Latest Water Samples @ Boulby

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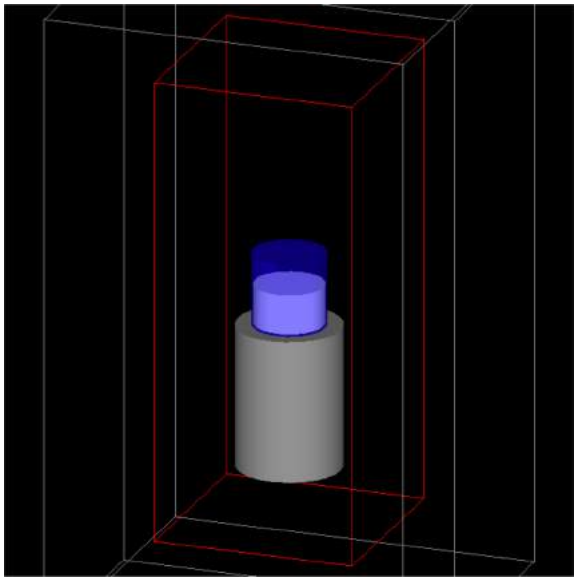
Introduction

- These slides give a brief overview of the water samples assayed at Boulby
  - 1) Calculating Efficiency
  - 2) Spectra
  - 3) Analyis

Efficiency

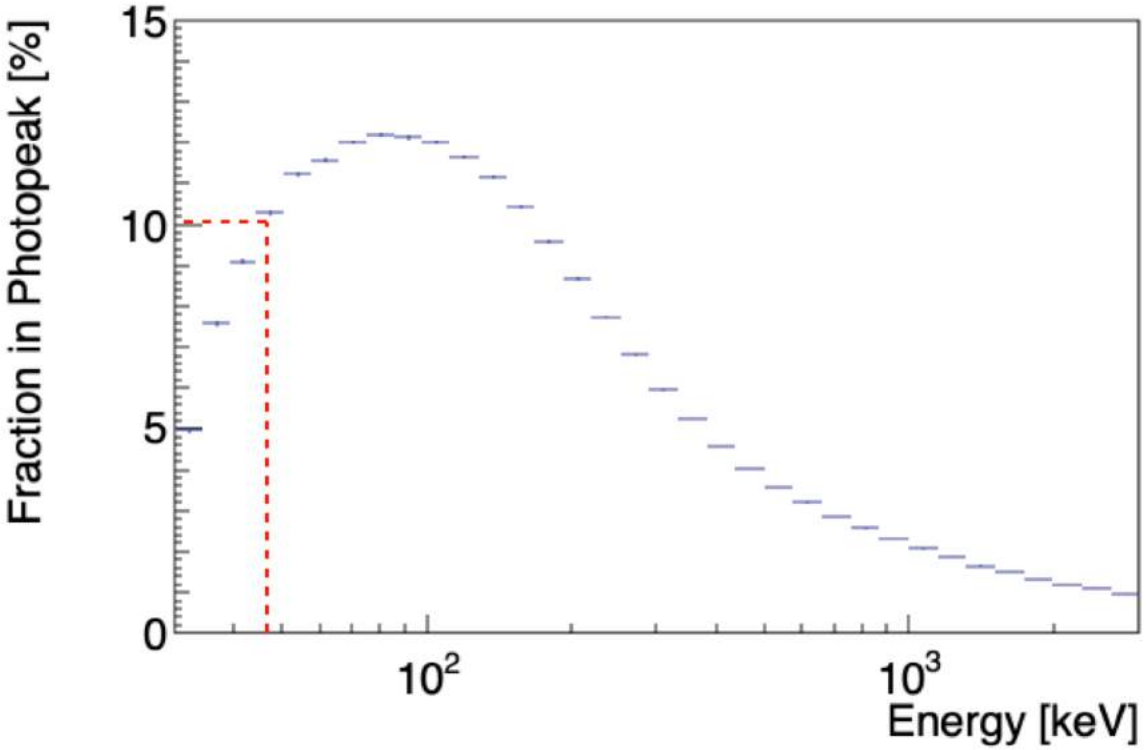
- The water samples are (pretty much) identical
- This makes life very simple
- We can run a single simulation to cover all samples



