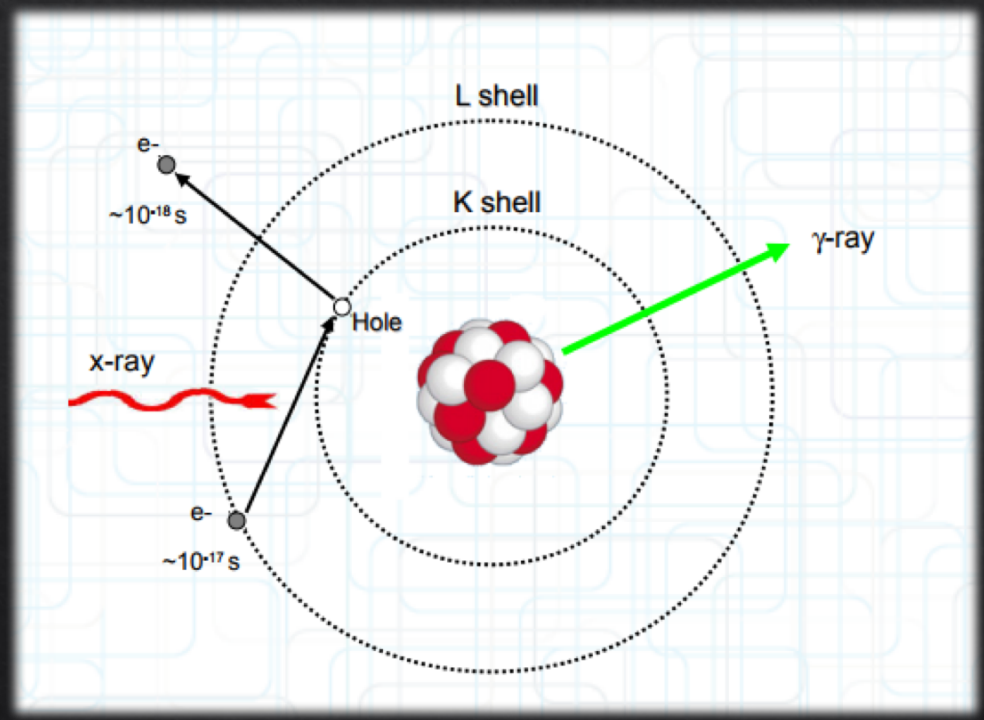
Precise Measurement of α_K for the 39.76-keV *E3* transition in ^{103}Rh:

A Further Test of Internal Conversion Theory

Blake Bryant
H.I. Park, N. Nica, V.E. Iacob, J.C. Hardy

Theory

Internal Conversion



γ Ray Emission

Total Internal Conversion Coefficient

$$\alpha = \alpha_K + \alpha_L + \alpha_M + \ldots$$

Theory

$$\alpha_K = \frac{e_K}{\gamma_K} = \frac{\frac{N_K}{\omega_K \varepsilon_K}}{\frac{N_\gamma}{\varepsilon_\gamma}} = \frac{N_K}{\omega_K \varepsilon_K} \frac{\varepsilon_\gamma}{N_\gamma}$$

α_K=K shell internal conversion coefficient
e_K=number of emitted electrons
γ_K=number of emitted gamma rays
ω_K=fluorescence yield

