RESPONSE TIME REDUCTION AND SENSITIVITY INCREASE DURING MASS SPECTROMETRIC HELIUM LEAK TESTING OF VERY LARGE SIZE SYSTEMS BY HOOD METHOD*

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LEAK TESTING

- **LEAK DETECTION IS AN ENGINEERING CHALLENGE WHEN IT COMES TO LARGE SYSTEMS**

- VESSELS OF VOLUME 500 TO 1000 M^3 PUMPED AT
- ~1000 M^3 /HOUR SPEED BY PUMPS,
- FOR WORKING AT A VACUUM OF ~10 MBAR
- BUT DEMAND A LEAK RATE OF BETTER THAN 10^{-4} MBAR L/S.

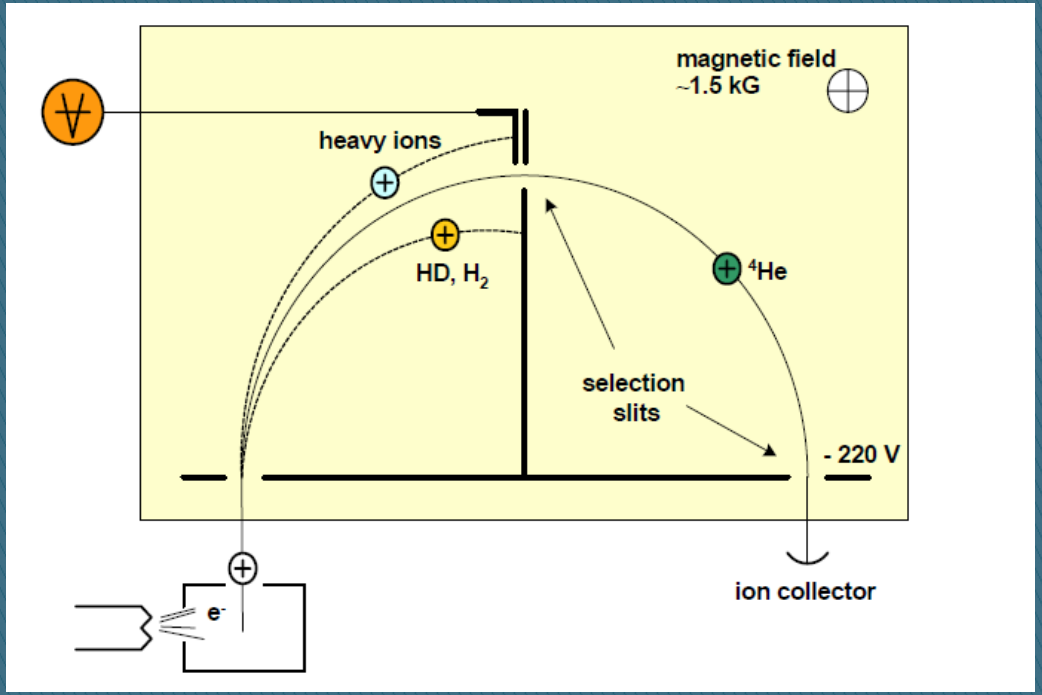
- VESSELS OF VOLUME ~10 M^3 GENERALLY
- PUMPED ONLY BY 50 M^3 /HOUR SPEED BY PUMPS,
- FOR WORKING AT A VACUUM OF ~ 10^{-3} MBAR
- BUT DEMAND A LEAK RATE OF BETTER THAN 10^{-6} MBAR L/S.

LEAK TESTING TECHNIQUES

- **IR THERMOGRAPHY**
- **IR SCATTERING**
- **OPTICAL SPECTROSCOPY COUPLED WITH GLOW DISCHARGE**
- **HYDROGEN MSLD**
- **HELIUM MSLD**

