Vacuum Experiment: Week 2

AP 4018
Columbia University

Week 2 Objectives

- Learn *more* about vacuum technology, instrumentation, and terminology
- Measure the pumping speed of the turbomolecular pump

Introductory Reading

- Please see class homepage at: http://sites.apam.columbia.edu/courses/ap4018y/ and
- Read background information about vacuum science and technology

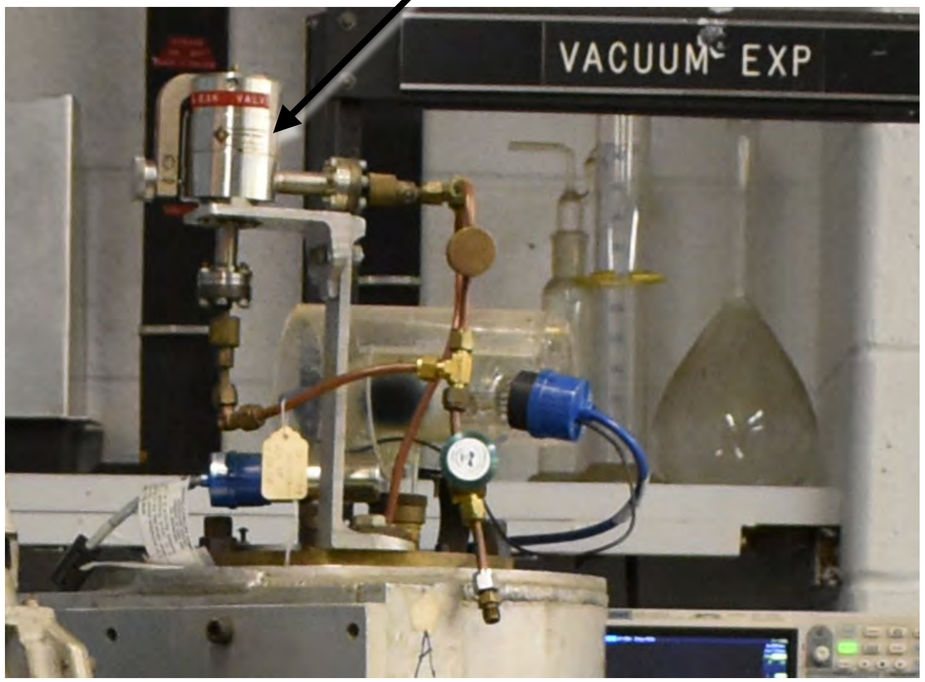
Very Good Introduction…

http://sites.apam.columbia.edu/courses/ap4018y/UHV_Seminar_Handbook.pdf

Overview of Week 2

- Adjust a controlled leak, Q_{leak}
- Wait for the pressure to become steady, measure the pressure when the pumping rate exactly balances the leak rate.
- “Quickly” close the gate value to the turbo pump, and allow the pressure to increase in the chamber. *This will be a linear increase.*
- Use the linear pressure increase to determine Q_{leak} and determine the pumping speed, S, of the turbo pump.
- Evaluate the pumping speed for difference gases and equilibrium pressures.

Precision Leak Valve



Ionization Gauge (and Controller)

Read more online how ionization gauges work.

Pressure indication:

$P_i = 10^{(V-11)}$ Torr or mbar

where V is controller output in Volts

Ionization Gauge Readings must be Corrected for Different Gas…

Table 4-2 *Scale Factors for Use with Ionization Gauges.*

(Do not use these scale factors for *CONVECTRON* Gauges)

Gas	Scale Factor	Gas	Scale Factor
He	5.56	H_20	8.93×10^{-1}
Ne	3.33	NO	8.62×10^{-1}
D_2	2.86	Ar	7.75×10^{-1}
H_2	2.17	CO_2	7.04×10^{-1}
N_2	1.00	Kr	5.15×10^{-1}
Air	1.00	SF	4.00×10^{-1}
O_2	9.90×10^{-1}	Xe	3.48×10^{-1}
CO	9.52×10^{-1}	Hg	2.75×10^{-1}

If the Stabil-Ion Gauge calibration is for a gas type other than N_2 (or air), we suggest placing a label near the first line of the display indicating the gas type or types used for calibration to prevent mix-ups.

