High Resolution (e,e'K^+) Spectroscopy at Jefferson Lab, Hall A

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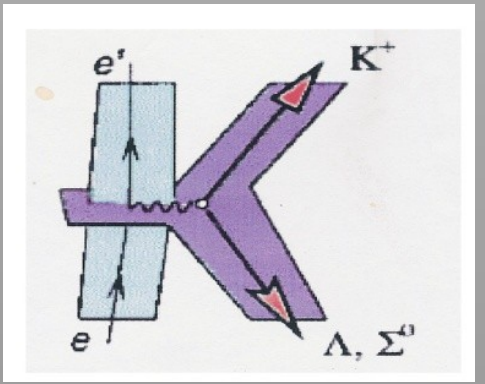
on behalf of Jefferson Lab **Hall A Collaboration**

- Electroproduction of hypernuclei at Jefferson Lab's Hall A
- Analysis of the missing-mass spectrum
  - "Systematics"
  - Peak searching
  - Peak fitting, global fit
  - Radiative correction
  - Results



Cross-Check of Event Selection and Systematics

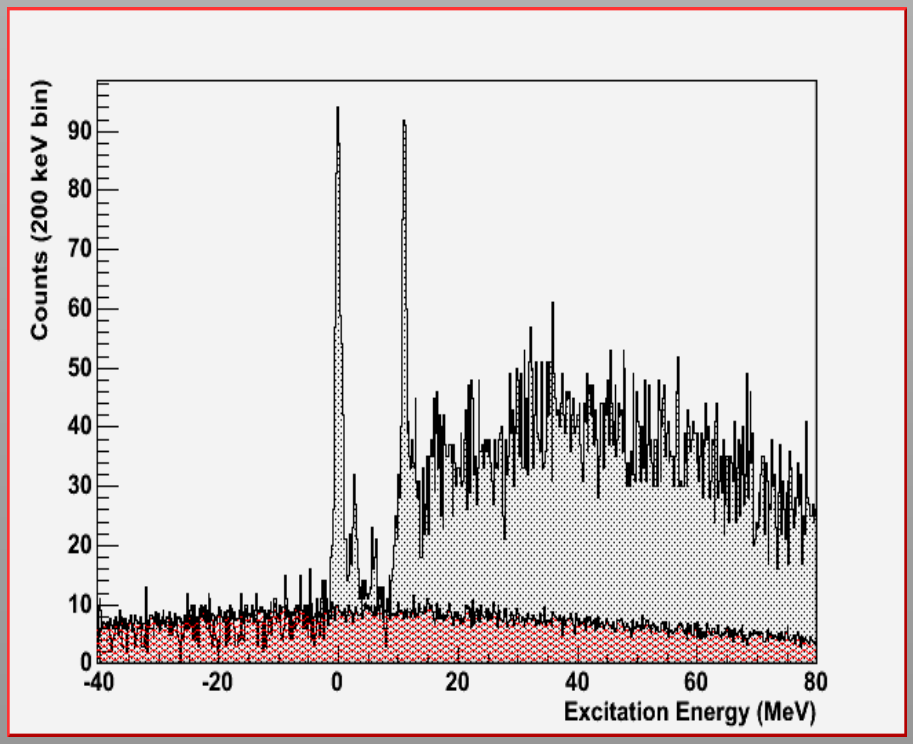
• Preliminary check of the background subtraction (off-CT vs fit at negative Excitation Energy)

• Preliminary check on dependence of missing-mass reconstruction on run-number, day/night, kinematics variables, etc

