Analysis of noise in production VPTs at 1.8T

I. VPTs with bar-codes 3501-5000

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1. Introduction

While most of the VPTs supplied by RIE perform satisfactorily in the RAL 1.8T test rig, a minority (less than 10%) display discharges at 1.8T, making them unsuitable for use in the CMS experiment. This note is an interim report summarising the VPTs with bar-codes in the range 3501-5000 which are observed to behave in this way. The complete analysis of all VPTs has been delayed by a technical fault in the RAL test apparatus; this fault has now been corrected, and the measurement programme has resumed. A final report on discharges observed in all of the tubes delivered so far will be compiled as soon as possible.

2. Rapid changes in VPT response

Some VPTs display rapid changes in response during the course of acceptance testing. This is common at low magnetic fields, but most of the VPTs become stable at fields above 1T. However, a small proportion continue to display this behaviour at 1.8T.

2.1 Response of stable VPTs

Figure 1 shows the expected response of a VPT to a sequence of light pulses. The tube was operated under the standard conditions, in a 1.8T magnetic field with the cathode earthed and the dynode and anode at 800V and 1000V respectively. The upper plot shows the VPT response to a set of 5000 light pulses at a frequency of approximately 80Hz, while the lower plot is a histogram of the response. The plot covers a period of approximately 1 minute.

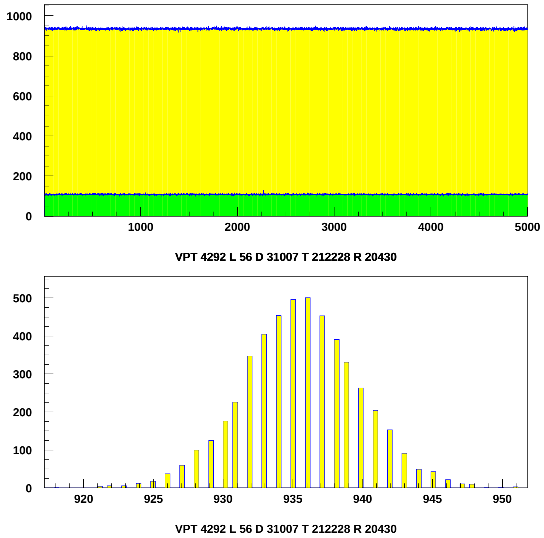

Figure 1. VPT 4292 - constant response to a series of uniform light pulses.

A stable VPT such as this generates a characteristic pattern of response as a function of angle to the magnetic field. Figure 2 shows the complete angle and magnetic-field scans obtained from VPT 4292. The response (shown by solid circles) varies in a periodic manner with angle in a 1.8T magnetic field, and is stable at fields above 1T (with the VPT held at an angle of 15° to they magnetic field). The response at each scan point is Gaussian, as shown in Figure 1, with a Gaussian width of approximately 3 ADC counts (shown by the open symbols, which refer to the scale on the right of the figure).

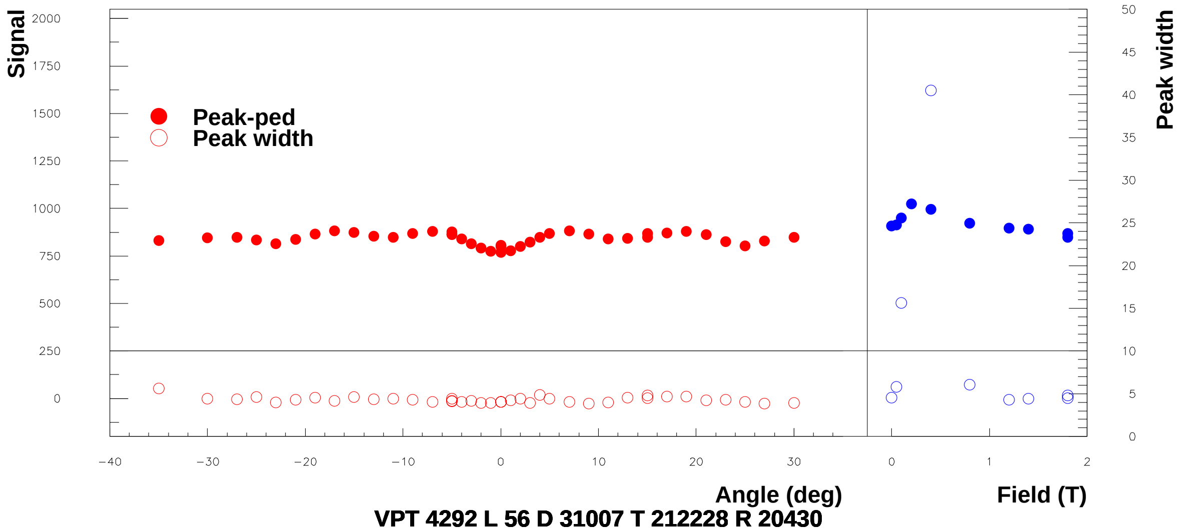

Figure 2. Angle and field scans on VPT 4292.

Some VPTs however display sharp spikes in the measured output, which are attributed to discharges occurring inside the VPT. An example of this behaviour is shown in Figure 3, taken from VPT 4756 at an angle of 17° to the 1.8T magnetic field. These spikes are reproducible over a period of many months, and can be made less severe by reducing the operating voltage of the VPTs, as described in [1].

