

Nucline™ *Cardio-C*

Dual Detector Cardiac Dedicated Gamma Camera

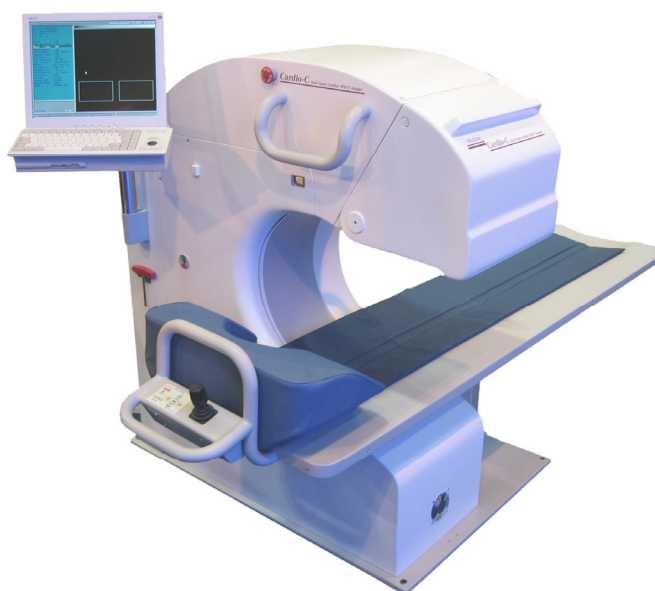
Data Sheet

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Overview

Cardio-C is an ultra-compact cardiac-optimized nuclear imaging system. It is comprised of two detectors in 90° geometry mounted inside a C-shaped gantry, a compact 4-axis imaging table and a dedicated acquisition station. Cardio-C is networked to Interview Processing & Review Station which features a comprehensive set of Cardiac applications



Clinical Applications

Cardio-C features a wide variety of cardiac imaging types, including static, dynamic, multigated planar, tomographic, and gated tomographic nuclear imaging procedures.

System Features

Detector Overview

The Cardio-C features two wide FOV high resolution, excellent stability rectangular detectors.

Each detectors include:

- 33 circular, 60 mm (2.4") and 4 circular, 38 mm (1.5") PMTs per detector
- UFOV: 370 mm x 210 mm
- Crystal thickness: 6.35 mm (1/4") – optimal for low energy imaging.
- Energy range: 40-200 keV

Detector Positioning

- The detectors are positioned at 90° geometry, optimal for Cardiac SPECT scanning procedures
- Detectors scanning motion is performed inside the gantry

- Top simplicity: SPECT Scanning is performed along a fixed radius: 248 mm (9.8")

Collimators

The Cardio-C accommodates the following optional set of two high-precision collimators for Nuclear Cardiology applications:

- LEGP collimator for high sensitivity cardiac SPECT scan
- LEHR collimator for high resolution cardiac SPECT scan

Collimators weight: 12...15 kg (26...33 lbs) each.

Operational Comfort

Operator convenience

- Operational simplicity: no need for gantry control commands, nor time-consuming setup.
- Easy patient setup by the gantry-side with effortless table swiveling to scanning position.
- Unmatched space efficiency with 2.6 m x 2.6 m (8'7" x 8'7") system footprint and gantry-mounted operator console

Patient Comfort

- Concealed detectors motion (inside the gantry) enhance patient perception of comfort and safety
- Ergonomic table design with integrated leg, head and arm support reduces patient motion and enhance patient comfort

Detector Performance Specifications Summary

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

SPECIFICATION	PARAMETER	DATA RANGE
Intrinsic Energy Resolution	UFOV FWHM	$< / = 9.7 \%$
Intrinsic Spatial Resolution	CFOV FWHM	$< / = 2.8 \text{ mm}$
	CFOV FWTM	$< / = 5.4 \text{ mm}$
	UFOV FWHM	$< / = 2.9 \text{ mm}$
	UFOV FWHM	$< / = 5.6 \text{ mm}$
Intrinsic Flood Field Uniformity:		
- Integral (Max. deviation)	UFOV	$< / = \pm 2.9 \%$
	CFOV	$< / = \pm 2.4 \%$
- Differential (Max deviation)	UFOV	$< / = \pm 2.4 \%$
	CFOV	$< / = \pm 1.9 \%$
Intrinsic Spatial Linearity:		
- Differential	UFOV	$< / = 0.20 \text{ mm}$
	CFOV	$< / = 0.18 \text{ mm}$
- Absolute	UFOV	$< / = 0.40 \text{ mm}$
	CFOV	$< / = 0.38 \text{ mm}$
Intrinsic Count Rate 20% count rate loss, 20% window		
- Incident		$> / = 200 \text{ kcps}$
- Observed		$> / = 160 \text{ kcps}$
- Maximum C. Rate , 20% window		$> / = 220 \text{ kcps}$
Multiple Window Spatial Registration (MWSR)		$< / = 1.5 \text{ mm}$

