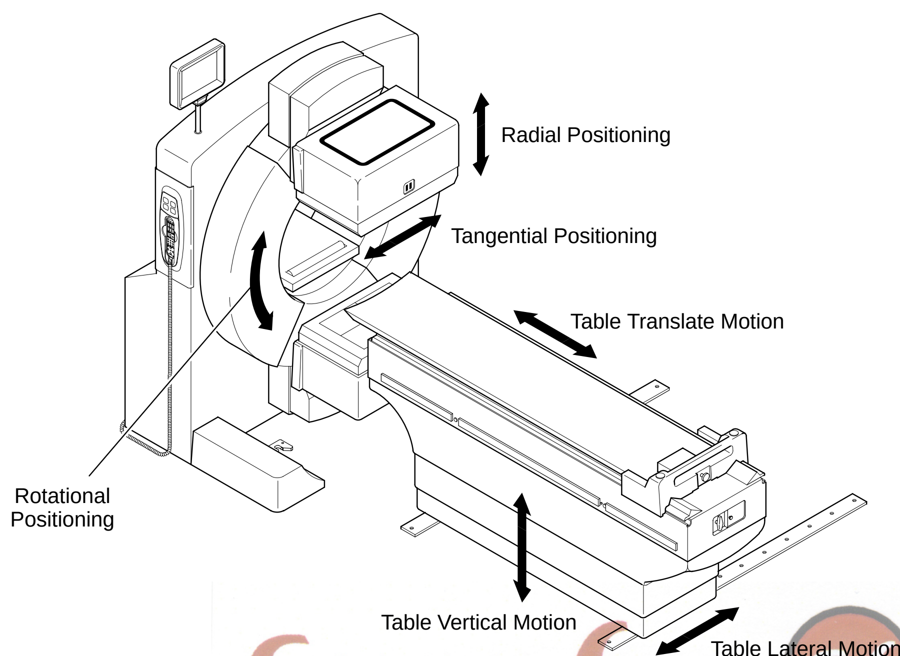
AXIS/IRIX

Number of detector heads	2 for AXIS 3 for IRIX

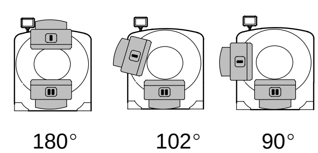
Detector

UFOV dimensions	UFOV: 393 mm x 533 mm (15-1/2” x 21”)
CFOV dimensions	CFOV: 295 mm x 400 mm (11.6” x 15.8”)
Crystal thickness	9.5 mm (3/8”) – standard 19.0 mm (3/4”) – thick
Exit window	Glass: 15.9 mm (5/8”)
Crystal size	470 mm x 593 mm (18-1/2” x 23-3/8”)
Number of PMTs	59 tubes per detector: 49 76.2 mm (3”) round tubes 10 50.8 mm (2”) round tubes
PMT shielding	High permeability mu-metal magnetic shields on every PMT. Maximum magnetic operating field: .5 gauss
FOV to detector edge	8.6 cm (3-1/2”) “brain reach”
Detector shielding	4 sides shielded with 17.4 mm (0.684”) lead minimum, base shielding of 18.28 mm (3/4”) lead

AXIS/IRIX Gantry and Table Motions



AXIS Transformations



IRIX Transformations

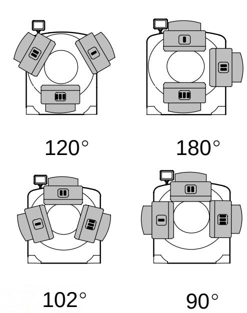


Table of Contents

Detector (Continued)

■ Detector shielding	No light-attenuating light pipe used
■ Energy range	50 to 511 KeV
■ Type of detector motion	Radial, tangential and rotational motion
■ Detector movement	Individually or simultaneously, either direction (maximum of two simultaneous motions)
■ Iso-center	95.6 cm (37-5/8”) from floor
■ Distance of crystal face from floor	Face up = 51.1 cm to 80.3 cm (20-7/8” to 31-5/8”) Face down = 110.8 cm to 137.5 cm (43-5/8” to 54-3/8”)
■ Total radial travel	26.7 cm (10-1/2”)
■ Total range	10.75 cm to 37.45 cm (4-13/16” to 15-9/16”) measured from low-energy collimator surface to center of rotation
■ Radial speed	<u>Acquisition</u> Maximum: 60 cm/min. Minimum: 3 cm/min. <u>Manual (Hand-held controller)</u> Maximum: 60 cm/min. Minimum: 30 cm/min.
■ Radial position resolution	Encoded to 0.007 mm
■ Radial position accuracy	± 1.0 mm
■ Tangential speed	<u>Acquisition</u> Maximum: 60 cm/min. Minimum: 3 cm/min. <u>Manual (Hand-held controller)</u> Maximum: 60 cm/min. Minimum: 30 cm/min.
■ Tangential position resolution	Encoded to 0.007 mm
■ Tangential position accuracy	± 1.0 mm
■ Detector locations	AXIS: 180° opposed, 102° and 90° cardiac IRIX: 120° standard, 180° opposed, 102° and 90° cardiac
■ Detector registration	Proprietary Image Registration Correction (IRC) aligns all heads to the axis of rotation and to each other through calibration using three point sources

Collimator

- Fabrication process — Foil
  Cast (S.O.I. required. Not available in all types of collimators.)
- Automatic collimator identification — Yes
- Collimator Server/Storer — AXIS – 2 collimators per server/storer
  IRIX – 3 collimators per server/storer
- Collision sensing device — Yes

Gantry

- Type — Variable angle – ring/cantilevered
- Rotation — 480° total rotation
  (–60° to +420°)
- Diameter of aperture — Maximum: 70 cm (27-1/2")
- Rotation accuracy — ± 0.1°
- Angle resolution — Encoded to 0.01°
- Rotation modes — Continuous and step-and-shoot
- Speed of rotation —
  Acquisition
  Maximum: 1.5 rpm
  Minimum: 0.025 rpm

  Manual (Hand-held controller)
  Fast speed: up to 1.5 rpm
  Slow speed: as slow as 0.25 rpm
- Rotation increments — Selectable in multiples of 1 degree
- Whole Body scan — Yes
- Gantry Whole Body scan travel — 0 cm to 231 cm (0" to 91")

Table of Contents

Gantry (Continued)

■ Gantry Whole Body imaging length	198 cm (78")	
■ Whole Body acquisition speed	Maximum: Minimum:	300 cm/min. 3 cm/min.
■ Operator programmable	Exact body contouring with learn mode	
■ Speed – manual control	Maximum: Minimum:	300 cm/min. 120 cm/min.
■ Digital display of gantry and detector movements	Yes	
■ Type of information displayed to the operator	Gantry: Detector: Table:	rotation angle linear translation radial position height translate
	Persistence imaging in real time Error information Help text to prompt operator Information on collimator status and gantry preprogrammed motions System status information (emergency stop, collision, etc.) Collimator type	
■ Gantry control accessible	Yes	Through operator Hand-held controller
■ Preprogrammed functions	Yes	Whole Body study setup Brain SPECT study setup (circular) Torso (heart) SPECT study setup (non-circular) Detector orientation, Upright study setup Patient and collimator load/unload

