



Playing Error Whack -A- Mole: Lessons Drawn Operating the Auto GC

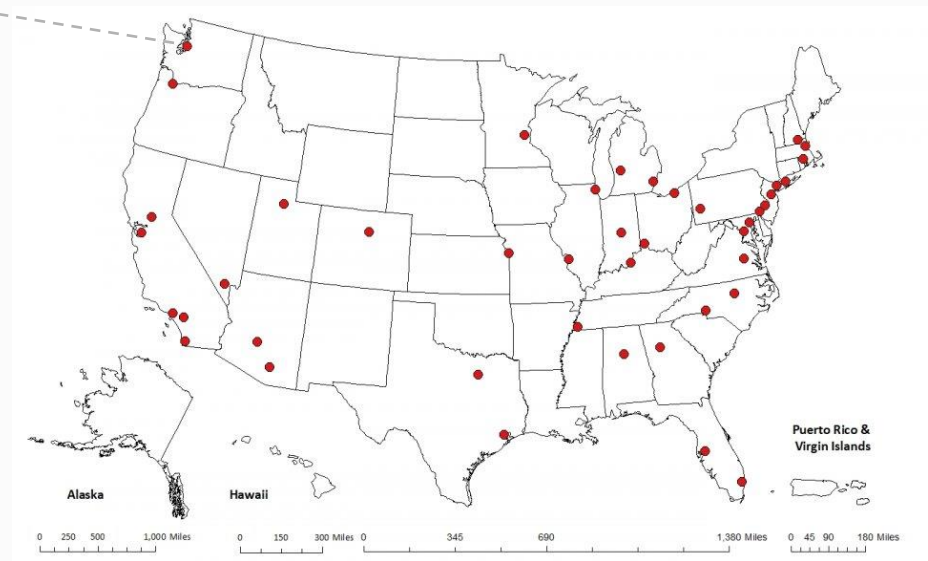
Juan (Jenny) Li

August 14, 2024

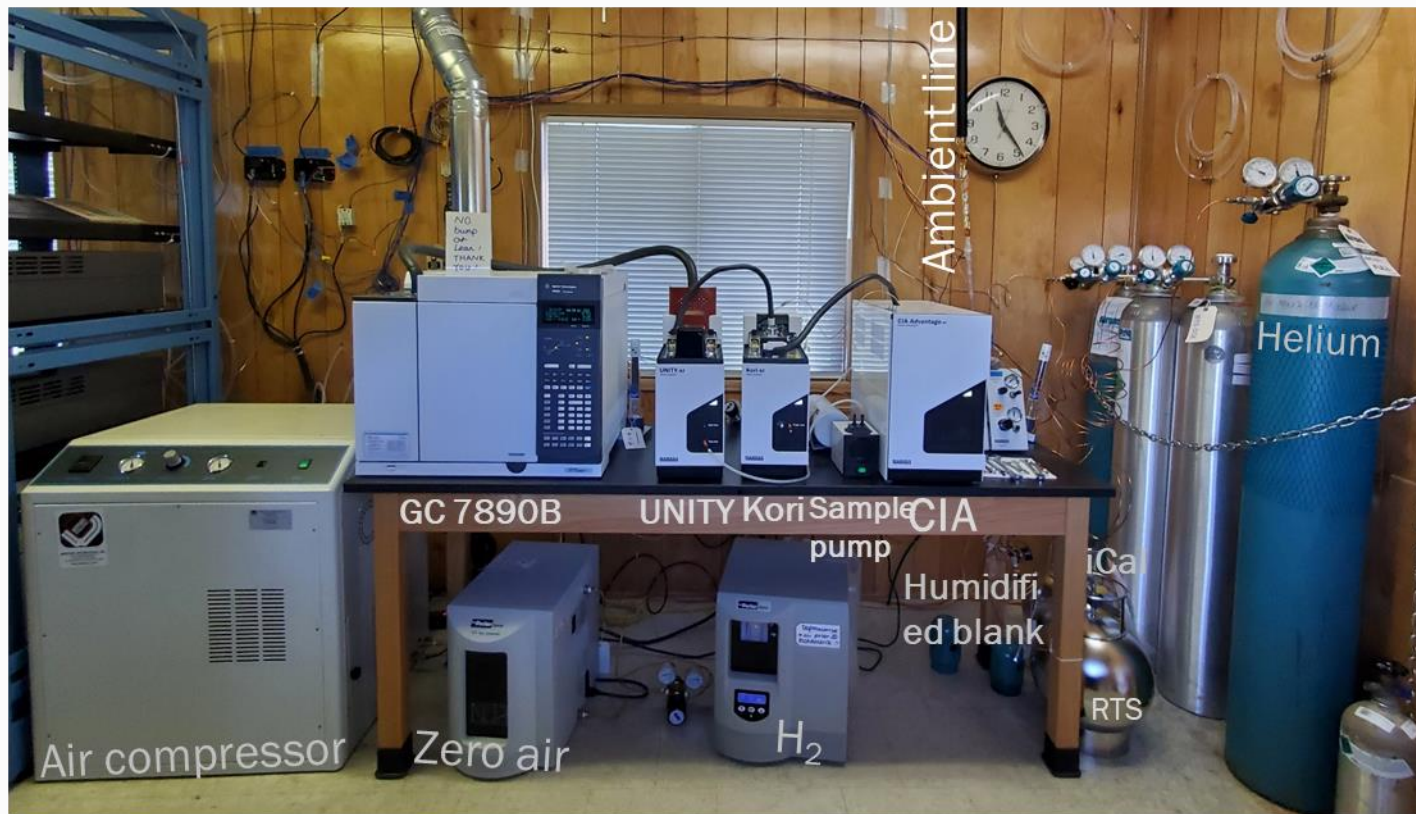
Outline

- Background
 - PAMS site in Seattle, WA
 - Auto GC – Markes/Agilent system
 - Chart of errors
- 3 Troubleshooting cases
 - No flow error
 - Leak
 - Failure calibrations
- Principles of Auto GC troubleshooting

