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Fiber Laser Applications Video- January 2007
Transcript Part III

What's nice about the fiber laser versus some of the older units is in the old days you'd always have a robot or x-y table or so forth. Let's say you have a set of x-y stages for cutting ……....this can run $60K to $120K. A robot like this can run about $30K. So I can have my x and y stages to move my part around and do all my flying cutting motion with the robot. And while I'm loading a new part I can actually scoot this robot off of that stage and then do complex geometries and so forth. So the workstations themselves are changeable.

But what I was pointing out here is again, cost savings and automation. What they do "lights out", they load the parts and then leave and come back the next day and the parts are processed. What's going on here is a standard solenoid system and then we switch through the bank internal to pick the gas. This is turning on the gas only when needed. So you're saving gas and it's also adjusting the flow rate based on the process. So again, it becomes a programmable tool rather than requiring an operator to make changes on a case by case basis.

To give you an idea of scale, a 6 kilowatt cabinet is this size and that's the chiller for it, the coolant. A 6 kilowatt laser in a traditional YAG would probably be about the size of this room and the chiller is usually larger than that. That causes some problems. If they've got a bulk chiller and they bring in house water, which you can see we're doing, that's one way to do it, with a water-water exchanger. The problem is a lot of times they'll drop a new laser product in and they'll have to put a chiller nearby, and in this case it's water to air. Which means I'm now taking heat out of the laser and blowing it into the room, which means now my HVAC and the facilities manager will have to take into account. That'll affect overall cost for the building. You have to keep the temperatures for the operators and the machines at a certain range.

What we - if you look at the back of any of our larger lasers you'll actually see a small air conditioning unit. That air conditioning unit is doing a few things. It's keeping the laser cooler so the chiller has to work less but it's also maintaining a dew point within the laser. I was at a facility last week in Philadelphia, metal Henry building, concrete pad, very thin walls, absolutely no air conditioning. In the summer let's say it's 78 degrees in the building. In the winter it's about 45 degrees. What they do is move air conditioning and heating units around to keep their operators comfortable, but the laser has to be maintained at a certain range and dew point. Dew point is important- you don't want water forming on your circuits and on your optics.

We don't build systems here, we just build lasers. So what'll happen is company A will have a part they want to cut. They have a price model they want to stay within. So they'll ask me to do a couple of things. They'll send me samples, and we'll choose the appropriate wavelength 1 micron, 1.5 micron (which is the eye-safe wavelength)

There's a nice graph in pretty much every physics optical textbook that shows the absorption spectrum of a material. Metals play really well at one micron, especially aluminum- there's a very nice peak around one micron. So our YAG, your YLF, your vanadate, your ytterbium - they're all at one micron- 1064, 1053, 1057 or 1070 (nm) in our case.

So if you have the absorption spectrum at that one point, that means I need less power to get the same amount of work done than if I work outside of that peak. And it falls off fairly sharply. So a lot of the traditional use for the YAG or the CO_2 is right around… for the metals. The problem is that if you go back to that now a YAG is 1060, just about 10 times greater than a CO_2, so now I just did the exact opposite of what I just told you; I've gone well outside of that absorption spectrum so I'm pumping in lots of power. Traditional YAGs or CO_2s is between 1 and 6% wall plug efficiency, so again getting back to trying to be aggressive and competitive financially if I'm putting in x amount of and only 2-4% of it is actually being used for work and the rest is being dumped out as heat, which is why I need those chillers, that's where I affect my HVAC, my heat load to my building, that's where my electricity bill comes into play. Certainly these are things we don't want to deal with if we don't have to. The fiber laser tends to be 25-35% wall plug efficient. We're getting much more efficient with better conversion rates. There's reasons for that as well; I'll get to them in a second.

Back to the selection. So you send me a part. It's a metal so I'm going to jump right on one micron, typically that's where my peak is. Now the question is how fast can I cut it, if I can interact with it at all. We'll usually do a matrix test. A matrix test is…typically you set up a series of cells, whatever you're doing, cutting, drilling, welding and so forth, and what it does is set the x axis for speed, 100 mm/sec, 200 mm/sec, 600 m/s- you usually want to do that as kind of a ramp. And in the y axis you'll do frequency- how fast am I pulsing it? A pulsed laser, I'm getting peak power by chirping the pulse that'll affect one thing. So a 20 watt average power laser can actually give you a 7 kilowatt peak.