Patient Table

■ Type	Non-cantilevered type, multiple interchangeable pallets
■ Material	Carbon-fiber
■ Dimensions of the pallets (Width x Length x Table Thickness)	
– Standard Table	38.1 cm (15”) x 198.1 cm (78”) x 1.6 cm (5/8”)
– Two Tier/Pediatric Table	38.1 cm (15”) x 198.1 cm (78”) x 1.6 cm (5/8”) 30.5 cm (12”) wide on the tiered end
– Infant Cradle	18.8 cm (7”) x 158.5 cm (62”) x .32 cm (1/8”)
■ Maximum patient weight load	182 kg (400 lbs.)
■ Attenuation information	7% attenuation at 140 KeV
■ Vertical movement	47 cm (49.5 cm to 96.5 cm measured from the floor) 18.5” (19.5” to 38” measured from the floor)
■ Minimum distance to floor	49.5 cm (19.5”)
■ Vertical speed	<u>Manual (Hand-held controller)</u> Fast speed: 60 cm/min. Slow speed: 30 cm/min. (with maximum load)
■ Horizontal movement during acquisition	198 cm (78”)
■ Lateral movement during acquisition	± 5.08 cm (2.0”) manually
■ Lateral motion accuracy	± 1 mm
■ Direct control to patient table accessible to the operator	Yes Through Hand-held controller (except lateral movement which is manual)
■ Head rest	Yes
■ Thickness of table	1.6 cm (5/8”)
■ Table weight	10.8 kg (20 lbs.)

Safety Features

Emergency stop switches	Two on the gantry, two on the table	
Collision sensing detection	Yes	Membrane sensing device standard with each collimator, gantry base, and catcher
Head retract function for detectors	Yes	
Collimator latch sensor	Yes	
Sensor for proper collimator mounting	Yes	
Regulatory compliance	ETL tested to UL–544 specifications TUV tested to IEC 601–1 specifications	
Quality compliance	ISO 9001 compliant	

BEACON (Non-Uniform Attenuation Correction)

Source	Ba^{133} 356 KeV 10 1/2 Yr Half-Life 2 – 10 mCi Point Sources
Permanent mounting and storing	Yes
Arm up/Arm down scanning	Yes
Emission/Transmission acquisition method	Sequential
Specialty Collimator	None Needed
Support scanning Configuration	102° – opposed 180°
Transmission acquisition time	6–9 minutes

Table of Contents

Detector Specifications

3/8” (9.5 mm) Crystal, Single Photon Mode

NEMA Performance Specifications*
Performance Characteristics**

Intrinsic **E**nergy **R**esolution (IER)			9.5%
Intrinsic **S**patial **R**esolution (ISR)	CFOV	FWHM	3.3 mm
		FWTM	6.3 mm
	UFOV	FWHM	3.3 mm
		FWTM	6.3 mm
Intrinsic Count Rate Perf. – full corr. with 20% energy window High Count Rate Mode	Max. Count Rate	CPS	310 K
	Observed 20% Count Loss Rate	CPS	210 K
Intrinsic Flood Field Uniformity (IFFU) at less than 20 KCPS	CFOV	DIFF	2.0%
		INTEGRAL	2.5%
	UFOV	DIFF	±2.5%
		INTEGRAL	±3.5%
Intrinsic **S**patial **L**inearity (ISL)	CFOV	DIFF	0.15 mm
		ABSOLUTE	0.4 mm
	UFOV	DIFF	0.2 mm
		ABSOLUTE	0.6 mm
Multiple Window Spatial Registration			0.6 mm
Reconstructed **S**ystem **S**patial **R**esolution (RSSR) with LEHR/LEUHR collimators	Central Axis	FWHM	11.0/10.0 mm
	Peripheral Axes Rad 7.5 cm	FWHM	10.8/10.5 mm
	Tan 7.5 cm	FWHM	7.8/7.0 mm
Measurement Parameters: NEMA Phantom with Scatter Views: 120	Algorithm: 360 Filtered BP Filter: Ramp		
System Dead Time	Application Specific Programmable Dead Time		

* Performance specifications for 15.5” x 21” rectangular detector with 3/8” (9.5 mm) NaI crystal NEMA NU1-1986 Performance Measurement of Scintillation Cameras

** All performance characteristics measured in Normal mode except where noted

3/4” (19 mm) Crystal, Single Photon Mode (Continued)

NEMA Performance Specifications*
Performance Characteristics**

Intrinsic **E**nergy **R**esolution (IER)			9.6%
Intrinsic **S**patial **R**esolution (ISR)	CFOV	FWHM	4.1 mm
		FWTM	7.8 mm
	UFOV	FWHM	4.1 mm
		FWTM	7.8 mm
Intrinsic Count Rate Perf. – full corr. with 20% energy window Standard Count Rate Mode******	Max. Count Rate	CPS	165 K
	Observed 20% Count Loss Rate	CPS	75 K
Intrinsic Count Rate Perf. – full corr. with 20% energy window High Count Rate Mode	Max. Count Rate	CPS	310 K
	Observed 20% Count Loss Rate	CPS	210 K
Intrinsic **F**lood **F**ield **U**niformity (IFFU) at less than 20 KCPS	CFOV	DIFF	2.0%
		INTEGRAL	2.5%
	UFOV	DIFF	±2.5%
		INTEGRAL	±3.5%
Intrinsic **S**patial **L**inearity (ISL)	CFOV	DIFF	0.15 mm
		ABSOLUTE	0.4 mm
	UFOV	DIFF	0.2 mm
		ABSOLUTE	0.6 mm
Multiple Window Spatial Registration			0.6 mm
System Dead Time	Application Specific Programmable Dead Time		

* Performance specifications for 15.5” x 21” rectangular detector with 3/4” (19 mm) Nal crystal NEMA NU1-1986 Performance Measurement of Scintillation Cameras

** All performance characteristics measured in Normal mode except where noted

*** This section has been removed from the Precision^{AZ} Product Data Sheet

Table of Contents

3/4” (19mm) Crystal, Single Photon Mode (Continued)

NEMA Performance Specifications*
Performance Characteristics**

Reconstructed **S**ystem **S**patial **R**esolution (RSSR) with LEHR collimators	Central Axis	FWHM	11.2 mm
	Peripheral Axis Rad 7.5 cm Tan 7.5 cm	FWHM FWHM	11.0 mm 8.2 mm
Measurement Parameters: NEMA Phantom with Scatter Views: 120	Algorithm: 360 Filtered BP Filter: Ramp		

* Performance specifications for 15.5” x 21” rectangular detector with 3/4” (19 mm) NaI crystal NEMA NU1-1986 Performance Measurement of Scintillation Cameras

** All performance characteristics measured in Normal mode except where noted

3/4” (19 mm) Crystal, γPET[AZ]

Intrinsic **E**nergy **R**esolution (IER)		10.0%
Reconstructed transverse spatial resolution measured with a Na-22 point source on the central axis (list mode acquisition)	FWHM	≤4.8 mm
Reconstructed transverse spatial resolution measured with a Na-22 point source placed 10 cm off the central axis (list mode acquisition)	FWHM	≤6.2 mm
Maximum True Coincidence Count Rate (KCPS)		AXIS: 30 IRIX: 42
Coincidence Sensitivity***** (NEMA Methodology) (KCPS/UCI/CC)	Axial Filter	AXIS: 50 IRIX: 60
	Open Frame	AXIS: 330 IRIX: 370
System Scatter Fraction %	Axial Filter	AXIS: 21 IRIX: 21
	Open Frame	AXIS: 28 IRIX: 28

* Product data sheet numbers were measured using a large enthropomorphic chest phantom. Camera-based PET increases count rate with large objects This advantage is not seen with NEMA phantom.

