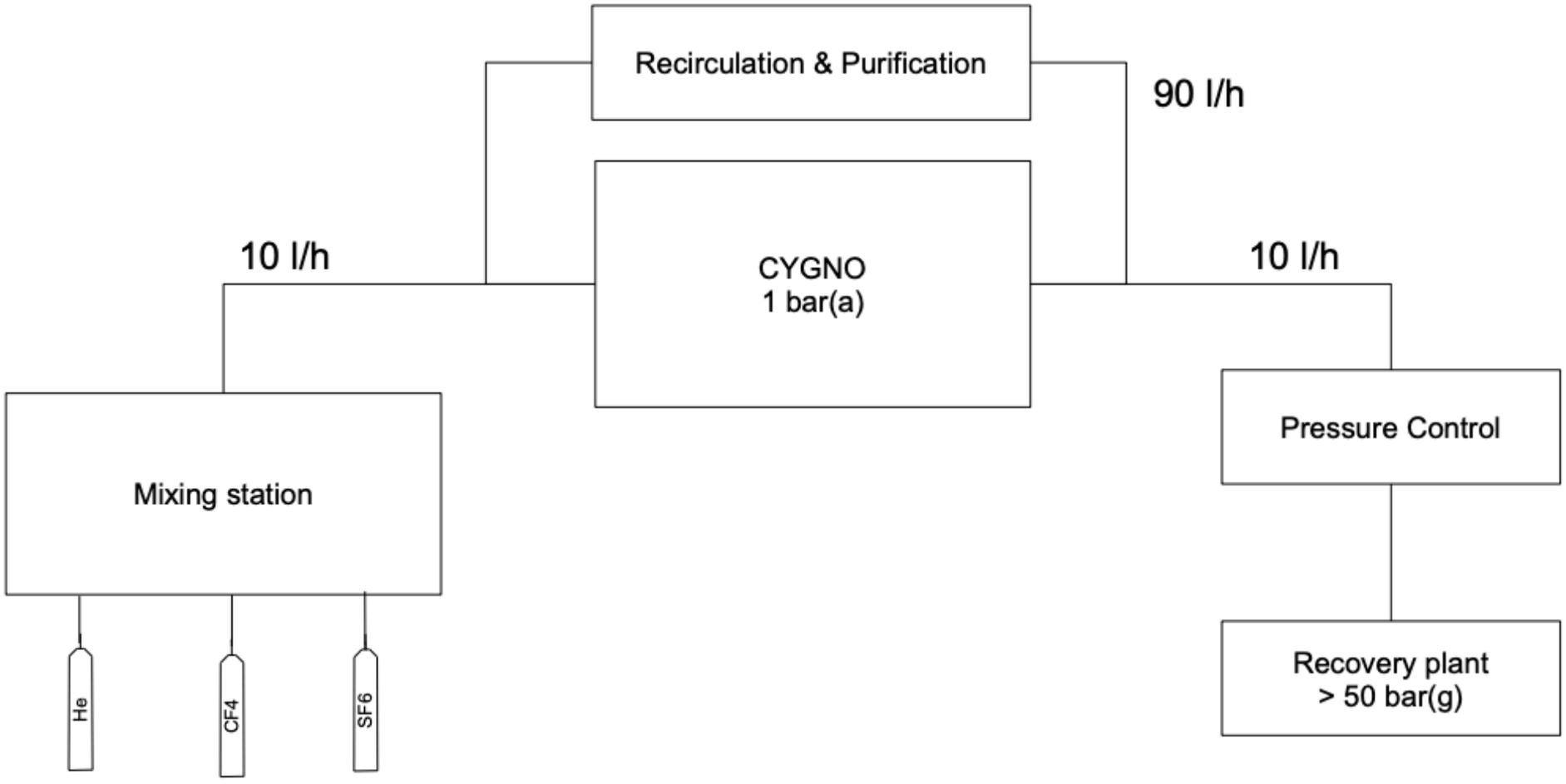
The University Of Sheffield.

