FINAL REPORT
ON
OPTICAL DAMAGE TESTS
SUBCONTRACT 9-X20-D9912-1
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INTRODUCTION:

This report presents the data resulting from a series of mirror damage tests conducted with the FLEX laser at KMS Fusion on March 14 through March 20, 1990 for Los Alamos National Laboratory.

The FLEX laser consists of a Nd:YLF master oscillator and four Nd:glass rod amplifiers operating at $1.05\ \mu\text{m}$. For this program, the laser was configured to produce a 3 ms long square wave envelope of mode locked pulses which was focused onto Los Alamos supplied targets via a 1200 mm focal length ($f/20$) lens at approximately normal incidence. The pulse energy and spot size were specified by Los Alamos personnel, the energy varying from approximately 10-40 Joules and the spot size ranging from approximately 100-300 μm . A total of 63 target shots and 19 calibration and/or test shots were conducted.

EXPERIMENT:

A schematic diagram of the laser and test layout is shown in Fig. 1. The Nd:YLF master oscillator is controlled via two feedback loops to drive the system to yield a square wave envelope of mode locked pulses. The individual mode locked pulse width is a nominal 100 ps with an inter-pulse interval of 8 ns. The shaped and amplified output pulse is focused onto the target via a 1200 mm focal length lens. The target is maintained at vacuum (< 1 micron) to prevent air breakdown by the focused laser pulse.

Equivalent Plane: In order to assess the spatial characteristics of the incident spot formed by the 1200 mm targeting lens, an "equivalent plane" spot is formed by an identical 1200 mm lens fed by the reflection off a diagnostic beamsplitter. The beamsplitter is equidistant from the 1200 mm target lens and the 1200 mm equivalent plane lens to ensure identical performance. The lens to target

distance and the lens to equivalent plane distance is determined by finding the lens position for best focus and calculating the offset required to yield a desired spot diameter. This offset is then applied to both the lens to target arm and the lens to equivalent plane arm. The equivalent plane is then reimaged (at 10x magnification) onto a CCD tv element for digitization and computer analysis. The equivalent plane computer analysis as well as a description of the analysis is presented in Appendix 1. A copy of the "raw" digitized image with approximately orthogonal line outs is also included in this Appendix. All targets were positioned "downstream" from focus by mutual agreement.

Energy Calibration: As indicated on the schematic, the second reflection off of the uncoated diagnostic beamsplitter is used to monitor the pulse energy. This reflection is input into a Scientech calorimeter and cross calibrated against another Scientech calorimeter temporarily exchanged for the target. This cross calibration was performed prior to and near the end of the experiment with excellent agreement.

Temporal Characteristics: The mode locked pulse square wave envelope was monitored with a photodiode measuring the "leakage" through the final turning mirror positioned nearest the target chamber. Copies of the temporal pulse envelope of the final output pulse (channel #1) as well as the shaped oscillator pulse (channel #2-inverted display) are presented in Appendix 2.

An autocorrelator was used to determine the width of the oscillator mode locked pulses. The autocorrelator output is a plot of the green output energy from a type II frequency doubling crystal vs. optical path length delay. The delay is scanned via a stepper motor over a sufficient interval to yield at least one half of the autocorrelation function since the complete function is symmetrical about the peak. The resulting traces from the pulse width measurements are used to

calculate the pulse width. The pulse width was maintained at a nominal 100 ps for the duration of this program and verified each day.

A summary of the target shot test matrix is presented in Table 1. The table displays the shot number, target number, test energy, desired nominal spot diameter, the quadrant of the target utilized and the cool down interval between shots. The laser spatial characteristics are somewhat dependent on the cool down interval (particularly for the nominal .1 mm spot size case) due to thermal effects in the laser rods.

Scattered Light: Commencing with shot #19, a photodiode was set up to monitor the light scattered by the target mirror to provide additional diagnostic information. The diode was "looking" at the target surface at approximately 45 degrees from the laser beam and was filtered to exclude all but 1.05 micron radiation. Oscilloscope traces of the photodiode output (all at 1ms/div.) are included in Appendix 3.

