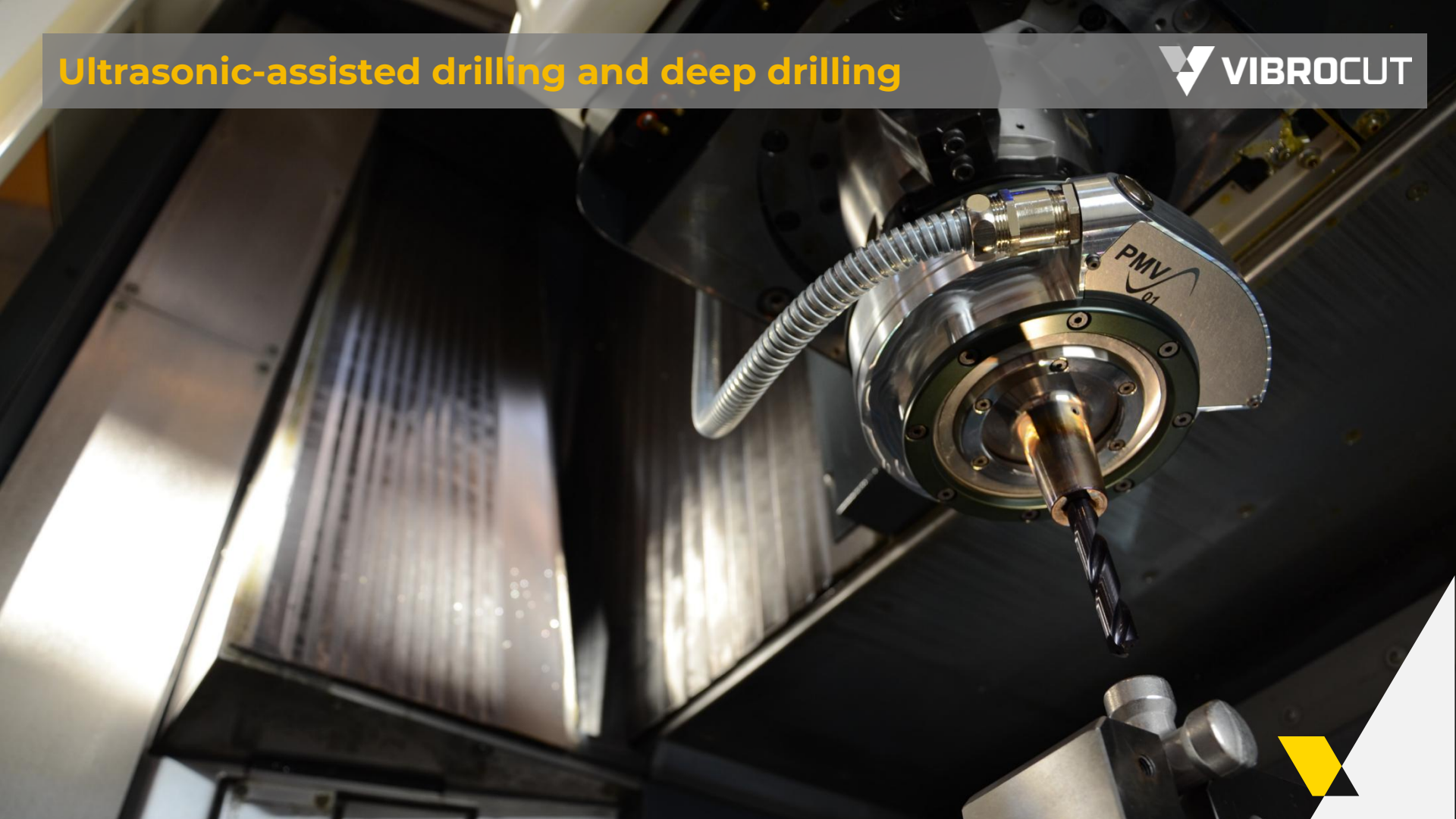


# Ultrasonic-assisted drilling and deep drilling

 VIBROCUT



## Classification of technology

### Manufacturing process:

- Drilling and deep drilling

### Mode:

- 1-dimensional (longitudinal)

