

Cherenkov Detector Construction

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Background

- The speed of light in a vacuum is defined as the **universal constant c**
- However, light may propagate through a material at a speed less than c (i.e. **$0.75c$ in water**)
- When a charged particle travels through a medium at a speed faster than light in that medium, the result is emitted **Cherenkov radiation**
- **Cherenkov radiation** is the optical equivalent of the sonic boom
- Cherenkov detectors use **photomultiplier tubes (PMTs)** to detect radiation emitted from particles in water

Methodology

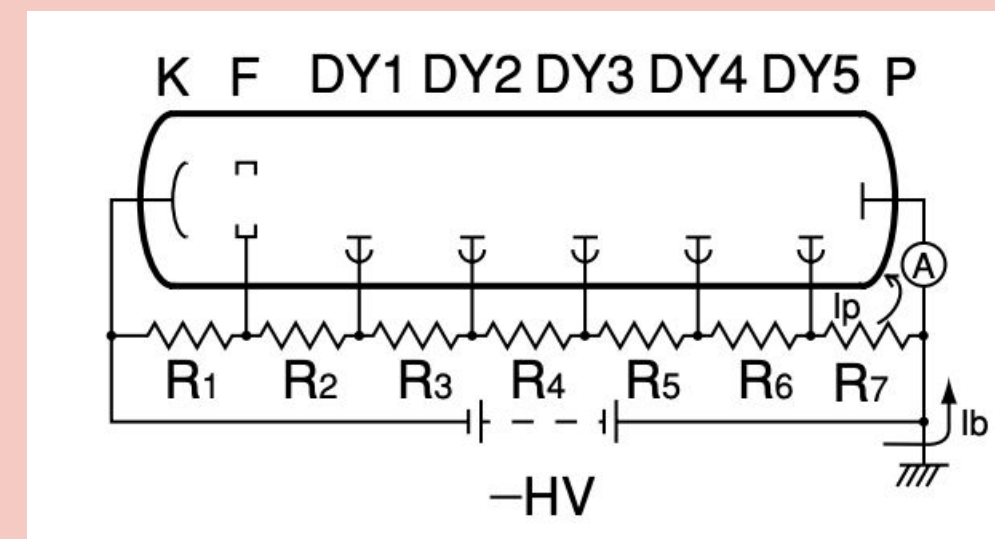
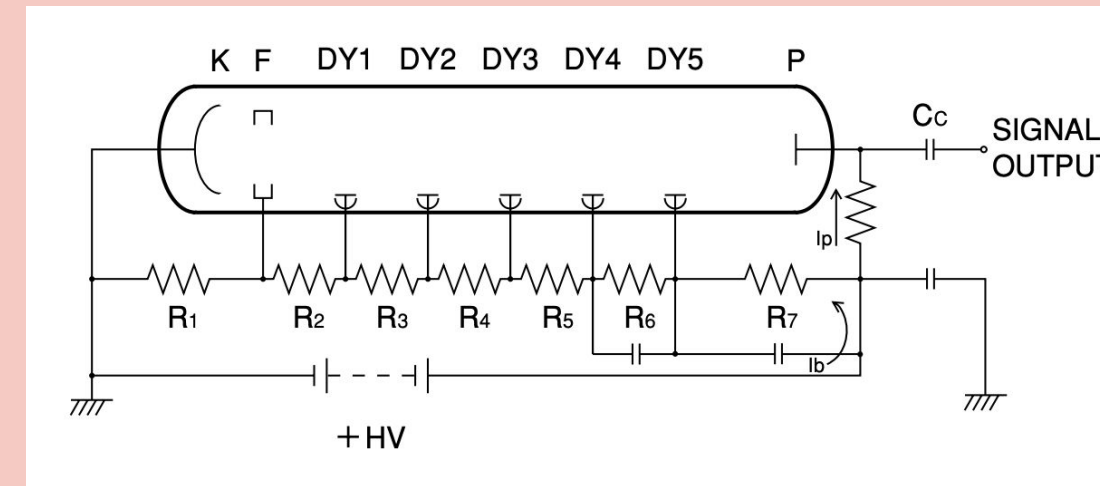


Figure 1: Two schematics for PMT voltage distribution (Hamamatsu)



Figure 2: Initial PCB design



Figure 3: Inside of the detector barrel painted white to maximize reflectivity



Figure 4: Fully assembled Cherenkov detector with Amperex xp2202b PMT

The initial PCB was designed for the Hamamatsu R1408 PMT, however the first design of the board was not suitable for our testing, so we replaced it with the Amperex xp2202b. The PMT was mounted onto the barrel lid and connected to an amplifier and a single-channel analyzer to count radioactive pulses

Objectives

- **Design** printed circuit boards (PCBs) to achieve high-voltage distribution across the PMT
- **Mount** PMT in the barrel containing water; ensure the barrel is light-tight
- **Set up** signal processing electronics to read out PMT
- **Identify** muon signals at various levels of elevation and shielding

Data Collection

The detector was taken to 3 floors of a garage to determine if the pulse count decreased with increased shielding from the environment.

