QUALITY ASSURANCE FOR RT EQUIPMENT

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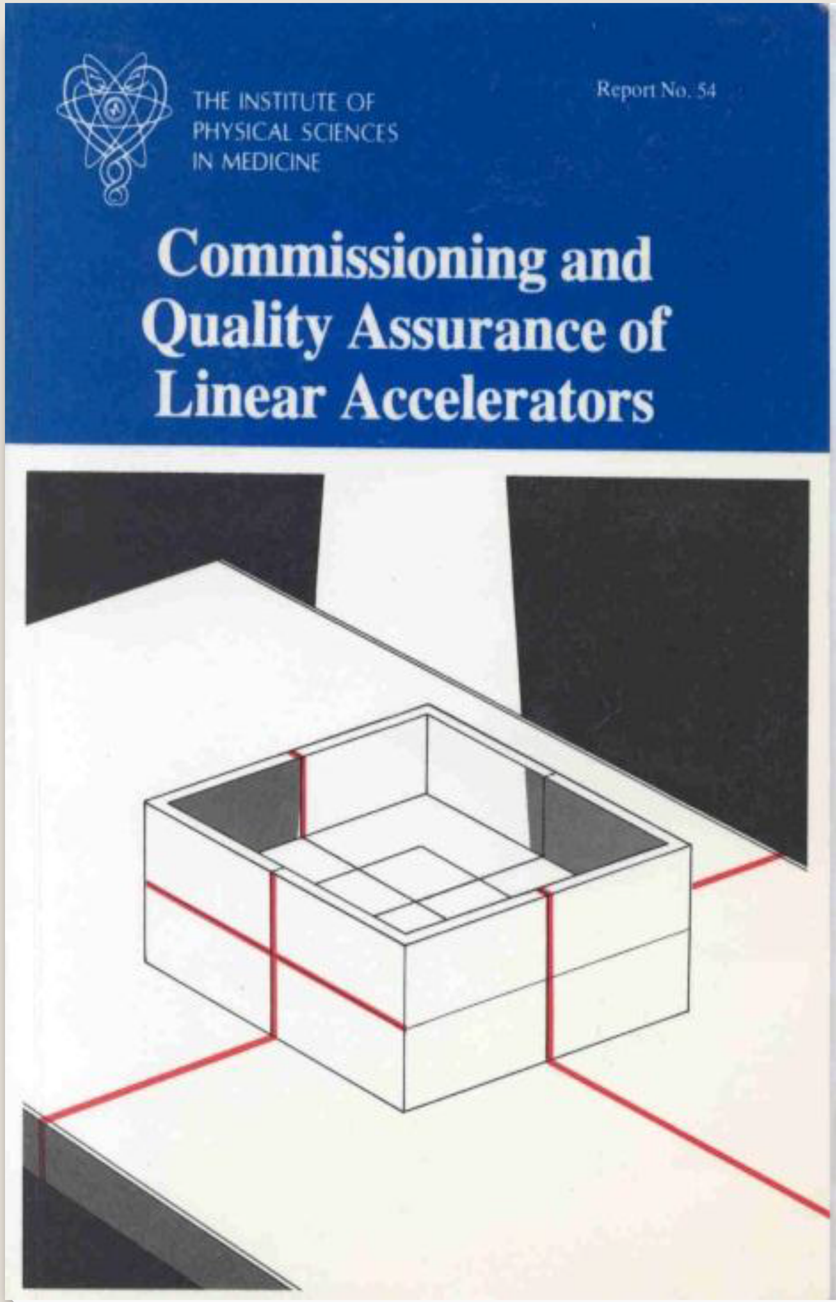
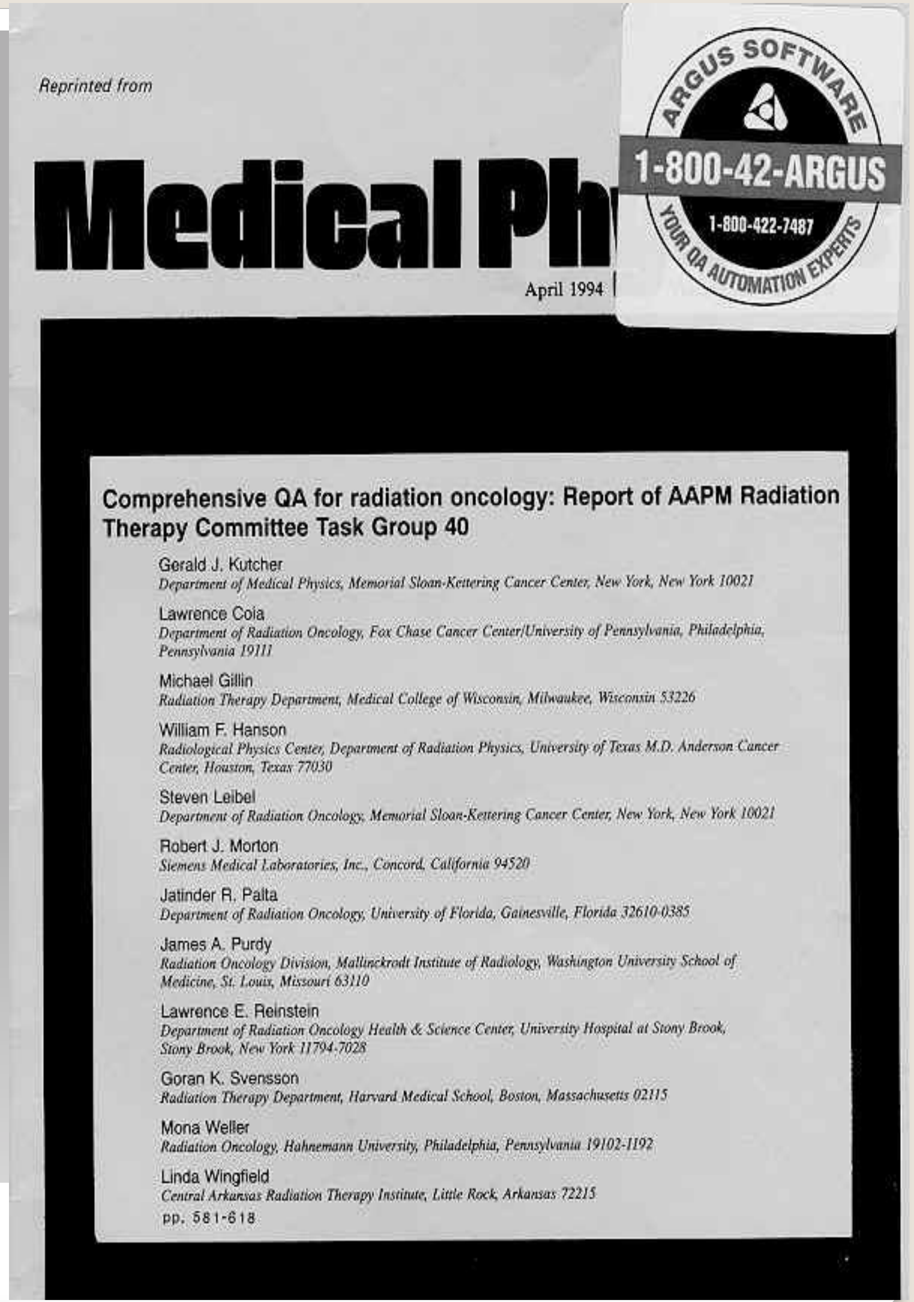
Objective:

To familiarize the student with the need and the concept of a quality assurance program in radiotherapy as well as with recommended quality procedures and tests.

