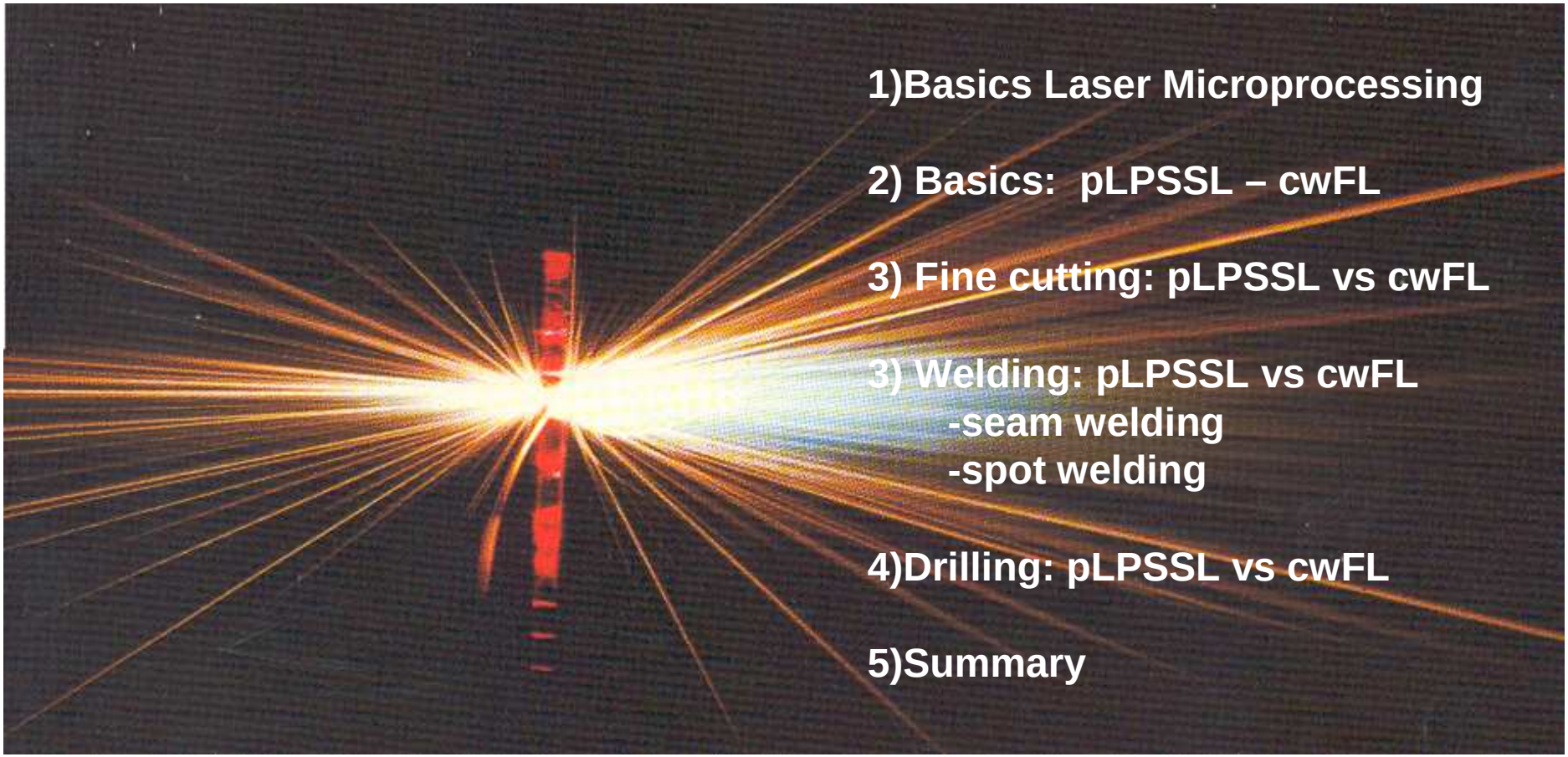
Rod-versus Fiberlaser in Thermal Laser Microprocessing



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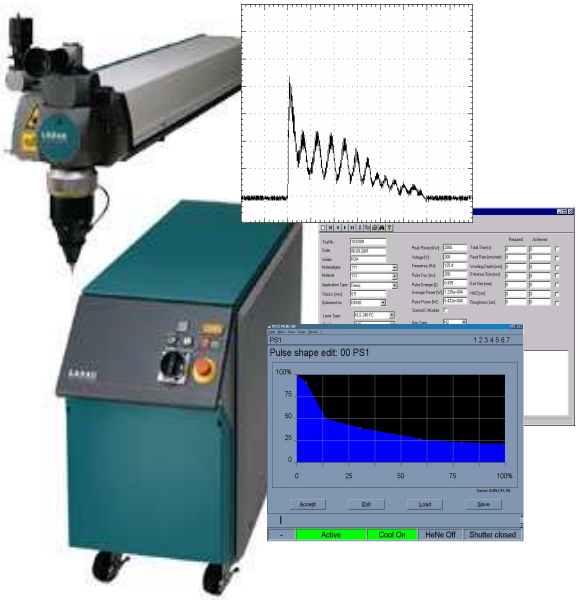
Industrial Lasers

Products

CW/pulsed Solid State Lasers (lamp pumped, Diode pumped)
Beam guiding technologies
Beam distribution
Beam forming
Process accessories
Process control

Solution for the customer



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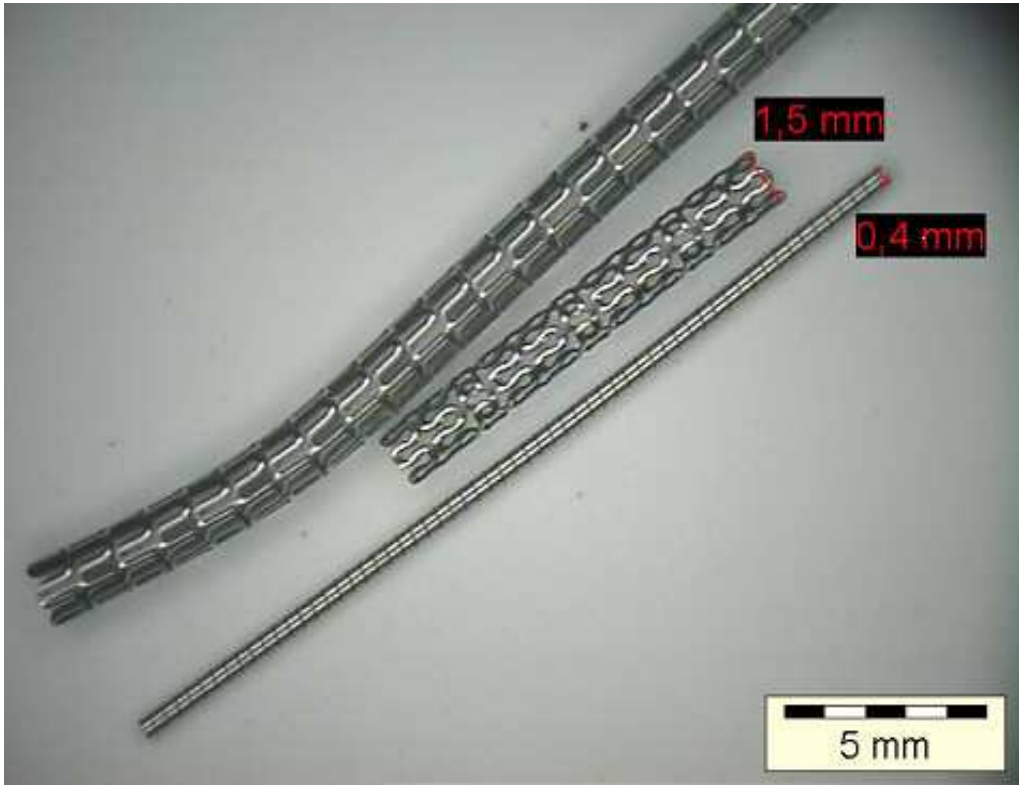
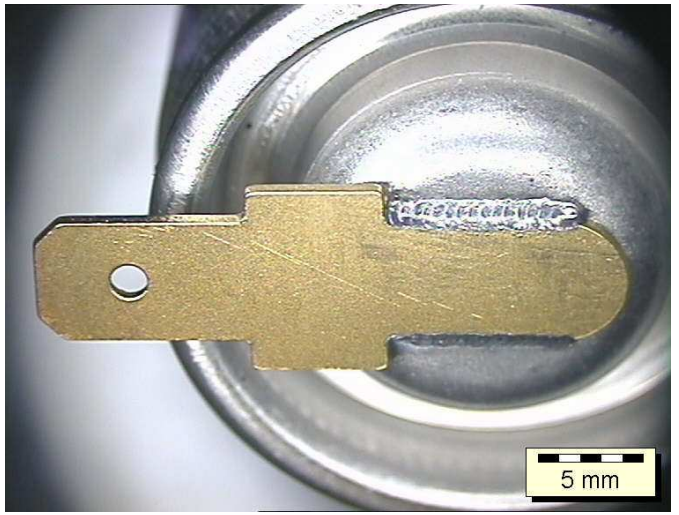
Industrial Lasers