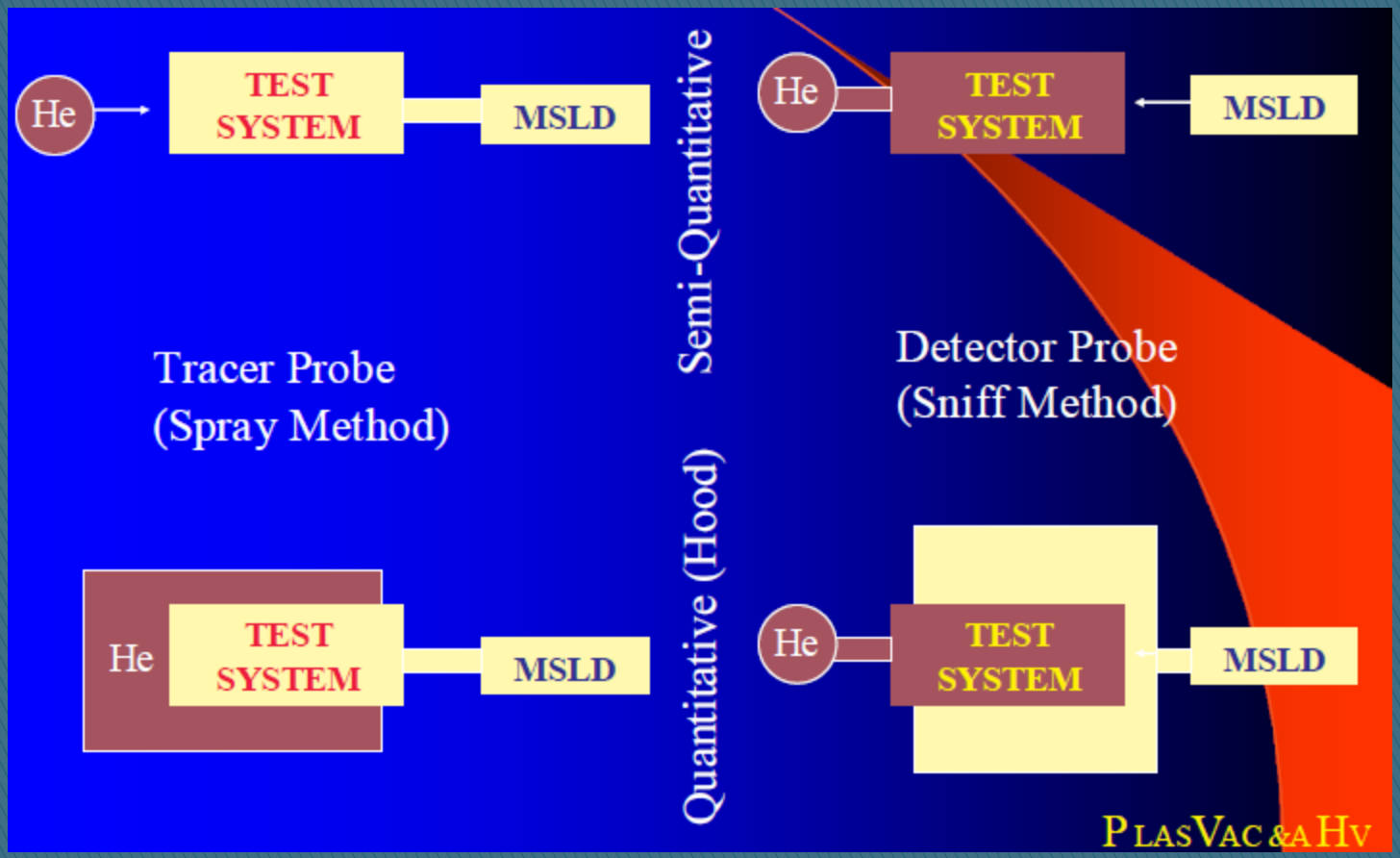
He-MSLD

- **RELIABLE & SENSITIVE**
- **USES MASS SPECTROMETRIC PRINCIPLES**
- **LIMITATIONS DUE TO HIGH VACUUM**



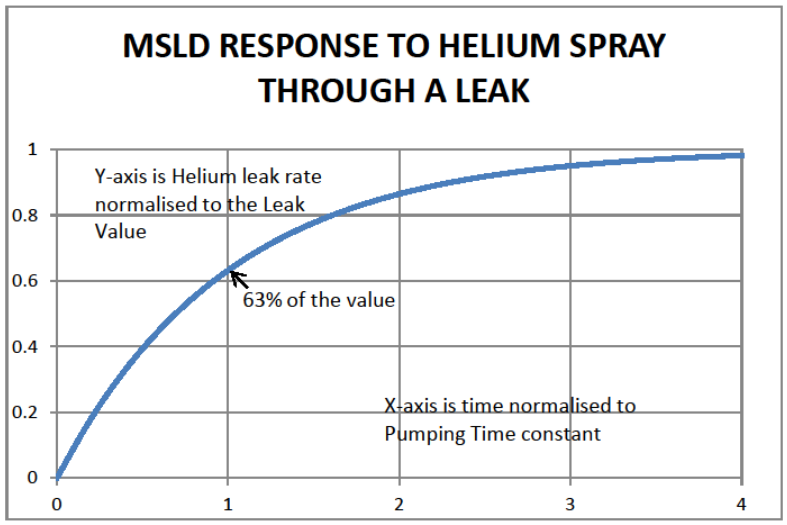
DYANMIC LEAKAGE MEASUREMENT

