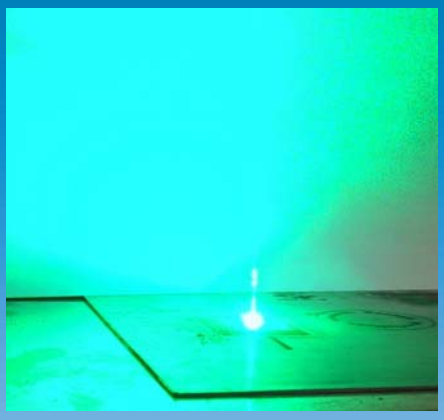
Laser-
möjligheternas teknik



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Vad används lasrar till ??

- Bearbetning
- Mätning
- Kommunikation
- Informationslagring
- Medicinsk teknik

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Bearbetningsprocesser

- Skärning
- Svetsning
- Ythärdning
- Omsmältning
- Påsvetsning
- Upplegering
- Ytimpregnering
- Märkning
- Gravering
- Borrning
- Scribing
- Mikrobearbetning
- Rapid Prototyping
- Formning
- Laser Assisted Machining
- Rengöring
- Polering

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Lasermarknad 2007

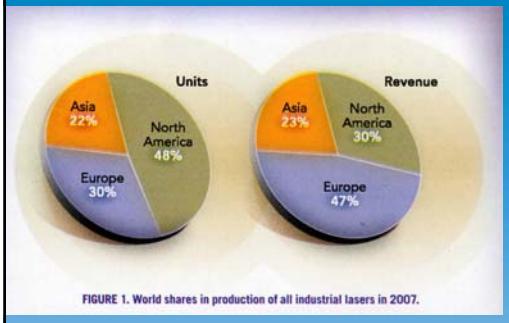

FIGURE 1. World shares in production of all industrial lasers in 2007.

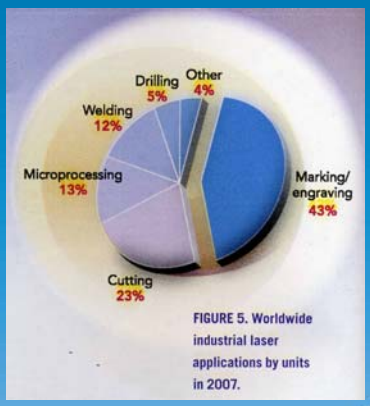

FIGURE 5. Worldwide industrial laser applications by units in 2007.

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MÖJLIGHETERNAS TEKNIK

Teknik

- Minimal energitillförsel
- Kontaktlös bearbetning
- Flexibel
- Lätt att styra
- Bearbetning av olika material
- Hög kvalitet

Ekonomi

- Ökad produktivitet
- Minskade material- och processkostnader
- Minskat arbetskraftsbehov
- Högre produktkvalitet
- Minskad/eliminerad om- och efterbearbetning
- Bättre arbetsmiljö
- On-line produktion
- Snabba omställningar
- En laser- flera processer
- Produktförbättringar

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Laserskärning

Flexibilitet

Produktivitet

Kvalitet

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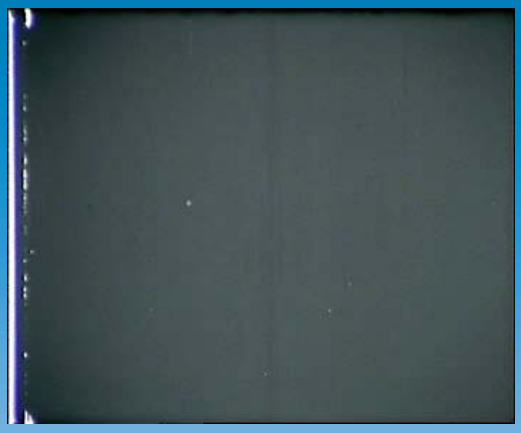
007



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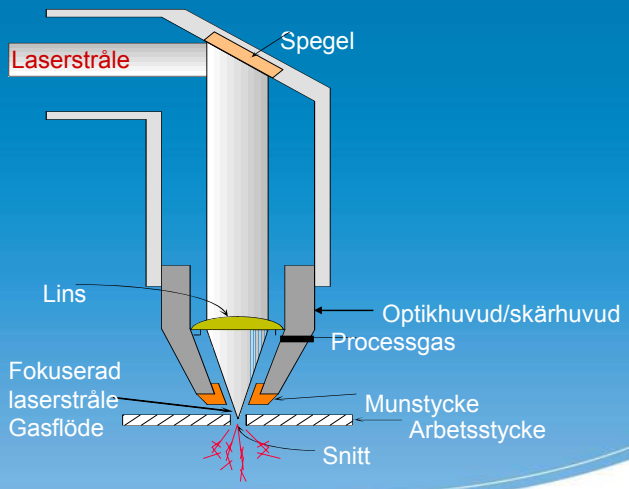
Laserskärning - princip



