



Vacuum phototriodes for the ECAL endcap: Status

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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, $5 \cdot 10^{14}$ n/cm²
- Gain (g) & quantum efficiency (p)
 - ▶ $g \doteq 7$ ($V_a = 1000V$, $V_d = 800V$, $V_k = 0$)
 - ▶ $p \doteq 0.15$
 - ▶ $1.4 \text{ } \epsilon \text{ } pg < 3.8$
- Loss of response at 4T
 - ▶ $< 20\%$ wrt performance at 0T

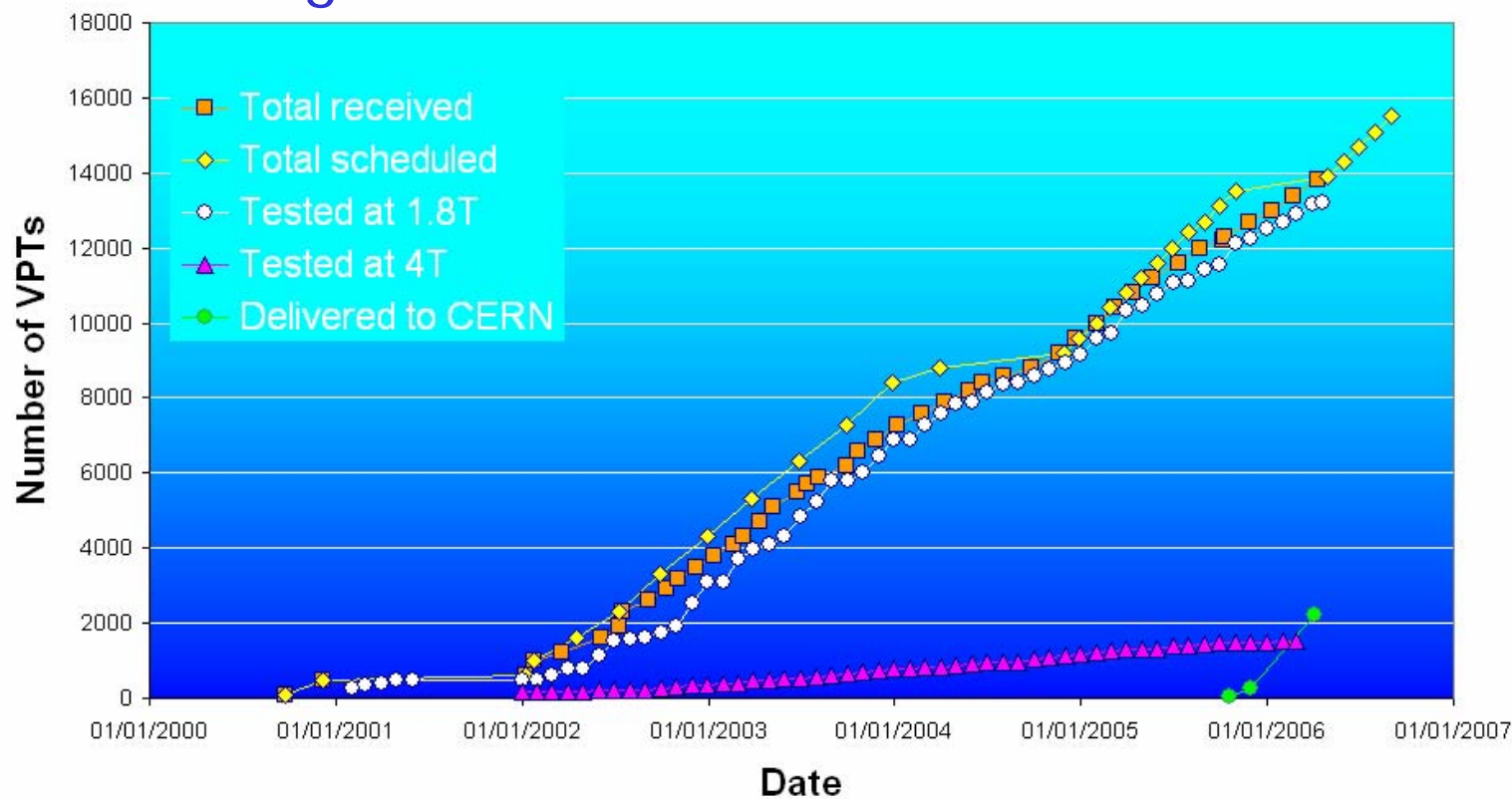




VPT deliveries



- Manufactured by RIE, St Petersburg
- VPT progress



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VPT statistics



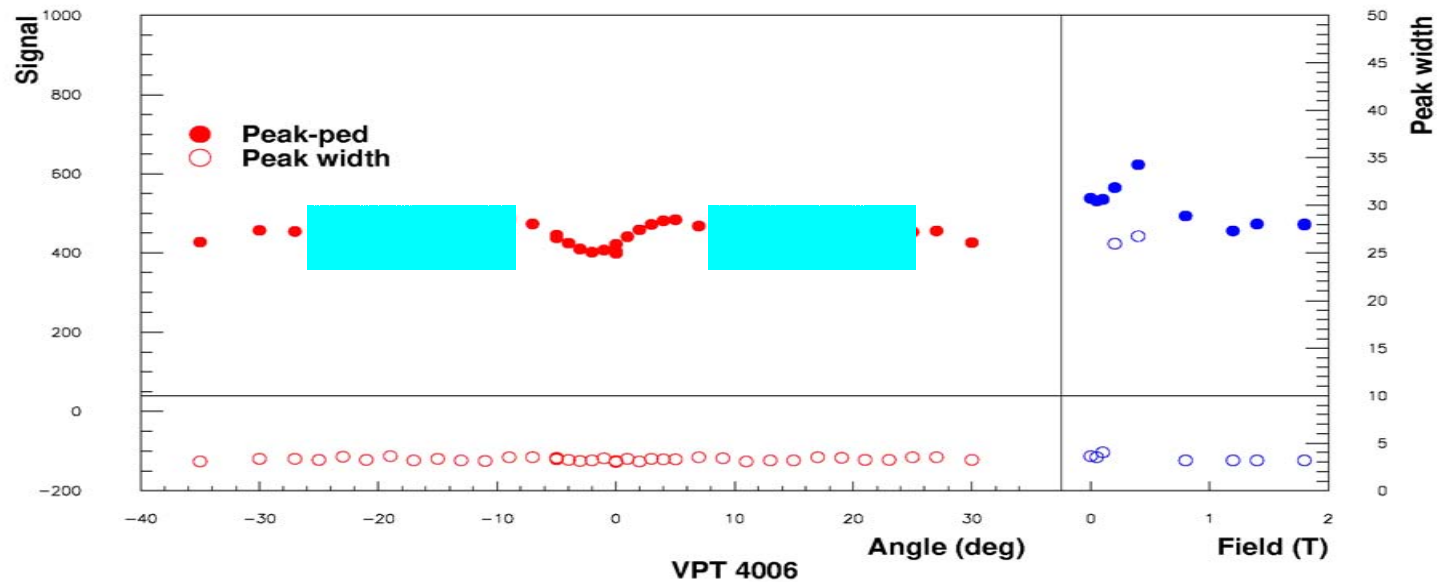
- Received: 13800 (inc 500 pre-production)
- Visual inspection: 13300
- Tested at 1.8T: 13220
- Tested in Brunel 4T rig: 1536
- Delivered to CERN: 2240



