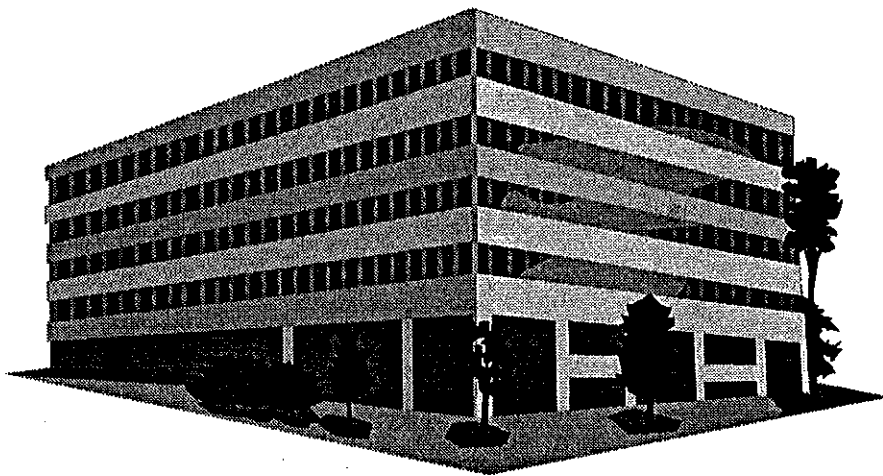


CREOL

Center for Research and Education in Optics and Lasers

AFFILIATES DAY



JANUARY 14, 1994

CREOL OPEN HOUSE
January 14, 1994

Contents

- Introductory Remarks M. J. Soileau
- Administrative Remarks, Objectives of the Open House, and Sources of Federal R&D Support C. M. Stickley
- Opportunities with High Power Lasers M. Richardson
- Theoretical and Experimental Studies of Laser-Aided Materials Processing A. Kar
- Processing and Characterization of New Glass Materials K. Richardson
- Infrared Systems G. Boreman
- Advanced Optical Coatings K. Guenther
- Semiconductor Optoelectronics P. Li Kam Wa
- High Speed Photonics for Instrumentation, Networking, and Signal Processing P. Delfyett
- Aspects of Stegeman Group Research: Nonlinear Optics in AlGaAs A. Villeneuve

CREOL

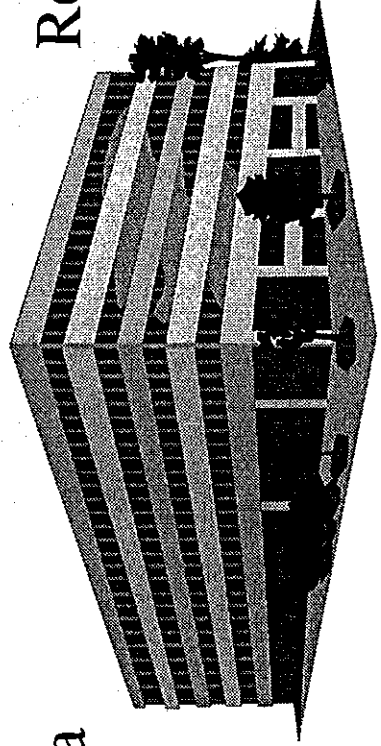
Center for Research and Education in Optics and Lasers

University of Central Florida Orlando, Florida

Director: M J Soileau

Asst Director: C M Stickley

University of Central Florida
Research Park

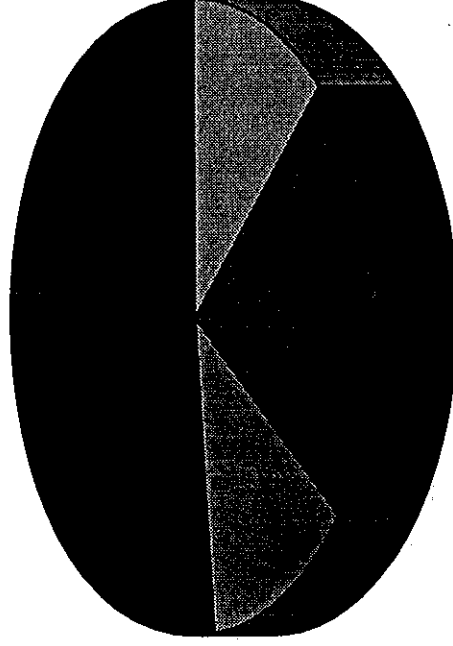


Research Pavillion
Suite 400

CREOL PERSONNEL

Total 165

85 Students



Faculty 21

20 Other

39

Technical Staff

~ \$7M/yr

Concept for CREOL ERC

Specific Projects and Applications

Program Thrust

Intermittent
Optics

Laser Machine
Tools

X-Ray Optics &
Remote Sensing

New Sources &
Optical Systems

Technology

Active
Optical

Optical
Systems

Electronics

Optical
Diodes

Optical
Fiber

Radio
Systems

Imaging

LID

Microline

Base

Optical
Systems

Optical
Systems

Optical
Systems

Optical
Systems

Optical
Systems

Optical
Systems

Optical
Systems

Administrative Remarks,

Objectives of the Open House,

and

Sources of Federal R&D Support

**C. Martin Stickley
Prof. of Electrical and
Computer Engineering
Assistant Director**

CREOL OPEN HOUSE

January 14, 1994

HOLIDAY INN UNIVERSITY BALLROOM

8:00	Registration; coffee and light breakfast	
8:30	Introduction	M. J. Soileau
8:35	Welcome	Pres. John Hitt
8:40	Objectives of the Open House; Sources of Federal R&D Support	C. M. Stickley
9:00	Opportunities with High Power Lasers	M. Richardson
9:20	Theoretical and Experimental Studies of Laser-Aided Materials Processing	A. Kar
10:00	Processing and Characterization of New Glass Materials	K. Richardson
10:20	Break	
10:40	Infrared Systems	G. Boreman
11:00	Advanced Optical Coatings	K. Guenther
11:20	Semiconductor Optoelectronics	P. LiKamWa
11:40	High Speed Photonics for Instrumentation, Networking, and Signal Processing	P. Delfyett
12:00	Aspects of Stegeman Group Research: Nonlinear Optics in AlGaAs	A. Villeneuve
12:20	Lunch	
1:00	Lab Visits and Tours (Transportation Provided) Research Pavillion, Bennett Hayes, Crystal Growth Lab	
4:30	Social Hour at Holiday Inn - Celebrations Lounge	

Our Changing R&D World

- There are still a lot of Federal \$ for R&D, and the “new money” is forcing teaming and focusing on utilization of the results
- Money for single investigator research is still there (the new NSF Director wants to increase it) but there are more of us competing for these dollars
- To improve chances of winning some “new money” the proposal team must
 - understand a 10x bigger world
 - articulate why your approach is better than others
 - focus on developing a commercialization path
- Matching money is frequently required.

Small Business Innovation Research Program

- SBIRs — The best so far
- Why?
 - Monies are fenced
 - No matching funds required
 - \$ for SBIRs will be growing
 - 93/94 - 1.5% of agency R&D budget
 - 95/96 - 2.0% of agency R&D budget
 - thereafter - 2.5%
- Phase I — up to 100K
- Phase II — up to 750K
- Phase III — can be government funded without competitive bid
- Not just for product development
- See the SBIR announcements

STTR (Cont.)

- Modeled after the SBIR program
 - monies are fenced
 - no matching funds required.
- STTR is an experimental program
 - being carried out at DoD, HHS, NASA, DoE and NSF
 - funding is smaller: 0.05% in FY 94, 0.1% in FY 95, and 0.15% in FY 96.
- Not less than 40% of the work to be done by the small business and 30% done by the research institution.
- Phase I — \$100K max for 12 months
Phase II — \$500K max for 24 months
Phase III — non-STTR funds

Navy 94 T001 Electronic Components & Systems/Electronics
(V. Schaper; 703-696-4286)

- Components, including quantum well devices

Air Force 94 T001 Aerospace Technology (Jill Dickman; 800-222-0336)

- Innovative ideas/concepts for achieving increased target detection range using advanced tracking/processing techniques
- Wind profiling techniques
- New techniques for high speed image processing

ARPA 94 T001 Low Cost Electronics Manufacturing
(Connie Jacobs; 703-696-2398)

- Low cost thermal imaging systems

NASA (John Glaab; 202-358-0691)

- General Aviation S/W and Systems: Integrated Flat Panel Display
- Robotics: Subminiature sensors and controllers

NSF (Michael Crowley; 703-306-1391)

- Analytical Chemical Instrumentation

**PROPOSALS ARE DUE MARCH 31!
OR WITHIN TWO WEEK OF THIS
DATE DEPENDING ON THE AGENCY**

Technology Reinvestment Project — TRP

	<u>FY 93</u>	<u>FY 94</u>
Develop- ment		
Defense Dual Use Critical Technology Partnerships	\$81.9M	\$150M
Commercial - Military Integration Partnerships	\$42.1M	\$100M
Defense Advanced Manufacturing Partnerships	\$23.5M	\$ 24M
Regional Technology Alliances Assistance Program	\$90.5M	\$100M
Deploy- ment		
Manufacturing Extension Programs	\$87.4M	\$ 24M
Defense Dual Use Assistance Extension Program	\$90.8M	0
Ed. and Training		
Manufacturing Engineering Education Program	\$43.6M	\$ 24M
Manufacturing Experts in the Classroom	\$ 4.6M	0
TRP-Related SBIR	<u>7.2M</u>	
	\$472M	\$404M

Advanced Technology Program - ATP

- The ATP
 - assists businesses in carrying out R&D on pre-competitive, generic technologies
 - emphasizes high risk, enabling technologies
- The focus is on commercial applications which have significant potential for improving US competitiveness
- 50% cost sharing is required — IRAD funds may not be acceptable
- ATP is enjoying rapid growth: FY 90 - 14M; FY 93 - 68M; FY 94 - 200M; FY 97 - 750M
- Funding
 - single applicants: up to 2M over 3 years
 - joint ventures: funds limited by the ATP budget over 5 years
 - joint ventures have received 73% of the funds
 - none of the ATP funds can be used to pay indirect costs

Line Items of Interest in the DoD Budget
(Appropriations Conference Report; Nov. 9, 1993)

- Army — 6.1 Research - down 6% from the request
 - Army — Laser burn research - \$2.0M
 - Army — Breast cancer research - \$25M
 - Army — Laser Weapons Technology - \$4.5M (up \$4.0M)
 - (Solid state dye laser - \$2.0M)
 - (High power diode laser - \$2.0M)
 - Army — Night vision advanced technology - \$34.8M (down \$4M)
 - Army — DoD High Energy Laser Test Facility - \$24.8M (up \$20.0M)
 - Army — Laser Vibration Sensing System - \$1.25M (new money)
 - Navy — 6.1 Research - down 4% from request
 - Navy — Free Electron Laser - \$5.0M (up \$5.0M)
- (Note: "Conferees direct the Navy to transfer funds to the Army to augment the existing FEL contract rather than initiate a new contract.")
- Navy — Laser Technology - (\$3.7M) (down \$3.7M)
 - Navy — Manufacturing Technology - \$142M (new money)

Line Items of Interest in the DoD Budget (Cont.)

- ARPA — Cross Disciplinary Materials Research - \$2.7M (new)
- ARPA — Process Synthesis - \$13.2M (new)
- ARPA — Infrared-Sensitive Materials - \$9.5M (new)
 ("Note: The Conferees agree to provide \$9.5M only for a project utilizing Group III-V materials for optoelectronics and infrared applications.)
- ARPA — Advanced lithography - \$12.7M (new)
 ("Note: The Conferees urge ARPA to investigate the use of x-ray and advanced optical lithography technologies through the use of consortia.")
- ARPA — Environmentally Conscious Manufacturing - \$20M (new)
- ARPA — Electric Vehicle Technology - \$46.5M (new)
 Etc.
 Etc.
 Etc.
 Etc.
- BMDO — Research and Support Activities - \$295M, down from \$385M

How to Improve Chances of Winning a Government Program

- Government program managers need ideas!!
- Develop your idea with your team
- Before the next announcement goes to press, present your idea informally to appropriate program manager(s)
 - attend a national meeting on the program
 - visit the program manager in his/her office
- Listen carefully to their guidance and respond to it
 - modify what you are proposing accordingly
 - communicate a revised version to them
- Expect to see your idea listed as being among the ones for which they are soliciting proposals!
- Get your state legislator to help create a state fund for matching monies.

The Laser Plasma Laboratory at CREOL

Faculty

Dr Martin C. Richardson, Professor of Physics & of Electrical Engineering
Dr William T. Silfvast, Professor of Physics & of Electrical Engineering

Visiting Scientists and Research Associates

Dr Paul Beaud, CREOL	Dr Ann Marie Eligon, CREOL
Dr Kai Gabel, U. of Jena, Germany	Prof Hisanori Fujita, U. Osaka, Japan
Dr Masataka Kado, U. Osaka, Japan	Dr David Salzmann, Soreq, Israel
Lan Sun, Shanghai I. of Opt., China	Dr Andrew Vasil'yev, Vavilov, Russia

Graduate Research Students

Howard Bender	(Physics)	Steven Grantham (Electr. Eng.)
Jason Eichenholz	[Electr. Eng.]	Feng Jin (Physics)
Edward Miesak	(Electr. Eng.)	Donna O'Connell (Electr. Eng.)
Mark Klosner	(Electr. Eng.)	

Undergraduate Research Assistants

Jim Darnell	Eric Schnetzer	Paul Reese
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Research Activities of the Laser Plasma Laboratory

CREOL

LPL

Laser Plasma X-ray Sources. Development of soft x-ray (100 eV) and hard x-ray (>200 eV) laser plasma point x-ray sources for Soft X-ray Projection Lithography. Advanced computer chips. Proximity X-ray Lithography. Next generation computer chips. Biological X-ray Microscopy. High resolution imaging of cells...

High Power Solid State Laser Development. New laser systems and technologies, especially in the UV, for laser plasma x-ray sources and advanced material processing techniques.

Ultrahigh Intensity Laser Science. 10 -100 TW laser pulse (<100 fs) generation. Extreme field interaction with matter. Ultrashort x-ray pulse generation. X-ray lasers.

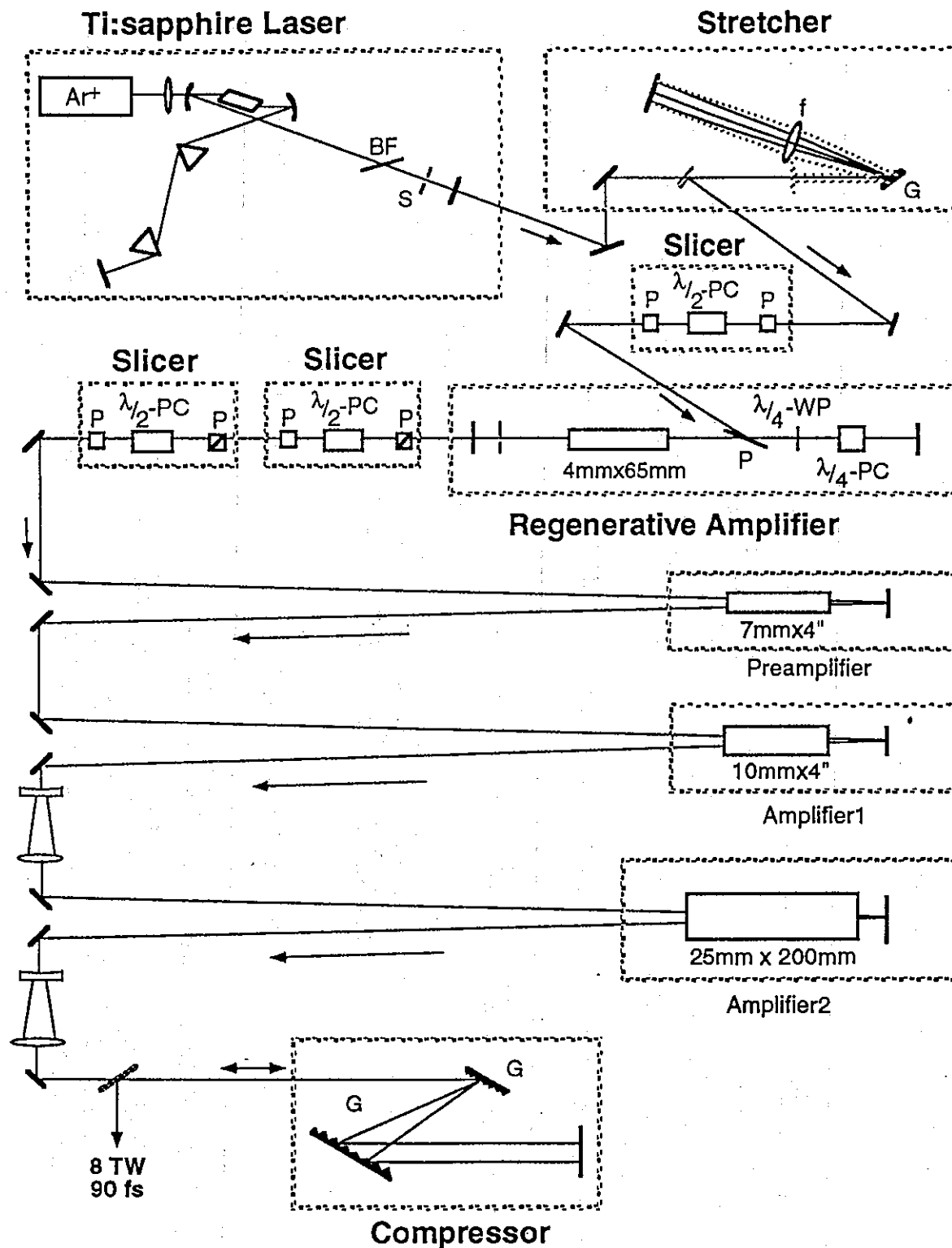
Advanced X-ray Imaging Technology. Development of sensitive, high resolution electron-optical x-ray imaging systems based on channelplates and electron-optical lenses.

