Radiation Dosimetry:
Depth-Dose Distributions and Treatment Planning

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Abstract

This report presents a comprehensive analysis of radiation dosimetry for external beam radiotherapy. We compute depth-dose distributions for photon, electron, and proton beams, analyze tissue inhomogeneity corrections, evaluate dose-volume histograms, and compare treatment planning techniques. All calculations use PythonTeX for reproducibility.

Contents

Chapter 1

Introduction

Radiation dosimetry quantifies energy deposition in tissue. The absorbed dose is defined as:

$$D = \frac{d\bar{\varepsilon}}{dm} \tag{1.1}$$

where $d\bar{\varepsilon}$ is the mean energy imparted to matter of mass dm.

1.1 Dose Quantities

- Absorbed dose D (Gy): Energy per unit mass
- Kerma K (Gy): Kinetic energy released per unit mass
- Exposure X (R): Ionization in air

Chapter 2

Photon Beam Dosimetry

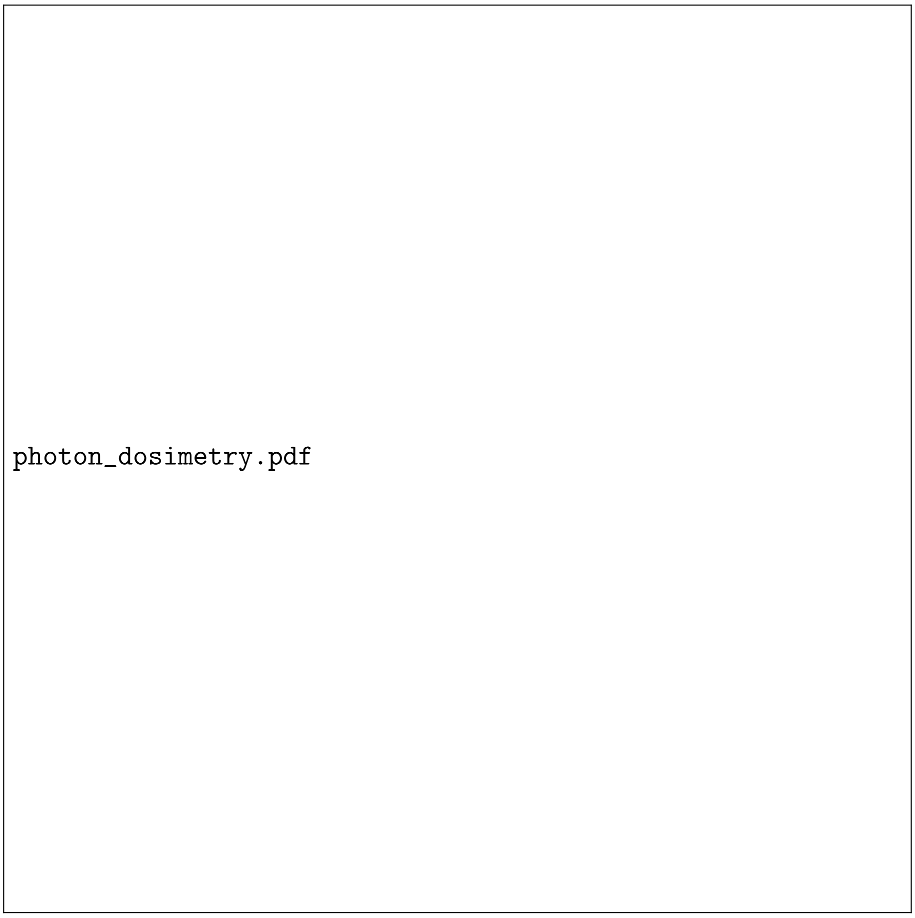

Figure 2.1: Photon dosimetry: (a) energy dependence, (b) field size, (c) PDD vs TAR, (d) characteristic depths, (e) buildup, (f) surface dose.

Chapter 3

Electron and Proton Beams

particle_dosimetry.pdf

Figure 3.1: Particle dosimetry: (a) electron PDD, (b) proton Bragg peaks, (c) SOBP, (d) beam comparison, (e) electron ranges, (f) proton range.

Chapter 4

Dose-Volume Analysis

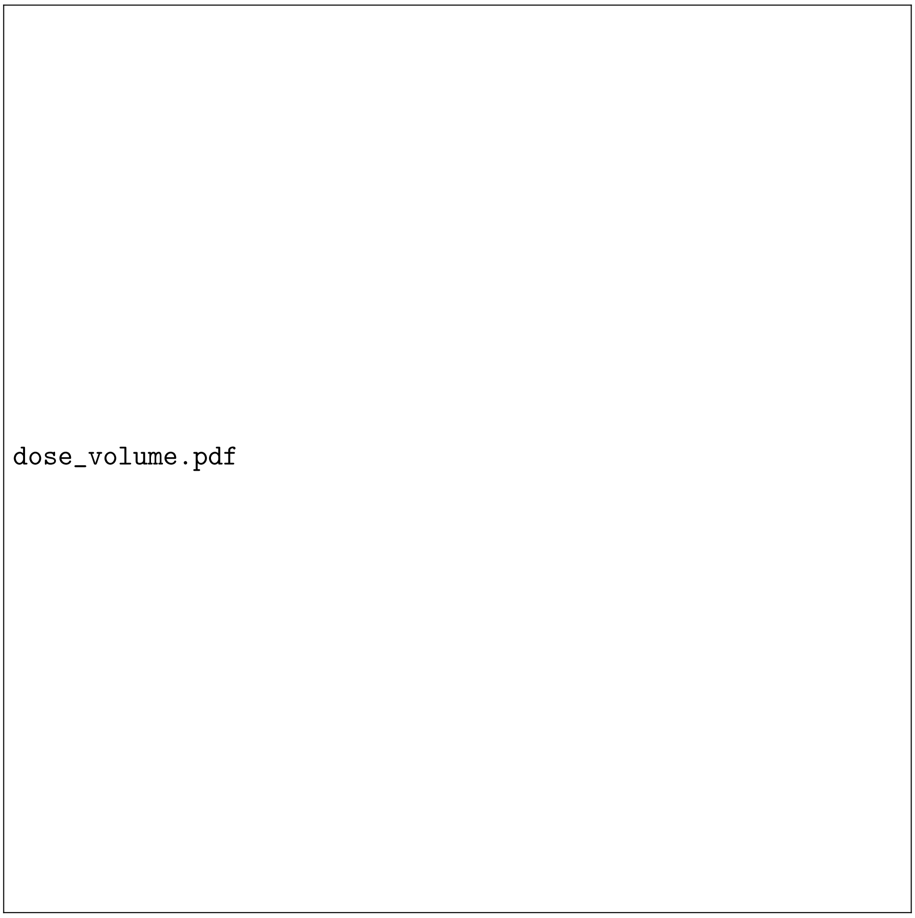

Figure 4.1: Dose-volume analysis: (a) cumulative DVH, (b) differential DVH, (c) DVH metrics.

Chapter 5

Numerical Results

Table 5.1: Radiation dosimetry results

Parameter	Value	Units
??	??	??
??	??	??
??	??	??
??	??	??
??	??	??
??	??	??

Chapter 6

Conclusions

1. Higher photon energies penetrate deeper with skin sparing
2. Electrons have sharp dose falloff at their range
3. Protons offer superior dose conformity with Bragg peak
4. SOBP allows tumor coverage with proton therapy
5. DVH analysis quantifies target coverage and OAR sparing
6. Treatment planning optimizes therapeutic ratio