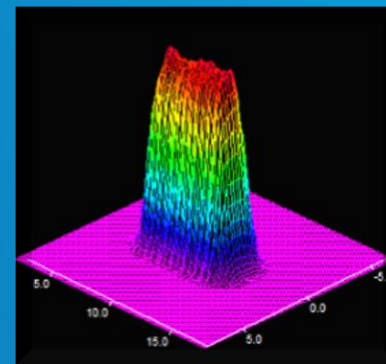
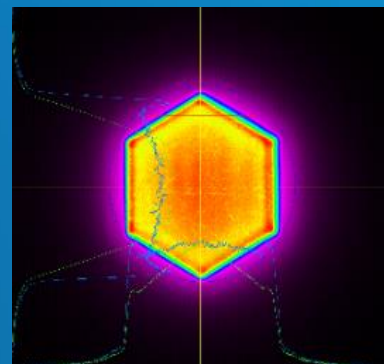
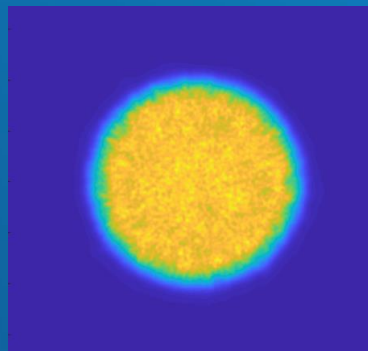
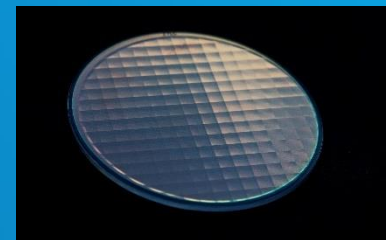
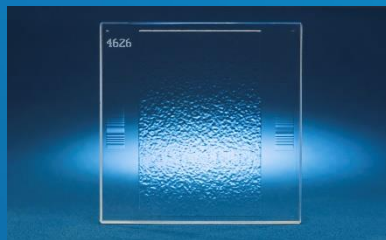




PowerPhotonic

High-performance beamshaping for laser applications

Roy McBride, CEO, PowerPhotonic Ltd

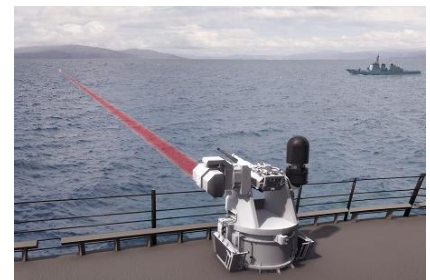
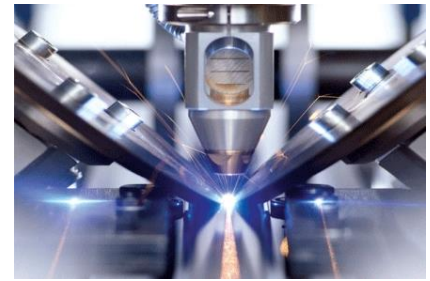




Applications of laser beamshaping

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- **Industrial**
 - Macro-processing: cutting, welding
 - Micro-processing: micro-ablation, marking, drilling
 - Wafer & glass processing: cutting, annealing, laser lift-off
 - Cladding and additive manufacturing
- **Imaging**
 - Laser projection display
 - Advanced microscopy
- **Defence**
 - Target illumination
 - LDEW
- **Scientific**
 - High energy pump sources
 - Optical tweezers
- **Medical**
 - Skin treatment
 - Tattoo removal

