Digitalisierung des Schleifprozesses in der Smart Factory 2030

Schleiftagung 2023

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INSTITUT FÜR FERTIGUNGSTECHNIK (IFT)
TECHNISCHE UNIVERSITÄT GRAZ

25. und 26. Januar 2023

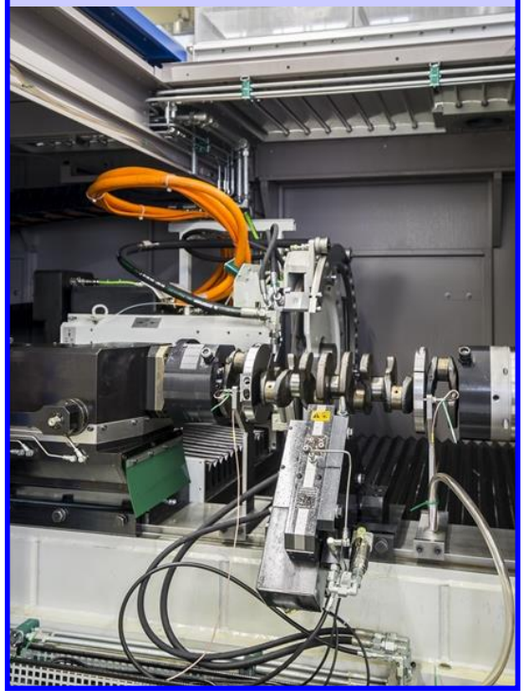
SCHLEIFTAGUNG

Agenda

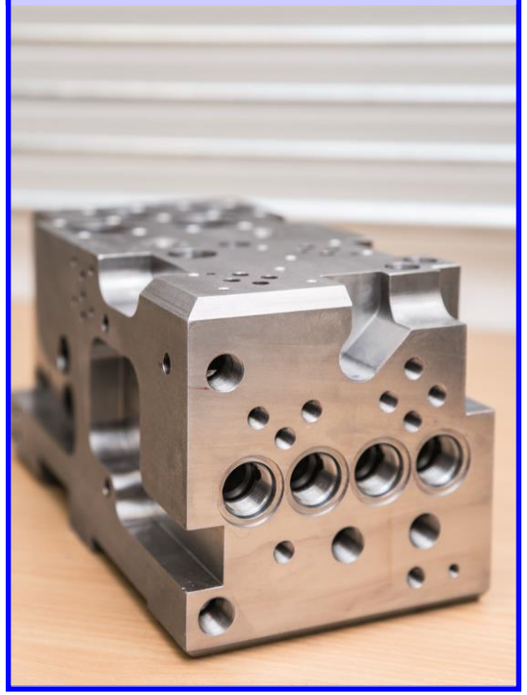
- Einführung und Institutsvorstellung
- Schleiftechnologie + Smart Factory 2030
- Handlungsfelder
  - „Edge Computing“
  - Künstliche Intelligenz (AI)
  - Vernetzung (5G)
  - Robotik
  - 3D-Druck
  - Digitaler Zwilling

