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論文 / 著書情報
Article / Book Information

題目(和文)	健診に利用可能な小口径全身PET装置の開発可能性に関する研究
Title(English)	Research on Feasibility of Small Diameter Entire-Body PET for a Physical Examination
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

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（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	Information Processing 専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of (Engineering)
学生氏名： Student's Name	ISMET ISNAINI	指導教員（主）： Academic Advisor(main)	Takashi Obi
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The current Positron Emission Tomography (PET)'s design is towards entire-body scanner. Despite of its high production cost, entire-body depth-of-interaction type PET scanners were expected to offer many benefits such as shorter time and dynamic PET acquisition, higher sensitivity and Noise Equivalent Count Rate (NECR). We investigated the advantage of establishing an entire-body PET scanner using smaller diameter. The entire-body scanner has an axial field of view (FOV) of 2 meter. The simulation was conducted using Monte-Carlo based software of Geant4 Application for Tomographic Emission (GATE) version 6.1, running on a 4 processor machines.

There are two main experiments as a benchmark of the performance of the entire-body PET namely the sensitivity and NECR test. First of all, these experiments were conducted using a scanner diameter of 80 cm. These simulations showed that in comparison to the conventional scanner which has a diameter of 80 cm and an axial FOV of 20 cm, the entire-body scanner reach a gain up to 68 in terms of sensitivity and 17.9 in terms of NECR peak. However, there are still many problems remain such as high cost production, parallax error and others. There are some solutions to these problems, for example the parallax errors can be reduced by implementing a depth of interaction (DOI) detectors in the scanner.

In order to minimize the problem of high cost production while maintaining high performance of such entire-body scanner, in this research, we focused on the feasibility of a smaller diameter of entire-body PET scanner with 60 cm diameter. We are interested in the high gain of sensitivity and NECR value, which can support the application of cancer screening in japan. The smaller scanner entire-body PET shows that it can achieve a gain almost 80 times (68 time for 80 cm diameter) in terms of system sensitivity and 15 times (17.9 times for 80 cm diameter) for NECR peak value in comparison to the conventional 20 cm length PET 80 cm diameter. It yields a high NECR peak value of around 835 kilo counts/second at 125 MBq.

However, this small diameter entire-body PET suffered the most single-data loss. We tried several options to minimize this problem, as well as reducing the high production cost. First of all, by managing grouping dead-time loss. Even though we cannot avoid the individual dead-time for each detector, we can still manage the grouping dead-time (256 ns), by reducing

or eliminating it. By removing the grouping dead time for example, the small-diameter PET can achieve the highest NECR peak values in comparison to other PET with higher diameter. Even by reducing the grouping dead-time to 50% of the original 256 ns, the smallest diameter PET can still have highest NECR peak and reduced a single-data loss rate.

The second method is by reducing the thickness of individual crystal. By reducing the thickness from 20 mm to 16 and 12 mm, the small-diameter entire-body PET can still have a sensitivity of 89% and 62% of the conventional PET scanner. However, we can reduced the cost up of crystal 40-60%.

The third method to overcome those problems above is by introducing gaps between the crystal rings. For example, having a gap with the size of 3 crystals can save the crystal usage up to 16.7%. However, this will cause the sensitivity and NECR peak values to be reduced to a reasonable amount.

Having understood the benefit of having smaller-diameter entire-body PET and its trade-off, we think that the scanner is very beneficial to the application of cancer screening in Japan. With the assumption of 30 minutes scanning for conventional PET (ignoring the injection and resting time) and 8 working hours a day (16 patients a day), the smaller scanner can serve 6 times number of patient per day assuming a scanning time of 5 minutes / per patient. In fact by rough comparison of sensitivity level, the scanning time can be reduced below 1 min. This will make patient more comfortable especially those with claustrophobia.

Current scanners used in cancer screening such as GE Advanced NXI and Siemens EXACT, has a recommended dose of 3.7 MBq/kg or 260MBq for 70 kg. With small-diameter PET scanner, we can have a lower injected dose, that is 1.8 MBq/kg or 125 MBq for 70 kg (where NECR reach its peak), which is also equal to 2.375 mSV (compared to 10 msV for CT scan).

In terms of image reconstruction, the smaller scanner should be able to perform a faster reconstruction process since the data size can be reduced up to 57% in comparison to the 80 cm diameter entire-body PET.

In short, the design of smaller diameter entire-body PET has achieved its goal by having a scanner which cover the whole body and at the same time having a higher sensitivity and NECR peak. It can also reduce its production cost and time scanning, which also mean having a lower injected dose which give more comfort for patients.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).