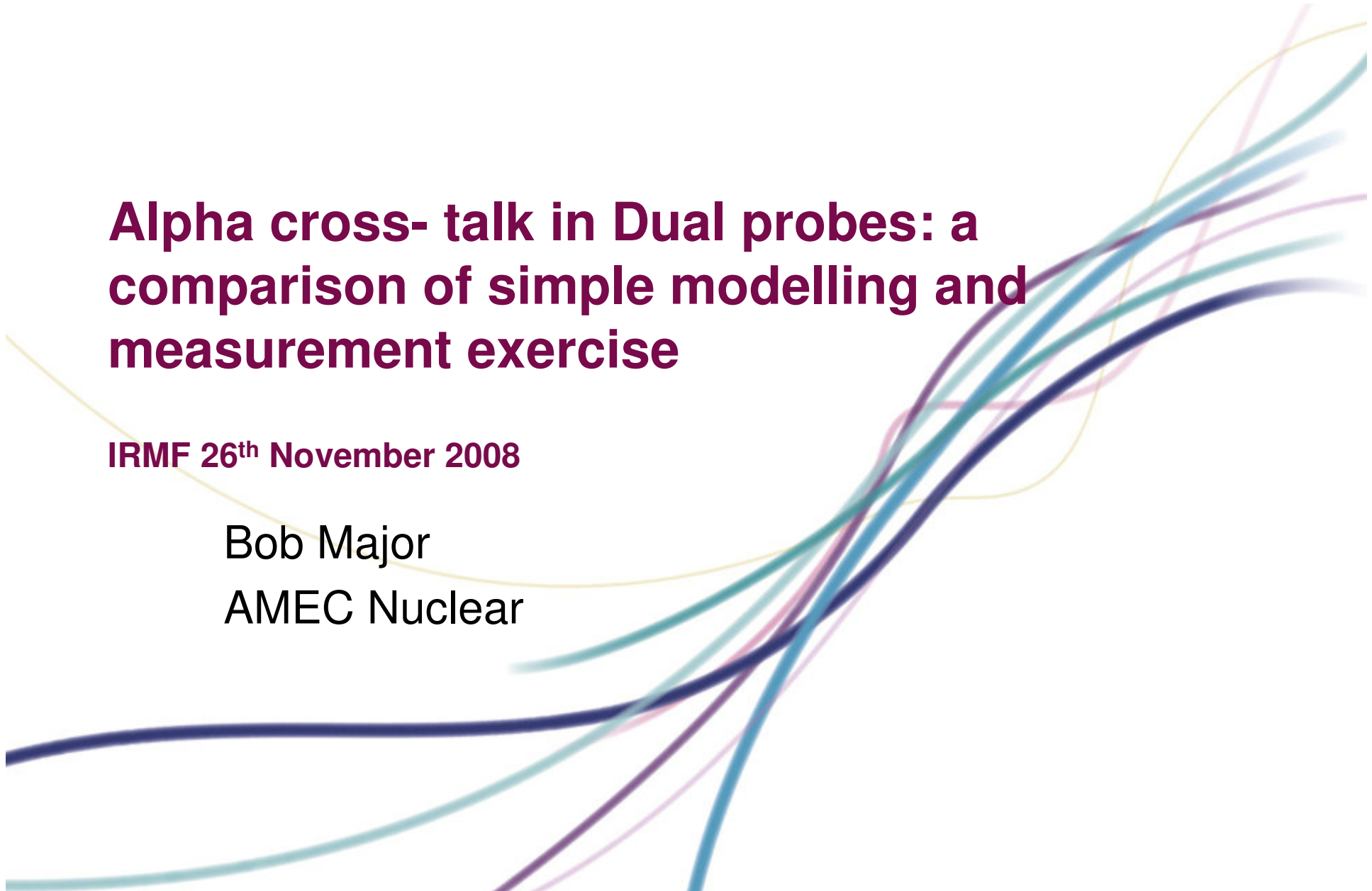


Alpha cross- talk in Dual probes: a comparison of simple modelling and measurement exercise

IRMF 26th November 2008

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AMEC Nuclear



Content

- Introduction
- Why did we do it
- What did we do
- Results
- Conclusions
- Acknowledgements

Why?