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Medical Ph

April 1994

Comprehensive QA for radiation oncology: Report of AAPM Radiation Therapy Committee Task Group 40

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pp. 581-618

Task Group 142 report: Quality assurance of medical accelerators[a)]

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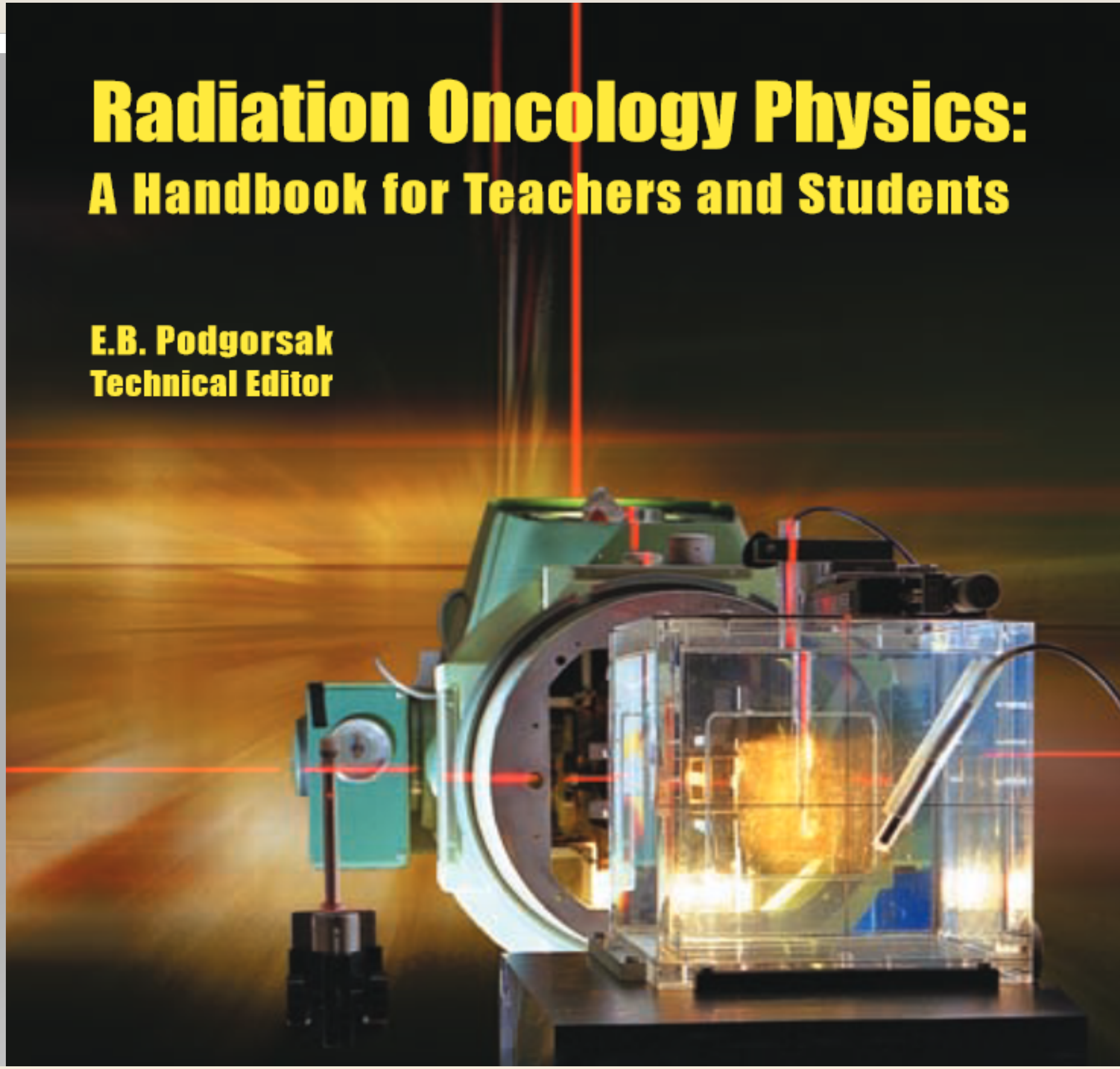

Chapter 12: Quality Assurance of External Beam Radiotherapy

Chapter 12: Quality Assurance of External Beam Radiotherapy

12.3 QUALITY ASSURANCE PROGRAMME FOR RADIATION TREATMENT EQUIPMENT

The Structure of an Equipment QA Program

(1) Initial specification, acceptance testing and commissioning

(2) Quality control tests

(3) Additional quality control tests

(4) Planned preventive maintenance program

The Structure of an Equipment QA Program

(1) Initial specification, acceptance testing and commissioning

- ✓ Specification to meet clinical needs
- ✓ Site visit
- ✓ Acceptance Testing to meet specs
- ✓ Commissioning for clinical use

- In preparation for procurement of equipment, a detailed specification document must be prepared.
- A multidisciplinary team from the department should be involved.
- This should set out the essential aspects of the equipment operation, facilities, performance, service, etc., as required by the department.

Equipment Specification

- Which patients will be affected by this technology?
- What is the likely number of patients per year?
- Number of procedures or fractions per year?
- Will the new procedure provide cost savings over old techniques?
- Would it be better to refer patients to a specialist institution?
- Is the infrastructure available to handle the technology?
- Will the technology enhance the academic program?
- What is the organizational risk in implementation of this technology?
- What is the cost impact?
- What maintenance is required?

Questions Related to Clinical Needs

- Once this information is compiled, the purchaser is in a good position to clearly develop his own specifications.
- Specification can also be based on:
  - Manufacturer's specification (brochures)
  - Published information
  - Discussions with other users
- Specification data must be expressed in measurable units.
- Decisions on procurement should again be made by a multidisciplinary team.

Equipment Specification and Clinical Needs Assessment

- Acceptance of equipment is the process in which the supplier demonstrates the baseline performance of the equipment to the satisfaction of the customer.
- After the new equipment is installed, the equipment must be tested in order to ensure, that it meets the specifications and that the environment is free of radiation and electrical hazards to staff and patients.
- Essential performance required and expected from the machine should be agreed upon **before** acceptance of the equipment begins.

Acceptance Testing

- It is a matter of the professional judgment of the responsible medical physicist to decide whether any aspect of the agreed acceptance criteria is to be waived.
- This waiver should be recorded along with an agreement from the supplier, for example, to correct the equipment should performance deteriorate further.
- Equipment can only be formally accepted to be transferred from the supplier to the customer when the responsible medical physicist either is satisfied that the performance of the machine fulfills all specifications as listed in the contract document or formally accepts any waivers.

Acceptance Testing

Commissioning

- **Commissioning** is the process of preparing the equipment for clinical service.
- Expressed in a more quantitative way: A full **characterization of its performance** over the whole range of possible operation must be undertaken.
- In this way the **baseline standards of performance** are established to which all future performance and quality control tests will be referred.
- Commissioning includes preparation of procedures, protocols, instructions, data book, etc., on the clinical use of the equipment.

Rev. 2 MCTG 10/7/2005

Decay Table for Cobalt A

(Theratron 780-C SN: 35)

Dose rate to a mini phantom of muscle in air at 80.5 cm, for a 10 cm x 10 cm field at 80 cm
Source is MDS Nordion SN:S-5605, 5556 Ci (205.6 TBq) on 9/7/2005, installed on 9/17/2005

Date	cGy/min.	Date	cGy/min.	Date	cGy/min.
9/15/05	147.90	1/15/07	124.07	1/15/09	95.32
10/15/05	146.28	2/15/07	122.71	2/15/09	94.28
11/15/05	144.69	3/15/07	121.37	3/15/09	93.25
12/15/05	143.11	4/15/07	120.05	4/15/09	92.23
		5/15/07	118.74	5/15/09	91.23
1/15/06	141.54	6/15/07	117.44	6/15/09	90.23
2/15/06	140.00	7/15/07	116.16	7/15/09	89.25
3/15/06	138.47	8/15/07	114.89	8/15/09	88.27
4/15/06	136.96	9/15/07	113.63	9/15/09	87.31
5/15/06	135.46	10/15/07	112.39	10/15/09	86.35
6/15/06	133.98	11/15/07	111.17	11/15/09	85.41
7/15/06	132.52	12/15/07	109.95	12/15/09	84.48
8/15/06	131.07				
9/15/06	129.64	1/15/08	108.75	1/15/10	83.55
10/15/06	128.22	2/15/08	107.56	2/15/10	82.64
11/15/06	126.82	3/15/08	106.39	3/15/10	81.74
12/15/06	125.44	4/15/08	105.23	4/15/10	80.85
		5/15/08	104.08	5/15/10	79.96
		6/15/08	102.94	6/15/10	79.09
		7/15/08	101.82	7/15/10	78.23
		8/15/08	100.70	8/15/10	77.37
		9/15/08	99.60	9/15/10	76.53
		10/15/08	98.52	10/15/10	75.69
		11/15/08	97.44	11/15/10	74.87
		12/15/08	96.38	12/15/10	74.05

This decay table is based on a half-life of 5.26 years for Co-60 source.
The dose rate was calibrated according to TG-51 protocol on 9/19/2005

Timer Correction = - 0.011 minute
Time Set for treatment = (Reference Dose/Reference dose rate) - 0.011 min