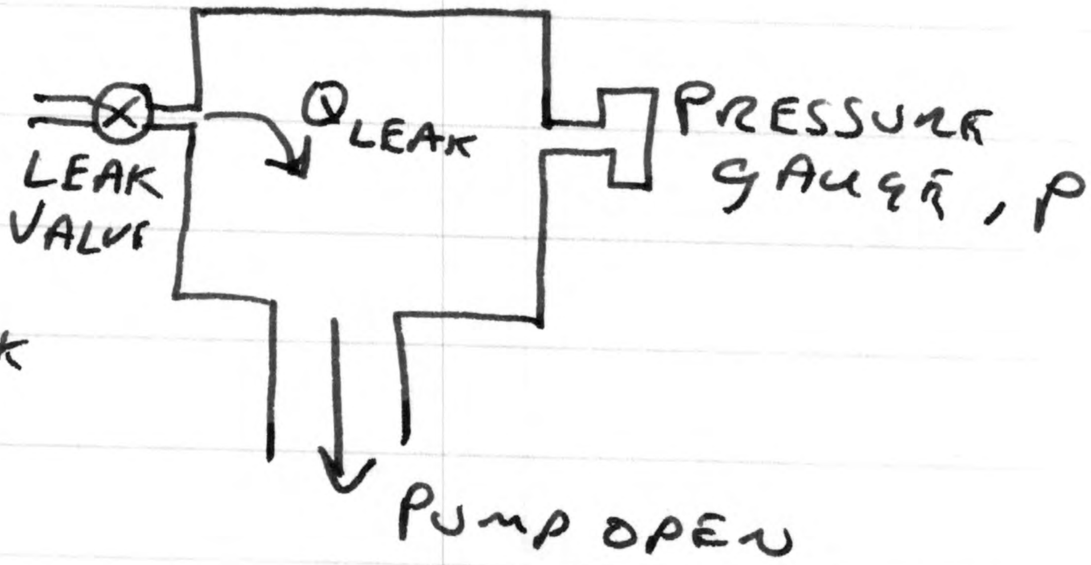
(Why?)

Procedure: Step 1

STEP #1 ADJUST LEAK VALVE TO A PARTICULAR EQUILIBRIUM PRESSURE.

$$V\frac{dP}{dt} \approx 0 \approx -SP + Q_{LEAK}$$

$$\therefore \quad S \equiv \frac{Q_{LEAK}}{P_{EQUILIBRIUM}}$$

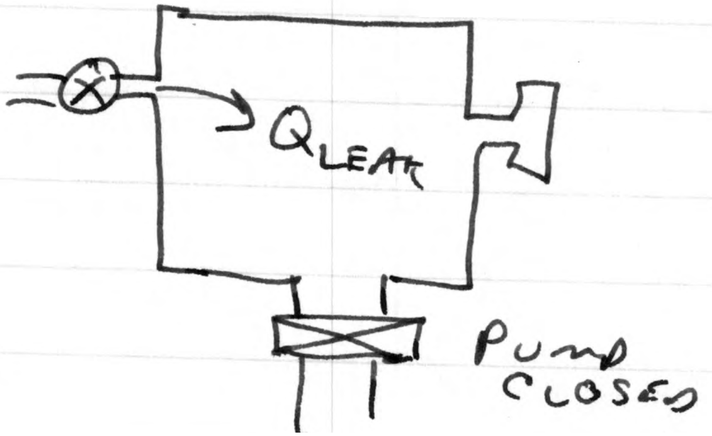


Procedure: Step 2

STEP #2

CLOSE PUMP GATE VALVE. MEASURE LINEAR RATE OF CHANGE OF PRESSURE. (BE SURE TO USE EITHER IONIZATION GAUGE OF CONVECTION GAUGE BUT NOT BOTH FOR A SINGLE CONDITION)

