

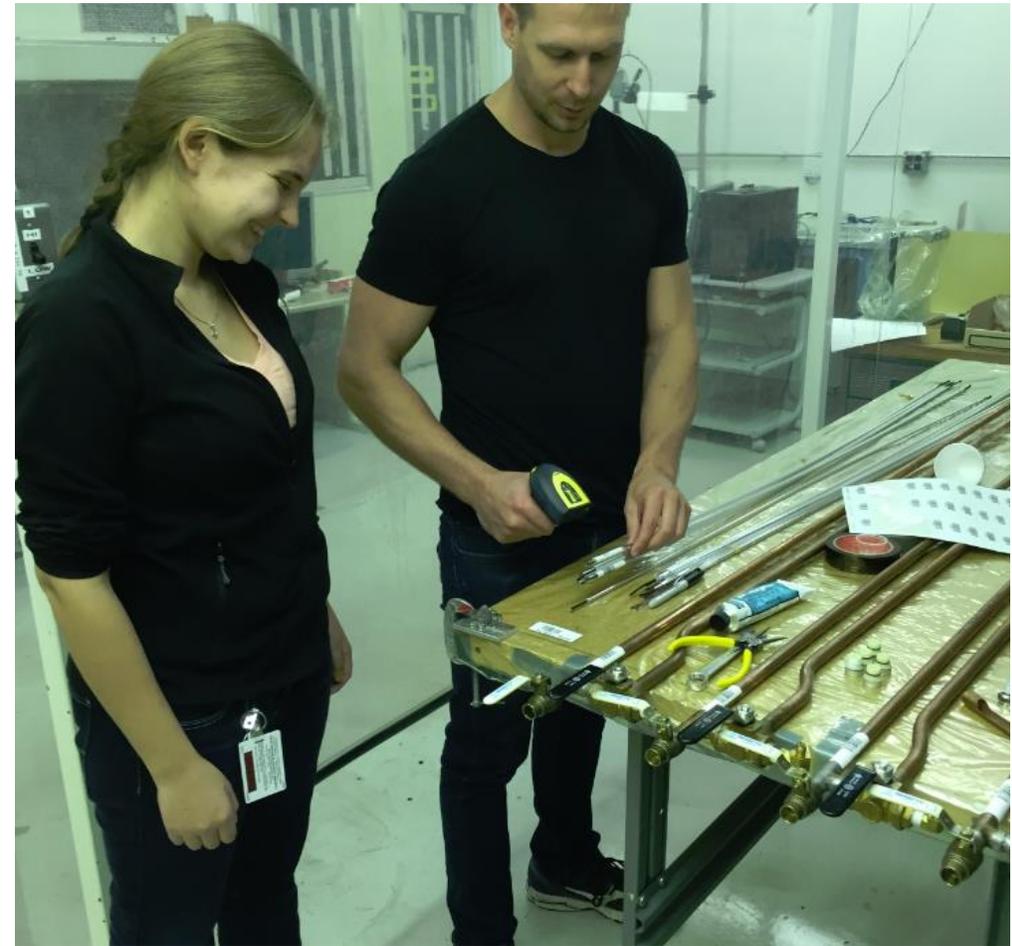
Straw leak update

Dan Ambrose

7/23/15

Straw Production

- Lauren, Jason and I (but mostly Lauren) have measured 30 straws in the last 2 days.
- Straws measurements can be made at a continuous rate. For 1 person operating the 5 chambers, by the time they are set prepping the straw for chamber 4, the straw in chamber 0 is ready to be removed and replaced.
- With 5 chambers, 1 person could measure 20 straws an hour with a 3σ confidence it is below max leak rate.

