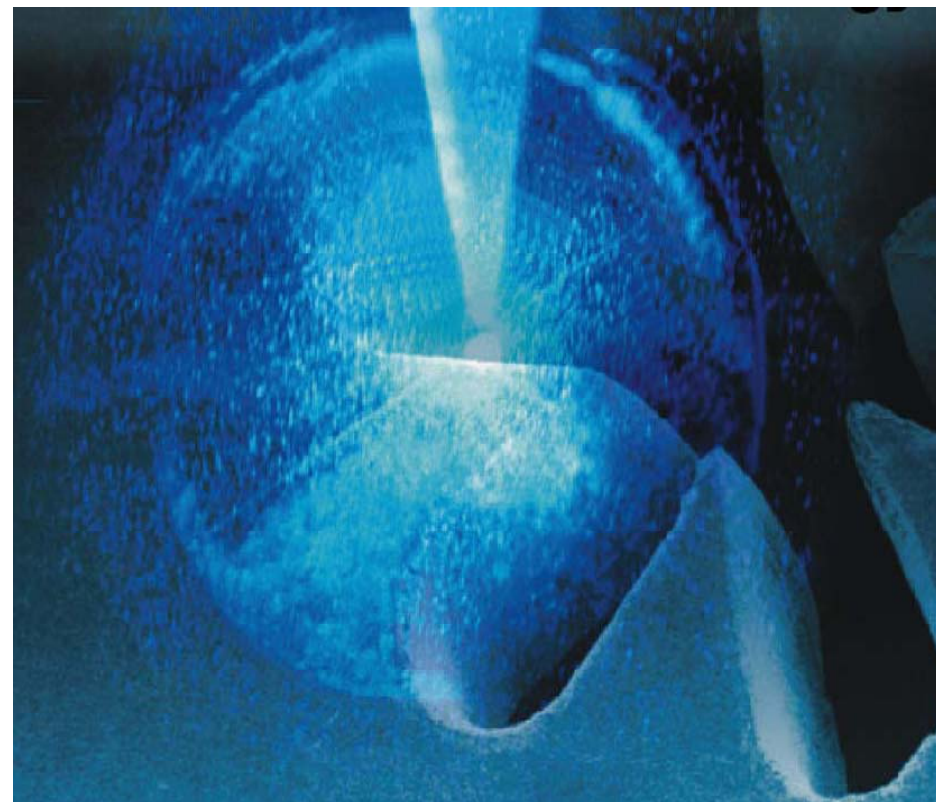


# A New Power Level for Industrial ps-Lasers: 50W at 532nm

**Dirk Müller**  
**Albert Seifert**  
**Ralf Knappe**  
**Hatim Haloui**  
**Bernhard Klimt**

[www. LUMERA-LASER .com](http://www.LUMERA-LASER.com)



# LUMERA Laser: Overview

---



- Founded in 2000, LUMERA LASER has established itself as the leading manufacturer of picosecond laser systems
- Since August 2008 financially backed by the ATON Group
- We strive to provide our customers with:
  - The best value in the industry
  - Knowledgeable customer service (before and after sales)
  - Long term partnerships

