Determining the Beam Energy

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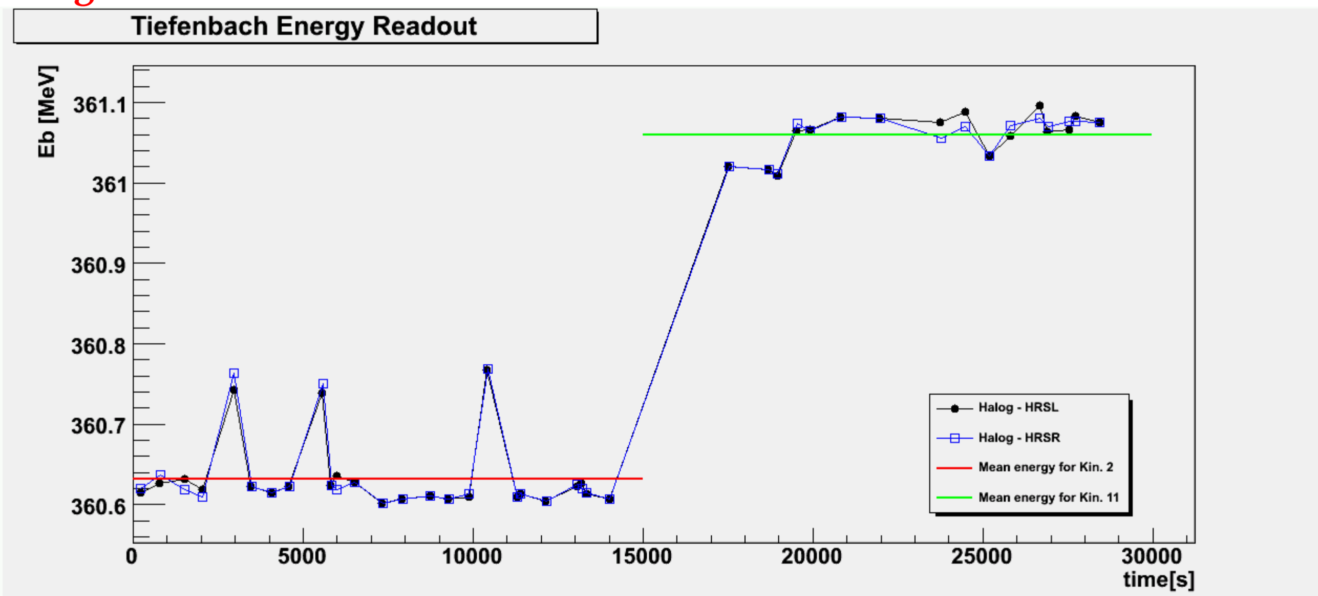
(15.7.2008)

Determining the beam energy from the EPICS information:

Image-1:



The mean energy for Kinematics **#2** : <Eb> = 360.623MeV ± 6.3E-3 MeV

The mean energy for Kinematics **#11** : <Eb> = 361.06MeV ± 4.5E-3 MeV

Calculation of Energy Losses:

$$\frac{-dE}{dx} = K\frac{Z}{A}\rho\frac{1}{\beta^2}[\ln(\tau^2(\tau+2)/(2(I/mc^2)^2)) + (1-\beta^2) + (\frac{\tau^2}{8} - (2\tau+1)\ln(2))/((\tau+1)^2) - \delta]$$

$$\delta = 2\ln[\frac{28.816}{I}\sqrt{\rho\frac{Z}{A}}] + 2\ln\frac{p}{(Mc)} - 1$$

$$\rho = \frac{pM}{RT}$$

Element	ρ [g/cm3]	q [g/cm2]	d [cm]	E0 [MeV]	A	Z	ΔE [keV] (without δ)	ΔE [keV] (with δ)
12C (Optics)	2.26	0.042	1.86E-2	362.0	12	6	-118.195	-85.21
Al (Dummy)	2.702	0.259	9.59E-2	362.0	27	13	-674.145	-503.3
Ta	16.65	0.0202	1.21E-3	362.0	181	73	-40.263	-30.83
LOOP 2 (4cm)								
H	1.23E-3	4.92E-3	4.0	362.0	1	1	-29.636	-25.1
Al (front window)	2.702	0.0343	0.0127	362.0	27	13	-89.3	-66.66
Al (back window)	2.702	0.030533	0.0113	362.0	27	13	-79.473	-59.344
					TOTAL		**-198.409**	**-151.104**
LOOP 3 (4cm)								
D	4.9E-3	0.0196	4.0	362.0	2	1	-59.03	-48.99
Al (front window)	2.702	0.02319	0.0112	362.0	27	13	-60.4	-45.1
Al (back window)	2.702	0.03783	0.0140	362.0	27	13	-98.466	-73.517
					TOTAL		**-217.896**	**-167.607**

Fitting Momentum Spectra

(Kinematics #2)

