CT SCANNER PERFORMANCE EVALUATION

GREEN LIGHT IMAGING, LLC
Medical Mobile Diagnostics
8348 Rosemead Blvd
Pico Rivera, CA 90660

(562)222-1321

CDPH Registration Number: FAC00078006

CT Trailer #4

GE LightSpeed QX/i CT Scanner

Gantry S/N: 252611CN9

Survey Date: March 30, 2019

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CT SCANNER PERFORMANCE EVALUATION SUMMARY

SITE:	**GREEN LIGHT IMAGING, LLC**	**Report Date:**	March 30, 2019
	8348 Rosemead Blvd	**Survey Date:**	March 30, 2019
	Pico Rivera, CA 90660		
X-Ray Unit Manufacturer:	GE Medical Systems	**Model:**	LightSpeed QX/i
Date Manufactured:	March 2000	**Room ID:**	CT Trailer #4
Medical Physicist:	Khachig A. Jerjian, Ph.D.	**Signature:**	K. Jerjian, Ph.D.

		PASS/FAIL/NA
1.	Review of Clinical CT Protocols	PASS
2.	Scout Prescription Accuracy Evaluation	PASS
3.	Laser Light Alignment Accuracy Evaluation	PASS
4.	Table Travel Accuracy Evaluation	PASS
5.	Radiation Beam Width Accuracy Evaluation	PASS
6.	Slice Thickness Accuracy Evaluation	PASS
7.	High Contrast Spatial Resolution Evaluation	PASS
8.	Low Contrast Performance Evaluation	PASS
9.	CT Number Accuracy Evaluation	PASS
	a. CT Number Accuracy and Linearity Evaluation	PASS
	b. CT Number Contrast Scale Evaluation	PASS
	c. CT Number Dependence on Slice Thickness Evaluation	PASS
	d. CT Number Dependence on kVp Evaluation	PASS
	e. CT Number and Image Uniformity Evaluation	PASS
10.	Artifact Evaluation	PASS
11.	Dosimetry Evaluation	PASS
12.	Acquisition Display Device Evaluation	PASS
	a. SMPTE Pattern Evaluation	PASS
	b. Scanner Distance Measurement and Spatial Distortion Evaluation	PASS
13.	Radiation Protection Evaluation	PASS
14.	Technologist Quality Control Program Evaluation	PASS

MEDICAL PHYSICS RECOMMENDATIONS & COMMENTS

1. CT scanner performance evaluation was found to be adequate. Performance evaluation test results were within ACR recommended action limits. Deviations in the indicated and measured $CTDI_{vol}$ dose values were within an acceptable range of ± 10%.

2. Select clinical protocols for adult and pediatric patients were reviewed and found to be adequate, with typical doses within ACR recommended Reference Dose Levels. To improve image quality, contrast-to-noise ratio and beam profile with the routine Adult Brain Protocols, recommend using a pitch of 0.75 instead of a pitch of 1.5 keeping all others factors the same. This can be achieved by changing the Table Speed from 15.0 mm/rot to 7.5 mm/rot with a resultant CTDIvol of 45.0 mGy.

3. Brain Perfusion CT protocols were not reviewed. Brain CT Perfusions are not performed on this scanner.

4. CT number calibration dependence on kVp (at 120 and 140 kVp) and on Slice Thickness was found to be adequate. CT Number linearity and contrast scale were also found to be adequate. However, 80 and 100 kVp settings are not calibrated. Scans using 80 and 100 kVp result in pronounced ring artifacts. Recommend avoiding the use of 80 and 100 kVp settings.

5. Detailed accounts of this performance evaluation may be obtained by contacting KJ Jerjian, Ph.D., at (949)683-5215.

K. Jerjian, Ph.D.

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Date: 2019.04.16 23:12:53 -06'00'

Khachig A. Jerjian, Ph.D., DABR
Medical Physicist

Date: 03/31/2019

1. REVIEW OF ROUTINE CLINICAL CT PROTOCOLS

This CT scanner performance evaluation was performed using the ACR CT Accreditation Program Phantom and routine clinical head and abdomen protocols used at this facility. Test procedures were consistent with ACR CT Accreditation Program guidelines and recommendations.

Table 1. Routine Protocols

For this section, techniques used on an average patient or average technique calculated from several patient images is recorded.	**Adult Head**	**Adult Abdomen**	**Pediatric Head (1 Year Old)**	**Pediatric Abdomen (5 Years Old)**
kVp	120	120	120	120
mA	180	250	100	70
Time per Rotation (sec)	1.0	1.0	0.8	0.8
System Calculated mAs	180	250	80	56
Effective mAs (or mAs per slice) as displayed	240	167	80	75
Scan FOV	Head	Large Body	Ped Head	Large Body
Scan FOV (cm)	25 cm	50 cm	25 cm	50 cm
Display FOV (cm)	21 cm	36 cm	18 cm	28 cm
Reconstruction Algorithm	Std	Std	Std	Std
Axial (A) or Helical (H) Scan	H	H	A	H
Acquisition Slice Thickness Z-Axis Collimation (T in mm)	2.5	2.5	2.5	3.75
Number of Slices per Tube Rotation - # of Data Channels Used (N)	4	4	4	4
Table Increment (mm) (axial scans) or Table Speed (mm/rot)(helical scans) (I)	7.50	15.0	10.0	11.25
IEC definition of Pitch for this protocol (Pitch = I / N * T) (calculated by the System)	0.75	1.50	1.0	0.75
Reconstructed Scan Width (mm)	5.0	5.0	5.00	5.0
Reconstructed Scan Interval (mm)	5.0	5.0	5.00	5.0
Dose Reduction Technique(s) used in routine patient scanning for these protocols (*Note: The ACR and CTDI phantoms are NOT scanned with dose reduction options.*)	n/a	Auto mA	n/a	Auto mA
Indicated $CTDI_{vol}$ (mGy)	45.01 mGy	16.86 mGy	15.00 mGy	7.00 mGy
Reference Dose Phantom Size	Head 16 cm	Body 32 cm	Head 16 cm	Body 32 cm

The facility clinical protocol acquisition and reconstruction parameters were reviewed for specific requirements of the diagnostic imaging task, image quality and dose. The above listed protocols were found to be adequate. The High Resolution Chest protocol was also found to be adequate. Brain Perfusion protocols were not reviewed. Brain Perfusions are not performed on this scanner.

2. SCOUT PRESCRIPTION ACCURACY EVALUATION

Phantom: ACR CT Accreditation Phantom

Technique: HR Chest Protocol
120 kVp, 250 mA, 0.8 sec Rotation Speed, 200 mAs, Axial Mode, 1x1.25 mm Detector Configuration, 1.25 mm Slice Thickness, Lung Reconstruction Algorithm, Large SFOV, 21 cm DFOV, 512x512 Image Matrix, 78.55 mGy CTDIvol.

Following proper position and leveling of the phantom on the scan table at the center of the gantry and acquisition of scout images, 1.25 mm thick axial images were prescribed at the center of modules 1 and 4 of the ACR CT Accreditation phantom at table landmark position of +0 mm and at table location 120 mm superior to the landmark position. Slice localization accuracy, laser light alignment and table travel accuracy were evaluated using images of embedded 1 mm diameter BBs at the surface of modules 1 and 4 of the ACR phantom.

Detector Configuration	Nominal Position	Actual Location	Deviation (mm)
1i 1x1.25 mm	Landmark Location	I 0.5 mm	- 0.5 mm
	Superior +120 mm	S119.5 mm	- 0.5 mm

Conclusion: Slice localization from scanned projection radiographs/scout was found to be adequate, accurate to within ± 1 mm.

3. LASER LIGHT ALIGNMENT ACCURACY EVALUATION

Detector Configuration	Nominal Position	Actual Location	Deviation (mm)
1i 1x1.25 mm	Landmark Location	I 0.5 mm	- 0.5 mm
	Azimuth 0° Laser	Left/Right	0.0 mm
	Azimuth 90° & 270°	Vertical	0.0 mm

- Maximum discrepancy between the internal and external axial laser lights and the plane of radiation field was determined to be less than ± 1 mm. The sagital and coronal laser light alignment accuracy was also found to be adequate, well within ± 2 mm limits.

Conclusion: Bed positioning accuracy and congruence of the laser light beam localizer with the imaging plane was found to be adequate.

4. TABLE TRAVEL ACCURACY EVALUATION

Detector Configuration	Nominal Position	Actual Location	Deviation (mm)
1i 1x1.25 mm	Landmark Location	I 0.5 mm	- 0.5 mm
	Superior +120 mm	S119.5 mm	- 0.5 mm

- Maximum discrepancy in bed repositioning was determined to be less than ± 1 mm.

Conclusion: CT scanner table motion was accurate, reproducible and consistent with digital system indicators. Bed travel and indexing/incrementation accuracy was found to be adequate and reproducible to within ±1 mm.

