Daniel

TG-142

Linac Calibration & QA Laboratory 2025

Exercise 1: Optical distance indicator vs front pointer

Questions & Answers:

1. Describe how we can test the optical distance indicator and any assumptions inherent in this test

ODI

front pointer

We use a metallic calibrated rod to match the actual wanted distances with the ODI

2. What did you observe when you performed this test?

the front pointer needs a mount
there's different size front pointers 90cm, 100cm, 110cm
adjust to the surface
±1mm in ODI
turn off lights, turn on ODI, is it at the desired d? ✓

If not... 3. What can the clinical physicist do if he or she detects an error in the optical distance indicator?

Check tolerance based on TG142 if off

call the engineer

100SSD being the most important to check

Exercise 2: Laser positioning and isocentricity

Questions & Answers:

4. What is the tolerance for laser localization?

1mm

5. Why is laser localization important? (Think about what could be impacted clinically if your lasers are off)

The radiologist uses the lasers as guide and on daily QA we trust ~~these~~ these, so if they are off we get off sets on dose profiles...

6. What can the clinical physicist do if he or she detects an error in laser positioning?

call the engineer

Again only if is truly off tolerance

7. What is the tolerance for isocenter coincidence?

Star Verification

{1 mm
{1°

Exercise 3: Radiation light field coincidence

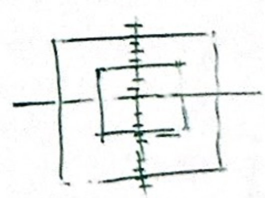
Questions & Answers:

8. What is the tolerance for radiation field light coincidence?

3% Daily
2% Monthly
1% Annual

9. Why is coincidence of the radiation field and the light field important?

This ensures the light field is accurately representing the radiation field during treatment



- The light field is used during setup of both phantoms and patients

10. What can the clinical physicist do if there is an error in the radiation field light coincidence?

call the engineer

ODI
field light } inside gantry head

Lasers in the wall.

Exercise 4: Linac output calibration (TG51)

Questions & Answers:

11. Write down your values for P_{TP}, P_{pol}, P_{ion}. What are typical ranges of values for P_{TP}, P_{pol}, and P_{ion}?

$P_{TP} = 1.20786$? 32°C

$P_{pol} = 1.002$ ✓

$P_{ion} = 1.0015$

n_{ℓ} → Electrometer readings

correction factors

around 1 If ~ 22°C & 101.33 kP
P_{TP}

P_{pol} 0.996 ~ 1.004

P_{ion} 1.0 - 1.05

12. What kinds of errors can contribute to the TG51 result deviating from 1 cGy/MU at d_{max}? What can the clinical physicist do when he or she detects each of these errors?

Setup Errors → Phantom
Chamber

ODI
light field / cross hair

Verify source of error, consider recent Daily QA

13. Why are most of our TG51 measurements obtained at 10cm instead of, say, d_{max}?

10 cm is reproducible, reliable

dmax you have to estimate

and changes or errors in this,

~~scale up~~ ~~more~~

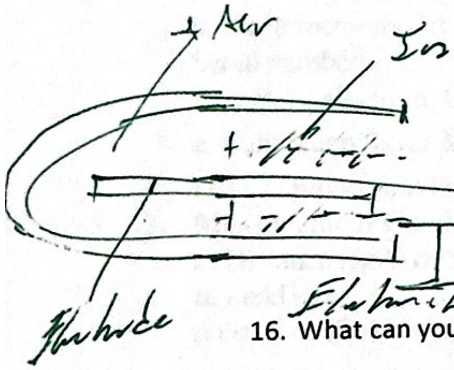
have a bigger impact

Additional questions:

14. How do each of the parameters tested relate to one another (e.g., how does laser localization impact TG51?), and what order would you perform the tests from this lab in the clinic?

Errors will cascade into the calculations.
If ODI, field size, or any other "mechanical" scheme is off, this means all calculations are off.
-> test all dependent measurements sequentially at the end

15. Describe how an ionization chamber works



A voltage is applied to polarize ions and capture them and obtain their charges or current. Ionizing radiation produce these ions in the air inside. the Electric field between V pull them out for measurements

16. What can you do if your chamber is not listed in TG51 or the addendum to obtain a k_Q value?

You make sure what you have matches physical properties of one listed. Institutions should get you the right chamber.

17. What is the purpose of k_Q?

Calibration factor for reference dosimetry
It takes values from ^{60}Co source to our setup

18. How do you know if your chamber can be used for "reference dosimetry"?

If is listed in TG51
and complies with requirements in table III

TG-51 Worksheet A: Photon Beams

1. **Site data**
   Institution: UNMC
   Physicist: David Juarez Luna
   Date:
   Accel or ^{60}Co Mfr.:
   Model & serial number:
   Nominal photon energy/beam identifier: 6x MV
2. **Instrumentation**
   a. Chamber model: PTW-N31003 0.3cc waterproof
   Serial number:
   Cavity inner radius (r_{cav}, Table III): 0.275 cm

   Waterproof: yes ☒ no ☐

   If no, is waterproofing ≤ 1 mm PMMA or thin latex?: yes ☐ no ☐
   b. Electometer model:
   Serial number:
   i. P_{elec}, electrom. Corr factor (Sec. VII.B): 0.999 C/C or C/rdg.
   c. Calibration factor $N_{D,w}^{60Co}$ (Sec.V): 10.11×10^7 Gy/C (or Gy/rdg)

