2015.03.28 – 2015.04.03

進捗報告

H. ITO

DOI-PET/WLSF pp.2 - 7

22Na test
GAGG + R-3 coll. eff. estimation
JPMS109事前スライド登録

M-ACC
なし

SrCounter pp.8

ANIMMA Full paper (CMS)の作成

Schedule pp.9
まとめ pp.10

DOI-PET/WLSF

2015.03.28 – 2015.04.03
進捗報告

前回までのおさらい

3/8-14：MPPCのcalibrationを実施
EASIROC PreAmp 150
SlowShaper 時定数 50 ns
におけるHV-Gainと
S/Nによる適正電圧を決定した。

3/16-27: 22NaでWLSF(R-3)読出しとGAGG直接読出しの関係を調べた。また、位置分解能測定を開始した。

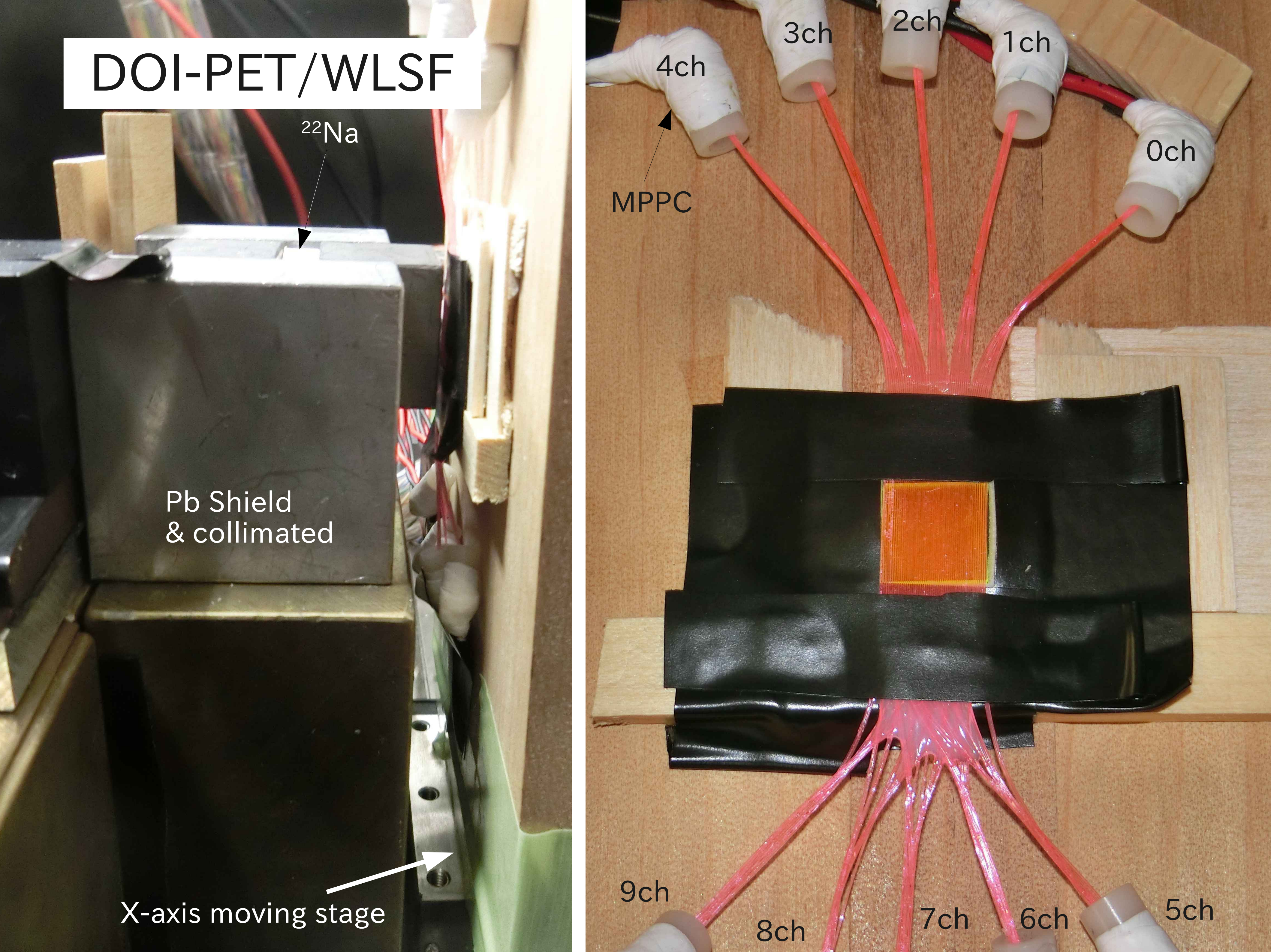
- 実際にGAGGとWLSF(R-3)を使用して、PMT読出しで、WLSF経由による光電子数を評価する。
- 位置検出のために光量は十分かを確認する。
- GAGGのエネルギー分解能を調べる。

