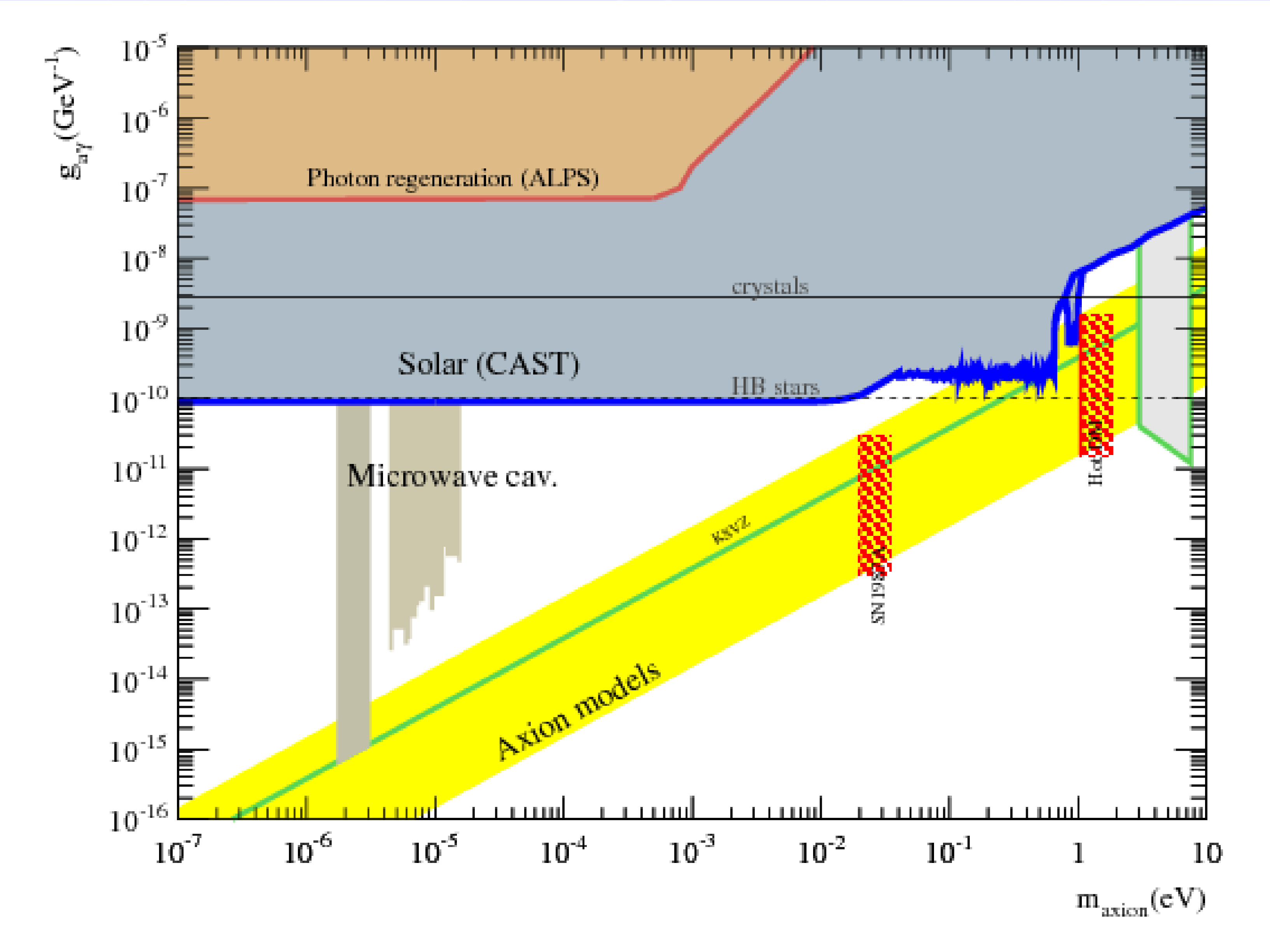
Ivan Lavrentyev

CAST and SDD Detector Analysis

CAST Recap

- Axion is a weakly interacting particle hypothesized to solve strong CP problem
- CP is not violated experimentally, but predicted in QCD theory
- Axion couples with photons, converts between forms in an E or B field
- Sun is a likely source of axions

