



Status of VPT measurements at RAL

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EE Jamboree, CERN, 1 April 2003

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Outline



- VPT specification
- VPT delivery schedule
- RAL and Brunel VPT test rigs
- Test procedure
 - ▶ Visual inspection
 - ▶ Measurements in test rig
- Summary of results (1.8T and 4T)
- Discussion of anomalous VPTs



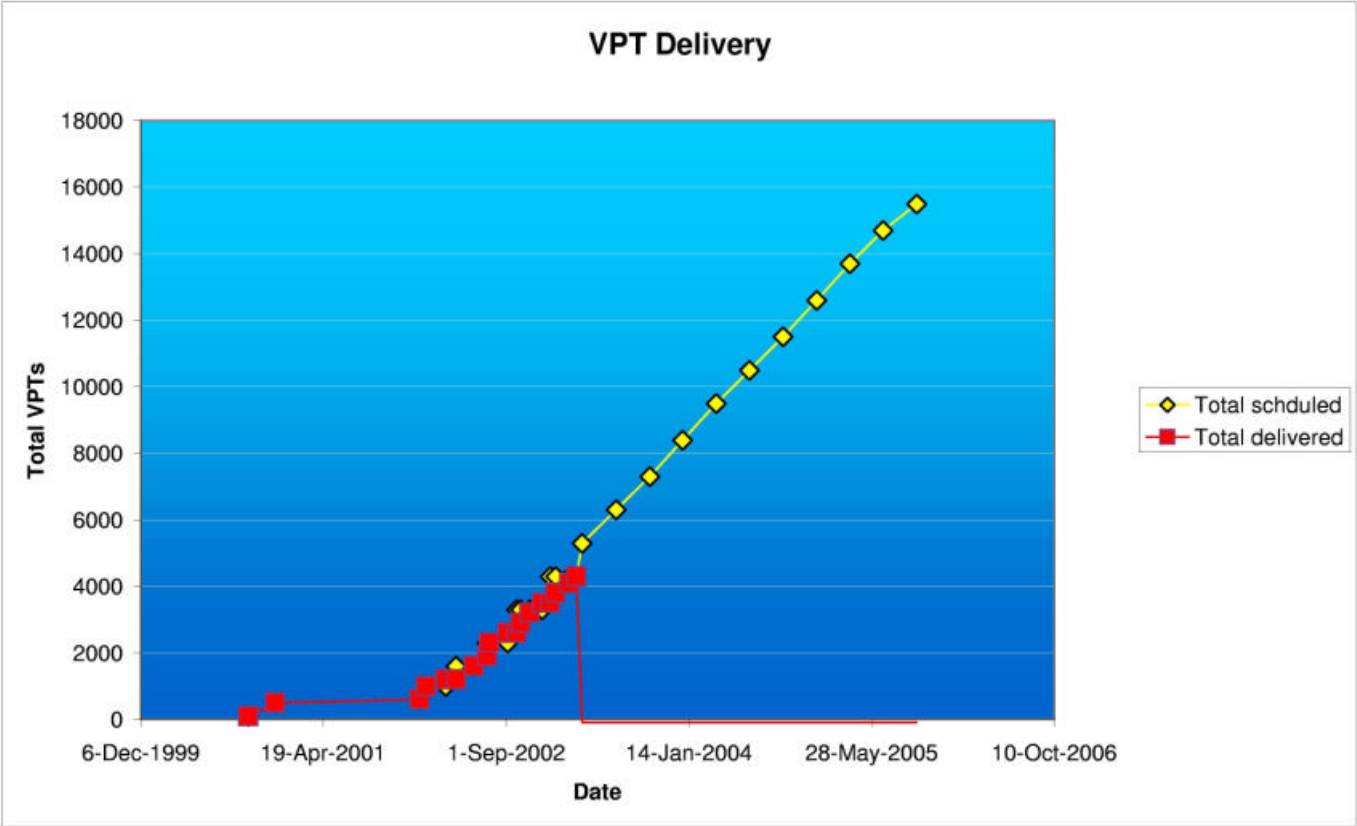
VPT specification



- Faceplate of rad-hard glass
 - ▶ All glass samples tested at Brunel
 - ▶ $< 10\%$ loss after 20kGy, 5×10^{14} n/cm²
- Gain (g) & quantum efficiency (p)
 - ▶ $g \geq 7$ ($V_a = 1000V$, $V_d = 800V$, $V_k = 0$)
 - ▶ $p \geq 0.15$
 - ▶ $1.4 \leq pg < 3.8$
- Loss of response at 4T
 - ▶ $< 20\%$ wrt performance at 0T