Commissioning Report for

Versa2 (Elekta VersaHD) S/N: 3142

Report Prepared by

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Jung 20th, 2014

Appendix D. RPC TLD calibration reports

IROC
IMAGING AND
RADIATION ONCOLOGY CORE

IROC Houston QA Center
8060 El Rio Street
Houston, TX 77054
Tel (713) 745-8989
Fax (713) 794-1364
Email: irochouston@mdanderson.org
http://irochouston.mdanderson.org

RESULTS OF OSLD CHECK OF PHOTON BEAM OUTPUT

v 8.0.2

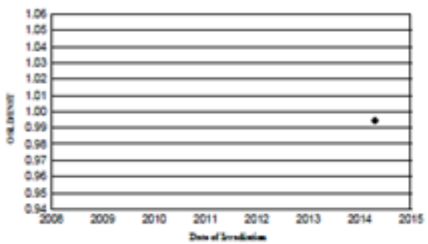
Institution:	M D Anderson Cancer Center, Houston, TX
RTF Number	1744
Person irradiating dosimeters:	Pei-Fong Wong, Ph.D.
Radiation Machine:	Versa HD Serial 3142 (Versa 2)
Radiation Quality:	6 MV X-rays
Distance from source to reference point:	101.6 cm

OUTPUT VERIFICATION:

Date of Irradiation	IROC Houston measured dose at dmax:*	Institution reported dose at dmax:*	**Ratio of absorbed dose determined by IROC Houston to that stated by institution: OSLD/INST**
08-Apr-2014	99.2 cGy to water	99.7 cGy to water	**0.99**

Agreement within 5% is considered a satisfactory check.

RESULT HISTORY FOR THIS BEAM



THIS INFORMATION SHOULD BE USED ONLY AS A CHECK OF MACHINE OPERATION AND NOT AS A MACHINE CALIBRATION, nor as an alternative to frequent calibration by a qualified physicist.

The OSLD dose was evaluated using the AAPM TG-51 Dosimetry Calibration Protocol.

OSLD read on: 25-Apr-2014
OSLD read by: Sonia Gonzalez
Checked by: Jessica Lowenstein, M.S.

*The variance of the dose determined by a single OSLD is less than 3%. The OSLD sample, therefore, has an uncertainty of 5% at a confidence level in excess of 90%. This analysis did not include uncertainties in the institutions' irradiation technique.

David S. Followill
Director

ACR
AMERICAN COLLEGE OF RADIOLOGY
Grants Administration

IROC Quality Assurance Center Locations
Houston|Ohio|Philadelphia|Rhode Island|St Louis
Sponsored by the National Cancer Institute

THE UNIVERSITY OF TEXAS
MD Anderson Cancer Center
Making Cancer History®

The Structure of an Equipment QA Program

(2) Quality control tests

- ✓ Establish QC program
- ✓ Establish QC tests
- ✓ Set up baselines
- ✓ Determine acceptable/action level

Quality Control Program

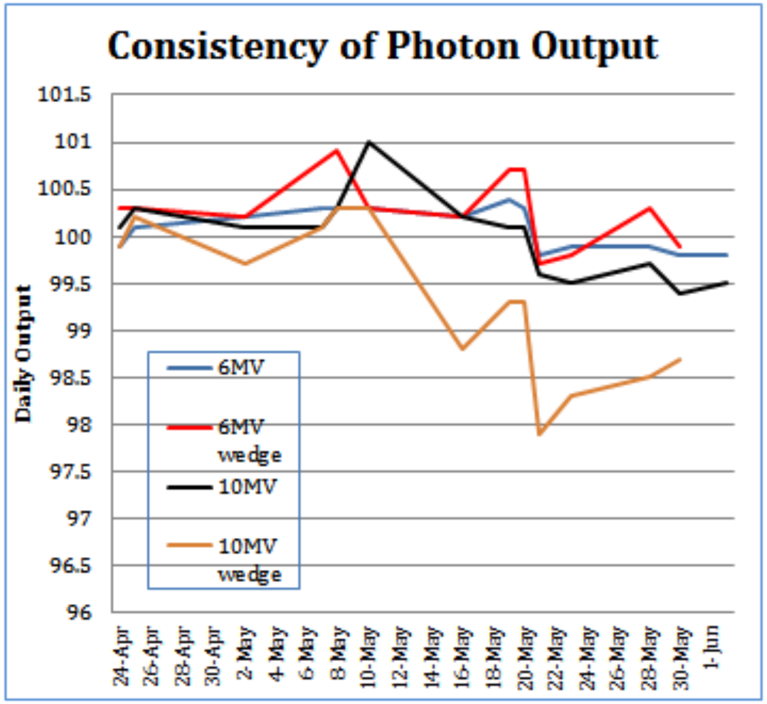
- Equipment quality control program should specify the following:
  - Parameters to be tested and the tests to be performed
  - Specific equipment to be used
  - Geometry of the tests
  - Frequency of the tests
  - Staff group or individual performing the tests
  - The individual supervising and responsible for the standards of the tests and for actions that may be necessary if problems are identified.

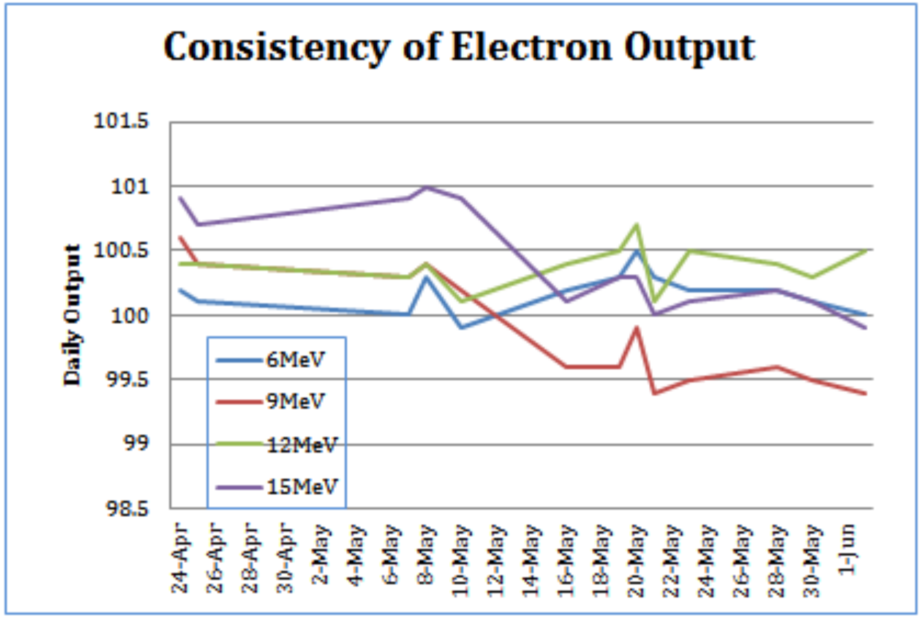
Quality Control Program

- Daily/Weekly Checks:
  - Usually done by RTTs, including the machine warm up procedures, simple output and mechanical checks, plus safety checks.
  - Results verified by physics
- Monthly Checks:
  - Usually done by physics staff, standardized dosimetry and mechanical tests
- Annual Calibration:
  - Usually done by QMP, including the absolute dose calibration for every beams.

- Consistency Check: It is essential that the performance of treatment equipment remain consistent within accepted tolerances throughout its clinical life
- Prior to Clinical Use: Ongoing quality control program of regular performance checks must begin immediately after acceptance/commissioning
- Monitor the Change: If these quality control measurements identify departures from expected performance, corrective actions are required.

Quality Control Program





Consistency Output Check

Versa2 Prior to Clinical Use

- Equipment quality control program should specify the following:
  - Expected results
  - Tolerance and action levels
  - Actions required when the tolerance levels are exceeded
- Actions required must be based on a systematic analysis of the uncertainties involved and on well defined tolerance and action levels.

