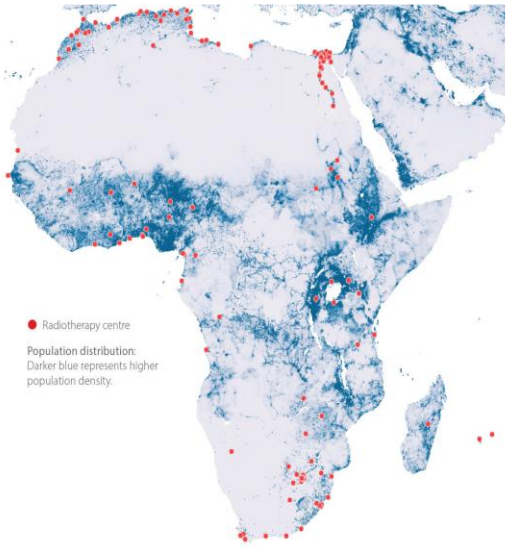
Ghana SAPPHIRE - Medical Physics workshop

Torsten Liebig



Overview

- Radiotherapy in LIMIC's
- Accra - Korle Bu Teaching Hospital
- STELLA initiative
- SAPPHIRE workshop
- Linac lectures



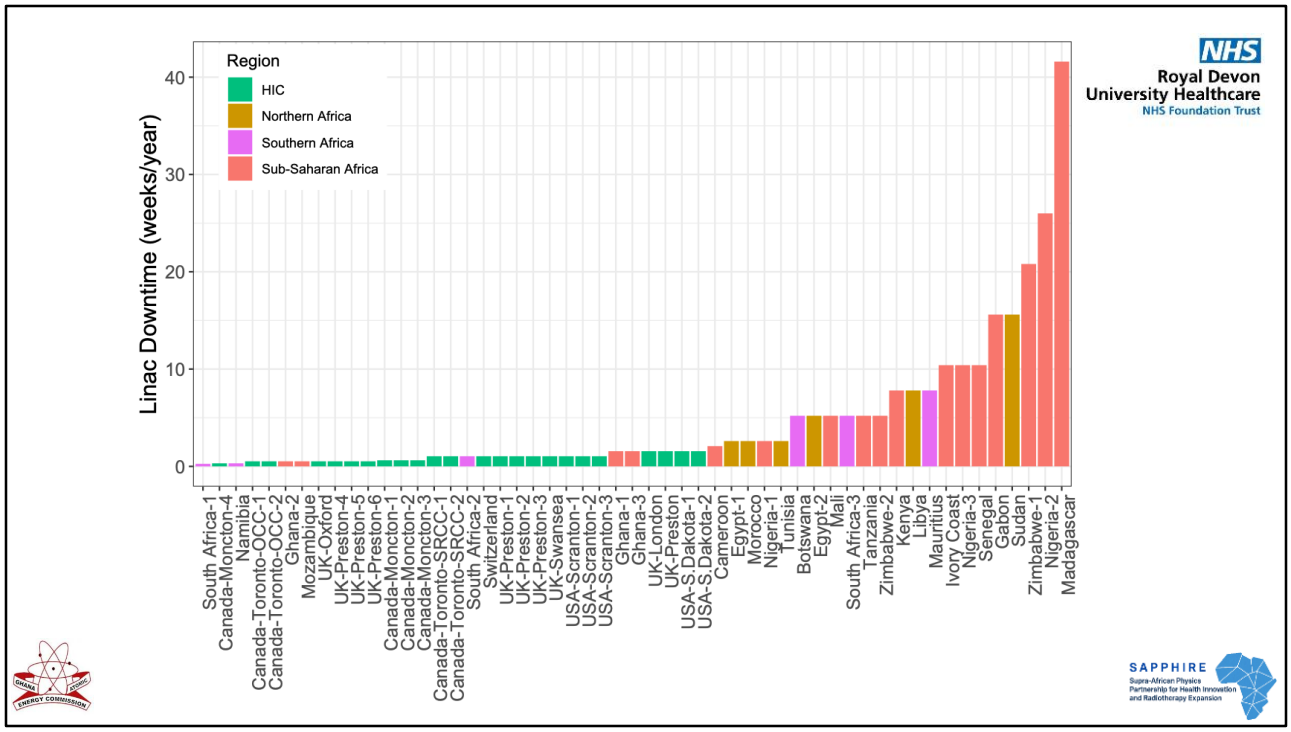
NHS
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University Healthcare
NHS Foundation Trust