Stents / Hypotubes

Laser - Applications

- (Fine) cutting
- precision drilling
- micro-welding
- “Scribing”



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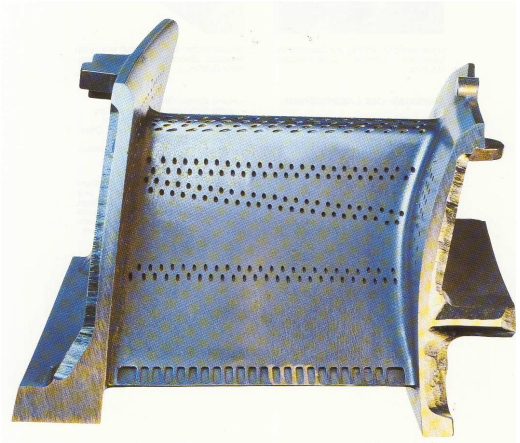
Industrial Lasers

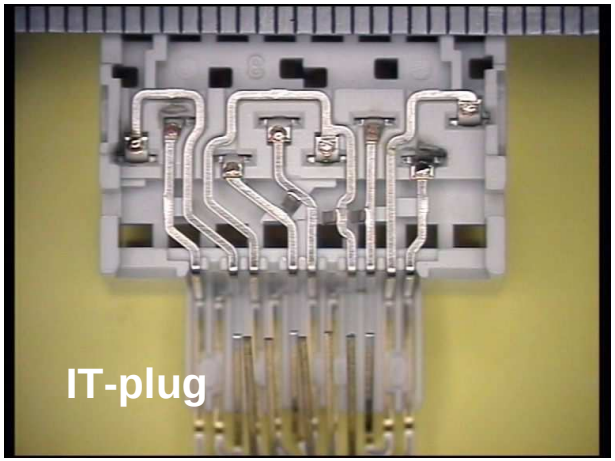
Markets

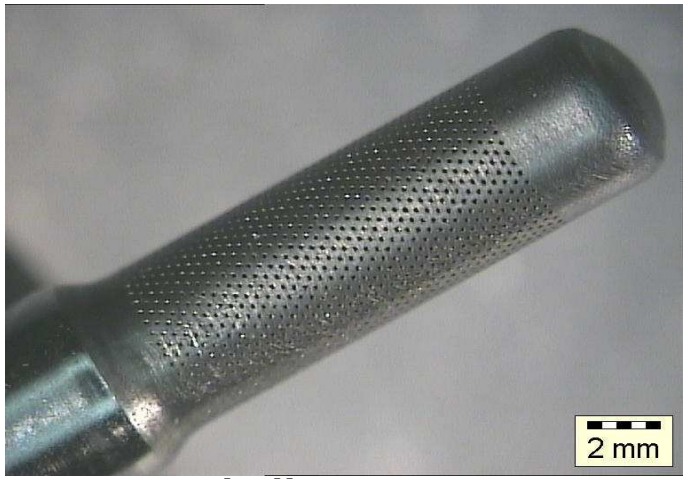
- Turbines (aero, gas)
- Medical (implants,instruments)
- Auto (powertrain)
- Solar (thermal Absorber)
- Electronics (contacts)
- White Ware (coffee machine))



Turbine component (cooling hole)

