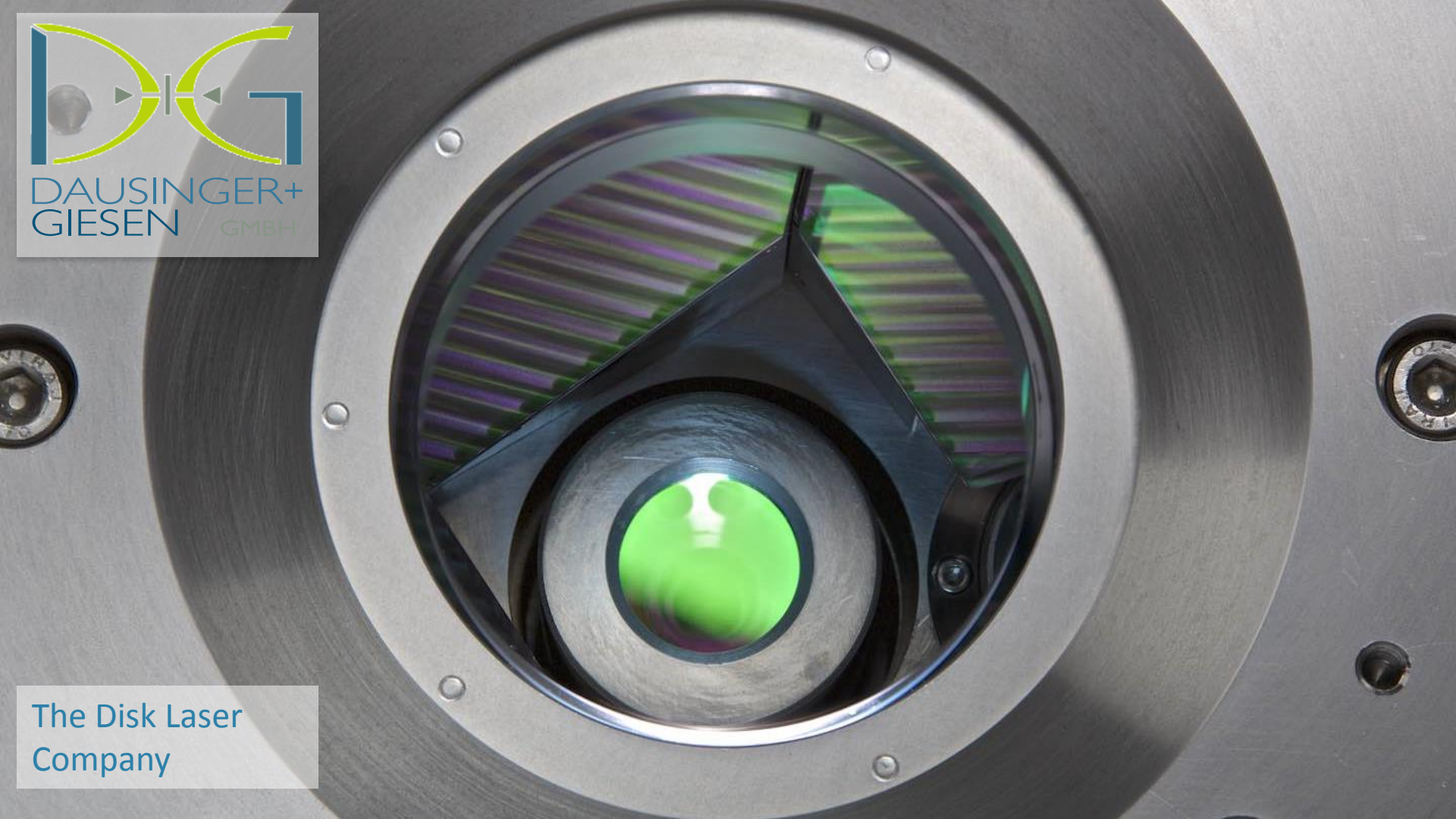
DAUSINGER+
GIESEN
GMBH
The Disk Laser
Company

Thin Disk Lasers and Thin Disk Components for Academic and Industrial Use

- Outline
  - Company Profile
  - D+G VaryDisk: Versatile Ultrafast Laser

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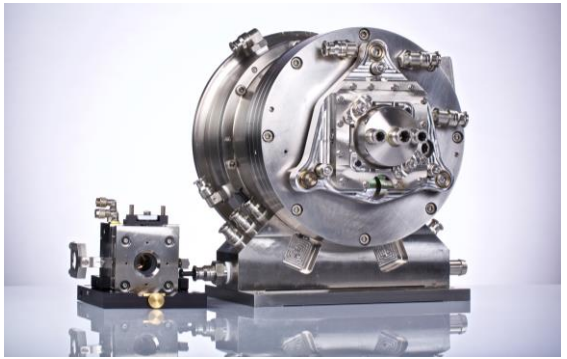
D+G Products
for academic and industrial users

- Disks:
  - Various diameters
- Pump modules for disk lasers:
  - Max. 30 kW pump power
- D+G VaryDisk:
  - High performance versatile ultrafast lasers
  - High pulse energy diagnostic lasers
  - OPCPA pump



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D+G Services:
Laser Material Processing

- Welding, cutting, marking, drilling, structuring
- Diagnostics and surveillance
- System technology consultancy
- Helical drilling optic

DAUSINGER+ GIESEN GMBH

The Founders: Friedrich Dausinger

- 1980 – 1986: BOSCH laser applications lab
- 1986 – 2007: Stuttgart university
  - development of laser applications
    - surface treatment
    - cutting
    - welding (Al, twin focus)
    - drilling (helical)
    - surface structuring
    - process monitoring
  - habilitation, professor
  - consultant of BOSCH and Daimler
  - coordinator of two national projects on ultrafast technology
- 2007 – today: CEO of D+G

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The Founders:
Adolf Giesen

- Inventor of the disk laser
- PhD in physics
- Senior researcher @ IFSW Stuttgart
- Head of Institute of Technical Physics of DLR (national aeronautic and space research centre of the Federal Republic of Germany)
- One of the most knowledgable people for the development of thin disk lasers

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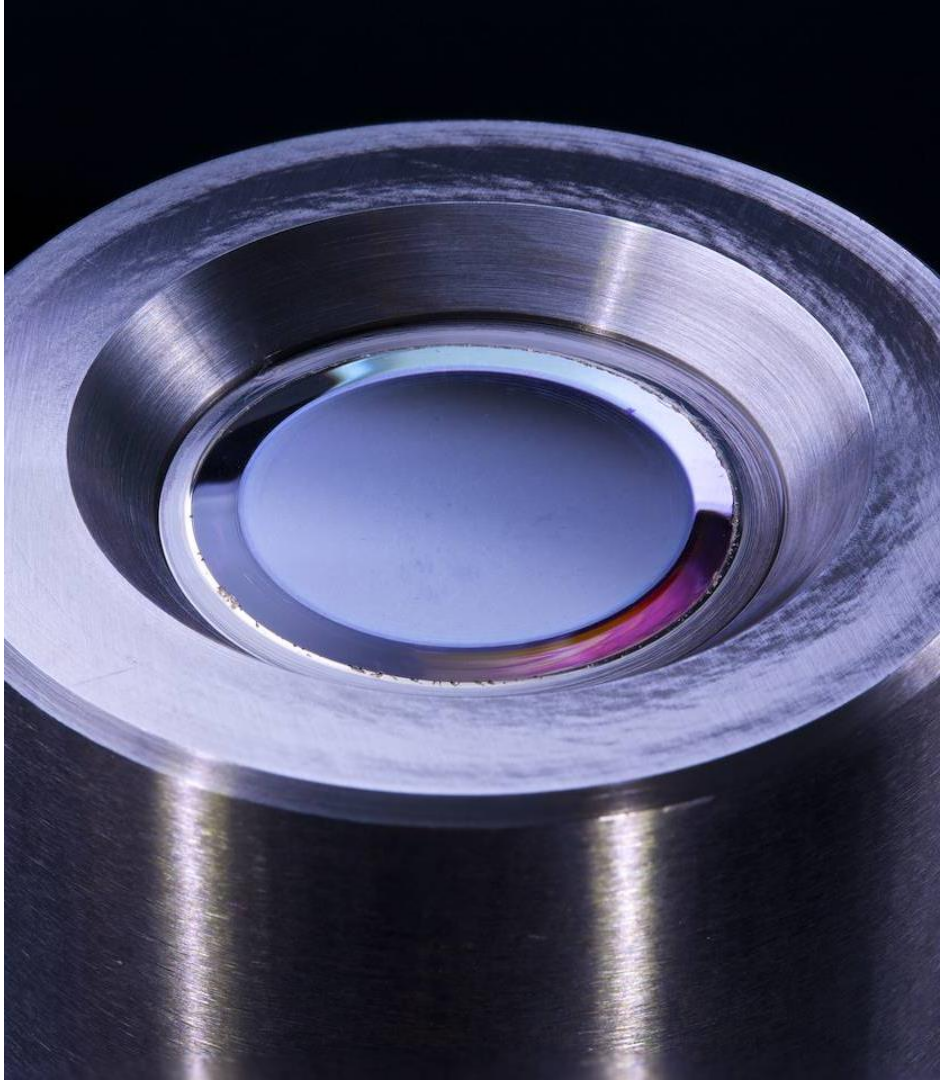
D+G Core Know How: Contacting of Disks

