

AD/A-002 586

**A REVIEW OF PARAMETRIC OSCILLATORS
AND MIXERS AND AN EVALUATION OF
MATERIALS FOR 2 - 6 MICROMETER
APPLICATIONS**

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**Air Force Avionics Laboratory
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July 1974

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFAL-TR-74-161	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER AD/A-002586
4. TITLE (and Subtitle) A REVIEW OF PARAMETRIC OSCILLATORS AND MIXERS AND AN EVALUATION OF MATERIALS FOR 2 - 6 μ m APPLICATIONS		5. TYPE OF REPORT & PERIOD COVERED Technical Report
7. AUTHOR(s) Elgene R. Nichols John C. Corbin, Jr. Vincent L. Donlan		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Air Force Avionics Laboratory Aerospace Research Laboratories Air Force Materials Laboratory		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Avionics Laboratory AFAL/TEO Wright-Patterson AFB, Ohio 45433		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 62204F 2001-01-16 61102F 7073-02-11 62102F 7371-01-01
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE July 1974
		13. NUMBER OF PAGES 119
		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in RI - 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Nonlinear Optics Parametric Oscillators Frequency Mixers		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) A tunable source of narrow line radiation in the 2-6 μ m band and, to a lesser extent, the 8-12 μ m band would be useful in several military applications. Only recently have nonlinear optical materials become available to permit construction of optical parametric oscillators (OPO's) and mixers operating at these wavelengths. In this report, a review of the progress in wavelength coverage and output of OPO's and mixers is given, the theoretical performance of eleven nonlinear materials is discuss in detail, and as an example, the		

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materials are compared for use in operating a singly resonant OPO in the 3-6 μ m band. For this application, the outstanding materials are HgS pumped at 1.06 μ m and ZnGeP₂ pumped at 2.1 μ m. Refractive index data on the nonlinear materials and details of the FORTRAN computer program used in the calculations are included in the Appendices.

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FOREWORD

This report covers work performed in the period 1 January 1974 through 15 May 1974. The work was a joint effort of AFAL, ARL, and AFML. AFAL participation was carried out under Project, Task and Work Unit number 2001-01-16, with E. R. Nichols as Project Scientist. ARL participation was under Project, Task and Work Unit number 7073-02-11, with J. C. Corbin, Jr. as Project Scientist. AFML participation took place under Project, Task and Work Unit number 7371-01-01, with V. L. Donlan as Project Scientist. The capable assistance of Mrs. Margie Smith who typed the greatest part of this report is greatly appreciated.

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SECTION I

INTRODUCTION

There are spectral regions in the infrared that are not occluded by atmospheric absorption¹. The coincidence of good detectors and atmospheric transparency in the 2-6 μm and the 8-12 μm bands makes these spectral regions of special interest. Military applications in the 2-6 μm band and, to a lesser extent, the 8-12 μm band have been discussed elsewhere². Prior to 1970, tunable sources had not been developed to provide continuous coverage of these bands, although discrete line lasers were available at fixed wavelengths throughout the bands. Since then, the availability of new nonlinear optical materials with wide band infrared transparency has made possible the construction of optical parametric oscillator (OPO) and mixer devices that operate continuously over the 2-6 μm and 8-12 μm bands. (Although tunable semiconductor sources such as the lead salt diodes and spin flip Raman lasers have recently been developed, we do not consider such devices in this report.)

In Section II, we discuss parametric oscillators. A review of the chronological development of wavelength coverage and a discussion of power output and efficiency vs wavelength are given. In Section III, we review recent work on tunable mixers. In Section IV, we calculate and discuss the theoretical performance of 11 nonlinear optical materials. In Section V we show, as an example, how the theoretical performance data can be used in selecting a pump wavelength and a nonlinear optical material for a singly resonant OPO operating in the 3-6 μm band. In the Appendices we include the refractive index data and Sellmeier equations for each nonlinear material and present the details of the computer program used for the calculations.

SECTION II

PARAMETRIC OSCILLATORS

A parametric oscillator generates two waves, a signal and an idler, from noise in a nonlinear crystal when properly excited by a laser pump beam. The energy and momentum conservation requirements on the pump, signal, and idler beams are:

$$\omega_p = \omega_s + \omega_i \quad \text{Energy Conservation} \quad (1)$$

$$\underline{k}_p = \underline{k}_s + \underline{k}_i \quad \text{Momentum Conservation} \quad (2)$$

The theoretical maximum efficiency of the process for generating signal energy is ω_s/ω_p and for idler energy is ω_i/ω_p (Figure 1). For the degenerate case, i.e. $\omega_i = \omega_s = \omega_p/2$, 100% conversion is possible to a single line. In practice, 67% conversion has been obtained in a degenerate oscillator³ and 100% conversion has been reported in the case of degenerate upconversion where the frequency of the pump is doubled.⁴ Detailed discussions of parametric oscillators are contained in References 5 and 6.

The chronological progress in spectral coverage for nonlinear devices is shown in Figure 2 for the visible and infrared region. The numbers in Figure 2 correspond to the reference numbers given in Table I and in the list of references at the end of this report. LiNbO_3 is the most commonly exploited material and has been used from the green to $3.7 \mu\text{m}$ where it is limited by absorption. The materials used for parametric oscillators must be transparent or low loss at the pump wavelength as well as the signal and idler; they must also have adequate optical quality to allow an oscillator cavity to be formed. Pumping LiNbO_3 ¹⁹ with different visible wavelengths

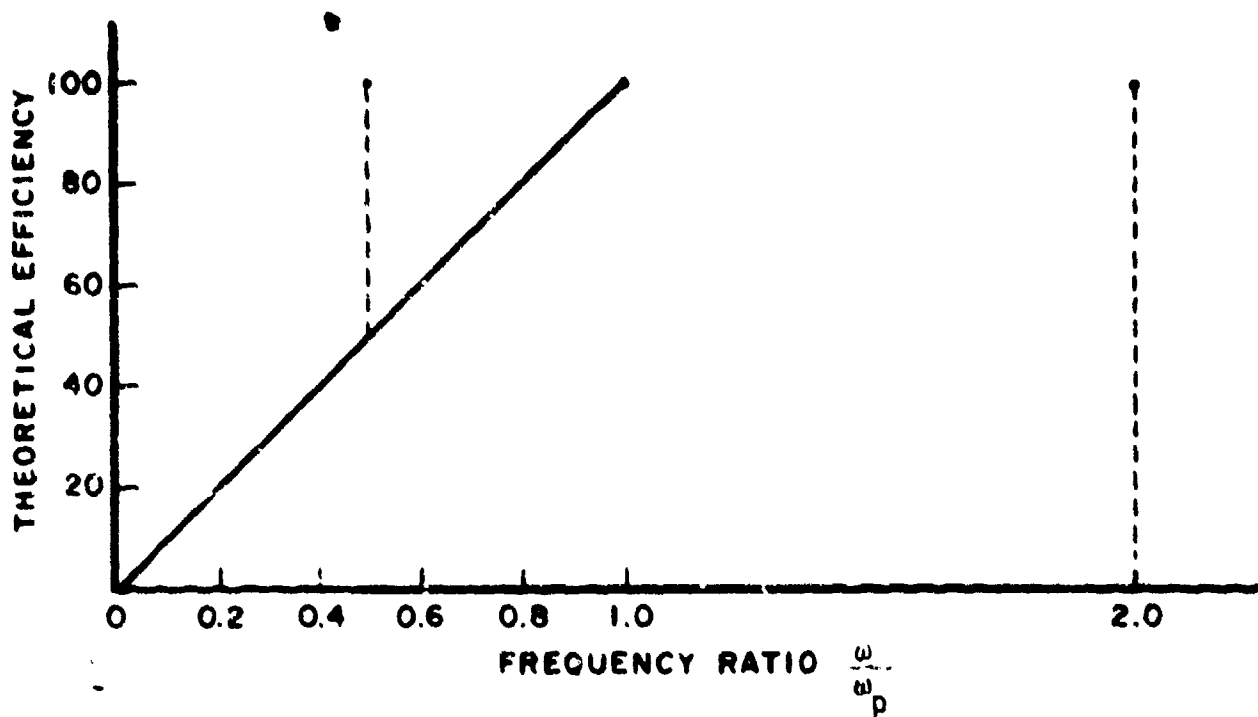


Figure 1. Theoretical Conversion Efficiency as a Function of the Ratio of the Generated Frequency to the Pump Frequency

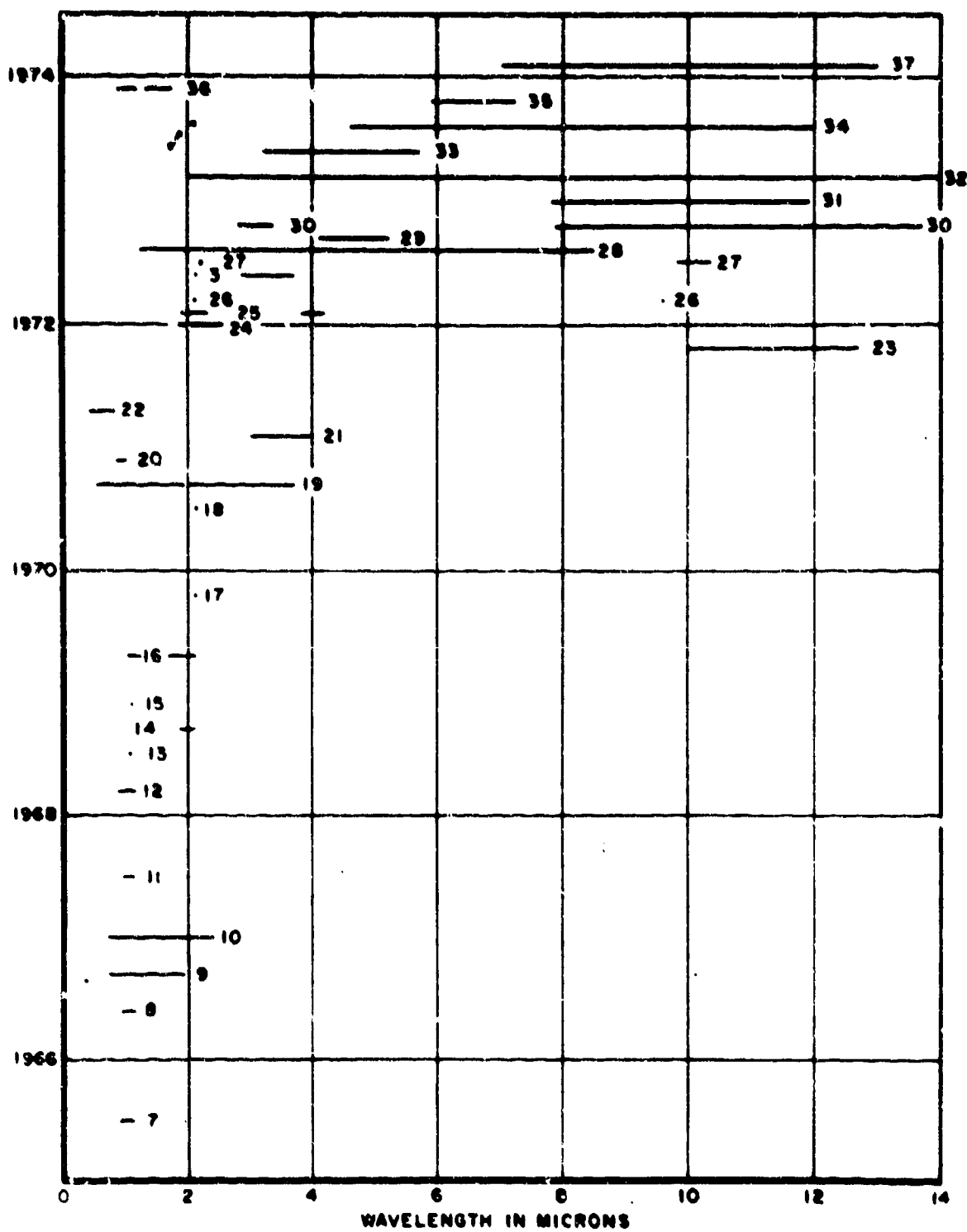


Figure 2. Chronological Development of Spectral Coverage

TABLE I. NONLINEAR EXPERIMENTS

REF.	PUMP LASER	PUMP POWER		PUMP PULSE LENGTH (ns)	TUNING TECHNIQUE	NONLINEAR MATERIAL	CAVITY		OUTPUT POWER OR ENERGY	OUTPUT PULSE LENGTH (ns)	REPEATITION RATE	WAVELENGTH COVERED (μ m)	REMARKS
		λ (μ m)	OR ENERGY				S - SRO	D - DRO					
7	Nd:CaWO ₄ doubled in LiNbO ₃	0.529	6.7 kW	Temperature	Temperature	LiNbO ₃	D		15W	15-40		0.97-1.15	
8	Nd:glass doubled in KDP	0.530		Angle	Angle	KDP	D		5kW			0.9575-1.1775	
9	Nd:CaWO ₄ Nd glass doubled	0.530	10 ⁵ W	Temperature	Temperature	LiNbO ₃	D		10 ³ W			0.7300-1.930	1% Peak Power Conversion
10	Nd:glass doubled	0.530	5x10 ⁴ W	Angle	Angle	LiNbO ₃	D		50W			0.684-2.355	0.1% Peak Power Conversion
11	Ruby	0.6943	3x10 ⁶ W	Electro-Optical and Angle	Electro-Optical and Angle	LiNbO ₃	D		38x10 ³ W			1 - 1.08	1% Peak Power Conversion
12	Nd:YAG doubled in Ba ₂ NbNb ₅ O ₁₅	0.532	300mW	Temperature	Temperature	Ba ₂ NbNb ₅ O ₁₅	D		1.5mW each direction	CW		0.98-1.06	1% Avg. Power Conversion
13	Ruby	0.6943	270kW	Fixed	Fixed	LiNbO ₃	D		60kW	20		1.04 + 2.08	22% Peak Power Conversion
	Ruby	0.6943	630kW	Fixed	Fixed	LiNbO ₃	S		41kW	-10		1.04	6% Peak Power Conversion
14	Argon	0.5145	1.148W	Temperature	Temperature	LiNbO ₃	D		1.4mW	CW		0.68-0.705 2.11-1.90	76% Pump Depletion
15	Ruby	0.6943	900kW	Fixed	Fixed	LiNbO ₃	S		250kW	2		1.06	28% Peak Signal Power Conversion
16	Ruby	0.6943	750kW	Angle and Temperature	Angle and Temperature	LiNbO ₃	S		340kW	10		1.64-2.05 1.20-1.05	25-45% Energy Depletion 45% Peak Power Conversion
17	Nd:YAG	1.06	200mW	Temperature	Temperature	LiNbO ₃	D		170W Peak 17 mW Avg	100	1-5kHz	2.13	8.5% Avg. Power Conversion
18	Nd:YAG	1.06		Temperature	Temperature	Ag ₃ AsS ₃	D			100	2 kHz	2.13	
19	Nd:YAG doubled in LiIO ₃	0.530 0.659 0.473-0.659		Temperature Temperature Temperature	Temperature Temperature Temperature	LiNbO ₃ LiNbO ₃ LiNbO ₃	S S S		70-105mW		1kHz 50 pps 50 pps	0.68-0.77 0.9-2.0 0.55-3.65	(67% Pump Depletion (46% Avg. Power Conversion
20	Nd:YAG	1.06		Temperature	Temperature	LiNbO ₃	D		95mW			0.92 to 0.98	OPO and Doubler Simultaneously
21	Ruby and Dye		4mW			LiNbO ₃	M		6kW			3 - 4	
22	Nd:YAG doubled and redoubled	0.2662	200kW	Temperature	Temperature	ADP	Parametric Generator		100 kW Peak 5 mW Avg	2	30 pps	0.42-0.73	25% Avg. Power Conversion
23	Ruby and Dye					Ag ₃ AsS ₃	M					10.1-12.7	
24	Nd:CaWO ₄	1.065	80kW	Angle	Angle	Ag ₃ AsS ₃	D		11W	25	2 pps	1.82-2.56	Peak Power Conversion >1%
25	Nd:YAG	1.064 1.064	1.7J/ Pulse 1.7J/ Pulse	Angle Angle	Angle Angle	LiIO ₃ LiIO ₃	D S		13kW Peak 20mW Avg 0.2mJ/pulse	15	80 pps	1.95-2.34 3.8-4.2	Internal Internal
26	Nd:YAG	1.833	2.4kW	Angle	Angle	CdSe	S		180W			2.2 & 9.6	40% Pump Depletion

22	Nd:YAG doubled and redoubled	0.2662	200kW	temperature	3	ADP	Ag ₃ AsS ₃	M	100 kW Peak 5 mm Avg	Parametric Generator	2	30 pps	0.42-0.73	25% A.g. Power Conversion
23	Ruby an. Dye						Ag ₃ AsS ₃	M					10.1-12.7	
24	Nd:CaWO ₄	1.065	80kW	Angle	26	Ag ₃ AsS ₃	D		13W		25	2 pps	1.82-2.56	Peak Power Conversion >15
25	Nd:YAG	1.064	1.7J/ Pulse	Angle	100	LiIO ₃	D		13W Peak 20W Avg 0.2mJ/Pulse		15	80 pps	1.95-2.34	Internal
		1.064	1.7J/ Pulse	Angle	100	LiIO ₃	S						3.8-5.2	Internal
26	Nd:YAG	1.833	2.4kW	Angle		CdSe	S		180W				2.2 & 9.5	40% Pump Depletion
3	Nd:YAlO ₃	1.08	1.3W Avg	Temperature		LiNbO ₃	D		10W Peak 1.2W Avg		2	4kHz	2.1	Internal
	Nd:YAlO ₃	1.08		Temperature		LiNbO ₃	D		500mW Avg				1.8-2.7	Internal - 2 lines
	Nd:YAlO ₃	1.08	2.65W	Temperature		LiNbO ₃	D		6W Peak 1.8W Avg		35	9kHz	2.1	Internal - 67% Avg. Power Conversion
	Nd:YAlO ₃	1.08		Temperature		LiNbO ₃	S		160-60W Peak 50-200 mW Avg		20	5.5kHz	2.84-3.71	Internal
27	Nd:YAG	1.833	5kW	Angle	300	CdSe	S					5 pps	2.2 & 9.8-10.4	40% Pump Depletion
28	Nd:CaWO ₄	1.065		Angle	25	Ag ₃ AsS ₃	S		100 W @ 4.5 μ				1.22 - 8.5	Noncollinear
29	Ru. and Dye		4W			LiIO ₃	M		100 W				4.1 - 5.2	
30	CaF ₂ :Dy ²⁺	2.36	100kW	Angle	60	CdSe	S		22.5kW		40		7.88 - 13.7 2.8 - 3.56	15% Energy Conv. at 90° 4% Energy Conv. at 60°
31	OPO	1.87-2.47	100W			Ag ₃ AsS ₃	M						7.8 - 11.9	
32	2 Dye Lasers + Raman from Potassium Metal Vapor					Potassium	M		100mW Peak				2 - 20	
33	Ruby and Dye					Ag ₃ AsS ₃	M						3.2 - 5.65	
34	Ruby and Dye		1MW		10	AgGaS ₂	M						4.6 - 12	
35	Ruby and Dye					AgAsS ₃	M						5.82 - 7.25	
36	Dye	0.586-0.605	6.3mJ/ Pulse	Dye Tuning		LiNbO ₃	S		0.12 mJ/Pulse 160W			20 pps	0.9 - 1.15 1.3 - 1.7	32% Pump Depletion
37	LiNbO ₃ OPO + 1.318 Nd:YAG					AsGaSe ₂	M						7 - 13	

yielded spectral coverage from 0.548 to 3.65 μm ; more recently, pumping LiNbO_3 with an electronically tunable dye laser³⁶ offered rapid selection of wavelengths in the near IR. Proustite (Ag_3AsS_3) pumped by Nd: CaWO_4 provided coverage out to 8.5 μm ;²⁸ CdSe pumped by $\text{CaF}_2:\text{Dy}^{2+}$ reached 13.7 μm .³⁰ Ammann, Yarborough and Falk²⁰ achieved simultaneous optical parametric oscillation and frequency doubling of the signal in LiNbO_3 pumped by 1.06 μm to generate wavelengths higher than the initial pump. Hence, the infrared and visible spectrum of interest can be covered by parametric oscillators.

The highest IR peak powers (Figure 3) were obtained from parametric oscillators pumped by ruby lasers,^{11,13,15,16} followed by the CdSe oscillator pumped by $\text{CaF}_2:\text{Dy}^{2+}$.³⁰ Peak powers up to 15 kilowatts have been obtained from parametric oscillators pumped by neodymium lasers. In contrast, all the high average power parametric oscillators have been pumped by neodymium lasers capable of high repetition rate performance (Figure 4). The only parametric oscillator shown in Figure 4 that was not pumped by neodymium was a CW argon laser-pumped lithium niobate oscillator.¹⁴ It should also be noted that the parametric oscillators of References 3 and 20 were internal parametric oscillators that exposed the oscillator to the total laser flux in the cavity. The parametric oscillator of Reference 19 was pumped in the green which resulted in 90° phase matching for high average power performance.

In Figure 5, power conversion efficiency for the various parametric oscillators is shown. The highest efficiency was that of the previously mentioned degenerate oscillator³ at 2.16 μm . Power conversion efficiency of 46% from a 0.659 μm pump to two tunable outputs was reported.¹⁹ A 45% peak power conversion to the signal was obtained in a ruby-pumped singly resonant oscillator.¹⁶ Conversion efficiency of 40% as measured by pump depletion

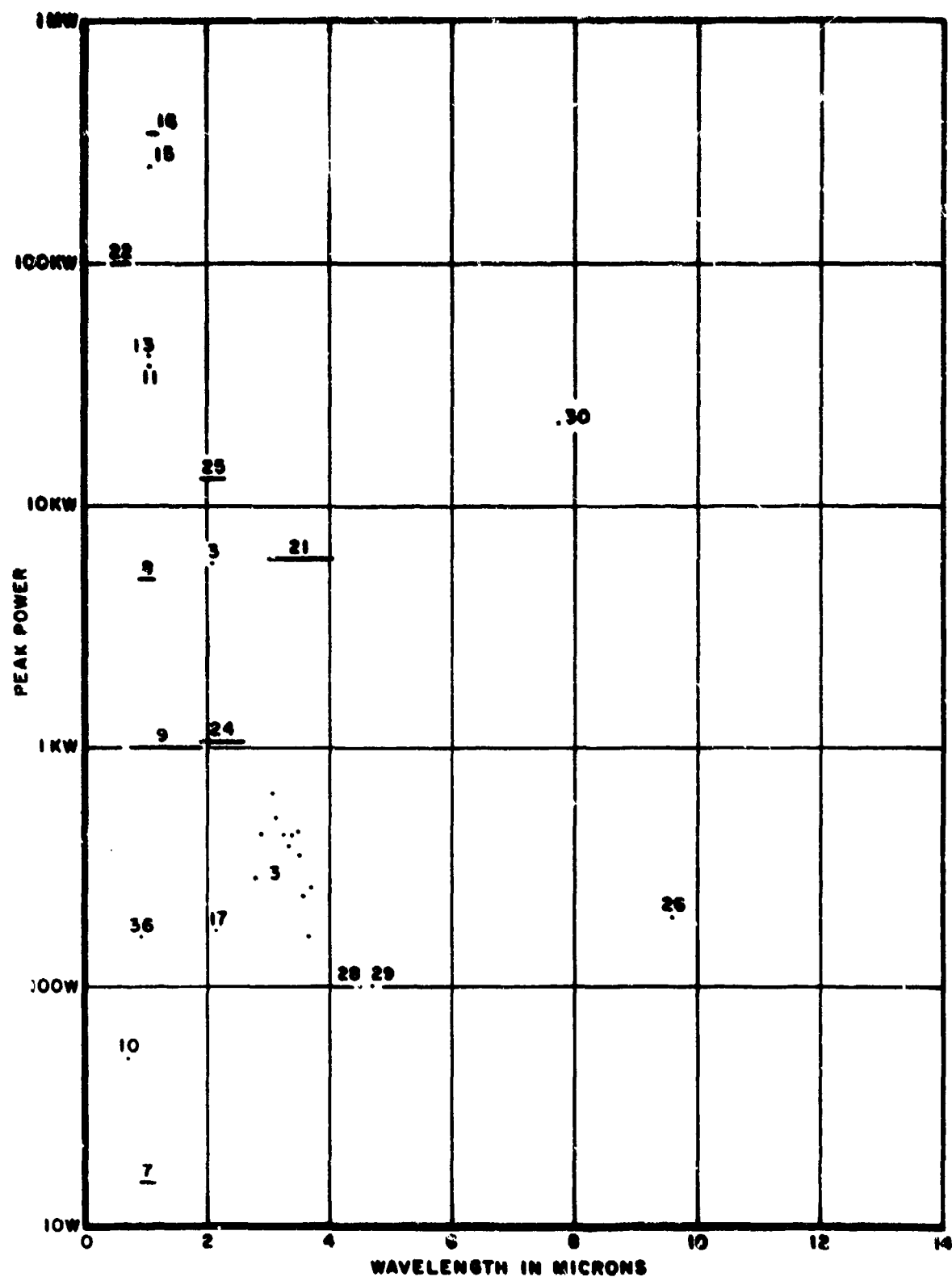


Figure 3. Peak Power vs Wavelength

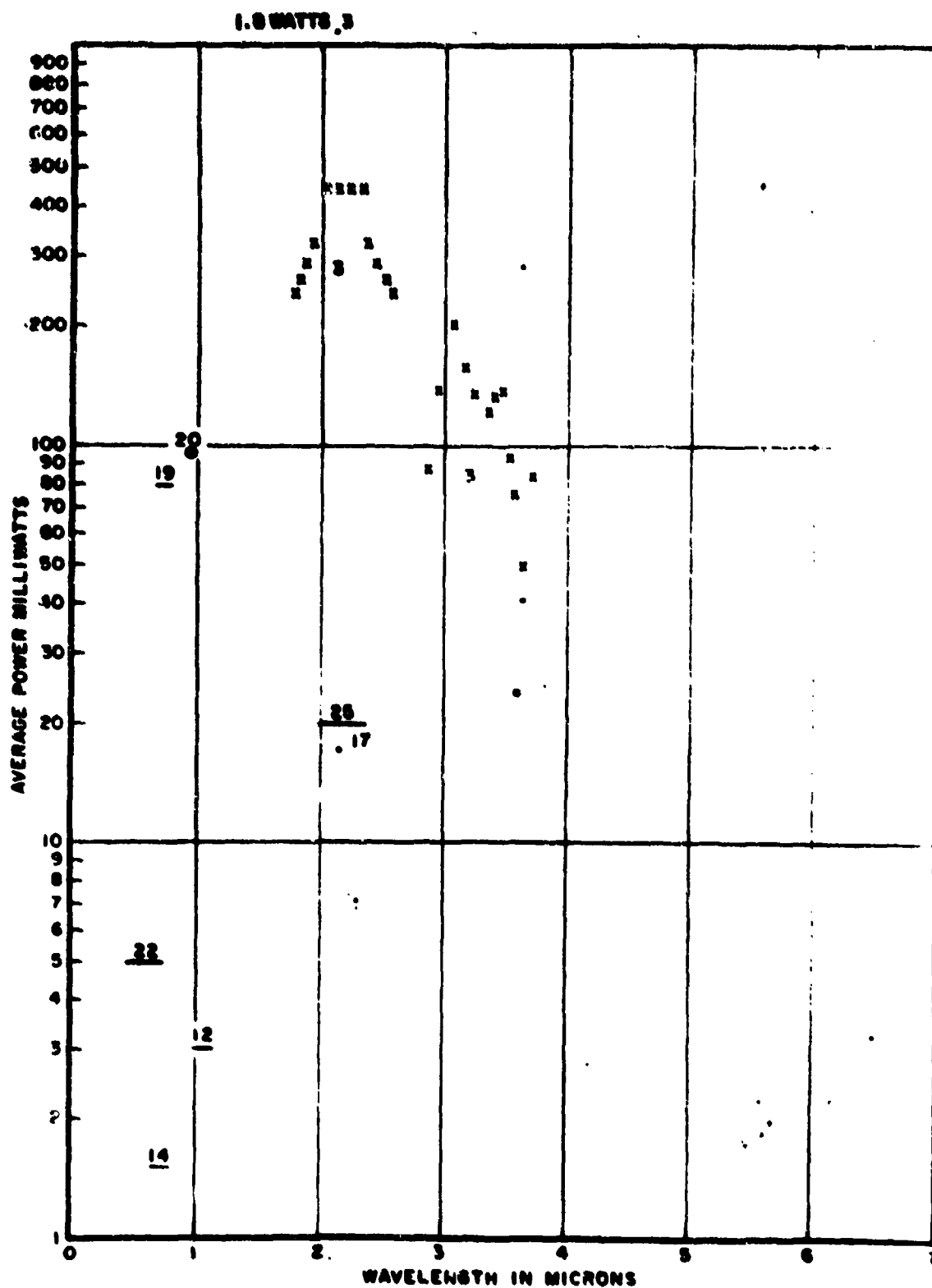


Figure 4. Average Power vs Wavelength

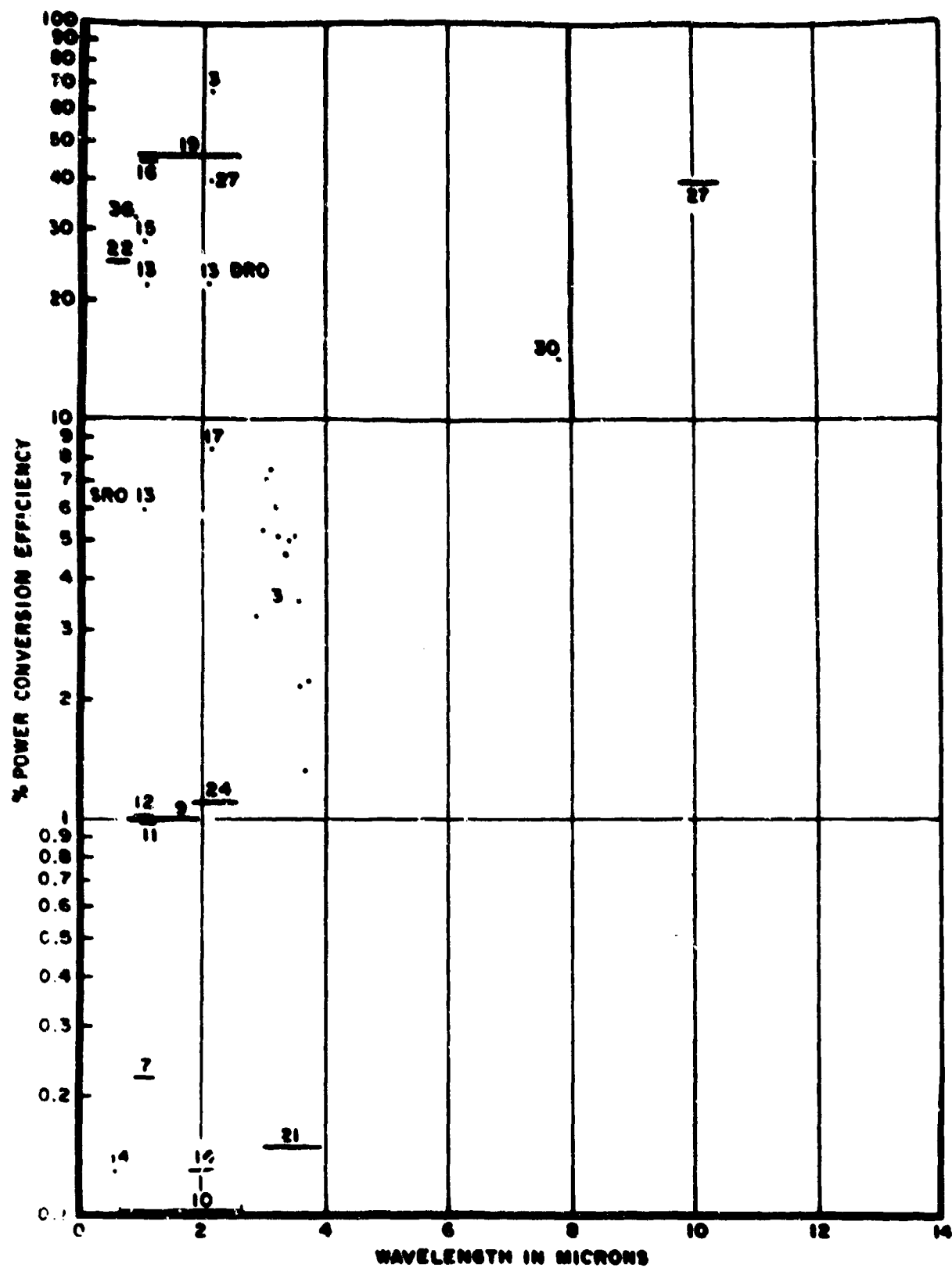


Figure 5. Power Conversion Efficiency vs Wavelength

was reported²⁷ for an oscillator with the signal resonated. The various means of reporting power conversion efficiencies were not totally self consistent, and in some cases, an interpretation was required. For explicit details on the efficiencies see the references and Table I.

There are three ways commonly cited to give an idea of the power conversion efficiency. Average power conversion efficiency is the ratio of the average output power of the parametric oscillator to the average input power of the pump. Peak power conversion refers to the ratio of the peak power of the parametric oscillator to that of the pump. Note from Table I that the pulse length of the oscillator is frequently shorter than that of the laser pump; this results in an apparent higher efficiency for peak power conversion because of pulse compression. Pump depletion is a measure of the amount of energy lost from the pump in passing through the parametric oscillator. This lost energy is converted to signal and idler energy in the parametric oscillator as well as absorbed and scattered in the parametric oscillator elements. Hence, not all energy measured by pump depletion is transformed to useful parametric oscillator output.

Parametric oscillators of lithium niobate have been tuned by angle, by temperature, and by the electrooptic effect (Table I). The bringing of the crystal to thermal equilibrium at new temperatures changes the indices of refraction, and hence, the frequency of the parametric oscillator. This process is a slower tuning technique than that of merely rotating the crystal. The technique of changing parametric oscillator frequency by changing the wavelength of the dye laser pump has been recently demonstrated using an acousto-optic filter.³⁶ This offers random frequency selection within the limits of the dye laser pump and maximum flexibility since

frequencies can be shifted on a pulse to pulse basis. Electrooptic effect tuning¹¹ demonstrated a frequency shift of $6.2 \text{ A}^\circ/\text{kV/cm}$ in LiNbO_3 , so it cannot be effectively used for large frequency excursions because of the voltage involved.

Bjorkholm succinctly points out¹³, "The advantage of a singly resonant oscillator is that it should be much more nearly continuously tunable than a doubly resonant oscillator. In the latter, because of the accidental distribution of the signal and idler cavity modes, frequency excursions from the operating point predicted by index-matching data can be large with respect to the axial mode spacing of the oscillator ($\sim 0.1 \text{ A}^\circ$). For the singly resonant oscillator, the tuning discontinuities should be no larger than one-half the mode spacing." In another article¹⁵ Bjorkholm remarks that the tunability of the SRO is at least five times and probably an order of magnitude more accurate than the tunability of the DRO.

SECTION III

TUNABLE MIXERS

Coherent infrared radiation can also be produced as the difference frequency generated when two coherent sources, the pump and the signal waves, are mixed in a suitable nonlinear crystal at the proper phase matching angle. Table II lists typical pump wavelengths and corresponding signal wavelengths required to generate IR wavelengths from 2 to 12 μm . Again, the energy and momentum relationships ($\omega_p - \omega_s = \omega_i$ and $\underline{k}_p - \underline{k}_s = \underline{k}_i$, respectively) must be satisfied to have efficient power transfer.

Most experiments to date have utilized single pass systems which do not require optical cavities and associated mirrors. Such systems offer the advantage of simplicity, but sacrifice the more efficient utilization of input power through multiple reflections in the cavity. However, crystals of very high optical quality are required for use in optical parametric oscillators, whereas poorer quality crystals can be used in mixers.

In January 1971, Dewey and Hocker²¹ reported infrared difference frequency generation by mixing the inputs of a Q-switched ruby laser and a tunable dye laser in a LiNbO_3 crystal. In their experiment, the output of an unpolarized Q-switched ruby laser was separated into two parts by a beam splitter. One beam pumped a tunable dye laser. The output from the dye laser was then combined with the second part of the ruby beam and directed into the LiNbO_3 crystal which was rotated to maintain the proper phase matching angle for different wavelengths. Pulses of approximately 6 KW of peak power were produced in the 3 to 4 μm range for an initial input of 4 MW from the ruby laser.

TABLE II. SIGNAL WAVELENGTHS REQUIRED TO GENERATE IR WAVELENGTHS FROM 2 TO 12 μm FOR SPECIFIED PUMP WAVELENGTHS

λ_i (μm)	λ_p (μm)	λ_s (μm)	λ_p (μm)	λ_s (μm)	λ_p (μm)	λ_s (μm)	λ_p (μm)	λ_s (μm)
2.0	0.53	0.419 0.721	0.694	0.515 1.063	0.946	0.642 1.795	1.06	0.693 2.255
3.0		0.450 0.644		0.564 0.903		0.719 1.382		0.783 1.639
4.0		0.468 0.611		0.591 0.840		0.765 1.239		0.838 1.442
5.0		0.479 0.593		0.609 0.806		0.795 1.167		0.875 1.345
6.0		0.487 0.561		0.622 0.785		0.817 1.123		0.901 1.287
7.0		0.493 0.573		0.631 0.770		0.833 1.094		0.921 1.249
8.0		0.497 0.568		0.639 0.760		0.846 1.073		0.936 1.222
9.0		0.501 0.563		0.644 0.752		0.856 1.057		0.948 1.202
10.0		0.503 0.560		0.649 0.746		0.864 1.045		0.958 1.186
11.0		0.506 0.557		0.653 0.741		0.871 1.035		0.967 1.173
12.0		0.508 0.554		0.656 0.737		0.877 1.027		0.974 1.163
2.0	1.30	0.788 3.714	1.83	0.956 21.53	2.10	1.024 ---		
3.0		0.907 2.294		1.137 4.692		1.235 7.000		
4.0		0.981 1.926		1.256 3.373		1.377 4.421		
5.0		1.032 1.757		1.340 2.886		1.479 3.621		
6.0		1.068 1.660		1.402 2.633		1.556 3.231		
7.0		1.096 1.597		1.451 2.478		1.615 3.000		
8.0		1.118 1.552		1.489 2.373		1.663 2.847		
9.0		1.136 1.519		1.521 2.297		1.703 2.739		
10.0		1.150 1.494		1.547 2.240		1.736 2.658		
11.0		1.163 1.474		1.569 2.195		1.763 2.596		
12.0		1.173 1.458		1.588 2.159		1.787 2.545		

The dye laser mixing technique was extended further into the IR region by Hanna, Smith, and Stanley¹⁰ when they reported (December 1971) that they had mixed the outputs of a ruby laser and a tunable dye laser (pumped by the ruby laser) in a proustite crystal to generate peak powers of a few watts at approximately 5 μm and over a range of 10.1 to 12.7 μm .

In June 1972, Meltzer and Goldberg²⁹ obtained tunable difference frequency generation in LiIO_3 over a range of 4.1 to 5.2 μm . They mounted the LiIO_3 crystal inside the dye laser cavity. The dye cell was pumped by a ruby laser and tuned with a diffraction grating. Phase matching was achieved by rotation of the crystal. IR output pulses of approximately 100 W peak power at 4.7 μm were obtained for a total ruby laser input of 4 MW. The dye laser power was approximately 70 kW.

In December 1972, Bhar, Hanna, Luther-Davies, and Smith³¹ reported the use of an OPO as their tunable source to generate two input wavelengths which, when mixed in a proustite crystal, produced tunable IR radiation over a range of 7.8 to 11.9 μm . The OPO was tuned from 1.87 to 2.47 μm . The total input power to the crystal was approximately 100 W.

Down-converted IR radiation from 4.6 to 12 μm was reported by Hanna, Rampal and Smith³⁴ in June 1973 when they mixed a ruby laser beam in silver thiogallate (AgGaS_2) with the output of various ruby-pumped dye lasers. The Q-switched ruby laser produced a peak output power of 1 MW (TEM_{00} mode) with a pulse duration of 10 nsec (fwhm). Part of this power was separated by a beam splitter and was used to pump the dye laser. Four separate dyes were used to cover the 4.6 to 12 μm spectral range. Peak powers of hundreds of milliwatts were produced.

Decker and Tittel^{33,35} reported (April 1973 and July 1973) tunable difference frequency generation in proustite over the range 3.2 to 5.65 μm with a Q-switched ruby laser and tunable dye laser and over the range 5.82 to 7.25 μm with the outputs of two independent ruby pumped dye lasers. Peak IR powers up to several KW were obtained.

Byer, Choy, Herbst, Chemla, and Feigelson³⁷ recently reported (January 1974) continuously tunable IR difference frequency generation in silver gallium selenide (AgGaSe_2) over the range 7 to 13 μm by mixing the outputs from a LiNbO_3 parametric oscillator. A 1.318 μm output from a Nd:YAG laser was doubled by a LiIO_3 crystal to obtain 0.659 μm which in turn pumped a LiNbO_3 temperature-tuned oscillator to produce a 1.62 to 1.47 μm signal. This signal was matched with the 1.318 μm pump to produce the 7 to 13 μm IR radiation.

Tunable coherent infrared radiation produced in a four-wave mixing process was reported in April 1973 by Sorokin, Wynne, and Lankard³². The mixing process was achieved by utilizing resonant enhancement of a third order optical nonlinearity in an alkali metal vapor (potassium at 500°C). A 100 kW nitrogen laser was used to simultaneously pump two dye lasers whose outputs were focused into a heat pipe oven containing the metal vapor. The beam from the first dye laser at frequency ω_1 , which was tuned to the 4s-5p resonance lines of potassium (0.404 μm), induced radiation (a Stokes wave) at frequency ω_2 by stimulated Raman scattering between the 5p-5s levels. The beam from the second dye laser at frequency ω_3 then "beat" together with the first two waves to create a fourth wave at frequency ω_4 (in the infrared) such that $\omega_4 = \omega_1 - \omega_2 - \omega_3$ (the energy matching relationship). The corresponding momentum relationship that had to be

satisfied was $\Delta n_4 \omega_4 = \Delta n_1 \omega_1 - \Delta n_2 \omega_2 - \Delta n_3 \omega_3$ where Δn is the dispersion in the refractive index. By changing the laser dyes and by mixing small amounts of other gases with the potassium vapor, it was possible to obtain continuously variable wavelengths from 2 to 20 μm . IR peak power outputs up to 100 mW were obtained.

