

Millennium™ MG

Multi-Geometry Digital CSE™ Dual Detector Gamma Camera S8003WF/WG

Overview

The Millennium™ MG Gamma Camera is a modular nuclear medicine imaging system. The MG gantry allows the detectors to be oriented in the 180 and 101.25 degree positions. The other modular core components of the Millennium MG family include a 3-axis universal imaging table, a GENIE acquisition computer, dual Digital CSE detectors, and collimators/collimator carts. The Millennium MG can be networked to a GENIE Processing & Review Station for processing and analysis.

Clinical Applications

The Millennium MG system is a general purpose camera allowing for static, dynamic, whole body, multigated cardiac, tomographic, and gated tomographic nuclear medicine studies.

Millennium MG Features

Detector Overview

The Millennium MG system uses two rectangular detectors based on a GE patented design known as Digital CSE (Correlated Signal Enhancement). This method uses row and column PMT signal summation (instead of the traditional "Anger" principle of weighting signals from individual PMTs) to produce high quality nuclear images.



Digital CSE Rectangular Detectors

- 48 square, 77 mm (3in) photomultiplier tubes (PMTs) per detector
- NEMA UFOV: 36 x 51 cm (14.1 x 20.1in; no cutoff corners)
- Available Imaging Area: 37 x 52 cm (14.5 x 20.5in., no cutoff corners)
- Crystal thickness: 8.5 mm (~ 3/8 in)
- Energy Range: 55 - 540 KeV
- Dead Time: 0.7 microsecond

Detector Positioning

- During patient handling and quality control, the gantry moves the detectors to the position desired, giving the patient and clinical personnel free access to the table.

- During service of the detector, the detector cover can be removed to provide free access to the circuit boards (without having to disconnect the detector cable).
- During collimator changing, the detectors are rotated to the 90 and 270 degree positions. This allows for simultaneous collimator changing.

Collimators

- All collimators are offered in the Microcast design.
- The collimators feature a protective covering to prevent incidental damage and are color-coded.



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- Each collimator set is housed in a collimator cart that also serves as the storage mechanism.
- Each collimator features a collision sensor on the surface closest to the patient. If a force is applied to the collimator surface e.g., in the case of a collision - power to all the motors is interrupted and all motions stop. The force to the touch plate has to be removed and the gantry manually reset before motions are enabled. The pause/resume function of the Acquisition console allows the study to resume, restart, or exit.

The GE Digital CSE™ Detector Benefits

- Square PMTs optimally fill the rectangular FOV
- Low PMTs and parts count for excellent reliability
- Digital self-calibration of gains and offsets for optimal stability and image uniformity
- Digital Correlated Signal Enhancement - CSE™ technology for optimized resolution
- Consistent high count rate performance with localized and distributed sources
- Digital normalization for excellent MWSR
- Digital interface from imaging head minimizes EMC susceptibility
- Remote diagnostics at the photomultiplier tube (PMT) level
- CE marking (EMC requirement)
- Advanced AutoTune™ for PMT gain stability
- Part of the GE continuum of products

The Millennium MG accommodates the following collimator sets:

COLLIMATOR TYPE	WEIGHT
Low Energy General Purpose (LEGP)	52 kg (114 lb.) x 2
Low Energy High Resolution (LEHR)	52 kg (114 lb.) x 2
Low Energy Ultra High Sensitivity (LEUHS)	49 kg (108 lb.) x 2
Medium Energy General Purpose (MEGP)	83 kg (183 lb.) x 2
High Energy General Purpose (HEGP)	97 kg (213 lb.) x 2
High Energy Pinhole (HEPINH)	82.5 kg (181 lb.)

Digital CSE Rectangular DETECTOR SPEC SUMMARY:

Measured per NU-1, 1994 using Tc-99m where applicable.

SPECIFICATION	PARAMETER	RANGE	DATA
Intrinsic Spatial Resolution	UFOV FWHM	</=	3.9 mm
	UFOV FWTM	</=	7.6 mm
	CFOV FWTM	</=	3.9 mm
	CFOV FWTM	</=	7.6 mm
Intrinsic Energy Resolution	UFOV FWHM	</=	9.7% Tc-99m @20kc/s
Intrinsic Flood Field Uniformity:			
- Integral (Max. deviation)	UFOV	</=, +/-	3.5 %
	CFOV	</=, +/-	3.0 %
- Differential (Max 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			
20% count rate loss, 20% window			
- Incident		>/=	260 kc/s
- Observed		>/=	325 kc/s
Maximum Count Rate (Observed)		>/=	325 kc/s
System Count Throughput (Nuclear)		>/=	480 kc/s
Point Source Sensitivity*		</=, +/-	3.0 %
Multiple Window Spatial Registration (MWSR)		</=	2.0 mm

* This specification is not measured per NU-1, 1994.



