

```
In[3]:= Needs["ErrorBarPlots`"]
```

CARBON SINGLE FOIL TARGET

HRSR CARBON RUNS

```
In[4]:= Values = {0.0124027, 0.0123852, 0.0123725, 0.0124599, 0.0125305,  
0.01231, 0.012344, 0.0124812, 0.012419, 0.0125718, 0.012549, 0.0124097};
```

```
In[5]:= Chi2Values[c_, sigma_] := 
$$\frac{1}{\text{Length}[\text{Values}] - 1} \sum_{i=1}^{\text{Length}[\text{Values}]} \frac{(\text{Values}[[i]] - c)^2}{\text{sigma}^2}$$

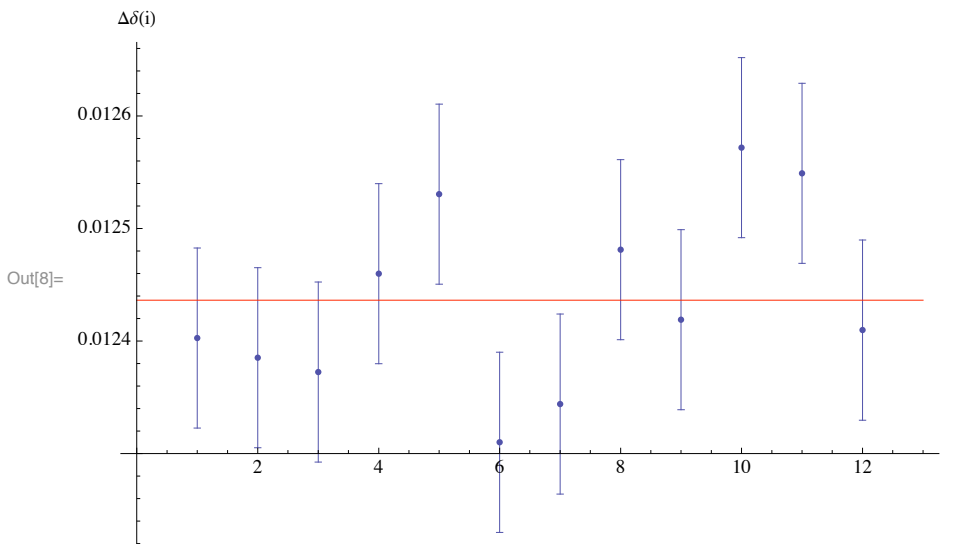
```

```
In[6]:= res = NMinimize[Chi2Values[c, 0.00008], c]
```

```
Out[6]:= {1.07666, {c -> 0.0124363}}
```

```
In[7]:=
```

```
In[8]:= Show[ErrorListPlot[Table[{{i, Values[[i]]}, ErrorBar[0.00008]}, {i, 1, Length[Values]}]],  
Plot[c /. res[[2]], {x, 0, 13}, PlotStyle -> {Hue[0]}], AxesLabel -> {"i", "Δδ(i)"}]
```



```
In[9]:= Δδ = c /. res[[2]]
```

```
Out[9]:= 0.0124363
```

```
In[10]:= Ec = 
$$\frac{4.4389}{\Delta\delta}$$

```

```
Out[10]:= 356.931
```

■ THIS IS NOT AN ERROR OF AN AVERAGE

```
In[11]:= 356.859 * 0.00008
```

```
Out[11]:= 0.0285487
```

■ CORRECT MEAN MOMENTUM AND ERROR

In[12]:= $\text{meanHRSR} = \frac{1}{\text{Length}[\text{Values}]} \text{Sum}[\text{Values}[[i]], \{i, 1, \text{Length}[\text{Values}]\}]$

Out[12]= 0.0124363

In[35]:= $\text{sigmaHRSR} = \text{Sqrt}\left[\frac{1}{\text{Length}[\text{Values}] - 1} \text{Sum}[(\text{Values}[[i]] - \text{meanHRSR})^2, \{i, 1, \text{Length}[\text{Values}]\}]\right]$

Out[35]= 0.0000830096

In[36]:= $\text{errorHRSR} = \frac{\text{sigmaHRSR}}{\text{Sqrt}[\text{Length}[\text{Values}]]}$

Out[36]= 0.0000239628

In[37]:= $\text{HRSRMomentum} = 4.4389/\text{meanHRSR}$

Out[37]= 356.931

In[38]:= $352.4 - 356.931$

Out[38]= -4.531

In[39]:= $\text{HRSRMomentumError} = \frac{4.4389}{\text{meanHRSR}^2} \text{errorHRSR}$

Out[39]= 0.687751

HRSL CARBON RUNS

In[18]:= $\text{carbonElasticRuns} = \{\{3377, 0.0190403\}, \{3378, 0.0190189\}, \{3379, 0.0190305\}, \{3380, 0.0190766\}, \{3381, 0.0190501\}, \{3390, 0.0190151\}, \{3391, 0.0190099\}, \{3392, 0.0190391\}\};$

In[19]:= $\text{carbonFirstExcitedRuns} = \{\{3377, 0.0066157\}, \{3378, 0.00668732\}, \{3379, 0.00661267\}, \{3380, 0.00667273\}, \{3381, 0.006709\}, \{3390, 0.00664742\}, \{3391, 0.00667373\}, \{3392, 0.00668601\}\};$

