

# Index

- 1- $\mu\text{m}$  YAG laser, (Nd:YAG laser)
  - 6, 9, 28, 29, 30, 32, 35, 41, 45,
  - 73, 113, 115, 122, 134, 157,
  - 159, 164, 175, 185, 284, 291,
  - 362, 525, 931
  - frequency doubled, 708, 709
- 2- $\mu\text{m}$  thulium laser, 11, 18, 135,  
137, 138, 525, 934
  - Tm:YAG laser, 936, 1004, 1016
- 3D tomography, 53
- 6.7-nm neon operation, 342
- 193-nm solid-state laser, 14
  
- Abel inversion, 286, 661
- ablation effect, 1087, 1099
- ablation imprints, 613
- ablation pattern, 617
- ablation threshold, 265, 607, 612
- absolutely calibrated in-band energy  
measurements, 511
- absorption coefficient, 5, 77, 90, 97,  
132, 154, 156, 167, 565, 641
- absorption spectroscopy, 640, 890
- absorption coefficient for IBA, 5
- absorption edge, 339, 387, 597, 688,  
728
- absorption spectra, 642, 890
- accelerators and compact storage  
rings for lithography and  
metrology, 1036, 1040
- acoustic intensity, 836
- acoustic wave, 662, 837, 874, 877,  
921
  
- actinic in-band mapping EUV  
reflectometry (AIMER™), 456
- actinic mask-blank inspection  
(ABI), 9
- actinic metrology tools, 14, 714
- actinic patterned-mask inspection  
(APMI), 8, 13, 714
- active materials for laser pulse  
generation, 931
- active mirror, 951, 1002
- active mode locking, 271
- adaptive mesh refinement (AMR),  
86, 102
- adhesive-free bonding, 955
- adjustable-phase undulator (APU),  
1095
- Adlyte AG, 10
- Advanced Light Source (ALS), 414,  
458, 679, 715, 918, 1135
- Aerial Image Metrology System  
(AIMS™), 9, 358, 359, 374,  
541, 714, 919, 1045
- AIXUV, 416, 417
- ALE-AMR code, 102
- all-normal dispersion (ANDi), 967
- amorphous carbon (a-C), 608, 616
- amplified spontaneous emission  
(ASE), 212, 265, 618, 820, 913,  
916, 927, 930, 967, 1002, 1056,  
1067
- amplifier function, 781
- anamorphic beam expansion, 828
- angle of acceptance, 17, 566

- anode, 350, 354, 360, 364, 384, 391, 416, 419, 427, 449, 808, 815, 1111, 1116, 1122, 1123
- anomalous transmission, 510, 514, 516
- anomalous transmission filter, 514, 516
- arbitrary Lagrange–Eulerian (ALE) technique, 85
- arc sections, 1078, 1083
- ArF excimer laser, 796, 803, 804, 813, 826, 828, 1066
- ArF immersion, 257, 803, 805
- argon, 342, 351, 388, 389, 390, 398, 404, 417, 433, 634, 640, 756, 760, 794, 851, 856, 1113
- atomic diffusion bonding (ADB), 955
- atomic opacity, 115, 120, 121, 122, 123, 134, 139
- atomic process timescales, 91, 92
- atomic scattering factors, 565
- Atomic Spectra Database, 437
- atomic tin data, 1195
- atomic xenon data, 1129
- attenuation length, 53, 612, 615
- attosecond pulses, 886, 889, 918
- automated endpoint detection, 494
- average charge state, 32, 125, 127, 131
- average ion charge, 5, 74
- axial cooling, 951
- AXUV diodes, 696, 702, 703
- B*-integral, 913, 921, 925, 954, 1006
- back focal length, 542
- back-illuminated CCD, 354, 453, 517, 521
- back-reflection, 279, 302, 487, 617
- backlighting images, 630
- BaF<sub>2</sub>, 820
- bandwidth control module (BCM), 835, 839
- BBO crystals, 960, 968, 970
- beam characterization, 604, 614
- beam expander, 278, 797
- beam imprinting, 612
- beam quality, 48, 211, 268, 290, 854, 862, 888, 914, 922, 938, 944, 1001, 1011, 1084, 1097
- Beamline 2 at SURF III, 681, 682
- Beamline 3 at SURF III, 682
- bending magnets, 679, 1039, 1040, 1050, 1052, 1055, 1081, 1084
- Bennet's equation, 11
- Berkeley Actinic Inspection Tool, 715
- BESSY II, 515, 519, 679, 683, 697
- “beyond EUV” (BEUV), 17, 43, 1097
- bias gas, 423, 447, 449
- bifurcation, 945
- big-aperture thulium (BAT) architecture and design, 1011
- laser concept, 1000
- lasers, 18, 1013
- Blue-X, 15, 18, 47, 50, 1097
- Boltzmann plot, 640
- bound state populations, 75
- Bragg condition, 514
- Bragg reflectors, 510
- breakdown voltage, 385, 418, 816, 1118, 1119
- bremsstrahlung, 90, 481, 487
- inverse, 5, 31, 32, 76, 77, 81, 89, 167, 180, 481, 482
- brightness, 8, 15, 30, 134, 335, 351, 366, 484, 485, 496, 605, 919, 1029, 1031, 1048, 1076
- broadband plasma source, 15, 16
- broadband radiation source, 482, 496, 688, 728
- broadband spectroscopy, 510
- broadband UV–visible radiation, 15
- buffer gas, 231, 234, 236, 239, 241, 243, 310, 398, 668, 755, 757, 767, 798, 823, 1118

- bunch charge, 1077, 1080
- bunch compression, 1083, 1086
- bunch length, 1051, 1076, 1080, 1083
- bunch repetition frequency, 1079, 1082, 1086
- burst mode, 306, 829, 961, 965
  
- CaF<sub>2</sub>, 820, 923, 934
- calibration, 498, 681, 703, 705, 861
- cap layer, 552
- catadioptric design, 819, 820
- cathode, 350, 354, 360, 364, 383, 392, 417, 449, 482, 489, 808, 1075, 1111, 1120, 1197
  - hollow, 12, 416
- cathode spot, 489
- cavity dumping, 939, 943
- Center for X-Ray Optics (CXRO), 235, 334, 341, 565, 679, 863
- central wavelength (CWL<sub>50</sub>), 7, 210, 262, 455, 456, 515, 517, 522, 809, 933, 974, 1004
- ceramic insulator, 415
- charge-state distribution (CSD), 125
- charging time, 816
- chirp rate, 273, 967
- chirped Bragg gratings, 947
- chirped mirrors, 942, 947, 958
- chirped-pulse amplification (CPA), 925, 946, 952, 958, 973, 977
- chromatic aberration, 264, 339, 797, 809, 819
- chromatic dispersion, 946
- circuit inductance, 818
- CIV3 (atomic code), 1196
- clean dry air (CDA), 417
- clearance ratio (CR), 814
- closed-loop control, 421, 444, 1039
- CO<sub>2</sub> amplifiers, 211, 779, 786
- CO<sub>2</sub> gas lasers, 11, 134
- CO<sub>2</sub> lasers with transverse-gas-flow, 780
  
