THESIS

LONG TERM STABILITY OF SENSATION THRESHOLDS FROM 10 MILLISECOND PULSES OF 2.01 MICROMETER LASER LIGHT

Submitted by

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In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Summer 2013

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ABSTRACT

LONG TERM STABILITY OF SENSATION THRESHOLDS FROM 10 MILLISECOND PULSES OF 2.01 MICROMETER LASER LIGHT

Current methods for diagnosing and evaluating efficacy for treatment of diabetic neuropathy either give only subjective data or are invasive. However, the use of laser induced sensations to evaluate threshold sensations gives precisely quantifiable and reproducible stimulus and is 100% non-invasive. In this study we evaluated whether or not laser sensation thresholds were stable in 12 human subjects over a four month period of time. Subjects' hands and feet were exposed over eight different exposure sessions to 10 ms pulses of laser light produced by a 50 W Tm: YAG laser system. Sensation threshold values (in mJ/mm^2) were determined for each session and compared by regression analysis. The results showed an upward trend in sensation thresholds over time in the majority of the subject's hands and feet, indicating that laser sensation thresholds are not stable over time. Subject desensitization to the sensation over time combined with too short a time between exposures, or variations in baseline skin temperature of the exposure site due to changes in weather are discussed as possible causes of the upward trend. Finally, suggestions are made for future studies to include a study over a longer period of time with more time between exposure sessions and more subjects as well as a study where the exposure sites are heated/cooled to a standardized baseline temperature prior to each exposure session.

ACKNOWLEDGMENTS

First and foremost, I would like to thank my wife and best friend of 20+ years Shannon. I would not have been able to make it through this process without her 100% support during the stressful long hours I was away from her and our two year old daughter, Skylar. Shannon, I love and appreciate you more than you know.

I would also like to thank my Committee members for their advice and support through the thesis research and writing process. Dr.'s Johnson and Brandl, your guidance has made me successful in this endeavor. Although not a Committee member, I would like to thank Dr. Pinder for helping me by providing his vast knowledge on statistics. I would have been lost without him.

Finally, I would like to thank all of the subjects who volunteered to be a part of this study. Without the selfless commitment of your time to help with my thesis research, I would not be where I am now.

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Introduction

1.1 Introduction

Determination of sensation thresholds using brief pulses of laser light is not a new idea. For decades, scientists have studied laser sensation thresholds as they apply to pain (Chen 2010), neuropathy (Agostino 2000), non-lethal weapons (Hambling 2005), and many other areas. Carbon dioxide (CO_2), Argon, and yttrium-aluminum-garnet (YAG) lasers have been the lasers used most in these studies.

Studies related to Aδ and C nociceptor activation have been prevalent due to the role of these specific sensory neurons in pain perception and neuropathy. Aδ and C nociceptors are categories of nerve fibers responsible for carrying the signal that is perceived as pain. Aδ nociceptors are fast conducting, myelinated fibers. When Aδ-fibers are stimulated they carry a signal that is perceived as a sharp pin-prick sensation. Since they are fast conducting, the pin-prick sensation is perceived before the sensation produced by the slow-conducting unmyelinated C-fibers. The signal carried by the C fibers is perceived as a dull burning sensation.

More study of sensation thresholds as they relate to diabetic neuropathy is needed and important. Diabetic neuropathy can damage Aδ and C-fibers, eventually causing a loss of sensation which can lead to ulcers, infection, and ultimately the loss of a limb. Diabetic neuropathy symptoms most commonly start in the feet and progress to the hands. Persistent hyperglycemia is believed to be the primary cause of diabetic neuropathy (Albers 2010). According to the Centers for Disease Control and Prevention (CDC) National Diabetes Fact Sheet, 2011, diabetes affects 25.8 million people in the United States (8.3% of the population), costs twice as much in direct medical expense as people without diabetes, and is the seventh leading cause of death in the U.S.. It was also noted in the same CDC fact sheet that 60% – 70% of people with diabetes have some form of nervous system damage, including impaired sensation and pain in the feet and/or hands.

In order to test the progression or efficacy of treatment for diabetic neuropathy, sensation thresholds over time need to be tested and compared. However, the longest period of time over which thresholds have been tested for stability in published research is eight days (Cornsweet 1962).

In this study, a 50 W thulium: yttrium-aluminum-garnet (Tm: YAG) laser system (λ = 2.01μm) delivered single 10 ms pulses of varying laser power to the palmar surface of the hand and the plantar surface of the foot. This laser was used to deliver stimuli in order to determine sensation thresholds behavior over a four month period in 12 healthy adult subjects. The Aδ nociceptor pin-prick sensation was used to establish all sensation threshold values.

1.2 Current Method of Evaluating Diabetic Neuropathy

Some of the current methods for diagnosing diabetic neuropathy, as related to Aδ and C nociceptors, are to test pain perception by neurotip, test hot/cold differentiation by hot/cold rods, and to assess intra-epidermal nerve fibers by punch biopsy (Tesfaye 2009). Neurotips are semi-sharp devices that allow up to 40 g of pressure to be applied without puncturing the skin in order to assess pain perception. Hot/cold rods of varying temperatures are applied to assess the loss of temperature differentiation. Punch biopsies are useful when other tests indicate no abnormalities.

These methods have their disadvantages. One, the pin and hot/cold rods only give subjective data (yes or no by the patient). Two, the punch biopsy, although a valuable tool, is invasive. On the other hand, using brief pulses of laser light not only yields precisely quantifiable and reproducible stimulus (Agostino 2000), but is 100% non-invasive.

1.3 Laser Use for Evaluating Diabetic Neuropathy

Laser light produced by a Tm:YAG laser at 2.01 μm has specific advantages over other wavelength lasers for diagnosing diabetic neuropathy. First, CO_2 laser light (λ = 10.6 μm), which is absorbed in the most superficial epidermal layers and stimulates nociceptors by heat conduction (Haimi-Cohen 1983), requires high skin temperatures to activate nociceptors, risking skin damage. Second, Argon lasers (λ = 488 and 515 nm) have weak output and penetrate beyond nociceptor depth (nociceptor depth range is 20-570 μm (Tillman 1995)), risking damage to blood vessels (Spiegel 2000). Conversely, Tm:YAG lasers (λ = 2.01 μm) have a 360 μm penetration depth and, therefore, can directly activate nociceptors with short stimulus durations (Spiegel 2000).

1.4 Previous Work

Most previous studies have concentrated on measuring and evaluating laser evoked potentials (LEPs) as they relate to sensation thresholds (Agostino 2000, Spiegel 2000). These studies focused on either comparing the use of laser induced LEPs to other methods of assessing neuropathy (Agostino 2000) or assessing the value of Tm: YAG LEPs in clinical evaluation of pain (Spiegel 2000). Other studies have focused on correlating laser induced sensation thresholds to temperature of the exposure site (Churyukanov 2012, Plaghki 2010) or determining the value of laser sensation thresholds (Cornsweet 1962, Johnson 2006), but not their behavior over an extended period of time.

At this time, lasers are not used in clinical settings to establish sensation thresholds or to measure changes in thresholds for judging the stage of the disease or efficacy of treatment. The reasons may be that the equipment is expensive, large, and complicated (Pertovaara 1988).

1.5 Goals of Study

The main goal of this study was to establish whether or not laser sensation thresholds are stable in healthy adult hands and feet over a four month period of time. As stated previously, the longest study of sensation threshold stability was eight days (Cornsweet 1962). In order to establish a baseline for sensation threshold behavior, a longer study was needed.

The second goal of this study was to assess any sources of uncertainty in the determination of sensation threshold stability and make recommendations for further research methods. Examples of these sources of uncertainty included beam area and splitter ratio measurements.

Chapter 2
Materials

2.1 Laser System and Components

All laser alignment and measurement components were attached to or supported by a Newport (Irvine, CA) optical table (Model: M-RS2000-510-12). Four Newport RL-2000 series LabLegs braced the table. An IPG Photonics (Oxford, MA) 2.01 µm, 50 W thulium: yttrium-aluminum-garnet (Tm:YAG) fiber laser (Model: TLR-50-2010, SN: PL0704233), was placed on the optical table, while the fiber optic cable output from the laser was attached to the table and aligned using a Thorlabs (Newton, NJ) C1503 kinematic V-clamp mount supported by a Thorlabs P1.5 Ø1.5" mounting post. Two Thorlabs PM1/M small clamping arms were used to fix the cable output to the V-clamp. This setup is displayed in Figure 1 below.

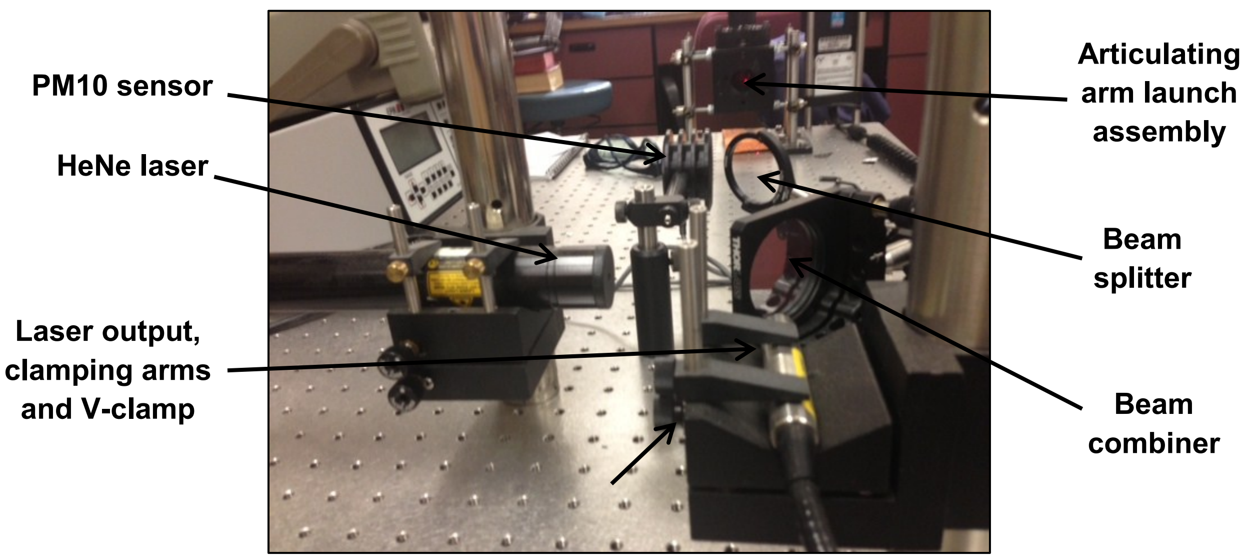

Figure 1. Laser output and various components

An IPG handheld power controller (SN: HH342221) was used to control the Tm: YAG laser output. The controller enabled the laser operator to turn the laser on and off, control power level and modulation, and monitor laser system temperature.

A Hewlett-Packard (Englewood, CO) function/arbitrary waveform generator (Model: 33120A, SN: US34015616), was placed on the optical table in a location convenient to the operator. The generator was used to establish a 50 Hz square wave and deliver a 10 ms TTL pulse to the Tm: YAG laser.

A CVI Melles Griot (Albuquerque, NM) 633 nm self-contained cylindrical helium neon (HeNe) laser (Model: 05-LLR-881, SN: 8273EA) was attached to the optical table and aligned using a Thorlabs (Newton, NJ) C1503 kinematic V-clamp mount supported by a Thorlabs P1.5 Ø1.5" mounting post. Two Thorlabs PM1/M small clamping arms were used to fix the HeNe laser to the V-clamp. The HeNe laser was used for alignment of the Tm: YAG laser as well as for a targeting beam. The HeNe laser was set perpendicular to the TM: YAG laser. A Thorlabs FM203 2" cold mirror was used to make the two laser beams co-linear. A Thorlabs KM200T threaded kinematic mount, mounted to the optical table with a 4" Newport stainless steel optical post (Model: 9623), was used to hold and align the cold mirror. The cold mirror transmitted > 85% of the Tm: YAG beam and reflected >90% of the HeNe beam.

A Thorlabs BP208 Ø2" pellicle beamsplitter was used to make a portion of the co-linear beams available for sampling. A Thorlabs BP207 Ø2" fixed pellicle mount, mounted to the optical table with a 6" Newport stainless steel optical post (Model: 9624) was used to hold and align the beamsplitter. The beamsplitter reflected 8% of the co-linear beams and transmitted the remaining 92%. The reflected portion of the beams was sampled using a Coherent (Santa Clara, CA) PM10 air-cooled thermopile sensor (SN: 8632) attached to the optical table by a 4" Newport stainless steel optical post (Model: 9623). The PM10 sensor was attached to a Coherent EPM2000 dual-channel joulemeter/power meter (SN: 0932C08) and used to measure the reflected beams' power for use in determining the main-to-reflected beam splitter ratio.

The transmitted portion of the co-linear beams was directed to a Laser Mechanisms, Inc. (Novi, MI) adjustable beam bender launch assembly (Model: PLBBA001). The launch assembly was attached to the optical table with four 6" Newport stainless steel optical posts (Model: 9624). A Laser Mechanisms seven-knuckle articulated arm assembly (Model: PLATA0428) was mounted to the top of the launch assembly and counterbalanced by a Laser Mechanisms articulated arm counterweight (Model: PLATW0002). A Thorlabs LB1901 Ø1" bi-convex lens was mounted in a Thorlabs SM13" slotted lens tube lens mount on the end of the articulated arm assembly. Finally, a separate Coherent PM10 sensor (SN: 0009F08R) was mounted on the optical table, connected to the EPM 2000, and used to measure the main beam power for use in determining the beam profile and the main-to-reflected beam splitter ratio. Pictures of various components listed in this section along with operating procedures can be reviewed in Appendix E. A schematic of the laser system setup is shown in Figure 2 below.

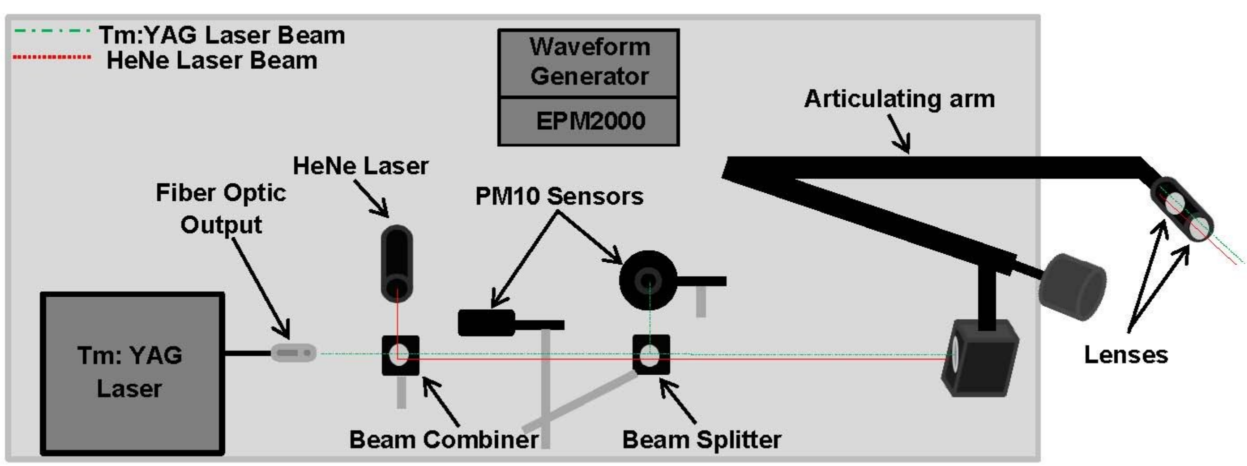

Figure 2. Schematic of optical table setup with major components

2.2 Laser Characterization Components

A New Focus (Santa Clara, CA) triple divide XYZ axis translation stage (Model: 9064-XYZ) was mounted to the optical table with four 2" Newport stainless steel optical posts (Model: 9621. A 160 mm C.L. Sturkey (Lebanon, PA) microtome knife (Model: K160D) was mounted on the translation stage for use in determining the laser beam profile.

2.3 Subject Chair

A Ritter Manufacturing Company (Rochester, NY) podiatrist chair (Model: B) was used to seat and position all subjects for the laser exposures to the hand and foot.

Chapter 3
Methods

3.1 Laser Characterization

3.1.1 Beam Profile

Each day of exposures, the laser beam width was determined by the scanning knife edge method, IAW ANSI Z136.4 *Recommended Practice for Laser Safety Measurements for Hazard Evaluation (2010)*. A microkeratome knife was moved across the laser beam to reduce beam power to 86.5% and 13.5% of its power in two perpendicular axes. The drop in power was measured by a Coherent PM10 sensor connected to the EPM2000 dual-channel joulemeter/power meter from section 2.1. The EPM 2000 was wavelength adjusted to 2010 nm to match the laser wavelength. The power measurements were taken at the same distance from the laser output, approximately 2.5 in (6.35 cm), as the subject exposures in order to ensure the beam area was consistent with the exposure area.

The translation stage position, in millimeters, was recorded at each percentage. The beam width was then determined by subtracting the translation stage position at 13.5% power from the position at 86.5% power. The beam area was then determined by the formula $\pi r_1\ r_2$, where r_1 and r_2 are the beam widths of the two perpendicular axes.

3.1.2 Pulse Duration

The 10 ms pulse duration was verified using a Coherent P5-01 ultra-fast pyroelectric detector (SN: 0292G07) connected to a Tektronix (Beaverton, OR) digital real-time oscilloscope (Model: TDS 644B, SN: B010655).

3.2 Subject Preparation

Twelve adult subjects, six males and six females, between the ages of 21 and 43, participated in the study. All subjects were briefed on the details of the study and the possible risks. Each subject then signed an informed consent form approved by Colorado State University's Institutional Review Board. All subjects were verbally screened to ensure they were not taking any medications that would increase their sensitivity to laser light. The complete human use protocol with all attachments including approval letters can be reviewed in Appendix A.

Upon arrival in the lab, subjects were seated in the podiatrist chair described in section 2.1. The chair was adjusted to ensure the subjects were comfortable. Once seated, the subjects removed their left shoe and sock. The plantar surface of each subject's foot was then washed with a mild soap and water solution to ensure no residue would interfere with the sensation threshold. Next, a grid of dots was applied to the plantar surface with an eyeliner pen. The dots, approximately one centimeter apart, formed a five by five square grid. The grid allowed for aiming and tracking laser exposures in a predetermined pattern and location. To maximize consistency of sensation, the grid on the foot was drawn within a single dermatome. A dermatome is an area of skin that is innervated by the sensory fibers of a single spinal nerve root. There are some slight variations in dermatome boundaries between individuals, but the general pattern is the same. The dermatomes of the hand and foot are displayed in Figure 3 below. The grid was drawn within the L5 dermatome of the left foot.

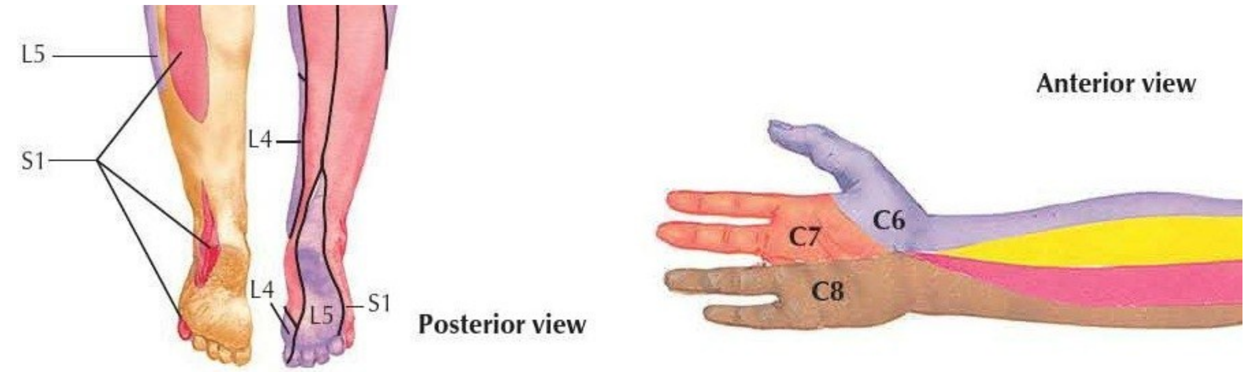

Figure 3. Dermatomes of the hand and foot (Netter 2011)

The subjects were informed that exposure would start at a low power and increase in power increments until a sensation was felt, at which time the power would be lowered and subsequently raised until three total sensations had been felt. Subjects were also informed that there may be shots fired at 0% power to test for false positives. Furthermore, the subjects were informed to expect a pinprick sensation and to report the sensation with a “yes” or “no” when asked. Finally, prior to beginning actual exposures, the subjects were blindfolded to minimize anticipation.

Once the sensation threshold had been determined for the foot, the subjects were asked to sit in a chair and rest their left arm on the foot rest of the podiatrist chair. This position was more comfortable for the subjects and more convenient for the laser operator. The palmar surface of the left hand was cleaned in the same manner as the foot, and a grid was drawn in the same manner as on the foot. The grid was drawn within the C7, 8 dermatome of the left hand. The same exposure procedure was used on the hand as on the foot.

Based on subject feedback, the electronic pulsing noise (a loud beep), produced by the function/arbitrary waveform generator whenever the laser was fired, was left on.

When the exposure session was tested without the pulsing noise present the subjects' false positive response rate was high. A possible explanation could be increased anticipation due to being blindfolded for up to 25 minutes with no auditory signal to indicate that an exposure had occurred.

3.3 Laser Operating Procedure

Prior to each session, the Tm: YAG laser was warmed up for at least an hour to stabilize laser temperature as well as power output. The function/arbitrary waveform generator was set to 50 Hz frequency, 2.5 V amplitude, 1.25 V offset, square wave, burst mode, single trigger to deliver a 10 ms TTL pulse to the Tm: YAG laser. The EPM 2000 was set to display either energy or power output, measured by the PM10 sensor, depending on the use at the time.

Each day, a splitter ratio was calculated in order to convert the peak power (mW_{peak}) measured by the PM10 sensor to the energy (mJ) delivered to the exposure site. The Tm: YAG laser was fired at 2.5% power increments from 25% - 60%, three times at each power setting. The main and splitter PM10 sensor readings, displayed on the EPM 2000, were recorded for each power setting. A plot of peak power vs. energy was then made, and an equation for the data trend line was calculated. This equation was used to convert the peak power measured to the energy delivered to the exposure site for each exposure.

Prior to each exposure, the handheld power controller was set to modulation mode to ensure a pulse was delivered to the exposure site. The power setting for each exposure was also set with the handheld power controller. The "single" button was pressed once to deliver a 10 ms pulse at the set power for each exposure.

3.4 Determination of Sensation Threshold

Sensation thresholds were determined by a forced choice method of levels staircase paradigm (Cornsweet 1962). Larger steps were made until first sensation followed by smaller steps to pinpoint the minimum sensation threshold.

The Tm: YAG laser output was initially set to 25% power (~1.3-1.4 mJ/mm^2) and increased in 5% increments until the first sensation was reported. The power was then decreased by 10% followed by 5% increases until the second sensation was reported. Finally, the power was dropped by 5% followed by 2.5% increases until the third sensation was reported. This procedure is displayed below in Table 1 and Figure 3.

Table 1. Subject exposure procedure

Power Increase	Sensation	Power Reduction
5%	Y	10%
5%	Y	5%
2.5%	Y	

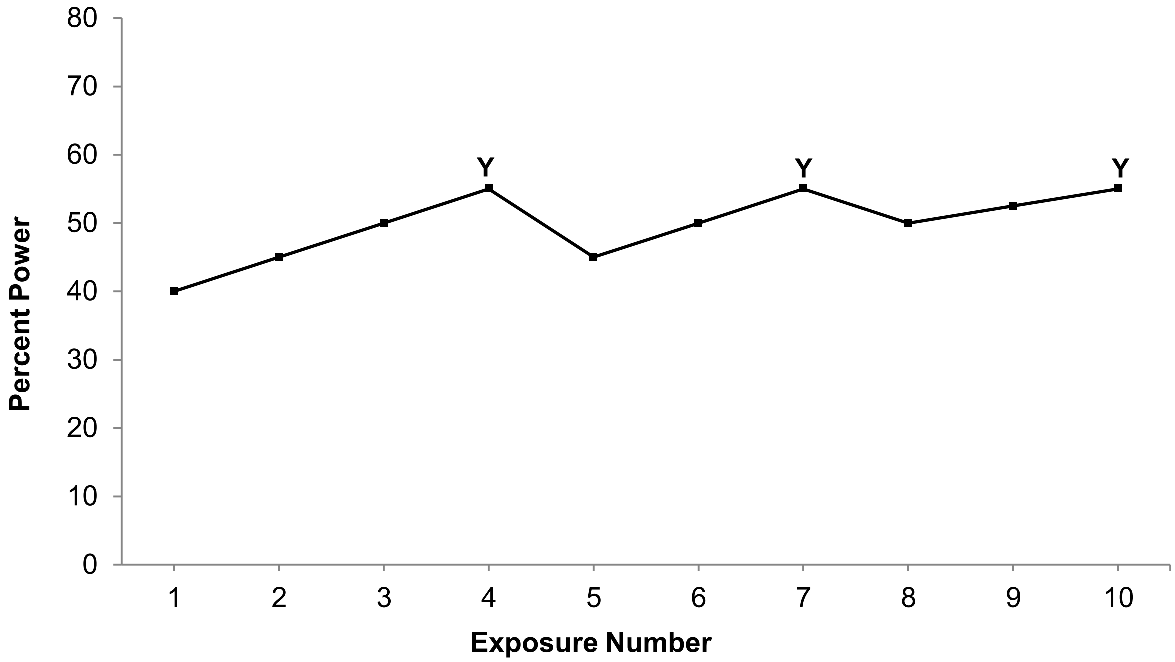

Figure 4. Subject exposure procedure

The interstimulus interval (ISI) was set at a minimum of 30 seconds to allow for complete skin cooling as well as ample time for the laser operator to change power settings and aim the laser. Previous work with 2.01 µm lasers used ISIs of 0.5 – 15 seconds (Ohara 2003, Raij 2003, and Spiegel 2003). Laser exposures were delivered to the skin between grid dots. Exposures were made on the plantar surface of the left foot medial to lateral, proximal to distal. Exposures were made on the palmar surface of the left hand superior to inferior, lateral to medial. An example of the grid and exposure patterns for the hand and foot is displayed below in Figure 4.

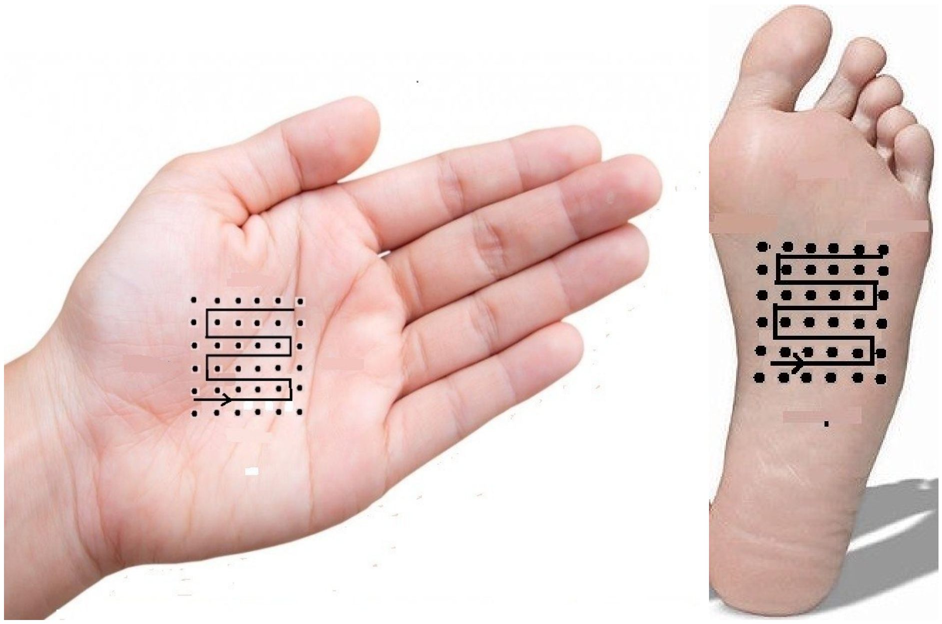

Figure 5. Example grid and exposure pattern

3.5 Quality Control and Quality Assurance

Three QA/QC tests were performed to validate that sensation threshold data was accurate and consistent. The three tests performed measured laser power consistency, laser beam area consistency, and false positive rate.

3.5.1 Laser Power Consistency

Laser power consistency was accounted for by determining a splitter factor each day of exposures, as described in section 3.3. The splitter factor was used to convert the peak power measured to the energy delivered to the exposure site for each exposure.

3.5.2 Laser Beam Area Consistency

Laser beam area consistency was measured by performed a scanning knife edge measurement in two perpendicular axes, as described in section 3.1.1. A second set of scanning knife edge measurements was performed approximately 25 minutes after the first, approximately the amount of time it took to perform each subject exposure session. The data were analyzed to determine if they were statistically consistent.

3.5.3 False Positive Rate

The false positive rate was measured by exposing each subject to at least three 0% power exposures during each session. The rate was calculated by adding all false positives and dividing by the total number of 0% power exposures.

Chapter 4
Results

4.1 Splitter Ratios

The splitter ratio factors used to convert the peak power measured to the energy delivered to the exposure site were recorded each day of exposures. An example of the data used to calculate the splitter ratio is demonstrated below in Table 2.

Table 2. Data from March 15, 2013 used to calculate the splitter ratio

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.1	30.5
25.00	9.1	30.7
25.00	9.3	30.4
27.50	12.1	35.9
27.50	11.4	36.8
27.50	11.9	35.9
30.00	14.1	41.2
30.00	14.4	41.7
30.00	14.5	40.9
32.50	16.7	46.4
32.50	16.6	46.8
32.50	16.1	46.6
35.00	18.0	53.0
35.00	18.1	53.3
35.00	18.6	53.5
37.50	21.9	58.7
37.50	21.8	58.4
37.50	21.9	58.5
40.00	24.4	64.7
40.00	23.9	64.2
40.00	24.4	64.2
42.50	25.6	69.2
42.50	25.9	69.6
42.50	26.4	69.2
45.00	29.4	74.8
45.00	29.3	75.3
45.00	28.1	74.9
47.50	31.3	80.3
47.50	30.1	80.2
47.50	31.1	80.1
50.00	31.8	85.9
50.00	32.2	85.9
50.00	33.3	86.9
52.50	34.6	92.7
52.50	33.7	92.4
52.50	34.6	92.2
55.00	37.4	98.2
55.00	37.3	98.1

55.00	35.9	98.4
57.50	40.6	104.4
57.50	39.0	103.8
57.50	40.3	105.1
60.00	43.5	110.0
60.00	42.0	109.5
60.00	42.8	110.1

The detector 1 vs. detector 2 data from Table 2 above was then plotted in Excel and a trend line was fit through the data with a resulting equation calculated for the trend line. The equation was used to convert that day's exposures from mW_{peak}, as measured by detector 1, to mJ. The plot, trend line and equation for the data in Table 2 are displayed in Figure 5 below. All splitter ratio data and plots for each day of exposures can be reviewed in Appendix B.

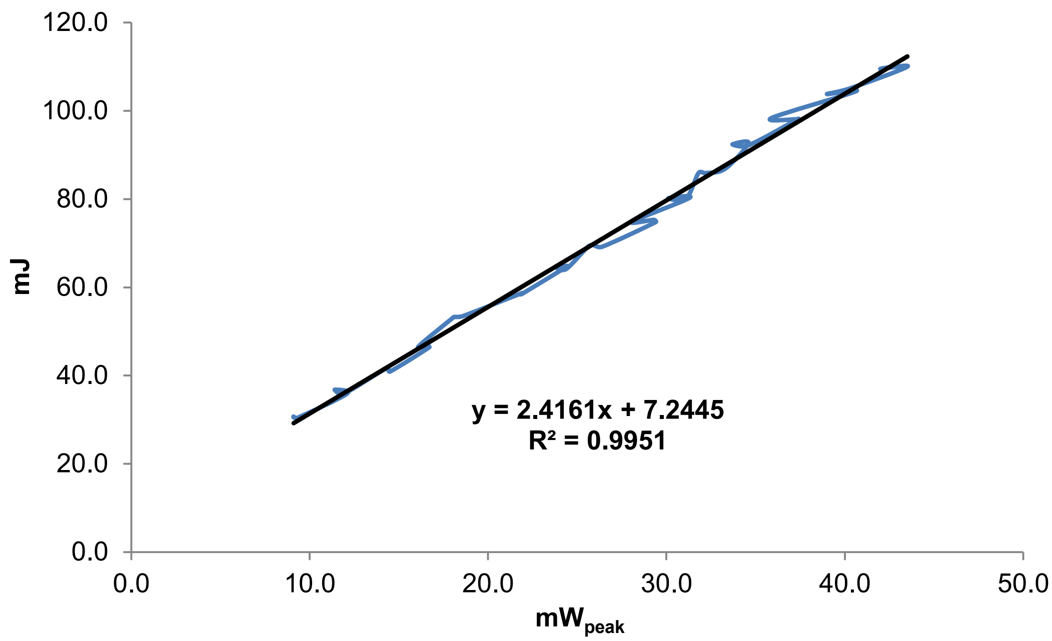

Figure 6. Splitter ratio for March 15, 2013

4.2 Beam Area

The beam area used in the calculation of all radiant exposures was determined by the scanning knife edge method, IAW ANSI Z136.4 *Recommended Practice for Laser Safety Measurements for Hazard Evaluation (2010)*. The beam width was measured ten times in each axis over a two hour period of time. The results of those 10 measurements and the associated uncertainty are shown below in Tables 3 and 4.