Einführung und Institutsvorstellung

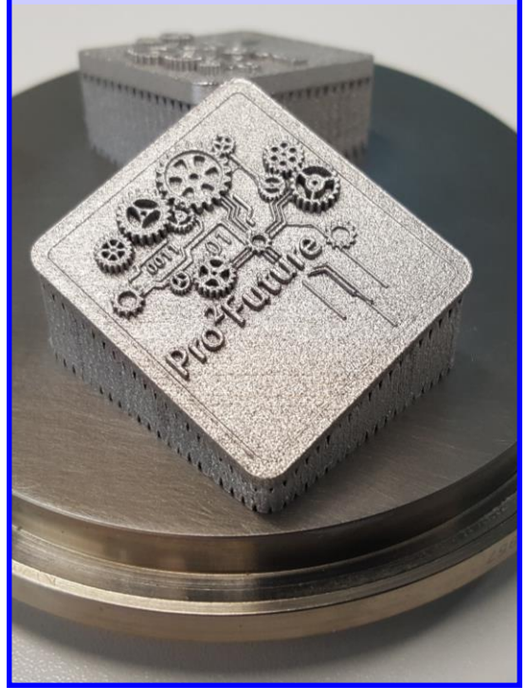
Precision Machining



Fluid Technology

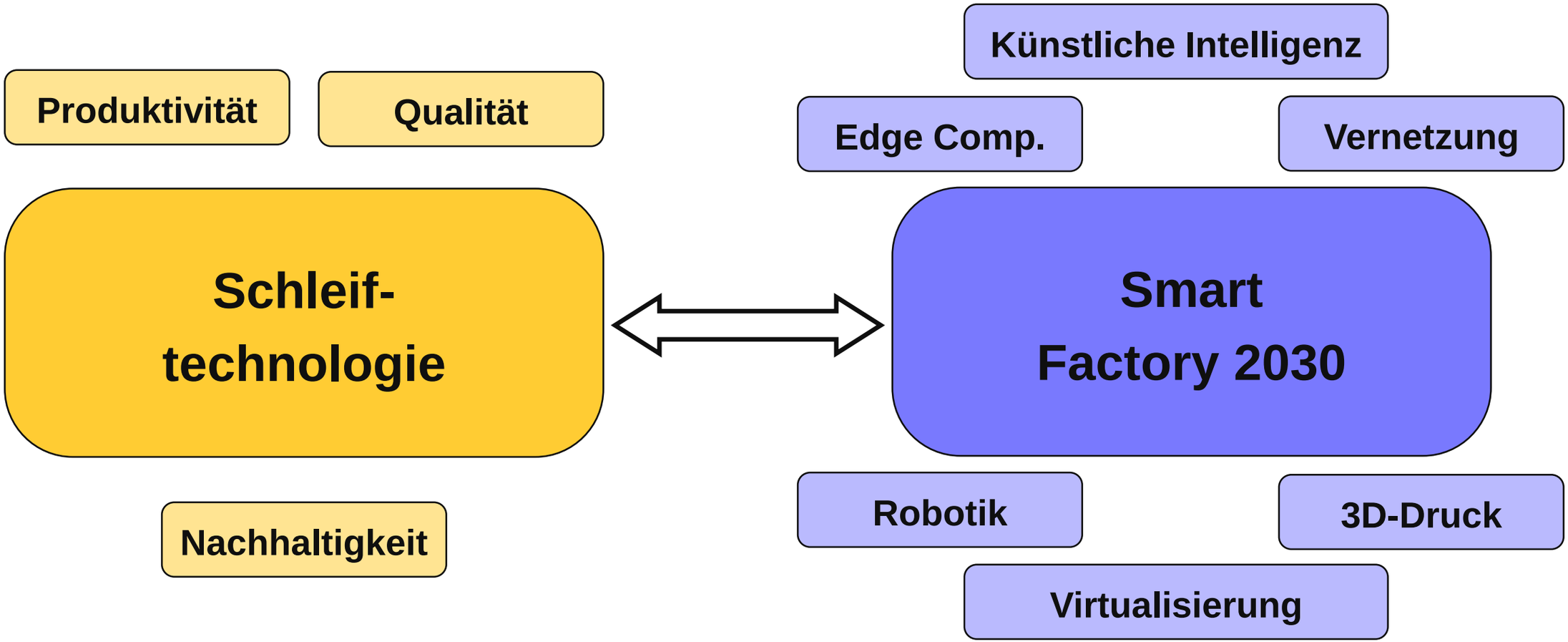


Additive Manufacturing

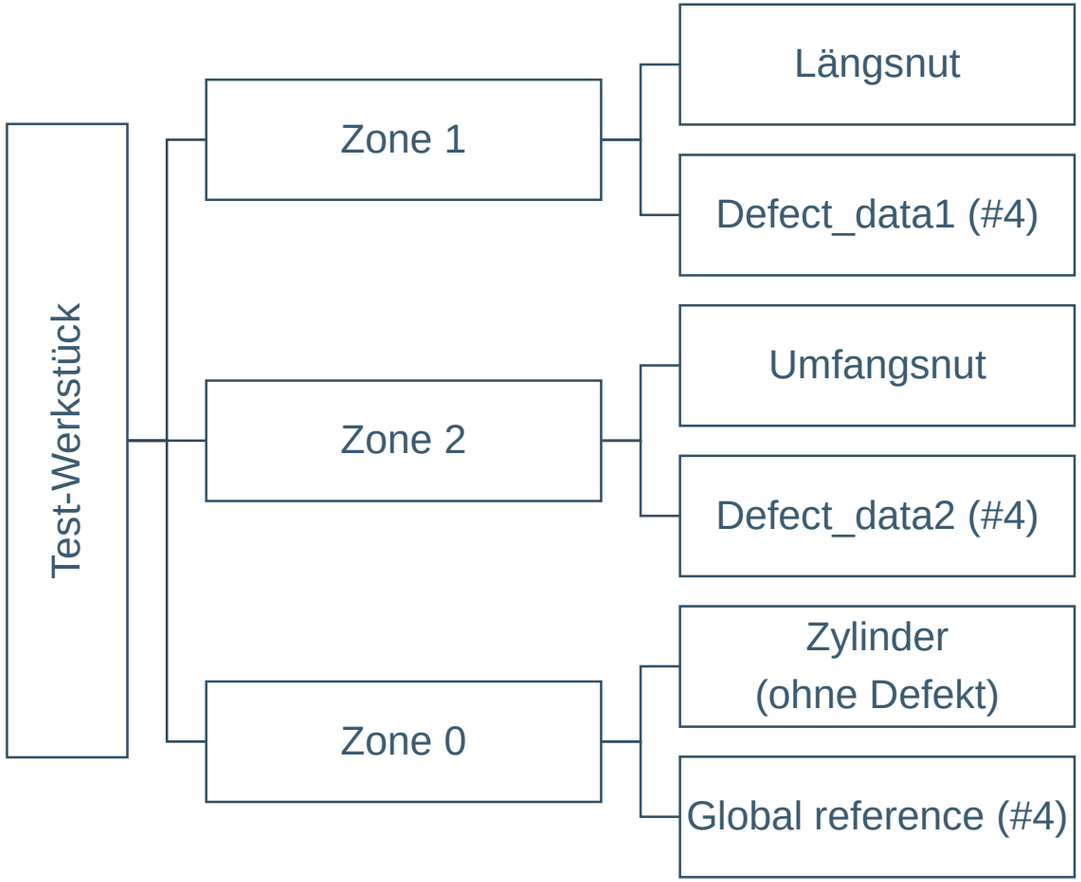


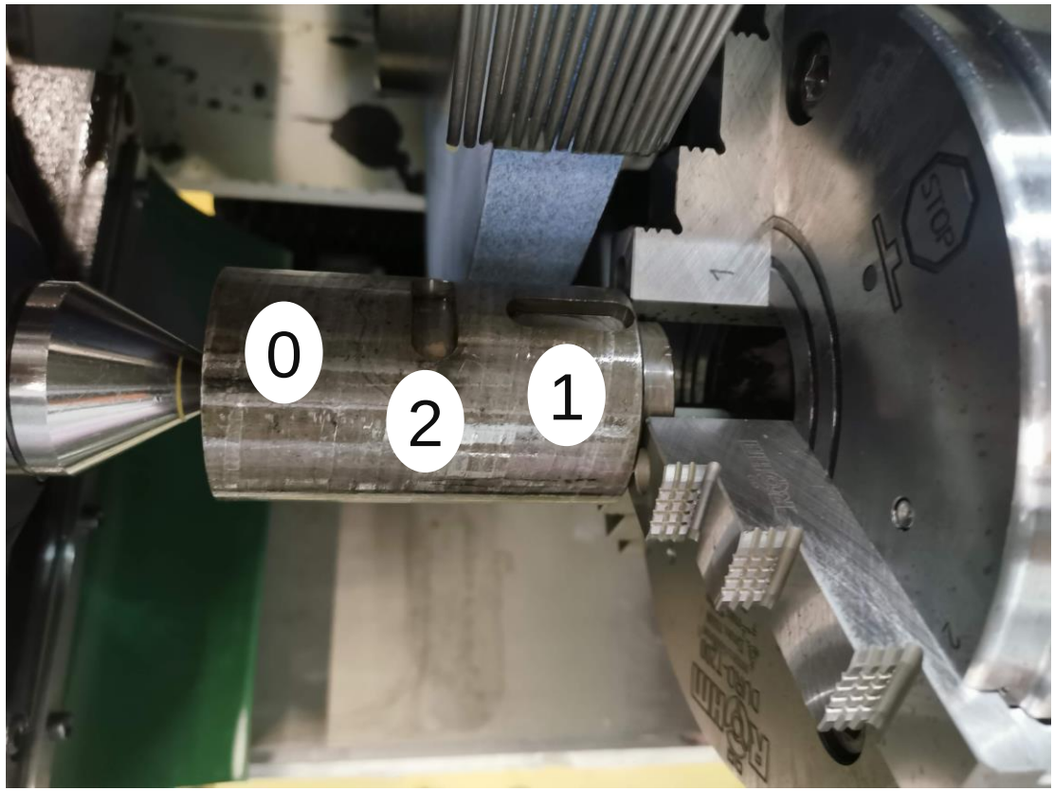
Smart Factory

Grinding Factory



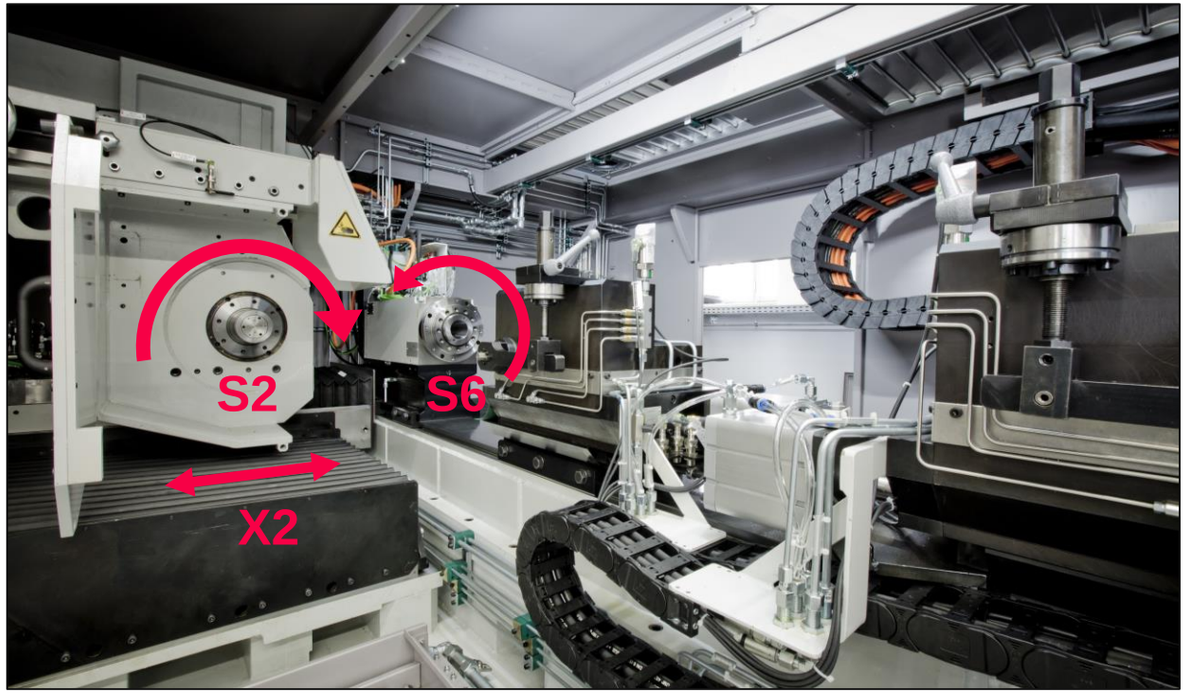
Hochfrequente Maschinendatenerfassung
P2D2 – **P**ower **P**rocessing for **D**efect **D**etection

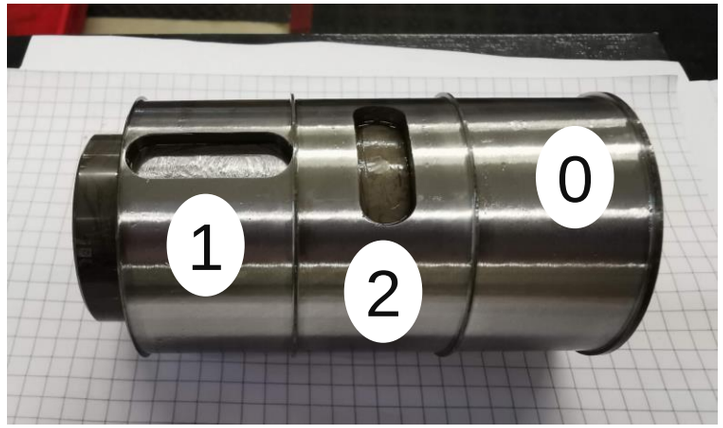




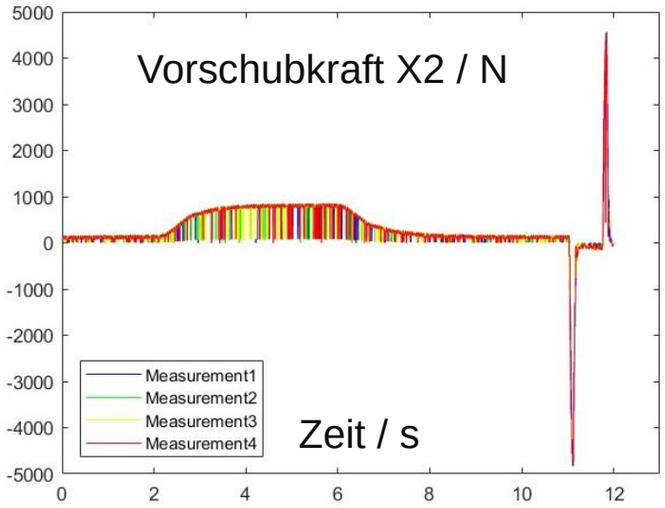
Messdaten

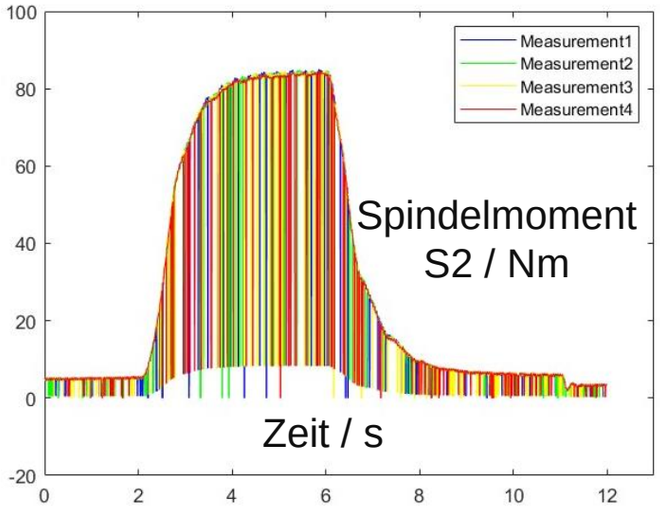
- Abtastrate 500 Hz, ta = 2 ms
- Messdaten des “Edge Devices”
  1. Vorschubkraft Linearachse X2
  2. Spindelmoment der Schleifscheibe S2 (Priorität 1)
  3. Spindelmoment des Werkstücks S6 (Priorität 2)
  4. Drehzahl S2
  5. Drehzahl S6
- Parameter: Vorschub, Drehzahlen, ..