# CYGNO Gas System and Sheffield

By Robert Renz Marcelo Gregorio

**Italy-UK CYGNO Meeting**
**27th March 2019**

# Conceptual Design




- **Gas used: Helium, $CF_4$ and $SF_6$**
- **Important to maintain pressure and gas ratio throughout recirculation**

***From Francesco Renga INFN Roma***

# Work Done with $SF_6$ Gas and Molecular Sieves in Sheffield

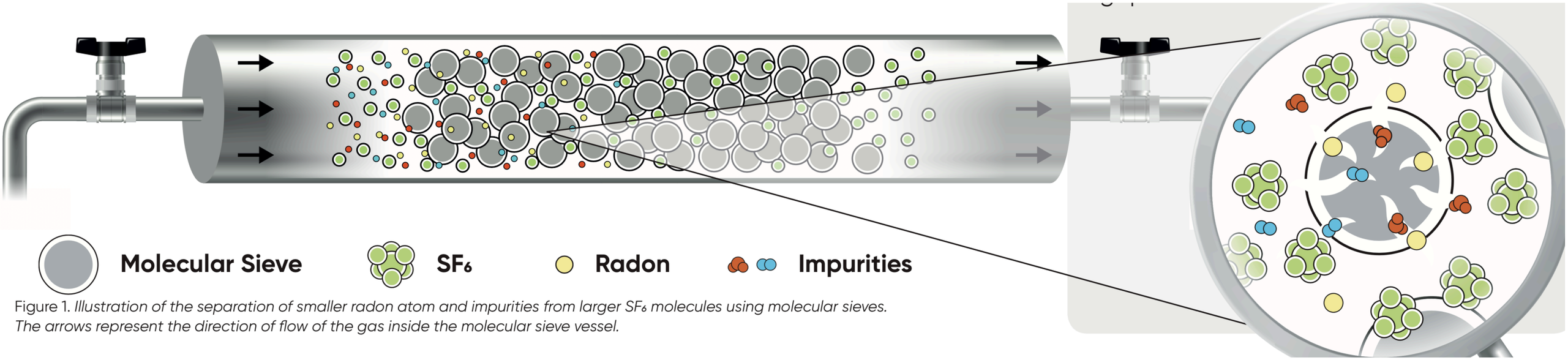



Figure 1. *Illustration of the separation of smaller radon atom and impurities from larger $SF_6$ molecules using molecular sieves. The arrows represent the direction of flow of the gas inside the molecular sieve vessel.*

- **Demonstrated up to 87% Reduction of Radon From $SF_6$ using Molecular Sieves**
- **Demonstrated the Reduction of Impurities such as $N_2$, $O_2$ (89%) and Water (79%) from $SF_6$ Using Molecular Sieves**