Axion Model

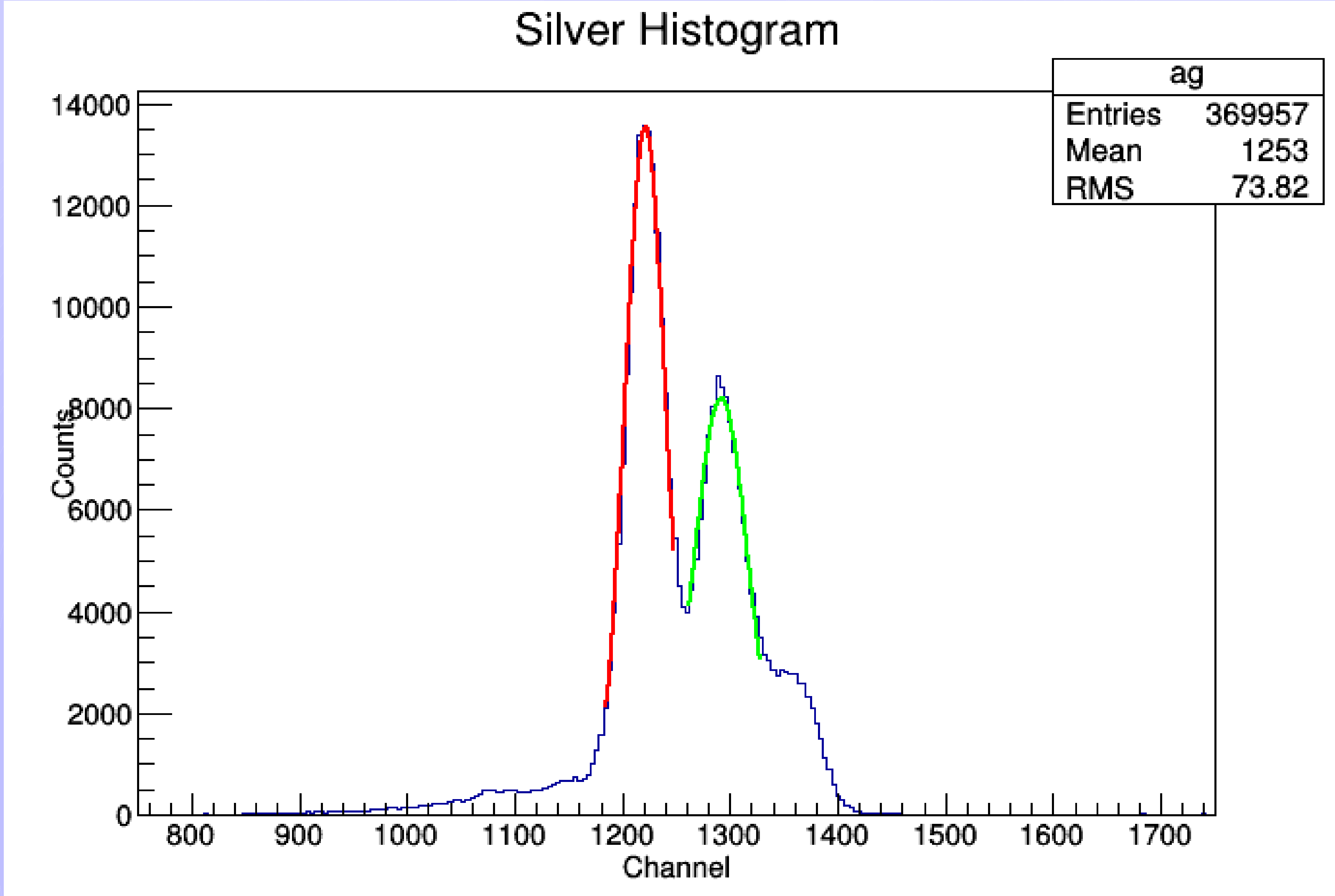


Photon regeneration (ALPS)
crystals
Solar (CAST)
HB stars
Microwave cav.
KSVZ
Axion models
SN 1987A
Hot DM
$g_{a\gamma}$ (GeV^{-1})
m_{axion} (eV)
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
1
10

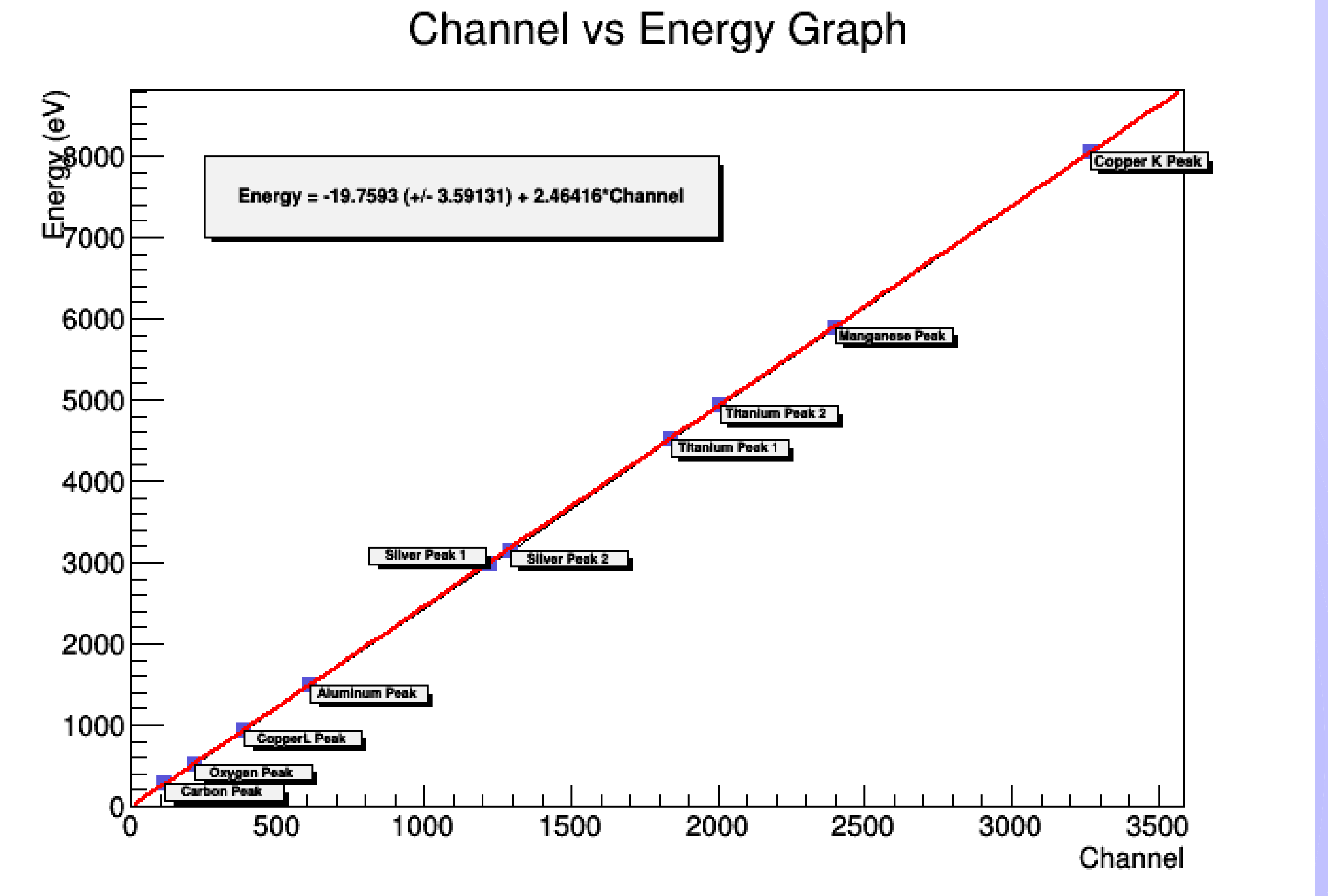
SDD Detector Calibration

- Detector records data in Channels
- Convert to Energy (calibration)
- Firing X-Rays at various metal targets
- Each target has a unique Transmission Spectrum for which the peak energies are known
- Plot the Channel number at the peaks versus the known Energy at the peak

