

The Photonics Industry: Enabling Technology or Mature Market

Presented by

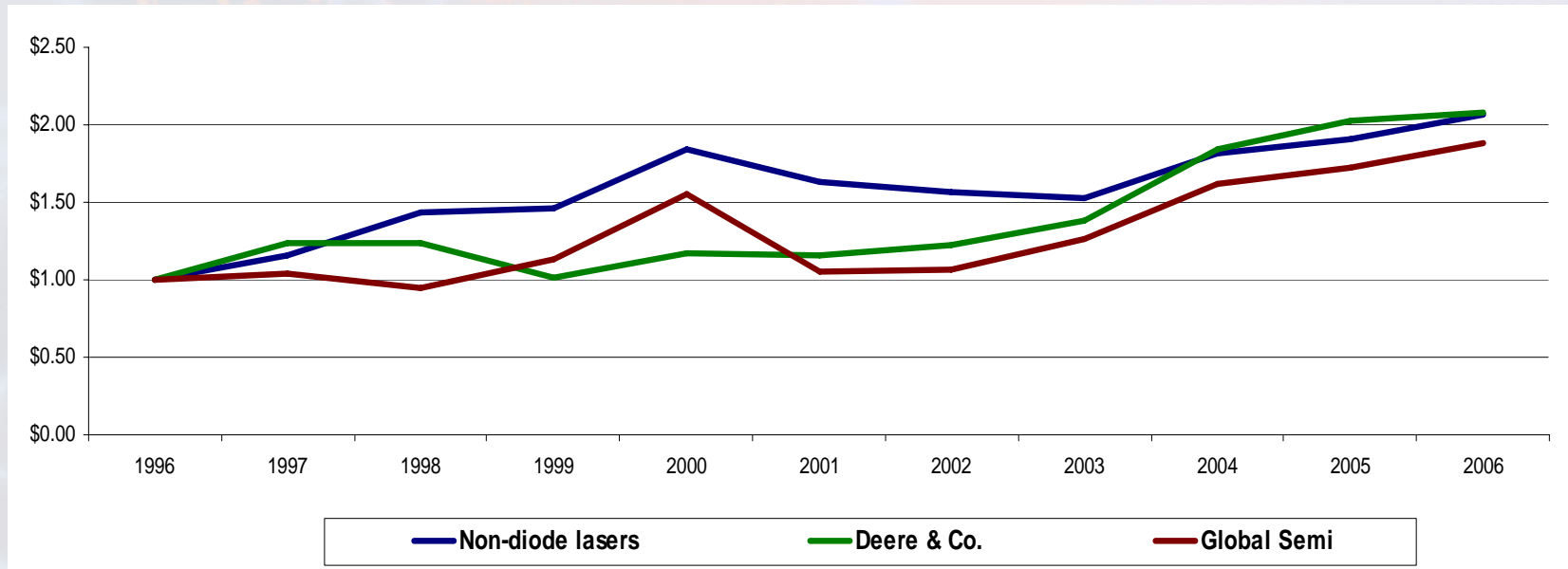
John Ambroseo

President & CEO, Coherent Inc.

Overview

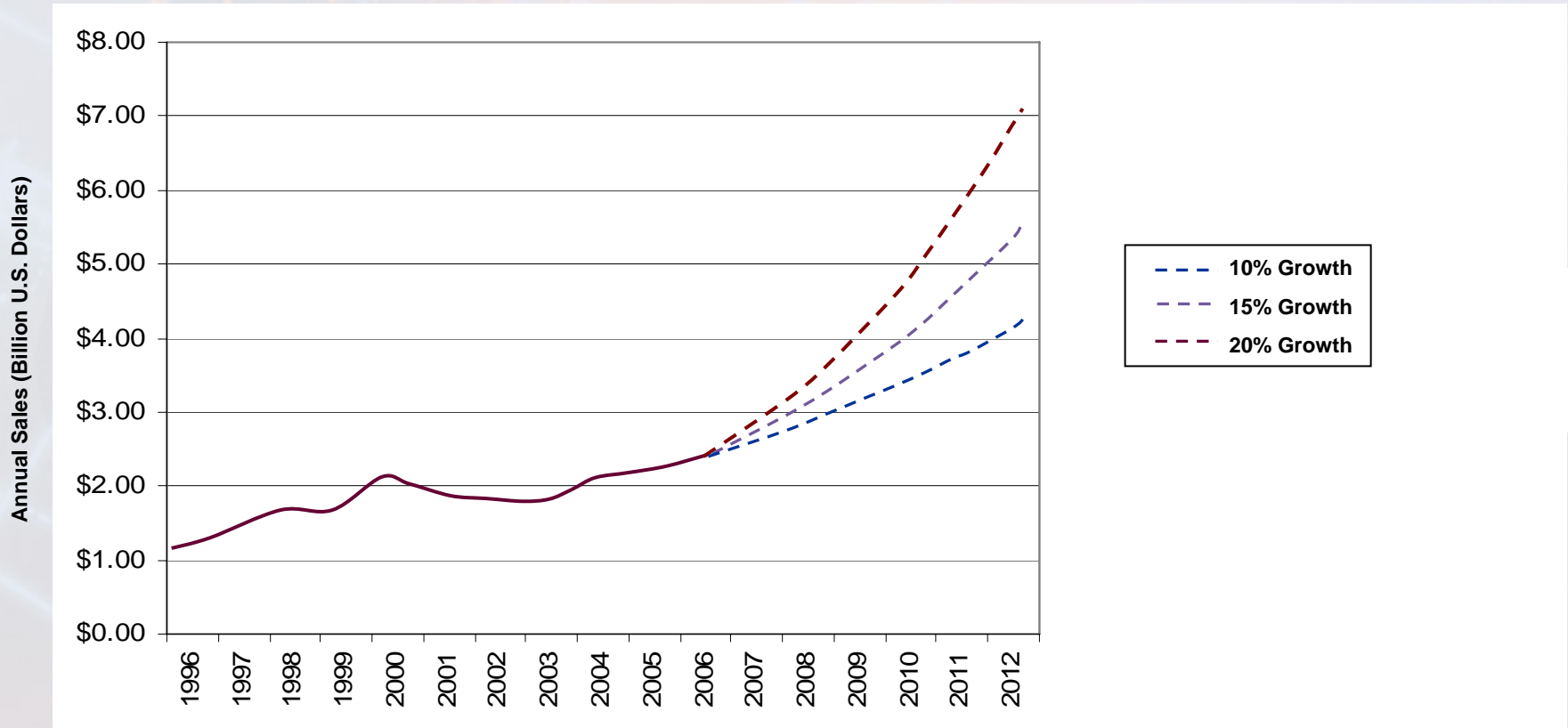
- Growth vs. SIA vs. Farm Equipment
- Laser Markets
- Scientific and the Ultrafast Dilemma
- Materials Processing
- Instrumentation
- Microelectronics
- The China Challenge
- PTI: One View of Education
- Takeaways