Table 3. X-plane beam width measurements

	x-plane beam width measurements (mm)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
86.5% power	21.82	21.79	21.87	21.87	21.85	21.87	21.85	21.85	21.88	21.89
13.5% power	19.23	19.25	19.30	19.28	19.27	19.27	19.27	19.28	19.29	19.30
Beam width	2.59	2.54	2.57	2.59	2.58	2.60	2.58	2.57	2.59	2.59
Mean Beam Width	2.58 ± 0.017 mm									

Table 4. Y-plane beam width measurements

	y-plane beam width measurements (mm)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
86.5% power	10.85	10.83	10.85	10.86	10.85	10.86	10.84	10.86	10.85	10.87
13.5% power	7.76	7.74	7.75	7.76	7.75	7.75	7.75	7.73	7.73	7.75
Beam width	3.09	3.09	3.10	3.10	3.10	3.11	3.09	3.13	3.12	3.12
Mean Beam Width	3.11 mm ± 0.014 mm									

The beam area was then calculated by the equation shown in Table 5 below:

Table 5. Beam area calculation

Beam area calculation
Beam area = (π)(x-plane mean beam width)(y-plane mean beam width)
Beam area = (π)(2.58 mm)(3.11 mm)
Beam area = 25.17 ± 0.022 mm^2

The beam width was also tested for variation over a 1 cm distance to account for the possible variance in distance from the laser output to the subject's exposure site. Ten measurements were taken in the x-plane at one distance followed by ten measurements in the x-plane at a distance 1 cm from the first ten. The first ten measurements are from Table 3. The second ten measurements at 1 cm from the first ten measurements are shown below in Table 6.

Table 6. X-plane beam width measurements at 1 cm different distance

	X-plane beam width measurements (mm)									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
86.5% power	23.11	23.20	23.20	23.24	23.18	23.19	23.37	23.31	23.39	23.49
13.5% power	20.59	20.67	20.72	20.76	20.72	20.66	20.87	20.85	20.94	20.97
Beam width	2.52	2.53	2.48	2.48	2.46	2.53	2.50	2.46	2.45	2.52
Mean Beam Width	2.49 ± 0.031 mm									

Since the measurements agreed within 0.09 mm, they are statistically consistent and, therefore, there is no variation in beam width over the possible 1 cm variation in distance from the laser output to the subject's exposure site. The beam area from Table 5 was used in all radiant exposure calculations.

4.3 Sensation Thresholds (ED_{50}'s)

The subjects' binary responses (1 for "yes", 0 for "no") to the laser stimuli were recorded and analyzed. The responses were paired with the radiant exposure (mJ/mm^2) for each exposure. For each of the 12 subjects, responses for both the left hand and left foot were recorded and analyzed over eight separate exposure sessions.

The ED_{50}'s for each subject's left hand and foot were calculated using Probit Version 2.1.2 (1998). There were not enough data points in each session to provide the statistical power necessary to calculate fiducial levels at 95% confidence. An example of the probit analysis for one subject's ED_{50} determination is illustrated in Figure 6 below.

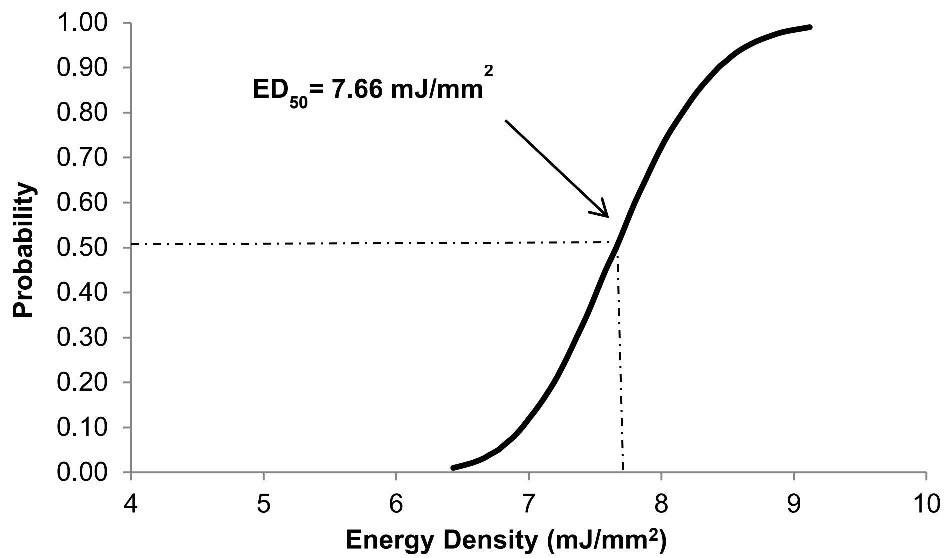

Figure 7. Probit analysis for subject 1 (male), left foot, session 3

A compiled list of ED_{50}'s for each subject's left hand and foot along with the data used for calculation can be viewed in Appendix C.

4.4 Stability of Sensation Thresholds

Each subject's ED50's for their left hand and foot were recorded and analyzed for stability using regression analysis in Excel (2010). An example of the regression analysis results plotted in Excel is displayed below in Figures 7 and 8. Plots of the results for all regression analyses can be reviewed in Appendix D.

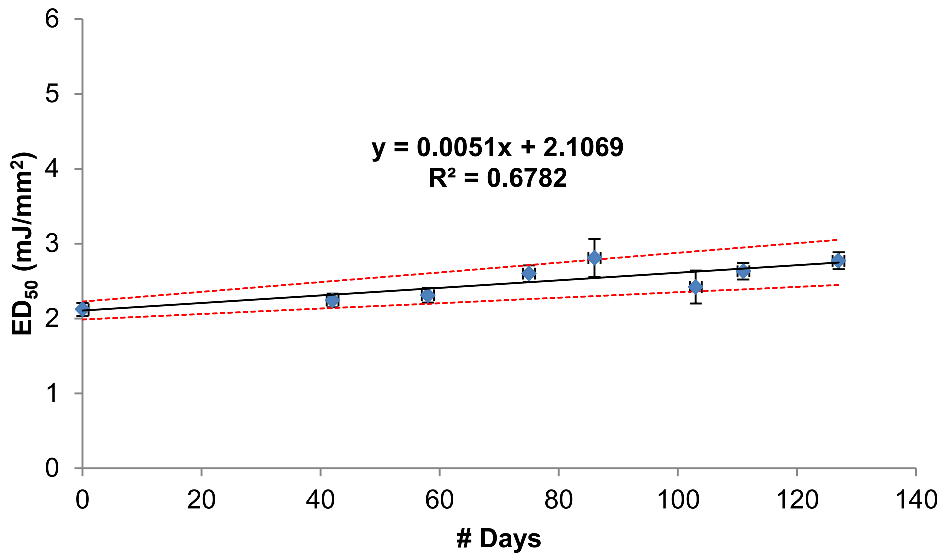

Figure 8. Regression analysis results for subject 10 (female), left hand

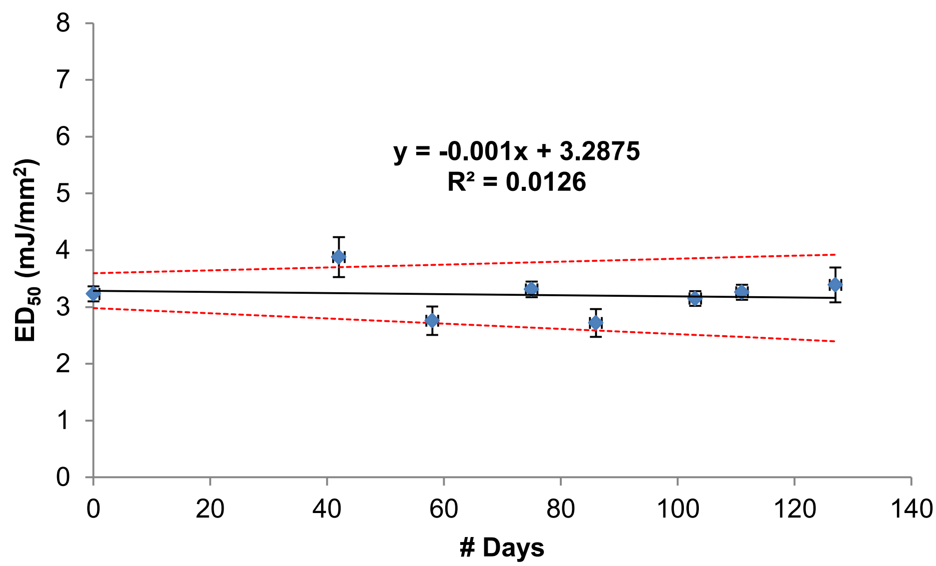

Figure 9. Regression analysis results for subject 10 (female), left foot

Uncertainties for the data trend lines were calculated by the regression analysis and added to the plots of the data (shown by the red dashed lines in Figures 5 and 6 above). Error bars were also calculated for each ED_{50} used in the regression analysis by calculating the square root of the sums of the squares of the ED_{50} and the beam area uncertainties. Total error bars were added to each ED_{50} on the plots of regression analysis data (shown in Figures 7 and 8 above). The equation for the resulting trend line was also added to the plots. A compiled list of the slopes and R^2's for each subject's regression analysis is shown below in Table 7.

Table 7. Slopes and R^2's for each subject's regression analysis

Subject #	Slope Hand	R^2	Slope Foot	R^2
001M	0.0101	0.6864	0.0062	0.2241
002M	0.0140	0.7201	0.0168	0.3742
003M	0.0081	0.5499	0.0184	0.5023
004M	0.0060	0.5238	0.0066	0.2196
005M	0.0077	0.6769	0.0104	0.4738
006M	0.0030	0.0674	0.0109	0.3654
007F	-0.0036	0.2310	-0.0054	0.2182
008F	0.0121	0.8695	0.0116	0.3790
009F	0.0117	0.5841	0.0035	0.0670
010F	0.0051	0.6782	-0.0010	0.0126
011F	0.0027	0.3115	0.0123	0.3702
012F	0.0052	0.2376	0.0034	0.0372

Chapter 5
Discussion

5.1 Stability of Sensation Thresholds

As seen in Table 7 and the regression analysis plots in Appendix C, 11 of the 12 subjects had a slight increase in their hand sensation threshold over time, ranging from 0.0027 $mJ/mm^2/day$ to 0.0140 $mJ/mm^2/day$ with an average of 0.0078 ± 0.0038 $mJ/mm^2/day$. Only one female subject had a slight decrease in hand sensation over time.

Also seen in Table 7 and the regression analysis plots in Appendix C, 10 of the 12 subjects had a slight increase in their foot sensation threshold over time ranging from 0.0034 $mJ/mm^2/day$ to 0.0184 $mJ/mm^2/day$ with an average of 0.0100 ± 0.0051 $mJ/mm^2/day$. Only two subjects had a slight decrease in foot sensation over time, also female.

The increase and decrease in hand and foot sensation thresholds over time indicate that sensation thresholds are not stable over time. This may possibly be explained by subject desensitization to the sensation over time combined with too short a time between exposures. The first time a subject is exposed to laser stimulus in order to elicit a sensation, the subject's senses are heightened since he/she does not know what to expect. This heightened awareness may result in a lower sensation threshold than during subsequent exposures, after the subject is familiar with the resulting sensation. Also, in this study, the time between exposures ranged from one to two weeks. That may not be enough time for the subjects to forget the feeling of laser induced sensation and, therefore, may result in higher sensation thresholds than if the time between exposure sessions was increased. The slight increase may actually plateau and become constant, but a longer study is needed to test this hypothesis.

Another possible explanation for the change in threshold over time is the change in weather which affects the skin temperature at the exposure site. This study was started in December and ended in April. The ambient temperature varied over a 60 F range during the study. A study where the exposure site is heated to a consistent baseline temperature for every exposure session may confirm whether or not weather is a factor. In fact, it has been shown that thresholds are dependent on the skin temperature at the exposure site preceding the test stimulus (Churyukanov 2012).

5.2 Sources of Uncertainty

Possible sources of uncertainty in the determination of sensation thresholds were analyzed. The slopes and R^2's were calculated with a varying beam area and splitter ratio, a varying beam area and constant splitter ratio, a constant beam area and varying splitter ratio, and a constant beam area and splitter ratio. The slopes and R^2's do show variation among the different methods, indicating that beam area and splitter ratio measurements contribute to the sources of uncertainty. A compilation of those slopes and R^2's is shown below in Tables 8 and 9.

Table 8. Slopes and R^2's for various hand ED_{50} calculation methods

Subject's Compiled Hand Data								
	Varying Beam Area and Splitter Ratio	Constant Beam Area and Splitter Ratio	Varying Beam Area and Constant Splitter Ratio	Constant Beam Area and Varying Splitter Ratio	Varying Beam Area and Splitter Ratio	Constant Beam Area and Splitter Ratio	Varying Beam Area and Constant Splitter Ratio	Constant Beam Area and Varying Splitter Ratio
Subject #	**Slope 1**	**Slope 2**	**Slope 3**	**Slope 4**	**R^2 1**	**R^2 2**	**R^2 3**	**R^2 4**
001M	0.0095	0.0183	0.0179	0.0101	0.4575	0.8524	0.7203	0.6864
002M	0.0142	0.0186	0.0190	0.0140	0.7401	0.8400	0.8356	0.7201
003M	0.0067	0.0134	0.0138	0.0081	0.2761	0.7898	0.7842	0.5499
004M	0.0072	0.0146	0.0154	0.0060	0.5791	0.7811	0.8063	0.5238
005M	0.0041	0.0119	0.0090	0.0077	0.3142	0.8302	0.7519	0.6769
006M	0.0047	0.0139	0.0152	0.0030	0.2048	0.6724	0.7515	0.0674
007F	-0.0088	0.0039	0.0018	-0.0036	0.5963	0.3253	0.1155	0.2310
008F	0.0086	0.0175	0.0151	0.0121	0.7637	0.8986	0.8449	0.8695
009F	0.0069	0.0183	0.0151	0.0117	0.2982	0.7985	0.7134	0.5841
010F	0.0030	0.0094	0.0078	0.0051	0.4691	0.7624	0.6453	0.6782
011F	0.0003	0.0094	0.0076	0.0027	0.0114	0.7410	0.6541	0.3115
012F	-0.0020	0.0127	0.0103	0.0052	0.0243	0.7775	0.7404	0.2376
Average	0.0045	0.0135	0.0123	0.0068	0.3946	0.7558	0.6970	0.5114

Table 9. Slopes and R^2's for various foot ED_{50} calculation methods

Subject's Compiled Foot Data								
	Varying Beam Area and Splitter Ratio	Constant Beam Area and Splitter Ratio	Varying Beam Area and Constant Splitter Ratio	Constant Beam Area and Varying Splitter Ratio	Varying Beam Area and Splitter Ratio	Constant Beam Area and Splitter Ratio	Varying Beam Area and Constant Splitter Ratio	Constant Beam Area and Varying Splitter Ratio
Subject #	**Slope 1**	**Slope 2**	**Slope 3**	**Slope 4**	**R^2 1**	**R^2 2**	**R^2 3**	**R^2 4**
001M	0.0048	0.0183	0.0173	0.0062	0.4747	0.7736	0.8732	0.2441
002M	0.0176	0.0238	0.0249	0.0168	0.4441	0.6952	0.7522	0.3742
003M	0.0196	0.0268	0.0270	0.0184	0.5385	0.7802	0.7661	0.5023
004M	0.0079	0.0175	0.0181	0.0066	0.2553	0.7637	0.7703	0.2196
005M	0.0031	0.0173	0.0111	0.0104	0.0458	0.8675	0.6474	0.4738
006M	0.0138	0.0253	0.0264	0.0109	0.4008	0.9181	0.8586	0.3654
007F	-0.0095	0.0033	0.0002	-0.0054	0.4097	0.0695	0.0004	0.2182
008F	0.0037	0.0212	0.0157	0.0116	0.0605	0.7125	0.5359	0.3790
009F	-0.0048	0.0130	0.0073	0.0035	0.1116	0.5379	0.2798	0.0670
010F	-0.0045	0.0051	0.0023	-0.0010	0.1720	0.2460	0.0489	0.0126
011F	0.0094	0.0197	0.0179	0.0123	0.2906	0.7055	0.6697	0.3702
012F	-0.0024	0.0111	0.0065	0.0034	0.0145	0.3639	0.1333	0.0372
Average	0.0049	0.0169	0.0146	0.0078	0.2682	0.6195	0.5280	0.2720

5.3 Other Findings

A two-way ANOVA with replication was performed to compare the change in thresholds over time of males vs. females and hands vs. feet. The results indicated a statistically significant difference between the thresholds of males and females with a p-value of 0.037.

Another interesting finding was that the two male subjects who exercised on a regular basis (to include running and some activity with the hands) had the highest thresholds of all 12 subjects for both hands and feet. The mean thresholds for male and female hands were 3.57 ± 0.80 mJ/mm^2 and 3.00 ± 0.59 mJ/mm^2 respectively. The mean thresholds for male and female feet were 5.62 ± 1.17 mJ/mm^2 and 4.46 ± 0.94 mJ/mm^2 respectively. The two male subjects who exercised had hand thresholds of 4.58 ± 0.54 mJ/mm^2 and 4.31 ± 0.48 mJ/mm^2 as well as foot thresholds of 6.85 ± 0.58 mJ/mm^2 and 6.38 ± 0.76 mJ/mm^2. These higher thresholds for both hands and feet are most likely due to larger skin thickness, requiring increased laser power to penetrate the skin and activate the nociceptors.

5.4 Recommendations for Future Work

Further investigation is needed to determine if laser sensation thresholds are stable over an extended period of time. A longer study (suggested length 2 years), with two month intervals between exposure sessions is recommended. This method would test whether total study time and time between exposure sessions have an effect on the subject's desensitization to the laser induced sensation and ultimately on the sensation threshold stability .

Another recommendation is that a study be conducted in which all subject's exposure sites are heated or cooled to a standardized baseline temperature prior to each exposure session. This method would test whether baseline temperature has an effect on sensation threshold stability.

Chapter 6
Conclusion

6.1 Conclusion

In conclusion, the data from this study indicate that laser sensation thresholds of healthy human hands and feet are not stable over time. The reasons may be subject desensitization to the sensation over time combined with too short a time between exposures, or variations in baseline skin temperature at the exposure site due to changes in weather. A longer study of at least two years with two months between exposure sessions as well as a study where the exposure site is heated/cooled to a standardized baseline temperature at each exposure session is needed to test whether the reasons listed above influence the stability of laser sensation thresholds over time. Also, many more subjects are need for the studies to provide statistical relevance.

If the studies mentioned above show that sensation thresholds are stable over time, this method of measuring sensation thresholds may prove to be a useful clinical tool, used by itself or in conjunction with other methods currently used, for diagnosing of diabetic neuropathy and evaluating the efficacy of treatment. Of course, studies of the behavior of laser sensation thresholds using this method in diabetics would be necessary for comparison to the results from healthy adult subjects.

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Appendix A

Consent to Participate in a Research Study
Colorado State University
11-3181H

TITLE OF STUDY: Thresholds of Sensation and Selective Activation of Nociceptors in the Healthy Human Foot

PRINCIPAL INVESTIGATOR:

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WHY AM I BEING INVITED TO TAKE PART IN THIS RESEARCH?

Healthy human adults are needed as subjects in order to gather the appropriate data for this study. Your participation will lead to a better understanding of the minimum laser energy needed to be felt in the healthy human hand/foot as well as the minimum laser energy needed to enable only specific feeling pathways to engage. By participating in this study, you will help scientists better understand these laser energies.

WHO IS DOING THE STUDY?

This study is not sponsored by an outside agency and is being conducted by the principal investigator and the co-principal investigator listed above.

WHAT IS THE PURPOSE OF THIS STUDY?

The purpose of this study is to determine the minimum laser energy needed to be felt in the healthy human hand and foot as well as the minimum laser energy needed to enable only specific feeling pathways to engage. The researchers hope is that this data may be compared to future data obtained from diabetic patients in order to establish an advanced technique for diagnosing and/or confirming certain problems with diabetic's hands and feet (diabetic data will not be obtained in this study).

WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT LAST?

All procedures for this study will take place in the Molecular and Radiological Biosciences building located on the CSU campus. A maximum of 12 two-hour appointments will be required to participate in this study. In addition, 24-hour follow up appointments will be made to check the exposure site for any redness.

WHAT WILL I BE ASKED TO DO?

You will be asked to participate in two parts of this study (both parts will occur on the top and bottom of the foot as well as the top and bottom of the hand):

Part 1: You will be subjected to single laser pulses generated by an infrared (invisible) Tm-YAG laser (wavelength 2.0 microns, duration approximately 3 milliseconds, IPG Photonics, Oxford, MA, USA)

Part 2: You will be subjected to multiple pulses generated by the specified laser listed above.

During this procedure, you may feel a slight pinprick and/or mild heat sensation. Both single and multiple pulses of laser energy will be directed at your skin. The pulse of energy will be for a fraction of a second (approximately 3 milliseconds). After the pulse, you will be asked specific questions related to what you felt.

1. Describe what sensation, if any was felt.
2. Over what area(s) did the sensation occur? How long did it last?
3. Do you wish to continue participating in this experiment?

The investigator will examine the skin in the area of exposure. If you did not feel anything and/or redness did not occur, and you are willing to be exposed again at a slightly higher energy level, the tests will continue to higher energies. The next exposure will take place after a waiting period of at least 45 seconds. This cycle will continue until you decide to terminate the exposures, the investigator decides to terminate the exposures, or a pre-determined level of energy is reached (30.5 mJ/mm^2 or millijoules per square millimeter, a measure of energy on an area of skin) as a precaution and to prevent any injury. ***You may choose to terminate your participation at any time.***

ARE THERE REASONS WHY I SHOULD NOT TAKE PART IN THIS STUDY?

As long as you meet the eligibility criteria listed below, there is no reason you should not participate in this study.

Who is eligible to take part in this study?

1. You must be at least 18 years old.
2. You must read and sign this consent form.
3. You must comply with study requirements and follow any rules provided to you.
4. You must not have a history of any clinically significant (examples listed below) disease including but not limited to:
    - Nervous system disorder
    - All types of diabetes
    - Active or widespread skin conditions such as eczema or psoriasis
    - History of allergic reactions to sunlight or other light
    - Take any medications on list of Common Medications that Increase Sensitivity to Light (attached to Health History Questionnaire).
5. Subject must not be pregnant, plan on becoming pregnant, or become pregnant during any part of this study.
6. You must not have a rash, fear of lasers, sunburn, tattoos in area of interest, or be sensitive to sunlight or light in general.
7. You must meet all entry criteria in order to participate in this study.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

Risks	**Likelihood of Risk**	**Severity and Possible Time Frame of Risk**	**Procedures to Minimize Risks**
Injury to cornea	In this study: Extremely unlikely with eye protection in place	Usually mild, can be serious Onset of risk: Immediate	All subjects will wear laser eye protection that complies with ANSI Z136.1-2000 guidelines or completely blocks all light Operating procedures are such that no exposures will take place until the subject is properly positioned with the correct safety equipment
Thermal Burn from high energy	In this study: Unlikely	Ranges from mild to serious depending on	Energy will be increased incrementally, with approximately 45 seconds minimum between

pulses		energy level, penetration depth, and skin sensitivity Onset of risk: Immediate	exposures. This will allow any inflammation or reddening of skin to develop and that person's participation in the study will be terminated.
Swelling, edema	In this study: Unlikely	Usually mild, heals within days Onset of risk: Immediate-2 hours	Energy will be increased incrementally, with approximately 45 seconds minimum between exposures. This will allow any inflammation or reddening of skin to develop and that person's participation in the study will be terminated.
Rash	In this study: Extremely unlikely	No cases ever reported Onset of risk: 24 hours	Enroll healthy adults. Screen out individuals (through handout) with significant preexisting rash or breaks in skin, or prior adverse effects from light.
Loss of hair at site of exposure	In this study: Likely	Lasers with shorter wavelengths are used with similar operating parameters to remove hair Onset of risk: Immediate	Regions where the laser is used may cause loss of hair. Procedures will be terminated on volunteer if this occurs. Not seen during *in-vivo* exposures.
Hypopigmentation (Discoloration of skin)	In this study: Unlikely	Highly pigmented individuals may have severe cases. Not serious Onset of risk: 24 hours-2 weeks	Termination of procedures when appears. Likely, only at energy levels in excess of those causing skin reddening.
Tattoo removal	In this study: Unlikely	Depth of penetration of the laser makes this	Volunteers with tattoos in the test area will be disqualified

		theoretically not possible, but it is not proven experimentally Onset of risk: Immediate	
Fear, nightmares	In this study: Unlikely since you have control over exposure levels	Not serious Onset of risk: Immediate-1 week	Recruit healthy volunteers through handout at beginning of study
Photosensitivity resulting in blisters, thermal injury	In this study: Unlikely, as you will be screened	Potentially serious only for sensitive population Onset of risk: Immediate	Screen subjects to ensure all are healthy, and not taking any photosensitizing medications

Although there is considerable evidence that the study is safe and no injuries will occur, there is specific evidence that any injury will be very superficial (on or near the surface of the skin), and will only involve a very thin layer of skin, no bleeding and a low probability of scar formation. Injuries are not expected, but should they occur, they may present as discomfort, swelling and an area of redness and perhaps even an area of blisters at the site of exposure. The spot of exposure will range from feeling like a mild bee sting to being burnt by a match. The area of exposure is smaller than the end of a pencil eraser. It is believed that any reddening that may occur will last for only 24 hours post exposure. You will not be exposed to the laser again until all reddening and/or side effects have gone away. Based on previous studies, the investigators will limit your exposure to less than what is expected to cause skin reddening. This will eliminate any permanent damage to the exposure area.

It is not possible to identify all potential risks in research procedures, but the researcher(s) have taken reasonable safeguards to minimize any potential risks.

ARE THERE ANY BENEFITS FROM TAKING PART IN THIS STUDY?

There are no direct benefits to you from taking part in this study. However, by participating in this study, you will help scientists better understand the minimum laser energy needed to be felt in the healthy human hand and foot as well as the minimum laser energy needed to enable only specific feeling pathways to engage.

DO I HAVE TO TAKE PART IN THE STUDY?

You may withdraw your consent at any time.

Your participation in this research is voluntary. If you decide to participate in the study, you may withdraw your consent and stop participating at any time without penalty or loss of benefits to which you are otherwise entitled.

WHAT WILL IT COST ME TO PARTICIPATE?

Your participation in this study will not cost you anything other than your time.

WHO WILL SEE THE INFORMATION THAT I GIVE?

All information you provide as part of this study will be confidential and will be protected to the fullest extent provided by law. Information that you provide and other records related to this study will be accessible to those persons directly involved in conducting this study and members of the Colorado State University Institutional Review Board (IRB) which provides oversight for protection of human research volunteers. All questionnaires, forms, charts, and videos will be kept in a restricted access, locked safe while not in use. Your name or any other identifying information will not be used in presentation or publications produced as a result of this study.

CAN MY TAKING PART IN THE STUDY END EARLY?

After each exposure, you will be asked a series of questions pertaining to the sensation and discomfort felt. At this time, the investigator will examine the site of exposure for any signs of damage. If any redness and/or side effect of any degree have occurred as a result of the exposure, you will not be asked to continue. If at any point during the study you become pregnant, you will be asked to terminate your participation.

The investigator may also reject volunteers for any other reason that may present undue risk involved in a particular person for this study.

WILL I RECEIVE ANY COMPENSATION FOR TAKING PART IN THIS STUDY?

There will be no compensation for taking part in this study.

WHAT HAPPENS IF I AM INJURED BECAUSE OF THE RESEARCH?

The Colorado Governmental Immunity Act determines and may limit Colorado State University's legal responsibility if an injury happens because of this study. Claims against the University must be filed within 180 days of the injury.

Although the risk of injury is low, if an injury would occur, you will be responsible for your own medical costs.

WHAT IF I HAVE QUESTIONS?

Before you decide whether to accept this invitation to take part in the study, please ask any questions that might come to mind now. Later, if you have questions about the study, you can contact the Primary investigator, Thomas Johnson at (970) 491-0563, thomas.e.johnson@colostate.edu or the Co-investigator, Ernest Scott at (970) 491-4098, ernscott@rams.colostate.edu. If you have any questions about your rights as a volunteer in this research, contact Janell Barker, Human Research Administrator at 970-491-1655. We will give you a copy of this consent form to take with you.

WHAT ELSE DO I NEED TO KNOW?

It has been shown that the types of lasers used in this study lack the typical side effects (skin redness and discoloration) that other lasers may cause. The investigators involved in this study have every reason to believe that no permanent damage will be caused as a result of this study. If any redness occurs after exposure, you will not be exposed again to eliminate the possibility of permanent damage.

Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing __6__ pages.

_______________________________________ ____________________
Signature of person agreeing to take part in the study Date

____
Printed name of person agreeing to take part in the study

_____________________________________ ____________________
Name of person providing information to participant Date

____
Signature of Research Staff

This consent form was approved by the CSU Institutional Review Board for the protection of human subjects in research on July 19, 2012.

Health History Questionnaire

If you have any of the following conditions you will be excluded from participating in this study. This is meant only to eliminate unnecessary permanent damage that may be caused by the laser used in this study.

- Nervous system disorder
- Clinically significant medical or psychiatric illness
- Diabetes
- History of allergic reaction to sunlight or other light
- Sensitivity to sunlight or light in general
- Take any medications that increase sensitivity to light
- Rash, sunburn and/or tattoos on the top or bottom of your hands or feet
- Fear of lasers
- Pregnant, plan on becoming pregnant or become pregnant during the study
- Any condition affecting sensitivity in your hands or feet

If you do not have a history or show clinical signs of the conditions listed above, an informed consent form will be given to you.

You should not take any over the counter medications 24 hours before the study. Are you taking Tylenol, Advil, or generic equivalent? Y____ N ____

You must read and sign the informed consent form in order to be eligible to participate in this study.

Common Medications that Increase Sensitivity to Light

If you take any of the following you will be eliminated from participating in this study. This is meant only to eliminate any unnecessary permanent damage that may be caused by the laser used in this study.

Acne medications
Accutane (Isotretinoin)
Retin-A (Tretinoin)

Antibacterials
Halogenated carbanilides
Halogenated phenols (antibacterials in deodorant bar soaps, antiseptics and cosmetics)
Halogenated salicylanilide
Nalidixic acid
Sulfamethoxazole
Sulfonamides (including Sulfamethoxazole, Sulfisoxazole, Trisulfapyridines)
Trimethoprim

Antibiotics
Achromycin (Tetracycline)
Azulfidine (Sulfasalazine)
Bactrim (Sulfamethoxazole-trimetho-prim)
Cinobac (Cinoxacin)
Declomycin (Demeclocycline)
Fansidar (Sulfadoxine-pyrimethamine)
Fulvicin-U/F (Griseofulvin)
Gris-PEG (Griseofulvin)
Gantanol (Sulfamethoxazole)
Gantrisin (Sulfisoxazole)
Minocin (Tetracycline, Minocycline)
NegGram (Nalidixic Acid)
Neotrizine (Sulfacytine)
Renoquid (Sulfacytine)
Rondomycin (Methacycline)
Septra (Sulfamethoxazole-trimethoprim)
Terramycin (Oxytetracycline)
Tetracycline
Thiosulfil (Sulfamethizole)
Vibramycin (Doxycycline)

Anticancer drugs
DTIC-Dome (Dacarbazine)
Efudex (Fluorouracil)
Fluoroplex (Fluorouracil)
Matulane (Procarbazine)

Mexate (Methotrexate)
Velban (Vinblastine)

Antidepressants
Adapin (Doxepin)
Asendin (Amoxapine)
Aventyl HCL (Nortriptyline)
Elavil (Amitriptyline)
Ludiomil (Maprotiline)
Marplan (Isocarboxazid)
Norpramin (Desipramine)
Pamelor (Nortriptyline)
Pertofrane (Desipramine)
Sinequan (Doxepin)
Surmontil (Trimipramine)
Tofranil (Imipramine)
Vivactil (Protriptyline)

Antihistamines
Benadryl, Benylin (Diphenhydramine)
Dimetane (Brompheniramine)
Periactin (Cyproheptadine)

Anti-inflammatory drugs
Advil, Motrin (Ibuprofen)
Butazolidin (Phenylbutazone)
Clinoril (Sulindac)
Feldene (Piroxicam)
Naprosyn (Naproxen)
Orudis (Ketoprofen)

Antiparasitics
Bitin (Bithionol)
Povan (Pyrvinium pamoate)
Quinine

Antipsychotic drugs/Tranquilizers
Compazine (Prochlorperazine)
Haldol (Haloperidol)
Mellaril (Thioridazine)
Navane (Thiothixene)
Permitil (Fluphenazine)
Prolixin (Fluphenazine)
Quide (Piperacetazine)
Stelazine (Trifluoperazine)
Temaril (Trimeprazine)

Teractan (Chlorprothixine)
Thorazine (Chlorpromazine)
Trilafon (Perphenazine)
Vesprin (Triflupromazine)

Antiseizure drugs
Dilantin (Phenytoin)
Paradione (Paramethadione)
Tridione (Trimethadione)

Diuretics
Anhydron (Cyclothiazide)
Aquatensen (Methyclothiazide)
Diamox (Acetazolamide)
Diucardin (Hydroflumethiazide)
Diuril (Chlorothiazide)
Enduron (Methyclothiazide)
Exna (Benzthiazide)
Hydrodiuril (Hydrochlorothiazide)
Hydromox (Quinethazone)
Lasix (Furosemide)
Metahydrin (Trichlormethiazide)
Midamor (Amiloride)
Naturetin (Bendroflumethiazide)
Renese (Polythiazide)
Zaroxolyn (Metolazone)

Hypoglycemics (diabetes)
Diabeta (Glyburide)
Diabinese (Chlorpropamide)
Dymelor (Acetohexamide)
Glucotrol (Glipizide)
Insulase (Chlorpropamide)
Micronase (Glyburide)
Orinase (Tolbutamide)
Tolinase (Tolazamide)

Psoralens
8-Methoxypsoralen
Oxsoralen
Trisoralen

Others
Americaine (Benzocaine)
Aralen (Chloroquine Hydrochloride)
Capoten (Captopril)

Cordarone (Amiodarone)
Diethylstilbestrol
Dermoplast (Benzocaine)
Gold salts (Myochrysine, Solganol)
Librium (Chlordiazepoxide)
Musk ambrette (in perfumes)
Norpace (Disopyramide)
Oils of bergamot, citron, lavender, lemon, lime, rosemary, sandalwood, cedar and musk ambrette (in perfumes and cosmetics)
Oral contraceptives (Estrogen)
PABA (Para-aminobenzoic acid)
Phenergan (Promethazine)
pHisoHex (Hexachlorophene)
Quinidine sulfate and gluconate
Solarcaine (Benzocaine)
Tattoos (Cadmium sulfide)
Tegretol (Carbamazepine)
6-methylcoumarin (in perfumes, shaving lotions, sunscreens)

Source of Data:
Medications that Increase Sensitivity to Light: A 1990 Listing, prepared by Jerome I. Levine, M.S., R.Ph., 12/90, US Dept of Health & Human Services, FDA 91-8280

Colorado State University
Knowledge to Go Places

Research Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011 Fort Collins, CO
TEL: (970) 491-1553
FAX: (970) 491-2293

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	July 26, 2012
TO:	Johnson, Thomas, 1681 Env & Rad Health Sciences
	Scott, Ernie, 1681 Env & Rad Health Sciences, Nickoloff, Jac, 1681 Env & Rad Health Sciences
FROM:	Barker, Janell, Coordinator, CSU IRB 1
PROTOCOL TITLE:	Selective Activation of A-Delta and C Nociceptors and Determination of Sensation Thresholds from 2.01 µm Laser Light Incident on the Human Hand and Foot.
FUNDING SOURCE:	NONE
PROTOCOL NUMBER:	11-3181H
APPROVAL PERIOD:	Approval Date: July 19, 2012 Expiration Date: February 16, 2013

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Selective Activation of A-Delta and C Nociceptors and Determination of Sensation Thresholds from 2.01 µm Laser Light Incident on the Human Hand and Foot.. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Colostate.edu
Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Colostate.edu

Barker, Janell

Janell Barker

Barker, Janell

The Amendment approval is to revise the protocol to include the tops and bottoms of hands as exposure sites. The revised consent form reflecting this change must be used.

