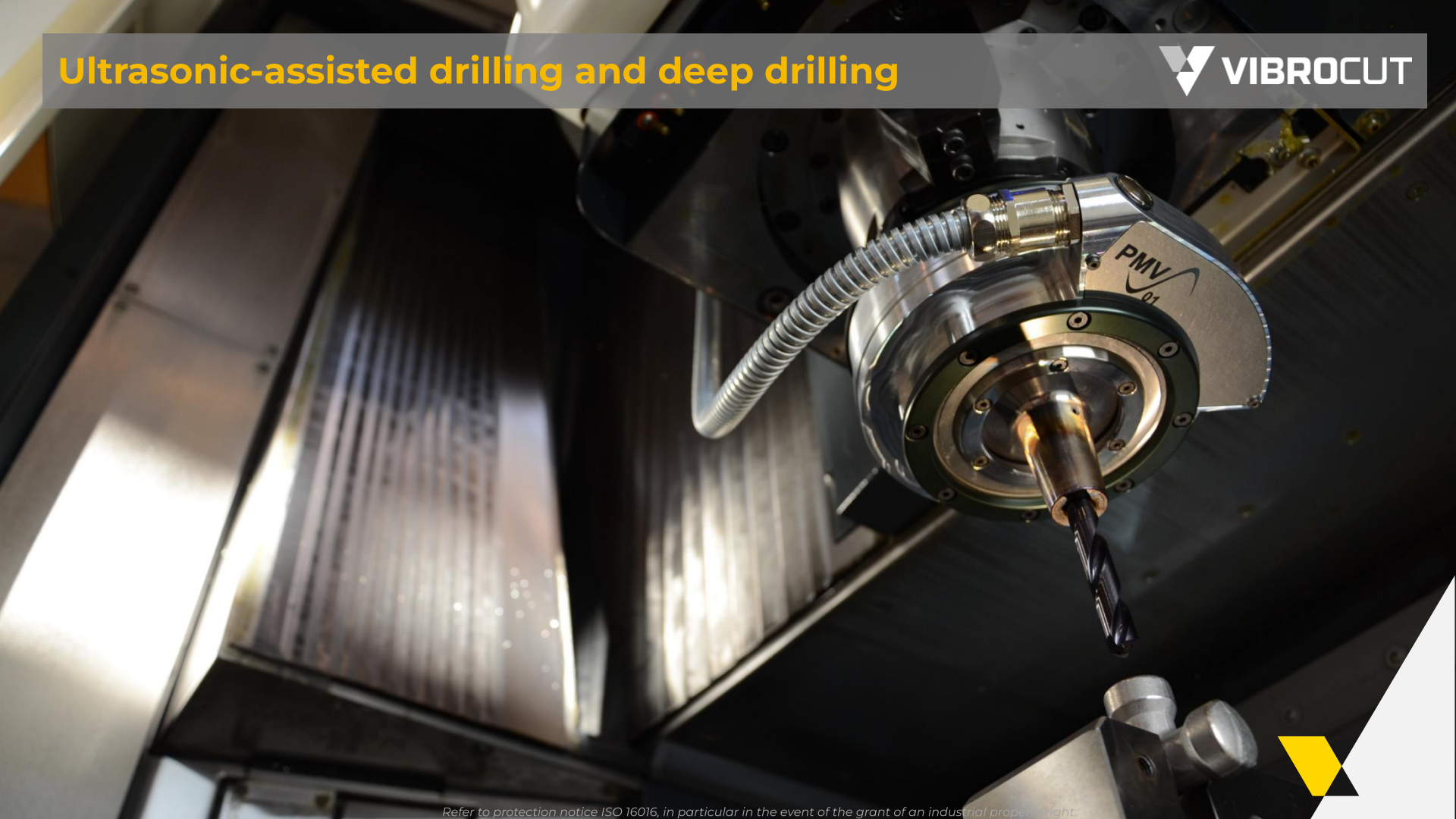
Ultrasonic-assisted drilling and deep drilling

VIBROCUT



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Ultrasonic-assisted drilling and deep drilling