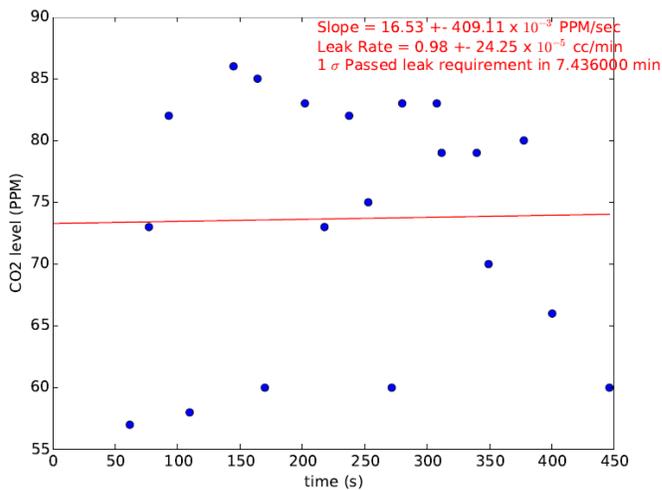


Measurement corrections

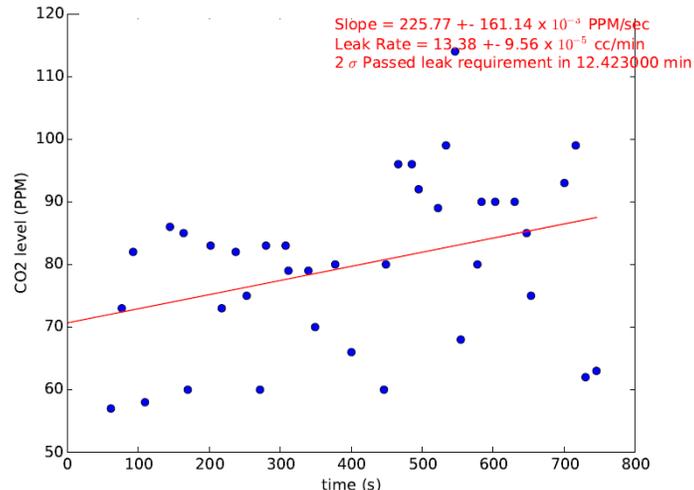
- CO₂ percent adjustment: 0.2 correction to leak rate
 - With 100% CO₂ in straw, partial pressure will be 1/5 when only 20% CO₂ and 80% Argon.
 - Argon gas is more than 20 times less permeable than CO₂
- Initial dead time: 60 seconds
 - From the first received data point for a straw, we wait a minute before using data. This minute is included in the needed time for measurement on previous page.
- Minimum Points: 10 valid measurements
 - Doesn't start fit until 10 measurements after initial dead time
- Cut off time: 2 hours
 - Stops fitting data if in for longer than 2 hours to avoid viton saturation change. Still records data though.
- Detector uncertainty: $\pm 20 \pm 2\%$
 - Different than $\pm 50 \pm 2\%$ listed by the company, however significantly more consistent with our measurements.
- Max PPM: 1800 PPM
 - Makes sure if straw blows up right away giving a flat line at 2000, that isn't a slope 0.
- Straw/tube volume: 50 cc subtracted from chamber volume
 - Straw Volume ~ 26.5 cc
 - Plastic tube Volume ~ 25.5 cc
 - Viton tubes ~ 2 cc

