

SPX-6

Integrated Digital Gamma Camera with Extra-Large Rectangular Field-of-View



Product Data

The APEX SPX-6 is a high performance, all-purpose, integrated digital gamma camera, optimally designed for superb WB, planar and SPECT imaging. It incorporates a 59-PMT extra-large 540x400 mm rectangular field-of-view, with advanced optronic detector design, yielding outstanding lesion detectability. Superior diagnostic power is provided by an array of 12 dedicated microprocessors featuring 74 MIPS, ranging from high-speed digital signal processing to 32-bit data processing. Raw computer power, a 1416 x 1168 resolution display*, and validated APEX software result in superior clinical reliability and exceptionally high throughput.

Key features and selected optional items include:

- Superb image quality and excellent lesion detectability throughout the entire 540 x 400 mm UFOV, real-time digital correction system and high-precision, micro cast parallel and fan-beam collimation*
- Ultra-fast acquisition and processing, utilizing state-of-the-art Intel microprocessors, enhanced by multi-processor array including an AMD 64-bit dedicated acquisition processor
- DIGITAL GUARD™, built-in optronic detector stabilization, guarantees optimal digital tuning at each energy level for highly accurate single and multi-isotope imaging
- Ultra-high count-rate performance, featuring maximal count rate of 500,000 cps
- Optimal ergonomic design for cardiac and brain imaging, featuring 3.2" "brain reach" and off-center magnification for superb brain SPECT scans
- High-performance integrated workstation featuring Intel processors, 1416 X 1168 resolution 21" color monitor* and a true multi-tasking operating system, ensures superior clinical diagnostic power.
- Compatibility and connectivity* with other APEX and XPert systems - ensure easy integration with current APEX or other vendors' systems*. Combining the benefits of both data and clinical software compatibility with earlier APEX models yields immunity from data and clinical software obsolescence.

* optional

- Multi-task environment allowing simultaneous acquisition, processing, and networking* for increased patient throughput.
- Outstanding PACS, featuring full archival unification throughout the network to ensure instantaneous data access to any of its systems, high performance laser multi-imagers or digital printers. Extended connectivity packages provide multi-standard ETHERNET networking* platforms, including TCP/IP* and ISO/OSI.
- A comprehensive clinical software package, including the full range of applications from automatic cardiac ventriculography analysis to quantitative SPECT. CLIP*, Elscint's unique clinical macro-programming language, with over 600 modular and linkable clinical functions, ensure both clinical versatility today and immunity from future software obsolescence.

SYSTEM DESCRIPTION

detector

High-performance detector features 3/8" NaI(Tl) crystal, 59 high quantum efficiency, optronically controlled photomultiplier tubes, and a rectangular 540x400 mm field-of-view, optimally shielded for imaging at 40-400 keV energy range.

gantry

A 85 cm (33") aperture computer controlled ring gantry supports the detector. Vacuum fluorescent flat panel display atop the gantry provides digital readout of system messages and detector head and gantry positioning. A 12-function hand-held remote command unit controls gantry motion and data acquisition.

patient handling system

APEX SPX-6 features two optional patient tables:

ECT table

Low attenuation carbon-fiber table-top with a motorized vertical motion.

WB table

Low attenuation flat-profile table with ultra-thin fiberzine table-top for single/dual-pass whole-body scanning.

integrated workstation

An acquisition and processing station, based on 32/64-bit multi-processor array including Intel processors, an acquisition dedicated array processor, a 21" color monitor with 1416 x 1168 resolution display*, 340 Mbyte magnetic fixed disk, 800 Mbyte optical disk* and a 5¼ ", 1.2 Mbyte flexible (floppy) disk.

software

The standard APEX clinical software repertoire, including: SPECT, Gated SPECT*, 3D display* package, CLIP programming* and ISO/OSI networking* protocols.