Africa: ~400 RT units for around **1.4 billion** people
1 machine per 2.8 million people
UK: **360 RT** units for around **68** million people
1 machine per 190,000

- By 2030, there will be **1.4** million new cases of cancer and there will be **1** million cancer deaths in Africa
- Over **60% are in just 3 countries**: South Africa, Egypt and Morocco
- 20 countries have none

3

SAPPHIRE
Supra-African Physics Partnership for Health Innovation and Radiotherapy Expansion



- 75% of downtime due to limited access to spare parts
- MLC issues main contributor to downtime

- Electrical power issues
- Environmental challenges (e.g. ventilation, dust, cooling)

National Radiotherapy Oncology and Nuclear Medicine Centre - Korle Bu Teaching Hospital

NHS Royal Devon University Healthcare NHS Foundation Trust





SAPPHIRE Supra-African Physics Partnership for Health Innovation and Radiotherapy Expansion

Accra – City of 4 million:
- 2 centres – 1 of which is privat
- 4 linacs (1 new Elekta currently in commissioning)

- Greater Manchester Area (3 million) 14-16 linacs

Korle Bu:
- 2 linacs, 1 brachy HDR (Bebig), 1 CT
- 7 physicists, 2 MPE's one of which is on secondment from Uni
- 2 for Brachy, 2 for planning, 2 everything else – 2 week rotas
- MPE is always on standby

STELLA

SMART TECHNOLOGY TO EXTEND LIVES WITH LINEAR ACCELERATORS

NHS Royal Devon University Healthcare NHS Foundation Trust

a global collaboration with experts from ICEC, CERN, STFC,UK Universities, US, 28 African countries and it is dedicated to:

- Expanding access to high-quality cancer treatment globally
- Developing an innovative and transformative radiotherapy treatment system
- Driving down the cost of RT and cancer care
- An enhanced training, education and mentoring program to catalyze radiotherapy treatment implementation globally

SAPPHIRE Supra-African Physics Partnership for Health Innovation and Radiotherapy Expansion

Linac to work in LIMIC's

What do I do:

- Involved in research to use neural networks for Linac fault prediction
- MLC design

SAPPHIRE

Supra-African Physics Partnership for Health Innovation and Radiotherapy Expansion

NHS
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NHS Foundation Trust

SAPPHIRE is a UK-led research and training initiative that partners with institutions in Ghana and South Africa to strengthen radiotherapy services through education, capacity building, and data-informed innovation.



SAPPHIRE
Supra-African Physics Partnership for Health Innovation and Radiotherapy Expansion

SAPPHIRE is a two-year programme funded by UK Research and Innovation (UKRI)

- Led by Manjit (visiting Prof Oxford Uni – formal senior advisor for medical applications Cern)
- Raj (Consultant – Addenbrooke's and Clinical Prof Ai in RT - Cambridge Uni)
- Greame (Professor of Particle Accelerator Engineering - Lancaster Uni)

SAPPHIRE Supra-African Physics Partnership for Health Innovation and Radiotherapy Expansion	Mon	Tue	Wed	Thur	Fri	Sat
9am	Welcome Francis & Intro M.Dosanjh	Electron guns and Servo's M. Carlone	Beam Steering R.Apsimon	Imaging in Radiotherapy Sonwabile Ngcezu	Varian Machines Torsten / Seminar for Medical Physics students at SNAS - Univ of Ghana (Manjit & Raj)	Hospital visit (Korle Bu Teaching Hospital)
10am	Clinical guide to Radiotherapy Hannah	RF Sources G. Burt	Radiation Transport in Matter R. Apsimon	Elekta Machines J.Ikede		
11am	Intro to medical Linacs G.Burt	Modulators and Electrical J.Ikede	Dosimetry Eric Addison			
12 noon	RF accelerators G. Burt	Student Introductions	Radiation Shielding and Safety E. Addison	QA on linacs S.Tagoe	Comparisson of kV and MV imaging Taofeeq Ige	
1pm	Lunch	Lunch	Lunch	Lunch	Lunch and Visit to Tourist sites	
2pm	Beam Loading G. Burt	Practicals (Simac RF Sources and Modulators)	Practicals (Simac Beam Steering and Collimation)	Practicals (Simac)		
3pm	Practicals (Simac Beam Loading)			Tour of GAEC		
4pm					Close	
Evening	Welcome reception		Worshop Dinner (Azmera)	Talk on IAEA (Godfrey Azangwe)		