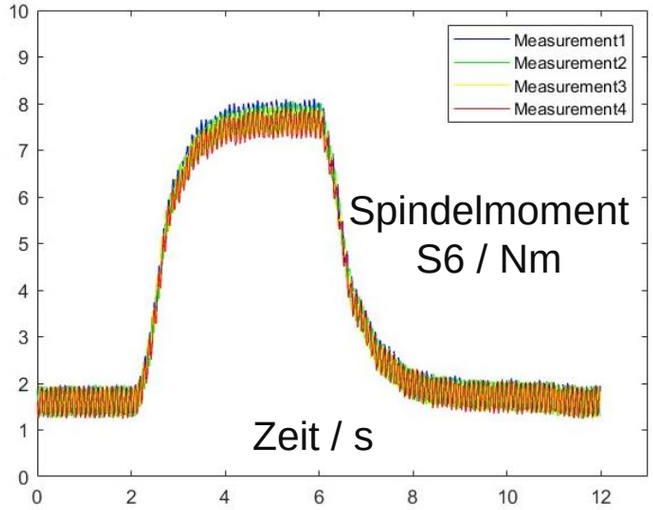


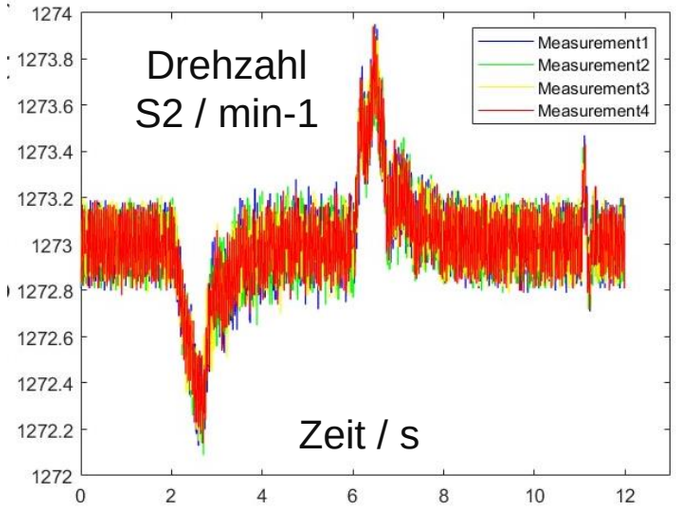


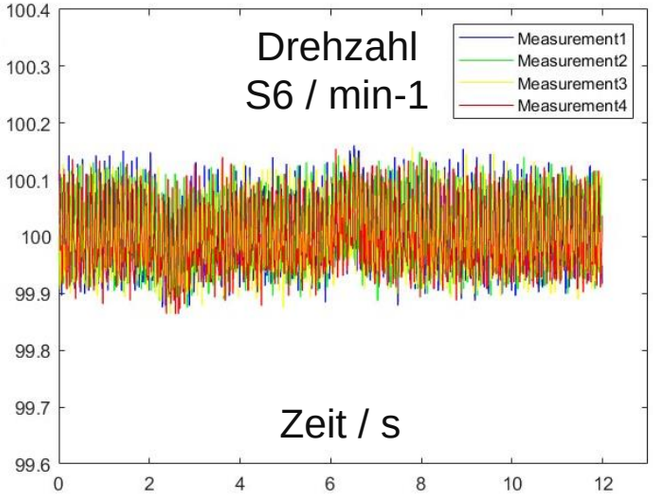
Referenzsignale (Data_0)



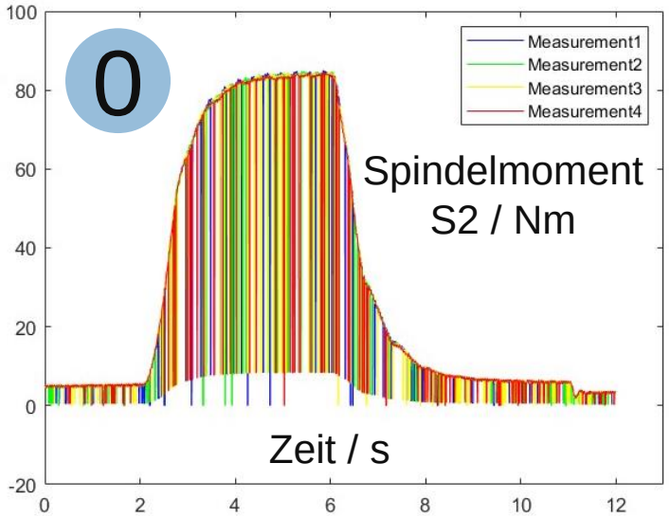


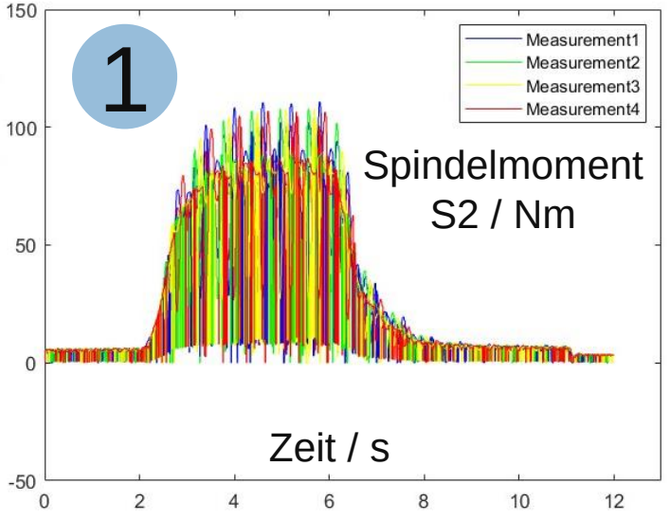


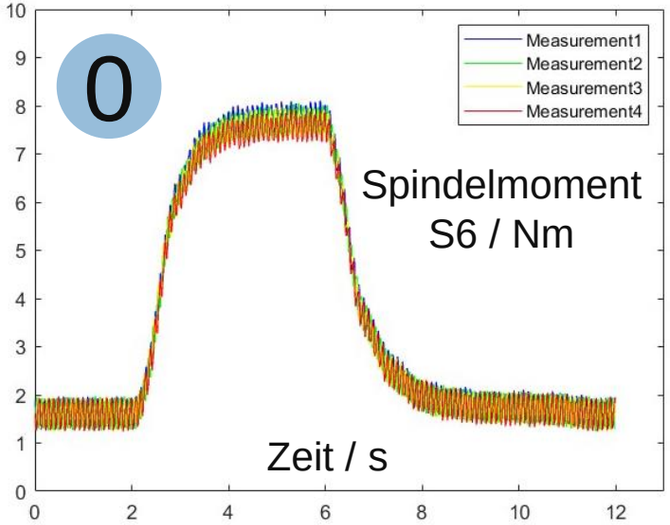


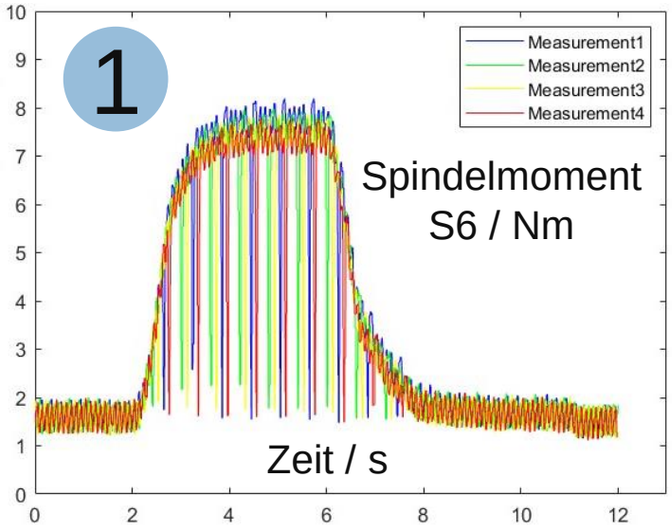


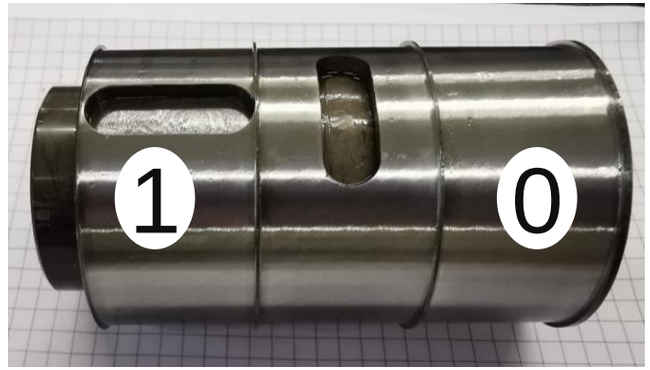
Drehmomente der Spindeln S2 und S6 (Data_0 vs. Data_1)



