

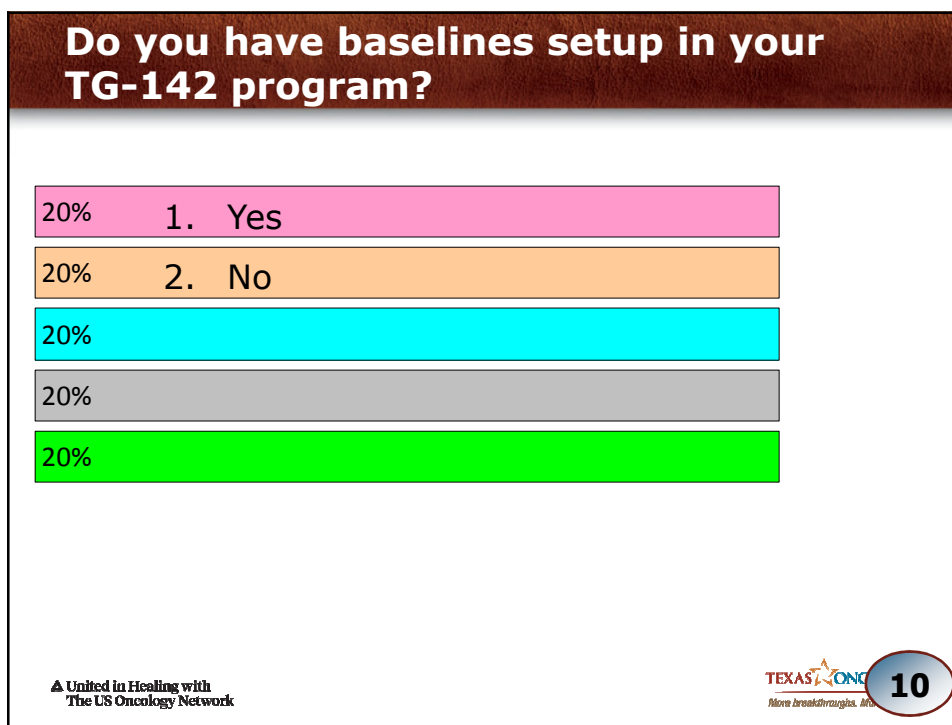
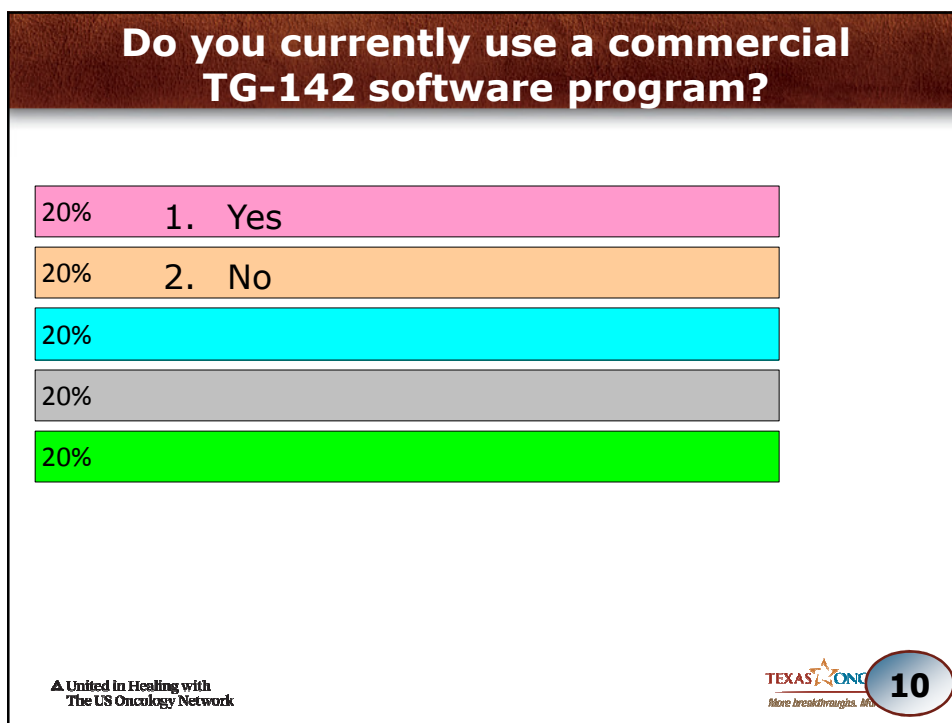
# Vendor Tools and Uses for TG-142

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Regional Director Medical Physics  
Texas Oncology  
March 8, 2015



## Disclaimer

No financial relationships to disclose with any of the companies discussed or presented in this talk



### Do you know where to find the baseline values for your TG-142 program?



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### Do you know who you could reach out to for help setting up your TG-142 program?



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## Goal of a QA program

To assure that the machine characteristics do not deviate significantly from their baseline values acquired at the time of acceptance and commissioning

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## Managing QA Results

- In-house
  - Paper
  - Electronic
- Commercial

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### Quote of the Day!

As of now, all Physics data (monthly, annuals, post-repair reports, post software upgrade reports, instrument calibration reports etc) are currently paper-based.

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### TG-142 Project

- Categories
- Business Plan
  - Pros and Cons
  - Outline of software requirements
- RFP
- Evaluation
- Implementation

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## TG-142 Project - Categories

- Major
  - Mechanical
  - Safety
  - Imaging
  - Dosimetry
- Minor
  - Respiratory Gating

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## PROS and CONS of commercial TG-142 software

- Pros
  - Setup Instructions within software
  - Implement baseline values
  - Trending
  - Frequency of Tests
    - Daily
    - Monthly
    - Annually
  - Standardization
  - Centralized location for all data
- Cons
  - Upfront cost
  - Maintenance
  - Conformity
  - Time

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## TG-142 Project – Software Requirements

- Software architecture
- Networking
- Centralization
- Connectivity
- Upgrades
- Customer support
- Functionality
- Features

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## TG-142 Project – Software Requirements

- Ease of Use
- Trending
- Reports
- Multi-functional
- Analysis tools
- Adaptable

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## TG-142 Project

- RFP
  - Software package #1
    - *Imaging*
  - Software package #2
    - *Mechanical*
    - *Dosimetry*
    - *Safety*
- Evaluation
  - Team assembled to evaluate each product
  - Evaluate each module within software package
  - Provide feed back to vendor on pros and cons of product
- Implementation