# $SF_6$ Absorption Testing with different Molecular Sieves

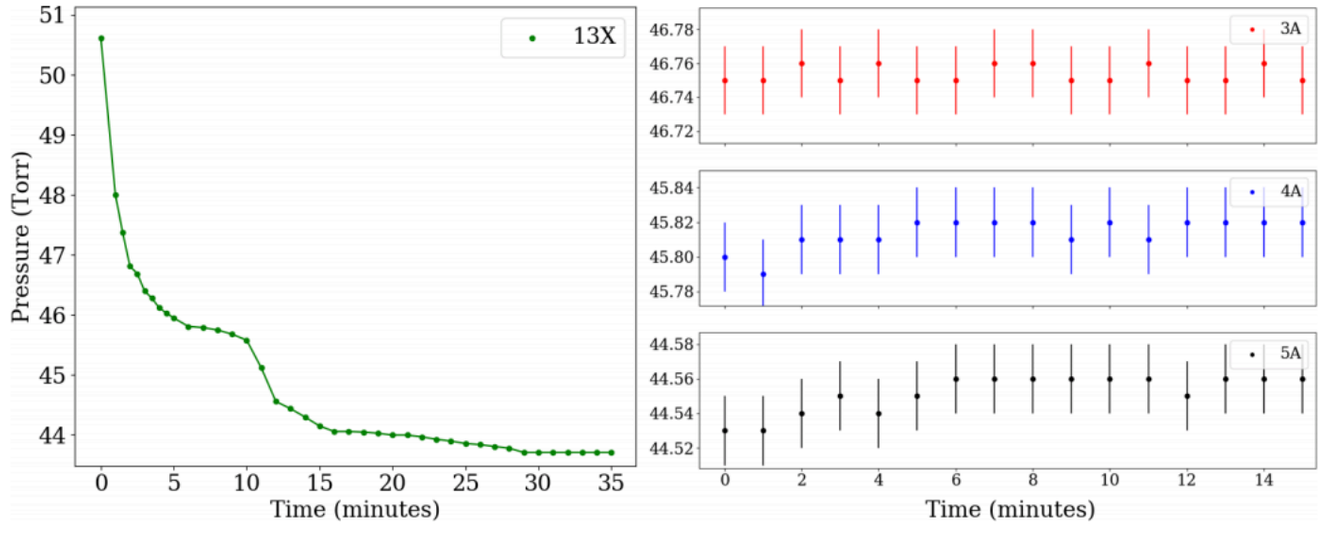



**Figure 5**. The pressure of the system as a function of time for 13X, 3Å, 4Å and 5Å molecular sieve filters. The filters were engaged at time zero for each individual measurement. The errors for the pressure measurement is ± 0.02 Torr; too small to be seen in the 13X data scale.

# Radon removal from $SF_6$

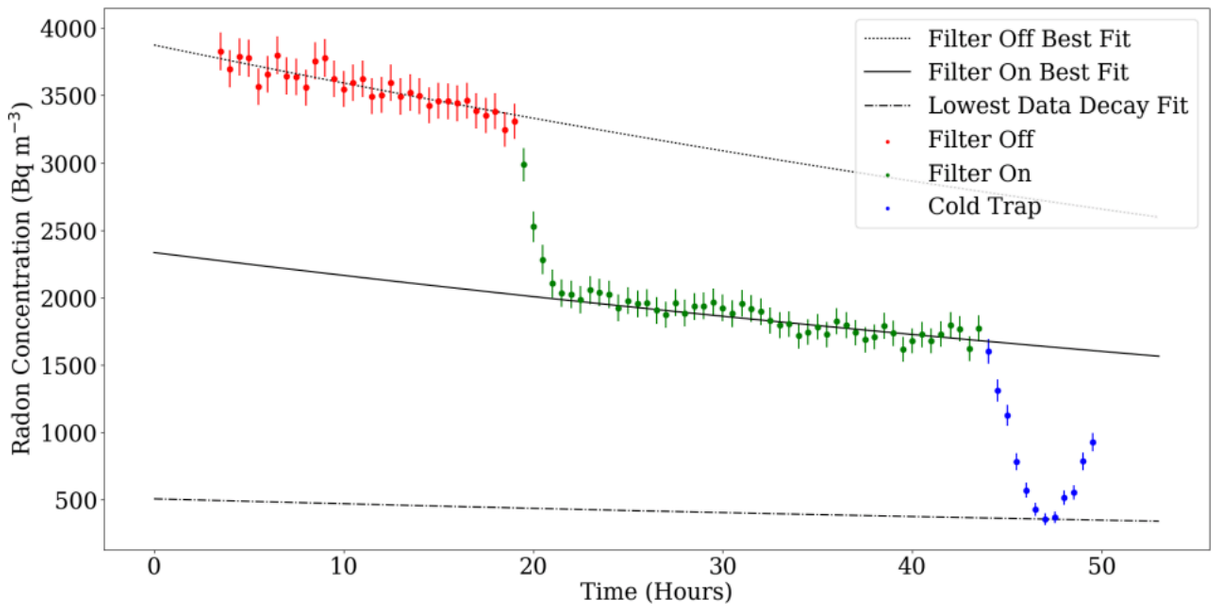
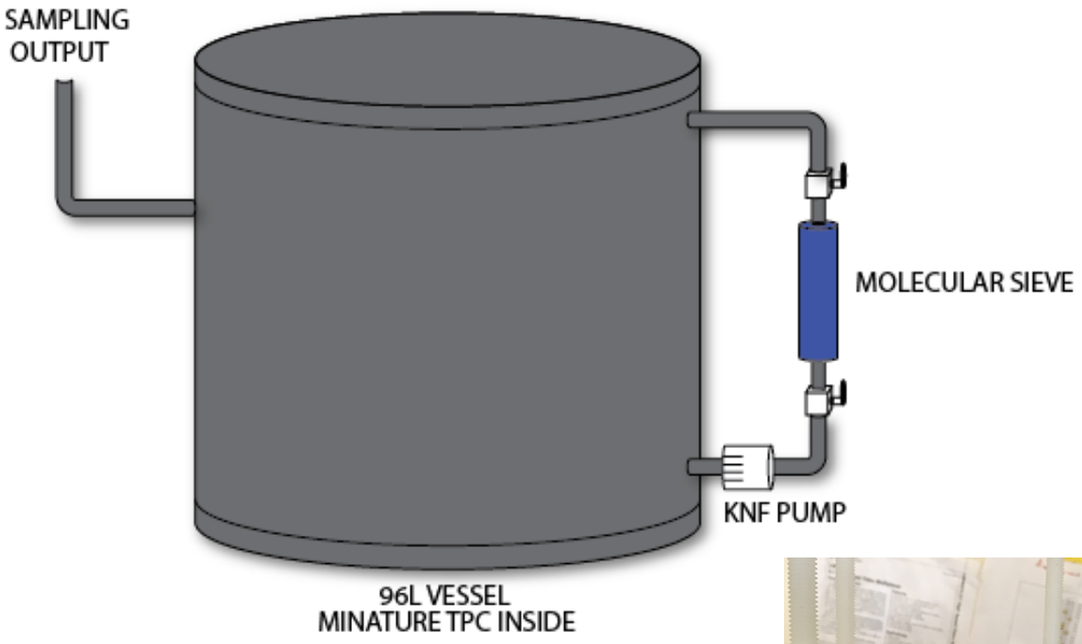


