# [A5. Compton Effec](https://wiki.harvard.edu/confluence/display/APL/A5.+Compton+Effect)t

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**Experimental Goals**: In this experiment, we will predict and observe the Compton shift caused by high energy gamma rays emitted by different radioactive sources and study the outcomes. Specifically, we plan to:

1. Predict and measure the Compton shift for three different gamma ray sources (Cs-137, Co-60, Am-241) and four different scattering targets (Al, Cu, Pb, and plastic), process and organize the data systematically as a function of angle. Compare the observed Compton shifts to the values predicted by the Klein-Nishina formula.
2. Observe the angular dependence of the cross section of gamma rays being scattered by electrons.
3. Study the failure of the impulse approximation by observing the compton shift or the lack thereof in high-Z scattering materials and by lowering the gamma ray intensity
4. Measure the electron momentum distribution of different scattering targets (Al, Cu, Pb, and plastic)

**Best Practices**:

Safety and Health Precautions:

We are working with highly radioactive materials. It is important to always follow the correct guidelines and procedures:

* Always make sure that the radioactive source is well-placed in its shield or collimator when holding, moving, and installing it.
* Wear a personal dosimeter in the lab and use a Geiger counter to measure and record the gamma radiation near the source and in the working area before and after the lab to make sure there are no leakages.
* Wear gloves when handling the lead used to shield radiation and be careful when moving the heavy lead blocks
* Read pp 36-38 of the Radiation Safety Manual

Experimentation Precautions:

* Be careful when using the pure germanium detector and make sure it is always cooled to the correct temperature before applying high voltages in order to avoid damages
* When calibrating the NaTI detector, avoid count rates much greater than Compton scattering count rates.
* Move the collimator by the cylinder itself, not by the gamma source.

**Tentative Plan**:

* Understand how the MCA software (MAESTRO) works
* Measure the background radiation in the lab
* Calibrate the pulse amplitudes

Cesium-137:

* Install the source
* Use NaI scintillation detector since Cs gamme energy is above 100 keV
* Measure the Compton shift. Compare with calculated value
* Improve the angular resolution if necessary
* Measure the shift systematically as a function of angle
* Apply the Klein-Nishina formula and compare to data

Americium-241:

* Use the planar germanium detector since Am gamma energy is below 100 keV
* Use Americium to study the failure of Impulse Approximation with high-Z scattering materials and low gamma energy? Since it’s the only one with Ge detector?
* Repeat steps as detailed above to measure the compton shift systematically, compare to calculated value, and verify the Klein-Nishina formula

Cobalt-60:

* Use NaI scintillation detector since Co gamma energy is above 100 keV
* Repeat steps as detailed above to measure the compton shift systematically, compare to calculated value, and verify the Klein-Nishina formula

Calibrate

Questions:

* **Experimental Setup:**
* What are the different scattering targets, can we just choose one or repeat the experiment for all of them?
* Why would we use the lead slits as opposed to just moving the source?
* Wouldn’t it be better if we just used helium to cool the dewar? Not worth it?
* What is the thin carbon fiber window on the Ge detector for?
* Cobalt was the hardest to collect data for, but it’s energy is in MeV. Why start with Am and Cs first? It’s because the radiation per second is slower than the rest. Cesium (start with this) and Americium do these instead of cobalt. You’re not gonna learn much from cobalt.
* **Vocabulary:**
* Gamma ray spectrometer: Preamp? Spectroscopy amp? Multi-channel analyzer?
* Pulse height analysis?
* “Intrinsic” germanium detector?
* Photomultiplier tube
* Mu-metal shield
* P-I-N structure
* Integral charge sensitive preamplifier
* Is free electron approximation and impulse approximation the same thing?