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Millennium MG Gantry

The Millennium MG gantry is a tomographic ring gantry supporting automated detector radial (in/out), axial (around the ring) and variable geometry (180 or 101.25 degree detector) motions.

The gantry is stationary and secured to the floor of the room. The gantry

may be controlled either by the handset or by pulldown menus from a GENIE Acquisition computer.

Universal 3-Axis Table

A single Universal, 3-axis Table is used for planar, whole body, and tomographic applications, allowing the operator to move the patient with three motions relative to the gantry:

longitudinal, vertical and lateral.

The whole body application is executed via a cantilevered tabletop for posterior and anterior scans simultaneously. The tabletop features motorized travel in the longitudinal direction. The table can be raised to 86 cm (34 in) and lowered to 61 cm (24 in) 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 tabletop is curved and is designed to ensure patient comfort. For PBC, motors provide travel in the lateral and vertical directions. The table allows controlled and more accurate patient positioning when conducting PBC studies. When combined with PBC, the table allows a reduced distance between the patient and detector during tomographic acquisitions. Circular and “elliptical” tomography is available for both 180 degree and 101.25 degree rotation angles.

The table is mobile and can be easily moved around the room. The table is designed to accommodate a 181 kg (400 lb) 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.

MG GANTRY DIMENSIONS/MOTIONS	DATA
Length	1.25 m (49 in)
Width	1.25 m (49 in)
Height	1.58 m (49 in)
Weight (Gantry /2 Detectors)	1630 kg (3586 lb)
Rotational Motion Speed	1 RPM (Fast) 0.2 RPM (Slow)
Radial Motion Speed	13 mm/sec (Fast) 5 mm/sec (Slow)
Emergency Stops	2
Axial (Around Ring)	540 (+/- 270) Degrees
Variable Geometry	180 & 101.25 Degrees
Detector Radius with LEGP collimators	Minimum 10.6 cm (4.2 in) Maximum 28.6 cm (11.3 in)

TABLE DIMENSIONS	DATA
Table Weight	370 kg (814 lb)
Maximum Scan Length	1.9 m (74in)
Table Top Width	38.7 cm (15.25 in)
Minimum Height	61 cm (24 in)
Maximum Height	86 cm (34 in)
Maximum Load Capacity	181 kg (400 lb)
Lateral Motion Range	+/- 11 cm (+/- 4.3 in)
Minimum/Maximum Speeds Handheld Controller)	
- Longitudinal	10 mm/sec; 40 mm/sec
- Vertical	5 mm/sec; 7.6 mm/sec
- Lateral	3 mm/sec; 20 mm/sec
Minimum/Maximum Speeds Computer Control)	
- Longitudinal	0.4 mm/sec; 40 mm/sec
- Vertical	0.1 mm/sec; 7.6 mm/sec
- Lateral	0.1 mm/sec; 20 mm/sec
Emergency Stops	2



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Gantry/Table/Detector Orientation

All studies are efficiently performed with the table perpendicular to the gantry ring. Whole Body studies are acquired as the cantilevered tabletop travels through the ring.

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 for operations of in/out and independent/together
- Slow and fast table scanning (longitudinal) motion control
- Slow and fast table lateral motion control
- Slow and fast table height motion control
- Clear persistence control

GENIE Acquisition System

The GENIE Acquisition System is a personal computer-based system (computer, monitor, keyboard), which provides the computer interface to the Millennium MG and provides 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 multigated framing
- Stores acquired data
- Displays “live” view of detected events (persistence)
- Provides gantry/table data status and table/gantry backup control
- Performs detector tuning and calibration
- Contains a graphic user interface for acquisition, display, and quality control
- Monitors acquisition data and patient positioning
- Interfaces to network devices such as a Processing & Review workstation
- Provides pre-programmed camera motions for gantry and table
- Contains Autotab™ filing system for commonality with eNTEGRA Processing and Review
- Permits constant acquisition monitoring while operating other database or display features

