

# UNIVERSITY WEST

## TROLLHÄTTAN, SWEDEN

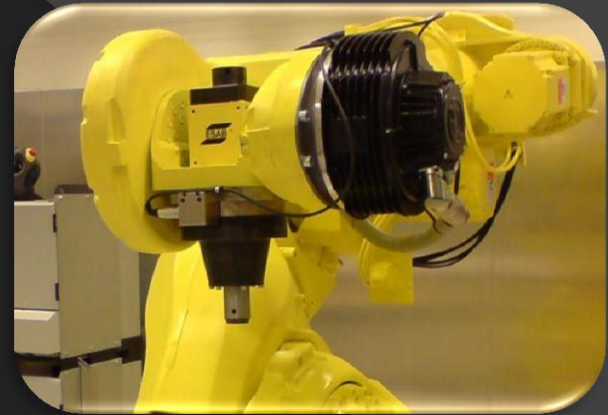


# ARoStir Research Project

- Increased Automation of Robotic Friction Stir Welding
- **Research project application “KK-hög”**
  - 3,44 million SEK financing over 2 years
  - Partners:
    - System
      - ESAB Engineering
    - Material & end users
      - SAPA
      - GKN Aerospace
      - AB Volvo (lastvagnar)
    - Tool
      - Sandvik Hard Materials
    - Experienced user - R&D
      - SKB

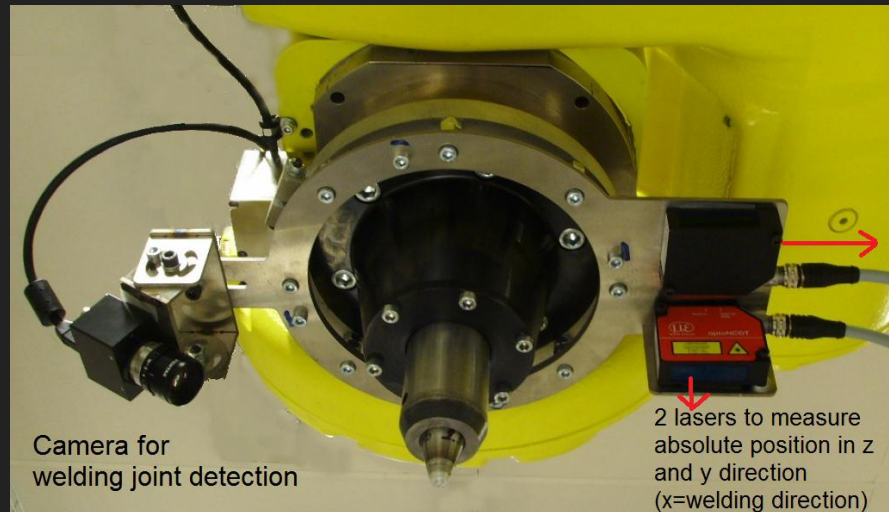
# Robot System for FSW

- ESAB ROSIO™ FSW Robot
  - Modified ABB IRB 7600
  - Last robot axis removed
  - Added motor, gears, spindle
  - Force sensor & Force-control
  - Max 14kN down force



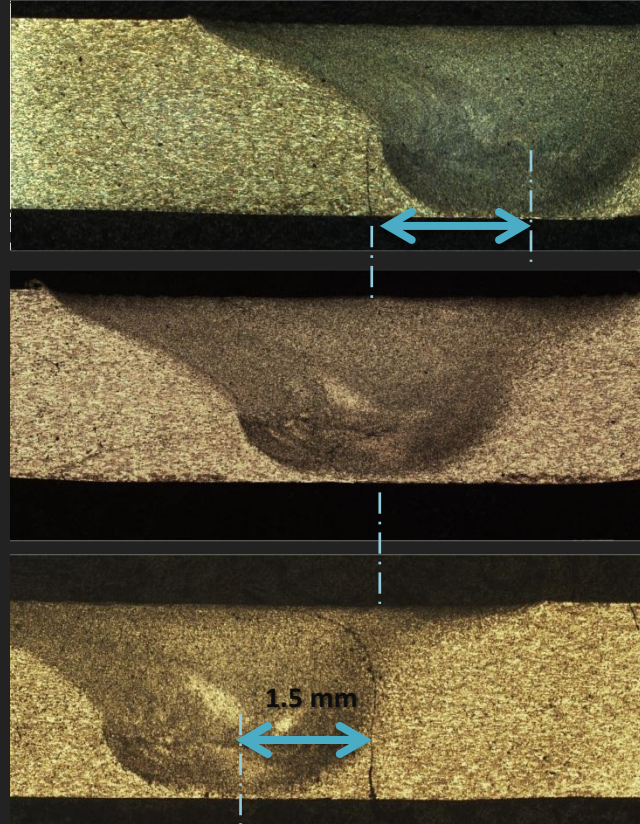
# Research question 1 (licentiate thesis)