- Efficient cooling
- Homogeneous heat flow
- Thermal stability
- Minimal geometrical distortion
- High gain



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Thin Disk Lasers and Thin Disk Components for Academic and Industrial Use

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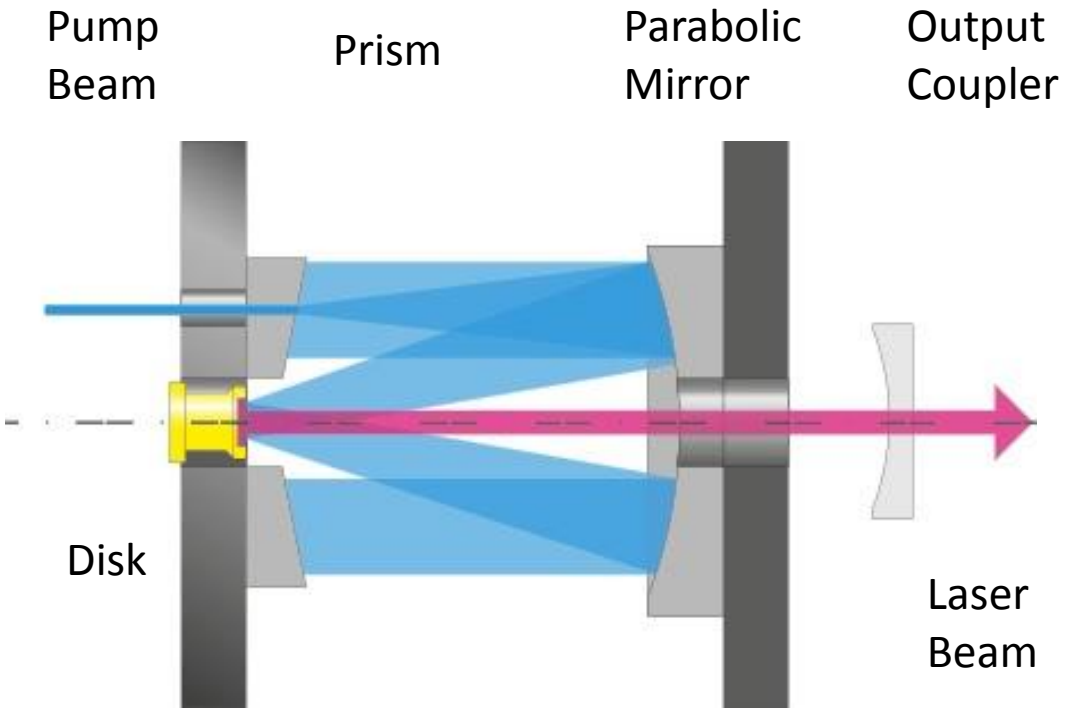
High Power Amplifier Concepts for sub ps Pulse Duration

	Fiber	Innoslab	Thin-disk	
			regenerative	multi-pass
Average power (fundamental mode)	> 5 kW	> 1 kW	< 0.1 kW	>1 kW
Mode area	< 0.004 mm²	0.1mm² ⇒ 2 mm²	1-10 mm²	>10 mm²
Amplification factor	> 60 dB	30 dB	> 60 dB	<10 dB
Nonlinearity @100W $B/(P_{peak}/P)$	$1 \cdot 10^{-3}$	$2 \cdot 10^{-5}$	$5 \cdot 10^{-6}$	10^{-10}
Pulse energy (CPA)	1 mJ	100 mJ	100 mJ	1 J
Repetition rate	>10 kHz	>10 kHz	10-500 kHz	>10 kHz

The Disk Laser Principle



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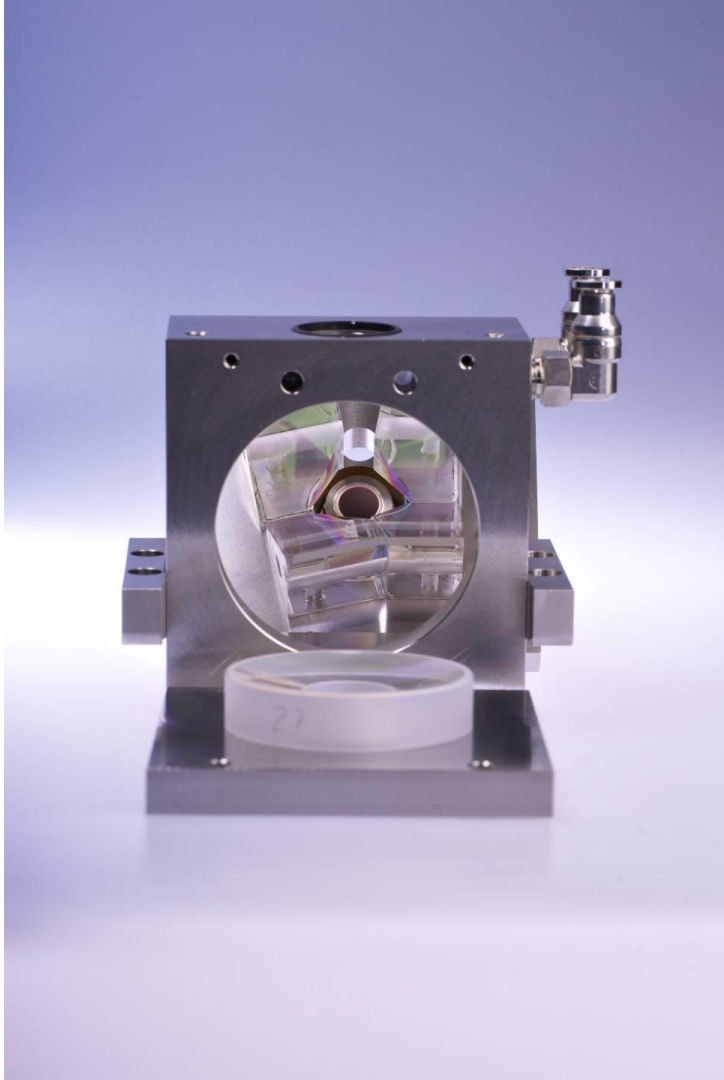

Advantages Disk Laser

- Unique combinations of
  - Power ➔ kW
  - Pulse energy ➔ J
  - Repetition rate ➔ MHz
  - Beam quality ➔ $M^2 < 1.3$
- Scalability
- Minimal nonlinear effects
- 24/7 stability

