Reaching 2 μm with High-Power OPOs (mostly)

2 μm Solid State Laser Technology Review
Washington, DC November 9, 1993

SEO

RESEARCH DIVISION

OUTLINE

Quick Review of 2-μm laser work at SEO

- **CW, single-frequency source**
- **Diode-pumped, pulsed Tm,Ho:YLF laser**

High-energy OPOs

- **Data on Nd:YAG-pumped KTP OPOs**
- **Calculations on long-pulse, high-energy system**

SINGLE-FREQUENCY, CW
Tm,Ho:YLF LASER - PERFORMANCE

Developed for classified customer

Design:

- **End-pumped by 500-mW, 100-um-aperture diode laser**
- **Proprietary line-narrowing scheme**

Performance

- **2.06 μm wavelength**
- **45 mW, single-frequency output power**
- **Continuous tuning over 140 GHZ range**
- **<1 MHz/min stability, to be improved**
- **?? short-term linewidth**

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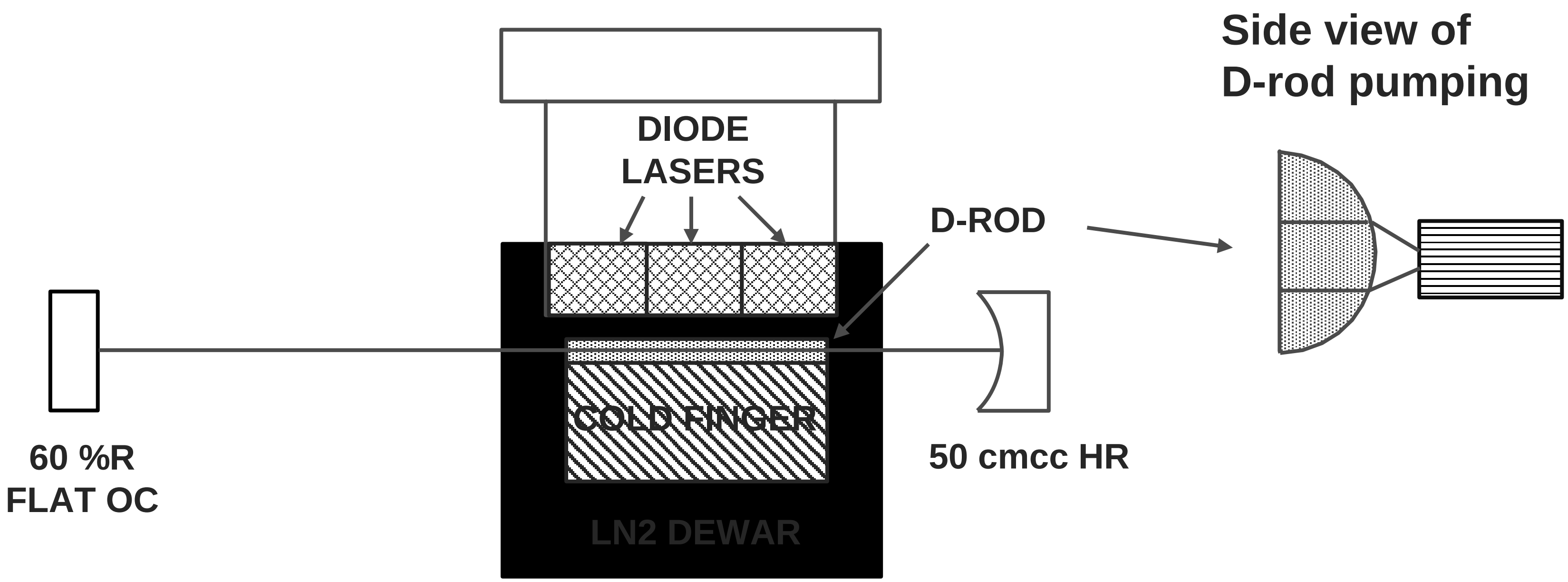
SCHEMATIC OF PULSED Tm,Ho:YLF LASER