### Frequency:

- High frequency (>16,000 Hz) - Ultrasound

### Generation:

- Resonant

### Orientation to process kinematics:

- In feed direction

**Objective:** Shifting of process process boundaries and limitations



Quality











Process reliability



Productivity

## Physical mechanisms and technological effects

 <b>Material effect</b>	<b>Reduction of process forces</b>	 Increase in productivity
	Reduction of burr formation	 Improving quality
	Improving straightness	 Increased tool life
 <b>Friction</b>	Reduction of tool wear	 Enhanced process reliability
	Improved chip removal	
 <b>Kinematics</b>	Reduction of built-up edge formation	 Cost savings

## Classification of technological effects and customer benefits by material



- Technological effects and benefits based on the material effect
- Material effect and force reduction primarily for non-ferrous materials
- Effects and benefits based on this only with corresponding materials
- For ferrous materials, the field of application is limited to deep drilling and the utilization of friction reduction.
- High-performance applications
  - Aluminum or copper alloys
  - Materials that are difficult to machine (titanium or nickel-based alloys)

	Ferrous materials	Non-ferrous materials
Process force reduction	-	X
Feed rate increase	-	X
Chip removal	X	X
Chip breaking	(X)	(X)
Increase tool life	(X)	X
Grass reduction	-	X
Better straightness	-	X

## Application for drilling copper alloys (plugs, welding electrodes etc.)

- Material: Copper alloy 2.1293 (CuCr1Zr)
- Drill / drilling depth: carbide  $\varnothing$  12 mm / 40 mm
- Cutting values:  $f = 0.05 \dots 0.25 \text{ mm}$ ;  $v_c = 90 \text{ m/min}$
- Ultrasound parameters:  $f_{US} = 17 \text{ kHz}$ ;  $\hat{A} = 12 \dots 20 \mu\text{m}$

➤ **Problem:** High machining forces

### Customer benefits

- ✓ Process force reduction 52%
- ✓ More stable process



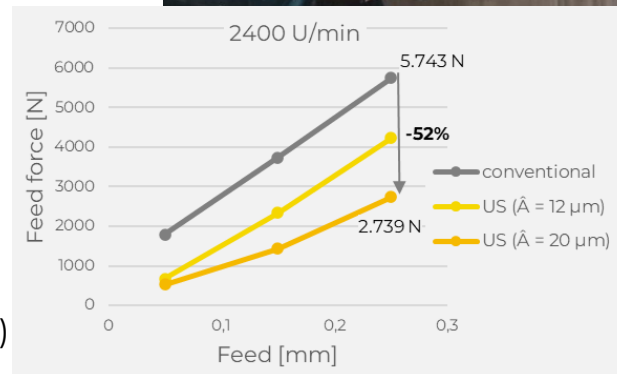
Improved process reliability



Increase in productivity and  
Feed rate increase > 50%



Increase in component quality (center run)



## Application for drilling aluminum die casting alloys (housing components, cylinder heads, aluminum rims, etc.)


- Material: EN AC-42000 (AlSi7Mg)
- Drill bit / depth: PCD, straight  $\varnothing$  8 mm / 67 mm
- Cutting values:  $f = 0.12 \dots 0.35$  mm;  $v_c = 138$  m/min
- Ultrasound parameters:  $f_{US} = 20$  kHz;  $\hat{A} = 15 \dots 25$   $\mu$ m

