ADVANDECED APPROACH TO ELIMINATE PULSATION BEHAVIOR OF A SINGLE SCREW EXTRUDER IN DIRECT EXTRUSION 3D PRINTING

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Agenda

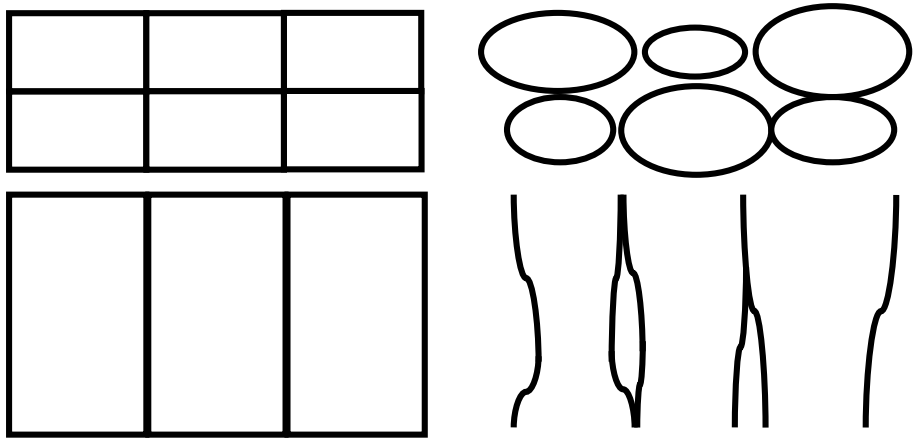
- Introduction
- Current status
- What is the problem?
- What are possible approaches to solve it?
- Experimental evaluation of the approaches
- Discussion of the results

