

Error Analysis II

Monte Carlo Technique

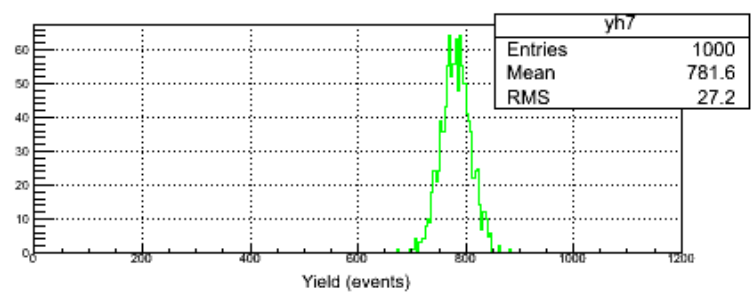
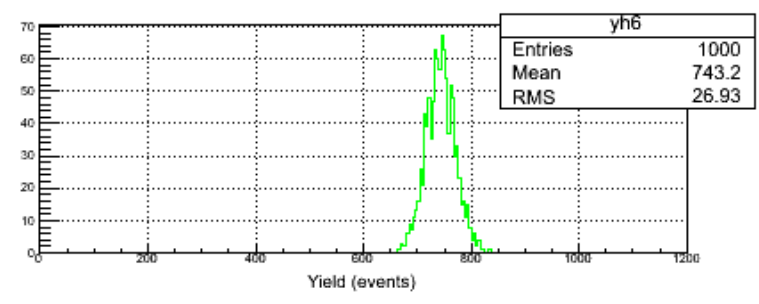
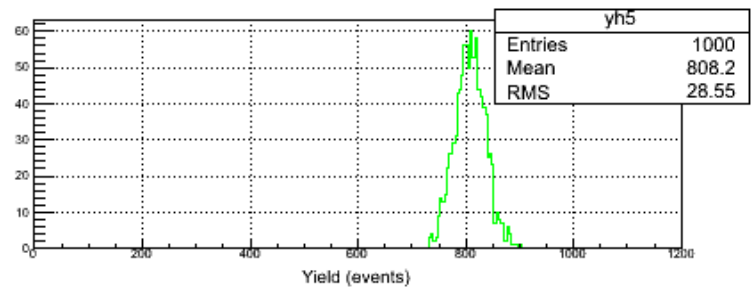
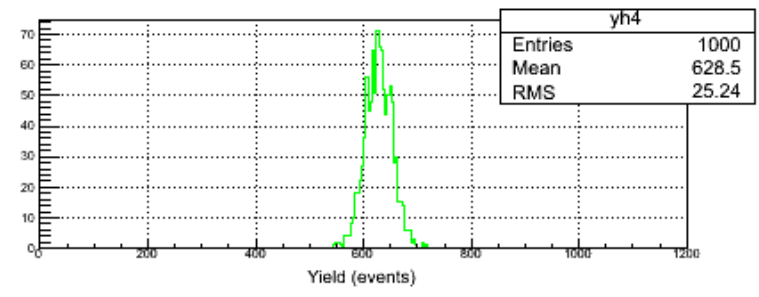
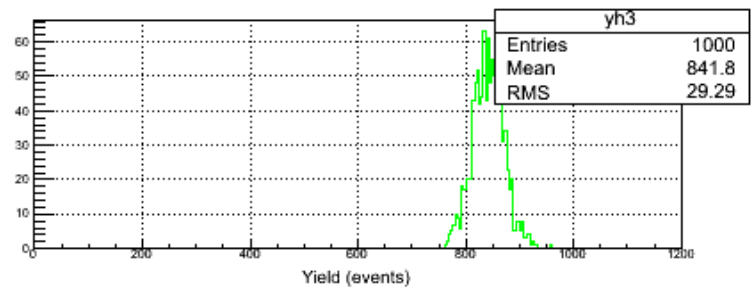
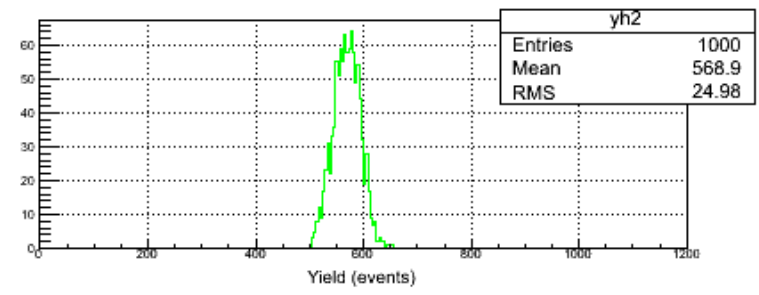
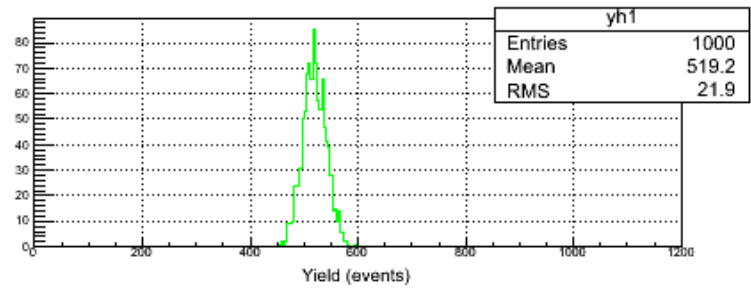
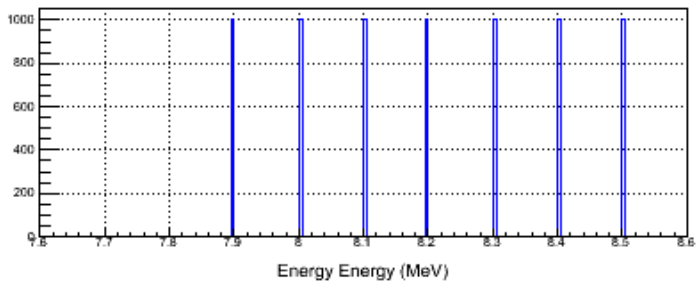
02 October 2013