FLEX LASER CONFIGURED FOR LANL DAMAGE TESTING

FIGURE 1

TABLE 1

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SHOT# #	TARGET #	QUADRANT #	ENERGY (J)	SPOT SIZE (MM)	COOL-DOWN (MIN.)	COMMENTS
1	618	1	>60	.3		
2	568	1	14.6	.3		
3	568	1	23.4	.3		
4	568	1	35.7	.3		
5	568	2	54.2	.3		
6	568	3	>60	.3		break up no shot
7	568					
8	568	4	30.2	.3		
9	569	1	31.0			
10	569	2	25.3	.3		
11	569	3	36.4	.3		
12	569	4	38.4	.3		break up
13	618	2	19.3	.3		
14	618	2	31.5	.3		
15	618	3	32.6	.3		no eq. plane
16	618	1a	17	.15		
17	618	1a	>58	.15		break up
18	618		31.6	.15		
19	618		42.7	.15		
20	618		43.6	.15		
21	618	4	19	.15		
22	618	4	32	.15	10	
23	618	4	39	.15	15	no eq. plane
24	619	1	42.5	.15	28	
25	619	2	39	.15	24	no eq. plane
26	619	3	33	.15	20	
27	619	4	37	.15		
28	621	1	40.3	.15	30	
29	621	2	31.8	.15	25	
30	621	2	34.7	.15	18	
31	621	3	38.7	.15	22	
32	621	3	41.3	.15	19	
33	621	4	41+-	.15	19	
34	056	1	20	.15	>12 hr	
35	056	2	28.9	.15	26	
36	056	2	41.4	.15	18	
37	056	3	42.7	.15	29	satur. eq. pl.

SHOT#	TARGET	QUADRANT	ENERGY	SPOT SIZE	COOL-DOWN	COMMENTS
#	#	#	(J)	(MM)	(MIN.)	
38	558	1	37.8	.15	33	
39	558	2	38	.15	21	
40	558	2	38.6	.10	35	
41	558	3	41.6	.10	85	
42	558	4	29.3	.10	14	
43	558	4	34.6	.10	21	
44	621	1a	41.2	.10	25	
45	621					no energy
46	621	2a	20.7	.10	19	no eq. plane
47	621	3a	20.9	.10	19	
48	621	4a	25.4	.10	22	
49	057	1	32.7	.10	26	
50	057	1	41.6	.10	20	satur. eq. pl.
51	057	2	34.9	.10	22	satur. eq. pl.
52	057	3	31.4	.10	20	
53	057	4	29.8	.10	24	
54	058	1	20.6	.10	22	
55	058	2	14.8	.10	23	
56	058	3	9.7	.10	19	
57	622	1	19.4	.10	>60	
58	622	2	13.4	.10	-	
59	622	2	16.2	.10	20	
60	622	3	18.2	.10	21	
61	570	1	20.3	.10	33	
62	570	2	29.7	.10	19	satur. eq. pl.
63	570	3	39.3	.10	21	

Computer Analysis
of
Equivalent Plane Images

After the equivalent plane images have been captured by the CCD tv camera and digitized they are transferred to the Vax 8700 computer system for analysis. Results are shown for each of the equivalent plane images captured.

The images are first transferred into a 512 by 512 element array in the Vax system. For the optical arrangement described, each array element corresponds to a $1.33 \mu\text{m}$ by $1.33 \mu\text{m}$ square in the equivalent plane image of the beam. A two dimensional least squares fit is then performed using the outer edges of the image to estimate the background levels for each element in the array. Following background subtraction, the position of the centroid of the beam is calculated. Plots of horizontal and vertical slices through the centroid of the beam are then produced on the output report.

Contour plots as well as "3-D" mesh plots of the beam profile are provided to aid in visualizing the spatial characteristics of the beam. The contour levels used in the contour plot are as follows: level 1: $.135 (1/e^2)$, level 2: $.368 (1/e)$, level 3: $.600$, level 4: $.800$, and level 5: 1.00 . The contour plots are scaled as indicated on the plot so that beam size within $1/e$ or $1/e^2$ points can be graphically determined. Due to resolution limits in the printing process, the "3-D" mesh plot produces mesh points only at every 5th array point, so some detail may be lost in these plots.

