

Quality Assurance for Linear Accelerator

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Equipments for QA

1. Ion chamber(游離腔) and electrometer(電量計)
2. Daily QA device- daily check board
3. Water phantom scanning system
4. Barometer(壓力計) and thermometer(溫度計)
5. Level(水平儀)
6. X-ray film scanner(X光片掃描儀) and densitometer(密度計)
7. Thermoluminescent dosimeters(熱發光劑量計) and reader(計讀儀)
8. Diode detector(二極體偵檢器)

Equipments for QA

9. Solid phantom(固態假體)- solid water phantom, acrylic, polystyrene
10. Survey meter(偵檢器)
11. Neutron detector(中子偵檢器)
12. Area monitor(區域監視器)

Equipments for QA

- ion chamber(游離腔)



Equipments for QA

- Electrometer(電量計)



Equipments for QA

- Daily QA device- daily check board (劑量輸出確認)



Equipments for QA

- Level(水平儀)



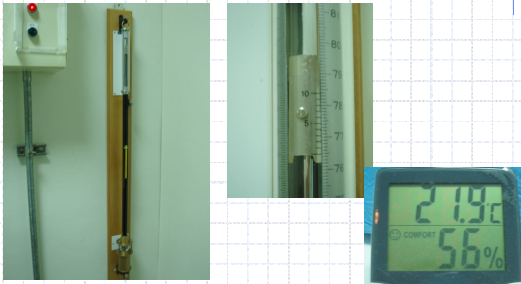
Equipments for QA

- Water phantom (水假體)



Equipments for QA

- Barometer and thermometer (溫壓計)



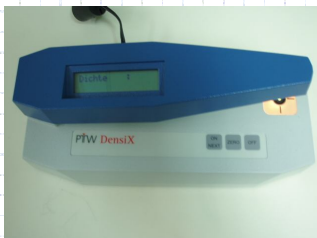
Equipments for QA

- Solid phantom (固態假體)



Equipments for QA

- Densitometer (光密度計)



Accelerator Installation

Preliminary tests

- Testing of presence of radiation (劑量輸出)
- Testing of door interlocks (鉛門連鎖裝置)
- Testing of proper operation of emergency off switches (緊急按鈕)
- Preliminary calibration of the machine output in all modes (劑量輸出校正)
- Radiation survey (環境監測)

Acceptance Testing (接收測試)

Equipment for acceptance testing

- 3-D water phantom scanner with computer interface (水假體測試)
- ion chambers, electrometers (游離腔、電量計)
- X-ray films, laser film scanner (X光片)
- Precision level (容許值)

Acceptance tests

- 安全聯鎖裝置及機械性裝置確認(gantry, collimator system, table)
- 劑量監控系統(再現性, 比例性, dependence on gantry rotation and gantry angle)
- 校正穩定性(one-day, one-week, moving beam therapy)
- 輻射等中心點(gantry, collimator, table)
- 深度劑量特性(photons and electrons)
- 照野均勻度(平坦度、對稱性)
- 輻射照野半影區

Linac with special modes

- TBI (全身光子治療):
 - maximum MU and dose rate
- TSI(全身皮膚治療):
 - maximum MU, dose rate and field size interlocks
- Electron
 - arc: MU/degree and dose rate
- IMRT (強度調控放射治療):
 - MLC and beam control

Commissioning

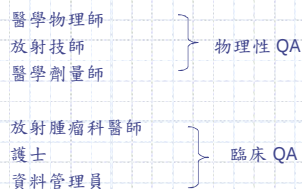
Commissioning

- 經由實際測量所有劑量參數來驗證由治療計畫系統所計算的結果
- 將射束參數輸入治療計畫系統中，並測試其準確度。並訂定治療程序及所有相關加速器操作之訓練
- 建立各輸出值之容許值以供品質保證作業之進行
- clinical commissioning report

Quality Assurance

Comprehensive QA team

- 實行QA的人員包含：



QA of medical accelerators

- i Dosimetry(劑量)
- i Mechanical(機械)
- i Safety(安全)

