



# Using a HPGe-PIPSBox detector system to compare the noble gases produced by fission from $^{235}\text{U}(\text{n},\text{f})$ and $^{248}\text{Cm}(\text{SF})$

Sifa Poulton<sup>1,2</sup>, Steven Bell<sup>2</sup>, Matt Goodwin<sup>3</sup>, Ayrton Jenkins<sup>3</sup>, Andy Pearce<sup>2</sup>, Andrew Petts<sup>4</sup>, Paddy Regan<sup>1,2</sup>, Matt Ryan<sup>5</sup>, Robert Shearman<sup>2</sup>

<sup>1</sup> University of Surrey, Guildford, UK, GU2 7XH

<sup>2</sup> National Physical Laboratory, Teddington, UK, TW11 0LW

<sup>3</sup> Atomic Weapons Establishment, Reading, UK, RG7 4PR

<sup>4</sup> EDF Hartlepool NPP, UK, TS25 2BZ

<sup>5</sup> National Nuclear Laboratory, Cumbria, UK, CA20 1PG

# Motivation



Nuclear  
Decommissioning  
Authority



UNIVERSITY OF  
SURREY



- Fission yields are affected by many factors including the parent isotope
- Comparing ratios of produced isotopes can help distinguish between sources
- Noble gasses are chemically inert and therefore easy to extract from samples

# $^{235}\text{U}(n,f)$ Experimental design



Nuclear  
Decommissioning  
Authority

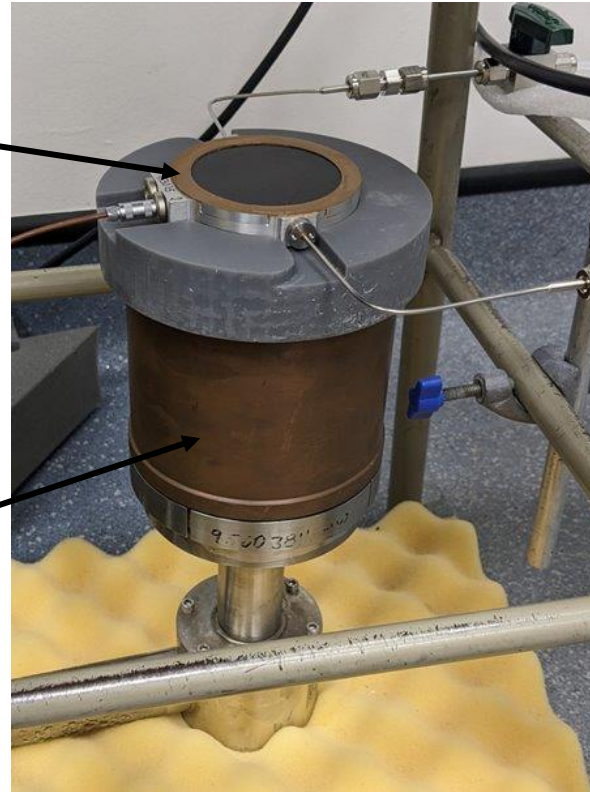


UNIVERSITY OF  
SURREY



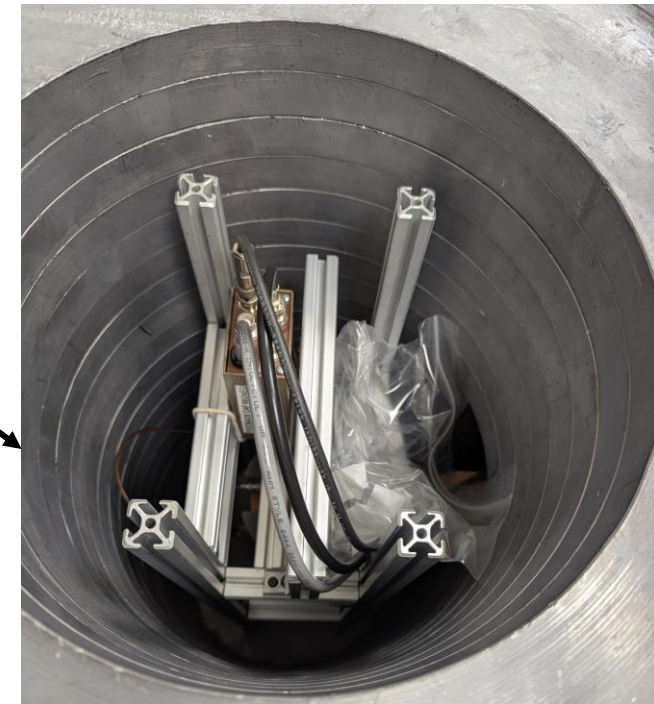
PIPSBox - two silicon detectors  
( $1200\text{mm}^2 \times 500\mu\text{m}$ ) either side of  
a 10.6 mL gas volume

