VOLUME II

LASER/TISSUE INTERACTIONS

by

Giuseppe Luigi Valderrama

Thesis
Chem.
1990
Valderrama
v. 2
4 LASER-INDUCED FLUORESCENCE SPECTROSCOPY OF BIOLOGICAL TISSUES

4.1 Introduction

As described in Section 1.2.2.1, a desire to develop a spectroscopic diagnostic technique for differentiation of normal from atherosclerotic cardiovascular (CV) tissue motivated the laser-induced fluorescence (LIF) studies. The diagnostic was envisioned as a remote sensing device; hence, compatibility with optical fiber technology was a design constraint. The CV tissue fluorescence studies can be divided roughly into three projects: 1) diagnostic technique evaluation, 2) optical fiber feasibility demonstration, and 3) elucidation of the nature of the fluorescence. Most of these experiments were conducted using in vitro human cardiovascular tissue, which will be the focus of this chapter.

Significant effort was directed towards quantitative analyses of the fluorescence data, primarily in the form of computer deconvolutions of the "supposed" three band origin of the tissue fluorescence spectra, and subsequent statistical analyses, which used deconvolution-determined parameters. These analyses have been described elsewhere for normal vs. malignant lung tissue. However, a discussion of the quantitative analyses for cardiovascular tissue has been omitted because in vivo studies conducted by others in the field invalidated the three band origin of the fluorescence which our deconvolution model presumed. The fluorescence structure so prevalent in in vitro CV tissue could not be reproduced during human in vivo experiments, indicating the presence of an artifact in the in vitro results. This other work demonstrated that in vitro fluorescence studies approximated the "true" in vivo fluorescence only in very limited circumstances (cf. Section 4.2.3).

This unexpected and highly significant revelation, coupled with our limited access to resources for conducting human in vivo studies, effectively terminated the project. Since a significant portion of this work has questionable direct extrapolation to the in vivo situation, the discussion which follows is limited and qualitative in nature. Nonetheless, the experimental approach was fundamentally sound and much insight into biological tissue fluorescence was gained. Consequently, these studies provide a foundation for possible future in vivo experiments.
4.2 Cardiovascular Tissue

The CV tissue fluorescence studies explored the fluorescence signatures produced by the various tissue types representing the progressive stages of atherosclerosis (cf. Table 3 in Section 2.2.1.1.3). Results for the coronary arteries [i.e. right coronary artery (RCA), left descending coronary artery (LDA), and the circumflex coronary artery (CFX)] and aorta (mostly thoracic with some iliac) have not been segregated because the LIF spectra did not appear to be a function of tissue type. These tissue types are referred to collectively as cardiovascular (CV) tissue. When appropriate, the specific tissue type used in any particular experiment will be given. Ultraviolet/Visible/Near Infrared (UV/VIS/NIR) absorption studies of CV tissue provided information on tissue absorption bands, which serve either as potential fluorescence excitation bands or artifact sources (cf. Section 1.2.2.2).

4.2.1 Laser-Induced Fluorescence Studies

4.2.1.1 Fluorescence Excitation Experiments

The first step was the selection of an optimal excitation wavelength $\lambda_{ex}$ for exciting and discriminating among the fluorescence spectra of the various CV tissue types. Only Ar-ion laser wavelengths were considered. Figure 56 shows a partial matrix of LIF spectra for four Ar-ion laser $\lambda_{ex}$ and three tissue types [i.e. normal (NOR) artery, noncalcified atherosclerotic plaque (NCP), and calcified atherosclerotic plaque (CAL); "fatty streaks" (FAT) were not present on the specimen used in this matrix] from the same donor specimen. Intensity (dimensionless; given as photon counts) vs. frequency $\tilde{\nu}$ (wavenumbers; units: per cm, cm$^{-1}$) is shown in the plot for each matrix element. Not surprisingly, the LIF spectra show that the "blue" (i.e. the shorter wavelength) shoulder of the broad fluorescence band is losing intensity as $\lambda_{ex}$ increases. Note the three distinct fluorescence signatures for the three tissue types which $\lambda_{ex} = 457.9$ nm yields, thus establishing the basis for its use throughout these studies.

4.2.1.2 $\lambda = 457.9$ nm Fluorescence Experiments

Figure 57 shows typical LIF spectra of NOR, FAT, NCP, and CAL cardiovascular tissue for $\lambda_{ex} = 457.9$ nm. These results have been reproduced in other studies.$^{[195]}$ The NOR, FAT, and NCP samples came from the same donor specimen. As Figure 57 also
depicts, the single feature which distinguished NOR samples from the other tissue types is the characteristic three peak shape, with intensity decreasing for longer wavelengths. There appears also to be a trend in the LIF band structure paralleling the progression of atherosclerosis. Briefly, atherosclerotic plaque formation is thought to begin with an injury to the endothelium (cf. Section 3.2.3.1). Smooth cells begin to migrate into the intima and proliferate. Lipid deposition (i.e. fatty streaks) is followed by fibrosis (i.e. noncalcified plaque) which is followed by the final disease stage of calcification (i.e. calcified atherosclerotic plaque). The LIF spectra indicate that, as atherosclerosis develops, the "resolved" three peak band structure gradually blends into one featureless band (i.e. calcified plaque). These results, seemingly confirmed by others (cf. Section 1.3.2), generated appreciable excitement because it appeared that discrimination between the various tissue types was possible using LIF. Calcified plaques tended to fluoresce more intensely than other tissue types.[26] Figure 58 shows the significant variations in the LIF spectra of NOR CV samples which occasionally were recorded. At the time, these extreme cases were disregarded as aberrational but, in retrospect, they reflected the presence of a reabsorption artifact (cf. Section 4.2.3).

4.2.1.3 Fluorescence Bleaching Rate Experiment

Early in the work, it became apparent that fluorescence absolute intensity decreased with time (i.e. bleached). This effect became more pronounced at higher laser irradiances. The Raman spectrophotometer used in these studies was sufficiently sensitive that, typically, irradiances of only ca. 100 µW/mm² were used. Figure 59 shows the effect of laser exposure duration on the absolute intensity of the LIF band. Successively less intense traces represent ca. 20 additional minutes (time period to scan the monochromator from ν = 24000 cm⁻¹ to 12000 cm⁻¹ and back to ν = 24000 cm⁻¹) of exposure time.

4.2.1.4 Fluorescence Collection Via Optical Fibers

Once the utility of fluorescence as a diagnostic for atherosclerosis appeared to have been established, it became important to demonstrate its effective application through optical fibers. Figure 60 shows spectra obtained using a single optical fiber (to carry both the excitation wavelength to the sample surface and the resulting fluorescence back to the
Figure 56. LASER-INDUCED FLUORESCENCE OF CARDIOVASCULAR TISSUE AS A FUNCTION OF EXCITATION WAVELENGTH AND TISSUE TYPE.
Figure 57. TYPICAL LASER-INDUCED FLUORESCENCE SPECTRA ($\lambda_{ex} = 457.9$ nm) OF NORMAL CARDIOVASCULAR TISSUE, FATTY STREAKS, NONCALCIFIED ATHEROSCLEROTIC PLAQUE, AND CALCIFIED ATHEROSCLEROTIC PLAQUE.
normal cv tissue

fatty streak

non-calcified plaque

calcified plaque

wavenumbers (cm⁻¹)
Figure 58. LASER-INDUCED FLUORESCENCE SPECTRA: EXTREME EXAMPLES OF NORMAL CARDIOVASCULAR TISSUE.
least-resolved normal spectrum

most-resolved normal spectrum
Figure 59. LASER-INDUCED FLUORESCENCE SPECTRA OF NORMAL CARDIOVASCULAR TISSUE: BLEACHING RATE MEASUREMENTS.
Figure 60. LASER-INDUCED FLUORESCENCE SPECTRA: NORMAL-ORIENTED OPTICAL FIBER COLLECTION.

Panel 1 shows a background spectrum of the Raman/LIF bands from the laser/fiber coupling point. Panel 2 shows the combined sample LIF spectrum and optical fiber Raman/LIF spectrum. Panel 3 shows the sample LIF spectrum obtained by digitally subtracting the spectrum in Panel 1 from the spectrum in Panel 2.
monochromator collection optics) in the configuration described in Section 2.3.2.1.2 and depicted in Detail B of Figure 20 (i.e. the optical fiber main axis oriented perpendicular to the sample surface). The first panel shows the background spectrum of the optical fiber's strong Raman bands (and a weak broad fluorescence band), originating from the point at which the laser was coupled to the fiber (i.e. at the focus of the first fluorescence collection lens) and with no sample positioned at the optical fiber fluorescence sampling end. The second panel in Figure 60 shows the combined LIF/Raman spectrum obtained when a calcified plaque sample was positioned at the optical fiber fluorescence sampling end. The third panel shows only the calcified plaque LIF spectrum, obtained by digitally subtracting the background spectrum from the combined LIF/Raman spectrum.

The first panel in Figure 61 shows the LIF spectrum of a specimen in the off-axis excitation configuration described in 2.3.2.1.1. The second panel shows the LIF spectrum of the same specimen at the same location obtained using a single optical fiber as just described, except in the configuration depicted in Detail C of Figure 20 (i.e. the optical fiber main axis oriented parallel to the sample surface). The optical fiber Raman bands were not digitally subtracted from the combined LIF/Raman spectrum. These spectra show that optical fiber collection of LIF reproduced the LIF results using the two lens collection system of the off-axis excitation configuration (cf. Section 2.3.2.1.1). Although the ability to collect LIF spectra via optical fiber was demonstrated early in these studies, the two lens collection system (i.e. no optical fiber) of the off-axis excitation configuration was retained for most of this work for convenience.

**4.2.1.5 Fluorescence of Mechanically Removed Plaque**

Figure 62 illustrates the effect of mechanically removing a calcified atherosclerotic plaque to determine if a "normal" fluorescence signature occurs at the plaque/nonplaque boundary (i.e. a first order approximation to the situation of a laser ablating through the plaque and encountering healthy tissue). A small (ca. 2 mm wide by 4 mm tall by 1 mm thick) calcified plaque surrounded by fatty streaks and noncalcified plaque was located in a specimen. The first panel shows typical LIF spectrum for this calcified plaque while still embedded in the bulk tissue. The second panel shows the calcified plaque sample after removal from the bulk tissue which, not surprisingly, is similar to the first panel
229

spectrum. The third panel is the LIF spectrum of the "subplaque" region exposed by removal of the calcified plaque. This LIF spectrum indicates "normal" tissue and contrasts greatly with the spectra of the first two panels. These results never were duplicated using a laser to ablate the plaque.

4.2.1.6 Fluorescence of Pure Chemical Components

During attempts to determine the chemical origin of CV tissue fluorescence, two candidate substances were studied. One study had reported that cellular autofluorescence (a medical term used to signify the "native" fluorescence of a substance as opposed to the "introduced" fluorescence of, say, a biological immunofluorescent probe) is probably due to endogenous flavoproteins. Figure 63 shows the LIF spectra for four riboflavin dilutions as labelled. The shape of the LIF band, however, appears too narrow to account entirely for the CV tissue fluorescence band.

The second substance analyzed was calcium hydroxyapatite \([\text{Ca}_6(\text{PO}_4)_3\text{OH}]\), the single largest component of calcified atherosclerotic plaque. I would like to thank Dr. Dieter Heymann of the Rice University Geology Department for kindly providing the specimen. Figure 64 shows the LIF spectrum of this specimen. It strongly resembles the calcified plaque bandshape, with peak intensity frequency displaced ca. 300 cm\(^{-1}\) to the red.

4.2.1.7 Fluorescence of Isolated Components:

During these studies, indirect evidence began to mount that blood somehow played a role in the fluorescence (cf. Section 4.2.3) of CV tissue. Dr. Michele Sartori graciously donated a small quantity of fresh human blood for experiments. Panel 1 of Figure 65 shows the LIF spectrum for freshly-drawn whole blood, indicating very little fluorescence. Another freshly-drawn whole blood specimen was centrifuged at ca. 6000 rotations per minute (RPM) for a period of one hour. Panel 2 shows the LIF spectrum of the supernatant, which consisted mostly of plasma and was amber in color. Interestingly, this plasma component of blood fluoresces moderately and its LIF spectrum is virtually identical to the riboflavin solution LIF spectrum shown in Figure 62. Panel 3 shows the LIF spectrum for the red blood cell fraction that had been centrifuged out of the whole blood. This LIF band was much broader but less intense than that of the supernatant component.
Figure 61. LASER-INDUCED FLUORESCENCE SPECTRA: COMPARISON OF OFF-AXIS EXCITATION CONFIGURATION vs. PARALLEL-ORIENTED OPTICAL FIBER CONFIGURATION.

Panel 1 shows the LIF spectrum of a specimen recorded using the off-axis excitation configuration. Panel 2 shows the LIF spectrum collected at the same point on the specimen used for the Panel 2 spectrum through a parallel-oriented (i.e. 45° aluminum-coated optical fiber end collecting fluorescence perpendicular to main fiber axis) optical fiber.
Figure 62. LASER-INDUCED FLUORESCENCE SPECTRA: EFFECT OF MECHANICAL REMOVAL OF CALCIFIED ATHEROSCLEROTIC PLAQUE.
calcified plaque in bulk tissue

isolated calcified plaque

"sub-plaque" tissue
Figure 63. LASER-INDUCED FLUORESCENCE SPECTRA: RIBOFLAVIN DILUTIONS.
Figure 64. LASER-INDUCED FLUORESCENCE SPECTRA: CALCIUM HYDROXYAPATITE.
Figure 65. LASER-INDUCED FLUORESCENCE SPECTRA: WHOLE BLOOD AND ISOLATED FRACTIONS.
4.2.2 UV/Vis/NIR Absorption Experiments

Figure 66 shows the measured total attenuation coefficient $\gamma$ (units: per cm, cm$^{-1}$) as a function of wavelength $\lambda$ (units: nm) for a section of normal aorta having a thickness of ca. 100 $\mu$m. The two bands in the mid-infrared spectral region, with maxima at $\lambda = 1450$ and 1930 nm, are overtone absorptions of tissue water. The bands in the UV/VIS spectral region, with maxima at $\lambda = 410, 540$ and 580 nm, are absorption bands of oxyhemoglobin and deoxyhemoglobin (the band at $\lambda = 410$ nm also is known as the Soret band).[97]

4.2.3 Role of Hemoglobin Reabsorption in Tissue Fluorescence

As discussed above, the in vivo work conducted by other groups (see Reference 28) demonstrated that an artifact was present in the in vitro studies which had been conducted up to that time. The probable culprit was hemoglobin reabsorption. For sufficiently large optical penetration depth $\delta_{\lambda}$, tissue absorption bands to the red of $\lambda_{ex}$ can filter (i.e. reabsorb) any emitted light of the same wavelength as the fluorescence passes through the resulting volume element in the tissue on its way to the surface. Figure 67 shows a UV/VIS absorption spectrum [absorbance (dimensionless, shown in arbitrary absorbance units) is plotted as a function of $\nu$ (units: wavenumbers, cm$^{-1}$)] of a thin section of normal aorta in the $\nu$ range of ca. 17000 to 21000 cm$^{-1}$ ($\lambda = 590 - 480$ nm) superimposed on a fluorescence spectrum of normal aorta. Note that the two tissue absorption bands due to hemoglobin coincide with the dips in the fluorescence spectrum. The results presented in the following subsections offer evidence which supports this model of in vitro fluorescence in CV tissues.

4.2.3.1 Near-in vivo Studies: Heart Transplant Tissue

Early in these studies, a concern existed that in vitro results might not represent accurately "true" in vivo fluorescence spectra. To approach one step closer to "true" spectra, specimens of CV tissue from heart transplant operations were obtained. Because these specimens came directly from the operating room to the spectrophotometer, it was hoped they would closely represent in vivo fluorescence. Figure 68 shows a typical LIF spectrum
of a normal section from one of four transplant CV specimens studied. The lack of the
three band structure observed in the in vitro normal CV tissue specimens, in retrospect,
should have raised greater inquiry at the time.

