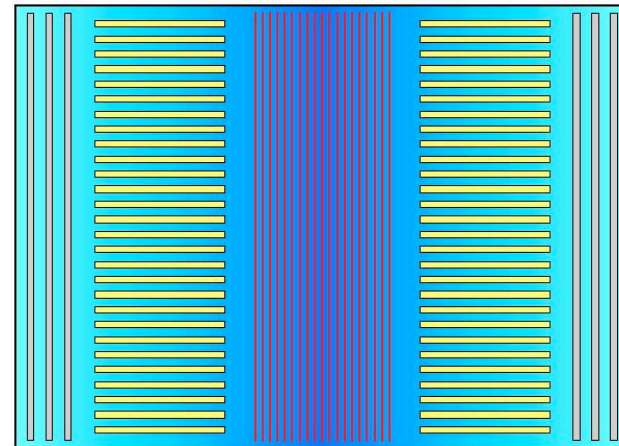
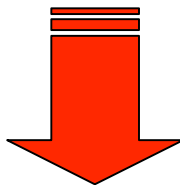
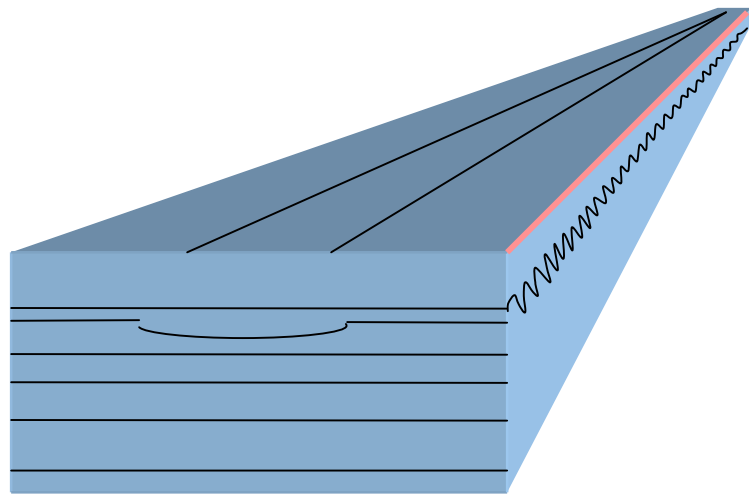


High Power Grating-Outcoupled Surface-Emitting Lasers Lasers





Advantages of GSE Lasers

No optical facet damage

Low-divergence output beam

Power scaling by length

High brightness

Narrow, temperature-stable spectral envelope

Wafer-level optical coatings

Pretest in wafer form (short pulse)

Visually prescreen defects through window

Low-cost packaging

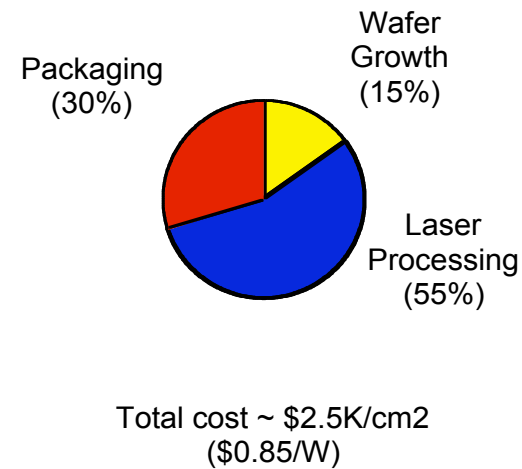
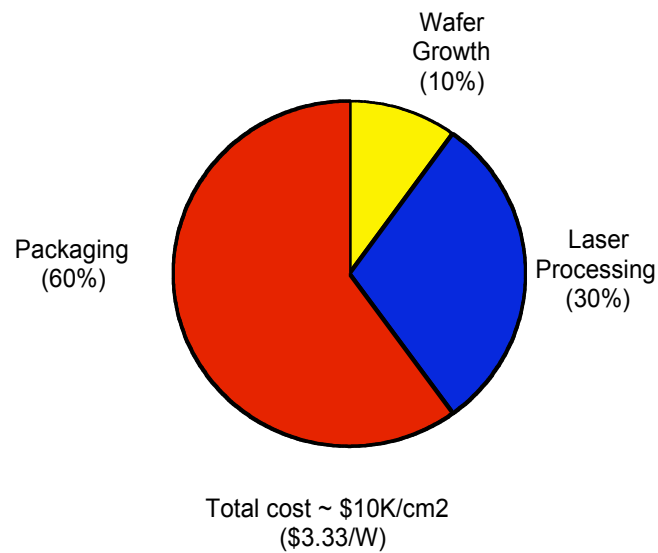
Low-cost collimation optics

