TIPP09
Electron Tracking Compton Gamma-ray Camera for Drug Design and Medical Imaging
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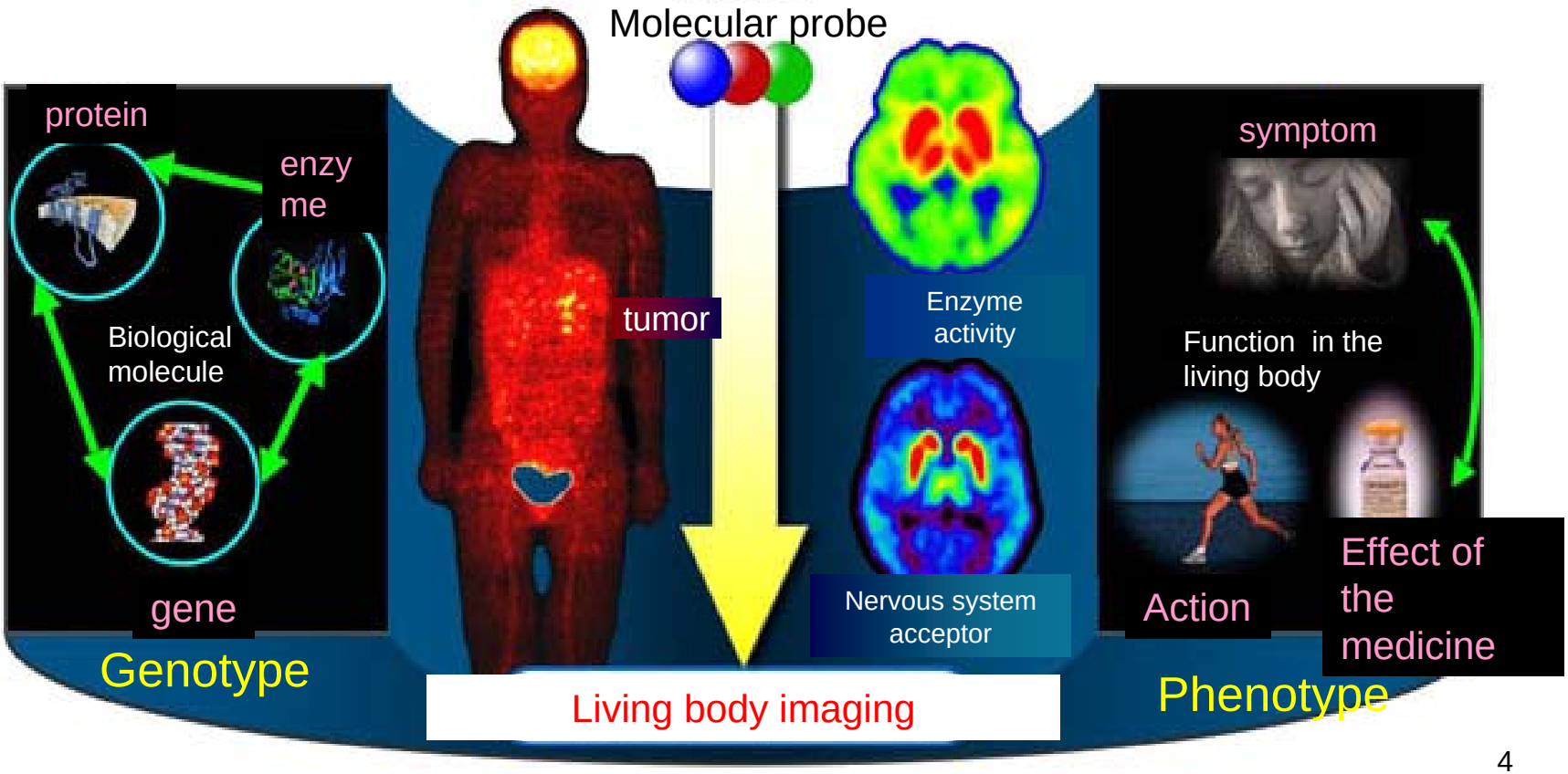
Contents

- Molecular imaging & Motivation
- Principle of Electron Tracking Compton Camera
- Performance of Electron Tracking Compton Camera
- New drug design for molecular imaging
- Summary

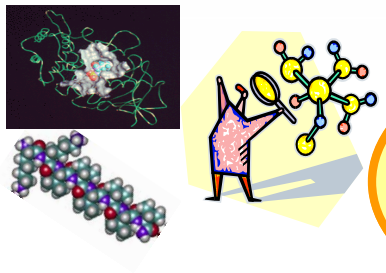
Molecular Imaging

Image the morbid life phenomenon and physiology of the living body at molecular level from the outside the body

(Radiology, 219 (2001).)



Molecular Imaging



New Probe

Molecular Probe

Visualize

- PET :E=511keV
- SPECT :E<300keV
- New device

New imaging material

Drug design・Clinical application

Bio Marker

Imaging detector

Features of ETCC to molecular imaging

Electron Tracking Compton Camera (ETCC)

