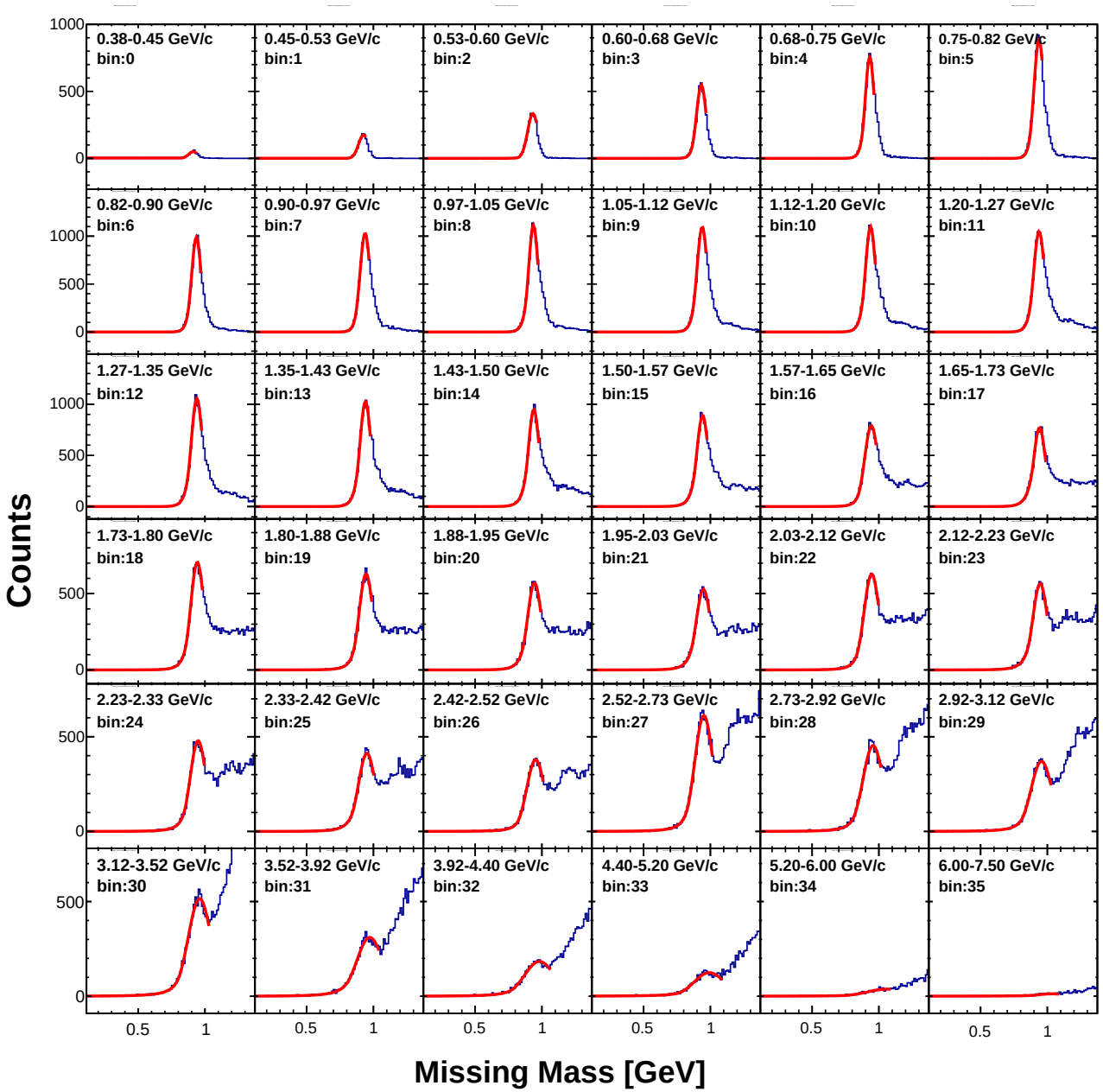
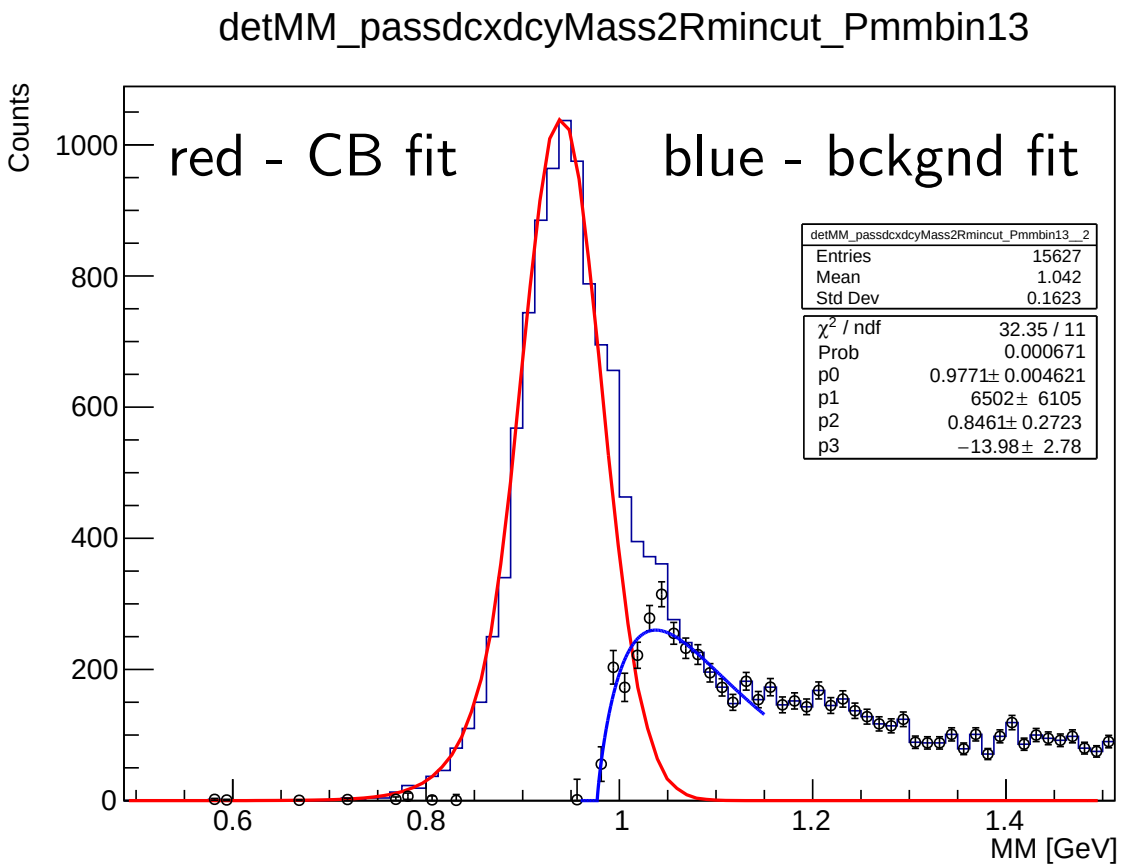
Fit Crystal Ball Function (Detected neutrons)