Efficiency

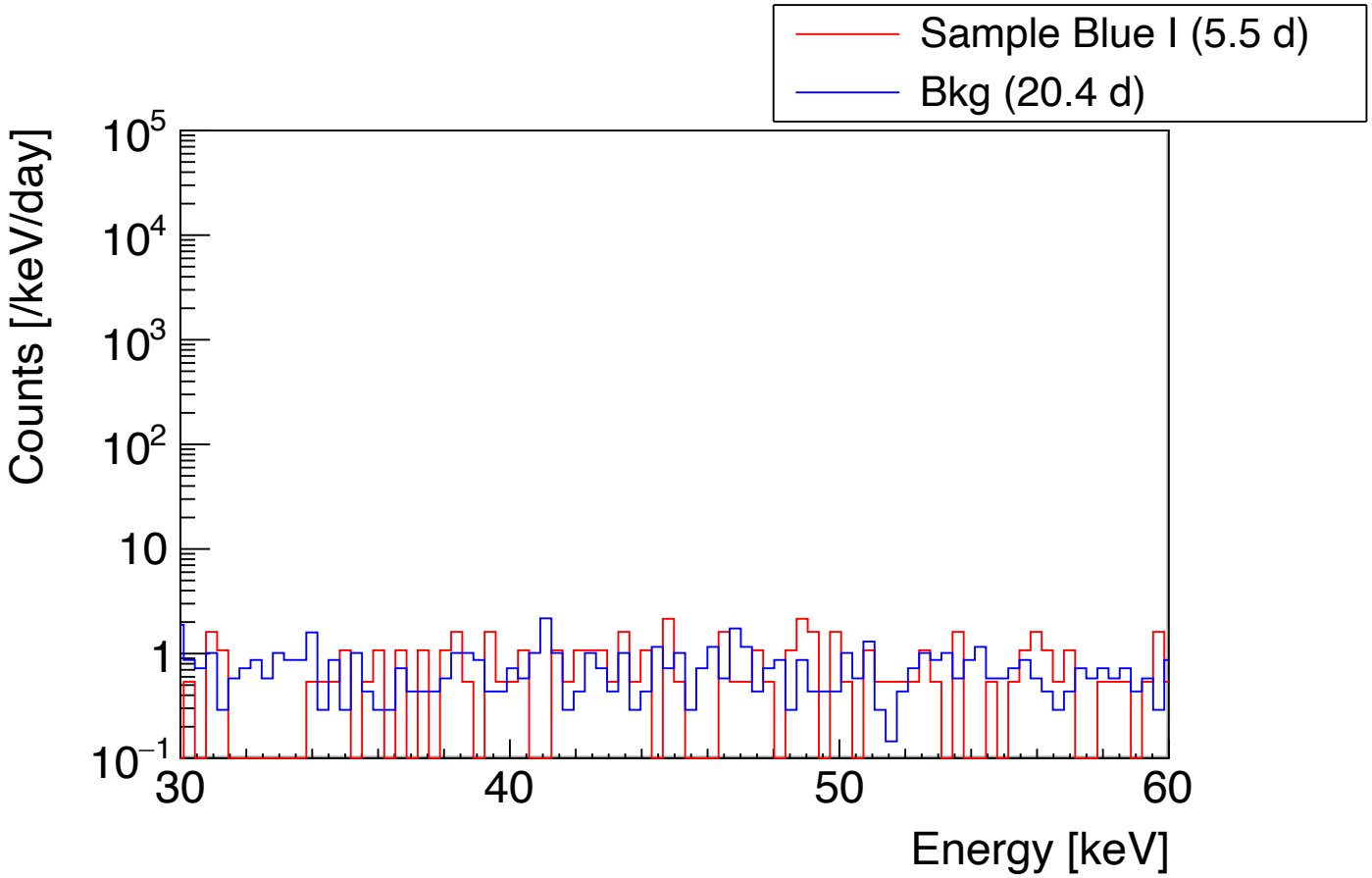
- Efficiency calculated in simple manner
  1. Fire a flat spectrum 0-3 MeV gamma-rays
  2. Plot all events where energy deposited >0.95x initial energy
  3. Scale to a ”percentage in photo-peak”
  4. Interpolate resultant histogram at 46.5 keV to get ^{210}Pb gamma-ray efficiency

