E06-007 : Impulse approximation limitations to the (e,e',p) reaction on ^{208}Pb identifying correlations and relativistic effects in the nuclear medium

June 12, 2008

Goals of the experiment

Use ^{208}Pb, a double magic, complex nuclei, a textbook case for the shell model. Measure ^{208}Pb(e,e'p)^{207}Ti cross sections at true quasielastic kinematics and at both sides of q. This has never been done before A $>$ 16 nucleus.

- Quasielastic kinematics: X_B=1, q=1GeV/c, ω=0.433GeV/c
- Determine momentum distributions: $0 < p_{\text{miss}} <$500MeV/c
- Determine A_{TL} by measuring cross sections on either side of q.

Procedure

- Establish optics corrected DB
- Perform raster corrections on all runs with raster
- Calculate effective charge Q_{eff}
- Use GEANT simulation to fit the individual peaks of the residual nuclei

Improving the optics database

Define $\mathbf{Y}' = F \cdot \mathbf{Y}$ where we let $F = 1 + \delta F$, leads to:

$$\mathbf{Y}' = Y + \delta F \cdot \mathbf{Y} = \mathbf{Y} + \delta(\mathbf{Y})$$

Considering momentum this means:

$$DP' = DP + \delta F \cdot \mathbf{Y} = DP + \delta(DP) = DP + P(DP, \Theta, \phi, Y)$$

where $P(DP, \Theta, \phi, Y)$ is a polynomial expression

Improving the optics database

The missing energy E_{miss}will also change as such:

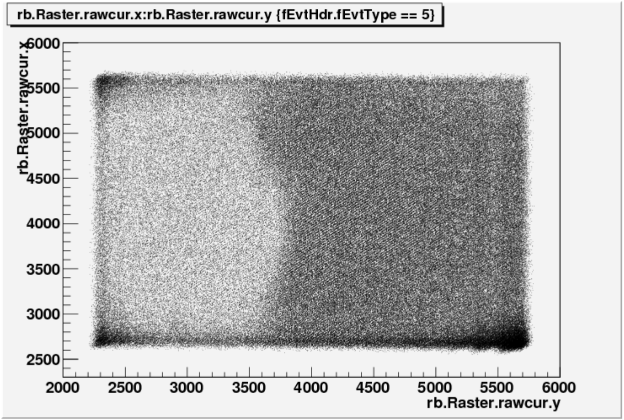
$$E_{miss}(DP') = E_{miss}(DP + \delta(DP)) = E_{miss}(DP) + \partial \frac{E_{miss}}{\partial(DP)} \delta(DP)$$
$$= E_{miss}(DP) + A(DP, \Theta, \phi, Y)$$

So an optimization involves finding the empirical polynomial $A(DP, \Theta, \phi, Y)$ in scattering coordinates. Finally we calculate:

$$\delta(DP) = \frac{E'_{miss} - E_{miss}}{\partial \frac{E_{miss}}{\delta(DP)}}$$

Effective Charge (Q_{eff})

^{209}Bi target, unfortunately, slipped of its frame



Effective Charge (Q_{eff})

^{209}Bi target, unfortunately, slipped of its frame

So we calculate an effective charge by:

$$Q_{\text{eff}} = Q_{\text{tot}} \left(\frac{A_{\text{eff}}}{A_{\text{tot}}} \right)$$

Effective Charge (Q_{eff})

^{209}Bi target, unfortunately, slipped of its frame

So we calculate an effective charge by:

$$Q_{\text{eff}} = Q_{\text{tot}} \left(\frac{A_{\text{eff}}}{A_{\text{tot}}} \right) (0.90 \pm 0.06)$$

Additionally we find some edge effects in the raster, which had to be cut and corrected for.

Second Run

There was a second run on January 2008

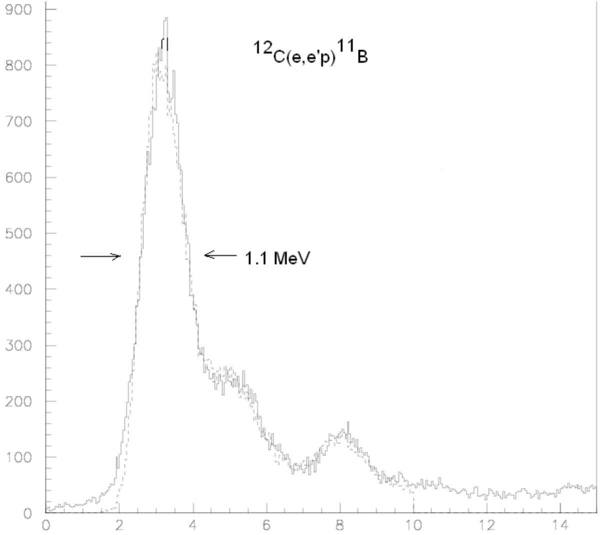
- Able to run target at higher currents
- Experience from first run guided target design for second run

GEANT fitting

GEANT produces good basis spectrum from which we can fit the individual energy peaks of the residual nuclei

- GEANT expects a perfectly corrected rastered spectrum
  - So one has to artificially gaussian broaden the spectrum to match the data.
- Perform the χ^2 fit
- If not satisfied with the fit
  - Vary the gaussian broadening until we get a good visual match

GEANT fitting



^{12}C cross sections after GEANT fit

Independently verified results, with independent definitions of a good visual fit. Studied cross sections with various spectrometer acceptances, and found the following results:

	dp (nc)	$\lvert dp\rvert < 0.03$	$\lvert dp\rvert < 0.015$
ϕ (nc)	$\sigma_d = 2.92$	$\sigma_d = 3.08$	$\sigma_d = 3.10$
θ (nc)	$\sigma_t = 3.52$	$\sigma_t = 3.59$	$\sigma_t = 3.64$
	$\sigma_d/\sigma_t = 0.83$	$\sigma_d/\sigma_t = 0.86$	$\sigma_d/\sigma_t = 0.85$
$\lvert\phi\rvert < .02$	$\sigma_d = 3.30$	$\sigma_d = 3.54$	$\sigma_d = 3.20$
$\lvert\theta\rvert < .04$	$\sigma_t = 3.59$	$\sigma_t = 3.65$	$\sigma_t = 3.70$
	$\sigma_d/\sigma_t = 0.92$	$\sigma_d/\sigma_t = 0.97$	$\sigma_d/\sigma_t = 0.86$
$\lvert\phi\rvert < .015$	$\sigma_d = 3.35$	$\sigma_d = 3.43$	$\sigma_d = 3.02$
$\lvert\theta\rvert < .03$	$\sigma_t = 3.61$	$\sigma_t = 3.69$	$\sigma_t = 3.73$
	$\sigma_d/\sigma_t = 0.93$	$\sigma_d/\sigma_t = 0.93$	$\sigma_d/\sigma_t = 0.81$

All cross sections listed are in units of 1x10^{-33} gm^2/(sr^2 MeV)

Possible vertical raster studies

We ask:

- Can a new target be used to study the optics for large vertical raster sizes
  - Such as a target with horizontal tungsten wires arranged vertically
- Perhaps other experiments can benefit from this