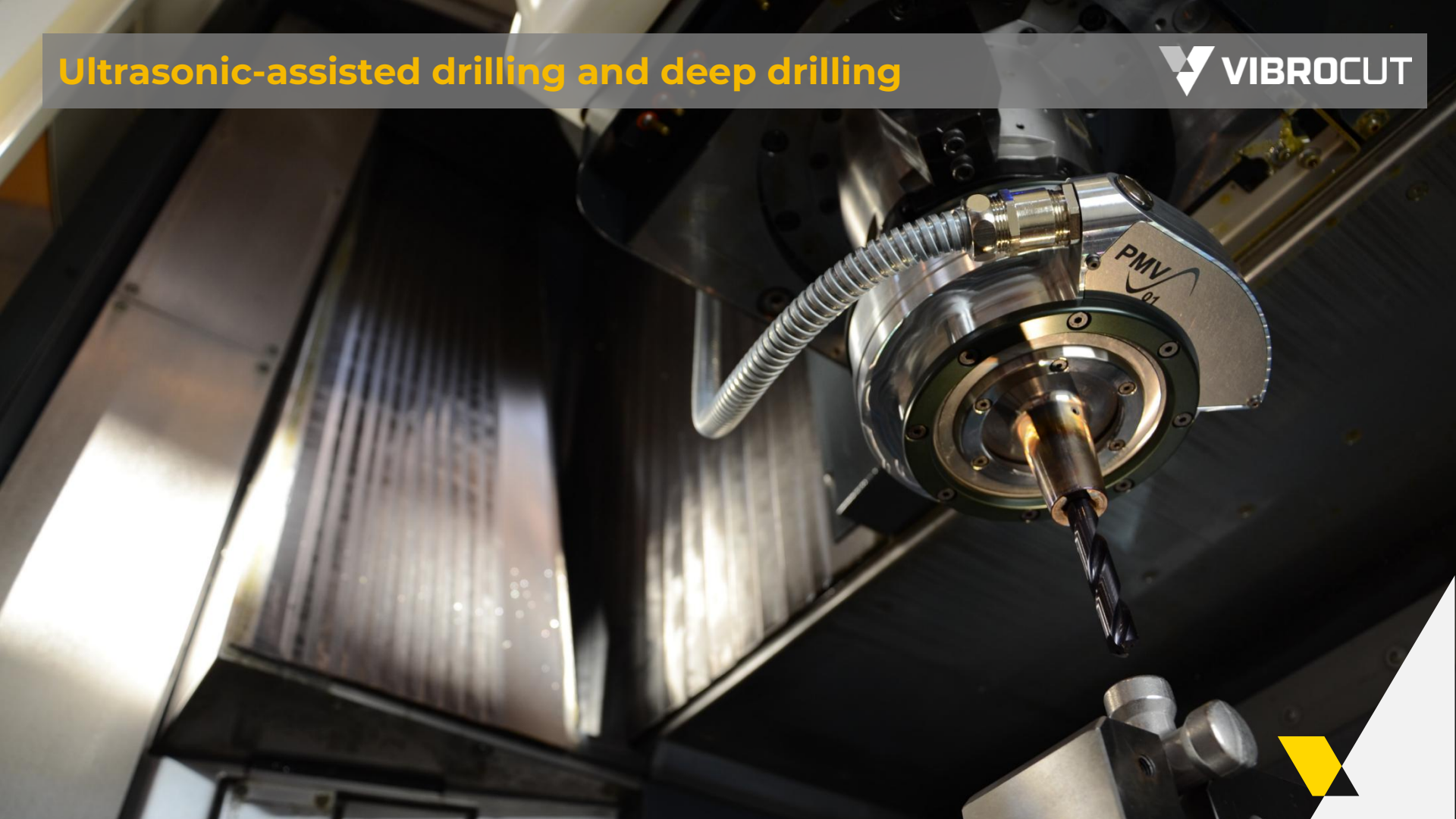VIBROCUT

Ultrasonic-assisted drilling and deep drilling

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

Speed

Feed rate

Ultrasound

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

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Physical mechanisms and technological effects

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

Ultrasonic-assisted drilling and deep drilling

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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