: Wide field of view

: Wide energy dynamic range

New lots of RI available

- The development of new RI drug.
- Long life nuclide, metal nuclide

  ⇒ visualize the anti body, enzyme, protein reaction

Multi-RI Imaging

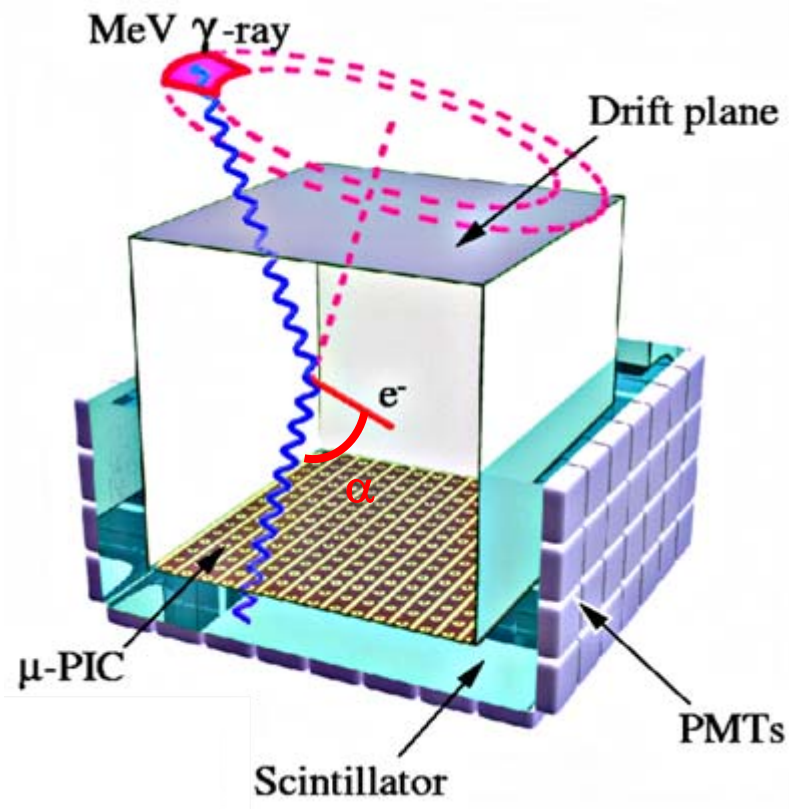
- Simultaneous observation of plural metabolism and interaction

Principle of Electron Tracking Compton Camera (ETCC)

Electronic track is caught with an original detector (Three patents).

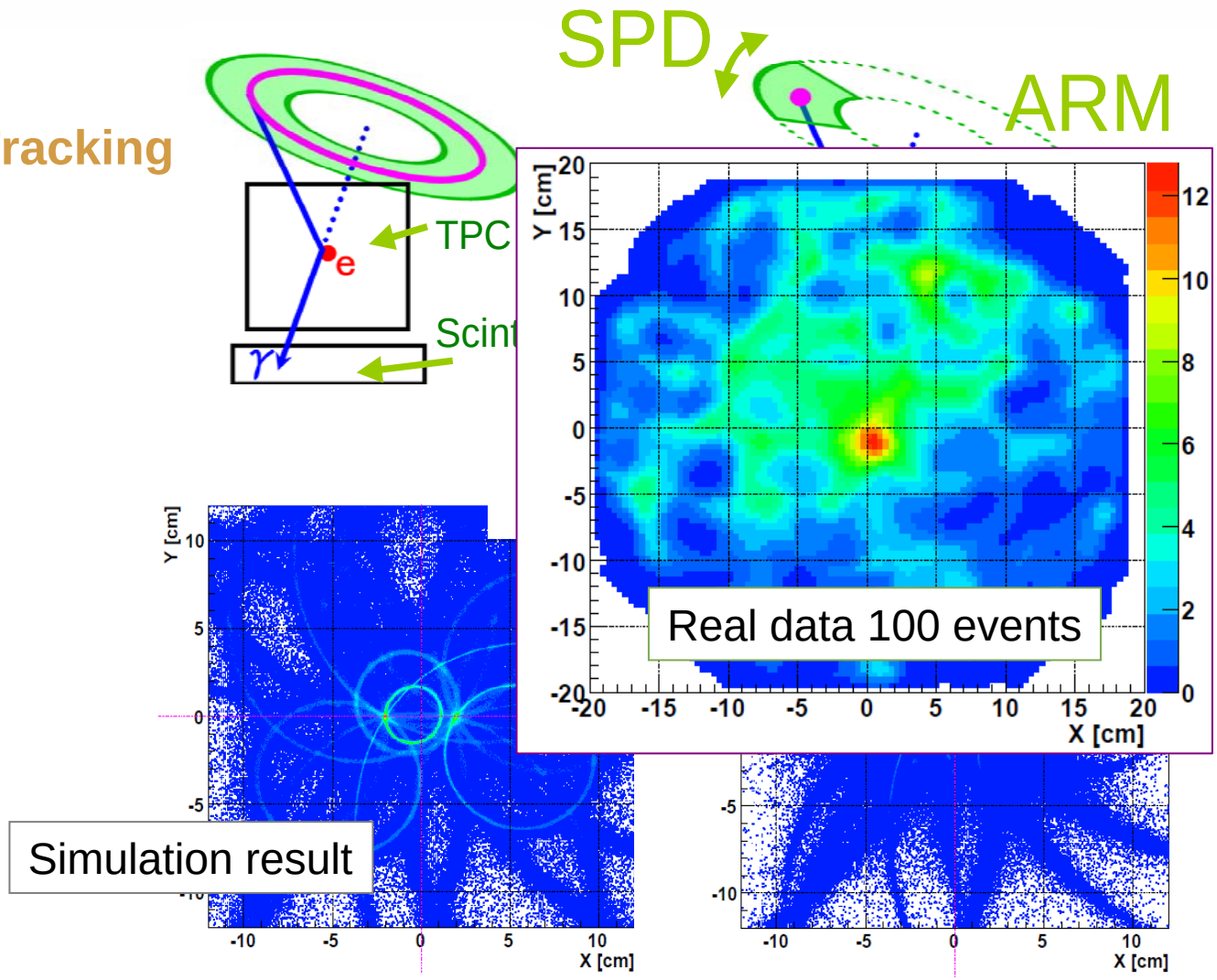
- An arrival direction of the gamma ray is calculated for every event.
- Noise is rejected by momentum and geometry information α.