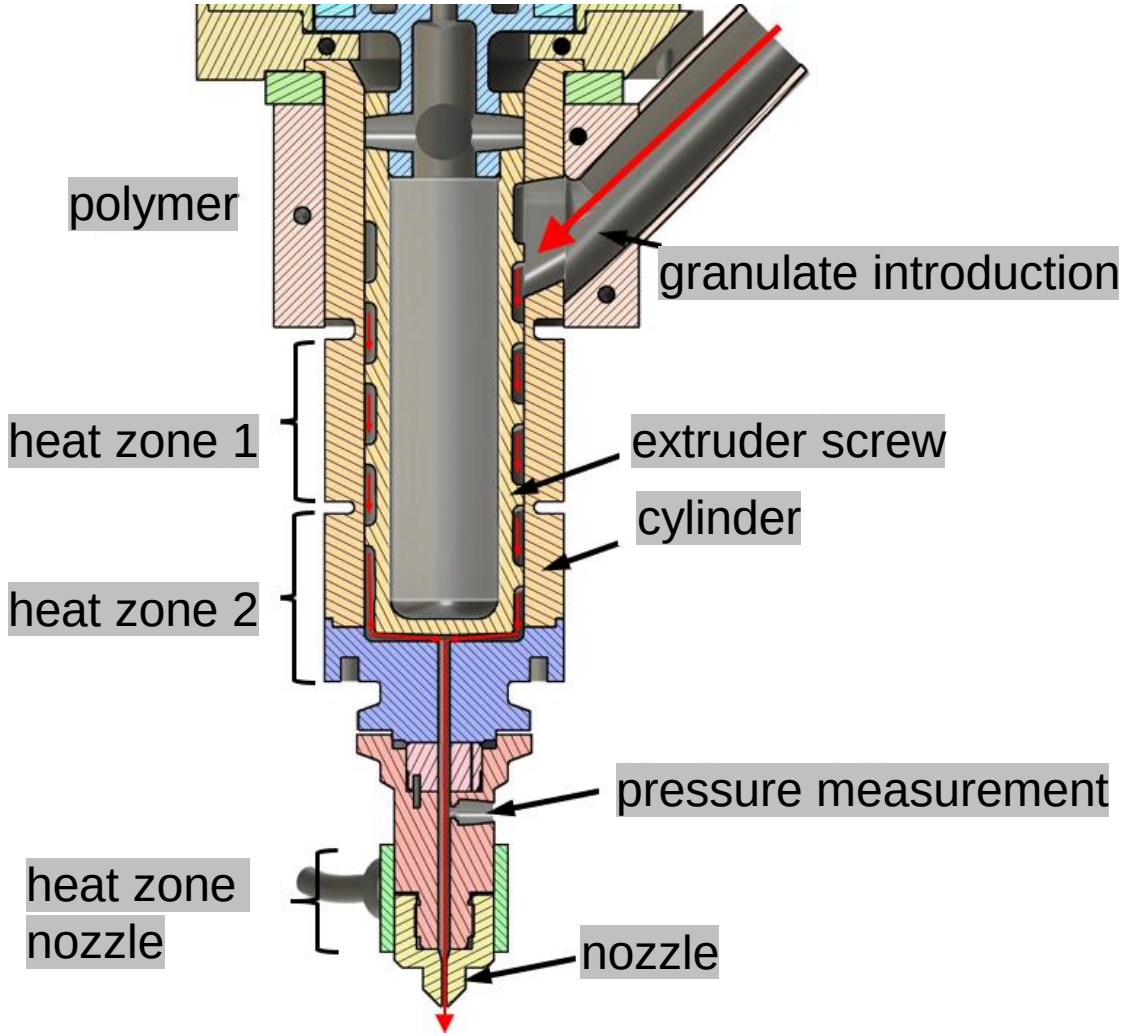
Introduction

Extrusion process

- Single screw extruder
- Plate plasticization

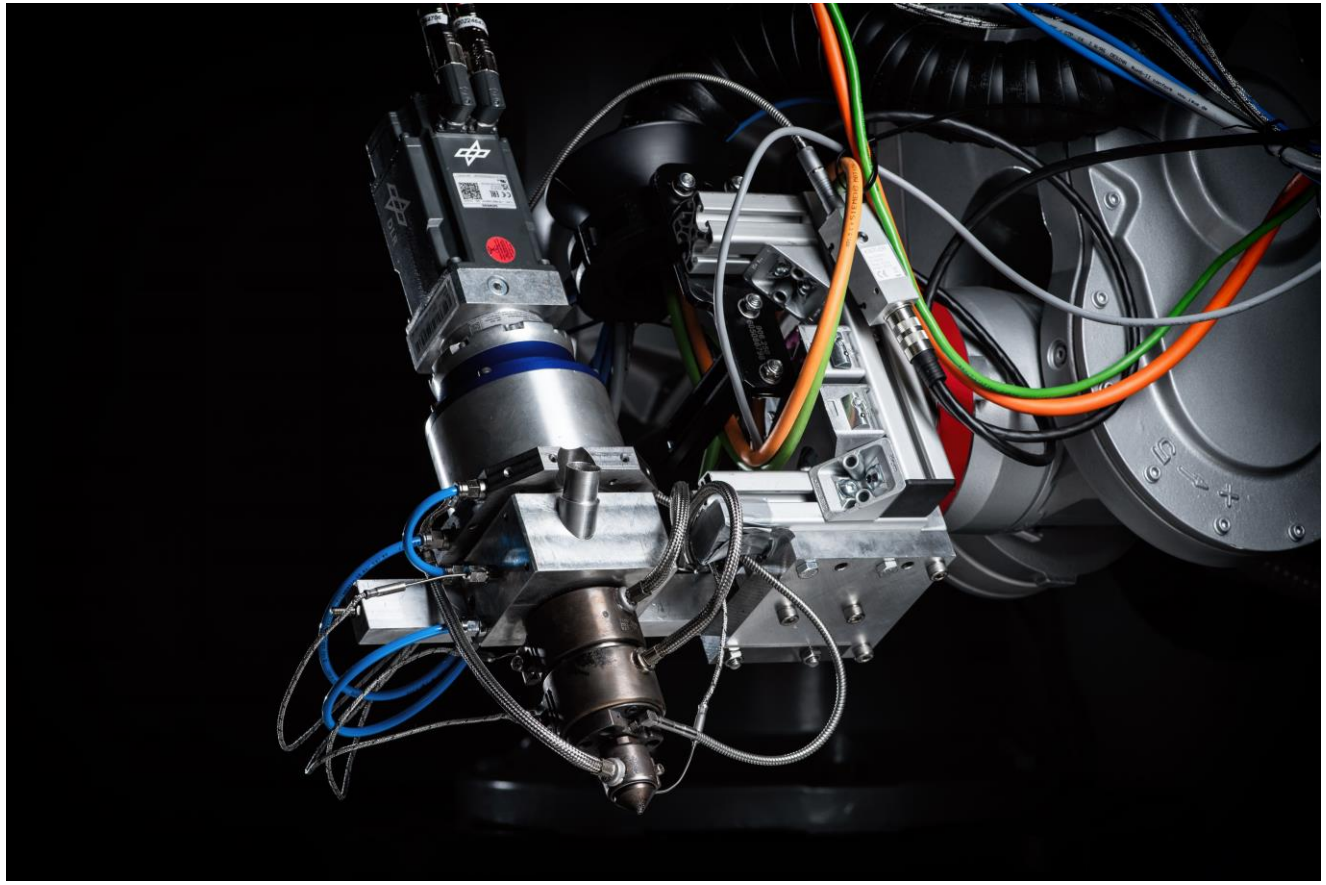
Idealized vs. real extrusion