Quality Control Program

Role of Uncertainty:

- When reporting the result, it is obligatory that some quantitative indication of the quality of the result be given.
- Otherwise whoever receives this QC report cannot really asses its reliability.
- Concept of measurement uncertainty has been introduced.
- In 1993, ISO has published a “Guide to the expression of uncertainty in measurement”

Corrective Actions

Role of Tolerance Level:

- Within the tolerance level, the performance of an equipment gives acceptable accuracy in any situation.
- Tolerance values should be set with the aim of achieving the overall uncertainties desired.
- However, if the measurement uncertainty is greater than the tolerance level set, then random variations in the measurement will lead to unnecessary intervention
- Therefore, it is practical to set a tolerance level at the measurement uncertainty at the 95% confidence level

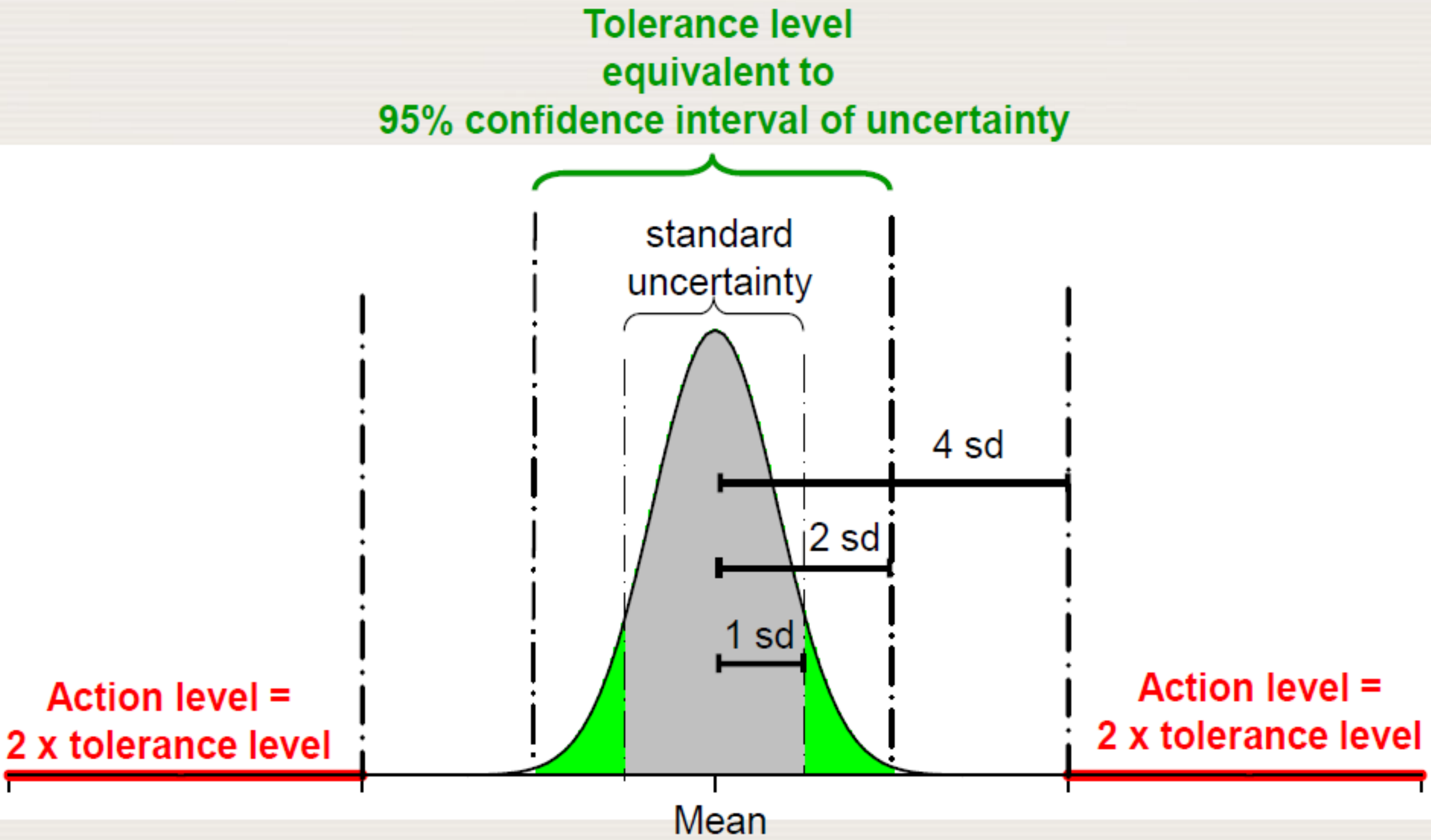
Corrective Actions

Role of Action Level:

- Performance outside the action level is considered unacceptable and demands action to remedy the situation.
- It is useful to set action levels higher than tolerance levels thus providing flexibility in monitoring and adjustment.
- Action levels are often set at approximately twice the tolerance level.
- However, some critical parameters may require tolerance and action levels to be set much closer to each other or even at the same value.

Corrective Actions

Illustration of a possible relation between uncertainty, tolerance level and action level

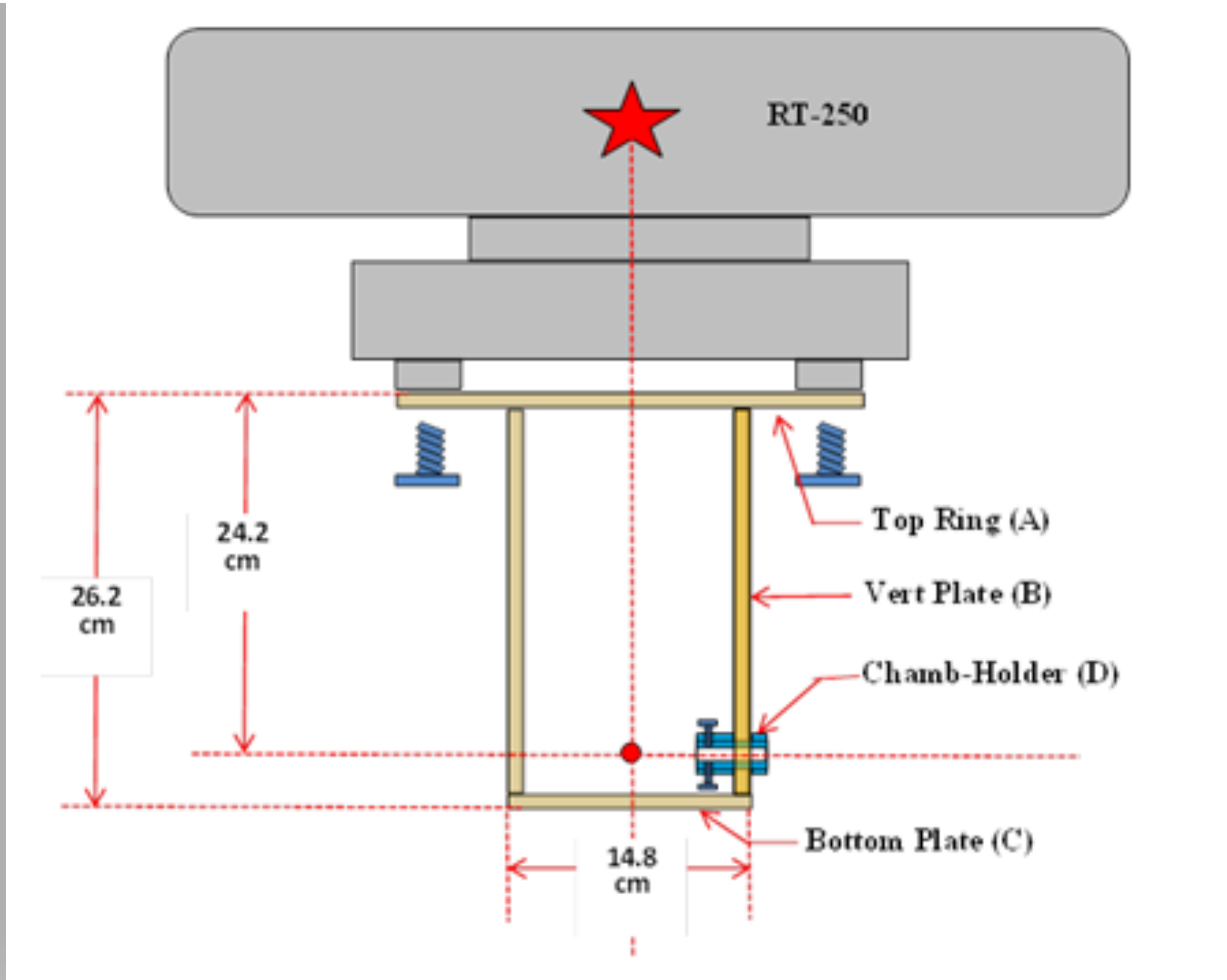


- If a measurement result is within the tolerance level, no action is required.
- If the measurement result exceeds the action level, immediate action is necessary and the equipment must not be clinically used until the problem is corrected
- If the measurement falls between tolerance and action levels, this may be considered as currently acceptable. But, the physicist review and repeated measurements are required.