# Ultrashort Pulsed Lasers

## How short is ultrashort?

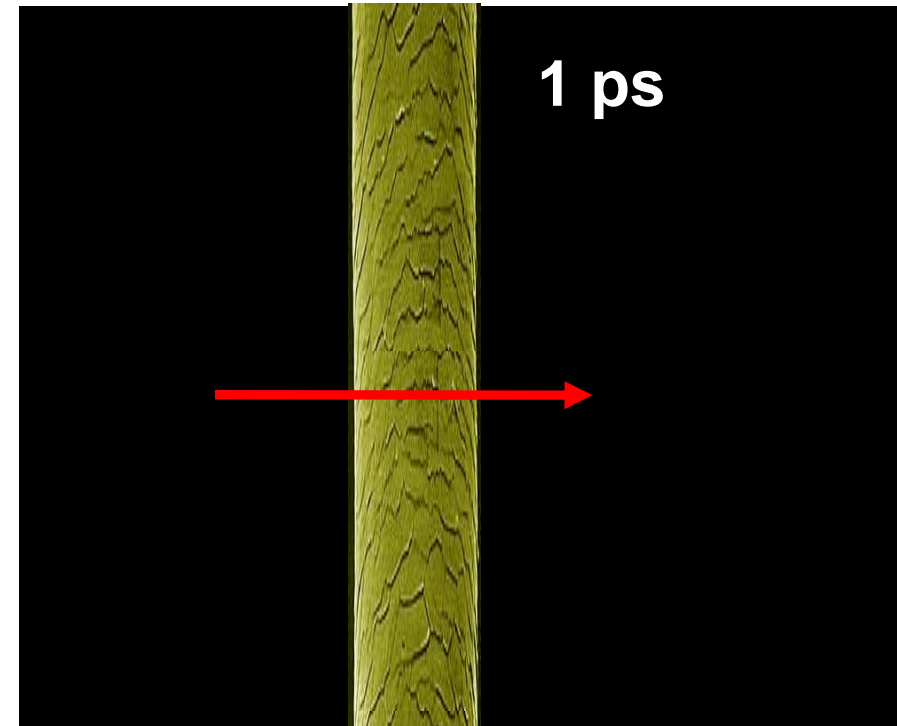
# Picoseconds

One millionth of one millionth of a second...  $10^{-12}$

a picosecond is  
to a second

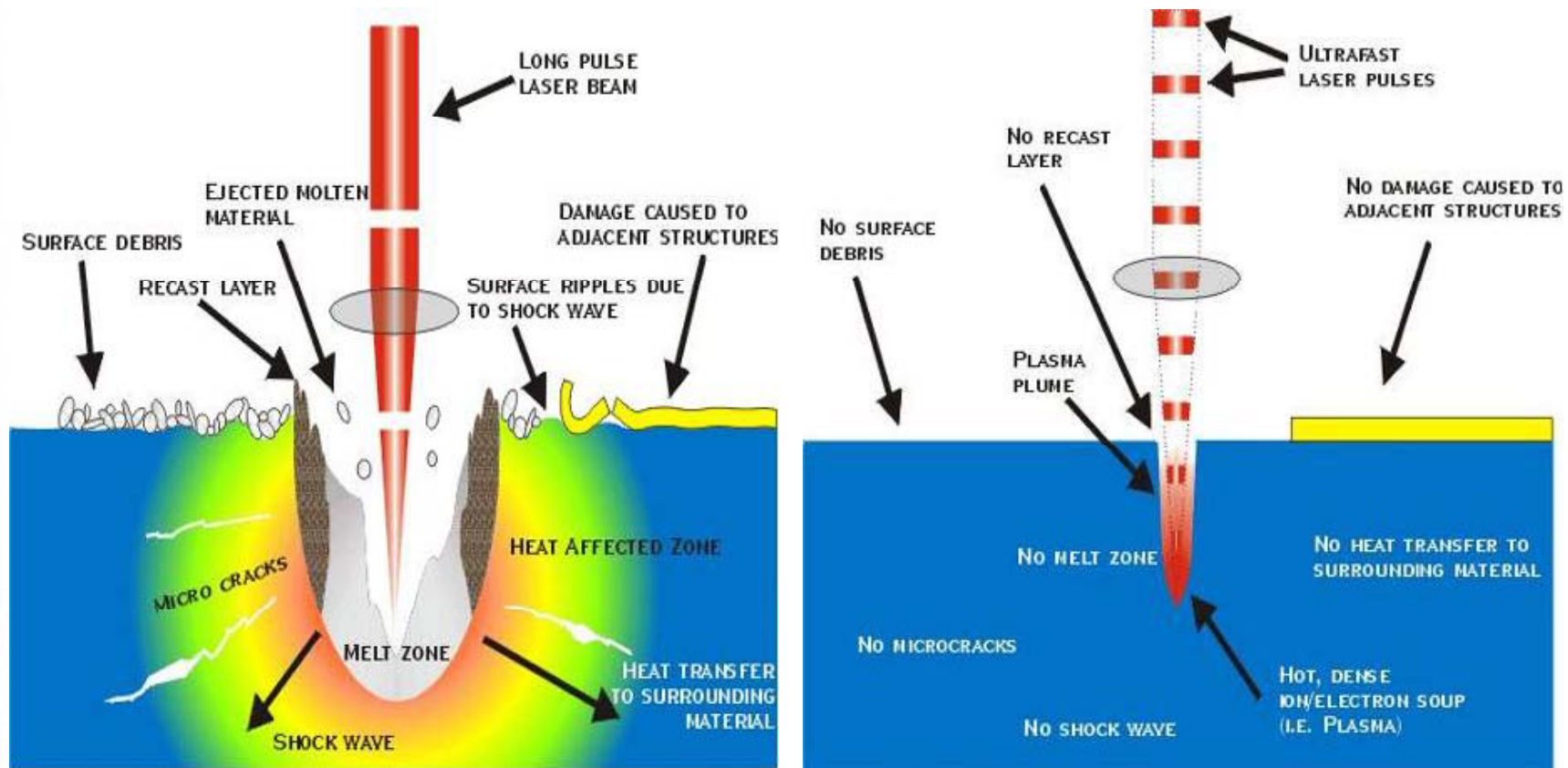
what a day is  
to the age of the  
universe

or...



$1 \text{ ps} \Leftrightarrow 3 \text{ x thickness of hair}$

# Long Pulse vs. Ultrafast pulse



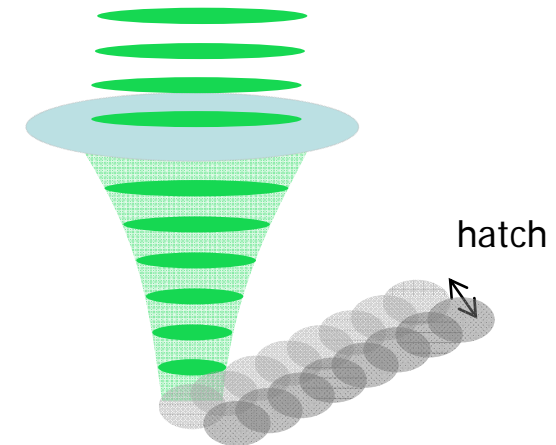
# Process Strategy

## One disk at a time

- Energy density  $\approx 1\text{J} / \text{cm}^2$
- $30\ \mu\text{m}$  spot  $\Rightarrow 10 \dots 50\ \mu\text{J}$
- Resolution: lateral  $\sim 1\ \mu\text{m}$
- One-shot ablation:  $50\ \text{nm} - 1\ \mu\text{m}$