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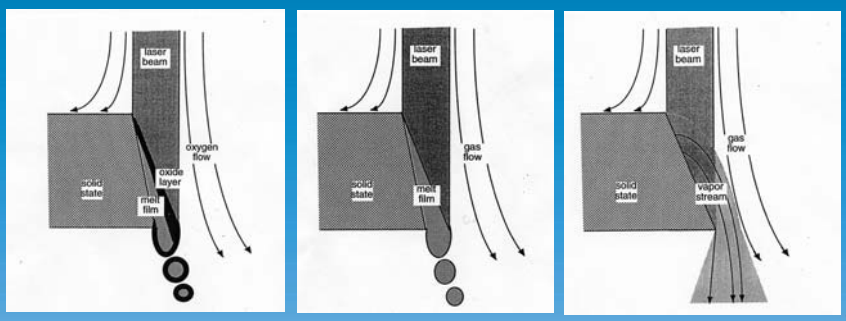
Laserskärning - processer

Brännskärning | Smältskärning | Sublimerskärning



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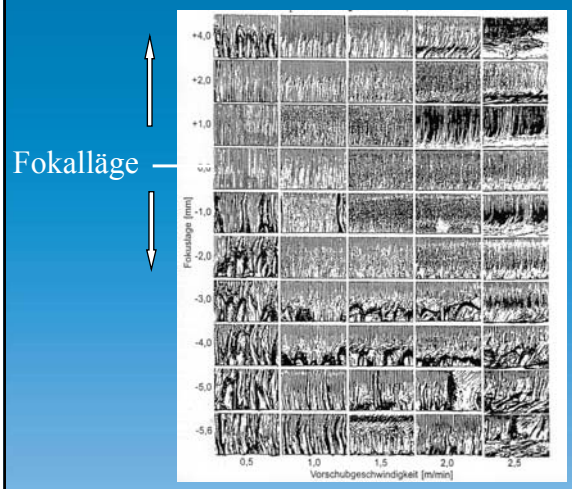
Processfönster



Fokalläge

Skärhastighet

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Skärparametrar

- **Utrustning**
  - Lasertyp, våglängd
  - Effektområde
  - Kontinuerlig (CW) /pulsad stråle
  - Intensitetsfördelning i strålen (strålkvalitet)
  - ”Produktionssystem”
- **Process**
  - Effekt
  - Skärhastighet
  - Fokallängd
  - Fokalläge
  - Skärgas typ/flöde
  - Kontinuerlig eller pulsad stråle
  - Typ av munstycken

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Laserskärning av 3D- detaljer

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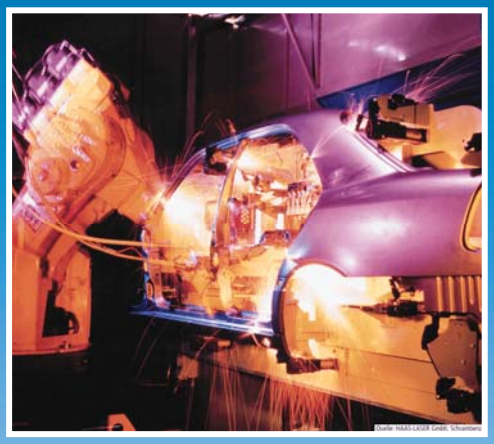
Laserskärning med Nd:YAG- laser och industrirobot



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Rör- och profilskärning

..\Videos\Rörskärning AdigeLT722.wmv

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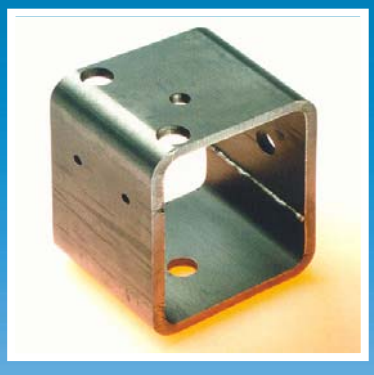
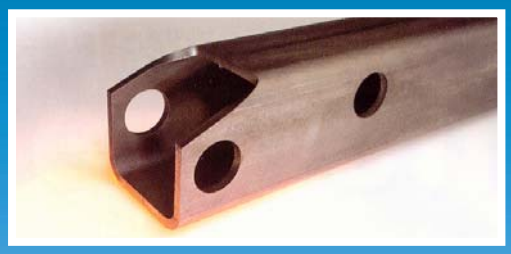
Rör- och profilskärning