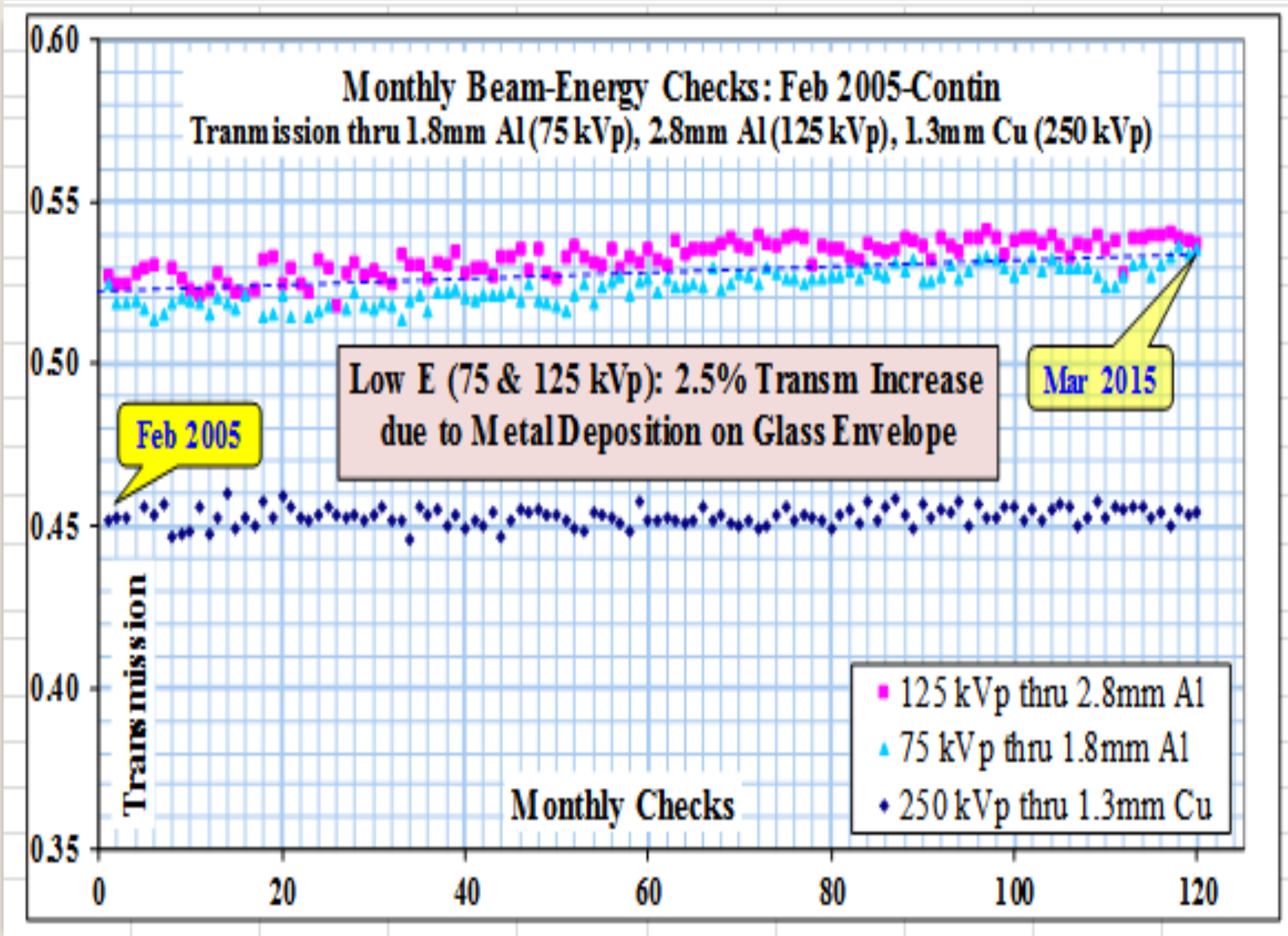
System of Actions

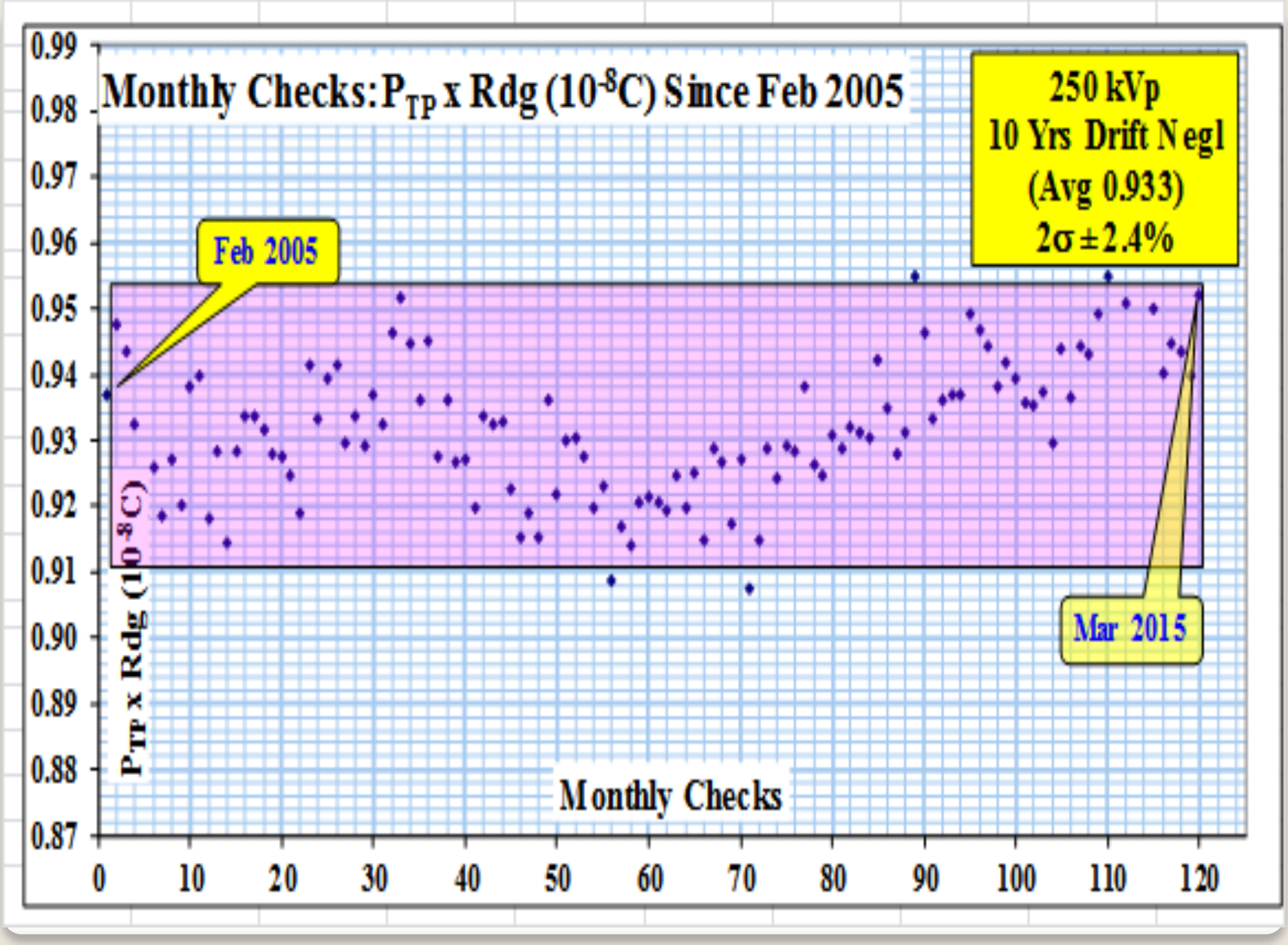

MDACC
RT-250 Unit
Control Console
Please Turn Unit OFF after the unit has been used.
Thank You.
(R. Tailor 3-2638)
Panasonic
READY
BEAM ON
TIME SET
OFF ON
POWER
KVP SELECTOR
OFF ON
X RAYS
CHECK
mA ADJUST
Set backup timer to 0.3 minutes more than primary timer
PHILIPS