QA tests and frequency

- 根據AAPM recommendations (TG-40)來建立QA的測試標準和頻次
- QA的標準和頻次可以各科需求而有所修改
- 所有QA的基礎都是建立在當初接機時的基礎資料上

Tolerance limits and action levels

- 容許值的限制通常希望整體劑量不確定性在 i 5%
- 若測試結果超出容許數值，則需要探討並研究其問題所在並加以校正

Daily QA

Dosimetry

X-ray output constancy	3%
Electron output constancy ^b	3%

Mechanical

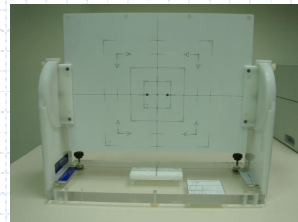
Localizing lasers	2 mm
Distance indicator (ODI)	2 mm

Safety

Door interlock	Functional
Audiovisual monitor	Functional

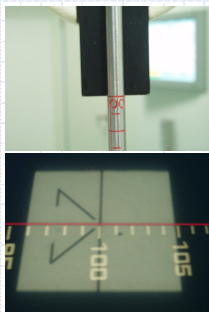
Daily QA

- 定位雷射



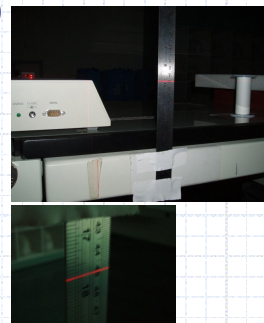
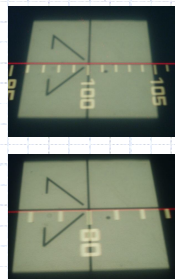
Daily QA

- 光學距離指示器(ODI)
ODI=100cm



Daily QA

- 光學距離指示器(ODI)
ODI=80cm, 120cm



Daily QA

- 光子輸出劑量
- 容許值 $\pm 3\%$



Daily QA

- 視聽監視器
- 治療室門連鎖

Monthly QA

Dosimetry	
x-ray output constancy ^c	2%
Electron output constancy ^c	2%
Backup monitor constancy	2%
x-ray central axis dosimetry parameter (PDD, TAR) constancy	2%
Electron central axis dosimetry parameter constancy (PDD)	2 mm @ therapeutic depth
x-ray beam flatness constancy	2%
Electron beam flatness constancy	3%
x-ray and electron symmetry	3%
Safety Interlocks	
Emergency off switches	Functional
Wedge, electron cone interlocks	Functional
Mechanical Checks	
Light/radiation field coincidence	2 mm or 1% on a side ^d
Gantry/collimator angle indicators	1 deg
Wedge position	2 mm (or 2% change in transmission factor)
T-ray position	2 mm
Applicator position	2 mm
Field size indicators	2 mm
Cross-hair centering	2 mm diameter
Treatment couch position indicators	2 mm/1 deg
Latching of wedges, blocking tray	Functional
Jaw symmetry ^c	2 mm
Field light intensity	Functional

