



LAPPEENRANTA
UNIVERSITY OF TECHNOLOGY

Laser Processing in Finland

Prof. Veli Kujanpää
Laserdag II
13.10.2005
Göteborg, Sverige



Lappeenranta Laser Processing Centre



Lappeenranta Laser Processing Centre

- Leading laser processing centre in Finland
- Joint research institute of **Lappeenranta University of Technology** and **VTT Industrial Systems**
- Totally 29 persons in research of laser technology
- First laser installations 1986

Goals

- To keep the Finnish industry on the front edge of laser technology
- To offer "Laser solution" to manufacturing problems of Finnish industry
- To carry out high quality basic research activities
- To listen and fulfil the requirements of the customers

PERSONNEL

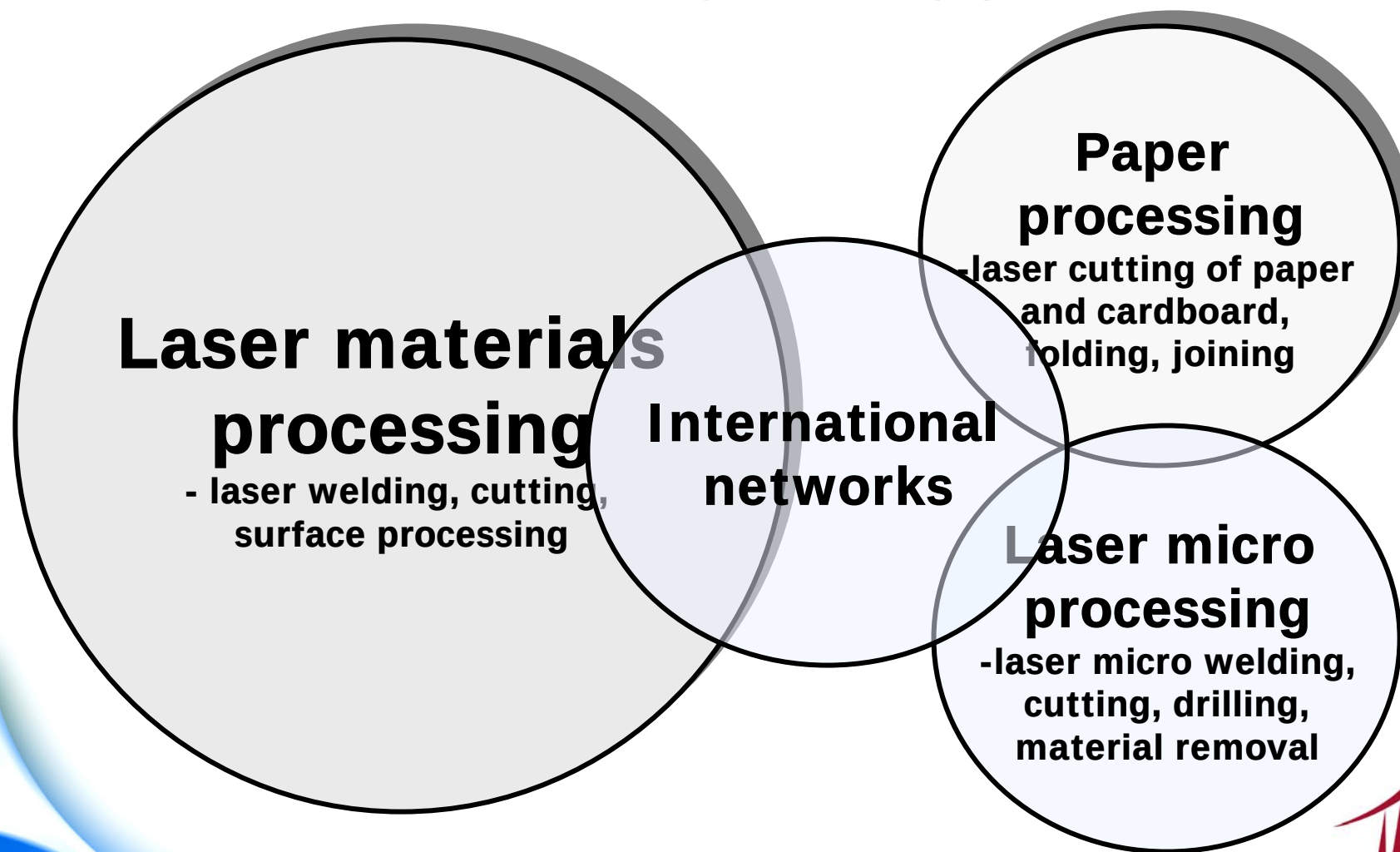
Veli Kujanpää, Dr.Tech., Professor
Tapani Moisio, Dr.Tech., Professor emeritus
Jon, John, Dr.Tech. (Docent, part-time)
Antti Salminen, Dr.Tech., Docent, Sen. Research Scientist
Tommi Jokinen, Dr.Tech., Sen. Research Scientist
Henrikki Pantsar, Dr.Tech., Research Scientist

Kalervo Leino, MSc., Sen. Research Scientist
Anna Fellman, MSc, Research Scientist
Jari Hovikorpi, MSc., Research Scientist
Mika Immonen, MSc , Research Scientist
Anssi Jansson, MSc., Research Scientist
Timo Kankala, MSc., Research Scientist
Miikka Karhu, MSc, Research Scientist
Saara Kouvo, MSc., Research Scientist
Petri Laakso, MSc., Research Scientist
Heidi Malmberg, MSc., Research Scientist
Raimo Penttilä, MSc., Research Scientist
Timo Savinainen, MSc., Research Scientist
Jukka Siltanen, MSc., Research Scientist
Ilkka Vanttaja, MSc., Research Scientist

Bukini Vamshi, MSc Student
Catharine Wandera, MSc Student
Raluca Blanca, MSc Student
Henri Fennander, MSc Student

Vesa Airas, Technician
Mervi Jaanu, Secretary
Marja Kokko, Secretary
Pertti Kokko, Technician
Jaakko Moisio, Technician
Mikko Pesari, Engineer

Activities



Facility

- 6 kW CO₂ laser
- 2.5 kW CO₂ laser punch press
- 3 kW lamp pumped Nd:YAG laser
- 3 kW diodelaser
- 200 W diodelaser
- 2.7 kW CO₂ laser (HQ2700)
- 15 W Cu-vapour laser
- 120 W Excimer laser
- Pulsed Nd:YAG laser
- 2 Marking laser units
- 100 W Fiber laser
- 15 kW electron beam unit

- 11*3*1 m³ portal workstation
- 2*1 m² portal workstation
- Robot workstation (16 kg)
- Robot workstation (125 kg)
- 0.5*1.5 m² linear drive workstation, acceleration 3 g

- Powder feeder
- Wire feeder
- Hybrid welding head
- Optical seam tracking
- Pyrometer
- Fibre optics for Nd:YAG, 5, 15 and 50m
- Various welding and heat treatment optics for CO₂, Nd:YAG and Diode lasers

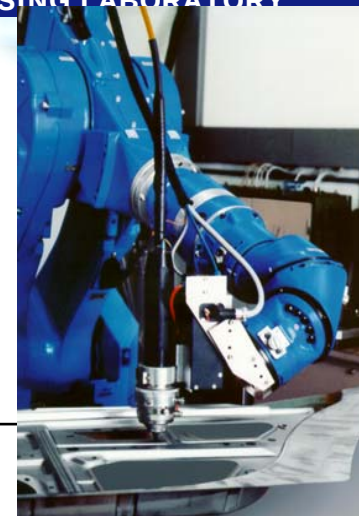


World markets of laser resonators (source Laser Focus World)

1. Lasers

(in Euro Billion)

	2003	2004	Growth Rate
Telecommunications	1.05 #)	1.13	+ 7.6 %
Materials Processing (incl. Microlithography)	1.30	1.65	+ 26.9 %
Information Technology (Consumer Electronics, Office Automation, Printing)	1.47	1.36	- 7.5 %
Medicine	0.43	0.53	+ 23.3 %
Measurement, Research, Other	0.32	0.34	+/- 6.3 %
Total	4.57	5.01	+ 9.6 %



World markets of laser systems (source Laser Focus World)



2. Laser Systems (in Euro Billion)

	2003	2004	Growth Rate
Telecommunications	7.0 #)	7.5	+ 7.1 %
Materials Processing *)	3.5	4.4	+ 25.7 %
Microlithography	2.1	3.4	+ 61.9 %
Information Technology (Consumer Electronics, Office Automation, Printing)	37	37.6	+ 1.6 %
Medicine +)	1.0	1.2	+ 20.0 %
Measurement and Research	1.5	1.6	+ 6.7 %
Total	52.1	55.7	+ 6.9 %

#) revised figures

*) without lasers, laser systems for microlithography

+) without accessories, consumables



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World Markets of Laser Systems (source Laser Focus World)

by Type of System (2004)

(in Euro Billion)

1. World Market for Lasers and Laser Systems for Materials Processing, 2004
2. Laser sales 38400 systems

(in Euro Billion)

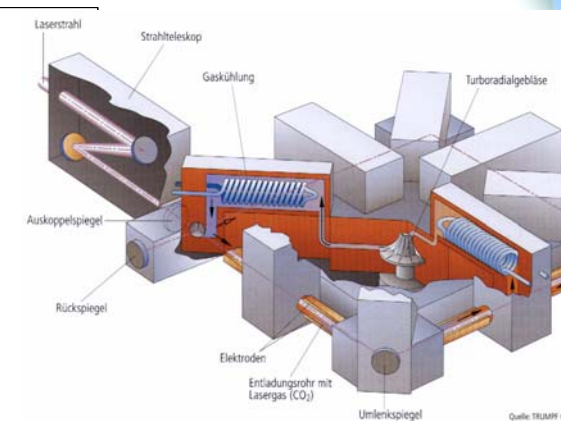
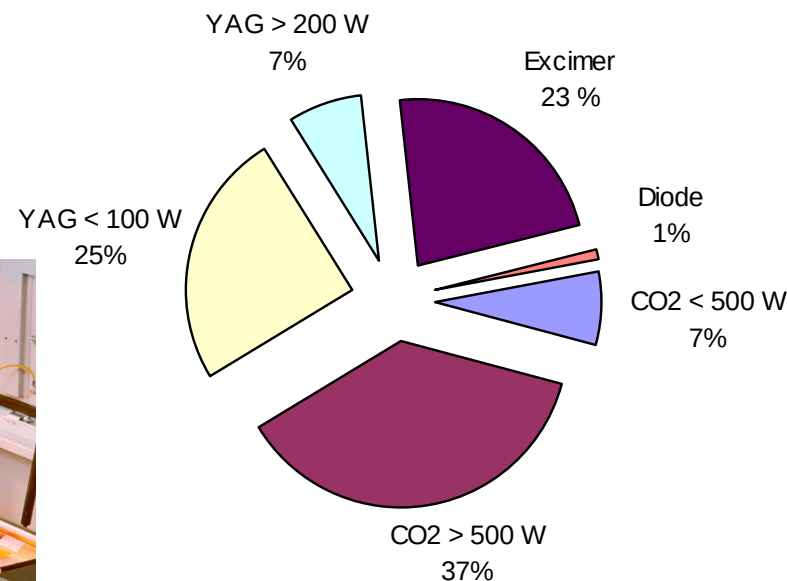
Laser Sources	1.65
Laser Systems	4.65