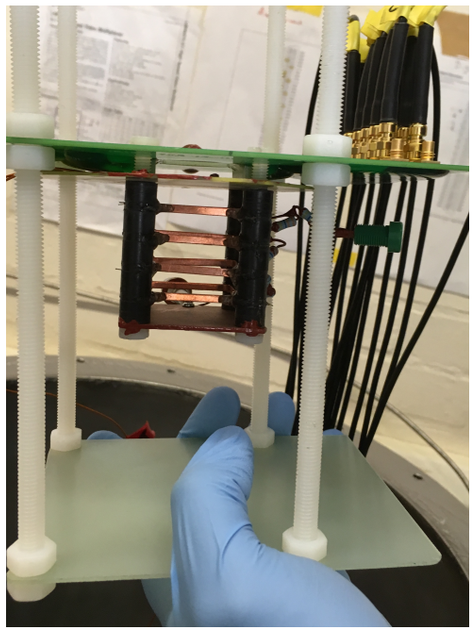

**Figure 10**. Radon concentration in $SF_6$ shown over time for the 5Å molecular sieve filter. The filter was engaged after 20 hours and the cold trap was engaged after 44 hours. The decay fit on the blue data set was determined using only one data point to extrapolate the lowest possible radon concentration achieved.

A.C. Ezeribe et al 2017

# Full $SF_6$ Application Testing in Progress

**Vessel is filled with $SF_6$ and continuously measured over a 7 day period with and without the molecular sieve**



***Impurities*** **and Water are measured by Residual Gas Analyser (RGA)**

***Radon*** **is measured by RAD7 Radon Detector**

***Gas Gain*** **is measured by ThGEM inside TPC Vessel**

# Towards CYGNO gas system R&D

**Work in Sheffield has been $SF_6$ orientated. However, we have developed test with molecular sieves that can be of use such as:**

- **Molecular sieve *gas x* absorption**
- **Molecular sieves ability to remove water and impurities from *gas x***
- **Molecular sieves ability to remove radon from *gas x***
- **Molecular sieve radio purity/material radon emanation rate**
- **Application of molecular sieve to miniature TPC**
- **Molecular sieve ability to maintain gas mixture ratio using RGA**