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Lasersvetsning

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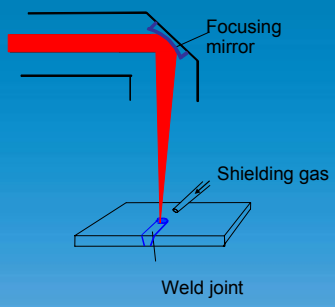
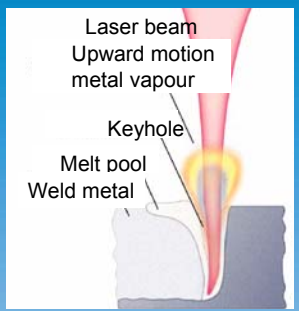
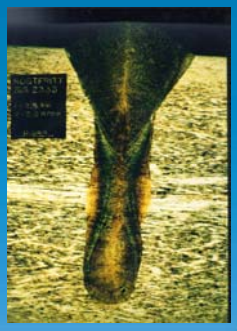
Lasersvetsprocessen







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För- och nackdelar med lasersvetsning

Fördelar

- Liten värmetillförsel
- Hög svetshastighet
- Smal och djup svets
- Kontaktlös
- Inget tillsatsmaterial
- Enkel automatisering

Nackdelar

- Höga precisionskrav
- Snabb stelning
- Hög investeringskostnad

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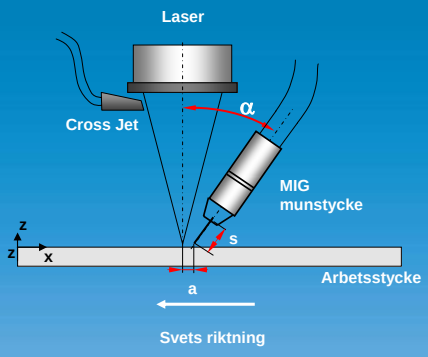
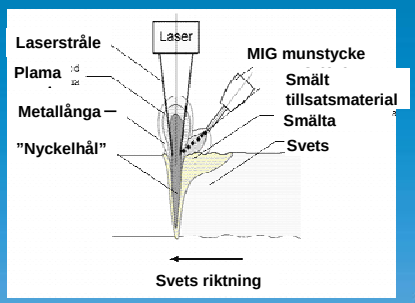
Laserhybridsvetsning





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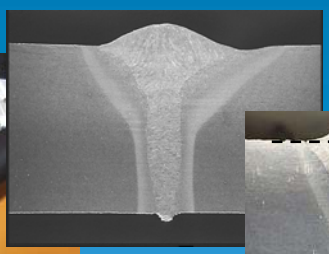
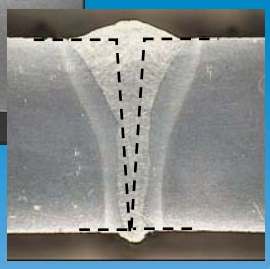
Laserhybridsvetsning





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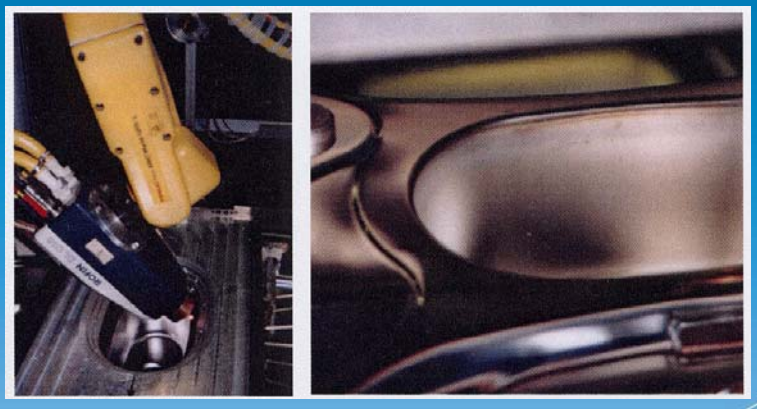
Svetsning med diodlaser



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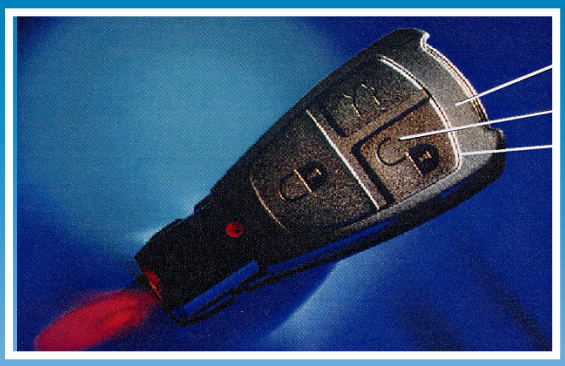
Svetsning polymerer med diodlaser



