GE Healthcare-Americas:
Milwaukee, WI, USA, Fax: +1 414 544 3384
GE Healthcare-Asia:
Hong-Kong Fax: +852 210 062 92
Tokyo, Japan, Fax: +81 3 3223 8560
GE Healthcare-Europe:
Buc, France, Fax: +33 1 30 70 98 55
Internet Web Site http://www.gemedical.com

Millennium® MPR

Digital CSE™ Single Detector Gamma Camera
H3000ZK Acquisition System

Direction 2405530-100 Rev.4 Jun. 2006

Overview

The Millennium MPR Gamma Camera is a multi-purpose single-head nuclear medicine imaging system, comprised of a Digital CSE multi-purpose square detector, a path-through counter-balanced ring gantry, a SPECT-optimized imaging table, and a collimator cart.

Clinical Applications

The Millennium MPR is a general-purpose camera featuring static, dynamic, multi-gated cardiac, tomographic, and gated tomographic nuclear medicine studies.

Key Millennium MPR Features

Detector Overview

The Millennium MPR detectors are based on a GE patented Digital CSE (Correlated Signal Enhancement) non-Anger design. The CSE detector employs rows and columns PMT signal summation to produce high quality nuclear images. AutoTune™ automatic PMT calibration and advanced diagnostics circuitry ensure both optimal imaging performance for each study and long-term stability.
A lightweight low-attenuation patient table optimized for SPECT applications may be removed, allowing for upright and hospital bed scanning.

Digital CSE Detector Design

- Crystal thickness: 8.5 mm (1/3”)
- Energy Range: 55 - 400 KeV
- Dead Time: 0.7 microsecond
- 48 square, 77 mm (3”) photo-multiplier tubes (PMTs) per detector
- NEMA UFOV: 36 x 51 cm (14.2” x 20.1”, no cutoff corners)
- Available FOV: 37 x 52 cm (14.5” x 20.5”, no cutoff corners)

Detector Positioning

- During patient handling and quality control, the gantry moves the detector to the position desired, facilitating both patient and clinical personnel free access to the table.
- During clinical imaging, the detector may be positioned in any angle, allowing both supine upright positions.
- The patient table may be removed to allow imaging of patients on a hospital bed.
- During collimator changing, the detector will be positioned vertically with the journals approximately 20” (50 cm) above the floor.
- During service of the detector, the detector cover can be removed to provide free access to circuit boards.

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Collimators

- Collimators feature high precision design and excellent planar and tomographic imaging performance.
- Collimators feature protective pressure-sensitive covers to prevent collision with other objects.
- Each collimator is housed in a collimator cart that also serves as its storage device.

COLLIMATOR TYPE
Low Energy General Purpose (LEGP)
Low Energy High Resolution (LEHR)
Ultra High Sensitivity (LEUHS)
Medium Energy General Purpose (MEGP)
Pinhole
High Energy General Purpose (HEGP)

Digital CSE™ Detector Benefits

- Digital Correlated Signal Enhancement (CSE) technology for optimized resolution
- Square PMTs optimally cover the entire square FOV
- Low PMTs and other parts count for excellent reliability
- Digital self-calibration of gains and offsets for optimal stability and image uniformity
- Consistent high count rate performance with localized and distributed sources
- Remote diagnostics at the photomultiplier tube (PMT) level
- Advanced AutoTune™ for PMT calibration
- CE marking (EMC requirement)

Digital CSE™ Detector Performance Specifications

Measured per NU-1, 2001 using Tc-99m where applicable.

SPECIFICATION	PARAMETER	RANGE	DATA
Intrinsic Spatial Resolution	UFOV FWHM	≤	3.9 mm (0.15”)
	UFOV FWTM	≤	7.6 mm (0.30”)
	CFOV FWTM	≤	3.9 mm (0.15”)
	CFOV FWTM	≤	7.6 mm (0.30”)
Intrinsic Energy Resolution	UFOV FWHM	≤	9.7% Tc-99m @ 20 k c/s
Intrinsic Flood Field Uniformity:			
- Integral (Maximum deviation)	UFOV	≤	3.5 %
	CFOV	≤	3.0 %
- Differential (Maximum deviation)	UFOV	≤	2.5 %
	CFOV	≤	2.0 %
Intrinsic Spatial Linearity:			
- Absolute	UFOV	≤	0.5 mm
	CFOV	≤	0.5 mm
- Differential	UFOV	≤	0.2 mm
	CFOV	≤	0.2 mm
Intrinsic Count Rate:			
Maximum Count Rate Observed 15% window		≥	220,000 c/s
Maximum Count Rate Observed Intrinsic, 20% count rate loss, 15% window		≥	155,000 c/s
MWSR		≤	2.0 mm (0.08”)