UCF

Experimental Set-Up

CREOL

LPL



UCF

NSF

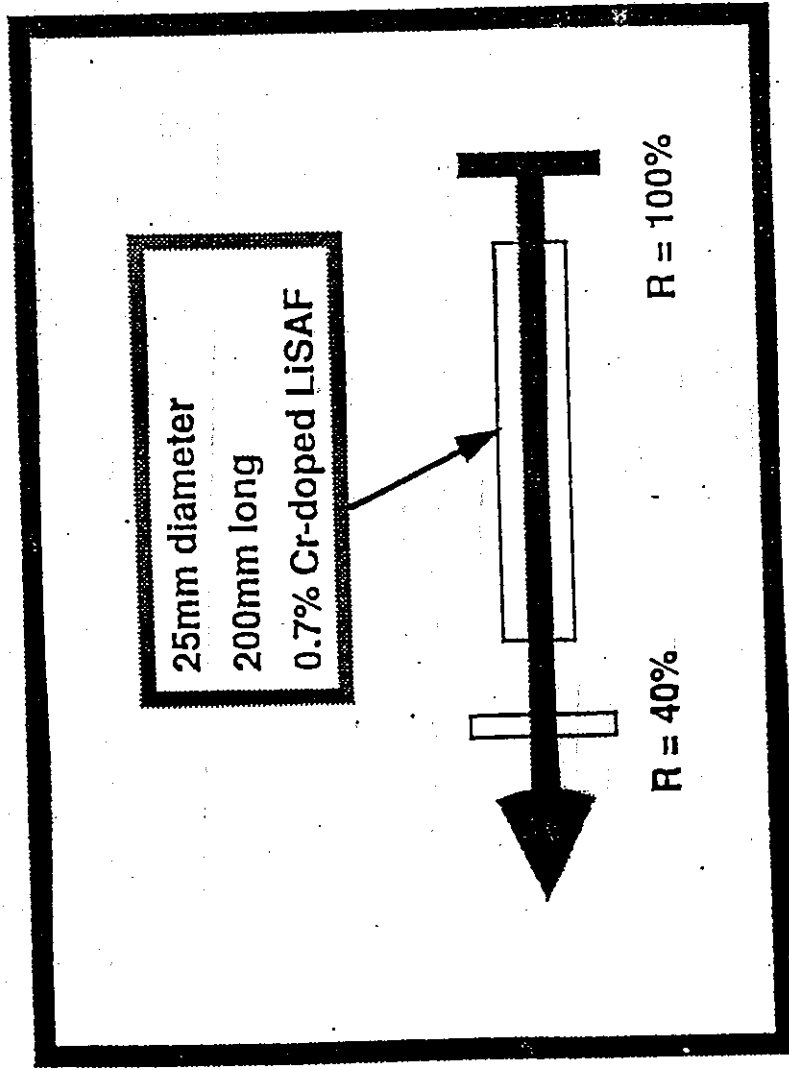
70 J OUTPUT FROM LARGE DIAMETER Cr: LiSAF

CREOL

LPL

Eight
flashlamp,
close-coupled
pump cavity
5kJ, 350 us

small signal gain
~0.1/cm



Special crystal processing by
Lightning Optical Corporation

UNIVERSITY OF CENTRAL FLORIDA

Laser Plasma Ice Target for 13 nm EUV Lithography

CREOL

LPL

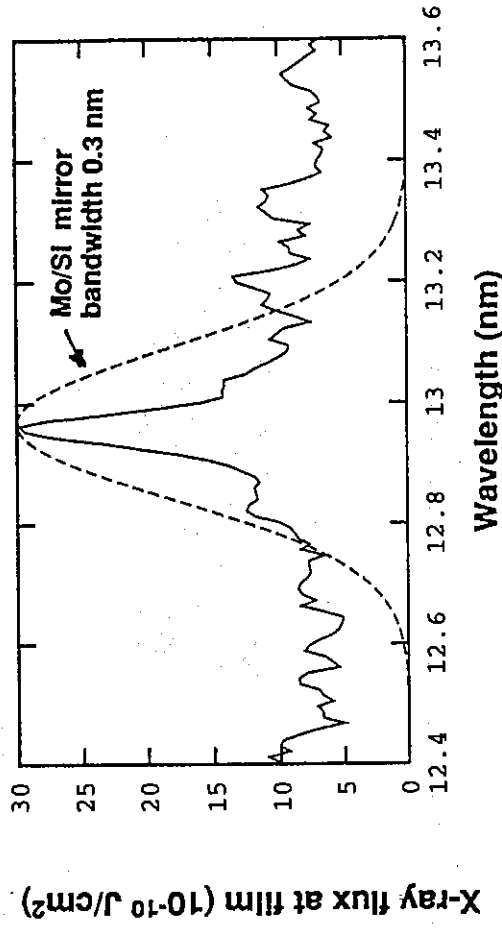
Advantages of Ice Laser Plasma

Strong 2p-4d line emission from Li-like O at 13nm, comparable to Sn target emission.

Minimal effects of target debris.

Limitless, low cost operation.

High repetition rate, limited mass configuration possible.



Debris

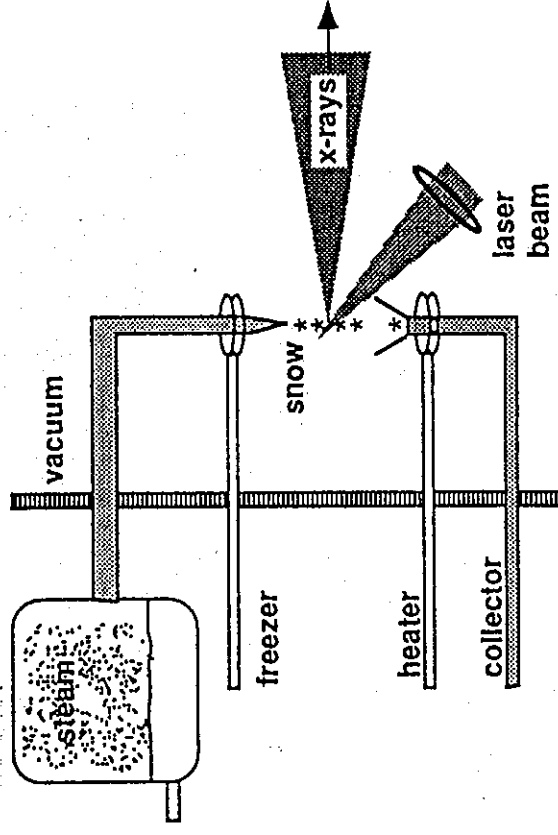
No progressive coating of collector mirror.

Efficient vapor extraction.

No debris observed at > 7 cm range.

No clusters with limited mass targets.

The Snow Machine Target



UCF

ARPA

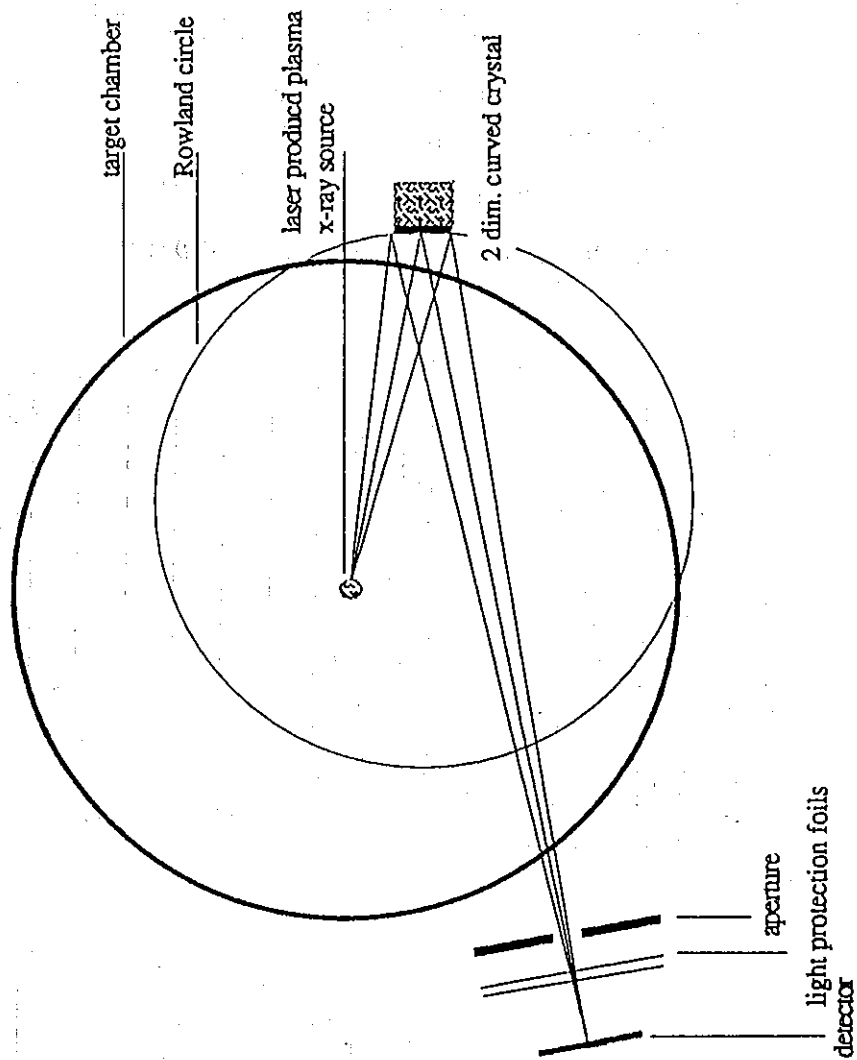
Pulsed (ns) X-Ray Microscopy of *in - vitro*
Human Chromosomes with a Laser - Plasma X-Ray Source



High resolution x-ray crystal imaging

CREOL

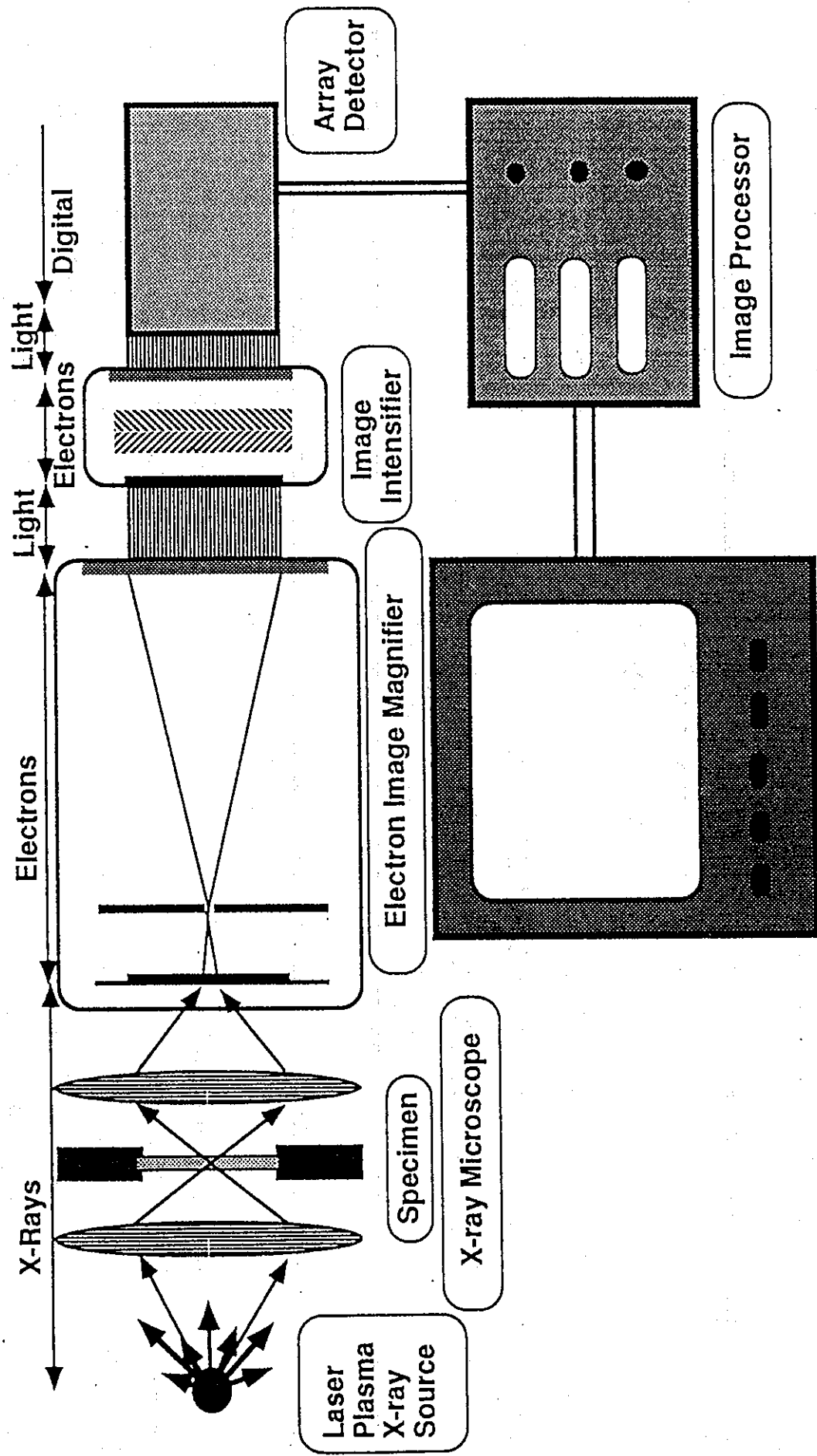
LPL



UCF

LLNL

Primary components of a laser-plasma source-based x-ray microscope



Theoretical and Experimental Studies in Laser-Aided Materials Processing

Aravinda Kar

Assistant Professor

Mechanical and Aerospace Engineering Department
Center for Research on Electro-Optics and Lasers (CREOL)
University of Central Florida, Orlando, Florida

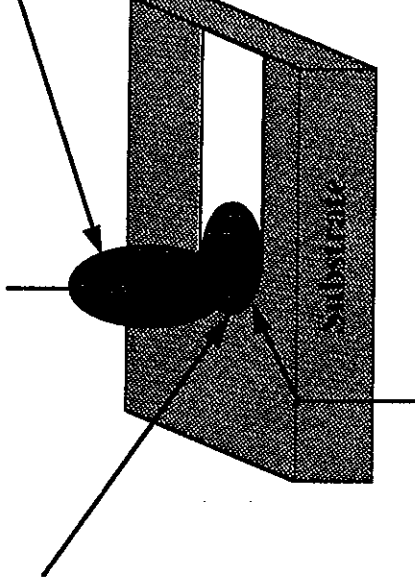
Flow Visualization

1. Surface Contour Measurement

Laser Beam

Spectroscopy
of Metal Vapor

1. Temperature Measurement
2. Velocity Measurement
3. Density Measurement



Mathematical Model

1. Navier-Stokes Equations - Velocity and Density Data are used as Boundary Conditions.
2. Energy Equations - Temperature Data are used as Boundary Conditions.
3. Model Prediction - Surface contour Data are used for Model Validation.

Laser Cladding/Welding

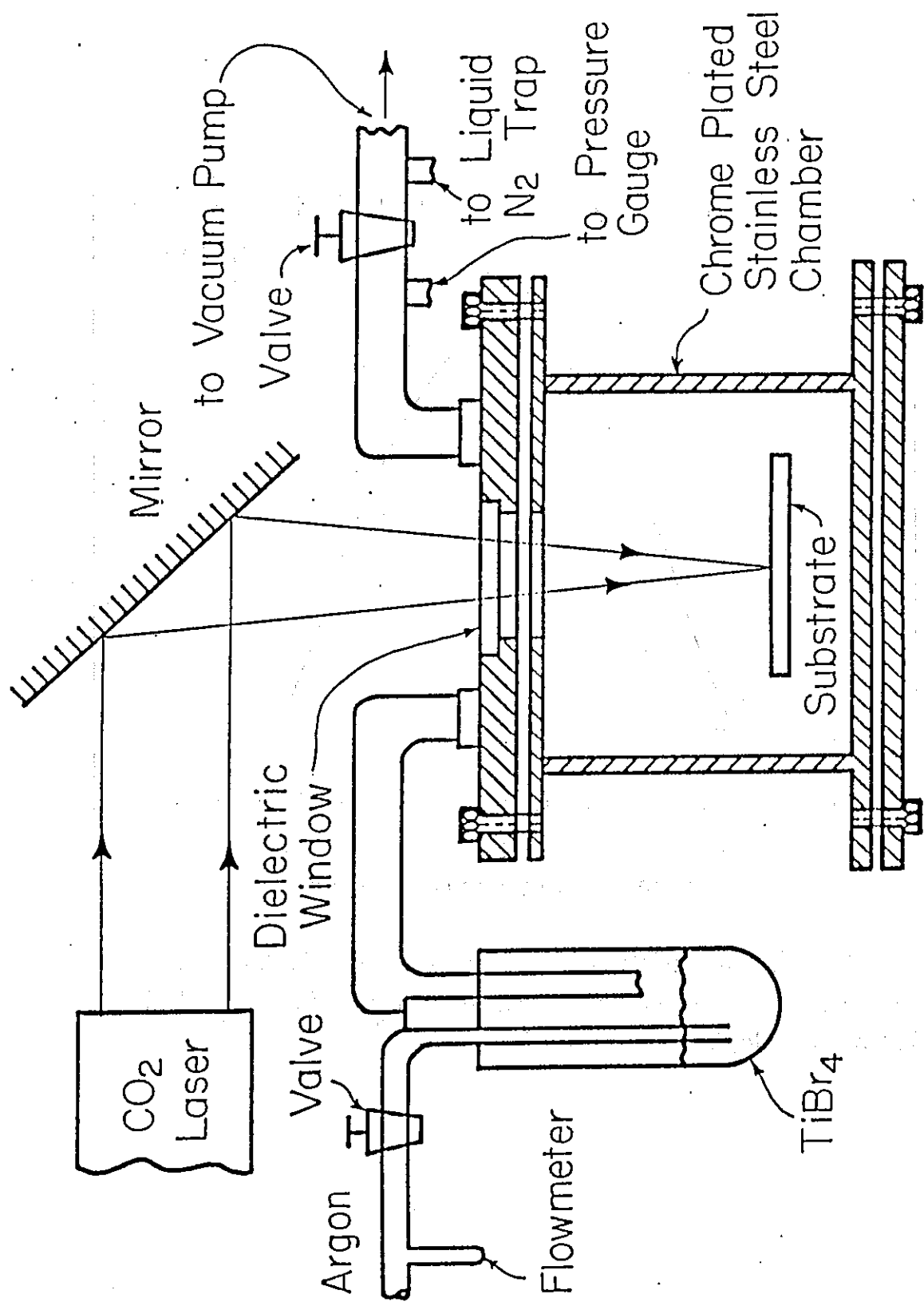
LASER CLADDING

1. Provides a means of surface modification for improved
 - (a) corrosion resistance
 - (b) oxidation resistance
 - (c) wear resistance
2. Allows novel metastable alloy development
3. Allows reverse machining
It allows to rebuild worn parts such as dies or vehicle components.