Table of Contents

Collimator Specifications

DESC.	PART NO.	FIELD OF VIEW at 100 mm (mm)	MAX. USEFUL ENERGY (KeV)	SEPTAL PENET. (%)	HOLE SIZE (mm)	HOLE LENGTH (mm)	SEPTA THICK-NESS (mm)	SYSTEM RESOLUTION (mm) FWHM at 0 mm		SYSTEM RESOLUTION (mm) FWHM at 100 mm		SYSTEM SENSITIVITY (cpm/μCi)		COLL WEIGHT (kg/lbs.)
Crystal Type								**3/8" (9.5mm)**	**3/4" (19mm)**	**3/8" (9.5mm)**	**3/4" (19mm)**	**3/8" (9.5mm)**	**3/4" (19mm)**	
Dynamic (DY)*	N210868	394 x 533	150	2.9	2.54	25.4	0.305	5.1	5.7	14.8	15.0	900	991	19/42
General All Purpose (GAP)	N210867	394 x 533	160	1.4	1.4	25.4	0.254	4.1	4.8	8.4	8.9	233	257	25/55
High Resolution (HR)	N210866	394 x 533	160	1.5	1.22	27.0	0.203	3.9	4.7	7.0	7.6	161	177	26/57
Ultra High Resolution (UHR)	N210865	394 x 533	160	0.8	1.78	58.4	0.152	4.1	4.8	6.0	6.7	84	93	33/73
Ultra High Resolution Fanbeam (AXIS)	N210869	394 x 383	160	0.6	1.4	34.9	0.152	3.8	4.3	5.6	5.7	185	224	25/55
Medium Energy General Purpose (MEGP)	N210872	394 x 533	300	4.7	3.40	58.4	0.864	5.7	6.4	10.2	10.6	226	250	74/163
High Energy (HE)	N210874	394 x 533	400	2.7	3.4	58.4	2.01	5.9	6.6	11.0	11.4	146	160	103/227
Pinhole (HE Pin)	N210875	145	400	N/A	3.0	N/A	N/A	5.1	5.7	6.4	6.8	N/A	N/A	105/231
					5.0			6.8	7.3	9.3	9.6			
					7.0			8.8	9.2	12.5	12.8			

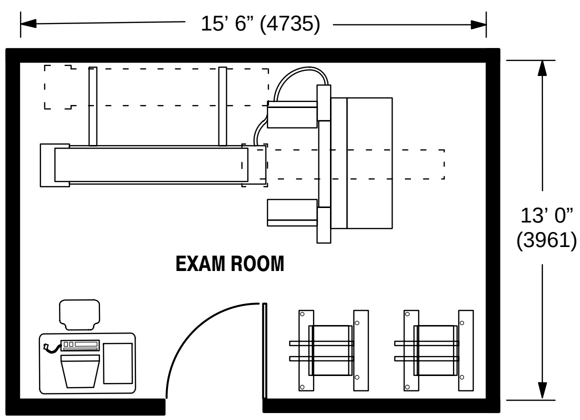
* Available with long lead upon request

Floor Plan

Minimum room size requirement – 13’ x 15’ 6”

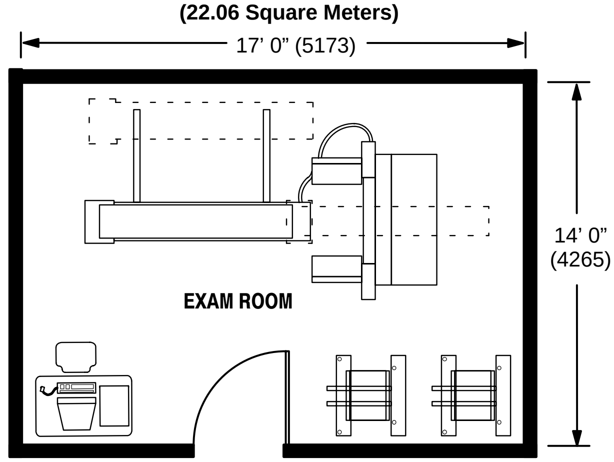
AXIS Floor Plan

Minimum Room Layout
(202.8 Square Feet)
(18.75 Square Meters)



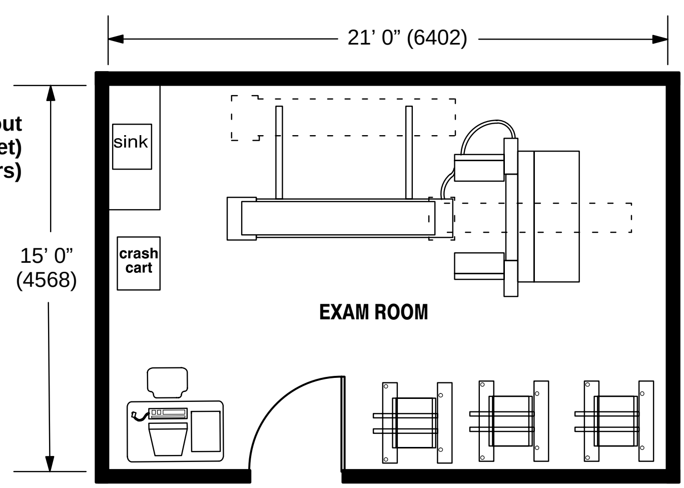
Short Track Configuration

Typical Room Layout
(238 Square Feet)
(22.06 Square Meters)



Standard Track Configuration

Ideal Room Layout
(315 Square Feet)
(29.24 Square Meters)



Standard Track Configuration

NOTE:
All metric dimensions are in (mm).
Dashed lines indicate range of motion of table.