Comparison of Indexed Revenue Growth



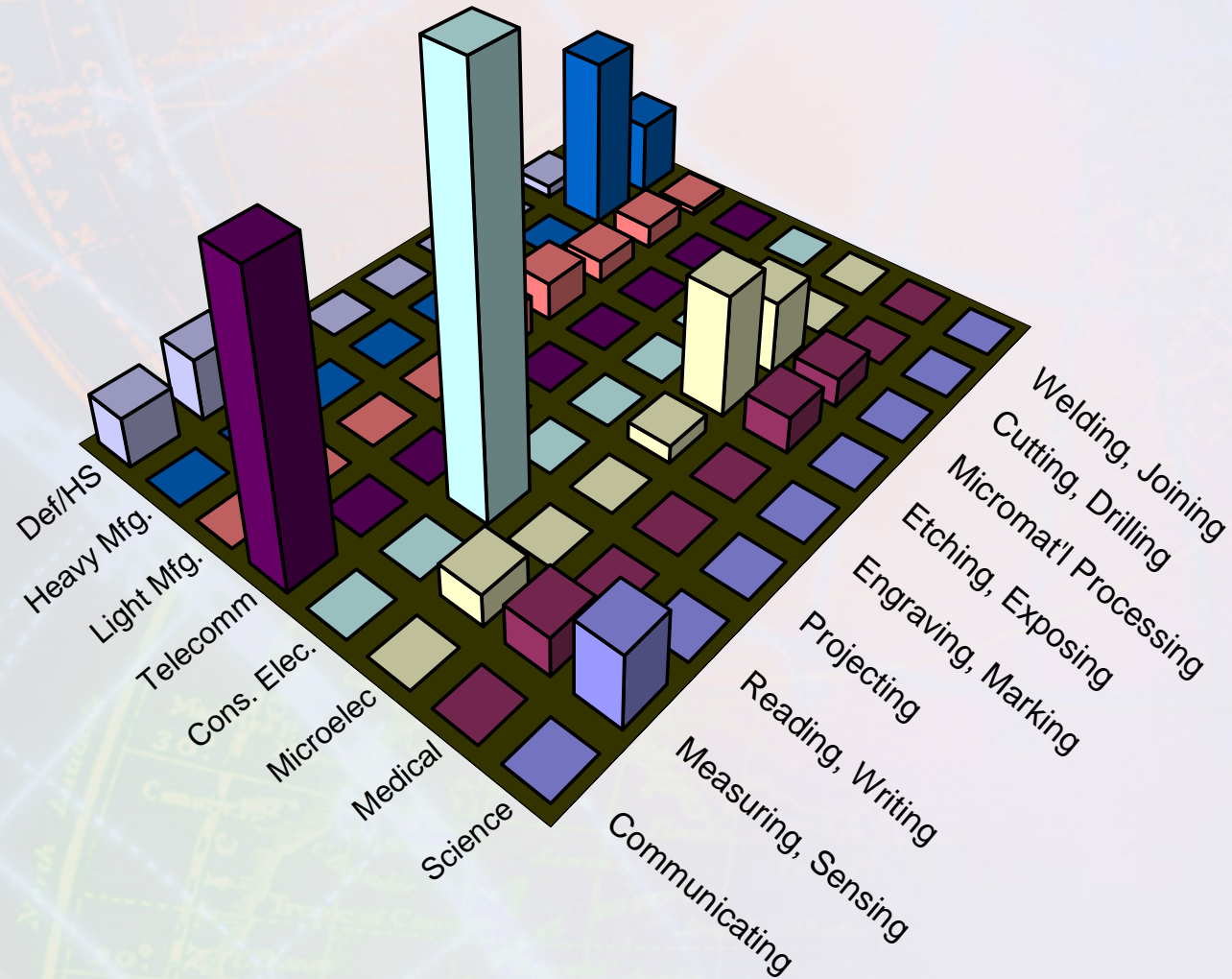
Sources: *Laser Focus World*, SIA
and The John Deere Company