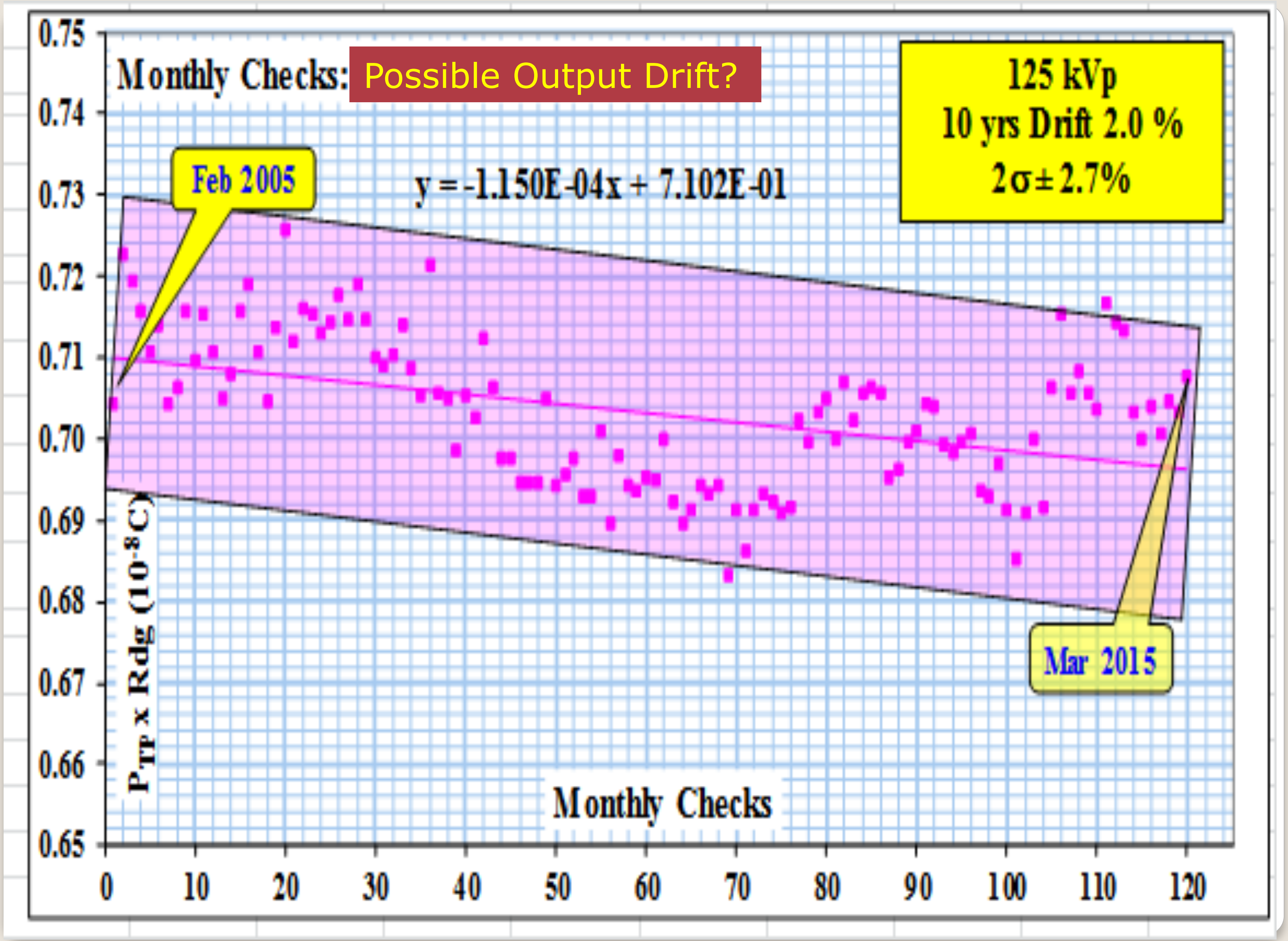
MDACC
RT-250 Unit



New Jig for RT-250 Monthly


Monthly Beam-Energy Checks: Feb 2005-Contin
Tranmission thru 1.8mm Al (75 kVp), 2.8mm Al (125 kVp), 1.3mm Cu (250 kVp)
Low E (75 & 125 kVp): 2.5% Transm Increase due to Metal Deposition on Glass Envelope
Feb 2005
Mar 2015
Transmission
Monthly Checks
125 kVp thru 2.8mm Al
75 kVp thru 1.8mm Al
250 kVp thru 1.3mm Cu
0.60
0.55
0.50
0.45
0.40
0.35
0
20
40
60
80
100
120


Monthly Checks: P_TP x Rdg (10^-8C) Since Feb 2005
250 kVp
10 Yrs Drift Negl
(Avg 0.933)
2σ ±2.4%
Feb 2005
Mar 2015
P_TP x Rdg (10^-8C)
Monthly Checks
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.90
0.89
0.88
0.87
0
10
20
30
40
50
60
70
80
90
100
110
120



Monthly Checks:
Possible Output Drift?
125 kVp
10 yrs Drift 2.0 %
2σ± 2.7%
Feb 2005
y = -1.150E-04x + 7.102E-01
Mar 2015
Monthly Checks
P_TP x Rdg (10^-8 C)
0.75
0.74
0.73
0.72
0.71
0.70
0.69
0.68
0.67
0.66
0.65
0
10
20
30
40
50
60
70
80
90
100
110
120

MDACC
Co-A Control

UT MD ANDERSON CANCER CENTER
DIVISION OF RADIATION ONCOLOGY

CoA Weekly Output Checks for Year 2007/2008

Machine: Cobalt-A Exposure: 1 minute, 2 readings
QA: 2103 Backup/CNMC Setup: 80 cm SSD, field size 10 cm x 10 cm
* If it is not acceptable, please call H&N physicists prior to patient treatment

Date mm/dd/yy	RTT Initials	Reading 1	Reading 2	Average Reading	Acceptable? Yes/No*	Physicist/ Comments

* Acceptable readings for each month (±3% from monthly standard):

Oct, 07: 115.2 – 122.4 Nov, 07: 114.0 – 121.1 Dec, 07: 112.7 – 119.8
Jan, 08: 111.5 – 118.4 Feb, 08: 110.2 – 117.1 Mar, 08: 109.0 – 115.9
Apr, 08: 107.8 – 114.6 May, 08: 106.6 – 113.3 Jun, 08: 105.5 – 112.1
July, 08: 104.3 – 110.8 Aug, 08: 103.2 – 109.6 Sep, 08: 102.0 – 108.4

		Monthly QA For Cobalt A Unit	By:	Sam Tung
			Date:	4/18/2007
A. Mechnical and Safety Checks				
Item Description	Criteria	OK?	Comments	
1. Warning Light	Functional	Y		
2. Door Interlock	Functional	Y		
3. Radiation Monitor	Functional	Y		
4. Beam Off	Functional	Y		
5. Audio/Video	Functional	Y		
6. Laser Alignment	2 mm	Y		
7. Cross-Hair Alignment	2 mm	Y		
8. ODI @ 65 cm to 80 cm	3 mm	Y	2 mm	
9. Distance Sticks	1 mm	Y		
10. Light field 5/10/20 cm	3 mm	Y	<2 mm	
11. Output Check	2.0%	Y	See measurement below	
12. Timer Error	0.5%	y	See measurement below	

CoA Monthly Check Summary

B. Output Check and Timer Error								
Electrometer: Keithley 604 _X__, Chamber S/N:1158 _X_, Bias: -300V, Leakage: < 5x10(-14) A								
Setup: 10x10 cm @ 80 cm SSD to top of CoA jig,					Temp (oC):	**25.0**	Pres (mm):	**758.4**
Readings	(nC)	Standard:	**120.00**	cGy/min		Ctp =	1.0123	
2 minute	**4.044**	**4.044**	**4.045**		Average R1 =	4.044		
4x0.5 min	**1.027**	**2.054**	**3.081**	**4.108**	R4 =	4.108		Ratio
Output =	(R1/2.011) x Ctp x Ce x Nd,w x Njig x Ndecay =					**119.90**	cGy/min	**0.999**
*	Note Start using new calibration factor for the new source							
Timer Error = 2 x (R4 - R1) / (4 x R1 - R4) =				0.0106	min.	**0.0**	%error = (1+e)/1.011	
	Use CNMC electrometer from 6EX fro this month only!!							