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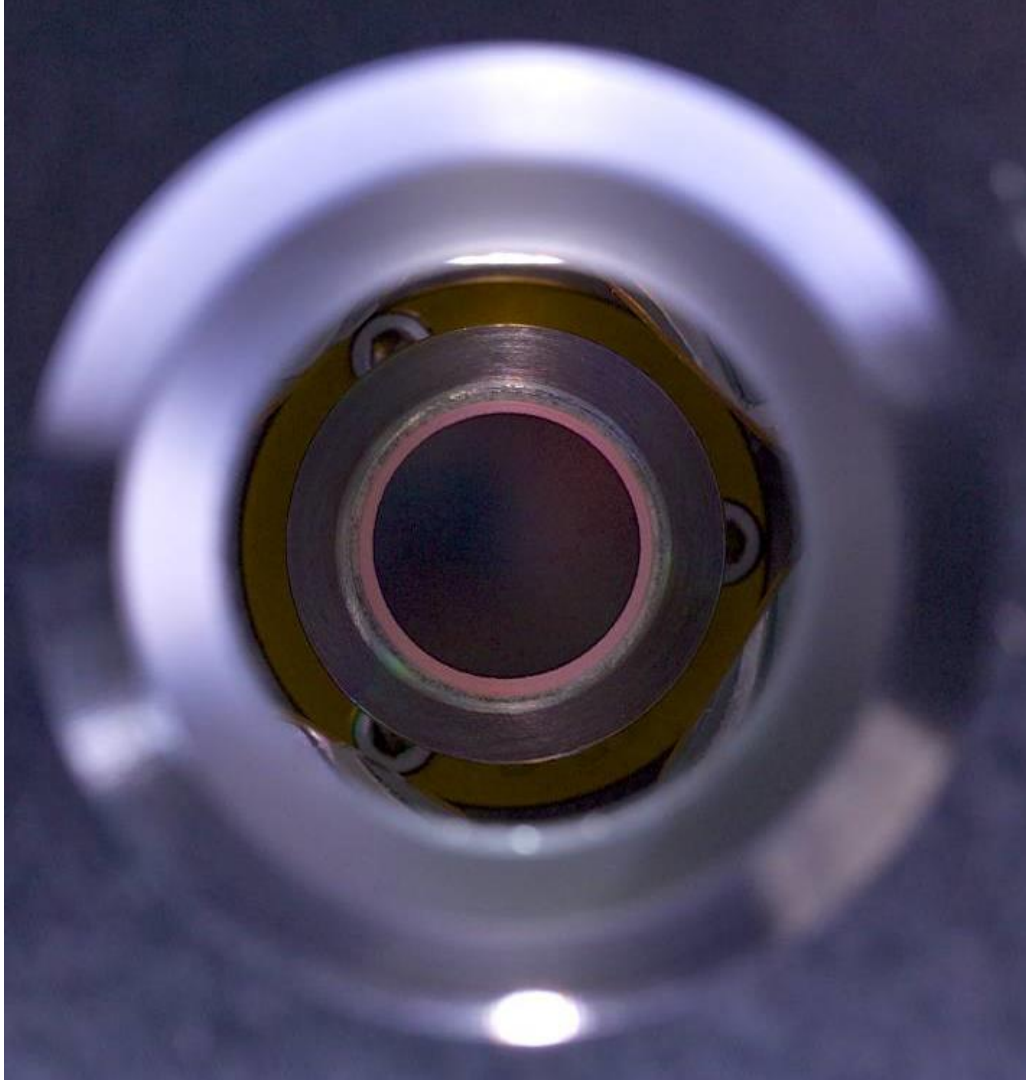
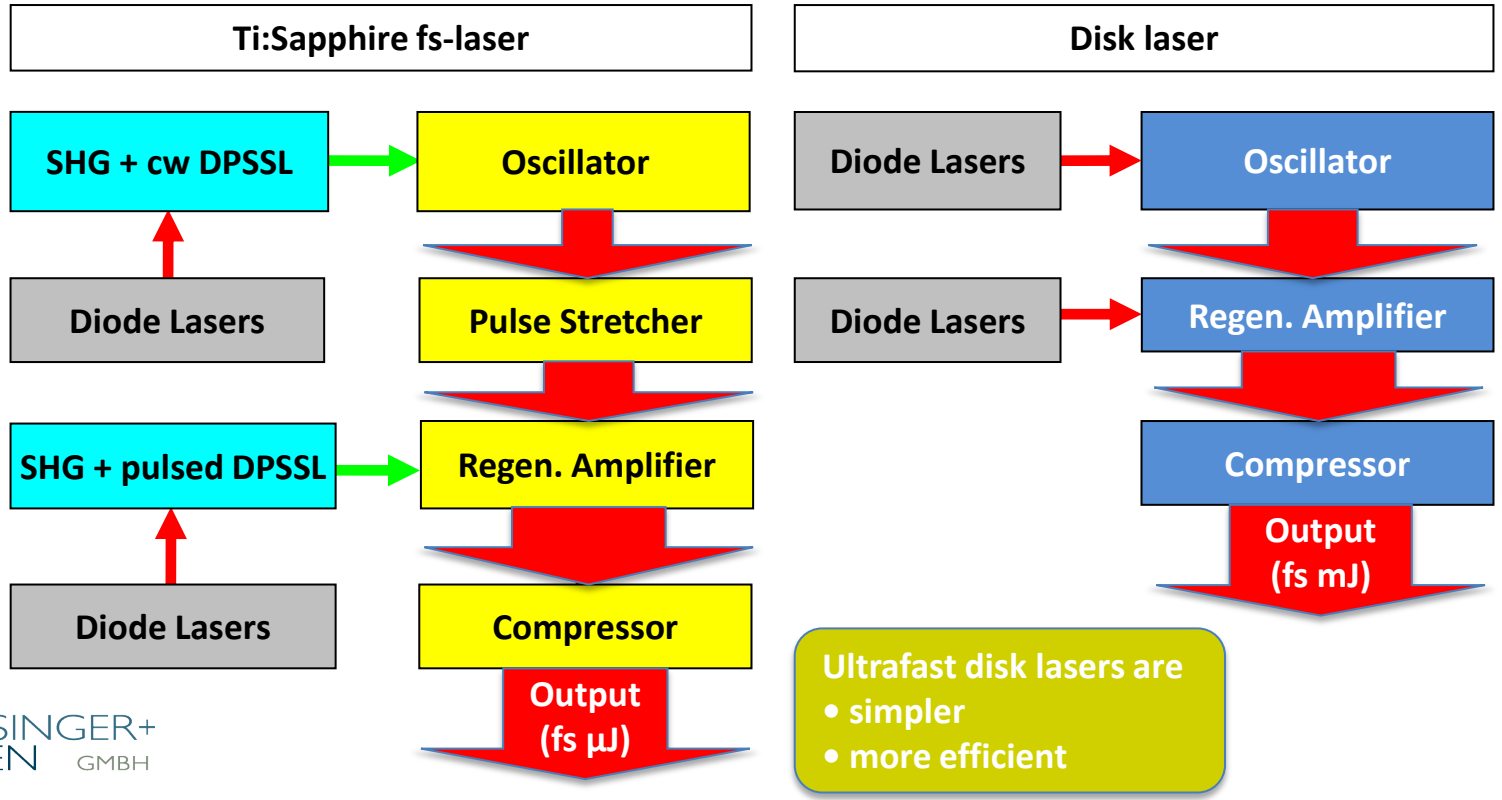


Competitive Technology
Comparison of Ti:Sapphire Laser and Disk Laser



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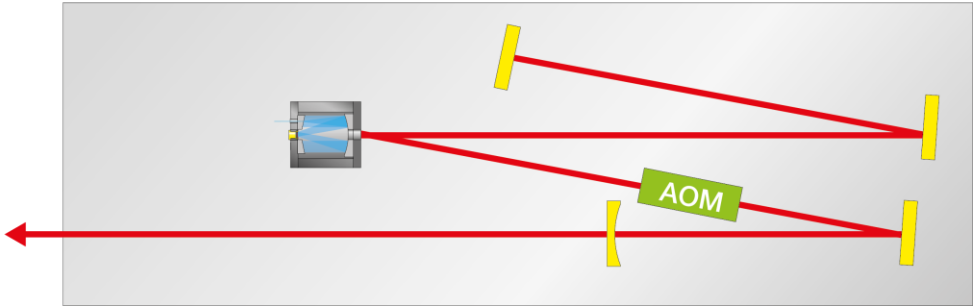
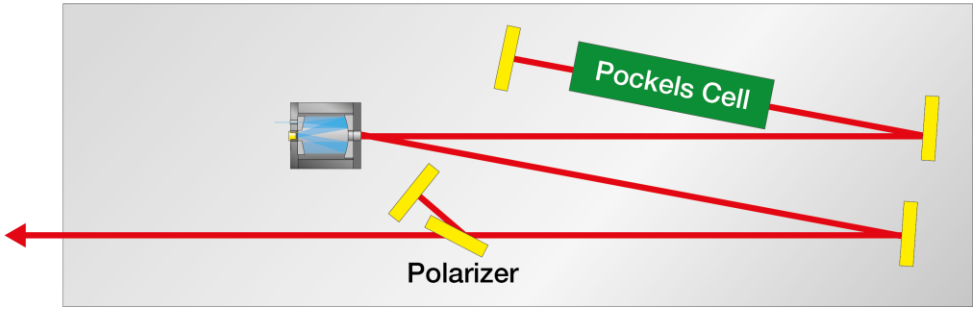
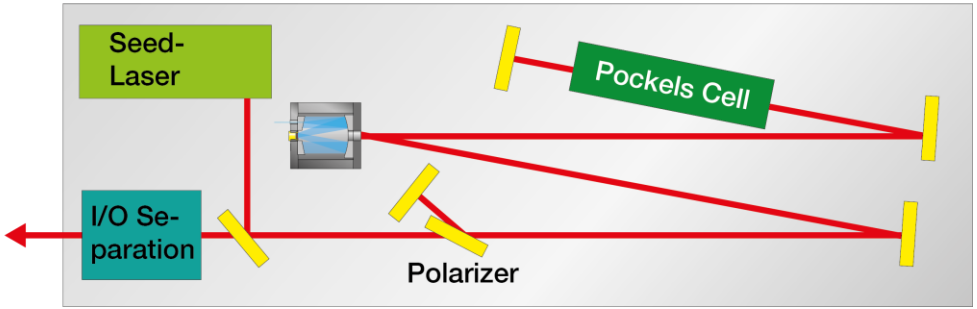
The Versatile VaryDisk Concept