5. BEAM WIDTH ACCURACY EVALUATION

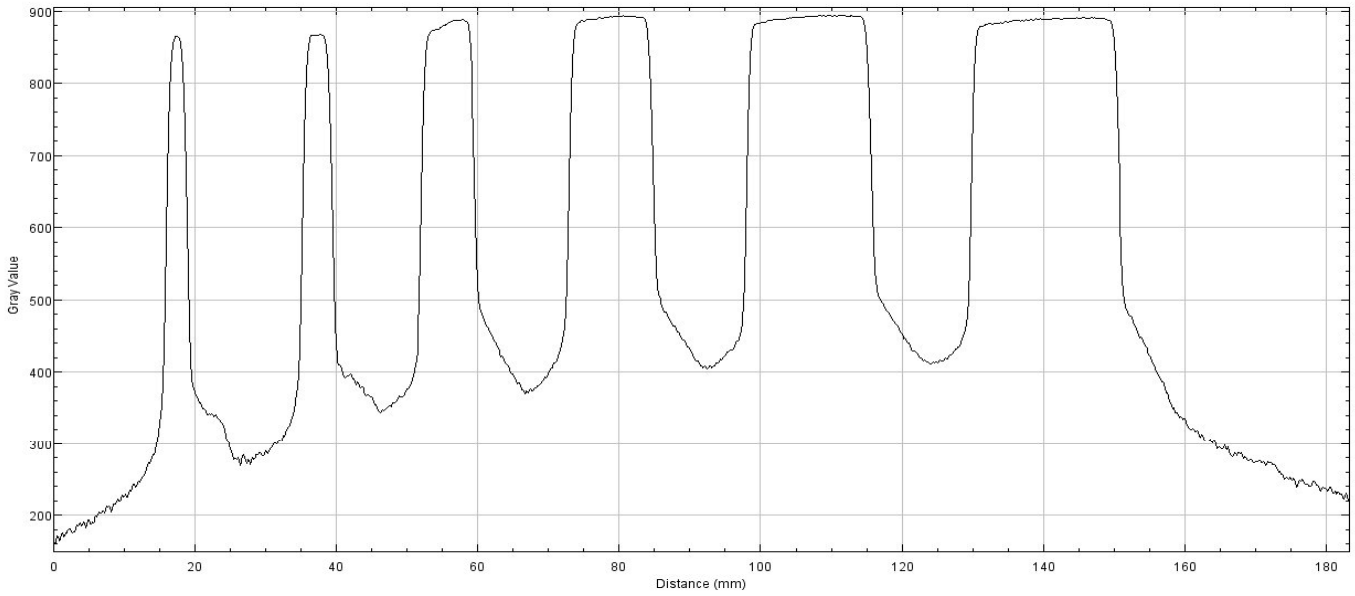
Phantom: CR Plate

Technique: 80 kVp, 10 mA, 0.8 sec Rotation Speed, 8 mAs, Axial Mode, Detector Configuration and Slice Thicknesses as indicated, Standard Reconstruction Algorithm, Large SFOV, 50 cm DFOV, 512x512 Image Matrix.

A CR plate was positioned at the iso-center and axial images were acquired at selected location. Beam widths were measured at the FWHM of the slice profiles.

Detector Configuration (Prescribed Beam Width NxT)	Prescribed Beam Width	Measured Beam Width	Action Limit PASS/FAIL
2i 2x0.63 mm (Sub mm Mode)	1.25 mm	2.9 mm	4.25 mm/PASS
1i 1x1.25 mm (HR Chest Mode)	1.25 mm	4.1 mm	4.25 mm/PASS
1i 4x1.25 mm	5.0 mm	7.5 mm	8.0 mm/PASS
4i 4x2.50 mm	10 mm	12.0 mm	13.0 mm/PASS
4i 4x3.75 mm	15 mm	17.6 mm	19.5 mm/PASS
4i 4x5.00 mm	20 mm	21.0 mm	26.0 mm/PASS

Conclusion: Measured beam widths were found to be in good agreement with indicated beam widths. Measured beam widths have to be within ± 3 mm or 30% of prescribed total nominal collimated beam widths, whichever is larger.



6. SLICE THICKNESS ACCURACY EVALUATION

Phantom: ACR CT Accreditation Phantom Module 1

Technique: 120 kVp, 250 mA, 1.0 sec Rotation Speed, 250 mAs, Axial Mode, Detector Configuration and Slice Thicknesses as indicated, Standard Reconstruction Algorithm, Large SFOV, 21 cm DFOV, 512x512 Image Matrix.

Axial images were acquired at the center of Module 1 of the ACR CT Accreditation phantom. Slice widths were assessed by counting the visible wires on the two ramps containing wires arranged in 0.5 mm z-axis increments.

Detector Configuration (Prescribed Beam Width NxT)	Prescribed Slice Width	Measured Slice Width	Difference
2i 2x0.625 mm	0.625 mm	1.0 mm	< 0.5 mm
4i 4x1.25 mm	1.25 mm	1.5 mm	< 0.5 mm
4i 4x2.5 mm	2.50 mm	2.5 mm	0.0 mm
4i 4x3.75 mm	3.75 mm	3.75 mm	0.0 mm
2i 4x5.0 mm	5.00 mm	5.0 mm	0.0 mm
2i 2x7.5 mm	7.50 mm	7.5 mm	0.0 mm
1i 1x10.0 mm	10.0 mm	10.0 mm	0.0 mm

Conclusion: Observed slice widths were found to be in good agreement with the nominal slice widths. Slice widths must be within ± 1.5 mm of the prescribed slice thickness.

7. HIGH CONTRAST SPATIAL RESOLUTION EVALUATION

Phantom: ACR CT Accreditation Phantom

Technique: Routine Adult Head, Adult Abdomen and HR Chest Protocols

The high contrast resolution insert, Module 4 of the ACR Phantom, contains eight bar patterns representing spatial frequencies corresponding to 4, 5, 6, 7, 8, 9, 10 and 12 lp/cm, respectively.

Protocol	High Contrast Spatial Resolution
Routine Adult Brain Protocol	7 lp/cm
Routine Adult Abdomen Protocol	7 lp/cm
HR Chest Protocol w/ Lung Algorithm	8 lp/cm
HR Chest Protocol w/ Bone+ Algorithm	10 lp/cm

Conclusion: The limiting high contrast spatial resolution is adequate. The ACR Pass/Fail criteria are 6 lp/cm for standard resolution head and body protocols and 8 lp/cm for the high resolution chest protocol.

8a. CONTRAST TO NOISE EVALUATION

Phantom: ACR CT Accreditation Phantom Module 2
Technique: Routine Adult Head and Adult Abdomen Protocols

The low contrast resolution insert, Module 2 of the ACR phantom, contains five different size rod sets with diameters equal to 6 mm, 5 mm, 4 mm, 3 mm, and 2 mm, respectively. The rod sets are considered to be resolved if all four rods of the same size can be clearly visualized .

Contrast to Noise (CNR) Evaluation:

The low contrast resolution insert, Module 2 of the ACR Phantom, was evaluated using a ROI of about

Protocol	Rod Insert ROI (H.U.)	Background ROI (H.U.)	Background ROI Std. Dev.	CNR
Adult Brain p=0.75	93.7	87.9	4.3	1.3
Adult Abdomen	95.3	88.9	4.9	1.3
Pediatric Brain	94.0	87.4	7.8	0.8
Pediatric Abd	95.5	89.8	7.7	0.7

Conclusion: Routine Brain and Body protocol contrast to noise ratios were found to be adequate. The CNR must be greater than 1.0 for the adult Brain and adult Abdomen protocols. CNR must be greater than 0.7 for Pediatric Brain and greater than 0.4 for Pediatric Abdomen protocol.

8b. LOW CONTRAST RESOLUTION EVALUATION

Phantom: ACR CT Accreditation Phantom Module 2
Technique: Routine Adult Head and Adult Abdomen Protocols

The low contrast resolution insert, Module 2 of the ACR phantom, contains five different size rod sets with diameters equal to 6 mm, 5 mm, 4 mm, 3 mm, and 2 mm, respectively. The rod sets are considered to be resolved if all four rods of the same size can be clearly visualized .

Protocol	Contrast Level	$CTDI_{vol}$ (mGy)	Low Contrast Resolution
Adult Brain	0.6%	45.01 mGy	4 mm
Adult Abdomen	0.6%	16.86 mGy	4 mm
Pediatric Brain (1 Year old)	0.7%	15.00 mGy	5 mm
Pediatric Abdomen (5 Year old)	0.6%	7.00 mGy	5 mm

Conclusion: The ACR Pass/Fail criteria indicate a resolution of 6 mm diameter rods with both adult abdomen and adult brain protocols. The scanner Low Contrast Resolution is estimated to better than 4 mm @ 0.6 % contrast at a dose of 45 mGy $CTDI_{vol}$.

9 (a). CT NUMBER ACCURACY AND LINEARITY EVALUATION

Phantom: ACR CT Accreditation Phantom Module 1
Technique: Routine Adult Brain and Adult Abdomen Protocols

Module 1 of the ACR phantom is used to assess CT number accuracy and linearity. There are five cylinders of different materials including a bone mimicking material ("Bone"), polyethylene, water equivalent material, acrylic and air. Each cylinder, except the water cylinder, has a diameter of 25 mm and a depth of 4 cm. The water cylinder has a diameter of 50 mm and a depth of 4 cm. ROI measurements were performed in each insert with an ROI area of ~ 200 mm^2.

Technique: Routine Adult Brain Protocol

ACR Phantom Insert	Mean CT Number (HU)	Acceptable CT Number Range		
Polyethylene	-95	-107 HU	to	-84 HU
Water Equivalent	0.5	-7 HU	to	7 HU
Acrylic	121	110 HU	to	135 HU
Bone	**996**	850 HU	to	970 HU
Air	-995	-1005 HU	to	-970 HU

Technique: Routine Adult Abdomen Protocol

ACR Phantom Insert	Mean CT Number (HU)	Acceptable CT Number Range		
Polyethylene	-94	-107 HU	to	-84 HU
Water Equivalent	0.4	-7 HU	to	7 HU
Acrylic	123	110 HU	to	135 HU
Bone	931	850 HU	to	970 HU
Air	-997	-1005 HU	to	-970 HU

Conclusion: CT number calibration accuracy was adequate. Mean CT number of tested inserts were mostly within ACR recommended ranges.

9 (b). CT NUMBER CONTRAST SCALE EVALUATION

Phantom: ACR CT Accreditation Phantom Module 1
Technique: Routine Adult Brain and Adult Abdomen Protocols

CT number contrast scale was evaluated using the Water and Acrylic inserts in Module 1 of the ACR Phantom. Acrylic/Water CT number contrast scale was represented by the difference in Acrylic and Water CT numbers.

PROTOCOL	Acrylic CT Number	Water CT Number	Contrast Scale	
Routine Adult Brain protocol	121	0	120	HU
Routine Adult Abdomen protocol	123	0	123	HU

Conclusion: Contrast scale is adequate. The acrylic and water CT number difference should be within the manufacturer recommended range of 120 ± 12 HU.

9 (c). CT NUMBER DEPENDNCE ON SLICE THICKNESS

Phantom: ACR CT Accreditation Phantom Module 1

Technique: Adult Abdomen equivalent axial protocol at 120 kVp, 250 mA, 1.0 sec Rotation Time, Large SFOV, 21 cm DFOV, Standard Body Algorithm, slice thicknesses as indicated and ROI areas of ~ 200 mm^2.

