From Coil to Press: Intelligent Inline Monitoring of Strip Behaviour in Forming Processes

Ondřej Vitoslavský

Our Projects

AIStraight   –   In progress

SmartCushionPin   –   Completed

What can go wrong in sheet metal forming

- Thickness variations
- Flatness/waviness
- Residual stresses/tension
- Everything

Wrinkling

Tearing

Unstable feeding

Springback

Monitor the strip along the whole process chain

- Without monitoring scrap rates up to **~15% in production**

- Goal is simple = Zero defect

- What is already measured?

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Rolling Mill

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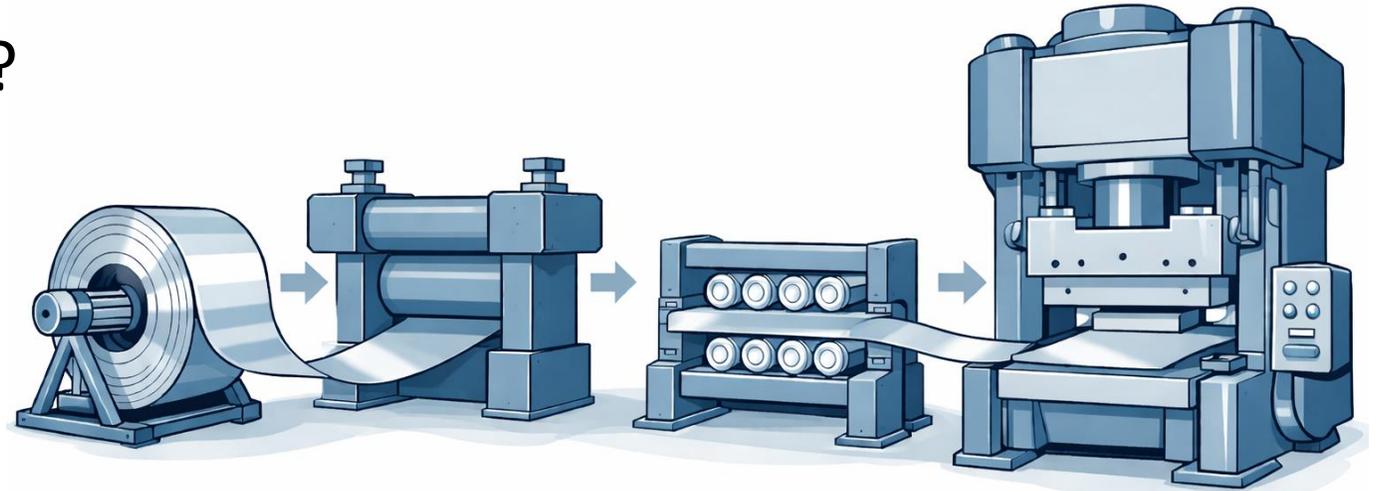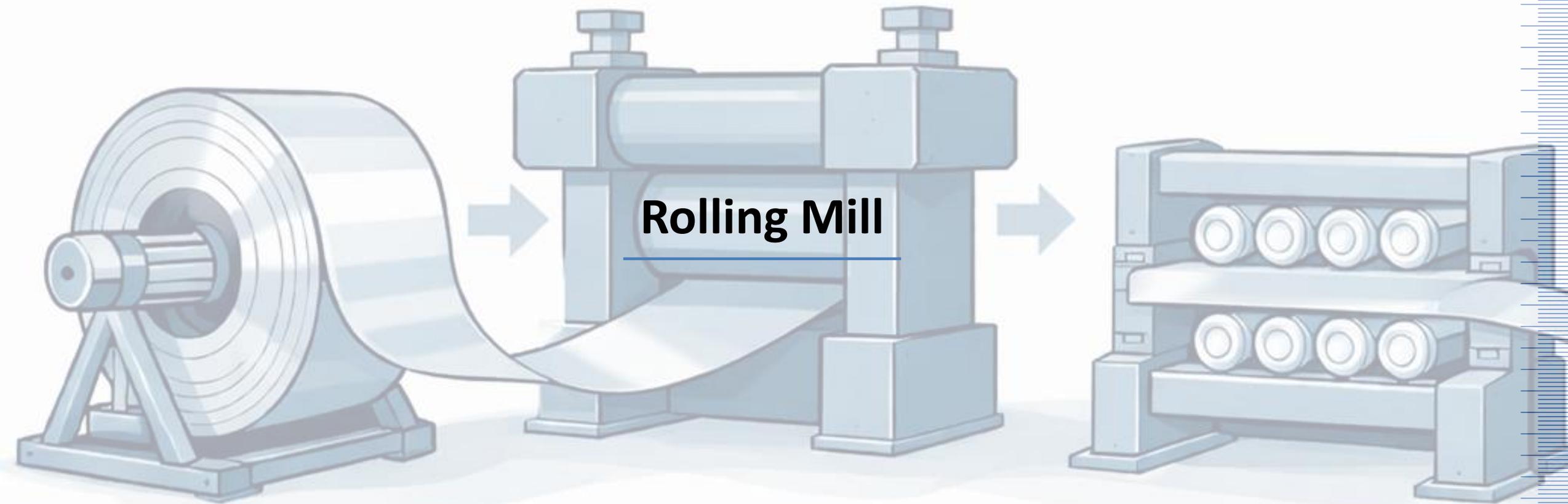
Thickness variations