- VaryDisk offers a wide tunable pulse length parameter range:
  - Q-Switch Mode
    - 0,5 - 2µs
  - Cavity dumping mode:
    - 10 ns- 800 ns
  - Regenerative amplifier mode:
    - 350 fs -2 ps (fs edition)
    - Additional pulse ranges possible
      - Additional seed lasers necessary







Technical Realisation may deviate

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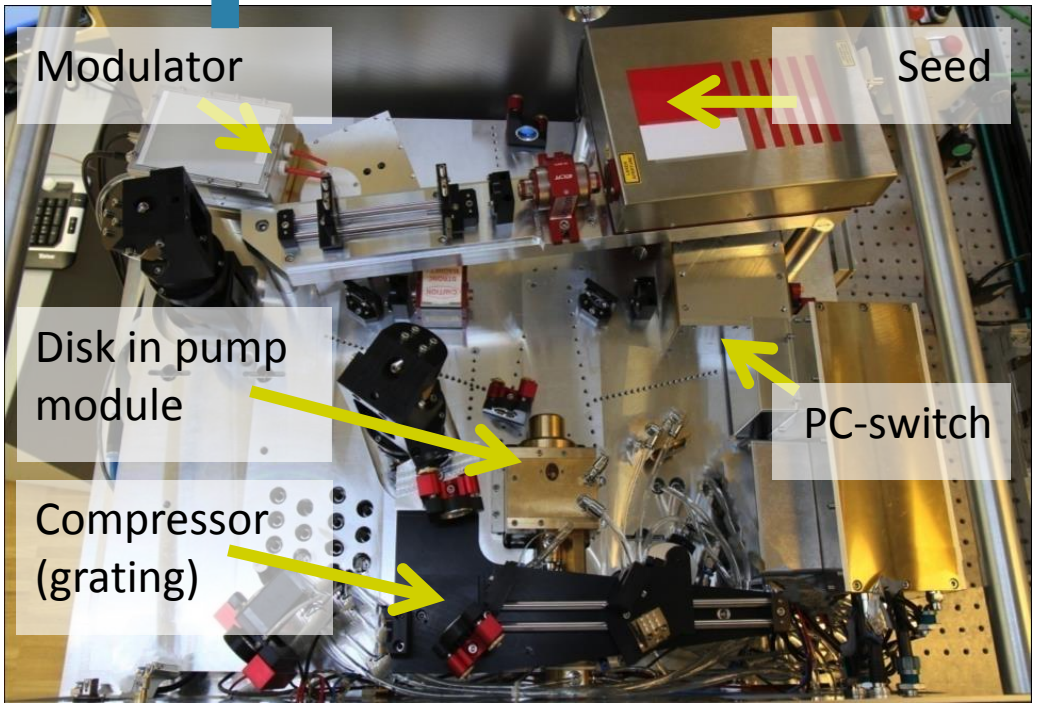
Technical Realization Sample: Setup of the Regenerative Amplifier



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Realization of the D+G VaryDisk

- Robust design
- Key components are made by D+G
- Precise assembly
- Commissioning in clean room environment
- Very high standards in all optical components

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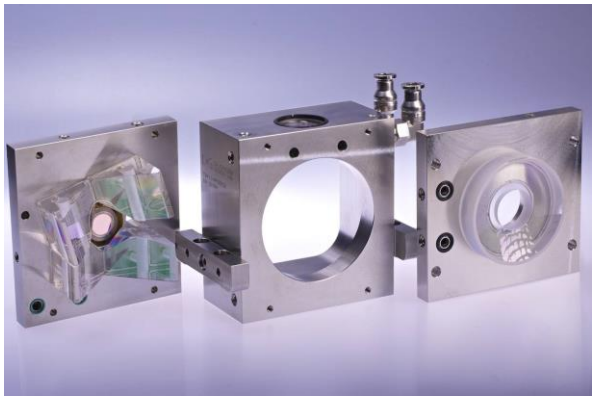
VaryDisk Technology Components by D+G

- Thin disks
- Thin disk module
- Pockels cell



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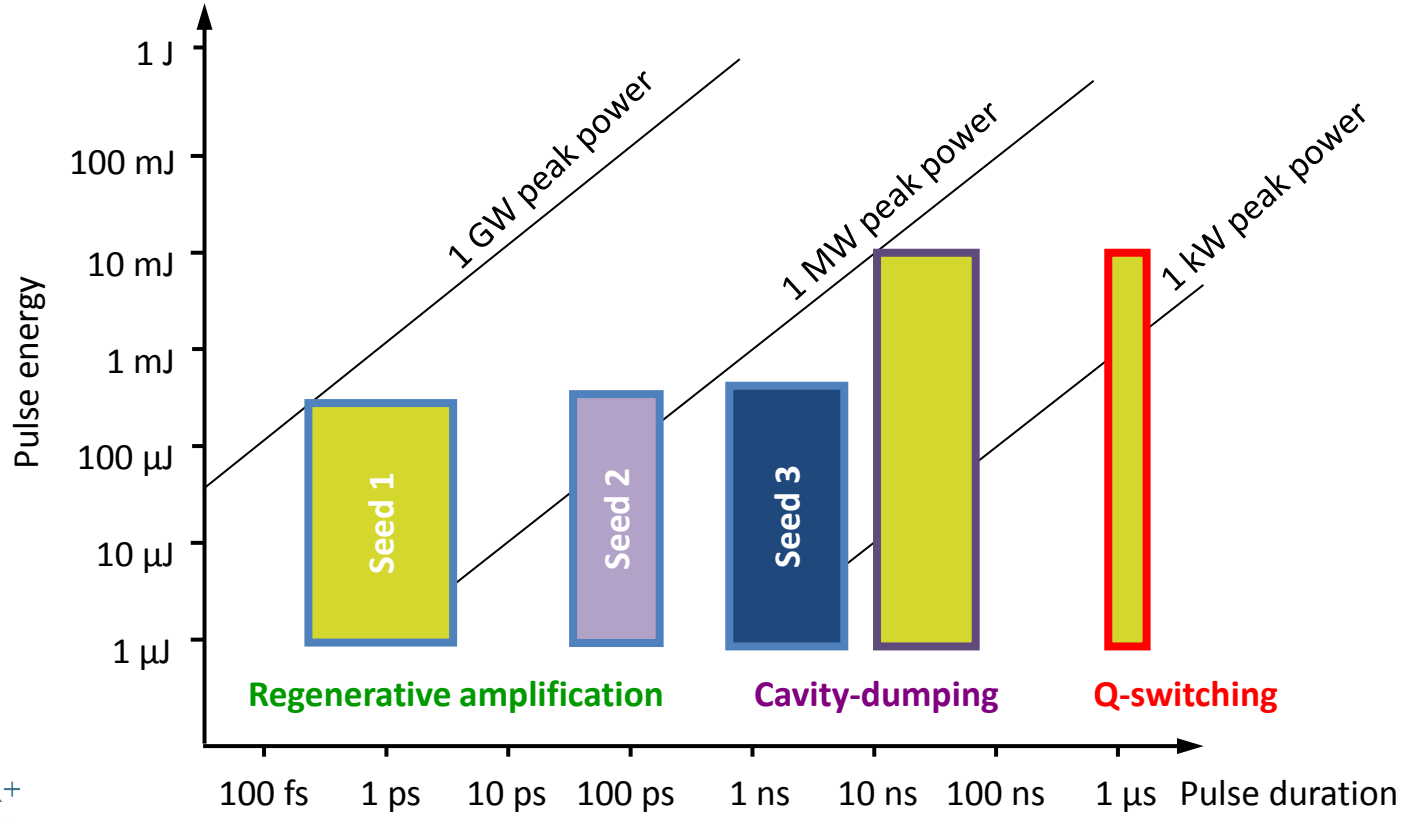
D+G VaryDisk Parameter Range