Fitting formula that I have used (from Happex):

$$f(E')=\sqrt{\frac{\pi}{2}}\frac{\sigma}{\alpha}\exp\left(\frac{1}{2\alpha}(\sigma^2/\alpha+2(E'-b))\right)Erfc\left(\frac{|\alpha|}{\sqrt{2}\sigma\alpha}(\sigma^2/\alpha+(E'-b))\right)+\frac{c_1}{1+\exp((E'-c_2)c_3)}$$

ABSOLUTE VALUES:

Image-1:

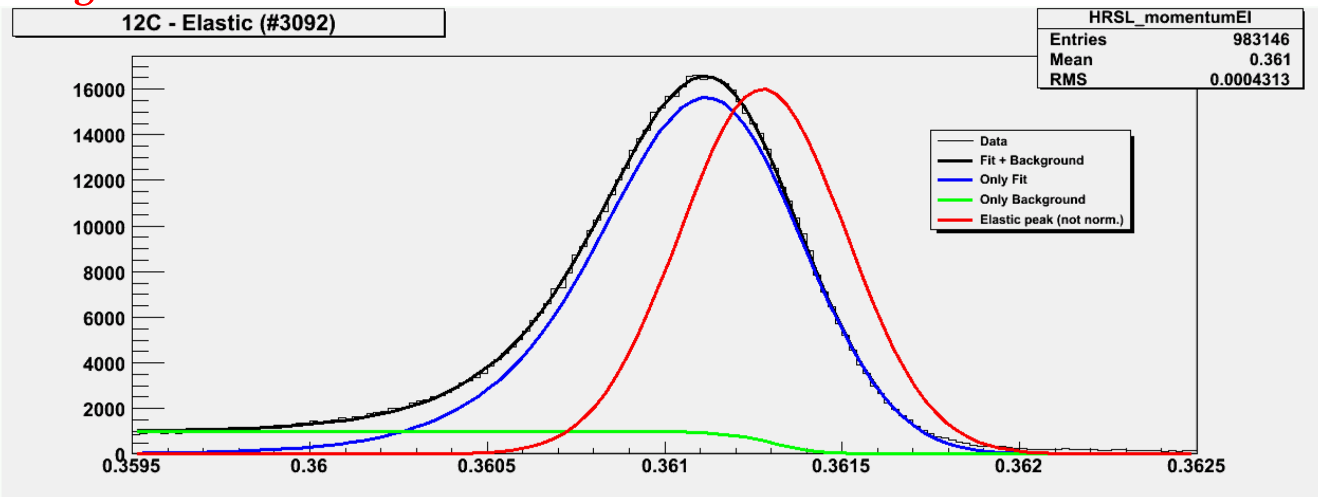


Image-2:

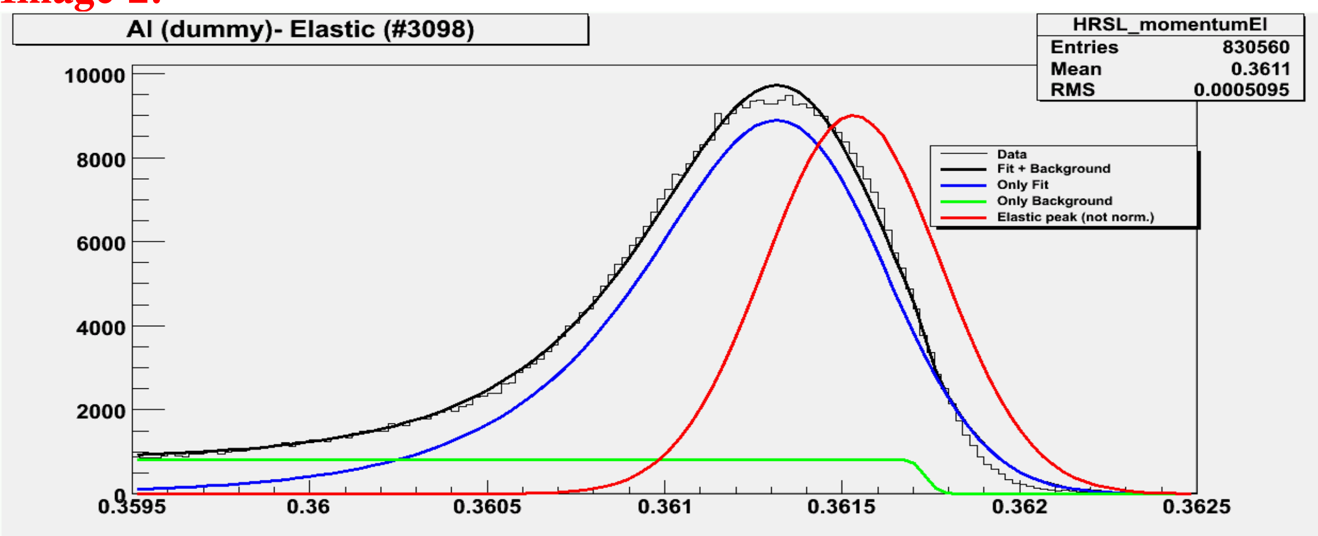
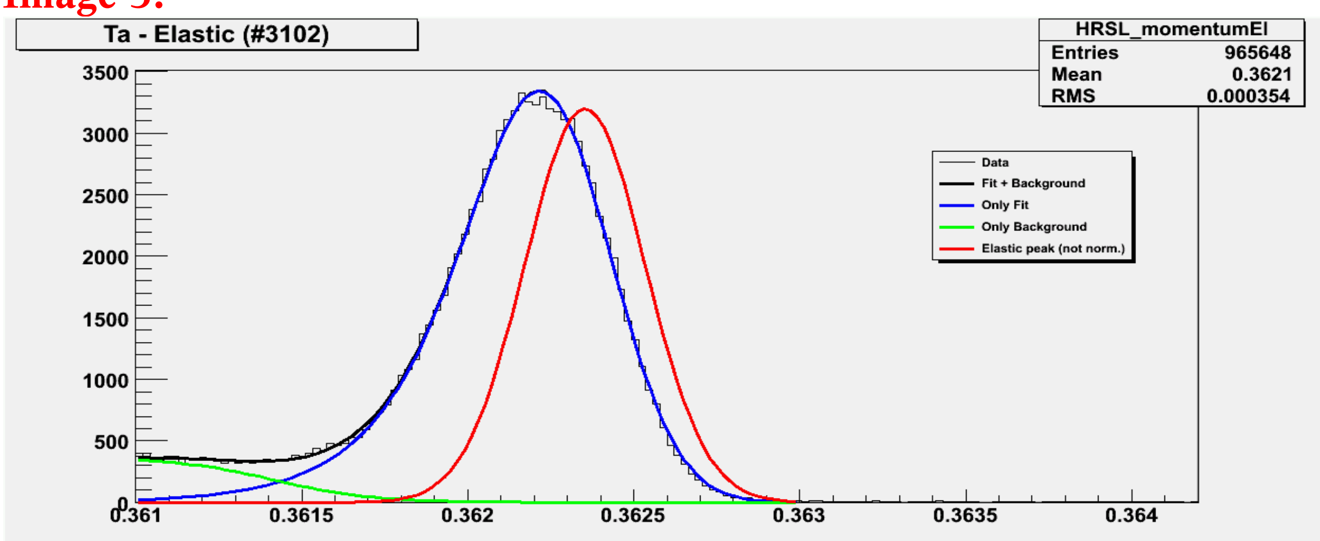