Flexible beam aspect ratio

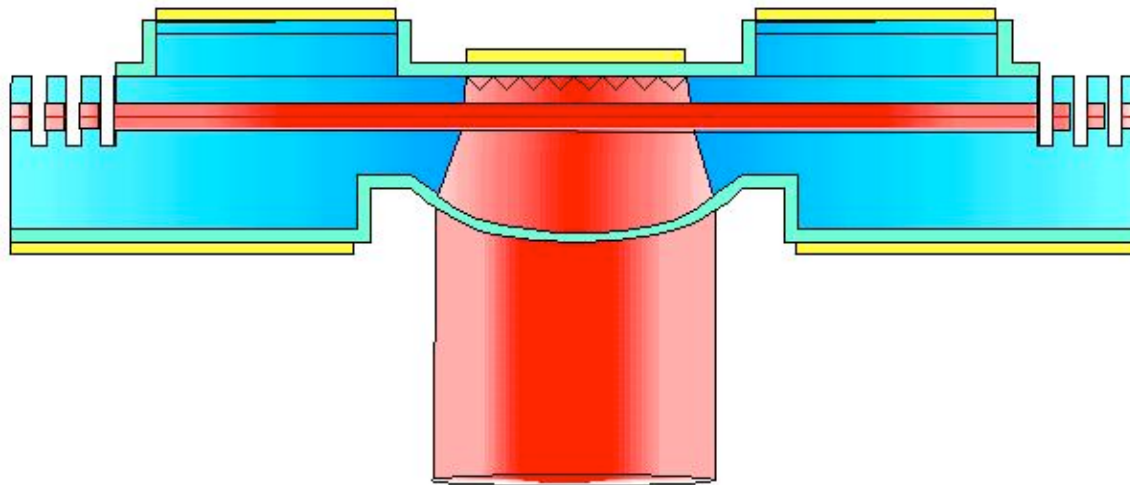
Low Cost Pump Solution

Rack and Stack

Monolithic GSE



High Power Single Aperture GSE

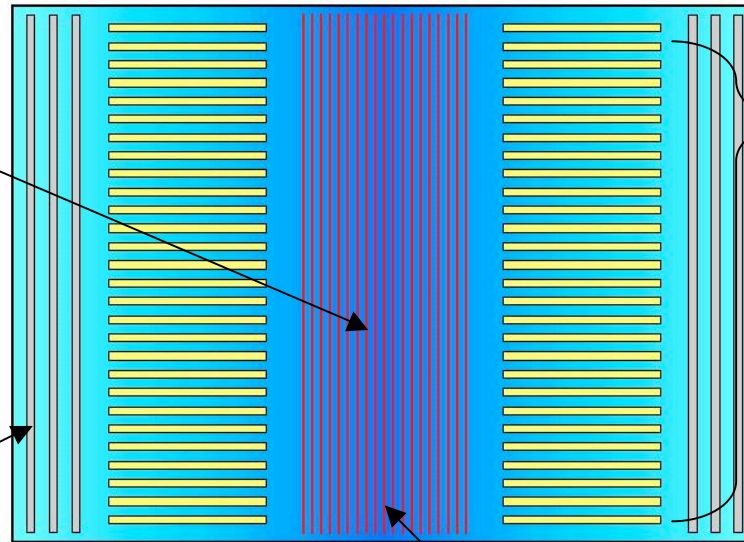


Air Force Program Goals:

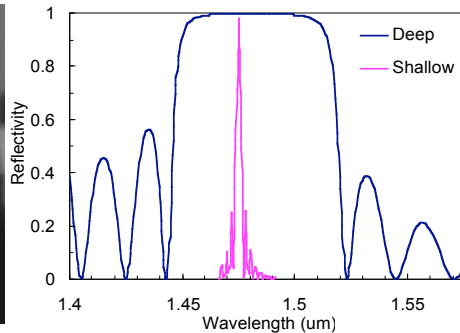
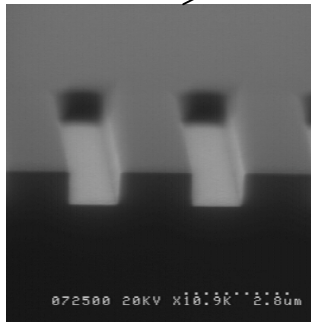
- High Power (>5W) Surface Emitting Laser
- Operating Wavelength: 1550 nm