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## Vendors

VARIAN  
medical systems  
Qumulate™

SUN NUCLEAR  
corporation

ZapIT!  
MEDICAL  
Better Medicine Through Collaboration

MOBIUS  
MEDICAL SYSTEMS  
DoseLab

Ma  
MACHINE

Machine™

Rt  
ROUTINE

ATLAS™

ZapIT! QA

STANDARD IMAGING

Iba

RIT  
RITG142

PIPSpro

myQA Machines

RAVEN  
LINAC QA BY LAP

PTW

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## Evaluation of TG-142 Imaging software

- User Interface
- Functionality
- Features
- Modules
  - CBCT
  - MV Imaging
  - kV Imaging
  - Star Shot
  - Winston Lutz
  - Light Field/Radiation Field
  - MLC

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## Evaluation of TG-142 Imaging software

- Functionality
  - Load Images
  - Analysis
  - Display results
  - Generate Report
  - Trending

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## Features - Software

- Imaging Toolbar
  - Window/Level
  - Ruler
  - Angle
  - Rotation
  - ROI
- Image Type
  - TIFF
  - JPG
  - DICOM
- Film Scanner
  - Color
  - Gray Scale
- Scale
- Line Profile
- Coordinate System
- Graticule
- Approve

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## Features - Report

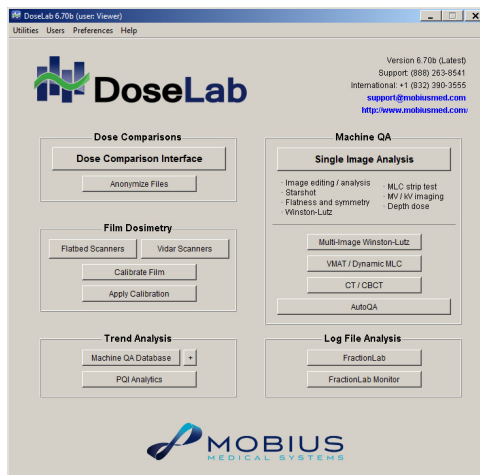
- Site
  - Logo
  - Name
- Machine
  - SN
- Image
  - Acquisition Date
  - Evaluation Date
- Baseline
- Tolerances
- Evaluator
- Approver
- Approval Date
- Customized
  - Full
  - Condensed

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
## User Interface



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## User Interface

**Dashboard**  **SUN NUCLEAR corporation**  
View Report Delete QA Task(s)  **Bret Heintz**  
1.3.0.4117

New QA Task

Machine: Novalis TX

Task Name	Date	Status	Task Execution History	
			Warnings	Failures
<input type="checkbox"/> Winston Lutz Imaging QA - Gantry & Table Angles	--	Baseline Needed	0	0
<input type="checkbox"/> Winston Lutz Imaging QA - Gantry & Collimator Angles	--	Baseline Needed	0	0
<input type="checkbox"/> VMAT MLC Leaf Speed QA	--	Baseline Needed	0	0
<input type="checkbox"/> VMAT Dose Rate and Gantry Speed QA	--	Baseline Needed	0	0
<input type="checkbox"/> VMAT DMLC Dosimetry	--	Baseline Needed	0	0
<input type="checkbox"/> VMAT Arc Dosimetry	--	Baseline Needed	0	0
<input type="checkbox"/> Star Shot Imaging QA - Table Angles	--	Baseline Needed	0	0
<input type="checkbox"/> Star Shot Imaging QA - Gantry Angles	--	Baseline Needed	0	0
<input type="checkbox"/> Star Shot Imaging QA - Collimator Angles	--	Baseline Needed	0	0
<input type="checkbox"/> Field Size Imaging QA - 10x10	--	Baseline Needed	0	0
<input type="checkbox"/> MLC Picket Fence Imaging QA - Angle 4	--	Baseline Needed	0	0
<input type="checkbox"/> MLC Picket Fence Imaging QA - Angle 3	--	Baseline Needed	0	0
<input type="checkbox"/> MLC Picket Fence Imaging QA - Angle 2	--	Baseline Needed	0	0
<input type="checkbox"/> MLC Picket Fence Imaging QA - Angle 1	--	Baseline Needed	0	0
<input type="checkbox"/> MLC Log Processing QA	--	Baseline Needed	0	0
<input type="checkbox"/> kV Imaging QA	--	Baseline Needed	0	0
<input type="checkbox"/> Field Size Imaging QA - 15x15	--	Baseline Needed	0	0
<input type="checkbox"/> CBCT Imaging QA	--	Baseline Needed	0	0
<input type="checkbox"/> MV Imaging QA	--	Baseline Needed	0	0

New QA Task

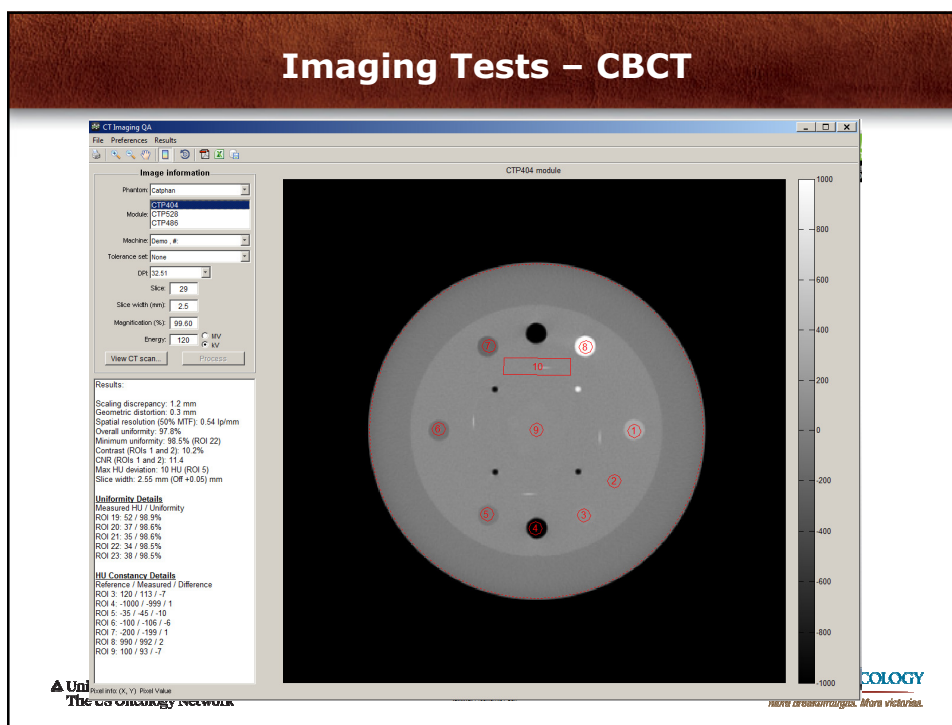
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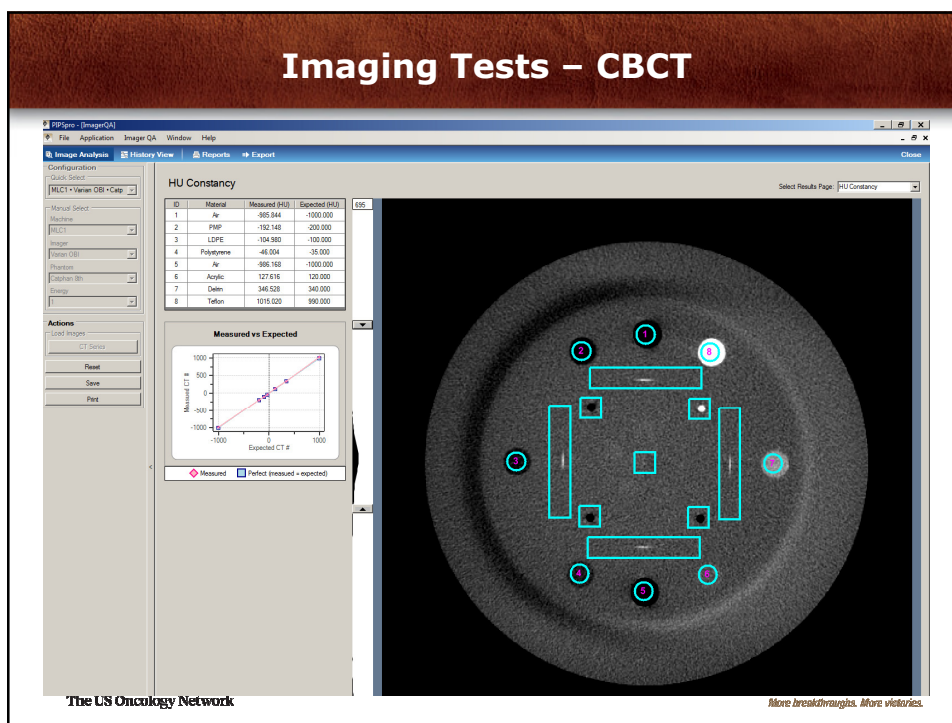
## User Interface