Ultrasonic-assisted drilling and deep drilling

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

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

➤ **Problem:** High machining forces

Customer benefits
✓ Process force reduction 52%
✓ More stable process

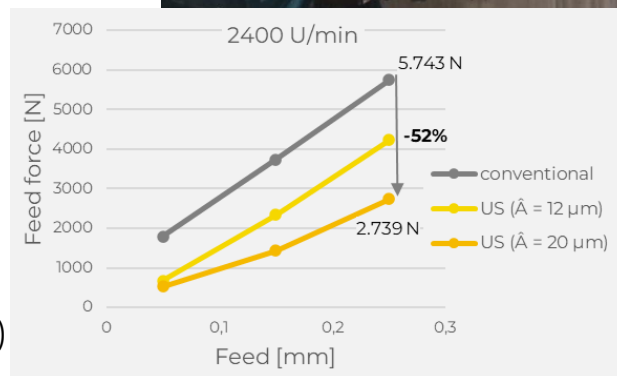🛡 Improved process reliability

⚙ Increase in productivity and Feed rate increase > 50%

✅ Increase in component quality (center run)

Feed force [N] vs Feed [mm], 2400 U/min

- 5.743 N
- -52%
- 2.739 N
- conventional
- US (Â = 12 µm)
- US (Â = 20 µm)

Ultrasonic-assisted drilling and deep drilling

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

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

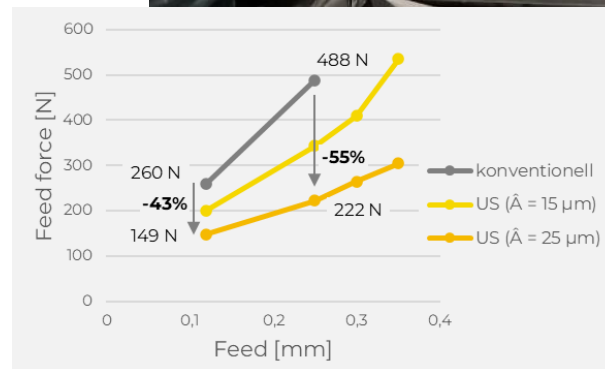➤ **Problem:** Cost pressure in series production

Customer benefits
✓ Process force reduction 55%
✓ More stable process

🛡 Improved process reliability

⏱ Increase in productivity and Feed rate increase > 50%

🏅 Increase in component quality (center run)

Feed force [N] vs Feed [mm] chart:
- 488 N
- 260 N
- 149 N
- -43%
- -55%
- 222 N
- konventionell
- US (Â = 15 µm)
- US (Â = 25 µm)

Ultrasonic-assisted drilling and deep drilling

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

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

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

Customer benefits

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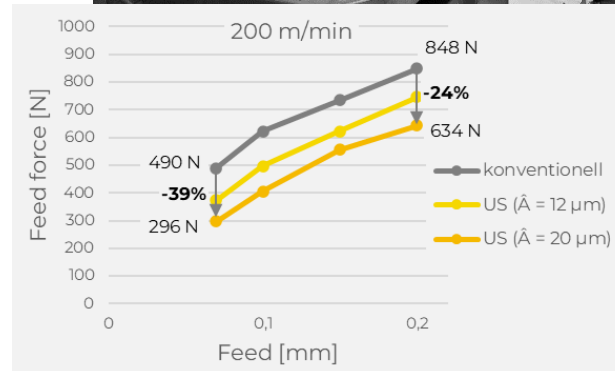✓ More stable process due to better chip removal

🛡 Improved process reliability

⏱ Increase in productivity and Feed rate increase > 50%

🏅 Increase in component quality (center run)

Chart: 200 m/min — Feed force [N] vs Feed [mm]
- 848 N; -24%; 634 N
- 490 N; -39%; 296 N
- konventionell
- US (Â = 12 µm)
- US (Â = 20 µm)

Ultrasonic-assisted drilling and deep drilling

VIBROCUT

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

- Material: EN AW-7075 (AlZn5.5MgCu)
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➤ **Problem definition:** Instabilities due to chip removal