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Millennium MPR Gantry

Millennium MPR features a path-through counterweight tomographic ring gantry with 3-axis rotation. The gantry is stationary and secured to the floor of the room. The tomographic ring gantry consists of two bent arms mounted within a ring for detector support. A counterweight opposite the detector balances detector motion.
Inbound/outbound (radial) motion of the detector is accomplished via an actuator tying the arms to the ring. The actuator is powered by a bi-directional motor drive. The actuator will support the counter weight during collimator changing. The gantry arms are fitted with collision detection pads and its motions have brake power fail motion.

Universal 3-Axis Table

A single universal, 3-axis table is used for planar, whole body and tomographic applications allowing operators to move the patient with three motions relative to the gantry: longitudinal, vertical, lateral.

The whole body application is executed via a cantilevered tabletop for posterior and anterior scans without disrupting the alignment of the table and gantry during the study. The tabletop features motorized travel in the longitudinal direction.

The table can be raised to 34" (86 cm) or lowered to 24" (61 cm) by a handset.
The table supports whole body contour applications by a learn mode method.
The tomographic application is supported for continuous and step-and-shoot circular tomography procedures and "elliptical" or programmable body contour (PBC).
The table top is curved and is designed to ensure patient comfort.

MPR GANTRY DIMENSIONS/MOTIONS	DATA
Length	190 cm (75")
Width	112 cm (44")
Height	145 cm (57.4 ")
Gantry Assembly Weight	1052 kg (2319 lb)
Gantry Aperture	71 cm (28")
Continuous Acquisition Rotation Speed	0.01 to 1 RPM
Rotation Motion Speed (Handset) Range: 0° to ± 360°	1 RPM (Fast) 0.2 RPM (Slow)
Detector Tilt Speed: (Handset) Range: -20° to +90°	.96 RPM (Fast) 0.2 RPM (Slow)
Radial Motion Speed (Handset) Range: 0 to 325 mm	20 mm/sec (Fast) 5 mm/sec (Slow)
Emergency Stops	2 (One on each side of gantry)
MPR TABLE DIMENSIONS	**DATA**
Table Weight	814 lb (370 kg)
Maximum Scan Length	74" (1.9 m)
Table Top Width	15.25" (38.7 cm)
Minimum Height	24" (61 cm)
Maximum Height	34" (86 cm)
Maximum Load Capacity	400 lb (181 kg)
Lateral Motion Range	± 3.5" (± 8.9 cm)
Min & Max Speeds (Handheld Controller) - Longitudinal - Vertical - Lateral	 0.4 & 1.6"/sec (10 & 40 mm/sec) 0.2 & 0.3"/sec (5 & 7.6 mm/sec) 0.1 & 0.8"/sec (3 & 20 mm/sec)
Min & Max Speeds (Computer Control) - Longitudinal - Vertical - Lateral	 0.01 & 1.6"/sec (0.4 & 40 mm/sec) 0.01 & 0.3"/sec (0.1 & 7.6 mm/sec) 0.01 & 0.8"/sec (0.1 & 20 mm/sec)
Emergency Stops	2

For PBC, motors provide travel in the lateral and vertical directions. The table allows controlled and accurate patient positioning when conducting PBC studies. When combined with PBC, the table allows a reduced distance between the patient and detector during tomographic studies.

The table is mobile and can be easily moved around the room. It is designed to accommodate a 400 lb (181 kg) patient. Straps are available with a table pad for patient comfort. The table is firmly locked to the floor with adjustable docking pins and floor plates.

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Ergonomic, Icon-based Handset

The ergonomic handset provides the following functions represented by icons:

- Acquisition start button
- Acquisition set/cancel button
- Slow and fast gantry axial rotation control
- Slow and fast gantry radial motion control
- Manual table height motion control
- Slow and fast detector tilt control
- Clear persistence control

GENIE Acquisition System (H3300MA)

The GENIE Acquisition System (GeniAcq) is a PC-based system, which is integrated via computer interface with the Millennium MPR gantry programmed motions, including the following functions:

- Receives digitized and corrected X and Y positional signals and full energy signal data from the camera
- Discriminates wanted from unwanted signals from the detector
- Terminates data acquisition based on a preset condition
- Frames data and applies whole body positional offsets
- Applies patient ECG trigger data and performs multi-gated framing
- Stores acquired data
- Displays “live” view of detected events (persistence)
- Provides gantry data status and gantry backup control
- Performs detector tuning and calibration
- Contains a graphic user interface for acquisition, display, quality control
- Monitors acquisition data and patient positioning
- Interfaces to networked stations such as Xeleris Processing and Review workstation.
- Permits constant acquisition monitoring while operating other database or display features
- IGNITE™ Single Key Workflow (requires Xeleris)

GENIE Acquisition is housed on a height-adjustable mobile stand. Detailed acquisition specifications are provided in the GENIE Acquisition System product datasheet.

