E06007

March 3 -> March 26, 2007

Jan 21->Jan 25, 2008

$^{208}Pb(e,e'p)^{207}Tl$, $^{209}Bi(e,e'p)^{208}Pb$

x=1, q = 1 GeV/c, w = 0.433 GeV, Q^2 = 0.81 to 1.97 $(GeV/c)^2$

Impulse Approximation limitations to the (e,e',p) reaction on ^{208}Pb, identifying correlations and relativistic effects in the nuclear medium

Students:

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Joaquin Lopez (U. Madrid)

1) Outline Objectives of experiment

2) Raster corrections and preliminary cross sections for $^{12}C(e,e'p)^{11}B$

3) Preliminary cross section for $^{209}Bi(e,e'p)^{208}Pb$

4) Semi-quantitative comparison of theory and data for $^{208}Pb(e,e'p)^{207}Tl$

5) Data taken and target performance in January 2008

Objectives

(I) Long Range Correlations search

a) Measure spectroscopic factors for states near the Fermi level. Spectroscopic factors depend on SRC and LRC.

b) Measure cross sections for these low lying states to 500 MeV/c in p_{miss}. Excess strength here is theoretically identified as due to LRC.

c) Search for Q^2 dependence of spectroscopic factors.

^{207}Tl, low lying states

g.s.	3s1/2
0.351	2d3/2
1.348	1h11/2
1.683	2d5/2
3.470	1g7/2

Objectives

(II) Identify dynamical relativistic effects in nuclear structure.

Measure cross section asymmetry A_{TL} around the three momentum transfer. Relativistic mean field theory predicts an A_{TL} dependence on $p_{miss} < 300$ MeV/c due to dynamical enhancement of the lower component of the nucleon wave function. Calculations which do not include the enhancement of the lower component predict a substantially different A_{TL} behavior.

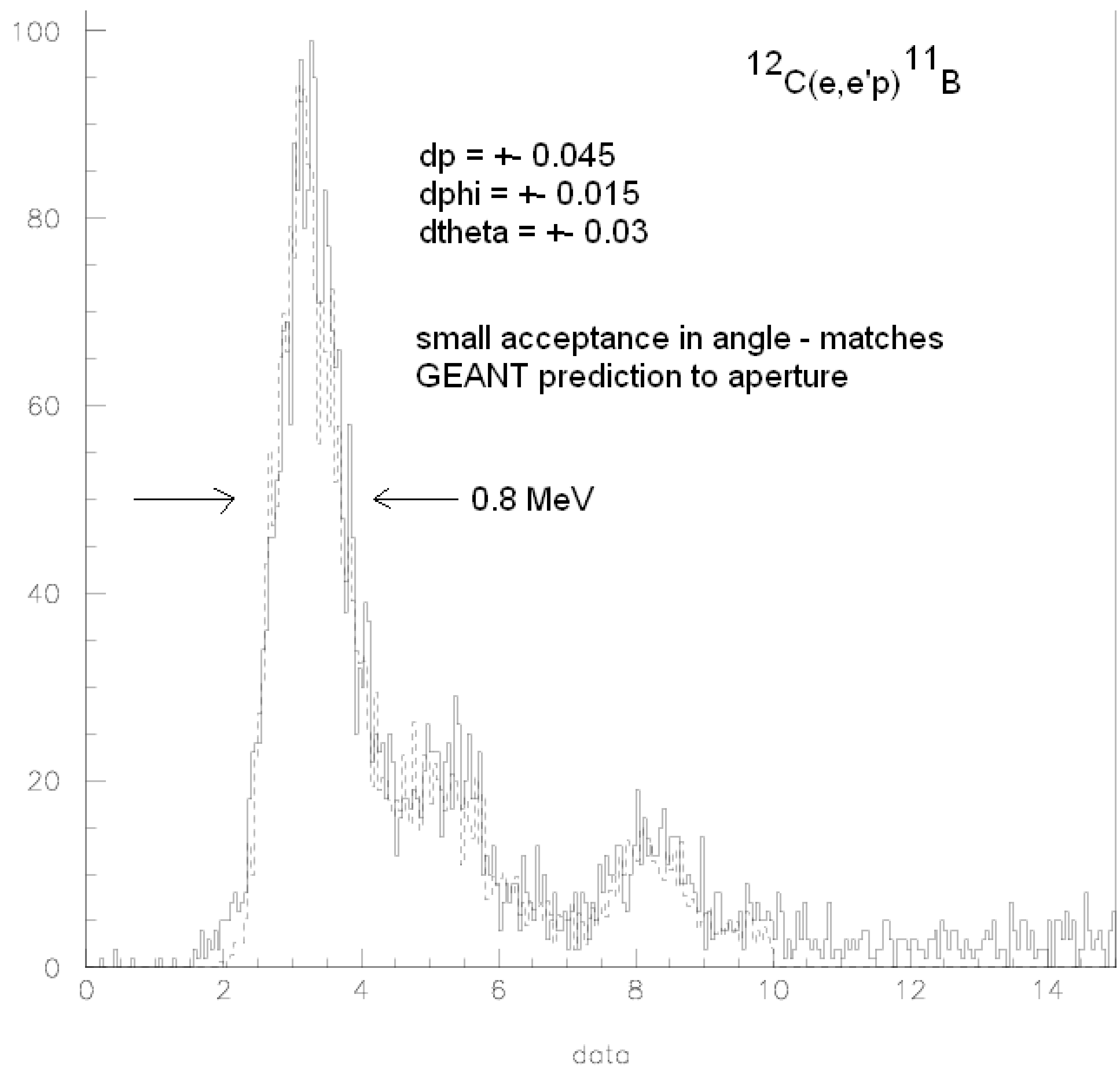
Carbon Cross Section Analysis

1) Can be done with raster off and on

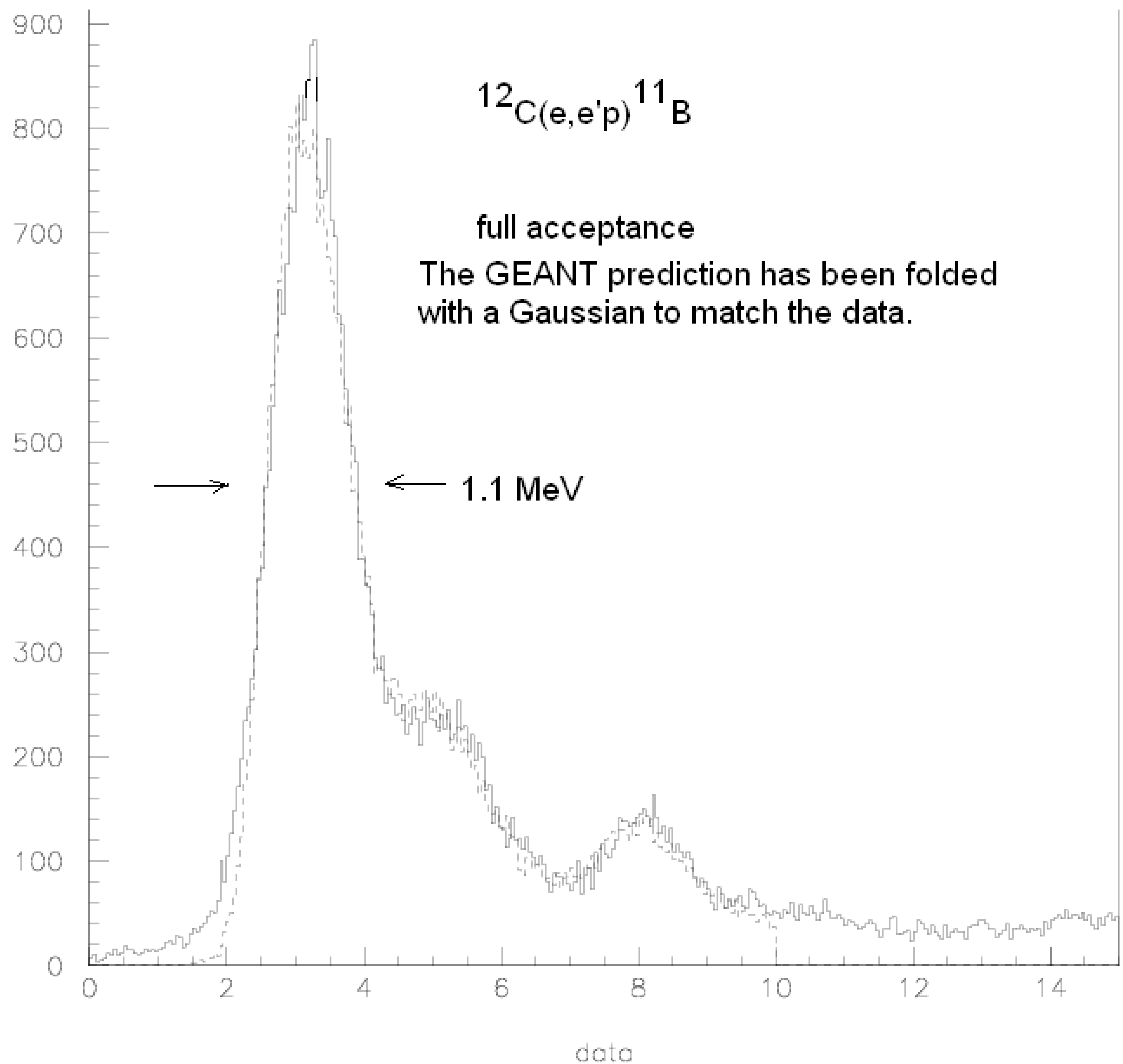
2) Determination of effective charge as a function of raster cut.
Large raster pattern and Bi target slipping requires determining charge in a given raster cut to obtain cross section.

