Mott Analysis Update

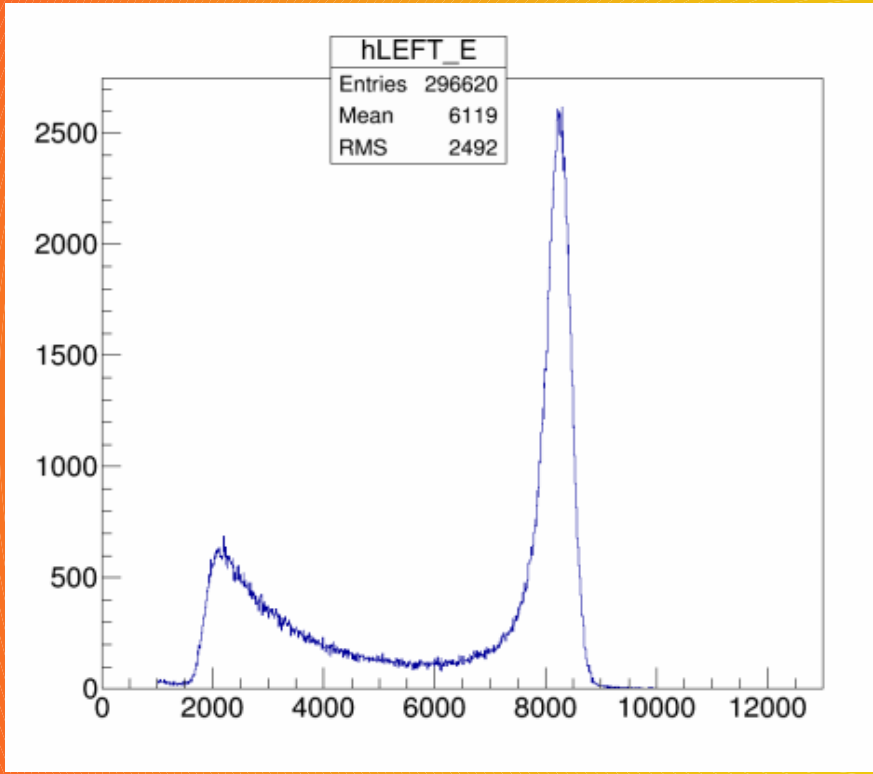
Summary

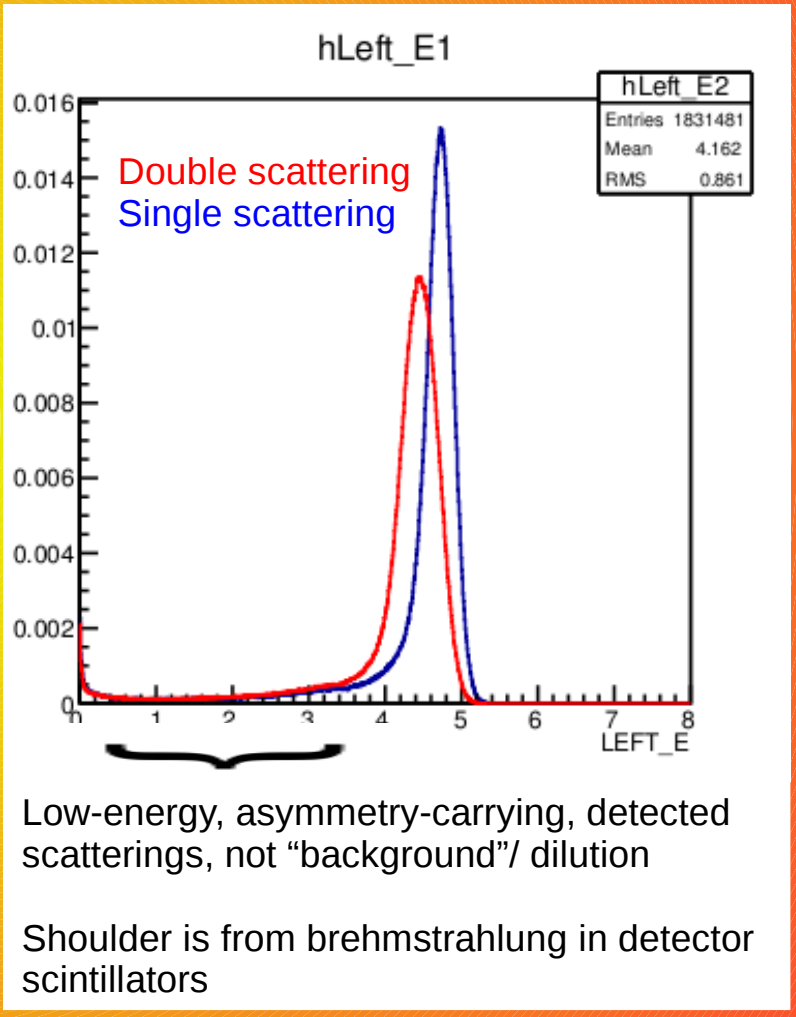
- Measured vs Simulated Energy Spectra
- Current Mott Analysis Code

  How we determine cuts, what do we cut away, what do we keep
- Alternate Analysis Approaches Fitting Energy spectra