Mixing experiments reported to date have demonstrated the feasibility of generating tunable infrared coherent radiation at very low power levels in a number of different materials. For the most part, pump sources have been single shot or low repetition rate lasers with outputs in the visible. To achieve worthwhile power levels requires that the two input sources, one of which must be tunable, operate in the 1-2.5 μm region for increased efficiency. The lack of a suitable high power tunable source at these wavelengths is a serious limitation at present.

SECTION IV

THEORETICAL PERFORMANCE OF NONLINEAR OPTICAL MATERIALS

The theory of parametric interaction of confocally focused light beams³⁸ was used to provide a basis for comparing materials for parametric generation of tunable radiation in the 2-6 and 8-12 μm regions. The effects of walkoff due to birefringence were taken into account.

The materials used in the comparison are listed in Table III along with the nonlinear coefficients used in the calculations. The refractive indices used were obtained from the references also listed in Table III. For completeness we have compiled in Appendix A the room temperature index data and Sellmeier equations for each material. The list of materials is not comprehensive but does contain materials already used in nonlinear optical devices as well as several promising materials recently synthesized. Of the 11 materials listed in Table III, only LiNbO_3 and LiIO_3 are commercially available. All the other materials are in various stages of development. Of the nine non-commercially available materials listed in Table III, both Ag_3AsS_3 ^{18,24,28} and CdSe ^{26,27,30} have been used in infrared parametric oscillators. Also, Ag_3AsS_3 ,^{31,33,35} AgGaS_2 ,³⁴ and AgGaSe_2 ³⁷ have been used for infrared mixing. These materials, then, may be considered to be the most advanced of the nine experimental nonlinear materials.

In Figures 6 to 12, curves of the parametric gain per watt of pump power as a function of oscillator output wavelength are given for the pump wavelengths 0.694, 0.946, 1.06, 1.3, 1.83, 2.1, and 5.3 μm , respectively. All of the materials of Table III that can be phase matched and which are transparent at a given pump wavelength are included in each figure. A crystal length of one cm was assumed in all cases. Each curve extends over

TABLE III NONLINEAR OPTICAL MATERIALS

Material	Crystal Class	Birefringence Type	NLO Coefficients ($\times 10^{12}/\epsilon_0$, m/V)	Refractive Indices	$d_{\text{eff}}(\theta)$
AgGaS ₂	$\bar{4}2m$	Negative	$ d_{36} = 12$ (Ref 39) $ d_{14} = d_{36} $	Ref. 39,40	$ d_{36} \sin\theta$ (Type I)
AgGaSe ₂	$\bar{4}2m$	Negative	$ d_{36} = 33$ (Ref 41) $ d_{14} = d_{36} $	Ref. 41,42	$(d_{14} + d_{36}) \sin\theta \cos\theta$ (Type II)
CdGeAs ₂	$\bar{4}2m$	Positive	$ d_{14} = 236$ (Ref 43)	Ref. 43,44	$ d_{14} \sin 2\theta$ (Type I)
ZnGeP ₂	$\bar{4}2m$	Positive	$ d_{14} = 75$ (Ref 45)	Ref. 45	$ d_{14} \sin\theta$ (Type II)
HgS	32	Positive	$ d_{11} = 50$ (Ref 46) $ d_{14} = 0$	Ref. 47,48	$ d_{11} \cos^2\theta + d_{14} \sin 2\theta$ (Type I) $ d_{11} \cos\theta$ (Type II)
Ag ₃ AsS ₃	3m	Negative	$ d_{21} = 25.6$ (Ref 49) $ d_{31} = 16.0$	Ref. 48,50	$ d_{21} \cos\theta + d_{31} \sin\theta$ (Type I) $ d_{21} \cos^2\theta$ (Type II)
Ag ₃ SbS ₃	3m	Negative	$ d_{21} = 13.4$ (Ref 51) $ d_{31} = 12.6$	Ref. 52	
LiNbO ₃	3m	Negative	$ d_{21} = 3.6$ (Ref 53) $ d_{31} = 6.25$	Ref. 48,54	
Tl ₃ AsSe ₃	3m	Negative	$ d_{21} = 44.2$ (Ref 55) $ d_{31} = 41.6$	Ref. 55	
LiIO ₃	6	Negative	$ d_{31} = 7.5$ (Ref 56) $ d_{14} = 0$	Ref. 56,57	$ d_{31} \sin\theta$ (Type I) $ d_{14} \sin\theta \cos\theta$ (Type II)
CdSe	6mm	Negative	$ d_{31} = 19$ (Ref 58)	Ref. 31	$ d_{31} \sin\theta$ (Type I) 0 (Type II)

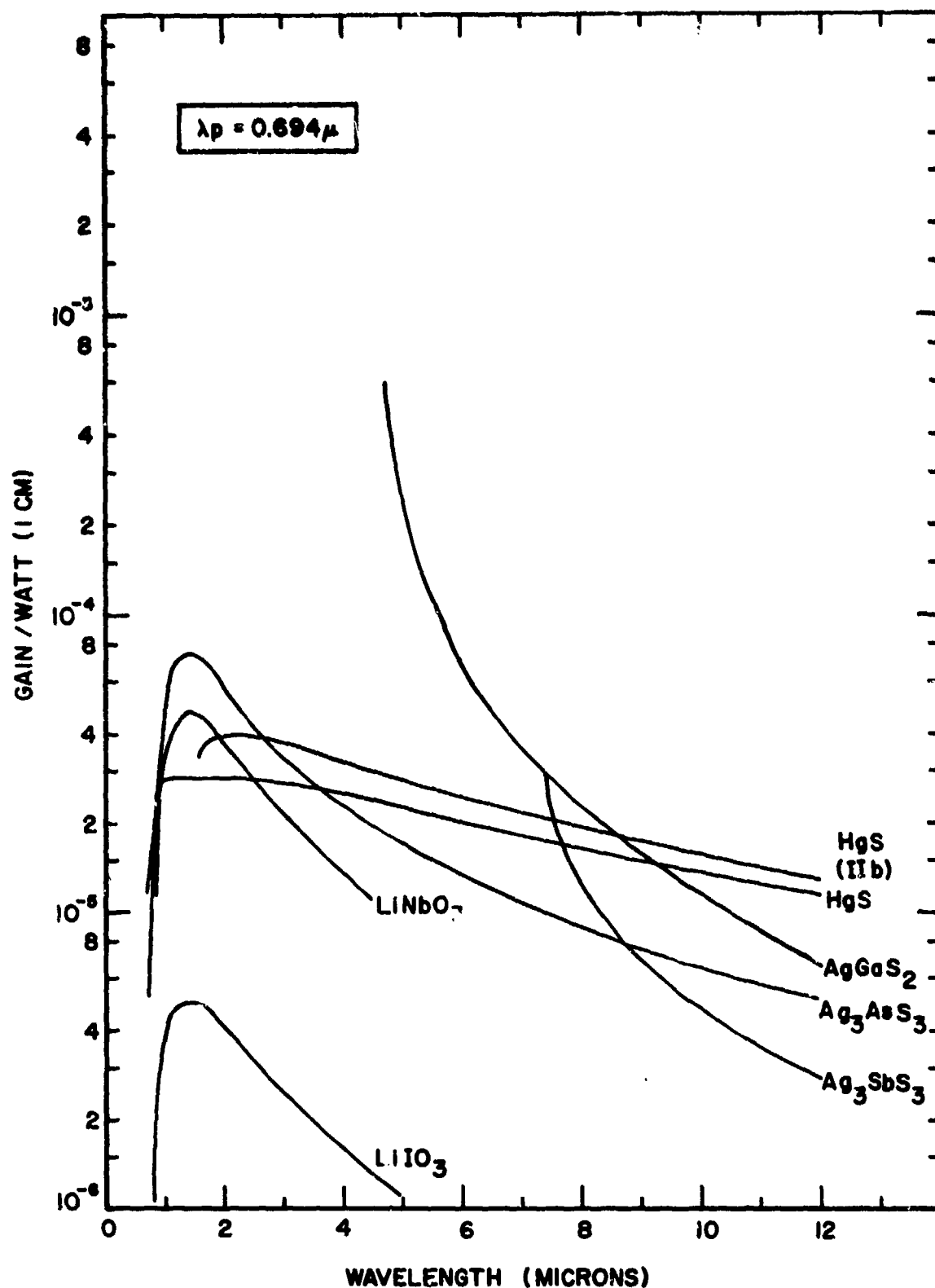


Figure 6. Parametric Gain Per Watt vs Output Wavelength for a Pump Wavelength of $0.694 \mu\text{m}$. A Crystal Thickness of 1 cm is Assumed. Curves are for Type I Phase Matching Unless Otherwise Noted.

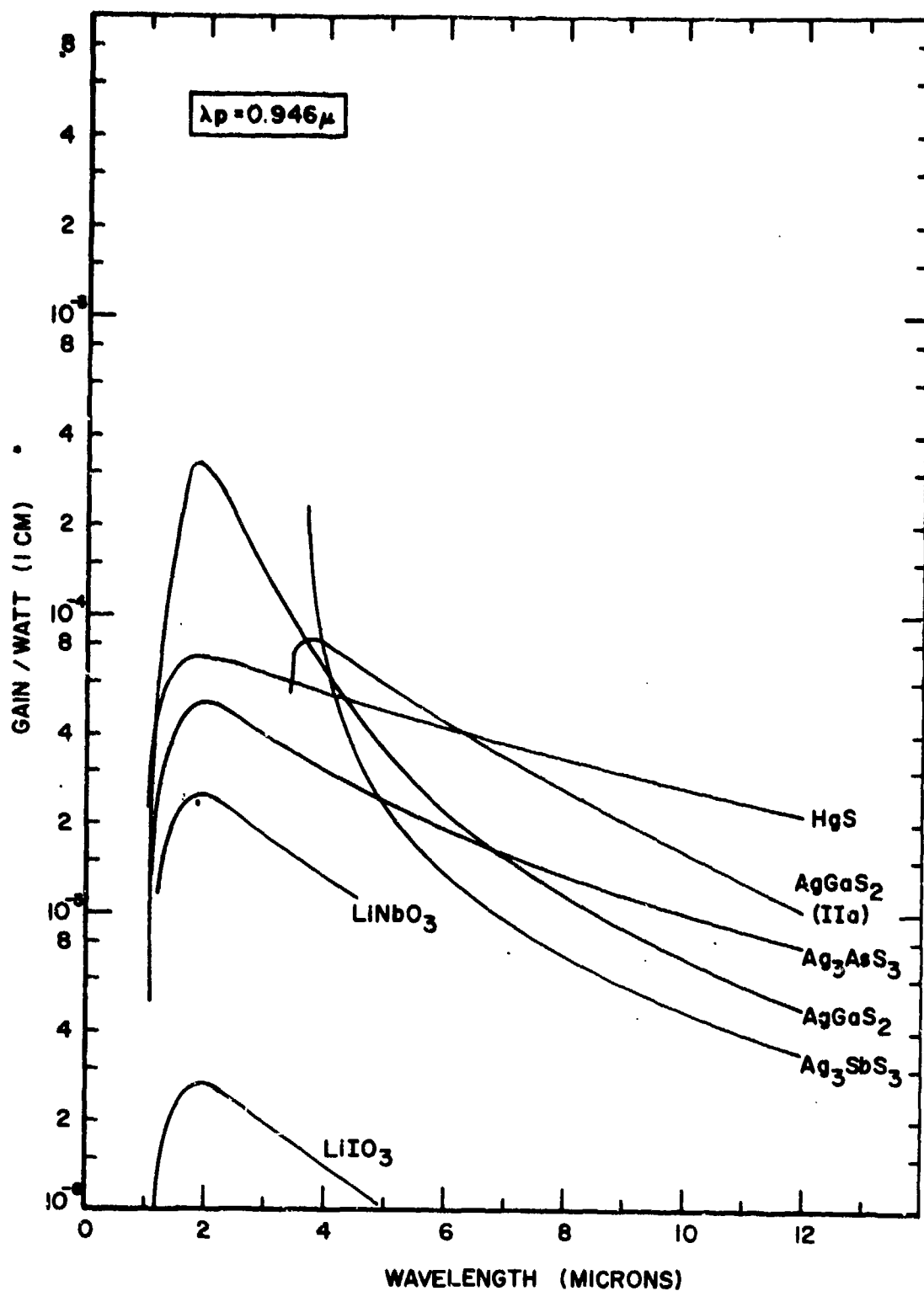


Figure 7. Parametric Gain Per Watt vs Output Wavelength for a Pump Wavelength of 0.946 μ m. Curves are for Type I Phase Matching Unless Otherwise Noted.

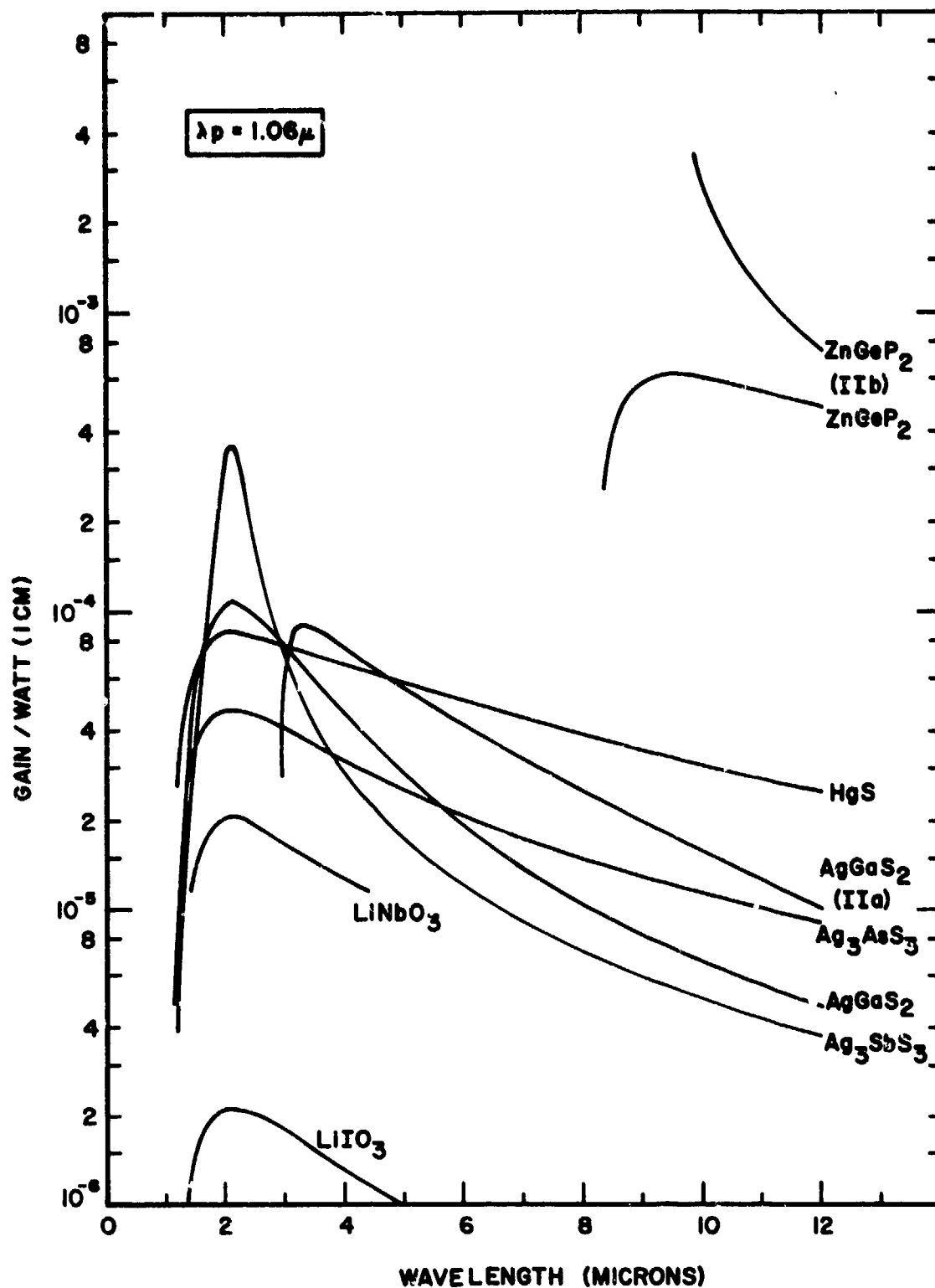


Figure 8. Parametric Gain Per Watt vs Output Wavelength for a Pump Wavelength of 1.06μ . Curves are for Type I Phase Matching Unless Otherwise Noted.

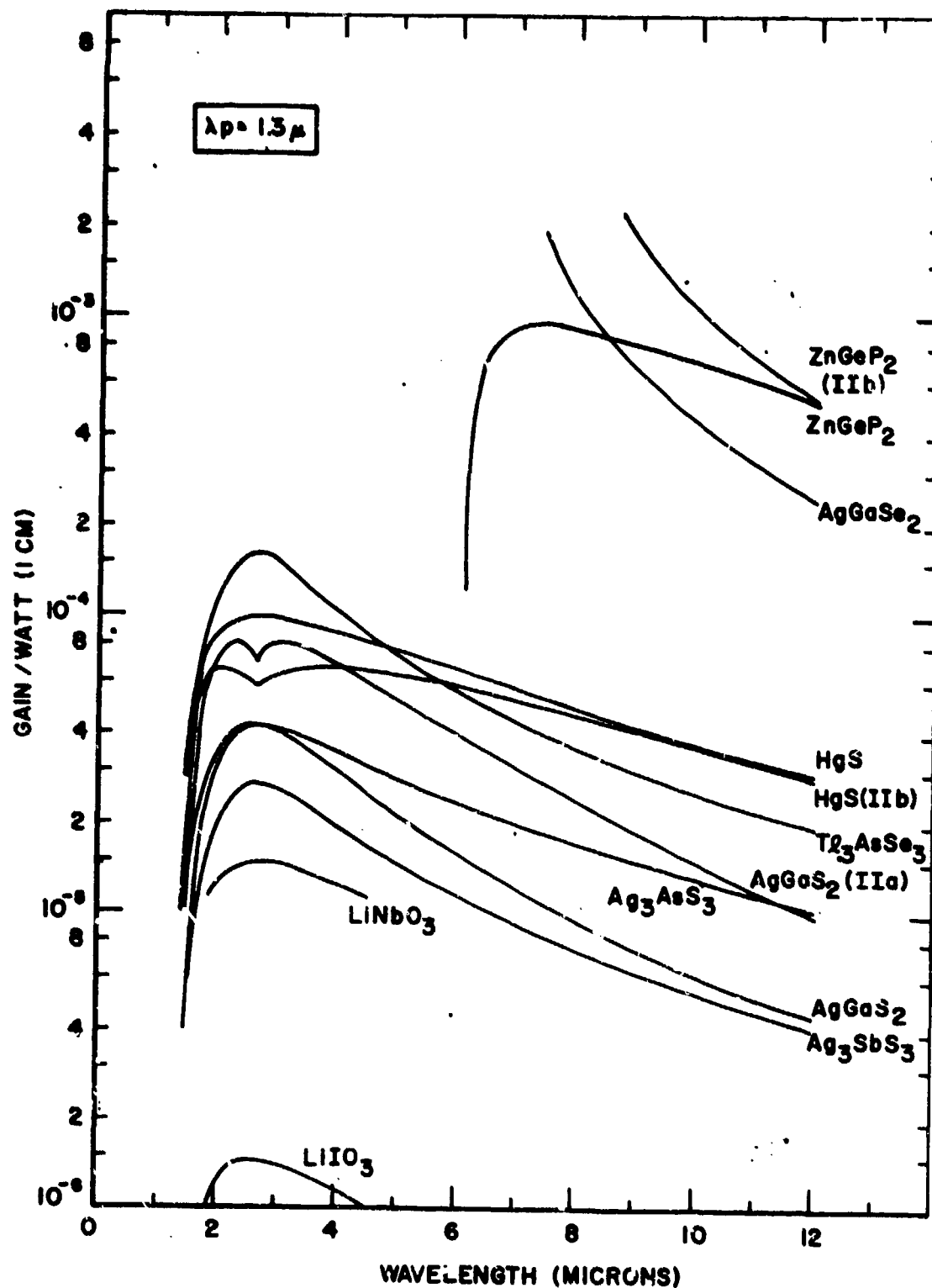


Figure 9. Parametric Gain Per Watt vs Output Wavelength for a Pump Wavelength of 1.3μ . Curves are for Type I Phase Matching Unless Otherwise Noted.

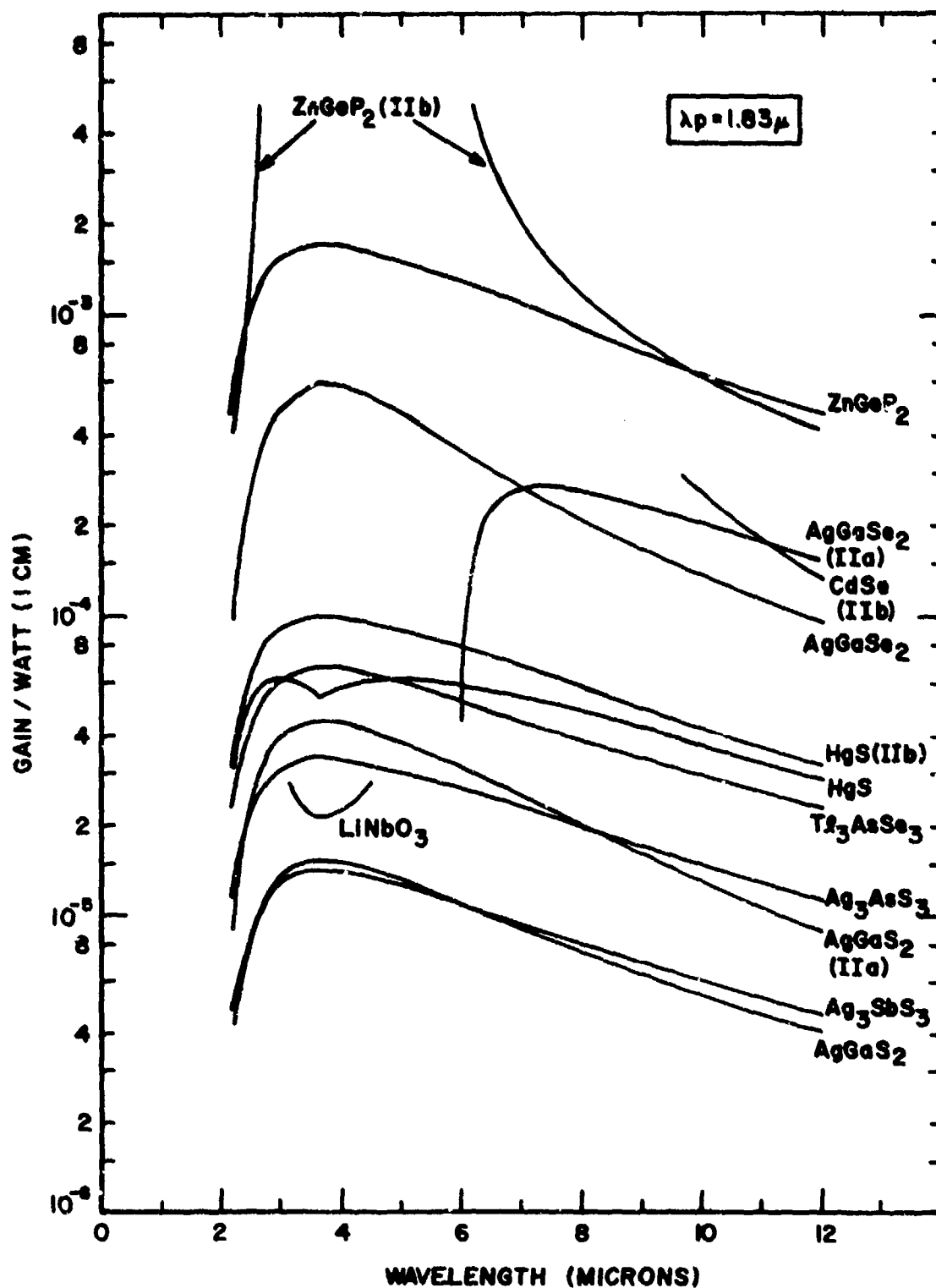


Figure 10. Parametric Gain Per Watt vs Output Wavelength for a Pump Wavelength of 1.83 μ m. Curves are for Type I Phase Matching Unless Otherwise Noted.

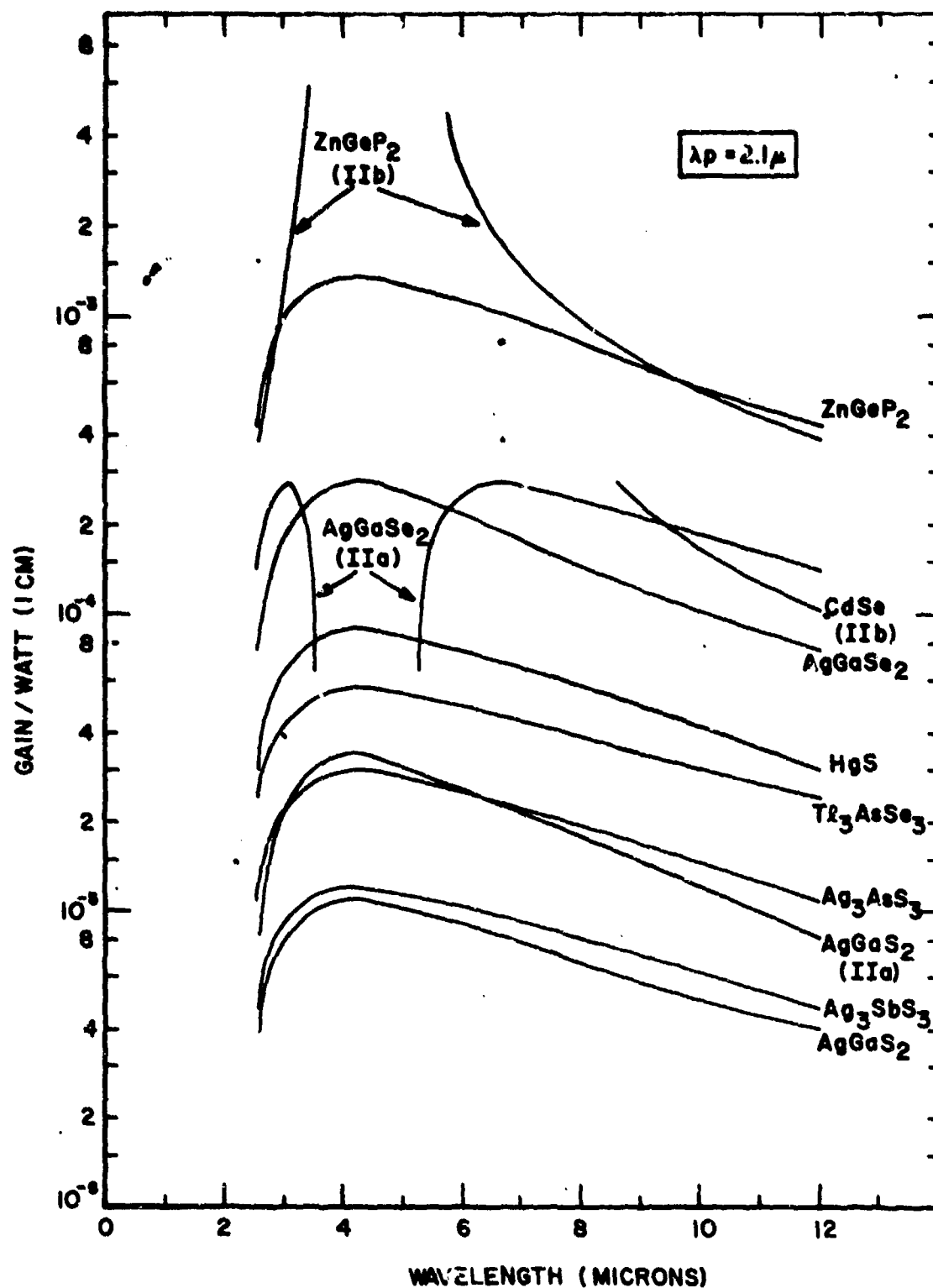


Figure 11. Parametric Gain Per Watt vs Output Wavelength for a Pump Wavelength of 2.1 μ m. Curves are for Type I Phase Matching Unless Otherwise Noted.

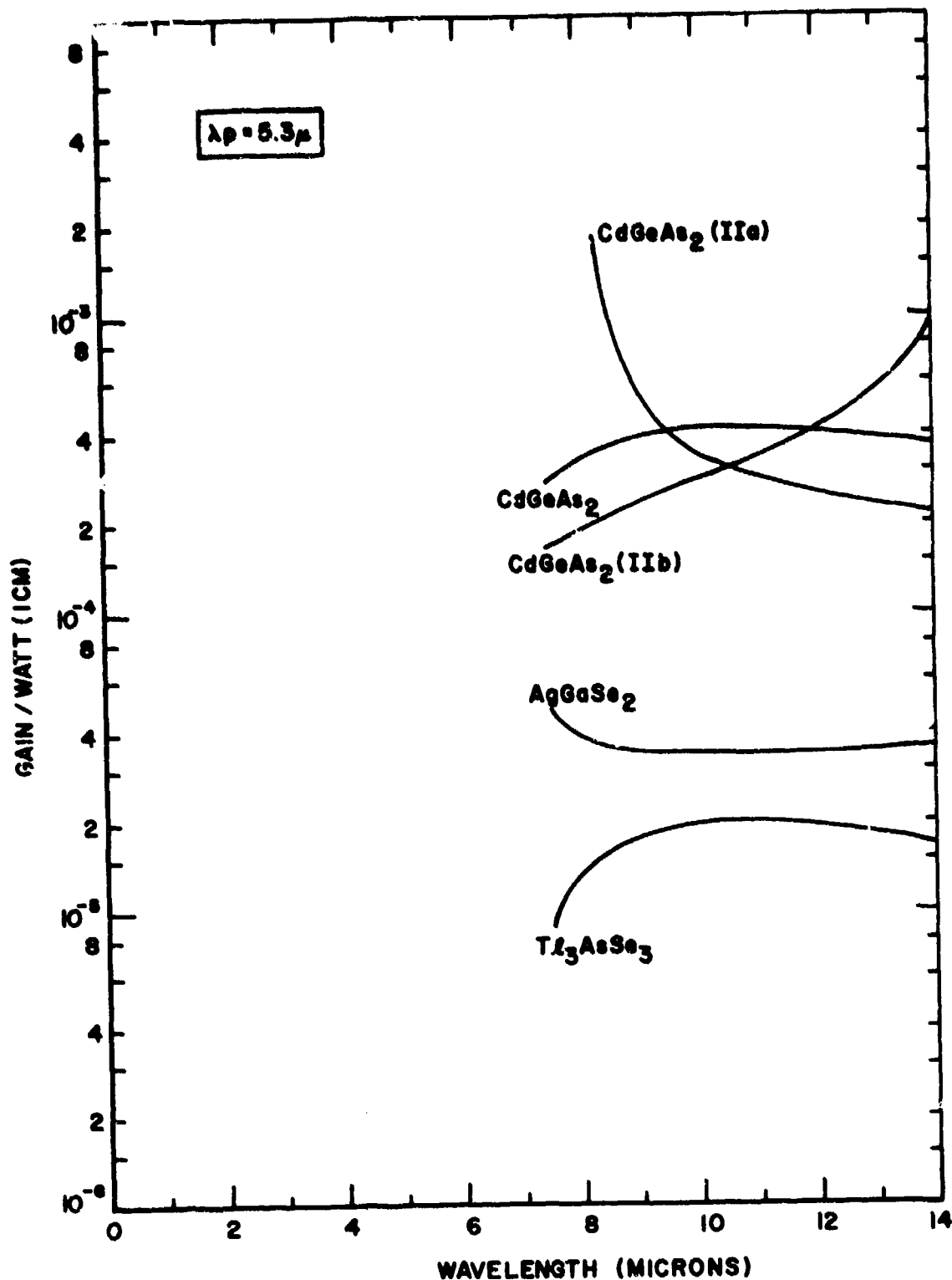


Figure 12. Parametric Gain Per Watt vs Output Wavelength for a Pump Wavelength of 5.3 μ m. Curves are for Type I Phase Matching Unless Otherwise Noted.

the transparency range of the material. In the case of the phosphides and sulfides, however, the longest practical wavelength is limited by multiphonon absorption to about 10 μm . The Roman numerals beside each material identify the type of phase matching (see the definitions given in Table IV). In cases where both Type I and Type II phase matching are possible, only the higher gain curve is shown if (as, for example, in the case of Ag_3AsS_3) the gains for the two types differ by a large factor. In cases where the gains for both types of phase matching are comparable, both curves are given. In previously published comparisons of materials,^{5,6} parametric gains are displayed as horizontal lines vs wavelength (denoting only the transparency range), and different pump wavelengths are included on the same diagram. The actual gain curves, their crossings, and their relative shifts from one pump wavelength to another, as seen in Figures 6 to 12, show that a simple composite diagram can be misleading.

High gain implies a low pumping power required to reach oscillator threshold. Thus, to build a practical device, one must select a material with sufficient gain to reach threshold and, ideally, saturation at a power level within the state-of-the-art of the pump laser. However, gain is a necessary but not a sufficient criterion on which to base the choice. If the high gain can be achieved only by such tight focusing that the pump power density exceeds the material's damage threshold, then obviously the material cannot be used. Other criteria are availability and optical quality of the material, and the availability of suitable anti-reflecting and high reflecting coatings.

To answer the question of power density requirements, we present a detailed comparison of materials at the pump wavelengths 0.694, 1.06, 1.3, and 2.1 μm in Tables V to VIII, respectively. These pump wavelengths are representative of the ruby, Nd^{3+} , and Ho^{3+} solid state lasers.

TABLE IV DEFINITION OF PHASE MATCHING TYPES

Birefringence Type	Phase Matching Type	Beam Polarizations		
		Signal ($\lambda_s < \lambda_p/2$)	Idler ($\lambda_i > \lambda_p/2$)	Pump
Positive ($n^e > n^o$)	I	e	e	o
	IIa	o	e	o
	IIb	e	o	o
Negative ($n^e < n^o$)	I	o	o	e
	IIa	o	e	e
	IIb	e	o	e

TABLE V. COMPARISON OF PARAMETRIC OSCILLATOR PERFORMANCE OF MATERIALS AT A PUMP WAVELENGTH OF 0.694 μ m

Material	λ_s (μ m)	λ_i (μ m)	Gain/Watt (1 cm) $\times 10^5$	P_t (KW)		P_s (KW)		A (cm^2) $\times 10^5$	P_t/A (MW/ cm^2)		P_s/A (MW/ cm^2)		ω_s ω_p		ω_i ω_p	
				SRO	DRO	SRO	DRO		SRO	DRO	SRO	DRO	SRO	DRO	SRO	DRO
AgGaS ₂ (I)	0.81	4.73	59	0.34	0.017	0.84	0.068	1.4	24	1.2	58	4.7	0.85	0.15	0.85	0.15
	0.78	6	6.9	2.9	0.14	7.2	0.58	5.1	57	2.8	140	11	0.88	0.12	0.88	0.12
	0.76	8	2.2	9.2	0.46	23	1.8	8.2	110	5.6	280	22	0.91	0.09	0.91	0.09
	0.75	10	1.2	17	0.87	43	3.5	9.0	190	9.7	480	39	0.93	0.07	0.93	0.07
Ag ₃ AsS ₃ (I)	1.39	1.39	7.4	(2.7)	0.14	(6.7)	0.54	150	(1.8)	0.089	(4.4)	0.36	0.50	0.50	0.50	0.50
	1.06	2	5.8	3.5	0.17	8.5	0.69	160	2.1	0.11	5.2	0.42	0.65	0.35	0.65	0.35
	0.84	4	2.3	8.7	0.43	21	1.7	170	5.0	0.25	12	1.0	0.83	0.17	0.83	0.17
	0.76	6	1.3	15	0.77	38	3.1	150	10	0.51	25	2.0	0.88	0.12	0.88	0.12
LiNbO ₃ (I)	0.76	8	0.89	22	1.1	55	4.5	130	17	0.85	42	3.4	0.91	0.09	0.91	0.09
	0.75	10	0.67	30	1.5	74	6.0	120	26	1.3	63	5.1	0.93	0.07	0.93	0.07
	1.39	1.39	4.8	(4.2)	0.21	(15)	0.84	29	(15)	0.73	(36)	2.9	0.50	0.50	0.50	0.50
	1.06	2	3.8	5.3	0.27	13	1.1	30	18	0.90	44	3.6	0.65	0.35	0.65	0.35
HgS (IIb)	0.84	4	1.4	14	0.72	36	2.9	31	47	2.3	120	9.4	0.83	0.17	0.83	0.17
	1.24	1.58	3.4	5.9	0.29	14	1.2	11	55	2.8	140	11	0.56	0.44	0.56	0.44
	1.06	2	3.9	5.0	0.25	13	1.0	140	3.7	0.18	9.1	0.74	0.65	0.35	0.65	0.35
	0.84	4	3.2	6.2	0.31	15	1.2	190	3.3	0.16	8.1	0.65	0.83	0.17	0.83	0.17
HgS (I)	0.78	6	2.4	8.2	0.41	20	1.6	160	5.3	0.26	13	1.1	0.88	0.12	0.88	0.12
	0.76	8	1.9	10	0.52	26	2.1	130	8.0	0.40	20	1.6	0.91	0.09	0.91	0.09
	0.75	10	1.6	13	0.64	31	2.5	110	11	0.57	28	2.3	0.93	0.07	0.93	0.07
	1.39	1.39	2.9	(7.0)	0.35	(17)	1.4	180	(3.9)	0.20	(9.7)	0.79	0.50	0.50	0.50	0.50
Ag ₃ SbS ₃ (I)	1.06	2	2.8	7.0	0.35	17	1.4	190	3.7	0.19	9.2	0.75	0.65	0.35	0.65	0.35
	0.84	4	2.5	8.0	0.40	20	1.6	170	4.6	0.23	11	0.92	0.83	0.17	0.83	0.17
	0.78	6	2.0	10	0.50	24	2.0	140	6.9	0.34	17	1.4	0.88	0.12	0.88	0.12
	0.76	8	1.6	12	0.61	30	2.4	120	9.9	0.49	24	2.0	0.91	0.09	0.91	0.09
Ag ₃ SbS ₃ (I)	0.75	10	1.4	14	0.72	36	2.9	110	13	0.67	33	2.7	0.93	0.07	0.93	0.07
	0.77	7.44	2.3	8.7	0.44	21	1.7	12	70	3.5	170	14	0.91	0.09	0.91	0.09
	0.76	8	1.2	17	0.85	42	3.4	24	70	3.5	170	14	0.91	0.09	0.91	0.09
	0.75	10	0.047	43	2.1	100	8.5	48	89	4.4	220	18	0.93	0.07	0.93	0.07

TABLE V. (Continued)

Material	λ_s (μm)	λ_i (μm)	Gain/Watt (1 cm) $\times 10^5$	P_t (KW)		P_s (KW)		A (cm^2) $\times 10^5$	P_t/A (MW/ cm^2)		P_s/A (MW/ cm^2)		ω_s ω_p		ω_i ω_p	
				SRO	DRO	SRO	DRO		SRO	DRO	SRO	DRO	SRO	DRO		
LiIO ₃ (1)	1.39	1.39	0.50	(40)	2.0	(99)	8.0	47	(86)	4.3	(210)	17	0.50	0.50	0.50	0.50
	1.06	2	0.41	49	2.5	120	9.8	45	110	5.5	270	22	0.65	0.35	0.65	0.35
	0.84	4	0.16	120	6.2	310	25	41	300	15	760	61	0.83	0.17	0.83	0.17
	0.79	5.5	0.096	210	10	510	42	42	500	25	1200	100	0.87	0.13	0.87	0.13

TABLE VI. COMPARISON OF PARAMETRIC OSCILLATOR PERFORMANCE OF MATERIALS AT A PUMP WAVELENGTH OF 1.06 μm

Material	λ_s (μm)	λ_i (μm)	Gain/Watt (1 cm) $\times 10^5$	P_t (KW)		P_s (KW)		A (cm^2) $\times 10^5$	P_t/A (MW/ cm^2)		P_s/A (MW/ cm^2)		$\frac{\omega_s}{\omega_p}$	
				SRO	DRO	SRO	DRO	SRO	DRO	SRO	DRO	SRO	DRO	$\frac{\omega_s}{\omega_p}$
ZnGeP ₂ (IIb)	1.19	9.55	550	0.036	0.0018	0.090	0.073	1.7	2.2	0.11	5.4	0.89	0.11	0.89
	1.19	10	270	0.074	0.0037	0.18	0.015	1.7	4.4	0.22	11	0.88	0.11	0.89
ZnGeP ₂ (I)	1.21	8.37	27	0.74	0.037	1.8	0.15	1.7	45	2.2	110	8.9	0.87	0.13
	1.20	9	58	0.35	0.017	0.86	0.69	1.7	21	1.0	51	4.2	0.85	0.12
	1.19	10	61	0.33	0.016	0.81	0.66	1.7	20	0.99	49	4.0	0.89	0.11
Ag ₃ SbS ₃ (I)	2.12	2.12	36	(0.55)	0.028	(1.4)	0.11	2.6	(22)	1.1	(54)	4.3	0.50	0.50
	1.64	3	6.9	2.9	0.14	7.1	0.57	18	16	0.81	40	3.2	0.65	0.35
	1.44	4	2.9	7.0	0.35	17	1.4	37	19	0.95	47	3.8	0.73	0.27
	1.29	6	1.2	17	0.83	41	3.3	53	31	1.6	77	6.5	0.82	0.18
	1.22	8	0.72	28	1.4	69	5.6	55	51	2.5	120	10	0.87	0.13
	1.19	10	0.49	41	2.0	100	8.2	53	76	3.8	190	15	0.89	0.11
AgGaS ₂ (I)	2.12	2.12	11	(1.9)	0.093	(4.6)	0.37	8.0	(23)	1.2	(57)	4.6	0.50	0.50
	1.64	3	7.6	2.6	0.13	6.5	0.52	8.8	30	1.5	74	6.0	0.65	0.35
	1.44	4	4.4	4.5	0.23	11	0.90	9.6	47	2.4	120	9.5	0.73	0.27
	1.29	6	1.9	10	0.52	26	2.1	9.7	110	5.4	260	21	0.82	0.18
	1.22	8	1.0	20	0.99	49	4.0	9.4	210	11	520	42	0.87	0.13
	1.19	10	0.67	30	1.5	74	6.0	9.0	330	17	820	66	0.89	0.11
AgGaS ₂ (IIa)	1.66	2.94	2.8	7.0	0.35	17	1.4	2.2	320	16	790	64	0.64	0.36
	1.64	3	6.3	3.2	0.16	7.9	0.64	2.2	140	7.2	360	29	0.65	0.35
	1.44	4	7.7	2.6	0.13	6.4	0.52	7.1	37	1.8	91	7.3	0.73	0.27
	1.29	6	4.3	4.7	0.23	12	0.93	9.7	48	2.4	120	9.6	0.82	0.18
	1.22	8	2.6	7.7	0.38	19	1.5	9.9	78	3.9	190	16	0.87	0.13
	1.19	10	1.6	13	0.63	31	2.5	10	120	6.0	290	24	0.89	0.11

