

New LSO Scintillator & New Dectectors

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Inorganic Scintillators

- ◆ NaI (TI) (1948-Hofstadter)
 - ◆ pros: high light output
 - ◆ cons: hygroscopic, low atomic number, low density, relatively slow
- ◆ BGO (late '70s)
 - ◆ pros: high density and atomic number, rugged and non-hygroscopic
 - ◆ cons: low light output, relatively slow, high index of refraction
- ◆ LSO (1990-Melcher)
 - ◆ pros: high light output, fast, high density, high atomic number, rugged, non-hygroscopic
 - ◆ cons: intrinsic radioactivity

Characteristics of Selected Scintillators

Parameter (* at 511 keV)	NaI(Tl)	BGO	LSO
Density (gm/cc)	3.67	7.13	7.4
Decay Time (ns)	230	300	40
Light Output [NaI(Tl) = 100]	100	15	75

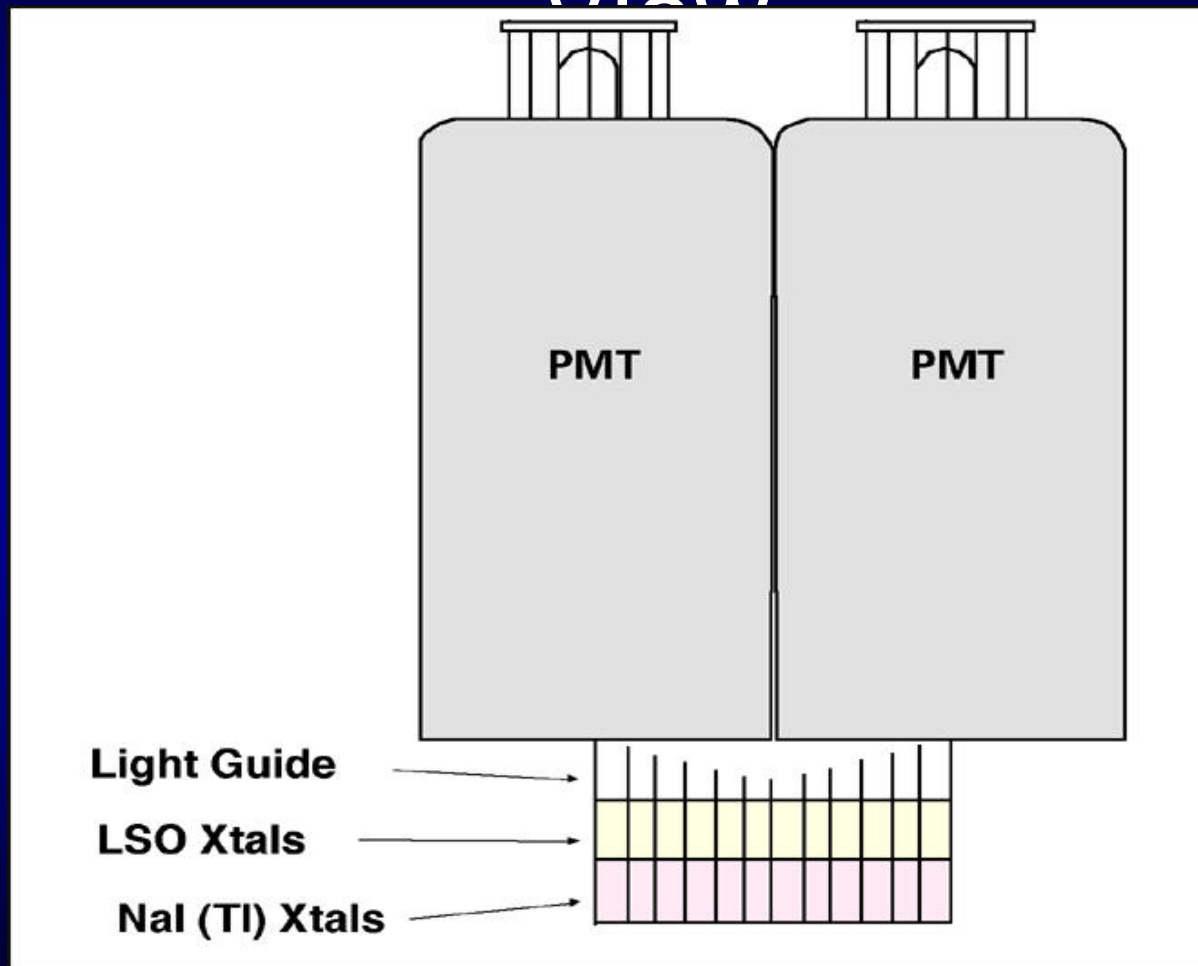
LSO Production



- 10 crystal pullers at CTI
- 14 more at external manufacturing site
- Electric supply lines from two separate substations

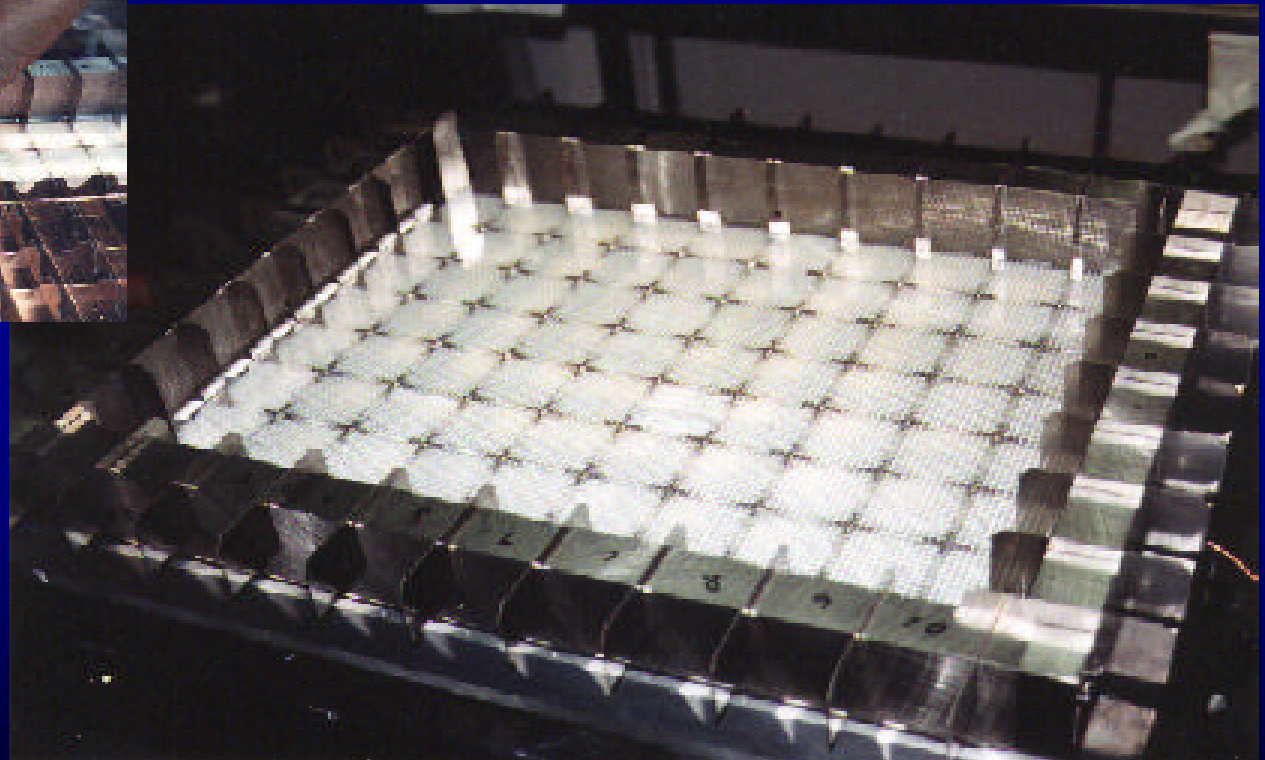
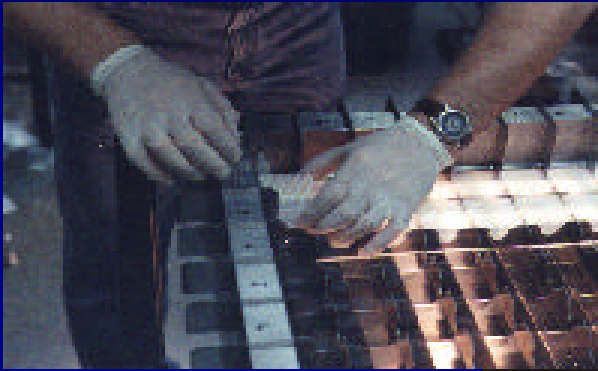
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PET/SPECT Detector Block – Side View