今回の仕事

4/4 – 4/9: コリメータを細くして。位置分解能測定を撮り直した。

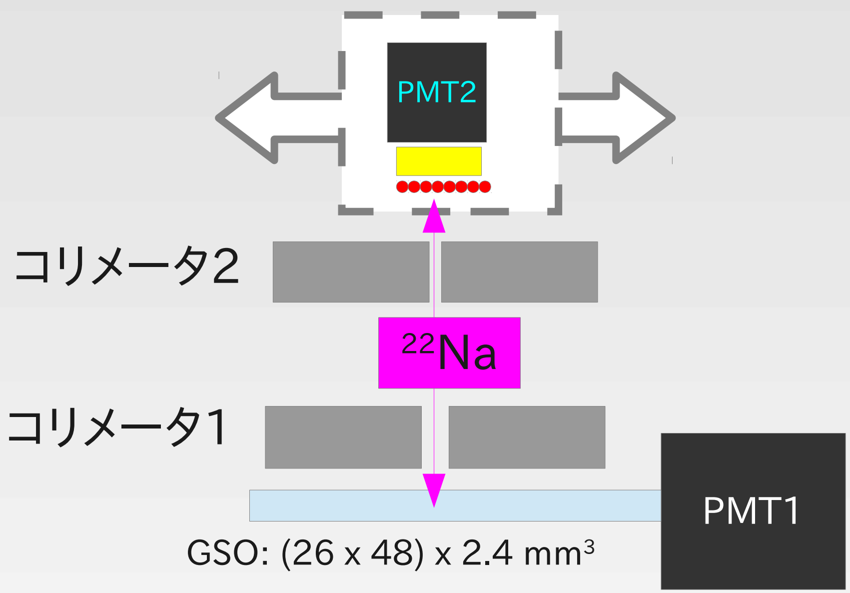
- GAGG側のコリメータを直径2mm
- GSO側を5mm
- 2mmステップから2mmステップで見よう

1. 医学物理学会の事前スライドの登録4/9必須
2. ANIMMA-2015兼子さんのPET/WLSFのFull paper (CMS)の手伝い


DOI-PET/WLSF
^{22}Na
Pb Shield
& collimated
X-axis moving stage
4ch
3ch
2ch
1ch
0ch
MPPC
9ch
8ch
7ch
6ch
5ch

