## Fit Crystal Ball Function (Detected neutrons)



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#### Parameters from Fits to Background Lineshape

## $bckgnd = [1](MM - [0])^{[2]}e^{[3](MM - [0])}$



## Weak Parameters in the Crystal Ball (Detected neutrons) 6

- Table shows results of two CB-fit passes through the detected neutrons.
- 2 Right all parameters free to vary. Left constrain n.
- **3** Changes in reduced  $\chi^2$  are small.

A	8	C	D	E	F	G	н	1		K	L	M
mylog14c	NDF	FCN	N		ECN/NDE		mylog14b	NDF	FCN	N		FCN/NDF
	6	5.94902	5.50E-11		0.992			6	5.9498	3.64E-05		0.992
	8	6.22077	8.22E-03		0.778			8	6.22077	1.30E-02		0.778
	12	7.55283	1.43E+00		0.629			12	7.55283	1.43E+00		0.629
	13	14.8548	1.00E+02		1.143			13	14.578	9.17E+05		1.121
	11	12.1959	1.00E+02		1.109			11	11.8137	8.60E+05		1.074
	13	25.3118	1.00E+02		1.947			13	24.4635	1.36E+06		1.882
	16	23.1791	1.00E+02		1.449			16	22.5901	1.42E+06		1.412
	17	14.6719	1.00E+02		0.863			17	14.5723	8.33E+05		0.857
	16	22.7083	1.00E+02		1.419			16	21.4336	2.03E+06		1.340
	18	15.6494	1.00E+02		0.869			18	14.9514	1.07E+06		0.831
	22	15.5754	1.00E+02		0.708			22	14.873	3.47E+06		0.676
	16	12.6243	1.00E+02		0.789			16	11.9618	9.75E+06		0.748
	21	26.2613	1.00E+02		1.251			21	25.3512	2.00E+06		1.207
	21	24.3957	1.00E+02		1.162			21	24.0063	1.92E+06		1.143
	24	20.0389	2.98E+01		0.835			24	20.0389	2.98E+01		0.835
	24	17.0437	1.47E+01		0.710			24	17.0437	1.47E+01		0.710
	35	37.2838	6.86E+00		1.065			35	37.2858	6.69E+00		1.065
	29	35.168	9.31E+01		1.213			29	35.168	9.30E+01		1.213
	28	25.0977	6.27E+00	(	0.896			28	25.0977	6.27E+00		0.896
	36	33.9184	5.21E+00	(	0.942			36	33.9184	5.21E+00		0.942
	33	44.385	7.89E+00		1.345			33	44.385	7.89E+00		1.345
	33	36,9161	6.91E+00		1.119			33	36.9161	6.91E+00		1.119
	40	45.6839	4.20E+00		1.142			40	45.6839	4.20E+00		1.142
	41	43.8068	5.69E+00	(	1.068			41	43.8068	5.69E+00		1.068
	40	41.7199	3.48E+00		1.043			40	41.7199	3.48E+00		1.043
	43	39.6484	4.28E+00		0.922			43	39.6484	4.28E+00		0.922
	38	43.8506	2.49E+00		1.154			38	43.8506	2.49E+00		1.154
	48	45.4617	2.88E+00	(	0.947			48	45.4617	2.88E+00		0.947
	53	73.1246	3.01E+00		1.380			53	73.1246	3.01E+00		1.380
	55	47.524	2.62E+00		0.864			55	47.524	2.62E+00		0.864
	64	58.1676	2.65E+00		0.909			64	58.1676	2.65E+00		0.909
	63	59.8998	3.33E+00	(	0.951			63	59.8998	3.33E+00		0.951
	62	62.0625	2.47E+00	(	1.001			62	62.0625	2.47E+00		1.001
	63	64.3042	1.54E+00		1.021			63	64.3042	1.54E+00		1.021
	52	34,4725	8.69E-01		0.663			52	34,4725	8.69E-01		0.663
	41	28.4802	8.71E-01		0.695			41	28.4802	8.71E-01		0.695
				AVE	1.028						AVE	1.016
				AVE2	1.155						AVE2	1.117
	mylogi4c	NOC 0   mylog14c 0 0   12 12 12   13 13 13   141 13 13   152 22 22   152 22 23   152 22 23   153 24 24   154 24 24   154 24 24   154 24 33   164 34 36   165 55 55   164 54 52   164 52 52   164 52 52   165 52 52   164 52 52   165 52 52   164 52 52   165 52 52   165 52 52   165 52 53   165 52 52   165 52 53	n NOE ECX   mylogl4c 80 5.94902   12 7.55283 13   13 12.551318 14.3648   13 12.551318 15.3138   13 12.551318 16.221078   14 16.221078 12.2439   12 12.6464 12.2439   12 12.6248 12.2439   12 12.6464 13.2318   21 26.3613 21.2439   22 13.2318 13.3184   23 35.168 25.9371   24 30.33184 43.8619   33 44.841 43.8668   44 43.0668 44.17189   43 30.4448 45.44477   55 47.524 64.58.4755   63 63.6398 63.63986   63 63.63986 63.63986   63 63.63986 63.63986   64 55.47.524 64.58.4752   64 28.44902 52.34.47	nylogike NOE EX1 N   1002 EX2 0 5.905-11 5.905-11   11 12 7.9528-11 5.905-11 1.915-10   12 7.9528-11 1.955-10 1.915-10 1.915-10   13 1.455-10 1.955-10 1.915-10 1.915-10   14 1.915-10 1.955-10 1.915-10 1.915-10   14 1.915-10 1.955-10 1.915-10 1.915-10   12 2.179 1.956-10 1.915-10	nylogike NOE EXI N C   000 6 6.9600 5.00611 5.00611   13 1.481-60 5.00611 1.181-60 5.00611   13 1.481-60 1.006-102 1.111-111 1.006-102   14 1.511-111 1.006-102 1.111-111 1.006-102   16 2.2.7083 1.006-102 1.006-102 1.006-102   16 2.2.7083 1.006-102 1.006	n n c c N c Foundation   0 6 5 94002 5 506:11 5 506:11 507:10 507:10 100:10 0.0778 100:10 0.0778 100:10 100:17 1	mpsplate NOE EX1 N E E S   mpsplate NOE E 5005:11 0.992 0.978   12 7.5523:11 1.488-60 0.692 1.141 0.979   13 1.488-60 1.067-62 1.141 0.979 1.079   13 1.488-60 1.067-62 1.144 0.029   14 1.131 1.051-72 1.144 0.141   16 2.2.708 1.067-62 1.449 0.499   17 1.64719 1.067-62 1.419 0.683   18 1.05441 1.067-62 1.1419 0.683   19 1.05572 1.067 0.083 0.083   20 2.2.083 1.067-62 1.162 0.035   21 2.2.3897 1.067-62 1.162 0.035   22 23.097 6.276-60 1.043 0.045 0.042 0.049 0.043 0.044 0.042 0.044 0.042 0.044 <	nylogik DE EXI I C EXI J C EXI J C EXI J C Digital mylogik	nyingl4c NOE CX3 M C CSM M C C CSM M C C M C C M C C M C C M C C M C <thc< td=""><td>nyingl4c NOE CX3 V E CSM V E SM E CSM V E SM E E SM <th< td=""><td>mpdg4c DE CO mpdg4c DE CO DE CO DE CO DE CO DE <thde< th=""> DE DE</thde<></td><td>n CO EX L E Co n DC EX L L   m/spice 0.62 1 0.992 0.978 0.62 0.992 0.62 0.992</td></th<></td></thc<>	nyingl4c NOE CX3 V E CSM V E SM E CSM V E SM E E SM <th< td=""><td>mpdg4c DE CO mpdg4c DE CO DE CO DE CO DE CO DE <thde< th=""> DE DE</thde<></td><td>n CO EX L E Co n DC EX L L   m/spice 0.62 1 0.992 0.978 0.62 0.992 0.62 0.992</td></th<>	mpdg4c DE CO DE CO DE CO DE CO DE <thde< th=""> DE DE</thde<>	n CO EX L E Co n DC EX L L   m/spice 0.62 1 0.992 0.978 0.62 0.992 0.62 0.992

