

Update: A test for full proportionality between flow rate and saturation activity of radon progeny

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Overview

- Review
- Background
- Introduction
- Methods and Set-Up
- Measurements
- Data Analysis
- Conclusions
- Uncertainties

Review

- Determine if there is a full proportional relationship between flow rate and initial filter activity of radon progeny

Date	Time	40L Flow Rate	75L Flow Rate
22 Sep 18	13:39 – 14:48	1.00 cfm	1.50 cfm
25 Sep 18	19:06 – 20:11	1.00 cfm	2.00 cfm
26 Sep 18	06:16 – 07:06	1.00 cfm	3.00 cfm
26 Sep 18	11:14 – 12:22	1.00 cfm	3.00 cfm
28 Sep 18	15:51 – 16:59	1.00 cfm	2.00 cfm
28 Sep 18	17:16 – 18:22	1.00 cfm	3.00 cfm
30 Sep 18	10:33 – 11:38	1.00 cfm	2.00 cfm
30 Sep 18	11:39 – 12:44	1.00 cfm	2.00 cfm

Review

Campaign	Average Ratio	P-Value
1	2.026 ± 0.087	0.5924
2	3.079 ± 0.053	0.1204

- For a 95% CL, null hypothesis was failed to be rejected for campaigns 1 (1.00 cfm – 2.00 cfm tests) and 2 (1.00 cfm – 3.00 cfm tests)