Processing & Connectivity

Integrated high-performance DICOM 3.0 networking including send to and query/retrieve from various Nuclear Medicine workstations including Xeleris Processing and Review (H3700JA), XPert, eNTEGRA and POWERstation.

Optional Accessories

- Optional R-Wave Triggers/ECG chart recorders (H2505JY / H2505JW).
- Optional Cardiac-SPECT Arm Support (H3602MA).
- Optional Fixed Head Holder for Brain SPECT (H3602MB).

Power Requirements

The system will not require externally mounted power conditioning devices. This functionality is incorporated into the primary power supply of the system, which is located at the base of the gantry. Base power requirements:

- 100-120 V_{AC}, ± 10%, 50/60 Hz
- 200-240 V_{AC}, ± 10%, 50/60 Hz
- 1 KVA

Environment

- Recommended Operating Temperature Range: 15-27° C (59-81° F)
- Storage Temperature: 7-40° C (45-104° F)
- Maximum Temp Gradient: 3° C (5° F) per hour
- Relative Humidity: 20-80% (non-condensing)

Warranty

The Company provides specific written warranties with respect to the products described. The applicable written warranties are available upon request. Operating and Basic System software will be provided and warranted under the terms of an Operating and Basic System Software Program License agreement.

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MILLENNIUM MPR FEATURES SUMMARY

SUBSYSTEM	KEY FEATURE	USER/PATIENT BENEFIT
GANTRY	Balanced position on floor; No rails	Gantry does not move on rails, providing for mechanical stability and improved reliability; reduces tripping hazards
	Tomographic ring with automated tilt, pitch, roll detector motions	Eliminates need to reset gantry after each acquisition with continuous gantry rotations in one direction without cable interference; Study flexibility; ease of use
	Bent gantry arms	Allows imaging on gurneys (stretchers); No whole body posterior obstructions
	Compact and light design	Less intimidating for patient; minimum pre-installation work
	Emergency stop buttons on either side of gantry	In case of emergency, able to stop all gantry/table motions for patient safety; ability to resume acquisition or store current data
	House Integrated Power Supply (Shielded Isolation Transformer)	Plug in standard outlet; Minimum pre-installation work
	Gantry design allows imaging of standing or sitting patients	Versatility to image patients in improved physiological positions for lung, renal, etc.; alternate positioning for patients unable to lie on tables
	Gantry arm sensors	Provides safety for the patient and the camera
	Simple and easy positioning	Ease of use and quick patient setup
	Supports step and shoot or continuous tomography	Greater SPECT flexibility
DETECTORS	Digital CSE detector technology	Improved count rate, uniformity and system reliability
	True square FOV	No cutoff corners for a complete square imaging area
	55 - 400 keV range	Allows broad energy range studies
	Self-leveling / angle retention detector motion	Eliminates need to level the detector after each radial movement
COLLIMATION	Collimator sensors	Provides safety for the patient and the camera
	Precision micro-cast and micro-linear collimators	Cast collimators maintain excellent image resolution and sensitivity
	Collimator storage/exchange device combined	Productivity; ease of use and safety;

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SUBSYSTEM	KEY FEATURE	USER/PATIENT BENEFIT
UNIVERSAL 3-AXIS TABLE	One table for all study types (planar, whole body, SPECT)	Ease of use and productivity for both whole body and SPECT procedures
	Patient weight load up to 400 lb (181 kg)	Capable of imaging > 97 % of patient population
	Table vertical travel range 75” (1.9 m)	Capable of imaging > 97 % of patient population
	Lateral tabletop motion of ± 3.5” (8.9 cm)	Improved accuracy and ease of patient positioning
	Mobile table	Study flexibility with ability to remove entire table from installed gantry location; reduced tripping hazard with only front and rear table floor pins; no rails
	Emergency stops on either side of table	In case of emergency, able to stop all gantry/table motions for patient safety; ability to resume acquisition or store current data
	Curved, 15” (38 cm) wide carbon-fiber table	Patient comfort to ensure less motion during study
	Metric / American standard rulers on tabletop edge	Positioning aide during patient setup
	Accommodates brain head holder	Optimizes patient positioning for brain tomography
	Accommodates table pad with straps	For patient comfort and maintain of optimum patient positioning
	Accommodates accessories (IV pole, catheter bag hook)	Provided for patient comfort, positioning, and convenience
HANDSET	Icon-based ergonomic design	Ease of use for all patient procedures
	Plugs into either side of gantry	Ease of use; flexibility; user can setup exam without leaving the patient’s side
	Stored on either side of gantry	For convenience to operate the handset from either side of gantry