Approval Period:	July 19, 2012 through February 16, 2013
Review Type:	FULLBOARD
IRB Number:	00000202

Colorado State University
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Research Integrity & Compliance Review Office
Office of the Vice President for Research
321 General Services Building - Campus Delivery 2011 Fort Collins, CO
TEL: (970) 491-1553
FAX: (970) 491-2293

NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE:	January 17, 2013	
TO:	Johnson, Thomas, 1681 Env & Rad Health Sciences	
	Scott, Ernie, 1681 Env & Rad Health Sciences, Nickoloff, Jac, 1681 Env & Rad Health Sciences	
FROM:	Barker, Janell, Coordinator, CSU IRB 1	
PROTOCOL TITLE:	Selective Activation of A-Delta and C Nociceptors and Determination of Sensation Thresholds from 2.01 μm Laser Light Incident on the Human Hand and Foot.	
FUNDING SOURCE:	NONE	
PROTOCOL NUMBER:	11-3181H	
APPROVAL PERIOD:	Approval Date: February 16, 2013	Expiration Date: February 15, 2014

The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: Selective Activation of A-Delta and C Nociceptors and Determination of Sensation Thresholds from 2.01 μm Laser Light Incident on the Human Hand and Foot.. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed.

If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice.

This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

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Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Colostate.edu

Barker, Janell

Janell Barker

Barker, Janell

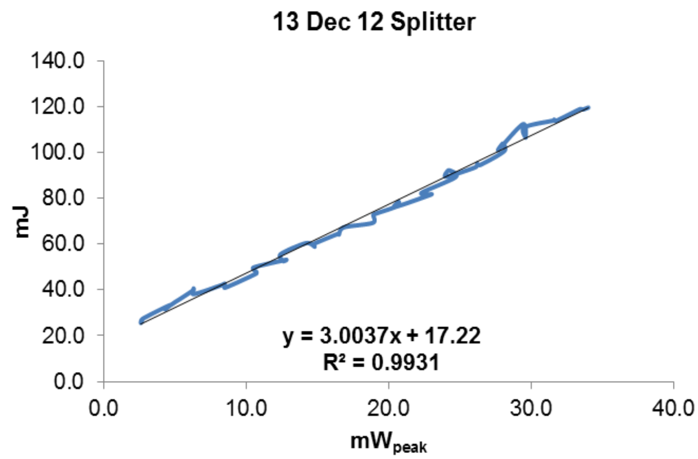
Approval is to continue to follow the 12 participants already recruited. No further participant accrual.

Approval Period:	February 16, 2013 through February 15, 2014
Review Type:	FULLBOARD
IRB Number:	00000202

Appendix B

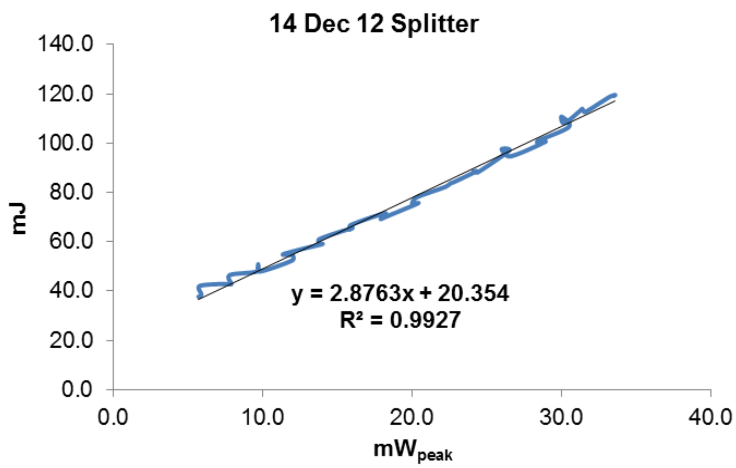
December 13, 2012 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
20.00	2.7	26.6
20.00	2.6	25.6
20.00	2.7	27.3
22.50	4.6	33.3
22.50	4.3	31.5
22.50	4.4	32.2
25.00	6.3	40.0
25.00	6.3	40.7
25.00	6.3	38.2
27.50	8.3	42.2
27.50	8.5	42.8
27.50	8.5	41.0
30.00	10.7	47.2
30.00	10.7	48.0
30.00	10.5	49.8
32.50	12.8	53.2
32.50	12.6	52.6
32.50	12.4	55.6
35.00	14.2	60.5
35.00	14.8	58.9
35.00	14.7	60.0
37.50	16.5	64.7
37.50	16.5	64.2
37.50	16.8	67.3
40.00	18.9	69.4
40.00	18.9	72.8
40.00	19.1	73.4
42.50	20.6	76.7
42.50	20.7	78.6
42.50	20.4	76.2
45.00	23.0	81.8
45.00	22.8	81.8
45.00	22.3	82.5
47.50	24.7	89.4
47.50	24.2	92.3
47.50	24.0	89.5
50.00	26.1	93.7
50.00	26.2	95.2
50.00	26.4	94.6
52.50	28.1	100.7
52.50	28.0	104.0
52.50	27.7	101.3
55.00	29.4	112.4
55.00	29.6	106.6
55.00	29.5	111.1
57.50	31.6	26.6
57.50	31.6	25.6
57.50	31.7	27.3
60.00	33.4	33.3
60.00	33.6	31.5
60.00	34.0	32.2



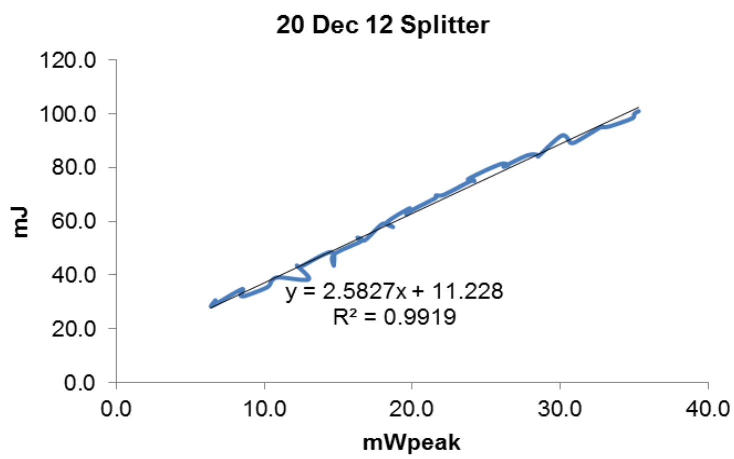
December 14, 2012 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	5.7	37.7
25.00	5.9	38.6
25.00	5.8	42.1
27.50	7.6	42.9
27.50	7.9	42.8
27.50	7.8	46.5
30.00	9.6	47.9
30.00	9.7	50.9
30.00	9.8	47.9
32.50	12.0	52.5
32.50	12.0	54.6
32.50	11.4	55.0
35.00	14.0	59.1
35.00	13.8	58.8
35.00	13.8	61.1
37.50	16.0	65.6
37.50	15.8	64.9
37.50	15.9	66.8
40.00	18.2	71.6
40.00	17.9	69.2
40.00	18.2	70.0
42.50	20.4	75.6
42.50	20.0	75.3
42.50	20.3	78.0
45.00	22.2	82.2
45.00	22.6	83.8
45.00	22.8	84.2
47.50	24.3	88.6
47.50	24.1	88.5
47.50	24.4	88.2
50.00	26.5	97.0
50.00	26.0	97.6
50.00	26.6	94.7
52.50	28.9	100.5
52.50	28.4	100.0
52.50	28.4	100.9
55.00	30.5	106.6
55.00	30.0	110.8
55.00	30.2	108.1
57.50	31.3	113.4
57.50	31.4	114.0
57.50	31.6	112.7
60.00	33.2	118.7
60.00	33.6	119.6
60.00	33.5	119.1



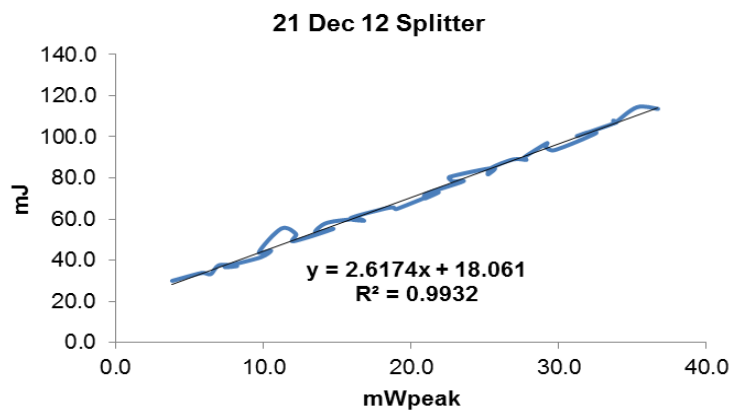
December 20, 2012 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.7	30.7
25.00	6.4	28.4
25.00	6.7	29.2
27.50	8.5	34.8
27.50	8.4	32.5
27.50	8.6	32.1
30.00	10.2	35.5
30.00	10.5	37.9
30.00	10.9	39.2
32.50	13.0	38.4
32.50	12.2	43.6
32.50	12.4	43.0
35.00	14.5	48.6
35.00	14.7	43.5
35.00	14.7	47.7
37.50	16.6	52.8
37.50	16.3	54.0
37.50	16.8	53.0
40.00	18.0	59.1
40.00	18.7	57.9
40.00	18.3	59.7
42.50	19.8	64.8
42.50	19.6	62.6
42.50	20.0	64.2
45.00	21.6	68.8
45.00	21.6	69.7
45.00	22.1	69.8
47.50	24.1	75.4
47.50	24.2	75.0
47.50	23.8	75.8
50.00	26.0	81.4
50.00	26.5	81.0
50.00	26.2	80.4
52.50	27.8	84.6
52.50	28.5	84.7
52.50	28.5	84.1
55.00	30.1	91.9
55.00	30.7	89.2
55.00	31.0	89.4
57.50	32.8	95.3
57.50	32.8	95.1
57.50	33.3	95.3
60.00	34.9	98.4
60.00	35.0	100.0
60.00	35.3	101.0



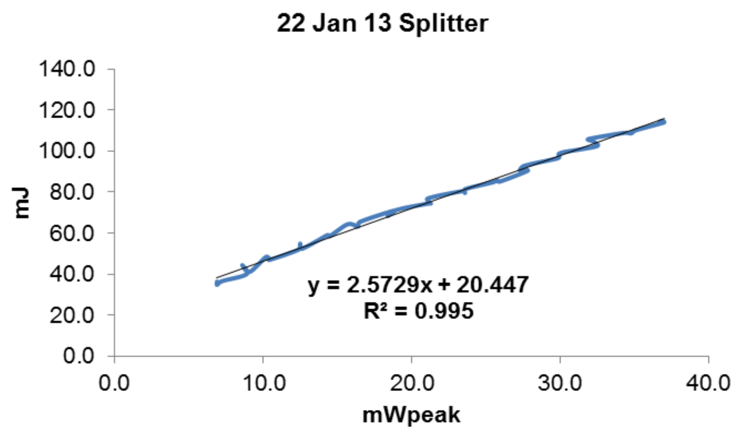
December 21, 2012 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	3.8	30.0
25.00	5.8	33.8
25.00	6.4	33.2
27.50	7.0	37.6
27.50	8.2	37.2
27.50	7.4	36.9
30.00	9.8	41.4
30.00	10.5	44.7
30.00	9.7	44.1
32.50	11.2	55.4
32.50	12.2	52.7
32.50	12.0	49.2
35.00	14.7	55.2
35.00	13.5	53.5
35.00	14.3	58.2
37.50	16.4	60.1
37.50	16.8	59.2
37.50	15.9	60.5
40.00	18.2	65.1
40.00	18.8	65.7
40.00	19.0	64.9
42.50	21.8	72.9
42.50	20.9	70.0
42.50	21.0	72.3
45.00	23.5	78.3
45.00	22.8	78.4
45.00	22.6	80.5
47.50	25.6	84.9
47.50	25.2	81.7
47.50	25.4	84.8
50.00	26.9	89.0
50.00	27.8	88.8
50.00	27.7	90.2
52.50	29.2	96.9
52.50	29.1	95.2
52.50	29.7	93.5
55.00	32.5	101.7
55.00	32.0	102.2
55.00	31.3	100.5
57.50	33.9	107.0
57.50	33.7	107.9
57.50	33.8	106.8
60.00	35.3	114.4
60.00	36.7	113.6
60.00	36.5	113.9



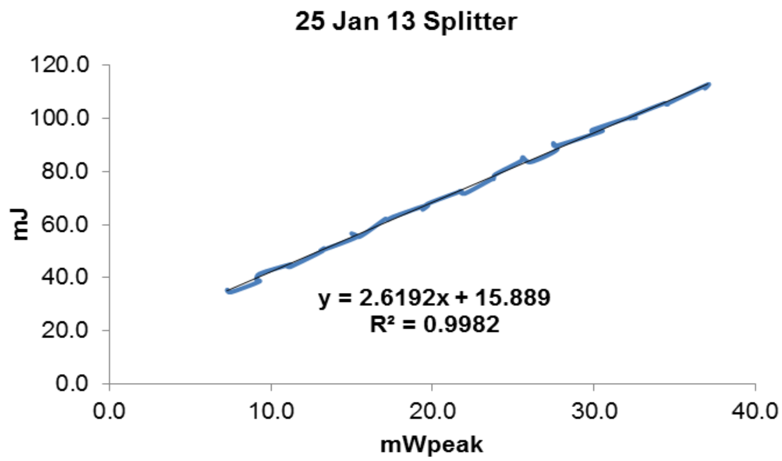
January 22, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.9	36.4
25.00	6.9	34.8
25.00	7.2	36.5
27.50	8.9	40.0
27.50	8.6	44.4
27.50	9.1	41.1
30.00	10.2	48.4
30.00	10.4	47.7
30.00	10.4	46.9
32.50	12.4	52.0
32.50	12.5	54.9
32.50	12.6	52.3
35.00	14.3	58.9
35.00	14.4	59.0
35.00	14.5	58.5
37.50	15.7	64.3
37.50	16.4	63.2
37.50	16.5	65.4
40.00	18.8	70.9
40.00	18.4	68.3
40.00	19.0	71.3
42.50	21.2	74.5
42.50	21.3	74.4
42.50	21.1	76.9
45.00	23.5	80.5
45.00	23.6	79.5
45.00	23.6	81.4
47.50	25.5	84.8
47.50	25.8	85.7
47.50	25.9	85.0
50.00	27.8	90.3
50.00	27.3	90.5
50.00	27.6	92.8
52.50	29.9	96.6
52.50	29.9	98.5
52.50	30.2	99.4
55.00	32.5	102.4
55.00	32.2	104.8
55.00	31.9	105.8
57.50	34.3	108.8
57.50	34.8	108.6
57.50	35.1	110.1
60.00	37.0	113.9
60.00	36.9	114.7
60.00	36.7	114.2



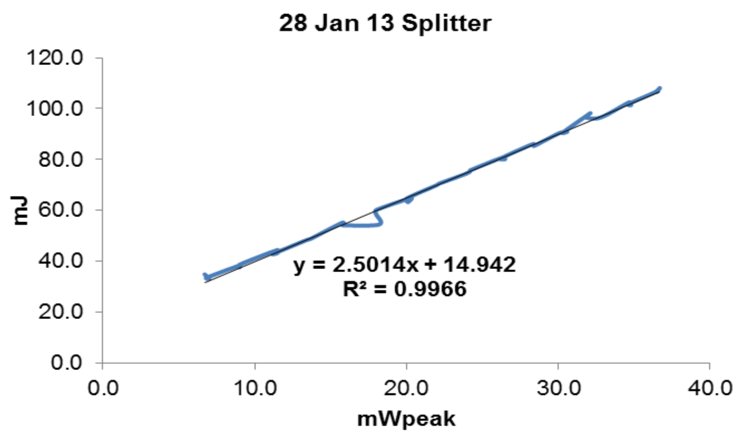
January 25, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	7.3	35.5
25.00	7.3	35.1
25.00	7.5	34.5
27.50	9.3	38.6
27.50	9.1	39.4
27.50	9.3	41.5
30.00	11.2	45.0
30.00	11.0	44.4
30.00	11.2	44.1
32.50	13.2	50.1
32.50	13.3	51.1
32.50	13.1	50.2
35.00	15.3	55.3
35.00	15.0	56.7
35.00	15.5	55.5
37.50	17.1	62.2
37.50	17.2	61.8
37.50	17.6	63.0
40.00	19.7	67.4
40.00	19.4	65.7
40.00	19.7	67.8
42.50	21.8	72.7
42.50	21.7	72.6
42.50	22.0	71.7
45.00	23.7	77.2
45.00	23.8	77.2
45.00	23.9	78.9
47.50	25.5	84.0
47.50	25.6	85.4
47.50	26.1	83.6
50.00	27.7	88.1
50.00	27.5	90.7
50.00	27.6	89.6
52.50	30.5	95.2
52.50	29.9	94.9
52.50	29.9	95.7
55.00	32.4	100.7
55.00	32.6	100.3
55.00	32.2	100.4
57.50	34.4	105.8
57.50	34.6	105.4
57.50	34.5	105.4
60.00	37.1	112.9
60.00	36.9	111.4
60.00	36.9	112.1



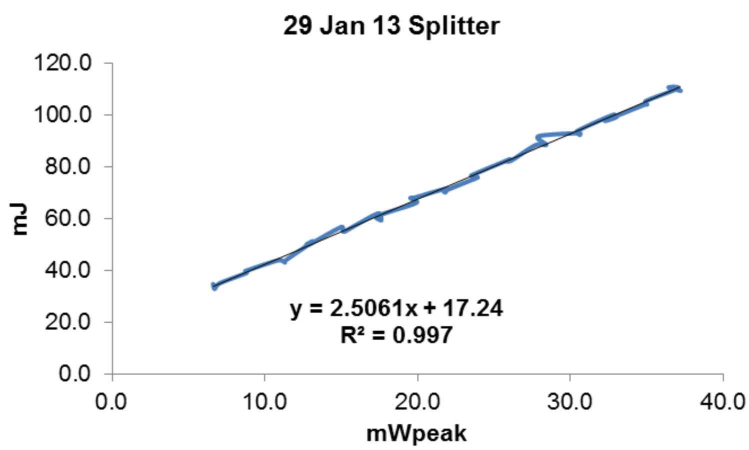
January 28, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.7	34.8
25.00	7.0	33.1
25.00	6.8	33.4
27.50	9.0	38.3
27.50	9.0	37.6
27.50	9.0	38.6
30.00	11.5	44.4
30.00	11.5	43.2
30.00	11.2	42.8
32.50	13.3	48.0
32.50	13.7	48.8
32.50	13.7	48.8
35.00	15.8	55.2
35.00	15.9	54.4
35.00	15.8	54.1
37.50	18.2	54.4
37.50	18.0	58.5
37.50	18.0	60.1
40.00	20.3	64.8
40.00	20.1	63.2
40.00	20.0	64.6
42.50	22.0	69.9
42.50	22.1	70.3
42.50	22.2	70.6
45.00	23.9	74.3
45.00	24.2	75.3
45.00	24.2	75.7
47.50	26.4	80.9
47.50	26.5	80.1
47.50	26.2	80.3
50.00	27.9	85.0
50.00	28.4	86.1
50.00	28.4	85.3
52.50	30.1	90.4
52.50	30.6	90.9
52.50	30.3	90.5
55.00	32.1	98.1
55.00	31.8	96.6
55.00	32.8	96.5
57.50	34.7	102.5
57.50	34.8	101.3
57.50	34.6	101.7
60.00	36.4	106.5
60.00	36.7	108.1
60.00	36.5	106.5



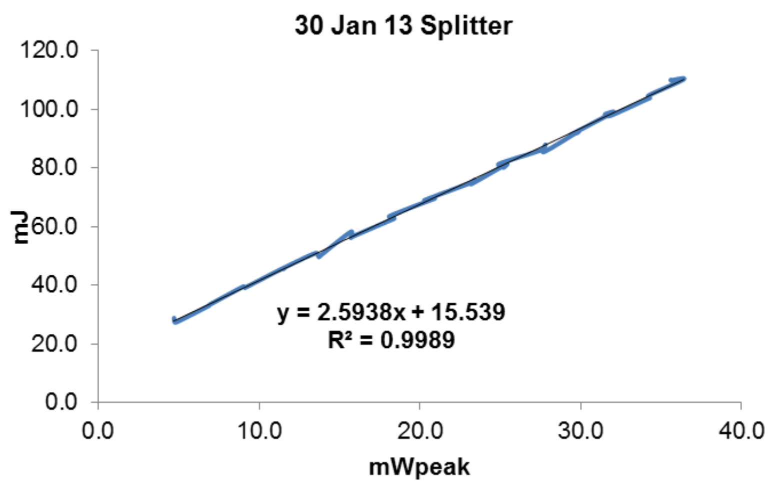
January 29, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.6	34.8
25.00	6.7	32.9
25.00	7.0	35.0
27.50	8.8	39.1
27.50	8.7	39.8
27.50	8.7	39.8
30.00	10.9	44.0
30.00	11.3	43.1
30.00	11.3	43.7
32.50	13.1	51.1
32.50	12.7	50.0
32.50	12.8	49.7
35.00	15.0	56.8
35.00	15.1	55.0
35.00	15.2	55.0
37.50	17.4	62.0
37.50	17.6	59.3
37.50	17.3	60.9
40.00	19.9	66.1
40.00	19.5	67.9
40.00	19.8	68.1
42.50	21.9	71.6
42.50	21.8	70.1
42.50	21.7	70.5
45.00	23.9	75.8
45.00	23.7	76.0
45.00	23.5	76.6
47.50	26.0	82.8
47.50	25.7	82.1
47.50	26.1	82.3
50.00	27.7	88.3
50.00	28.4	88.4
50.00	27.9	91.7
52.50	30.6	92.9
52.50	30.6	92.2
52.50	30.4	93.6
55.00	32.8	100.0
55.00	33.0	99.1
55.00	32.3	97.8
57.50	34.9	104.0
57.50	35.0	103.9
57.50	34.9	105.2
60.00	37.0	110.1
60.00	36.4	110.5
60.00	37.2	109.2



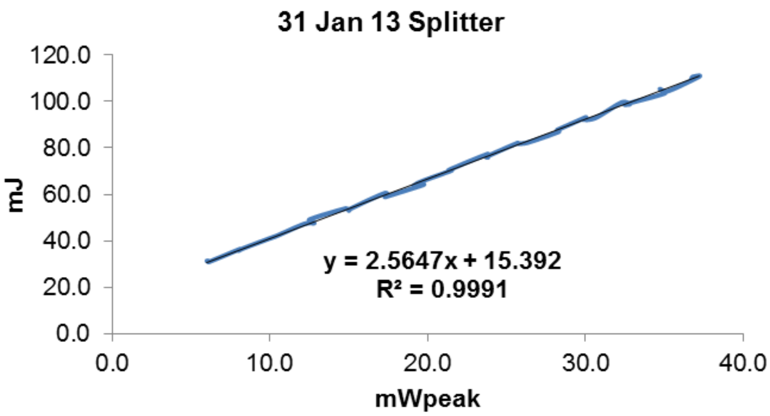
January 30, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	4.7	28.8
25.00	4.7	28.4
25.00	4.8	27.3
27.50	6.9	33.1
27.50	6.9	33.3
27.50	7.0	33.6
30.00	9.0	39.5
30.00	9.1	39.3
30.00	9.1	39.1
32.50	11.6	46.1
32.50	11.5	45.5
32.50	11.5	45.8
35.00	13.5	50.9
35.00	13.7	49.6
35.00	13.9	50.5
37.50	15.7	58.2
37.50	15.7	56.1
37.50	15.7	56.3
40.00	18.1	62.0
40.00	18.4	62.7
40.00	18.1	63.5
42.50	20.9	69.5
42.50	20.7	69.1
42.50	20.3	69.0
45.00	23.3	75.2
45.00	23.4	75.9
45.00	23.2	74.5
47.50	25.4	81.3
47.50	25.2	80.1
47.50	24.9	81.3
50.00	27.6	86.2
50.00	27.8	87.9
50.00	27.7	85.4
52.50	29.9	92.6
52.50	29.8	92.0
52.50	29.4	91.3
55.00	32.0	98.9
55.00	31.5	98.2
55.00	31.8	97.7
57.50	34.2	103.6
57.50	34.3	103.8
57.50	34.2	104.6
60.00	36.4	110.2
60.00	35.6	109.8
60.00	35.6	110.0



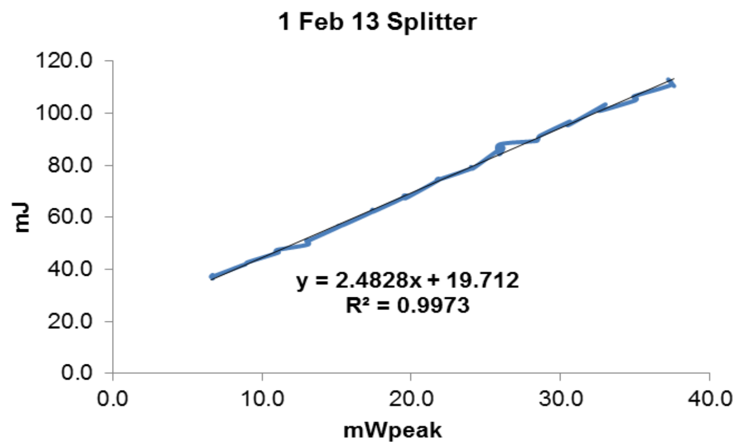
January 31, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.0	31.3
25.00	6.1	31.3
25.00	6.1	30.8
27.50	8.1	36.4
27.50	8.0	35.7
27.50	8.3	36.7
30.00	10.3	41.8
30.00	10.3	41.7
30.00	10.4	42.0
32.50	12.2	47.3
32.50	12.8	47.6
32.50	12.5	49.1
35.00	14.8	53.9
35.00	15.0	53.0
35.00	15.1	53.8
37.50	17.3	60.6
37.50	17.5	59.4
37.50	17.3	58.9
40.00	19.7	64.1
40.00	19.1	63.6
40.00	19.5	65.3
42.50	21.5	70.3
42.50	21.3	70.3
42.50	21.5	71.0
45.00	23.8	77.4
45.00	23.8	75.9
45.00	23.7	76.2
47.50	25.7	82.2
47.50	25.7	81.9
47.50	26.3	82.3
50.00	28.3	87.0
50.00	28.2	87.8
50.00	28.2	87.8
52.50	30.0	93.2
52.50	29.8	92.3
52.50	30.6	92.9
55.00	32.3	99.7
55.00	32.8	98.9
55.00	32.5	98.8
57.50	35.0	103.6
57.50	34.7	105.4
57.50	35.2	104.5
60.00	37.2	110.9
60.00	36.8	110.7
60.00	36.7	109.9



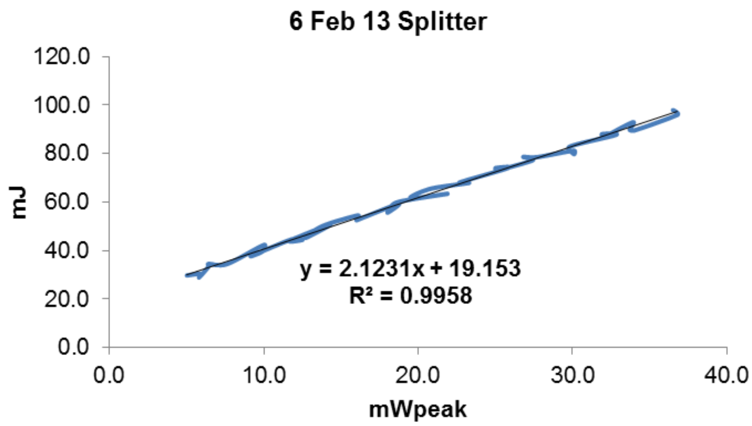
February 1, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.7	36.5
25.00	6.7	37.9
25.00	6.6	37.1
27.50	8.6	41.4
27.50	8.9	42.0
27.50	9.0	42.7
30.00	11.1	46.5
30.00	10.9	46.5
30.00	11.0	47.5
32.50	13.1	49.6
32.50	13.0	51.3
32.50	13.0	50.8
35.00	15.3	56.8
35.00	15.1	56.7
35.00	15.4	57.0
37.50	17.4	62.2
37.50	17.4	63.0
37.50	17.4	62.1
40.00	19.7	68.2
40.00	19.5	68.4
40.00	19.6	67.3
42.50	21.9	74.6
42.50	21.8	74.9
42.50	21.7	74.3
45.00	24.0	78.7
45.00	24.0	79.4
45.00	24.1	78.7
47.50	26.1	86.8
47.50	25.9	84.2
47.50	25.9	88.0
50.00	28.4	89.4
50.00	28.5	90.2
50.00	28.6	91.3
52.50	30.6	96.8
52.50	30.4	96.2
52.50	30.5	95.4
55.00	33.0	103.4
55.00	32.9	102.9
55.00	32.6	100.9
57.50	35.0	104.9
57.50	35.1	105.6
57.50	34.9	106.5
60.00	37.4	110.9
60.00	37.2	113.0
60.00	37.6	110.4



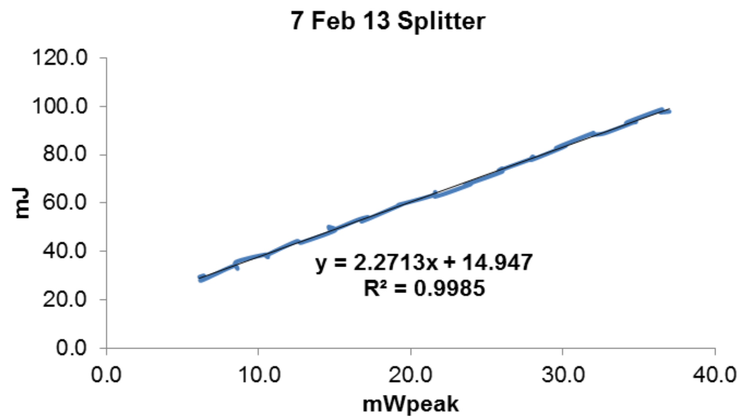
February 6, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	5.0	29.7
25.00	5.9	30.4
25.00	5.8	28.9
27.50	6.4	33.3
27.50	6.4	34.5
27.50	7.6	34.4
30.00	10.0	42.3
30.00	9.9	39.6
30.00	9.2	37.8
32.50	11.8	44.6
32.50	12.5	44.4
32.50	11.7	44.1
35.00	14.3	50.7
35.00	12.7	45.2
35.00	13.8	50.1
37.50	16.1	54.5
37.50	16.1	53.2
37.50	16.0	52.5
40.00	18.7	59.2
40.00	18.0	55.6
40.00	18.6	59.8
42.50	21.9	63.4
42.50	19.5	61.5
42.50	20.7	65.3
45.00	22.9	67.5
45.00	23.3	67.9
45.00	22.7	68.1
47.50	25.8	74.0
47.50	25.0	74.0
47.50	25.1	73.1
50.00	27.4	77.2
50.00	26.8	78.6
50.00	27.7	78.5
52.50	30.1	81.2
52.50	30.1	79.7
52.50	29.8	82.8
55.00	32.8	87.7
55.00	31.9	88.0
55.00	32.0	86.8
57.50	33.9	92.9
57.50	33.7	89.8
57.50	34.0	89.5
60.00	36.8	96.0
60.00	36.6	97.6
60.00	36.5	97.9



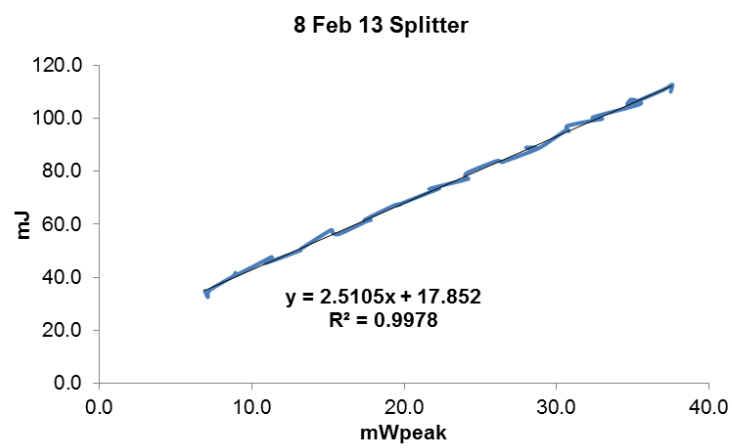
February 7, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.1	29.5
25.00	6.4	30.0
25.00	6.2	28.0
27.50	8.4	34.2
27.50	8.6	32.9
27.50	8.5	35.7
30.00	10.5	38.8
30.00	10.6	37.7
30.00	10.5	38.4
32.50	12.5	44.3
32.50	12.7	43.7
32.50	12.8	43.7
35.00	15.0	48.7
35.00	14.6	50.2
35.00	14.8	48.8
37.50	16.6	53.3
37.50	17.2	54.2
37.50	16.8	52.5
40.00	19.0	58.4
40.00	19.5	59.8
40.00	19.2	59.3
42.50	21.5	63.3
42.50	21.6	64.6
42.50	21.6	62.7
45.00	23.9	67.7
45.00	24.0	68.5
45.00	23.6	67.6
47.50	26.0	73.0
47.50	26.0	74.3
47.50	25.8	73.5
50.00	28.1	78.7
50.00	28.0	79.2
50.00	27.9	77.8
52.50	30.0	83.1
52.50	30.2	83.8
52.50	29.6	82.9
55.00	32.0	89.0
55.00	31.9	88.4
55.00	32.7	88.8
57.50	34.7	93.5
57.50	34.8	93.5
57.50	34.2	93.3
60.00	36.5	98.7
60.00	36.4	97.5
60.00	37.0	97.8