Cracked connecting rod





Fuel Filter

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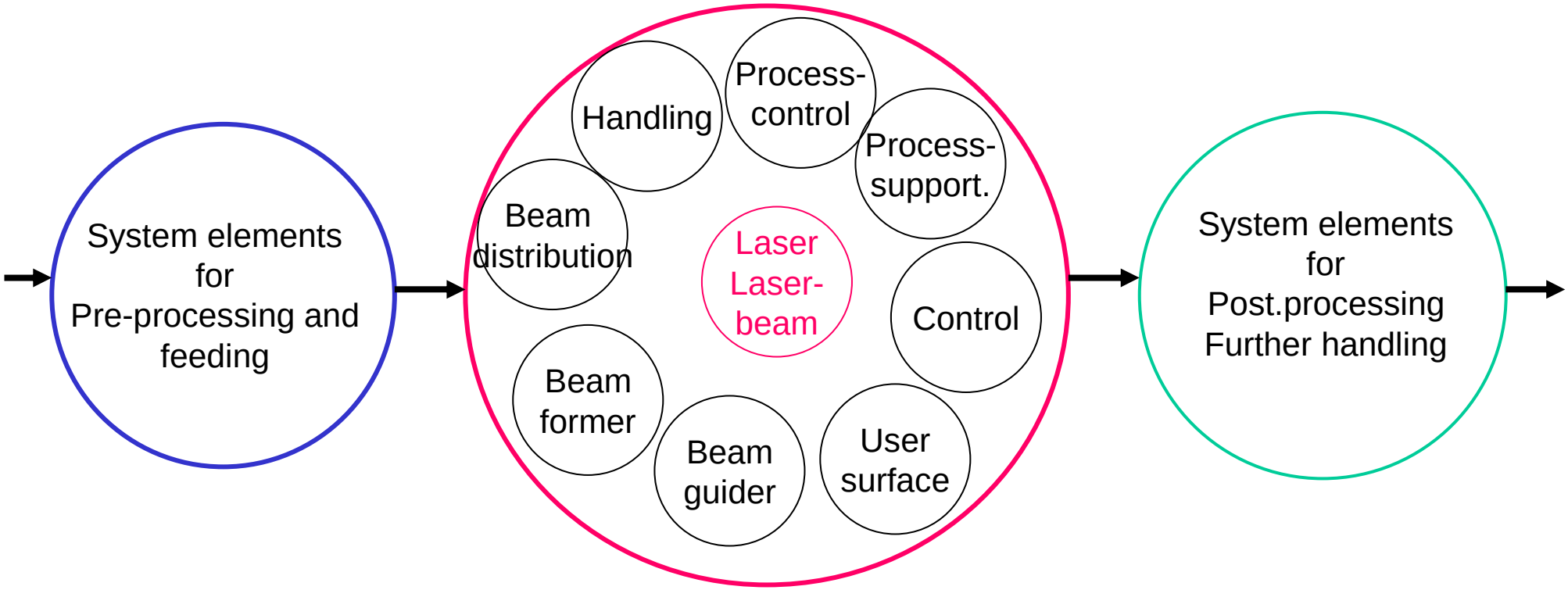
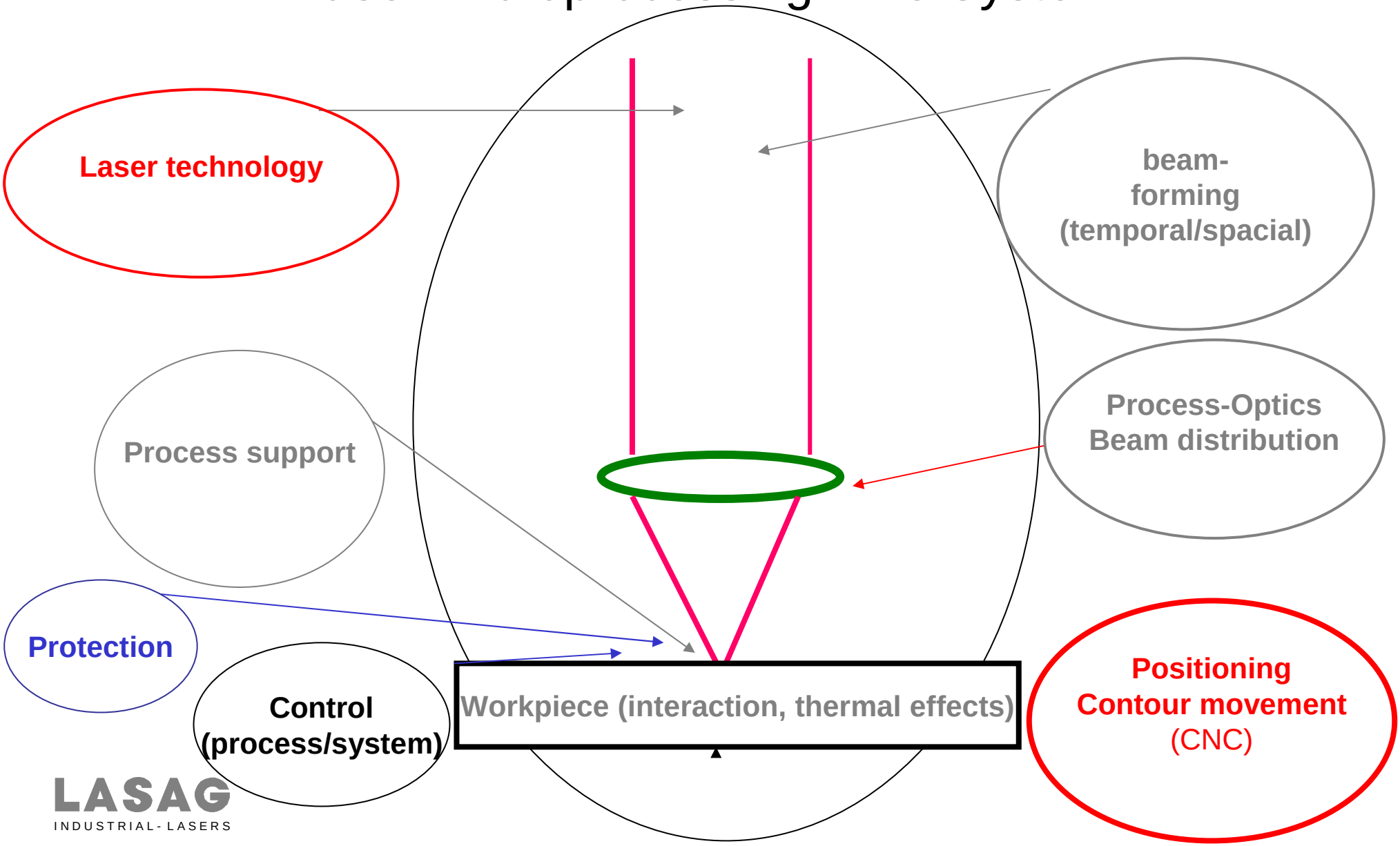
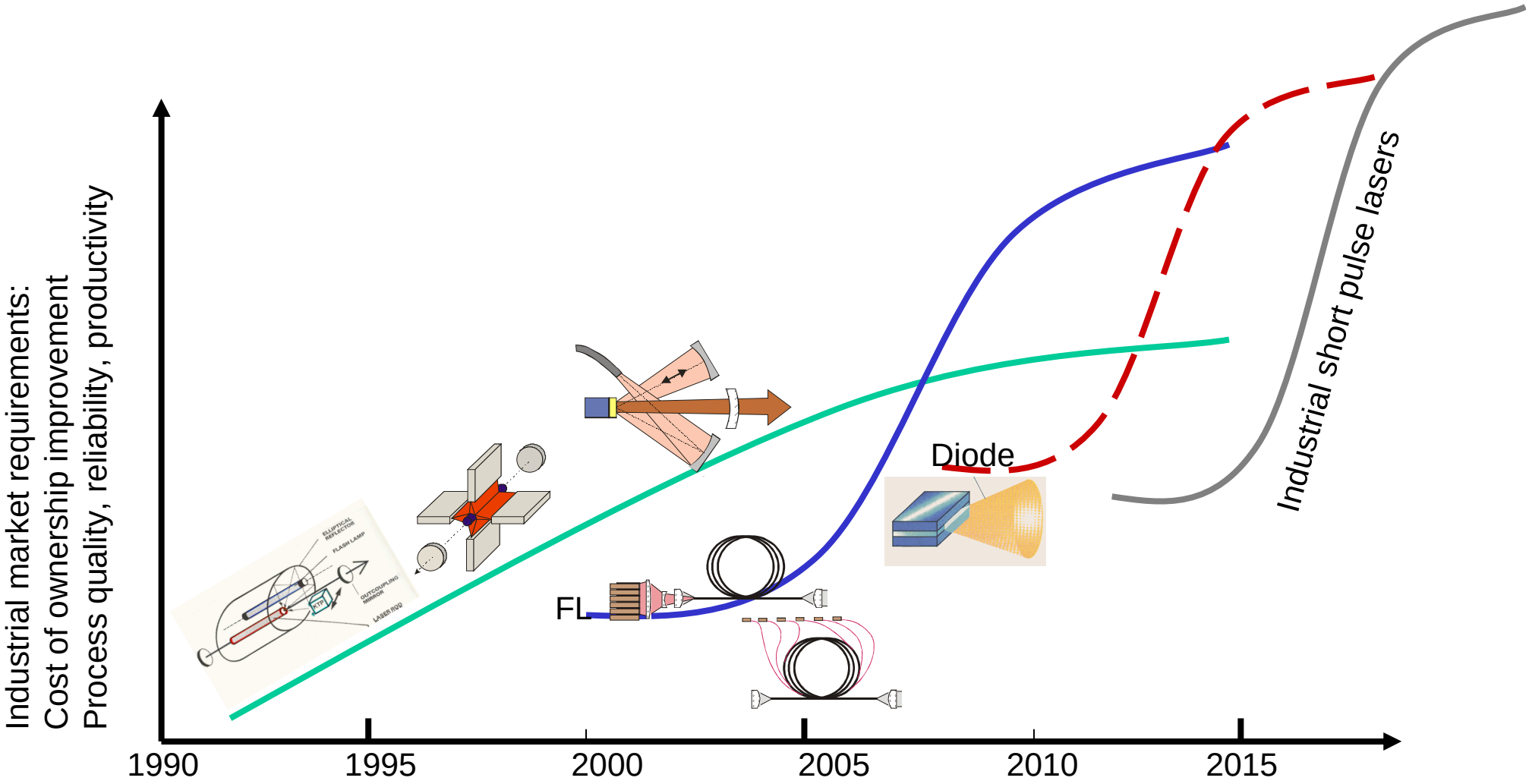
Lase Microprocessing in Industrial Production



Laser Microprocessing: The System



Disruptive Technologies in Laser Mikroprocessing?