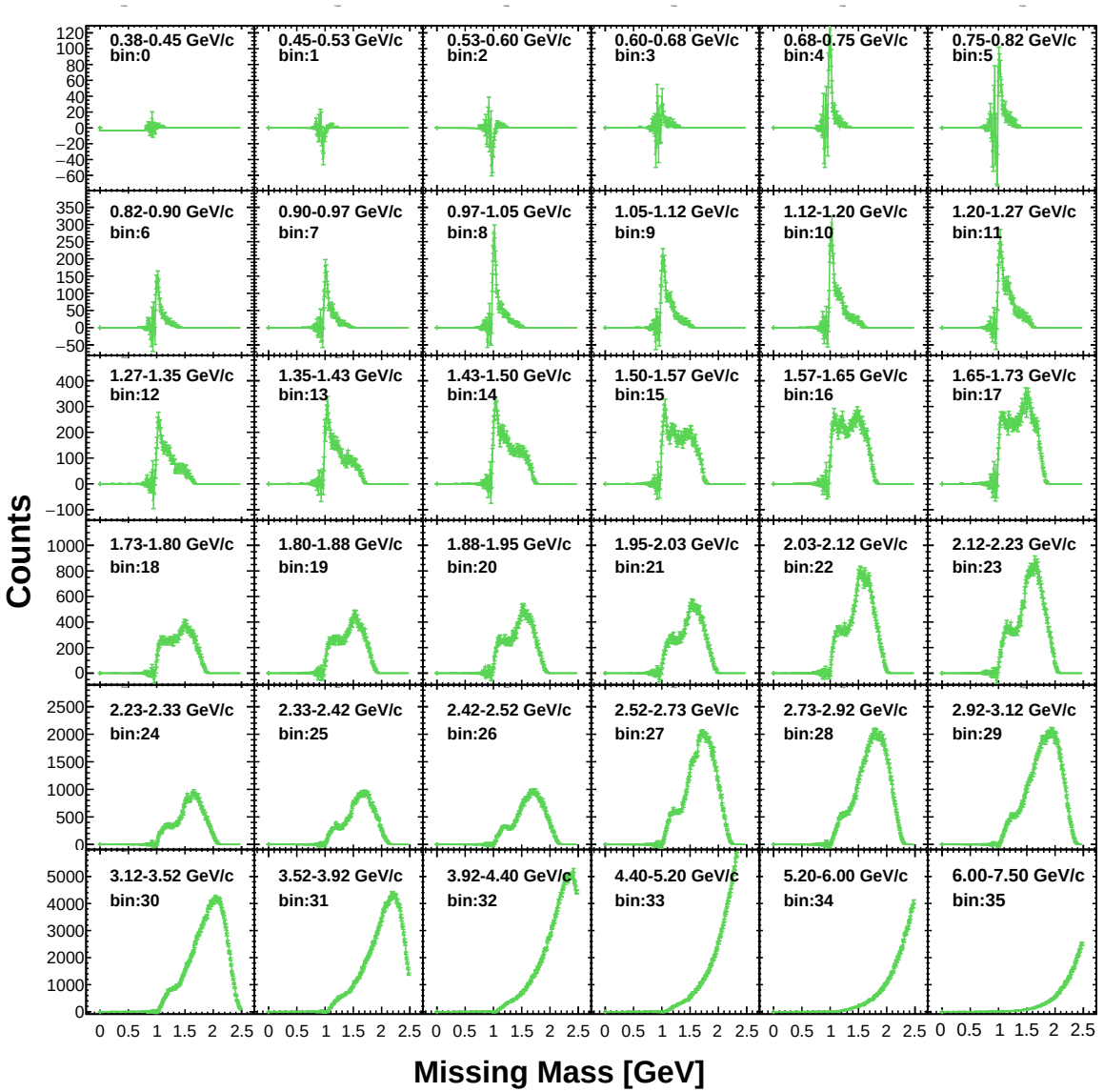


Data file:
data10p6nosidiscutv4.root

Histograms:
detMM_passdcxdcyMass2Rmincut_Pmmbin

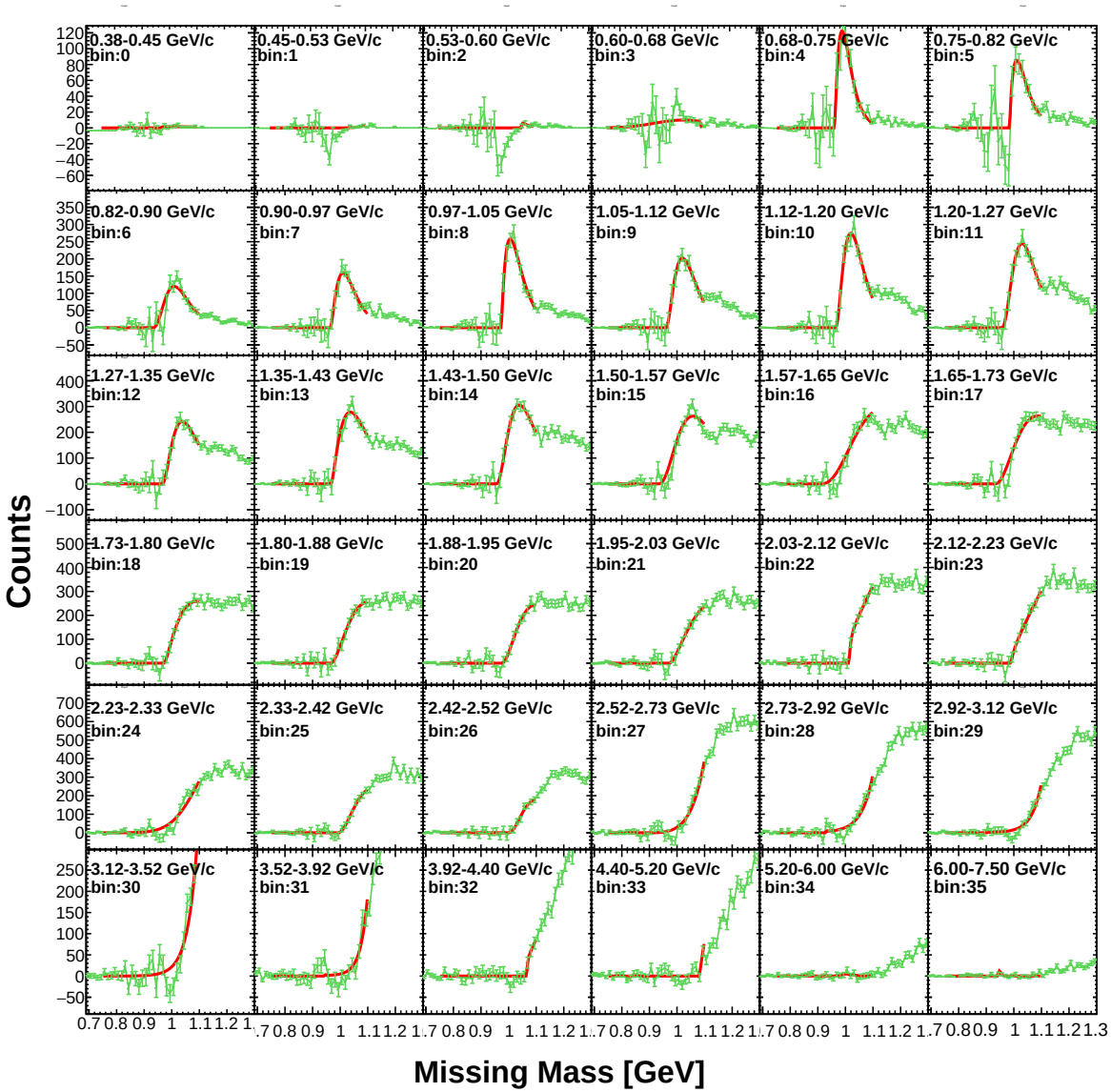


1. Fit the range from $MM = 0 \rightarrow \overline{MM} + \sigma$ with Crystal Ball fn.
2. Using full data range subtract fit from data $\Delta = N_{data} - M_{fit}$
3. Use result to guide choice of fitting function.
4. $bckgnd = N(MM - MM_0)^n e^{\lambda(MM - MM_0)}$



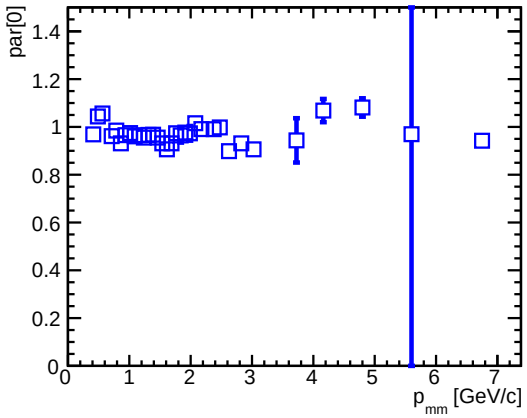
1. Fit the range from $MM = 0 \rightarrow \overline{MM} + \sigma$ with Crystal Ball fn.
2. Using full data range subtract fit from data $\Delta = N_{data} - M_{fit}$
3. Use result to guide choice of fitting function.
4. $bckgnd = N(MM - MM_0)^n e^{\lambda(MM - MM_0)}$

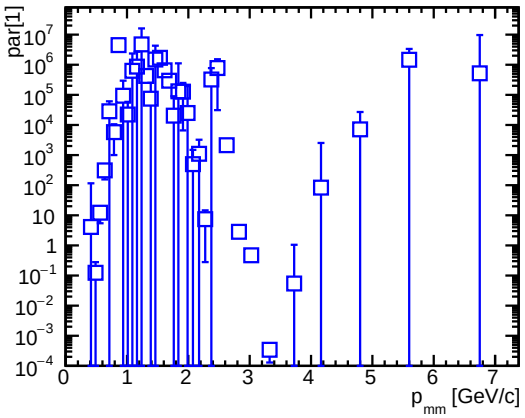
Background Lineshape (Detected neutrons)