CONFIGURATIONS

The configurations employ the same advanced electronic and software architecture, including a wide spectrum of clinical protocols, CLIP (a clinical macro-programming language), and a range of APEX functions. ECT and Whole Body (AWB) software packages and scanning attachments may be added to the standard configuration.

standard

The standard APEX SPX-6 imaging system features a high performance workstation integrated with an extra large rectangular FOV detector, mounted on a computer-controlled motor-driven ring-shaped gantry.

optional

ECT: The standard configuration plus computer-controlled orbiting capability, scanning table, and supplementary SPECT software package.

AWB: The standard configuration plus scanning table, horizontal single-pass scanning capabilities, and supplementary whole body scanning software package.

ECT+AWB: The standard configuration plus scanning tables, computer-controlled orbiting capability, horizontal single/dual-pass scanning capabilities, and supplementary SPECT and whole body scanning software packages.

WORKSTATION

computer architecture

The SPX integrated computing system, APEX's 3rd generation, accelerates processing by a factor of 450% while maintaining software compatibility with thousands of existing APEX clinical programs. Unprecedented raw computer power is integrated on-board the camera; a 12-processor array ranges from HI-RES 50MHz, 24-bit digital signal processing; through 64-bit AMD acquisition-dedicated array processor; to Intel's CISC micro-computing power. These capabilities yield 74 MIPS cumulative peak performance from: 500,000 cps detection and real-time correction of nuclear events; through 0.22 second-per-slice tomographic reconstruction speed; to 17 second comprehensive cardiac multi-gated analysis. APEX SPX advanced micro-architecture incorporates more than 16 MB RAM, on-chip virtual memory management, 64-bit inter-unit transfer bus and 106 Mbyte/sec Burst Bus rates. Its dedicated control and data buses permit simultaneous multi-unit access to a dual-ported RAM. High integration features on-chip floating-point processing unit and data cache memory bank. This powerful architecture is designed to support high count-rate acquisition and compute-intensive multiprocessing environment simultaneously, without compromising performance speeds.

operator console

The integrated workstation includes an ergonomically-designed operator console featuring a 21" 1416 x 1168 high-resolution image color display*, a 14" alpha-numeric control monitor and an extended keyboard with both standard and functional keypads. The functional keypad includes 96 keys — 24 of which are user-programmable; a highly sensitive trackball and positional keys for interactive graphics control; two control knobs enabling fine digital tuning of the display; and a cine-rate adjustment knob.

SYSTEM PERFORMANCE**MECHANICAL SPECIFICATIONS****gantry**

Computer controlled gantry movements

rotational diameter (in/out)

Range: 0 to 63 cm (0 to 25")

Velocity: 1/4 rpm or 1 rpm

C.O.R height: 98 cm (38.6")

head tilt

TILT GUARD™:

Special mechanism maintains detector alignment while adjusting scan diameter.

Range: -75 to +185

gantry rotation

Range: ±360°

Velocity: fast - 1 rpm; slow -1/4 rpm

gantry lateral motion*

Range:

AWB 200 cm (78.7")

AEL 100 cm (39.3") - elliptical ECT orbit

Velocity:

Fast 150 cm/min (59"/min)

Slow 5 cm/min (19.7"/min)

patient handling system:

227 kg (500 lb) max. load

vertical motion

Range:

min. 65 cm (26")

max. 95 cm (37")

NEMA PERFORMANCE**SPECIFICATIONS******calibration**

DIGITAL GUARD™, a high-speed, automatic optronic detector calibration package

energy range 40 - 400 keV

intrinsic spatial resolution

CFOV: FWHM ≤4.3 mm

FWTM ≤8.1 mm

UFOV: FWHM ≤4.3 mm

FWTM ≤8.2 mm

intrinsic energy resolution ≤10.6%

intrinsic linearity

CFOV: Absolute ≤0.5 mm

Differential ≤0.1 mm

UFOV: Absolute ≤0.7 mm

Differential ≤0.1 mm

flood field uniformity

CFOV: Integral ≤4.0%

Differential ≤2.1%

UFOV: Integral ≤4.5%

Differential ≤2.4%

point source sensitivity ≤2.5%

high count rate performance

All corrections apply at all count rates.