Efficiency

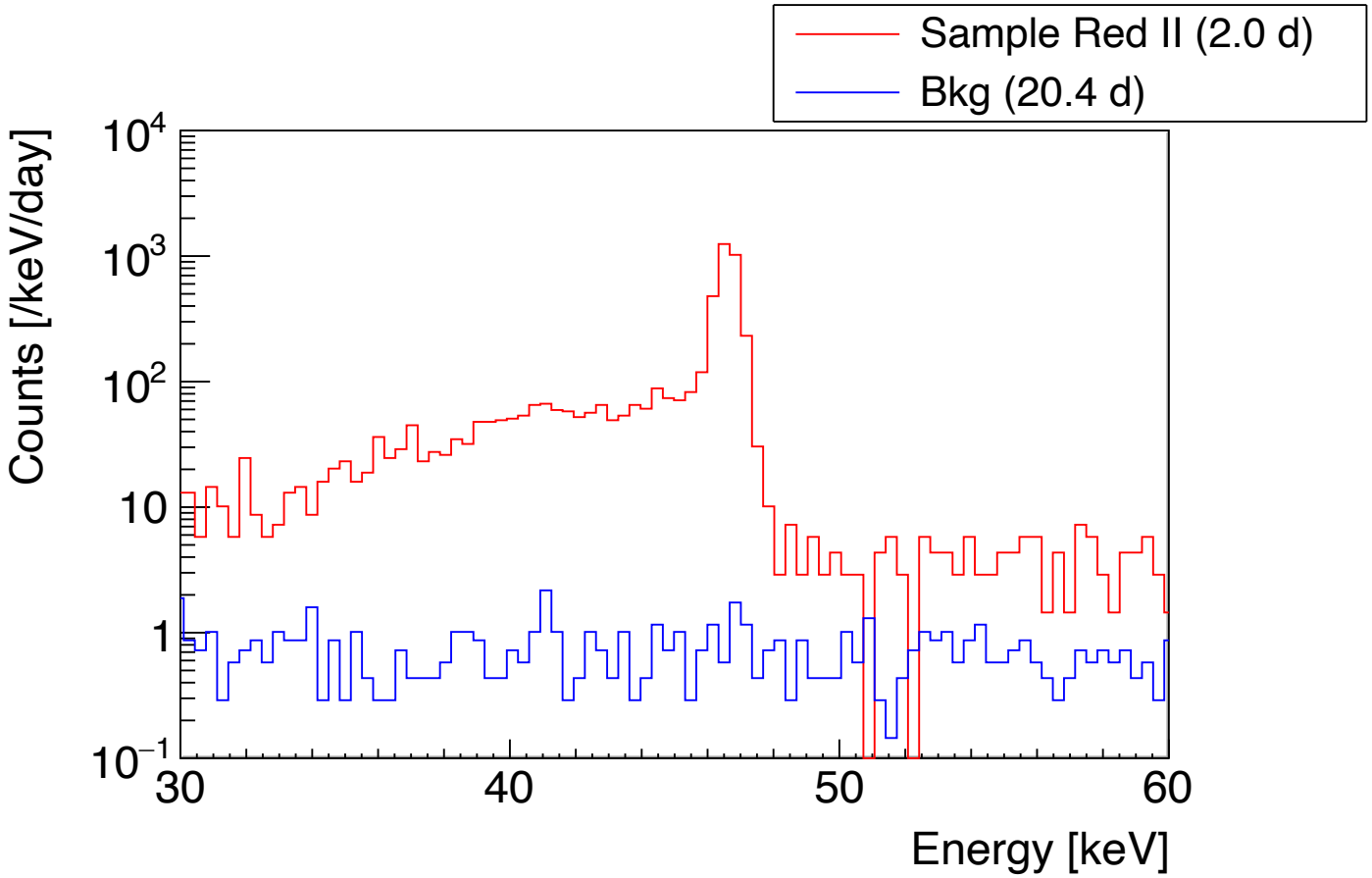


46.5 keV -> 10.1% efficiency

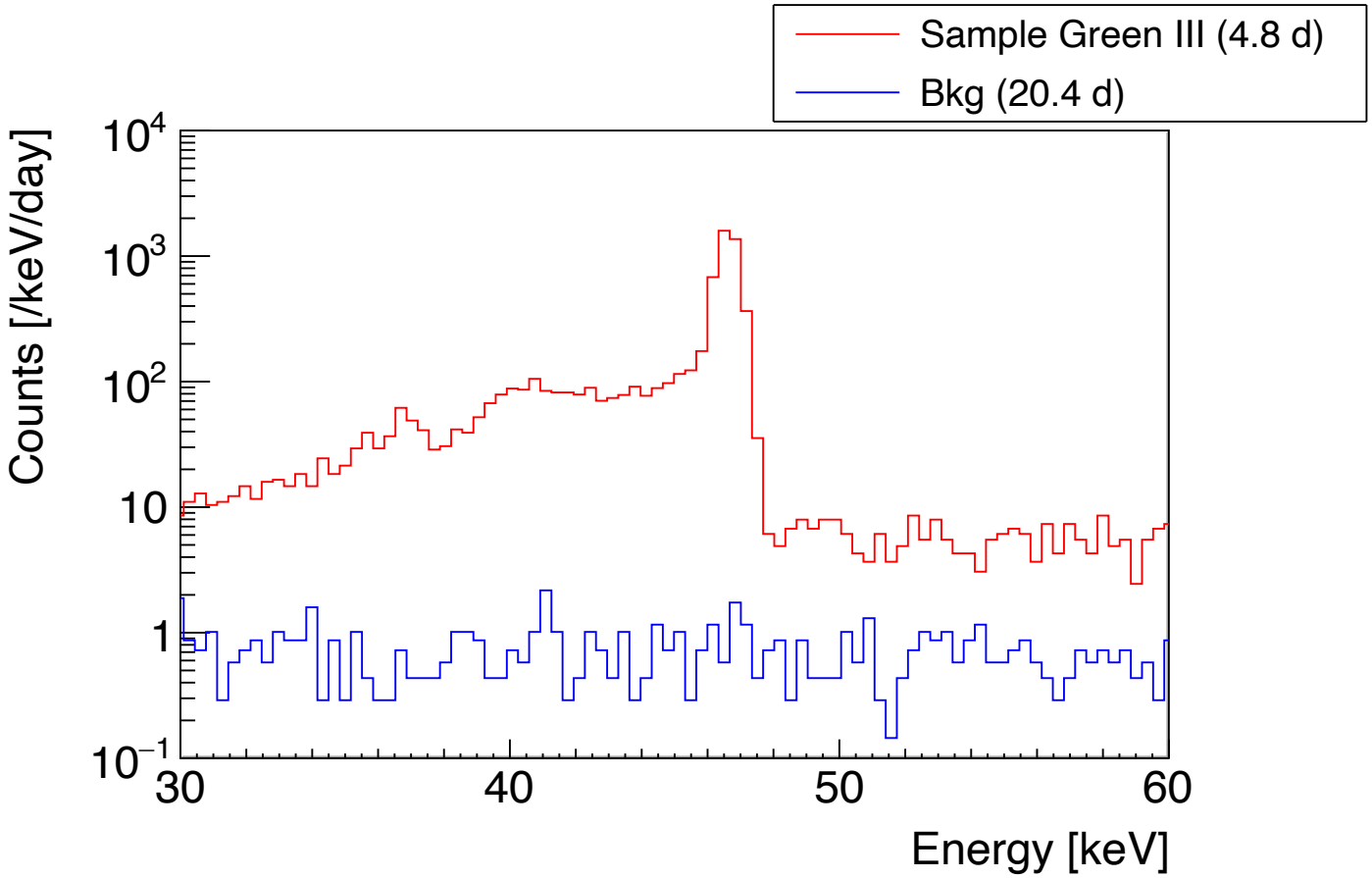
Spectrum – Blue I



