Leak test update

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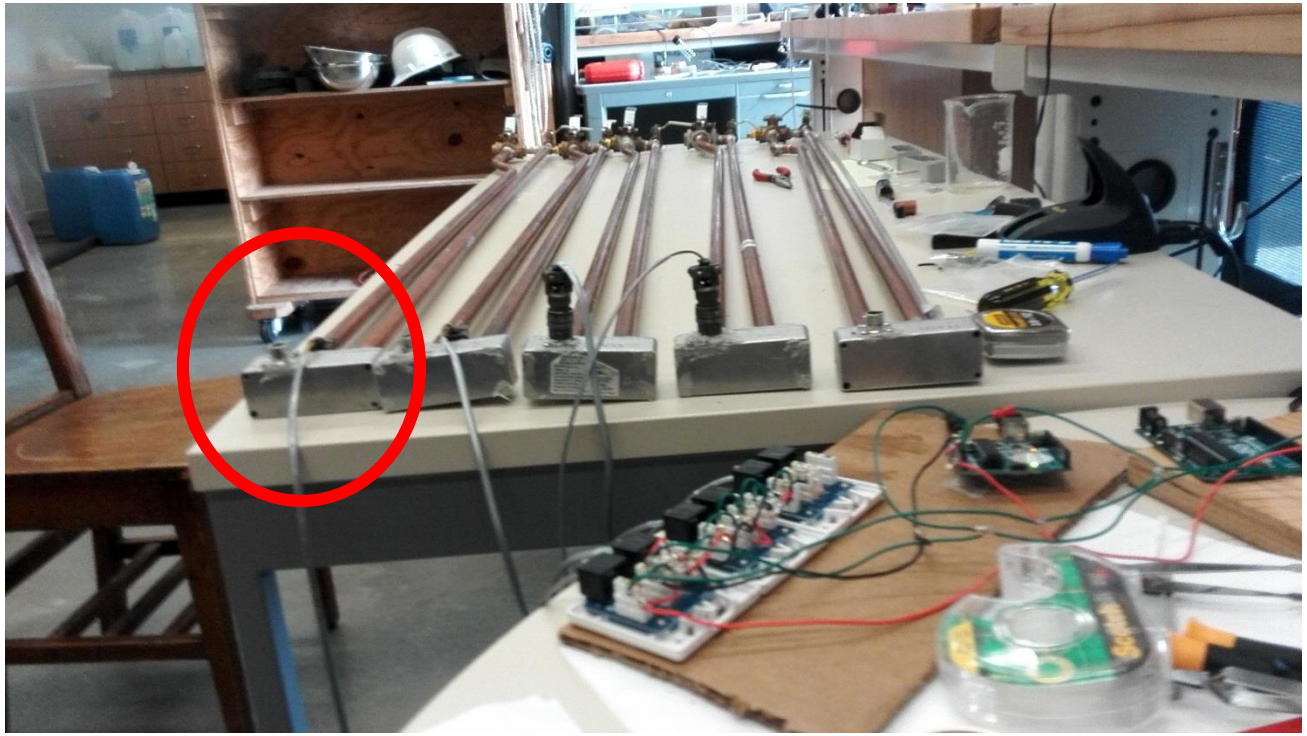