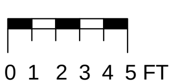
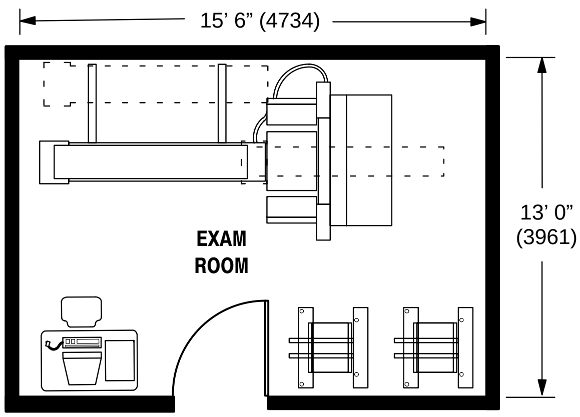


Table of Contents

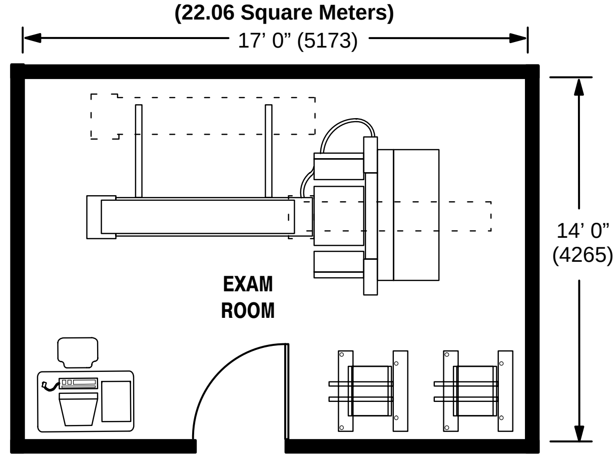
IRIX Floor Plan

Minimum Room Layout
(202.8 Square Feet)
(18.75 Square Meters)



Short Track Configuration

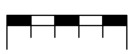
Typical Room Layout
(238 Square Feet)
(22.06 Square Meters)

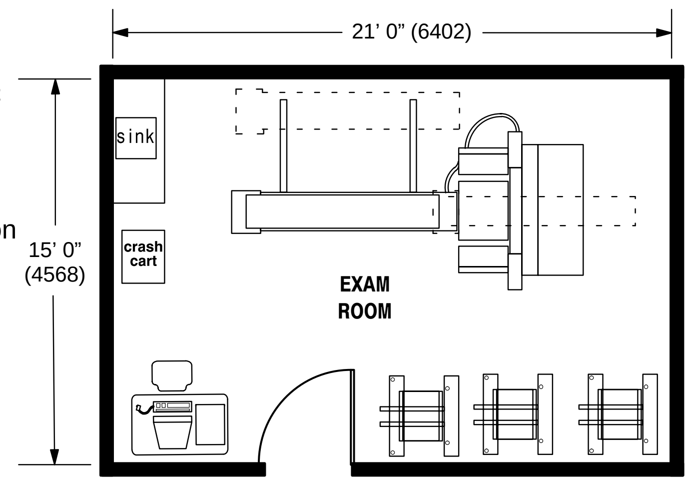


Standard Track Configuration

Ideal Room Layout
(315 Square Feet)
(29.24 Square Meters)

NOTE:
All metric dimensions are in (mm).
Dashed lines indicate range of motion of table.





Standard Track Configuration

Physical Specifications

Component	Weight (lbs.)	Weight (kg)
Gantry/Table Assembly (AXIS)	5,400	2,455
Gantry/Table Assembly (IRIX)	6,900	3,112
Collimator Server (without collimators)	175	79.6
Collimator Server (with 2 LE Collimators)	289	132
*Odyssey*FX Computer	70	32
*Odyssey*FX Display Monitor	72	32.5
Optional Acquisition and Display Terminal	72	32.5
Collimators	Refer to Collimator Specification Sheet	

Power Requirements

Component	Power	Heat Output
Gantry Assembly	208/220/240 V, 20 Amp, Single Phase (60 Hz/50 Hz)	6800 BTU/hr. (peak) 3400 BTU/hr. (avg)
*Odyssey*FX Computer	105 – 125 V, 20 Amp, Single Phase (60 Hz/50 Hz)	1000 BTU/hr.
Optional Acquisition and Display Terminal	105 – 125 V, 15 Amp, Single Phase (60 Hz/50 Hz)	1500 BTU/hr.

Table of Contents

Source Configuration

The power source supplying AXIS or IRIX system shall be single phase, 2-wire plus dedicated/isolated ground and neutral (4-wire). The source should be sized for 10 kVA load.

Nominal AC Volts	208, 220 or 240
Line Phase	Single
Voltage Regulation	7%
Full Load kVA	10
Line Amps	48
Utilization Voltage	198 – 252
Voltage Variation	+7% –7%
Distribution Transformer	10 kVA

Quality of Power

Power quality specifications are based on measurements taken at the Nuclear Room power distribution panel.

Transient Voltage

> 240 V	None allowed
180 – 240 V, <100 micro sec	1/day max
90 – 180 V, <400 micro sec	6/hr., 24/day max
50 – 90 V, <800 micro sec	6/hr., 24/day max

If transients on the line exceed specified tolerances, a transient suppressor is recommended to prevent equipment damage.

Voltage Fluctuations (Sags/Surges)

Sags and surges in the line shall not cause the line-to-line or line voltage to deviate from either its nominal or average value by more than 7%, whichever is less. For example, assuming a nominal voltage of 120 volts, if the line sags below 111 volts or surges above 128 volts, line conditioning is recommended.

Brownouts

If there are consistent voltage losses of greater than 8 cycles (120 msecs), a battery UPS is recommended.

Environmental Specifications

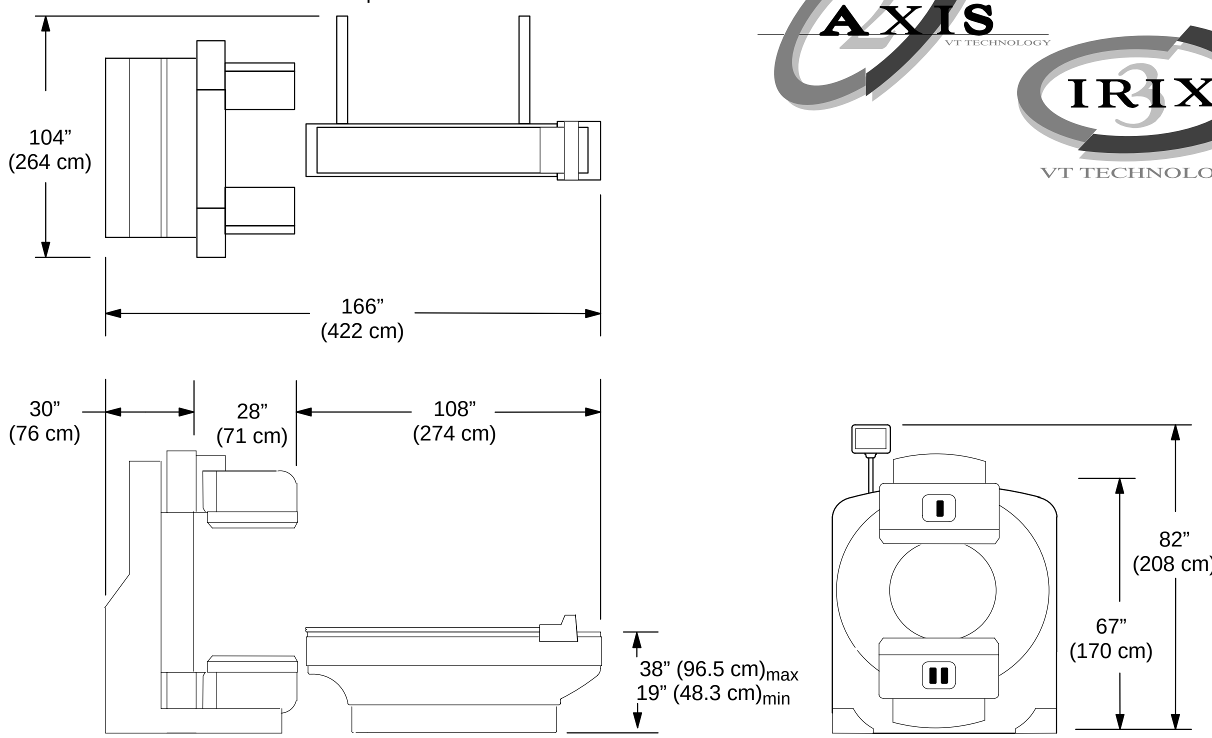
Component	Heat Output (BTU/HR)	(KiloWatt)
Gantry Assembly (includes CAP)	6800 (peak) 3400 (avg)	**tbd**
*Odyssey*FX Computer	2500	0.735
*Odyssey*FX Display Monitor, Keyboard, Mouse	1225	0.30
Optional Acquisition and Display Terminal	1225	0.30
Codonics Color Printer	700	0.40