## Imaging Tests – CBCT



## Imaging Tests – CBCT



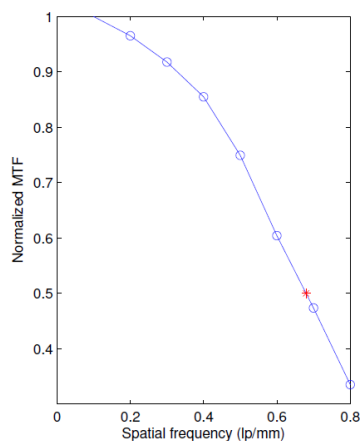
## Imaging Tests – CBCT Report

### DoseLab CT Imaging QA Results

Summary: All tests passed

DoseLab version: 6.70b  
 Date: March 05, 2015  
 Machine: Demo, #:  
 Phantom: Catphan  
 Magnification: 100.00%  
 Energy: 120 kV  
 Expected slice width: 2.5 mm  
 Matrix size: 512x512  
 Performed by: eric  
 Tolerance set: MLC1

Scaling discrepancy: 0.0 mm (Pass)  
 Geometric distortion: 0.2 mm (Pass)  
 Spatial resolution (50% MTF): 0.68 lp/mm (Pass)  
 Overall uniformity: 94.0% (Pass)  
 Minimum uniformity (ROI 21): 95.2% (Pass)  
 Contrast (ROIs 1 and 2): 10.4% (Pass)  
 CNR (ROIs 1 and 2): 3.1 (Pass)  
 Max HU deviation (ROI 9): 25 HU (Pass)  
 Slice width: 3.40 mm (Pass)



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## Imaging Tests – CBCT Report

### CTP404 module results

#### Contrast ROI details

Measured HU

1: 353

2: 98

#### HU constancy ROI details

Reference / Measured / Difference

3 (Acrylic): 120 / 123 / 3

4 (Air): -1000 / -988 / 12

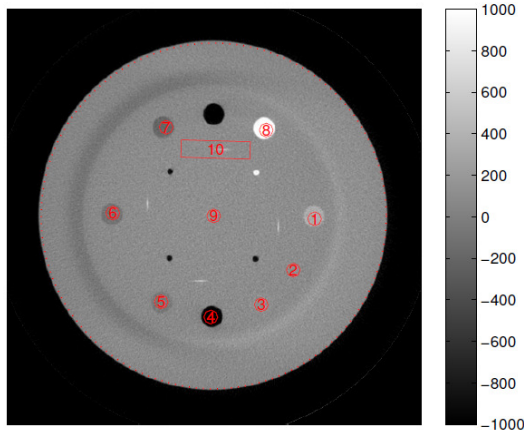
5 (Polystyrene): -35 / -46 / -11

6 (LDPE): -100 / -104 / -4

7 (PMP): -200 / -194 / 6

8 (Teflon): 990 / 1012 / 22

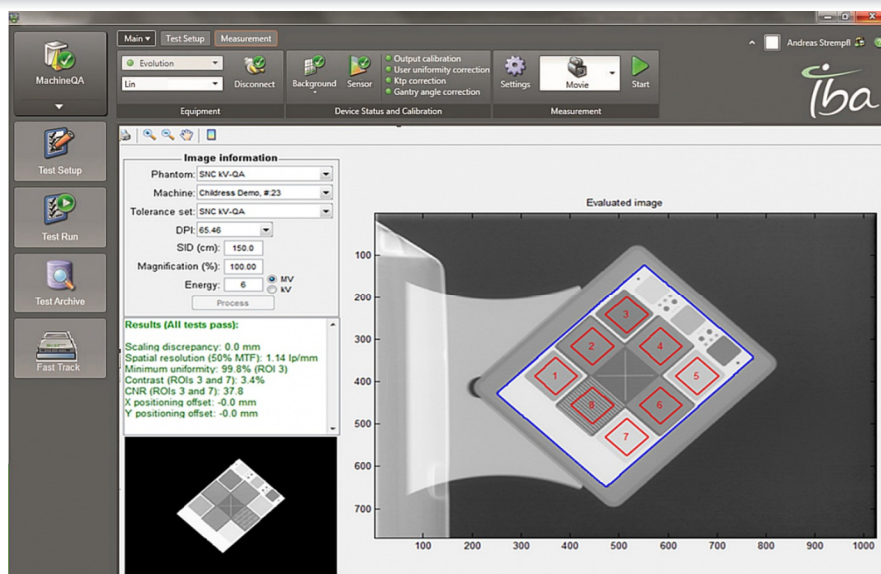
9 (CTP404): 100 / 125 / 25



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## Imaging Tests – MV/kV tests