  1. Simulation-driven energy spectra fit form
  2. Seeded 5-parameter exp+gauss

Measured vs Simulated

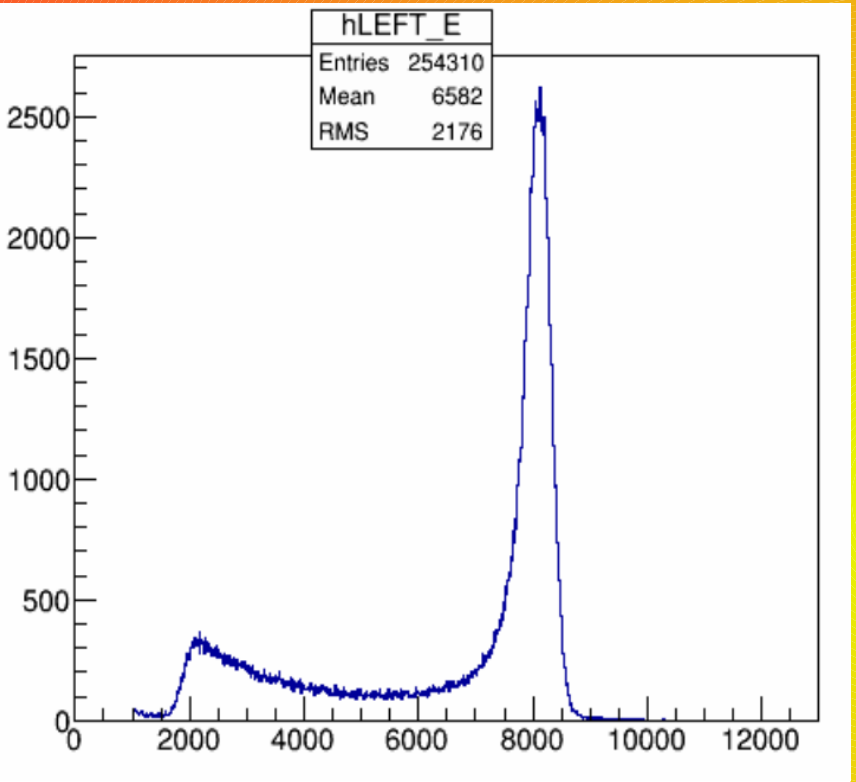




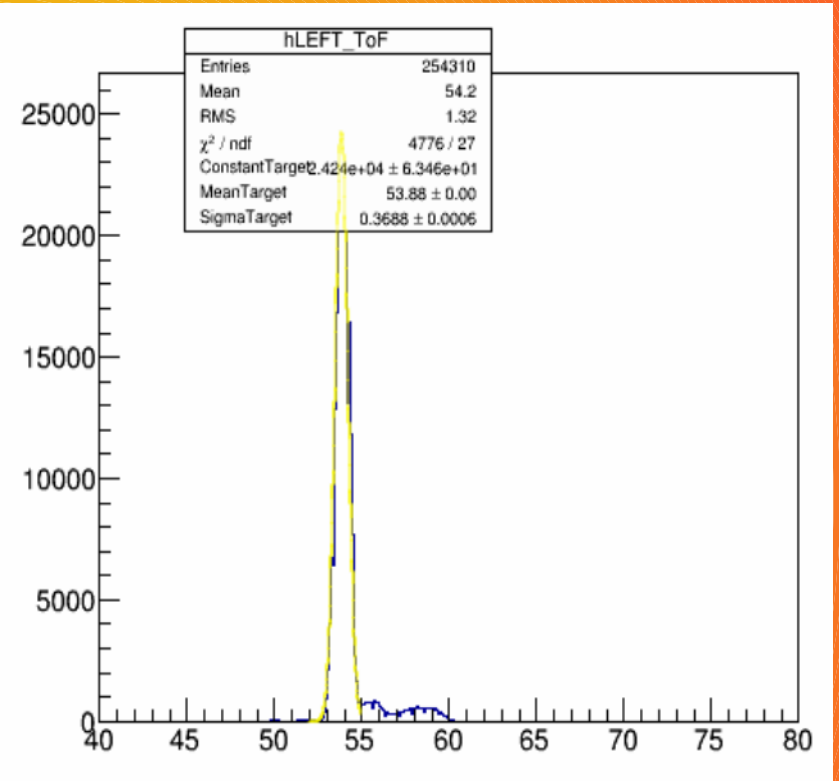
Low-energy, asymmetry-carrying, detected scatterings, not “background”/ dilution