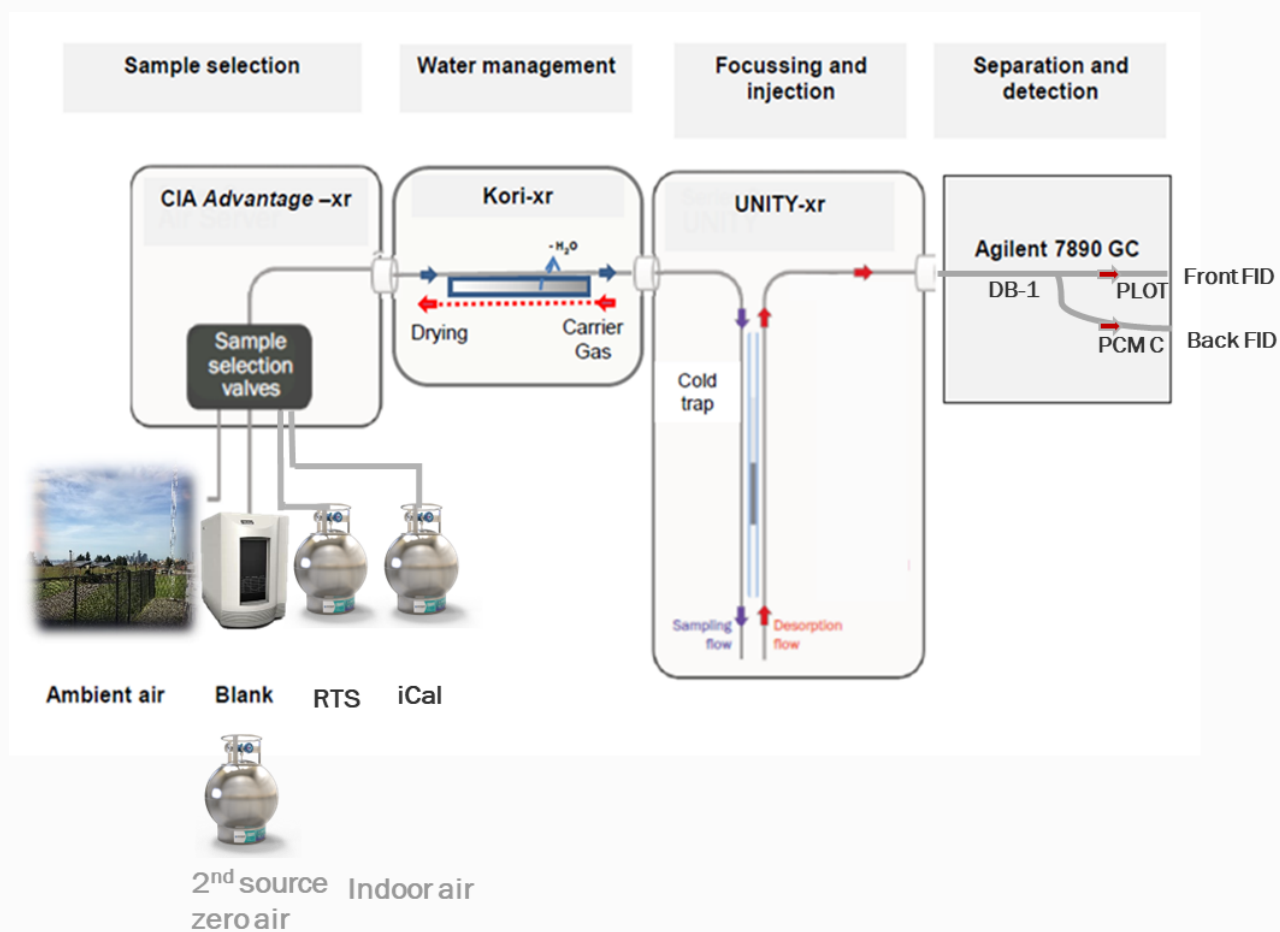
The PAMS site in Seattle, WA



Automated Gas Chromatograph (Auto GC) Markes/Agilent



Automated Gas Chromatograph (Auto GC)



Errors!

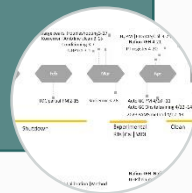
- No flow error
- Leak test (high) error
- No peak within chromatograms
- CIA offline
- UNITY heated valve leak
- Kori heated valve leak
- CIA IS leak
- Kori not heating

2022



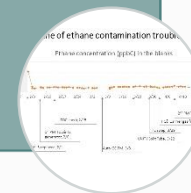
- Kori not heating
- Extreme unknown peaks
- Noise blanks
- CIA port leak
- Helium shortage

2023

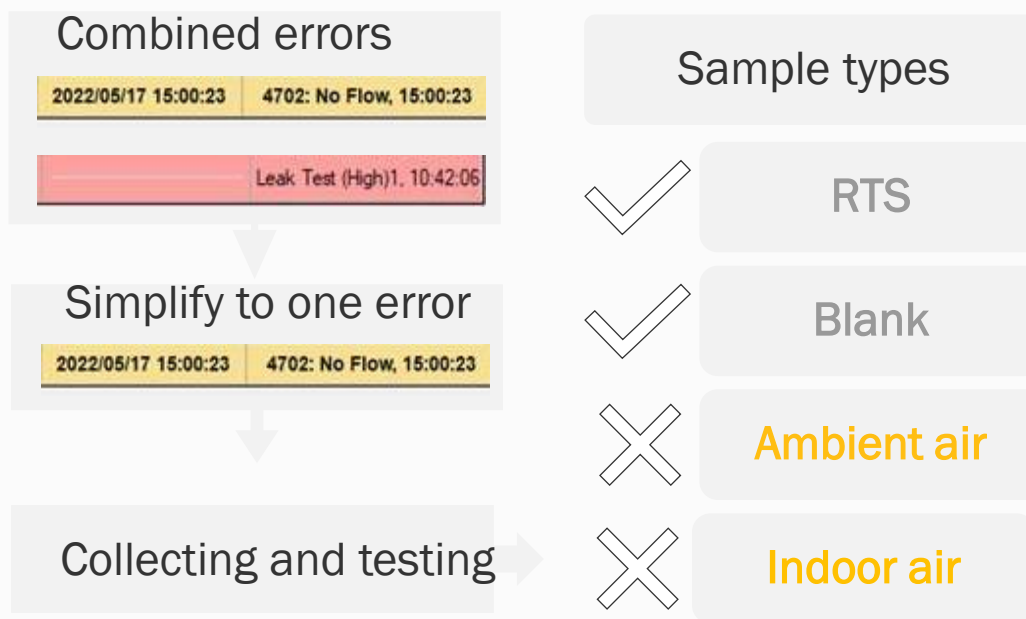


- Kori heated valve leak
- CIA IS leak
- Contaminated helium carrier gas
- Calibration failures
- Extreme high unknown peaks

