

INDEX

ABA (*see Aetron-Blume-Atkinson*)
Absorption devices, 705–771
Accelerator components and systems
 alignment system, 65, 66, 821–885
 cooling water, 71, 72, 935–988
 drive and phasing, 70, 271–301, 383–409
 high power modulators, 69, 411–462
 injector, 69, 70, 241–269
 instrumentation and control, 74–78, 489–544
 klystrons, 66–68, 303–344
 positron source, 72–74, 545–583
 structure, 63–65, 95–162
 vacuum system, 70, 71, 887–933
Accelerator design
 economic considerations, 100
 electric gradient, 100
 feed interval, 101–103
 frequency, choice of, 95
 frequency, dependence of machine parameters on, 96
 length, 99
 repetition rate, 104
 RF power sources, 101
 RF pulse length, 103, 104
Accelerator housing, 1121–1124
Accelerator structure, 63–65, 95–162
 attenuation parameter, 115

beam loading, 116
cold test, 131, 132
constant gradient, 109–115
constant impedance, 109–115
conversion efficiency, 117
coupled resonator wave, equations for, 120, 121
coupler asymmetry, 144–148
elementary principles of operation, 60–62
empirical design of, 126–136
energy loss in idle sections, 118
fabrication, 148–157
filling time, 118
filter characteristics, 119, 120
frequency sensitivity, 118
group velocity, 118, 133, 134
matching, 136–142
operating mode, 104–108
phase velocity, 61, 62, 133
 Q , 135
space harmonic amplitude, 135
transient behavior, 123–125
tuning, 136–142, 153–157
Accelerator support system, 821–885
accelerator sections, 849–583
beam analyzing stations, 858, 859
beam switchyard, 867–882
 alignment of components, 877–882

- calculations, 869, 870
- laser reference line 869,
- requirements, 867, 868
- support stands, 875–877
- tape bench, 873–875
- beam switchyard support girders, 860
- design criteria, 844–846
- drift sections, 853–855
- injector girder, 858
- installation, 861–866
- laser alignment hardware, 848, 849
- light pipe vacuum restraints, 860, 861
- monument target system, 855, 856
- positron source girders, 857, 858
- quadrupole singlets, 859, 860
- twenty-four inch light pipe, 846–848
- Administration**, 39–53
 - fiscal experience, 47–52
 - manpower, 52
 - organization, 39–45
 - scheduling, 45–47
 - staff classification, 41–43
- Administration and engineering building**, 1102–1104
- Aetron-Blume-Atkinson**, 34
- Alignment system**, 65, 66, 821–885
 - (*see also Accelerator support system*)
- Altenmueller, O.**, 211
- Amplitron**, 303, 304
- Antiparticles**, 10
- Architecture, buildings**, 1099, 1100
- Asymmetry, coupler**, 144–148
- Atomic Energy Commission**, 7, 8
- Attenuation parameter**, 115
- Auditorium**, 1104, 1105

- Barber, W. C.**, 32
- Beam absorption devices**, 705–771
- Beam analyzing stations**, 193, 522–529
 - (*see also Instrumentation and control*)
- Beam breakup**, 88, 89, 115, 203–237
 - coupled resonator model, 209
 - differential equation, 207
 - effect of focusing, 209
 - effects of space charge, 204
 - isolated cavity model, 214–216
 - multicavity model, 206
- numerical computation**, 209
- observation and experimental laws**, 217–233
- remedies**, 234–237
 - brute force, 235
 - choice of, 235
 - improvement in threshold, 235–237
 - Landau damping, 234
 - RF cancellation, 234
 - RF fixes, 234
 - starting noise suppression, 234
- resistive wall effects**, 204
- starting sources**, 207
- theory and calculations**, 203–217
- Beam characteristics**, 84–89
- Beam control system**, 193–202
 - beam analyzing stations, 193
 - degaussing and magnetic shielding, 193
 - description, 195, 196
 - effects of magnetic fields, 195–197
- long ion chamber**, 193
- standard drift section**
 - beam intensity monitor, 194
 - beam position monitor, 193
 - beam profile monitor, 194
 - beam scraper, 194
 - quadrupole doublet, 193
 - reference cavity, 193
 - steering dipole, 194
- Beam current monitor**, 625–658
- Beam deflectors, injector**, 257–259
- Beam dynamics**, 163–237
 - equations of motion, 163–166
 - external focusing, 166–192
 - phase space, 167–169, 201, 202
- Beam guidance system**, 517–520
- Beam induction technique** (*see Phasing*)
- Beam interaction with materials**, 706–717
 - cascade shower development, 706–709
 - heat transfer problems, 712–715
 - low power dump, 727, 729
 - design, 728, 729
 - power deposition and temperature rise, 709–712
- thermal fatigue**, 716, 717
- thermal shock**, 717
- thermal stress development**, 715, 716