setup

セットアップ



コリメータ2:
L=20 mm
Φ=2 mm

コリメータ1:
L=20 mm
Φ=5 mm

GAGG
D=2mm

WLSF(R-3)
d = 0.4 mm
25 strip

GSOで光電効果が起こった場合は必ず、GAGGには同様の立体角で壁に当たらず入射しているはず。

PMT1とPMT2の光電ピーク領域でデータカットしてWLSF(R-3)に接続されたMPPCの信号を解析する。

ガンマ線の入射位置を少しづつ移動させて、再構成位置との線形性を確認する。

DOI-PET/WLSF

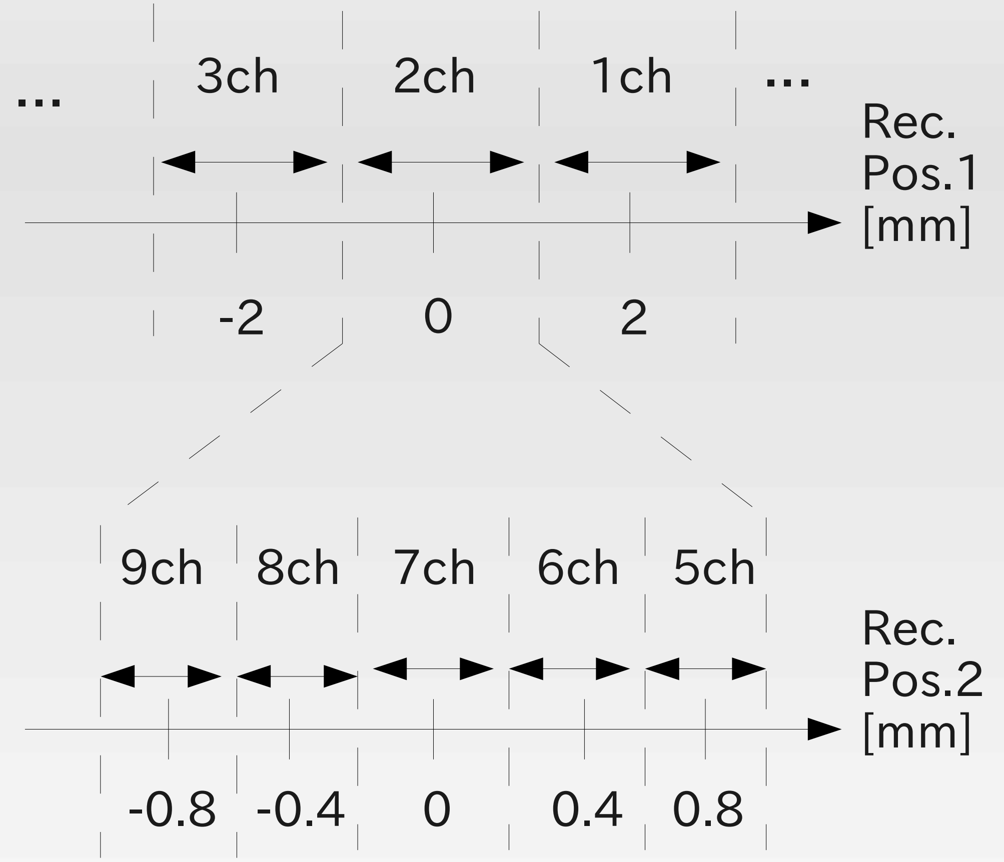
2015.03.28 – 2015.04.03
進捗報告

解析手法

MPPCのp.e.とch番号から位置を
再構成する。

X1 = Σ(qi* di *(2 - i))/ Σqi
@ i = 0 – 4, di = 2 mm
X2 = Σ(qj* dj * (7 - j))/ Σqj
@ j = 5 – 9, dj = 0.4 mm
X = X1 + X2