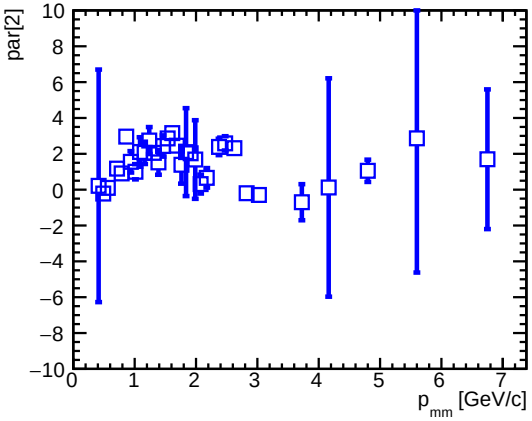


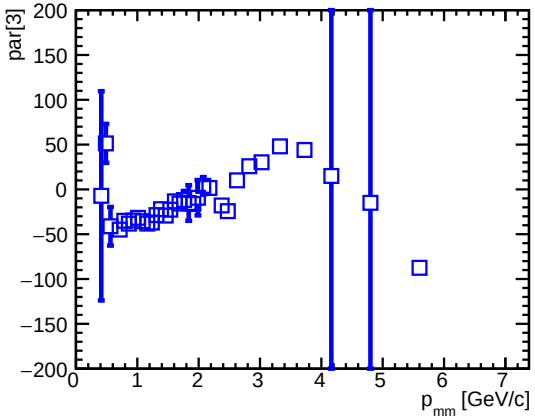
1. Fit the range from $MM = 0 \rightarrow \overline{MM} + \sigma$ with Crystal Ball fn.
2. Using full data range subtract fit from data $\Delta = N_{data} - M_{fit}$
3. Use result to guide choice of fitting function.
4. $bckgnd = N(MM - MM_0)^n e^{\lambda(MM - MM_0)}$

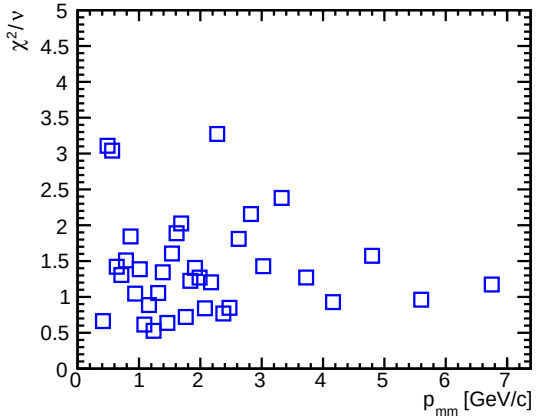
$$bckgnd = [1](MM - [0])^{[2]} e^{[3](MM-[0])}$$











Wed Jul 13 16:24:15 2022

Weak Parameters in the Crystal Ball (Detected neutrons) 6

1. 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 χ^2 are small.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	mylog14c	NDF	FCN	N		FCN/NDF		mylog14b	NDF	FCN	N		FCN/NDF
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
4		12	7.55283	1.43E+00		0.629			12	7.55283	1.43E+00		0.629
5		13	14.8548	1.00E+02		1.143			13	14.578	9.17E+05		1.121
6		11	12.1959	1.00E+02		1.109			11	11.8137	8.60E+05		1.074
7		13	25.3118	1.00E+02		1.947			13	24.4635	1.36E+06		1.882
8		16	23.1791	1.00E+02		1.449			16	22.5901	1.42E+06		1.412
9		17	14.6719	1.00E+02		0.863			17	14.5723	8.33E+05		0.857
10		16	22.7083	1.00E+02		1.419			16	21.4336	2.03E+06		1.340
11		18	15.6494	1.00E+02		0.869			18	14.9514	1.07E+06		0.831
12		22	15.5754	1.00E+02		0.708			22	14.873	3.47E+06		0.676
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
15		21	24.3957	1.00E+02		1.162			21	24.0063	1.92E+06		1.143
16		24	20.0389	2.98E+01		0.835			24	20.0389	2.98E+01		0.835
17		24	17.0437	1.47E+01		0.710			24	17.0437	1.47E+01		0.710
18		35	37.2838	6.86E+00		1.065			35	37.2858	6.69E+00		1.065
19		29	35.168	9.31E+01		1.213			29	35.168	9.30E+01		1.213
20		28	25.0977	6.27E+00		0.896			28	25.0977	6.27E+00		0.896
21		36	33.9184	5.21E+00		0.942			36	33.9184	5.21E+00		0.942
22		33	44.385	7.89E+00		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
24		40	45.6839	4.20E+00		1.142			40	45.6839	4.20E+00		1.142
25		41	43.8068	5.69E+00		1.068			41	43.8068	5.69E+00		1.068
26		40	41.7199	3.48E+00		1.043			40	41.7199	3.48E+00		1.043
27		43	39.6484	4.28E+00		0.922			43	39.6484	4.28E+00		0.922
28		38	43.8506	2.49E+00		1.154			38	43.8506	2.49E+00		1.154
29		48	45.4617	2.88E+00		0.947			48	45.4617	2.88E+00		0.947
30		53	73.1246	3.01E+00		1.380			53	73.1246	3.01E+00		1.380
31		55	47.524	2.62E+00		0.864			55	47.524	2.62E+00		0.864
32		64	58.1676	2.65E+00		0.909			64	58.1676	2.65E+00		0.909
33		63	59.8998	3.33E+00		0.951			63	59.8998	3.33E+00		0.951
34		62	62.0625	2.47E+00		1.001			62	62.0625	2.47E+00		1.001
35		63	64.3042	1.54E+00		1.021			63	64.3042	1.54E+00		1.021
36		52	34.4725	8.69E-01		0.663			52	34.4725	8.69E-01		0.663
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													
41					AVE2	1.155						AVE2	1.117
42													

Weak Parameters in the Crystal Ball (Detected neutrons) 7

1. 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 χ^2 are small.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	mylog14c	NDF	FCN	N		FCN/NDF		mylog14b	NDF	FCN	N		FCN/NDF
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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15		21	24.3957	1.00E+02		1.162			21	24.0063	1.92E+06		1.143
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17		24	17.0437	1.47E+01		0.710			24	17.0437	1.47E+01		0.710
18		35	37.2838	6.86E+00		1.065			35	37.2858	6.69E+00		1.065
19		29	35.168	9.31E+01		1.213			29	35.168	9.30E+01		1.213
20		28	25.0977	6.27E+00		0.896			28	25.0977	6.27E+00		0.896
21		36	33.9184	5.21E+00		0.942			36	33.9184	5.21E+00		0.942
22		33	44.385	7.89E+00		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
24		40	45.6839	4.20E+00		1.142			40	45.6839	4.20E+00		1.142
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33		63	59.8998	3.33E+00		0.951			63	59.8998	3.33E+00		0.951
34		62	62.0625	2.47E+00		1.001			62	62.0625	2.47E+00		1.001
35		63	64.3042	1.54E+00		1.021			63	64.3042	1.54E+00		1.021
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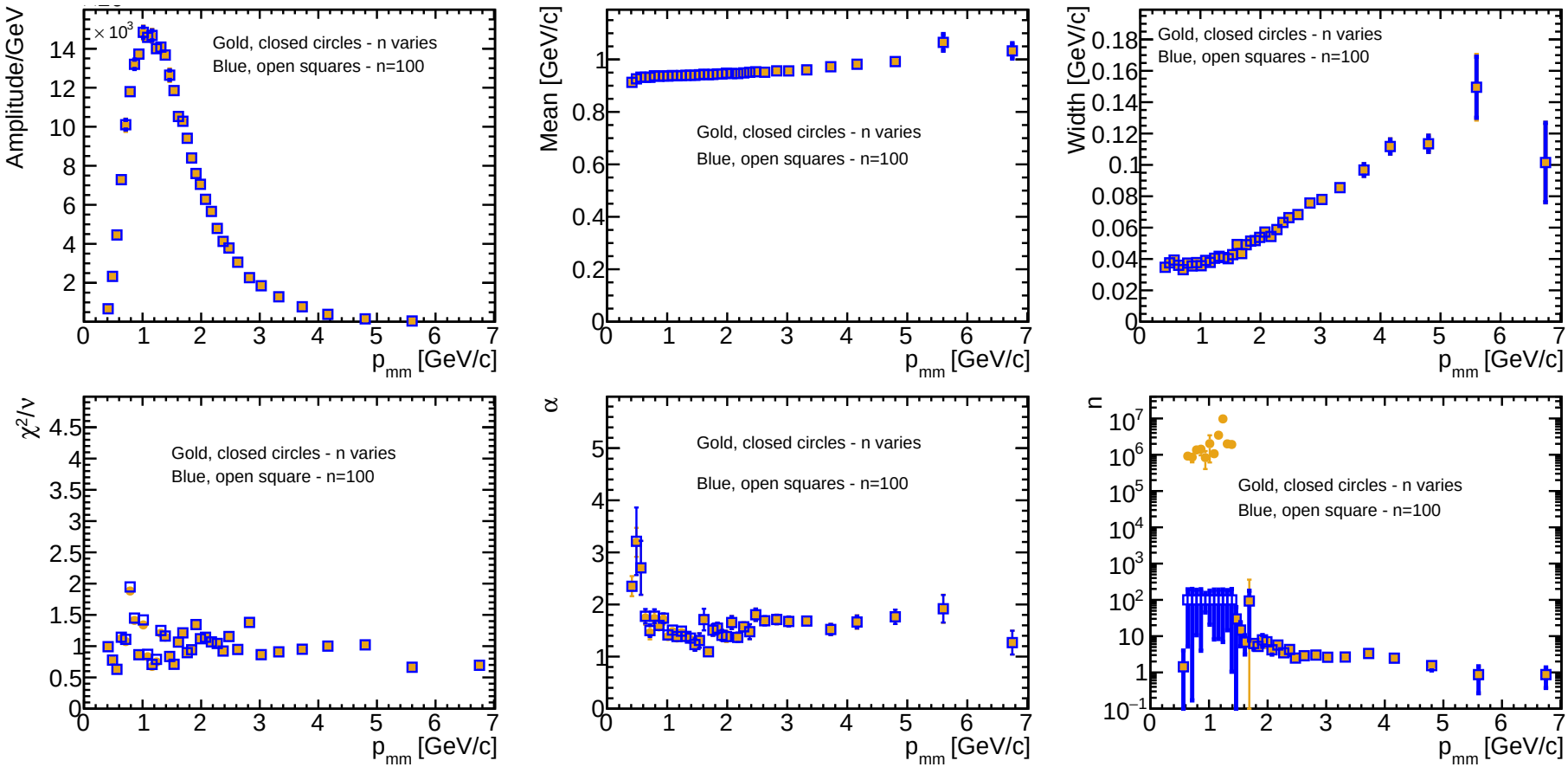
42													