$$\cos\alpha = \left(1 - \frac{m_e c^2}{E_g}\right)\sqrt{\frac{K_e}{K_e + 2m_e c^2}}$$



Gamma-ray Imaging

Electron Tracking method

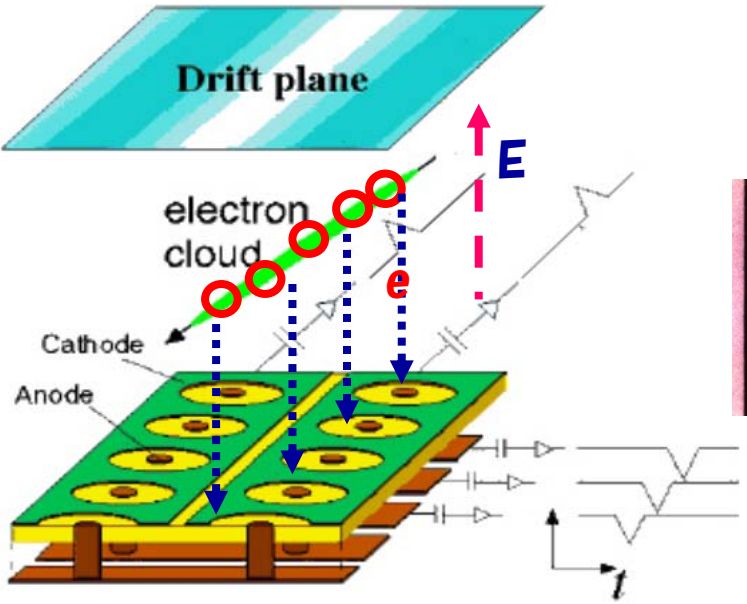


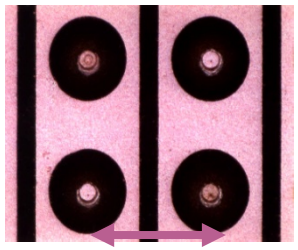
μ-PIC technology

Schematic view of μ-PIC technology

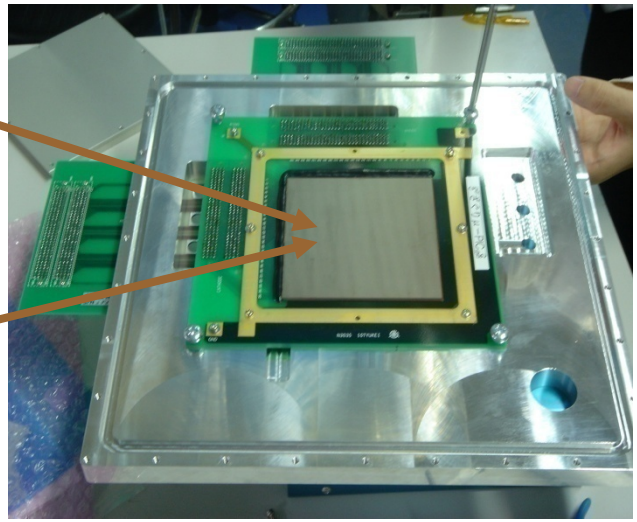
μ-PIC
Micro Pixel Chamber

Gas sealed vessel





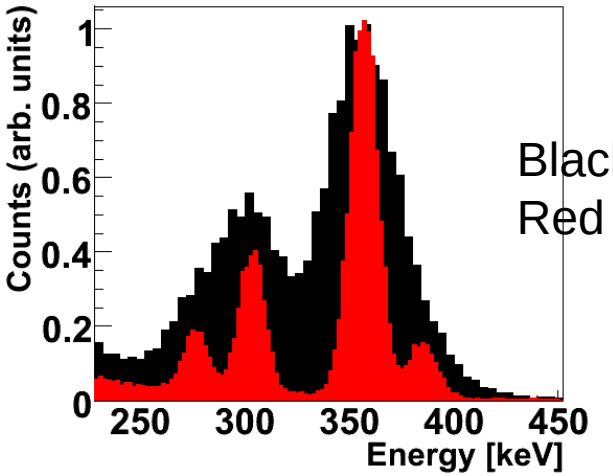
400mm



GSO and $LaBr_3$ Scintillator

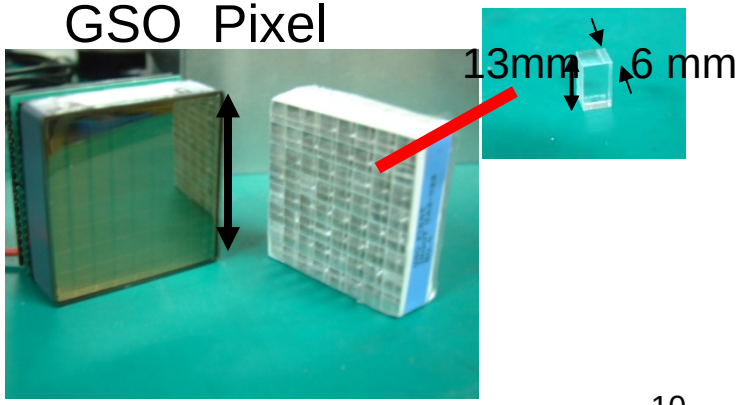
$10x10cm^2$ Camera
（GSO or $LaBr_3$）

- Number of pixels: 576
- Pixel size　　$6 \times 6 \times 13mm^3$　　（GSO）
  　　$6 \times 6 \times 15, 20mm^3$（$LaBr_3$）
- GSO Enery resolution　:10.0 %（@662keV,FWHM)
- $LaBr_3$ Energy resolution: 6.5%　（@662keV,FWHM)
- Position resolution: 6mm