Hus för elektronik

Lock med tryckknappar

Svetsfog

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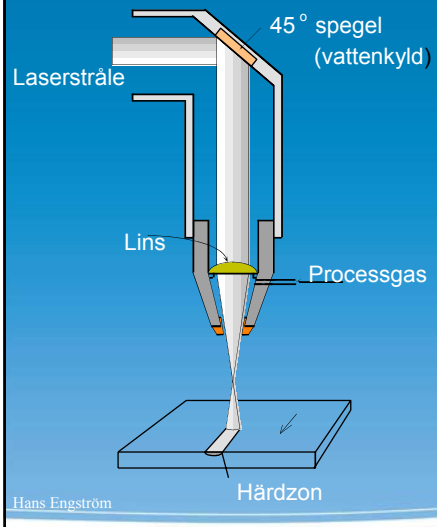
Laserhärdning



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Härdning med diodlaser

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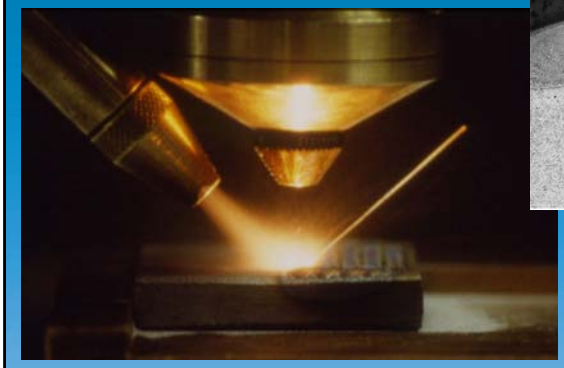
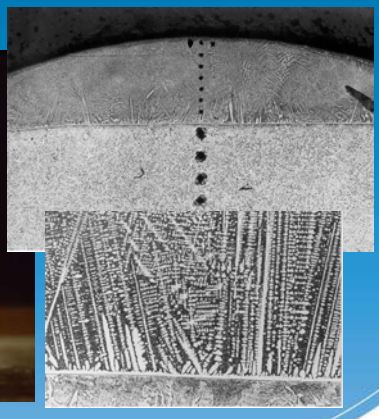
Laserpåsvetsning





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Märkning

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VOLVO
LASER LASERGRUPPEN

L ight

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R adiation

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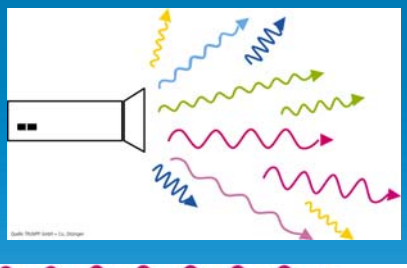
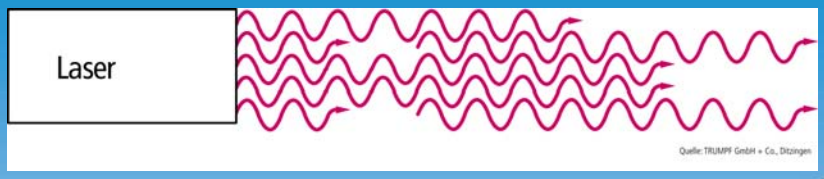
PERMANOVA Lasersystem ab
TRUMPF
VOLVO
LASER LASERGRUPPEN

LASERLJUS





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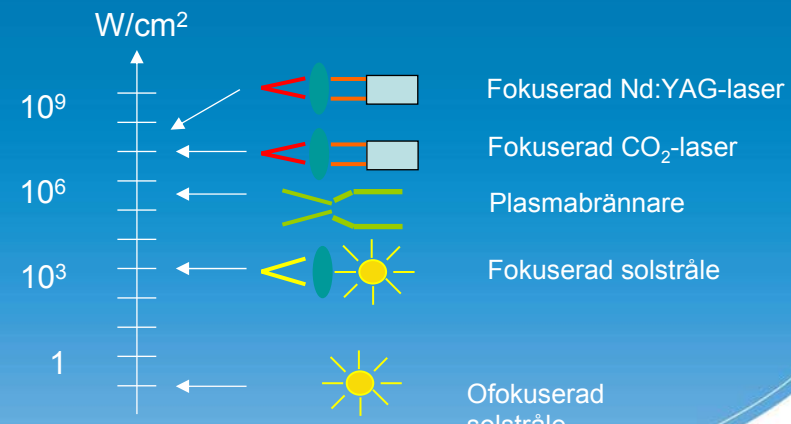
Effekttäthet för olika strålkällor