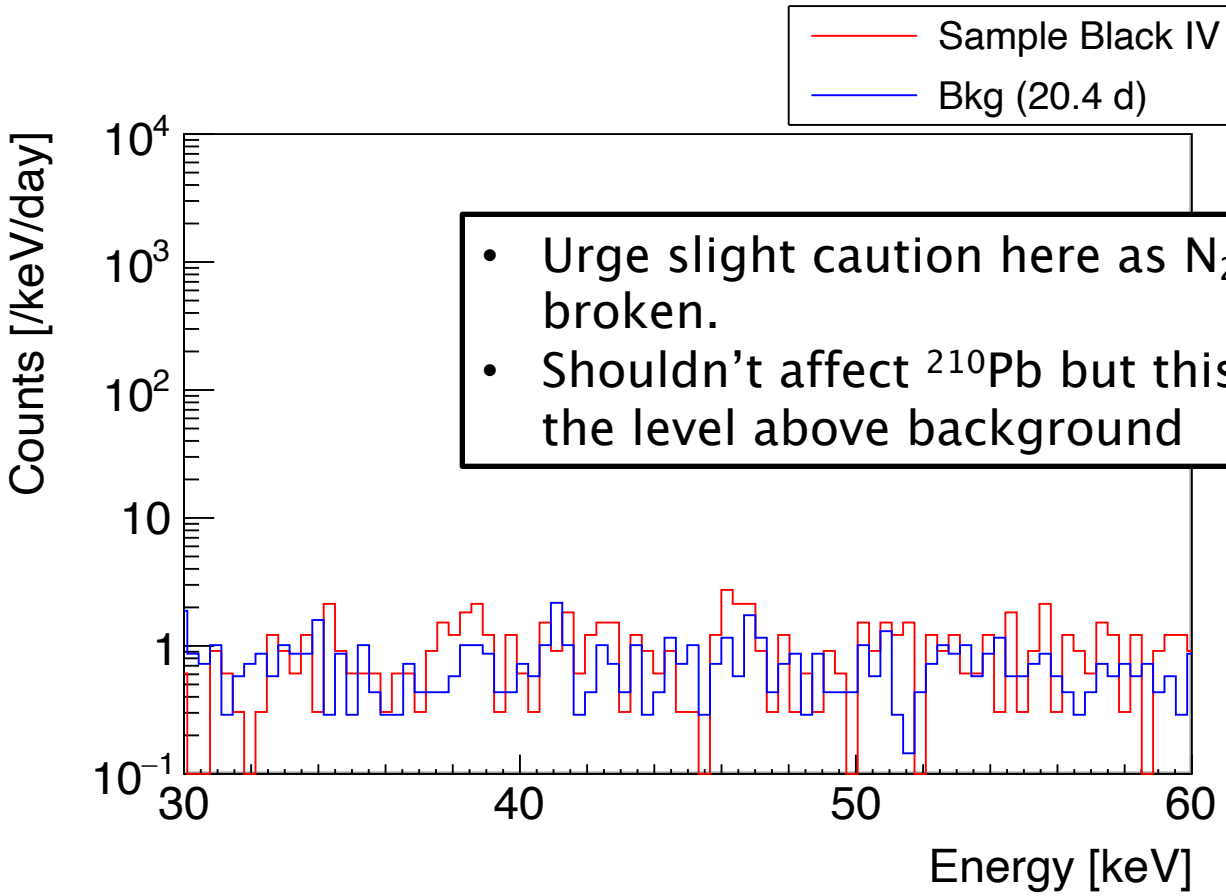
Spectrum – Red II



Spectrum – Green III

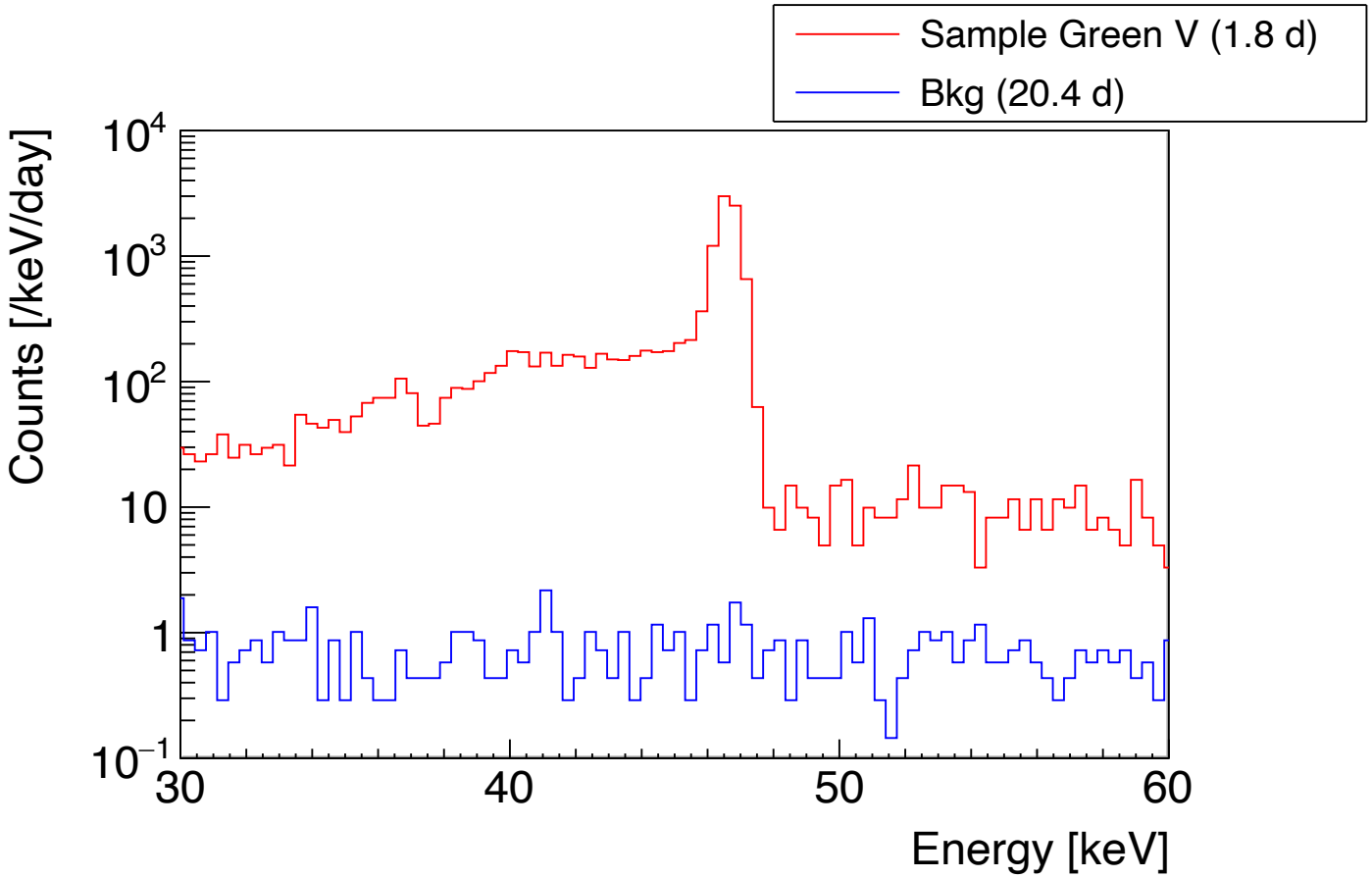


Spectrum – Black IV