TABLE VI. (Continued)

Material	λ_s (μm)	λ_i (μm)	Gain/Watt (1 cm) $\times 10^5$	P_t (kW)		P_s (kW)		A (cm^2) $\times 10^5$	P_t/A (MW/ cm^2)		P_s/A (MW/ cm^2)		η_s $\frac{\eta_s}{\eta_p}$	
				SRO	DRO	SRO	DRO		SRO	DRO	SRO	DRO		
HgS (I)	2.12	2.12	8.5	(2.4)	0.12	(5.8)	0.47	106	(2.2)	0.11	(5.5)	0.44	0.50	0.50
	1.64	3	7.8	2.6	0.13	6.3	0.51	101	2.5	0.13	6.3	0.51	0.65	0.35
	1.44	4	6.7	3.0	0.15	7.3	0.59	91	3.3	0.16	8.1	0.65	0.73	0.27
	1.29	6	5.1	3.9	0.20	9.7	0.79	74	5.3	0.27	13	1.1	0.82	0.18
	1.22	8	3.9	5.1	0.25	13	1.0	63	8.1	0.40	20	1.6	0.87	0.13
	1.19	10	3.1	6.4	0.32	16	1.3	56	11	0.57	28	2.3	0.89	0.11
HgS (IIb)	2.12	2.12	5.3	(3.8)	0.19	(9.4)	0.76	160	(2.3)	0.12	(5.9)	0.48	0.50	0.50
	1.64	3	6.3	3.2	0.16	7.8	0.64	140	2.3	0.12	5.7	0.46	0.65	0.35
	1.44	4	6.1	3.3	0.17	8.1	0.66	115	2.9	0.14	7.1	0.58	0.73	0.27
	1.29	6	4.9	4.1	0.20	10	0.81	87	4.7	0.24	12	0.94	0.82	0.18
	1.22	8	3.9	5.1	0.25	13	1.0	71	7.2	0.36	18	1.4	0.87	0.13
	1.19	10	3.1	6.4	0.32	16	1.3	61	10	0.52	26	2.1	0.89	0.11
Ag ₃ AsS ₃ (I)	2.12	2.12	4.7	(4.3)	0.21	(11)	0.85	120	(3.6)	0.18	(8.8)	0.71	0.50	0.50
	1.64	3	4.1	4.9	0.24	12	0.98	110	4.3	0.21	11	0.86	0.65	0.35
	1.44	4	3.2	6.2	0.31	15	1.2	100	5.9	0.30	15	1.2	0.73	0.27
	1.29	6	2.1	9.5	0.47	23	1.9	86	11	0.55	27	2.2	0.82	0.18
	1.22	8	1.5	13	0.66	32	2.6	74	18	0.89	44	3.5	0.87	0.13
	1.19	10	1.1	17	0.87	43	3.5	65	27	1.3	65	5.3	0.89	0.11
LiNbO ₃ (I)	2.12	2.12	2.0	(9.8)	0.49	(24)	2.0	28	(35)	1.8	(87)	7.1	0.50	0.50
	1.64	3	1.7	12	0.58	29	2.3	28	42	2.1	100	8.4	0.65	0.35
	1.44	4	1.3	15	0.76	38	3.1	27	56	2.8	140	11	0.73	0.27
LiIO ₃ (I)	2.12	2.12	0.21	(94)	4.7	(230)	19	35	(270)	13	(670)	54	0.50	0.50
	1.64	3	0.18	110	5.6	270	22	36	310	16	770	62	0.65	0.35
	1.33	5.3	0.091	220	11	540	44	44	500	25	1200	100	0.80	0.20

TABLE VII. COMPARISON OF PARAMETRIC OSCILLATOR PERFORMANCE OF MATERIALS AT A PUMP WAVELENGTH OF 1.3 μ m

Material	λ_s (μ m)	λ_i (μ m)	Gain/Watt (1 cr) $\times 10^5$	P_t (KW)		P_s (KW)		A (cm^2) $\times 10^5$		P_t/A (MW/ cm^2)		P_s/A (MW/ cm^2)		ω_s/ω_p		ω_i/ω_p	
				SRO	DRO	SRO	DRO			SRO	DRO	SRO	DRO				
ZnGeP ₂ (IIb) ²	1.55	8.12	450	0.044	0.0022	0.11	0.0088	2.0		2.1	0.11	5.3	0.43	0.84	0.16		
	1.49	10	110	0.19	0.0094	0.47	0.038	2.0		9.2	0.46	23	1.8	0.87	0.13		
ZnGeP ₂ (I)	1.65	6.09	12	1.6	0.081	4.0	0.32	2.0		79	3.9	190	16	0.79	0.21		
	1.55	8	92	0.22	0.011	0.53	0.043	2.0		11	0.53	26	2.1	0.84	0.16		
	1.49	10	70	0.29	0.014	0.70	0.057	2.6		11	0.56	28	2.2	0.87	0.13		
AgGaSe ₂ (I)	1.57	7.50	180	0.11	0.0056	0.28	0.022	2.5		4.5	0.23	11	0.90	0.85	0.17		
	1.55	8	120	0.17	0.0083	0.41	0.033	2.5		6.7	0.33	16	1.3	0.84	0.16		
	1.49	10	45	0.45	0.022	1.1	0.089	2.5		18	0.90	45	3.6	0.87	0.13		
Tl ₃ AsSe ₃ (I)	2.60	2.60	16	(1.2)	0.062	(3.1)	0.25	46		(2.7)	0.13	(6.6)	0.54	0.50	0.50		
	2.29	3	15	1.3	0.066	3.3	0.26	48		2.8	0.14	6.8	0.55	0.57	0.43		
	1.93	4	11	1.9	0.095	4.7	0.38	57		3.4	0.17	8.3	0.67	0.67	0.33		
	1.66	6	5.6	3.6	0.18	8.8	0.72	65		5.5	0.27	14	1.1	0.78	0.22		
	1.55	8	3.6	5.6	0.28	14	1.1	65		8.7	0.45	21	1.7	0.84	0.16		
	1.49	10	2.6	7.8	0.39	19	1.6	61		13	0.64	32	2.6	0.87	0.13		
	1.46	12	2.0	10	0.51	25	2.0	57		18	0.89	44	3.6	0.89	0.11		
HgS (I)	2.60	2.60	9.9	(2.0)	0.10	(5.0)	0.40	74		(2.7)	0.14	(6.7)	0.54	0.50	0.50		
	2.29	3	9.7	2.1	0.10	5.1	0.40	74		2.8	0.14	6.9	0.55	0.57	0.43		
	1.93	4	8.6	2.3	0.12	5.7	0.46	68		3.4	0.17	8.4	0.68	0.67	0.33		
	1.66	6	6.5	3.1	0.15	7.6	0.62	57		5.4	0.27	13	1.1	0.78	0.22		
	1.55	8	4.9	4.1	0.20	10	0.82	50		8.1	0.41	20	1.6	0.84	0.16		
	1.49	10	3.8	5.3	0.26	13	1.1	46		12	0.58	28	2.3	0.87	0.13		
HgS (IIb)	2.60	2.60	5.7	(3.5)	0.18	(8.7)	0.70	130		(2.8)	0.14	(6.8)	0.55	0.50	0.50		
	2.29	3	6.4	3.1	0.16	7.7	0.63	120		2.7	0.14	6.7	0.55	0.57	0.43		
	1.93	4	6.7	3.0	0.15	7.4	0.60	94		3.2	0.16	7.8	0.63	0.67	0.33		
	1.66	6	5.7	3.5	0.17	8.6	0.70	71		4.9	0.25	12	0.99	0.78	0.22		
	1.55	8	4.6	4.4	0.22	11	0.88	59		7.5	0.37	18	1.5	0.84	0.16		
	1.49	10	3.6	5.5	0.28	14	1.1	52		11	0.53	26	2.1	0.87	0.13		

TABLE VII. (Continued)

Material	λ_s (μm)	λ_i (μm)	Gain/Watt (1 cm) $\times 10^5$	P_t (KW)		P_s (KW)		A (cm^2) $\times 10^5$	P_t/A (MW/ cm^2)		P_s/A (MW/ cm^2)		ω_s		ω_i	
				SRO	DRO	SRO	DRO		SRO	DRO	SRO	DRO	ω_p		ω_p	
AgGaS ₂ (IIa)	2.60	2.60	6.8	(2.9)	0.15	(7.3)	0.59	2.7	(110)	5.4	(270)	22	0.50	0.50	0.50	0.50
	2.29	3	8.2	2.4	0.12	6.0	0.49	5.3	46	2.3	110	9.2	0.57	0.57	0.43	0.43
	1.93	4	6.8	3.0	0.15	7.3	0.59	8.5	35	1.7	86	6.9	0.67	0.67	0.33	0.33
	1.66	6	4.0	5.0	0.25	12	1.0	9.4	53	2.7	130	11	0.78	0.78	0.22	0.22
	1.55	8	2.4	8.3	0.42	21	1.7	9.6	87	4.3	210	17	0.84	0.84	0.16	0.16
	1.49	10	1.5	13	0.66	33	2.7	10	130	6.5	320	26	0.87	0.87	0.13	0.13
AgAsS ₃ (I)	2.60	2.60	4.2	(4.8)	0.24	(12)	0.96	88	(5.4)	0.27	(13)	1.1	0.50	0.50	0.50	0.50
	2.29	3	4.1	4.9	0.25	12	0.98	87	5.6	0.28	14	1.1	0.57	0.57	0.43	0.43
	1.93	4	3.5	5.7	0.29	14	1.1	81	7.1	0.35	17	1.4	0.67	0.67	0.33	0.33
	1.66	6	2.4	8.3	0.41	20	1.7	68	12	0.61	30	2.4	0.78	0.78	0.22	0.22
	1.55	8	1.7	11	0.57	28	2.3	59	19	0.97	48	3.9	0.84	0.84	0.16	0.16
	1.49	10	1.3	15	0.75	37	3.0	53	28	1.4	70	5.7	0.87	0.87	0.13	0.13
AgGaS ₂ (I)	2.60	2.60	4.2	(4.8)	0.24	(12)	0.95	9.4	51	2.5	(120)	10	0.50	0.50	0.50	0.50
	2.29	3	4.0	5.0	0.25	12	1.0	9.4	53	2.7	130	11	0.57	0.57	0.43	0.43
	1.93	4	2.9	6.8	0.34	17	1.4	9.3	73	3.6	180	15	0.67	0.67	0.33	0.33
	1.66	6	1.5	13	0.65	32	2.6	8.9	150	7.3	360	29	0.78	0.78	0.22	0.22
	1.55	8	0.93	22	1.1	53	4.3	8.5	250	13	630	51	0.84	0.84	0.16	0.16
	1.49	10	0.62	32	1.6	80	6.5	8.2	390	20	970	79	0.87	0.87	0.13	0.13
Ag ₃ SbS ₃ (I)	2.60	2.60	2.7	(7.4)	0.37	(18)	1.5	48	(15)	0.77	(38)	3.1	0.50	0.50	0.50	0.50
	2.29	3	2.6	7.8	0.39	19	1.6	49	16	0.80	39	3.2	0.57	0.57	0.43	0.43
	1.93	4	2.0	10	0.51	25	2.1	52	20	0.99	49	3.9	0.67	0.67	0.33	0.33
	1.66	6	1.1	18	0.88	43	3.5	53	33	1.7	82	6.6	0.78	0.78	0.22	0.22
	1.55	8	0.75	27	1.3	65	5.3	50	53	2.6	130	11	0.84	0.84	0.16	0.16
	1.49	10	0.55	37	1.8	90	7.3	47	79	3.9	190	16	0.87	0.87	0.13	0.13
LiNbO ₃ (I)	2.60	2.60	1.5	(13)	0.67	(33)	2.7	26	(51)	2.5	(125)	10	0.50	0.50	0.50	0.50
	2.29	3	1.5	14	0.69	34	2.8	26	52	2.6	130	10	0.57	0.57	0.43	0.43
	1.93	4	1.2	16	0.81	40	3.2	25	64	3.2	160	13	0.67	0.67	0.33	0.33
LiIO ₃ (I)	2.60	2.60	0.15	(140)	6.8	(340)	27	39	(350)	17	(860)	70	0.50	0.50	0.50	0.50
	2.29	3	0.14	140	7.1	350	28	40	360	18	880	71	0.57	0.57	0.43	0.43
	1.76	5	0.090	220	11	550	44	48	460	23	1100	92	0.74	0.74	0.26	0.26

TABLE VIII. COMPARISON OF PARAMETRIC OSCILLATOR PERFORMANCE OF MATERIALS AT A PUMP WAVELENGTH OF 2.1 μ m

Material	λ_s (μ m)	λ_i (μ m)	Gain/Watt (1 cm) $\times 10^5$	P_t (KW)		P_s (KW)		A (cm^2) $\times 10^5$	P_t/A (MW/ cm^2)		P_s/A (MW/ cm^2)		ω_s/ω_p	
				SRO	DRO	SRO	DRO		SRO	DRO	SRO	DRO	SRO	DRO
ZnGeP ₂ (IIb)	3.28	5.83	374	0.054	0.0027	0.13	0.011	3.3	1.6	0.081	3.9	0.32	0.64	0.36
	3.23	6	306	0.065	0.0032	0.16	0.013	3.3	2.0	0.098	4.9	0.39	0.65	0.35
	2.85	8	96	0.21	0.010	0.51	0.042	3.3	6.3	0.31	15	1.3	0.74	0.26
	2.66	10	56	0.35	0.018	0.88	0.072	3.3	11	0.54	27	2.2	0.79	0.21
ZnGeP ₂ (I)	4.20	4.20	138	(0.15)	0.0072	(0.36)	0.029	3.3	(4.4)	0.22	(11)	0.87	0.50	0.50
	3.62	5	131	0.15	0.0076	0.38	0.031	3.3	4.6	0.23	11	0.92	0.58	0.42
	3.23	6	114	0.17	0.0087	0.43	0.035	3.3	5.3	0.26	13	1.1	0.65	0.35
	2.85	8	92	0.24	0.012	0.60	0.049	3.3	7.3	0.37	18	1.5	0.74	0.26
CdSe (IIb)	2.66	10	59	0.34	0.017	0.84	0.068	3.3	10	0.51	25	2.1	0.79	0.21
	2.76	8.75	26	0.77	0.038	1.9	0.15	4.3	18	0.90	45	3.6	0.76	0.24
	2.74	9	23	0.85	0.042	2.1	0.17	4.3	20	1.0	49	4.0	0.77	0.23
	2.66	10	17	1.2	0.060	2.9	0.24	4.3	28	1.4	69	5.6	0.79	0.21
AgGaSe ₂ (I)	2.55	12	10	1.9	0.097	4.8	0.39	4.3	46	2.3	110	9.1	0.82	0.18
	4.20	4.20	28	(0.71)	0.035	(1.8)	0.14	4.0	(18)	0.88	(44)	3.5	0.50	0.50
	3.62	5	26	0.76	0.038	1.9	0.15	4.0	19	0.95	47	3.8	0.58	0.42
	3.23	6	22	0.92	0.046	2.3	0.18	4.0	23	1.1	56	4.6	0.65	0.35
AgGaSe ₂ (IIa)	2.85	8	15	1.4	0.065	3.4	0.28	4.0	34	1.7	85	6.9	0.74	0.26
	2.66	10	10	1.9	0.097	4.8	0.39	4.0	49	2.4	120	9.7	0.79	0.21
	2.55	12	7.7	2.6	0.13	6.4	0.52	4.0	65	3.2	160	13	0.82	0.18
	3.50	5.25	6.4	3.1	0.16	7.7	0.62	4.0	78	3.9	190	16	0.60	0.40
AgGaSe ₂ (IIa)	3.23	6	26	0.77	0.039	1.9	0.15	4.0	19	0.96	47	3.8	0.65	0.35
	2.85	8	25	0.82	0.041	2.0	0.16	4.0	20	1.0	50	4.1	0.74	0.26
	2.66	10	19	1.1	0.054	2.7	0.22	4.0	27	1.3	66	5.4	0.79	0.21
	2.55	12	14	1.4	0.071	3.5	0.28	4.0	35	1.8	87	7.1	0.82	0.18

TABLE VIII. (Continued)

Material	λ_s (μm)	λ_i (μm)	Gain/Watt (1 cm) $\times 10^5$	P_t (KW)		P_s (KW)		A (cm^2) $\times 10^5$	P_t/A (MW/ cm^2)		P_s/A (MW/ cm^2)		$\frac{\omega_s}{\omega_p}$		$\frac{\omega_i}{\omega_p}$	
				SRO	DRO	SRO	DRO		SRO	DRO	SRO	DRO	SRO	DRO	SRO	DRO
HgS(I)	4.20	4.20	9.0	(2.2)	0.11	(5.3)	0.43	38	(5.7)	0.29	(14)	1.1	0.50	0.50	0.50	0.50
	3.62	5	8.6	2.3	0.12	5.8	0.47	37	6.2	0.31	15	1.2	0.58	0.42	0.58	0.42
	3.23	6	7.6	2.6	0.13	6.5	0.53	37	7.1	0.36	18	1.4	0.65	0.35	0.65	0.35
	2.85	8	5.6	3.6	0.18	8.8	0.71	36	9.8	0.49	24	2.0	0.74	0.26	0.74	0.26
	2.66	10	4.1	4.9	0.24	12	0.98	36	13	0.67	33	2.7	0.79	0.21	0.79	0.21
Ti ₃ AsSe ₃ (I)	4.20	4.20	5.8	(3.5)	0.17	(8.6)	0.70	53	(6.6)	0.33	(16)	1.3	0.50	0.50	0.50	0.50
	3.62	5	5.5	3.6	0.18	9.0	0.73	52	7.0	0.35	17	1.4	0.58	0.42	0.58	0.42
	3.23	6	4.9	4.0	0.20	10	0.81	50	8.1	0.40	20	1.6	0.65	0.35	0.65	0.35
	2.85	8	3.8	5.2	0.26	13	1.0	45	12	0.58	28	2.3	0.74	0.26	0.74	0.26
	2.66	10	3.0	6.6	0.33	16	1.3	41	16	0.81	40	3.2	0.79	0.21	0.79	0.21
	2.55	12	2.5	8.1	0.41	20	1.6	37	22	1.1	54	4.3	0.82	0.18	0.82	0.18
AgGaS ₂ (IIa)	4.20	4.20	3.4	(5.9)	0.29	(15)	1.2	8.6	(68)	3.4	170	14	0.50	0.50	0.50	0.50
	3.62	5	3.2	6.3	0.32	15	1.3	8.9	70	3.5	170	14	0.58	0.42	0.58	0.42
	3.23	6	2.7	7.5	0.37	18	1.5	9.1	82	4.1	200	16	0.65	0.35	0.65	0.35
	2.85	8	1.8	11	0.56	27	2.2	9.6	120	5.8	290	23	0.74	0.26	0.74	0.26
	2.66	10	1.2	16	0.82	40	3.3	11	160	7.8	390	31	0.79	0.21	0.79	0.21
Ag ₃ AsS ₃ (I)	4.20	4.20	3.0	(6.7)	0.33	(16)	1.3	44	(15)	0.76	(37)	3.0	0.50	0.50	0.50	0.50
	3.62	5	2.9	6.9	0.35	17	1.4	43	18	0.80	39	3.2	0.58	0.42	0.58	0.42
	3.23	6	2.6	7.8	0.39	19	1.6	42	18	0.92	45	3.7	0.65	0.35	0.65	0.35
	2.85	8	1.9	10	0.52	26	2.1	40	26	1.3	64	5.2	0.74	0.26	0.74	0.26
	2.65	10	1.5	14	0.68	34	2.7	39	35	1.8	87	7.0	0.79	0.21	0.79	0.21
Ag ₃ SbS ₃ (I)	4.20	4.20	1.2	(16)	0.82	(40)	3.3	39	(41)	2.1	(100)	8.3	0.50	0.50	0.50	0.50
	3.62	5	1.2	17	0.85	42	3.4	39	44	2.2	110	8.8	0.58	0.42	0.58	0.42
	3.23	6	1.1	19	0.95	47	3.8	37	51	2.5	130	10	0.65	0.35	0.65	0.35
	2.85	8	0.81	25	1.2	61	4.9	34	72	3.6	180	14	0.74	0.26	0.74	0.26
	2.66	10	0.62	32	1.6	79	6.4	32	100	5.0	250	20	0.79	0.21	0.79	0.21

TABLE VIII. (Continued)

Material	λ_s (μm)	λ_i (μm)	Gain/Watt (1 cm) $\times 10^5$	P_c (mW)		P_s (mW)		A (cm^2) $\times 10^5$	P_c/A (mW/ cm^2)		P_s/A (mW/ cm^2)		$\frac{w_s}{w_p}$	$\frac{w_i}{w_p}$
				SRO	DRO	SRO	DRO		SRO	DRO	SRO	DRO		
AgGaS ₂ (1)	4.20	4.20	1.1	(18)	0.91	(45)	3.6	7.3	(250)	12	(610)	50	0.50	0.50
	3.62	5	1.0	19	0.96	47	3.8	7.3	260	13	640	52	0.58	0.42
	3.23	6	0.91	22	1.1	54	4.4	7.3	300	15	740	60	0.65	0.35
	2.85	3	0.67	30	1.5	74	5.9	7.4	400	20	990	81	0.74	0.25
	2.66	10	0.51	40	2.0	98	7.9	7.6	520	26	1300	100	0.79	0.21

The first column in Tables V to VIII identifies the material and the type of phase matching. The second and third columns give the output wavelengths. The fourth column is the gain per watt for a 1 cm thick crystal. The next two columns give the pump power required to reach threshold for singly and doubly resonant oscillators according to the following relationships:⁵

$$(\text{gain/watt}) \times p_t = 2 \alpha_s \quad (\text{SRO}) \quad (3)$$

$$(\text{gain/watt}) \times p_t = \alpha_s \alpha_i \quad (\text{DRO}) \quad (4)$$

where α_s and α_i are the single pass power losses at the signal and idler wavelengths, respectively. For the comparison presented in Tables V to VIII, we have assumed values of $\alpha_s = \alpha_i = 0.1$. At degeneracy ($\lambda_s = \lambda_i$), a singly resonant oscillator has the same threshold as a doubly resonant oscillator. Hence, the numbers given in parentheses in the SRO columns are fictitious and should be interpreted as the pump power for an SRO operating near degeneracy.

The next two columns give the pump power required for pump depletion (saturation) according to⁵

$$P_s = (\pi/2)^2 P_t \quad (\text{SRO}) \quad (5)$$

$$P_s = 4P_t \quad (\text{DRO}) \quad (6)$$

In Equations 5 and 6, it is assumed that the pump pulse length is much greater than the time required to build up the signal from the incoherent background noise. In cases where buildup time is not negligible, the pump powers required for high conversion efficiency depend on the gain per pass and the ratio of pulse length to oscillator cavity round trip time.⁶ Since these parameters can vary over wide ranges, the problem of buildup time is

not treated here. However, a good rule of thumb is that a parametric oscillator pumped by pulses shorter than -100 ns may be expected to be limited by buildup time.

The columns labeled A in Tables V to VIII are the cross-section areas of the Gaussian beams at the cavity confocal point and are given by

$$\begin{aligned} A &= \pi w_0^2 / 2 \\ &= b_0 \lambda_p / (n_s + n_i) \end{aligned} \quad (7)$$

where, for a 1 cm crystal,

$$b_0 = B^2 / 2 \quad B^2 > 2 \quad (8)$$

$$b_0 = 1 \quad B^2 \leq 2$$

$$B^2 = \pi \rho^2 n_p^2 / 4 \lambda_p \quad (9)$$

In these equations, w_0 is the Gaussian beam waist, λ_p is the pump wavelength, n_s , n_i , and n_p are the refractive indices at the signal, idler, and pump wavelengths, and ρ is the walkoff angle. Equations 8 maximize the confocal parameter b_0 (and, hence, minimize the power density at the focus) for a given value of the walkoff parameter B . Values of b_0 larger than given by Equations 8 are, to a good approximation, offset by a reduction in gain, so the cross-sections in the Tables V to VIII are essentially optimum.

The columns following A give the power densities at threshold and at saturation. The final two columns give the theoretical maximum conversion efficiency at the two output wavelengths.

SECTION V

RANKING OF MATERIALS FOR A SPECIFIC APPLICATION

As an example of how the detailed data presented in Section IV can be used, let us consider a specific application, namely, a parametric oscillator with output in the 3-6 μm region, at a prf of 5 kHz in an SRO configuration. To achieve this repetition rate at the power levels needed to drive a parametric oscillator requires either a Nd^{3+} or Ho^{3+} pump laser operating in a Q-switched, cw-pumped mode. To obtain the highest possible average power, the Nd^{3+} laser should operate on the 1.06 μm (1.08 μm) line of YAG:Nd^{3+} ($\text{YAlO}_3:\text{Nd}^{3+}$), rather than at other possible Nd^{3+} wavelengths (0.94 μm , 1.3 μm , etc.). At an average power output of 10 watts TEM_{00} (a reasonable upper limit for the present state-of-the-art), a train of 100 nsec pulses at 5 kHz will have a peak power per pulse on the order of 20 kW at the 1.06 μm or 1.08 μm pump wavelength. The Ho^{3+} laser operates at 2.1 μm . A reasonable upper limit for state-of-the-art YAG:Ho^{3+} laser output is 2 watts TEM_{00} . Thus, the pump limit is about 4 kW per pulse at the 2.1 μm pump wavelength.

Using the data in Tables VI and VIII, we can rank the parametric oscillator materials in the order of their merit for the application just posed. This ranking is displayed in Tables IX and X. For purposes of ranking materials in Tables IX and X, we have assumed damage threshold power densities of 100 MW/cm^2 for LiNbO_3 and LiIO_3 and 50 MW/cm^2 for all other materials.

According to Tables IX and X, HgS and ZnGeP_2 are the best materials for pumping at 1.06 and 2.1 μm , respectively. Both materials have peak power and power density requirements well below the upper limits discussed previously. For SRO configurations, AgGaSe_2 pumped at 2.1 μm is the only other material

TABLE IX
LIMITATIONS OF MATERIALS FOR 1.06 μm -PUMPED SINGLY RESONANT PARAMETRIC OSCILLATORS
OPERATING IN THE 2-6 μm OUTPUT RANGE AT 5 KHz PRF

Material	Threshold Power Less than 20KW?	Saturation Power Less Than 20 KW?	Threshold Power Density Less Than Damage Threshold?	Saturation Power Density Less Than Damage Threshold?
HgS	Yes	Yes	Yes	Yes
Ag ₃ AsS ₃	Yes	Yes ^a	Yes	Yes
Ag ₃ BS ₃	Yes	Yes ^b	Yes	Yes ^b
AgGaS ₂	Yes	Yes	Yes	No
LiNbO ₃ ^c	Yes	No	Yes	Yes ^d
LiIO ₃ ^e	No	No	No	No

^a but not beyond $\sim 5\mu\text{m}$

^b but not beyond $\sim 4\mu\text{m}$

^c limited by absorption to wavelengths shorter than $\sim 4.5\mu\text{m}$

^d but not beyond $\sim 3\mu\text{m}$

^e limited by absorption to wavelengths shorter than $\sim 5.5\mu\text{m}$

TABLE X
LIMITATIONS OF MATERIALS FOR 2.1 μm -PUMPED SINGLY RESONANT PARAMETRIC OSCILLATORS
OPERATING IN THE 3-6 μm OUTPUT RANGE AT 5 KHz PRF

Material	Threshold Power Less Than 4 KW?	Saturation Power Less Than 4 KW?	Threshold Power Density Less Than Damage Threshold?	Saturation Power Density Less Than Damage Threshold?
ZnGeP_2	Yes	Yes	Yes	Yes
AgGaSe_2	Yes	Yes	Yes	Yes
HgS	Yes	No	Yes	Yes
Tl_3AsSe_3	Yes	No	Yes	Yes
Ag_3AsS_3	No	No	Yes	Yes
Ag_3SbS_3	No	No	Yes	No
AgGaS_2	No	No	No	No

that has saturation power and power density levels within the state-of-the-art. However, most other materials can be used in SRO configurations up to some level between threshold and complete pump depletion. The materials that can be categorically excluded from consideration in SRO configurations are LiIO_3 pumped at $1.06 \mu\text{m}$ and AgGaS_2 , Ag_3SbS_3 , and Ag_3AsS_3 pumped at $2.1 \mu\text{m}$.

SECTION VI

SUMMARY AND CONCLUSIONS

In this report, we have reviewed the state-of-the-art of parametric oscillators and mixers, and have provided detailed theoretical performance data on the most promising materials for use in the 2 to 6 and 8 to 12 μm regions, and have performed a critical evaluation of the materials usable in the 2 to 6 μm region. The spectral coverage available from parametric oscillators and mixers has increased dramatically since 1970. This has been made possible by the development of new nonlinear optical materials such as Ag_3AsS_3 , CdSe , and AgGaSe_2 . High average powers and conversion efficiencies have yet to be obtained over the entire infrared bands of interest. Substantial improvements in power and efficiency can be made by further development and use of materials such as HgS and ZnGeP_2 .

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APPENDIX A

Ag₃AsS₃ (Proustite)

Sellmeier Equation:⁴⁸

$$(n^o)^2 = 7.4822 + \frac{0.4635}{\lambda^2 - 0.1160} - 0.0016 \lambda^2$$

$$(n^e)^2 = 6.3434 + \frac{0.3352}{\lambda^2 - 0.1117} - 0.0007 \lambda^2$$

Refractive Index Data:^{50,59}

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^e	$n^e - n^o$
0.5876	1.7018		2.7896	
0.6328	1.5803	3.0190	2.7391	-0.2799
0.6516	1.5347	2.9970	2.7230	-0.2740
0.6678	1.4975	2.9804	2.7094	-0.2710
0.6943	1.4403	2.9550	2.6910	-0.2640
1.014	0.9862	2.8264	2.5901	-0.2363
1.129	0.8857	2.8067	2.5756	-0.2311
1.367	0.7315	2.7833	2.5570	-0.2263
1.530	0.6536	2.7728	2.5485	-0.2243
1.709	0.5851	2.7654	2.5423	-0.2231
2.50	0.4000	2.7478	2.5282	-0.2196
3.56	0.2809	2.7379	2.5213	-0.2166
4.62	0.2165	2.7318	2.5178	-0.2140
10.6	0.0943	2.7030	2.5040	-0.1990

AgGaS₂ (Silver Thiogallate)

Sellmeier Equation:⁴⁰

$$(n^o)^2 = 4.28 + \frac{0.2410}{\lambda^2 - 0.0870} - 0.00210 \lambda^2$$

$$(n^e)^2 = 5.497 + \frac{0.2026}{\lambda^2 - 0.1307} - 0.00233 \lambda^2$$

Refractive Index Data:³⁹

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^e	$n^e - n^o$
.4900	2.0488	2.7148	2.7287	.0138
.5000	2.0000	2.6916	2.6867	-.0049
.5250	1.9048	2.6503	2.6239	-.0264
.5500	1.8182	2.6190	2.5834	-.0356
.5750	1.7391	2.5944	2.5537	-.0407
.6000	1.6667	2.5748	2.5303	-.0444
.6250	1.6000	2.5577	2.5116	-.0461
.6500	1.5385	2.5437	2.4961	-.0476
.6750	1.4815	2.5310	2.4824	-.0486
.7000	1.4286	2.5205	2.4706	-.0499
.7500	1.3333	2.5049	2.4540	-.0509
.8000	1.2500	2.4909	2.4395	-.0514
.8500	1.1765	2.4802	2.4279	-.0522
.9000	1.1111	2.4716	2.4192	-.0525
.9500	1.0526	2.4644	2.4118	-.0526
1.0000	1.0000	2.4582	2.4053	-.0529
1.1000	.9091	2.4486	2.3954	-.0532
1.2000	.8333	2.4414	2.3881	-.0533
1.3000	.7692	2.4359	2.3819	-.0540
1.4000	.7143	2.4315	2.3781	-.0534

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^e	$n^e - n^o$
1.5000	.6667	2.4280	2.3745	-.0535
1.6000	.6250	2.4252	2.3716	-.0535
1.8000	.5556	2.4206	2.3670	-.0536
2.0000	.5000	2.4164	2.3637	-.0527
2.2000	.4545	2.4142	2.3604	-.0537
2.4000	.4167	2.4119	2.3583	-.0535
2.6000	.3846	2.4102	2.3567	-.0535
2.8000	.3571	2.4094	2.3539	-.0535
3.0000	.3333	2.4080	2.3545	-.0535
3.2000	.3125	2.4068	2.3534	-.0534
3.4000	.2941	2.4062	2.3522	-.0540
3.6000	.2778	2.4046	2.3511	-.0535
3.8000	.2632	2.4024	2.3491	-.0533
4.0000	.2500	2.4024	2.3488	-.0536
4.5000	.2222	2.4003	2.3461	-.0542
5.0000	.2000	2.3955	2.3419	-.0536
5.5000	.1818	2.3938	2.3401	-.0537
6.0000	.1667	2.3908	2.3369	-.0539
6.5000	.1538	2.3874	2.3334	-.0540
7.0000	.1429	2.3827	2.3291	-.0536
7.5000	.1333	2.3787	2.3252	-.0535
8.0000	.1250	2.3757	2.3219	-.0538
8.5000	.1176	2.3699	2.3163	-.0536
9.0000	.1111	2.3663	2.3121	-.0542
9.5000	.1053	2.3606	2.3064	-.0542
10.0000	.1000	2.3548	2.3012	-.0536
10.5000	.0952	2.3486	2.2948	-.0538
11.0000	.0909	2.3417	2.2880	-.0537
11.5000	.0870	2.3329	2.2789	-.0540
12.0000	.0833	2.3266	2.2716	-.0550
12.5000	.0800	2.3177		
13.0000	.0769	2.3076		



Sellmeier Equation:⁴²

$$(n^o)^2 = 3.9362 + \frac{2.9113}{1 - \left(\frac{0.38821}{\lambda}\right)^2} + \frac{1.7954}{1 - \left(\frac{40}{\lambda}\right)^2}$$

$$(n^e)^2 = 3.3132 + \frac{3.3616}{1 - \left(\frac{0.38261}{\lambda}\right)^2} + \frac{1.7677}{1 - \left(\frac{40}{\lambda}\right)^2}$$

Refractive Index Data:⁴¹

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^e	$n^e - n^o$
.7250	1.3793	2.8452	2.8932	.0480
.7500	1.3333	2.8191	2.8415	.0224
.8000	1.2500	2.7849	2.7866	.0017
.8500	1.1765	2.7598	2.7522	-.0077
.9000	1.1111	2.7406	2.7275	-.0130
.9500	1.0526	2.7252	2.7085	-.0167
1.0000	1.0000	2.7132	2.6934	-.0198
1.1000	.9091	2.6942	2.6712	-.0230
1.2000	.8333	2.6806	2.6554	-.0253
1.3000	.7692	2.6705	2.6438	-.0267
1.4000	.7143	2.6624	2.6347	-.0277
1.6000	.6250	2.6516	2.6224	-.0292
1.8000	.5556	2.6432	2.6131	-.0301
2.0000	.5000	2.6376	2.6071	-.0305
2.2000	.4545	2.6336	2.6027	-.0309
2.4000	.4167	2.6304	2.5992	-.0313
2.6000	.3846	2.6286	2.5968	-.0317
2.8000	.3571	2.6261	2.5943	-.0318
3.0000	.3333	2.6245	2.5925	-.0320
3.2000	.3125	2.6231	2.5912	-.0319
3.4000	.2941	2.6221	2.5899	-.0321

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^o	$n^o - n^o$
3.6000	.2778	2.6213	2.5889	-.0324
3.8000	.2632	2.6200	2.5876	-.0324
4.0000	.2500	2.6189	2.5863	-.0325
4.5000	.2222	2.6166	2.5840	-.0325
5.0000	.2000	2.6144	2.5819	-.0326
5.5000	.1818	2.6128	2.5800	-.0328
6.0000	.1667	2.6113	2.5784	-.0329
6.5000	.1538	2.6094	2.5765	-.0329
7.0000	.1429	2.6070	2.5743	-.0327
7.5000	.1333	2.6049	2.5723	-.0326
8.0000	.1250	2.6032	2.5704	-.0328
8.5000	.1176	2.6009	2.5681	-.0329
9.0000	.1111	2.5988	2.5659	-.0329
9.5000	.1053	2.5964	2.5635	-.0329
10.0000	.1000	2.5939	2.5608	-.0331
10.5000	.0952	2.5917	2.5585	-.0332
11.0000	.0909	2.5890	2.5555	-.0335
11.5000	.0870	2.5868	2.5536	-.0332
12.0000	.0833	2.5837	2.5505	-.0332
12.5000	.0800	2.5805	2.5473	-.0333
13.0000	.0769	2.5771	2.5439	-.0331
13.5000	.0741	2.5731	2.5404	-.0327

Ag_3SbS_3 (Pyrargyrite)

Sellmeier Equation:⁵²

$$(n^o)^2 = 1 + \frac{6.585 \lambda^2}{\lambda^2 - 0.16} + \frac{0.1133 \lambda^2}{\lambda^2 - 225}$$

$$(n^e)^2 = 1 + \frac{5.845 \lambda^2}{\lambda^2 - 0.16} + \frac{0.0202 \lambda^2}{\lambda^2 - 225}$$

Refractive Index Data: Data not tabulated.

CdGeAs₂

Sellmeier Equation:⁴³

$$(n^o)^2 = 4 + \frac{8.891}{1 - \left(\frac{0.5524}{\lambda}\right)^2} + \frac{1.886}{1 - \left(\frac{36}{\lambda}\right)^2}$$

$$(n^o)^2 = 4 + \frac{9.521}{1 - \left(\frac{0.6847}{\lambda}\right)^2} + \frac{1.909}{1 - \left(\frac{36}{\lambda}\right)^2}$$

Refractive Index Data:⁴⁴

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^o	$n^o - n^o$
2.3000	.4348	3.6076		
2.4000	.4167	3.5973		
2.5000	.4000	3.5895	3.7545	.1572
2.6000	.3846	3.5823	3.7316	.1420
2.7000	.3704	3.5773	3.7156	.1333
2.8000	.3571	3.5721	3.7030	.1257
2.9000	.3448	3.5684	3.6926	.1206
3.0000	.3333	3.5645	3.6846	.1162
3.1000	.3226	3.5615	3.6775	.1131
3.2000	.3125	3.5581	3.6714	.1099
3.4000	.2941	3.5536	3.6661	.1080
3.6000	.2778	3.5503	3.6574	.1038
3.8000	.2632	3.5468	3.6508	.1005
4.0000	.2500	3.5440	3.6454	.0986
4.2000	.2381	3.5415	3.6402	.0962
4.4000	.2273	3.5391	3.6368	.0954
4.6000	.2174	3.5372	3.6329	.0938
4.8000	.2083	3.5354	3.6299	.0928
5.0000	.2000	3.5336	3.6273	.0919
5.5000	.1818	3.5285	3.6249	.0914
6.0000	.1667	3.5251	3.6178	.0893
6.5000	.1538	3.5223	3.6134	.0883
			3.6104	.0881

<u>λ (μm)</u>	<u>λ^{-1} (μm^{-1})</u>	<u>n^o</u>	<u>n^e</u>	<u>$n^e - n^o$</u>
7.0000	.1429	3.5200	3.6073	.0873
7.5000	.1333	3.5175	3.6050	.0875
8.0000	.1250	3.5157	3.6030	.0873
8.5000	.1176	3.5140	3.6009	.0869
9.0000	.1111	3.5120	3.5988	.0868
9.5000	.1053	3.5098	3.5966	.0867
10.0000	.1000	3.5078	3.5942	.0864
10.5000	.0952	3.5054	3.5922	.0868
11.0000	.0909	3.5031	3.5896	.0865
11.5000	.0870	3.5004	3.5871	.0868
12.0000	.0833	3.4977		
12.5000	.0800	3.4950		

CdSe

Sellmeier Equation:³¹

$$(n^o)^2 = 4.1321 + \frac{1.8587 \lambda^2}{\lambda^2 - 0.2187} + \frac{3.0461 \lambda^2}{\lambda^2 - 3380}$$

$$(n^e)^2 = 4.0829 + \frac{2.0038 \lambda^2}{\lambda^2 - 0.2075} + \frac{3.5540 \lambda^2}{\lambda^2 - 3629}$$

Refractive Index Data:⁵⁸

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^e	$n^e - n^o$
1.0139	0.9863	2.5481	2.5677	0.0196
1.1287	0.8860	2.5246	2.5444	0.0198
1.3673	0.7314	2.4971	2.5170	0.0199
1.5295	0.6538	2.4861	2.5059	0.0198
1.7109	0.5845	2.4776	2.4974	0.0198
2.3253	0.4301	2.4627	2.4823	0.0196
3.0	0.3333	2.4553	2.4748	0.0195
4.0	0.2500	2.4500	2.4694	0.0194
5.0	0.2000	2.4464	2.4657	0.0193
6.0	0.1667	2.4434	2.4625	0.0191
7.0	0.1429	2.4398	2.4586	0.0188
8.0	0.1250	2.4367	2.4552	0.0185
9.0	0.1111	2.4333	2.4514	0.0181
10.0	0.1000	2.4294	2.4475	0.0181
11.0	0.0909	2.4252	2.4430	0.0178
12.0	0.0833	2.4204	2.4379	0.0175

HgS (Cinnabar)

Sellmeier Equation:⁴⁸

$$(n^o)^2 = 6.9445 + \frac{0.3658}{\lambda^2 - 0.1357} - 0.0019\lambda^2$$

$$(n^e)^2 = 8.3922 + \frac{0.5390}{\lambda^2 - 0.1388} - 0.0027\lambda^2$$

Refractive Index Data:⁴⁷

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^e	$n^o - n^e$
0.62	1.6129	3.2560	2.9028	0.3532
0.65	1.5385	3.2064	2.8655	0.3409
0.68	1.4706	3.1703	2.8384	0.3319
0.70	1.4286	3.1489	2.8224	0.3265
0.80	1.2500	3.0743	2.7704	0.3039
0.90	1.1111	3.0340	2.7387	0.2957
1.00	1.0000	3.0050	2.7120	0.2930
1.20	0.8333	2.9680	2.6884	0.2796
1.40	0.7143	2.9475	2.6730	0.2745
1.60	0.6250	2.9344	2.6633	0.2711
1.80	0.5556	2.9258	2.6567	0.2691
2.00	0.5000	2.9194	2.6518	0.2676
2.20	0.4545	2.9146	2.6483	0.2663
2.40	0.4167	2.9108	2.6455	0.2653
2.60	0.3846	2.9079	2.6433	0.2646
2.80	0.3571	2.9052	2.6414	0.2638
3.00	0.3333	2.9036	2.6401	0.2635
3.20	0.3125	2.9017	2.6387	0.2630
3.40	0.2941	2.9001	2.6375	0.2626
3.60	0.2778	2.8987	2.6358	0.2629
3.80	0.2632	2.8971	2.6353	0.2618
4.00	0.2500	2.8963	2.6348	0.2615
5.00	0.2000	2.8863	2.6267	0.2596
6.00	0.1667	2.8799	2.6233	0.2566

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^*	$n^o - n^*$
7.00	0.1429	2.8741	2.6156	0.2585
8.00	0.1250	2.8674	2.6112	0.2562
9.00	0.1111	2.8608	2.6066	0.2542
10.00	0.1000	2.8522	2.6018	0.2504
11.00	0.0909	2.8434	2.5914	0.2520



Sellmeier Equation:*

$$(n^o)^2 = 3.463 + \frac{0.0214}{\lambda^2 - 0.0958} - 0.00677 \lambda^2$$

$$(n^e)^2 = 2.961 + \frac{0.0142}{\lambda^2 - 0.0915} - 0.00423 \lambda^2$$

Refractive Index Data: ^{56, 57}

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^e	$n^e - n^o$
0.400	2.500	1.948	1.780	-0.168
0.436	2.294	1.931	1.766	-0.165
0.500	2.000	1.908	1.754	-0.154
0.530	1.887	1.901	1.750	-0.151
0.578	1.730	1.888	1.742	-0.146
0.690	1.449	1.875	1.731	-0.144
0.800	1.250	1.868	1.724	-0.144
1.060	0.943	1.860	1.719	-0.141

*Equation fit to refractive index data and curves in Ref. 56 and 57.