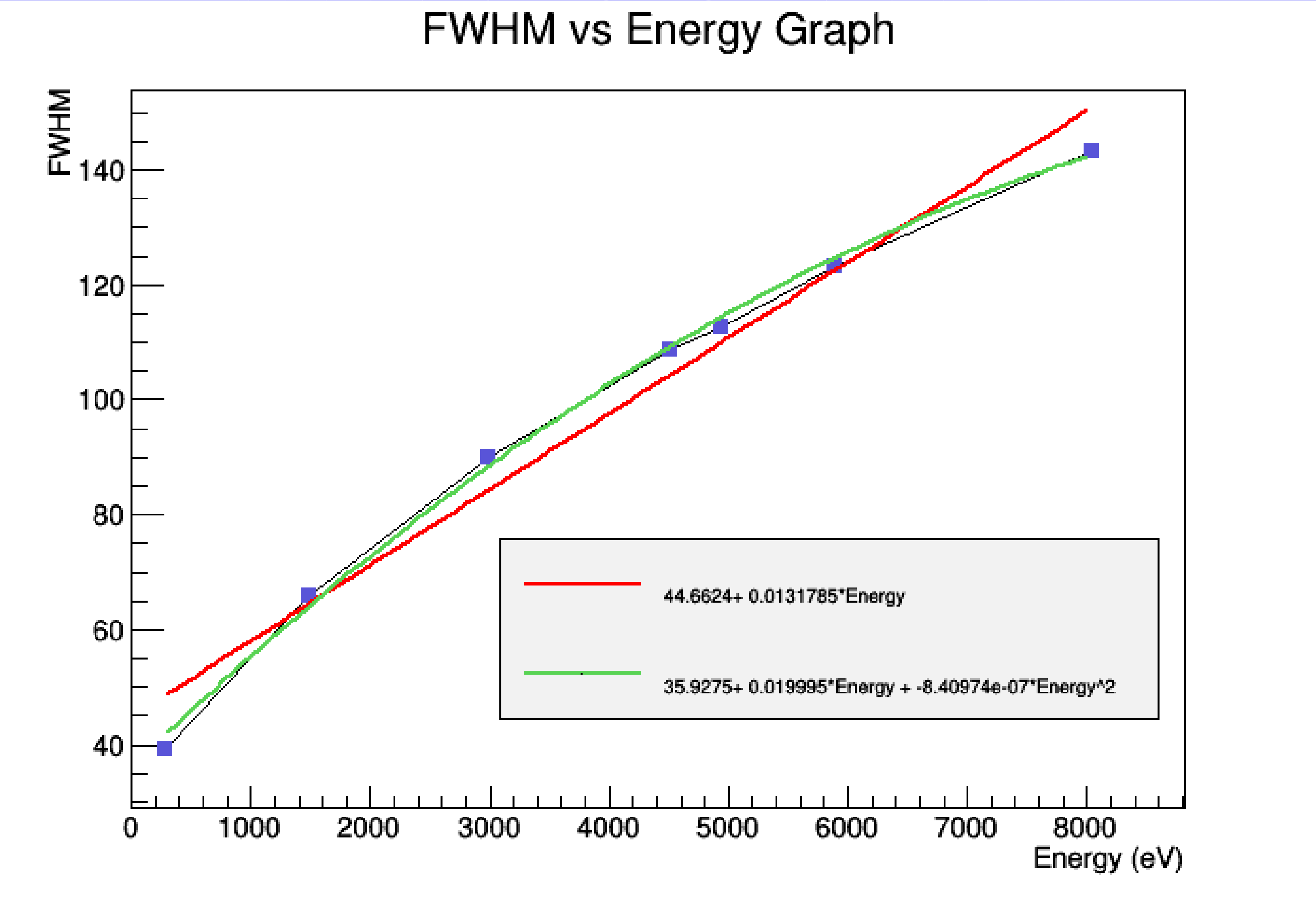
Detector Calibration



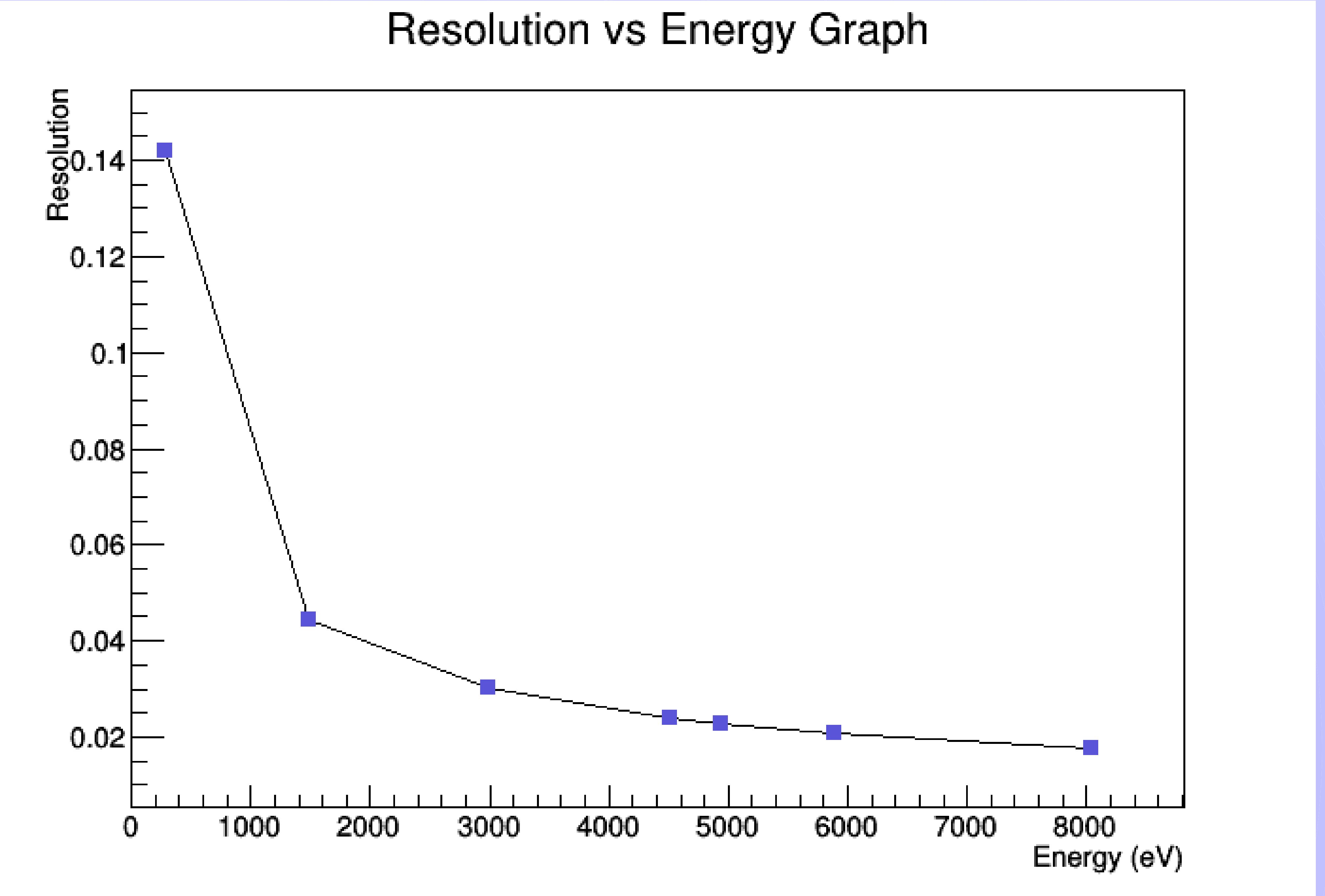
Detector Calibration



Resolution Calibration

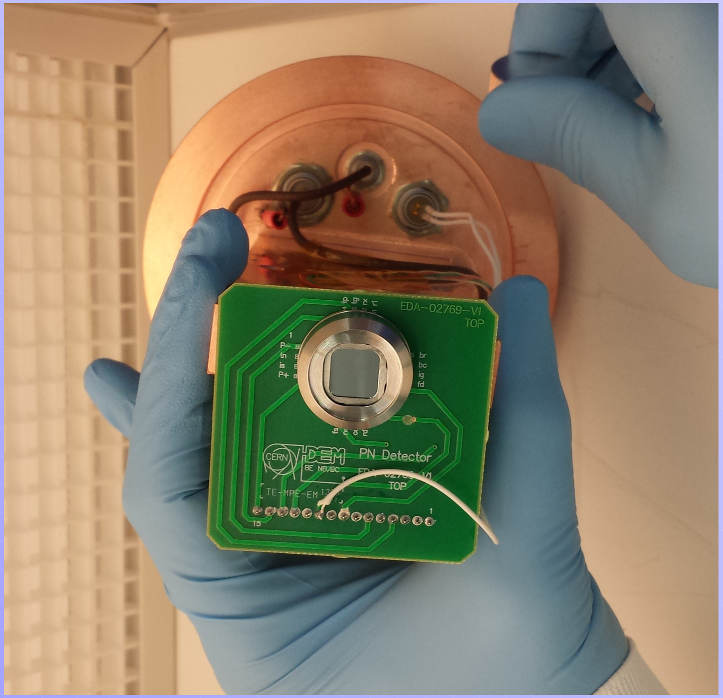


Resolution Calibration