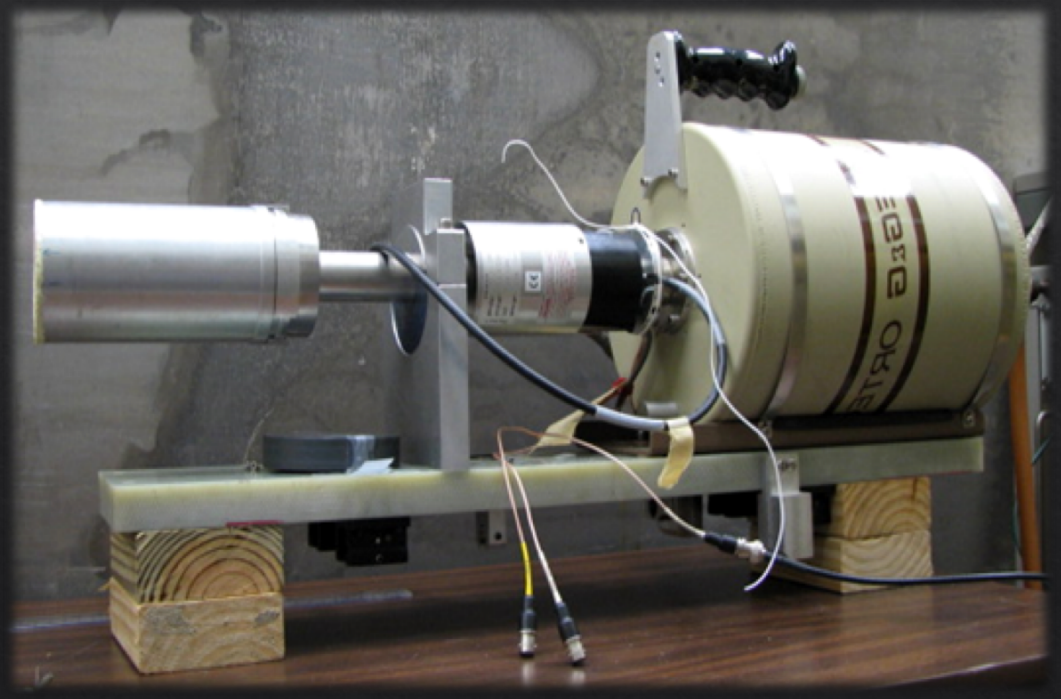
N_K=number of detected x-rays
N_γ=number of detected gamma rays
ε_K=detector efficiency for x-rays
ε_γ=detector efficiency for gamma rays

Source Preparation

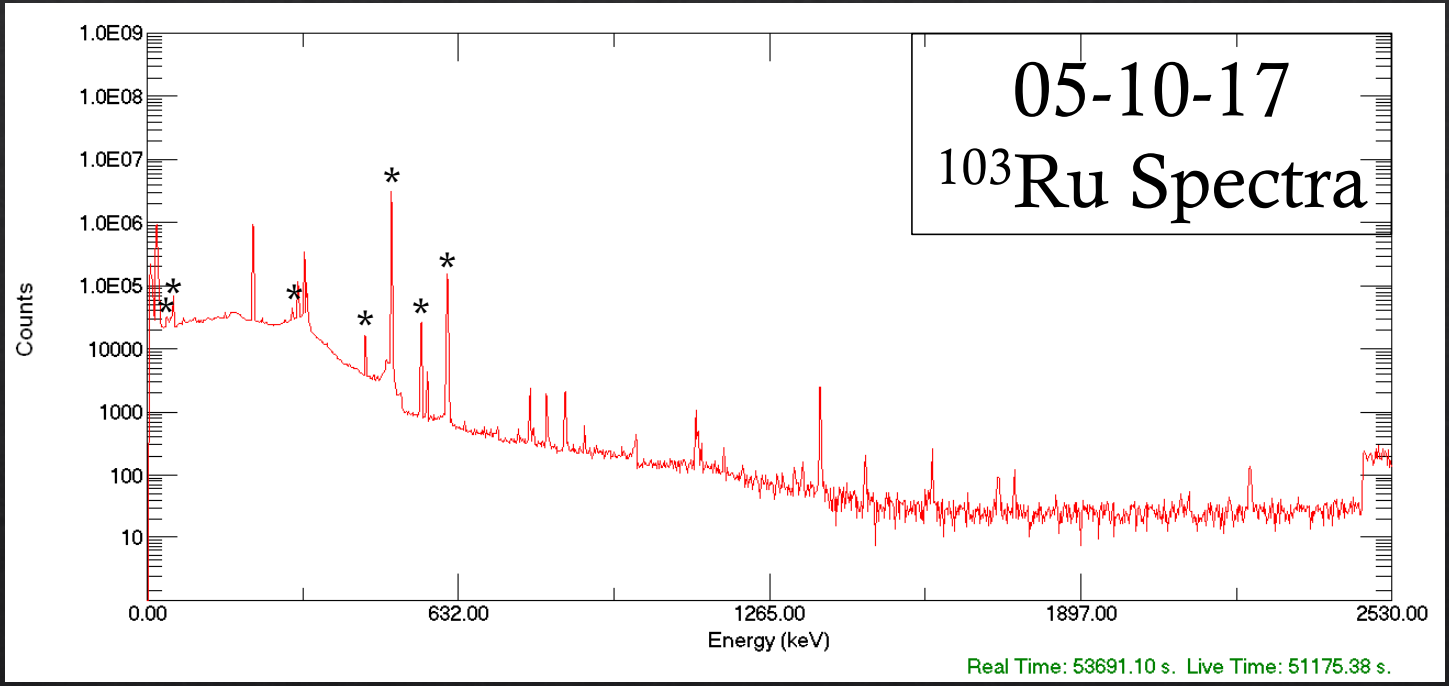
- Commercial sample of high chemical purity Ruthenium Chloride [natural abundance]
- Chemically converted into Ruthenium Nitrate
- Electrochemically deposited on aluminum backing, baked into Ruthenium Oxide
- Thermal Neutron Activation

