

PHYS3710 Short experimental projects I
Department of Physics
The Chinese University of Hong Kong, Hong Kong
Topic: ***Verification of Special Relativity and β spectroscopy***
designed by
H.K. Wong, March 17, 2004

Topics you should know first:

1. Special relativity
2. β decay

Objectives:

1. Verify energy-momentum equation in special relativity.
2. Learn β spectroscopy.

Check-list for the project:

1. Review special relativity and basic nuclear physics. (Ref. 1)
2. Read manual (Ref. 2) and learn how to handle radioactive materials. (Ref. 3)
3. Set up equipment.

Please be careful:

- a. To pump down, use mechanical pump first to get $P < 100\text{mTorr}$.
- b. To break vacuum, turn off detector voltage and then close sorption pump valve.***

4. ***Part I: Momentum calibration***

Calibrate Hall sensor. Plot $B = a(V - V_0)$ for 1 mA sensor current.

5. ***Part II: (Kinetic) energy calibration***

- a. Plot energy spectrum of ^{137}Cs : intensity (counts/sec) vs. channel number.
(Note: counting time ~ 2000 sec.)

- b. Check linearity and offset using a pulser:

(Note: Detach preamp from detector first.)

Plot pulse height vs peak channel number: $H = b_H(k - k_0)$.

Energy calibration curve: $T = b(k - k_0)$.

6. ***Part III. Energy spectra: $N(T_e)$ vs T_e***

- a. Plot energy spectrum of ^{133}Ba .
- b. Plot energy spectrum of ^{204}Tl .

(Note: Convert channel number to T_e .)

7. ***Part IV. Momentum spectrum of ^{204}Tl :***

- a. Plot $N(p_e)$ vs p_e using $N(T_e) dT_e = N(p_e) dp_e$ where dT_e is related to dp_e .

8. ***Part V. Verification of special relativity***

a. Energy spectrum for various B (200 to 750 Gauss).

(Note: counting time ~ 2000 sec.)

b. Plot peak energy T vs. p .

c. Plot $\frac{p^2 c^2}{2T}$ vs $\frac{T}{2}$.

References:

1. K.S. Krane, "Introductory nuclear physics" (QC777.K73 1988)
2. Lab manual*
3. Radiation safety notes*
4. J.G. Couch and T.K. Dorries, "Measuring relativistic electrons in the undergraduate laboratory", Am. J. Phys. 50, pp.917-921 (1982).
5. J. W. Luetzelschwab, "Apparatus to measure relativistic mass increase", Am. J. Phys. 71, pp. 878-884 (2003).
6. G.J. Aubrecht II, "Comment on "Apparatus to measure relativistic mass increase,"" Am. J. Phys. 72, pp.970-971 (2004).

* available on CoursePage.