VPT deliveries

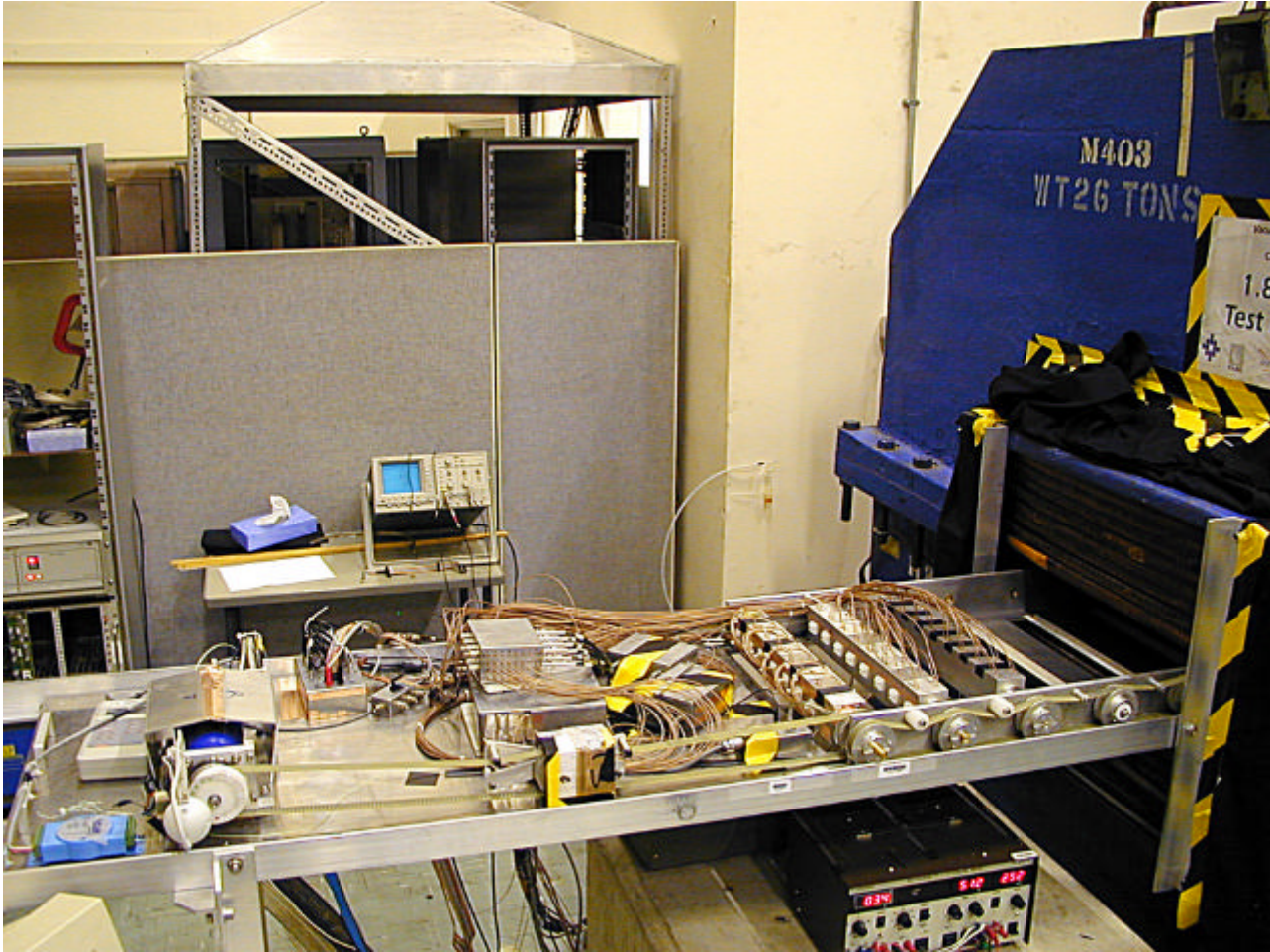


- Manufactured by RIE, St Petersburg

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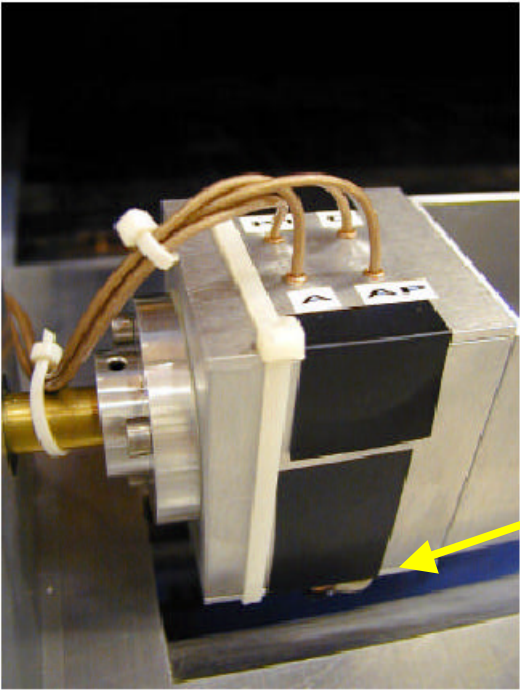
RAL 1.8T test rig



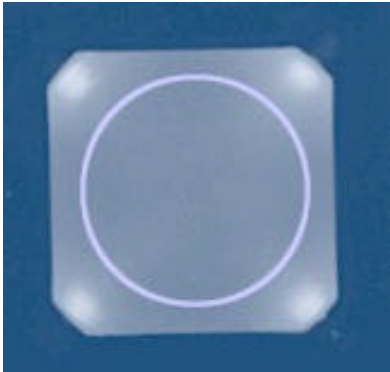
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Details of RAL test rig



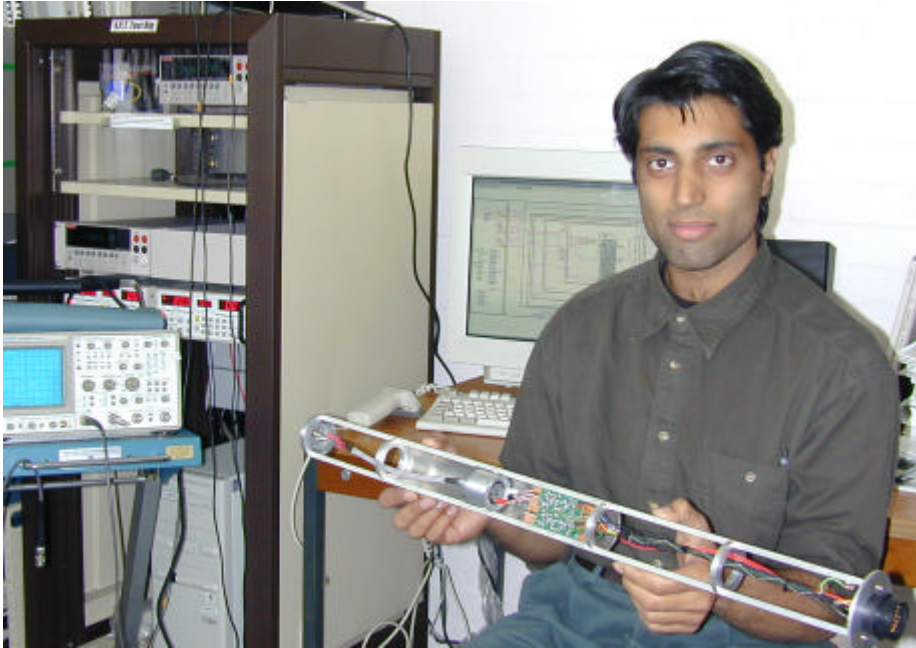
VPT holder



Diffuser plate to ensure uniform illumination



Brunel 4T test rig



System based on 4T
superconducting magnet

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VPT statistics



- Delivered: 4300 (inc 500 pre-production)
- Visual inspection: 4100
- Tested at 1.8T: ~4090
 - ▶ ~10 not tested – could not take high voltage
- Tested in Brunel 4T rig:
 - ▶ 270 production
 - ▶ 185 pre-production