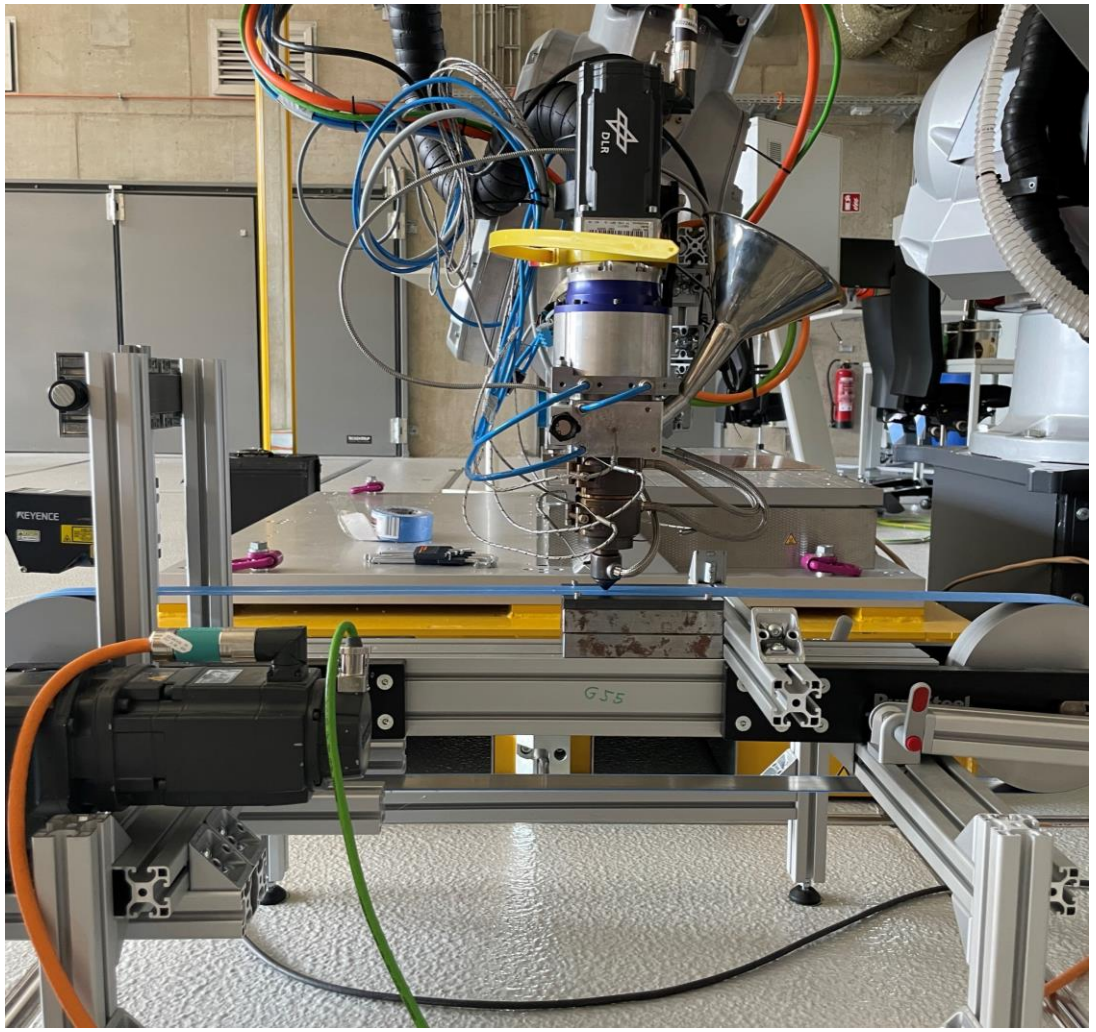
Current status

- Use E-factor and speed to control for extrusion
- No melt flow control mechanism
- Speed steps are hard to use without a decrease in quality