- Q1a: *How can root defects, due to tool path deviations be avoided in FSW?*
  - Laser and camera-based path compensation (seam tracking)



# Q1: Compensation for deflections

- Uncompensated (Clockwise)
- Compensated  
→ No root defects
- Uncompensated (Counter clockwise)

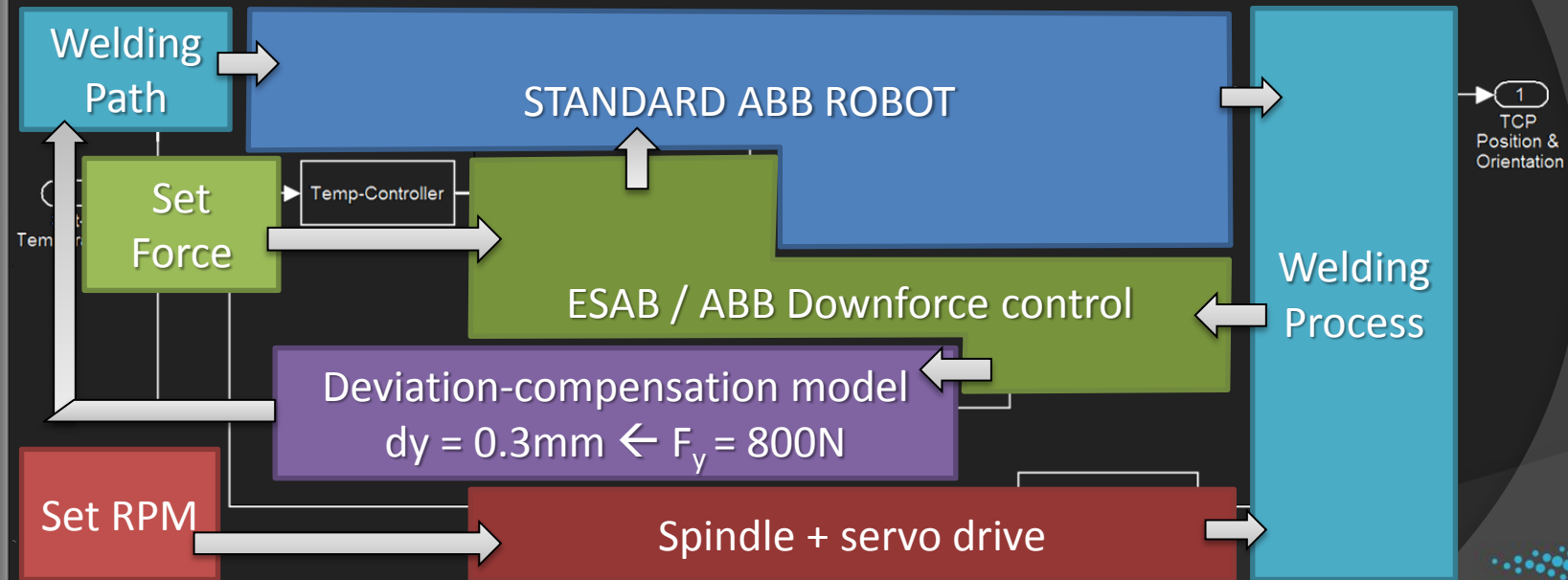


# Research question 1 (licentiate thesis)

- Q1b: *Can the robot deflection be compensated without introducing extra sensors to the system?*
  - Strategy for compensation without sensors using robot deflection model