• Cross-check of quality improvement with the run (event) selection

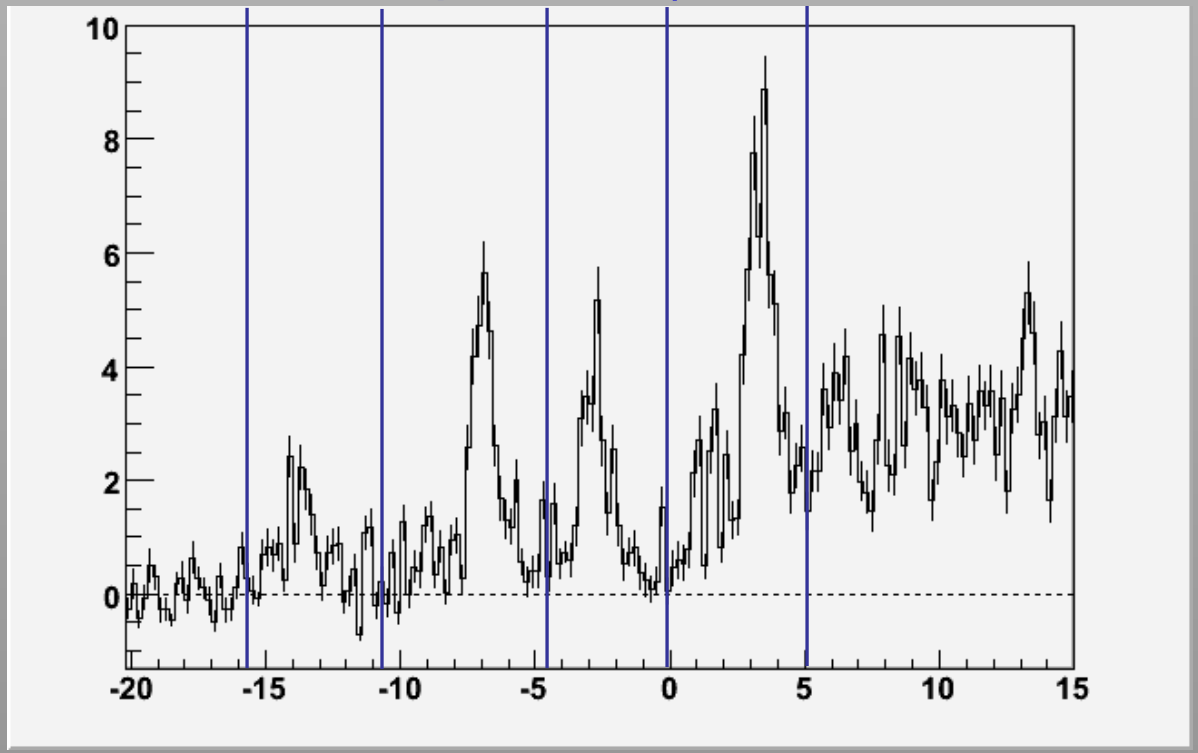
• check (or determination) of the binding energy from the missing mass: quasi-free background, absolute reference (Waterfall target), other experiments

• rough check of the absolute cross-section calculation



Peak Searching

A χ^2–based algorithm is used to detect the individual peaks out of the background fluctuations (Y. Qiang et al, the search of pentaquark partners)



Fit Procedure

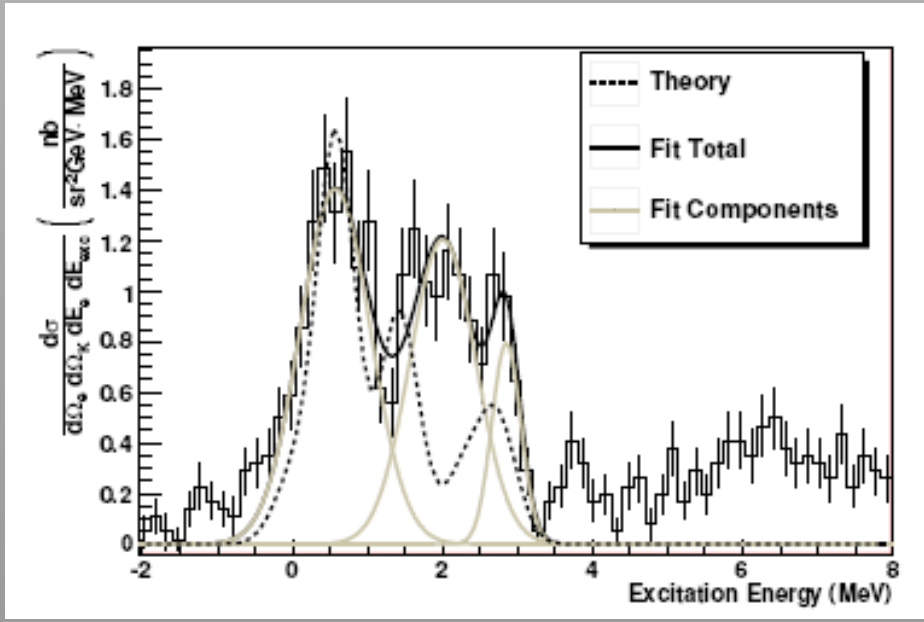
• Assuming the number of peaks according to “the search procedure”, individual and global fit with Voigt function is performed (ROOT)