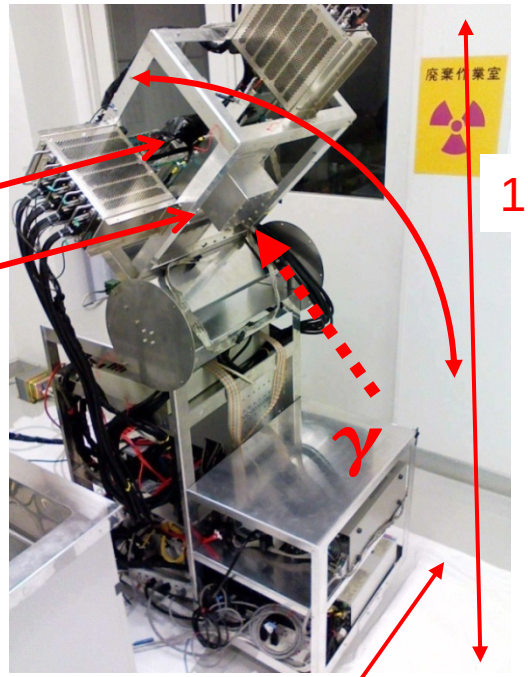
Black :GSO
Red　: LaBr3

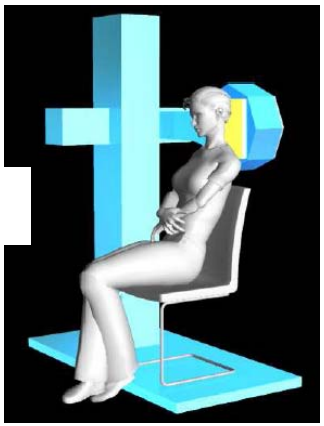
GSO Pixel



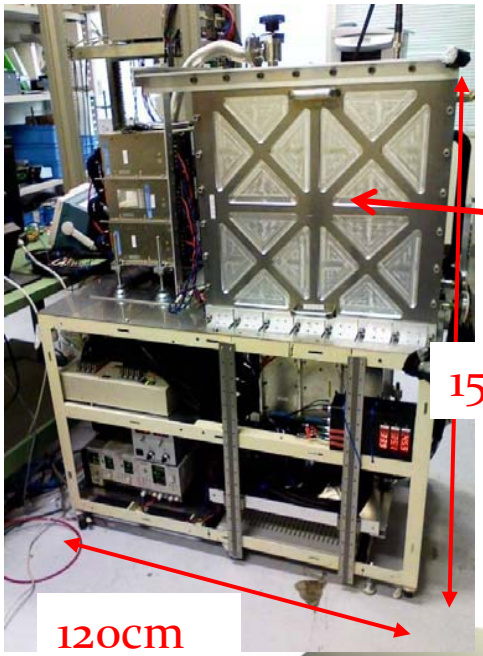
Developed ETCC

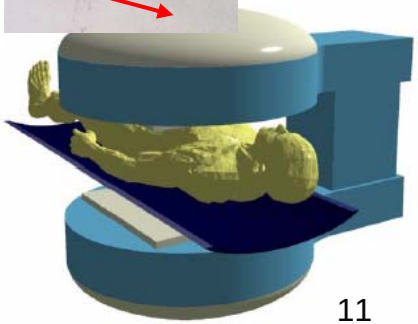
10x10cm^2 Camera





30x30cm^2 Camera





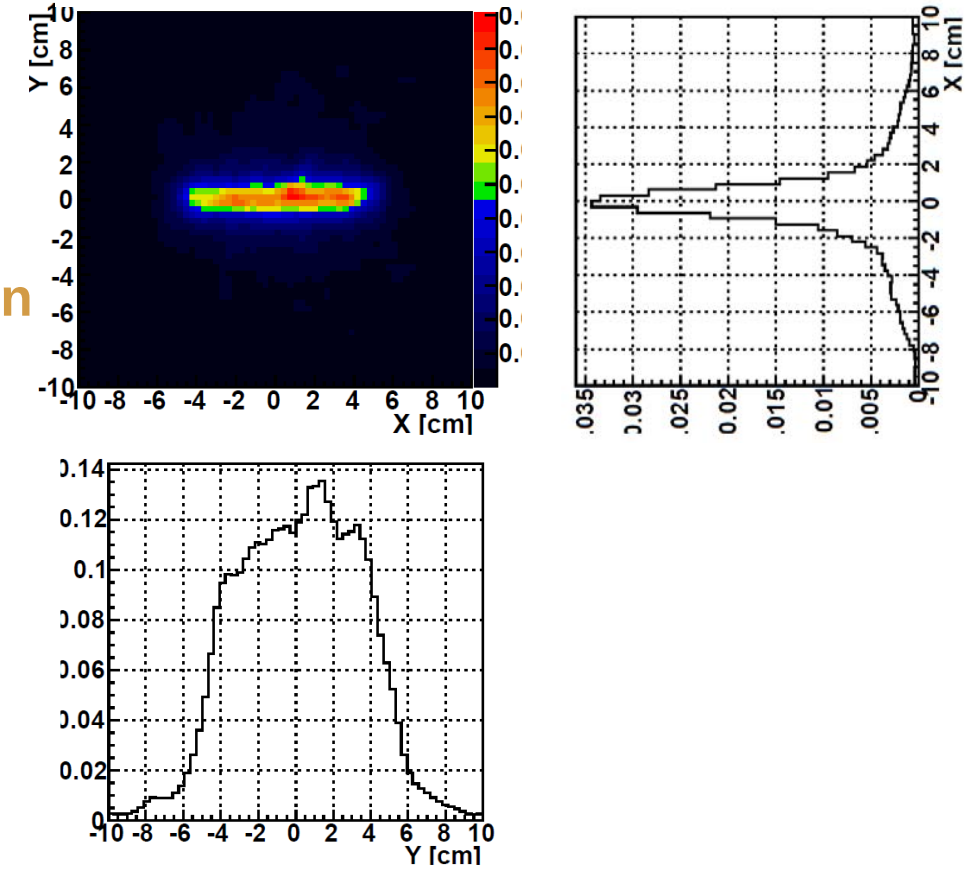
K. Ueno poster C-5

Imaging Method

List mode
Maximum Likelihood
Expectation Maximization