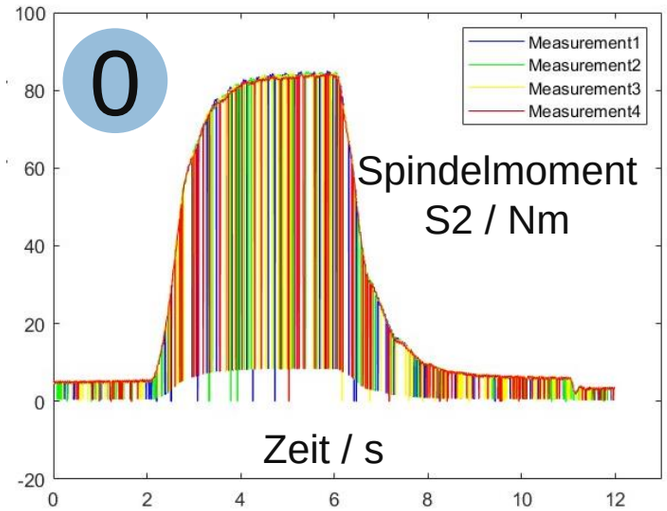


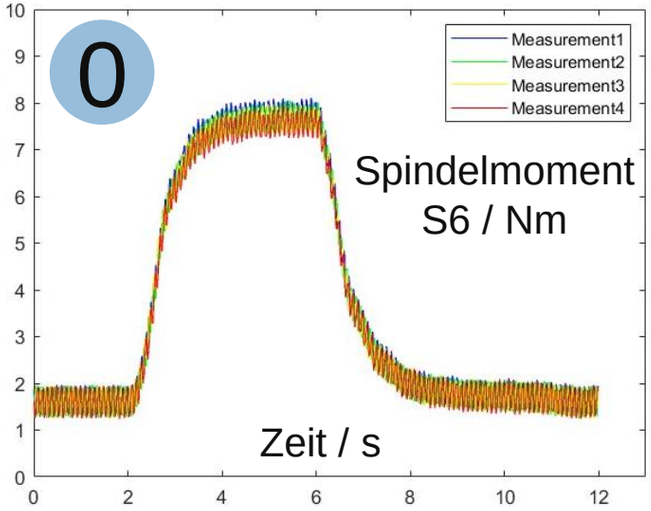


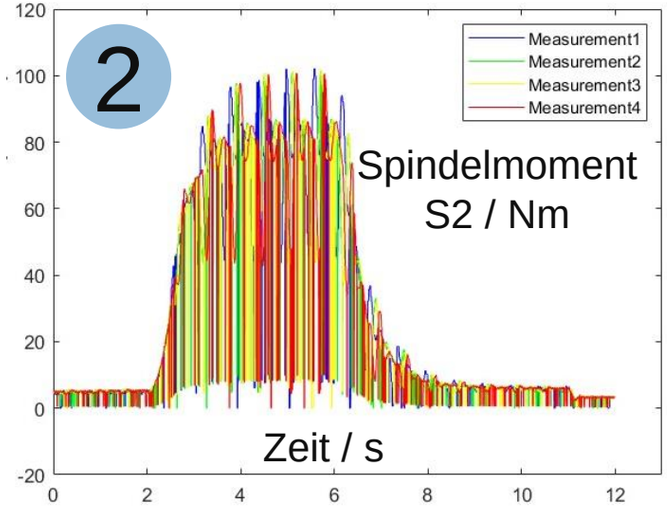


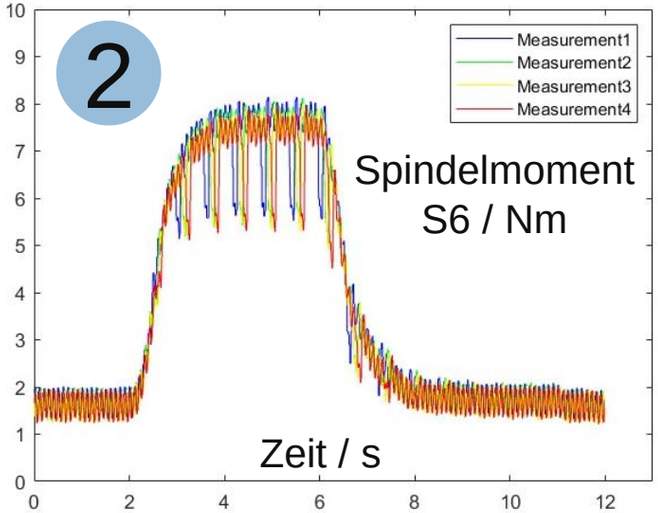


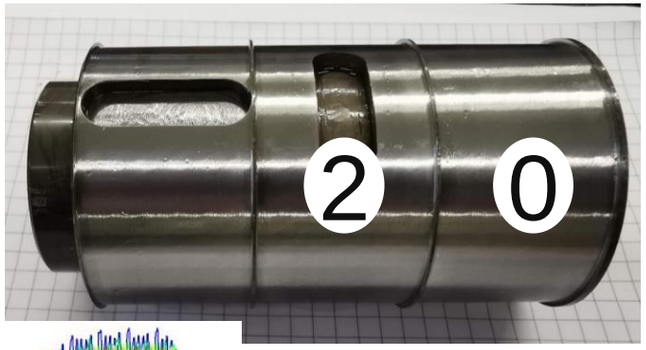
Drehmomente der Spindeln S2 und S6 (Data_0 vs. Data_2)

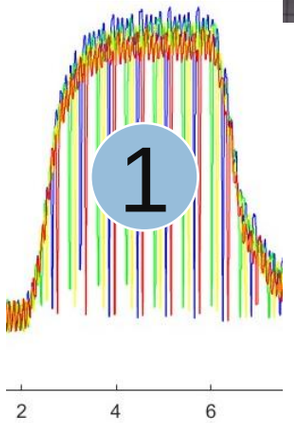




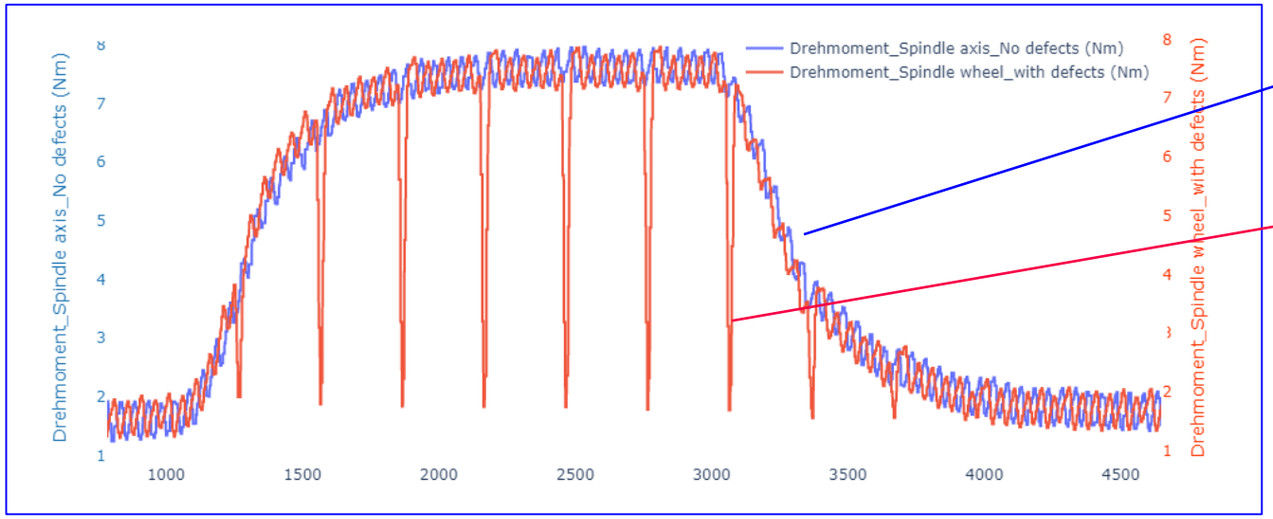






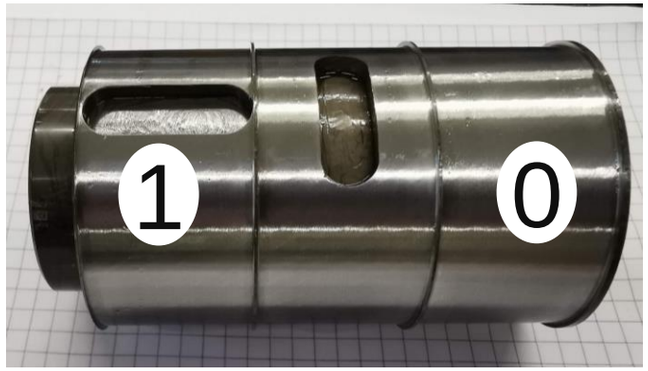


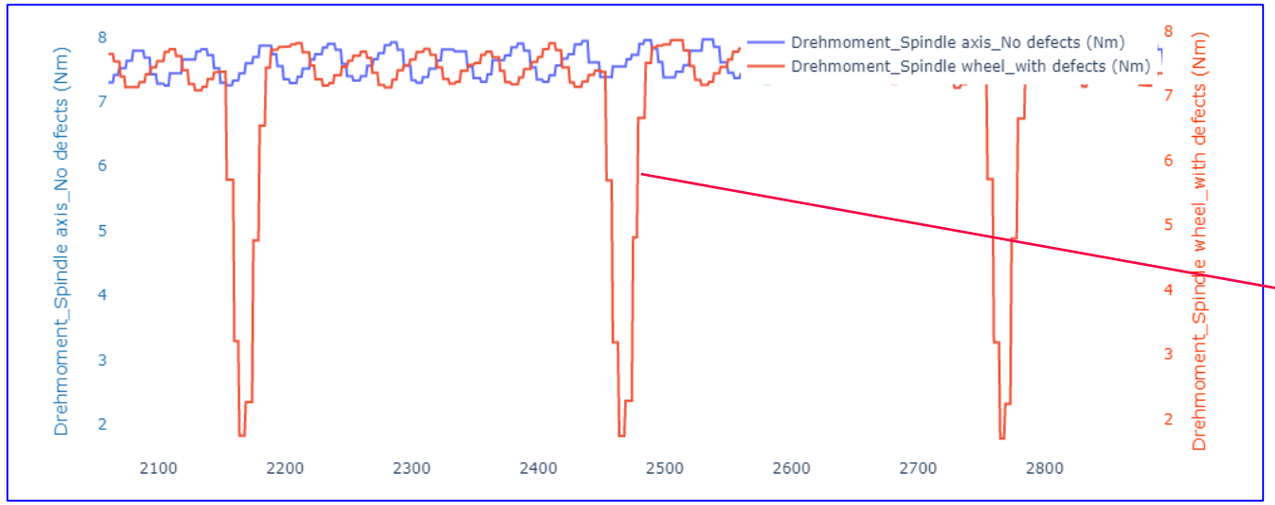
Werkstückmoment S6 (Data_0 vs. Data_1)



Blaue Kurve repräsentiert das Drehmoment ohne Defekte (Zone 0).