3) Can be done with varying acceptances to determine empirically acceptance effects.
Measured average cross section depends on acceptance effects and physics effects.

4) Interesting in its own right. Never been measured before in these kinematics.



$^{12}C(e,e'p)^{11}B$
dp = +- 0.045
dphi = +- 0.015
dtheta = +- 0.03
small acceptance in angle - matches
GEANT prediction to aperture
0.8 MeV
0
20
40
60
80
100
0
2
4
6
8
10
12
14
data



$^{12}C(e,e'p)^{11}B$
full acceptance
The GEANT prediction has been folded
with a Gaussian to match the data.
1.1 MeV
900
800
700
600
500
400
300
200
100
0
0
2
4
6
8
10
12
14
data

$^{12}C(e,e'p)^{11}B$ preliminary cross sections at p_{miss} = 100 MeV/c

Raster off, $|dp|<0.045$

^{11}B state (MeV)	dphi,dtheta full	$\lvert dphi\rvert<0.02$, $\lvert dtheta\rvert<0.04$
Gs	2.92	3.30
2.124	0.44	0.45
5.020	0.26	0.36

Units 10^{-33} $cm^2/MeV/sR^2$

The average cross section as a function of acceptance should change.

$^{12}C(e,e'p)^{11}B_{gs}$ average cross sections and theory

|dp|<0.045

Raster off results

phi wide open theta wide open	1.10 MeV, FWHM sig = 2.92e-33 $cm^2/sr^2/MeV$ <theory> = 3.52e-33 data/theory = 0.83
|phi| < 20 |theta| < 40	0.95 MeV, FWHM sig = 3.30e-33 <theory> = 3.59e-33 data/theory = 0.92
|phi| < 15 |theta| < 30	0.79 MeV, FWHM sig = 3.35e-33 <theory> = 3.61e-33 data/theory = 0.93

Theory assumes there are 2.8 protons in the 1p3/2 shell.

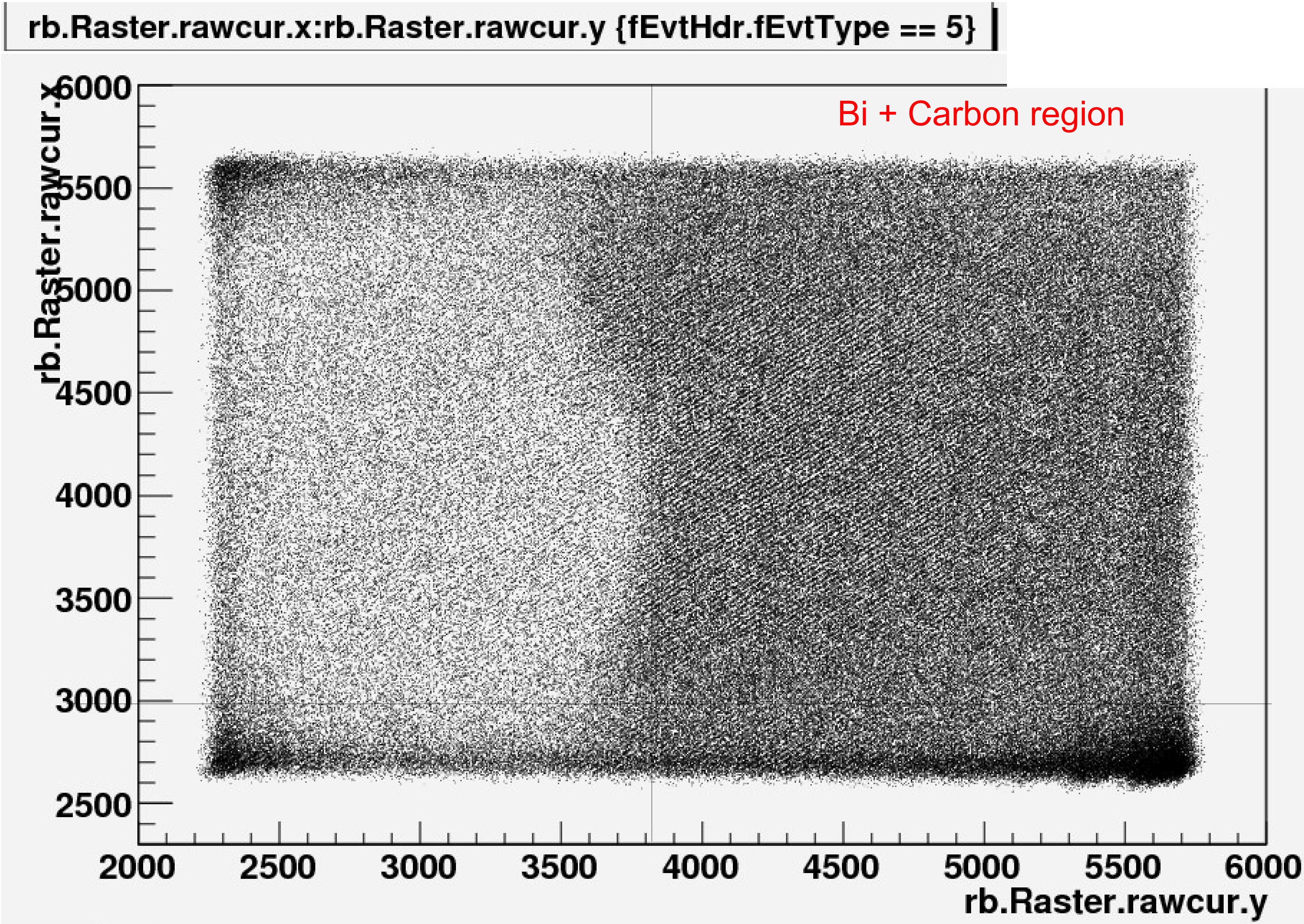
Theory is averaged over the acceptance to the entrance of the spectrometers.

Comparison of raster on/off cross sections for $^{12}C(e,e'p)^{11}B$

phi wide open theta wide open dp - no cut	1.10 MeV, FWHM sig = 2.92e-33 $cm^2/sr^2/MeV$ <theory> = 3.52e-33 data/theory = 0.83	1.41 MeV, FWHM sig = 2.80e-33 <theory> = 3.52e-33 data/theory = 0.80
|phi| < 20 |theta| < 40 dp -no cut	0.95 MeV, FWHM 3.30e-33 <theory> = 3.59e-33 data/theory = 0.92	1.21 MeV, FWHM sig = 3.30e-33 <theory> = 3.59e-33 data/theory = 0.92
	Raster is off	Raster is on

Raster on/off cross sections agree but FWHM is larger for raster on.

Raster Pattern on Bismuth target, March 2007

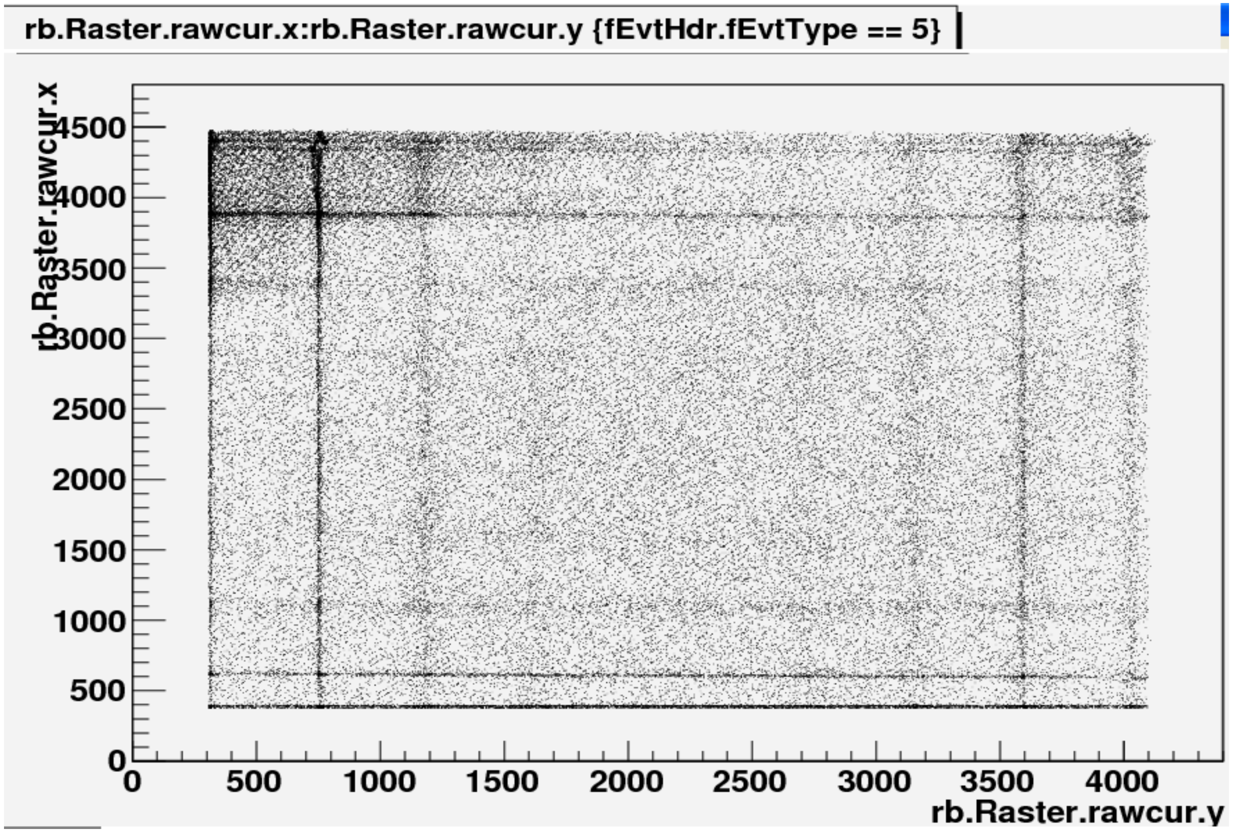


Raster cut and effective charge, Q_{eff}

The Hall A raster should be uniform(NIM 539A,1,2005,Yan, Sinekine, Wojcik)