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## Imaging Tests – Star shot

**Image Registration: Star Shot Imaging QA - Collimator Angles**  ▲ Bret Henitz 1.3.0.4117

**Star Shot Imaging QA - Collimator Angles Registration**

**Magnification**

**Pan**  **Threshold**

**Star Shot**

**Shift Template**


**Resize**

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## Imaging Tests – Star shot

**Task Results: Passed Pending** | [Trend](#) | [Image Registration](#) | [Baseline Setup](#)

Parameter	Measurement	Results			Tolerance Settings		
		Baseline	Difference	Status	Opera...	Warning	Failure
Optimal circle diameter (SID) (mm)	 0.12	0.15	0.03	✓ Passed	+ / -	0.20	0.20

**Images**

**Starshot With Spokes**

**Starshot Optimal Circle**

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**QTY**  
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## Imaging Tests – Star shot report

Machine: MLC1

Execute Date: 2/25/2015

Task Name: Star Shot Imaging QA - Collimator Angles

Status: Passed Pending

Requestor: Heintz, Bret

Approved by: N/A

Details

Computed spoke angles: 81.63°, 117.32°, 146.54°, 0.84°, 54.88°

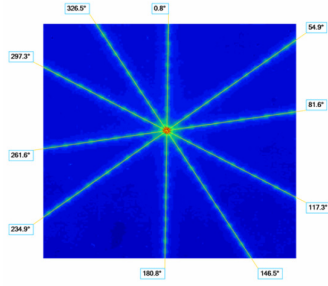
Task Results

Parameter	Results			Status	Tolerance	
	Measurement	Baseline	Difference		Warning	Failure
Optimal circle diameter (SID) (mm)	0.12	0.15	0.03	Passed	+/- 0.20	+/- 0.20

Comment

Images

Starshot With Spokes



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## Imaging Tests – Winston Lutz

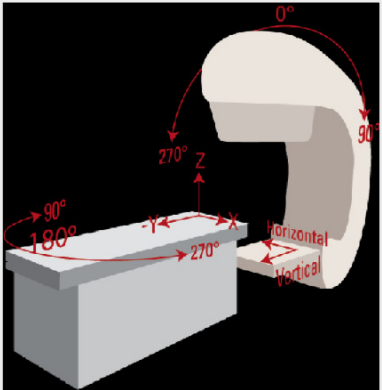
Select Coordinate System

Select Coordinate System

Varian IEC 1217

1. Choose a Coordinate System from the menu.  
2. Verify correct labels on the image below.  
3. Click Apply.

Preview



Apply

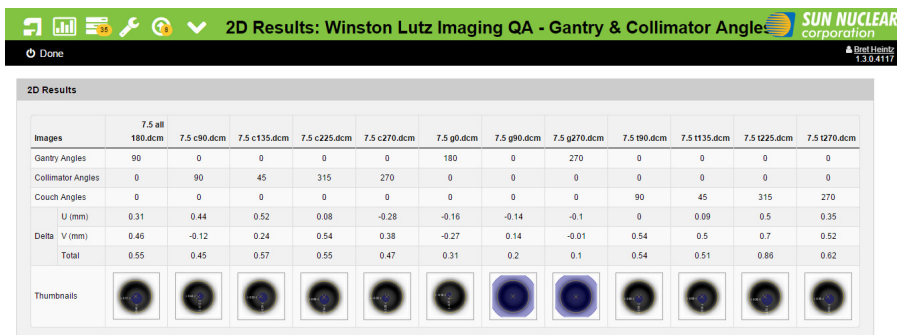
Close

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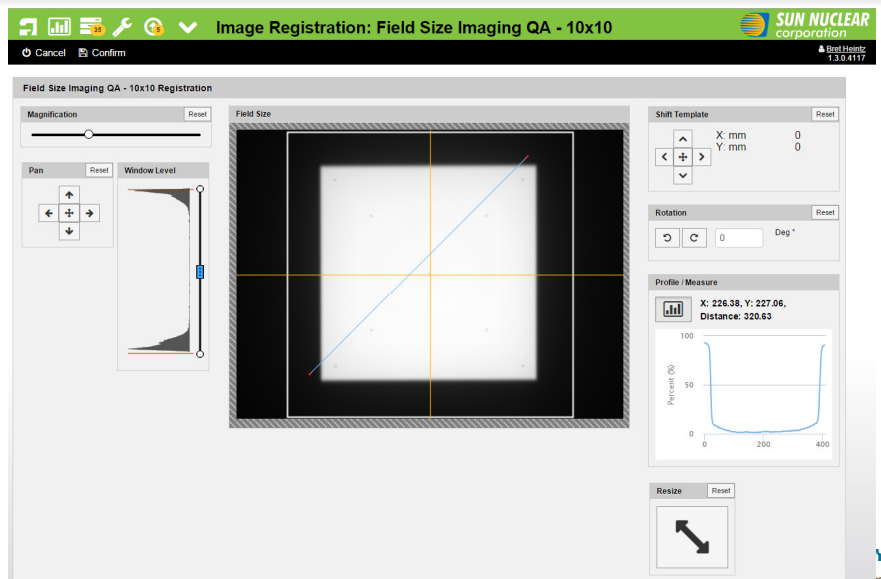
## Imaging Tests – Winston Lutz