Test procedure



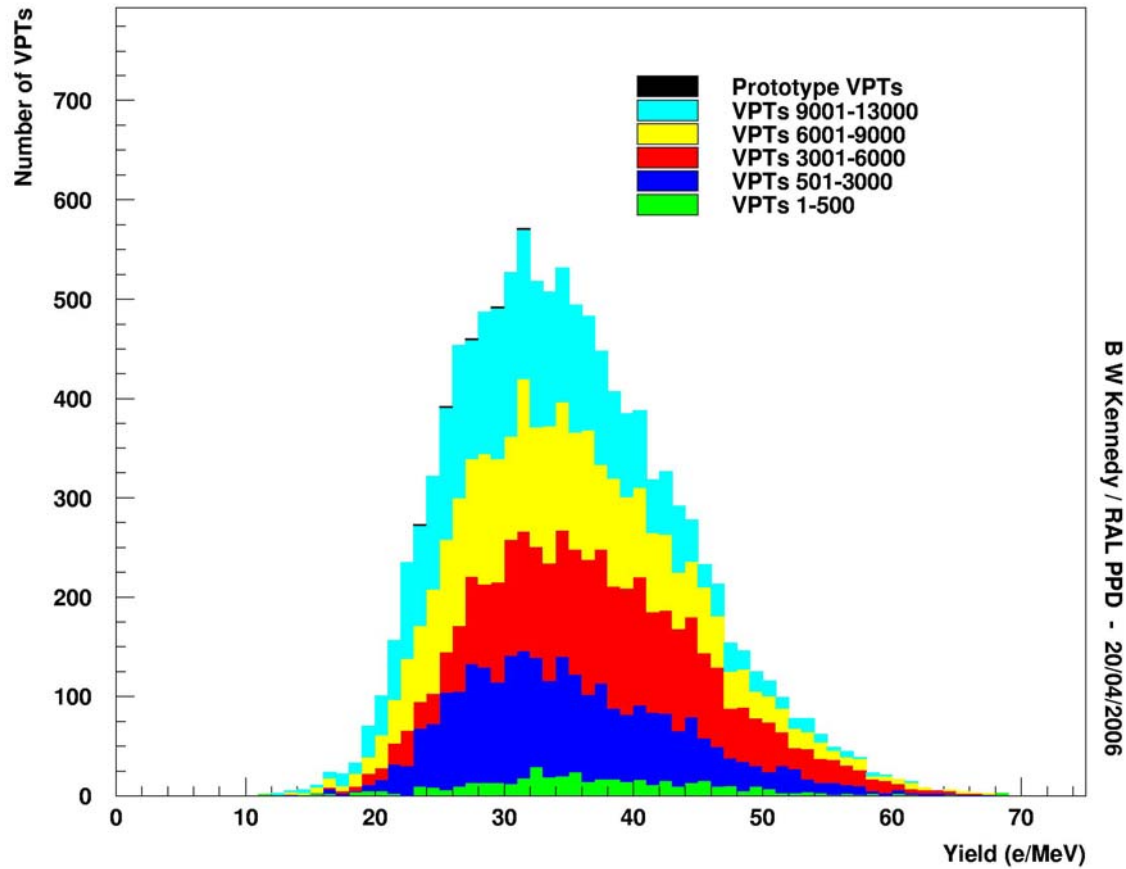
- Yield measurements
 - ▶ Response v angle at 1.8T
 - ▶ Response v field at 15