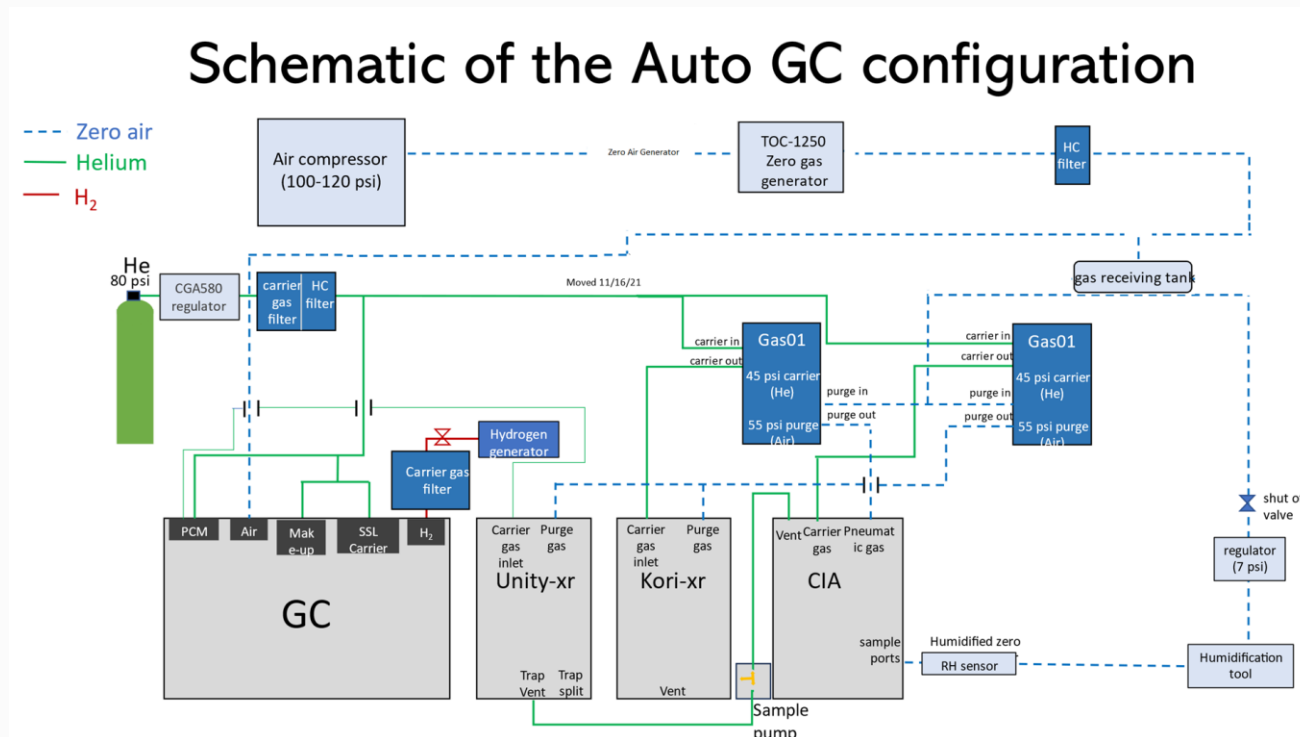
2024



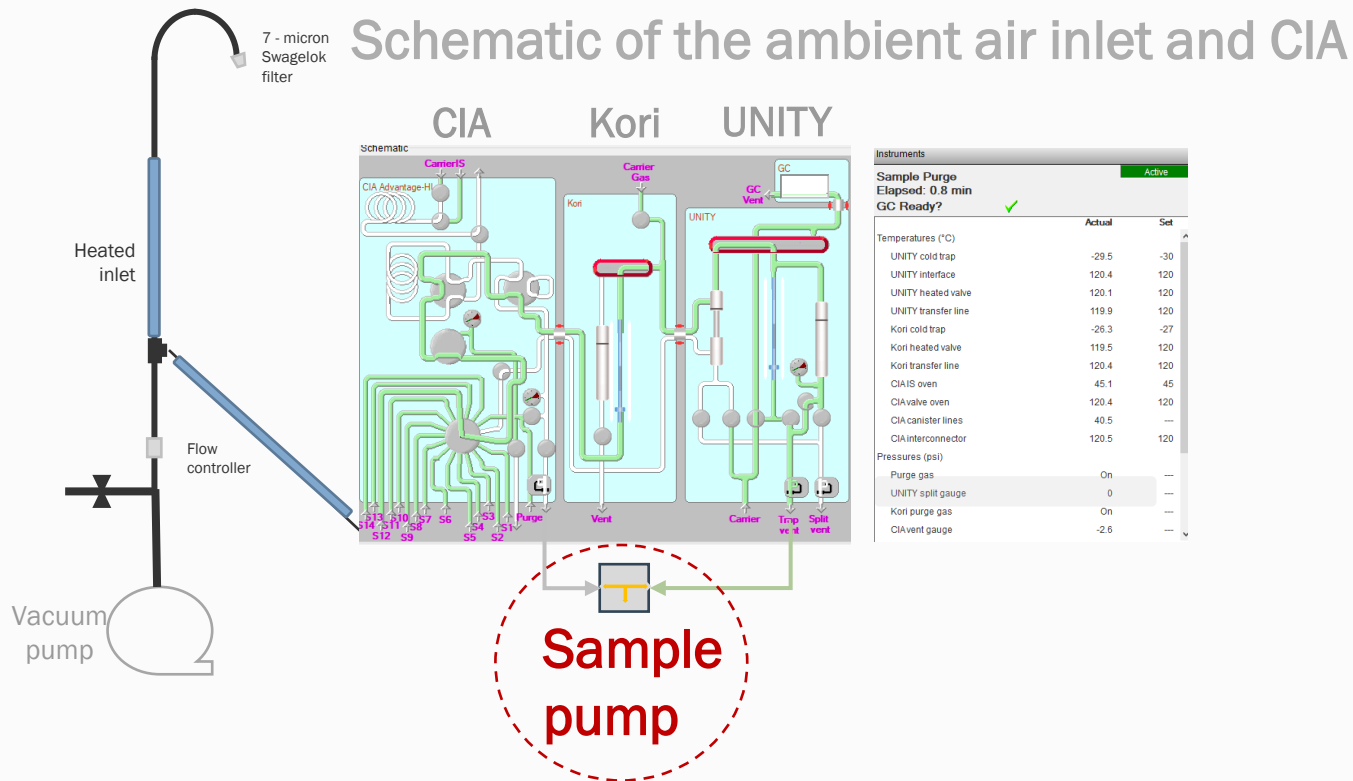
Troubleshooting case 1 - No flow error



Troubleshooting case 1 - No flow error



Troubleshooting case 1 - No flow error



Troubleshooting case 2 - leak

What a He leak incident looks like

He leak incidents

1. In August 2022, >2/3 tank He consumed ~ 10 days;
2. In 2024 New Year, 1500 psi He gone in a week

Troubleshooting philosophy specific to the Auto GC

Good understanding of expected instrument behavior

One thing at a time

Troubleshooting case 2 -Leak approaches