Weak Parameters in the Crystal Ball (Detected neutrons) 8

Compare n varies with $n = 100$



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

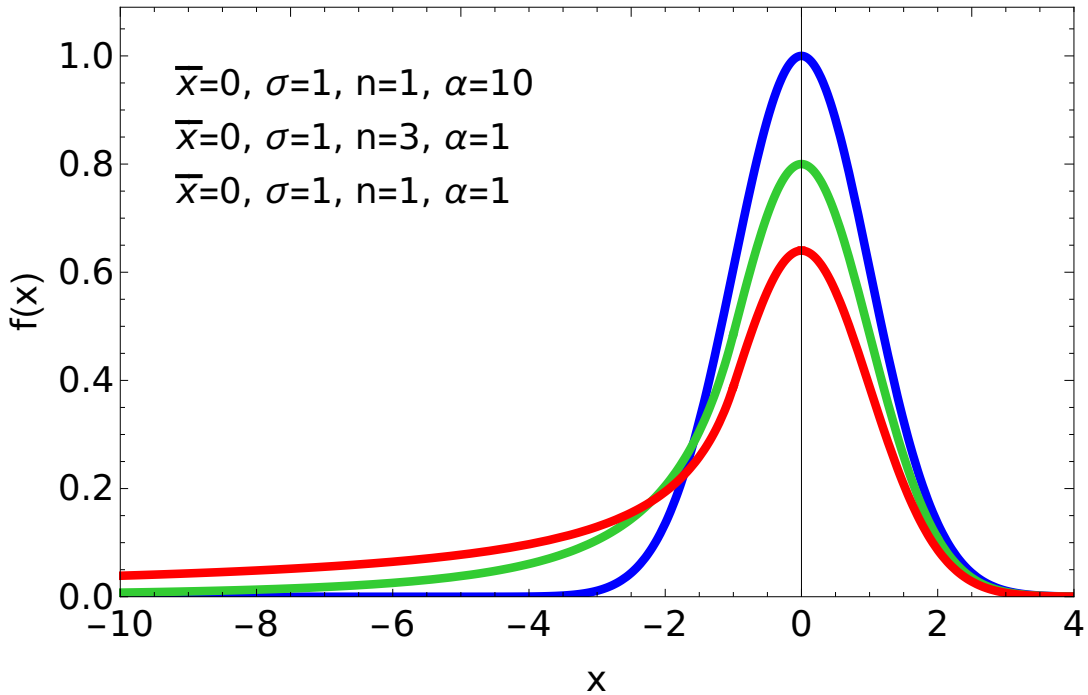
$$A = \left(\frac{n}{|\alpha|}\right)^n\cdot\exp\left(-\frac{|\alpha|^2}{2}\right),$$

$$B = \frac{n}{|\alpha|} - |\alpha|,$$

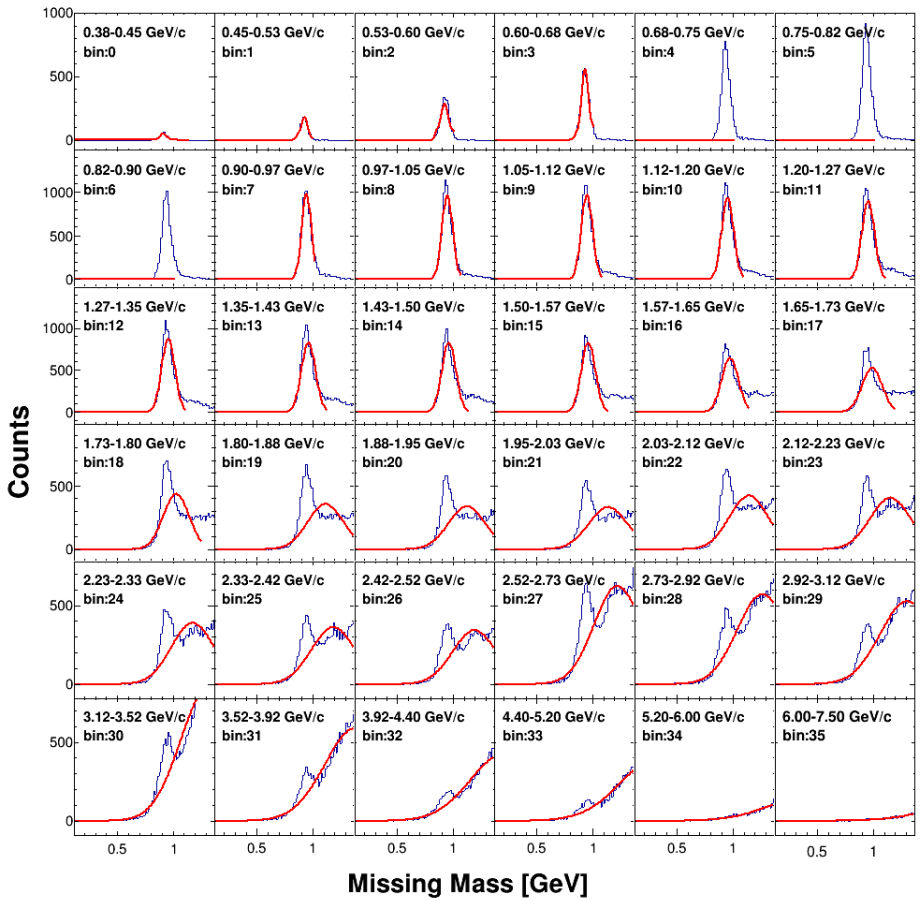
$$N = \frac{1}{\sigma(C+D)},$$

$$C = \frac{n}{|\alpha|}\cdot\frac{1}{n-1}\cdot\exp\left(-\frac{|\alpha|^2}{2}\right),$$