Then fraction of the total energy within a given radius is also calculated. This is calculated by starting at the centroid of the beam and then calculating the total integrated exposure within various radii from the center. The fraction of

energy within a given radius is then the ratio of the total integrated exposure within that radius and the total integrated exposure over the whole field. As can be seen on some of the results of these calculations, if the beam image occupies only a small fraction of the total area of the image, exposure from low level background noise becomes a significant fraction of the total integrated exposure. This results in energy fractions that are slightly lower than absolute levels. This also causes the calculation of the beam radius which contains 90% of the energy to be somewhat larger than the real beam size. One is cautioned to examine the noise levels and beam size on each image before using these numbers!

The final plot shown on the beam analysis is a histogram of the fraction of energy delivered in each of 20 logarithmically spaced "fluence bins". The total integrated exposure is calculated for all the array elements within each of these 20 exposure ranges. The ratio of the integrated exposure in each of these bins to the total integrated exposure over the whole image is then calculated and displayed.

The "peak fluence" is calculated by finding the ratio of the maximum array element to the total integrated exposure over the whole image and dividing by the area of one array element. This number must be multiplied by the total energy (E) in the beam to provide an absolute fluence level. Likewise the "average fluence" is simply the inverse of the area of a circle which includes 90% of the total energy of the beam. Again this number must be multiplied by the total energy (E) to obtain an actual fluence level. Again, caution is advised in using these numbers without examining the noise levels in a particular image. A single pixel element with a large noise spike can produce an unrealistically high peak fluence calculation. Likewise, high background noise levels can produce unrealistically low average fluence levels.

SHOT NO. :SHOT-4

PEAK FLUENCE = 5851.

AVERAGE FLUENCE = 1442.

* E J/CM**2

* E J/CM**2

ENERGY	RADIUS
50%	.0777 mm
75%	.1106 mm
90%	.1485 mm

CONTOUR LEVELS

level 1: .135

level 2: .368

level 3: .600

level 4: .800

level 5: 1.00

Fraction of Energy within Radius

Fluence

SHOT NO. :SHOT-4

PEAK FLUENCE = 5851.

AVERAGE FLUENCE = 1442.

* E J/CM**2

* E J/CM**2

ENERGY RADIUS

50% .0777 mm

75% .1106 mm

90% .1485 mm

CONTOUR LEVELS

level 1: .135

level 2: .368

level 3: .600

level 4: .800

level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT-5T
 PEAK FLUENCE = 4224.
 AVERAGE FLUENCE = 902.6

* E J/CM**2
 * E J/CM**2

ENERGY	RADIUS
50%	.0971 mm
75%	.1403 mm
90%	.1878 mm

CONTOUR LEVELS
 level 1: .135
 level 2: .368
 level 3: .600
 level 4: .800
 level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT-6

PEAK FLUENCE = 2898.

AVERAGE FLUENCE = 923.5

* E J/CM**2

* E J/CM**2

ENERGY	RADIUS
50%	.1076 mm
75%	.1458 mm
90%	.1857 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT-9

PEAK FLUENCE = 5453.

AVERAGE FLUENCE = 979.9

* E J/CM**2

* E J/CM**2

ENERGY RADIUS

50% .0959 mm

75% .1356 mm

90% .1802 mm

CONTOUR LEVELS

level 1: .135

level 2: .368

level 3: .600

level 4: .800

level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_10

PEAK FLUENCE = 8325.

AVERAGE FLUENCE = 1406.

* E J/CM**2

* E J/CM**2

ENERGY RADIUS

50% .0773 mm

75% .1111 mm

90% .1505 mm

CONTOUR LEVELS

level 1: .135

level 2: .368

level 3: .600

level 4: .800

level 5: 1.00

Fraction of Energy within Radius

Fluence / Total Energy (1/cm**2)

SHOT NO. :SHOT_11

PEAK FLUENCE = 5549.

AVERAGE FLUENCE = 1400.