• The leading parameter is χ^2

• When peak shape of width is “strange”, complex structure is verified

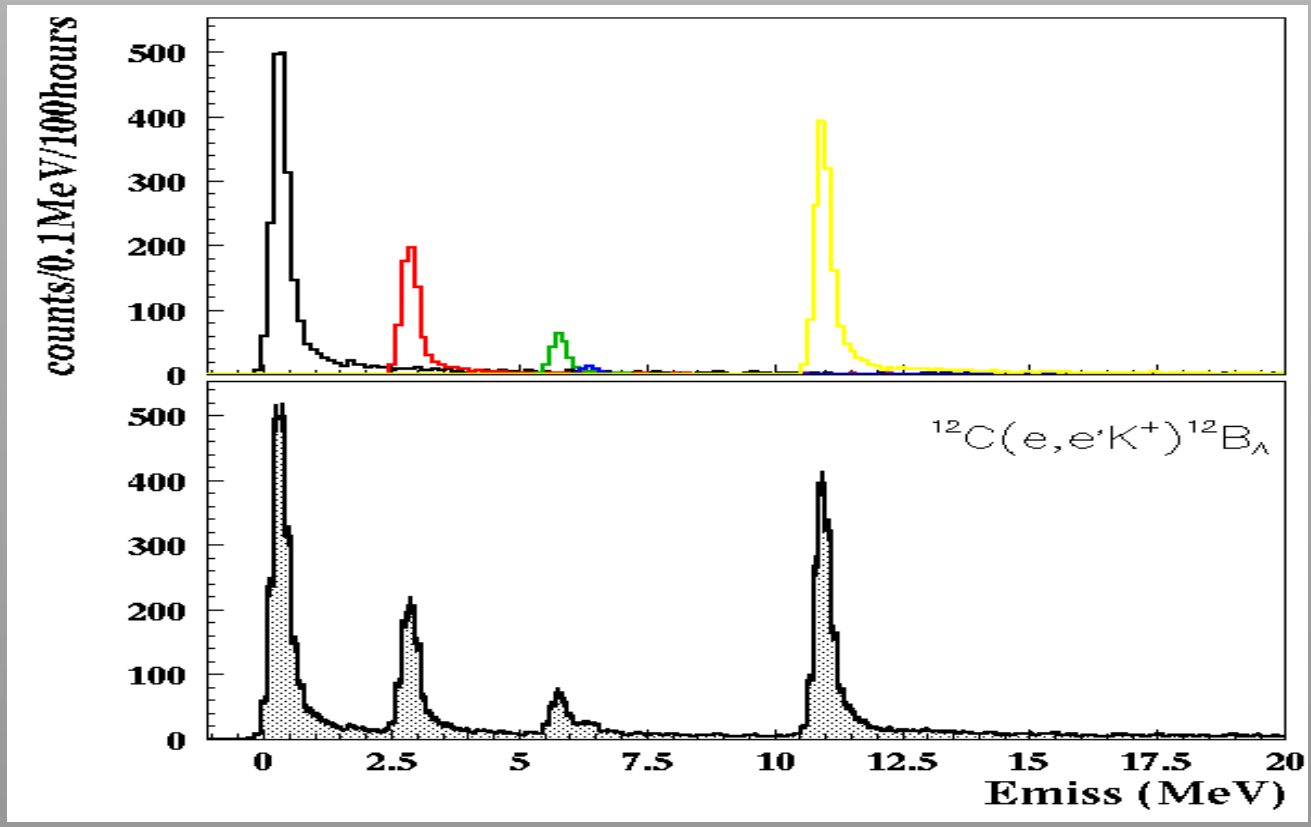
• Fit returns peak position, strength, errors.