Diode lasers: 6-bar stacks of 60-W bars

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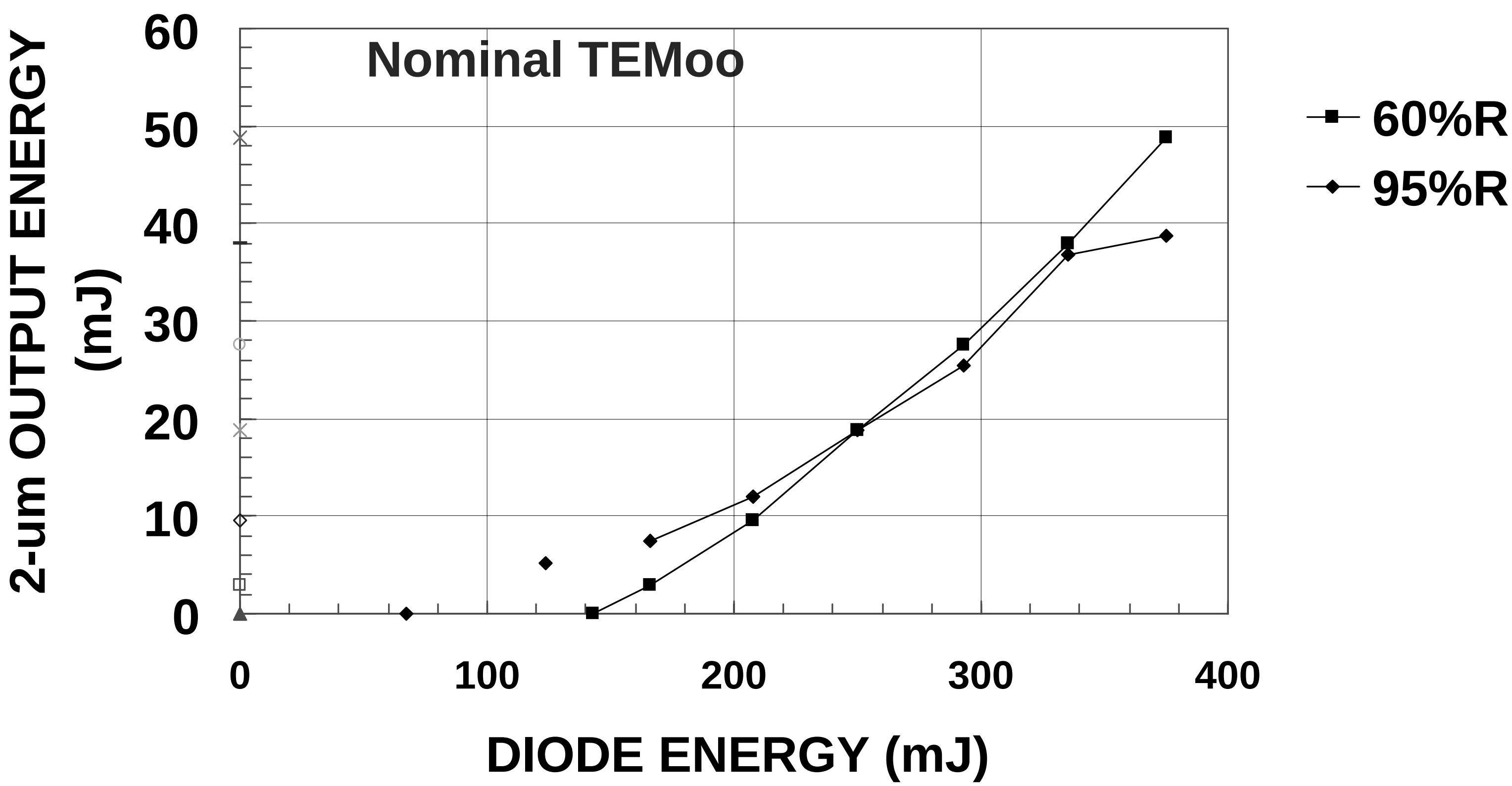
INPUT-OUTPUT: PULSED Tm,Ho:YLF LASER



HIGH-ENERGY OPO: WHY? AND WHY NOT?

Why?

- **Based on well-developed Nd-laser technology**
  300 K operating temperature
  Low saturation fluence, high gain
- **Can access maximally eye-safe wavelengths (1.6 μm)**

Why not?

- **OPO materials limitations**
  KTP: idler absorption; KTA: size, quality
- **Limits to beam quality from heating, nonlinear effects**
- **Difficulty in stretching, scaling Nd laser output**