Test procedure 1



- Visual inspection
 - ▶ Photocathode uniformity
 - ▶ Attachment of leads & pins
 - ▶ Condition of anode grid
- Some PK problems in preproduction
- Very rare in production batches
 - ▶ Manufacturer responds well to feedback

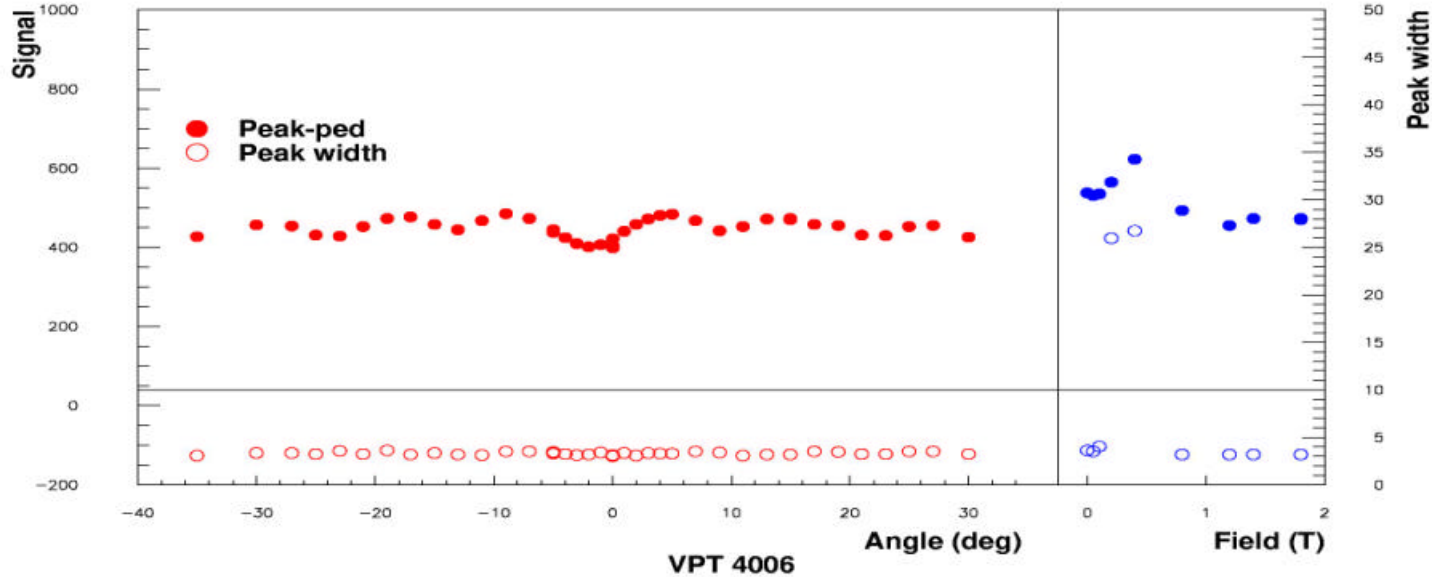