High Power Array

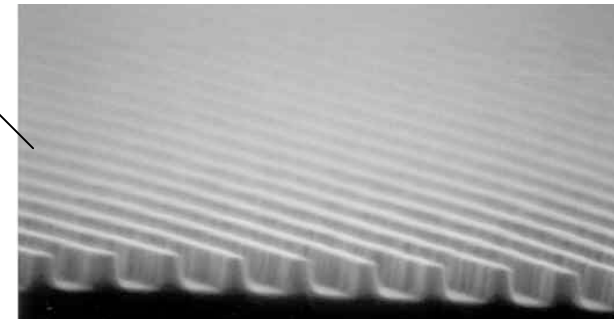
Emitting Aperture:
400 μm x 400 μm



Ridge Waveguides



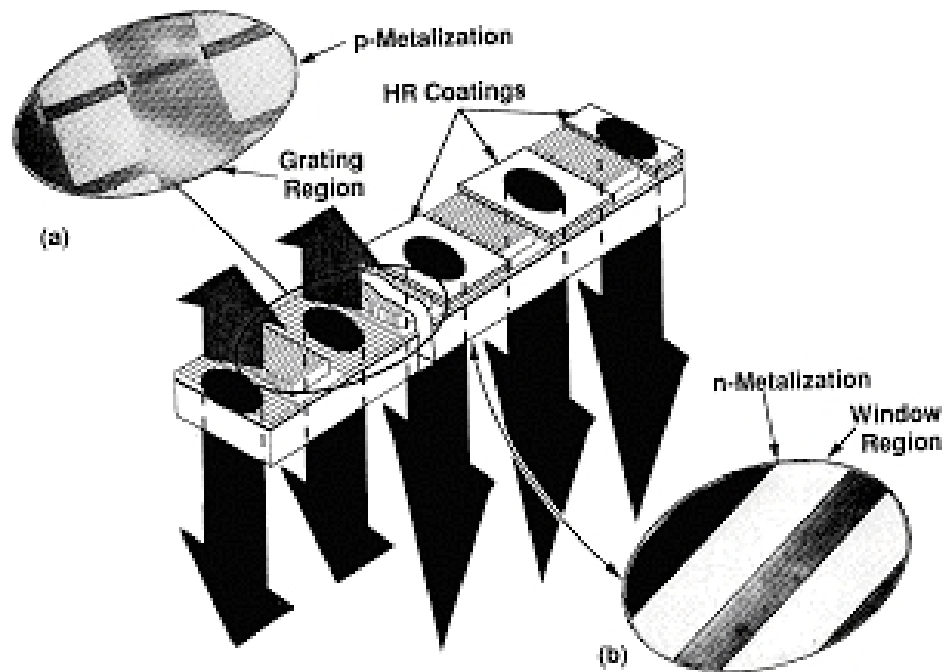
Broadband Reflectors



Outcouplers

June 2004

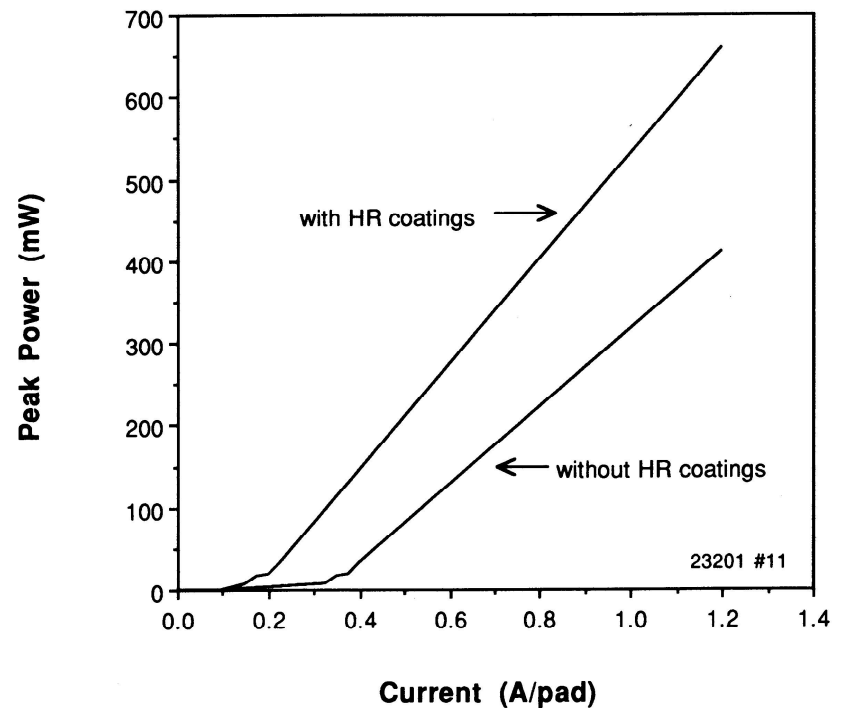
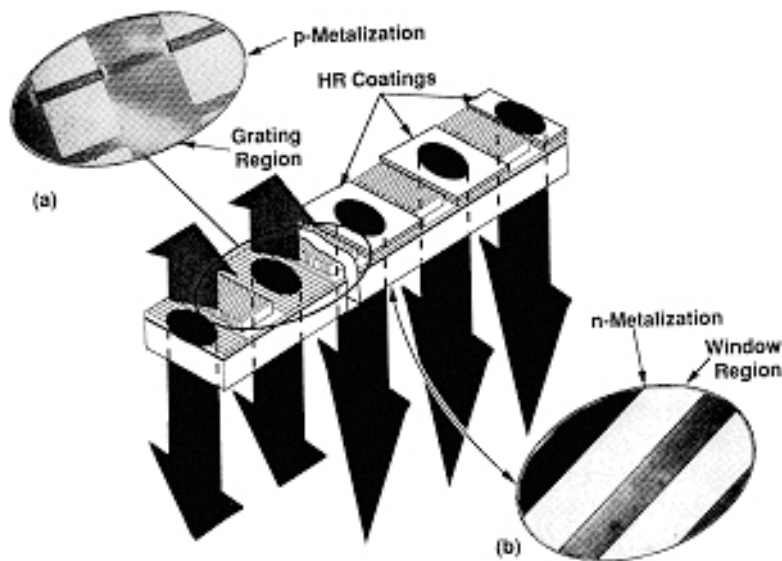
High Power Multi-Aperture GSEs