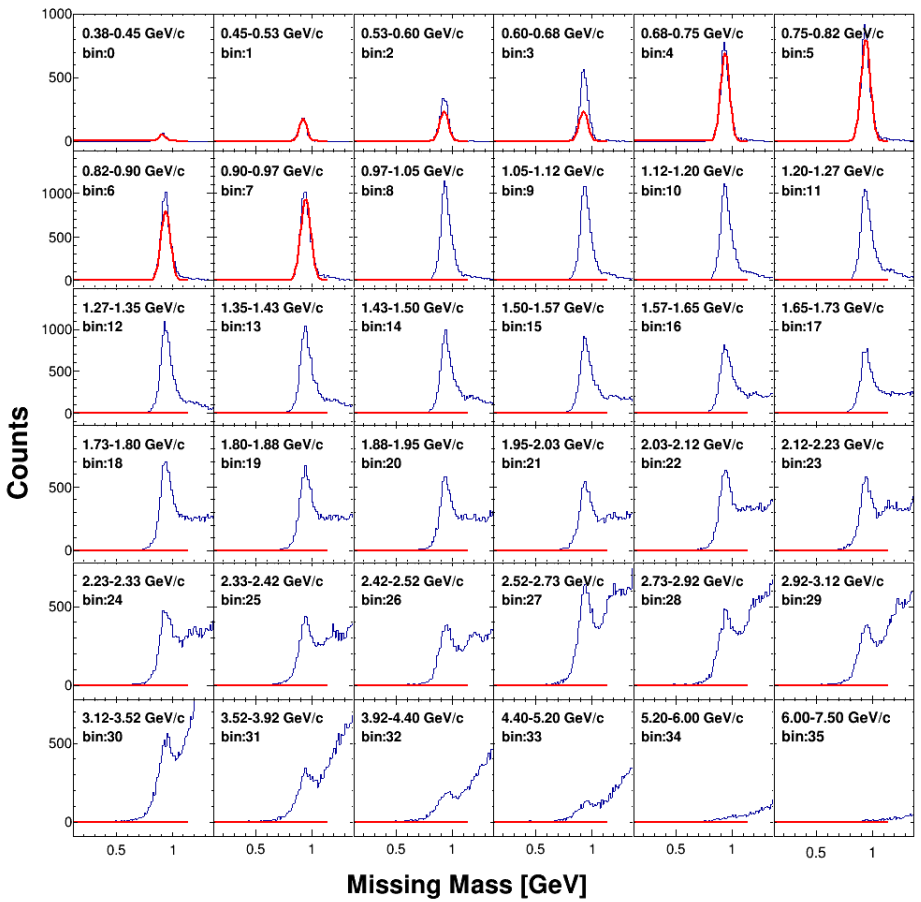
$$D = \sqrt{\frac{\pi}{2}}\left(1+\text{erf}\left(\frac{|\alpha|^2}{2}\right)\right)$$