$$t = \frac{\hat{p} - p_o}{\sigma/\sqrt{N}}$$

$$H_o: p_o = 2, 3$$

$$H_a: p_o \neq 2, 3$$

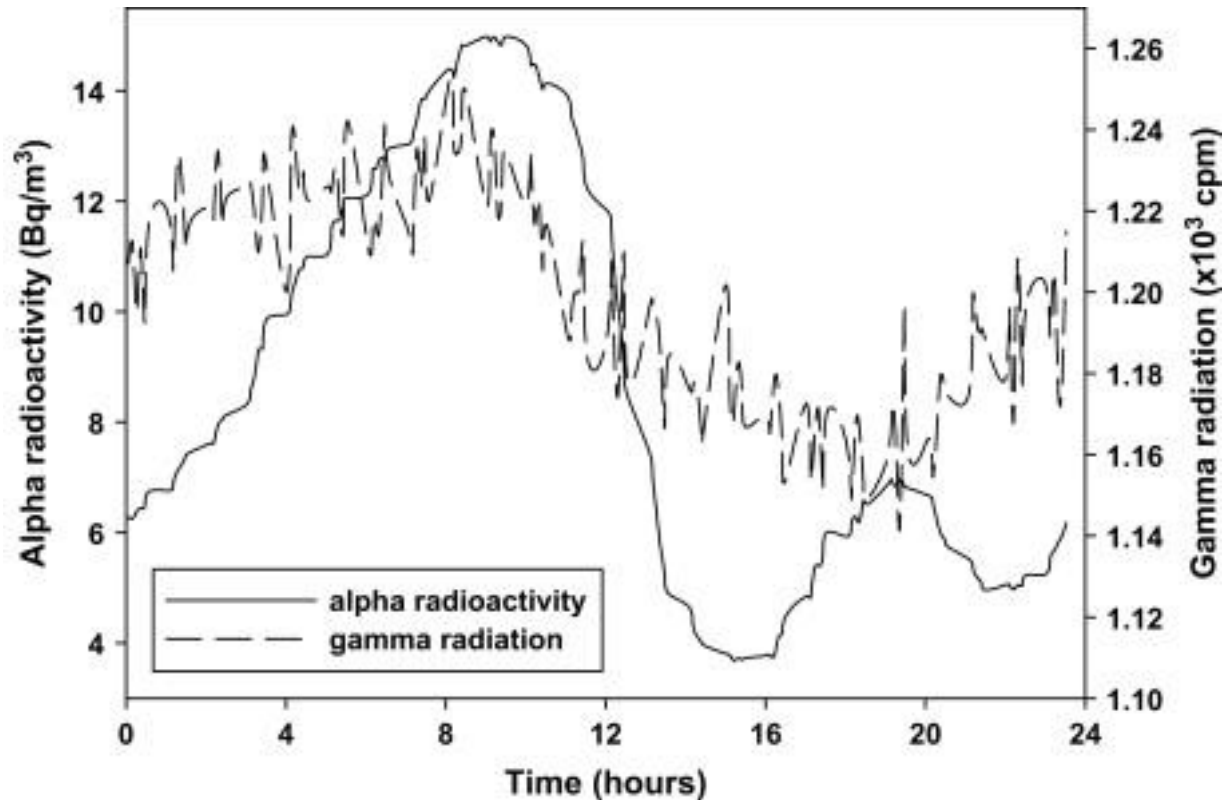
Review

- Diurnal changes observed in initial filter activity

Sampler Run-Time	Saturation Activity (cpm)
06:16 – 07:01	320.1
10:33 – 11:33	144.6
11:15 – 12:15	86.67
11:39 – 12:39	88.15
15:51 – 16:51	99.99
17:17 – 18:17	161.2
19:16 – 20:16	104.9

- Further experiments conducted to investigate and characterize this diurnal variation

Background



Introduction

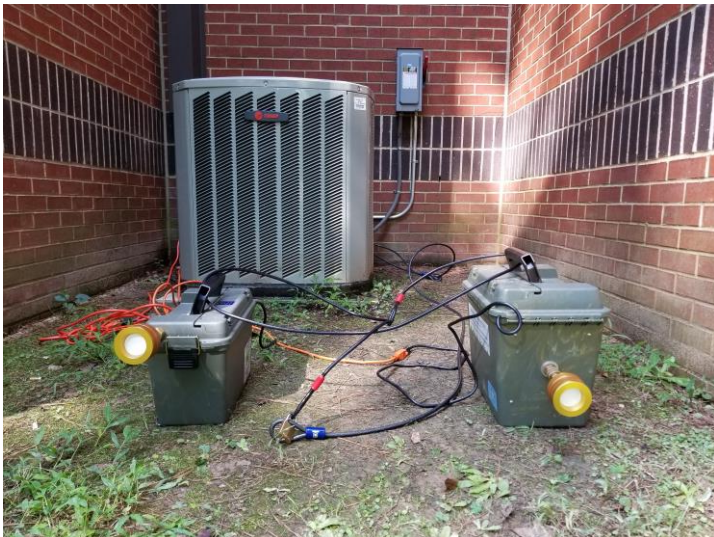
- Objective: Investigate diurnal variations in gross initial filter activity for 1.00 cfm flow rates
- Two different dates: Late October, Early February
- It is predicted that there will be a minimum at 13:00
 - Maximum at 18:00

Methods and Set-Up



<https://www.ne.ncsu.edu/rdna/laboratory/>

- Location: Research Building II, Raleigh, NC
- Times: 12:00 – 18:00
- Sampler run for 1 hr, counts taken for 1 hr – process repeated
- 1.00 cfm flow rates used