Test procedure 2

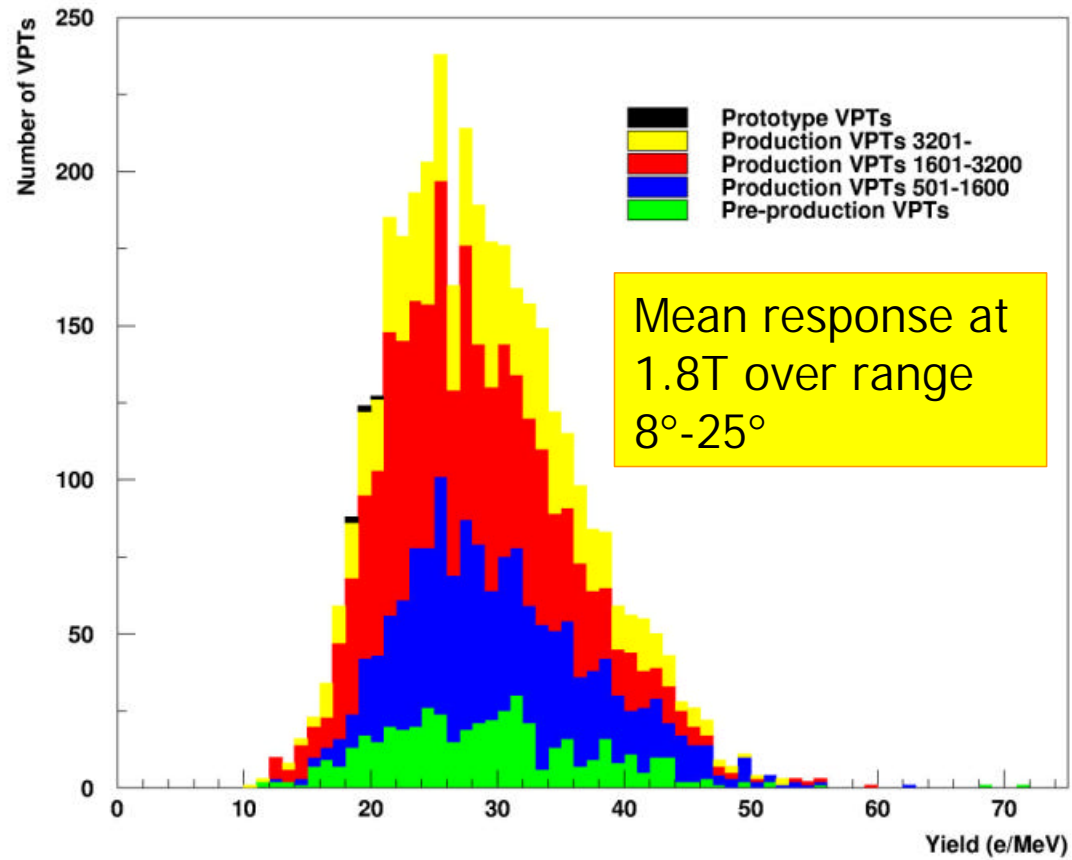


- Yield measurements
 - ▶ Response v angle at 1.8T
 - ▶ Response v field at 15°





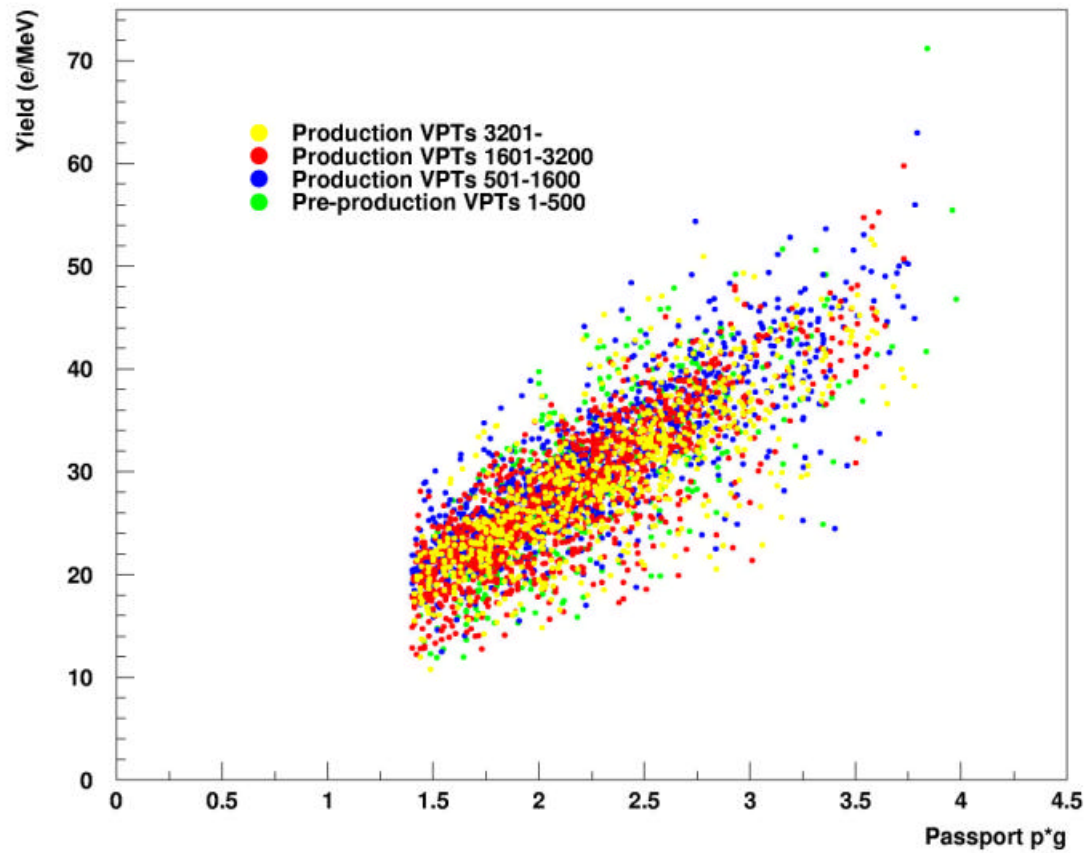
VPT yield measurements



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Comparison with RIE data

