ATHANASSIOS KALIUDIS

„I find the disk as amazing as ever“

Adolf Giesen had his head in the clouds when he came up with the idea for a disk laser in 1991. In this interview, he describes how the laser is reaching for the stars to rid the Earth’s orbit of space debris.

Your plan is to vaporize space debris using a laser beam It’s a bit audacious, isn’t it?

Not at all! It’s completely realistic. At the German Aerospace Center (DLR) we’re already using lasers with high-energy short and ultrashort pulses to detect space junk. We can calculate their trajectories down to the nearest meter.

But to vaporize pieces of debris the laser would have to be considerably more powerful!

We’ll certainly need a good few kilojoules to vaporize the surface of each piece of debris. We’ll do that using laser ablation, which will have a “push” effect, slowing the debris down and ultimately causing it to burn up in the lower atmosphere. The idea may sound a bit up in the air, but we actually already have concepts on the table.

And where will this huge increase in laser power come from?

A disk laser is obviously the best choice.

Personal

Prof. Dr. Adolf Giesen was born in December 19, 1946. He obtained his doctorate in physics from Bonn University. His doctoral thesis reveals that he had already developed a keen interest in lasers. His second passion is music. Adolf Giesen plays the piano.

Stations

From 1982 to 1986, Adolf Giesen worked on high-power CO^2 lasers at the DLR Institute of Technical Physics in Stuttgart. From 1986 to 2007, he headed up the laser and laser optics department at the University of Stuttgart’s Institute for Beam Tools (IFSW). It was during this period that he developed the basic concept for the disk laser. In 2007, he was appointed as the director of the DLR Institute of Technical Physics in Stuttgart. In that same year, he founded the company Dausinger und Giesen GmbH with his colleague Friedrich Dausinger.

Awards

Adolf Giesen won the Berthold Leibinger Innovation Prize in 2002. He received the Rank Prize in 2004 and the Charles Hard Townes Award in 2017.

You came up with the concept for the disk laser 26 years ago. Did you realize back then exactly how much potential it had? I notice that you based your first publication on the assumption that each disk would provide just a few hundred watts of output power.

I didn’t want to stick my head out too much back then, but I had already realized that the disk could generate a lot of power. At that time, I was lucky enough to be working together with Klaus Wittig, an outstanding theoretician, as well as with Andreas Voss and Uwe Brauch.We collaborated on the design of a model that demonstrated that we could turn my idea into a scalable concept.

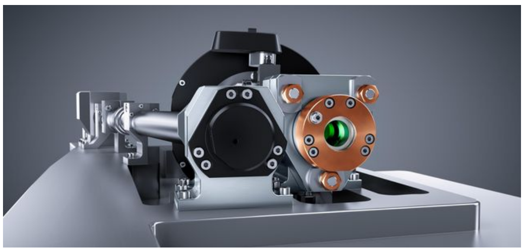
Even then it was clear to us that the disk laser wouldn’t be restricted to the kilowatt range. In fact, that was what kept me working on the concept, because I said right from the start that I didn’t see the point if the output power was limited.

The basic concept of a disk laser occurred to you in an unusual place. So, unlike most of us, you don’t spend your time flicking through magazines when you’re on a plane, right?

(laughs) You really have done your homework! You’re talking about my flight from the USA to Japan in the fall of 1991. And you’re right, I really did make good use of it.

That’s putting it mildly! You laid the foundations for an entirely new manufacturing technology. How did it actually come about?

I had just come back from a conference on solid-state lasers. One of the sessions focused on the active laser medium Yb:YAG. The presenter was tremendously enthusiastic about this highly promising material that could be used to build beam sources for high-power lasers if only a way could be found to cool the material sufficiently, a problem that seemed insurmountable at the time. And I couldn’t get that thought out of my mind.



Optics oft he new TruDisk lasers by TRUMPF

So, you cracked the seemingly insurmountable problem of cooling?

Yes, the idea of a disk just came to me on the plane. Because a disk that was thin enough would be particularly easy to cool across its whole area. That was the basic idea at least, and my team and I then spent the next three months developing a concept that essentially looked much the same back then as it does today.