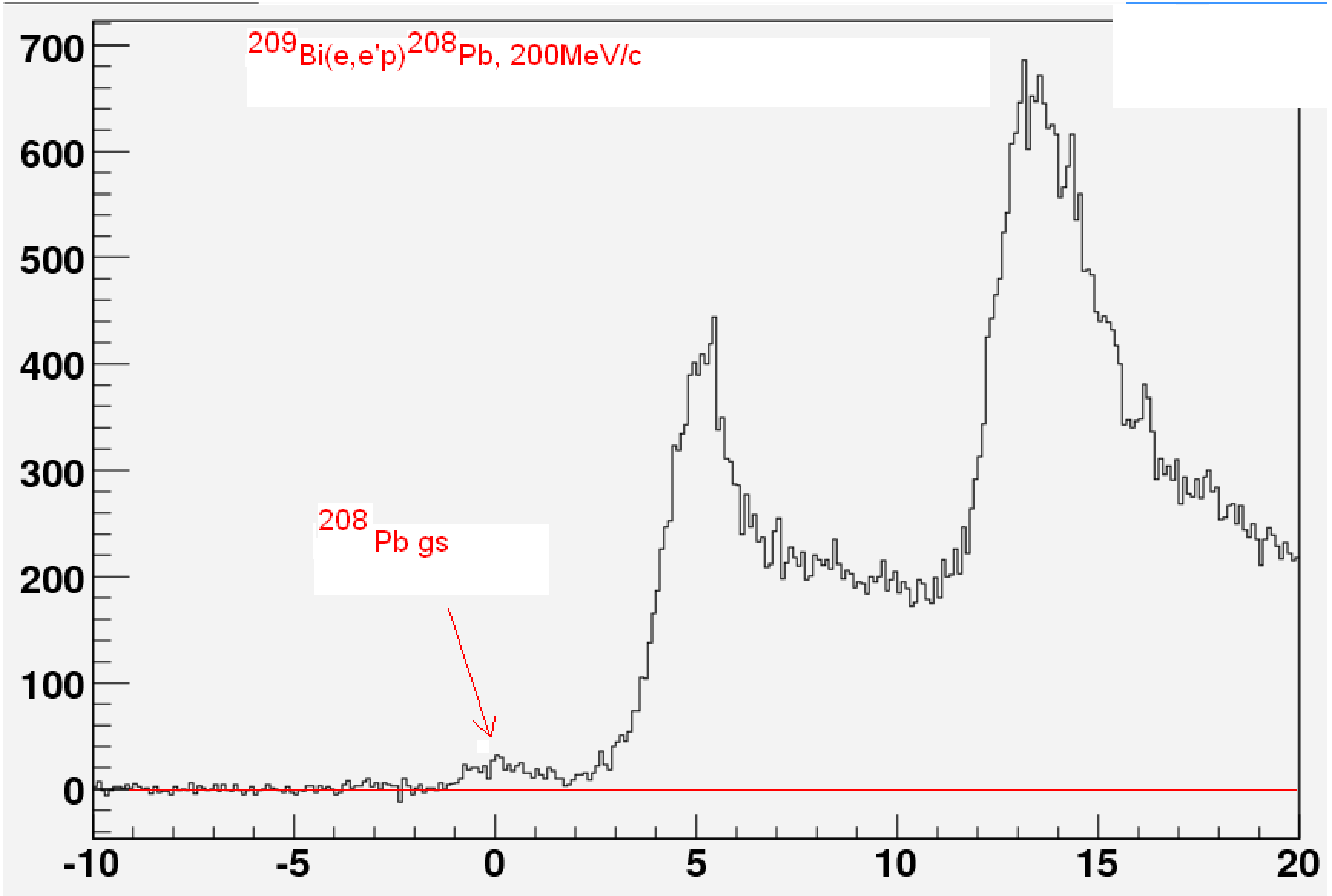
$Q_{eff}=(A_{eff}/A_{tot})*q_{tot}*(0.90 +- 0.06)$

Carbon run



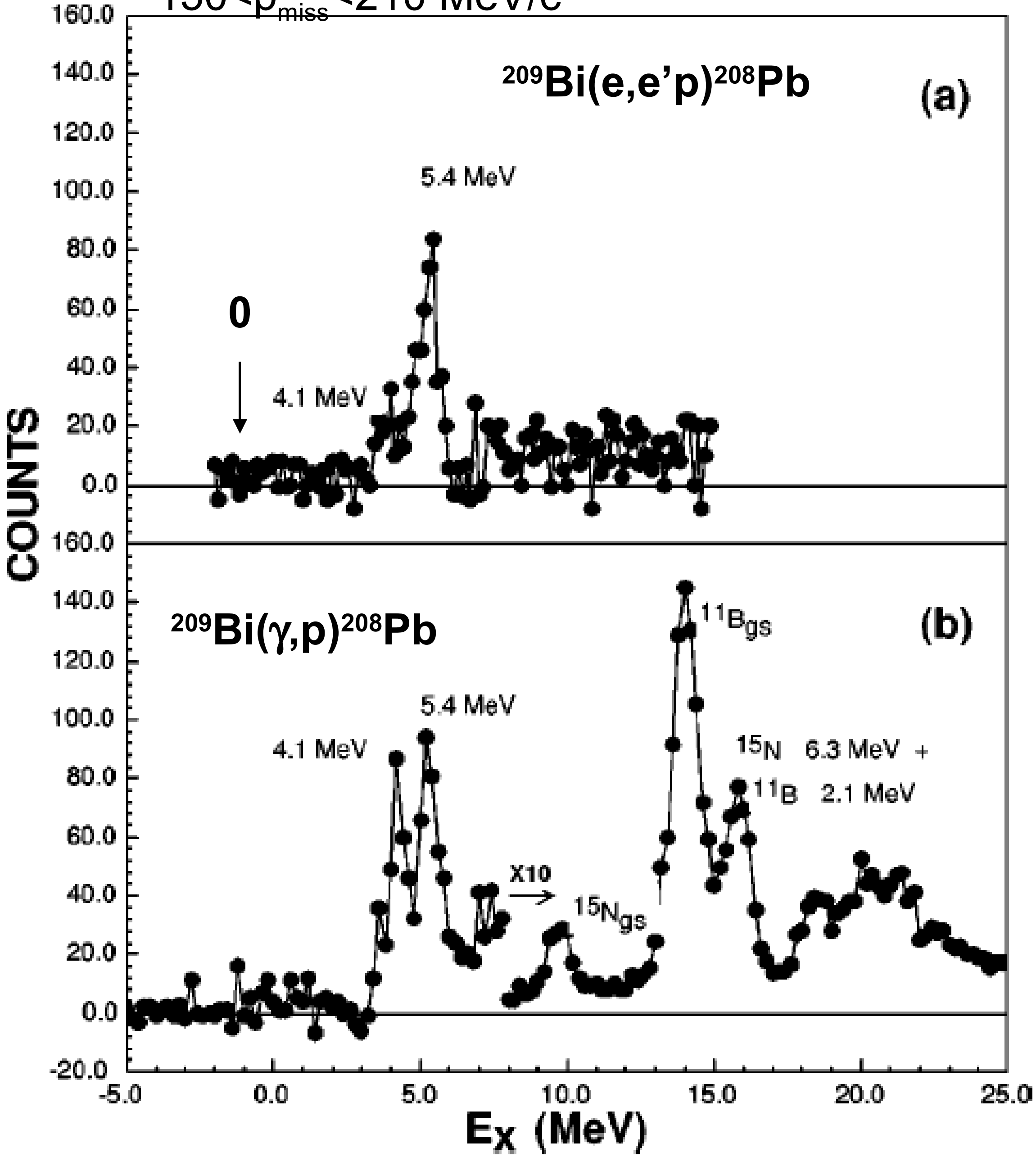
The yield is uniform inside the pattern but there is an enhancement at the edges.

Is there an algorithm for getting Q_{eff} event by event?