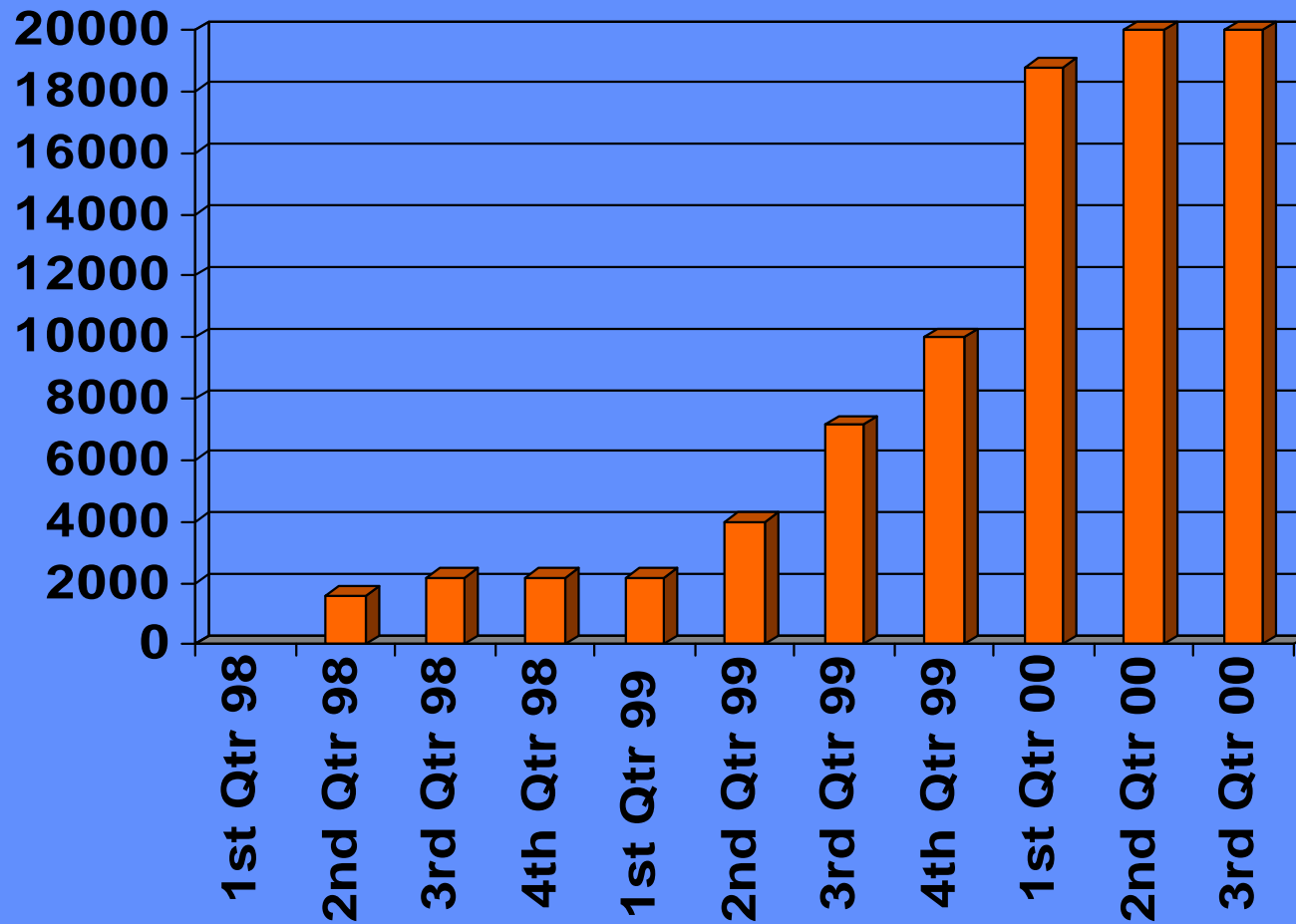
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Detector Head Assembly

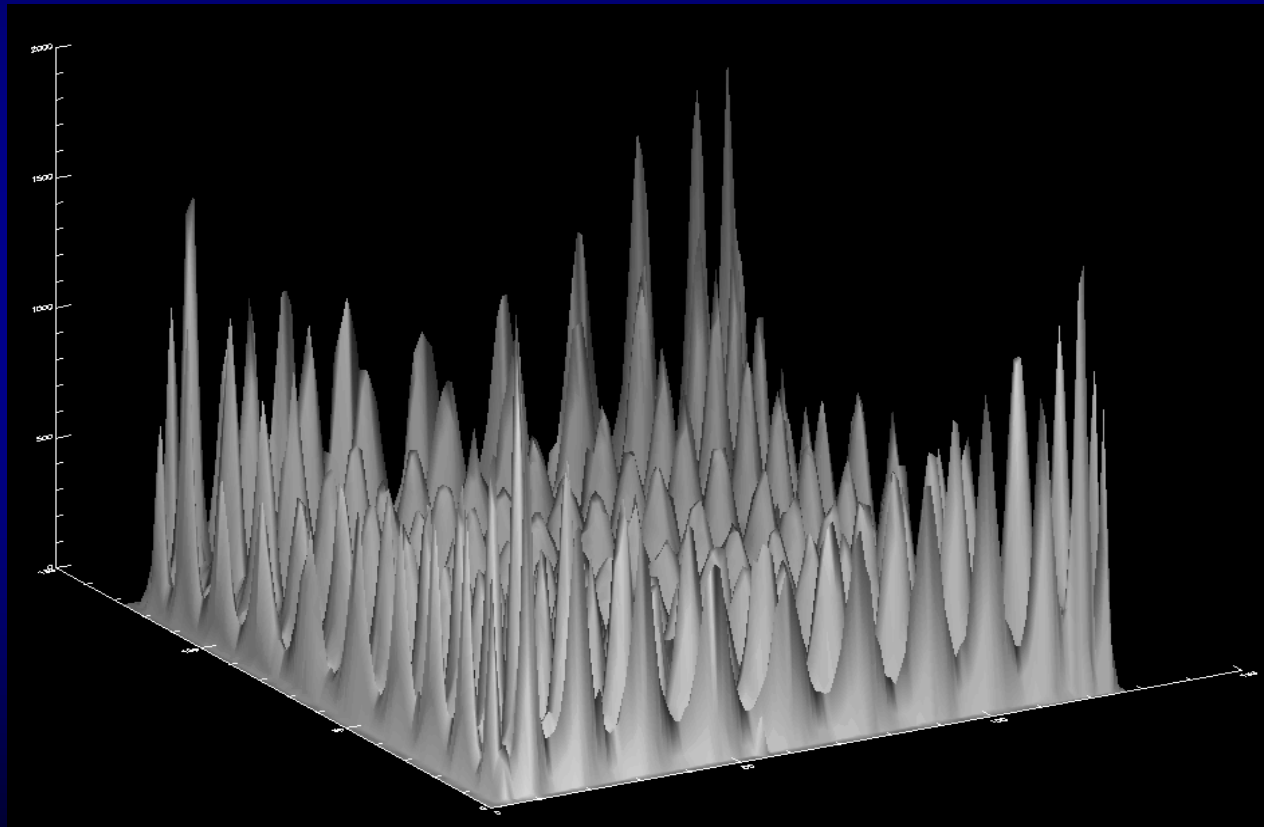


LSO PRODUCTION STATUS

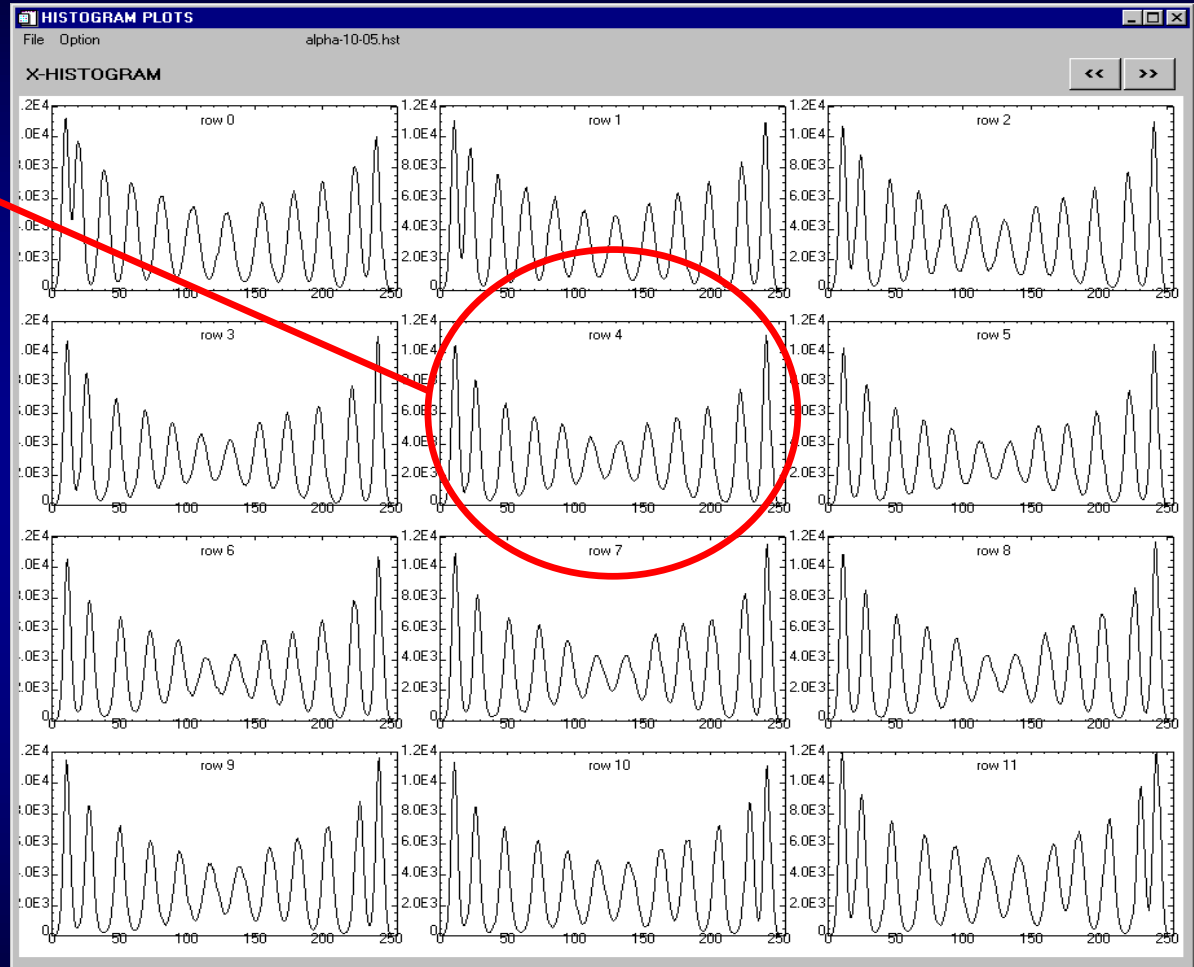
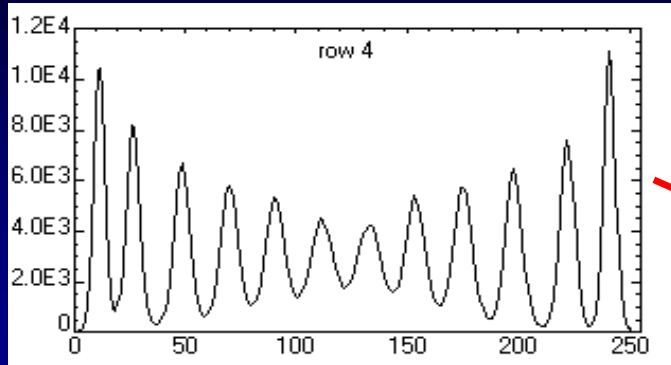
Production in
CC/month



