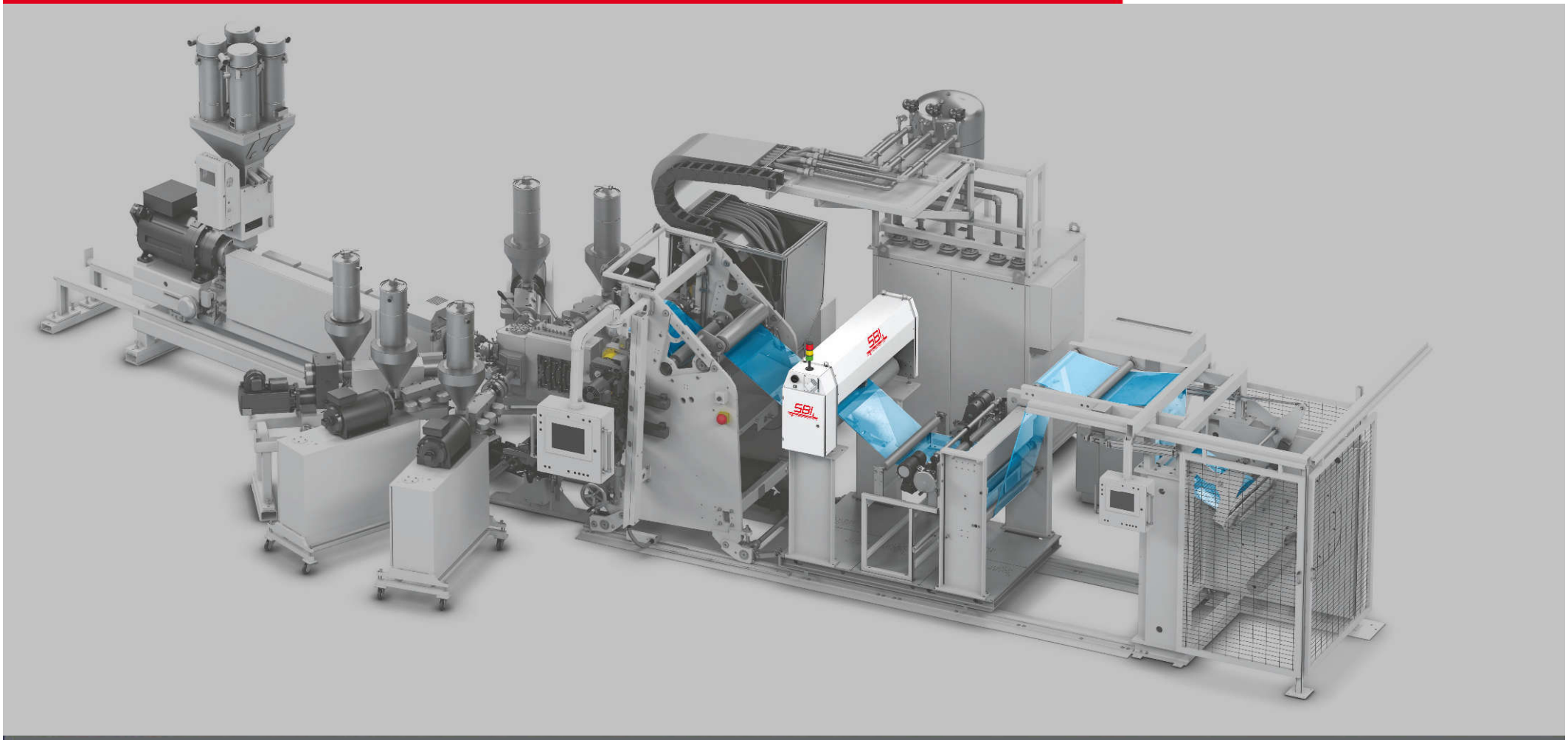
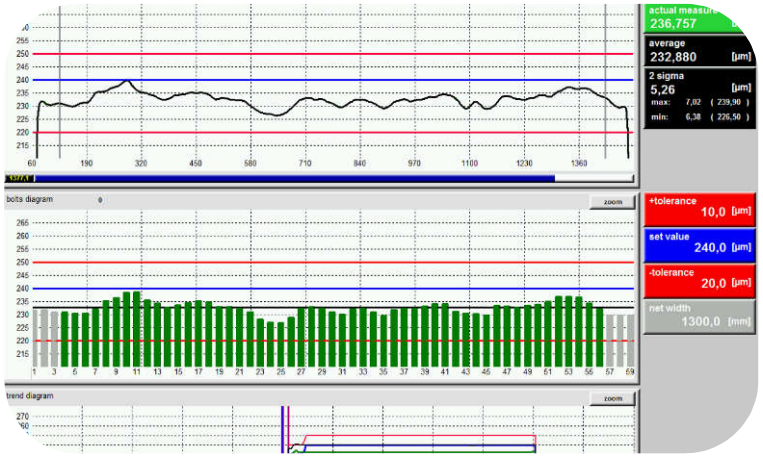
THICKNESS CONTROL IN SHEET EXTRUSION