4.2.3.2 Time-Resolved Fluorescence

Brief time-resolved fluorescence studies of in vitro normal aorta were conducted at
the Shell Westhollow Research Laboratories. I would like to thank Dr. Thomas Cellucci
and Shell Westhollow for their generosity in providing laboratory equipment and personnel
support. Emission was excited at \( \lambda_{\text{ex}} = 458 \) nm using a broad band visible source passing
through a monochromator. Emission was collected in separate experiments at \( \lambda = 516 \) and
553 nm (the maxima of the two most intense bands in the three band LIF spectrum of
normal CV tissue). Measurements were not conducted on the lowest intensity band because
of limited equipment time (the first two experiments were conducted over a time period
of ca. 6 hours each). Decay constants derived from a tri-exponential function [i.e. a
weighted sum of exponential terms: \( A_1 \exp(-t/\tau_1) + A_2 \exp(-t/\tau_2) + A_3 \exp(-t/\tau_3) \)] fit to
the time-resolved fluorescence decay curves are listed in Table 15. The similarity of these
time constants for the two bands indicates that the origin of the emission is the same.
Furthermore, these constants resemble fluorescence decay constants of flavins for similar
\( \lambda_{\text{ex}} \).[98] Although histologic studies have suggested that the structural proteins elastin and
collagen are responsible for the fluorescence,[28] we suspect otherwise. Elastin and collagen
do not absorb at \( \lambda_{\text{ex}} = 457.9 \) nm (i.e. \( \lambda_{\text{ex}} \) for these studies) or 476.0 nm (\( \lambda_{\text{ex}} \) for Reference
28). On the other hand, flavoproteins in aqueous solution (cited above in Reference 96
as the likely fluorophore in cellular fluorescence) strongly absorb these \( \lambda_{\text{ex}} \), having an
absorption band peaking at \( \lambda \approx 450 \) nm.[99]
Figure 66. UV/VIS/NIR TOTAL ATTENUATION SPECTRUM OF 100μm THICK NORMAL AORTA SECTION.
UV/Vis/NIR absorption spectrum:
human normal aorta: 100 µm
Figure 67. SUPERIMPOSED LASER-INDUCED FLUORESCENCE AND UV/VIS/NIR TOTAL ATTENUATION SPECTRA: NORMAL AORTA.
Figure 68. LASER-INDUCED FLUORESCENCE SPECTRA: NEAR-\textit{in vivo} HEART TRANSPLANT CORONARY ARTERY TISSUE.
coronary artery transplant tissue

wavenumbers (cm\(^{-1}\))
Table 15  TIME-RESOLVED FLUORESCENCE DECAY CONSTANTS FOR NORMAL AORTA: $\lambda_{ex} = 458$ nm.

<table>
<thead>
<tr>
<th>Emission nm</th>
<th>$A_1$ (±0.1)</th>
<th>$A_2$ (±0.03)</th>
<th>$A_3$ (±0.01)</th>
<th>$\tau_1$ (±0.1)</th>
<th>$\tau_2$ (±0.2)</th>
<th>$\tau_3$ (±0.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>516</td>
<td>0.8</td>
<td>0.35</td>
<td>0.04</td>
<td>0.7</td>
<td>3.3</td>
<td>9.7</td>
</tr>
<tr>
<td>553</td>
<td>1.0</td>
<td>0.37</td>
<td>0.06</td>
<td>0.7</td>
<td>3.4</td>
<td>9.1</td>
</tr>
</tbody>
</table>

4.2.3.3 Fluorescence Depth-Proﬁling: Sample Thin Sections

Figure 69 shows spatially-resolved LIF spectra for normal aorta. A specimen with a thickness of ca. 1 mm was sectioned into three slabs of approximately 300 $\mu$m thickness each using a cryostat/microtome. The origin of each slab within the original specimen is indicated in the figure. The LIF spectra of the slab closest to the surface (probably consisting of both the intimal and medial layers) resembled the LIF of normal CV tissue. The LIF spectra of the central slab (probably consisting of only the medial layer) had almost no structure. The LIF spectra of the outer slab (probably consisting of medial and adventitial layers) had the most structure fluorescence of the three. The thickness of ca. 300 $\mu$m was chosen because thinner sections (typically, ≤ 150 $\mu$m) exhibited little, if any, structured fluorescence, indicating a pathlength dependence which reabsorption would be expected to exhibit (cf. Section 4.2.3.5). The spatial dependence of the LIF spectra as a function of section depth suggests hemoglobin diffusion (i.e. contamination) of the outer layers of the arterial wall.

4.2.3.4 Fluorescence Structure Bleaching: Saline Immersion

Panel 1 of Figure 70 shows the LIF spectrum of a normal aorta specimen. To mimic physiological conditions, this specimen was immersed in a Kreb’s solution (a 0.9% saline solution including physiological concentrations of various electrolytes present) at a temperature of ca. 37 °C (i.e. normal body temperature) for a time period of 2 hours. Panel 2 shows the LIF spectrum collected at the same position on the specimen as used for Panel 1. Not only has the LIF structure almost disappeared, but the LIF intensity has
increased. This indicates that this procedure dissolved the hemoglobin (i.e. the reabsorption species) out of the specimen. The reverse experiment of soaking the tissue in blood to reintroduce the three band structure to the LIF spectrum was not performed.

4.2.3.5 Fluorescence Pathlength Dependence: Optical Fiber Penetration

This set of experiments, coupled with the results of the UV/Vis/NIR absorption experiments (cf. Section 4.2.2), proved hemoglobin reabsorption to be the origin of the structured LIF observed in normal aorta samples. The apparatus used for these experiments is described in Section 2.3.2.1.3 and depicted in Figure 21 (both in Chapter 2). LIF spectra of a normal aorta sample (thickness: ca. 1.25 mm) were collected as a function of volume element to determine any pathlength dependence which reabsorption phenomena should exhibit. Figure 71 shows LIF spectra as a function of optical fiber penetration (i.e. increasing penetration decreases the volume element pathlength) into the sample. Each spectrum represents an additional sample penetration of ca. 250 μm. The difference between the sample thickness (i.e. 1.25 mm) and the optical fiber penetration depth is the pathlength of the fluorescence volume element being measured.

This series of LIF spectra indicates clearly that the structure of the three band fluorescence in normal aorta is due to reabsorption. Panel 1 of Figure 72 shows a LIF spectrum of the same specimen with the optical fiber "drill" retracted to the ca. 750 μm sample depth position (corresponding to the middle LIF spectra in Figure 71) to demonstrate that changes in the five LIF spectra shown in Figure 71 were not time-dependent phenomena (i.e. this spectrum was recorded at the conclusion of recording the five spectra). Panel 2 shows the LIF spectrum of the normal specimen used in these experiments at a surface point almost directly "beneath" the optical fiber penetration "hole", recorded with the apparatus in the normal off-axis excitation configuration. The relative peak heights of this spectrum closely resembles those of the LIF spectrum recorded at the ca. 500 μm depth, which may indicate the approximate depth dimension of the fluorescence volume element being sampled in the off-axis excitation configuration.
Figure 69. LASER-INDUCED FLUORESCENCE SPECTRA: SPATIAL DEPENDENCE ON SAMPLING DEPTH FOR NORMAL AORTA.
300 μm thick section
(50 μm - 350 μm deep)

300 μm thick section
(375 μm - 675 μm deep)

300 μm thick section
(700 μm - 1000 μm deep)
Figure 70. LASER-INDUCED FLUORESCENCE SPECTRA: EFFECT OF SALINE IMMERSION AT 37°C.
before soaking in 37 °C
Kreb's solution

after soaking in 37 °C
Kreb's solution
Figure 71. LASER-INDUCED FLUORESCENCE SPECTRA: FLUORESCENCE VOLUME ELEMENT PATHLENGTH DEPENDENCE (OPTICAL FIBER PENETRATION EXPERIMENT).
Figure 72. LASER-INDUCED FLUORESCENCE SPECTRA: CONTROL SPECTRA FOR OPTICAL FIBER PENETRATION EXPERIMENT.
$\Delta x \approx 750 \mu m$

control LIF spectrum
4.3 Conclusions

Although the most promising fluorescence feature of in vitro cardiovascular tissue studies ultimately proved to be a post-mortem artifact, these studies have contributed much to the development of remote spectroscopic diagnostic techniques for atherosclerosis and the understanding of tissue optical properties in the visible spectral region. The hypothesis under which we set out remains viable. One should be able to differentiate spectroscopically between two such chemically dissimilar tissue types as normal and atherosclerotic cardiovascular tissue. Certainly, future studies, benefitting from these studies, should concentrate on using only fresh transplant tissues for all in vitro experiments to minimize the presence of post-mortem artifacts. Thorough excitation and corresponding emission studies should be conducted at all wavelengths in the ultraviolet and visible. Studies currently exploring excitation wavelengths in the ultraviolet spectral region have reported initial success in differentiating normal from atherosclerotic in vitro cardiovascular tissue. However, as the experience of these studies has shown, in vivo experiments would appear essential to confirm any spectroscopic results involving in vitro biological tissues.
5 Bibliography


44. "Helios cw HF/DF Chemical Lasers," Helios Inc.

45. "Zero Order Grating Coupler," Helios Inc.


51. W.Q. Jeffers (personal communication).
53. J.D. Goosey (personal communication).
70. D. Sliney and M. Wolbarsht, Safety with Lasers and Other Optical Sources (Plenum, New York, 1980) Section 2.16.


6 APPENDICES
6.1 Houston Advanced Research Center CW HF/DF Chemical Laser Test Resource
The Houston Area Research Center (HARC) cw HF/DF Chemical Laser Test Resource

The HARC cw hydrogen fluoride (HF)/deuterium fluoride (DF) chemical laser test resource includes a cw HF/DF chemical laser system, a test chamber, and beam, target, and plume diagnostic instrumentation equipped with a realtime computer data acquisition and processing system. The facility has been used to study cw HF/DF chemical laser interactions with more than 120 different materials in order to analyze their intrinsic ablation performance and to measure their time-resolved responses and properties under well-characterized laser irradiation conditions. Fundamental studies of laser/materials interactions have been performed in order to obtain mechanistic understanding of the physical and chemical processes that produce the phenomenology and effects associated with thermal coupling and thermochemical ablation of carbon-based and other materials irradiated by cw infrared lasers at irradiances up to 200 kW/cm². In addition, the facility has been used to complete screening measurements on candidate laser hardened materials in preparation for larger scale laser effects testing.

Figure 1 shows a typical experimental configuration. The basic apparatus components are:

1) a cw HF/DF chemical laser system (Helios Model CLIV) that produces up to 150 W multiline output in the 2.6-3.1 μm (HF) and 3.7-4.1 μm (DF) spectral regions [the system also produces up to 40 W single line output in grating-tuned operation],

2) an optical delivery system that is suitable for irradiating samples with excellent control of beam position, irradiance, and time on target,

3) laser beam diagnostics that characterize wavelengths, short term and long term power levels, beam profiles, and irradiance distributions on target,

4) an evacuable sample chamber that incorporates a carousel with sixteen samples and accurate positioning controls; the chamber permits experiments in vacuum and in controlled atmospheres and has several viewing ports together with an internally mounted integrating sphere reflectance measurement system,

5) a computer controlled laser probe absorption spectrometer system that provides quantitative time-resolved measurements on plume species,

6) additional target and plume diagnostics instrumentation (an optical multichannel analyzer for plume emission spectroscopy, optical pyrometers for front and back surface temperature measurements, a burnthrough detector, a microbalance for determination of mass losses, videotape and fast framing cameras and recorders, a quadrupole mass spectrometer for analysis of ablated species, and a photomicrography system), and

7) fast (up to 100 MHz bandwidth) transient digitizers and digital oscilloscopes plus a minicomputer system for experimental control and data acquisition and processing (for sixteen channels of information with a 40 kHz/channel acquisition rate).

The experimental program has led to the identification of new high performance materials and their important properties and to the development of mechanistic models that guide the design of superior laser hardened and/or oxidation resistant materials.

For further information, contact Dr. Michael Berry at (713) 363-7970.
HARC cw HF/DF Chemical Laser Test Resource: Statement of Capabilities

The HARC continuous wave (cw) hydrogen fluoride (HF) and deuterium fluoride (DF) chemical laser test resource can be used to:

1) Irradiate samples with very well-characterized cw HF/DF chemical laser beams with a near-Gaussian beam profile, peak irradiances up to 200 kW/cm², and peak powers up to 150 W;

2) Irradiate samples for fixed and well-measured periods of time (10 ms up to minutes) in vacuum or under controlled atmospheres (air, inert gas, etc.) at pressures up to 1 atmosphere;

3) Carry out time-resolved measurements of target responses and laser/materials interaction phenomena as functions of laser parameters (irradiance, spot size, angle of incidence, etc.), sample geometry, and atmosphere; these time-resolved measurements include:
   - A) burnthrough time (and times for partial burnthroughs),
   - B) front and back surface temperatures,
   - C) front surface reflectance at HF/DF laser wavelengths and (optionally) at other infrared, near infrared, visible, and ultraviolet wavelengths, and
   - D) plume absorptions and/or emissions due to atomic, molecular, particulate, and plasma species;

4) Record these time-resolved data with transient digitizers and a fast minicomputer system for rapid analysis and processing;

5) Obtain videotape and fast framing camera movies of target responses during laser irradiation;

6) Measure mass losses, morphological changes, and other post-irradiation properties of samples; and

7) Obtain photomicrographic records of pre- and post-irradiated materials.

Other optional experiments that can be performed include irradiation at CO₂, excimer, and other wavelengths (including the overtone HF chemical laser near λ = 1.3 μm), irradiation by lasers with pulsed waveforms, and analyses of ablated species by mass spectrometry and by matrix isolation infrared spectroscopy.

Many experimental capabilities are mobile for use at other laser test facilities.

The attached description on "The Houston Area Research Center (HARC) cw HF/DF Chemical Laser Test Resource" provides details on the experimental apparatus.

For further information, contact Dr. Michael Berry at (713) 363-7970.
Continuous wave (cw) hydrogen fluoride (HF)/deuterium fluoride (DF) laser/materials interaction apparatus. A cw HF/DF chemical laser irradiates samples contained within a vacuum chamber. Portions of the laser beam are directed by a beamsplitter BSI and a wedged chamber window onto beam diagnostics equipment (a power meter, a fast response power monitor, and a fast response beam profile monitor). A fast acting shutter S controls irradiation times on target. An optical delivery system (comprising attenuators, beam steering mirrors M1 and M2, and a focusing lens) provides accurately positioned beams on target with controlled and measured irradiance distributions. An alignment scope facilitates accurate positioning of the focused laser beam onto the target surface. Realtime target responses are monitored with time-resolved target diagnostics instrumentation [optical pyrometers for front and back surface temperature measurements, a burnthrough detector, an integrating sphere with a filter plus fast response detector for reflectance measurements, camera systems (both videotape and fast framing cameras, not shown), and an optical multichannel analyzer for target and plume emission measurements]. Signals from the beam, target, and plume diagnostics are digitized, recorded, and processed using transient digitizers, digital oscilloscopes, and a minicomputer system.

A laser probe absorption spectrometer is also combined with the laser/materials interaction apparatus to provide spectroscopic measurements on plume vapor and plasma species. In the bottom part of the figure, a cw ion laser pumps a single frequency tunable cw ring dye laser system (Coherent, Inc. Model 699–21) which produces spectral outputs over the visible/near infrared (λ = 400–900 nm wavelength) spectral regions. The dye laser system can also be combined with intracavity (not shown) and external second harmonic (2ω) generation crystals to produce tunable ultraviolet (λ = 200–400 nm wavelength) spectral outputs. The visible spectral region of the cw dye laser systems is scanned electronically over a 30 GHz bandwidth and is passed through an electro-optical modulator (a "noise eater", not shown) to obtain stable low noise probe signals. A reference cavity within the dye laser system is used to verify single frequency operation during scans. The low noise scanned (or fixed frequency) dye laser probe beam is directed toward the vacuum chamber by the beam discriminator (used to isolate the frequency doubled beam from the fundamental dye laser beam), focused to a narrow beam waist in front of the target surface and within the ablation plume by lens L, and detected by a filter and/or small monochromator plus fast photodiode PD1 combination. Beamsplitter BS2 directs a portion of the probe beam to photodiode PD2 for power and ratioed absorption measurements. The dye laser output wavelength is calibrated by monitoring tellurium (Te) or iodine (I₂; not shown) cell absorption signals detected by photodiode PD3 and by using an interferometric measurement system (wavemeter). The probe beam can be positioned accurately within the ablation plume for spatial resolution of plume absorptions as functions of distance from the sample surface and of distance from the plume centerline (i.e., the axis of cylindrical symmetry). The laser probe absorption spectrometer and all the detection electronics are computer controlled by a LSI-11/Camac-based system.