Monthly QA

- 光子電子輸出劑量校正 100MU=100cGy
- 容許值 ±2%



Monthly QA

- 緊急關閉按鈕



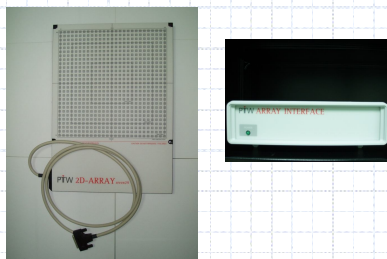
- 楔形濾器、電子錐連鎖裝置

Monthly QA

- 光子射束中心軸劑量參數 容許值 ±2%
- 電子射束中心軸劑量參數 容許值 ±2%或 ±2mm

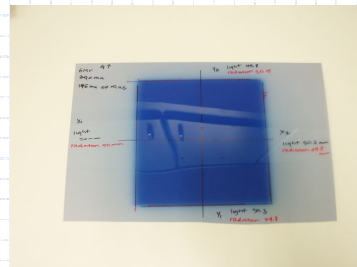
Monthly QA

- 光子及電子射束平坦性及對稱性
電子容許值 ±3%，光子平坦性 ±2%、對稱性 ±3%



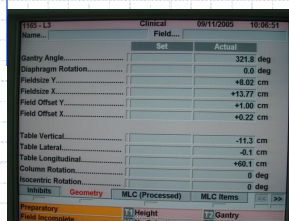
Monthly QA

- 光照野與輻射照野一致性
- 容許值 ±2mm或 ±1%照野



Monthly QA

- 旋轉臂及準直儀角度指示器
- 容許值 $\pm 1^\circ$



Monthly QA

- 十字交叉線中心位置
容許值直徑2mm以內
- 照野指示器、準直儀對稱性
容許值 $\pm 2\text{mm}$ 或 $\pm 1\%$ 照野

Annual QA

Dosimetry

x-ray/electron output calibration constancy	2%
Field size dependence of x-ray output constancy	2%
Output factor constancy for electron applicators	2%
Central axis parameter constancy (PDD, TAR)	2%
Off-axis factor constancy	2%
Transmission factor constancy for all treatment accessories	2%
Wedge transmission factor constancy	2%
Monitor chamber linearity	1%
x-ray output constancy vs gantry angle	2%
Electron output constancy vs gantry angle	2%
Off-axis factor constancy vs gantry angle	2%
Are mode	Mfrs. specs.

Safety Interlocks

Follow manufacturers test procedures

Mechanical Checks

Collimator rotation isocenter	2 mm diameter
Gantry rotation isocenter	2 mm diameter
Couch rotation isocenter	2 mm diameter
Coincidence of collimator, gantry, couch axes with isocenter	2 mm diameter
Coincidence of radiation and mechanical isocenter	2 mm diameter
Table top sag	2 mm
Vertical travel error	2 mm

Annual QA

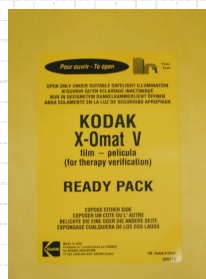
- 準直儀機械旋轉中心 Collimator mechanical isocenter
 - 旋轉臂機械旋轉中心 Gantry mechanical isocenter
 - 治療床機械旋轉中心 Couch mechanical isocenter
 - 準直儀輻射旋轉中心 Collimator radiation isocenter
 - 旋轉臂輻射旋轉中心 Gantry radiation isocenter
 - 治療床輻射旋轉中心 Couch radiation isocenter
- 以上容許值均為直徑2mm以內
- 區域監測器 Area monitor
 - 治療床垂直升降的直線性
Alignment of vertical travel of couch
容許值 $\pm 2\%$

Annual QA

- 安全性連鎖(含門、緊急停止與臨時中斷)
Safety interlock
- 光子照野因子穩定度, 容許值2%內
- 電子錐因子穩定度, 容許值2%內
- 光子/電子中心軸百分深度劑量比/組織與空氣比穩定度, 容許值2%內
- 穿透因子穩定度, 容許值2%內
- 楔形濾器穿透因子穩定度, 容許值2%內
- 監測游離腔之線性, 容許值2%內

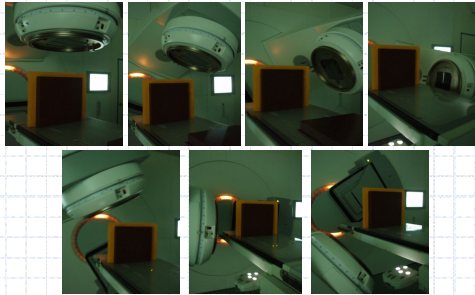
Exercise

- Films for QA



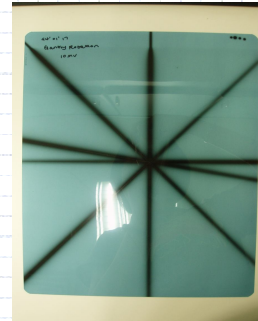
Exercise

- Gantry rotation isocenter



Exercise

- Result



Reference material

- AAPM Task Group Reports TG21, 35, 40, 45, and 51
- Linear Accelerator Acceptance and Commissioning
Jatinder palta, PhD, 45th AAPM Annual Meeting