

The image features a blue university crest centered at the top. The crest consists of a shield with a crown on top, supported by two lions. The shield itself has a white background with a blue border and contains a blue and white geometric pattern. The text "Dual phosphor probe setup" is overlaid in red, bold, serif font across the middle of the crest.

Dual phosphor probe setup

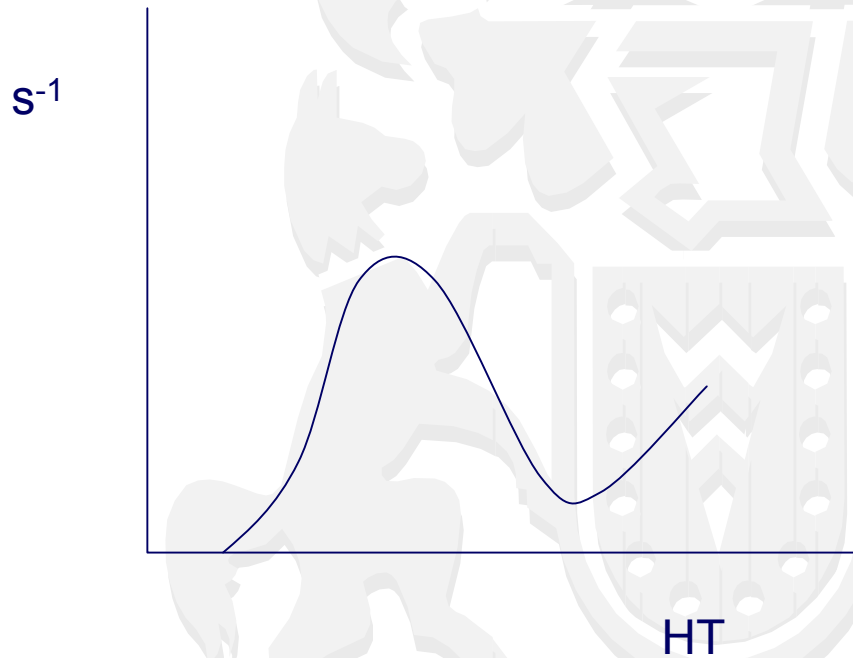
Pete Burgess

Current standard approach 1

- Used with Thermo DP probes
- Set the alpha threshold at 15 times the beta threshold
- Use an Am-241 or Pu-238 alpha source 3mm from the probe face
- Set the ratemeter on the beta range
- Increase the high voltage. The count rate increases, then falls and then increases.
- The correct HV is at the count rate minimum

Example

- Count rate in beta channel



What's happening?

- At low HTs, the gain is low and the alpha interactions go into the beta channel
- As the HT, and hence the gain, increases, an increasing fraction goes into the alpha channel and the beta count rate falls.
- Beyond a given point, the beta count rate rises because of double pulse counting?
- And, ultimately, rise in noise.

Current standard approach 2

- The same 15:1 alpha/beta threshold ratio
- Use a Sr-90 + Y-90 source at 3 mm.
- Select the alpha channel.
- Increase the HT until the Sr-90 + Y-90 is just ($<0.1\%$) breaking through into the alpha channel
- Both methods give results within 25 volts normally