- Theoretical linac labs
- Practical's supported by SIMAC software (virtual linac)

Varian iX linac – challenges managing RT linac's

Royal Devon University Healthcare NHS Foundation Trust

External factors
- Electrical stability
- Dust
- Ventilation
- Cooling

Machine challenges
- High level of radiation
- High voltages
- High temperatures
- moving parts require very high accuracy
- Small changes upstream can have large consequences downstream

Vendors
- High prices contracts, parts, training
- Access to documentation
- Access to machine data



SAPPHIRE Supra-African Physics Partnership for Health Innovation and Radiotherapy Expansion

Varian iX linac – Varian documentation

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myvarian.com

- Beam Quality guidelines for HE clinac systems (CTB-GE-681)
- Clinac Technical Reference Guide
- Millennium MLC System and Maintenance Guide
- Annual PMP/PMI parts kits and lubricants for Varian linacs

- Databooks

TABLE 3: BEAM QUALITY GUIDELINES FOR COLLIMATOR PART REPLACEMENTS & ALIGNMENTS – HIGH ENERGY CLINAC

This table provides the minimum test requirements, in sequential order, that are required after completing a specific maintenance task.

Tests with the QA icon are standard quality assurance tests (per AAPM guidelines) for patient safety. The customer is ultimately responsible for all QA tests. These tests can be performed with the assistance of the service engineer, or the customer can elect to perform these tests on their own. The service engineer must perform all other tests.

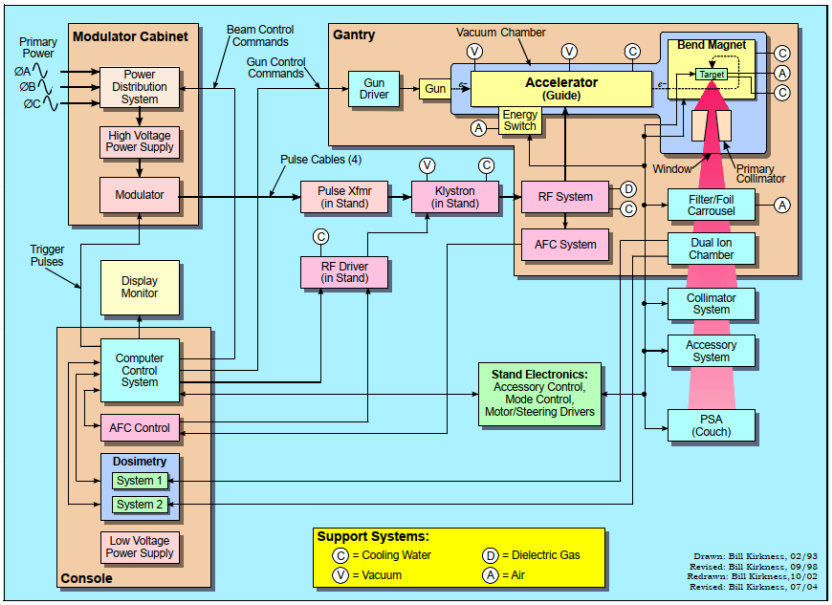
If a Varian Customer Support Representative, or authorized Varian service agent, was involved with the repair action, then their Service Report will contain the following Quality Statement to inform the customer of their responsibilities.
"Customer is responsible for all calibration verifications. Beam quality tests and alignments completed per TT-GE-00668 require the customer to perform the beam QA tests per CTB-GE-681 before treatments can resume."