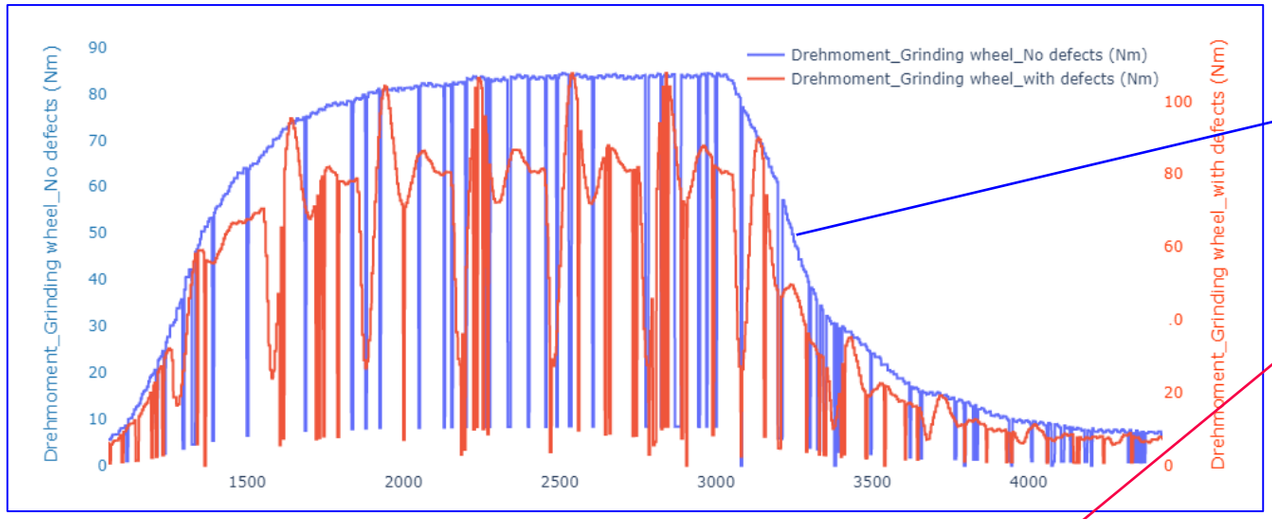
Rote Kurve repräsentiert das Drehmoment mit Längsnut (Zone 1) – periodische Signalschwankung.

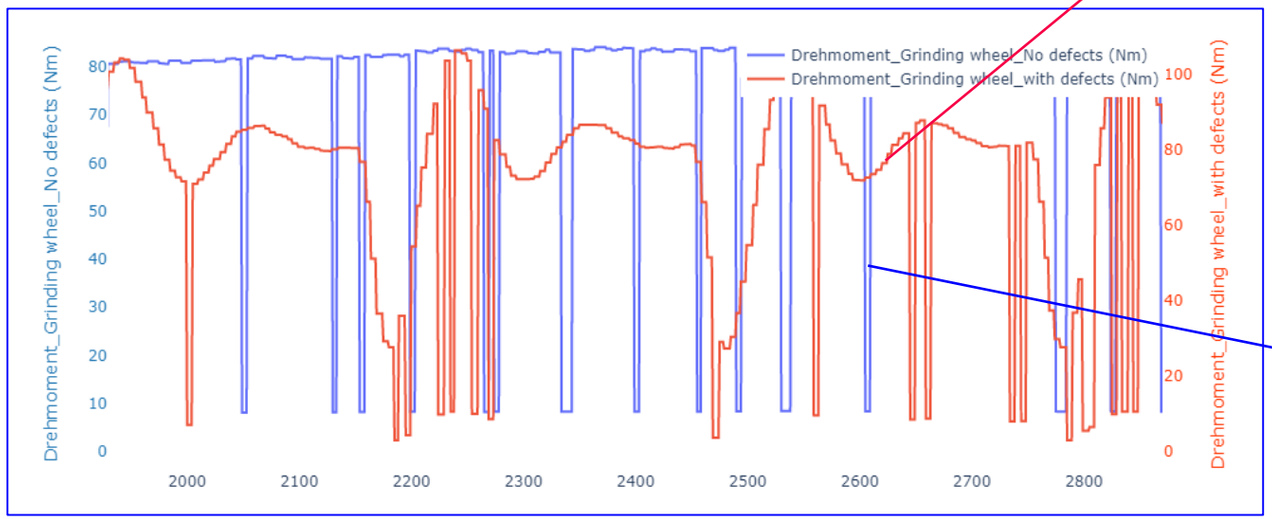




Vergrößerte Darstellung von drei Werkstückumdrehungen

Schleifspindelmoment S2 (Data_0 vs. Data_1)





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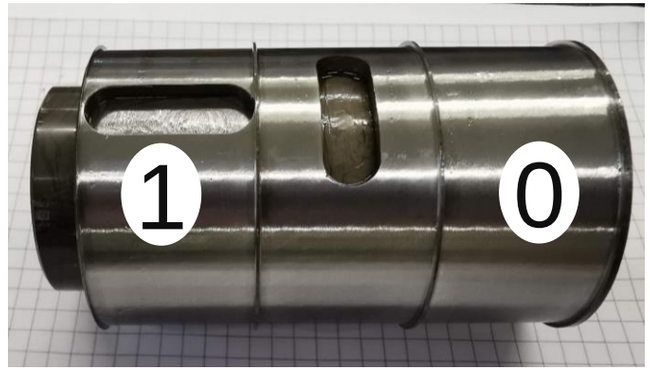
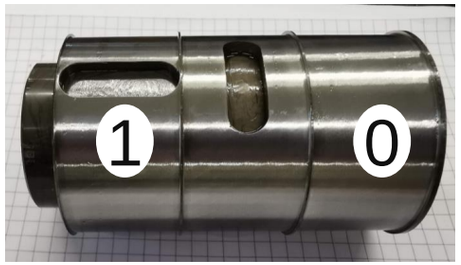
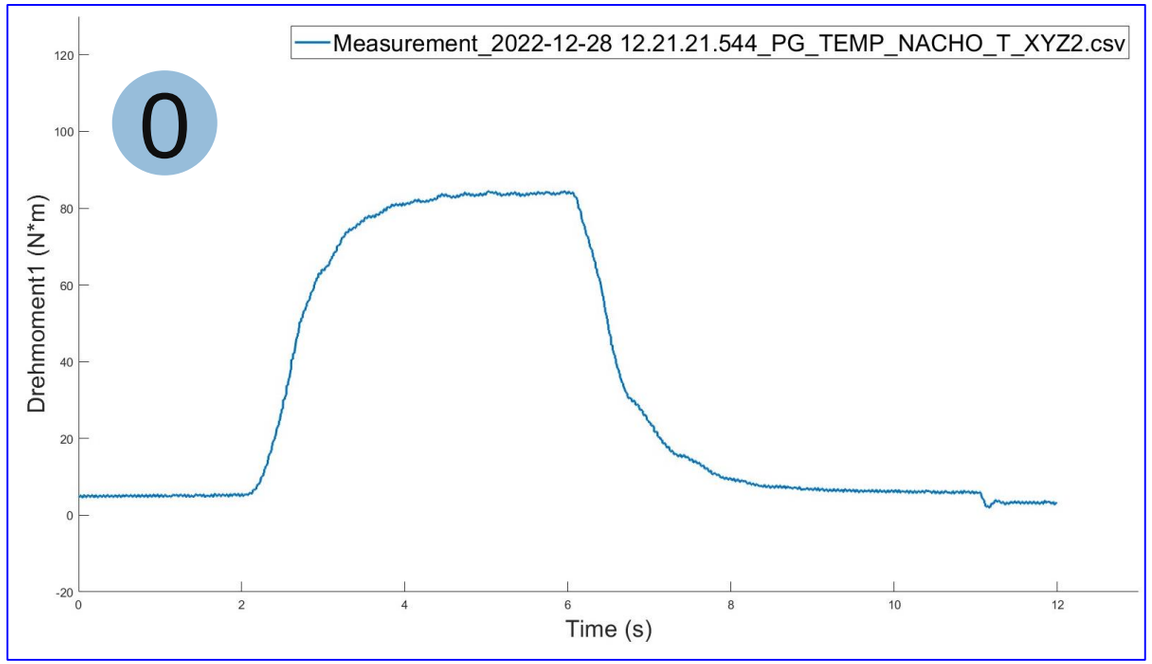