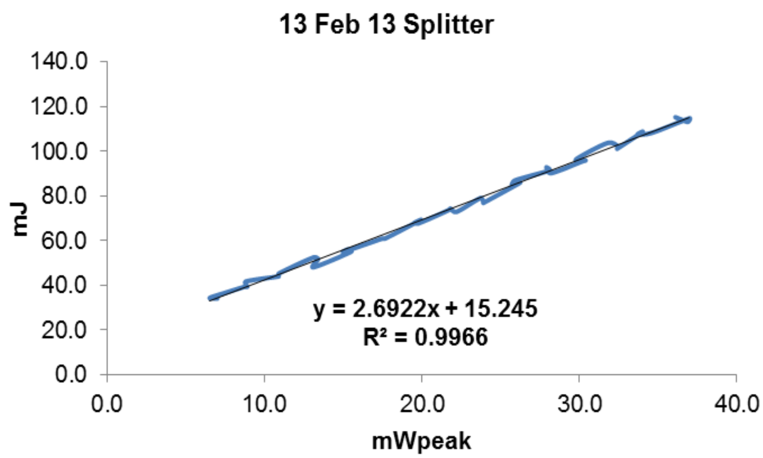
February 8, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.9	34.9
25.00	7.1	32.5
25.00	7.2	35.0
27.50	8.8	40.6
27.50	8.9	41.7
27.50	8.9	40.7
30.00	11.3	47.7
30.00	11.3	47.5
30.00	10.9	45.4
32.50	13.2	50.2
32.50	13.2	50.2
32.50	13.2	50.7
35.00	15.2	57.9
35.00	15.3	56.7
35.00	15.7	56.3
37.50	17.6	61.4
37.50	17.8	61.6
37.50	17.4	61.7
40.00	19.4	67.3
40.00	19.8	67.7
40.00	19.5	67.2
42.50	22.1	73.1
42.50	22.3	73.6
42.50	21.7	73.5
45.00	24.2	77.2
45.00	24.0	77.6
45.00	24.1	79.4
47.50	26.1	84.0
47.50	26.4	83.5
47.50	26.6	83.9
50.00	28.7	88.5
50.00	28.0	89.0
50.00	28.8	88.7
52.50	30.7	95.9
52.50	30.8	95.2
52.50	30.7	97.2
55.00	33.0	99.9
55.00	32.9	99.7
55.00	32.4	100.5
57.50	35.5	105.5
57.50	34.9	107.2
57.50	34.7	105.3
60.00	37.0	110.8
60.00	37.6	112.8
60.00	37.5	110.1



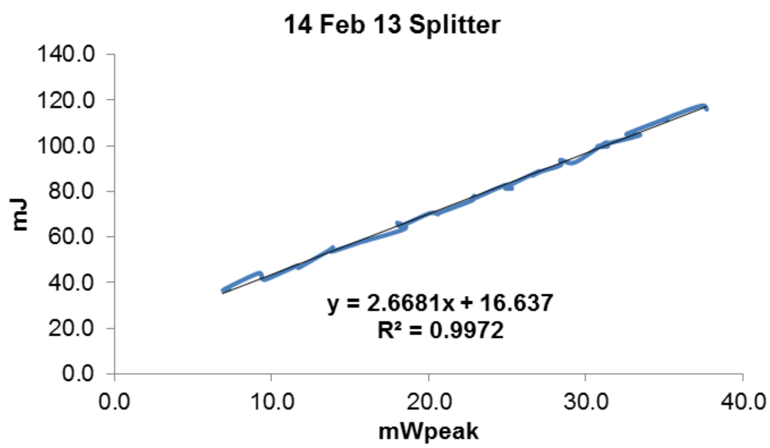
February 13, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	7.0	34.1
25.00	6.5	34.3
25.00	6.6	34.7
27.50	8.7	39.3
27.50	8.9	39.4
27.50	8.8	41.7
30.00	10.9	44.0
30.00	10.9	44.1
30.00	10.9	45.3
32.50	13.1	52.5
32.50	13.4	51.8
32.50	13.1	48.1
35.00	15.5	55.1
35.00	15.3	56.1
35.00	15.0	55.0
37.50	17.5	61.0
37.50	17.5	61.0
37.50	17.7	61.1
40.00	19.9	69.2
40.00	19.5	67.9
40.00	19.8	67.8
42.50	21.7	73.7
42.50	21.8	74.4
42.50	22.2	72.9
45.00	23.7	79.0
45.00	23.9	77.4
45.00	23.9	76.9
47.50	26.2	85.8
47.50	25.7	84.5
47.50	25.9	86.9
50.00	28.1	91.4
50.00	27.9	92.8
50.00	28.2	90.2
52.50	30.2	95.5
52.50	30.4	95.9
52.50	29.8	96.4
55.00	31.8	103.7
55.00	32.5	101.9
55.00	32.4	101.1
57.50	34.0	108.6
57.50	33.7	107.5
57.50	34.6	108.2
60.00	37.0	114.7
60.00	36.9	113.1
60.00	36.1	115.2



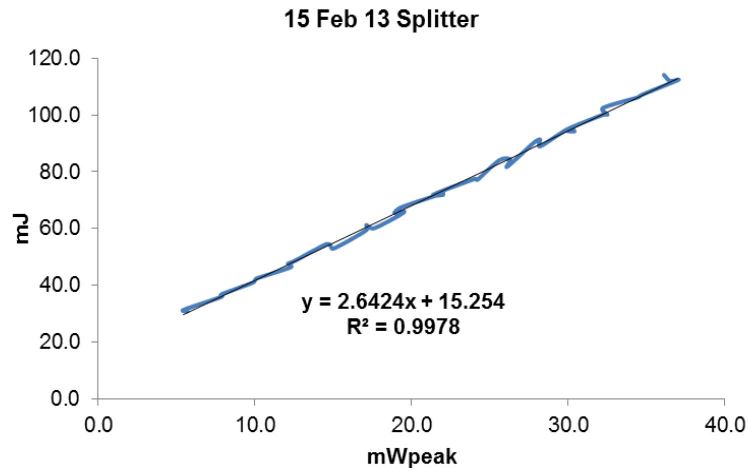
February 14, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.9	36.6
25.00	7.3	37.2
25.00	7.0	37.1
27.50	9.2	44.2
27.50	9.4	41.7
27.50	9.6	41.3
30.00	11.7	47.6
30.00	11.7	46.6
30.00	11.7	46.4
32.50	13.7	54.3
32.50	13.9	55.5
32.50	13.8	53.6
35.00	16.1	58.8
35.00	15.7	57.9
35.00	16.1	58.6
37.50	18.5	63.7
37.50	18.0	66.3
37.50	18.2	64.8
40.00	20.1	70.5
40.00	20.6	70.0
40.00	20.6	70.4
42.50	22.8	76.2
42.50	22.9	78.0
42.50	22.8	76.7
45.00	24.9	82.8
45.00	25.3	81.3
45.00	24.9	81.7
47.50	27.0	88.8
47.50	26.6	86.9
47.50	27.1	88.6
50.00	28.4	91.5
50.00	28.4	93.8
50.00	29.3	92.7
52.50	31.3	101.5
52.50	31.4	99.8
52.50	30.8	99.9
55.00	33.4	104.5
55.00	32.7	104.6
55.00	32.6	105.2
57.50	35.0	111.6
57.50	35.2	111.5
57.50	34.9	111.4
60.00	36.7	116.2
60.00	37.5	117.6
60.00	37.7	115.9



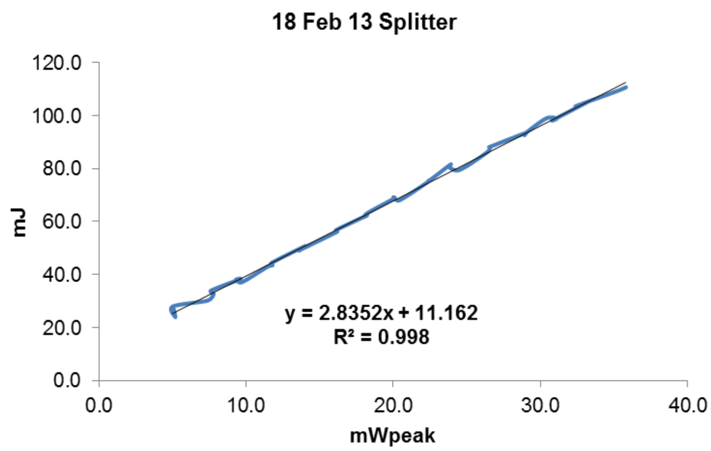
February 15, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	5.4	31.0
25.00	5.7	30.8
25.00	5.4	31.2
27.50	7.9	36.0
27.50	7.8	36.4
27.50	7.9	36.9
30.00	9.9	41.0
30.00	10.0	41.8
30.00	10.1	42.4
32.50	12.3	46.4
32.50	12.1	47.6
32.50	12.5	48.5
35.00	14.5	54.4
35.00	14.8	54.3
35.00	15.0	52.9
37.50	17.1	59.4
37.50	17.1	61.2
37.50	17.6	60.1
40.00	19.5	65.7
40.00	18.9	65.5
40.00	19.3	67.4
42.50	22.0	72.4
42.50	22.0	71.9
42.50	21.4	72.0
45.00	23.9	77.3
45.00	24.1	77.5
45.00	24.2	77.2
47.50	25.6	84.1
47.50	26.3	84.4
47.50	26.1	81.8
50.00	27.8	90.3
50.00	28.2	91.4
50.00	28.2	89.0
52.50	30.0	95.2
52.50	30.4	94.3
52.50	29.9	94.9
55.00	32.2	100.1
55.00	32.5	100.2
55.00	32.2	102.5
57.50	34.4	106.2
57.50	34.5	106.4
57.50	34.7	107.2
60.00	37.0	112.4
60.00	36.5	112.0
60.00	36.1	114.2



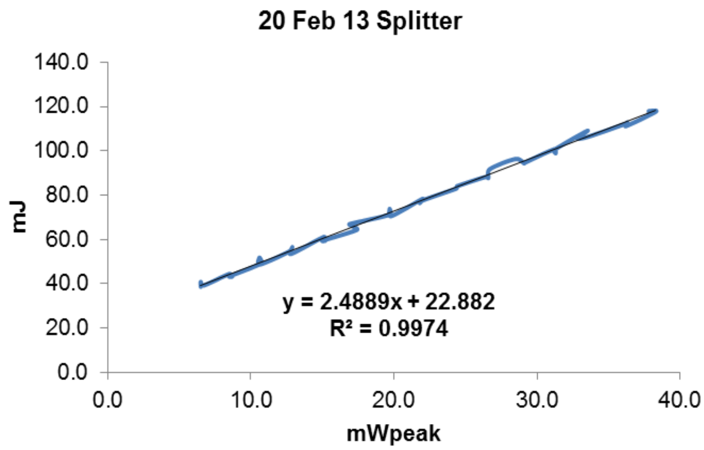
February 18, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	5.1	26.8
25.00	5.2	23.9
25.00	5.0	27.9
27.50	7.4	30.2
27.50	7.8	32.7
27.50	7.6	33.9
30.00	9.6	38.3
30.00	9.3	38.1
30.00	9.7	37.1
32.50	11.5	43.1
32.50	11.8	43.5
32.50	11.7	44.3
35.00	14.0	50.7
35.00	13.6	49.0
35.00	13.7	49.4
37.50	16.2	56.2
37.50	16.1	56.4
37.50	16.1	56.8
40.00	18.2	62.3
40.00	18.0	61.7
40.00	18.2	63.1
42.50	20.1	68.9
42.50	20.0	69.2
42.50	20.4	68.0
45.00	22.3	74.8
45.00	22.4	75.5
45.00	22.5	75.7
47.50	23.9	81.6
47.50	23.8	80.5
47.50	24.5	79.5
50.00	26.4	86.3
50.00	26.6	88.3
50.00	26.5	88.1
52.50	29.0	93.5
52.50	28.9	92.6
52.50	29.0	93.5
55.00	30.4	99.0
55.00	31.1	98.9
55.00	30.8	98.2
57.50	33.2	105.2
57.50	32.8	104.2
57.50	32.4	103.6
60.00	35.2	109.3
60.00	35.8	110.7
60.00	35.7	110.4



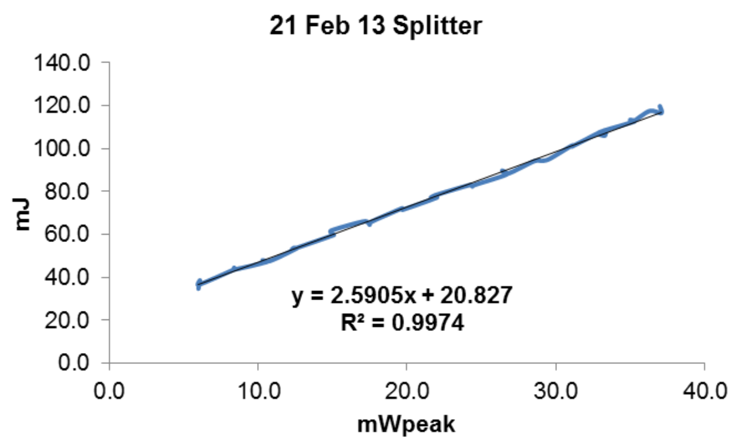
February 20, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.5	38.6
25.00	6.5	40.8
25.00	6.7	39.2
27.50	8.5	44.4
27.50	8.7	43.2
27.50	8.5	43.3
30.00	10.7	49.1
30.00	10.6	51.8
30.00	10.6	48.6
32.50	12.7	54.6
32.50	12.9	56.5
32.50	12.8	53.4
35.00	15.1	61.1
35.00	15.2	59.4
35.00	15.0	59.4
37.50	17.4	64.3
37.50	17.1	66.0
37.50	16.9	66.9
40.00	19.7	71.2
40.00	19.7	73.8
40.00	19.8	70.5
42.50	22.0	78.3
42.50	21.8	76.4
42.50	22.0	77.6
45.00	24.3	82.8
45.00	24.4	83.2
45.00	24.4	84.0
47.50	26.4	88.2
47.50	26.6	87.7
47.50	26.7	91.7
50.00	28.5	96.3
50.00	29.1	94.3
50.00	29.1	94.5
52.50	31.2	100.7
52.50	31.3	98.9
52.50	31.2	100.4
55.00	33.5	109.0
55.00	32.8	105.5
55.00	33.6	106.4
57.50	36.3	112.5
57.50	36.3	112.8
57.50	36.2	111.1
60.00	38.3	117.7
60.00	37.8	117.9
60.00	37.8	117.7



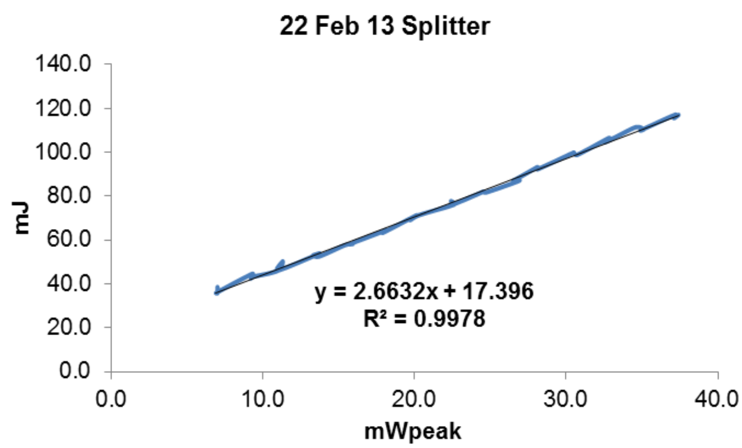
February 21, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW$_{peak}$)	Detector 2 (mJ)
25.00	6.0	34.7
25.00	6.1	38.6
25.00	6.0	36.5
27.50	8.4	43.7
27.50	8.4	44.5
27.50	8.4	43.6
30.00	10.6	47.2
30.00	10.3	47.9
30.00	10.8	47.6
32.50	12.6	53.5
32.50	12.4	53.7
32.50	12.3	53.0
35.00	15.1	59.7
35.00	15.1	59.7
35.00	14.9	61.7
37.50	17.2	66.1
37.50	17.5	64.5
37.50	17.6	65.8
40.00	19.7	72.2
40.00	19.7	71.8
40.00	19.7	71.4
42.50	22.0	77.1
42.50	21.6	77.0
42.50	21.9	78.2
45.00	24.3	83.1
45.00	24.4	82.3
45.00	24.5	82.9
47.50	26.7	87.9
47.50	26.4	89.7
47.50	26.8	88.3
50.00	28.6	94.2
50.00	29.1	94.2
50.00	29.6	95.2
52.50	31.0	101.0
52.50	31.2	101.5
52.50	31.1	100.9
55.00	33.3	108.5
55.00	33.3	105.9
55.00	32.9	107.4
57.50	35.3	112.6
57.50	35.0	113.3
57.50	35.2	112.5
60.00	36.3	117.4
60.00	37.1	116.5
60.00	37.0	119.7



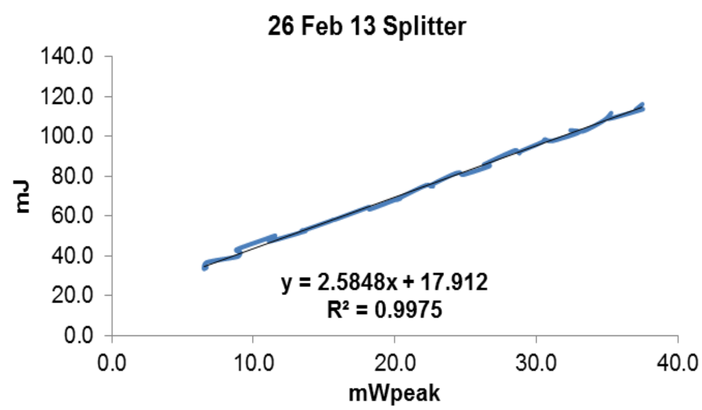
February 22, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	7.0	38.6
25.00	7.0	35.8
25.00	6.9	35.9
27.50	9.3	44.6
27.50	9.2	42.5
27.50	9.3	43.2
30.00	11.0	46.1
30.00	11.3	50.3
30.00	11.0	46.2
32.50	13.7	53.8
32.50	13.3	53.0
32.50	13.7	52.5
35.00	15.4	57.7
35.00	15.9	58.2
35.00	16.0	58.9
37.50	18.0	64.2
37.50	18.1	64.6
37.50	17.9	63.3
40.00	20.1	71.2
40.00	19.7	69.1
40.00	20.3	71.4
42.50	22.6	76.2
42.50	22.4	77.8
42.50	22.6	76.5
45.00	24.5	82.0
45.00	24.5	82.1
45.00	24.7	81.7
47.50	26.9	87.1
47.50	26.6	87.5
47.50	26.5	87.0
50.00	28.1	93.3
50.00	28.0	92.9
50.00	28.1	92.3
52.50	30.4	99.6
52.50	30.5	99.9
52.50	30.7	98.8
55.00	32.8	106.5
55.00	32.5	104.5
55.00	33.1	106.4
57.50	34.6	111.5
57.50	35.1	110.5
57.50	34.9	110.0
60.00	37.2	117.2
60.00	37.1	115.6
60.00	37.4	117.1



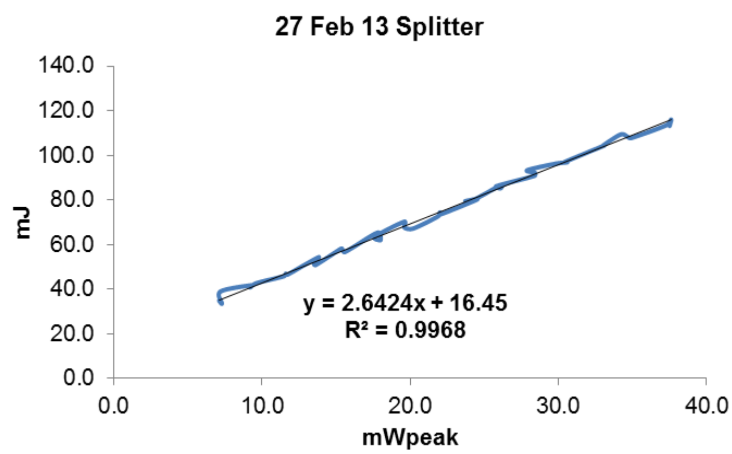
February 26, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	6.7	34.2
25.00	6.5	33.6
25.00	6.7	36.8
27.50	8.9	39.7
27.50	9.1	41.8
27.50	8.8	43.2
30.00	11.5	50.1
30.00	11.2	47.5
32.50	13.7	52.6
32.50	13.5	53.0
32.50	13.4	52.5
35.00	15.5	57.7
35.00	15.6	58.1
35.00	15.8	58.4
37.50	17.9	63.9
37.50	18.2	64.6
37.50	18.2	63.4
40.00	20.3	69.0
40.00	20.4	68.9
40.00	20.1	68.3
42.50	22.2	75.5
42.50	22.7	75.0
42.50	22.5	75.4
45.00	24.1	81.0
45.00	24.6	81.9
45.00	24.8	80.8
47.50	26.7	85.2
47.50	26.5	86.3
47.50	26.3	86.0
50.00	28.5	93.1
50.00	28.8	91.6
50.00	28.9	92.6
52.50	30.4	97.2
52.50	30.6	98.6
52.50	31.1	97.8
55.00	33.0	102.1
55.00	32.4	103.2
55.00	33.3	102.7
57.50	34.8	108.3
57.50	35.3	111.9
57.50	35.1	109.0
60.00	37.5	113.7
60.00	37.0	113.3
60.00	37.5	116.3



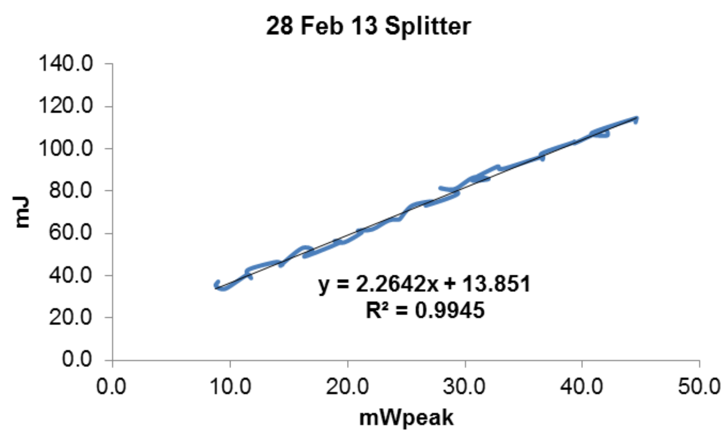
February 27, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	7.1	34.8
25.00	7.3	33.5
25.00	7.2	38.9
27.50	9.3	41.7
27.50	9.2	40.7
27.50	9.6	42.6
30.00	11.5	45.8
30.00	11.6	46.9
30.00	11.7	46.4
32.50	13.8	54.2
32.50	13.5	51.7
32.50	13.6	50.7
35.00	15.3	58.0
35.00	15.4	58.1
35.00	15.6	56.6
37.50	17.8	65.3
37.50	18.0	61.9
37.50	17.6	63.4
40.00	19.6	70.2
40.00	19.6	67.6
40.00	20.2	67.1
42.50	21.9	72.7
42.50	22.0	74.4
42.50	22.0	73.4
45.00	24.5	80.1
45.00	23.7	79.4
45.00	24.4	80.4
47.50	26.2	86.9
47.50	26.1	85.1
47.50	25.8	86.1
50.00	28.4	90.8
50.00	28.4	92.2
50.00	27.9	93.3
52.50	29.8	96.2
52.50	30.6	96.8
52.50	30.4	96.9
55.00	32.6	103.0
55.00	33.1	104.4
55.00	33.0	104.3
57.50	34.2	109.3
57.50	34.7	108.1
57.50	34.9	107.7
60.00	37.3	113.5
60.00	37.6	116.0
60.00	37.5	113.1



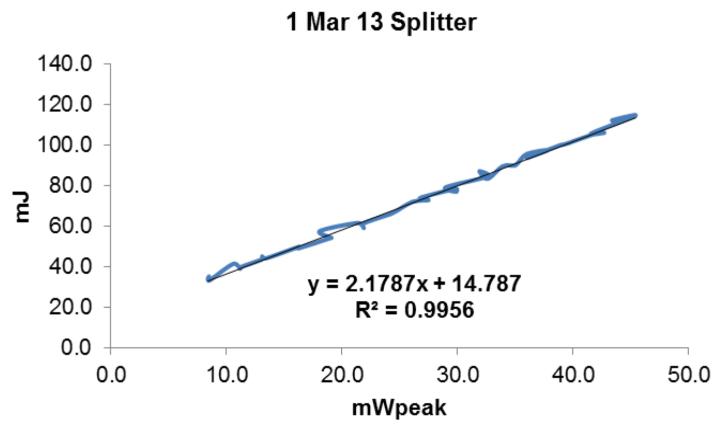
February 28, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.0	37.2
25.00	8.8	35.1
25.00	9.6	33.8
27.50	11.5	40.5
27.50	11.8	38.8
27.50	11.5	42.6
30.00	13.9	46.4
30.00	14.5	45.4
30.00	14.3	44.8
32.50	16.1	52.9
32.50	17.0	52.2
32.50	16.4	49.1
35.00	19.4	55.8
35.00	18.9	56.3
35.00	19.7	55.7
37.50	21.2	60.4
37.50	20.9	61.3
37.50	22.1	61.9
40.00	23.5	66.1
40.00	24.4	66.6
40.00	24.5	67.1
42.50	25.5	73.1
42.50	27.2	75.1
42.50	26.7	73.2
45.00	29.4	78.8
45.00	27.9	81.4
45.00	29.1	80.9
47.50	30.7	86.4
47.50	32.0	85.7
47.50	30.6	85.3
50.00	32.8	91.7
50.00	32.9	90.4
50.00	33.5	90.9
52.50	36.6	96.3
52.50	36.6	94.9
52.50	36.5	97.7
55.00	39.3	103.2
55.00	39.3	103.4
55.00	39.3	102.6
57.50	41.9	109.0
57.50	42.1	106.3
57.50	40.8	107.5
60.00	44.6	114.6
60.00	44.6	114.5
60.00	44.5	112.5



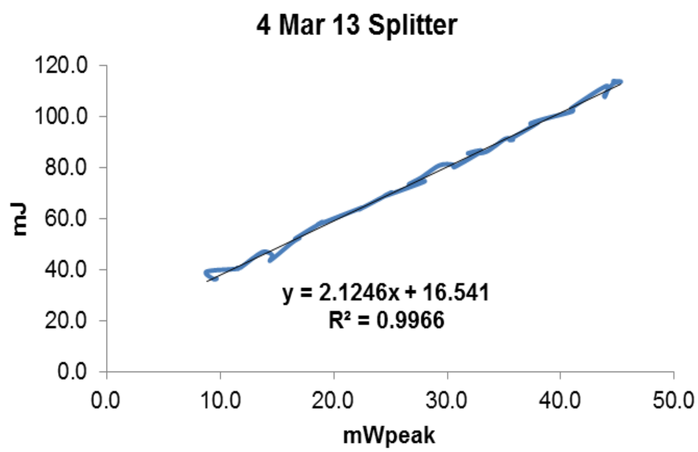
March 1, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	8.5	35.2
25.00	8.4	33.9
25.00	8.5	33.1
27.50	10.6	41.4
27.50	11.2	39.0
27.50	11.3	39.9
30.00	13.1	43.7
30.00	13.1	45.1
30.00	13.4	44.1
32.50	16.3	49.9
32.50	16.3	49.8
32.50	16.2	49.0
35.00	19.0	54.1
35.00	19.1	54.3
35.00	18.1	57.6
37.50	21.4	61.6
37.50	21.9	59.1
37.50	21.8	61.2
40.00	24.3	66.2
40.00	24.1	65.9
40.00	24.6	67.1
42.50	26.1	72.0
42.50	27.5	72.9
42.50	26.8	74.0
45.00	29.9	78.5
45.00	29.9	77.0
45.00	29.0	79.2
47.50	32.6	84.6
47.50	31.9	87.1
47.50	32.6	83.4
50.00	33.9	89.5
50.00	34.9	89.9
50.00	35.2	91.0
52.50	36.0	95.6
52.50	37.8	97.5
52.50	36.0	93.7
55.00	38.9	100.0
55.00	39.1	100.2
55.00	39.5	100.8
57.50	41.8	105.4
57.50	42.7	106.1
57.50	41.6	105.8
60.00	45.4	114.6
60.00	43.4	112.3
60.00	43.7	111.9



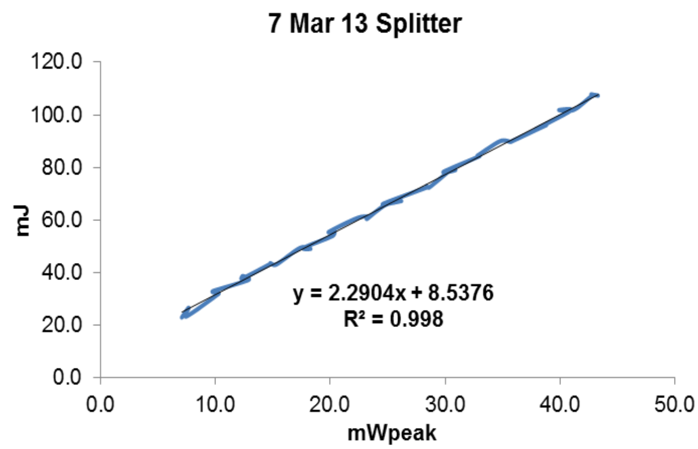
March 4, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.7	36.4
25.00	9.4	36.3
25.00	8.8	39.2
27.50	11.6	40.3
27.50	11.5	40.7
27.50	11.8	40.8
30.00	13.7	46.8
30.00	14.6	45.6
30.00	14.4	43.5
32.50	16.4	50.8
32.50	17.0	52.4
32.50	16.6	52.1
35.00	18.7	57.8
35.00	19.0	58.7
35.00	18.6	57.6
37.50	22.5	64.3
37.50	22.2	63.5
37.50	22.4	63.9
40.00	24.2	68.1
40.00	25.1	70.3
40.00	24.5	68.8
42.50	28.0	74.5
42.50	26.6	73.3
42.50	27.7	76.0
45.00	29.3	80.8
45.00	30.5	81.1
45.00	30.6	80.1
47.50	33.0	86.4
47.50	31.8	85.5
47.50	33.4	86.1
50.00	35.1	91.2
50.00	35.8	90.9
50.00	35.5	90.9
52.50	38.0	97.6
52.50	37.3	97.2
52.50	38.3	98.7
55.00	41.0	101.9
55.00	41.1	102.4
55.00	40.9	103.1
57.50	44.0	111.9
57.50	43.9	107.7
57.50	43.8	108.1
60.00	44.6	112.8
60.00	45.3	113.6
60.00	44.6	113.8



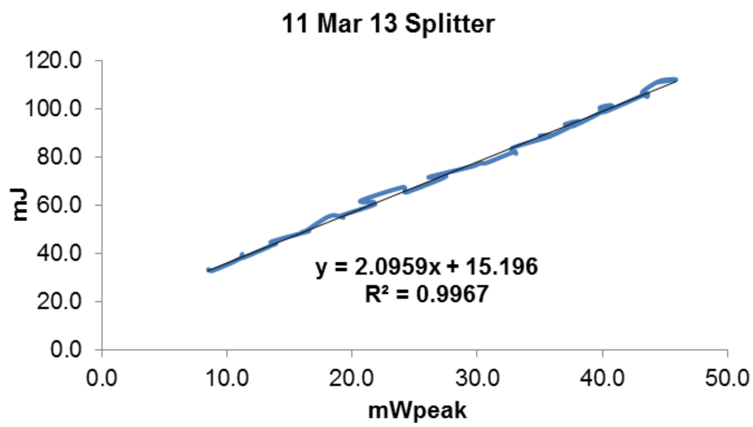
March 7, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	7.1	22.9
25.00	7.7	26.6
25.00	7.5	23.3
27.50	10.3	31.9
27.50	10.3	32.3
27.50	9.8	32.9
30.00	12.9	37.2
30.00	12.4	38.7
30.00	12.3	37.6
32.50	14.8	43.3
32.50	14.8	43.6
32.50	15.3	43.0
35.00	17.4	49.4
35.00	18.3	49.0
35.00	17.7	49.4
37.50	20.2	53.9
37.50	20.4	55.4
37.50	19.9	55.5
40.00	22.4	60.8
40.00	23.4	61.3
40.00	23.2	60.4
42.50	24.8	65.7
42.50	26.2	67.2
42.50	24.6	66.1
45.00	28.4	72.4
45.00	28.4	72.9
45.00	28.6	72.3
47.50	30.7	79.8
47.50	30.9	79.0
47.50	29.9	78.4
50.00	33.0	84.3
50.00	32.8	84.4
50.00	32.9	84.7
52.50	34.8	90.0
52.50	35.7	89.7
52.50	35.8	89.9
55.00	38.7	95.9
55.00	38.8	96.1
55.00	37.9	94.5
57.50	40.9	101.6
57.50	39.9	101.8
57.50	41.2	101.9
60.00	42.8	107.3
60.00	43.3	107.3
60.00	42.7	107.8



