

Linac Professional Education Platform Contents

1. Access to radiotherapy content library

- Medical Physics textbook (contents below)
- Physics Quality Assurance textbook (contents below)
- Service Technician textbook (contents below)
- Quizzes for each chapter

2. Access to SIMAC

- clinical medical linear accelerator simulator for both Klystron and magnetron based linacs.

3. Classroom platform to monitor and teach material

- Student access management
- Grading features
- Transcript records

4. SIMAC Labs

- Labs on clinical medical linear accelerator procedures

Physics Textbook

Chapter 1: Accelerator waveguides

- Introduction
- Direct acceleration
- Series adding of electron energy
- Waveguides
- Phase velocity and guide wavelength
- Wave Impedance
- Acceleration timing
- Real accelerator structures
- Standing wave and travelling wave accelerating waveguides
- Energy Switch
- Summary
- Accelerator Waveguide Quiz

Chapter 2: Electron Beams

- Electron Path Through the Medical Linac
- Gun Emission
- Electron energy gain
- Bending Magnet
- Summary
- Electron Beam Quiz

Chapter 3: Photon Beams

- Classical Theory of Bremsstrahlung
- Quantum mechanical theory of Bremsstrahlung
- Energy dependence of angular photon distribution
- Thin and thick targets
- Thick target spectrum
- Beam quality specification
- Bremsstrahlung directional dependence
- Bremsstrahlung production efficiency
- Bremsstrahlung in SIMAC
- Results of bremsstrahlung calculations in SIMAC
- Beam flattening
- Energy dependence of beam flattening and beam flatness
- Beam symmetry

Chapter 4: Medical Linac Configuration

- Medical Linac Configurations
- Treatment Head Configuration
- Linac Mode Configuration

Chapter 5: Beam Steering

- Beam Symmetry
- The Elekta beam steering system

Chapter 6: Beam Dosimetry & PRF

- Ion Chambers in Medical Linacs*
- Ion chamber current collection*
- Linac Calibration*
- Dose Rate Control*
- Dose rate servo*

Chapter 7: Klystrons

- Microwave power sources for medical linear accelerators*
- Klystron overview*
- Description of the klystron's mode of operation*
- Bunching process*
- Klystron saturation*
- Klystron Modelling*
- Magnetic focusing*
- Klystron construction*

Chapter 8: Magnetrons

- Mode of Oscillation*
- Magnetron anode and RF*
- Resonant modes*
- Mode separation*
- Magnetron cathode*
- Bunch formation in rotational motion*
- Output coupler and frequency tuning*
- Magnetron operating values*

Chapter 9: Modulators

- Resonant Charging*
- Pulse Forming Network (PFN)*
- Thyratron switch*
- PFN Discharge*
- Pulse transformer*
- Pulse noise*

Chapter 10: Waveforms

- Pulse timing in a medical linear accelerator*
- Pulsed nature of the linear accelerator*
- Relationship between gun injection, reflected RF power, and beam output*

Physics Quality Assurance Textbook

Chapter 1: Maintaining the Quality of Radiotherapy Treatments

Chapter 2: Quality Assurance Protocols

Chapter 3: Frequency of Quality Assurance Testing

Chapter 4: Return to service Process

Chapter 5: Repairs and Return to Service

Chapter 6: Water Tank Measurements

Chapter 7: Beam Flatness and Symmetry

Chapter 8: Adjusting Beam Symmetry

-The Varian Sterring System

-The Elekta Sterring System

Chapter 9: Description of QA Tests

-Output Constancy

-Radiation to Light field Coincidence

-Isocentre

-Treatment Table

-Laser Alignment

-Optical Distance Indicator

-Dosimetric Leaf Gap

-Picket Fence Test

Chapter 10: Instruments for Linear Accelerator Quality Assurance

-Ion Chambers and electrometers

-Water and Solid Water Phantoms

-Ion Chamber Arrays

-Devices for VMAT and Patient Specific Measurements

Service Technician Textbook

Chapter 1: Electron Gun

- Electron Path Through the Medical Linac*
- Behaviour of the electron gun*
- Dispenser Cathodes*
- Thermionic Diode*
- Diode Electrical Characteristics*
- Capture Efficiency*
- Gun Current Control*

Chapter 2: Accelerator Waveguide

- Direct Acceleration*
- Series Adding of Electron Energy*
- Waveguides*
- Phase Velocity and Guide Wavelength*
- Accelerator Timing*
- Wave Impedance*
- Shunt Impedance*
- Accelerator Energy Gain*
- Real Accelerator Structures*
- Energy Switch*
- Trouble Shooting the Accelerator Waveguide*