Straw fit certainty

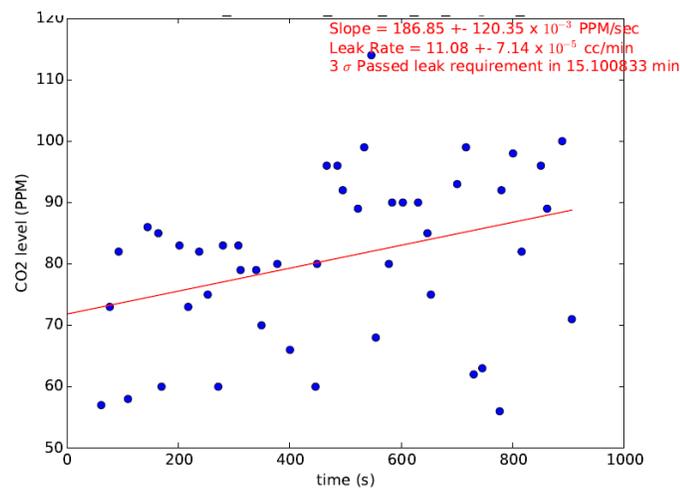
Passed 1σ in 7.4 minutes



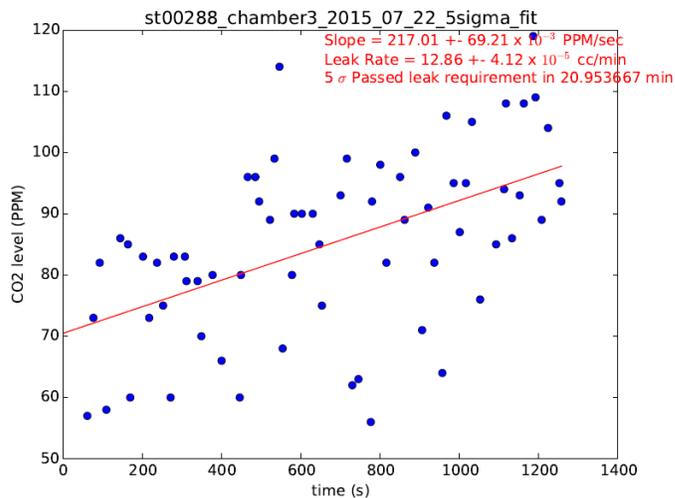
Passed 2σ in 12.4 minutes



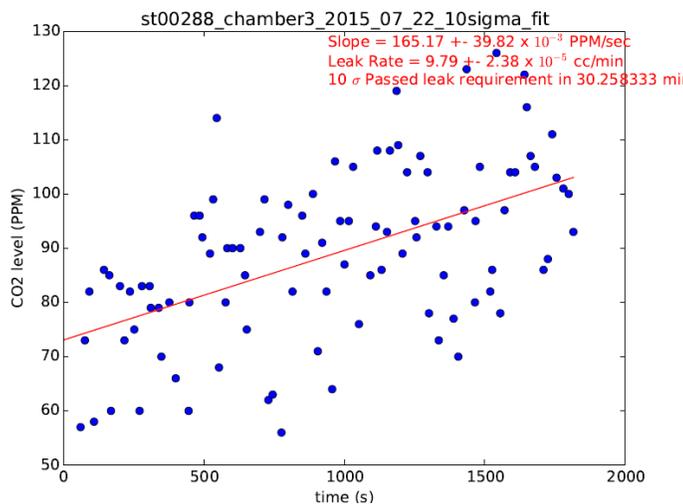
Passed 3σ in 15.1 minutes



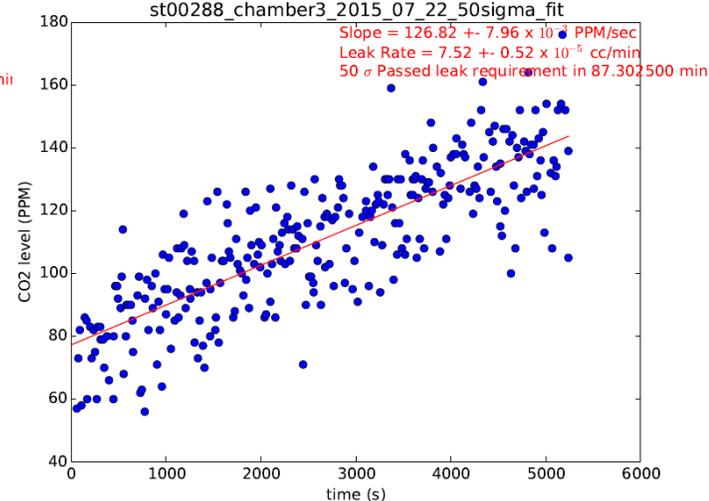
| σ | Leak rate $\times 10^{-5}$ ccm |
|----------|-----------------------------------|
| 1σ | 1 ± 24 |
| 2σ | 13 ± 10 |
| 3σ | 11 ± 7 |
| 5σ | 13 ± 4 |
| 10σ | 9.8 ± 2.4 |
| 50σ | 7.5 ± 0.5 |