Result

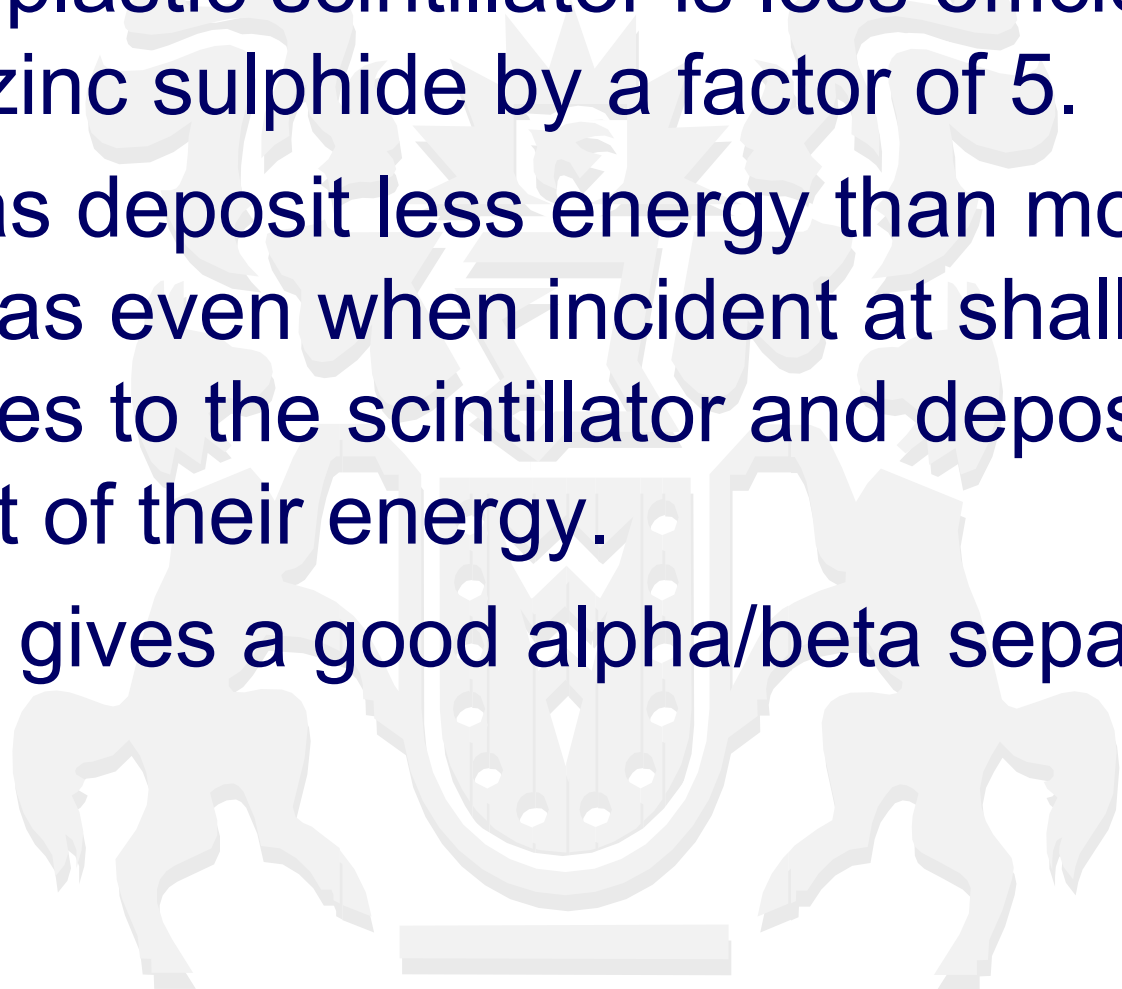
- Alpha activity is well onto its plateau for calibration sources and contamination of clean surfaces
- Energetic beta activity is also well onto its plateau
- Minimum useful beta energy is at or about Co-60, which is still off its plateau. Increasing the HT will improve the Co-60 response but put betas into the alpha channel.

Physics background 1

- Alphas are stopped in the zinc sulphide. This is an efficient scintillator which, combined with the high alpha maximum energy, produces a large pulse.
- Betas deposit some energy in the zinc sulphide but most ends up in the relatively thick plastic scintillator. For high energy betas at normal incidence, the minimum energy deposited is 200 keV.
- These cross and escape with most energy remaining