CoA Monthly Output Check

Procedure or item to be tested	Action level
Output constancy	2 %
Field size dependence of output constancy	2 %
Central axis dosimetry parameter constancy	2 %
Transmission factor constancy for all standard accessories	2 %
Wedge transmission factor constancy	2 %
Timer linearity and error	1 %
Output constancy versus gantry angle	2 %

Co Unit Annual Tests

Procedure or item to be tested	Action level
Beam uniformity with gantry angle	3 %
Safety interlocks: Follow procedures of manufacturer	Functional
Collimator rotation isocenter	2 mm diameter
Gantry rotation isocenter	2 mm diameter
Table rotation isocenter	2 mm diameter
Coincidence of collimator, gantry and table axis with the isocenter	2 mm diameter

Co Unit Annual Tests

Procedure or item to be tested	Action level
Coincidence of radiation and mechanical isocentre	2 mm diameter
Table top sag	2 mm
Vertical travel of table	2 mm
Field light intensity	Functional

Co Unit Annual Tests

AAPM Task Group 142

TABLE I. Daily.

Procedure	Machine-type tolerance		
	Non-IMRT	IMRT	SRS/SBRT
Dosimetry			
X-ray output constancy (all energies)			
Electron output constancy (weekly, except for machines with unique e-monitoring requiring daily)		3%	
Mechanical			
Laser localization	2 mm	1.5 mm	1 mm
Distance indicator (ODI) @ iso	2 mm	2 mm	2 mm
Collimator size indicator	2 mm	2 mm	1 mm
Safety			
Door interlock (beam off)		Functional	
Door closing safety		Functional	
Audiovisual monitor(s)		Functional	
Stereotactic interlocks (lockout)	NA	NA	Functional
Radiation area monitor (if used)		Functional	
Beam on indicator		Functional	

LINAC Daily Tests (RTT)

AAPM Task Group 142

TABLE II. Monthly.

Procedure	Machine-type tolerance		
	Non-IMRT	IMRT	SRS/SBRT
Dosimetry			
X-ray output constancy			
Electron output constancy		2%	
Backup monitor chamber constancy			
Typical dose rate[a] output constancy	NA	2% (@ IMRT dose rate)	2% (@ stereo dose rate, MU)
Photon beam profile constancy		1%	
Electron beam profile constancy		1%	
Electron beam energy constancy		2%/2 mm	

LINAC Monthly Tests (Physics)

AAPM Task Group 142

Mechanical			
Light/radiation field coincidence[b]		2 mm or 1% on a side	
Light/radiation field coincidence[b] (asymmetric)		1 mm or 1% on a side	
Distance check device for lasers compared with front pointer		1mm	
Gantry/collimator angle indicators (@ cardinal angles) (digital only)		1.0°	
Accessory trays (i.e., port film graticle tray)		2 mm	
Jaw position indicators (symmetric)[c]		2 mm	
Jaw position indicators (asymmetric)[d]		1 mm	
Cross-hair centering (walkout)		1 mm	
Treatment couch position indicators[e]	2 mm/1°	2 mm/1°	1 mm/0.5°
Wedge placement accuracy		2 mm	
Compensator placement accuracy[f]		1 mm	
Latching of wedges, blocking tray[g]		Functional	
Localizing lasers	±2 mm	±1 mm	<±1 mm

LINAC Monthly Tests (Physics)

AAPM Task Group 142

Safety	
Laser guard-interlock test	Functional
Respiratory gating	
Beam output constancy	2%
Phase, amplitude beam control	Functional
In-room respiratory monitoring system	Functional
Gating interlock	Functional

[a] Dose monitoring as a function of dose rate.
[b] Light/radiation field coincidence need only be checked monthly if light field is used for clinical setups.
[c] Tolerance is summation of total for each width or length.
[d] Asymmetric jaws should be checked at settings of 0.0 and 10.0.
[e] Lateral, longitudinal, and rotational.
[f] Compensator based IMRT (solid compensators) require a quantitative value for tray position (wedge or blocking tray slot) set at a maximum deviation mm from the center of the compensator tray mount and the cross hairs.
[g] Check at collimator/gantry angle combination that places the latch toward the floor.

LINAC Monthly Tests (Physics)

Mechanical Checks	☑ Indicates Pass		☒ Indicates Fail : See Comments Below				
Gantry Readout 0^0	☑	ODI 90 cm	☐	ODI 110cm	☑	ODI 100 cm	☑
Horizontal laser	☑	Vertical laser	☑	Sagittal laser	☑	Ceiling laser	☑
Asym: X1=-2 cm(1.9)	☑	Asym: X2=-2 cm	☑	Asym: Y1=-2 cm	☑	Asym: Y1=-10 cm	☑
Asym: Y2=-2 cm	☑	Asym: Y2=-10 cm	☑	6x6 cm Field	☑	20x20 cm Field	☑
10x10 cm Field	☑	Door Beam On Light	☑	Cosole Beam Off	☑	Area Radiation Monitor	☑
Door Interlock	☑	TV Monitor	☑	Intercom	☑	X Hair Alignment/Graticule	☑

Flatness and Symmetry* 3/24/2015 DL

Setup: 100 MU, 20x20cm^2, coll 0, 100cm at top of profiler, SNO: 5499724

Energy	*Additional BUILDUP*	*In plane (Y)*		*Cross plane (X)*	
		Flatness %	*Sym %*	*Flatness*	*Sym*
18x/profiler2	**2cm**	1.5	0.5	1.6	-0.8
18x/film					
6x/profiler2	**2cm**	1.3	0.5	1.5	-0.5
6x/film					
6e	-	1.0	-0.1	0.8	-0.2
9e	-	0.8	0.0	0.5	-0.1
12e	-	1.0	-0.1	0.4	-0.3
16e	--	0.5	-0.3	1.2	-0.5
20e	-	1.0	-0.3	0.8	-0.2

*Complete results on profiler laptop, 2100 folder

MLC QA* MC/DL 3/23/2015 and

Picket fence, tol 0.4mm

Gantry	*Failure (%)*
0	0.00
90	0.00
180	0.00
270	0.00
VMAT	0.00

Gantry, MLC speed, Dose rate

Test	*Max deviation*
GS/DR	0.984±0.004
MLC speed	1.008±0.004

*Complete results in MLC folder

MDACC LINAC QC Form

2109 - Varian Clinac 2100EX SN 2365	Chamber	Electrometer	Initials Physicist(s)	MC/DL
Monthly Calibration	PTW N30001 #0282	CNMC 206 #3659206	Date	3/23/2015
	$N^d_w = 5.319 \times 10^7$ Gy/C	$N_e = 1.001 \times 10^{-9}$ C/Rdg	Calib. Date:	9/8/2014

Setup	Output Checks Photons / Electrons	Energy Check Photons	Energy Check Electrons
200 MU, 10x10cm^2, 600 MU/Min			
Buildup ⇒		FGL	
SSD=100 cm to top of ⇒	A	A	A F,G,L
	Base Block B	Base Block B	Base Block B

Output Checks		*2/20/2015*		T °C =	23.0	P mmHg =	759.0	C_{TP}	1.0047
Energy	*Buildup Added* BUILDUP	*Rdg nC x 10^{-8} per 200 MU* Rdg1	Rdg2	Rdg3	*Avg Rdg* nC x 10^{-8}	*Rdg Corrected* Avg Rdg * C_{TP}	*STD* 10^{-8} C	*RATIO*	*Accept ?* (Within 2%)
6x	E	35.09	35.07		35.08	35.25	**34.97**	1.008	PASS
6x DW 60º	E	23.26	23.05		23.16	23.26	**23.03**	1.010	PASS
18x	E	39.14	39.15		39.15	39.33	**39.29**	1.001	PASS
18x DW 60º	E	28.49	28.67		28.58	28.71	**28.65**	1.002	PASS
6e-	--	39.33	39.39		39.36	39.55	**40.00**	0.989	PASS
20 e-	--	43.02	42.96		42.99	43.19	**43.60**	0.991	PASS
9 e-	C	40.14	40.20		40.17	40.36	**40.85**	0.988	PASS
12e-	D	41.49	41.54		41.52	41.71	**42.21**	0.988	PASS
16e-	D	42.37	42.41		42.39	42.59	**42.99**	0.991	PASS

Energy Checks

E	Total BUILDUP*	H_20^+	Rdg 200MU C x 10-8	Calib Rdg	Rdg / Cal Rdg	Acceptable Range	Accept ?
6x	A,F,G,L (8.0 cm	9.0 cm	30.74	35.080	0.876	0.856 – 0.891	Yes
18x	A,F,G,L (8.0 cm	9.0 cm	36.30	39.145	0.927	0.907 – 0.945	Yes
20e	A,F,G,L (8.0 cm	9.0 cm	16.48	42.990	0.383	0.334 – 0.404	Yes
	A,G,J (5.8 cm	6.5 cm	34.50		0.803	0.776 – 0.836	Yes
16e	A,G,J (5.8 cm	6.5 cm	21.19	42.390	0.500	0.415 – 0.524	Yes
	A,J (4.8 cm	5.4 cm	32.93		0.777	0.711 – 0.817	Yes
12e	A,E (4.4 cm	4.8 cm	23.50	41.515	0.566	0.539 – 0.645	Yes
	A,G,F,C (3.4 cm	3.8 cm	34.73		0.837	0.780 – 0.886	Yes
9e	A,G,F,C (3.4 cm	3.8 cm	21.37	40.170	0.532	0.416 - 0.614	Yes
	A,G,F (3.0 cm	3.4 cm	29.16		0.726	0.614 - 0.812	Yes
6e	A,G (2.5 cm	2.8 cm	16.36	39.360	0.416	0.277 - 0.509	Yes
	A,F (2.0 cm	2.2 cm	29.55		0.751	0.624 - 0.856	Yes

NOTE: * Added to the top of base block "B".