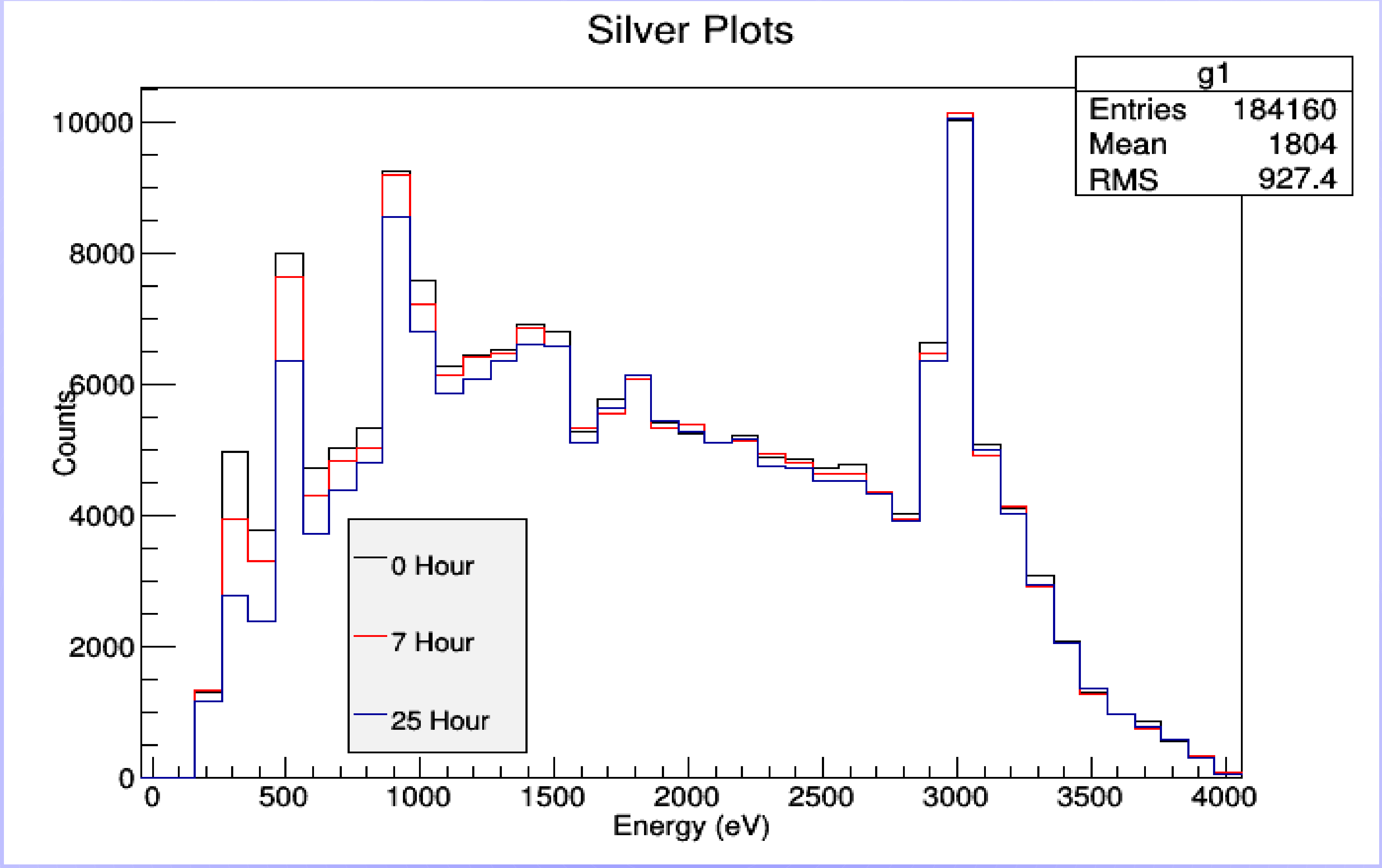


Decrease in Transmission over time

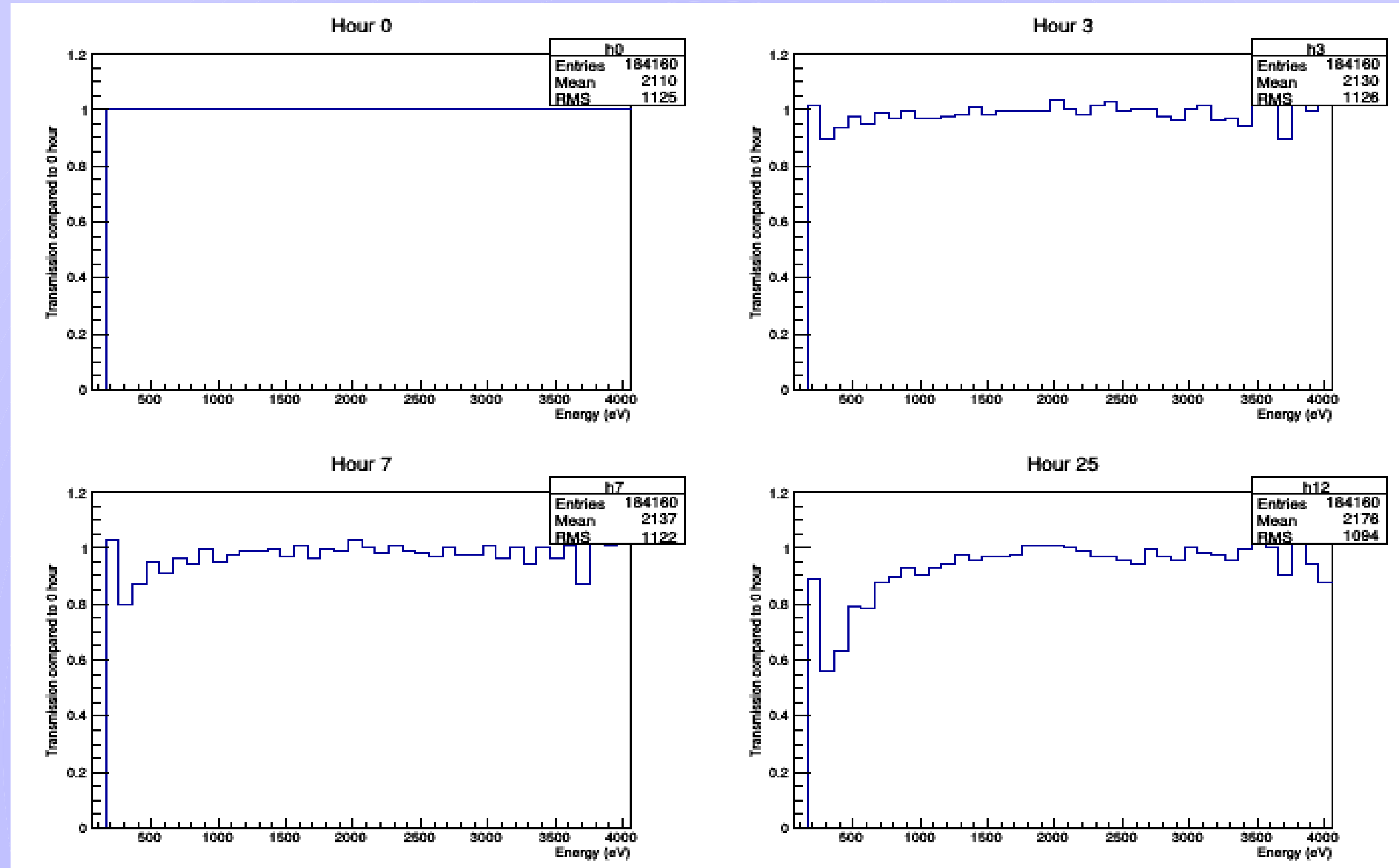
- There is a decrease in Transmission over time, while the detector is kept running
- Could be due to accumulation of unknown compound along the detector, acting as a filter
- When the detector cools, a gaseous compound condenses on the detector, interfering with the data
- Goal is to account for the compound in a model and analyze its effect on Transmission percentage



