Characteristics and magnetic field properties of the Hamamatsu R11265 Multi-Anode Photomultiplier Tubes

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Introduction

- Upgrade:
  - The p-p collision luminosity will increase to 2×10^{33} cm^2 s^{-1}, therefore a readout of 40MHz is required after the upgrade
  - HPDs of the RICH system will be replaced due to limited readout bandwidth
- Multi-Anode Photomultiplier Tube R11265:
  - Large bandwidth
  - Single photon sensitivity (200-600nm)
  - High Quantum Efficiency
  - Large active area
  - High spatial resolution
  - Low dark and leakage current
- Lab test:
  - Individual pixel characteristics
  - Magnetic field properties

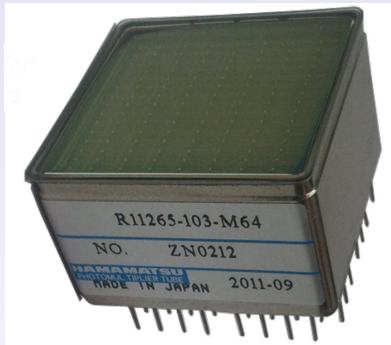
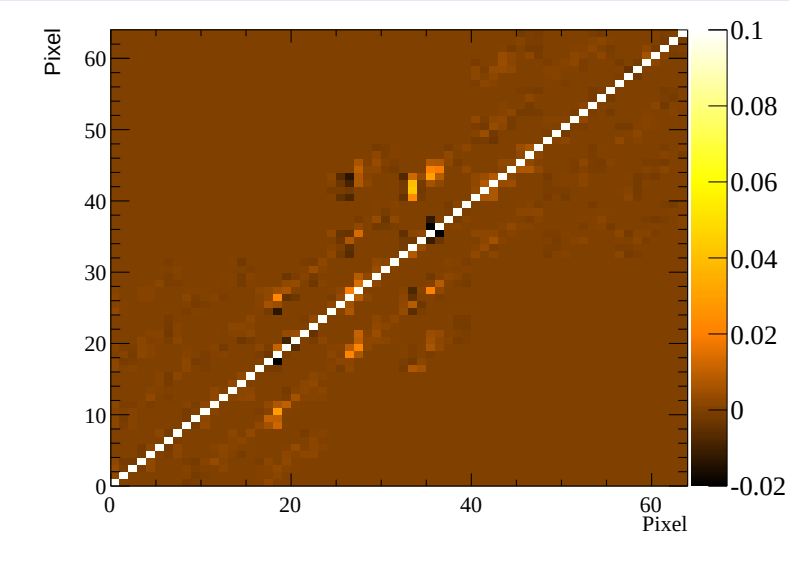


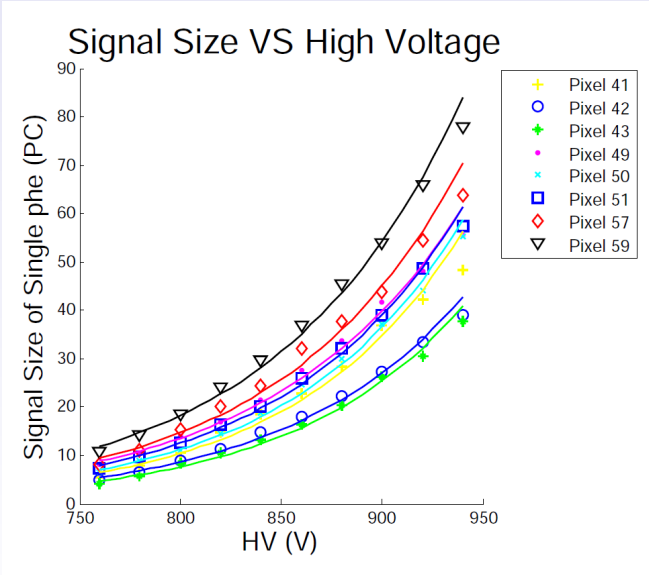
Photo of R11265

Basic Characteristics

- Signal spectrum: clear signal and noise separation
- Cross talk: to the neighbours of $< 2\%$ and all neighbours of $< 8\%$
- Signal size: exponentially increases with High Voltage (HV)
- Signal loss: typically less than 4%, exponentially reduces with HV, larger gain pixels show smaller signal loss