209Bi(e,e'p)208Pb, 200MeV/c
208Pb gs
700
600
500
400
300
200
100
0
-10
-5
0
5
10
15
20

150<p_{miss}<210 MeV/c



D. Branford et al.

PRC 63 014310 (2000)

E_0 = 293 and 410 MeV,

Parallel kinematics

States at 4.1 and 5.4 MeV are 500 keV wide.

Believed to be configuration mixed states:

$p(1h9/2)x(3s1/2)^{-1}$

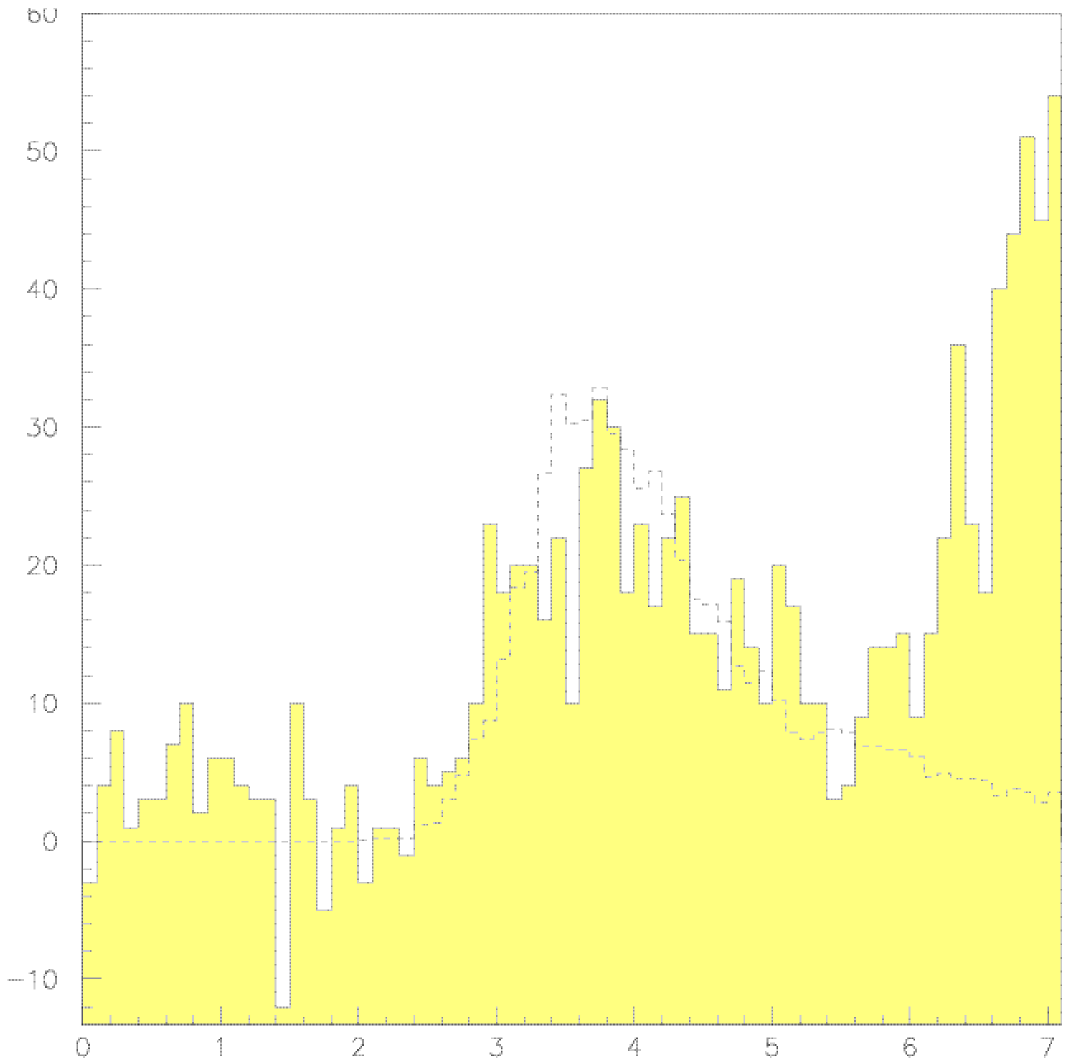
$p(1h9/2)x(2d3/2)^{-1}$

$p(1h9/2)x(1h11/2)^{-1}$

$p(1h9/2)x(2d5/2)^{-1}$

Bismuth cross section, $^{209}Bi(e,e'p)^{208}Pb_{gs}$,200 MeV/c

Wide open acceptance

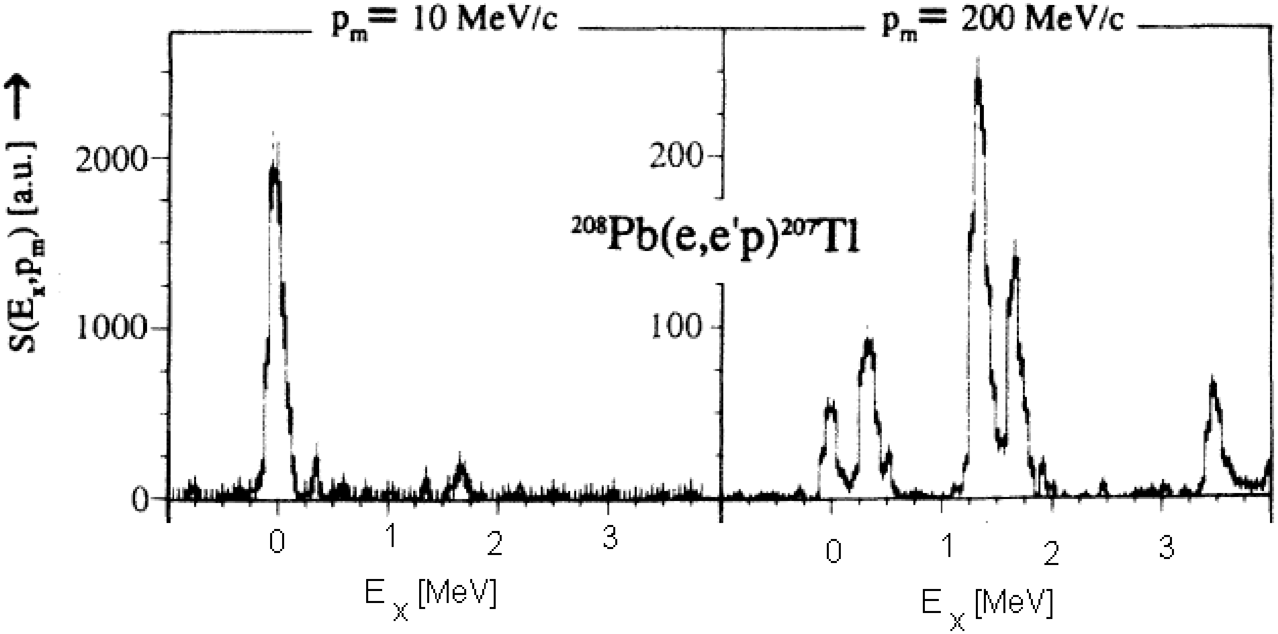


<sigma_exp> = (0.34 +- 0.024) e-33 $cm^2/MeV/sR^2$

<sigma_theory> = 0.38 e-33 $cm^2/MeV/sR^2$

<exp>/<theory> = 0.90 +- 0.06

Theory assumes there are 0.75 protons in the 1h9/2 shell.

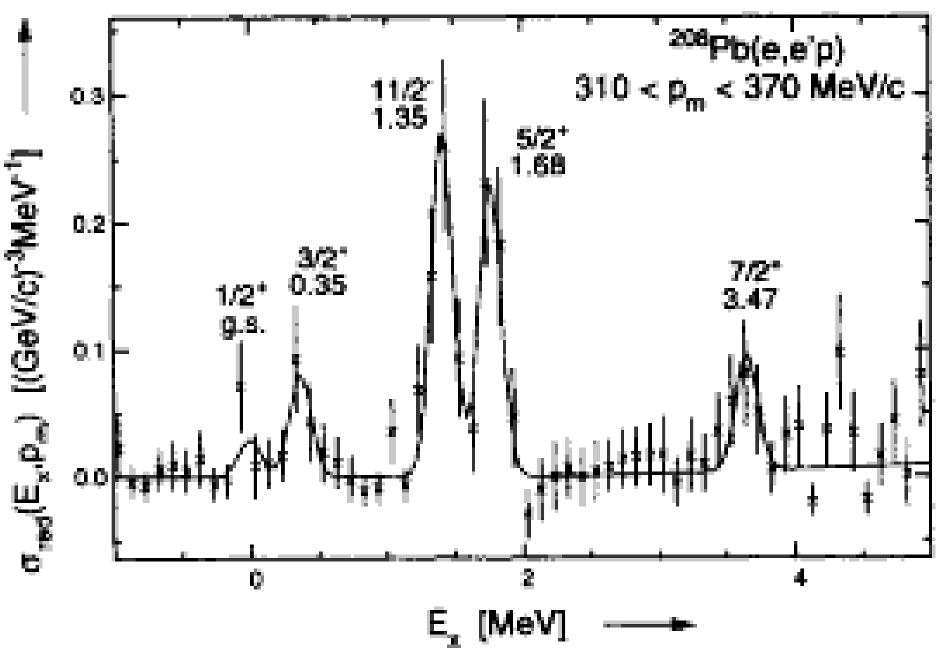


Quint et al. PRL 57, 186 (1986)