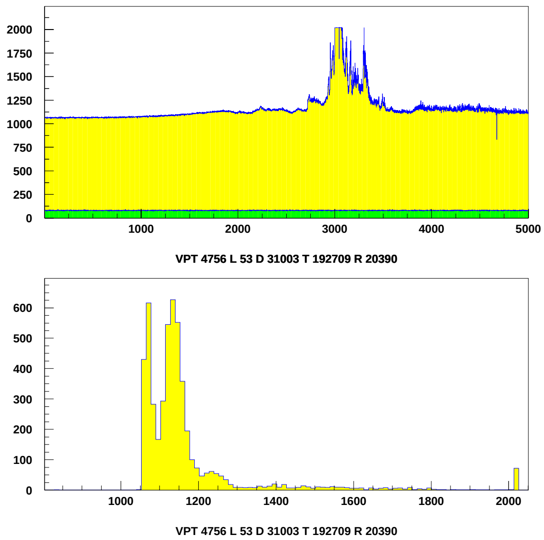

Figure 3. Discharge at an angle of 17° to the magnetic field.

3. VPTs displaying discharges

A list of VPTs showing spikes of the kind illustrated in Figure 3 is given in Table 1. This list covers all tubes with bar-codes in the range 3501-5000. Unfortunately a technical problem in the RAL test rig has held up the re-measurement of some VPTs whose initial tests were ambiguous. This fault has been corrected and the remeasurement programme has resumed. A complete list of noisy VPTs covering the full range of bar-codes delivered so far by RIE will be presented as soon as possible.

Bar-code / Production-number for noisy VPTs					
3511 / 6815	3592 / 6993	3594 / 7005	3610 / 7012	3647 / 7075	3663 / 7019
3704 / 7252	3705 / 7134	3714 / 6636	3744 / 7298	3756 / 7295	3760 / 7279
3762 / 7274	3782 / 6684	3786 / 6293	3798 / 4254	3822 / 7292	3826 / 7329
3833 / 7241	3836 / 7360	3903 / 7087	3904 / 7371	3907 / 5794	3909 / 6887
3911 / 6923	3928 / 7539	3930 / 7556	3932 / 7561	3946 / 7576	3951 / 7590
3956 / 2884	3985 / 7099	4000 / 7619	4010 / 7627	4013 / 7632	4017 / 7648
4046 / 7262	4059 / 7468	4082 / 7673	4090 / 7739	4107 / 7802	4124 / 7332
4150 / 7843	4151 / 7854	4157 / 3406	4205 / 8106	4210 / 7983	4212 / 7281
4221 / 8021	4281 / 8165	4303 / 6287	4314 / 8196	4326 / 8194	4328 / 8215
4336 / 8247	4353 / 8220	4374 / 8301	4377 / 8319	4385 / 8160	4393 / 7989
4399 / 8248	4409 / 8311	4465 / 8376	4490 / 8396	4508 / 8331	4509 / 8381
4517 / 8426	4519 / 8438	4550 / 8443	4551 / 8457	4563 / 8483	4565 / 8514
4568 / 8707	4623 / 8746	4626 / 8773	4642 / 8454	4644 / 8744	4649 / 8784
4650 / 8785	4661 / 8798	4701 / 8820	4705 / 8871	4710 / 8581	4718 / 8623

4731 / 8891	4754 / 8855	4756 / 8901	4758 / 8904	4765 / 8928	4775 / 8850
4784 / 8945	4786 / 8453	4833 / 7053	4844 / 9248	4848 / 8931	4867 / 9259
4899 / 7853	4900 / 7940	4908 / 8353	4945 / 9303	4956 / 9347	4980 / 9364
4983 / 8325					

Table 1. List of VPTs displaying discharges at 1.8T (given as bar-code/production-number).

The distribution of these VPTs as a function of bar-code number is shown in Figure 4. This plot shows very distinct peaks and troughs; this structure may help in understanding the cause of the observed discharges.

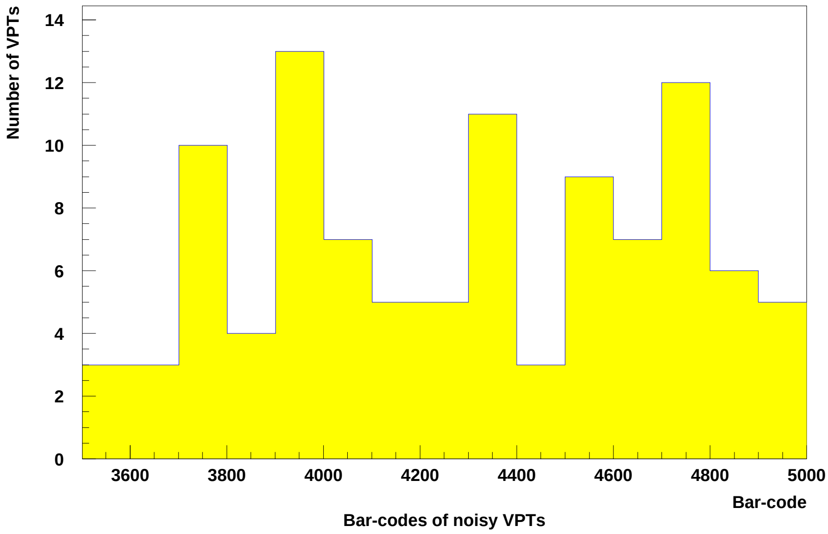

Figure 4. Distribution of bar-codes of noisy VPTs.

4. Summary and conclusions

This note has presented data on the bar-codes and production numbers of all VPTs with bar-codes in the range 3501-5000 which have displayed discharges when measured in the RAL 1.8T test rig. The distribution of these devices in bar-code number is not uniform, and this may help to understand the cause of the discharge behaviour.

5. References

[1] 'Observation of noise in production VPTs at 1.8T', B W Kennedy, 10 February 2003