# Planned work (spring 2013)

- Model based compensation for path deviations
- Control of heat input by temperature measurement





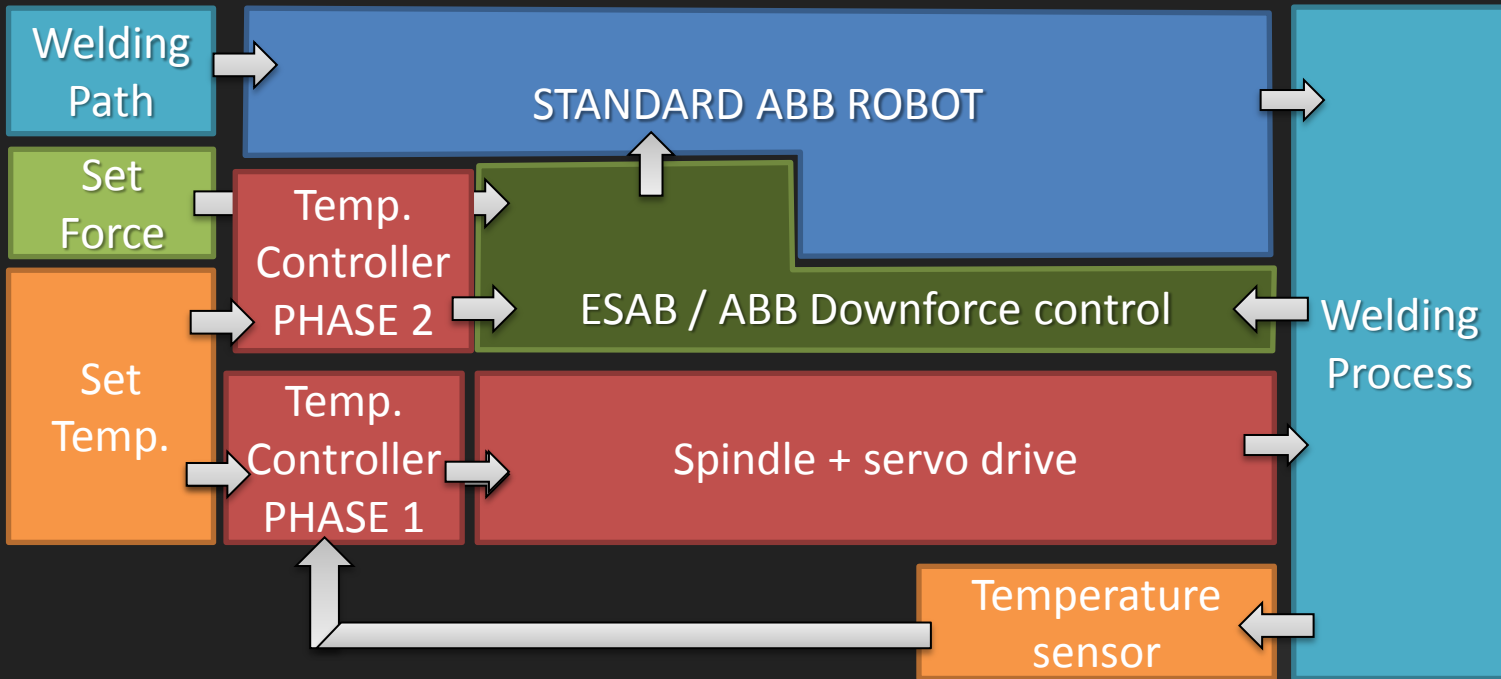
# Research Question 2 (Licentiate Thesis)

- *Q2. Which additional parameters have to be controlled to guarantee a robust FSW process for welding complex geometries in an automated production line?*