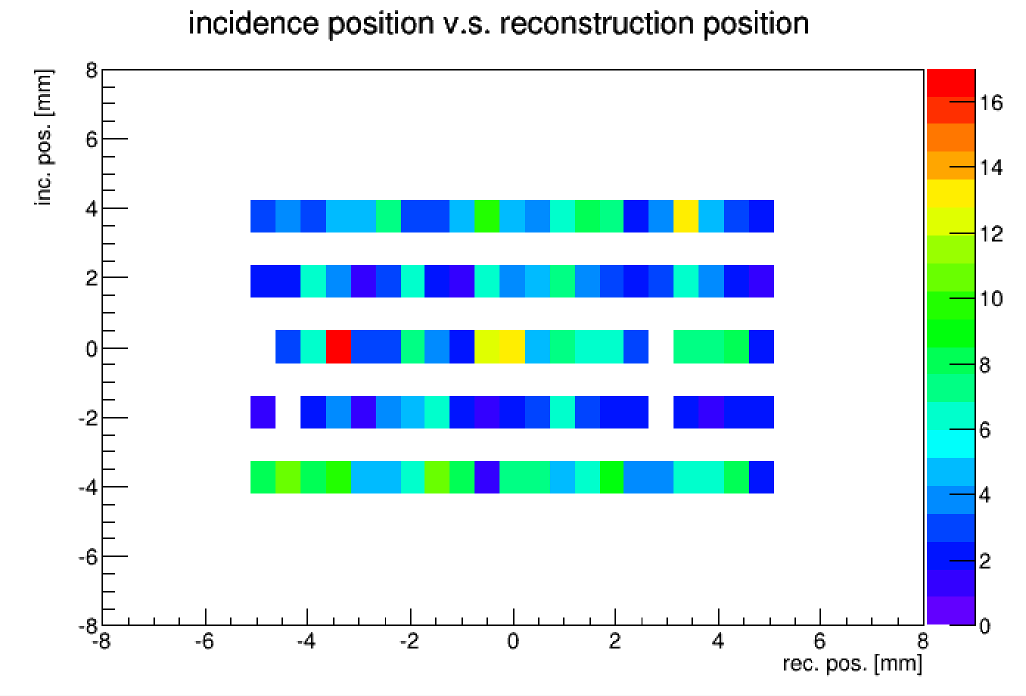
Qiしきい値は0.5p.e.とする

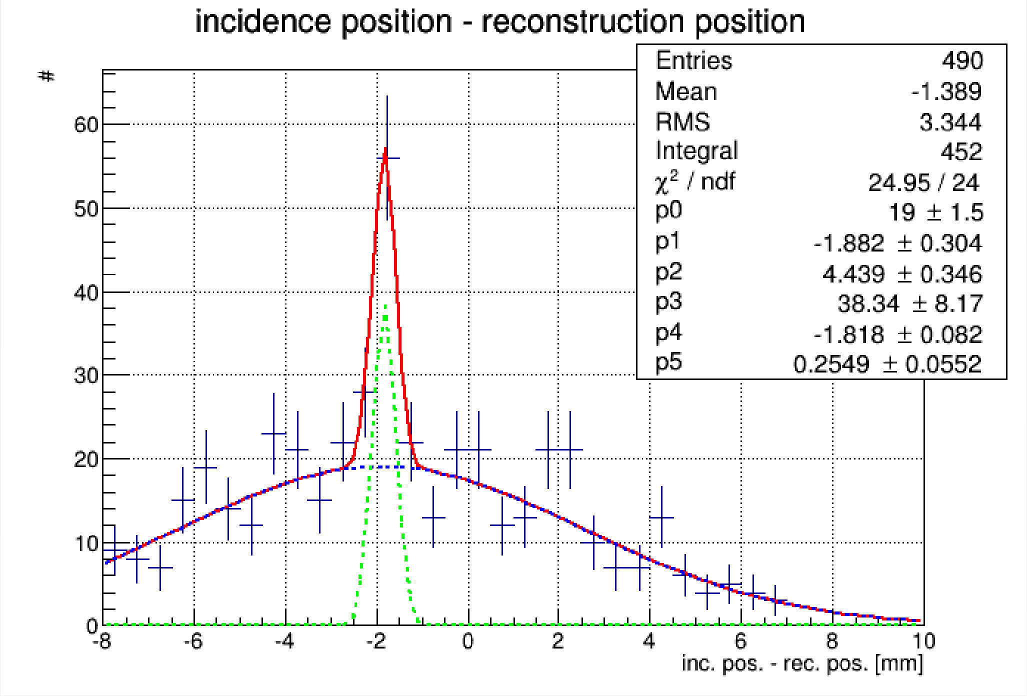


DOI-PET/WLSF

2015.03.28 – 2015.04.03