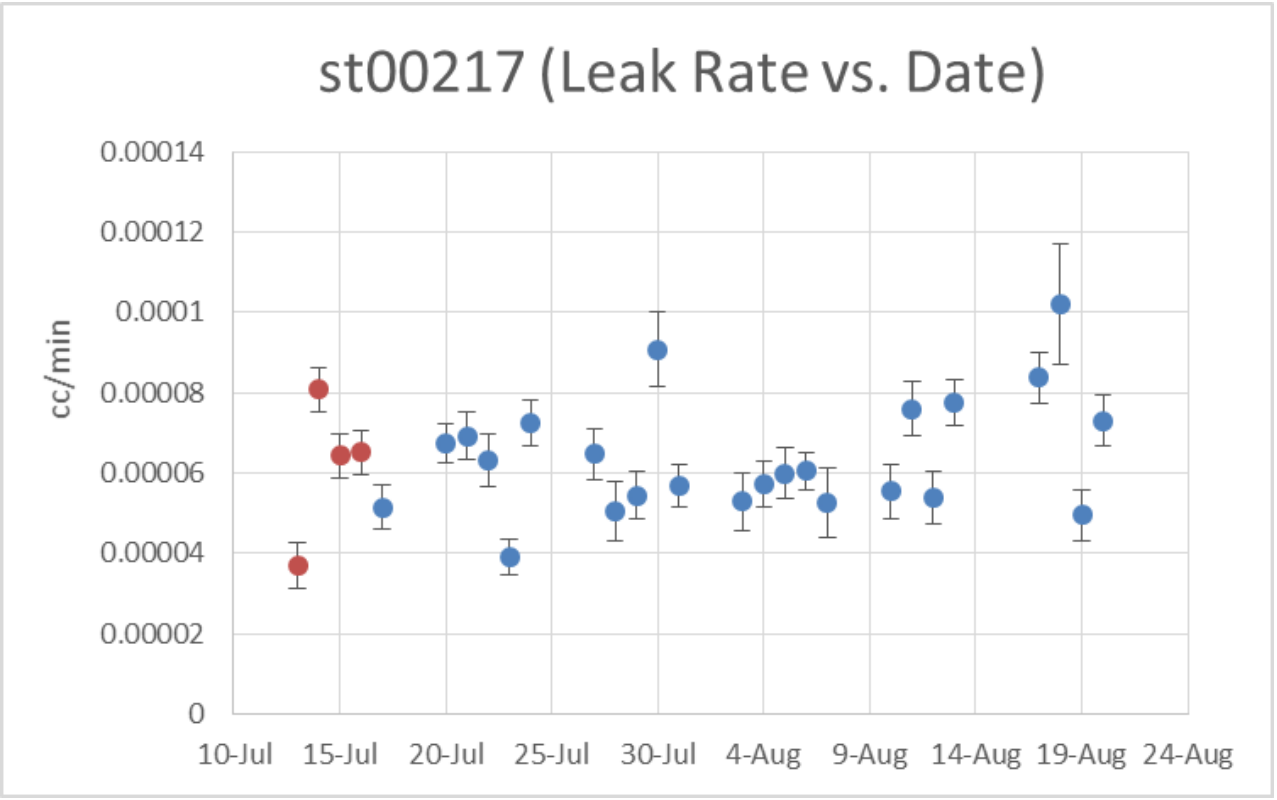
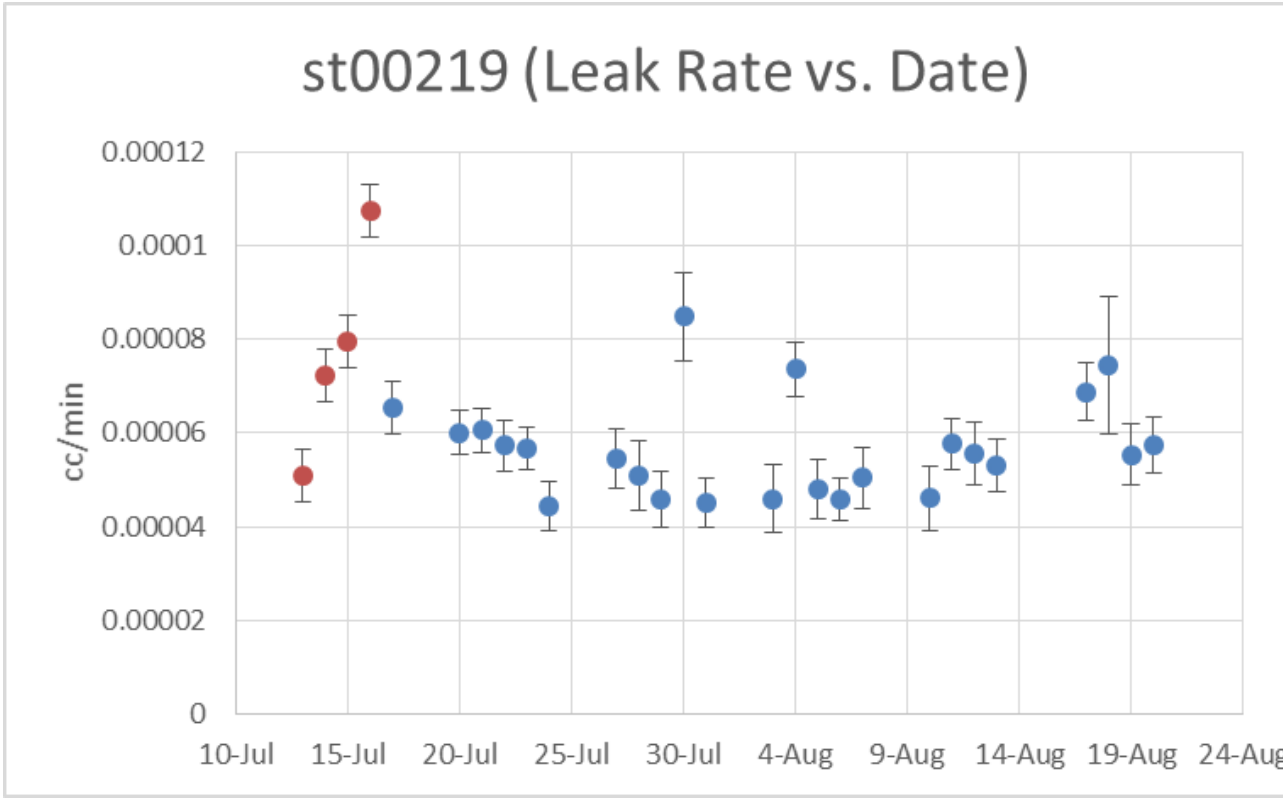
Apparatus update