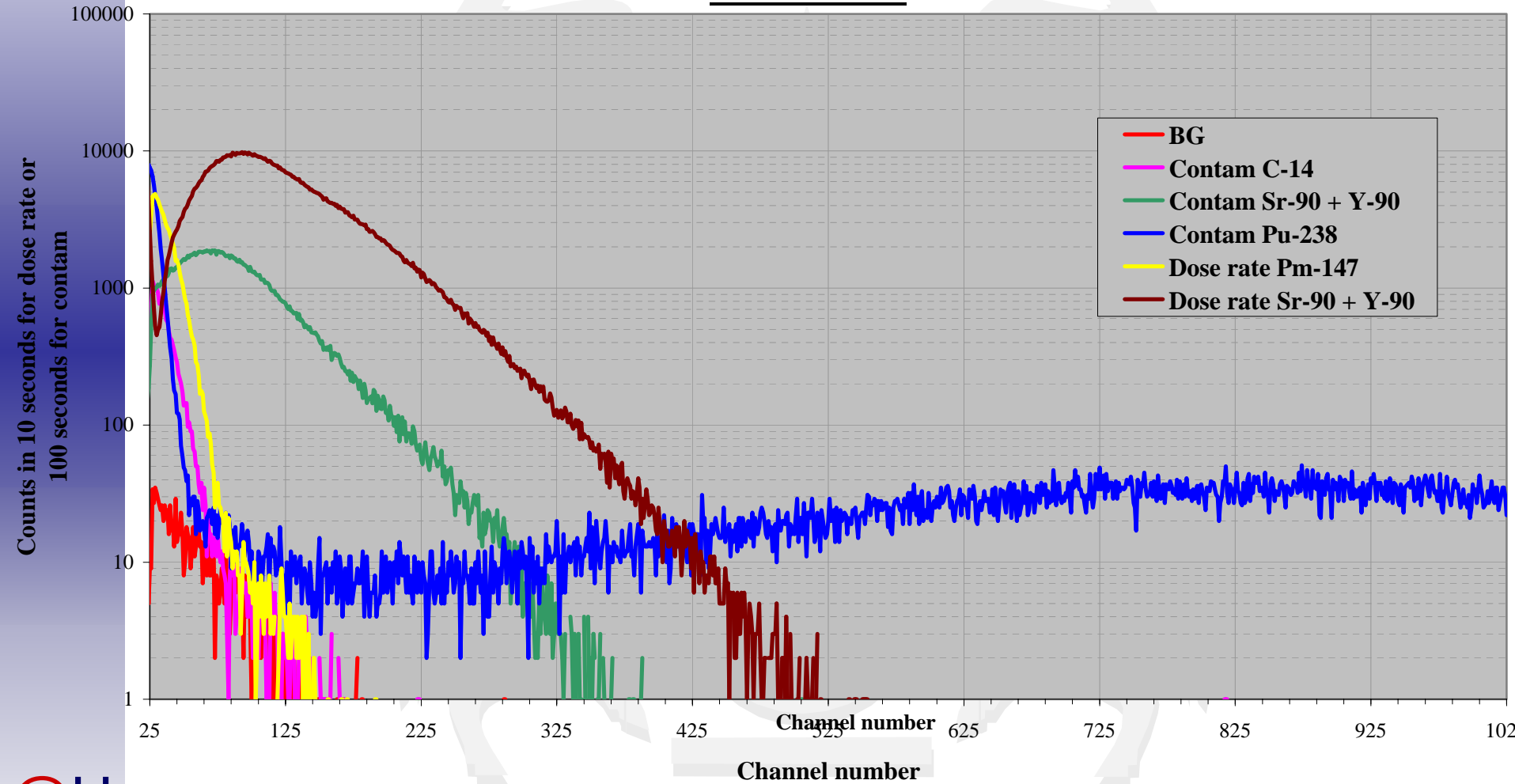
Physics background 2

- The plastic scintillator is less efficient than the zinc sulphide by a factor of 5.
- Betas deposit less energy than most alphas even when incident at shallow angles to the scintillator and depositing most of their energy.
- This gives a good alpha/beta separation