Classification of the technology

Manufacturing process:
- Drilling and deep drilling

Form:
- 1-dimensional (longitudinal)

Frequency:
- High-frequency (>16,000 Hz) - ultrasound

Generation:
- Resonant

Orientation to process kinematics:
- In feed direction

Objective: Shifting process limits and limitations



Quality **Process reliability** **Productivity**

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Ultrasonic-assisted drilling and deep drilling

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Physical mechanisms and technological effects

	Reduced process forces	Higher productivity
Material effect	Reduced burr formation	Improved quality
	Improved hole straightness	Longer tool life
	Reduced tool wear	
Friction	Improved chip evacuation	Greater process reliability
Kinematics	Less built-up edge formation	Cost savings

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Ultrasonic-assisted drilling and deep drilling

Technological effects and customer benefits classified by material



- Technological effects and benefits rely partly on the material effect
- Material effect and force reduction mainly with non-ferrous materials
- Effects and benefits based on this only with the relevant materials
- For ferrous materials, application limited to deep drilling and use of the friction reduction

- High-performance applications
  - Aluminium or copper alloys
  - Hard-to-machine materials (titanium or nickel-based alloys)

	Ferrous materials	Non-ferrous materials
Process force reduction	-	X
Feed increase	-	X
Chip evacuation	X	X
Chip breaking	(X)	(X)
Longer tool life	(X)	X
Burr reduction	-	X
Better hole straightness	-	X

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Ultrasonic-assisted drilling and deep drilling

Application in drilling copper alloys (connectors, welding electrodes etc.)

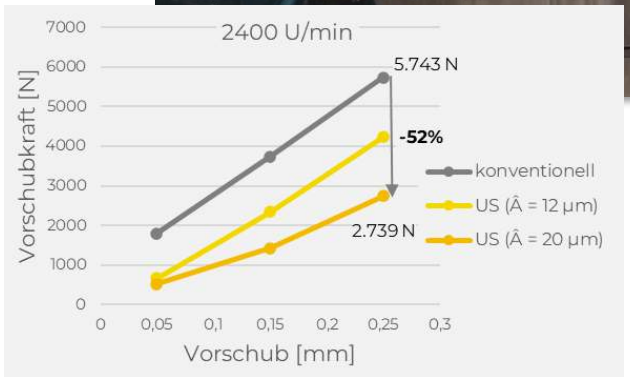
- Material: Copper alloy 2.1293 (CuCr1Zr)
- Drill / depth: Solid carbide Ø 12 mm / 40 mm
- Cutting data: f = 0.05...0.25mm; v_c= 90 m/min
- Ultrasonic parameters: f_{US}= 17 kHz; Â = 12...20 µm

- **Problem:** High machining forces



Customer benefits

- Process force reduction 52%
- More stable process



Improved process reliability

Productivity and feed in-crease > 50%

Higher component quality (hole straightness)

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Ultrasonic-assisted drilling and deep drilling

Application in drilling die-cast aluminium alloys (housing components, cylinder heads, aluminium wheels etc.)

- Material: EN AC-42000 (AlSi7Mg)
- Drill / depth: PCD, straight Ø 8 mm / 67 mm
- Cutting data: f = 0.12...0.35 mm; v_c = 138 m/min
- Ultrasonic parameters: f_{US} = 20 kHz; Â = 15...25 µm

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



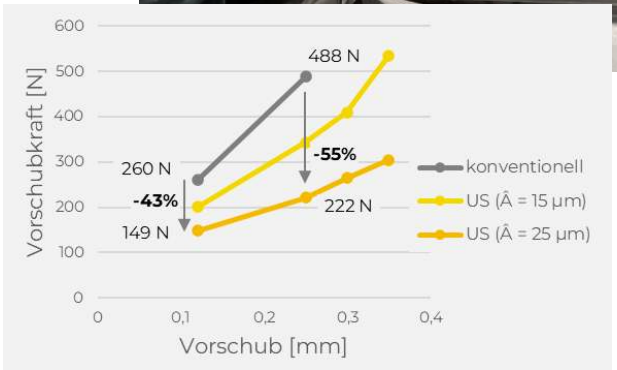
Customer benefits

- Process force reduction 55%
- More stable process

Improved process reliability

Productivity and feed increase > 50%

Higher component quality (hole straightness)