* E J/CM**2

* E J/CM**2

ENERGY RADIUS

50% .0821 mm

75% .1154 mm

90% .1508 mm

CONTOUR LEVELS

level 1: .135

level 2: .368

level 3: .600

level 4: .800

level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_12

PEAK FLUENCE = 4964.

AVERAGE FLUENCE = 1409.

* E J/CM**2

* E J/CM**2

ENERGY	RADIUS
50%	.0815 mm
75%	.1147 mm
90%	.1503 mm

CONTOUR LEVELS

level 1: .135

level 2: .368

level 3: .600

level 4: .800

level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_14

PEAK FLUENCE = 8495.

AVERAGE FLUENCE = 1481.

* E J/CM**2

* E J/CM**2

ENERGY RADIUS

50% .0870 mm

75% .1175 mm

90% .1466 mm

CONTOUR LEVELS

level 1: .135

level 2: .368

level 3: .600

level 4: .800

level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_16

PEAK FLUENCE = $0.5220 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 529.5 J/cm^2

ENERGY	RADIUS
50%	.0388 mm
75%	.0687 mm
90%	.2452 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_18

PEAK FLUENCE = $0.2686 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 2285. J/cm^2

ENERGY	RADIUS
50%	.0490 mm
75%	.0762 mm
90%	.1180 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_19

PEAK FLUENCE = $0.1921\text{E}+05 \cdot E \text{ J/CM}^{**2}$

AVERAGE FLUENCE = 3768. $\cdot E \text{ J/CM}^{**2}$

ENERGY	RADIUS
50%	.0422 mm
75%	.0646 mm
90%	.0919 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

SHOT NO. :SHOT_20

PEAK FLUENCE = $0.1953 \times 10^5 \text{ J/cm}^2$
 AVERAGE FLUENCE = 3479. J/cm^2

ENERGY	RADIUS
50%	.0451 mm
75%	.0675 mm
90%	.0956 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_21

PEAK FLUENCE = $0.4669E+05 \cdot E \text{ J/CM}^{**2}$

AVERAGE FLUENCE = 499.4 $\cdot E \text{ J/CM}^{**2}$

ENERGY	RADIUS
50%	.0470 mm
75%	.0794 mm
90%	.2525 mm

CONTOUR LEVELS

- level 1: .135
- level 2: .368
- level 3: .600
- level 4: .800
- level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_22

PEAK FLUENCE = $0.2900E+05 \cdot E \text{ J/CM}^{**2}$

AVERAGE FLUENCE = 2246. $\cdot E \text{ J/CM}^{**2}$

ENERGY	RADIUS
50%	.0531 mm
75%	.0821 mm
90%	.1190 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_23

PEAK FLUENCE = $0.2056 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 3526. J/cm^2

ENERGY	RADIUS
50%	.0454 mm
75%	.0692 mm
90%	.0950 mm

CONTOUR LEVELS

level 1: .135
level 2: .368
level 3: .600
level 4: .800
level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_26

PEAK FLUENCE = $0.2057 \times 10^5 \text{ J/cm}^2$
 AVERAGE FLUENCE = 2271. J/cm^2

ENERGY	RADIUS
50%	.0455 mm
75%	.0725 mm
90%	.1184 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

SHOT NO. :SHOT_27

PEAK FLUENCE = $0.1896 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 2451. J/cm^2

ENERGY	RADIUS
50%	.0456 mm
75%	.0716 mm
90%	.1140 mm

CONTOUR LEVELS

- level 1: .135
- level 2: .368
- level 3: .600
- level 4: .800
- level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_28

PEAK FLUENCE = $0.1800\text{E}+05 \cdot E \text{ J/CM}^{**2}$

AVERAGE FLUENCE = 2812. $\cdot E \text{ J/CM}^{**2}$

ENERGY RADIUS

50% .0432 mm

75% .0672 mm

90% .1064 mm

CONTOUR LEVELS

level 1: .135

level 2: .368

level 3: .600

level 4: .800

level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_29

PEAK FLUENCE = $0.2274 \times 10^5 \cdot E \text{ J/CM}^2$
 AVERAGE FLUENCE = $2243. \cdot E \text{ J/CM}^2$

ENERGY	RADIUS
50%	.0434 mm
75%	.0694 mm
90%	.1191 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