Chapter 3: Bending Magnet

- Achromatic focusing*
- Bending Magnet Current*
- Energy Slits*
- Bending Magnet Examples*
- Bending Magnet Construction*

Chapter 4: Treatment Head

- *Summary*

Chapter 5: Target

- Simple Theory of Bremsstrahlung*
- Example with Tungsten*
- Bremsstrahlung Production Efficiency*
- Energy Dependence of Angular Photon Distribution*
- Bremsstrahlung Directional Dependence*
- Flattening Filter: Beam Flatness and Symmetry*

Chapter 6: Ion Chamber

- The Triax Cable*
- Ion Chamber in Medical Linacs*
- Ion Chamber Current Collection*
- Varian Style Ion Chamber*
- Elekta Style Ion Chamber*

- Linac Calibration
- Dose Rate Control
- Dose Rate Servo

Chapter 7: Carousel

- Mechanical Makeup of the Carrousel
- Flattening Filters

Chapter 8: Collimator

- The Collimator Jaws and Light Field
- The Multi-Leaf Collimator (MLC)

Chapter 9: Klystron

- Microwave Power Sources for Medical Linear Accelerators
- Klystron Overview
- Description of the Klystron's Mode of Operation
- Bunching Process
- Klystron Saturation
- Magnetic Focusing
- Klystron Construction

Chapter 10: Magnetron

- Power Sources
- Mode of Oscillation
- Magnetron Anode and RF
- Resonant Modes
- Filament heater cutback
- Bunch Formation in Rotational Mode
- Output Coupler and Frequency Tuning
- Magnetron Operating Values

Chapter 11: Modulators

- PFN Discharge
- PFN Charging
- Thyratron Switch
- Pulse Transformer
- Modulator Module Preventative Maintenance

Chapter 12: Safety Theory

- Safety Concepts
- Systems
- STAMP

Chapter 13: Linac Hazards

- Disabling linac operation when servicing
- Transmission waveguide
- Presence of other hazardous materials in the linear accelerator - Material Safety Data Sheets
- Ozone
- Mechanical hazards in medical linear accelerators
- Electric Shock Hazard

- Microwave Tube Operating Hazards*
- High Temperature Surfaces*
- Laser Beams*
- Other safety areas*

Chapter 14: Linac Incidents

- Incident at Białystok, Poland*
- Incident at Zaragoza, Spain*
- Therac 25 accidents*
- Varian Symmetry Recall*

Chapter 15: Interlocks

- Case Study 1: Therac 25*
- Case Study 2: Spain Incident*
- Case Study 3: Poland Incident*
- Varian Interlock Upgrade*
- Interlocks & Safety Systems Summary*

Chapter 16: Waveforms and Numbers

- Pulse timing in a medical linear accelerator*
- Pulsed nature of the linear accelerator*
- RF Reflected pulse*
- Typical values, and the use of preventative maintenance*

Chapter 17: Heat Management

- Sources of heat in medical linacs*
- Water cooling*
- Cooling circuits for two accelerator configurations*
- Accelerator temperature control*

Chapter 18: AFC

- Principles of an Automatic Frequency Control system*
- AFC systems for linear accelerator frequency control*
- AFC components*

Chapter 19: Preventive Maintenance

- Scheduling*
- Downtime Reduction*

Chapter 20: Corrective Maintenance

- Service request Process*
- Site Preparation*
- Trouble Shooting*
- Repairs*
- Commissioning and Decommissioning*
- Maintenance Management*
- Parts*
- Waste Disposal*

SIMAC Labs

SIMAC Version 1 Labs:

- Beam Loading*
- Energy Correction with Bending Magnet*
- Flattening Filters*
- Beam Steering Part 1*
- Beam Steering Part 2*
- Adjusting the RF Driver*
- Adjusting the Klystron Pulse Voltage*
- Beam Finding*

SIMAC Version 2 Labs:

- The PFN charging cycle*
- The de spiking circuit*
- Magnetron output power*
- RF reflected pulse*
- Electron Gun*
- Beam loading for travelling wave accelerator with diode gun*
- Beam loading for standing wave accelerator with triode gun*
- RF feedback phase adjustment for travelling wave accelerator*
- Steering for 270 degree bend magnet*
- Steering for slalom style bending magnet*
- 270 degree bending magnet*
- Slalom style bending magnet*
- Klystron pulse voltage*
- Electron beam angle of incidence on target*
- Effect of feedback loop on travelling wave load line*
- Effect of energy switch on load line for a standing wave accelerator*