Slice Thickness	Mean CT Number (HU)	Acceptable CT Number Range		
0.625 mm	1.9	-7 HU	to	7 HU
1.25 mm	1.8	-7 HU	to	7 HU
2.50 mm	0.8	-7 HU	to	7 HU
3.75 mm	1.0	-7 HU	to	7 HU
5.0 mm	0.9	-7 HU	to	7 HU
7.5 mm	1.0	-7 HU	to	7 HU
10.0 mm	0.8	-7 HU	to	7 HU

Conclusion: CT number dependence on slice thickness is adequate. Mean CT numbers should be within the ACR recommended range of ± 7 HU, and preferably within ± 5 HU.

9 (d). CT NUMBER DEPENDNCE ON kVp

Phantom: ACR CT Accreditation Phantom Module 1

Technique: Routine Adult Abdomen equivalent protocol in 2ix5.0 mm axial mode, 4x2.5 mm Detector Configuration, kVp values as indicated, ROI areas of ~ 200 mm^2.

kVp	Mean CT Number (HU)	Acceptable CT Number Range		
80	**22**	-7 HU	to	7 HU
100	**17**	-7 HU	to	7 HU
120	1.0	-7 HU	to	7 HU
140	1.0	-7 HU	to	7 HU

Conclusion: CT number dependence on kVp at 120 and 140 kVp was found to be adequate. Mean CT numbers should be within the ACR recommended range of ± 7 HU, and preferably within ± 5 HU. According to FSE 80 kVp and 100 kVp stations are not calibrated because they are not generally used clinically. Recommend avoiding use of 80 kVp and 100 kVp techniques until such time when unit is recalibrated.

9 (e). IMAGE UNIFORMITY EVALUATION

Phantom: ACR CT Accreditation Phantom Module 3

Technique: Routine Adult Abdomen Protocol

The uniformity section insert, Module 3 of the ACR phantom, contains Teflon beads embedded in a uniform water equivalent background. ROI measurements were performed at the center and periphery of the phantom. Area of ROI used was ~ 400 mm^2. Image spatial uniformity was depicted by the edge-to-center mean CT number differences.

ACR Phantom	Location	Mean ROI CT Number (H.U.)	ROI Standard Deviation (H.U.)	Difference Center to Edge ROI (H.U.)
ROI ~ 400 mm^2	Center	-2.5	5.7	---
	3 O'clock	-0.8		1.7
	6 O'clock	0.1		2.6
	9 O'clock	0.3		2.8
	12 O'clock	-0.3		2.2

Conclusion: Mean CT number and image spatial uniformity is adequate. The measured mean CT numbers should be in the range of 0 ± 7 Hounsfield Units (HU) and preferably within 0 ± 5 HU. Image spatial uniformity, depicted by the edge-to-center mean CT number differences is also within recommended limits. Edge-to-center mean CT number differences must be less than 5 HU for all four edge positions.

10. ARTIFACT EVALUATION

Phantom: ACR CT Accreditation and CTDI Dose Phantoms
Technique: Routine Adult Brain and Adult Abdomen Protocols

With all graphics turned off and with reduced room lighting, images were viewed for artifacts such as rings or streaks.

Conclusion: No significant streaks, rings or any other type of equipment related artifacts were noted using 4x2.5 mm Collimation. Artifacts were noted while scanning using 4x5.0 mm Collimation at a helical pitch of 1.5. Recommend avoiding use of 4x5.0 mm Collimation at a helical pitch of 1.5.

11. CT DOSIMETRY EVALUATION

A. CT SCANNER INDICATED COMPUTED TOMOGRAPHY DOSE INDEX $CTDI_{VOL}$ EVALUATION

Phantom: 16 cm CTDI Acrylic Head and 32 cm CTDI Acrylic Body Phantom

Dosimeter used: Radcal Accu-Pro Model 9096 S/N 96-0544 (Calibration Date: 01/09/2018)

Ion Chamber: Radcal 10X6-3CT Ion Chamber (Calibration Date: 01/09/2018)

Technique: Routine Adult Brain and Abdomen Protocols (Axial Mode Equivalents)

Weighted $CTDI_{w,100}$ Dose Measurements using CTDI Dose Phantoms:

Scan Protocols (Detector Configuration)	kVp	mA	Scan Time (sec)	SFOV (cm)	Scan Type	Indicated $CTDI_{vol}$ (mGy)	Measured $CTDI_w$ (mGy)	Percent Difference
Adult Head (4x2.5 mm) w/ Small Phantom in Head Holder	120	180	1.0	Head	Axial	33.76	31.18	-8%
Adult Body (4x2.5 mm) w/ Large CTDI Phantom on Table	120	250	1.0	Large	Axial	25.29	22.85	-10%
Pediatric Head (4x2.5 mm) w/ Small CTDI Phantom on Table	120	100	0.8	Head	Axial	15.00	13.77	-8%
Pediatric Body (4x3.75 mm) w/ Large CTDI Phantom on Table	120	110	0.8	Large	Axial	5.25	4.94	-6%

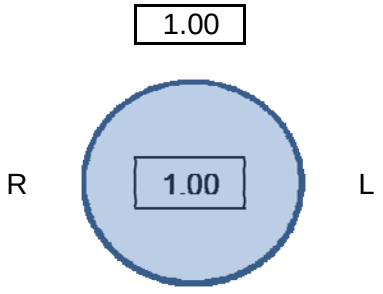
Conclusion: Measured $CTDI_w$ values were found to be consistent with scanner indicated $CTDI_{vol}$ dose values. Percent differences were within an acceptable range of ± 10%.

RADIATION DOSE UNIFORMITY*

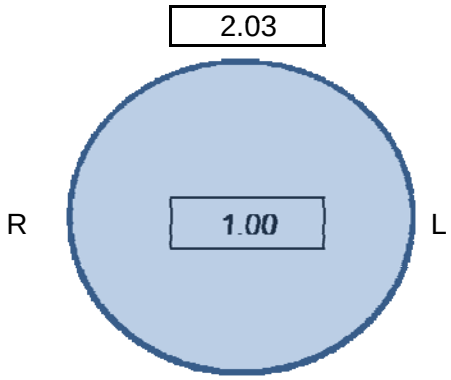
**Note: Phantom surface dose factors normalized to the value at the center location*

Technique: 120 kVp techniques with 4x2.5 mm collimation configuration as indicated.

16 cm CTDI Head Dose Phantom



32 cm CTDI Body Dose Phantom



11. CT DOSIMETRY EVALUATION (Continued)

B. PATIENT DOSE EVALUATION FOR REPRESENTATIVE CT EXAMINATIONS

Phantom: 16 cm CTDI Acrylic Head and 32 cm CTDI Acrylic Body Phantom
Technique: Routine Adult Brain and Adult Abdomen Protocols

Correspondence of Measured and Indicated $CTDI_{vol}$ Doses for Select Clinical Protocols:

Protocols	Measured $CTDI_{vol}$ (mGy)	Indicated $CTDI_{vol}$ (mGy)	Reference CTDI Dose Phantom	Percent Difference
Adult Brain	41.58 mGy	45.01 mGy	Head 16 cm	-8%
Adult Abdomen	15.23 mGy	16.86 mGy	Body 32 cm	-10%
Pediatric Brain	13.77 mGy	15.00 mGy	Head 16 cm	-8%
Pediatric Abdomen	6.59 mGy	7.00 mGy	Body 32 cm	-6%

Conclusion: Measured $CTDI_{vol}$ values were found to be consistent with scanner indicated dose values. Measured CTDIvol values should be less than the ACR Pass/Fail Criteria tabulated below, and preferably less than the ACR Reference Dose Levels. Percent differences were within an acceptable range of ± 10%.

Effective Dose Estimates for Select Clinical Protocols

Protocols	Measured $CTDI_{vol}$ (mGy)	Scan Length	Dose Length Product DLP (mGy.cm)	Effective Dose (mSv)
Adult Brain	41.58 mGy	17.5 cm	728 mGy.cm	1.5 mSv
Adult Abdomen(SSDE)	15.61 mGy	25.0 cm	390 mGy.cm	5.9 mSv
Pediatric Brain	13.77 mGy	12.0 cm	165 mGy.cm	1.1 mSv
Ped Abdomen(SSDE)	12.40 mGy	15.0 cm	186 mGy.cm	3.7 mSv

Conclusion: $CTDI_{vol}$ dose values and Effective Dose estimates are within the ACR recommended limits. Attached, please find the dose calculator spreadsheets for further details.

ACR $CTDI_{vol}$ Pass/Fail Criteria and CT Dose Reference Levels

CT Examination	ACR Pass/Fail Criteria $CTDI_{vol}$ (mGy)	ACR Reference Levels $CTDI_{vol}$ (mGy)
Adult Head	80 mGy	75 mGy
Adult Abdomen	30 mGy	25 mGy
Pediatric Head (1 year old)	40 mGy	35 mGy
Pediatric Abdomen (40-50 lb, 16 cm Diameter CTDI Phantom)	20 mGy	15 mGy
Pediatric Abdomen (40-50 lb, 32 cm Diameter CTDI Phantom)	10 mGy	7.5 mGy

12 (a). ACQUISITION DISPLAY DEVICE EVALUATION

Acquisition display devices were evaluated using a standard SMPTE test pattern. Display device presentation of the SMPTE pattern was found to be adequate. The 5% and 95% squares were adequately resolved from their respective backgrounds. The gradation of the gray scale patterns were uniform and adequately resolved. High contrast resolution patterns were also properly displayed and resolved. No significant distortions or non-uniformities were noted.

Acquisition Display Workstation Monitor	Black Level (cd/m^2)	White Level (cd/m^2)	% Luminance Non-Uniformity
MultiSync LCD 1990SXi	1.0	122	6%

Conclusion: The acquisition display monitor was found to be adequate. There are no significant distortions and non-uniformities of images on the monitors. The maximum brightness of the monitor was found to be adequate. For diagnostic workstations, the maximum brightness should be greater than 90 cd/m^2, the Black Level performance should not exceed 1.2 cd/m2, and the percent non-uniformity in luminance measurements at the center and corners of the display monitor should not exceed 15%.

12 (b). SPATIAL DISTORTION EVALUATION

Phantom: ACR CT Accreditation Phantom Module 3
Technique: Routine Adult Abdomen Protocol

Spatial distortion and distance measurement accuracy was evaluated by measuring the known dimensions of the ACR phantom and set distance between the Teflon BB's in Module 3.