Various fixed frequency probe lasers are also used to obtain quantitative measurements on atomic, molecular, particulate, and plasma species contained in the laser induced ablation plumes.
cw HF/DF LASER TEST RESOURCE
6.2 SPEX.BAS
This program transfers single data files from the SPEX DATAMATE to the IBM PC via the RS232 port. The first two lines of any SPEX file consist of file parameters. Line 1 contains the title of the file as entered on the DATAMATE. Line 2 contains the number of points, the start scan position, the scan increment, the laser line, the data type, and some unidentified characters. However, those parameters are all contained in a single string. Thus, in the first part of subroutine 10000, each individual parameter is separated from the string. (A detailed description of the sequence of information within the first two lines can be found in the SPEX DATAMATE INSTRUCTION MANUAL, page 3-48.) In the second part of subroutine 10000, the rest of the SPEX file (i.e. the spectral intensity data points) is then transferred to the array STORE$(n)$. In subroutine 20000, (x,y) or (scan position, spectral intensity) data pairs are generated based on the above parameters and STORE$(n)$. The data pairs along with the title of the file are then stored on disk in a user-specified file. Note that even though all SPEX files are transferred in terms of absolute wavenumbers, this program will automatically convert to delta wavenumbers if the file consists of a Raman spectrum. This is done by checking for the presence of a laser line. That is, fluorescence spectra are scanned in absolute wavenumbers on the DATAMATE so no laserline is present.

KEY OFF:CLOSE
ON ERROR GOTO 30000
DIM STORE$(5005)  'be sure to change line 10700 also if you change the size of array STORE

1000 CLS
GOSUB 10000
BEEP
GOSUB 20000
IF (REPEATS="Y" OR REPEATS="y") THEN GOTO 1000
GOTO 30000

10000 'open RS232 port and receive/store data transmission from SPEX

PRINT"Please begin transmitting SPEX data file."
PRINT"(enter 'TRA,F<filename>' on the DATAMATE)"
OPEN "COM1:9600,N,8,1,CS,DS,CO,LF" AS #1
INPUT #1,STORES(1)
INPUT #1,STORES(2)
TITLELENGTH=LEN(STORES(1)) - 4
TITLES=MIDS(STORES(1), 2, TITLELENGTH)
NUMPTS=VAL(MIDS(STORES(2), 2, 5))
STARTW=VAL(MIDS(STORES(2), 7, 9))
INCREMENT=VAL(MIDS(STORES(2), 16, 9))
LASERLINE=VAL(MIDS(STORES(2), 25, 9))

10700 IF NUMPTS>5005 THEN GOTO 10800

PRINT "Data transmission in progress."
PRINT "File being received is: ", TITLES
PRINT
CLOCK=0: TICK=6: TIME=NUMPTS \ TICK
LOCATE 8,15:PRINT TIME
LASTI=NUMPTS+2
FOR I=3 TO LASTI
INPUT #1, STORES(I)
STORES(I)=MIDS(STORES(I), 3, 12)
CLOCK=CLOCK +1
IF CLOCK=TICK THEN TIME=TIME -1: LOCATE 8,15: PRINT TIME: CLOCK=0
NEXT I
CLOSE
CLS
GOTO 10900

10800 'Error message that file is too large
CLS
PRINT "The file you are trying to transfer is too large."
PRINT "You will need to modify this program by changing the"
PRINT "dimension of the array STORE(n) to n =", NUMPTS +2,".".
PRINT "You will also need to modify the file size filter in"
PRINT "line 10700 (i.e. 'IF NUMPTS > size of array STORE')."
END

10900 RETURN

20000 'Store data file on disk as per user and check to continue
FILES
PRINT: PRINT
PRINT "Transmission completed. File is ready for disk storage."
PRINT "File transferred was: ", TITLES
PRINT
INPUT "Do you want to store this file on disk? (Y/N):", REPLYS
IF NOT (REPLYS = "Y" OR REPLYS = "y") THEN GOTO 20500
INPUT "Enter the name to store this file under: ", FILES
PRINT "File storage to disk in progress."
PRINT
OPEN FILES FOR OUTPUT AS #2
PRINT #2, TITLES
IF LASERLINE = 0.00 THEN CHANGESIGN = -1 ELSE CHANGESIGN = 1
FOR J = 1 TO NUMPTS
    WAVELENGTH = LASERLINE - CHANGESIGN * (STARTWAVE - ((J - 1) * INCREMENT))
    PRINT #2, USING "#.#####.#" " " WAVELENGTH;
    PRINT #2, USING "#.#######" " " VAL(STORE$(J + 2));
NEXT J
CLOSE
PRINT "File storage completed."
PRINT
20500 INPUT "Transfer and/or store another file? (Y/N): ", REPEATS
20900 RETURN

30000 'exit program
CLOSE
PRINT
PRINT "Exiting program."
END

C:\GLV\DISKDUMP>
6.3 SPX1PLOT.BAS
REM STITLE: 'SPX1PLOT.BAS • Plotting and Graphing ...
REM SLINESIZE:120 SPAGESIZE:55

'original core program: PLOTTING.BAS
'K. V. Reddy, 03 May 1984
'Does graphics on Hercules board and HP7470A plotter
'Draws 2 curves

'present modified program: SPX1PLOT.BAS
'modified beginning 18·JUL·85
'By J. Valderrama and R. Chin
'To plot and graph data transmitted from SPEX RAMALOG microcomputer with program SPEX.BAS

DEFINT I·N,G
DIM X(2100),Y(2100),Z(2100),DAT(2,2100),TITLESS(3)
REM X ARRAY IS HORIZONTAL, Y ARRAY VERT. PEN 1, Z ARRAY VERT. PEN 2
GRFMTS="L"
NCURV=1
NXTIC=S
NYTIC=S
XV=1
YV=2
NONUN=1
CALL GNOME
KEY OFF
ON ERROR GOTO 20000

GOSUB 1000

230 LINE INPUT="PLT> ",REPS
PARMS=LEFTS(REPS,2)
PARMS=MIDS(REPS,3,2)
L=LEN(REPS)
L1=INSTR(REPS,"")
XVALS=RIGHTS(REPS,L-L1)
XVALS="0"
XVALS=="0"
L2=LEN(XVALS)
IF L2<1 THEN GOTO 300
L3=INSTR(XVALS,"",""")
IF L3<1 THEN XVALS=XVALS
IF L3<1 THEN GOTO 300
XVALS=LEFTS(XVALS,L3-1)
XVALS=RIGHTS(XVALS,L2-L3)

'PROMPT
'GET COMMAND CODE
'2ND COMMAND CODE
'GET LENGTH OF REPLY
'FIND THE "=" SIGN
'HERE'S THE PARAMETERS
'ZERO THESE PARMS
'GET LENGTH OF PARM STR
'NO PARMS ENTERED
'FIND THE COMMA
'NO SECOND PARM
'#1 PARM
'#2 PARM
E1 = VAL(XVAL1S)
E2 = VAL(XVAL2S)

IF ABS(VAL(PARM2S)) > 0 THEN E1 = VAL(PARM2S); E2 = VAL(XVAL1S); E3 = VAL(XVAL2S)

IF PARM1S = "LI" THEN GOSUB 1000; PFLG = 1 'LIST REQUESTED
IF PARM1S = "TI" THEN GOSUB 3000; PFLG = 1 'GET TITLE INFO
IF PARM1S = "CL" THEN CALL CLRSCR; LOCATE 1,1; PFLG = 1
IF PARM1S = "PL" THEN GOSUB 10000; PFLG = 1 'GO PLOT
IF PARM1S = "XM" THEN GOSUB 100000; PFLG = 1 'NUMBER OF CURVES
IF PARM1S = "GS" THEN XINCH = E1; YINCH = E2; PFLG = 1 'PLOT SIZE

LOCATE 1,1
CALL CLRSCR
PRINT "2nd Filespec:"; FILENAMES
PRINT "Filespec:"; DATAFLES
PRINT "X-variable:"; XV
PRINT "Y-variable:"; YV
PRINT "Number of curves:"; NCURV

LOCATE 1,30: PRINT "Title:"; TITLES
LOCATE 2,30: PRINT "X-axis Label:"; XLABELS
LOCATE 3,30: PRINT "Y-axis Label:"; YLABELS
LOCATE 4,30:PRINT"Graph Format:";GRFMT$ 
LOCATE 1,60:PRINT"HP7470A:" 
LOCATE 2,60:PRINT"Graph Size:" 
LOCATE 3,60:PRINT"Height:";YINCH 
LOCATE 4,60:PRINT"Width:";XINCH 
LOCATE 7,1:PRINT"Scaling (A/M):";SCLS$ 
PRINT"XMIN:";XMIN 
PRINT"XMAX:";XMAX 
PRINT"YMIN:";YMIN 
PRINT"YMAX:";YMAX 
RETURN 

3000 LINE INPUT"Enter 3rd line of title for plot:";TITLE$(3) 
RETURN 

3200 LINE INPUT"Enter X-axis Label:";XLABEL$ 
RETURN 

3400 LINE INPUT"Enter Y-axis Label:";YLABEL$ 
RETURN 

3600 'SUBROUTINE SCALING 
INPUT"XMIN,XMAX,YMIN,YMAX:";XMIN,XMAX,YMIN,YMAX 
SCLS="M" 
RETURN 

3700 'Subroutine to scale X axis only 
IF PARM2="N" THEN INPUT"XMIN:";XMIN:GOTO 3790 
IF PARM2="AX" THEN INPUT"XMAX:";XMAX:GOTO 3790 
INPUT"XMIN,XMAX:";XMIN,XMAX 
3790 SCLS="M" 
RETURN 

3800 'Subroutine to scale Y axis only 
IF PARM2="N" THEN INPUT"YMIN:";YMIN:GOTO 3890 
IF PARM2="AX" THEN INPUT"YMAX:";YMAX:GOTO 3890 
INPUT"YMIN,YMAX:";YMIN,YMAX 
3890 SCLS="M" 
RETURN 

10000 'CRT Graphics 
IF PARM2="A" OR PARM2="A*" THEN SCLS="A" 
IF SCLS="M" THEN GOTO 10020 
REM DETERMINE THE ARRAY MIN AND MAX VALUES 
XMIN=1E+30:XMAX=1E+30 
YMIN=1E+30:YMAX=1E+30 
ZMIN=1E+30:ZMAX=1E+30
FOR J=1 TO NPTS
IF X(J)<XMIN THEN XMIN=X(J)
IF X(J)>XMAX THEN XMAX=X(J)
IF Z(J)<ZMIN THEN ZMIN=Z(J)
IF Z(J)>ZMAX THEN ZMAX=Z(J)
IF Y(J)<YMIN THEN YMIN=Y(J)
IF Y(J)>YMAX THEN YMAX=Y(J)
NEXT J
NTCURV=NTCURV
WHILE NTCURV<>2
IF ZMAX>YMAX THEN YMAX=ZMAX
IF ZMIN<YMIN THEN YMIN=ZMIN
NTCURV=0
WEND
10010 'Determine the Ranges
XMIN=0.95*XMIN : XMAX=1.05*XMAX
YMIN=0.95*YMIN : YMAX=1.05*YMAX
10020 XRANGE = XMAX-XMIN
YRANGE = YMAX-YMIN
NYTIC=1 : NXTIC=5
XTIC=XRANGE/NXTIC
YTIC=YRANGE/NYTIC
REM Start sending plot to crt
CLS
CALL GMODE
CALL CLRSCR
GXMIN=95:GXMAX=695:GYMIN=315:GYMAX=15
GX1=GXMIN:GY1=GYMIN
GY1=GY1+7:GY2=GY1+7
XSF=XRANGE/XRANGE : YSF=YRANGE/YRANGE
FOR GX=GXMIN TO GXMAX STEP GX1
CALL MOVE(GX,GY1)
CALL DLINE(GX,GY1)
NEXT GX
CALL PLOT (GXMIN,GYMIN)
GYPREV=GYMIN : GX=GXMIN + 10
FOR GY=GYMIN TO GYMAX STEP GY1
CALL MOVE(GXMIN,GY1)
CALL PLOT (GXMIN,GY1)
NEXT GY
NEXT GY
   CALL PLOT (GXMIN, GYMAX)
   GYD = GYMAX + 7
   FOR GX = GXMIN TO GXMAX STEP GXTIC
      CALL MOVE(GX, GYMAX): CALL DLINE(GX, GYD)
      GX1 = GX + GXTIC
      IF GX1 > GXMAX THEN GX1 = GXMIN
      CALL MOVE(GX, GYMAX): CALL DLINE(GX1, GYMAX)
   NEXT GX
   CALL PLOT(GXMAX, GYMIN)
   GXL = GXMIN - 10
   CALL MOVE(GXMAX, GYMIN): CALL DLINE(GXL, GYMIN)
   GYPREV = GYMIN
   FOR GY = GYMIN TO GYMAX STEP GYTIC
      CALL MOVE(GXMAX, GYPREV)
      CALL DLINE(GXMAX, GY)
      CALL MOVE(GXMAX, GY): CALL DLINE(GXL, GY)
      GYPREV = GY
   NEXT GY

'Begin plotting data points
' Check for the graph format, if lines are req. goto 10120,
' if both lines & symbols are req. goto 10140
' if none specified just plot symbols
   IF GRFMTS = "L" OR GRFMTS = "l" THEN GOTO 10120
   IF GRFMTS = "SL" OR GRFMTS = "sl" THEN GOTO 10140
   IF GRFMTS = "LS" OR GRFMTS = "ls" THEN GOTO 10140
' Plot with lines that connect the data points
   FOR J = 1 TO NPTS
      X = X(J): Y = Y(J)
      IF Y > YMAX THEN Y = YMAX
      GX = XSF * (X - XMIN) + GXMIN
      GY = YSF * (Y - YMIN) + GYMIN
      IF GX < GXMIN OR GX > GXMAX THEN 10100
      IF GT > GYMIN OR GT < GYMAX THEN 10100
      GYP = GY - 3: GYD = GY + 3: GXL = GX - 5: GXR = GX + 5
      CALL MOVE(GX, GYP): CALL DLINE(GX, GYM)
      CALL MOVE(GXL, GY): CALL DLINE(GXR, GY)
   NEXT J
   IF NCURV = 2 THEN GOTO 10132
   GOTO 10200

'Plot with lines that connect the data points
   FOR J = 1 TO NPTS
      X = X(J): Y = Y(J)
      IF Y > YMAX THEN Y = YMAX
      GX = XSF * (X - XMIN) + GXMIN
      GY = YSF * (Y - YMIN) + GYMIN
      IF GX < GXMIN OR GX > GXMAX THEN 10130
   NEXT J

   IFPOINT = 0  'Init. first point plotted
   FOR J = 1 TO NPTS
      X = X(J): Y = Y(J)
      IF Y > YMAX THEN Y = YMAX
      GX = XSF * (X - XMIN) + GXMIN
      GY = YSF * (Y - YMIN) + GYMIN
      IF GX < GXMIN OR GX > GXMAX THEN 10130
IF GY>GYMIN OR GY<GYMAX THEN 10130
IF IFPOINT=0 THEN CALL MOVE(GX,GY) : IFPOINT=1
CALL DLINE(GX,GY)

10130 NEXT J

'Plot 2nd curve

10132 NTCURV=NTCURV
WHILE NTCURV=2
IFPOINT=0 'Init. first point plotted
FOR J=1 TO NPTS
X=X(J) : Y=Y(J)
IF Y>YMAX THEN Y=YMAX
GX=XSF•(X•XMIN)+GXMIN
GY=YSF•(Y•YMIN)+GYMIN
IF GX<GXMIN OR GX>GXMAX THEN 10134
IF GY>GYMIN OR GY<GYMAX THEN 10134
IF IFPOINT=0 THEN CALL MOVE(GX,GY) IFPOINT=1
CALL DLINE(GX,GY)
10134 NEXT J
NTCURV=0
WEND
GOTO 10200