Laser Macro Processing Systems (for cutting, welding, marking etc.)	3.45
Laser Micro Processing Systems for Processing of Semiconductors, Printed Circuit Boards, and Electronic Components	1.2

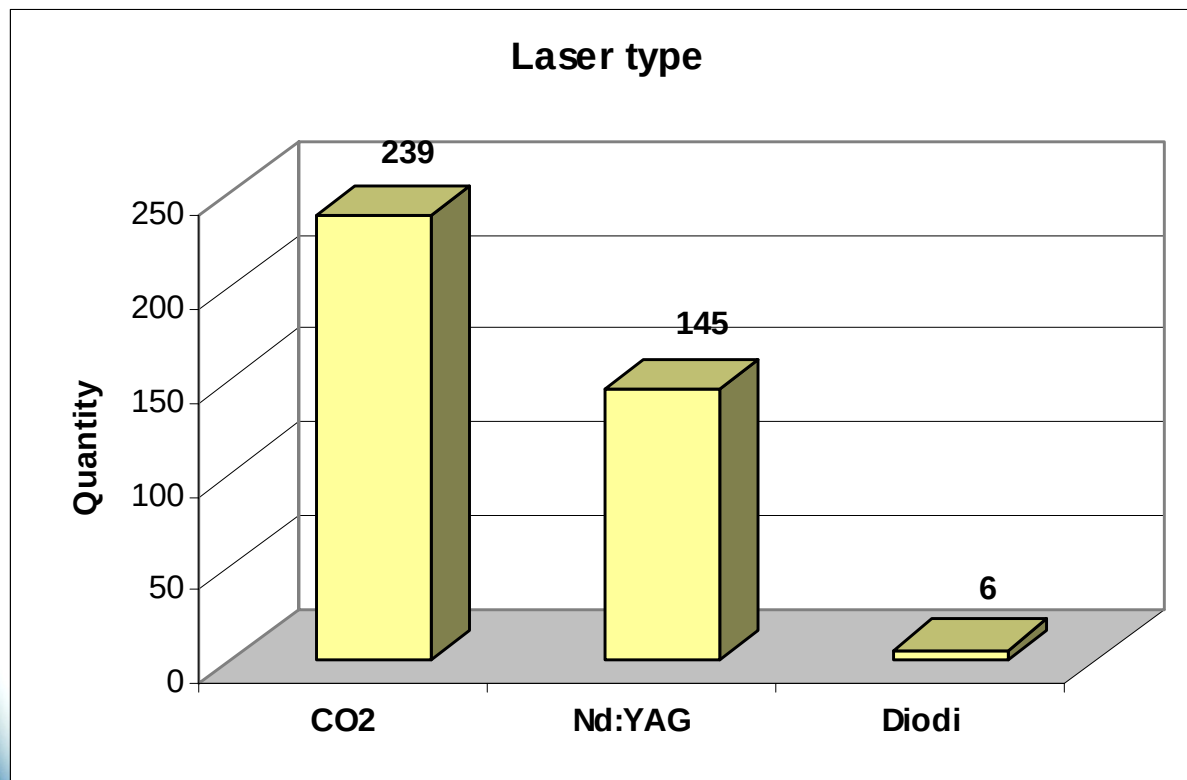
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World markets vs. laser types (source Optec Consulting)

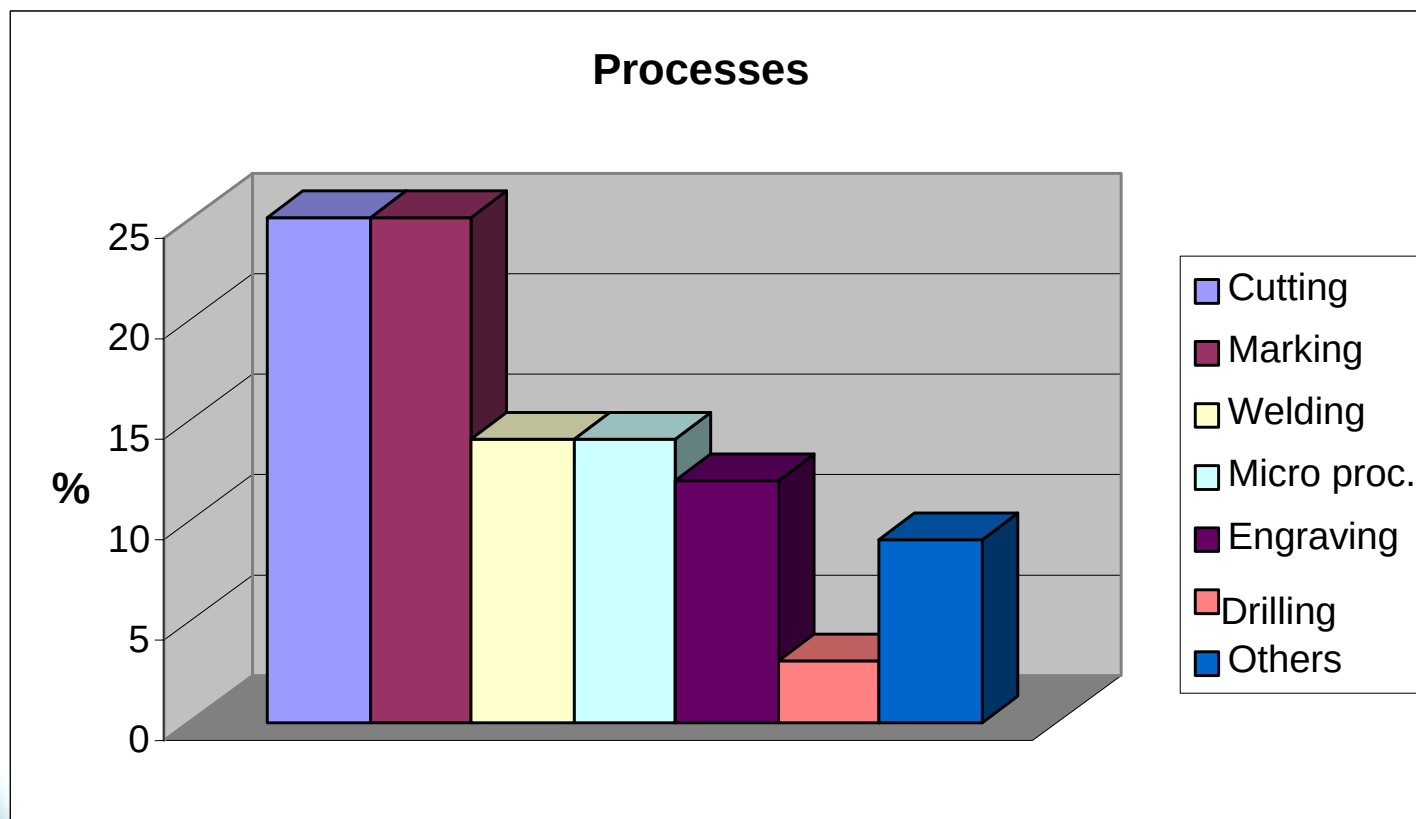
World markets vs. laser types



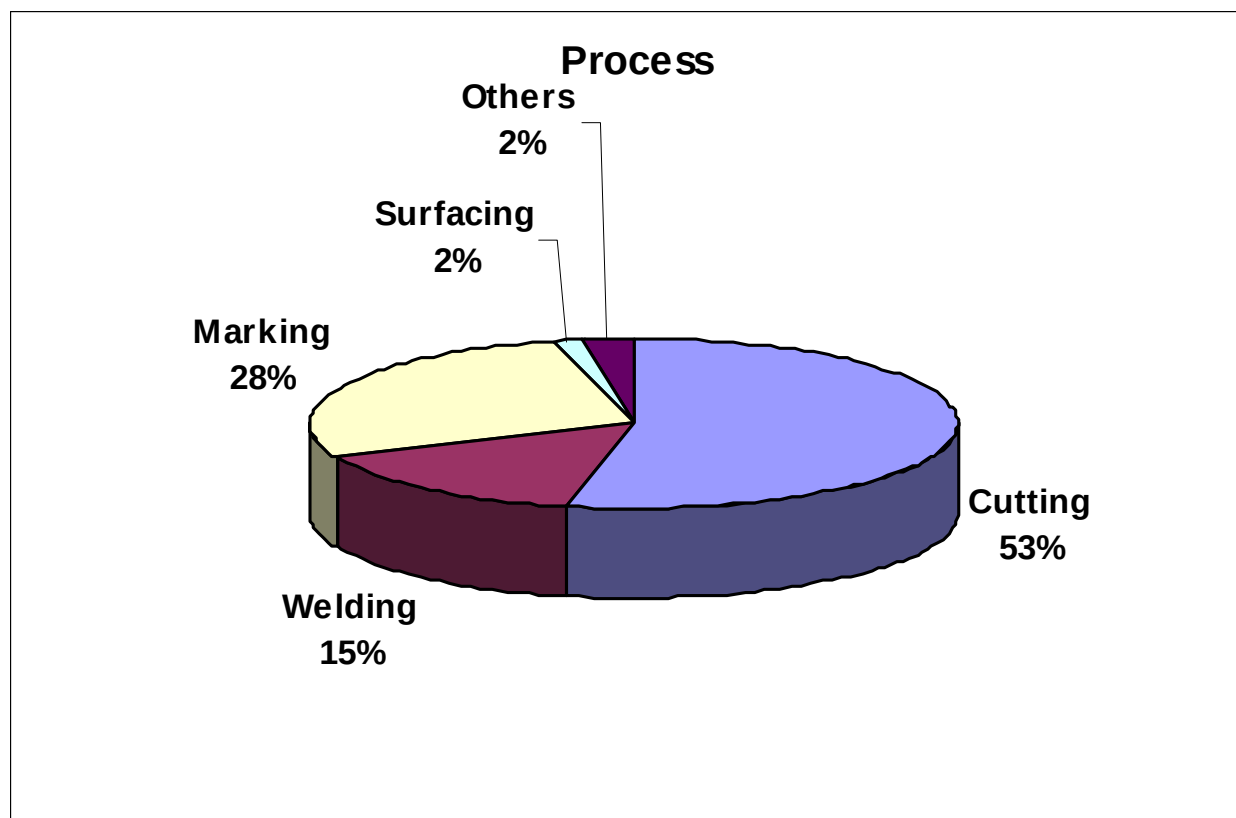
Finnish laser activity 2005 (total cumulated number)