GENIE Acquisition is housed on a height-adjustable mobile stand. For the MG system, movement from 180-opposed to 101.25 detector position is done via a pre-programmed operation on the GENIE Acquisition system. Detailed acquisition specifications are provided in the GENIE Acquisition System Product datasheet, H3300MA.

eNTEGRA Processing & Review - Connectivity

Datasets from the Millennium MG systems are acquired on a GENIE Acquisition Terminal and are processed on a GENIE Processing &

Review Station. Data is sent from GENIE Acquisition to eNTEGRA Processing & Review via DICOM. eNTEGRA Processing & Review is DICOM 3.0 and Interfile compatible. Detailed specifications are provided in the eNTEGRA Processing & Review Product datasheet, H3400JZ

Power Requirements

The primary power supply of the system is located at the base of the gantry. Base power requirements:

- 100VAC +/- 10%, 30 A, 50 Hz
- 120VAC +/- 10%, 20 A, 60 Hz
- 200VAC +/- 10%, 15 A, 50 Hz
- 220VAC +/- 10%, 10 A, 50 Hz
- 240VAC +/- 10%, 10 A, 50 Hz

Environment

Operating Temperature Range:
15 - 35 C (59 - 95 F)

Recommended Operating Temperature Range:
15 - 27 C (59 - 81 F)

Storage Temperature:
7 - 40 C (45 - 104 F)

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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SUBSYSTEM	KEY FEATURE	USER/PATIENT BENEFIT
GANTRY	Secured position on floor; No rails	Gantry does not move on rails, providing for mechanical stability and improved reliability; reduces tripping hazards
	Tomographic ring	Eliminates need to reset gantry after each acquisition with continuous gantry rotations in one direction without cable interference
	Externally mounted dual detectors	Improved patient well being - less claustrophobia; ease and speed of patient positioning
	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
	Motorized radial detector movement	Positioning flexibility; Optimum COR stability
	Gantry design allows imaging of sitting patients between detectors	Versatility to image seated patients in improved physiological positions for lung, renal, etc.; alternative positioning for patients unable to lie on a table
	Variable geometry capability (180 & 101.25)	Maximum throughput configurations for cardiac SPECT and wholebody imaging; ability to perform dual opposing static views
	Automatic predefined positions	Ease of use and quick patient setup with automatic positions for collimator changing, table settings to fully extended, fully retracted, wheelchair height and gurney (stretcher) height, and changing between 180 and 101.25 gantry positions
	Supports step and shoot or continuous tomography	Greater SPECT flexibility
	Supports "elliptical" tomography	Improved image quality with Programmable Body Contouring
	Supports Learn Mode Whole Body Contouring	Improved wholebody image quality
DETECTORS	Two rectangular digital CSE detectors	Improved count rate, uniformity and system reliability
	True rectangular FOV	No cutoff corners for a complete rectangular imaging area
	55 - 540 keV range	Allows broad energy range studies(510k approved up to 540 keV)
	Brain reach maximum 9cm (3.5")	Ability to image the entire brain
COLLIMATION	Collimator sensors	Provides safety for the patient and the camera
	Precision micro-cast collimators	Cast collimators maintain excellent image resolution and sensitivity over time
	Collimator storage/exchange device combined	Productivity; ease of use and safety; both collimators removed and replaced during one exchange session



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SUBSYSTEM	KEY FEATURE	USER/PATIENT BENEFIT
UNIVERSAL 3-AXIS IMAGING TABLE	One table for all study types	Ease of use and productivity for both wholebody and SPECT procedures without changing table positions
	Patient weight load up to 181 kg (400 lb)	97% patient population
	Tabletop longitudinal travel accommodates 1.9 m (75") patient scan	97% patient population
	Table vertical travel range 61 - 86 cm (24"- 34")	Ease of patient transfer from wheelchair or stretcher Ideally suited for geriatric and pediatric patients
	Tabletop lateral +/- 11 cm (3.9")	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, wide (15"+) carbon-fiber table with flat underside	Patient comfort means less motion, leading to improved image quality
	Metric/American Standard rulers on tabletop edge	Positioning aide during patient setup
	Accommodates tabletop extender	Ability to image taller patients
	Accommodates brain headholder	Optimizes patient positioning for brain tomography
	Accommodates accessories (IV pole, catheter bag hook)	Provided for patient comfort, positioning, convenience
	Accommodates table pad with wholebody straps	For patient comfort and maintain of optimum patient positioning
HANDSET	Icon-based ergonomic design	Ease of use for all patient procedures
	Plugs into either side of gantry and table	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 MG Features Summary