# Ongoing work

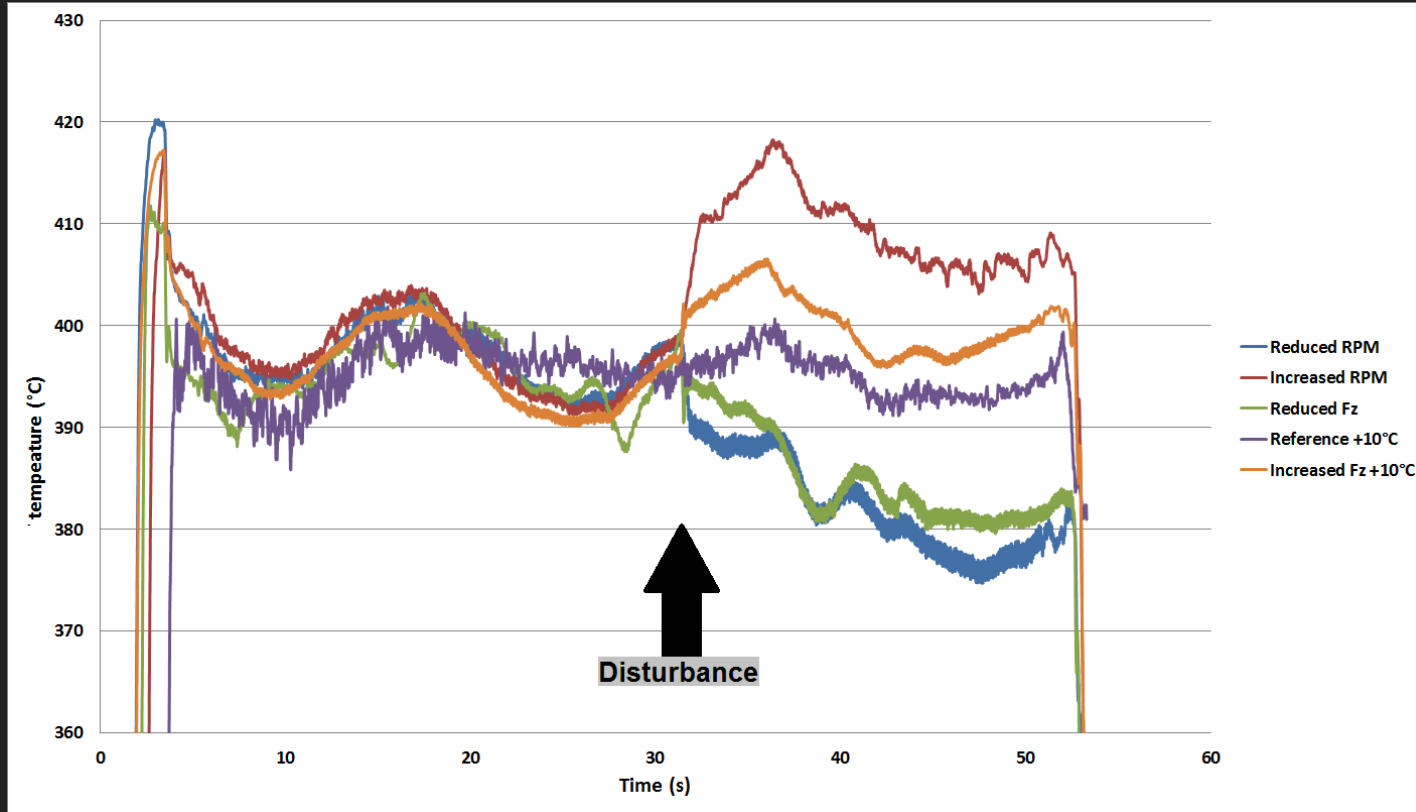
- Control of heat input by temperature measurement



# Temperature controller

- Phase 1: Implemented:
  - Measure temperature → Modify RPM
  - PI-controller
- Phase 2: Concept:
  - If requested RPM is lower than min RPM  
→ LOWER DOWNFORCE
  - If requested RPM is higher than max RPM  
→ INCREASE DOWNFORCE
  - How?