HPGe "Odin"



Gasses extracted from U-235  
sample (600 Bq) irradiated in NPL's  
thermal pile for 5 hours with fluence  
averaging  $2 \times 10^7 \text{ cm}^{-2}\text{s}^{-1}$

Detectors placed in lead  
shielding



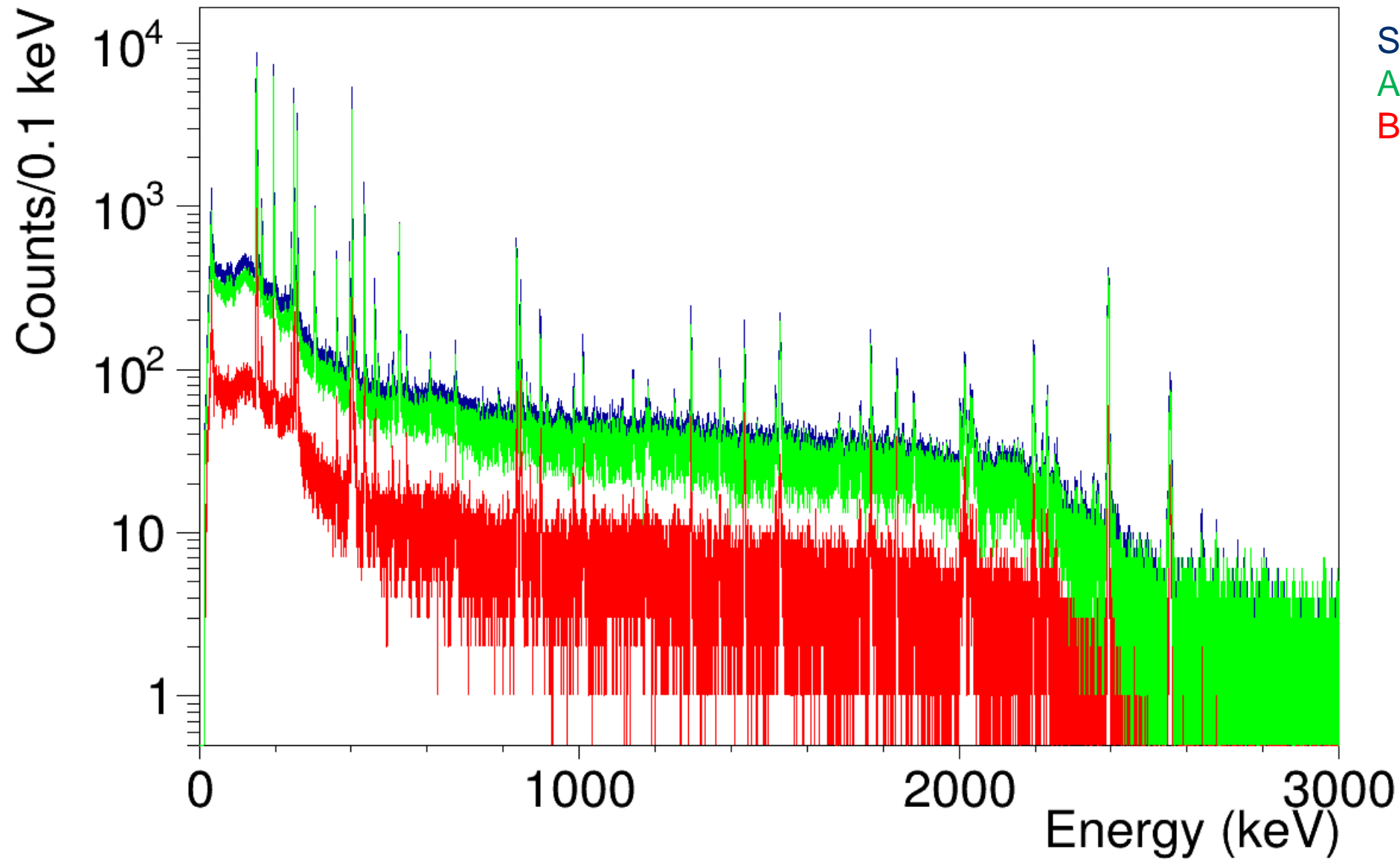