   Date of report (not to exceed 2 years):
3. **Measurement Conditions** (10 x 10 cm^2, point of measurement at 10 cm depth (water equivalent)
   a. Distance (SSD or SAD): 100 cm SAD ☐ or SSD ☒
   b. Field size: 10 x 10 cm^2
   on surface (SSD setup) ☒

   at detector (SAD setup): ☐
   c. Number of monitor units: 200 MU (min for ^{60}Co)
4. **Beam Quality** (Sec. VIII.B – not needed for ^{60}Co
   If energy <10 MV, use no lead foil.
   Measure *%dd* (10) [% depth-dose at 10 cm depth for curve shifted upstream by $0.6r_{cav}$]

   Field size 10 x 10 cm^2 on surface, SSD = 100 cm: yes ☒ no ☐
   a. $\%dd(10)_x = \%\, dd(10)$ 66.2%

   X If energy ≥ 10 MV
   Distance of 1 mm lead foil phantom surface 50 ± 5 cm ☐ 30 ± 1 cm ☐
   Measure % $dd(10)_{Pb}$ [% depth-dose at 10 cm depth for curve shifted upstream by 0.6 r_{cav}]

   Field size 10 x 10 cm^2 on surface, SSD = 100 cm: yes ☐ no ☐

   $\%dd(10)_{Pb}$(includes e$^-$contamination):
   50 cm: $\%dd(10)_x = [0.8905 + 0.00150\%dd(10)_{Pb}]\%dd(10)_{Pb}$ [$\%dd(10)_{Pb} \geq 73\%$] Eq.(13)
   30 cm: $\%dd(10)_x = [0.8116 + 0.00264\%dd(10)_{Pb}]\%dd(10)_{Pb}$ [$\%dd(10)_{Pb} \geq 71\%$] Eq. (14)
   If $\%dd(10)_{Pb} < 71\%$ (30 cm) or 73% (50 cm): $\%dd(10)_x = \%dd(10)_{Pb}$
   b. $\%dd(10)_x$ (for open beam):
   Has lead foil been removed? yes ☐ no ☐

   X Interim alternative for energy > 10MV & with ≥ 45 cm clearance: using no lead foil
   Measure $\%dd(10)$ [% depth-dose at 10 cm depth for curve shifted upstream by 0.6 r_{cav}]
   $\%dd(10)$: No lead
   $\%dd(10)_x = 1.267\ (\%dd(10) - 20.0$ [for 75% <$\%dd(10) \geq 89\%$
   c. $\%dd(10)_x =$

TG-51 Worksheet A: Photon Beams (cont'd) MU = 200

5 **Determination of k_Q** (Sec. IX. B)
Chamber model used to get k_Q: PTW - N31003
a. %dd(10)$_x$ (from 4, above): 66.2%
b. k_Q [Table I or Fig. 4]: 0.992

6. Temperature/pressure Correction (Sec.VII.C)
a. Temperature: 32.2 °C
b. Pressure: 28.7 in/Hg ~~kPa~~ $\left[= \text{mmHg}\frac{101.33}{760.}\right]$ → 728.98 mm Hg → 97.19 kPa
c. P_{TP}: 1.0786 $\left[Eq.(10) = \left(\frac{273.2+6a}{295.2}\right)\left(\frac{101.33}{6b}\right)\right]$

7. Polarity correction (Sec. VII. A.)
M^{+}_{raw}: 12.65 C or rdg
M^{-}_{raw}: 12.7 C or rdg
a. M_{raw} (for polarity of calibration): 12.65 C or rdg
b. P_{pol}: 1.002 $\left[Eq.(9) = \left|\frac{M^{+}_{raw} - M^{-}_{raw}}{2M_{raw}}\right|\right]$

8. P_{ion} measurements (Sec.VII. D. 2)
Operating voltage = V_H: 300 V
Lower voltage V_L: 150 V
M^{H}_{raw}: 12.65 nC or rdg
M^{L}_{raw}: 12.63 nC or rdg
^{60}Co treated as general recombination
a. $P_{ion}(V_H)$ (Eq.(11)); 1.0005 $\left[\left(1.-\left(\frac{V_H}{V_L}\right)^2\right) \Big/ \left(\frac{M^{H}_{raw}}{M^{L}_{raw}} - \left(\frac{V_H}{V_L}\right)^2\right)\right]$

Pulsed/swept beams
b. $P_{ion}(V_H)$ (Eq.(12)) 1.0015 $\left[\left(1.-\frac{V_H}{V_L}\right) \Big/ \left(\frac{M^{H}_{raw}}{M^{L}_{raw}} - \frac{V_H}{V_L}\right)\right]$

If $P_{ion} > 1.05$, another ion chamber should be used.

9. Corrected ion. ch. rdg. M (Sec.VII) at 10 cm depth, water equivalent

$$M = P_{ion}P_{TP}P_{elec}P_{Pol}M_{raw} = [8(a\cdot or\cdot b)\cdot 6c\cdot 2bi\cdot 7b\cdot 7a]$$

(1.0015)(1.0786)(0.999)(1.002)(12.65) = 13.6
Fully corrected M (Eq.(8)): 13.67839386 nC

10. Dose to water at 10 cm depth: $D^{Q}_{w} = Mk_Q N^{60Co}_{D,w} = [9\cdot 5b\cdot 2c]$ Eq. (3)
a. Dose to water at 10 cm depth = 1.371822 Gy

b. Dose/ MU(or min ^{60} Co) at 10 cm depth $\boxed{6.859112 \quad \text{Gy/MU}}$ [10a/3c]

11. Dose to water/MU(or min, ^{60}Co) at d_{max} (if relevant locally)
a. Clinical %dd(10) for SSD setup / 100.: 66.2%
or clinical TMR(10, 10 x 10) for SAD setup:
b. Dose / MU(or min, ^{60}Co) at d_{max}: Gy/MU [10b/(11a)] 1.036119 cGy (water)/MU