• SNR is evaluated (when possible)



Radiative Corrections

MonteCarlo based iterative procedure is used to take into account of the radiative tail of the peak



Results on ^{12}C target – Hypernuclear Spectrum of $^{12}B_{\Lambda}$

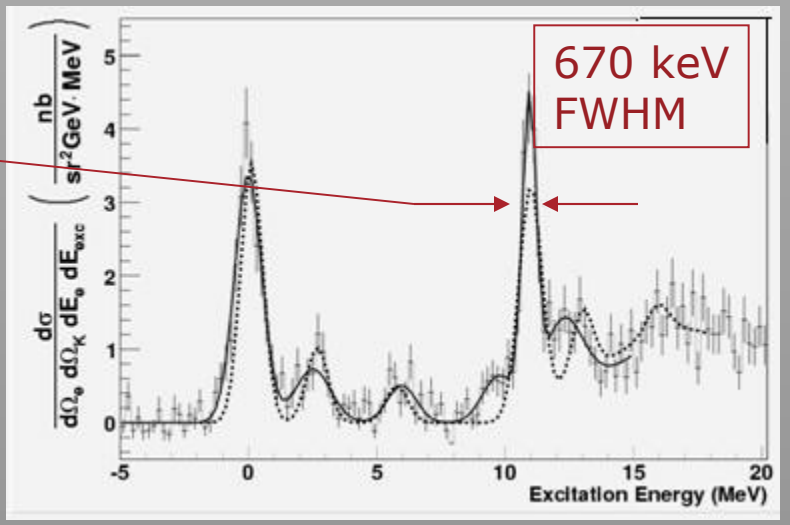
Experimental data			
Position (MeV)	Width (FWHM, MeV)	SNR	Cross section (nb/sr^2/GeV)
0.0 ± 0.03	1.15 ± 0.18	19.7	4.48 ± 0.29(stat) ± 0.63(syst)
2.65 ± 0.10	0.95 ± 0.43	7.0	0.75 ± 0.16(stat) ± 0.15(syst)
5.92 ± 0.13	1.13 ± 0.29	5.3	0.45 ± 0.13(stat) ± 0.09(syst)
9.54 ± 0.16	0.93 ± 0.46	4.4	0.63 ± 0.20(stat) ± 0.13(syst)
10.93 ± 0.03	0.67 ± 0.15	20.0	3.42 ± 0.50(stat) ± 0.55(syst)
12.36 ± 0.13	1.58 ± 0.29	7.3	1.19 ± 0.36(stat) ± 0.35(syst)