A. Distance Gauge Check:

Orientation of BB's	Actual Distance Between BB's	Scanner Measured Distance	Percent Difference
45°	10.0 cm	10.0 cm	0.0%

B. Aspect Ratio of Video Monitor and Imager (if available):

ACR Phantom	Aspect Ratio
Ratio of Horizontal to Vertical Dimensions of Circular Phantom Object	1.00
Ratio of Horizontal to Vertical Dimensions of Object on the Monitor	1.00
Ratio of Horizontal to Vertical Dimensions of Object on Film	N/A

Conclusion: The scanner distance measurement accuracy is adequate. There are no significant spatial distortion of the image on the monitors.

13. RADIATION SAFETY EVALUATION

A. Visual Inspection

A visual safety inspection of the CT scanner trailer and surroundings was conducted. No unsafe conditions were noted.

B. Audible and Visual Warning Signs

System audible and visual warning signs are functional and performing adequately. Dose Notification and scan alert features are activated and functioning properly.

C. Posting Requirements

A “Caution X-Ray” warning sign should be posted at the scanner room door.

14. TECHNOLOGIST QUALITY CONTROL PROGRAM

A. A daily CT QC program is recommended to be established consistent with manufacturer recommendations and ACR CT QC manual guidelines. The following QC procedures should be performed at each location where the scanner is used and at the minimum frequencies specified.

Quality Control Procedures	Responsible Individual	Frequency	STATUS
1. Water CT Number Accuracy Eval	CT Technologist	Daily	N/A
2. Image Noise Evaluation	CT Technologist	Daily	N/A
3. Artifact Evaluation	CT Technologist	Daily	N/A
4. Visual Checklist	CT Technologist	Monthly	N/A
5. Dry Laser QC	CT Technologist	N/A	N/A
6. Acquisition Display QC	CT Technologist	Monthly	N/A

B. Preventive maintenance program should be established consistent with manufacturer recommendations. Regular PMs should be performed and documented by qualified field service engineers.

ACR CT ACCREDITATION DOSE SPREADSHEET

IMPORTANT NOTE: This Excel Workbook contains formulae essential to accurate reporting of dose for ACR CT Accreditation. It is intended to be used with both Windows and Mac operating systems. Please note, ANY alteration of the formulae will very likely result in errors of reported data, and could adversely affect our accreditation results. You must enter accurate data from this workbook into the ACRedit online testing package. Please check the results from this workbook against the results shown in the ACRedit database online testing package before submission.

Dose Calculator Spreadsheet (Exposure)

CTAP ID Number

Radiation Dosimetry (Adult Head)

Use the TAB key to move between data entry cells in the column named *Measured* .

CTDI Head Phantom (16-cm diameter PMMA Phantom)	**Measured**	**Calculated**
kV	120	
mA	180	
Exposure time per rotation (s)	1	
# data channels used (N)[1]	4	
Z-axis collimation (T)[1]	2.5	
Axial (A): Table Increment (mm) OR Helical (H):Table Speed (mm/rot)	7.5	
Active Chamber length (mm)	100	
Chamber correction factor	1	
Center		
Measurement 1 (mR)	357.2	
Measurement 2 (mR)	358.3	
Measurement 3 (mR)	358.8	
Average of above 3 measurements (mR)		358.1
Head CTDI at isocenter in phantom (mGy)		31.2
12 o'clock position		
Measurement 1 (mR)	363.7	
Measurement 2 (mR)	354.6	
Measurement 3 (mR)	357.4	
Average of above 3 measurements (mR)		358.6
Head CTDI at 12 o'clock position in phantom (mGy)		31.2
CTDIw (mGy)		31.2
Clinical exam dose estimates (using measured CTDIw and site's Adult Head Protocol from Table 1)		
CTDIvol (mGy)	=CTDIw*N*T/I	41.6
CTDIvol reported by scanner (mGy) for the protocol entered in the phantom site scanning data form (using 16-cm diameter PMMA phantom)	45.01	
Percent difference between calculated and reported CTDIvol and CTDIvol by scanner		7.6%
Dose Notification Value (mGy) as described in XR-29 (if applicable)		
DLP (mGy-cm)	=CTDIvol*17.5	728

[1]See definitions in the CT Accreditation Testing Instructions.

ACR CT ACCREDITATION DOSE SPREADSHEET

IMPORTANT NOTE: This Excel Workbook contains formulae essential to accurate reporting of dose for ACR CT Accreditation. It is intended to be used with both Windows and Mac operating systems. Please note, ANY alteration of the formulae will very likely result in errors of reported data, and could adversely affect our accreditation results. You must enter accurate data from this workbook into the ACRedit online testing package. Please check the results from this workbook against the results shown in the ACRedit database online testing package before submission.

Dose Calculator Spreadsheet (Exposure)

CTAP ID Number

Radiation Dosimetry (Adult Abdomen)

Use the TAB key to move between data entry cells in the column named *Measured* .

CTDI Body Phantom (32-cm diameter PMMA Phantom)	**Measured**	**Calculated**
kV	120	
mA	250	
Exposure time per rotation (s)	1	
# data channels used (N)[1]	4	
Z-axis collimation (T)[1]	2.5	
Axial (A): Table Increment (mm) = (I)[1] OR Helical (H):Table Speed (mm/rot) = (I)[1]	15	
Active Chamber length (mm)	100	
Chamber correction factor	1	
Center		
Measurement 1 (mR)	155.4	
Measurement 2 (mR)	156.7	
Measurement 3 (mR)	155.7	
Average of above 3 measurements (mR)		155.9
Body CTDI at isocenter in phantom (mGy)		13.6
12 o'clock position		
Measurement 1 (mR)	312.7	
Measurement 2 (mR)	322.9	
Measurement 3 (mR)	312.0	
Average of above 3 measurements (mR)		315.9
Body CTDI at12 o'clock position in phantom (mGy)		27.5
CTDIw (mGy)		22.8
Clinical exam dose estimates (using measured CTDIw and site's Adult Abdomen Protocol from Table 1)		
CTDIvol (mGy)	=CTDIw*N*T/I	15.2
CTDIvol reported by scanner (mGy) for the protocol entered in the phantom site scanning data form (using 32-cm diameter PMMA phantom)	16.8	
Percent difference between calculated CTDIvol and CTDIvol reported by scanner		9.5%
Dose Notification Value (mGy) as described in XR-29 (if applicable)		
DLP (mGy-cm)	=CTDIvol*25	381
SSDE for 35 cm water equivalent diameter (mGy)	=SSDE(35 cm)	15.61

[1] See definitions in the CT Accreditation Testing Instructions.

ACR CT ACCREDITATION DOSE SPREADSHEET

IMPORTANT NOTE: This Excel Workbook contains formulae essential to accurate reporting of dose for ACR CT Accreditation. It is intended to be used with both Windows and Mac operating systems. Please note, ANY alteration of the formulae will very likely result in errors of reported data, and could adversely affect our accreditation results. You must enter accurate data from this workbook into the ACRedit online testing package. Please check the results from this workbook against the results shown in the ACRedit database online testing package before submission.

Dose Calculator Spreadsheet (Exposure)

CTAP ID Number

Radiation Dosimetry (Pediatric Head, 1 year old)

Use the TAB key to move between data entry cells in the column named *Measured* .

CTDI Head Phantom (16-cm diameter PMMA Phantom)	Measured	Calculated
kV	120	
mA	100	
Exposure time per rotation (s)	0.8	
# data channels *used* (N)[1]	4	
Z-axis collimation (T)[1]	2.5	
Axial (A): Table Increment (mm) OR Helical (H):Table Speed (mm/rot)	10	
Active Chamber length (mm)	100	
Chamber correction factor	1	
Center		
Measurement 1 (mR)	153.9	
Measurement 2 (mR)	152.3	
Measurement 3 (mR)	152.8	
Average of above 3 measurements (mR)		153.0
Head CTDI at isocenter in phantom (mGy)		13.3
12 o'clock position		
Measurement 1 (mR)	162.2	
Measurement 2 (mR)	161.2	
Measurement 3 (mR)	159.3	
Average of above 3 measurements (mR)		160.9
Head CTDI at 12 o'clock position in phantom (mGy)		14.0
CTDIw (mGy)		13.8
Clinical exam dose estimates (using measured CTDIw and site's Pediatric Head (1 year old) Protocol from		
CTDIvol (mGy)	=CTDIw*N*T/I	13.8
CTDIvol reported by scanner (mGy) for the protocol entered in the phantom site scanning data form (using 16-cm diameter PMMA phantom)	15.0	
Percent difference between calculated CTDIvol and CTDIvol reported by scanner		8.2%
Dose Notification value as desciribed in XR-29 (if applicable)		
DLP (mGy-cm)	=CTDIvol*12	165

[1] See definitions in the CT Accreditation Testing Instructions.

ACR CT ACCREDITATION DOSE SPREADSHEET

Dose Calculator Spreadsheet (Exposure) **CTAP ID Number**

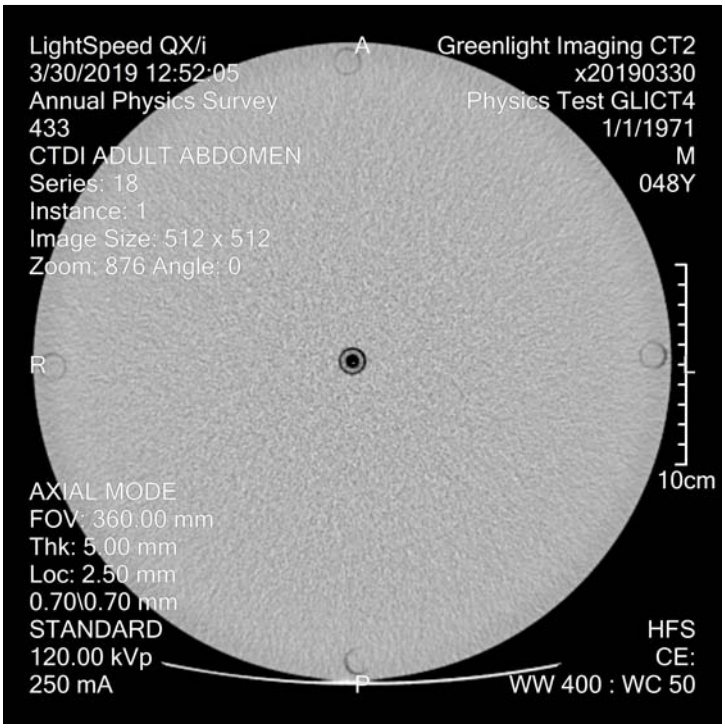
Radiation Dosimetry (Ped Abdomen, 40-50 lb)

Note: For pediatric abdomen (40-50 lb.)protocols, some CT scanners report CTDIvol using the 16 cm phantom, while others use the 32 cm phantom. The physicist should use the phantom (16 or 32 cm) that is used by the scanner to report CTDIvol.