➤ **Problem:** Cost pressure in series production

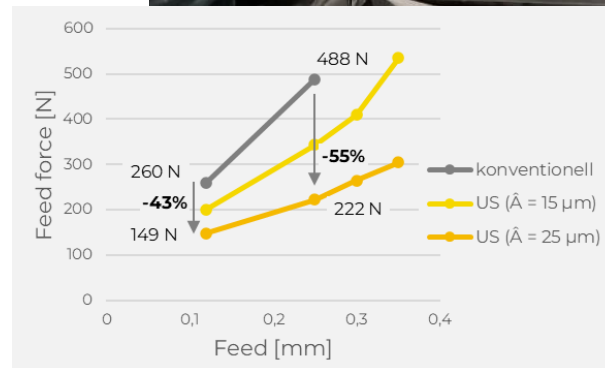
### Customer benefits

- ✓ Process force reduction 55%
- ✓ More stable process

 Improved process reliability

 Increase in productivity and  
Feed rate increase > 50%

 Increase in component quality (center run)



## Application for drilling wrought aluminum alloys (structural components in aviation)

- Material: EN AW-7075 (AlZn5.5MgCu)
- Drill bit / depth: carbide straight  $\varnothing$  8 mm / 20 mm
- Cutting values:  $f = 0.07 \dots 0.2$  mm;  $v_c = 200$  m/min
- Ultrasound parameter:  $f_{US} = 27$  kHz;  $\hat{A} = 12 \dots 20$   $\mu$ m

➤ **Problem definition:** Instabilities due to chip removal

### Customer benefits

- ✓ Process force reduction 24...39%
- ✓ More stable process due to better chip removal



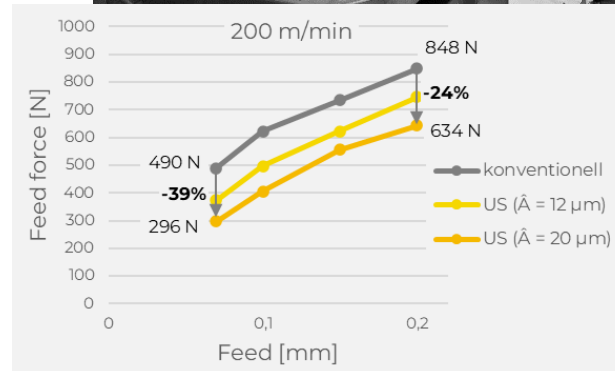
Improved process reliability



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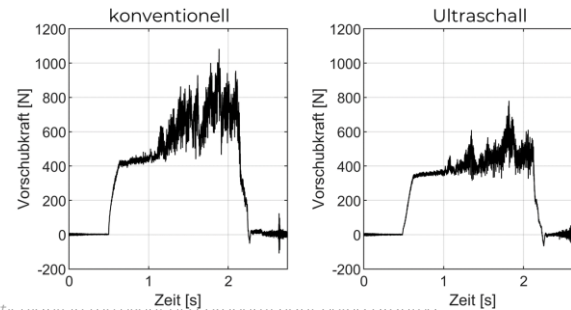
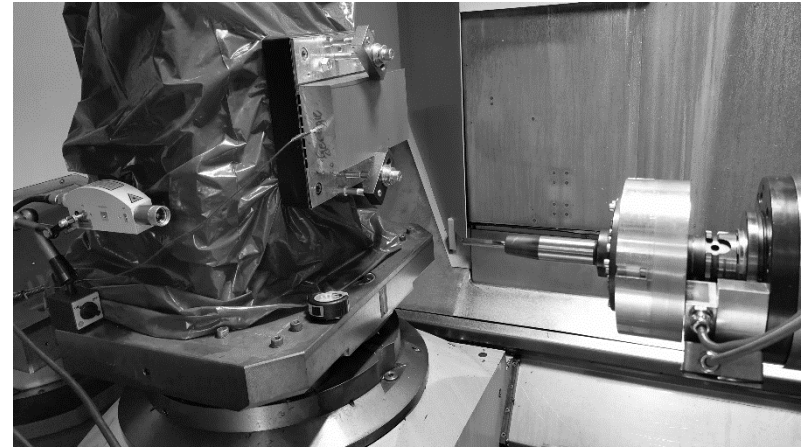
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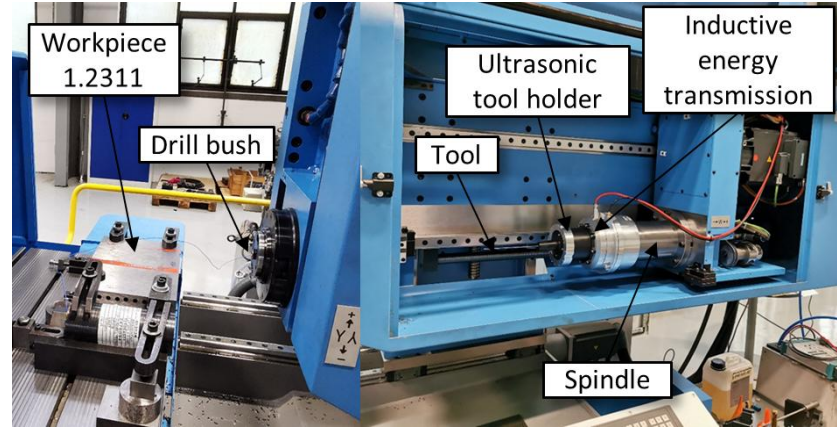
## Application for deep drilling of tool steel (molds for toolmaking)