$$V \frac{dP}{dt} = Q_{LEAK}$$



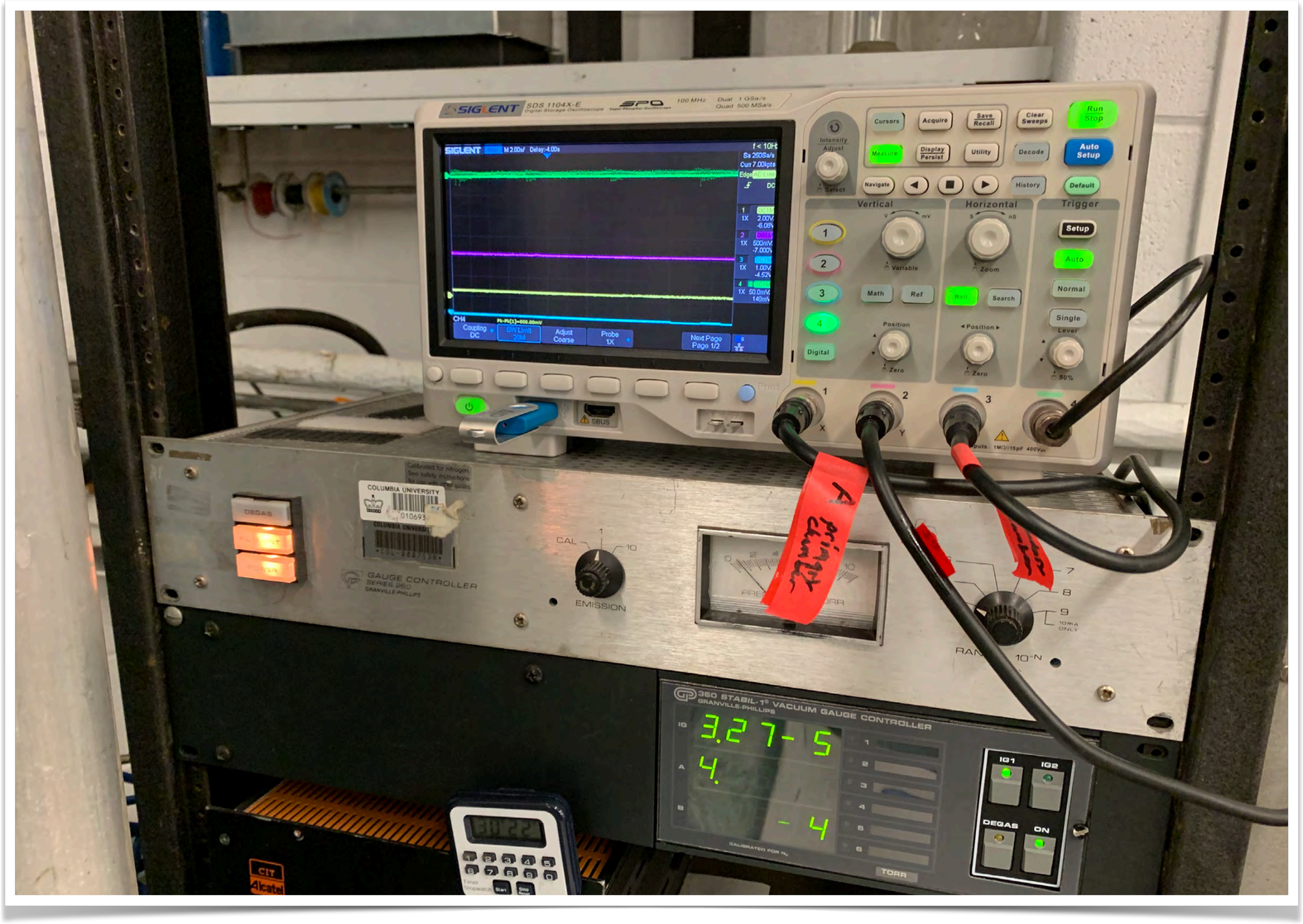
MEASURE Q_{LEAK}.
CALCULATE S