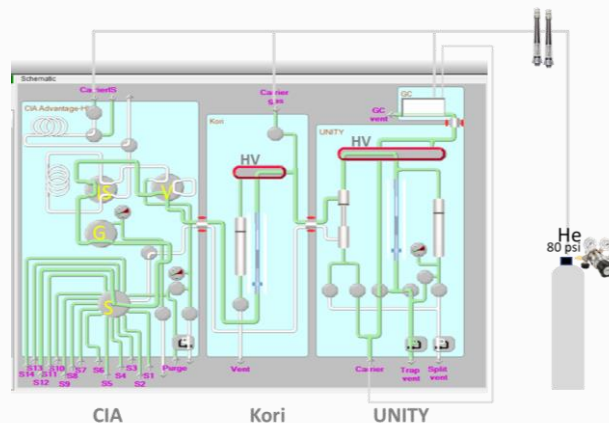
- Using MIC for CIA, Kori and UNITY
 - Leak → pressure drop < 7.5% in 45 s
- Leak detector
- Helium gauges,
 - Good indicator !

NO Snoop®!

Troubleshooting case 2- leak

What is a normal range of helium use?

Schematic of helium carrier gas line



In theory, daily He use

$$= \frac{3978 \frac{\text{ml}}{\text{run}} * 24 \text{ run/day} * 14.7 \text{ psi}}{1000 \text{ ml/L} * 48.99 \text{ L}} = 28.6 \text{ psi/day}$$

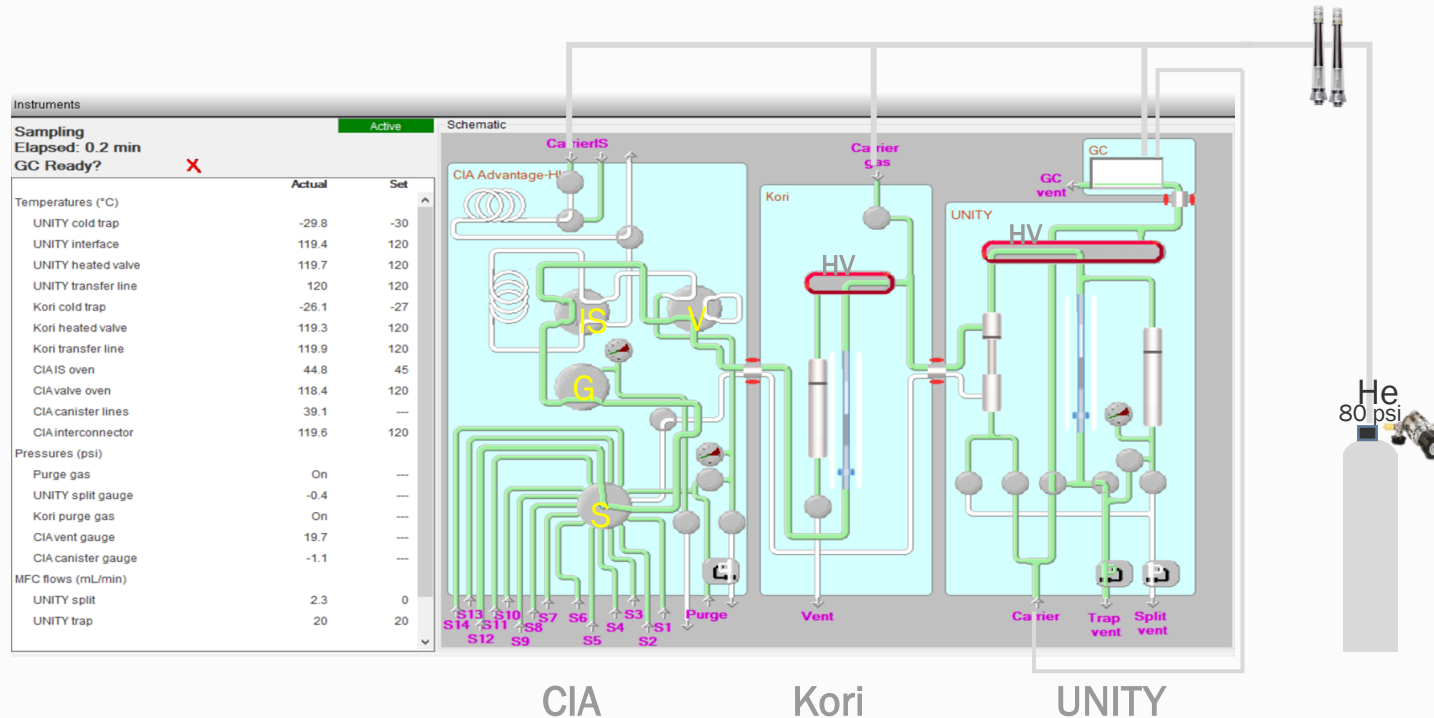
Ideally, a full tank may last about 90 days.