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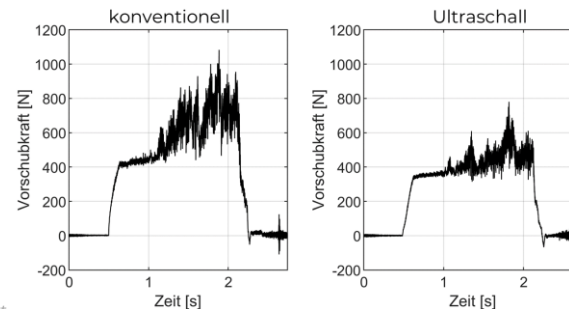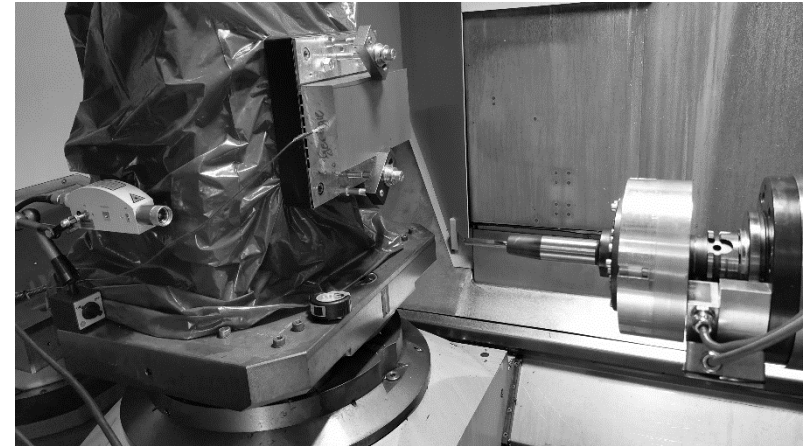- ✓ More stable process due to better chip removal

🛡 Improved process reliability

⏱ Increase in productivity and Feed rate increase > 50%

🏅 Increase in component quality (center run)

konventionell

Ultraschall

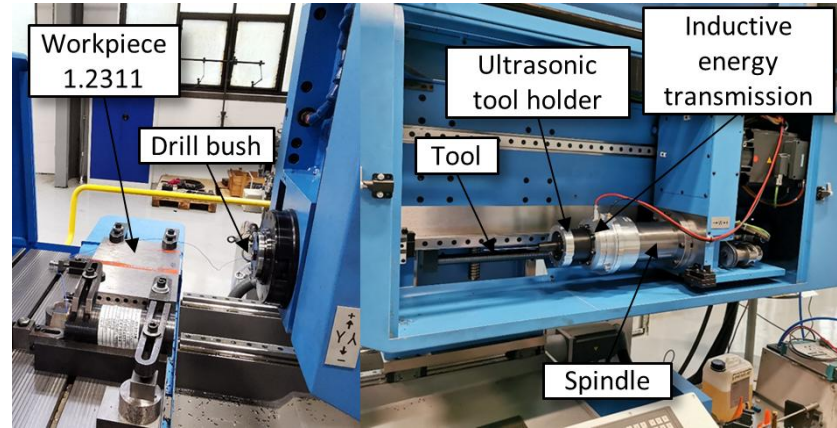# Ultrasonic-assisted drilling and deep drilling

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 = 0.06mm; v_c = 51 m/min
- Ultrasound parameters: f_{US} = 19.5 kHz; Â = 5.7 µm

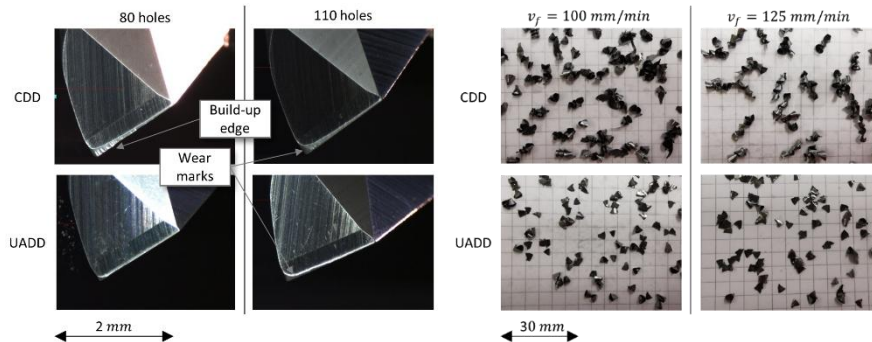➤ **Problem:** Instabilities due to chip removal