# $^{235}\text{U}(n,f)$ gamma spectra



Nuclear  
Decommissioning  
Authority



UNIVERSITY OF  
SURREY



Singles  
Anti-Coincidence  
Beta-gated

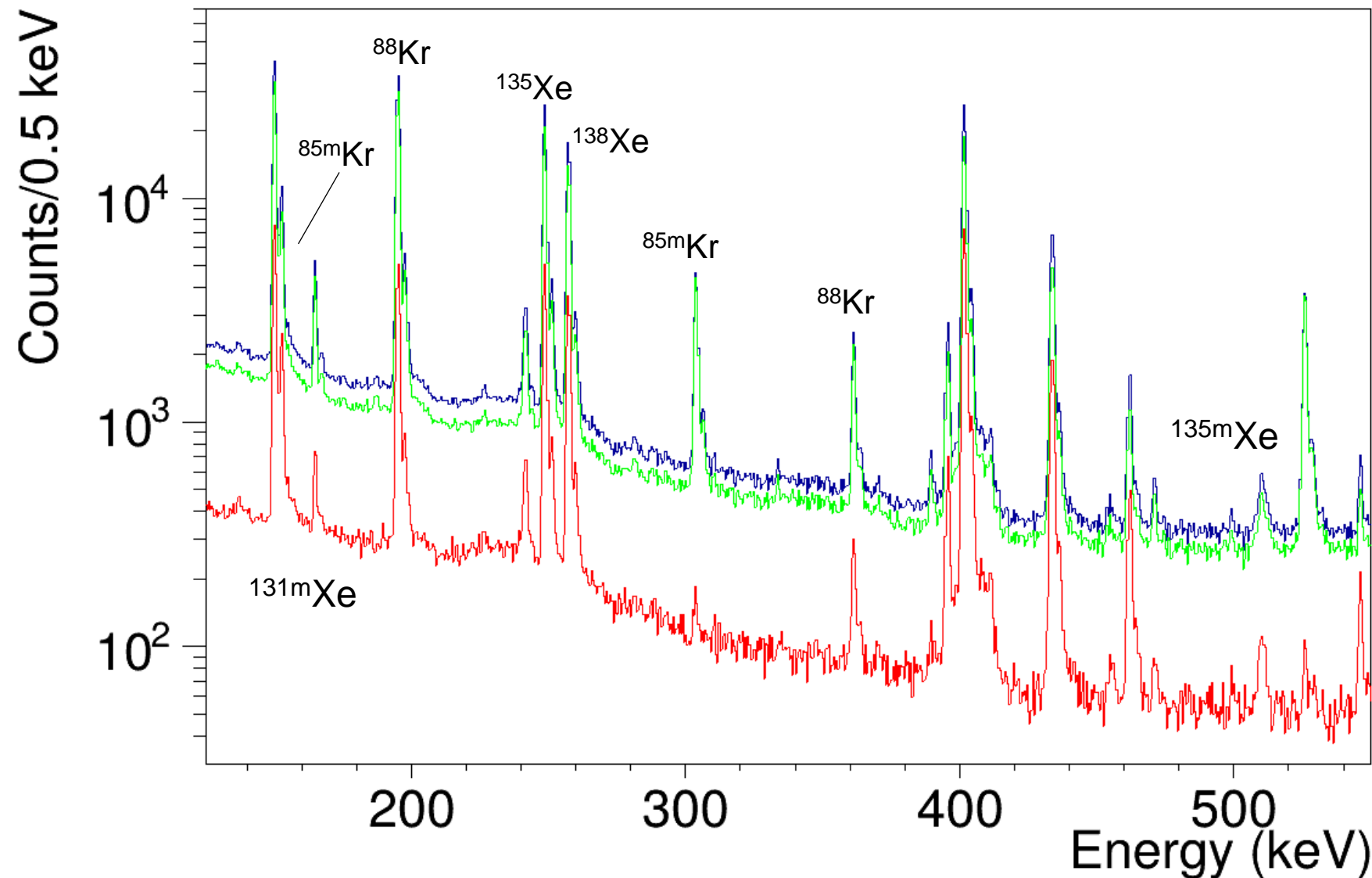
# $^{235}\text{U}(n,f)$ gamma spectra



Nuclear  
Decommissioning  
Authority