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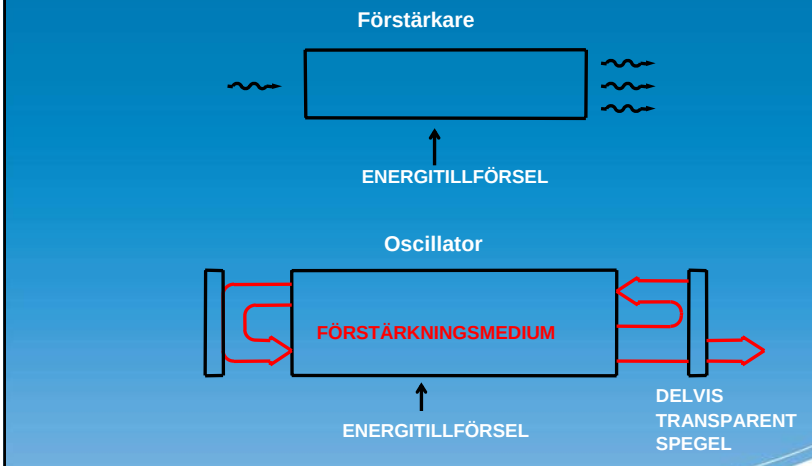
Light Amplification....



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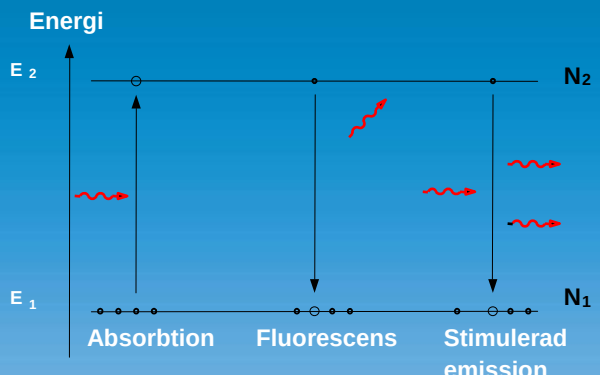
LA....Stimulated Emission of Radiation



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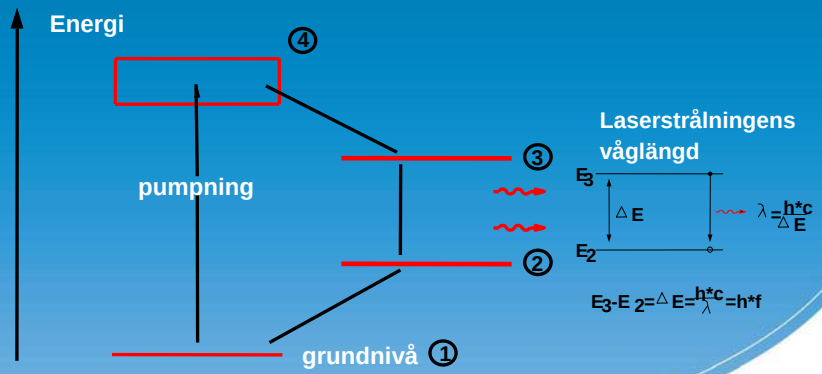
Energinivåer i en laser



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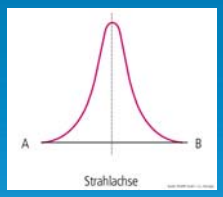
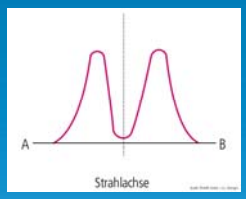
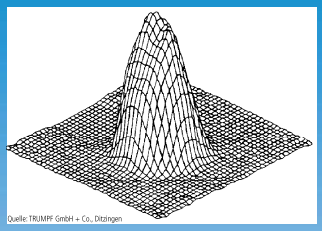
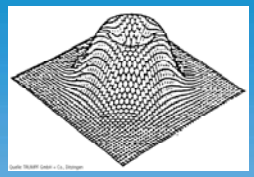
Laserstrålen









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Fokusering av laserstrålen

Stråldiameter

$d_s \sim f\,\theta \sim \lambda\, f/\pi w_0$

λ= våglängd

f= fokallängd

w_0= radie i strålens midja

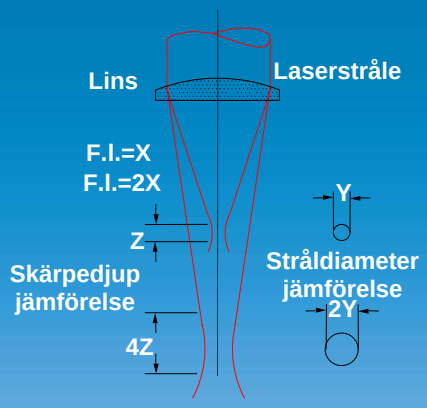
θ = divergens (halv-vinkel)