**‘Gas x’= $SF_6$, $CF_4$ and Helium**

**‘NEWS-G experiment uses Oxisorb to purify its He:CH4 mixture’**

# Other gas separation technology

- **Membrane to separate $SF_6$ and $CF_4$ from He and smaller molecules**
- **Pressure swing adsorption to remove He from other small molecules**
- **This is Not a RECIRCULATION process as gas mixture ratio will not be conserved**
- **a multi step $SF_6$, $CF_4$ and He recovery process**

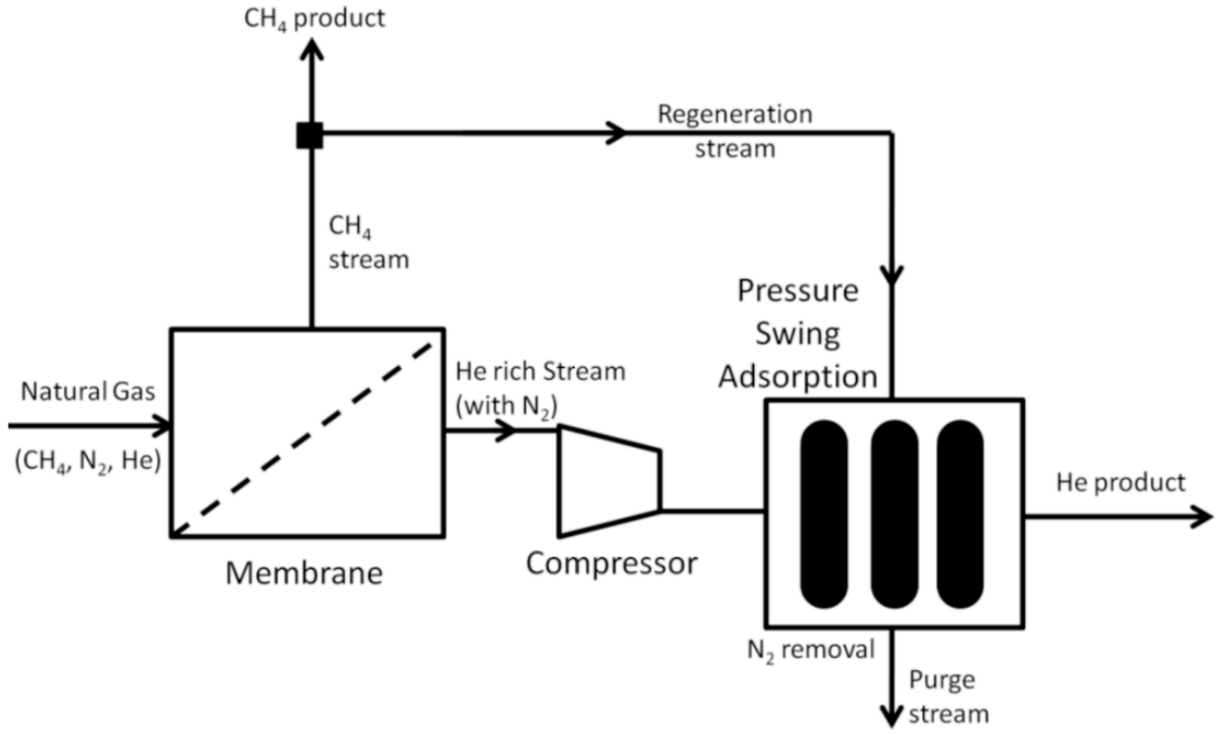
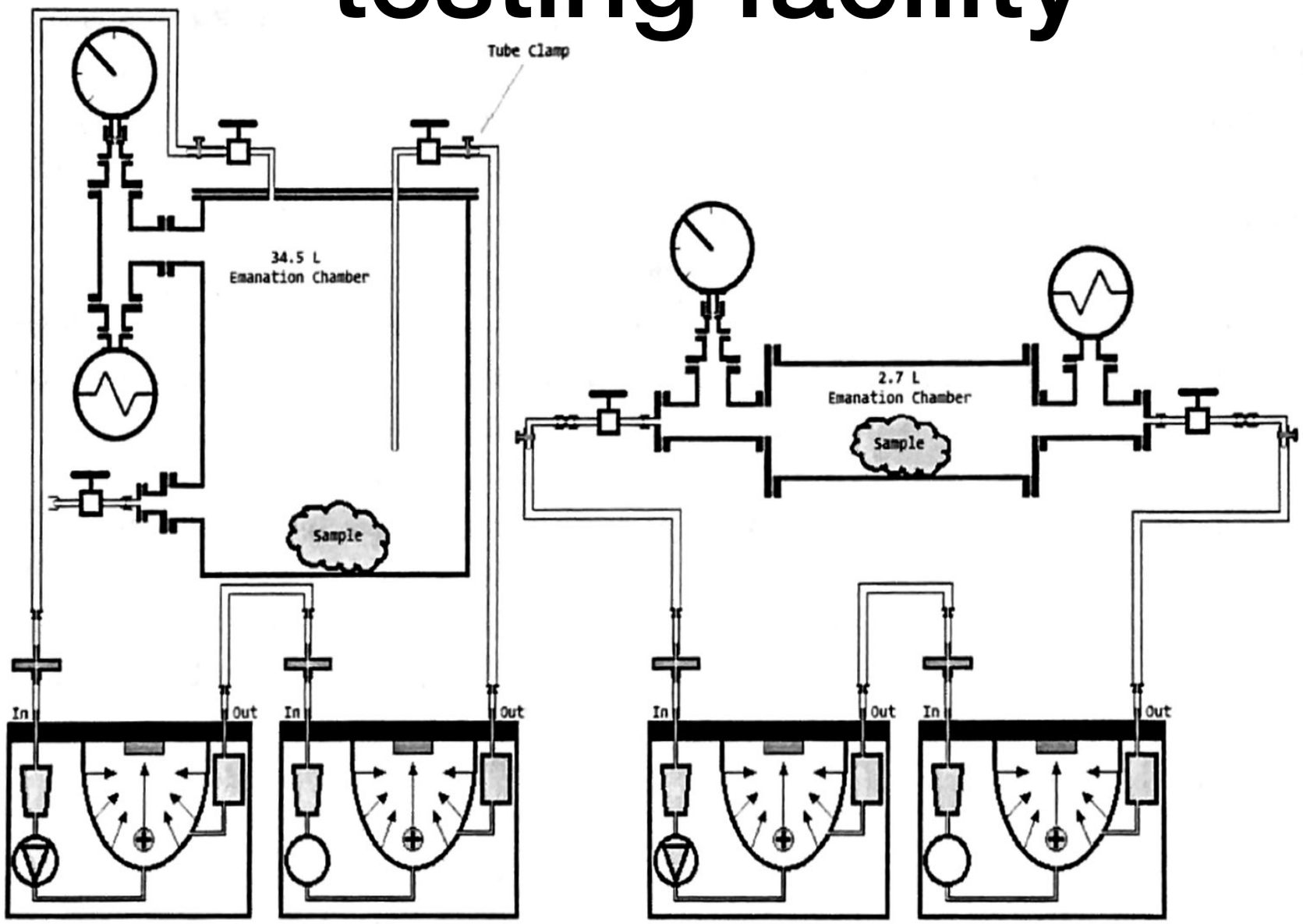



**Figure 3.** Process combining membrane separation with pressure swing adsorption (PSA) for the recovery and purification of helium.