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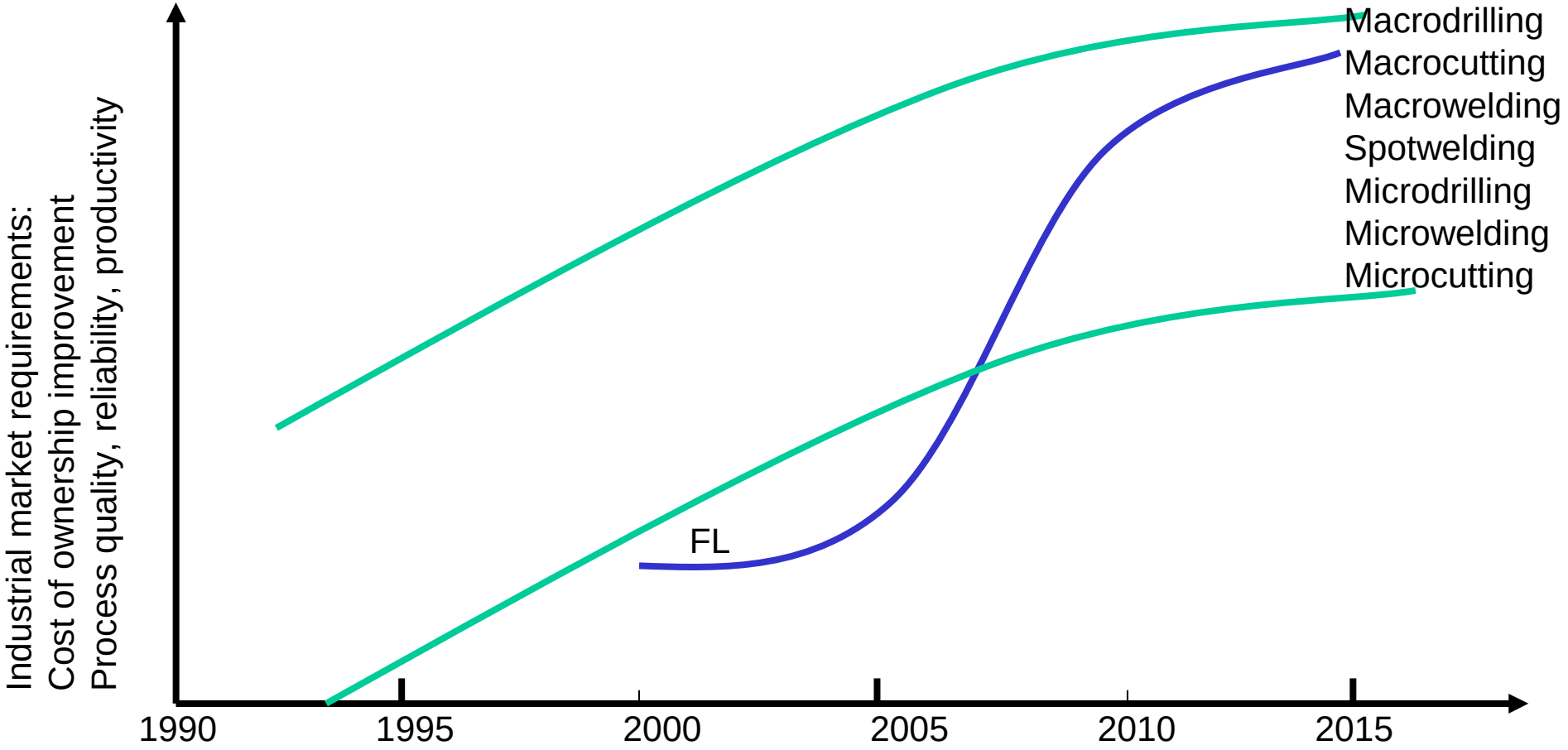
Influence of disruptive FL-cw technology on LPSSL markets



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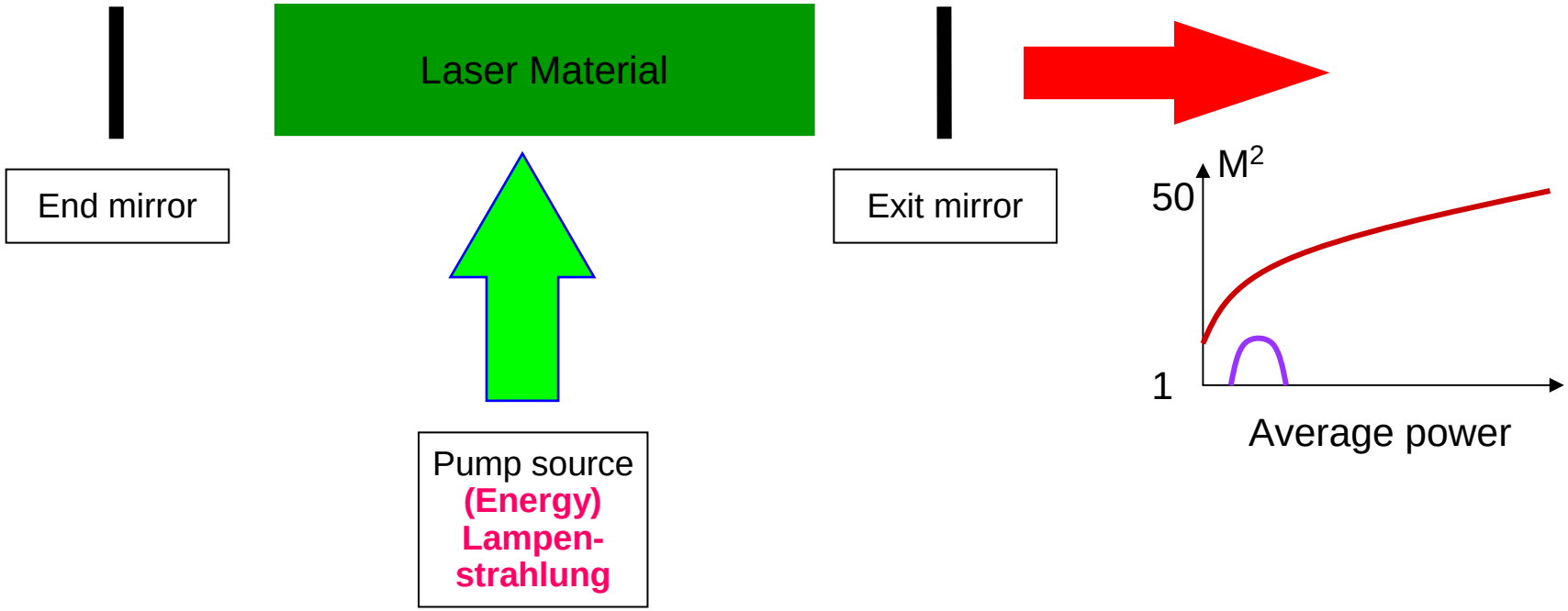
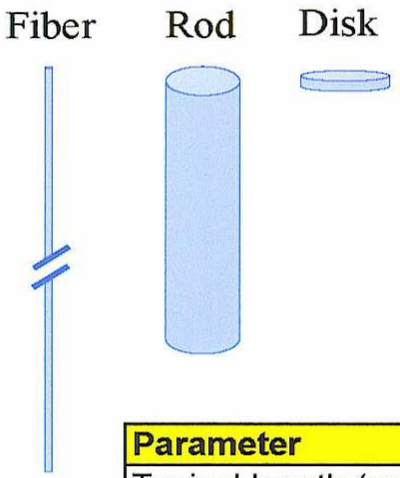
Basic problem of LPSSL/DPSSL: influence of heat on beam quality



