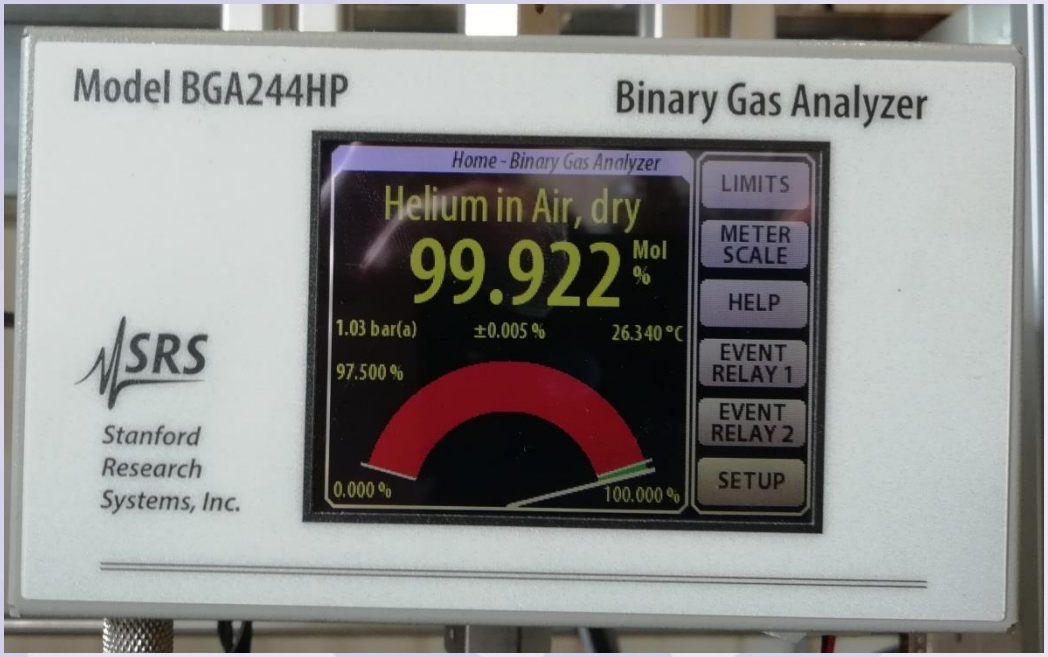
Helium Purity

- RAL ISIS experiment collect all and compress it. It is then checked for purity and stored as clean >98% pure or dirty <98% pure.

- Trying to liquefy low purity Helium causes problems with the liquefaction plant. Also Helium contaminated with Hydrogen can block up their Cryostats when trying to get to milli Kelvin.