Use the TAB key to move between data entry cells in the column named *Measured* .

CTDI Phantom (16 or 32 cm diameter PMMA Phantom)	**Measured**	**Calculated**
Size of phantom the scanner uses to report CTDIvol for routine pediatric abdomen protocol (40-50 lb.)	**32 cm**	
kV	120	
mA	70	
Exposure time per rotation (s)	0.8	
# data channels *used* (N)[1]	4	
Z-axis collimation (T)[1]	3.75	
Axial (A): Table Increment (mm) = (I)[1] OR Helical (H):Table Speed (mm/rot) = (I)[1]	11.25	
Active Chamber length (mm)	100	
Chamber correction factor	1	
Center		
Measurement 1 (mR)	50.4	
Measurement 2 (mR)	50.8	
Measurement 3 (mR)	50.5	
Average of above 3 measurements (mR)		50.6
Ped Body CTDI at isocenter in phantom (mGy)		2.9
12 o'clock position		
Measurement 1 (mR)	100.1	
Measurement 2 (mR)	106.5	
Measurement 3 (mR)	100.8	
Average of above 3 measurements (mR)		102.5
Ped Body CTDI at12 o'clock position in phantom (mGy)		5.9
CTDIw (mGy)		4.9
Clinical exam dose estimates (using measured CTDIw and site's Pediatric Abdomen (40-50 lb.) Protocol from Table 1)		
CTDIvol (mGy)	=CTDIw*N*T/I	6.6
CTDIvol reported by scanner (mGy) for the protocol entered in the phantom site scanning data form	7.0	
Percent difference between calculated CTDIvol and CTDIvol reported by scanner		5.9%
Dose Notification Value as described in XR-29 (if applicable)		
DLP (mGy-cm)	=CTDIvol*15	98.8
SSDE for 18.5 cm water equivalent diameter (mGy)	=SSDE(18.5 cm)	12.4