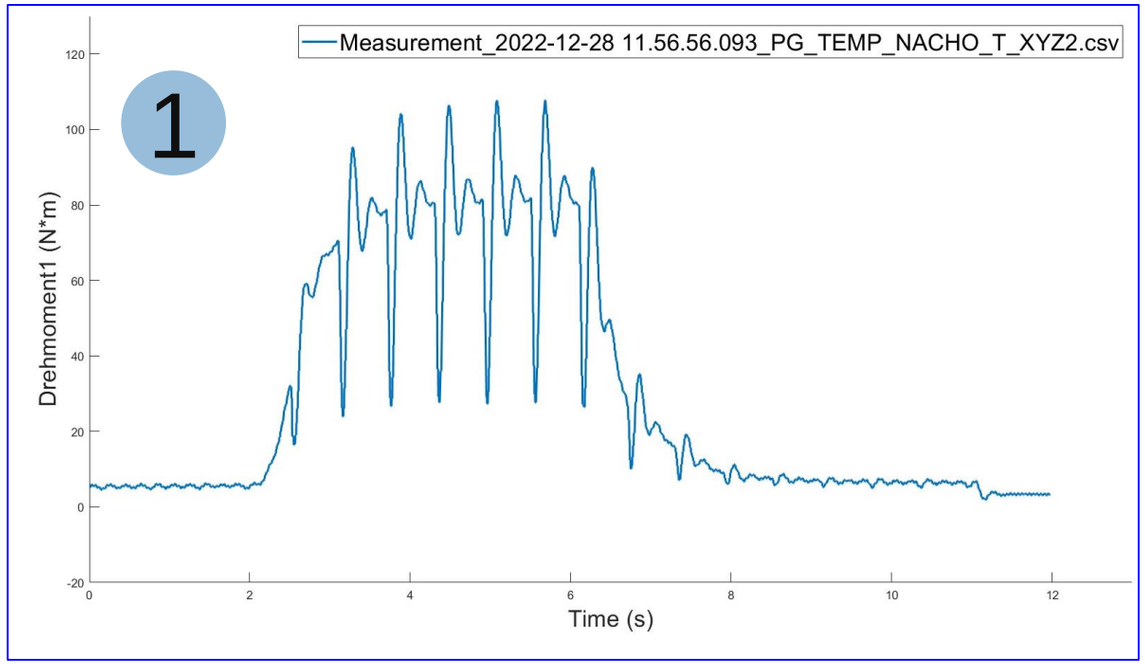
Rauschen des Signals als plötzlicher Abfall des Messwertes.

Schleifspindelmoment S2 (Data_0 vs. Data_1)



Signalrauschen wurde gefiltert.



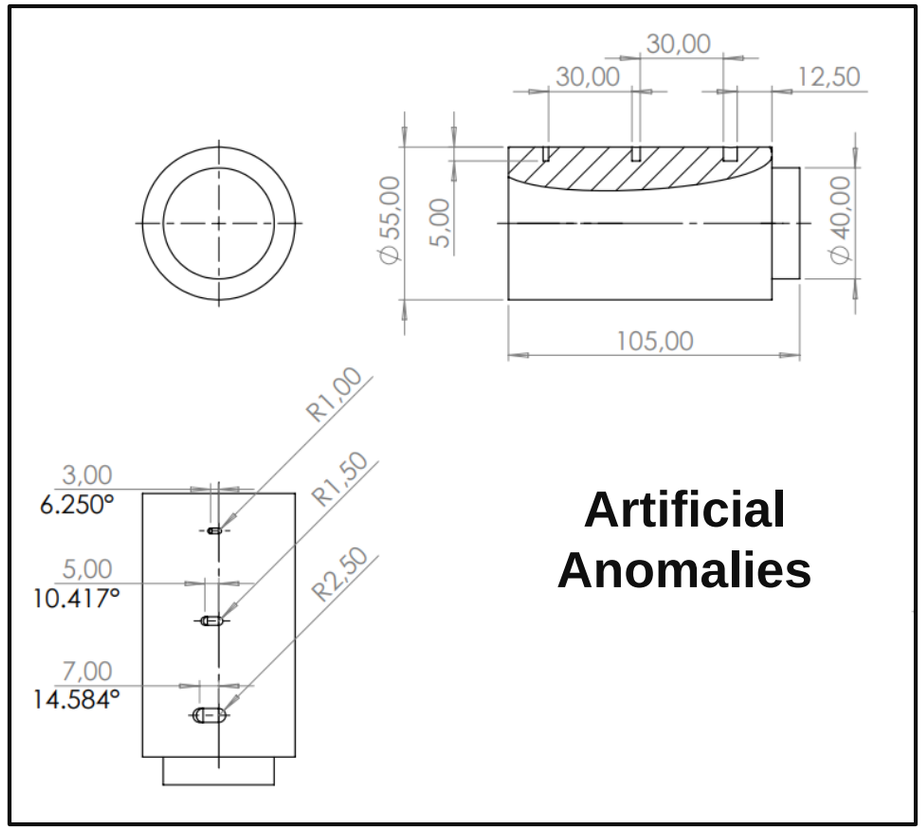


Algorithmen des “Machine Learnings” zur Anomalie-Detektion

1.Pearson Correlation Coefficient (PCC): Der Pearson Korrelationskoeffizient (r) ist eine Zahl zwischen -1 und 1, Maß für Stärke und Richtung der Beziehung zwischen zwei Variablen misst.
https://www.scribbr.com/statistics/pearson-correlation-coefficient/

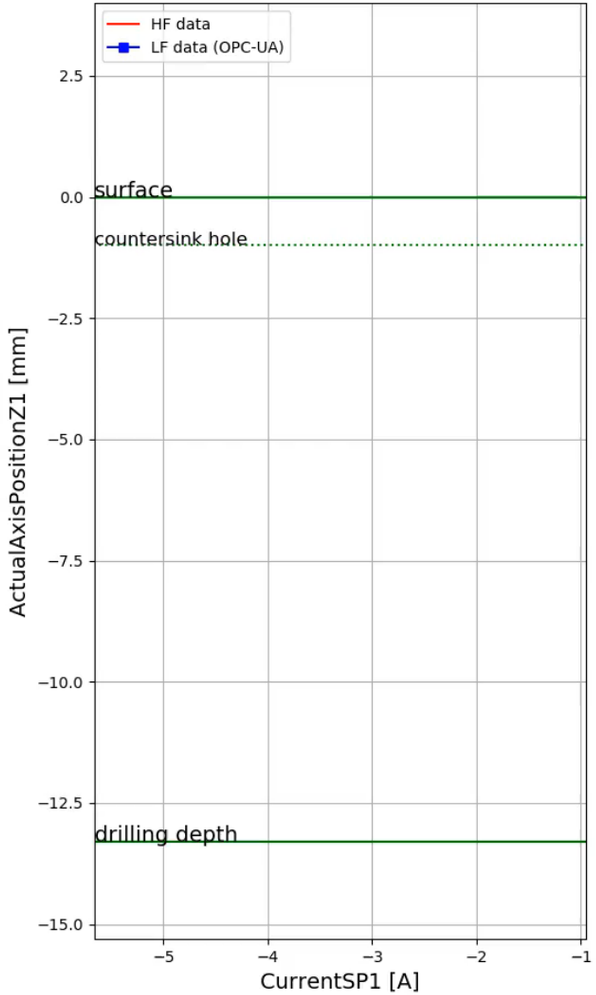
2. Linear regression:
https://www.scribbr.com/statistics/simple-linear-regression/

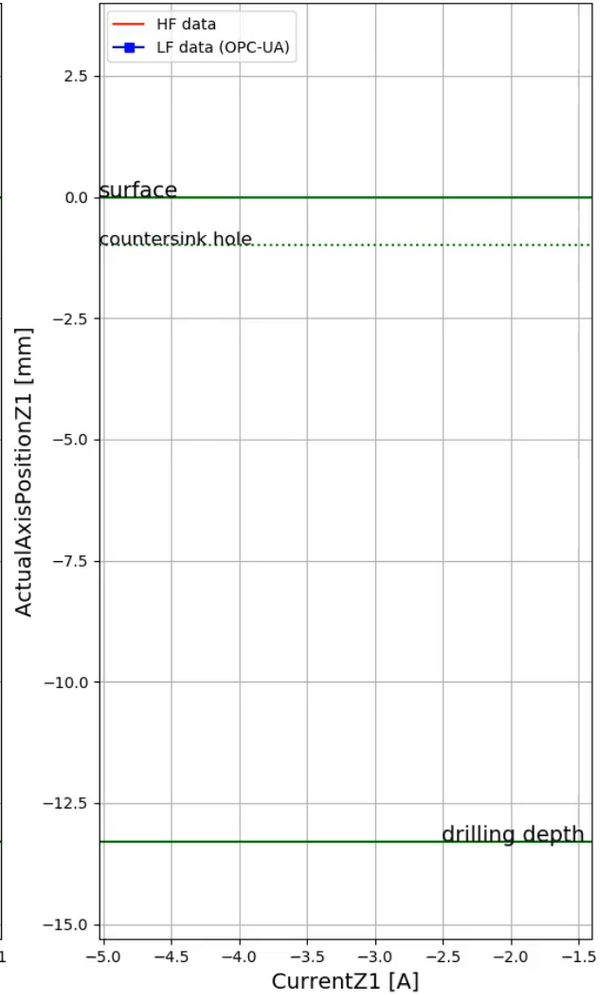
3. Isolation forest:
https://www.analyticsvidhya.com/blog/2021/07/anomaly-detection-using-isolation-forest-a-complete-guide/



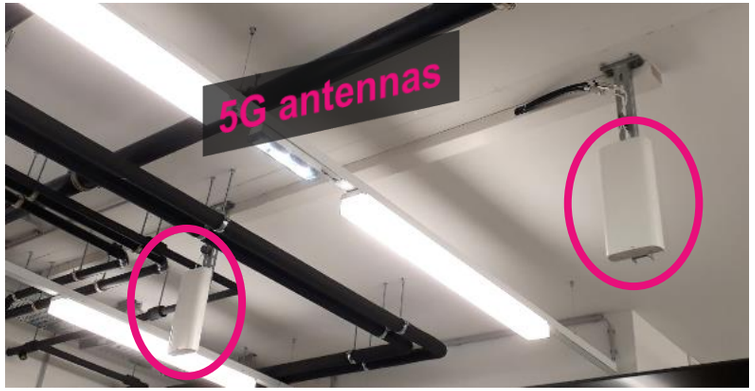
Vergleich: OPC-UA und „High Frequency Data“