Wall plug efficiency LP<5% / DP15%
energy is „waisted“

Elements of disruptive FL-Technology vs Rod

Fiber Laser – Thermal Management

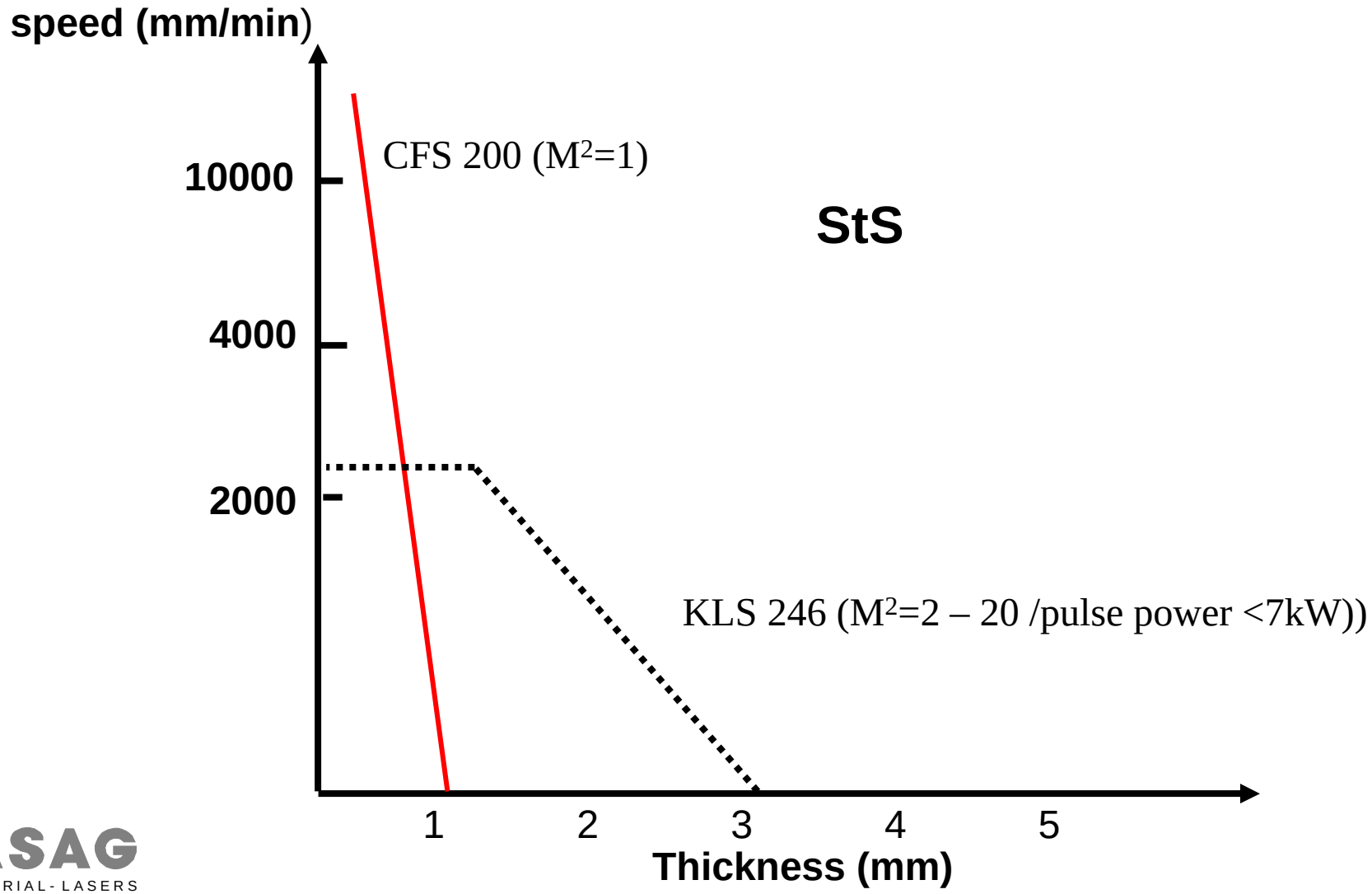


Fiber Laser Advantages

- Air cooled
- No thermal loading
- No thermal role-over
- No thermal lensing

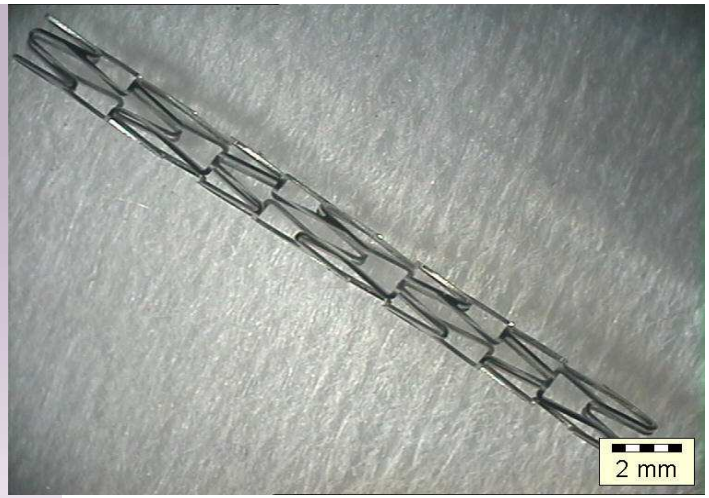
Parameter	Rod	Disk	Fiber
Typical length (mm)	150	0.15	20,000
Outer diameter (mm)	9	10	0.125
Volume (mm3)	9,538	12	245
Cooled surface (mm2)	4,239	39	7,850
Cooled surface/ volume (1/mm)	**0.44**	**3.33**	**32**

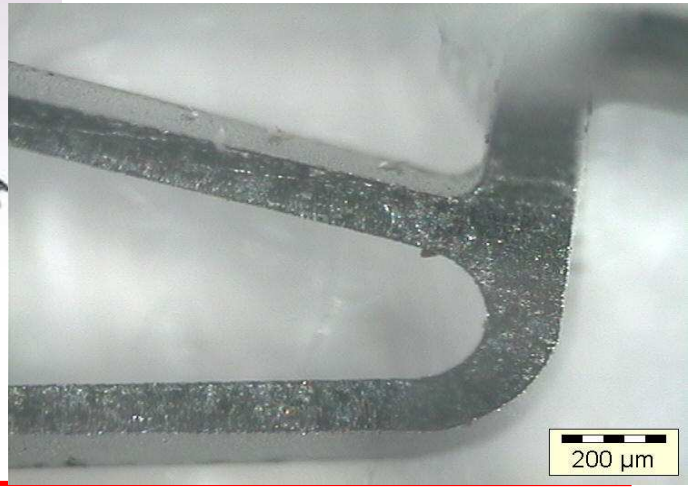
Fine cutting: pulsed 200 W Nd:YAG – cw 200 W Fiberlaser



Example: Metal - Stent

LLT – Stent Cutter





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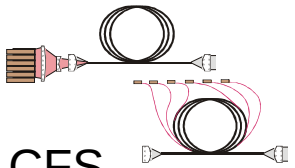
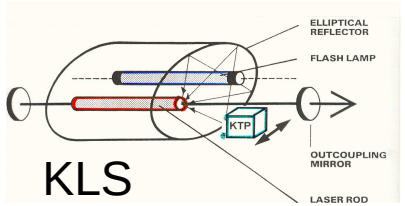
200W pulsed YAG – 200W SM Fiberlaser
(fine cutting)