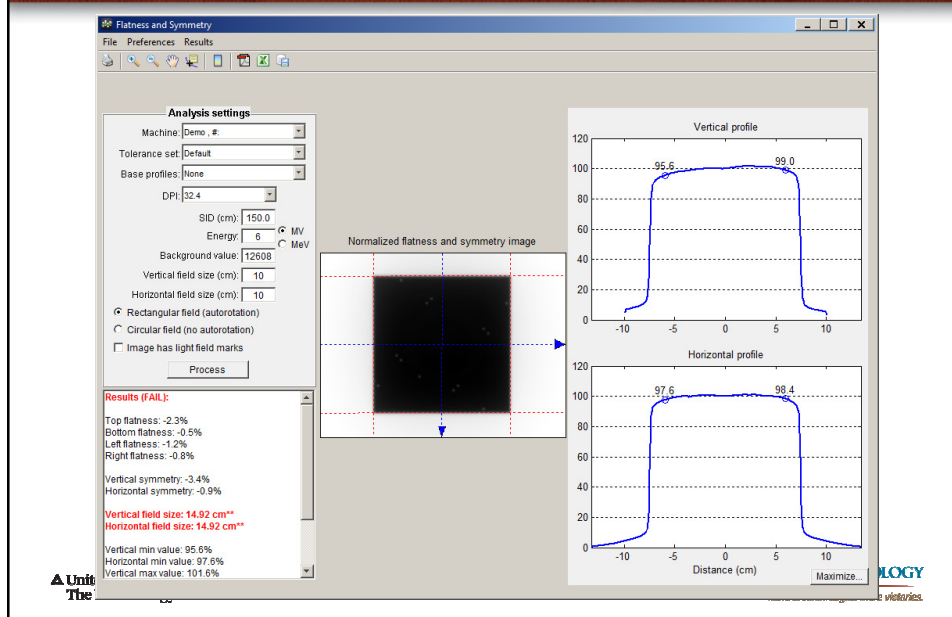
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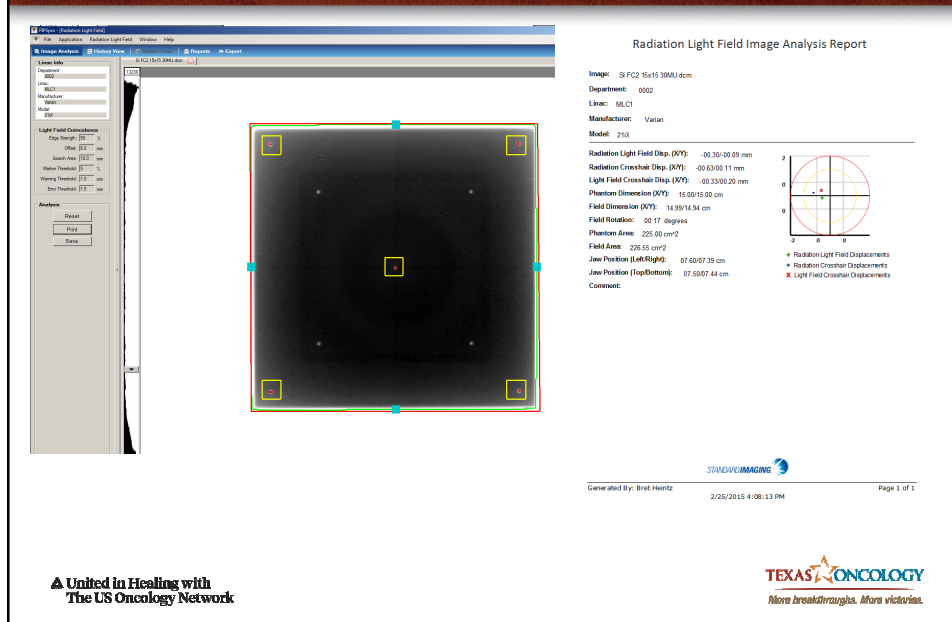
## Imaging Tests – Light Field / Radiation Field



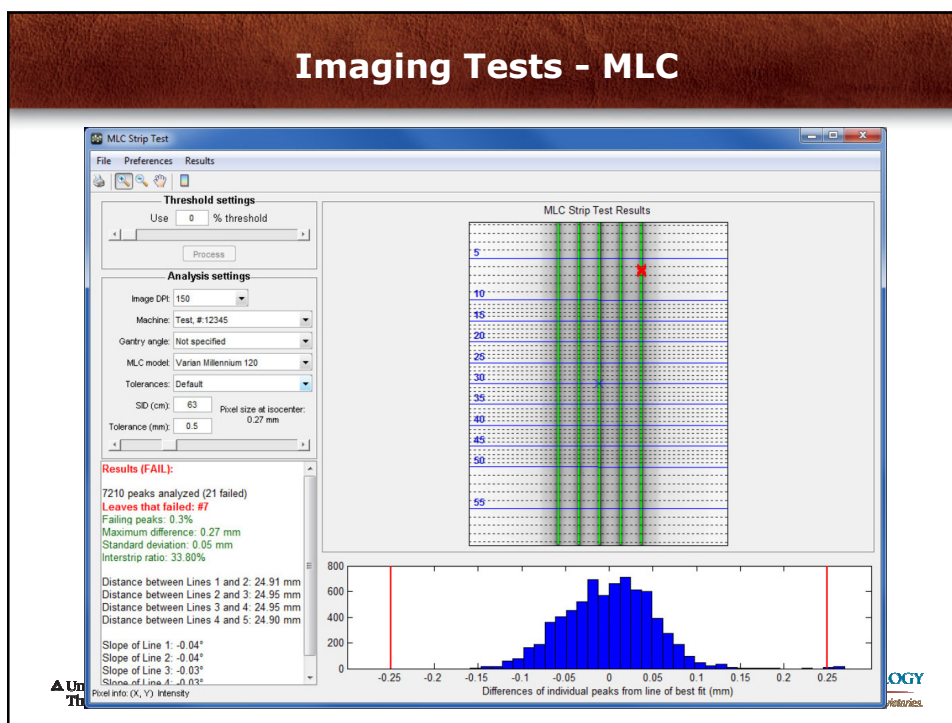
## Imaging Tests – Light Field Radiation Field



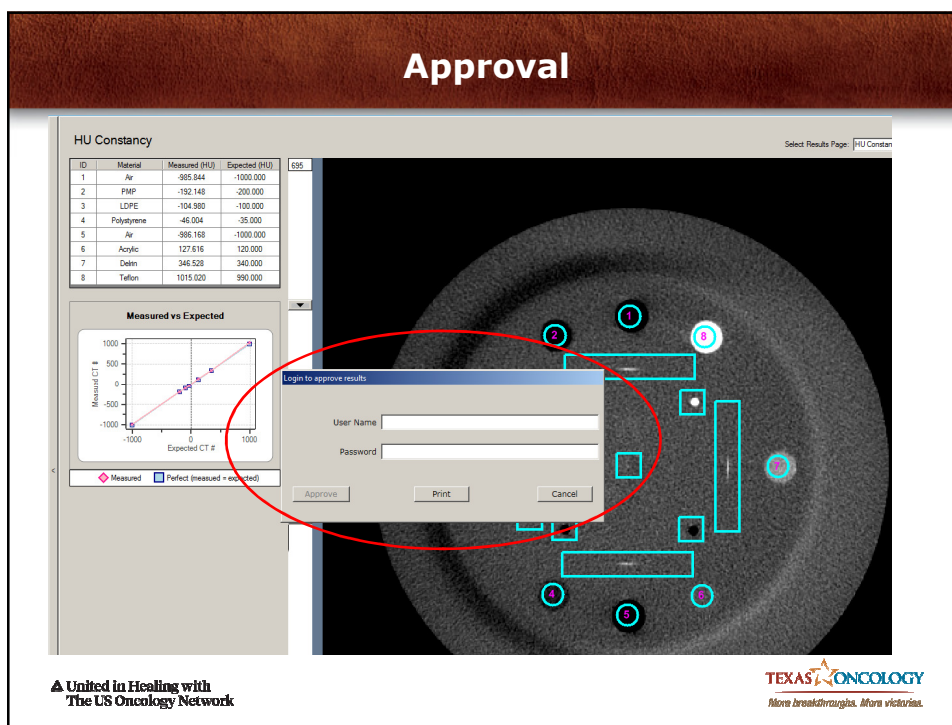
## Imaging Tests – Light Field / Radiation Field