KEY SUBSYSTEM	KEY FEATURE	CUSTOMER/MARKETING BENEFIT
GENIE ACQUISITION	Common Graphical User Interface with eNTEGRA Processing & Review workstation	Product line commonality; Ease of use between acquisition and processing computers
	Same user interface on MPR/MPS, Optima NX, etc.	Product line commonality; Maintaining a continuum path
	GE defined / user customizable protocols	Productivity and ease of use; Flexible acquisition setup procedure
	Located on mobile, height-adjustable cart	Patient positioning flexibility
	Standard high end PC running real time UNIX; standard hardware and software components	Improved price to performance ratio; Non-proprietary system ensures against obsolescence; easily upgradeable
	Multi-tasking, client server	Allows acquisition, archive, display and networking simultaneously while maintaining performance
	DICOM network to eNTEGRA	Non-proprietary communication protocols; Open system
eNTEGRA WORKSTATION	Off-the-shelf technology and platform independence	Windows NT Operating System: - Well defined software upgrade path - Excellent price / performance - Continuum to existing and future GE NM products
	Complete Suite of Nuclear Medicine Tools	Most comprehensive package of Nuclear Cardiology Tools: - Cardiac SPECT, Emory Cardiac Toolbox, Cedars Quantitative Perfusion SPECT/ Quantative Gated SPECT First Pass, L-R Shunt, E-F Analysis, Cardiac SPECT Compare, Iterative Reconstruction / Attenuation Correction
	“Managed windows” environment - AutoTab	Intuitive and easy to use; easy to train; No getting lost in layers of windows
	Intuitive programming flexibility - Aladdin	Uses a Visual Basic-based programming tool for power and flexibility at multiple user levels
	Connectivity via DICOM/Interfile	Open system allows interoperability and continuum path
CUSTOMER PRODUCTIVITY	Minimum room size: 15' x 10' (4.57 x 3.05 m) Optimum room size: 15' x 15' (4.57 x 4.57 m)	Flexible siting (for minimum room size, may require collimator storage outside imaging room)
	Installation time 1.5 - 2 days	Up and running fast; minimal scheduling lead times



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Millennium MG Collimators

Each collimator set contains two micro-cast collimators along with a collimator changing cart, which is also used for storage. Each pair of collimators has a sensitivity matched to within 5%.

DESCRIPTION	CATALOG NUMBER (a)	FIELD OF VIEW (mm) (b)	CALCULATED % PENETRATION		SYSTEM SENSITIVITY (cts/min./μCi) @ 100 mm per detector (d)	SYSTEM RESOLUTION FWHM (mm) @ 100 mm (e)	TYPE OF HOLE	HOLE DIAMETER (mm)	# OF HOLES	SEPTAL THICKNESS (mm)	HOLE LENGTH (mm)	COLOR	WEIGHT kg/lb
			5% keV (c)	15% keV									
Low Energy General Purpose LEGP	H2505RA	536 x 380	180	218	316	10	Hex	2.5	31,107	0.25	43	Blue Graphic	52/114
Low Energy High Resolution LEHR	H2505RB	536 x 380	176	214	180	7.9	Hex	1.8	60,007	0.18	41	White Graphic (Accent Gray)	52/114
Medium Energy General Purpose MEGP	H2505RC	536 x 380	311	393	294	13.4	Hex	3.0	13,336	1.2	42	Black Graphic	83/183
High Energy General Purpose HEGP	H2505RD	536 x 380	360	462	257	13.5	Hex	3.4	9,225	1.65	46	Brown Graphic	97/213
Low Energy Ultra-High Sensitivity LEUHS	H2505RE	536 x 380	167	202	902	15.2	Hex	3.4	16,729	0.36	34.5	Yellow Graphic	49/108
High Energy Pinhole HEPINH (f)	H2505RG	192	N/A		Co57 / I-131 53 / 26 233 / 86 716 / 226	Co57 / I-131 4.56 / 6.08 8.44 / 10.35 14.49 / 16.60	Circ	3 Inserts 2 4.45 8	1	N/A	N/A	Brown Graphic	82.5/181 (g)

(a) Catalog numbers include 2 collimators and carts for changing and storage

(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) The values quoted are the cpm/μCi for the appropriate isotope for the collimator (Tc99m with a 20% window for low energy collimators). Sensitivity measured with a tolerance of ±10%.