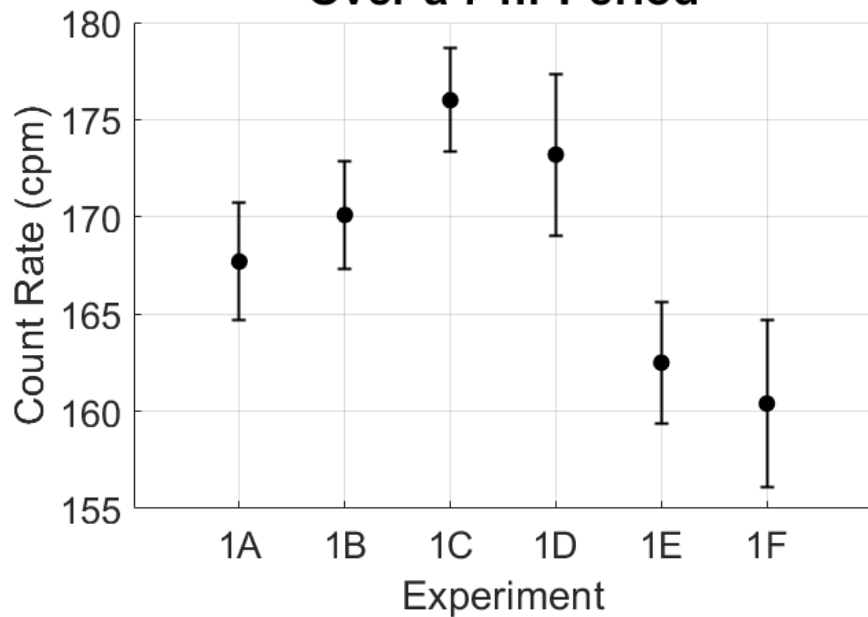


Measurements

- 2 experiments conducted from 10/28/18 to 2/09/19
- Air sampler run for 1 hr
- Counts taken for 1 hr
- Process repeated 6 times

Data Analysis (10/28/18)

**Initial Activity of Individual Filters
Over a 7 hr Period**

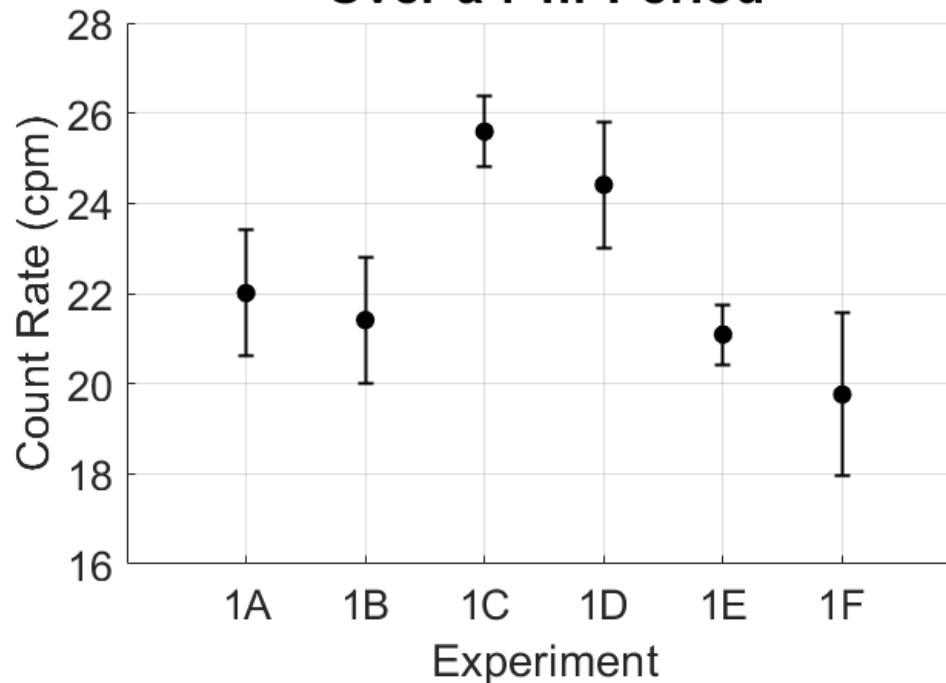


Experiment	Sampler Run Time	Initial Activity (cpm)
1A	10:24 – 11:24	167 ± 3.0
1B	11:26 – 12:26	170.1 ± 2.8
1C	13:35 – 14:35	176 ± 2.7
1D	14:38 – 15:38	173.2 ± 4.2
1E	15:42 – 16:43	162.5 ± 3.1
1F	16:48 – 17:48	160.4 ± 4.3

Data Analysis (10/28/18)