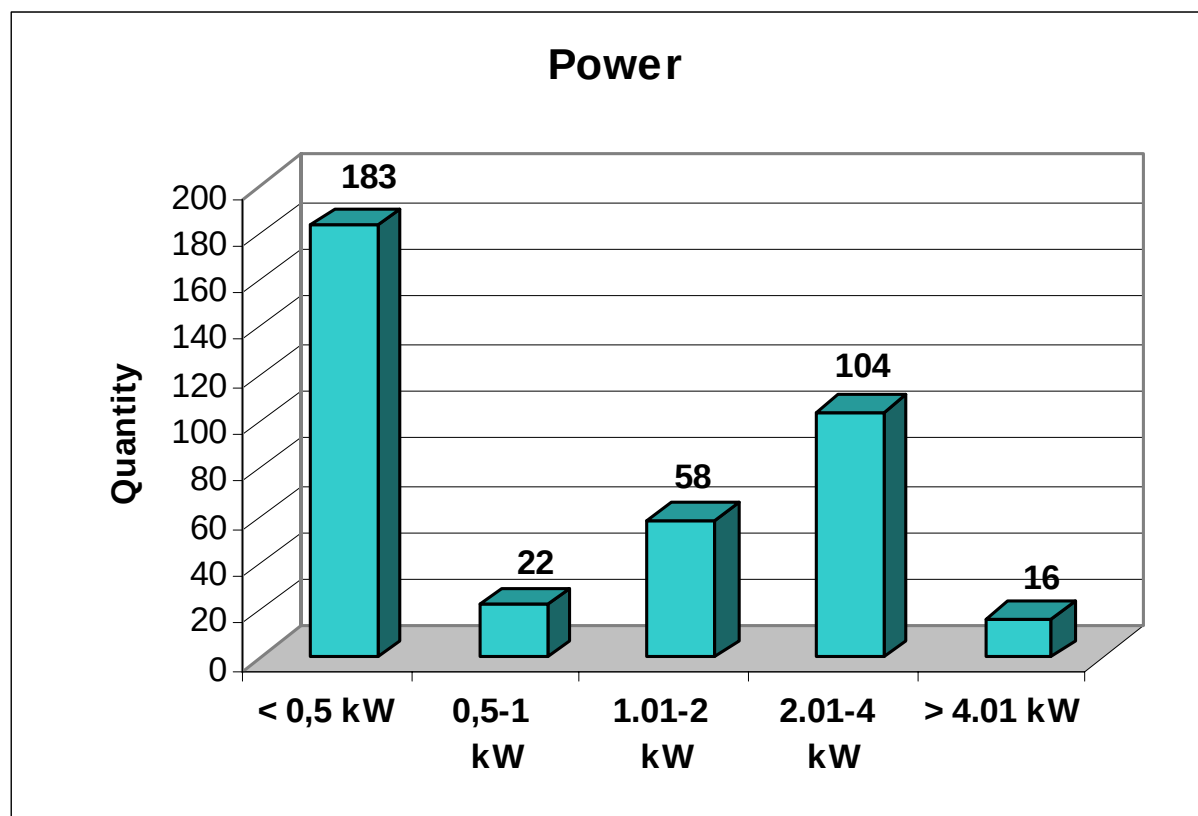
World markets (source Optec consulting)



