Momentum distribution measurement with a ^{78}Kr beam

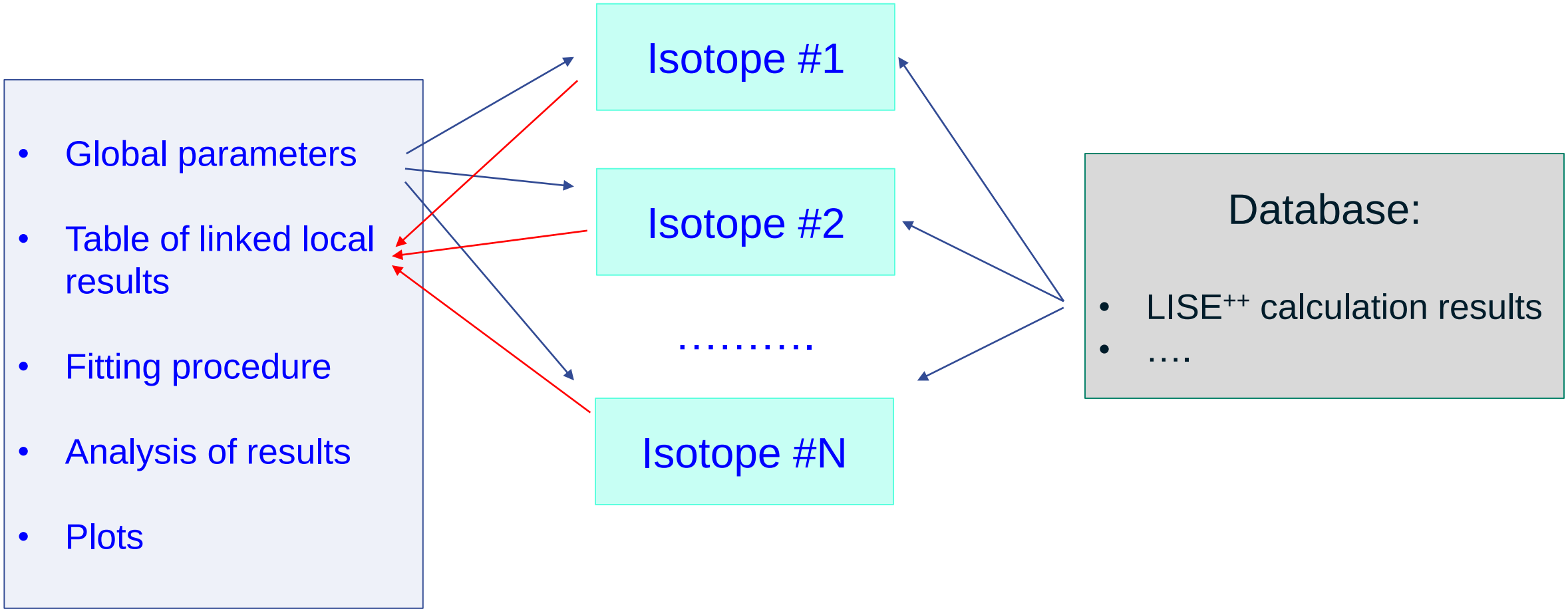
- Global fit: Modification of Elaine's file
- Initial plots
- Minimization results
- Width of momentum distributions

- What settings should be used for qualitative predictions in the proton-rich region?
- Physics motivation : why is velocity difference between proton- and neutron-rich regions?

- What is real Energy ?
  - Previous experiments and analysis
  - A1900 optics discussion: Segment #0
  - Dipole effective lengths measurement
  - History: Misalignment or initial beam spot shift?

Global fit: Modification of Elaine's file

Sheets

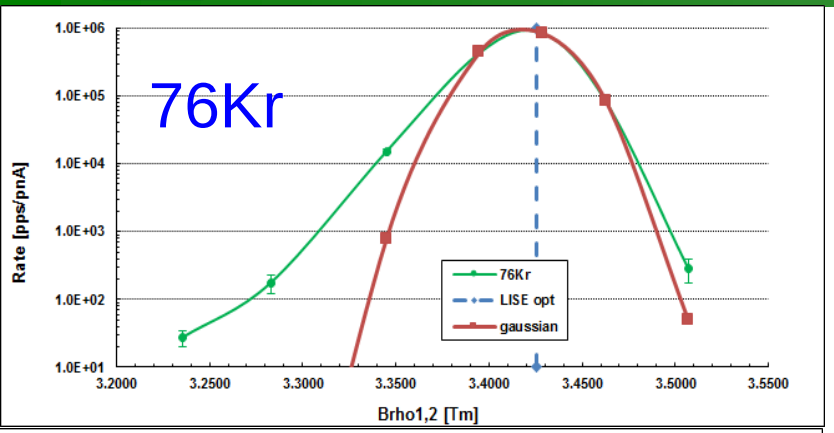


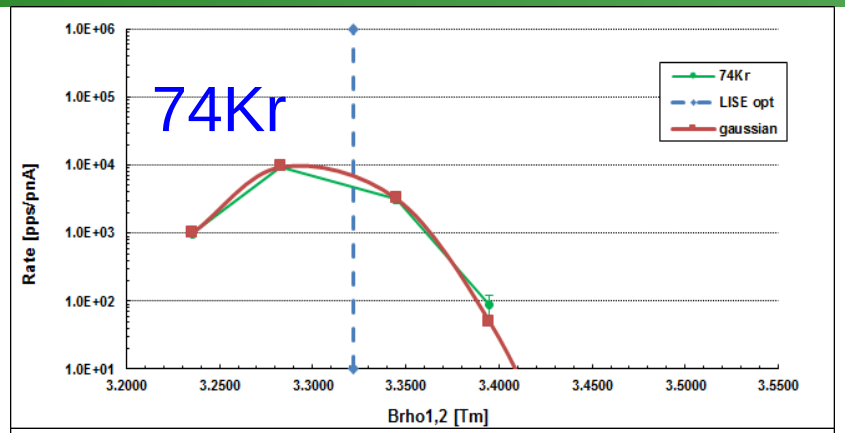
- Global parameters
- Table of linked local results
- Fitting procedure
- Analysis of results
- Plots

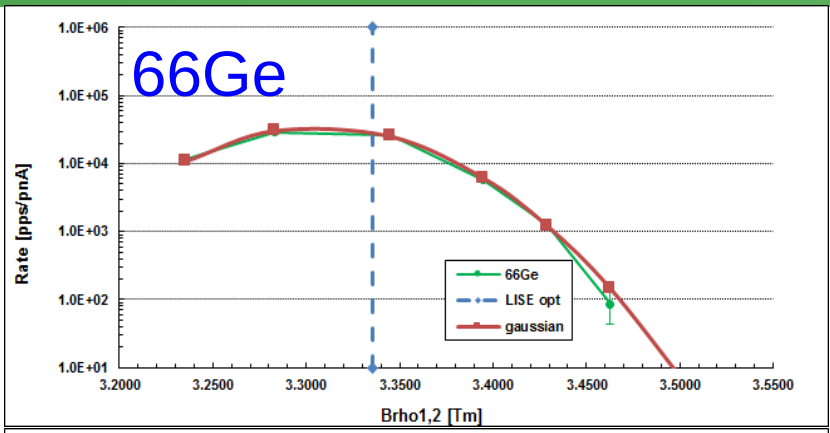
Allows to

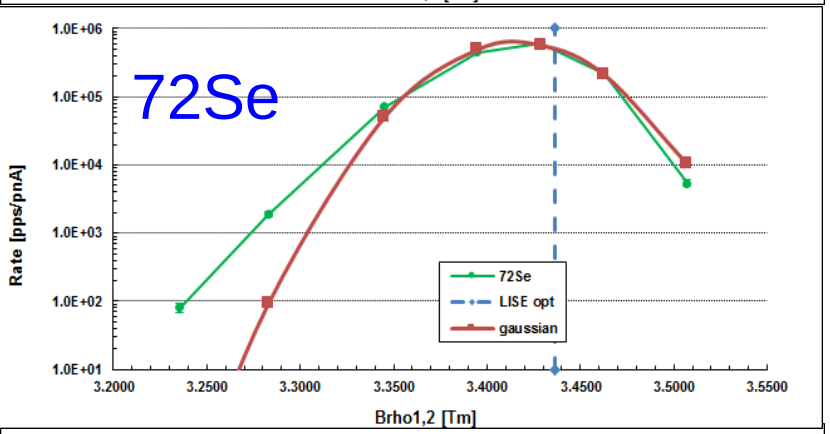
- Perform global fit with different sheets
- Decrease probabilities typos and copy-paste
- Easy and safe change of parameter values
- Easy re-connection with a new (updated) database