(Listmode MLEM)

10cm line source
365 keV image

List mode MLEM



Energy Dynamic Range

Measured sources

	Ce-139	Cr-51	Ba-133	I-131	Au-198	Na-22	F-18	Cu-64	Cs-137	Mn-54	Fe-59	Zn-65	Co-60
Energy [keV]	167	320	354	364	412	511, 1275	511	511	662	835	1095, 1292	1116	1173, 1333

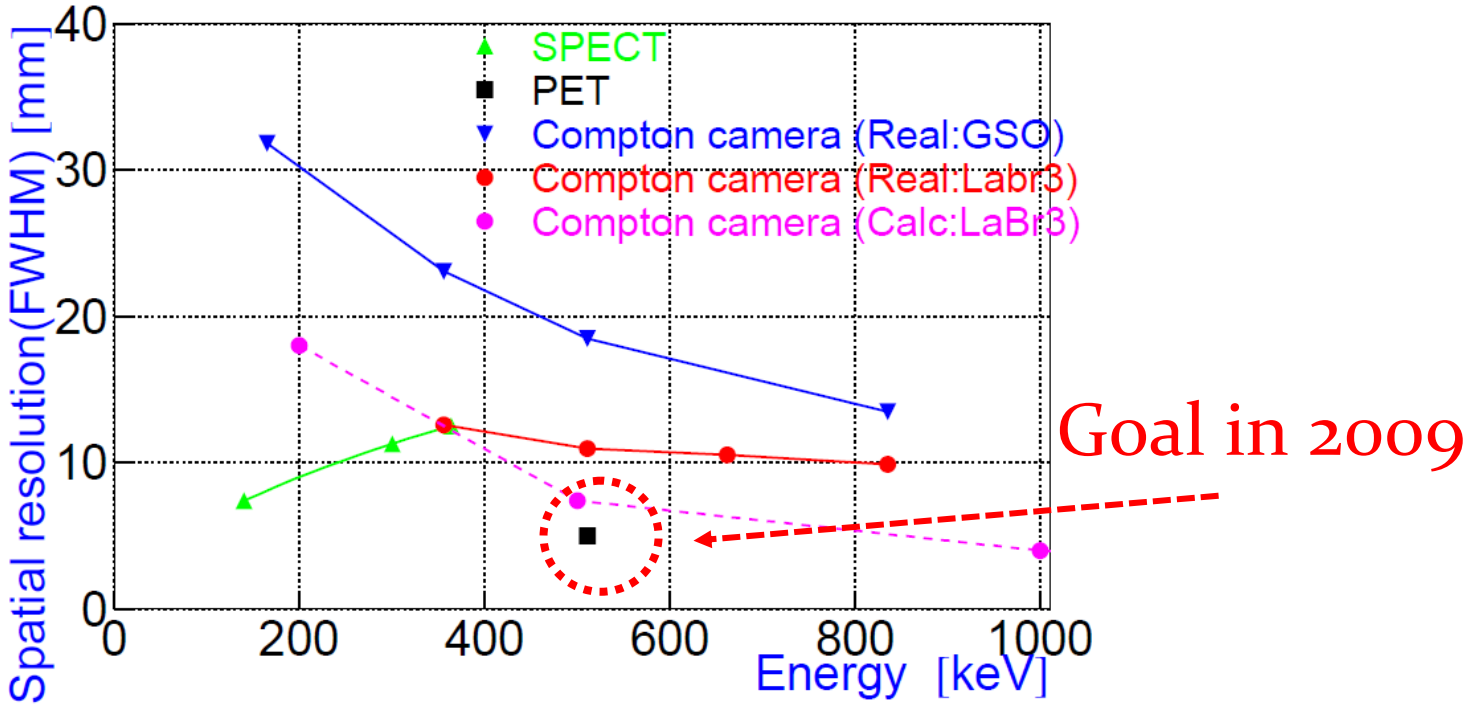
SPECT

PET

Energy dynamic range : 167 – 1333 keV.

