



RAL PPD CMS group: Input to UK discussion on DRD6 involvement

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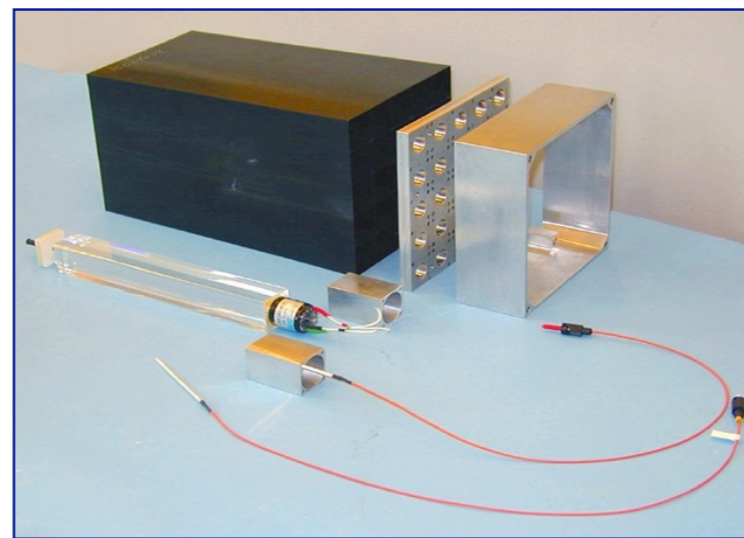
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Experience with CMS ECAL

- **RAL PPD has played a leading role in ECAL design, construction, operation**
 - led the **design, construction & installation of ECAL endcaps (EE)**, in partnership with **RAL TD**
 - developed and delivered radiation tolerant **VPT photodetectors for EE** (with Research Institute Electron, St Petersburg), following prior experience on OPAL
 - designed/operates the **VPT High Voltage system**
 - expertise in **Lead tungstate crystal performance**, calibration and longevity
 - expertise in **electron/photon reconstruction** in both trigger and offline, with expertise in **CPU, GPU, FPGA** programming. Expertise in the rejection of “**APD spikes**”
 - **Almost 30 years of UK involvement in CMS and ECAL (from initial Letter of Intent)**



one of 14648 EE Vacuum Phototriodes (VPTs)



Elements of a EE supercrystal (5x5 channels)