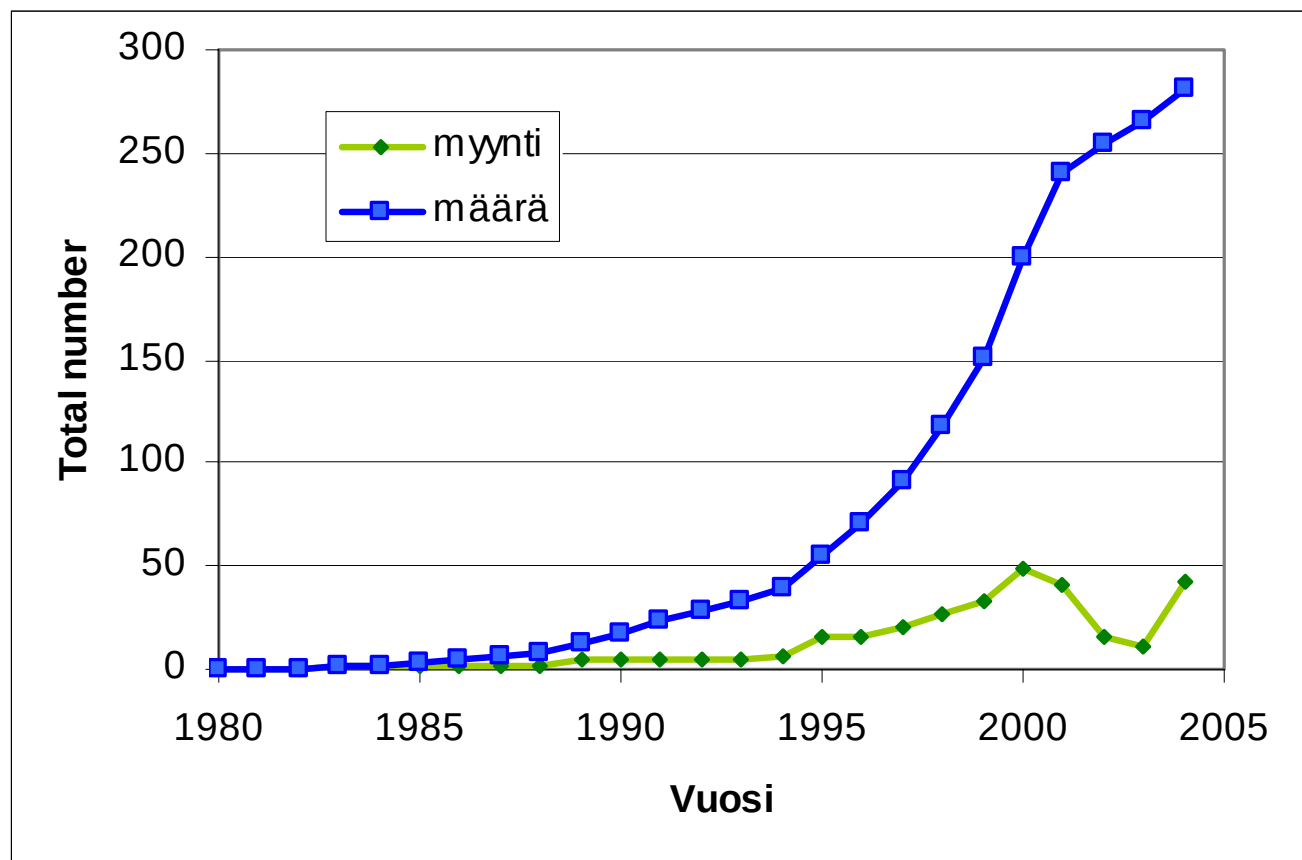
Finnish laser activity



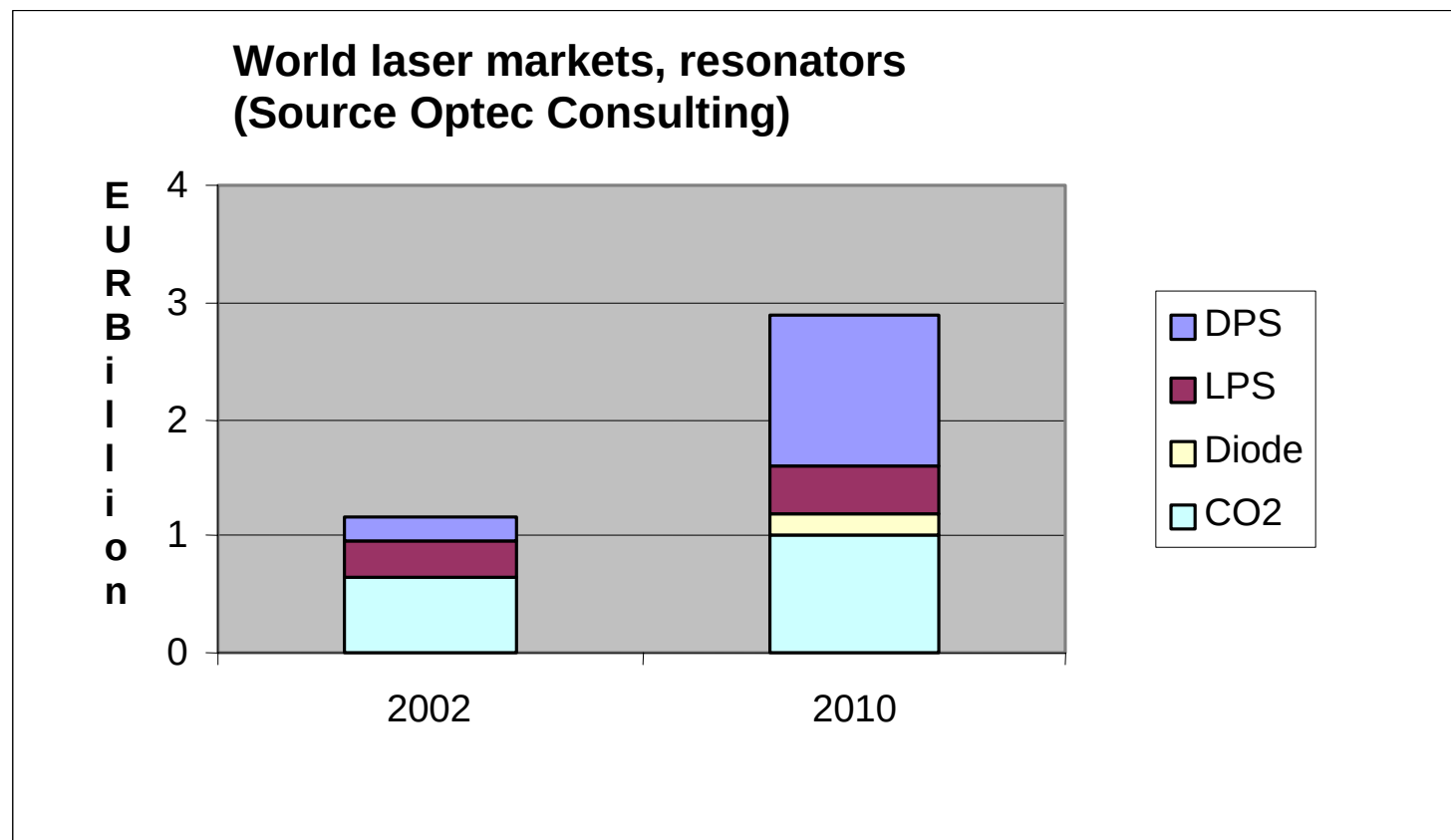
Finnish laser activity



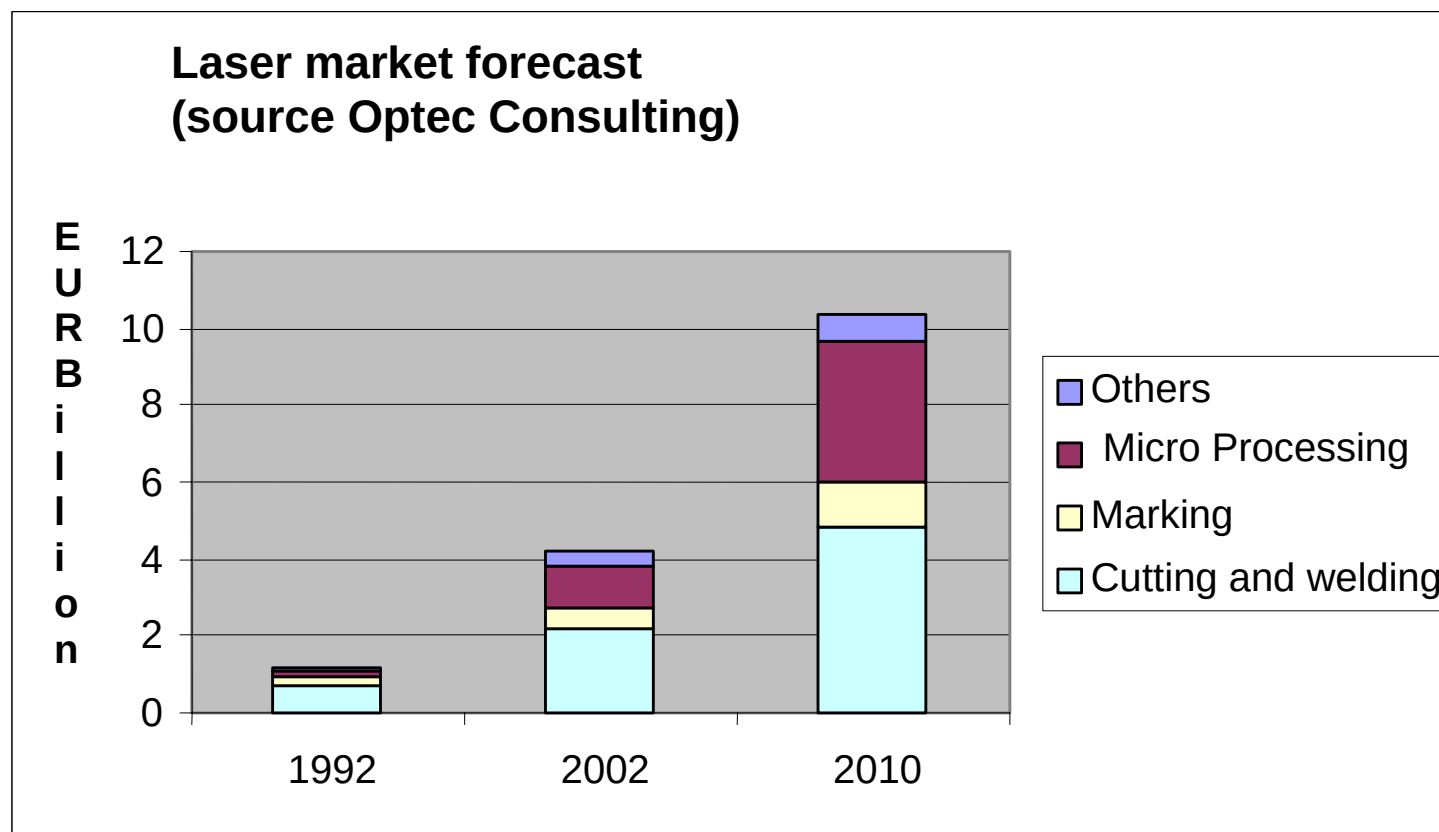
Finnish laser activity



World forecast on laser markets, resonators



Forecast on markets of laser system markets



Research activity in Finland, universities

- Lappeenranta Laser Processing Centre
 - Lappeenranta University of Technology
 - VTT Industrial Systems
- Tampere University of Technology

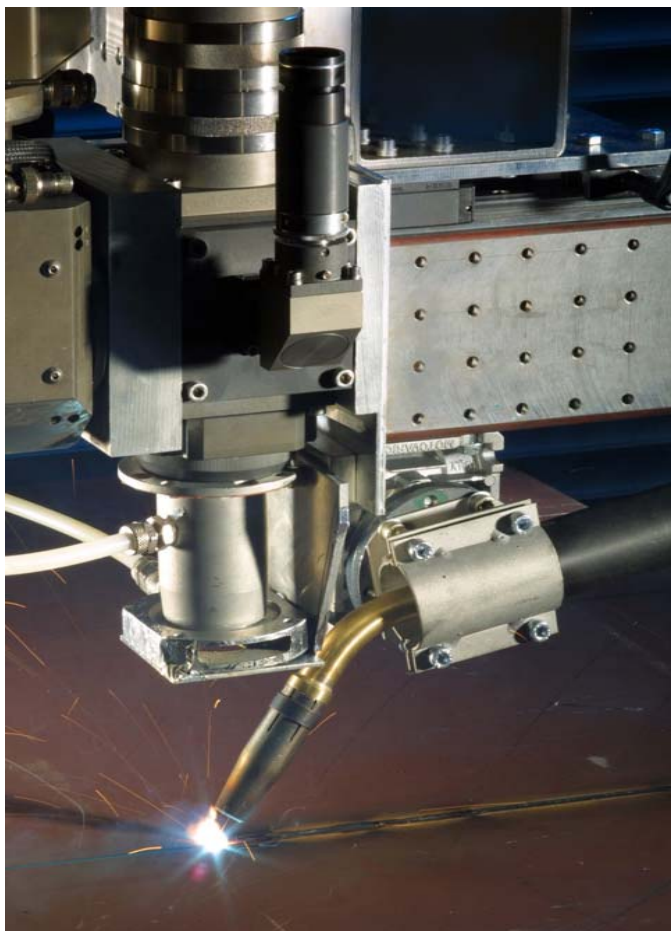
Schools in laser processing

- Laitila Innova center (Nd:YAG 4kW)
- Nivala (Yb:YAG Disk 4kW)
- Kokkola (Diode-pumped Nd:YAG 3,5 kW)
- Tornio (CO2 3 kW, 3d system)
- Turku machine center (Nd:YAG to be)
- Riihimäki (diode 3 kW)
- Lieksa (2,7 kW laser cutting)
- Keuruu (2,5 kW laser 3d cutting)

Hybrid laser welding

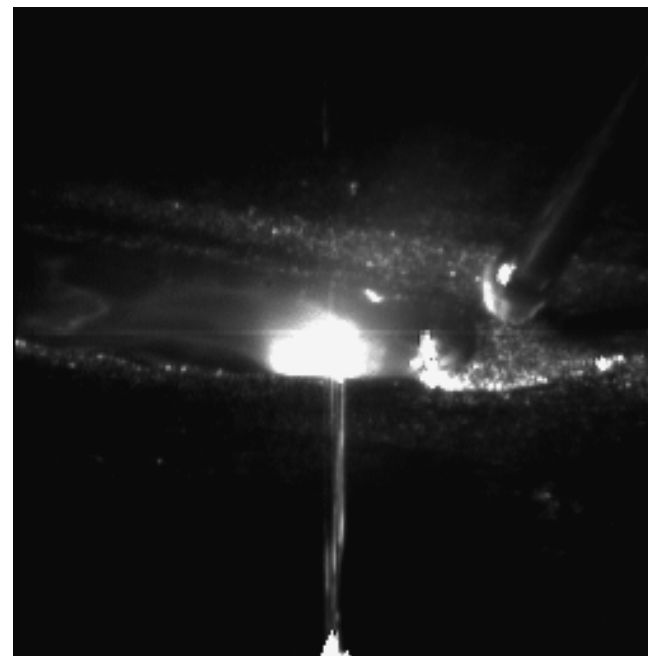
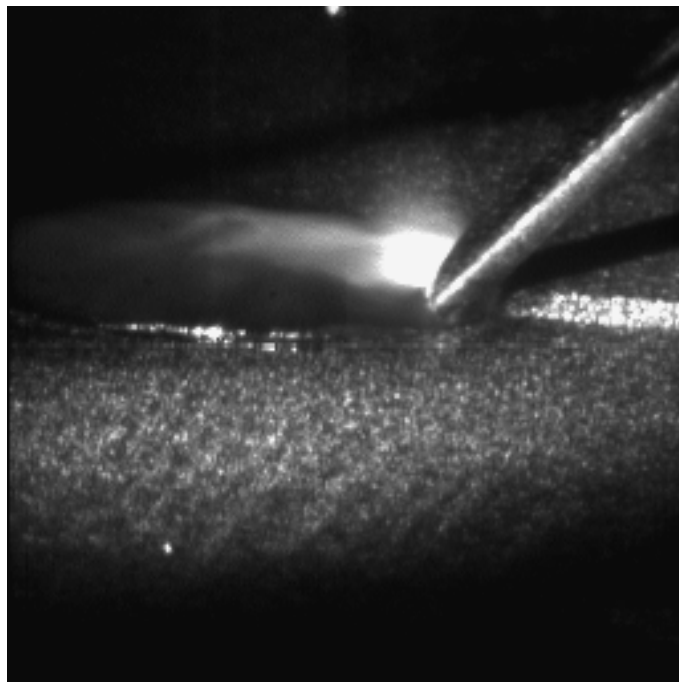