maximum count rate# 500,000 cps

performance at high count rates#

maximum with 20% window > 320,000 cps

with 20% window: (observed) (incident)

20% loss> 180,000 cps 225,000 cps

maximum with 30% window > 400,000 cps

with 30% window (observed) (incident)

20% loss> 220,000 cps 275,000 cps

intrinsic spatial resolution (at 75 Kcps)

FWHM: 4.6 mm; FWTM: 8.8 mm

flood field uniformity (at 75 Kcps)

CFOV: Integral ≤5.7%

Differential ≤2.4%

UFOV: Integral ≤5.8%

Differential ≤2.7%

multiple window spatial registration

Max. displacement (⁶⁷Ga): 1.5 mm

system imaging performance

system resolution	LEHR collimator (APC-45RS)	LEGP collimator (APC-35RS)
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FWHM(mm)

without scatter 7.4 8.7

with scatter 7.8 9.6

FWTM(mm)

without scatter 13.6 15.6

with scatter 16.7 19.5

system sensitivity

counts/min/μCi 160 270

ACQUISITION

APEX SPX-6 can acquire images in Static, Dynamic, Multi-gated, List mode, SPECT*, Gated SPECT*, and Whole Body* acquisition modes.

- Simultaneous acquisition processing and networking
- Acquisition termination by preset time, preset count, overflow or manual stop
- User-definable preset protocols for easy acquisition set-up
- Up to four isotopes/peaks enabling multi-isotope or multi-peak (summed) acquisition modes
- Persistence mode display
- Continuous range off-center magnification
- Rotated and reflected acquisition modes (in steps of 1°)
- 512 channel PHA display

SPECT imaging performance

Measurements were taken using an APC-45RS collimator, 120 views, 3° per view, 15 cm radius-of-scan, acquisition magnification factor x2, Ramp-filtered back projection, 128² frame size:

reconstructed system spatial resolution (mm)

Tangential FWHM	6.8
Radial FWHM	9.6
Central FWHM	9.8

multi-gated acquisition

- Equi-time and equi-phase gating modes
- Dual buffer acquisition for accurate irregular beat rejection
- ECG display during acquisition
- On-line R to R histogram display
- Live cine display during acquisition
- Multi-buffer design enabling accumulation of both accepted and rejected beats

multi-gated acquisition capacity

matrix	max. frames/cycle
256 × 256 × 16	2
256 × 256 × 8	4
128 × 128 × 16	8
128 × 128 × 8	16
64 × 64 × 16	32
64 × 64 × 8	64

ECT acquisition***angular view resolution**

1, 2, 3, 4, 5, 6 and 9 degrees

acquisition modes

- *Continuous*: 1 min or 4 min per revolution
- *Step & Shoot*: 1 sec to 300 sec per step

scan orbits

- Circular (max. diameter 63 cm)
- Elliptical*: Patient width 0-100 cm

matrix size

64 x 64 or 128 x 128

AWB acquisition***scanning modes**

Single pass, left to right / right to left scanning with the detector head over or under the table.

Continuous sequential multi-spot advanced scanning modes* enable automatic transition from posterior to anterior scans and interactive body contouring (dual-pass)

scanning area

Single-pass: 54 cm width, 200 cm length with parallel hole collimator

matrix size

256 x 1024

dynamic acquisition**frame mode**

Up to five frame rate intervals may be defined per dynamic study

frame rates

matrix	max. frames/sec
256 × 256 × 16	1
256 × 256 × 8	3
128 × 128 × 16	6
128 × 128 × 8	12
64 × 64 × 16	25
64 × 64 × 8	50
32 × 32 × 16	100
32 × 32 × 8	200

list mode

- Simultaneous acquisition of up to two energy peaks
- Time markers, resolution 1 msec
- List of R-wave time markers, acquisition of digital ECG or other physiological signals
- Resolution 256 x 256 for single isotope; 128 x 128 for up to four isotopes
- Data reframing and curve generation using list mode data

static acquisition capacity

matrix	single isotope or 2 peak summing		
	dual isotope	quad isotope	
512 x 512	8 bits	----	----
256 x 256	8 or 16 bits	8 or 16 bits	8 bits
128x128	8 or 16 bits	8 or 16 bits	8 or 16 bits
64x64	8 or 16 bits	8 or 16 bits	8 or 16 bits
32x32	8 or 16 bits	8 or 16 bits	8 or 16 bits