UNIVERSITY OF  
SURREY



Singles  
Anti-Coincidence  
Beta-gated

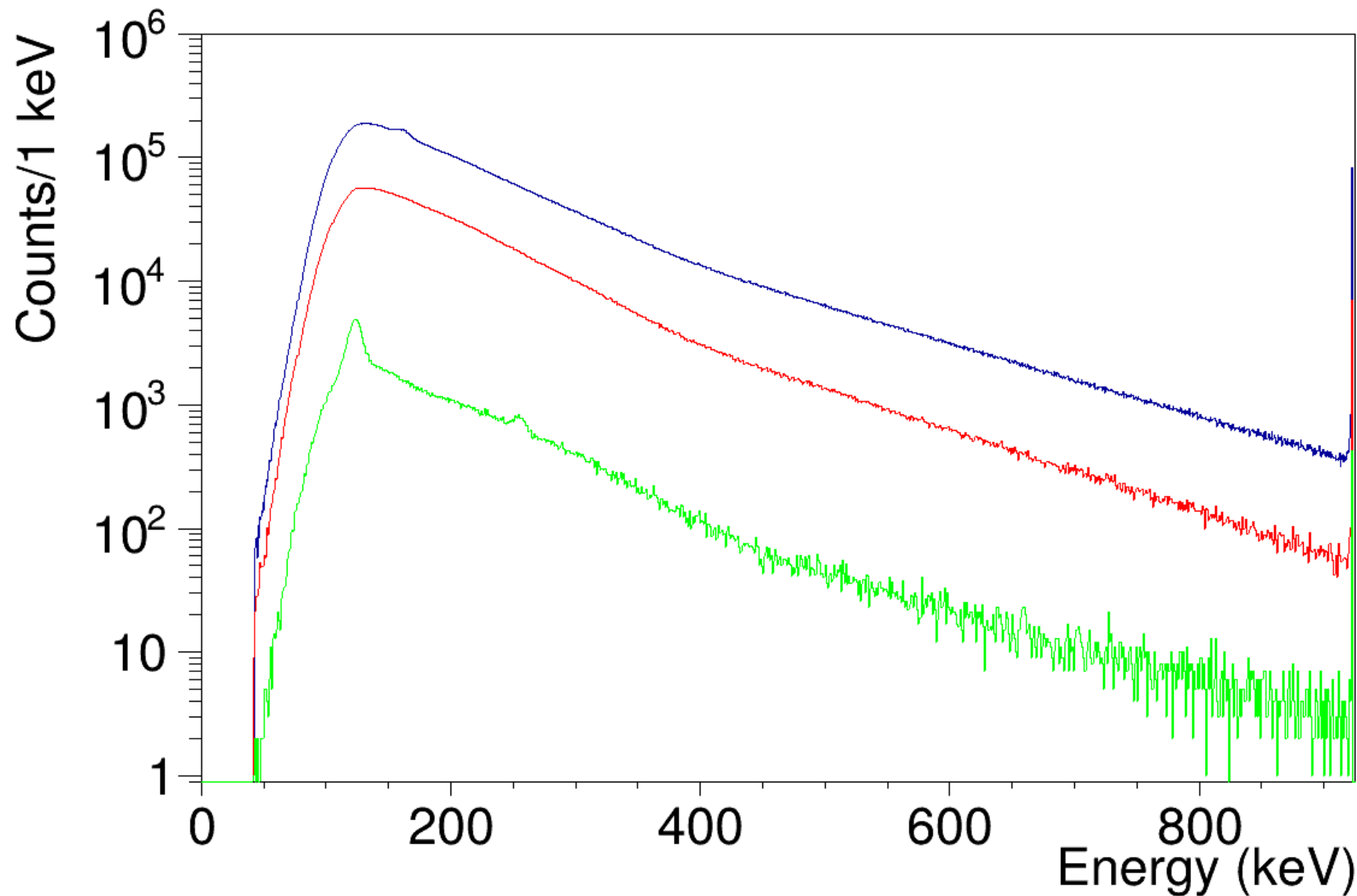
# $^{235}\text{U}(n,f)$ beta spectra



Nuclear  
Decommissioning  
Authority



UNIVERSITY OF  
SURREY



Singles

Beta-gated

Gated on 29-36 keV  
(Xe and Cs X-rays)