Core Laser Industry Growth



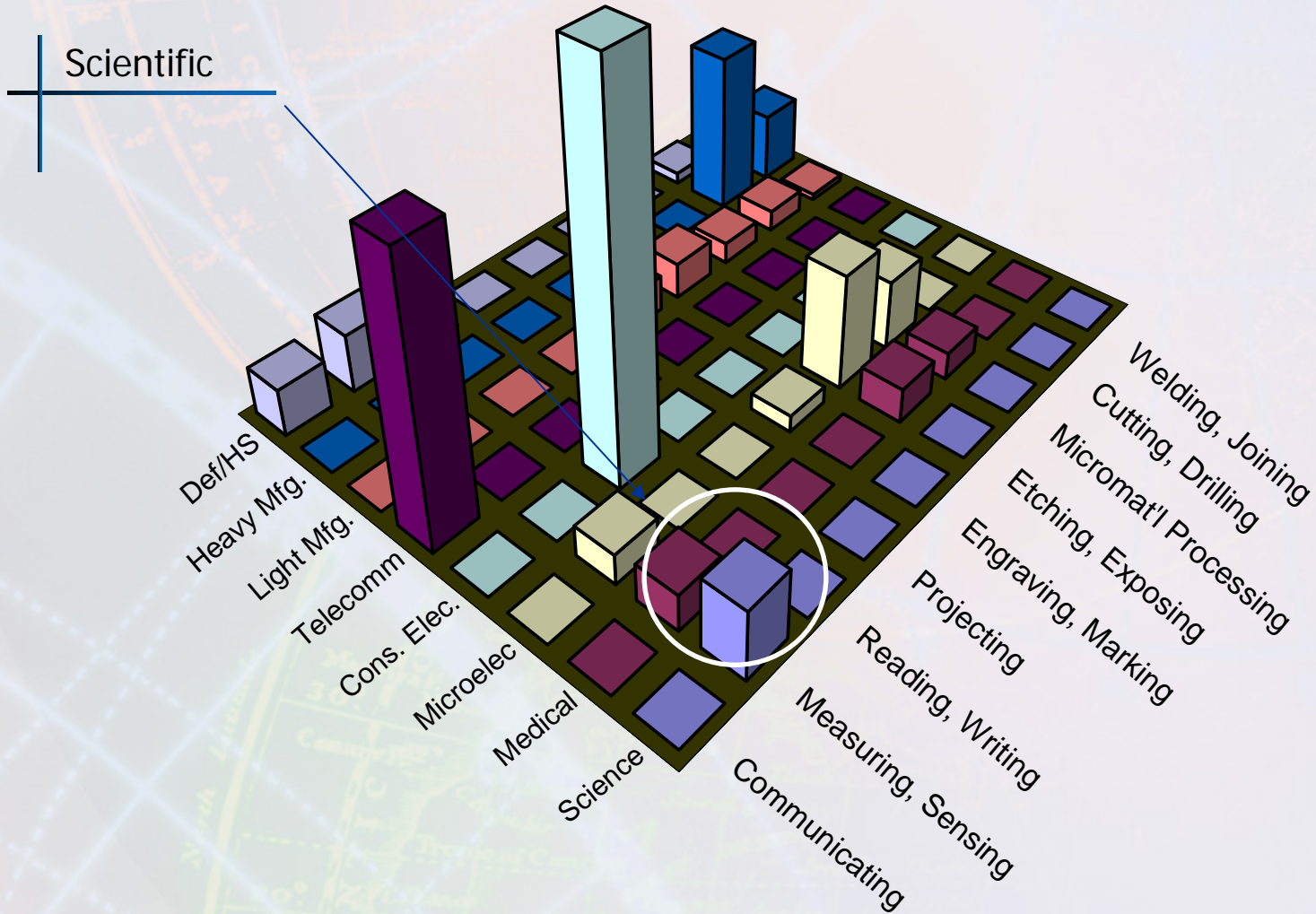
2006 Industry Map

Industry Revenue \$9B (including telecom, CE)