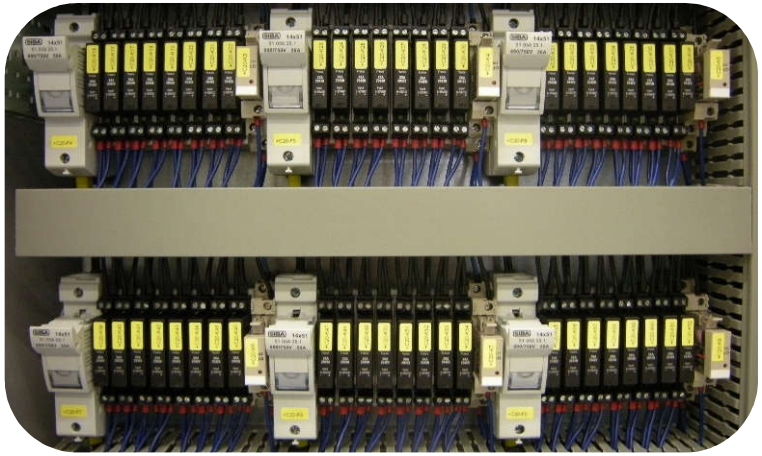
SBI Produktion techn. Anlagen GmbH & CO KG

HARDWARE / Components in extrusion lines

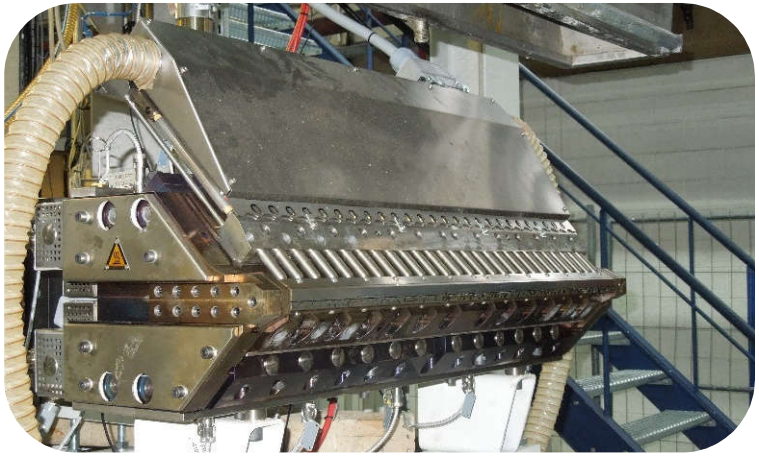
Thickness gauge



Software



Controlling components

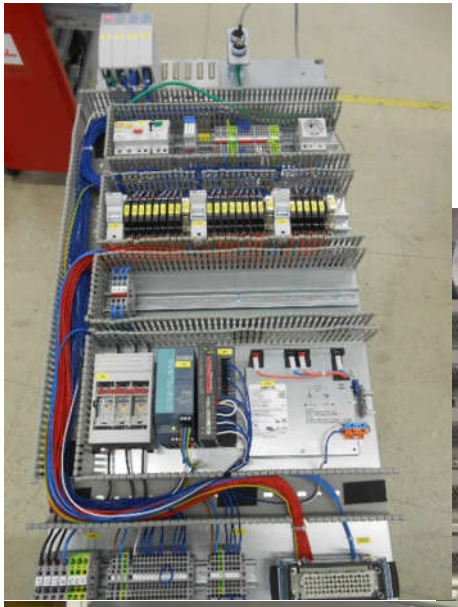


Automatic system

HARDWARE / Overview

Standard solution

Customer solutions



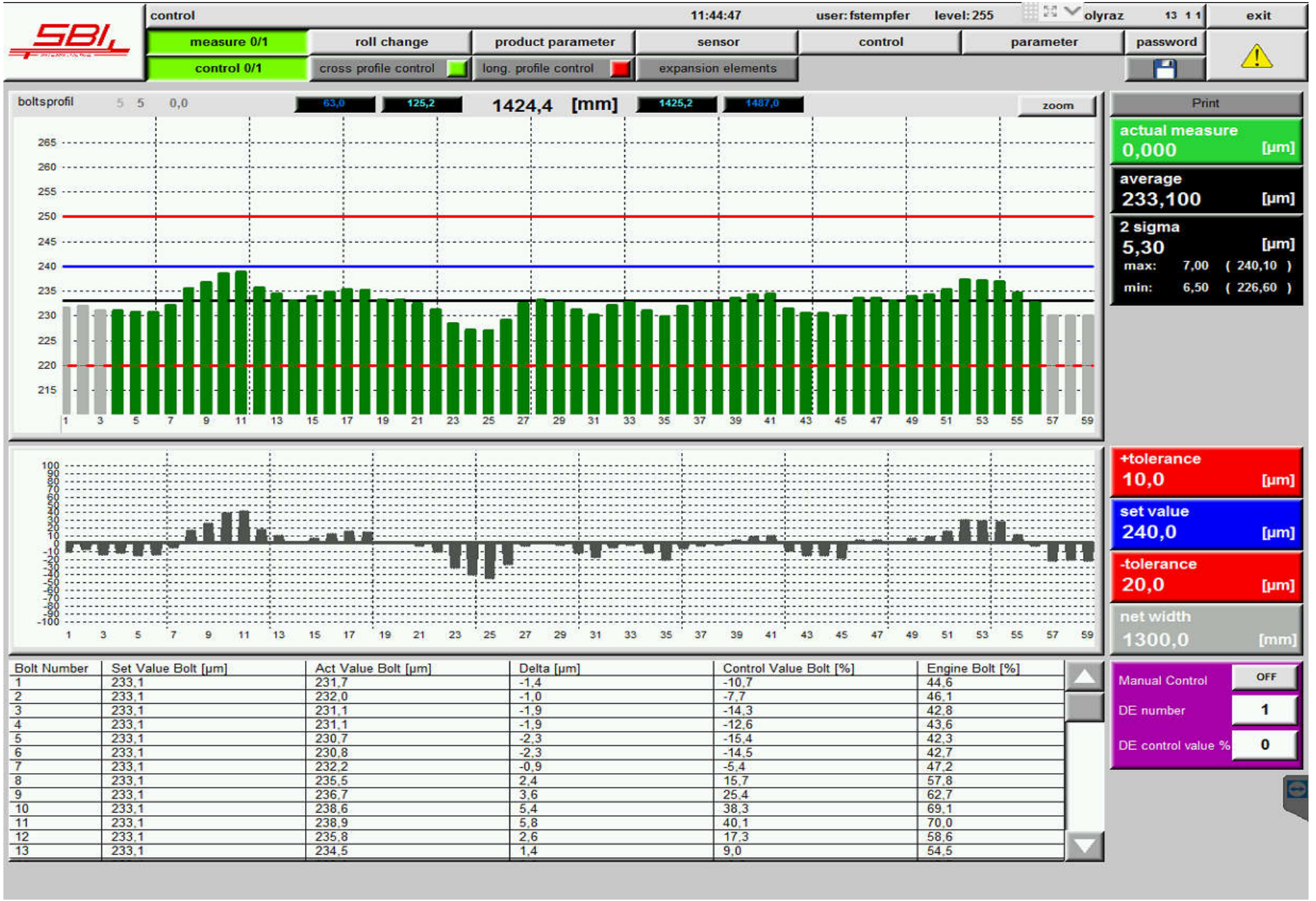
➢Controlling Hardware

- Solid State Relays
  - 1 piece for each die bolt
  - Devided into groups of 8 die bolts