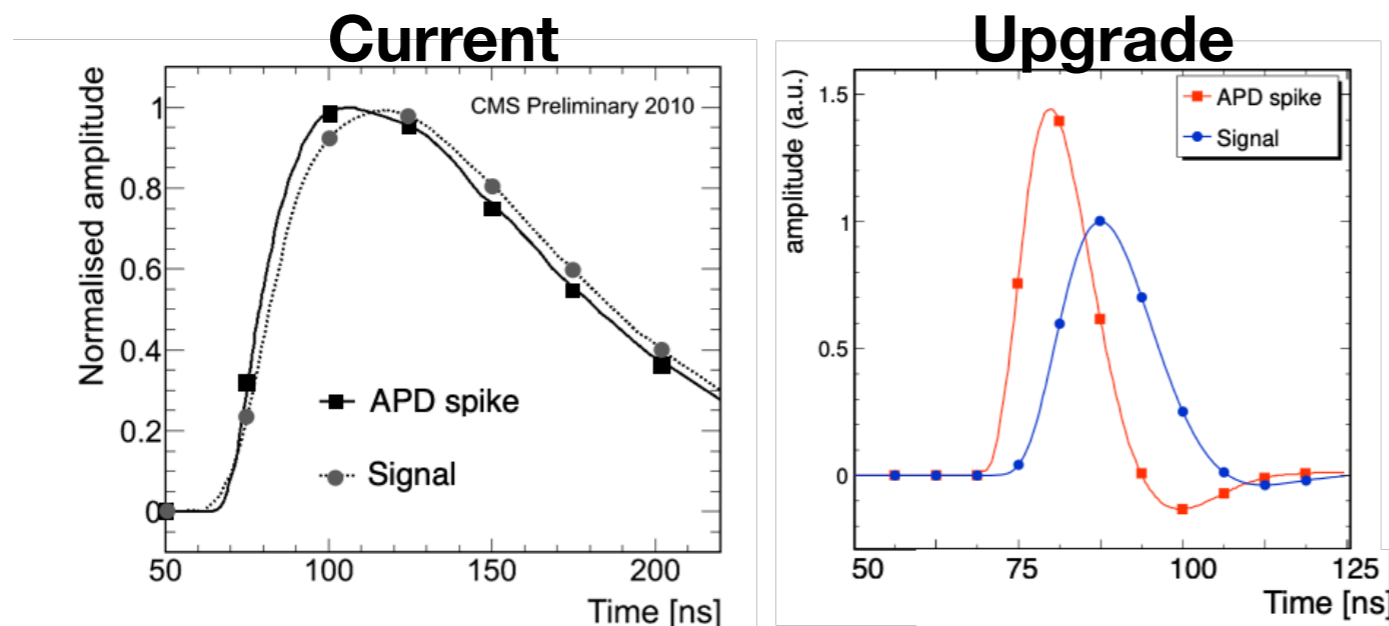


Endcap mechanics and construction

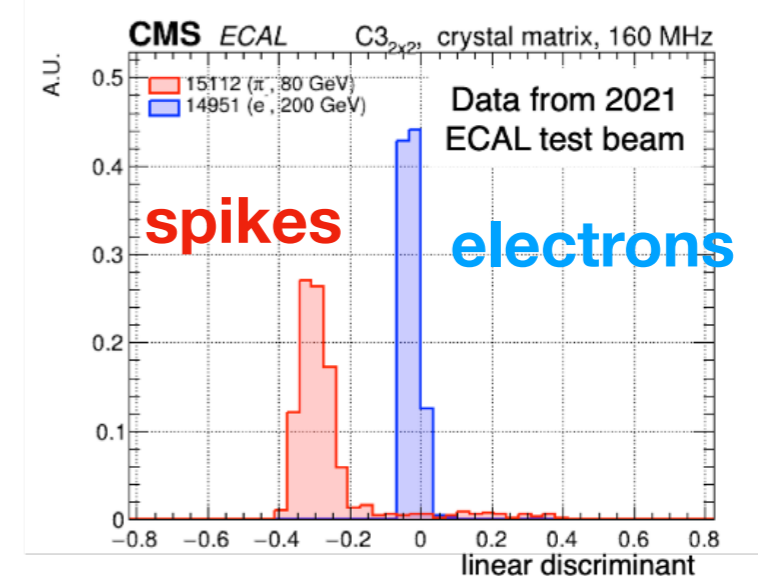
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Future plans for CMS ECAL

- **Our involvement in the current ECAL detector (up to end 2025)**
 - will maintain responsibility for detector operations and performance throughout Run 3
 - will maintain and operate EE HV system until end of Phase 1
 - specific focus on EE longevity and crystal/photodetector response monitoring
 - HLT/Offline software development - migrating key reconstruction code to GPUs
- **Our involvement in the ECAL Phase 2 detector upgrade**
 - develop new and more advanced ECAL energy clustering and spike rejection algorithms for the calorimeter trigger in firmware and software
 - deliver optical fibre router system for sharing crystal data between ECAL off detector boards
 - develop ECAL reconstruction code that makes the largest possible use of GPUs/FPGAs
 - participate in test beam campaigns and detector refurbishment/recommissioning during LS3



**Improved Phase-2 Pulse shape discrimination
(electrons vs spikes)**



**Pulse shape discrimination in 2021
ECAL Phase 2 test beam @ CERN**

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Future interests beyond CMS ECAL

- **We are currently engaged in more detailed internal discussions to define the precise scope of our future engagement in DRDs**
- **Regarding DRD6, our experience and interests most clearly align with:**
 - **Track 3: “Optical calorimeters: Scintillating based sampling and homogenous calorimeters”**
- **We are interested in new scintillator-based calorimeter concepts that can use our experience and skills**
- **In particular, we have an interest in Photodetector R&D for future experiments**
 - **opportunity to build on previous experience with CMS, and partner with other R&D activities ongoing/planned at RAL**
 - **development of SiPMs for LHCb upgrade**
 - **development of new PMTs for Hyper-K**

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Specific expertise for future scintillator-based calorimeters

- **RAL detector expertise is in crystal calorimetry (albeit with a much smaller group than we had during CMS construction).**
 - Could contribute ideas and 20+ years of CMS experience, if there is significant interest in a scintillator-based calorimeter within the UK community
 - We also have strong links to CERN calorimeter groups who are likely be a significant player in any crystal or fibre-based calorimeter, and can be a point of contact with them
- **We have significant trigger expertise that can be leveraged for future projects**
 - Hardware/firmware/algorithm expertise, in both calorimeter, tracker and trigger systems
 - Interest in algorithms that combine tracker and calo signatures in future L1 trigger systems
 - Interest in front-end processing, in collaboration with RAL TD