

# New Tube Cutting Technology Meets Next Generation Production Needs

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Stents and hypodermic tubes (hypotubes) are used in countless applications and the demand is growing rapidly in response to the continued demand of stent applications and growth of minimally invasive surgery. The sheer number and diversity of devices is rapidly increasing – and with it the demand for more and more laser cut stents, flexible tubing, cannulas and micro cannulas, needles, biopsy devices, and other minimally invasive tools. **Figure 1** shows examples that represent common features of modern stents.



*Figure 1 – Laser cut stents*

While legacy stent and tube cutting systems have performed well during the recent decades, new cutting technologies coming onto the market offer faster and better cuts, with higher production rates.

## REPLACING LEGACY CUTTING SYSTEMS

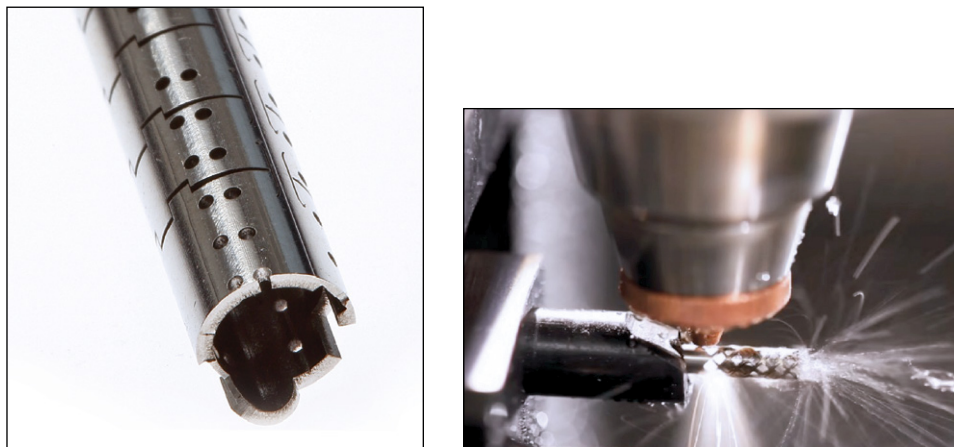
The pulsed neodymium-doped yttrium aluminum garnet (Nd:YAG) lasers used in the past decade have definitely been great workhorses. They have performed well and been excellent profit centers for many companies.

Unfortunately, the original integrated pulsed Nd:YAG lasers that remain in operation are now obsolete and difficult to service. While many of these systems have been upgraded to fiber lasers, they still have stage sets that are well past their sell-by date, running on slow and aging controllers with legacy software. At some point even the trusty old pickup needs to be replaced!

Simply put, the laser, stages, controller, software, water systems, and automated tube loader technology have all moved on to enable faster and better cuts with higher production rates and less down time. Here's how.

### Laser

The pulsed Nd:YAG lasers formerly used have been superseded by fiber lasers with better beam quality that does not change with pulse energy and average power. These lasers also provide pulse frequencies up to and beyond 5 kilohertz (kHz) to maximize acceleration and speed for a range of part thickness and features. What's more, they produce pulse durations down to tens of microseconds for fine feature cutting. From an operational standpoint, the fiber lasers have a number of advantages. They are air cooled, run off single phase 240 volt electrical power, and have diodes with lifetimes that are greater than 70,000 hours, which equates to minimal operational costs. **Figure 2** shows an example of a tube produced by one of the new laser tube cutters on the market (left) and a close-up of laser tube cutting (right).



*Figure 2 – Laser tube cutting*

## **Water system**

In many legacy system designs, the water system was a weak point, requiring constant attention and maintenance to keep the machine running. Such issues as small water tank sizes, short lifetime pumps, and lack of internal flow monitoring all added up to an unreliable system. This was compounded by equipment that was difficult to access, even when simply changing water filters. Fast forward to newer systems, which have a 10-gallon tank size, 4 level debris filtering, intelligent programmable flow valves, multiple solenoid switches to prevent large water leaks, and drawer-mounted hardware that enables filter changing in seconds. The user interface provides the operator all necessary information, along with pre-cutting safeguards and go/no go limits to ensure that all is well.

## **System design**

A final advantage of the latest fiber laser cutting systems is that the machine can be designed without the previous constraints posed by fixed beam delivery and a granite support structure. Using newer fiber laser technology enables the laser to be mounted in the machine base with the flexible fiber routed to the focus head. The use of a composite base that has better vibration damping than granite also allows for a cantilever arm support, providing a very open machine from an operator accessibility perspective.

## **NEW ON THE SCENE – FEMTOSECOND DISK LASERS**

Femtosecond (fs) lasers offer a new cutting regime that sets them apart even from the newer microsecond pulsing fiber lasers. Fs light pulses are ultra-short pulses (USPs). One fs =  $10^{-15}$  seconds and, as a calibration point, a 300 fs pulse equates to a physical length of pulse of only 90 micrometers ( $\mu\text{m}$ ).

Whereas fiber lasers cut by a melt and eject process using a high pressure coaxial gas, femtosecond lasers sublimate the material from solid to vapor. This material removal process produces cuts of the highest quality with no burrs and with high dimensional accuracy.

Since the laser's pulse duration is around 400 fs, the pulse has a shorter duration than the conduction time of metals, so the material can be cut with no thermal input to the remaining material. This so-called "cold processing" enables cutting of very fine features and eliminates any potential for micro cracking that can be an issue for nitinol.

In the world of stents and hypo tube cutting, the amount of post processing can be significant, especially for materials such as nitinol. Femtosecond lasers remove the need to post-process the parts for burr removal, and so eliminates this costly manufacturing element. Although the cutting speed of femtosecond laser is sometimes slower than that of fiber lasers, eliminating the post-process step can justify the return on investment (ROI).

## **IT ALL ADDS UP TO INCREASES THROUGHPUT AND REDUCED CYCLE TIME**

The new laser types and system design improvements are leading to an increase in throughput, which is happening organically based on greater equipment up time and reduced cutting cycle times. The reduction in cycle time is based on the complexity of the cut pattern and the number of discrete cuts on the part. The reduction in cycle time for a stent or cutting a flexible tube is estimated at around 30 percent.

The keys metrics of up time, running costs, yield and production throughput will be somewhat case-specific, but on average, ROI for purchasing new cutting equipment is expected to be within 3-4 years.