Sheet metal cutting with fiber lasers

- About Bystronic
- Introduction
- Results and Discussion
- Summary

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Bystronic Laser AG
Bystronic: Key Figures

- Established in 1985
- Field of activity: Sheet Metal Processing Systems
- Headquarters: Niederönz (CH)
- Since 1994 part of the Conzzeta Group
- Sales 500 mio. € (2008)
- Employees 1627
Bystronic: Core Activities

Laser Cutting

Waterjet Cutting

Bending

- Process chain: cutting - bending
- All from a single source
- For all flat materials and all shapes

Handling & Automation

Software & Control

Services & Support

- Automation of the complete materials and data flow
- For increased productivity and cost efficiency
Introduction/Motivation

Wish list for a laser cutting system

- Cost-effective
- Reliable autonomous operation
- Energy-efficient
- Compact layout
- Simple operation
- Little maintenance
- Continuous high output
- Good cut quality

Source: PM By

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Optic configurations

\[ d_{\text{Focus}} = (f_f / f_C) \cdot d_{\text{Fiber}} \]

Several optic configurations

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Cutting results 2005: Aluminum

**Speed**

- > 4mm similar to 2 kW CO₂
- < 4mm faster than 5 kW CO₂

**Quality**

Similar to CO₂.
Cutting results 2005: Steel (O₂)

**Speed**
- > 5mm similar to 2 kW CO₂
- < 5mm similar to 5 kW CO₂

**Quality**
- < 6mm very good
- > 6mm good
Cutting results 2005: Stainless steel

**Speed**
- > 4mm similar to 2 kW CO₂
- < 4mm faster than 5 kW CO₂

**Quality**
- Rather rough cut,
  worse than CO₂
Cutting results 2005: Stainless steel

- **Fiber Laser**: 4mm stainless steel rough cut; $R_z \approx 30 \mu m$ (lower region)

- **CO₂ Laser**: 4mm stainless steel smooth surface with $R_z < 10 \mu m$
Cutting possibilities: Fiber vs. CO2

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<th>N2</th>
<th>Good cut quality only with CO2-laser</th>
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<td>Fiber laser cuts faster</td>
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<td>Comparable cut quality of fiber- and CO2-laser</td>
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1mm - 5mm | 5mm - 20mm

comparison with equal optical power / Source: Optech Consulting, 2009
Situation today

Today, most fiber laser cutting machines are used for thin sheets.

-ByVention Fiber 2 kW
2007 Munich

(presented on Laser 2007 WORLD OF PHOTONICS, Munich)

-several fiber laser cutting machines have been presented on Euroblech 08, Hannover.
an approach to improve cut quality
Angle of incidence

\[ \nu_{\text{min}} = \tan^{-1}\left(\frac{D_{\text{sheet}}}{D_{\text{Laser beam}}}\right) \]
Angle of incidence: sheet thickness

\[ \nu_{\text{min}} = \tan^{-1} \left( \frac{D_{\text{sheet}}}{D_{\text{Laser beam}}} \right) \]

\[ \lambda = 1\mu m \]

\[ \lambda = 10\mu m \]
Angle of incidence: beam tilting

$D_{\text{sheet}} = 4 \text{ mm}$, $D_{\text{Laser}} = 0.3 \text{ mm}$
Angle of incidence: elongated beam

\[ v_{\text{min}} = \tan^{-1}\left( \frac{D_{\text{sheet}}}{D_{\text{Laser beam}}} \right) \]
Angle of incidence: focal position
Cut quality improvements

Standard cut (@2kW)

26.1 µm
47.3 µm
70.2 µm
1.430 mm, D=6mm

Cut with extreme focal position (@2kW)

16.9 µm
21.7 µm
28.0 µm

→ Reduced burrs
→ Reduced roughness
Summary

- 1µm lasers have inherent disadvantage concerning fusion cutting of thick sheet metals (and v.v. concerning thin sheet metals)

- Improvements of cut quality can be achieved by improved incoupling of laser radiation

Thank you for your attention