## Imaging Tests - MLC



## Approval



## Implementation

- Software Package #2
  - Categories
    - Mechanical
    - Safety
    - Dosimetry
  - Frequency
    - Daily
    - Monthly
    - Annually
  - Customization/Development
    - Machine types
      - HDR
      - CT
    - Error Log
    - Documents
    - X-ray and RAM

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## Daily QA

ATLAS QA

Location: Texas Oncology - 8th Ave Machine: MLC2 SN0.679 Device: 2/24/2015

Basic Advanced

☐ Show all Daily Tests

Results	Name	Category	Type	Device	Instructions	Comments	Maintenance	Ordering
<input checked="" type="checkbox"/>	Daily LINAC Safety Tests	Safety	Room Test	na				1
<input checked="" type="checkbox"/>	Daily LINAC Mechanical Tests	Mechanical	Room Test	na				2
<input checked="" type="checkbox"/>	Lasers within $\pm 2$ mm	Mechanical	Room Test	na				3
<input checked="" type="checkbox"/>	9 MeV Daily	Dosimetry	Beam Test	DQA3				4
<input checked="" type="checkbox"/>	12 MeV Daily	Dosimetry	Beam Test	DQA3				5
<input checked="" type="checkbox"/>	16 MeV Daily	Dosimetry	Beam Test	DQA3				6
<input checked="" type="checkbox"/>	20 MeV Daily	Dosimetry	Beam Test	DQA3				7
<input checked="" type="checkbox"/>	6 MeV Daily	Dosimetry	Beam Test	DQA3				8
<input checked="" type="checkbox"/>	18 MV Daily	Dosimetry	Beam Test	DQA3				9

Test Results

Results	Name	Units	Measured	Pass/Fail	# of Results	Equipment
<input checked="" type="checkbox"/>	Radiation On Door Light			PASS	1	
<input checked="" type="checkbox"/>	Radiation Monitor			PASS	1	
<input checked="" type="checkbox"/>	Door Interlock			PASS	1	
<input checked="" type="checkbox"/>	Video Monitors			PASS	1	
<input checked="" type="checkbox"/>	Audio			PASS	1	
<input checked="" type="checkbox"/>	Beam Off Button			PASS	1	
<input checked="" type="checkbox"/>	Back Up Counter			PASS	1	

Cancel Save

User: Bret Heintz Atlas is in Production Mode Connected Database: ATLASFTWorth Current Version: 1.4.0.27716

## Daily QA - Safety

### Test Results

#### Results

Results	Name	Units	Measured	Pass/Fail	# of Results	Equipment
	Radiation On Door Light			PASS	1	
	Radiation Monitor			PASS	1	
	Door Interlock			PASS	1	
	Video Monitors			PASS	1	
	Audio			PASS	1	
	Beam Off Button			PASS	1	
	Back Up Counter			PASS	1	

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## Daily QA - Mechanicals

### Test Results

#### Results

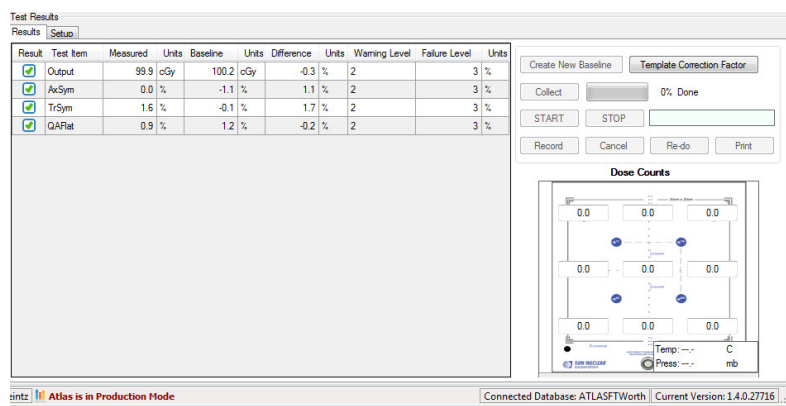
Results	Name	Units	Measured	Pass/Fail	# of Results	Equipment
	Room Temperature	°C	19.5		1	Room Ther...
	Room Pressure	mb	1004		1	Room Baro...
	Filament Timer	hrs	43747.5		1	
	Beam On Timer	hrs	3240		1	
	H2O Pressure	psi	80		1	
	H2O Temperature	°C	40		1	
	Gas (SF6) Pressure	psi	32		1	
	H2O Level			PASS	1	
	ODI Light			PASS	1	
	Front Pointer			PASS	1	
	ODI within ± 2 mm			PASS	1	
	Field Light at 100 cm SSD			PASS	1	

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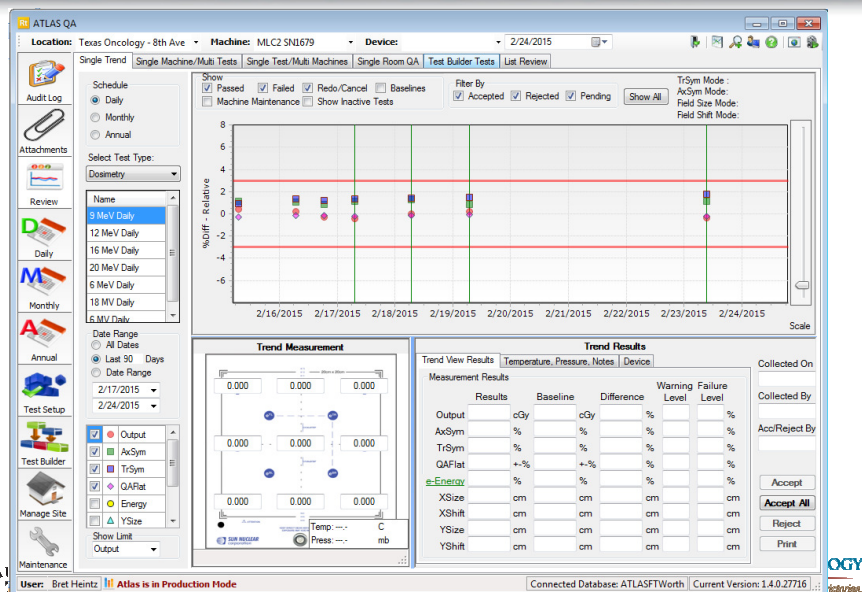
## Daily QA - Dosimetry