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

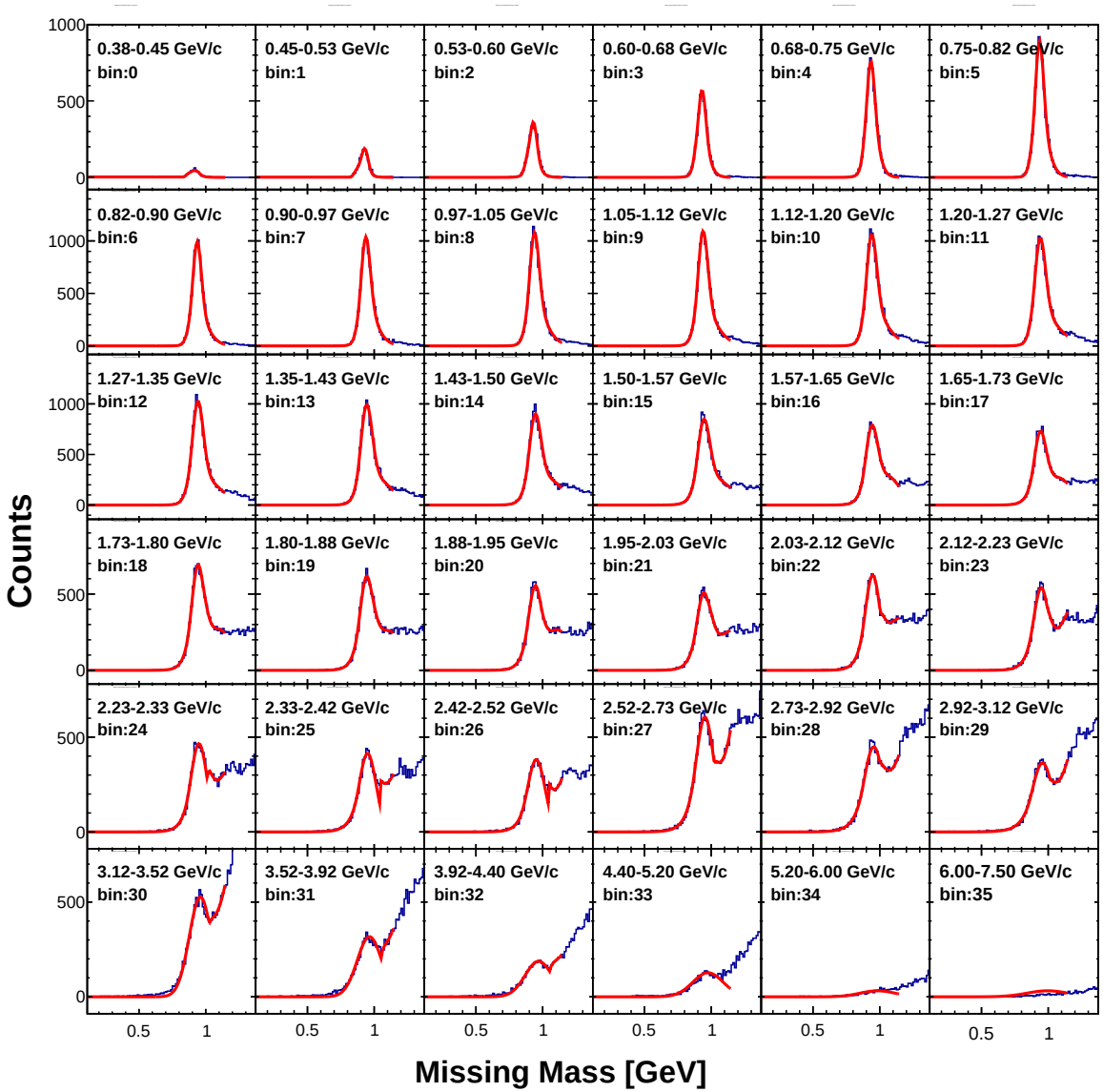


all float, range to $\mu+3\sigma$



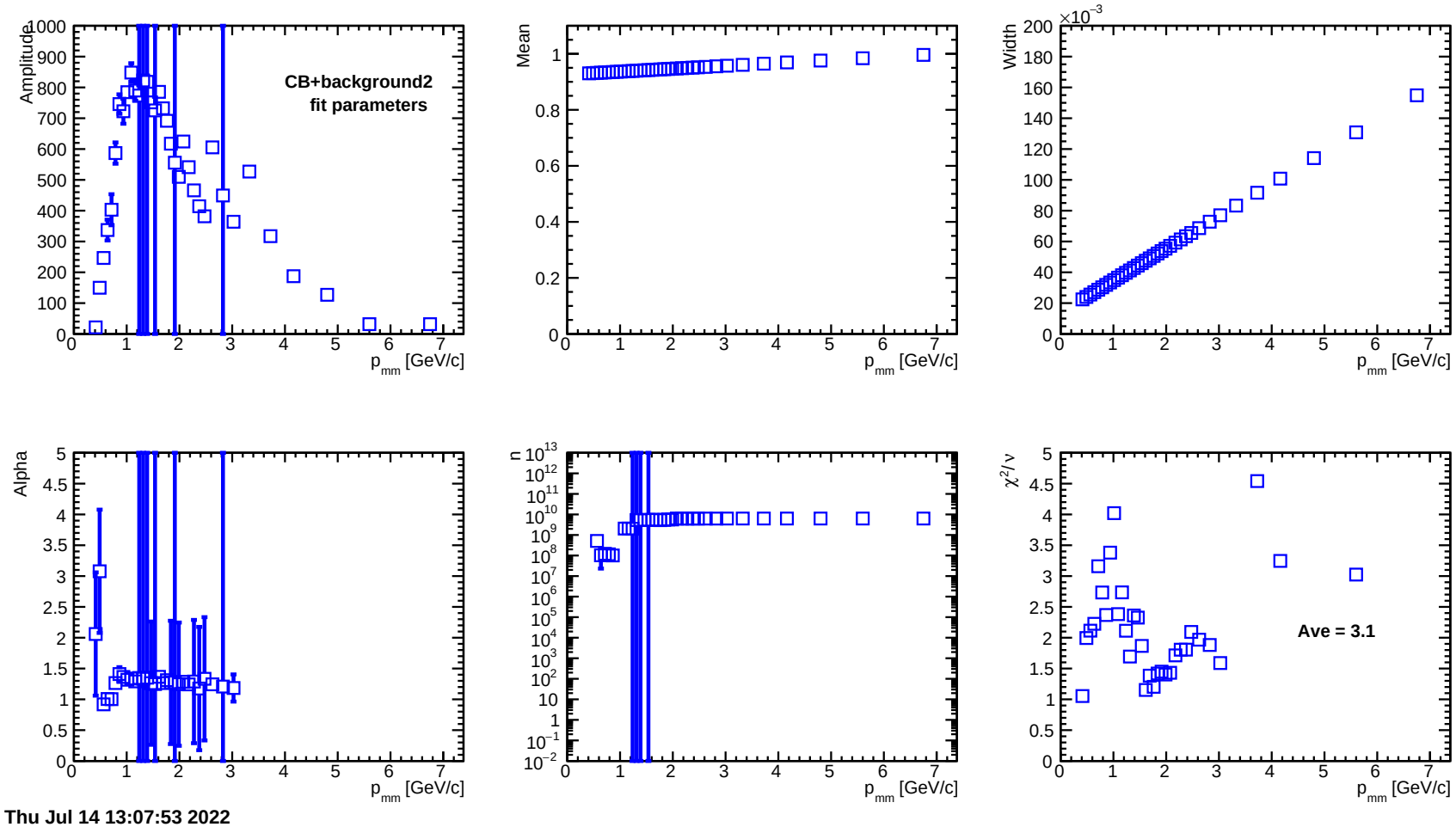
all float, range to 1.15 GeV

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



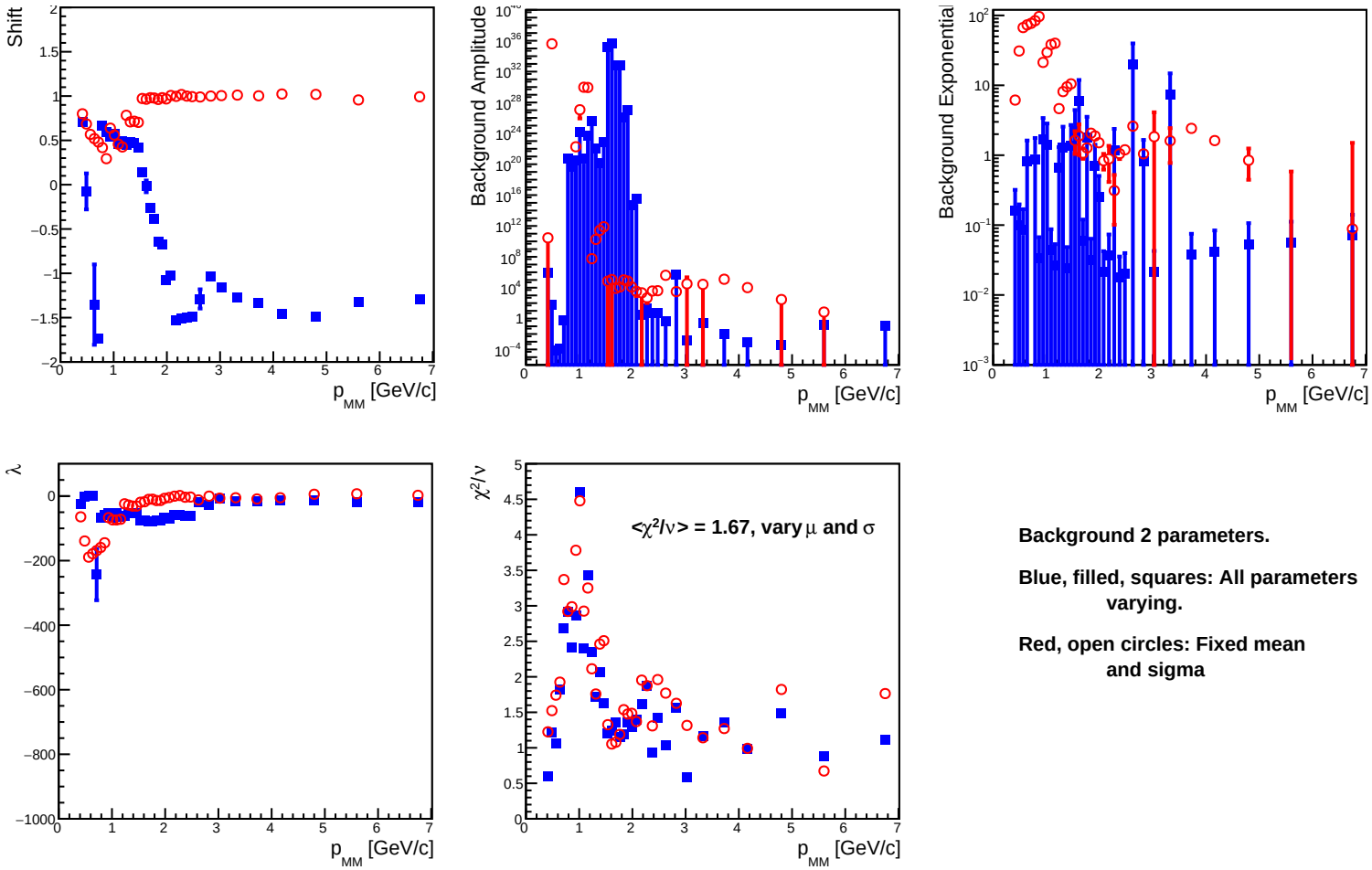
fix μ and σ, range to 1.15 GeV

Fit Parameters from CB LE+core fits - 1



fix μ and σ, range to 1.15 GeV

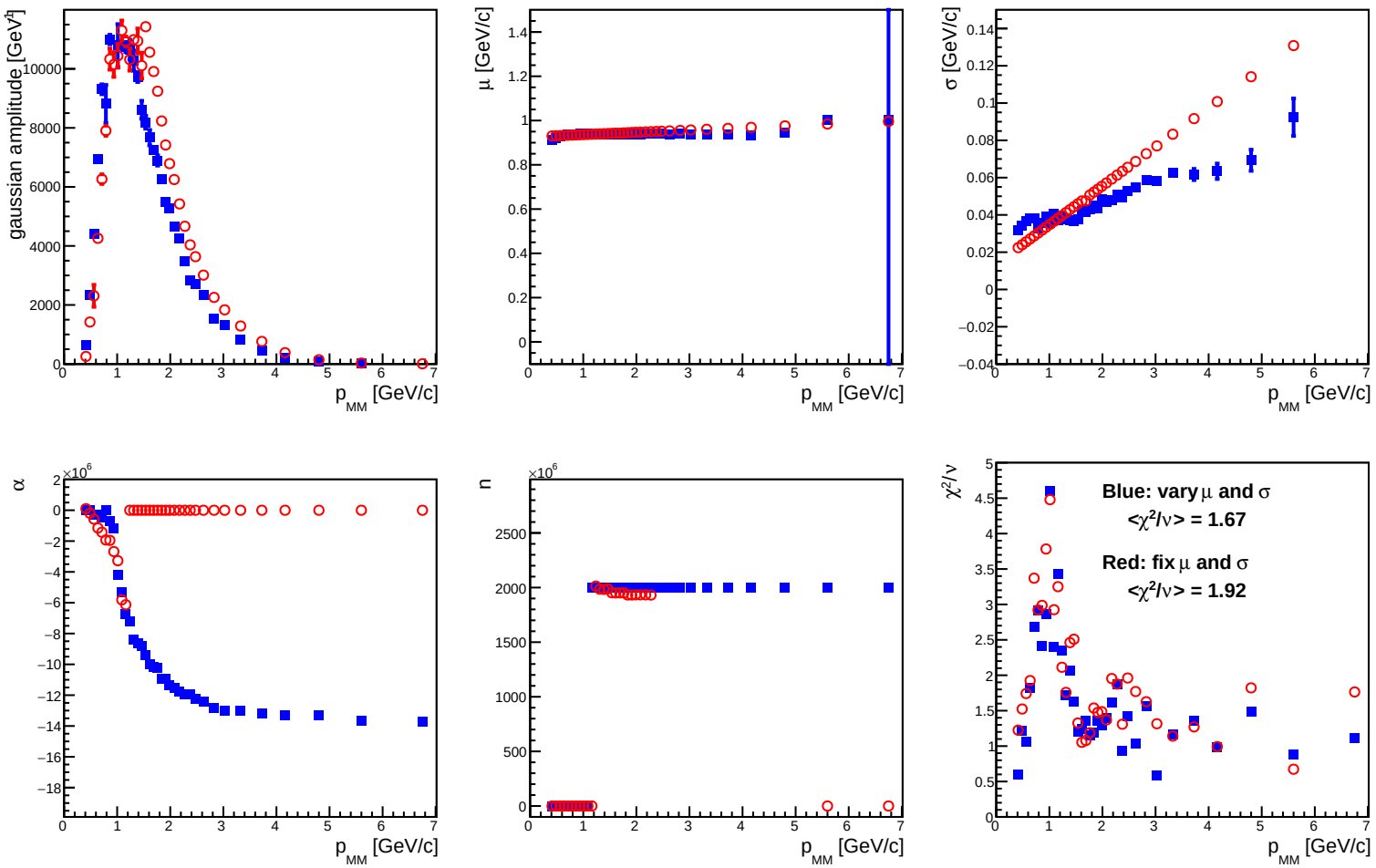
Fit Parameters from CB LE+core fits - 2



Red: fix μ and σ, range to 1.15 GeV