And I want to see exactly where that material will play well for certain speeds. And I can look at that matrix and say ok at 200 mm/sec at 20 watts at 50 kHz I have very good material interaction. So I have a very quick process instead of having to go through huge deal the matrix is a quick way to do this. The other reason we do that is that this is a large part. A lot of the parts we get are medical parts, and they tend to be about 2 mm by 2 mm in area and they don't have a lot of real estate to play with. So we have to find out very quickly. And they tend to be very expensive parts so we don't get a lot, only get about half a dozen total, and at least half of those have to be final parts to return to the customer with a good process. So I have a very little amount of real estate to deal with. We try to come up with the best way to maximize the testing.

So lets say we go through and find out that this material reacts very well at 3 kilowatts at 18 meters per minute. That's perfect, except the customer only wants to spend half that amount of money. So now I have to choose a laser in their price range, and say, ok this is your best process, what is the best process in your dollar band…….. So that would be a one micron test.

What we're doing now- and we'll show you a machine we're working with across the hall- there are other materials you use say, ceramics, so you've got green ceramics (before they're fired), white ceramics, low shrinkage blue ceramics some of which are used for implantables like defibrillators, pacemakers. Ceramics typically work really well with the CO_2. The old rule of thumb is that if it's a CO_2, it's organics; blood, bone, wood, paper, these types of applications.

If you went into outer space and looked down at the earth and did a spectral, you're actually going to see a very large peak for CO_2. That's why the interaction takes place there. So what we're doing now is, we've got a CO_2 laser that's been very well qualified and understood in the field, and we're taking that same system and putting a fiber laser on and processing the same materials. We're gonna do it one micron, at 1.5, at 2.1, so, ytterbium, thulium, erbium wavelengths, and we want to see what material behaves best at what wavelength. But we're doing it on the same machine for a reason because if I take one machine and two laser tools, and it's the same physical machine, I can take the machine out of the equation. And now it's laser versus laser. Because if I did some tests on the robot and everything else on the CO_2 on a different test bed, there are different- backlash in the machine, standoffs in the machine and so forth. But if I do them all on one test machine it's a true comparison study.

[What about the spot size compared to CO_2? You're doing some very delicate...]

Oh, certainly. Again, when you're dealing with the wavelength you're thinking what is the fundamental limit that I can get with my laser. Something that's really important- it's hard to explain to people up front if they don't understand it, they don't want to deal with the math and they're used to dealing with, say, and end mill- is if I take a spot that's, say 100 microns and I do one set of process parameters. If I halve that spot, I haven't doubled the power, I've done it by a factor of four because you have to think of the area. A lot of people don't think of that- well, I've doubled my spot – well, halved my spot so I've doubled my power. No, it's actually four times the power. That's a good point to bring up.

That can again be affected by changing the fiber diameter that we talked about, changing the collimator length or the focal length. In a lot of cases you'll see that our lasers of lower power will come with a fixed collimator. Typically they give about a 7 mm spot size and there's a reason for that as well. A lot of the processes we do are galvo based. So here we're actually moving the laser across the part, or across the hall you'll see them moving the part below a fixed beam for perpendicularity with smaller parts.

In a lot of cases they'll want a fixed part and they're actually steering the beam with galvos. Galvos are just high speed mirrors that are selected for size based on the spot coming in. The smaller mirror you can use, the smaller clear aperture you need, the faster you can go. The problem is, the smaller the beam, the larger it can actually get on the workpiece. So if I can get the beam to be larger prior to coming into the final focusing lens, I'm filling the aperture of the lens and I can actually get a smaller spot on target. A smaller spot on target means a higher fluence, so I can get a smaller laser to do the same work. So again, for the customer, the price of the laser goes down. And actually the efficiency goes because you're using less energy to run the laser so electrical consumption goes down. That's very important as well.