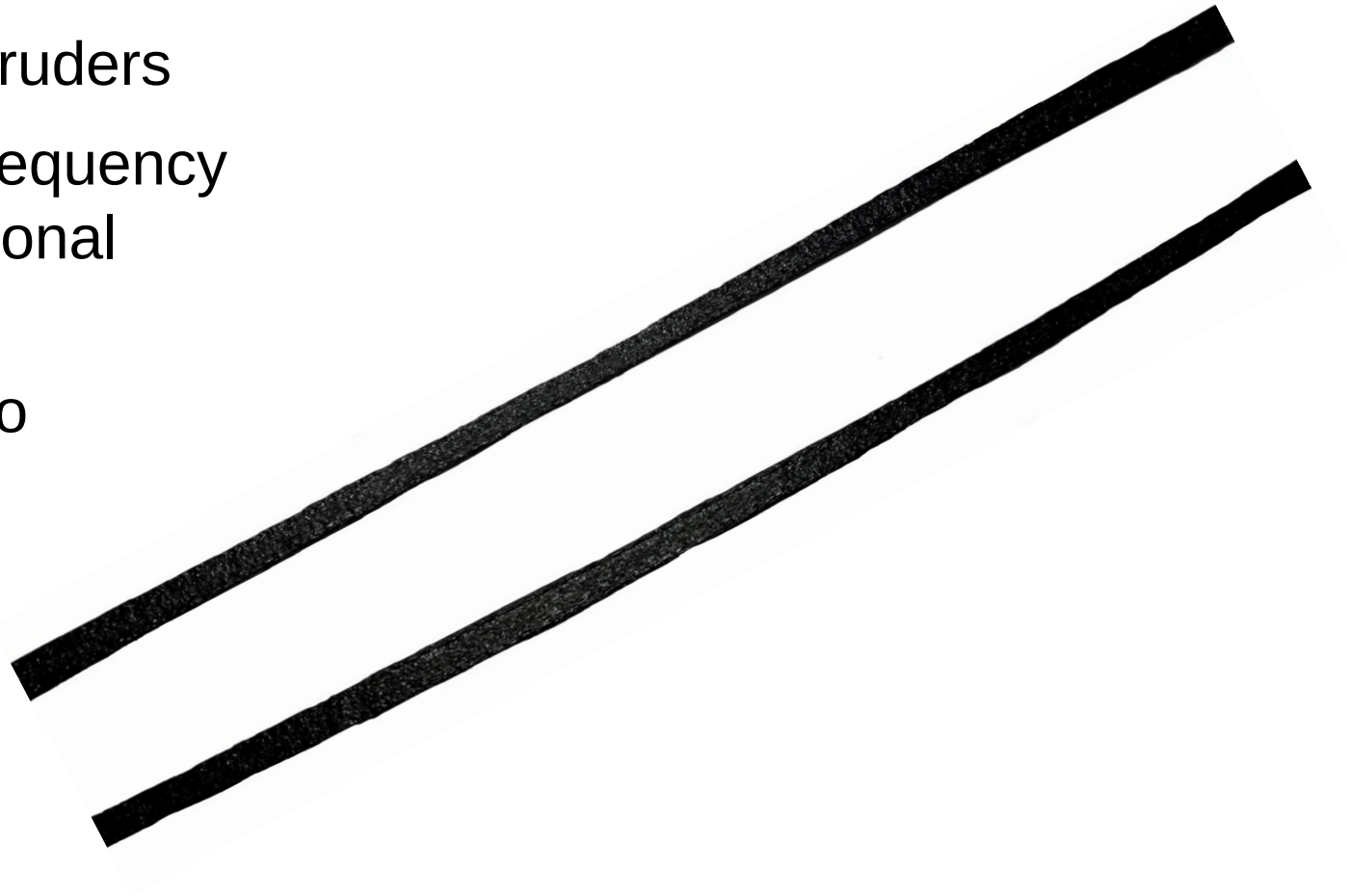
Measuring setup

- External measuring setup
- Measurement:
  - Height/width/area of polymer bed
  - Melt pressure