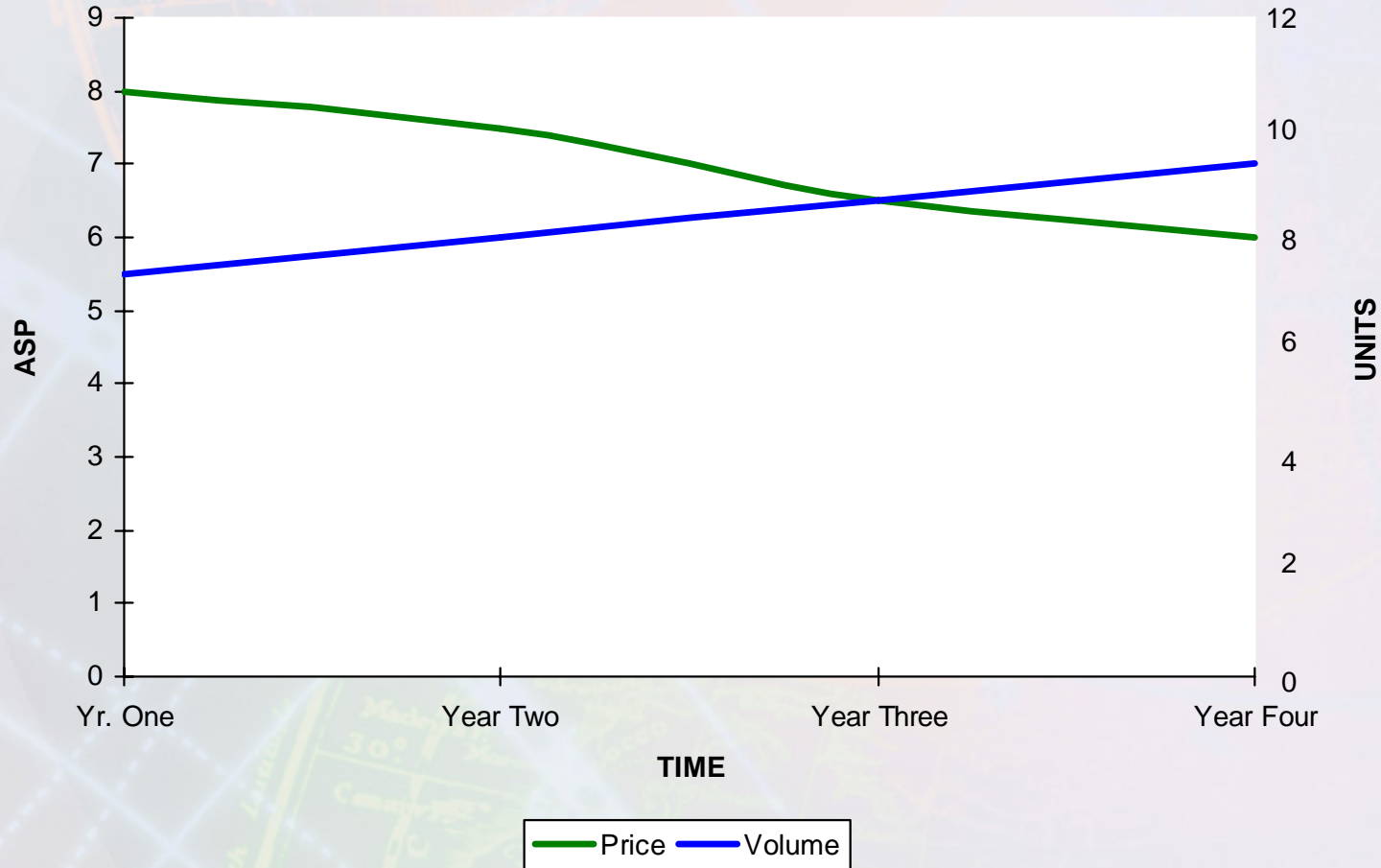


2006 Industry Map

Industry Revenue \$9B (including telecom, CE)



Price Volume Curve - Scientific Laser Market



Scientific Market Characterized by Rapid Adoption and Low Growth

Scientific and the Ultrafast Dilemma

- Is it possible to leverage developments for bleeding edge research into robust and cost-effective, commercial technologies?
- The last major innovation was Ti:Sapphire back in **1991** since then it has been series of evolutionary steps
- Today's market is bifurcated between high performance, high ego researchers (physicists, chemists) and turn-key (biologists) users
- Does one invest in highly flexible platforms or market-specific solutions?