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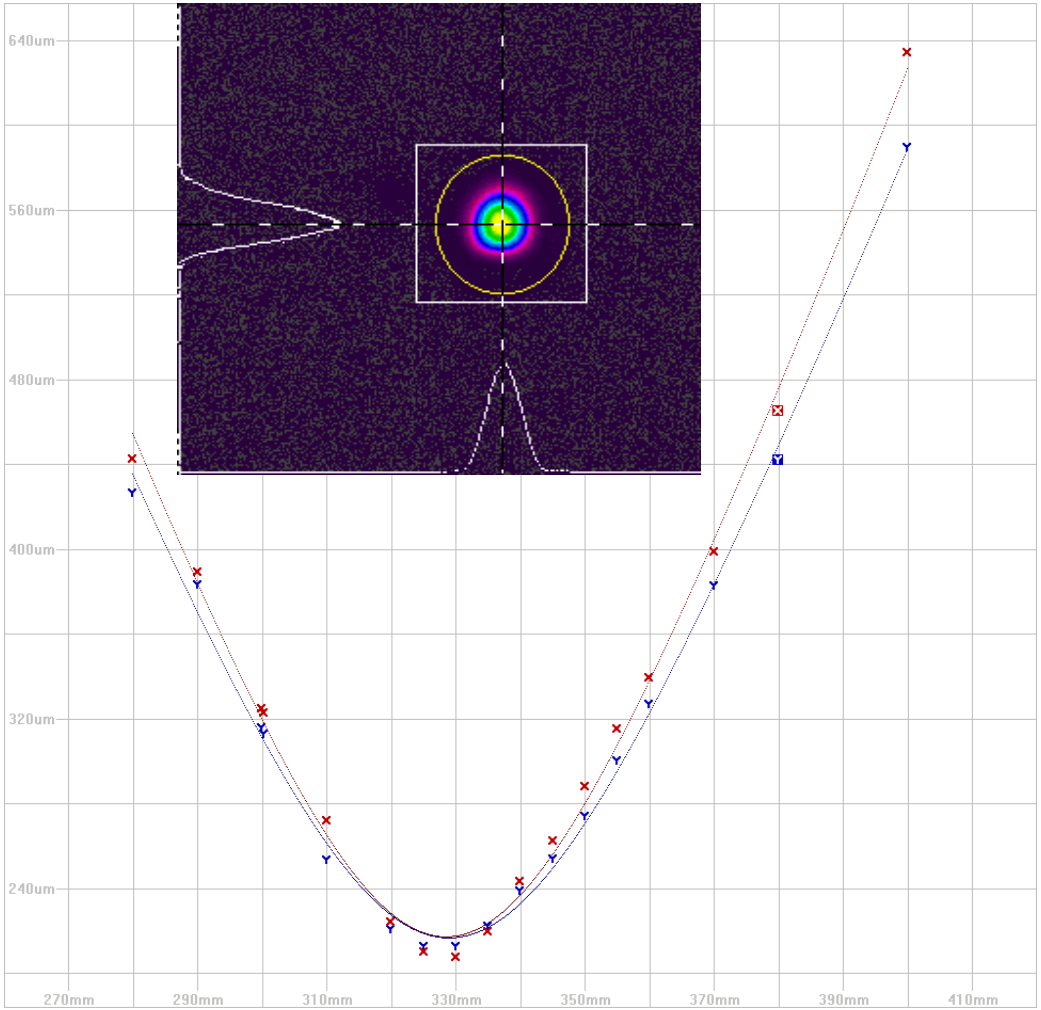
D+G VaryDisk: Beam Quality

- Measuring conditions:
  - 39.0 W
  - 1030 nm
  - 700 fs
  - 1 MHz
- $M^2(x) = 1.121$
- $M^2(y) = 1.092$



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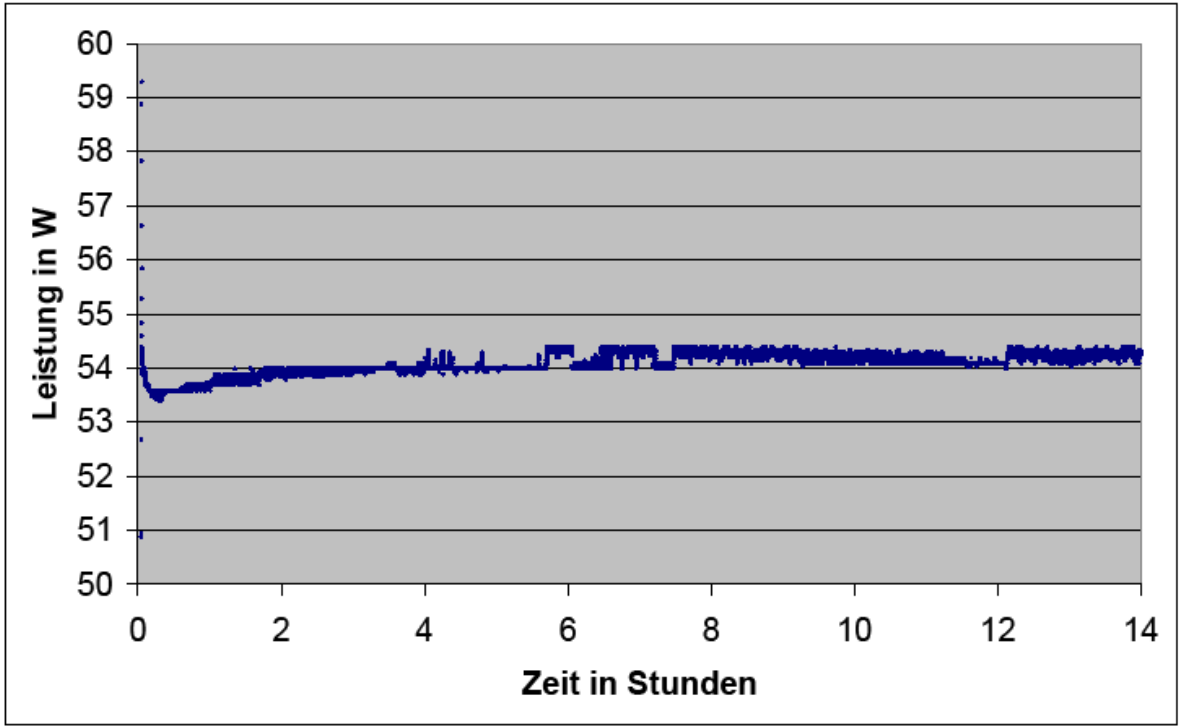
D+G VaryDisk: Output Power Stability

- Measuring conditions:
  - 39.0W
  - 1030 nm
  - 700fs
  - 1MHz
- Stability of laser power:
  - +/- 1 % over 12 h
- Pulse to pulse stability:
  - +/- 0,6 % over 1 h
  - min. - max. 2,1 %



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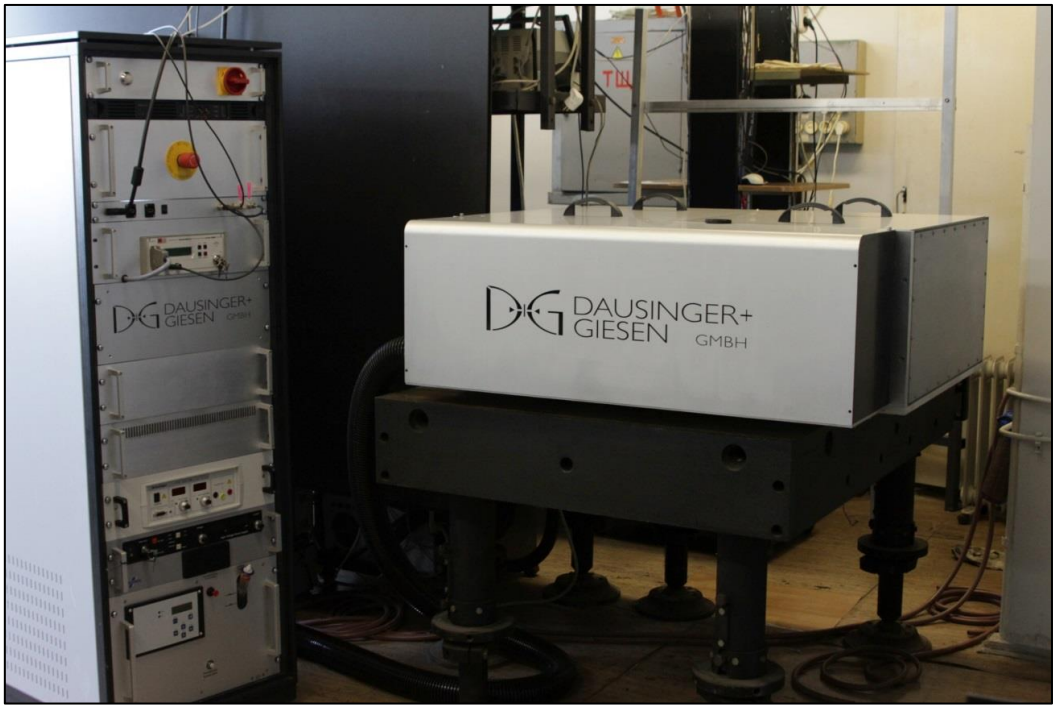
D+G VaryDisk 40/fs @ GPI, Moscow