- Protection for each group of 8 (fuse)
  - Shut down in case of a fault
  - Fuse monitioring for fault insertion

➢PLC Components

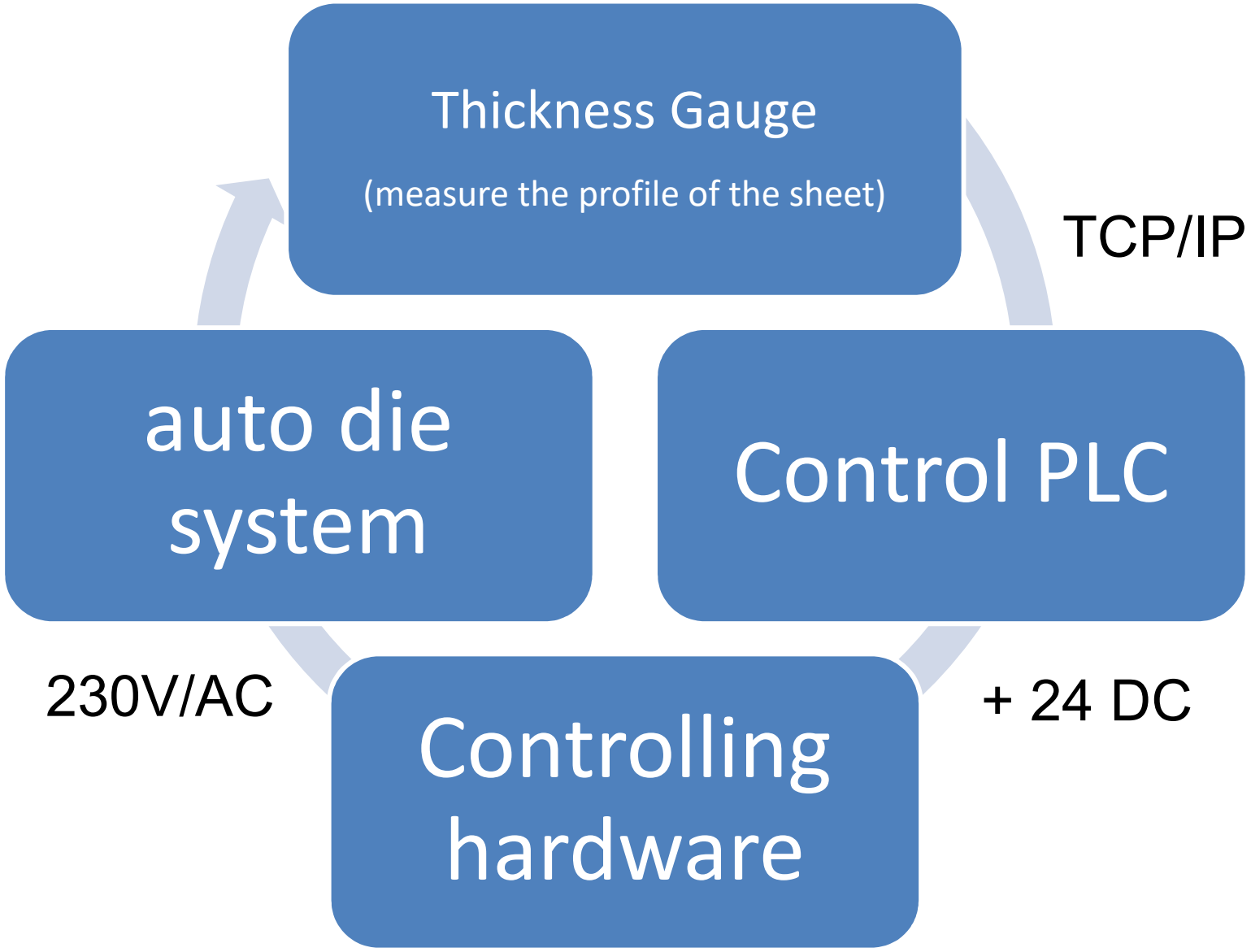
- Dedicated CPU
  - Controlling software
  - Communication to the thickness gauge via TCP/IP
- Digital output modules
  - For controlling the individual relays
  - Signal exchange with the extrusion line *(e.g. control on,…)*
- Digital input modules
  - Monitoring the group fusing
  - Signal exchange with the extrusion line *(e.g. die ready,…)*