  - Screw angle
  - Drive torque load
- Time synchronization of robot and measuring setup



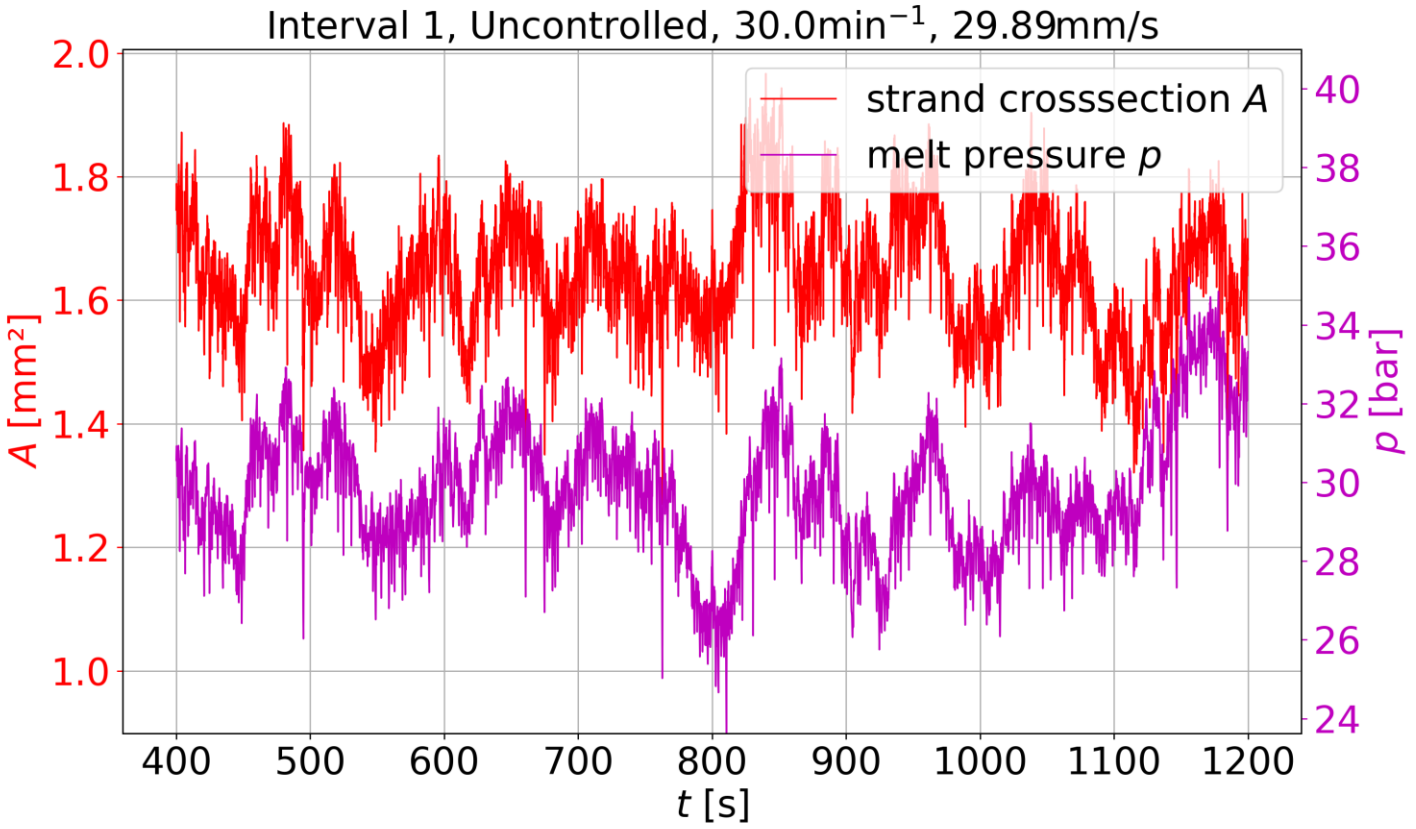
What is the problem?