ARCHIVING

Management of clinical data flow and storage within the system and through the ApexNet. Access to clinical data by patient name, patient I.D., date or study label. Archive data includes images, curves, ROIs, markers, reports and alphanumeric information. The following table represents archive storage capacity available on the standard 340 Mbyte disk:

standard fixed disk capacity

matrix	Capacity
512 × 512	1000 frames
256 × 256	4000 frames
128 × 128	16000 frames
64 × 64	64000 frames
32 × 32	256000 frames

DISPLAY**display matrix**

- Standard 708 x 584 pixels resolution (non-interlaced) 256 gray levels
- Optional High Definition Display featuring:
 - 21" high resolution color monitor (1416 x 1168 graphic pixels)
 - Simultaneous display of both acquired data and concurrent data-processing activity
 - High resolution (1416 x 1168 pixels) hard copy

High Definition Display* formats

- 4 x 512², 16 x 256², 64 x 128², 256 x 64², 1024 x 32², or combinations thereof
- Cine, windowing and baseline settings can be handled independently for each image in formats of 4 x 256² and 16 x 128², 64 x 128²
- Special modes:
 - 2 x 512² + 2 x 256 x 1024 for simultaneous data processing and Whole Body scan viewing
 - 4 x 256 x 1024 for Whole Body scan reports

color tables

- 256 shades
- Virtually unlimited number of color tables can be created interactively by user.

zoom factors

- 2, 4, 8
- Real-time interpolated zoom during cine

PROCESSING

image processing

Smoothing, normalization, interpolation, background subtraction, magnification, inter-frame arithmetic, non-linear contrast enhancement, grouping, cyclic addition, isocontour display, profile display.

regions of interest

Simultaneous display of up to 250 ROIs of any shape, including duplication, reflection, motion, and automatic edge detection.

curve management

Up to 64 curves displayed side-by-side or overlaid, featuring curve scaling, smoothing, normalization, interpolation, inter-curve arithmetic, fitting, deconvolution, integration, and differentiation in various display formats.

clinical protocols

APEX clinical software includes dozens of clinical packages in the following categories

- Cardiac First Pass
- Cardiac gated equilibrium
- Planar myocardial perfusion
- Tomographic myocardial perfusion
- Cedars-Sinai Quantitative SPECT*
- Gated tomography*
- 3D interactive display*
- Renal analysis
- Tomographic HMPAO and dynamic uptake brain studies
- Planar cerebral perfusion
- Lung ventilation/perfusion
- Thyroid uptake
- Gastric emptying

ECT data processing*

normalization

Sensitivity correction for collimator non-uniformities. Corrections of rotation speed, center of rotation (on line possibility), isotope decay.

attenuation correction

Chang method

reconstruction

Modes: Interactive or batch mode transaxial, coronal, sagittal and oblique reconstruction.

Transaxial Reconstruction Time:

0.22 sec/slice (60 x 64² matrix)

0.68 sec/slice (60 x 128² matrix)

Other planes reconstructed in real-time

Format: 64 x 64 (up to 64 slices)

or 128 x 128 (up to 128 slices)

back projection filters

Based on user-defined parameters: Hanning, Hamming, Butterworth, Parzen, Shepp-Logan and Ramp.

Adaptive: Metz and Wiener.

display formats

- Standard two dimensional multi-plane tomograms
- Interactive and dynamic 3D* display in surface and volume rendering modes

NETWORKING

ApexNet communication*

- Local area network to all APEX systems (ISO/OSI Ethernet standard). TCP/IP link available through ApexView or ACM-14
- Modem networking available through ApexView
- The APEX SPX Series is software compatible, data compatible and connective through the ApexNet with all existing APEX systems.