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Detector Design Highlights

- High quantum efficiency PMTs feature enhanced energy resolution, long term stability and improved magnetic shielding
- Enhanced intrinsic spatial resolution due to a light-guide-free detector design
- Computerized digital auto tuning for fast adjustment and excellent stability
- HV module provides extended long-term stability
- Minimal dead space between the detectors and the patient for higher resolution scans

Compact Gantry

- Small footprint enables installation in a room as small as 2.6 m x 2.6 m (8'7" x 8'7")
- Concealed detectors motion: Absence of visible moving parts serves to reduce patients anxiety and enhance their comfort level
- Open gantry design facilitate patient setup and access
- Smart handles facilitate patient loading
- Emergency stop buttons enhance operational safety
- Robotic cables in energy chain cable carriers extend the service life of the camera
- The gantry weighs less than 550 kg including the detectors and a collimator set, minimizing site preparation requirements
- No floor preparation needed as no anchor points are used to attach the gantry to floor
- Minimal number of parts in the assembly inherently increases reliability

GANTRY DIMENSIONS/MOTIONS	DATA	
	Length	222 cm
Width	237 cm	93 inch
Height	137.6 cm	54 inch
Weight (with detectors and collimators)	550 kg	1214 lbs
Diameter of Imaging Tube	47 cm	19 inch
Length of Axial FOV	21 cm	8 inch
Height of Camera Axis	77.6 cm	31 inch

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Four-Axis Compact Patient Table

- The patient table is located at the side of the gantry facilitating unrestricted patient access.
- Once activated, the table's unique swivel mechanism gently transports the patient to the gantry for the scanning procedure.
- Compact four-axis table designed to maximize detectors-to-patient proximity during scan.
- Low attenuation (5% at 140 keV)
- Ergonomic tabletop made of a 2.5mm thin, strong aluminium alloy.
- Supporting handles maximize patient comfort and facilitate patient setup.
- Easy patient positioning with a special joystick situated at the patient's bed end.
- Unique swiveling table is locked in scanning position by a strong electromagnet
- Maximum 200 kg (440 lbs) patient weight
- Maximum 200 cm (6'7") patient length (with leg support)

TABLE DIMENSIONS	DATA	
Length with Handle	222 cm	87 inch
Width	47.9 cm	19 inch
Speed of Axial Motion	1.8 cm/s	0.7 inch/s
Maximum Length of Axial Motion	15 cm	6 inch
Speed of Tangential Motion	1.8 cm/s	0.7 inch/s
Maximum Length of Tangential Motion	12 cm	5 inch
Speed of Lifting	1.6 cm/s	0.6 inch/s
Minimum Table Top Height	52.7 cm	21 inch
Maximum Table Top Height	82.7 cm	33 inch
Maximum Load Capacity	200 kg	442 lbs
Attenuation @ 140 keV	<5%	

Acquisition Station

- Cardio-C acquisition provides a simple user interface to gamma camera functions including detector calibration and tuning, display of gantry position, real-time display of camera images and energy spectra, image review, definition and set-up of acquisition protocols including static, dynamic, multigated, tomographic and gated tomographic studies.
- The acquisition system provides basic acquisition types with predefined default parameters and clinical acquisition protocols comprised of multiple acquisition types in a predefined sequence which come with default parameters.
- Data acquired on the acquisition system is transferred to a Interview Processing and Review workstation.