Parallel kinematics,

E_0 = 410, 350 MeV

Low p_{miss}



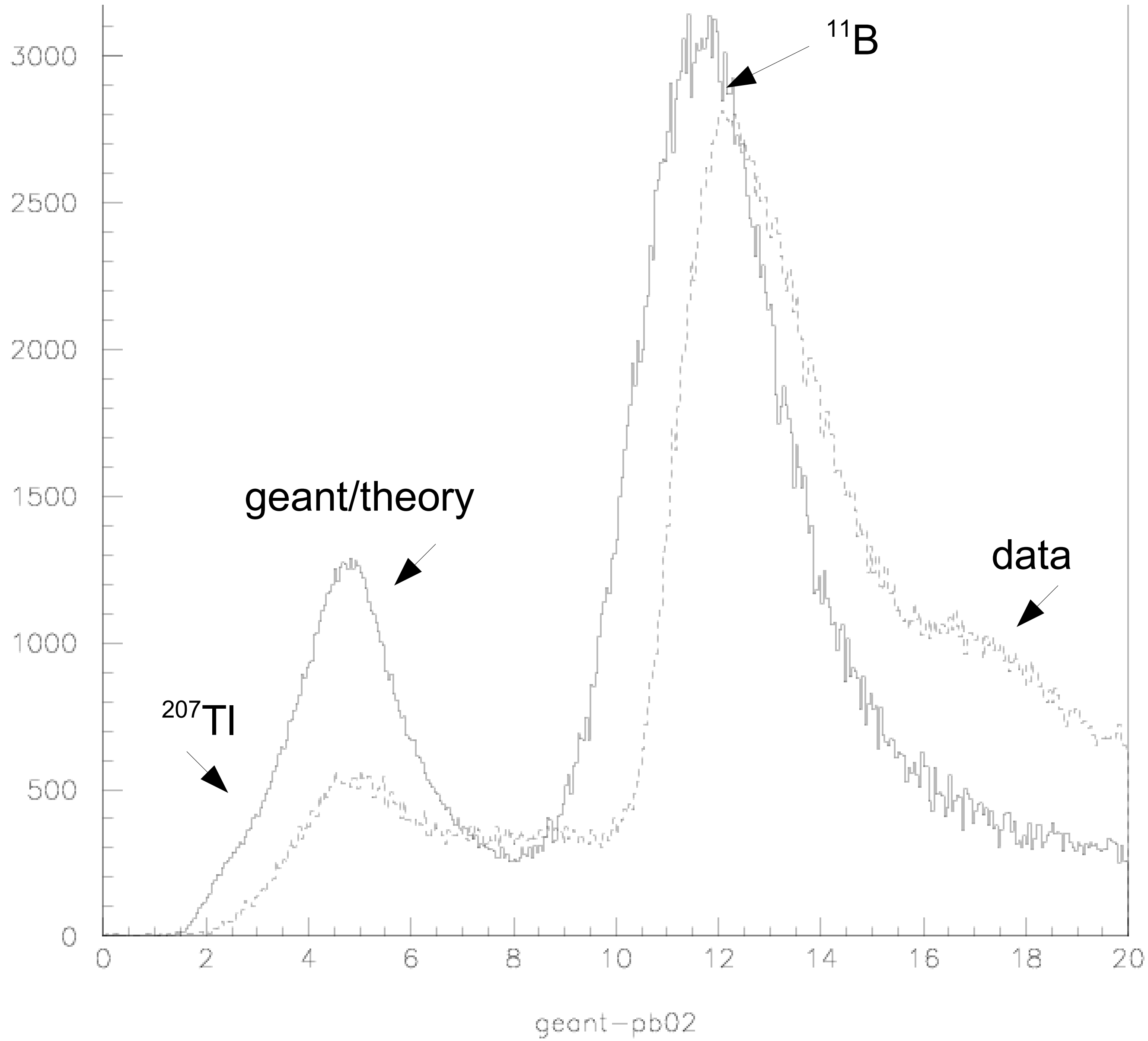
^{207}Tl, low lying states

g.s.	3s1/2
0.351	2d3/2
1.348	1h11/2
1.683	2d5/2
3.470	1g7/2

E_0 = 487.3 MeV, x_B = 0.18

High p_{miss}

Bobeldiik et al., PRL 73, 2864 (1994)



Pb-diamond target at p_{miss} = 100 MeV/c

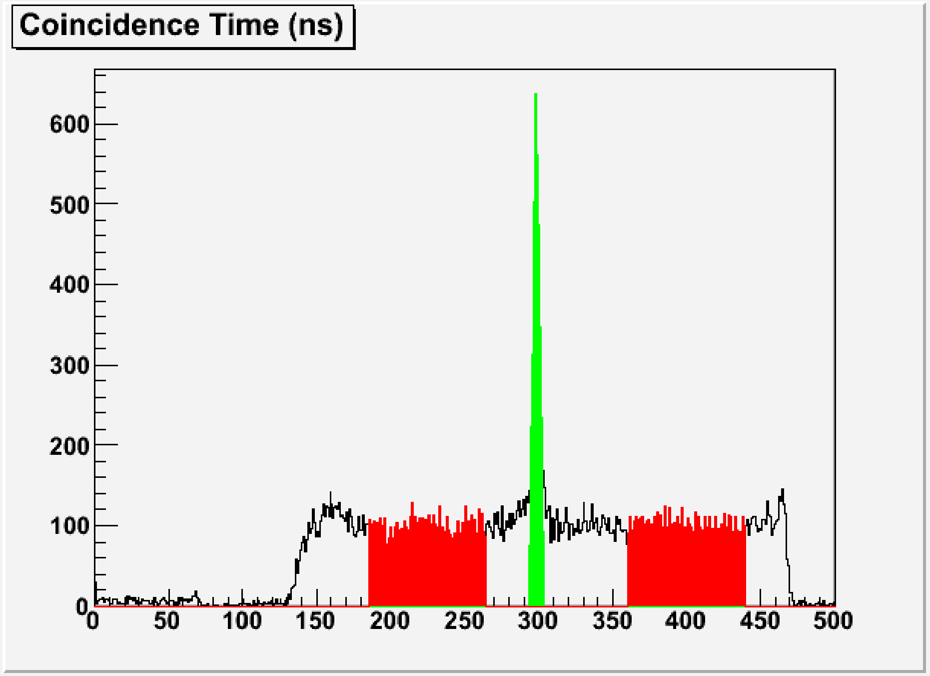
E06007 – Run 2 (Jan 2008)

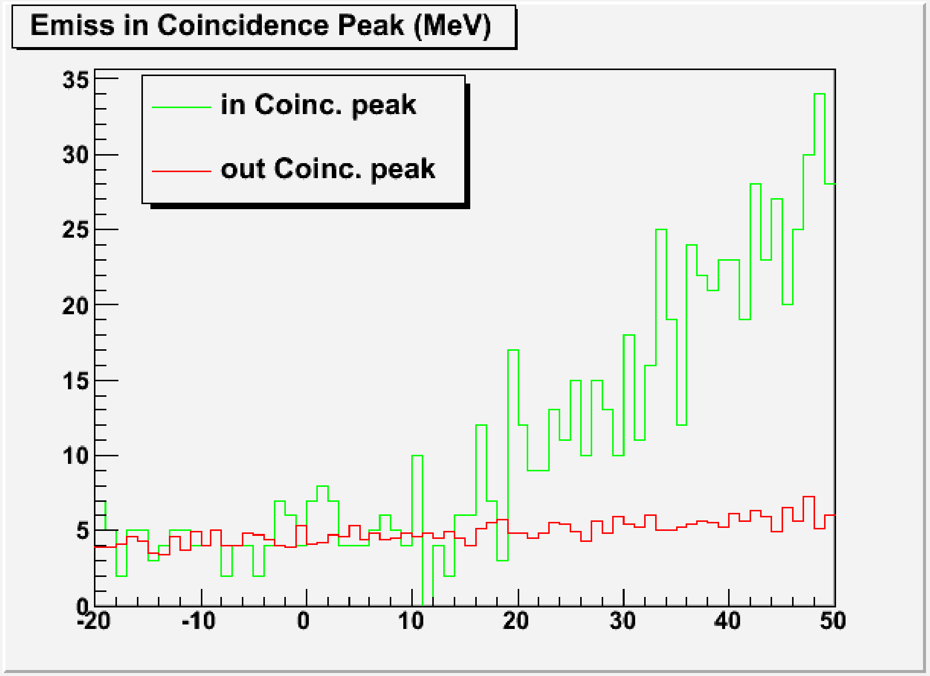
Charge in Coulombs (time) Run Nos.

Kinematics (Pmiss)	Thick Pb	Thin Pb	Bi	C
Kin 8 (+400)	2.723 (919) 3151-3184	2.329 (605) 3337-3354		
Kin 9 (−400)	1.469 (572) 3236-3272	0.632 (158) 3367-3373		
Kin 10 (+500)	2.592 (849) 3185-3221	0.177 (55) 3273-3275 1.132 (258) 3355-3364		
Kin 11 (−500)		2.130 (646) 3276-3306		
Kin 1 (0)	0.201 (57.4) 3228-3230 0.048 (14.5) 3310-3311 0.054 (15.2) 3366	0.229 (78) 3232-3234 0.110 (32) 3309 0.047 (16.6) 3365		0.202 (59) 3231
Kin 2 (+100)	0.215 (60.5) 3222-3227			
Kin 3 (-100)		0.21 (60) 3307-3308		
Kin 4 (+200)			0.562 (183) 3312-3336	

New and improved target design capable of 80 uA running.

