The ability to detect and identify hazardous radioactive sources is a crucial aspect of our nation’s security. We are working to create a model to predict how various types of detectors react to sources under different conditions. With this model, we hope to combine the strongest elements of each detector to provide the best possible picture of a given situation. In addition, we are looking at the potential of combining information from distributed, highly portable, small detectors to create a clear view of specific circumstances.

### Radiations

In the most basic sense, radiation is energy. Visible light is one type of radiation people experience every day. Here, our focus is on gamma rays. Both visible light and gamma rays are electromagnetic radiation, only we can see visible light because it is at the visible range of the electromagnetic spectrum while gamma rays have a much higher energy and are not visible to our eyes.

Hazardous radiation, known as ionizing radiation, comes from unstable atoms. These atoms release radiation (energy) to achieve a more stable state. Peaks can be seen in the detector spectra as a result of the quantization of energy in atoms. Part of our nation’s security relies on the ability to detect and identify radiation to determine if it is a threat.

### Detectors

**NaI: Sodium Iodide**
- 2 x 4 x 16 inch crystal
- Lowest resolution (7%)
- Highest efficiency

**LaBr₃: RadSeeker**
- 1.5 x 1.5 inch crystal
- Medium resolution (3%)
- Middle efficiency

**HPGe: MicroDetective**
- 50 mm diameter, 40 mm depth crystal
- Highest resolution (0.5%)
- Lowest efficiency

**CsI: Polimaster Personal Radiation Detector (PRD)**
- 4 cm³ crystal
- Low resolution
- Low efficiency
- Highly portable

### Experimental Setup

Fig. 2. Hybrid project experimental setup with NaI, Radseeker (LaBr₃), and Microdetection (HPGe) detectors.

### Results: Hybrid Project

Fig. 3 shows the energy spectra of all three detectors from the hybrid project measuring the same source (Eu-152) for one minute. The differences in counts and resolution are clearly evident in the heights of the spectra and width of the peaks. Fig. 4 shows the simulated model results of four NaI detectors versus three NaI detectors with one LaBr₃-similar detector measuring a Cs-137 source.

### Results: Distributed Detector Project

Fig. 5 shows two separate results from the distributed detector project in which a detection event was created by walking near a suspected Cs-137 source with two PRDs. No distinct peaks are visible when the entire 60 minutes of data are plotted. By choosing to plot 75 seconds of data when the count rate was elevated, a new trend appears. Fig. 6 shows a one minute measurement of the same location using the Radseeker. The new data shows a low energy peak that suggests the source is not Cs-137 but perhaps Am-241.

### Future Applications:

Hybrid Project: combining detectors with different strengths
- Computer model better than a single detector
- Addition of shielding data to the computer model
- Reduced mass of modular mobile detector systems
- Increased portability of detector systems

Distributed Detector Project: combining multiple weak detectors
- Computer model to accurately combine data
- Create blanket surveillance across the country

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