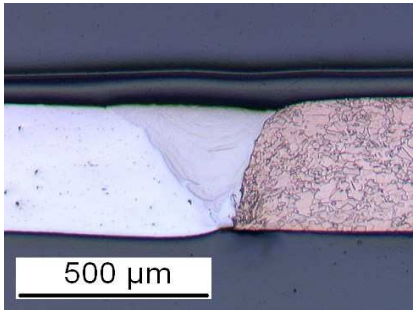


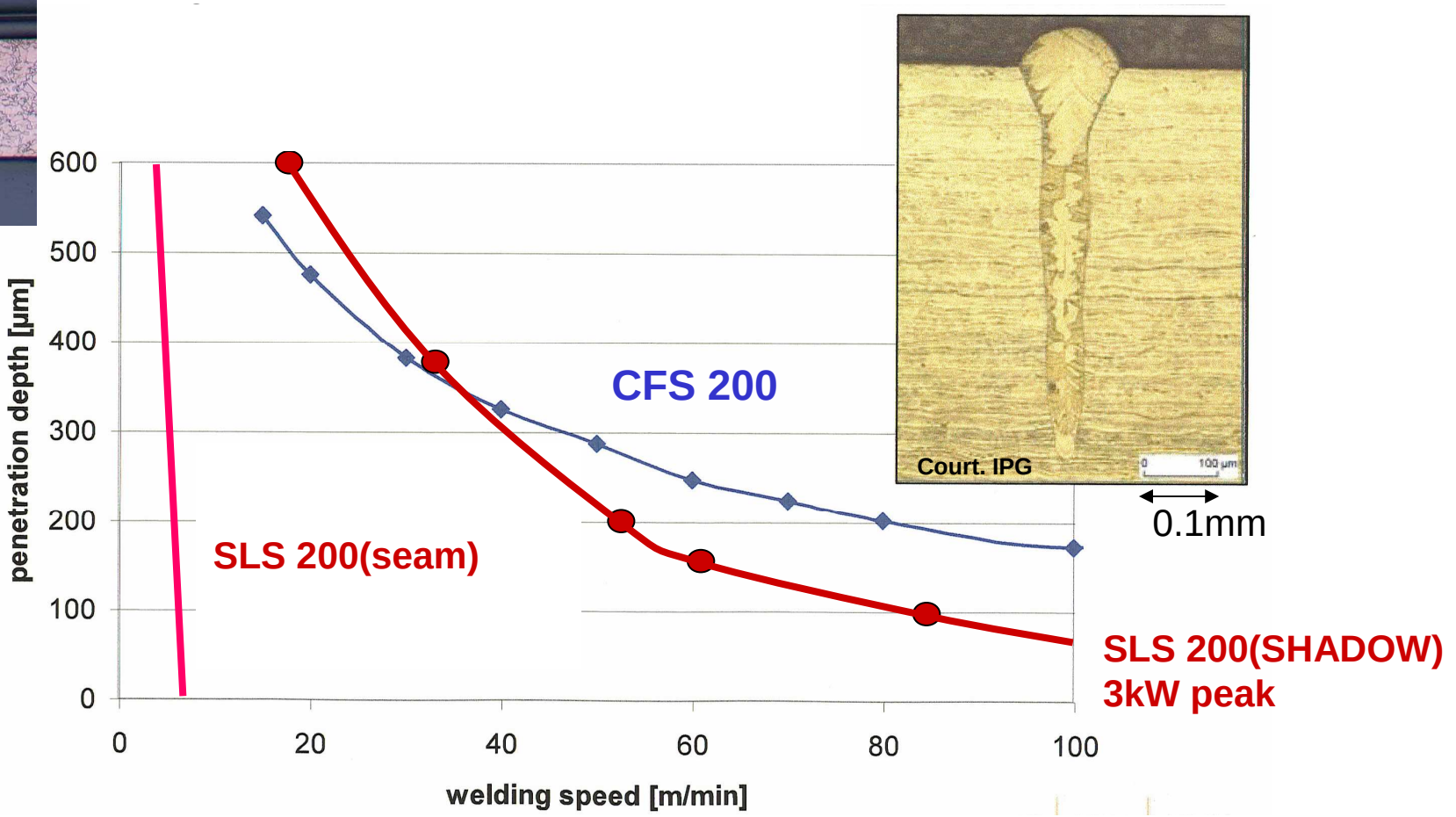


Application relevant parameters	CFS	KLS
Beam quality number M^2	1.2	2-20
Average power/cw power(W)	200	50 - 200
frequency(kHz)	<50	<1
Wall plug efficiency (%)	<30	2 – 5
Fine cutting (pulse duration 0.1ms)		
Average power on workpiece	40 -100	50-200
Intensity 50mm Objectiv (BE 1-6)(MW)	10 ->100	>100-0.2
Depth of Focus(mm)	0.3	0.06-8
Fine cutting St.St 0.5/1/2mm*	see diagram	

*Problems FL :Quality begin of cut /high reflecting metals

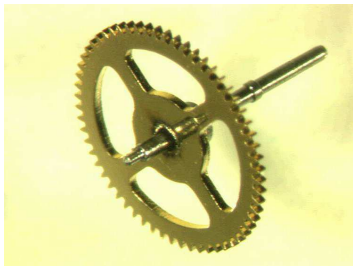
Material Processing: Seam-Welding SLS 200-CFS 200
Influence of „Brilliance“

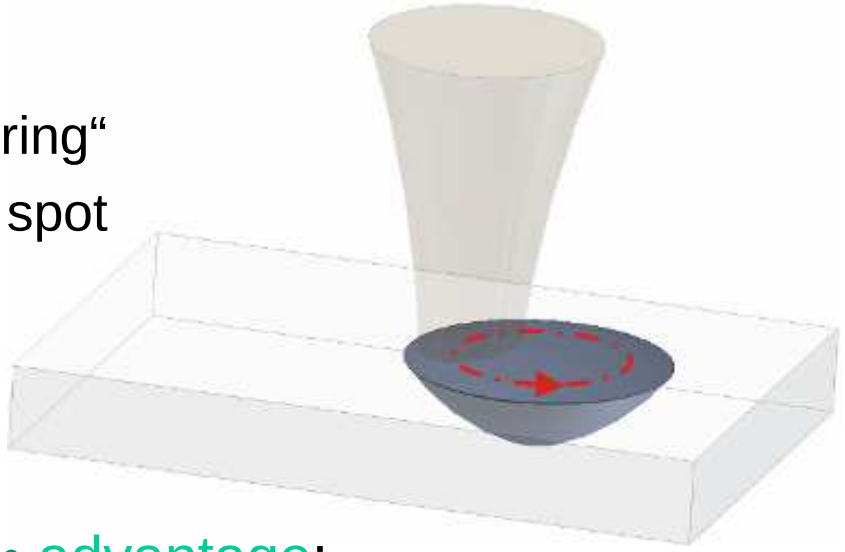




Spot welding:
SHADOW®-Microring or single spot

- FL/LPSSL approach: “stiring“
- LPSSL approach: single spot





Stepless
High Speed
Accurate and
Discrete
One Pulse
Welding

- advantage:
- Allows spot welding for low power lasers
  - High power(densities) for fast coupling
  - Movement avoids overheating(spattering)
  - disadvantage
  - Needs scanner and time

