

Contents

1	Introduction	1
	References	3
 Part I Basics		
2	Ultra Short and Intense Laser Pulses	7
2.1	Mathematical Description	7
2.2	Single Electron Interaction	10
2.3	Ponderomotive Force	12
	References	14
3	Plasma Physics	17
3.1	Light Propagation in Plasmas	17
3.2	Debye Length	20
3.3	Plasma Expansion	21
	References	23
4	Ion Acceleration	25
4.1	Absorption Mechanisms	25
4.1.1	Resonance Absorption	25
4.1.2	Brunel Absorption (Vacuum Heating)	27
4.1.3	Ponderomotive Acceleration, Hole Boring and $j \times B$ Heating	28
4.2	Target Normal Sheath Acceleration	29
4.3	Alternative Acceleration Mechanisms	32
	References	34
5	Laser System	37
5.1	Ti:Sa Laser System	37
5.2	Nd:glass Laser System	40

5.3 Synchronization	41
References	44

Part II Proton Beam Characterization

6 Proton and Ion Spectra	47
6.1 Thomson Spectrometer	47
6.2 Quasi-Monoenergetic Deuteron Bursts	50
6.3 Irregularities of the Thomson Parabolas.	51
References	52
7 Beam Emittance.	55
7.1 Virtual Source	56
7.2 Measurement of the Beam Emittance	57
References	59
8 Virtual Source Dynamics	61
8.1 Energy Dependent Measurement of Pinhole Projections	61
8.2 Shape of the Proton Beam.	64
8.3 Energy Dependence of the Virtual Source.	67
References	67

Part III Proton Imaging

9 Principle of Proton Imaging	71
9.1 Principle Experimental Setup.	71
9.2 Gated Multi-Channel Plates	73
9.3 Time Resolution.	74
References	75
10 Imaging Plasmas of Irradiated Foils	77
10.1 Experimental Setup.	77
10.2 2D-Proton Images.	78
References	81
11 Mass-Limited Targets.	83
11.1 Experimental Setup.	84
11.2 Water Droplet Generation	85
11.3 Proton Images of Irradiated Water Droplets.	87
11.4 3D-Particle Tracing.	91
References	93

12	Streak Deflectometry	97
12.1	The Proton Streak Camera.	97
12.2	Streaking Transient Electric Fields	99
12.3	Fitting Calculations.	101
12.4	Particle Tracing	103
	References	106
13	Summary and Outlook	107
 Part IV Appendix		
14	Zernike Polynomials	111
	Reference	112
15	Gated MCPs	113
	Curriculum Vitae	117
	Index	121