LiNbO_3

Sellmeier Equation:⁴⁸

$$(n^o)^2 = 4.9260 + \frac{0.1170}{\lambda^2 - 0.0473} - 0.0275 \lambda^2$$

$$(n^e)^2 = 4.5778 + \frac{0.0964}{\lambda^2 - 0.0446} - 0.0221 \lambda^2$$

Refractive Index Data:⁵⁴

λ (μm)	λ^{-1} (μm^{-1})	n^e	n^o	$n^e - n^o$
0.42	2.3810	2.3038	2.4144	-0.1106
0.45	2.2222	2.2765	2.3814	-0.1049
0.50	2.0000	2.2446	2.3444	-0.0998
0.55	1.8182	2.2241	2.3188	-0.0947
0.60	1.6667	2.2083	2.3002	-0.0919
0.65	1.5385	2.1964	2.2862	-0.0898
0.70	1.4286	2.1874	2.2756	-0.0882
0.80	1.2500	2.1741	2.2598	-0.0857
0.90	1.1111	2.1647	2.2487	-0.0840
1.00	1.0000	2.1580	2.2407	-0.0827
1.20	0.8333	2.1481	2.2291	-0.0810
1.40	0.7143	2.1410	2.2208	-0.0798
1.60	0.6250	2.1351	2.2139	-0.0788
1.80	0.5556	2.1297	2.2074	-0.0777
2.00	0.5000	2.1244	2.2015	-0.0771
2.20	0.4545	2.1187	2.1948	-0.0761
2.40	0.4167	2.1138	2.1882	-0.0744
2.60	0.3846	2.1080	2.1814	-0.0734
2.80	0.3571	2.1020	2.1741	-0.0721
3.00	0.3333	2.0955	2.1663	-0.0708
3.20	0.3125	2.0886	2.1580	-0.0694
3.40	0.2941	2.0814	2.1493	-0.0679
3.60	0.2778	2.0735	2.1398	-0.0663
3.80	0.2632	2.0652	2.1299	-0.0647
4.00	0.2500	2.0564	2.1193	-0.0629



Sellmeier Equation: ⁵⁵

$$(n^o)^2 = 1 + \frac{9.977 \lambda^2}{\lambda^2 - (0.435)^2} + \frac{0.067 \lambda^2}{\lambda^2 - (20)^2}$$

$$(n^e)^2 = 1 + \frac{8.783 \lambda^2}{\lambda^2 - (0.435)^2} + \frac{0.051 \lambda^2}{\lambda^2 - (20)^2}$$

Refractive Index Data: ⁵⁵

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^e	$n^e - n^o$
1.553 $\pm$ 0.03	0.644	3.443	3.248	-0.195
2.66 $\pm$ 0.05	0.376	3.356	3.170	-0.186
3.29 $\pm$ 0.1	0.304	3.339	3.152	-0.187
3.365 $\pm$ 0.065	0.297	3.337	3.155	-0.182
3.38 $\pm$ 0.16	0.296	3.339	3.152	-0.187
4.35 $\pm$ 0.09	0.230	3.332	3.148	-0.184
4.46 $\pm$ 0.17	0.224	3.330	3.142	-0.192
4.55 $\pm$ 0.2	0.220	3.326	3.142	-0.184
5.26 $\pm$ 0.3	0.190	3.321	3.141	-0.180
5.3 $\pm$ 0.1	0.189	3.326	3.142	-0.184

ZnGeP₂

Sellmeier Equation:*

$$(n^o)^2 = 9.7497 + \frac{0.6889}{\lambda^2 - 0.1402} - 0.00278 \lambda^2$$

$$(n^e)^2 = 9.9870 + \frac{0.7451}{\lambda^2 - 0.1489} - 0.00271 \lambda^2$$

Refractive Index Data:⁴⁵

<u>λ (μm)</u>	<u>λ^{-1} (μm^{-1})</u>	<u>n^o</u>	<u>n^e</u>	<u>$n^e - n^o$</u>
0.64	1.5625	3.5052	3.5802	0.0750
0.66	1.5152	3.4756	3.5467	0.0710
0.68	1.4706	3.4477	3.5160	0.0684
0.70	1.4286	3.4233	3.4885	0.0652
0.75	1.3333	3.3730	3.4324	0.0595
0.80	1.2500	3.3357	3.3915	0.0558
0.85	1.1765	3.3063	3.3593	0.0530
0.90	1.1111	3.2830	3.3336	0.0506
0.95	1.0526	3.2638	3.3124	0.0486
1.00	1.0000	3.2478	3.2954	0.0476
1.10	0.9091	3.2232	3.2688	0.0456
1.20	0.8333	3.2054	3.2493	0.0438
1.30	0.7692	3.1924	3.2346	0.0423
1.40	0.7143	3.1820	3.2244	0.0423
1.60	0.6250	3.1666	3.2077	0.0411
1.80	0.5556	3.1562	3.1965	0.0403
2.00	0.5000	3.1490	3.1889	0.0399
2.20	0.4545	3.1433	3.1829	0.0396
2.40	0.4167	3.1388	3.1780	0.0391
2.60	0.3846	3.1357	3.1745	0.0388
2.80	0.3571	3.1327	3.1717	0.0390
3.00	0.3333	3.1304	3.1693	0.0388
3.20	0.3125	3.1284	3.1671	0.0386

λ (μm)	λ^{-1} (μm^{-1})	n^o	n^e	$n^o - n^e$
3.40	0.2941	3.1263	3.1647	0.0384
3.60	0.2778	3.1257	3.1632	0.0376
3.80	0.2632	3.1237	3.1616	0.0380
4.00	0.2500	3.1223	3.1608	0.0386
4.20	0.2381	3.1209	3.1595	0.0386
4.50	0.2222	3.1186	3.1561	0.0374
4.70	0.2128	3.1174	3.1549	0.0375
5.00	0.2000	3.1149	3.1533	0.0383
5.50	0.1818	3.1131	3.1518	0.0387
6.00	0.1667	3.1101	3.1480	0.0379
6.50	0.1538	3.1057	3.1445	0.0387
7.00	0.1429	3.1040	3.1420	0.0380
7.50	0.1333	3.0994	3.1378	0.0384
8.00	0.1250	3.0961	3.1350	0.0389
8.50	0.1176	3.0919	3.1311	0.0392
9.00	0.1111	3.0880	3.1272	0.0392
9.50	0.1053	3.0836	3.1231	0.0395
10.00	0.1000	3.0788	3.1183	0.0396
10.50	0.0952	3.0738	3.1137	0.0399
11.00	0.0909	3.0689	3.1087	0.0398
11.50	0.0870	3.0623	3.1008	0.0386
12.00	0.0833	3.0552	3.0949	0.0397

*Equation fit to refractive index data in Ref. 45.

APPENDIX B

The calculations presented in this report were carried out on a CDC 6600 computer, using a program called NONLIN. A listing of program NONLIN is given in this Appendix.

Three units must be added to NONLIN in order to perform a calculation. The first unit consists of the index of refraction equations for the material of interest. The indices are defined by the arithmetic function OINDEX (X) and EINDEX (X), when X is wavelength in microns. These two functions are to be inserted before the first executable statement in NONLIN; a pair of comment statements (see lines NON 74 and NON 75) have been included in the program to indicate the correct location for the index functions. (In the actual deck of cards used, this pair of comment cards was of a different color than the rest of the deck to aid in locating them.) A listing of the index of refraction functions for all the materials appearing in Table III is given in Appendix C.

The second unit that must be added to NONLIN is the subroutine DSQUAR. This subroutine is to be inserted immediately after NONLIN. The purpose of DSQUAR, as explained in the comments section of NONLIN, is to compute the square of the effective nonlinear optical coefficient as a function of the phase matching angle θ . This subroutine will vary depending on the crystallographic point group to which the material of interest belongs. The various DSQUAR subroutines that were used for this report are listed in Appendix D. These subroutines are based on the expressions for $d_{\text{eff}}(\theta)$ given in Table III.

The third unit to be added to NONLIN is the input. For the CDC SCOPE System, an end-of-record card (7/8/9 in column 1) must be inserted between subroutine DSQUAR and the input.

As an example of the calculations done for this report, the output generated for cinnabar (HgS, point group 32) is reproduced in Appendix E.

PROGRAM NONLIN(INPUT,OUTPUT,TAPE3=INPUT,TAPE4=OUTPUT)	NON 1
C	NON 2
C PROGRAM TO COMPUTE PHASE MATCHING CURVES AND SMALL SIGNAL GAIN FOR	NON 3
C COLINEAR THREE WAVE OPTICAL PARAMETRIC INTERACTION. THEORY OF	NON 4
C CONFOCALLY FOCUSED PHASE MATCHING IS USED (REFERENCES - " G.O. BOYO	NON 5
C AND D. A. KLEINMAN (R AND K), "PARAMETRIC INTERACTION OF FOCUSED	NON 6
C GAUSSIAN LIGHT BEAMS", J. APPL. PHYS. VOL. 39,3597(1968), AND S. E.	NON 7
C HARRIS, "TUNABLE OPTICAL PARAMETRIC OSCILLATORS", IEEE PROC. VOL. 57,	NON 8
C 2896(1969)). A CRYSTAL THICKNESS OF 1 CM IS ASSUMED.	NON 9
C	NON 10
C INPUT - - CARD 1	NON 11
HEAD	NON 12
HEAD	NON 13
	NON 14
	NON 15
CARD 2	NON 16
IBIF,0	NON 17
IF(IBIF.LE.0)	NON 18
IF(IBIF.GT.0)	NON 19
	NON 20
	NON 21
	NON 22
	NON 23
D	NON 24
	NON 25
	NON 26
	NON 27
CARDS 3,4,ETC. PUMP,CUTOFF	NON 28
PUMP	NON 29
	NON 30
	NON 31
CUTOFF	NON 32
	NON 33
	NON 34
	NON 35
	NON 36
	NON 37
	NON 38
	NON 39
	NON 40
	NON 41
	NON 42
C THE OUTPUT IS SELF EXPLANATORY. THETA IS THE P.M. ANGLE, RHO IS THE	NON 43
C BIREFRINGENCE WALKOFF ANGLE, AND D-EFF IS THE EFFECTIVE NLO	NON 44
C COEFFICIENT (VARIES WITH THETA). H(R) IS THE FUNCTION DEFINED BY R	NON 45
C AND K, (EQ 3.49). THIS FUNCTION TAKES WALKOFF INTO ACCOUNT THROUGH THE	NON 46
C PARAMETER B, DEFINED BY R AND K (EQ 3.35). GAIN/WATT (MAX) IS THE	NON 47
C GAIN/WATT FOR AN INFINITELY THICK, LOSSLESS CRYSTAL. AREA IS THE	NON 48
C OPTIMUM BEAM WAIST CROSS SECTION.	NON 49
C	NON 50
C THE SUBROUTINE DSQUAR(DSQ,THETA,R,I) MUST BE SUPPLIED BY THE USER. IT	NON 51

C RETURNS THE VALUE OF D-EFF (SQUARED) AS A FUNCTION OF THETA, FOR THE	NON 52
C FOLLOWING CASES - -	NON 53
C	NON 54
C I=0 NEGATIVE BIREF., TYPE I P.M. (O + O = E)	NON 55
C I=1 NEGATIVE BIREF., TYPE II P.M. (O + E = E) OR (E + O = E)	NON 56
C I=2 POSITIVE BIREF., TYPE I P.M. (E + E = O)	NON 57
C I=3 POSITIVE BIREF., TYPE II P.M. (O + E = O) OR (E + O = O)	NON 58
C	NON 59
C SUBROUTINE DSQUAR MUST ALSO CONTAIN THE FOLLOWING CARD	NON 60
COMMON/COEF/D(5)	NON 61
C	NON 62
C INSERT BETWEEN THE TWO BLUE COMMENT CARDS BELOW THE FUNCTIONS	NON 63
C OINDEX(X) AND EINDEK(X), WHERE OINDEX AND EINDEK ARE FUNCTIONS THAT	NON 64
C CALCULATE THE ORDINARY AND EXTRAORDINARY REFRACTIVE INDICES FOR THE	NON 65
C MATERIAL AS A FUNCTION OF WAVELENGTH (X = WAVELENGTH IN MICRONS).	NON 66
C	NON 67
DIMENSION HEAD(8)	NON 68
REAL IDLER,LHS	NON 69
DATA NEG,IPOS,C2,C3/8HNEGATIVE,8HPOSITIVE,1.189815528E-3,	NON 70
13.1415926536/	NON 71
DATA TA,T9,AA,AB,AC,AD,AF,AF/1H,1HI,10HO + O = E),10HO + E = E),	NON 72
11JHE + O = E),10HE + E = O),10HO + E = O),10HE + O = O)/	NON 73
C INSERT OINDEX(X) AND EINDEK(X) HERE.	NON 74
C NOW YOU ARE IN BUSINFSS.	NON 75
C1=180./C3	NON 76
READ(3,10) HEAD,IBIF,D	NON 77
10 FORMAT(8A10/I3.5F10.3)	NON 78
IF(IBIF) 15,15,16	NON 79
15 IKIND=NEG	NON 80
GO TO 20	NON 81
16 IKIND=IPOS	NON 82
20 READ(3,25) PUMP,CUTOFF	NON 83
25 FORMAT(2F10.3)	NON 84
IF(E0F(3)) 26,27	NON 85
26 STOP	NON 86
27 PRINT 30,HEAD,IKIND,PUMP,D,CUTOFF	NON 87
30 FORMAT(1H1,*PROGRAM NONLIN--COLINEARLY PHASE MATCHED OPO*/1H0/1H ,	NON 88
18A10/1H0/1H ,*PHASE MATCHING FOR *,AB,* BIREFRINGENT CRYSTAL*/1H0,	NON 89
2*PUMP WAVELENGTH(MICRONS)=*,F12.3/1H0,*NONLINEAR COEFFICIENTS(X10	NON 90
3F12 M/V)=*,5F15.3/1H0,*CUTOFF WAVELENGTH=*,F12.3)	NON 91
CUTOFF=1./CUTOFF	NON 92
L=0	NON 93
T=0	NON 94
OMEGAP=1./PUMP	NON 95
OEL=OMEGAP/150.	NON 96
XO=OINDEX(PUMP)	NON 97
31 SIGNAL=2.*PUMP	NON 98
OMEGAS=1./SIGNAL	NON 99
OMEGAI=OMEGAS	NON100
IDLER=SIGNAL	NON101
IF(L.EQ.0) GO TO 34	NON102
GO TO (112,112,1060,1086),L	NON103

34 IF(IBIF) 35,35,1000	NON104
35 XE=EINDEX(PUMP)	NON105
YO=OINDEX(SIGNAL)	NON106
ZZERO=YO	NON107
X=XO*XO-XE*XE	NON108
IF(X) 74,74,40	NON109
40 IF(XE.LE.YO) GO TO 65	NON110
PRINT 45,TA,AA,PUMP	NON111
45 FORMAT(1H0,*,THIS MATERIAL CANNOT BE TYPE I*,A1,2H (,A10,*, PHASE MA	NON112
1TCHED FOR THE PUMP WAVELENGTH*,F12.3,*, MICRON*)	NON113
50 OMEGAS=OMEGAS+DEL	NON114
IF(OMEGAS.GE.OMEGAP) GO TO 100	NON115
OMEGAI=OMEGAP-OMEGAS	NON116
IF(OMEGAI.LT.CUTOFF) GO TO 100	NON117
SIGNAL=1./OMEGAS	NON118
IDLER=1./OMEGAI	NON119
IF(I.EQ.2) GO TO 1005	NON120
YO=OINDEX(SIGNAL)	NON121
ZO=OINDEX(IDLER)	NON122
IF((OMEGAP*XE).GT.(OMEGAS*YO+OMEGAI*ZO)) GO TO 50	NON123
PRINT 60,SIGNAL, IDLER	NON124
60 FORMAT(1H *,*IN THE WAVELENGTH REGION*,F12.3,*, TO*,F12.3,*, MICRON*)	NON125
GO TO 80	NON126
74 PRINT 75,IKIND,SIGNAL,IDLER	NON127
75 FORMAT(1H0,*,THE CALCULATED INDICES FOR THIS MATERIAL DO NOT GIVE *	NON128
1,48,*, RIREFRINGENCE FOR SIGNAL=*,F12.3,*, IDLER=*,F12.3,*, NEXT CAS	NON129
2E*)	NON130
GO TO 110	NON131
65 ZO=YO	NON132
80 PRINT 91,TA,AA	NON133
91 FORMAT(1H0,*,RESULTS FOR TYPE I*,A1,2H (,A10,*, PHASE MATCHING ARE*/	NON134
11H)	NON135
PRINT 90	NON136
90 FORMAT(1H0,*,SIGNAL IDLER THETA RHO THETA RH	NON137
10 0-EFF R H(R) GAIN/WATT GAIN/WATT ARE	NON138
2A*/1H ,11X,2(8X,5H(RAD)),3X,2(3X,5H(DEG)),2X,9H(*10.E12),24X,	NON139
35H(1CM),8X,5H(MAX),7X,7H(SQ CM)/1H)	NON140
85 Y=(OMEGAP*XO/(OMEGAS*YO+OMEGAI*ZO))**2-1.	NON141
SINTH=XE*SQRT(Y/X)	NON142
IF(SINTH.GE.1.) GO TO 1035	NON143
THETAR=ASIN(SINTH)	NON144
SINSQ=SINTH*SINTH	NON145
Y=X*SINSQ+XE*XE	NON146
RHOR=.5*SIN(2.*THETAR)*X/Y	NON147
89 Z=XO*XE/SQRT(Y)	NON148
88 RHOR=ATAN(RHOR)	NON149
THETAD=C1*THETAR	NON150
RHOD=C1*RHOP	NON151
CALL DSQUAR(DSQ,THETAR,I)	NON152
R=Z*(100.*RHOR)**2/PUMP	NON153
H1=1.068/(1.+1.068*R)	NON154
H4=1./R	NON155

R=C3*B/4.	NON156
IF(R.LE.2.) GO TO 93	NON157
RJ=B/2.	NON158
GO TO 94	NON159
93 RJ=1.	NON160
94 B=SQRT(8)	NON161
AREA=5.E-5*B0*PUMP/77ERO	NON162
DEFF=SQRT(DSQ)	NON163
GAIN1=C2*DSQ*PUMP/(SIGNAL*SIGNAL*IDLER*IDLER*7*Z)	NON164
GAINM=GAIN1*HM	NON165
GAIN1=GAIN1*H1	NON166
PRINT 95,SIGNAL,IDLER,THETAR,RHOR,THETAD,RHOD,DEFF,B,H1,GAIN1,	NON167
1GAINM,AREA	NON168
95 FORMAT(1H ,F5.2,F8.2,1PE13.3,E13.3,0PF9.2, F8.2, F9.2, F9.2,F11.5,	NON169
13(1PE13.3))	NON170
96 OMEGAS=OMEGAS+DEL	NON171
IF(OMEGAS.GE.OMEGAP) GO TO 110	NON172
OMEGAI=OMEGAP-OMEGAS	NON173
IF(OMEGAI.LT.CUTOFF) GO TO 110	NON174
SIGNAL=1./OMEGAS	NON175
IDLER=1./OMEGAI	NON176
Y0=OINDEX(SIGNAL)	NON177
Z0=OINDEX(IDLER)	NON178
IF(I.EQ.0) GO TO 85	NON179
GO TO (105,180,1050,1050,1105),L	NON180
100 PRINT 105	NON181
105 FORMAT(1H ,*TYPE II IS ALSO EXCLUDED.*)	NON182
GO TO 20	NON183
106 ZE=EINDEX(IDLER)	NON184
GO TO 135	NON185
110 IF(L.EQ.2) GO TO 20	NON186
IF(I.EQ.0) GO TO 111	NON187
IF(I.EQ.1) GO TO 160	NON188
IF(L-4) 1055,1085,20	NON189
111 L=1	NON190
I=1	NON191
GO TO 31	NON192
112 Y0=OINDEX(SIGNAL)	NON193
Z0=Y0	NON194
ZE=EINDEX(IDLER)	NON195
IF((Y0+ZE).GE.(2.*XE)) GO TO(130,175),L	NON196
GO TO (114,164),L	NON197
114 PRINT 45,TR,AR,PUMP	NON198
121 OMEGAS=OMEGAS+DEL	NON199
IF(OMEGAS.GE.OMEGAP) GO TO 160	NON200
OMEGAI=OMEGAP-OMEGAS	NON201
IF(OMEGAI.LT.CUTOFF) GO TO 160	NON202
SIGNAL=1./OMEGAS	NON203
Y0=OINDEX(SIGNAL)	NON204
IDLER=1./OMEGAI	NON205
ZE=EINDEX(IDLER)	NON206
IF((OMEGAS*Y0+OMEGAI*ZE).LT.(OMEGAP*XE)) GO TO 120	NON207

```

PRINT 60,SIGNAL,IDLER
Z0=OINDEX(IDLER)
130 PRINT 91,TR,AR
PRINT 90
135 XI=70*Z0-7E*7E
IF(XI) 74,74,137
137 SINSQ=0.
DEC=.1
140 LHS=OMEGAS*Y0+OMEGAI*70*7E/SQRT(XI*SINSQ+ZE*ZE)
141 RHS=OMEGAP*X0*XE/SQRT(X*SINSQ+XE*XE)
142 IF(LHS,GE,RHS) GO TO 150
145 SINSQ=SINSQ+DEC
IF(SINSQ,GE,1.) GO TO 1035
GO TO (140,195,1025).L
150 IF(DEC,LE,1.E-6) GO TO 155
SINSQ=SINSQ-DEC
DEC=.1*DEC
GO TO 145
155 THETAR=SQRT(SINSQ)
THETAR=ASIN(THETAR)
SIN2=.5*SIN(2.*THETAR)
IF(L,EQ,3) GO TO 1045
Y=X*SINSQ+XE*XE
RP=SIN2*X/Y
GO TO (156,200).L
156 YI=XI*SINSQ+7E*7E
RI=SIN2*YI/YI
PHOR=AMAX1(RP,RI)
GO TO 89
160 L=2
GO TO 31
164 PRINT 45,TR,AC,PUMP
170 OMEGAS=OMEGAS+DEL
IF(OMEGAS,GE,OMEGAP) GO TO 20
OMEGAI=OMEGAP-OMEGAS
IF(OMEGAI,LT,CUTOFF) GO TO 20
SIGNAL=1./OMEGAS
YE=EINDEX(SIGNAL)
TOLER=1./OMEGAI
Z0=OINDEX(TOLER)
IF((OMEGAS*YE+OMEGAI*Z0).LT,(OMEGAP*XE)) GO TO 170
PRINT 60,SIGNAL,IDLER
Y0=OINDEX(SIGNAL)
175 PRINT 91,TR,AC
PRINT 90
180 YE=EINDEX(SIGNAL)
XS=Y0*Y0-YE*YE
IF(XS) 74,74,190
190 SINSQ=0.
DEC=.1
195 LHS=OMEGAS*Y0*YE/SQRT(XS*SINSQ+YE*YE)+OMEGAI*70
GO TO 141

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NON258
NON259

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200	YS=XS*SINSQ+YE*YE	NON260
	RS=SIN2*XS/YS	NON261
	RHOR=AMAX1(RP,RS)	NON262
	GO TO 89	NON263
1000	I=2	NON264
	L=3	NON265
	YE=EINDEX(SIGNAL)	NON266
	ZZERO=YE	NON267
	IF(XO.LE.YE) GO TO 1010	NON268
	PRINT 45,TA,AD,PUMP	NON269
	GO TO 50	NON270
1005	YE=EINDEX(SIGNAL)	NON271
	ZE=EINDEX(IDLER)	NON272
	IF((OMEGA*YO).GT.(OMEGA*YE+OMEGA*ZE)) GO TO 50	NON273
	PRINT 60,SIGNAL,IDLER	NON274
	GO TO 1015	NON275
1010	ZE=YE	NON276
1015	YO=OINDEX(SIGNAL)	NON277
	ZO=OINDEX(IDLER)	NON278
	PRINT 91,TA,AD	NON279
	PRINT 90	NON280
1016	XS=YE*YE-YO*YO	NON281
	IF(XS) 74,74,1020	NON282
1020	XI=ZE*ZE-ZO*ZO	NON283
	IF(XI) 74,74,1021	NON284
1021	SINSQ=0.	NON285
	DEC=.1	NON286
1025	LHS=OMEGA*YO*YE/SQRT(YE*YE-XS*SINSQ)+OMEGA*ZO*ZE/SQRT(ZE*ZE-	NON287
	1 XI*SINSQ)	NON288
	RHS=OMEGA*YO	NON289
	GO TO 142	NON290
1035	PRINT 1040,SIGNAL,IDLER	NON291
1040	FORMAT(1H0,*PHASE MATCHING CUTS OFF AT SIGNAL=*,F12.3,* AND IDLER=	NON292
	1*,F12.3)	NON293
	GO TO 96	NON294
1045	YS=YE*YE-XS*SINSQ	NON295
	YI=ZE*ZE-XI*SINSQ	NON296
	RS=SIN2*XS/YS	NON297
	RI=SIN2*XI/YI	NON298
	RHOR=AMAX1(RS,RI)	NON299
	Z=XO	NON300
	GO TO 88	NON301
1050	YE=EINDEX(SIGNAL)	NON302
	ZE=EINDEX(IDLER)	NON303
	GO TO 1016	NON304
1055	I=3	NON305
	GO TO 31	NON306
1060	L=4	NON307
	YO=OINDEX(SIGNAL)	NON308
	ZE=EINDEX(IDLER)	NON309
	ZO=YO	NON310
	IF((YO+ZE).GE.(2.*XO)) GO TO 1070	NON311

	PRINT 45,TR,AE,PUMP	NON312
1065	OMEGAS=OMEGAS+DEL	NON313
	IF(OMEGAS.GE.OMEGAP) GO TO 31	NON314
	OMEGAI=OMEGAP-OMEGAS	NON315
	IF(OMEGAI.LT.CUTOFF) GO TO 31	NON316
	SIGNAL=1./OMEGAS	NON317
	IDLER=1./OMEGAI	NON318
	Y0=OINDEX(SIGNAL)	NON319
	ZE=EINDEX(IDLER)	NON320
	IF((OMEGAS*Y0+OMEGAI*ZE).LT.(OMEGAP*X0)) GO TO 1065	NON321
	Z0=OINDEX(IDLER)	NON322
	PRINT 60,SIGNAL,IDLER	NON323
1070	PRINT 91,TR,AE	NON324
	PRINT 90	NON325
1075	XI=ZE*ZE-Z0*Z0	NON326
	IF(XI) 74,74,1076	NON327
1076	Y=1.-(OMEGAI*Z0/(OMEGAP*X0-OMEGAS*Y0))**2	NON328
	SINTH=ZE*SQR(Y/XI)	NON329
	IF(SINTH.GE.1.) GO TO 1035	NON330
	THETAR=ASIN(SINTH)	NON331
	SINSQ=SINTH*SINTH	NON332
	Y=ZE*ZE-XI*SINSQ	NON333
	RHOR=.5*SIN(2.*THETAR)*XI/Y	NON334
	Z=X0	NON335
	GO TO 88	NON336
1080	ZE=EINDEX(IDLER)	NON337
	GO TO 1075	NON338
1085	GO TO 31	NON339
1086	L=5	NON340
	YE=EINDEX(SIGNAL)	NON341
	Z0=OINDEX(IDLER)	NON342
	Y0=Z0	NON343
	IF((YE+Z0).GE.(2.*X0)) GO TO 1095	NON344
	PRINT 45,TR,AF,PUMP	NON345
1090	OMEGAS=OMEGAS+DEL	NON346
	IF(OMEGAS.GE.OMEGAP) GO TO 20	NON347
	OMEGAI=OMEGAP-OMEGAS	NON348
	IF(OMEGAI.LT.CUTOFF) GO TO 20	NON349
	SIGNAL=1./OMEGAS	NON350
	IDLER=1./OMEGAI	NON351
	YE=EINDEX(SIGNAL)	NON352
	Z0=OINDEX(IDLER)	NON353
	IF((OMEGAS*YE+OMEGAI*Z0).LT.(OMEGAP*X0)) GO TO 1090	NON354
	Y0=OINDEX(SIGNAL)	NON355
	PRINT 60,SIGNAL,IDLER	NON356
1095	PRINT 91,TR,AF	NON357
	PRINT 90	NON358
1096	XS=YE*YE-Y0*Y0	NON359
	IF(XS) 74,74,1100	NON360
1100	Y=1.-(OMEGAS*Y0/(OMEGAP*X0-OMEGAI*Z0))**2	NON361
	SINTH=YE*SQR(Y/XS)	NON362
	IF(SINTH.GT.1.) GO TO 1035	NON363

```

    THETAR=ASIN(SINTH)
    SINSQ=SINTH*SINTH
    Y=YE*YE-XS*SINSQ
    RHOR=.5*SIN(2.*THETAR)*XS/Y
    Z=X0
    GO TO 88
1105 YE=EINDEX(SIGNAL)
    GO TO 1096
END

```

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NON364
NON365
NON366
NON367
NON368
NON369
NON370
NON371
NON372

```

APPENDIX C

SILVER GALLIUM SULFIDE

OINDEX(X)=SQRT(5.728+.241/(X*X-.087)-.0021*X*X)
FINDEX(X)=SQRT(5.497+.2026/(X*X-.1307)-.00233*X*X)

SILVER GALLIUM SELENIDE

OINDEX(X)=SQRT(3.9362+2.9113*X*X/(X*X-.38821*.38821)+1.7954*X*X/
1(X*X-1600.))
EINDEX(X)=SQRT(3.3132+3.3616*X*X/(X*X-.38201*.38201)+1.7677*X*X/
1(X*X-1600.))

CADMIUM GERMANIUM ARSENIDE

OINDEX(X)=SQRT(4.+8.891*X*X/(X*X-.5524*.5524)+1.886*X*X/(X*X-1296.
1))
FINDEX(X)=SQRT(4.+9.521*X*X/(X*X-.6847*.6847)+1.909*X*X/(X*X-1296.
1))

ZINC GERMANIUM PHOSPHIDE

OINDEX(X)=SQRT(9.7497+.6889/(X*X-.1402)-.00278*X*X)
FINDEX(X)=SQRT(9.987+.7451/(X*X-.1489)-.00271*X*X)

CINNABAR

OINDEX(X)=SQRT(6.9445+.3658/(X*X-.1357)-.0019*X*X)
EINDEX(X)=SQRT(8.3922+.539/(X*X-.1388)-.0027*X*X)

PROUSTITE

OINDEX(X)=SQRT(7.4822+.4635/(X*X-.116)-.0016*X*X)
EINDEX(X)=SQRT(6.3434+.3352/(X*X-.1117)-.0007*X*X)

PYRRARGYRITE

OINDEX(X)=SQRT(1.+6.585*X*X/(X*X-.16)+.1133*X*X/(X*X-225.))
EINDEX(X)=SQRT(1.+5.845*X*X/(X*X-.16)+.0202*X*X/(X*X-225.))

LITHIUM NIORATE

OINDEX(X)=SQRT(4.926+.117/(X*X-.0473)-.0275*X*X)
EINDEX(X)=SQRT(4.5778+.0964/(X*X-.0446)-.0221*X*X)

THALLIUM ARSENIC SELENIDE

OINDEX(X)=SQRT(1.+10.125*X*X/(X*X-.445*.445)+.1*X*X/(X*X-400.))
FINDEX(X)=SQRT(1.+8.93*X*X/(X*X-.445*.445)+.05*X*X/(X*X-400.))

LITHIUM IODATE

OINDEX(X)=SQRT(3.467+.0215/(X*X-.0958)-.00677*X*X)
FINDEX(X)=SQRT(2.961+.0142/(X*X-.0915)-.00423*X*X)

CADMIUM SELENIDE

OINDEX(X)=SQRT(4.1321+1.8587*X*X/(X*X-.2187)+3.0461*X*X/(X*X-3380.
1))
EINDEX(X)=SQRT(4.0829+2.0038*X*X/(X*X-.2075)+3.554*X*X/(X*X-3629.
1))

APPENDIX D

```
SUBROUTINE DSQUAR(DSQ,THETAR,I)
COMMON/COEF/D(5)
```

C
C THE FOLLOWING CARDS ARE FOR POINT GROUP 4(BAR)2M. THE COEFFICIENTS
C MUST BE LISTED ON THE INPUT CARD IN THE ORDER D(14), D(36).

C
SINTH=SIN(THETAR)
SIN2=SIN(2.*THETAR)
IF(I.NE.0) GO TO 10
DSQ=D(2)*D(2)*SINTH*SINTH
RETURN
10 IF(I-2) 15,20,25
15 DSQ=.25*SIN2*SIN2*(D(1)+D(2))**2
RETURN
20 DSQ=D(1)*D(1)*SIN2*SIN2
RETURN
25 DSQ=D(1)*D(1)*SINTH*SINTH
RETURN
END

```
SUBROUTINE DSQUAR(DSQ,THETAR,I)
COMMON/COEF/D(5)
```

C
C THE FOLLOWING CARDS ARE FOR POINT GROUP 32 . THE COEFFICIENTS MUST
C BE LISTED ON THE INPUT CARD IN THE ORDER D(11), D(14).

C
SINTH=SIN(THETAR)
COSSQ=1.-SINTH*SINTH
IF(I.NE.0) GO TO 10
25 DSQ=D(1)*D(1)*COSSQ
RETURN
10 IF(I-2) 15,20,25
15 SIN2=SIN(2.*THETAR)
DSQ=(D(1)*COSSQ+.5*D(2)*SIN2)**2
RETURN
20 SIN2=SIN(2.*THETAR)
DSQ=(D(1)*COSSQ+ D(2)*SIN2)**2
RETURN
END

```
SUBROUTINE DSQUAR(DSQ,THETAR,I)
COMMON/COEF/D(5)
```

C
C THE FOLLOWING CARDS ARE FOR POINT GROUP 3M. THE COEFFICIENTS MUST
C BE LISTED ON THE INPUT CARD IN THE ORDER D(21), D(31), D(15)
C

```
SINSQ=(SIN(THETAR))**2
COSSQ=1.-SINSQ
SIN2=SIN(2.*THETAR)
IF(I.NE.0) GO TO 10
DSQ=D(1)*D(1)*COSSQ+D(2)*D(2)*SINSQ+D(1)*D(2)*SIN2
RETURN
10 IF(I-2) 15,15,20
15 DSQ=COSSQ*COSSQ*D(1)*D(1)
RETURN
20 DSQ=D(3)*D(3)*SINSQ+D(1)*D(1)*COSSQ+D(1)*D(3)*SIN2
RETURN
END
```

```
SUBROUTINE DSQUAR(DSQ,THETAR,I)
COMMON/COEF/D(5)
```

C
C THE FOLLOWING CARDS ARE FOR POINT GROUP 6. THE COEFFICIENTS MUST
C BE LISTED ON THE INPUT CARD IN THE ORDER D(15), D(31), D(14).
C

```
SINTH=SIN(THETAR)
SIN2=SIN(2.*THETAR)
IF(I.NE.0) GO TO 10
DSQ=D(2)*D(2)*SINTH*SINTH
RETURN
10 IF(I-2) 15,20,25
15 DSQ=.25*D(3)*D(3)*SIN2*SIN2
RETURN
20 DSQ=D(3)*D(3)*SIN2*SIN2
RETURN
25 DSQ=D(1)*D(1)*SINTH*SINTH
RETURN
END
```



```
SUBROUTINE DSQUAR(DSQ,THETAR,I)  
COMMON/COEF/D(5)
```

```
C  
C THE FOLLOWING CARDS ARE FOR POINT GROUP 6MM. THE COEFFICIENTS MUST  
C BE LISTED ON THE INPUT CARD IN THE ORDER D(15), D(31).  
C
```

```
    SINTH=SIN(THETAP)  
    IF(I.NE.0) GO TO 10  
    DSQ=D(2)*D(2)*SINTH*SINTH  
    RETURN  
10  IF(I-2) 15,15,25  
15  DSQ=0.  
    RETURN  
25  DSQ=D(1)*D(1)*SINTH*SINTH  
    RETURN  
    END
```

APPENDIX E

PROGRAM NONLIN--COLINEARLY PHASE MATCHED OPO

CINVARAR

PHASE MATCHING FOR POSITIVE BIREFRINGENT CRYSTAL

PUMP WAVELENGTH(MICRONS)= .694

NONLINAR COEFFICIENTS(X10 E12 M/V)= 50.000

CUTOFF WAVELENGTH= 10.000

RESULTS FOR TYPE I (E + E = 0) PHASE MATCHING ARE

SIGNAL	IDLER	THETA (RAD)	PHO (RAD)	THETA (DEG)	RHO (DEG)	D-EFF (*10.E12)	R	H(R)	GAIN/MATT (ICW)	GAIN/MATT (MAY)	AREA (SQ CM)
1.39	1.39	8.883E-01	9.705E-02	50.90	5.56	19.89	17.36	.00260	2.858E-05	2.865E-05	1.775E-03
1.37	1.41	8.882E-01	9.714E-02	51.89	5.57	19.89	17.36	.00259	2.853E-05	2.865E-05	1.770E-03
1.35	1.43	8.879E-01	9.724E-02	52.87	5.57	19.91	17.40	.00259	2.849E-05	2.856E-05	1.762E-03
1.33	1.45	8.874E-01	9.735E-02	53.85	5.58	19.93	17.42	.00258	2.845E-05	2.852E-05	1.756E-03
1.32	1.47	8.867E-01	9.745E-02	54.80	5.58	19.97	17.44	.00258	2.841E-05	2.849E-05	1.750E-03
1.30	1.49	8.858E-01	9.757E-02	55.75	5.59	20.01	17.46	.00257	2.838E-05	2.845E-05	1.744E-03
1.29	1.51	8.847E-01	9.769E-02	56.69	5.60	20.07	17.48	.00256	2.836E-05	2.843E-05	1.738E-03
1.27	1.53	8.833E-01	9.782E-02	57.61	5.60	20.13	17.50	.00256	2.834E-05	2.841E-05	1.732E-03
1.25	1.55	8.818E-01	9.795E-02	58.52	5.61	20.21	17.52	.00255	2.832E-05	2.839E-05	1.726E-03
1.24	1.56	8.801E-01	9.808E-02	59.42	5.62	20.30	17.55	.00254	2.831E-05	2.837E-05	1.720E-03
1.22	1.60	8.781E-01	9.822E-02	60.31	5.63	20.39	17.57	.00254	2.830E-05	2.837E-05	1.714E-03
1.21	1.63	8.760E-01	9.836E-02	61.19	5.64	20.50	17.60	.00253	2.829E-05	2.836E-05	1.708E-03
1.20	1.65	8.736E-01	9.850E-02	62.06	5.64	20.61	17.62	.00252	2.829E-05	2.836E-05	1.702E-03
1.18	1.68	8.711E-01	9.865E-02	62.91	5.65	20.74	17.65	.00251	2.829E-05	2.836E-05	1.696E-03
1.17	1.71	8.683E-01	9.880E-02	63.75	5.66	20.87	17.68	.00251	2.829E-05	2.836E-05	1.690E-03
1.16	1.73	8.654E-01	9.895E-02	64.58	5.67	21.02	17.70	.00250	2.829E-05	2.837E-05	1.684E-03
1.14	1.76	8.622E-01	9.910E-02	65.40	5.68	21.17	17.73	.00249	2.829E-05	2.837E-05	1.678E-03
1.13	1.79	8.589E-01	9.924E-02	66.21	5.69	21.34	17.76	.00249	2.829E-05	2.837E-05	1.672E-03
1.12	1.83	8.553E-01	9.939E-02	67.01	5.69	21.52	17.78	.00248	2.829E-05	2.837E-05	1.666E-03
1.11	1.86	8.515E-01	9.954E-02	67.79	5.70	21.70	17.81	.00247	2.829E-05	2.837E-05	1.660E-03
1.10	1.89	8.476E-01	9.969E-02	68.56	5.71	21.90	17.83	.00246	2.829E-05	2.837E-05	1.654E-03
1.08	1.93	8.434E-01	9.982E-02	69.32	5.72	22.11	17.86	.00246	2.829E-05	2.837E-05	1.648E-03
1.07	1.96	8.390E-01	9.995E-02	69.07	5.73	22.32	17.88	.00245	2.829E-05	2.837E-05	1.642E-03
1.06	2.00	8.345E-01	1.001E-01	69.81	5.73	22.55	17.91	.00244	2.829E-05	2.837E-05	1.636E-03
1.05	2.04	8.297E-01	1.003E-01	70.54	5.74	22.79	17.93	.00243	2.829E-05	2.837E-05	1.630E-03
1.04	2.08	8.246E-01	1.005E-01	71.25	5.75	23.04	17.95	.00242	2.829E-05	2.837E-05	1.624E-03
1.03	2.12	8.196E-01	1.006E-01	71.96	5.75	23.29	17.96	.00242	2.829E-05	2.837E-05	1.618E-03
1.02	2.17	8.142E-01	1.007E-01	72.65	5.76	23.56	17.98	.00242	2.829E-05	2.837E-05	1.612E-03
1.01	2.21	8.086E-01	1.008E-01	73.34	5.76	23.84	18.01	.00242	2.829E-05	2.837E-05	1.606E-03
1.00	2.26	8.028E-01	1.009E-01	74.03	5.77	24.13	18.01	.00241	2.829E-05	2.837E-05	1.600E-03
.99	2.31	7.966E-01	1.007E-01	74.65	5.77	24.43	18.01	.00241	2.829E-05	2.837E-05	1.594E-03
.98	2.37	7.904E-01	1.007E-01	75.30	5.77	24.74	18.02	.00241	2.829E-05	2.837E-05	1.588E-03
.97	2.42	7.842E-01	1.007E-01	75.93	5.77	25.06	18.02	.00241	2.829E-05	2.837E-05	1.582E-03
.96	2.48	7.776E-01	1.007E-01	76.55	5.77	25.39	18.02	.00241	2.829E-05	2.837E-05	1.576E-03
.96	2.54	7.707E-01	1.007E-01	77.16	5.77	25.73	18.02	.00241	2.829E-05	2.837E-05	1.570E-03