Strålkvalitet

$K = 4\,\lambda / \pi w_0\,\theta = 1/M^2$

eller

$\theta\, w_0$



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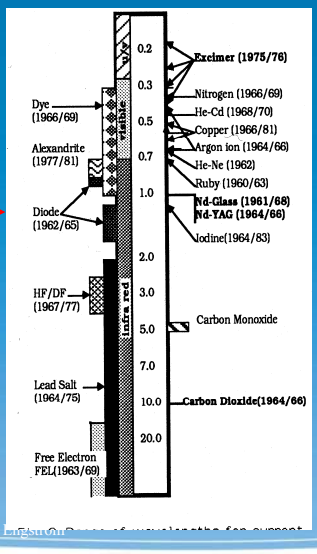
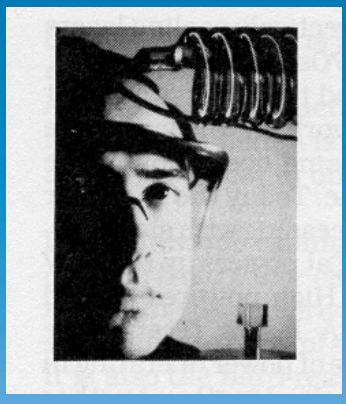
Lasertyper



Fiberlaser
Skivlaser



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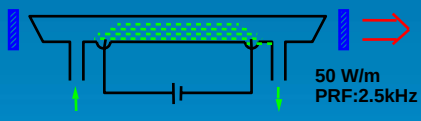
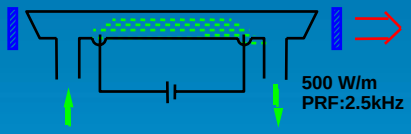
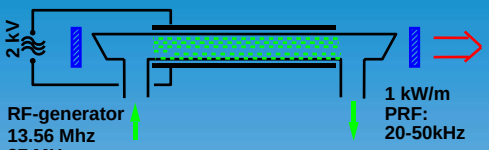
Grundkonstruktioner CO_2-lasrar



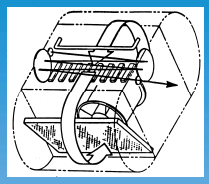
Långsamt axiellt gasflöde, axiell urladdning



Snabbt axiellt gasflöde, axiell urladdning



Snabbt axiellt gasflöde, RF-excitation



Snabb transversell

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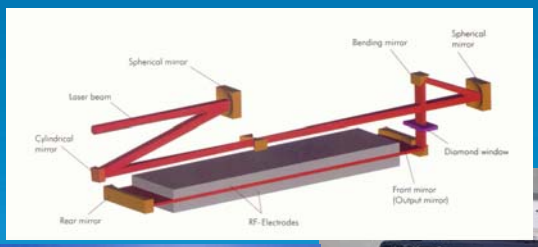
CO_2- ”slab” laser



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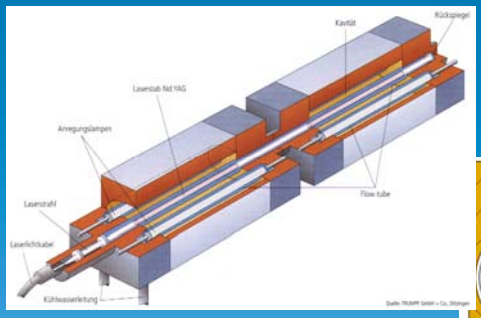
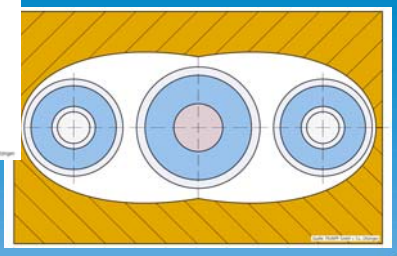
Nd:YAG- laser





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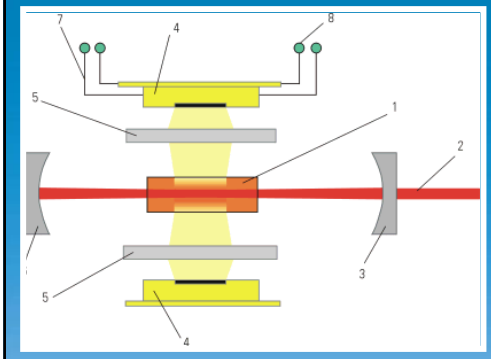
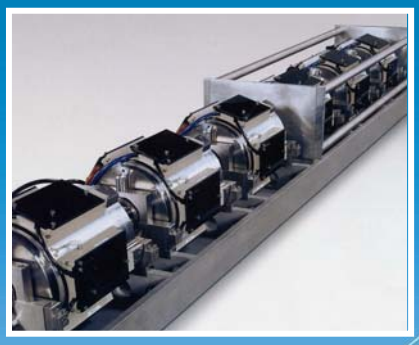
Diodpumpad Nd:YAG- laser