LSO Detector Flood Response



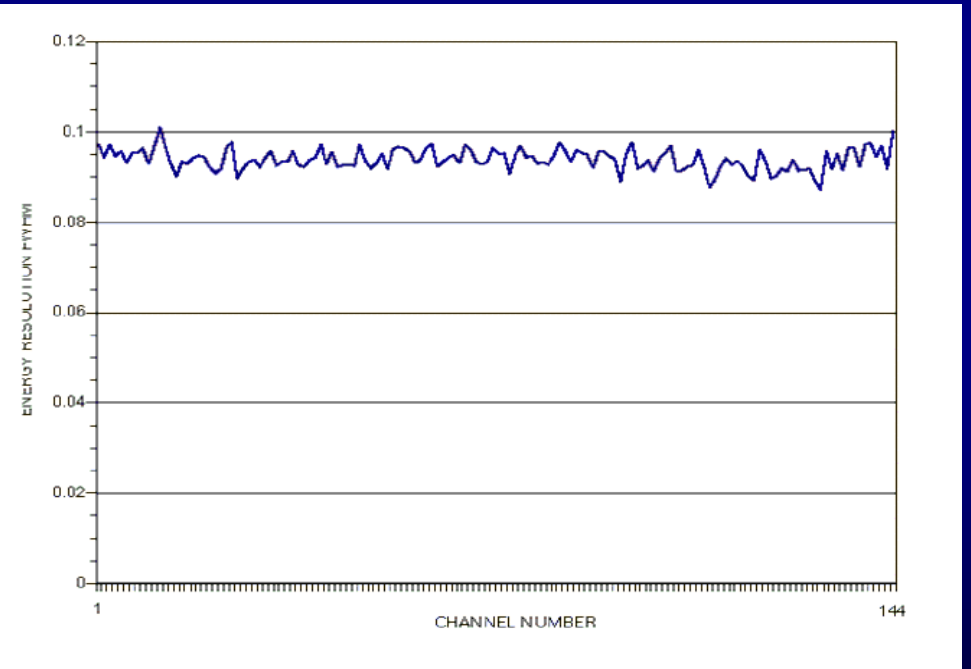
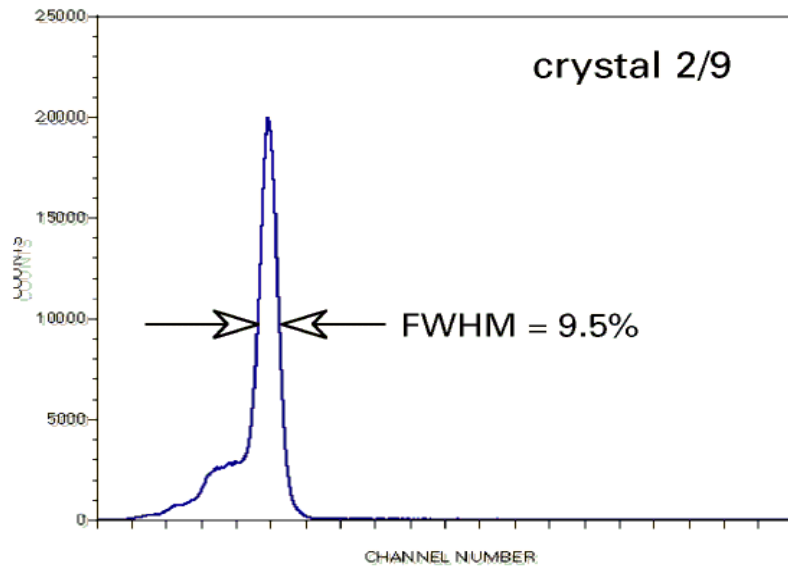
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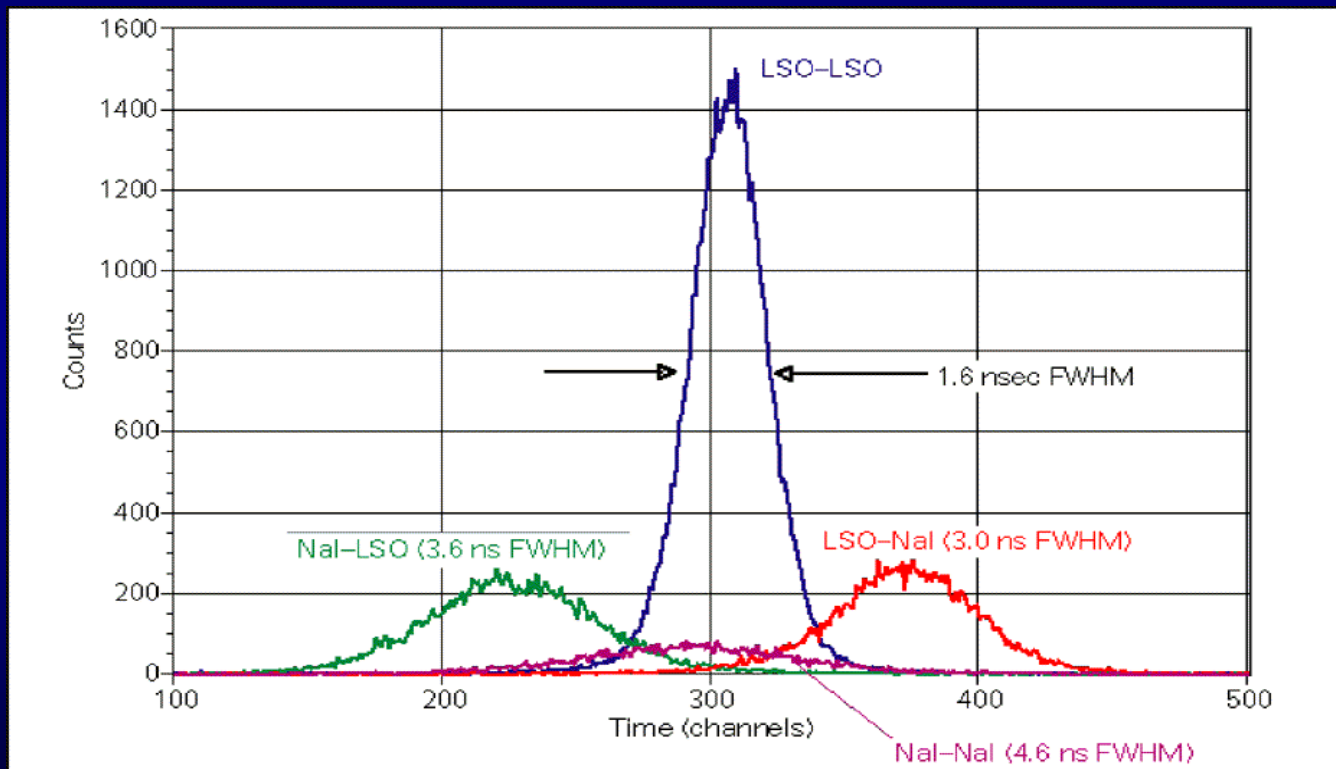
140 keV Photons
(NaI Layer)

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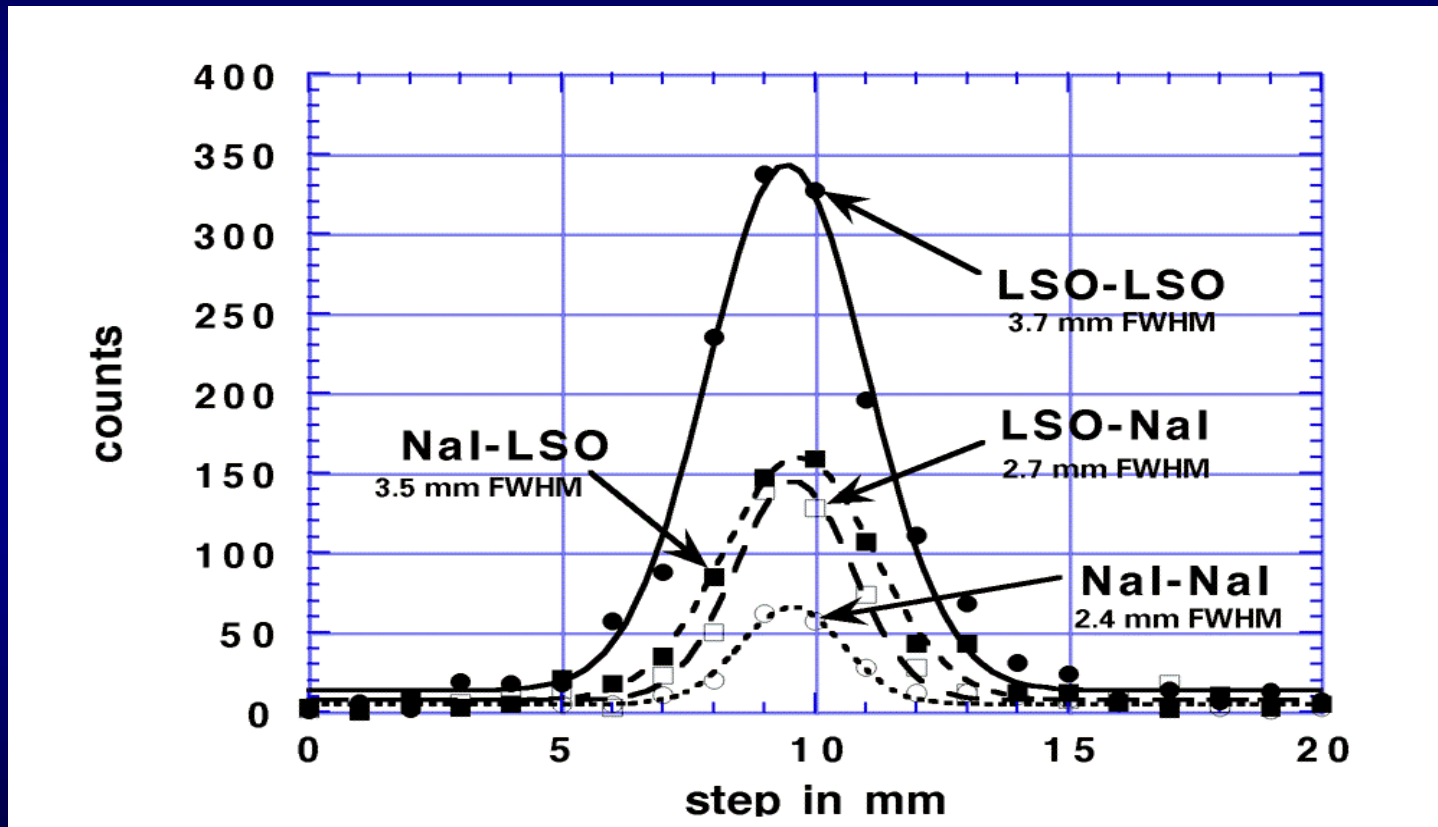
140 keV Photons (NaI layer)