Target performance at 80 uA – January 2008





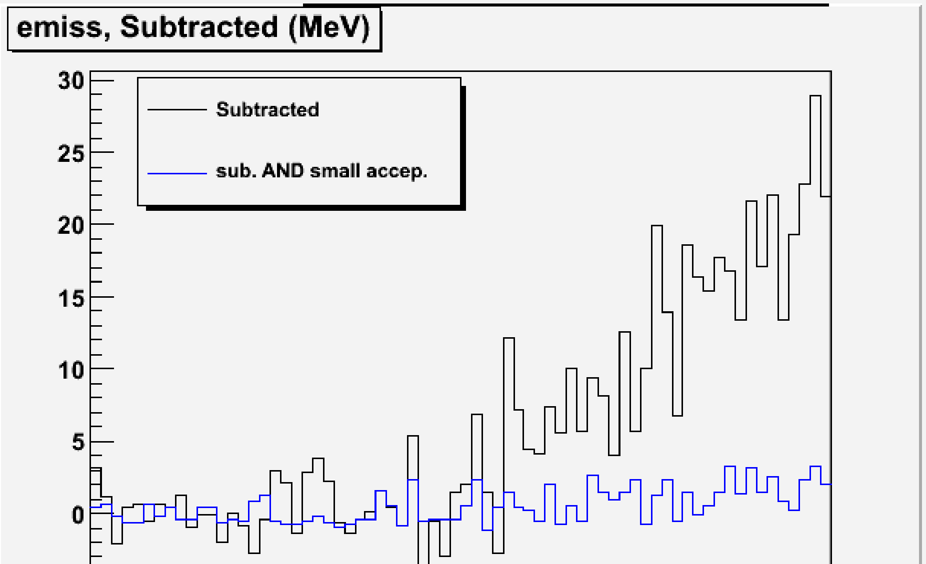
test kin 8 - 80uA

Good Events: in coinc peak (subtracted)

Total (> 0 MeV): 3583 (2853)

Pb (0 - 10 MeV): 58 (6)

C as Pb (13 - 18 MeV): 37 (3)

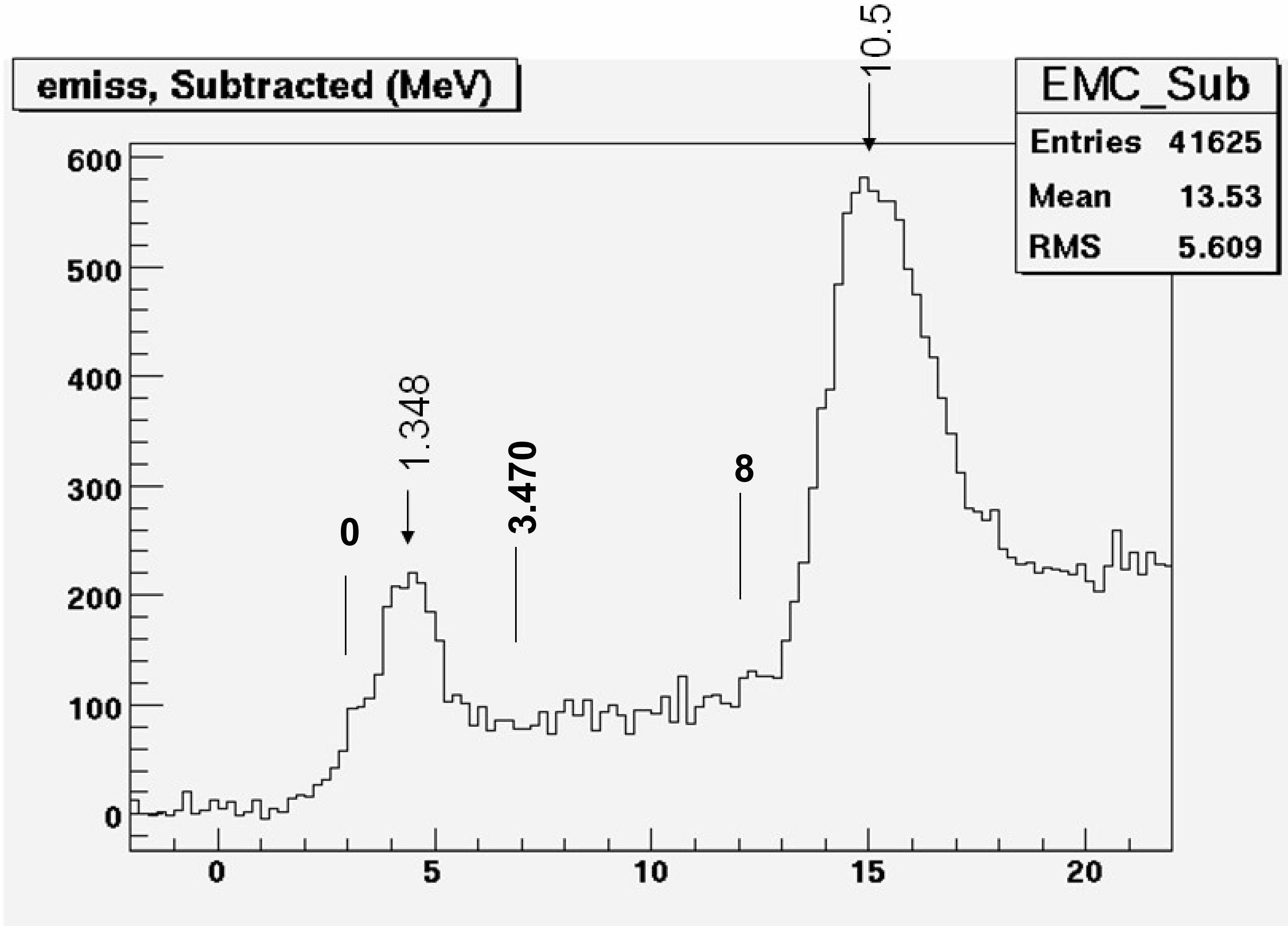


Issues needing attention

- Measure vertical raster sweep against vertical ladder target
- Measure optics for a vertical ladder target
- Improve optics? – best possible emiss resolution = 1 MeV
- Extract measured carbon spectra from the target sandwich
- Finish analysis of run 1
- Combine results from run 1 and run 2
- Further investigation of determining effective charge, Qeff

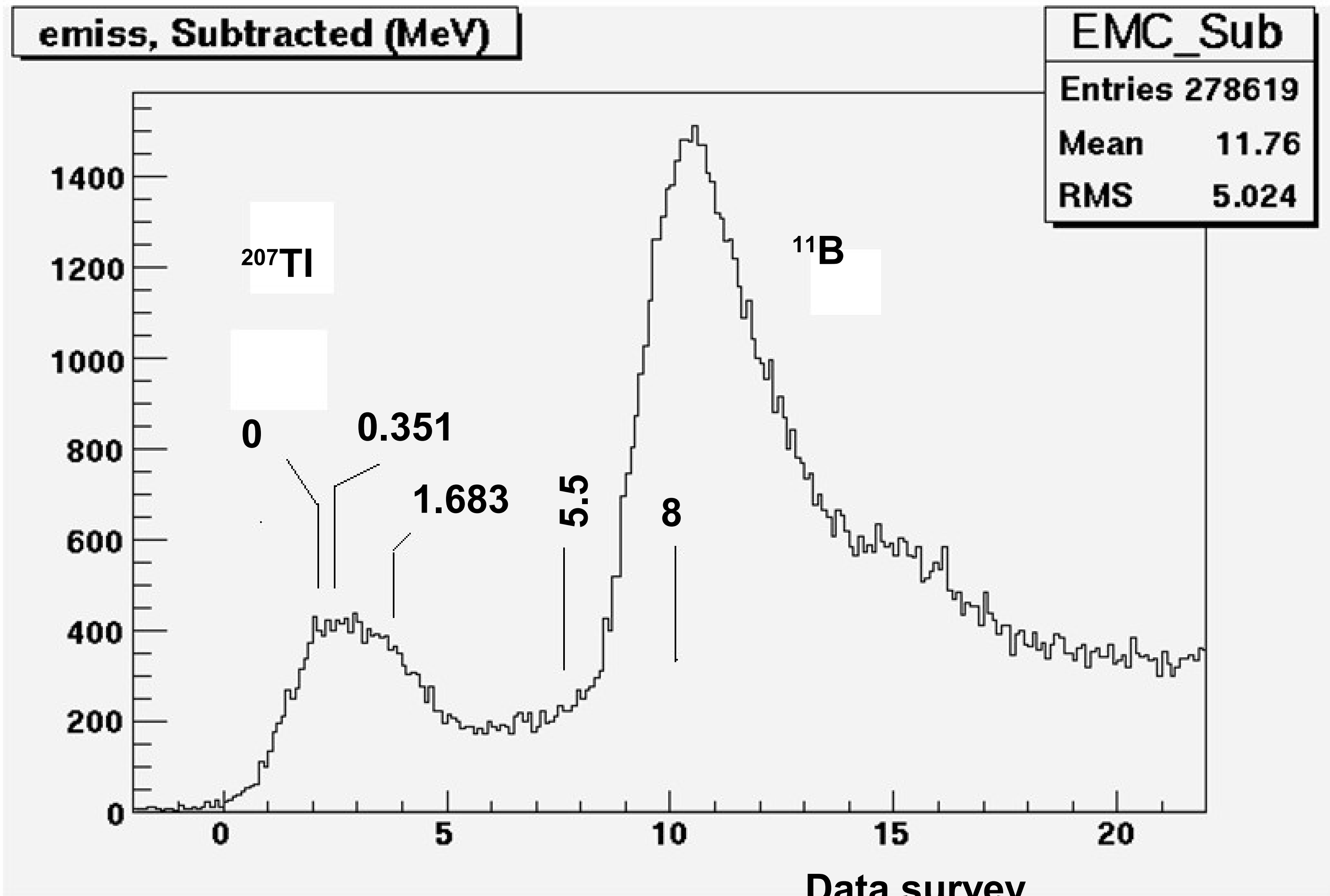
State | Page | Landscape | 1.000 | A4 | /net/fs.home/adaq/e06007/aniol/Pbkin06_all_24MeV_fullscale.ps: EMC_Sub, Pbk | Sun Mar 18 12:48:07 200