Spatial Resolution

Spatial resolution vs. Energy



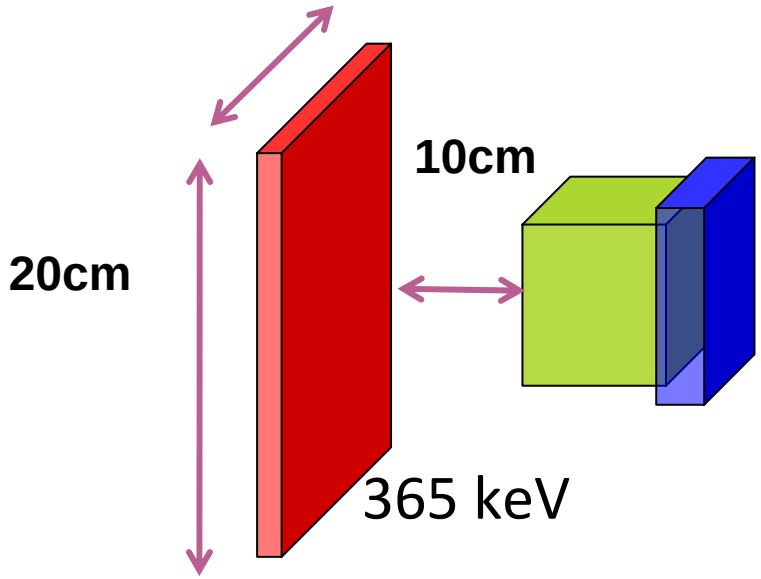
Goal : Same resolution as human PET @ 511keV