- (*see also* Radiation damage to components)
- Beam knockout system, 69, 484
- Beam loading, 116
- Beam monitoring system, 500–516
(*see also* Instrumentation and control)
- Beam switchyard, 78–80, 585–615, 1129–1134
- beam current monitor, 652–658
 - beam monitors, 651
 - description, 585–589
 - design, 609–612, 651, 652
 - equipment protection system, 651
 - instrumentation, 651–704
 - interlock system, 687–694
 - description, 687, 688
 - differential current interlock, 694
 - electronics, 688, 689
 - ionization chamber, 689–691
 - pulsed magnet, 693, 694
 - thermal protection, 691, 692
 - magnet power supplies, 651
 - magnets, 611, 612
 - operating experience, 612, 613
 - position monitors, 658–660
 - profile monitors, 660–666
 - Cerenkov light, 662, 663
 - optics and TV system, 665–667
 - synchrotron light, 660–662
 - zinc-sulfide screens, 664, 665
 - secondary emission monitors, 667, 668
 - shielding, 608, 609
 - spectrum instrumentation
 - drift indicator, 673
 - spectrum analyzer, 671, 672
 - tune-up monitor, 670
 - support and alignment system (*see* Accelerator support system)
 - transport and momentum analysis, 589–593
 - transport control system, 651
 - transport system
 - A and B, 591, 592
 - alignment, 602–604
 - computer, 675–682
 - control, 673–687
 - design, 593–599
 - induced radioactivity, 607, 608
 - magnetic measurements, 674, 675
 - manual magnet control, 673, 674
 - optimization of system A, 599–601
 - primary radiation, 606
 - secondary radiation, 606, 607
 - selection of parameters, 592, 593
 - slit/collimator control, 683–687
 - thermal effects, 605, 606
 - vacuum system, 610, 916–929
 - water systems, 610, 972–988
- Beam transport system, 166–192
- adiabatically varying, 171, 172
 - choice of, 187, 188
 - description, 197, 198
 - effects of quadrupole misalignment, 179–181
 - equation of motion, 169
 - error analysis of, alternative systems, 181–187
 - injector, 266–268
 - matrix formulation, 169, 170
 - operation, 200
 - periodic, 170
 - properties of alternative types of, 173–179
 - transport properties, 199, 200
 - transverse perturbations
 - accelerator misalignment, 191, 192
 - coulpler asymmetry, 190, 191
 - scattering by residual gas, 188
 - stray magnetic fields, 189, 190
- Becker, G. E., 28
- Betatron, 27
- Bohr, N., 10
- Brown, K. L., 28, 32
- Bubble chambers, 24, 25
- Buildings, 55–57, 1095–1149
- accelerator housing, 1121–1124
 - administration and engineering, 1102–1104
 - architectural considerations, 1099, 1100
 - auditorium and cafeteria, 1104, 1105
 - beam switchyard, 1129–1134
 - central control building, 1127, 1128
 - central laboratory, 1106–1108
 - central utility building, 1117, 1118
 - crafts shop, 1115, 1116
 - cryogenic laboratory, 1109–1111