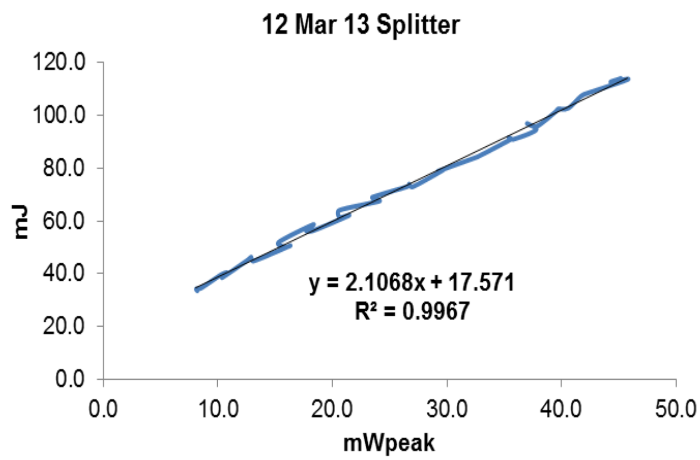
March 11, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	8.5	32.9
25.00	8.5	33.4
25.00	8.8	32.8
27.50	11.0	37.8
27.50	11.2	39.7
27.50	11.2	38.1
30.00	13.9	44.1
30.00	13.7	43.6
30.00	13.5	44.8
32.50	16.5	49.2
32.50	16.0	48.9
32.50	16.1	48.7
35.00	18.2	55.5
35.00	19.3	54.9
35.00	19.1	55.6
37.50	21.8	60.3
37.50	21.7	61.3
37.50	20.7	61.9
40.00	24.1	67.5
40.00	24.2	65.3
40.00	24.8	66.2
42.50	27.5	71.9
42.50	26.1	71.5
42.50	26.9	72.7
45.00	29.6	76.1
45.00	30.2	77.3
45.00	30.7	77.5
47.50	33.0	82.2
47.50	33.1	81.4
47.50	32.8	83.7
50.00	35.9	88.7
50.00	35.0	88.8
50.00	35.9	88.8
52.50	38.1	94.6
52.50	37.0	93.5
52.50	37.7	92.9
55.00	40.7	100.9
55.00	39.8	100.5
55.00	40.1	98.6
57.50	43.6	106.3
57.50	43.6	105.0
57.50	43.2	106.9
60.00	44.6	111.5
60.00	45.9	112.1
60.00	44.3	110.9



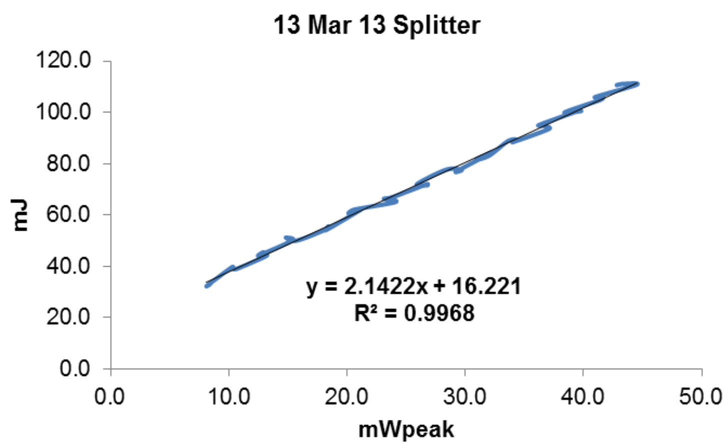
March 12, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	8.2	33.5
25.00	8.1	34.3
25.00	8.5	34.5
27.50	10.3	39.7
27.50	10.8	40.4
27.50	10.4	38.6
30.00	12.6	45.2
30.00	12.9	46.3
30.00	13.1	44.8
32.50	16.3	50.6
32.50	15.9	50.0
32.50	15.3	51.9
35.00	18.3	58.6
35.00	17.7	56.2
35.00	18.3	56.3
37.50	21.4	62.0
37.50	20.6	61.3
37.50	20.6	64.0
40.00	24.1	67.5
40.00	23.7	68.1
40.00	23.5	69.0
42.50	26.6	73.1
42.50	26.7	74.0
42.50	27.0	72.9
45.00	29.7	79.4
45.00	29.2	78.8
45.00	29.2	78.8
47.50	32.7	84.3
47.50	32.6	84.2
47.50	32.7	84.3
50.00	35.6	91.0
50.00	35.4	91.6
50.00	35.8	90.9
52.50	37.8	94.5
52.50	37.0	96.9
52.50	37.9	96.0
55.00	39.5	101.4
55.00	39.7	102.4
55.00	40.6	102.7
57.50	41.7	107.2
57.50	42.3	108.4
57.50	42.0	108.0
60.00	45.8	113.6
60.00	44.3	112.6
60.00	45.2	114.0



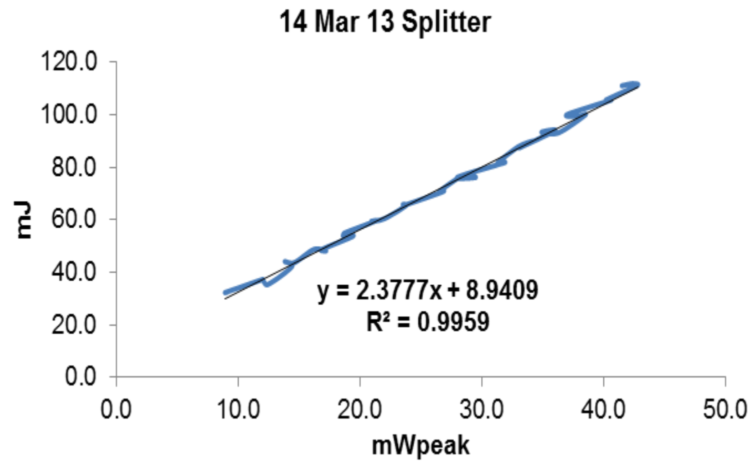
March 13, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	8.5	33.6
25.00	8.3	32.7
25.00	8.1	32.3
27.50	10.3	39.8
27.50	10.4	38.9
27.50	10.7	39.1
30.00	13.2	44.2
30.00	12.9	45.5
30.00	12.5	44.2
32.50	15.4	50.2
32.50	14.8	51.2
32.50	15.7	50.0
35.00	18.1	54.2
35.00	18.4	55.6
35.00	18.2	54.1
37.50	21.2	62.3
37.50	20.1	60.7
37.50	20.6	62.1
40.00	24.1	65.1
40.00	23.1	66.3
40.00	23.8	66.9
42.50	26.8	72.1
42.50	26.8	71.6
42.50	25.9	72.0
45.00	28.4	77.7
45.00	29.7	77.5
45.00	29.2	76.9
47.50	32.3	84.5
47.50	30.9	81.6
47.50	32.0	83.1
50.00	33.6	88.8
50.00	34.3	89.4
50.00	34.0	88.4
52.50	37.1	93.6
52.50	36.6	94.8
52.50	36.2	95.0
55.00	39.7	100.8
55.00	39.8	100.5
55.00	38.4	100.0
57.50	41.5	105.0
57.50	41.7	106.2
57.50	41.0	106.0
60.00	44.5	110.8
60.00	43.4	111.1
60.00	42.8	110.6



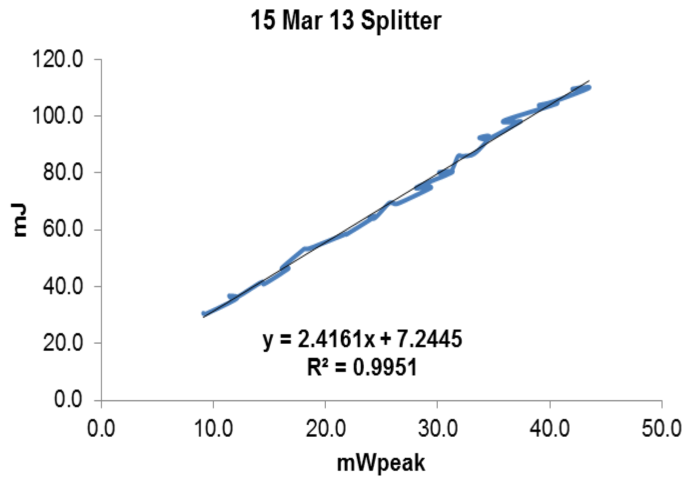
March 14, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.0	32.3
25.00	9.1	32.6
25.00	8.9	32.3
27.50	12.0	37.3
27.50	12.0	37.3
27.50	12.4	35.3
30.00	14.4	42.2
30.00	13.8	44.1
30.00	14.6	43.7
32.50	16.2	48.7
32.50	17.2	48.1
32.50	16.8	48.6
35.00	19.4	53.7
35.00	18.6	53.7
35.00	18.7	54.9
37.50	21.3	59.6
37.50	20.9	59.4
37.50	22.0	60.4
40.00	23.8	65.5
40.00	23.5	65.8
40.00	23.7	65.6
42.50	26.7	70.5
42.50	26.9	71.0
42.50	26.5	70.7
45.00	28.5	77.0
45.00	29.5	76.1
45.00	28.0	76.2
47.50	31.9	81.8
47.50	31.7	82.1
47.50	31.3	81.7
50.00	33.0	87.8
50.00	34.2	89.9
50.00	33.1	87.4
52.50	36.0	93.9
52.50	34.9	93.3
52.50	36.3	93.1
55.00	38.5	99.9
55.00	38.0	99.5
55.00	37.0	100.0
57.50	40.6	105.5
57.50	40.2	105.2
57.50	40.2	105.6
60.00	42.8	111.2
60.00	42.4	111.8
60.00	41.5	111.0



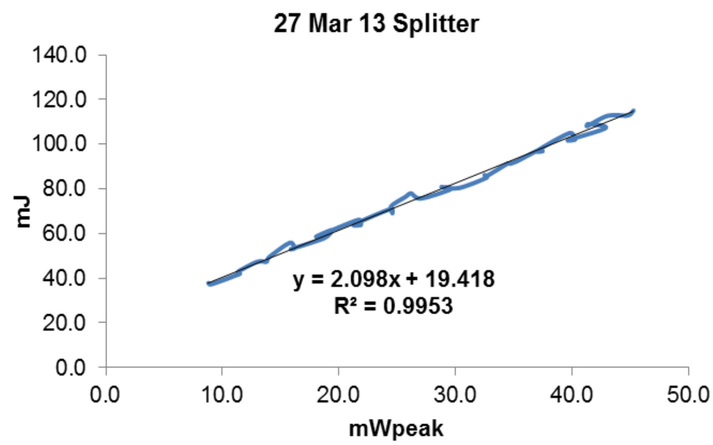
March 15, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.1	30.5
25.00	9.1	30.7
25.00	9.3	30.4
27.50	12.1	35.9
27.50	11.4	36.8
27.50	11.9	35.9
30.00	14.1	41.2
30.00	14.4	41.7
30.00	14.5	40.9
32.50	16.7	46.4
32.50	16.6	46.8
32.50	16.1	46.6
35.00	18.0	53.0
35.00	18.1	53.3
35.00	18.6	53.5
37.50	21.9	58.7
37.50	21.8	58.4
37.50	21.9	58.5
40.00	24.4	64.7
40.00	23.9	64.2
40.00	24.4	64.2
42.50	25.6	69.2
42.50	25.9	69.6
42.50	26.4	69.2
45.00	29.4	74.8
45.00	29.3	75.3
45.00	28.1	74.9
47.50	31.3	80.3
47.50	30.1	80.2
47.50	31.1	80.1
50.00	31.8	85.9
50.00	32.2	85.9
50.00	33.3	86.9
52.50	34.6	92.7
52.50	33.7	92.4
52.50	34.6	92.2
55.00	37.4	98.2
55.00	37.3	98.1
55.00	35.9	98.4
57.50	40.6	104.4
57.50	39.0	103.8
57.50	40.3	105.1
60.00	43.5	110.0
60.00	42.0	109.5
60.00	42.8	110.1



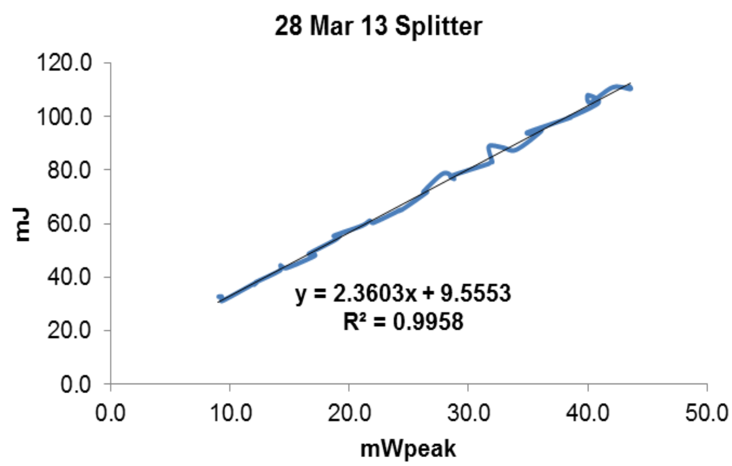
March 27, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	8.8	37.8
25.00	8.8	37.9
25.00	9.0	37.2
27.50	11.5	42.0
27.50	11.3	41.9
27.50	11.4	43.1
30.00	13.0	47.4
30.00	13.8	47.4
30.00	14.0	49.4
32.50	15.8	55.9
32.50	16.2	53.4
32.50	15.9	53.1
35.00	18.8	58.1
35.00	19.4	61.6
35.00	18.1	58.7
37.50	21.7	66.2
37.50	21.9	63.9
37.50	21.3	64.1
40.00	24.5	71.1
40.00	24.6	69.1
40.00	24.5	72.3
42.50	25.7	76.4
42.50	26.2	78.0
42.50	27.0	75.7
45.00	29.6	79.9
45.00	28.8	80.9
45.00	30.3	80.4
47.50	32.7	85.1
47.50	32.5	86.2
47.50	32.8	86.1
50.00	34.5	91.4
50.00	34.7	91.3
50.00	35.4	92.7
52.50	37.1	97.3
52.50	37.5	96.9
52.50	37.0	97.0
55.00	39.8	105.0
55.00	40.3	102.2
55.00	39.7	101.9
57.50	42.9	107.3
57.50	41.4	109.1
57.50	41.3	108.1
60.00	43.1	112.8
60.00	44.8	112.9
60.00	45.3	115.1



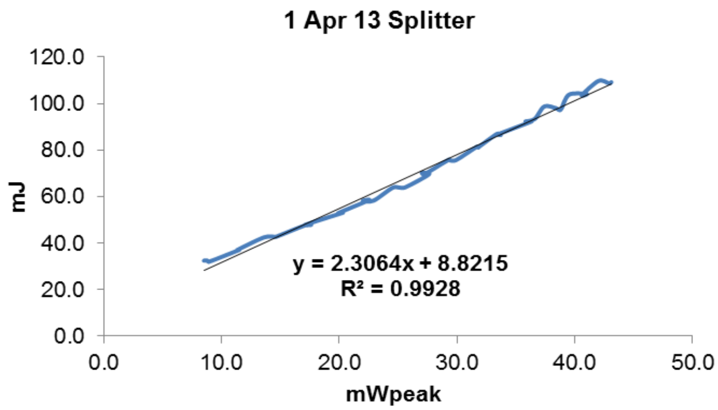
March 28, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.0	32.7
25.00	9.3	32.7
25.00	9.3	31.1
27.50	12.2	38.1
27.50	12.0	37.2
27.50	12.1	38.0
30.00	14.2	42.6
30.00	14.2	44.4
30.00	14.7	43.4
32.50	17.1	48.0
32.50	16.9	48.9
32.50	16.6	48.8
35.00	18.8	53.9
35.00	19.2	55.6
35.00	18.7	55.5
37.50	21.1	59.3
37.50	21.7	61.1
37.50	22.0	60.3
40.00	24.3	65.2
40.00	24.0	64.6
40.00	24.4	65.2
42.50	26.5	71.7
42.50	26.2	71.3
42.50	26.2	71.9
45.00	27.9	78.8
45.00	28.8	76.7
45.00	28.5	77.7
47.50	31.7	82.4
47.50	31.9	83.3
47.50	32.0	83.0
50.00	31.7	88.9
50.00	32.9	88.4
50.00	34.0	87.6
52.50	36.1	94.6
52.50	35.3	93.6
52.50	34.9	94.0
55.00	38.6	99.7
55.00	38.6	100.0
55.00	38.2	99.1
57.50	40.9	105.1
57.50	40.0	108.0
57.50	40.2	105.2
60.00	42.1	110.9
60.00	43.6	110.3
60.00	43.5	111.3



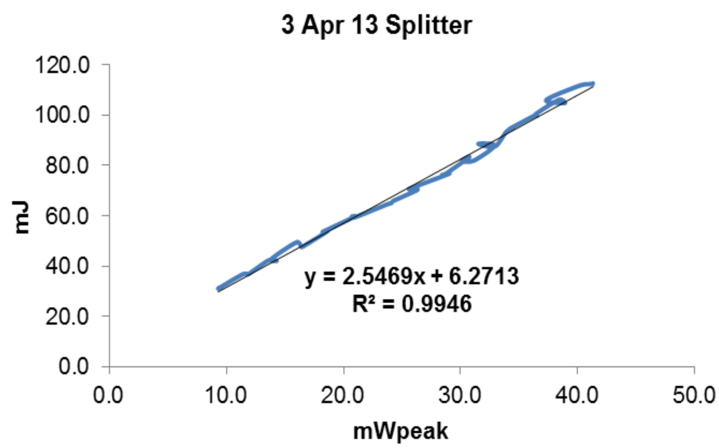
April 1, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	8.5	32.5
25.00	8.8	32.5
25.00	8.9	32.0
27.50	11.5	37.1
27.50	11.5	37.1
27.50	11.3	37.0
30.00	13.6	42.5
30.00	14.6	42.7
30.00	14.7	42.9
32.50	17.1	47.7
32.50	17.6	47.9
32.50	17.1	47.9
35.00	20.3	53.1
35.00	20.3	53.2
35.00	19.9	52.9
37.50	22.5	58.5
37.50	22.0	58.3
37.50	22.9	58.3
40.00	24.5	63.8
40.00	25.1	63.9
40.00	25.6	64.0
42.50	27.6	69.6
42.50	27.0	70.2
42.50	27.2	69.6
45.00	29.3	75.9
45.00	29.4	75.6
45.00	29.9	75.7
47.50	31.7	81.5
47.50	31.8	81.1
47.50	31.8	81.2
50.00	33.4	87.0
50.00	33.7	86.5
50.00	33.5	86.8
52.50	36.3	92.3
52.50	35.8	92.3
52.50	36.6	93.4
55.00	37.4	98.7
55.00	38.4	98.0
55.00	38.8	97.4
57.50	39.5	103.8
57.50	41.0	104.1
57.50	40.6	103.6
60.00	42.0	109.7
60.00	42.9	108.7
60.00	43.1	109.2



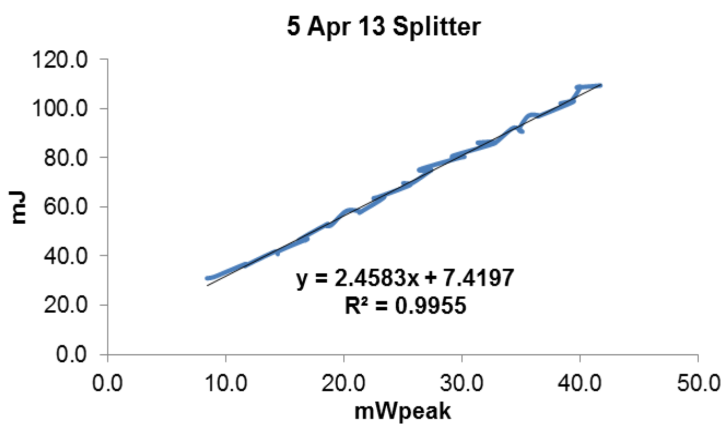
April 3, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.6	31.6
25.00	9.4	31.5
25.00	9.3	31.1
27.50	11.4	36.8
27.50	11.8	36.9
27.50	11.9	36.9
30.00	13.6	42.3
30.00	14.3	42.1
30.00	13.8	42.7
32.50	16.0	49.5
32.50	16.4	47.6
32.50	16.6	48.0
35.00	18.6	53.8
35.00	18.2	53.5
35.00	18.3	53.8
37.50	21.0	59.8
37.50	20.7	59.7
37.50	20.9	59.3
40.00	23.8	64.7
40.00	24.1	65.1
40.00	24.2	65.8
42.50	26.3	70.3
42.50	25.9	70.6
42.50	25.6	70.7
45.00	29.0	76.7
45.00	28.4	76.2
45.00	28.5	76.0
47.50	30.7	83.2
47.50	30.1	81.9
47.50	31.1	81.9
50.00	32.9	87.9
50.00	31.5	88.6
50.00	32.9	87.5
52.50	33.9	93.4
52.50	34.5	95.0
52.50	34.2	94.6
55.00	36.5	100.3
55.00	36.5	99.7
55.00	36.4	100.4
57.50	38.4	106.1
57.50	38.9	104.8
57.50	37.3	106.0
60.00	40.2	111.8
60.00	41.1	112.3
60.00	41.3	112.6



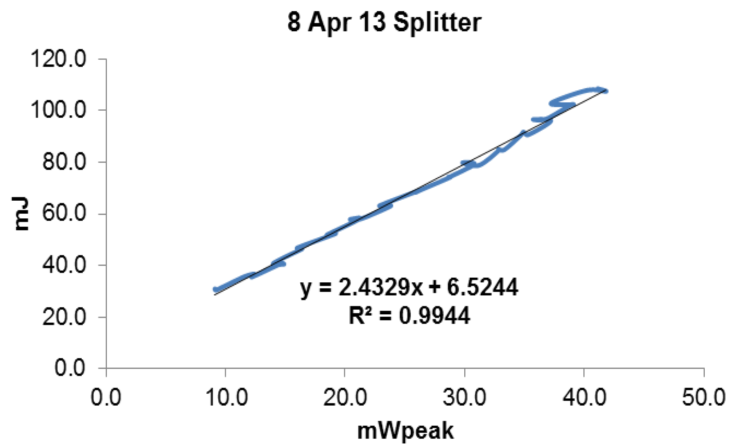
April 5, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	8.4	31.0
25.00	8.6	31.1
25.00	9.0	31.5
27.50	11.7	36.9
27.50	11.7	36.1
27.50	11.6	36.0
30.00	14.2	41.9
30.00	14.4	40.8
30.00	14.4	41.9
32.50	16.9	47.0
32.50	16.7	46.4
32.50	16.2	46.6
35.00	18.6	53.1
35.00	18.4	52.5
35.00	18.9	52.6
37.50	20.2	58.4
37.50	21.4	58.2
37.50	21.3	57.7
40.00	23.4	64.0
40.00	22.5	63.6
40.00	22.5	63.4
42.50	25.6	69.0
42.50	25.0	69.7
42.50	25.7	69.6
45.00	27.3	74.8
45.00	27.4	75.1
45.00	26.4	75.3
47.50	29.7	80.0
47.50	30.2	80.5
47.50	29.2	80.8
50.00	32.8	86.1
50.00	31.3	86.2
50.00	32.6	85.7
52.50	34.3	92.2
52.50	35.1	90.7
52.50	34.8	91.7
55.00	35.6	97.2
55.00	36.5	97.3
55.00	36.4	96.9
57.50	39.4	102.9
57.50	38.3	102.2
57.50	39.1	102.6
60.00	40.0	108.9
60.00	39.7	108.7
60.00	41.7	109.5



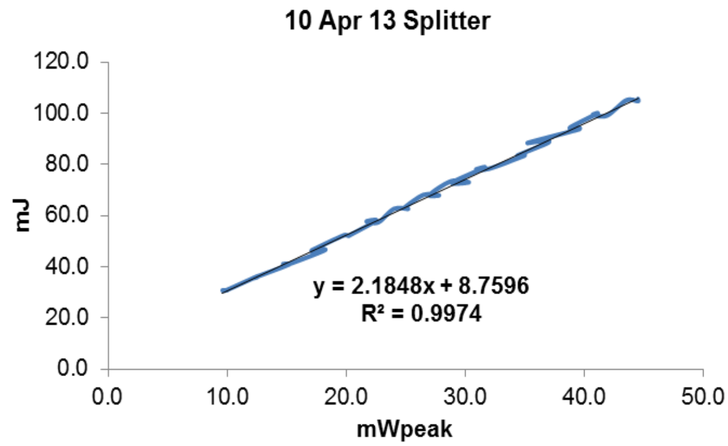
April 8, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.2	30.9
25.00	9.1	31.0
25.00	9.2	30.5
27.50	11.6	35.8
27.50	12.4	36.8
27.50	12.2	35.6
30.00	14.7	40.9
30.00	14.9	40.6
30.00	14.0	40.9
32.50	16.4	46.5
32.50	16.4	46.6
32.50	16.0	46.9
35.00	19.2	52.4
35.00	19.0	52.6
35.00	18.5	52.0
37.50	21.2	58.1
37.50	20.4	57.9
37.50	21.3	58.1
40.00	23.8	63.1
40.00	23.4	63.4
40.00	22.9	63.3
42.50	26.0	68.8
42.50	25.9	68.4
42.50	26.1	68.9
45.00	28.8	74.3
45.00	28.6	74.3
45.00	28.7	74.3
47.50	30.8	79.3
47.50	29.8	79.9
47.50	31.2	78.9
50.00	32.9	84.9
50.00	32.8	85.1
50.00	33.3	84.9
52.50	34.7	90.6
52.50	34.9	91.8
52.50	35.3	90.7
55.00	37.2	96.1
55.00	35.7	96.6
55.00	36.8	96.8
57.50	38.9	102.4
57.50	39.1	102.4
57.50	37.2	102.9
60.00	40.2	107.9
60.00	41.8	107.5
60.00	41.1	108.6



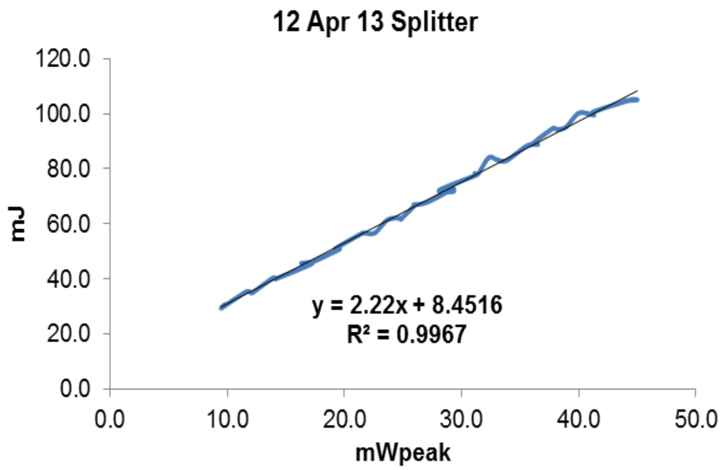
April 10, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	10.0	30.8
25.00	9.6	30.8
25.00	9.9	30.8
27.50	12.6	36.4
27.50	12.5	35.9
27.50	12.2	35.6
30.00	15.2	40.9
30.00	14.7	41.1
30.00	15.1	40.9
32.50	18.2	46.5
32.50	17.1	46.1
32.50	17.1	46.4
35.00	19.8	52.3
35.00	20.2	52.1
35.00	20.4	52.6
37.50	22.5	58.0
37.50	21.7	57.7
37.50	22.7	57.4
40.00	24.0	62.6
40.00	25.2	62.6
40.00	24.9	63.1
42.50	26.5	68.1
42.50	27.8	67.9
42.50	27.0	68.1
45.00	28.8	73.4
45.00	30.3	73.0
45.00	28.9	72.9
47.50	31.6	78.7
47.50	30.9	78.0
47.50	32.0	78.3
50.00	34.9	83.3
50.00	35.0	83.6
50.00	34.4	83.5
52.50	37.0	88.6
52.50	36.1	88.9
52.50	35.3	88.5
55.00	39.6	93.8
55.00	39.6	94.3
55.00	38.8	94.4
57.50	41.1	99.9
57.50	40.7	99.4
57.50	41.9	99.1
60.00	43.5	105.0
60.00	44.5	104.7
60.00	44.5	105.6



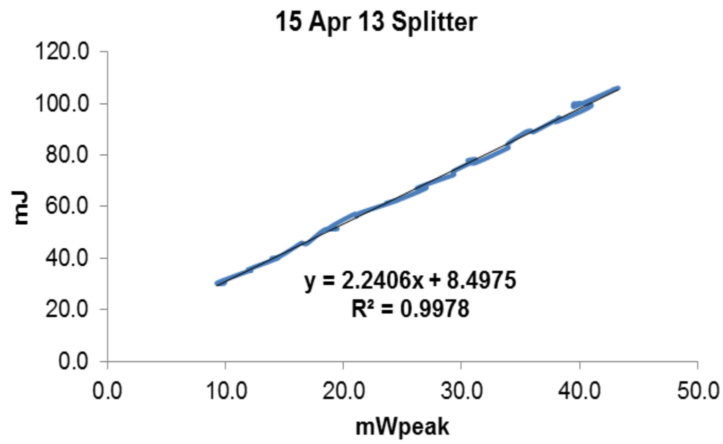
April 12, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.5	29.5
25.00	9.8	30.7
25.00	9.5	29.4
27.50	11.6	35.3
27.50	12.0	35.1
27.50	12.1	34.8
30.00	13.9	40.3
30.00	14.2	40.1
30.00	14.1	39.9
32.50	17.2	45.5
32.50	16.3	45.6
32.50	17.2	46.0
35.00	19.6	50.8
35.00	19.6	51.0
35.00	19.2	50.9
37.50	21.5	56.5
37.50	21.8	56.6
37.50	22.6	56.7
40.00	23.7	61.5
40.00	24.9	62.0
40.00	24.8	61.6
42.50	26.0	66.7
42.50	25.9	66.9
42.50	27.0	67.7
45.00	29.3	72.7
45.00	29.3	71.7
45.00	28.1	72.2
47.50	31.3	77.8
47.50	31.1	78.3
47.50	31.4	78.1
50.00	32.3	84.0
50.00	33.0	83.3
50.00	33.8	82.9
52.50	35.6	88.4
52.50	36.5	88.8
52.50	36.1	89.2
55.00	37.8	94.7
55.00	38.1	94.3
55.00	38.9	95.1
57.50	40.0	100.2
57.50	41.3	99.5
57.50	41.2	100.6
60.00	44.5	105.1
60.00	45.0	105.0
60.00	43.9	104.7



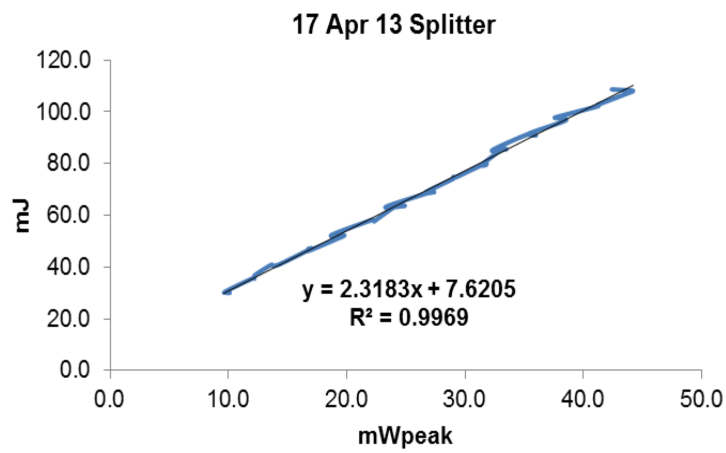
April 15, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	10.0	31.7
25.00	9.9	30.3
25.00	9.3	30.5
27.50	12.0	35.1
27.50	12.2	35.2
27.50	11.9	35.6
30.00	14.5	40.2
30.00	13.9	40.0
30.00	14.7	41.0
32.50	16.4	45.9
32.50	16.5	46.0
32.50	16.9	45.7
35.00	18.4	51.1
35.00	19.5	51.4
35.00	18.8	51.8
37.50	21.0	57.3
37.50	21.1	56.2
37.50	21.3	57.4
40.00	24.6	62.5
40.00	23.6	61.4
40.00	24.6	62.6
42.50	27.0	67.2
42.50	26.2	67.1
42.50	26.8	68.3
45.00	29.3	72.3
45.00	29.4	72.6
45.00	29.3	73.7
47.50	31.2	78.1
47.50	30.5	77.9
47.50	31.1	76.9
50.00	34.0	82.9
50.00	34.0	83.0
50.00	33.9	84.3
52.50	35.4	88.9
52.50	35.9	89.4
52.50	36.1	89.0
55.00	38.3	94.4
55.00	38.2	94.5
55.00	38.0	92.9
57.50	41.0	99.1
57.50	39.5	100.0
57.50	39.5	98.7
60.00	43.1	105.8
60.00	43.3	106.0
60.00	42.8	105.4



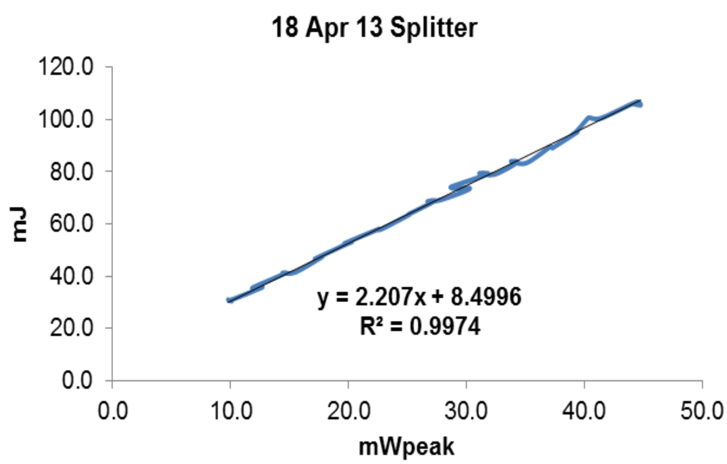
April 17, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.6	30.2
25.00	10.1	30.1
25.00	9.7	30.5
27.50	12.1	35.8
27.50	12.2	35.6
27.50	12.2	36.8
30.00	13.6	40.9
30.00	13.8	40.5
30.00	14.3	41.1
32.50	17.0	47.2
32.50	16.7	47.0
32.50	16.7	46.2
35.00	19.7	52.0
35.00	19.8	52.3
35.00	18.7	52.4
37.50	22.1	58.2
37.50	22.3	58.0
37.50	22.3	57.7
40.00	24.1	63.4
40.00	24.9	63.7
40.00	23.3	63.3
42.50	27.1	69.0
42.50	27.4	69.0
42.50	26.7	69.0
45.00	29.0	74.2
45.00	29.0	74.9
45.00	29.2	74.7
47.50	31.8	80.3
47.50	31.8	79.6
47.50	31.4	79.5
50.00	33.1	85.4
50.00	33.5	85.6
50.00	32.3	85.2
52.50	35.4	91.5
52.50	36.0	90.9
52.50	35.4	91.6
55.00	38.5	96.7
55.00	37.8	97.6
55.00	37.6	97.8
57.50	41.3	102.3
57.50	41.2	102.7
57.50	41.4	103.1
60.00	44.2	108.0
60.00	44.2	108.2
60.00	42.4	108.7