- Q-switched mode
  - τ = 0.8 µs
  - Q_{IR} < 15 mJ
  - f_p = < 20 kHz
- Cavity dumped mode
  - τ = 10 ns – 0.8 µs
  - Q_{IR} < 15 mJ
  - f_p = < 300 kHz
- Regenerative amplifier mode
  - τ = 350 fs – 2 ps
  - τ = 50 ps – 200 ps
  - Q_{IR} = 200 µJ, Q_{green} = 100 µJ
  - $f_p \leq$ 1 MHz
  - P_{avg}: > 40W

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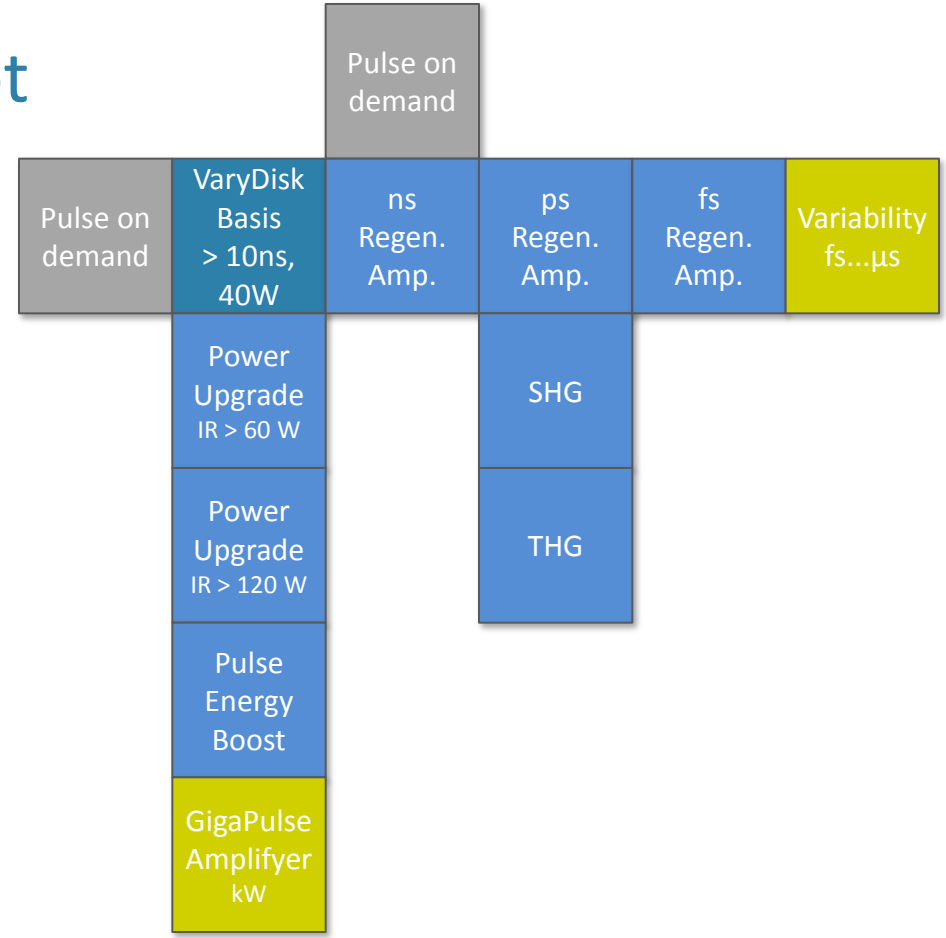
D+G VaryDisk
Modular Versatile Concept

- The VaryDisk offers a wide range of options, taylored to the needs of our customers applications
- In all variations, state of the art performance data can be achieved
- The combination of specific performance data is subject to a detailed technical clarification



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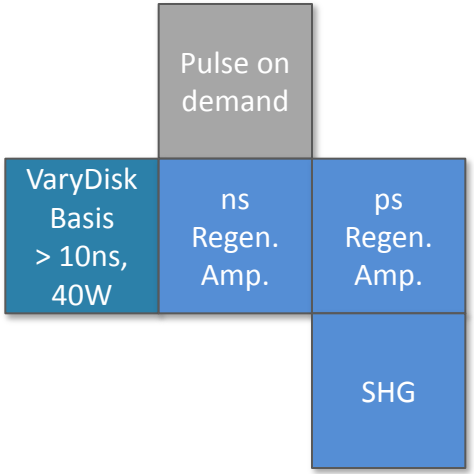

Example 1:
- 60 W @ 515 nm
- 3 ps
- 1 MHz

for industrial glass cutting

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D+G VaryDisk
Modular Versatile Concept

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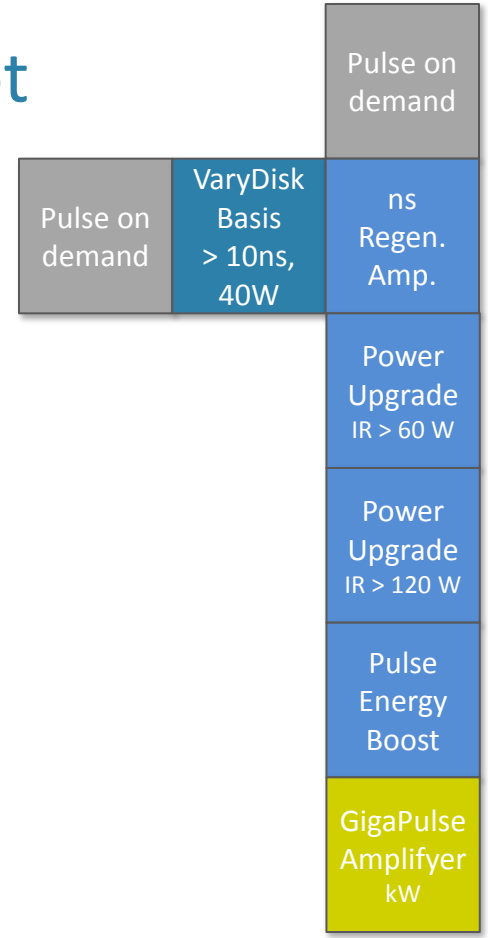

Example 2:
- > 1 kW
- > 750 mJ
- > 1 kHz
- < 3 ps
- 1030 nm

for HiLASE

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VaryDisk GigaPulse within HiLASE Framework

Seed laser

osc., booster, AOM, stretcher

Output:
- >5 µJ
- 1 … 1.75 kHz
- ≈ 1 ns

Regen. amplifier

2 disks, Pockels cell

Output:
- 100 … 200 mJ
- 1- 1.75 kHz
- ≈ 1 ns

Linear amplifier

1 … 2 disks, multipass, adaptive mirror

Output:
- > 940 mJ
- 1 … 1.75 kHz
- ≈ 1 ns

Compressor

grating compressor

Output:
- 750 mJ
- 1 .. 1.75 kHz
- < 3 ps

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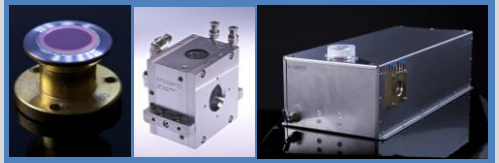
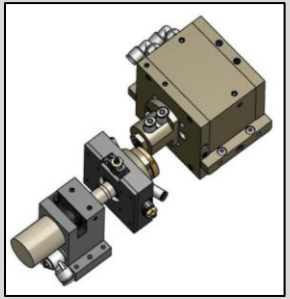
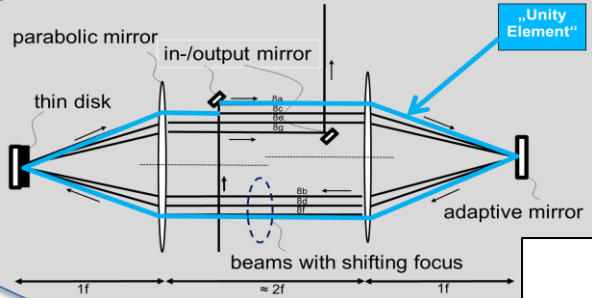
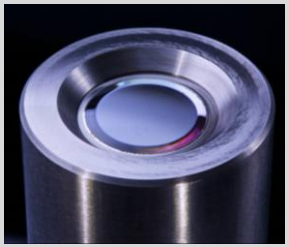
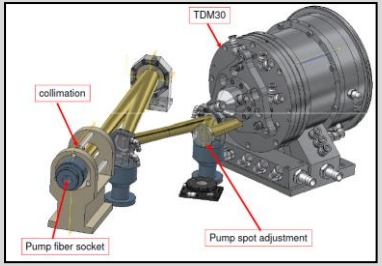
Regenerative amplifier D+G components