Purity Measurement

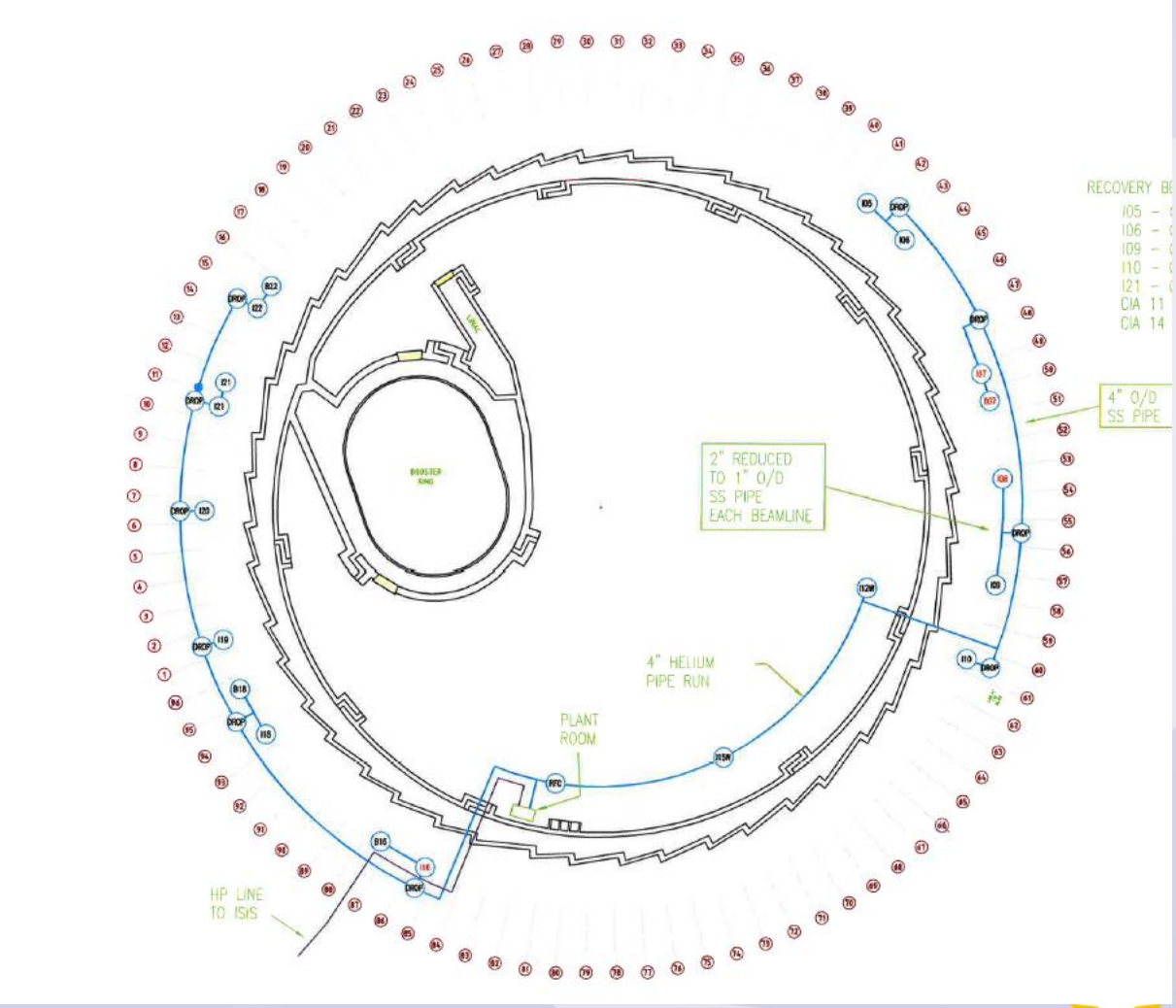
- Binary Purity
- meter > £3K



- De Ox Sun
- Diving Helium Meters <£1K

Two common methods, thermal conductivity of gas or speed of sound principle!

Overview of system



Local Collection Manifolds

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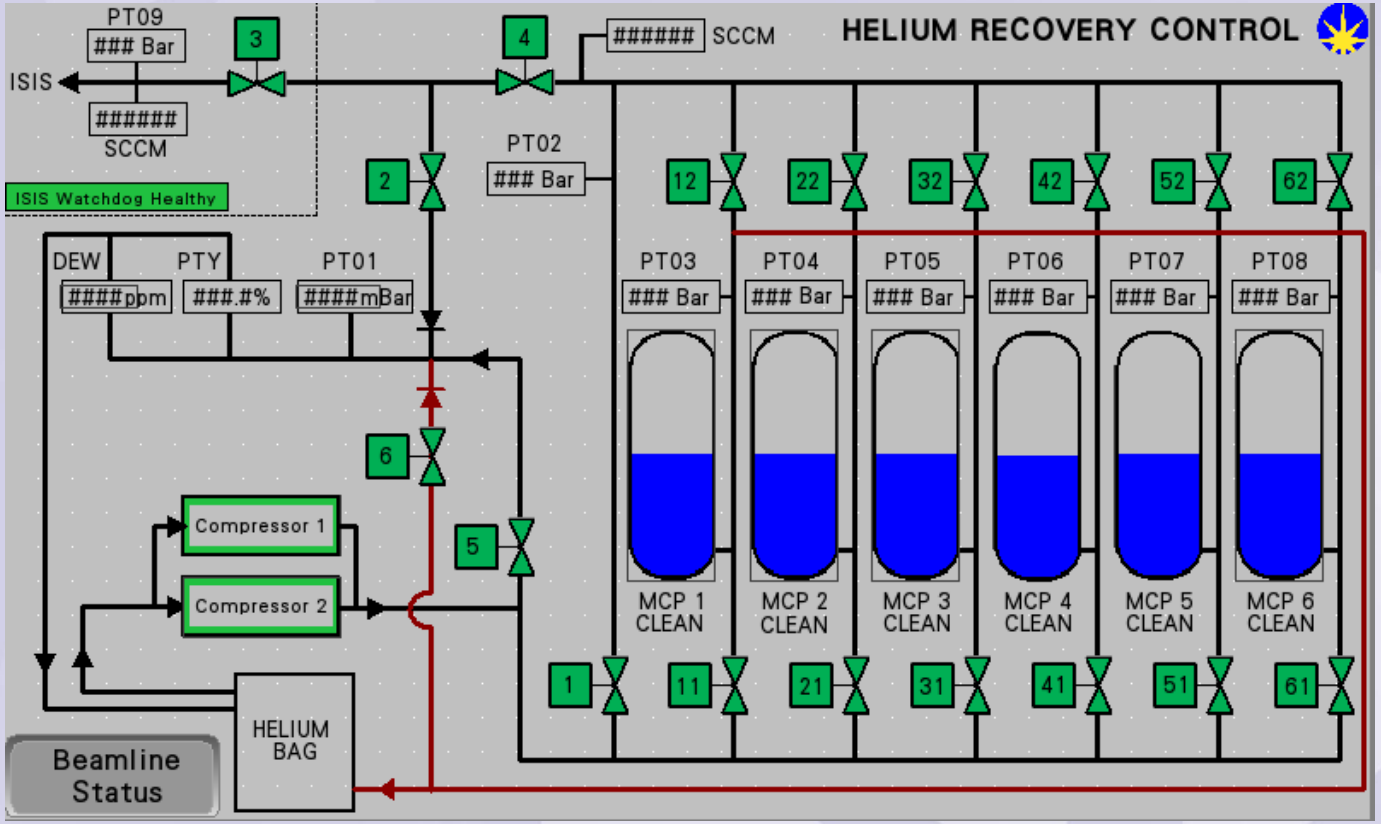
Local Collection Controls