Silver target data for various times



Transmission % compared to first hour of data

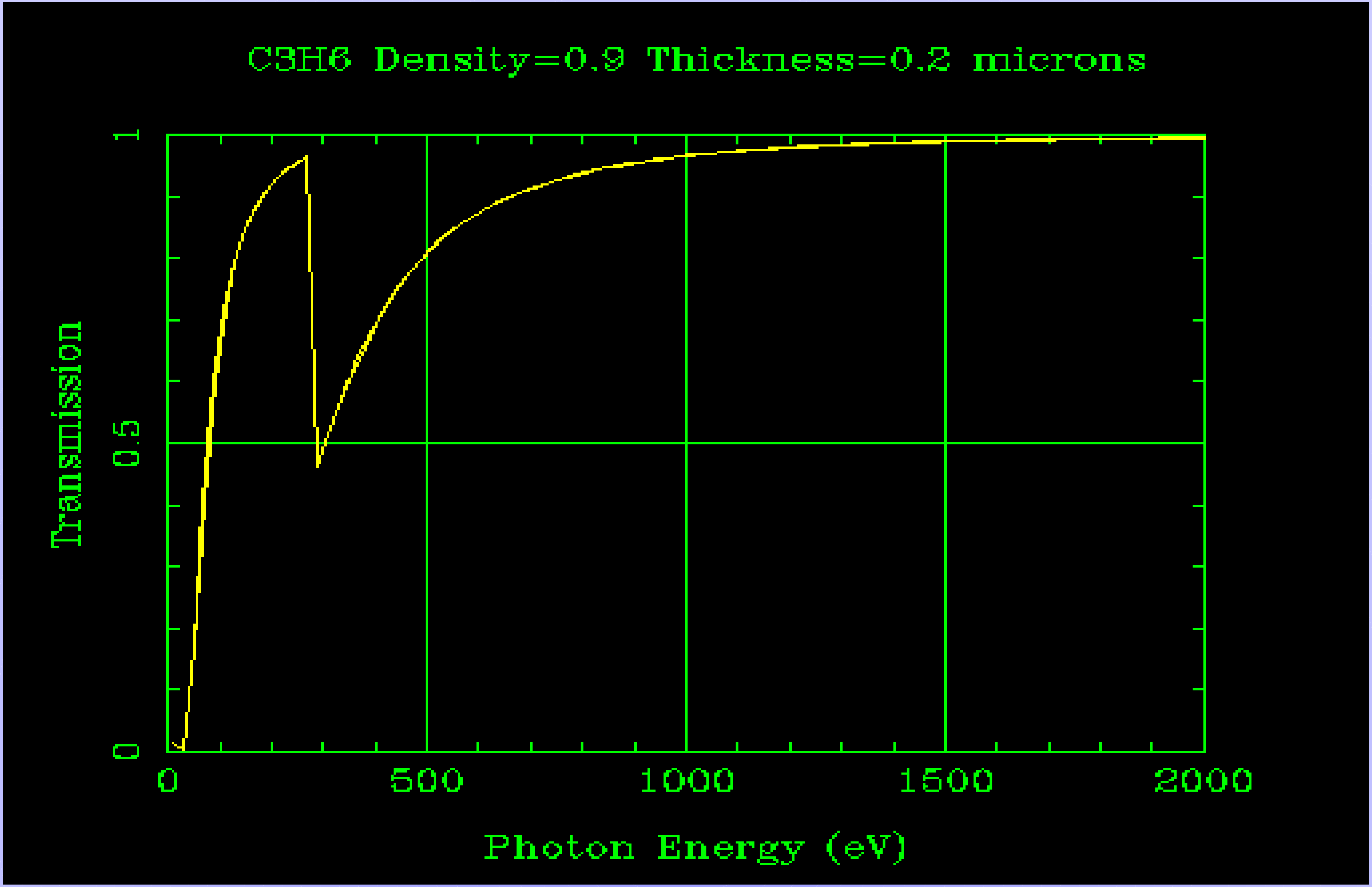


- To find the Transmission decrease over time, we can compare known experimental data for several filters

- The Transmission plot of C_3H_6 seems to fit the data nicely

- Using a set of data points for the compound, several curves were used to fit the data to approximate the equation of Transmission