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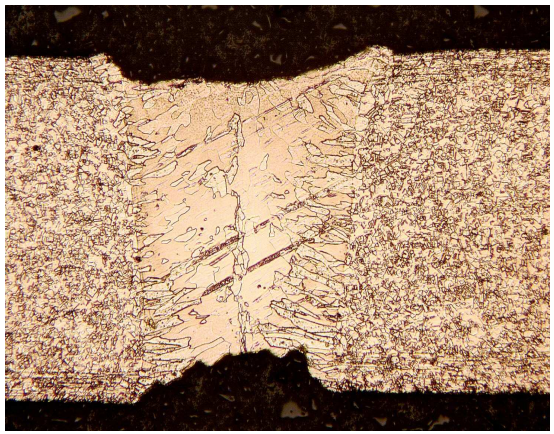
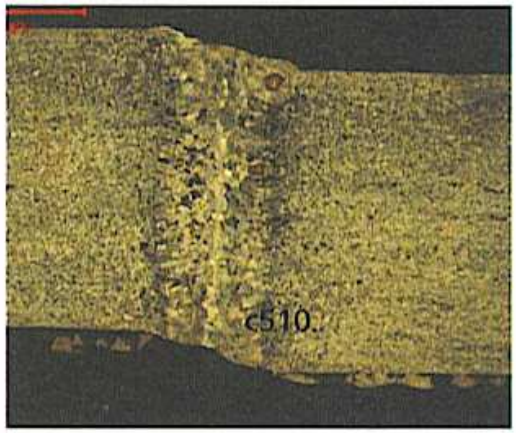
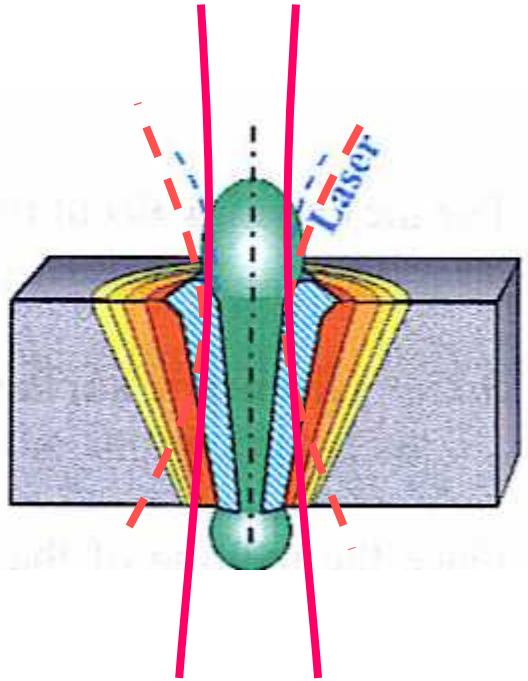
Fraunhofer Institut Lasertechnik

Influence of „Brilliance“ on deep welding performance

Brilliance ~Watt/Spot x cone angle (W/cm²sr)



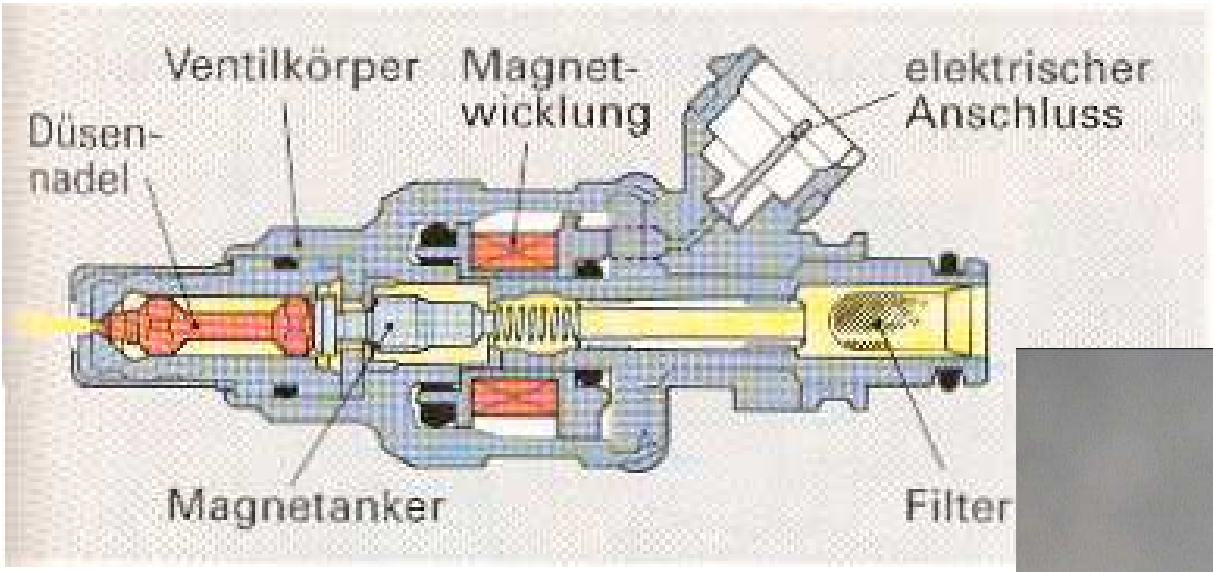


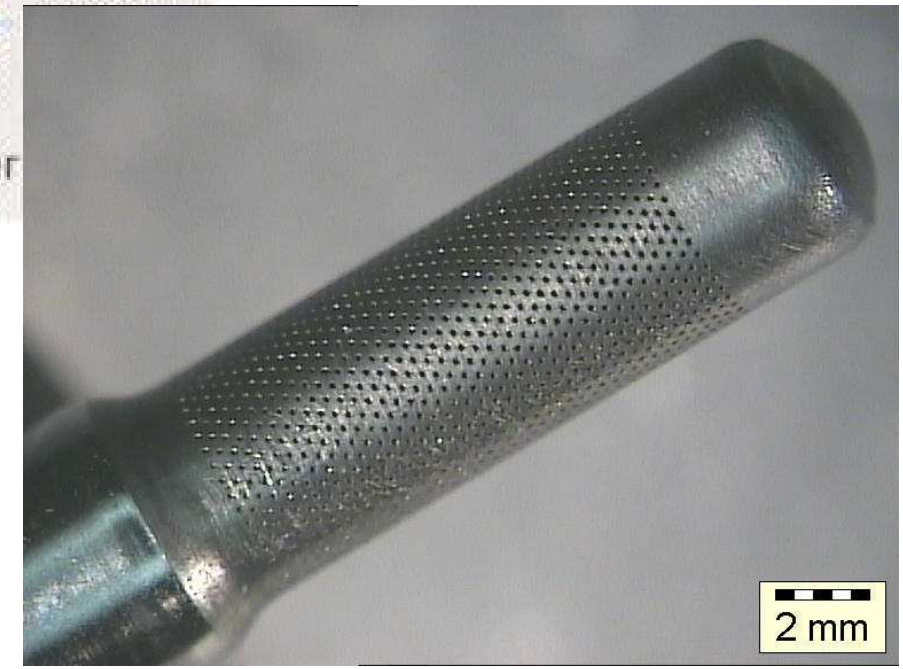


IWS(Dresden)/Dt. Kupferinstitut.

Material:	***Cu***	***Cu***
Laser:	***p - Nd:YAG(240W)***	***cw – IPG-FL (4kW)***
Parameter:	***4 kW Pulsleistung***	***4kW***
	35 J Pulsenergie	
Tiefe:	***1 mm***	***3mm***
Speed:	***0.1m/min***	***3m/min***

Drilling of Filters





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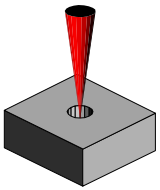

Hole Diameter(µm)

1000

100

10

1

Limit:
Intensity, pulse energy

**Single Shot „on the fly*
Drilling (200W)
Processing time <2s
Aspect 10
StSt (0.5mm)**

Limit at necessary energy:
Pulse frequency
Average Power
Movement

Limit:
Beam Quality

pLPSSL

cwFL(modulated)