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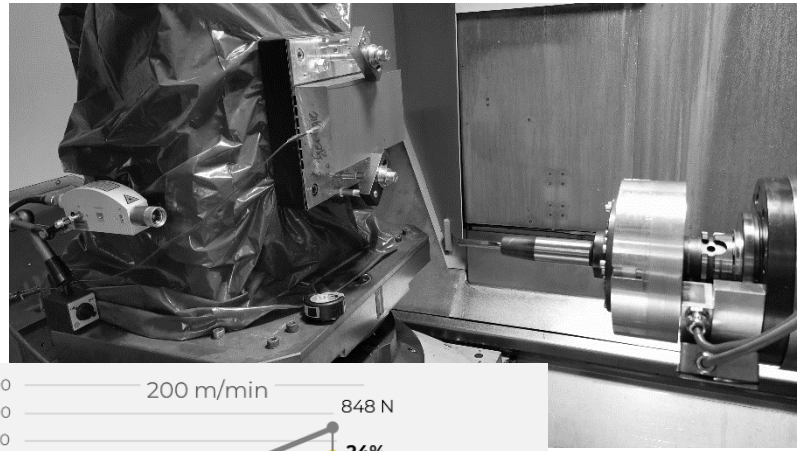
Ultrasonic-assisted drilling and deep drilling

Application in drilling wrought aluminium alloys (landing gear and structural parts in aviation)

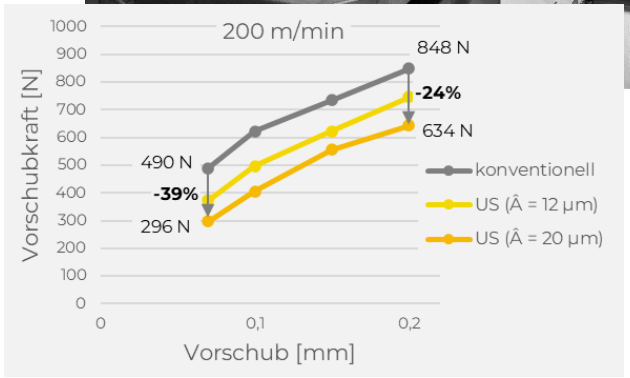
- Material: EN AW-7075 (AlZn5.5MgCu) solid
- Drill / depth: carbide, straight Ø 8 mm / 20 mm
- Cutting data: f = 0.07...0.2 mm; v_c= 200 m/min
- Ultrasonic parameters: f_{US}= 27 kHz; Â = 12...20 µm

- **Problem:** Instabilities due to chip evacuation



Customer benefits

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



Improved process reliability

Productivity and feed increase > 50%

Higher component quality (hole straightness)

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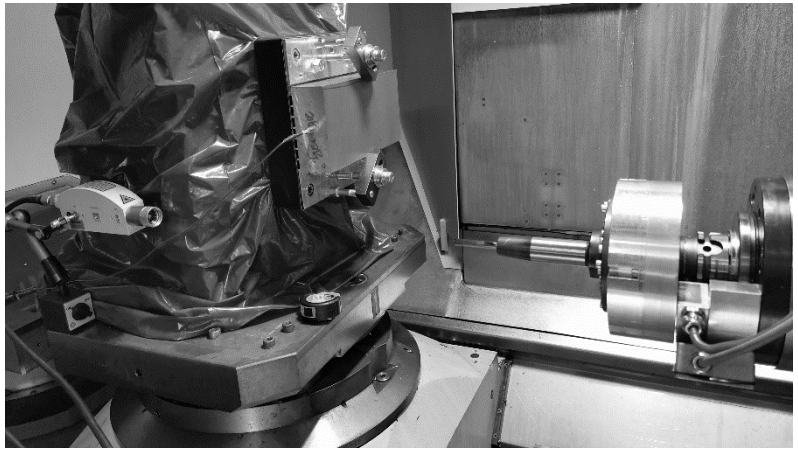