進捗報告

結果





入射位置と再構成位置の関係
これだけだとあまりわからない

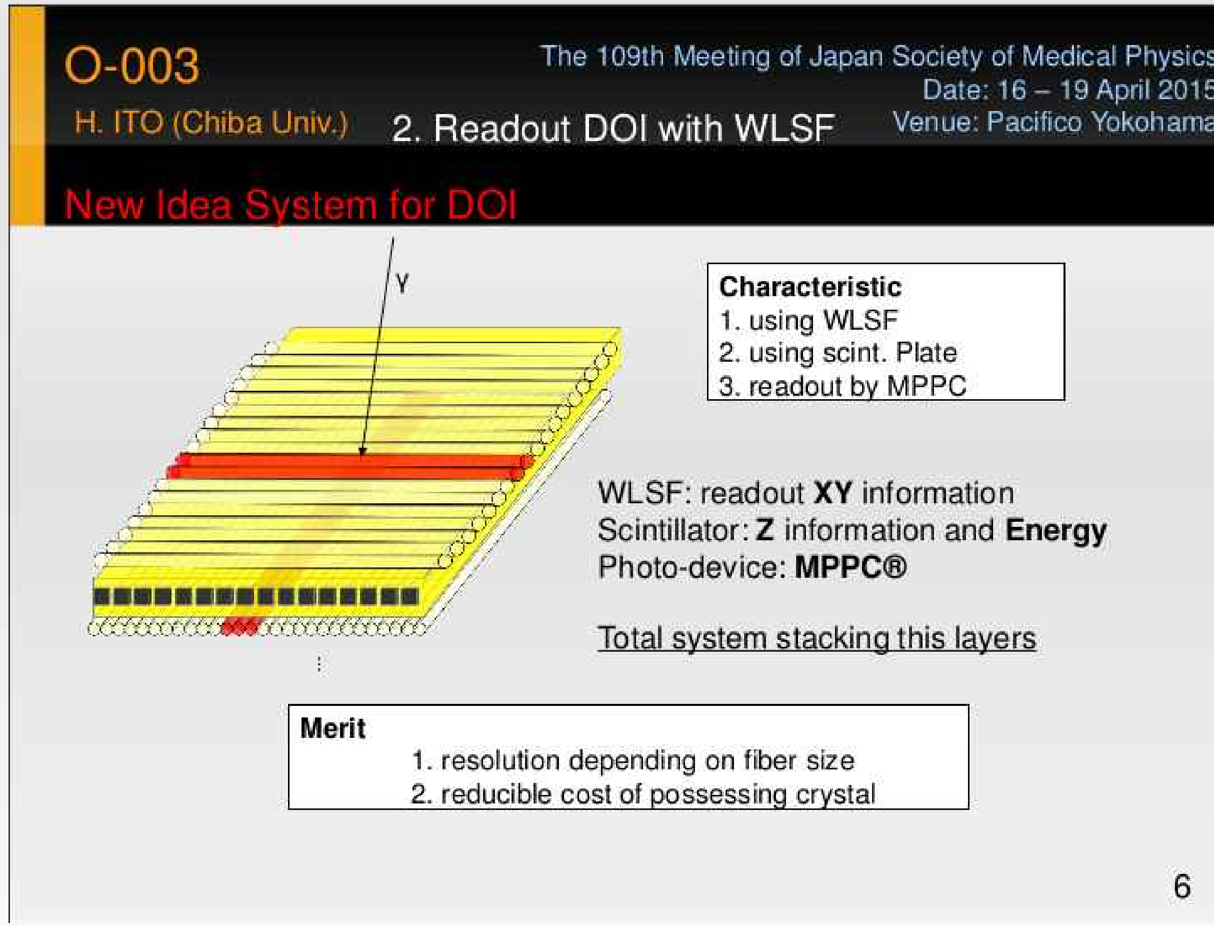
分解能:標準偏差0.255mm
FWHM=2.35σ
Achieved 0.65 mm