SOFTWARE



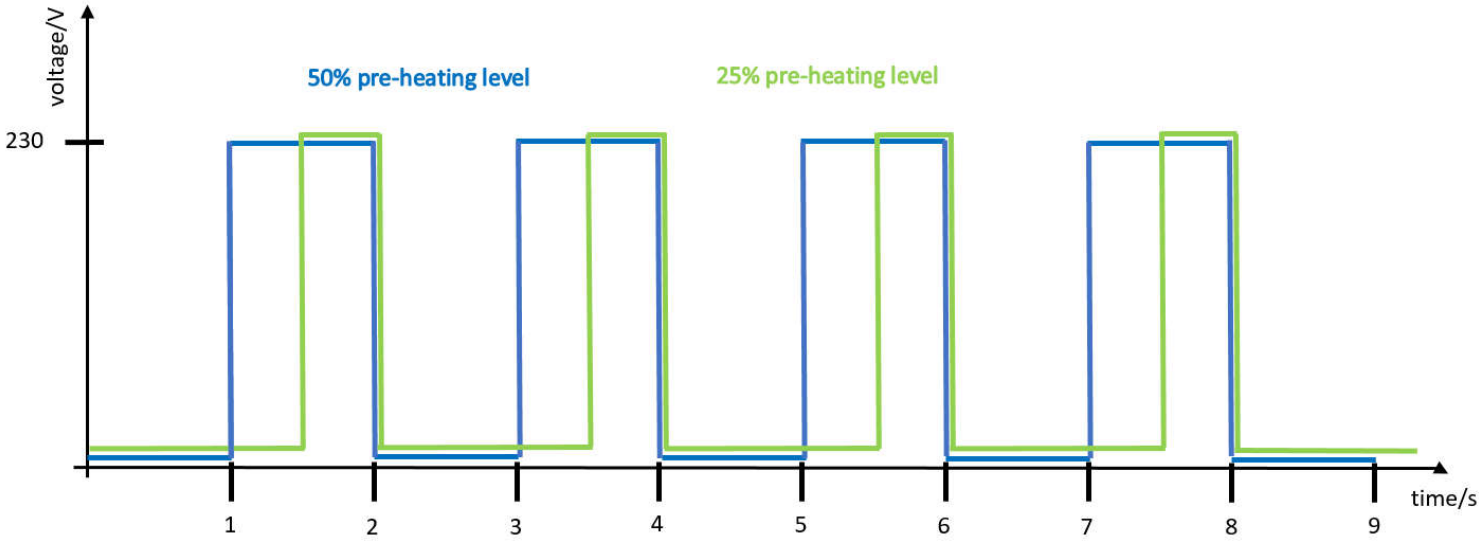
Bolt Number	Set Value Bolt [µm]	Act Value Bolt [µm]	Delta [µm]	Control Value Bolt [%]	Engine Bolt [%]
1	233,1	231,7	-1,4	-10,7	44,6
2	233,1	232,0	-1,0	-7,7	46,1
3	233,1	231,1	-1,9	-14,3	42,8
4	233,1	231,1	-1,9	-12,6	43,6
5	233,1	230,7	-2,3	-15,4	42,3
6	233,1	230,8	-2,3	-14,5	42,7
7	233,1	232,2	-0,9	-5,4	47,2
8	233,1	235,5	2,4	15,7	57,8
9	233,1	236,7	3,6	25,4	62,7
10	233,1	238,6	5,4	38,3	69,1
11	233,1	238,9	5,8	40,1	70,0
12	233,1	235,8	2,6	17,3	58,6
13	233,1	234,5	1,4	9,0	54,5

SOFTWARE / Flow Chart



SOFTWARE / Pre - Heating

To be able to regulate the die lip in **+** and **-** direction at all, the die bolts must be **preheated**.