Detector

- HPGe Detector
- ±0.15% Relative Precision efficiency calibration
- Cooled to extremely low temperatures using liquid nitrogen

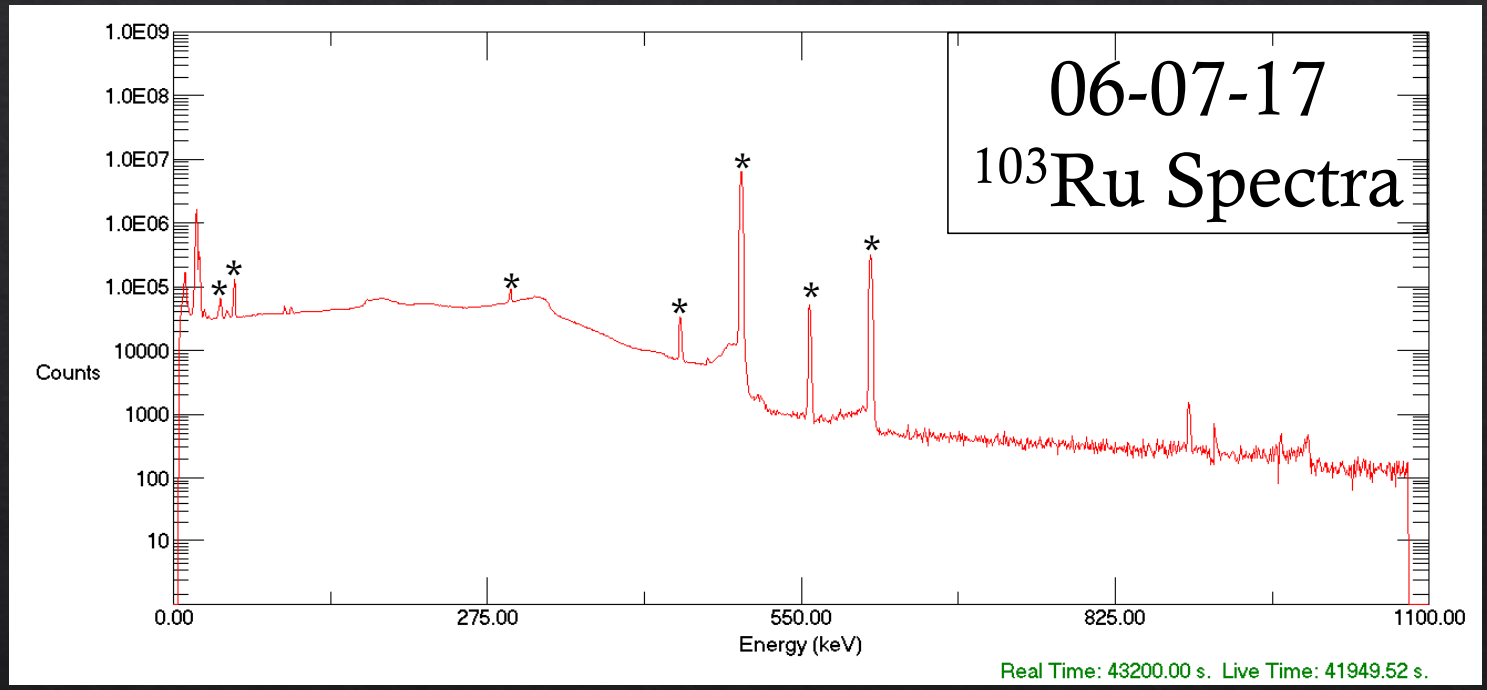