- data assembly building, 490, 1134, 1135
 electrical substations, 1118, 1119
 electronics building, 1114, 1115
 fabrication building, 1113, 1114
 fire station, 1119, 1120
 general services building, 1116, 1117
 heavy assembly building, 1112, 1113
 klystron gallery, 1124–1126
 laser room, 1128, 1129
 master plan, 1095, 1096
 research area, 81, 82, 1135–1150
 - B-beam line, 1146
 - beam dump east, 1143, 1144
 - counting house, 1139
 - end station A, 1139–1142
 - 54-inch spark chamber, 1149
 - 40-inch bubble chamber, 1149
 - portable, 1149, 1150
 - streamer chamber, 1143
 - yard, 1137–1139
 shops dining room, 1115
 shops and support buildings, 1111–1135
 space requirements, 1096–1098
 structural design, 1100
 temporary computer facility, 1108, 1109
 test laboratory, 1101, 1102
Bunker, F. W., 29
- Cafeteria**, 1104, 1105
 Cascade shower development, 706–709
Caswell, D. A., 28
Central control (*see* Instrumentation and control)
 Central control building, 1127, 1128
 Central laboratory, 1106–1108
 Central utility building, 1117, 1118
 Characteristics, beam, 84–89
 Chodorow, M., 28, 29
 Chu, E. L., 27, 29
 Collimators and slits, 730–770
 - actuation and drive, 750–759
 - high power, 731–746
 - high Z, 746–750
 - protection collimators, 759–770
 Conservation, 11
 Constant gradient, 109–115
- Constant impedance, 109–115
 Conversion efficiency, 117
 Cooling water systems, 71, 72, 935–988
 - accelerator systems, 943–968
 - B-beam target, 976–978
 - beam switchyard and end stations, 610, 972–988
 - cooling towers, 968
 - disk-loaded waveguide, 945–952
 - distilled water plant, 940, 941
 - general purpose, 936–940
 - klystron, 955–959
 - magnet coil, 972–974
 - magnet power supplies, 974, 975
 - operating experience, 969–971, 986, 987
 - positron source, 959–968
 - pulsed magnets, 976
 - radioactive systems, 978–982
 - rectangular waveguide, 952–955
 - target area, 982–985
 Coupler asymmetry, 144–148
 Crafts shop, 1115, 1116
 Cryogenic laboratory, 1109–1111
 Current monitor, beam, 652–658
- Data assembly building, 490, 1134, 1135
 Data handling system, 529–538
Debs, R., 32
 Degaussing, 193–197
Dirac, P. A. M., 10
 Directional couplers, waveguide, 364–376
Drell, S. D., 18
 Drift indicator, 673
 Drift section, 193–194
 Drive system, 70, 271–301
 - basic requirements, 271
 - drop out cables, 298, 299
 - frequency multipliers, 275, 288–291
 - IφA* unit, 275, 297, 298
 - main booster amplifier, 275, 279–281, 299, 300
 - main drive line, 275, 281–287
 - master oscillator, 274–278, 299
 - standby equipment, 299, 300
 - sub-booster klystron, 292, 293
 - sub-booster modulator, 275, 293–296, 300

- sub-drive line, 275, 287, 288
 switchable phase shifter, 298
Drop-out cables (*see* Drive system)
- Eldredge, A. L.**, 28, 29
Electrical power system, 989–1028
 emergency power, 1020, 1021
 fire alarm system, 1016, 1017
 grounding, 1017–1020
 operational experience, 1022–1026
 power consumption, 1024, 1025
 power contracts, 1024, 1025
 power costs, 1024, 1025, 1027
 power factor correction, 1025, 1026
 primary services
 master substation, 994–997
 220 and 60 kV lines, 992–994
 secondary distribution
 beam switchyard, 1005–1007
 campus facilities, 1015, 1016
 end station area, 1007, 1008
 klystron gallery, 1001–1004
 positron source, 1004, 1005
 12.47 kV distribution, 997–1001
Electrical substations, 1118, 1119
Electron accelerators, 2
Electron gun, klystron, 308–310
Electron gun (*see* Injector)
Electron scattering, 30
Electronics building, 1114, 1115
Emergency power, 1020, 1021
Erosion control, site, 1092, 1093
Experiments
 acceptance, 6
 criteria for selection, 6
 execution, 7
 proposals, 6
 records, 7
- Fabrication, accelerator structure**, 148–157
Fabrication building, 1113, 1114
Filling time, 118
Fire alarm system, 1150, 1151
Fire station, 1119, 1120
Flanges, waveguide, 374–376
Focusing, 167–192
 (*see also* Beam dynamics)
- Franklin, L. H.**, 29
Frequency, accelerator, 95, 96
Frequency multipliers (*see* Drive system)
Fresnel lens (*see* Laser alignment system)
- Geisler, W. S.**, 29
General services building, 1116, 1117
Geology, site, 1089, 1090
Ginzton, E. L., 27–29
Girder assembly and installation, 157–160
Group velocity, 118, 133, 134
- Hansen, W. W.**, 27, 29
Harrison, A. E., 28
Heavy assembly building, 1112, 1113
Herrmannsfeldt, W. B., 244, 262
Hiestand, N. P., Jr., 28
High Energy Physics Laboratory, 31
High power collimators, 731–746
High power dump, 717–727
 criteria, 717, 718
 design, 718–720
 materials, 723
 radiolysis and radioactivity, 725–727
 water system, 723, 724
 window, 721, 722
High Z collimators, 746–750
Hildebrand, R. H., 36
Hofstadter, R., 18, 30, 32
- I_φA unit** (*see* Drive system)
Initial operating results, 82–94
Initial research equipment
 bubble chambers, 24
 large analyzing magnets, 24
 spectrometers, 22
Injector, 69, 70, 241–269
 beam structure equipment
 initial beam deflector, 257–259
 second beam deflector, 259
 beam transport, 266–268
 radial phase space, 267, 268
 solenoid, 267
 system description, 266, 267
 electron gun
 computer design, 244, 245