- General strip thickness

- Controlled by AGC – Automatic Gauge Control

- Variation in forming forces

- Change in springback

- Double-checking before pressing machine

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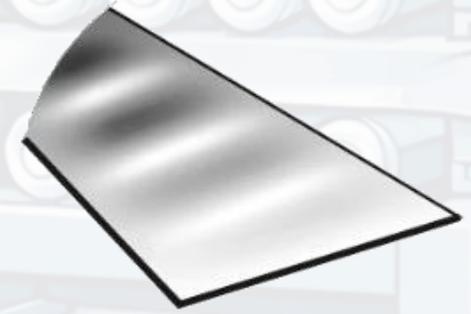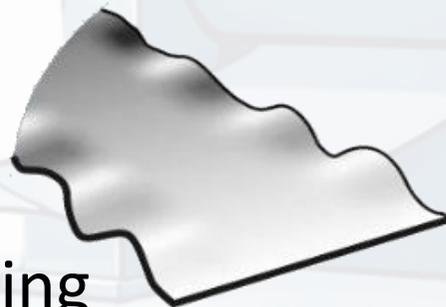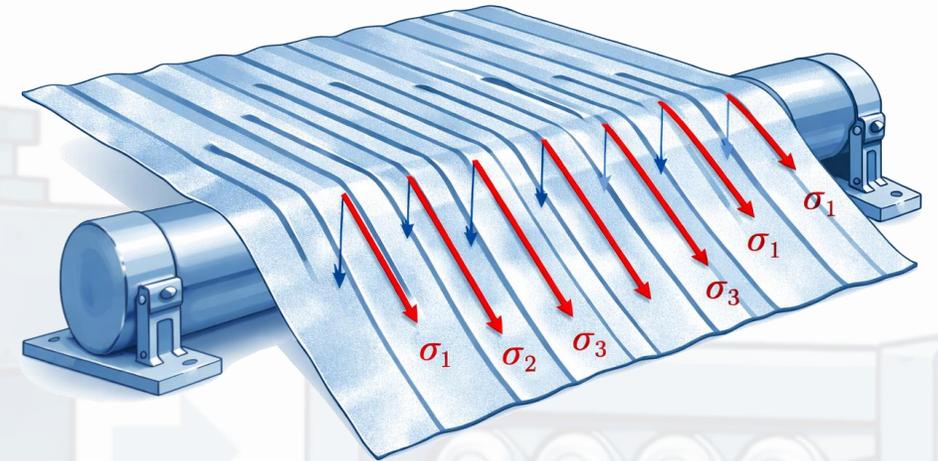
Thickness variations