Hybrid Nd:YAG - MIG Welding

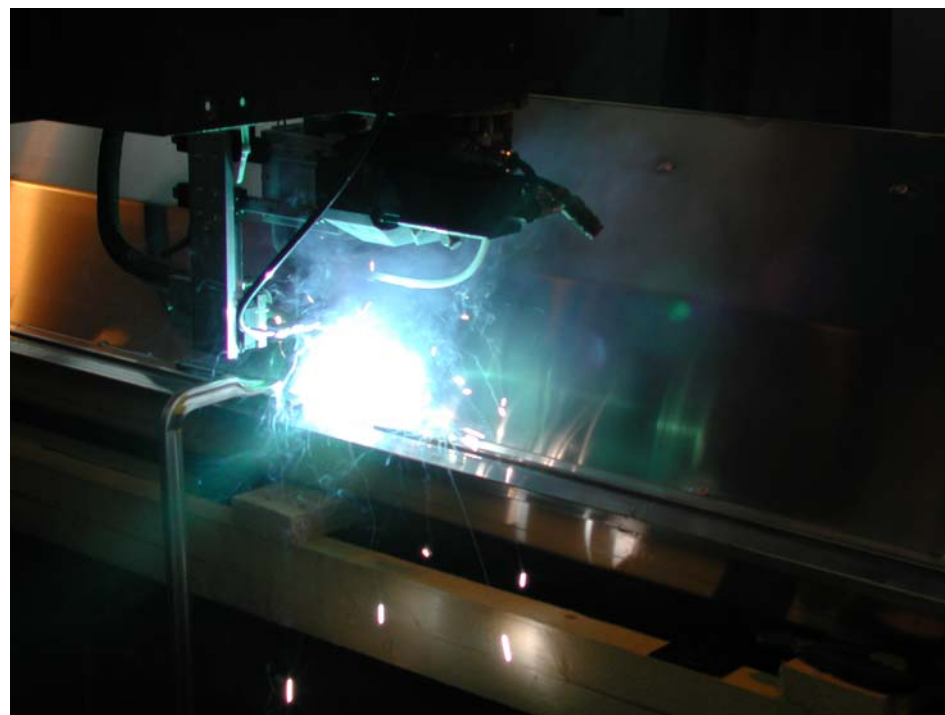
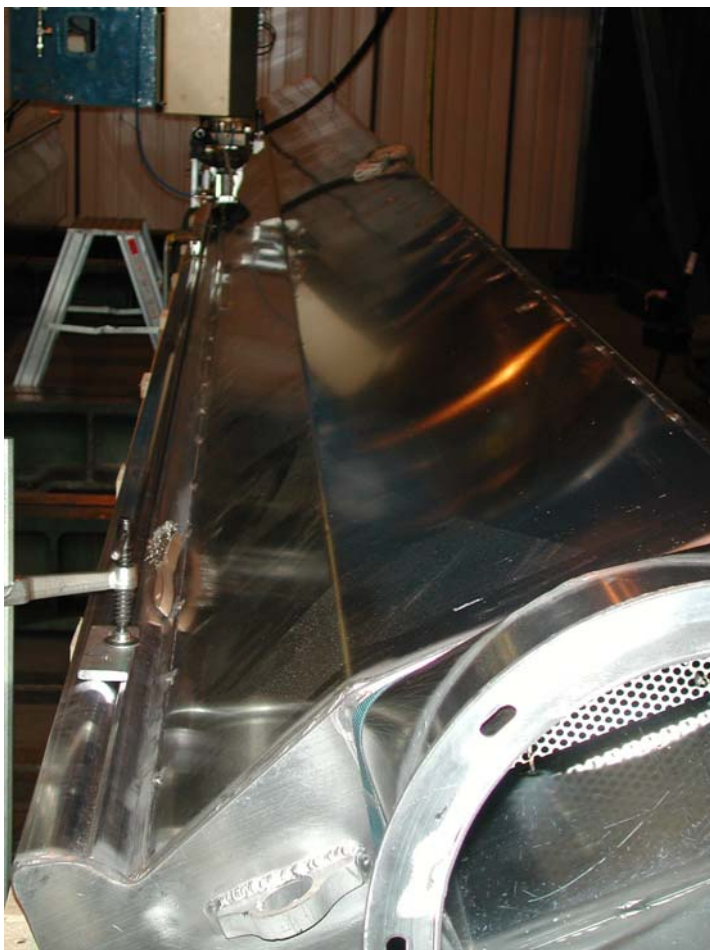


- Greater penetration
- Single pass I butt welds
- Nd:YAG laser welding of root face of Y-butt joint
- MIG filling of Y-butt joint
- Shipbuilding appns.

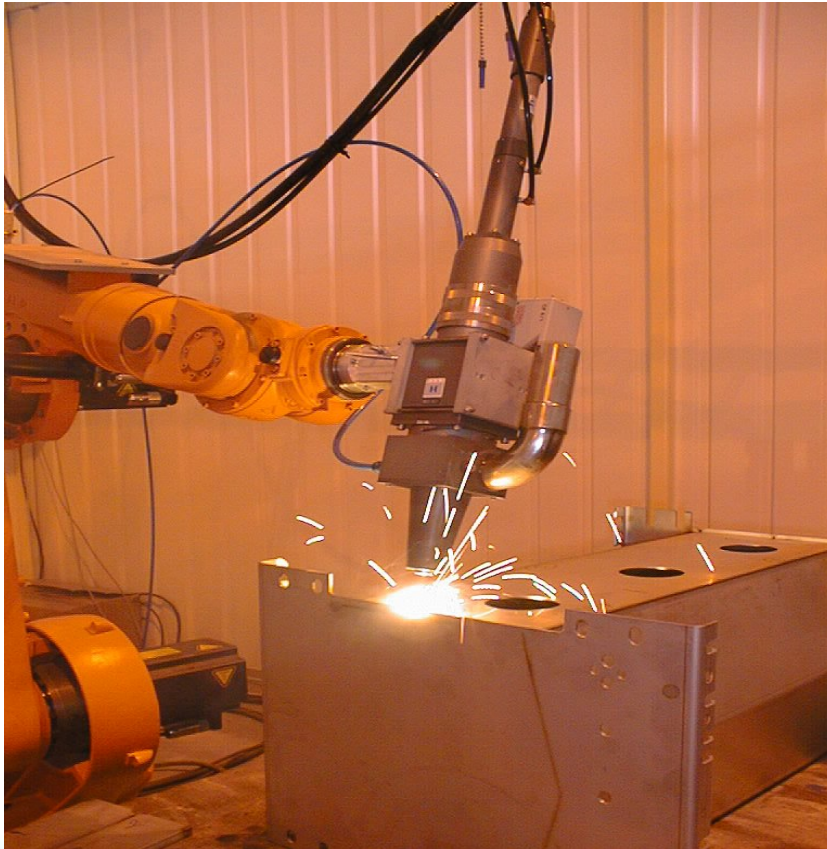
Filler metal welding



Aluminium hybrid laser welding



Nd:YAG laser beam welding



- Welding of complex geometries
- Penetration to 8 mm
- Low distortion
- High productivity

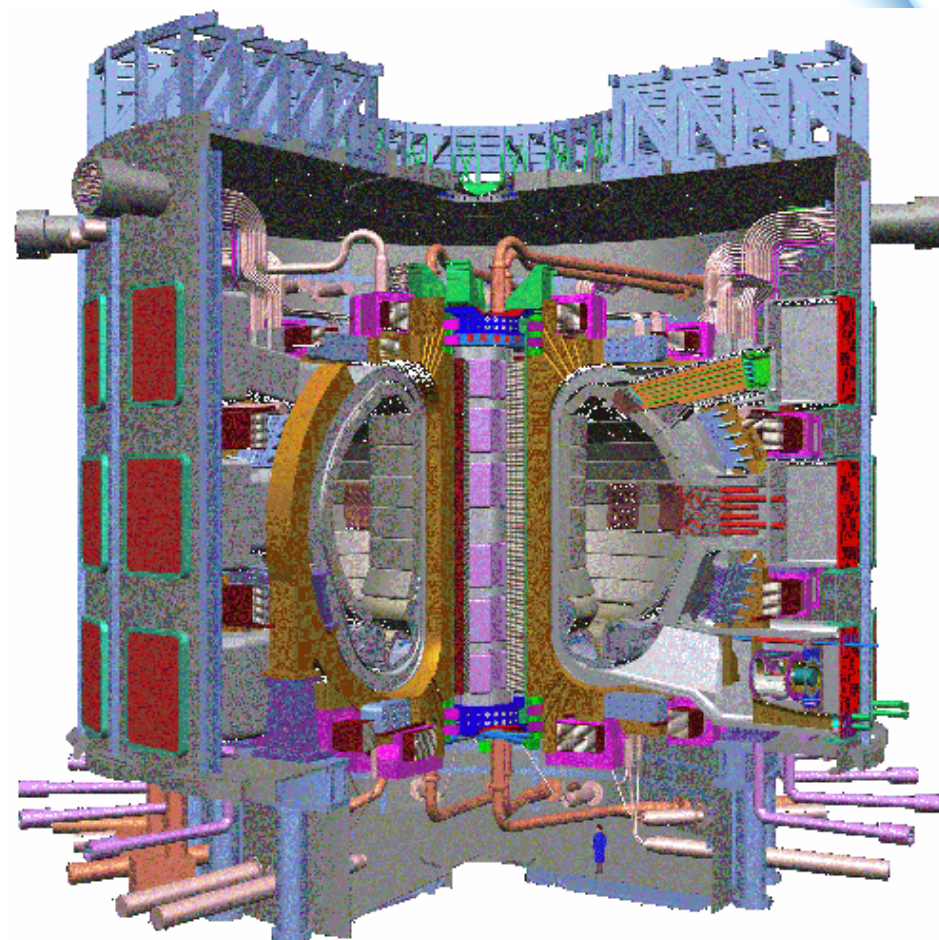
Laser welding of maintenance levels made of sandwich panels

- 2 maintenance levels made of 5 individual sandwich panels
- 7900...8370 mm x 896...1660 mm x 118 mm
- Roll-formed core
- Total 640 m of weld

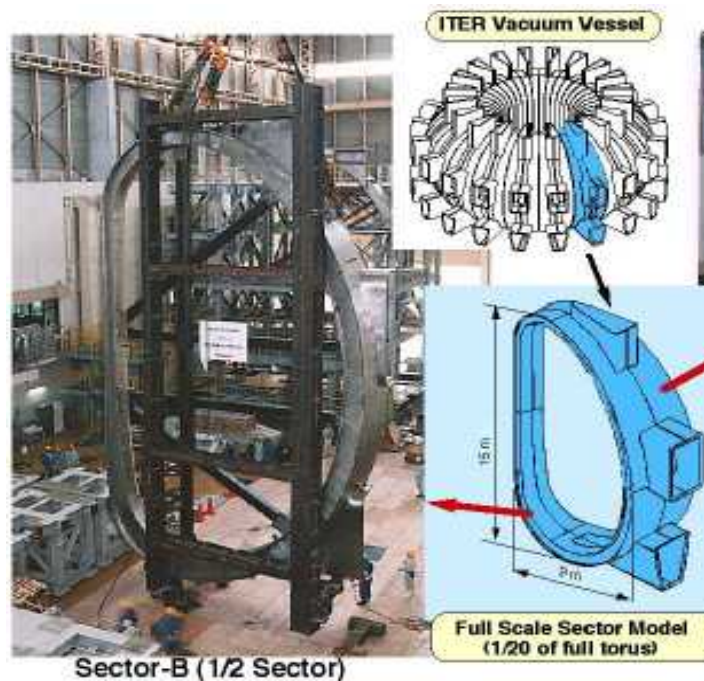


Multi-pass welds

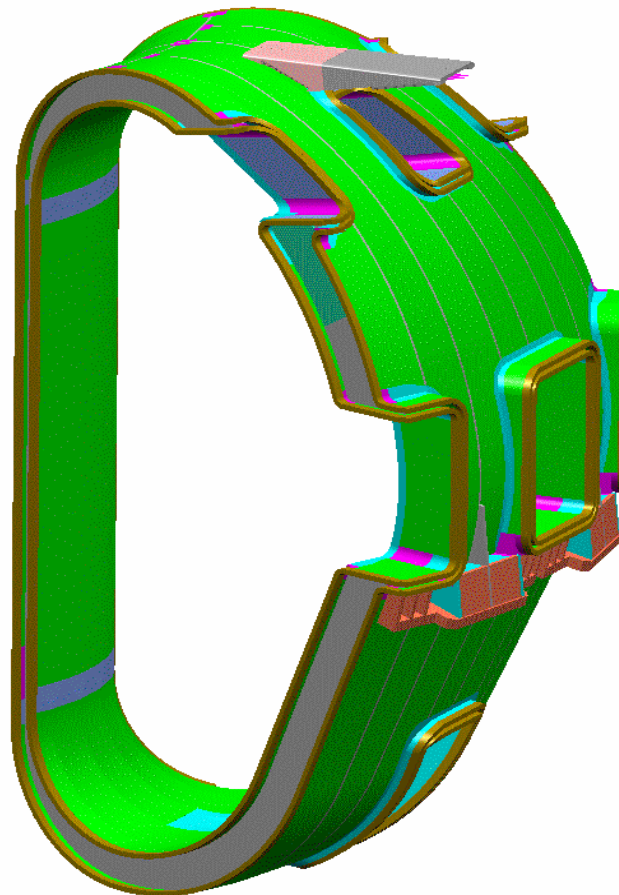
- Application for multi-pass welds is the development of fusion reactor ITER
- Vacuum vessel: 10 m high and 15 m wide, wall thickness 60 mm
- Demands: distortions below 1 mm