- general characteristics, 243, 244
- mechanical design, 246–249
- performance, 249–251
- phase space, 245, 246
- girder, 858**
- gun modulator, 253–256**
 - bias programming, 254, 255
 - physical design, 253, 254
 - pulse width programming, 255, 256
- microwave system, 259–266**
 - accelerator section, 263, 264
 - bunch monitor, 264, 265
 - buncher, 259–263
 - measurement of bunching, 265, 266
 - prebuncher, 263
- modulator, 484**
 - multiple beam capability, 252–259
 - specifications, 241–243
- Instrumentation and control, 74–78, 489–544**
 - beam analysis stations, 522–529
 - electromagnet characteristics, 525, 526
 - energy analyzer foils, 526, 527
 - optical design, 523–525
 - beam control concepts, 492, 493
 - beam guidance system
 - controllers, 519, 520
 - power supplies, 517–519
 - beam monitoring system, 500–516
 - beam switchyard monitors, 507–510
 - cavities, 503–507
 - construction and installation, 506, 507
 - data transmission and display, 514–516
 - detector panels, 506, 507
 - end station monitor, 511, 512
 - results, 510, 511
 - sector electronics, 512–514
 - beam profile monitors, 521, 522
 - beam switchyard, 651–704
 - central control, 490
 - description, 538–540
 - maintenance and servicing, 542, 543
 - operation, 540–542
 - programming, 543
 - control requirements, 491–495
 - criteria, 489–491
 - data assembly building, 490
 - data handling system
 - analog, 534–536
 - remote control, 533
 - status monitoring, 529–532
 - video cable, 536–538
 - interlocks, 493, 494, 775–777
 - klystron control, 497
 - klystron-modulator control signals, 497, 498, 500
 - local control areas, 491
 - modulator-klystron protection, 498–500
 - positron source, 577–581
 - signals, 494, 495
 - variable voltage station control, 496, 497

(*see also* Protection systems and Trigger system)
- Interlocks, 493, 494, 775–778**
 - access controls, 785
 - beam switchyard, 687–694
 - CCR display panels, 789
 - DAB display panel, 788, 789
 - emergency stop circuit, 790, 791
 - machine shutoff system, 783–785
 - personnel accessways, 787, 788
 - special accessways, 788
 - warning signals, 785–787
 - wiring, 790
- Ion chamber, long, 193**
- Jasberg, J. H., 29, 32**
- Jaynes, E. T., 28**
- Jones, C. B., 29**
- Kaisel, S. F., 28**
- Kennedy, W. R., 28**
- Kerst, D. W., 27**
- Klystron, 66–68, 303–344**
 - collector design, 312, 313
 - compared to amplitron, 303, 304
 - control, 497
 - cooling water system, 955–959
 - design and development, 308–313
 - drive requirements, 272
 - efficiency, 310, 311, 319, 320