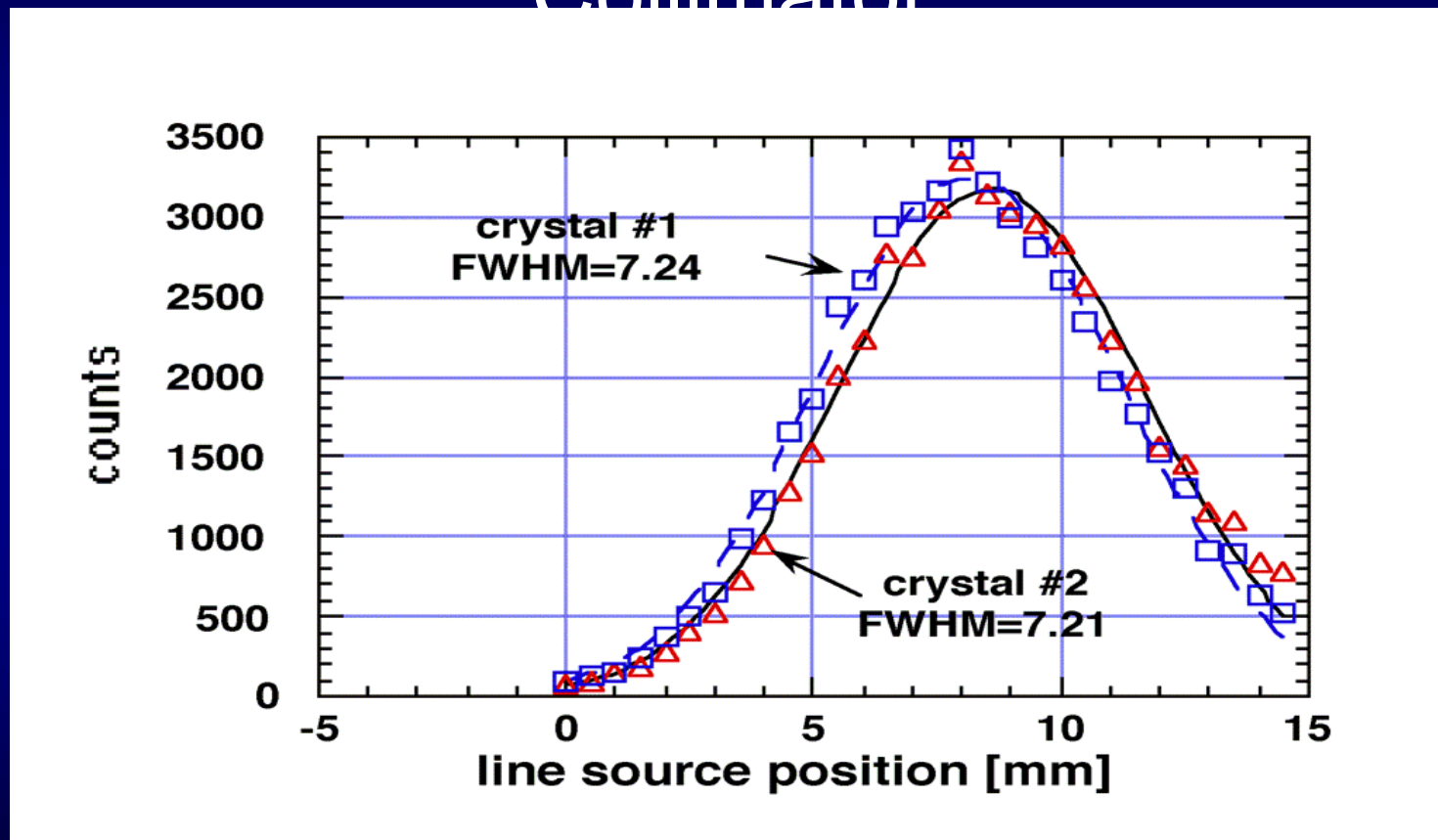
Coincidence Time Spectrum



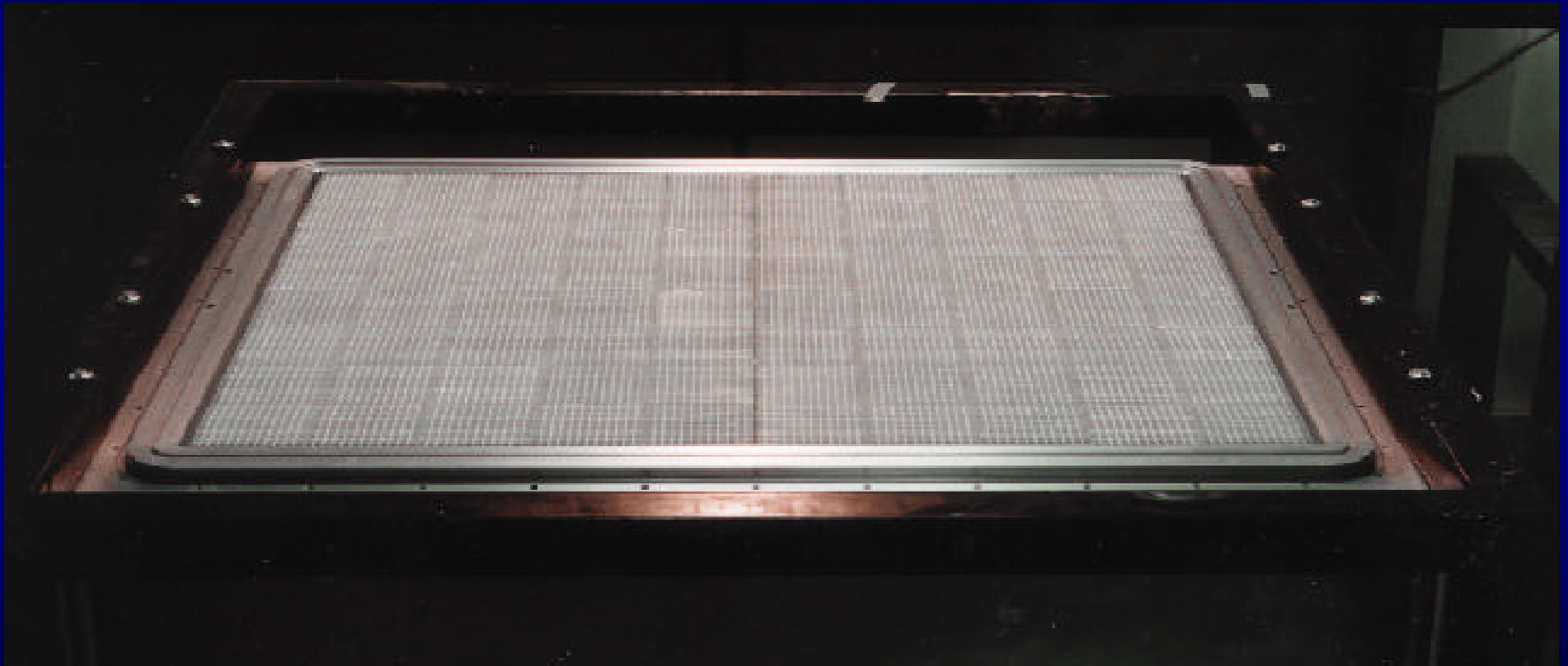
PET Line Spread Function



SPECT Image Resolution - High Res Collimator

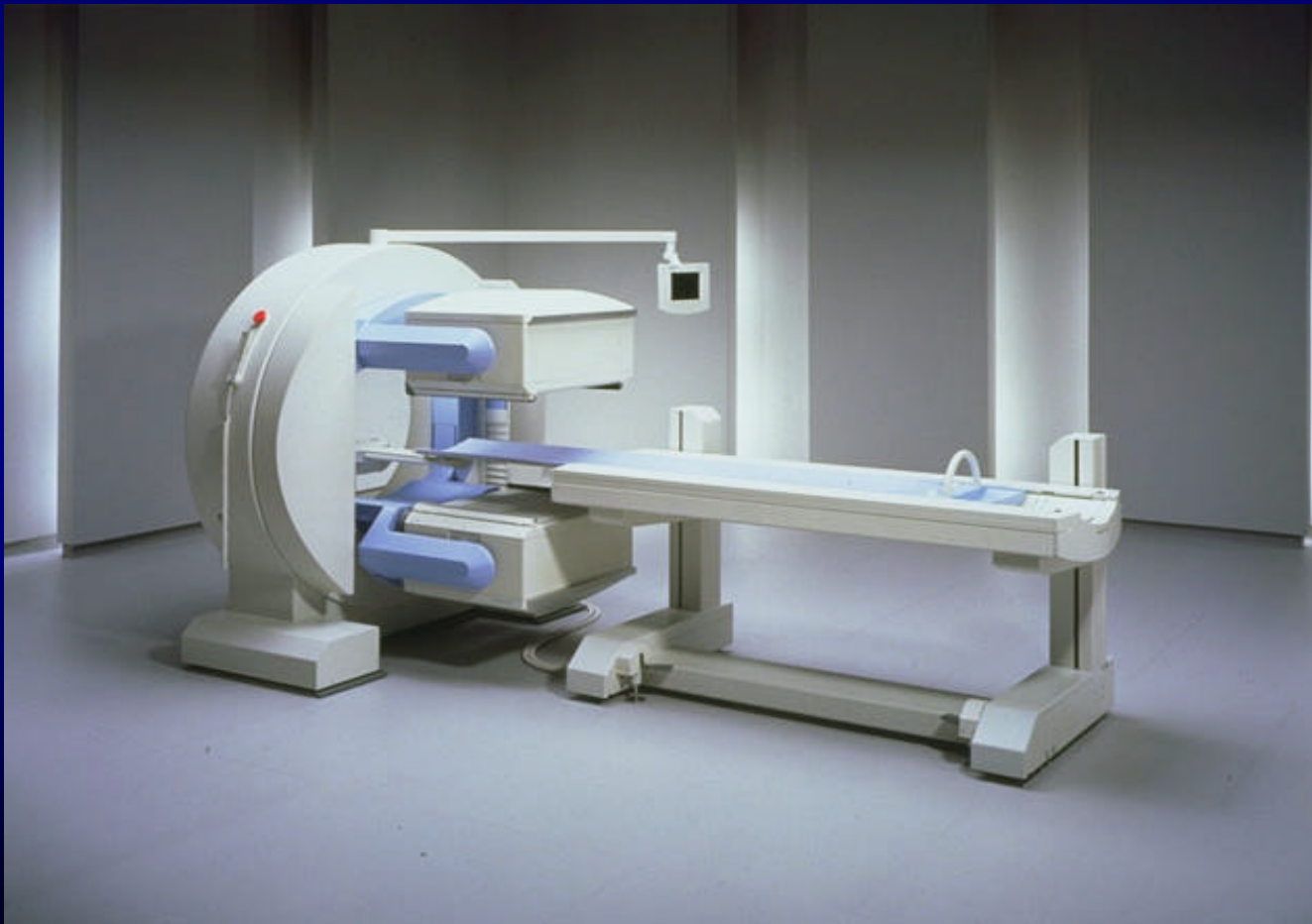


LSO/NaI Detector Head



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E.CAT

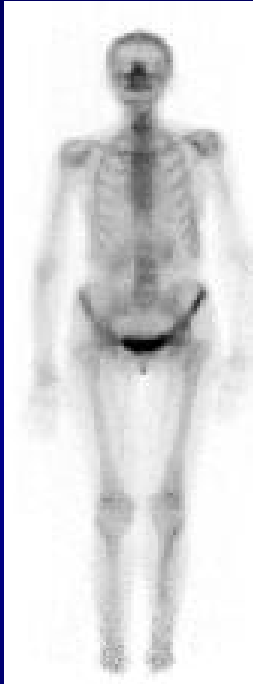


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1998 Society of Nuclear Medicine

"Image of the Year"

Henry Wagner, M.D. • Johns Hopkins



LSO/NaI PET/SPECT Camera