[1] See definitions in the CT Accreditation Testing Instructions.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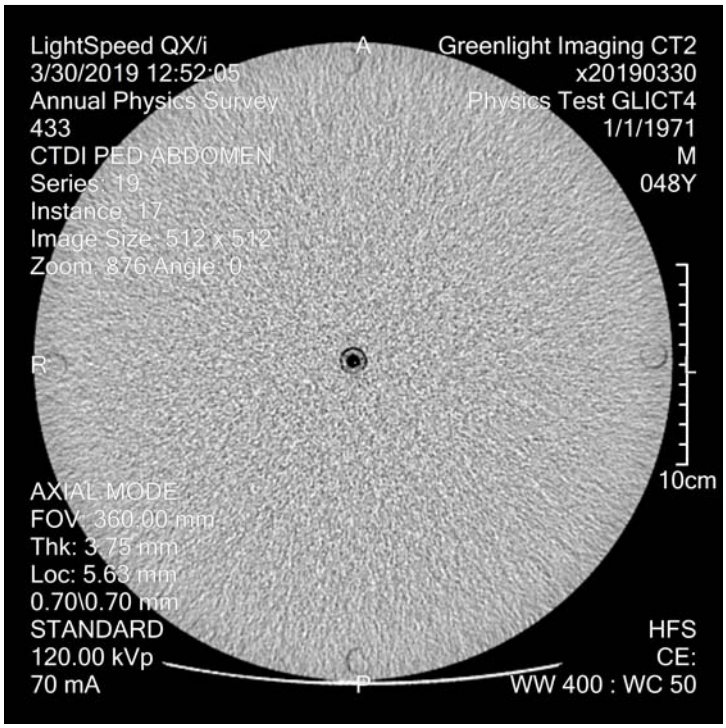
A
Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
10cm
AXIAL MODE
FOV: 360.00 mm
Thk: 5.00 mm
Loc: 2.50 mm
0.70\0.70 mm
STANDARD
120.00 kVp
250 mA
HFS
CE:
P
WW 400 : WC 50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Zoom: 876 Angle: 0
A
Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
10cm
AXIAL MODE
FOV: 360.00 mm
Thk: 3.75 mm
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0.70\0.70 mm
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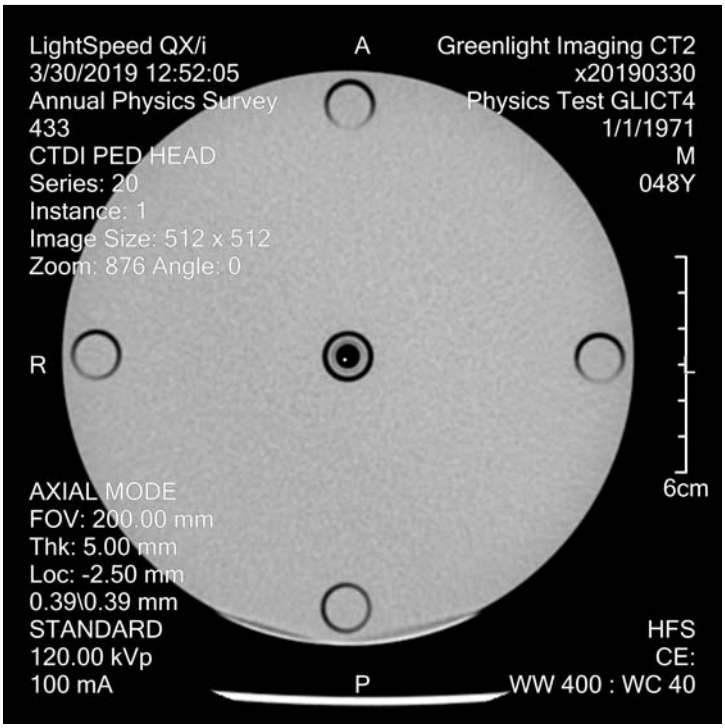
70 mA
HFS
CE:
P
WW 400 : WC 50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Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
6cm
AXIAL MODE
FOV: 200.00 mm
Thk: 5.00 mm
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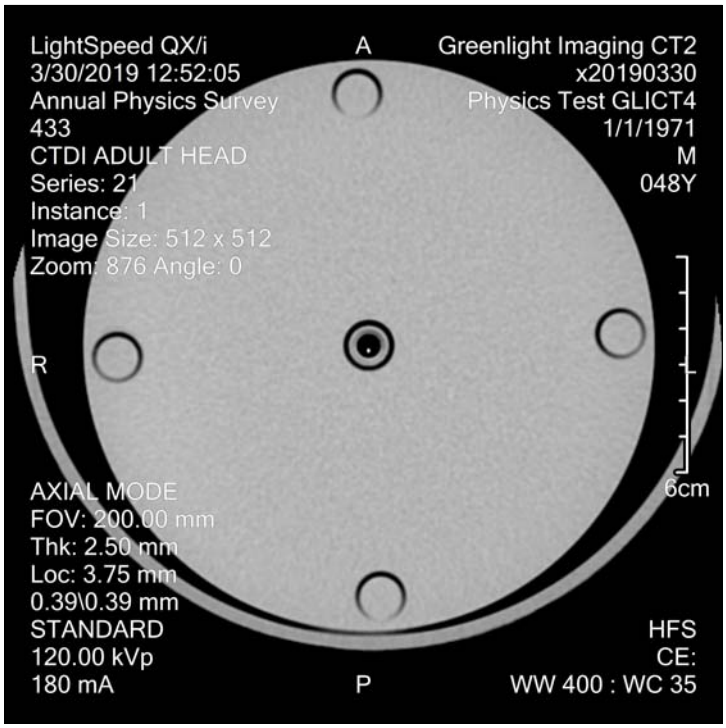
0.39\0.39 mm
STANDARD
120.00 kVp
100 mA
HFS
CE:
P
WW 400 : WC 40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Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
6cm
AXIAL MODE
FOV: 200.00 mm
Thk: 2.50 mm
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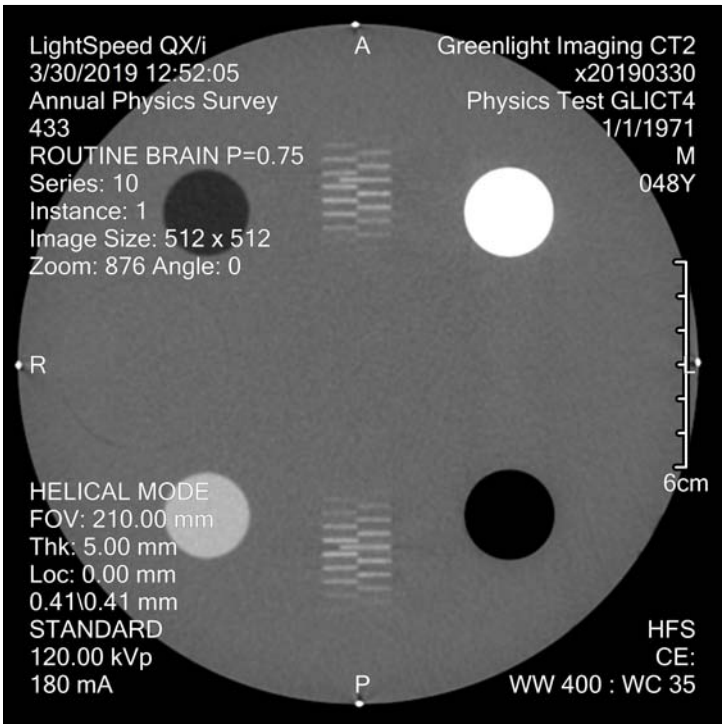
0.39\0.39 mm
STANDARD
120.00 kVp
180 mA
HFS
CE:
P
WW 400 : WC 35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Physics Test GLICT4
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1/1/1971
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M
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048Y
Instance: 1
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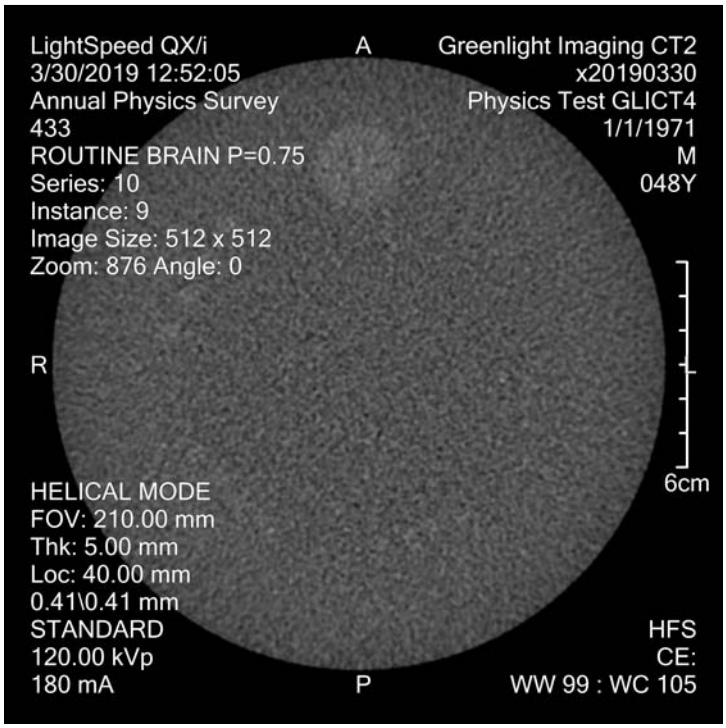
Zoom: 876 Angle: 0
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 0.00 mm
0.41\0.41 mm
STANDARD
HFS
120.00 kVp
CE:
180 mA
P
WW 400 : WC 35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Annual Physics Survey
Physics Test GLICT4
433
1/1/1971
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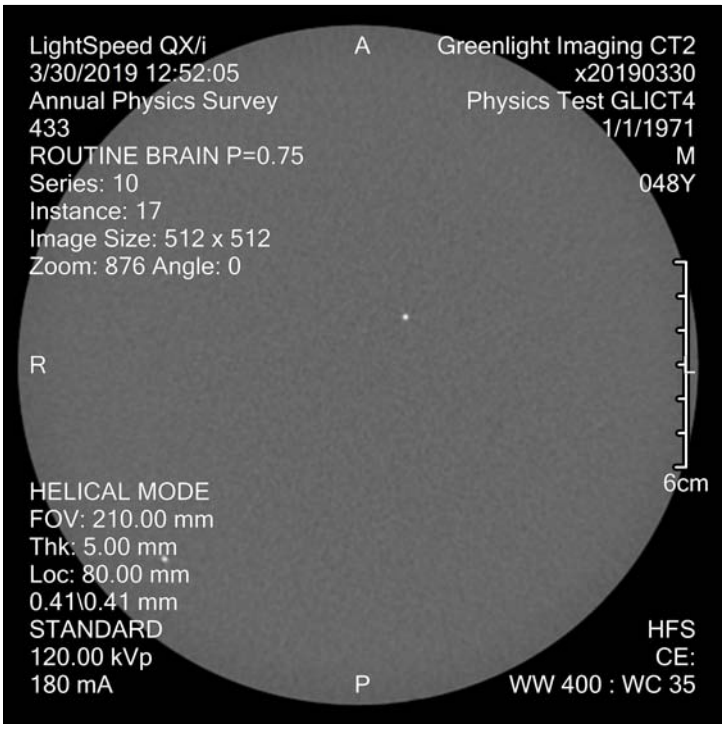
M
Series: 10
048Y
Instance: 9
Image Size: 512 x 512
Zoom: 876 Angle: 0
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 40.00 mm
0.41\0.41 mm
STANDARD
HFS
120.00 kVp
CE:
180 mA
P
WW 99 : WC 105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Physics Test GLICT4