Procedure: Step 3

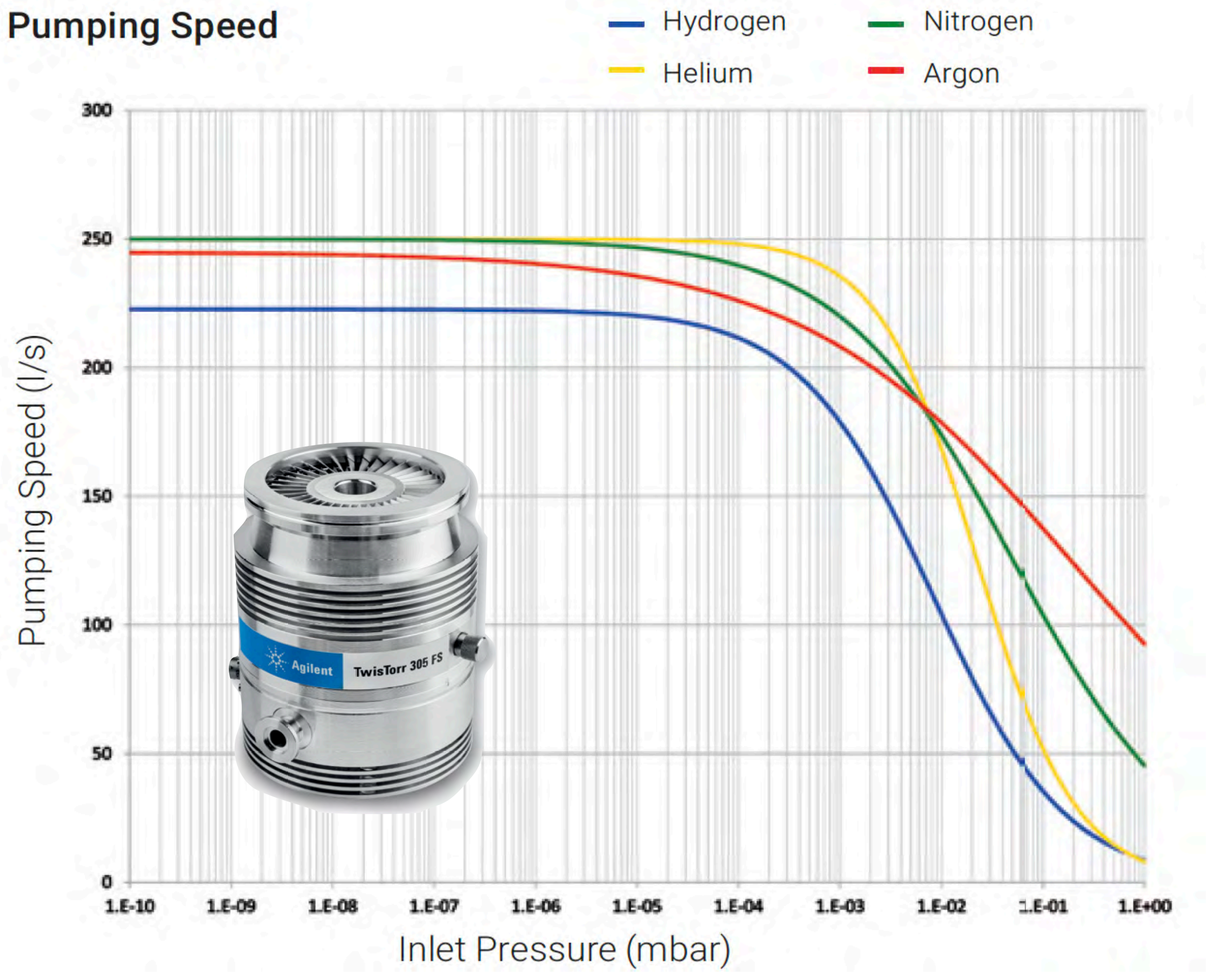
Repeat for different gas and different equilibrium pressure.