- Andrew, Hajime, Chen and I built the 5th chamber.
- Background leak is 0.03±0.1 ccm. Excellent leak rate.

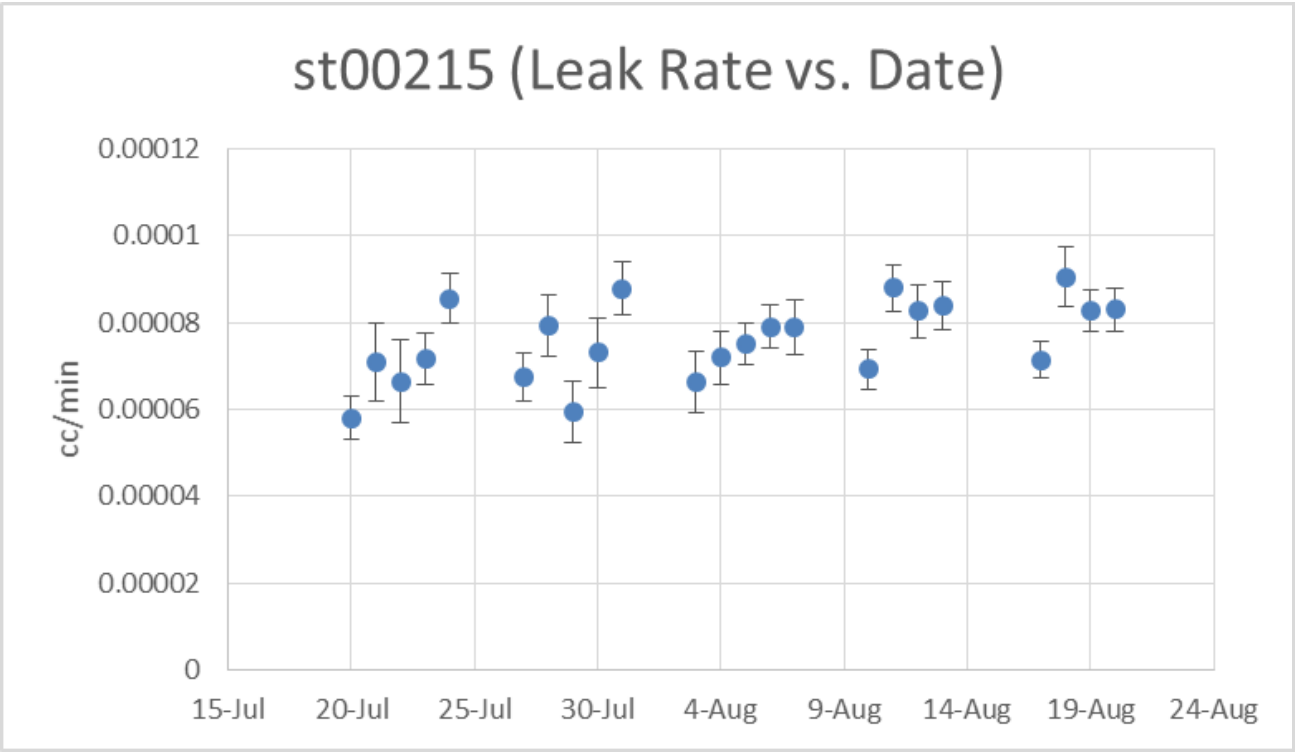