Varian representatives are not authorized to adjust the dose calibration potentiometer (MU1) without customer approval and guidance.

		QA Verify Light Field Alignment	QA Verify Crosshair Alignment	Verify ICVI Mount Keyed to Interface Mount Clamp Plate	Verify Attachment of ICVI Mount to Interface Mount	Verify Attachment of Accessory Mount to Interface Mount	QA Verify Alignment of ICVI Mount to Collimator Axis	QA Verify LF vs. X-ray Coincidence NOTE 12	QA Verify MLC Leaf Alignment (graph paper visual check)	QA Verify Jaw PRO Calibration	QA Verify Collimator PRO Calibration	QA Verify Collimator Spoke Shot	QA Verify Beam Symmetry NOTE 4	Steering Interlock PCB Auto-Cal (required if AAS or PCB Balance pots adjusted)	Run PMP Clinical Test Patient (Morning Checkout can be used if PMP is NA)	QA Verify Winston-Lutz Accuracy (FBIA option only)	QA Verify Dose Calibration
3.1	Collimator Replacement	●	●				●	●	●	●	●	●	●	●	●	●	●
3.2	Collimator Lift & Reinstallation (same collimator)										●		●[4]		●	●	●
3.3	Crosshair Replacement or Realignment	●	●						●	●							
3.4	Mirror Removal or Replacement	●	●					●	●						●		
3.5	Light Field Lamp Replacement	●	●														
3.6	Light Field Lamp Realignment	●	●					●	●	●							
3.7	X or Y Jaw Maintenance (that could affect jaw tilt or position)							●		●			●	●			●
3.8	Interface Mount Replacement NOTE 11		●	●	●	●	●						●				
3.9	Interface Mount Rear Retainer Replacement or Adjustment NOTE 11				●	●	●						●				
3.10	Interface Mount Latch Adjustment NOTE 11				●	●	●						●				
3.11	Electron Applicator Replacement (applies to electron energies only)												●	●			●
3.12	ICVI Mount Conical Seat Assembly & Shroud/Pillar Assembly Removal or Adjustment				●	●	●										

SAPPHIRE Supra-African Physics Partnership for Health Innovation and Radiotherapy Expansion

Varian iX linac – system overview



Varian iX linac – machine states and interlocks

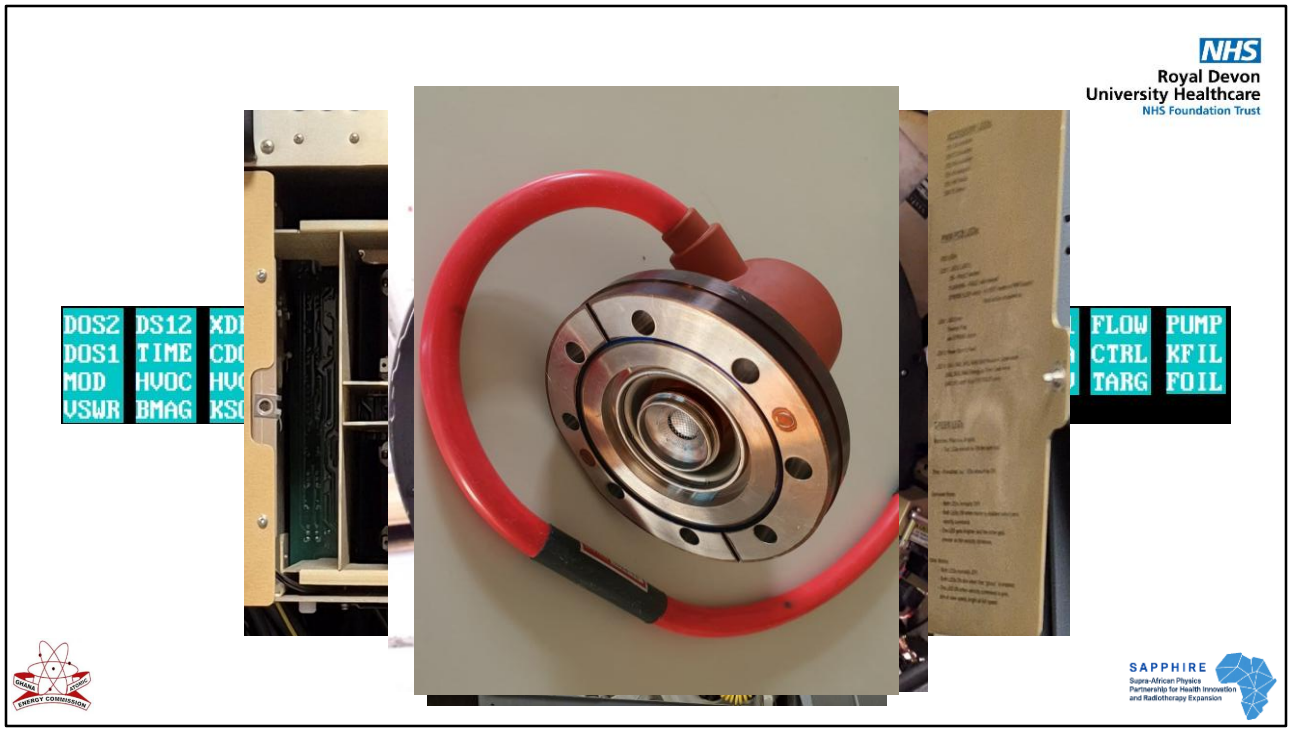
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1. Emergency OFF → No power
2. Standby → Limited power (i.e.: movements, water pump)
3. On → producing heat (KFIL, KSOL, ASOL, Gun)
4. Ready → to treat (BMAG and Gun set)
5. Beam ON → high voltage on (PFN)