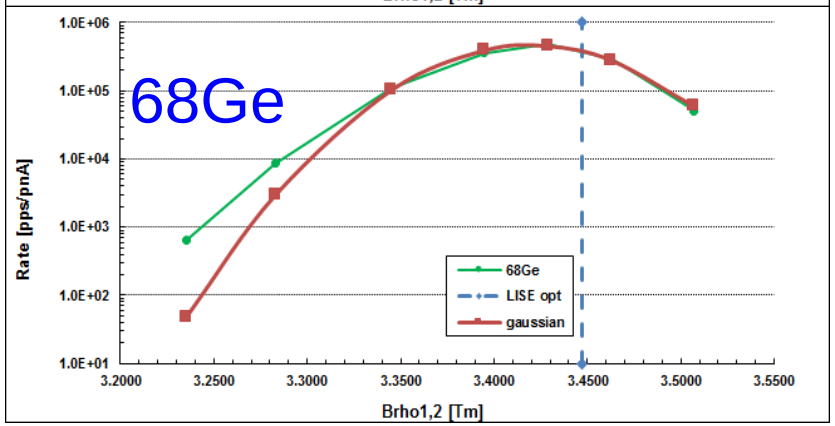
Isotope momentum distribution analysis

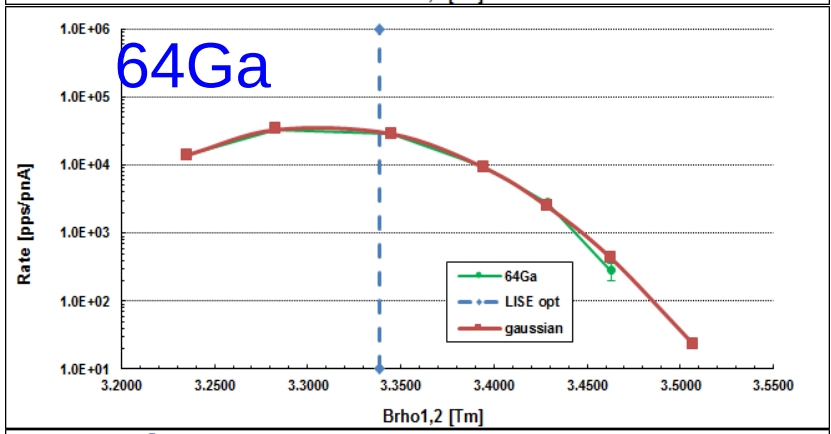


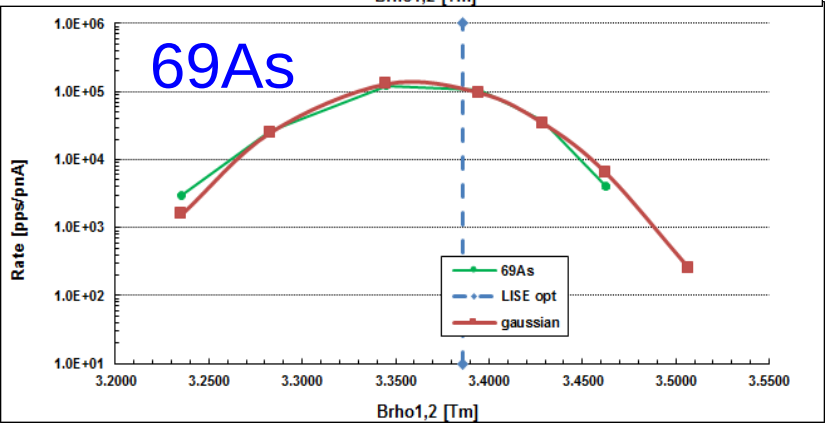


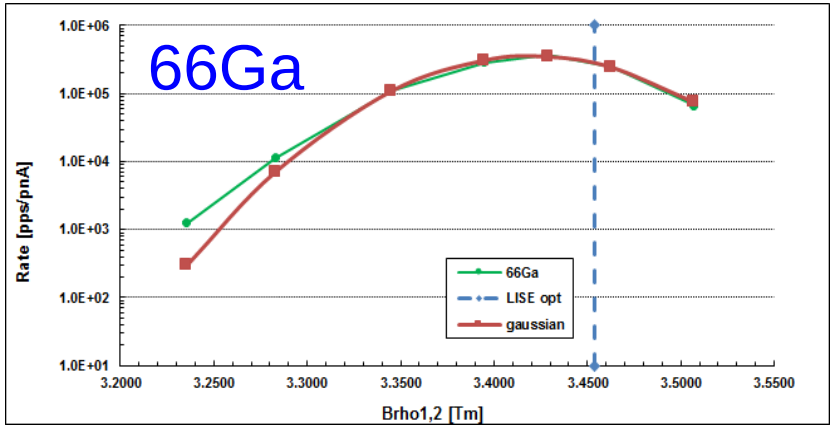


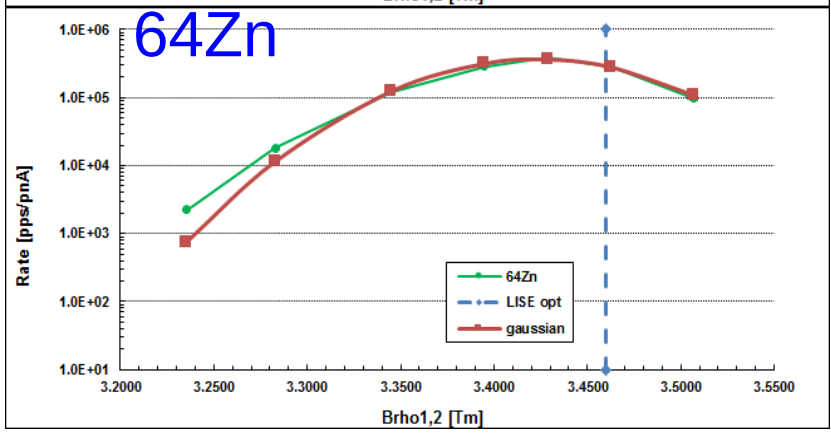






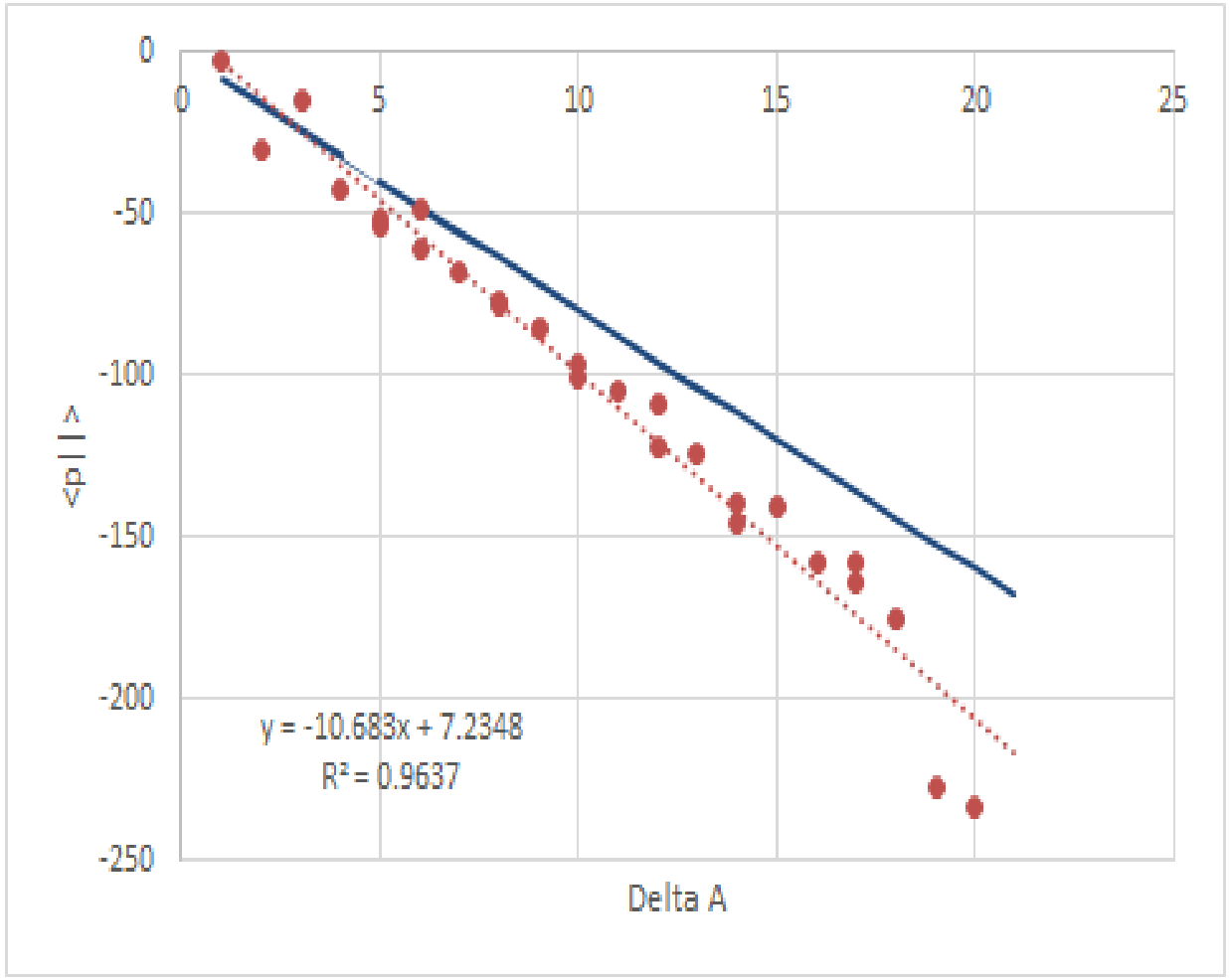






LISE opt lines correspond to the convolution model (default settings) and E_{beam}=150 Mev/u