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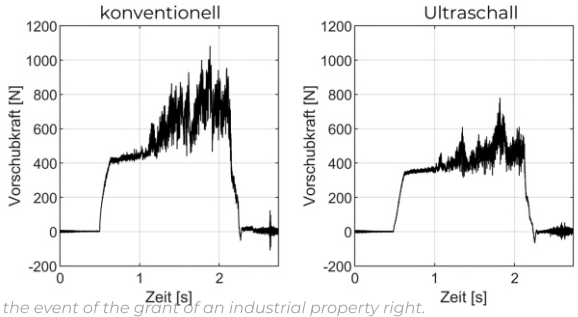

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Ultrasonic-assisted drilling and deep drilling

Application in deep drilling of tool steel (moulds for toolmaking)

- Material: Tool steel 1.2311 (40CrMnMo7)
- Drill / depth: Gun drill Ø 6 mm / 160 mm
- Cutting data: f = 0.06mm; v_c= 51 m/min
- Ultrasonic parameters: f_{US}= 19.5 kHz; Â = 5.7 µm

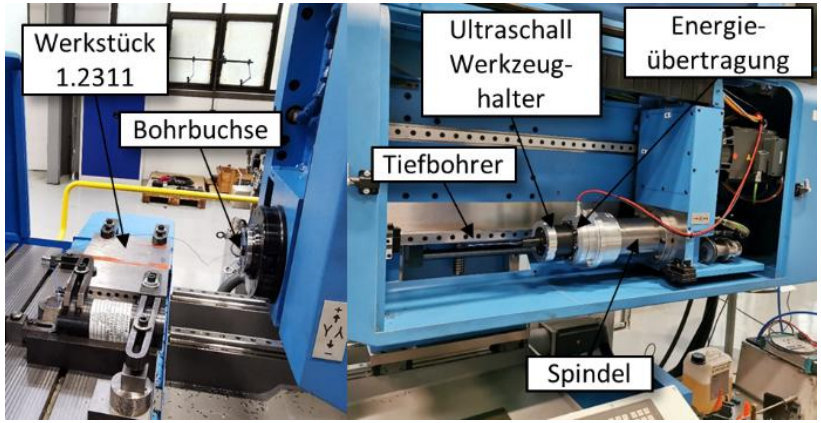
- **Problem:** Instabilities due to chip evacuation