.95	2.60	7.637E-01	1.036E-01	43.75	5.77	26.09	19.01	.00242	2.790E-05	2.804E-05	1.908E-03
.94	2.67	7.564E-01	1.005E-01	43.34	5.76	26.45	17.99	.00242	2.789E-05	2.799E-05	1.906E-03
.93	2.74	7.489E-01	1.005E-01	42.91	5.76	26.82	17.97	.00243	2.779E-05	2.784E-05	1.902E-03
.92	2.81	7.412E-01	1.003E-01	42.47	5.75	27.21	17.95	.00243	2.768E-05	2.772E-05	1.897E-03
.91	2.89	7.335E-01	1.002E-01	42.01	5.74	27.60	17.92	.00244	2.752E-05	2.758E-05	1.890E-03
.90	2.97	7.251E-01	9.997E-02	41.54	5.73	28.01	17.89	.00245	2.736E-05	2.742E-05	1.883E-03
.89	3.06	7.167E-01	9.973E-02	41.06	5.71	28.43	17.84	.00246	2.718E-05	2.724E-05	1.874E-03
.88	3.15	7.080E-01	9.946E-02	40.57	5.70	28.85	17.80	.00247	2.699E-05	2.705E-05	1.864E-03
.87	3.25	6.991E-01	9.915E-02	40.06	5.68	29.29	17.74	.00249	2.677E-05	2.683E-05	1.852E-03
.86	3.36	6.900E-01	9.880E-02	39.53	5.66	29.74	17.68	.00251	2.653E-05	2.659E-05	1.839E-03
.85	3.47	6.806E-01	9.839E-02	39.00	5.64	30.20	17.60	.00253	2.628E-05	2.634E-05	1.824E-03
.84	3.59	6.710E-01	9.794E-02	38.44	5.61	30.67	17.52	.00255	2.597E-05	2.604E-05	1.808E-03
.83	3.72	6.610E-01	9.744E-02	37.87	5.58	31.15	17.43	.00258	2.566E-05	2.572E-05	1.790E-03
.82	3.86	6.508E-01	9.688E-02	37.29	5.55	31.65	17.33	.00261	2.531E-05	2.537E-05	1.769E-03
.81	4.00	6.403E-01	9.627E-02	36.69	5.52	32.15	17.22	.00264	2.494E-05	2.500E-05	1.746E-03
.80	4.16	6.295E-01	9.559E-02	36.07	5.48	32.67	17.10	.00268	2.453E-05	2.459E-05	1.722E-03
.79	4.34	6.184E-01	9.484E-02	35.43	5.43	33.19	16.97	.00272	2.409E-05	2.415E-05	1.695E-03
.78	4.53	6.070E-01	9.402E-02	34.78	5.39	33.73	16.82	.00277	2.362E-05	2.368E-05	1.666E-03
.77	4.73	5.952E-01	9.313E-02	34.10	5.34	34.28	16.66	.00282	2.311E-05	2.317E-05	1.634E-03
.76	4.96	5.831E-01	9.216E-02	33.41	5.28	34.84	16.49	.00288	2.259E-05	2.265E-05	1.600E-03
.75	5.20	5.706E-01	9.110E-02	32.69	5.22	35.41	16.30	.00295	2.198E-05	2.204E-05	1.564E-03
.74	5.48	5.578E-01	8.995E-02	31.96	5.15	35.99	16.09	.00302	2.133E-05	2.139E-05	1.524E-03
.73	5.78	5.445E-01	8.870E-02	31.20	5.08	36.59	15.87	.00311	2.065E-05	2.071E-05	1.482E-03
.72	6.12	5.307E-01	8.734E-02	30.41	5.00	37.19	15.63	.00321	1.992E-05	1.998E-05	1.437E-03
.71	6.51	5.166E-01	8.587E-02	29.60	4.92	37.80	15.36	.00332	1.915E-05	1.921E-05	1.389E-03
.70	6.94	5.019E-01	8.428E-02	28.76	4.83	38.43	15.08	.00344	1.832E-05	1.838E-05	1.339E-03
.69	7.44	4.867E-01	8.257E-02	27.89	4.73	39.06	14.77	.00359	1.744E-05	1.749E-05	1.284E-03
.68	8.01	4.710E-01	8.071E-02	26.99	4.62	39.70	14.44	.00375	1.649E-05	1.655E-05	1.227E-03
.67	8.67	4.547E-01	7.870E-02	26.05	4.51	40.36	14.09	.00395	1.549E-05	1.555E-05	1.167E-03
.66	9.46	4.378E-01	7.653E-02	25.08	4.39	41.01	13.69	.00417	1.442E-05	1.448E-05	1.104E-03
.65	10.41	4.202E-01	7.419E-02	24.04	4.25	41.64	13.27	.00444	1.328E-05	1.334E-05	1.037E-03
.64	11.57	4.020E-01	7.168E-02	22.93	4.11	42.35	12.82	.00475	1.207E-05	1.212E-05	9.680E-04
.63	13.01	3.831E-01	6.897E-02	21.95	3.95	43.01	12.34	.00513	1.077E-05	1.082E-05	8.964E-04
.62	14.87	3.636E-01	6.610E-02	20.83	3.79	43.68	11.83	.00559	9.384E-06	9.433E-06	8.231E-04
.61	17.35	3.438E-01	6.307E-02	19.70	3.61	44.32	11.28	.00613	7.902E-06	7.947E-06	7.499E-04
.60	20.82	3.242E-01	6.000E-02	18.59	3.44	44.92	10.73	.00677	6.313E-06	6.354E-06	6.783E-04
.59	26.02	3.065E-01	5.715E-02	17.56	3.27	45.45	10.23	.00746	4.618E-06	4.650E-06	6.154E-04

THIS MATERIAL CANNOT BE TYPE II (E + E = 0) PHASE MATCHED FOR THE PUMP WAVELENGTH .694 MICRON

THIS MATERIAL CANNOT BE TYPE II (E + 0 = 0) PHASE MATCHED FOR THE PUMP WAVELENGTH .694 MICRON

IN THE WAVELENGTH REGION 1.239 TO 1.577 MICRON

RESULTS FOR TYPE II (E + 0 = 0) PHASE MATCHING ARE

SIGNAL	IDLER	THETA (RAD)	RHO (RAD)	THETA (DEG)	RHO (DEG)	0-EFF (*10.E12)	R	WCR	GAIN/WATT (1CM)	GAIN/WATT (MAX)	AREA (SQ CM)
1.24	1.58	1.461E+00	2.377E-02	83.69	1.36	5.50	4.25	.04172	3.407E-05	3.549E-05	1.065E-04
1.22	1.60	1.409E+00	3.452E-02	80.73	1.98	8.06	6.18	.02020	3.518E-05	3.595E-05	2.249E-04
1.21	1.63	1.370E+00	4.237E-02	78.48	2.43	9.98	7.59	.01349	3.579E-05	3.625E-05	3.382E-04
1.20	1.65	1.337E+00	4.874E-02	76.60	2.79	11.53	8.72	.01023	3.627E-05	3.662E-05	4.477E-04
1.18	1.68	1.308E+00	5.417E-02	74.93	3.10	13.00	9.69	.00830	3.669E-05	3.698E-05	5.538E-04
1.17	1.71	1.261E+00	5.892E-02	71.41	3.39	14.28	10.54	.00702	3.787E-05	3.732E-05	6.541E-04

1.16	1.73	1.257F+00	6.314E-02	72.00	3.62	15.45	11.30	.00612	3.742E-05	3.763E-05	7.512E-04
1.14	1.76	1.234F+00	6.594E-02	70.69	3.84	16.54	11.94	.00545	3.774E-05	3.793E-05	8.442E-04
1.13	1.79	1.212F+00	7.039E-02	69.44	4.03	17.55	12.59	.00493	3.803E-05	3.821E-05	9.333E-04
1.12	1.83	1.191F+00	7.352E-02	68.25	4.21	18.52	13.15	.00452	3.830E-05	3.846E-05	1.019E-03
1.11	1.86	1.171F+00	7.543E-02	67.12	4.39	19.44	13.67	.00419	3.854E-05	3.870E-05	1.100E-03
1.10	1.89	1.152F+00	7.905E-02	65.02	4.53	20.32	14.14	.00391	3.891E-05	3.907E-05	1.177E-03
1.09	1.93	1.134F+00	8.147E-02	64.06	4.67	21.17	14.58	.00360	3.896E-05	3.909E-05	1.251E-03
1.07	1.96	1.116F+00	8.373E-02	63.33	4.80	21.98	14.94	.00332	3.913E-05	3.926E-05	1.321E-03
1.06	2.00	1.098E+00	8.591E-02	62.92	4.92	22.76	15.35	.00332	3.927E-05	3.939E-05	1.387E-03
1.05	2.04	1.081F+00	8.777E-02	61.94	5.03	23.52	15.70	.00318	3.939E-05	3.951E-05	1.450E-03
1.04	2.08	1.064E+00	8.943E-02	60.94	5.13	24.25	16.01	.00305	3.948E-05	3.960E-05	1.509E-03
1.03	2.12	1.048E+00	9.112E-02	59.04	5.22	24.97	16.30	.00295	3.955E-05	3.966E-05	1.565E-03
1.02	2.17	1.032F+00	9.262E-02	59.11	5.31	25.67	16.57	.00295	3.955E-05	3.966E-05	1.616E-03
1.01	2.21	1.016E+00	9.400E-02	58.20	5.39	26.35	16.82	.00277	3.959E-05	3.970E-05	1.665E-03
1.00	2.26	1.000E+00	9.526E-02	57.30	5.46	27.01	17.04	.00270	3.957E-05	3.967E-05	1.718E-03
.99	2.31	9.846F-01	9.640F-02	56.42	5.52	27.66	17.25	.00263	3.952E-05	3.962E-05	1.751E-03
.98	2.37	9.693F-01	9.744E-02	55.54	5.54	28.29	17.43	.00259	3.945E-05	3.954E-05	1.789E-03
.97	2.42	9.542E-01	9.838F-02	54.67	5.64	28.91	17.60	.00253	3.934E-05	3.943E-05	1.824E-03
.96	2.48	9.391F-01	9.921E-02	53.81	5.64	29.52	17.75	.00249	3.922E-05	3.929E-05	1.855E-03
.95	2.54	9.242F-01	9.995F-02	52.95	5.73	30.12	17.88	.00245	3.913E-05	3.912E-05	1.882E-03
.94	2.60	9.094F-01	1.005E-01	52.10	5.76	30.71	18.00	.00242	3.892E-05	3.891E-05	1.907E-03
.93	2.67	8.946F-01	1.011E-01	51.26	5.80	31.29	18.10	.00237	3.859E-05	3.867E-05	1.928E-03
.92	2.74	8.799E-01	1.016E-01	50.42	5.82	31.85	18.14	.00235	3.832E-05	3.840E-05	1.945E-03
.91	2.81	8.653E-01	1.020E-01	49.58	5.84	32.42	18.25	.00235	3.801E-05	3.810E-05	1.959E-03
.90	2.89	8.507E-01	1.023E-01	48.74	5.86	32.97	18.30	.00234	3.776E-05	3.776E-05	1.970E-03
.89	2.97	8.361F-01	1.026E-01	47.90	5.87	33.52	18.33	.00233	3.730E-05	3.730E-05	1.978E-03
.88	3.05	8.215F-01	1.026E-01	47.07	5.88	34.06	18.35	.00233	3.690E-05	3.690E-05	1.982E-03
.87	3.15	8.069F-01	1.026E-01	46.23	5.84	34.59	18.36	.00233	3.645E-05	3.645E-05	1.987E-03
.86	3.25	7.923E-01	1.025E-01	45.40	5.87	35.11	18.34	.00233	3.597E-05	3.597E-05	1.981E-03
.85	3.36	7.777F-01	1.024E-01	44.56	5.87	35.63	18.32	.00234	3.545E-05	3.545E-05	1.975E-03
.84	3.47	7.630F-01	1.022E-01	43.71	5.85	36.14	18.28	.00235	3.490E-05	3.490E-05	1.966E-03
.83	3.59	7.482F-01	1.019E-01	42.87	5.83	36.65	18.22	.00236	3.431E-05	3.431E-05	1.954E-03
.82	3.72	7.334F-01	1.014E-01	42.02	5.81	37.15	18.15	.00238	3.375E-05	3.375E-05	1.938E-03
.81	3.86	7.186F-01	1.009E-01	41.17	5.78	37.64	18.06	.00240	3.300E-05	3.300E-05	1.919E-03
.80	4.00	7.034F-01	1.003E-01	40.33	5.75	38.13	17.95	.00243	3.229E-05	3.229E-05	1.897E-03
.79	4.16	6.883F-01	9.966E-02	39.44	5.71	38.62	17.83	.00246	3.154E-05	3.154E-05	1.871E-03
.78	4.34	6.730F-01	9.899E-02	38.56	5.67	39.10	17.69	.00250	3.075E-05	3.075E-05	1.842E-03
.77	4.53	6.576F-01	9.831E-02	37.68	5.62	39.57	17.54	.00255	2.992E-05	2.992E-05	1.810E-03
.76	4.73	6.420F-01	9.764E-02	36.78	5.56	40.05	17.36	.00262	2.905E-05	2.905E-05	1.774E-03
.75	4.96	6.262F-01	9.697E-02	35.84	5.53	40.51	17.17	.00266	2.813E-05	2.813E-05	1.735E-03
.74	5.20	6.102F-01	9.629E-02	34.96	5.43	40.98	16.96	.00272	2.717E-05	2.717E-05	1.693E-03
.73	5.48	5.939E-01	9.550F-02	34.03	5.36	41.44	16.73	.00280	2.617E-05	2.617E-05	1.647E-03
.72	5.78	5.774F-01	9.479E-02	33.09	5.24	41.89	16.44	.00289	2.512E-05	2.512E-05	1.598E-03
.71	6.12	5.607F-01	9.397E-02	32.12	5.19	42.35	16.20	.00298	2.403E-05	2.403E-05	1.549E-03
.70	6.51	5.436F-01	9.315E-02	31.14	5.09	42.79	15.91	.00309	2.289E-05	2.289E-05	1.498E-03
.69	6.94	5.261E-01	9.233E-02	30.14	4.99	43.24	15.59	.00322	2.171E-05	2.171E-05	1.438E-03
.68	7.44	5.083F-01	9.151E-02	29.12	4.84	43.68	15.25	.00337	2.047E-05	2.047E-05	1.368E-03
.67	8.01	4.901E-01	9.064E-02	28.08	4.76	44.11	14.87	.00354	1.919E-05	1.919E-05	1.282E-03
.66	8.67	4.714F-01	8.971F-02	27.01	4.64	44.55	14.44	.00373	1.786E-05	1.786E-05	1.192E-03
.65	9.46	4.523E-01	7.852E-02	25.91	4.50	44.97	14.05	.00396	1.648E-05	1.648E-05	1.102E-03
.64	10.41	4.326F-01	7.595E-02	24.79	4.35	45.39	13.59	.00424	1.504E-05	1.504E-05	1.007E-03
.63	11.57	4.124F-01	7.321E-02	23.63	4.19	45.81	13.10	.00456	1.354E-05	1.354E-05	1.018E-03
.62	13.01	3.917F-01	7.024E-02	22.44	4.03	46.21	12.57	.00494	1.198E-05	1.198E-05	9.386E-04
.61	14.87	3.705E-01	6.717E-02	21.23	3.85	46.61	12.02	.00541	1.035E-05	1.035E-05	8.502E-04
.60	17.35	3.492E-01	6.393E-02	20.01	3.66	46.98	11.44	.00597	8.645E-06	8.645E-06	7.701E-04

.72	20.02	3.291F-01	6.064E-02	19.87	3.47	47.33	10.85	.00663	6.862E-06	6.944E-06	6.929E-04
.71	26.32	3.090F-01	5.759F-02	17.71	3.30	47.63	10.30	.00735	4.998E-06	5.832E-06	6.247E-04

PROGRAM NONLIN--COLINEARLY PHASE MATCHED OPO

CINMARAR

PHASE MATCHING FOR POSITIVE PIPEFRINGENT CRYSTAL

PUMP WAVELENGTH(MICROONS)= .946

NONLINEAR COEFFICIENTS(K10 F12 M/V)= 50.000

CUTOFF WAVELENGTH= 30.000

RESULTS FOR TYPE 1 (F + E = 0) PHASE MATCHING ARG

SIGNAL	IDLER	THETA (RAD)	RHO (RAD)	THETA (DEG)	RHO (DEG)	D-EFF (*10.E12)	R	MIR)	GAIN/WATT (1CH)	GAIN/WATT (MAX)	AREA (SQ CM)
1.89	1.89	5.718E-01	8.379E-02	32.76	4.80	35.36	12.60	.00492	7.208E-05	7.314E-05	1.206E-03
1.87	1.92	5.717E-01	8.383E-02	32.76	4.80	35.36	12.61	.00492	7.272E-05	7.306E-05	1.207E-03
1.94	1.94	5.716E-01	8.385E-02	32.75	4.80	35.37	12.61	.00491	7.263E-05	7.297E-05	1.207E-03
1.82	1.97	5.713E-01	8.387E-02	32.73	4.81	35.38	12.61	.00491	7.253E-05	7.286E-05	1.208E-03
1.80	2.00	5.709E-01	8.388E-02	32.71	4.81	35.40	12.62	.00491	7.240E-05	7.274E-05	1.208E-03
1.77	2.03	5.704E-01	8.389E-02	32.68	4.81	35.42	12.62	.00491	7.226E-05	7.260E-05	1.208E-03
1.75	2.06	5.698E-01	8.390E-02	32.65	4.81	35.45	12.61	.00491	7.211E-05	7.244E-05	1.208E-03
1.73	2.09	5.693E-01	8.391E-02	32.61	4.80	35.48	12.61	.00492	7.194E-05	7.227E-05	1.207E-03
1.71	2.12	5.688E-01	8.392E-02	32.56	4.80	35.52	12.61	.00492	7.176E-05	7.209E-05	1.206E-03
1.69	2.15	5.678E-01	8.377E-02	32.51	4.80	35.56	12.60	.00492	7.159E-05	7.189E-05	1.205E-03
1.67	2.18	5.664E-01	8.372E-02	32.45	4.80	35.60	12.59	.00493	7.134E-05	7.167E-05	1.203E-03
1.65	2.22	5.652E-01	8.366E-02	32.39	4.79	35.66	12.58	.00494	7.110E-05	7.143E-05	1.201E-03
1.63	2.25	5.640E-01	8.359E-02	32.31	4.79	35.71	12.57	.00495	7.085E-05	7.116E-05	1.200E-03
1.61	2.29	5.628E-01	8.351E-02	32.24	4.78	35.77	12.56	.00496	7.058E-05	7.091E-05	1.200E-03
1.59	2.33	5.612E-01	8.342E-02	32.15	4.78	35.84	12.55	.00497	7.030E-05	7.063E-05	1.200E-03
1.58	2.36	5.596E-01	8.331E-02	32.06	4.77	35.91	12.53	.00498	7.000E-05	7.033E-05	1.200E-03
1.56	2.41	5.579E-01	8.320E-02	31.96	4.77	35.99	12.51	.00499	6.960E-05	7.001E-05	1.200E-03
1.54	2.45	5.561E-01	8.308E-02	31.86	4.76	36.07	12.50	.00501	6.934E-05	6.967E-05	1.200E-03
1.53	2.49	5.542E-01	8.294E-02	31.75	4.75	36.15	12.47	.00502	6.899E-05	6.931E-05	1.200E-03
1.51	2.53	5.521E-01	8.279E-02	31.64	4.74	36.24	12.45	.00504	6.861E-05	6.894E-05	1.200E-03
1.49	2.58	5.500E-01	8.263E-02	31.51	4.73	36.34	12.43	.00506	6.822E-05	6.854E-05	1.200E-03
1.48	2.63	5.477E-01	8.246E-02	31.39	4.72	36.44	12.40	.00508	6.780E-05	6.813E-05	1.200E-03
1.46	2.68	5.454E-01	8.228E-02	31.25	4.71	36.55	12.38	.00510	6.737E-05	6.769E-05	1.200E-03
1.45	2.73	5.429E-01	8.209E-02	31.10	4.70	36.66	12.35	.00513	6.692E-05	6.724E-05	1.200E-03
1.43	2.78	5.403E-01	8.187E-02	30.95	4.69	36.77	12.31	.00515	6.644E-05	6.676E-05	1.200E-03
1.42	2.84	5.375E-01	8.164E-02	30.83	4.68	36.89	12.29	.00518	6.594E-05	6.627E-05	1.200E-03
1.40	2.90	5.347E-01	8.141E-02	30.66	4.65	37.02	12.24	.00521	6.542E-05	6.575E-05	1.200E-03
1.39	2.96	5.319E-01	8.115E-02	30.46	4.65	37.15	12.21	.00525	6.489E-05	6.520E-05	1.200E-03
1.38	3.02	5.294E-01	8.089E-02	30.29	4.63	37.29	12.17	.00528	6.432E-05	6.464E-05	1.190E-03
1.36	3.08	5.254E-01	8.061E-02	30.10	4.62	37.42	12.12	.00532	6.373E-05	6.405E-05	1.189E-03
1.35	3.15	5.220E-01	8.030E-02	29.91	4.60	37.57	12.08	.00536	6.312E-05	6.343E-05	1.181E-03
1.34	3.22	5.184E-01	7.998E-02	29.71	4.58	37.72	12.03	.00540	6.248E-05	6.279E-05	1.171E-03
1.33	3.30	5.151E-01	7.965E-02	29.51	4.56	37.87	11.95	.00544	6.181E-05	6.213E-05	1.162E-03
1.31	3.38	5.113E-01	7.930E-02	29.29	4.54	38.03	11.93	.00549	6.112E-05	6.143E-05	1.151E-03
1.30	3.46	5.074E-01	7.893E-02	29.07	4.52	38.20	11.87	.00554	6.040E-05	6.071E-05	1.141E-03

SIGNAL	TOLER	THETA (RAD)	RHO (RAD)	THETA (DEG)	RHO (DEG)	D-EFF (*10.E12)	R	H(R)	GAIN/WATT (1CH)	GAIN/WATT (MAX)	AREA (SQ CM)
1.29	3.55	5.034E-01	7.854E-02	28.44	4.50	38.36	11.81	.00560	5.965E-05	5.996E-05	1.129E-03
1.28	3.64	4.993E-01	7.813E-02	28.61	4.48	38.54	11.75	.00566	5.887E-05	5.918E-05	1.110E-03
1.27	3.73	4.950E-01	7.771E-02	28.36	4.45	38.72	11.69	.00572	5.806E-05	5.838E-05	1.104E-03
1.26	3.84	4.908E-01	7.728E-02	28.11	4.43	38.90	11.62	.00579	5.722E-05	5.753E-05	1.093E-03
1.24	3.94	4.861E-01	7.679E-02	27.85	4.40	39.09	11.55	.00586	5.639E-05	5.669E-05	1.079E-03
1.23	4.05	4.814E-01	7.629E-02	27.58	4.37	39.29	11.47	.00593	5.555E-05	5.576E-05	1.064E-03
1.22	4.17	4.765E-01	7.578E-02	27.30	4.34	39.48	11.40	.00601	5.471E-05	5.491E-05	1.051E-03
1.21	4.30	4.715E-01	7.523E-02	27.02	4.31	39.68	11.32	.00610	5.387E-05	5.406E-05	1.038E-03
1.20	4.43	4.664E-01	7.467E-02	26.72	4.28	39.89	11.23	.00619	5.299E-05	5.320E-05	1.021E-03
1.19	4.58	4.611E-01	7.408E-02	26.42	4.24	40.10	11.14	.00629	5.147E-05	5.170E-05	1.005E-03
1.18	4.73	4.556E-01	7.346E-02	26.11	4.21	40.32	11.05	.00651	5.038E-05	5.069E-05	9.879E-04
1.17	4.89	4.500E-01	7.281E-02	25.78	4.17	40.54	10.95	.00651	4.929E-05	4.956E-05	9.780E-04
1.16	5.07	4.442E-01	7.213E-02	25.45	4.13	40.77	10.85	.00663	4.808E-05	4.838E-05	9.526E-04
1.15	5.26	4.383E-01	7.142E-02	25.11	4.09	41.00	10.74	.00676	4.687E-05	4.717E-05	9.340E-04
1.14	5.46	4.321E-01	7.069E-02	24.76	4.05	41.23	10.63	.00690	4.561E-05	4.591E-05	9.148E-04
1.14	5.68	4.258E-01	6.991E-02	24.40	4.01	41.47	10.52	.00706	4.431E-05	4.460E-05	8.949E-04
1.13	5.91	4.193E-01	6.911E-02	24.03	3.96	41.71	10.39	.00722	4.299E-05	4.329E-05	8.744E-04
1.12	6.17	4.126E-01	6.827E-02	23.64	3.91	41.96	10.27	.00748	4.159E-05	4.188E-05	8.533E-04
1.11	6.45	4.058E-01	6.739E-02	23.25	3.86	42.21	10.14	.00759	4.010E-05	4.038E-05	8.319E-04
1.10	6.76	3.987E-01	6.648E-02	22.85	3.81	42.46	10.00	.00780	3.859E-05	3.887E-05	8.091E-04
1.09	7.09	3.915E-01	6.552E-02	22.43	3.75	42.72	9.86	.00803	3.702E-05	3.730E-05	7.861E-04
1.08	7.47	3.841E-01	6.453E-02	22.00	3.70	42.98	9.71	.00827	3.549E-05	3.568E-05	7.624E-04
1.08	7.88	3.764E-01	6.350E-02	21.57	3.64	43.24	9.55	.00854	3.372E-05	3.399E-05	7.382E-04
1.07	8.35	3.686E-01	6.243E-02	21.12	3.58	43.51	9.39	.00884	3.197E-05	3.224E-05	7.139E-04
1.06	9.87	3.605E-01	6.131E-02	20.66	3.51	43.77	9.22	.00916	3.016E-05	3.042E-05	6.883E-04
1.05	9.46	3.525E-01	6.016E-02	20.19	3.45	44.04	9.05	.00989	2.827E-05	2.853E-05	6.627E-04
1.04	10.14	3.442E-01	5.897E-02	19.72	3.38	44.31	8.87	.00989	2.632E-05	2.656E-05	6.367E-04
1.04	10.92	3.357E-01	5.775E-02	19.24	3.31	44.57	8.69	.01031	2.429E-05	2.453E-05	6.107E-04
1.03	11.82	3.273E-01	5.651E-02	18.75	3.24	44.83	8.50	.01076	2.218E-05	2.241E-05	5.847E-04
1.02	12.90	3.190E-01	5.526E-02	18.27	3.17	45.09	8.31	.01125	1.999E-05	2.021E-05	5.590E-04
1.01	14.19	3.105E-01	5.401E-02	17.79	3.09	45.33	8.12	.01177	1.772E-05	1.792E-05	5.341E-04
1.01	15.77	3.020E-01	5.281E-02	17.34	3.03	45.56	7.94	.01230	1.538E-05	1.556E-05	5.107E-04
1.00	17.74	2.953E-01	5.171E-02	16.92	2.96	45.76	7.78	.01283	1.296E-05	1.312E-05	4.895E-04
.99	20.27	2.893E-01	5.040E-02	16.58	2.91	45.93	7.64	.01329	1.050E-05	1.063E-05	4.724E-04
.99	23.65	2.856E-01	5.025E-02	16.36	2.88	46.03	7.56	.01358	8.030E-06	8.133E-06	4.622E-04
.98	28.38	2.861E-01	5.039E-02	16.40	2.89	46.02	7.53	.01351	5.621E-06	5.693E-06	4.647E-04

RESULTS FOR TYPE I (0 + E = 0) PHASE MATCHING ARE

1.63	2.25	9.402E-01	9.334E-02	51.87	5.35	29.48	14.04	.00397	3.876E-05	3.891E-05	1.595E-03
1.61	2.29	9.406E-01	9.296E-02	54.32	5.33	29.16	13.98	.00400	3.789E-05	3.804E-05	1.562E-03
1.59	2.33	9.560E-01	9.255E-02	54.77	5.30	28.84	13.92	.00404	3.702E-05	3.716E-05	1.560E-03
1.58	2.36	9.640E-01	9.211E-02	55.23	5.28	28.51	13.85	.00408	3.614E-05	3.628E-05	1.553E-03
1.56	2.41	9.720E-01	9.164E-02	55.69	5.25	28.18	13.78	.00412	3.525E-05	3.539E-05	1.538E-03
1.54	2.45	9.802E-01	9.114E-02	56.16	5.22	27.84	13.71	.00416	3.436E-05	3.450E-05	1.521E-03
1.53	2.49	9.884E-01	9.062E-02	56.63	5.19	27.50	13.63	.00421	3.347E-05	3.360E-05	1.503E-03
1.51	2.53	9.967E-01	9.016E-02	57.11	5.15	27.15	13.55	.06126	3.257E-05	3.270E-05	1.485E-03
1.49	2.58	1.005E+00	8.947E-02	57.59	5.13	26.80	13.46	.00432	3.167E-05	3.180E-05	1.466E-03
1.46	2.63	1.014E+00	8.894E-02	58.07	5.09	26.44	13.36	.00438	3.078E-05	3.090E-05	1.445E-03
1.46	2.68	1.022E+00	8.815E-02	58.57	5.05	26.08	13.26	.00445	2.988E-05	3.000E-05	1.424E-03
1.45	2.73	1.031E+00	8.744E-02	59.07	5.01	25.70	13.16	.00452	2.898E-05	2.910E-05	1.401E-03
1.43	2.78	1.040E+00	8.674E-02	59.57	4.97	25.32	13.05	.00458	2.808E-05	2.820E-05	1.378E-03
1.42	2.84	1.049E+00	8.596E-02	60.04	4.93	24.94	12.93	.00468	2.719E-05	2.731E-05	1.353E-03
1.40	2.90	1.058E+00	8.514E-02	60.51	4.89	24.54	12.81	.00477	2.630E-05	2.641E-05	1.327E-03
1.39	3.02	1.076E+00	8.428E-02	61.14	4.83	24.14	12.68	.00487	2.541E-05	2.552E-05	1.300E-03
1.36	3.08	1.086E+00	8.340E-02	62.22	4.72	23.70	12.39	.00509	2.364E-05	2.376E-05	1.243E-03
1.35	3.15	1.096E+00	8.138E-02	62.79	4.66	22.87	12.54	.00522	2.277E-05	2.288E-05	1.212E-03
1.34	3.22	1.106E+00	8.030E-02	63.36	4.60	22.42	12.04	.00536	2.190E-05	2.202E-05	1.181E-03
1.33	3.30	1.116E+00	7.916E-02	63.94	4.54	21.96	11.91	.00551	2.103E-05	2.115E-05	1.147E-03
1.31	3.38	1.126E+00	7.794E-02	64.54	4.47	21.49	11.73	.00564	2.019E-05	2.030E-05	1.113E-03
1.30	3.46	1.137E+00	7.664E-02	65.16	4.39	21.01	11.53	.00587	1.935E-05	1.946E-05	1.076E-03
1.29	3.55	1.148E+00	7.532E-02	65.79	4.32	20.50	11.33	.00608	1.852E-05	1.863E-05	1.039E-03
1.28	3.64	1.159E+00	7.389E-02	66.44	4.23	19.94	11.11	.00632	1.769E-05	1.780E-05	9.994E-04
1.27	3.73	1.171E+00	7.235E-02	67.12	4.15	19.44	10.88	.00659	1.686E-05	1.698E-05	9.583E-04
1.26	3.84	1.184E+00	7.071E-02	67.81	4.05	18.88	10.63	.00690	1.604E-05	1.616E-05	9.153E-04
1.24	3.94	1.198E+00	6.895E-02	68.54	3.95	18.29	10.37	.00725	1.524E-05	1.536E-05	8.705E-04
1.23	4.05	1.209E+00	6.707E-02	69.29	3.84	17.68	10.09	.00766	1.451E-05	1.461E-05	8.235E-04
1.22	4.17	1.223E+00	6.503E-02	70.08	3.73	17.03	9.78	.00815	1.374E-05	1.385E-05	7.743E-04
1.21	4.30	1.236E+00	6.283E-02	70.92	3.60	16.35	9.45	.00872	1.299E-05	1.310E-05	7.227E-04
1.20	4.43	1.253E+00	6.043E-02	71.80	3.46	15.62	9.09	.00942	1.225E-05	1.236E-05	6.685E-04
1.19	4.58	1.270E+00	5.779E-02	72.74	3.31	14.84	8.69	.01029	1.153E-05	1.164E-05	6.115E-04
1.18	4.73	1.287E+00	5.484E-02	73.75	3.14	13.99	8.25	.01141	1.082E-05	1.094E-05	5.513E-04
1.17	4.89	1.306E+00	5.161E-02	74.85	2.96	13.07	7.76	.01288	1.013E-05	1.025E-05	4.877E-04
1.16	5.07	1.327E+00	4.791E-02	76.06	2.75	12.05	7.21	.01491	9.443E-06	9.577E-06	4.203E-04
1.15	5.26	1.351E+00	4.363E-02	77.42	2.50	10.89	6.56	.01793	8.773E-06	8.923E-06	3.486E-04
1.14	5.46	1.378E+00	3.854E-02	78.99	2.21	9.55	5.80	.02287	8.110E-06	8.287E-06	2.728E-04
1.14	5.68	1.412E+00	3.220E-02	83.88	1.85	7.92	4.84	.03246	7.437E-06	7.670E-06	1.899E-04
1.13	5.91	1.456E+00	2.353E-02	83.41	1.35	5.74	3.54	.05925	6.679E-06	7.072E-06	1.013E-04
1.12	6.17	1.545E+00	5.392E-03	84.50	.31	1.31	.81	.56380	3.046E-06	6.493E-06	1.619E-05

PHASE MATCHING CUTS OFF AT SIGNAL=	1.199 AND IDLER=	6.450
PHASE MATCHING CUTS OFF AT SIGNAL=	1.100 AND IDLER=	6.757
PHASE MATCHING CUTS OFF AT SIGNAL=	1.092 AND IDLER=	7.095
PHASE MATCHING CUTS OFF AT SIGNAL=	1.083 AND IDLER=	7.468
PHASE MATCHING CUTS OFF AT SIGNAL=	1.075 AND IDLER=	7.883
PHASE MATCHING CUTS OFF AT SIGNAL=	1.067 AND IDLER=	8.347
PHASE MATCHING CUTS OFF AT SIGNAL=	1.059 AND IDLER=	8.869

PHASE MATCHING CUTS OFF AT SIGNAL= 1.051 AND TOLER= 9.460
 PHASE MATCHING CUTS OFF AT SIGNAL= 1.043 AND TOLER= 10.136
 PHASE MATCHING CUTS OFF AT SIGNAL= 1.036 AND TOLER= 10.915
 PHASE MATCHING CUTS OFF AT SIGNAL= 1.028 AND TOLER= 11.825
 PHASE MATCHING CUTS OFF AT SIGNAL= 1.021 AND TOLER= 12.900
 PHASE MATCHING CUTS OFF AT SIGNAL= 1.014 AND TOLER= 14.190
 PHASE MATCHING CUTS OFF AT SIGNAL= 1.006 AND TOLER= 15.767
 PHASE MATCHING CUTS OFF AT SIGNAL= .999 AND TOLER= 17.737
 PHASE MATCHING CUTS OFF AT SIGNAL= .992 AND TOLER= 20.271
 PHASE MATCHING CUTS OFF AT SIGNAL= .985 AND TOLER= 23.650
 PHASE MATCHING CUTS OFF AT SIGNAL= .979 AND TOLER= 28.380

RESULTS FOR TYPE II (E + 0 = 0, PHASE MATCHING ARE

SIGNAL	TOLER	THETA (RAD)	RHO (RAD)	THETA (DEG)	RHO (DEG)	D-EFF (*10.E12)	A	H(A)	GAIN/WATT (1CM)	GAIN/WATT (MAX)	AREA (SQ CM)
1.69	1.89	8.493E-01	9.535E-02	48.66	5.50	33.03	14.45	.00375	4.839E-05	4.856E-05	1.659E-03
1.87	1.92	8.419E-01	9.614E-02	48.24	5.51	33.30	14.46	.00374	4.910E-05	4.927E-05	1.652E-03
1.84	1.94	8.345E-01	9.620E-02	47.82	5.51	33.54	14.47	.00374	4.979E-05	4.997E-05	1.649E-03
1.82	1.97	8.272E-01	9.624E-02	47.40	5.51	33.85	14.48	.00374	5.046E-05	5.064E-05	1.646E-03
1.80	2.00	8.199E-01	9.626E-02	46.98	5.52	34.11	14.48	.00373	5.112E-05	5.129E-05	1.642E-03
1.77	2.03	8.126E-01	9.626E-02	46.56	5.52	34.38	14.44	.00373	5.175E-05	5.193E-05	1.637E-03
1.75	2.06	8.053E-01	9.624E-02	46.14	5.51	34.64	14.48	.00373	5.236E-05	5.254E-05	1.636E-03
1.73	2.09	7.980E-01	9.621E-02	45.72	5.51	34.91	14.47	.00374	5.295E-05	5.313E-05	1.635E-03
1.71	2.12	7.908E-01	9.615E-02	45.31	5.51	35.17	14.46	.00374	5.351E-05	5.370E-05	1.633E-03
1.69	2.15	7.835E-01	9.607E-02	44.89	5.50	35.42	14.45	.00375	5.405E-05	5.424E-05	1.630E-03
1.67	2.18	7.762E-01	9.597E-02	44.48	5.50	35.64	14.44	.00376	5.457E-05	5.476E-05	1.626E-03
1.65	2.22	7.690E-01	9.586E-02	44.06	5.49	35.93	14.42	.00376	5.506E-05	5.525E-05	1.622E-03
1.63	2.25	7.617E-01	9.572E-02	43.64	5.48	36.14	14.40	.00378	5.552E-05	5.572E-05	1.618E-03
1.61	2.29	7.545E-01	9.557E-02	43.23	5.48	36.43	14.37	.00379	5.596E-05	5.616E-05	1.612E-03
1.59	2.33	7.472E-01	9.540E-02	42.81	5.47	36.68	14.35	.00380	5.636E-05	5.657E-05	1.606E-03
1.58	2.36	7.399E-01	9.520E-02	42.39	5.45	36.93	14.32	.00382	5.674E-05	5.695E-05	1.602E-03
1.56	2.41	7.326E-01	9.499E-02	41.98	5.44	37.17	14.29	.00383	5.709E-05	5.730E-05	1.600E-03
1.54	2.45	7.254E-01	9.475E-02	41.56	5.43	37.41	14.25	.00385	5.741E-05	5.762E-05	1.604E-03
1.53	2.49	7.181E-01	9.451E-02	41.14	5.42	37.65	14.22	.00387	5.769E-05	5.790E-05	1.635E-03
1.51	2.53	7.107E-01	9.424E-02	40.72	5.40	37.89	14.17	.00389	5.794E-05	5.816E-05	1.620E-03
1.49	2.58	7.034E-01	9.395E-02	40.30	5.39	38.13	14.13	.00392	5.816E-05	5.838E-05	1.616E-03
1.48	2.63	6.961E-01	9.364E-02	39.88	5.37	38.37	14.08	.00394	5.835E-05	5.856E-05	1.606E-03
1.46	2.68	6.887E-01	9.332E-02	39.46	5.35	38.60	14.04	.00397	5.850E-05	5.872E-05	1.594E-03
1.45	2.73	6.813E-01	9.297E-02	39.04	5.33	38.84	13.98	.00400	5.861E-05	5.883E-05	1.582E-03
1.43	2.78	6.739E-01	9.260E-02	38.61	5.31	39.07	13.93	.00403	5.869E-05	5.891E-05	1.570E-03
1.42	2.84	6.665E-01	9.221E-02	38.19	5.28	39.30	13.87	.00407	5.872E-05	5.895E-05	1.557E-03