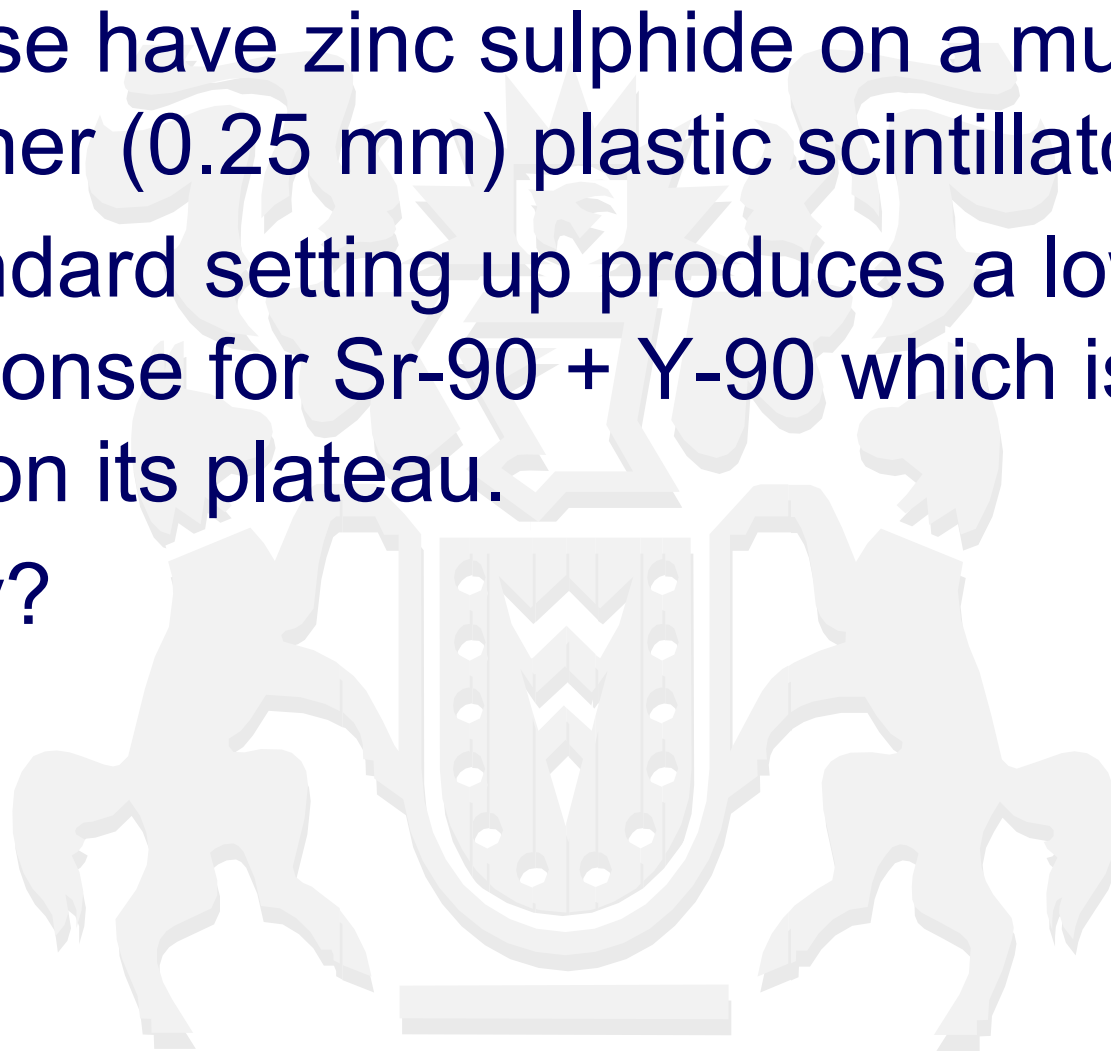
MCA results for a DP6

Contam Pu-238



Ludlum dual phosphor probes

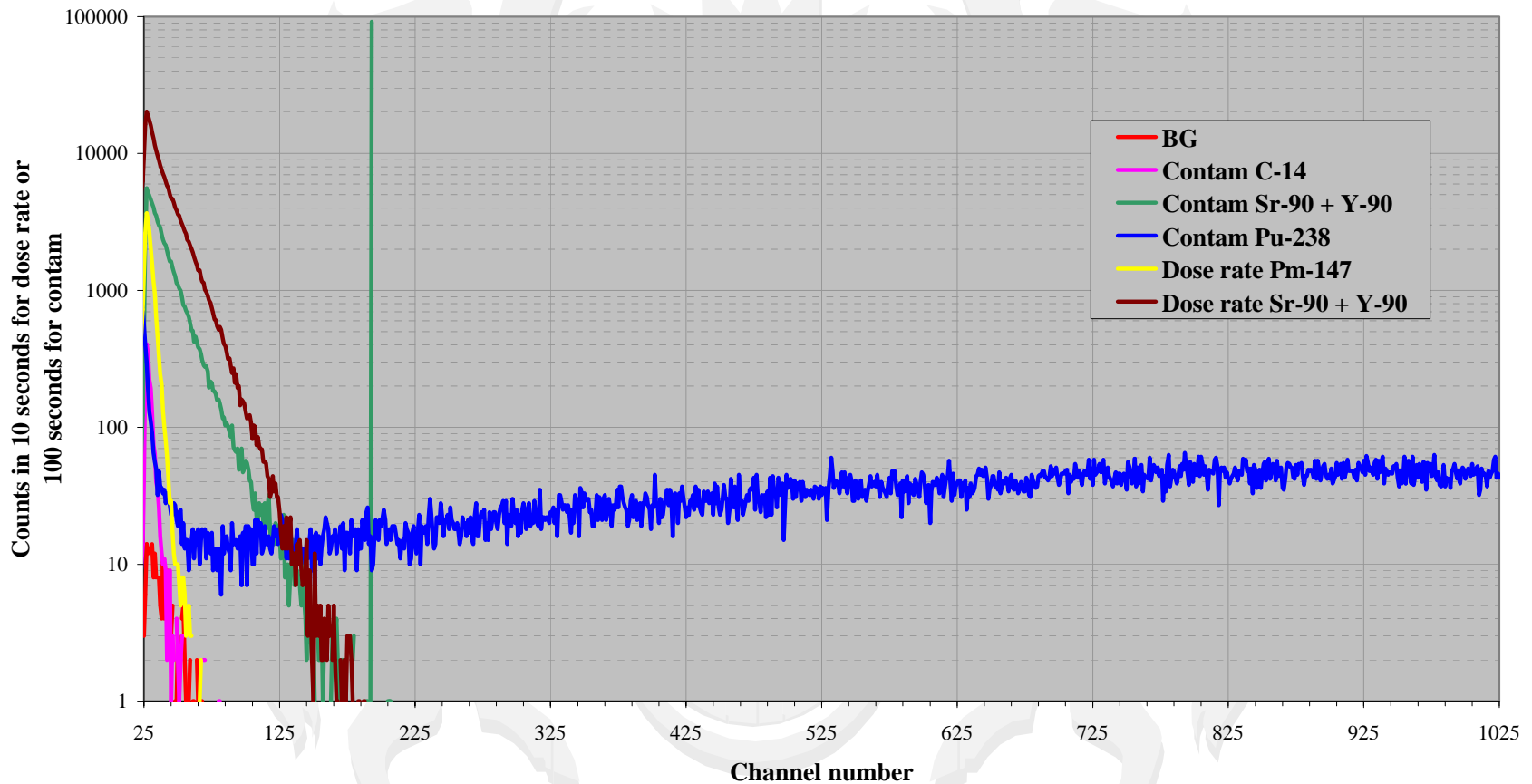
- These have zinc sulphide on a much thinner (0.25 mm) plastic scintillator.
- Standard setting up produces a low response for Sr-90 + Y-90 which is also not on its plateau.
- Why?



Ludlum dual beta characteristics

- The plastic scintillator is much thinner, 0.25 mm compared to 1 mm.
- Normal incidence high energy betas will only deposit about 50 keV
- The overall beta efficiency is lower when compared to the alpha signal.
- Using a 15:1 alpha/beta threshold means these pulses may be below the beta threshold.

MCA results for a Ludlum dual phosphor



The solution

- Increase the alpha threshold to 22.5:1. This corresponds to lowering the beta channel energy threshold.
- This allows detection of the high energy beta pulses.
- Higher would be better, allowing detection of lower energy beta particles which stop in the scintillator, e.g. C-14
- Not used because the beta channel count rate, when exposed to alphas, climbs rapidly as the effective beta threshold energy is reduced.
- Gamma sensitivity also increases

Cause of this effect?

- Amplifier overload caused by very large alpha pulses? The beta threshold will be less than 1% of the alpha pulse max.
- Genuine signal from the detector produced by slow decays in the zinc sulphide?
- Some manufacturers inhibit the beta channel for a period after an alpha pulse, getting rid of this effect

UKAEA and RWE Nukem method

- Set alpha:beta threshold at 22.5
- Use a C-14 source at 3 mm. Increase HT until the detection efficiency for 2π emission = 3%
- This gives good alpha/beta separation both ways and a well-defined low energy end to the beta response
- Possibly dependent on the exact geometry

Acknowledgements

- Mike Renouf (BNG) for stimulating the making of the spectral measurements and for being right about the lower beta efficiency.
- Chris Hill (HPA-RPD) for making the measurements
- Reg Bosley (RWE-Nukem) for facilities generally
- Bill Snooks (Pycko) for equipment