(e) Tolerance of ±4% on resolution.



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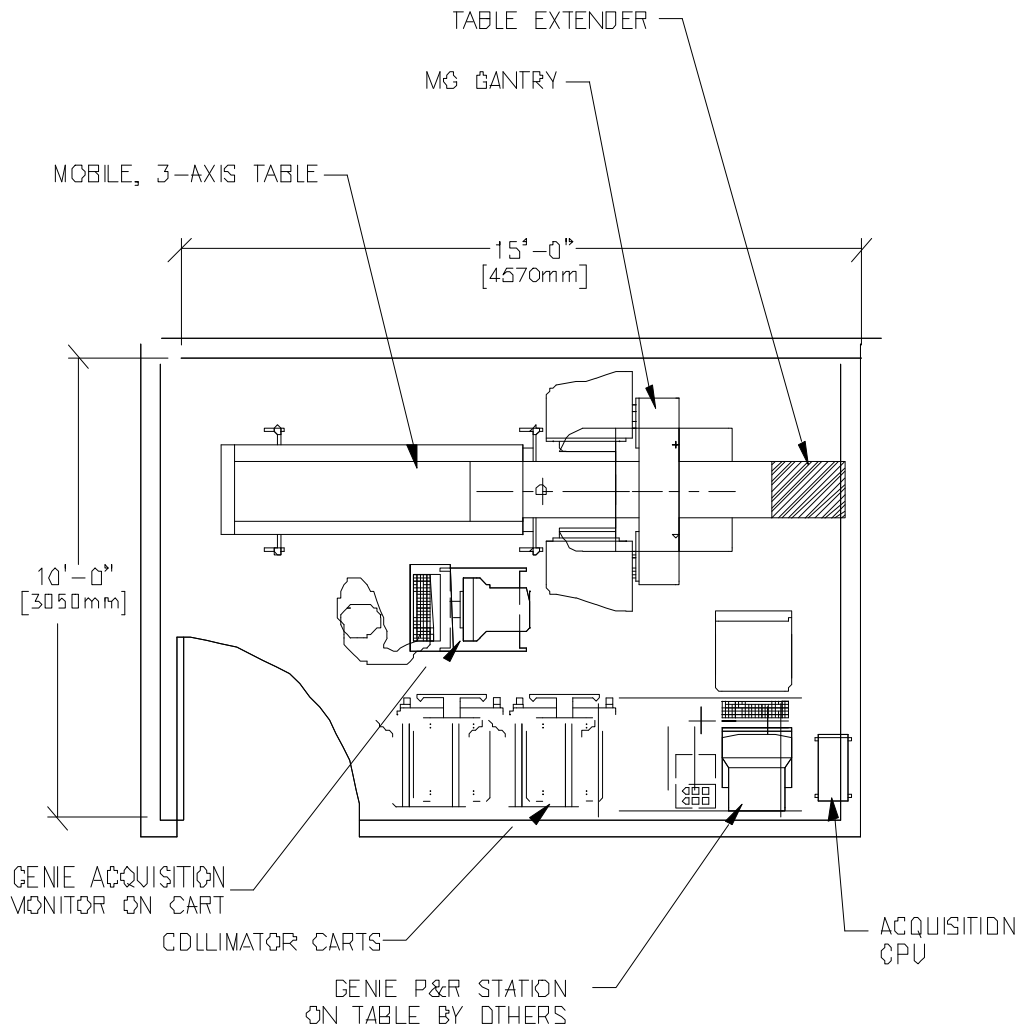
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Optimal Room Layout: Millennium Mg System



ROOM DIMENSIONS	LENGTH & WIDTH	CEILING HEIGHT
OPTIMAL	12'-0" x 15'-0" [3660mm x 4570mm]	8'-0" [2440mm]
MINIMUM:	10'-0" x 15'-0" [3050mm x 4570mm]	8'-0" [2440mm]

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Minimum Room Layout: Millennium Mg System