10140 'Plot both symbols and lines
IFPOINT=0 'Init. first point plotted
FOR J=1 TO NPTS
X=X(J) : Y=Y(J)
IF Y>YMAX THEN Y=YMAX
GX=XSF•(X•XMIN)+GXMIN
GY=YSF•(Y•YMIN)+GYMIN
IF GX<GXMIN OR GX>GXMAX THEN 10150
IF GY>GYMIN OR GY<GYMAX THEN 10150
IF IFPOINT=0 THEN CALL MOVE(GX,GY) IFPOINT=1
CALL DLINE(GX,GY)
GYUP=GY-3 : GYDN=GY+3 : GXLFT=GX-5 : GXRT=GX+5
CALL MOVE(GX,GYUP) CALL DLINE(GX,GYDN) '•make '+' symbol
CALL MOVE(GXLFT,GY) CALL DLINE(GXRT,GY)
CALL MOVE(GX,GY)
10150 NEXT J

10200 'Done with plotting data points

'Plot Fitted Curve
GXSTEP=GXMAX-GXMIN
XSTEP=(XMAX-XMIN)/GXSTEP
FOR J=0 TO GXSTEP
X=XMIN+XSTEP*J
Y=0
FOR K=1 TO N
Y=Y+COEFF(K)•(X^*(K-1))
NEXT K
REM Label y-axis units
FOR J = 0 TO NYTIC
    Y = YMIN + YTIC * J
    GY = YRANGE / YRANGE * (Y - YMIN) + GYMIN
    YS = STRS(Y) : NCCHARX = LEN(YS)
    NE = 0 : NE = INSTR(YS, "E") : KNE = NE - 1 : IF KNE > 5 THEN KNE = 5
    WHILE NE > 0
        YNS = 0.00 : MID$(YNS, 1, KNE) = MID$(YS, 1, KNE)
        YNS = YNS + RIGHTS(YS, NCCHARX - NE + 1) : YS = YNS : NCCHARX = LEN(YS)
        NE = 0
    WEND
    GX = GXMIN - 9 * (NCCHARX - .5)
    GY = GY/5
    IF Y = YMIN THEN GY = GY - 5
    CALL TEXT8(GX, GY, Y$)
NEXT J

REM: LABEL THE X-AXIS UNITS
GY = GMIN + 11
FOR J = 0 TO NXTIC
    X = XMIN + XTIC * J
    GX = XSF * (X - XMIN) + GXMIN
    XS = STRS(X) : NCCHARX = LEN(XS)
    NE = 0 : NE = INSTR(XS, "E") : KNE = NE - 1 : IF KNE > 5 THEN KNE = 5
    WHILE NE > 0
        XNS = 0.00 : MID$(XNS, 1, KNE) = MID$(XS, 1, KNE)
        XNS = XNS + RIGHTS(XS, NCCHARX - NE + 1) : XS = XNS : NCCHARX = LEN(XS)
        NE = 0
    WEND
    IF J = NXTIC THEN 10300
GOTO 10310
10300 IF NCCHARX > 2 THEN GX = GX - (9 * (NCCHARX - 2)) / 3
    IF NCCHARX < 3 THEN GX = GX - (9 * (NCCHARX - 1)) / 4
GOTO 10320
10310 GX = GX - (9 * (NCCHARX - 1)) / 2
10320 CALL TEXT8(GX, GY, XS)
NEXT J

REM: LABEL THE PLOT TITLE, XLABEL, YLABEL
' Label Title
NCHAR = LEN(TITLES) : IF NCHAR = 0 THEN TITLES$ = " "
NCHAR = INT(LEN(TITLES$)) / 2
GY=GMMAX-4
GX=359-9-NCHAR%
CALL TEXTB(GX,GY,TITLES)
GX=550:D$=DATES: CALL TEXTB(GX,GY,D$)
’Label X-axis
NCHAR=LEN(XLABELS) : IF NCHAR=0 THEN XLABELS=" =
NCHAR%=INT((LEN(XLABELS))/2)
GY=343
GXo:359-9-NCHAR%
CALL TEXTB(GX,GY,XLABELS)
’Label Y-axis
NCHAR=LEN(YLABELS) : IF NCHAR=0 THEN YLABELS=" =
NCHAR%= (LEN(YLABELS))
IF NCHAR%=22 THEN NCHAR%=22
GY=174-(NCHAR%*7)
FOR J%=1 TO NCHAR%
GX=0
GY=GY+14
Y$= MIDS(YLABELS,J%,1)
CALL ieliB(GX,GY,YS)
NEXT JX
RETURN

‘Interact with user to check his satisfaction
GX=5 : GY=343 : PROMPTS="Is Plot Ok(y/n)?
CHNGXYS="Enter new XMIN,XMAX,YMIN,YMAX: 
HPPROMPTS="Do you want to plot on HP-7470A(y/n)?
CALL TEXTB(GX,GY,PROMPTS)
D$=INPUTS(1)
’WHILE D$=" : D$=INKEYS : WEND
IF D$="Y" OR D$="y" THEN GOTO 10350
LOCATE 1,12: PRINT SPACES(66)
LOCATE 1,12 :PRINT CHNGXYS; INPUT XMIN,XMAX,YMIN,YMAX
GOSUB 10020
D$="=
10350 CALL TEXTB(GX,GY,HPPROMPTS)
D$=INPUTS(1)
’WHILE D$=" : D$=INKEYS : WEND
IF D$ = "Y" or D$="y" THEN GOSUB 11000
’Plot on HP-7470A
D$="=
10400 ‘Plot another set of data points, with filled Squares
WD%=10 : HT%=6
FOR J%=1 TO NPTS
GX=XSF*(X(J)-XMIN)+GXMIN
GY=YSF*(Z(J)-YMIN)+GYMIN
IF GX<GMIN OR GX>GMAX THEN 10420
IF GF>GYMIN OR GF<GYMAX THEN 10420
10420 NEXT J
RETURN

10500 'Plot Fitted Curve
GXSTEP=GXMAX·GXMIN
XSTEP=(XMAX·XMIN)/GXSTEP
FOR J=0 TO GXSTEP
X=XMIN+XSTEP·J
Y=SlopeofLine·X+Ordinatet Intercept
GX=XSF·(X-XMIN)+GXMIN
GY=YSF·(Y-YMIN)+GYMIN
IF GX<GXMIN OR GX>GXMAX THEN 10520
IF GY<GYMIN OR GY>GYMAX THEN 10520
CALL PLOT(GX,GY)
10520 NEXT J
RETURN

11000 'HP 7470A PLOTTER PROGRAM, NAME: HP7470SR.BAS
'Drives HP 7470A plotter that has serial interface
'Baud Rate = 9600 : Parity = none : Comm.Port = 1
'If you don't like to use comm.port 1, change line 350 appropr.
'X Array is Horizontal, Y Array is Vert. PEN 1
'Pass X() , Y() Arrays, and NPTS
GOTO 11010
REM Determine the X and Y Array Bounds
XMIN=+1E+30:XMAX=-1E+30
YMIN=+1E+30:YMAX=-1E+30
FOR J=1 TO NPTS
IF X(J)<XMIN THEN XMIN=X(J)
IF X(J)>XMAX THEN XMAX=X(J)
IF Y(J)<YMIN THEN YMIN=Y(J)
IF Y(J)>YMAX THEN YMAX=Y(J)
NEXT J
11010 'Determine Ranges
IHPRANGE=5000: INPMAX=5000: INPRANGE=IHPRANGE·INPMIN
XRANGE = XMAX-XMIN : YRANGE = YMAX-YMIN
XTIC=XRANGE/NXTIC : YTIC=YRANGE/NYTIC
XSF=INPRANGE/XRANGE : TSF=INPRANGE/YRANGE
INPXTIC=INT(XTIC*XSF): INPYTIC=INT(YTIC*TSF)
BUFS=CHR$(27)*$. B* : ES=CHR$(27)*$. E
OPEN "COM1:9600,N,8,1,CS,DS65000" AS #1
REM START SENDING DATA TO HP-7470A
INPMIN=INT((XSF·(XMIN-XMIN))+IPMIN)
INPMAX=INT((XSF·(XMAX-XMIN))+IPMAX)
INPMIN=INT((YSF·(YMIN-YMIN))+IPMIN)
INPMAX=INT((YSF·(YMAX-YMIN))+IPMIN)
INPMIN=STR$(INPMIN): INPMAX=STR$(INPMAX)
INPYMIN=STR$(INPYMIN): INPYMAX=STR$(INPYMAX)
Start Sending to the plotter

IF XINCH=0 THEN XINCH=8
IF YINCH=0 THEN YINCH=5.25
NXINCH=INT(XINCH*1000)+2000 : NYINCH=INT(YINCH*1000)+1500
PRINT #1,PLOTS
PLOTS="IN;SP1;1P 1300,750 ,"+STRS(NXINCH).-,-.STRS(NYINCH)+;•
PRINT #1,PLOTS

'Draw Axes
IF PARM2="NA" THEN GOTO 11030
PLOTS="PA;PU-.IHPXMINS+•,"+IHPYMIN+•,•;•:PRINT t1,PLOTS
FOR IHX=IHPXMIN TO IHPXMAX STEP IHPTIC
PLOTS="PD"+STRS(IHX)+•,+IHPYMIN+•;XT;":PRINT #1,PLOTS
NEXT IHX
FOR IHY=IHPYMIN TO IHPYMAX STEP IHPTIC
PLOTS="PA;PD .. IHPXMIN+•,+STRS(IHY)+•;YT;":PRINT #1,PLOTS
NEXT IHY
FOR IHX=IHPXMIN TO IHPXMAX STEP IHPTIC
PLOTS="PD"+STRS(IHX)+•,+IHPYMAX+•;XT;":PRINT #1,PLOTS
NEXT IHX
FOR IHY=IHPYMIN TO IHPYMAX STEP IHPTIC
PLOTS="PA;PD .. IHPXMAX+•,+STRS(IHY)+•;YT;":PRINT #1,PLOTS
NEXT IHY

11030 'Start Plotting Data Points
IF GRFMTS="S" or GRFMTS="s" THEN PLOTS="SM+•": GOTO 11060
IF GRFMTS="L" or GRFMTS="l" THEN PLOTS="SM;•
IF GRFMTS="SL" or GRFMTS="sl" THEN PLOTS="PU;SM+•
IF GRFMTS="LS" or GRFMTS="ls" THEN PLOTS="PU;SM;•
PRINT #1,PLOTS

'plot with lines or symbols and lines
IFPOINT=0
FOR J=1 TO NPTS
Y=Y(J):X=X(J)
IF Y>YMAX THEN Y=YMAX
IF X<XMIN OR X>XMAX THEN 11050
IF Y<YMIN OR Y>YMAX THEN 11050
IHX=INT(((XSF*(X-XMIN))+IHPMIN))
IHY=INT(((YSF*(Y-YMIN))+IHPMIN))
XS=STRS(IHX) : YS=STRS(IHY) : XYS=XS+•,\YS+•;
IF IFPOINT=0 THEN PLOTS="PU+XYS=•PU;":PRINT #1,PLOTS:IFPOINT=1
FOR
11050 NEXT J

11052 NTCURV=NCURV

WHILE NTCURV=2

PLOTS="PU;SP2;": PRINT #1,PLOTS
IFPOINT=0
FOR J=1 TO NPTS
X=X(J) : Y=Z(J)
IF X<XMIN OR X>XMAX THEN 11054
IF Y<YMIN THEN 11054
IF Y>YMAX THEN Y=YMAX
INX=INT(((XSF*(X-XMIN))+IHPMIN))
INT=INT(((YSF*(Y-YMIN))+IHPMIN))
XS=STRS(INX) : YS=STRS(INT) : XYS=XS"","YS=";"
IF IFPOINT=0 THEN PLOTS="PU+XY=PU;": PRINT #1,PLOTS: IFPOINT=1
PLOTS="PU+XY=": PRINT #1,PLOTS
NEXT J

PLOTS="": PRINT #1,PLOTS
NTCURV=0
WEND
PLOTS="PU;SM;": PRINT #1,PLOTS
GOTO 11100

11060 PRINT #1,PLOTS

'Plot symbols only
IFPOINT=0
FOR J=1 TO NPTS
X=X(J) : Y=Z(J)
IF X<XMIN OR X>XMAX THEN 11070
IF Y<YMIN THEN 11070
IF Y>YMAX THEN Y=YMAX
INX=INT(((XSF*(X-XMIN))+IHPMIN))
INT=INT(((YSF*(Y-YMIN))+IHPMIN))
XS=STRS(INX) : YS=STRS(INT) : XYS=XS"",Y=";"
IF IFPOINT=0 THEN PLOTS="PU+XY=PU;": PRINT #1,PLOTS: IFPOINT=1
PLOTS="PU+XY=": PRINT #1,PLOTS
NEXT J

PLOTS="PU;SM;": PRINT #1,PLOTS

IF FIT=1 THEN GOTO 11052

'Plot 2 nd curve
GOTO 11100

11070 NEXT J

PLOTS="PU;SM;": PRINT #1,PLOTS

IF FIT=1 THEN GOTO 11052

'Plot symbols only
IFPOINT=0
FOR J=1 TO NPTS
X=X(J) : Y=Z(J)
IF X<XMIN OR X>XMAX THEN 11074
IF Y<YMIN THEN 11074
IF Y>YMAX THEN Y=HMAX
IHX=INT(((XSF*(X-XMIN))+1HPMIN))
IHY=INT(((YSF*(Y-YMIN))+1HPMIN))
XS=STRS(IHX) : YS=STRS(IHY) : XYS=X+"a",Y+"a":
IF IFPOINT=0 THEN PLOTS="PU+XYS="PU;" :PRINT #1,PLOTS:IFPOINT=1
PLOTS="PU+XYS="PS;" :PRINT #1,PLOTS
11074 NEXT J
PLOTS="PU;SM;SP;" :PRINT #1,PLOTS
TCURV=0
WEND

11100 'Label Y-Axis Units in scientific notation
IF NONUH.0 THEN GOTO 11280 'graph axes but no labels
IF PARN2Sa"NA" THEN GOTO 11280 'graph without axes or labels
IF PARN2s"NS" THEN GOTO 11120 'non-scientific notation labels
PLOTS="SR .75,1.5;":PRINT #1,PLOTS 'set char size
FOR Y=YMIN+YTIC TO YMAX STEP YTIC
YNUM=Y/(10^INTY)
YNUM=INT(YNUM*100)/100 'get rid of floating point shit
IHY=INT((YSF*(Y-YMIN))+1HPMIN)
NCHAR=LEN(STRS(YNUM))
IF NCHAR=5 THEN ZEROS=CHRS(0)
IF NCHAR=4 THEN ZEROS=CHRS(48)
IF NCHAR=2 THEN ZEROS=CHRS(48)+CHRS(48)+CHRS(48)
NCHAR=8.5
PLOTS="PU+1HPXMINS=".STRS(IHY)+";CP=STRS(NCHAR)+",.-25;LB=STRS(YNUM)+ZEROS+CHRS(69)
PRINT #1,PLOTS
NEXT Y
GOTO 11150

11120 'Label Y axis in numeric (i.e. not scientific) notation
'determine length of longest y axis label for label indentation
MAXLEN=0
FOR Y=YMIN+YTIC TO YMAX STEP YTIC
IF ABS(Y)>1 THEN KYCINT=100 ELSE KYCINT=10000
Y=INT(Y*KYCINT)/KYCINT 'get rid of floating point shit
LENGTH=LEN(LEFTS(STRS(Y),6))
IF LENGTH>MAXLEN THEN MAXLEN=LENGTH
NEXT Y
NCHAR=-1*(MAXLEN+.5) 'set indentation for y axis tick label

'begin labelling y axis
FOR Y=YMIN+YTIC TO YMAX STEP YTIC
IF ABS(Y)>1 THEN KYCINT=100 ELSE KYCINT=10000
Y = CINT(Y * KYCINT) / KYCINT  'get rid of floating point shit

IHY = INT((YSF * (Y - YMINT)) + IHYMIN)

PLOTS = "PU" + IHYMIN + ";" + STRS(IHY) + ";" + CP" + STRS(NCHAR) + ";" + -.25; LB"+ LEFTS(STRS(Y), 6) + CHRS(3)
PRINT #1, PLOTS
NEXT Y

