POLARIZED ELECTRONS AT CEBAF

An Innocent Bystander's View

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Why and how use $\vec{e}$

Delivering $\vec{e}$ to multiple halls

$\vec{e}$ experiments (highlights)

Hall B specific issues

WHY AND HOW USE POLARIZED ELECTRONS

Physics

measure physical effect that is too small to be observed as a direct change in reaction probability (cross section)

Strategy: amplify effect via interference with large effect

Technique

flip spin direction and look for changes

flip frequency >> time scale for change in experimental setup

average over many reversal cycles (eliminates noise and changes)

experiments easy (as long as beam parameters remain EXACTLY the same)

Types of Experiments

1. only electrons polarized

   parity violation: effects are very small (10^{-4} – 10^{-7})

2. electron **and** target polarized

   typical example: G_E^n in Hall C (effects 10^{-1} – 10^{-3})
   hadron typically detected in direction of momentum transfer

3. electron polarized **and** polarization of coincident final state particle measured

   typical example: G_E^p in Hall A

4. electron polarized **and** hadron detected away from momentum transfer

   typical example: pion electroproduction in Hall B's CLAS

DELIVERING POLARIZED ELECTRONS TO MULTIPLE HALLS

Problem

- only longitudinally polarized electrons are useful for experiments
- electrons for all 3 halls originate at the source with long. pol.
- but:

  transfer lines to halls are different

  energies to halls can be different

  → spin precession different for different halls

Solution

- use Wien filter **and** linac energy setting as free parameters

Practical Consequence

- one hall wants $\vec{e}$: no restrictions
- two halls want $\vec{e}$: perfect spin transfer for selected (periodic) energies
- three halls want $\vec{e}$: approximate solutions for selected (periodic) energies

POLARIZED ELECTRON EXERIMENTS (Highlights)

07/97 first experiment: $^{16}O(\vec{e},\ e'\ \vec{p})X$

bulk GaAs photocathode

single 1500 MHz laser

$P_e \approx (34 - 37)\%$

04/98 first quarter of HAPPEX parity violation experiment: $p(\vec{e},\ e')X$

bulk GaAs photocathode

single 1500 MHz laser

$P_e \approx 35\%,\ I \approx 100 \mu A$

08/98 first use of strained GaAs

single 1500 MHz laser, $P_e \approx 70\%$

Hall C: 100 nA on $\vec{d}$ for G_E^n

Hall B: 10 nA on $\vec{p}$ for spin structure function

Hall A: 10 μA on $^3\vec{H}e$ for spin structure function

04/99 HAPPEX II

strained GaAs

three 500 MHz lasers

$P_e \approx 70\%,\ I \approx 40 \mu A$

now all experiments use strained GaAs

single 1500 MHz or three 500 MHz laser

no current limitation, $P_e \geq 80\%$

TODAY's OPERATING CONDITIONS (October 26, 2001)

Injector strained GaAs photocathode
3 independent 500 MHz lasers

Linacs energy/pass E = 1.139 GeV (other options: 1.111, 1.167 GeV)

Hall A

experiment: $^{16}O(e, e'p)X$ $\rightarrow$ properties of nucleons in nuclei
target: waterfall
E_A = 4.620 GeV
I_A = (100–140) μA
polarization: unpolarized

Hall B

experiment: $p(\vec{e},\ e')X$ $\rightarrow$ meson production and N^* excitations
target: liquid hydrogen
E_B = 5.759 GeV
I_B = 10 nA
polarization transfer: optimum

Hall C

experiment: $\vec{D}(\vec{e},\ e'n)p$ $\rightarrow$ neutron electric form factor, G_E^n
target: solid state polarized deuterium
E_C = 3.481 GeV
I_C = 150 nA
polarization transfer: optimum

HALL B SPECIFIC ISSUES

Luminosity:

Hall B uses larges acceptance detector, CLAS

acceptance ≈10,000 larger than A and C

current required ≈10,000 smaller than A and C

want ≈10 nA (instead of 100 μA)

Polarization:

CLAS measures several reaction channels simultaneously

good chance that at least one of them will benefit from $\vec{e}$

→ Hall B experiments always want polarized electrons