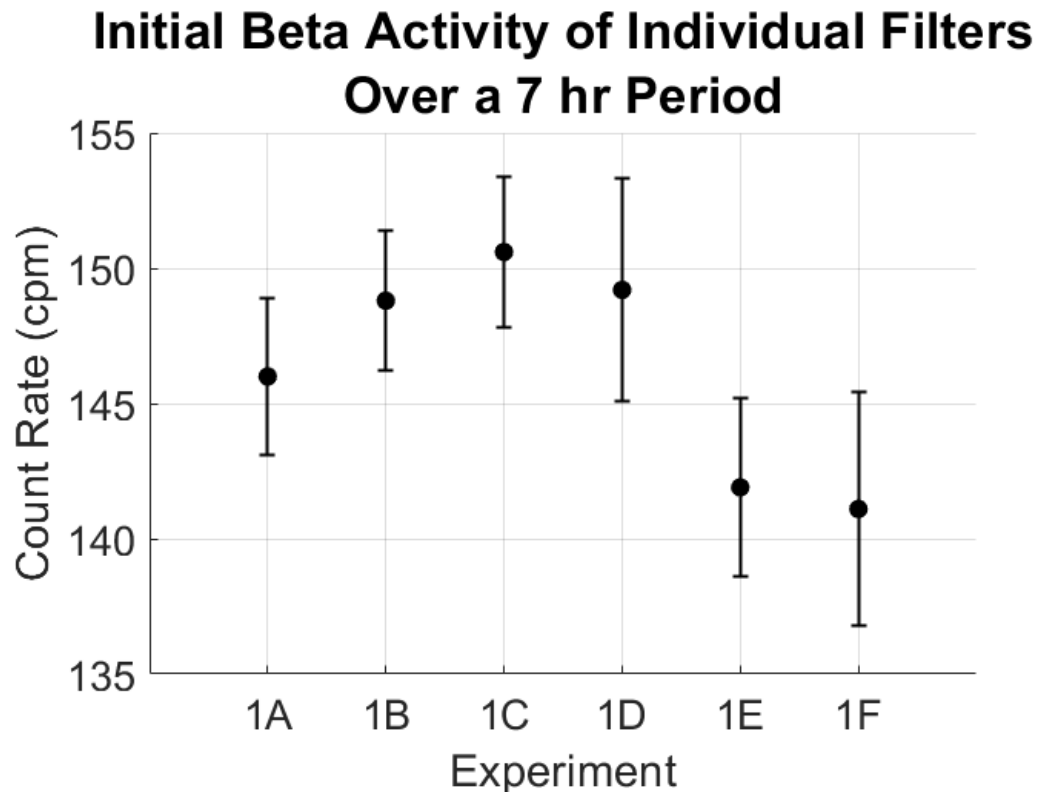
- Peak at approximately 14:30
- Slow decrease to trough at 18:00

**Initial Alpha Activity of Individual Filters
Over a 7 hr Period**



Data Analysis (10/28/18)