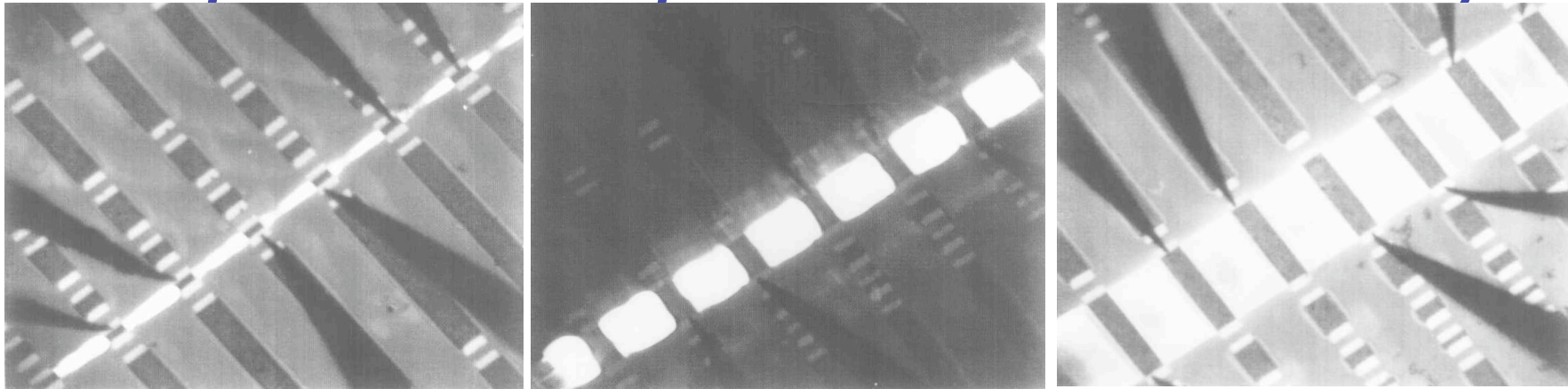
Pioneering work performed at RCA Laboratories (now Sarnoff Corp.) during the Phase Integrated Laser Optical Technology program (1985 - 1992)

10x4 GSE laser array

Substrate Emission with Reflector



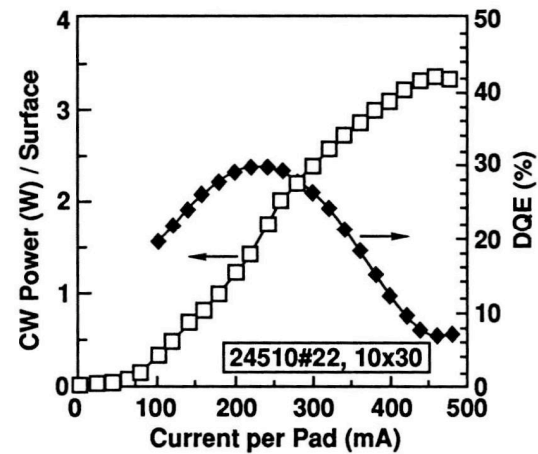
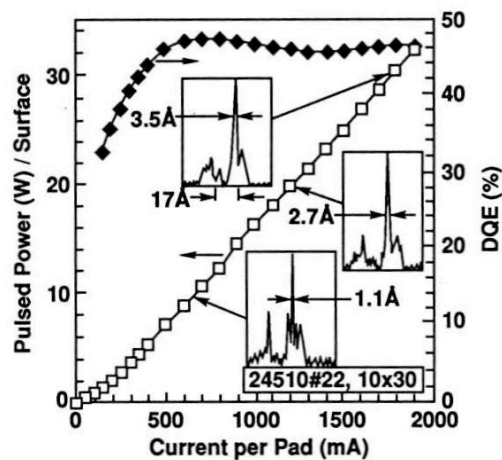
40 μm to 500 μm wide GSE Arrays



10-element-wide GSE array;

50-element-wide GSE array

125-element-wide GSE array.

