Coherent Beam Combining (CBC) is the holy grail of the laser industry, a long sought after technology enabling to **electro-optically combine** many channels of high power lasers without sacrificing beam quality. CBC enables reaching very high laser power in single mode and also enables **many other unique advantages** in many applications. **CBC is modular, scalable and uses relatively inexpensive components.**

**Civan is a world leader** in utilizing CBC in an affordable, robust and efficient high power laser systems. Civan’s unique ability to apply its proprietary CBC and manufacturing technologies into robust high power laser systems is the result of nearly 20 years of research and the development of **state of the art Electro-Optics and Optical packaging abilities.**

**Civan is:**

- Vertically Integrated, Leader in Coherent Beam Combining

**Civan Offers:**

- High Power, high brightness diode & fiber Lasers & unique custom laser systems
Civan offers **Optical Phased Array** (OPA) CBC Lasers. Our OPA technology enables **ultra fast, electro optical beam shaping, positioning, focusing and modulation**. All dynamic features are achieved without any mechanical movement and can be done at **MHz speeds**. The dynamic control is **software programmable**.

### Unique features & abilities of Civan’s OPA Lasers for Materials Processing:

1) **Variable Beam Parameter Product (VBPP).**
   The inherent ability to change spot size and BPP in MHz speeds, dynamically and mid-process, without any mechanical changes.

2) **Dynamic beam focusing.**
   The focusing distance of the beam can be changed electro optically in MHz speeds, dynamically and mid-process.

3) **Dynamic beam shaping in MHz speeds.**
   Unique beam shapes can be created electro optically to improve the process speed and quality. These shapes are digitally generated and can be dynamically changed during the process at MHz speed.

4) **Ultra Fast beam movement of the beam**
   The ability to “steer” the beam at MHz rates, dynamically and mid-process in a variety of shapes and pattern, to optimize application efficiency. i.e **circular beam movement, back and forth (wobble), figure “8” etc.**

5) **Fast Power Modulation (temporal Modulation)**
   The ability to modulate laser power mid-process at MHz rates.

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**Fig 1:** Electro Optically, digitally generated beam shapes

**Video:** OPA demo of beam Wobble, slowed down for exemplification.

**Video:** OPA demo of beam modulation, slowed down for exemplification.

**Figure:** OPA demo system
Fusion & Remote Cutting

Beam shaping:
- One optics enables - thin & thick plate cutting
- Optimized piercing process
- Adjustable kerf width

Fast beam movement
- Reduction of surface roughness and dross;
- Increase of cutting speed;
- Improvement of process quality;
- Adjustable kerf width

Fast power modulation
- Reduction of surface roughness and dross, debris and recast
- Cutting of filigree contours
- Save of process gas

Traditional & remote Laser welding

Beam shaping:
- One optics - deep penetration welding & optimization of outer weld geometry
- Adjustable seam width for overlap joints
- Optimized gap bridging
- Adjustable weld seam width

Fast beam movement
- Improved weld quality for hard-to-weld materials like Aluminium die casting, AA5xxx with high Mg-content;
- Increase of welding speed
- Adjustable seam width for overlap joints

Fast power modulation
- In combination with fast beam movement new process features for improved process stability
- Adjustable penetration depth for 3D-welding / change of beam incidence angle

Additive Manufacturing

Fast beam movement
- Increase of metal sintering rates >X10, achieved by dynamic MHz rate Electro – Optic scanning from OPA CBC in combination with platform’s scanning Head.
- Enable accurate edge forming with unique beam shapes
- Reducing time per part and cost per part

Fast power modulation
- Optimize process quality and modulate at high rates when needed.
High Power at different wavelengths unlocked by CBC

The key for any successful and efficient laser based application is good interaction between the laser light and the material. For some important industrial materials, the main high power industrial lasers existing today at wavelengths of 795 – 976nm (diode), 1070nm (ytterbium fiber laser) or 10.6μm (CO2 lasers) are absorbed poorly and cause bad interaction with the material, making it difficult and non efficient to use lasers to process them.