- electron gun, 308–310
- gallery, 1124–1126
- interaction space, 310–312
- mechanical design, 314–316
- modulator, 1001
- operating conditions, 337, 338
- operation experience, 338–341
- oscillations, 310–312
- performance, 89–91, 316–320
- procurement, 306, 307
- radiation shielding, 315, 316
- specifications for SLAC, 305, 306
- window
 - assembly details, 326, 327
 - boundary failure, 332, 333
 - breakdown, 320, 323
 - coating, 335–337
 - development, 320–332
 - dielectric failure, 328, 329
 - materials, 322–326
 - multipactor, 333–337
 - testing, 321, 322
 - thermal failure, 329–332
- (*see also* Instrumentation and control)
- Koroza, V. I., 208
- Kyhl, R. L., 29

- Landscaping, site, 1093, 1094
- Larsen, R., 211
- Laser alignment system, 821–844
 - baffles, 840
 - description, 821–824
 - detector, 829–831
 - detector signals, 836–840
 - image pattern, 831–836
 - lens design and fabrication, 824–829
 - light source, 824
 - target intensity maximization, 882–885
 - vacuum requirements, 840–842
- Laser room, 1128, 1129
- Lichtenberg, A. J., 259
- Lisin, A., 350–356
- Loew, G. A., 211
- Long ion chamber, 193

- Machine characteristics
 - beam current, 3
- beam duty cycle, 14
- beam energy, 3, 13
- beam intensity, 14
- geometrical properties of the beam, 16
- operational flexibility, 17
- spectrum width, 14
- Magnet power supplies
 - A bending magnet, 701, 702
 - B bending magnet, 702, 703
 - dc, 697–699
 - dump magnet, 700, 701
 - pulsed bending magnet, 694–697
 - quadrupole, 702, 703
 - steering, 697, 703
 - (*see also* Beam switchyard)
- Magnetic measurements, 637–643
- Magnetic shielding, 193–197
- Magnetron, 28, 29
- Magnets, beam switchyard, 617–649
 - costs, 637
 - data reduction of, 644–646
 - dc steering magnets, 635–637
 - description, 617–619
 - design, 619–621
 - dump magnet, 633–635
 - 8 cm quadrupoles, 626–629, 643
 - 8.6 cm quadrupoles, 645
 - 18.6 cm quadrupoles, 629–632, 643, 645
 - location, 646, 647
 - momentum analysis by, 647, 648
 - photon beam magnets, 637
 - pulsed, 621–623
 - pulsed steering magnets, 635
 - 3° bending, 623–626, 637–645
 - (*see also* Beam switchyard)
- Main booster amplifier (*see* Drive system)
- Main drive line (*see* Drive system)
- Mallory, K., 29, 32
- Manpower, 52
- Master oscillator (*see* Drive system)
- Master trigger generator, 476
- Measurements, magnetic, 637–643
- Mendeleev, D. I., 10
- Messimer, R. C., 29
- Modulators, 69, 411–462
 - choice of type, 411, 412
 - de Q'ing, 415, 427–436