Impurity Analysis



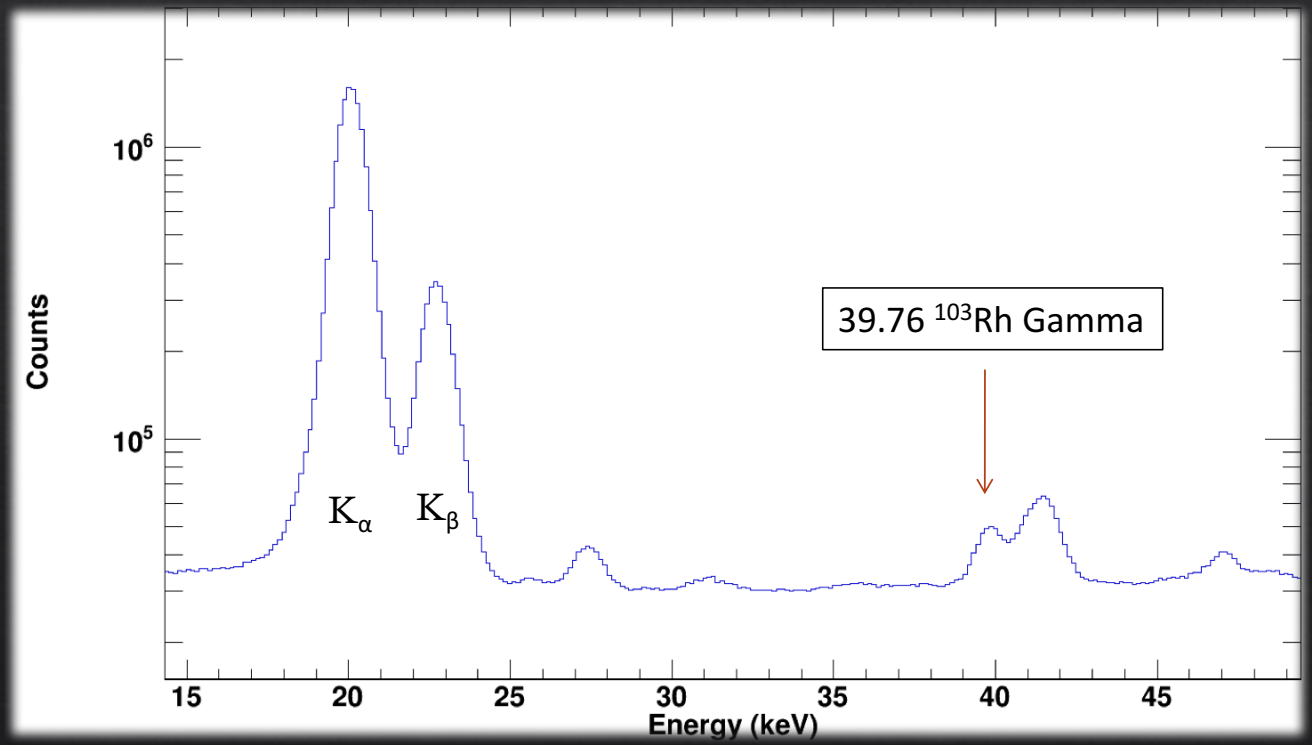
Impurities: ^{105}Rh, ^{97}Ru, ^{96}Tc, ^{97m}Tc, ^{24}Na, ^{46}Sc, ^{65}Zn, ^{60}Co, ^{140}La, ^{153}Gd, ^{161}Tb, ^{199}Au