- Thickness profile across the width

- Mostly done offline
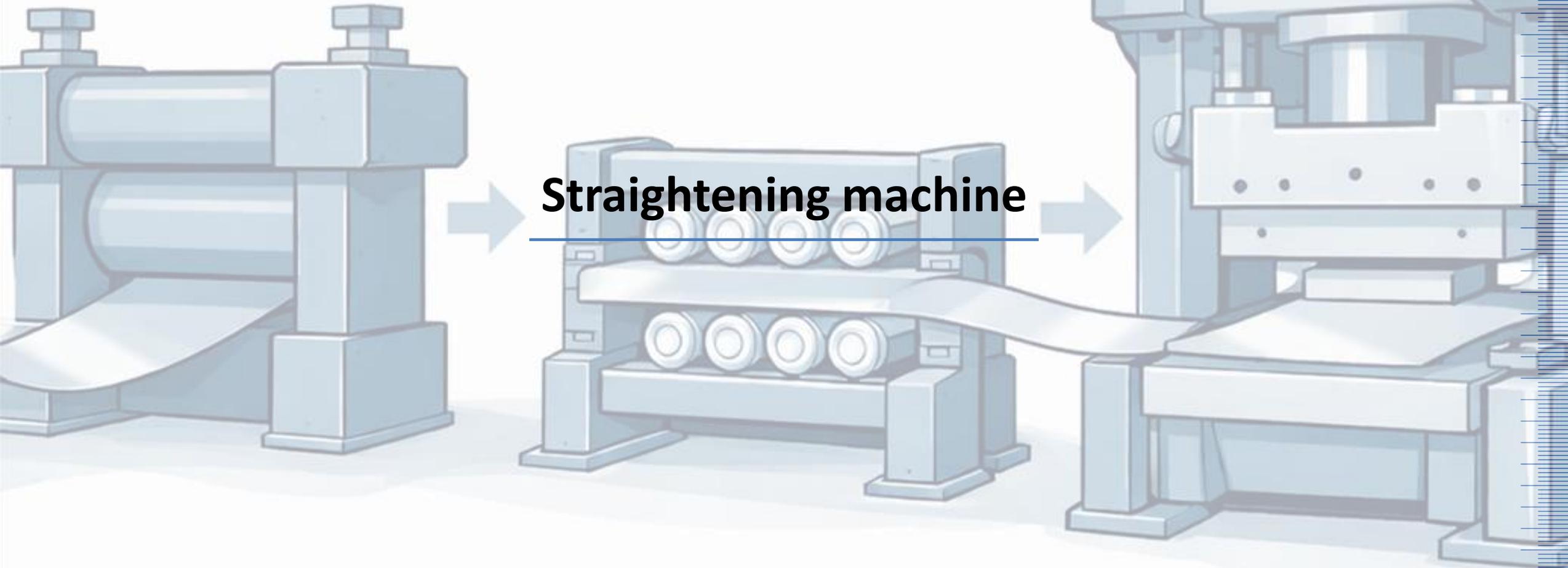
- Pressing machine overload

- Tool damage

Strip thickness profile
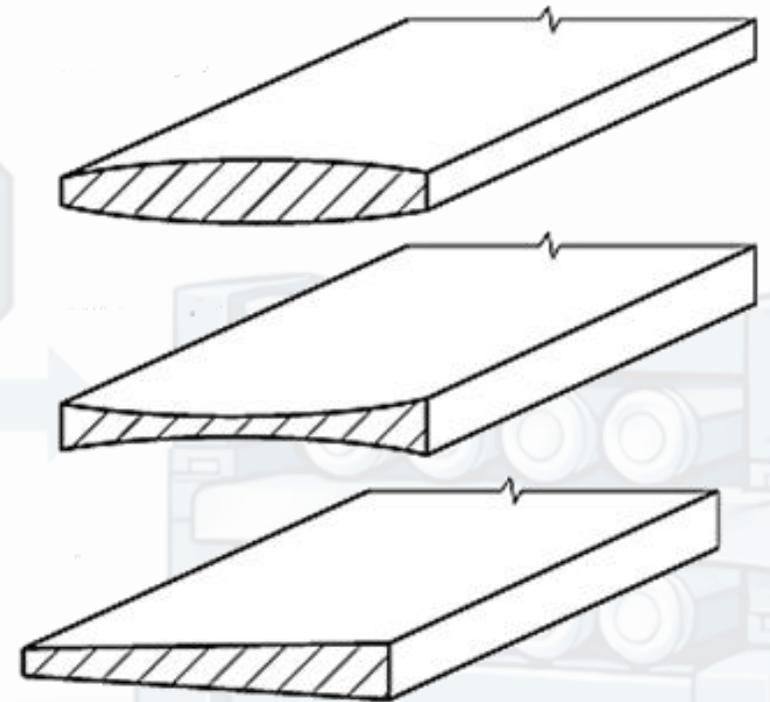
Flatness and tension distribution