- Operating Temperature Range: 68° F – 75° F (20° C – 24° C)
- Relative Humidity Range: 45% – 80%, non-condensing optimum 55%
- Temperature Gradient: 5° F/hr. maximum (3° C/hr. maximum)

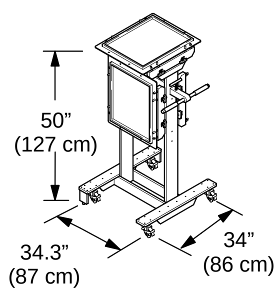
Table of Contents

Equipment Views

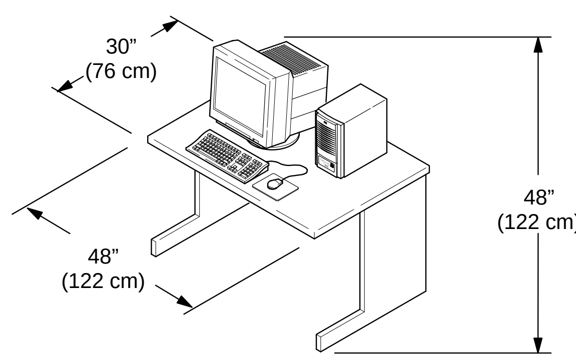
Top



Side Gantry and Patient Table Front



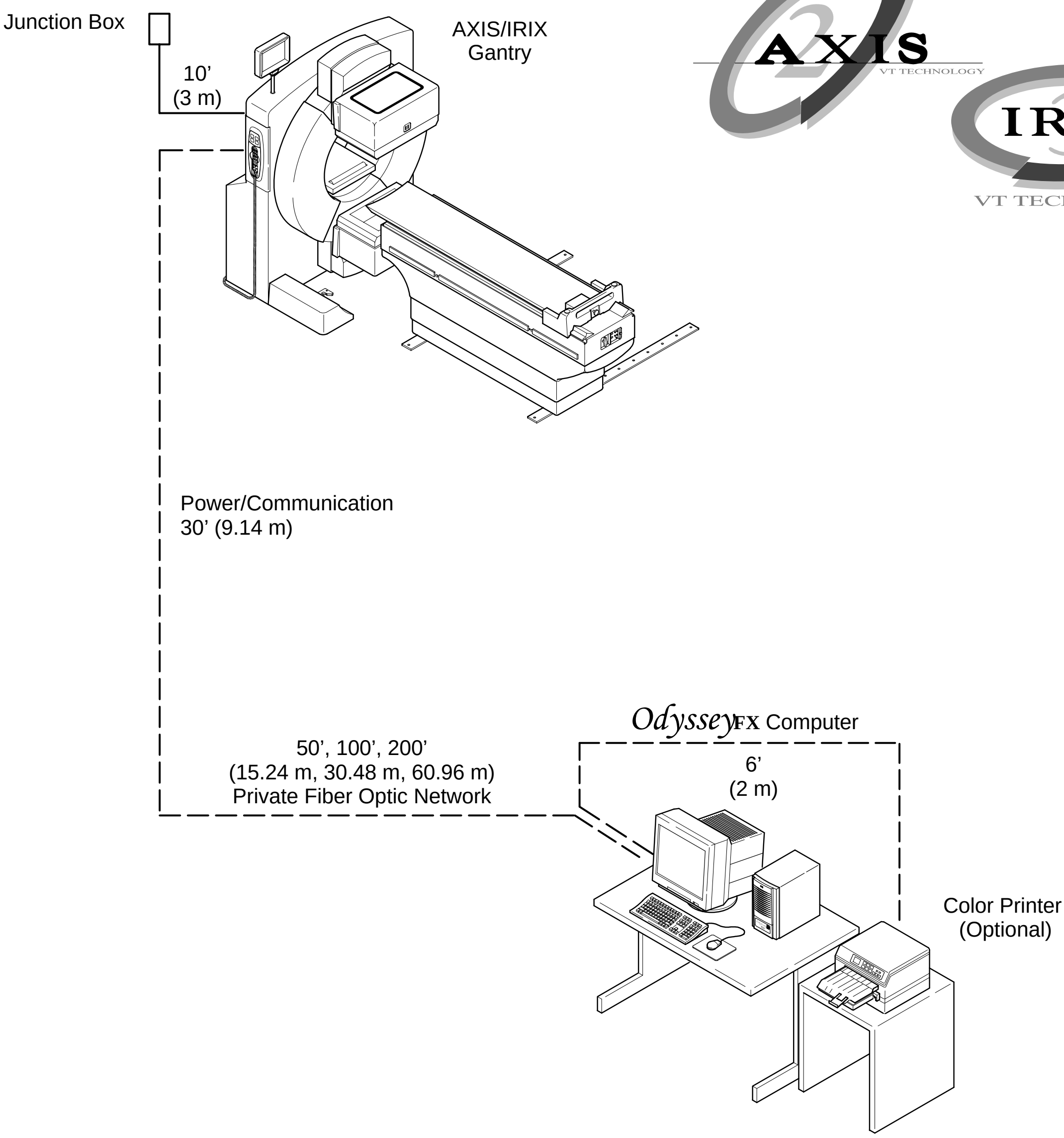
Collimator Servers/Storer



*Odyssey*FX Computer

Table of Contents

Cable Interconnect



Cables (pick cable):

- CAP Electronics Cabinet to *Odyssey*FX Computer (50’ cable) part number N711066
- CAP Electronics Cabinet to *Odyssey*FX Computer (100’ cable) part number N711065
- CAP Electronics Cabinet to *Odyssey*FX Computer (200’ cable) part number N711064