Blue: allow μ and σ to vary, MM range to 1.15 GeV

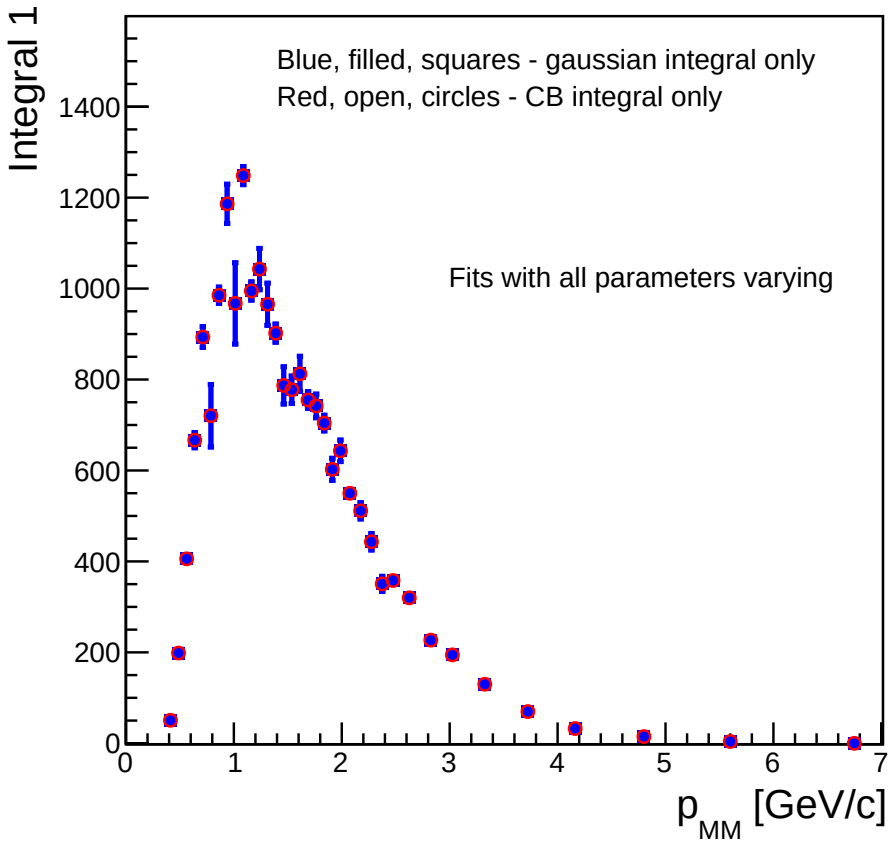
Fit Parameters from CB LE+core fits - 3

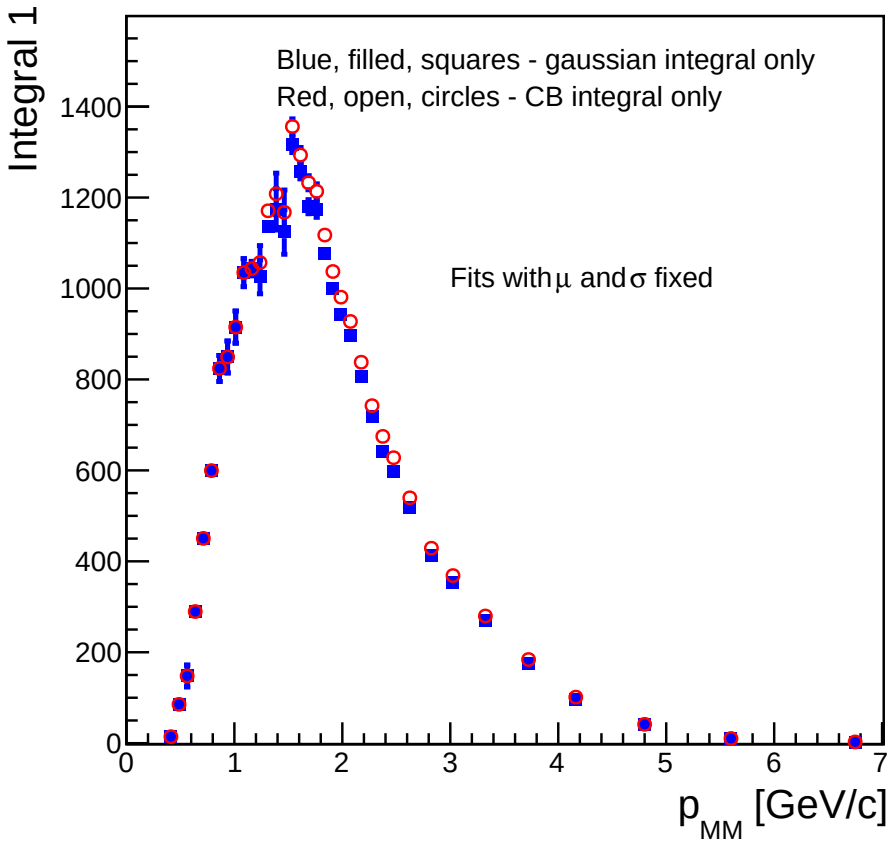


Red: fix μ and σ, range to 1.15 GeV

Blue: allow μ and σ to vary, MM range to 1.15 GeV

Fit Parameters from CB LE+core fits - 4



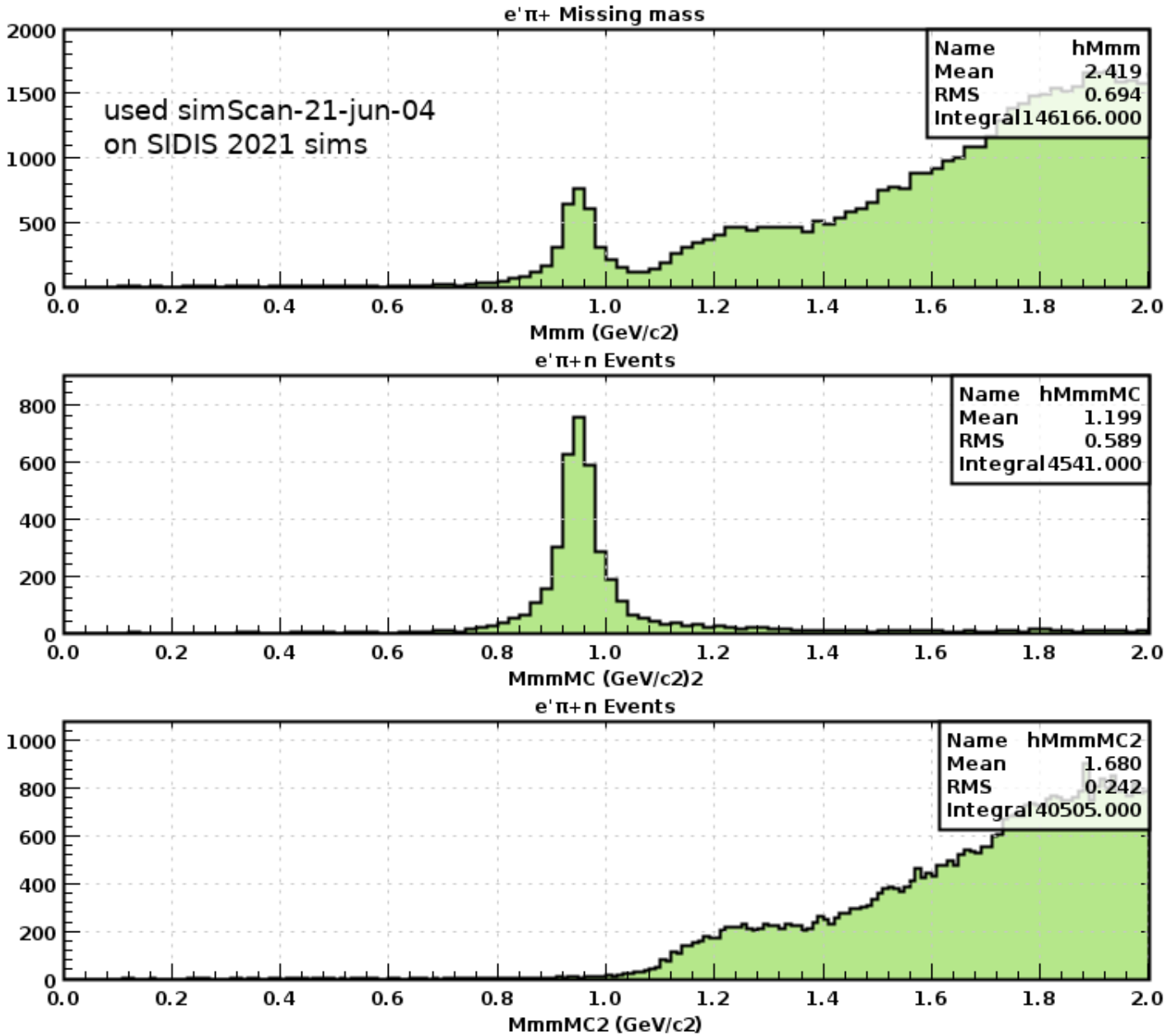


Red: fix μ and σ, range to 1.15 GeV

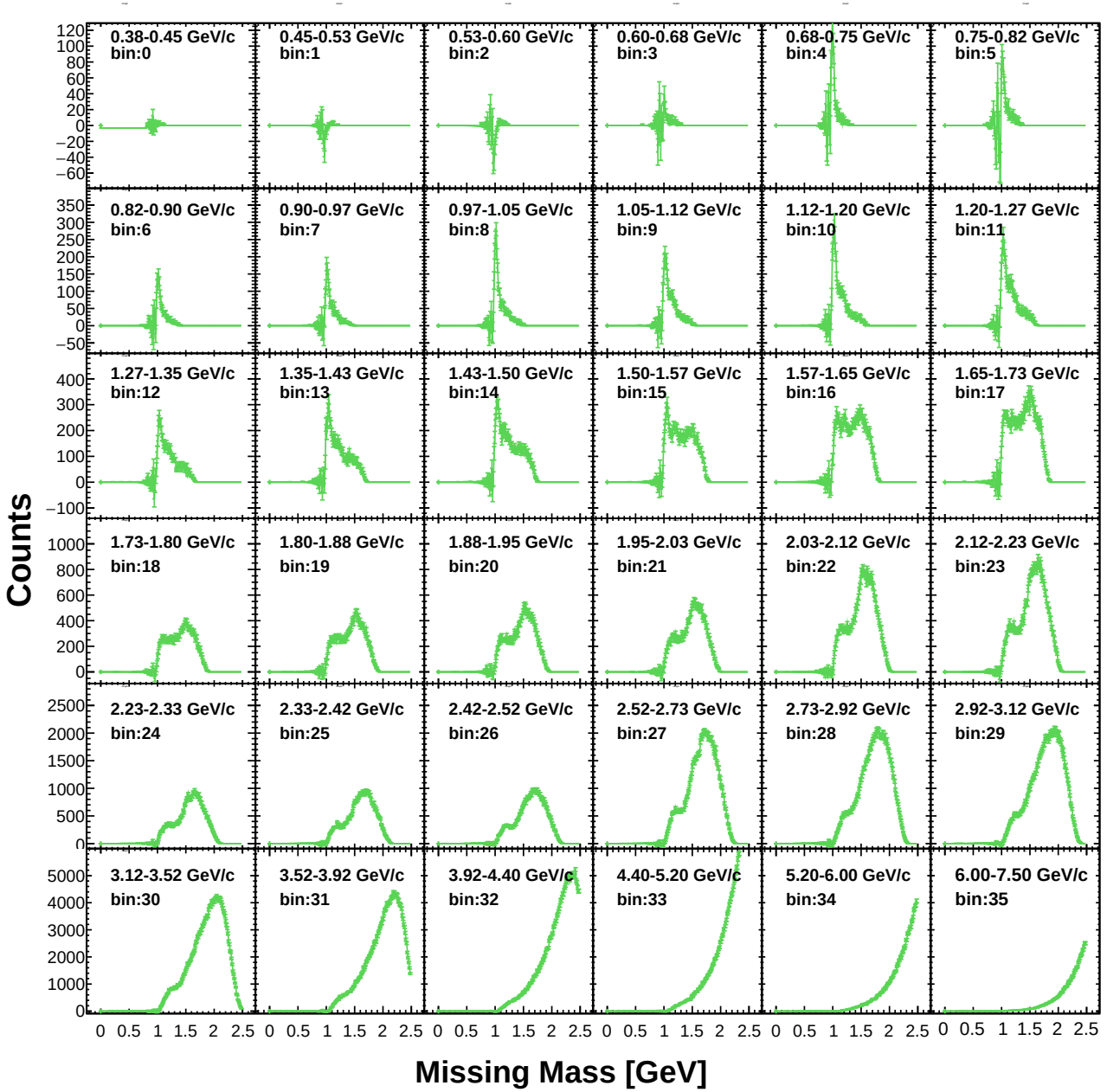
Blue: allow μ and σ to vary, MM range to 1.15 GeV

Additional Slides