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VPT yield measurements



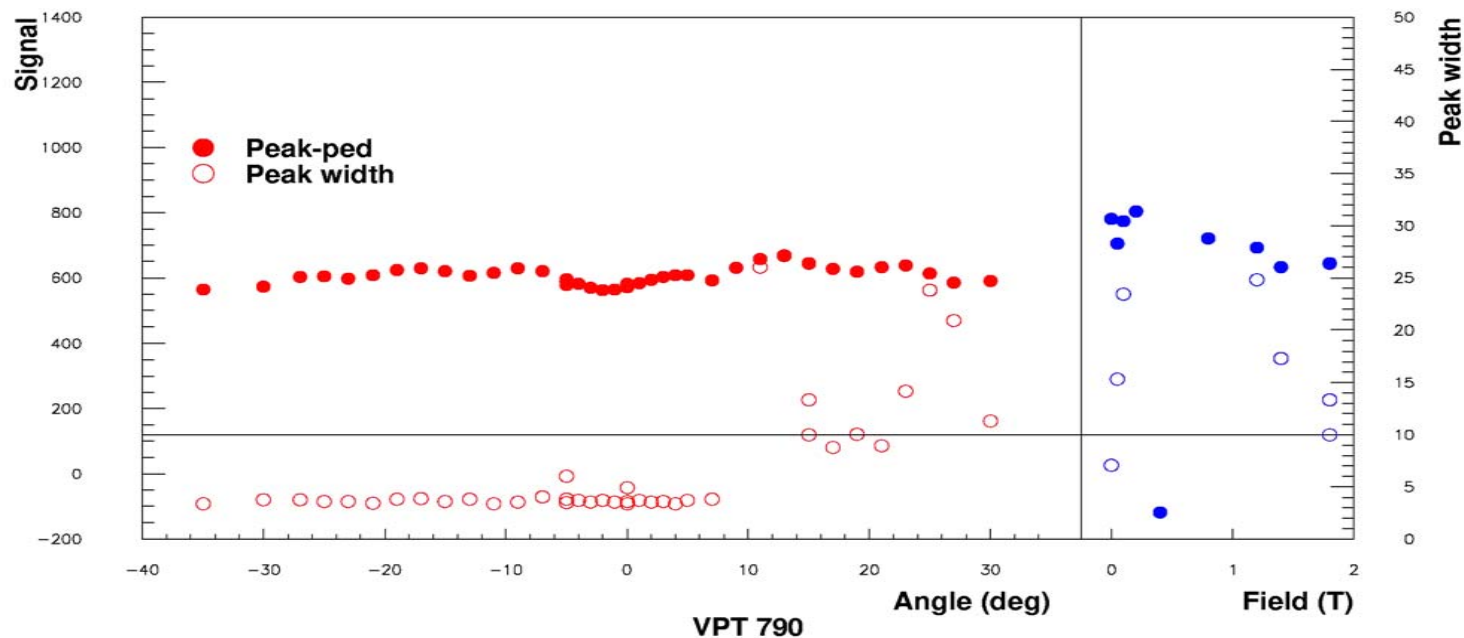
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Anomalous VPT behaviour



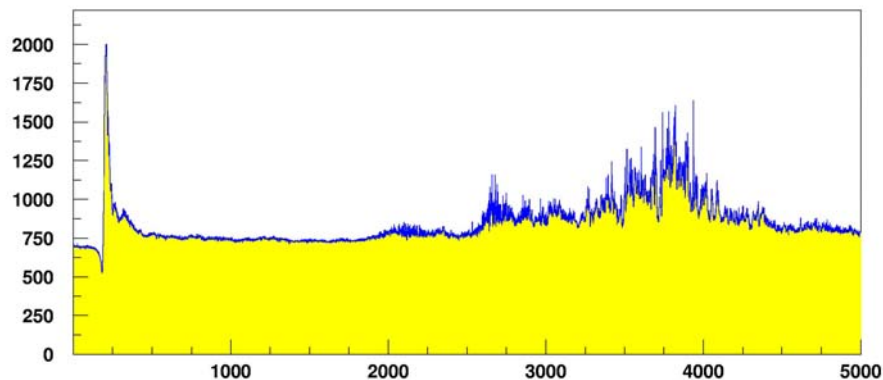
- Majority of VPTs perform well at 1.8T
- Small fraction (few %) show “discharges”
 - ▶ Indicated by increase in signal width



