PRNC043

PRNC- 43

PUERTO RICO NUCLEAR CENTER

A SIMPLE DEVICE FOR HALF-LIFE MEASUREMENTS

OF HIGH GAMMA RAYS EMITTERS

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A Ginpla Device for Half-Life Mesgurenents of High Gana Rays anitters!

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N.S. 7. Divieton

ork performed at Puerto Rigo Muclear Center,

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Comission Contact AP-(40-1)-1855.

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: 1 de Fy Facestt, Santiago Pinte

Puerto Rico livslenr Center,? Naclenr Selence and Technology Mirision

Haseaer,

ABSTRACT

The bec orinetple Involved is the Gleintegrstion of deuterium

ty high enc: y goa photons te produce fast neutrons, which are

otereted ty 15 optim thtelmese of paraffin vo eebieve the best

alance etvoo? ncderaiton aad cepture, ?The moderated neutrons are

detected ty « >, counter.

Tr) cotor 49 eade of te concent

fe volyethylene bottles

with @ 2s d vith B,0. The outer bottle has » dtsneter

of 12.4 cx, ihe Caner Uottie te filed with paraffin and @ 1.8 em.

hole @riticd to iccete « BF counter.

The Peleat css of Me?, 97, cat, MoM, AsT®, and Poston

products fren the PRM

fuel elements have been weasured.

Prerat

Cmate-ton.

+ Usterraity of Puerto Ries for the Atomte meray

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?Tue results of other workers(*+7,3,4,5,8) wich neutrons produced

tm the phote Motntegration of deutertis

indicate the possibility of

studying sous nue?

crozertien, ssing &

wutrope. For this it

to of interest to

veloy ® oimple y

cron convertion device,

raction contrtbute te the cross section of the

Wy nip

etton: phetnede

fand yhotomgnatic internetions. In

?woth cases che ine

ent. y ray interacts vith only the proton. Fig. 1

shove the cvous section for the disintegration of D ty electric

Alpole abeorstton. The naxtoum cro

section of 2.23 wb. occurs

at B= NG mee.

Monoenergetic rays profuse @ nonoouengetic group of neutrons.

Tt can be

wn that themerey §, (in nev) of the enitted neutrons

from a deuteriun target le aporoxinately equal to:

a suef, - 9

{@ the shresnolé energy (in nev) tor the (y,n) reaction

a

where, 2

and 8, ic the photon enmay up to 10 sev.

Since for

10D (yy0) H renction, § = 2.23 mev., a rough

estizate of the photoneutron energy ?p terms of the enerey of the

7 rays exittod from various reatotactopes can be obtained fron eq. (1).

Although most of yields from 9 (~,n) p have been obtained!**) these

will change vith the geomatry and distance of the source fron the

aetector.

1, B, BeLL and G, aitot, Pys. Rev. 79,280 (1950)

2. R. Mobley and R. Laubenstetn, Phys. Rev. 89,509 (1950)

3. R, Shor J. Hetpern and AtMann., Phys. Rev. Bk,387 (1952)

Wa, se

bere, Paya. Rev. 71,497 (2947)

5. S. Russ-l, D. Sachs., A.tittenters and R.Pields: Pays. Rev. 75,545 (1958)

6. 8. Beretein, M.S. Preston, G.io1? and R.Siattery Phys. Rev. 71,545 (1947)

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?A, DESIGN OF THRESHOLD DSTESTOR: Since neutrons coming from the photodisintegration of D have energies of the order of @ fraction

of an mev., it fe necessary to therealize then prior to thelr de-

tection with BP, counter.

?An experinent ume performed to estinate the optimum ehicknet

of paraffin required for maximum number of neutrons detected. Fig. 2 shows @ diagram of che experimental set up. Fig. 3 shove the ex-

Perinental reeults ond it wes concluied that » maxima count rate

was obtained vith o paraffin thickness of bout 7 om. Using @

ere

fin thickness of 5.5 cm. a good balance between moderation and

capture was achieved.

Fig. 4 shows the devatle of construction of the threshold de-

tector. Tt ie made of two concentric polyethylene hotties with a

2m. gap filled with DO. The outer bottle has a dteucter of 12.h om,

?The {nner vovtle te filled with paraffin anda 1.8 en. hole drilled

ft the conter to locate « BF, counter.