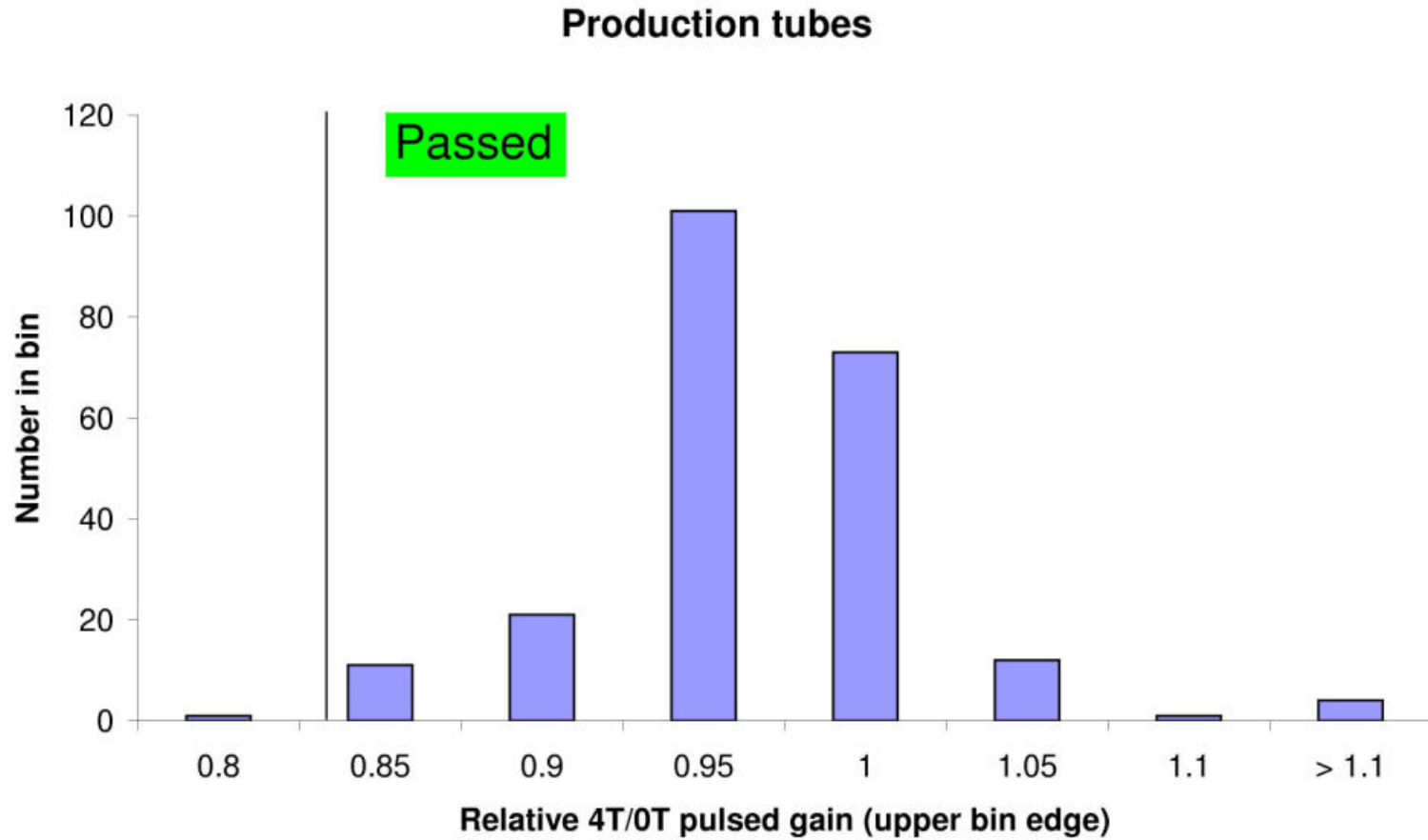


Gain, q_e measured by manufacturer at 0T

Compared with RAL measurement at 1.8T



Response at 4T and 15°



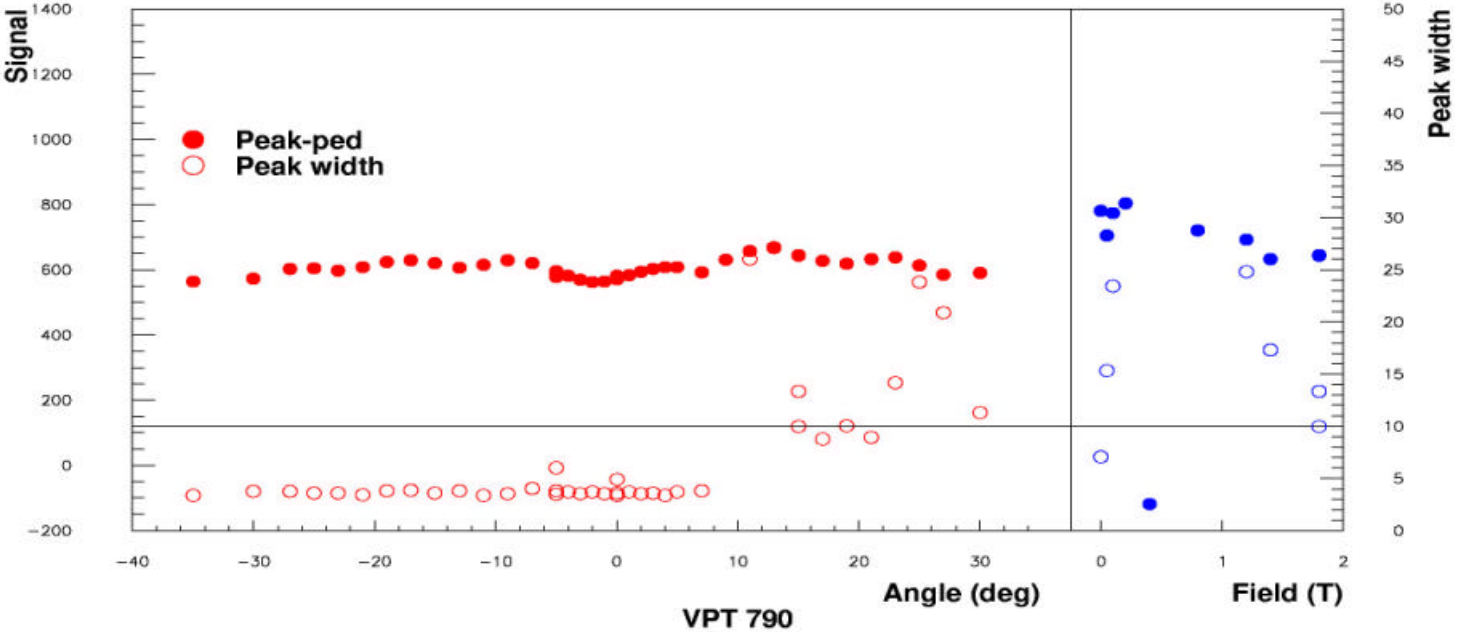
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Anomalous VPT behaviour

