# Measure the leak rate of CO<sub>2</sub> from Mylar straws

Yan Ke May 31,2016

### Introduction

- Straw will be running in vacuum in real Mu2e experiment. ie. It will be vacuum outside the straw and 1 atm ArCO<sub>2</sub> kept being flushed inside the straw. Therefore we need 1 atm pressure difference. We need pressurized straw to 2 atm when testing.
- We now have ArCO<sub>2</sub> gas, but may use pure CO<sub>2</sub> for testing in the future.



### Experimental apparatus



### Experimental apparatus

Straw





### Experimental apparatus





# Arduino, sensor and leak test code

- The Arduino chip get tested ppm value from CO<sub>2</sub> sensor around every 15 secs.
- Sensors returns an measurement in ppm. The measurement will be in the range of 0~2000ppm
- We will run a python code (by Dan Ambrose) that is used for testing the leak rate. It updates the leak rate in every 15 secs. There will be a test result in pdf format as well.

# Experiment process

- Background test:
- 1.The reason why we do this: To see whether the chamber leaks.
- 2.The experiment:
  - Flush the chamber with
  - nitrogen first and then
  - run the sensor in internal mode.



Note: Air background value is different between sensors. But they should be in the range of 300~500 ppm.

# Experiment process

- Test the CO<sub>2</sub> leakage of straws:
  1.Pressurize the straw with CO<sub>2</sub> /Ar gas and seal the straw with end pieces.
  - 2.Put the straw into the chamber
  - 3. Flush the chamber with nitrogen gas
  - 4.Run the chamber in internal mode.
    - in real test, we test each straw in ~20mins
  - 5. After testing, take out the straw.

Note: Don't purge  $CO_2$  into the chamber. Since  $CO_2$  could stuck on wall of the chamber and give us a "fake" leak. Also remember to take out the straw after measurement otherwise excessive  $CO_2$  will stuck on the wall just like purging  $CO_2$  inside the chamber.



# Pressurize the straws with $CO_2$ /Ar gas

#### (1)Flush the straw



(2)Use the end piece seal the other end of the straw

(3)Wait till the pressure goes to the value we want and then seal this side







### Measure the volume of the chambers by injecting CO2



<b>Results W</b>	ithout count in (0,1)	Results with(0,1)	geometric method	
Chamber	volume (cc)	volume (cc)	volume (cc)	ΔV
#1	380±14	382±7	466	84
#2	403±11	399±6	461	62
#3	407±19	391±9	454	63
#4	422±19	422±9	455	33

 Will measure mass (weight) to see if pipe used is the same in each case

### Result

• Background test result:



ppm2 = 0.248t + 33.637

ppm1 = 0.7152t + 20.707

### The problem comes from the black viton tube



### Consistency test w/ flushing N<sub>2</sub>



st00217 standard deviation with flushing N<sub>2</sub>: 1.2E-05

st00219 standard deviation with flushing N2 :1.2E-05

- St00217 and st00219 have never been measured before these measurements.
- Blue: Straws were flushed with N<sub>2</sub> each time after measurement.
- Red: Results without flushing N<sub>2</sub>.
- The memory issue seems to be mitigated if flushed the straws with N<sub>2</sub>.

### Consistency test by replacing the viton tubes



#### st00219 standard deviation: 8.7016E-06

- St00215 and st00216 have never been measured before these measurements.
- Viton was left for desaturation for 1~2 days.
  - St00216 : viton tubes were replaced every other day.
  - St00215 : viton tubes were replaced everyday.

 The standard deviation of results by replacing viton is comparable to the results by flushing with N<sub>2</sub>.

# Thank you!