DOI-PET/WLSF

2015.03.28 – 2015.04.03
進捗報告

医学物理学会第109回大会
　事前スライド登録
　登録完了

こんな感じ →
全17ページ
発表時間10分
　口 7分
　質 3分



内訳:
P1 – 5: 1m00s
P6: 1m00s
P7 – 9: 0m30s
P10 – 11: 0m30s
P12-13: 1m00s
P14,15: 1m00s
P16: 1m00s
P17: 1m00s
計 7m00s

SrCounter

2015.03.28 – 2015.04.03
進捗報告

ANIMMA Full paper (CMS) dead line 4/6

提出完了

1. Introduction
1.1. The Risk of Contaminated Water
1.2. Difficulty of Radioactivity Measurement
1.3. The inspection by chemical extraction
1.4. This study purpose

2. Reall-time ^{90}Sr counter
2.1. Scintillating fibers trigger counter
2.2. Aerogel Cherenkov Counter
2.3. Cosmic ray veto counter
2.4. Electronics
2.5. Mechanism of identification of ^{90}Sr

3. Performance estimation and demonstration
3.1. Performance estimation
3.2. Demonstration in environment existing
3.3. Uniformity of the sensitivity

4. Consideration and conclusion
4.1. Detection Limit of Bq/cm^2
4.2. Detection Limit of Bq/kg
4.3. conclusion

Real-time ^{90}Sr Counter

Hiroshi ITO, Soorim Han, Naomi Kaneko, Hideyuki Kawai, Satoshi Kodama, Atsushi Kobayashi, Makoto Tabata

***Abstract*—Radioisotopes have been emitted around Japan due to a nuclear accident at the Fukushima daiichi nuclear power station in March 2011. A problem is the contaminated water including the atomic nucleus which relatively has a long half-life time and soluble such as ^{90}Sr, ^{137}Cs. Internal exposures by ^{90}Sr are more dangerous than ^{137}Cs's because Sr has effective half-life time of 18 years and property of accumulation in a born. We have developed real-time ^{90}Sr counter which is sensitive beta-ray of maximum kinematic energy of 2.28 MeV from ^{90}Sr and insensitive of beta-ray of maximum kinematic energy of 1.17 MeV and gamma-ray from ^{90}Sr by Cherenkov detection. This counter composes of Cerenkov counter, trigger scintillation counter and veto counter. Silica aerogel for Cherenkov counter can obtain refractive index between 1.017 and 1.049 easily. And wavelength shifting fiber (WLSF) is used as a light guide for extending effective area and producing lower cost. A mechanism of the identification of ^{90}Sr is explained in following. In case of ^{90}Sr, when the trigger counter reacts on the beta-ray from ^{90}Sr, aerogel emits the Cherenkov light and WLSF reacts and read the Cherenkov light. On the other hand, in case of ^{137}Cs, the trigger counter reacts on the beta-ray, aerogel stops the beta-ray and Cherenkov light is not emitted. Therefore, aerogel has a function as a radiator and shielding material. the gamma-ray is not reacted on the lower density detector. Cosmic rays would be also reacted by the veto counter. A prototype counter whose the effective area is 30 cm × 10 cm was obtained $(2.0 \pm 1.2)^{3}$ of mis-identification as $^{137}Cs/^{90}Sr$. Detection limit in the surface contamination inspection depends on measurement time and effective area mainly. The sensitivity of wide range, $10^{-2} - 10^{4}$ Bq/cm^2, is obtained by adjustment of detection level in circuit of this counter. A lower radioactive sample ($< 10 - 2$ Bq/cm^2) allows be detected significantly by heating treatment to evaporate water shielding the beta-rays.**

I. Introduction

In 2011, the nuclear accident at Fukushima daiichi nuclear power station in Japan has emitted radioactivity around Japan. Even now, this impact has not disappeared yet. Particularly, an important problem is the contaminated water including the atomic nucleus which relatively has a long half-life time and soluble such as ^{90}Sr, ^{137}Cs.