Standard Anger Camera
University of Tennessee Medical Center, Knoxville

Tc-99m MDP whole-body bone scans on an 81-year-old woman – anterior view

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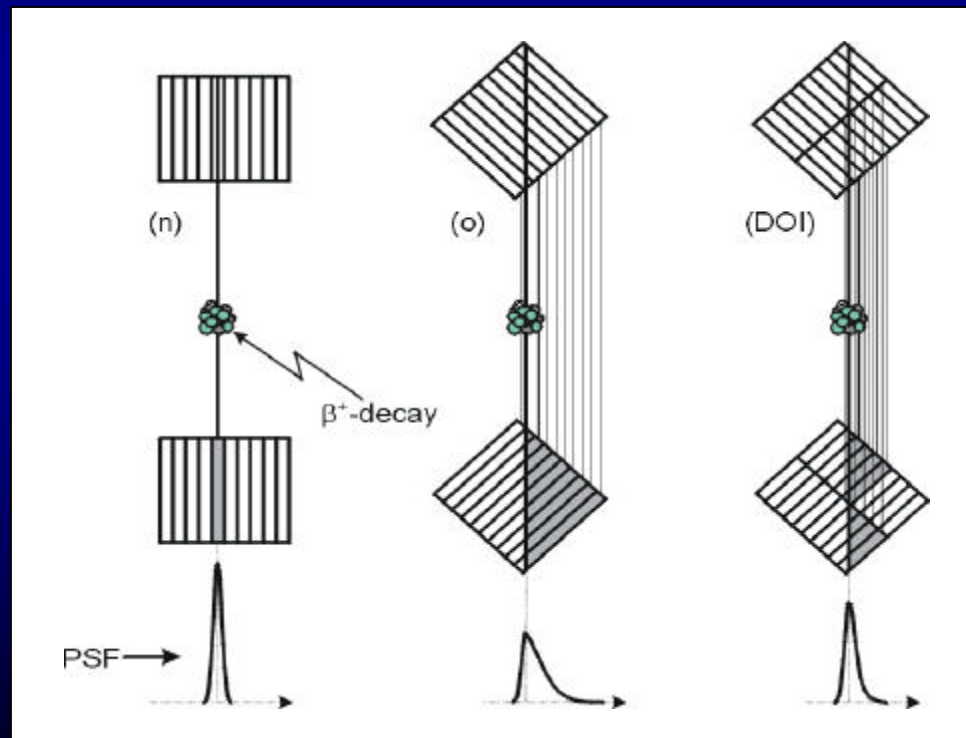
High Resolution PET - LSO!

- ◆ LSO (lutetium oxyorthosilicate:Ce)
 - ◆ higher scintillation light yield
 - ◆ smaller crystals
 - ◆ faster scintillation light decay time
 - ◆ lower dead time
 - ◆ faster coincidence timing

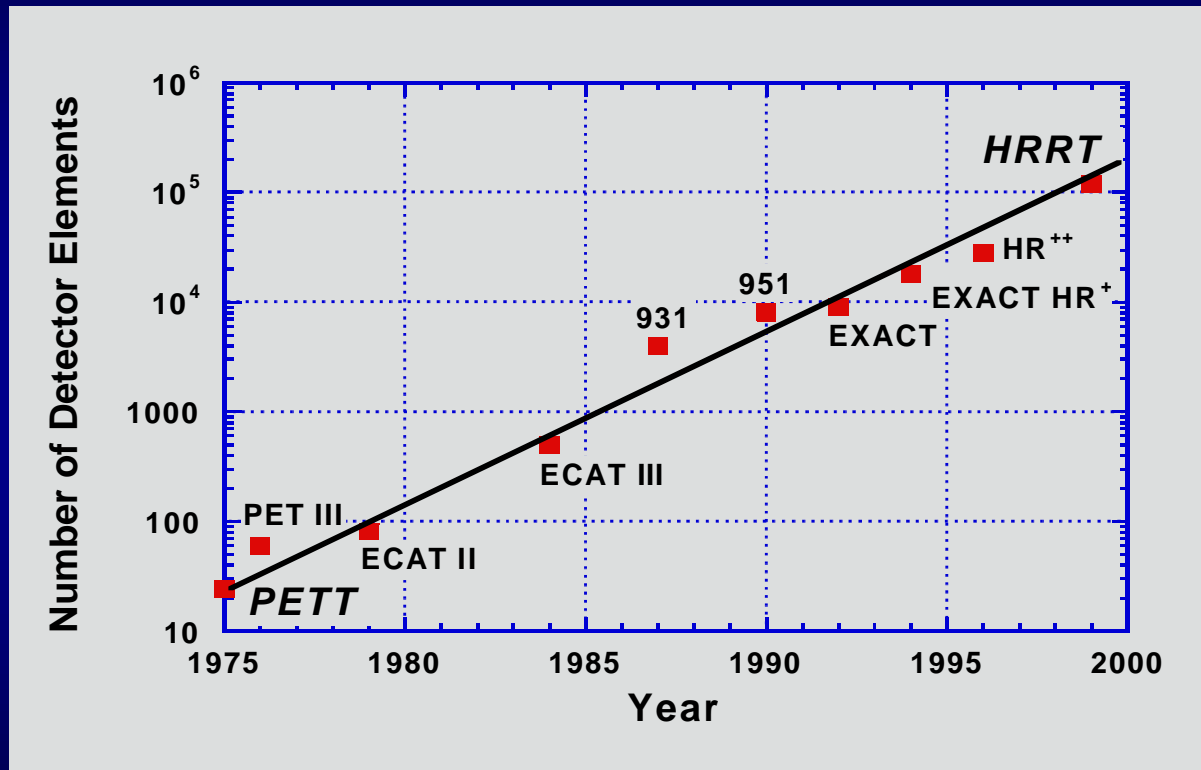
(than BGO)

Fourth dimension in PET - DOI!