Interlocks event:

- Prevent linac from entering machine state
- Takes linac out of machine state
- To protect patient, staff, machine

SAPPHIRE Supra-African Physics Partnership for Health Innovation and Radiotherapy Expansion



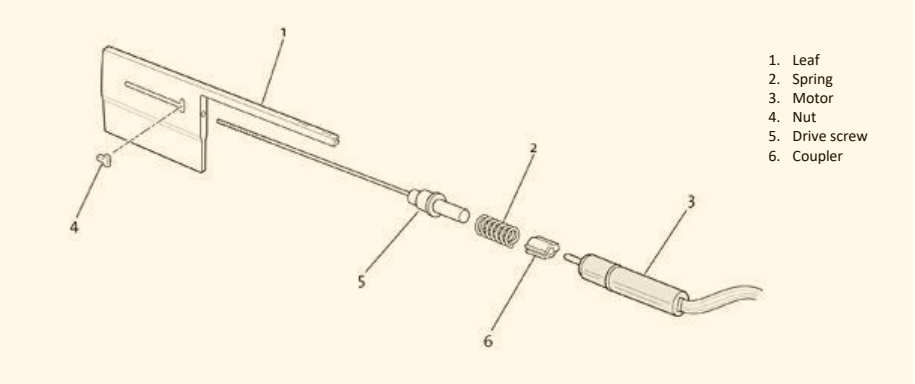
- Challenges managing Linac's
- Documentation
- Varian Clinac overview
- Machine states and interlocks
- Modulator
- Console
- Stand
- VacIon system
- Auxiliary electronics and machine modes
- Carrousel
- E-Gun
- Water system

Varian iX linac imaging – system overview

Components covered in lecture
- MV panel
- kV panel
- X-ray tube
- Norm chamber
- MV digitiser



Varian iX linac MLC – system overview



1. Leaf
2. Spring
3. Motor
4. Nut
5. Drive screw
6. Coupler

- Collision avoidance drivetrain
- Drive nuts are designed to be sacrificed to prevent damage to drivetrain in event of collision

MLC Performance tests:
- Backlash
- PWM
- Velocity

Dosimetry system lecture
Modulator lecture



Show and tell:

- iX target
- Electron gun
- VacIon pump
- Stripped MLC carriage
- Position and Angle Steering coils
- Parts broken through radiation damage





- Visit to Ghana Atomic Energy commission – labs
- University visit
- Ghana national museum
- Art market


Questions