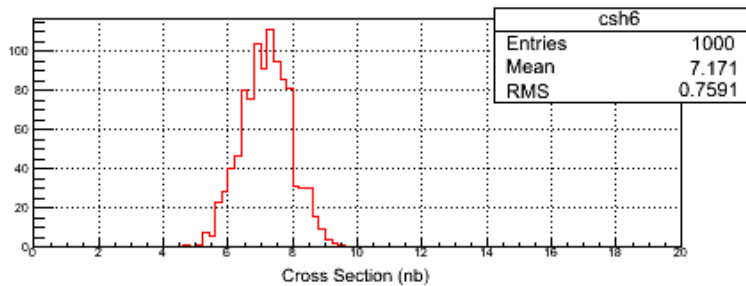
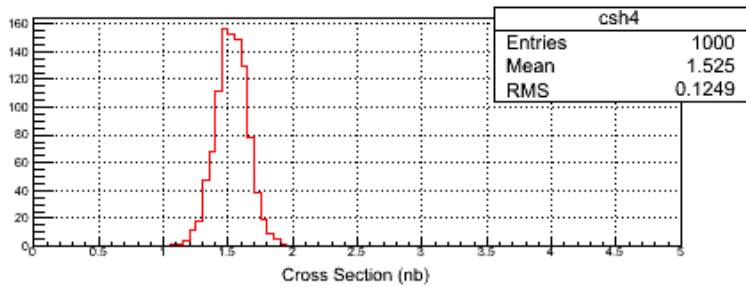
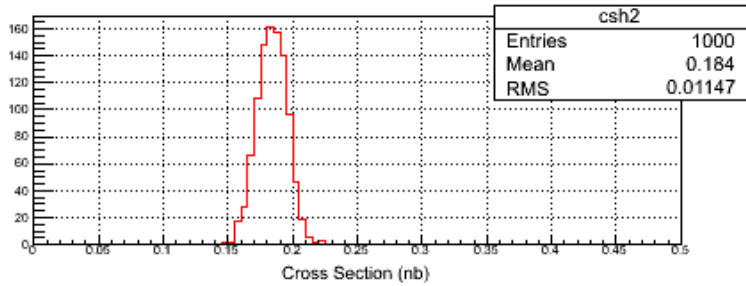
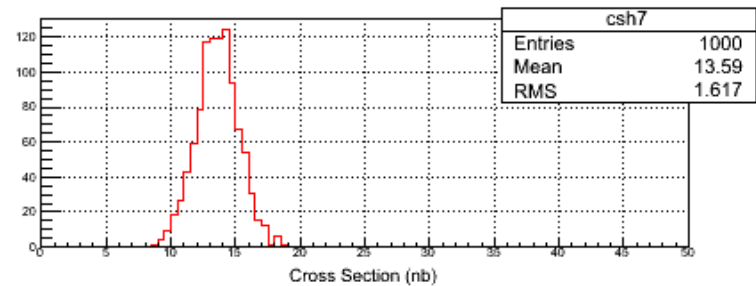
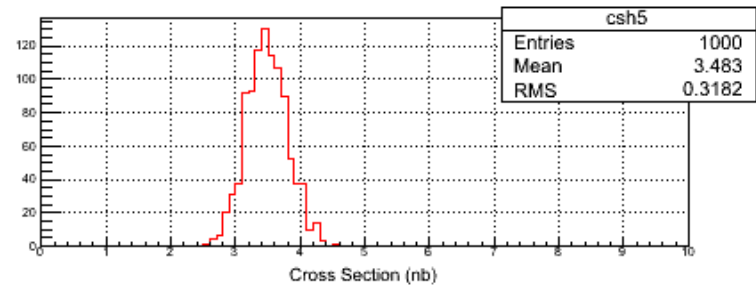
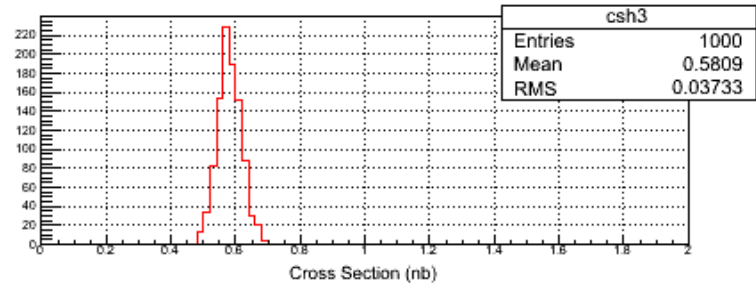
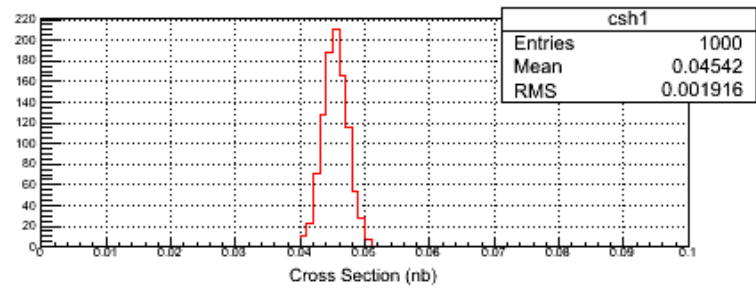
Statistical Error – No Background

- I. Calculate the yield
- II. Allow for statistical fluctuations:

$$y_i = \text{gRandom} \rightarrow \text{Gaus}(y_i, \text{Sqrt}(y_i))$$

- III. Unfold cross section
- IV. Repeat for 1000 tries





Electron Beam K. E.	Beam Current (μA)	Time (hour)	y_i	dy_i (no bg)	dy_i/y_i (no bg, %)
7.9	100	100	519	22	4.2
8.0	100	20	569	25	4.4
8.1	80	10	842	29	3.5
8.2	20	10	629	25	4.0
8.3	10	10	808	29	3.5
8.4	4	10	743	27	3.6
8.5	2	10	782	27	3.5