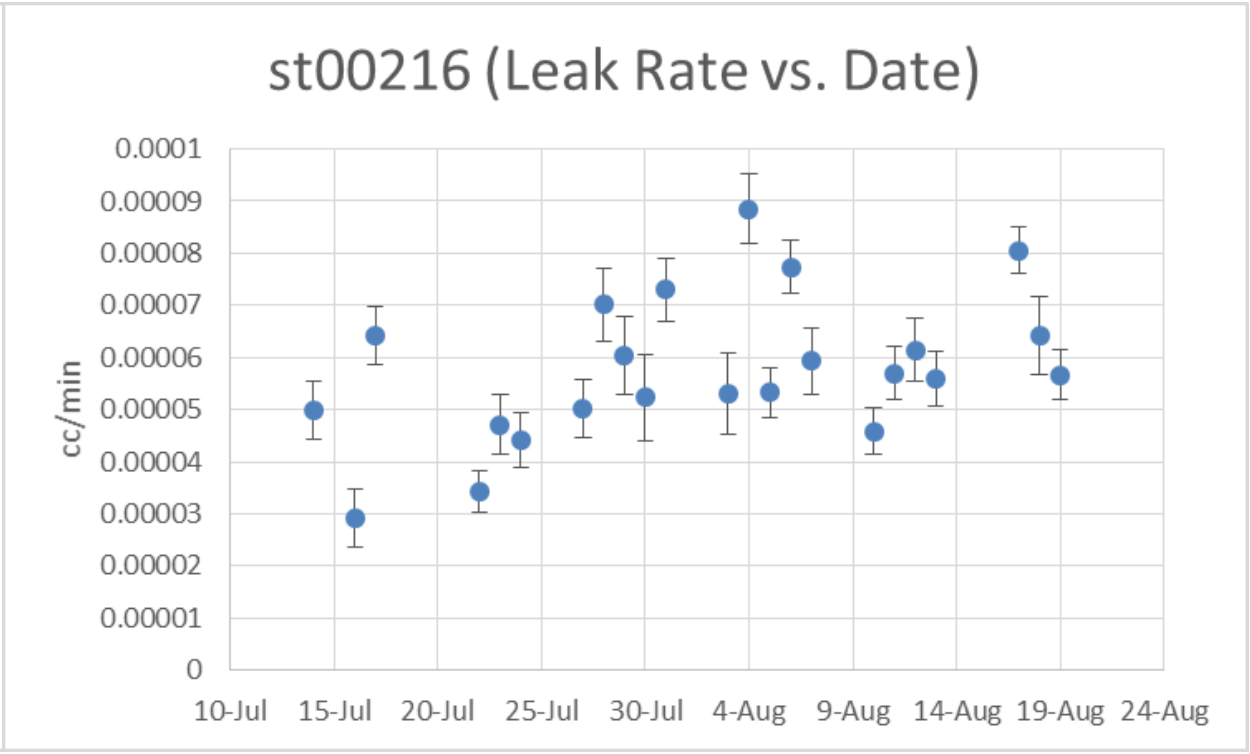
Consistency test (Flush N_2)





Consistency test (replace viton)