Acquisition Station Hardware

- PC acquisition station attached to the gantry; driven by Windows™ Operating System
- The acquisition control monitor and keyboard are integrated in the gantry structure
- Five channel AD acquisition card per head simultaneously sampling the signals at the rate of 40 MHz
- 1024 multichannel analyzer energy channels (40-400 keV), with digitized picture binned up to 4096 x 4096 image pixels

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Multiple digital corrections:

- On-line direct addressing linearity correction with FOV-expanding technology
- On-line energy correction
- Uniformity correction without count rate loss
- Automatic real-time uniformity cross-correction for various collimators
- Pile-up recovery and resolution enhancing technology for high count rates

The acquisition unit performs the following major functions:

- Receives X and Y positional signals and full energy signal data from camera
- Terminates data acquisition based on a preset count or time
- Synchronizes patient ECG trigger data with multi-gated framing
- Stores acquired data in the patient archive
- Provides gantry/table data status
- Performs detector tuning and calibration
- Employs Graphic User Interface for acquisition, display, and quality control
- Monitors acquisition data and patient positioning
- Interfaces to network devices such as P & R workstations

Common Acquisition features

- Cardio-C Acquisition includes the following fixed elements:
 - Basic acquisition types
 - Pre-defined Clinical protocols
- In addition Cardio-C features User-Configurable protocols
- Digital "on-the-fly" linearity and energy corrections for optimized uniformity
- 2562 resolution energy and spatial correction matrix (interpolated to 32,7682) for improved accuracy.
- Operator selectable energy correction sets for different isotope combinations
- Energy spectrum histogram display ensures accurate photo-peaking for each isotope(s)
- Up to three energy windows per dataset with user selectable widths and offsets
- Up to four separate energy sets acquired per detector
- 256 Megabytes of framing memory per detector

Pan/Zoom function:

- User specified zoom factor ranging from 1.00 to 16.00 step
- Acquired image frames may be rotated interactively

Acquisition Types

Static

Data may be acquired in any of the following frame-sizes: 32x32, 64x64, 128x128, 256x256, and 512x512

Fast Dynamic

- Data may be acquired by any of the detectors or both in any of the following frame-sizes: 32x32, 64x64, 128x128, 256x256,
- Maximal frame capacity and frame-rates are listed below :

Single Detector

Image Size	1 Energy Set	
	Max Frames	Frames /sec
32 ²	630	100
64 ²	630	100
128 ²	630	100
256 ²	630	100

Dual Detector

Image Size	1 Energy Set	
	Max Frames	Frames /sec
32 ²	630	100
64 ²	630	100
128 ²	630	100
256 ²	630	100

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Gated planar

- On-line irregular beat rejection
- User-selectable R-R window
- Frame capacity and frame-rates are listed below :

	Single energy
	Max Frames/cycle
32 ²	64
64 ²	64
128 ²	64
256 ²	64
512 ²	64

Gated Tomography

- "Step & Shoot" Acquisition mode
- User defined number of projection from 4 to 192

	1 Energy Set	
	Max # of projections	Frames/cycle
32 ²	192	64
64 ²	192	64
128 ²	192	64
256 ²	192	64

Networking and workflow features

- DICOM 3.0 or Interfile compatible output and automatic data transfer

Streamlined workflow based on:

- Modality worklist-defined patient imaging protocols (including multiple basic acquisition sessions)
- Auto-launched data processing of acquired data on the networked Interview Processing and Review workstation

Tomography

- "Step & Shoot" Acquisition mode
- User defined number of projection from 4 to 192

	1 Energy Set
	Max # of projections
32 ²	192
64 ²	192
128 ²	192
256 ²	192

Common Display features

The acquisition display includes :

- Real time presentation of acquired events and a clear definition of the active detector mask
- Threshold and windowing control for current image or all displayed image sets
- Selection of display color maps.
- Acquisition parameters and optional settings.

Patient Catalog and data archiving features

- Patient archive is comprised of a list of all patient entries, including both acquired and scheduled patients.
- Patient archive is modality worklist supported . It includes both worklist-generated and manually-entered patient records.