Vessel sector



View of full-scale sector model of ITER vessel in September 1997 with dimensional accuracy

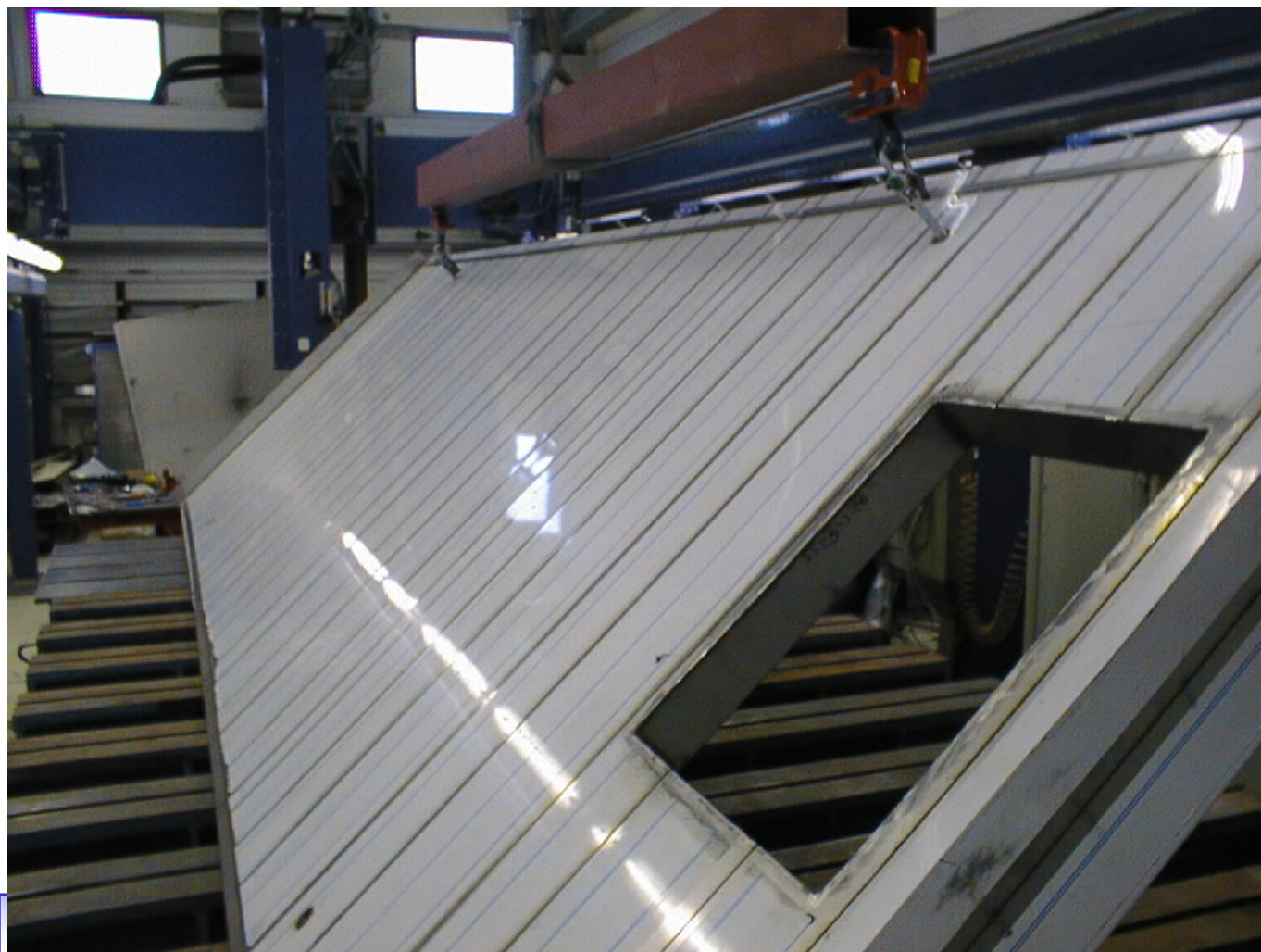


Multi-pass welds

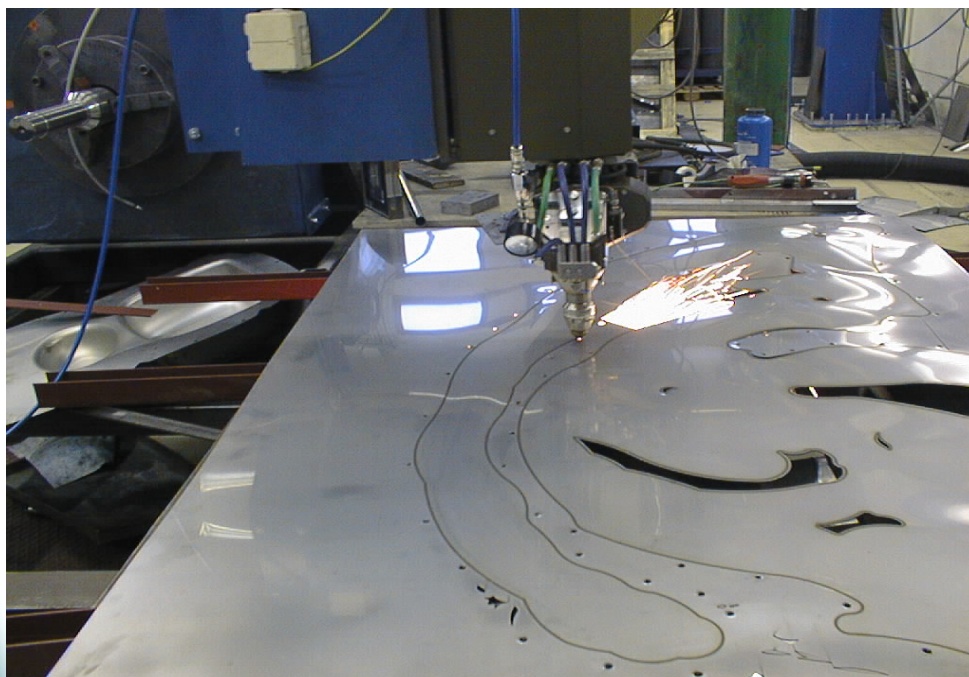
- Caused by the huge size, the vacuum vessel of fusion reactor will be installed on-site -> position welding is essential



Case 2: Laser welding of a water guidance panel



CO₂ laser beam cutting



- Stainless steel artwork
- Rapid CAD - workstation transfer of designs
- Flexible cutting of large parts

Laser beam cladding



- Rotor blades from pulp screening drum
- Stellite clad edges
- Low distortion
- High tolerances
- Reduced final machining



Laser beam hardening

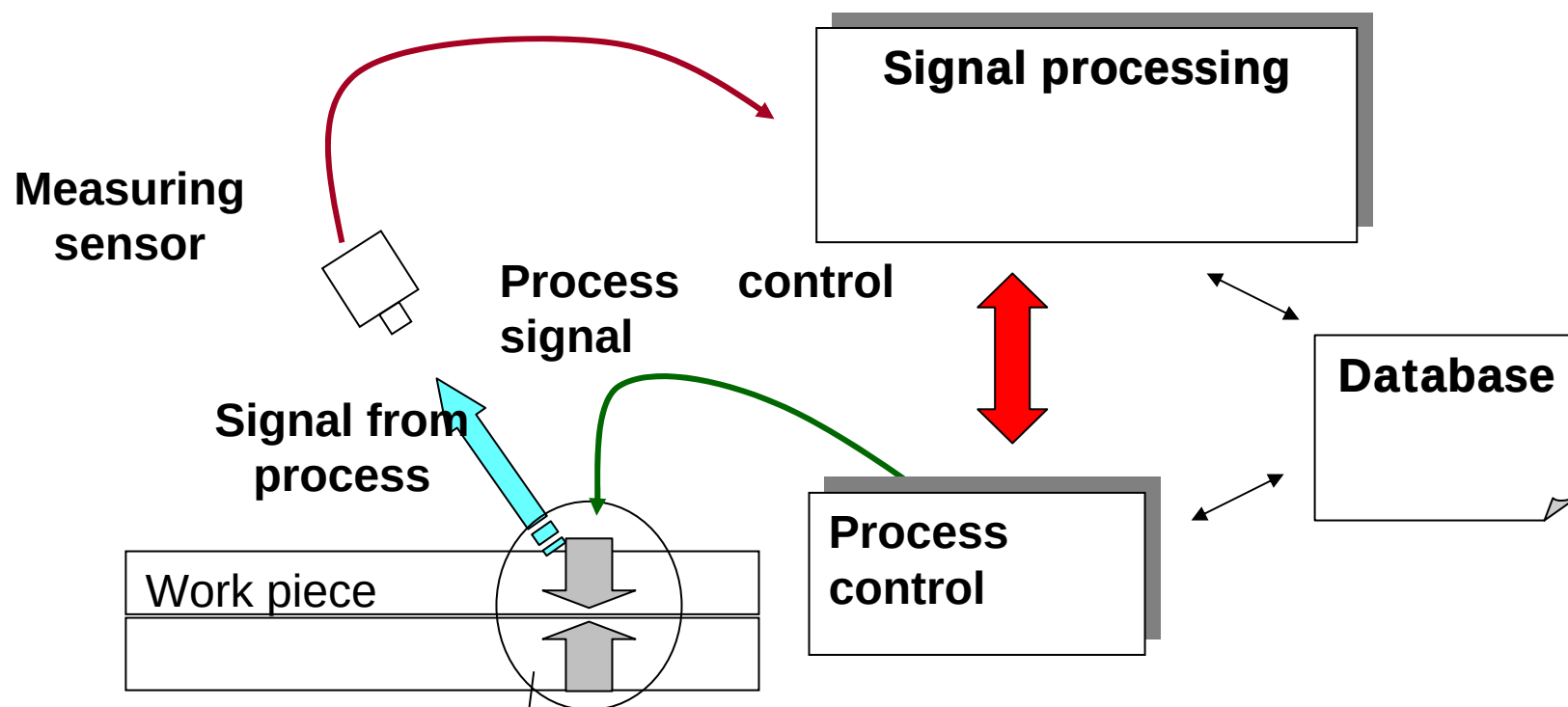


- Cast iron cylinder lathe slide
- Transformation hardened surface
- Flexible hardening geometries
- Hardening of discrete areas