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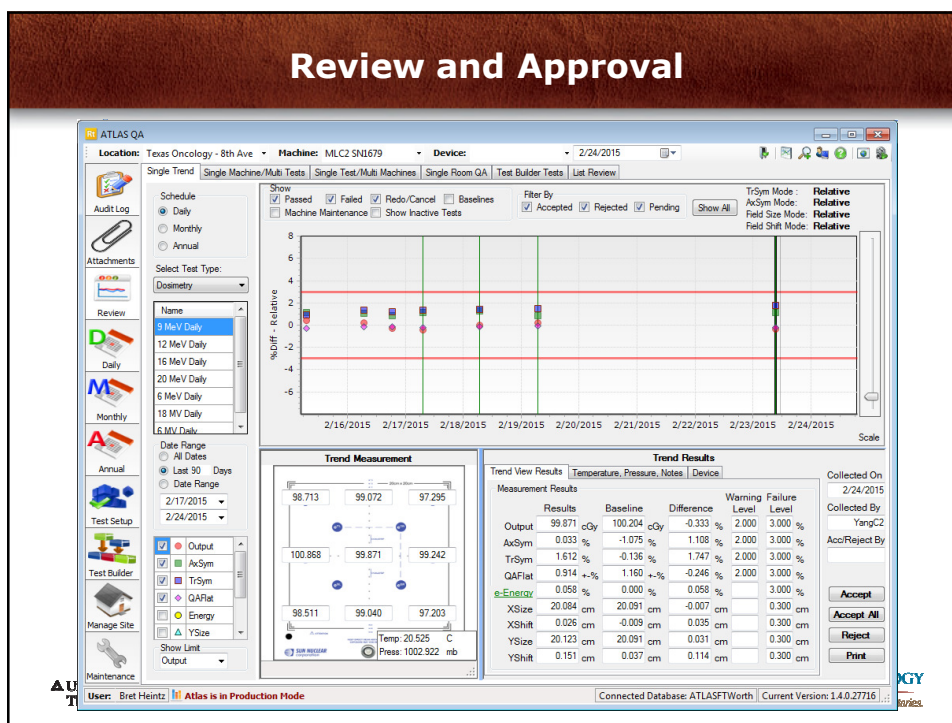
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## Tolerances and Trending





## Review and Approval



## Review and Approval

Trend Results

Trend View Results

Temperature, Pressure, Notes

Device

Measurement Results

	Results	Baseline	Difference	Warning Level	Failure Level	
Output	100.142 cGy	100.204 cGy	-0.062 %	2.000	3.000 %	
AxSym	-0.387 %	-1.075 %	0.688 %	2.000	3.000 %	
TrSym	1.485 %	-0.136 %	1.620 %	2.000	3.000 %	
QAFlat	1.069 +-%	1.160 +-%	-0.091 %	2.000	3.000 %	
e-Energy	0.108 %	0.000 %	0.108 %		3.000 %	
XSize	20.103 cm	20.091 cm	0.012 cm		0.300 cm	
XShift	0.182 cm	-0.009 cm	0.191 cm		0.300 cm	
YSize	20.097 cm	20.091 cm	0.005 cm		0.300 cm	
YShift	0.156 cm	0.037 cm	0.120 cm		0.300 cm	

Collected On

3/6/2015

Collected By

bellm

Acc/Reject By

bheintz

Accept

Accept All

Reject

Print

## Monthly Mechanical

Sheet View Attachments

Save Cancel Review Measurement Results Partial Save Calculate Results Print Measurement Details Load Clear

Institution: Texas Oncology - 8th Ave Date: 2/17/2015 12:00:00 AM  
Machine Name: MLC2 SN1679 Test Performer: neffr  
Machine Serial Number: 1679 Texas License #: TMP10529

**1. ODI**

Equipment	Name	Model	Serial Number
	LYNAC Front Pointer Set	N/A	N/A

Setup Instructions (Details)  
1. Set the SSD value to phantom surface using Front Pointer  
2. Record value of the ODI to the phantom surface

Tolerance:  $\pm 1$  mm at 100 cm,  $\pm 2$  mm for all other distances

	80	90.00	100	110
ODI Set (cm)	80	90.00	100	110
Measured (cm)	79.90	90.00	100.00	110.00
Result (cm)				

Comments

**2. Treatment Couch Position Indicators**

Equipment	Name	Model	Serial Number
	Graph Paper	In-Room Equipment	N/A

Setup Instructions (Details)  
1. Align graph paper to cross hair. Use front pointer to set the 100 cm SSD to top of graph paper  
2. Enter reference (digital) readout value in first column (LNG, LAT & VRT). Move couch to the set distance  
3. Record couch digital readout by the light field alignment to the graph paper  
4. Alternate couch LNG measurement position each month. Even months = Pelvis region, Odd months = Head region  
5. Rotate couch to set value. Record couch digital readout  
6. Rotate couch to set value. Record couch digital readout

Tolerance  
Couch LNG, LAT & VRT:  $\pm 2.0$  mm digital display  
Couch rotation:  $\pm 1.0^\circ$  for digital display

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## Monthly output

Sheet View Attachments

Save Cancel Review Measurement Results Partial Save Calculate Results Print Measurement Details

Institution: Texas Oncology - Arlington South Date:   
Machine Name: 21XAS SN5799 Physicist: bheintz  
Machine Serial #: 5799 Texas License #: LMP 0600

**TG-51: Monthly Output**

EQUIPMENT SETTINGS		CALIBRATION DATE		T & P SETTINGS	
Ion Chamber	PTW N30013 7092	Ion Chamber	14-Aug-2013	H2O T(°C)	24.30
Electrometer	PC Elec. 70338007	Electrometer	4-Nov-2013	P (inchHg)	29.62
Phantom	Water			CTP	1.018

SETUP PARAMETERS		PARAMETERS	
SSD (cm)	100	Pelect	1.004E-09
MU	100	Nd,w (Gy/C)	54130000.0
Bias Voltage	300	kcal	0.897
Dose Rate	400		

MEASUREMENTS							
Energy	6 MV	18 MV	6 MeV	9 MeV	12 MeV	16 MeV	20 MeV
Meas. Depth	10	10	1.45	2.20	3.05	4.06	5.05
Mrow1							
Mrow2							
Mrow3							
Mavg (raw)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Dose (cGy/MU)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
CO	200 200	200 200	200 200	200 200	200 200	200 200	200 200