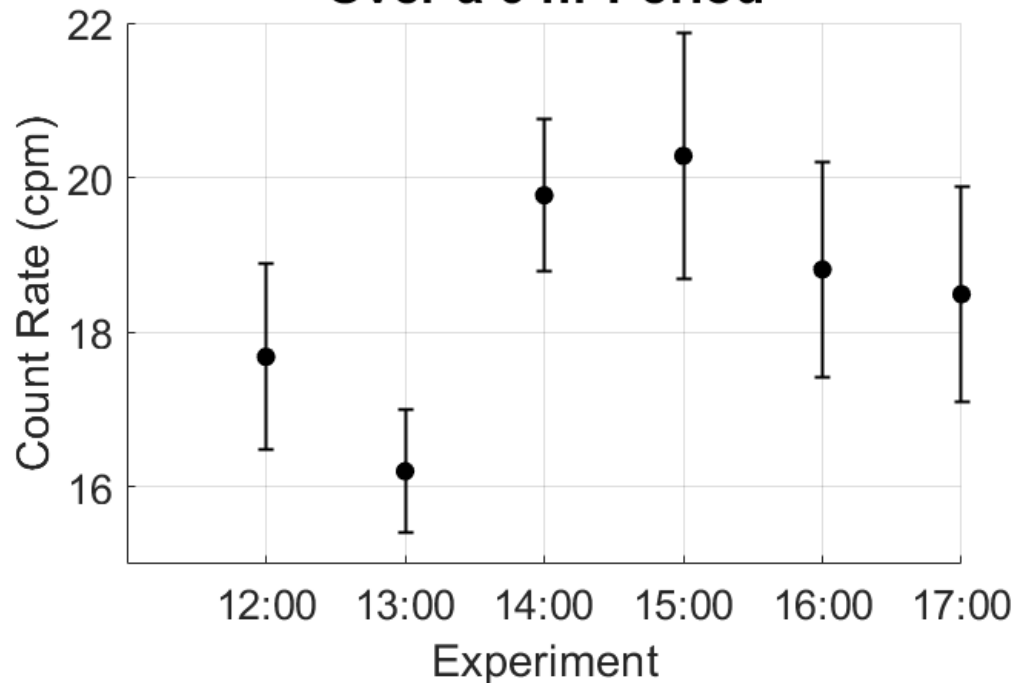
- Peak at approximately 14:30
- Slow decrease to trough at 18:00



Data Analysis (02/09/19)

- Peak at approximately 15:00
- Apparent drop at 13:00

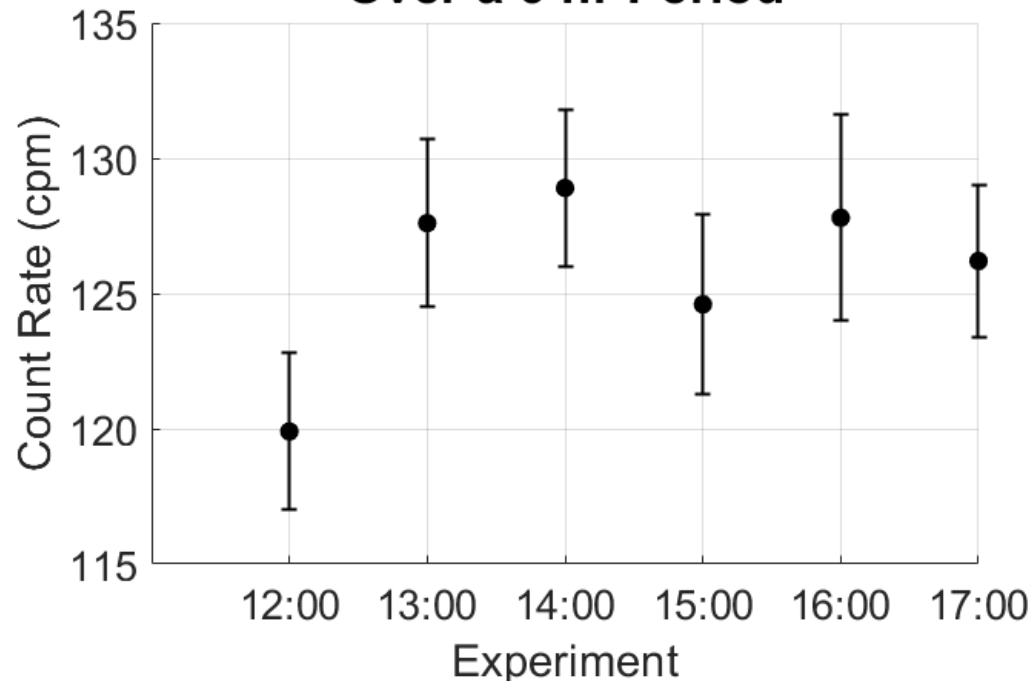
**Initial Alpha Activity of Individual Filters
Over a 6 hr Period**