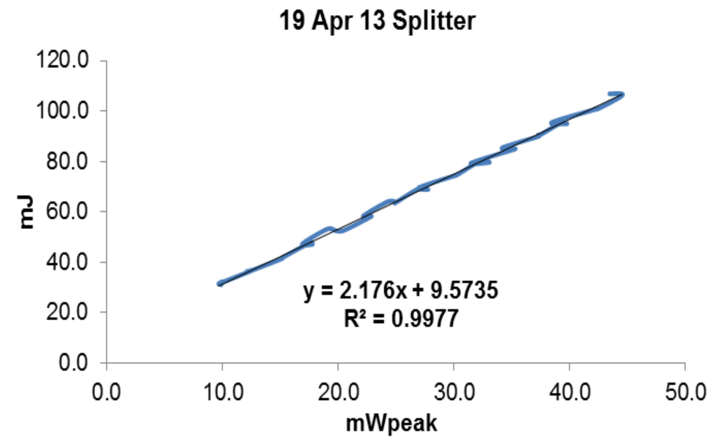
April 18, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	10.1	30.4
25.00	9.8	31.0
25.00	9.9	30.6
27.50	12.7	35.7
27.50	12.7	36.1
27.50	11.9	35.6
30.00	14.7	41.2
30.00	14.4	41.2
30.00	15.5	41.5
32.50	17.8	47.5
32.50	17.7	47.3
32.50	17.2	46.7
35.00	20.0	52.6
35.00	20.3	53.1
35.00	19.7	52.6
37.50	22.6	58.1
37.50	22.5	57.7
37.50	22.8	58.0
40.00	25.1	63.4
40.00	25.3	64.1
40.00	25.1	63.7
42.50	27.3	68.8
42.50	26.7	68.6
42.50	27.8	69.2
45.00	30.3	73.5
45.00	29.0	73.6
45.00	28.7	74.2
47.50	31.8	79.1
47.50	31.1	79.4
47.50	32.4	79.0
50.00	34.3	83.6
50.00	33.8	84.0
50.00	35.1	83.4
52.50	37.1	89.5
52.50	37.3	89.2
52.50	37.3	89.1
55.00	39.4	95.2
55.00	39.0	94.3
55.00	39.3	95.3
57.50	40.3	100.5
57.50	40.4	100.8
57.50	41.4	100.5
60.00	44.5	106.9
60.00	44.8	105.6
60.00	44.2	106.0



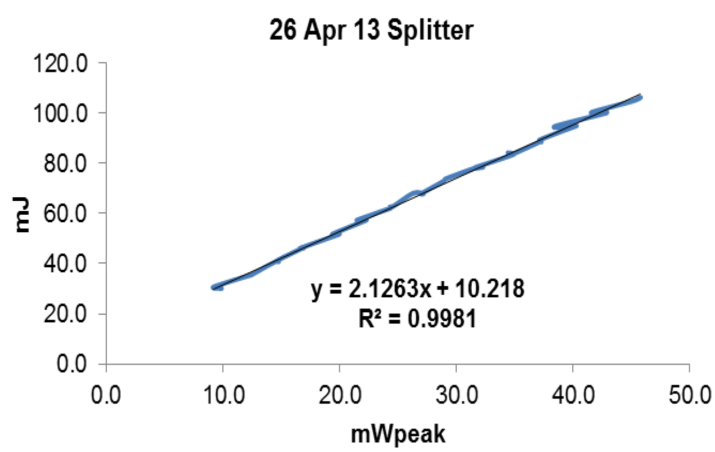
April 19, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.9	31.1
25.00	10.0	32.4
25.00	9.7	31.6
27.50	12.5	36.7
27.50	12.1	36.4
27.50	12.7	37.1
30.00	15.2	41.6
30.00	15.2	41.7
30.00	15.2	41.9
32.50	17.7	48.1
32.50	17.8	47.2
32.50	16.9	47.3
35.00	19.1	53.3
35.00	19.8	52.6
35.00	20.5	52.7
37.50	22.9	58.3
37.50	22.8	58.5
37.50	22.2	58.5
40.00	24.3	64.1
40.00	25.0	64.0
40.00	24.9	63.5
42.50	27.0	69.3
42.50	27.8	68.9
42.50	27.0	69.7
45.00	30.2	74.6
45.00	30.1	74.5
45.00	30.2	74.5
47.50	32.2	79.9
47.50	33.1	79.7
47.50	31.5	79.4
50.00	35.3	85.0
50.00	34.8	84.6
50.00	34.2	85.5
52.50	37.4	90.1
52.50	37.3	90.6
52.50	37.4	90.4
55.00	39.3	95.4
55.00	39.8	95.0
55.00	38.5	95.6
57.50	42.6	101.2
57.50	42.1	100.7
57.50	42.5	101.0
60.00	44.6	106.4
60.00	43.5	106.9
60.00	43.8	106.8



April 26, 2013 Splitter Ratio Data and Plot

% Power	Detector 1 (mW_{peak})	Detector 2 (mJ)
25.00	9.8	30.2
25.00	9.9	30.1
25.00	9.2	30.7
27.50	12.4	35.5
27.50	12.5	35.8
27.50	12.4	35.4
30.00	14.5	40.8
30.00	14.8	40.8
30.00	14.6	41.1
32.50	17.0	46.6
32.50	16.9	46.2
32.50	16.6	46.1
35.00	20.0	51.8
35.00	20.0	52.1
35.00	19.4	51.8
37.50	22.3	57.4
37.50	22.0	57.5
37.50	21.5	57.4
40.00	24.4	62.2
40.00	24.3	62.6
40.00	24.6	62.9
42.50	26.3	68.1
42.50	27.2	67.9
42.50	27.0	67.9
45.00	28.9	72.9
45.00	29.0	73.2
45.00	29.0	73.7
47.50	31.7	78.3
47.50	32.3	78.5
47.50	31.6	78.3
50.00	34.9	83.6
50.00	34.4	84.2
50.00	34.8	83.7
52.50	37.3	88.9
52.50	37.3	88.6
52.50	37.1	89.3
55.00	40.3	95.0
55.00	40.2	94.8
55.00	38.4	94.7
57.50	42.9	100.2
57.50	42.8	100.9
57.50	41.6	100.4
60.00	45.2	105.0
60.00	45.8	106.3
60.00	45.5	105.7



Appendix C

		Left Hand			Left Foot		
Subject	**Session #**	**Radiant Exposure (mJ/mm^2)**	**Sensation**	**ED_{50} Hand (mJ/mm^2)**	**Radiant Exposure (mJ/mm^2)**	**Sensation**	**ED_{50} Foot (mJ/mm^2)**
001 M	1	1.42	0		1.44	0	
		2.30	0		2.27	0	
		3.10	0		3.13	0	
		3.11	0		3.98	0	
		3.15	0		4.90	0	
		3.37	0	3.55	4.94	0	5.77
		3.55	1		5.43	0	
		3.56	0		5.44	0	
		3.60	1		5.67	0	
		3.97	1		5.89	1	
		4.06	1		5.91	1	
					5.92	1	
	2	3.40	0		4.65	0	
		3.43	0		5.04	0	
		3.80	0		5.47	0	
		3.84	0		5.86	0	
		3.86	0		6.39	0	
		4.05	0	4.19	6.42	0	6.69
		4.21	0		6.44	0	
		4.21	1		6.65	1	
		4.22	1		6.77	0	
		4.25	1		6.79	1	
		4.53	1		7.39	1	
	3	3.98	0		6.49	0	
		3.99	0		6.95	0	
		4.00	0		6.96	0	
		4.16	0	4.41	7.15	0	7.66
		4.42	1		7.24	1	
		4.48	0		7.28	0	
		4.48	1		7.34	1	
		4.99	1		7.40	0	
					7.80	0	
					7.82	0	
					7.85	1	

				8.27	1	
				8.28	1	
4	4.07	0		6.19	0	
	4.32	0		6.67	0	
	4.36	0		6.68	0	
	4.39	0		6.75	0	
	4.66	0		7.01	1	
	4.76	1	4.87	7.13	0	7.14
	4.83	0		7.17	0	
	4.84	0		7.24	1	
	5.03	1		7.60	1	
	5.38	1		7.78	1	
	5.44	1				
5	4.54	0		5.58	0	
	4.63	0		5.99	0	
	5.11	0		6.03	0	
	5.13	0	5.27	6.20	1	6.33
	5.17	0		6.53	1	
	5.36	1		6.57	0	
	5.56	1		6.59	1	
	5.65	1		7.14	1	
6	3.18	0		6.16	0	
	3.71	0		6.51	0	
	3.87	0		6.66	0	
	4.07	1		6.72	0	
	4.18	1		6.77	0	
	4.20	0	4.48	6.80	0	6.94
	4.23	0		6.81	1	
	4.59	0		7.04	1	
	4.66	0		7.05	0	
	4.77	1		7.05	1	
	5.22	1		7.59	1	
	5.29	1				
7	4.63	0		6.74	0	
	4.69	0	5.02	6.85	1	7.16
	4.71	0		6.99	0	
	4.96	1		7.11	1	

		5.09	0		7.17	1	
		5.23	1		7.18	0	
		5.63	1		7.52	0	
					7.75	1	
	8	4.00	0	4.85	6.60	0	7.09
		4.00	0		6.61	0	
		4.46	0		6.78	0	
		4.49	0		6.98	0	
		4.75	0		7.05	0	
		4.77	0		7.14	1	
		4.92	1		7.23	1	
		5.15	1		7.25	1	
		5.39	1				
002M	1	1.61	0	2.43	1.60	0	4.54
		1.89	0		2.11	0	
		2.10	0		2.57	0	
		2.10	0		3.13	0	
		2.12	0		3.59	0	
		2.13	0		4.13	0	
		2.34	1		4.15	0	
		2.36	0		4.15	0	
		2.41	1		4.28	0	
		2.58	0		4.56	1	
		2.59	1		4.60	1	
		3.12	1		4.63	0	
					5.03	1	
	2	1.09	0	2.24	0.98	0	2.76
		1.50	0		1.42	0	
		1.70	0		1.82	0	
		1.89	0		1.89	0	
		1.90	0		2.11	0	
		1.92	0		2.21	0	
		1.93	0		2.24	0	
		2.08	1		2.29	0	
		2.10	1		2.47	0	
		2.27	0		2.49	0	
		2.31	0		2.59	1	
		2.61	1		2.60	0	

	2.67	1		2.62	0	
				2.63	0	
				2.75	0	
				2.94	1	
				3.04	1	
				3.49	1	
3	1.78	0		3.46	0	
	2.21	0		3.91	0	
	2.57	1		4.10	1	
	2.61	0	2.64	4.32	0	5.78
	2.65	0		4.37	0	
	2.79	1		4.48	1	
	3.02	1		4.58	0	
				4.67	1	
				4.74	0	
				5.18	0	
				5.53	0	
				5.58	1	
				5.60	0	
				5.99	1	
				6.09	0	
				6.44	1	
4	2.77	0		5.54	0	
	2.99	0		5.89	0	
	3.19	0		6.01	0	
	3.25	1	3.43	6.04	0	6.29
	3.25	0		6.19	0	
	3.48	1		6.40	1	
	3.67	0		6.49	1	
	3.71	1		6.52	1	
	4.10	1				
5	3.16	0		5.50	0	
	3.46	0		5.70	0	
	3.58	0		5.79	0	
	3.62	0	3.71	5.91	0	6.22
	3.81	1		5.92	1	
	3.98	1		6.03	1	
	4.10	1		6.29	0	

					6.36	1	
					6.45	0	
					6.96	1	
					7.05	1	
	6	3.47	0		4.77	0	
		3.50	0		5.20	1	
		3.59	0		5.32	1	
		3.64	1	3.84	5.48	0	5.36
		3.90	1		5.88	0	
		3.99	0		5.98	1	
		4.40	1		6.58	1	
	7	3.99	0		5.31	0	
		4.03	0		5.93	0	
		4.06	0		5.97	0	
		4.27	1	4.30	6.05	1	6.47
		4.30	1		6.27	1	
		4.41	0		6.54	0	
		4.97	1		6.58	1	
					6.87	0	
					7.54	1	
	8	2.99	0		4.51	0	
		3.00	0		4.54	0	
		3.10	0		5.00	1	
		3.35	0	3.42	5.10	0	5.12
		3.35	1		5.22	0	
		3.42	0		5.23	1	
		3.61	1		5.55	1	
		3.77	1		5.73	1	
003M	1	1.56	0		1.59	0	
		2.09	0		2.09	0	
		2.10	0		2.64	0	
		2.12	0		3.12	0	
		2.35	0	2.78	3.61	1	4.37
		2.52	0		3.65	0	
		2.58	1		3.65	0	
		2.60	0		3.91	1	
		2.61	0		4.05	1	

	2.87	0		4.15	0	
	3.06	1		4.59	1	
	3.07	1		4.60	0	
	3.09	1		5.04	0	
				5.49	1	
2	1.12	0		1.10	0	
	1.53	0		1.52	0	
	1.56	0		2.02	0	
	1.93	0		2.41	0	
	1.97	0	2.24	2.43	0	3.38
	2.00	0		2.66	0	
	2.22	0		2.84	0	
	2.26	1		2.86	0	
	2.39	1		3.01	0	
	2.39	1		3.02	1	
				3.21	1	
				3.23	0	
				3.24	0	
				3.42	1	
				3.60	0	
				4.00	1	
3	2.09	0		3.37	0	
	2.09	0		3.41	0	
	2.29	0		3.45	0	
	2.55	1	2.52	3.64	0	4.27
	2.57	0		3.88	0	
	2.57	1		3.90	1	
	3.01	1		3.90	1	
				3.91	0	
				4.11	0	
				4.32	0	
				4.32	1	
				4.33	1	
				4.34	1	
				4.37	0	
				4.72	0	
				4.76	1	
				5.12	1	

4	2.20	0		4.90	0	
	2.68	0		5.29	0	
	2.72	0		5.84	0	
	2.94	0		5.95	0	
	3.14	1	3.18	6.18	1	6.56
	3.17	1		6.29	1	
	3.21	1		6.31	0	
	3.66	0		6.41	0	
	4.04	1		6.83	1	
				6.92	0	
				7.38	1	
5	3.20	0		5.43	0	
	3.50	0		5.52	0	
	3.53	0		5.54	0	
	3.61	0	3.72	5.78	0	6.53
	3.83	1		5.86	1	
	3.97	1		5.88	1	
	3.98	1		6.04	0	
				6.40	0	
				6.54	1	
				6.98	0	
				7.14	1	
6	2.64	0		4.90	0	
	2.87	0		4.92	0	
	3.01	1	3.20	4.97	1	5.21
	3.05	0		5.41	0	
	3.12	1		5.43	1	
	3.57	1		5.75	1	
	3.58	0				
	3.92	1				
7	2.65	0		4.72	0	
	2.91	0		5.00	1	
	3.07	1		5.38	1	
	3.15	0	3.33	5.50	0	5.66
	3.37	1		5.92	0	
	3.56	0		5.93	1	
	3.95	1		6.32	0	
				6.80	1	

	8	2.94	0	3.32	5.07	0	6.01
		3.00	0		5.70	0	
		3.00	0		5.71	0	
		3.08	1		5.72	0	
		3.27	1		5.85	1	
		3.35	0		5.99	1	
		3.42	0		6.16	0	
		3.70	1		6.56	1	
		3.85	1				
004M	1	1.54	0	2.90	1.45	0	3.63
		1.99	0		1.93	0	
		2.04	0		2.24	0	
		2.23	0		2.89	0	
		2.50	0		2.91	0	
		2.51	0		3.20	0	
		2.80	0		3.40	1	
		3.00	1		3.47	0	
		3.06	1		3.55	1	
					3.83	0	
					4.37	1	
	2	2.22	0	2.98	3.10	0	4.14
		2.66	0		3.50	0	
		2.68	0		3.94	1	
		2.68	0		3.94	0	
		2.88	0		3.99	0	
		3.08	1		4.21	0	
		3.11	1		4.40	1	
		3.12	1		4.45	1	
	3	2.81	0	3.38	4.16	0	4.57
		3.26	0		4.34	0	
		3.28	0		4.55	1	
		3.48	1		4.55	1	
		3.70	1		5.09	1	
		3.70	1		5.58	0	
					5.99	1	
	4	2.21	0	2.81	4.46	0	4.97

	2.68	0		4.53	0	
	2.72	0		4.62	0	
	2.90	1		4.96	0	
	3.18	1		4.96	0	
	3.19	1		4.98	1	
				5.00	1	
				5.43	1	
				5.44	1	
5	2.67	0		3.10	0	
	3.10	0		3.60	0	
	3.17	0		3.61	0	
	3.19	0	3.42	3.73	1	3.68
	3.39	0		3.99	1	
	3.44	1		4.01	1	
	3.50	1		4.79	1	
	3.61	1				
6	2.80	0		3.16	0	
	2.82	0		3.70	0	
	2.96	0	3.30	3.71	0	3.75
	3.21	0		3.77	1	
	3.24	1		4.08	1	
	3.26	0		4.14	1	
	3.26	0				
	3.50	1				
	3.67	1				
	3.73	1				
7	2.88	0		3.75	0	
	2.97	0		4.04	0	
	2.99	0		4.12	0	
	3.11	0		4.18	0	
	3.32	1	3.37	4.45	1	4.62
	3.37	1		4.67	0	
	3.39	0		4.67	1	
	3.40	0		4.68	0	
	3.72	1		5.11	1	
	3.74	1		5.13	1	
8	2.93	0	3.86	4.64	0	5.04

		3.41	0		4.65	0	
		3.42	0		4.65	0	
		3.82	0		4.74	1	
		3.85	0		5.13	0	
		3.86	1		5.17	0	
		4.03	1		5.20	1	
		4.09	1		5.21	1	
					5.65	1	
					5.69	1	
005M	1	1.11	0		1.01	0	
		1.54	0		1.43	0	
		1.56	0		2.26	0	
		1.77	0		2.50	0	
		1.95	0		3.17	0	
		1.96	1	2.32	3.59	0	4.25
		2.00	0		3.63	0	
		2.21	0		3.65	0	
		2.35	0		3.84	0	
		2.57	1		4.03	1	
		2.77	1		4.06	0	
					4.07	0	
					4.10	0	
					4.35	0	
					4.44	1	
					4.52	1	
					4.52	1	
	2	2.22	0		3.56	0	
		2.22	0		4.01	0	
		2.42	0		4.46	0	
		2.62	1	2.62	4.48	0	6.16
		2.63	0		4.88	0	
		2.66	1		4.94	0	
		3.13	1		5.38	1	
					5.41	0	
					5.42	0	
					5.75	0	
					5.76	0	
					5.84	1	
					6.17	0	

				6.21	1	
				6.27	1	
				6.69	0	
				7.18	1	
3	1.69	0		3.12	0	
	2.03	0		3.58	0	
	2.06	0		3.94	0	
	2.24	0		4.28	0	
	2.38	0	2.63	4.34	0	5.32
	2.42	1		4.70	1	
	2.44	0		4.71	0	
	2.61	1		4.71	0	
	2.79	0		5.05	1	
	3.11	1		5.07	0	
				5.07	1	
				5.42	0	
				5.44	1	
				5.45	0	
				5.77	0	
				5.77	1	
				6.08	1	
4	2.88	0		5.14	0	
	2.88	0		5.46	0	
	3.06	1	3.18	5.53	0	5.78
	3.30	0		5.54	0	
	3.36	1		5.69	1	
	3.78	1		5.92	0	
				5.94	1	
				6.00	1	
				6.82	1	
5	2.66	0		4.05	0	
	2.82	0		4.27	0	
	2.86	1		4.43	0	
	3.13	1	3.51	4.67	0	5.40
	3.14	0		4.77	0	
	3.16	0		5.09	1	
	3.61	0		5.20	0	
	3.94	1		5.31	1	

					5.71	0	
					6.11	1	
	6	2.68	0		4.80	0	
		2.89	0		5.26	0	
		3.06	0		5.45	1	
		3.17	1	3.28	5.63	1	6.28
		3.42	1		5.64	0	
		3.43	0		6.08	1	
		3.82	1		6.08	0	
					6.14	0	
					6.40	0	
					7.24	1	
	7	2.90	0		5.49	0	
		2.97	0		5.81	1	
		3.22	1	3.23	5.98	1	6.15
		3.28	1		6.11	0	
		3.35	0		6.54	0	
		3.76	1		7.16	1	
	8	2.42	0		5.00	0	
		2.63	0		5.46	1	
		2.80	0		5.46	0	
		2.92	1	3.19	5.52	1	5.84
		3.08	0		5.91	0	
		3.30	0		6.18	1	
		3.35	1		6.59	0	
		3.79	1		6.77	1	
006M	1	1.44	0		1.45	0	
		1.89	0		1.83	0	
		2.33	0		2.26	0	
		2.81	0		2.75	0	
		2.83	0		3.24	0	
		3.32	0	4.58	3.72	0	4.69
		3.81	0		3.75	0	
		3.81	0		4.24	0	
		3.84	0		4.29	0	
		4.09	0		4.32	0	
		4.23	0		4.55	0	

	4.27	0		4.72	1	
	4.50	0		4.73	1	
	4.66	1		4.76	0	
	4.72	1		4.81	1	
	4.73	1				
2	2.69	0		3.75	0	
	3.05	0		4.15	0	
	3.05	0		4.58	0	
	3.08	0		4.96	0	
	3.26	0		5.00	1	
	3.43	1	3.48	5.11	0	6.43
	3.47	0		5.30	0	
	3.47	1		5.30	1	
	3.52	0		5.31	0	
	3.86	1		5.53	1	
	3.88	1		5.67	1	
				5.68	0	
				5.73	0	
				6.10	0	
				6.13	1	
				6.58	0	
3	3.13	0		5.30	0	
	3.56	0		5.91	0	
	3.58	0		6.42	0	
	3.59	0	3.67	6.77	0	7.31
	3.74	1		6.91	0	
	3.96	1		6.96	0	
	4.00	1		7.15	1	
				7.23	1	
				7.33	0	
				7.37	0	
				7.83	1	
				7.91	1	
4	3.55	0		5.83	0	
	3.97	0		6.35	0	
	4.02	0	4.65	6.35	0	6.77
	4.02	0		6.36	1	
	4.29	0		6.41	0	

	4.42	0		6.76	0	
	4.44	1		6.85	1	
	4.54	0		6.86	0	
	4.71	0		7.30	1	
	4.81	1		7.31	1	
	5.03	1				
5	3.49	0		5.56	0	
	3.92	0		5.81	0	
	3.94	0		6.02	0	
	3.99	0	4.36	6.05	0	6.29
	4.19	0		6.19	1	
	4.27	1		6.36	1	
	4.29	1		6.39	0	
	4.32	1		7.03	1	
	4.70	0				
	5.10	1				
6	4.30	0		5.51	0	
	4.46	0		5.95	0	
	4.60	0		6.18	1	
	4.81	1	4.80	6.19	0	6.33
	4.86	0		6.21	0	
	4.88	1		6.24	1	
	5.32	1		6.48	0	
				6.56	1	
				7.18	1	
7	3.89	0		4.91	0	
	4.15	0		5.87	0	
	4.19	0		5.89	0	
	4.48	1	4.45	5.92	1	6.52
	4.49	1		6.08	0	
	4.62	0		6.29	1	
	4.65	1		6.40	1	
	4.99	1		6.41	0	
				6.91	0	
				7.61	1	
8	3.62	0	4.49	4.56	0	6.68
	4.22	0		6.54	0	

		4.22	0		6.56	0	
		4.25	0		6.60	1	
		4.47	0		6.71	0	
		4.50	1		6.88	1	
		4.62	1		6.90	1	
		4.73	1				
007F	1	1.45	0		1.45	0	
		2.26	0		2.30	0	
		3.08	0		3.15	0	
		3.15	0		3.99	0	
		3.33	1		4.00	0	
		3.55	1	3.65	4.01	0	4.64
		3.93	0		4.25	0	
		3.98	0		4.52	0	
		4.05	1		4.54	1	
		4.44	1		4.69	0	
		4.99	1		4.89	1	
					4.99	1	
	2	2.36	0		3.67	0	
		2.75	0		3.69	0	
		2.77	0		4.12	0	
		3.22	1	3.27	4.12	0	5.21
		3.25	0		4.51	0	
		3.25	0		4.54	0	
		3.42	1		4.59	1	
		3.64	1		4.70	0	
					4.98	0	
					4.99	0	
					5.26	0	
					5.28	1	
					5.49	1	
	3	3.16	0		3.91	0	
		3.18	0		3.96	0	
		3.18	0		4.36	0	
		3.36	1	3.64	4.39	0	5.54
		3.50	0		4.79	0	
		3.50	1		4.79	1	
		3.51	0		4.79	0	

	3.59	1		5.12	1	
	3.94	0		5.13	0	
	3.96	1		5.18	0	
				5.40	1	
				5.40	0	
				5.44	0	
				5.53	0	
				5.63	1	
				5.80	0	
				5.86	1	
				6.24	1	
4	3.20	0		4.22	0	
	3.29	0		4.43	1	
	3.59	1		4.60	0	
	3.71	0	3.70	4.65	1	4.60
	3.74	0		4.98	0	
	3.76	1		5.00	1	
	4.18	1		5.38	1	
	4.21	1				
5	2.48	0		4.22	0	
	2.49	0		4.55	1	
	2.74	0		4.55	1	
	2.85	0	2.93	4.75	0	4.59
	2.86	1		5.13	1	
	2.98	1		5.33	0	
	2.99	0		5.74	1	
	3.31	1				
	3.44	1				
6	2.87	0	3.64	4.32	0	5.05
	3.01	0		4.66	0	
	3.18	0		4.73	0	
	3.38	1		5.00	0	
	3.47	1		5.11	1	
	3.49	0		5.15	1	
	3.50	0		5.22	1	
	3.91	1				
	3.95	0				
	4.14	1				

	7	2.38	0	3.10	4.11	0	4.42
		2.70	0		4.35	1	
		2.80	1		4.65	1	
		2.87	0		4.66	0	
		3.13	1		5.15	1	
		3.36	0		5.63	1	
		3.73	1				
	8	2.50	0		3.83	0	
		2.89	1		4.04	1	
		2.97	0		4.26	1	
		3.24	0	3.05	4.59	0	3.99
		3.30	1		4.63	1	
		3.43	1		5.05	0	
		3.74	1		5.69	1	
008F	1	0.85	0		1.02	0	
		0.99	0		1.38	0	
		1.44	0		1.81	0	
		1.44	0		2.25	0	
		1.45	0	1.66	2.31	1	3.33
		1.69	1		2.57	0	
		1.70	0		2.75	0	
		1.70	1		2.80	0	
		1.95	1		2.81	1	
					3.01	0	
					3.24	0	
					3.31	1	
					3.32	1	
					3.74	0	
					4.36	1	
	2	1.34	0		2.62	0	
		1.76	0		3.08	0	
		1.77	0		3.54	0	
		1.81	0	2.04	3.99	0	5.01
		1.94	0		4.01	0	
		2.15	1		4.15	0	
		2.23	1		4.43	1	
		2.25	1		4.43	0	

				4.45	0	
				4.72	0	
				4.87	0	
				4.88	1	
				4.92	0	
				4.94	1	
				5.33	0	
				5.39	1	
				5.82	1	
3	2.21	0		4.41	0	
	2.24	0		4.42	0	
	2.24	0		4.42	0	
	2.42	0		4.65	0	
	2.64	0		4.77	1	
	2.65	0	2.66	4.86	0	6.19
	2.66	1		4.86	1	
	2.66	0		5.23	1	
	2.91	1		5.31	0	
	3.12	1		5.75	0	
	3.14	1		6.13	0	
				6.17	1	
				6.48	0	
				6.95	1	
4	1.36	0		3.64	0	
	1.80	0		3.93	0	
	1.81	0		4.12	0	
	1.82	1		4.14	1	
	2.04	0		4.29	1	
	2.28	1	2.56	4.55	1	4.78
	2.28	0		4.91	0	
	2.51	0		4.93	0	
	2.73	1		5.00	1	
	2.77	0		5.38	0	
	2.99	1		5.43	1	
				5.50	0	
				5.89	1	
				5.96	1	
5	2.09	0	2.95	4.67	0	5.39

	2.58	0		4.79	0	
	2.63	0		4.89	1	
	2.65	0		4.90	0	
	2.90	0		5.06	1	
	3.00	1		5.08	1	
	3.04	1		5.14	0	
	3.12	1		5.28	0	
				5.62	1	
				6.02	0	
				6.24	1	
6	2.08	0		4.64	0	
	2.51	0		4.99	0	
	2.57	0		5.21	0	
	2.63	0		5.21	0	
	2.80	0		5.44	0	
	2.99	1	3.00	5.46	1	5.78
	2.99	0		5.56	1	
	3.00	1		5.60	0	
	3.01	0		5.84	1	
	3.13	1		6.16	0	
	3.45	1		6.59	1	
7	2.58	0		4.61	0	
	2.94	0		4.95	0	
	2.98	0		5.03	1	
	3.30	1	3.53	5.07	0	5.06
	3.31	0		5.22	1	
	3.31	0		5.62	1	
	3.38	0		5.92	1	
	3.61	0				
	3.67	1				
	3.76	1				
8	2.02	0		4.70	0	
	2.40	0		4.83	0	
	2.44	1		5.02	1	
	2.77	0	3.02	5.20	1	5.56
	2.87	0		5.40	0	
	2.90	1		5.50	1	
	3.07	0		5.97	0	

		3.15	1		6.12	1	
					6.56	0	
					6.63	1	
009F	1	1.45	0		0.99	0	
		1.50	0		1.44	0	
		1.67	0		1.95	0	
		1.70	0		2.41	0	
		1.91	0		2.93	0	
		1.91	1		2.94	0	
		1.94	1	2.10	3.13	0	3.78
		2.16	1		3.36	0	
		2.38	0		3.39	0	
		2.38	0		3.58	0	
		2.41	1		3.60	0	
		2.65	1		3.80	1	
		2.86	1		3.81	0	
					3.82	1	
					4.01	1	
	2	1.86	0		1.81	0	
		2.29	0		2.15	0	
		2.32	0		2.74	0	
		2.72	0		3.16	0	
		2.76	0	3.11	3.18	0	4.10
		2.81	0		3.26	0	
		3.02	0		3.45	0	
		3.21	1		3.65	0	
		3.21	1		3.65	0	
		3.22	1		3.85	0	
					3.99	0	
					4.02	1	
					4.03	1	
					4.04	1	
					4.39	0	
					4.79	1	
	3	2.37	0		2.77	0	
		2.42	0	3.21	2.77	0	3.87
		2.77	0		3.00	0	
		2.79	0		3.12	0	

	2.79	0		3.13	0	
	2.98	1		3.17	1	
	3.16	0		3.36	0	
	3.16	1		3.55	0	
	3.16	1		3.55	1	
	3.54	0		3.56	1	
	3.87	1		3.92	0	
				3.93	0	
				3.94	1	
				4.28	0	
				4.31	1	
				4.70	1	
4	3.32	0		4.20	0	
	3.73	0		4.61	0	
	3.78	0		4.66	0	
	3.81	0	4.11	4.89	1	5.25
	3.98	1		5.07	1	
	4.25	0		5.09	0	
	4.25	1		5.51	0	
	4.64	1		5.96	1	
5	3.48	0		3.84	0	
	3.51	0		4.43	0	
	3.77	0	3.88	4.43	1	4.49
	3.86	0		4.45	0	
	3.91	1		4.80	1	
	3.94	1		4.82	1	
	4.30	1				
6	2.56	0		3.51	0	
	2.82	0		3.76	1	
	3.02	0		3.87	1	
	3.16	0	3.29	4.43	1	3.53
	3.18	0		4.47	0	
	3.40	1		4.80	0	
	3.53	1		5.60	1	
	3.90	1				
7	3.32	0	4.07	3.68	0	4.10
	3.43	0		3.79	0	

		3.45	0		4.03	0	
		3.79	0		4.17	1	
		3.80	0		4.20	1	
		3.84	0		4.60	1	
		4.02	1				
		4.05	1				
		4.18	0				
		4.66	1				
	8	2.92	0		4.21	0	
		3.21	0		4.28	0	
		3.32	0		4.34	1	
		3.37	1	3.71	4.63	1	4.90
		3.40	1		4.69	0	
		3.67	0		5.13	0	
		3.82	1		5.66	1	
		4.09	0				
		4.70	1				
010F	1	1.17	0		1.16	0	
		1.59	0		1.59	0	
		2.02	0		2.05	0	
		2.03	0	2.12	2.44	0	3.23
		2.04	0		2.83	0	
		2.20	1		2.86	0	
		2.45	1		3.20	0	
		2.46	1		3.23	1	
					3.23	1	
					3.27	0	
					3.61	1	
					3.61	1	
	2	1.65	0		3.41	0	
		2.08	0		3.42	0	
		2.11	0		3.82	0	
		2.14	0	2.24	3.82	1	3.88
		2.34	1		3.83	0	
		2.55	1		4.29	1	
		2.57	1		4.31	1	
	3	1.72	0	2.31	2.65	0	2.76