# Response to parameter changes

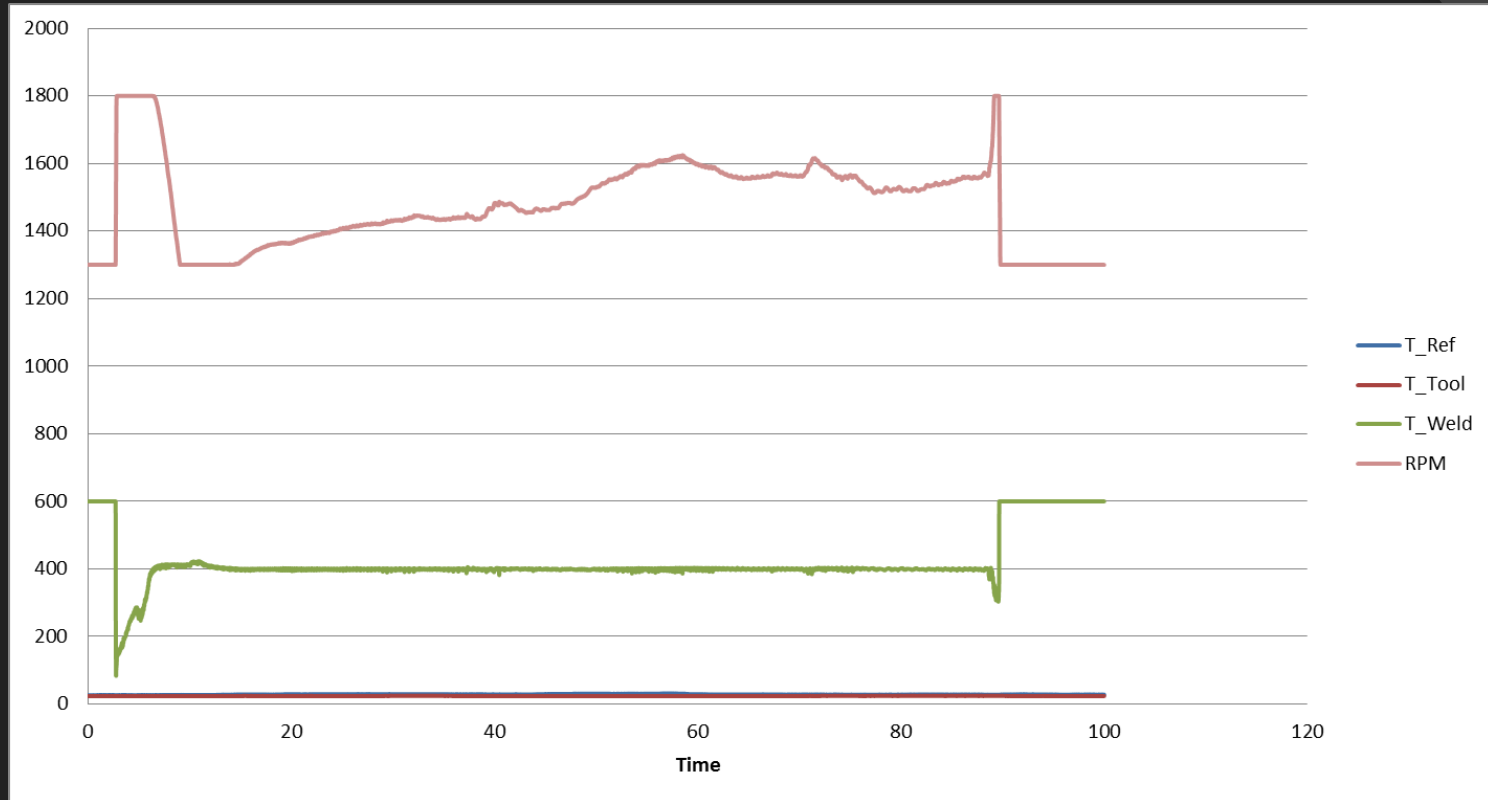


# Temperature measurement

- National Instruments modules (TC, AI,...)
- Labview application
  - Thermocouple Measurement
  - Controller