## Move beam and repeat

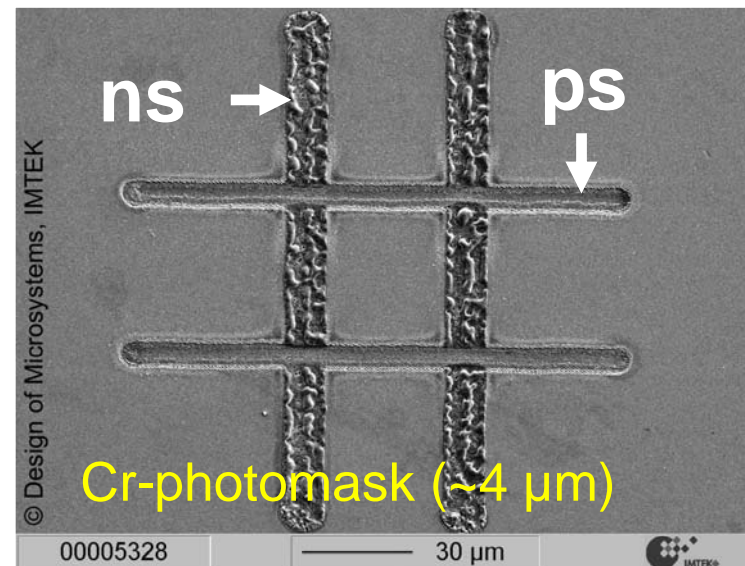
- Hatch multiple lines
- High repetition rate ( $> 500\text{kHz}$ )
- Max out scanner speed ( $> 10\text{m/s}$ )



$\sim 30\%$   
overlapping

# Advantages of Picosecond

- No heat affected zone, gentle machining
- High spatial precision and quality
- Machining ANY material with one tool

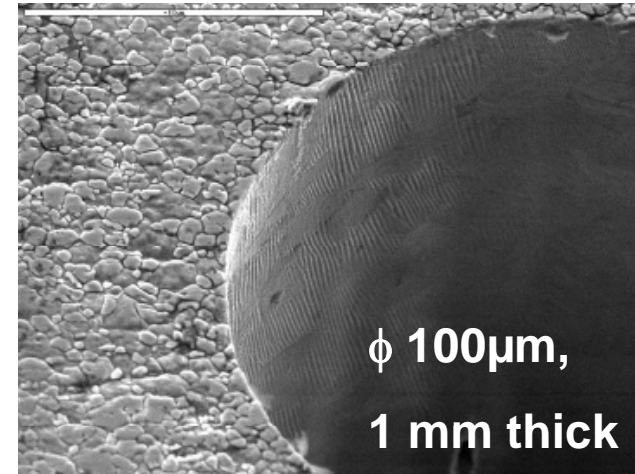
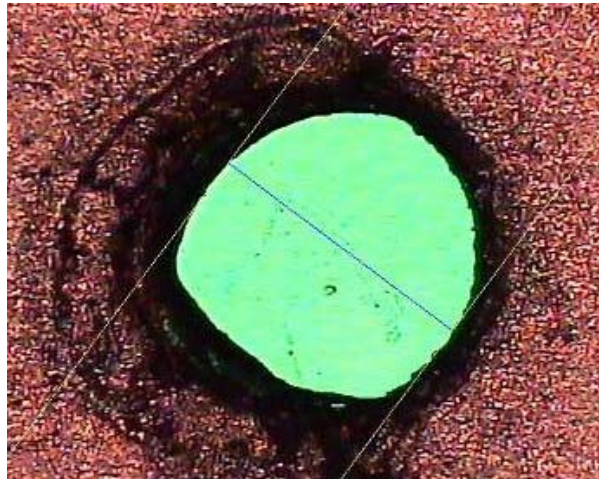


# Nanosecond vs. Picosecond

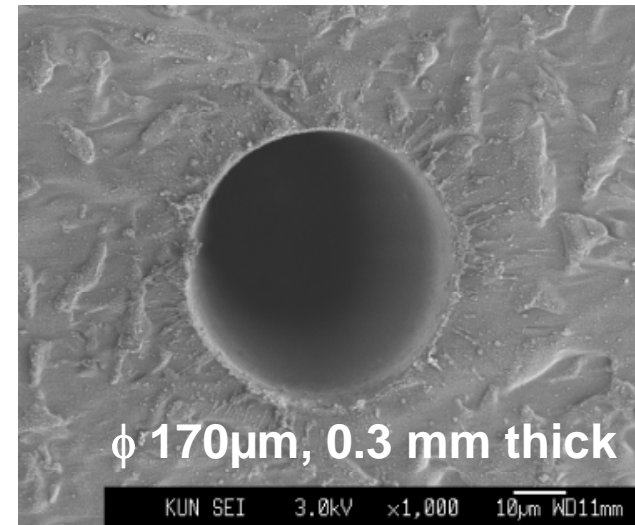
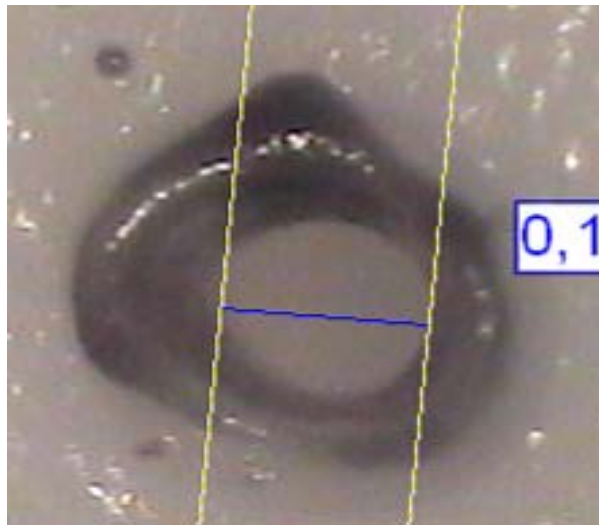
nano