Scientific and the Ultrafast Dilemma

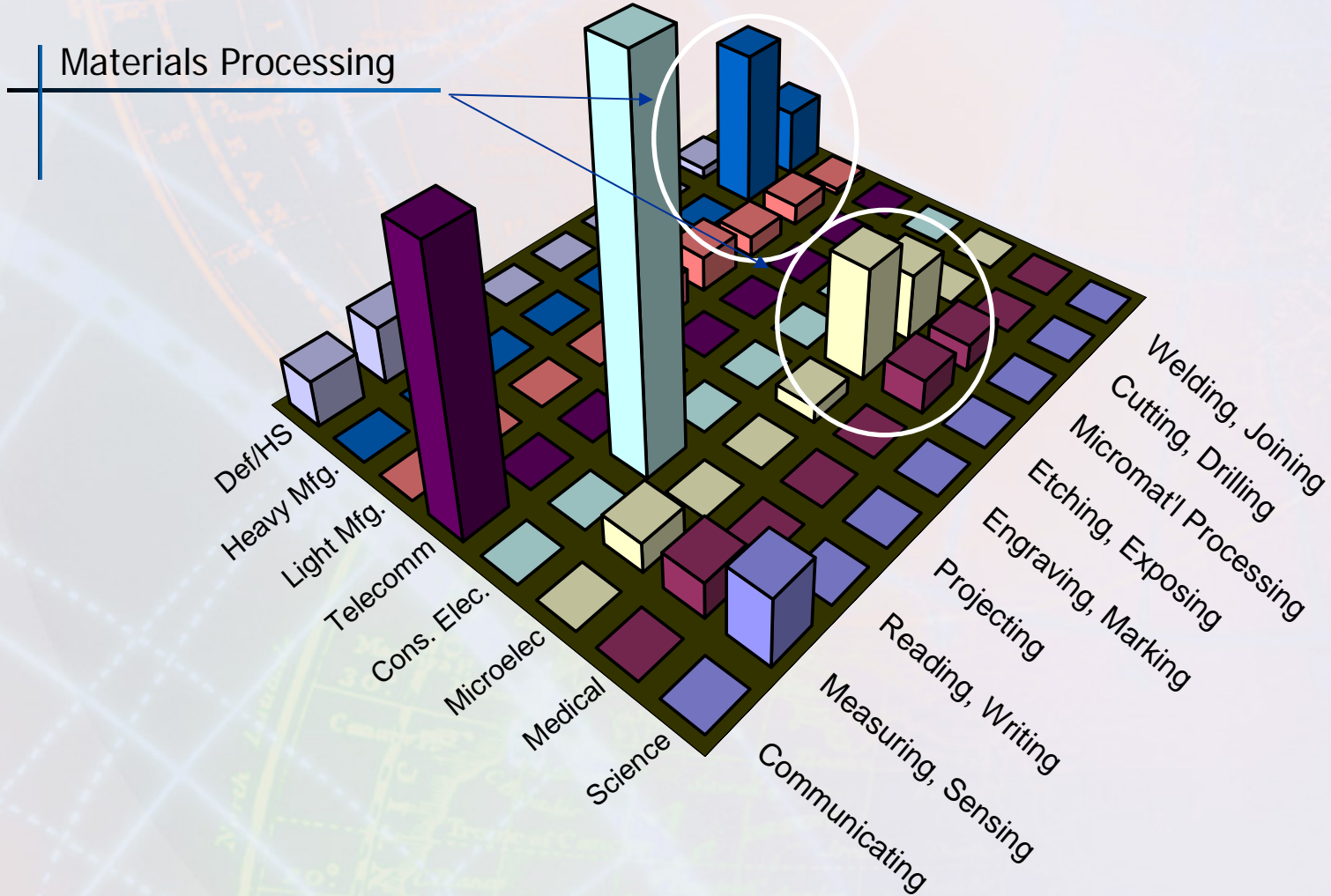
- A casual survey of vendors suggests the custom business is attractive due to the ability to differentiate, but produces margins below (sometimes well below) the industry average
- Serially produced lasers represent the battleground in the scientific market where competitors engage in a seemingly endless game of leap frog (defending sales!)
- Margins in the serial market tend to mimic overall company margins
- Both are low growth, ~WW GDP, and have high R&D and service costs

Scientific and the Ultrafast Dilemma

- This combination is a challenge for all companies, especially public ones
- Shareholders expect top line and bottom line growth, but profitability rules – again reinforcing defensive tactics
- What are the likely outcomes over the next 5 years?
 - Companies become much more targeted
 - Consolidation is a possibility, but the economics are tough
 - Vertical integration into customer space is also a distinct possibility

2006 Industry Map

Industry Revenue \$9B (including telecom, CE)



Materials Processing

- The largest market outside of consumer electronics and communications
- Highly diffuse market – applications and light sources
 - Heavy industrial (e.g., metal cutting)
 - Light industrial (e.g., converting, textile)
 - Marking and Engraving
 - CO₂, solid-state, direct diodes, fiber
- Growing strongly in Asia
- Seasonality is on the decline

Materials Processing

- Conventional solutions have the benefit of simplicity, boast years of proven deployment and rely on readily available components
- Despite ample marketing hype, there are few examples of the ubiquitous “uniquely enabled applications” in the materials processing space
- Laser solutions must deliver better yields, increase throughput or offer process flexibility (i.e., multiple methods on a single tool)
- It’s all about cost of ownership!