- Code Comparison workshop, 13
- coherent beam combining, 950
- coherent diffractive imaging (CD), 867
- coherent EUV light sources based on high-order harmonic generation, 847
- coherent EUV-scattering microscope (CSM), 721, 724
- coherent EUV source, 918
- coherent scattering microscope with *in situ* accelerated contamination system, 724
- coherent synchrotron radiation (CSR), 1084
- cohesive energy, 605
- collection efficiency, 206, 265, 305, 388, 401, 695, 704, 712, 914
- collective scattering, 662
- collector
  - ellipsoidal, 204, 209, 227, 228, 305, 541, 545, 578, 636
  - paraboloidal, 633, 643
- collector contamination, 748, 758
- collector lifetime, 11, 231, 235, 310, 373, 400, 558, 757, 769
- collector mirror, 228, 245, 310, 426, 540, 557, 697, 699
- collector module, 402, 554
- collector optics, 28, 201, 208, 263, 373, 405, 538, 555, 672, 681, 698
- collision frequency, 76, 77, 156, 659
- collisional–radiative (CR) equilibrium, 31, 43
- collisional–radiative (CR) modeling, 32, 124
- collisional rate, 91, 124, 126
- COLTRIMS, 890
- complex reflectivity coefficient, 564
- Compton scattering, 919, 952
- configuration-averaged calculation, 93

- configuration interaction (CI), 117, 125, 1133, 1197
- configuration interaction (CI)  
convergence, 117, 120
- configuration-mixing  
approximation, 1196
- contact exposure, 1124
- contamination, 224, 239, 308, 382, 429, 511, 540, 555, 612, 685, 688, 700, 710, 724, 748, 758, 821, 861, 883, 915
- contamination damage, 612
- contamination growth process, 710
- continuous optical discharge, 477
- continuum hypothesis, 84
- convective flow, 490
- conversion efficiency (CE), 11, 28, 29, 96, 113, 136, 150, 175, 184, 185, 203, 206, 210, 226, 261, 309, 334, 358, 362, 367, 375, 385, 389, 391, 417, 437, 443, 497, 525, 556, 656, 694, 850, 854, 855, 857, 914, 918, 999, 1016, 1067
- of laser photons to EUV photons, 18
- steady-state theoretical  
maximum, 185, 187
- wall-plug to photon, 11
- convolved spectral bandwidth, 824
- cost of ownership (CoO), 209, 480, 699, 805, 1040, 1044
- Coulomb logarithm, 6, 75, 90, 168, 181
- Courant condition, 84, 85, 100
- crater profiles, 614
- critical angle, 564, 604, 608
- critical-dimension, error, 839, 479, 493, 496
- critical (electron) density, 6, 33, 41, 73, 75, 78, 82, 121, 134, 150, 180, 203, 656, 848
- critical ionization level, 854
- cross-flow fan (CFF), 814
- cross-relaxation process, 935, 936
- cutoff rule, 853
- cyberspace, 778
- damage pattern, 604
- damage threshold, 278, 595, 609, 913, 926, 933, 946
- DC photocathode gun, 1079
- Debye length, 31, 74, 84, 428, 662
- debris management, 758, 764
- debris mitigation, 9, 30, 227, 233, 241, 267, 280, 310, 351, 372, 398, 423, 425, 450, 557, 748, 754, 769
- magnetic, 10
- debris mitigation buffer gas, 755
- debris (mitigation) shield, 350, 367
- deconvolution, 389, 829
- deconvolved spectral bandwidths, 812, 825
- deep UV (DUV), 7, 206, 208, 229, 262, 478, 497, 524, 548, 688, 705, 714, 748, 795, 803, 840
- deflecting charged particles, 426
- depth of focus, 53, 795, 883
- desorption, 605, 607, 612, 1038, 1053
- desorption printing, 614
- desorption/ablation model, 607
- diagnostic etalon, 811
- dielectric constant, 76, 879
- dielectronic recombination, 31, 645, 1133, 1135
- diffraction efficiency, 519, 521, 527, 683, 860, 873, 974
- diffraction-limited beam, 938, 959
- diffraction-limited storage ring (DLSR), 1032, 1036
- diffraction order, 520, 680, 694, 727
- diffusion limit, 154
- Digital Signal Registration, 443
- digitalization, 778

- diode pumping, 928, 931, 934, 937, 1001
- dioptric design, 819
- discharge chamber, 665, 798, 826
- discharge circuit parameters, 796
- discharge head, 423, 424
- discharge lamp, 1107
- discharge-produced EUV source, 416
- discharge-produced plasma (DPP), 11, 203, 256, 367, 374, 382, 405, 416, 478, 510, 521, 539, 755
- discrete ordinates ( $S_N$ ), 97, 101
- disk target, 225, 270, 309, 525
- dissociation, 238, 281, 302, 312, 628, 635, 642, 759, 890, 921
- distribution function, 75, 81, 91, 95, 124, 662, 667
- dome targets, 270
- Doppler broadening, 438, 662
- dose–contrast curve, 452, 886
- dose control, 244, 301, 450, 510, 808
- dose stability, 200, 202, 210, 245, 293, 298, 301, 796, 830, 838
- double-laser ignition, 360, 362, 364
- DPP EUV sources, 416
- drift velocity, 661
- drive laser, 11, 18, 54, 101, 113, 134, 200, 209, 213, 216, 226, 271, 284, 296, 304, 521, 525, 528, 540, 547, 553, 660, 999
- droplet position stability, 267, 288
- Drude model, 659
- dump line, 1078, 1087
- dumping speed, 798
- durability assessment, 604
- duty cycle, 7, 9, 17, 206, 209, 226, 294, 310, 359, 386, 422, 708, 1045, 1056
- DUV lithography, 263, 748, 803
- dynamic aperture, 1039, 1050
- dynamic gas lock (DGL), 7, 243, 426, 431
- E95 value, 837, 839
- E-CAM, 432, 445
- edge placement error (EPE), 16, 496
- edge pumping, 950
- effective area, 586, 611
- effective plasma temperature, 121, 525
- effective reflectance ( $R_{\text{eff}}$ ), 458
- effective temperature, 129, 137
- elastic tensor, 879
- electrode erosion, 12, 351, 375, 39, 405
- electrode lifetime, 374, 425, 450
- electromagnetic pump, 355
- electron beam, 14, 415, 519, 679, 794, 1031, 1041, 1068, 1097, 1134
- electron beam ion trap (EBIT), 1134, 1136
- electron beam photoresist, 886
- electron bunch, 606, 916, 1044, 1051, 1069, 1085
- electron density, 6, 31, 75, 121, 177, 270, 361, 387, 628, 647, 656, 659, 665
- electron diagnostics, 659
- electron–electron collisions, 80, 82
- electron gun, 1075, 1078
- electron–hole pair, 702
- electron impact ionization cross-section, 41
- electron–ion collisions, 74, 82, 154
- electron plasma frequency, 6, 659
- electron storage ring, 678, 684, 1035, 1042, 1047, 1076
- electron temperature, 6, 12, 29, 42, 81, 124, 168, 204, 270, 344, 361, 382, 640, 655, 765
- electron velocity distribution function, 662
- electro-optic switch, 968
- electro-optical modulation, 271
- electrostatic analyzer, 671