\+ Equivalent depth in water using a scaling factor of 1.12 and accounting for 1.5 cm of acrylic from block "A".

Energy Check Setup: **Photons**, SSD setup is 100 cm to top of block "A". **Electrons**, reset SSD to be 100 cm to top of A,F,G,L.

Action Level

Varian 2109 | Physicist Initial: MC/DL
Serial No: 2365 | Date: 3/30/2015
OBI TESTS
Patient: ZZZA2109 2011 Cube

1 Safety checks

Test	Pass (y/n)
Pressure plate safety switches (KV, MV PANELS, SIDES TUBE)	y
Is x-ray generator interlocked if door open	y
Warning lights on during X-ray	y
Waring Sound on during X-ray	y

2 Leeds test

Leeds phantom on OBI detector, copper filter on source (scan parameters : 75kV, 200mA, 50ms)

	Acceptance	Actual	
No of circles observed (Specs > 12)	12	17	Pass
No of Line pairs/mm detected (Specs > 9)	10	13	Pass

3 CBCT tests

Place CAT phan on box by lining the dots with laser

Protocol: Low Dose Head | Full Fan

CT Number Linearity (±40 HU)

Fan Type	Materials	Standard	Measured	Pass/Fail
full	Air	-1000	-996	Pass
	PMP	-200	-204	Pass
	LDPE	-100	-104	Pass
	Polystyrene	-35	-54	Pass
	Acrylic	120	114	Pass
	Delrin	340	344	Pass
	Teflon	990	997	Pass

Image Uniformity (Specs ±40 HU)

Fan Type	Center	Top	Bottom	RT	LT	Pass/Fail	AVG
full	11	-20.4	-5	-4.5	1.3	Pass	-3.52

Low contrast resolution (Specs > 1, Acceptance 8)

full	Measured	5	na

High Contrast Resolution (Specs > 6)

full	Measured	8	Pass

Spatial Linearity (50 ± 0.5 mm)

full	Horizntl1	49.9	Pass
	Horizntl2	50.1	Pass
	Vertical1	50.1	Pass
	Vertical2	50.1	Pass

4 Las Vegas test

Las Vegas phantom at 100cm SSD, deliver 2MU

Measurement Specs

6MV Specs	6MV Acceptance	6MV Actual	18MV Specs	18MV Acceptance	18MV Actual
4	5	5	4	4	
4	5	5	4	4	
4	5	5	3	4	
3	5	5	3	3	
3	3	4	-	-	-

5 Iso check cube*

kV (with correction file)

S Angle	Vert. Distance, mm	Horiz. Distance mm	Radial	Pass ?
270	0.2	0	0.2	Pass
0	0.4	0	0.4	Pass
90	0.3	0	0.3	Pass
180	0.3	0	0.3	Pass

MV

G Angle	Vert. Distance, mm	Horiz. Distance mm	Radial	Pass ?
270	0	0	0.0	Pass
0	0.4	0.2	0.4	Pass
90	0	0	0.0	Pass
180	0.3	0.1	0.3	Pass

*positive number means above or right of graticule

6 Isocal*

Maximum change to previous calibration (MV):	
Maximum change to previous calibration (kV):	
Isocenter calibration	

*Complete results in isocal folder

OBI Monthly Tests (Partial List)

The Structure of an Equipment QA Program

(3) Additional quality control tests

- ✓ After significant repair
- ✓ After major parts replacement
- ✓ After significant adjustment
- ✓ After adding new procedures
- ✓ Indication of a change of performance

TOTAL SKIN ELECTRON IRRADIATION

Daily Pre-Treatment Record – <u>2108</u> ***(Revised 02/01/2013)***

	Record Data				**Calculations**		**Results in Range?**		**Initials**	
Date	*MU*	$R_{113°}$	$R_{90°}$	$R_{67°}$	$(R_{113} + R_{67})$	$\frac{R_{113°} + R_{67°}}{R_{90°}}$	*Yes*	*No*	*RTT*	*Phys*
	250						☐ Continue to treat	☐ Notify Phys		
	250						☐ Continue to treat	☐ Notify Phys		
	250						☐ Continue to treat	☐ Notify Phys		
	250						☐ Continue to treat	☐ Notify Phys		
	250						☐ Continue to treat	☐ Notify Phys		
	250						☐ Continue to treat	☐ Notify Phys		
Acceptable Data Range:					*15.18–16.11*	*0.960–1.020*				

- Take readings at 67°, 90°, and 113°, 250 MU. **Use CNMC 206 SN 3659204 (1.002 C_E)**
- Calculate sum and ratio.
- If the values are within the limits at the bottom of the table, write your initials in the last column and proceed with treatment.
- If any of the calculated values are outside of the range of acceptable values, **do not** treat. Call the physicist responsible for TSEB immediately.

The Structure of an Equipment QA Program

(4) Planned preventive maintenance program

- ✓ To prevent from major problem
- ✓ Quarterly PM is reasonable
- ✓ In accordance with the manufacture's recommendations
- ✓ Regulatory Requirements

MDACC Radiation Physics Department
Cobalt-A Unit Physics Service Year: 2007

Month	Therapist Weekly QA	Physics Monthly QA	Unescorted User Update	RSO Source Inventory	RSO Source Leak Test	Annual Calibration	Chamber Calibration	5-Year Inspection
Jan	wk 1 wk 2 wk 3 wk 4							
Feb	wk 1 wk 2 wk 3 wk 4							
Mar	wk 1 wk 2 wk 3 wk 4							
Apr	wk 1 wk 2 wk 3 wk 4							
May	wk 1 wk 2 wk 3 wk 4							
June	wk 1 wk 2 wk 3 wk 4							
July	wk 1 wk 2 wk 3 wk 4							
Aug	wk 1 wk 2 wk 3 wk 4							
Sep	wk 1 wk 2 wk 3 wk 4							Due Sep 2010
Oct	wk 1 wk 2 wk 3 wk 4							
Nov	wk 1 wk 2 wk 3 wk 4							
Dec	wk 1 wk 2 wk 3 wk 4							

Summary: The Structure of an Equipment QA Program

(1) Initial specification, acceptance testing and commissioning

(2) Quality control tests

(3) Additional quality control tests

(4) Planned preventive maintenance program

- It is recommended that a departmental QA team be formed to support all the QA activities and draft necessary policies and procedures. The policy should establish the roles and responsibilities of involved QA personnel.

Summary: Task Group 142

- The first step is to establish institution-specific baseline and absolute reference values for all QA measurements. The results should be reviewed regularly to
  - Ensure the consistency of machine performance
  - Determine any significant trend of dose deviations from the base line.

Summary: Task Group 142

- A QMP should lead the QA team.
- In general, the daily QA tasks may be carried out by a radiation therapist using a cross-calibrated dosimetry system.
- Monthly QA tasks should be performed by a QMP or by individuals directly supervised by a QMP.
- The annual QA items in the report represent the most extensive tests on the machine performance. it is recommended that the annual measurements be performed by a QMP with involvement of other QA team members.

Summary: Task Group 142

- An end-to-end system check is recommended to ensure the fidelity of overall system delivery whenever a new or revised procedure is introduced
- During the annual QA review, absolute machine output should be calibrated as per the TG51 calibration protocol using ionization chamber with a NIST traceable calibration

Summary: Task Group 142