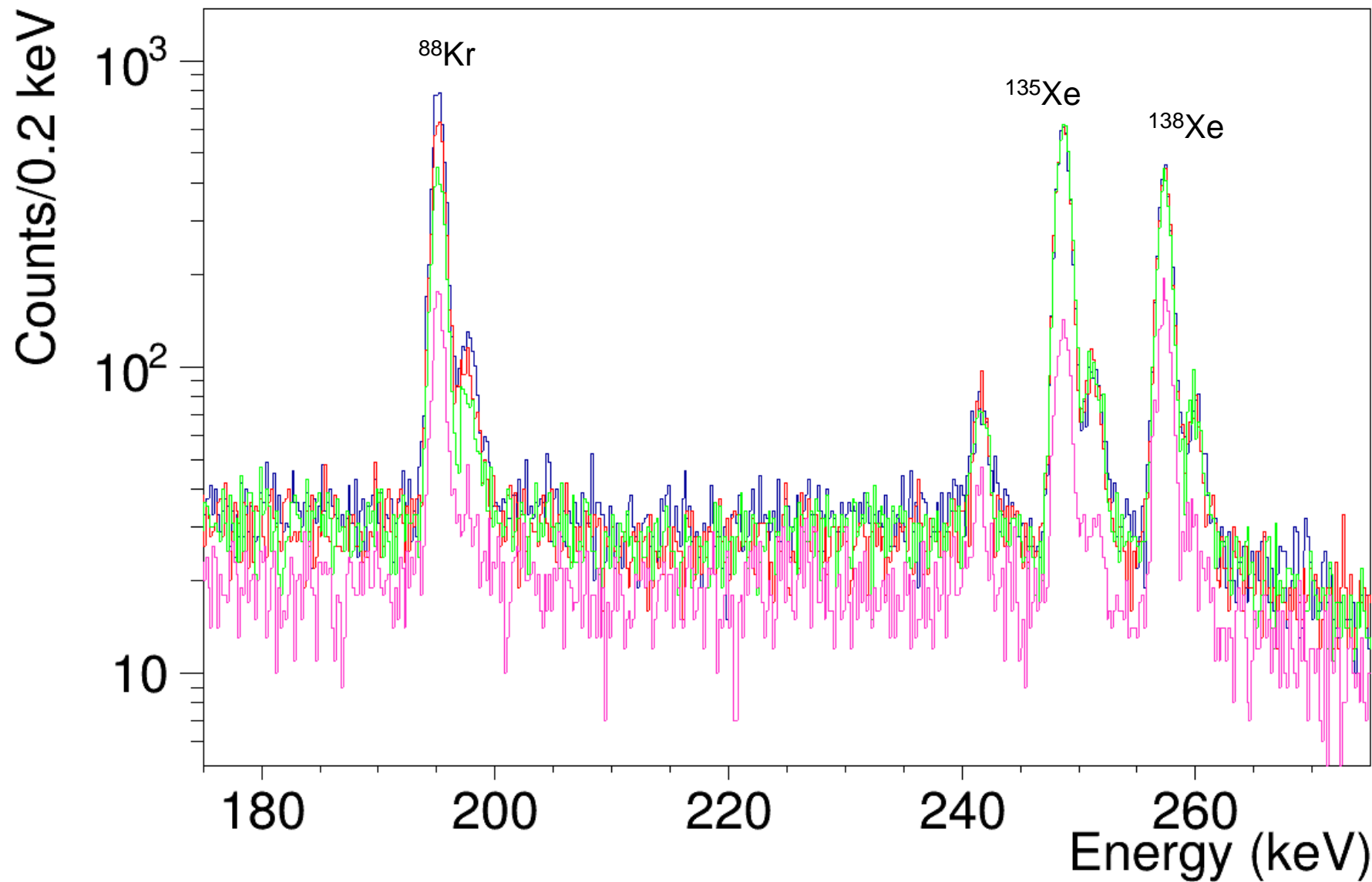
# $^{235}\text{U}(n,f)$ gamma spectra



Nuclear  
Decommissioning  
Authority



UNIVERSITY OF  
SURREY



Gated betas 100 to 150 keV  
Gated betas 150 to 200 keV  
Gated betas 200 to 300 keV  
Gated betas >300 keV