1 10 100 1000 10000

Holes per Second

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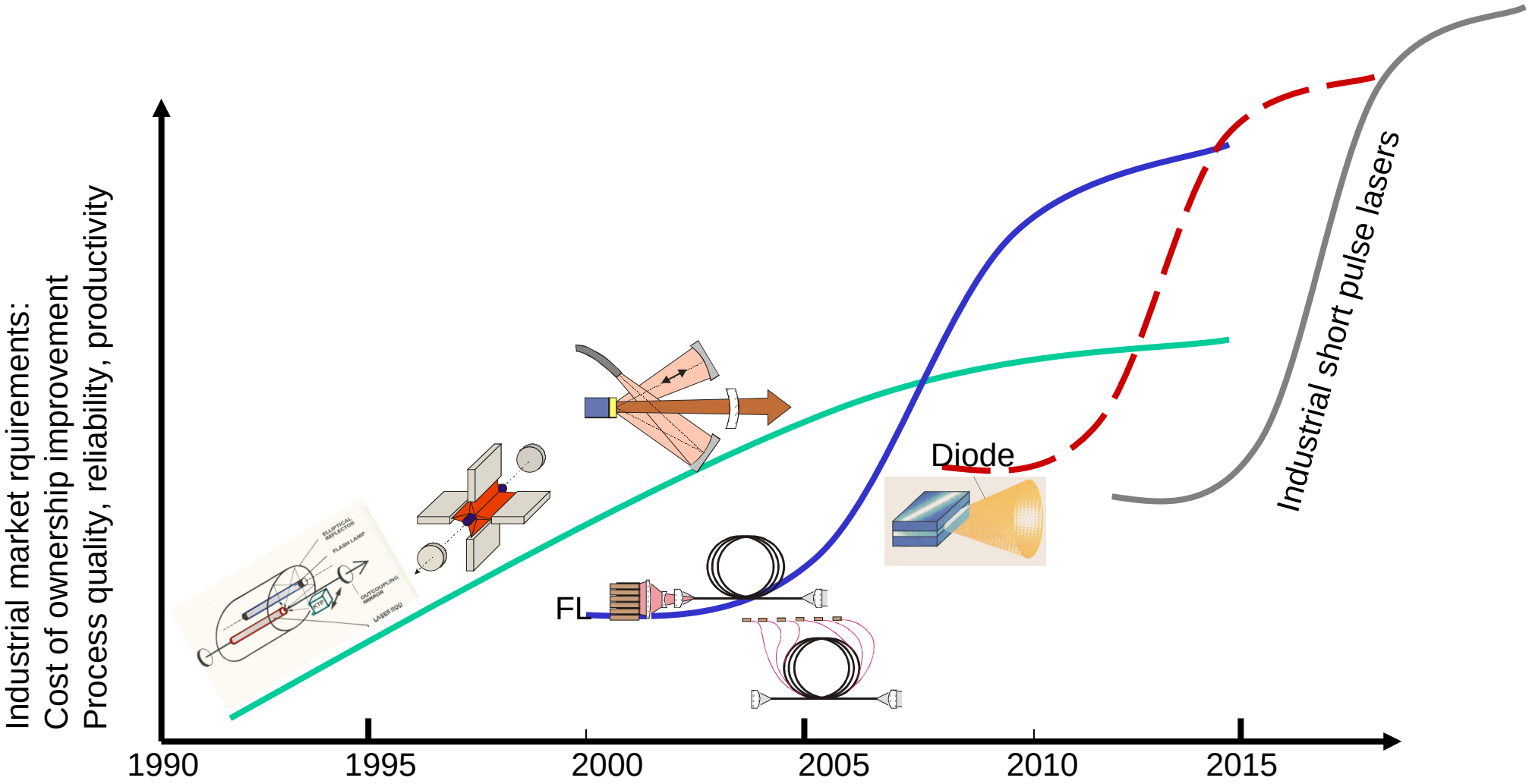
A COMPANY OF THE SWATCH GROUP

Disruptive Technologies in Laser Mikroprocessing?



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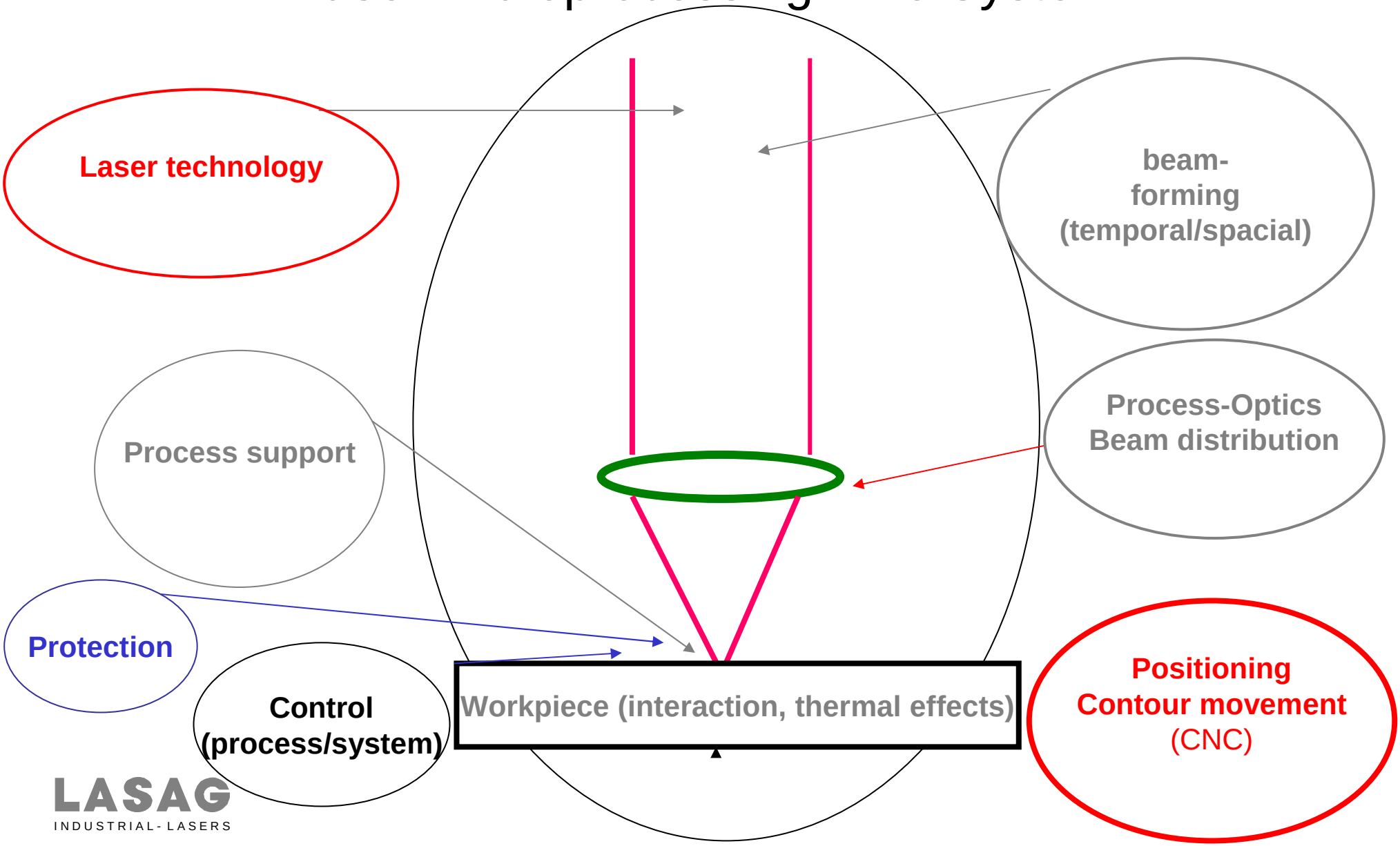
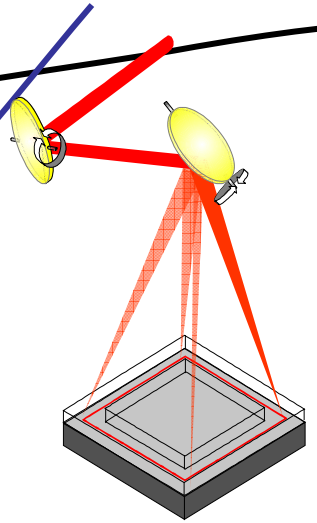
Laser Microprocessing: The System



„CNC“ disruptive Technology for high speed laser processing

Precision „cost of ownership“ — Speed +Precision — Superspeed+Precision

Umsetzung Laser-Vorgaben Marktbedürfnisse



1995 2000 2005 2010 2015 2020

Rod-versus Fiberlaser in Thermal Laser Microprocessing