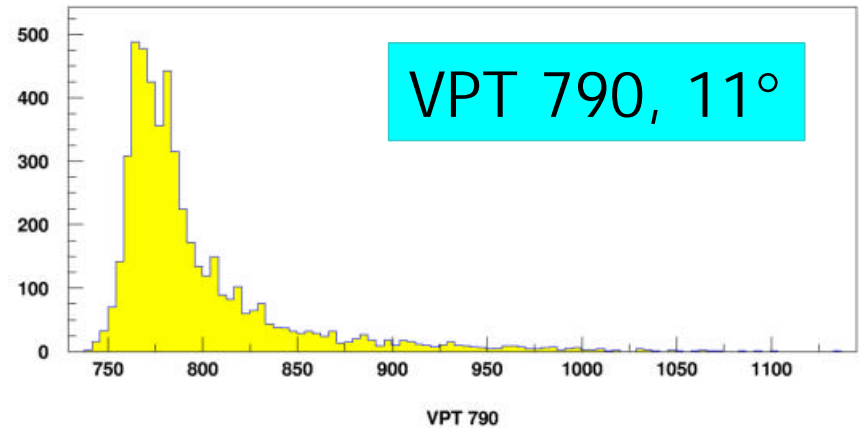
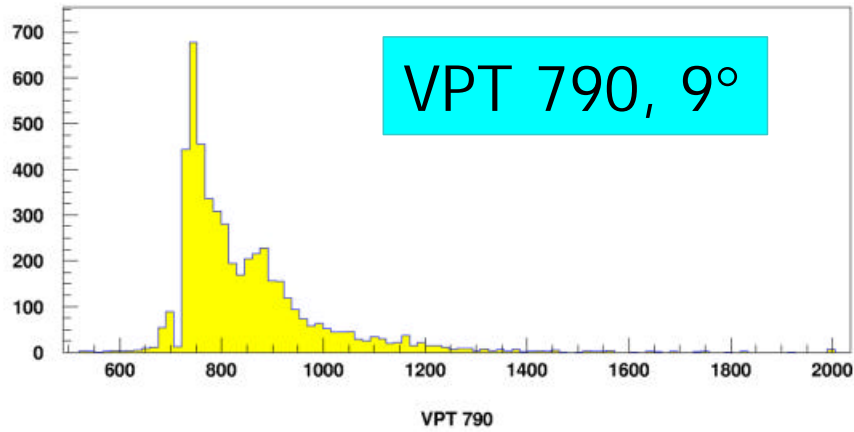
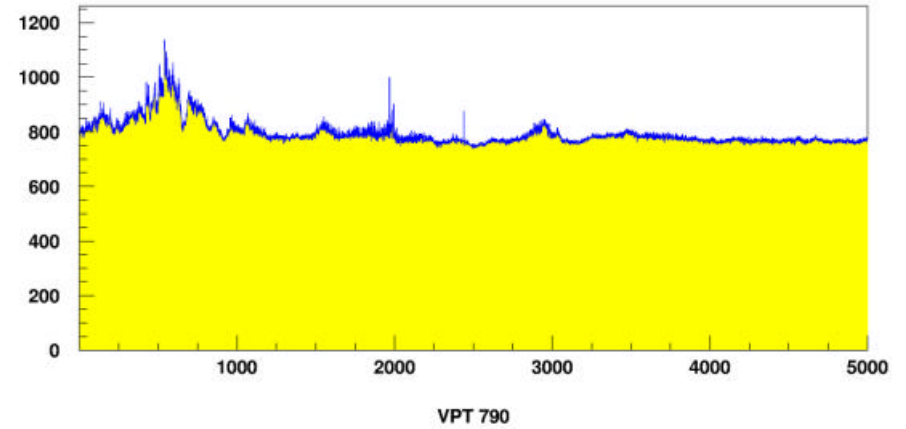
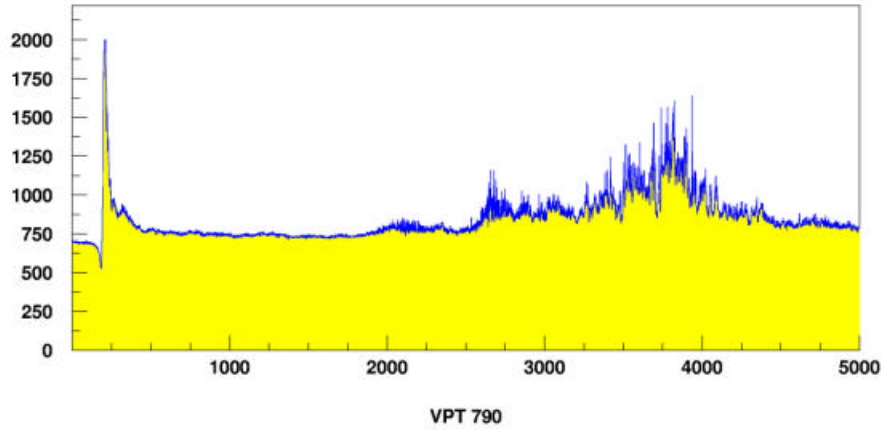


- Majority of VPTs perform well at 1.8T
- Small fraction (~5-6%) show “discharges”
 - ▶ Indicated by increase in signal width





Example of discharge





Characteristics of discharges



- Repeatabable
 - ▶ Appear in same range of angles for given VPT
 - ▶ Persist over weeks / months
- Most common at $>10^\circ$ to magnetic field
- Not seen in zero field
- Incidence reduced at lower voltage
 - ▶ Tests at $V_a/V_d = 800/600$ show fewer spikes
- Fraction of anomalous tubes constant in
 - ▶ Delivery date
 - ▶ VPT serial number



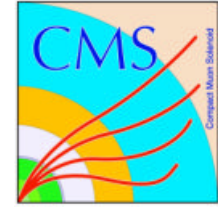
Tests on anomalous VPTs 1



- Angle scans at 4T
 - ▶ Time-consuming & laborious
 - ▶ 2 tested so far (noisy at 1.8T)
 - ▶ Noise seen at 4T
 - ▶ Suggestion that angle of onset may vary with field
- More statistics needed