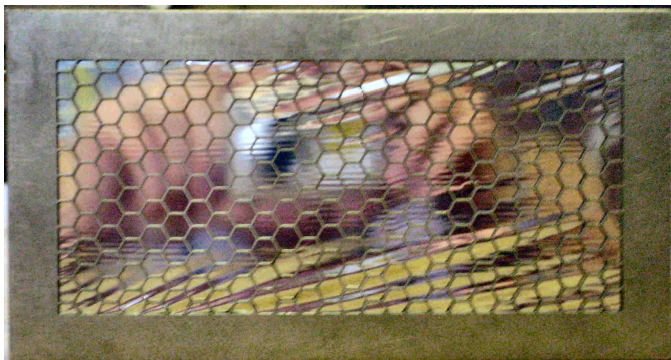
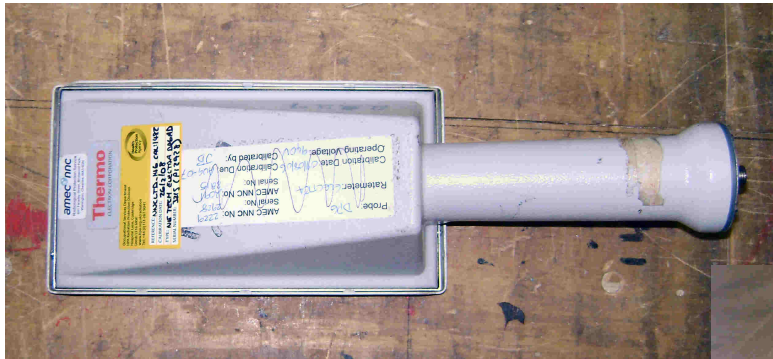
- 2 reasons
- Can we use our modelling capability for non standard radiations, i.e. not n, p or e
- Can we produce any useful information?
 - Infer any useful information on instrumentation responses
 - Derivation of P factors for non standard sources ,e.g. porous materials

What

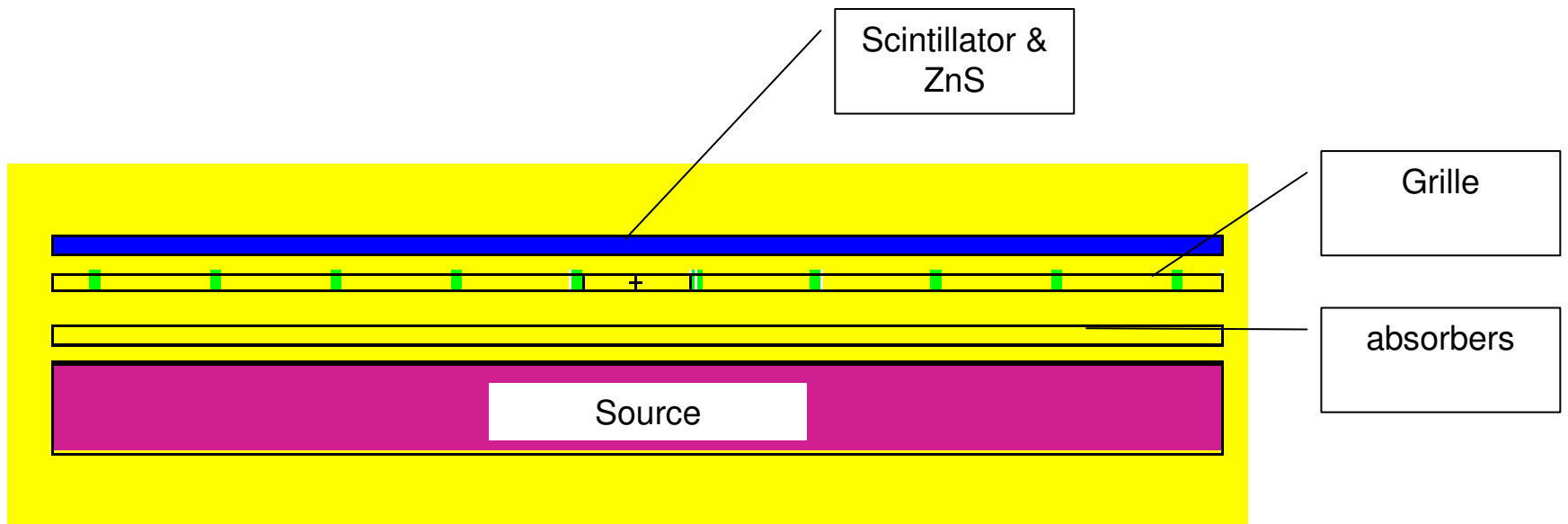
- Modelling: Use of MCNPX
 - Simple Model of DP6
 - Track alpha particle interactions in phosphor and scintillation layer
 - (note no account of electronics/pulse height/shape taken into account)