Automotive industry is slowly adopting this technology. It is used extensively in aerospace industries to repair the expensive turbine blades.

Truck camshafts are rebuilt with a 1.5 kW CO₂ laser in the U.S.S.R.

Laser Chemical Vapor Deposition (LCVD)



Schematic of the LCVD system

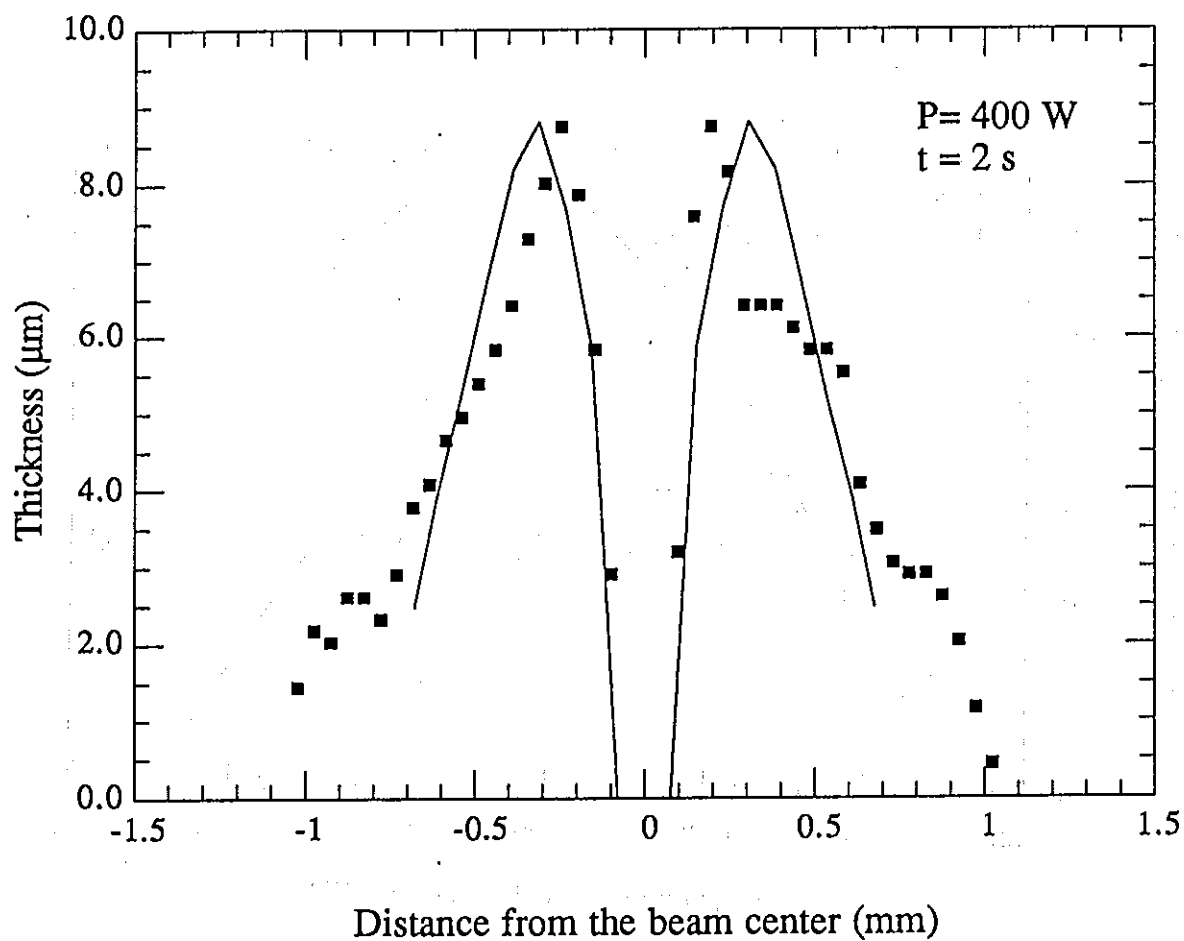
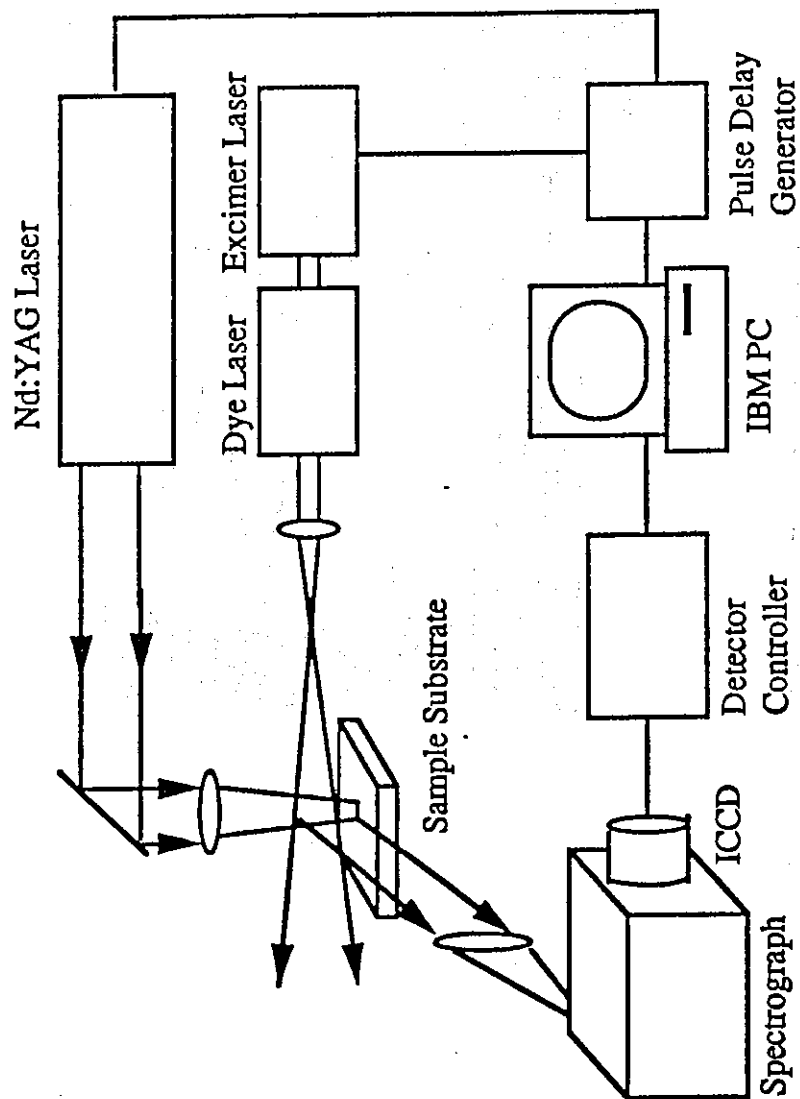


FIG. 5. Spatial variation of the thickness of TiN deposits.
 ■ experimental; — calculated: $r=1.0 \text{ mm}$, $T_m=1473 \text{ K}$, $T_M=1640 \text{ K}$,
 $E=11.0 \text{ Kcal/mole}$, $k_0=8.4 \times 10^2 \text{ cm/s}$.

Schematic of the LIF Diagnostics



Laser Ablation

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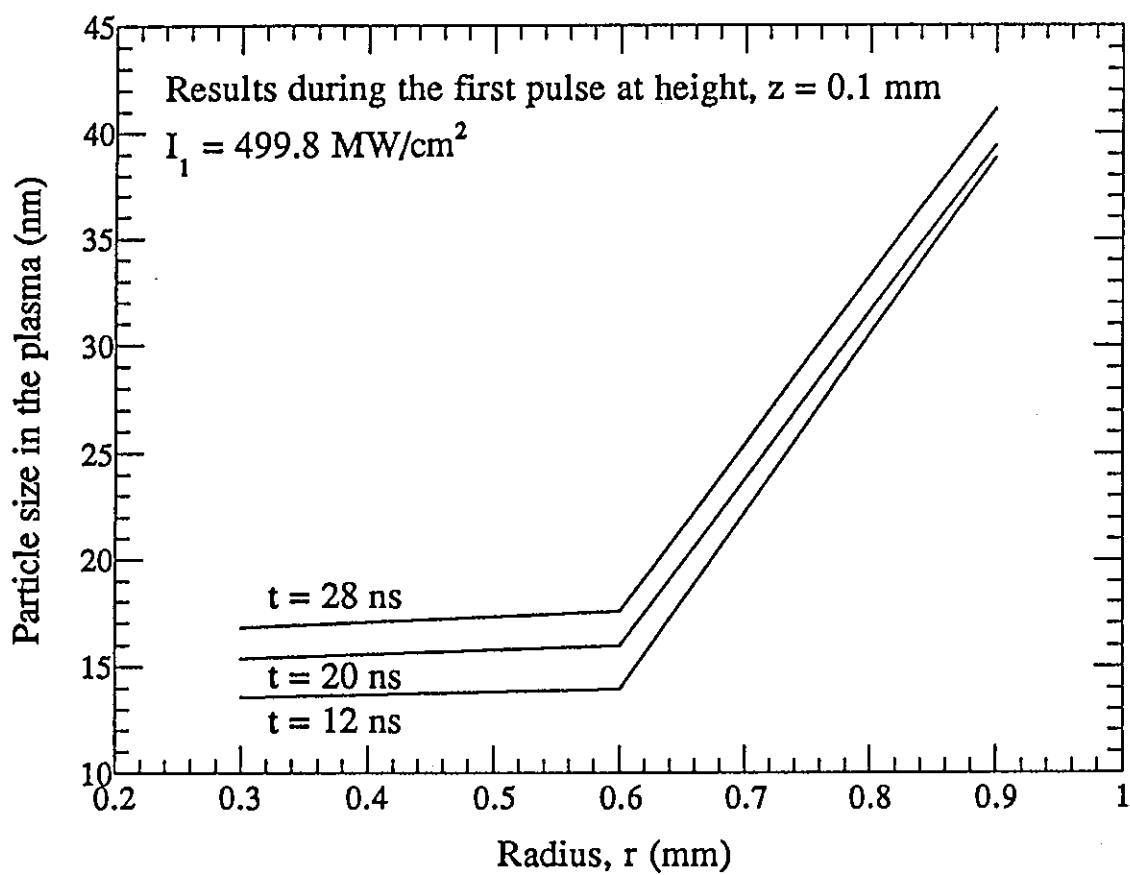
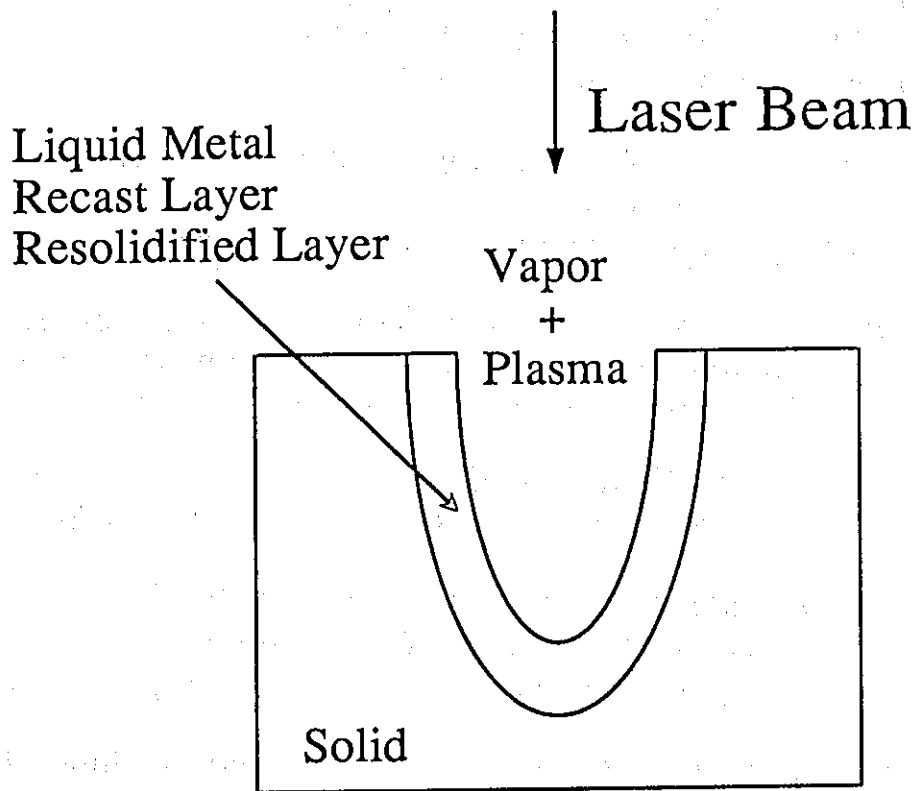


FIG. 11. Distribution of particle size in the plasma phase during laser ablation.

Laser Drilling



Critical Issues:

- (a) Tapering Angle (Cylindricity)
- (b) Recast Layer Thickness
- (c) Aspect Ratio
- (d) Laser Pulse Width
- (e) Energy per Pulse
- (f) Repetition Rate
- (g) Waist Size
- (h) Beam Divergence

ADVANTAGES OF LASER DRILLING

1. No tool wear (the hardness of the work-piece is not critical)
2. Low distortion (can drill into very fragile components)
3. Easy access (can reach into complex geometries)
4. Ability to drill into curved surfaces or at low angles
5. Precision (very tight tolerances possible)
6. Small hole size (diameters down to 0.01 mm)
7. Ease of automation
8. High speed (can reach millions of holes/hour in some cases)