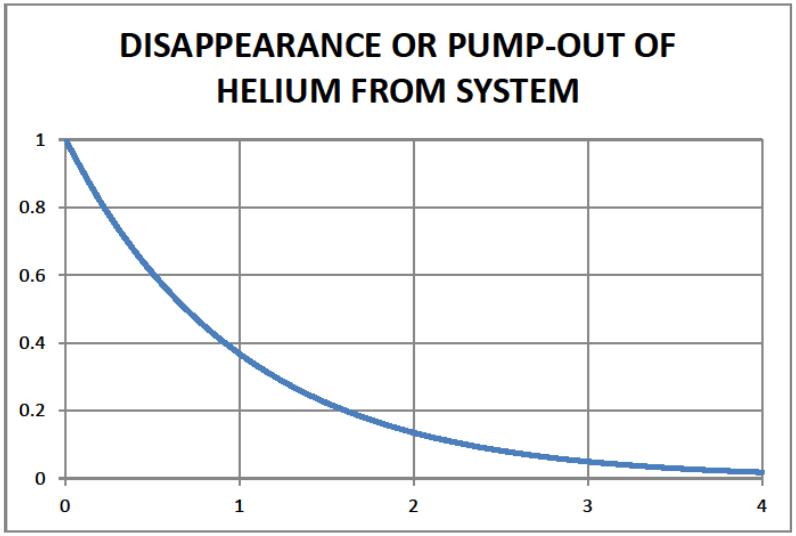
- Outside-in and Inside-out Methods



RESPONSE TIME AND SENSITIVITY

- **RESPONSE TIME & SENSITIVITY ARE RELATED TO THE QUANTITY OF HELIUM MOLECULES REACHING THE DETECTOR AND DOMINATED BY THE PUMPING TIME CONSTANT**