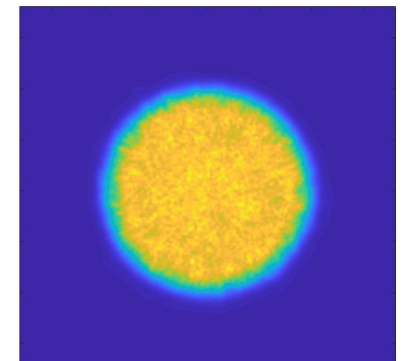
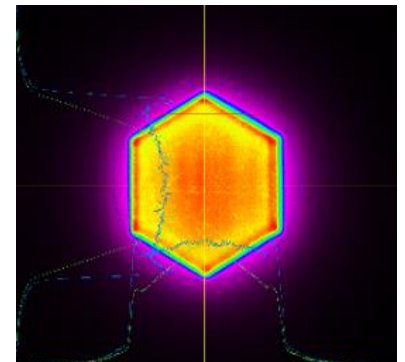
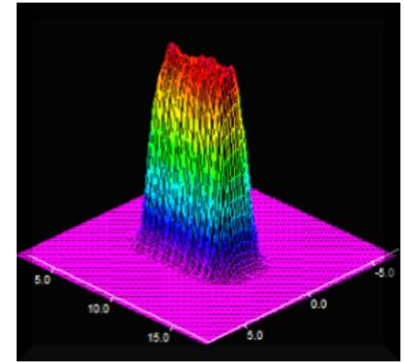




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Requirements for high performance

- **High efficiency**
 - Low scatter & absorption loss
- **High power and fluence handling**
 - Multi-kW CW
 - Multi-joule ns, ps, fs
- **Free choice of input beam**
 - Source beam shape and profile
 - Source spatial coherence
- **High precision output beam**
 - Precise control of beam shape and profile





PowerPhotonic

Company overview

Summary

- Freeform design and manufacture of precision fused silica micro-optics
- 35 staff
- Class 1000 cleanroom fabrication
- Shipping freeform micro-optics since 2006

Technology Leadership

- Proprietary patented laser direct-write process
- One process from prototype to volume
- 24/7 lights-out automated production
- Class-leading performance

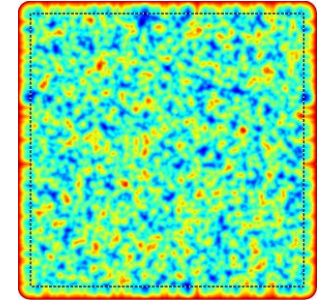
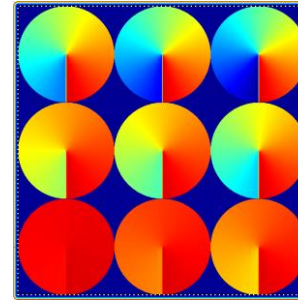
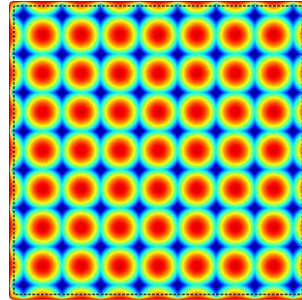
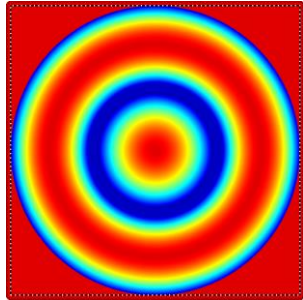




Freeform, direct-write optical fabrication

PowerPhotonic

Free choice of surface profile



Increasing complexity

- **Freeform = design freedom**
 - Free from symmetry constraints
 - Realise complex optical designs
 - Wide range of functionality
- **Direct-write = flexibility**
 - No masks, no moulds
 - Trial, iterate and optimise design
 - Prototype to volume in one process
- **High-performance**
 - Precision fabrication
 - Low scatter, low loss
- **High fluence and power handling**
 - Multi-kW CW
 - Multi-joule ns, ps, fs
- **Broad wavelength range**
 - From <200nm to >2 μ m