◆ $\text{PET}(x,y,t) \Rightarrow \text{DOI-PET}(x,y,z,t)$

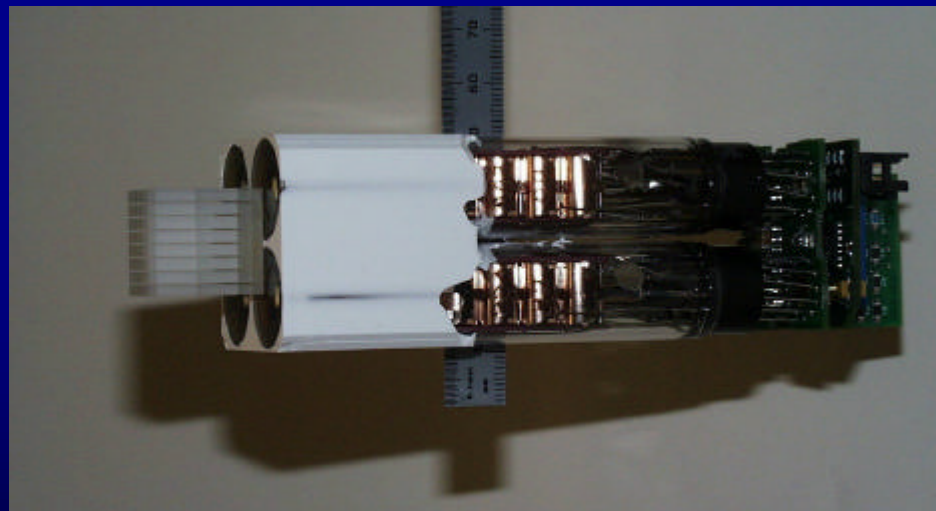


Nutt law

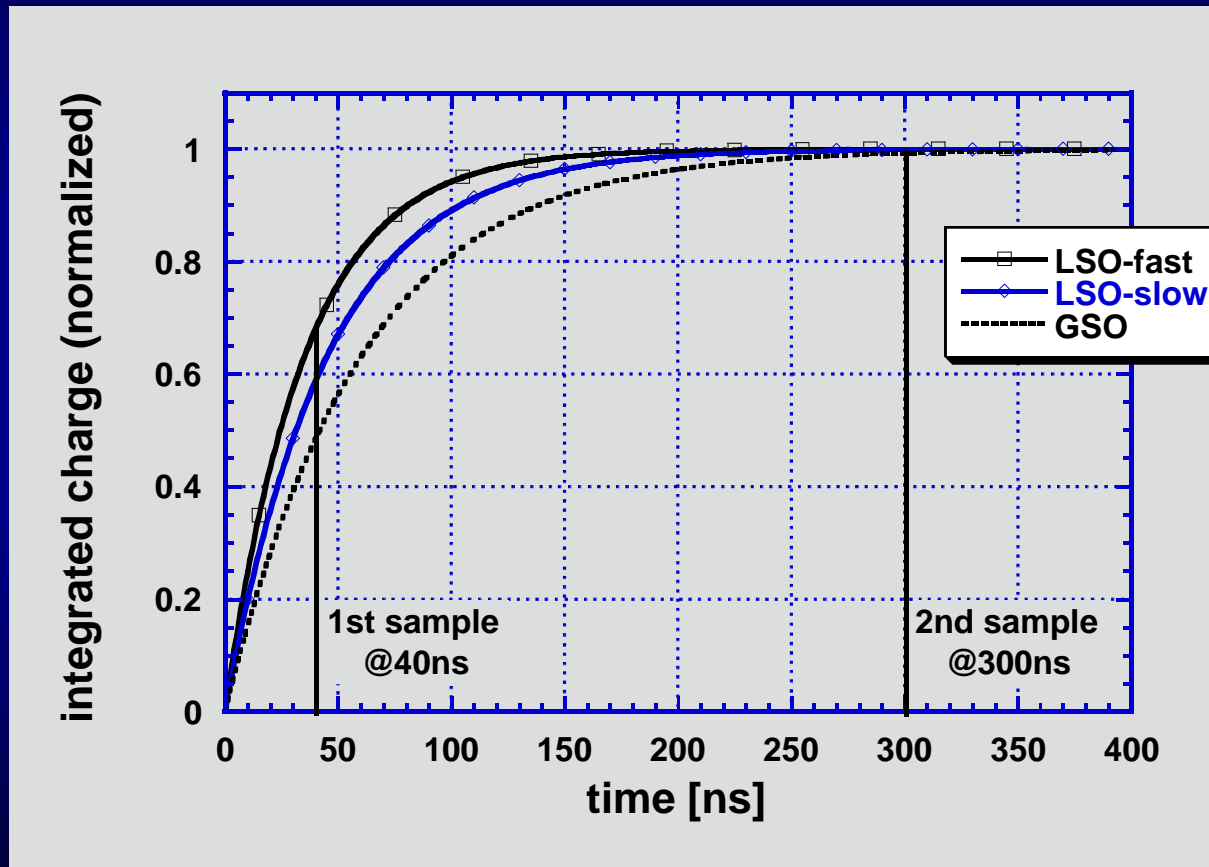


Quadrant sharing design

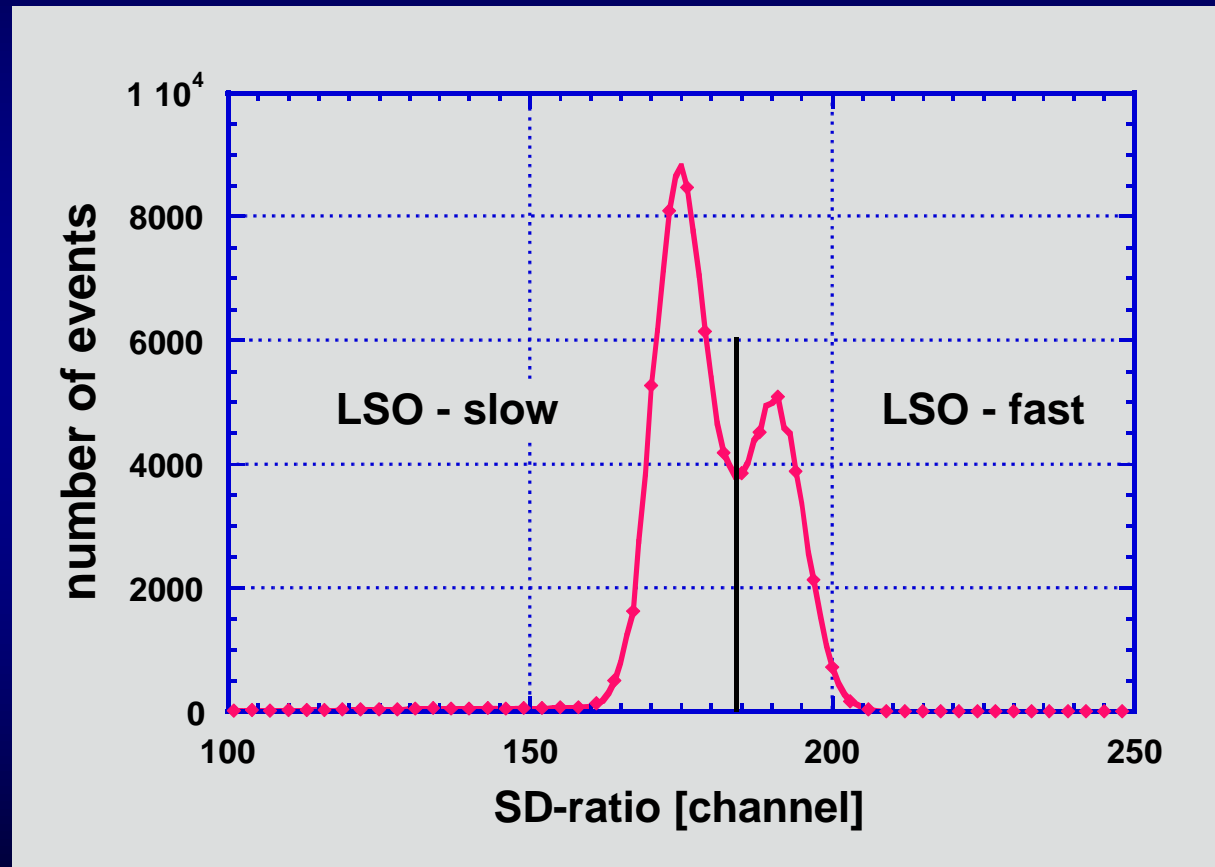
- ◆ 8x8 crystal matrix
- ◆ 128 single crystals in 2 layers