- Measurement: use of Pluslink to measure DP6 response
 - Plateau
 - Response of Am241 in alpha and beta windows
 - Bare source and with thin absorber (clingfilm)
 - Co60 and C14 also measured

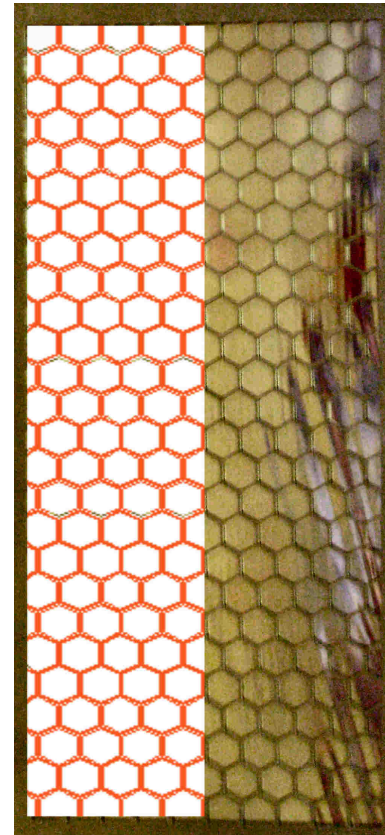
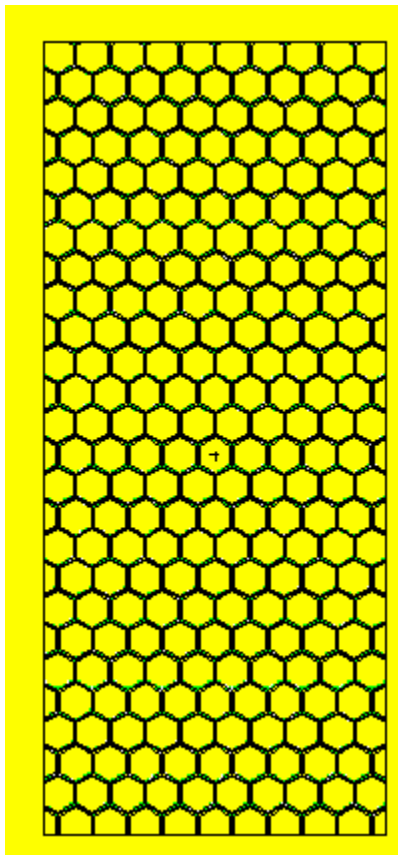
DP6 Probe