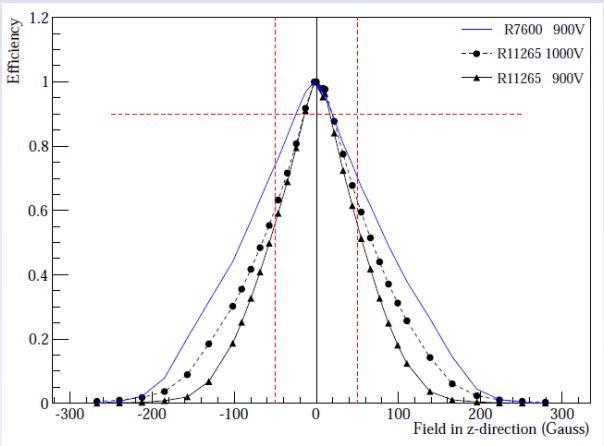
Cross talk



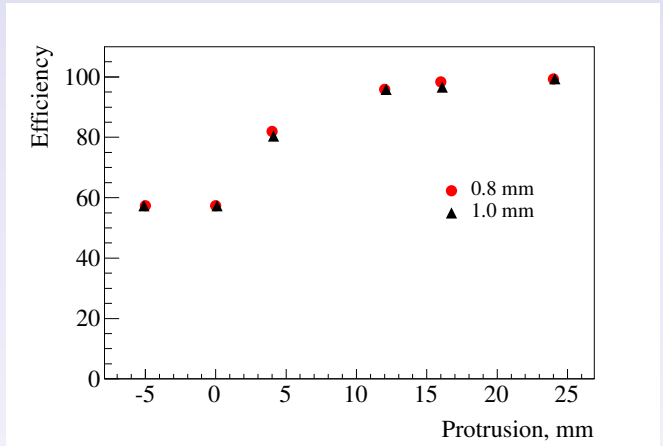
Signal size

Magnetic field properties and Conclusion

- Magnetic field properties:
  - Signal efficiency is sensitive to magnetic field, especially when the magnetic field is perpendicular to the UV glass
  - Mu metal can effectively shield the magnetic field