- ellipsoidal mirror, 209, 306, 510, 547, 567, 573, 577, 594, 633
- emission coefficient, 89, 1011
- emission cross-section, 923, 931, 1004, 1010, 1014
- emission profile, 388, 661
- emission spectroscopy, 635
- emission wavelength, 491, 923, 928, 932, 967, 977
- emissivity, 94, 120, 285, 401, 1122, 1202
  - EUV, 664
- emittance, 680, 917, 1031, 1048, 1051, 1072, 1079
- E-Mon™ energy meter, 424, 725
- endpoint detection for etching, 493
  - CVD and CMP processes, 494
- end pumping, 929, 948
- energy extraction efficiency, 275, 944
- energy instability, 945
- energy level diagram, 116, 1008, 1110
- energy-recovery linac (ERL), 1068, 1075
- energy spectra, 668
- ensemble simulations, 104
- epoxy bonding, 955
- equation of state (EOS), 84, 152
  - Frankfurt EOS (FEOS) model, 155
- equilibration timescales, 81
- ERL-FEL, 1068, 1076
- E-SPEC, 432, 731
- etalon, 797, 811
- étendue, 7, 8, 9, 17, 28, 53, 202, 206, 263, 333, 358, 401, 482, 541, 1045
- Euler equations, 84
- Eulerian method, 85
- European XFEL, 615
- EUV-Lamp, 413
- EUV applications, 13, 369, 541, 782
- EUV microscope (EUVM), 715, 721
- EUV source requirements, 7, 9, 204, 358
  - étendue of source output, 7
  - EUV power (in-band), 7
  - integrated energy stability, 7
  - maximum solid angle input to illuminator [sr], 7
  - reflectivity degradation, 7
  - repetition frequency, 7
  - source cleanliness, 7
  - spectral purity, 7
- EUV/x-ray sources, 605, 608
- excimer lasers, ArF and KrF, 778, 794, 796
  - line-narrowed, 821, 826
- exciplex, 794
- excited dimer, 794
- excited-state distribution, 92
- explicit method, 84
- extreme-ultraviolet (EUV)
  - ablation, 614
  - brightness, 30, 362, 366, 369, 374
  - collector optics, 539, 672
  - dose control, 244
  - emission waveform, 359
  - FEL beam, 608, 614
  - exposure, 256, 287, 450, 521, 647, 885
  - induced chemical dynamics, 888
  - induced plasmas for materials treatment, 647
  - interference lithography for resist characterization, 883
  - laser, 607, 612, 616, 848, 1055
  - laser beams, 612
  - metrology sources, 15
  - optical elements, 604, 610
  - optical train, 537
  - pellicle, 459, 460
  - photon sources, 510, 517
  - photon sources spectral characteristics, 521

- plasma, 220, 261, 262, 285, 385, 645, 656, 669, 756, 758, 769
- power/brightness metrology, 333
- radiometry, 678, 684, 696
- radiometry beamline at the MLS, 685, 687
- reflectometer, 450, 699
- resist exposer, 450
- scanner sources, 7
- source cleanliness, 7, 206, 372
- source description and requirements, 6
- source metrology, 122, 432, 509, 514, 679
- Extreme-Ultraviolet Lithography System Development Association (EUVA), 257, 259
  
- F<sub>2</sub> laser, 696, 805, 819, 825
- F<sub>2</sub> lithography, 805, 819
- fabrication threshold fluence, 595
- far field, 228, 539, 543, 554, 720, 868, 1011
- Faraday cups, 668
- Faraday rotator, 960, 970
- fast axial flow (FAF), 211, 275, 780
- fast high-voltage discharge, 798
- fast transverse flow (FTF), 211, 275, 780
- feedback control, 265, 294, 358, 371, 808
- FEL-induced surface structure, 617
- FEL parameter, 1071, 1082, 1086
- femtosecond oscillator, 952
- femtosecond laser, 51, 594, 849, 872, 889, 934
- femtosecond pulse generation, 913
- Feshbach resonance, 891
- fiber lasers, 478, 789, 938, 948, 978, 1002
- fiber oscillator, 967
  
- filters for spectroscopy from the soft x-ray to visible wavelength range, 520
- FLASH (free-electron laser facility in Hamburg, Germany), 608
- flashlamp pumping, 1000
- Flexible Atomic Code (FAC), 1195
- fluorescence lifetime, 923, 1009
- fluorine gas, 798
- flux limiter, 82
- Flying Circus (FC), 294, 511, 514, 707, 709, 725
- focused-beam characterization, 604
- foil filter, 511, 688
- foil trap, 398, 399
- “forbidden” transitions, 341, 1133, 1151
- Forschungszentrum Jülich, 433
- Fourier propagation, 868
- Fourier-transform infrared (FT-IR), 499–500
- Fourier-transform method, 660, 829, 852, 867, 964, 1073
- Fourier synthesis, 715
- Fourier ptychography, 718
- Fourier’s law, 174, 871, 874
- Frantz–Nodvik equation, 785, 943, 944
- Fraunhofer ILT, 386, 416, 428, 461
- free-bound transitions, 481
- free-free absorption, 482
- free-free radiation, 481
- free-electron laser (FEL), 14, 265, 593, 608, 616, 917, 961, 1031, 1040, 1068, 1075
- Fresnel number, 275
- frequency conversion, 853, 913, 917, 975
- fringe shift, 660
- full width at half maximum (FWHM), 515, 657, 659, 691, 917

- Fundamental Data Working Group, 1130, 1139, 1141
- GaAsP/Au Schottky diode, 695, 726
- gain medium, 212, 779, 785, 801, 923, 939, 944, 951, 957, 972, 1003, 1012, 1068
- gain narrowing, 944, 959, 967
- gain switching, 271, 939
- gas flow design, 427
- gas lifetime, 810, 840
- gas monitor detector (GMD), 608
- gas puff target, 629, 647
- gas purging, 428
- gate turn-off thyristor (GTO), 807, 808
- Gaunt factor, 90, 168
- Gaussian beam, 56, 614
- geometrical optics, 76, 77, 78, 155
- geometry of laser gain media for high-power lasers, 948
- Gigaphoton Inc., 9, 260, 284, 296
- graphical–user interface (GUI), 424
- grating-like structure, 610, 616, 618
- grazing-incidence angle, 564
- grazing-incidence conditions, 604, 614, 728, 1088
- grazing-incidence mirror, 611, 688, 692
- grazing-incidence optical elements, 604, 606
- grazing-incidence optics, 540, 564, 593, 604
- grazing-incidence x-ray optics (GIXO), 565–566
- harmonic frequencies, 976
- heat extraction, 355, 925, 948, 950, 1003
- heat flux, 82
- heat transport, 160, 871
- heatsink, 926, 942, 950, 955, 972
- Helmholtz equation, 78, 155, 190, 611
- Herriot cell, 966
- high-CE technology, 268
- high-energy amplifier, 9223, 1003
- high gain, 930, 049, 952, 1012, 1088
- high-harmonic cutoff, 856
- high-NA multiple patterning, 17
- high net-gain, 944
- high-order harmonic generation (HHG), 15
- high-order harmonics, 604, 848
- high-power CO<sub>2</sub> lasers, 17, 779, 921
- high-power light source for EUV lithography based on energy recovery linac (ERL)–free-electron laser (FEL), 1065
- high-power pulsed lasers, 628, 638
- high-power regenerative amplifier, 968
- high-power semiconductor switching device, 807
- high-power ultrashort-pulse lasers for applications in EUV, x-ray generation, laser Compton scattering, and FEL, 913, 919
- high repetition rate, 289, 415, 604, 611, 643, 796, 921, 961, 978, 1000
- high-resolution transmission gratings, structure, and fabrication, 518
- high-volume manufacturing, 71, 199, 376, 461, 480, 493, 510, 523, 539, 655, 700, 748, 760, 802, 914, 999, 1040, 1067
- high-voltage breakdown, 480
- higher-harmonic generation (HHG), 15, 415, 521, 848, 854, 865, 877, 886, 918, 1046
- higher-order methods, 87
- highly charged ion (HCI), 31, 386, 1130, 1133