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Adaptive laser welding



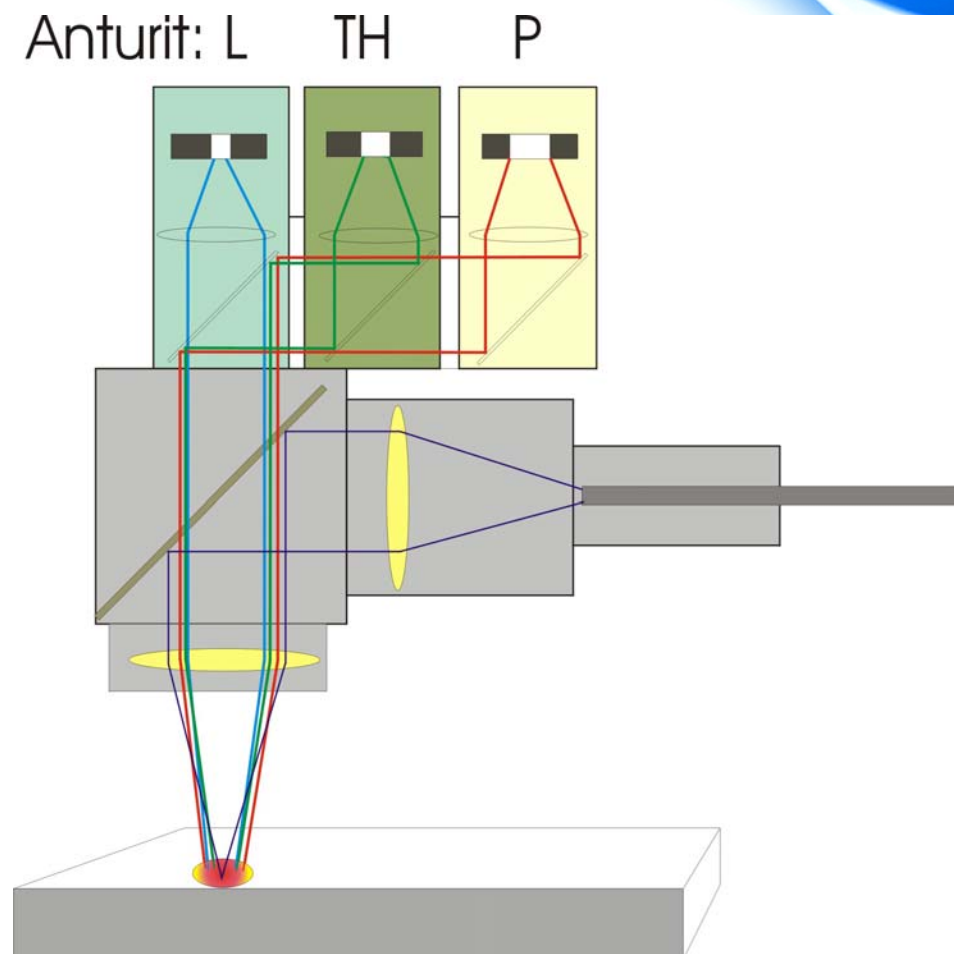
Laser welding process

LLPC

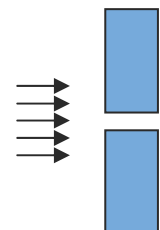
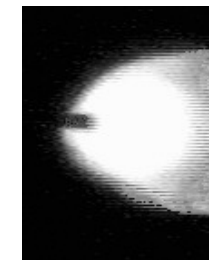
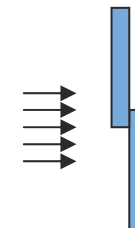
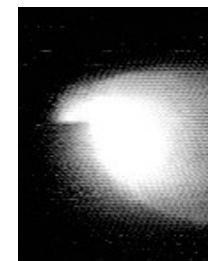
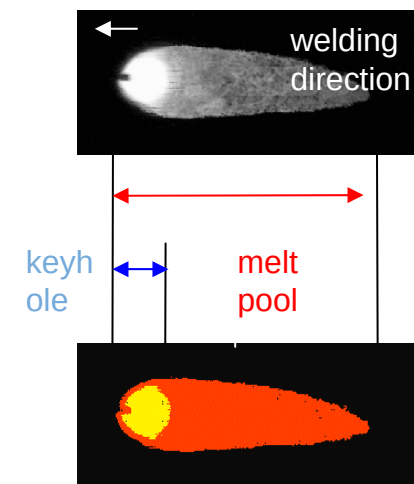
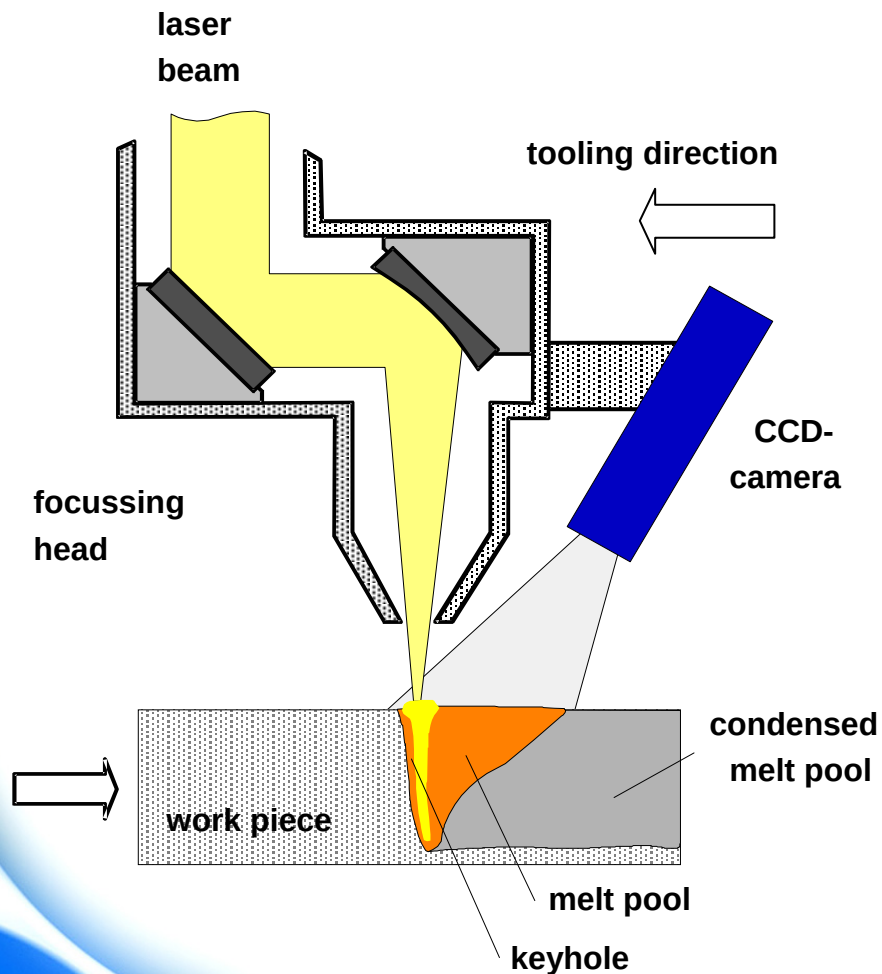
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Sensors

- Sensors possible to use
 - temperature
 - reflection
 - plasma intensity
- Measuring coaxial with the laser beam



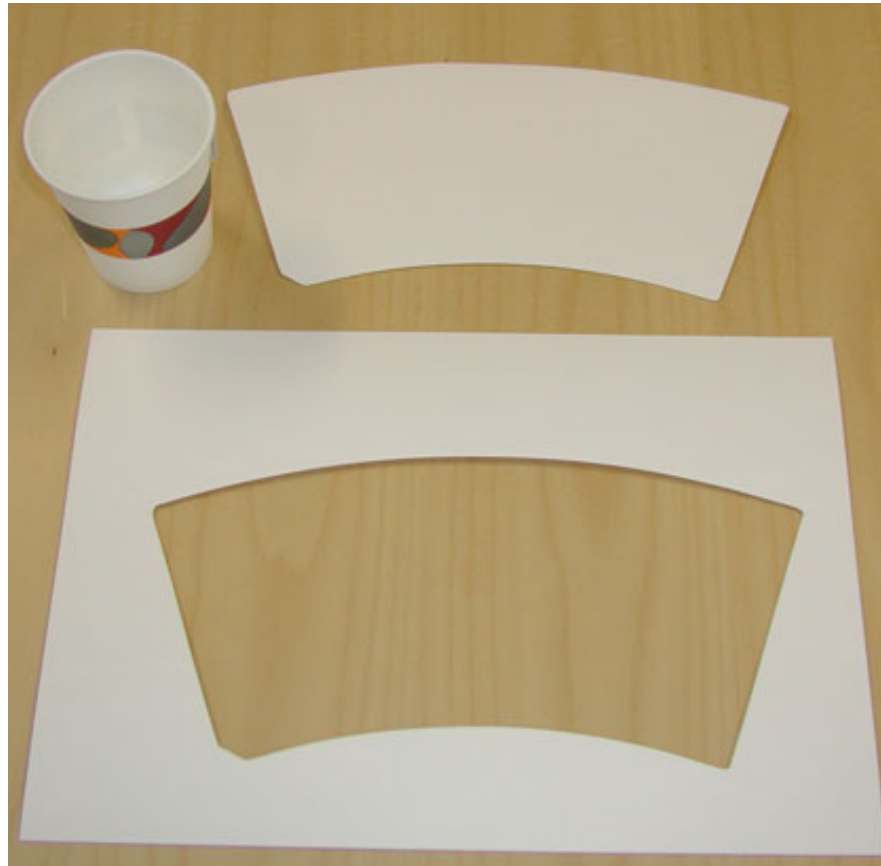
CMOS camera



Laser cutting in the modern packaging process



Case Cup



PROJECTS, Networking

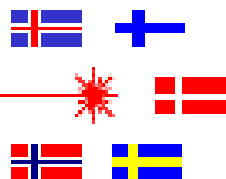
ELI, European Laser Institute (LUT, 15 Eur. Institutes)

EULASNET (LUT, 50 European Institutes)

NOR-LAS, Nordic Laser Network (LUT, 6 Nordic institutes)