CLINICAL PROGRAMMING*

powerful clinical programming

APEX software awards its users with a wide array of clinical software packages and powerful programming tools. Used in over ten million procedures, they fall into the following categories:

- CLIP Programming, a simple, friendly "Basic" type interpreter language capable of invoking any of the APEX functions (more than 600), and linking them together into a clinical program.
- PLM-86 high level programming language along with comprehensive libraries of modules interfacing user-generated code to APEX software.

- A large selection of user-friendly editors, enabling modifications in the dialogs, menu windows, user-generated programs and acquisition protocols, are available in the standard APEX software. This powerful clinical programming toolbox guarantees both high clinical versatility today and immunity from software obsolescence in the future.

advanced clinical software

Strong cooperation with APEX users and CLIP's advanced programming tools make APEX clinical software extremely modular and highly efficient. The clinical programs fall into three categories:

- Built-in CLIP programs covering the widest spectrum of nuclear medicine processing protocols.
- More than 600 modular and linkable APEX functions, each optimized to handle a specific processing task. These functions are used as building blocks for the CLIP programs.
- An ever-growing number of user-generated CLIP programs which are not included in standard APEX software versions.

operational simplicity

APEX operator interface is designed to match both routine operation and advanced processing requirements.

- Multi-Operational Modes: APEX software may be activated by single key, by clinically driven menu windows or by command lines.
 - Friendly Dialogs: Parameters may be entered via an interactive simple-format series-of-queries, called dialog.
 - Help Menus: APEX built-in Help Menus minimize operator dependence on documentation. They are available any time on any level of the interaction for any command.
- The advanced human interface of APEX software is a built-in guarantee of operational simplicity without compromising clinical diagnostic power.

OPTIONS**SCANNING ATTACHMENTS****ECT-X**

SPECT scanning including: ECT patient table, computerized gantry motion control including side long arm-rest, ECT reconstruction and processing package

AEL-S

Elliptical orbit option for systems equipped with ECT

AWB-S

Whole Body scanning option (enables elliptical orbit on systems with ECT option), including Whole Body patient table and software package

ASCN-1

Advanced Whole Body scanning modes

ADST

Head support attachment — optimized for brain SPECT

AHG-1

Hand grip for cardiac/torso SPECT (overhead arm support)

ARM-1

Arm support for ECT patient table

DATA STORAGE DEVICES**MINIMAX 3000S**

0.8 Gbyte, optical disk (two cartridges included)

ODC-3

3 MINIMAX-3000S optical disk cartridges

ACCESSORIES**DISPLAY-HD**

High definition display (1416 x 1168 pixels), including 21" color monitor (in lieu of the 14" monitor)

AXM-14

Auxiliary 14" persistence image monitor

AEG-1A

ECG amplifier/synchronizer

ATC-15

Extended cable terminal to electronics cabinet

AMX-1S

Auxiliary camera multiplexer

CLINICAL PACKAGES**GSPECTS**

Gated ECT acquisition and processing

A3D-1

Interactive 3D display of tomographic studies

ACSP-1

Cedars-Sinai polar mapping package for TI²⁰¹ tomographic studies, including comparisons to the Cedars-Sinai normal data base

ACSP-2

"CEQUAL" - Cedars-Emory Quantitative Analysis. Tc^{99m} MIBI SPECT package (including normal patients data base)

ASF1-1

Scatter-free imaging package

PROGRAMMING LANGUAGES**CLIP**

Clinical macro programming language

APL-1-PLMS

PLM-86 programming language

NETWORKING**ACM-22S**

Single port fast Ethernet link (with thin cable connector)