- hollow cathode, 384, 417  
hollow-cathode-triggered pinch (HCTP), 416  
  plasma, 417  
holmium-based lasers, 936  
  Ho:YAG laser, 978  
host material, 922, 931, 949, 977  
hot plasma, 28, 30, 187, 381, 395, 417, 430, 439, 490, 565, 578, 656  
HULLAC code, 117, 123, 656, 664, 1196  
HYDRA code, 100  
hydrodynamic equations, 83, 165  
hydrodynamics, 71, 83, 99, 135, 153, 197, 270  
  multifluid, 88  
  single-fluid, 87  
hydrogen gas, 233, 311, 628, 667, 758  
hydrogen plasma, 51, 628, 655, 667, 760, 767  
  EUV-induced, 667  
hydrogen radical and hydrogen plasma etching, 759, 760  
hyper-NA, 17  
  
i-line, 803, 1109, 1113, 1125  
illumination, 35, 53, 83, 207, 262, 331, 403, 479, 485, 517, 548, 578, 590, 657, 695, 703, 714, 720, 796, 848, 868, 1046, 1118  
illumination optics, 204, 239, 256, 305, 333, 510, 541, 721, 1067  
image sharpness, 795  
imaging region, 796  
imaging reflectometry for  
  compositional analysis, 869  
imaging spectrometer, 728  
implicit methods, 99  
in-band emission, 43, 113, 150, 159, 176, 186, 231, 387, 415, 441, 510, 517  
  in-band interval, 155  
  in-band pulse energy, 261  
  in-band wavelength range, 150  
  induction, 331, 679, 956  
  industrial revolution, 788  
  Infineon, 450  
  injection lock, 801, 832, 840  
  injector, 288, 1040, 1054, 1075, 1080  
  inner-shell emission, 636, 644  
  inner-shell ionization, 635  
  *in situ* tin cleaning, 758  
  integrated coherence, 796  
  intensified CCD (ICCD) camera, 664  
  intensity distribution, 368, 401, 543, 568, 570, 588, 610, 929, 1037, 1089, 1115  
  intensity gain, 570, 582  
  interaction of intense EUV pulses with atomic and molecular gases, 627  
  interference lithography, 883  
  interference pattern, 496, 617, 874, 883  
  intermediate coupling, 120  
  intermediate focus (IF), 7  
  intracavity  $Q$ -switching, 271  
  intrinsic phase, 852  
  inverse bremsstrahlung absorption (IBA), 5  
  inverse Compton scattering (ICS), 919  
  ion acoustic wave damping, 662  
  ion average charge state, 270  
  ion-component spectrum, 662  
  ion density, optimum, 268  
  ion diagnostics, 668  
  ion energy distribution, charge-state-resolved, 670  
  ion kinetic energy distribution, 669  
  ionic charge-state, 656  
  ionization balance, 92, 93, 95

- ionization energies of the first 18 stages of xenon, 1134
- ionization state, 79, 99, 182, 525
- ionization temperature, 125
- irradiation tool, 403
- irreversible changes due to intense radiation, 603
- ISTEQ B.V., 10
- jj* coupling, 1132
- $k_1$ , 4
- Kerr effect, 966
- Kerr medium, 942, 943
- Kerr-lens mode locking, 942, 956
- kilowatt-class pre-pulse picosecond Yb:YAG laser system, 966
- Kirchhoff's law, 90
- Kirkpatrick–Baez optics, 579
- KLA Tencor Corp., 10
- KrF excimer laser, 797, 804  
thyatron-based, 804
- KrF excimer laser scanner, 813
- krypton (Kr), 388, 433, 629, 794, 856, 928, 1113
- Lagrangian (or Eulerian) method, 85
- Lambert–Beer law, 612
- Langdon effect, 81
- Larmor motion, 280
- laser, 5, 14, 28, 54, 73, 113, 134, 161, 175, 203, 244, 271, 284, 350, 477, 521, 596, 628, 659, 779, 794, 802, 863, 912, 999  
short-wavelength, 604, 614
- laser ablation, 151, 161, 607, 914
- laser-assisted discharge-produced plasma (LDP), 12  
EUV sources
- laser cavity, 212, 796, 926, 942, 956, 969
- laser desorption, 607
- laser diode, 490, 928, 934, 950, 968, 1000, 1011
- laser-driven plasma, 477, 485, 527, 528
- laser energy deposition, 159, 155, 183  
hybrid model, 155  
inverse-bremsstrahlung  
absorption coefficient, 167  
RH transport mode, 155  
H transport mode, 156  
X transport mode, 155
- laser heads, 954
- laser-induced damage threshold (LIDT), 926
- laser interferometry, 659
- laser light absorption, 121, 291
- laser-discharge plasma (LDP), 350, 352, 360, 370, 378, 416, 477, 488, 491, 539
- laser-driven light source, 478
- laser-driven plasma source, 477  
long-term output stability, 489
- laser-induced periodic surface structure (LIPSS), 616
- laser interferometry, 659
- laser micromachining, 966
- laser platform PERLA<sup>®</sup>, 966
- laser pre-pulse technology, 213, 225, 267, 308, 375
- laser-produced plasma (LPP), 24–25  
sources, 27
- laser-sustained plasma, 478
- laser Thomson scattering, 661
- Lawrence Berkeley National Laboratory (LBNL), 715, 750
- leading-edge semiconductor, 804
- Lehrstuhl für Lasertechnik, 416
- lens stepper, 808
- light recycling, 487
- line broadening, 438, 481, 1197
- line-center analysis module (LAM), 828