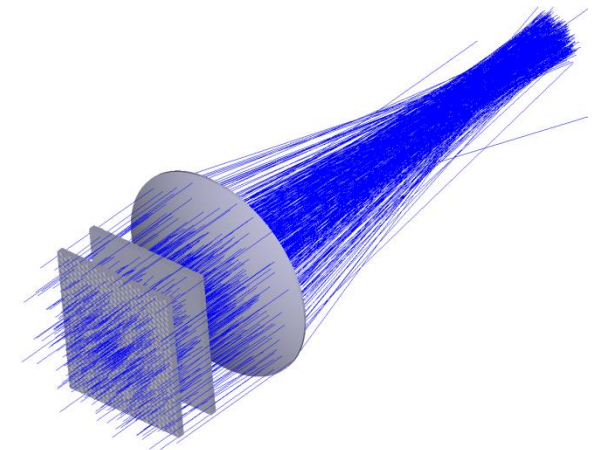
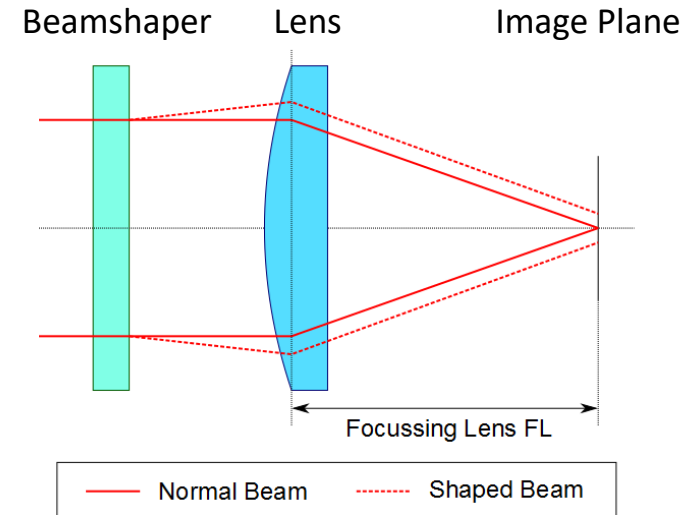
Laser beamshaping: optical configuration

Typical system

- Beamshaper generates far-field (angular distribution)
- Lens images far-field profile onto near-field at process plane

Design starts with beam properties

- Source spatial coherence (# spatial modes) drives choice of beam shaper type
- Input and output beam profiles drive detailed design