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## Error Log Documentation

**Machine Maintenance**

Institution: Texas Oncology - Arlington S Machine: 21EX6A SN2221 Show Machine Downtime

Maintenance Records

Page Size: 15 Page 1/1

Issue	Start	End	Operational	Test
Test	3/7/2013 11:22 AM	3/7/2013 11:23 AM	Full	

Attachments

Name	Description

Clear Add Delete

Notes History

3/7/2013 11:23 AM By Manish Goyal  
tested OK

3/7/2013 11:22 AM By Manish Goyal  
test only

First Page Previous Page Next Page Last Page

Update Record Add Record Send Message

Heintz Atlas is in Production Mode Connected Database: ATLASFTWorth Current Version: 1.4.0.27716

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## HDR-QA

Texas Oncology - 8th Ave Machine: HDR 8th-VS329 Device: 2/24/2015

Basic Advanced

Show all Daily Tests

Tests

Results	Name	Category	Type	Device	Instructions	Comments	Maintenance	Ordering	Date
<input checked="" type="checkbox"/>	HDR Treatment Day QC Checks	Safety	Room Test	na				0	

Test Results

Results

Results	Name	Expected	Units	Tolerance 1	Measured	Pass/Fail	# of Results	Equipment
<input type="checkbox"/>	Console Key Test					0		
<input type="checkbox"/>	Afterloader Key Test					0		
<input type="checkbox"/>	Door Interlock Test					0		
<input type="checkbox"/>	Catheter Misconnect Test					0		
<input type="checkbox"/>	Obstruction Detection Test					0		
<input type="checkbox"/>	Divell Timer Test					0		
<input type="checkbox"/>	Radiation Area Monitor Test					0		
<input type="checkbox"/>	Console Emergency Stop T...					0		
<input type="checkbox"/>	Remote Emergency Stop Test					0		
<input type="checkbox"/>	Open/Close Door Test					0		
<input type="checkbox"/>	Display Test					0		
<input type="checkbox"/>	Primary Video Test					0		
<input type="checkbox"/>	Backup Video Test					0		
<input type="checkbox"/>	Intercom Test					0		
<input type="checkbox"/>	Aplicator Inspection					0		
<input type="checkbox"/>	Completion of Emergency Kit					0		
<input type="checkbox"/>	Afterloader Indicators/Statu...					0		
<input type="checkbox"/>	Source Decayed Activity Wl...					0		

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## CT QA

Texas Oncology - 8th Ave • Machine: PET CT 8th-Discover • Device: 2/24/2015

Basic **Advanced**

☐ Show all Daily Tests

Results	Name	Category	Type	Device	Instructions	Comments	Maintenance	Ordering	Date
<input checked="" type="checkbox"/>	Lasers within $\pm 2$ mm	Imaging	RoomTest	na				1	
<input checked="" type="checkbox"/>	Axial - Water CT Number & Std. Deviat...	Imaging	RoomTest	na				4	
<input checked="" type="checkbox"/>	Axial - Artifact Evaluation	Imaging	RoomTest	na				5	

Test Results

Results	Name	Expected	Units	Tolerance 1	Measured	Pass/Fail	# of Results	Equipment
<input checked="" type="checkbox"/>	Water Mean HU	0	HU	7	.75		1	Water/AC...
<input checked="" type="checkbox"/>	Water Standard Deviation	3.2	HU	1	2.78		1	Water/AC...

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## Recommendations - Vendors

- Simplify
- Images
- Generic imaging toolbar for all modalities
  - Window\Level
  - Ruler
  - Angle
  - ROI
  - Rotation
- Line Profile
- Uniform Graphical Interface (GUI)
- Approval
- Reports

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## Recommendations - Customers

- Develop
    - How will the site use the software
    - Must have features
    - Implementation plan
  - Baseline data
    - Acquire or restore
  - Tolerances
    - Develop and implement
  - Validate the algorithms before implementing module clinically
  - Support
    - Reach out to vendors
- Reach out to fellow AAPM members

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## Summary

- RFP has been a very challenging and time consuming project for several physicists
- TG-142 software programs
  - Daily, Monthly, Annually
  - Dosimetry, Mechanical, Safety, and Imaging
  - PROS and CONS
  - Functionality
  - Features
- Product Enhancements

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## Recognition

- Texas Oncology
  - Eric Stauffer, MS
  - Marc Kleiman, MS
  - Ed Scarbrough, MS
  - Manish Goyal, MS
  - Colin Delaney, MS
  - Kyle Antes, MS
  - Several other team members
- Vendors

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## What are the four main categories tested in TG-142?

- 20% 1. Dosimetry, Mechanical, Safety, MLC
- 20% 2. Dosimetry, Mechanical, Safety, Training
- 20% 3. Mechanical, Safety, Training, CBCT
- 20% 4. Safety, Imaging, Training, Driving
- 20% 5. Dosimetry, Mechanical, Safety, Imaging

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## Answer

### Dosimetry, Mechanical, Safety, Imaging

- Quality Assurance of medical accelerators: Task Group Report – 142, Medical Physics 36 (9), September 2009

## What are some PROS of a TG-142 software program?

20% 1. Trending, Standardization

20% 2. Dosimetry

20% 3. Mechanical

20% 4. Training

20% 5. Gating

## Answer

### Trending and Standardization

- Quality Assurance or medical accelerators: Task Group Report – 142, Medical Physics 36 (9), September 2009

The software program should be tested for \_\_\_\_\_ and \_\_\_\_\_ prior to clinical use?

- |     |                             |
|-----|-----------------------------|
| 20% | 1. Accuracy                 |
| 20% | 2. Consistency              |
| 20% | 3. Accuracy and Consistency |
| 20% | 4. Safety and Accuracy      |
| 20% | 5. Dosimetry and Mechanical |

### Answer 3

#### Accuracy and Consistency

- *Quality Assurance or medical accelerators: Task Group Report – 142, Medical Physics 36 (9), September 2009*

### The baseline data should come from which of the following?

20% 1. Customer Acceptance Testing

20% 2. Similar machine

20% 3. After annual evaluation

20% 4. TG-142 software vendor

20% 5. Friend

## Answer 4

Customer Acceptance Testing

- AAPM code of practice for radiotherapy accelerators: Report of AAPM Radiation Therapy Task Group No. 45

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## The Pass/Fail criteria should be based on:

- 20% 1. TG-142 software vendor
- 20% 2. TG-43
- 20% 3. Baseline data collected from specific machine over given period of time
- 20% 4. Similar machine
- 20% 5. Survey monkey results

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## Answer 5

Baseline data collected from specific machine over given period of time

- *Quality Assurance of medical accelerators: Task Group Report – 142, Medical Physics 36 (9), September 2009*