Manuscript received April 6, 2015.
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A. The Risk of Contaminated Water

Atomic nuclear including in contaminated water by radioactivity are ^{90}Sr and ^{137}Cs mainly. ^{90}Sr is Alkali earth metal and has physical life-time of 29 years, biological life-time of 49 years and effective life-time of 18 years. On the other hands, ^{137}Cs is Alkali metal and has physical life-time of 30 years, biological life-time of 70 days and effective life-time of 70 days. When the nuclei is absorbed in the body, ^{90}Sr is accumulated into the born. In the case of ^{137}Cs, it is flowed out by the basal metabolism. The effective life-time τ_{eff} is defined as

$$\tau_{eff}^{-1} = \tau_{phys}^{-1} + \tau_{phys}^{-1}, \quad (1)$$

which τ_{eff} is physical life-time and τ_{bio} is biological life-time, and describes the incubation period in the body.

After the ^{90}Sr emitted into the sea, these accumulate into the fish. Therefore, we have dangerous to take them. Since of the ^{90}Sr's property accumulating into the born, there is possibility that the fish is accumulated them depending on the period from the accident. A reference value of radioactivity which is included in the food has been defined as 100 Bq/kg by Health, Labour and Welfare phase, Japan in 2012.

B. Difficulty of Radioactivity Measurement

^{137}Cs has decay mode: (1) beta-ray of maximum 1.17 MeV and (2) beta-ray of maximum 0.51 MeV and gamma-ray of 0.662 MeV. Since of detection 0.662 MeV spectrum, ^{137}Cs is identifiable easily. Adding since of gamma-ray's property of permeability, it is possible to suppress background from beta-ray of small energy by sheltering measurement. On the other hands, ^{90}Sr has decay mode of 2 beta-rays of maximum 2.28 MeV and 0.55 MeV. beta-ray detection is only surface contamination inspection because it has less permeability. And in the case of environment existing ^{137}Cs, it is difficult to identify ^{90}Sr by background of ^{137}Cs's beta-ray.

C. The inspection by chemical extraction

Schedule

2015.03.28 – 2015.04.03
進捗報告

4/11: ポスター作成と発表練習
4/14: RI教育訓練
4/16: JPMS109発表当日
4/17: 健康診断
4/19-26: ポルトガル出張
　　4/22: Srカウンター発表当日
5/5: IEEE 2015Abstract〆切

2015年 4月

SUN	MON	TUE	WED	THU	FRI	SAT
			1	2 exp3	3	4
5	6 ANIMMA Full Paper	7	8	9 医物スライド締め切り	10	11
12	13 ポスター完成予定 発表練習	14	15	16 医学物理学会	17	18
19	20 ANIMMA@ポルトガル	21	22 発表当日	23	24	25
26	27	28	29 昭和の日	30		

2014年 5月

SUN	MON	TUE	WED	THU	FRI	SAT
				1	2	3 憲法記念日
4 みどりの日	5 こどもの日 IEEE 2015 Abstract〆切	6 振替休日	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

まとめ

● DOI-PET/WLSFはとりあえず結果が出た。
- 入射-再構成によるヒストグラムでFWHM0.65mmのDOI分解能が得られた。
- やっぱりそれでも統計数が少なく、入射と再構成の関係は見えにくい。

●SrCounterのANIMMA Full paper (CMS)の提出完了
●DOI-PET/WLSF:JPMS109事前提出の完了

●スケジュール
4/11-15: ポスター作成と発表練習
4/16: 医学物理学会発表当日(横浜)
4/19 – 26: ANIMMA のためポルトガルへ
おそらく、そのあと学振を出す必要があるから、書類作成要