Could you briefly explain how it works?

Well at its core, as I said, is a Yb:YAG disk that is just about a few hundred micrometers thick—the surface area to volume ratio solves the cooling problem. What's more, the direction of the temperature gradients is almost exclusively axial, which results in minimal thermal lens effects. The laser medium is pumped in a multipass configuration that consists of a parabolic mirror and a deflection system. It actually sounds relatively simple, but the technology is highly complex. The pump beam is refocused by a mirror into the laser crystal.

The highly reflective coating on the back of the disk reflects back any non-absorbed radiation. Repeat that enough times and you get highly efficient absorption of the pump light, and the pump source doesn't even have to be particularly brilliant for the disk laser to exhibit good beam quality.

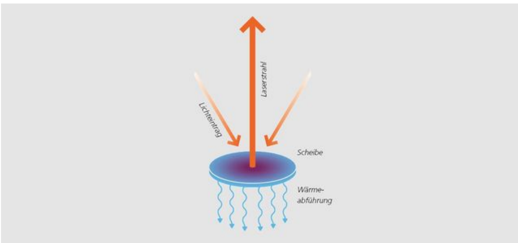
I suppose people welcomed the idea with open arms?

Well, first we had to overcome a few difficulties. For example, the way in which the disk is bonded to the heat sink was—and still is—a crucial issue. But we successfully tackled all those problems. And we made steady progress year after year with support from the German Federal Ministry of Education and Research and with the collaboration of industry partners. Jenoptik presented the first disk laser at the laser exhibition in Munich in 1997, and TRUMPF followed suit in 2000.

And now the disk laser is a well-established, robust and highly successful workhorse and you're talking about pulse energies in the kilojoule range. How do you intend to tackle the cooling problem with that kind of output power?

You're right that cooling has always been the key issue. It really does go hand-in-hand with any attempt to boost the laser power. A disk laser features less thermal deformation in real-life operation than a traditional laser by a factor of around 100.

But there's more room for optimization even in that area. For example, there are publications from the U.S. on liquid nitrogen-cooled lasers. And we have already shown that temperatures between -30 and -100 degrees Celsius lead to significant improvements. But it's difficult to imagine those kinds of cooling systems in an industrial setting.



Because the disk is thin with a large surface area, heat dissipates quickly—often even passively via a heat sink.

OK, but experts say that you don't need more than 6,000 watts for a disk laser in industrial use.

(laughs) Right. And in 1982 the experts said that industry wouldn't need more than 500 watts! Back then they were talking about the CO2 laser that TRUMPF developed in collaboration with the German Aerospace Center. Our goal was an output of 1,000 watts. The TRUMPF experts pledged to support us even though they figured that a maximum power of 500 watts would easily be enough for industrial applications.

And now look where we are. 6,000-watt disk lasers have almost become the norm for industrial use. Obviously, there are limits, because you have to deliver the laser power to the workpiece in a controlled way. But I feel sure that there will always be a demand for more power and that we'll be able to supply it.

You recently left the German Aerospace Center to enjoy your retirement. When I see your enthusiasm for the disk laser, I find it hard to believe that you can ever let go!

You're right, it's not easy. My colleague Friedrich Dausinger and I founded a company in 2007. It's based in Stuttgart and now employs 15 people. We plan, develop and build disk lasers for companies and institutes that need high-power lasers for very specific applications, and we provide support to companies that are using this technology for the first time. And it's going very well.

It seems extraordinary that such a sophisticated and pioneering technology wasn’t immediately seized upon by manufacturers everywhere. Why was that?

The disk laser was a total departure from how lasers had been built before. It requires a complete shift in thinking, and that’s not exactly easy.
Take TRUMPF for example, which has worked hard on developing this technology and invested a great deal. You need some serious capacity for that to pay off, because it really is a big investment.

But the disk laser has big potential for the future, too. That’s why we are striving to make that know-how more widely available. It’s true that I’ve retired, and I’m enjoying spending time with my family, but I still want to keep tabs on what’s happening and help shape things in whatever way I can.

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