TCM-12S

Thick cable Ethernet transceiver

ACM-2A

Thick cable for Ethernet network

ACM-2B

Thin cable for Ethernet network

ACM-14

Multiple port TCP/IP networking server communication link

ADT-1

Data transfer to/from "Non-ELSCINT" computers via 5¼" diskette

AAN-1

Analog X, Y, and Z outputs

HARDCOPY DEVICES**Helios 810**

Polaroid Digital Laser Imager with dry development (additional networking server, ACM-14, is required)

Agfa Drystar/N

Networked color or black and white multi-imager with dry processing (additional networking server, ACM-14, is required)

Codonics NP-1600

Digital color printer with dye sublimation (additional networking server, ACM-14, is required)

Visiplex/LR

Video multi-imager multi-format (1, 4) with conventional film processing including one 8x10" film cassette

Shinko CHC-S443

Mitsubishi Video color printer with dye sublimation

PHYSICAL CHARACTERISTICS**ELECTRICAL REQUIREMENTS****power consumption**

2300 VA, 1850 watt

including options

heat dissipation

6300 BTU/H

mains

115/230V ±10%, 20/10 A
(maximum current with all motors in operation)
60/50 ±1Hz (single phase)

GANTRY FLOOR LOAD

350 kg (771 lbs) at each of 4 support points
[Points are at corners of a 45 x 77 cm
(18" x 30") rectangle]

OPERATING ENVIRONMENT**temperature**

18°C-27°C (64°F-80°F)