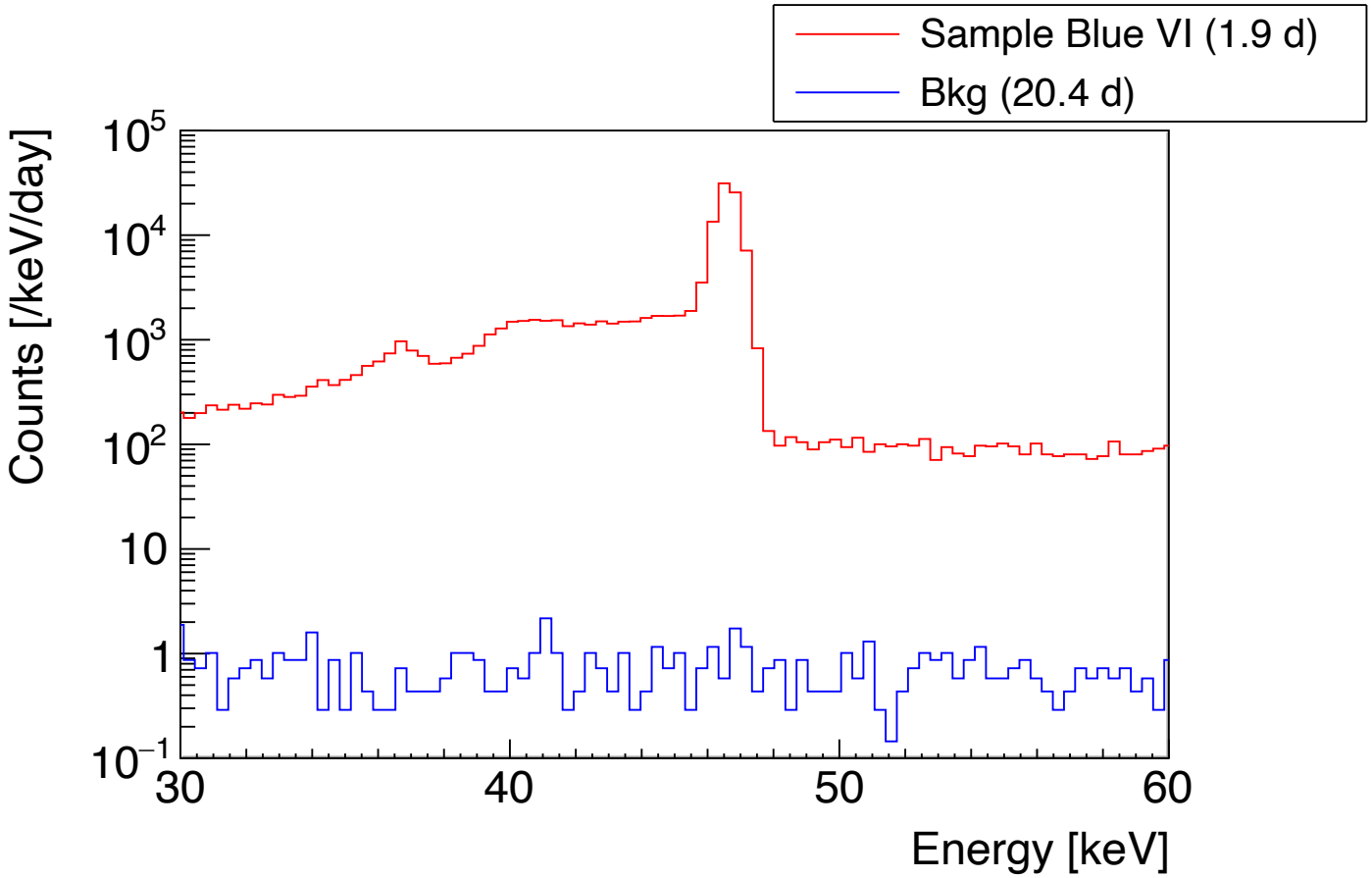


- Urge slight caution here as N_2 purge was broken.
- Shouldn't affect ^{210}Pb but this **may** explain the level above background