- line-narrowing module (LNM), 811, 824, 832
- line spectrum, 481, 1033, 1109
- linear accelerator (linac), 920, 1031, 1072, 1077
- liquid tin, 30, 102, 179, 190, 209, 220, 264, 305, 350
- liquid tin circulation, 355
- lithium (Li), 13, 976
- lithographic masks, 919
- lithography, 4, 43, 71, 124, 150, 199, 255, 342, 382, 432, 493, 517, 538, 603, 634, 655, 678, 747, 777, 787, 794, 848, 883, 912, 999, 1030, 1066, 1078, 1099, 1107
- lobster-eye (LE) optics, 579
- local thermodynamic equilibrium (LTE), 75, 115, 479
- opacity tables, 98
- longitudinal acoustics waves, 877
- longitudinal dispersion, 1083
- longitudinal modes, 941
- Lorentzian waveform, 813
- Los Alamos National Laboratory, 120
- low-inductance circuit, 355
- low nonlinearities, 948
- low-temperature plasmas driven by intense EUV pulses, 634
- LPP EUV sources, 72, 152, 187, 635, 648
- integrated simulation of, 152
- LS* coupling, 1132
- L-shell absorption edge, 597
- Mach–Zender interferometer, 659
- machine learning, 98, 104, 493
- magnetic assist technology, 806
- magnetic bearing, 798, 832
- magnetic compression circuit, 816
- magnetic confinement, 234, 331, 394, 710
- magnetic debris mitigation, 9
- magnetic field, 84, 239, 261, 280, 291, 302, 331, 426, 481, 679, 753, 914, 1033, 1040, 1068, 1093
- magnetic field mitigation, 280
- magnetic switch, 330, 800
- magnetic trap, 428
- main linac, 1077, 1081, 1085, 1096
- main pulse, 33, 46, 56, 102, 135, 152, 184, 213, 225, 244, 269, 272, 309, 523, 664, 1012
- mandrel, 575, 590
- manufacturing and metrology in optical and x-ray regions, 575, 587
- Martinez stretcher, 947
- mask, 8, 205, 218, 256, 414, 450, 485, 537, 616, 713, 721, 788, 808, 867, 885, 916, 1030, 1046, 1067, 1114, 1124
- mask blank, 339, 414, 434, 455, 713, 722, 1045
- mask inspection, 15, 350, 369, 713, 715, 919, 1030, 1047, 1055
- mask metrology, 713, 1045
- mass-limited targets, 204
- master oscillator (MO), 212, 271, 276, 827, 938
- master oscillator–power amplifier (MOPA), 200, 271, 801, 921
- material expansion, 608, 951
- material removal (erosion), 605
- materials damage by EUV photons and laser processing, 607
- materials processing, 593, 604, 614, 779, 795
- with focused EUV/soft-x-ray pulses, HHS, and FEL, 593
- Maxwell–Boltzmann statistics, 122
- Maxwellian distribution, 73, 81
- mean free path, 75, 84, 95, 132, 165, 174, 762, 871

- mean reflectivity, 549, 554  
mean time between failures (MTBF), 422, 449  
mechanical properties at the nanoscale, 877  
mechanical shutters, 426  
megahertz pulse trains, 611  
mercury-xenon lamps, 803  
Metrology Light Source (MLS), 1057  
metrology source, 8, 15, 17, 330, 414, 428, 480  
metrology tools, 8, 14, 354, 422, 450, 479, 493, 510, 527, 576, 678, 713, 871  
Michelson interferometer, 659  
micro-CSM, 721  
micro-/nanoprocessing, 593  
micropatterning, 617  
micro-roughness, 923  
microscopy, 55, 339, 374, 388, 498, 519, 564, 578, 590, 608, 695, 714, 850, 868  
microwave cavity resonance spectroscopy (MCRS), 665  
mid-infrared (IR) light, 55, 272, 477, 548, 855, 976, 1004  
mid-infrared spectral range, 976  
Ministry of Economy, Trade, and Industry (METI), Japan, 819  
mirror array, 961, 965, 972, 1133  
Mitsubishi, 211, 261, 276, 297, 313  
mode-locked thin-disk oscillators, 956  
mode-locked Ti:sapphire lasers, 853  
mode locking, 853, 941, 956, 967  
modular design, 777, 788  
molybdenum (Mo), 51, 55, 394, 405, 417, 426, 510, 543, 633, 749, 1047, 1111, 1113, 1120  
momentum-changing collisions, 74  
momentum spread, 1085  
Monte Carlo method, 97  
Moore's law, 4  
MOPA scheme, 801, 938  
multi-bend achromat (MBA), 1032, 1039, 1055  
multiblock grid/mesh, 86, 100  
multiconfiguration Dirac–Fock (MCDF) code, 1196  
multiconfiguration Hartree–Fock (MCHF) code, 1196  
multi-foil collector, 631  
multi-foil mirror, 580  
multi-foil optics (MFO), 564  
multilayer mirror, 7, 28, 48, 113, 262, 334, 340, 353, 392, 429, 441, 460, 510, 511, 616, 634, 644, 656, 667, 685, 691, 724, 749, 761, 1066, 1088, 1098  
multilayer mirror (MLM) exposure to hydrogen plasma, 767  
multi-line operation, 272  
multi-pass amplifier architecture, 962, 967, 972  
multi-pass amplifier Fourier transform architecture, 964  
multi-pass amplifier nearly collimated beam propagation (NCBP) scheme, 962, 972  
multi-pass amplifier relay imaging architecture, 962  
multi-pass amplifiers, 274, 945, 956, 961, 978  
multi-pass regenerative FEL amplifier (RAFEL), 1070, 1073  
multi-turn energy-recover linac, 1096  
multiple amplifying paths, 781  
multiple-exposure lithography, 804  
multiple patterning (MP), 16  
multiple-shot exposure, 611, 615  
multiplexing, 404, 920, 945, 961  
multiply charged ions, 112, 115, 635  
multiply excited states, 34, 89, 115, 122, 131

- multi-pulse extraction (MPE), 1002, 1005, 1016
- nanolithography, 112, 134, 510, 525
- nanometrology applications, 493
- nanopatterning, 604  
of solids, 614
- National Institute of Standards and Technology (NIST), 29, 437, 512, 678
- Navier–Stokes equations, 84
- Nb<sub>3</sub>Sn, 1091
- Nd:YAG laser, 28, 35, 45, 73, 113, 121, 134, 157, 177, 284, 291, 350, 360, 525, 629, 708, 913, 923  
for pre-pulse
- Nd:YAG-laser-produced plasma source, 525
- N-doping, 1091
- nearly collimated beam propagation (NCBP) scheme, 962, 965, 972
- neodymium-doped yttrium aluminum garnet (Nd:YAG), 28
- neon, 342, 389, 422, 433, 637, 857
- net gain, 959
- neural network, 98
- New Energy and Industrial Technology Department Organization (NEDO), 257, 276, 297
- NewSubaru, 681, 721
- NIST reflectometer chamber, 697
- nitrided Si photodiode, 703
- nitrogen, 48, 237, 339, 388, 425, 447, 647, 756, 1091
- noble gas halides, 794
- non-collective scattering, 662
- nondiffusive thermal transport, 872
- non-Gaussian beams, 614
- nonlinear phonon relaxation, 953
- nonlinear refractive index, 924
- non-local thermodynamic equilibrium (NLTE), 75, 89, 92, 97, 121
- plasmas, 100
- non-telecentricity, 713
- nonthermal ablation threshold, 612
- nonthermal solid-to-solid phase transition, 608
- nonthermally ablated layer, 614
- normal-incidence collector optics, 537  
for EUV sources, 537
- normal-incidence conditions, 604
- normal-incidence optical elements, 604
- Nomarski microscopy, 608
- numerical aperture (NA), 4
- numerical simulation, 284, 644, 799, 836, 1070
- off-axis parabolic (OAP) mirror, 485
- opacity, 32, 42, 99, 119, 130, 157, 176, 284, 1134
- operator splitting, 99
- operation frequency, 7
- optical cavity, 797, 944
- optical depth, 32, 78, 95, 115, 134, 136, 172
- optical element, 351, 382, 398, 425, 512, 538, 564, 604, 683, 719, 728, 963, 973  
surface damage, 965
- optical parametric amplifier (OPA), 920, 976, 1005
- optical parametric chirped-pulse amplification (OPCPA), 918
- optical parametric generator (OPG), 976
- optical path difference (OPD), 926
- optical projection lithography, 4
- optical system, hybrid, 586
- optical thickness, 150, 161, 180, 659