# $^{248}\text{Cm}(\text{SF})$ Experimental design



Nuclear  
Decommissioning  
Authority

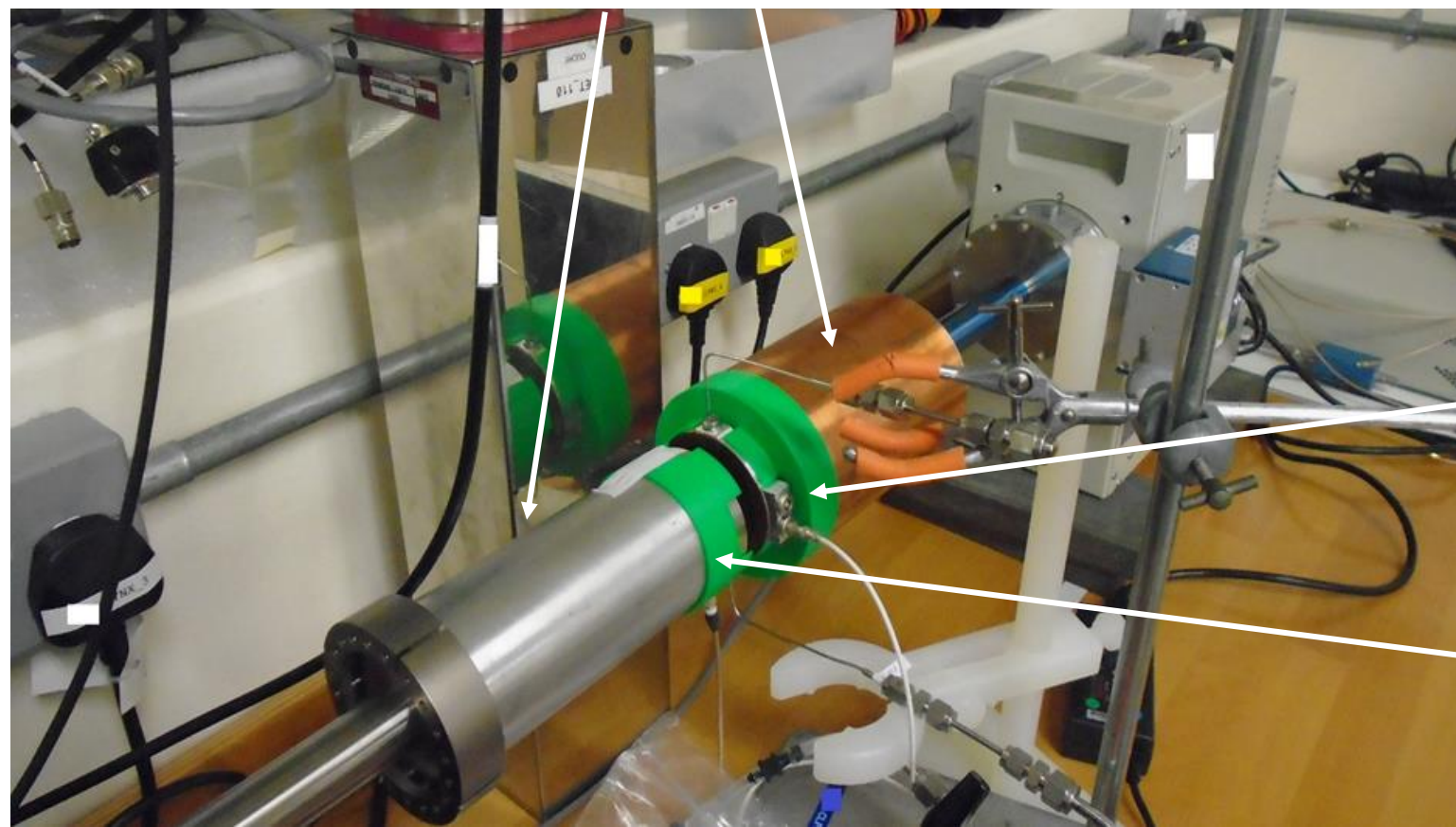


UNIVERSITY OF  
SURREY



Source: head  
gases from a  
 $^{248}\text{Cm}$  source  
(injected)

2 HPGe



PIPSBox (one  
working channel)