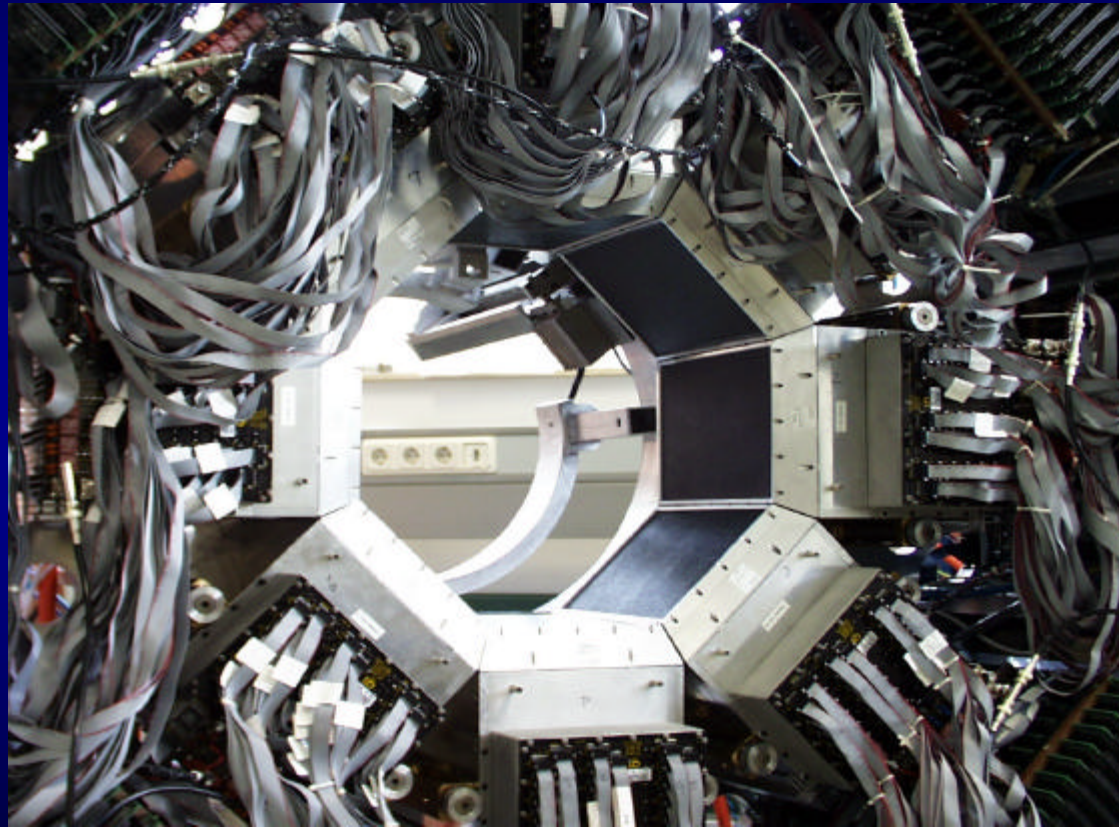
PSD by charge integration



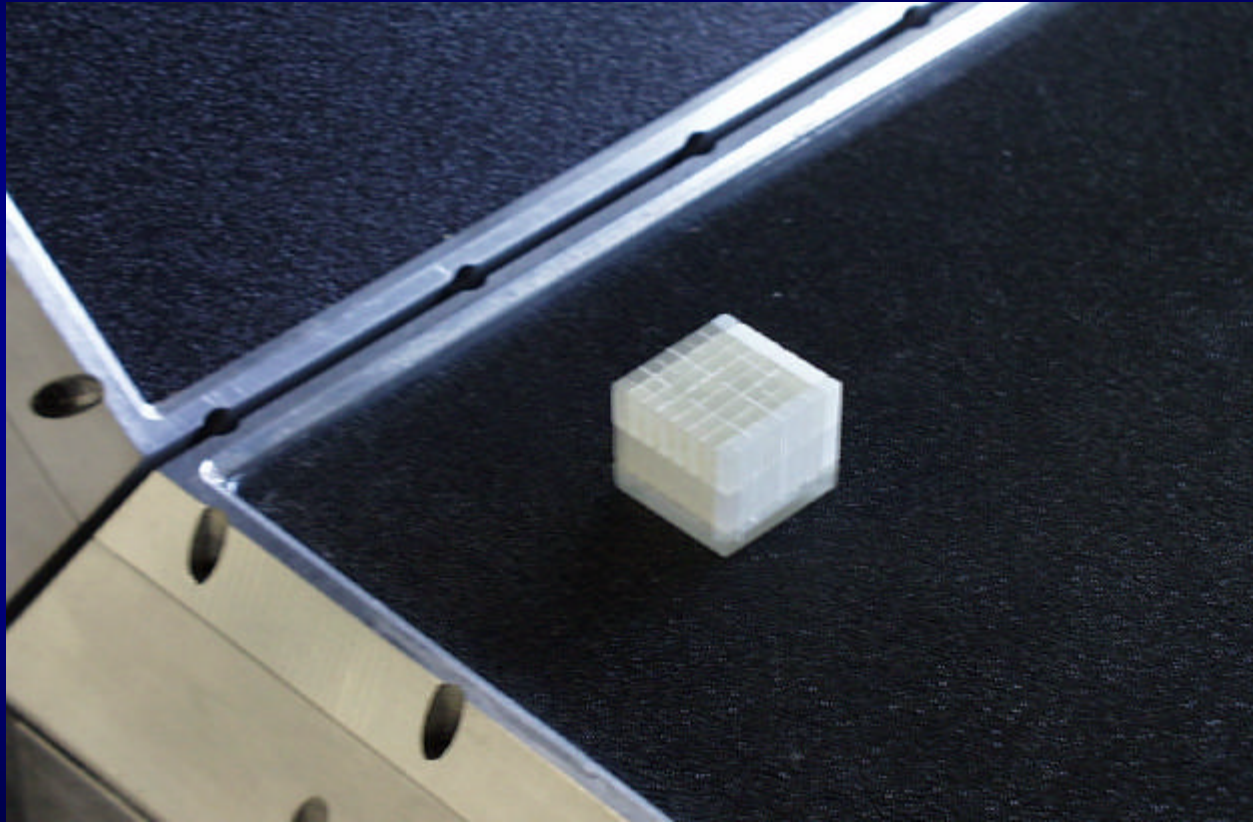
Pulse shape spectra



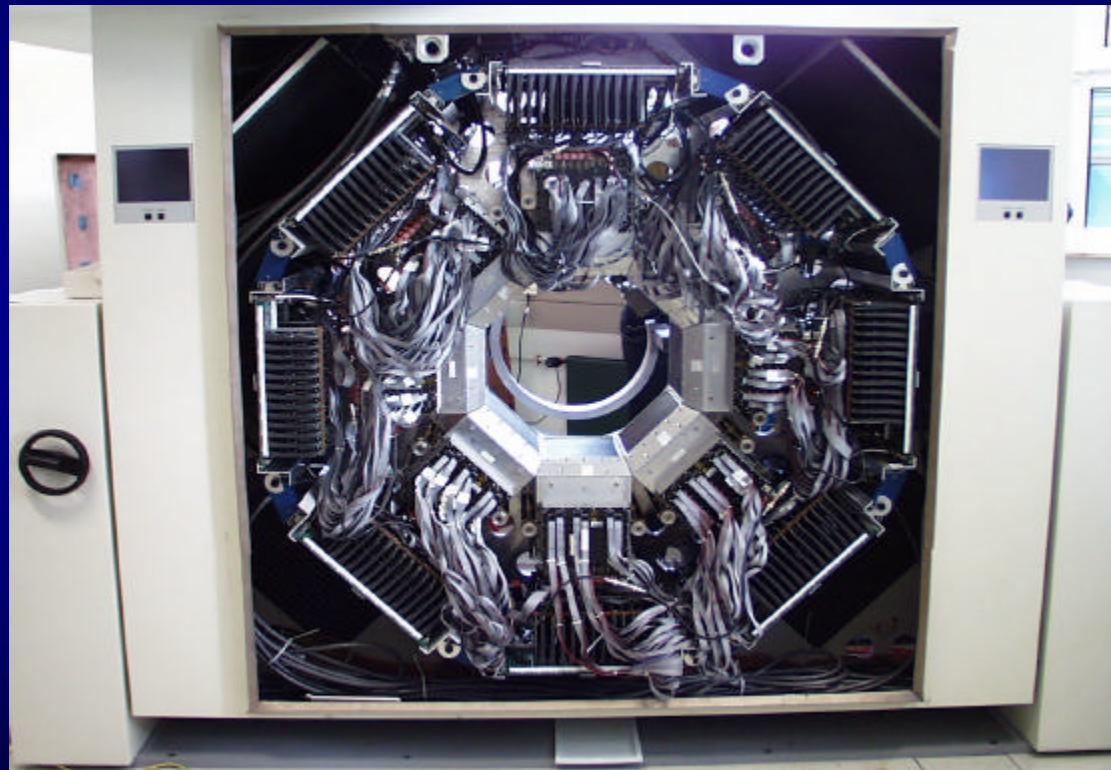
Octagon - 120,000 crystals



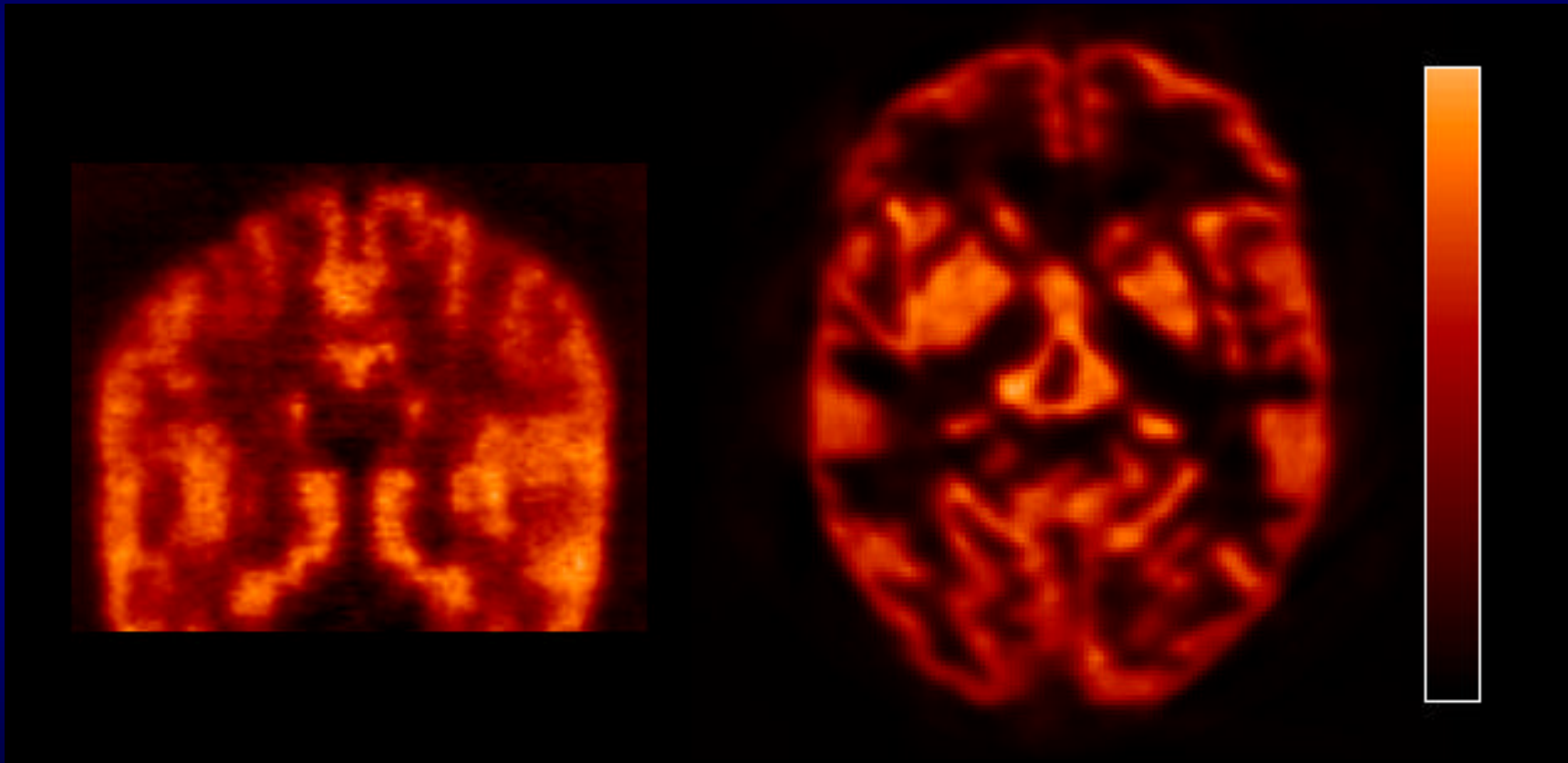
117 blocks per head



936 electronic channels
 $4.486 \cdot 10^9$ LORs

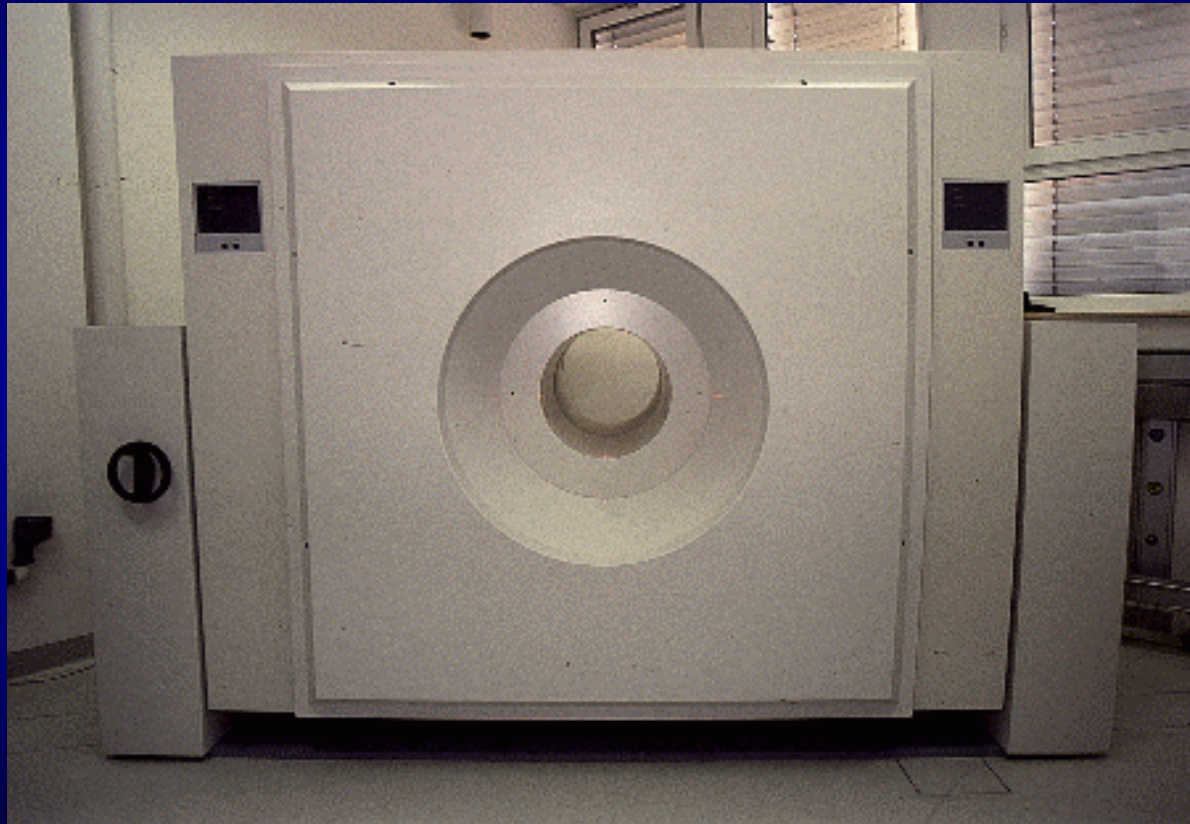


First images

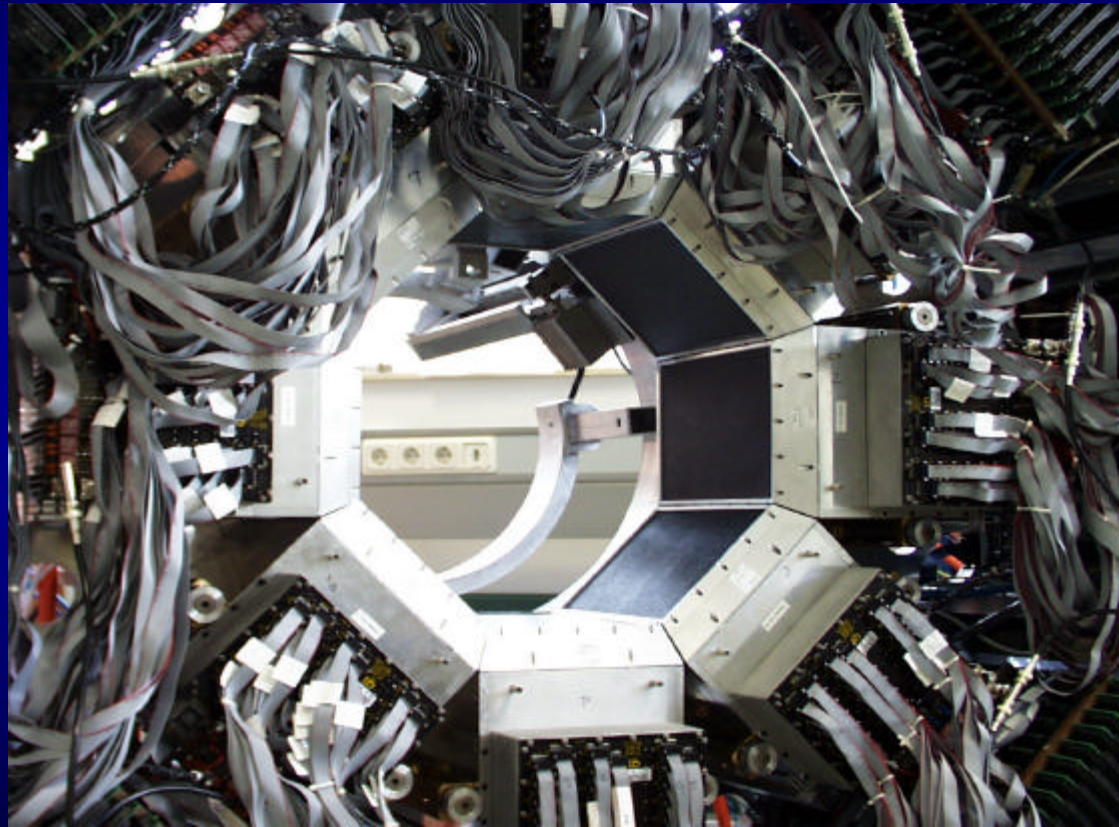


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first LSO - first DOI - PET



Octagon - 120,000 crystals



LSO (lutetium oxyorthosilicate:Ce)