SHOT NO. :SHOT_30

PEAK FLUENCE = $0.2143 \times 10^5 \text{ J/cm}^2$
 AVERAGE FLUENCE = 2128. J/cm^2

ENERGY	RADIUS
50%	.0462 mm
75%	.0748 mm
90%	.1223 mm

CONTOUR LEVELS
 level 1: .135
 level 2: .368
 level 3: .600
 level 4: .800
 level 5: 1.00

SHOT NO. :SHOT_32

PEAK FLUENCE = $0.1734 \times 10^5 \text{ J/cm}^2$
 AVERAGE FLUENCE = 2626. J/cm^2

ENERGY	RADIUS
50%	.0465 mm
75%	.0728 mm
90%	.1101 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_33

PEAK FLUENCE = $0.1675 \times 10^5 \cdot E \text{ J/CM}^2$
 AVERAGE FLUENCE = 2535. $\cdot E \text{ J/CM}^2$

ENERGY	RADIUS
50%	.0470 mm
75%	.0739 mm
90%	.1121 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_34

PEAK FLUENCE = $0.4757E+05 \cdot E \text{ J/CM}^{**2}$

AVERAGE FLUENCE = 2949. $\cdot E \text{ J/CM}^{**2}$

ENERGY	RADIUS
50%	.0300 mm
75%	.0490 mm
90%	.1039 mm

CONTOUR LEVELS

- level 1: .135
- level 2: .368
- level 3: .600
- level 4: .800
- level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_35

PEAK FLUENCE = $0.3020 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 4864. J/cm^2

ENERGY	RADIUS
50%	.0332 mm
75%	.0514 mm
90%	.0809 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_36

PEAK FLUENCE = $0.2367 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 5241. J/cm^2

ENERGY	RADIUS
50%	.0368 mm
75%	.0546 mm
90%	.0779 mm

CONTOUR LEVELS

- level 1: .135
- level 2: .368
- level 3: .600
- level 4: .800
- level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_38

PEAK FLUENCE = $0.2675 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 5551. J/cm^2

ENERGY	RADIUS
50%	.0347 mm
75%	.0525 mm
90%	.0757 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_40

PEAK FLUENCE = $0.3897\text{E}+05 \cdot E \text{ J/CM}^{**2}$

AVERAGE FLUENCE = 2978. $\cdot E \text{ J/CM}^{**2}$

ENERGY	RADIUS
50%	.0297 mm
75%	.0484 mm
90%	.1034 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_41

PEAK FLUENCE = $0.3744 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 5274. J/cm^2

ENERGY	RADIUS
50%	.0288 mm
75%	.0468 mm
90%	.0777 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_42

PEAK FLUENCE = $0.6309 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 447.6 J/cm^2

ENERGY	RADIUS
50%	.0313 mm
75%	.0507 mm
90%	.2667 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_43

PEAK FLUENCE = $0.5561E+05 \cdot E \text{ J/CM}^{**2}$

AVERAGE FLUENCE = 447.6 $\cdot E \text{ J/CM}^{**2}$

ENERGY	RADIUS
50%	.0304 mm
75%	.0497 mm
90%	.2667 mm

CONTOUR LEVELS

- level 1: .135
- level 2: .368
- level 3: .600
- level 4: .800
- level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_44

PEAK FLUENCE = $0.4116 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 5165. J/cm^2

ENERGY	RADIUS
50%	.0314 mm
75%	.0484 mm
90%	.0785 mm

CONTOUR LEVELS

level 1: .135
level 2: .368
level 3: .600
level 4: .800
level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_47

PEAK FLUENCE = $0.8970 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 447.6 J/cm^2

ENERGY	RADIUS
50%	.0366 mm
75%	.0636 mm
90%	.2667 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_48

PEAK FLUENCE = $0.6925 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 447.6 J/cm^2

ENERGY	RADIUS
50%	.0325 mm
75%	.0534 mm
90%	.2667 mm

CONTOUR LEVELS
level 1: .135
level 2: .368
level 3: .600
level 4: .800
level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_49

PEAK FLUENCE = $0.3119 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 654.0 J/cm^2

