INVESTIGATE THE BIPO DECAY WITH FADC 500MHZ

Le Cong Hao(1), Doan Thi Hien(1), Vo Hong Hai(1), Tran Duy Tap(1), Chau Van Tao(1),
Masaharu Nomachi(2), Shinya Kanamaru(2), Yosuke Kono(2),
Yuta Otake(2), Itahashi Takahisa(2)
(1) University of Natural Sciences, VNU-HCM
(2) Department of Physics, Osaka University, Japan

ABSTRACT: Investigation of BIPO decay to measure the purity of $^{208}$Tl and $^{214}$Bi in the $\beta\beta$
source foils plays an important role in SuperNEMO international collaboration project. In this article, we
report the successful results in the measurement of both long and short life of BiPo events with FADC
500Mhz. Especially, a very low of BiPo events from Yunohara powder is correctly detected and measured.

Key word: BiPo decay, double beta decay, Yunohana, ga ta

1. INTRODUCTION

Today's experiments in searching for neutrino less double $\beta$ decay (0v2$\beta$), as well as
projects of next-generation experiments (SuperNEMO), have run into a serious problem
in monitoring the radioactive purity of structural materials. The required sensitivity of the
experimental data is so high that the traditional low-background semiconductor detectors are not
sensitive enough to detect the radioactive contamination of structural materials by the
uranium and thorium series of natural radioactivity. In the SuperNEMO experiment the
content of $^{208}$Tl and $^{214}$Bi are the main background source in the search for 0v2$\beta$ decay
[1]. Observing the so-called BiPo process (a sequence of decays of radioactive bismuth and
polonium isotopes followed by an emission of charged particles) allows one to reach such a
sensitivity. This process is part of the chain of radioactive decays of natural-radioactivity
uranium and thorium. The energies of the electrons and $\alpha$ particles produced in these
decays are sufficient enough for them to be
registered adequately in plastic scintillator
detectors; the mean lifetimes of the intermediate
isotopes are no longer than several hundred
microseconds, which permits the sequential
registration of decays. In this article, we had
success in the measuring both two long and
short life of BiPo events from Yunohara powder
by using two scintillator detectors and FADC
500Mhz. Also in this case, a very low of BiPo

2. MATERIAL AND INSTRUMENTS [2]

2.1. Material

Purpose of the BiPo decay experiment is to
measure the contamination in $^{208}$Tl and $^{214}$Bi of
the $\beta\beta$ source foils which are used for double
beta decay experiment. And material to make
BiPo detector is called Yunohana powder which
contains BiPo decay. In this study Yunohana is
placed as sandwich of two photomultipliers
(PMTs)

2.2. Instruments

Two scintillator detectors (6cm×6cm×1cm),
advanced TCA-crate, trigger module, SpW
network, Spacecube, Pc and FADC 500MHZ are
used for this study.

3. EXPERIMENT [2]

The decay chain of BiPo processes is
showed in Fig. 1.
In this work, the measurement of BiPo decay includes the detection of the $\beta$ particle in one PMT and the other for the delayed $\alpha$ particle.

Fig. 1. BiPo processes for $^{214}$Bi and $^{208}$Tl

Fig. 2. Set up FADC 500 Mhz for the experiment

For this purpose, the carton paper is placed behind the Yunohana source foil to absorb all of the $\alpha$ particle to PMT A. It means that the Yunohana only faces to PMT B. Therefore, the PMT A gets the signal of the $\beta$ particles only. A true BiPo event is only in case PMT B detects the $\alpha$ particles and PMT A detects the $\beta$ particles in different time. If two hits in time are observed in the two PMTs, this is not a BiPo event.
Before the measurement of BiPo decay from Yunohana, we have to calibrate energy to identify the energy of $\beta$ and $\alpha$ particles emitted from BiPo decay. And The $^{207}$Bi isotope with relatively high electron yield of 92.26% ($Q_\beta = 976$ keV) and half-life of 31.55 years was used.
Fig. 4. Scheme of the detector-source arrangement: (a) Measuring of both gamma and beta rays; (b) measuring of gamma rays only.

Fig. 5. Energy calibration for $^{207}$Bi
4. RESULTS AND DISCUSSION

The Yunohana sample has been measured in 9 hours with number of events: 30000 visual scaler: 30302. After taking data, we used “Ana” program (Nomachi’s group) and “Paw” (Cern) software for the analysis BiPo events.

![Graphs showing energy levels](image)

**Fig. 6.** Energy of the β and α particles

The energy of the β and α particles emitted from BiPo decay in the Yunohana sample is identified as showing in Fig. 6. And haft - time for both long life and soft life are obtained as fig 7
5. CONCLUSION

By using FADC we can observe both long and haft life in BiPo source that is limited by experiment using NIM & CAMAC instrument [3]. However, there are also some present problems for FADC:
- Data size is too large
- Event selection can not be done until data are copied to CPU memory

Despite of the draw-backs mentioned above, FADC is the most suitable choice thank to many advantages this method can be used for good investigation of the BiPo decay.

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NGHIÊN CỨU PHÂN RĂ BIPO VỚI FADC 500MHZ

Lê Công Hảo(1), Đoàn Thị Huyền(1), Võ Hồng Hải(1), Trần Duy T appalling(1), Châu Văn Tạo(1), Masaharu Nomachi(2), Shinya Kanamaru(2), Yosuke Kono(2), Yuta Otake(2), Itahashi Takahisa(2)
(1) Trường Đại Học Khoa Học Tự Nhiên, Đại Học Quốc Gia Tp.Hồ Chí Minh
(2) Đại Học Osaka, Nhật Bản

TÓM TẮT: Ngày nay việc nghiên cứu phân ră BiPO nhằm xác định sự tính nhiệt không nhiễm bán 208 Tl và 214 Bi của những phổ nguồn phát ββ đồng vai trò cực kỳ quan trọng trong dự án quốc tế SuperNEMO. Trong báo cáo nay chúng tôi đã thành công trong việc xác định chính xác cả hai lượng sợi sỏ ngắn và dài của những sự kiện phân ră BiPo với thiết bị diện tử FADC 500MHZ. Trong đó rõ rệt nhất là sự xuất hiện của những sự kiện BiPo trong bột Yumohara đã được phát hiện và được nhận một cách chính xác.

Từ khóa: Phân ră BiPo, phân ră double beta, Yumohara

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