pico

Al

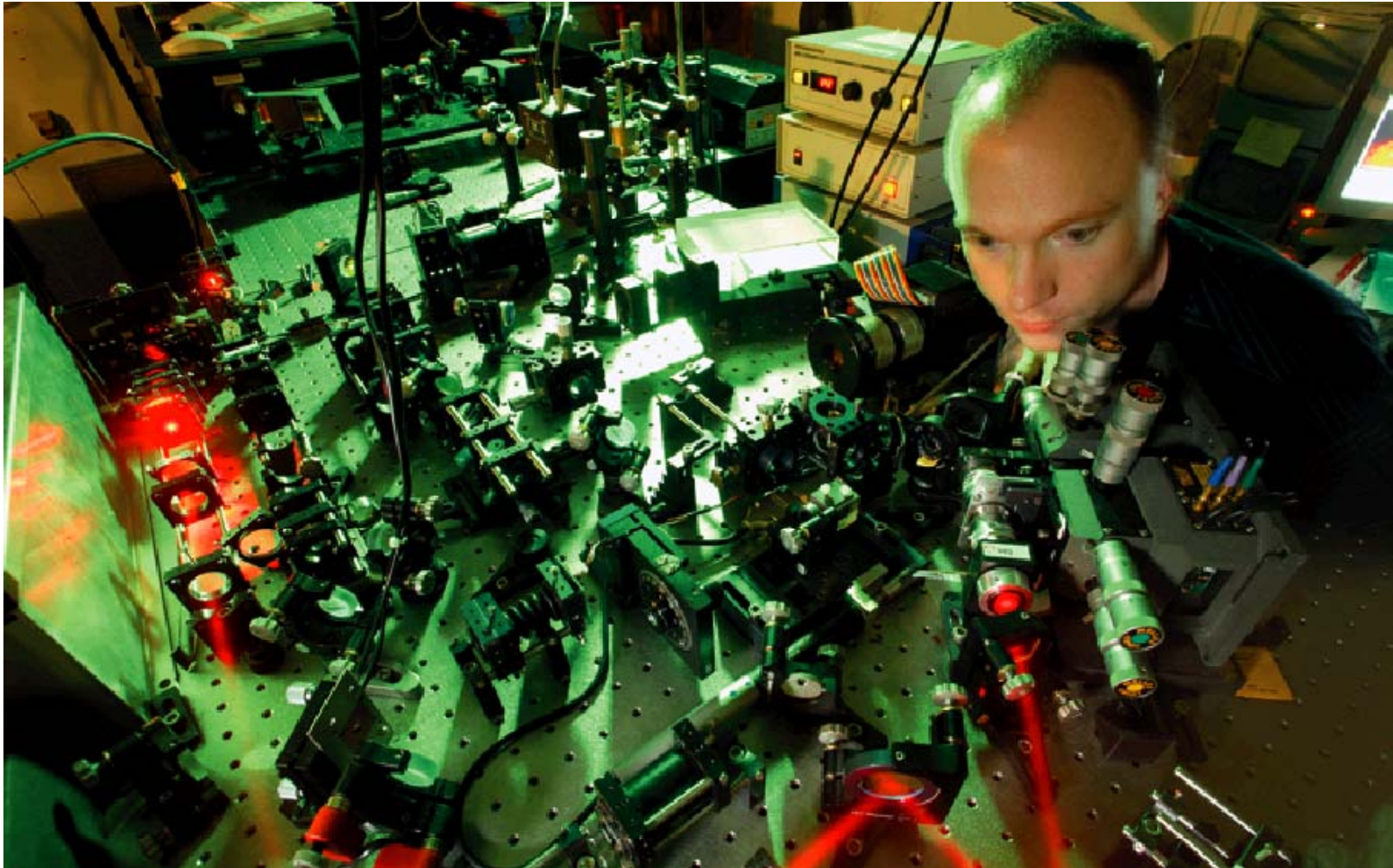


PVC



# Picosecond Lasers: What's Inside?

# ps-laser ... in the beginning

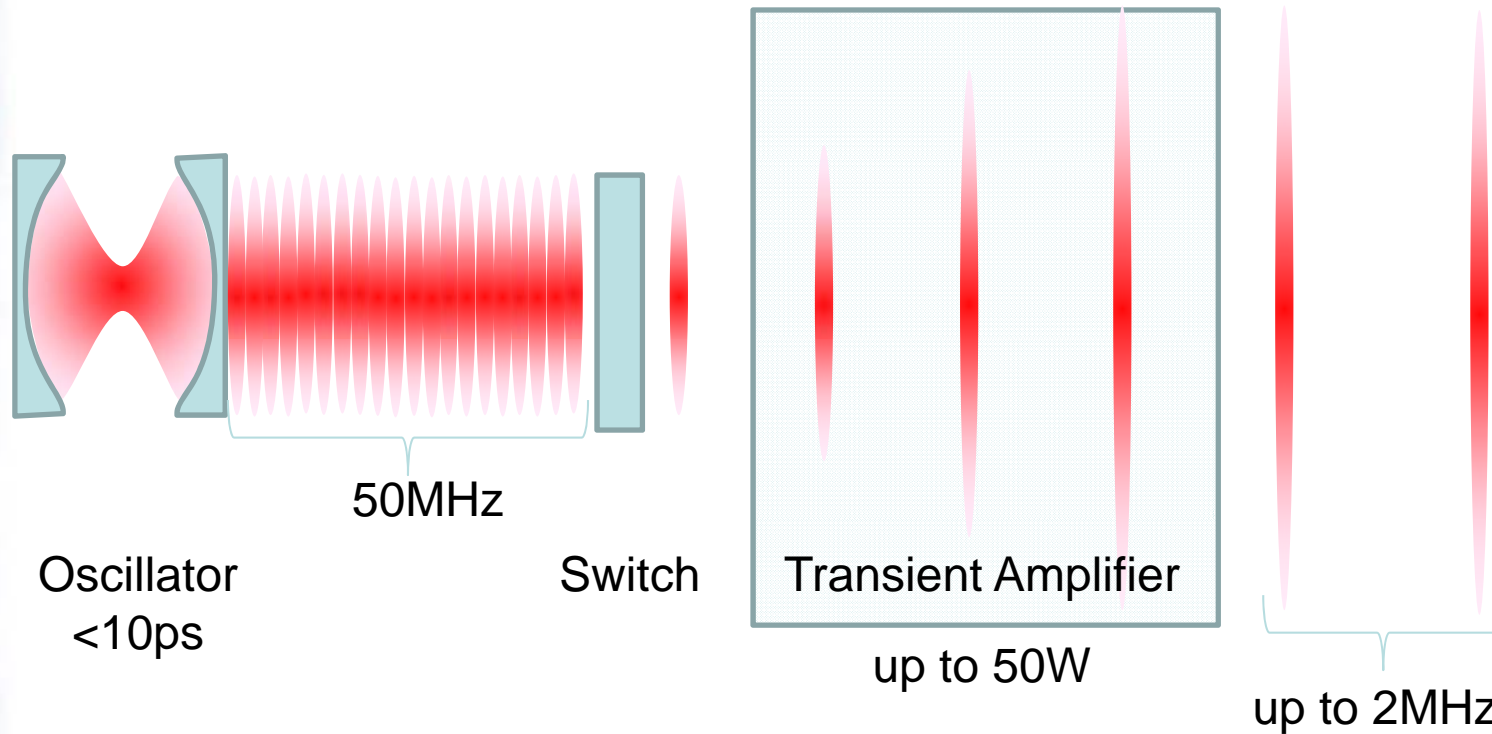


...today



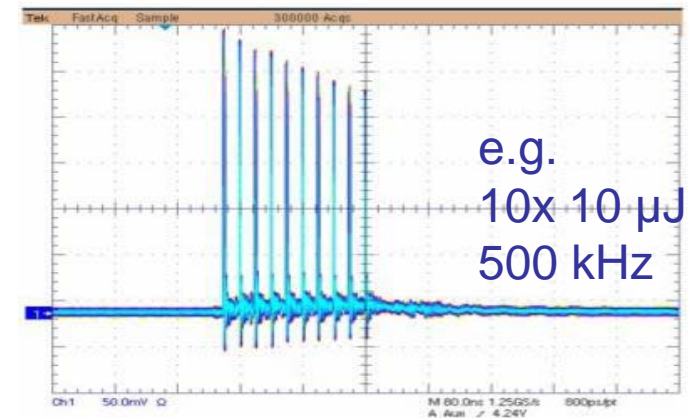
A New Power Level for Industrial ps-Lasers: 50W at 532nm

# Industrial Picosecond Laser System



## Transient-amplifier architecture:

- large average power (>100W)
- modular design
- high repetition rate (up to 2MHz)
- low cost of ownership (6-12€/hr)



# High Power Needs

Metal cylinders for printing or embossing  
(engraving of  $\sim m^2$ )

- Laser goal: 200- 400 W,  $>10\mu J$  @  $>10\text{MHz}$
- Very fine structures, no burrs, smooth surface
- High scan velocity (rot. drum)  $\gg 10\text{m/s}$