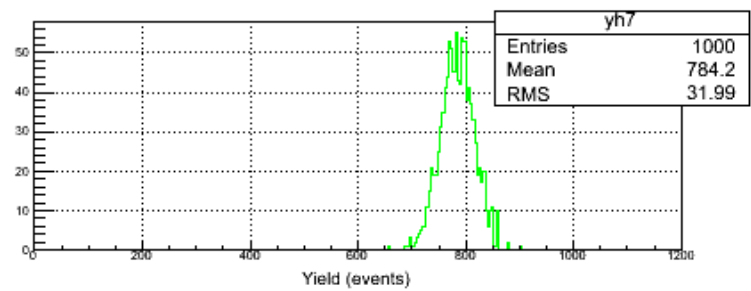
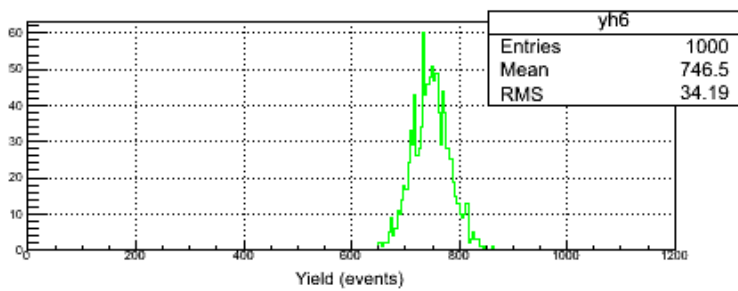
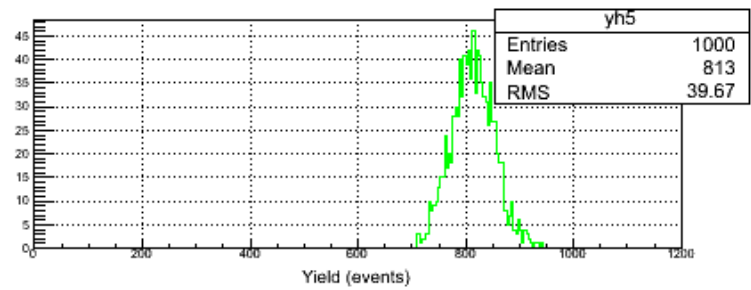
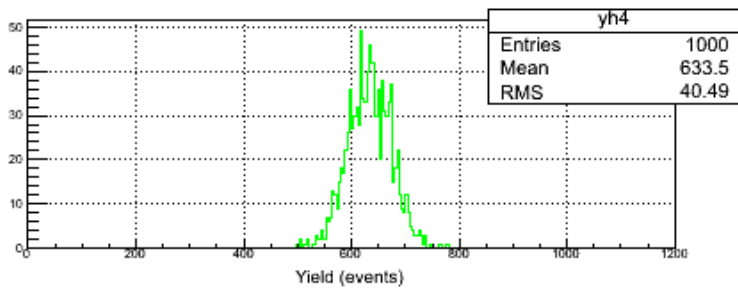
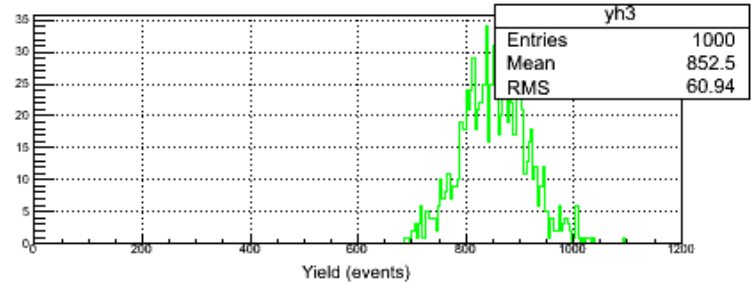
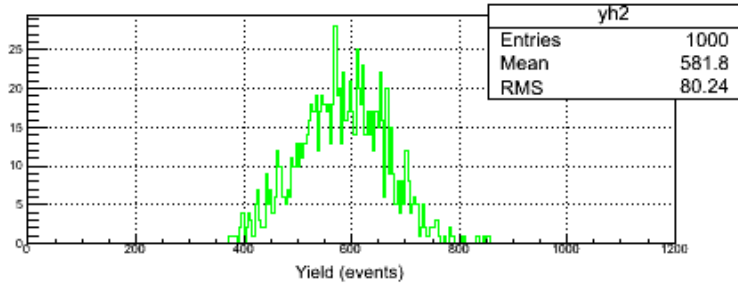
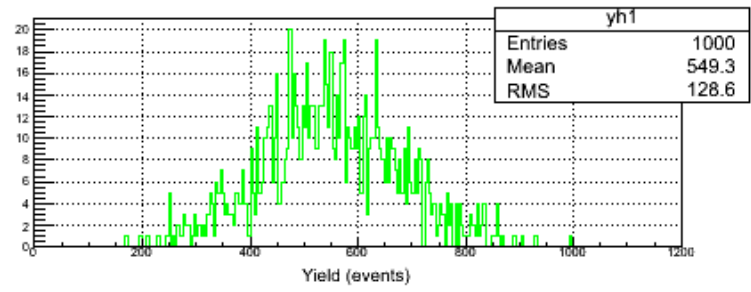
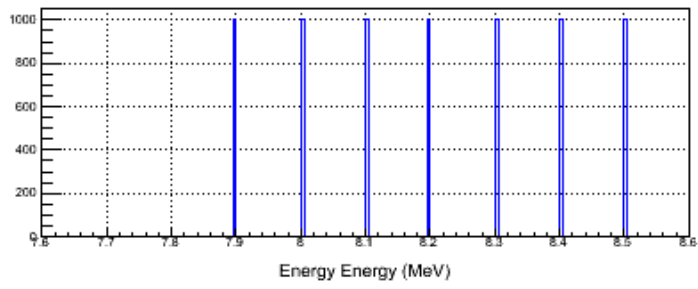
Electron Beam K. E.	Cross Section (nb)	Stat Error (no bg, %)
7.9	0.045	4.2
8.0	0.184	6.2
8.1	0.58	6.4
8.2	1.53	8.2
8.3	3.48	9.1
8.4	7.2	10.6
8.5	13.6	11.9

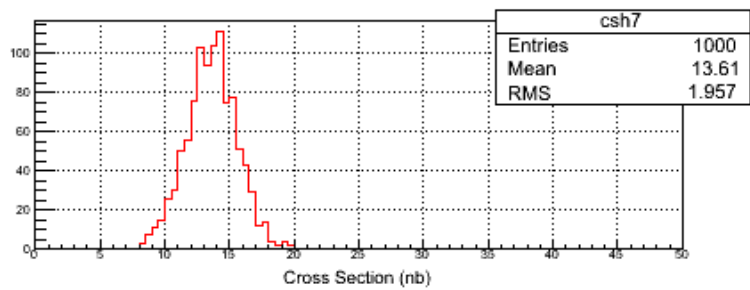
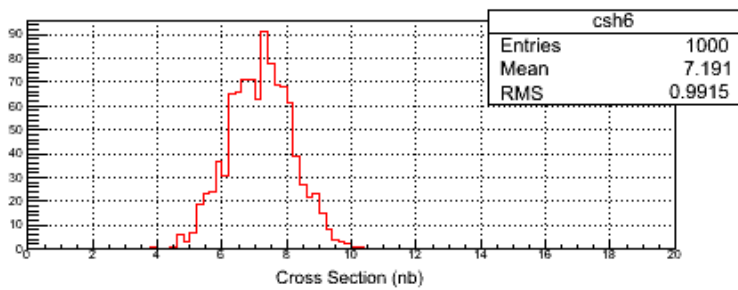
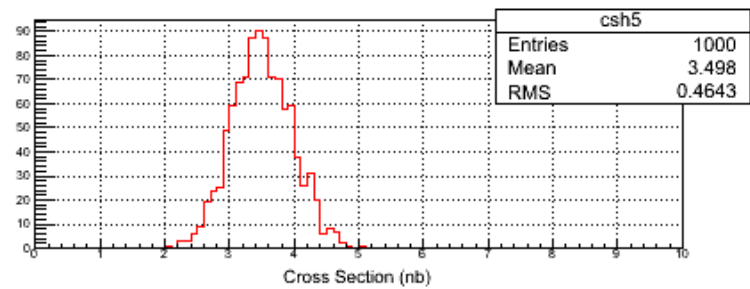
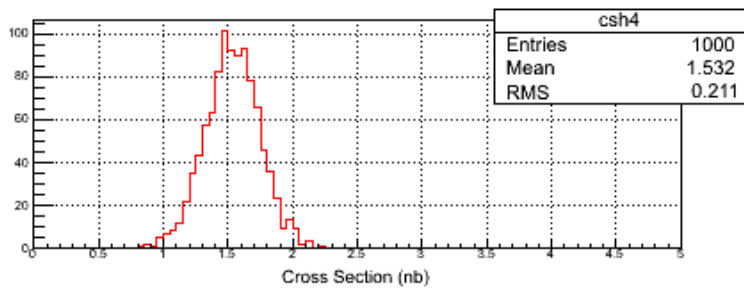
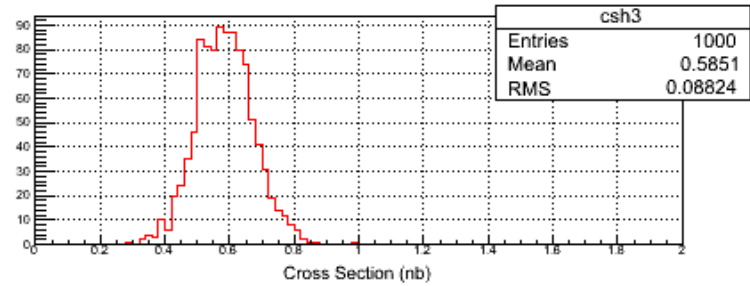
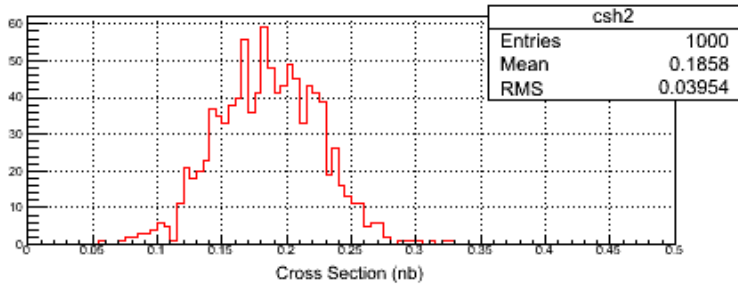
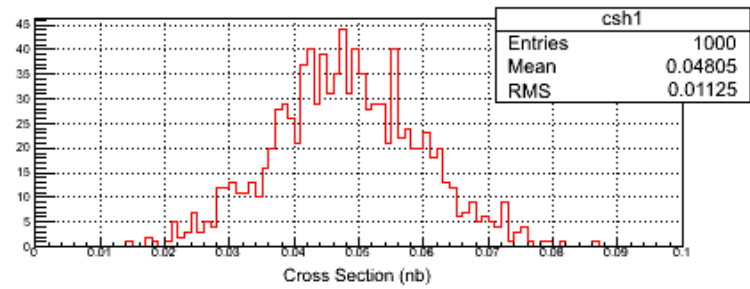
Statistical Error – With Background