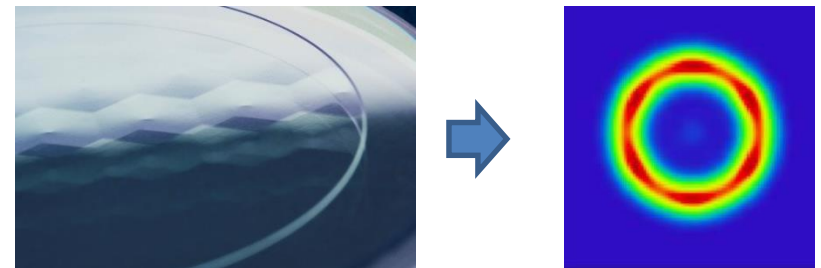
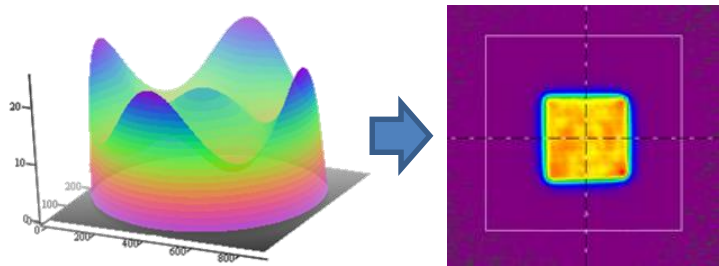
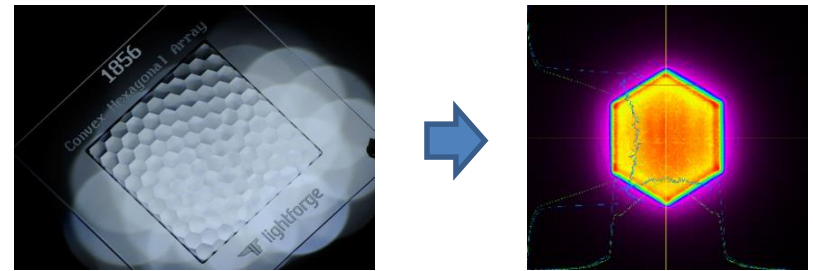
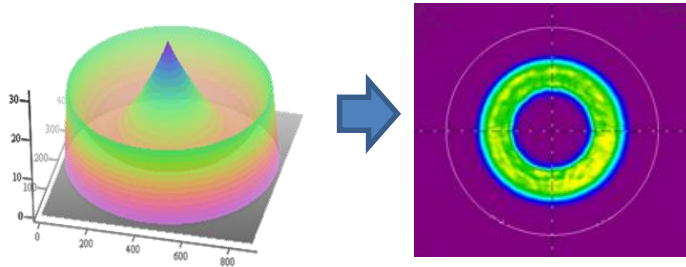
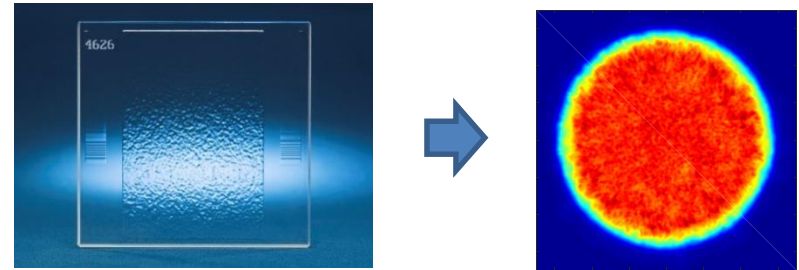
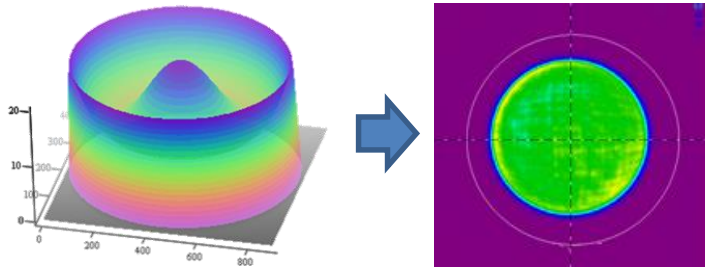


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Beamshaper selection: how many modes in source beam?