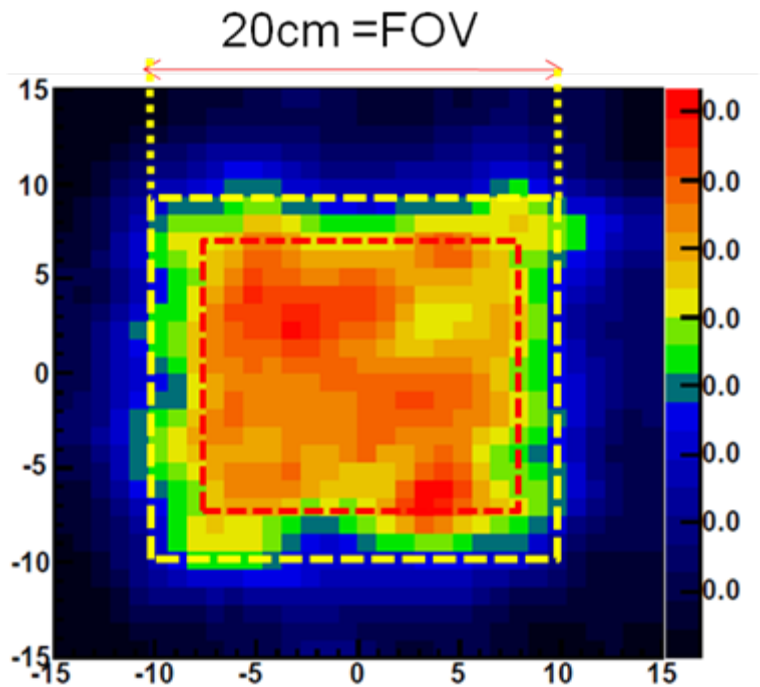
Uniformity of the Field of View

Keio University

Uniformity of ETCC

- Flat Panel size = FOV
- Energy =365keV

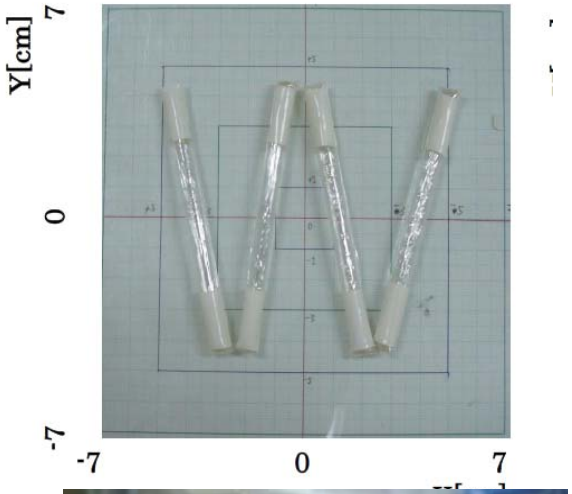


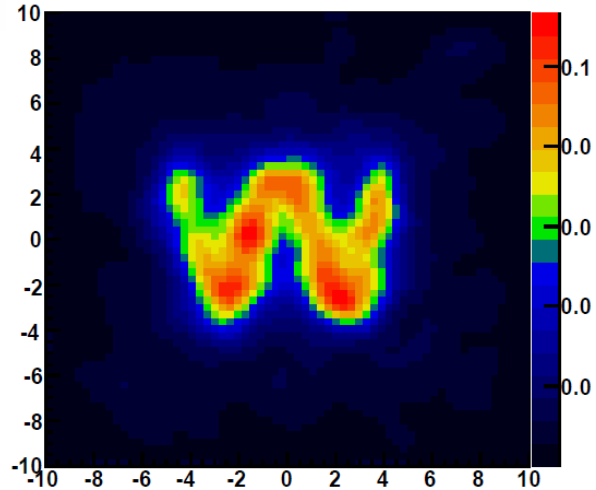


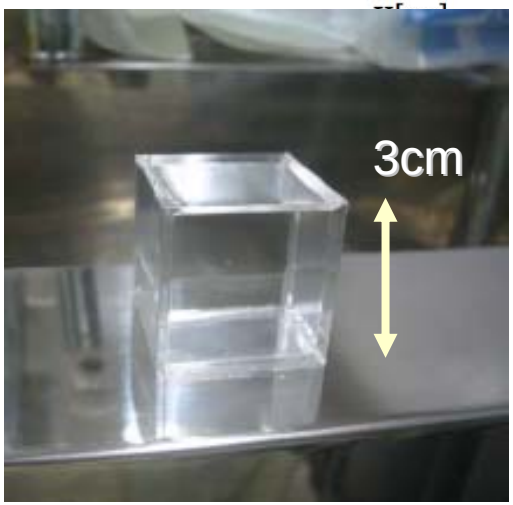
Red line ：±7cm
Yellow line ：±10cm

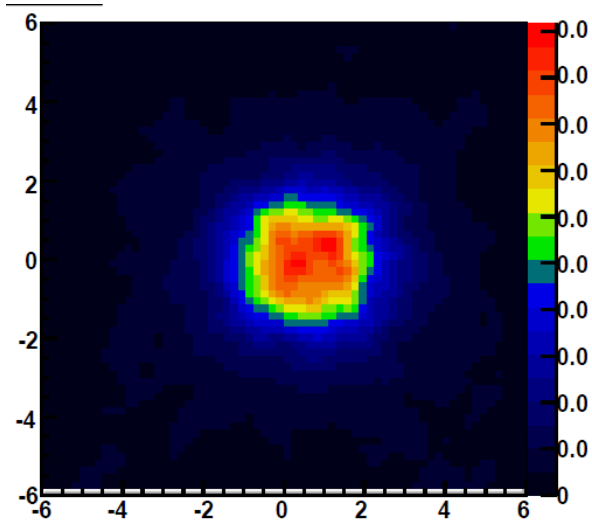
Uniformity |x, y|< 7cm ： 11.1% (1σ)

Example Images









Medical imaging

Kyoto university medical & pharmaceutical department

- Molecular Imaging

  I-131-5IA nAChRs imaging
- Drug Delivery System (DDS)

  Au-198-nanoparticles
- Double Clinical Tracer Imaging

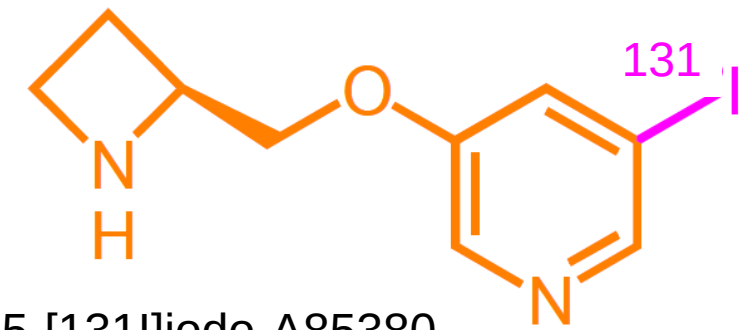
  FDG & I-131-MIBG
- High energy nuclide Imaging

  Zn-65-porphyrin Imaging

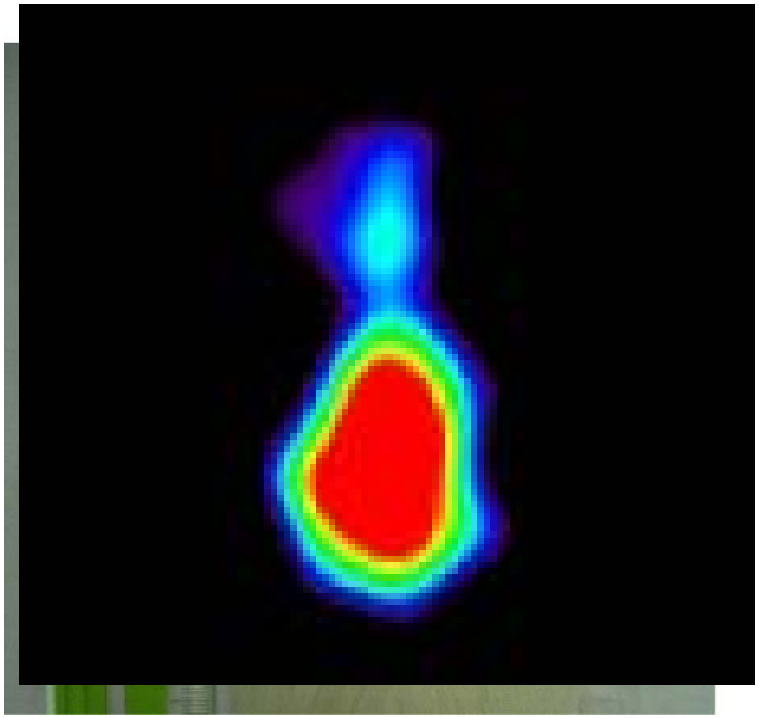
I-131-5IA acetylcholine receptor imaging (365keV)

I-131-5-IA nAChR imaging

I-131-5IA have been developed by the H. Saji lab for molecular imaging. We performed the imaging of nicotine acetylcholine receptor (nAChR) in the rat central nervous system using I-131-5IA.