Practically, 70 days per tank is acceptable.

Leak is part of the nature of auto GC.

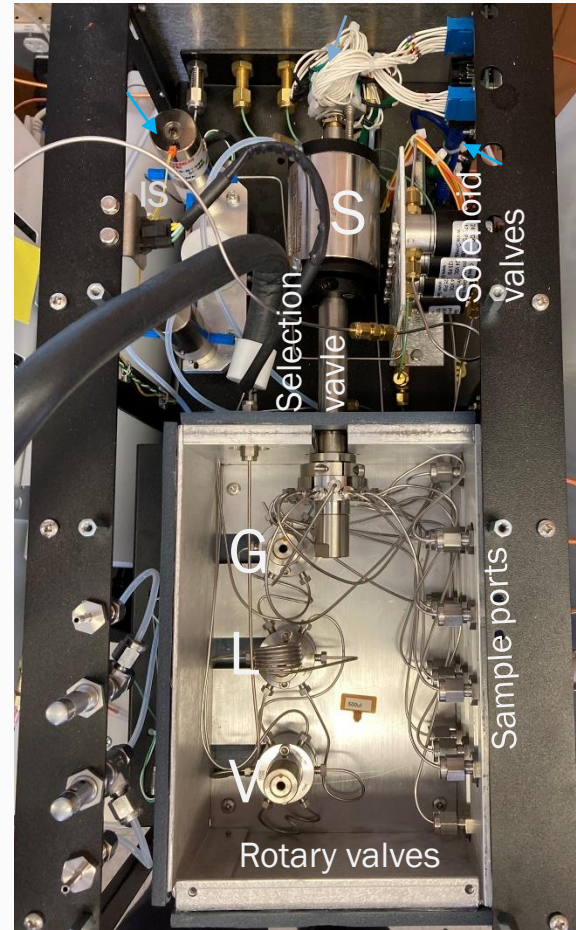
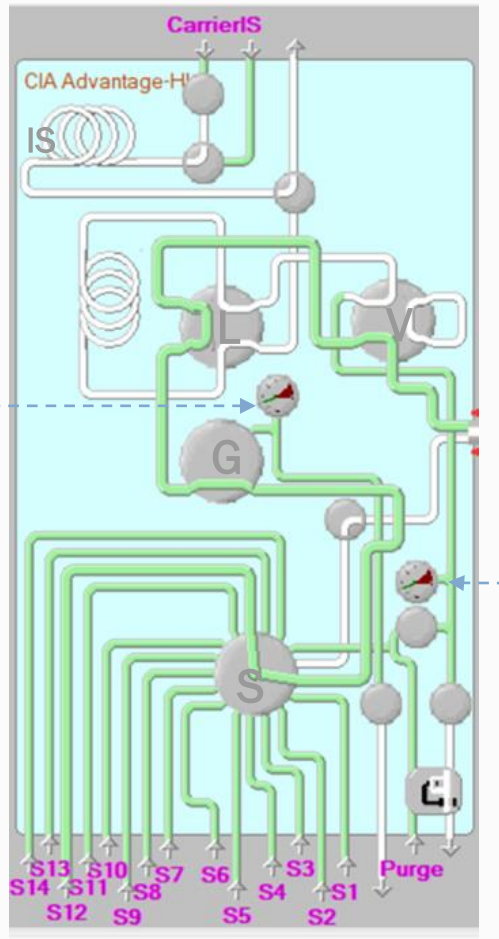
Troubleshooting case 2- leak

What cause the leak?

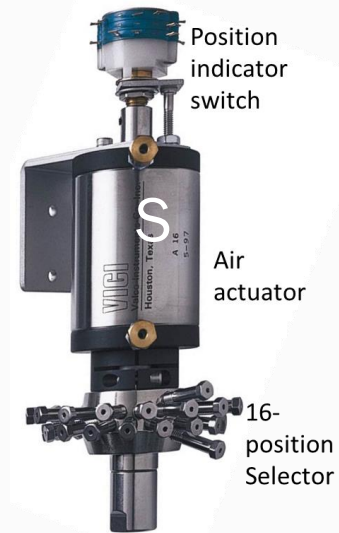


Sample stream flow path and helium carrier gas line

CIA Sample Selection



Core of CIA



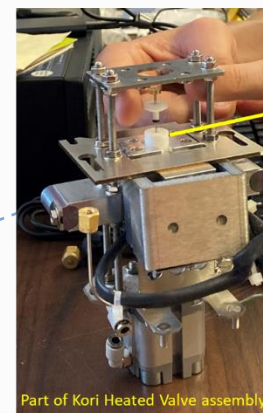
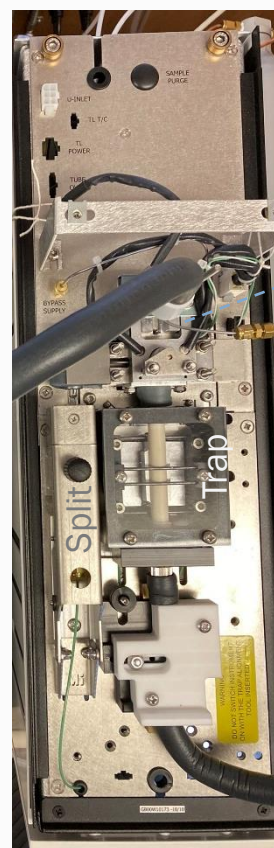
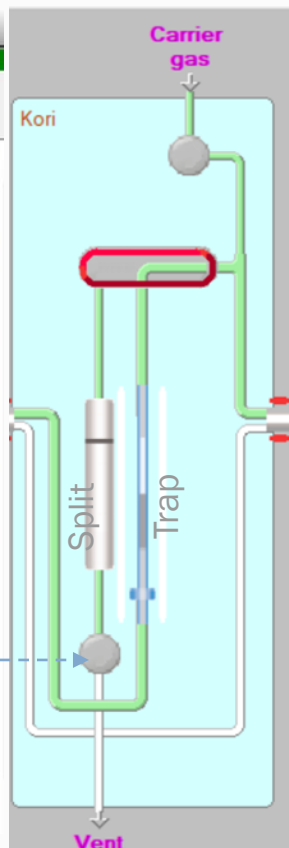
Kori-xr Water management