Image-3:



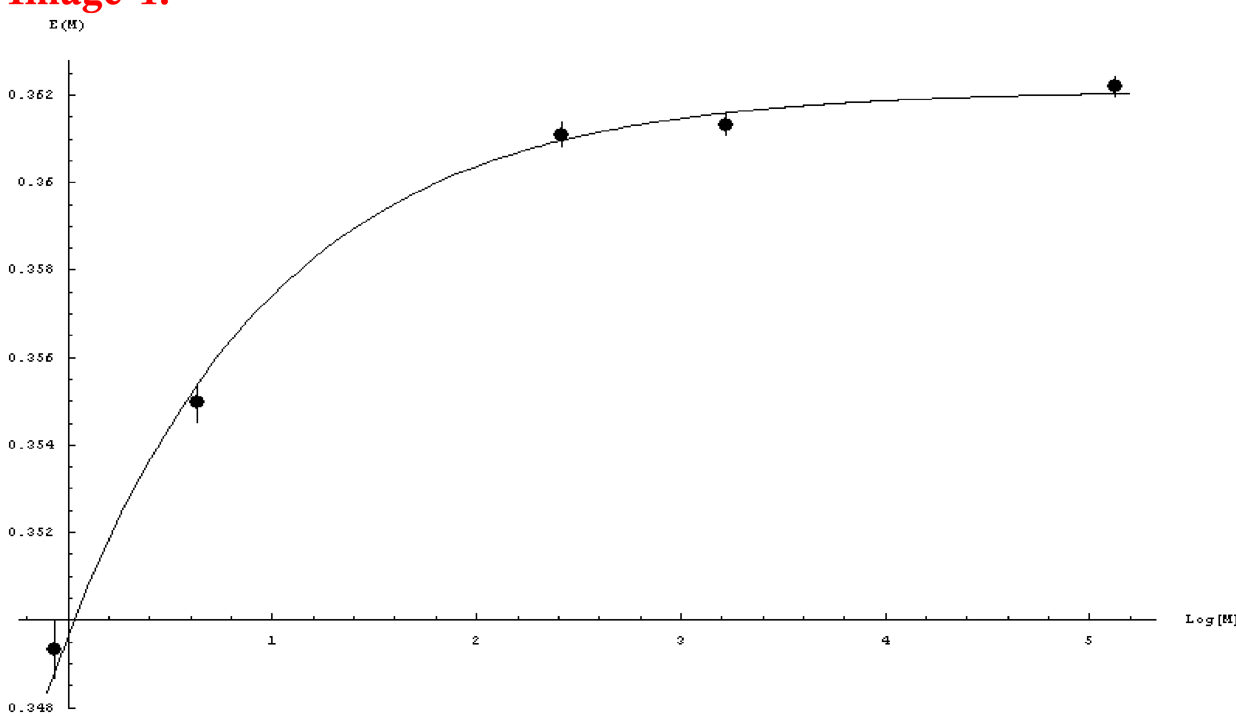
HRSL (absolute values):