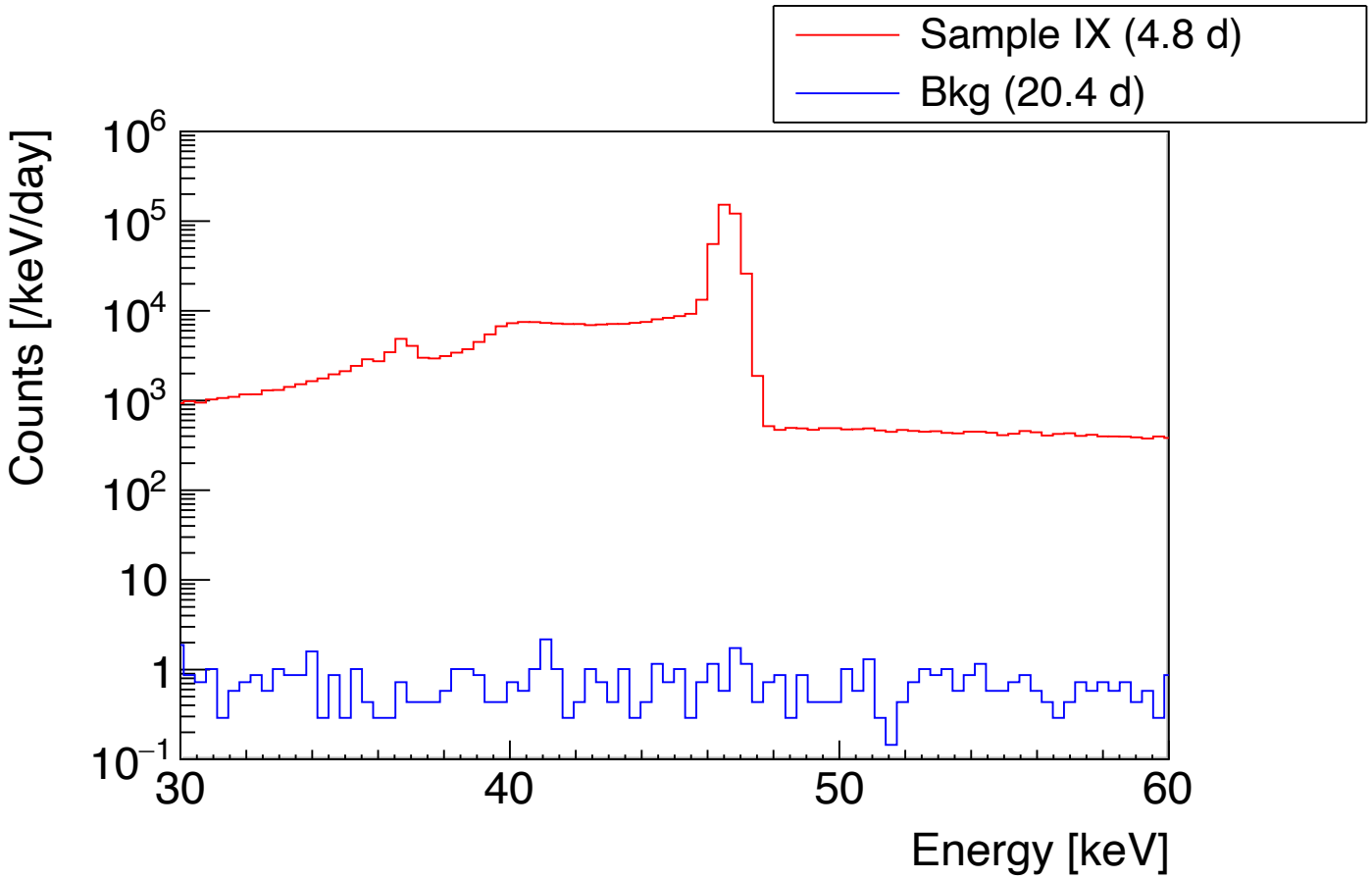
Spectrum – Green V



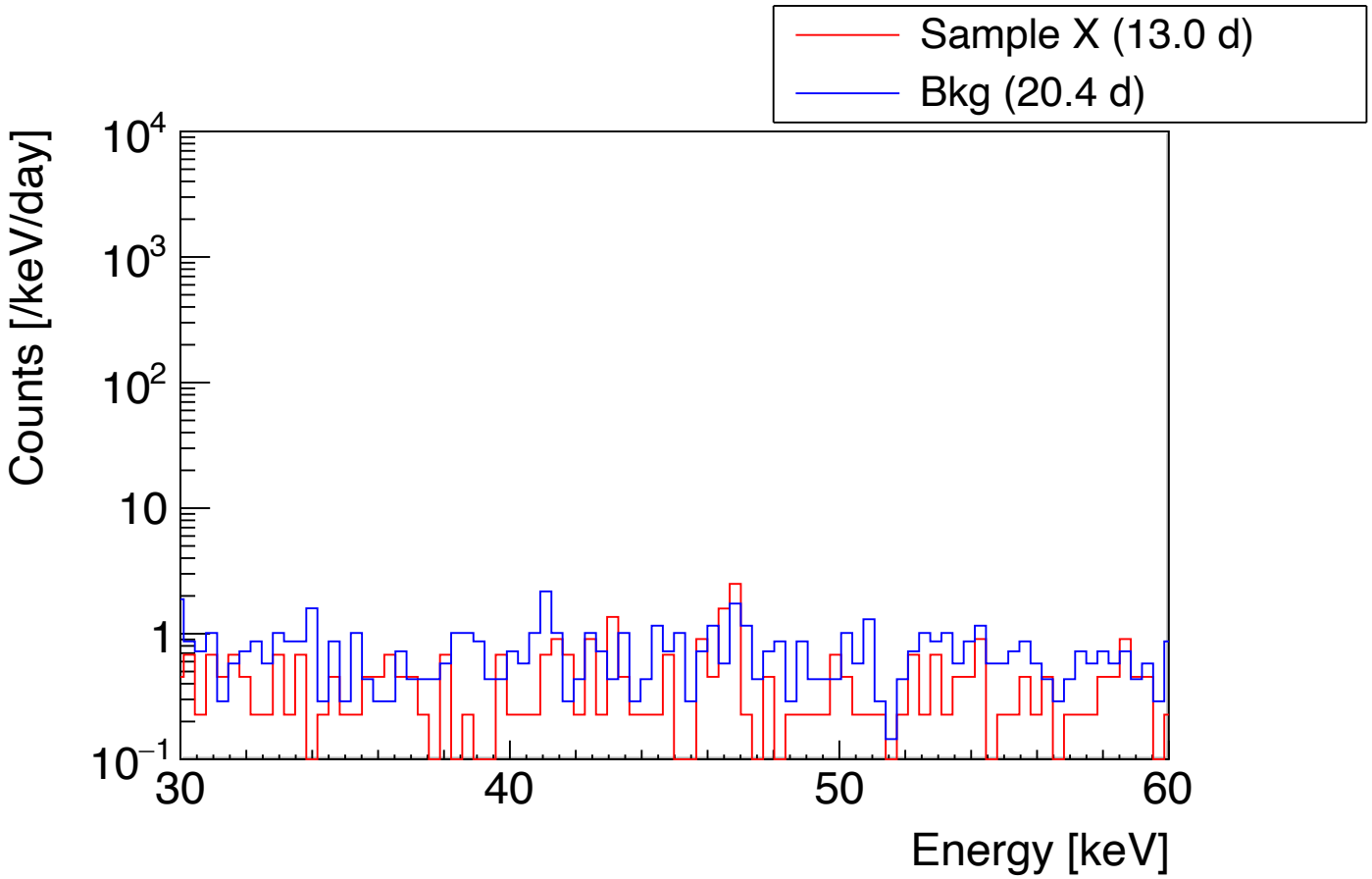
Spectrum – Blue VI



Spectrum – Sample IX



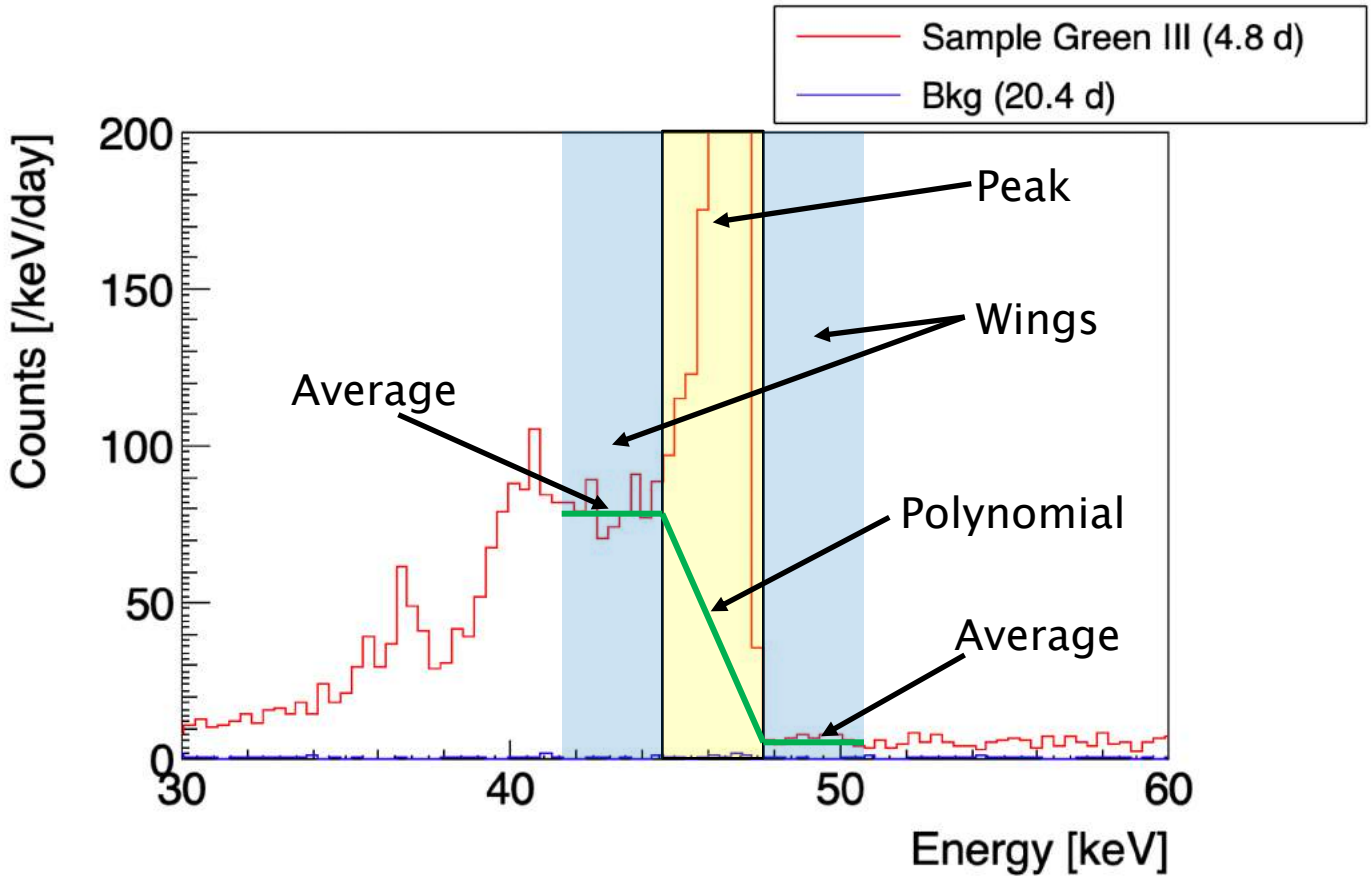
Spectrum – Sample X



Analysis

- Due to large peaks, this was kept very simple
- No gaussian fits to data
  - Define lower and upper bound of peak
  - Define lower and upper bound of background (wings)
  - Simple polynomial fit to wings to determine background contribution to peak
  - Subtract background from peak
  - Result
- Pictorial on next slide, don’t worry!

Analysis



Analysis

- The exact same range is used for *all* samples with no bias
- Take Green III as an example

Bin	Energy (keV)	Gross Counts					
262	44.39	73					
263	44.56	72					
264	44.73	78	Ave		Slope	-43.7	Fit Parameters
265	44.9	81			Intercept	2085.1	
266	45.07	98	87.8				
267	45.23	90					
268	45.4	85					
269	45.57	116		BKG	PEAK-BKG		
270	45.74	97		87.8			
271	45.91	189		80.4	108.6		
272	46.08	390		72.9	317.1		
273	46.25	721		65.5	655.5		
274	46.42	1215		58.1	1156.9		
275	46.59	1387		50.7	1336.3	6299.2	Total Counts
276	46.76	1294		43.2	1250.8		
277	46.93	937		35.8	901.2		