Pb, p_{miss} = 300 MeV/c



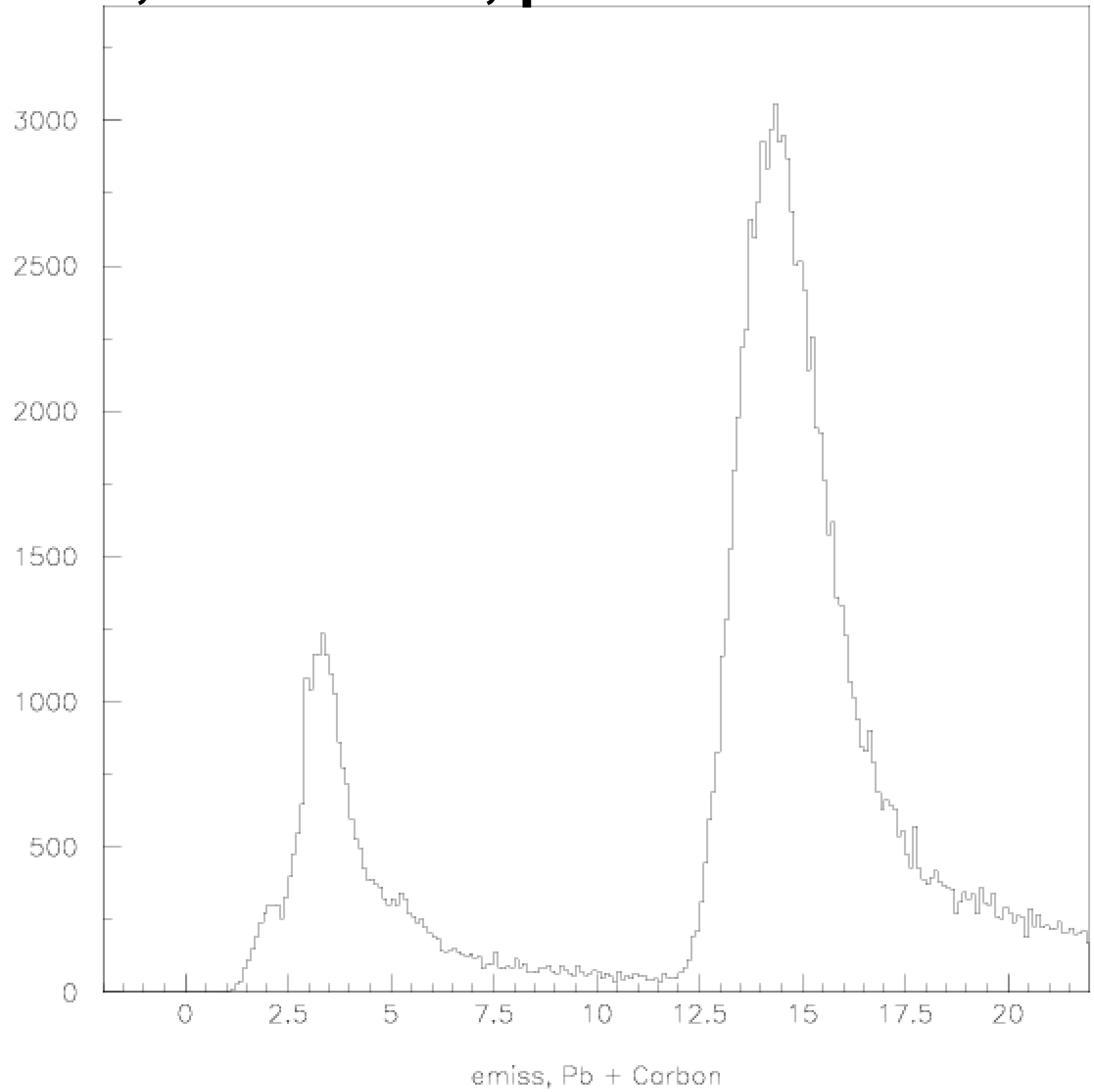
Data survey

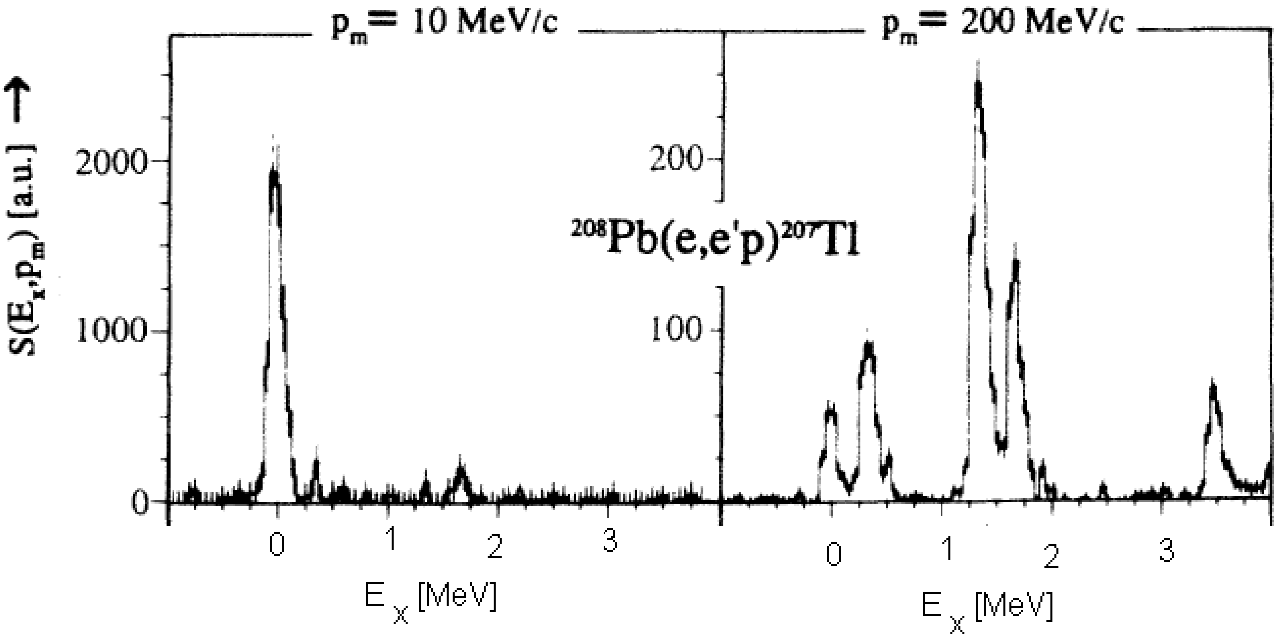
P_{miss}=0 MeV/c



Data survey

Pb, simulation, pmiss = 300 MeV/c





Quint et al. PRL 57, 186 (1986)

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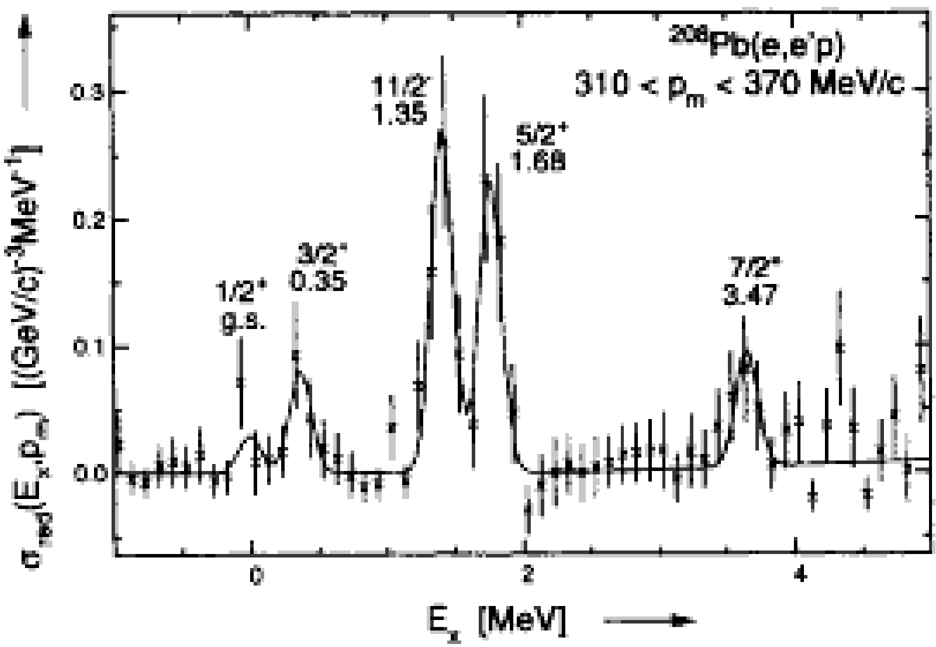
Low p_{miss}