Power Requirements

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

- Line voltage: ~ 115V (optional 230V)
- ±10%, 45-63 Hz, single phase
- Power consumption: less than 1250 VA .
- Required fuse: less than 12A (6A for 230V) contact breaker
- Backup power supply shall ensure power regulation and safe removal of the patient upon power outage

Environment

- Operating Temperature Range: 18 - 24 °C (68 - 75 F).
- Storage Temperature: 20 - 25 °C (68 - 77 F) 3 C (5.4 F) per hour
- Relative Humidity: 40 - 60% (non-condensing)

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Cardio-C Features Summary

SUBSYSTEM	KEY FEATURE	USER/PATIENT BENEFIT
GANTRY	Open, C-shaped tomographic gantry	Accommodates patient comfort ease and speed of patient positioning. Close proximity scans → better image quality
	Compact and simple design	Less intimidating for patient; minimal footprint, minimal siting requirements
	Integrated table and console	Simple and convenient workflow for technicians
	Secured position on floor	Mechanical stability, reliability
	Internally mounted dual detectors	Enhance patient comfort and safety Accurate C.O.R. for maximal SPECT image quality
	Emergency stop buttons on either side of gantry	Increases patient safety (upon emergency)
	House Integrated Power Supply (Shielded Isolation Transformer)	Plug in standard outlet; Minimum pre-installation work
	Fixed 90° detectors geometry	Maximum scanning efficiency for cardiac SPECT scans
	Minimal # of parts	Inherently more reliable; lower ongoing service costs
DETECTORS	Two rectangular wide FOV detectors	Excellent accessibility – optimized for cardiac scans
	Outstanding imaging specifications	Better specifications result in better diagnostic images
	Only single axis of motion - along a single rail	Perfect C.O.R. by design
	¼" NaI(Tl) crystal	Outstanding spatial resolution
	High Count rate	Allows broad range studies including 1st pass RNA
COLLIMATION	Complete choice of collimators	Full coverage of all cardiac applications
	Precision design collimators	Excellent image resolution and sensitivity
	Collimator exchange performed manually	Productivity; ease of use, fast collimator exchange

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SUBSYSTEM	KEY FEATURE	USER/PATIENT BENEFIT
4-AXIS PATIENT IMAGING TABLE	3-axis motorized motion with patient-table-mounted joystick	Ease of use and quick patient setup Precise and fast patient positioning
	Unique swivel of table (90°)	Minimal footprint maximizes space efficiency while facilitating patient comfort.
	Patient self-positioning Accommodates arm support attachment	High degree of patient comfort → study quality
	Minimal tabletop height 52.7 cm (21")	Ease of patient transfer from wheelchair or stretcher Ideally suited for geriatric and other restricted populations
	Patient weight load up to 200 kg (440 lb)	Permits scanning of 99% patient population
	Up to 200 cm (6'7") patient length	Permits scanning of 99% patient population
	Tabletop attenuation < 5% (0% at the Cardiac Imaging bay)	Enhanced image quality
CUSTOMER PRODUCTIVITY	Faster – simpler patient / camera setup	Higher patient throughput
	Fits in minimal room size: 8'7" x 8'7"	Would easily fit in any outpatient facility
	Installation time 1.5 - 2 days	Up and running fast; minimal scheduling lead times
	System weight < 550 kg	Minimal floor loading, no floor preparation needed

Collimator Types

Nucline™ Cardio-C collimators consist of a honeycomb structured lead core with a support frame. The collimators can be changed easily by removing the rear panel of the gantry. This panel is attached by easy-to-open clasps only.

The following optional sets of high-precision collimator pairs are available: LEGP, LEHR.

The following table contains the specification for the available collimators.

name	hole length [mm]	hole size [mm]	septal thickness [mm]	nominal energy [keV]	septal penetration at nominal energy	geometric/system resolution at 10 cm [FWHM mm]	geometric/system sensitivity [cpm/μCi] ±7%
LEGP(1)	33	1.8	0.16	140	2.6%	8.1 / 8.7	320 / 250 ⁽³⁾
LEHR(1)	33	1.4	0.16	140	1.0%	6.4 / 7.1	180 / 145 ⁽³⁾