Standalone PIPS

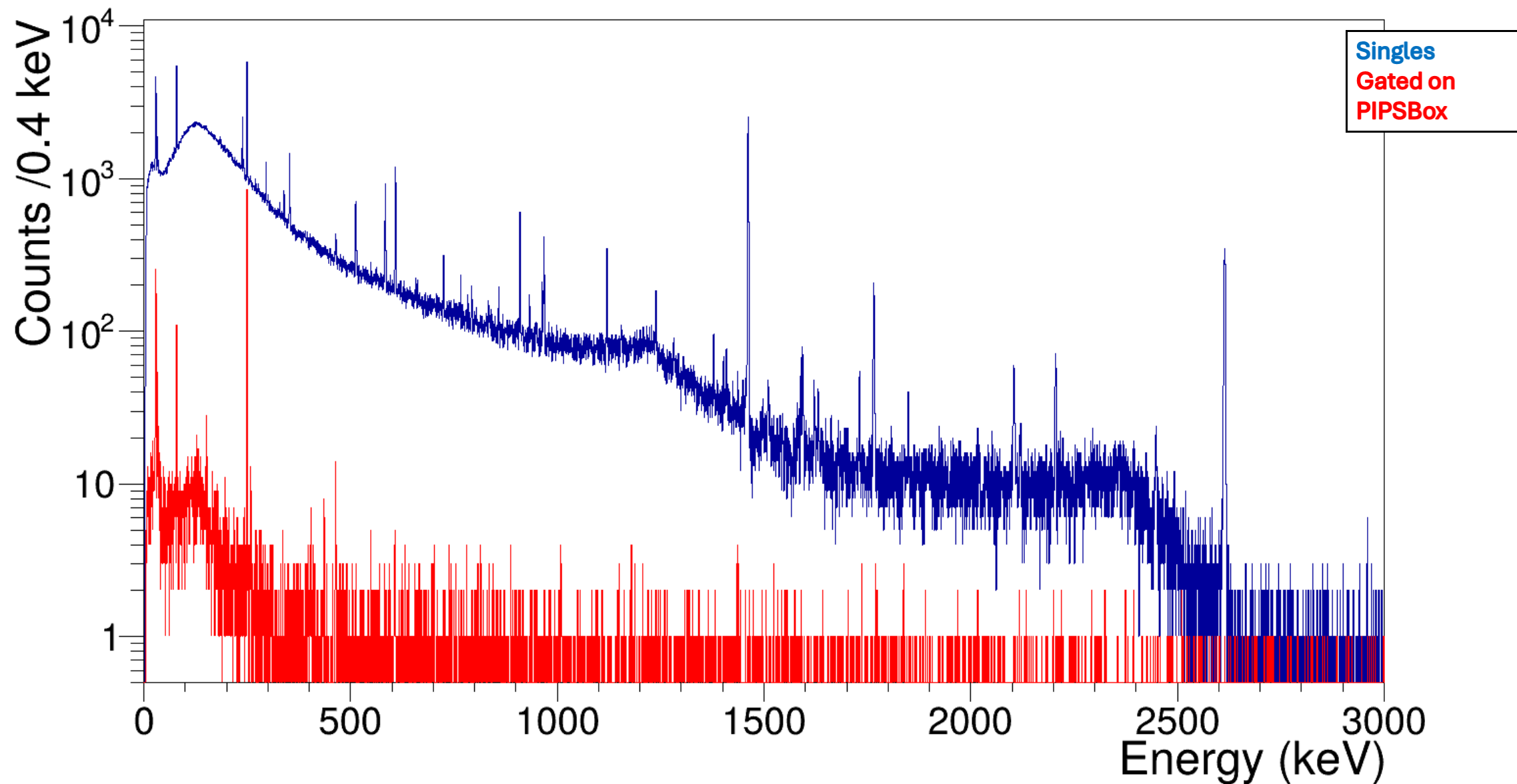
# $^{248}\text{Cm}(\text{SF})$ gamma spectra