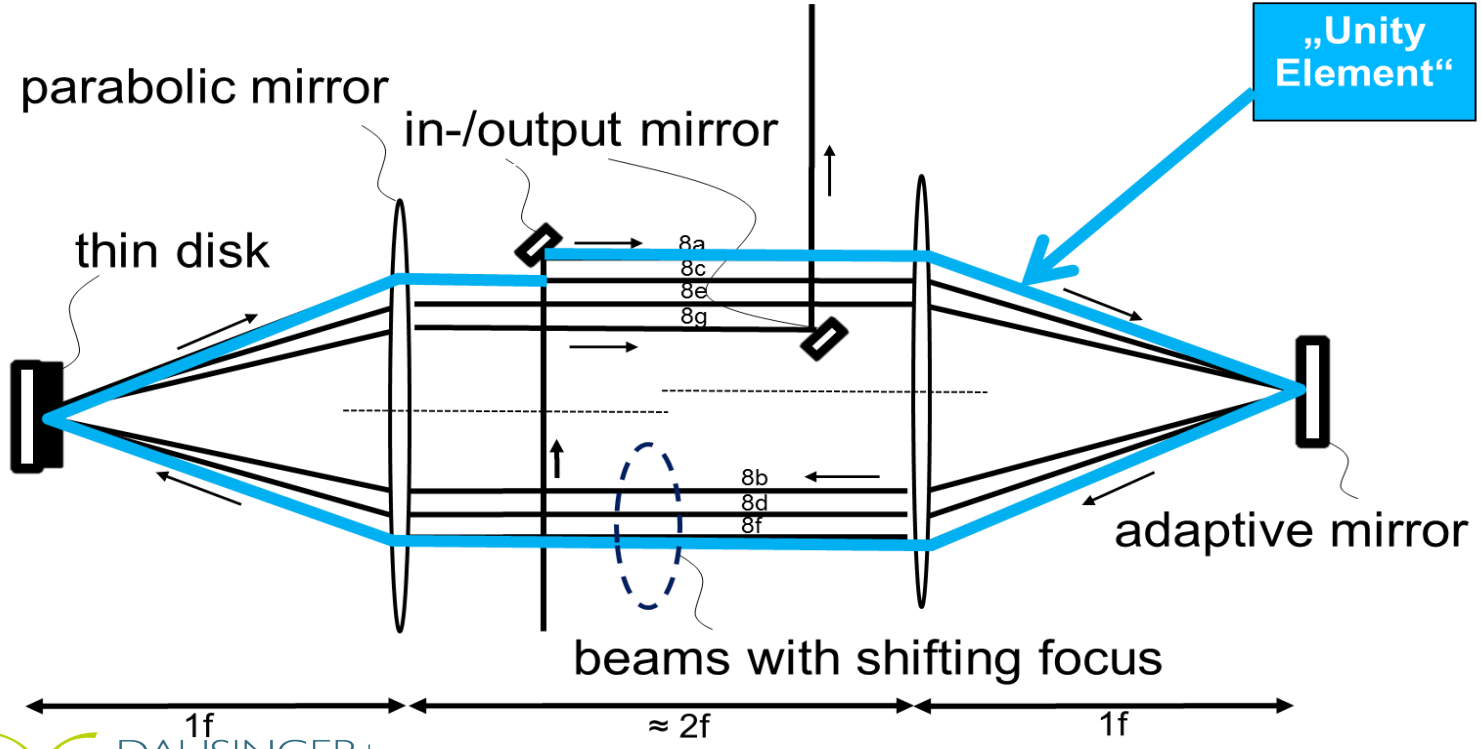


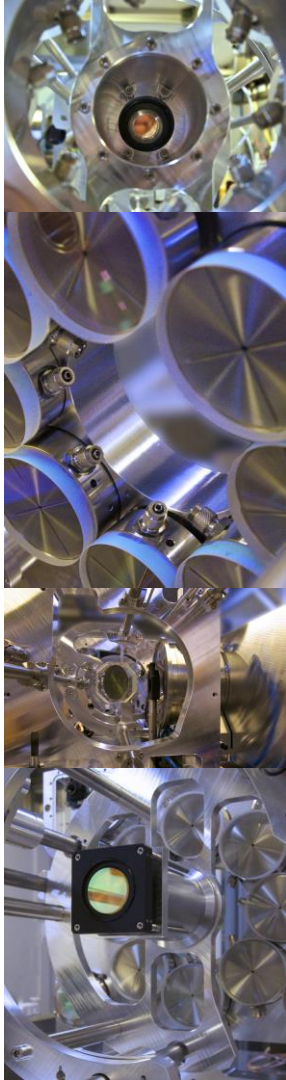




on track !

VaryDisk GigaPulse:
Optical Layout Linear Amplifier





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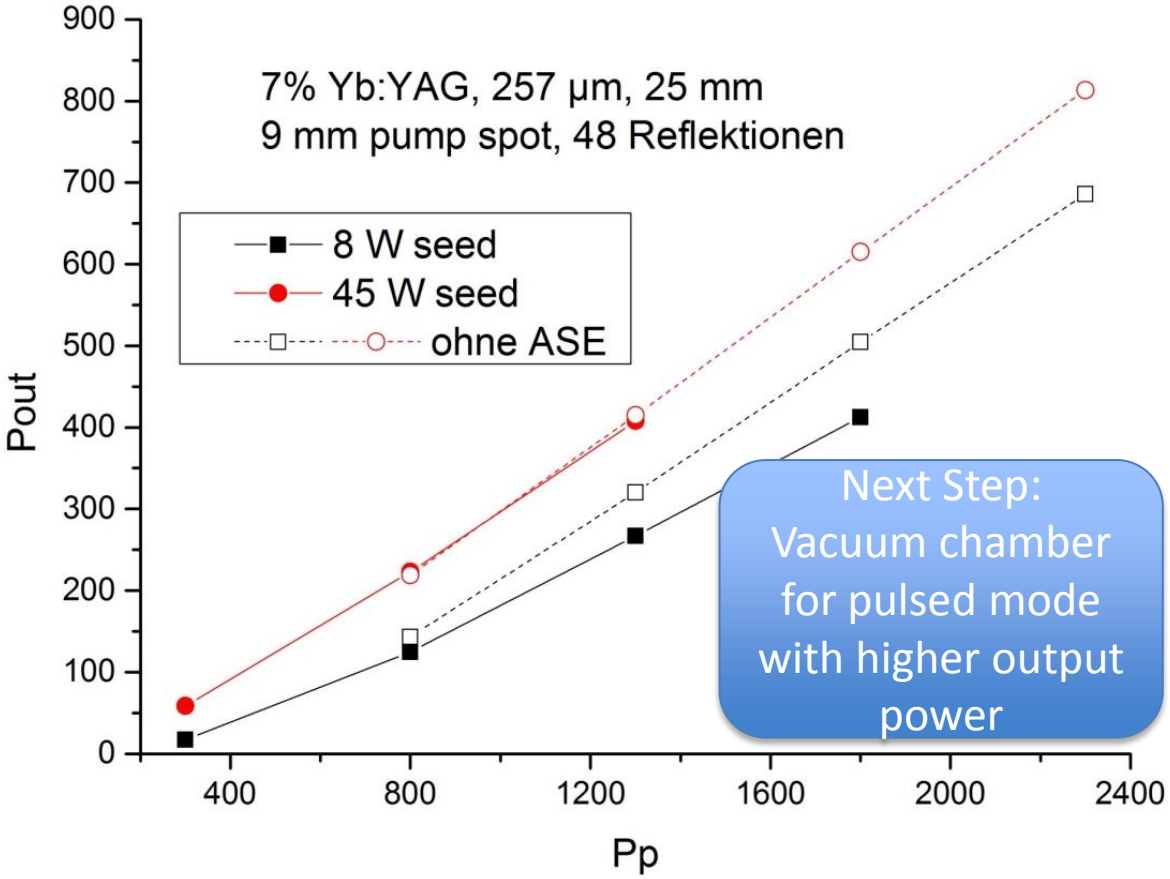
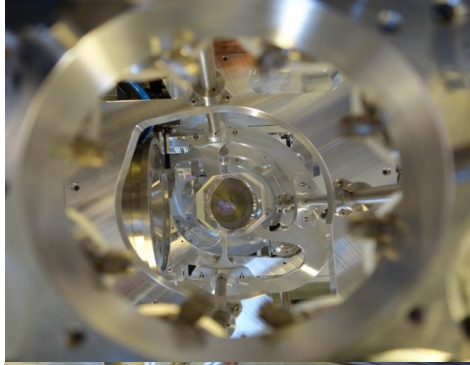
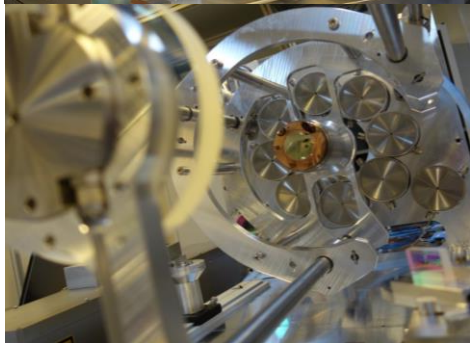
VaryDisk GigaPulse: On Schedule