11150  'Label X-Axis units
IF NONUM = 0 THEN GOTO 11280
FOR X = XMIN TO XMAX STEP XTIC
IHX = INT((XSF * (X - XMIN)) + IHXMIN)
NCHAR = (LEN(STRS(X))) / 2
PLOTS = "PU" + STRS(IHX) + ";" + IHYMIN + ";" + CP" + STRS(NCHAR) + ";" - 1; LB"+ STRS(X) + CHRS(3)
PRINT #1, PLOTS
NEXT X

'Label the plot title, xlabel, ylabel
PLOTS = "SR 1.2, 2.2;"
PRINT #1, PLOTS
FOR I = 1 TO 3
PLOTS = "SP2; PU" + STRS(IHPXMIN + IHPRANGE / 2) + ";" + STRS(IHPYMAX + (.8 - I * .2) * 2000) + ";"
PRINT #1, PLOTS
TITLES = TITLES$ + I
NCHAR = LEN(TITLES)
PLOTS = "CP" + STRS(-NCHAR / 2) + ";" - 0.25; LB"+ TITLES + CHRS(3)
PRINT #1, PLOTS
NEXT I
NCHAR = ((LEN(XLABELS)) / 2)
PLOTS = "PU" + STRS(IHPXMIN + IHPRANGE / 2) + ";" + STRS(IHPYMIN - 2000 * .45) + ";"
PLOTS = "CP" + STRS(NCHAR) + ";" - 0.25; LB"+ XLABELS + CHRS(3); PLOTS = PLOTS + PLOT2S
PRINT #1, PLOTS
'plot ylabel
NCHAR = ((LEN(YLABELS)) / 4)
NCHAR = -6
PLOTS = "PU" + STRS(IHPXMIN) + ";" + STRS(IHRANGE / 2) + ";" + CP" + STRS(NCHAR1) + ";" + STRS(NCHAR) + ";"
PLOTS = "DI 0, 1; LB" + YLABELS + CHRS(3) + "DI 1, 0;"
PLOTS = PLOTS + PLOT2S
PRINT #1, PLOTS

11280 PLOTS = "PU; SPO;" : PRINT #1, PLOTS  'store pen
CLOSE #1
RETURN

11300  'SUBROUTINE TO LIST DIRECTORY

PRINT: FILES; PRINT
RETURN

11400  'SUBROUTINE TO READ DATA
PRINT "Data File Name:"; DATAFILES; INPUT "", RS: IF RS<>"" THEN DATAFILES=R$ 

INPUT "Enter number of columns in File ": FSTC 
Z%=0 

TITLE$(2)=DATAFILES 

OPEN DATAFILES FOR INPUT AS #1 
INPUT #1, TITLE$(1) 

11405 IF EOF(1) THEN GOTO 11410 

Z%=Z%+1 
FOR K=1 TO FSTC 
INPUT #1, DAT(K, Z%) 
NEXT K 
GOTO 11405 

11410 NPTS=Z% 
CLOSE #1 
FOR J=1 TO NPTS 
IF XNF=O THEN X(J)=DAT(XV, J) 
IF YNF=O THEN Y(J)=DAT(YV, J) 
IF NCURV=2 AND ZNF=O THEN Z(J)=DAT(ZV, J) 
NEXT J 

11490 RETURN 

20000 'Error Message Subroutine 
CLS 
RESUME 230 
RETURN 

22000 'Help Subroutine 
PRINT "LI... List current status of all parameters" 
PRINT "CL... Clears screen" 
PRINT "P... Plot data on screen" 
PRINT "GR... Graph data on plotter" 
PRINT "GRNA... Graph No Axes" 
PRINT "GRNS... Graph No Scientific notation" 
PRINT "XA... set X Axis label" 
PRINT "YA... set Y Axis label" 
PRINT "NC=#... Number of Curves to plot" 
PRINT "GS=#.#... set Graph Size" 
PRINT "RD... Read data file (RD=1 for manual input of data)" 
PRINT "GF... Graph Format (GFS or GFL or GFSL)" 
PRINT "SC... Scale plot (SC=#.#.#.#)" 
PRINT "YM... set Y scale Max and min (also YMAX or YMIN)" 
PRINT "XM... set X scale Max and min (also XMAX or XMIN)" 
PRINT "XV=#... set column number for x data (also TV or ZV)" 
PRINT "EX... Exit the program" 
PRINT "NT=#.#... set Number of Ticks on x and y axes" 
PRINT "NN=#... No Numbers (0 for no numbers, 1 for numbers)" 
PRINT "?... type help list"
6.4 PE330.BAS
To control PE330 remotely via IBM PC and RS-232 interface

- set all scan parameters
- transfer all data to memory and floppy disk
- plot data to HP7470 plotter

CALL CLRSCR
DEFFINT I-N,G
DIM X(2100),Y(2100),Z(2100),S(1),TITLES(3),DAT(2,2100)
GRFTPS="L"
IWAIT=3
NCRV=1
CALL GNOME
KEY OFF
ON ERROR GOTO 25000 'GOTO HELP

XV=1;TV=2;XINC=7.5;YINC=5.25 'PLOTTER DEFAULT VALUES
OPEN*COM1:2400,N,8,1,CS,DS,CD,LF" AS #1
GOSUB 500  'WAIT
PRINT #1,"E,1,0"  'COMMUNICATE WITH PE
GOSUB 500  'WAIT
PRINT #1,"F,35,3"
GOSUB 500
PRINT #:"F,35,1"
LOCATE 1,1: CALL CLRSCR
INPUT*"PLOT (P) OR PERKIN ELMER (E)";INS
IF INS="E" THEN GOSUB 40000 'LIST FOR PERKIN ELMER ACQUISITION PARGS
IF INS="E" THEN GOTO 230
GOSUB 1000 'OTHERWISE DO PLOTTING LIST

230 LINE INPUT *"PLT=",REPS
      'PROMPT
      PARM1=LEFTS(REPS,2)
      PARM2S=LEFTS(REPS,3,2)
      L=LEN(REPS)
      L1=INSTR(REPS,"=")
      XVALS=RIGHTS(REPS,L-L1)
      XVALS="0"
      XVALS="0"
      L2=LEN(XVALS)
      IF L2<1 THEN GOTO 300
      IF L2<1 THEN GOTO 300
      L3=INSTR(XVALS,";",")
      IF L3<1 THEN XVAL1S=XVALS
      IF L3<1 THEN GOTO 300
      XVAL1S=LEFTS(XVALS,L3-1)
      XVAL2S=RIGHTS(XVALS,L3-L3)
      "#1 PARM
      "#2 PARM

300 E1=VAL(XVAL1S)
      E2=VAL(XVAL2S)
      IF ABS(VAL(PARM2S)) > 0 THEN E1=VAL(PARM2S):E2=VAL(XVAL1S):E3=VAL(XVAL2S)
IF PARM1$="LI" THEN GOSUB 1000:PFLOG=1 'LIST REQUESTED
IF PARM1$="TI" THEN GOSUB 3000:PFLOG=1 'GET TITLE INFO
IF PARM1$="CL" THEN CALL CLRSCR:LOCATE 1,1:PFLOG=1
IF PARM1$="PL" THEN GOSUB 10000:PFLOG=1 'GO PLOT
IF PARM1$="X" THEN GOSUB 3200:PFLOG=1 'GET X-AXIS LABEL
IF PARM1$="ST" THEN GOSUB 11350:PFLOG=1 'STORE
IF PARM1$="YA" THEN GOSUB 3400:PFLOG=1 'STORE
IF PARM1$="NC" THEN NCURVES1:PFLOG=1 'NUMBER OF CURVES
IF PARM1$="GS" THEN XINCH=E1:YINCH=E2:PFLOG=1 'PLOT SIZE
IF PARM1$="D" THEN FILES:PFLOG=1 'LIST DIRECTORY
IF PARM1$="YM" THEN GOSUB 5000:PFLOG=1 'RESCALE YMAX
IF PARM1$="RD" THEN MAIN=E1:GOSUB 11400:PFLOG=1
IF PARM1$="GF" THEN GRFMTS=PARM2$:PFLOG=1
IF PARM1$="SC" THEN GOSUB 3600:PFLOG=1 'GO SCALE PLOT
IF PARM1$="XV" THEN XV=E1:PFLOG=1:XNF=E2
IF PARM1$="SG" THEN SG=E1:PFLOG=1:SGF=E2 'SIGMA COL FOR TDK
IF PARM1$="TV" THEN TV=E1:PFLOG=1:YNF=E2
IF PARM1$="GR" THEN AX=E1:GOSUB 11000:PFLOG=1 'GO GRAPH
IF PARM1$="FT" THEN FIT=E1:PFLOG=1
IF PARM1$="FP" THEN GOSUB 24000:PFLOG=1
IF PARM1$="EX" THEN CALL TMODE:END:PFLOG=1
IF PARM1$="?" THEN GOSUB 25000:PFLOG=1 'HELP FILE
IF PARM1$="ZV" THEN ZV=E1:ZNF=E2:PFLOG=1
IF PARM1$="E" THEN GOSUB 40000:PFLOG=1
IF PARM1$="") THEN GOSUB 1000:PFLOG=1
IF PARM1$="(" THEN GOSUB 20025:PFLOG=1 'DIV Y/Z
'START OF PERKIN ELMER ACQUISITION PARM
IF PARM1$="MD" THEN GOSUB 50000:PFLOG=1 'SET MODE
IF PARM1$="RG" THEN GOSUB 51000:PFLOG=1 'SET START
IF PARM1$="RT" THEN GOSUB 53000:PFLOG=1 'SET RESPONSE
IF PARM1$="SL" THEN GOSUB 56000:PFLOG=1 'SET SLIT
IF PARM1$="SS" THEN GOSUB 54000:PFLOG=1 'SET SCAN SPEED
IF PARM1$="Y" THEN GOSUB 55000:PFLOG=1 'SET SCALE
IF PARM1$="AZ" THEN GOSUB 57000:PFLOG=1 'SET AUTO 0
IF PARM1$="GT" THEN GOSUB 58000:PFLOG=1 'GOTO WAVELENGTH
IF PARM1$="GO" THEN GOSUB 59000:PFLOG=1 'START SCAN
IF PARM1$="EZ" THEN GOSUB 60000:PFLOG=1 'GET HELP LIST FOR PE
IF PARM1$="RM" THEN GOSUB 61000:PFLOG=1 'SET PE RECORD MODE
IF PARM1$="RC" THEN GOSUB 63000:PFLOG=1 'RECONNECT PC TO PE
IF PARM1$="GT" THEN GOSUB 62000:PFLOG=1 'GET TO MANUAL MODE
IF PARM1$="SC" THEN GOSUB 64000:PFLOG=1 'SET BACKGROUND CANCEL
IF PARM1$="CF" THEN CLOSE #1:CLOSE#2
IF PFLOG=0 THEN BEEP:BEEP
PFLOG=0
AX=0
GOTO 230

'SUBROUTINE IWAIT(IWAIT=1,32 SECONDS)
FOR IT=1 TO IWAIT*1000:TT=IT/100:NEXT IT
RETURN

1000 'SUBROUTINE LIST-----------------------------------------------
LOCATE 1,1
CALL CLRSCR
PRINT"2nd Filespec:";FILENAME$
PRINT"X-variable:";XV
PRINT"Z-variable:";ZV
PRINT"Y-variable:";YV
PRINT"Number of curves:";NCURV
LOCATE 1,3:PRINT"TITLE1:";TITLESS(1)
LOCATE 2,3:PRINT"TITLE2:";TITLESS(2)
LOCATE 3,3:PRINT"TITLE3:";TITLESS(3)
LOCATE 4,3:PRINT"X-axis Label:";XLABEL$ 
LOCATE 5,3:PRINT"Y-axis Label:";YLABEL$
LOCATE 6,3:PRINT"Graph Format:";GRFMT$
LOCATE 7,3:IF AX=1 THEN PRINT"No Axis and Labels"
LOCATE 1,6:PRINT"Height:";YINCH
LOCATE 2,6:PRINT"Width:";XINCH
LOCATE 7,1:PRINT"Scaling (A/M):";SCL$
PRINT"XMIN:";XMIN
PRINT"XMAX:";XMAX
PRINT"YMIN:";YMIN
PRINT"YMAX:";YMAX
RETURN

3000 PRINT"TITLE L#1:";TITLESS(1);:LINE INPUT";TS:IF TS<>" THEN TITLESS(1)=TS
PRINT"TITLE L#2:";TITLESS(2);:LINE INPUT";TS:IF TS<>" THEN TITLESS(2)=TS
TITLESS(3)=DATAFILES
RETURN

3200 LINE INPUT"Enter X-axis Label:";XLABEL$
RETURN

3400 LINE INPUT"Enter Y-axis Label:";YLABEL$
RETURN

3600 'SUBROUTINE SCALING
INPUT"XMIN,XMAX,YMIN,YMAX:";XMIN,XMAX,YMIN,YMAX
SCLS="M"
RETURN
5000 'Subroutine to rescale ymax only
INPUT"YMAX:";YMAX
SCLS="M"
RETURN

10000 'CRT Graphics
IF (PARM2S="A" OR PARMSZS="A") THEN SCLS="A"
IF SCLS="M" THEN GOTO 10020
REM DETERMINE THE ARRAY MIN AND MAX VALUES
XMIN=1E+30;XMAX=-1E+30
YMIN=1E+30;YMAX=-1E+30
ZMIN=1E+30;ZMAX=-1E+30
FOR J=1 TO NPTS
IF X(J)<XMIN THEN XMIN=X(J)
IF X(J)>XMAX THEN XMAX=X(J)
IF Z(J)<ZMIN THEN ZMIN=Z(J)
IF Z(J)>ZMAX THEN ZMAX=Z(J)
IF Y(J)<YMIN THEN YMIN=Y(J)
IF Y(J)>YMAX THEN YMAX=Y(J)
NEXT J
NTCURV=NCURV
WHILE NTCURV=2
IF ZMAX>YMAX THEN YMAX=ZMAX
IF ZMIN<YMIN THEN YMIN=ZMIN
NTCURV=0
WEND
10010 'Determine the Ranges
XMIN=0.95*XMIN : XMAX=1.05*XMAX : YMIN=0.95*YMIN : YMAX=1.05*YMAX
10020 XRANGE = XMAX-XMIN
YRANGE = YMAX-YMIN
NYTIC=5 : NXTIC=5
XTIC=XRANGE/NXTIC
YTIC=YRANGE/NYTIC
REM Start sending plot to crt
CLS
CALL GMODE
CALL CLRSCR
GXMIN=95:GDMAX=695:GYMIN=315:GYMAX=15
GXRANGE=GDHAX-GXMIN
GYRANGE=GYMAX-GYMIN
GXTIC=GXRANGE*XTCIC/XRANGE
GYTIC=GYRANGE*YTCIC/YRANGE
REM: Draw axes
CALL PLOT(GXMIN,GYMIN)
GX0=GXMIN:GYO=GYMIN
GTO=GYO-7:GTO=GYO+7
XSF=GXRANGE/XRANGE : YSF=GYRANGE/YRANGE
FOR GX=GXM TO GXMAX·GXTIC STEP GXTIC
CALL MOVE(GX,GYO)
CALL DLINE(GX,GYU)
GX1=GX+GXTIC
CALL MOVE(GX,GYO):CALL DLINE(GX1,GYO)
NEXT GX
CALL PLOT(GXMIN,GYMIN)
GYPREV=GYMIN : GXR = GXMIN + 10
FOR GY=GYMIN TO GYMAX·GYTIC STEP GYTIC
CALL MOVE(GXMIN,GY) : CALL DLINE(GXR,GY)
GY=GY+GYTIC
CALL MOVE(GXMIN,GY):CALL DLINE(GXMIN,GY1)
NEXT GY
CALL PLOT(GXMIN,GYMAX)
GYO=GYMAX+7
FOR GX=GXM TO GXMAX·GXTIC STEP GXTIC
CALL MOVE(GX,GYMAX):CALL DLINE(GX,GYO)
GX1:GX+GXTIC
CALL MOVE(GX,GYMAX):CALL DLINE(GX1,GYMAX)
NEXT GX
CALL PLOT(GXMAX,GYMIN)
GXL=GXMAX-10
CALL MOVE(GXMAX,GYMIN):CALL DLINE(GXL,GYMIN)
GYPREV=GYMIN
FOR GY=GYMIN TO GYMAX STEP GYTIC
CALL MOVE(GXMAX,GY) : CALL DLINE(GXL,GY)
CALL DLINE(GXMAX,GY)
CALL MOVE(GXMAX,GY1):CALL DLINE(GXMIN,GY)
GYPREV=GY
NEXT GY

