

# Anomalous behaviour of VPTs

Addendum: behaviour of two VPTs at 4T

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## 1. Introduction

Two of the tubes showing anomalous behaviour at 1.8T (bar-code numbers 1118 and 1133) have been tested at 4T. Measurements have been performed at angles from  $0^\circ$  to  $15^\circ$  to the field in the 4T superconducting magnet at Brunel University. These tubes show spikes and multiple peaks respectively at 1.8T. The data presented here show that the irregular behaviour seen at 1.8T is also present at 4T, the field at which the devices will operate in CMS.

## 2. VPT 1118

Figure 1 shows the variation in resolution, defined as (peak width)/(signal size), with angle for VPT 1118 at 1.8T. The noisy behaviour is clearly seen in the range from  $-26^\circ$  to  $-10^\circ$ , and also intermittently at positive angles. The corresponding data at 4T is shown in Figure 2. Excessive noise is still visible, though over a more limited angular range.

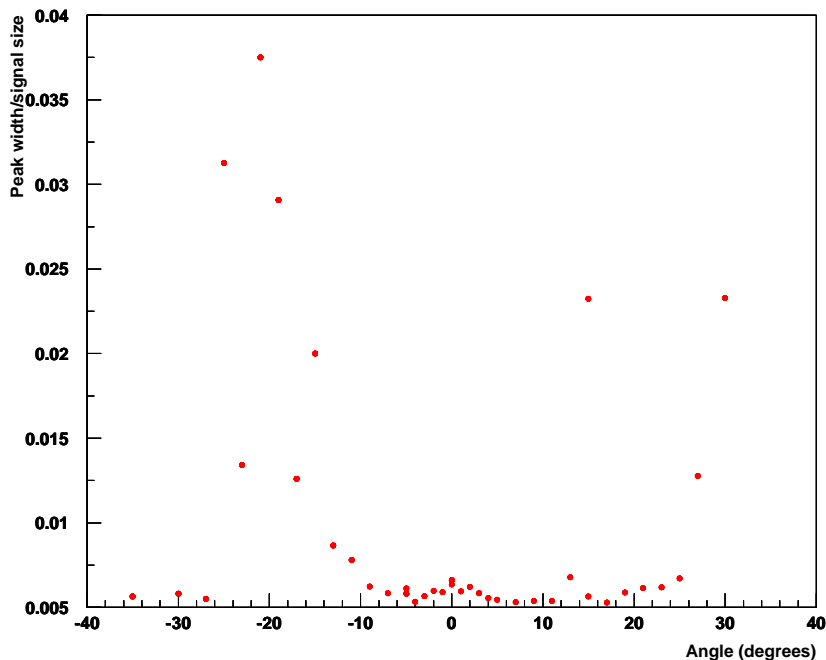
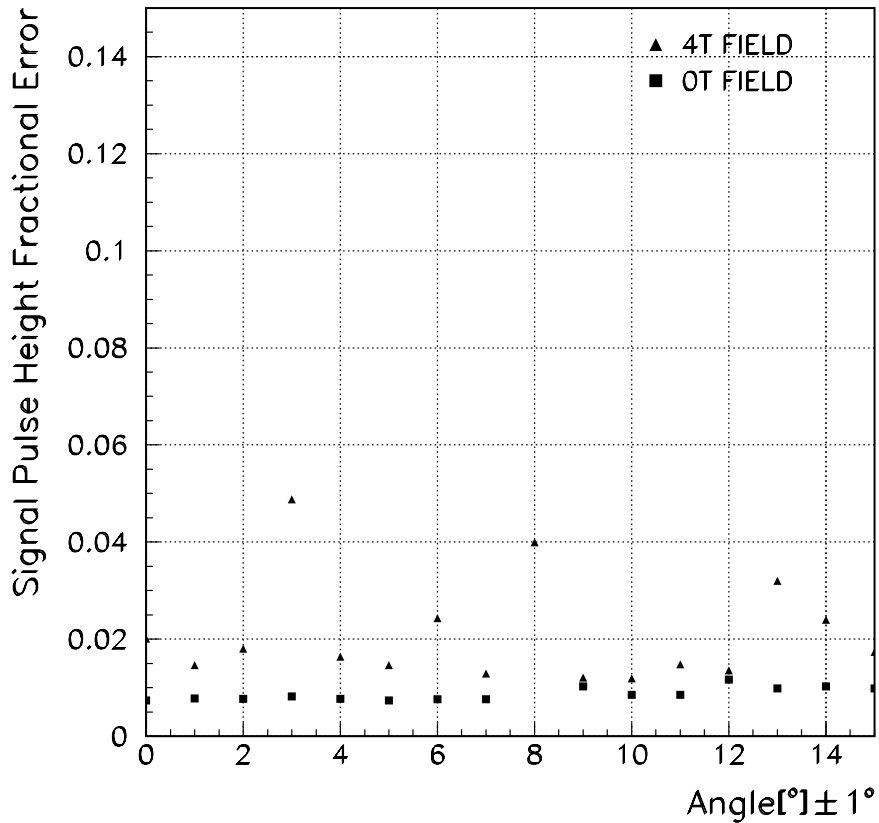