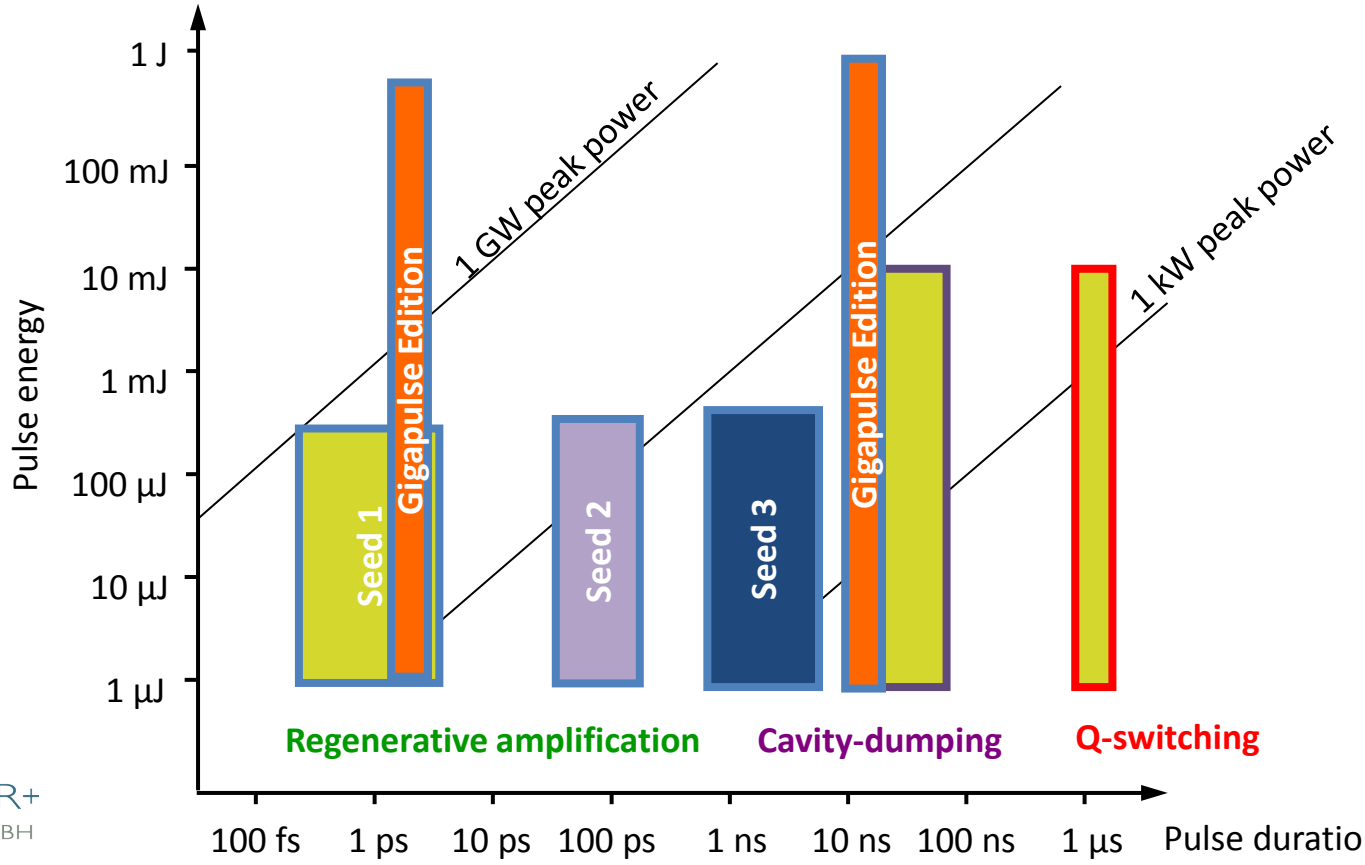


Next Step:
Vacuum chamber for pulsed mode with higher output power





D+G VaryDisk Parameter Range



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Summary and Outlook

- D+G delivers reliable components to build high perfomance disk laser installations
- Disk Lasers deliver high pulse energy and high average power
- D+G VaryDisk and Gigapulse lasers are build to spec according our modular approach
- We like to support You to make Your application possible

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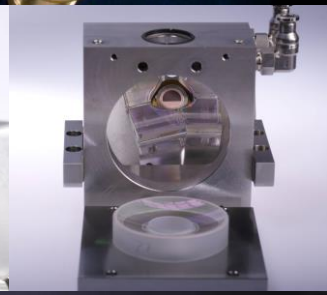

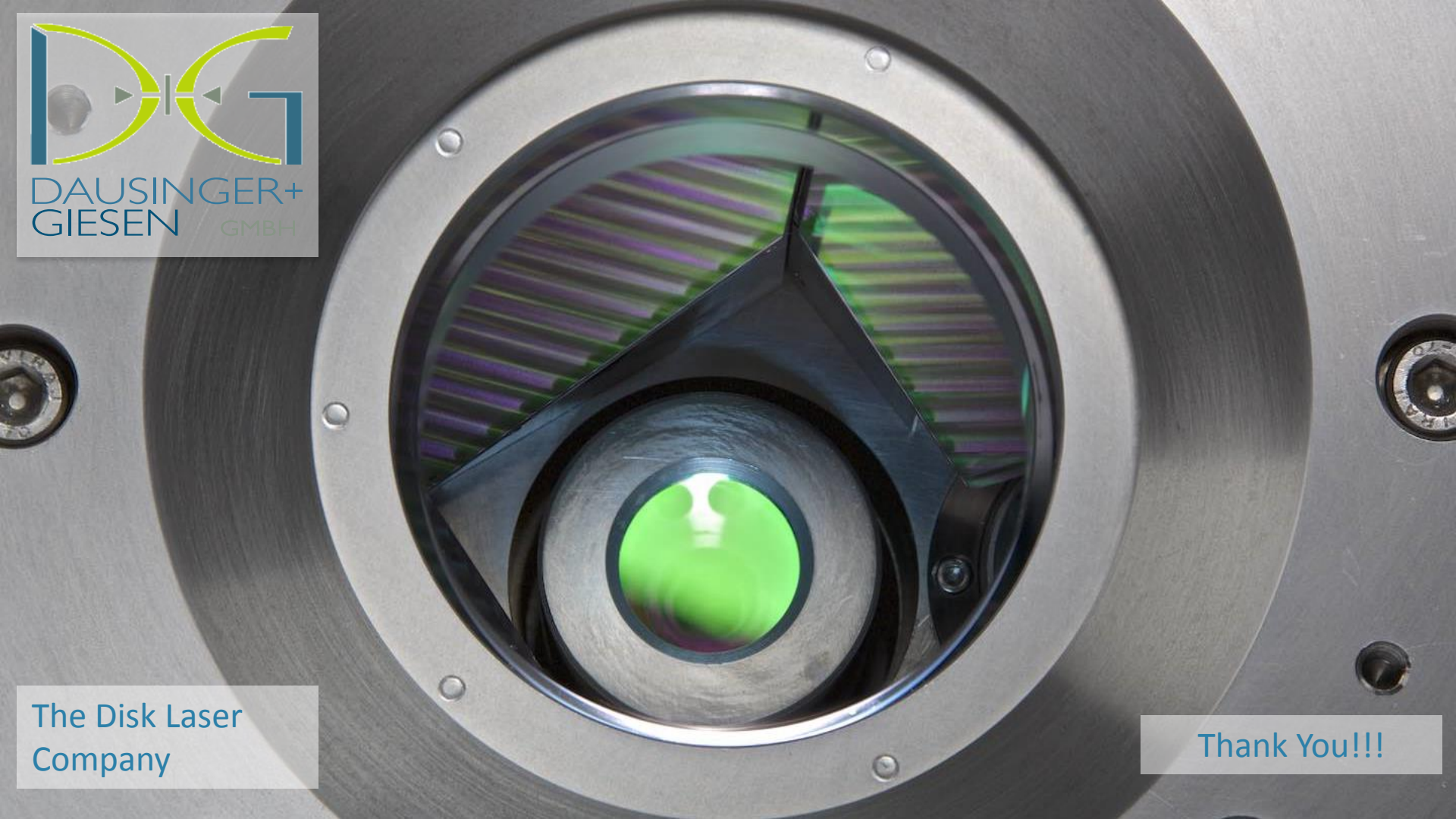
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The Disk Laser Company
Thank You!!!