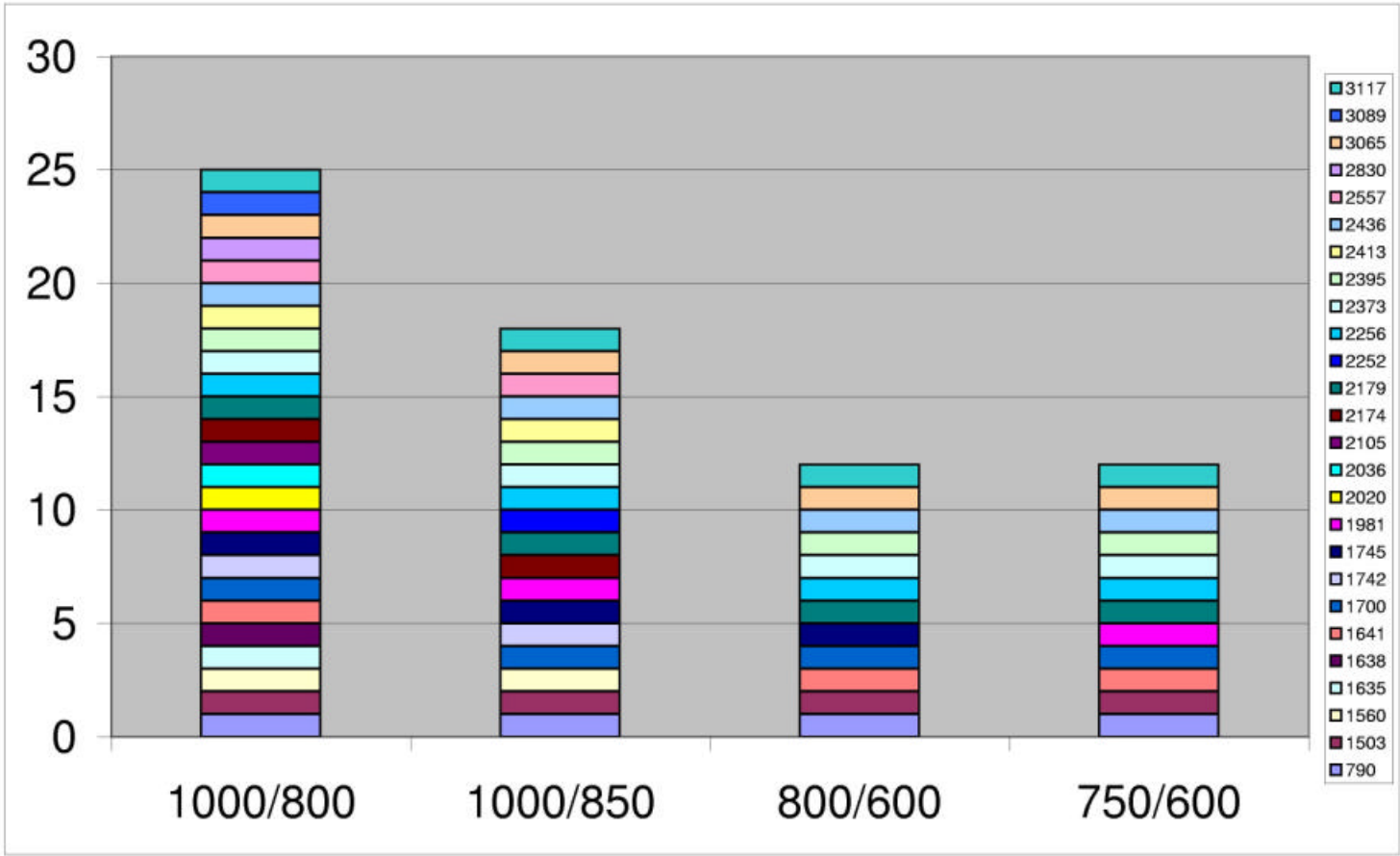
Tests on anomalous VPTs 2



- Modification of applied voltage
 - ▶ Standard is $V_a/V_d = 1000V/800V$
 - ▶ Test runs at:
 - ▶▶ 1000/850
 - ▶▶ 800/600
 - ▶▶ 750/600
- Define peak width >10 as “noisy”