CREOL Program in Processing and Characterization of New Glasses

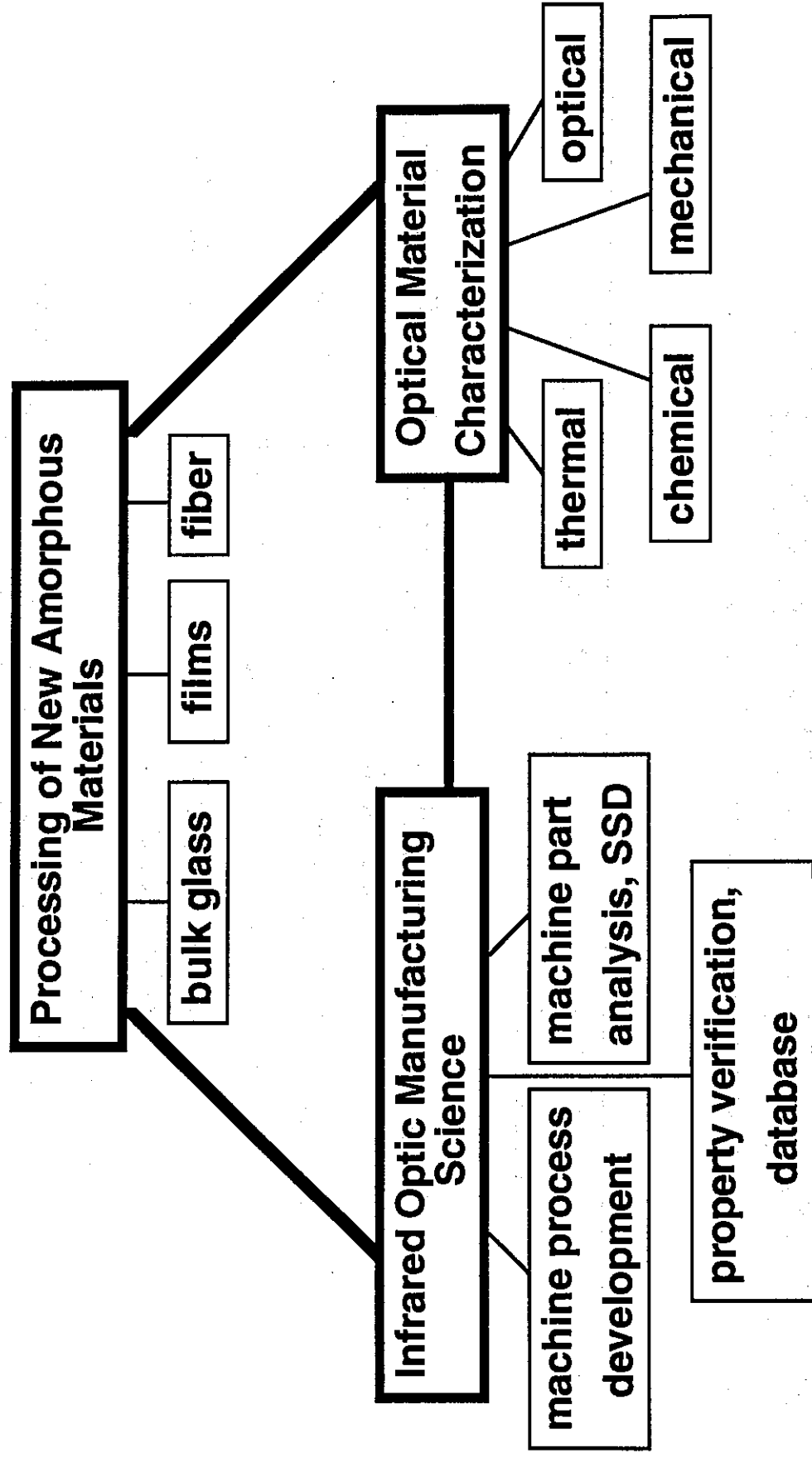
Dr. Kathleen Richardson

**Asst. Prof. of Chemistry
and Mechanical and Aerospace Engineering**

Affiliates Day, January 14 1993

Glass Processing and Characterization

Glass Processing and Characterization



IR Manufacturing Science

IR Physical Property
Database: collate

Experimental Verification
of mechanical and thermal
properties

Use of Dynamic Hardness Testing
to examine *low load* mechanical
properties

SSD process development:
etchant identification
dimpling technique
optimization

IR material: coolant
compatibility study

Integrated Processing Studies
with Texas Instruments

Glass Processing and Characterization

Process Science Partners

Byelocorp Scientific	CNC Systems	Corning Inc.
Crystal Systems	Galileo E-O	J.L. Wood
JML Optical	Kodak	Hughes
IMO/Varo	LaCroix Optical	Lawrence Livermore
Lightning Optical	Litton Itek	Martin Marietta
Meller Optics	Morton Int'l	Monroe Comm College
Optical Components	Optikos	Pacific Optical
Precision Optical	Rank Pneumo	Spectra Physics
Schott Optical	Speedring	Texas Instruments
Tropel/GCA	Two-Six	Zygo
U of Arizona	U of Central Florida	U of Rochester

Optical Material Characterization

- thermal
 - softening/melting, decomposition temperatures, specific heat, weight loss
 - thermal expansion
- mechanical
 - strength, microhardness, fracture toughness, surface modulus
 - Young's modulus
- chemical
 - chemical compatibility (ZnSe fabrication)
 - durability (laser rod/coolant interactions)
 - pH, thermo-chemical interactions
- optical
 - stress-optic coefficient
 - index, dn/dT

Acknowledgments

We acknowledge the support of the following who have provided funding or materials for these studies:

Center for Optics Manufacturing

University of Central Florida

U.S. Army Materiel Command

Texas Instruments

II-VI, Inc.

Lightning Optical Corp.

Corning Inc.

Eagle-Picher

Optovac

Crystal Systems

Amorphous Materials, Inc.

Infrared Systems Research at CREOL

CREOL Open House

January 14, 1994

Dr. Glenn Boreman

Associate Professor

CREOL & Electrical Engineering

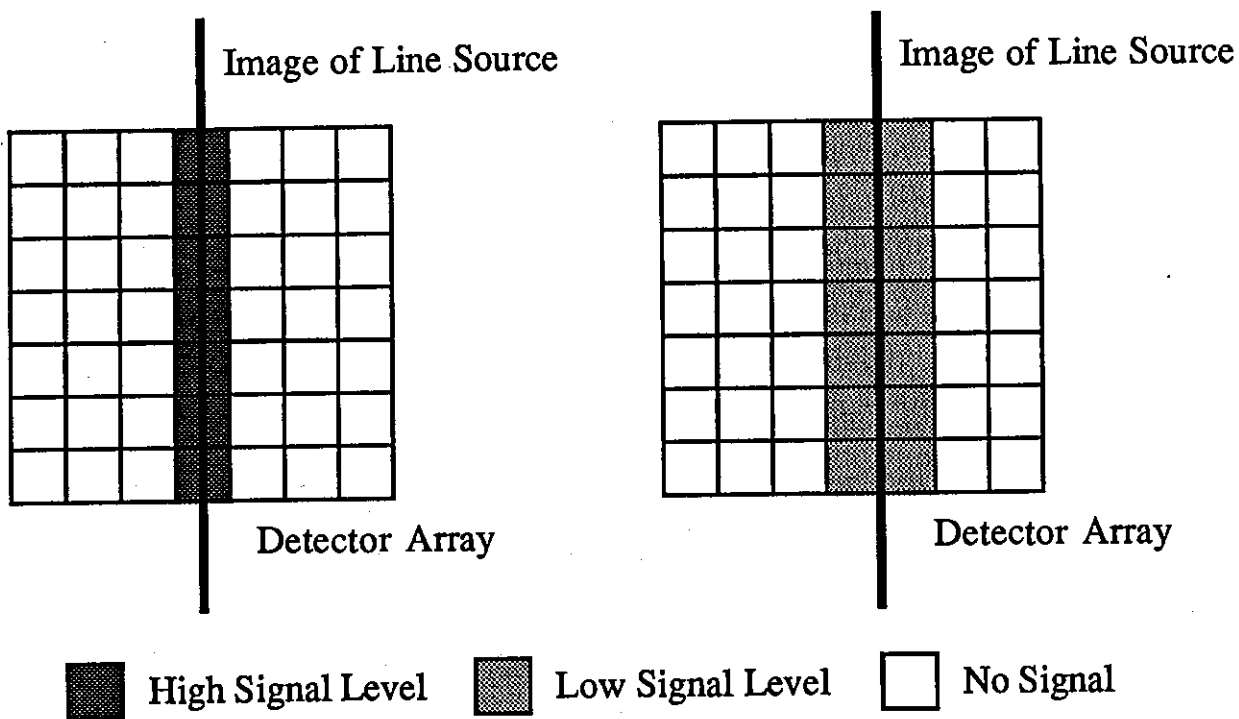
(407) 658-6815

Research areas:

- * **Characterization of IR systems**
- * **Performance modeling of IR systems**
- * **Applications of IR in medicine and materials processing**
- * **Microantennas for IR detectors**

Why use noise-like test targets for resolution testing?

Deterministic targets have a position dependence with respect to discrete detector locations - this affects the measurement

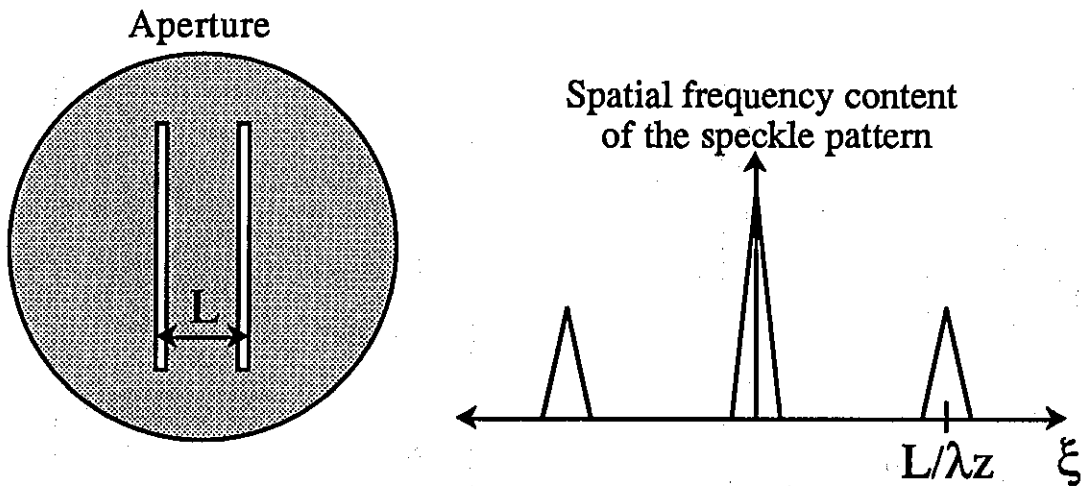
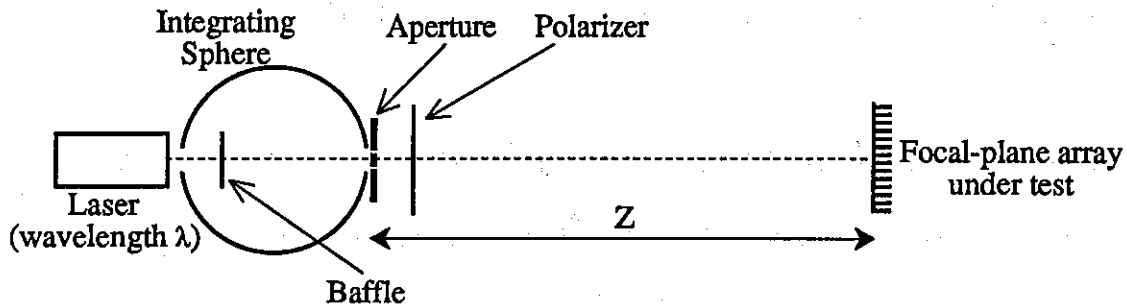


Requires precise alignment and high degree of operator skill --
not amenable to automation or high-volume testing

Noise-like test targets average out this position dependence

Laser-speckle technique tests detector arrays alone

(developed for Eglin AFB and Army Research Lab)



Resulting speckle has a narrow spatial frequency content

Frequency changes as z changes

Measure the modulation depth of the fringes - yields MTF

Performance Modeling of IR Systems

Research currently supported by:

Army, Redstone Technical Test Center, Huntsville, AL
Westinghouse Electro-Optics, Orlando, FL

We participate in a variety of systems-modeling efforts for the next generation of military IR sensor systems

Our activities with Redstone are in support of the TOW program office and involve system design, engineering trade-off analysis, and design of new test methods

Our activities with Westinghouse involve a class of IR sensors known as Signal Processing in the Element (SPRITE) detectors

SPRITEs employ a charge-integrating photoconductive detector

Our previous research in this area was sponsored by Army
Night Vision Lab and McDonnell Douglas

Our published* models for SPRITE performance were adopted
in the standard Army Night Vision Lab computer model
(FLIR-92) for IR system design

*G. Boreman and A. Plogstedt, "Modulation transfer function and number of equivalent elements for SPRITE detectors," Appl. Opt. 27, 4331-4335 (1988).

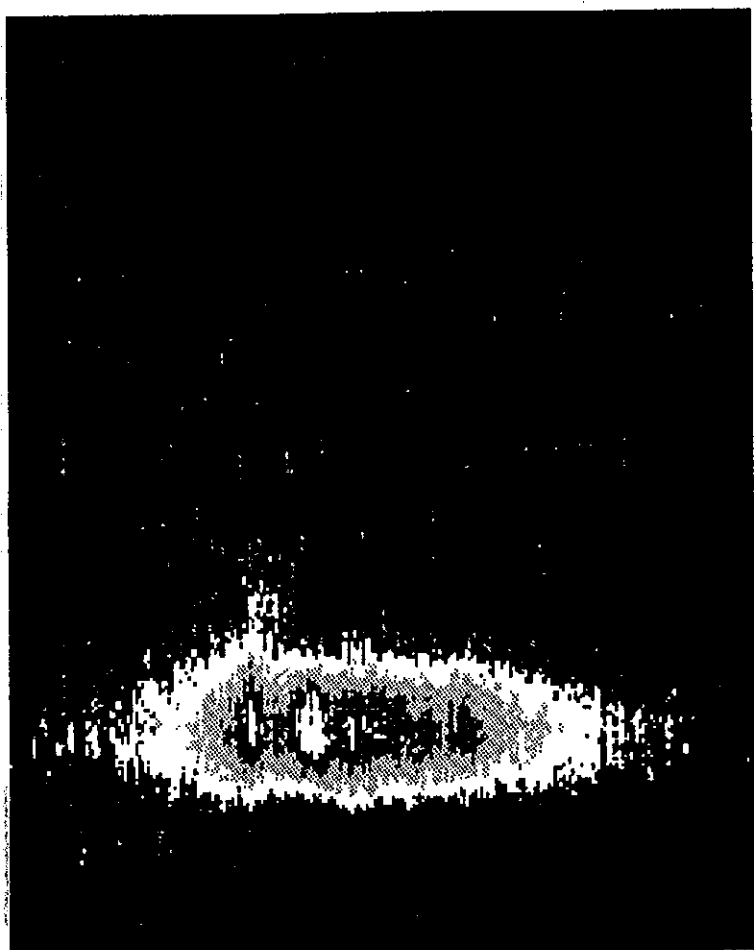
*G. Boreman and A. Plogstedt, "Spatial filtering by a line-scanned nonrectangular detector: Application to SPRITE readout MTF," Appl. Opt. 28, 1165-1168 (1989).



Materials Processing

A demonstration of the potential for IR techniques in process control is shown on the following slides, where a sample of pyrolytic graphite has been irradiated with a single pulse of radiation from a YAG laser

The material has an order of magnitude difference in thermal conductivity in the horizontal and vertical directions



Microantennas for IR Detectors

Research currently supported by:

Florida High Technology Council

We have a Cooperative Research & Development Agreement (CRADA) in place with National Institute for Standards & Technology (NIST), Boulder, CO for investigation of planar lithographic antennas used to couple radiation into IR detectors

NIST has recently demonstrated* antenna coupling to a bolometer at 10 μm wavelength

Antenna-coupling techniques stand to increase the sensitivity of existing IR sensors by more than an order of magnitude

Our cooperation with NIST uses NIST's fabrication facilities and CREOL's capabilities in numerical analysis and IR detector measurement

We use Cray YMP supercomputer for finite-element analysis of the antenna structures that NIST has already fabricated

* Grossman et al.,

"Lithographic spiral antennas at short wavelengths", Appl. Phys. Lett. 59, 3225-7.

Our numerical models will be compared with the antenna patterns measured at NIST

These models will allow us to investigate new designs for specific applications

We are currently designing instrumentation that will allow measurement of antenna performance over the range of 3 to 30 μm using tunable IR diode lasers

Summary

CREOL's IR Systems Lab

**We have a track record of successful collaborations with
industry and government**

**We would like to explore opportunities for collaboration with
your company in areas of mutual interest**

Advanced Optical Thin Films

Karl H. Guenther

Associate Professor
Department of Electrical and Computer Engineering
Department of Physics
Center for Research in Electro-Optics and Lasers
(CREOL)

University of Central Florida

12424 Research Parkway
Orlando, FL 32826

Phone (407) 658-6832
FAX (407) 658-6880
Internet: guenther@admin.creol.ucf.edu
kguenther@aol.com
dtnd89a@prodigy

Objectives

To study and exploit:

- ♦ Linear optical effects, $n = f$ (thin film structure, composition): Interference, polarization, absorption, scattering, guided optical waves

Applications: Optical coatings (intra- and extra-cavity), metrology of optical surfaces and thin films, sensors

- ♦ Quantum optical effects: Bandgap shift of optical materials (Si) due to nanometer size thickness and structure

Applications: Photo- and electroluminescence of Si for surface emitting diodes and vertical cavity lasers

Aiming at:

Low-loss thin films, suitable for high power lasers, optical communication, waveguide sensors, displays

People Involved

Faculty / Principal Investigator:

Dr. Karl H. Guenther, Associate Professor of
Engineering Science and Physics

Research Scientists:

K. Balasubramanian, Ph.D. (OSC/UAZ), Adjunct
Assistant Professor EE (1989-1992), now self empl.

Marc Himel, Ph.D. (OSC/UAZ), now at AT&T Bell Labs

Sohrab Zarrabian, Ph.D. (Chemistry/UF), now at Airco
Coatings, Concord, CA

Thomas Kimble, M.S. (Physics/UCF), Valencia CC

International Visitors:

H. Schink (U. Hannover, FRG), Z. Taubenfeld (Israel),

G. Fanmui (ENSPM, Marseille, France), K. Montkau

(U. Hannover, FRG), S. Ogura (Kobe, Japan), X.-Q Hu

(Zhejiang U., PRC), Z. Yang (Chonging Inst., PRC),

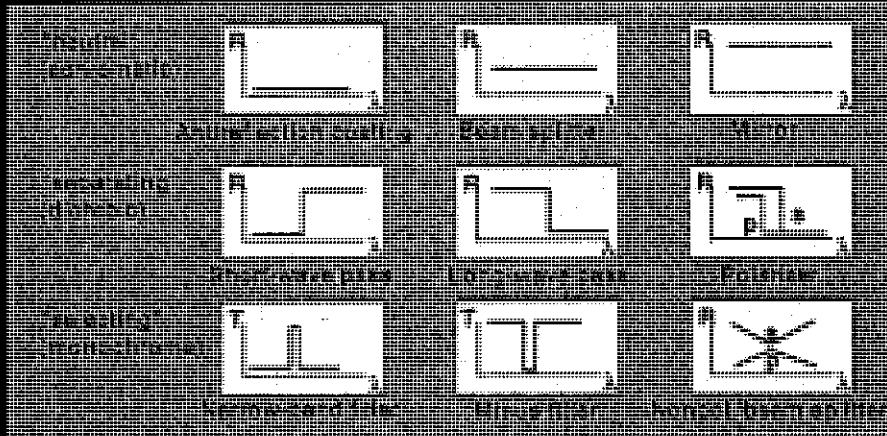
B. Zeyben (FHS Berlin, FRG).

