Contents

Chapter 1	**Radiation Sources**	**1**
I.	Units and Definitions	2
II.	Fast Electron Sources	3
III.	Heavy Charged Particle Sources	6
IV.	Sources of Electromagnetic Radiation	11
V.	Neutron Sources	19
Chapter 2	**Radiation Interactions**	**29**
I.	Interaction of Heavy Charged Particles	30
II.	Interaction of Fast Electrons	43
III.	Interaction of Gamma Rays	48
IV.	Interaction of Neutrons	55
V.	Radiation Exposure and Dose	57
Chapter 3	**Counting Statistics and Error Prediction**	**65**
I.	Characterization of Data	66
II.	Statistical Models	70
III.	Application of Statistical Models	79
IV.	Error Propagation	86
V.	Optimization of Counting Experiments	92
VI.	Limits of Detectability	94
VII.	Distribution of Time Intervals	97
Chapter 4	**General Properties of Radiation Detectors**	**103**
I.	Simplified Detector Model	103
II.	Modes of Detector Operation	104
III.	Pulse Height Spectra	110
IV.	Counting Curves and Plateaus	111
V.	Energy Resolution	113
VI.	Detection Efficiency	116
VII.	Dead Time	119
Chapter 5	**Ionization Chambers**	**129**
I.	The Ionization Process in Gases	129
II.	Charge Migration and Collection	133
III.	Design and Operation of DC Ion Chambers	136
IV.	Radiation Dose Measurement with Ion Chambers	140
V.	Applications of DC Ion Chambers	145
VI.	Pulse Mode Operation	148

Chapter 6	**Proportional Counters**	**159**
I.	Gas Multiplication	159
II.	Design Features of Proportional Counters	164
III.	Proportional Counter Performance	169
IV.	Detection Efficiency and Counting Curves	184
V.	Variants of the Proportional Counter Design	188
Chapter 7	**Geiger–Mueller Counters**	**201**
I.	The Geiger Discharge	202
II.	Fill Gases	204
III.	Quenching	204
IV.	Time Behavior	206
V.	The Geiger Counting Plateau	208
VI.	Design Features	210
VII.	Counting Efficiency	212
VIII.	Time-to-First-Count Method	214
IX.	G-M Survey Meters	215
Chapter 8	**Scintillation Detector Principles**	**219**
I.	Organic Scintillators	220
II.	Inorganic Scintillators	231
III.	Light Collection and Scintillator Mounting	247
Chapter 9	**Photomultiplier Tubes and Photodiodes**	**265**
I.	Introduction	265
II.	The Photocathode	266
III.	Electron Multiplication	270
IV.	Photomultiplier Tube Characteristics	274
V.	Ancillary Equipment Required with Photomultiplier Tubes	283
VI.	Photodiodes as Substitutes for Photomultiplier Tubes	287
VII.	Scintillation Pulse Shape Analysis	292
VIII.	Hybrid Photomultiplier Tubes	297
IX.	Position-Sensing Photomultiplier Tubes	300
X.	Photoionization Detectors	302
Chapter 10	**Radiation Spectroscopy with Scintillators**	**307**
I.	General Consideration in Gamma-Ray Spectroscopy	307
II.	Gamma-ray Interactions	308
III.	Predicted Response Functions	312
IV.	Properties of Scintillation Gamma-Ray Spectrometers	326
V.	Response of Scintillation Detectors to Neutrons	342
VI.	Electron Spectroscopy with Scintillators	343
VII.	Specialized Detector Configurations Based on Scintillation	344
Chapter 11	**Semiconductor Diode Detectors**	**353**
I.	Semiconductor Properties	354
II.	The Action of Ionizing Radiation in Semiconductors	365
III.	Semiconductors as Radiation Detectors	367
IV.	Semiconductor Detector Configurations	377
V.	Operational Characteristics	382

VI.	Applications of Silicon Diode Detectors	391
Chapter 12	**Germanium Gamma-Ray Detectors**	**405**
I.	General Considerations	405
II.	Configurations of Germanium Detectors	406
III.	Germanium Detector Operational Characteristics	413
IV.	Gamma-Ray Spectroscopy with Germanium Detectors	426
Chapter 13	**Other Solid-State Detectors**	**457**
I.	Lithium-Drifted Silicon Detectors	457
II.	Semiconductor Materials Other than Silicon or Germanium	477
III.	Avalanche Detectors	489
IV.	Photoconductive Detectors	491
V.	Position-Sensitive Semiconductor Detectors	492
Chapter 14	**Slow Neutron Detection Methods**	**505**
I.	Nuclear Reactions of Interest in Neutron Detection	505
II.	Detectors Based on the Boron Reaction	509
III.	Detectors Based on Other Conversion Reactions	517
IV.	Reactor Instrumentation	522
Chapter 15	**Fast Neutron Detection and Spectroscopy**	**537**
I.	Counters Based on Neutron Moderation	538
II.	Detectors Based on Fast Neutron-Induced Reactions	545
III.	Detectors that Utilize Fast Neutron Scattering	553
Chapter 16	**Pulse Processing and Shaping**	**577**
I.	Device Impedances	577
II.	Coaxial Cables	578
III.	Pulse Shaping	585
Chapter 17	**Linear and Logic Pulse Functions**	**605**
I.	Linear and Logic Pulses	605
II.	Instrument Standards	606
III.	Application Specific Integrated Circuits (ASICs)	607
IV.	Summary of Pulse-Processing Units	608
V.	Components Common to Many Applications	610
VI.	Pulse Counting Systems	619
VII.	Pulse Height Analysis Systems	626
VIII.	Digital Pulse Processing	647
IX.	Systems Involving Pulse Timing	659
X.	Pulse Shape Discrimination	679
Chapter 18	**Multichannel Pulse Analysis**	**685**
I.	Single-Channel Methods	685
II.	General Multichannel Characteristics	687
III.	The Multichannel Analyzer	691
IV.	Spectrum Stabilization and Relocation	700
V.	Spectrum Analysis	704

Chapter 19	**Miscellaneous Detector Types**	**711**
I.	Cherenkov Detectors	711
II.	Gas-Filled Detectors in Self-Quenched Streamer Mode	714
III.	High-Pressure Xenon Spectrometers	716
IV.	Liquid Ionization and Proportional Counters	717
V.	Cryogenic and Superconducting Detectors	719
VI.	Photographic Emulsions	727
VII.	Thermoluminescent Dosimeters and Image Plates	731
VIII.	Track-Etch Detectors	736
IX.	Superheated Drop or "Bubble Detectors"	741
X.	Neutron Detection by Activation	744
XI.	Detection Methods Based on Integrated Circuit Components	751
Chapter 20	**Background and Detector Shielding**	**757**
I.	Sources of Background	757
II.	Background in Gamma-Ray Spectra	762
III.	Background in Other Detectors	766
IV.	Shielding Materials	767
V.	Active Methods of Background Reduction	771
Appendix A	**The NIM and CAMAC Instrumentation Standards**	**777**
Appendix B	**Derivation of the Expression for Sample Variance in Chapter 3**	**783**
Appendix C	**Statistical Behavior of Counting Data for Variable Mean Value**	**785**
Appendix D	**The Shockley-Ramo Theorem for Induced Charge**	**789**
List of Tables		**795**
Index		**796**