- Material: Tool steel 1.2311 (40CrMnMo7)
- Drill bit / depth: ELB Ø 6 mm / 160 mm
- Cutting values:  $f = 0.06\text{mm}$ ;  $v_c = 51\text{ m/min}$
- Ultrasound parameters:  $f_{US} = 19.5\text{ kHz}$ ;  $\hat{A} = 5.7\text{ }\mu\text{m}$

➤ **Problem:** Instabilities due to chip removal

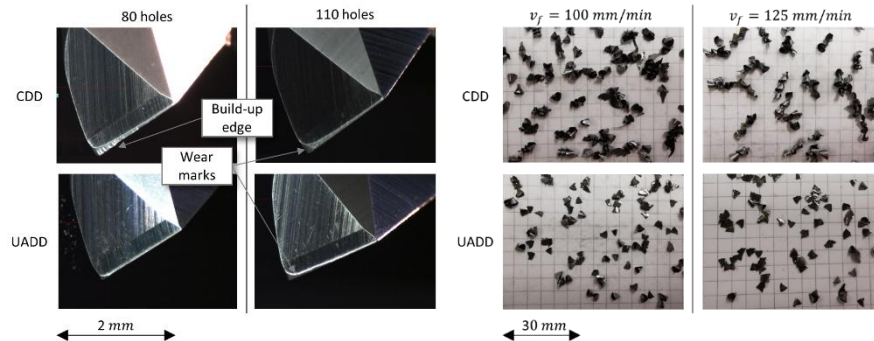
### Customer benefits

- ✓ More stable process due to better chip shape and removal
- ✓ Reduction of tool wear