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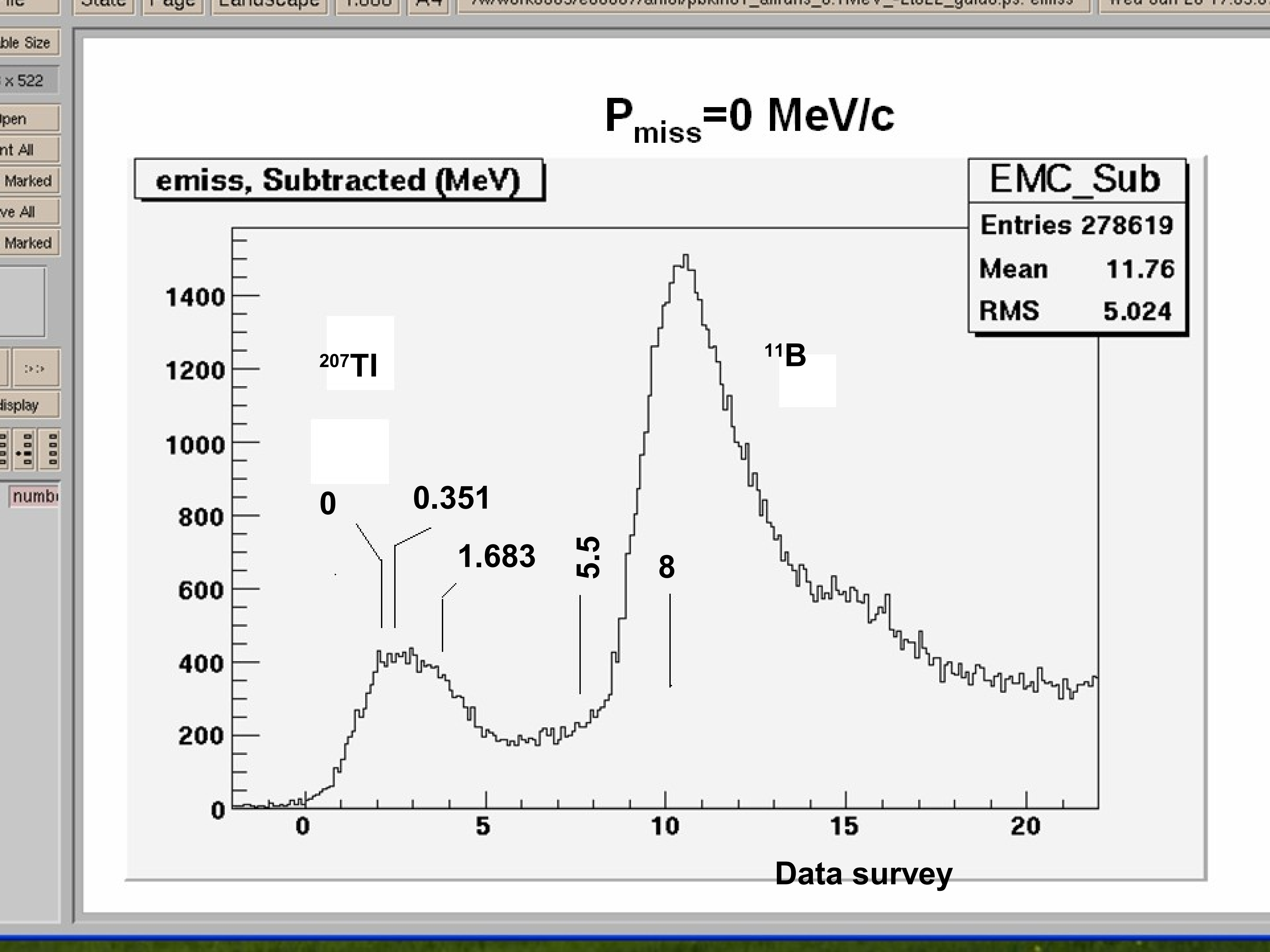

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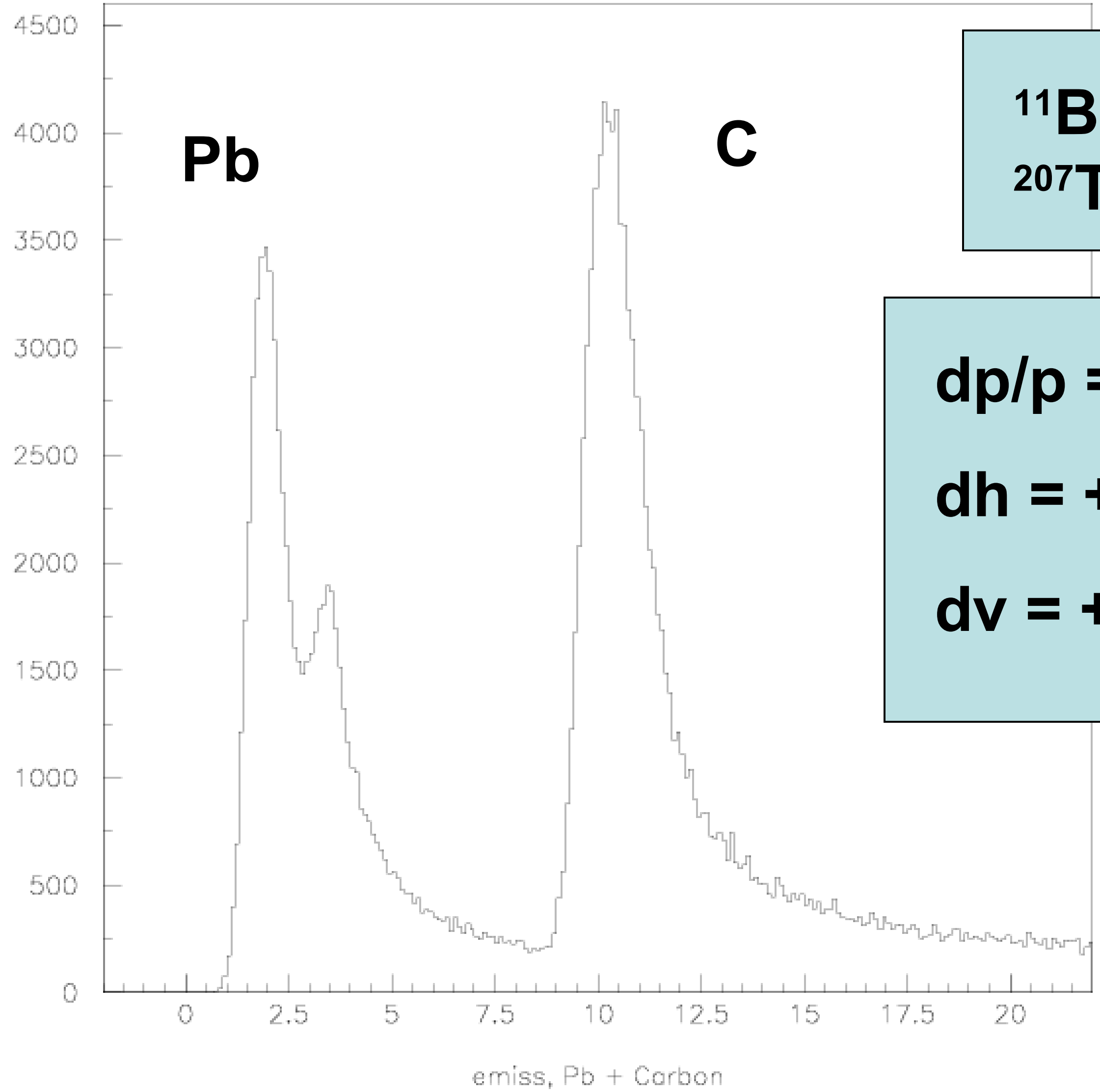
numb
P_{miss}=0 MeV/c
emiss, Subtracted (MeV)
EMC_Sub
Entries 278619
Mean 11.76
RMS 5.024
^{207}Tl
^{11}B
0
0.351
1.683
5.5
8
1400
1200
1000
800
600
400
200
0
0
5
10
15
20
Data survey

GEANT simulation, C with Pb kinematics, p_{miss} = 0 MeV/c



^{11}B gs and no ^{207}Tl continuum

dp/p = +- 1.0e-4,

dh = +- 0.3mr,

dv = +- 1.0mr