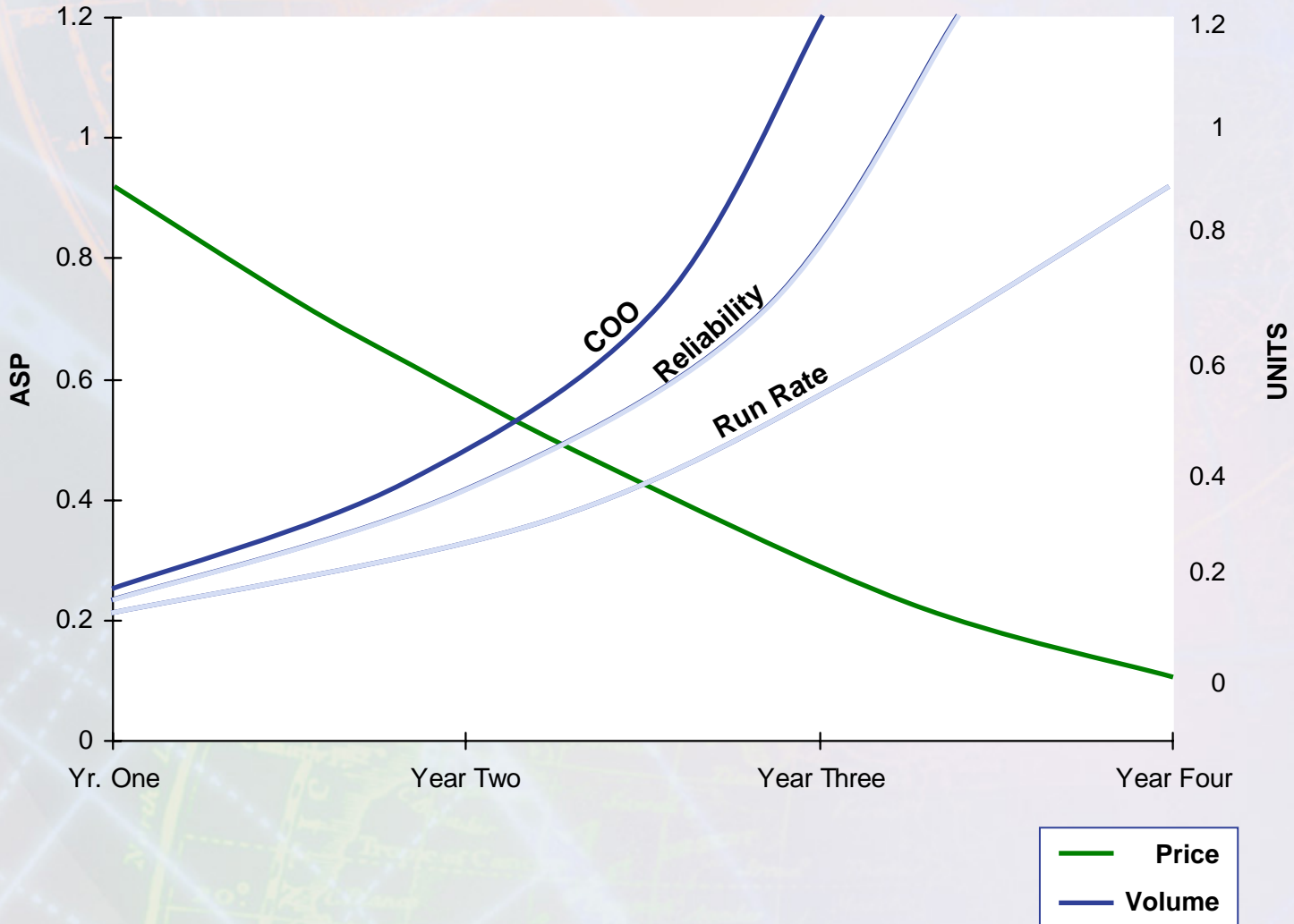
Growth in Materials Processing

- The Holy Grail: spot welding in automotive and aerospace manufacturing
 - Process development and cost (think direct diodes!)
- Product coding and safety
 - Speed and cost barriers
 - Environmental benefits
- Marking and Engraving for product traceability
 - Existing process
 - Margin stacking between laser manufacturers and OEM
 - Going vertical up and down

Other Emerging or Resurgent Areas

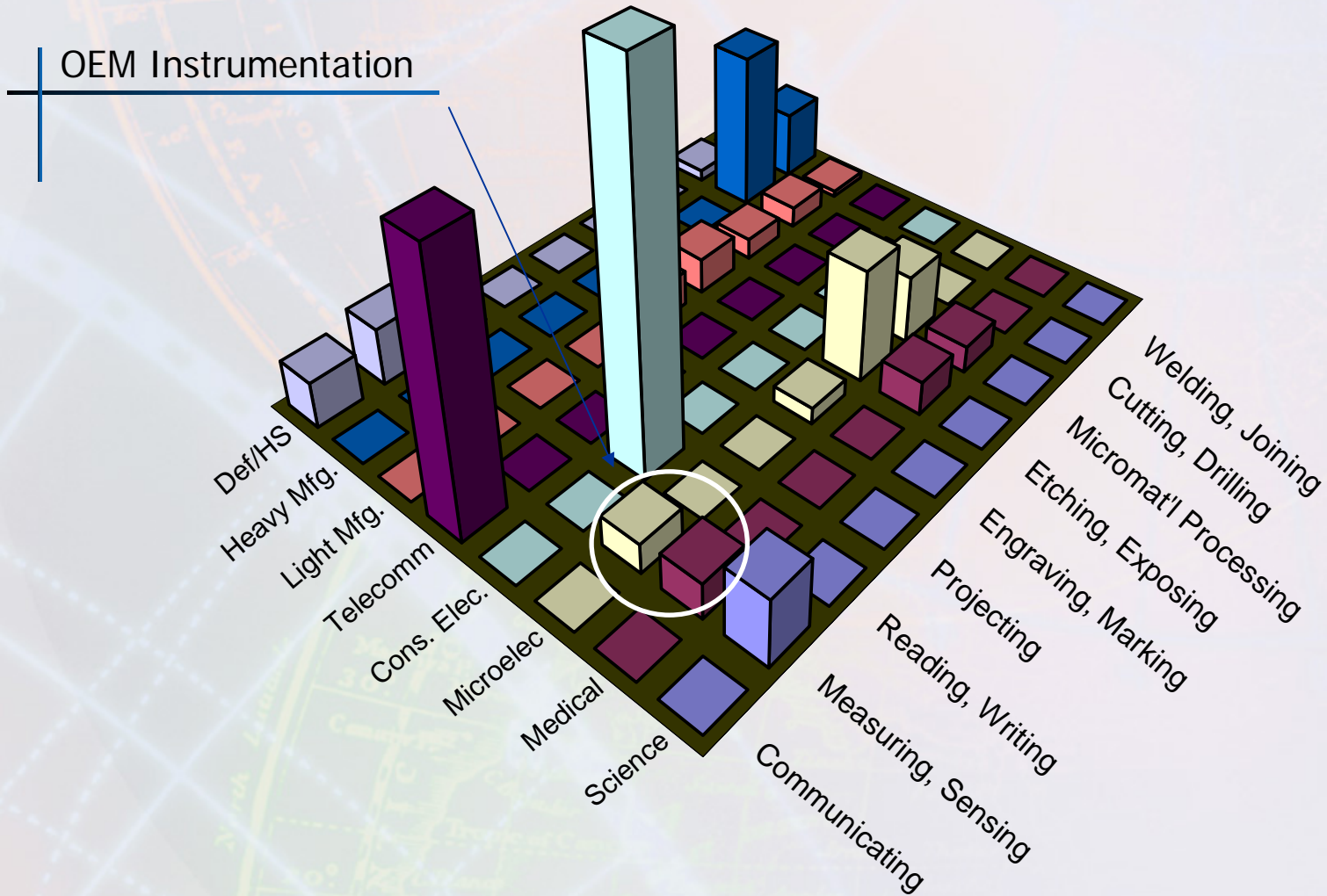
- Material modification
- Silicon recrytallization
- Implant damage annealing
- Metal recrystalization using excimer lasers for automotive emission control
- Metal hardening and cladding