1.40	2.90	6.590E-01	9.180E-02	37.76	5.26	39.53	13.01	.00410	5.073E-05	5.895E-05	1.543E-03
1.39	2.96	6.516E-01	9.137E-02	37.33	5.24	39.76	13.74	.00414	5.868E-05	5.891E-05	1.529E-03
1.38	3.02	6.440E-01	9.092E-02	36.90	5.21	39.98	13.69	.00418	5.860E-05	5.890E-05	1.514E-03
1.36	3.05	6.365E-01	9.045E-02	36.47	5.18	40.21	13.60	.00423	5.848E-05	5.871E-05	1.498E-03
1.35	3.15	6.289E-01	8.996E-02	36.03	5.15	40.43	13.53	.00427	5.832E-05	5.855E-05	1.482E-03
1.34	3.22	6.213E-01	8.944E-02	35.60	5.12	40.66	13.45	.00432	5.811E-05	5.835E-05	1.465E-03
1.33	3.30	6.136E-01	8.891E-02	35.16	5.09	40.88	13.37	.00437	5.786E-05	5.810E-05	1.447E-03
1.31	3.38	6.059E-01	8.835E-02	34.71	5.06	41.10	13.29	.00443	5.765E-05	5.780E-05	1.429E-03
1.30	3.46	5.981E-01	8.777E-02	34.27	5.03	41.32	13.20	.00449	5.722E-05	5.746E-05	1.410E-03
1.29	3.55	5.903E-01	8.716E-02	33.82	4.99	41.54	13.11	.00455	5.683E-05	5.708E-05	1.391E-03
1.28	3.64	5.825E-01	8.653E-02	33.37	4.96	41.76	13.02	.00462	5.648E-05	5.664E-05	1.371E-03
1.27	3.73	5.746E-01	8.588E-02	32.92	4.92	41.97	12.92	.00469	5.592E-05	5.616E-05	1.350E-03
1.26	3.84	5.666E-01	8.520E-02	32.46	4.88	42.19	12.82	.00476	5.538E-05	5.563E-05	1.329E-03
1.24	3.94	5.586E-01	8.450E-02	32.00	4.84	42.40	12.71	.00484	5.480E-05	5.505E-05	1.307E-03
1.23	4.05	5.505E-01	8.377E-02	31.54	4.80	42.61	12.60	.00492	5.417E-05	5.442E-05	1.285E-03
1.22	4.17	5.423E-01	8.302E-02	31.07	4.76	42.83	12.49	.00501	5.348E-05	5.373E-05	1.262E-03
1.21	4.30	5.341E-01	8.224E-02	30.60	4.71	43.04	12.37	.00511	5.274E-05	5.300E-05	1.238E-03
1.20	4.43	5.258E-01	8.143E-02	30.13	4.67	43.25	12.25	.00521	5.195E-05	5.221E-05	1.214E-03
1.19	4.58	5.174E-01	8.059E-02	29.65	4.62	43.46	12.12	.00532	5.110E-05	5.136E-05	1.189E-03
1.18	4.73	5.089E-01	7.973E-02	29.16	4.57	43.66	11.99	.00543	5.020E-05	5.045E-05	1.164E-03
1.17	4.89	5.004E-01	7.893E-02	28.67	4.52	43.87	11.86	.00556	4.924E-05	4.950E-05	1.138E-03
1.16	5.07	4.918E-01	7.791E-02	28.18	4.46	44.07	11.72	.00569	4.823E-05	4.848E-05	1.111E-03
1.15	5.26	4.830E-01	7.695E-02	27.68	4.41	44.28	11.57	.00583	4.715E-05	4.741E-05	1.084E-03
1.14	5.46	4.742E-01	7.596E-02	27.17	4.35	44.48	11.41	.00598	4.601E-05	4.627E-05	1.056E-03
1.13	5.68	4.653E-01	7.494E-02	26.66	4.29	44.68	11.27	.00615	4.482E-05	4.508E-05	1.028E-03
1.12	6.17	4.563E-01	7.389E-02	26.14	4.23	44.88	11.11	.00632	4.356E-05	4.382E-05	9.994E-04
1.11	6.45	4.471E-01	7.279E-02	25.62	4.17	45.08	10.95	.00651	4.223E-05	4.249E-05	9.781E-04
1.10	6.76	4.379E-01	7.166E-02	25.09	4.11	45.28	10.78	.00672	4.084E-05	4.110E-05	9.483E-04
1.09	7.09	4.285E-01	7.050E-02	24.55	4.04	45.48	10.60	.00694	3.939E-05	3.964E-05	9.188E-04
1.08	7.47	4.191E-01	6.930E-02	24.01	3.97	45.67	10.42	.00718	3.796E-05	3.812E-05	8.793E-04
1.07	8.75	4.095E-01	6.806E-02	23.46	3.90	45.87	10.24	.00744	3.627E-05	3.652E-05	8.401E-04
1.06	9.67	3.998E-01	6.679E-02	22.91	3.83	46.06	10.04	.00773	3.460E-05	3.485E-05	8.166E-04
1.05	10.14	3.900E-01	6.547E-02	22.34	3.75	46.25	9.85	.00804	3.286E-05	3.311E-05	7.848E-04
1.04	10.92	3.800E-01	6.412E-02	21.77	3.67	46.43	9.64	.00830	3.105E-05	3.129E-05	7.528E-04
1.03	12.90	3.700E-01	6.274E-02	21.20	3.59	46.62	9.44	.00875	2.915E-05	2.939E-05	7.286E-04
1.02	14.19	3.599E-01	6.132E-02	20.62	3.51	46.80	9.22	.00915	2.717E-05	2.741E-05	6.884E-04
1.01	15.77	3.498E-01	5.987E-02	20.04	3.43	46.97	9.01	.00960	2.512E-05	2.534E-05	6.563E-04
1.00	20.27	3.397E-01	5.841E-02	19.47	3.35	47.14	8.79	.01008	2.297E-05	2.319E-05	6.256E-04
.99	23.65	3.297E-01	5.694E-02	18.89	3.26	47.31	8.56	.01060	2.074E-05	2.095E-05	5.936E-04
.98	28.38	3.200E-01	5.549E-02	18.33	3.16	47.46	8.35	.01116	1.842E-05	1.862E-05	5.637E-04
.97		3.106E-01	5.408E-02	17.78	3.10	47.61	8.13	.01174	1.602E-05	1.620E-05	5.355E-04
.96		3.021E-01	5.274E-02	17.21	3.02	47.74	7.94	.01232	1.355E-05	1.370E-05	5.108E-04
.95		2.948E-01	5.157E-02	16.64	2.96	47.84	7.77	.01285	1.102E-05	1.115E-05	4.888E-04
.94		2.899E-01	5.093E-02	16.07	2.92	47.91	7.66	.01322	8.471E-06	8.578E-06	4.749E-04
.93		2.891E-01	5.086E-02	15.57	2.91	47.92	7.65	.01325	5.983E-06	6.058E-06	4.736E-04

PROGRAM NONLIN--COLINARLY PHASE MATCHED OPT

CINMAR

PHASE MATCHING FOR POSITIVE BIREFRINGENT CRYSTAL

PUMP WAVELENGTH(MICRONS)= 1.060

NONLINEAR COEFFICIENTS(X10 F12 M/V)= 50.000

CUTOFF WAVELENGTH= 30.000

RESULTS FOR TYPE I (F + E = 0) PHASE MATCHING ARE

SIGNAL	WAVELENGTH	THETA (RAD)	PHO (RAD)	THETA (DEG)	OMC (DEG)	0-EFF (*10.E12)	R	H(0)	GAIN/MATT (10M)	GAIN/MATT (MAX)	AREA (SQ CM)
2.12	2.12	4.095E-01	7.624E-02	24.62	4.37	39.53	10.30	.00669	8.444E-05	8.530E-05	1.060E-03
2.09	2.15	4.095E-01	7.631E-02	24.62	4.37	38.53	10.40	.00669	8.477E-05	8.530E-05	1.060E-03
2.06	2.18	4.095E-01	7.632E-02	24.61	4.37	38.54	10.40	.00669	8.467E-05	8.520E-05	1.061E-03
2.04	2.21	4.095E-01	7.633E-02	24.60	4.37	38.55	10.40	.00669	8.455E-05	8.509E-05	1.061E-03
2.01	2.24	4.095E-01	7.632E-02	24.59	4.37	38.55	10.40	.00669	8.441E-05	8.496E-05	1.061E-03
1.99	2.27	4.095E-01	7.631E-02	24.55	4.37	38.54	10.40	.00669	8.424E-05	8.477E-05	1.060E-03
1.96	2.30	4.095E-01	7.624E-02	24.53	4.37	38.60	10.40	.00669	8.406E-05	8.459E-05	1.060E-03
1.94	2.34	4.095E-01	7.625E-02	24.49	4.37	38.62	10.79	.00670	8.395E-05	8.434E-05	1.059E-03
1.92	2.37	4.095E-01	7.621E-02	24.45	4.37	38.65	10.79	.00671	8.381E-05	8.416E-05	1.057E-03
1.89	2.41	4.095E-01	7.615E-02	24.41	4.36	38.69	10.74	.00672	8.366E-05	8.390E-05	1.056E-03
1.87	2.45	4.095E-01	7.609E-02	24.36	4.36	38.72	10.77	.00673	8.304E-05	8.360E-05	1.054E-03
1.85	2.48	4.095E-01	7.602E-02	24.31	4.36	38.76	10.76	.00674	8.278E-05	8.330E-05	1.052E-03
1.83	2.52	4.095E-01	7.593E-02	24.25	4.35	38.80	10.75	.00676	8.245E-05	8.290E-05	1.050E-03
1.81	2.56	4.095E-01	7.584E-02	24.14	4.35	38.85	10.73	.00677	8.210E-05	8.263E-05	1.047E-03
1.79	2.61	4.095E-01	7.574E-02	24.11	4.34	38.90	10.72	.00679	8.173E-05	8.229E-05	1.044E-03
1.77	2.65	4.095E-01	7.562E-02	24.03	4.33	38.95	10.70	.00681	8.133E-05	8.186E-05	1.041E-03
1.75	2.69	4.095E-01	7.549E-02	27.95	4.33	39.01	10.69	.00683	8.091E-05	8.143E-05	1.038E-03
1.73	2.74	4.095E-01	7.535E-02	27.87	4.32	39.08	10.67	.00686	8.047E-05	8.099E-05	1.034E-03
1.71	2.79	4.095E-01	7.521E-02	27.74	4.31	39.14	10.65	.00689	8.000E-05	8.052E-05	1.030E-03
1.69	2.84	4.095E-01	7.505E-02	27.64	4.30	39.21	10.62	.00692	7.950E-05	8.002E-05	1.025E-03
1.67	2.89	4.095E-01	7.487E-02	27.53	4.29	39.29	10.60	.00695	7.898E-05	7.950E-05	1.021E-03
1.66	2.94	4.095E-01	7.469E-02	27.47	4.24	39.36	10.57	.00698	7.843E-05	7.895E-05	1.016E-03
1.64	3.00	4.095E-01	7.450E-02	27.35	4.27	39.44	10.55	.00702	7.786E-05	7.837E-05	1.010E-03
1.62	3.06	4.095E-01	7.429E-02	27.23	4.26	39.53	10.52	.00706	7.726E-05	7.777E-05	1.005E-03
1.61	3.12	4.095E-01	7.407E-02	27.11	4.24	39.62	10.48	.00710	7.663E-05	7.714E-05	9.999E-04
1.59	3.18	4.095E-01	7.384E-02	26.94	4.23	39.71	10.45	.00714	7.598E-05	7.649E-05	9.927E-04
1.57	3.24	4.095E-01	7.359E-02	26.84	4.22	39.81	10.42	.00719	7.529E-05	7.580E-05	9.861E-04
1.56	3.31	4.095E-01	7.333E-02	26.70	4.20	39.91	10.34	.00724	7.458E-05	7.509E-05	9.791E-04
1.54	3.39	4.095E-01	7.306E-02	26.55	4.19	40.01	10.34	.00729	7.384E-05	7.434E-05	9.719E-04
1.53	3.46	4.095E-01	7.277E-02	26.40	4.17	40.12	10.30	.00735	7.306E-05	7.357E-05	9.643E-04
1.51	3.53	4.095E-01	7.247E-02	26.24	4.15	40.23	10.26	.00741	7.226E-05	7.277E-05	9.563E-04
1.50	3.61	4.095E-01	7.216E-02	26.07	4.13	40.34	10.21	.00748	7.143E-05	7.193E-05	9.480E-04
1.49	3.70	4.095E-01	7.182E-02	25.90	4.12	40.46	10.17	.00754	7.056E-05	7.106E-05	9.393E-04
1.47	3.79	4.095E-01	7.144E-02	25.72	4.10	40.58	10.12	.00762	6.966E-05	7.016E-05	9.303E-04
1.46	3.88	4.095E-01	7.112E-02	25.54	4.07	40.71	10.07	.00769	6.873E-05	6.923E-05	9.208E-04

1.45	3.97	4.423E-01	7.074E-02	25.34	4.05	40.84	10.01	.00778	6.776E-05	6.826E-05	9.111E-04
1.43	4.08	4.349E-01	7.034E-02	25.15	4.03	40.97	9.96	.00786	6.676E-05	6.725E-05	9.809E-04
1.42	4.18	4.353E-01	6.993E-02	24.94	4.01	41.11	9.90	.00796	6.572E-05	6.621E-05	8.904E-04
1.41	4.30	4.317E-01	6.950E-02	24.73	3.98	41.25	9.84	.00805	6.464E-05	6.513E-05	8.794E-04
1.39	4.42	4.279E-01	6.905E-02	24.52	3.96	41.39	9.77	.00816	6.353E-05	6.402E-05	8.681E-04
1.38	4.54	4.240E-01	6.859E-02	24.29	3.93	41.54	9.71	.00827	6.206E-05	6.206E-05	8.564E-04
1.37	4.68	4.199E-01	6.819E-02	24.06	3.90	41.69	9.64	.00839	6.119E-05	6.167E-05	8.443E-04
1.36	4.82	4.158E-01	6.752E-02	23.82	3.87	41.84	9.57	.00851	5.995E-05	6.043E-05	8.318E-04
1.35	4.97	4.115E-01	6.706E-02	23.58	3.84	42.00	9.49	.00865	5.868E-05	5.916E-05	8.188E-04
1.34	5.13	4.071E-01	6.651E-02	23.33	3.81	42.16	9.41	.00879	5.736E-05	5.784E-05	8.055E-04
1.33	5.30	4.028E-01	6.594E-02	23.07	3.78	42.32	9.33	.00894	5.600E-05	5.647E-05	7.918E-04
1.31	5.48	3.980E-01	6.535E-02	22.80	3.74	42.49	9.25	.00910	5.459E-05	5.506E-05	7.776E-04
1.30	5.68	3.932E-01	6.474E-02	22.53	3.71	42.66	9.16	.00927	5.313E-05	5.360E-05	7.631E-04
1.29	5.89	3.883E-01	6.413E-02	22.25	3.67	42.83	9.07	.00946	5.163E-05	5.209E-05	7.481E-04
1.28	6.12	3.833E-01	6.344E-02	21.96	3.63	43.01	8.98	.00965	5.008E-05	5.053E-05	7.328E-04
1.27	6.36	3.781E-01	6.275E-02	21.66	3.60	43.19	8.88	.00986	4.847E-05	4.892E-05	7.170E-04
1.26	6.62	3.728E-01	6.204E-02	21.36	3.55	43.37	8.78	.01004	4.681E-05	4.726E-05	7.009E-04
1.25	6.91	3.674E-01	6.131E-02	21.05	3.51	43.55	8.68	.01023	4.510E-05	4.554E-05	6.844E-04
1.24	7.23	3.618E-01	6.055E-02	20.73	3.47	43.74	8.57	.01058	4.333E-05	4.376E-05	6.676E-04
1.23	7.57	3.561E-01	5.977E-02	20.40	3.42	43.92	8.46	.01086	4.150E-05	4.192E-05	6.504E-04
1.22	7.95	3.503E-01	5.896E-02	20.07	3.38	44.11	8.35	.01116	3.960E-05	4.002E-05	6.330E-04
1.21	8.37	3.444E-01	5.813E-02	19.73	3.33	44.30	8.23	.01148	3.765E-05	3.806E-05	6.152E-04
1.20	8.83	3.384E-01	5.724E-02	19.39	3.28	44.49	8.11	.01182	3.563E-05	3.603E-05	5.973E-04
1.20	9.35	3.323E-01	5.640E-02	19.04	3.23	44.68	7.98	.01215	3.354E-05	3.393E-05	5.752E-04
1.19	9.94	3.262E-01	5.551E-02	18.69	3.18	44.87	7.86	.01257	3.139E-05	3.176E-05	5.511E-04
1.18	10.60	3.200E-01	5.461E-02	18.33	3.13	45.05	7.73	.01298	2.916E-05	2.952E-05	5.268E-04
1.17	11.36	3.138E-01	5.370E-02	17.98	3.08	45.24	7.60	.01342	2.686E-05	2.721E-05	5.025E-04
1.16	12.23	3.077E-01	5.280E-02	17.63	3.03	45.41	7.47	.01388	2.458E-05	2.493E-05	4.786E-04
1.15	13.25	3.018E-01	5.192E-02	17.29	2.97	45.58	7.35	.01435	2.236E-05	2.271E-05	4.549E-04
1.14	14.45	2.962E-01	5.104E-02	16.97	2.93	45.74	7.23	.01482	1.995E-05	1.983E-05	4.311E-04
1.14	15.90	2.911E-01	5.016E-02	16.68	2.88	45.89	7.12	.01526	1.740E-05	1.724E-05	4.089E-04
1.13	17.67	2.860E-01	4.967E-02	16.43	2.85	46.00	7.03	.01566	1.440E-05	1.461E-05	3.849E-04
1.12	19.87	2.808E-01	4.922E-02	16.26	2.82	46.09	6.97	.01594	1.179E-05	1.197E-05	3.611E-04
1.11	22.71	2.742E-01	4.879E-02	16.20	2.81	46.11	6.95	.01602	9.208E-06	9.349E-06	3.389E-04
1.10	26.50	2.651E-01	4.851E-02	16.34	2.84	46.04	7.01	.01576	6.738E-06	6.832E-06	3.162E-04

RESULTS FOR TYPE II (O + F = 0) PHASE MATCHING APP

SIGNAL	IDLER	THETA (DEG)	RHO (DEG)	D-EFF (*10.E12)	q	H(M)	GAIN/WATT (1CM)	GAIN/WATT (MAX)	AREA (SQ CM)		
2.12	2.12	7.308E-01	9.376E-02	41.86	5.37	57.24	13.27	.00444	5.257E-05	5.279E-05	1.681E-03
2.09	2.15	7.365E-01	9.394E-02	42.20	5.38	57.04	13.30	.00442	5.108E-05	5.202E-05	1.607E-03
2.06	2.18	7.424E-01	9.411E-02	42.53	5.39	56.84	13.32	.00441	5.102E-05	5.123E-05	1.613E-03
2.04	2.21	7.482E-01	9.426E-02	42.87	5.40	56.64	13.34	.00439	5.021E-05	5.042E-05	1.618E-03
2.01	2.24	7.541E-01	9.441E-02	43.21	5.41	56.44	13.36	.00438	4.939E-05	4.959E-05	1.623E-03
1.99	2.27	7.600E-01	9.454E-02	43.54	5.42	56.24	13.38	.00437	4.855E-05	4.875E-05	1.627E-03
1.96	2.30	7.659E-01	9.465E-02	43.88	5.42	56.04	13.40	.00436	4.770E-05	4.789E-05	1.631E-03
1.94	2.34	7.718E-01	9.477E-02	44.22	5.43	55.83	13.41	.00435	4.683E-05	4.702E-05	1.635E-03
1.92	2.37	7.777E-01	9.485E-02	44.56	5.44	55.63	13.43	.00434	4.595E-05	4.614E-05	1.638E-03
1.89	2.41	7.834E-01	9.494E-02	44.90	5.44	55.42	13.44	.00433	4.506E-05	4.524E-05	1.641E-03
1.87	2.45	7.891E-01	9.501E-02	45.24	5.44	55.21	13.45	.00432	4.416E-05	4.434E-05	1.644E-03
1.85	2.48	7.950E-01	9.507E-02	45.58	5.45	55.00	13.46	.00432	4.324E-05	4.342E-05	1.646E-03
1.83	2.52	8.015E-01	9.511E-02	45.92	5.45	54.78	13.46	.00432	4.232E-05	4.249E-05	1.647E-03

1.81	2.56	A.075E-01	9.514E-02	46.27	5.45	34.56	13.47	.00431	4.139E-05	4.155E-05	1.648E-03
1.79	2.61	A.134E-01	9.514E-02	46.61	5.45	34.56	13.47	.00431	4.061E-05	4.061E-05	1.648E-03
1.77	2.65	A.196E-01	9.517E-02	46.96	5.45	34.12	13.47	.00431	3.950E-05	3.950E-05	1.648E-03
1.75	2.69	A.257E-01	9.515E-02	47.31	5.45	33.90	13.47	.00431	3.855E-05	3.855E-05	1.648E-03
1.73	2.74	A.318E-01	9.517E-02	47.66	5.45	33.68	13.47	.00431	3.759E-05	3.759E-05	1.648E-03
1.71	2.79	A.380E-01	9.509E-02	48.01	5.45	33.45	13.46	.00432	3.663E-05	3.663E-05	1.647E-03
1.69	2.84	A.441E-01	9.509E-02	48.37	5.45	33.22	13.45	.00433	3.566E-05	3.566E-05	1.647E-03
1.67	2.89	A.504E-01	9.494E-02	48.72	5.44	32.99	13.44	.00433	3.469E-05	3.469E-05	1.642E-03
1.66	2.94	A.566E-01	9.489E-02	49.08	5.44	32.75	13.43	.00434	3.372E-05	3.372E-05	1.640E-03
1.64	3.00	A.629E-01	9.480E-02	49.44	5.43	32.51	13.42	.00434	3.275E-05	3.275E-05	1.636E-03
1.62	3.06	A.693E-01	9.468E-02	49.81	5.42	32.27	13.40	.00435	3.178E-05	3.178E-05	1.632E-03
1.61	3.12	A.755E-01	9.455E-02	50.17	5.42	32.02	13.38	.00437	3.081E-05	3.081E-05	1.628E-03
1.59	3.18	A.817E-01	9.440E-02	50.54	5.41	31.78	13.36	.00438	2.984E-05	2.984E-05	1.623E-03
1.57	3.24	A.879E-01	9.424E-02	50.92	5.40	31.52	13.34	.00440	2.887E-05	2.887E-05	1.617E-03
1.56	3.31	A.942E-01	9.405E-02	51.29	5.39	31.27	13.31	.00441	2.790E-05	2.790E-05	1.611E-03
1.54	3.38	A.014E-01	9.385E-02	51.66	5.38	31.01	13.28	.00443	2.694E-05	2.694E-05	1.604E-03
1.53	3.46	A.086E-01	9.363E-02	52.04	5.36	30.74	13.25	.00445	2.599E-05	2.599E-05	1.596E-03
1.51	3.53	A.158E-01	9.338E-02	52.42	5.35	30.47	13.22	.00448	2.504E-05	2.504E-05	1.588E-03
1.50	3.61	A.224E-01	9.312E-02	52.80	5.34	30.20	13.18	.00450	2.409E-05	2.409E-05	1.579E-03
1.49	3.70	A.294E-01	9.283E-02	53.25	5.32	29.92	13.14	.00453	2.316E-05	2.316E-05	1.569E-03
1.47	3.79	A.365E-01	9.252E-02	53.70	5.30	29.63	13.10	.00456	2.223E-05	2.223E-05	1.559E-03
1.46	3.88	A.436E-01	9.218E-02	54.07	5.28	29.34	13.05	.00459	2.131E-05	2.131E-05	1.547E-03
1.45	3.97	A.511E-01	9.181E-02	54.50	5.26	29.04	13.01	.00463	2.039E-05	2.039E-05	1.535E-03
1.43	4.04	A.584E-01	9.142E-02	54.93	5.24	28.73	12.94	.00471	1.949E-05	1.949E-05	1.522E-03
1.42	4.13	A.653E-01	9.099E-02	55.37	5.21	28.42	12.88	.00476	1.858E-05	1.858E-05	1.508E-03
1.41	4.21	A.724E-01	9.057E-02	55.82	5.19	28.09	12.81	.00481	1.767E-05	1.767E-05	1.492E-03
1.39	4.29	A.792E-01	9.014E-02	56.24	5.16	27.76	12.74	.00487	1.676E-05	1.676E-05	1.476E-03
1.38	4.38	A.855E-01	8.973E-02	56.75	5.13	27.41	12.67	.00494	1.585E-05	1.585E-05	1.458E-03
1.37	4.46	A.925E-01	8.925E-02	57.24	5.09	27.06	12.59	.00501	1.494E-05	1.494E-05	1.440E-03
1.36	4.54	A.994E-01	8.878E-02	57.74	5.06	26.64	12.50	.00508	1.403E-05	1.403E-05	1.421E-03
1.35	4.62	A.067E-01	8.835E-02	58.21	5.02	26.30	12.40	.00517	1.312E-05	1.312E-05	1.397E-03
1.34	4.70	A.134E-01	8.794E-02	58.69	4.98	25.90	12.29	.00527	1.221E-05	1.221E-05	1.373E-03
1.33	4.78	A.203E-01	8.754E-02	59.17	4.93	25.47	12.18	.00538	1.130E-05	1.130E-05	1.348E-03
1.32	4.86	A.272E-01	8.714E-02	59.66	4.89	25.03	12.05	.00551	1.039E-05	1.039E-05	1.323E-03
1.31	4.94	A.341E-01	8.674E-02	60.14	4.82	24.56	11.91	.00565	9.48E-06	9.48E-06	1.298E-03
1.30	5.02	A.410E-01	8.634E-02	60.63	4.76	24.06	11.76	.00582	8.57E-06	8.57E-06	1.273E-03
1.29	5.09	A.479E-01	8.594E-02	61.12	4.69	23.52	11.59	.00602	7.66E-06	7.66E-06	1.248E-03
1.28	5.17	A.548E-01	8.554E-02	61.61	4.61	22.94	11.39	.00625	6.75E-06	6.75E-06	1.223E-03
1.27	5.25	A.617E-01	8.514E-02	62.10	4.52	22.31	11.17	.00654	5.84E-06	5.84E-06	1.198E-03
1.26	5.33	A.686E-01	8.474E-02	62.59	4.42	21.62	10.92	.00690	4.93E-06	4.93E-06	1.173E-03
1.25	5.41	A.755E-01	8.434E-02	63.08	4.30	20.85	10.63	.00736	4.02E-06	4.02E-06	1.148E-03
1.24	5.49	A.824E-01	8.394E-02	63.57	4.17	19.99	10.29	.00797	3.11E-06	3.11E-06	1.123E-03
1.23	5.57	A.893E-01	8.354E-02	64.06	4.00	19.00	9.89	.00863	2.20E-06	2.20E-06	1.098E-03
1.22	5.65	A.962E-01	8.314E-02	64.55	3.80	17.95	9.39	.00941	1.29E-06	1.29E-06	1.073E-03
1.21	5.73	A.031E-01	8.274E-02	65.04	3.55	16.47	8.78	.01030	4.38E-06	4.38E-06	1.048E-03
1.20	5.81	A.100E-01	8.234E-02	65.53	3.25	14.76	7.97	.01122	3.47E-06	3.47E-06	1.023E-03
1.19	5.89	A.169E-01	8.194E-02	66.02	2.78	12.52	6.86	.01222	2.56E-06	2.56E-06	1.000E-03
1.18	5.97	A.238E-01	8.154E-02	66.51	2.09	9.25	5.16	.01322	1.65E-06	1.65E-06	1.000E-03
1.17	6.05	A.307E-01	8.114E-02	67.00	.29	1.21	.69	.01422	7.64E-06	7.64E-06	1.000E-03

PHASE MATCHING CUTS OFF AT SIGNAL= 1.161 AND TOLER= 12.231

PHASE MATCHING CUTS OFF AT SIGNAL= 1.152 AND TOLER= 13.250

PHASE MATCHING CUTS OFF AT SIGNAL= 1.144 AND TOLER= 14.455

PHASE MATCHING CUTS OFF AT SIGNAL= 1.116 AND IOLR= 15.908
 PHASE MATCHING CUTS OFF AT SIGNAL= 1.120 AND IOLR= 17.667
 PHASE MATCHING CUTS OFF AT SIGNAL= 1.120 AND IOLR= 19.875
 PHASE MATCHING CUTS OFF AT SIGNAL= 1.112 AND IOLR= 22.714
 PHASE MATCHING CUTS OFF AT SIGNAL= 1.104 AND IOLR= 26.500

RESULTS FOR TYPE II (E + G = 0) PHASE MATCHING ARE

SIGNAL	IOLR	THETA (RAD)	PHO (RAD)	THETA (DEG)	RHO (DEG)	D-EFF (*10.E12)	R	WIR	GAIN/WATT (1CM)	GAIN/WATT (MAX)	AREA (SQ CM)
2.12	2.12	7.304F-01	9.375E-02	41.46	5.37	37.24	13.27	.00444	5.257E-05	5.279E-05	1.601E-03
2.09	2.15	7.264F-01	9.357E-02	41.53	5.36	37.43	13.24	.00446	5.332E-05	5.355E-05	1.594E-03
2.06	2.18	7.199F-01	9.336E-02	41.19	5.35	37.63	13.22	.00448	5.403E-05	5.420E-05	1.587E-03
2.04	2.21	7.131F-01	9.315E-02	40.42	5.34	37.82	13.19	.00450	5.476E-05	5.499E-05	1.580E-03
2.01	2.24	7.072F-01	9.292E-02	40.52	5.32	38.01	13.15	.00452	5.548E-05	5.568E-05	1.572E-03
1.99	2.27	7.013F-01	9.269E-02	40.14	5.31	38.20	13.12	.00454	5.611E-05	5.635E-05	1.564E-03
1.96	2.30	6.955F-01	9.243E-02	39.45	5.30	38.39	13.08	.00457	5.675E-05	5.699E-05	1.556E-03
1.94	2.34	6.897F-01	9.217E-02	39.61	5.29	38.58	13.05	.00459	5.737E-05	5.761E-05	1.547E-03
1.92	2.37	6.837F-01	9.189E-02	39.17	5.26	38.76	13.01	.00462	5.799E-05	5.821E-05	1.537E-03
1.89	2.41	6.778F-01	9.160E-02	38.84	5.25	38.95	12.97	.00465	5.852E-05	5.877E-05	1.528E-03
1.87	2.45	6.719F-01	9.130E-02	38.50	5.23	39.13	12.92	.00468	5.905E-05	5.931E-05	1.518E-03
1.85	2.48	6.660F-01	9.099E-02	38.16	5.21	39.31	12.88	.00471	5.958E-05	5.982E-05	1.507E-03
1.83	2.52	6.601F-01	9.067E-02	37.82	5.19	39.50	12.83	.00475	6.008E-05	6.038E-05	1.497E-03
1.81	2.56	6.542F-01	9.033E-02	37.44	5.18	39.68	12.79	.00478	6.048E-05	6.076E-05	1.486E-03
1.79	2.61	6.483F-01	8.998E-02	37.14	5.16	39.86	12.74	.00482	6.090E-05	6.117E-05	1.474E-03
1.77	2.65	6.424F-01	8.965E-02	36.80	5.13	40.04	12.69	.00486	6.128E-05	6.156E-05	1.462E-03
1.75	2.69	6.365F-01	8.928E-02	36.46	5.11	40.22	12.63	.00490	6.163E-05	6.192E-05	1.450E-03
1.73	2.74	6.307F-01	8.896E-02	36.11	5.09	40.39	12.58	.00494	6.195E-05	6.224E-05	1.438E-03
1.71	2.79	6.248F-01	8.865E-02	35.77	5.07	40.57	12.52	.00499	6.223E-05	6.252E-05	1.425E-03
1.69	2.84	6.189F-01	8.834E-02	35.42	5.04	40.74	12.46	.00503	6.248E-05	6.277E-05	1.411E-03
1.67	2.89	6.129F-01	8.799E-02	35.08	5.02	40.92	12.40	.00508	6.269E-05	6.299E-05	1.398E-03
1.66	2.94	6.071F-01	8.768E-02	34.73	4.99	41.09	12.34	.00513	6.290E-05	6.316E-05	1.384E-03
1.64	3.00	6.012F-01	8.728E-02	34.39	4.97	41.27	12.28	.00519	6.299E-05	6.330E-05	1.369E-03
1.62	3.06	5.952F-01	8.685E-02	34.03	4.94	41.44	12.21	.00524	6.308E-05	6.348E-05	1.355E-03
1.61	3.12	5.893F-01	8.645E-02	33.69	4.91	41.61	12.14	.00530	6.318E-05	6.349E-05	1.340E-03
1.59	3.18	5.834F-01	8.605E-02	33.32	4.89	41.78	12.07	.00536	6.315E-05	6.347E-05	1.324E-03
1.57	3.24	5.774F-01	8.575E-02	32.97	4.86	41.95	12.00	.00543	6.312E-05	6.344E-05	1.309E-03
1.56	3.31	5.715F-01	8.545E-02	32.61	4.83	42.12	11.93	.00549	6.308E-05	6.337E-05	1.292E-03
1.54	3.38	5.656F-01	8.515E-02	32.25	4.80	42.29	11.85	.00556	6.299E-05	6.325E-05	1.276E-03
1.53	3.46	5.597F-01	8.485E-02	31.89	4.76	42.45	11.77	.00564	6.276E-05	6.309E-05	1.259E-03
1.51	3.53	5.538F-01	8.455E-02	31.52	4.73	42.62	11.69	.00572	6.255E-05	6.289E-05	1.242E-03
1.50	3.61	5.479F-01	8.425E-02	31.16	4.70	42.79	11.61	.00580	6.229E-05	6.263E-05	1.225E-03
1.49	3.70	5.420F-01	8.395E-02	30.79	4.66	42.95	11.52	.00588	6.199E-05	6.233E-05	1.207E-03
1.47	3.79	5.361F-01	8.365E-02	30.42	4.63	43.12	11.44	.00597	6.163E-05	6.198E-05	1.189E-03
1.46	3.88	5.302F-01	8.335E-02	30.05	4.59	43.28	11.35	.00607	6.123E-05	6.158E-05	1.170E-03
1.45	3.97	5.243F-01	8.305E-02	29.67	4.56	43.44	11.26	.00616	6.077E-05	6.113E-05	1.151E-03
1.43	4.08	5.184F-01	7.955E-02	29.30	4.52	43.61	11.16	.00627	6.027E-05	6.062E-05	1.132E-03
1.42	4.18	5.125F-01	7.917E-02	28.92	4.48	43.77	11.06	.00638	5.971E-05	6.006E-05	1.113E-03

1.41	4.30	4.940F-01	7.747E-02	24.53	4.44	43.93	10.97	.00649	5.909E-05	5.945E-05	1.893E-03
1.39	4.42	4.912F-01	7.675E-02	24.15	4.40	44.09	10.56	.00651	5.842E-05	5.878E-05	1.873E-03
1.38	4.54	4.844F-01	7.602E-02	27.76	4.35	44.25	10.75	.00674	5.769E-05	5.806E-05	1.852E-03
1.37	4.64	4.776F-01	7.526E-02	27.36	4.31	44.41	10.75	.00688	5.691E-05	5.728E-05	1.831E-03
1.36	4.82	4.707F-01	7.449E-02	26.97	4.27	44.56	10.54	.00702	5.607E-05	5.644E-05	1.810E-03
1.35	4.97	4.637F-01	7.364E-02	26.57	4.22	44.72	10.43	.00717	5.517E-05	5.554E-05	1.800E-04
1.34	5.13	4.567F-01	7.249E-02	26.17	4.18	44.88	10.32	.00733	5.428E-05	5.458E-05	1.8071E-04
1.33	5.30	4.494F-01	7.205E-02	25.76	4.13	45.03	10.20	.00750	5.331E-05	5.355E-05	1.851E-04
1.31	5.48	4.425F-01	7.119E-02	25.35	4.04	45.19	10.04	.00769	5.247E-05	5.247E-05	1.820E-04
1.30	5.68	4.352F-01	7.032E-02	24.94	4.03	45.34	9.95	.00787	5.094E-05	5.132E-05	1.803E-04
1.29	5.89	4.280F-01	6.942E-02	24.52	3.98	45.49	9.83	.00807	4.972E-05	5.010E-05	1.774E-04
1.28	6.12	4.206E-01	6.850E-02	24.10	3.92	45.64	9.70	.00829	4.843E-05	4.881E-05	1.746E-04
1.27	6.36	4.132F-01	6.755E-02	23.67	3.87	45.79	9.56	.00852	4.708E-05	4.746E-05	1.711E-04
1.26	6.62	4.057F-01	6.660E-02	23.24	3.82	45.94	9.43	.00877	4.565E-05	4.603E-05	1.675E-04
1.25	6.91	3.981F-01	6.561E-02	22.81	3.76	46.09	9.29	.00903	4.415E-05	4.453E-05	1.639E-04
1.24	7.23	3.905F-01	6.450E-02	22.37	3.70	46.24	9.14	.00931	4.259E-05	4.296E-05	1.600E-04
1.23	7.57	3.828F-01	6.335E-02	21.93	3.64	46.38	9.03	.00961	4.094E-05	4.131E-05	1.557E-04
1.22	7.95	3.751F-01	6.251E-02	21.49	3.58	46.52	8.85	.00993	3.922E-05	3.959E-05	1.510E-04
1.21	8.37	3.673F-01	6.146E-02	21.04	3.52	46.67	8.70	.01028	3.742E-05	3.778E-05	1.467E-04
1.20	8.83	3.595F-01	6.037E-02	20.60	3.46	46.80	8.55	.01065	3.554E-05	3.590E-05	1.423E-04
1.19	9.35	3.516F-01	5.926E-02	20.15	3.40	46.94	8.39	.01105	3.357E-05	3.392E-05	1.379E-04
1.17	9.94	3.438F-01	5.815E-02	19.70	3.33	47.07	8.23	.01147	3.152E-05	3.187E-05	1.335E-04
1.16	10.60	3.360F-01	5.702E-02	19.25	3.27	47.20	8.07	.01192	2.939E-05	2.972E-05	1.291E-04
1.15	11.36	3.282F-01	5.590E-02	18.81	3.20	47.33	7.91	.01240	2.717E-05	2.749E-05	1.249E-04
1.14	12.23	3.207F-01	5.479E-02	18.37	3.14	47.45	7.76	.01298	2.484E-05	2.517E-05	1.205E-04
1.13	13.25	3.133F-01	5.370E-02	17.95	3.08	47.57	7.60	.01342	2.247E-05	2.276E-05	1.158E-04
1.12	14.45	3.063F-01	5.266E-02	17.55	3.02	47.67	7.45	.01395	2.008E-05	2.027E-05	1.104E-04
1.11	15.90	2.999F-01	5.169E-02	17.14	2.96	47.77	7.32	.01447	1.746E-05	1.770E-05	1.046E-04
1.10	17.67	2.944F-01	5.086E-02	16.87	2.91	47.85	7.20	.01494	1.447E-05	1.468E-05	9.849E-05
1.09	19.87	2.901F-01	5.022E-02	16.52	2.88	47.91	7.11	.01532	1.224E-05	1.242E-05	9.233E-05
1.08	22.71	2.879F-01	4.991E-02	16.50	2.86	47.94	7.07	.01551	9.636E-06	9.774E-06	8.536E-05
1.07	26.50	2.831F-01	5.013E-02	16.56	2.87	47.93	7.10	.01537	7.112E-06	7.216E-06	8.577E-05

PROGRAM NONLIN--COLLINEARLY PHASE MATCHED QND

CUMMANS

PHASE MATCHING FOR POSITIVE RIPOFFRINGENT CRYSTAL

PUMP WAVELENGTH(MICROMETERS)= 1.300

NONLINEAR COEFFICIENTS(X10 E12 W/V)= 50.000

RIPOFF WAVELENGTH= 30.000

RESULTS FOR TYPE I (E + E = 0) PHASE MATCHING ARE

SIGNAL	WAVELENGTH	THETA (DEG)	PHO (DEG)	D-EFF (*10.E12)	Q	MIRI	GAIN/WATT (1CM)	GAIN/WATT (MAX)	AREA (SQ CM)
2.68	2.60	4.000E-01	6.400E-02	42.39	0.14	.01172	9.929E-05	1.004E-04	7.410E-04
2.57	2.64	4.000E-01	6.401E-02	42.39	0.14	.01171	9.922E-05	1.003E-04	7.413E-04
2.53	2.67	4.000E-01	6.402E-02	42.39	0.14	.01171	9.912E-05	1.002E-04	7.414E-04
2.50	2.71	4.000E-01	6.403E-02	42.40	0.14	.01171	9.890E-05	1.001E-04	7.413E-04
2.47	2.75	4.000E-01	6.400E-02	42.41	0.14	.01172	9.881E-05	9.991E-05	7.410E-04
2.44	2.79	4.000E-01	6.399E-02	42.42	0.14	.01172	9.861E-05	9.970E-05	7.405E-04
2.41	2.83	3.997E-01	6.395E-02	42.43	0.14	.01173	9.837E-05	9.946E-05	7.390E-04
2.38	2.87	3.992E-01	6.391E-02	42.45	0.13	.01175	9.810E-05	9.919E-05	7.304E-04
2.35	2.91	3.987E-01	6.387E-02	42.46	0.13	.01177	9.779E-05	9.888E-05	7.370E-04
2.32	2.95	3.982E-01	6.384E-02	42.46	0.12	.01179	9.746E-05	9.854E-05	7.366E-04
2.29	3.00	3.976E-01	6.375E-02	42.51	0.11	.01131	9.709E-05	9.817E-05	7.351E-04
2.27	3.05	3.969E-01	6.367E-02	42.53	0.10	.01104	9.660E-05	9.776E-05	7.334E-04
2.24	3.10	3.961E-01	6.359E-02	42.56	0.09	.01087	9.624E-05	9.732E-05	7.315E-04
2.22	3.15	3.953E-01	6.350E-02	42.59	0.09	.01190	9.577E-05	9.644E-05	7.294E-04
2.19	3.20	3.944E-01	6.340E-02	42.62	0.07	.01194	9.526E-05	9.633E-05	7.271E-04
2.17	3.25	3.934E-01	6.329E-02	42.65	0.05	.01198	9.471E-05	9.579E-05	7.246E-04
2.14	3.31	3.924E-01	6.317E-02	42.69	0.04	.01202	9.413E-05	9.521E-05	7.219E-04
2.12	3.36	3.913E-01	6.305E-02	42.73	0.02	.01207	9.352E-05	9.459E-05	7.190E-04
2.10	3.42	3.902E-01	6.291E-02	42.77	0.00	.01212	9.287E-05	9.394E-05	7.159E-04
2.07	3.48	3.890E-01	6.276E-02	42.81	7.98	.01218	9.219E-05	9.325E-05	7.126E-04
2.05	3.55	3.877E-01	6.261E-02	42.86	7.96	.01224	9.147E-05	9.253E-05	7.091E-04
2.03	3.61	3.863E-01	6.244E-02	42.90	7.94	.01230	9.071E-05	9.177E-05	7.053E-04
2.01	3.68	3.849E-01	6.227E-02	42.95	7.92	.01237	8.991E-05	9.097E-05	7.014E-04
1.99	3.75	3.834E-01	6.209E-02	43.00	7.90	.01244	8.908E-05	9.013E-05	6.972E-04
1.97	3.82	3.818E-01	6.190E-02	43.06	7.87	.01252	8.821E-05	8.926E-05	6.929E-04
1.95	3.90	3.801E-01	6.169E-02	43.12	7.85	.01260	8.738E-05	8.839E-05	6.883E-04
1.93	3.98	3.784E-01	6.147E-02	43.17	7.82	.01269	8.656E-05	8.743E-05	6.835E-04
1.91	4.06	3.767E-01	6.125E-02	43.24	7.79	.01279	8.573E-05	8.641E-05	6.786E-04
1.89	4.15	3.749E-01	6.103E-02	43.30	7.76	.01289	8.490E-05	8.530E-05	6.734E-04
1.88	4.24	3.729E-01	6.077E-02	43.36	7.73	.01294	8.408E-05	8.431E-05	6.680E-04
1.86	4.33	3.709E-01	6.051E-02	43.43	7.70	.01309	8.326E-05	8.320E-05	6.623E-04
1.84	4.43	3.688E-01	6.024E-02	43.50	7.66	.01321	8.243E-05	8.204E-05	6.565E-04
1.82	4.53	3.667E-01	5.997E-02	43.57	7.63	.01333	8.160E-05	8.085E-05	6.505E-04
1.81	4.64	3.645E-01	5.969E-02	43.65	7.59	.01345	8.077E-05	7.961E-05	6.442E-04
1.79	4.76	3.622E-01	5.941E-02	43.72	7.55	.01359	7.994E-05	7.833E-05	6.370E-04