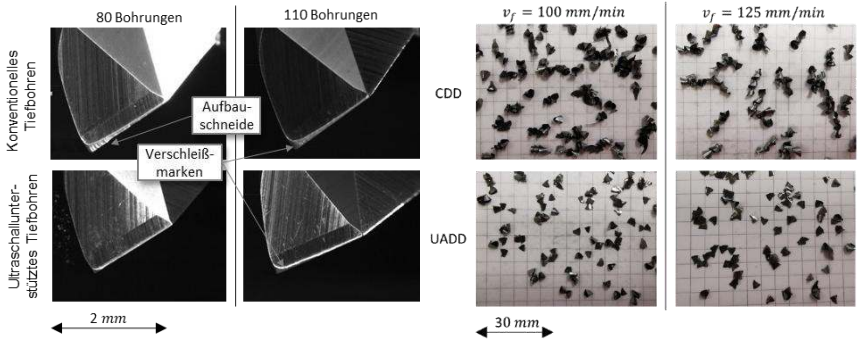
Customer benefits

- More stable process due to better chip form and evacuation
- Reduced tool wear

Improved process reliability

Longer tool life





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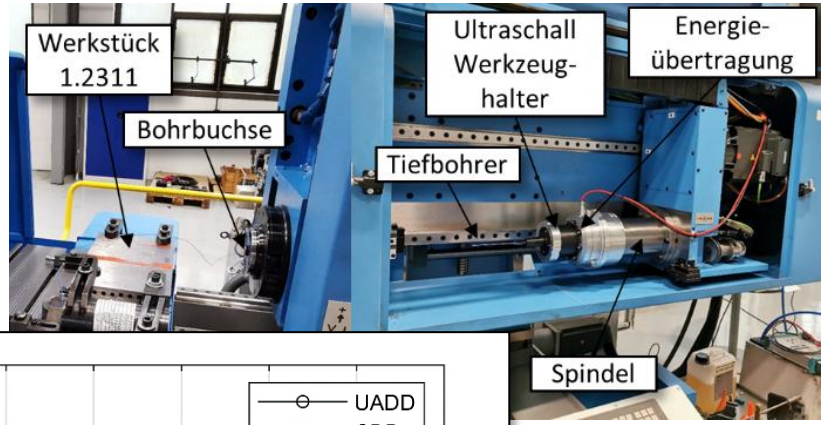

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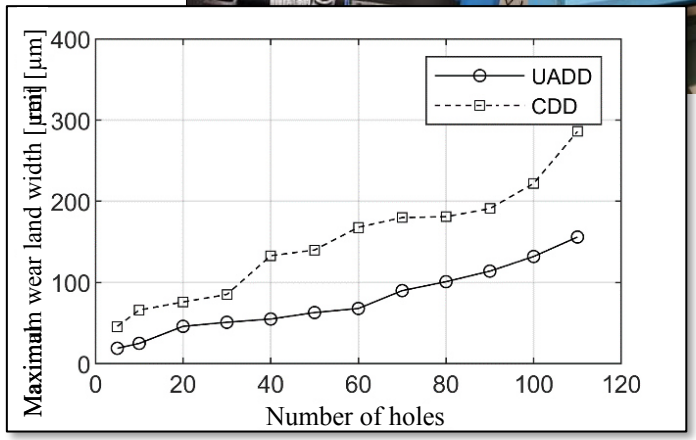

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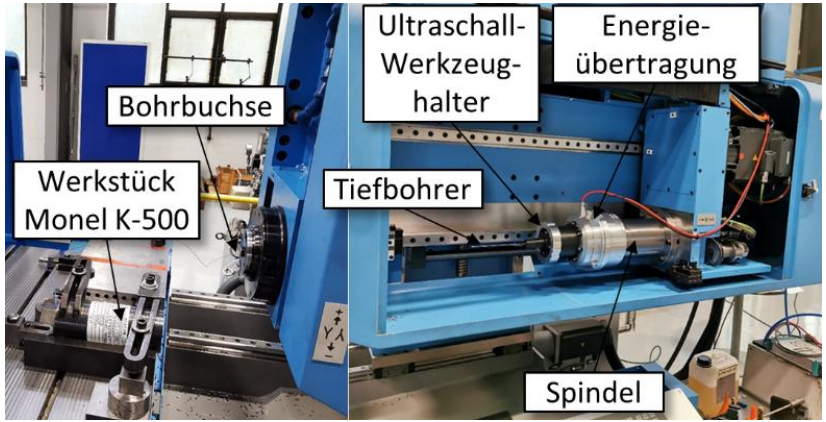
Ultrasonic-assisted drilling and deep drilling

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

- Material: Monel k-500 2.4375
- Drill / depth: Gun drill Ø 6 mm / 145 mm
- Cutting data: f = 0.011mm; v_c= 30 m/min
- Ultrasonic parameters: f_{US}= 19.5 kHz; Â = 4.5 µm

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



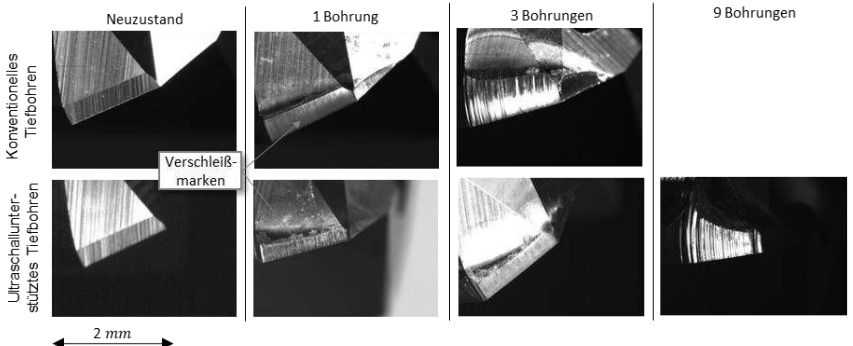
Customer benefits

- Achieving a stable deep drilling process
- Reduced tool wear

Improved process reliability (stable deep drilling process)