Students

Undergraduate:	Graduate:	grad. date
J. Mabry, ET	A. Rubin, ECE	current
M. Bitterman, ECE (NSF/REU)	S. Qian, ECE	current
J. Gibbs, ECE (NSF/REU)	S. Raneru, ECE	current
S. Nunez, Comp. Sci.	S. Zarrabian, ECE	Summer 93
J. Cryer, Comp. Sci.	X.-F. Han, ECE	Summer 93
J. Richmond, ET	C. Lee, EE	Spring 92
J. Santiago, Physics	T. Kimble, Phys.	Fall 91
K. Karpinchik, Physics	D.-X. Sun, EE	Summer 91
I. Penny, Physics	T. V. Le, EECS	Fall 90
A. Hutchinson, ET	S. Savrda, EECS	Fall 90
P. Sachdeva, EECS		

Thin Film Optics

Radiation filters (dielectric multilayer coatings) based on
Interference and Polarization



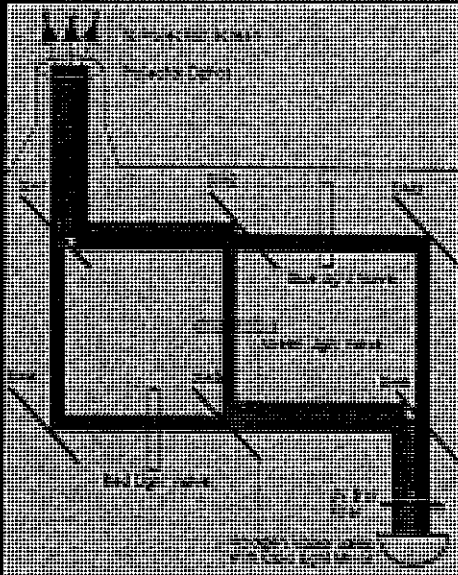
Ring Laser Gyroscope



Scientific American Vol. 267 Nr. 6 p. 29 (Dec. 1992)

Optical Coatings for HDTV

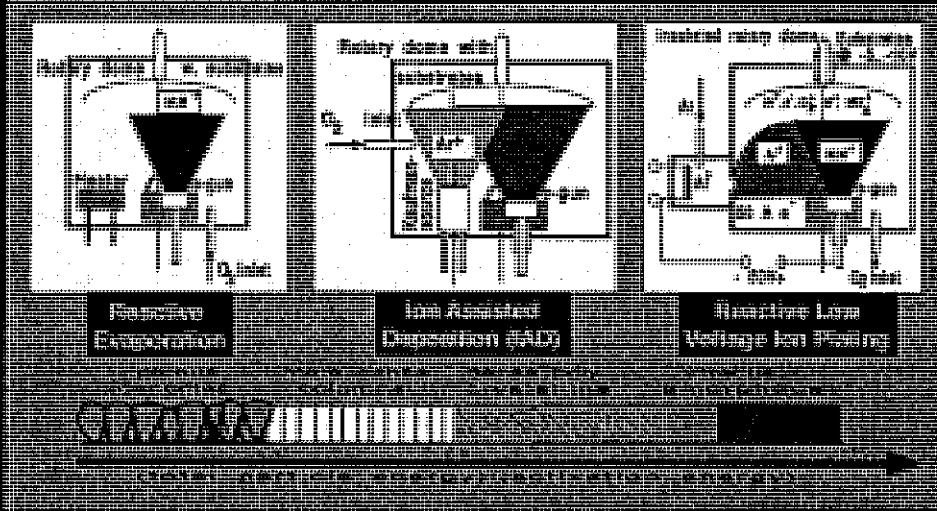
(Projection with RGB Light Valves)



Thin films are used for:

- Broad-band antireflection coatings on projection optics (lenses) and light valve covers
- Transparent conductive coatings (ITO) for liquid crystals
- Dichroic mirrors (DM1...DM5) reflecting the following colors:
 - DM1...blue, green
 - DM2...green
 - DM3...blue
 - DM4...red
 - DM5...green
 - DM6...green, red
- UV and IR protection filter
- Cold light mirror

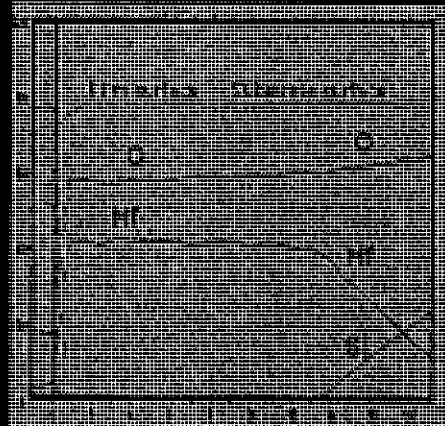
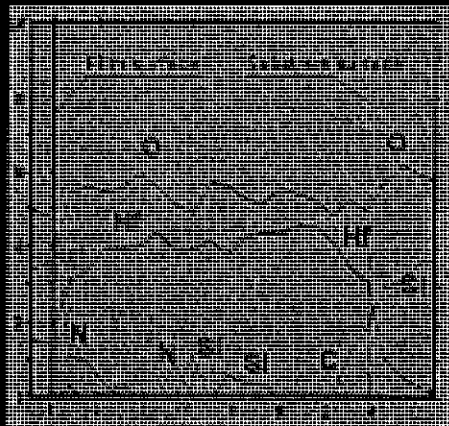
Comparison of Evaporation-based Physical Vapor Deposition (PVD) Processes



ESCA Depth Profiles of HfO_2 Films

a. electron-beam (EB) evaporation

b. ion plating (IP)

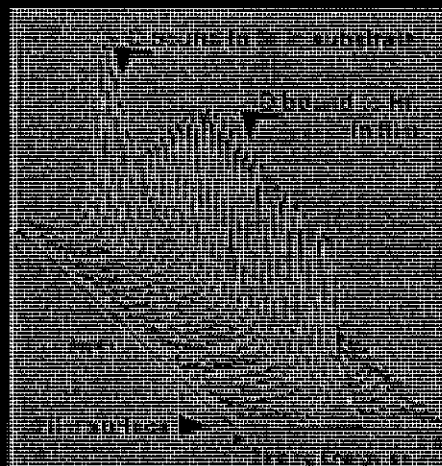
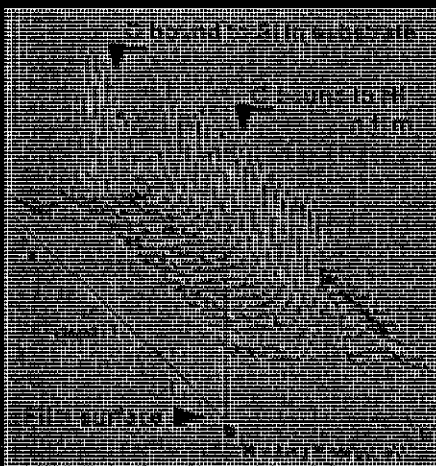


(Courtesy of M. Edgell, Charles Evans & Associates, Redwood City, Cal.)

Oxygen Binding Energy in HfO_2 Films

a. electron-beam (EB) evap.

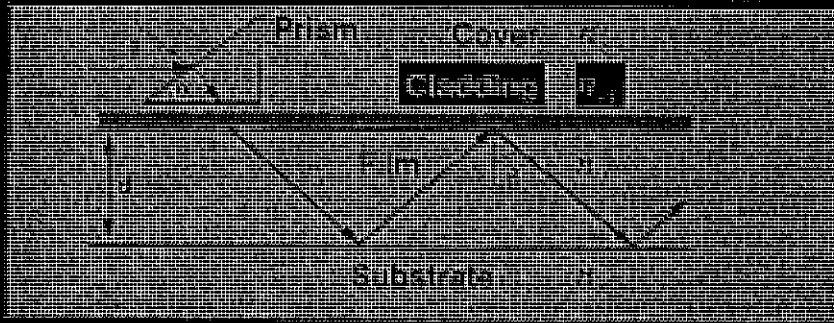
b. ion plated (IP) sample



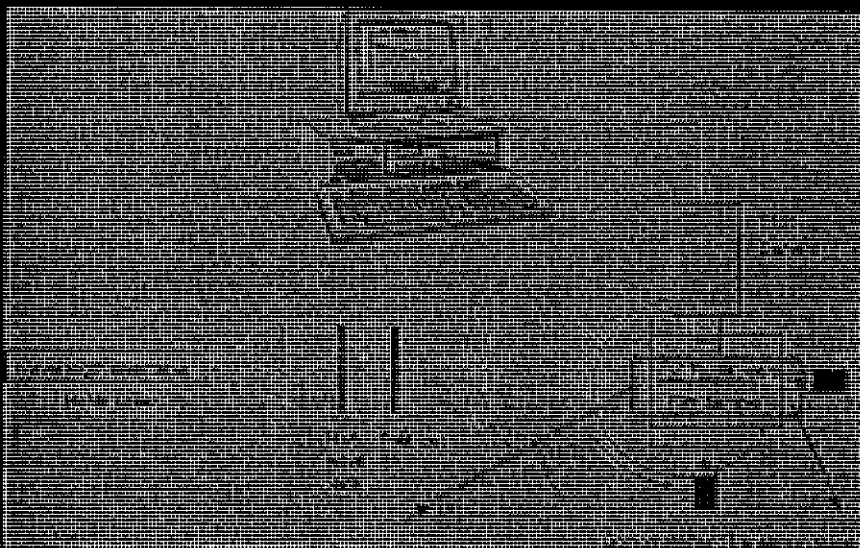
(Courtesy of M. Edgell, Charles Evans & Associates, Redwood City, Cal.)

Metal-clad Planar Optical Waveguide

- Surface of dielectric waveguide coated with transparent metal film (Palladium)
- Metallic cladding n_{cl} changes wave propagation conditions (mode angle)
- For same angle θ , incoupling efficiency decreases
- Ad- or Absorption of gas (H_2) supposedly changes n_{cl}



Set-up for Optical Waveguide Loss Measurements of Pd-clad Tantalum Films



Optical Thin Film R&D at CREOL/UCF Using Energetic Particle Processes (1)

- ❑ Advanced PVD processes for optical coatings
 - Ion Assisted Deposition (IAD): "industry standard," in collaboration with Virgo Optics (Port Richey, FL)
 - Reactive Low Voltage Ion Plating (RLVIP): "top solution," employing a state-of-the-art Balzers BAP 800 coater
- ❑ Process and thin film characterization
 - Optical emission spectroscopy, using an EG&G monitor
 - Optical waveguide properties: attenuation (loss)
 - ESCA depth profiling (chemical composition, Ch. Evans)
 - Surface imaging and roughness measurement using STM (KFU Graz) and AFM (FIU Miami, FSU Jena)
 - Ultra - micro-hardness testing (at TU Vienna, Austria)

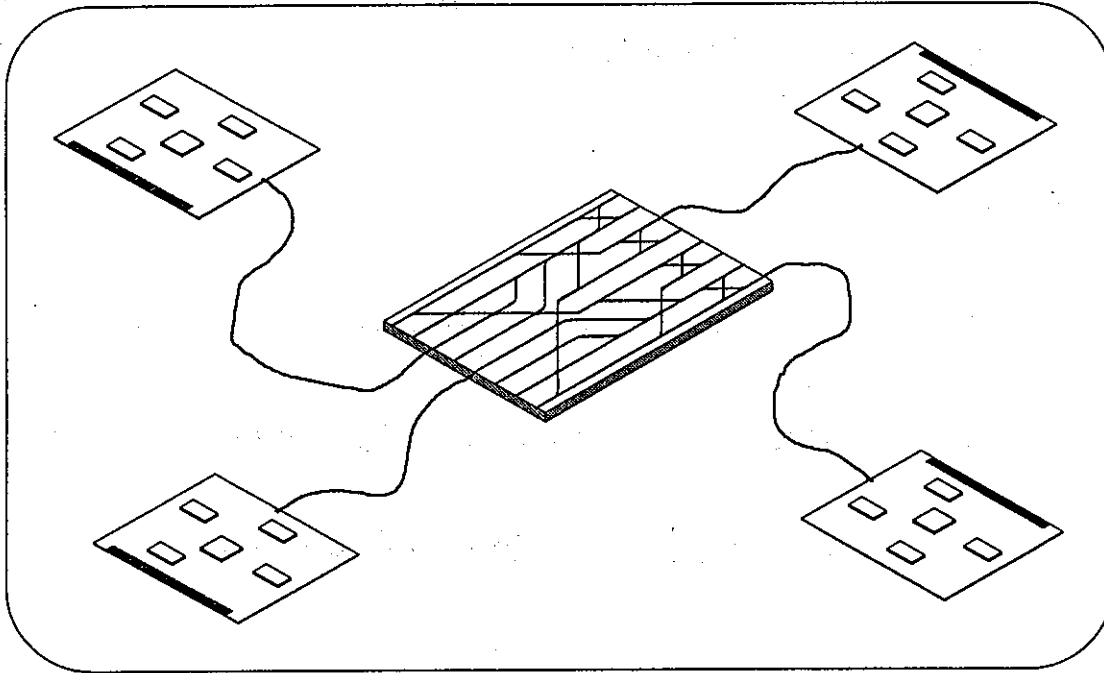
Optical Thin Film R&D at CREOL/UCF Using Energetic Particle Processes (2)

- ❑ Outlook and future work
 - Coating of plastic substrates (completed SBIR-II sub)
 - Diamond-like carbon films (abrasion / erosion resistant): Preliminary results with evaporation of spongy graphite and methane plasma in BAP 800 show feasibility
 - Co-deposition from up to 3 evaporation sources (BAP 800) for multi-component glass films: tailored mixed oxides, laser glass
 - Nonlinear optical devices: waveguide lasers, NLO laser protection filters (proposal with Schwartz Electro-Optics)

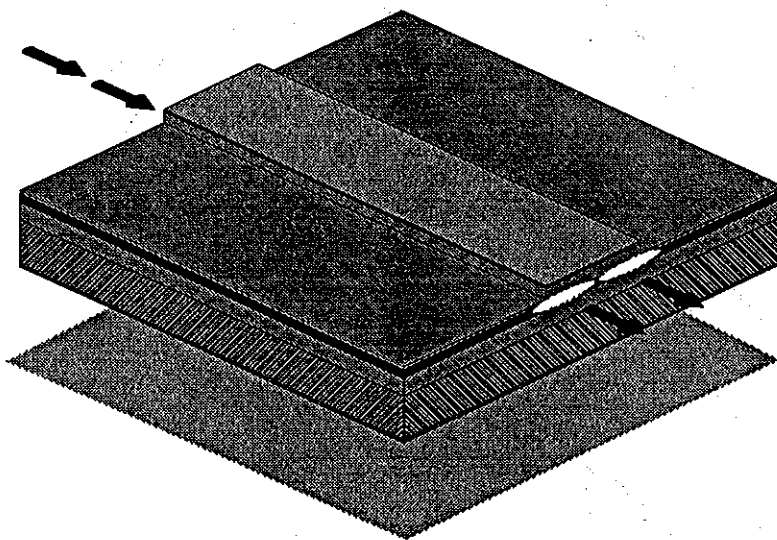
SEMICONDUCTOR OPTOELECTRONICS

Patrick Li Kam Wa

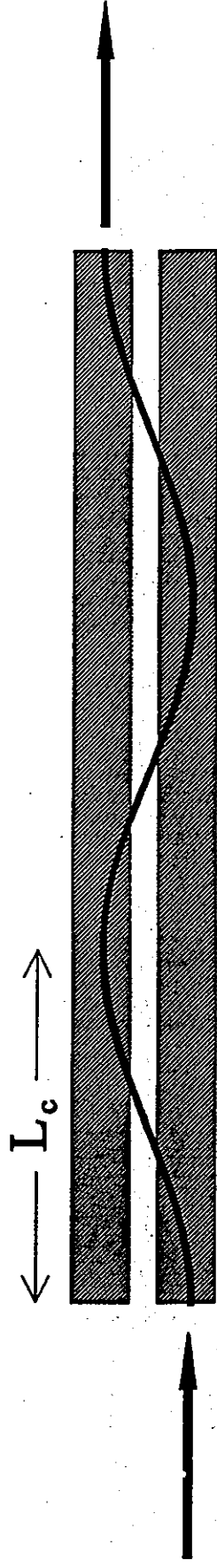
Asst. Professor Electrical and Computer Engineering