- optically pumped CO<sub>2</sub> laser, 921  
 optics and detectors for EUVL, 691  
 optics design rules and ray tracing, 571, 582  
 optics geometry, 567  
   ellipsoidal 568  
   parabolic 567  
 optimum laser pulse duration, 33  
 optimum pre-pulse duration, 34  
 oscillator strength, 36, 88, 117, 131  
 out-of-band (OOB) light, 517, 540, 826  
 out-of-band (OOB) power, 7  
 out-of-band (OOB) radiation, 113, 228, 450, 497, 681, 725, 759, 858  
   suppression, 439, 460  
 output coupler (OC), 821, 942, 958  
 oxidation, 685, 704, 750, 763, 858, 1120  
 oxide charging by photoelectrons, 703  
 oxygen (O), 47, 338, 388, 422, 642, 690, 704, 767, 821  
  
 parabolic mirror, 581, 683, 954  
 parasitic seeding, 272  
 parasitic oscillation, 275, 787, 930  
 particle acceleration, 934, 952  
 partition function factor, 116, 132  
 Paschen's curve, 417  
 Paschen's law, 418, 1118  
 Paul Scherrer Institute (PSI), 414, 679  
 PbWO<sub>4</sub>, 612  
 PbI<sub>2</sub>, 612  
 peak current, 350, 383, 417, 489, 800, 1071, 1094  
 peak intensity, 30, 231, 366, 402, 496, 797, 853, 865, 925, 945, 963, 1087, 1115  
 pedestal, 214, 272, 290, 865, 974  
 phase matching, 853  
  
 phase shift, 659, 868, 1085  
 phase space, 95, 1031, 1052, 1071, 1083  
 phase transition, 155, 190, 608, 975  
 Philips EUV GmbH, 417  
 photodiode, 334, 359, 385, 415, 443, 492, 510, 643, 685, 694, 702, 710, 730, 811, 860  
 photodiode array monitors, 811  
 photoionization, 5, 124, 481, 608, 628, 635, 889, 1134  
 photoionization cross-section, 1135  
 photoionized plasmas, 627, 637, 647  
 photon distribution, 76, 91  
 photon phase space distribution function, 95  
 Physikalische-Technische Bundesanstalt (PBT), 353, 434, 455, 512, 678, 683, 700, 724  
 picosecond pulses, 912, 921, 932, 950, 961, 975, 1001  
 pinch effect, 11, 360  
 pinch plasma, 363, 384, 402, 436  
   hollow-cathode triggered (HCT), 12, 383  
   pinch condition, 436  
 Planck function, 90, 136  
 Planck's law, 439  
 plasma, 5, 17, 28, 73, 112, 131, 150, 199, 203, 256, 285, 330, 350, 428, 477, 539, 627, 647, 655, 760, 1129, 1197  
 plasma-based lasers, 604, 617  
 plasma current, 291, 331  
 plasma debris and its mitigation, 30, 233, 280, 312, 398  
 plasma diagnostics, 655  
 plasma emission spectra, 635, 644  
 plasma frequency, 6, 73, 96, 659  
 plasma implosion, 360  
 plasma instability, 188  
 plasma kinetics code, 121  
 plasma opacity, 285

- plasma properties, 73, 90, 541  
Pockels cell, 939, 959, 968  
Pohang Accelerator Laboratory (PAL), 724  
polarization dependence in mirror reflectance, 696  
polarized electric field, 80  
polymer chain scissions, 606  
poly(methyl methacrylate) (PMMA), 595, 616  
ponderomotive energy, 850  
population distribution function, 116  
population inversion, 635, 795, 927, 939, 949  
post-compression, 913, 978  
  of ultrashort pulses, 966  
power amplifier (PA), 213, 275, 801, 827, 921, 938, 943, 960, 1006  
power requirements, 6, 14, 202, 557, 692, 826, 1049  
power scaling, 210, 225, 264, 307, 416, 539, 956, 978, 1038  
pre-ionization, 818  
pre-pulse, 9, 33, 51, 101, 151, 187, 200, 213, 225, 244, 264, 280, 293, 308, 523, 656, 913, 959, 966, 1012  
pre-pulse laser, 35, 51, 101, 267, 284, 293, 375, 664, 913, 959  
  technology, 210, 267, 308, 375  
primary source standards, 679  
prisms, 86, 640, 797, 824, 942  
programmable logic controller (PLC), 422  
projection exposure, 1114, 1123  
projection mirror, 510  
projection optics, 202, 256, 510, 537, 548, 684  
proximity exposure, 1123  
PTB soft-x-ray radiometry  
  beamline, 684  
PtSi Schottky-barrier diodes, 696  
ptychography, 718, 867  
pulse compression, 807, 865, 948, 973  
  chirped volume Bragg grating (CVBG), 947, 973  
  dielectric grating, 971  
pulse duration, 28, 33, 47, 137, 160, 187, 267, 298, 350, 361, 383, 393, 512, 521, 629, 658, 669, 796, 801, 814, 832, 853, 863, 877, 887, 914, 925, 934, 941, 956, 977, 1003, 1032  
pulse length, 33, 54, 134, 512, 606, 916, 941, 1076  
pulse power module (PPM), 814  
pulse stretching, 817, 946  
pulse-to-pulse energy stability, 808, 914  
pulsed high current, 357  
pulsed power circuit, 794, 805, 840  
pump cavity, 954  
pump chamber, 968  
pump diodes, 924, 949, 960, 972  
pump head, 954, 972  
purge gas, 428, 444  
PZT (fine) actuators, 828  
  
*Q*-switching, 271, 939  
*Q*-value, 1078, 1091  
quadrupole magnets, 1081  
quantum cascade laser (QCL), 272  
quantum defect, 864, 928, 953, 977, 1006  
quasi-Moseley's law, 41  
quasi-phase matching, 857  
quasi-three-level system, 932  
  
radiation damage, 604, 608, 703, 1095  
radiation-dominated (RD) laser-ablation fronts, 151, 170  
1D boundary conditions, 161, 336