Preliminary results from Elain's analysis

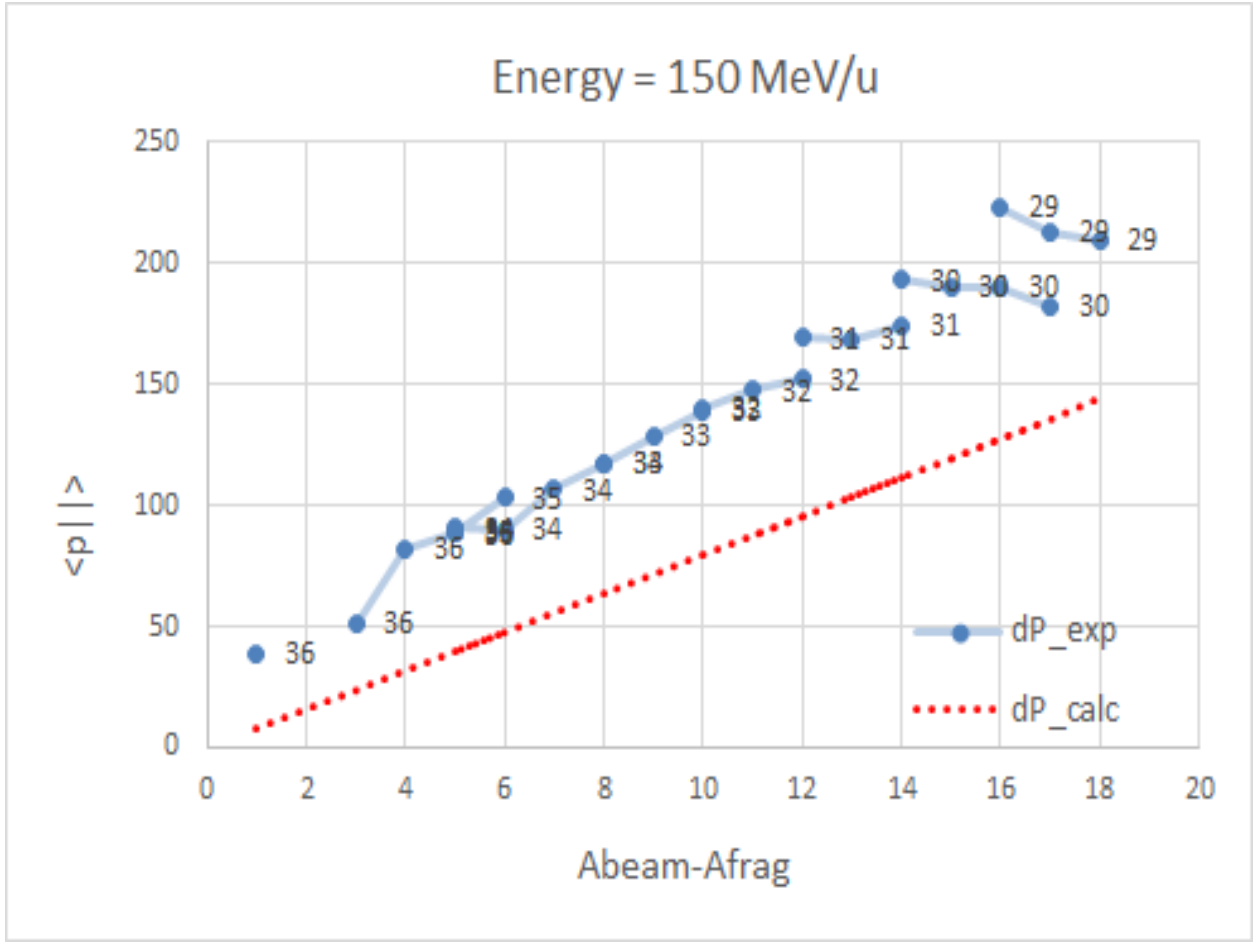


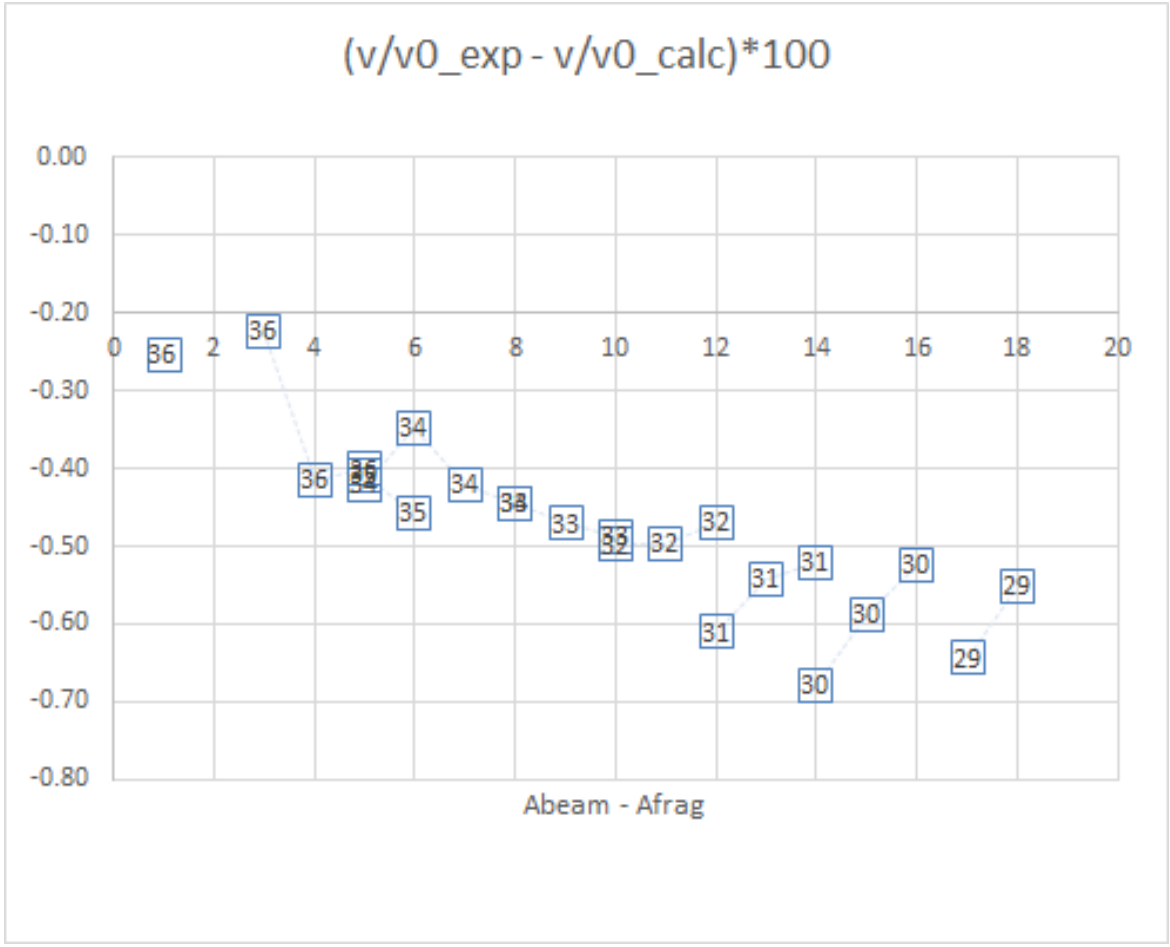
Centers of Gaussian distributions obtain from minimization of experimental distribution were used to plot <p||> (DJM) values

Pay attention on the non-zero free coefficient of the linear trend

Experimental deduced velocities with default settings

E_beam = 150 MeV/u Thick = 374.506 mg/cm2 DJM_coef = 8



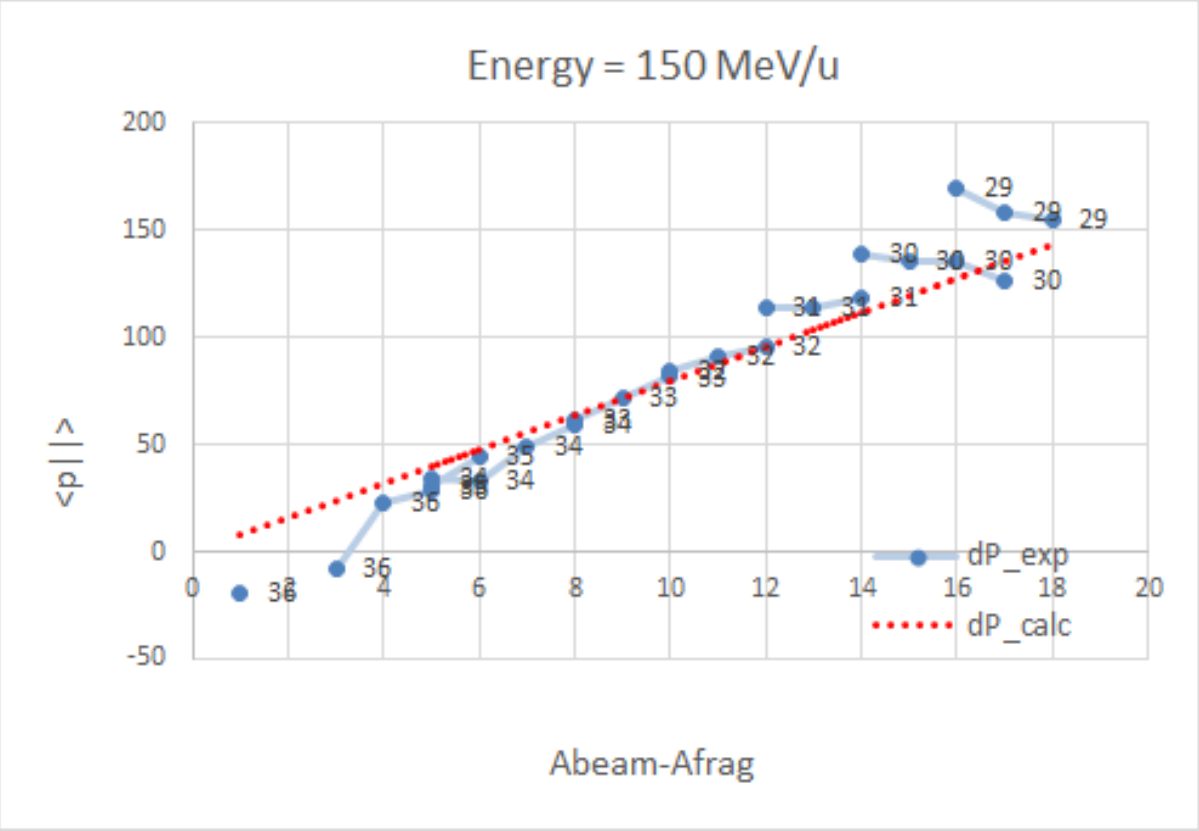


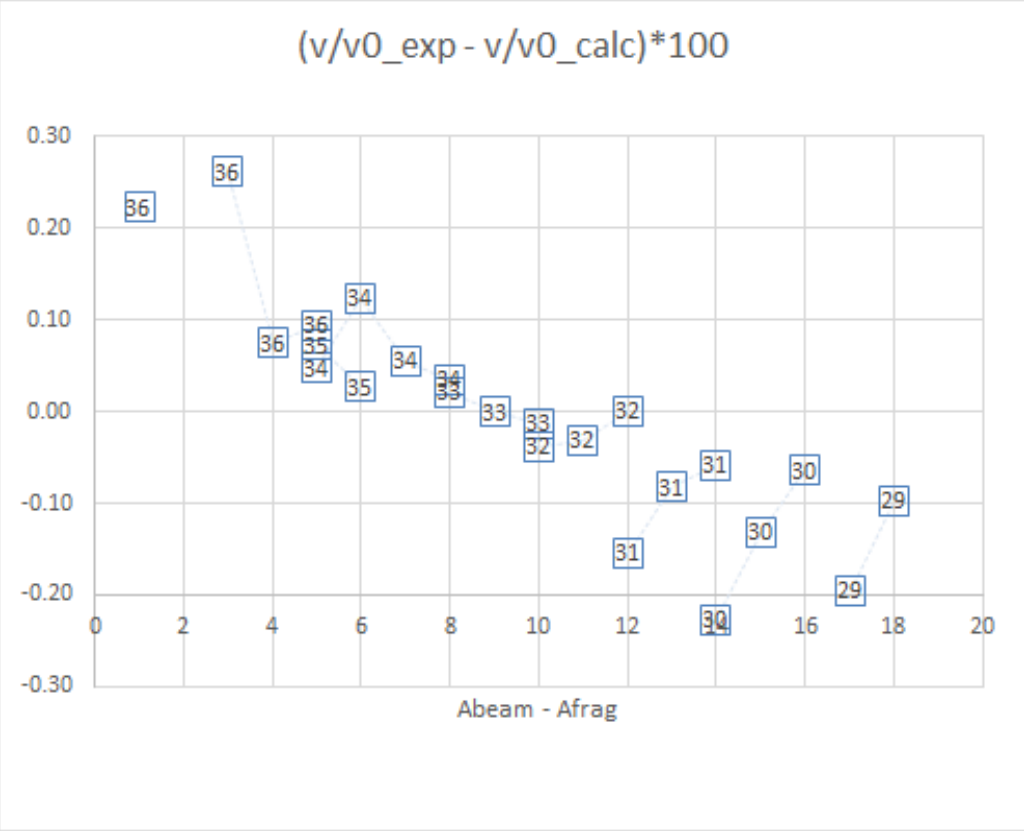
Labels are atomic numbers of isotopes

Experimental deduced velocities: target thickness variation

	Minimization target value	E_beam, MeV/u	Thick, mg/cm2	DJM_coef
Initial	11.31	150	374.5	8
After minimization	2.1	150	394.5	8