In many wavelengths there no laser solutions providing sufficiently high power outputs. Achieving high power in unique wavelengths through CBC by coherently combining many lower power lasers unlocks possibilities for new applications with new materials and improved performance in existing ones.

One Material for example is copper, vastly used in the electronics and automotive industries for its good thermal and electrical conductivity. The best laser for copper processing is a high brightness (single mode) 532nm (green) fiber laser, achieved by using a doubling (Second Harmonic Generation) crystal with a 1064nm fiber laser. This method is limited in achievable power due to the Crystal’s damage threshold. Using CBC Civan can offer high power lasers at 532nm. Green single mode laser modules of 50W can be combined coherently to achieve much higher powers (>500W) needed in the industry to improve laser processing in various materials. This is true for other wavelengths as well.

![Fig 8: light absorption in materials as function of wavelength](image1)

![Fig 9: example the difference in copper welding results between 1064nm and 532nm wavelengths](image2)
With CBC lasers, by coherently combining separate laser channels it is possible to bypass the physical limitation (non-linear effects + SBS) of the maximal laser output power that is achievable in single mode beam quality. Civan can offer **single mode CBC fiber lasers with power outputs > 10kW**, at competitive market prices comparable to the price of traditional multimode fiber lasers, This Unlocks new possibilities for Industrial materials processing applications;

- **Ultra High power Density on the work surface:**
  Getting the job done with less output power, saving money, electrical costs and time.

- **Improved abilities for remote cutting operation:**
  Today, cutting speeds of thin metal are no longer limited by laser power but by the actual speed in which a heavy traditional laser cutting head can move and turn across the work surface. In remote operation with a high power single mode CBC laser, **fast ablation cutting can be achieved and cutting speeds can increase x10!** Single Mode Remote cutting of thin metals is faster, more versatile and cheaper.

**Video:** example of the advantages in speed & process gas reduction of a multi kW single mode laser against a traditional multi mode multi kW laser. Video rights Belong to Fraunhofer IWS.

- **Improved abilities for remote welding operation (large area scanner welding):**
  Welding is one of the largest applications for high power industrial lasers. Civan CBC Single mode fiber laser can offer unmatched versatility and speed for producing deep welds or shallow conduction welds. With a standard industrial multimode laser (either diode or fiber), even when attached to a robotic arm and scanning optics, the distance at which the laser must be from the work surface is limited to several tens of centimeters, at a greater distance, beam quality will not be sufficient for producing high quality, high precision welds. This means that for every weld the laser must be brought close to the work surface, costing in time and money. To offset this, many laser welding systems are sometimes used simultaneously. The **superb beam quality of Civan’s** high power single mode laser means that the process can be done successfully with the laser located at a large distance from the work surface. **Providing improved speed and versatility.**

**Fig 10:** A typical layout of several laser welding robots at an Automotive assembly line, the robots must “waste” time and get close enough to the material.

**Video:** An example of how a high power single mode fiber laser can save time and increase throughput in an automated manufacturing line. Video rights Belong to Fraunhofer IWS.
Summary of Unique Advantages & Features of Civan’s CBC Laser Systems

OPA CBC: Ultra High Speed, DIGITALLY Controlled Dynamic Beam Shaping & control

- The Digitalization of the laser— one laser Can be suited to many different tasks at the touch of a keyboard, without any hardware modification required! Unmatched Versatility.
- MHz speed beam steering and control – crushing current benchmark for beam control speeds, unlocking new possibilities, and improving process efficiencies.
- Fully Dynamic control, even mid process. A laser industry’s first

High Power at different wavelengths unlocked by CBC

- Ideal Match between material and wavelength
- Reaching High Power in Single Mode in 532nm and other wavelengths

High Power in Single Mode beam (up to 10’s of kW)

- Ultra High power Density
- Improved abilities for remote operation
- Small spot size and high power densities at large distances

Civan’s Versatile high Power CBC lasers Enjoy From all of these advantages, unlocking new possibilities and breakthrough performance in many different applications.