 Improved process reliability

 Longer tool life



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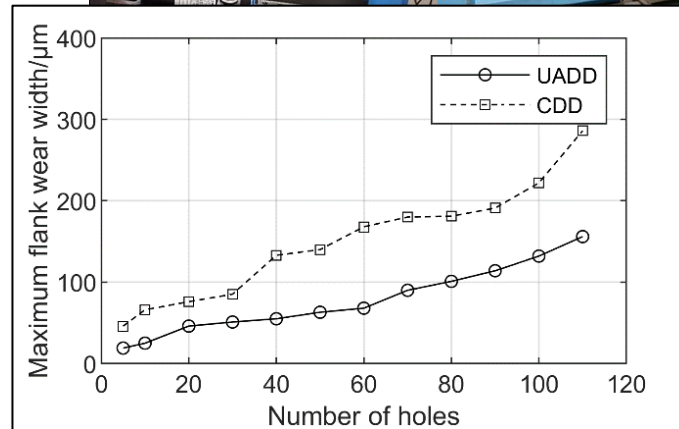
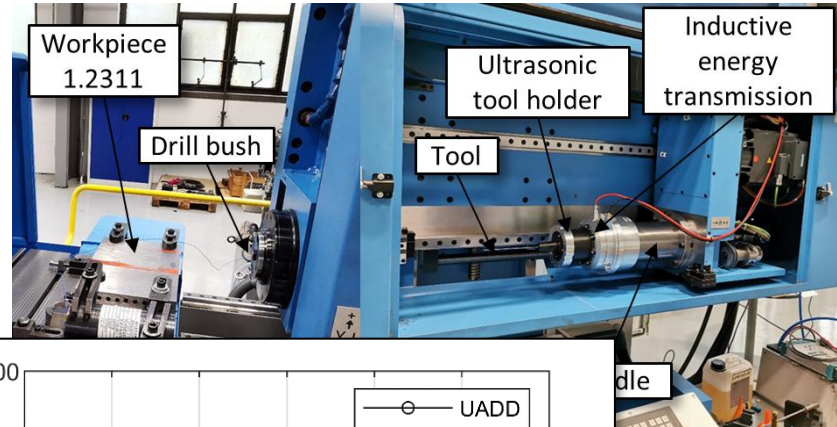
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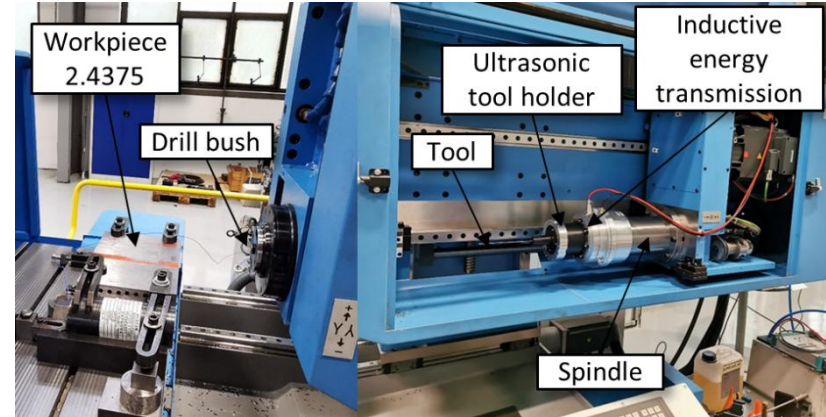
## Application for deep drilling of nickel-based alloys (drill heads, engine components etc.)

- Material: Monel k-500 2.4375
- Drill bit / depth: ELB Ø 6 mm / 145 mm
- Cutting values:  $f = 0.011\text{mm}$ ;  $v_c = 30\text{ m/min}$
- Ultrasound parameters:  $f_{US} = 19.5\text{ kHz}$ ;  $\hat{A} = 4.5\text{ }\mu\text{m}$

➤ **Problem:** Unstable process / high wear

### Customer benefits

- ✓ Realization of stable deep drilling process
- ✓ Reduction of tool wear



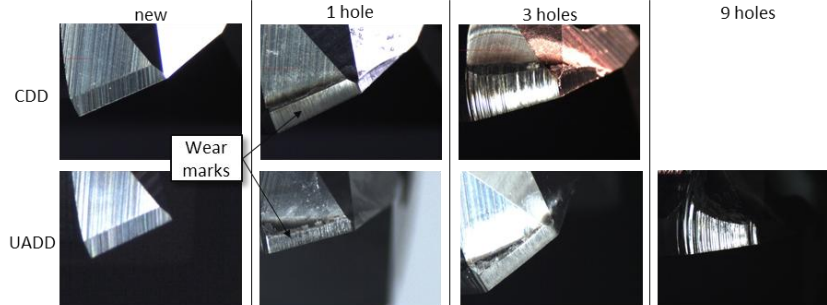
Improved process reliability  
(Stable deep drilling process)