## Weak Parameters in the Crystal Ball (Detected neutrons) 7

- Table shows results of two CB-fit passes through the detected neutrons.
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	A	8	C	D	E	F	G	н	1	1	K	L	M
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2		6	5.94902	5.50E-11		0.992			6	5.9498	3.64E-05		0.992
3		8	6.22077	8.22E-03		0.778			8	6.22077	1.30E-02		0.778
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13		16	12.6243	1.00E+02		0.789			16	11.9618	9.75E+06		0.748
14		21	26.2613	1.00E+02		1.251			21	25.3512	2.00E+06		1.207
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22		33	44.385	7.89E+00	0	1.345			33	44.385	7.89E+00		1.345
23		33	36.9161	6.91E+00		1.119			33	36.9161	6.91E+00		1.119
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37		41	28.4802	8.71E-01		0.695			41	28.4802	8.71E-01		0.695
38													
39					AVE	1.028						AVE	1.016
40							1						
41					AVE2	1.155						AVE2	1.117

Compare *n* varies with n = 100



#### Crystal Ball Equations

The Crystal Ball function is given by

$$f(x; \alpha, n, \overline{x}, \sigma) = N \exp\left(-\frac{(x-\overline{x})^2}{2\sigma^2}\right), \qquad \text{for} \frac{x-\overline{x}}{\sigma} > -\alpha$$
$$= N \cdot A \cdot \left(B - \frac{x-\overline{x}}{\sigma}\right)^{-n}, \qquad \text{for} \frac{x-\overline{x}}{\sigma} < -\alpha$$

where



#### First Fits to Full Neutron Mass Range

#### $bckgnd = [1](MM - [0])^{[2]}e^{[3](MM - [0])}$



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NDE Fitting 1

#### Use results for mean and width from CB LE+core fits 11



fix  $\mu$  and  $\sigma$ , range to 1.15 GeV

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NDE Fitting 1



fix  $\mu$  and  $\sigma$ , range to 1.15 GeV

# Additional Slides

## Simulated (SIDIS) Proton Results



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#### Background Lineshape (Detected neutrons)



- Fit the range  $MM = 0 \rightarrow \overline{MM} + \sigma$ with Crystal Ball fn.
- 2 Using full data range subtract fit from data  $\Delta = N_{data} M_{fit}$
- Use result to guide choice of fitting function.

## Background Fitting (Expected neutrons)

expMM\_Pmmbin18



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