Run #	Target	A	b [GeV]	σ [GeV]	α	c1	c2	c3
3082	H	19039.1	0.34977	5.749E-4	7.851E-4	888.834	0.347108	5483.7
3082	Al (cell)	6.809E3	0.36095	2.305E-4	3.88E-4	318.187	0.3611	3.2E4
3088	D	8.437E3	0.35526	3.525E-4	3.99E-4	4.0E3	0.35078	601.318
3088	Al (cell)	6.0815E3	0.360782	2.364E-4	4.66E-4	1.921E2	0.360273	3.575E4
3092	12C	19755	0.361276	2.342E-4	2.269E-4	991.998	0.3613	14832
3098	Al (dummy)	12945	0.361531	2.495E-4	3.625E-4	821.721	0.361737	60743
3101	Ta	4.566E3	0.362357	1.822E-4	2.195E-4	377.98	0.36139	9176.38
3102	Ta	4.456E3	0.362356	1.807E-4	2.07E-4	364.4	0.361417	6802.7
3105	Ta (raster)	2.459E3	0.362326	1.923E-4	1.28E-4	235.7	0.362072	34789
3106	Ta (raster)	2.546E3	0362333	1.879E-4	1.394E-4	227.11	0.362062	35423

A fit to these data using the formula :

$$p_{measured} = \frac{E_0}{1 + \frac{E_0}{M}(1 - \cos\theta)}$$

Image-4:



Although the fit looks great, the values of parameters E0 and and θ are incorrect (Total disagreement with Tiefenbach or nonsensical values depending on the initial values of the fit parameters. For example: The angle theta is off for more than 1 deg).

RELATIVE VALUES

First I was trying to determine the momentum scale in both HRS spectrometers. To do this I have used three well known peaks in 12C runs:

Image-5:

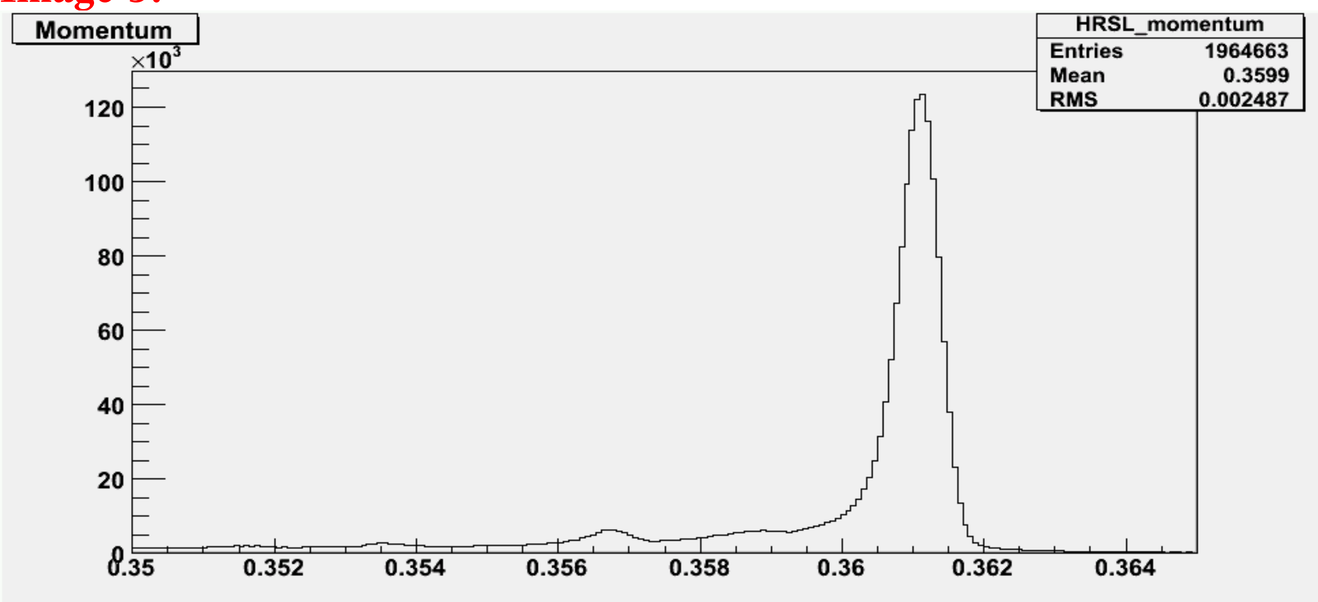


Image-6:

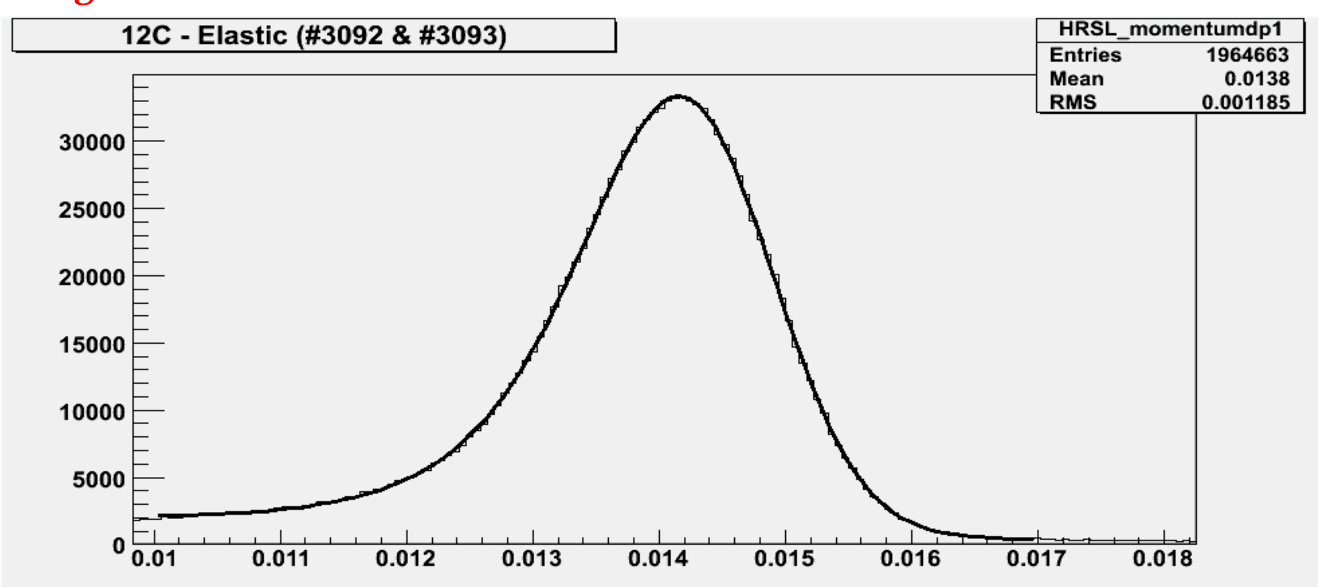


Image-7:

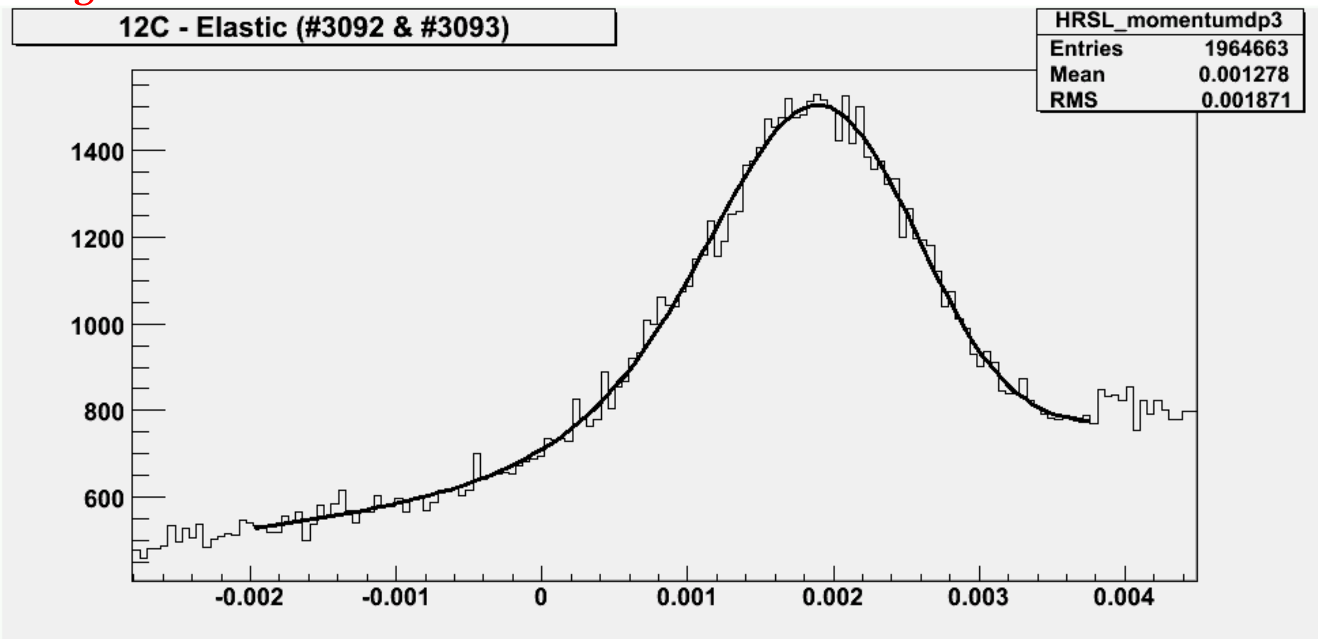


Image-8:

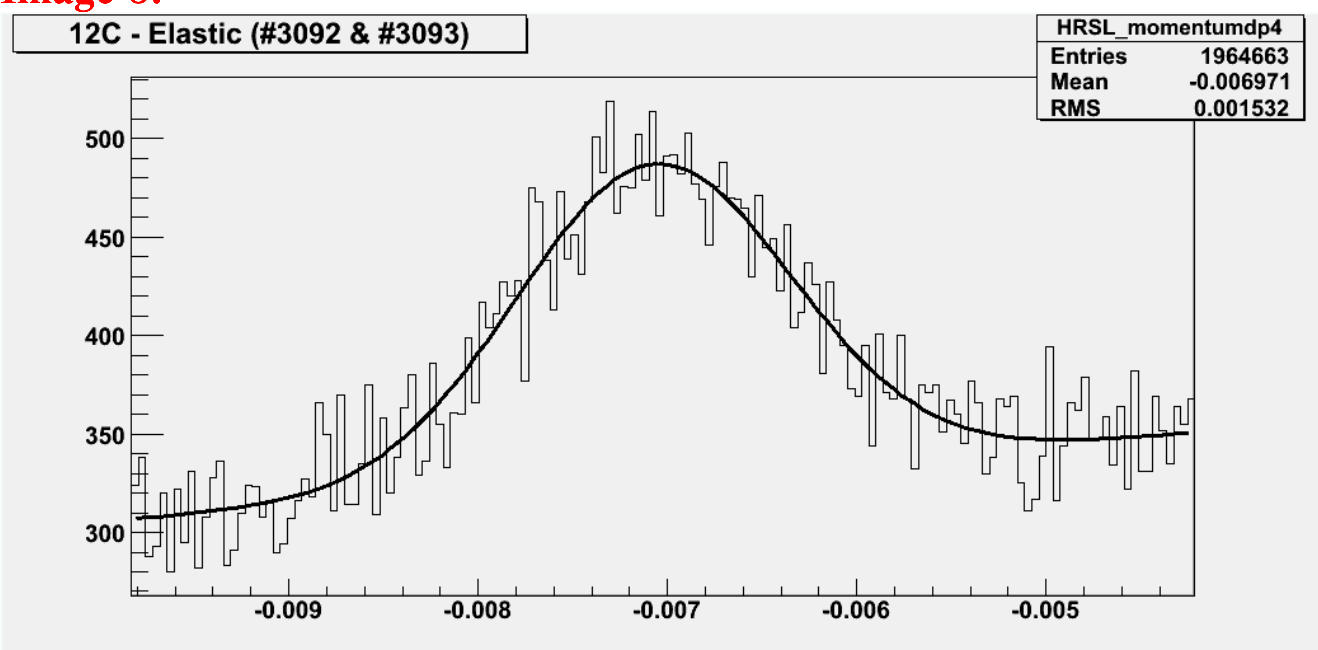
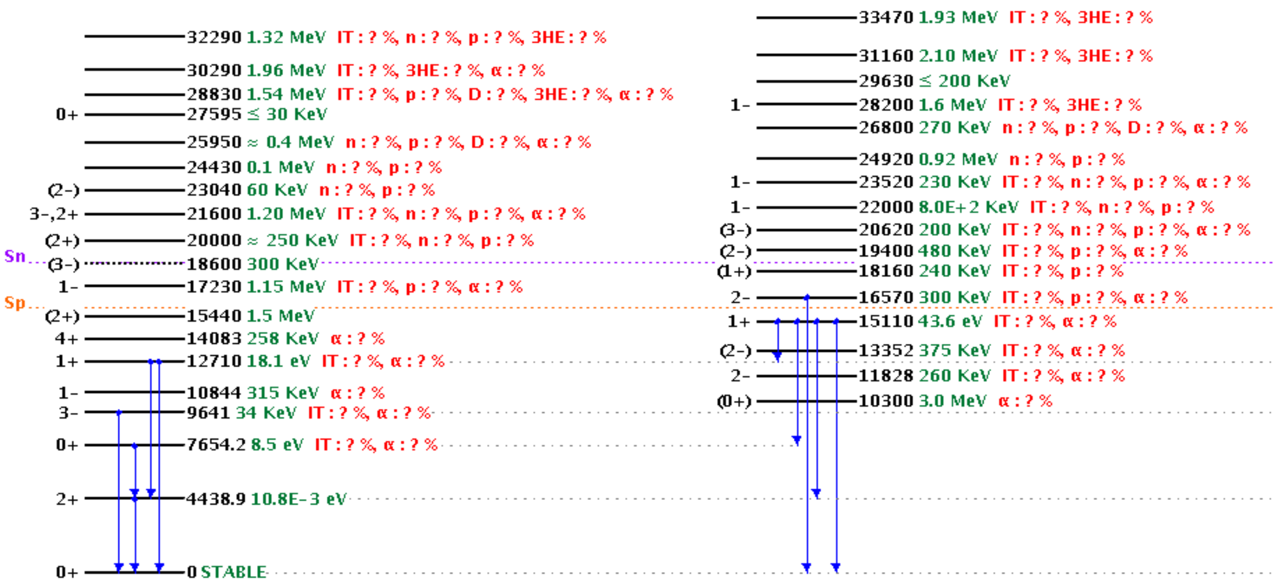
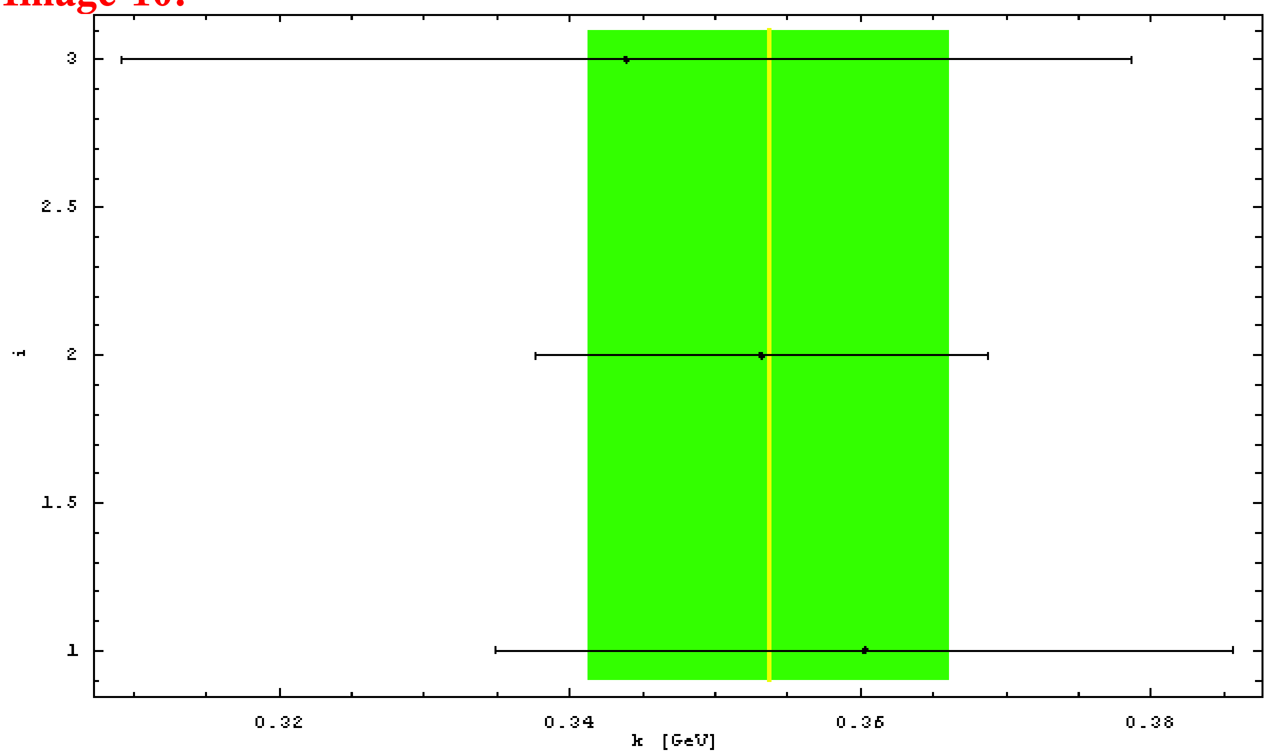