Impurity Analysis



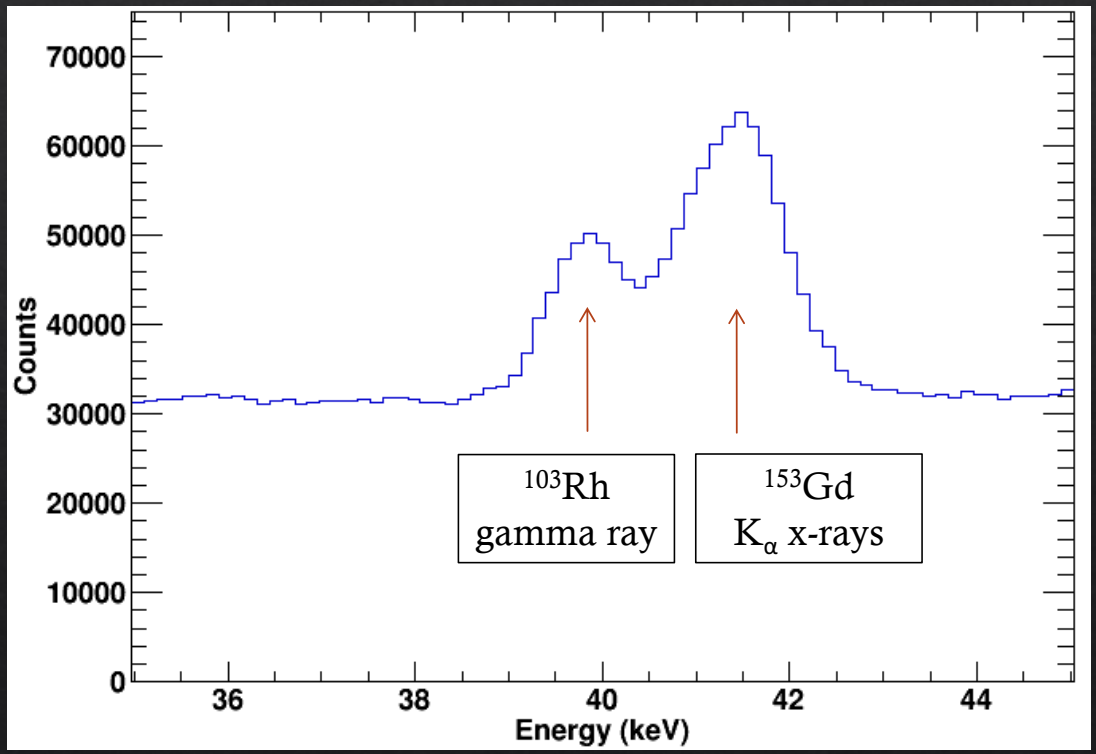
Impurities: ^{46}Sc, ^{153}Gd

Region of Interest



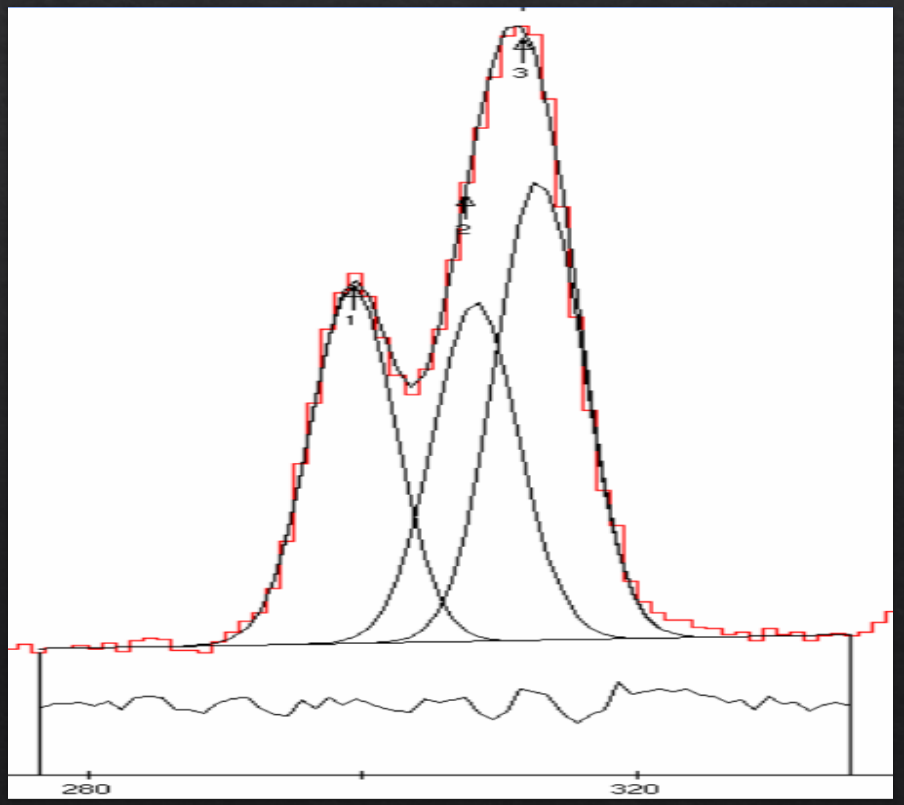
Overlapping Peaks

- 39.87 keV ^{103}Rh gamma ray
- K_α x-ray group from ^{153}Gd
- $K_{\alpha 1}$ at 41.5 keV
- $K_{\alpha 2}$ at 40.9 keV



GF3 Fit

- Fitting program from Radware Package
- Three Gaussian structures and a background function



Corrections

- ω_K=fluorescence yield=0.809(4)
- ε_K=detector efficiency for x-rays=0.9042