Customer benefits

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

🛡 Improved process reliability

⏱ Longer tool life

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 mm; v_c = 51 m/min
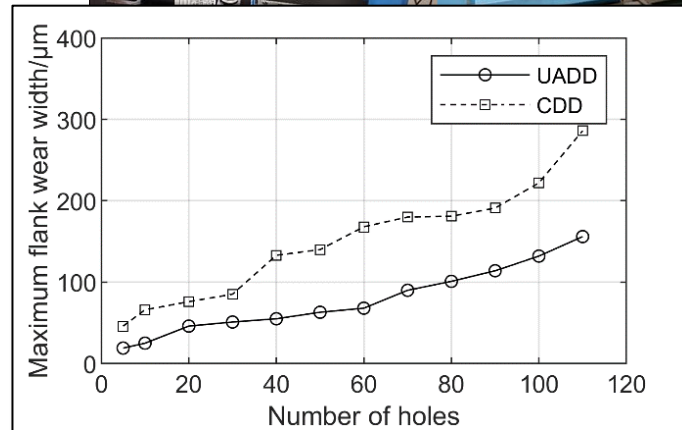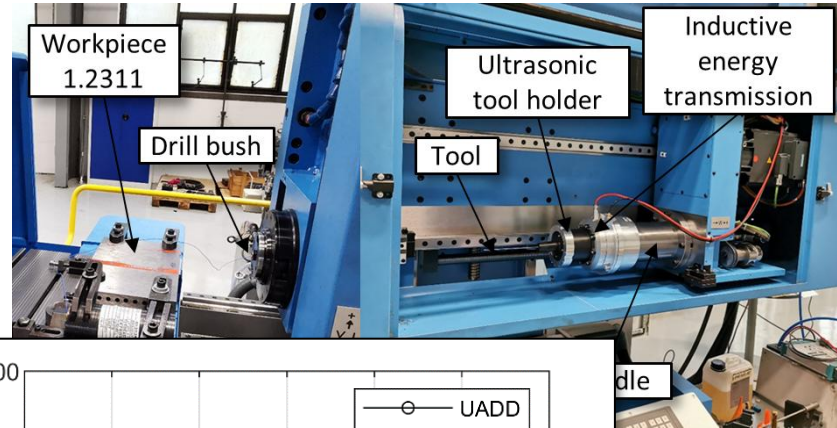- Ultrasound parameters: $_{US}f$ = 19.5 kHz; Â = 5.7 µm

➢ **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

Workpiece 1.2311 · Drill bush · Tool · Ultrasonic tool holder · Inductive energy transmission

Maximum flank wear width/µm vs Number of holes — UADD, CDD

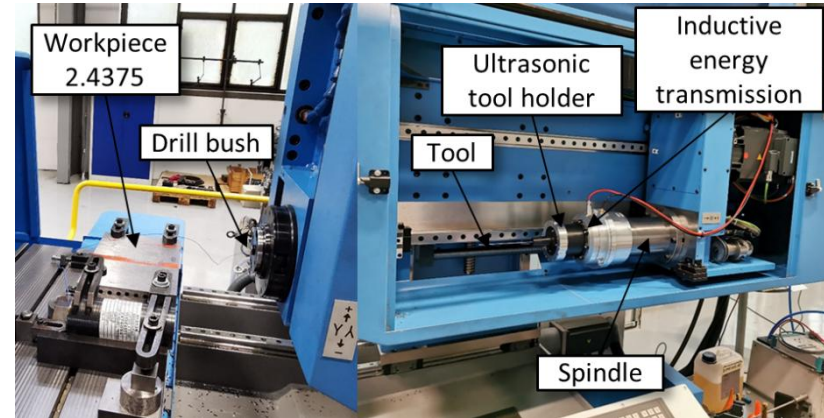# Ultrasonic-assisted drilling and deep drilling

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 = 0.011mm; v_c = 30 m/min
- Ultrasound parameters: f_{US} = 19.5 kHz; Â = 4.5 µm