Instruments

Sampling Elapsed: 0.2 min Active

GC Ready? X

	Actual	Set
Temperatures (°C)		
UNITY cold trap	-29.8	-30
UNITY interface	119.4	120
UNITY heated valve	119.7	120
UNITY transfer line	120	120
Kori cold trap	-26.1	-27
Kori heated valve	119.3	120
Kori transfer line	119.9	120
CIAIS oven	44.8	45
CIAvalve oven	118.4	120
CIA canister lines	39.1	—
CIA interconnector	119.6	120
Pressures (psi)		
Purge gas	On	—
UNITY split gauge	-0.4	—
Kori purge gas	On	—
CIA vent gauge	19.7	—
CIA canister gauge	-1.1	—
MFC flows (mL/min)		
UNITY split	2.3	0
UNITY trap	20	20



Part of Kori Heated Valve assembly



Insert



Pin and O-ring

Core of Kori heated valve

Front inlet total flow rate

Instruments		
Sampling Active		
Elapsed: 10.3 min		
GC Ready? X		
	Actual	Set
Kori heated valve	119.5	120
Kori transfer line	119.5	120
CIAIS oven	45.2	45
CIA valve oven	123.5	120
CIA canister lines	38.5	---
CIA interconnector	120	120
Pressures (psi)		
Purge gas	On	---
UNITY split gauge	-0.4	---
Kori purge gas	On	---
CIA vent gauge	18.5	---
CIA canister gauge	-1.1	---
MFC flows (mL/min)		
UNITY split	2.3	0
UNITY trap	20	20
CIA vent	0.7	0

Select... **Split-Splitless Inlet** Select Liner... Al Dpt

- ALS
- Valves
- Inlets**
- Columns
- Oven
- Detectors
 - FID - Front
 - FID - Back
- Events
- Signals
- Configuration
 - Miscellaneous
 - Columns
 - Modules
 - ALS
- Backflush
- Readiness
- GC Calculators

Actual

Heater: **150 °C** Setp: 150 °

Pressure: **45.6 psi** 37.52

Total Flow: **5.511 mL/min** 26 m

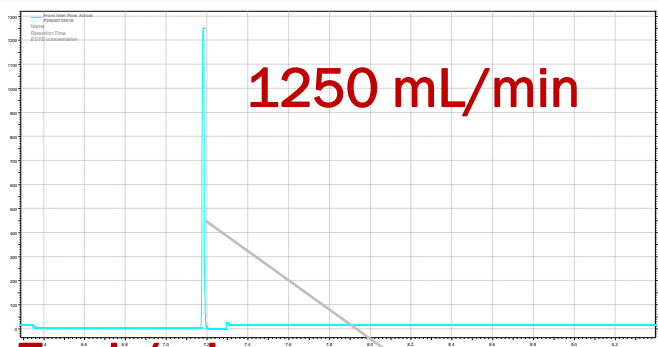
Septum Purge Flow: **3.001 mL/min** 3 mL

Septum Purge Flow Mode: **Standard**

Inlet Mode (Splitless)

Splitless Purge Flow to 20 mL/min

Front inlet actual flow rate

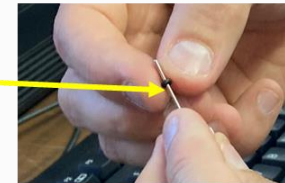
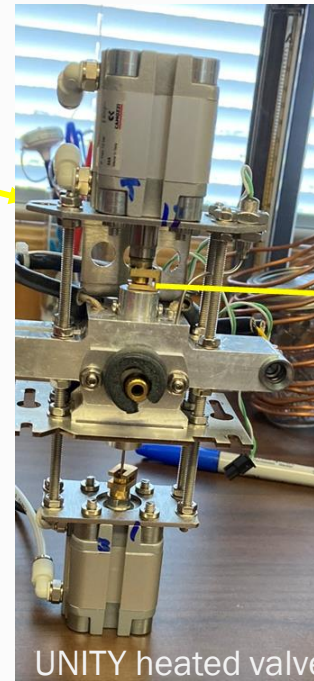
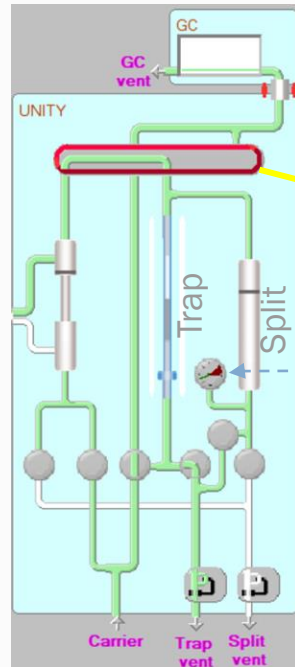


5 mL/min

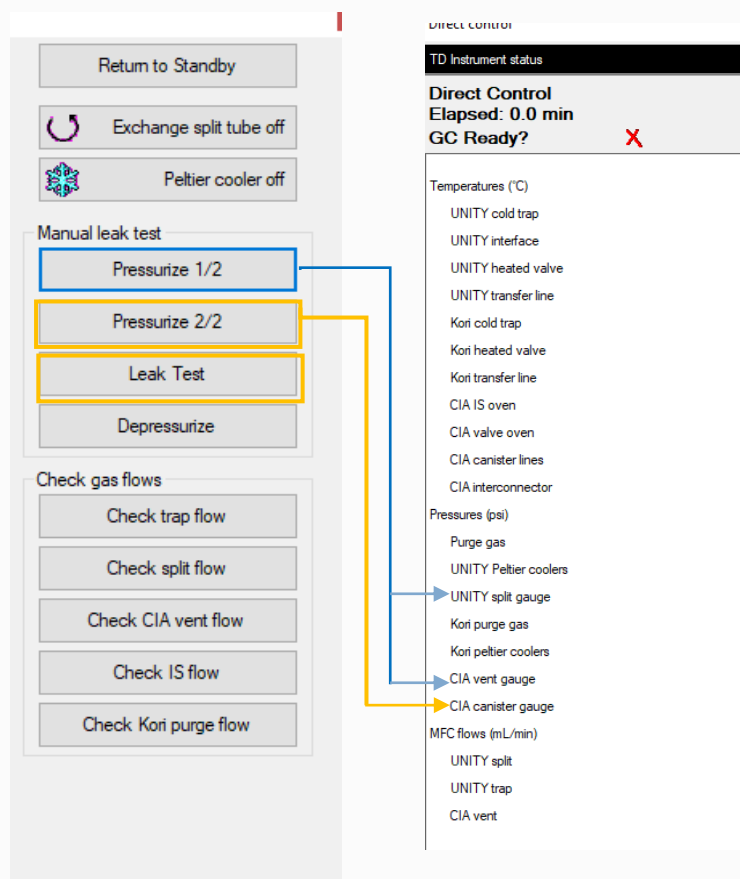
Kori equilibrium to wait for sample start

