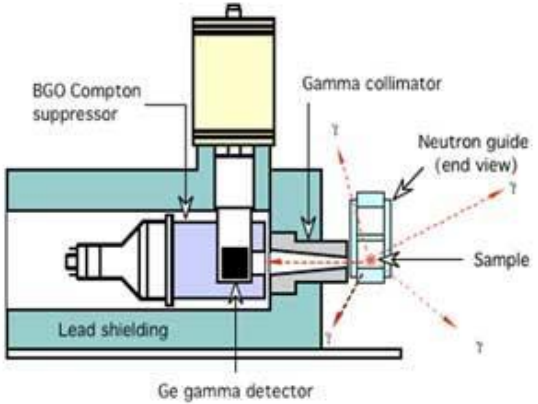
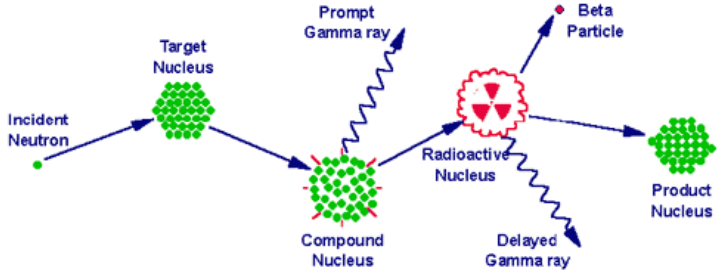
OpenAGS: an Analysis Program for Prompt Gamma Activation Spectra

Christopher Stallard - Poolesville High School
Mentor: Heather Chen-Mayer

How PGAA Works

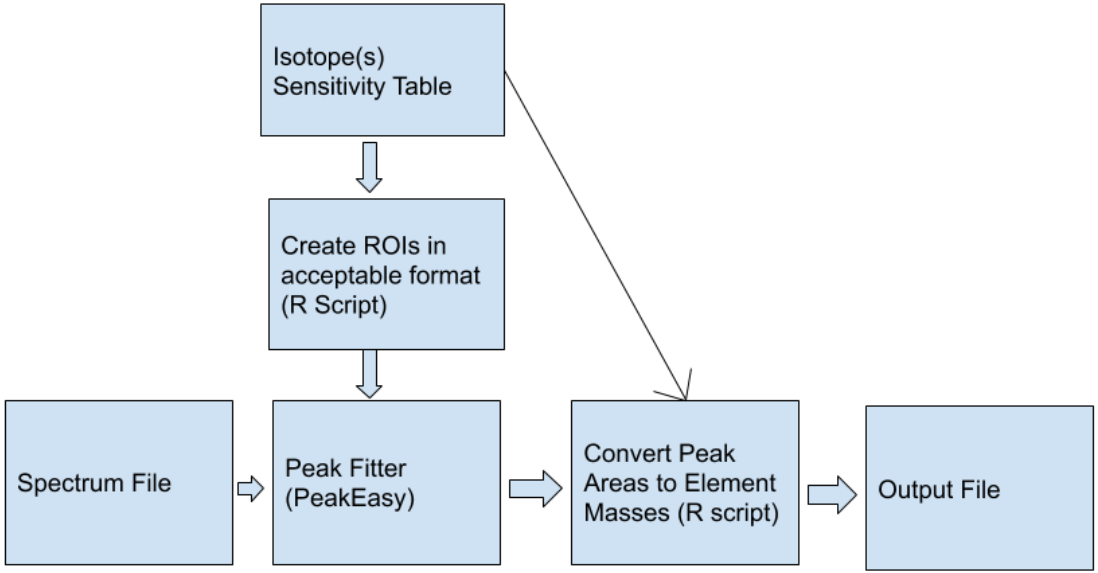
- The sample in question is irradiated using a neutron beam
- Sample nuclei become excited
- Nuclei emit gamma rays upon de-excitation
- The energy of these gamma rays depends on the specific element that produced them
- Several advantages over traditional INAA
- Detects a few specific elements (B, Cd, Sm, Gd) at 10-100 ppb, many others at 1-10 ppm





Project Goals

Current Workflow for PGAA Data Analysis:



Project Goals

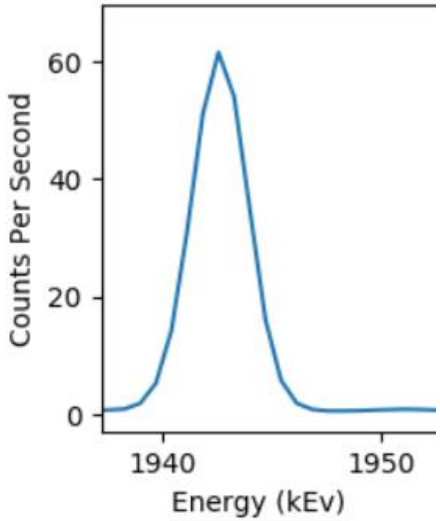
Planned Workflow:

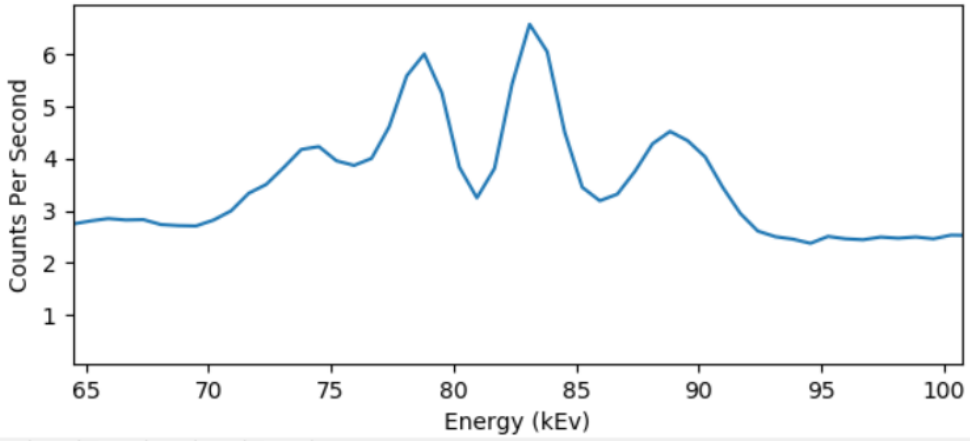
Finding Elemental Mass from Data

- Plot counts per second as a function of energy
- Look for peaks at predetermined locations
- Find area under peak (A)
- Sensitivities (S) have already been determined by irradiating a known amount of the target element (S = A/mass)
- Mass = A/S
- So given a peak with area 20 cps and sensitivity 2 cps/mg, we can determine that there are 10 mg of the associated element in the sample

Finding the True Area of Peaks

- Overlapping Peaks
- Background Noise
- Peaks not in predictions library
- Solution: Nonlinear Least-Squares Fitting

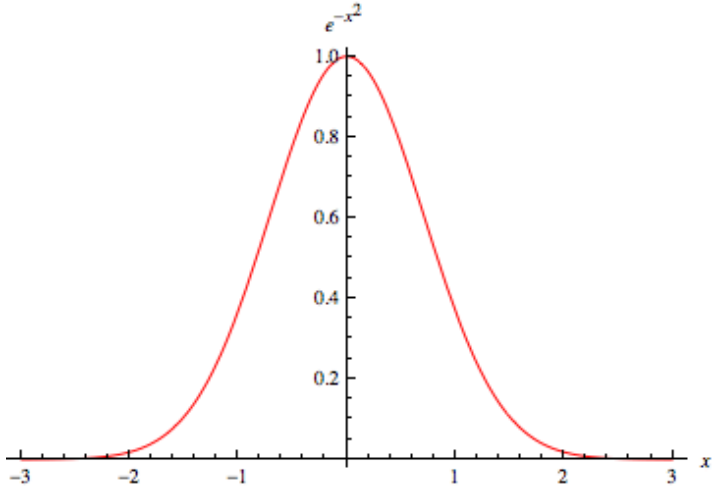




Gaussian Peaks and why they Matter

- Like Normal distributions, but area underneath can be any value
- Caused by detector response to gamma rays at a single frequency (the center)
- Overall equation to model multiple peaks