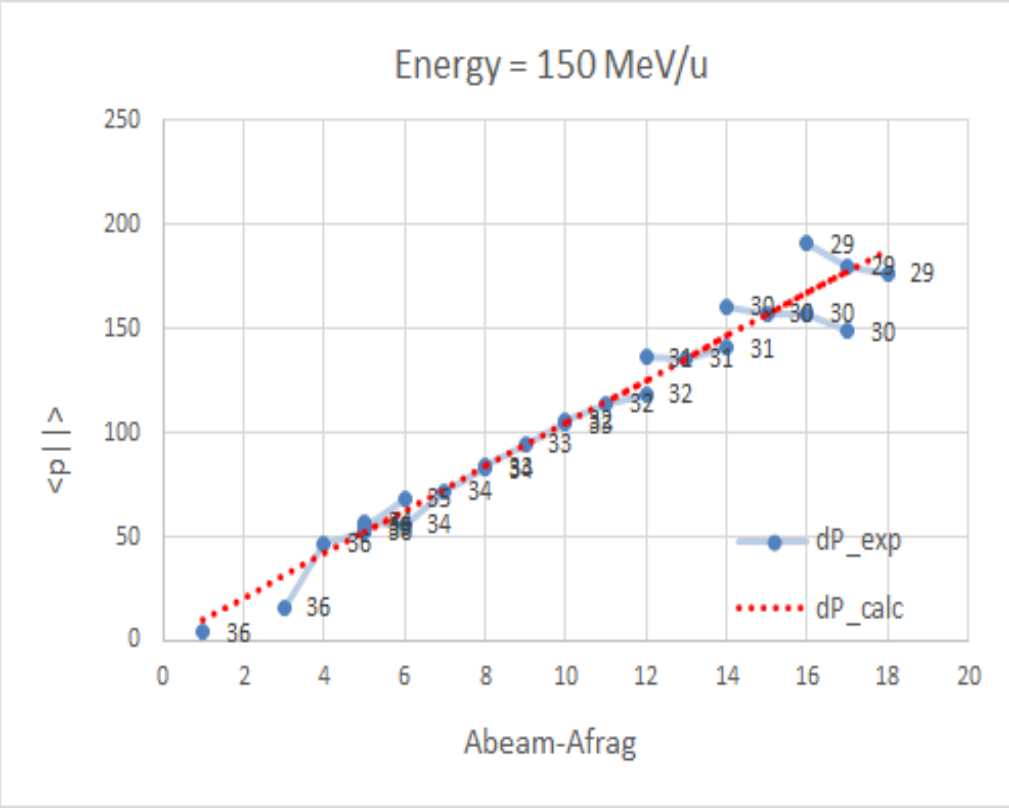
It's very large deviation for target thickness!

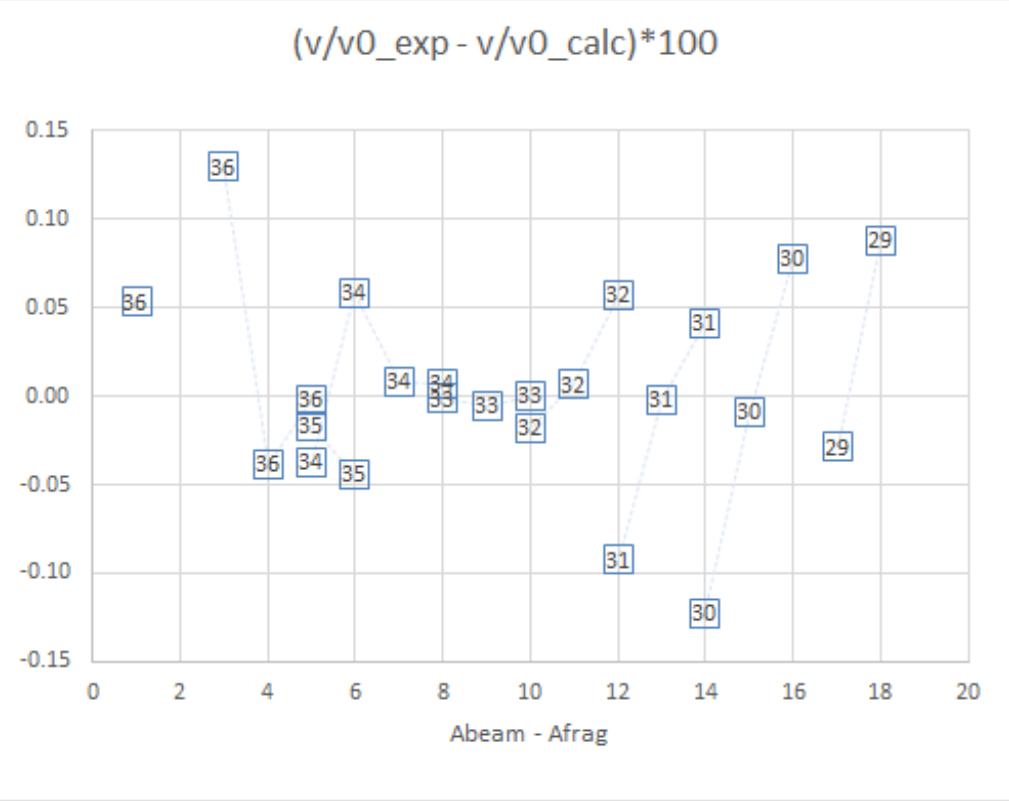




Experimental deduced velocities: target thickness variation 2

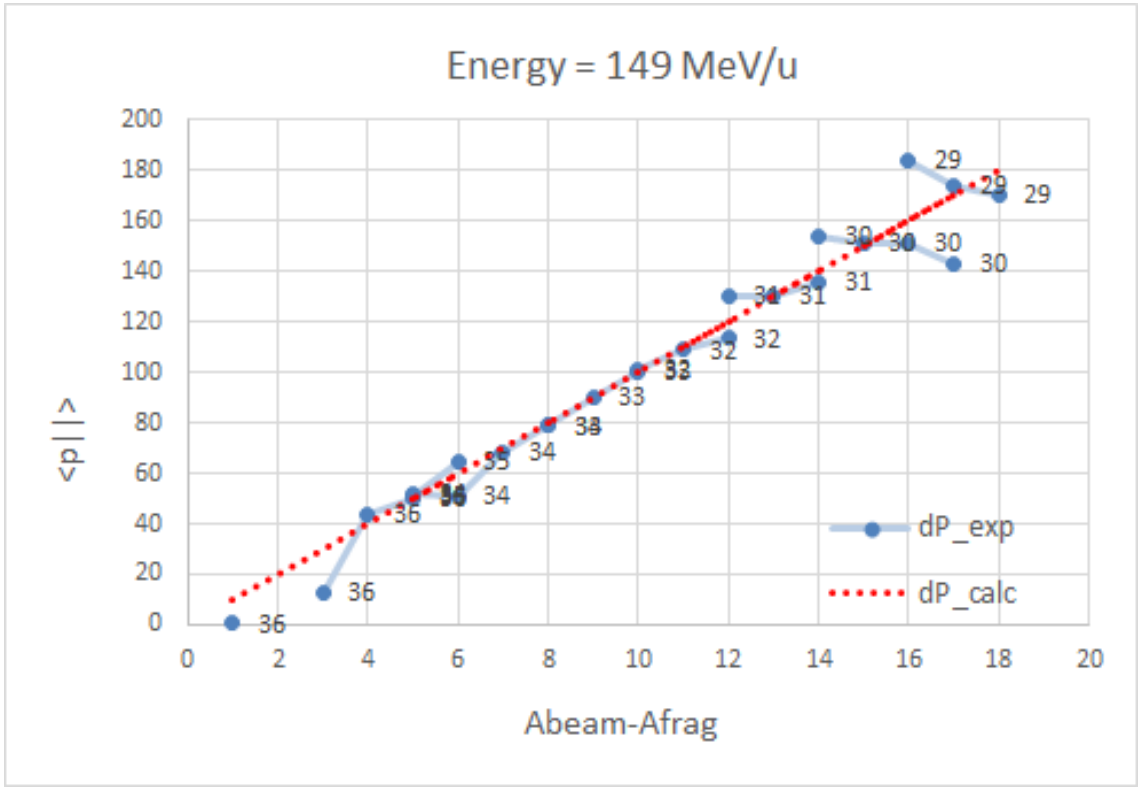
	Minimization target value	E_beam, MeV/u	Thick, mg/cm2	DJM_coef
Initial	11.31	150	374.5	8
After minimization	0.95	150	386.5	10.4

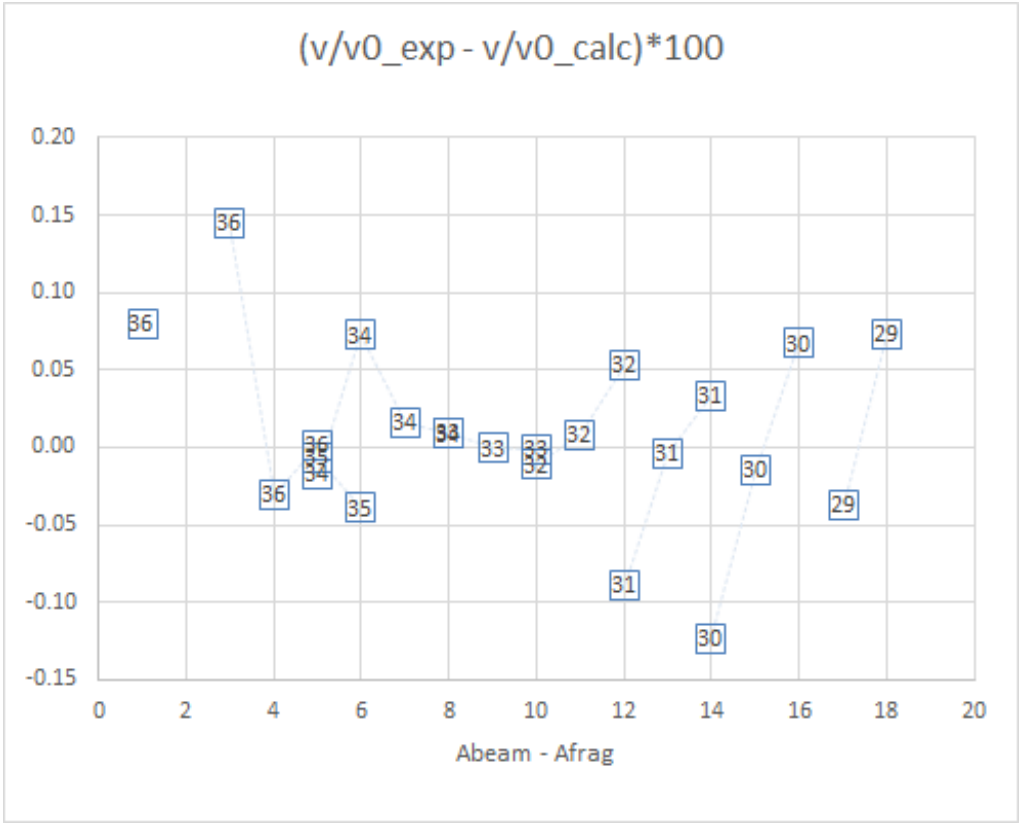




Experimental deduced velocities: beam energy variation

	Minimization target value	E_beam, MeV/u	Thick, mg/cm2	DJM_coef
Initial	11.31	150	374.5	8
After minimization	0.7961	149.014	374.5	10.0131