- Strip flatness

- Tension distribution across the width

- Waves in the strip

- Unstable feeding

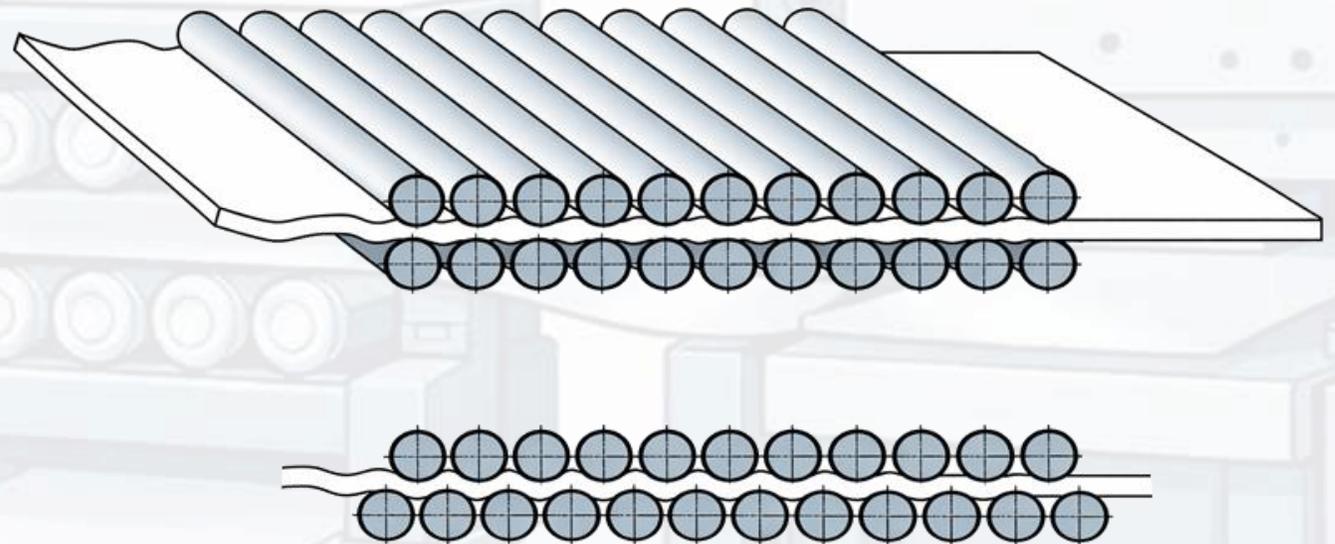- Uneven forming

- Asymmetric tool loading

Straightening machine

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What happens in a straightener

- Alternating bending between rolls

- Gradual reduction of curvature

- Manual adjustment

- $S_{final} = f(H, d, i, l)$
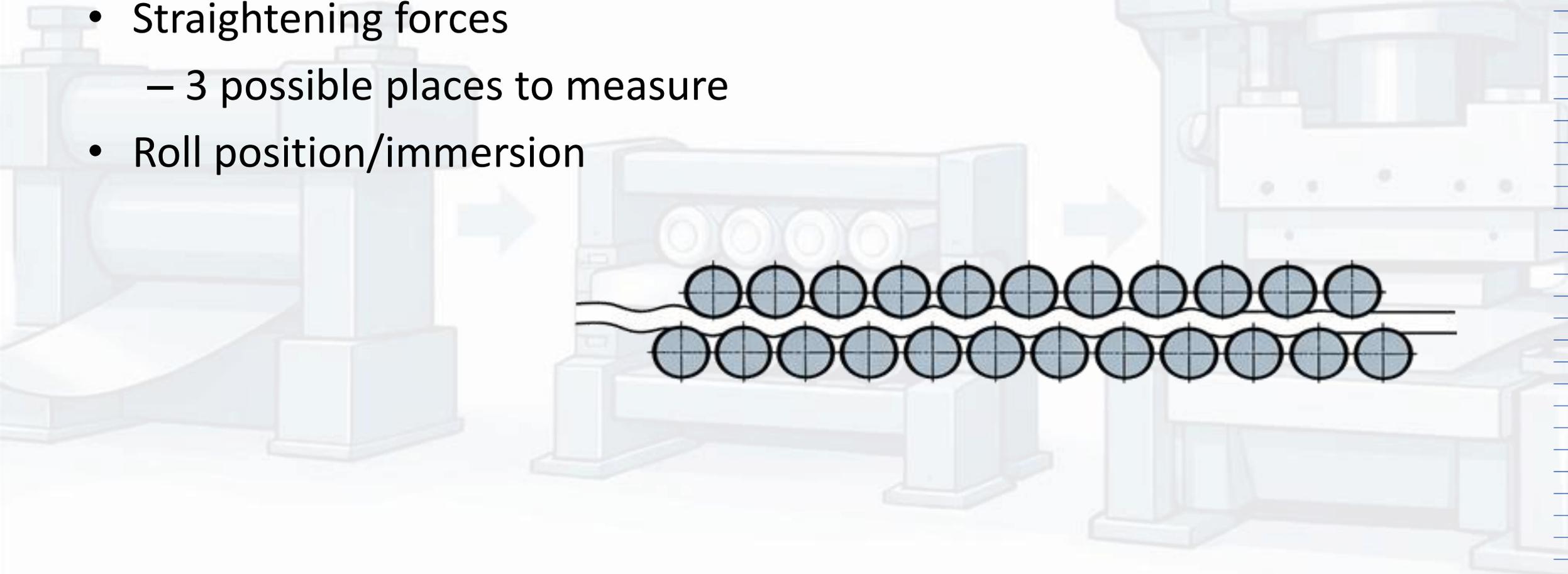
- $S_{final} =$ How does it look