Gas Bag collection

- Hold 24 m^3 of gas
- Operate a 7-17m bar range.
- Has dual pressure sensor fitted
- Fitted with auto pressure relief and vents out into the courtyard.

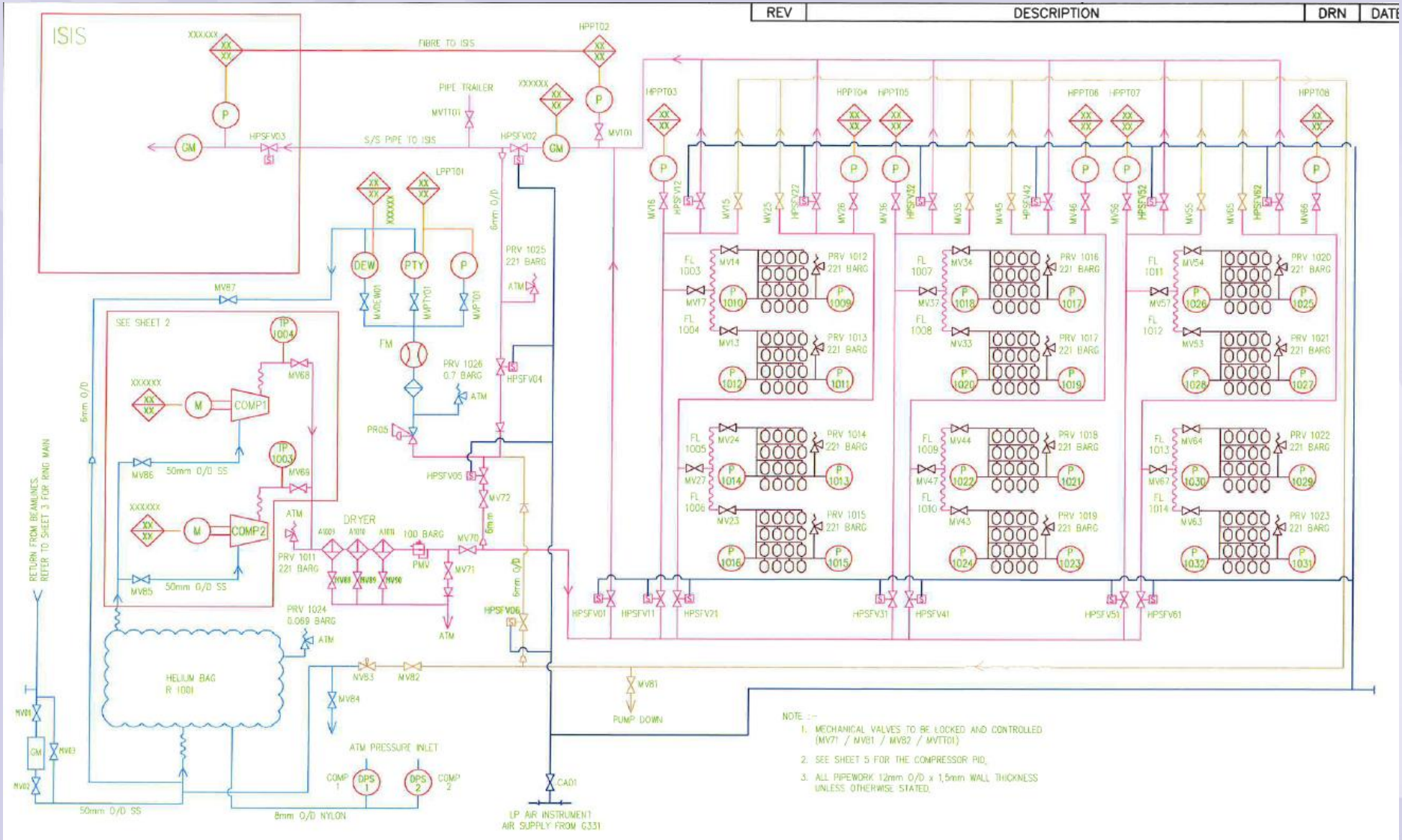
Helium Compressors

Main PLC



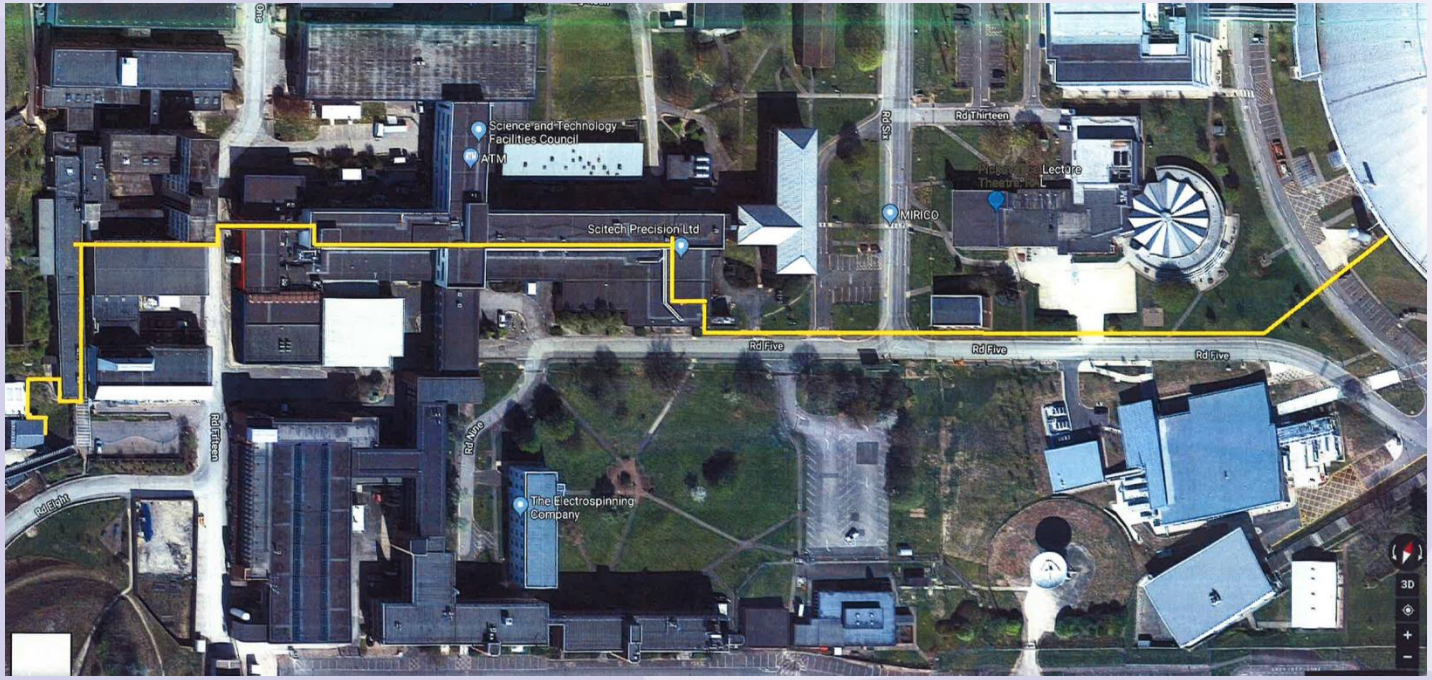
CJ 2 series PLC talking Ethernet IP to the local collection CP1L PLC's and Profinet to remote IO over fibre Ethernet link at the ISIS end.

Compressor & storage system



Transfer to ISIS

- From Zone 12 Diamond to R108



Storage MCP's

ISIS Linde TCF 20 Liquefier

- It take 6-8 hours to cool down as it does not have a Nitrogen pre-cooler
- Can make 18 liquid Ltrs/hr or 480 a day.
- Takes 13,626 litres of gas to make liquid for just 1 hour (757:1) hence the reason we store at 200 bar!
- Impurities can clog up the system as things like methane and oxygen freeze up before helium.

ISIS Helium Liquefaction plant

Risks????

- PSSR Pressure systems safety regulation 2000
- Following the Machinery directive.
- Hazard ID performed for the complete system, broken down into Collection, delivery, low pressure storage, compressors, high pressure storage and transfer.
- Risk assessments then follow to shape the design.
- Operating user manuals, functional specifications, drawings, applicable directives and standards, test documentation, sign off sheets & ultimately Incorporation certification signed by the Head of Engineering.

In summary

- Collect not waste
- Compress, sort into clean and dirty and store until enough is ready to justify running the liquefaction plant.
- Send it across to ISIS and wait for it to be returned as nice clean liquid helium.
- Bask in the warm glow of knowing you are helping protect a finite resource!

Questions....anyone?