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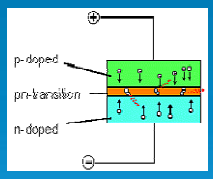
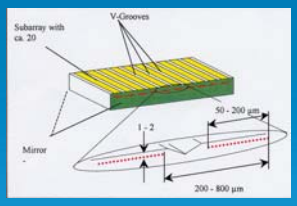
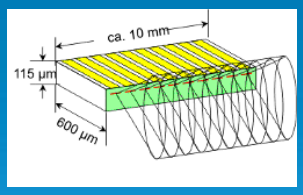
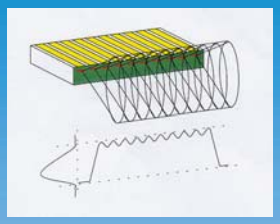
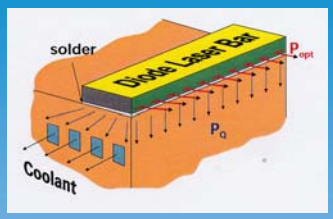
Diodlaser

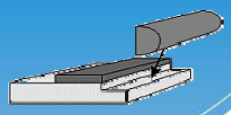






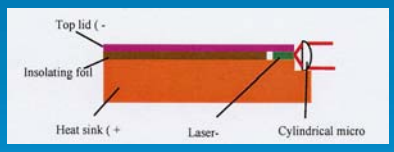


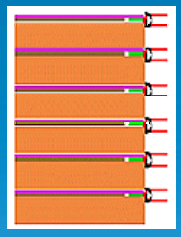


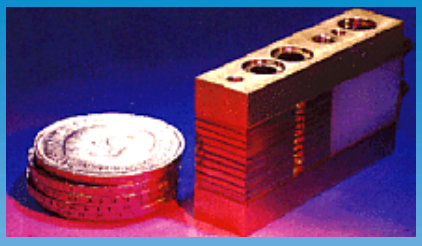


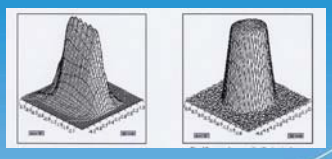
Hans Engström

Diodlaser









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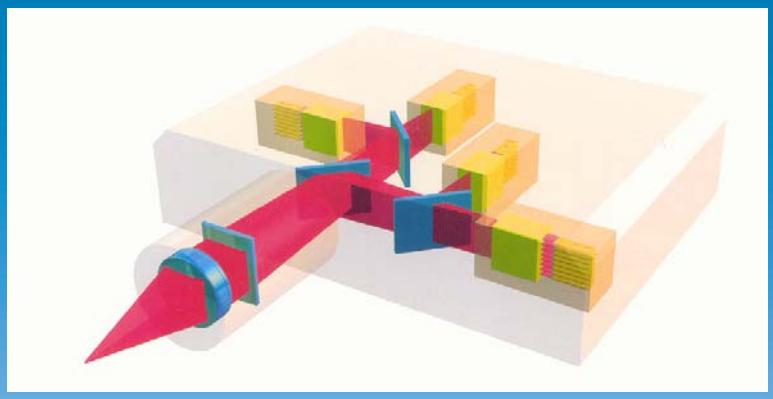
Diodlaser



Hans Engström

Diodlaser

Hans Engström

Fiberlaser

Lång interaktionslängd

- Hög förstärkning och verkningsgrad
- Utomordentlig kylning (stor area som kyler)
- Mycket hög strålkvalitet
  - Bestäms av brytningsindex profil och kärndiameter
- Kompakt

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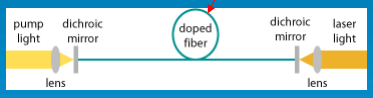
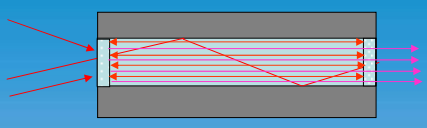
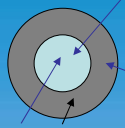
Fiberlaser princip

Ytterbium, Erbium- dopad fiber







Fiber (kvartsglas)

"Single mode" ø~5 μm

Cladding

$n_1 > n_2$

Pumpljus
-Hög stålkvalitet
-Låg effekt

Laserljus
-Högsta strålkvalitet (single mode)
-Begränsad effekt

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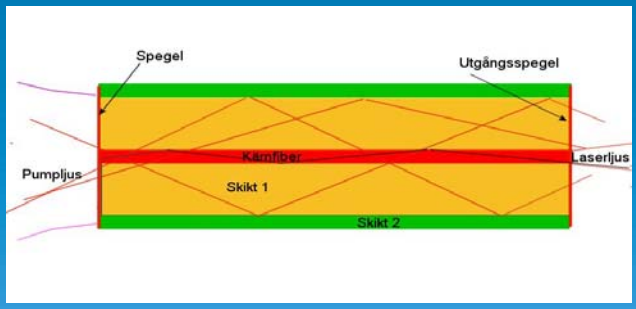
Fiberlaser - skiktpumpning