Single mode / few mode: field mapper

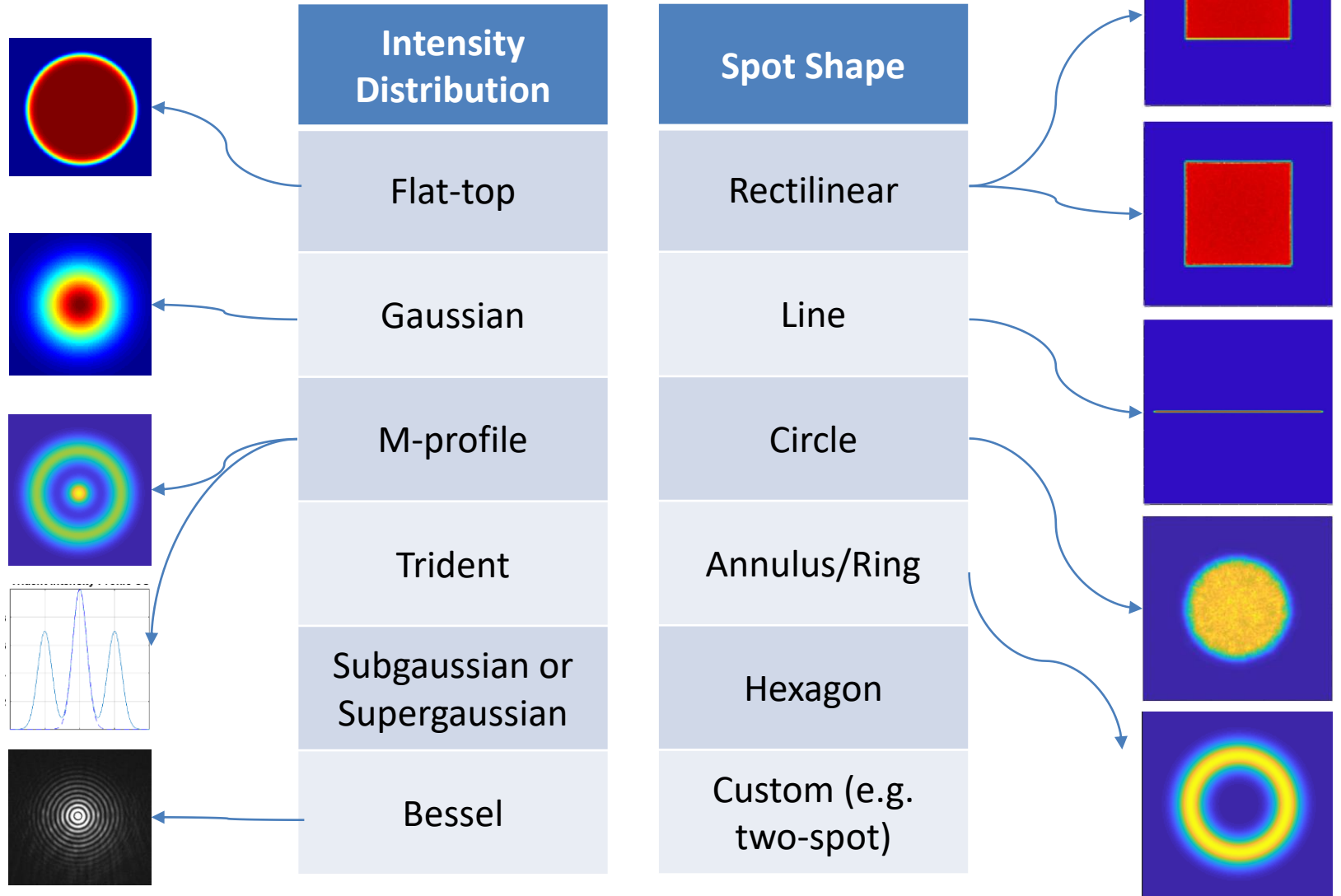
Multi-mode: homogeniser





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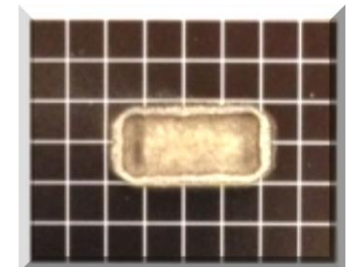
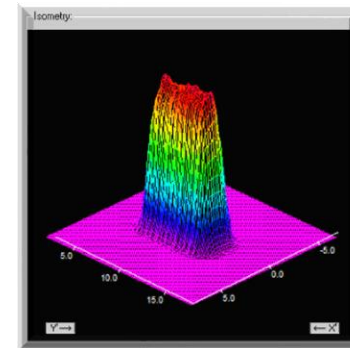
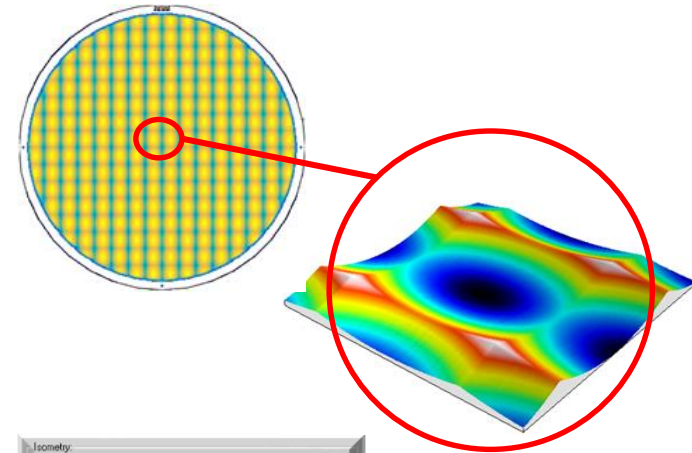
Beam Shaping Options & Examples





