

Performance evaluation of a high sensitivity high resolution PET scanner design based on large area LSO panel detectors (P39-5H)

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### Topics

- description of system
- performance specifications
- patient imaging studies
- future work and applications

**Previous work:**

C. Nahmias et al. PET tomograph designed for five minute routine whole body studies. *J Nucl Med* 43(5) 11P, 2002

M. Conti et al. Performance measurements of an LSO panel detector PET prototype. *IEEE MIC Conference, Norfolk VA, 2002.*

B. Jakoby: Performance Analysis on a New Generation Positron Emission Tomograph (PET) - Evaluation of Image Quality. Diploma Thesis, August 2004

### LSO panel detectors

- block: 12 x 12 array of 4 x 4 x 20 mm<sup>3</sup>
- 7 blocks (transaxial) x 10 blocks (axial)
- panel: 36 cm (transaxial) x 52 cm (axial)
- 8 x 11 array of 52 mm square PMTs
- phase II electronics

### Panel detectors and P39-5H scanner

- 5 heads; 30 rpm rotation of assembly
- <sup>68</sup>Ge point sources (2 x 10 x 1 mCi)
- list mode Em and Tx acquisition
- simultaneous Em and Tx acquisition

**P39-5H schematic**

### Transmission sources

- lead collimators (arrowed)
- two rows of 10 slit collimators with <sup>68</sup>Ge point sources (each about 1 mCi)
- every slit results in a fan beam
- every <sup>68</sup>Ge point source has a dedicated LSO crystal and electronics
- coincidences between the LSO crystal and the opposite panel identifies a transmission event.

### P39-5H: console and control room at UTMC

## P39-5H and HI-REZ

	P39-5H	HI-REZ
Detector blocks	12 x 12	13 x 13
Crystals (mm <sup>2</sup> )	4 x 4 x 20	4 x 4 x 20
LORs	3.22 x 10 <sup>8</sup>	0.35 x 10 <sup>8</sup>
Axial length (cm)	52.0	16.2
Patient port (cm)	70	70
Coincidence (ns)	6.0	4.5
LLD, ULD (keV)	400, 650	425, 650
Recon matrix	160x160x239	168x168x81
Algorithm	*OP+OSEM3D	FORE+AWOSEM

\*Xuan Liu, Comtat C, et al. Comparison of 3-D reconstruction with 3D-OSEM and with FORE+OSEM for PET. *IEEE TMI* 20(8) 804-814, 2001

## Performance specifications

Sensitivity:

70 cm line source; 0.6 mCi <sup>18</sup>F

Sensitivity at center: 2.0%

Sensitivity at 10 cm: 1.8%



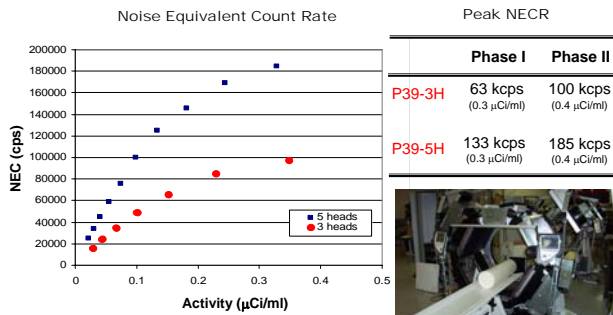
Spatial resolution

Measured with: 1 mm point source of <sup>18</sup>F (~ 10 μCi)

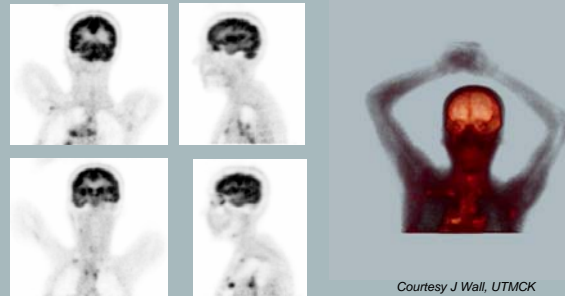
	r = 2 cm	r = +12 cm
In plane (mm)	4.4	5.0
Axial (mm)	5.0	6.0