Shoulder is from brehmstrahlung in detector scintillators

Current Mott Analysis Code



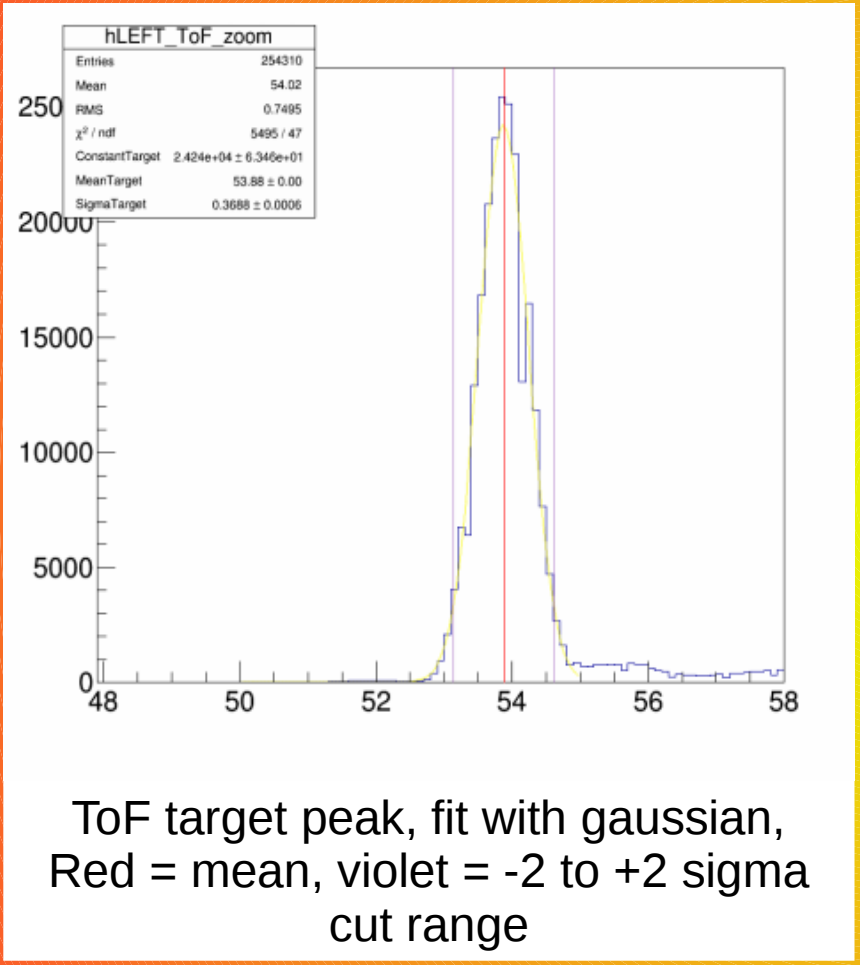
Un-cut, raw measured energy spectra in left detector



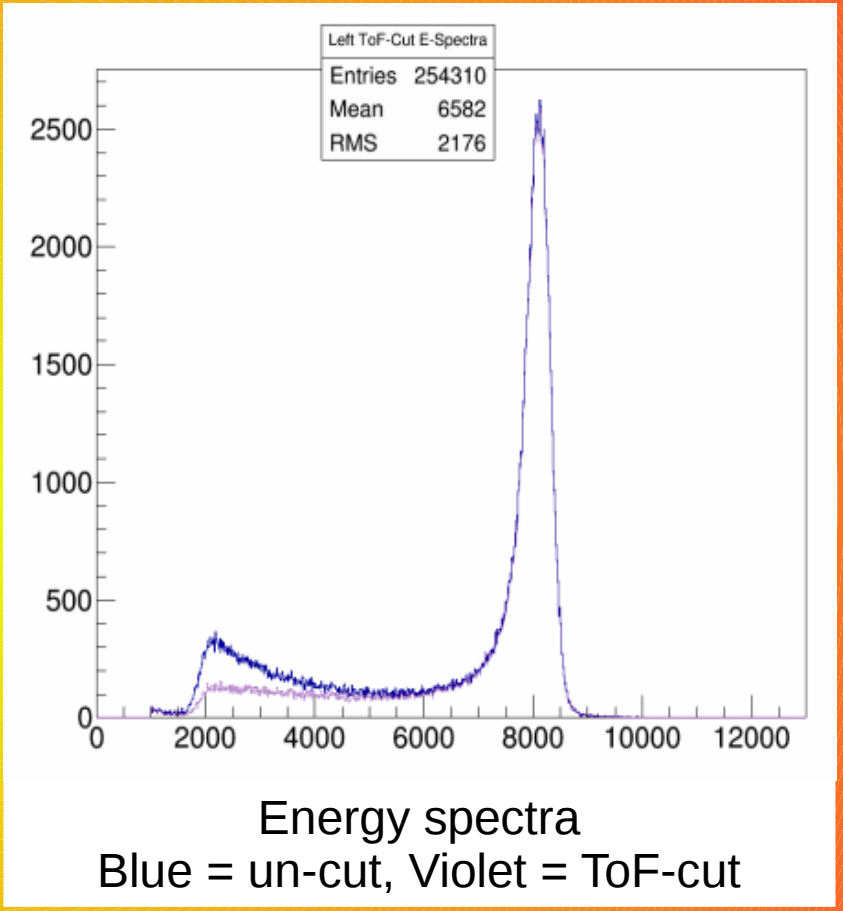
Time of Flight spectra for left detector, yellow is gaussian fit of target peak

Run 8530, from Run II Asymmetry vs Thickness study, 500 nm foil, with hardware ToF veto