Price Volume Curve - Commercial Laser Market



2006 Industry Map

Industry Revenue \$9B (including telecom, CE)



OEM Instrumentation

- Steady 10-15% growth over the last 5 years
- Multiple submarkets including medical OEM and bioinstrumentation
- All platforms are trending toward black boxes
- Dramatically different product expectations
 - The average medical laser will log less than 500 hours during its entire useful life
 - Lasers used in bioinstrumentation run between 4000-8000 hours per year

Bioinstrumentation

- Growth in bioinstrumentation is being driven by the continued migration of test protocols (i.e., bioassays) into clinical labs
 - DNA Sequencing
 - Drug Discovery
 - Blood Analysis
- Footprint has been crucial to transition (filled a table top, now about the size of a microwave oven) coupled with a new generation of compact, energy efficient visible and UV lasers
- What is the market asking for? New wavelengths for specific assays. Not easy using traditional lasers
- The number of competitors vying for this business is unbelievable, >25 companies chasing <\$50M in laser revenues

OEM Instrumentation

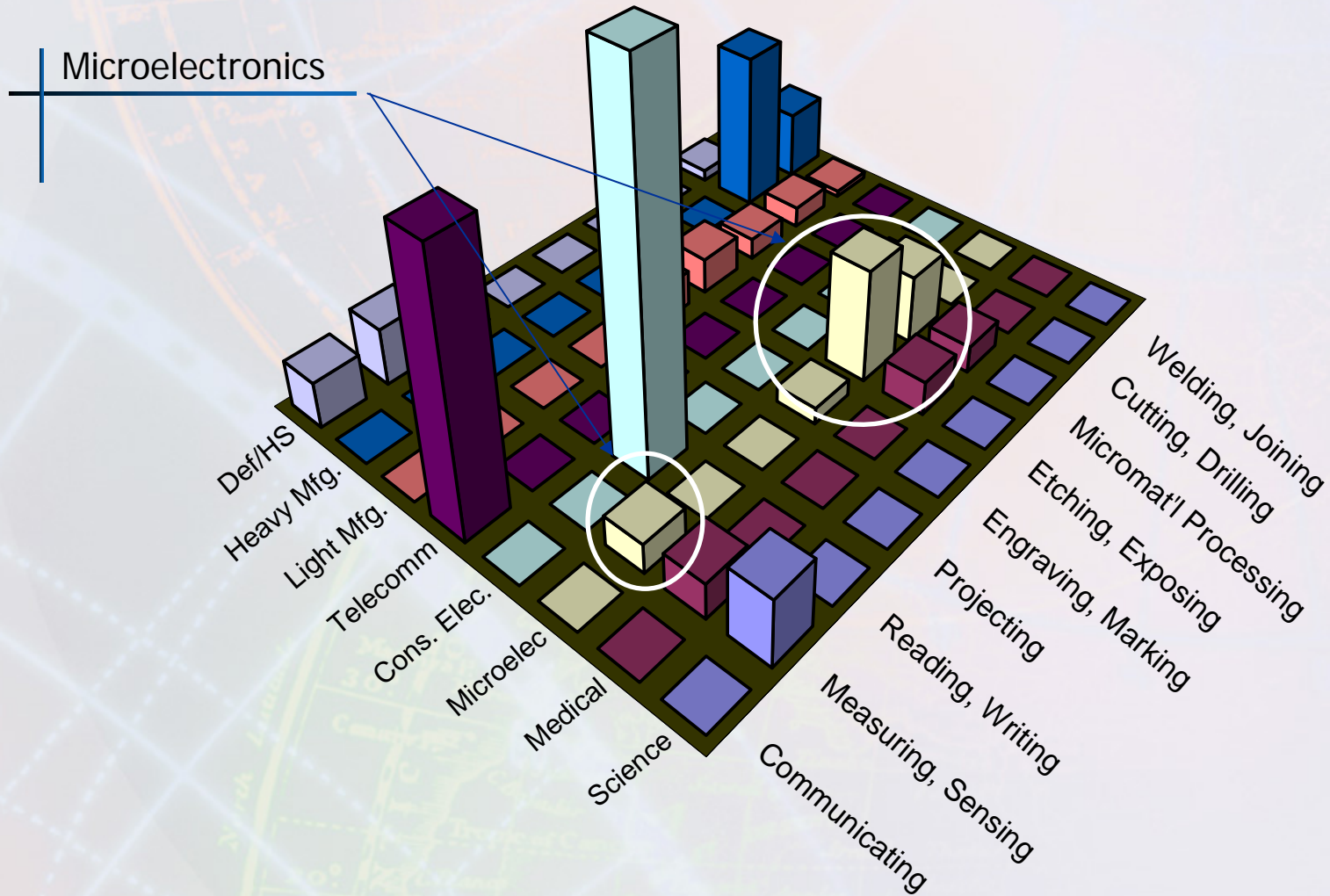
- The medical OEM market has largely relied upon time-tested technology, instead focusing their efforts on the procedure
 - GUI development has been impressive, serving to minimize the role of the physician
 - Recovery from laser surgery is shorter on average than standard surgical techniques
 - Old laser technology (e.g., FPL's) works just fine
- With the advent of new high power lasers, specifically our OPS™ products and fiber lasers, can break the trend by offering new, more efficacious treatment