- ε_γ=detector efficiency for gamma rays=1.0103
- F_1=attenuation correction=1.0049
- F_2=Voigt correction=1.0012
- ^{103}Ru impurity:12.68(14)%
- ^{97}Ru impurity:0.098(9)%
- ^{97m}Tc impurity:0.077(8)%

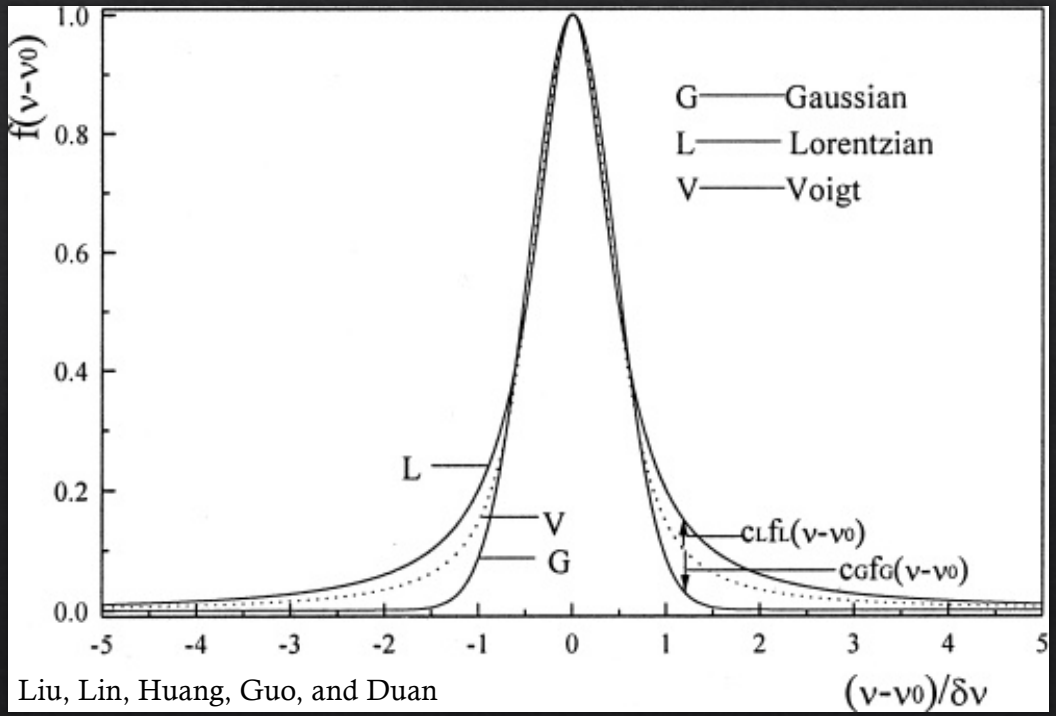
Preliminary Result

Experimental	Vacancy	No Vacancy
134.6(19)	135.2	127.4

The preliminary experimental value demonstrates that *the atomic vacancy created in the internal conversion process must be considered in theoretical calculations.*