Figure 1. Resolution v angle for VPT 1118 at 1.8T

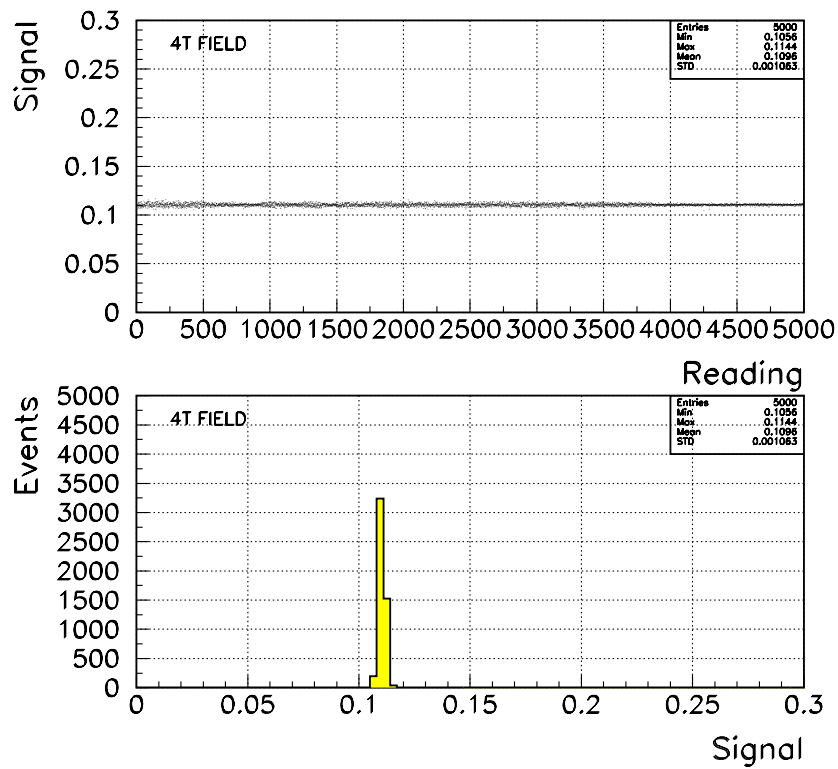
# VPT 1118



**Figure 2. Resolution v angle for VPT 1118 at 4T.**

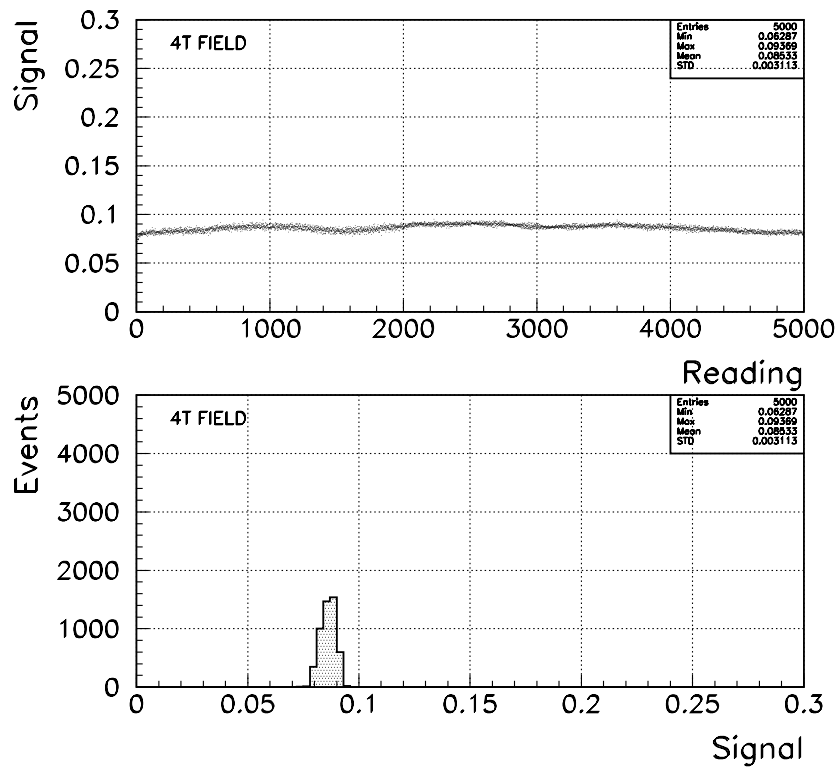
The next three figures show the signal event-by-event at 4T at three angles. Firstly, Figure 3 is the VPT response at 2°. The response is flat as a function of time, and the corresponding point in Figure 2 shows that the resolution is good. However, at 3° the VPT becomes unstable. The data, shown in Figure 4, fluctuate significantly as a function of time. A slightly different type of variation is seen at 8° (Figure 5); here the VPT response rises sharply after 600 and 2950 events, in each case falling slowly back towards the original level.

### VPT 1118 at 2°



**Figure 3. Response of VPT 1118 at 2° in a 4T field.**

### VPT 1118 at 3°



**Figure 4. Response of VPT 1118 at 3° in a 4T field**

## VPT 1118 at 8°

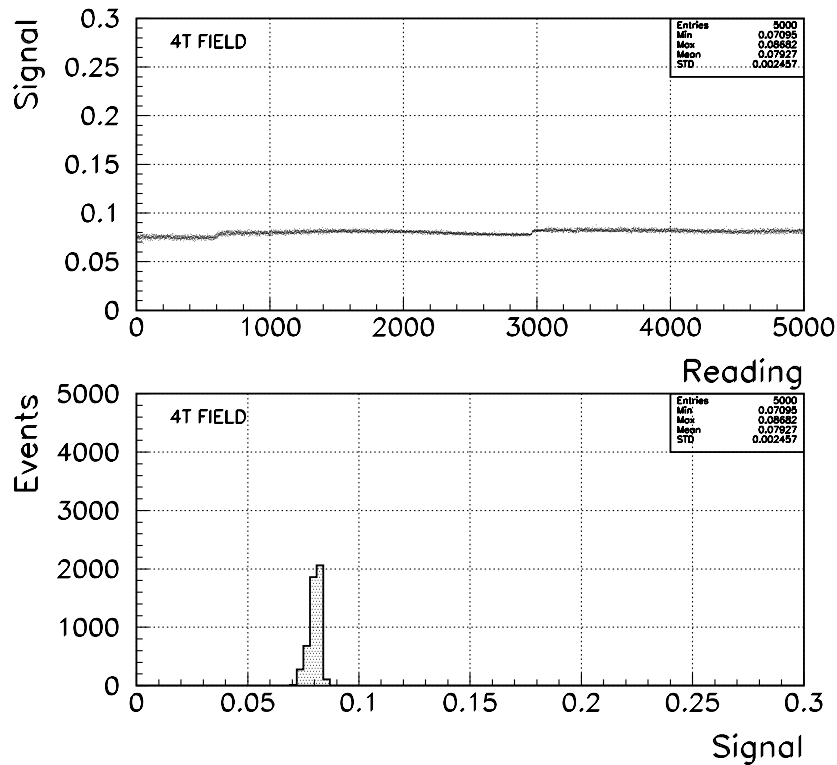


Figure 5. Response of VPT 1118 at 8° in a 4T field.

### 3. VPT 1133

This VPT displays similar behaviour to that seen in VPT 1118. Figure 6 shows the resolution as a function of angle at 1.8T, while the corresponding plot at 4T is shown in Figure 7. At the higher field, the noisy response is again limited to a small number of sharply-defined angle points.

The response at 2° is shown in Figure 8. The resolution at this angle is good, and the VPT output is correspondingly stable as a function of time. At 9°, the response (shown in Figure 9) shows an oscillatory structure for the first 2000 events, followed by a slow fall up to event 4000, and then appears to rise slowly for the remaining 1000 events of the run. The resolution at this angle is very poor.