UNITY-xr Thermal Desorption trap

Instruments		
Sampling Active Elapsed: 0.2 min GC Ready? X		
	Actual	Set
Temperatures (°C)		
UNITY cold trap	-29.8	-30
UNITY interface	119.4	120
UNITY heated valve	119.7	120
UNITY transfer line	120	120
Kori cold trap	-26.1	-27
Kori heated valve	119.3	120
Kori transfer line	119.9	120
CIAIS oven	44.8	45
CIA valve oven	118.4	120
CIA canister lines	39.1	---
CIA interconnector	119.6	120
Pressures (psi)		
Purge gas	On	---
UNITY split gauge	-0.4	---
Kori purge gas	On	---
CIA vent gauge	19.7	---
CIA canister gauge	-1.1	---
MFC flows (mL/min)		
UNITY split	2.3	0
UNITY trap	20	20



Troubleshooting case 2- leak Solutions



1. Incident in August 2022

Replaced O-rings in a carrier gas filter;

Replaced the regulator on the top of helium tank

Tightened a Union and other connections along the helium carrier gas line

Replaced the CIA IS (inter standard) assembly

Replaced the Kori heated valve

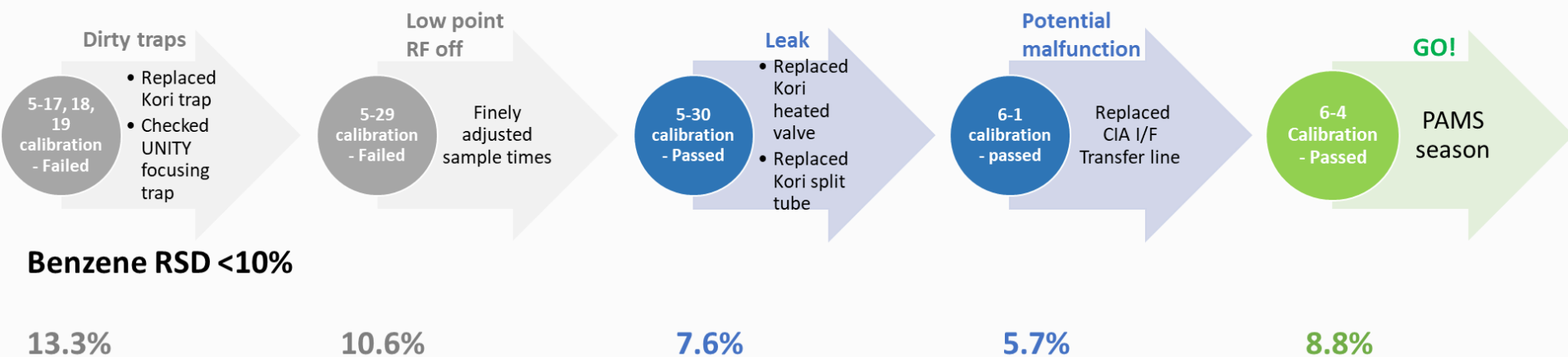
Replaced O-rings in the Kori insert

2. Incident in 2024 New Year

Replaced the Kori heated valve

Replaced CIA IS (Inter standard) assembly

Troubleshooting case 3 - Failure calibration



Kori cold trap (PN:U-T1KORI)



Replaced Kori cold trap

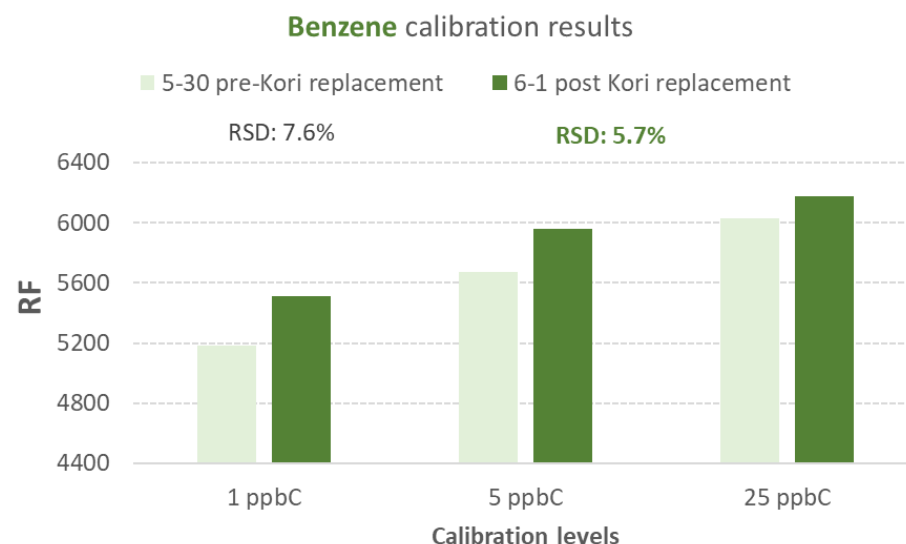
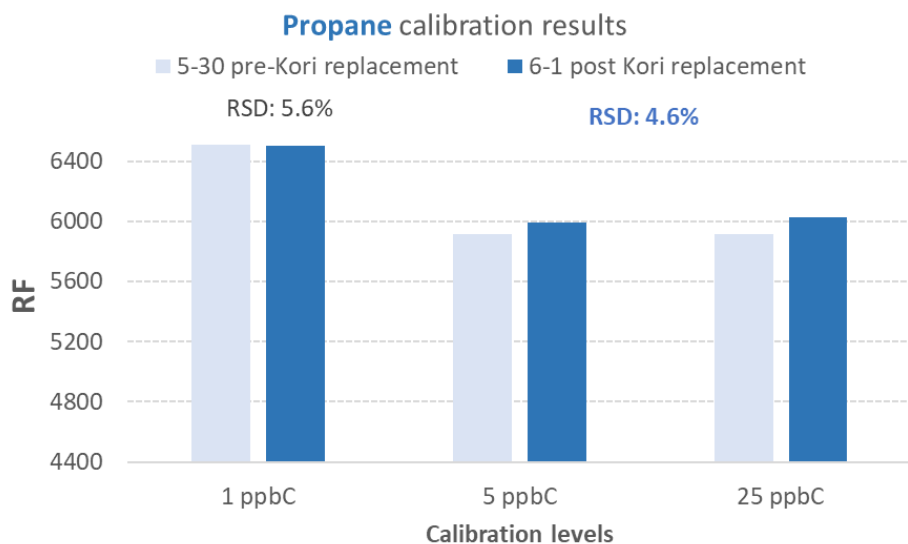
KORI split tube (PN:SERAAA-1600)