- Pulsation of single screw extruders
- Global oscillating and high frequency scattering of melt cross-sectional area
- Height and with distribution to nominal geometry
- Uneven thickness of walls
- Captured voids
- Not 100% predictable



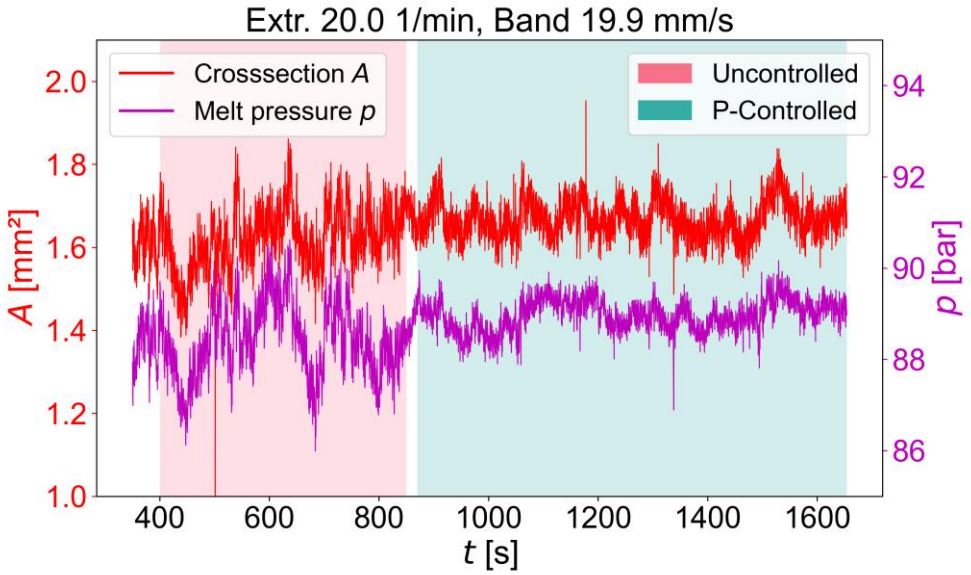
Procedure

- Find correlation between different data streams
- Correlation between nozzle pressure and areal pulsation: 94%
- Frequency analysis show superposition of pulsation