Controlling Flow of Data in Local Area Optical Networks



All-Optical Directional Coupler Switch



E-field
symmetric
mode



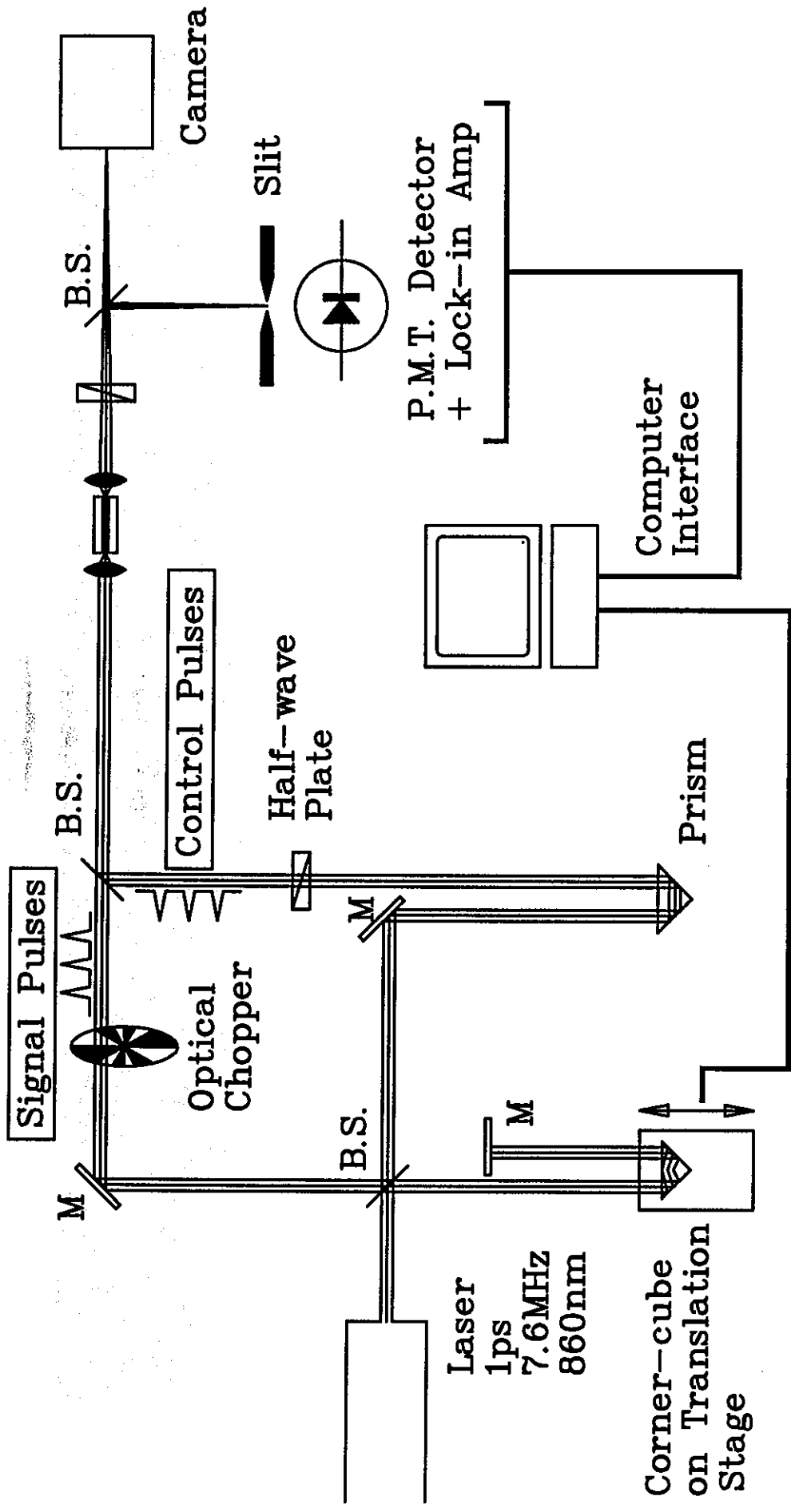
E-field
anti-
symmetric
mode



Intensity
combined
modes



Waveguide Directional Coupler

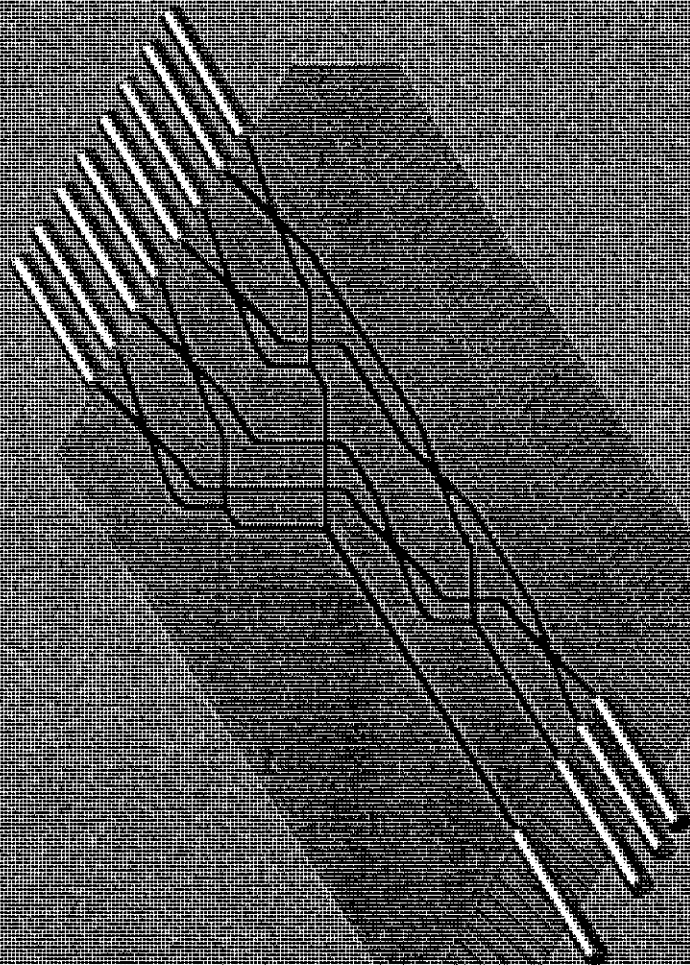


Time resolved optical pump-probe set-up

Switching Speed Enhanced by Carrier Sweep-Out



Integrated All-Optical Data Routing Circuit



Objectives

1. Optimize all-optical switches that operate close to the exciton resonance.
2. Characterize selective area disordering of MQW structures and fabricate low loss waveguides in the intermixed regions.
3. Fabricate a prototype 1 to 8 all-optical routing circuit on one single chip.

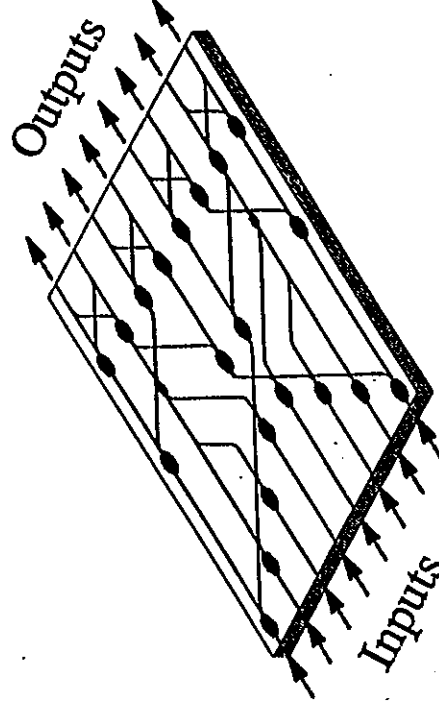
Approach

1. Design new MQW structures and optimized nonlinear directional coupler switches.
2. Fabricate all-optical devices using active semiconductor MQW material to provide gain for cascading.
3. Employ a simple process of impurity free selective area disordering of MQW's and fabricate low loss ridge waveguides.

Accomplishments

1. A zero-gap nonlinear directional coupler with a 10:1 contrast has been demonstrated.
2. Carrier sweep-out times of a few picoseconds have been measured in a QW waveguide.
3. A simple method of impurity free disordering of MQW's has been achieved and low-loss intermixed waveguides have been fabricated.

A conceptual switching network fabric



High Speed Photonics for Instrumentation, Networking and Signal Processing

Peter J. Delfyett

Center for Research and Education in Optics and Lasers

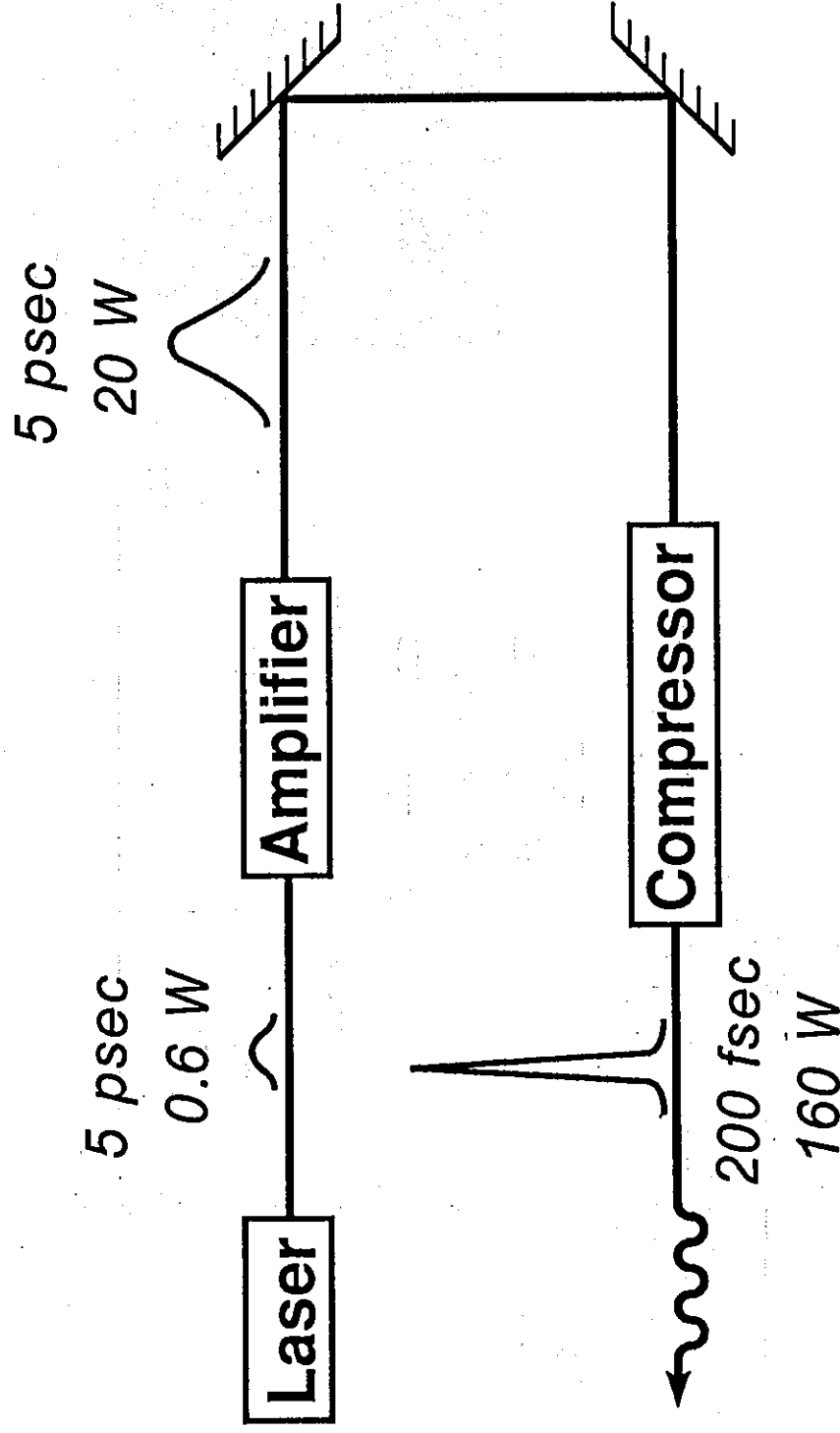
Electrical and Computer Engineering

University of Central Florida

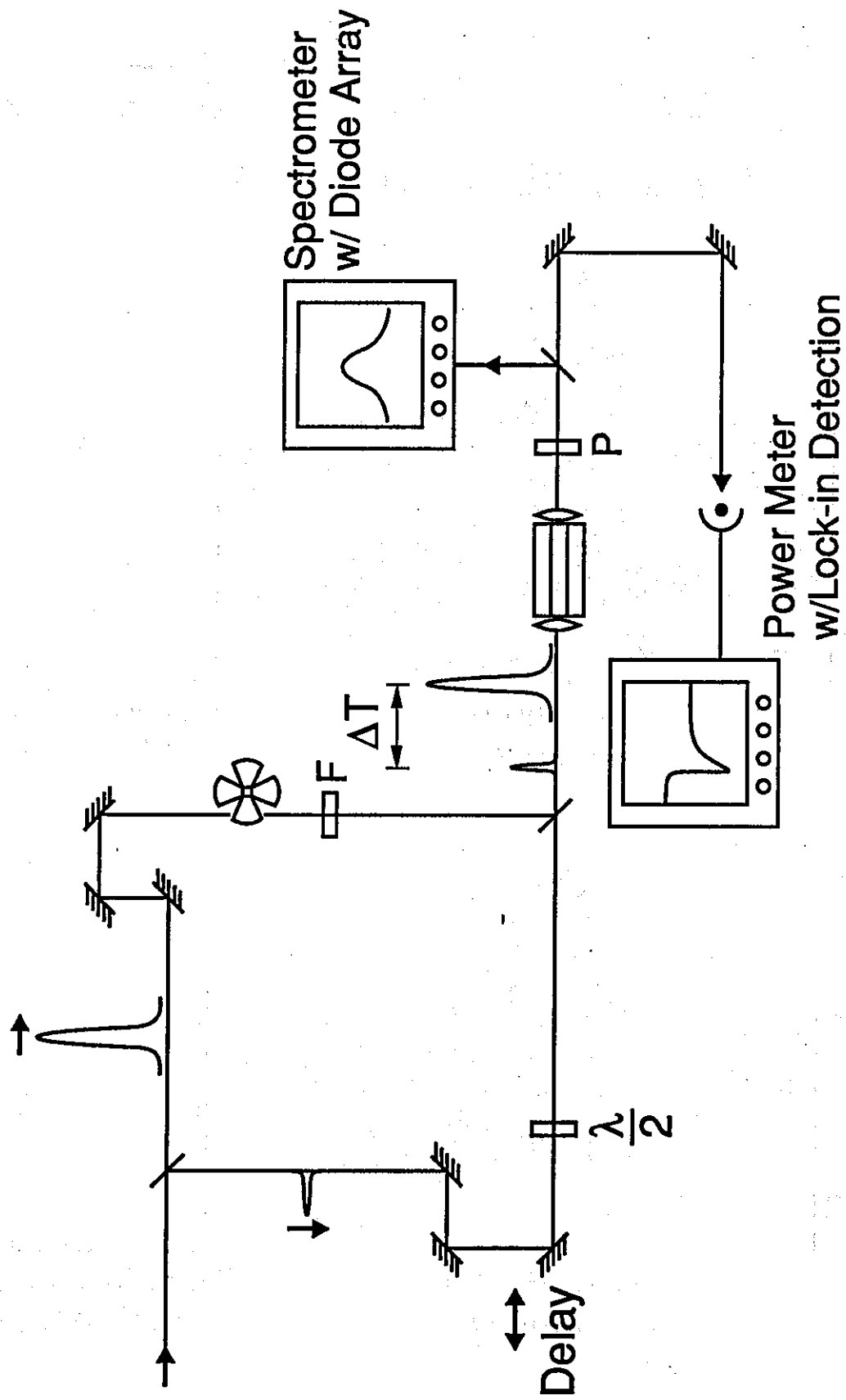
Introduction

- Goal -- To develop and utilize novel high speed opto-electronic devices and systems for uses in networking, signal processing and instrumentation.
- Motivation -- Inherently large bandwidth which photonics provides allows for information processing rates beyond 1 terabit per second.