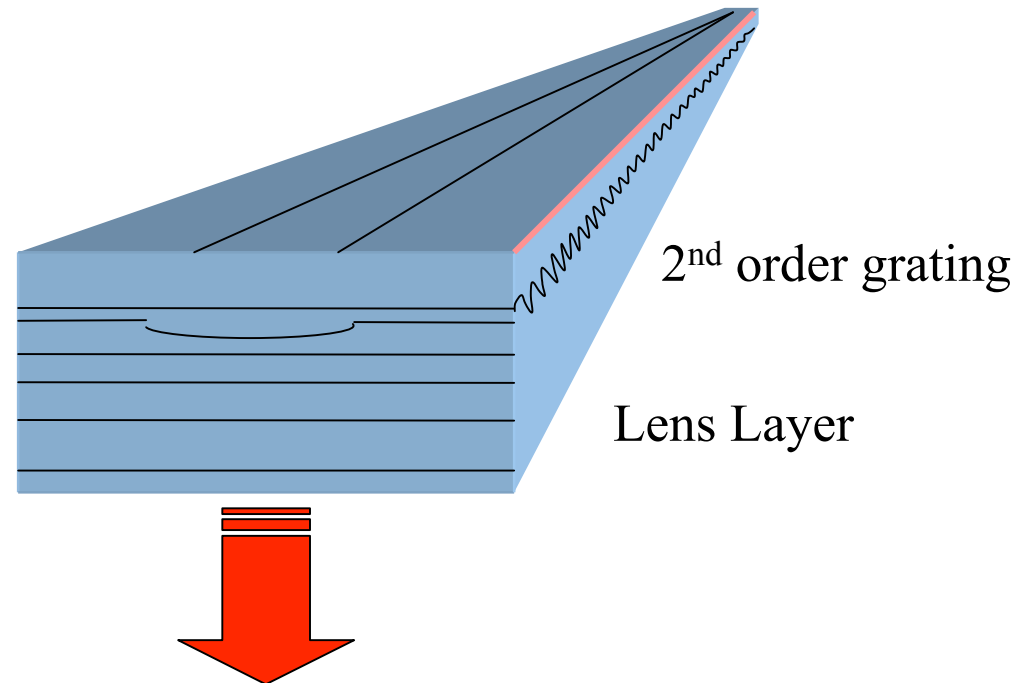


Lens-Like GSE Laser

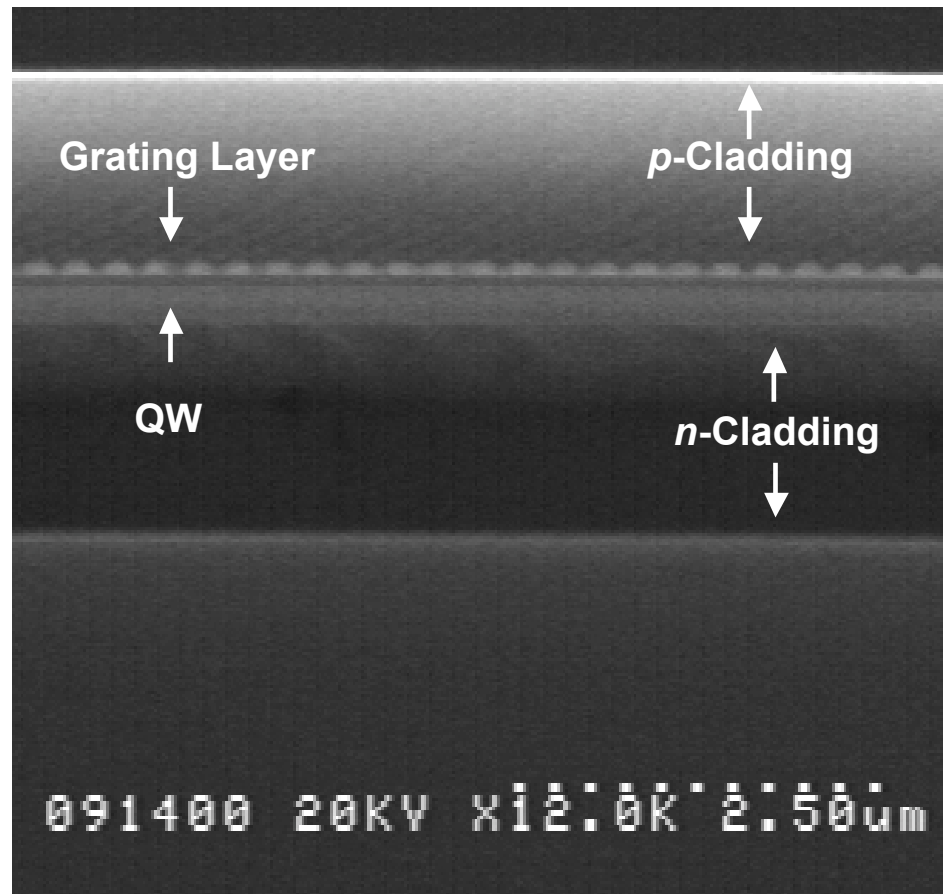
Air Force Program

- High Brightness
- Surface Emission
- Single Frequency
- 975 nm