M.Iodice et al., Phys. Rev. Lett. 99 (2007) 052501

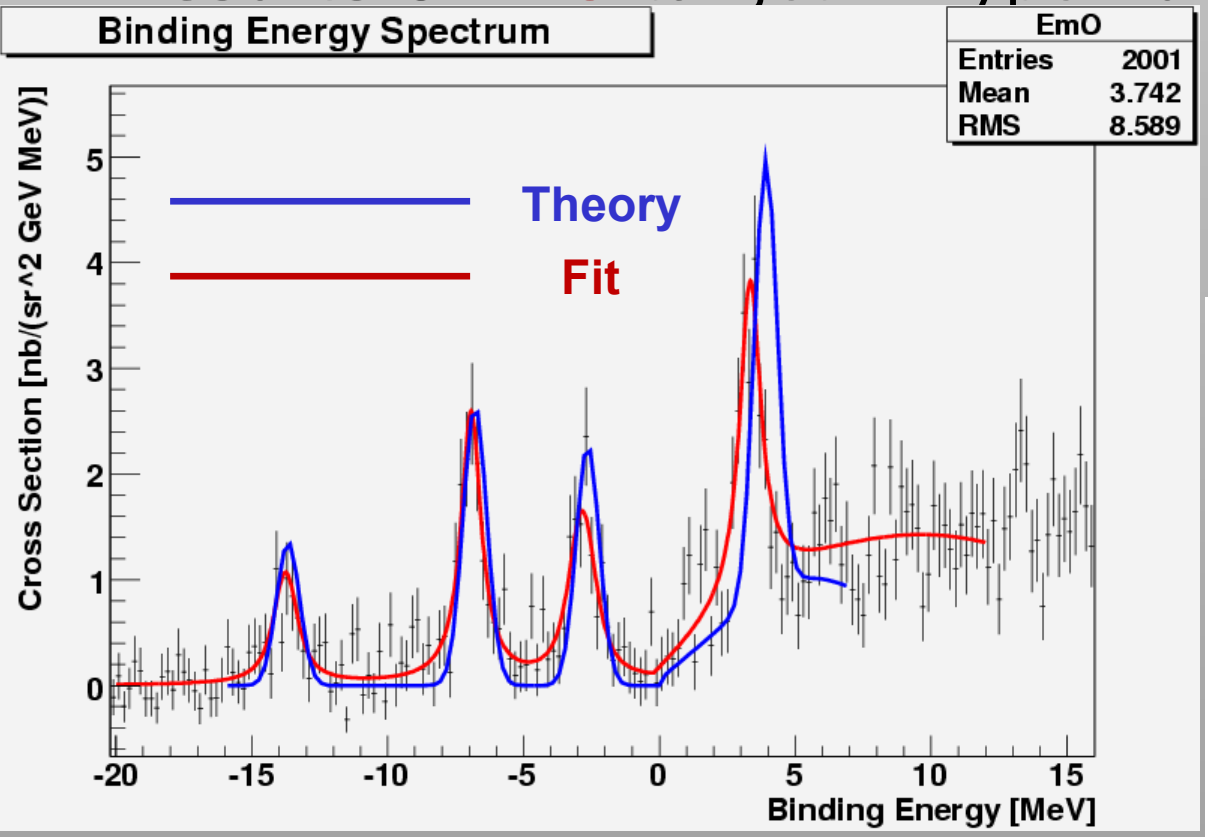
experiment resolution < 700 keV

Precise detection of core-excited states, strong indication of a mixture state

Why have a systematc shift w.r.t. Hall C?



Results on ^{16}O target – Hypernuclear Spectrum of $^{16}_{\Lambda}$N



E_x (MeV)	Width (FWHM, MeV)	Cross section $(nb/sr^2/GeV)$
0.00 / 13.76 ±0.16	1.71 ± 0.70	1.45 ± 0.26
6.83 ± 0.06	0.88 ± 0.31	3.16 ± 0.35
10.92 ± 0.07	0.99 ± 0.29	2.11 ± 0.37
17.10 ± 0.07	1.00 ± 0.23	3.44 ± 0.52

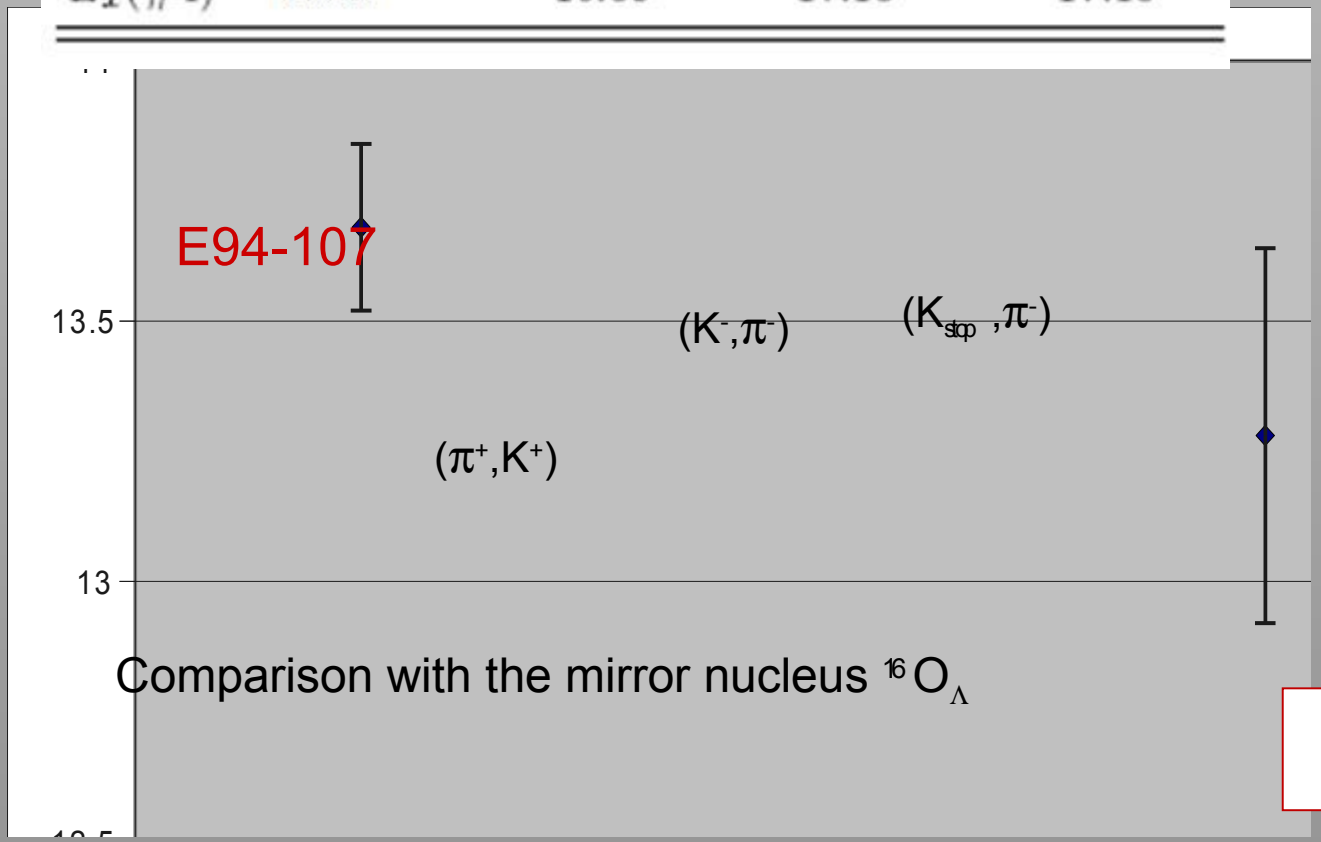
- Fit to the data (red line): Fit 4 regions with 4 Voigt functions $\Rightarrow$ χ^2_{ndf} = 1.19
- Theoretical model (blu line) based on :
  - i) SLA p(e,e'K+)Λ (elementary process, Petr Bydzovsky)
  - ιι) ΛN interaction fixed parameters from KEK and BNL $^{16}_{\Lambda}$O spectra (D. J. Millener, M. Sotona)