DP6 model: section across centre line

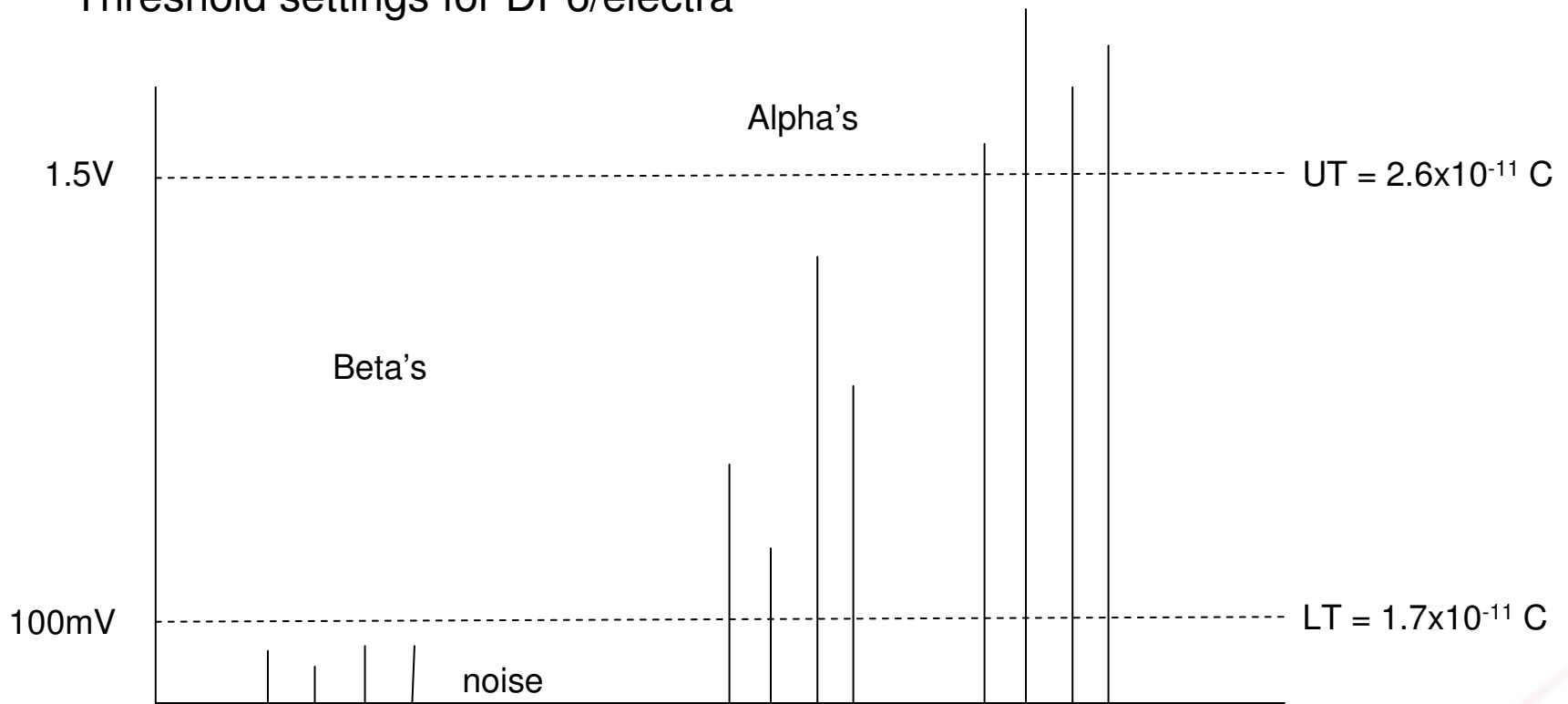


DP6 model: plan view of grille



DP6 measurements

- Threshold settings for DP6/electra



Plus links results

- Am241 results E = 5.4 MeV

HV	Background		Americium-241		%Eff 241Am		Americium-241 (cf)		%Eff 241Am (cf)	
	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha
600	0	0	29	0	29%	0%	15	0	15%	0%
620	0	0	29	0	29%	0%	17	0	17%	0%
640	0	0	32	0	32%	0%	19	0	19%	0%
660	0	0	31	1	31%	1%	20	0	20%	0%
680	0	0	30	5	30%	5%	22	0	22%	0%
700	1	0	26	11	25%	11%	22	1	21%	1%
720	1	0	20	14	19%	14%	21	3	20%	3%
740	2	0	16	22	14%	22%	17	6	15%	6%
760	2	0	12	22	10%	22%	14	11	12%	11%
780	4	0	9	29	5%	29%	14	15	10%	15%
800	4	0	9	28	5%	28%	12	14	8%	14%
820	4	0	7	31	3%	31%	11	18	7%	18%
840	4	0	8	31	4%	31%	9	18	5%	18%
860	5	0	8	33	3%	33%	9	19	4%	19%
880	6	0	8	34	2%	34%	8	21	2%	21%
900	5	0	8	33	3%	33%	9	21	4%	21%
920	7	0	11	35	4%	35%	8	21	1%	21%
940	6	0	19	33	13%	33%	9	21	3%	21%
960	6	0	31	34	25%	34%	13	22	7%	22%
980	7	0	64	39	57%	39%	21	22	14%	22%
1000	7	0	105	36	98%	36%	40	25	33%	25%
1020	8	0	182	43	173%	43%	61	26	53%	26%
1040	8	1	248	41	239%	40%	96	26	88%	25%
1060	9	1	383	51	373%	50%	144	29	135%	28%
1080	9	1	459	47	449%	46%	192	30	182%	29%
1100	10	2	632	54	620.0%	52%	271	32	260%	30%

Modelling Results

- Am241 results from simple model

	%Eff 241Am		%Eff 241Am (cf)	
	Beta	Alpha	Beta	Alpha
900V	3%	33%	4%	21%
MCNPX				
calc'd 4pi	7	17	2	12
equivalent 2 pi	14	34	5	23

- Good agreement (surprisingly!) for alpha efficiency
- Not so good for alpha in beta channel (thickness of ZnS phosphor?)