1.77	4.87	3.599E-01	5.497E-02	20.62	3.38	43.89	7.51	.01373	7.601E-05	7.780E-05	6.311E-04
1.76	5.30	3.574E-01	5.874E-02	20.44	3.37	43.88	7.47	.01388	7.655E-05	7.963E-05	6.242E-04
1.74	5.13	3.549E-01	5.941E-02	20.34	3.35	43.96	7.43	.01404	7.724E-05	7.422E-05	6.372E-04
1.73	5.27	3.524E-01	5.937E-02	20.19	3.33	44.84	7.39	.01420	7.174E-05	7.275E-05	6.099E-04
1.71	5.42	3.497E-01	5.771E-02	20.04	3.31	44.14	7.34	.01438	7.028E-05	7.124E-05	6.024E-04
1.70	5.57	3.470E-01	5.724E-02	19.88	3.29	44.22	7.29	.01456	6.073E-05	6.968E-05	5.948E-04
1.68	5.74	3.443E-01	5.695E-02	19.72	3.26	44.38	7.25	.01475	6.713E-05	6.807E-05	5.849E-04
1.67	5.91	3.414E-01	5.657E-02	19.56	3.24	44.49	7.20	.01495	6.548E-05	6.641E-05	5.789E-04
1.65	6.09	3.385E-01	5.617E-02	19.39	3.22	44.64	7.15	.01516	6.374E-05	6.478E-05	5.787E-04
1.64	6.29	3.356E-01	5.575E-02	19.27	3.19	44.84	7.09	.01539	6.203E-05	6.273E-05	5.623E-04
1.63	6.50	3.326E-01	5.533E-02	19.05	3.17	44.67	7.04	.01562	6.022E-05	6.112E-05	5.538E-04
1.61	6.72	3.294E-01	5.489E-02	18.87	3.15	44.77	6.98	.01587	5.836E-05	5.924E-05	5.451E-04
1.60	6.96	3.262E-01	5.445E-02	18.69	3.12	44.67	6.93	.01612	5.645E-05	5.731E-05	5.363E-04
1.59	7.22	3.230E-01	5.399E-02	18.51	3.09	44.96	6.87	.01639	5.448E-05	5.533E-05	5.273E-04
1.57	7.50	3.197E-01	5.353E-02	18.32	3.07	45.06	6.81	.01667	5.245E-05	5.328E-05	5.183E-04
1.56	7.80	3.164E-01	5.305E-02	18.13	3.04	45.16	6.75	.01697	5.037E-05	5.114E-05	5.092E-04
1.55	8.12	3.131E-01	5.257E-02	17.94	3.01	45.26	6.69	.01727	4.822E-05	4.902E-05	5.000E-04
1.54	8.48	3.098E-01	5.209E-02	17.75	2.98	45.35	6.63	.01759	4.602E-05	4.679E-05	4.908E-04
1.52	8.86	3.064E-01	5.159E-02	17.56	2.96	45.45	6.56	.01792	4.376E-05	4.451E-05	4.816E-04
1.51	9.29	3.030E-01	5.111E-02	17.37	2.93	45.55	6.50	.01826	4.144E-05	4.216E-05	4.725E-04
1.50	9.75	2.997E-01	5.062E-02	17.17	2.90	45.64	6.44	.01861	3.906E-05	3.975E-05	4.636E-04
1.49	10.26	2.964E-01	5.014E-02	16.98	2.87	45.73	6.38	.01896	3.662E-05	3.728E-05	4.548E-04
1.48	10.83	2.930E-01	4.967E-02	16.80	2.85	45.82	6.32	.01931	3.413E-05	3.475E-05	4.463E-04
1.47	11.47	2.897E-01	4.922E-02	16.63	2.82	45.91	6.26	.01966	3.158E-05	3.217E-05	4.382E-04
1.46	12.19	2.873E-01	4.879E-02	16.46	2.80	45.99	6.21	.02000	2.906E-05	2.954E-05	4.306E-04
1.44	13.08	2.847E-01	4.840E-02	16.31	2.77	46.06	6.16	.02032	2.635E-05	2.686E-05	4.238E-04
1.43	13.93	2.824E-01	4.807E-02	16.14	2.75	46.12	6.11	.02069	2.367E-05	2.414E-05	4.179E-04
1.42	15.00	2.805E-01	4.774E-02	15.97	2.74	46.17	6.04	.02082	2.099E-05	2.149E-05	4.133E-04
1.41	16.25	2.793E-01	4.763E-02	15.80	2.73	46.21	6.06	.02097	1.829E-05	1.866E-05	4.104E-04
1.40	17.73	2.794E-01	4.750E-02	15.64	2.73	46.21	6.06	.02108	1.562E-05	1.594E-05	4.090E-04
1.39	19.50	2.798E-01	4.775E-02	15.03	2.76	46.12	6.07	.02188	1.301E-05	1.327E-05	4.124E-04
1.38	21.67	2.822E-01	4.815E-02	15.17	2.75	46.12	6.13	.02253	1.048E-05	1.069E-05	4.175E-04
1.37	24.37	2.871E-01	4.893E-02	16.45	2.80	45.99	6.22	.02909	8.095E-06	8.248E-06	4.338E-04
1.36	27.86	2.954E-01	5.024E-02	16.92	2.84	45.75	6.30	.01888	5.987E-06	5.813E-06	4.566E-04

RESULTS FOR TYPE II (D + F = 0) PHASE MATCHING AGE

SIGNAL	IDLER	THETA (RAD)	QMD (RAD)	THETA (DEG)	QMD (DEG)	N-EFF (=10.E12)	Q	WFO	GAIN/WATT (1CM)	GAIN/WATT (MAY)	AREA (50 CM)
2.60	2.60	5.780E-01	8.363E-02	33.12	4.79	41.44	10.64	.00469	5.722E-05	5.739E-05	1.265E-03
2.57	2.64	5.423E-01	8.394E-02	33.37	4.81	41.76	10.64	.00464	5.621E-05	5.657E-05	1.270E-03
2.53	2.67	5.046E-01	8.432E-02	33.61	4.83	41.64	10.73	.00478	5.538E-05	5.574E-05	1.286E-03
2.50	2.71	5.510E-01	8.465E-02	33.94	4.85	41.52	10.77	.00473	5.453E-05	5.488E-05	1.296E-03
2.47	2.75	5.953E-01	8.498E-02	34.11	4.87	41.40	10.81	.00469	5.366E-05	5.400E-05	1.367E-03
2.44	2.79	5.096E-01	8.532E-02	34.35	4.89	41.29	10.85	.00463	5.277E-05	5.310E-05	1.317E-03
2.41	2.83	6.039E-01	8.564E-02	34.60	4.91	41.16	10.90	.00458	5.186E-05	5.218E-05	1.327E-03
2.38	2.87	6.082E-01	8.596E-02	34.85	4.93	41.03	10.94	.00453	5.094E-05	5.125E-05	1.337E-03
2.35	2.91	5.125E-01	8.627E-02	35.10	4.94	40.91	10.94	.00448	5.000E-05	5.030E-05	1.346E-03
2.32	2.95	6.169E-01	8.658E-02	35.34	4.96	40.78	11.01	.00444	4.904E-05	4.934E-05	1.356E-03
2.29	3.00	6.215E-01	8.689E-02	35.59	4.98	40.66	11.01	.00439	4.807E-05	4.836E-05	1.365E-03
2.27	3.05	6.261E-01	8.717E-02	35.84	4.99	40.53	11.09	.00435	4.709E-05	4.737E-05	1.375E-03
2.24	3.10	6.298E-01	8.746E-02	36.09	5.01	40.40	11.13	.00431	4.610E-05	4.637E-05	1.384E-03
2.22	3.15	6.343E-01	8.775E-02	36.34	5.03	40.27	11.16	.00427	4.509E-05	4.536E-05	1.393E-03

2.19	3.20	6.307E-01	8.803E-02	36.60	5.04	40.14	11.26	.00623	6.608E-05	6.434E-05	1.402E-03
2.17	3.25	6.431E-01	8.830E-02	36.85	5.06	40.61	11.23	.00619	6.306E-05	6.331E-05	1.410E-03
2.14	3.31	6.474E-01	8.857E-02	37.10	5.07	39.88	11.27	.00615	6.227E-05	6.252E-05	1.419E-03
2.12	3.36	6.520E-01	8.884E-02	37.36	5.09	39.74	11.30	.00611	6.094E-05	6.122E-05	1.428E-03
2.10	3.42	6.565E-01	8.909E-02	37.62	5.10	39.61	11.33	.00606	5.994E-05	6.017E-05	1.436E-03
2.07	3.48	6.610E-01	8.935E-02	37.87	5.12	39.47	11.37	.00604	5.909E-05	5.911E-05	1.444E-03
2.05	3.55	6.655E-01	8.960E-02	38.14	5.13	39.33	11.40	.00601	5.793E-05	5.885E-05	1.452E-03
2.03	3.61	6.702E-01	8.984E-02	38.46	5.15	39.19	11.43	.00598	5.678E-05	5.698E-05	1.460E-03
2.01	3.68	6.744E-01	9.008E-02	38.80	5.16	39.04	11.46	.00595	5.571E-05	5.591E-05	1.468E-03
1.99	3.75	6.794E-01	9.031E-02	39.13	5.17	38.90	11.49	.00592	5.465E-05	5.495E-05	1.475E-03
1.97	3.82	6.841E-01	9.054E-02	39.20	5.19	38.75	11.52	.00589	5.359E-05	5.378E-05	1.483E-03
1.95	3.90	6.889E-01	9.075E-02	39.47	5.20	38.60	11.55	.00586	5.253E-05	5.271E-05	1.490E-03
1.93	3.98	6.937E-01	9.094E-02	39.74	5.21	38.45	11.57	.00583	5.147E-05	5.164E-05	1.497E-03
1.91	4.06	6.985E-01	9.119E-02	40.02	5.22	38.29	11.60	.00580	5.041E-05	5.057E-05	1.504E-03
1.89	4.15	7.035E-01	9.139E-02	40.31	5.24	38.13	11.63	.00578	4.935E-05	4.951E-05	1.511E-03
1.88	4.24	7.084E-01	9.159E-02	40.59	5.25	37.97	11.65	.00575	4.830E-05	4.845E-05	1.517E-03
1.86	4.33	7.135E-01	9.174E-02	40.84	5.26	37.80	11.68	.00573	4.725E-05	4.740E-05	1.524E-03
1.84	4.43	7.187E-01	9.197E-02	41.18	5.27	37.63	11.71	.00571	4.621E-05	4.635E-05	1.530E-03
1.82	4.53	7.239E-01	9.214E-02	41.44	5.28	37.46	11.74	.00566	4.517E-05	4.531E-05	1.536E-03
1.81	4.64	7.293E-01	9.232E-02	41.70	5.29	37.28	11.77	.00564	4.413E-05	4.427E-05	1.542E-03
1.79	4.76	7.347E-01	9.244E-02	42.10	5.30	37.10	11.77	.00561	4.309E-05	4.323E-05	1.547E-03
1.77	4.87	7.403E-01	9.263E-02	42.42	5.31	36.91	11.79	.00563	4.205E-05	4.219E-05	1.552E-03
1.76	5.00	7.461E-01	9.274E-02	42.75	5.32	36.72	11.80	.00561	4.102E-05	4.116E-05	1.557E-03
1.74	5.13	7.520E-01	9.292E-02	43.08	5.32	36.52	11.82	.00558	4.000E-05	4.014E-05	1.562E-03
1.73	5.27	7.580E-01	9.305E-02	43.43	5.33	36.31	11.84	.00556	3.898E-05	3.912E-05	1.566E-03
1.71	5.42	7.643E-01	9.316E-02	43.79	5.34	36.09	11.87	.00554	3.796E-05	3.810E-05	1.570E-03
1.70	5.57	7.707E-01	9.327E-02	44.16	5.35	35.87	11.89	.00552	3.694E-05	3.708E-05	1.574E-03
1.68	5.74	7.775E-01	9.336E-02	44.55	5.35	35.63	11.91	.00550	3.592E-05	3.606E-05	1.577E-03
1.67	5.91	7.845E-01	9.344E-02	44.95	5.35	35.39	11.93	.00548	3.490E-05	3.504E-05	1.579E-03
1.65	6.09	7.916E-01	9.349E-02	45.37	5.36	35.13	11.95	.00546	3.388E-05	3.402E-05	1.581E-03
1.64	6.29	7.995E-01	9.352E-02	45.81	5.36	34.85	11.98	.00544	3.286E-05	3.299E-05	1.583E-03
1.63	6.50	8.076E-01	9.354E-02	46.27	5.36	34.56	11.99	.00542	3.184E-05	3.197E-05	1.585E-03
1.61	6.72	8.157E-01	9.352E-02	46.76	5.36	34.25	11.90	.00540	3.082E-05	3.095E-05	1.587E-03
1.60	6.96	8.252E-01	9.347E-02	47.28	5.36	33.92	11.89	.00538	2.980E-05	2.993E-05	1.589E-03
1.59	7.22	8.355E-01	9.339E-02	47.84	5.35	33.56	11.88	.00536	2.878E-05	2.891E-05	1.591E-03
1.57	7.50	8.464E-01	9.324E-02	48.44	5.34	33.17	11.86	.00534	2.776E-05	2.789E-05	1.593E-03
1.56	7.80	8.577E-01	9.303E-02	49.09	5.33	32.75	11.84	.00532	2.674E-05	2.687E-05	1.595E-03
1.55	8.12	8.691E-01	9.275E-02	49.79	5.31	32.24	11.81	.00530	2.572E-05	2.585E-05	1.597E-03
1.54	8.48	8.824E-01	9.237E-02	50.57	5.29	31.76	11.75	.00528	2.470E-05	2.483E-05	1.599E-03
1.52	8.86	8.977E-01	9.197E-02	51.43	5.26	31.17	11.69	.00526	2.368E-05	2.381E-05	1.601E-03
1.51	9.28	9.145E-01	9.119E-02	52.40	5.23	30.51	11.61	.00524	2.266E-05	2.279E-05	1.603E-03
1.50	9.75	9.334E-01	9.030E-02	53.49	5.17	29.75	11.49	.00522	2.164E-05	2.177E-05	1.605E-03
1.49	10.26	9.555E-01	8.910E-02	54.75	5.10	28.86	11.33	.00520	2.062E-05	2.075E-05	1.607E-03
1.48	10.83	9.810E-01	8.747E-02	56.21	5.01	27.81	11.13	.00518	1.960E-05	1.973E-05	1.609E-03
1.47	11.47	1.011E+00	8.522E-02	57.94	4.94	26.54	10.94	.00516	1.858E-05	1.871E-05	1.611E-03
1.46	12.19	1.040E+00	8.236E-02	59.05	4.70	24.96	10.64	.00514	1.756E-05	1.769E-05	1.613E-03
1.44	13.00	1.097E+00	7.741E-02	62.70	4.44	22.93	9.85	.00512	1.654E-05	1.667E-05	1.615E-03
1.43	13.93	1.155E+00	7.024E-02	68.18	4.03	20.19	8.94	.00510	1.552E-05	1.565E-05	1.617E-03
1.42	15.00	1.242E+00	5.829E-02	71.13	3.34	16.17	7.62	.00508	1.450E-05	1.463E-05	1.619E-03
1.41	16.25	1.396E+00	3.263E-02	70.01	1.87	8.67	4.15	.00506	1.348E-05	1.361E-05	1.621E-03

PHASE MATCHING CUTS OFF AT SIGNAL = 1.493 AND TOLER = 17.727

PHASE MATCHING CUTS OFF AT SIGNAL = 1.393 AND TOLER = 19.500

PHASE MATCHING CUTS OFF AT SIGNAL = 1.393 AND TOLER = 21.667

PHASE MATCHING CUTS OFF AT SIGNAL= 1.373 AND TOLER= 24.375

PHASE MATCHING CUTS OFF AT SIGNAL= 1.364 AND TOLER= 27.457

RESULTS FOR TYPE II (F + 0 = 0) PHASE MATCHING ARE

SIGNAL	TOLER	THETA (RAD)	RHO (RAD)	THETA (DEG)	RHO (DEG)	D-FFF (*10.E12)	R	H(M)	GAIN/MATT (1CM)	GAIN/MATT (MAX)	AREA (SQ CM)
2.60	2.60	5.74CF-01	8.361E-02	33.12	4.79	41.88	10.64	.08609	5.702E-05	5.739E-05	1.269E-03
2.57	2.64	5.737F-01	8.327E-02	32.97	4.77	41.99	10.59	.08695	5.791E-05	5.819E-05	1.254E-03
2.53	2.67	5.564F-01	8.291E-02	32.63	4.75	42.11	10.55	.08781	5.857E-05	5.895E-05	1.243E-03
2.50	2.71	5.451F-01	8.254E-02	32.34	4.73	42.23	10.50	.08784	5.931E-05	5.970E-05	1.232E-03
2.47	2.75	5.604F-01	8.217E-02	32.13	4.71	42.34	10.45	.08714	6.002E-05	6.043E-05	1.221E-03
2.44	2.79	5.585F-01	8.179E-02	31.88	4.69	42.46	10.41	.08720	6.071E-05	6.112E-05	1.210E-03
2.41	2.83	5.521F-01	8.141E-02	31.64	4.66	42.57	10.36	.08727	6.137E-05	6.179E-05	1.199E-03
2.38	2.87	5.474F-01	8.102E-02	31.39	4.64	42.68	10.31	.08734	6.200E-05	6.242E-05	1.187E-03
2.35	2.91	5.435F-01	8.062E-02	31.14	4.62	42.80	10.26	.08741	6.260E-05	6.303E-05	1.176E-03
2.32	2.95	5.391F-01	8.022E-02	30.89	4.60	42.91	10.21	.08749	6.316E-05	6.361E-05	1.164E-03
2.29	3.00	5.348F-01	7.981E-02	30.64	4.57	43.02	10.15	.08756	6.370E-05	6.416E-05	1.152E-03
2.27	3.05	5.305F-01	7.939E-02	30.39	4.55	43.13	10.10	.08764	6.421E-05	6.467E-05	1.140E-03
2.24	3.10	5.265F-01	7.897E-02	30.14	4.52	43.24	10.05	.08772	6.460E-05	6.508E-05	1.128E-03
2.22	3.15	5.214F-01	7.854E-02	29.89	4.50	43.35	9.99	.08781	6.511E-05	6.559E-05	1.116E-03
2.19	3.20	5.172F-01	7.811E-02	29.63	4.48	43.46	9.94	.08790	6.552E-05	6.609E-05	1.104E-03
2.17	3.25	5.128F-01	7.767E-02	29.38	4.45	43.57	9.88	.08798	6.588E-05	6.638E-05	1.091E-03
2.14	3.31	5.084F-01	7.722E-02	29.13	4.42	43.68	9.82	.08808	6.621E-05	6.671E-05	1.079E-03
2.12	3.36	5.039F-01	7.675E-02	28.87	4.40	43.78	9.77	.08817	6.649E-05	6.708E-05	1.066E-03
2.10	3.42	4.995F-01	7.630E-02	28.62	4.37	43.89	9.71	.08827	6.674E-05	6.728E-05	1.053E-03
2.07	3.49	4.950F-01	7.584E-02	28.36	4.34	44.00	9.65	.08837	6.695E-05	6.747E-05	1.040E-03
2.05	3.55	4.905F-01	7.538E-02	28.10	4.32	44.11	9.59	.08849	6.711E-05	6.765E-05	1.027E-03
2.03	3.61	4.860F-01	7.491E-02	27.84	4.29	44.21	9.53	.08860	6.723E-05	6.778E-05	1.014E-03
2.01	3.69	4.814F-01	7.444E-02	27.59	4.26	44.32	9.46	.08870	6.731E-05	6.786E-05	1.001E-03
1.99	3.75	4.769F-01	7.398E-02	27.32	4.23	44.43	9.40	.08882	6.734E-05	6.790E-05	9.875E-04
1.97	3.82	4.723F-01	7.351E-02	27.05	4.20	44.53	9.34	.08896	6.732E-05	6.789E-05	9.741E-04
1.95	3.90	4.677F-01	7.297E-02	26.80	4.17	44.63	9.27	.08906	6.726E-05	6.784E-05	9.609E-04
1.93	3.99	4.631F-01	7.235E-02	26.54	4.15	44.73	9.20	.08919	6.715E-05	6.773E-05	9.480E-04
1.91	4.06	4.585F-01	7.182E-02	26.27	4.11	44.84	9.14	.08933	6.699E-05	6.758E-05	9.330E-04
1.89	4.15	4.539F-01	7.124E-02	26.00	4.08	44.94	9.07	.08947	6.678E-05	6.737E-05	9.191E-04
1.88	4.24	4.492F-01	7.074E-02	25.74	4.05	45.04	9.00	.08961	6.651E-05	6.712E-05	9.051E-04
1.86	4.33	4.445F-01	6.992E-02	25.47	4.02	45.14	8.93	.08976	6.620E-05	6.681E-05	8.910E-04
1.82	4.53	4.350F-01	6.905E-02	25.20	3.99	45.24	8.86	.08992	6.583E-05	6.644E-05	8.769E-04
1.81	4.64	4.303F-01	6.844E-02	24.92	3.96	45.34	8.78	.01004	6.540E-05	6.602E-05	8.620E-04
1.79	4.76	4.255F-01	6.794E-02	24.65	3.92	45.44	8.71	.01025	6.492E-05	6.553E-05	8.482E-04
1.77	4.87	4.206F-01	6.729E-02	24.38	3.87	45.54	8.64	.01043	6.438E-05	6.501E-05	8.337E-04
1.76	5.00	4.158F-01	6.659E-02	24.10	3.86	45.64	8.56	.01061	6.374E-05	6.442E-05	8.192E-04
1.74	5.13	4.104F-01	6.584E-02	23.82	3.82	45.74	8.49	.01080	6.312E-05	6.376E-05	8.048E-04
1.73	5.27	4.041F-01	6.504E-02	23.54	3.79	45.84	8.41	.01100	6.240E-05	6.305E-05	7.905E-04
1.71	5.42	4.011F-01	6.433E-02	23.26	3.75	45.93	8.33	.01121	6.161E-05	6.227E-05	7.764E-04
1.70	5.57	3.952F-01	6.349E-02	22.99	3.71	46.03	8.25	.01142	6.076E-05	6.142E-05	7.624E-04
1.68	5.74	3.912F-01	6.254E-02	22.70	3.68	46.12	8.17	.01165	5.985E-05	6.051E-05	7.484E-04
1.67	5.91	3.865F-01	6.149E-02	22.42	3.64	46.22	8.09	.01188	5.887E-05	5.953E-05	7.344E-04
			6.249E-02	22.13	3.60	46.32	8.00	.01213	5.782E-05	5.849E-05	7.195E-04

1.85	6.09	3.812E-01	6.223E-02	21.84	3.57	46.41	7.92	.01239	5.671E-05	5.737E-05	5.04E-04
1.64	6.29	3.762E-01	6.155E-02	21.55	3.53	46.50	7.83	.01266	5.552E-05	5.618E-05	6.85E-04
1.63	6.50	3.712E-01	6.099E-02	21.27	3.49	46.60	7.74	.01294	5.426E-05	5.492E-05	6.70E-04
1.61	6.72	3.661E-01	6.019E-02	20.94	3.45	46.69	7.66	.01323	5.292E-05	5.359E-05	6.55E-04
1.60	6.96	3.610E-01	5.950E-02	20.68	3.41	46.79	7.57	.01354	5.152E-05	5.218E-05	6.40E-04
1.59	7.22	3.558E-01	5.890E-02	20.39	3.37	46.87	7.48	.01386	5.033E-05	5.099E-05	6.25E-04
1.57	7.50	3.508E-01	5.839E-02	20.10	3.33	46.95	7.39	.01419	4.884E-05	4.912E-05	6.10E-04
1.56	7.60	3.458E-01	5.788E-02	19.81	3.29	47.04	7.30	.01454	4.683E-05	4.747E-05	5.95E-04
1.55	8.12	3.407E-01	5.667E-02	19.52	3.25	47.13	7.21	.01490	4.511E-05	4.575E-05	5.80E-04
1.54	8.48	3.357E-01	5.595E-02	19.23	3.21	47.21	7.12	.01528	4.331E-05	4.394E-05	5.63E-04
1.52	8.86	3.307E-01	5.524E-02	18.95	3.16	47.29	7.03	.01567	4.142E-05	4.204E-05	5.52E-04
1.51	9.29	3.257E-01	5.453E-02	18.66	3.12	47.37	6.94	.01607	3.946E-05	4.008E-05	5.37E-04
1.50	9.75	3.208E-01	5.392E-02	18.38	3.09	47.45	6.85	.01649	3.741E-05	3.803E-05	5.24E-04
1.49	10.26	3.161E-01	5.313E-02	18.11	3.04	47.52	6.76	.01692	3.528E-05	3.585E-05	5.10E-04
1.48	10.83	3.115E-01	5.245E-02	17.85	3.01	47.59	6.67	.01735	3.307E-05	3.362E-05	4.95E-04
1.47	11.47	3.070E-01	5.190E-02	17.59	2.97	47.66	6.59	.01779	3.079E-05	3.132E-05	4.77E-04
1.46	12.19	3.027E-01	5.117E-02	17.35	2.93	47.73	6.51	.01822	2.843E-05	2.892E-05	4.73E-04
1.44	13.00	2.988E-01	5.059E-02	17.12	2.90	47.78	6.44	.01863	2.600E-05	2.646E-05	4.63E-04
1.43	13.93	2.952E-01	5.005E-02	16.92	2.87	47.84	6.37	.01902	2.352E-05	2.394E-05	4.53E-04
1.42	15.00	2.922E-01	4.961E-02	16.74	2.84	47.88	6.31	.01936	2.098E-05	2.137E-05	4.45E-04
1.41	16.25	2.894E-01	4.926E-02	16.60	2.82	47.92	6.27	.01963	1.842E-05	1.877E-05	4.39E-04
1.40	17.73	2.869E-01	4.905E-02	16.52	2.81	47.94	6.24	.01982	1.595E-05	1.615E-05	4.35E-04
1.39	19.50	2.840E-01	4.902E-02	16.50	2.81	47.94	6.24	.01982	1.331E-05	1.356E-05	4.34E-04
1.38	21.67	2.819E-01	4.925E-02	16.58	2.82	47.92	6.27	.01964	1.082E-05	1.103E-05	4.30E-04
1.37	24.37	2.793E-01	4.915E-02	16.79	2.86	47.87	6.34	.01918	8.455E-06	8.609E-06	4.49E-04
1.36	27.86	3.001E-01	5.097E-02	17.19	2.92	47.77	6.48	.01836	6.256E-06	6.365E-06	4.69E-04

PROGRAM NONLIN--COLINEARLY PHASE MATCHED QPO

CINMARAR

PHASE MATCHING FOR POSITIVE DIFFRACTING CRYSTAL

PUMP WAVELENGTH(MICRONS)= 1.430

NONLINEAR COEFFICIENTS(K10 K12 M/V)= 50.000

CUTOFF WAVELENGTH= 30.000

RESULTS FOR TYPE I (E + E = 0) PHASE MATCHING ARE

SIGNAL	IDLER	THETA (RAD)	QNO (RAD)	THETA (DEG)	RHO (DEG)	0-EFF (*10.E12)	R	H(R)	GAIN/MATT (1CM)	GAIN/MATT (MAX)	AREA (SQ CM)
3.66	3.66	2.985E-01	4.924E-02	17.10	2.82	45.67	5.25	.02768	9.938E-05	1.028E-04	4.363E-04
3.51	3.71	2.985E-01	4.925E-02	17.10	2.82	45.68	5.26	.02768	9.931E-05	1.028E-04	4.364E-04
3.50	3.76	2.985E-01	4.925E-02	17.10	2.82	45.68	5.26	.02767	9.920E-05	1.018E-04	4.365E-04
3.52	3.81	2.984E-01	4.925E-02	17.10	2.82	45.68	5.26	.02768	9.904E-05	1.017E-04	4.364E-04
3.47	3.87	2.983E-01	4.924E-02	17.09	2.82	45.68	5.26	.02768	9.884E-05	1.015E-04	4.363E-04
3.43	3.92	2.981E-01	4.923E-02	17.08	2.82	45.69	5.26	.02770	9.858E-05	1.012E-04	4.361E-04
3.39	3.98	2.980E-01	4.921E-02	17.07	2.82	45.69	5.25	.02771	9.828E-05	1.009E-04	4.358E-04
3.35	4.04	2.978E-01	4.919E-02	17.06	2.82	45.70	5.25	.02774	9.793E-05	1.005E-04	4.355E-04
3.31	4.10	2.975E-01	4.917E-02	17.05	2.82	45.70	5.25	.02776	9.753E-05	1.001E-04	4.350E-04
3.27	4.16	2.973E-01	4.914E-02	17.03	2.82	45.71	5.25	.02780	9.708E-05	9.967E-05	4.345E-04
3.23	4.22	2.970E-01	4.910E-02	17.02	2.81	45.72	5.24	.02784	9.658E-05	9.917E-05	4.339E-04
3.19	4.29	2.967E-01	4.905E-02	17.00	2.81	45.73	5.24	.02788	9.604E-05	9.861E-05	4.332E-04
3.16	4.36	2.963E-01	4.902E-02	16.99	2.81	45.74	5.23	.02793	9.544E-05	9.801E-05	4.324E-04
3.12	4.43	2.959E-01	4.897E-02	16.96	2.81	45.75	5.23	.02798	9.480E-05	9.735E-05	4.315E-04
3.08	4.50	2.955E-01	4.892E-02	16.93	2.80	45.76	5.22	.02804	9.411E-05	9.665E-05	4.306E-04
3.05	4.57	2.951E-01	4.888E-02	16.91	2.80	45.77	5.22	.02810	9.337E-05	9.589E-05	4.296E-04
3.02	4.65	2.946E-01	4.884E-02	16.89	2.80	45.78	5.21	.02817	9.258E-05	9.509E-05	4.285E-04
2.95	4.73	2.941E-01	4.878E-02	16.85	2.79	45.80	5.20	.02825	9.174E-05	9.423E-05	4.274E-04
2.92	4.80	2.936E-01	4.865E-02	16.82	2.79	45.81	5.20	.02833	9.085E-05	9.333E-05	4.261E-04
2.89	4.99	2.925E-01	4.851E-02	16.76	2.78	45.84	5.19	.02850	8.991E-05	9.237E-05	4.248E-04
2.86	5.04	2.918E-01	4.843E-02	16.72	2.77	45.86	5.17	.02859	8.891E-05	9.137E-05	4.235E-04
2.83	5.18	2.912E-01	4.834E-02	16.69	2.77	45.88	5.16	.02869	8.789E-05	9.031E-05	4.220E-04
2.80	5.28	2.906E-01	4.825E-02	16.65	2.76	45.90	5.15	.02880	8.680E-05	8.928E-05	4.206E-04
2.77	5.38	2.899E-01	4.816E-02	16.61	2.76	45.91	5.14	.02891	8.567E-05	8.804E-05	4.190E-04
2.75	5.49	2.892E-01	4.805E-02	16.57	2.75	45.93	5.13	.02902	8.448E-05	8.683E-05	4.174E-04
2.72	5.60	2.885E-01	4.796E-02	16.53	2.75	45.95	5.12	.02912	8.324E-05	8.557E-05	4.157E-04
2.69	5.72	2.877E-01	4.786E-02	16.49	2.74	45.97	5.11	.02926	8.202E-05	8.429E-05	4.140E-04
2.67	5.84	2.870E-01	4.775E-02	16.44	2.74	45.99	5.10	.02939	8.081E-05	8.299E-05	4.122E-04
2.64	5.97	2.862E-01	4.764E-02	16.40	2.73	46.02	5.09	.02952	7.962E-05	8.167E-05	4.103E-04
2.61	6.10	2.854E-01	4.753E-02	16.35	2.72	46.04	5.07	.02965	7.846E-05	8.038E-05	4.084E-04
2.59	6.24	2.846E-01	4.742E-02	16.31	2.72	46.06	5.06	.02979	7.731E-05	7.911E-05	4.065E-04
2.57	6.38	2.838E-01	4.730E-02	16.26	2.71	46.08	5.05	.02993	7.617E-05	7.786E-05	4.046E-04
2.54	6.54	2.830E-01	4.719E-02	16.21	2.70	46.10	5.04	.03008	7.503E-05	7.660E-05	4.027E-04
2.52	6.70	2.821E-01	4.707E-02	16.16	2.70	46.12	5.02	.03022	7.389E-05	7.531E-05	4.008E-04

SIGNAL	IOLR	THETA (RAD)	RHO (DB)	THETA (DEG)	RHO (DEG)	0-EFF (*10.E12)	R	W(R)	GAIN/WATT (1CM)	GAIN/WATT (MAX)	AREA (SQ CM)
2.50	6.96	2.913F-01	4.695E-02	16.12	2.69	46.15	5.01	.03037	6.010E-05	7.009E-05	3.904E-04
2.47	7.04	2.805F-01	4.583E-02	16.07	2.68	46.17	5.00	.03052	6.631E-05	6.026E-05	3.946E-04
2.45	7.22	2.796F-01	4.671E-02	16.02	2.68	46.19	4.99	.03067	6.630E-05	6.630E-05	3.926E-04
2.43	7.42	2.788F-01	4.659E-02	15.97	2.67	46.21	4.97	.03083	6.250E-05	6.644E-05	3.907E-04
2.41	7.62	2.780F-01	4.648E-02	15.93	2.66	46.23	4.96	.03097	6.065E-05	6.246E-05	3.887E-04
2.39	7.84	2.772F-01	4.637E-02	15.88	2.66	46.26	4.95	.03112	5.866E-05	6.043E-05	3.868E-04
2.37	8.07	2.764F-01	4.626E-02	15.84	2.65	46.28	4.94	.03126	5.664E-05	5.834E-05	3.849E-04
2.35	8.32	2.757F-01	4.615E-02	15.79	2.64	46.30	4.93	.03140	5.456E-05	5.622E-05	3.830E-04
2.33	8.58	2.750F-01	4.605E-02	15.75	2.64	46.31	4.92	.03153	5.245E-05	5.404E-05	3.810E-04
2.31	8.85	2.743F-01	4.596F-02	15.72	2.63	46.33	4.91	.03166	5.029E-05	5.183E-05	3.791E-04
2.29	9.15	2.737F-01	4.588E-02	15.68	2.63	46.35	4.90	.03177	4.810E-05	4.957E-05	3.772E-04
2.27	9.47	2.732F-01	4.580E-02	15.65	2.62	46.36	4.89	.03187	4.586E-05	4.727E-05	3.753E-04
2.25	9.80	2.727F-01	4.574E-02	15.63	2.62	46.37	4.88	.03195	4.360E-05	4.494E-05	3.734E-04
2.23	10.17	2.724F-01	4.570E-02	15.61	2.62	46.38	4.88	.03205	4.130E-05	4.258E-05	3.715E-04
2.21	10.56	2.721F-01	4.567E-02	15.59	2.62	46.39	4.87	.03206	3.898E-05	4.019E-05	3.696E-04
2.20	10.99	2.720F-01	4.566E-02	15.59	2.62	46.39	4.87	.03204	3.664E-05	3.778E-05	3.677E-04
2.18	11.44	2.721F-01	4.566E-02	15.59	2.62	46.39	4.88	.03204	3.428E-05	3.535E-05	3.658E-04
2.16	11.93	2.723F-01	4.572F-02	15.60	2.62	46.38	4.88	.03197	3.192E-05	3.298E-05	3.639E-04
2.14	12.48	2.727F-01	4.580E-02	15.63	2.62	46.37	4.89	.03187	2.955E-05	3.046E-05	3.620E-04
2.13	13.07	2.735F-01	4.592E-02	15.67	2.63	46.35	4.90	.03171	2.719E-05	2.802E-05	3.599E-04
2.11	13.72	2.745E-01	4.609E-02	15.73	2.64	46.33	4.92	.03148	2.484E-05	2.559E-05	3.580E-04
2.10	14.45	2.758F-01	4.631E-02	15.80	2.65	46.29	4.94	.03119	2.252E-05	2.320E-05	3.561E-04
2.08	15.25	2.776F-01	4.660E-02	15.91	2.67	46.24	4.97	.03082	2.023E-05	2.084E-05	3.542E-04
2.06	16.15	2.799F-01	4.696E-02	16.04	2.69	46.18	5.01	.03036	1.800E-05	1.853E-05	3.523E-04
2.05	17.16	2.829F-01	4.742E-02	16.21	2.72	46.11	5.06	.02979	1.583E-05	1.628E-05	3.504E-04
2.03	18.30	2.855F-01	4.799E-02	16.42	2.75	46.01	5.12	.02910	1.374E-05	1.412E-05	3.485E-04
2.02	19.61	2.911E-01	4.870E-02	16.68	2.79	45.88	5.20	.02828	1.174E-05	1.206E-05	3.466E-04
2.00	21.12	2.968F-01	4.958E-02	17.00	2.84	45.72	5.29	.02732	9.851E-06	1.011E-05	3.447E-04
1.99	22.87	3.039F-01	5.067E-02	17.41	2.90	45.52	5.41	.02618	8.092E-06	8.295E-06	3.428E-04
1.97	24.95	3.129F-01	5.202E-02	17.93	2.98	45.26	5.55	.02487	6.478E-06	6.632E-06	3.409E-04
1.96	27.45	3.243F-01	5.372E-02	18.58	3.08	44.92	5.74	.02335	5.024E-06	5.136E-06	3.390E-04

RESULTS FOR TYPE II (O + E = 0) PHASE MATCHING ARE

2.98	4.73	4.822F-01	7.326F-02	27.63	4.20	44.30	7.82	.01269	3.855E-05	3.901E-05	9.650E-04
2.99	4.82	4.855E-01	7.365E-02	27.84	4.22	44.21	7.86	.01255	3.750E-05	3.795E-05	9.761E-04
2.92	4.90	4.896F-01	7.414E-02	28.05	4.24	44.13	7.90	.01242	3.695E-05	3.690E-05	9.869E-04
2.89	4.99	4.934F-01	7.444E-02	28.27	4.27	44.04	7.95	.01229	3.539E-05	3.580E-05	9.971E-04
2.86	5.08	4.973F-01	7.484E-02	28.49	4.29	43.94	7.99	.01216	3.472E-05	3.472E-05	1.009E-03
2.83	5.18	5.013F-01	7.524E-02	28.72	4.31	43.85	8.03	.01203	3.326E-05	3.364E-05	1.019E-03
2.80	5.28	5.053F-01	7.565E-02	28.95	4.33	43.75	8.03	.01191	3.219E-05	3.255E-05	1.038E-03
2.77	5.34	5.095F-01	7.617E-02	29.19	4.36	43.65	8.12	.01178	3.111E-05	3.146E-05	1.058E-03
2.75	5.49	5.134F-01	7.664E-02	29.44	4.38	43.54	8.17	.01165	3.004E-05	3.037E-05	1.078E-03
2.72	5.60	5.182F-01	7.691E-02	29.69	4.41	43.44	8.21	.01152	2.896E-05	2.932E-05	1.098E-03
2.69	5.72	5.227F-01	7.734E-02	29.95	4.43	43.32	8.26	.01140	2.789E-05	2.819E-05	1.078E-03
2.67	5.84	5.274F-01	7.777E-02	30.22	4.46	43.21	8.30	.01127	2.642E-05	2.682E-05	1.060E-03
2.64	5.97	5.322F-01	7.822E-02	30.49	4.48	43.08	8.35	.01115	2.575E-05	2.602E-05	1.041E-03
2.61	6.10	5.372F-01	7.867E-02	30.74	4.51	42.96	8.40	.01102	2.469E-05	2.495E-05	1.018E-03
2.59	6.24	5.423F-01	7.913E-02	31.07	4.53	42.83	8.45	.01089	2.364E-05	2.380E-05	1.027E-03
2.57	6.38	5.477F-01	7.959E-02	31.38	4.56	42.69	8.50	.01077	2.259E-05	2.282E-05	1.048E-03
2.54	6.54	5.532F-01	8.017E-02	31.70	4.59	42.54	8.55	.01064	2.155E-05	2.177E-05	1.154E-03
2.52	6.70	5.590E-01	8.055E-02	32.03	4.62	42.39	8.60	.01052	2.052E-05	2.073E-05	1.169E-03
2.50	6.86	5.651F-01	8.105E-02	32.38	4.64	42.23	8.65	.01039	1.950E-05	1.970E-05	1.182E-03
2.47	7.04	5.714F-01	8.155E-02	32.74	4.67	42.06	8.71	.01026	1.860E-05	1.880E-05	1.197E-03
2.45	7.22	5.781F-01	8.207E-02	33.12	4.70	41.88	8.76	.01013	1.751E-05	1.767E-05	1.212E-03
2.43	7.42	5.851F-01	8.259E-02	33.52	4.73	41.68	8.82	.01001	1.653E-05	1.669E-05	1.227E-03
2.41	7.62	5.925F-01	8.313E-02	33.95	4.76	41.48	8.87	.00988	1.557E-05	1.571E-05	1.244E-03
2.39	7.84	6.003F-01	8.368E-02	34.40	4.79	41.26	8.93	.00975	1.462E-05	1.476E-05	1.269E-03
2.37	8.07	6.085F-01	8.424E-02	34.87	4.83	41.02	8.99	.00962	1.370E-05	1.382E-05	1.277E-03
2.35	8.32	6.175F-01	8.481E-02	35.34	4.86	40.77	9.05	.00950	1.279E-05	1.291E-05	1.294E-03
2.33	8.58	6.270F-01	8.539E-02	35.82	4.89	40.45	9.12	.00937	1.191E-05	1.201E-05	1.312E-03
2.31	8.85	6.372F-01	8.598E-02	36.31	4.93	40.19	9.18	.00924	1.105E-05	1.114E-05	1.330E-03
2.29	9.15	6.482F-01	8.657E-02	37.14	4.96	39.86	9.24	.00912	1.021E-05	1.030E-05	1.349E-03
2.27	9.47	6.601F-01	8.716E-02	37.82	4.99	39.50	9.31	.00899	9.395E-06	9.475E-06	1.367E-03
2.25	9.80	6.730E-01	8.775E-02	38.56	5.03	39.10	9.37	.00886	8.609E-06	8.681E-06	1.386E-03
2.23	10.17	6.872F-01	8.832E-02	39.37	5.06	38.65	9.43	.00876	7.915E-06	7.915E-06	1.404E-03
2.21	10.56	7.028F-01	8.897E-02	40.27	5.09	38.15	9.49	.00865	7.121E-06	7.179E-06	1.421E-03
2.20	10.98	7.200F-01	8.937E-02	41.25	5.12	37.59	9.54	.00856	6.422E-06	6.474E-06	1.437E-03
2.18	11.44	7.392F-01	8.991E-02	42.35	5.15	36.95	9.59	.00848	5.755E-06	5.801E-06	1.451E-03
2.16	11.93	7.602F-01	9.013E-02	43.59	5.16	36.22	9.62	.00842	5.122E-06	5.162E-06	1.462E-03
2.14	12.48	7.852F-01	9.029E-02	44.99	5.17	35.36	9.64	.00839	4.523E-06	4.554E-06	1.467E-03
2.13	13.07	8.131F-01	9.020E-02	46.59	5.17	34.36	9.63	.00840	3.991E-06	3.991E-06	1.464E-03
2.11	13.72	8.455F-01	9.075E-02	48.44	5.14	33.17	9.58	.00849	3.433E-06	3.460E-06	1.449E-03
2.10	14.45	8.836F-01	9.172E-02	50.87	5.08	31.72	9.47	.00868	2.944E-06	2.964E-06	1.416E-03
2.08	15.25	9.292F-01	9.279E-02	53.24	4.97	29.92	9.27	.00907	2.494E-06	2.515E-06	1.355E-03
2.06	16.15	9.857F-01	9.342E-02	56.46	4.78	27.63	8.91	.00981	2.042E-06	2.102E-06	1.252E-03
2.05	17.16	1.057F+00	7.755E-02	60.57	4.44	24.57	8.28	.01134	1.710E-06	1.729E-06	1.082E-03
2.03	18.30	1.156F+00	6.699E-02	66.22	3.83	20.16	7.24	.01518	1.376E-06	1.396E-06	8.052E-04
2.02	19.61	1.316E+00	4.423E-02	75.40	2.53	12.61	4.72	.03410	1.068E-06	1.104E-06	3.521E-04