Vision: AI Straightening

- Concept
  - Sensor data from straightener
  - Information about material state
  - Process model or AI algorithm
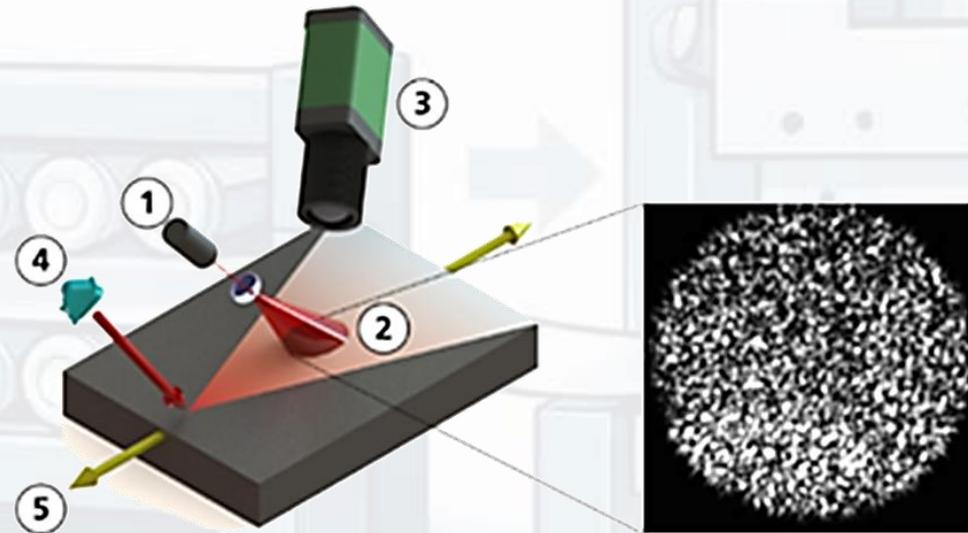- Goal
  - Automatic adjustment of roll settings

What can be measured in the straightener

- Straightening forces
  - 3 possible places to measure
- Roll position/immersion

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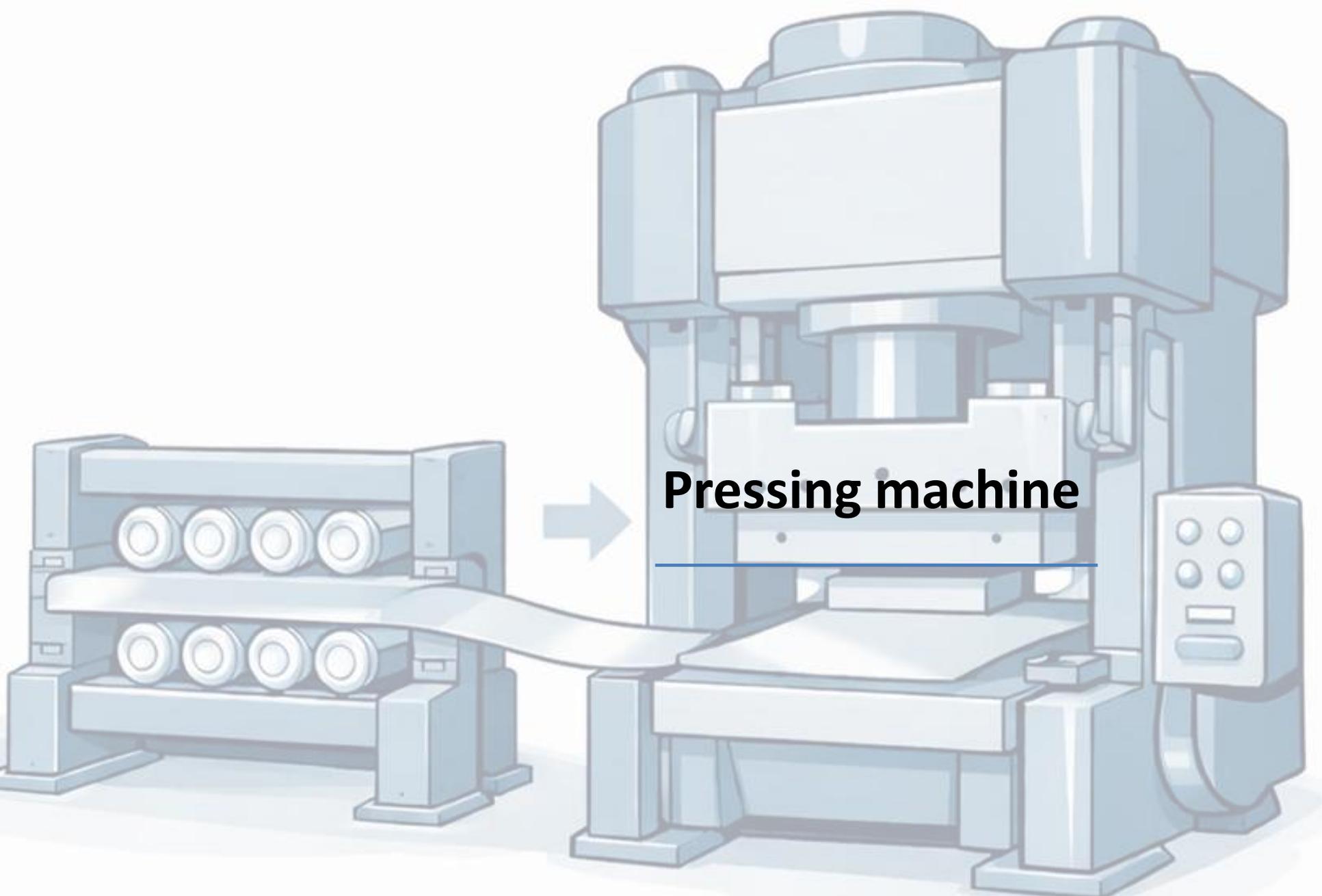
Measuring material state inline