- 10 W

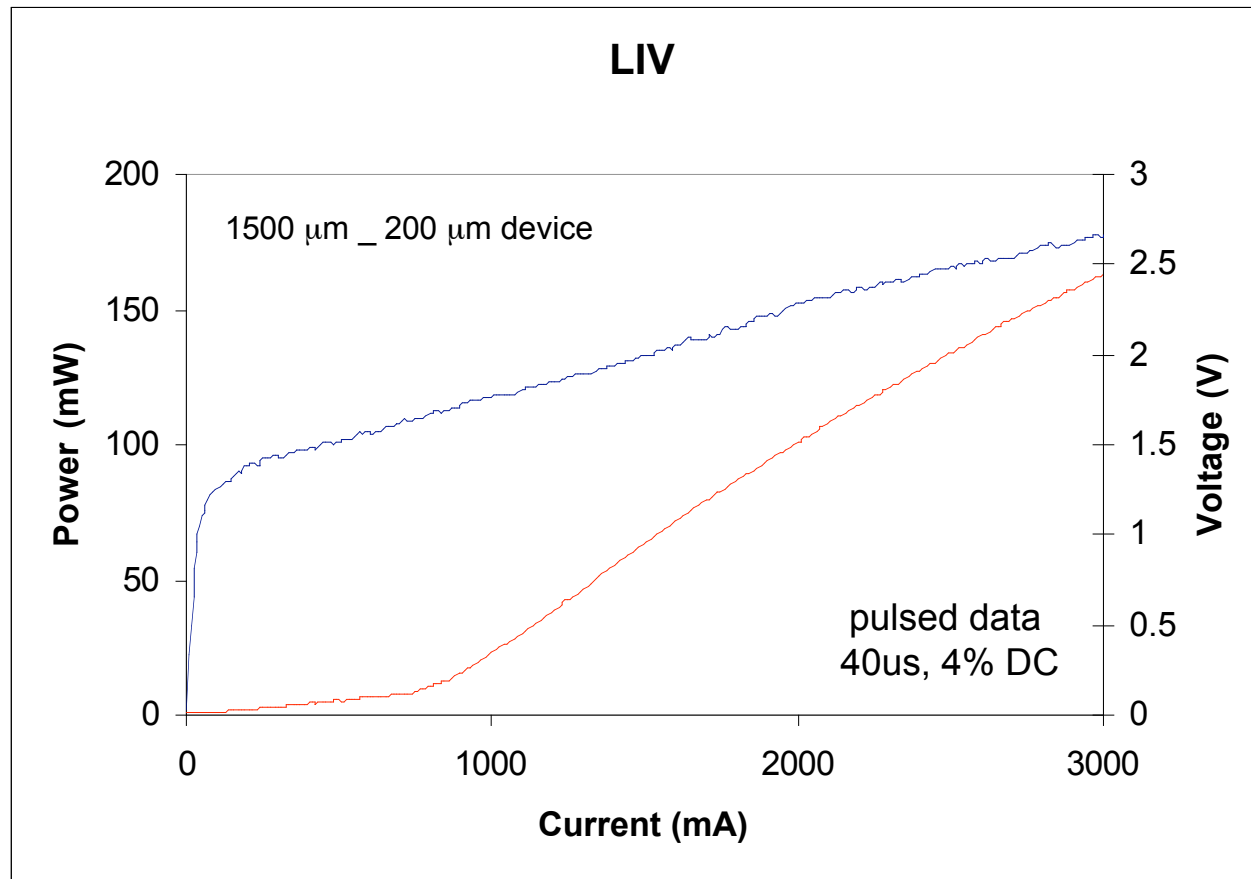
DBR Stacks



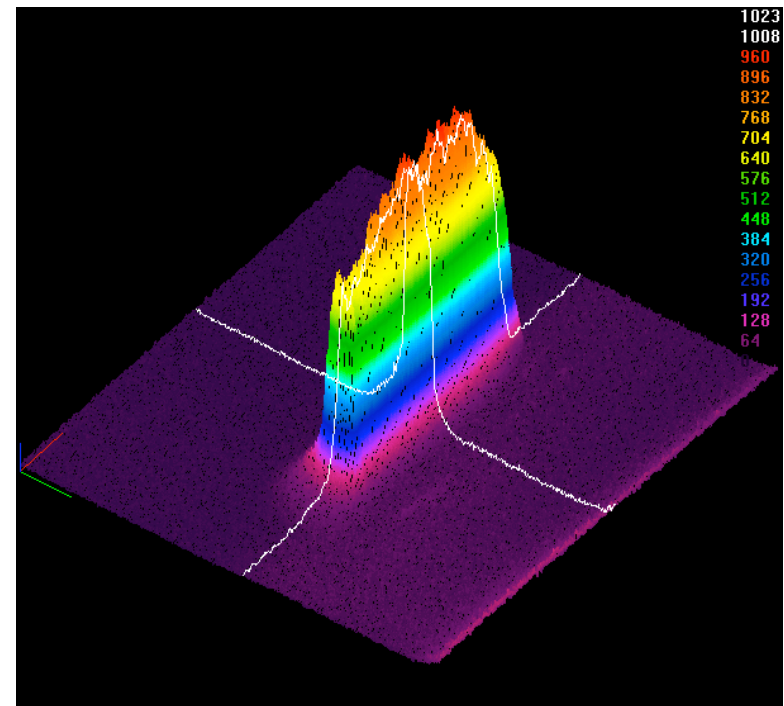
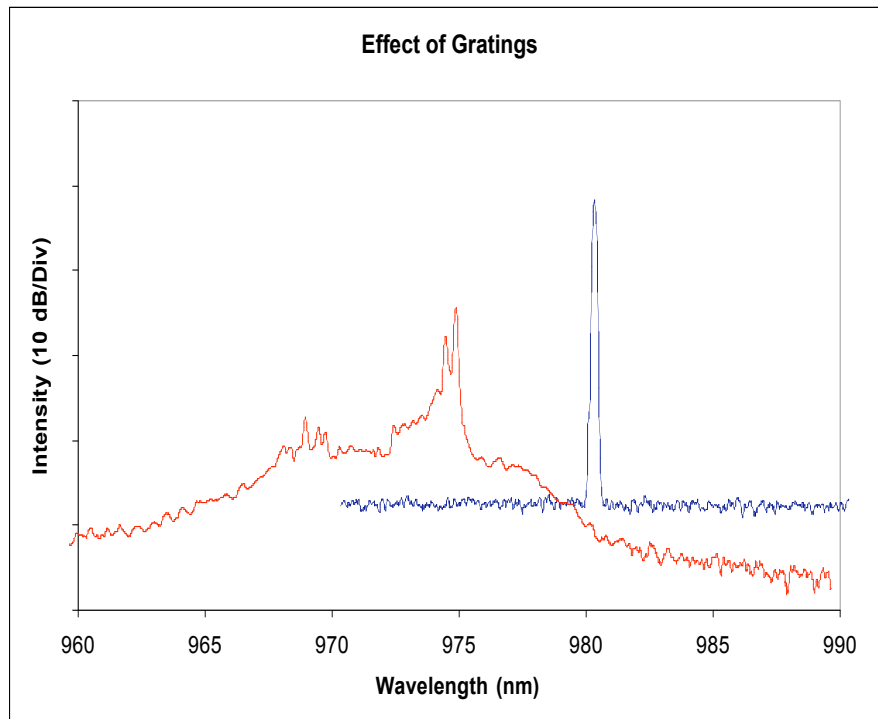
SEM of Regrown 2nd Order Gratings