- I. Calculate the yield
- II. Calculate the background yield from ^{18}O
- III. Allow for statistical fluctuations:

$$y_i = \text{gRandom} \rightarrow \text{Gaus}(y_i, \text{Sqrt}(y_i + 2y_i^{bg}))$$

- IV. Unfold cross section
- V. Repeat for 1000 tries





Electron Beam K. E.	Beam Current (μA)	Time (hour)	y_i	dy_i (with bg)	dy_i/y_i (with bg, %)
7.9	100	100	549	129	23.4
8.0	100	20	582	80	13.8
8.1	80	10	852	61	7.1
8.2	20	10	633	40	6.4
8.3	10	10	813	40	4.9
8.4	4	10	747	34	4.6
8.5	2	10	784	32	4.1

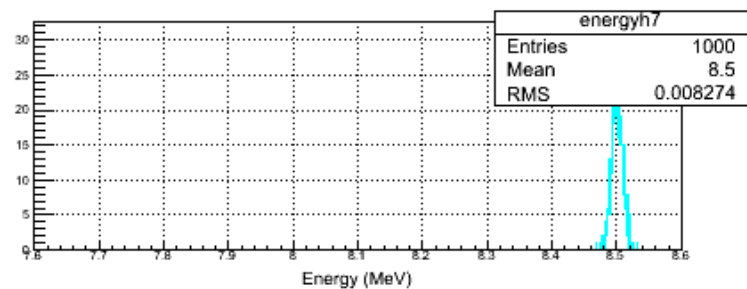
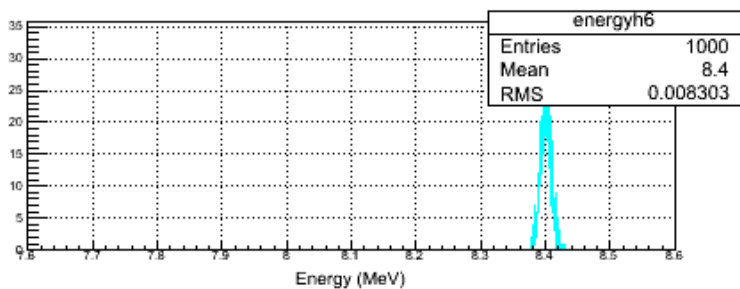
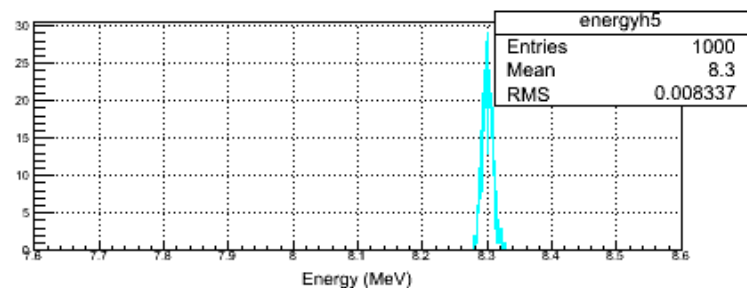
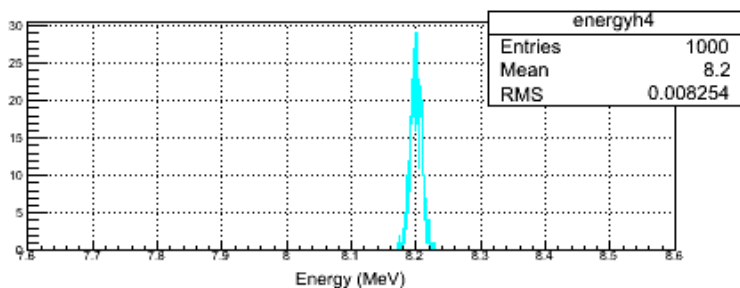
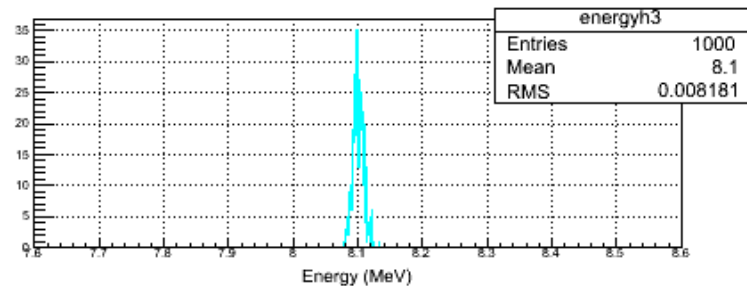
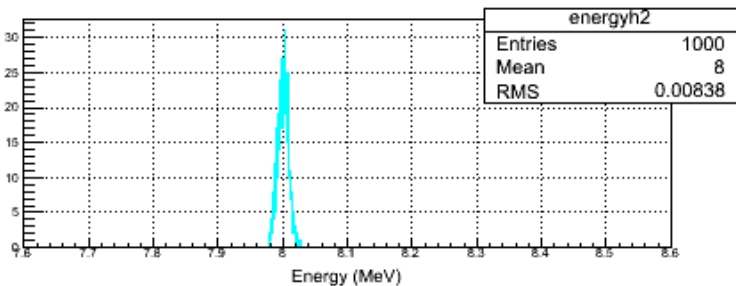
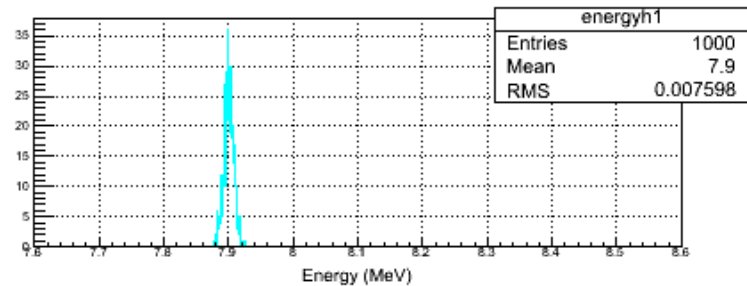
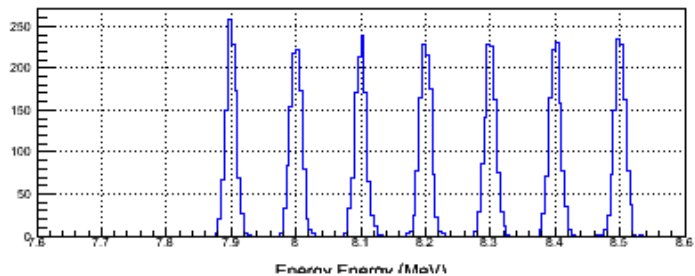
Electron Beam K. E.	Cross Section (nb)	Stat Error (with bg, %)
7.9	0.048	23.4
8.0	0.186	21.3
8.1	0.59	15.1
8.2	1.53	13.8
8.3	3.50	13.3
8.4	7.2	13.8
8.5	13.6	14.4