**Colin A. Scholes and Ujjal K. Ghosh (2017)**

# Other Facilities in Sheffield

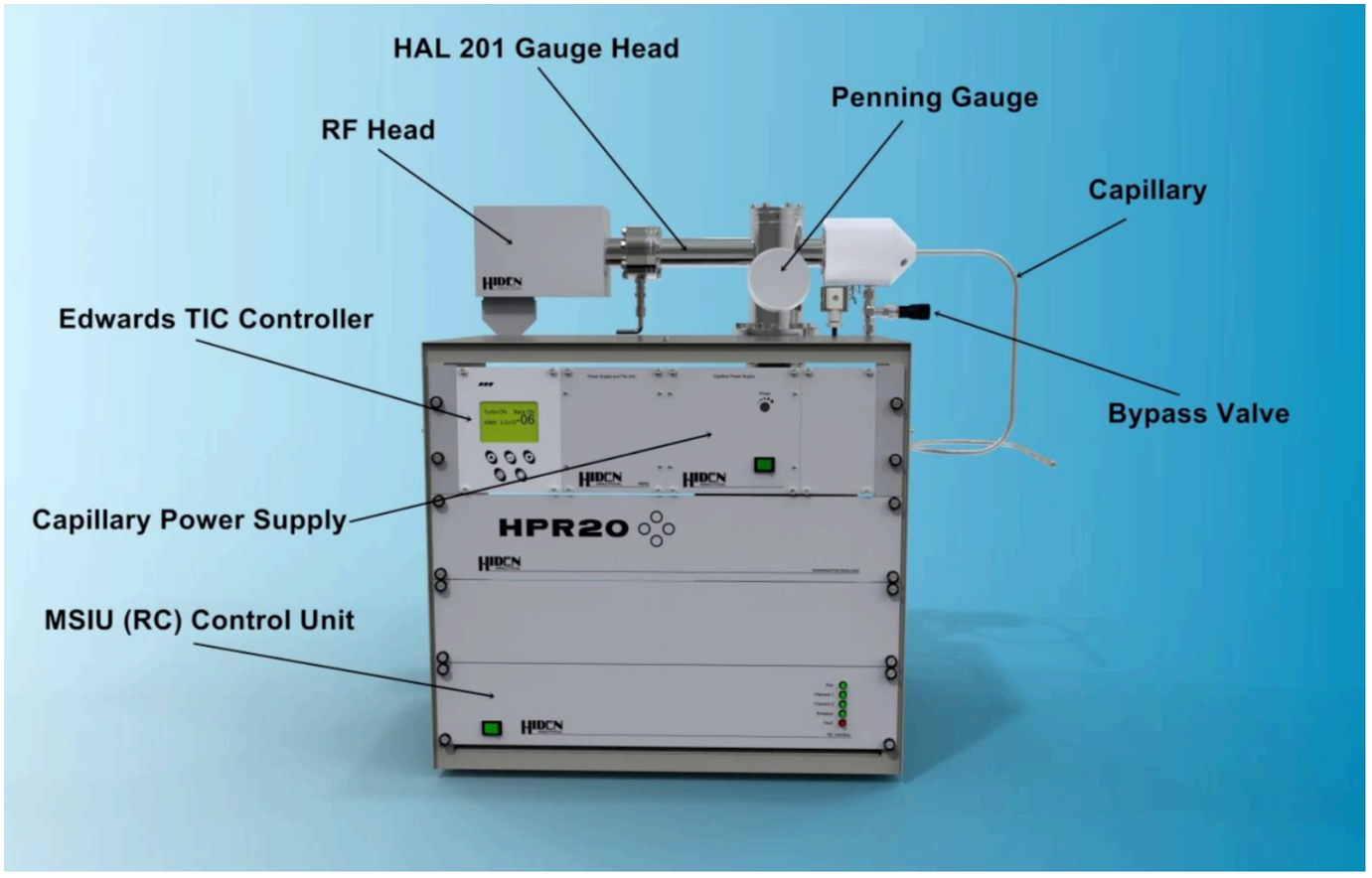
# Ultra-low radon emanation testing facility




**Large Vessel** 34.5L
**intrinsic background:** 0.29±0.11 decay/min

**Small Vessel** 2.7L
**intrinsic background:** 0.09±0.03 decay/min

# Residual Gas Analyser




**The Hiden RGA mass spectrometers provide for routine, fast, wide dynamic range residual gas analysis, measuring the partial pressures of the species that are critical to vacuum quality and process requirements.**