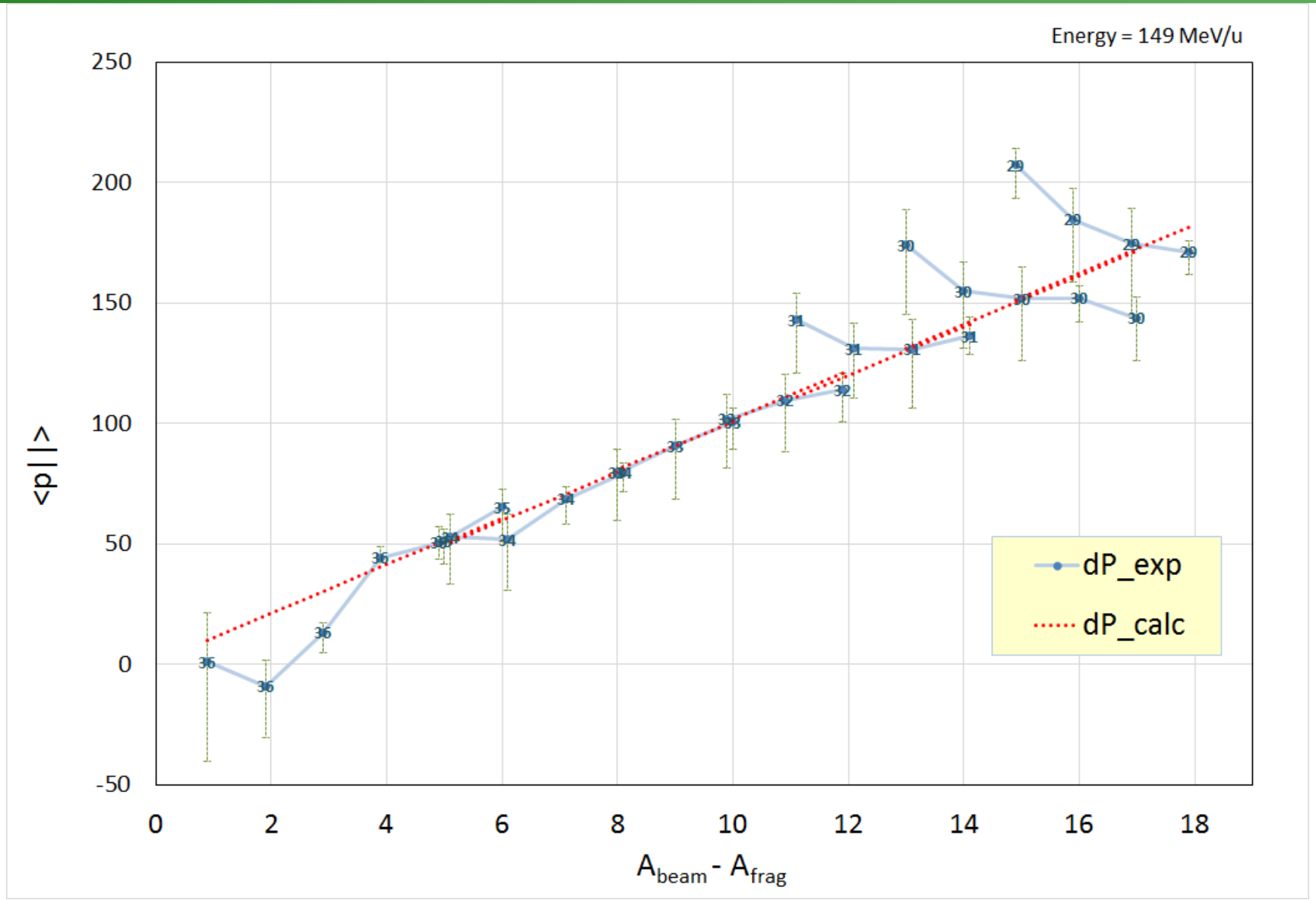




Experimental deduced velocities: Final

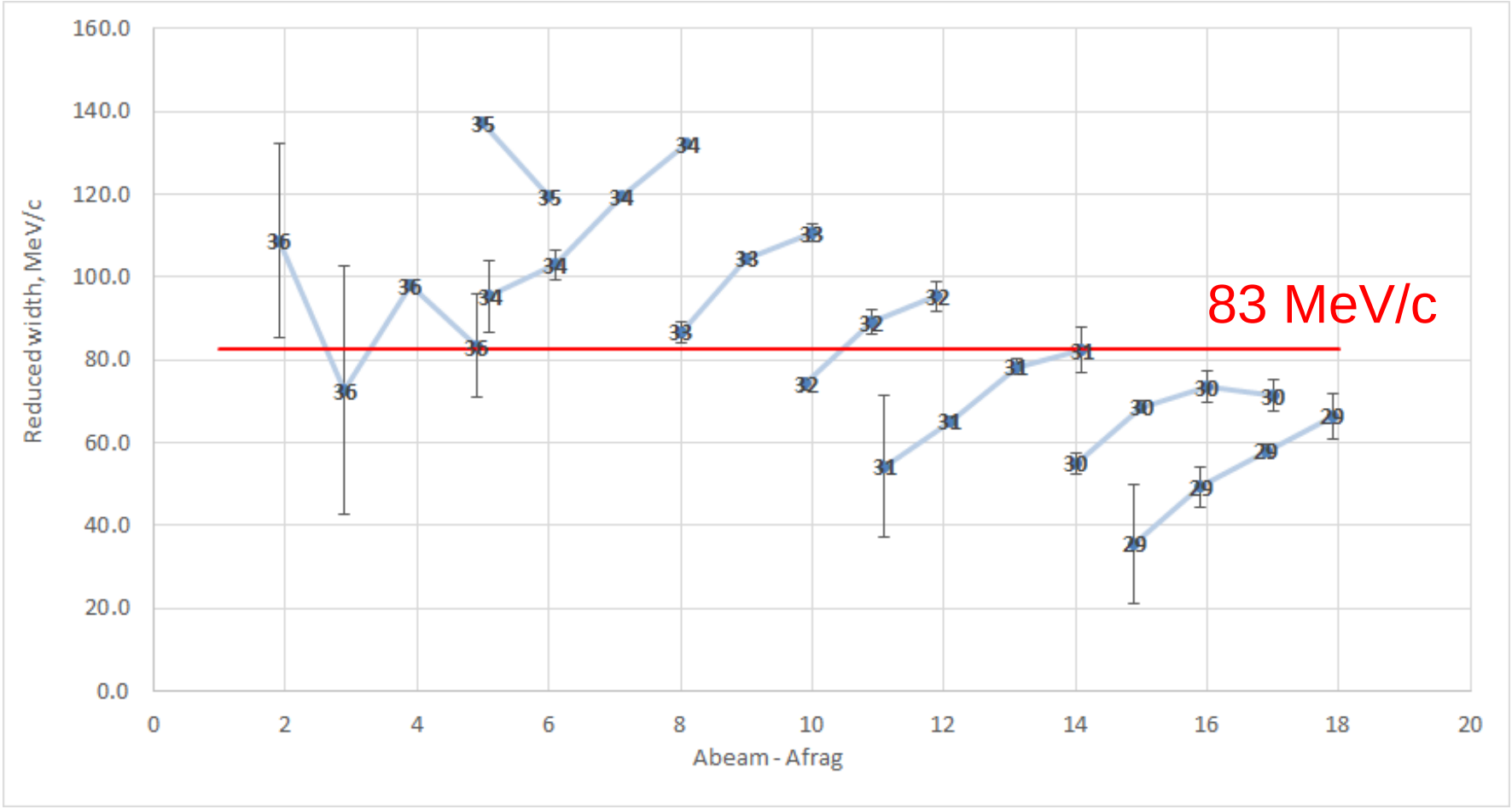
E_beam, MeV/u	149.014
Thick, mg/cm2	374.5
DJM_coef	10.0131

- Errors are coming from comparison with analysis by asymmetric normal distributions
- Includes edge points not-used in the minimization



Final file : http://lise.nscl.msu.edu/paper/velocity/71Se_Ratescan_2019_v7_sym.xlsx

Deduced width of momentum distributions



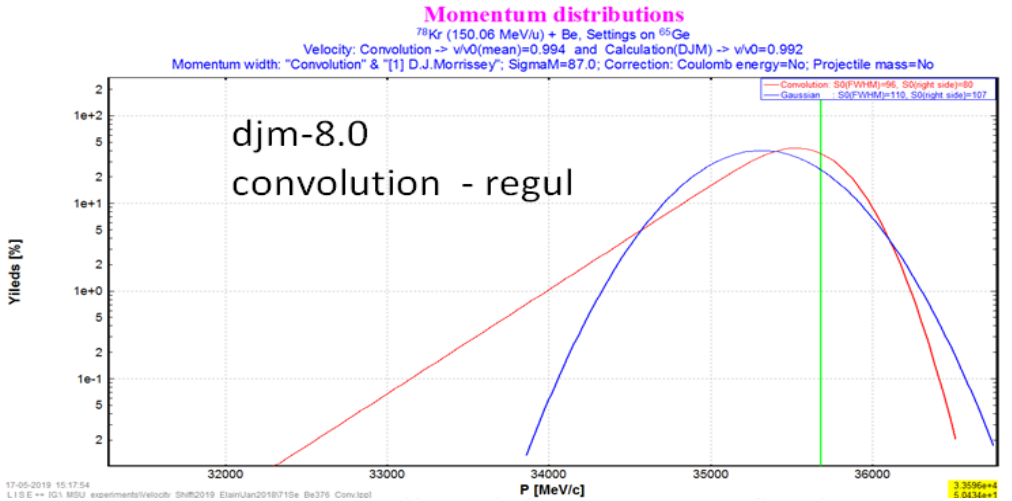
- Errors are coming from comparison with analysis by asymmetric normal distributions
- Initial beam emittance (Gaussian), energy straggling (Gaussian), energy loss difference (Rectangle) were used in de-convolution of observed momentum distributions

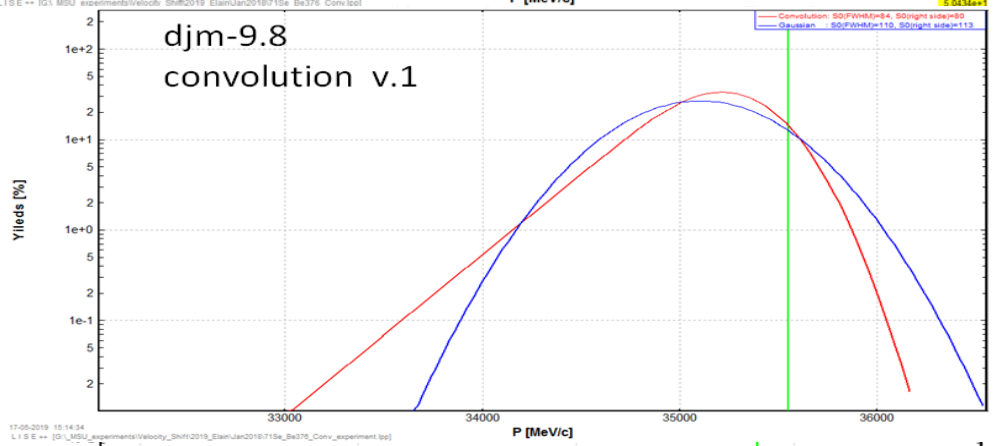
What settings should be used for qualitative predictions in the proton-rich region?