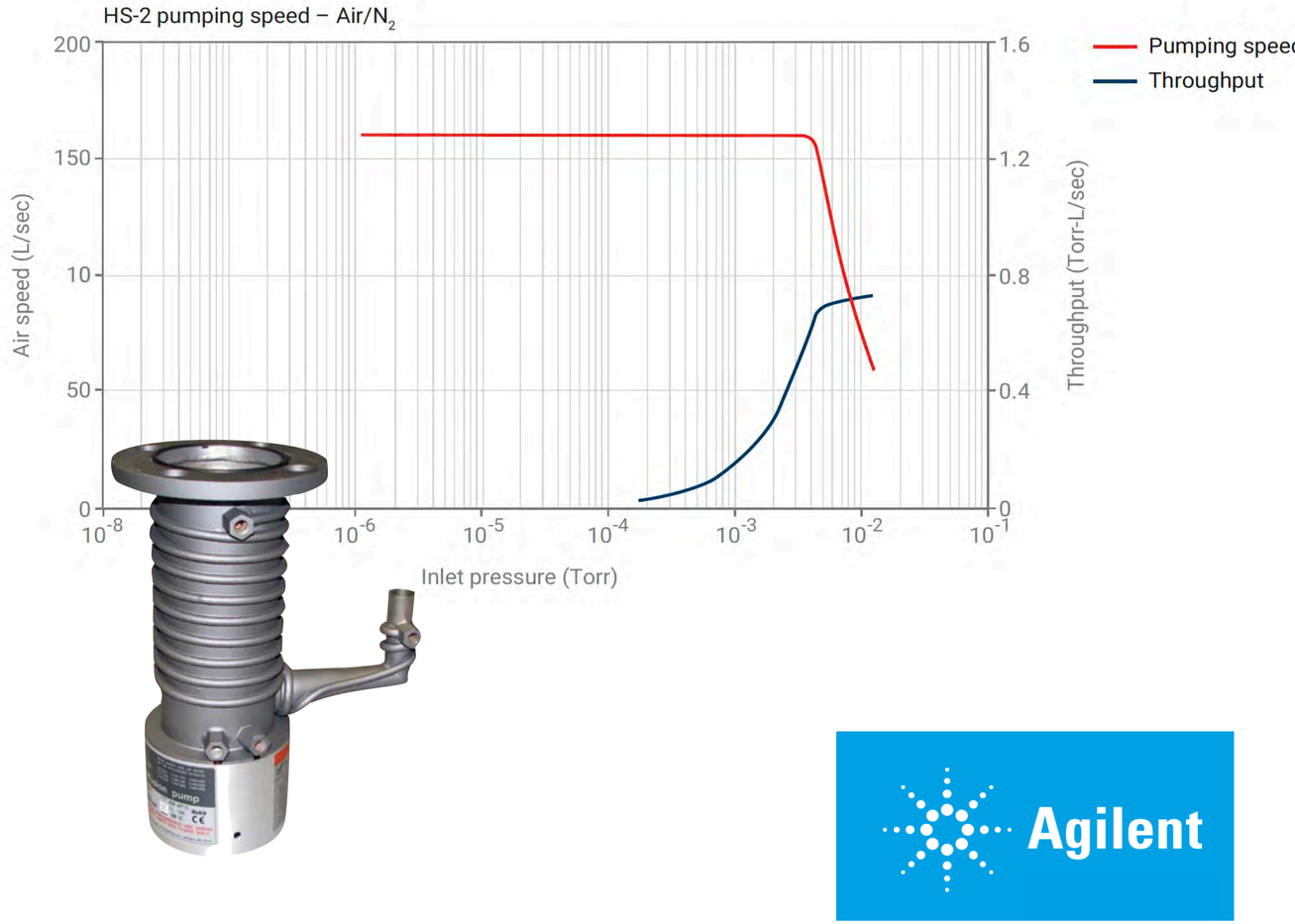
Components of Your Vacuum System

- Oscilliscope can measure up to four signals simultaneously
- For Week #2, we record two:
  - Convectron Analog Output
  - Ionization Gauge Analog Output



Examples Available Today





https://www.agilent.com/en/product/vacuum-technologies/turbo-pumps-controllers/turbo-pumps

https://www.agilent.com/en/product/vacuum-technologies/diffusion-pumps/small-diffusion-pumps