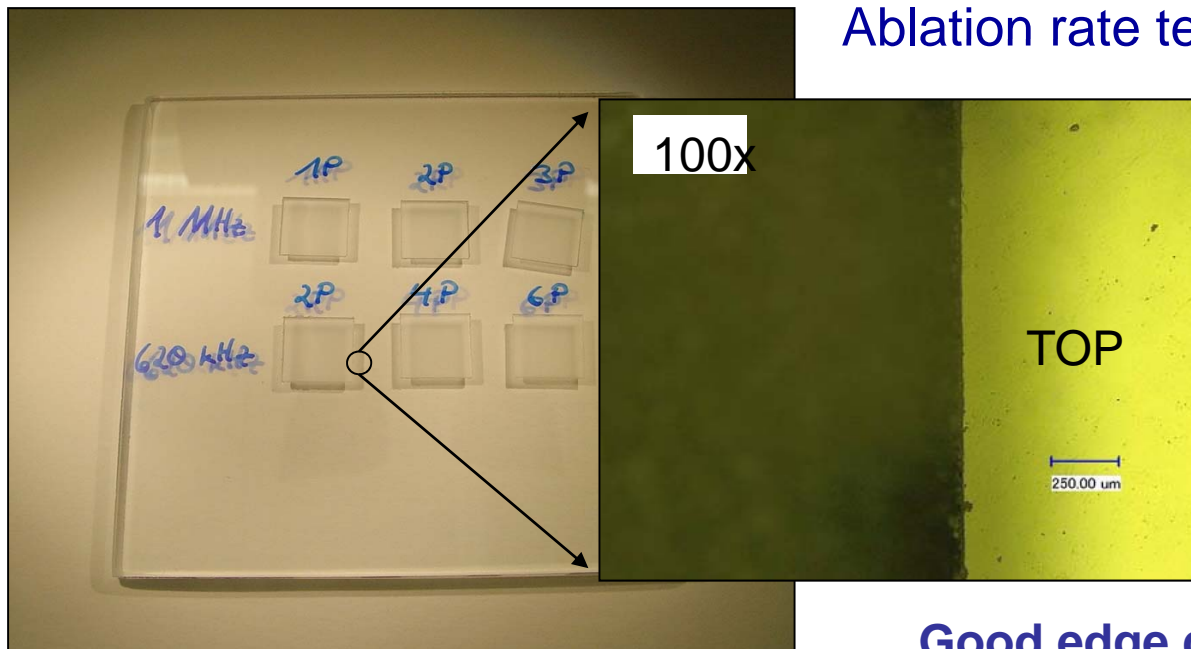
**BMBF Project Pikoflat**  
Saueressig GmbH, MDC Schepers GmbH,  
SAUER-Lasertec, Fraunhofer ILT  
Lumera Laser GmbH, Edgewave GmbH