(¹) Low Energy General Purpose collimator

(²) Low Energy High Resolution collimator

(³) Measured with 99mTc-in 20%-window

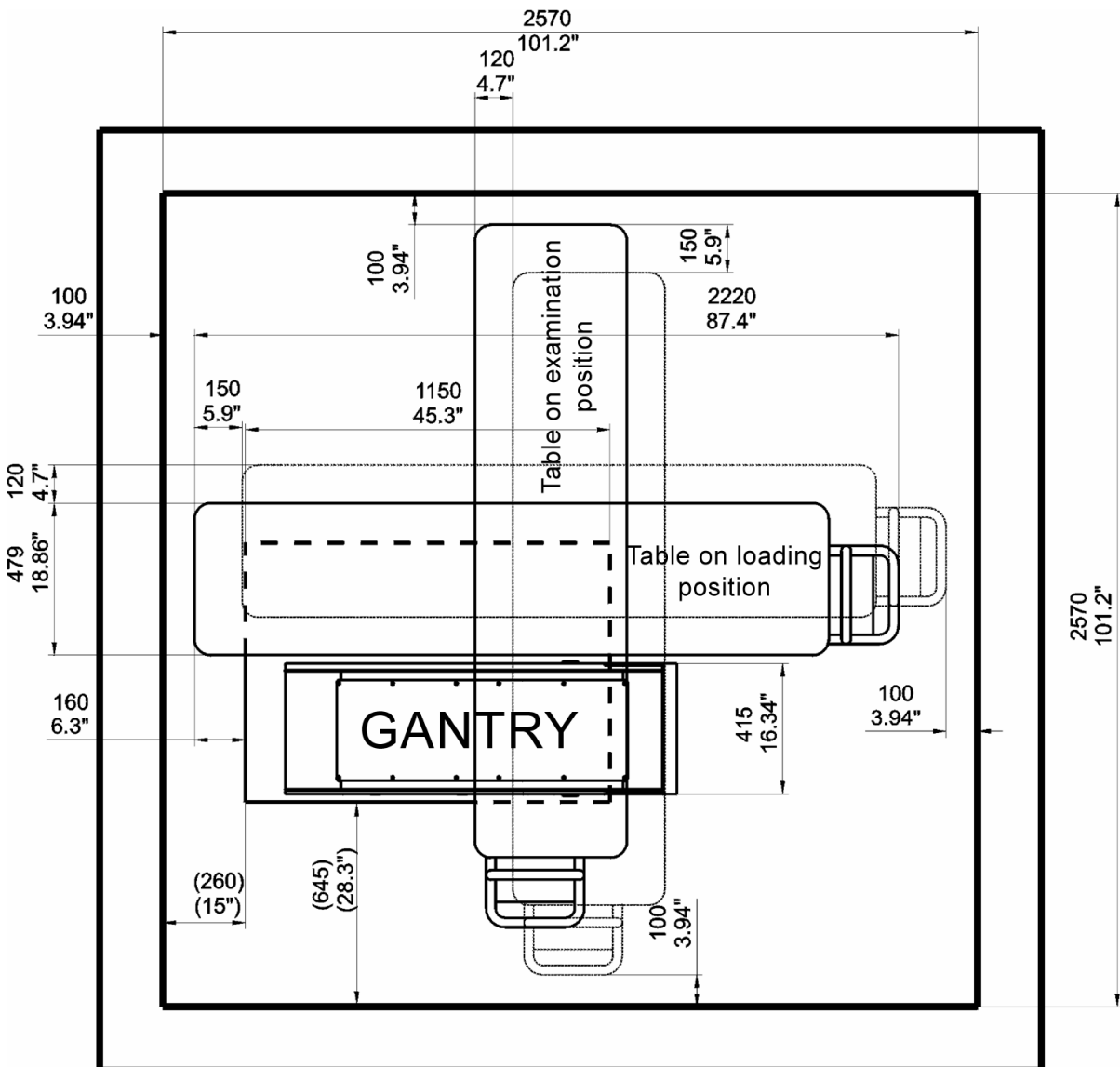
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Camera room layout

(The processing workstation is outside the room.)