- Material strain
  - Laser Speckle Photometry [Fraunhofer]
  - Digital Image Correlation
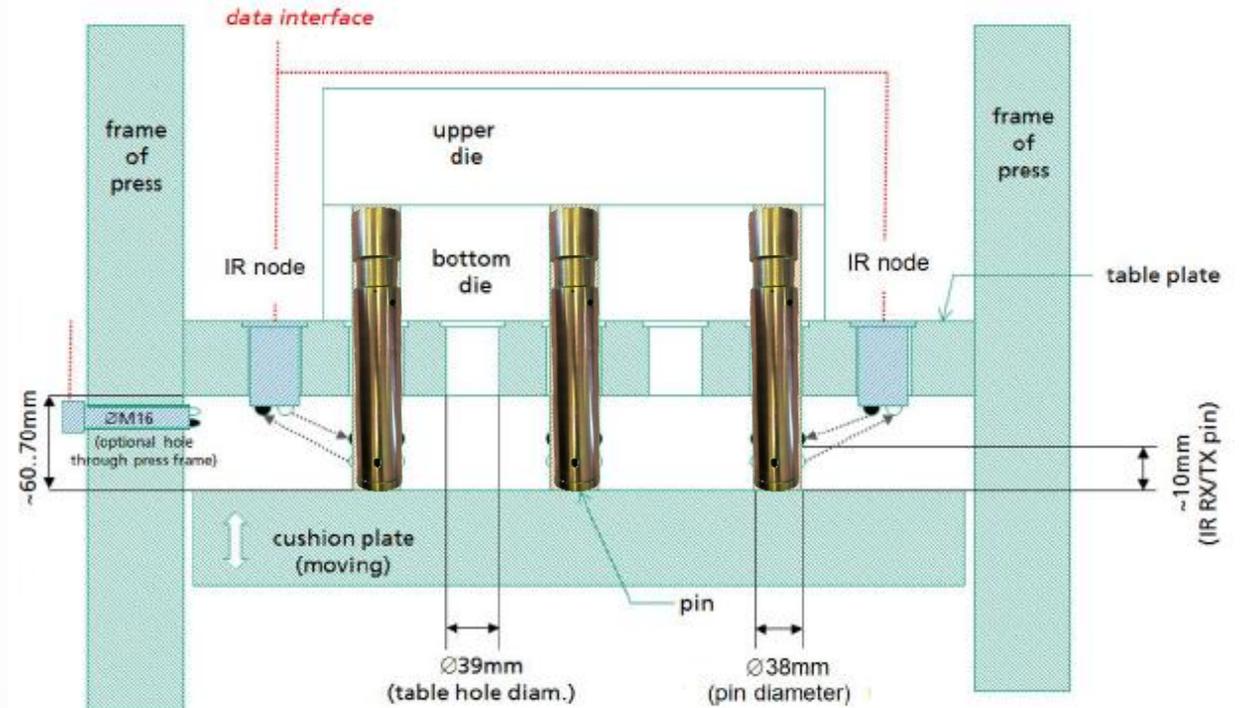- Residual stress
  - Barkhausen noise, LSP