- boundary-value problem, 161, 173
- Chapman–Jouget regime, 163
- numerical profiles, 163
- qualitative structure, 150
- scaling laws, 151, 161, 167
- semi-analytical treatment, 152, 164
- radiation-dominated (RD) plasma, 151, 161
- radiation field, 75, 95, 126, 151, 189, 645
- radiation-hydrodynamic (RH) code, 72, 83, 93, 99
- radiation-hydrodynamic (RH) modeling, 71, 129
- radiation-hydrodynamic (RH) simulations, 72, 92, 126, 135
- radiation transport/transfer, 95, 122, 151, 190, 285
  - equation, 84, 96, 125, 171
  - in plasma, 480
- radiative emission, 88, 93, 389
- radiative properties, 89, 181, 645
- radiative rate, 91, 189
- radiofrequency (RF) accelerator, 1073
- RADIOM model, 125
- Raizer, Yu., 477, 483
- RALEF-2D code, 151, 153
- rate matrix, 91, 125
- Rayleigh range, 223
- Rayleigh's criterion, 4, 53
- Rayleigh's equation, 1108
- raytracing, 76, 100, 567, 570, 582
- reaction microscope, 890
- recirculation loop, 1076
- recollision, 848
- reflectance, 43, 227, 262, 310, 441, 455, 461, 543, 685, 691, 679, 700, 728, 860, 869
- reflective/refractive optical elements, 608
- reflective coating, 231, 310, 552
- refraction, 76, 96, 155, 177, 490, 544, 564, 749, 853, 1003
- refractive index, 17, 76, 90, 490, 544, 565, 612, 656, 780, 795, 834, 853, 924, 950
- regenerative amplifiers, 940, 951, 960, 972
- requirements sources for mask defect metrology tools, 8
- requirements for next-generation wafer inspection (non-actinic) tools, 17
  - source wavelength, 17
  - bandwidth, 17
  - source étendue, 17
  - brightness, 17
  - energy stability, 17
  - pulse repetition rate, 17
  - duty cycle, 17
- radiation-hydrodynamic requirements for optical wafer inspection metrology tools, 17
  - defect sensitivity, 17
  - throughput (unpatterned), 17
  - throughput (patterned), 17
  - availability, 17
- RESCAN, 719
- Research Instrument (RI), 13, 416
- resonance absorption, 80
- resonance frequency, 665
- resonance transitions, 13, 29, 43, 112, 121, 139
- response linearity, 512, 705
- reticle, 205, 510, 680, 715, 721, 1114, 1124
- RF CO<sub>2</sub> laser, 1016
- ring cavity, 960, 970
- rod-type gain medium, 948
- roof reflectors, 954
- rotating disk electrodes, 540
- rotationally symmetric GIXO, 566, 590



- roughness (RMS), 615, 969, 977  
RWTH Aachen University, 416  
RZLINE code, 285
- SACLA, 615  
Saha equation, 90, 126  
Saha–Boltzmann distribution, 75, 90  
Saha–Boltzmann equilibrium, 75  
SASE-FEL, 1068, 1070, 1100  
saturable absorber, 936, 956  
saturation effects under pulsed irradiation, 708  
saturation energy, 709, 939  
saturation parameter, 709  
scaling factors, 120  
scanner interface, 243  
scanning white light interferometry (SWLI), 496  
scatterometry, 479, 493, 681, 715, 872, 879  
Schlieren-measured data, 799  
Schmidt arrangement, 579  
seed wavelength, 273  
self-amplified spontaneous emission (SASE), 265, 606, 916, 1067, 1070  
self-calibration, 702  
self-diagnostic system, 831  
self-focusing, 183, 925, 949, 959  
self-phase modulation, 925, 958  
semiconductor HVM, 265, 804, 840  
semiconductor metrology, 482, 493, 497  
semiconductor saturable absorber mirror (SESAM), 942, 956  
serial resistance, 707  
sextupole magnets, 1034, 1084  
shadowgraph, 225, 269, 286, 309, 656, 669  
SHARP microscope, 715  
shock wave, 31, 87, 224, 798, 833  
short-wavelength laser, 604, 614  
shorter-wavelength sources, 43  
shorter-period undulators, 1093  
shot noise, 455, 1067  
side-pumped laser, 929  
side pumping, 948  
silicon (Si), 488, 510, 543, 583, 593, 612, 643, 684, 694, 702, 712, 749, 761, 858, 876, 955, 1047, 1066, 1108  
silicon carbide, 396, 995  
Si/Mo multilayer, 616  
simulation, 72, 85, 92, 104, 121, 135, 152, 175, 187, 270, 284, 285, 360, 494, 564, 582, 588, 628, 644, 661, 785, 836, 850, 1000, 1016, 1053, 1078, 1085, 1118  
single-multipole approximation, 1196  
single-pass SASE, 1070  
single-pass self-seeding FEL, 1070  
SiriusXT microscope, 55  
slab gain medium, 951  
slab-waveguide diffusion-cooled geometry, 275  
smart energy, 778  
smart manufacturing, 778  
smart mobility, 788  
 $S_n$  method, 154  
Sn VII, Sn VIII, Sn IX, Sn X, and Sn XI, 1197  
Sn plasma spectra, 1197  
soft-x-ray photons, 628  
soft-x-ray radiation, 918  
software packages, 568  
solid-state 2- $\mu\text{m}$  laser drivers, 999  
solid-state lasers, 14, 134, 271, 525, 789, 911, 999  
solid-state pulsed power circuit (SPC), 805  
solid-state pulsed power module (SSPPM), 804  
source  
    low-peak-power, 605