- de-spiking network, 437–439
- end of line clipper, 425–427
- general description, 412–417
- injector, 484
- main, 411–453
- power supplies, 418–423
- pulse cable assembly, 451, 452
- pulse forming network, 413–415, 423
424
- pulse transformer, 448–451
- sub-booster, 453–462
- switch tubes, 439–446
- thyatron trigger system, 446, 447
- (*see also* Instrumentation and control)
- National laboratory, 3
- Neal, R. B., 29, 32
- Neilson, I. R., 29
- Neutron, 10
- Nuclear atom, 10
- Oglesby, C., 33
- Operating results, initial, 82–84
- Operating statistics, 92–94
- Organisation, 39–45
- Oscillator, master (*see* Drive system)
- Page, B., 33
- Panofsky, W. K. H., 32
- Particles
 - basic laws, 12
 - classification schemes, 11
 - interactions forces, 11
 - intrinsic properties, 11
- Pattern, generator, 465, 484–488
- Pearson, P. A., 29
- Periodic table, 10
- Phase shifters, 396, 401, 402
- Phase velocity, 61, 62, 133
- Phasing, 70, 383–409
 - accuracy requirement, 272
 - beam induction method, 387–392
 - detectors for, 390–392
 - phase wobbling, 392–395
- cables, 401
- electronics, 404–406
- energy spectrum as function of, 383, 384
- procedures, 406, 407
- programmer, 404
- results, 407, 408
- RF detectors, 402, 408
- sector phasing equipment, 396–398
 - electronics, 392–395, 397, 398
 - operation, 398, 399
 - special features, 400, 401
- techniques
 - beam energy maximization, 384, 385
 - direct phase comparison, 385
 - reactive beam loading, 386
 - resistive beam loading, 385, 386
- Photon, 10
- Physical plant, 1069–1158
 - initial construction, 1069–1071
 - installation of accelerator equipment, 1071–1085
 - planning and management, 1069–1088
 - recent construction, 1085–1088
- Pindar, F. V. L., 32
- Position monitors, 658–660
- Positron source, 72–74, 545–583
 - calculated yield, 549, 550
 - cooling water system, 959–968
 - description, 545, 546
 - focusing, 551–561, 572–576
 - girders, 857, 858
 - instrumentation and control, 577–581
 - operating experience, 581, 582
 - radiator, 547, 548
 - slug, 563, 564
 - wand, 565–568
 - wheel, 569–572
- Post, R. F., 29
- Power, electrical (*see* Electrical power system)
- Power supplies, magnet, 697–703
 - (*see also* Beam switchyard)
- Profile monitors, 660–666
 - Cerenkov light, 662, 663
 - optics and TV system, 665–667
 - synchrotron light, 660–662
 - zinc-sulfide screens, 664, 665
- Program Advisory Committee, 6, 37

- Protection collimators, 759–770
 Protection systems, 775–819
 description, 781–791
 design criteria, 779, 780
 equipment, 810–819
 long ion chamber, 814–817
 manway monitors, 802
 meteorological measurements, 808–810
 operation, 792–794
 peripheral monitoring, 798–801
 personnel beam shutoff, 805, 806
 radiation monitoring, 794–810
 radioactive gas monitor, 804, 805
 research area monitoring, 796–798
 water monitor, 802, 803
 (*see also* Interlocks)
- Proton accelerators, 2
- Pulse forming network (*see* Modulators)
- Pulse length, RF, and beam, 103, 104
- Pulse transformer (*see* Modulators)
- Q*, accelerator structure, 135
- Radiation
 damage to components, 606–608, 619, 652
 (*see also* Shielding and radiation)
- Remote control system, 75
- Repetition rate, 104
- Research area, 81, 82, 1135–1150
- Research equipment, initial 22–24
- Research objectives, 9
- Research program
 early, 18
 elastic scattering, 18
 experiments, 6, 7
 muon scattering, 21
 new particle search, 21
 photoproduction, 20
 strong-interaction experiments, 21
- Resonant accelerator, 27
- Rutherford, E., 10
- Scheduling, 45–47
- Schiff, L., 32
- Scientific Policy Committee, 4, 5, 36
 Secondary emission monitors, 667, 668
 Serebryakov, Y. N., 208
 Shielding, beam switchyard, 608, 609
 Shielding, magnetic, 193–197
 Shielding and radiation, 1029–1067
 electromagnetic cascade, 1029–1032
 muon production, 1047–1053
 neutron production and attenuation, 1035–1040
 neutron spectrum in penetrations, 1056, 1057
 photon radiation, 1032–1035
 photoneutron measurement, 1040–1047
 radiation in tunnel and penetrations, 1053–1057
 residual radiation, 1057–1062
 shielding calculations, 1062, 1063
- Site and site improvements, 55–57, 1088–1094
 erosion control, 1092, 1093
 fencing and main entryway, 1095
 geology, 1089, 1090
 landscaping, 1093, 1094
 roads, yards, and parking, 1091, 1092
 site investigation program, 1088, 1089
 soil mechanics, 1090, 1091
 storm drainage, 1092
- SLAC
 as national facility, 3, 4
 compared to other accelerators, 2
 design and construction, 1
 experimental scheduling policy, 4
 general plan, 57–60
 general policies, 4
 operating statistics, 92–94
 principles of operation, 60–63
 Program Advisory Committee, 6
 relationship to AEC, 7, 8
 relationship to Stanford University, 7, 8
 scheduling, 7
 Scientific Policy Committee, 4, 5
 site description, 55–57
- Slits, beam (*see* Collimators and slits)
- Soderstrom, J. C., 29
- Sonkin, S., 29, 32