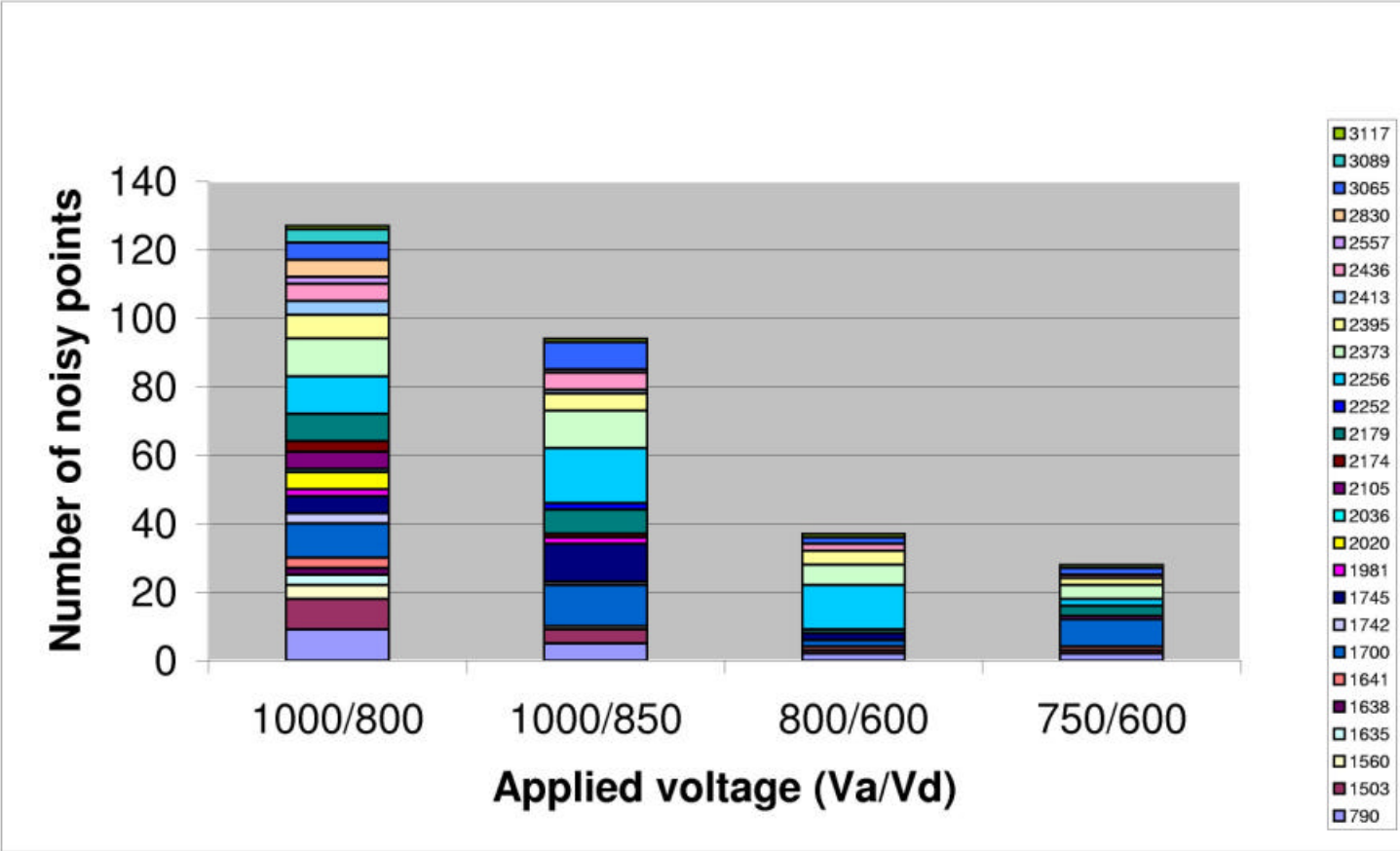
Noisy VPTs v Voltage



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Noisy points v voltage





Tests on anomalous VPTs 3



- Long runs at reduced voltage
 - ▶ 24-hour exposure at 800/600
 - ▶ Hoped to reduce discharges
 - ▶ No obvious effect seen so far (3 long runs)
- Further data analysis in progress



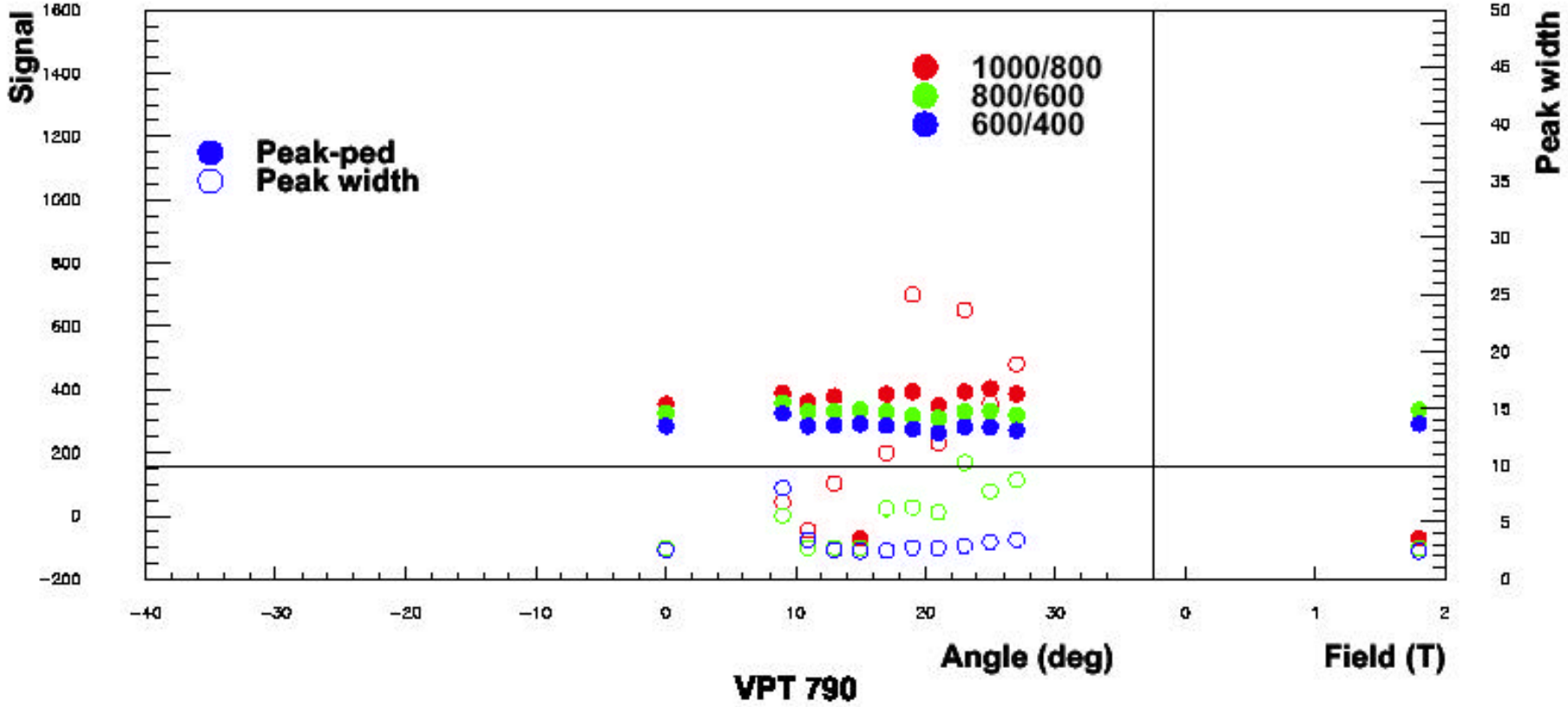
Tests on anomalous VPTs 4



- Gradual voltage ramping
 - ▶ Successive test runs at fixed angle at
 - ▶▶ 0/0, 600/400, 800/600, 1000/800
 - ▶ "Gentle" treatment could reduce noise
 - ▶ Tests over limited range of angles so far
 - ▶ Noise low at low volts, but returns at 1000/800



Example of slow V ramping



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Summary and conclusions



- VPT deliveries are ~ on schedule
 - ▶ 500 pre-prod + 3800 production VPTs delivered
- Magnetic field tests at RAL and Brunel are progressing well
 - ▶ 4100 measured at 1.8T in RAL variable-angle rig
 - ▶ >450 tested at 4T in Brunel rig
- Small proportion (5-6%) anomalous at 1.8T
 - ▶ Further tests continuing
 - ▶ Good response from manufacturer to address the problem