'Begin plotting data points
'Check for the graph format, if lines are req. goto 10120,
'if both lines & symbols are req. goto 10140
'if none specified just plot symbols
IF GRFMTS="L" OR GRFMTS="l" THEN GOTO 10120
IF GRFMTS="SL" OR GRFMTS="sl" THEN GOTO 10140
IF GRFMTS="LS" OR GRFMTS="ls" THEN GOTO 10140
'Plot symbols only section
FOR J=1 TO NPTS
GX=XSF*(X(J)-XMIN)+GXMIN
GY=YSF*(Y(J)-YMIN)+GYMIN
IF GX<GXMIN OR GX>GXMAX THEN 10100
IF GY>GYMIN OR GY<GYMAX THEN 10100
GYUP=GY·3 : GYDN=GY+3 : GXLF=GX·5 : GXRT=GX+S
CALL MOVE(GX,GYUP) CALL DLINE(GX,GYDN)
CALL MOVE(GXLF,GY) CALL DLINE(GXRT,GY)
GYPREV=GY
NEXT J
10100
IF NCURV=2 THEN GOTO 10132
'PLOT SECOND CURVE W/LINES
GOTO 10200
Plot with lines that connect the data points

10120 IFPOINT=0 'Init. first point plotted
FOR J=1 TO NPTS
X=X(J) : Y=Y(J)
GX=XSF*(X-XMIN)+GXMIN
GY=YSF*(Y-YMIN)+GYMIN
IF GX<GXMIN OR GX>GXMAX THEN 10130
IF GT>GYMIN OR GT<GYMAX THEN 10130
IF IFPOINT=0 THEN CALL MOVE(GX,GY) : IFPOINT=1
CALL DLINE(GX,GY)
10130 NEXT J

'Plot 2nd curve

10132 NTCURV=NCURV
WHILE NTCURV=2
10134 IFPOINT=0 'Init. first point plotted
FOR J=1 TO NPTS
X=X(J) : Y=Y(J)
GX=XSF*(X-XMIN)+GXMIN
GY=YSF*(Y-YMIN)+GYMIN
IF GX<GXMIN OR GX>GXMAX THEN 10140
IF GT>GYMIN OR GT<GYMAX THEN 10140
IF IFPOINT=0 THEN CALL MOVE(GX,GY) : IFPOINT=1
CALL DLINE(GX,GY)
10140 NEXT J
NTCURV=0
WEND
GOTO 10200

'Plot both symbols and lines

10140 IFPOINT=0 'Init. first point plotted
FOR J=1 TO NPTS
GX=XSF*(X(J)-XMIN)+GXMIN
GY=YSF*(Y(J)-YMIN)+GYMIN
IF GX<GXMIN OR GX>GXMAX THEN 10150
IF GT>GYMIN OR GT<GYMAX THEN 10150
IF IFPOINT=0 THEN CALL MOVE(GX,GY) : IFPOINT=1
CALL DLINE(GX,GY)
GYUP=GY+3 : GYDN=GY-3 : GXLF=GX-5 : GXRT=GX+5
CALL MOVE(GX,GYUP) CALL DLINE(GX,GYDN) 'make '+' symbol
CALL MOVE(GXLF,GY) : CALL DLINE(GXRT,GY)
CALL MOVE(GX,GY)
10150 NEXT J

10200 'Done with plotting data points
'
'Plot Fitted Curve
'
GXSTEP=GMAX-GXMIN
XSTEP=(XMAX-XMIN)/GXSTEP
FOR J=0 TO GXSTEP

REM Label y-axis units
FOR J=0 TO NYTIC
  Y=YMIN+YTIC*J
  GY=GYRANGE/YRANGE*(Y-YMIN)+GYMIN
  YS=STRS(Y): NCHARX=LEN(YS)
  NE=0: NE=INSTR(YS,"E") : KNE=NE+1 : IF KNE>4 THEN KNE=5
  WHILE NE>0
    YNS=0.00: MIDS(YNS,1,KNE)=MIDS(YS,1,KNE)
    YNS=YNS+RIGHTS(YS,NCHARX-NE+1): YS=YNS: NCHARX=LEN(YS)
    NE=0
  WEND
  GX=GXMIN+9*(NCHARX-.5)
  GY=GY+5
  IF Y=YMIN THEN GY=GY-5
  CALL TEXTB(GX,GY,YS)
NEXT J

REM: LABEL THE X-AXIS UNITS
GY=GYMIN+11
FOR J=0 TO NXTIC
  X=XMIN+XTIC*J
  GX=XSF*(X-XMIN)+GXMIN
  XS=STRS(X): NCHARX=LEN(XS)
  NE=0: NE=INSTR(XS,"E") : KNE=NE+1 : IF KNE>5 THEN KNE=5
  WHILE NE>0
    XNS=0.00: MIDS(XNS,1,KNE)=MIDS(XS,1,KNE)
    XNS=XNS+RIGHTS(XS,NCHARX-NE+1): XS=XNS: NCHARX=LEN(XS)
    NE=0
  WEND
  IF J=NXTIC THEN 10300
  GOTO 10310
10300 IF NCHARX>2 THEN GX=GX-(9*(NCHARX-2))-3
  IF NCHARX<3 THEN GX=GX-(9*(NCHARX-1))-4
  GOTO 10320
10310 GX=GX-(9*(NCHARX+1))/2
10320 CALL TEXTB(GX,GY,XS)
NEXT J
REM: LABEL THE PLOT TITLE, XLABEL, YLABEL

' Label Title
TITLES=DATAFLES
NCHAR=LEN(TITLES) : IF NCHAR=0 THEN TITLES=""
NCHARX=INT(LEN(TITLES)/2)
GY=GYMAX-4
GX=359-9*NCHAR%
CALL TEXTB(GX,GY,TITLES)
GX=S50 :DS=DATES: CALL TEXTB(GX,GY,DS)

' Label X-axis
NCHAR=LEN(XLABELS) : IF NCHAR=0 THEN XLABELS=""
NCHARX=INT((LEN(XLABELS))/2)
GY=343
GX=359-9*NCHAR%
CALL TEXTB(GX,GY,XLABELS)

' Label Y-axis
NCHAR=LEN(YLABELS) : IF NCHAR=0 THEN YLABELS=""
NCHARX=LEN(YLABELS)
IF NCHARX>22 THEN NCHARX=22
GY=174-(NCHARX*7)
FOR J%=1 TO NCHARX
  GX=O
  GY=GY+14
  YS= MIDS(YLABELS,J%,1)
  CALL TEXTB(GX,GY,YS)
NEXT J%
RETURN

' Interact with user to check his satisfaction
GX=5 : GY=343 : PROMPTS="Is Plot Ok(y/n)?"
CHNGXYS="Enter new XMIN,XMAX,YMIN,YMAX:
HPPROMPTS="Do you want to plot on HP-7470A(y/n)?"
CALL TEXTB(GX,GY,PROMPTS)
DS=INPUT$(1)
' WHILE DS="": DS=INKEYS : WEND
IF DS="Y" OR DS="y" THEN GOTO 10350
LOCATE 1,12 : PRINT SPACES(66)
LOCATE 1,12 : PRINT CHNGXYS; :INPUT XMIN,XMAX,YMIN,YMAX
GOSUB 10020
DS=""

10350 CALL TEXTB(GX,GY,HPPROMPTS)
DS=INPUT$(1)
' WHILE DS="": DS=INKEYS : WEND
IF DS="Y" OR DS="y" THEN GOSUB 11000
DS=""
RETURN

10400 ' Plot another set of data points, with filled Squares
FOR J=1 TO NPTS
GX=KSF*(X(J)-XMIN)+GXMIN
GY=YSF*(Y(J)-YMIN)+GYMIN
IF GX<GXMIN OR GX>GXMAX THEN 10420
IF GY<GYMIN OR GY>GYMAX THEN 10420
GYUP=GY-(HT%Z/2): GYDN=GY+(HT%Z/2): GXLF=GX-(MD%Z/2): GXRT=GX+(MD%Z/2)
CALL BLKFILL(GXLF,GYDN,MDX,HTX)
10420 NEXT J
RETURN

10500 'Plot Fitted Curve
GXSTEP=GMAX-GDMIN
XSTEP=(XMAX-XMIN)/GXSTEP
FOR J=0 TO GXSTEP
X=XMIN+XSTEP*J
Y=Slope of Line*X+Ordinate Intercept
GX=KSF*(X-XMIN)+GXMIN
GY=YSF*(Y-YMIN)+GYMIN
IF GX<GXMIN OR GX>GXMAX THEN 10520
IF GY<GYMIN OR GY>GYMAX THEN 10520
CALL PLOTC(GX,GY)
10520 NEXT J
RETURN

11000 'HP 7470A PLOTTER PROGRAM, NAME: HP7470SR.BAS
'Drives HP 7470A plotter that has serial interface
'Baud Rate = 9600 : Parity = none : Comm.Port = 1
'If you don't like to use comm.port 1, change line 350 appropr.
'X Array is Horizontal, Y Array is Vert. PEN 1
'Pass X() , Y() Arrays, and NPTS
GOTO 11010
REM Determine the X and Y Array Bounds
XMIN=-1E+30:XMAX=1E+30
YMIN=-1E+30:YMAX=1E+30
FOR J=1 TO NPTS
IF X(J)<XMIN THEN XMIN=X(J)
IF X(J)>XMAX THEN XMAX=X(J)
IF Y(J)<YMIN THEN YMIN=Y(J)
IF Y(J)>YMAX THEN YMAX=Y(J)
NEXT J

11010 'Determine Ranges
INPMIN=-5000 : INPMAX=5000 : INPRANGE=INPMAX-INPMIN
XRANGE = XMAX-XMIN : YRANGE = YMAX-YMIN
XTIC=XRANGE/5 : YTIC=YRANGE/5
XSF=INPRANGE/XRANGE : YSF=INPRANGE/YRANGE
INPRTC=INT(XTIC*XSF) : INPYTIC=INT(YTIC*YSF)
BUFS=CHR$(27)+*: ES=CHR$(27)+*: E=
CLOSE
OPEN *COM1:9600,N,8,1,CS,DS10000* AS #1
REM START SENDING DATA TO HP-7470A
IHPXMIN=CINT((XSF*(XMIN-XMIN))+IHPMIN)
IHPXMAX=CINT((XSF*(XMAX-XMIN))+IHPMIN)
IHPYMIN=CINT((YSF*(YMIN-YMIN))+IHPMIN)
IHPYMAX=CINT((YSF*(YMAX-YMIN))+IHPMIN)
IHPXMINSTRS(IHPXMIN):IHPXMAXSTRS(IHPXMAX)
IHPYMINSTRS(IHPYMIN):IHPYMAXSTRS(IHPYMAX)
'Start Sending to the plotter
IF XINCH=0 THEN XINCH=6
IF YINCH=0 THEN YINCH=4.5
NXINCH=CINT(XINCH*1000)+2000 : NYINCH=CINT(YINCH*1000)+1500
PLOTS="IN;SP1;IP 850,750 ,",STRS(NXINCH)="",STRS(NYINCH)="";
PRINT #1,PLOTS
PLOTS="SC ="IHPXMIN="",="IHPXMAX="",="IHPYMIN="",="IHPYMAX="":
PRINT #1,PLOTS
'Draw Axes
IF AX=1 THEN GOTO 11030
IF PARM2$="HAX" THEN GOTO 11030
PLOTS="PA;PU+IHPXMIN="",="IHPYMIN="":PRINT #1,PLOTS
PLOTS=" =
FOR IX=IHPXMIN TO IHPXMAX STEP IHPXTIC
PLOTS="PD+"STRS(IX)+"",="IHPYMIN="":PRINT #1,PLOTS
NEXT IX
PLOTS="PU;PU+IHPXMIN="",="IHPYMIN="":PRINT #1,PLOTS
FOR IY=IHPYMIN TO IHPYMAX STEP IHPYTIC
PLOTS="PA;PD+IHPXMIN="",="IHPXMIN="":PRINT #1,PLOTS
NEXT IY
PLOTS="PU;:PRINT #1,PLOTS
FOR IX=IHPXMIN TO IHPXMAX STEP IHPXTIC
PLOTS="PD+"STRS(IX)+"",="IHPMAX="$:PRINT #1,PLOTS
NEXT IX
FOR IY=IHPYMIN TO IHPYMAX STEP IHPYTIC
PLOTS="PA;PD+"IHPMAX="",="IHPXMAX="":PRINT #1,PLOTS
NEXT IY
11030 'Start Plotting Data Points
IF GRFMTS="S" or GRFMTS="L" THEN PLOTS="PU+SM;": GOTO 11060
IF GRFMTS="L" or GRFMTS="L" THEN PLOTS="PU;SM;"
IF GRFMTS="L" or GRFMTS="L" THEN PLOTS="PU;SM;"
PRINT #1,PLOTS
'plot with lines or symbols and lines
IFPOINT=0
FOR J=1 TO NPTS
IF X(J)<XMIN OR X(J)>XMAX THEN 11050
IF Y(J)<YMIN OR Y(J)>YMAX THEN 11050
INX=CINT(((XSF*(X(J)-XMIN))+IHPMIN))
INY=CINT(((YSF*(Y(J)-YMIN))+IHPMIN))
XS=STRS(INX) ; YS=STRS(INY) ; XYS=XS="=YS=";"
IF IFPOINT=0 THEN PLOTS="PU"+XYS="PU";" :PRINT #1,PLOTS:IFPOINT=1
PLOTS="PD"+XYS
PRINT #1,PLOTS

11050 NEXT J

11052 NTCURV=NCURV 'Plot 2 nd curve
WHILE NTCURV=2
PLOTS="PU;SP2;" ; PRINT #1,PLOTS
IFPOINT=0
FOR J=1 TO NPTS
X=X(J) ; Y=Y(J)
IF X<XMIN OR X>XMAX THEN 11054
IF Y<YMIN OR Y>YMAX THEN 11054
INX=CINT(((XSF*(X-XMIN))+IHPMIN))
INY=CINT(((YSF*(Y-YMIN))+IHPMIN))
XS=STRS(INX) ; YS=STRS(INY) ; XYS=XS="=YS=";"
IF IFPOINT=0 THEN PLOTS="PU"+XYS="PU";" :PRINT #1,PLOTS:IFPOINT=1
PLOTS="PD"+XYS
PRINT #1,PLOTS
11054 NEXT J

PLOTS=" ="
11056 PRINT #1,PLOTS 'label y-axis units
IFPOINT=0
FOR J=1 TO NPTS
X=X(J) ; Y=Y(J)
IF X<XMIN OR X>XMAX THEN 11070
IF Y<YMIN OR Y>YMAX THEN 11070
INX=CINT(((XSF*(X-XMIN))+IHPMIN))
INY=CINT(((YSF*(Y-YMIN))+IHPMIN))
XS=STRS(INX) ; YS=STRS(INY) ; XYS=XS="=YS=";"
IF IFPOINT=0 THEN PLOTS="PU"+XYS="PU";" :PRINT #1,PLOTS:IFPOINT=1
PLOTS="PD"+XYS
PRINT #1,PLOTS
11070 NEXT J

11070 PRINT #1,PLOTS
IF FIT=1 THEN GOTO 11052 "DRAW LINES
NTCURV=NCURV
WHILE NTCURV=2
PLOTS="PU;SP2;SM;" : PRINT #1,PLOTS
IFPOINT=0
FOR J=1 TO NPTS
  X=X(J) ; Y=Z(J)
  IF X<XMIN OR X>XMAX THEN 11074
  IF Y<YMIN OR Y>YMAX THEN 11074
  IHX=CINT((XSF*(X-XMIN)+IHPMIN))
  IHY=CINT((YSF*(Y-YMIN)+IHPMIN))
  XS=STRS(IHX) : YS=STRS(IHY) : XTS=XS+".000;" : YTS=YS+".000;"
  IF IFPOINT=0 THEN PLOTS="PU"+XYS+"PU;" : PRINT #1,PLOTS:IFPOINT=1
  PLOTS="PU"+XYS="PU;" : PRINT #1,PLOTS
11074 NEXT J
PLOTS="PU;SM;SP1;" : PRINT #1,PLOTS
NTCURV=0
WEND