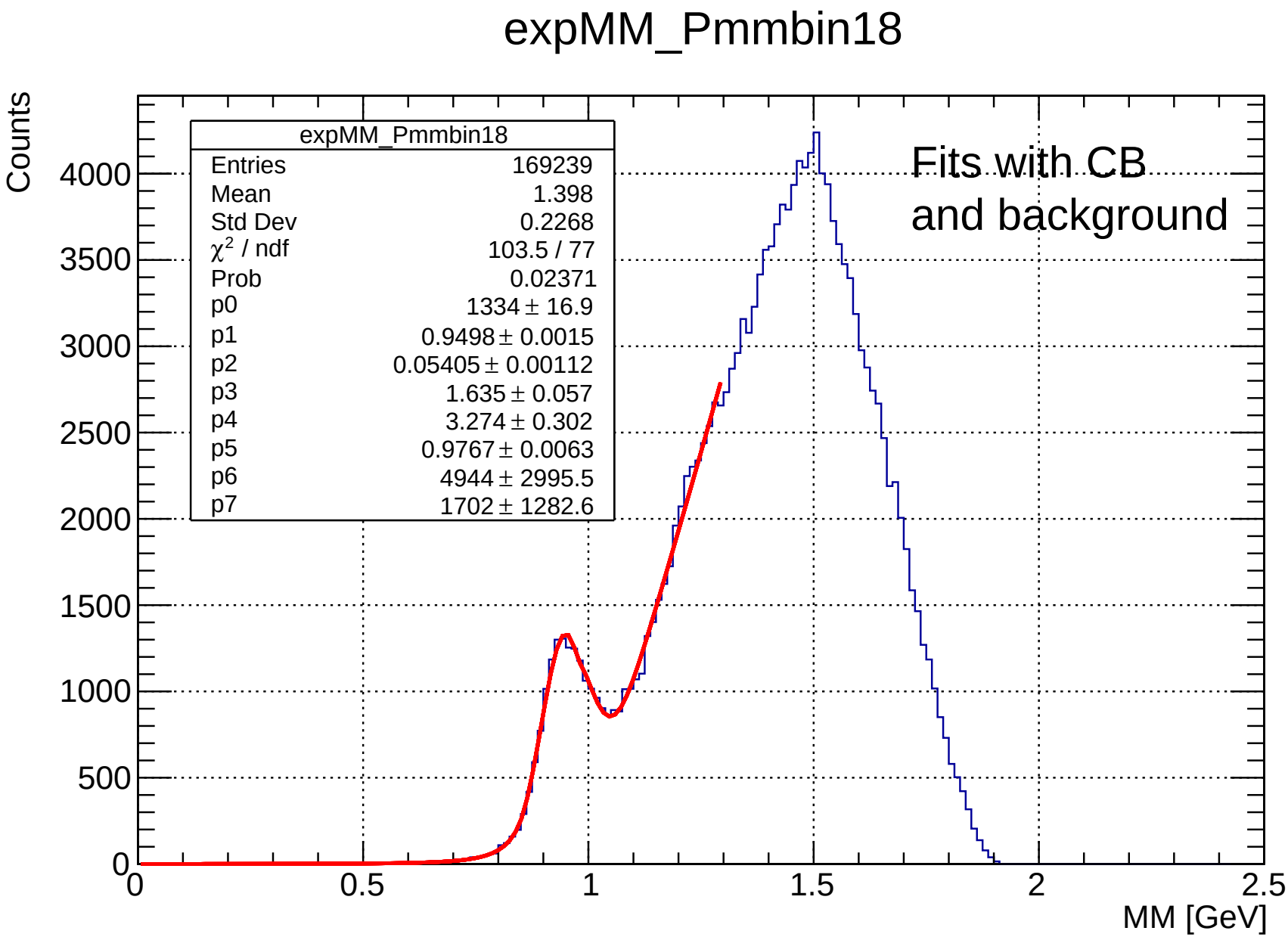
Simulated (SIDIS) Proton Results



Background Lineshape (Detected neutrons)



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


expMM_Pmmbin18
Counts
MM [GeV]
Fits with CB
and background
expMM_Pmmbin18
Entries 169239
Mean 1.398
Std Dev 0.2268
χ² / ndf 103.5 / 77
Prob 0.02371
p0 1334 ± 16.9
p1 0.9498 ± 0.0015
p2 0.05405 ± 0.00112
p3 1.635 ± 0.057
p4 3.274 ± 0.302
p5 0.9767 ± 0.0063
p6 4944 ± 2995.5
p7 1702 ± 1282.6
0
500
1000
1500
2000
2500
3000
3500
4000
0
0.5
1
1.5
2
2.5