High Power Mode Locked Diode Laser System



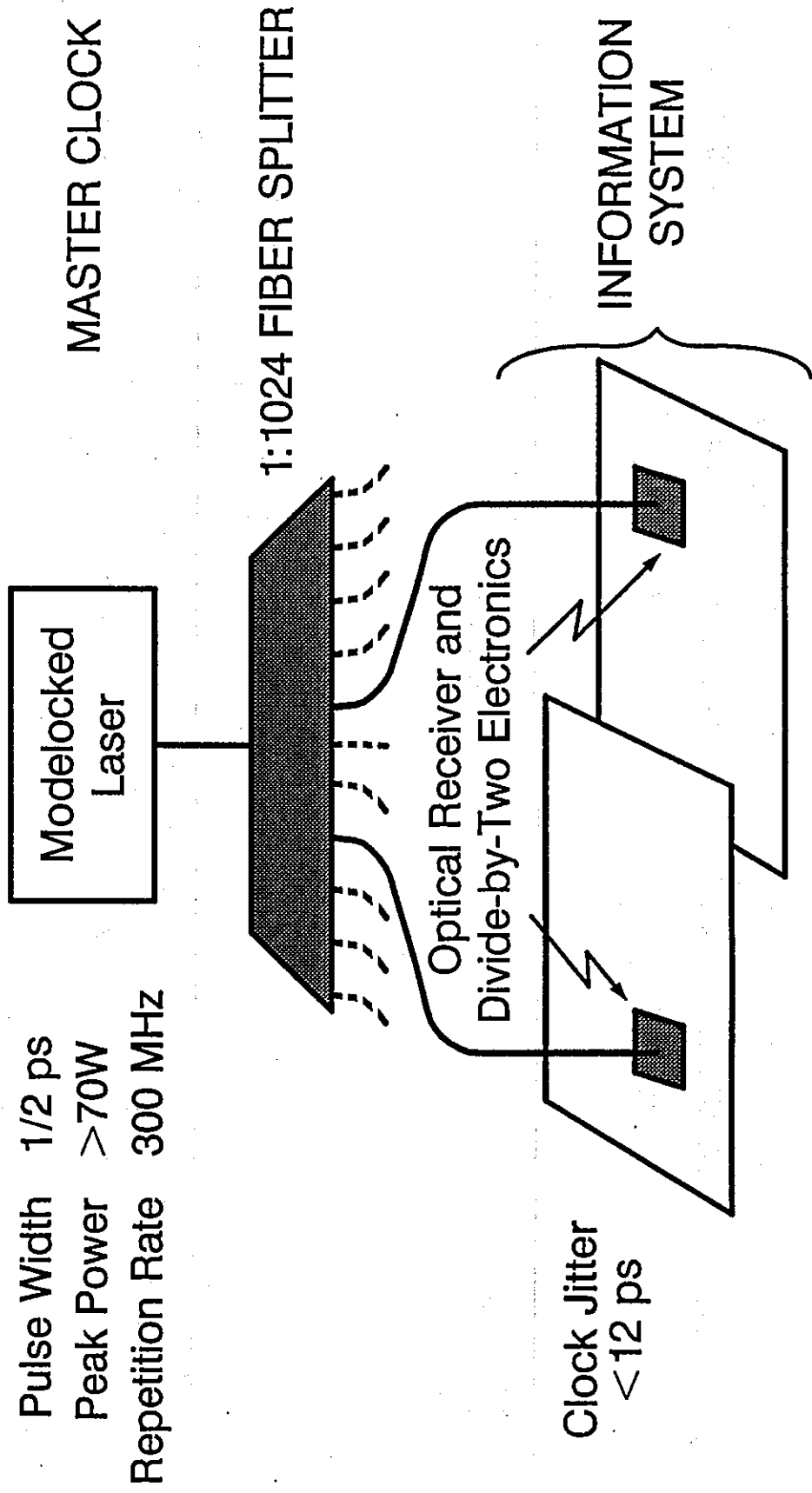
Experimental Setup



High Power Hybrid Modelocked Diode Lasers

Optical Clock Distribution

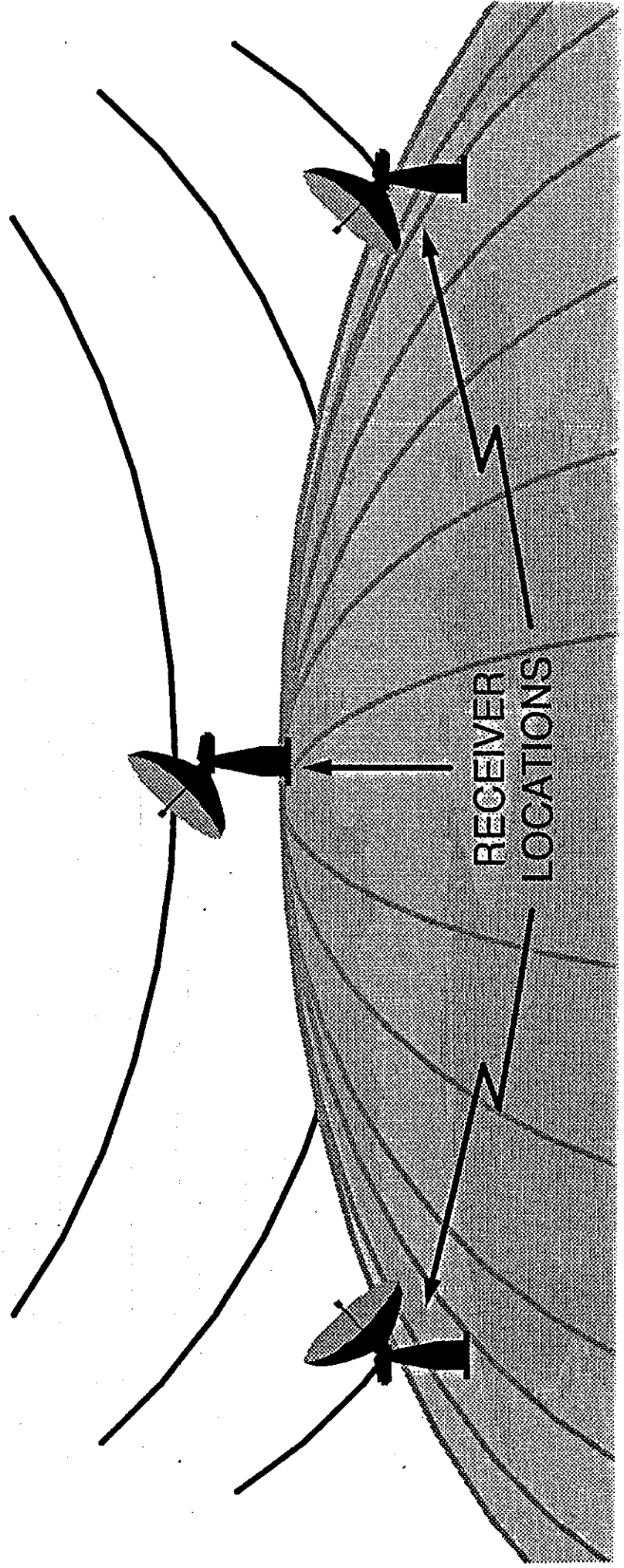
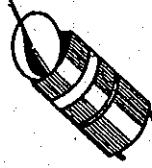
Pulse Width 1/2 ps
Peak Power >70W
Repetition Rate 300 MHz



Synchronously Driven Modelocked Diode Lasers

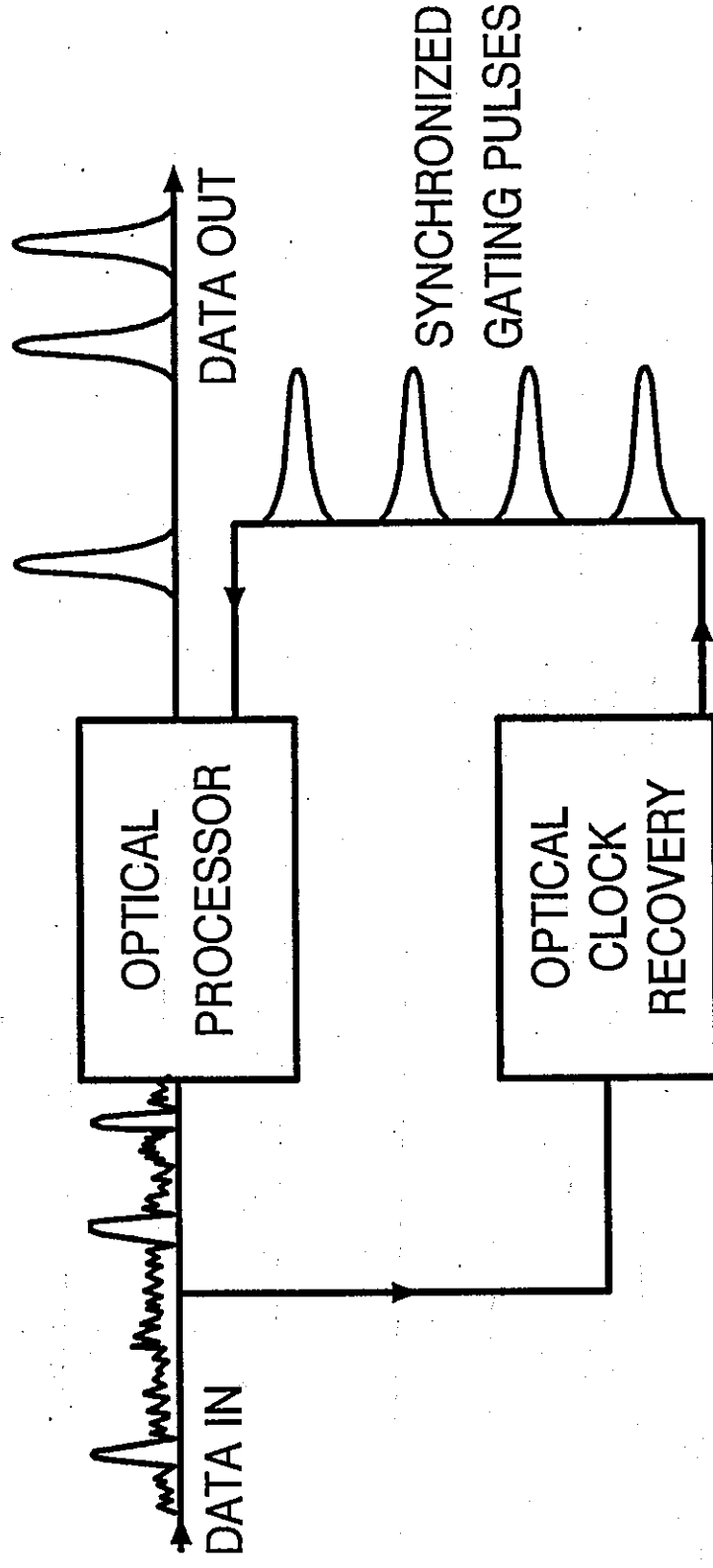
Global Synchronization

PRIMARY
REFERENCE
SOURCE



Injection Modelocked Diode Lasers

Optical Clock Recovery



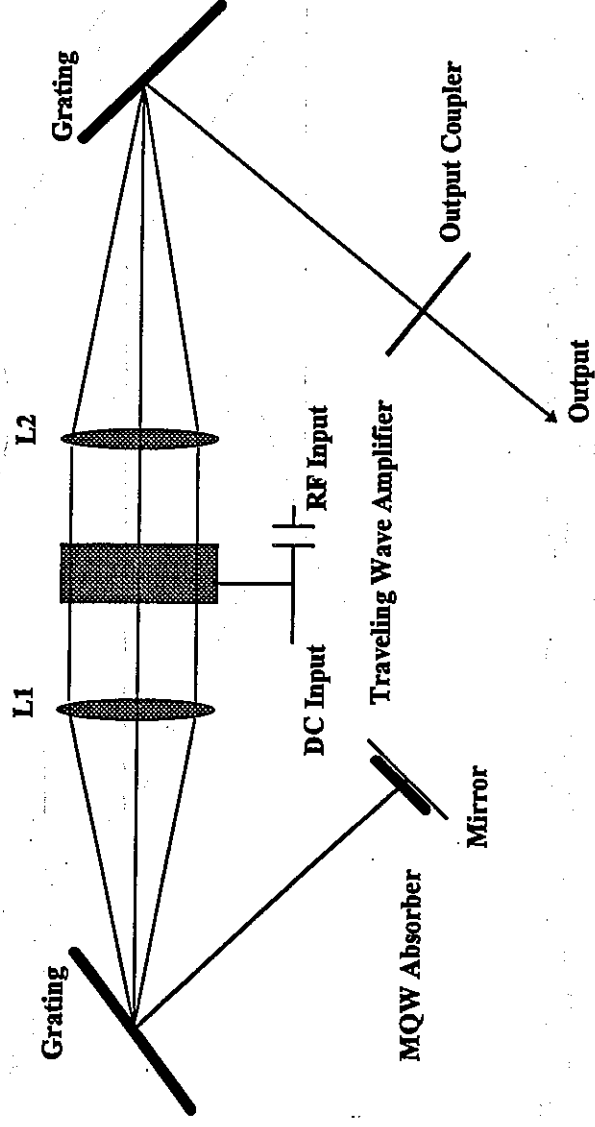
Applications

- Photonic switching
- Add-drop multiplexers
- CDMA & holographic pulse processing

Multiwavelength Modelocked Source for WDM-TDM

Photonic Networks

Spatially Dispersive Optical Cavity Arrangement



Conclusions

- Development of a compact, efficient source of high power ultrashort optical pulses from semiconductor laser devices.
- Demonstrated applications towards ultrafast measurements and photonic network applications.
- Highlighted several areas for future research planned for compact source development, and photonic networking.

NONLINEAR WAVEGUIDES

Dr. George Stegeman, Professor of Physics, CREOL/UCF

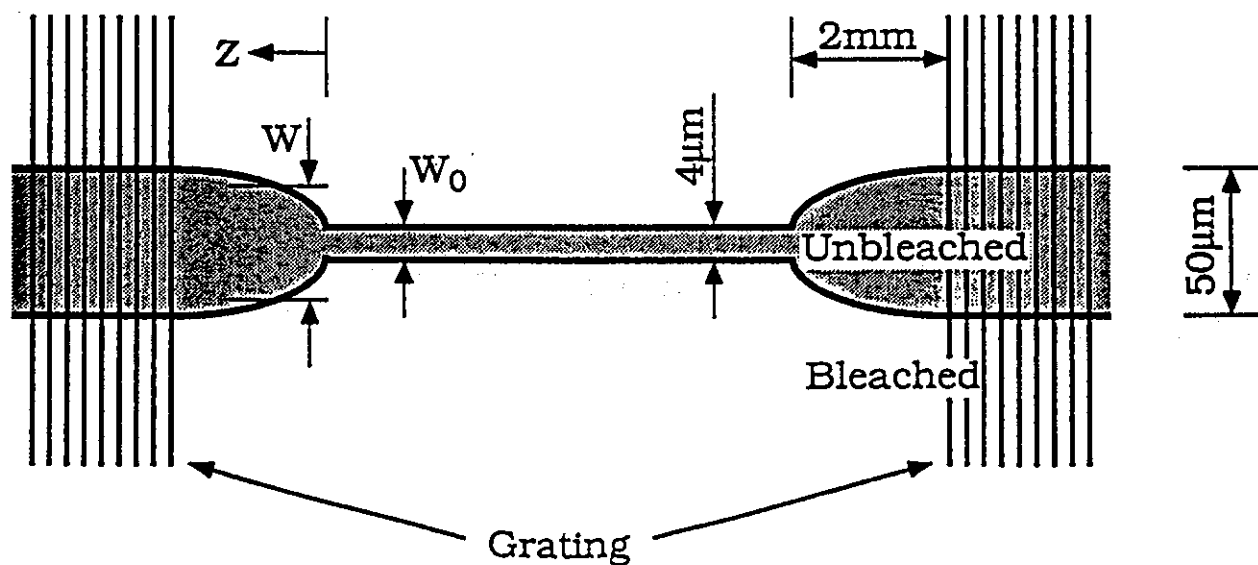
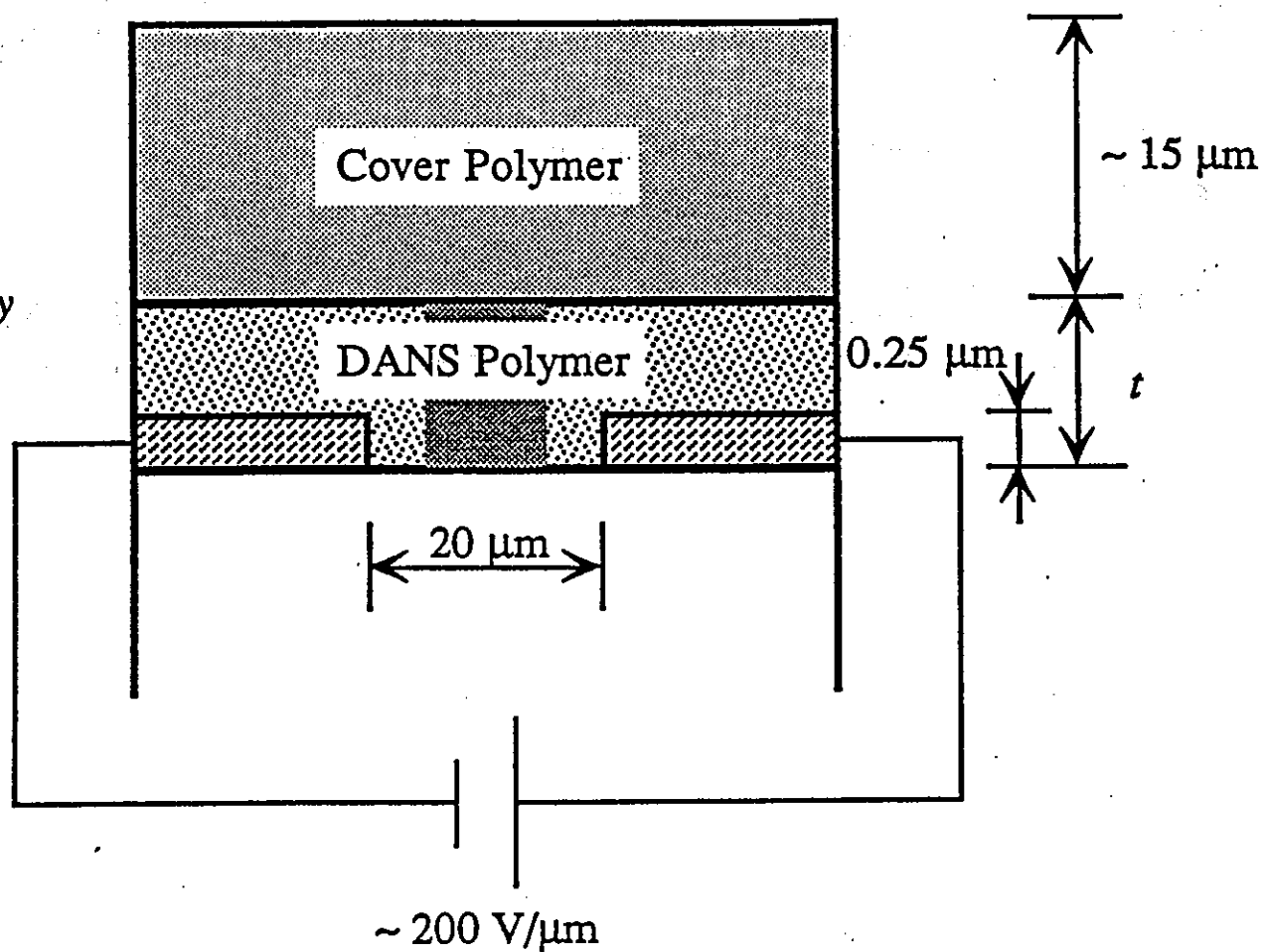
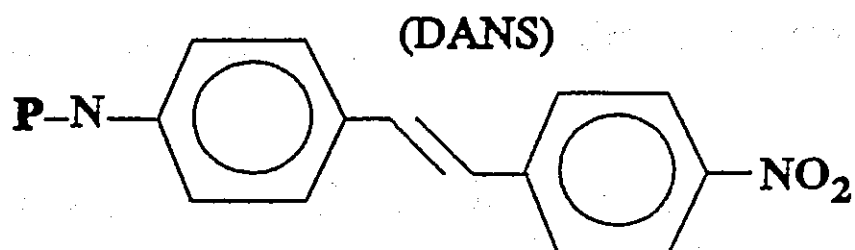
Objectives:

Long Term - Study the physics, engineering and applications of nonlinear optics in waveguides.