11100 'Label Y-Axis Units
IF AX=1 THEN GOTO 11280
PLOTS="SR .75,1.5;" : PRINT #1,PLOTS  'set char size
FOR Y=YMIN TO YMAX STEP YTIC
  IHY=CINT((YSF*(Y-YMIN)+IHPMIN))
  NCHAR=LEN(STRS(Y))
  NCHAR = (NCHAR+1)
  PLOTS="PU"+IHPMIN="C";CP"+STRS(NCHAR)+",.25;"+STRS(Y)+CHRS(3)
  PRINT #1,PLOTS
NEXT Y

'Label X-Axis units
FOR X=XMIN TO XMAX STEP XTIC
  IHX=CINT((XSF*(X-XMIN)+IHPMIN))
  NCHAR=LEN(STRS(X))/2
  PLOTS="PU"+STRS(IHX)+""+IHPMIN=";CP"+STRS(NCHAR)+",-1;"+STRS(X)+CHRS(3)
  PRINT #1,PLOTS
NEXT X

'Label the plot title, xlabel,ylabel
PLOTS="SR 1.2,2.2;"  
PRINT #1,PLOTS
TITLES$(3)=DATAFILES
FOR I=1 TO 3
  PLOTS="SP2;PU"+STRS(IHPXMIN+IHP RANGE/2)+"C;STRS(IHPYMIN+IHPYMAX+(.8-1*.2)*IHPYTIC)+";"  
  PRINT #1,PLOTS
  TITLES=TITLES$(1)
  NCHAR=LEN(TITLES)
  PLOTS="CP"+STRS(-NCHAR/2)+",-0.25;LB"+TITLES+CHRS(3)
  PRINT #1,PLOTS
NEXT I
NCHAR=-(LEN(XLABELS))/2
PLOTS="PU"+STRS(IHPXMIN+IHP RANGE/2)+"C;STRS(IHPYMIN-IHPYTIC*.45)+";"  
PLOTS="CP"+STRS(NCHAR)+",-0.25;LB"+XLABELS+CHRS(3);PLOTS=PLOTS+PLOT2$
PRINT 11, PLOTS
' Manual Entering of the data
INPUT "Enter No. of Data Points: ", NPTS
FOR J = 1 TO NPTS
  IF NCURV = 2 THEN INPUT "Enter X,Y,Z Pair: ", X(J), Y(J), Z(J) ELSE INPUT "Enter X,Y Pair: ", X(J), Y(J)
NEXT J
SS = """"""n
11350 PRINT "Do you want to Store Data on Disk(Y/N): ", DS
WHILE DS = ""
  INPUT "Enter Name of file for Storage: ", OUTFIL$;
  INPUT "Enter the number of columns of data in file: ", FSTC
  U = 0
  DS = """"n
  IF SS = ""y"" OR DS = ""y"" THEN SS = ""y"
  IF SS = ""y""
    INPUT "Enter line label (USE QUOTATION MARKS AND FOUR LEADING AND TRAILING BLANKS!): ", SLABELS
  OPEN OUTFIL$ FOR OUTPUT AS 12
  FOR J = 1 TO NPTS
    WRITE 12, X(J), Y(J)
  NEXT J
  CLOSE 12
WEND
RETURN

11400 ' SUBROUTINE TO READ DATA FROM TWO FILES
CLOSE 11 ' FIX EXIT PROBLEM
IF XNF = 2 THEN GOSUB 11505: RETURN
IF YNF = 2 THEN GOSUB 11505: RETURN
IF ZNF = 2 THEN GOSUB 11505: RETURN
PRINT "Data File Name: ", DATAFIL$;
INPUT " ", RS: IF RS = ""
DATAFIL$ = RS
INPUT "Enter the number of columns of data in file: ", FSTC
Z = 0
OPEN DATA FILES FOR INPUT AS #1

11405 IF EOF(1) THEN GOTO 11410
Z% = Z% + 1
FOR K = 1 TO FSTC
    INPUT #1, DAT(K, Z%)
NEXT K
GOTO 11405
11410 NPTS = Z%
CLOSE #1
FOR J = 1 TO NPTS
    IF XNF = 0 THEN X(J) = DAT(XV, J)
    IF YNF = 0 THEN Y(J) = DAT(YV, J)
    IF NCURV = 2 AND ZNF = 0 THEN Z(J) = DAT(ZV, J)
NEXT J
11490 RETURN

SUBROUTINE TO READ FROM 2NC FILE
PRINT"Enter 2nd Date File Name:"; FILENAMES; INPUT",RS:IF RS<>"" THEN FILENAMES=RS
INPUT"Enter number of columns in file":SNOC
OPEN FILENAMES FOR INPUT AS #2
N% = 0
11605 IF EOF(2) THEN GOTO 11610
N% = N% + 1
FOR H = 1 TO SNOC
    INPUT #2, DAT(H, N%)
NEXT H
GOTO 11605
11610 NPTS = N%
CLOSE #2
FOR I = 1 TO NPTS
    IF XNF = 2 THEN X(I) = DAT(XV, I)
    IF YNF = 2 THEN Y(I) = DAT(YV, I)
    IF NCURV = 2 AND ZNF = 2 THEN Z(I) = DAT(ZV, I)
NEXT I
RETURN

SUBROUTINE TO DIVIDE Y/Z (FROM TWO DIFFERENT FILES)
FOR I = 1 TO NPTS
    Y(I) = Y(I)/Z(I)
    IF X(I)>700 THEN Y(I) = Y(I)*86.5 "REFLECTANCE VALUES FOR TILE"
    IF X(I)<=700 THEN Y(I) = 100*Y(I)*(-5.744+3.473E-2*X(I)-6.089E-5*X(I)^2+3.538E-8*X(I)^3)
NEXT I
RETURN

SUBROUTINE FIT DATA
IF FIT = 1 THEN NCURV = 2 ELSE RETURN
SX# = 0: SY# = 0: SX5Q# = 0: SY5Q# = 0: S# = 0
INPUT"DO YOU WANT TO WEIGHT DATA POINTS? (+Y,-N)"; CHK
FOR I = 1 TO NPTS
  IF CHK < 0 THEN WT = 1  
  'DO U WANT TO WEIGHT
  IF CHK < 0 THEN GOTO 24100  
  'IF NOT
  IF X(I) = 0 AND Y(I) = 0 GOTO 24050  
  'WANT IT TO GO THRU (0,0) BAD?
  WT = 1 / (S(I)^2)  
  'WT IS INVERSE OF VARIANCE
  GOTO 24100  
  'ONLY OPTION INPUT WT FOR 0, 0
24050  
  INPUT "WEIGHT FOR POINT (0,0) > "; WT  
  'HERE IS YOUR OPTION
24100  
  SX(I) = SX(I) * WT  
  'SUM THE WTS
  SY(I) = SY(I) * Y(I) * WT  
  'START THE USUAL FORMULAE
  SYX = SYX + X(I) * Y(I) * WT  
  SXX = SXX + X(I)^2 * WT  
  SYSQ = SYSQ + Y(I)^2 * WT
  NEXT I  
  'NEXT PEAK
  DELTA = S*SXXSOSQ - SX^2  
  'SEE DATA REDUCTION TEXT FOR REF
  ALIN = (SYSQ - SXXSOSY) / DELTA  
  'THE INTERCEPT
  BLIN = S*SXY - SXSY / DELTA  
  'THE SLOPE
  SIGA = SQR(SYSQ / DELTA)  
  'SIG FOR INTERCEPT
  SIGB = SQR(SX^2 / DELTA)  
  'SIG FOR SLOPE
  RLIN = (S*SXY - SXSY) / SQR(DELTA * (S*SXXSOSQ - SX^2))  
  'CORR COEFF
  PRINT "INTERCEPT= " ; ALIN  
  " SLOPE= " ; BLIN  
  " R= " ; RLIN
  PRINT "SIG INTER= " ; SIGA  
  " SIG SLOPE= " ; SIGB
  FOR I = 1 TO NPTS  
  'CALC POINTS FROM FITTED LINE
  Z(I) = ALIN + BLIN * X(I)
  NEXT I
  CLOSE
GOSUB 11350
RETURN  
'DOES SLOPE
INPUT "ENTER INITIAL POINT X,Y" ; X1, Y1
INPUT "ENTER FINAL POINT X,Y" ; X2, Y2
SLOPE = (Y2 - Y1) / (X2 - X1)
TSEP = Y1
FOR I = 1 TO NPTS
  Z(I) = TSEP + SLOPE * X(I)
  Y(I) = Y(I) - Z(I)
  NEXT I
PRINT "SLOPE = " ; SLOPE
PRINT "INTSEP = " ; TSEP
GOSUB 11350
RETURN

25000  
RESUME 230  
'LOCATE 1,1: CALL CLRSCL  
'MAKE NICE SCREEN
PRINT*  
'LI.............LIST SETTINGS
PRINT*  
'TI................TITLE
PRINT*  
'CL...............CLEAR SCREEN
PRINT*  
'PL..("A ").........PLOT GRAPH ON SCREEN
PRINT*  
'XA..............X AXIS LABEL
PRINT*  
'YA..............Y AXIS LABEL
40000 'LIST FOR PE DATA ACQUISITION
LOCATE 1,1:CALL CLRSCR
LOCATE 2,25:PRINT"PE330 PARAMETER LIST"
LOCATE 4,1:PRINT"MODE >";MS
LOCATE 4,25:PRINT"YMN >";YMN$ 
LOCATE 5,25:PRINT"YMX >";YMX$ 
LOCATE 5,1:PRINT"SCAN SPEED >";SS$ 
LOCATE 6,1:PRINT"XSTART >";XSTS$ 
LOCATE 7,1:PRINT"XEND >";XENDS$ 
LOCATE 6,25:PRINT"BACKGRND START >";BC1$ 
LOCATE 7,25:PRINT"BACKGRND END >";BC2$ 
LOCATE 8,1:PRINT"SLIT WIDTH >";SWS$ 
LOCATE 8,25:PRINT"RESPONSE TIME >";RTS$ 
RETURN

50000 'SUBROUTINE FOR SETTING MODE TO PE
IF XVAL1S="A" THEN PRINT "F,1,0":MS="ABSORPTION" 'FOR ABSORPTION 
IF XVAL1S="T" THEN PRINT "F,2,0":MS="TRANSMISSION" 'FOR IT 
IF XVAL1S="SB" THEN MS="SINGLE BEAM" 'FOR SINGLE BEAM 
IF XVAL1S="SB" THEN INPUT"INPUT GAIN >";GMS$ 
IF XVAL1S="SB" THEN PRINT "F,3,";GMS$ 
RETURN

51000 'SUBROUTINE FOR SETTING STARTING WAVELENGTH
PRINT "F,22,="XVAL1S:XSTS=XVAL1S 
GOSUB 500 'WAI
PRINT "F,22,="XVAL2S:XENDS=XVAL2S 
XSTCP=E1:XENDCP=E2
PRINT XENDCP
RETURN

53000 'SUBROUTINE FOR SETTING RT
PRINT #1,"F,12,""=XVAL1S:RTS=XVAL1S
RETURN

56000 'SUBROUTINE FOR SETTING SLIT WIDTH
PRINT #1,"F,14,""=XVAL1S:SWS=XVAL1S
RETURN

54000 'SUBROUTINE FOR SETTING SCAN SPEED
PRINT #1,"F,6,""=XVAL1S:SSS=XVAL1S
RETURN

55000 'SUBROUTINE FOR SETTING SCALE
PRINT #1,"F,15,""=XVAL1S:YMOG=XVAL1S
GOSUB 500
PRINT #1,"F,15,""=XVAL2S:YMOG=XVAL2S
YRCP=E1
RETURN

57000 'SUBROUTINE FOR SETTING AUTO ZERO
PRINT #1,"F,11,0"
RETURN

58000 'SUBROUTINE FOR GO TO WAVELENGTH
PRINT #1,"F,5,""=XVAL1S:WAVE=VAL(XVAL1S)
GOSUB 500 "WAIT
58010 PRINT #1,",D,1,0":LINE INPUT #1,TEMPS
LOCATE 20,5:PRINT"
LOCATE 20,5:TEMP=VAL(LEFTS(TEMPS,7)):PRINT TEMP
IF TEMP=E1 THEN GOTO 58010
RETURN

59000 'SUBROUTINE FOR STARTING SCAN
GXRCP=695:YRCP=-310:GXRCPC=15:GYRCP=325
XRCP=XSTCP-XENDCP:IF YRCP=0 THEN YRCP=100
CALL CLSCHR
PRINT #1,"F,4,0"
I=0
59001 I=I+1
LINE INPUT #1,ES
E1S=LEFTS(ES,7):EZS=RIGHTS(ES,7)
X(I)=VAL(E1S):Y(I)=VAL(EZS)
IF X(I)=0 THEN I=I+1:GOTO 59001
IX=695/XRCP+(X(I)-XENDCP)*15
IY=-310/YRCP+(Y(I))+325
IX=CINT(IX):IY=CINT(IY)
CALL PLOT(Ix,Iy)

LOCATE 1,5:PRINT X(I),Y(I),I
AS=INKEY$:IF AS="S" THEN 59002 'STOP SCAN
IF X(I)=XENDCP THEN GOTO 59002
GOTO 59001

59002 PRINT #1, "C,4,0"
NPTS=1
RETURN

60000 'HELP LIST FOR PE
LOCATE 1,1:CALL CLRSCR
PRINT
PRINT"MO=A,T,SB........SET MODE"
PRINT"RG=##,##........SET START, END WAVELENGTH"
PRINT"RT=##............SET RESPONSE TIME"
PRINT"SL=##............SET SLIT WIDTH"
PRINT"SS=##............SET SCAN SPEED"
PRINT"MOV,SO,OF......SET PE PLOTTING MODE"
PRINT"TS=##............SET TMAX FOR SCREEN PLOT DURING SCAN"
PRINT
PRINT"AZ..................SET AUTO ZERO"
PRINT"BC=##,##........CANCEL BACKGROUND OVER INDICATED RANGE"
PRINT
PRINT"GT=##.............GOTO WAVELENGTH"
PRINT"GO..................START SCANNING PE"
PRINT"GT..................PUT PE BACK IN MANUAL MODE"
PRINT"RC..................RECONNECT PE TO IBM PC"
PRINT
PRINT"E?..................HELP FILE: PE330"
PRINT"?..................HELP FILE: MAIN AND PLOTTING"
PRINT"P.................PLOTTING MODE"
PRINT"E..................PE 330 SCANNING MODE"
PRINT

RETURN

61000 'SUBROUTINE FOR SETTING RECORD MODE OF PE (OVERLAY,SEQ,OFF)
IF XVAL1$="OV" THEN PRINT #1,"F,16,0"
IF XVAL1$="SD" THEN PRINT #1,"F,17,0"
IF XVAL1$="OF" THEN PRINT #1,"F,18,0"
RETURN

62000 'SUBROUTINE TO DISCONNECT PC FROM PE
PRINT #1,"C,35,0"
GOSUB 500 'WAIT
PRINT #1,"E,2,0"
RETURN

63000 'SUBROUTINE TO RECONNECT PE TO PC
CLOSE
OPEN"COM1:2400,N,B,1,CS,DS,CD,LF" AS #1
GOSUB 500  'WAIT
PRINT #1,"E,1,0"
GOSUB 500  'WAIT
PRINT #1,"F,35,3"
GOSUB 500
PRINT #1,"F,35,1"  '11M INC
RETURN

64000  'SUBROUTINE FOR STORING BACKGROUND OVER DESIRED RANGE
PRINT #1,"F,26,="+XVAL1$:BC1$:XVAL1$
GOSUB 500  'WAIT
PRINT #1,"F,26,="+XVAL2$:BC2$:XVAL2$
RETURN
END
6.5 ABLDATA.BAS
author: G.L. Valderrame

DEFINT K-N
DIM STOREDATA(100,5),NOTES(100,2)
STOREFILENAMES="TESTFILE.DAT"