Camera room layout
Dimensions are in mm and inch

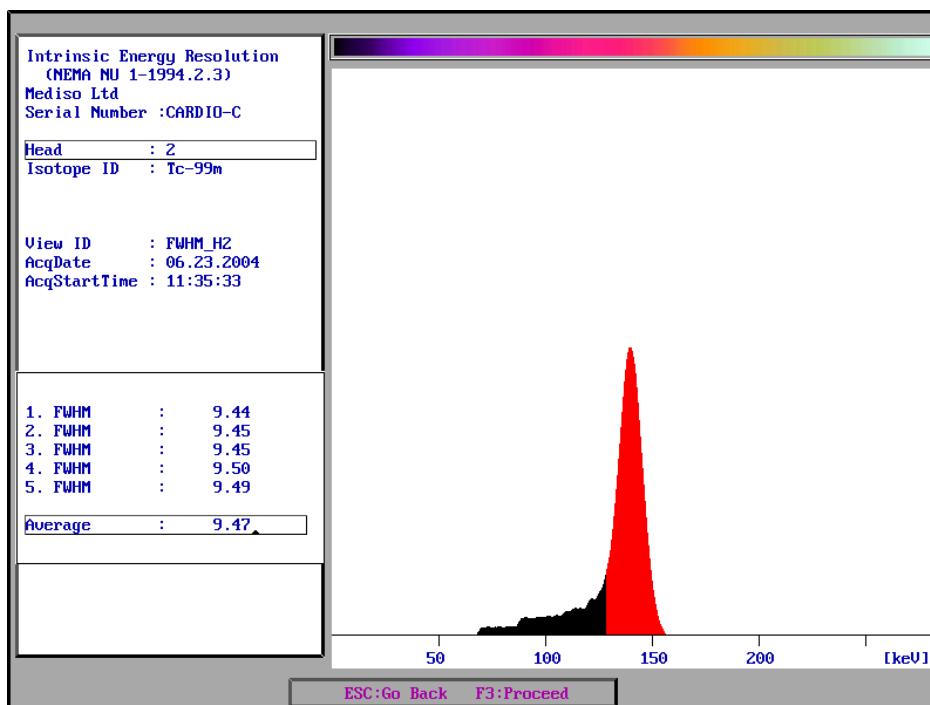
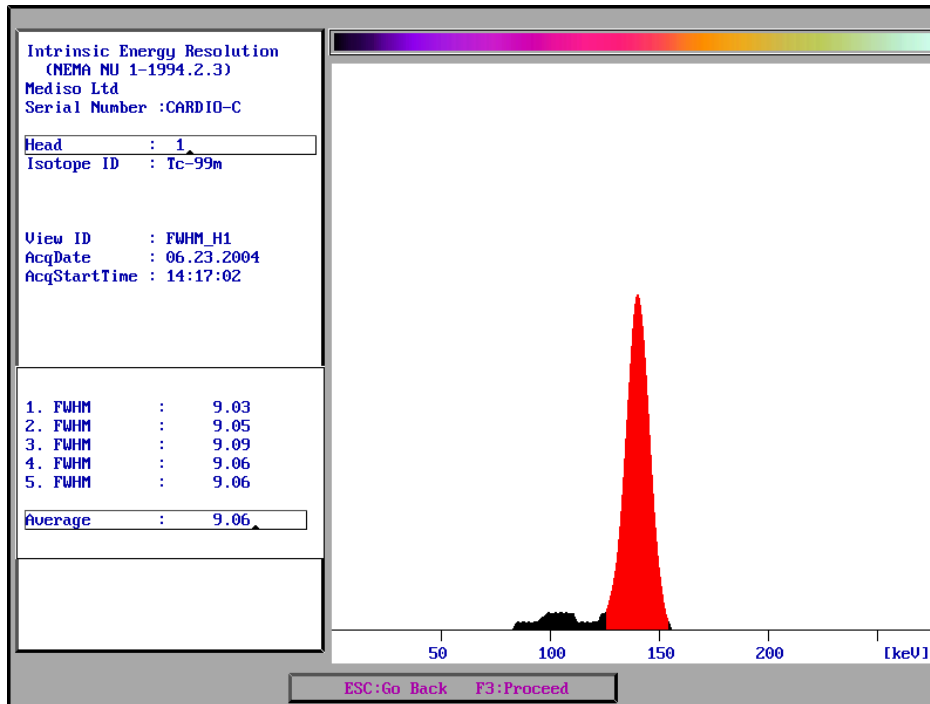
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NEMA Pictures