Table of Contents

System Summary Specifications

- Patient Comfort
  - Must have open, unshrouded detector design in order to minimize anxiety in claustrophobic patients
  - Must provide comfortable patient imaging table with integral head rest and a 400 pound (182 kgs) weight limit
  - Imaging table must include soft, non-porous, washable patient pad
  - Must have available optional attenuation free head positioner
- Safety
  - Must include contact-sensing devices in collimator faces that halt all detector motion should the collimator touch a foreign object during imaging procedure. Must be able to continue or abort a study after contact sensor has been reinitialized. (Continuous and dynamics excluded)
- Image Quality
  - Must have low attenuation (≤7% at 140 KeV), high strength carbon fiber imaging table to minimize image degradation caused by excessive radiation absorption
  - Must have detector surround of 8.6 cm (3.5”) or less (“brain reach”) to assure maximum brain stem imaging and highest resolution brain images
  - Must incorporate detector side and top shielding of at least 17 mm (0.684”) thickness of lead (Pb) or equivalent
  - Must incorporate operator-loaded and protocol-specific correction tables to assure highest quality images at all times
  - Must provide circular orbit capability and easily set up non-circular orbit capability for optimum image quality
  - Must provide automated non-circular cardiac SPECT setup
  - Must provide for multiple, complete SPECT studies acquired continuously by redefined protocol decreasing chance of lost studies due to patient motion
  - Triple head system must be capable of triple head SPECT, Whole Body and Planar studies
  - Must be capable of performing PET imaging

System Summary Specifications (Continued)

- Patient table must be ≤ 3/4” thick for optimal image quality
- Each detector must have a UFOV of 393 mm x 533 mm (15.5” x 21”)
- Must provide automated quality control procedures
- Must provide linear Whole Body speeds from 3 cm/min. to 300 cm/min.

■ Computer Power

- Must provide a separate, real-time operating system, with a separate acquisition processor for enhanced utility and to permit gated cardiac acquisitions
- Must include a 64 bit superscalar RISC architecture image processing computer as protection against obsolescence
- Must provide minimum memory of at least 64 MBytes
- Must provide as an option real-time 3-D reconstruction
- Must provide pop-up menus. The X Window System capability and Ethernet connectivity using TCP/IP protocol
- Must provide NFS (**N**etwork **F**ile **S**ystem), transparent sharing of disks
- Must provide minimum of 9 GByte disk storage (18 GByte disk storage optional) and 12/24 GByte DAT tape storage
- Must supply as an option a 4.3 GByte magneto-optical disk with multiple read and write capability
- Must provide the standard file format, Interfile, for conversion of files to the existing computers
- The computer should utilize the industry standard OSF/MOTIF graphical user interface
- Must offer easy access (800#) for application questions and issues
- Must be programmable in the C language
- Must allow up to eight different studies to be processed simultaneously without interfering with acquisition and system maintenance functions
- Must provide Iterative MLEM/OSEM reconstruction techniques
- Must be hardware upgradable to allow simultaneous dual acquisition and dual processing functions
- Must have phone modem for service/engineering support
- Must provide DICOM capability as an option

Table of Contents

System Summary Specifications (Continued)

- Convenience
  - Must include a real-time persistence image at the gantry with tableside erase control
  - Must provide the ability to look at persistence images on the processing console while processing other patients
  - Must include a “smart” gantry to automatically move to patient imaging position
  - Must provide operator controlled linear contouring (learn mode) as part of Whole Body set-up
  - Must provide a “smart” gantry which automatically moves to the collimator changing position
  - Must provide operator configurable acquisition and processing protocols
  - Service must be located within ______ hours/miles of, or from, the site
  - The gantry footprint should be no greater than 13’ x 15’ 6” to minimize room requirement
  - A single table should be optimized for *both* SPECT and Whole Body studies minimizing patient setup time
  - Collimator changing should use a practical, quick method without requiring bolts or screws
  - Must provide automated anterior/posterior Whole Body imaging
  - Must provide 27.5 **C**ustomer **E**ducation **U**nits (CEU) for 4 days on-site training
  - Must provide 30.0 CEU for ODYSSEY Workshop class
  - Must provide 16.0 CEU for PIXIE Enthusiast class

Table of Contents

AXIS/IRIX Precision Detector

■ What is CAP?	CAP stands for **C**amera **A**cquisition **P**rocessor. It provides real-time control of AXIS/IRIX.

PHA (Pulse Height Analyzer)

■ Number of windows	8	
■ Window width range	1% – 200%	
■ Window width increment	1%	
■ Window centerline range	3.5:1	
■ Asymmetry indicator	Yes	Up to ±5% off peak
■ High voltage control	Yes	
■ Digital or analog P-Scope	Digital P-Scope on gantry and persistence images on processing computer screen at operator command	
■ Number of channels of PHA	256	
■ Scaler/Rate meter	Range: Resolution:	0 – 1000 kcps 0.1 kcps
■ EKG trigger compatibility	TTL +3V to +6V BNC plug compatibility	

Acquisition Memory

■ Memory resolution	2K x 4096, 16 bits deep
■ Output data transfer to *Odyssey*FX Computer	Ethernet Fiber Optic

Data Storage

■ Type	9.1 GByte hard disk for system, protocols, tables files, and temporary patient file storage prior to transfer to *Odyssey*FX.
■ Transfer rate (Hard Disk)	30 MBytes/second – Typical (80 MBytes/second Burst Rate)

Table of Contents

Central Processing Unit

■ Microprocessor	MPC 750 PowerPC 233 MHz
■ Memory	32 MBytes of RAM (program memory)

Image Corrections

■ Electronic corrections applied to the image data	ELF (**E**nergy, **L**inearity and **F**lood uniformity) correction and IRC (**I**mage **R**egistration **C**orrection)

Energy Correction

■ Algorithm	Real-time multiplication
■ Matrix size	128 x 128
■ Operator calibratable	Yes

Linearity Correction

■ Algorithm	Real-time Hermite Interpolation
■ Matrix size	128 x 128
■ Operator calibratable	No Service function (only on demand). Typically only once per year during preventive maintenance.

Uniformity Correction

■ Algorithm	Real-time random add/subtract
■ Matrix size	256 x 256
■ Operator calibratable	Yes

IRC (Image Registration Correction)

■ Look up table resolution	1°
■ Operator calibratable	Yes

Quality Assurance and Maintenance Procedures

Procedure	Frequency	Operator/ Service	Features	Approx. Time to Acquire
Flood Uniformity Test	Daily	Operator	Visual uniformity test	10 min.
Energy/Flood Calibration	Monthly	Operator	Re-generate the energy and/or flood correction tables necessary to maintain maximum imaging performance	3–4 hrs. (usually overnight)
IRC Calibration	As needed	Operator	Re-generate IRC tables (X and Y for each detector head) to maintain detector registration and COR (**C**enter **o**f **R**otation)	1-1/2 hrs.
SPECT Performance Test	As needed	Operator	Qualitative measurement of SPECT performance: Spatial resolution, Uniformity, and Lesion Detectability	20–30 min.
PMT Balance	As needed	Service	PMT auto calibration from daily floods with the back up capability of individual tube checks	–
Linearity Calibration	As needed	Service		–

All operator acquired Q.C. procedures are automated. The operator simply sets up the acquisition; the AXIS/IRIX or PRISM XP system does the rest. No “downtime” required during operational hours. Most often the operator starts the procedure at the end of the day and leaves the system acquiring during off hours.