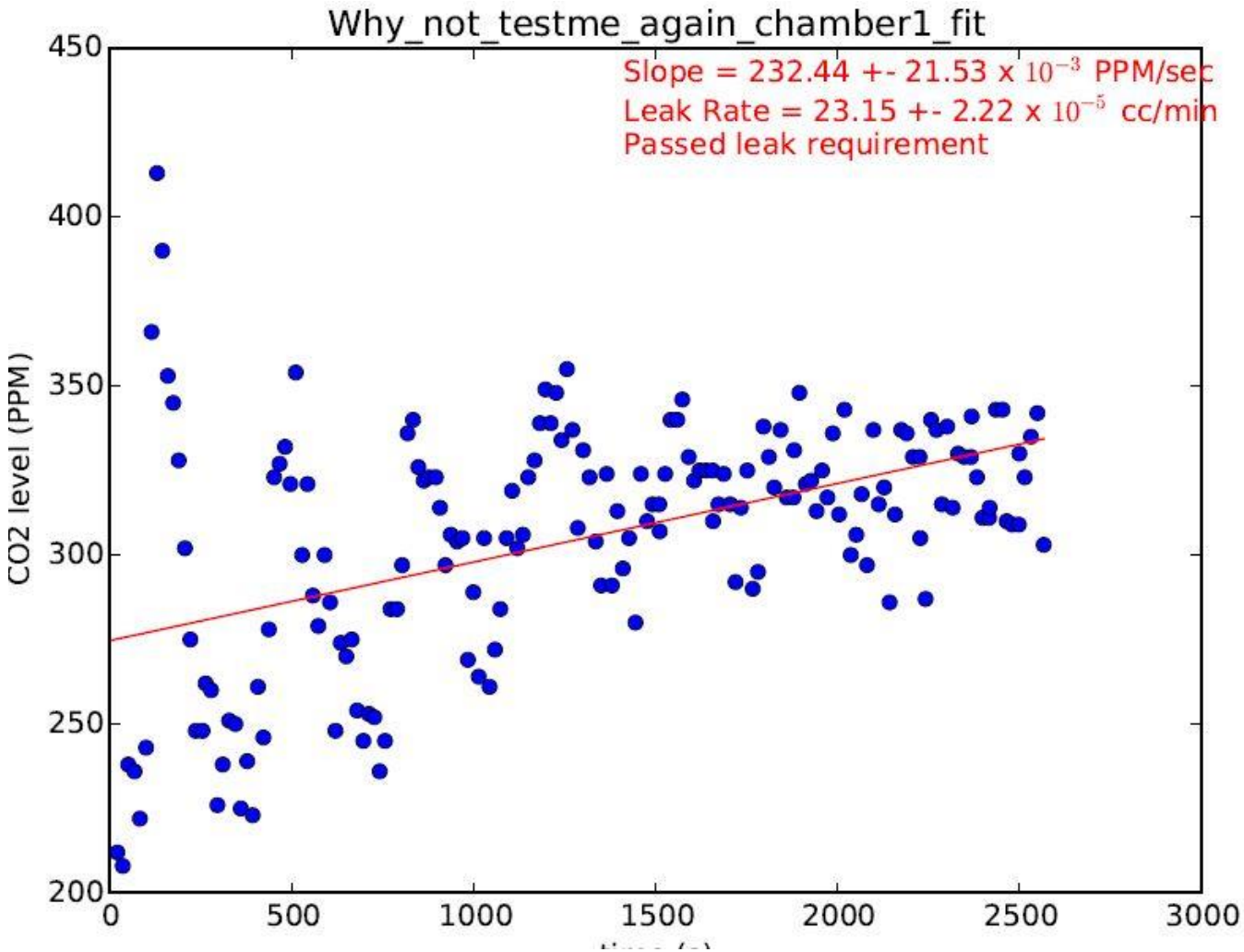
Volume measurement by using water

- Water test has been done on ch#0,1,2,4.
- Test results:

- Geometric1: use the inner diameter I measured
- Geometic2: use the inner diameter on webpage
- Note: water with box volume=water test without box + box estimate(41cc)

Chamber	with(0,1) (cc)	geometric1 (cc)	geometric2 (cc)	water with box	ΔV(water-injection)
#1	382±17	411	471	498±10	116
#2	399±17	407	464	492±10	93
#3	391±18	400	459	485±11	94
#4	422±19	455	484	507±10	85
#0	398±19	413	472	497±12	99