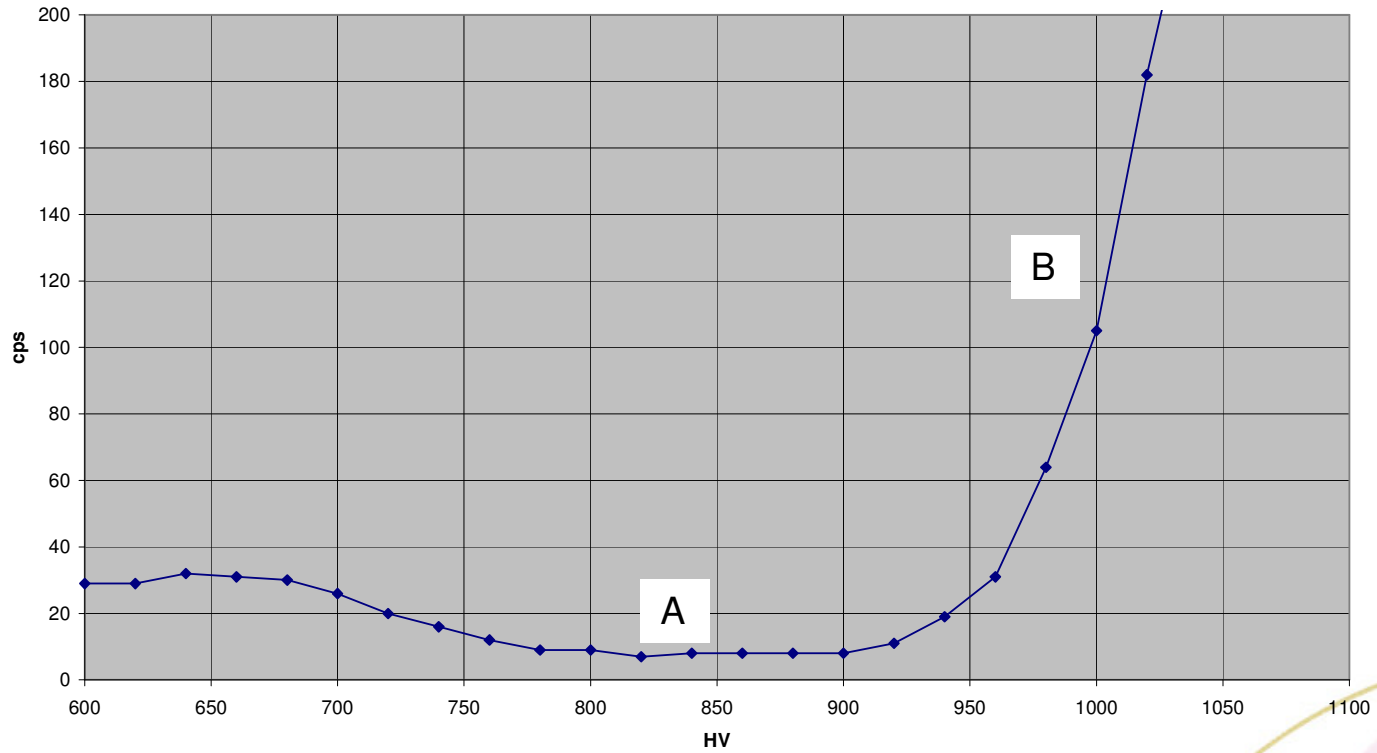
Modelling Results

- Also varied energy of alpha emission
- Found fraction penetrating ZnS into BC400 increased with increase in alpha energy

Results

- Am241: count rate in beta channel vs HV

Am 241 :count rate in beta channel vs HV



Question

- Why doesn't A fall to zero?
 - Model indicates you don't get complete absorption of alphas in ZnS
 - BC400 good alpha response cf BP19 response
 - But
 - Inspection of measured beta contribution appears independent of absorber thickness whereas the model results predict a reduction to $1/3^{\text{rd}}$
 - Therefore due to gammas from Am241?



Question

- Why B, alpha in beta takeoff?
- Low amplitude alpha pulses in BC400 being amplified to push them above the 100mV lower threshold?