Current Mott Analysis Code



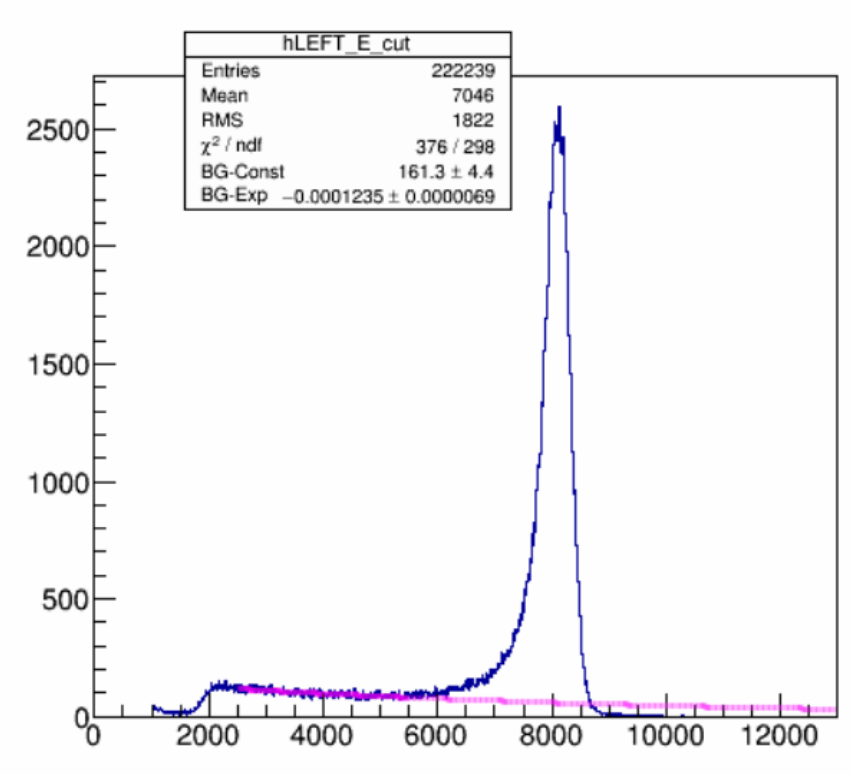
ToF target peak, fit with gaussian,
Red = mean, violet = -2 to +2 sigma cut range



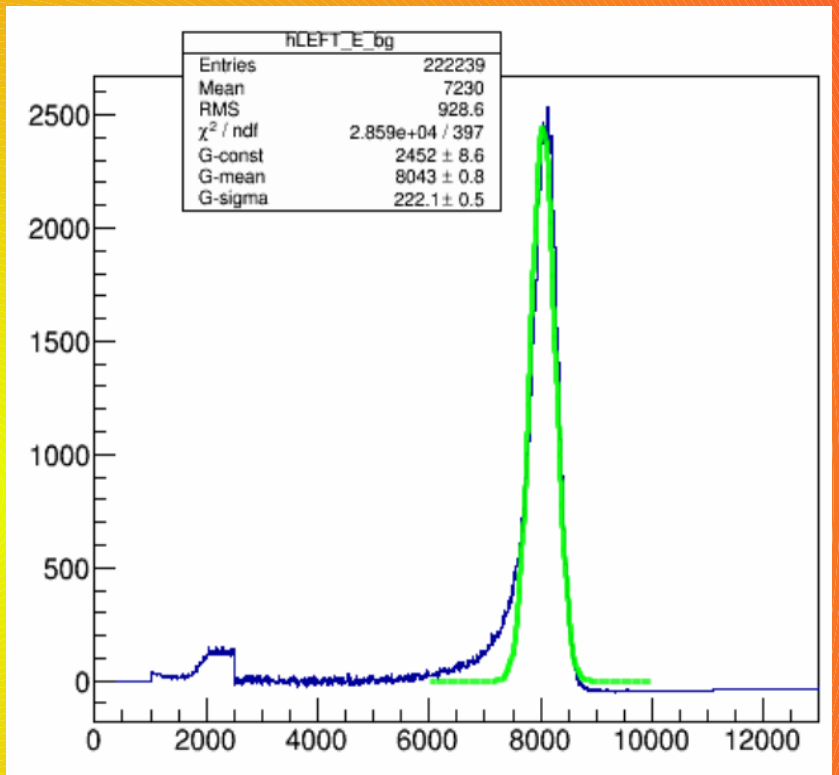
Energy spectra
Blue = un-cut, Violet = ToF-cut

Run 8530, from Run II Asymmetry vs Thickness study, 500 nm foil, with hardware ToF veto