stress → strain → surface deformation → speckle pattern change

Pressing machine

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Smart Cushion Pin

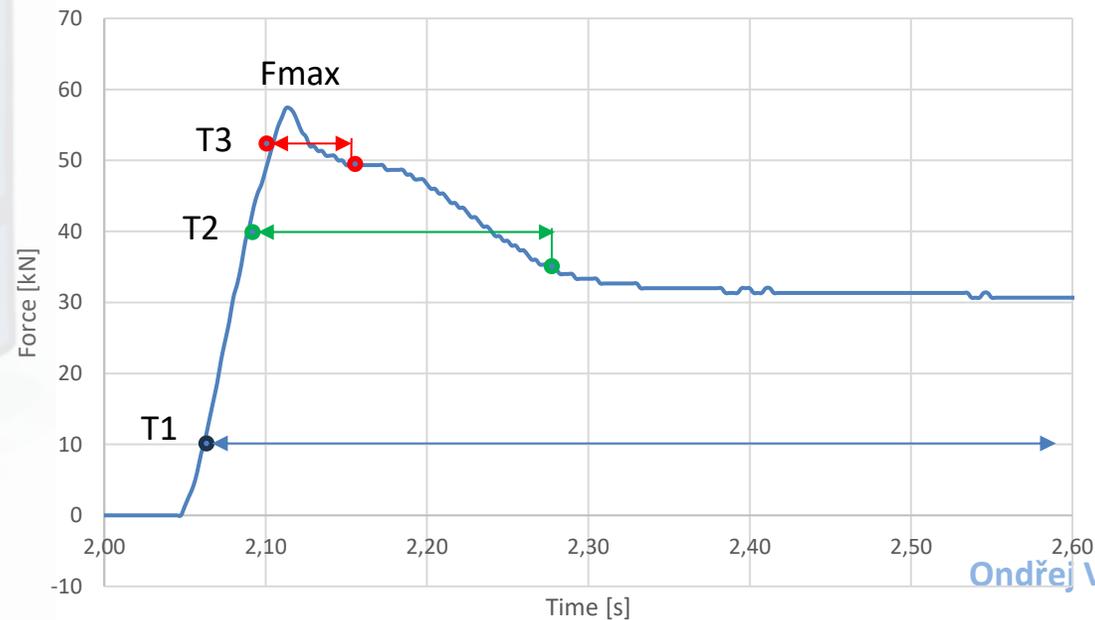- Replacing standard cushion pin
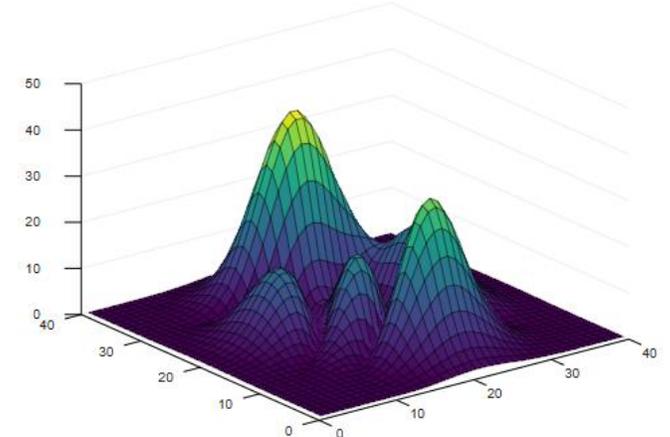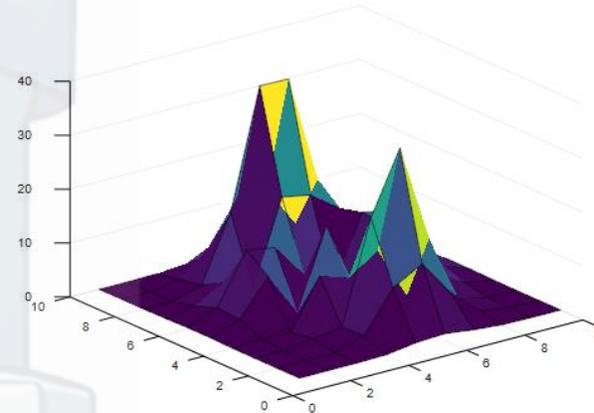- Measuring forces during metal sheet forming