Image-9:



Calculated central momentum of the HRSL:

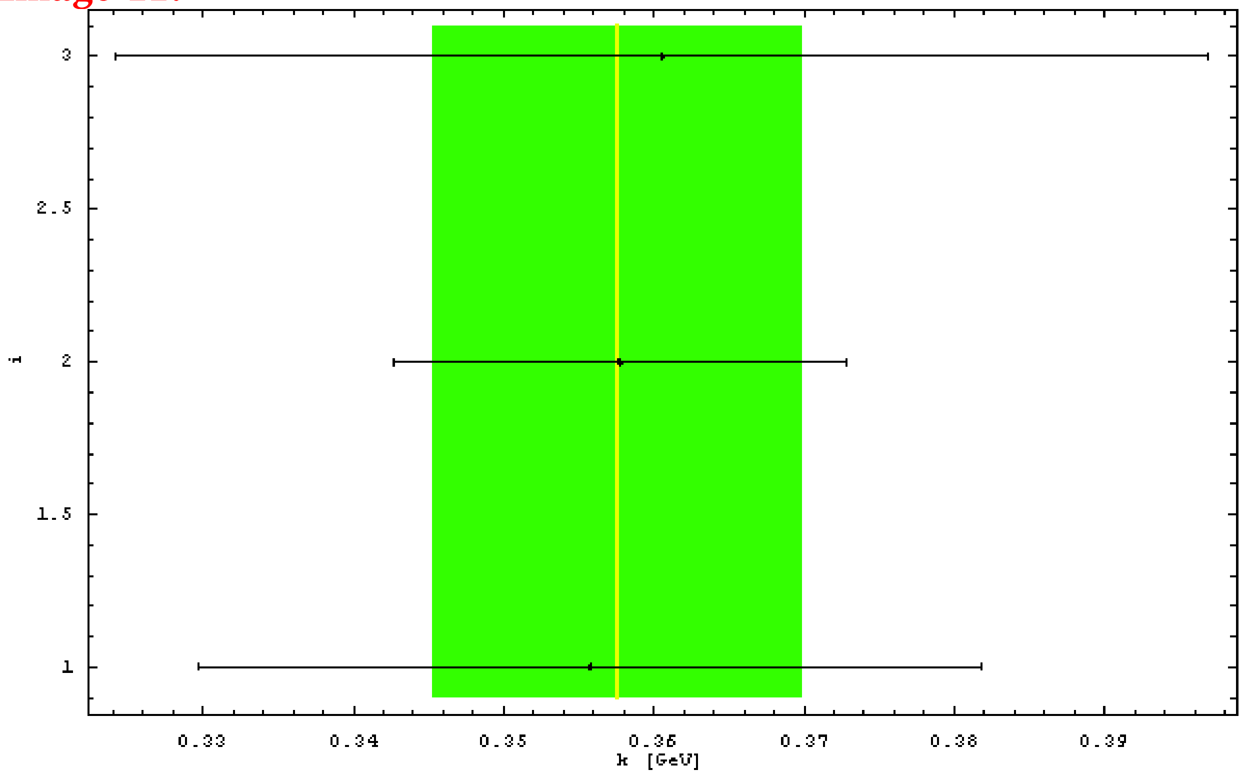
Image-10:



<Pcentral> = k = 0.353712 ± 0.012396 GeV **(Not Good !!!)**

Calculated central momentum of the HRSR:

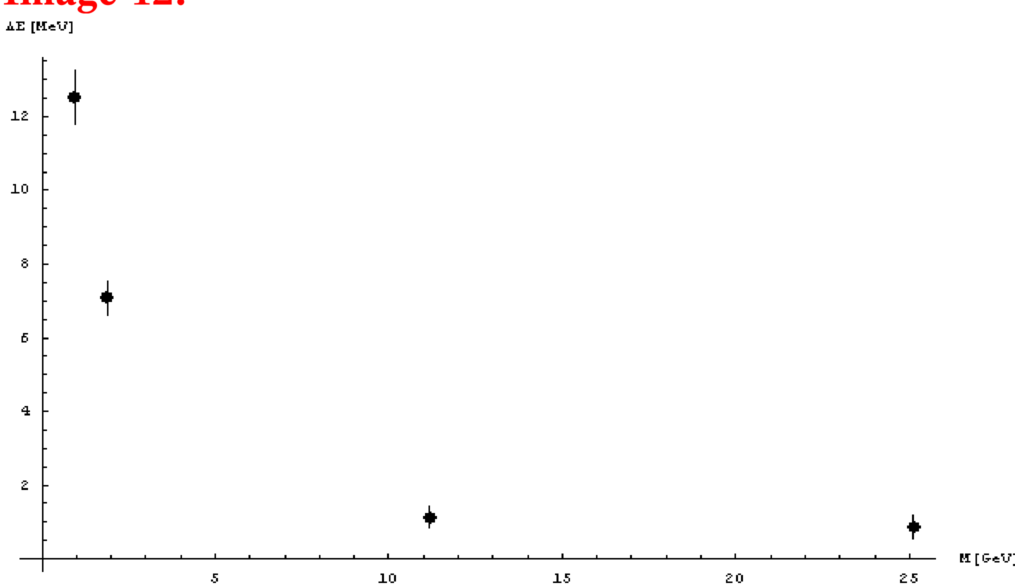
Image-11:



<Pcentral> = k = 0.357648 ± 0.012279 GeV **(Not Good !!!)**

Energy differences between various elements and Ta:

Image-12:



Due to big errors we can fit almost anything to these points although this is not obvious until you try it.

Another approach

To keep the relative error small it is better to fit total energies not differences between them.

Assuming that the uncertainty Δp0 in the HRS central momentum is < few MeV we can use:

$$E' = p_{central}(1+\delta) = p_0\left(1+\frac{\Delta p_0}{p_0}\right)(1+\delta) = p_0(1+\delta) + \Delta p_0 + \Delta p_0 \delta \approx p_0 + \delta p_0 + \Delta p_0 + (Something < 0.01\mathrm{MeV})$$

Then we can use the function:

$$p_{measured} = -\Delta p_0 + \frac{E_0}{1+\frac{E_0}{M}(1-\cos\theta)}$$

to directly fit our primary data.

This fit is very UNSTABLE. Because the minimum of the Chi^2 function is very broad it is very hard to find the correct minimum. There are many combinations (E0, θ, Δp0) that give a good fit to our data. However the values of these parameters are wrong.

We are still looking for the right approach to find a good fit. Any Ideas?

I am currently trying to:

- add a set of additional conditions that will constrain my fit a bit more
- add additional data points (excited 12C and Ta states).
- Bayesian analysis (if it turns out to be promising).