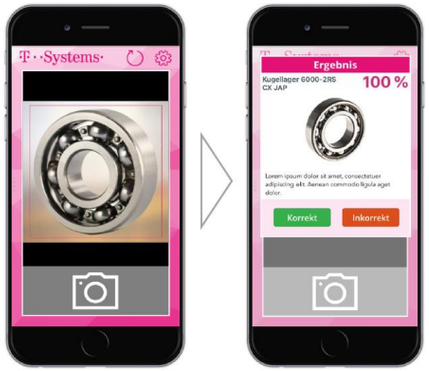
n = 13300 min^{-1}
f = 0,12 mm

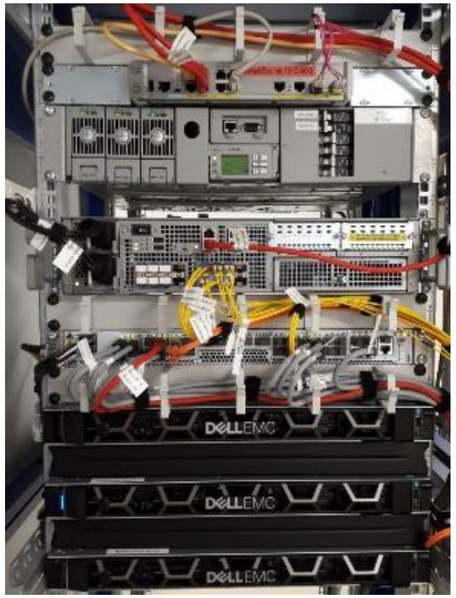




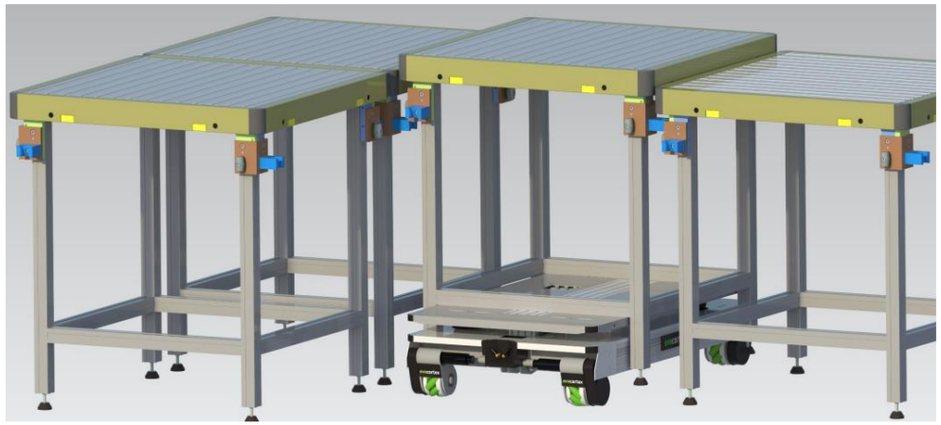
Vernetzung mit 5G Campus Netzwerk



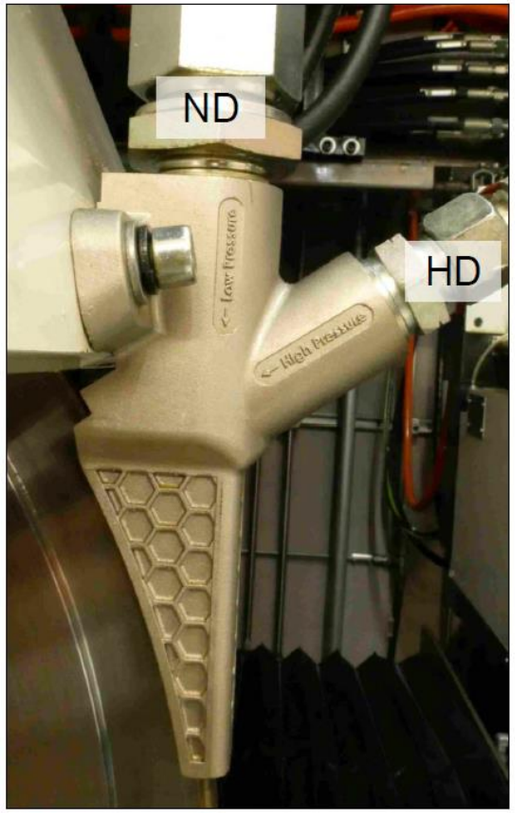


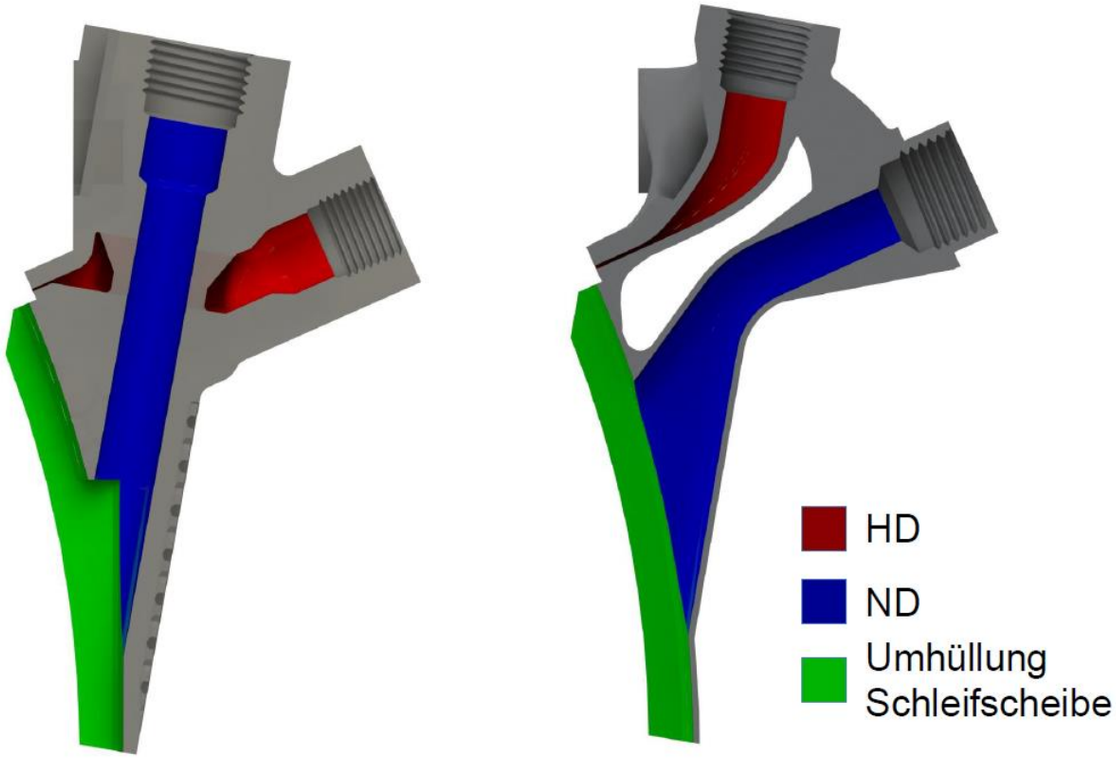


Selbst konfigurierbares Produktionssystem



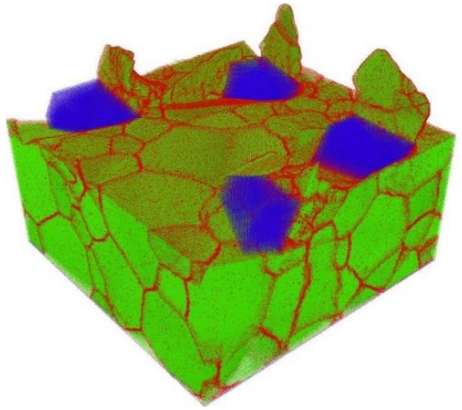
3D-Druck als „Enabler“ von Innovationen



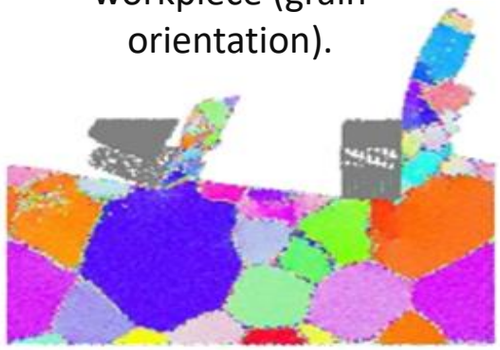


Virtualisierung – Prozess-Simulation

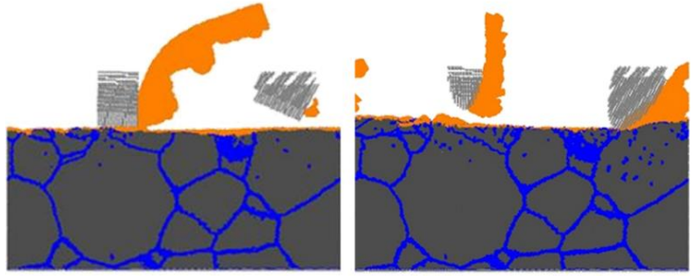
Sketch of a polycrystalline, periodic, ferritic workpiece.