Productivity and  
feed rate increase



Longer tool life  
(due to ultrasound 300%)




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➤ **Problem:** Unstable process / high wear

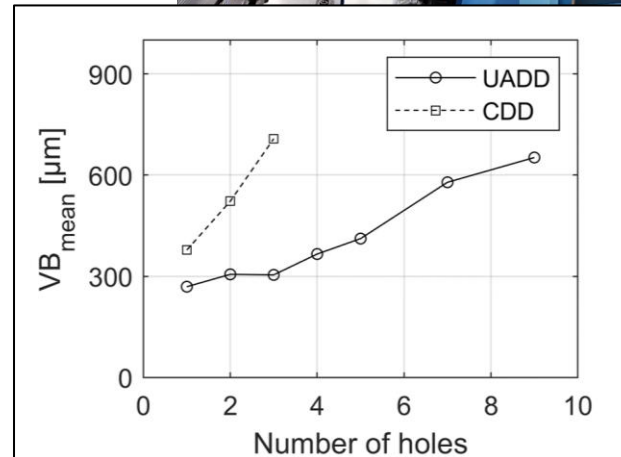
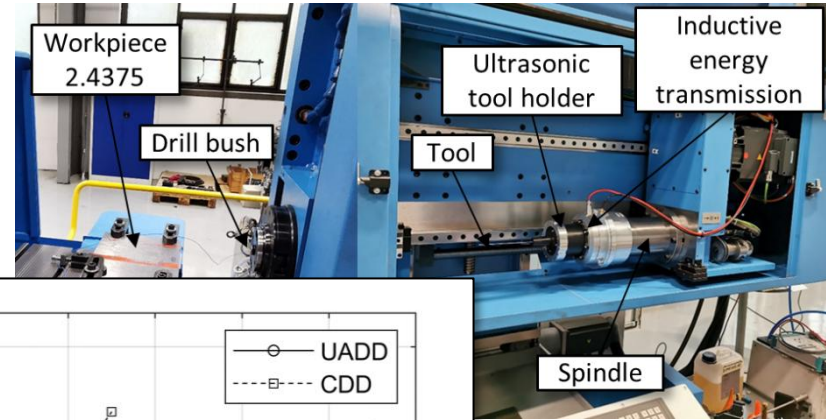
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- ✓ Realization of stable deep drilling process
- ✓ Reduction of tool wear

 Improved process reliability (Stable deep drilling process)

 Productivity and feed rate increase

 Longer tool life (due to ultrasound 300%)



## Advantages of using VibroCut *ultrasonic* for drilling and deep hole drilling



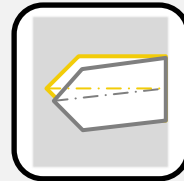
Increased cutting values and productivity



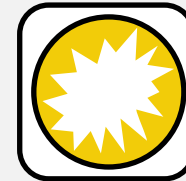
Increasing process reliability



Increasing the  
tool life



Improvement of straightness



Reduction of burr  
formation

**ROI < 1 year**

**ROI-calculator:** <https://vibrocut.de/en/cost-savings-with-vibrodrill-ultrasonic/>

## ROI < 1 year



Increase productivity



Increase tool life



Increase TCO and OEE



Improving process reliability



Reduction of burr formation



Improving straightness

### Calculation example for increasing the feed rate



Hourly machine rate: 75 €/h



Planned occupancy time: 6000 h/year  
750 shifts/year



Proportion of main drilling time to cycle time 45%  
Increasing the drilling feed rate  
25...100%

**ROI < 1 year**

Feed rate increase	Productivity increase	Savings per machine
25%	9.0%	40,500 €
50%	15.0%	67,500 €
100%	22.5%	101,250 €

<https://vibrocut.de/en/cost-savings-with-vibrodrill-ultrasonic/>

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*"VibroCut combines  
technique and technology  
for hybrid machining"*