### 4. Summary

Data have been presented on two VPTs (1118 and 1133) at angle from 0° to 15° in a 4T magnetic field. At certain angles to the field, both of these tubes show anomalies in their response to light pulses of constant intensity. Both VPTs show similar instability in a 1.8T field. The cause of the instability is not yet understood.

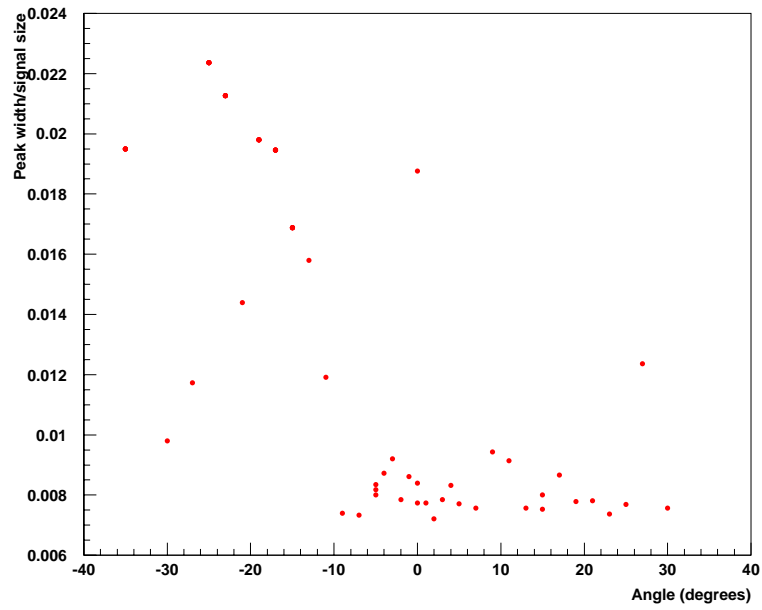


Figure 6. Resolution v angle for VPT 1133 at 1.8T

### VPT 1133

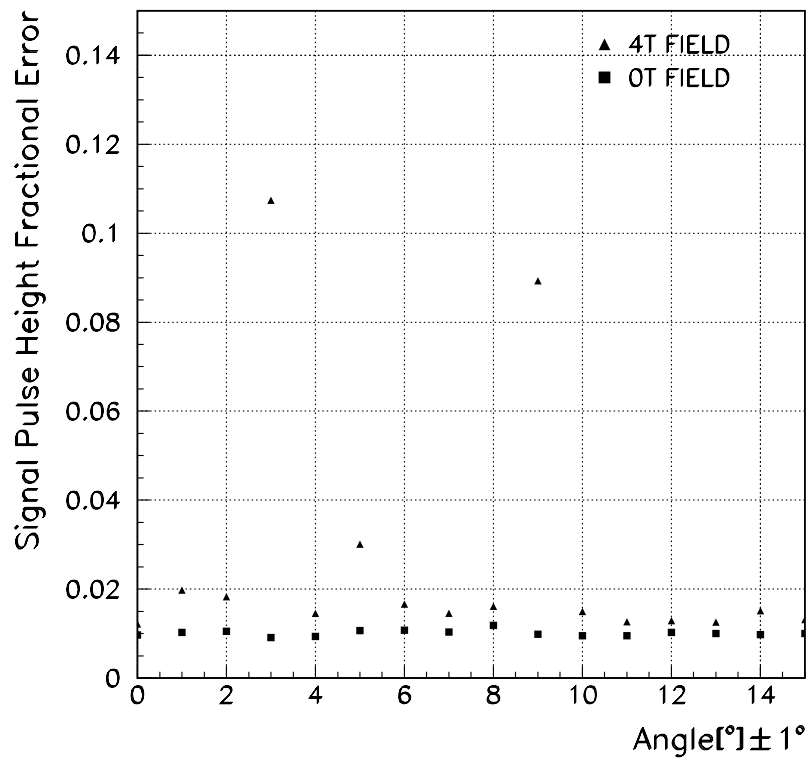


Figure 7. Resolution v angle for VPT 1133 at 4T.