LLGSE LIV



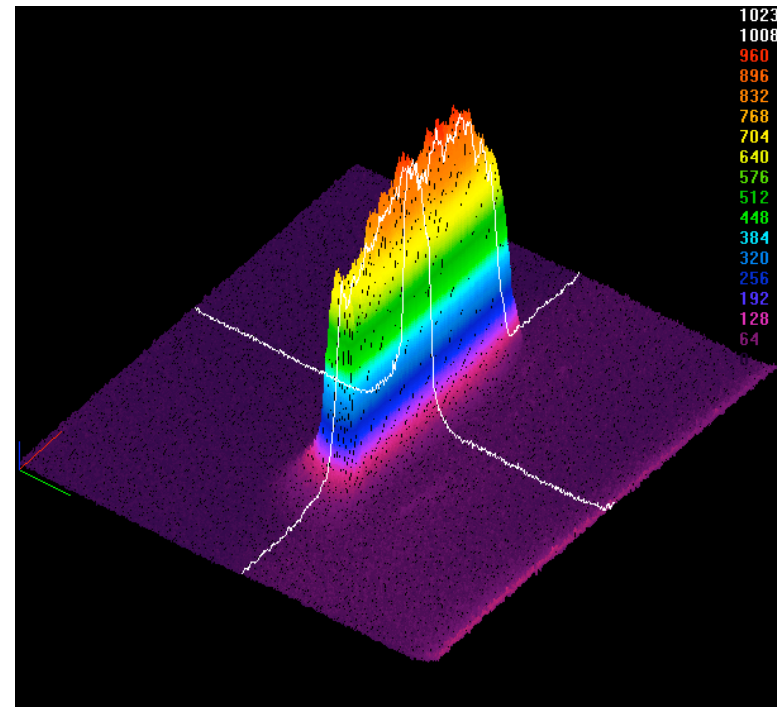
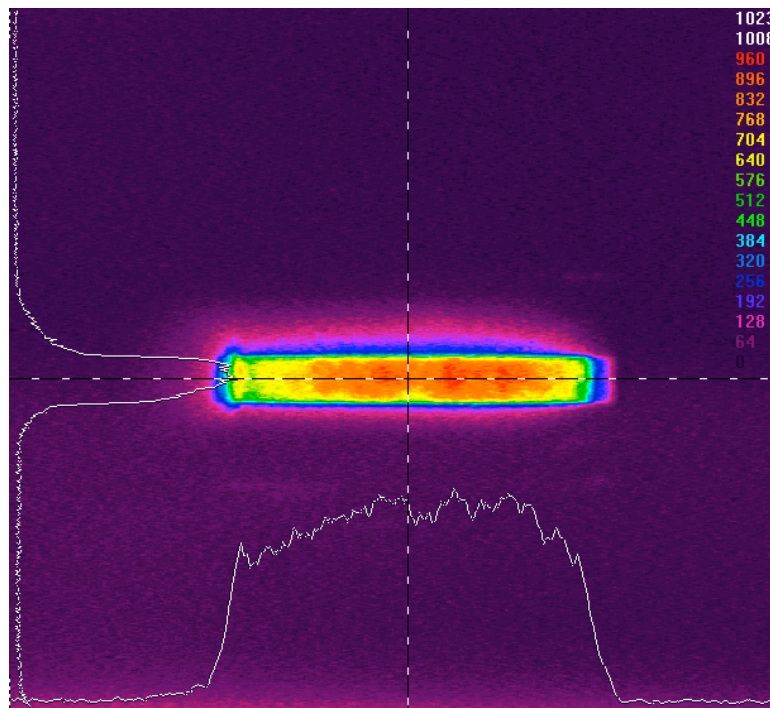
LLGSE Spectrum and Near Field



Air Force Research Laboratory's Directed Energy Directorate
Contract F29601-98-C-0063

June 2004

LLGSE Near Field Images

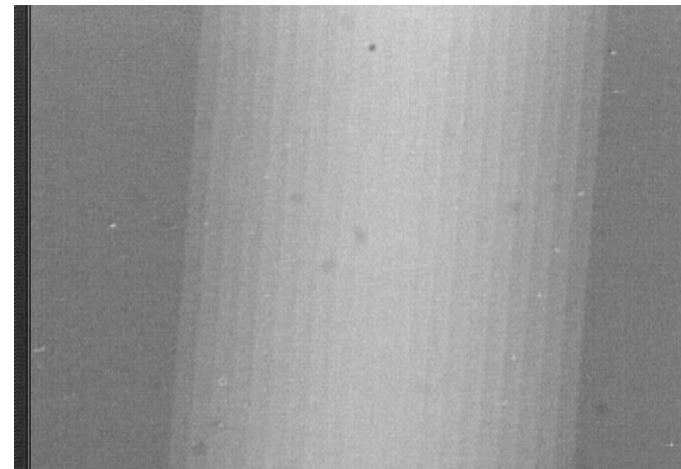
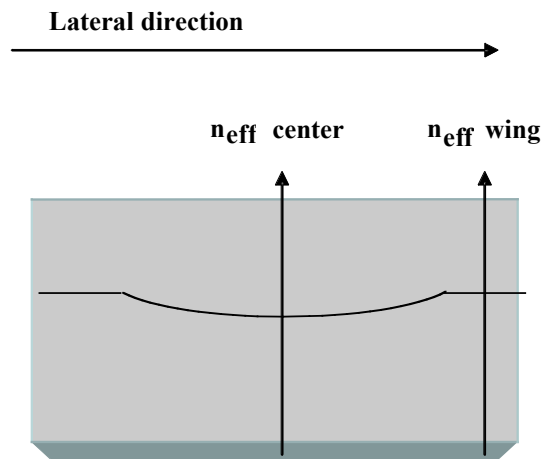