3, IRRADIATIONS: The y-ray emitting Leotopea were activated

in the PANG renctor operated @t the pover level of IMM. and at a

flux of 2 x 10m ea*see"? Either the sviming pool or the

Pheunatic systen facilities vere used. The activities obteined

were up t0 0.5 ©.

MATERIALS: ?The trradieted anterials vers enalytical or yesgent grate NaZCO,, Ye power, 080, §, A,0,, Ss ant UD_(10,), .6H0.

D. COUNTING PROCEDURES: Depending upon the > source, each

experizent vas performed

follove:

Determination of the background in the absence of

?the source.

2+ Determination of any sontsation in the BF, counter

due to the y radiation. It vas noticed that at 1507.

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above the plateau, y-rays affected the

counter.

3. A eyster eintlar to the thresholé detactor,

Tout without

»,0 was placed nour the source.

Ir

source was not Lesion products, the

count rate due to photodisintezration in

peraftin was neghiethie

Tf che gamma source wme the £4

on products

fe vatting time ven required for the decay of

etl delayed neutrons.

RESULTS AND DISCUSSION

Significant response of the detector toy mys, indicates that such photons are above the threshold of 2.23 sev. In euch a case, the detector can be used to measured accurately helf-lives of Andividual or aixtures of y emitters. Furthemore, this technique permite the investigation of nev high nergy > rays.

8) He®* nd Mn; The decey rate of these radionuclides oe measured together. Both sources were placed in euch 8 vay thet each radiomuclide contributed to about the Fig. (5) shove the decay curve reaolved into Lte componente. The half-lives measured, 15 hr. for Na®* and 2.58 hr. for Ma agreed vith those measured ty standard procedures(7) ,

) cat®: Mais tsocope we choosen to confirm the existence of ite high energy y rey recently reportea'®) Fig. (6) shove the

7. D, Struminger, J. M. Hollender and G. 7. Sesborg. Rev. of Nod. Phys., 30, 585 (2958)

8. G. D. O'Keltey, N. H. Lazer, and 2, Sichler Phys. Rev. 101, 1059 (2996).

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decry curve. ?The half-life of 6.8 cin. measured, agreed with that obtained ty stender* oroecaures.

e) Ag": Taree > rays over 2.25 nev. are or as7e(@)

persed

The tine of irredetion vac 4 hr, and the unowt 1.5 g. The

count race wie folloved for 72 br. Fig. (7) chowe the decay curve;

ok with chat reportea(?)

4) ST: 4 single experiment vee pestormed ?rradfezing eWphur.

Sines tne syns cession aad Loctoy.e concentimtion of S are

very lov, the count rate after 95 nin. irradiation wae also lov.

Fig. (8) shows the decay

ee. of 5.2 min. measured,

agreed with other reported ental?)

©) Se: Several irmadintions were perfomed, using up 10 g.

of natural Se. No evidence vac found of the exiatence of the y rey

of 2.29 nev(#1),

Three expertnenss vere performed vo ctudy the ¢tesion products

decay rate:

2. ith the reactor shut dom, a survey vas unde

vith the detector in the pool to Tind a position

where the background wee mbout 109 ¢/min, then

8 fuel element from the reestor was placed at.

about 2 Pt. fron che detector. Fig. 9 shows the gross

9. R. Ghrats, RA. Riced and R.V, Lieshart, fuel. Phys. 25,462 (2959)

10. J. G. Snot and ¥.c, Young, Much. Se, and ang. 5,55 (2959)

AL. RG, Cochran and W.it, Reatt, Pays. Rev. 115,952 (1959)

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ctivicy end the foar componente resolved Crys the curve, ?The

half-lives of chase componente vere 3h br. bb heey LE bray

end 27 stn.

2. One gran of urenyl nitrate was ievsilated for 1

in. Neasurenente vero ede 2 rin., after

Arredistton co that che deey of che dslayed

neutrons would be negiigible with respect +0

the longer Lit photoneutrons. Fig. 1° shows the

gross activity and the three componente revolved tron the curve.