maximum temp. gradient

3°C (5°F) per hour

humidity

40%-60%, non-condensing

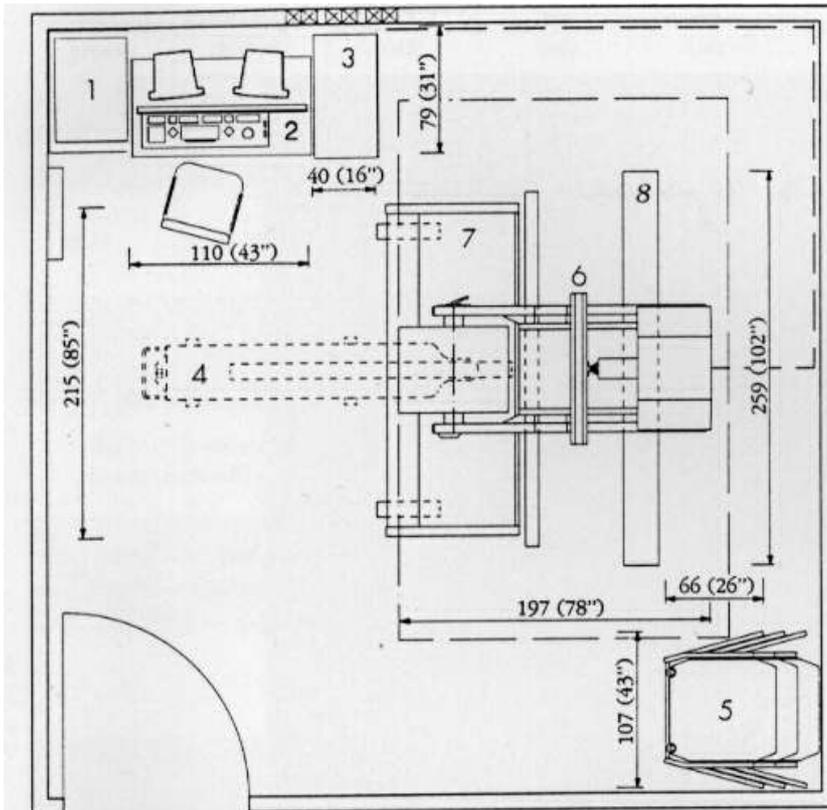
standards

Designed to meet UL544

IEC-601.1 certified

COLLIMATORS SPECIFICATIONS

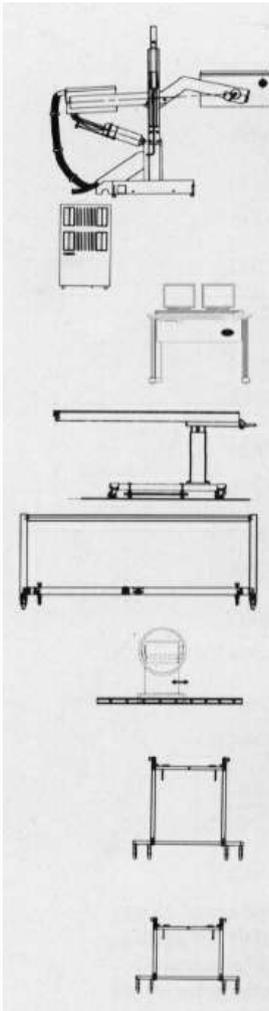
Name	Application	Energy keV	Septal Penetration %	Geometric Res. FWHM (mm)		System Res. FWHM (mm) @100 mm	Sensitivity Counts/min/ μ ci	Weight Kg(lbs)
				@0	@100			
APC-1RS-C LEUHS	Cardiac 1st Pass	140	2.6	4.9	17.4	17.6	1520	71(156)
APC-2RS-C LEHS	Gated cardiac (stress)	140	3.7	3.9	14.9	15.1	990	71(156)
APC-3RS-C LEHS	Gated cardiac	140	2.3	2.9	10.1	10.4	440	75(158)
APC-34RS-C LEAP	All purpose	140	2.4	2.4	9.1	9.4	360	72(158)
APC-35RS-K-C Cast/LEGP	General purpose	140	0.8	2.1	8.4	8.7	290	70(154)
APC-4RS-C LEHR	Brain scans	140	1.9	1.9	7.2	7.9	220	73(160)
APC-45RS-K-C Cast/LEHR	Bone scans	140	0.3	2.0	6.7	7.4	195	72(158)
APC-5RS-C Cast/MEGP	⁶⁷ Ga studies	300	2.4	3.2	10.5	10.7	190	70(154)
APC-6RS-C Cast/HEGP	¹³¹ I studies	360	2.0	3.6	11.3	10.4	140	79(173)
AFC-74RS-C Fan beam Cast/LEHR	Brain SPECT	140	0.1	2.0	5.5	7.0	275	75(165)
APC-8RS-C HEGP Pinhole	Thyroid scans (3 Inserts)	360	-	-	-	4.3 7.0 12.2	34 136 374	69(152)



TYPICAL ROOM LAYOUT

1. Multi-imager
2. Operator Console
3. Cabinet
4. ECT Scanning Table
5. Collimator Carts
6. Gantry
7. Scanning Table
8. AWB Track

DIMENSIONS & WEIGHTS



	HEIGHT cm (in)	WIDTH cm (in)	DEPTH cm (in)	WEIGHT Kg (in)	HEAT DISSIPATION (BTU/H)	POWER CONSUMPTION (WATTS)
GANTRY	173 (68)	98 (38.6)	197 (77.6)	1100 (2426)	1530	450
ELECTRONIC CABINET	70 (27.6)	40 (15.7)	80 (31.5)	70 (155)	3740	1100
CONSOLE	140 (55)	110 (43)	79 (31)	132 (290)	1020	300
ECT TABLE	95 (37.4)	37 (14.6)	200 (78.7)	80 (176)	Included in "GANTRY" specifications (above)	
AWB TABLE	83 (32.7)	215 (84.7)	87 (34.3)	110 (243)	Included in "GANTRY" specifications (above)	
AWB TRACK	8 (3.1)	259 (102)	23 (9)	35 (77)	-	-
CART-TR	105 (41.3)	107 (42.1)	66 (26)	15 (33)	-	-
CART-MR	89 (35)	107 (42.1)	66 (26)	14 (31)	-	-
CART-SR	78 (30)	107 (42.1)	66 (26)	13 (29)	-	-

* *Optional*** *Based on NEMA publication NU 1-1994**** *Nema class standard*# *"Fast acquisition" mode*

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Elscint

The Intelligent Image

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