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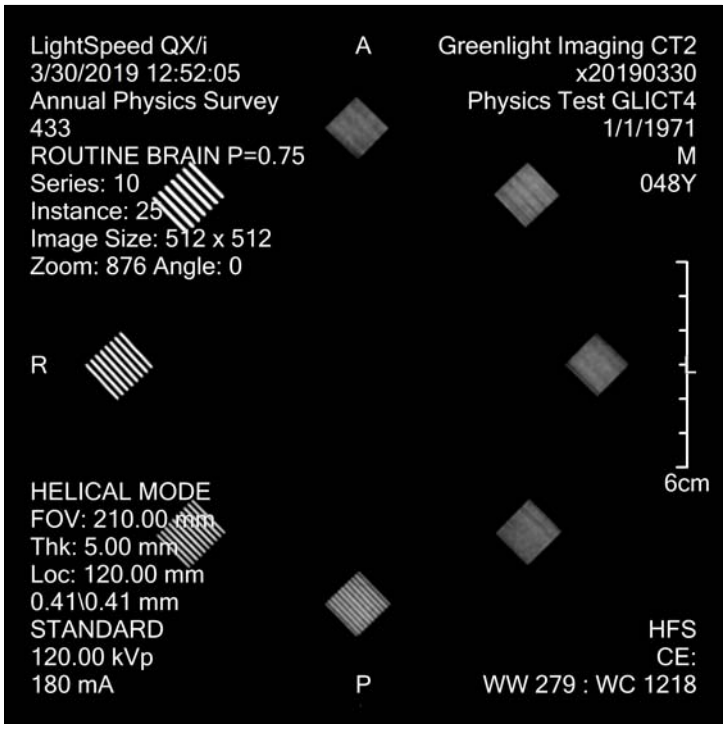
1/1/1971
ROUTINE BRAIN P=0.75
M
Series: 10
048Y
Instance: 17
Image Size: 512 x 512
Zoom: 876 Angle: 0
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 80.00 mm
0.41\0.41 mm
STANDARD
HFS
120.00 kVp
CE:
180 mA
P
WW 400 : WC 35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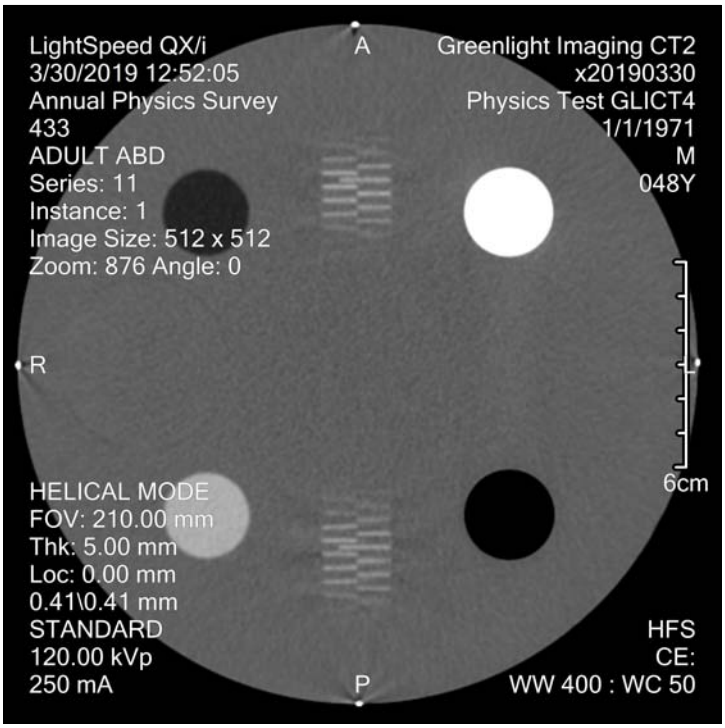
x20190330
Annual Physics Survey
Physics Test GLICT4
433
1/1/1971
ROUTINE BRAIN P=0.75
M
Series: 10
048Y
Instance: 25
Image Size: 512 x 512
Zoom: 876 Angle: 0
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 120.00 mm
0.41\0.41 mm
STANDARD
HFS
120.00 kVp
CE:
180 mA
P
WW 279 : WC 1218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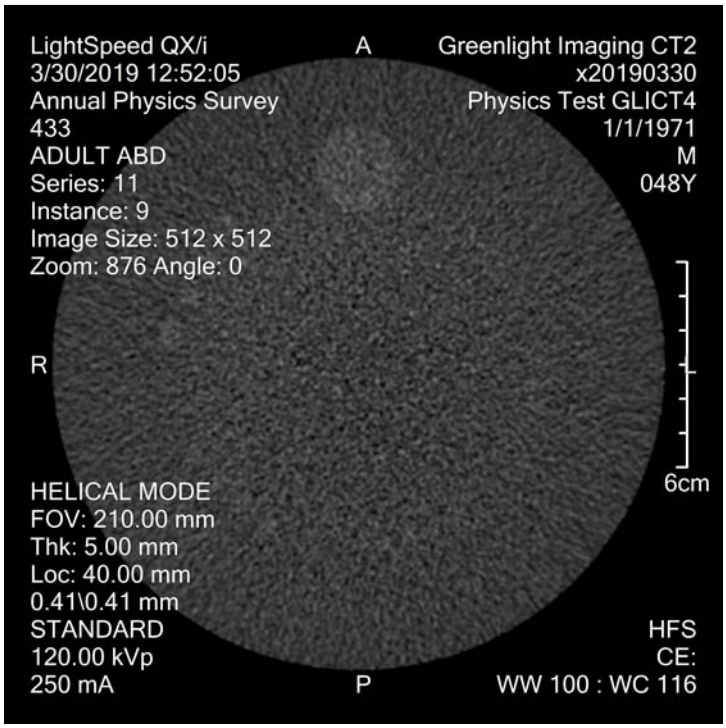
Zoom: 876 Angle: 0
A
Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 0.00 mm
0.41\0.41 mm
STANDARD
120.00 kVp
250 mA
P
HFS
CE:
WW 400 : WC 50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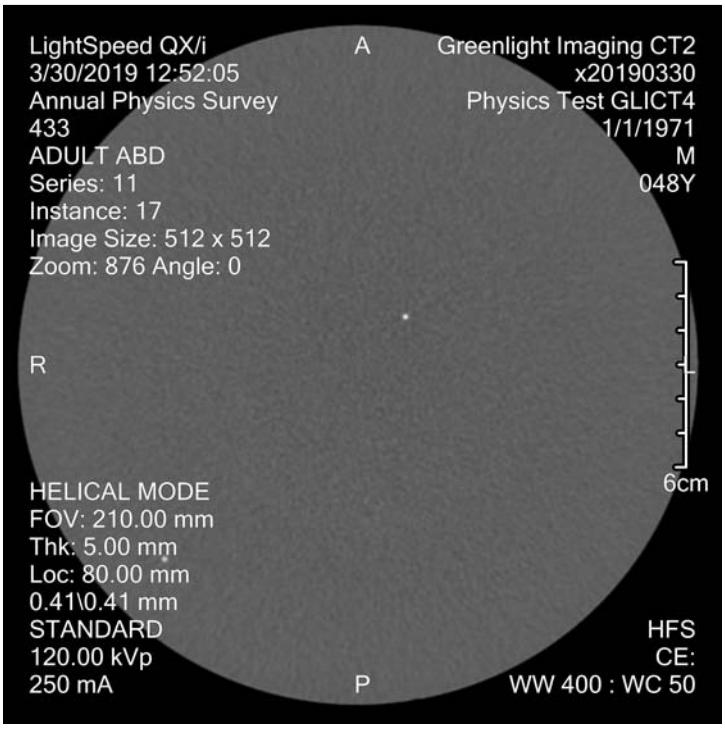
Zoom: 876 Angle: 0
A
Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 40.00 mm
0.41\0.41 mm
STANDARD
120.00 kVp
250 mA
P
HFS
CE:
WW 100 : WC 116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Zoom: 876 Angle: 0
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Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
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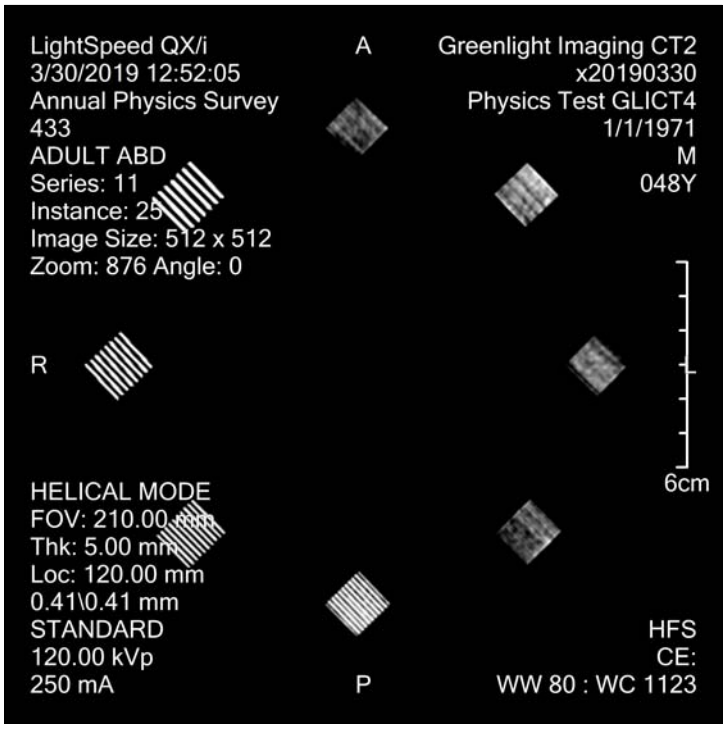
0.41\0.41 mm
STANDARD
120.00 kVp
250 mA
P
HFS
CE:
WW 400 : WC 50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Instance: 25
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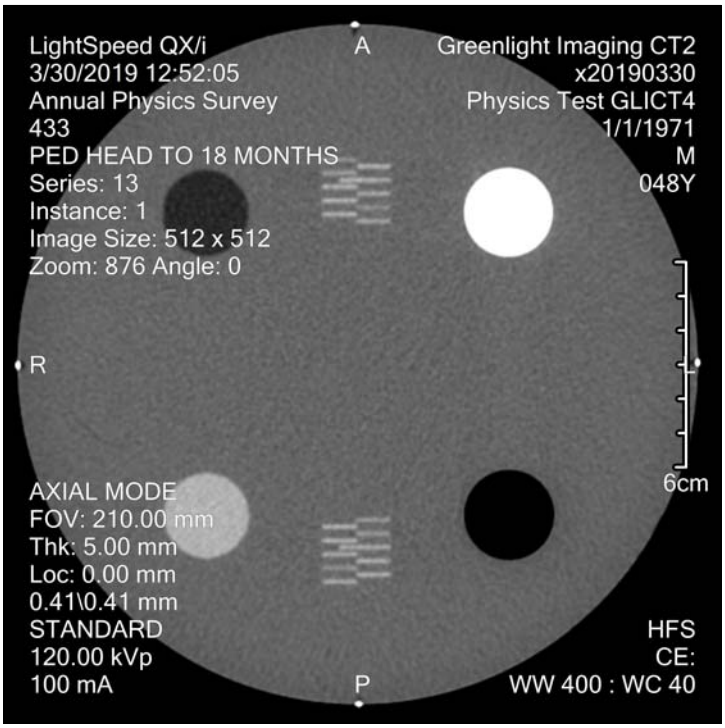
Zoom: 876 Angle: 0
A
Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 120.00 mm
0.41\0.41 mm
STANDARD
120.00 kVp
250 mA
P
HFS
CE:
WW 80 : WC 1123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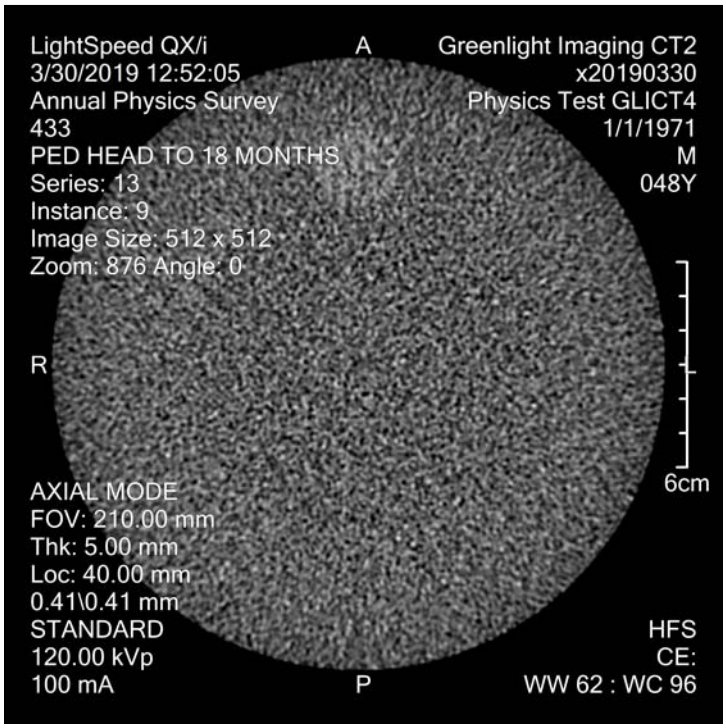
Annual Physics Survey
Physics Test GLICT4
433
1/1/1971
PED HEAD TO 18 MONTHS
M
Series: 13
048Y
Instance: 1
Image Size: 512 x 512
Zoom: 876 Angle: 0
R
6cm
AXIAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 0.00 mm
0.41\0.41 mm
STANDARD
HFS
120.00 kVp
CE:
100 mA
P
WW 400 : WC 40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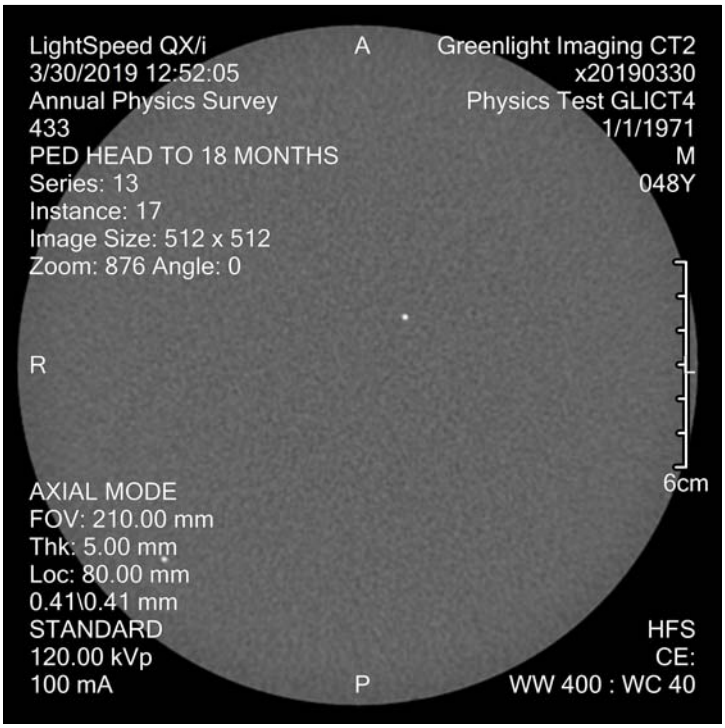