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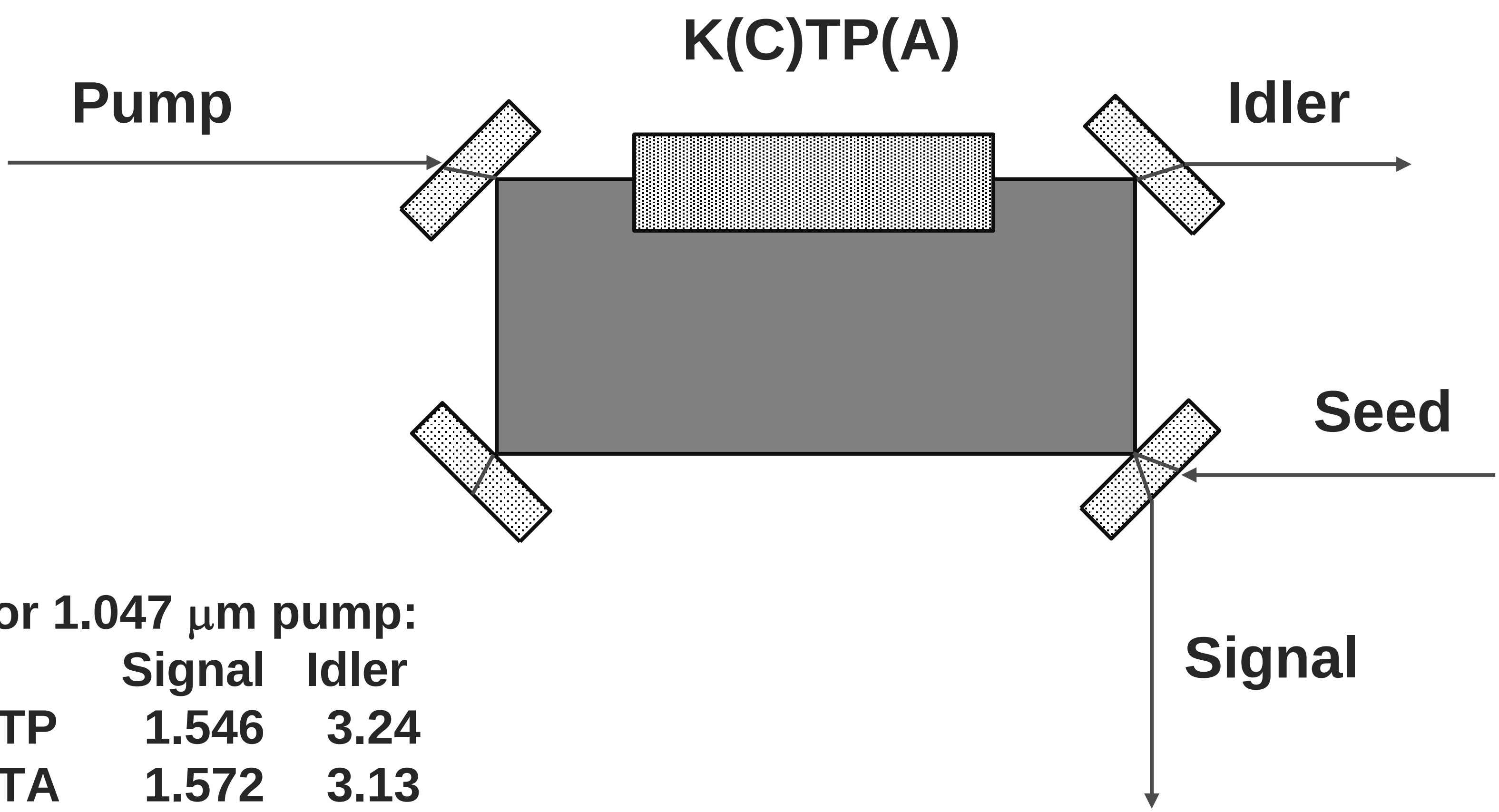
HIGH-ENERGY OPO: WHAT'S NEXT?

Build moderate-energy, stretched-pulse Nd laser

Test OPO performance

Measure damage properties of materials, coatings at long pulse durations

OPO SCHEMATIC LAYOUT



For 1.047 μm pump:

	Signal	Idler
KTP	1.546	3.24
KTA	1.572	3.13
CTA	1.956	2.25

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OPO THRESHOLD CALCULATION: INPUTS

Walkoff angle =	1E-07	rad
alpha @ sig =	0.01	1/cm
d eff =	3	pm/V
n @ pump =	1.7485	
n @ signal =	1.737	
n @ idler =	1.7726	
Lambda pump =	1.047	µm
Lambda signal =	1.546	µm
Pump PW (FWHM)=	250	ns
Pump radius =	0.25	cm
Signal radius =	0.1	cm
Reff =	0.5	

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OPO THRESHOLD CALCULATION: OUTPUTS

Inputs		Outputs for single-pass pump						
xtal	Phys.Cav	Opt. Cav		Loss	Energy	Intensity	Absolute	Energy
Length	Length	Length	l eff	Term	Threshold	Threshold	Threshold	Threshold
(cm)	(cm)	(cm)	(cm)		(J/cm2)	(W/cm2)	(W)	(mJ)
------	-----	-----	-----	-----	-----			
1	5	5.75	1.00	1.07	63.127	2.43E+08	4.77E+07	12,395
1.5	5	6.12	1.50	1.09	28.633	1.10E+08	2.16E+07	5,622
2	5	6.50	2.00	1.10	16.434	6.32E+07	1.24E+07	3,227
3	5	7.25	3.00	1.12	7.600	2.92E+07	5.74E+06	1,492
4	5	7.99	4.00	1.14	4.444	1.71E+07	3.36E+06	873
4	10	12.99	4.00	1.15	4.548	1.75E+07	3.43E+06	893
4	20	22.99	4.00	1.18	4.760	1.83E+07	3.59E+06	935
4	40	42.99	4.00	1.23	5.197	2.00E+07	3.92E+06	1,020