278	47.09	432		28.8	403.2		
279	47.26	164		21.4	142.6		
280	47.43	41		14.0	27.0		
281	47.6	17		6.6			
282	47.77	5					
283	47.94	5	Ave	Background Component	Net Counts		
284	48.11	4					
285	48.28	4	6.6				
286	48.45	7					
287	48.62	4					
288	48.79	2					
289	48.95	11					

Analysis

- Once the total peak counts from a sample is calculated, the background component can be removed
  - Same method used to get background ^{210}Pb counts
  - 0.3 counts per day background
- Divide through by sample mass, efficiency and gamma-ray emission probability to get specific activity

Results

Sample Name	Live Time (s)	Peak Counts	Background Subtracted Counts	Err	**Specific Activity (Bq/kg)**	**Err**
Blue I Data	388692	0.3	<0.0		**0**	
Red II Data	89975	1978.4	1978.1	44.5	**26.9**	**0.6**
Green III Data	331108	6299.2	6298.0	79.4	**23.3**	**0.3**
Black IV Data	752191	20.7	18.0	4.2	**0.029**	**0.007**
Green V Data	68381	4331.9	4331.7	65.8	**77**	**1**
Blue VI Data	79178	48827.7	48827.4	221.0	**754**	**3**
Sample IX	417484	464261.2	564259.7	751.2	**1652**	**2**

Results Compare Expectation

Sample Name	Description	Live Time (days)	Specific Activity (Bq/kg)	Activity, A (Bq)	Expected Activity, E_A (Bq)	$(A-E_A)/E_A$