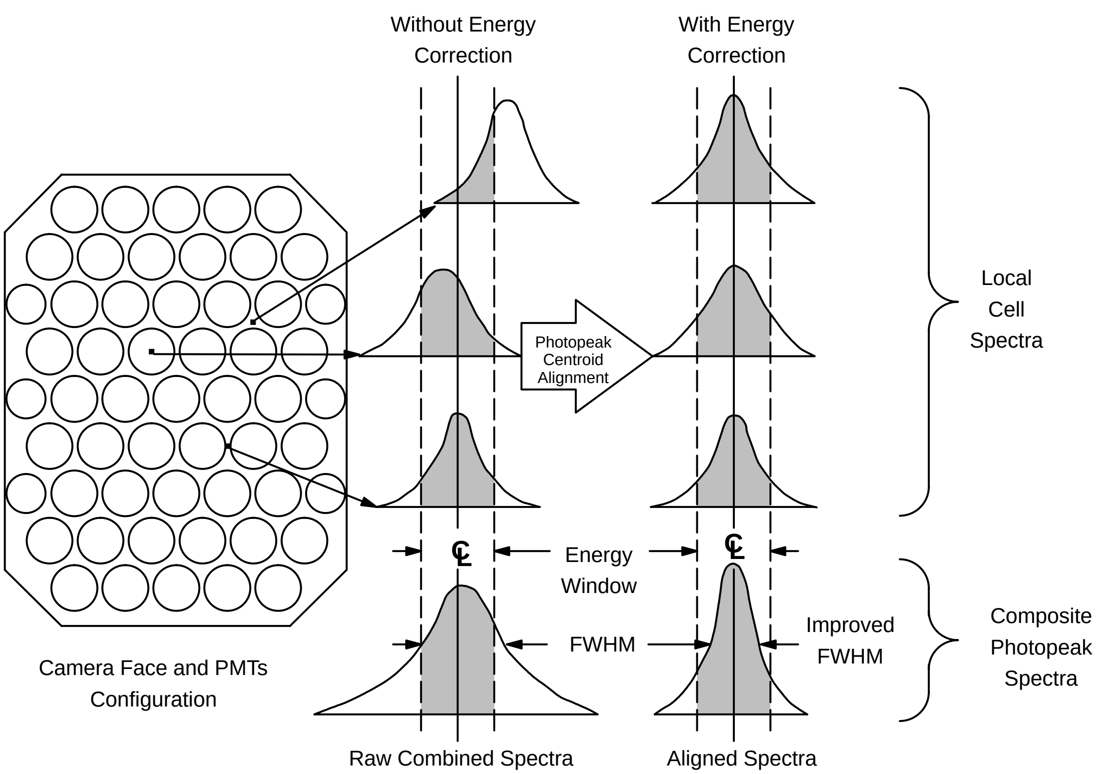
Energy Correction

Problem:

The spread in energy of the primary photopeak indicates the effectiveness with which a detector can measure gamma energy. The ideal photopeak has the smallest possible spread. However, variations in light sensitivity on the detector cause misalignment of the photopeak centroids recorded at each crystal location. The variations are caused by the natural distortion of the photomultiplier tubes, crystal variations and anomalies in PMTs. The misalignment of the photopeak centroids has an effect of spreading the energy spectrum in the neighborhood of the energy of interest. As a result, the energy selectivity of the detector will be degraded. This phenomenon is seen in *all* gamma cameras.

Solution:

During the short energy calibration (approximately 20 minutes), the on-board processor computes correction factors required to align the individual spectra and stores them in a position-dependent 128 x 128 reference table. These correction factors then will be applied, on an event-by-event and point-by-point basis, to align each position-dependent photopeak to its appropriate energy level. As a result of the energy correction on all of the individual spectra, there is a significant improvement in both the energy selectivity and the uniformity.



Linearity Correction

Problem:

Spatial distortion or non-linearity is due to the natural distortion of the photomultiplier tubes. At a particular energy, this spatial distortion has two causes. First, the collection efficiency of the PM tubes varies non-linearly based on the relative position of the scintillation events to the photocathodes. Second, variations in sampling the scintillation events occur because a discrete number of tubes are used to report events that occur over a continuous crystal surface.

Solution:

During the Linearity Calibration process, the on-board processor computes correction factors to reduce inherent system non-linearity. Linearity correction is accomplished with the aid of a calibrated high precision hole pattern mask placed on the camera detector. Using a gamma source placed above the mask, scintillation events are constrained to known X and Y coordinates. Based on these known coordinates, correction factors are then generated and stored in two 128 x 128 digital correction matrixes (both X and Y). These factors will be used during the imaging process to interpolate the scintillation events, on an event by event basis, into 4K x 4K points using a bivariate Hermite interpolation algorithm.

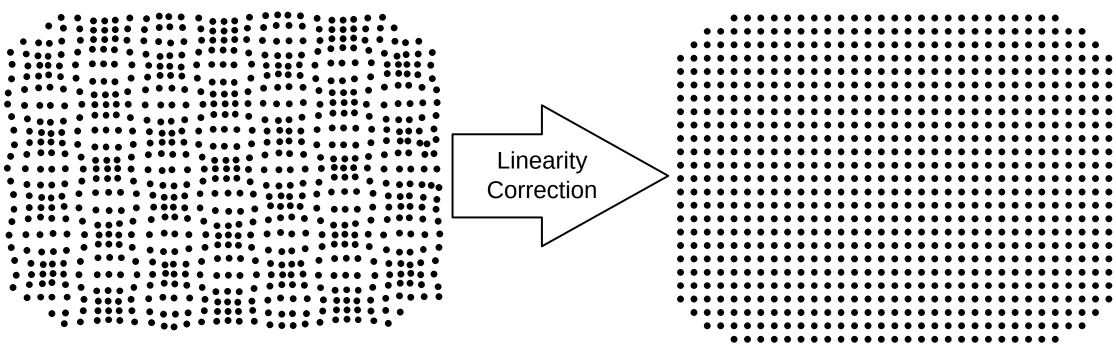
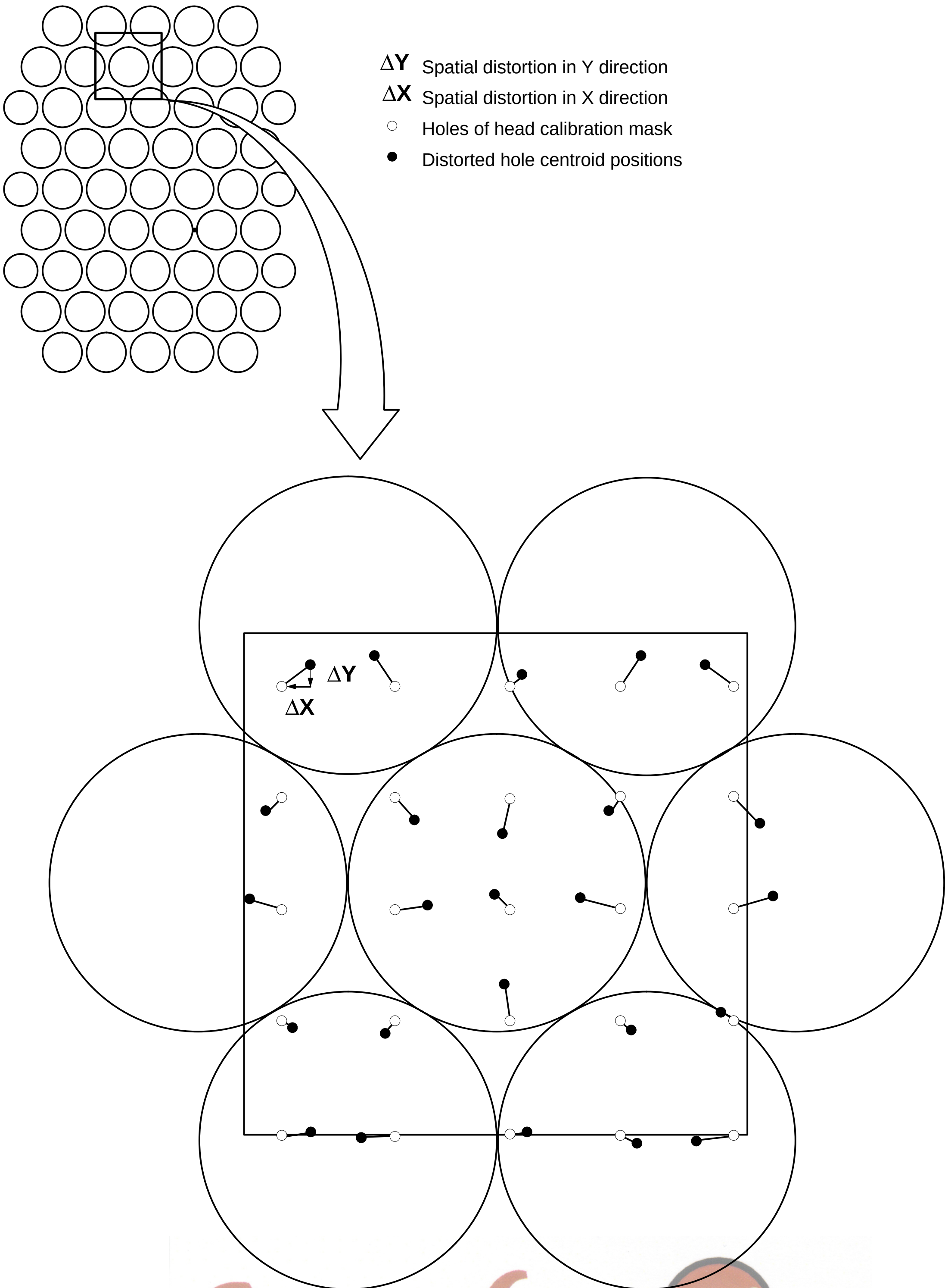