- adjustable preheating level
- automatically or manually preheating

After preheating: Manual centering of the die lip.

The **control interval** is the time required for the cross profile control unit to compare the set-profile against the actual profile and then send a new correcting variable to the controller.

Correcting variable calculation:

Next correcting variable =

Sheet runtime between die and thickness gauge + Time for 1 measurement

Sheet runtime:

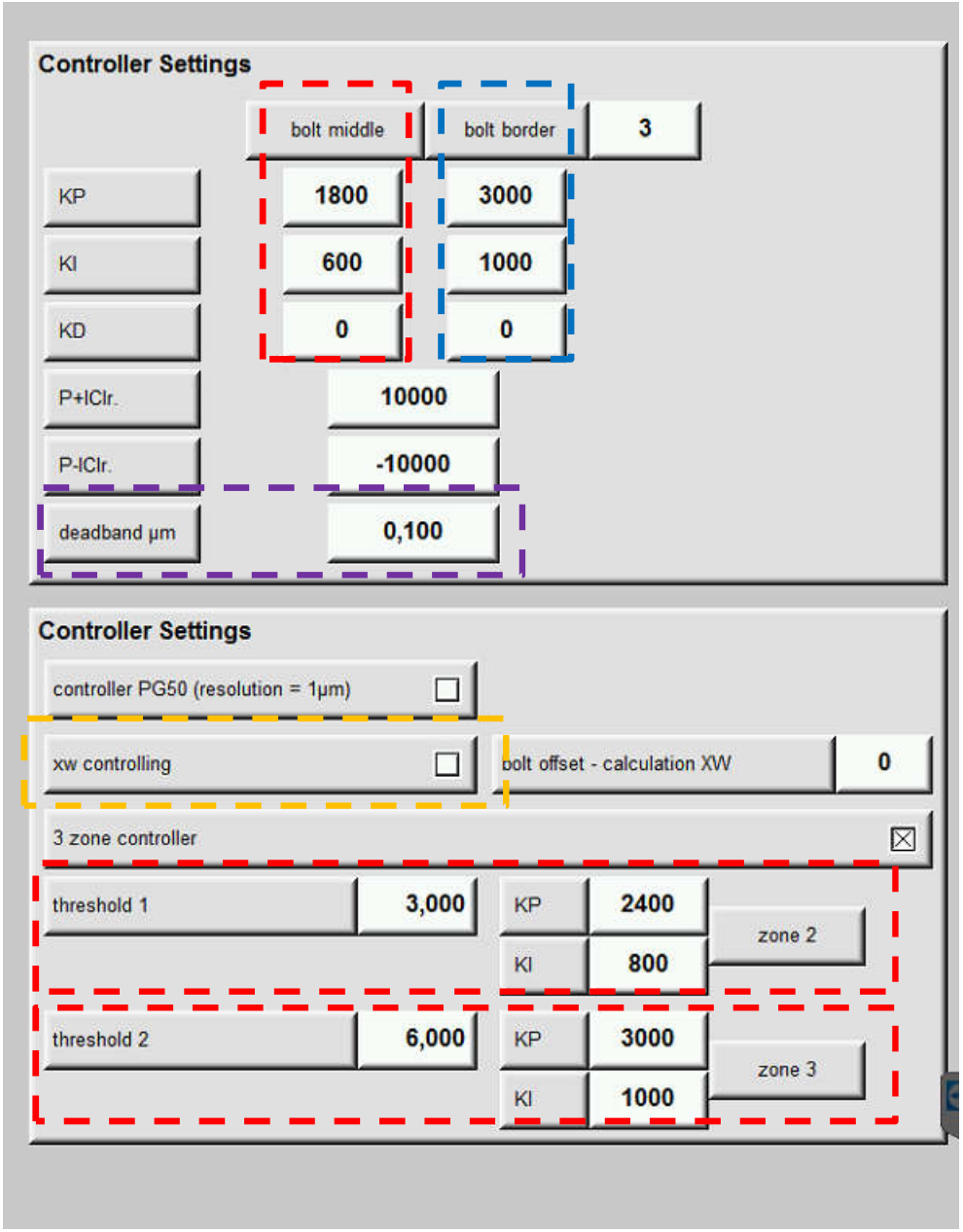
- Line Speed *(Measured with the measuring roller of the thickness gauge)*
- Distance between extrusion die and thickness gauge
  (needs to be measured once during start-up)

SBI is using a **3- step PID Controller**:

- Actuating variable > max. threshold
  - Large correcting variable
- Actuating variable ≤ max. threshold v ≥ min. threshold
  - average correcting variable
- Actuating variable < min. threshold
  - smaller correcting variable