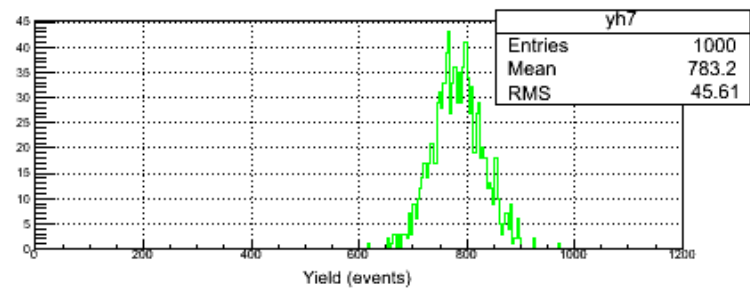
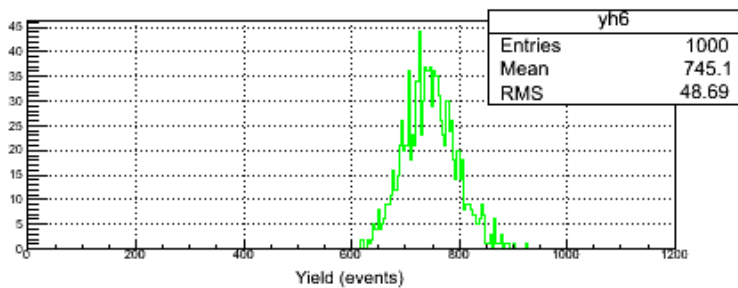
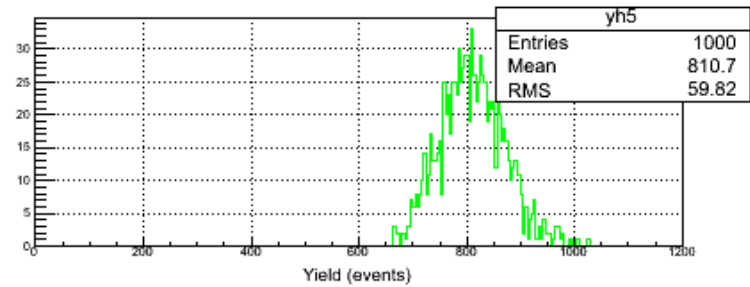
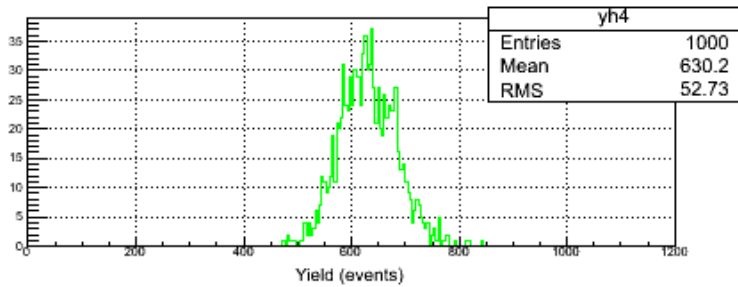
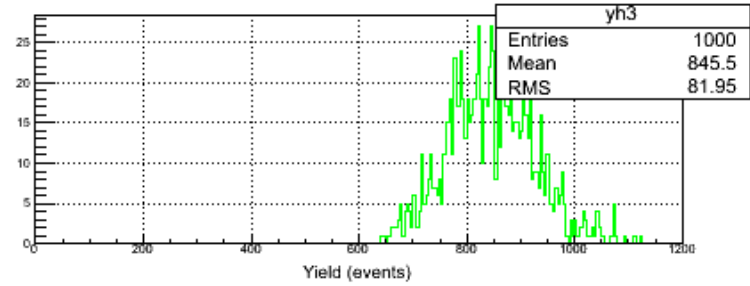
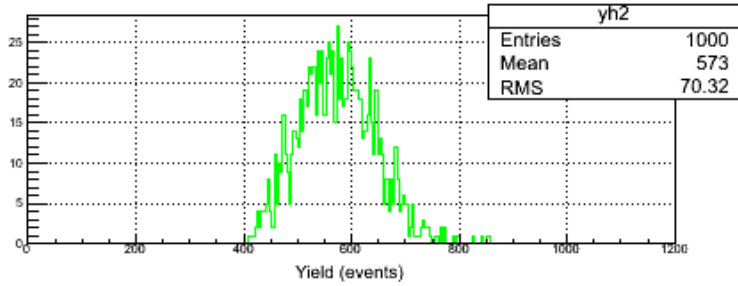
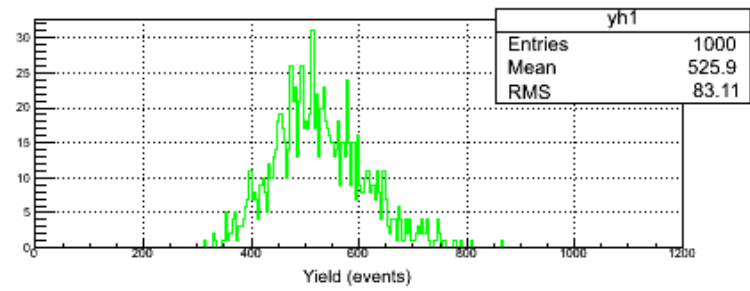
Systematic Error – Beam Energy