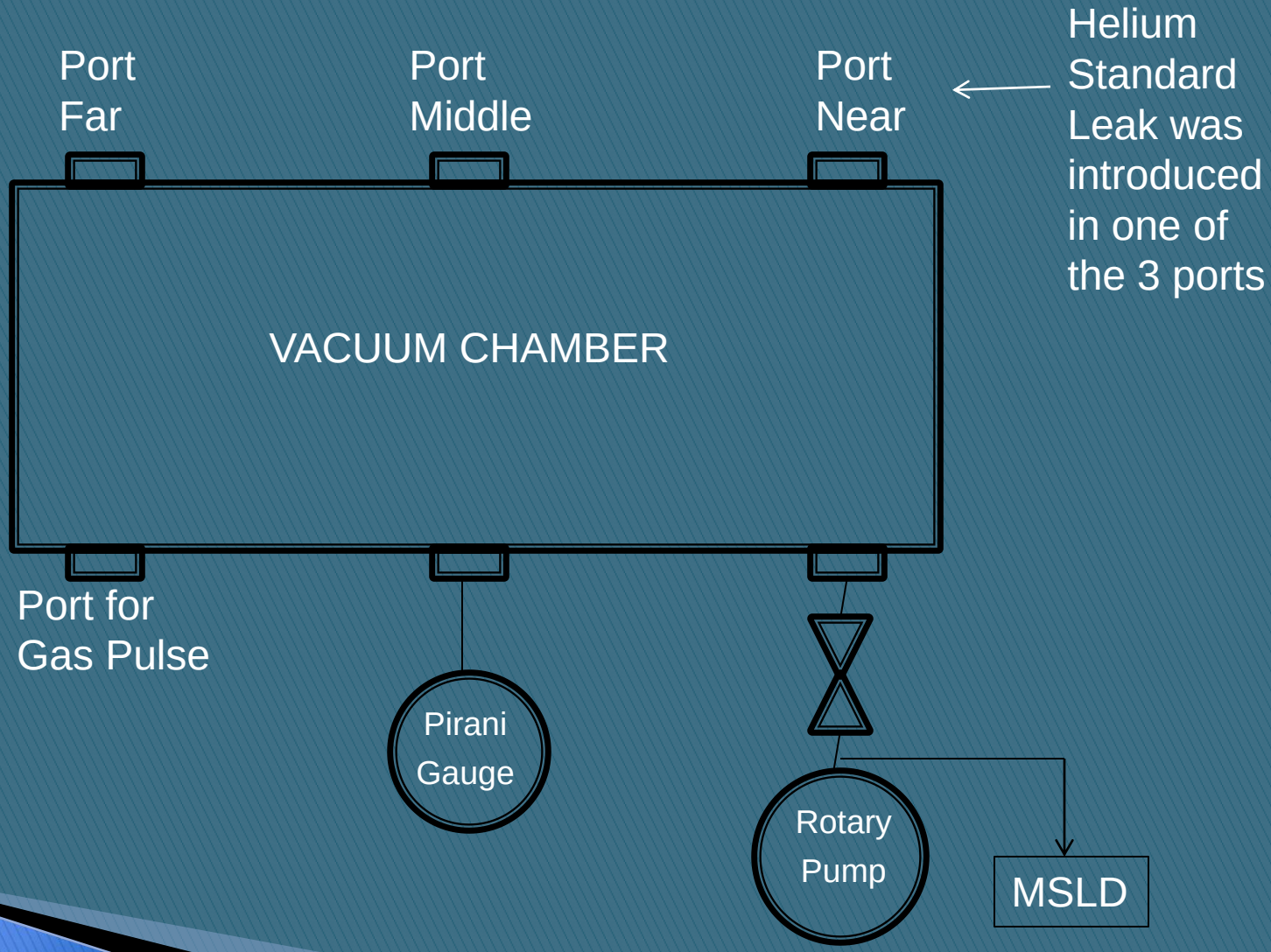
PROBLEM OF RESPONSE TIME

Volume (Liters)	Speed (L/S)	Pumping Time Constant (S)
10	10	1
200	100	2
2000	500	4
10000	1000	10
100000	100	1000

Small and Large High vacuum systems do not have the problem of response time

Very large size Low vacuum systems suffer due to very high response time

SCHEMATIC OF SET UP



DETAILS OF SET UP

Helium Leak Detector used : ADIXEN ASM310

Steel Chamber size 1.2 m (Length) x 1.0 m (Width) x 1.2 m (Height)