Medical Therapy and Diagnostics

- Ophthalmology and Dermatology/Aesthetics dominate due to efficacy and financial terms
 - Excimer vision correction widely practiced
 - Aesthetic treatments use a focused laser underneath the skin to create a wound which facilitates a rejuvenation process
- Diagnostics and Imaging are finally developing laser based techniques as costs come down and sources mature to be more robust (OCT and laser based confocal microscopy)

2006 Industry Map

Industry Revenue \$9B (including telecom, CE)



Microelectronics: Semi, API and FPD

- Historically a sweet spot for the laser industry due to a combination of performance, value and pricing
- Today, the market is split between three areas
 - Semiconductor fab, test, metrology and inspection
 - Advanced packaging and integration
 - Flat panel display manufacturing and inspection
- Semiconductor manufacturers continue to press for increasing performance in order to build smaller features on larger wafers
- The result: Few opportunities at very high prices

Microelectronics: Semi, API and FPD

- While high prices are attractive, they belie the inherent risk: Will anyone be able to afford them?
- Consider the case of an EUV stepper with a projected price tag of \$40-50M of which the laser is \$10-15M
- A single EUV fab will cost billions of dollars, putting the investment out of reach of most companies except for the likes of Intel, IBM and several foundries
- A simple ROI suggests the total number of EUV steppers will be in the hundreds
- Great profits to be made, but potentially short-lived

Microelectronics: Semi, API and FPD

- The API market has seen significant growth over the past 10 years
- The early growth spurt was in via formation in circuit boards for handheld devices
- This business follows the cycle of cellphone demand, which is currently sluggish
- Several other applications are growing or poised for growth including LDI, stacked memory and silicon machining
- Existing lasers are ok, but expect rapid improvement

Microelectronics: Semi, API and FPD

- FPD has become a hotbed of activity
- Key applications include Si annealing, ITO structuring, color filter formation, cutting and sealing
- Market dynamic is intriguing
- End customers operate on razor thin gross margins, routinely <10%
- FPD pricing is dropping 30-40% per year
- Manufacturers are actively seeking manufacturing technologies to lower costs, including lasers
- Big opportunity, but proceed with caution

The China Challenge

- According to s a senior member of German Federal Cartel Office, Chinese laser manufacturers do not exert competitive pressure in the global market since their products “lack the quality expected by German customers”.
- So what exactly does China mean to the photonics industry?
- Is it a fast growing market? An LCR? An emerging competitor?

The China Challenge

- China represents highest growth rate (Japan the largest revenue base)
- Most Western laser companies are experiencing CAGRs of 20-30% in China
- Chinese laser manufacturers (>150 and growing) are on 50-75% annual growth curves driven predominantly by their domestic market
- Are the rest of us laggards?

The China Challenge

- Price/performance
 - Western companies are comfortable pushing the price/performance curve up while Chinese customers want the right price-performance
- Quality/reliability/cost tradeoffs
 - Western companies see quality and reliability as badges of honor, but Chinese customers are much more pragmatic
- Business terms
 - Can we accept 180-365 day receivables?

The China Challenge

- Lasers are generally characterized by high material and moderate to low labor costs in their BOM
- Current architectures do not lend themselves to full leverage of LCR strategies
- Supply chain benefits/IP risks
- Do we dumb down Western designs to achieve price/performance/reliability for the Chinese market or do we design and manufacture products in China for the domestic, Indian and South American markets?

Pardon The Interruption: Education

- This year, U.S. colleges and universities will confer between 60,000-75,000 engineering degrees (numbers in Europe are not much better)
- Many of these students will return to their countries of origin to pursue careers
- By contrast, China will produce ~250,000 engineering graduates per year
- With baby boomers retiring at an ever increasing rate, new graduates do not represent a steady state, which is very different from the legal profession

Pardon The Interruption: Education

- Western industry has a choice either recruit internationally, outsource knowledge creation or address the root cause – get kids interested in science and math
- Biggest issue is improving the quality of instruction since only 35-40% of elementary and middle school math and science teachers have any formal math and/or science training
- Various programs sponsored by OSA and SPIE
- Middle School Math Initiative – Laboratory for Learning

Key Takeaways

- Every market has distinct characteristics and we need to respect them
- The market wants performance, reliability and cost – we have to manage all three
- If you don't have a strategy for China, get one
- Let's work to create the next generation of great optical engineers – support educational initiatives