Data Analysis (02/09/19)

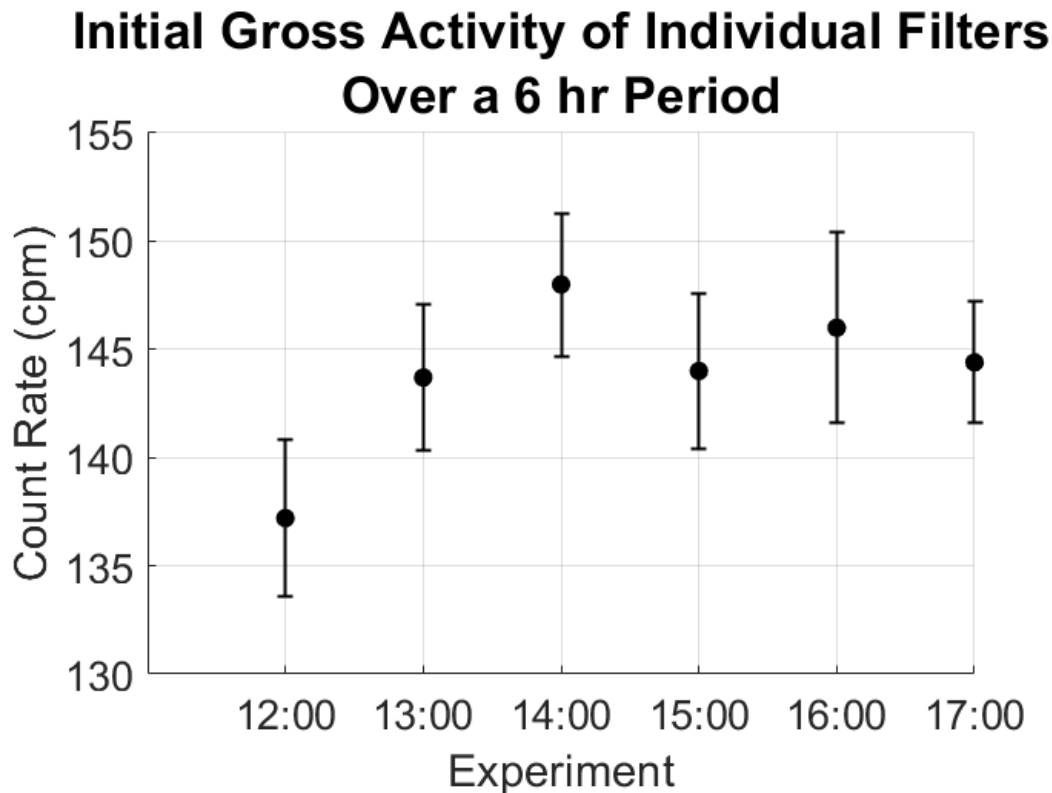
- No proper peak
- Increase from 12:00 – 14:00 and from 15:00 – 16:00

**Initial Beta Activity of Individual Filters
Over a 6 hr Period**



Data Analysis (02/09/19)

- Similar plot as beta activity
- Minimum still at 12:00



Conclusions

- Alpha activity for both 10/28 and 2/09 tests have a similar plot
 - Quick drop from 12:00 – 13:00
 - Maximum from 14:00 – 15:00, slow decrease to trough
- Beta and gross activity plots look similar
 - Different for 10/28 and 2/09

Conclusions

- Observations differ slightly with literature
 - Evening peak occurs earlier
- Alpha activity appears to be more affected by diurnal trends
- Beta activity is larger relative to alpha activity
 - Gross activity plot resembles beta shape

Uncertainties

- Humidity, rainfall, soil composition
 - Unmeasured
 - Higher temperatures cause dry soil, which “pushes” radon from soil (I. Seftelis et. al., 2007)
- Human error in transfer of materials, timing
- Different seasons, time of year*

Summary

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Questions?

Special thanks to:

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N.C. State University, Department of Nuclear
Engineering