C3H6 Transmission Model



Create a Monte Carlo Simulation

- Equation to Model the Transmission is

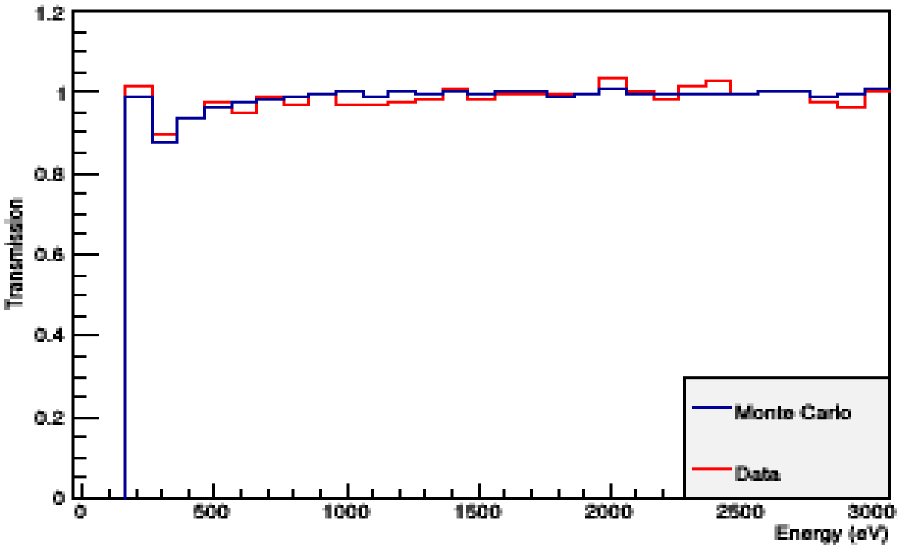
  $T = I / I_0 = \exp [- \mu \rho \tau]$

  μ is attenuation coefficient, τ is thickness of filter (microns)

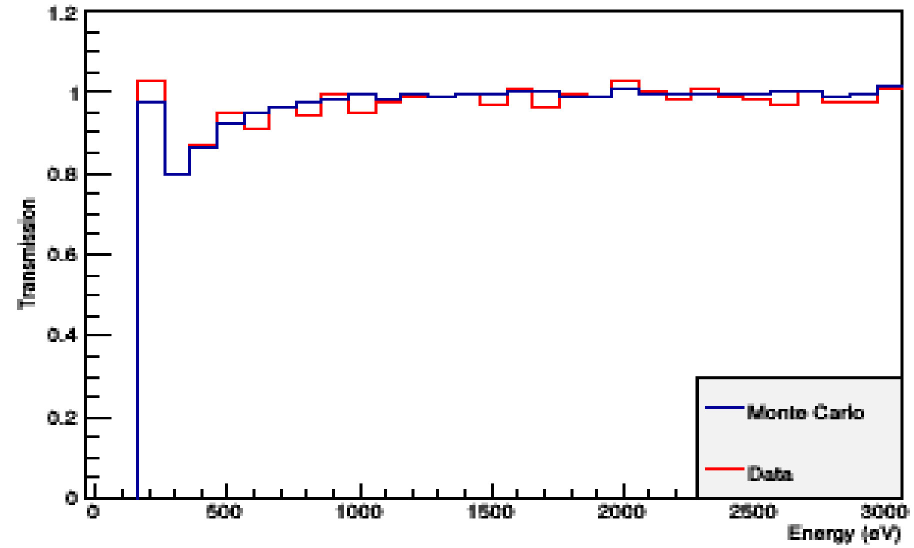
- Knowing the attenuation lengths for various energies, create a Monte Carlo that models the Transmission
- Adjust Monte Carlo to the resolution of the detector
- Perform Chi-Squared analysis to find Monte Carlo that best fits the data for each hour of data.
- Find an equation of Transmission vs. Time using the results of the Chi-Squared fit