Current Mott Analysis Code



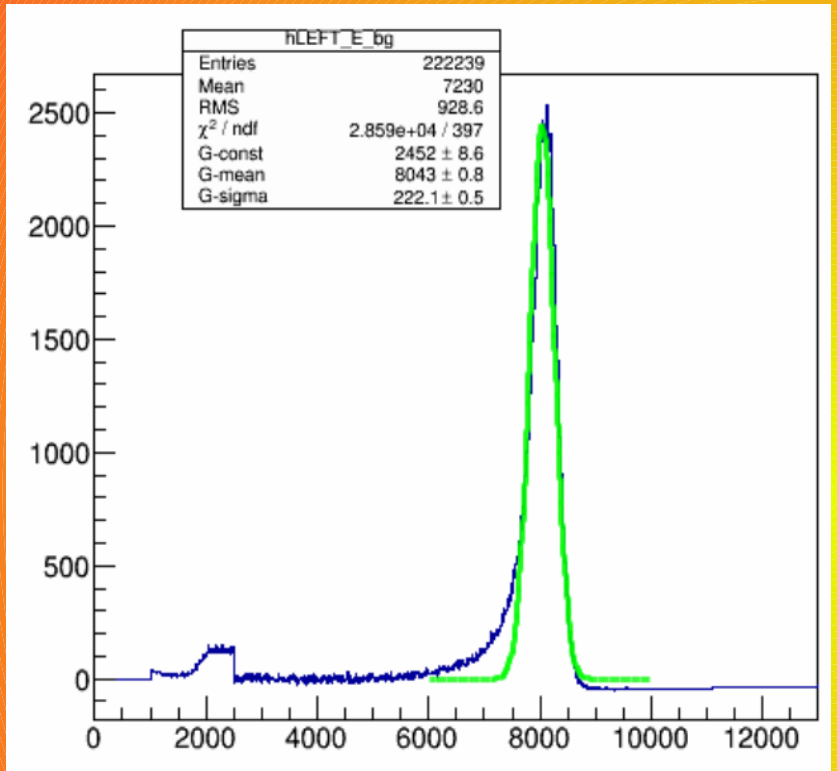
Blue = ToF-Cut energy spectra (formerly violet), pink = decaying exponential fit, fit from [2500:5500] and extrapolated to [2500:13000]



Blue = ToF-Cut, exponential dilution / ”background” fit subtracted energy spectra, green = gaussian fit in range [6000:10000]

Run 8530, from Run II Asymmetry vs Thickness study, 500 nm foil, with hardware ToF veto

Current Mott Analysis Code



From fit, we take mean and sigma, and determine our energy cut range, -0.5 to +2 sigma about the mean