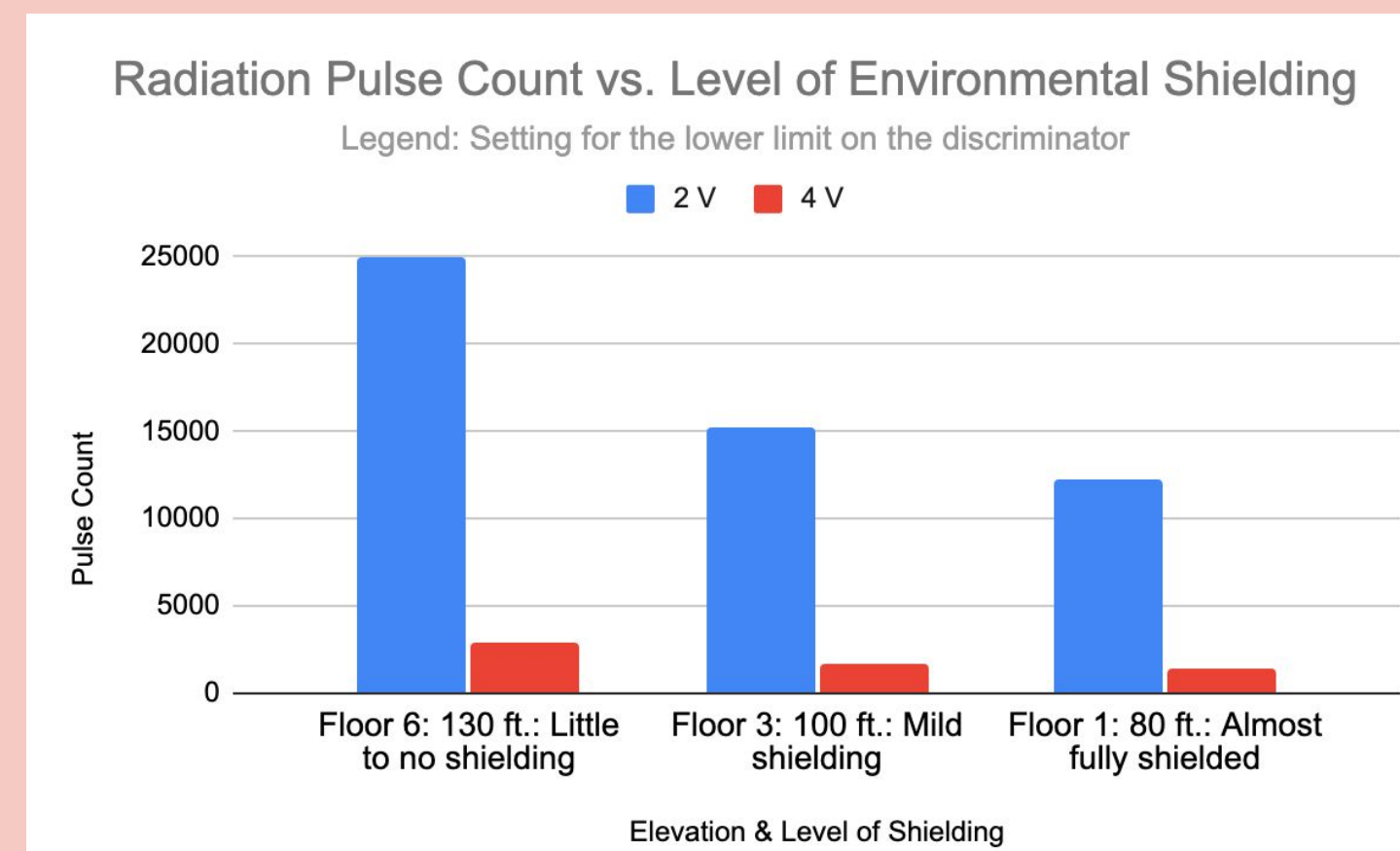


Figure 5 (above): electronics setup in the van for the garage.

Figure 6 (left): graph of pulse counts

Future Testing

- Detector successfully counted fewer pulses with increased shielding
- Future experimentation includes refining the PCB for the R1408 PMT and testing it



Figure 7: Garage detector setup

Lower Limit of Discriminator:	2 V	4 V
Floor 6: 130 ft.: Little to no shielding	25006	2925
Floor 3: 100 ft.: Mild shielding	15278	1621
Floor 1: 80 ft.: Almost fully shielded	12261	1460

Figure 8: Data table of garage pulse counts