Actuating variable: deviation (offset) between real- and set- thickness

SOFTWARE / Controller settings



3 zone PID parameter

special parameter for edge bolts

adjustable deadband

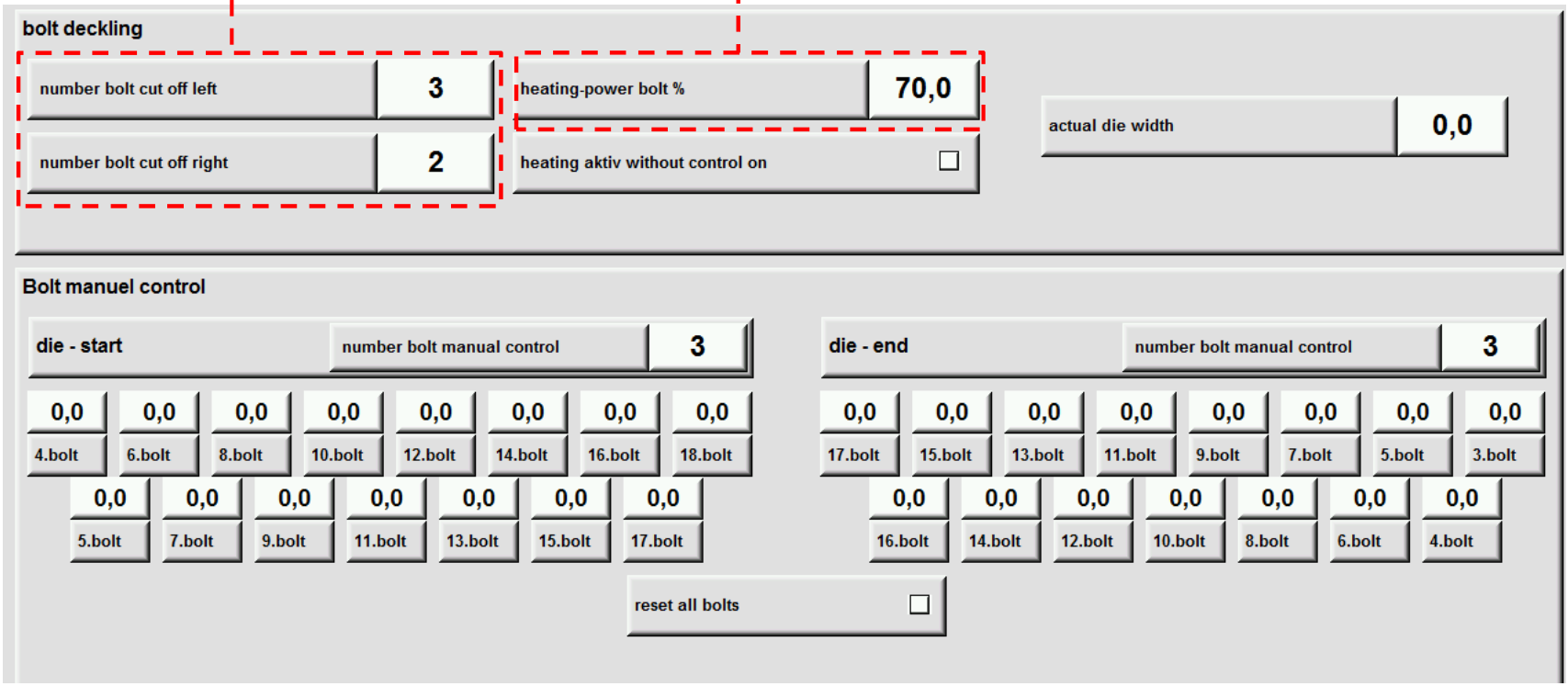
xw- controller

Special controlling mode to keep the area of the lip gap constant.