Kori heated valve (SERWAD-5002)



Comparison of Propane & Benzene RFs at 3 levels before and after the replacement



After replaced the Kori heated valve and swapped Kori split tube with one filled with charcoal(PN:SERAAA-1600),

- Benzene RFs significantly improve, especially at 1 ppbC level
- Propane RFs at 3 levels remains stable

Benzene is much affected by these traps and tubes

Basic principle of Auto GC troubleshooting

- Be patient
- Know the system
- Focus on one thing at a time
- Document troubleshooting steps
- Ask for help

Acknowledge

- Jonathan Meyer, Amy Plummer and Carol Meyer of Orsat response to each question so swiftly as always.
- Tyson Harrison of Agilent and Matt Bates of Markes based in Germany have provided detailed technical support for these years
- Lara Hrobak with NH DES has walked along with me to operate the system.
- Mitch Howell of ERG is pretty good to keep standards turnaround on time
- All teammates of WA Ecology Air Quality Program





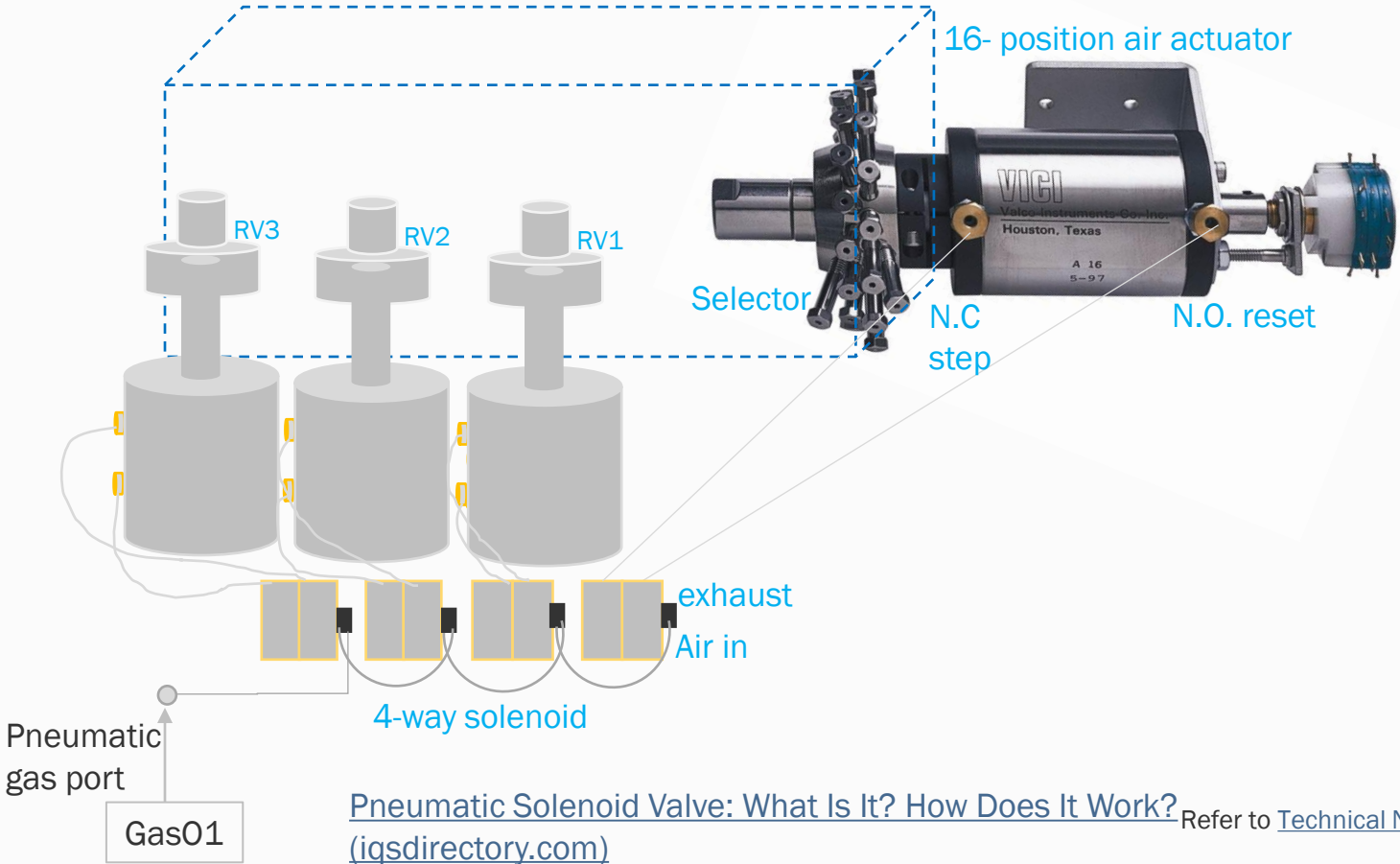
Thank you!

Juan (Jenny) Li

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CIA Pneumatic system

- Regulates:
- 1. 16-position air actuator
 - 2. Rotary valves



[Pneumatic Solenoid Valve: What Is It? How Does It Work?](http://iqsdirectory.com) Refer to [Technical Note 426](#)