Blue I Data	UPW Only	4.5	0	0	0	-
Red II Data	UPW + 210Pb	1	26.9(6)	5.4(1)	7.928	-0.32
Green III Data	1st Reduction	3.8	23.3(3)	4.7(1)	4.571	0.02
Black IV Data	Condensate 1	8.7	0.029(7)	0.006(1)	0	-
Green V Data	2nd Reduction	0.8	77(1)	15.5(2)	13.34	0.16
Blue VI Data	3rd Reduction	0.9	754(3)	144(1)	142.073	0.01
Sample IX	Final Source Sample	4.8	1652(2)	338(1)	336	0.01
Sample X	Condensate 2	14	0	0	0	-
			Total	**508.2(9)**	**503.9**	**0.01**

Results Compare UNAM

			Specific Activity (Bq/kg)				
Sample Name	**Description**	**Mass (g)**	**Boulby (Gilmore) [stat]**	**Boulby (Custom Software) [stat]**	**UNAM (Gilmore) [stat+sys]**	**UNAM (ROOT) [stat+sys]**	**Calculated from Expected Bq**
Blue I Data	UPW Only	200	0	0	3.4	0	0
Red II Data	UPW + 210Pb	200	26.9(6)	29.1(7)	26(4)	26(4)	40
Green III Data	1st Reduction	200	23.3(3)	24.9(4)	17(2)	23(3)	22
Black IV Data	Condensate 1	200	0.029(7)	0	2.5(4)	0	–
Green V Data	2nd Reduction	200	77(1)	82.1(14)	71(10)	65(10)	70
Blue VI Data	3rd Reduction	191	754(3)	836(4)	837(124)	746(110)	744
Sample IX	Final Source Sample	205	1652(2)	1684(1)	–	–	1639
Sample X	Condensate 2	200	0	0	–	–	0