PHASE MATCHING CUTS OFF AT SIGNAL= 2.004 AND TOLER= 21.115

PHASE MATCHING CUTS OFF AT SIGNAL= 1.999 AND TOLER= 22.875

PHASE MATCHING CUTS OFF AT SIGNAL= 1.975 AND TOLER= 24.955

PHASE MATCHING CUTS OFF AT SIGNAL= 1.951 AND TOLER= 27.450

RESULTS FOR TYPE II (E + 0 = 0) PHASE MATCHING ARE

SIGNAL	ISLER	THETA (°)	PHO (°)	THETA (°)	PHO (°)	D-EFF (°10.E12)	R	WIR	GAIN/MATT (10M)	GAIN/MATT (10M)	AREA (100 CM)
3.66	3.66	4.264F-01	6.691E-02	24.43	3.03	45.52	7.14	.01517	5.410E-05	5.410E-05	0.050E-04
3.61	3.71	4.234F-01	6.655E-02	24.26	3.81	45.54	7.10	.01534	5.402E-05	5.402E-05	7.960E-04
3.56	3.76	4.204F-01	6.619E-02	24.09	3.79	45.65	7.07	.01551	5.515E-05	5.515E-05	7.651E-04
3.52	3.81	4.174F-01	6.581E-02	23.92	3.77	45.71	7.03	.01568	5.617E-05	5.617E-05	7.794E-04
3.47	3.87	4.145F-01	6.545E-02	23.75	3.75	45.77	6.99	.01585	5.690E-05	5.690E-05	7.787E-04
3.43	3.92	4.115E-01	6.519E-02	23.59	3.73	45.83	6.95	.01603	5.748E-05	5.748E-05	7.621E-04
3.39	3.98	4.086F-01	6.471E-02	23.41	3.71	45.84	6.91	.01621	5.796E-05	5.796E-05	7.535E-04
3.35	4.04	4.056F-01	6.434E-02	23.24	3.69	45.84	6.87	.01639	5.849E-05	5.849E-05	7.458E-04
3.31	4.10	4.027F-01	6.399E-02	23.07	3.67	46.00	6.83	.01657	5.899E-05	5.899E-05	7.325E-04
3.27	4.16	3.999F-01	6.361E-02	22.91	3.64	46.06	6.79	.01676	5.944E-05	5.944E-05	7.197E-04
3.23	4.22	3.969F-01	6.324E-02	22.74	3.62	46.11	6.75	.01696	5.986E-05	5.986E-05	7.113E-04
3.19	4.29	3.941F-01	6.297E-02	22.58	3.60	46.17	6.71	.01715	6.033E-05	6.033E-05	7.030E-04
3.16	4.36	3.912F-01	6.259E-02	22.41	3.58	46.22	6.67	.01735	6.077E-05	6.077E-05	6.946E-04
3.12	4.43	3.883F-01	6.217E-02	22.25	3.56	46.28	6.63	.01756	6.122E-05	6.122E-05	6.864E-04
3.08	4.50	3.855F-01	6.176E-02	22.09	3.54	46.33	6.59	.01777	6.168E-05	6.168E-05	6.782E-04
3.05	4.57	3.826F-01	6.139E-02	21.92	3.52	46.38	6.55	.01798	6.215E-05	6.215E-05	6.700E-04
3.02	4.65	3.798F-01	6.102E-02	21.76	3.50	46.44	6.51	.01819	6.262E-05	6.262E-05	6.618E-04
2.98	4.73	3.770F-01	6.065E-02	21.60	3.47	46.49	6.47	.01841	6.310E-05	6.310E-05	6.537E-04
2.95	4.82	3.742E-01	6.028E-02	21.44	3.45	46.54	6.43	.01864	6.358E-05	6.358E-05	6.457E-04
2.92	4.90	3.714F-01	5.990E-02	21.28	3.43	46.59	6.40	.01887	6.406E-05	6.406E-05	6.377E-04
2.89	4.99	3.686F-01	5.953E-02	21.12	3.41	46.64	6.36	.01910	6.454E-05	6.454E-05	6.297E-04
2.86	5.08	3.658F-01	5.916E-02	20.96	3.39	46.69	6.32	.01934	6.502E-05	6.502E-05	6.217E-04
2.83	5.18	3.630F-01	5.879E-02	20.80	3.37	46.74	6.28	.01958	6.550E-05	6.550E-05	6.137E-04
2.80	5.28	3.603F-01	5.841E-02	20.64	3.35	46.79	6.24	.01982	6.598E-05	6.598E-05	6.057E-04
2.77	5.38	3.575F-01	5.804E-02	20.48	3.33	46.84	6.20	.02006	6.646E-05	6.646E-05	5.977E-04
2.75	5.49	3.548F-01	5.766E-02	20.33	3.30	46.89	6.15	.02033	6.694E-05	6.694E-05	5.897E-04
2.72	5.60	3.521F-01	5.729E-02	20.17	3.28	46.94	6.12	.02059	6.742E-05	6.742E-05	5.817E-04
2.69	5.72	3.494F-01	5.692E-02	20.02	3.26	46.99	6.08	.02086	6.790E-05	6.790E-05	5.737E-04
2.67	5.84	3.467F-01	5.654E-02	19.86	3.24	47.03	6.04	.02113	6.838E-05	6.838E-05	5.657E-04
2.64	5.97	3.440F-01	5.617E-02	19.71	3.22	47.07	6.00	.02140	6.886E-05	6.886E-05	5.577E-04
2.61	6.10	3.413F-01	5.580E-02	19.56	3.20	47.12	5.96	.02168	6.934E-05	6.934E-05	5.497E-04
2.59	6.24	3.386F-01	5.543E-02	19.40	3.19	47.16	5.92	.02197	6.982E-05	6.982E-05	5.417E-04
2.57	6.38	3.360F-01	5.506E-02	19.25	3.15	47.20	5.88	.02225	7.030E-05	7.030E-05	5.337E-04
2.54	6.54	3.334F-01	5.470E-02	19.10	3.13	47.25	5.84	.02253	7.078E-05	7.078E-05	5.257E-04
2.52	6.70	3.308F-01	5.434E-02	18.96	3.11	47.29	5.80	.02284	7.126E-05	7.126E-05	5.177E-04
2.50	6.86	3.283F-01	5.398E-02	18.81	3.09	47.33	5.76	.02314	7.174E-05	7.174E-05	5.097E-04
2.47	7.04	3.257F-01	5.362E-02	18.67	3.07	47.37	5.72	.02344	7.222E-05	7.222E-05	5.017E-04
2.45	7.22	3.233F-01	5.327E-02	18.52	3.05	47.41	5.69	.02375	7.270E-05	7.270E-05	4.937E-04
2.43	7.42	3.208F-01	5.292E-02	18.39	3.03	47.45	5.65	.02406	7.318E-05	7.318E-05	4.857E-04
2.41	7.62	3.184F-01	5.257E-02	18.25	3.01	47.49	5.61	.02436	7.366E-05	7.366E-05	4.777E-04
2.39	7.84	3.161F-01	5.224E-02	18.11	2.99	47.52	5.58	.02467	7.414E-05	7.414E-05	4.697E-04
2.37	8.07	3.138E-01	5.191E-02	17.99	2.97	47.56	5.54	.02498	7.462E-05	7.462E-05	4.617E-04
2.35	8.32	3.115F-01	5.158E-02	17.85	2.96	47.59	5.51	.02529	7.510E-05	7.510E-05	4.537E-04
2.33	8.58	3.093F-01	5.127E-02	17.73	2.94	47.63	5.47	.02559	7.558E-05	7.558E-05	4.457E-04
2.31	8.85	3.071F-01	5.097E-02	17.61	2.92	47.66	5.44	.02593	7.606E-05	7.606E-05	4.377E-04
2.29	9.15	3.053F-01	5.065E-02	17.49	2.90	47.69	5.41	.02618	7.654E-05	7.654E-05	4.297E-04
2.27	9.47	3.035F-01	5.040E-02	17.38	2.89	47.72	5.38	.02646	7.702E-05	7.702E-05	4.217E-04
2.25	9.80	3.015F-01	5.014E-02	17.29	2.87	47.74	5.35	.02673	7.750E-05	7.750E-05	4.137E-04
2.23	10.17	2.999F-01	4.990E-02	17.18	2.86	47.77	5.33	.02698	7.798E-05	7.798E-05	4.057E-04
2.21	10.56	2.983F-01	4.967E-02	17.09	2.85	47.79	5.30	.02722	7.846E-05	7.846E-05	3.977E-04

2.28	10.96	2.949F-01	17.81	2.83	67.81	5.24	.02743	3.338E-05	3.618E-05	4.489E-04
2.18	11.44	2.957F-01	16.95	2.83	67.83	5.26	.02761	3.151E-05	3.229E-05	4.379E-04
2.16	11.93	2.968F-01	16.49	2.82	67.84	5.25	.02776	2.949E-05	3.027E-05	4.358E-04
2.14	12.48	2.980F-01	16.05	2.81	67.85	5.24	.02788	2.753E-05	2.827E-05	4.332E-04
2.13	12.97	2.936F-01	16.02	2.81	67.85	5.23	.02794	2.554E-05	2.623E-05	4.322E-04
2.11	13.72	2.936F-01	16.01	2.81	67.86	5.23	.02795	2.354E-05	2.417E-05	4.320E-04
2.10	14.45	2.937F-01	16.03	2.81	67.86	5.24	.02798	2.153E-05	2.218E-05	4.329E-04
2.08	15.25	2.944F-01	16.07	2.82	67.85	5.25	.02777	1.952E-05	2.044E-05	4.349E-04
2.06	16.15	2.956F-01	16.94	2.83	67.83	5.27	.02755	1.753E-05	1.799E-05	4.384E-04
2.05	17.16	2.975F-01	17.04	2.84	67.77	5.30	.02724	1.545E-05	1.597E-05	4.430E-04
2.03	18.30	3.080F-01	17.19	2.87	67.71	5.34	.02682	1.364E-05	1.399E-05	4.508E-04
2.02	19.61	3.035F-01	17.34	2.86	67.71	5.48	.02626	1.179E-05	1.280E-05	4.608E-04
2.00	21.12	3.082F-01	17.65	2.94	67.64	5.48	.02556	1.081E-05	1.025E-05	4.735E-04
1.99	22.87	3.162F-01	19.00	2.99	67.55	5.57	.02470	8.329E-06	8.526E-06	4.984E-04
1.97	24.95	3.220F-01	19.45	3.06	67.43	5.70	.02365	6.765E-06	6.918E-06	5.184E-04
1.96	27.65	3.321F-01	19.83	3.14	67.27	5.86	.02248	5.339E-06	5.458E-06	5.419E-04

PROGRAM NONLIN--COLLINEARLY PHASE MATCHED OPO

CINMARAR

PHASE MATCHING FOR POSITIVE BIREFRINGENT CRYSTAL

PUMP WAVELENGTH(MICRONS)= 2.100

NONLINEAR COEFFICIENTS(X10 F12 M/V)= 50.000

CUTOFF WAVELENGTH= 30.000

RESULTS FOR TYPE Y (E + F = 0) PHASE MATCHING ARE

SIGNAL	IDLER	THETA (DEG)	RMQ (RAD)	THETA (DEG)	RMQ (DEG)	n-EFF (*10.E12)	Q	NCN	GAIN/WATT (1CM)	GAIN/WATT (MAX)	AREA (SQ CM)
4.20	4.20	2.759F-01	4.573E-02	15.81	2.52	46.29	4.55	.03668	8.967E-05	9.289E-05	3.760E-04
4.14	4.26	2.759F-01	4.574E-02	15.81	2.62	46.29	4.55	.03658	8.961E-05	9.279E-05	3.761E-04
4.09	4.32	2.759F-01	4.574E-02	15.81	2.62	46.29	4.55	.03658	8.958E-05	9.267E-05	3.762E-04
4.04	4.38	2.759F-01	4.575E-02	15.80	2.62	46.29	4.55	.03657	8.933E-05	9.250E-05	3.762E-04
3.99	4.44	2.759F-01	4.575E-02	15.80	2.62	46.29	4.55	.03657	8.912E-05	9.228E-05	3.762E-04
3.94	4.50	2.757F-01	4.574F-02	15.80	2.62	46.29	4.55	.03658	8.895E-05	9.200E-05	3.762E-04
3.89	4.57	2.756F-01	4.574E-02	15.79	2.62	46.30	4.55	.03659	8.854E-05	9.168E-05	3.761E-04
3.84	4.63	2.754F-01	4.573E-02	15.79	2.62	46.30	4.55	.03660	8.817E-05	9.130E-05	3.759E-04
3.80	4.70	2.754F-01	4.572E-02	15.78	2.62	46.30	4.55	.03662	8.775E-05	9.086E-05	3.758E-04
3.75	4.77	2.752F-01	4.571E-02	15.77	2.62	46.31	4.55	.03664	8.727E-05	9.037E-05	3.755E-04
3.71	4.85	2.751F-01	4.569E-02	15.76	2.62	46.31	4.55	.03666	8.679E-05	8.983E-05	3.753E-04
3.66	4.92	2.749F-01	4.567E-02	15.75	2.62	46.32	4.55	.03669	8.610E-05	8.924E-05	3.750E-04
3.62	5.00	2.747F-01	4.565E-02	15.74	2.62	46.32	4.54	.03672	8.555E-05	8.860E-05	3.746E-04
3.58	5.08	2.745E-01	4.563E-02	15.73	2.61	46.33	4.54	.03676	8.487E-05	8.790E-05	3.743E-04
3.54	5.16	2.743E-01	4.561E-02	15.72	2.61	46.33	4.54	.03680	8.414E-05	8.714E-05	3.739E-04
3.50	5.25	2.741F-01	4.559E-02	15.70	2.61	46.34	4.54	.03684	8.336E-05	8.634E-05	3.734E-04
3.46	5.34	2.739F-01	4.554E-02	15.69	2.61	46.34	4.53	.03689	8.253E-05	8.548E-05	3.729E-04
3.42	5.43	2.736F-01	4.551E-02	15.68	2.61	46.35	4.53	.03693	8.165E-05	8.457E-05	3.724E-04
3.39	5.53	2.733F-01	4.549E-02	15.66	2.61	46.36	4.53	.03698	8.072E-05	8.361E-05	3.719E-04
3.35	5.62	2.731F-01	4.546E-02	15.65	2.60	46.36	4.52	.03704	7.973E-05	8.268E-05	3.713E-04
3.32	5.73	2.728F-01	4.544E-02	15.63	2.60	46.37	4.52	.03709	7.878E-05	8.153E-05	3.708E-04
3.29	5.83	2.725F-01	4.538E-02	15.61	2.60	46.38	4.52	.03715	7.761E-05	8.041E-05	3.702E-04
3.25	5.94	2.722F-01	4.531E-02	15.60	2.60	46.39	4.51	.03721	7.640E-05	7.924E-05	3.696E-04
3.21	6.06	2.719F-01	4.530E-02	15.58	2.60	46.39	4.51	.03727	7.529E-05	7.822E-05	3.689E-04
3.18	6.18	2.716F-01	4.526E-02	15.56	2.59	46.40	4.51	.03733	7.406E-05	7.694E-05	3.682E-04
3.15	6.30	2.713F-01	4.522E-02	15.55	2.59	46.41	4.50	.03740	7.278E-05	7.562E-05	3.677E-04
3.12	6.43	2.710F-01	4.519E-02	15.53	2.59	46.42	4.50	.03746	7.144E-05	7.430E-05	3.670E-04
3.09	6.56	2.707E-01	4.514F-02	15.51	2.59	46.42	4.49	.03752	7.006E-05	7.281E-05	3.664E-04
3.06	6.70	2.704F-01	4.510E-02	15.49	2.58	46.43	4.49	.03758	6.863E-05	7.114E-05	3.657E-04
3.03	6.85	2.701F-01	4.507E-02	15.48	2.58	46.44	4.49	.03764	6.719E-05	6.961E-05	3.651E-04
3.00	7.00	2.698F-01	4.503E-02	15.46	2.58	46.45	4.48	.03770	6.563E-05	6.803E-05	3.645E-04
2.97	7.16	2.696F-01	4.500E-02	15.44	2.58	46.45	4.48	.03776	6.406E-05	6.641E-05	3.640E-04
2.94	7.33	2.693F-01	4.496E-02	15.43	2.58	46.45	4.48	.03781	6.249E-05	6.474E-05	3.635E-04
2.92	7.50	2.691E-01	4.493E-02	15.42	2.57	46.47	4.47	.03786	6.079E-05	6.302E-05	3.630E-04
2.89	7.68	2.688F-01	4.491E-02	15.40	2.57	46.47	4.47	.03790	5.908E-05	6.126E-05	3.624E-04

2.86	7.87	2.687E-01	4.489E-02	15.39	2.57	46.48	4.67	.03794	5.734E-05	5.945E-05	3.822E-04
2.84	8.08	2.687E-01	4.487E-02	15.34	2.57	46.44	4.47	.03797	5.555E-05	5.768E-05	3.619E-04
2.81	8.29	2.684E-01	4.485E-02	15.38	2.57	46.48	4.47	.03798	5.373E-05	5.571E-05	3.617E-04
2.79	8.51	2.683E-01	4.485E-02	15.37	2.57	46.43	4.47	.03799	5.187E-05	5.378E-05	3.617E-04
2.76	8.75	2.687E-01	4.485E-02	15.37	2.57	46.49	4.47	.03799	4.997E-05	5.181E-05	3.617E-04
2.74	9.00	2.687E-01	4.487E-02	15.37	2.57	46.43	4.47	.03797	4.804E-05	4.981E-05	3.619E-04
2.72	9.25	2.684E-01	4.485E-02	15.38	2.57	46.44	4.47	.03793	4.608E-05	4.778E-05	3.623E-04
2.69	9.55	2.686E-01	4.492E-02	15.39	2.57	46.44	4.47	.03784	4.429E-05	4.571E-05	3.628E-04
2.67	9.84	2.684E-01	4.497E-02	15.40	2.58	46.47	4.48	.03761	4.208E-05	4.362E-05	3.639E-04
2.65	10.16	2.681E-01	4.518E-02	15.42	2.58	46.46	4.48	.03771	4.046E-05	4.151E-05	3.645E-04
2.63	10.50	2.684E-01	4.510E-02	15.45	2.58	46.45	4.48	.03759	3.799E-05	3.938E-05	3.657E-04
2.60	10.86	2.702E-01	4.520E-02	15.48	2.59	46.46	4.50	.03743	3.593E-05	3.723E-05	3.673E-04
2.58	11.25	2.709E-01	4.535E-02	15.52	2.60	46.42	4.51	.03725	3.385E-05	3.507E-05	3.719E-04
2.56	11.67	2.717E-01	4.546E-02	15.57	2.60	46.40	4.51	.03782	3.177E-05	3.291E-05	3.719E-04
2.54	12.12	2.728E-01	4.563E-02	15.63	2.61	46.37	4.54	.03676	2.969E-05	3.075E-05	3.743E-04
2.52	12.60	2.748E-01	4.581E-02	15.70	2.63	46.34	4.56	.03645	2.762E-05	2.868E-05	3.776E-04
2.50	13.12	2.789E-01	4.605E-02	15.79	2.64	46.30	4.59	.03689	2.557E-05	2.666E-05	3.819E-04
2.48	13.70	2.793E-01	4.634E-02	15.89	2.66	46.25	4.61	.03567	2.353E-05	2.439E-05	3.861E-04
2.46	14.32	2.73E-01	4.657E-02	16.01	2.67	46.20	4.65	.03519	2.153E-05	2.226E-05	3.919E-04
2.44	15.00	2.814E-01	4.705E-02	16.14	2.70	46.13	4.68	.03465	1.956E-05	2.021E-05	3.979E-04
2.42	15.75	2.866E-01	4.749E-02	16.31	2.72	46.06	4.73	.03482	1.763E-05	1.822E-05	4.054E-04
2.40	16.58	2.879E-01	4.800E-02	16.50	2.75	45.97	4.78	.03332	1.577E-05	1.627E-05	4.142E-04
2.39	17.50	2.918E-01	4.850E-02	16.72	2.78	45.86	4.84	.03253	1.396E-05	1.448E-05	4.246E-04
2.37	18.53	2.993E-01	4.929E-02	16.99	2.82	45.74	4.91	.03165	1.223E-05	1.261E-05	4.368E-04
2.35	19.69	3.017E-01	5.010E-02	17.28	2.87	45.59	4.99	.03166	1.059E-05	1.098E-05	4.519E-04
2.33	21.00	3.079E-01	5.105E-02	17.64	2.93	45.41	5.09	.02956	9.033E-06	9.298E-06	4.688E-04
2.32	22.50	3.144E-01	5.217E-02	18.07	2.99	45.19	5.19	.02834	7.544E-06	7.791E-06	4.893E-04
2.30	24.23	3.233E-01	5.349E-02	18.58	3.06	44.92	5.32	.02788	6.246E-06	6.489E-06	5.144E-04
2.28	26.25	3.350E-01	5.506E-02	19.19	3.15	44.60	5.48	.02552	5.029E-06	5.153E-06	5.451E-04
2.27	28.64	3.441E-01	5.695E-02	19.95	3.26	44.18	5.67	.02388	3.939E-06	4.038E-06	5.822E-04

RESULTS FOR TYPE II (O + E = 0) PHASE MATCHING ARE

SIGNAL	IDLER	THETA (RAD)	PHO (RAD)	THETA (DEG)	KHO (DEG)	D-FFF ('19.E12)	R	MMI	GAIN/WATT (IC4)	GAIN/WATT (MAX)	AREA ISO CM
4.28	4.20	3.935E-01	6.254E-02	22.55	3.58	46.18	6.23	.01989	4.849E-05	4.941E-05	7.832E-04
4.14	4.26	3.967E-01	6.290E-02	22.71	3.68	46.12	6.26	.01966	4.783E-05	4.872E-05	7.112E-04
4.09	4.32	3.991E-01	6.325E-02	22.87	3.62	46.07	6.30	.01943	4.713E-05	4.801E-05	7.192E-04
4.04	4.38	4.020E-01	6.362E-02	23.03	3.64	46.01	6.33	.01923	4.641E-05	4.726E-05	7.278E-04
3.99	4.44	4.049E-01	6.398E-02	23.20	3.67	45.96	6.37	.01902	4.567E-05	4.649E-05	7.359E-04
3.94	4.50	4.078E-01	6.435E-02	23.37	3.69	45.90	6.41	.01880	4.498E-05	4.578E-05	7.444E-04
3.89	4.57	4.109E-01	6.472E-02	23.54	3.71	45.84	6.44	.01859	4.418E-05	4.488E-05	7.538E-04
3.84	4.63	4.139E-01	6.509E-02	23.71	3.73	45.79	6.48	.01838	4.329E-05	4.405E-05	7.617E-04
3.80	4.70	4.170E-01	6.547E-02	23.89	3.75	45.72	6.52	.01817	4.249E-05	4.319E-05	7.708E-04
3.75	4.77	4.201E-01	6.584E-02	24.07	3.77	45.65	6.56	.01797	4.168E-05	4.231E-05	7.796E-04
3.71	4.85	4.233E-01	6.624E-02	24.25	3.80	45.59	6.59	.01776	4.072E-05	4.141E-05	7.888E-04
3.66	4.92	4.264E-01	6.663E-02	24.44	3.82	45.52	6.63	.01756	3.983E-05	4.058E-05	7.981E-04
3.62	5.00	4.299E-01	6.702E-02	24.63	3.84	45.45	6.67	.01736	3.893E-05	3.957E-05	8.078E-04
3.58	5.08	4.333E-01	6.742E-02	24.82	3.86	45.39	6.71	.01715	3.801E-05	3.863E-05	8.178E-04
3.54	5.16	4.367E-01	6.783E-02	25.02	3.89	45.31	6.75	.01695	3.707E-05	3.767E-05	8.271E-04
3.50	5.25	4.402E-01	6.824E-02	25.22	3.91	45.23	6.79	.01675	3.612E-05	3.678E-05	8.372E-04
3.46	5.34	4.438E-01	6.865E-02	25.43	3.93	45.16	6.83	.01655	3.516E-05	3.572E-05	8.474E-04
3.42	5.43	4.475E-01	6.908E-02	25.64	3.96	45.08	6.88	.01635	3.428E-05	3.473E-05	8.579E-04

3.39	5.53	4.513F-01	6.951F-02	25.86	3.98	44.99	6.92	.01616	3.322E-05	3.373E-05	0.600E-04
3.35	5.62	4.552F-01	6.994F-02	26.09	4.01	44.91	6.96	.01596	3.223E-05	3.272E-05	0.799E-04
3.32	5.73	4.591F-01	7.039F-02	26.31	4.03	44.82	7.01	.01576	3.124E-05	3.171E-05	0.987E-04
3.28	5.83	4.632F-01	7.084F-02	26.54	4.06	44.73	7.05	.01556	3.025E-05	3.069E-05	0.119E-04
3.25	5.94	4.674F-01	7.132E-02	26.78	4.08	44.64	7.10	.01537	2.925E-05	2.967E-05	0.139E-04
3.21	6.06	4.718F-01	7.176E-02	27.03	4.11	44.54	7.14	.01517	2.824E-05	2.865E-05	0.159E-04
3.18	6.18	4.763F-01	7.224E-02	27.29	4.14	44.44	7.19	.01497	2.724E-05	2.763E-05	0.179E-04
3.15	6.30	4.809F-01	7.273E-02	27.55	4.17	44.33	7.24	.01478	2.623E-05	2.660E-05	0.198E-04
3.12	6.43	4.857F-01	7.323E-02	27.81	4.20	44.22	7.29	.01458	2.523E-05	2.558E-05	0.218E-04
3.09	6.56	4.906F-01	7.374E-02	28.11	4.22	44.10	7.34	.01438	2.423E-05	2.456E-05	0.237E-04
3.06	6.70	4.956F-01	7.426E-02	28.41	4.25	43.98	7.39	.01418	2.323E-05	2.355E-05	0.256E-04
3.03	6.85	5.011F-01	7.479E-02	28.71	4.29	43.85	7.45	.01398	2.224E-05	2.254E-05	0.275E-04
2.97	7.16	5.067F-01	7.533E-02	29.03	4.32	43.72	7.50	.01378	2.125E-05	2.153E-05	0.294E-04
2.94	7.33	5.125F-01	7.589E-02	29.37	4.35	43.58	7.56	.01358	2.025E-05	2.054E-05	0.313E-04
2.92	7.50	5.184F-01	7.647E-02	29.72	4.38	43.43	7.61	.01338	1.925E-05	1.952E-05	0.332E-04
2.89	7.68	5.243F-01	7.706E-02	30.08	4.42	43.27	7.67	.01318	1.825E-05	1.850E-05	0.351E-04
2.86	7.87	5.302F-01	7.766E-02	30.45	4.45	43.10	7.73	.01298	1.725E-05	1.748E-05	0.370E-04
2.84	8.08	5.362F-01	7.826E-02	30.83	4.49	42.92	7.79	.01278	1.625E-05	1.647E-05	0.389E-04
2.81	8.29	5.422F-01	7.886E-02	31.21	4.52	42.73	7.86	.01257	1.525E-05	1.546E-05	0.408E-04
2.79	8.51	5.482F-01	7.946E-02	31.59	4.56	42.52	7.92	.01237	1.425E-05	1.441E-05	0.427E-04
2.76	8.75	5.542F-01	8.006E-02	32.00	4.60	42.30	7.99	.01217	1.325E-05	1.341E-05	0.446E-04
2.74	9.00	5.602F-01	8.066E-02	32.41	4.64	42.06	8.06	.01196	1.225E-05	1.240E-05	0.465E-04
2.72	9.26	5.662F-01	8.130E-02	32.83	4.68	41.81	8.13	.01176	1.125E-05	1.140E-05	0.484E-04
2.69	9.55	5.722F-01	8.194E-02	33.25	4.72	41.53	8.20	.01155	1.025E-05	1.040E-05	0.503E-04
2.67	9.84	5.782F-01	8.258E-02	33.67	4.76	41.22	8.27	.01135	0.925E-05	0.940E-05	0.522E-04
2.65	10.16	5.842F-01	8.322E-02	34.10	4.80	40.89	8.35	.01115	0.825E-05	0.840E-05	0.541E-04
2.63	10.50	5.902F-01	8.386E-02	34.53	4.85	40.53	8.42	.01095	0.725E-05	0.740E-05	0.560E-04
2.60	10.86	5.962F-01	8.450E-02	35.00	4.89	40.12	8.50	.01076	0.625E-05	0.640E-05	0.579E-04
2.58	11.25	6.022F-01	8.514E-02	35.47	4.94	39.68	8.57	.01058	0.525E-05	0.540E-05	0.598E-04
2.56	11.67	6.082F-01	8.578E-02	35.94	4.98	39.24	8.65	.01040	0.425E-05	0.440E-05	0.617E-04
2.54	12.12	6.142F-01	8.642E-02	36.41	5.02	38.61	8.72	.01023	0.325E-05	0.340E-05	0.636E-04
2.52	12.60	6.202F-01	8.706E-02	36.88	5.06	37.99	8.79	.01008	0.225E-05	0.240E-05	0.655E-04
2.50	13.12	6.262F-01	8.770E-02	37.35	5.09	37.25	8.86	.00996	0.125E-05	0.140E-05	0.674E-04
2.48	13.70	6.322F-01	8.834E-02	37.82	5.11	36.42	8.90	.00987	0.025E-05	0.040E-05	0.693E-04
2.46	14.32	6.382F-01	8.898E-02	38.29	5.12	35.45	8.99	.00982	0.000E-05	0.000E-05	0.712E-04
2.44	15.00	6.442F-01	8.962E-02	38.76	5.12	34.30	9.03	.00985	0.000E-05	0.000E-05	0.731E-04
2.42	15.75	6.502F-01	9.026E-02	39.23	5.08	32.93	9.03	.00998	0.000E-05	0.000E-05	0.750E-04
2.40	16.58	6.562F-01	9.090E-02	39.70	5.01	31.26	9.08	.01024	0.000E-05	0.000E-05	0.769E-04
2.39	17.50	6.622F-01	9.154E-02	40.17	4.86	29.18	9.13	.01089	0.000E-05	0.000E-05	0.788E-04
2.37	18.53	6.682F-01	9.218E-02	40.64	4.61	26.49	9.18	.01209	0.000E-05	0.000E-05	0.807E-04
2.35	19.69	6.742F-01	9.282E-02	41.11	4.17	22.33	9.23	.01475	0.000E-05	0.000E-05	0.826E-04
2.33	21.00	6.802F-01	9.346E-02	41.58	3.34	17.32	9.28	.02288	0.000E-05	0.000E-05	0.845E-04
					.99	4.85	1.72	.21255	0.000E-05	0.000E-05	0.864E-04

PHASE MATCHING CUTS OFF AT SIGNAL= 2.316 AND IDLER= 22.500

PHASE MATCHING CUTS OFF AT SIGNAL= 2.299 AND IDLER= 24.231

PHASE MATCHING CUTS OFF AT SIGNAL= 2.283 AND IDLER= 26.250

PHASE MATCHING CUTS OFF AT SIGNAL= 2.266 AND IDLER= 28.636

RESULTS FOR TYPE II (E + O = 0) PHASE MATCHING ARE

SIGNAL	IDLER	THETA (RAD)	RHO (RAD)	THETA (DEG)	RHO (DEG)	D-EFF (%10.E12)	A	H(9)	GAIN/WATT (1CM)	GATE/WATT (MAX)	AREA (ISO CM)
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4.20	3.935E-01	6.254E-02	22.55	3.69	46.19	6.23	.019A9	4.849E-05	4.941E-05	7.032E-04
4.26	3.008E-01	6.219E-02	22.39	3.56	46.23	6.19	.02011	4.913E-05	5.007E-05	6.952E-04
4.32	3.840E-01	6.194E-02	22.23	3.54	46.24	6.16	.02033	5.073E-05	5.078E-05	6.074E-04
4.38	3.853E-01	6.149E-02	22.14	3.52	46.33	6.12	.02056	5.031E-05	5.130E-05	6.797E-04
4.44	3.927E-01	6.114E-02	21.93	3.50	46.34	6.09	.02079	5.038E-05	5.186E-05	6.721E-04
4.50	3.800E-01	6.090E-02	21.77	3.48	46.43	6.05	.02102	5.136E-05	5.239E-05	6.645E-04
4.57	3.774E-01	6.045E-02	21.62	3.46	46.44	6.02	.02125	5.184E-05	5.289E-05	6.571E-04
4.63	3.748E-01	6.012E-02	21.44	3.44	46.53	5.98	.02149	5.227E-05	5.335E-05	6.497E-04
4.70	3.723E-01	5.978E-02	21.33	3.43	46.57	5.95	.02173	5.268E-05	5.377E-05	6.424E-04
4.77	3.698E-01	5.944E-02	21.14	3.41	46.67	5.92	.02197	5.304E-05	5.415E-05	6.353E-04
4.85	3.673E-01	5.911E-02	21.04	3.39	46.77	5.89	.02221	5.345E-05	5.453E-05	6.282E-04
4.92	3.648E-01	5.878E-02	20.90	3.37	46.71	5.85	.02246	5.385E-05	5.488E-05	6.211E-04
5.00	3.623E-01	5.845E-02	20.76	3.35	46.75	5.82	.02270	5.424E-05	5.527E-05	6.142E-04
5.08	3.598E-01	5.812E-02	20.62	3.33	46.80	5.79	.02295	5.464E-05	5.565E-05	6.073E-04
5.16	3.573E-01	5.779E-02	20.48	3.31	46.84	5.75	.02321	5.504E-05	5.602E-05	6.005E-04
5.25	3.548E-01	5.747E-02	20.35	3.29	46.89	5.72	.02347	5.543E-05	5.639E-05	5.938E-04
5.34	3.523E-01	5.715E-02	20.21	3.27	46.92	5.69	.02372	5.582E-05	5.675E-05	5.872E-04
5.42	3.504E-01	5.682E-02	20.04	3.26	46.96	5.65	.02399	5.624E-05	5.712E-05	5.807E-04
5.53	3.484E-01	5.650E-02	19.94	3.24	47.00	5.63	.02425	5.664E-05	5.749E-05	5.742E-04
5.62	3.465E-01	5.618E-02	19.81	3.22	47.04	5.60	.02452	5.704E-05	5.786E-05	5.678E-04
5.73	3.435E-01	5.585E-02	19.64	3.20	47.09	5.56	.02478	5.744E-05	5.823E-05	5.616E-04
5.84	3.415E-01	5.553E-02	19.56	3.19	47.15	5.53	.02505	5.784E-05	5.860E-05	5.554E-04
5.96	3.395E-01	5.521E-02	19.43	3.17	47.19	5.50	.02533	5.824E-05	5.897E-05	5.492E-04
6.06	3.375E-01	5.489E-02	19.30	3.15	47.24	5.47	.02560	5.864E-05	5.934E-05	5.430E-04
6.18	3.355E-01	5.457E-02	19.18	3.13	47.29	5.44	.02588	5.904E-05	5.971E-05	5.368E-04
6.30	3.326E-01	5.425E-02	19.06	3.12	47.34	5.41	.02615	5.944E-05	6.008E-05	5.306E-04
6.43	3.305E-01	5.393E-02	18.94	3.10	47.39	5.38	.02643	5.984E-05	6.045E-05	5.244E-04
6.56	3.285E-01	5.361E-02	18.82	3.08	47.44	5.35	.02671	6.024E-05	6.082E-05	5.182E-04
6.70	3.264E-01	5.329E-02	18.70	3.07	47.49	5.33	.02699	6.064E-05	6.119E-05	5.120E-04
6.85	3.244E-01	5.297E-02	18.59	3.05	47.54	5.30	.02727	6.104E-05	6.156E-05	5.058E-04
7.00	3.223E-01	5.265E-02	18.44	3.03	47.59	5.27	.02754	6.144E-05	6.193E-05	4.996E-04
7.16	3.202E-01	5.233E-02	18.37	3.02	47.64	5.24	.02782	6.184E-05	6.230E-05	4.934E-04
7.33	3.181E-01	5.201E-02	18.26	3.00	47.69	5.22	.02810	6.224E-05	6.267E-05	4.872E-04
7.50	3.160E-01	5.169E-02	18.16	2.99	47.74	5.19	.02837	6.264E-05	6.304E-05	4.810E-04
7.68	3.139E-01	5.137E-02	18.05	2.97	47.79	5.17	.02864	6.304E-05	6.341E-05	4.748E-04
7.87	3.118E-01	5.105E-02	17.95	2.96	47.84	5.14	.02891	6.344E-05	6.378E-05	4.686E-04
8.08	3.097E-01	5.073E-02	17.86	2.95	47.89	5.12	.02919	6.384E-05	6.415E-05	4.624E-04
8.29	3.076E-01	5.041E-02	17.77	2.93	47.94	5.10	.02947	6.424E-05	6.452E-05	4.562E-04
8.51	3.055E-01	5.009E-02	17.68	2.92	47.99	5.07	.02975	6.464E-05	6.489E-05	4.500E-04
8.75	3.034E-01	4.977E-02	17.60	2.91	48.04	5.05	.03003	6.504E-05	6.526E-05	4.438E-04
9.00	3.013E-01	4.945E-02	17.52	2.90	48.09	5.03	.03031	6.544E-05	6.563E-05	4.376E-04
9.26	2.992E-01	4.913E-02	17.45	2.89	48.14	5.02	.03059	6.584E-05	6.600E-05	4.314E-04
9.55	2.971E-01	4.881E-02	17.38	2.88	48.19	5.00	.03087	6.624E-05	6.637E-05	4.252E-04
9.84	2.950E-01	4.849E-02	17.32	2.87	48.24	4.98	.03115	6.664E-05	6.674E-05	4.190E-04
10.16	2.929E-01	4.817E-02	17.26	2.86	48.29	4.97	.03143	6.704E-05	6.711E-05	4.128E-04
10.56	2.908E-01	4.785E-02	17.22	2.85	48.34	4.96	.03171	6.744E-05	6.748E-05	4.066E-04
10.96	2.887E-01	4.753E-02	17.15	2.84	48.39	4.95	.03199	6.784E-05	6.785E-05	4.004E-04
11.25	2.866E-01	4.721E-02	17.13	2.84	48.44	4.94	.03227	6.824E-05	6.822E-05	3.942E-04
11.67	2.845E-01	4.689E-02	17.12	2.84	48.49	4.94	.03255	6.864E-05	6.860E-05	3.880E-04
12.12	2.824E-01	4.657E-02	17.12	2.84	48.54	4.94	.03283	6.904E-05	6.898E-05	3.818E-04
12.60	2.803E-01	4.625E-02	17.13	2.84	48.59	4.94	.03311	6.944E-05	6.936E-05	3.756E-04
13.12	2.782E-01	4.593E-02	17.15	2.85	48.64	4.94	.03339	6.984E-05	6.974E-05	3.694E-04

2.48	13.70	2.999F-01	4.979E-02	17.12	2.05	47.77	4.96	.03186	2.105E-03	2.231E-05	4.694E-04
2.46	14.32	3.608F-01	4.993E-02	17.24	2.06	47.75	4.97	.03087	2.118E-03	2.070E-05	4.642E-04
2.44	15.00	3.322F-01	5.014E-02	17.31	2.07	47.73	4.99	.03067	1.031E-03	1.905E-05	4.319E-04
2.42	15.75	3.039F-01	5.041E-02	17.41	2.09	47.71	5.02	.03231	1.009E-03	1.739E-05	4.504E-04
2.40	16.56	3.062E-01	5.075E-02	17.54	2.91	47.68	5.95	.02991	1.522E-03	1.564E-05	4.631E-04
2.39	17.58	3.090E-01	5.110E-02	17.70	2.93	47.63	5.09	.02942	1.502E-03	1.401E-05	4.709E-04
2.37	18.53	3.124F-01	5.178E-02	17.90	2.96	47.58	5.05	.02804	1.206E-03	1.240E-05	4.806E-04
2.35	19.69	3.167F-01	5.234E-02	18.14	3.00	47.51	5.21	.02816	1.006E-03	1.009E-05	4.920E-04
2.33	21.08	3.219F-01	5.312E-02	18.44	3.04	47.43	5.29	.02737	9.126E-04	9.304E-06	5.077E-04
2.32	22.50	3.282F-01	5.405E-02	18.80	3.10	47.33	5.38	.02645	7.705E-04	7.902E-06	5.297E-04
2.30	24.23	3.359F-01	5.518E-02	19.25	3.16	47.21	5.49	.02541	6.400E-04	6.646E-06	5.479E-04
2.28	26.25	3.454F-01	5.655E-02	19.79	3.24	47.05	5.63	.02422	5.313E-04	5.436E-06	5.790E-04
2.27	28.64	3.571F-01	5.823E-02	20.46	3.34	46.85	5.88	.02287	4.242E-04	4.330E-06	6.099E-04