SOFTWARE / die bolt settings

number of bolts for symetric/asymetric deckling

adjustable heating power for closed bolts



manual settings for die bolts in border area

SOFTWARE / Settings

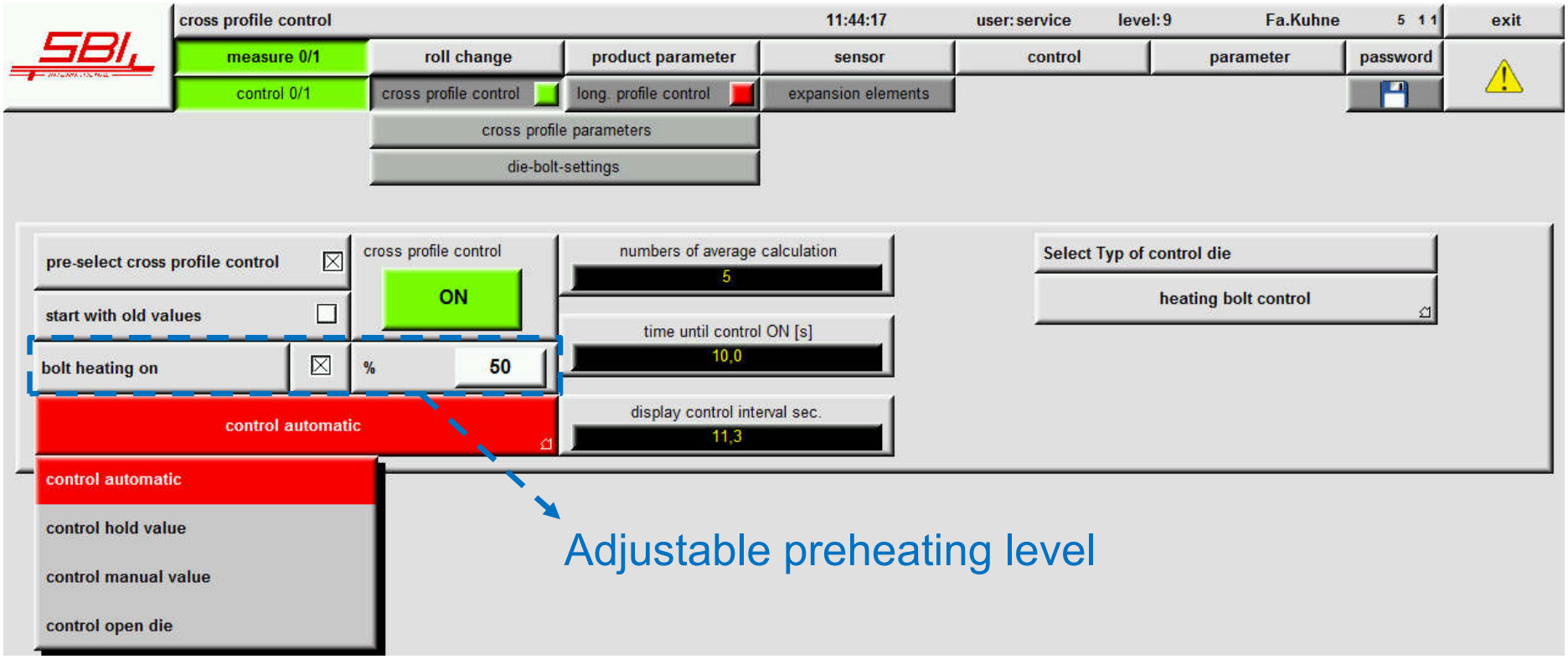
Bolt Number	Set Value Bolt [µm]	Act Value Bolt [µm]	Delta [µm]	Control Value Bolt [%]	Engine Bolt [%]
1	233,1	231,7	-1,4	-10,7	44,6
2	233,1	232,0	-1,0	-7,7	46,1
3	233,1	231,1	-1,9	-14,3	42,8
4	233,1	231,1	-1,9	-12,6	43,6
5	233,1	230,7	-2,3	-15,4	42,3
6	233,1	230,8	-2,3	-14,5	42,7
7	233,1	232,2	-0,9	-5,4	47,2
8	233,1	235,5	2,4	15,7	57,8
9	233,1	236,7	3,6	25,4	62,7
10	233,1	238,6	5,4	38,3	69,1
11	233,1	238,9	5,8	40,1	70,0
12	233,1	235,8	2,6	17,3	58,6
13	233,1	234,5	1,4	9,0	54,5

Average thickness
- set profile for controller

heating profile of the die bolts

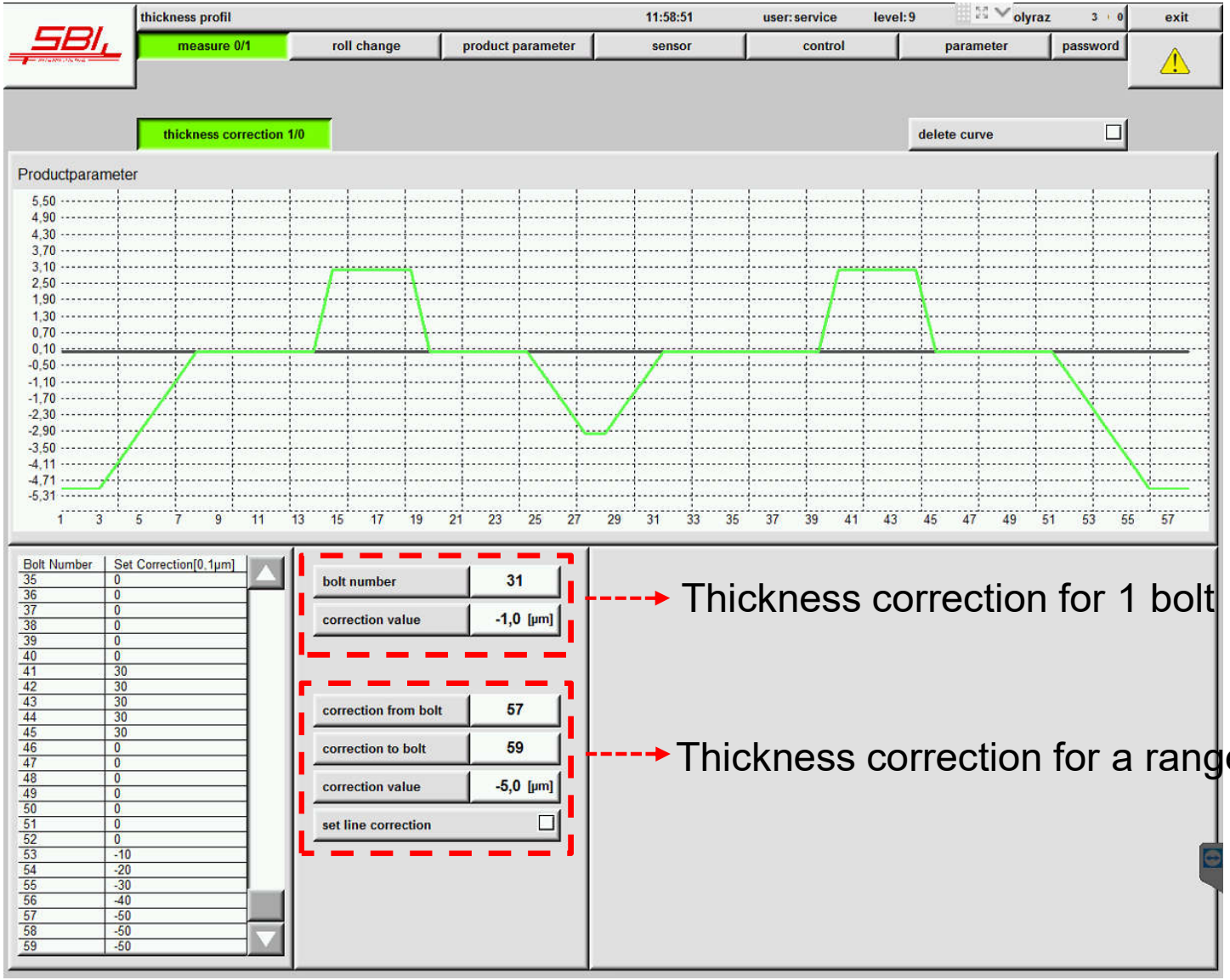
thickness profile divided into die bolts