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MILLENNIUM MPR FEATURES SUMMARY

KEY SUBSYSTEM	KEY FEATURE	CUSTOMER BENEFIT
GENIE ACQUISITION	Common Graphical User Interface with Xeleris Processing & Review workstation	Product line commonality; Ease of use; Short learning curve
	Common user interface with MG, MC, MPR, MyoSIGHT..	Product line commonality; Simplified documentation, service and applications support
	GE-defined protocols that are user customizable	Productivity and ease of use; Flexible acquisition setup procedure
	Mobile, height-adjustable cart	Ergonomic flexibility for operator
	High-end PC with real time UNIX OS Industry standard hardware and software	Excellent price/performance; Non-proprietary system reduces obsolescence issues
	Multi-tasking operating system	Allows acquisition, archiving, image display and networking simultaneously without compromising performance
	DICOM 3.0 compatibility	Non-proprietary communication protocols; Open system
Xeleris PROCESSING & REVIEW; CONNECTIVITY	Off-the-shelf technology and platform independence	Xeleris Operating System; Well-defined software upgrade path
	Complete Suite of Nuclear Medicine Tools (for full details see Xeleris data sheet)	Most comprehensive package of Nuclear Cardiology Tools: • Cardiac SPECT / Cardiac SPECT Compare • Myovation, side by side reconstruction • Emory Cardiac Toolbox (3rd-party Option) • Cedars Quantitative Perfusion SPECT/ Quantitative Gated SPECT (3rd-party Option) • First Pass • L-R Shunt • EF Analysis • Iterative Reconstruction/Attenuation Correction
	AutoTab - "Managed windows" environment	Intuitive and easy to use; Easy to learn; No getting lost in layers of windows
	Aladdin - Intuitive programming flexibility	Uses a Visual Basic-based programming tool for power and flexibility at multiple user levels
	DICOM/Interfile conformance	Open system allows multi-modality data transfer
CUSTOMER PRODUCTIVITY	Minimum/Typical room size: 17'2" x 15'6" (5.24 m x 4.72 m)	Flexible siting (small rooms may require collimator storage outside the imaging room). See site drawings for important regulatory compliance information.
	Installation time: 1.5 - 2 days	Up and running fast; minimal scheduling lead times

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Description	Catalog Number (a)	Field Of View (mm) (b)	Calculated % Penetration 5% keV	Calculated % Penetration 15% keV (c)	Radioactive Source	System sensitivity, C/min*μCi (Cps/MBq) @100 mm (d)	SYSTEM RESOLUTION FWHM (mm) @100 mm	Type of Hole	Hole Width (mm)	# of Holes	Septal Thick (mm)	Hole Length (mm)	Color (graphic)	Weight kg/lb
Low Energy General Purpose LEGP	H2505LA	536 x 380	180	218	TC99m	262 (118)	10.2	Hex	2.5	31,100	0.25	43	Blue	52/114 (x 2)
Low Energy High Resolution LEHR	H2505LB	536 x 380	176	214	TC99m	135 (61)	8.3	Hex	1.8	60,000	0.18	41	Gray	52/114 (x 2)
Medium Energy General Purpose MEGP	H2505LC	536 x 380	311	393	Gallium	255 (115)	12.7	Hex	3.0	13,330	1.2	42	Black	83/183 (x 2)
High Energy General Purpose HEGP	H2505LD	536 x 380	360	440	I-131	180 (81)	13.8	Hex	3.4	9,220	1.65	48	Brown	97/213 (x 2)
Low Energy Ultra-High Sensitivity LEUHS	H2505LE	536 x 380	167	202	TC99m	833 (374)	16	Hex	3.4	16,720	0.35	34.5	Yellow	49/108 (x 2)
Low Energy Pinhole HEPINH	H2505LG	116	N/A		N/A	N/A	N/A	Circ	3 Inserts 4 4 5	1	N/A	N/A		50/110 (x 1)

Millennium MPR COLLIMATORS (Measured per NEMA NU-I 2001)

(a) Each collimator is mounted on a mobile cart used for storage and collimator changing,
(b) Value quoted is collimator field of view.
(c) The calculated % penetration values indicate the photon energies at which 5% and 15% of the incident photons are transmitted along the shortest path through the septum.
(d) Sensitivity of LEHR, LEGP and LUHS is defined with 15% energy window. MEGP, HEGP is defined with 20% window, Per NEMA 2001.