Binding Energy B_{Λ}=13.76 ± 0.16 (stat) ± 0.05 (sys) MeV

Measured for the first time with this level of accuracy

Results on ^{16}O target – Hypernuclear Spectrum of $^{16}N_{\Lambda}$

	$(e,e'K^+)$ This expt.	(π^+,K^+) KEK [1]	(K^-,π^-) CERN [2]	(K^-_{stop},π^-) KEK [3]
$B_\Lambda(\#1)$	13.76(16)	12.42(5)	13.28(36)	13.40(40)
$E_x(\#2)$	6.83	6.23	5.96	6.39
$E_x(\#3)$	10.92	10.57	10.62	10.84
$E_x(\#4)$	17.10	16.59	17.15	17.15



[1] O. Hashimoto, H. Tamura, Part Nucl Phys 57, 564 (2006)

[2] private communication from D. H. Davis, D. N. Dovee, fit of data from Phys Lett B 79, 157 (1978)

[3] private communication from H. Tamura, erratum on Prog Theor Phys Suppl 117, 1 (1994)

Difference expected with respect to mirror nucleus: 400 – 500 keV (M. Sotona)

Phys Rev Lett 103 (2009) 202501

Results on ^{9}Be target – Hypernuclear Spectrum of ^{9}Li$_{\Lambda}$

E_x (MeV)	Cross section $(nb/sr^2/GeV)$	Resolution FWHM (MeV)
0.0 ± 0.04	1.25 ± 0.15	1.10 ± 0.18
1.39 ± 0.07	1.12 ± 0.15	1.02 ± 0.21
2.25 ± 0.05	0.38 ± 0.11	0.44 ± 0.12

The value of χ^2/NDF for the fit is 1.34

E_x (MeV)	Cross section $(nb/sr^2/GeV)$	E_x (MeV)	J^π	Cross section $(nb/sr^2/GeV)$
0.00	0.25 ± 0.13	0	$3/2^+$	0.159
0.73 ± 0.07	1.02 ± 0.25	0.58	$5/2^+$	1.04
1.73 ± 0.34	0.45 ± 0.15	1.43	$1/2^+, 3/2^+$	0.591
2.12 ± 0.11	0.41 ± 0.14	2.27	$5/2^+$	0.169
2.82 ± 0.04	0.48 ± 0.12	2.73	$7/2^+$	0.311

The value of χ^2/NDF for the fit is 1.14.