Table of Contents

Linearity Correction (Continued)



Uniformity Correction

Problem:

Non-uniformities occur as a result of several factors: inhomogeneities in the crystal, collimator non-uniformities and imperfections of both energy and linearity corrections. During the energy correction process, local energy spectra are aligned, thereby improving the composite energy spectrum of the system. Local energy spectra also individually vary in shape causing different fractional portions of the photopeak to occur within the energy window. The effect of energy window fraction variations is seen as a slight change in sensitivity across the detector which accounts for some residual non-uniformity.

Solution:

During the Uniformity Calibration, a controlled flood data is collected. Based on this flood data, the on-board computer calculates the local variation in uniformity and stores these values in a 256 x 256 x 16 bit RAM memory as position-dependent correction factors. These correction factors represent the pixel-by-pixel deviations of the calibration flood image from a uniform image. During image acquisition, these correction factors are applied on an event by event basis to affect the final adjustment to uniformity by randomly subtracting or adding counts in those areas that respectively exceed or fall below the arithmetic mean of the control flood. The correction process does not change the net count rate, thus preserving the overall statistical information. Uniformity corrections are dependent on collimator design. For every different collimator design, a different set of correction factors will be generated and written to disk. These provide collimator-specific uniformity correction for SPECT imaging.

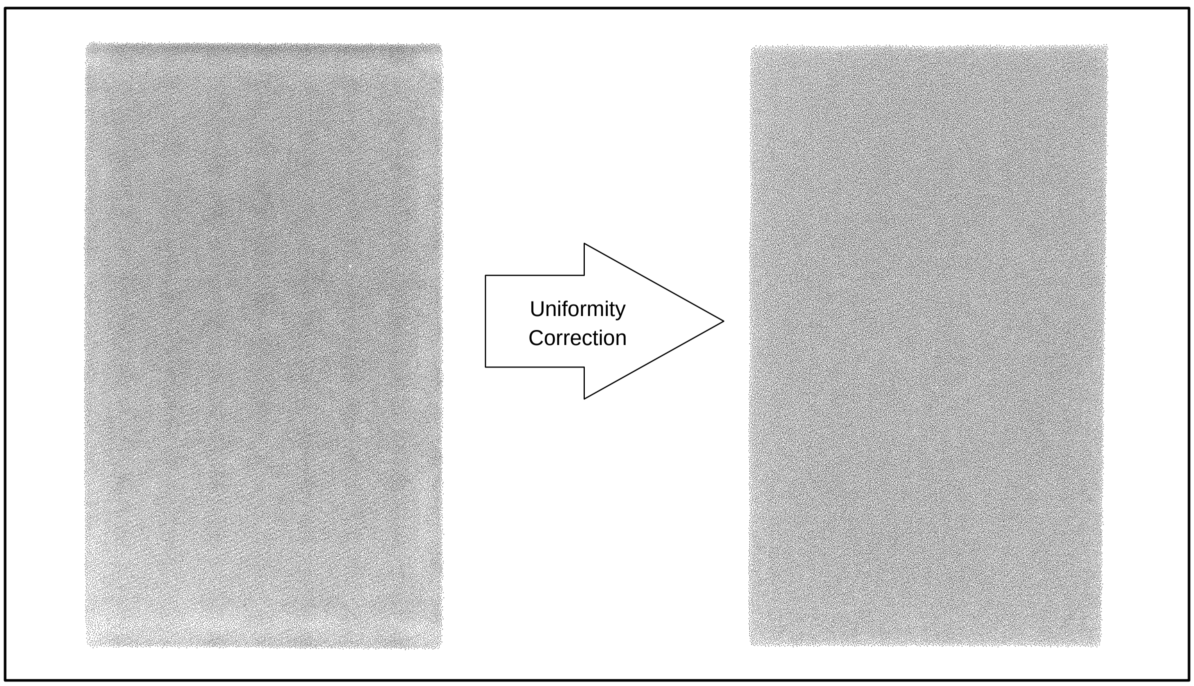


Table of Contents

IRC (Image Registration Correction)

Problem:

All camera systems display some degree of structural flex and misalignment that can create angle-dependent displacement of projection data in both X and Y camera axes. This can cause the summed angular projections to be improperly registered during backprojection, yielding degraded resolution and contrast in the final image.

Solution:

IRC (**I**mage **R**egistration **C**orrection) measures the amount of data shifting in both X and Y directions at 120 points of detector rotation. The measurements are taken at both minimum and maximum detector's location (radial). At each acquisition point, the deviation of the reported source from the actual position in both X and Y axis are registered in an angle dependent correction table. During the image reconstruction process, this table will be used to correct the projection data to its proper value.