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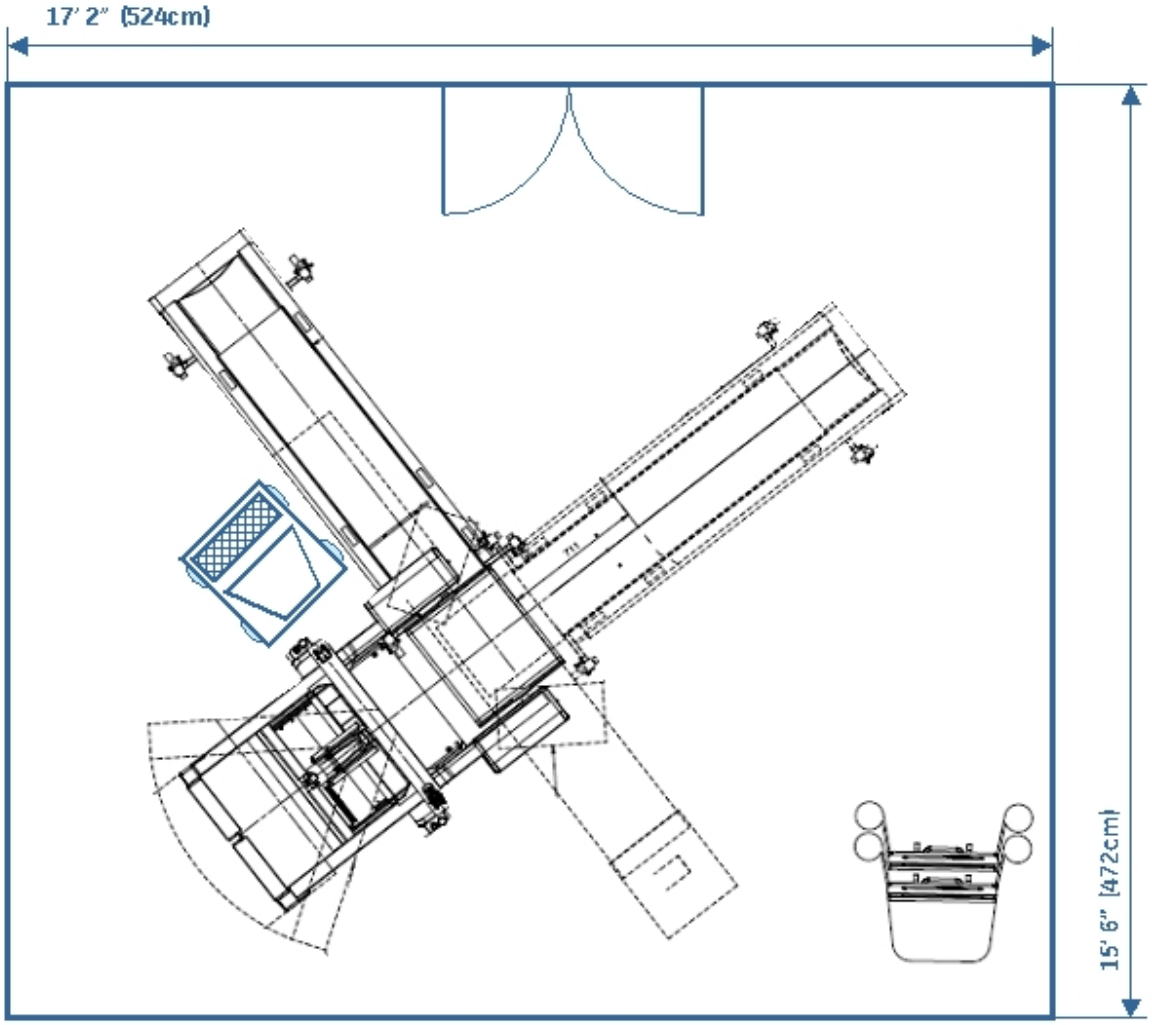
Millennium MPR Typical Room Layout – 17'2" x 15'6" (524 cm x 472 cm)



The above drawing meets clearance requirements under U.S. Federal Regulations and National Standards: 29 CFR 1910 (OSHA), NFPA 70E (Standard for Electrical Safety in the Workspace), and NFPA 101 (Life Safety Code). Specific room layouts are also subject to local and regulatory requirements.