Near field images of spontaneous emission captured below threshold

LLGSE Lens Channel

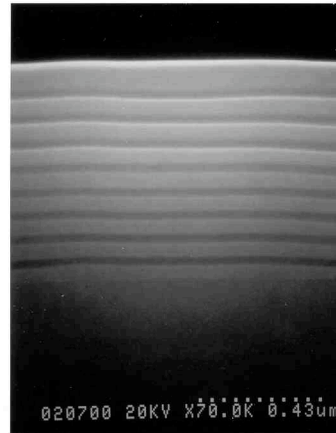
Optimize coupling with grating (κL) for efficient surface emission

Integrate Lens-like layer for further mode stability



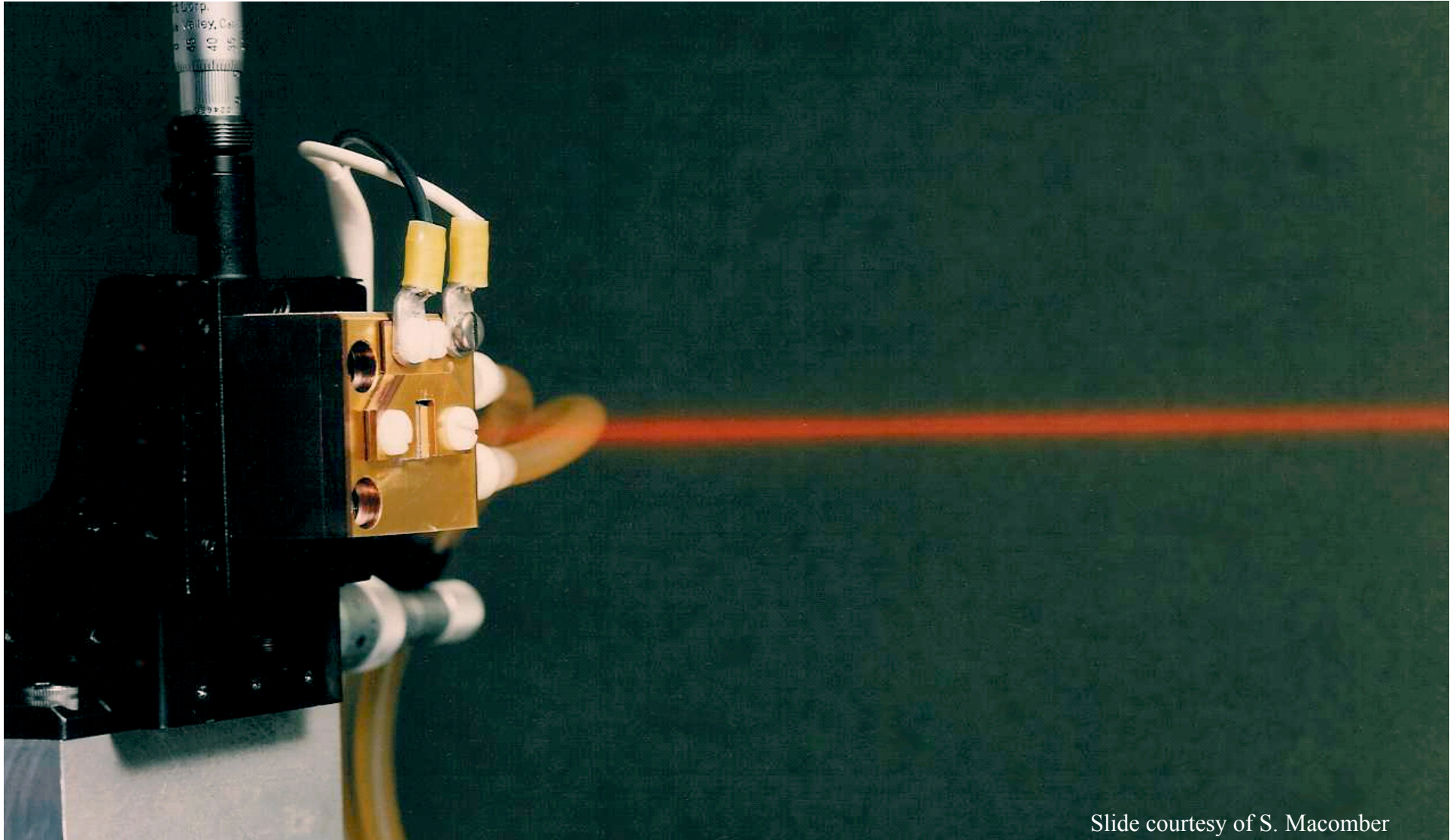
LLGSE Reflector Stack

- Integrate distributed Bragg reflector (DBR) stack for higher output power



- Scale device dimension to hit target power

Low-divergence Output Beam



Comparison of Source Brightness

Device	Parameters	Radiance	Beam Quality
Single wide-stripe edge emitter	2 W, 8° FWHM, 140 μm stripe width	10 MW/cm ² -sr	23 × 1
Lensed bar	40 W, 1 cm, 8° FWHM 2×diff. limit fast axis	1.5	1,700 × 2
GSE Bar	30 W, 250 μm × 9000 μm	30	10 × 10