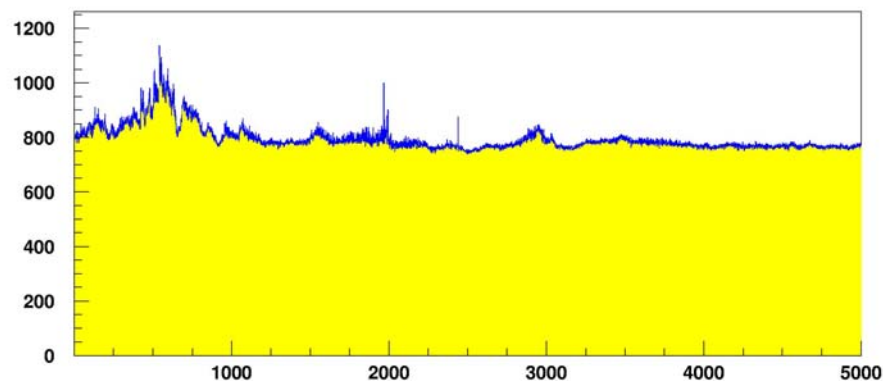
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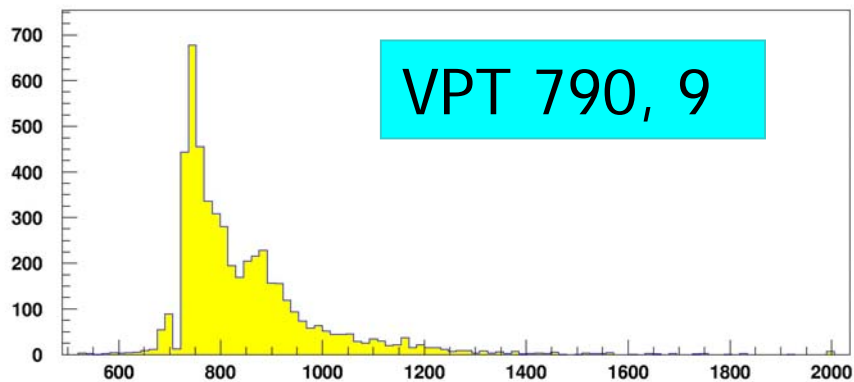
Example of discharge