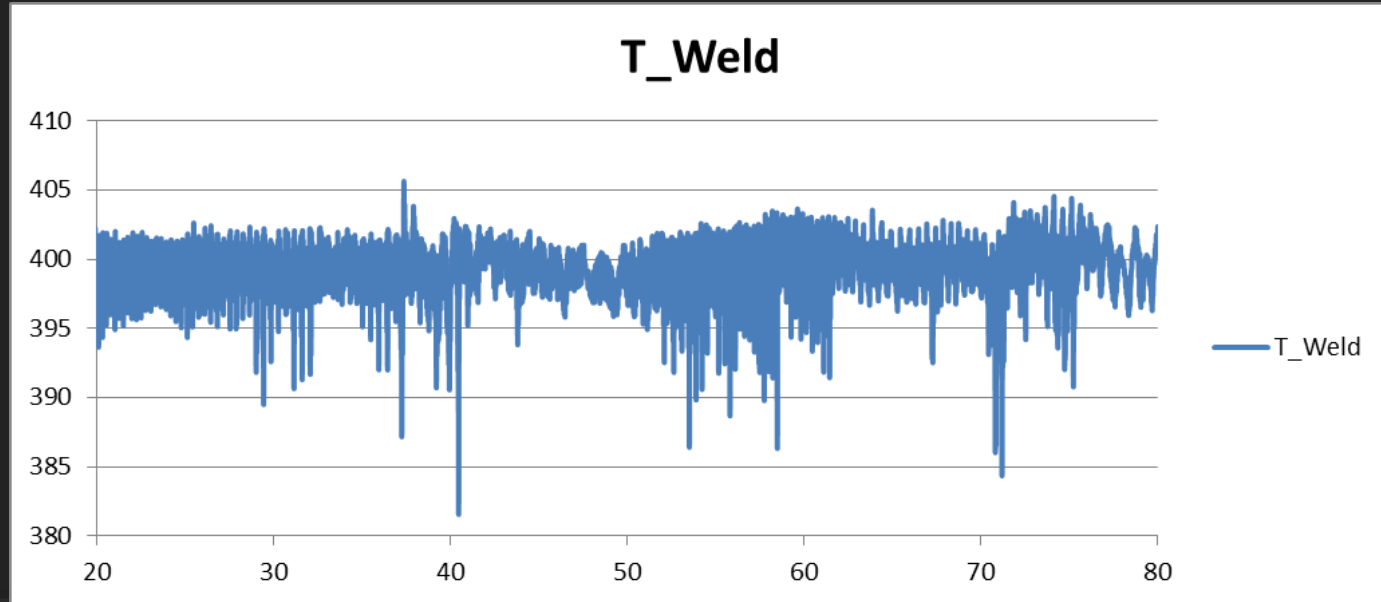


# PI-Controller



# Controller Accuracy

- Measurement error, rather than controller
- Stronger filter



# Demonstrator: ~~Volvo Aero~~ component *GKN Aerospace*

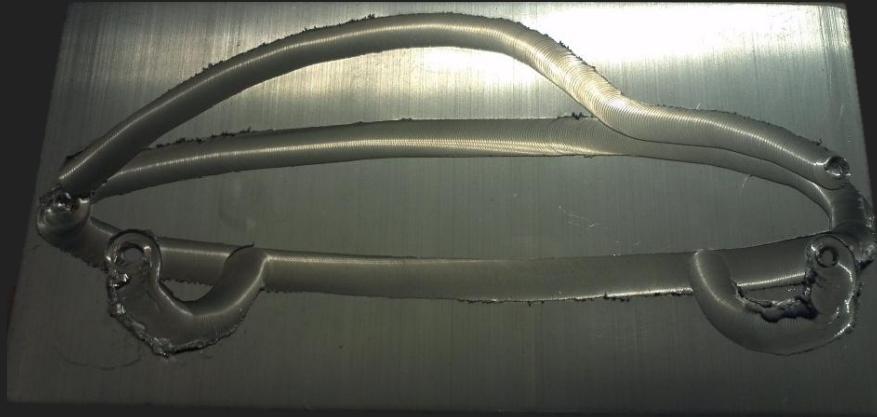
- Reduction of forces by parameter tuning
- First robotic FSW of high-temperature alloys





# PTC Innovation

- Vinnova project
  - Aim: Commercialisation of research results
  - Product development, Market potential, Novelty search, Patents,...
- Development of FSW “product”
  - Novel temperature measurement method
  - Temperature control
  - Control interface for FSW (demo...)



*Tack!*