Monte Carlo Plots for various times

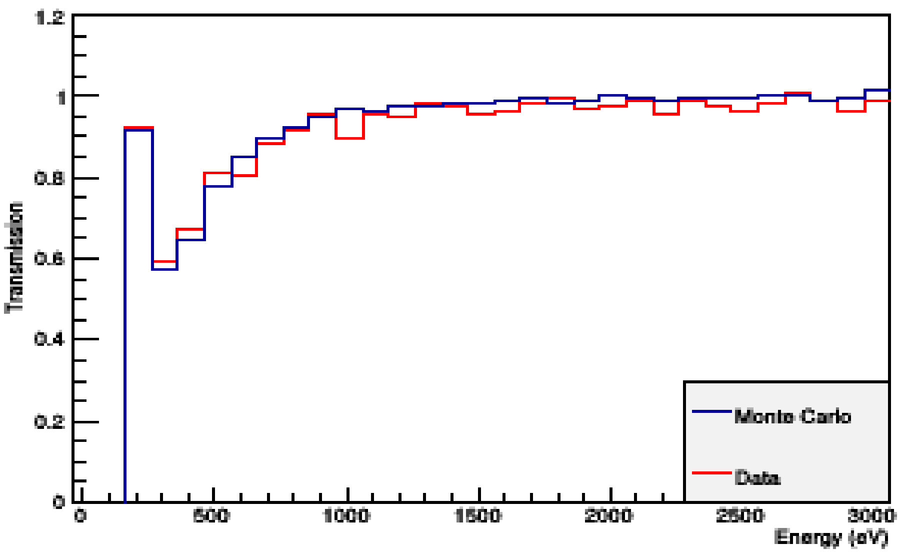
3 Hours, Thickness .035 microns



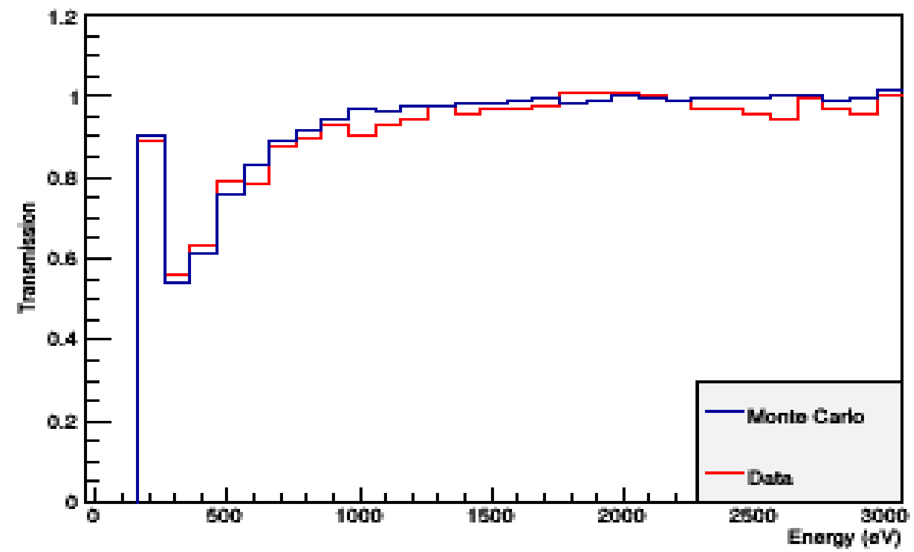
7 Hours, Thickness .075 microns



21 Hours, Thickness .225 microns



25 Hours, Thickness .25 microns



Thickness = .0107*(Hour) - .0027

- The relation between thickness and time is almost linear

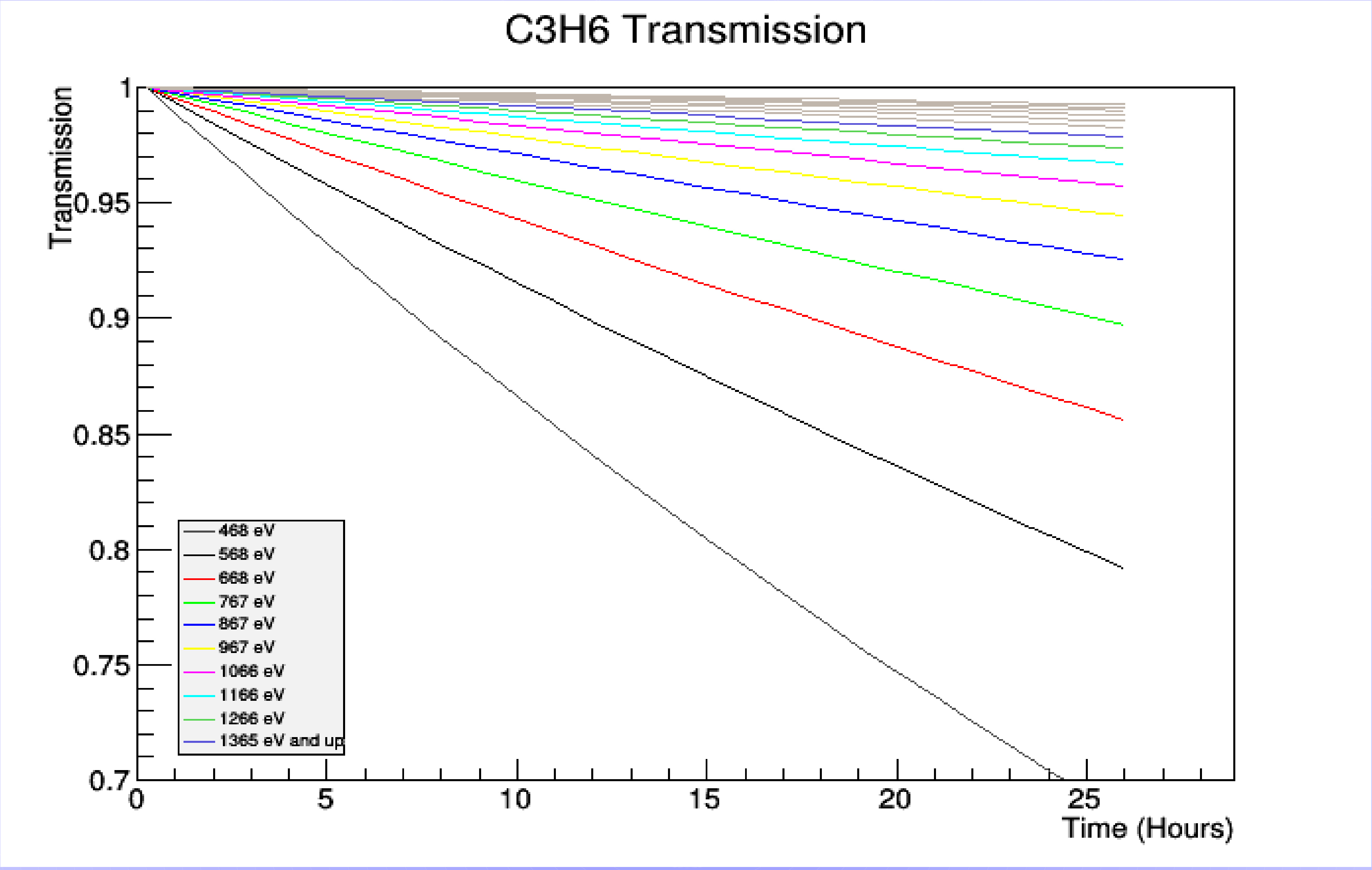
- The thickness can be plugged into the previous Intensity equation

  $T = I / I_0 = \exp [- \mu \rho \tau]$

  to find the theoretical transmission percentage over time

- This can be compared to the experimental plot of the Transmission over time

Theoretical Transmission



Future analysis

- Perform an analysis of the experimental Transmission obtained from the data
- Take additional data and try to replicate the same results
- Find an accurate relationship between Transmission percentage and time
- Use this knowledge to understand how the detector performs

Summer Work

- CAST is taking data during June-July
- I will be working data taking shifts throughout this period
- Possibility to get published in paper soon
- Might also try to find a side project to work on during the summer besides CAST

Sources

- http://henke.lbl.gov/optical_constants/
- http://xdb.lbl.gov/Section1/Table_1-3.pdf