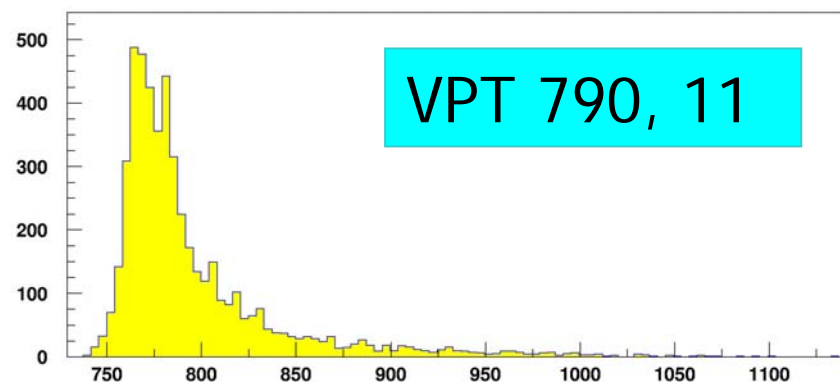
VPT 790



VPT 790



VPT 790



VPT 790



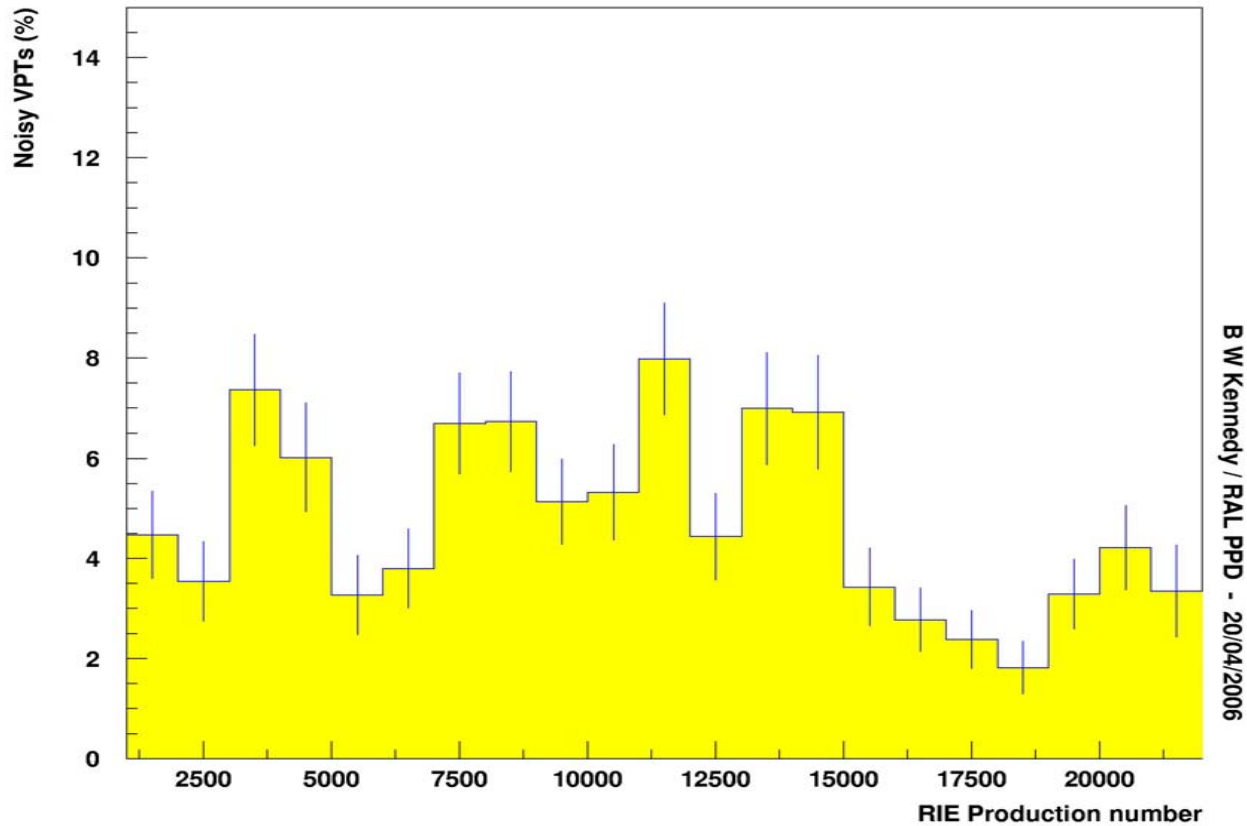
Characteristics of discharges



- Repeatable
 - ▶ Appear in same range of angles for given VPT
 - ▶ Persist over weeks / months
- Most common at >10 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 reduced after late 2004
 - ▶ Action taken by manufacturer to improve vacuum conditions