- Spectrometers, 22–24
 Spectrum analyzer, 671, 672
 Stanford Linear Accelerator Center (*see*
 SLAC)
 Sterling, J. E. Wallace, 33
 Sub-booster klystron (*see* Drive system)
 sub-booster klystron and modulator (*see*
 Drive system)
 Sub-booster modulator
 choice of switch tubes, 458, 459
 circuit, 453–458
 description, 453
 driver circuit, 459, 460
 fall time, 458
 high-voltage regulator circuit, 462
 main high-voltage supply, 461, 463
 power supplies, 461
 (*see also* Drive system)
 Sub-drive line (*see* Drive system)
 Support and alignment, 821–885
 (*see also* Accelerator support system
 and Laser alignment system)
 Switchyard, beam, 79, 80, 585–615
 Symmetry, 11
 Test laboratory, 1101, 1102
 Transient behavior, accelerator struc-
 ture, 123–125
 Transport system, beam, 166–192
 Transport system, beam switchyard (*see*
 Beam switchyard)
 Trigger system, 463–488
 beam loading compensation, 472, 473
 clock, 474–476
 comparator, 476, 477
 delays, 469–472
 distribution, 465, 479, 480
 generator
 sector, 468, 469
 standard, 467, 468
 logic, 464, 465
 master clock, 465
 master trigger generator, 476
 pattern generator, 465, 484–488
 principles of operation, 463–465
 programming for multiple beams,
 465–467
 sector trigger generator, 480–484
 sequence generator, 475, 476
 signal waveforms, 473, 474
 switchyard trigger generator, 484
 Tune-up monitor, 670
 Tuning, accelerator structure, 136–142,
 153–157
 Utilities, 1150–1156
 central heating water, 1152, 1153
 chilled water, 1153
 compressed air, 1154
 domestic water, 1151
 natural gas, 1153, 1154
 paging system, 1155, 1156
 sewer system, 1152
 telephone and radio, 1154–1156
 Vacuum systems, 70, 71, 887–933
 accelerator, 888–913
 beam line fast acting valves, 902–
 904
 cryosorption roughing pumps, 908–
 911
 design, 888, 889
 gauges and controllers, 904–908
 klystron gallery valves, 902
 manifold piping, 899–902
 operating experience, 912, 913
 pumping speeds and pressures, 889–
 894
 sputter-ion pumps, 897–899
 sub-system, 894–897
 alignment light pipe system, 913–916
 description, 914, 915
 design, 913–915
 instrumentation and control, 914, 915
 operating experience, 916
 beam switchyard, 610, 916–929
 beam-line fast-acting valves, 924–
 926
 beam-line isolation valves, 924
 design, 916, 917
 differential pumping stations, 919,
 920
 diffusion pumping stations, 918, 919
 divergent chambers, 920, 921
 instrumentation and control, 926–
 929

- operating experience, 929–931
piping and bellows assemblies, 921,
 922
quick disconnect couplers, 923, 924
sub-system arrangement, 917, 918
- Valves, vacuum
beam-line fast-acting, 902–904, 924–
 926
beam-line isolation, 924
klystron gallery, 902
waveguide vacuum, 362–364
- Variable voltage substation, 1001
- Varian, 27
- Voskresenkii, G. V., 208
- Water systems (*see* Cooling water sys-
 tems)
- Waveguide, 345–382
- design for higher energy, 346
dimensional stability, 351–355
directional couplers, 364–374
 cross guide coupler, 373–374
 modified Bethe hold coupler, 371–
 373
 power divider, 367–371
flanges, 374–376
insulation and heat control, 355–357
layout, 346–350
loads, 377–381
mechanical mounting, 347, 348
phasing, 357–361
power dividers, 346, 347
selection of, 350–352
vacuum valves, 362–364
windows, 345, 346
- Windows, klystron, 320–337
- Windows, waveguide, 345, 346
- Woodyard, J. R., 27