$$ae^{-\frac{(x-b)^2}{2c^2}}$$



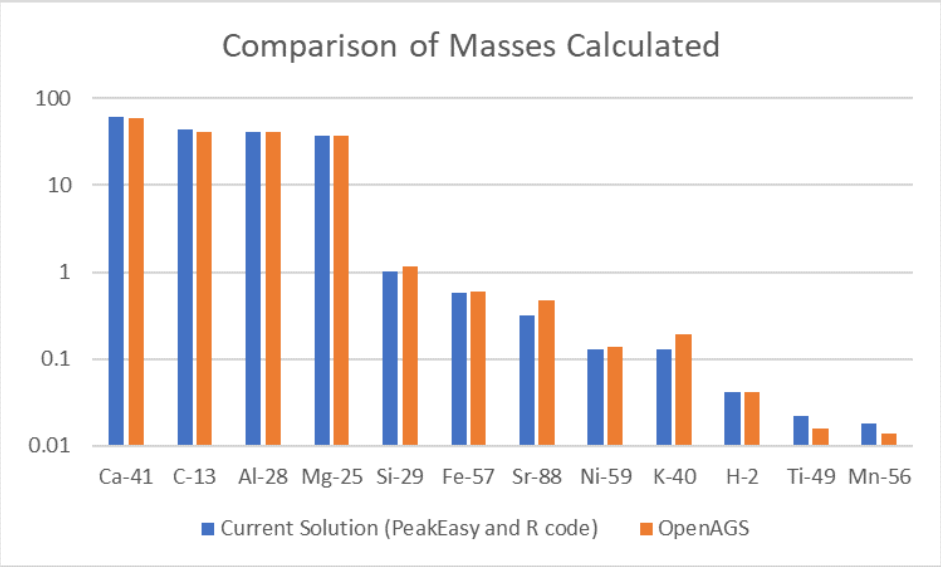
My Approach to the Problem

- Find local maxima
- Guess initial parameters for Gaussians
- Guess the equation of a line that models background data
- Use a curve fitter (scipy.curve_fit) to optimize my guesses
- Match peaks to isotopes
- Divide by sensitivity, and output the mass

Live Demo

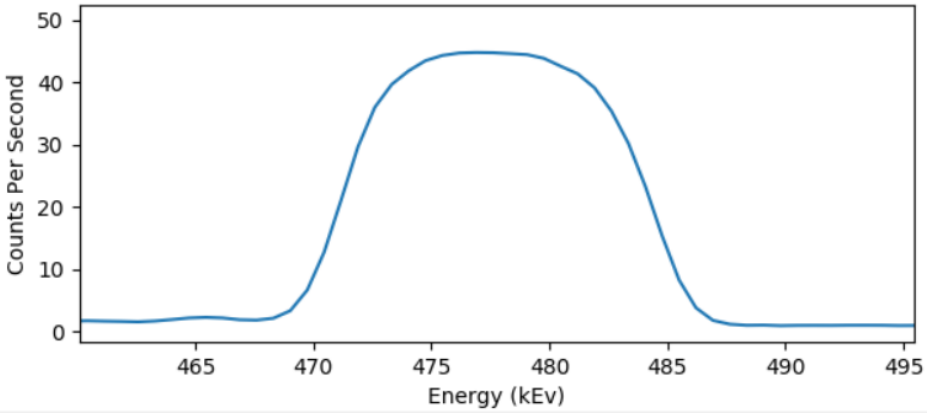
Comparison With Existing Solution

Software	Integration	Proprietary Software	Time for Setup	Batch Processing	ROI Editing	Peak Fitting
Existing Solution (R Code and PeakEasy)	3 steps, several intermediate files	PeakEasy, closed source and only available to US Government	10-30min	Yes	Simultaneous, can manually adjust region	Predetermined fit with 1-2 Gaussians
OpenAGS	1 step	None	Comparable	Yes	Sequential, can manually adjust region and add/remove Gaussians	Fits multiple Gaussians and background line



Future Work

- Present more data to the user during the analysis process
- Fit Doppler-Broadened Gaussians like the B-11 peak
- Add support for more complex functions to model the Detector Response
- Add a feature which allows the user to calculate sensitivities from spectra created by irradiating known masses



Questions?