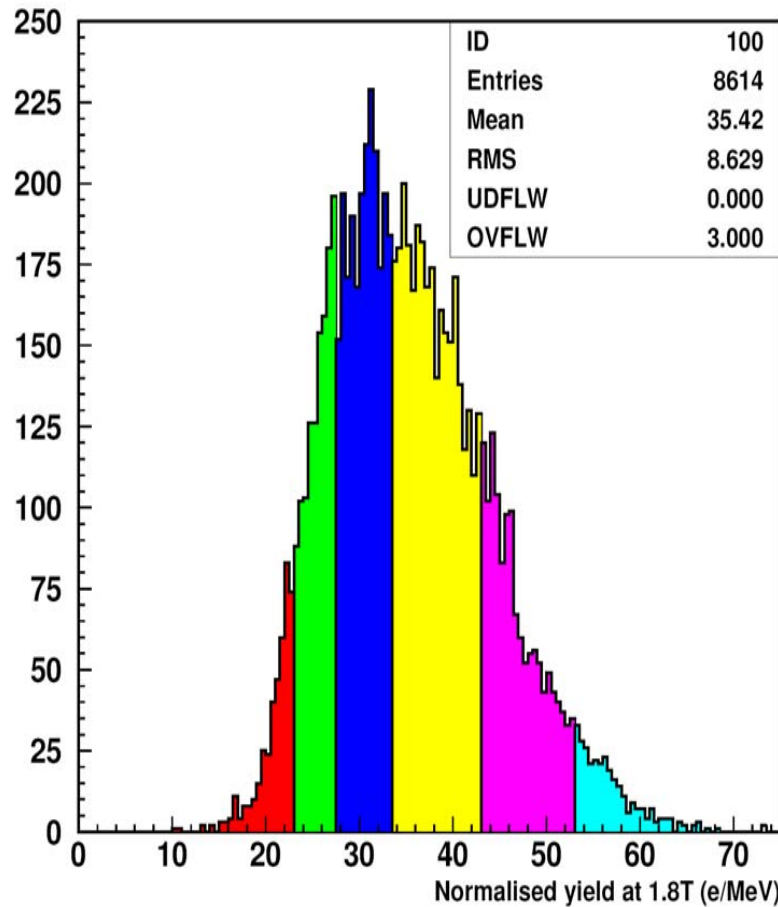
Fraction of VPTs showing discharges



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Sorting VPTs by yield



Yield (e/MeV)	Needed in ECAL	% in histogram
10-23.5	768	4.9
23.5-28	2200	14.3
28-34	4000	26.5
34-43.5	5000	35.0
43.5-53.5	2200	15.7
53.5-70	480	3.5

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Delivery to VPTs to CERN

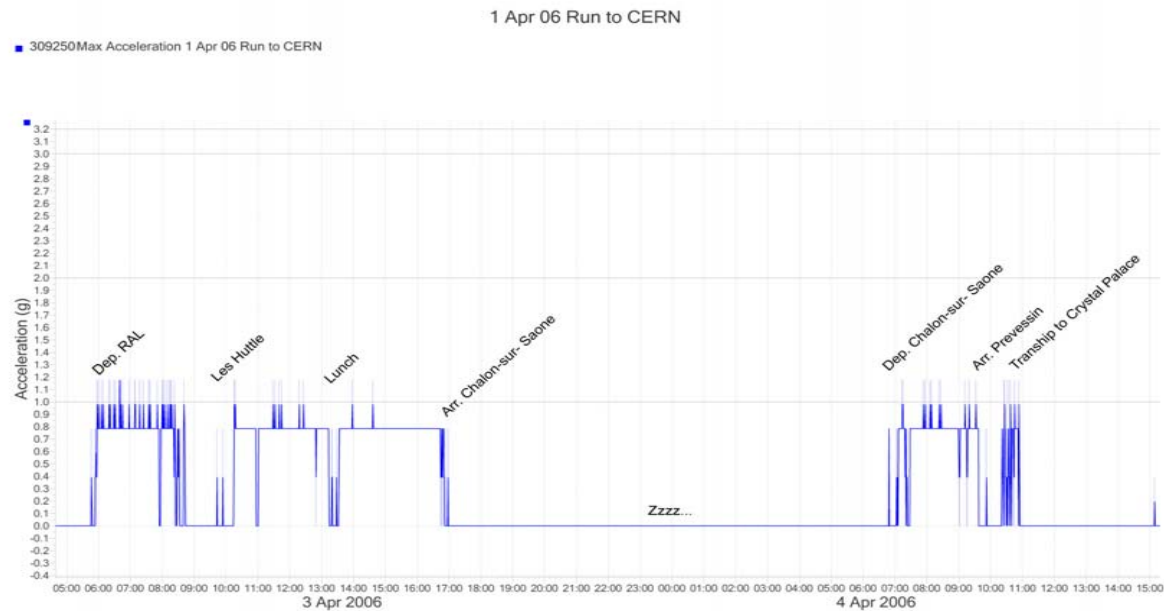


2000 delivered 4 Apr 2006 by van (Tony Lodge + Joolz Williams)

Acceleration monitored throughout journey

$$a_{\max} < 2g$$

VPTs can tolerate at least 20g, so negligible risk of damage during journey.



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Summary and conclusions



- VPT deliveries are scheduled for completion in late 2006
 - ▶ 500 pre-prod + 13300 production VPTs received at RAL
- Magnetic field tests at RAL and Brunel are keeping up with deliveries
- Small proportion (few %) anomalous at 1.8T
 - ▶ Manufacturer has investigated problem and taken action to reduce the number of anomalous VPTs.
 - ▶ Manufacturer will supply up to 600 extra VPTs to replace anomalous tubes.
- >2000 VPTs already delivered to CERN