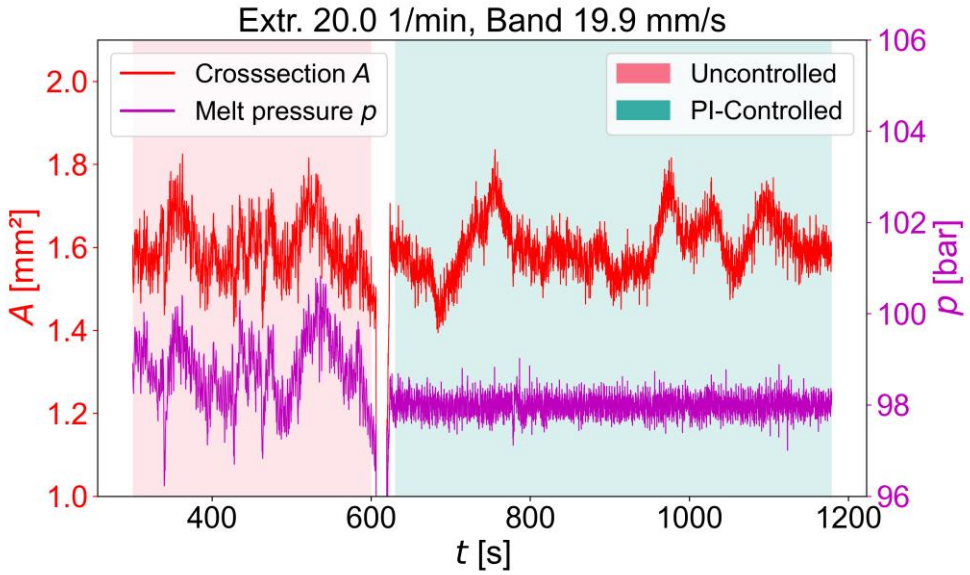


Different controller strategies

P-control



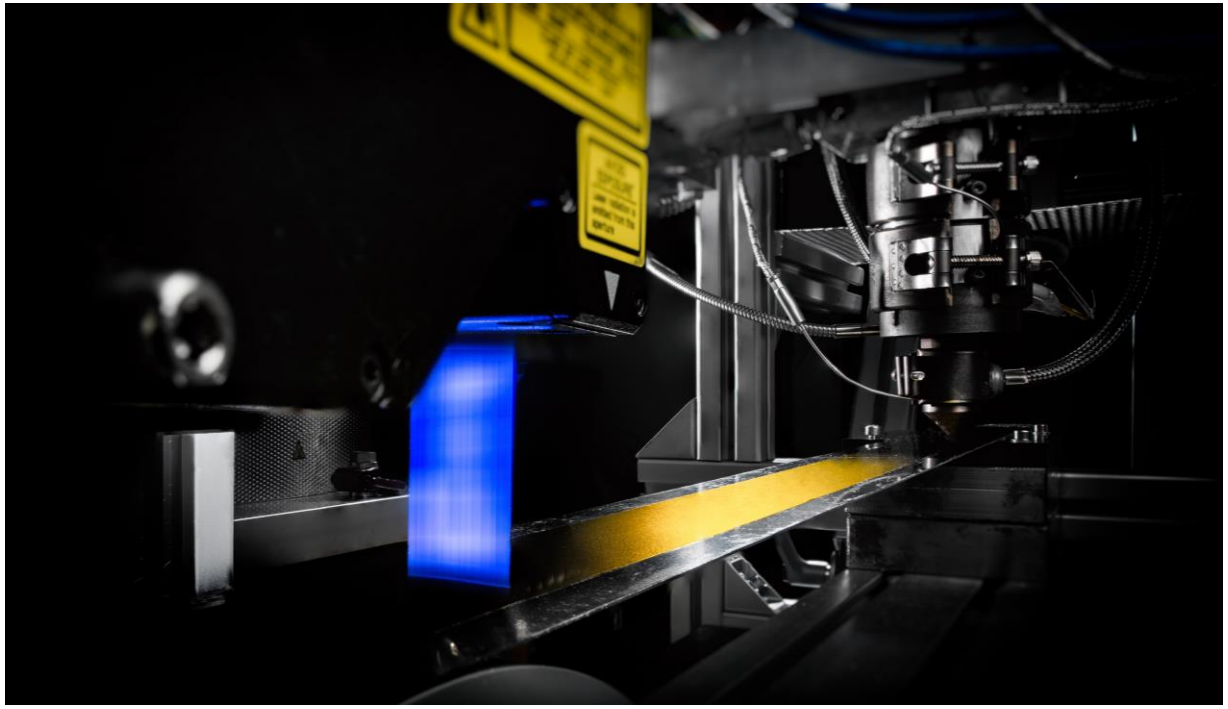
PI-control



- Improvement $\sigma(A)$ so far: 38%
- Perspective: additional feed-forward control of screw speed
- Control parameter: Pressure, Control aim: Cross-sectional Area