Intrinsic Energy Resolution



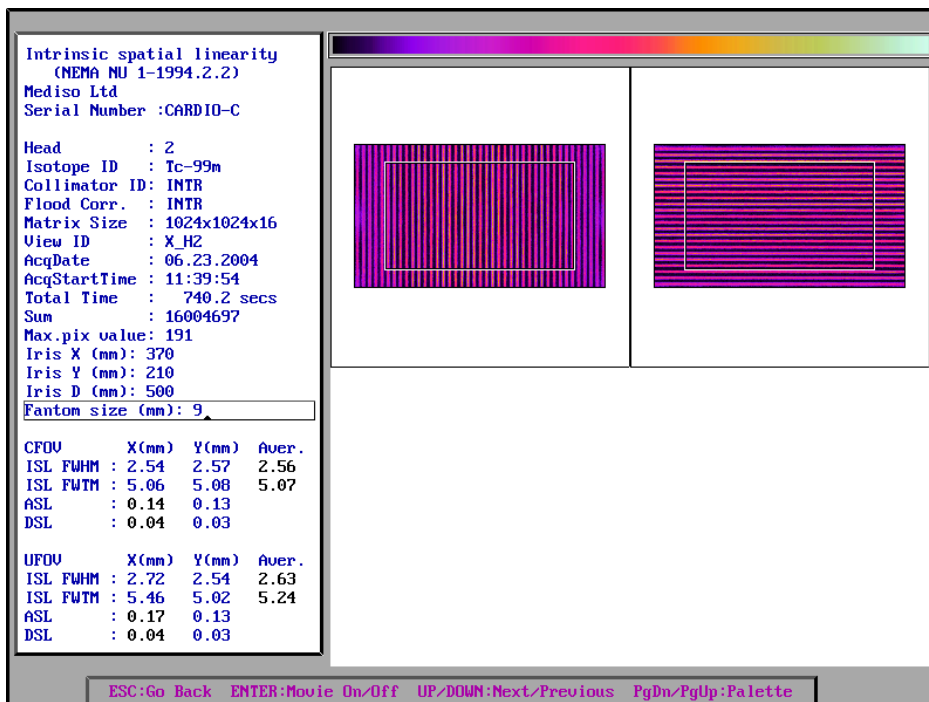
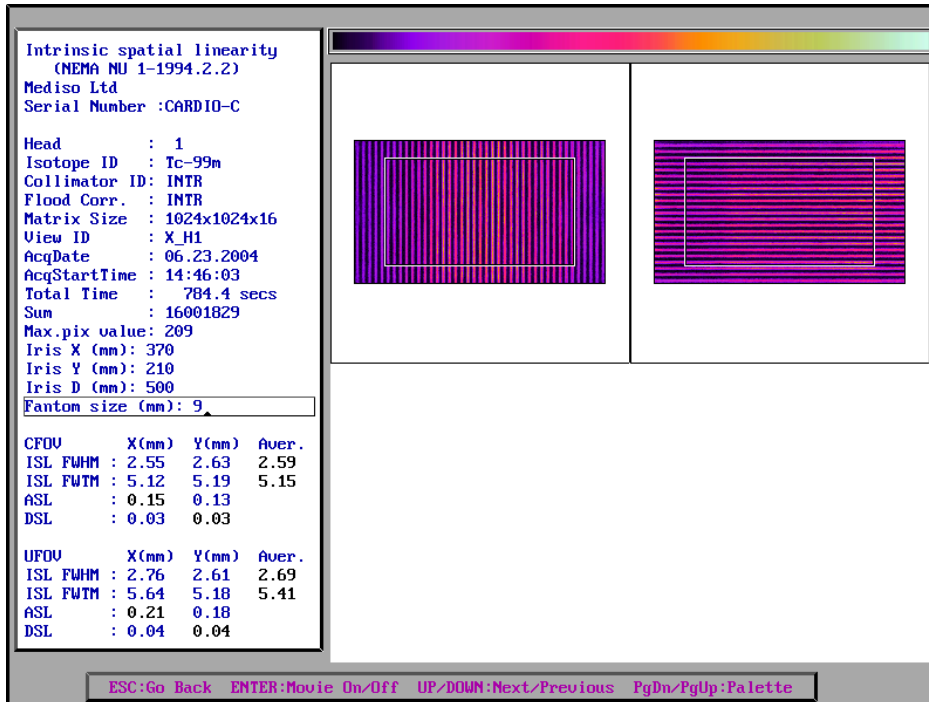
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NEMA Pictures

Intrinsic Spatial Linearity



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NEMA Pictures

Uniformity test