	2.18	0		2.89	1	
	2.18	0		3.14	1	
	2.21	0		3.62	0	
	2.41	1		3.62	1	
	2.65	1		4.04	0	
	2.69	1		4.08	1	
				4.57	1	
4	2.26	0		3.17	0	
	2.26	0		3.18	0	
	2.51	0	2.60	3.43	1	3.31
	2.69	1		3.62	1	
	2.75	1		4.13	1	
	3.24	1				
5	2.16	0		2.58	0	
	2.37	1		2.67	0	
	2.61	0	2.81	2.78	1	2.72
	2.64	0		3.06	1	
	2.64	1		3.40	1	
	2.96	0				
	3.06	1				
	3.09	0				
	3.44	1				
	3.46	1				
6	2.09	0		2.52	0	
	2.11	0		2.90	0	
	2.38	1	2.42	3.01	0	3.15
	2.51	0		3.13	0	
	2.61	1		3.14	0	
	3.08	1		3.14	1	
				3.21	1	
				3.52	1	
				3.60	1	
7	2.54	0		2.87	0	
	2.54	0		2.92	0	
	2.58	0	2.63	3.00	0	3.26
	2.69	1		3.09	1	
	2.93	1		3.41	0	

		3.00	1		3.44	1	
					3.72	1	
	8	2.02	0		2.91	0	
		2.28	0		3.21	0	
		2.39	1		3.29	0	
		2.43	0	2.77	3.30	0	3.39
		2.45	0		3.48	1	
		2.60	0		3.70	1	
		2.87	0		3.72	1	
		2.87	1				
		3.19	1				
011F	1	1.34	0		1.33	0	
		1.38	0		1.76	0	
		1.82	0		2.17	0	
		1.83	0		2.68	0	
		2.20	1		3.04	0	
		2.25	0		3.09	0	
		2.25	0	3.24	3.41	0	4.08
		2.46	0		3.49	0	
		2.66	0		3.51	0	
		2.68	0		3.75	0	
		2.90	0		3.93	1	
		3.01	1		3.94	1	
		3.12	0		3.97	1	
		3.32	1		3.98	0	
					4.45	0	
					4.85	1	
	2	2.17	0		3.11	0	
		2.18	0		3.49	0	
		2.66	0		3.52	0	
		2.66	0		3.53	0	
		3.10	1		3.70	0	
		3.12	0	3.28	3.97	0	4.16
		3.14	0		3.98	0	
		3.35	1		3.99	0	
		3.53	1		4.00	1	
		3.58	0		4.23	0	
		3.64	1		4.38	1	

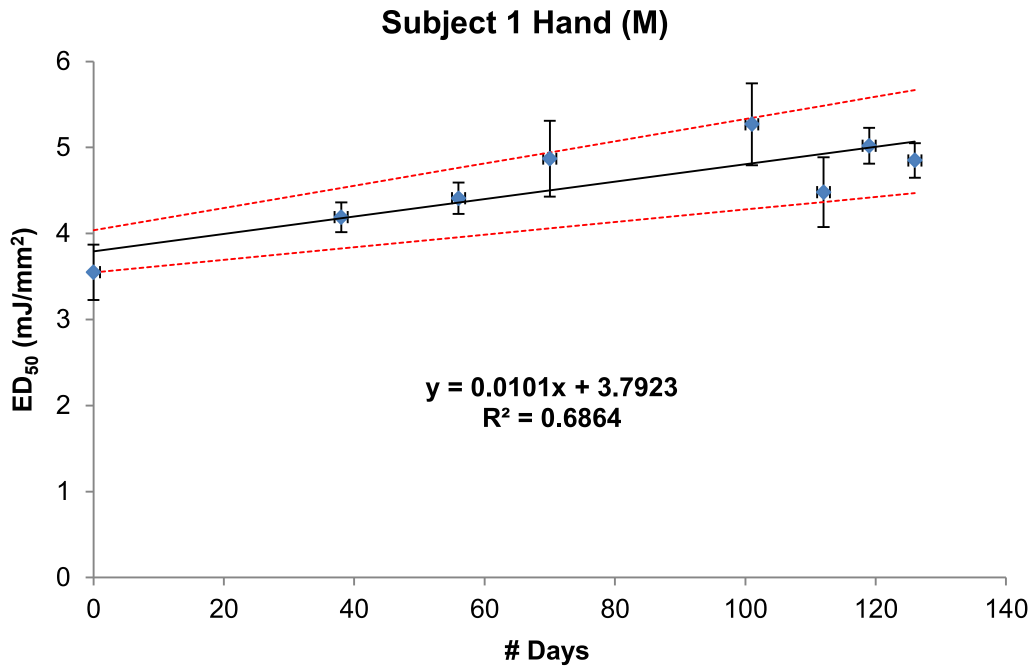
				4.38	1	
				4.47	1	
3	2.63	0		3.96	0	
	3.08	0		4.41	0	
	3.11	0		4.84	0	
	3.12	0	3.38	4.86	0	5.75
	3.29	0		4.86	0	
	3.48	1		5.05	0	
	3.55	1		5.23	1	
	3.56	1		5.28	1	
				5.29	0	
				5.70	1	
				5.76	0	
				6.12	0	
				6.60	1	
4	3.25	0		4.63	0	
	3.26	0		4.92	0	
	3.32	0		5.10	0	
	3.45	1	3.59	5.48	0	6.18
	3.70	0		5.55	0	
	3.74	1		5.58	0	
	4.17	1		5.80	0	
				5.98	1	
				6.07	0	
				6.10	1	
				6.10	1	
				6.55	0	
				7.05	1	
5	3.10	0		4.46	0	
	3.20	0		4.94	0	
	3.21	0		5.01	0	
	3.59	0	3.66	5.22	0	5.79
	3.62	0		5.26	0	
	3.69	1		5.29	0	
	3.81	1		5.53	0	
	4.00	1		5.60	1	
				5.60	1	
				5.76	1	

					6.25	0	
					6.69	1	
	6	2.65	0		4.23	0	
		3.04	0		4.36	0	
		3.15	0		4.36	0	
		3.15	0	3.23	4.50	0	5.18
		3.30	1		4.61	1	
		3.43	1		4.75	0	
		3.55	1		4.75	1	
					5.08	1	
					5.10	0	
					5.53	0	
					6.00	1	
	7	2.91	0		4.69	0	
		2.99	0		5.04	0	
		3.35	0		5.14	0	
		3.37	0	3.50	5.23	1	6.20
		3.49	0		5.31	0	
		3.52	1		5.42	0	
		3.83	1		5.58	1	
		3.86	1		5.64	0	
					5.89	1	
					6.30	0	
					6.43	1	
					6.90	0	
					7.10	1	
	8	3.35	0		4.46	0	
		3.43	1		4.72	1	
		3.65	0	3.75	5.02	1	5.12
		3.68	1		5.09	0	
		4.06	0		5.60	0	
		4.49	1		5.96	1	
012F	1	1.68	0		2.89	0	
		1.88	0		2.92	0	
		2.05	0	2.37	3.20	1	3.44
		2.23	1		3.36	1	
		2.29	0		3.40	0	

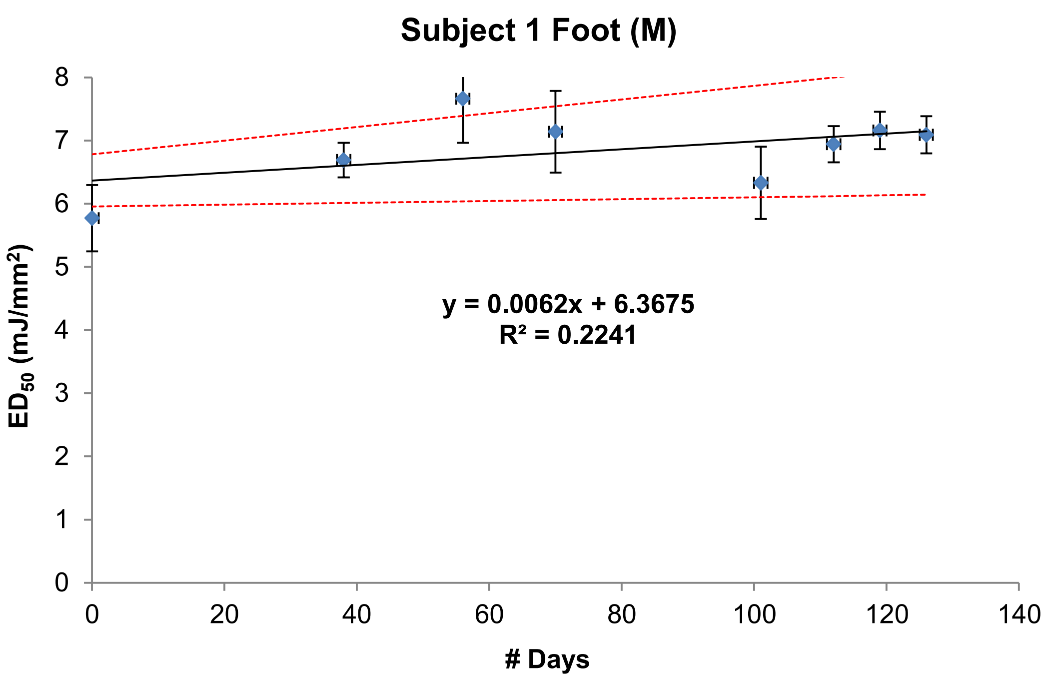
	2.47	1		3.65	0	
	2.48	0		3.86	1	
	2.69	1				
2	1.67	0		2.75	0	
	2.01	0		3.14	0	
	2.03	0		3.49	0	
	2.03	0	2.13	3.49	0	4.23
	2.24	1		3.51	0	
	2.37	1		3.66	1	
	2.39	1		3.84	0	
				3.87	1	
				4.21	1	
				4.23	0	
				4.57	0	
				4.93	1	
3	2.39	0		3.71	1	
	2.80	0		4.15	1	
	2.83	0	2.83	4.18	0	4.88
	2.84	1		4.62	0	
	3.19	1		4.65	1	
	3.26	1		4.67	0	
				5.04	1	
				5.09	0	
				5.46	0	
				5.48	1	
				5.84	0	
				6.26	1	
4	1.74	0		3.04	0	
	2.14	0		3.34	1	
	2.16	0	2.23	3.53	1	3.17
	2.30	1		3.93	0	
	2.58	1		4.03	1	
	2.63	1		4.38	1	
				4.47	0	
				4.82	1	
				4.89	1	
				4.90	0	
				5.28	1	

5	2.72	0		3.58	0	
	2.81	0		4.01	0	
	2.83	0	3.11	4.10	0	4.18
	3.07	1		4.26	1	
	3.20	0		4.44	1	
	3.25	1		4.58	1	
	3.70	1				
6	2.08	0		3.59	0	
	2.13	0		3.59	0	
	2.30	0	2.48	3.95	0	4.40
	2.68	1		3.96	0	
	2.69	1		4.20	0	
	3.13	1		4.29	0	
				4.38	0	
				4.43	1	
				4.57	1	
				4.80	1	
				5.00	1	
7	2.04	0		3.86	0	
	2.25	0		4.13	0	
	2.46	0	2.80	4.28	0	4.33
	2.54	0		4.38	1	
	2.55	1		4.57	1	
	2.78	1		4.66	1	
	2.95	1				
	2.98	0				
	2.98	0				
	3.28	1				
	3.42	1				
8	2.49	0		3.36	0	
	2.77	1		3.81	0	
	2.86	1	2.63	3.88	0	3.92
	3.41	0		3.96	1	
	3.79	1		4.34	1	
				4.35	1	

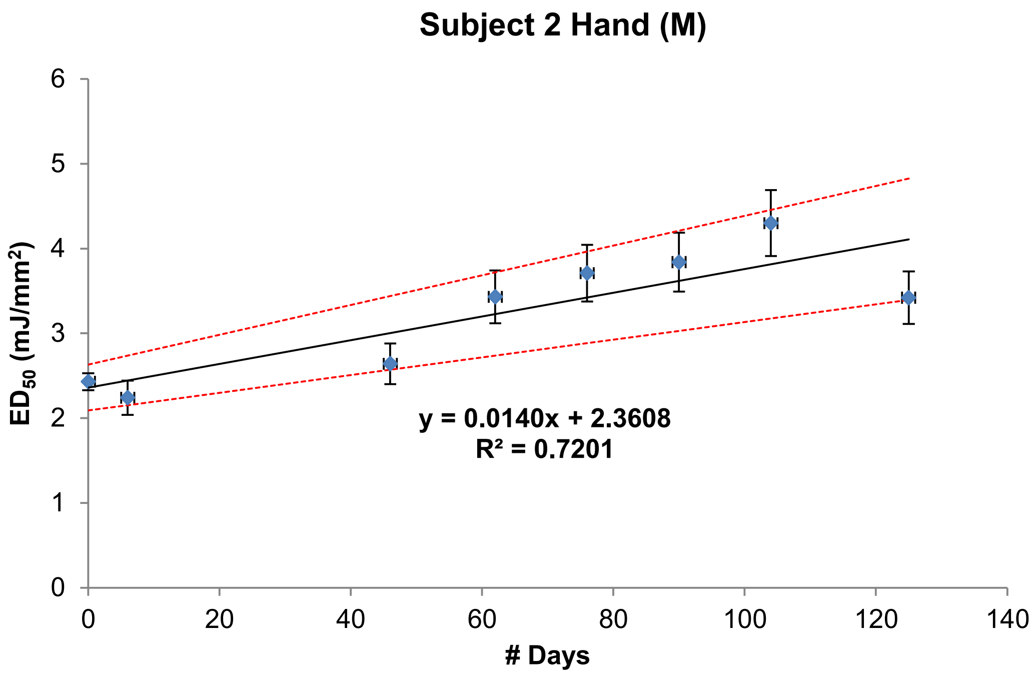
Appendix D

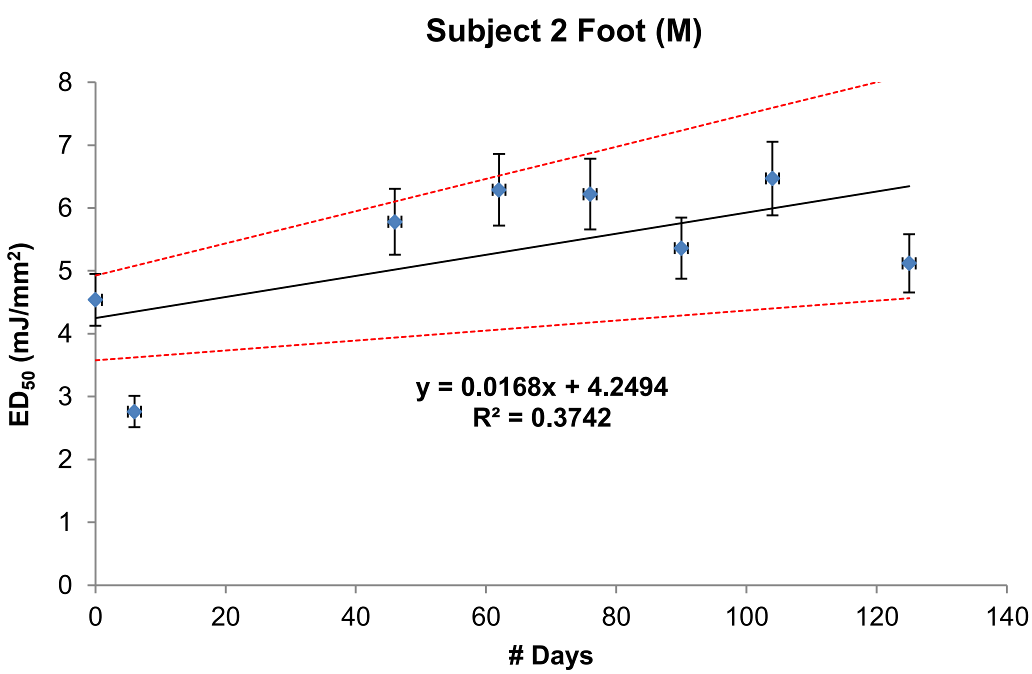


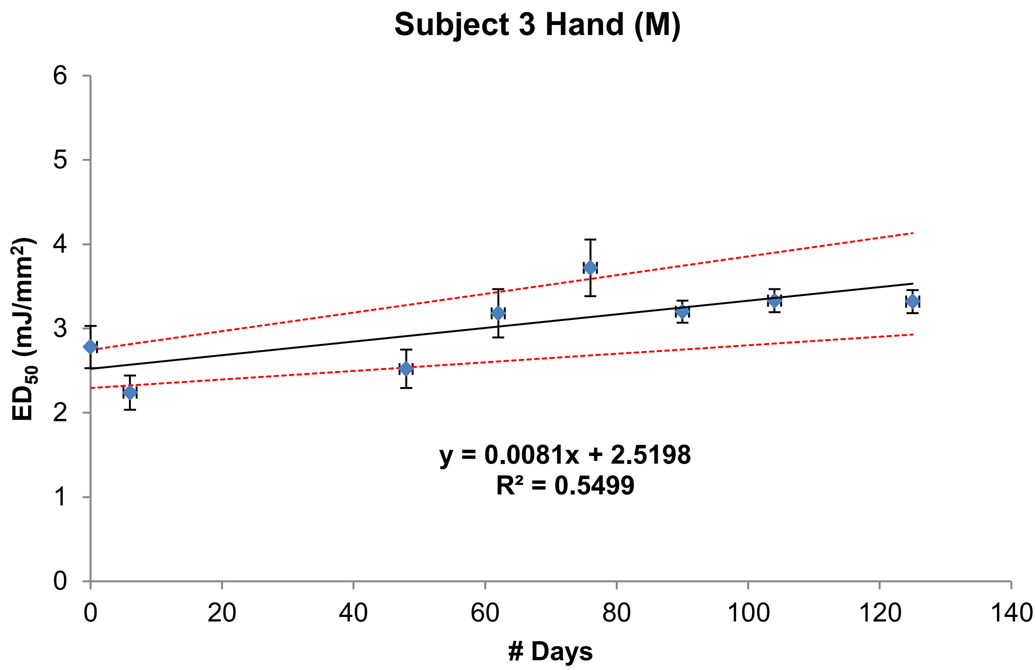
Subject 1 Hand (M)
ED50 (mJ/mm2)
y = 0.0101x + 3.7923
R² = 0.6864
# Days
0
20
40
60
80
100
120
140
0
1
2
3
4
5
6

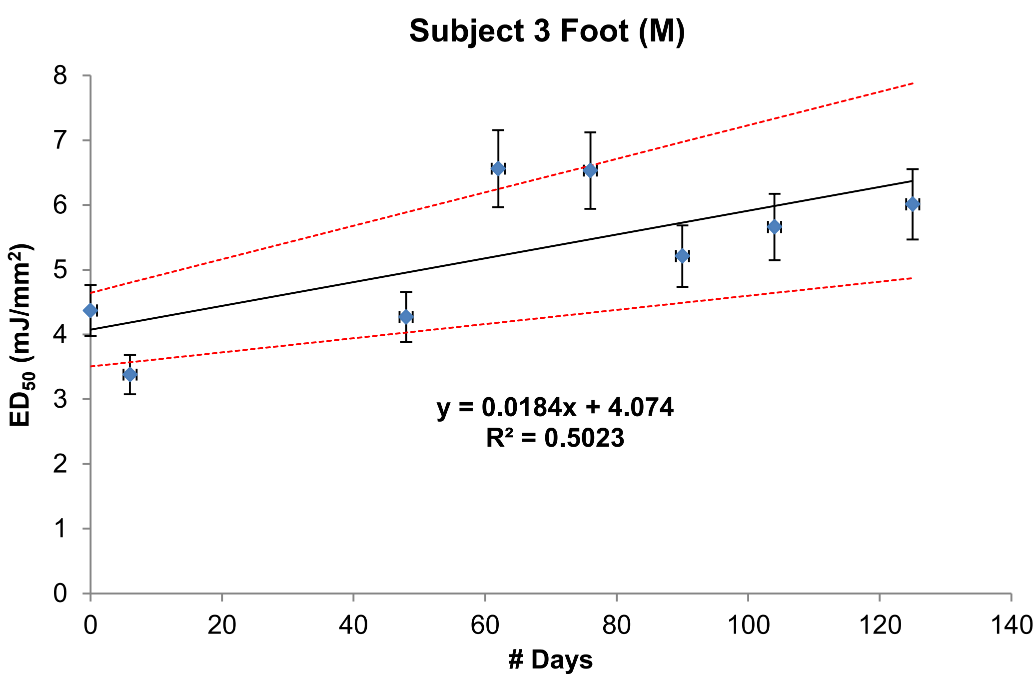


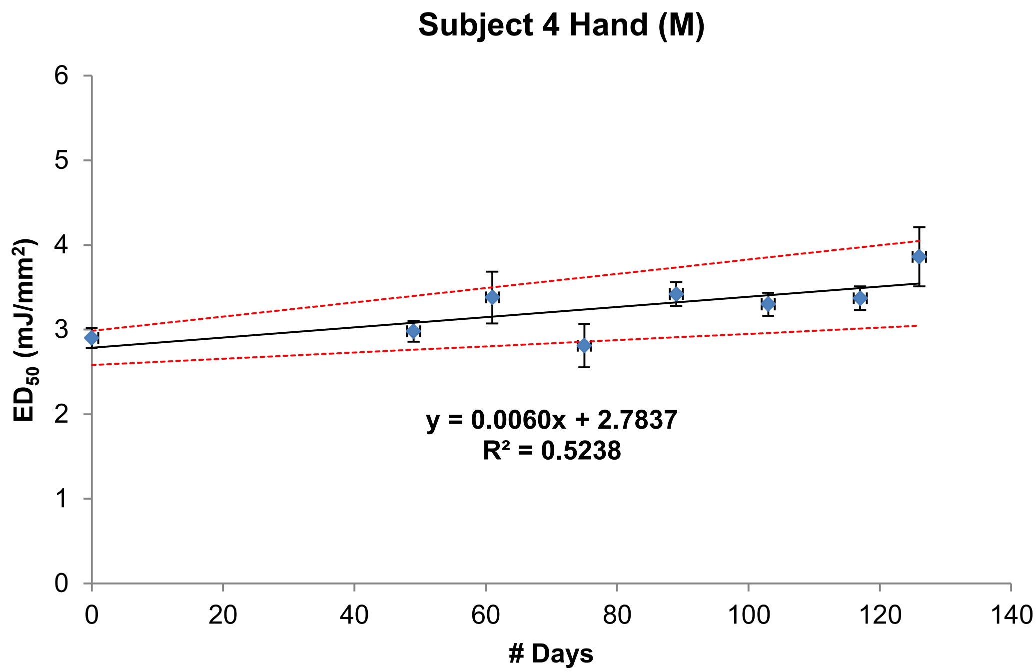
Subject 1 Foot (M)
ED50 (mJ/mm2)
y = 0.0062x + 6.3675
R² = 0.2241
# Days
0
20
40
60
80
100
120
140
0
1
2
3
4
5
6
7
8

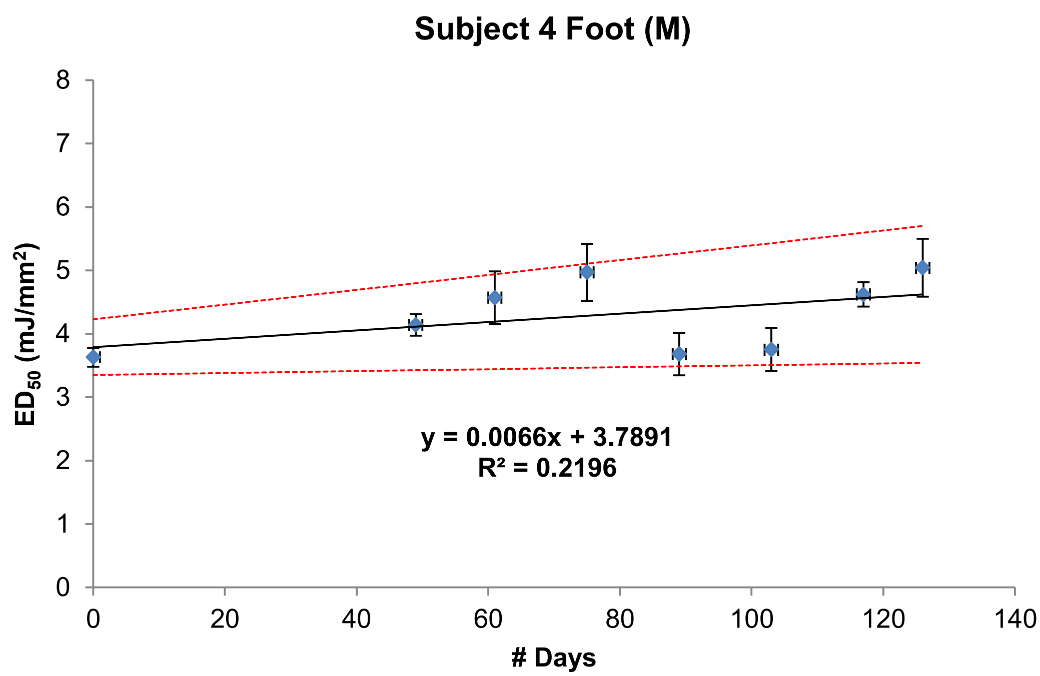

Subject 2 Hand (M)
ED50 (mJ/mm2)
# Days
y = 0.0140x + 2.3608
R² = 0.7201
0
1
2
3
4
5
6
0
20
40
60
80
100
120
140

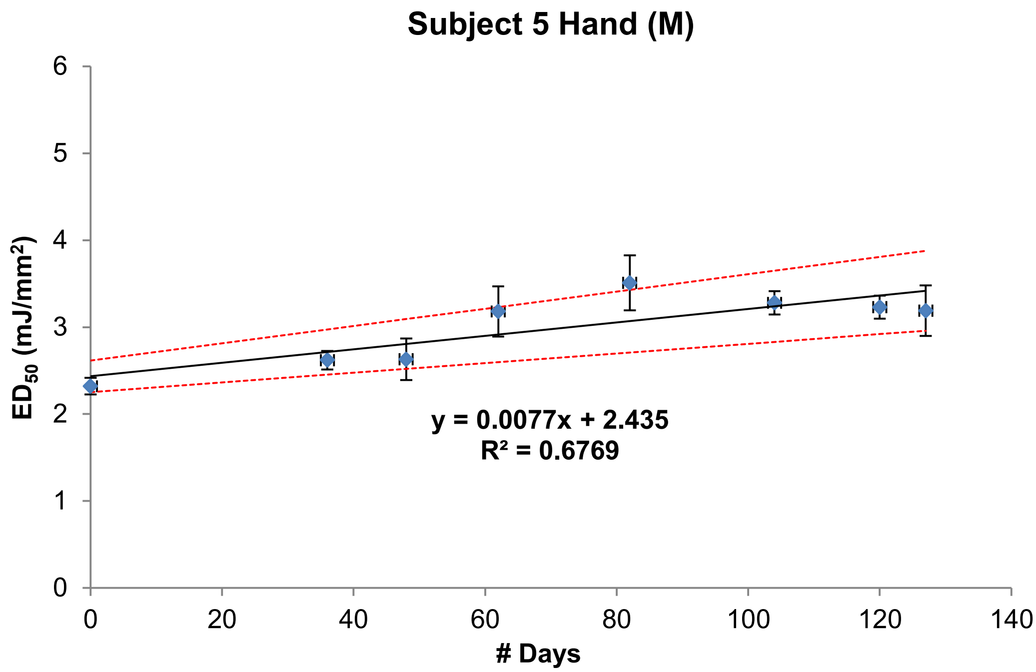

Subject 2 Foot (M)
ED50 (mJ/mm2)
# Days
y = 0.0168x + 4.2494
R² = 0.3742
0
1
2
3
4
5
6
7
8
0
20
40
60
80
100
120
140

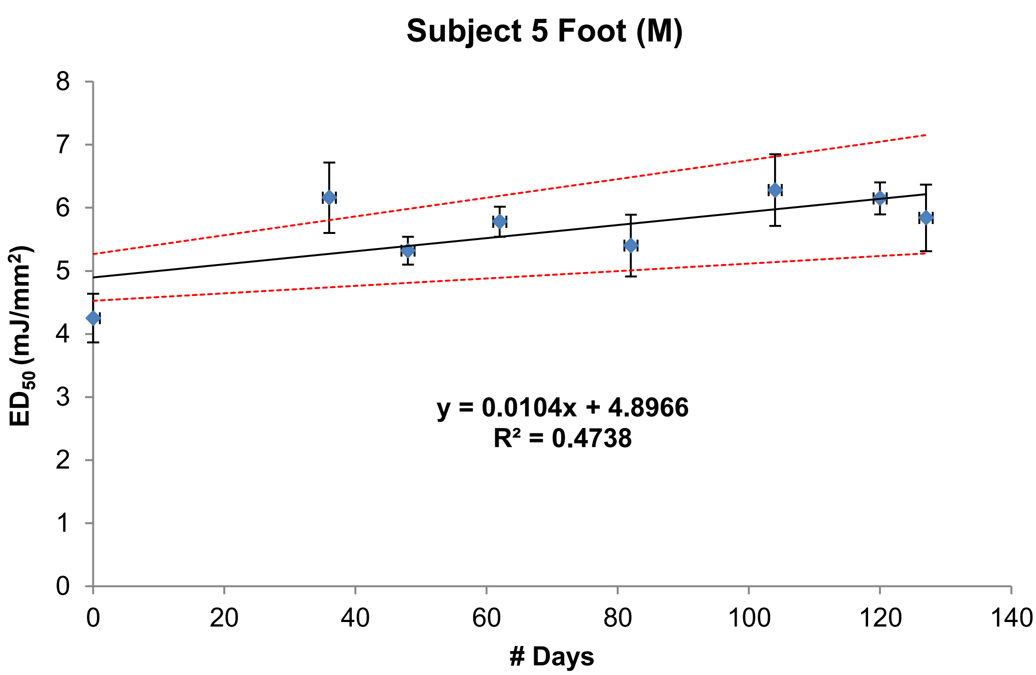

Subject 3 Hand (M)
6
5
4
3
2
1
0
ED50 (mJ/mm²)
y = 0.0081x + 2.5198
R² = 0.5499
0
20
40
60
80
100
120
140
Days

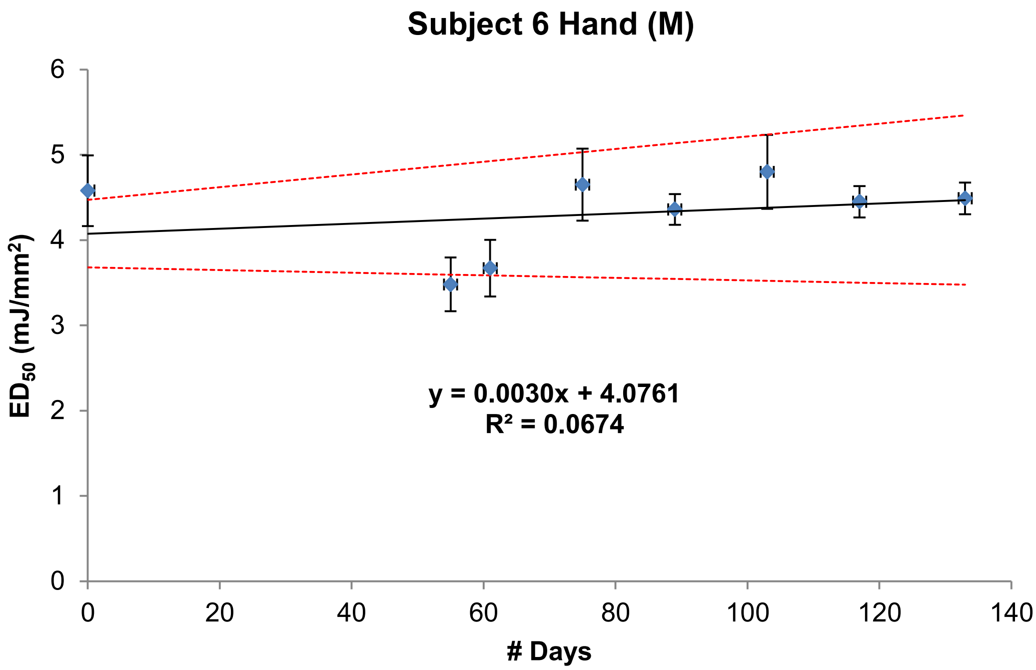

Subject 3 Foot (M)
8
7
6
5
4
3
2
1
0
ED50 (mJ/mm²)
y = 0.0184x + 4.074
R² = 0.5023
0
20
40
60
80
100
120
140
Days

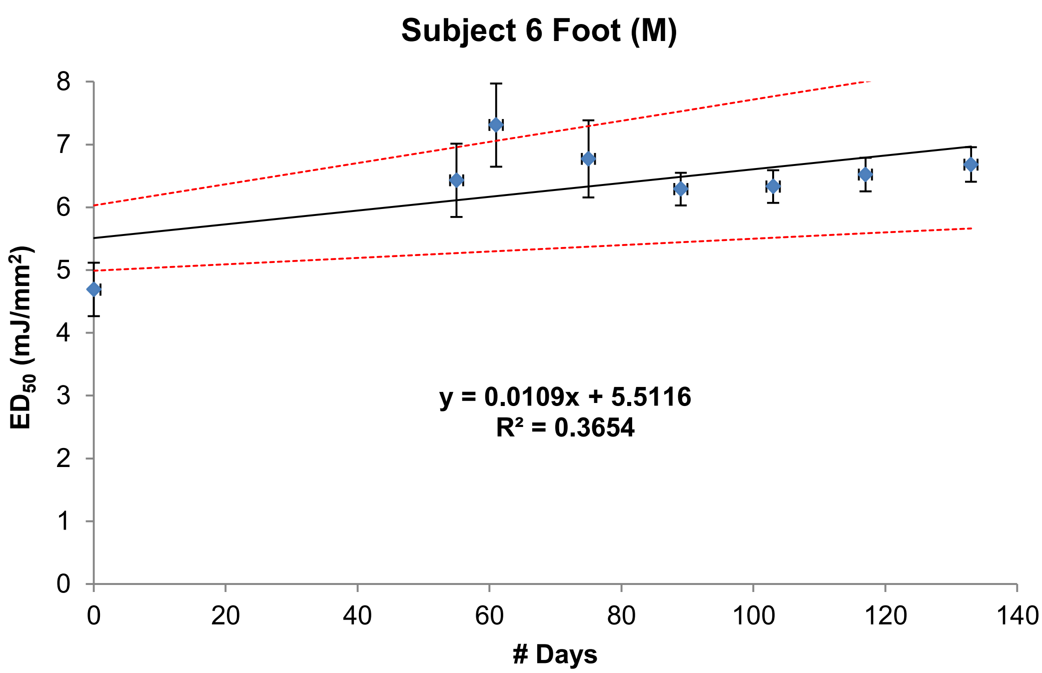

Subject 4 Hand (M)
6
5
4
3
2
1
0
ED50 (mJ/mm²)
y = 0.0060x + 2.7837
R² = 0.5238
0
20
40
60
80
100
120
140
Days