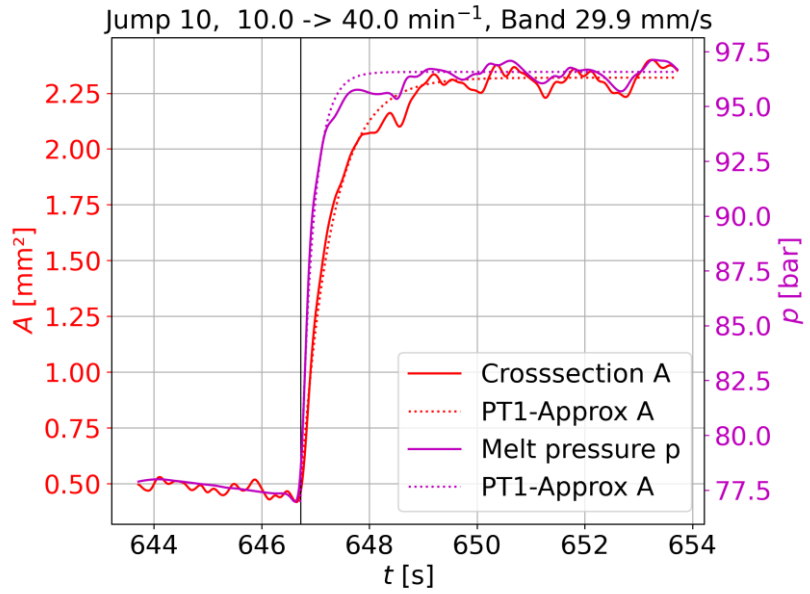
Current tasks

- Different control strategies result in different amplitude reduction
- Pressure as a control parameter reduces the amplitudes of the area
- Implementation of combined control and pre-control mechanism
- Generate data sets for different materials

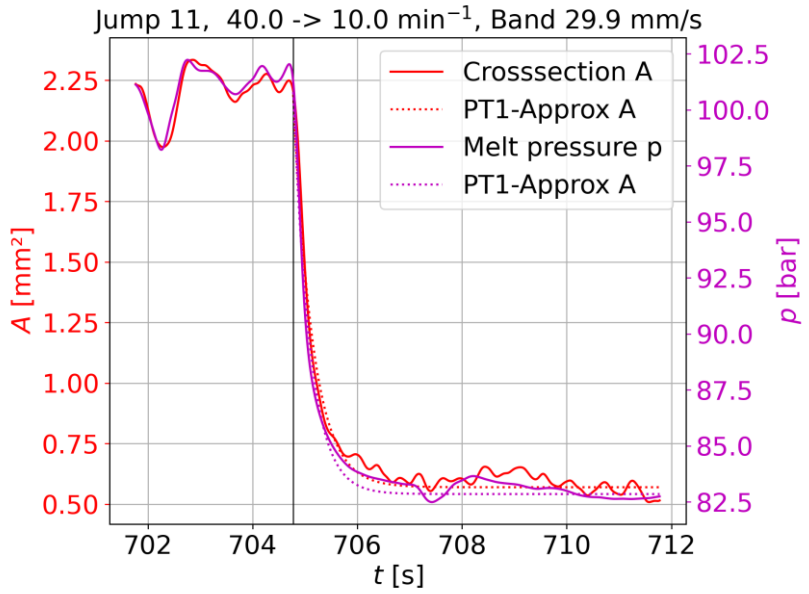


Currents tasks

Ramp-up



Oozing



- Improve pre-control for flow ramp-up and oozing behavior

Summary

- It is possible to find an inline parameter for melt-flow distribution
- Long- and short term pulsation combine and need to be tackled with a combined approach of control and pre-control
- Oozing and Ramp-up can be improved similarly

- ~40% improvement so far -- and there is more to come

THANK YOU