SOFTWARE / Conrolling modes



- control automatic → cross profile control is in automatic mode
- control hold value → freezing the last heating profile
- control manual value → set all die bolts to adjustable heating value
- control open die → open the die lip (e.g. cleaning the die lip,..)

SOFTWARE / Adjustable Thickness Profile



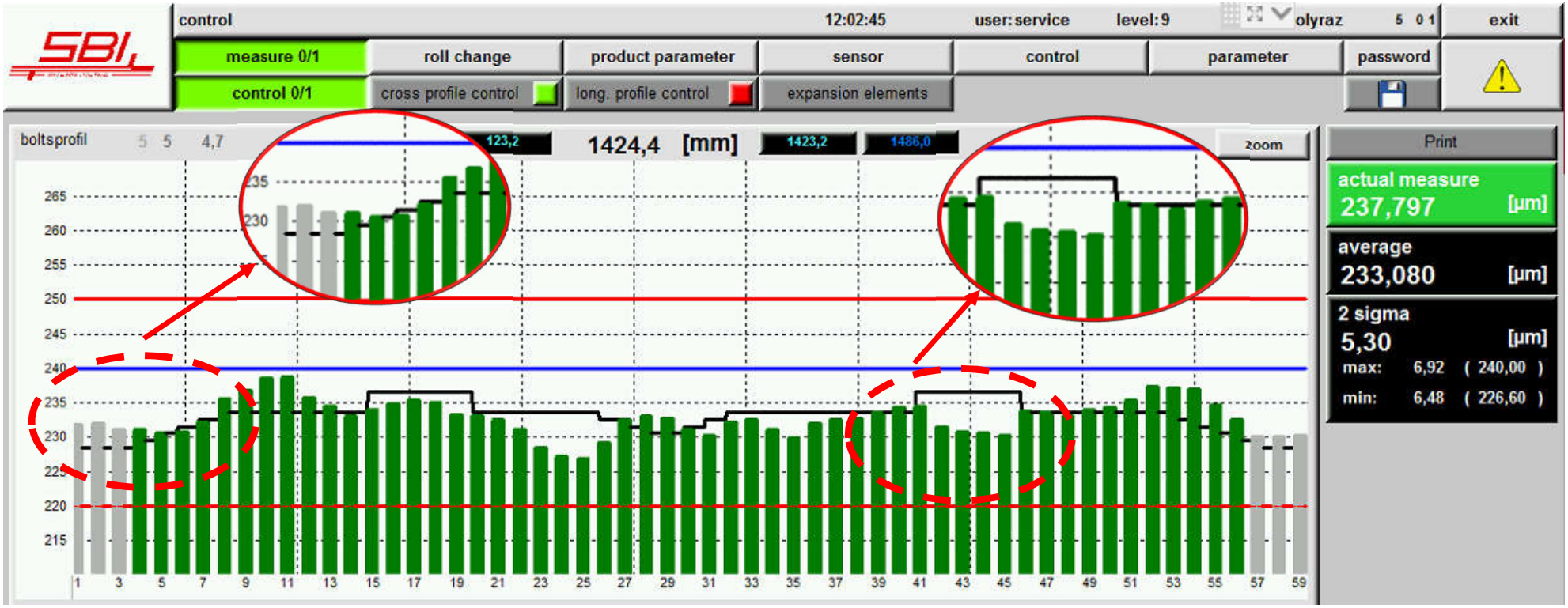
Thickness profile

- correction of average

Thickness correction for 1 bolt

Thickness correction for a range of bolts

SOFTWARE / Adjustable Thickness Profile



CONTACT

SBI Produktion techn. Anlagen GmbH & Co KG
Gewerbering 15,
3710 Ziersdorf
Austria
+43-2952-34139-0
www.sbi.at