Of green gaussian fit,

Mean = 8043, Sigma = 222

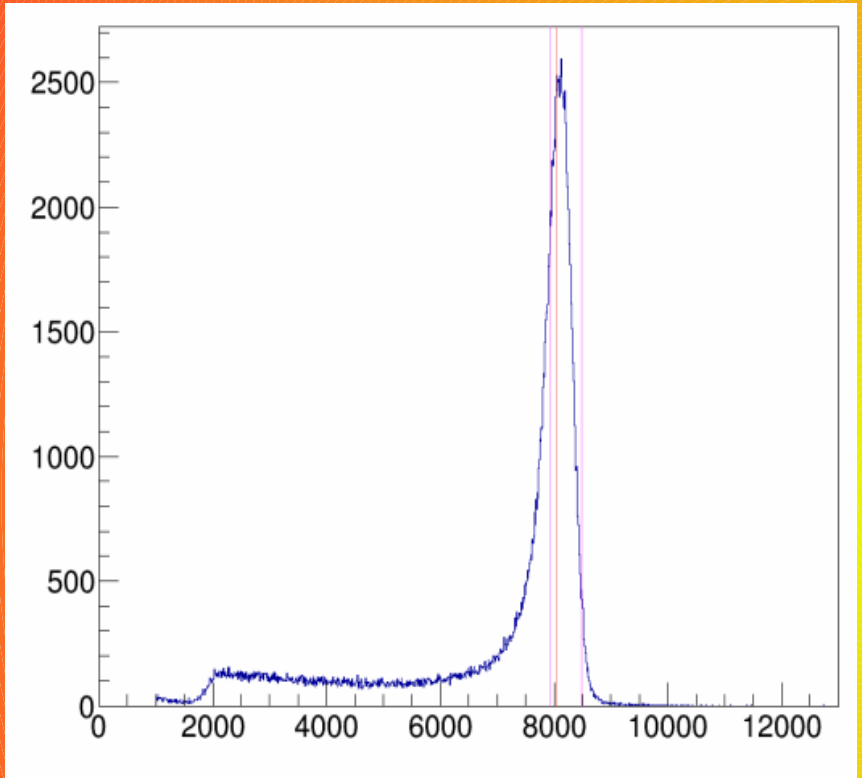
=>

E1 = 7932, E2 = 8487

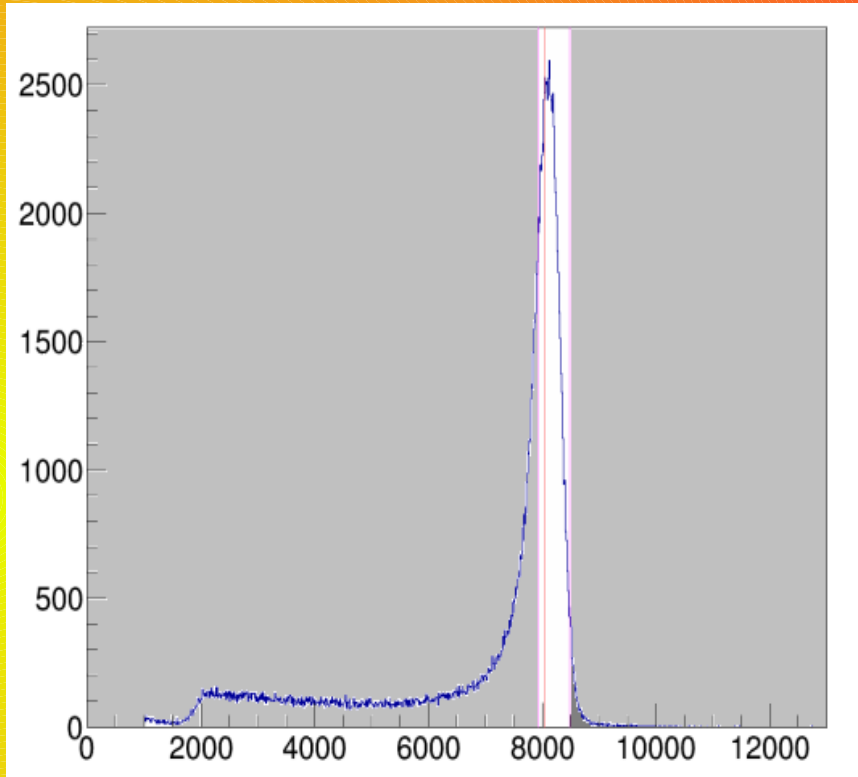
Everything up to this point is the first loop (of three) of the analysis code. From it, we get [T1, T2, E1, E2] – our cut ranges, that are passed on to the second loop where asymmetries are calculated from only “good” events, ie events within these cuts

Run 8530, from Run II Asymmetry vs Thickness study, 500 nm foil, with hardware ToF veto

Current Mott Analysis Code



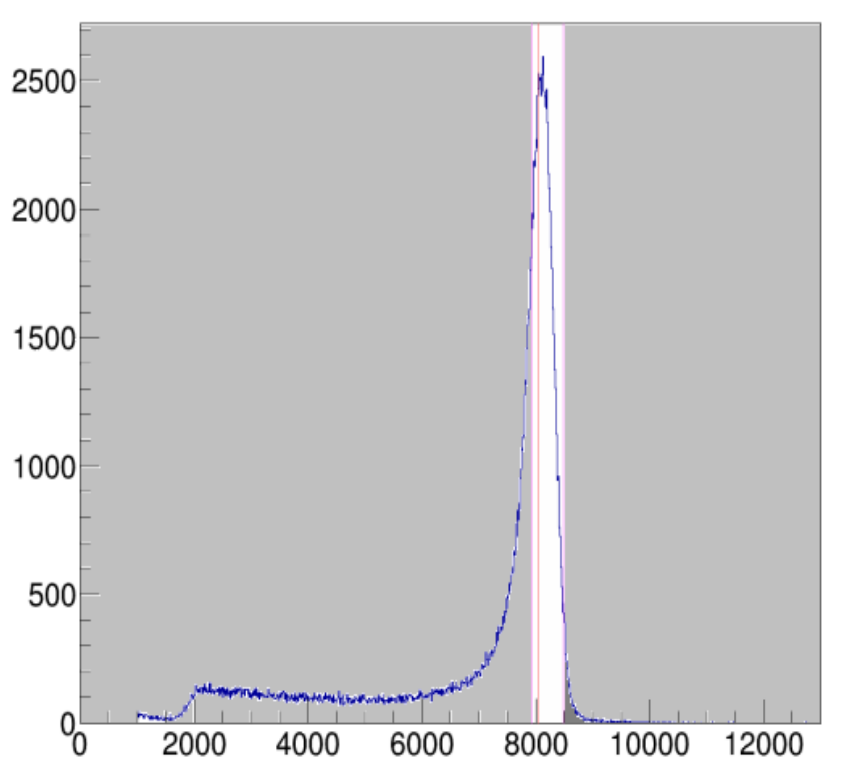
Blue = ToF-Cut energy spectra
Red = mean of gaussian fit
Magenta = upper and lower bounds of Energy cut from -0.5 to +2 sigma