Signal efficiency



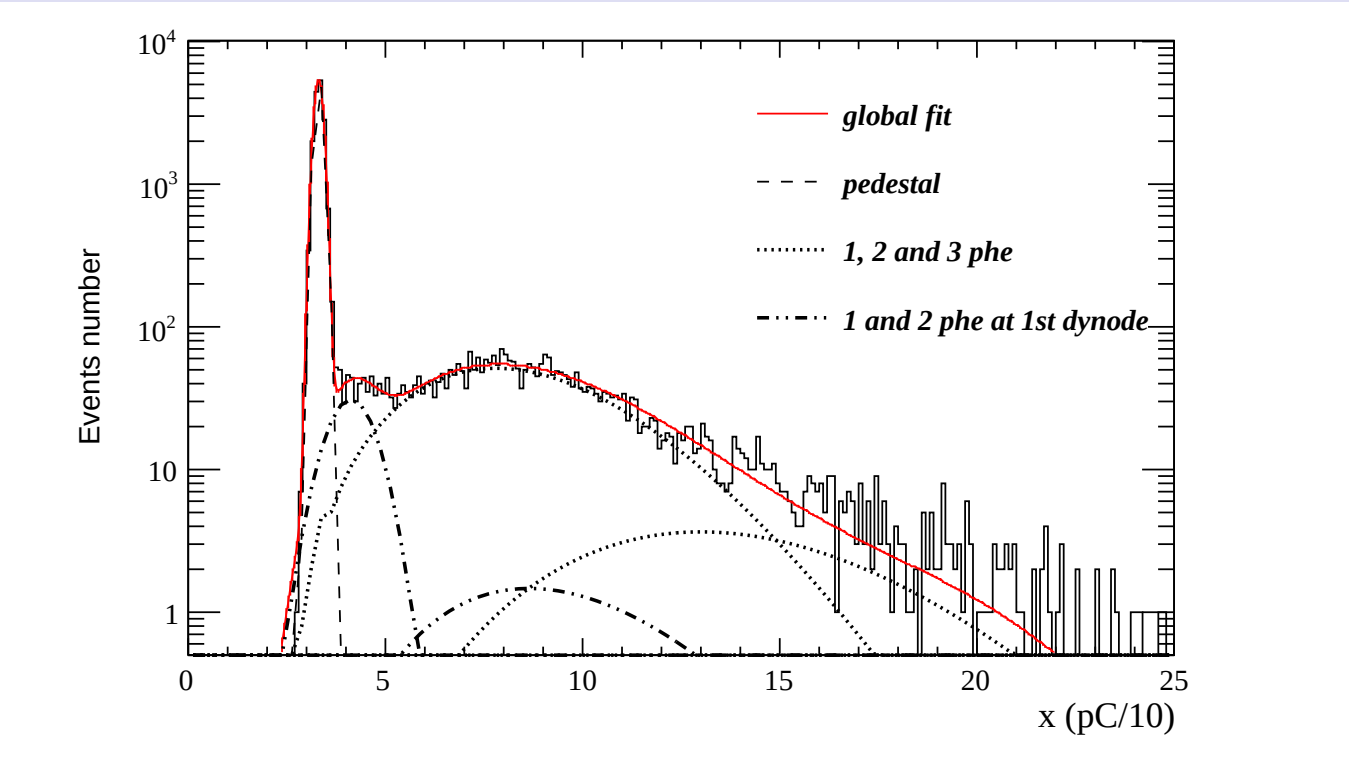
Mu metal shielding

- Conclusion:
  - The low cross talk, small signal loss, large bandwidth and effective Mu metal shielding properties make R11265 the most prospective photon detector for the LHCb upgrade

Back Up

Signal spectrum

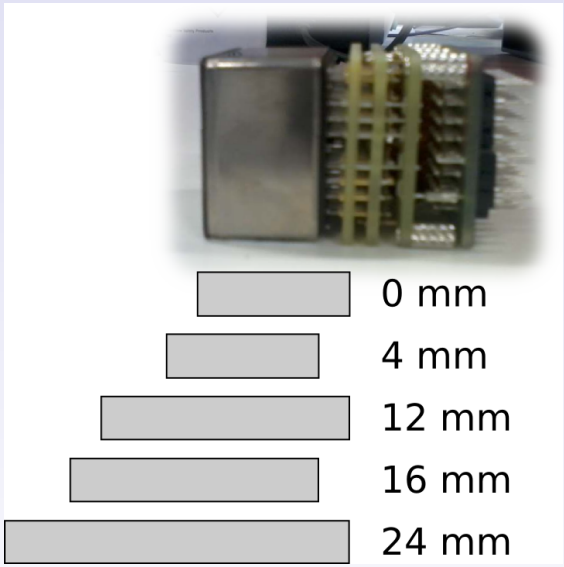
- Pulsed LED light is used to illuminate the R11265
- Signal spectrum is taken by a single test system



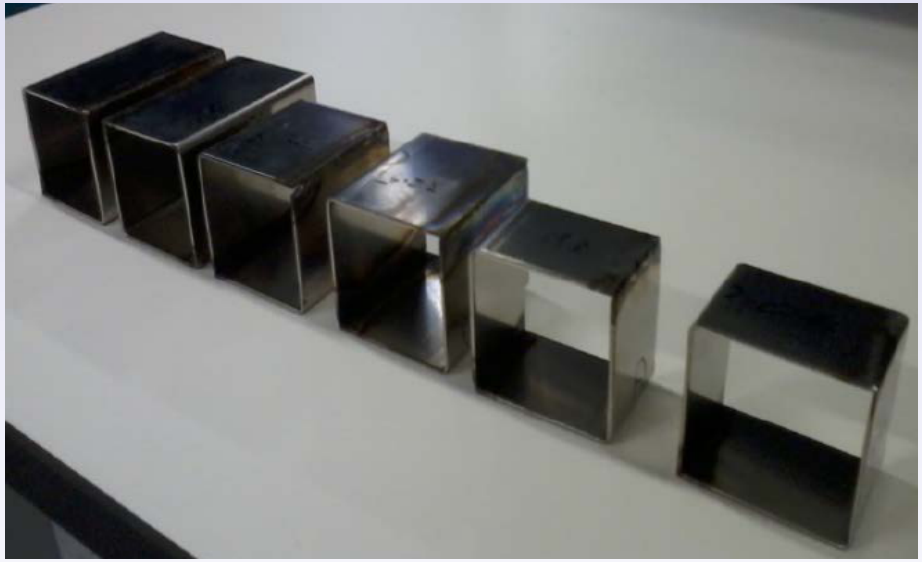
A typical signal spectrum fitted by the combination of Poisson and Gaussian distributions.

Mu metal shielding

- Magnetic field can significantly affect the signal efficiency
- Mu metal is adopted to shield a 2×2 MaPMTs matrix



Insert depth of Mu metal


Mu metal