Beta response

- Co-60 (measured) $E_{av} = 96 \text{ keV}$, $E_{max} = 318 \text{ keV}$

HV	Cobalt-60		% Eff 60Co		Cobalt-60 (cf)		% Eff 60Co (cf)	
	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha
600	0	0	0%	0%	0	0	0%	0%
620	0	0	0%	0%	0	0	0%	0%
640	0	0	0%	0%	0	0	0%	0%
660	0	0	0%	0%	0	0	0%	0%
680	1	0	1%	0%	1	0	1%	0%
700	2	0	1%	0%	3	0	2%	0%
720	3	0	2%	0%	3	0	2%	0%
740	5	0	2%	0%	5	0	2%	0%
760	10	0	7%	0%	9	0	6%	0%
780	13	0	7%	0%	11	0	6%	0%
800	16	0	10%	0%	14	0	8%	0%
820	19	0	12%	0%	17	0	11%	0%
840	21	0	14%	0%	20	0	13%	0%
860	24	0	16%	0%	23	0	15%	0%
880	24	0	15%	0%	25	0	16%	0%
900	28	0	19%	0%	24	0	16%	0%
920	26	0	16%	0%	26	0	16%	0%
940	31	0	21%	0%	29	0	19%	0%
960	32	0	22%	0%	29	0	19%	0%
980	34	0	22%	0%	31	0	20%	0%
1000	35	1	23%	1%	32	1	21%	1%
1020	40	2	27%	2%	35	1	22%	1%
1040	41	2	27%	1%	38	1	25%	0%
1060	45	3	30%	2%	42	2	27%	1%
1080	46	4	31%	2%	44	4	29%	2%
1100	52	6	35%	3%	52	7	35%	4%

Beta response

- Co-60 (modelled)

	%Eff 60Co		%Eff 60Co (cf)	
	Beta	Alpha	Beta	Alpha
900V	19%	0%	16%	0%
MCNPX				
calc'd 4pi	11	19	10	17
equivalent 2 pi	22	37	20	34

- Poor agreement with alpha channel response but note model doesn't account for pulse shape
- Good agreement with beta efficiency

Beta response

- C-14 (measured) $E_{av} = 49 \text{ keV}$, $E_{max} = 156 \text{ keV}$

HV	Carbon-14		% Eff 14C		Carbon-14 (cf)		% Eff 14C (cf)	
	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha
600	0	0	0%	0%	0	0	0%	0%
620	0	0	0%	0%	0	0	0%	0%
640	0	0	0%	0%	0	0	0%	0%
660	0	0	0%	0%	0	0	0%	0%
680	0	0	0%	0%	0	0	0%	0%
700	0	0	0%	0%	1	0	0%	0%
720	0	0	0%	0%	1	0	0%	0%
740	1	0	0%	0%	1	0	0%	0%
760	2	0	0%	0%	2	0	0%	0%
780	4	0	0%	0%	2	0	0%	0%
800	10	0	0%	0%	5	0	0%	0%
820	24	0	1%	0%	13	0	0%	0%
840	44	0	1%	0%	24	0	1%	0%
860	72	0	2%	0%	33	0	1%	0%
880	91	0	2%	0%	48	0	1%	0%
900	106	0	3%	0%	60	0	1%	0%
920	136	0	3%	0%	72	0	2%	0%
940	168	0	4%	0%	98	0	2%	0%
960	206	0	5%	0%	118	0	3%	0%
980	265	0	7%	0%	150	0	4%	0%
1000	333	0	8%	0%	182	0	4%	0%
1020	412	0	10%	0%	226	0	6%	0%
1040	512	1	13%	0%	284	0	7%	0%
1060	614	1	16%	0%	336	0	8%	0%
1080	725	1	18%	0%	402	1	10%	0%
1100	874	1	22%	0%	480	1	12%	0%

Beta response

- C-14 (modelled)

	%Eff 14C		%Eff 14C (cf)	
	Beta	Alpha	Beta	Alpha
900V	3%	0%	1%	0%
MCNPX				
calc'd 4pi	3	9	2	7
equivalent 2 pi	6	18	4	14

- Poor agreement with alpha channel response but note model doesn't account for pulse shape
- Not so good agreement with beta efficiency

Conclusion

- Simple model gave good agreement between Am241 model and measured alpha response
- Reasonable agreement with Co60 beta in beta channel
- Identification of mechanism for some features in HV alpha in beta curve
- Derivation of P factors for non standard sources ,e.g. porous materials
 - – possible ..but..
- Difficult to measure thickness of Clingfilm with micrometers.
- Areas of further work
 - Sensitivity to ZnS thickness
 - Repeat with thicker absorberr

Acknowledgements

- Robin Crosse and Chris Knight, Thermo
- Jen Barnes AMEC