### VPT 1133 at 2°

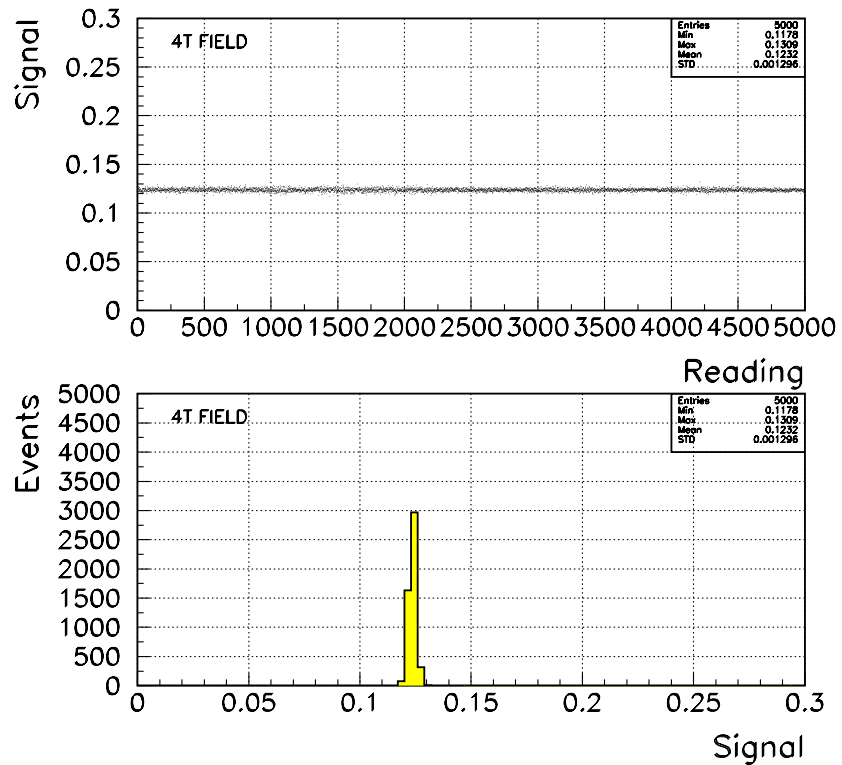


Figure 8. Response of VPT 1133 at 2° in a 4T field.

### VPT 1133 at 9°

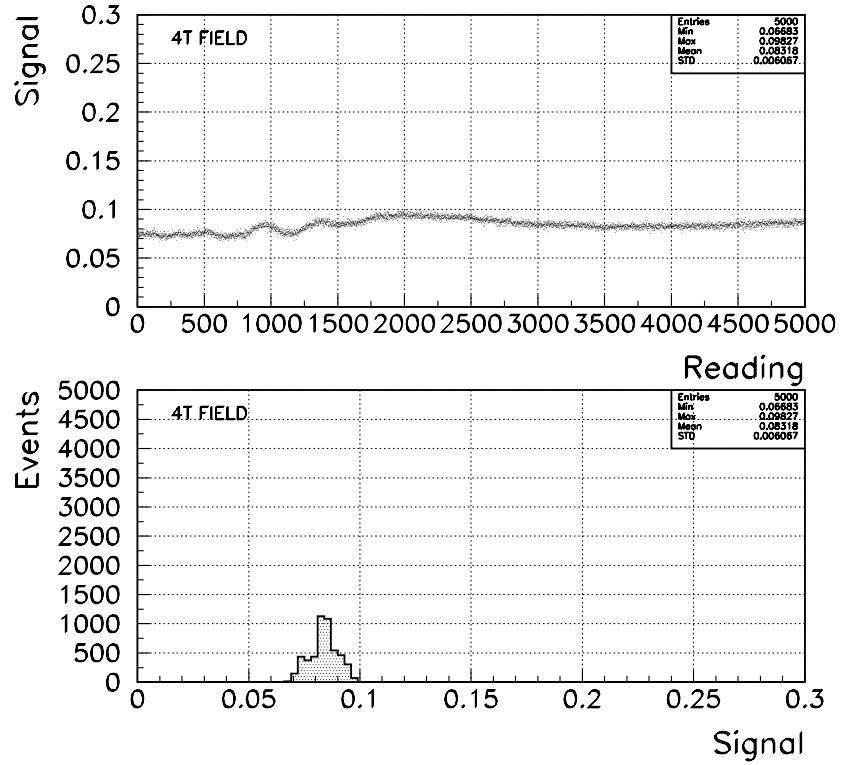


Figure 9. Response of VPT 1133 at 9° in a 4T field.