In[20]:= $\text{carbonRazlikaRuns} = \text{Table}[\{\text{carbonElasticRuns}[[i, 1]], \text{carbonElasticRuns}[[i, 2]] - \text{carbonFirstExcitedRuns}[[i, 2]]\}, \{i, 1, \text{Length}[\text{carbonElasticRuns}]\}]$

Out[20]= $\{\{3377, 0.0124246\}, \{3378, 0.0123316\}, \{3379, 0.0124178\}, \{3380, 0.0124039\}, \{3381, 0.0123411\}, \{3390, 0.0123677\}, \{3391, 0.0123362\}, \{3392, 0.0123531\}\}$

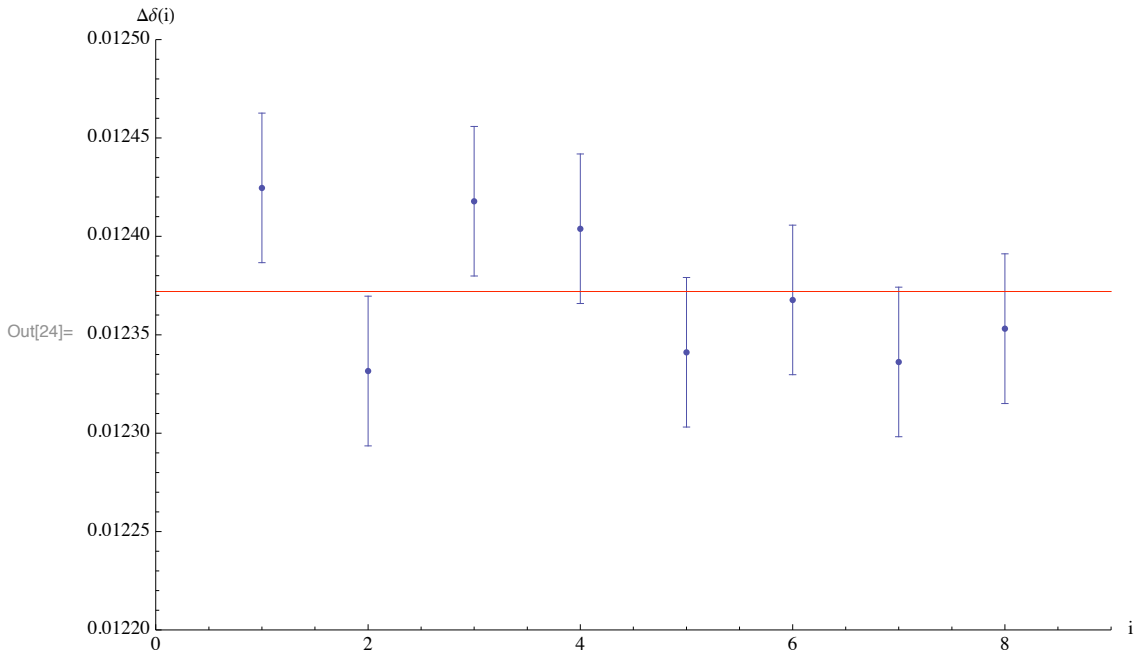
In[21]:= $\text{Chi2Values}[c, \text{sigma}_] := \frac{1}{\text{Length}[\text{carbonRazlikaRuns}] - 1} \sum_{i=1}^{\text{Length}[\text{carbonRazlikaRuns}]} \frac{(\text{carbonRazlikaRuns}[[i, 2]] - c)^2}{\text{sigma}^2}$

In[22]:= $\text{res} = \text{NMinimize}[\text{Chi2Values}[c, 0.000038], c]$

Out[22]= $\{1.00232, \{c \rightarrow 0.012372\}\}$

In[23]=

```
In[24]:= Show[ErrorListPlot[Table[{{i, carbonRazlikaRuns[[i, 2]]}, ErrorBar[0.000038]},
  {i, 1, Length[carbonRazlikaRuns]}], Plot[c /. res[[2]], {x, 0, 9}, PlotStyle -> {Hue[0]}],
  AxesLabel -> {"i", "Δδ(i)", PlotRange -> {{0, 9}, {0.0122, 0.0125}}]
```



■ MEAN CENTRAL MOMENTUM AND ERROR

```
In[25]:= mean =  $\frac{1}{\text{Length}[\text{carbonRazlikaRuns}]}$ 
  Sum[carbonRazlikaRuns[[i, 2]], {i, 1, Length[carbonRazlikaRuns]}]
```

Out[25]= 0.012372

```
In[26]:= sigma = Sqrt[ $\frac{1}{\text{Length}[\text{carbonRazlikaRuns}] - 1}$ 
  Sum[(carbonRazlikaRuns[[i, 2]] - mean)2, {i, 1, Length[carbonRazlikaRuns]}]]
```

Out[26]= 0.0000380441

```
In[27]:= error =  $\frac{\text{sigma}}{\text{Sqrt}[\text{Length}[\text{carbonRazlikaRuns}]]}$ 
```

Out[27]= 0.0000134506

```
In[28]:= HRSLMomentum = 4.4389 / mean
```

Out[28]= 358.786

```
In[29]:= 353.8 - 358.785
```

Out[29]= -4.985

```
In[30]:= HRSLMomentumError =  $\frac{4.4389}{\text{mean}^2}$  error
```

Out[30]= 0.390066