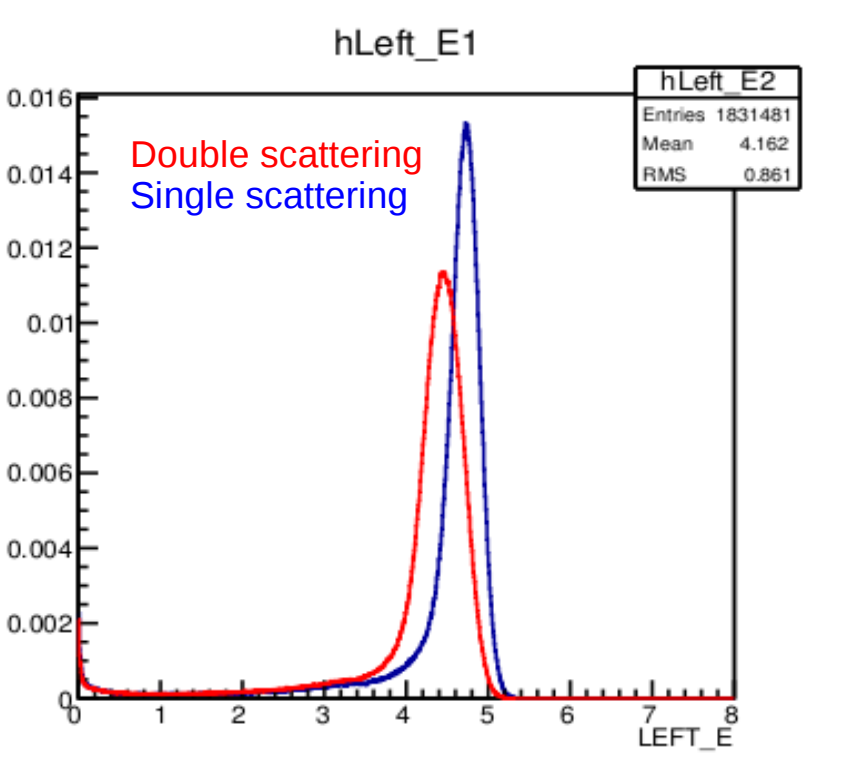


E1 = 7932, E2 = 8487 => 555 bins kept, white region
Gray region = events cut away by energy cut, after ToF cut

Run 8530, from Run II Asymmetry vs Thickness study, 500 nm foil, with hardware ToF veto

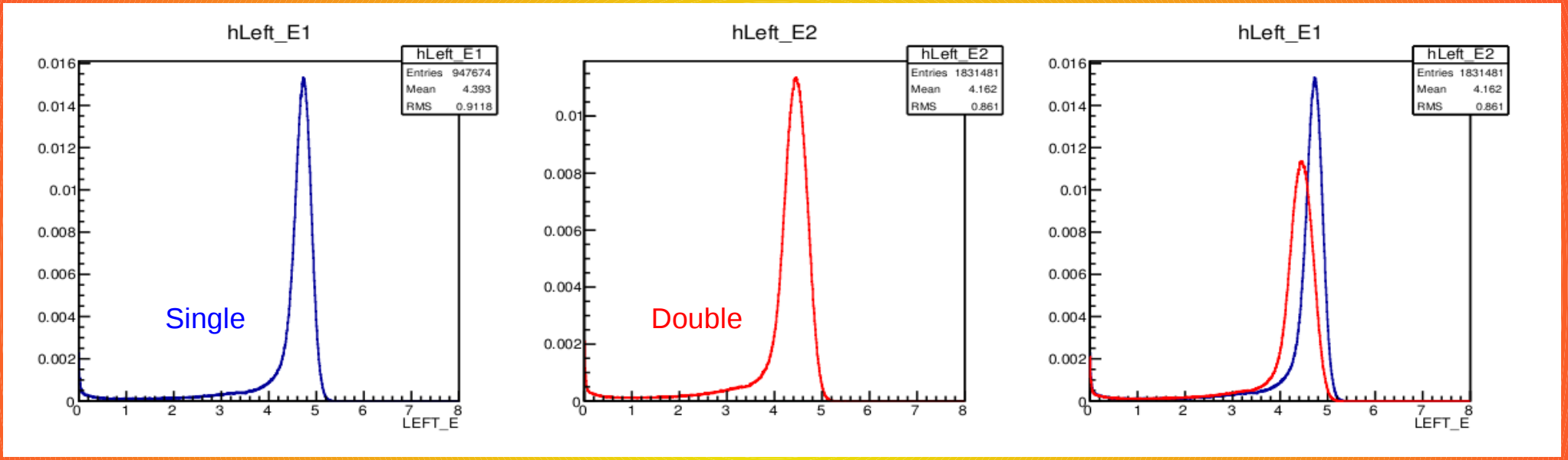
Current Mott Analysis Code





Are we cutting away good physics scatterings? Particularly double scatterings.

Alternate Analysis Approaches Fitting Energy Spectra
Simulation Driven Energy Spectra Fit



GEANT4 simulation gives us –

- The above energy spectra for single and double scattering
- No motivated functional form for spectra curves
- Inherently “background”-less spectra – all events from scatterings

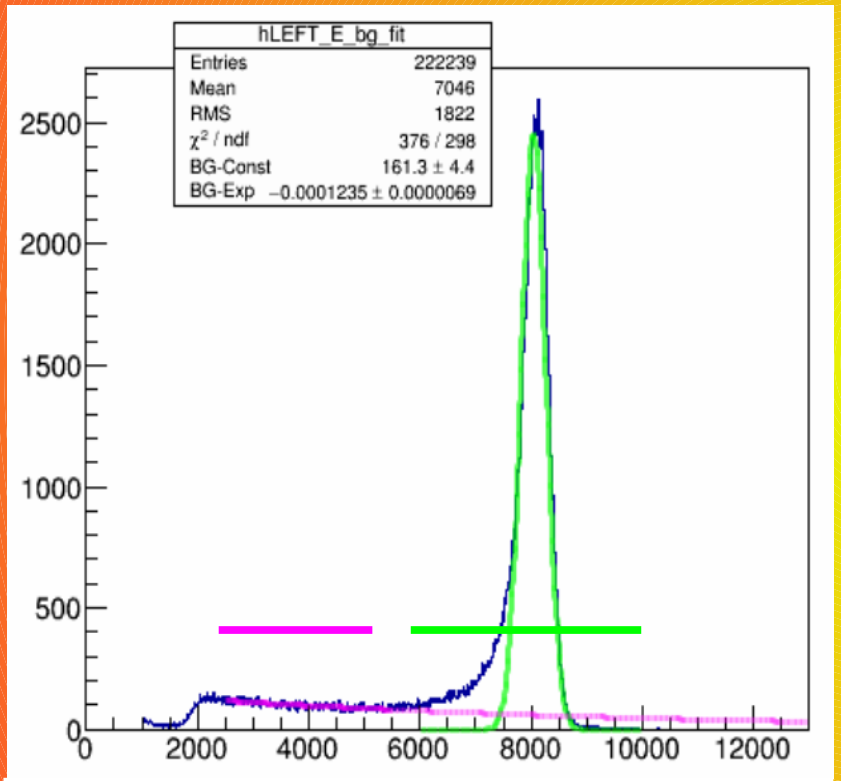
Alternate Analysis Approaches Fitting Energy Spectra