Minutes GA3- 15.06.2004 – p.1/3

NORLAS



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Industrial applications

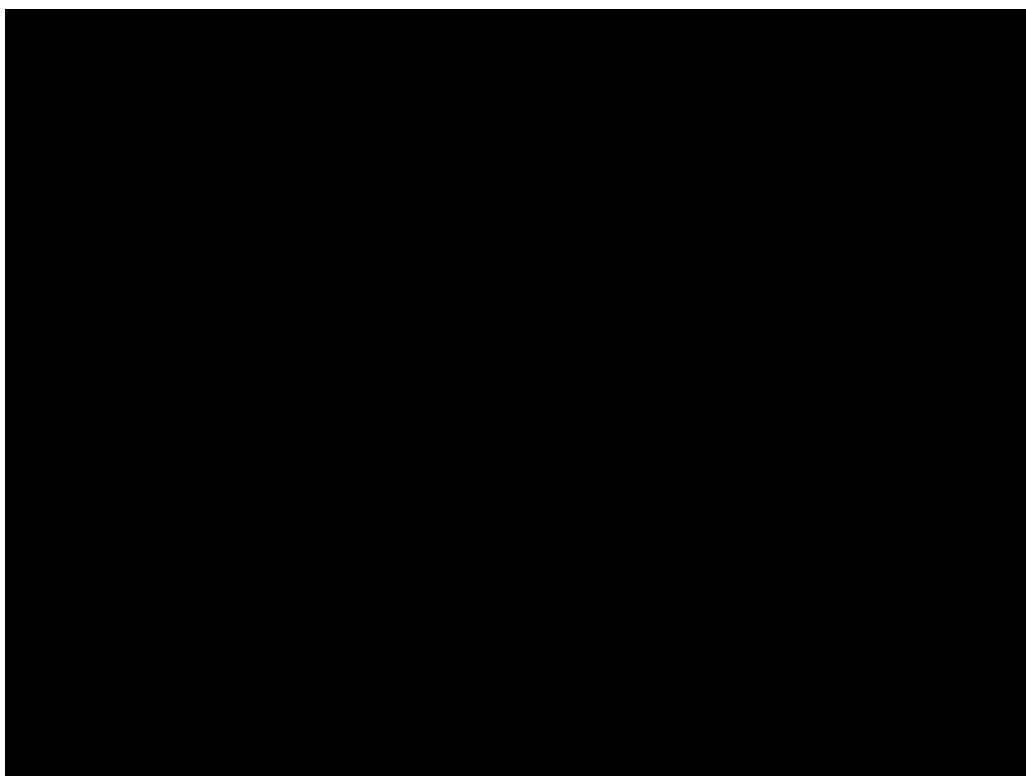


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CO₂ laser cutting manufacturing

- Finnpower, Kauhava

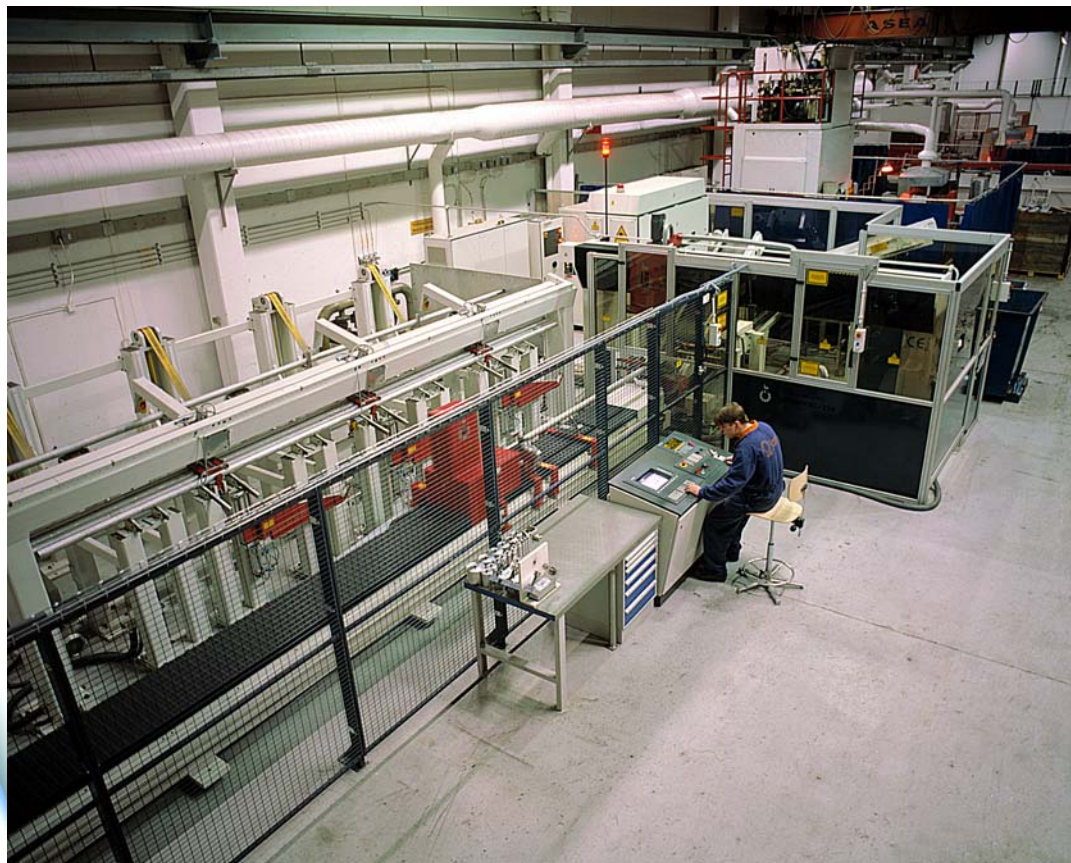


CO₂ laser beam welding of stainless steel tubes



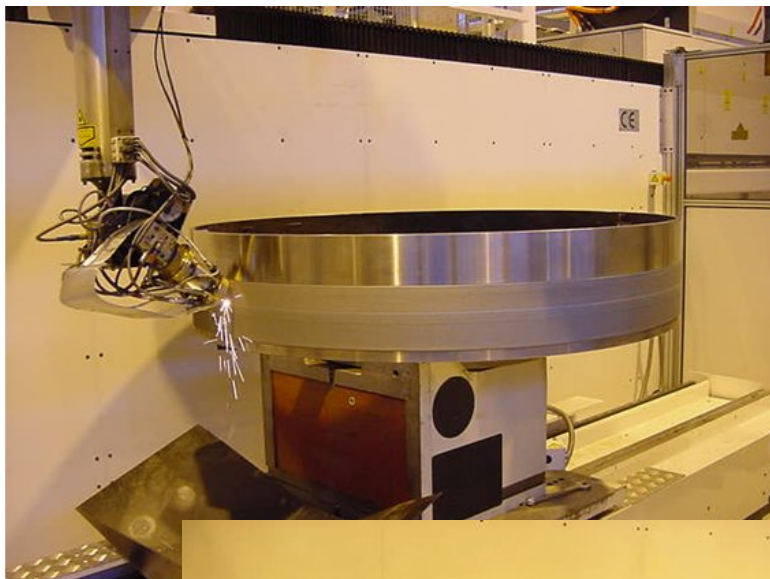
- Outokumpu Stainless Tubular Products, Pietarsaari

CO₂ laser beam cutting of stainless steel tube bend blanks

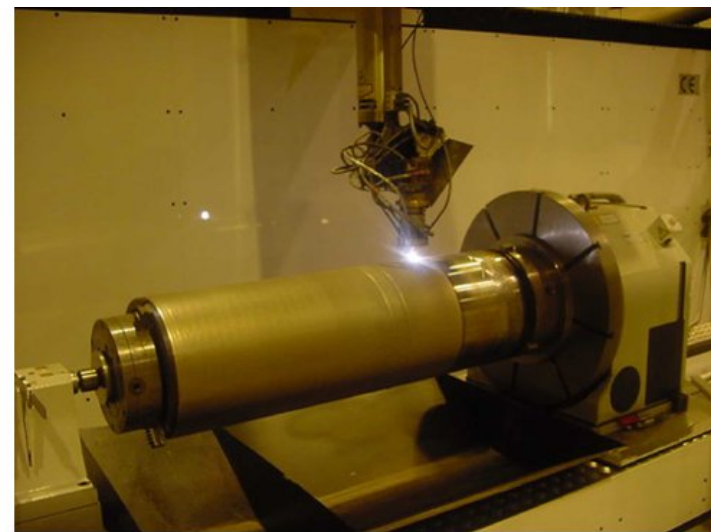
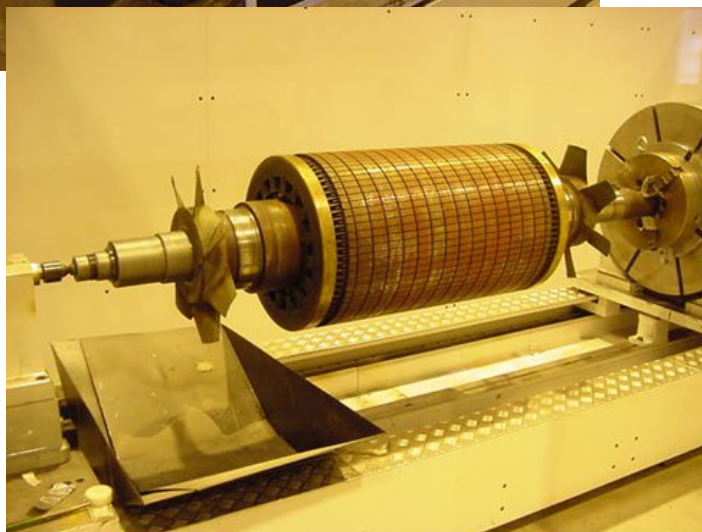


- Outokumpu Stainless Tubular Products, Pietarsaari

CO₂ laser cladding



- Kokkola LCC, Kokkola



CO₂ laser beam cutting of glass



- Laser cutting of monitors (Proventia Automation Oy, Forssa, world patent)

Diode laser welding of catalytic converters

- Ecocat Oy, Vihtavuori



Other industrial welding applications

- Laser panel factory (3 laser cutting and welding systems), Mizar, Uusikaupunki
- Laser welding subcontracting companies
 - High Metal Production, Vantaa
 - LaserPlus, Riihimäki
 - ProLaser, Savitaipale and Riihimäki
 - Laserle, Vantaa
 - Veslatec, Vaasa
- Filler metal welding of steel foils in RAP line (Outokumpu Stainless, Tornio)

National Networking in laser processing

- Beam Processing Club (under Finnish Welding Society)
- Laser Forum (to be started)

Conclusions

- In Finland there are about 500 lasers in laser processing
 - 250 CO2, 150 Nd:YAG, 6 Diode
 - Cutting and marking are the most usual processes
- Some quite new application in welding, cutting and cladding
- In research, Lappeenranta Laser Processing Centre most active