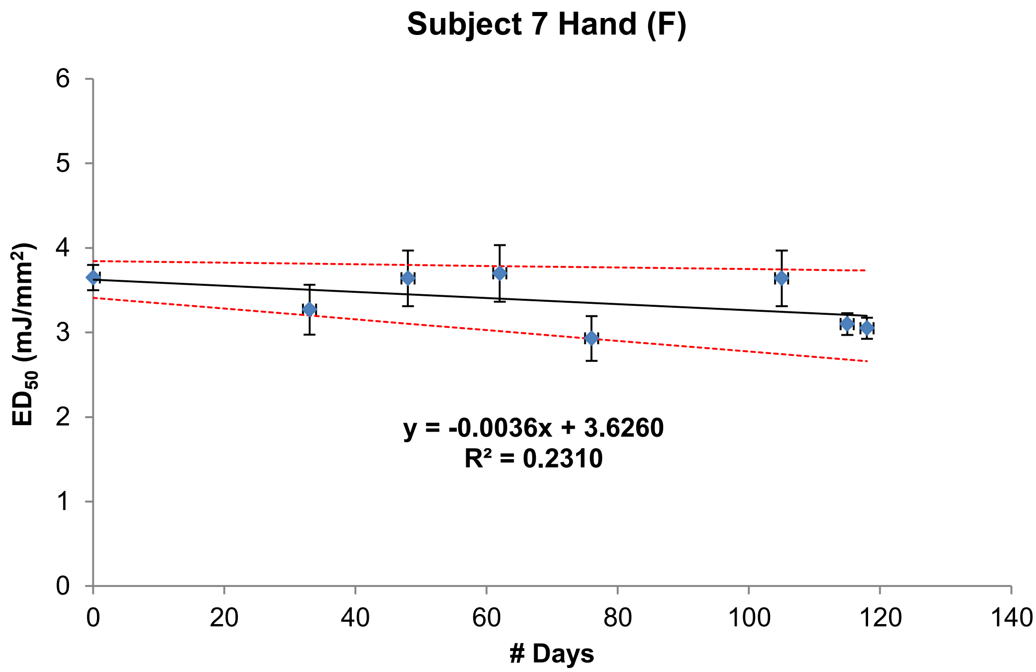

Subject 4 Foot (M)
8
7
6
5
4
3
2
1
0
ED50 (mJ/mm²)
y = 0.0066x + 3.7891
R² = 0.2196
0
20
40
60
80
100
120
140
Days


Subject 5 Hand (M)
ED50 (mJ/mm2)
6
5
4
3
2
1
0
y = 0.0077x + 2.435
R² = 0.6769
0
20
40
60
80
100
120
140
Days

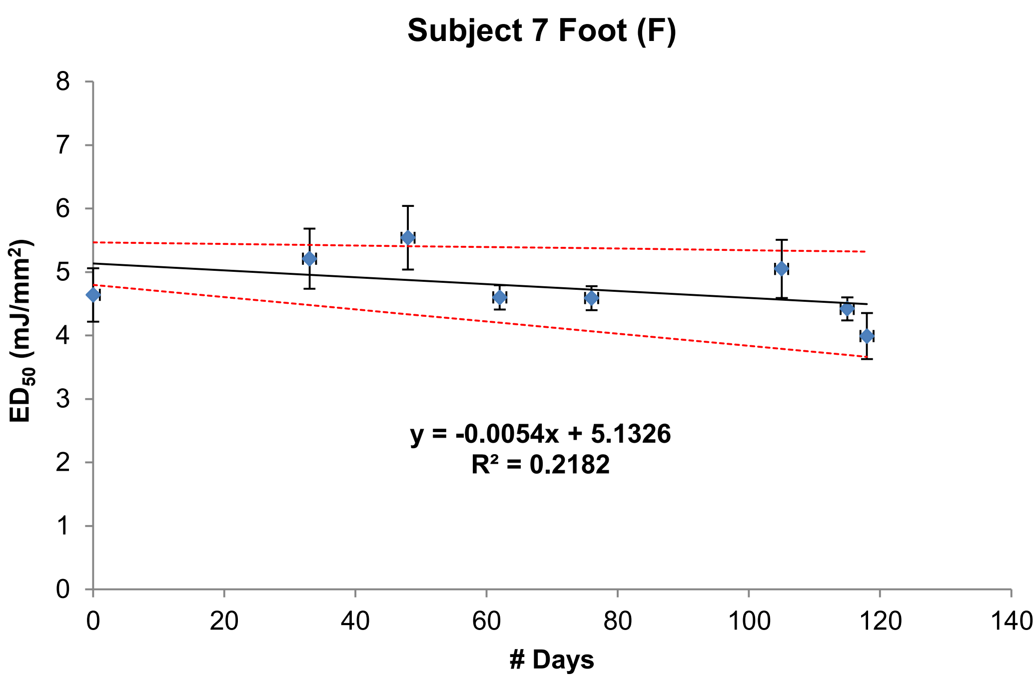

Subject 5 Foot (M)
ED50 (mJ/mm2)
8
7
6
5
4
3
2
1
0
y = 0.0104x + 4.8966
R² = 0.4738
0
20
40
60
80
100
120
140
Days


Subject 6 Hand (M)
ED50 (mJ/mm2)
y = 0.0030x + 4.0761
R² = 0.0674
# Days
0
1
2
3
4
5
6
0
20
40
60
80
100
120
140

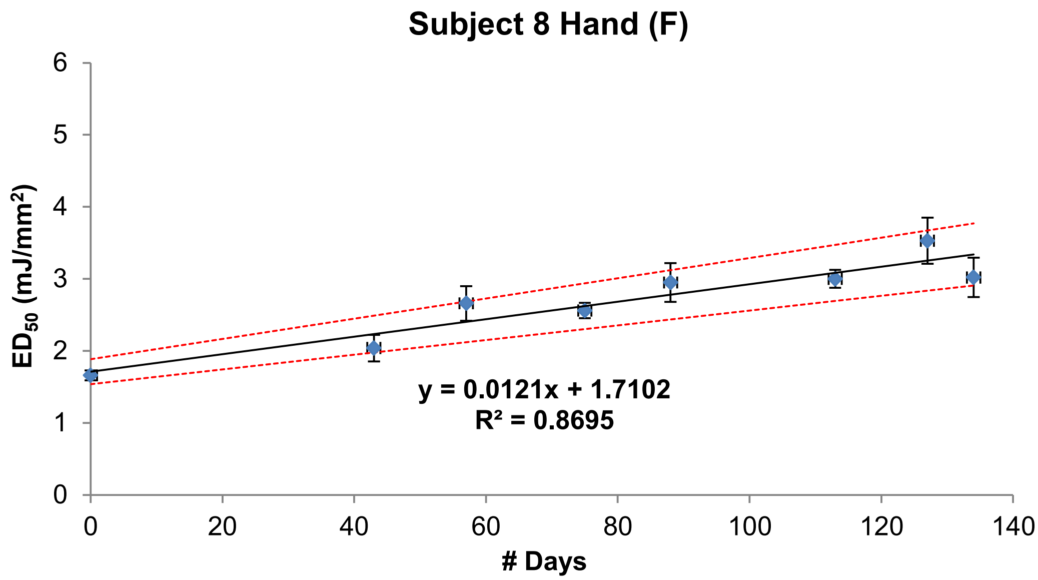

Subject 6 Foot (M)
ED50 (mJ/mm2)
y = 0.0109x + 5.5116
R² = 0.3654
# Days
0
1
2
3
4
5
6
7
8
0
20
40
60
80
100
120
140

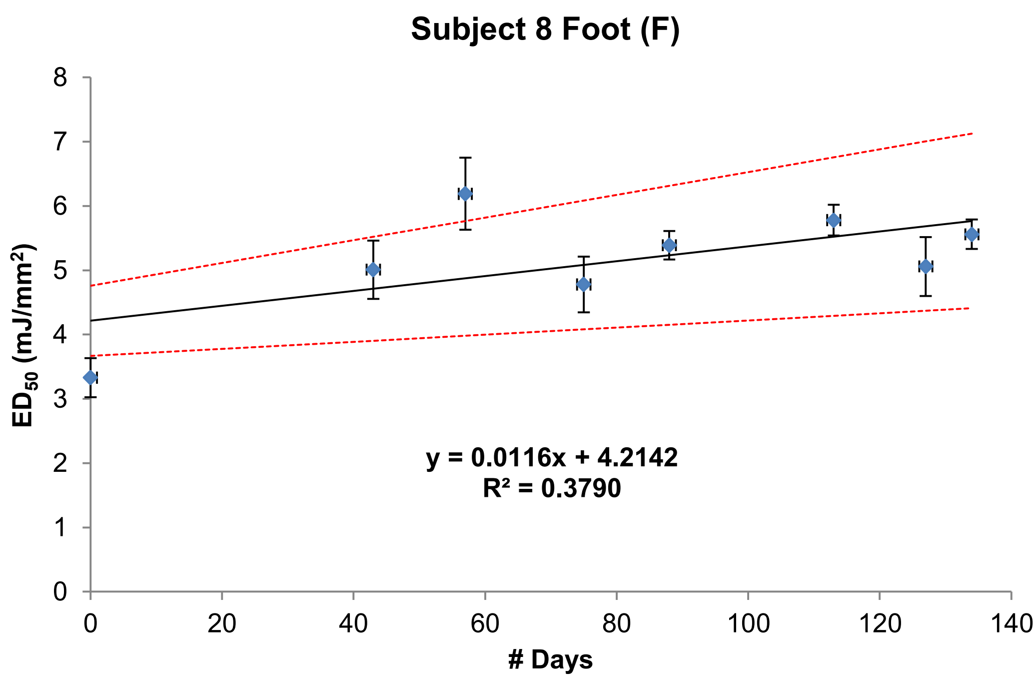


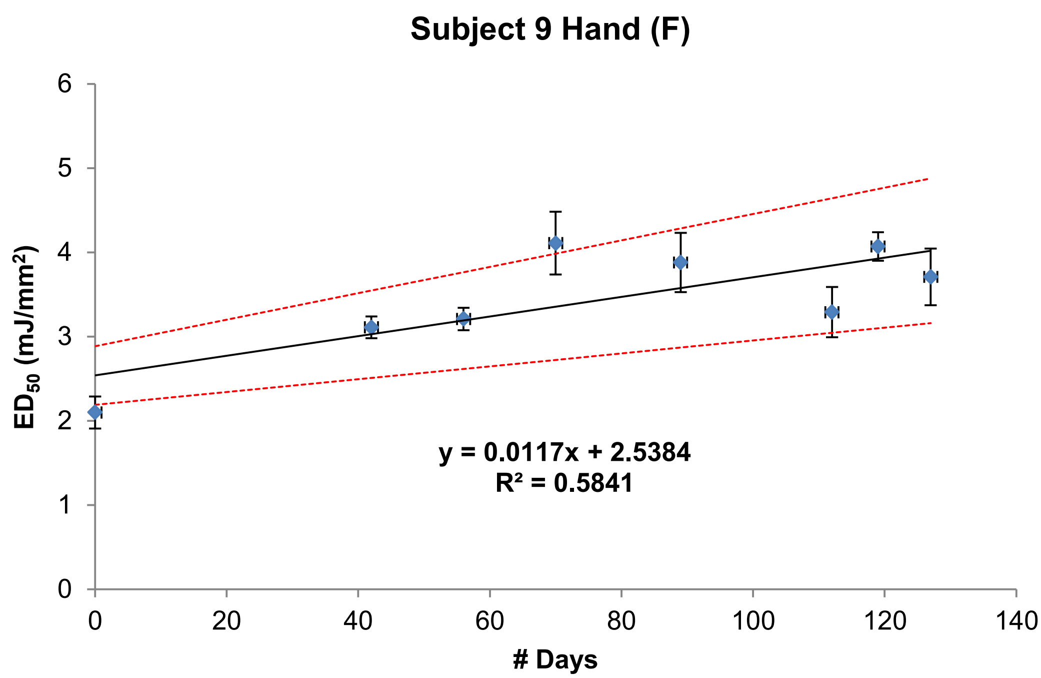
Subject 7 Hand (F)
ED50 (mJ/mm2)
6
5
4
3
2
1
0
y = -0.0036x + 3.6260
R² = 0.2310
0
20
40
60
80
100
120
140
Days

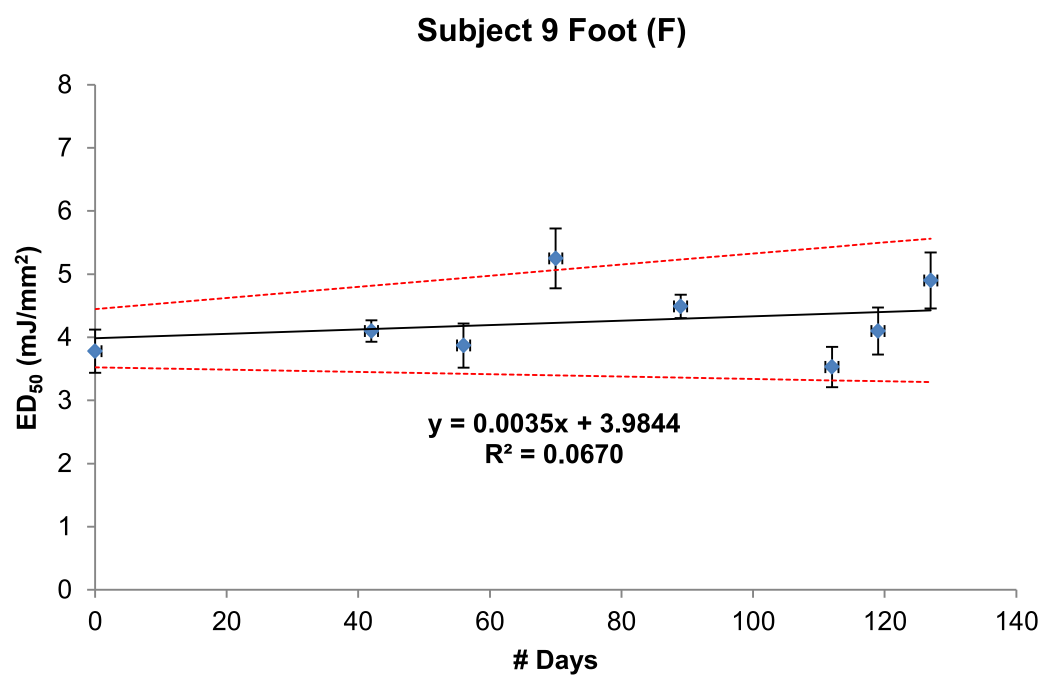


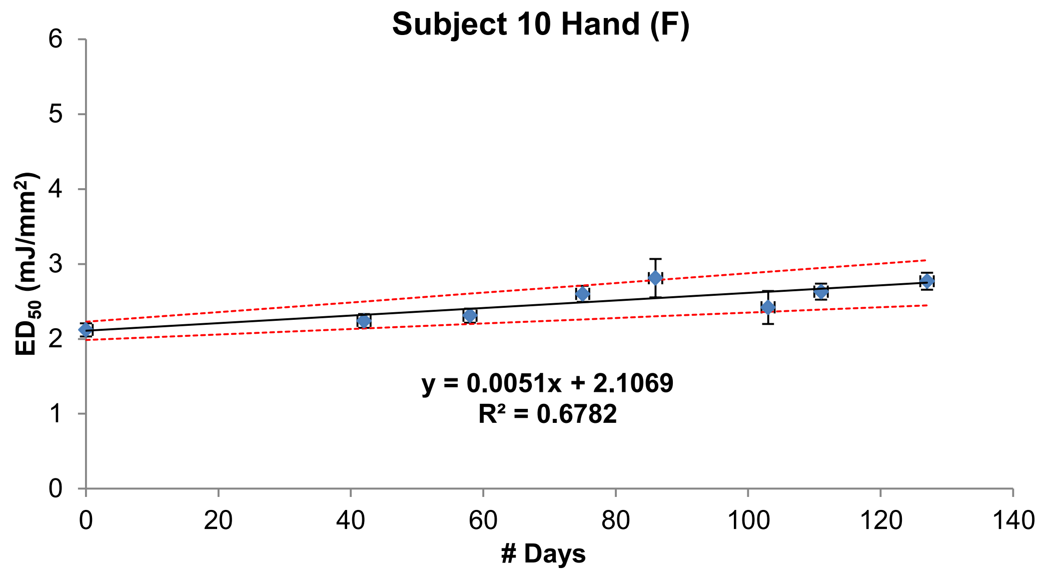
Subject 7 Foot (F)
ED50 (mJ/mm2)
8
7
6
5
4
3
2
1
0
y = -0.0054x + 5.1326
R² = 0.2182
0
20
40
60
80
100
120
140
Days

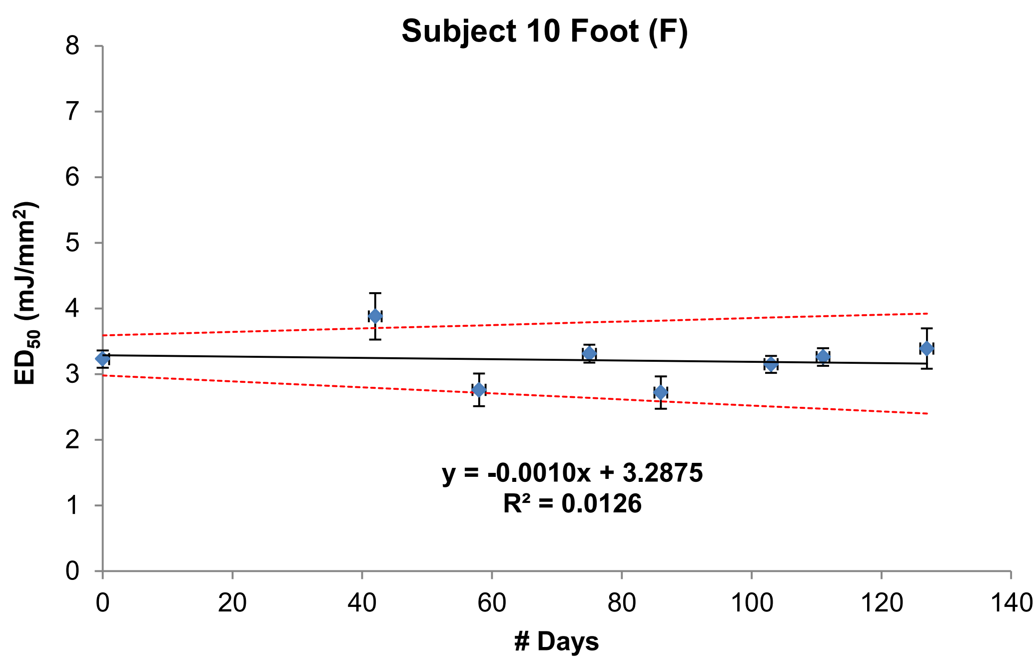

Subject 8 Hand (F)
ED50 (mJ/mm²)
# Days
y = 0.0121x + 1.7102
R² = 0.8695
0
1
2
3
4
5
6
0
20
40
60
80
100
120
140

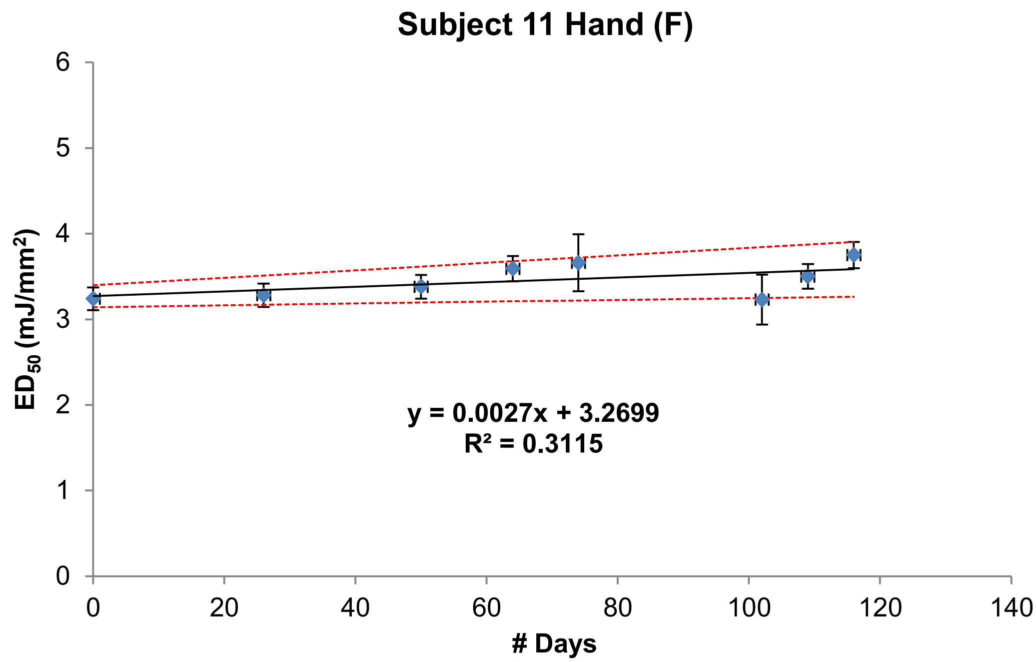

Subject 8 Foot (F)
ED50 (mJ/mm²)
# Days
y = 0.0116x + 4.2142
R² = 0.3790
0
1
2
3
4
5
6
7
8
0
20
40
60
80
100
120
140

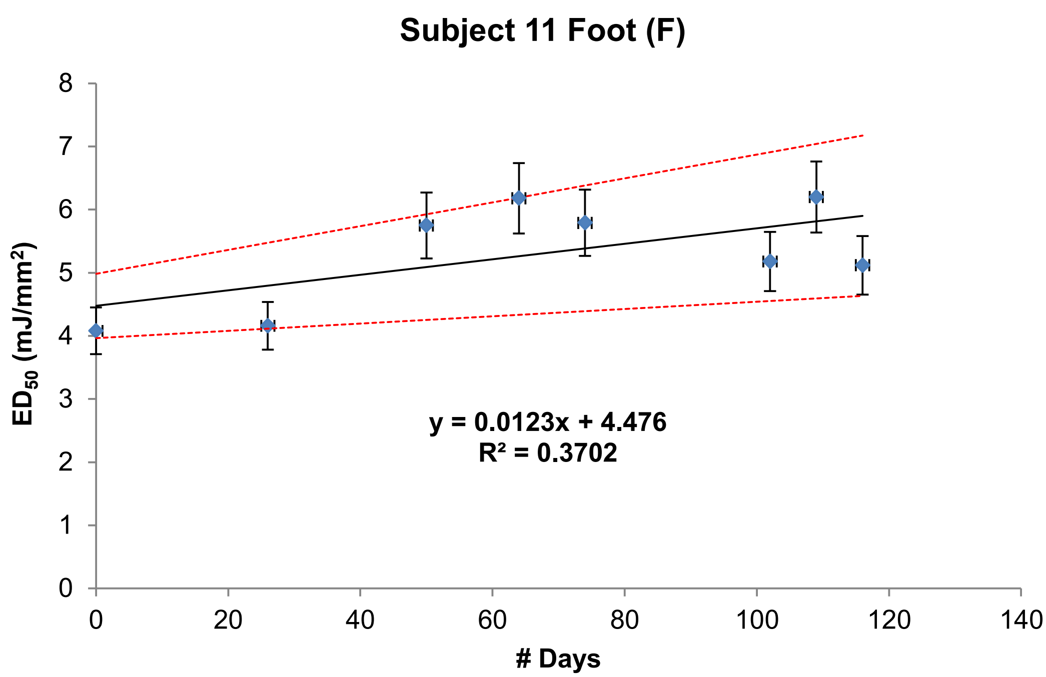

Subject 9 Hand (F)
ED50 (mJ/mm2)
0
1
2
3
4
5
6
0
20
40
60
80
100
120
140
# Days
y = 0.0117x + 2.5384
R² = 0.5841

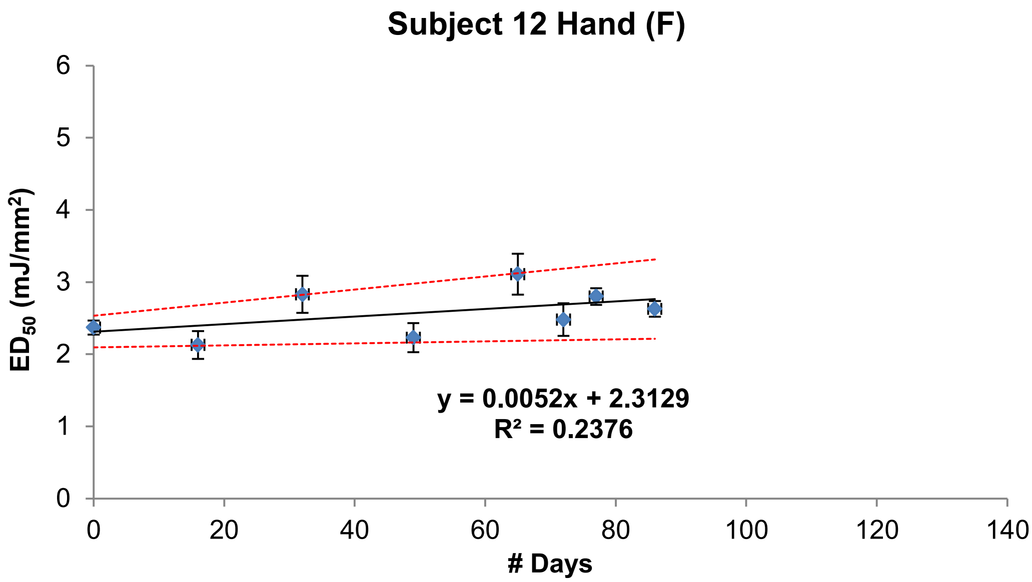

Subject 9 Foot (F)
ED50 (mJ/mm2)
0
1
2
3
4
5
6
7
8
0
20
40
60
80
100
120
140
# Days
y = 0.0035x + 3.9844
R² = 0.0670

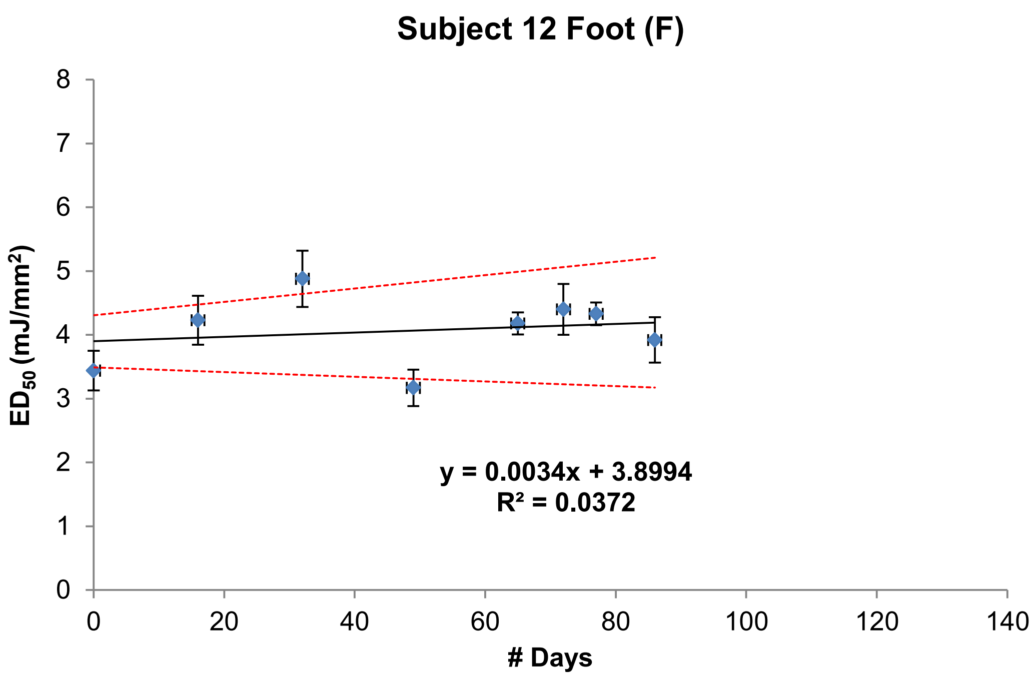

Subject 10 Hand (F)
ED50 (mJ/mm²)
6
5
4
3
2
1
0
y = 0.0051x + 2.1069
R² = 0.6782
0
20
40
60
80
100
120
140
Days


Subject 10 Foot (F)
ED50 (mJ/mm²)
8
7
6
5
4
3
2
1
0
y = -0.0010x + 3.2875
R² = 0.0126
0
20
40
60
80
100
120
140
Days


Subject 11 Hand (F)
ED$_{50}$ (mJ/mm^2)
y = 0.0027x + 3.2699
R² = 0.3115
# Days
0
1
2
3
4
5
6
20
40
60
80
100
120
140


Subject 11 Foot (F)
ED$_{50}$ (mJ/mm^2)
y = 0.0123x + 4.476
R² = 0.3702
# Days
0
1
2
3
4
5
6
7
8
20
40
60
80
100
120
140


Subject 12 Hand (F)
ED50 (mJ/mm2)
# Days
y = 0.0052x + 2.3129
R² = 0.2376
0
1
2
3
4
5
6
0
20
40
60
80
100
120
140

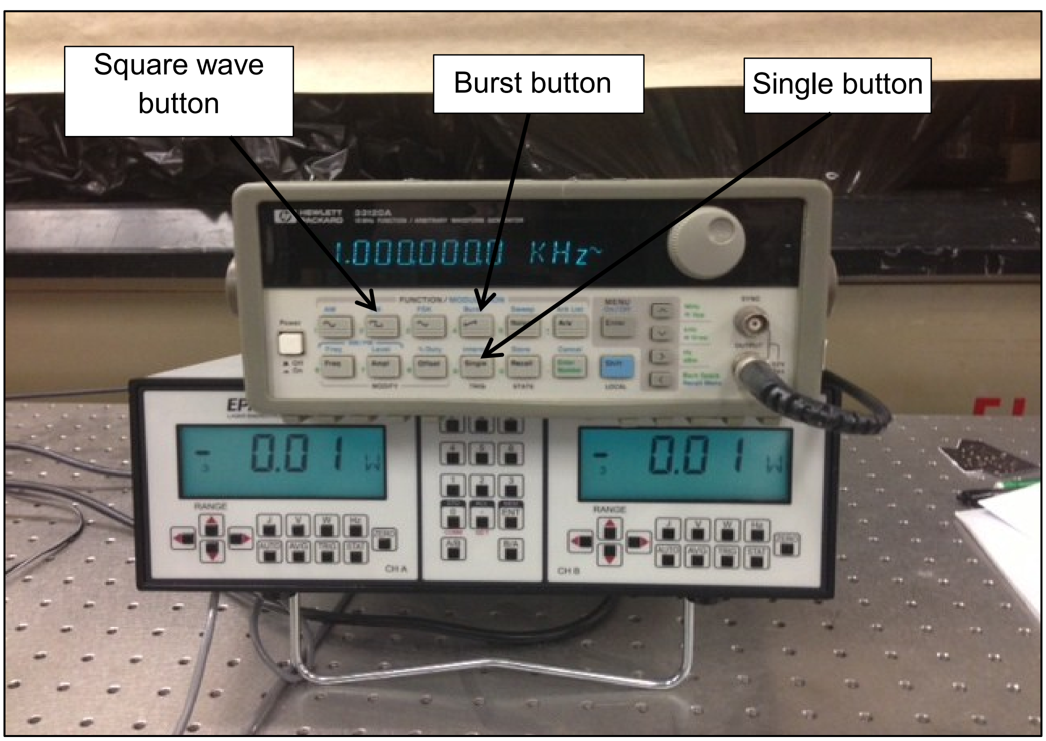

Subject 12 Foot (F)
ED50 (mJ/mm2)
# Days
y = 0.0034x + 3.8994
R² = 0.0372
0
1
2
3
4
5
6
7
8
0
20
40
60
80
100
120
140

Appendix E

Standard Operating Procedure
TLR-50-2010
Thulium: YAG Laser

Frequency Generator Setup

1. Plug the frequency generator into the BNC on the back of the laser console. The frequency generator allows the operator to set the desired laser parameters (frequency, amplitude, offset).
2. For a 10 ms pulse, the frequency generator should be set to 50 Hz frequency, 2.5 VPP amplitude, and 1.25 V offset.
3. To produce a square wave output, press the square wave button.
4. To control the number of pulses in a pulse train, enable bust mode by first pressing the shift button, and then pressing the saw tooth wave button (it has the word "burst" in light blue above the button). The number of pulses in a pulse train should be set to 1. This is done by pressing the menu button, then the left (←) arrow button, and then the down (↓) arrow button to access the count number screen. Select 1 as the number of pulses.
5. To enable the external trigger on the back of the frequency generator, press the "single button.
6. Now, when the laser is on, the frequency generator will produce a single 10 ms pulse when the "single" button is pushed.



Laser Setup

1. Turn the key on the front of the laser console to the “on” position.
2. When prompted, press the green “start” button.

3. For exposure sessions, ensure that modulation is enabled on the handheld controller.
    a. Press F2 on the handheld controller to get to the modulation screen, and then press F1 to enable modulation mode. If modulation is disabled, the laser will be in continuous mode instead of modulation (single pulse mode). Press F4 to return to main screen.

4. Set the desired laser power by pressing the F1 button on the handheld controller main screen, and then entering the power with the number keys followed by pressing enter.
5. When ready, press the F4 button to turn the laser on at the set power level. The laser is now ready to fire. The laser will emit a 10 ms pulse at the set power each time the “single” button is pressed on the frequency generator.

6. Turn the EPM 2000 on by flipping the switch on the back of the unit. When the laser is pulsed, ensure the EPM 2000 responds as expected.

Laser Shutdown

1. First, set the power to 0%.
2. Turn the laser emission off by pressing the F4 button.
3. Shutdown the laser by turning the front-panel key to “off”.
4. Turn off the EPM 2000 and frequency generator.