Pumpljus från diodstavar
- högre effekt
- sämre strålkvalitet

Brytningsindex

Laserljus
- hög effekt ~ 1 kW
- hög strålkvalitet
(single mode)

Hans Engström

Högeffekt fiberlaser

Våglängder

Ytterbium	(Yb)	1070-1100 nm
Erbium	(Eb)	1540-1560 nm
Thulium	(Tm)	1800-2000 nm

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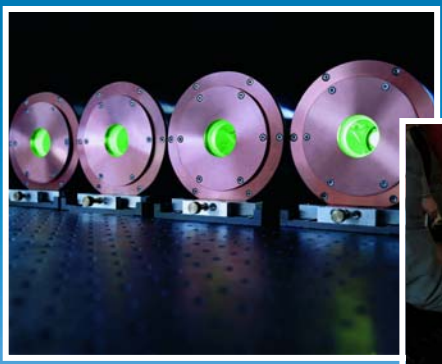
Fiberlaser 15 kW
16 mm svetsdjup

Källa: LTU
Hans Engström

LULEÅ TEKNISKA UNIVERSITET
PERMANOVA Lasersystem ab
TRUMPF
VOLVO
LASER LASERGRUPPEN

Skivlaser



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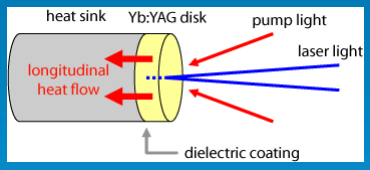
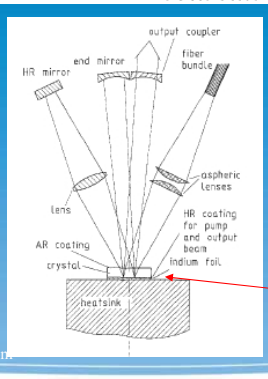
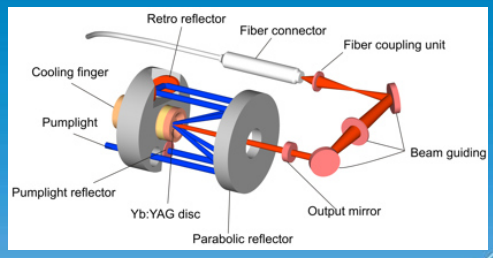
PERMANOVA Lasersystem ab
TRUMPF
VOLVO
LASER LASERGRUPPEN

Skivlaser - princip







Disk: t = 0. 3 mm; ø = 2mm

Hans Engström

Skivlaser- några karakteristika

- Ingen ”thermal lensing” hos kristallen
  - En-dimensionell temperaturgradient i kristallen
- Hög strålkvalitet
- Hög verkningsgrad (> 25 %)
- Hög effekt - skalbarhet
- Pulsbarhet (korta pulser ~ ps)

Hans Engström

Skivlaser - några data

Lasereffekt	0.5 kW	1 kW	2 kW	4 kW	6 kW	8 kW
Strålkvalitet [mmxmrad]	4	t≤7	8	8	8	8
Fiberdiameter [µm]	100	150	200	200	200	200

Hans Engström

Skaderisker vid laseranvändning

Strålningsskador

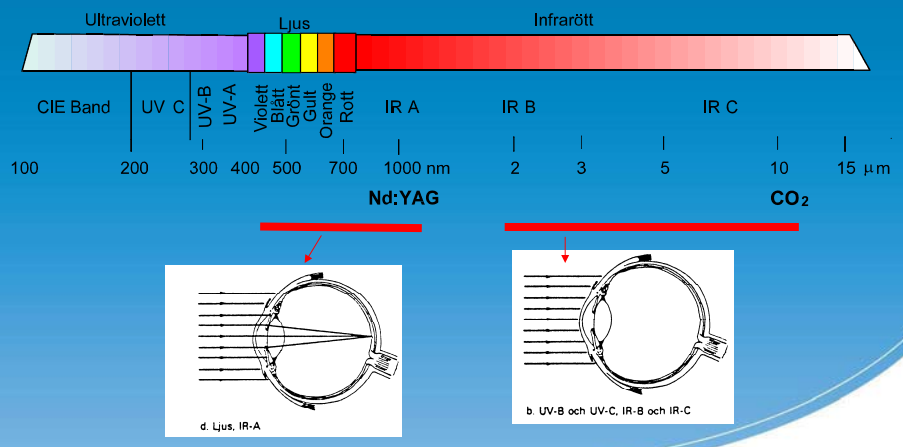
Ögonskador

Brännskador

El-skador

Hans Engström

Skaderisker för öga vid exponering av laserstrålning



Hans Engström

Lanterna magica

Hans Engström