10 PRINT "Press 'Enter' to create an ablation experiment summary datafile."
PRINT "Enter 'P' to print an existing datafile."
INPUT "Enter 'C' to create a SPX1PLOT-type file of etch depth vs. fluence data:

IF REPLYS="P" OR REPLYS="p" THEN GOTO 2000
IF REPLYS="C" OR REPLYS="c" THEN GOTO 4000

CLS
90 INPUT "Year in which experiment was done: ",YEAR$".
INPUT "Laser used in ablation experiment: ",LASER$".
INPUT "Wavelength: ",WAVELENGTH$".
INPUT "Repetition rate: ",REPRATES$".
INPUT "Joulemeter conversion factor (V/J): ",JOULEMETERFACTOR$".
INPUT "Laser spot size in target plane (cm²): ",SPOTSIZES$".
PRINT
INPUT "Number of datapoints to be entered: ",NUMPTS
PRINT
95 INPUT "Need to make corrections? (Y/N) ",reply$".
IF REPLYS="Y" OR REPLYS="y" THEN CLS: GOTO 90
IF REPLYS="N" THEN REPLYS="N"
IF REPLYS="n" THEN GOTO 95
PRINT
98 CLI
FOR I=FIRSTI TO NUMPTS
100 PRINT
PRINT "Datapoint number: ",I
PRINT "Sample name (use XXXXXX format, '/' increments by one): ",SAMPLENAMES$".
IF SAMPLENAMES="" AND I>1 THEN SAMPLENAMES=STORENAMES:GOTO 105
IF SAMPLENAMES<="" AND LEN(SAMPLENAMES)<8 THEN PRINT: PRINT "Incorrect format"
IF SAMPLENAMES="" AND I>1 THEN SAMPLENAMES=NOTES(1-1,1) ELSE GOTO 110
LETTERS=RIGHTS(SAMPLENAMES,1)
BASENAMES=LEFTS(SAMPLENAMES,7)
NEXTLETTERS=CHR$(ASC(LETTERS) + 1)
NEWNAMES=BASENAMES + NEXTLETTERS
SAMPLENAMES=NEWNAMES
105 PRINT "Assumed sample name: ",SAMPLENAMES
PRINT
110 NOTES(1,1)=SAMPLENAMES
STORENAMES=SAMPLENAMES
INPUT number of shots to target: "STOREDATA(1,1)
INPUT attenuator scheme: "NOTESS(1,1)
INPUT average joulemeter reading (mV): "STOREDATA(1,2)
INPUT sample crater depth (microns): "STOREDATA(1,3)
PRINT
115 INPUT need to make corrections? (Y/N) = reply$,
IF REPLYS = "Y" OR REPLYS = "Y" THEN GOTO 100
IF REPLYS = "N" THEN REPLYS = "N"
IF REPLYS <> "N" THEN GOTO 115
PRINT NEXT 1

117 INPUT Do you need to correct any entries? (Y/N) = REPLYS
IF REPLYS = "Y" OR REPLYS = "Y" THEN INPUT datapoint number: ""ON:FIRSTI=ON:NUMPTS=ON:GOTO 98
IF REPLYS = "N" THEN REPLYS = "N"
IF REPLYS <> "N" THEN GOTO 117
CLS
PRINT
INPUT Do you wish to store on disk? (Y/N) = REPLYS
IF REPLYS = "Y" THEN REPLYS = "Y"
IF REPLYS = "Y" THEN GOTO 120
IF REPLYS <> "Y" THEN INPUT Are you sure? (Y/N) = REPLYS
IF REPLYS = "N" THEN REPLYS = "N"
IF REPLYS <> "N" THEN GOTO 2000

120 FILES
PRINT
INPUT enter filename for storage: "FILENAMES
STOREFILENAMES = FILENAMES
OPEN FILENAMES FOR OUTPUT AS #1
PRINT #1, YEARS
PRINT #1, LASERS
PRINT #1, WAVELENGTHS
PRINT #1, REPRATES
PRINT #1, JOULEMETERFACTOR
PRINT #1, SPOTSIE
FOR N = 1 TO NUMPTS
PRINT #1, NOTESS(N, 1)
PRINT #1, NOTESS(N, 2)
PRINT #1, STOREDATA(N, 1)
PRINT #1, STOREDATA(N, 2)
PRINT #1, STOREDATA(N, 3)
NEXT N
1000 CLOSE #1

2000 INPUT How many copies do you wish to print out? = NUMCOPIES
IF NUMCOPIES>0 THEN INPUT "Ensure printer is ready then hit 'ENTER' to proceed."
'INPUT "Do you need to read a file from the disk? (Y/N) ":REPLYS
'IF REPLYS="Y" THEN REPLYS="Y"
'IF REPLYS="Y" THEN CLS:FILES ELSE CLS:PRINT "using current file":GOTO 3000
CLS:FILES
PRINT "enter datafile to print: ":
PRINT STOREFILENAMES;
INPUT ",",DATAFILES
IF DATAFILES="Y" THEN DATAFILES=STOREFILENAMES
STOREFILENAMES=DATAFILES
NUMPTS=0
OPEN DATAFILES FOR INPUT AS #1
INPUT #1,YEARS
INPUT #1,LASERS
INPUT #1,WAVELENGTHS
INPUT #1,REPRATES
INPUT #1,JOULEMETERFACTOR
INPUT #1,SPOTSIZE
2100 IF EOF(1) THEN GOTO 2500
NUMPTS=NUMPTS+1
INPUT #1,NOTES(NUMPTS,1)
INPUT #1,NOTES(NUMPTS,2)
INPUT #1,STOREDATA(NUMPTS,1)
INPUT #1,STOREDATA(NUMPTS,2)
INPUT #1,STOREDATA(NUMPTS,3)
GOTO 2100
2500 CLOSE #1
3000 "printing subroutine (ENSURE laserprinter is in 108 font)"
DENSITY=1.00 "specify in units of g/cm^3"
FOR COPY=1 TO NUMCOPIES
WIDTH ="LPT1:" ,132
LPRINT "RP ABLATION EXPERIMENT SUMMARY"
LPRINT "-----------------------------"
LPRINT
MOMS=MIDS(DATAFILES,4,2)
DAYS=MIDS(DATAFILES,6,2)
LPRINT "experiment date: ";MOMS;"/";DAYS;"/";YEARS
LPRINT
LPRINT "datafile: ";DATAFILES
LPRINT "laser: ";LASERS
LPRINT "wavelength: ";WAVELENGTHS
LPRINT "pulse repetition rate: ";REPRATES
LPRINT
LPRINT "joulemeter/energy correction factor: ";JOULEMETERFACTOR
LPRINT "sample density (units: g/cm^3): ";
LPRINT USING = #.##;DENSITY
LPRINT
LPRINT
LPRINT = SAMPLE SHOT ATTENUATOR JOULEMETER AVERAGE TOTAL ENERGY SPOT FLUENCE
LPRINT = NAME TOTAL SCHEME READING PULSE ENERGY TO SAMPLE SIZE
LPRINT = (mV) (J) (J) (cm²) (J/cm²)
LPRINT

FOR L=1 TO NUMPTS
LPRINT USING\" ";NOTESS(L,1); 'sample name
NUMSHOTS=STOREDATA(L,1)
LPRINT USING = ### ";NUMSHOTS;
LPRINT USING = \" ";NOTESS(L,2); 'attenuator scheme
JOULEMETER=STOREDATA(L,2)
LPRINT USING = ###### ";JOULEMETER;
AVGENERGY=(JOULEMETER/1000)/JOULEMETERFACTOR
LPRINT USING = #.##### ";AVGENERGY;
TOTALENERGY=NUMSHOTS*AVGENERGY
LPRINT USING = #.##### ";TOTALENERGY;
LPRINT USING = #.##### ";SPOTSIZE;
FLUENCE=AVGENERGY/SPOTSIZE
LPRINT USING = ### ";FLUENCE;
ETCHDEPTH=STOREDATA(L,3)
LPRINT USING = #### ";ETCHDEPTH;
ETCHRATE=ETCHDEPTH/NUMSHOTS
LPRINT USING = ### ";ETCHRATE;
IF ETCHRATE=0 OR DEPTH=0 THEN LPRINT" no value":GOTO 3950
OSTAR=(FLUENCE/1000)/(DENSITY*(ETCHRATE/10000))
LPRINT USING = #.##### ";OSTAR;
LPRINT USING = #.##### ";LOG(FLUENCE)

NEXT L

LPRINT =---------------------------------------------------------------

WIDTH =LPT1=",80
LPRINT CHR$(12); 'send FORM FEED to printer
NEXT COPY
GOTO 10000

4000 'Create ETCHRATE vs. FLUENCE SPX1PLOT-type datafile
CLS:FILES
INPUT="enter name of INPUT datafile: ",DATAFILES
NUMPTS=0
OPEN DATAFILES FOR INPUT AS #1
INPUT #1,YEARS
INPUT #1,LASERS
INPUT #1,WAVELENGTHS
INPUT #1,REPRATES
INPUT #1,JOULEMETERFACTOR
INPUT #1,SPOTSIZE
4100 IF EOF(1) THEN GOTO 4500
NUMPTS=NUMPTS+1
INPUT #1,NOTESS(NUMPTS,1)
INPUT #1, NOTESS(NUMPTS, 2)
INPUT #1, STOREDATA(NUMPTS, 1)
INPUT #1, STOREDATA(NUMPTS, 2)
INPUT #1, STOREDATA(NUMPTS, 3)
GOTO 4100

GOTO 4500

CLOSE #1

PRINT "Read in of datafile completed."
PRINT
PRINT "Enter filename for storage of DEL vs F data: ", FILENAMES
PRINT "Enter SPX1PLOT-type datafile header label: ", SPEXLABELS
OPEN FILENAMES FOR OUTPUT AS #1
PRINT #1, SPEXLABELS
FOR L = 1 TO NUMPTS
NUMSHOTS = STOREDATA(L, 1)
JOULEMETER = STOREDATA(L, 2)
AVGENERGY = (JOULEMETER / 1000) / JOULEMETERFACTOR
FLUENCE = AVGENERGY / SPOTSIZE
ETCHDEPTH = STOREDATA(L, 3)
ETCHRATE = ETCHDEPTH / NUMSHOTS
PRINT #1, FLUENCE, ETCHRATE
NEXT L

CLOSE #1

INPUT "Do you wish to continue? (Y/N) ", REPLYS
IF REPLYS = "Y" OR REPLYS = "y" THEN GOTO 10 ELSE CLS
END
'modified 5-DEC-88 by Joe Valderrama
'based on LABEL.BAS by Joe Valderrama
'This program creates RP ablation photomicrograph labels using
'either:
'1) Epson-type dot-matrix printer & Avery 4013 3.5"x15/16" label
'2) HP LaserJet series II printer & Avery 5161 1"x4" labels.

'LABEL1.BAS requires datafiles resulting from raw data input
'into data analysis program ABL6.BAS (current version).

CLS
FILES
PRINT"To exit this program, enter Q after any STRING input statement"
PRINT
10 INPUT"enter filename with label information: ";FILENAMES
IF FILENAMES="Q" OR FILENAMES="q" THEN GOTO 10000
100 INPUT"enter sample type using XXX format (enter F to start on another file): ";TYPES
IF TYPES="Q" OR TYPES="q" THEN GOTO 10000
1000 'print label subroutine for dot-matrix printers
OPEN FILENAMES FOR INPUT AS 11
\retrieve data values from "filenames"
INPUT #1,YEARS,LASERS,WAVELENGTHS,REPRATES
INPUT #1,JOULEMETERFACTOR,SPOTSIZE
FOCUS=" (crater bottom) "
FOR I=1 TO 200
IF EOF(1) THEN GOTO 1900
INPUT #1,EXPTNAMES,ATTENUATORSS,NUMSHOTS,AVGENERGY,ETCHDEPTH
MONS=MIDS(EXPTNAMES,4,2) 'GET THE MONTH CODE
DAYS=MIDS(EXPTNAMES,6,2) 'GET THE DAY
IF LEFTS(EXPTNAMES,3) <> TYPES THEN GOTO 1800
'PRINT THE LABEL
FLUENCE=((AVENERGY/1000)/JOULEMETERFACTOR)/SPOTSIZE
ETCHRATE=ETCHDEPTH/NUMSHOTS

FOR J=1 TO 2
IF FOCUS$=" (crater surface)" THEN FOCUS$=" (crater bottom)
FOR K=1 TO NUMLABELS
LPRINT CHR$(15)
LPRINT CHR$(27) CHRS(71)
LPRINT IFUCSS=";FOCUS$;";DATE: ";MONS;"-";DAYS;"-";YEARS
LPRINT USING "fluence: ###.## J/cm2";FLUENCE;
LPRINT "LASERS: ";WAVELENGTHS; "REPRATES:";
LPRINT USING "etch rate: ### um/pulse";ETCHRATE;
LPRINT USING "number of shots: ###";NUMSHOTS
LPRINT USING "etch depth: ### um";ETCHDEPTH;
LPRINT USING "spot size: ### cm2";SPOTSIZE
NEXT K
NEXT J

1800 NEXT
1900 CLOSE #1
GOTO 100

2000 'print label subroutine for HP laser printers

CLOSE
WIDTH "LPT1:="132
OPEN FILENAMES FOR INPUT AS #1
OPEN "LPT1:" FOR OUTPUT AS #2
'RETRIEVE DATA VALUES FROM FILENAMES'
INPUT #1,YEARS,LASERS,WAVELENGTHS,REPRATES
INPUT #1,JOULEMETERFACTOR,SPOTSIZE
FOCUS$=" (crater bottom)""

ECS=CHR$(27) 'escape control character
LFS=CHR$(10) 'line feed control character
CRS=CHR$(13) 'carriage return control character
BSS=CHR$(8) 'half line feed control character

PRINT #2,ECS;"E;";

FOR I=1 TO 200
IF EOF(#) THEN GOTO 2900
INPUT #1,EXPTNAMES,ATTENUATORS,NUMSHOTS,AVENERGY,ETCHDEPTH
MONS=MIDS(EXPTNAMES,4,2) 'GET THE MONTH CODE
DAYS=MIDS(EXPTNAMES,6,2) 'GET THE DAY

IF LEFTS(EXPTNAMES,3) <> TYPES THEN GOTO 2800
'PRINT THE LABEL
FLUENCE=((AVENERGY/1000)/JOULEMETERFACTOR)/SPOTSIZE
ETCHRATE=ETCHDEPTH/NUMSHOTS

GOTO 100
FOR J=1 TO 2
IF FOCUS$=" (crater surface) " THEN FOCUS$=" (crater bottom)
FOR K=1 TO NUMLABELS
PRINT #2,CRS;
PRINT #2,TAB(5);EXPTNAMES;FOCUS$;"date: ";MINS;"-";DAYS;"-";YEARS
PRINT #2,TAB(5);USING "fluence: #.#.# J/cm^2";FLUENCE;
PRINT #2," ;LASERS;" ;WAVELENGTHS; (";REPRATES;")
PRINT #2,TAB(5);USING "etch rate: #.# um/pulse";ETCHRATE;
PRINT #2,USING "number of shots: #.#";NUMSHOTS
PRINT #2,TAB(5);USING "etch depth: #.# um";ETCHDEPTH;
PRINT #2,USING " spot size: #.### cm^2";SPOTSIZ
PRINT #2,EC$="E-5R"
PRINT #2,TAB(75);EXPTNAMES;FOCUS$;"date: ";MINS;"-";DAYS;"-";YEARS
PRINT #2,TAB(75);USING "fluence: #.#.# J/cm^2";FLUENCE;
PRINT #2," ;LASERS;" ;WAVELENGTHS; (";REPRATES;")
PRINT #2,TAB(75);USING "etch rate: #.# um/pulse";ETCHRATE;
PRINT #2,USING "number of shots: #.#";NUMSHOTS
PRINT #2,TAB(75);USING "etch depth: #.# um";ETCHDEPTH;
PRINT #2,USING " spot size: #.### cm^2";SPOTSIZ
PRINT #2,LFS;
NEXT K
NEXT J
2800 NEXT I
2900 PRINT #2,EC$="E";
CLOSE#1:CLOSE #2
GOTO 100
10000 END