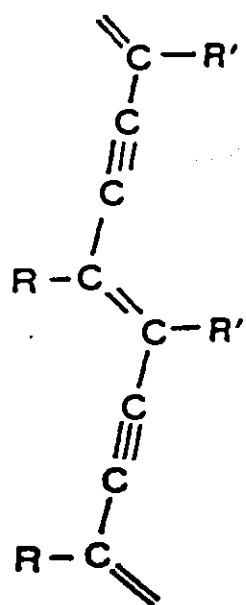
Short Term -

- Search for progressively better nonlinear optical materials via careful materials characterization.**
- Compare material properties against device driven materials figures of merit.**
- Investigate nonlinear optical interactions in waveguides.**
- Investigate second harmonic and electro-optic devices in polymers.**
- Investigate all-optical devices such demultiplexers, logic gates, transistors, interconnects, switching networks and nodes, modulators etc.**
- Assess novel applications of nonlinear phenomena such as solitons etc.**

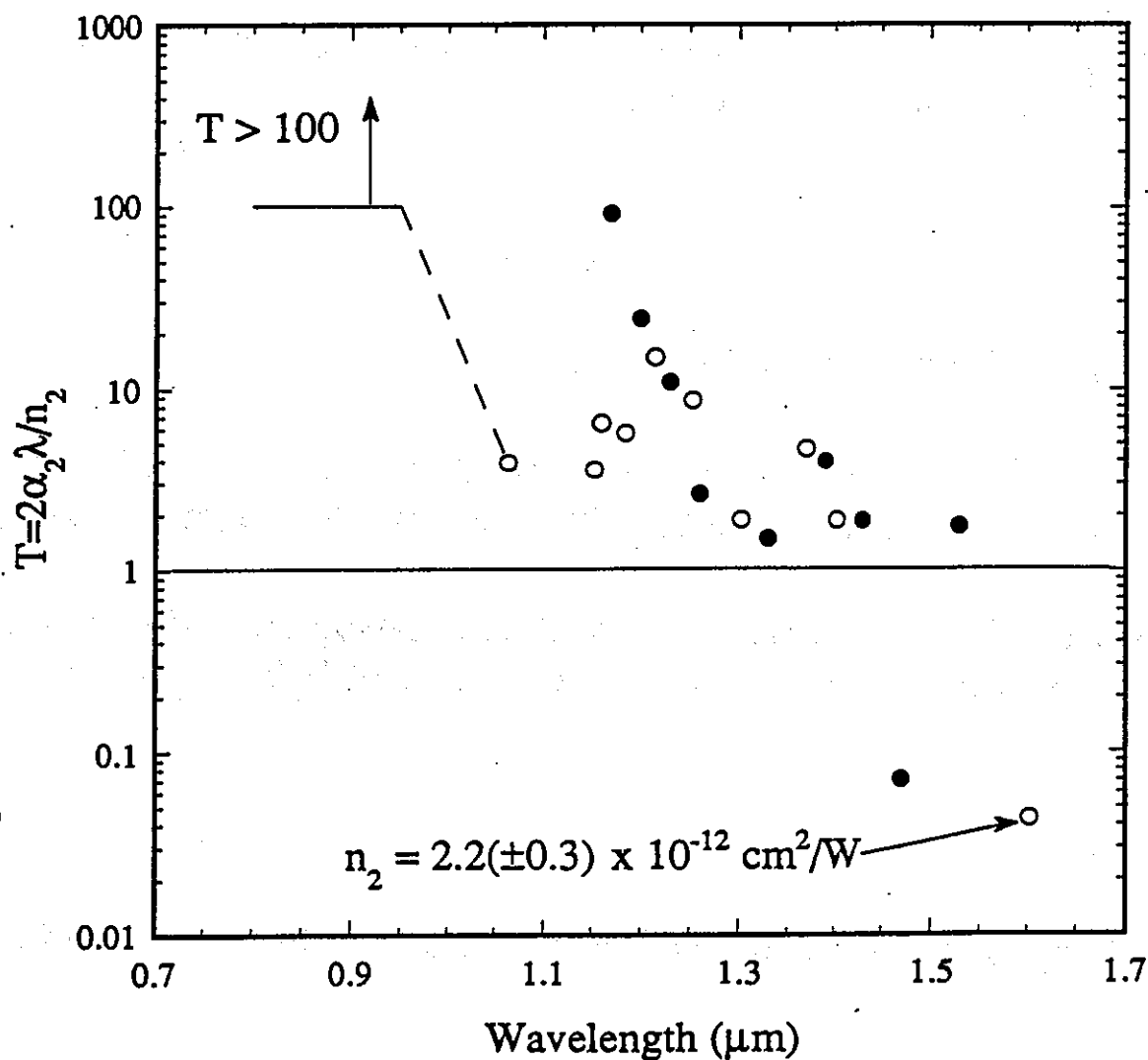
DANS SAMPLE FOR CP SHG



T PARAMETER: PTS



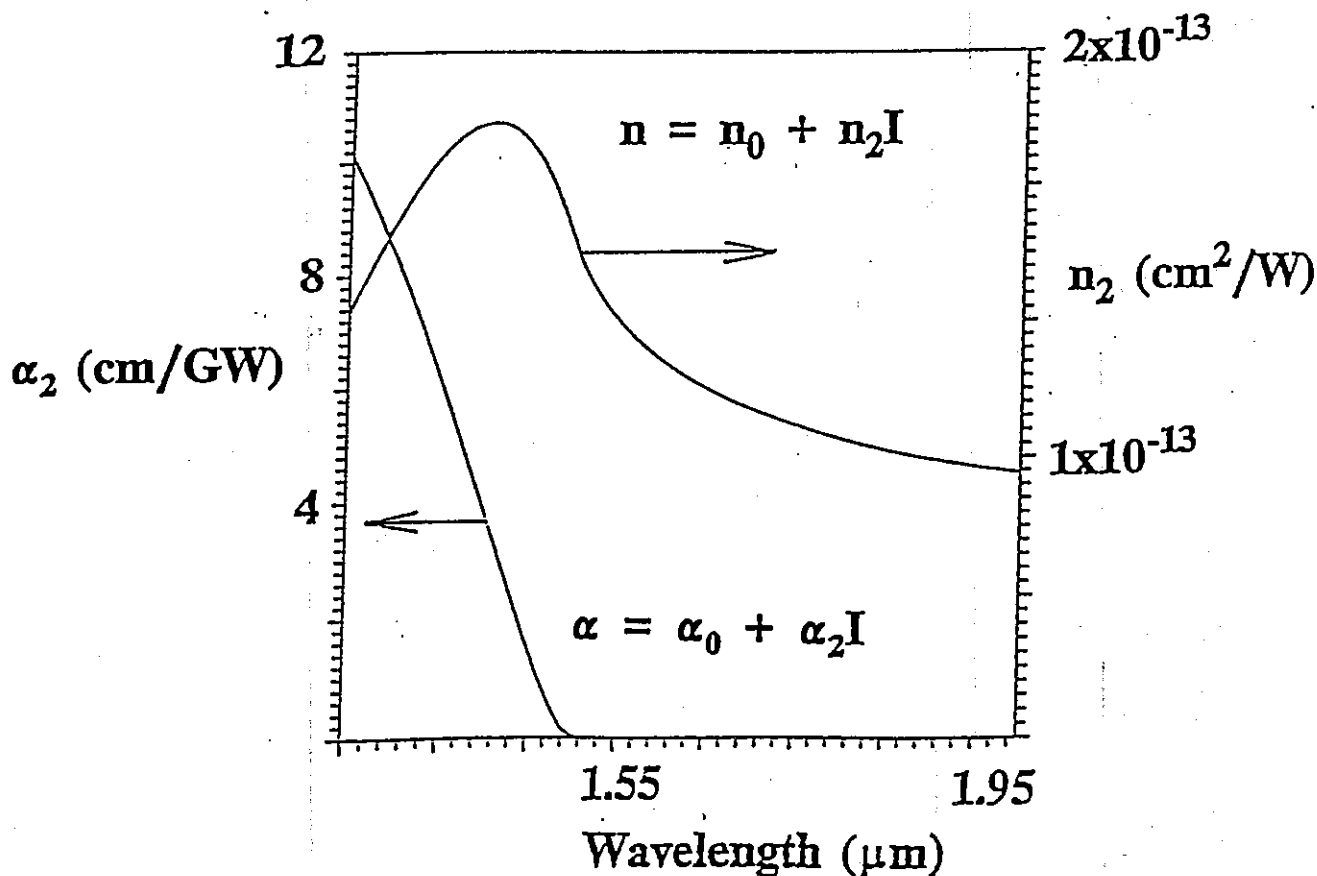
delocalized π -electrons of C=C and C $\equiv$ C bonds ($2p_z$ orbital above and below the plane) give large nonlinearities



ALL-OPTICAL SWITCHING IN SEMICONDUCTORS USED AT HALF THE BAND GAP

- All-optical devices including switches, logic gates, demultiplexers, modulators etc. in AlGaAs
- Operation at 1550 gives very high throughputs, no multiphoton absorption, and ultrafast nonlinearities
- Switching and demultiplexing operations with switching energies of tens of picojoules have been achieved with sub-picosecond pulses

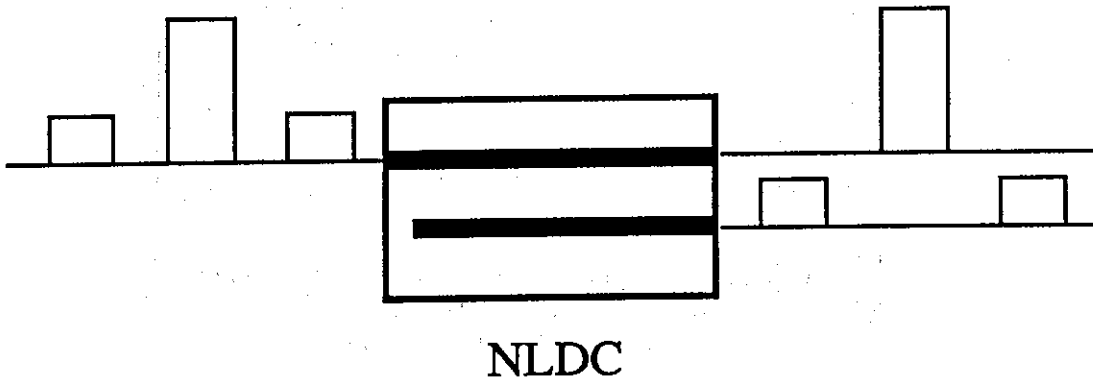
$\text{Al}_{0.18}\text{Ga}_{0.82}\text{As}$ $E_g/2 = 1550 \text{ nm}$



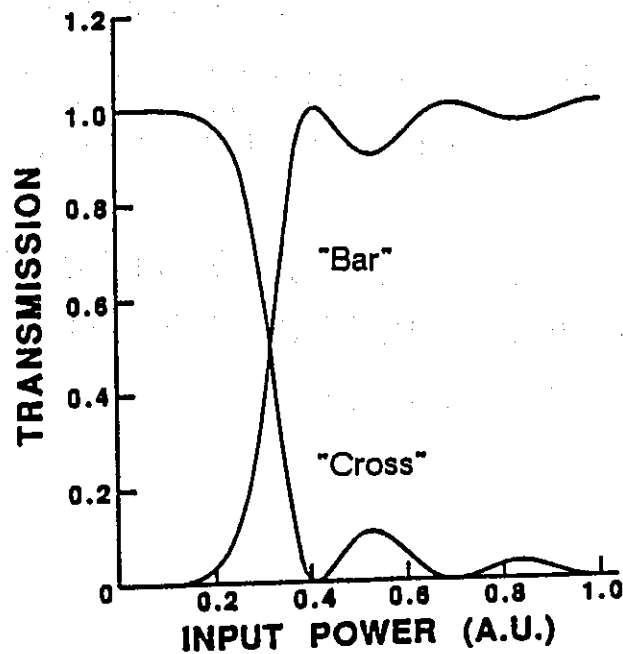
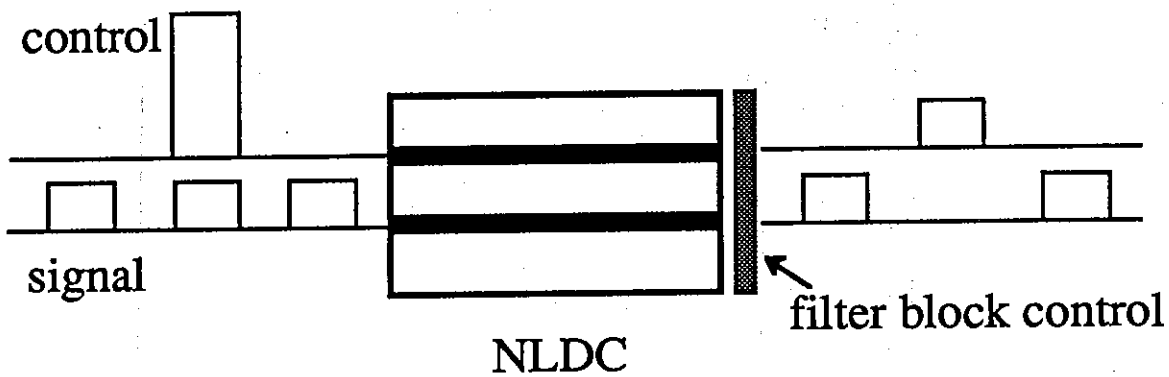
HALF BAND GAP NONLINEARITIES

ALL-OPTICAL SWITCHING

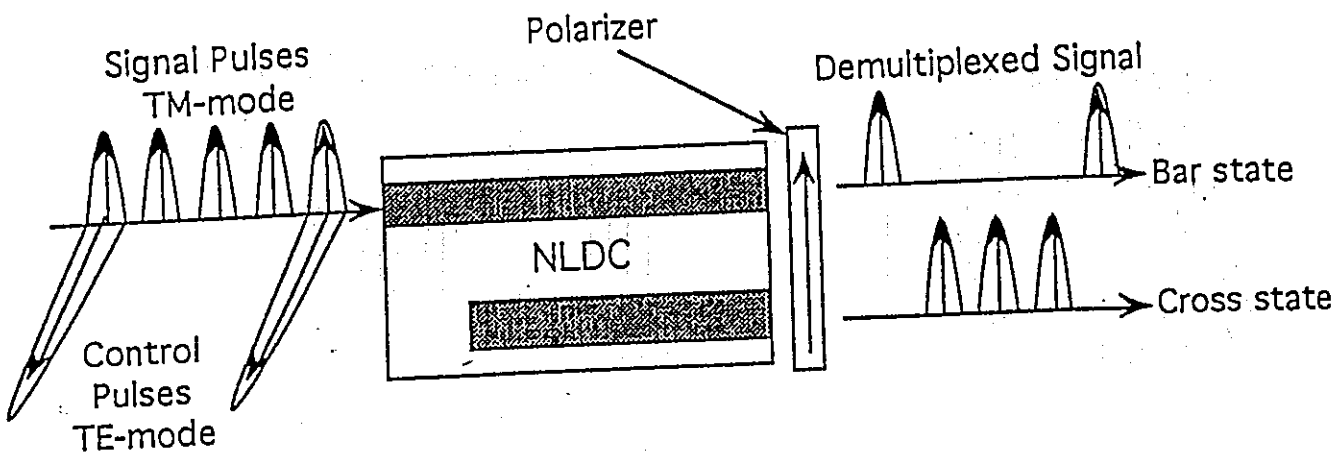
SELF SWITCHING



DEMULTIPLEXING



DEMULTIPLEXING - CONCEPT

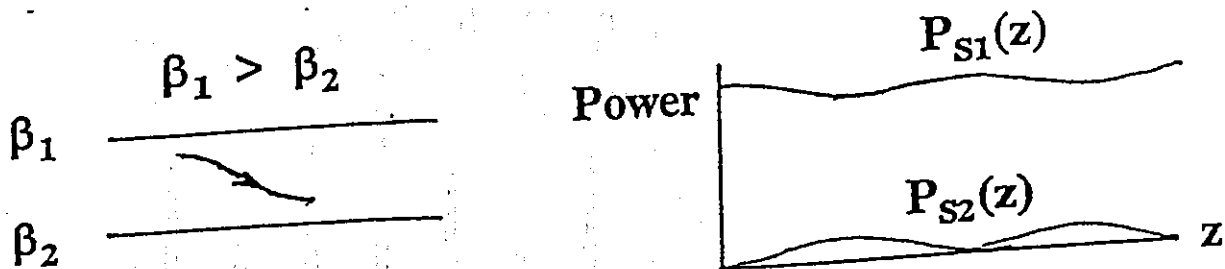


$$\beta_1(0) = \beta_0 + \Delta\beta_0 P_c(0)$$

$$\beta_2(0) = \beta_0$$

$P_{S1}(z)$

$P_{S2}(z)$



- Control pulse present in channel 1, power $P_c(0)$

⇒ it changes index in channel 1

⇒ the channels are mismatched

⇒ no power transfer between channels for signal pulse

OTHER ACHIEVEMENTS

- X-JUNCTION
- SPATIAL SOLITON STEERING
- SPATIAL SOLITON BASED DEVICES
- DEMULTIPLEXER WITHOUT PULSE BREAK-UP
- NONLINEAR POLARIZATION ROTATION
- WAVELENGTH SHIFTING