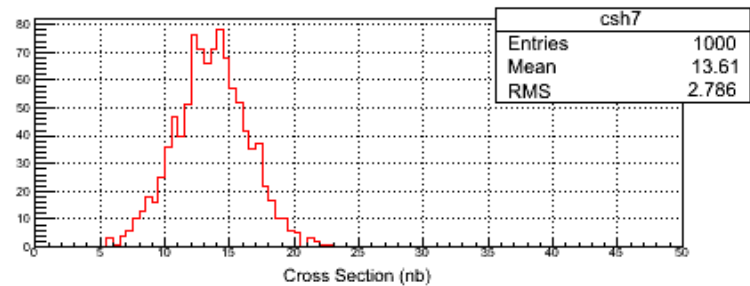
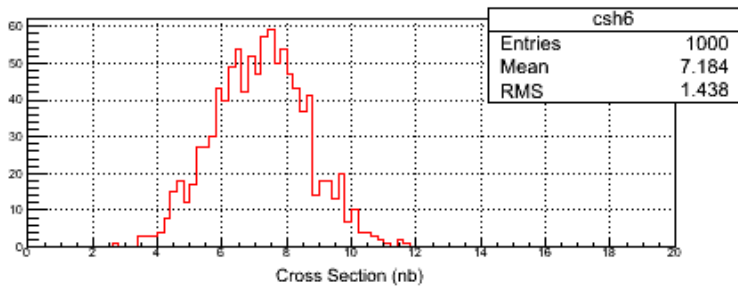
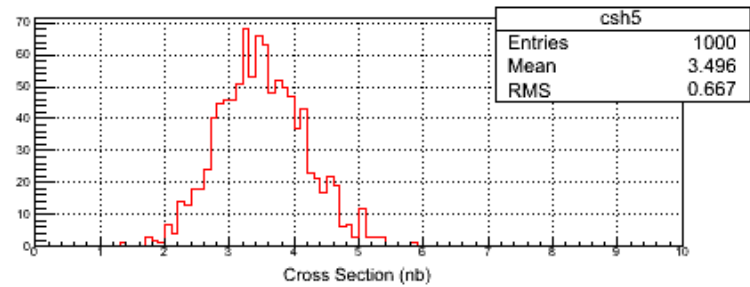
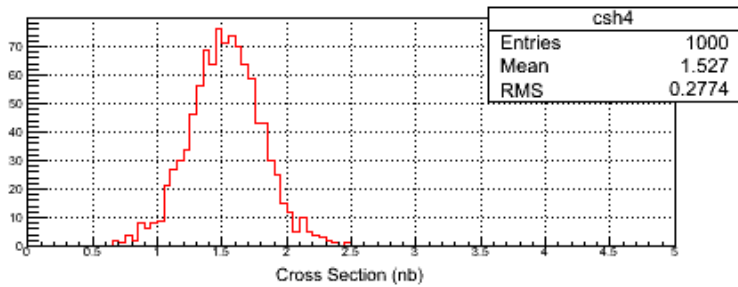
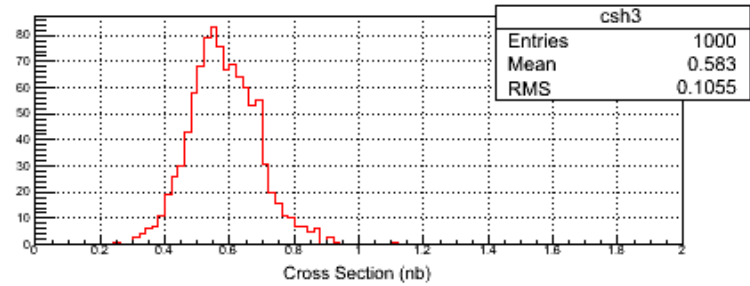
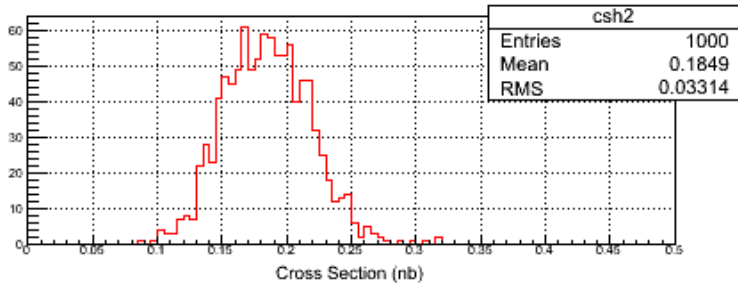
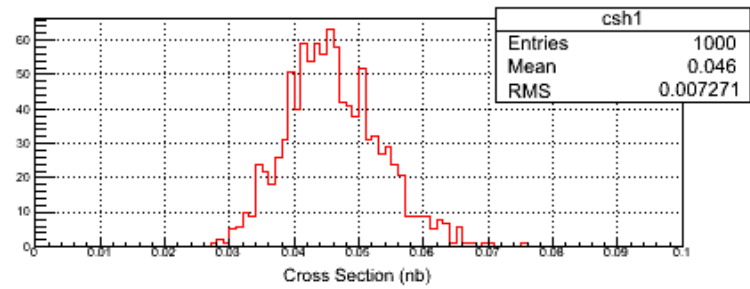
- I. Calculate the N_{ij} for each nominal beam energy, E_i (since we will use GEANT4)
- II. Allow for absolute beam energy to change by:

$$E_i = E_i * gRandom \rightarrow Gaus(1, 0.001)$$

- III. Calculate the yield
- IV. Unfold cross section
- V. Repeat for 1000 tries







Electron Beam K. E.	Beam Current (μA)	Time (hour)	y_i	dy_i/y_i (%)
7.9	100	100	526	15.8
8.0	100	20	573	12.3
8.1	80	10	846	9.7
8.2	20	10	630	8.4
8.3	10	10	811	7.4
8.4	4	10	745	6.5
8.5	2	10	783	5.8

Electron Beam K. E.	Cross Section (nb)	Sys Error (Energy, %)
7.9	0.046	15.8
8.0	0.185	17.9
8.1	0.58	18.1
8.2	1.53	18.2
8.3	3.49	19.1
8.4	7.2	20.0
8.5	13.6	20.5

Systematic Error – Relative Beam Energy

- I. Calculate the N_{ij} for each nominal beam energy, E_i (since we will use GEANT4)
- II. Allow for absolute beam energy 7.9 MeV to change by:

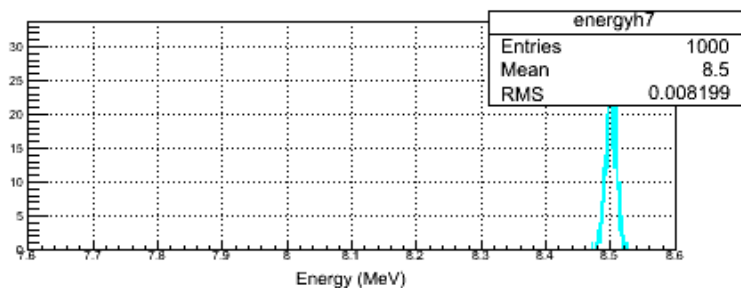
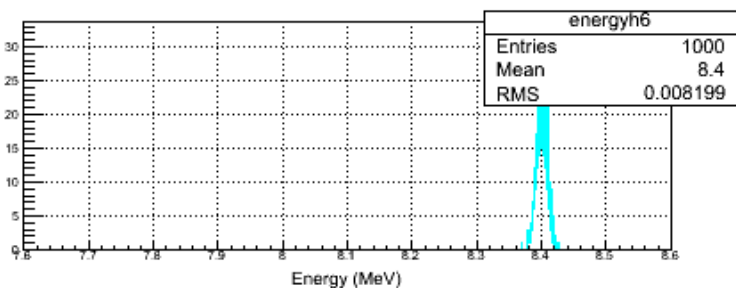
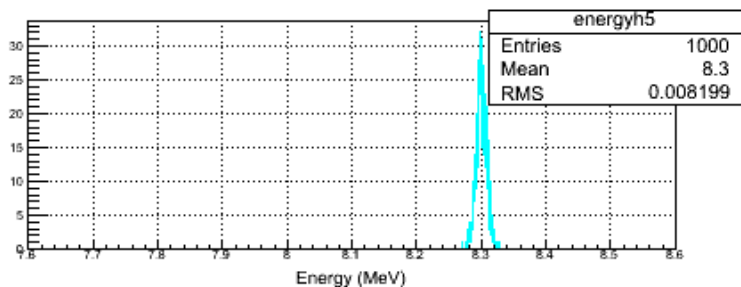
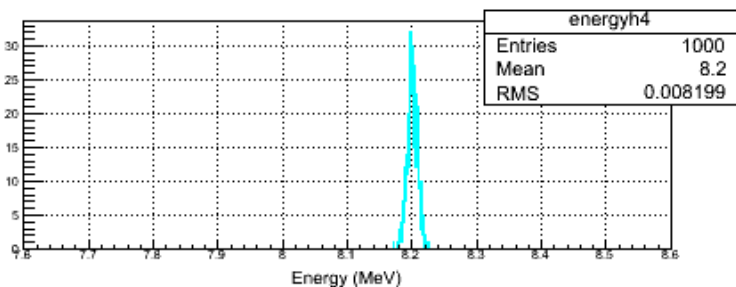
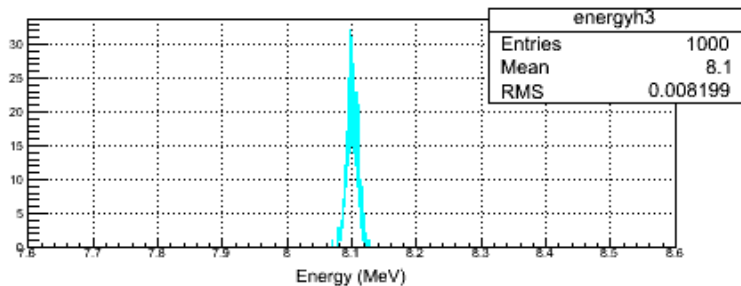
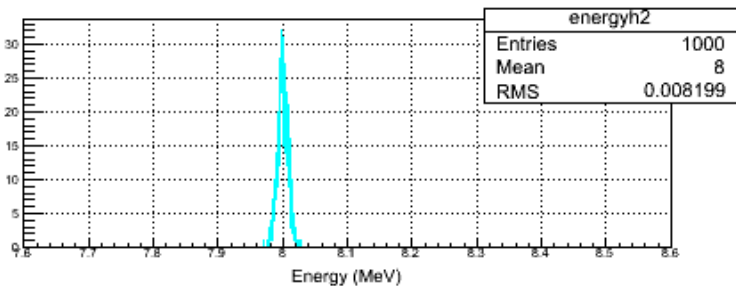
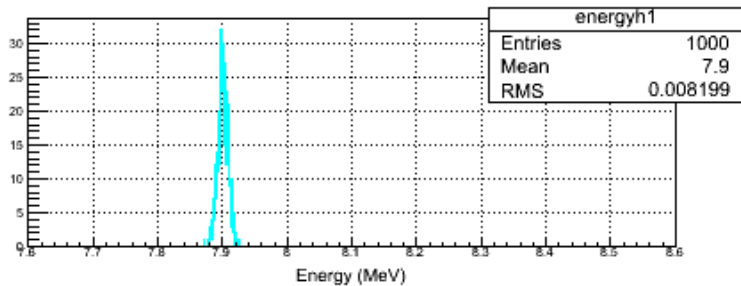
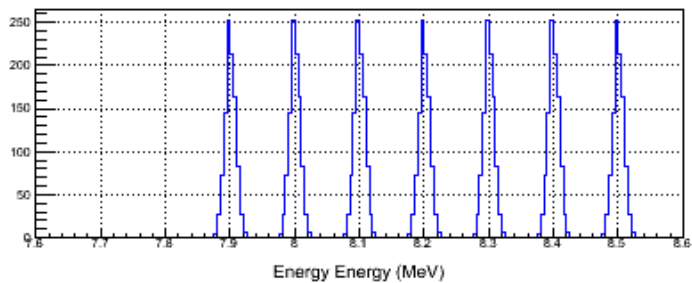
$$E_1 = 7.9 * gRandom \rightarrow Gaus(1, 0.001)$$

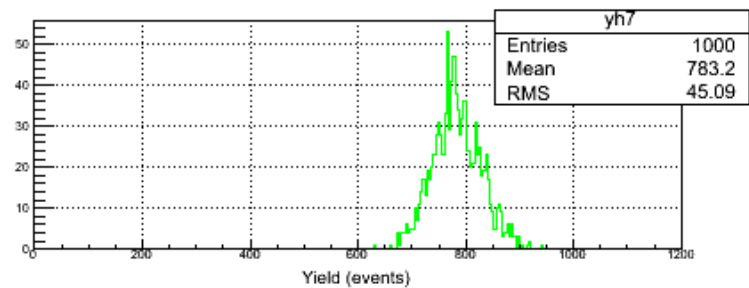
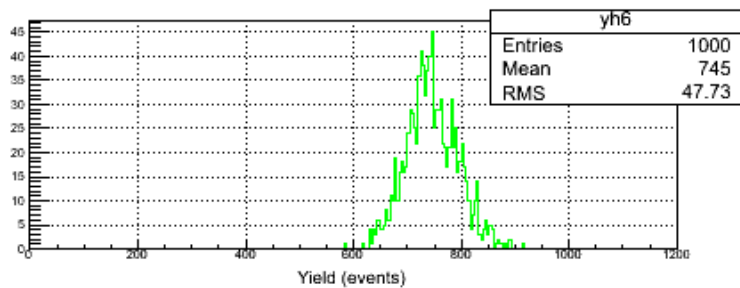
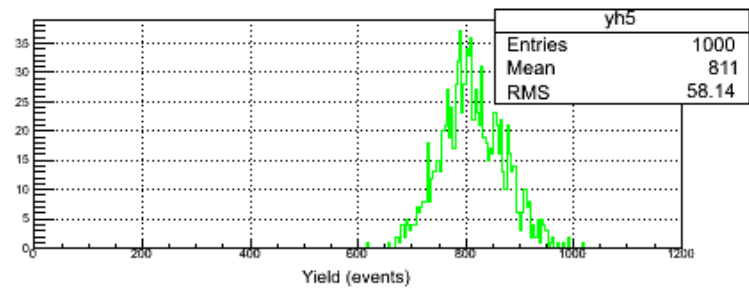
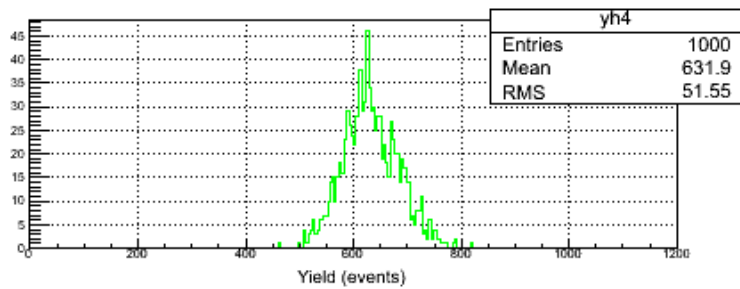
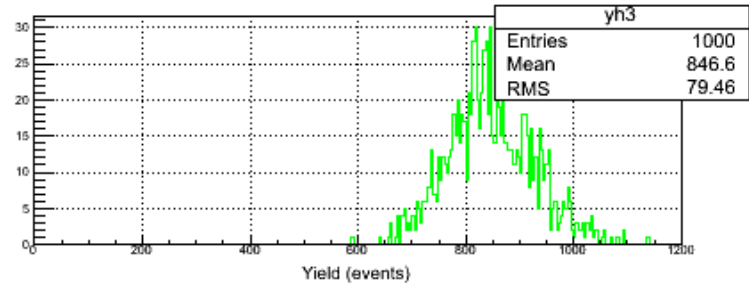
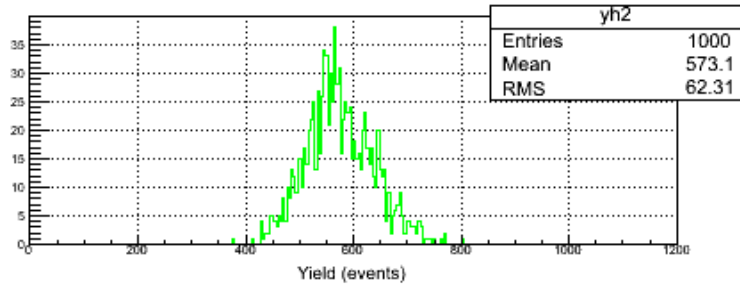
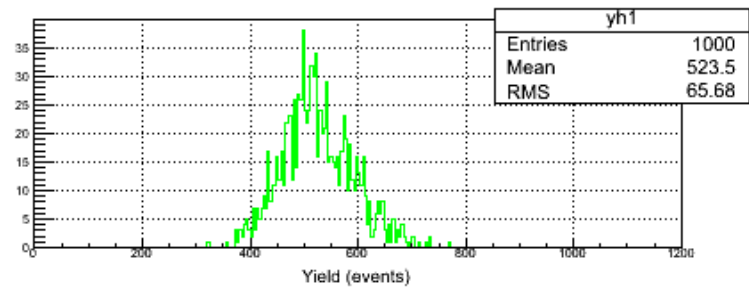
- III. Higher energies has zero relative error,