Passed 5σ in 21.0 minutes



Passed 10σ in 30.3 minutes



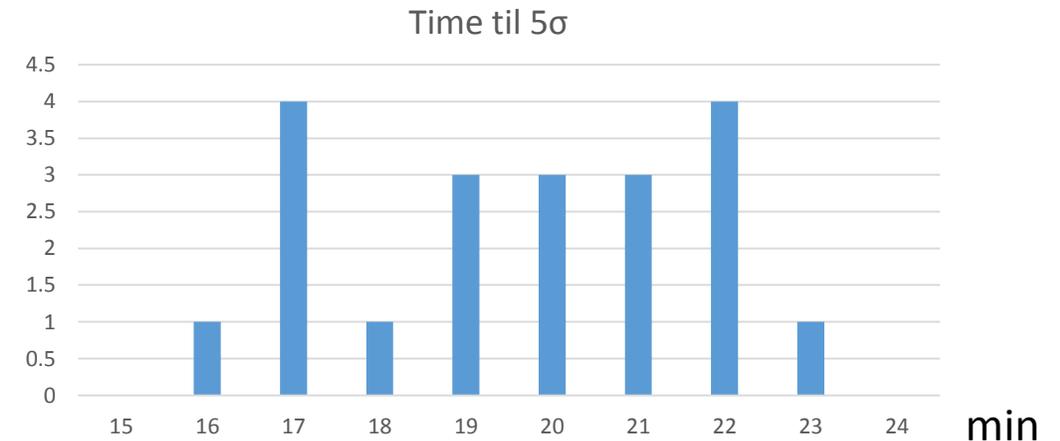
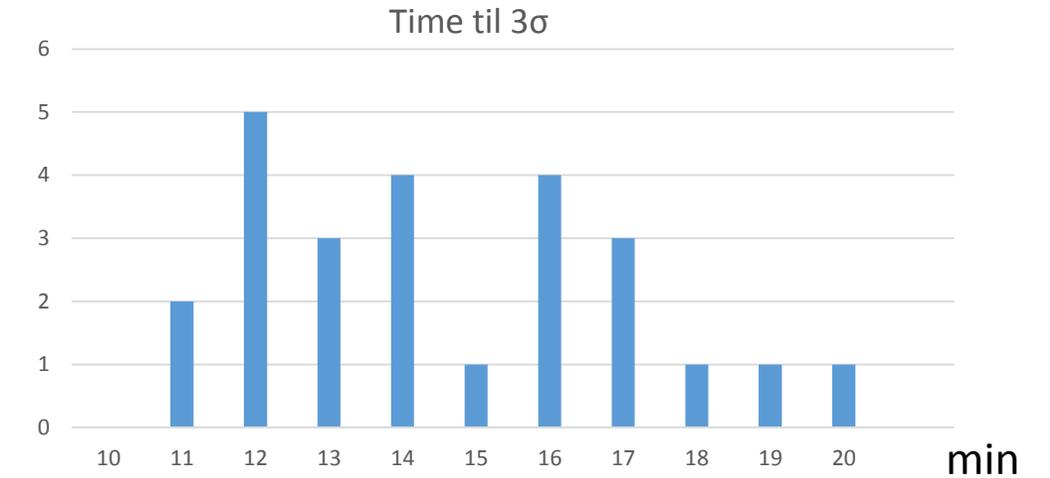
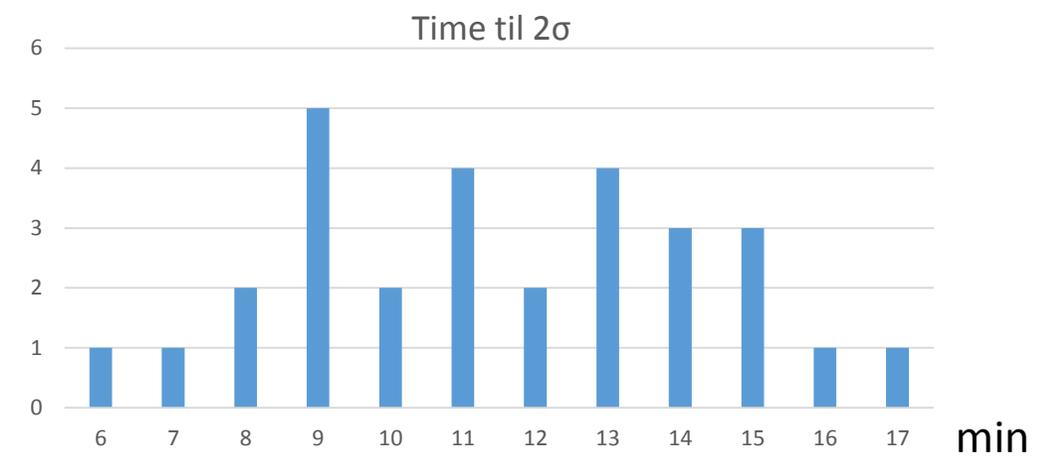
Passed 50σ in 87.3 minutes

How long do measurements take?

Current opinion is to enforce for 3σ confidence level as it is both accurate and quick.

| σ | Average time (min) |
|------------|--------------------|
| 1σ | 7.6 ± 2.4 |
| 2σ | 11.4 ± 3.1 |
| 3σ | 14.1 ± 2.4 |
| 5σ | 19.1 ± 2.0 |
| 10σ | 30.2 ± 1.8 |
| 50σ | 87.1 ± 5.1 |

From the 30 straws measured in the last 2 days. *only 10 were left to reach 50σ



Room for improvement

- Barcode scanners currently work great but we will probably want to move them out of keyboard mode for production.
- Certain chambers(specifically 0 and 4) when the PPM exceeds 2000 freezes the Arduino. Current theory is they take too much power to operate at this level and shuts down(see next bullet point). This might cause a problem during production if we have to try and figure out what sensor is freezing the program.
- The current Arduino code freezes if we remove a sensor while it is running.
- We will need to set up code to save to this information to the database.