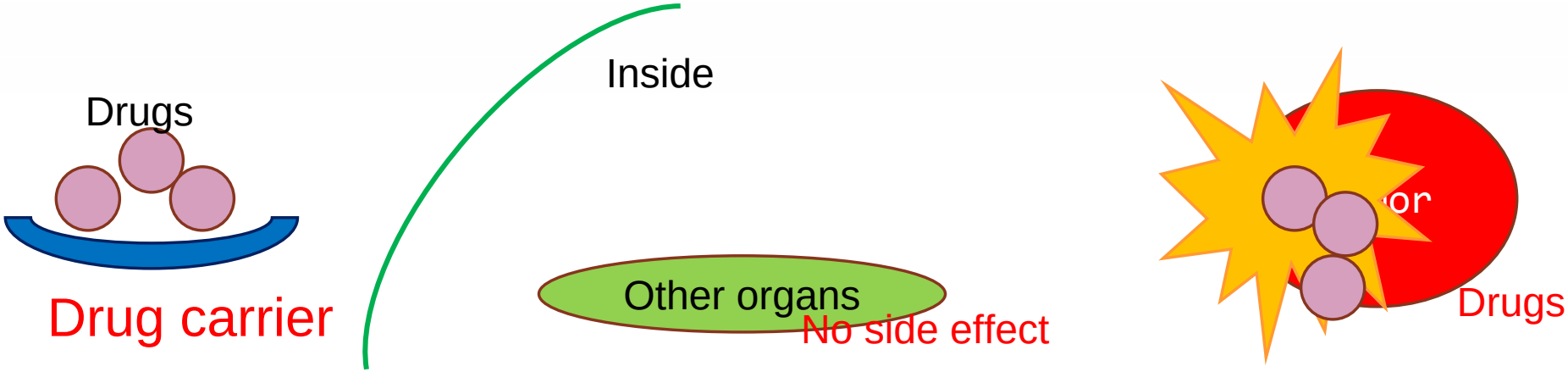


5-[131I]iodo-A85380



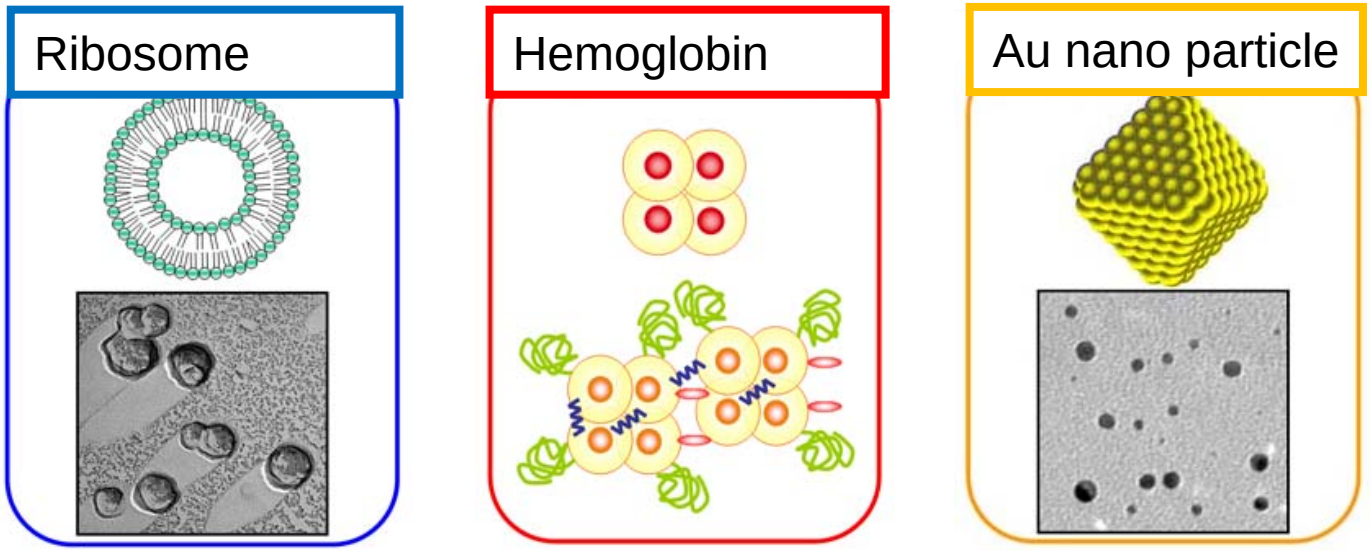
The high accumulation in the brain was visualized.

Drug Delivery System (DDS)



Drug carrier candidates

TUS
Yuasa lab.
WEB page



Another Chemical reagent study

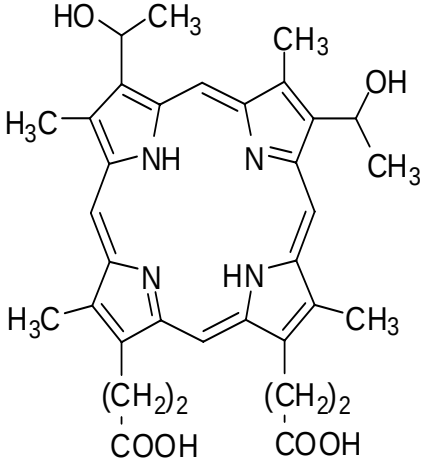
TUS
Tsukuba univ.
Koto-ken

Yuasa lab.
Matsui lab.
Nakai lab.

Porphylins accumulation in tumors.

Therapy
→ PDT(Photodynamic therapy)

Diagnosis
→ PDD(Photodynamic diagnosis)



hematoporphyrin

Application for cancer imaging

E.G. Stomach Cancer

This probe is available for the stomach cancer that it is hard to detect using FDG.

Porphylin + ^{59}Fe, ^{54}Mn, ^{65}Zn imaging using ETCC

Summary

- Compton Camera has a wide energy dynamic range and wide field of view.

- We have developed the ETCC camera for molecular imaging.
  - Spatial resolution 11mm(FWHM)@511keV
  - Uniformity 11.1% (1σ)
- We have studied the new probes for molecular imaging.
  - I-131-5IA
  - double tracer I-131-MIBG & FDG
  - Au-198 DDS
  - Zn-65-Porphyrin