The half-lives of these componente vere 27.5 sin. 7.5 sin, and

2.25 min. Thie experiment confimed the ayicten

of 27 ain.

ectivity end shoved another ectivicy much shorter than 2

25 ain.

?The shorter ones vere difficult to resolve Necause of the presence

of delayed neutrons:

To assign 2 nuclide to each measured half-life, the following

characteristics of fission protucts were considered:

1. Hate-Ltves teken trom the reforeneas(7>2) vere

compared.

22. Wi, Seelmnn - Eggebort etal. - Tiakidkerte ait Srauterumgen

<2 Auflege -Rarlersbe (2951)

J-Bloneke ond M. Tota = Om 2127 (1957

GM. iron: Atonte Suergy sete (Stited ty %. 6. Tueckmur)

3-97 = Ba

Jervorthe (1962)

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Tne radtossotopes vith » rays over 2.25 Mev

were choosen:

In sone cesee, comprehensive data of *

charecteristics of the radicisotope Se not

yet avatler chowe uslides

with totel disintegration eneray over 2.23 Mev

sone chooeen

4. The Sesion yield of she teovope, vas also taken

into sesoune!

1.3 min: No qucltde with this half-life wae reported.

However, 7° ana xe8® with 7 1

2.25 Mev ere Ynown'*?), te can be assused thet these nuclides

9 and 2.8 stn., and y rave

are measured together with other of ghorver half-lives. Tt should ve

kept in mind, thet this half-ite was difficult to resolve, due to

the delayed neutrons activity.

1/2 + 7.5 mtn: Tt agrees vith that reported for sr and

Rai®?, However, for these isotopes, » rays over 2.23 Mev are

luminovn. On the other hand, the total disintegration energy of these

are 5.25 ov end 4.16 Mev.

D1/2 = 27.5 min: Thie ean attrshuted co a mixture of cal9?

(52 min.) end ¥* (20 mtn.)

Tie = 16 mre: Algo to a sixture of Ke®? and Lat?

D1/e = Mk hr.: This agreed vith those reported for RAS

and sv, However, they have no 7 rays over 2.23 Mev. reported.

Pi/e +54 nr. The only radioteotope with high > ray over

2.23 Mev., and vith half-Life in the neigtbortocd of 5h hr., 40

tal, vith T1/2 +40 hr, The Sh hr. meseured half-life, can be

1B. A. G. Cameron, A revised seai-emptrical Atomic Mase formla-

CORP 690 (1958) .

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explained for this tsotope, only on the baste of an equilsbriue

vith BeM° in the fieston chen, In such @ case, hovever, the Lal4? activity obtained in fteston vould be 5 tines grater than thet for 340mm, vaich is not easy to accept. Thexefore, this half-life should be attributed to a new fission product, with 7 over 2.23 Mev. or an equiltbriun with a daughter of these characteristics.

Ainoviedgnent- The authors vish to thank Mr. E. Barcelo? and his start

for the irradiations and assistance in the Reactor Butlding.

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IN MILIBARNS

Fig. 1

4 = 1

® 16

PHOTON ENERGY (Mev.)

Paoto-electrie cross section of the deuteron.

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3009}

8

ACTIVITY (e/m)

Fig. 3

2 4 6 8 10 1416 182082

THICKNESS OF PARAFFIN (Cm.)

Neutron attenuation curve for obtaining the maximum paraffin

thickness.

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THRESHOLD DETECTOR

be asem a! am

S

aa

NEUTRON

OE TECTOR

2,0 (3.04

THICKNESS

POLETHYLENE:

?CONTAINER

bh 2408 4

Fig. 4 Sehenasic Magram of the decestor,

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server oA

Me.

5

?yee

?TME ?revs

?Typteal decay curve of Na** and ¥n®.

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ACTIVITY (e/m)

TIME (min)

Fig. 6 Decay curve of Cat®

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actwiry (6/10

Pte.

7

TINE now

Decay curve of AsT®.

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aeTivity (erm)

Fig. 10

© % 36 3

TIME (nin)

Decay of the 1 min. exposure of U0_(WO,) 68_0.- Curve T:

total activity: IT: extrapolated activity of 73/2 = 27.7

ain.; ITT: extrapolated activity of T 1/2 = 7.8 ain; curve

IV : activity of 2.3 min.

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