- high-peak-power, 606
- source collector module, 400, 539, 550
- source étendue, 7, 208, 263, 542
- source function, 95, 154
- sources for beyond EUV
  - lithography (BEUVL), 43, 56
- sp<sup>3</sup>-to-sp<sup>2</sup> conversion, 608
- space charge effects, 1080
- spatial instability, 489
- specific intensity, 95
- spectator electron, 89
- spectral analysis module (SAM), 828
- spectral absorption coefficient, 154
- spectral broadening, 134, 483, 919, 966, 1116
- spectral content, 202, 207, 228
- spectral filter, 231, 305, 400, 441, 456, 518, 549, 725
- spectral opacities, 155
- spectral purity, 71, 29, 47, 113, 134, 175, 206, 680, 690, 820, 1073
- spectral purity filter (SPF), 8, 430, 441, 549
- spectral radiance, 136, 478, 485
- spectral reflectometry, 453
- spectral resolution, 434, 453, 488, 518, 664, 728
- spectroscopic reflectometry (SR), 479, 488
- spectroscopic ellipsometry (SE), 479, 488, 495
- spectroscopy, 150, 272, 283, 479, 498, 517, 520, 563, 580, 590, 617, 635, 640, 665, 767, 871, 890, 1004, 1142, 1162
- specular spectroscopic scatterometry, 494
- sputter rate, 374, 395
- sputter yield, 395
- sputtering, 280, 302, 331, 373, 391, 426, 484, 668, 710, 752, 767, 814
- stability for high radiation, 695, 710
- standing-wave cavity, 960, 970
- STAR code, 185
- stannane, 234, 281, 312, 710, 758
- steady-state approximation, 78, 92, 126, 160, 176
- Stefan–Boltzmann law, 150, 1122
- stochastic effect, 202, 1067, 1098
- storage rings for metrology
  - applications, 679
- storage ring lattice, 1035, 1047
- stray light reduction, 664
- super-high-pressure mercury lamps, 1107, 1114, 1125
- superconducting radiofrequency accelerator, 1073, 1090
- SUPERSTRUCTURE (atomic code), 1196
- surface acoustic waves, 878
- surface contamination, 612, 685
- surface scattering, 551
- synchrotron radiation, 678, 703, 714, 1034, 1042, 1076, 1084, 1100
- synchrotron radiation, physics of, 1032
- synchrotron-radiation metrology
  - for EUV source applications, 696
- synchrotron radiation sources, 604, 679, 695, 1030, 1040
- Synchrotron Ultraviolet Radiation Facility (SURF), 678, 681
- system integration, 724
- system qualification, 539, 554
- Talbot effect, 617
- TEA CO<sub>2</sub> laser, 921
- temporal chirp, 946
- temporal measurements, 643
- temporal stability, 336, 490, 685
- Tesla Test Facility Free-Electron Laser, Phase 1 (TTF1 FEL), 616

- Test EUVL (TEUVL) tool, 450  
thermal conductivity, 165, 237, 351, 394, 551, 757, 925, 1025, 1123  
thermal deformation, 278, 290, 963  
thermal distribution, 75, 81  
thermal expansion coefficient, 926  
thermal gradient, 925, 951, 1002  
thermal lensing, 926, 943, 959  
thermal plasma, 478, 479  
thermal shock resistance, 926  
thermal transport, 81, 100, 871  
thermally induced OPD, 852, 1007  
thermomechanical processes, 613  
thermo-optic coefficient, 926, 952, 978, 1007  
THERMOS code, 156  
thin-disk amplifiers, 934, 956  
thin-disk laser technology, 918, 978  
thin-disk lasers, 922, 931, 945, 951, 960, 977, 1002  
thin-disk multi-pass amplifiers, 951, 961  
thin-disk regenerative amplifiers, 958  
thin-disk oscillators, 942  
Thomson parabola, 670  
Thomson scattering, 270, 285, 661  
throughput, 6, 17, 202, 218, 258, 287, 455, 488, 496, 510, 539, 558, 691, 714, 748, 796, 813, 865, 885, 919, 1040, 1122  
thulium (Tm), 922, 935, 977, 1004  
thulium lasers, 11, 934, 978  
thyatron, 799, 806  
time-of-flight (TOF), 668  
tin (Sn), 200, 220, 234, 306, 510, 525, 748  
tin bath, 12, 350  
tin delivery systems, 220  
tin droplets, 161, 175, 209, 220, 243, 265, 288, 305, 358, 541, 556, 787, 913, 959, 975  
tin fuel, 5, 220, 306, 351, 754  
tin ions, 13, 113, 313, 668, 710  
    fundamental atomic data for, 13  
    multiply charged, 112, 138  
tin management, 239  
tin plasma, 71, 113, 122, 131, 165, 260, 285, 293, 313, 521, 662, 885, 914  
    CO<sub>2</sub> laser produced, 260  
titanium-doped sapphire, 850  
Ti:sapphire, 45, 521, 657, 850, 863, 913, 923, 934, 1001  
Tm:YLF, 936, 1000, 1007  
    laser properties, 1007  
total external reflection, 566, 856  
transient absorption spectroscopy, 890  
transition energies, 88, 339, 1130  
transmission grating spectrometer, 510, 517  
transmission mask, 452, 617  
transverse gas flow, 781, 788  
Treacy compressor, 946  
TRIM software, 399  
troubleshooting, 831  
tungsten (W), 41, 394, 405, 482, 493, 664, 760, 1111, 1123  
twin-chamber excimer laser, 805  
twin-chamber technology, 800  
two-color laser irradiation, 152  
    CE optimization strategy, 175, 185  
    master laser, 180  
    optimized density profiles, 177, 185  
    optimized steady-state CE  
        results of optimization, 185  
    slave laser, 152, 175, 186  
    transient peak of CE, 185  
U49 undulator, 684  
ultra-narrow seed laser, 820  
ultrashort-pulse lasers, 913, 977  
ultrashort pulses, 608, 925, 940, 952, 966, 978, 1004

- ultraviolet (UV), 112, 256, 301, 414, 478, 497, 548, 564, 603, 627, 638, 688, 794, 850, 928, 999, 1066, 1113, 1125
- ultraviolet lamps for lithography, 1107
- uncertainty quantification, 104
- undulator system, 1078, 1084
- undulator tapering, 1085
- undulators, 1036, 1056, 1084, 1093
- unresolved transition array (UTA), 29, 42, 1139
- unstable resonator, 821
  
- vacuum seal, 355, 431
- vacuum spark, 12, 1195, 1202
- vacuum ultraviolet (VUV), 478, 548
- velocity-map imaging, 890
  
- wafer inspection, 15
- wall cooling, 780
- wall-plug-to photon conversion efficiency, 11
- warm dense matter (WDM), 604
- water window
  - imaging in, 53
  - microscope illuminator, 329, 338
  - sources, 18, 47
- wavelength
  - calibration, 437, 455, 728, 1198
  - reduction, 4, 18
- wavemeter, 811
- wavenumber vector, 662
- white light interferometry, 493
- Wien's displacement law, 439
- wiping mechanism, 354
- Wolter-type optics, 569, 581
  
- x-ray, 47, 155, 334, 381, 415, 510, 530, 547, 563, 575, 580, 588, 593, 604, 627, 662, 679, 702, 720, 850, 870, 912, 920, 934, 976, 1030, 1040, 1056, 1073
  - applications, 913, 921, 976
  - backlighting, 630
  - sources, 563, 605, 627, 679, 912, 978, 1000
  - optical systems, 563, 582
  - optics, 564, 580
- xenon (Xe), 5, 10, 13, 284, 330, 383, 396, 404, 417, 425, 432, 442, 480, 539, 583, 636, 794, 856, 928, 1113, 1129
  - emission spectrum, 387, 434
  - ions, fundamental data for, 13
  - plasma, 331, 419
  - spectra, 437, 1132
- XeCl laser, 794
- XeF excimer laser, 795
- XE LPP, 10
  
- Yb: fiber lasers, 863
- Yb:LuAG, 933, 943, 968
- Yb:YAG laser, 966
- Young's modulus, 879, 880, 928
- yttrium-aluminum garnet (YAG), 931
  
- Z-pinch, 11, 329, 351, 362, 436, 511, 563, 628, 756, 885
  - electrode-less, 329
  - inductive, 329
- zig-zag configuration, 951