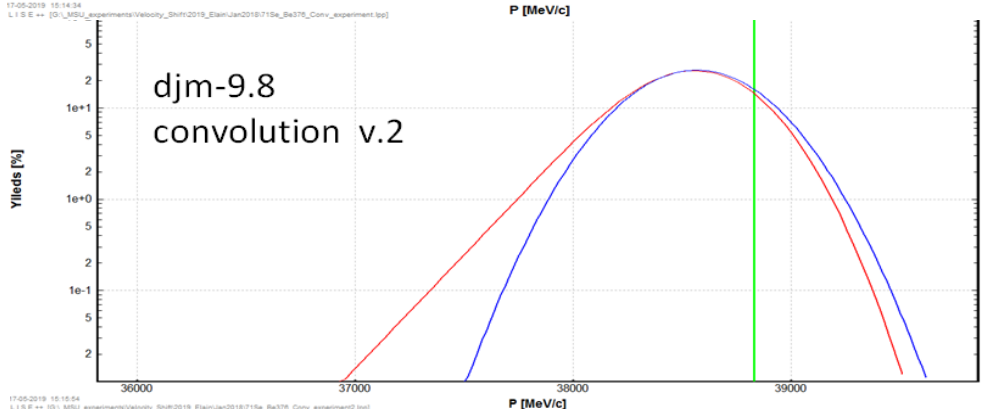
1. Use energy of 149 MeV/u instead 150 MeV/u in the case of a ^{78}Kr beam (or 2nd and 3rd dipole Brho values obtained with the effective dipole length measurements)

2.

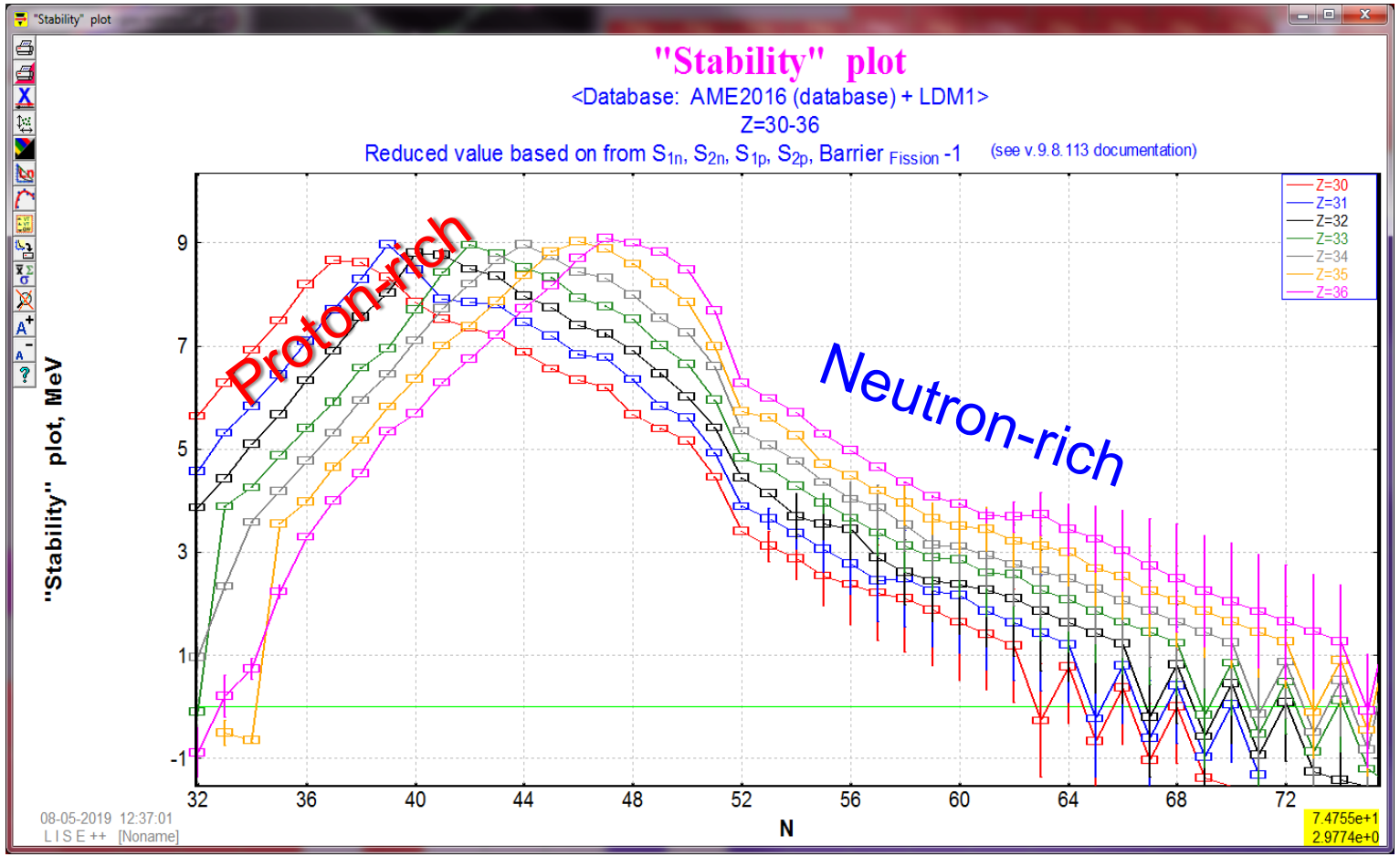
	DJM		Convolution			
	old 8.0	new 9.8	regul	regul	v1	v2
			Max	Mean	Max	Max
median from experiment	-0.73%	-0.01%	-1.45%	-0.93%	-0.34%	-0.20%
StDeV	0.26%	0.22%	0.54%	0.41%	0.37%	0.39%
Model parameteres						
DJM coef	8	9.8				
conv coef			3	3	2	2
shift			0.149	0.149	-0.7	-0.8
sigma0			91.5	91.5	91.5	120







Physics motivation



under investigation is lower. An analysis with asymmetric distributions to reproduce the mean velocity of fragments has shown that the neutron-rich separation energy parameter in the model [36] for the nuclei observed in the present work in the region $A_P/2 \leqslant A_F \leqslant A_P$ can be represented by a linear decrease with the number of removed nucleons:

$$E_S = 8 - 9.2\Delta A/A_P, \qquad (1)$$

2-4

PHYSICAL REVIEW C **87**, 054612 (2013)

Our experiments in the Neutron-rich region

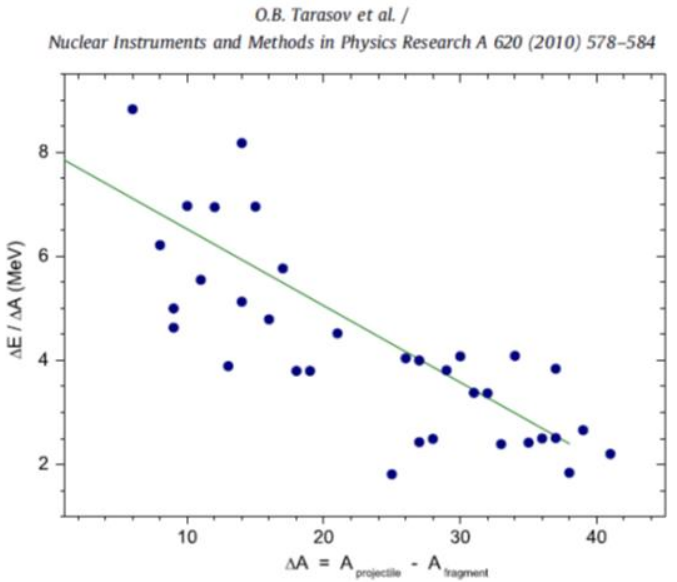


Fig. 6. (Color online) Separation energy values ($E_S = \Delta E/\Delta A$) for Morrissey's model deduced from the experimental data shown in Fig. 2. Values are plotted as a function of the number of removed nucleons ($\Delta A = A_P - A_F$). The solid line represents a linear fit ($E_S = 8 - 11.2\Delta A/A_P$).

E9016: ^{82}Se – target thickness scanning → 139 MeV/u!

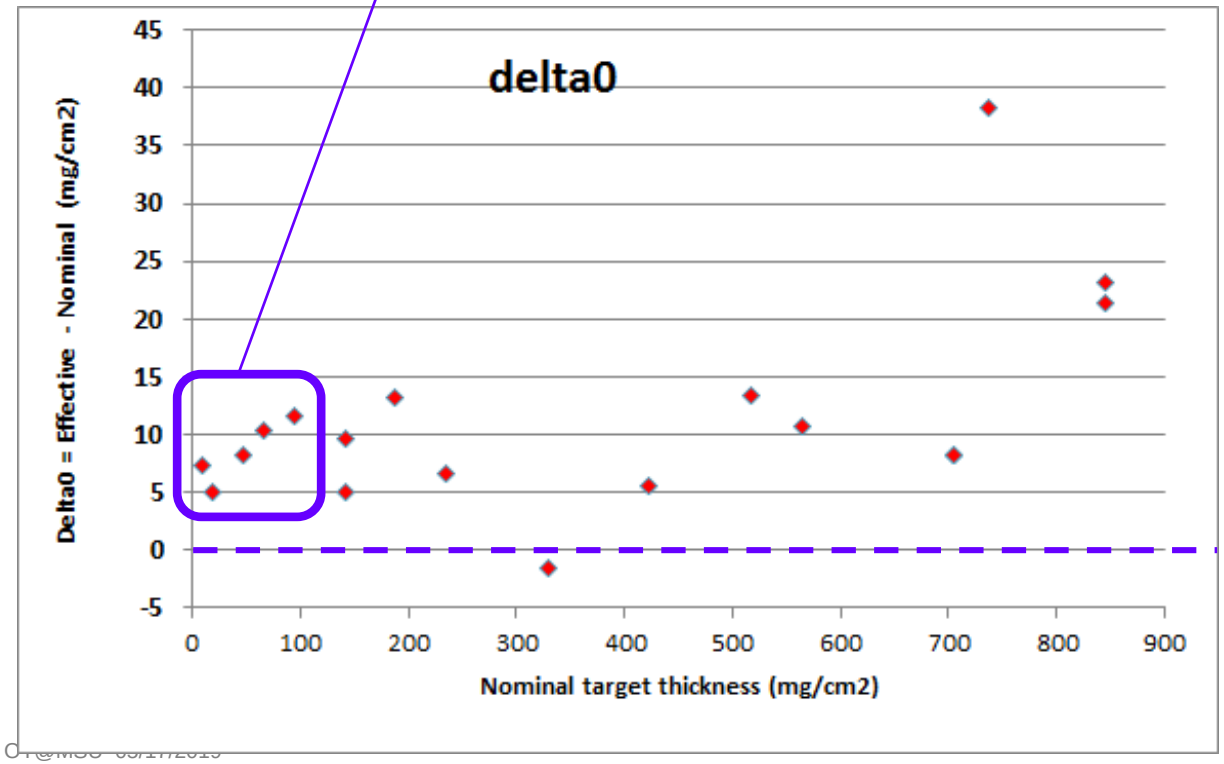
	Barney	Use Br1-eff	Use Br2-eff	
Brho=	4.5217	4.5254	4.5053	Tm
Energy=	140.00	140.21	139.05	MeV/u