Productivity and feed increase

Longer tool life (300% with ultrasound)



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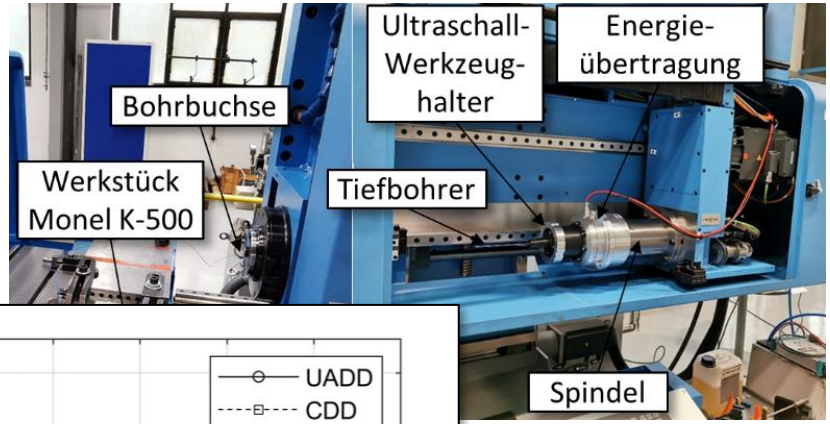
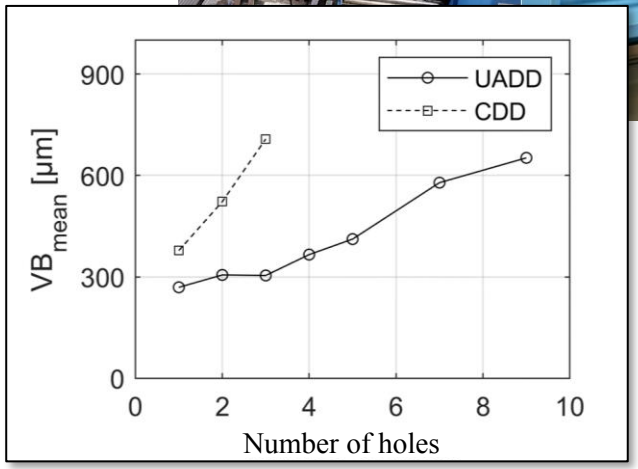


Customer benefits

- Achieving a stable deep drilling process
- Reduced tool wear



Improved process reliability (stable deep drilling process)

Productivity and feed increase

Longer tool life (300% with ultrasound)

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Ultrasonic-assisted drilling and deep drilling

VIBROCUT

Benefits of using VibroCut *ultrasonic* in drilling and deep drilling

Higher cutting data and productivity

Greater process reliability



Longer
tool life



Improved hole
straightness



Reduced burr
formation

ROI < 1 year

ROI calculator: https://vibrocut.de/kosteneinsparung-mit-vibrocut-ultrasonic-test/

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Ultrasonic-assisted drilling and deep drilling

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ROI < 1 year

- Higher productivity
- Longer tool life
- Improved TCO and OEE
- Improved process reliability
- Reduced burr formation
- Improved hole straightness

Sample calculation: feed increase

Machine hourly rate: €75/h

Planned operating time: 6,000 h/year 750 shifts/year

Drilling cutting time share of cycle time 45% Increase in drilling feed 25...100%

ROI < 1 year

Feed increase	Productivity increase	Savings per machine
25%	9,0%	**€40,500**
50%	15,0%	**€67,500**
100%	22,5%	**€101,250**

https://vibrocut.de/kosteneinsparung-mit-vibrocut-ultrasonic-test/

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VibroCut – Hybrid machining

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"VibroCut combines technique and technology for hybrid machining"

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