Gamma vs. Voigt Functions

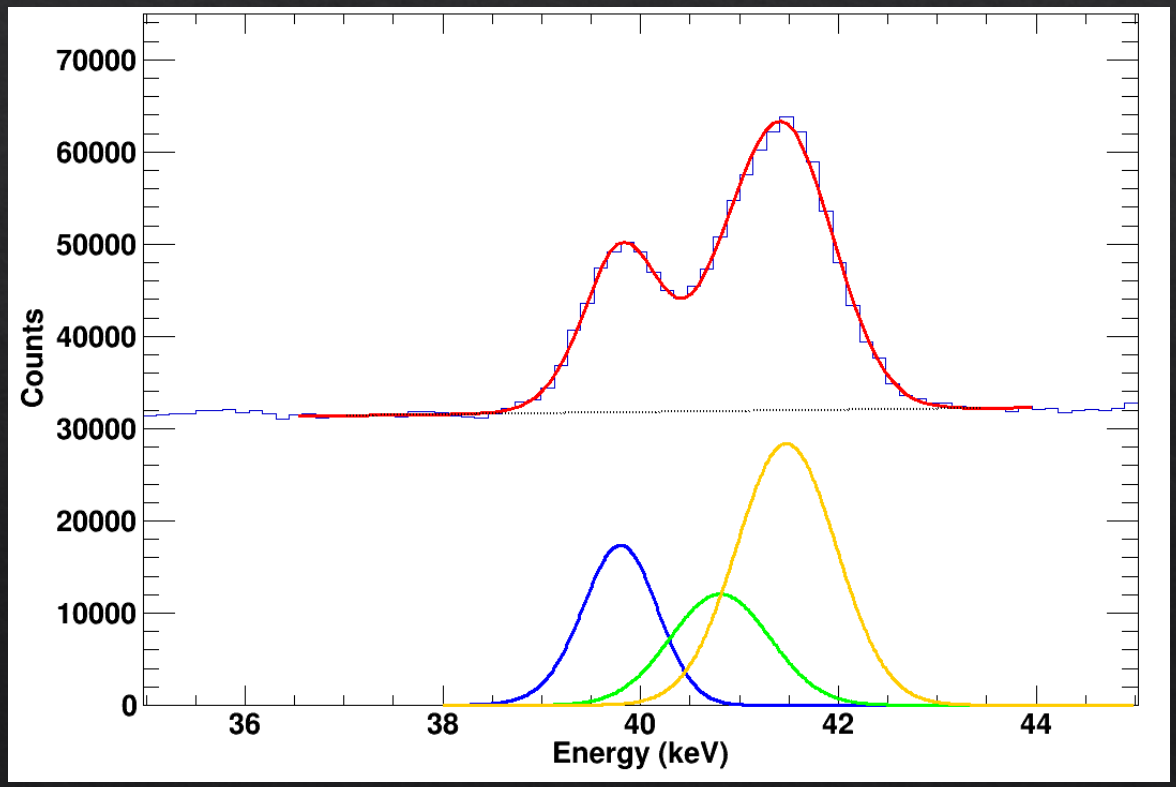
- Gamma and x-rays are inherently shaped as a Lorentzian function
- Detected gamma rays well described by Gaussian function
- Detected x-rays not well described by Gaussian functions but are by Voigt Functions



Liu, Lin, Huang, Guo, and Duan

ROOT Fit

- ROOT fit Framework developed by CERN
- Normalized Chi-squared=4.1
- Blue - Skewed Gaussian
- Green - $K_{\alpha 2}$ Voigt
- Yellow - $K_{\alpha 1}$ Voigt



Acknowledgements

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