ENERGY	RADIUS
50%	.0353 mm
75%	.0617 mm
90%	.2206 mm

CONTOUR LEVELS

- level 1: .135
- level 2: .368
- level 3: .600
- level 4: .800
- level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_50

PEAK FLUENCE = $0.2934 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 1831. J/cm^2

ENERGY	RADIUS
50%	.0360 mm
75%	.0544 mm
90%	.1318 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_51

PEAK FLUENCE = $0.3097\text{E}+05 \cdot E \text{ J/CM}^2$
 AVERAGE FLUENCE = $929.7 \cdot E \text{ J/CM}^2$

ENERGY	RADIUS
50%	.0331 mm
75%	.0544 mm
90%	.1850 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

SHOT NO. :SHOT_52

PEAK FLUENCE = $0.2592 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 447.6 J/cm^2

ENERGY	RADIUS
50%	.0440 mm
75%	.1383 mm
90%	.2667 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_53

PEAK FLUENCE = $0.3739\text{E}+05 \cdot \text{E J/CM}^{**2}$

AVERAGE FLUENCE = $494.7 \cdot \text{E J/CM}^{**2}$

ENERGY	RADIUS
50%	.0374 mm
75%	.0693 mm
90%	.2537 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_54

PEAK FLUENCE = $0.4532 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 447.6 J/cm^2

ENERGY	RADIUS
50%	.0374 mm
75%	.0928 mm
90%	.2667 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

Fluence

SHOT NO. :SHOT_55

PEAK FLUENCE = $0.4563 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 454.7 J/cm^2

ENERGY	RADIUS
50%	.0368 mm
75%	.0747 mm
90%	.2646 mm

CONTOUR LEVELS
level 1: .135
level 2: .368
level 3: .600
level 4: .800
level 5: 1.00

SHOT NO. :SHOT_56

PEAK FLUENCE = $0.2653 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 601.3 J/cm^2

ENERGY	RADIUS
50%	.0389 mm
75%	.0705 mm
90%	.2301 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_57

PEAK FLUENCE = $0.3694 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 847.1 J/cm^2

ENERGY	RADIUS
50%	.0316 mm
75%	.0570 mm
90%	.1938 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_58

PEAK FLUENCE = $0.5214 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 491.9 J/cm^2

ENERGY	RADIUS
50%	.0378 mm
75%	.0768 mm
90%	.2544 mm

CONTOUR LEVELS

- level 1: .135
- level 2: .368
- level 3: .600
- level 4: .800
- level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_59

PEAK FLUENCE = $0.4578 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 557.1 J/cm^2

ENERGY	RADIUS
50%	.0392 mm
75%	.0739 mm
90%	.2390 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_60

PEAK FLUENCE = $0.3808E+05 \cdot E \text{ J/CM}^{**2}$

AVERAGE FLUENCE = 745.0 $\cdot E \text{ J/CM}^{**2}$

ENERGY	RADIUS
50%	.0370 mm
75%	.0662 mm
90%	.2067 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_61

PEAK FLUENCE = $0.3137 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 1120. J/cm^2

ENERGY	RADIUS
50%	.0343 mm
75%	.0597 mm
90%	.1686 mm

CONTOUR LEVELS

- level 1: .135
- level 2: .368
- level 3: .600
- level 4: .800
- level 5: 1.00

Fraction of Energy within Radius

SHOT NO. :SHOT_62

PEAK FLUENCE = $0.2553 \times 10^5 \text{ J/cm}^2$

AVERAGE FLUENCE = 1775. J/cm^2

ENERGY	RADIUS
50%	.0399 mm
75%	.0647 mm
90%	.1339 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

Fluence

SHOT NO. :SHOT_63

PEAK FLUENCE = $0.2729 \times 10^5 \text{ J/cm}^2$
 AVERAGE FLUENCE = 612.6 J/cm^2

ENERGY	RADIUS
50%	.0383 mm
75%	.0662 mm
90%	.2280 mm

CONTOUR LEVELS

level 1:	.135
level 2:	.368
level 3:	.600
level 4:	.800
level 5:	1.00

Fraction of Energy within Radius

END

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