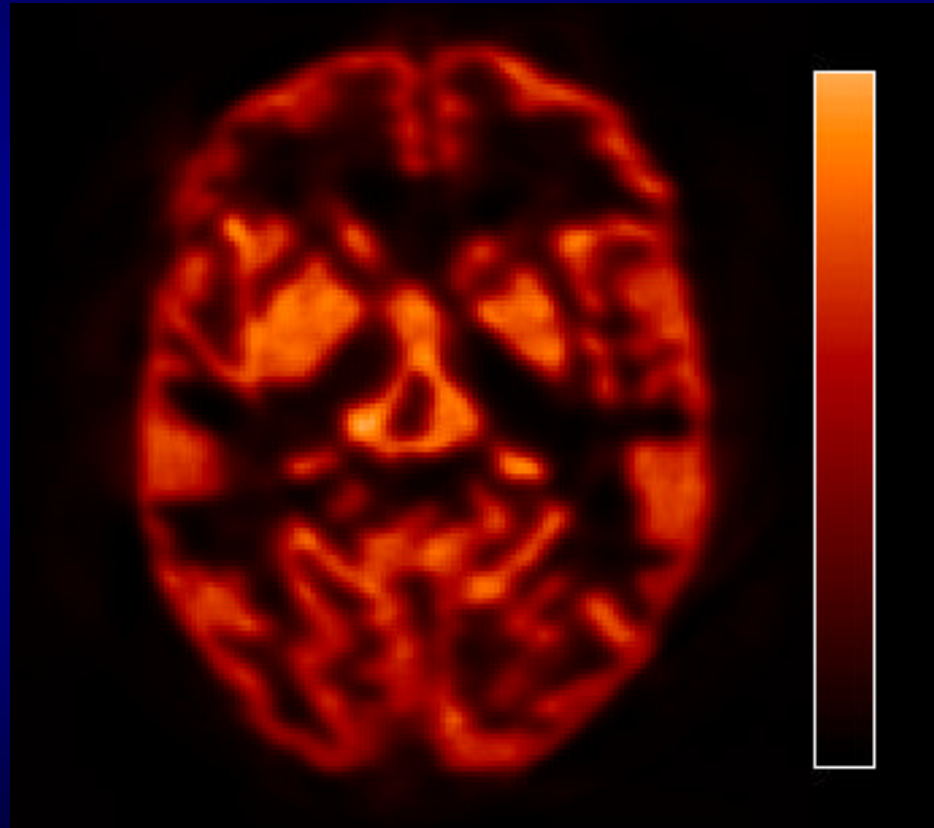
- ◆ higher scintillation light yield
 - ◆ smaller crystals
 - ◆ more efficient crystal to PMT coupling
- ◆ faster scintillation light decay time
 - ◆ lower dead time and higher count rate
 - ◆ faster coincidence timing (random rejection)

(than BGO)

Future PET design with LSO

- ◆ Flexible
 - ◆ Current performances of dedicated PET at lower cost
 - ◆ Improved PET performances at current price
- ◆ Innovative
 - ◆ Hybrid system
 - ◆ Depth of interaction

2D brain phantom on HRRT



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