Nuclear  
Decommissioning  
Authority



UNIVERSITY OF  
SURREY



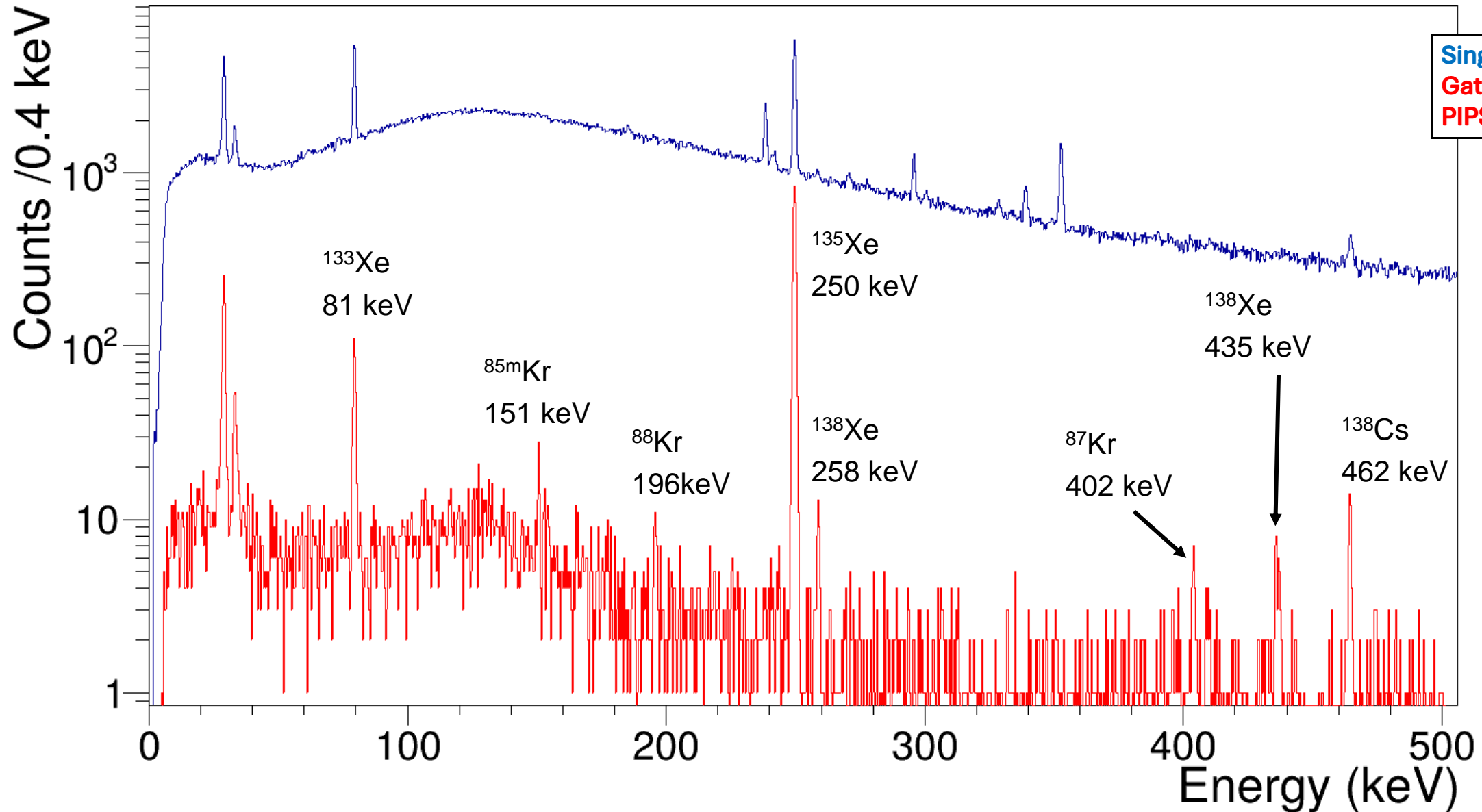
# $^{248}\text{Cm}(\text{SF})$ gamma spectra



Nuclear  
Decommissioning  
Authority



UNIVERSITY OF  
SURREY



# $^{88}\text{Kr} : ^{135}\text{Xe}$ ratio



Nuclear  
Decommissioning  
Authority



UNIVERSITY OF  
SURREY



$^{235}\text{U}(\text{n,f})$		$^{248}\text{Cm}(\text{SF})$
1 : (0.0584 ± 0.0035)	<i>Singles</i>	
1 : (0.0762 ± 0.0048)	<i>All beta</i>	
1 : (0.0610 ± 0.0043)	<i>100-150 keV beta gate</i>	
1 : (0.0768 ± 0.0054)	<i>150-200 keV beta gate</i>	1 : (17.4 ± 5.6)
1 : (0.1092 ± 0.0079)	<i>200-300 keV beta gate</i>	<i>Gated</i>
1 : (0.084 ± 0.010)	<i>300-400 keV beta gate</i>	
1 : (0.0671 ± 0.0072)	<i>300+ keV beta gate</i>	



**Any questions?**