Oscillation occurs again



Kink investigation

- Chen and I think the oscillation after inject CO_2 inside the chamber is damped harmonic oscillator.
- CO_2 was injected between the tube and straw, but not too deep. CO_2 comes out quickly. So there is only a driven force for the oscillator in a relatively short time.
- For the kink, CO_2 has been flushed deep inside the tube. So it may act like a step driven force.
- Driven harmonic oscillator:

$$\frac{\mathrm{d}^2x}{\mathrm{d}t^2} + 2\zeta\omega_0\frac{\mathrm{d}x}{\mathrm{d}t} + \omega_0^2 x = \frac{F(t)}{m}.$$

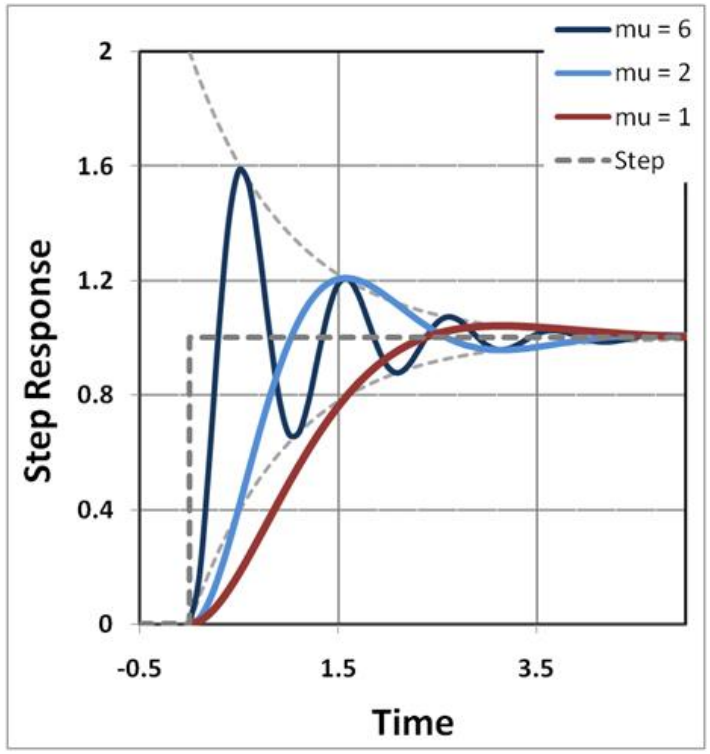
In the case $\zeta < 1$ and a unit step input with $x(0) = 0$:

$$\frac{F(t)}{m} = \begin{cases} \omega_0^2 & t \geq 0 \\ 0 & t < 0 \end{cases}$$

the solution is:

$$x(t) = 1 - \mathrm{e}^{-\zeta\omega_0 t}\frac{\sin\left(\sqrt{1-\zeta^2}\,\omega_0 t + \varphi\right)}{\sin(\varphi)},$$