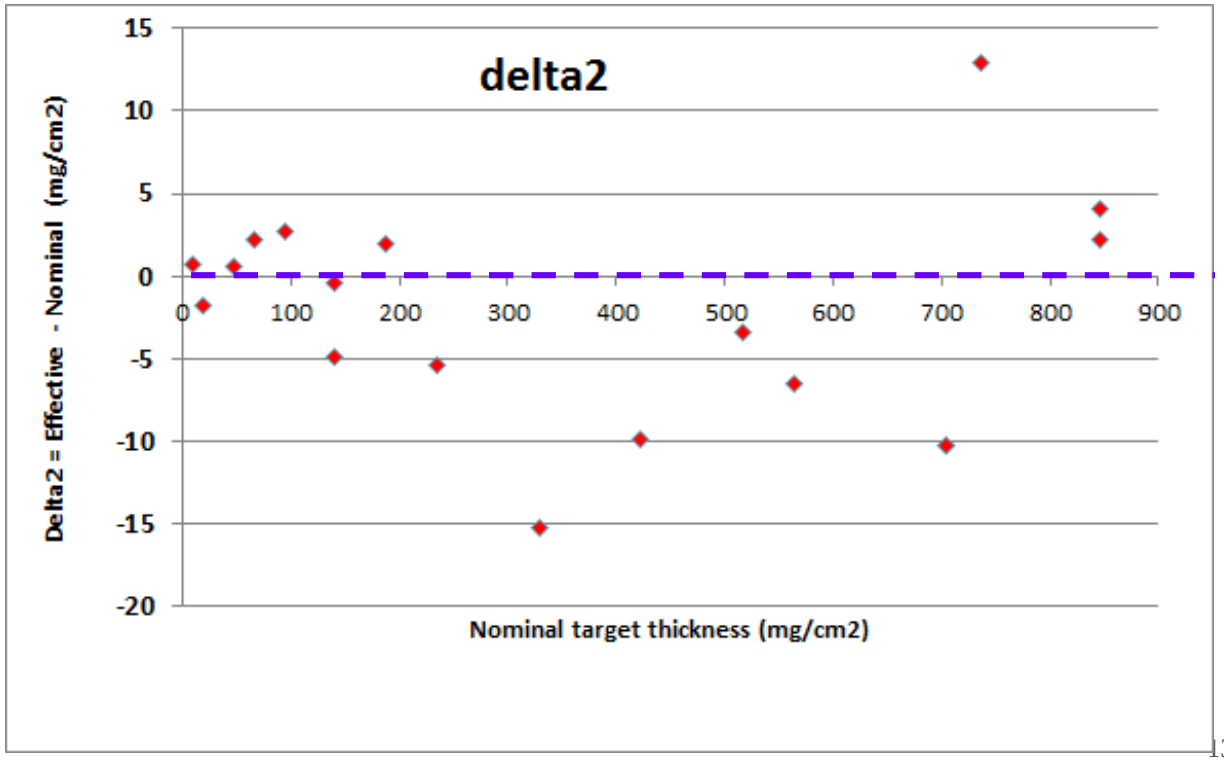
delta0 delta2

target	thickNom	Z	location	BrFix	Br2_cor	Thick0	Thick2	delta0	delta2	delta0	delta2
				Tm	Tm	mg/cm2	mg/cm2	mg/cm2	mg/cm2	%	%
Be 9	9	4	Z015	4.2384	4.2299	16.3	9.7	*7.3*	**0.7**	81%	7%
Be 19	19	4	Z016	4.2300	4.2217	24.1	17.3	*5.1*	**-1.7**	27%	-9%
Be 47	47	4	Z015	4.1962	4.1887	55.2	47.6	*8.2*	**0.6**	18%	1%
Be 66	66	4	Z015	4.1729	4.1659	76.4	68.2	*10.4*	**2.2**	16%	3%
Be 94	94	4	Z015	4.1403	4.1341	105.7	96.7	*11.7*	**2.7**	12%	3%
Be 141	141	4	Z015	4.0891	4.0840	150.7	140.6	*9.7*	**-0.4**	7%	0%
Be 141	141	4	Z016	4.0944	4.0892	146.1	136.1	*5.1*	**-4.9**	4%	-3%
Be 235	235	4	Z015	3.9814	3.9785	241.7	229.6	*6.7*	**-5.4**	3%	-2%
Be 329	329	4	Z015	3.8740	3.8730	327.5	313.8	*-1.5*	**-15.2**	0%	-5%
Be 423	423	4	Z015	3.7391	3.7403	428.6	413.2	*5.6*	**-9.8**	1%	-2%
Be 517	517	4	Z015	3.5920	3.5954	530.4	513.7	*13.4*	**-3.3**	3%	-1%

???

???





Chronology of Brho value ratios

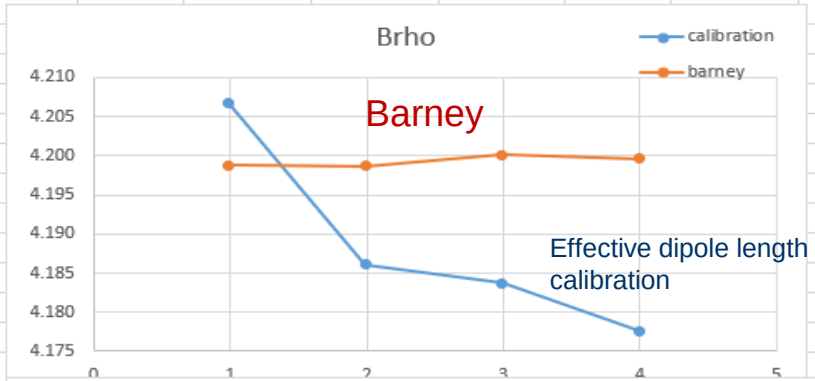
< 2011		A	Z	Qinit	M	Beam list energy		Brho ratio	Energy ratio
	238U72+	238	92	72	238.01	86		D1/D234	D1/D234
06503 experiment		B	RadFit	Brho_real	Energy	Brho	Energy		
Radius1=	3.0988	1.4598	3.079	4.4945	85.27	4.4945	85.3	0.56%	1.07%
Radius2=	3.1014	1.4585	3.067	4.4732	84.50				
Radius3=	3.0960	1.4611	3.054	4.4627	84.12	4.4692	**84.4**		
Radius4=	3.0976	1.4603	3.062	4.4719	84.46	sig=	0.2		
	238U72+	238	92	72	238.01	86			
05120 experiment		B	RadFit	Brho_real	Energy	Brho	Energy		
Radius1=	3.0988	1.4580	3.079	4.4891	85.08	4.4891	85.1	0.54%	1.03%
Radius2=	3.1015	1.4567	3.067	4.4676	84.30				
Radius3=	3.0956	1.4597	3.054	4.4585	83.97	4.4649	**84.2**		
Radius4=	3.0962	1.4592	3.062	4.4686	84.34	sig=	0.2		
	76Ge30+	76	32	30	75.90	130 (131)			
08024 experiment		B	RadFit	Brho_real	Energy	Brho	Energy		
Radius1=	3.0988	1.3955	3.082	4.3010	130.29	4.3010	130.3	0.55%	1.03%
Radius2=	3.1016	1.3943	3.070	4.2811	129.16				
Radius3=	3.0955	1.3970	3.057	4.2702	128.54	4.2772	**128.9**		
Radius4=	3.0961	1.3968	3.065	4.2805	129.13	sig=	0.3		
	238U69+	238	92	69	238.01	80 (81)			
05048 experiment		B	RadFit	Brho_real	Energy	Brho	Energy		
Radius1=	3.0988	1.4774	3.078	4.5473	80.37	4.5473	80.4	0.54%	1.04%
Radius2=	3.1015	1.4762	3.066	4.5257	79.64				
Radius3=	3.0959	1.4789	3.054	4.5159	79.31	4.5227	**79.5**		
Radius4=	3.0966	1.4785	3.061	4.5264	79.66	sig=	0.2		
								0.55%	1.04%

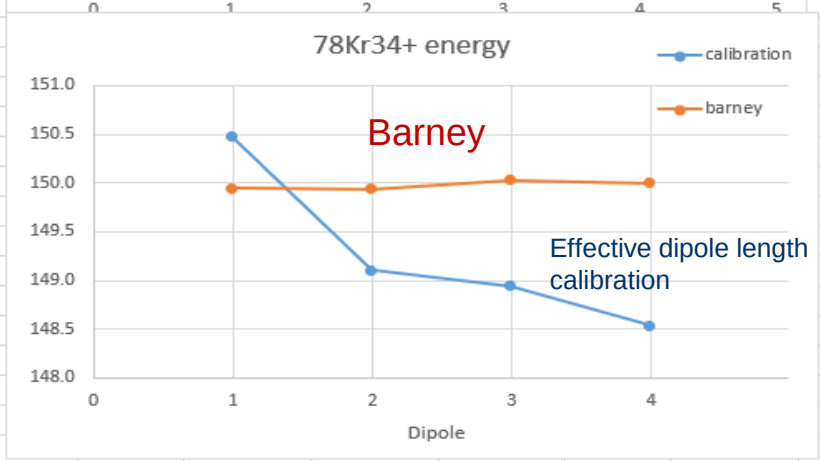
2011		A	Z	Qinit	M	Beam list energy		Brho ratio	Energy ratio
	82Se32+	82	34	32	81.90	140		D1/D234	D1/D234
9016 experiment		B	RadFit	Brho_real	Energy	Brho	Energy		
Radius1=	3.0758	1.4701	3.078	4.5253	140.26	4.5253	140.3	0.47%	0.88%
Radius2=	3.0775	1.4693	3.066	4.5052	139.10				
Radius3=	3.0696	1.4731	3.054	4.4986	138.72	4.5040	**139.0**		
Radius4=	3.0708	1.4725	3.062	4.5083	139.28	sig=	0.3		
40711	48Ca20+	48	20	20	47.94	140 (141)			
10023 experiment		B	RadFit	Brho_real	Energy	Brho	Energy		
Radius1=	3.0844	1.3731	3.083	4.2331	139.94	4.2331	139.9	0.49%	0.91%
Radius2=	3.0883	1.3714	3.072	4.2124	138.66	4.2124	**138.7**		
Radius3=	3.0811		3.251						
Radius4=	3.0831		3.282						
	238U69+	238	92	69	238.01	80 (81)			
09068 experiment		B	RadFit	Brho_real	Energy	Brho	Energy		
Radius1=	3.0988	1.4772	3.078	4.5466	80.35	4.5466	80.3	0.47%	0.91%
Radius2=	3.1015	1.4759	3.066	4.5250	79.62	4.5250	**79.6**		
Radius3=	3.0959								
Radius4=	3.0966								
	78Kr34+	78	36	34	77.90	150			
2019 A1900 MDT		B	RadFit	Brho_real	Energy	Brho	Energy		
Radius1=	3.0988	1.3643	3.083	4.2067	150.47	4.2067	150.5	0.58%	1.07%
Radius2=	3.1015	1.3626	3.072	4.1861	149.10				
Radius3=	3.0959	1.3684	3.057	4.1837	148.94	4.1825	**148.9**		
Radius4=	3.0966	1.3627	3.066	4.1777	148.54	sig=	0.3		
	124Sn45+	124	50	45	123.88	120			
11003		B	RadFit	Brho_real	Energy	Brho	Energy		
Radius1=	3.0765	1.4563	3.079	4.4840	120.23	4.4840	120.2	0.50%	0.94%
Radius2=	3.0774	1.4559	3.067	4.4653	119.29				
Radius3=	3.0712	1.4588	3.054	4.4559	118.81	4.4616	**119.1**		
Radius4=	3.0738	1.4576	3.062	4.4636	119.20	sig=	0.3		
								0.52%	0.97%