Simulation Driven Energy Spectra Fit

New Approach:

- Determine best fit of simulated energy spectra in ~entire energy range [0:8]MeV (possible forms: exp. + gaussian, lorentzian, lorentzian + gaussian)
- Fit ~entire measured energy spectra (ToF-cut, or not) with simulation-motivated fit form
- Events under the fit curve are good physics scatterings
- Benefit – retain low-energy scattering events previously cut away

Alternate Analysis Approaches Fitting Energy Spectra
Seeded Exponential+Gaussian Fit

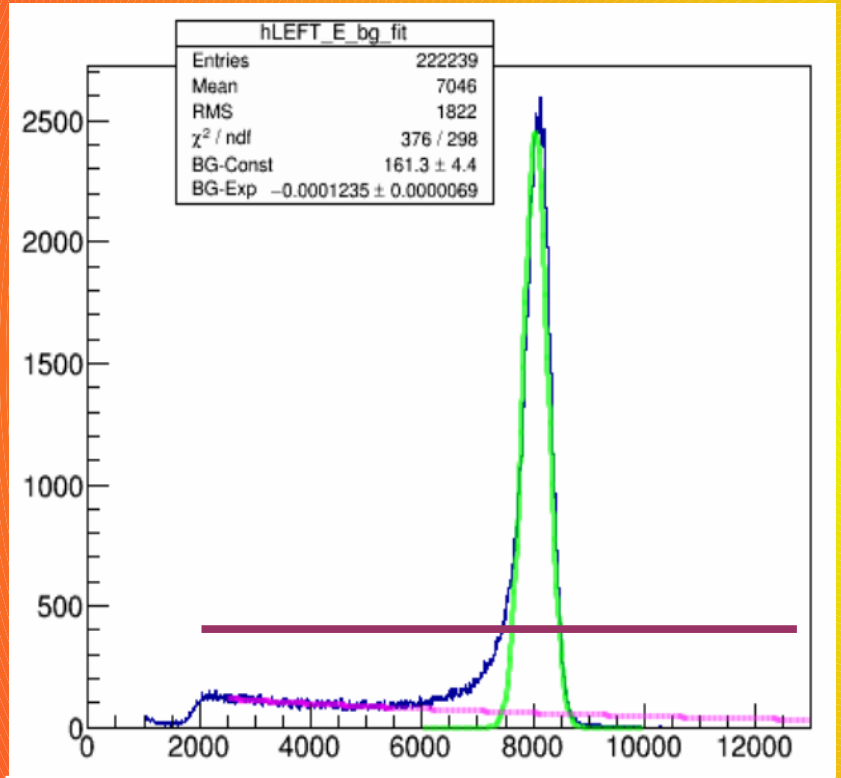


Run 8530, 500 nm foil, w/ Timing veto
Energy spectra after ToF Cut (blue) with dilution fit (pink) and scattering peak fit (green)

Current analysis code

- fits an exponential curve in a small range before the peak (pink line),
- extrapolates it to the entire spectra, and then subtracts events from the original histogram under it (dilution subtraction)
- Then, gaussian is fit to a range with the peak (green line) and its mean and sigma are used to determine energy cut
- 5 parameters generated –
  - $A*\exp(-\lambda*E)$; A and λ
  - $B*\exp(-[(E-\mu)^2 / 2\sigma^2)])$; B, μ and σ

Alternate Analysis Approaches Fitting Energy Spectra
Seeded Exponential+Gaussian Fit



Run 8530, 500 nm foil, w/ Timing veto
Energy spectra after ToF Cut (blue) with dilution fit (pink) and scattering peak fit (green)

New Approach:

- Fit exponential and gaussian in reduced ranges as done before to ToF-cut spectra
- Do Not extrapolate and subtract out dilution, rather
- Use generated values of A, λ, B, μ and σ as seeding parameters for a fit over ~entire(purple line) spectra range of form

  $A'*\exp(-\lambda'*E) + B'*\exp(-[(E-\mu')^2 / 2\sigma'^2)])$
- Keep all events under fit curve as good physics scatterings
- Retain low-energy scattering events

Alternate Analysis Approaches Fitting Energy Spectra

Convergence of proposed alternate methods –

Seeded function

$$A'*\exp(-\lambda'*E) + B'*\exp(-[\ (E-\mu')^2 / 2\sigma'^2\ )]$$

becomes one of the possible simulation-motivated fits when λ' changes sign, something to explore