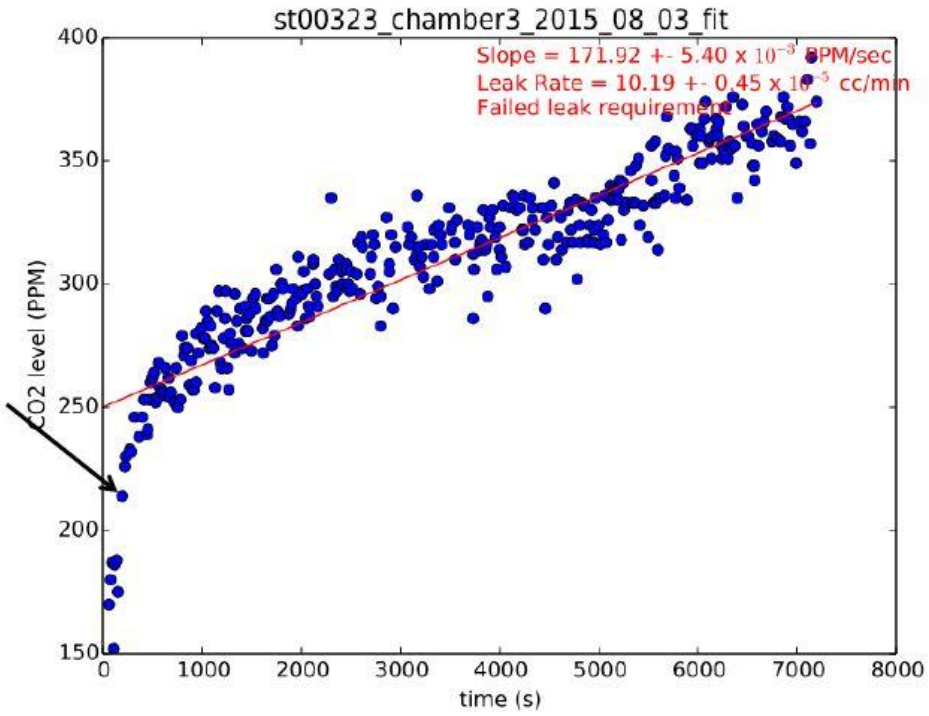
Kink investigation



$\mu = \omega_1 = \omega_0\sqrt{1-\zeta^2}$.

In our case, ω_0 the CO_2 release rate from the tube

This is the most extreme example we've seen...



From Lauren's talk. This is when injected too much CO_2 (ω_0 too large). It is similar to the blue line on the left figure. They had glue issue, so the CO_2 might release for such a long time.

Kink investigation

- Another evidence is the kink happened on ch#2 only once and all the rest is happened on ch#3. ch#3 is the chamber when injected 0.6cc CO_2, it need almost an hour to become steady.
- We suggest flush the tube with N_2 before each measurement although I don't know why there is still kink after flushing.

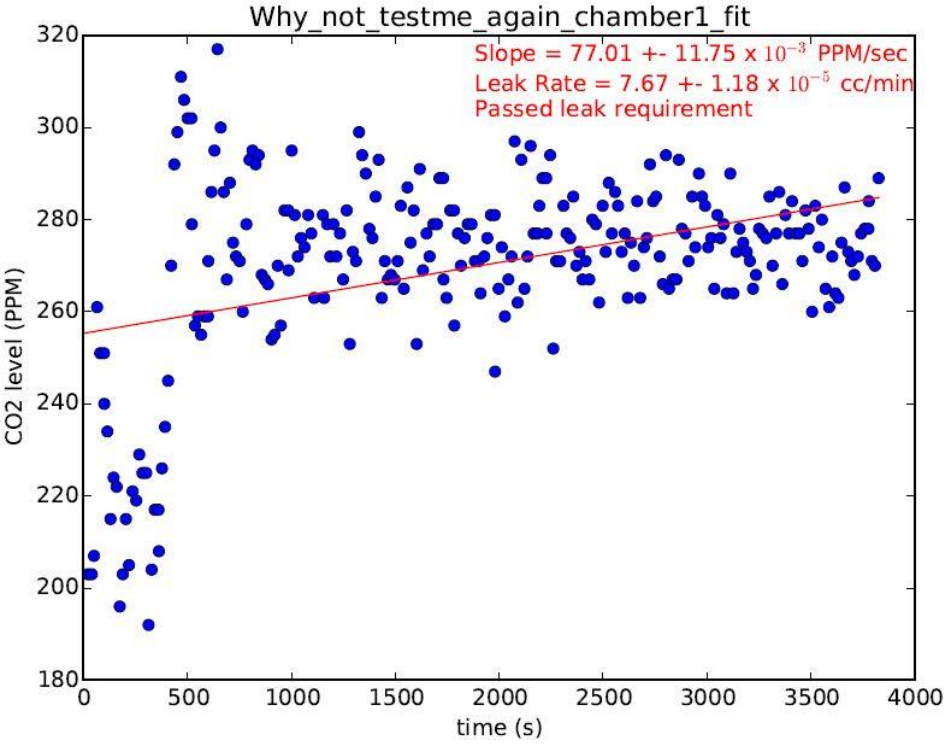


Figure on the left is the cap with hole which Dan suggested to do.