Application: high power welding

- **Multi kW metal welding**
- **Concave, toroidal lens array**
 - Multimode fibre laser source: intermediate spatial coherence
 - Rectangular flat-top spot at workpiece
 - No retrofocus
- **Installed in LaserMech FiberWeld process head**
- **Improved weld quality at 10kW CW**

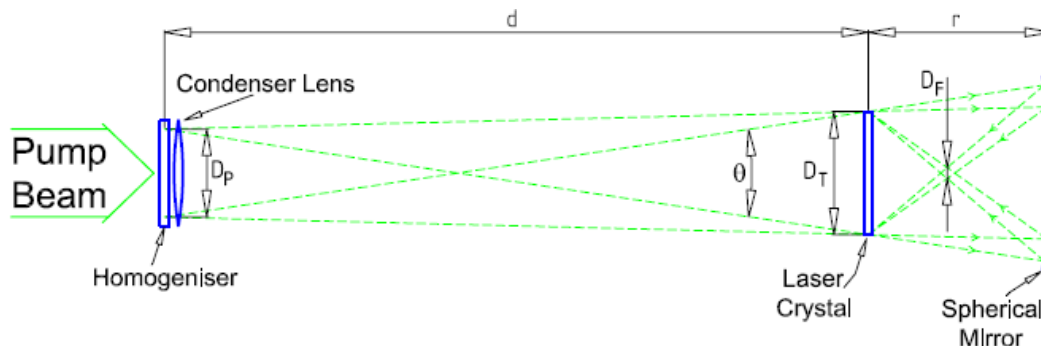




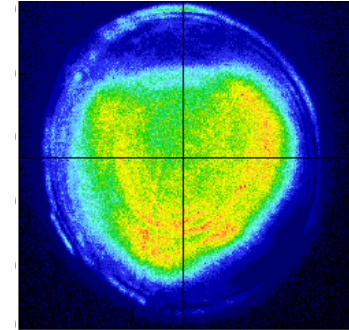
Application: high fluence pump laser

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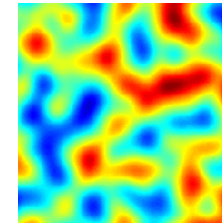
- High-efficiency circular flat-top homogeniser for RAL's Gemini laser
- 532nm, 25J, fs pulse = Petawatt peak power
- Estimated PRIME efficiency = 98%
- No zeroth order
- Enables higher power experiments, lower laser power for longer lifetime



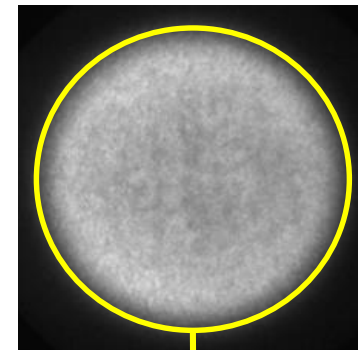
Input beam profile



Beamshaper surface profile



Output beam profile



48mm diameter



High-performance beamshaping - summary

PowerPhotonic

- **Application-specific beamshapers tailored to**
 - Source properties - beam shape, profile and spatial coherence
 - Process requirements - beam shape and profile
- **Used with broad range of lasers**
 - CW to fs
 - UV to NIR
- **High power handling, high efficiency**
 - mW to multi-kW CW
 - mJ to multi-J pulsed
- **Ideas? Problems? Solutions?**
 - Ask now, or contact us later!