Annual Physics Survey
Physics Test GLICT4
433
1/1/1971
PED HEAD TO 18 MONTHS
M
Series: 13
048Y
Instance: 9
Image Size: 512 x 512
Zoom: 876 Angle: 0
R
6cm
AXIAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 40.00 mm
0.41\0.41 mm
STANDARD
HFS
120.00 kVp
CE:
100 mA
P
WW 62 : WC 96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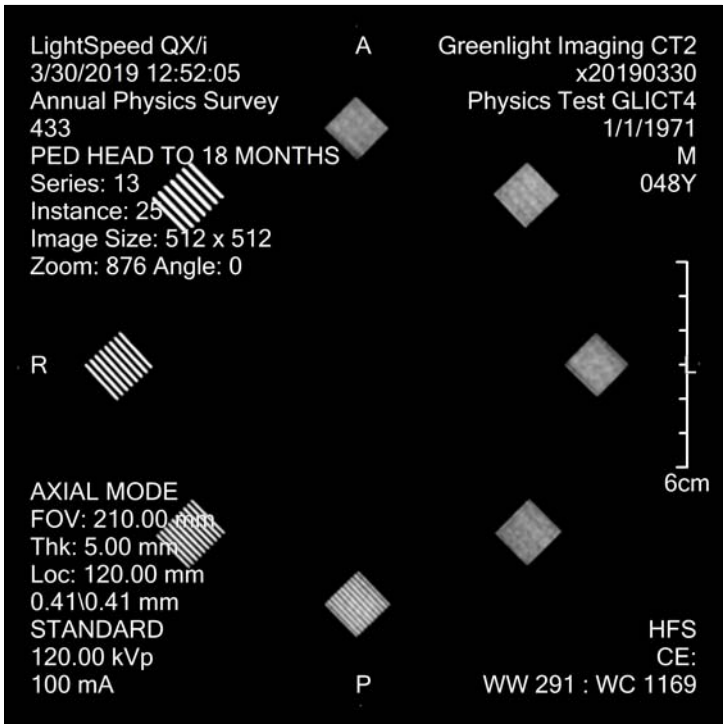
Annual Physics Survey
Physics Test GLICT4
433
1/1/1971
PED HEAD TO 18 MONTHS
M
Series: 13
048Y
Instance: 17
Image Size: 512 x 512
Zoom: 876 Angle: 0
R
6cm
AXIAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 80.00 mm
0.41\0.41 mm
STANDARD
HFS
120.00 kVp
CE:
100 mA
P
WW 400 : WC 40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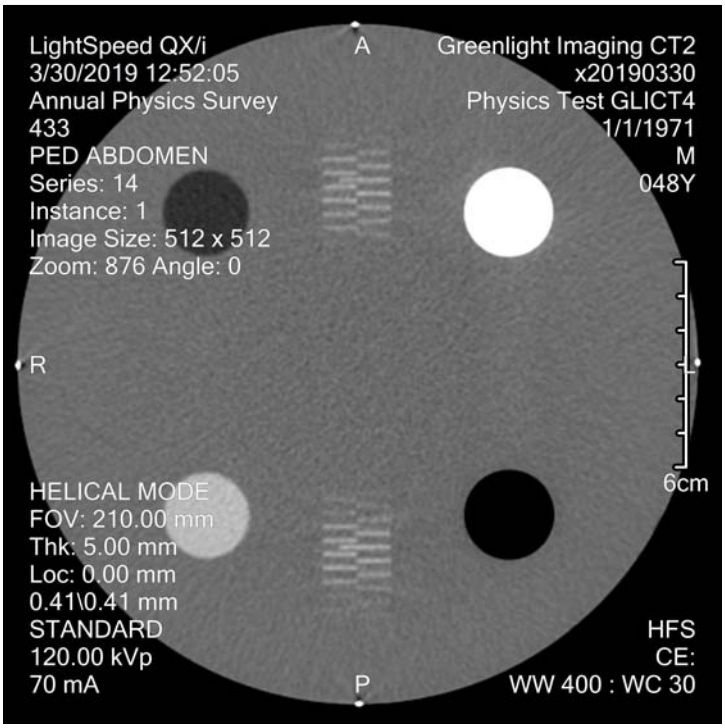
x20190330
Annual Physics Survey
Physics Test GLICT4
433
1/1/1971
PED HEAD TO 18 MONTHS
M
Series: 13
048Y
Instance: 25
Image Size: 512 x 512
Zoom: 876 Angle: 0
R
6cm
AXIAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 120.00 mm
0.41\0.41 mm
STANDARD
HFS
120.00 kVp
CE:
100 mA
P
WW 291 : WC 1169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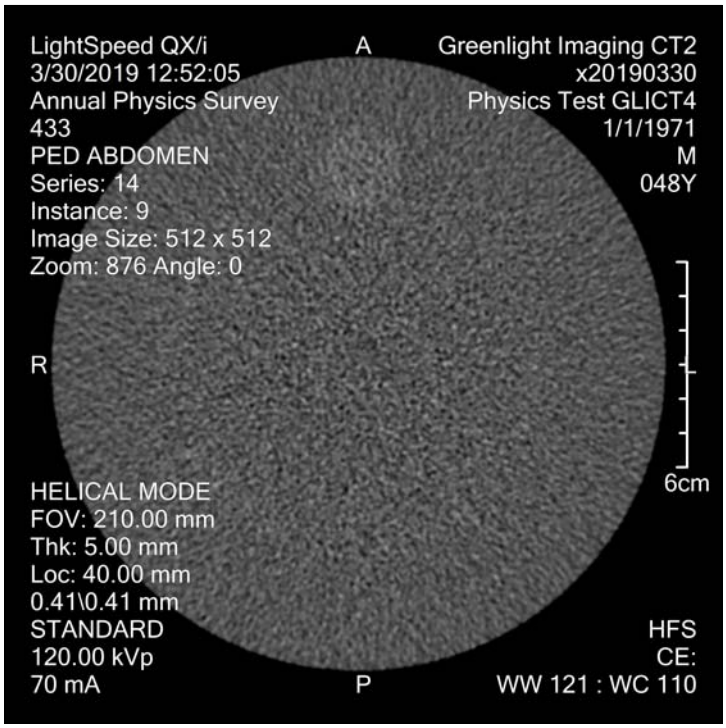
Zoom: 876 Angle: 0
A
Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 0.00 mm
0.41\0.41 mm
STANDARD
120.00 kVp
70 mA
P
HFS
CE:
WW 400 : WC 30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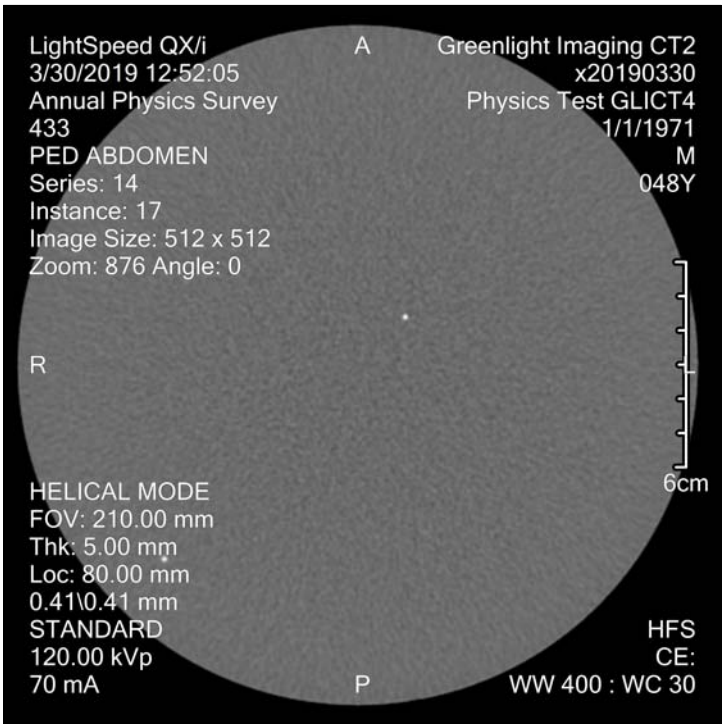
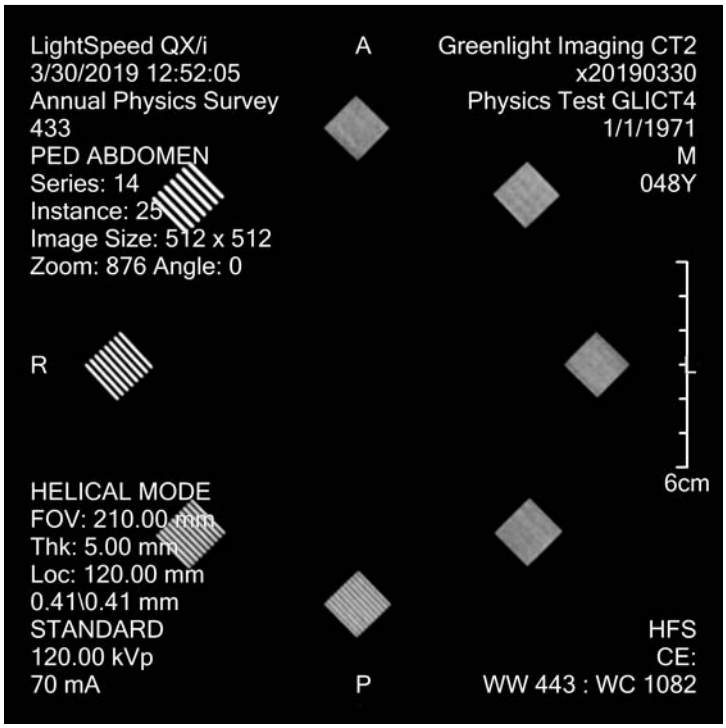
Annual Physics Survey
433
PED ABDOMEN
Series: 14
Instance: 9
Image Size: 512 x 512
Zoom: 876 Angle: 0
A
Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 40.00 mm
0.41\0.41 mm
STANDARD
120.00 kVp
70 mA
P
HFS
CE:
WW 121 : WC 110


LightSpeed QX/i
3/30/2019 12:52:05
Annual Physics Survey
433
PED ABDOMEN
Series: 14
Instance: 17
Image Size: 512 x 512
Zoom: 876 Angle: 0
A
Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 80.00 mm
0.41\0.41 mm
STANDARD
120.00 kVp
70 mA
P
HFS
CE:
WW 400 : WC 30


LightSpeed QX/i
3/30/2019 12:52:05
Annual Physics Survey
433
PED ABDOMEN
Series: 14
Instance: 25
Image Size: 512 x 512
Zoom: 876 Angle: 0
A
Greenlight Imaging CT2
x20190330
Physics Test GLICT4
1/1/1971
M
048Y
R
6cm
HELICAL MODE
FOV: 210.00 mm
Thk: 5.00 mm
Loc: 120.00 mm
0.41\0.41 mm
STANDARD
120.00 kVp
70 mA
P
HFS
CE:
WW 443 : WC 1082