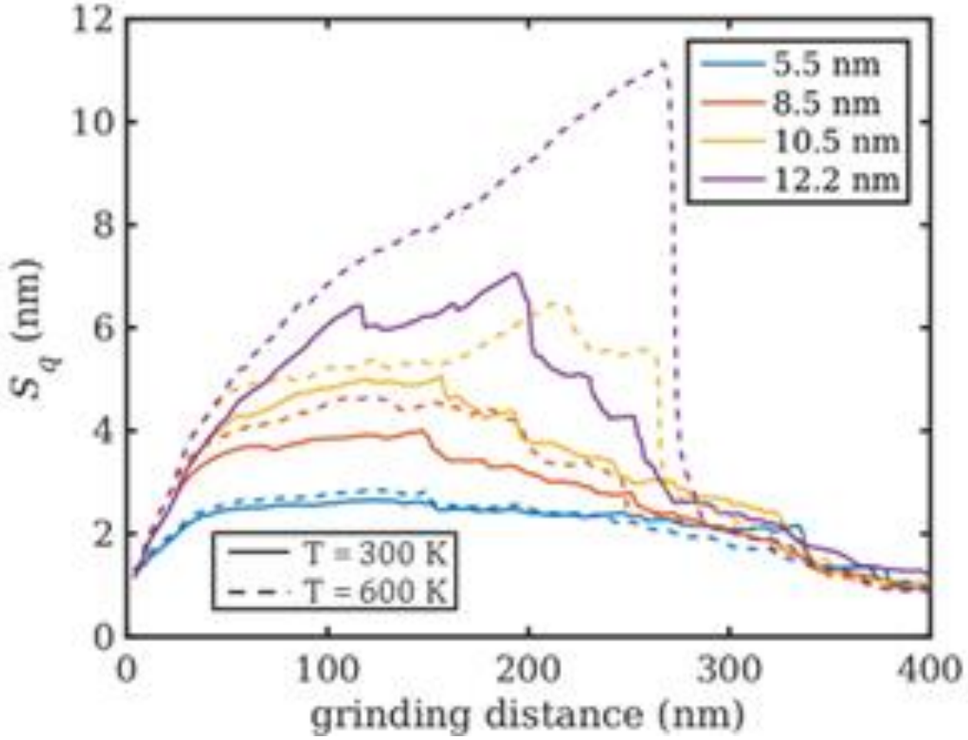
Representative tomographic section through the workpiece (grain orientation).



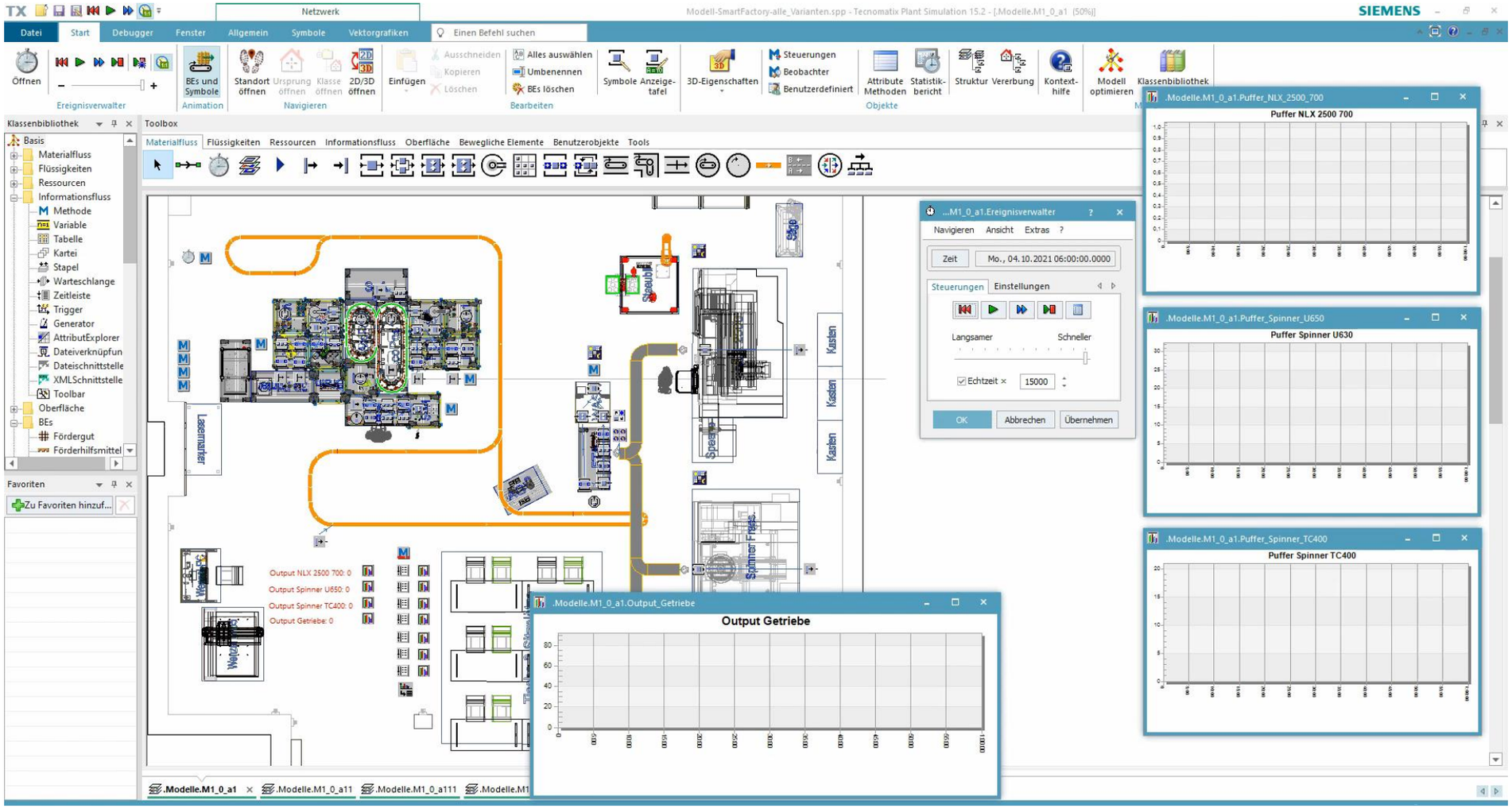
Chip (orange) formation with sharp (LEFT) and blunt (RIGHT) abrasives.



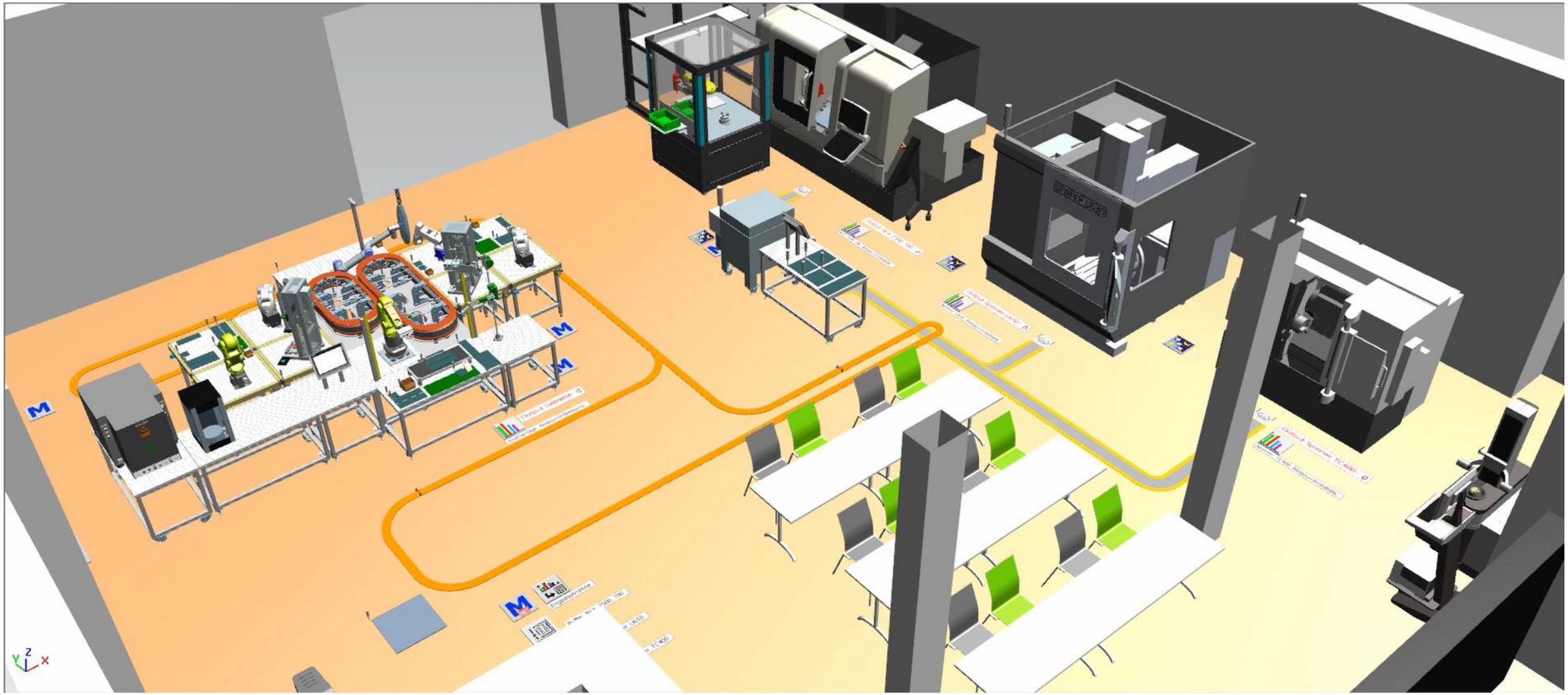
Development of the surface roughness (Sq)



Virtualisierung – Produktions-Simulation (2D)



Virtualisierung – Produktions-Simulation (3D)



We ~~turn~~ it into REALITY.

grind

Resource-efficient
Economic
Autonomous
Liveable