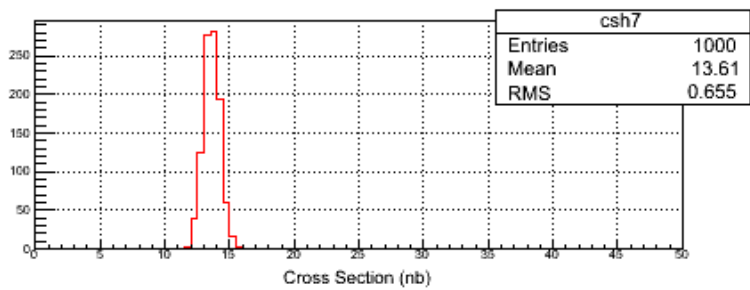
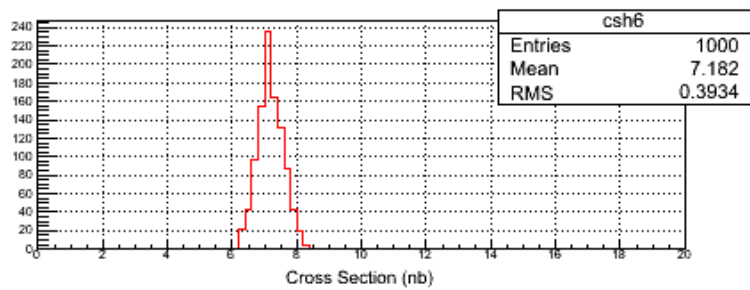
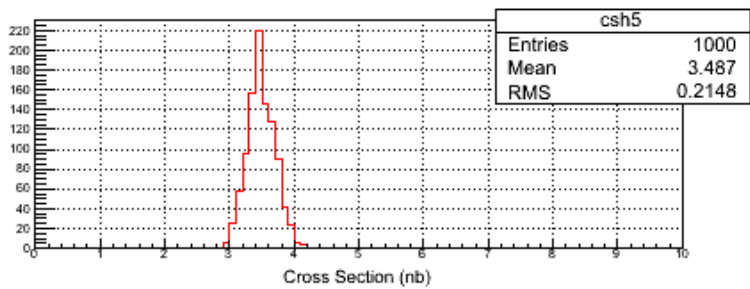
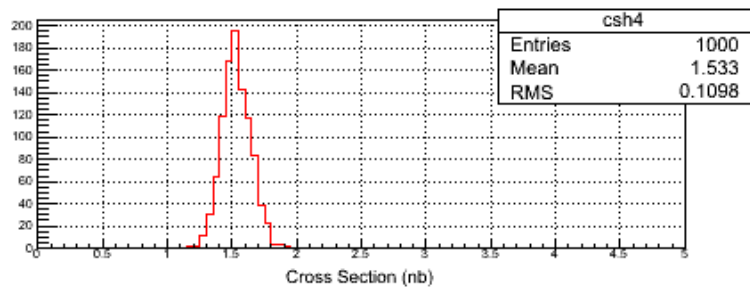
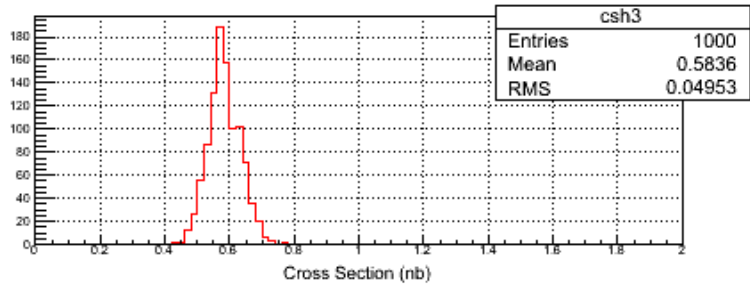
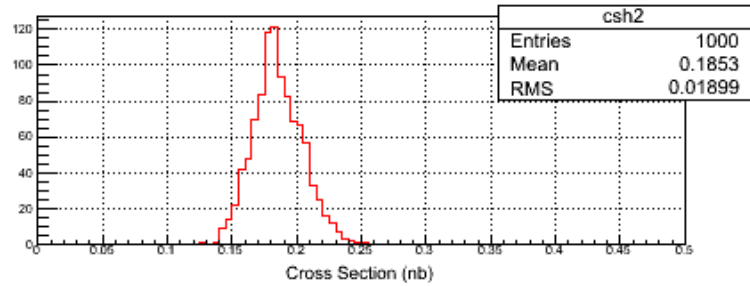
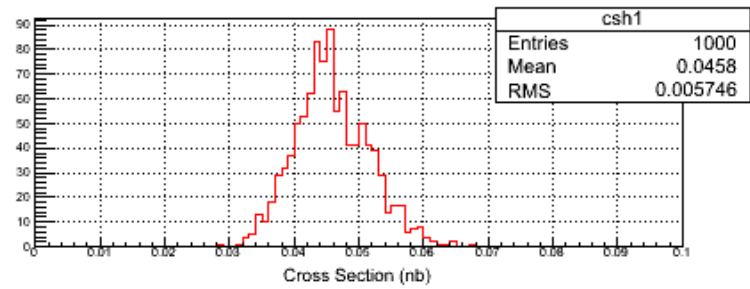
$$E_i = E_1 + i * \Delta$$

- IV. Calculate the yield
- V. Unfold cross section
- VI. Repeat for 1000 tries

Now, we have to worry about beam stability (RF stability). Need injector FFB system to maintain relative beam stability







Electron Beam K. E.	Beam Current (μA)	Time (hour)	y_i	dy_i/y_i (%)
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