No changes for this period (2006-2019)

^{78}Kr : 150 or 149 MeV/u?

		radius		Brho		Energy			A	78
dipole	field	calibration	barney	calibration	barney	calibration	barney		Z	36
1	1.36434	3.0833	3.0775	4.2067	4.1988	150.47	149.94		q	34
2	1.36264	3.0721	3.0813	4.1861	4.1987	149.10	149.94		M	77.90171
3	1.36841	3.0574	3.0694	4.1837	4.2001	148.94	150.03			
4	1.36273	3.0656	3.0818	4.1777	4.1996	148.54	150.00			
			median	4.1849	4.1992					





C:\buffer_LAB\A1900_settings\txt\Print05Feb18_12h35.txt

Segment 1						
Z017TA	3.539	10.458	1.057000	1.057000	27.4211	27.529
Z019TB	-3.322	-9.366	1.010000	1.010000	-24.6476	-24.657
Z021TC	2.407	6.996	1.043000	1.043000	14.6664	14.712
Z026DS	3.226	9.013	1.004226	1.004546	54.7916	54.482
Z031TA	2.926	8.177	1.000000	1.000000	17.1268	17.214
Z033TB	-3.613	-10.092	1.000000	1.000000	-29.1978	-29.234
Z035TC	3.183	8.906	1.000000	1.000000	18.6506	18.740
Segment 2						
Z039TA	3.183	8.906	1.000000	1.000000	18.6089	18.679
Z041TB	-3.562	-9.948	1.000000	1.000000	-28.7712	-28.868
Z043TC	2.924	8.172	1.000000	1.000000	17.0609	17.153
Z048DS	-3.226	-8.997	1.002611	1.002734	-57.0685	-57.204
Z053TA	2.800	7.793	1.000000	1.000000	16.3538	16.360
Z053TA	2.800	7.793	1.000000	1.000000	16.3538	16.360
Z055TB	-3.665	-10.262	1.000000	1.000000	-27.6861	-27.647
Z057TC	3.264	9.313	1.000000	1.000000	90.3132	90.146
Segment 3						
Z062TA	3.264	8.786	1.000000	1.000000	85.0696	84.927
Z064TB	-3.665	-9.695	1.000000	1.000000	-26.1368	-26.122
Z066TC	2.800	7.367	1.000000	1.000000	15.4285	15.444
Z071DS	-3.226	-8.540	1.006672	1.006672	-52.3338	-52.492
Z076TA	2.924	7.723	1.000000	1.000000	16.2147	16.299
Z078TB	-3.562	-9.401	1.000000	1.000000	-27.2310	-27.098
Z080TC	3.183	8.414	1.000000	1.000000	17.6110	17.641
Segment 4						
Z084TA	3.097	8.340	1.019000	1.019000	17.4807	17.519
Z086TB	-3.403	-8.927	0.994000	0.994000	-25.8626	-25.755
Z088TC	2.767	7.439	1.018000	1.018000	15.5501	15.566
Z093DS	3.226	8.502	1.002153	1.002153	51.7807	51.735
Z098TA	2.501	6.490	0.978000	0.978000	13.5675	13.491
Z100TB	-3.039	-7.742	0.965000	0.965000	-20.3658	-20.384
Z102TC	1.454	3.435	0.903000	0.903000	9.0266	9.035

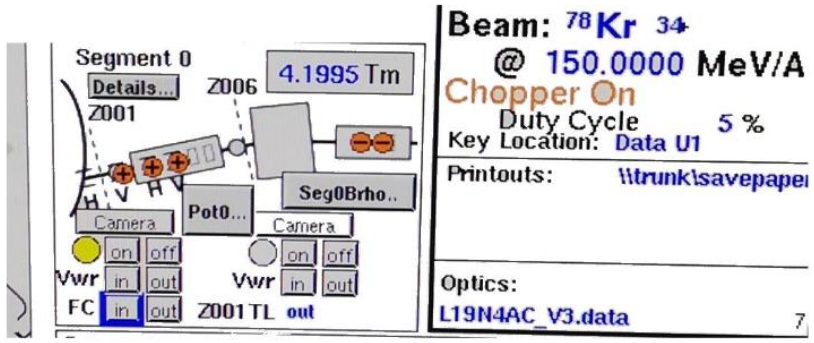
Segment	LISE/Barney	LISE/median
1	0.19%	0.52%
2	-0.30%	0.03%
3	-0.39%	-0.03%
4	-0.52%	-0.17%
Brho median	-0.34%	

Quad Fudging factors are correlated to deviations with Brho dipole values obtained from the effective dipole length

A1900 optics discussion: Segment #0

http://lise.nscl.msu.edu/paper/velocity/2019_05_09_Segment0.pdf

A1900 optics discussion ^{78}Kr 150 MeV/u



- Segment 1 : ^{78}Kr 149 MeV/u
- Segment 0: Transport → LISE++
- Segment 0: ^{78}Kr (version “v1”, “v2”, “v3a”, “v3b”)
- Segment 1 : ^{78}Kr 149 MeV/u with input of Segment0-d2
- Configurations summary
- History

Location of “Segment0*.lpp” files: http://lise.nscl.msu.edu/doc/A1900/

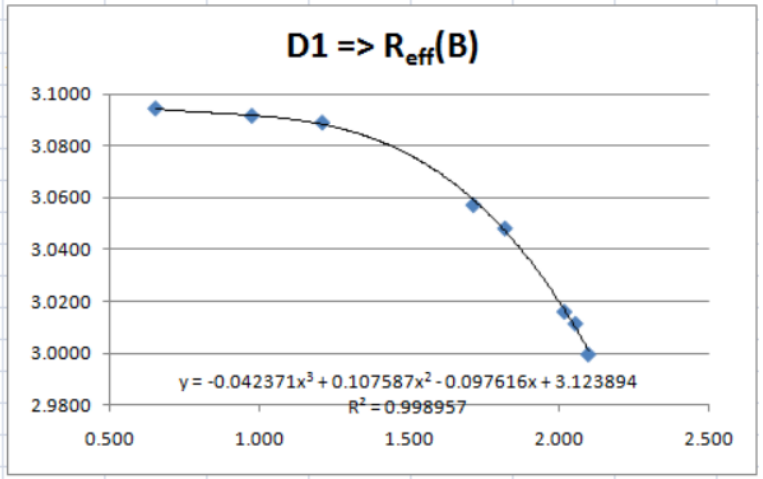
OT@MSU 05/09/2019 1

Dipole effective lengths measurement

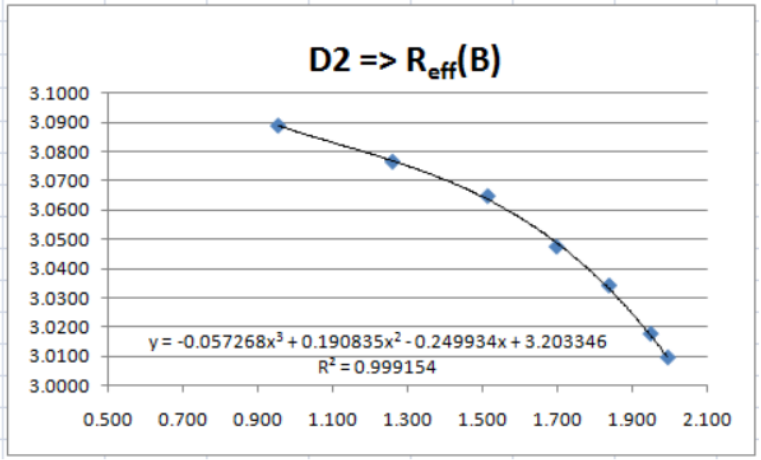
http://lise.nscl.msu.edu/paper/2011/2011_07_effective_values.pdf

R_{eff} of first two A1900 dipoles

A1900 Dipole D1			
Hall Probe (Tesla)	Current (amps)	1/2 Effective Length (cm)	R eff (m) @ 45 deg
0.000			
0.653	40	121.511	3.0942
0.975	60	121.400	3.0914
1.211	75	121.297	3.0888
1.716	120	120.064	3.0574
1.822	135	119.708	3.0483
2.020	170	118.440	3.0160
2.057	180	118.258	3.0114
2.100	190	117.790	2.9995



A1900 Dipole D2			
Hall Probe (Tesla)	Current (amps)	1/2 Effective Length (cm)	R eff (m) @ 45 deg
0.000			
0.954	60	121.302	3.0889
1.259	80	120.816	3.0766
1.513	100	120.352	3.0647
1.697	120	119.669	3.0473
1.837	140	119.147	3.0341
1.948	160	118.495	3.0175
1.994	170	118.176	3.0093



History: Misalignment or initial beam spot shift?

lise.nscl.msu.edu/9_6/Edipole/9_6_117.pdf#page=23

08/07/2013

3.1 Optical block "Shift" : triplet misalignment

LISE++ file: http://lise.nscl.msu.edu/9_6/Edipole/misalignemnt_A1900_extended_COSY.lpp

Example:
1st triplet 5 mm

Playing with Dipoles
to be for Images
at the central axis

	Brho, Tm		
	Initial	Set	Set/Init
Beam	3	3	-
Dipole 1	3	3.0082	0.27%
Dipole 2	3	3	-
Dipole 3	3	3	-
Dipole 4	3	2.9965	-0.12%