Smart Cushion Pin

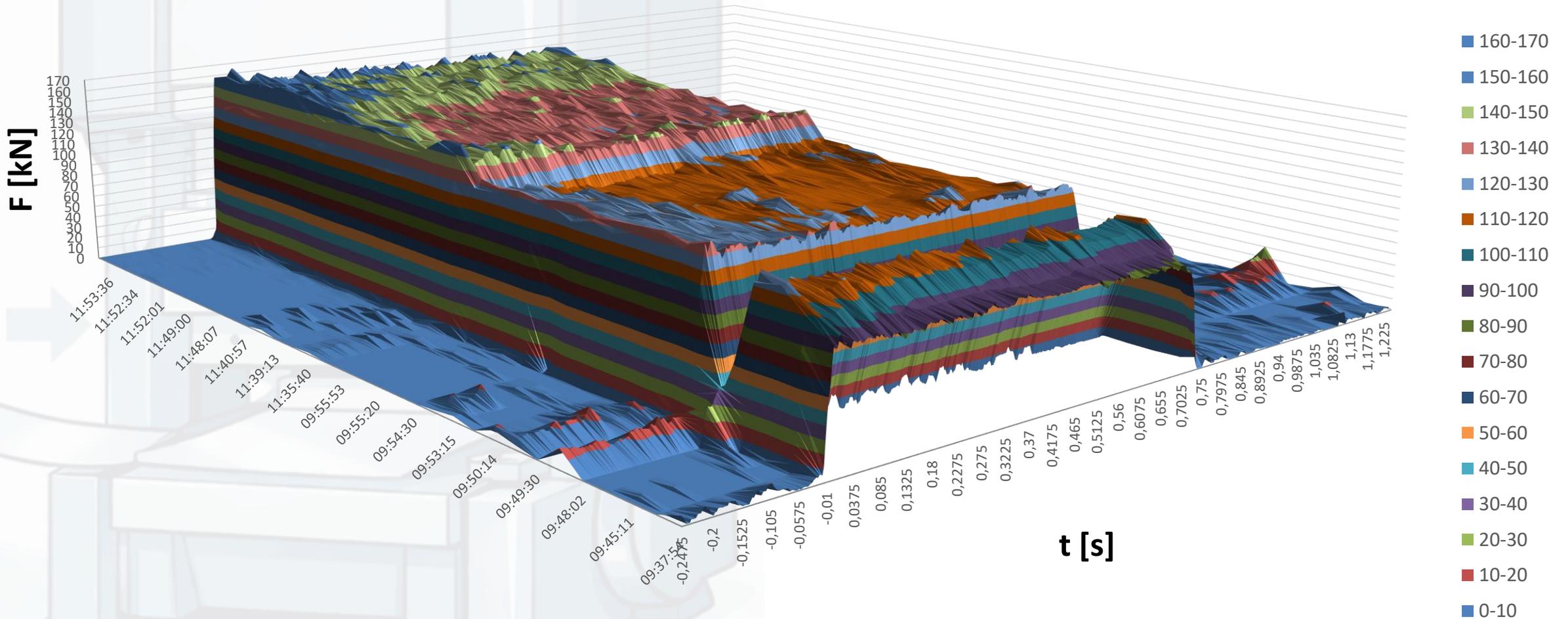IR node

Data collection/visualisation

- Up to 120 Smart cushion pins

- Up to 32 IR Nodes

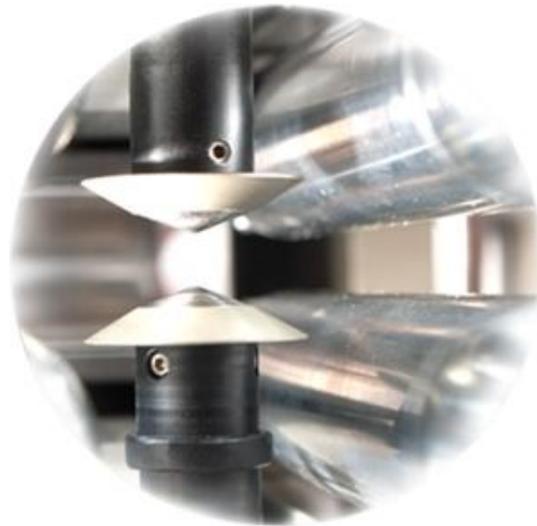- 400 Samples per second

- Up to 60 measurements per minute

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Single SmartCushionPin measurement

Multiple SmartCushionPin measurements

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Thank you for your attention!

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