Overview

Foro Energy is commercializing high power lasers for the oil, natural gas, geothermal, and mining industries.

Our unique capability and hardware platform to transmit high power lasers over long distance fiber optic cables enables step change performance in applications to drill, complete, and workover wells.

Launched in 2009, Foro Energy is built upon a decade of academic work at the Colorado School of Mines with a novel approach to bust through the "sound barrier" of Stimulated Brillouin Scattering that previously made it impossible to transmit high power lasers over long distance fiber optic cables. Soon thereafter, this innovation was recognized with a large award from the U.S. Department of Energy's ARPA-E transformational energy technology program.

Our world class team with 200+ years of advanced technical experience in high power lasers and oilfield engineering has subsequently made 8 enabling technical achievements that allow deploying high power lasers for the first time in these markets.

With this unique capability and a portfolio of 40+ US and international patent filings, Foro Energy works together closely to enable access to the next generation of the world's energy resources.

Why Now?

Discussion and research on using high power lasers in the oil, gas, geothermal, and mining markets extends back to the 1960s. Until now the available high power gas lasers required high voltages and precision alignments that made them extremely large, inefficient, and too fragile to transport.

The fiber laser however consists of modular architecture of coupling individual high power laser diodes to an active fiber that is built from the "bottom up" to create higher and higher powers.

Over the past decade, advancements in this fiber laser technology have:

- Increased power availability from less than 1 kW to greater than 50 kW
- Reduced costs from greater than $1000/W to less than $50/W
- Allowed rugged field transportation and operation

For context, 1 kW of laser power can rapidly cut a steel plate.

Unique Capability to Transmit High Power Lasers over Long Distances

The experts consensus was that multi-kW, multi-mile high power laser transmission is “impossible” due to a physics limitation known as “Stimulated Brillouin Scattering (SBS).

$$-\frac{i}{2k_L}\nabla_T^2 E_L + \frac{n_L}{c}\frac{\partial E_L}{\partial t} + \frac{\partial E_L}{\partial z} + \frac{1}{2}\alpha_L E_L = \frac{i\omega_L \gamma_e}{4cn\rho_0} E_S \rho$$
$$\frac{i}{2k_S}\nabla_T^2 E_S + \frac{n_S}{c}\frac{\partial E_S}{\partial t} - \frac{\partial E_S}{\partial t} + \frac{1}{2}\alpha_S E_S = \frac{i\omega_S \gamma_e}{4cn\rho_0} E_L \rho^*$$
$$\frac{\partial \rho}{\partial t} + \frac{\Gamma_B}{2}\rho = \frac{i\gamma_e \epsilon_0 K_B}{4v} E_L E_S^*$$

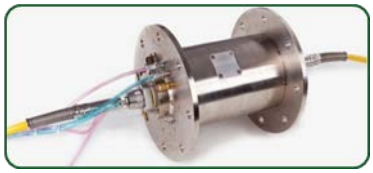
Foro Energy’s proprietary technology overcomes these and other limitations to allow “world first” transmission of:

- High power, by overcoming SBS
- Over long distances, by overcoming SBS
- With low loss, through a proprietary fiber optic specification
- In downhole environments, through a proprietary cabling package

Enabling Hardware Platform

To deliver laser power into a spool and downhole through a tool, Foro Energy built and demonstrated a set of enabling laser hardware components including:

- Optical slip ring for a rotating coupling of laser power into a spool
- Downhole connector for plugging into an optics package
- Optics packages for delivering the high power laser energy.



Foro Energy developed, and continues to develop, the know-how and experience curve of deploying high power laser systems in the field that can only come from being the first company to take a high power lase r under theground.

Partners

Foro Energy has a best-in-class partnership model working with

- Colorado School of Mines in a worldwide exclusive partnership
- U.S. Department of Energy award in “transformational energy technology” program
- Leading industry partners

Contact

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