Reconstruction: FORE + OSEM; Matrix: 320 x 320 x 239

## Performance specifications: count rate



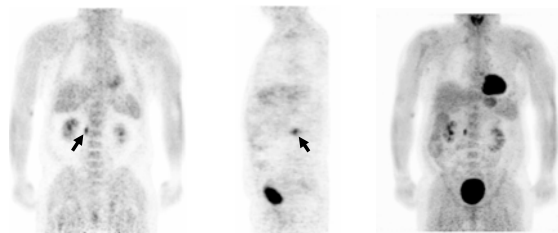
## Patient study #1: Eaton Lambert Syndrome



Courtesy J Wall, UTMCK

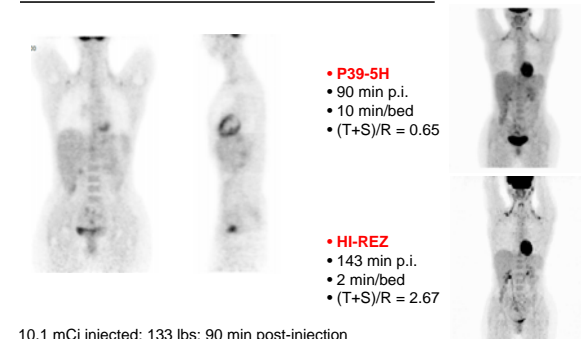
9.8 mCi injected; 110 lbs; 142 min post-injection; one bed position; 15 min scan  
Extensive mediastinal disease consistent with malignancy - probably SCLC

## Patient study #2: Lymphoma



12.2 mCi injected; 236 lbs; 186 min post-injection; two bed positions; 15 min/bed  
Left thoracic paraspinal and right upper lumbar paraspinal focal activity

## Patient study #3

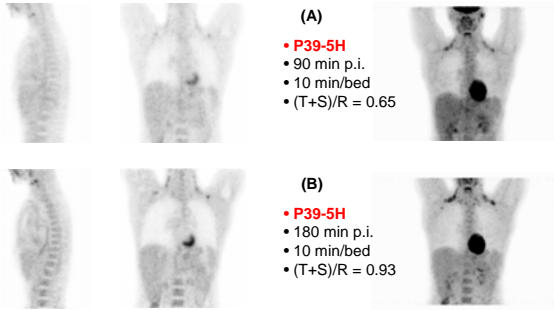


• P39-5H  
• 90 min p.i.  
• 10 min/bed  
• (T+S)/R = 0.65

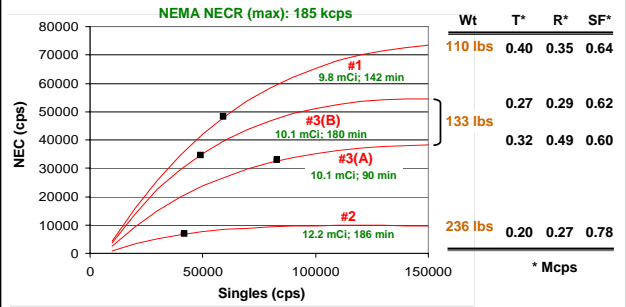
• HI-REZ  
• 143 min p.i.  
• 2 min/bed  
• (T+S)/R = 2.67

10.1 mCi injected; 133 lbs; 90 min post-injection  
2 bed positions; 10 min/bed position

### Patient study #3: count rate and image quality



### Patient NECRs



Watson CC, Casey M, et al. Evaluation of clinical PET count rate performance. *IEEE Trans Nucl Sci* 50 1379-1385, 2003

### Summary: future work and applications



- understand count rate / image quality
- improve pulse pile-up correction
- improve cross-talk rejection
- improve DAC and rebinner (PDR)
- image lower activity levels in patients
- naturally-occurring cancers in animals
- whole-body imaging of neonates

Courtesy J Wall, UTMCK