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

Customer benefits
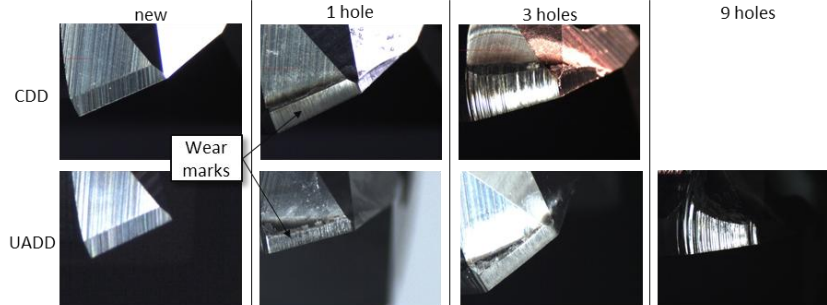✓ Realization of stable deep drilling process
✓ Reduction of tool wear

Improved process reliability
(Stable deep drilling process)

Productivity and
feed rate increase

Longer tool life
(due to ultrasound 300%)

Workpiece 2.4375 | Ultrasonic tool holder | Inductive energy transmission | Drill bush | Tool | Spindle

new | 1 hole | 3 holes | 9 holes

CDD

Wear marks

UADD

2 mm

Ultrasonic-assisted drilling and deep drilling

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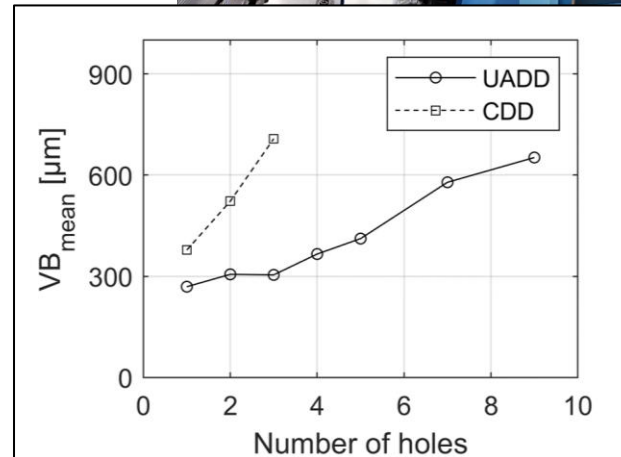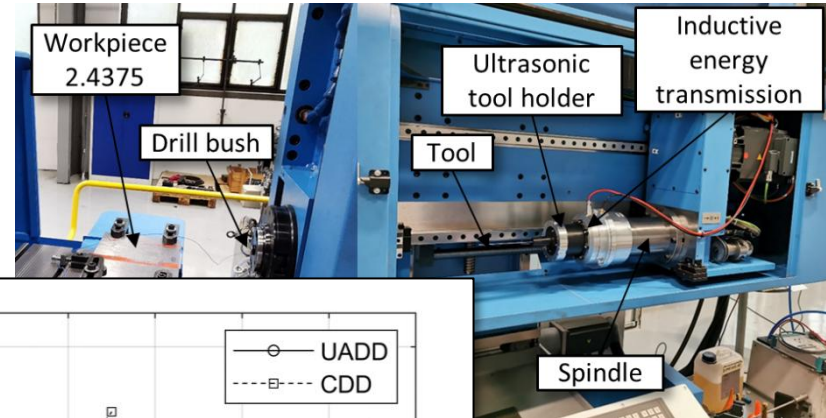
➢ **Problem:** Unstable process / high wear

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%)

Ultrasonic-assisted drilling and deep drilling

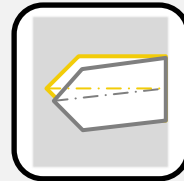## Advantages of using VibroCut *ultrasonic* for drilling and deep hole drilling

Increased cutting values and productivity
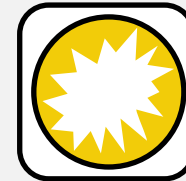
Increasing process reliability

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/

Observe the protection notice in accordance with ISO 16016, particularly in the event of a property right being granted.

Ultrasonic-assisted drilling and deep drilling

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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/

VibroCut – Hybdrid machining

VIBROCUT

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"VibroCut combines technique and technology for hybrid machining"