Vacuum Pump : Hindhivac Model ED15;Vacuum achieved : 5×10^{-3} mbar

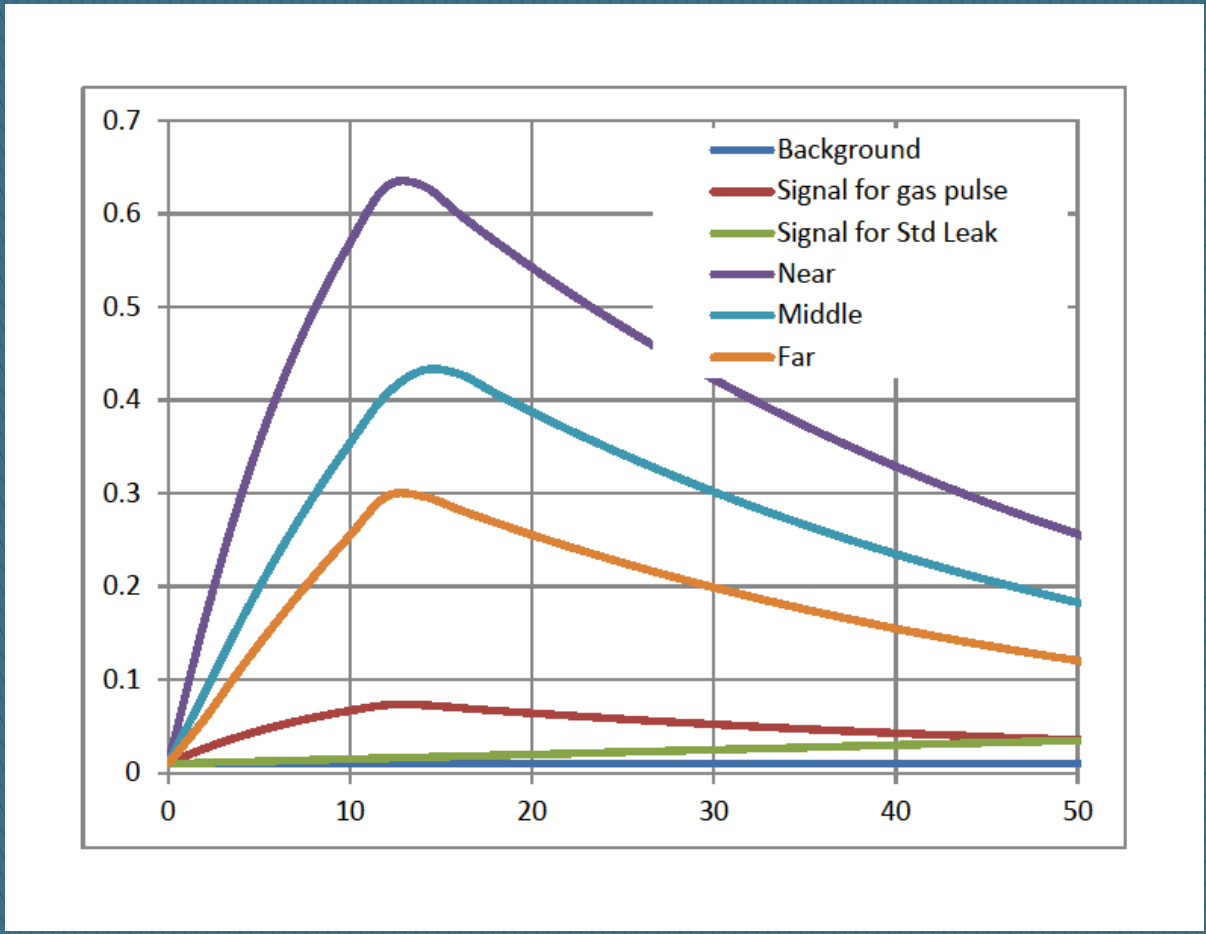
Vacuum Gauge : Hindhivac Digital High Pressure Pirani Gauge

Helium Standard Leak used : Hindhivac 3.2×10^{-8} mbar l/s

Nitrogen Gas Pulse : 5 seconds duration; A solenoid operated gas injection valve was used. Maximum pressure at the pumping inlet went up to 10^{-2} mbar due to gas pulse injection.

OBSERVATIONS

The Y-axis represents the difference between the observed Helium signal in Mass Spectrometer and the background signal. Unit is 10^{-8} mbar l/s



X-axis is Time in Seconds. Note that the N_2 gas pulse duration is only 5 seconds from zero and the pumping time constant is 20 minutes

REQUIRED STEP TO GO FORWARD

- **SINCE THE MOTION OF GAS / PARTICLES IS COMPLEX TO DEFINE IN THE GEOMETRY OF THE SYSTEM DUE TO LOCALISATION OF SOURCE POINTS, CONCEPTS OF "FLOW" AND "CONDUCTANCE" ARE DIFFICULT, IF NOT IMPOSSIBLE.**

- THE LARGER TRANSPORT OF HELIUM CAN ONLY BE
- EXPLAINED BY ROLES OF INTER-MOLECULAR AND
- MOLECULE – WALL COLLISIONS.

- A FIINITE-ELEMENT APPROACH WOULD PAVE THE WAY FOR BETTER UNDERSTANDING AND PREDICTABILITY.

CONCLUDING REMARKS

- **USE OF NON-TRACER GAS PULSES CAN IMPROVE HELIUM TRANSPORT TO LEAK DETECTOR**
- SUCH A SCHEME WOULD INCREASE THE SENSTIVITY OF DETECTION OF HELIUM IN THE SYSTEM AS WELL AS REDUCE THE RESPONSE TIME OF HELIUM DETECTION.
- FROM THE OBSERVED MAGNITUDE AND NATURE OF HELIUM RESPONSE TO INJECTION OF NON-TRACER GAS PULSES, IT MAY BE POSSIBLE TO ESTIMATE THE HELIUM LEAK RATE IN LARGE SYSTEMS.