# High Power Machining of Glass

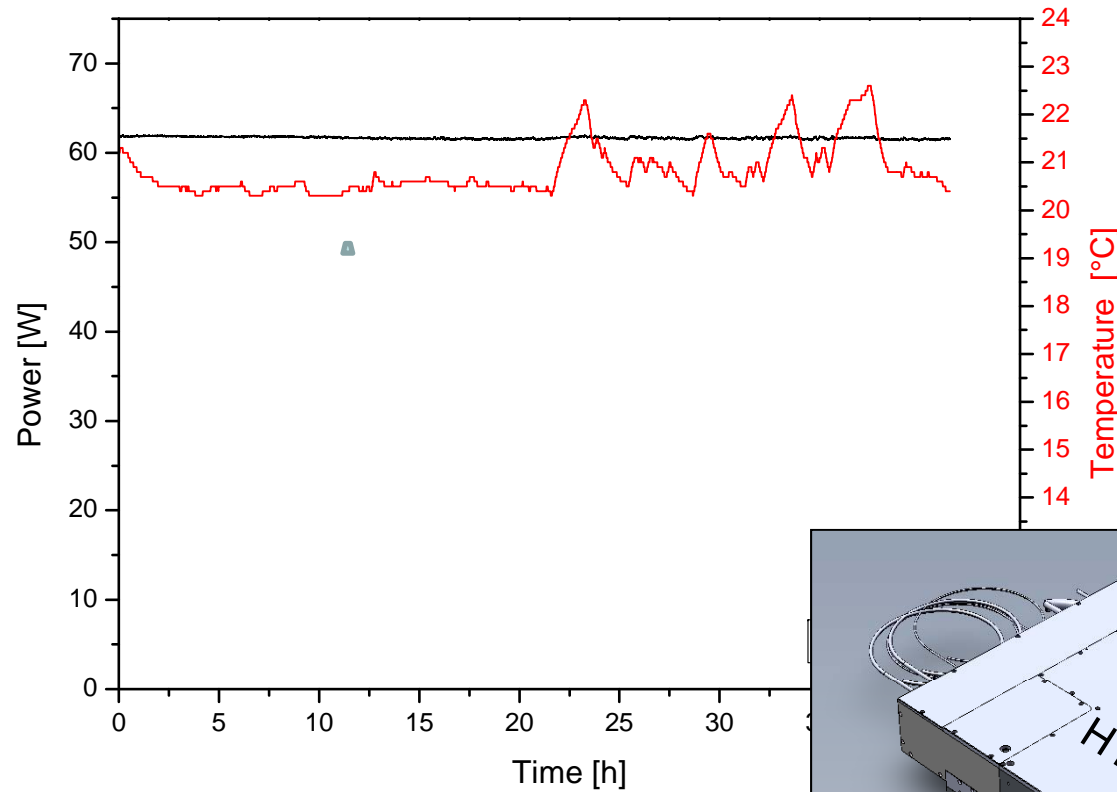


Ablation rate tests for cutting glass

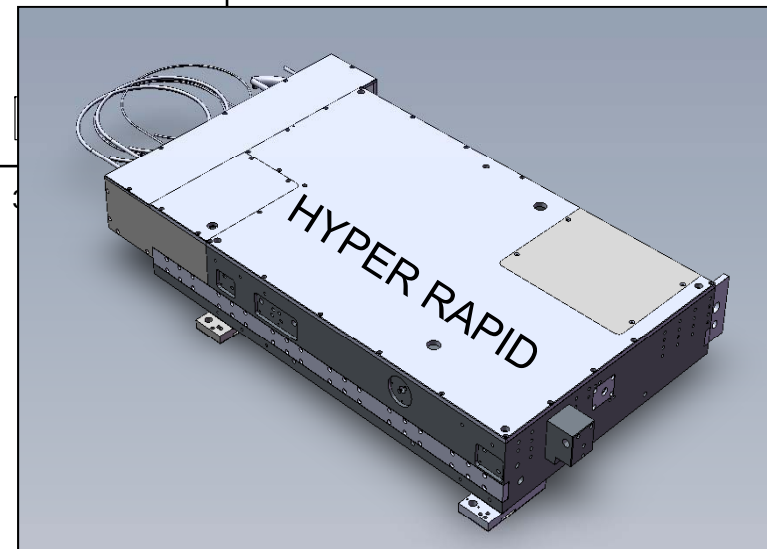


Good edge quality

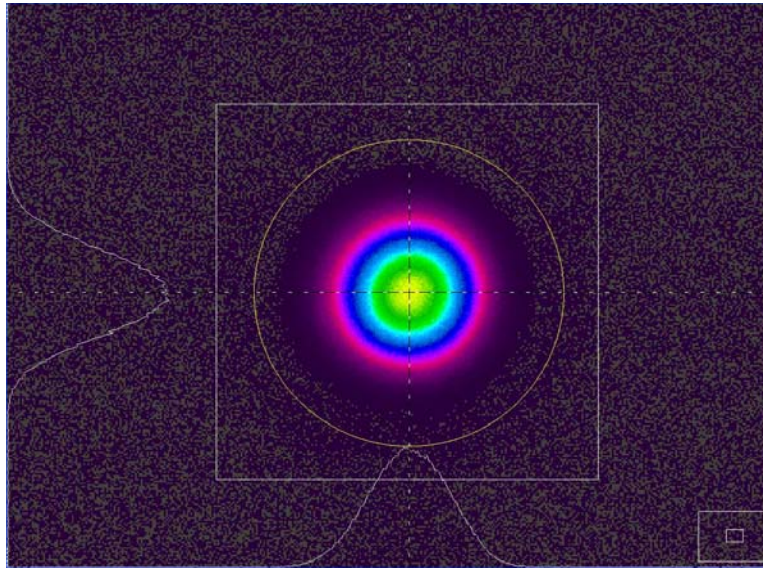
# Ps-Laser with 50W @ 532nm



Power fluctuation <1%



# 532nm Beam Performance at 50W

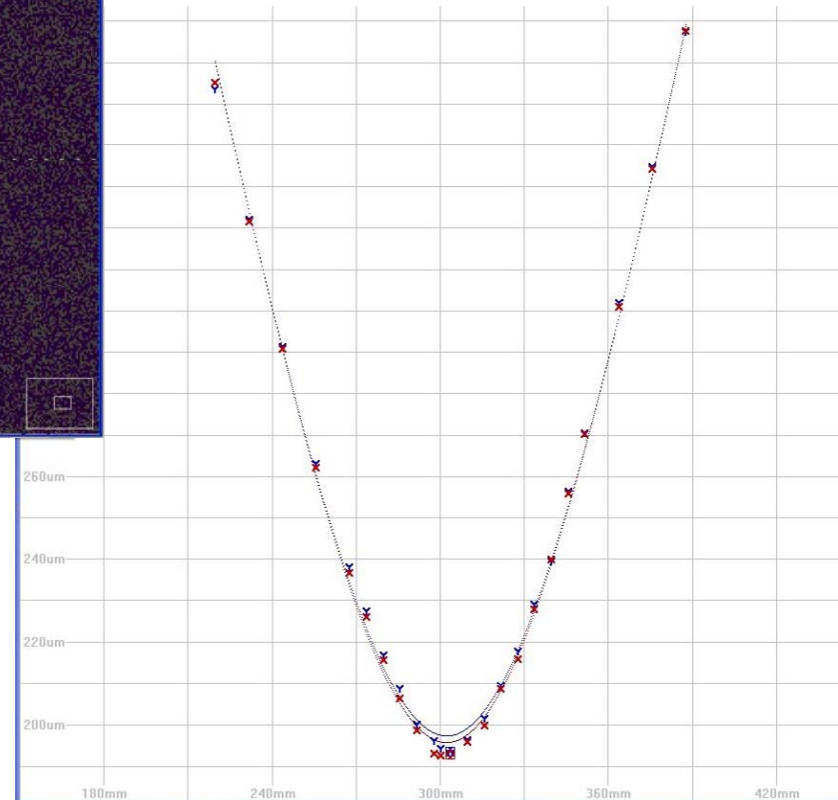


**$M_x < 1.1$**

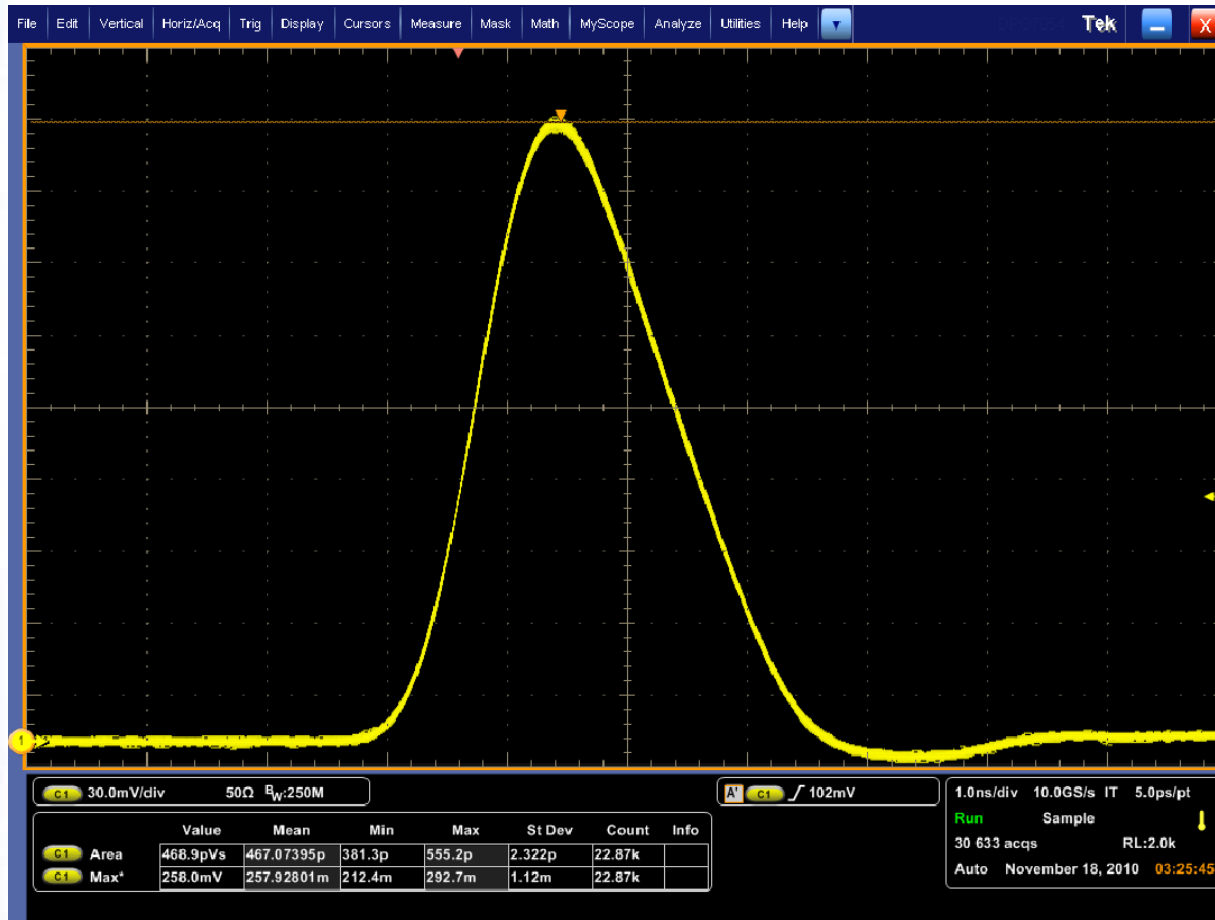
**$M_y < 1.1$**

**Astigm. 1 %**

**Asym. 0 %**



# Longer Term Pulse to Pulse Stability

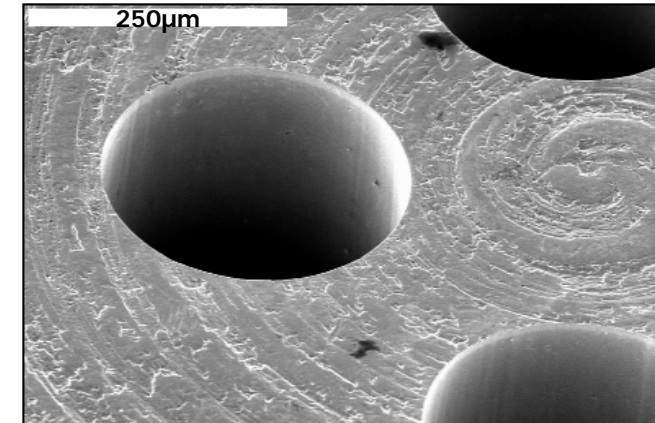


**30.633 Pulse-Statistics:**

**~ 0.43%**

# Points to Take Home

- ps allows high resolution
- ANY material
- 50W at 532nm ready for industry
- Superb beam quality at high power
- Excellent long-term and short-term stability
- Low cost of ownership (6-12€/hr)



# Thank You...

A large, rectangular iceberg floats in the ocean under a clear blue sky. The water is a deep blue, and the sky is a lighter blue. The iceberg's surface is textured with snow and ice. The text is overlaid on the lower half of the image.

...we have just seen the tip of the ice berg  
when it comes to ps-laser micro-machining