ADVANTAGES OF *ES|||*™ FULL AUTOMATIC CONTROL OF GLASS FEEDERS

GLASS SERVICE

Menno Eisenga, Erik Muijsenberg

June 2017

Introduction

- The first paper about ***ESIII*™** advanced control of container glass feeders incl. control of the job changes was presented at the DGG Glastechnische Tagung in 2014.
- At that time, results where presented from the first 2 installations for flint glass only.
- Since that time we have further developed the technology.
- Today we have **31** ***ESIII*™** installations on container glass feeders with **8** different customers using this new technology; **185** ***ESIII*™** installations on furnaces and feeders.
- Only in 2017 we have done already **22** ***ESIII*™** installations on container glass feeders, more installations are scheduled for later this year.
- Installations done on wide variety of container glass feeders in terms of:
  - Design: simple straight, curved, F-shape, Y-shape, tandem feeders.
  - Operation: gas firing (left/right), E-boost, (in)direct cooling, cooling dampers.
  - Glass type: flint, amber and green glass.
- A standard control strategy has been developed that is simply applicable to all these different glass feeders; flexible for tailor-made solutions to meet specific requirements.

Motivation

- Glass feeder/forehearth is a ‘simple’ channel for transportation and homogenization of glass from furnace to production machines.
- Feeders in container, tableware, tubing and fiber (reinforced/insulation) glass production.
- During product changes feeder temperatures and glass pull needs adjustment.
- Fast process stabilization after job change means early start of production and less production losses.
- Demand for more flexible production: shorter production runs implies more job changes per week.
- Shortage of experienced feeder operators in plants.

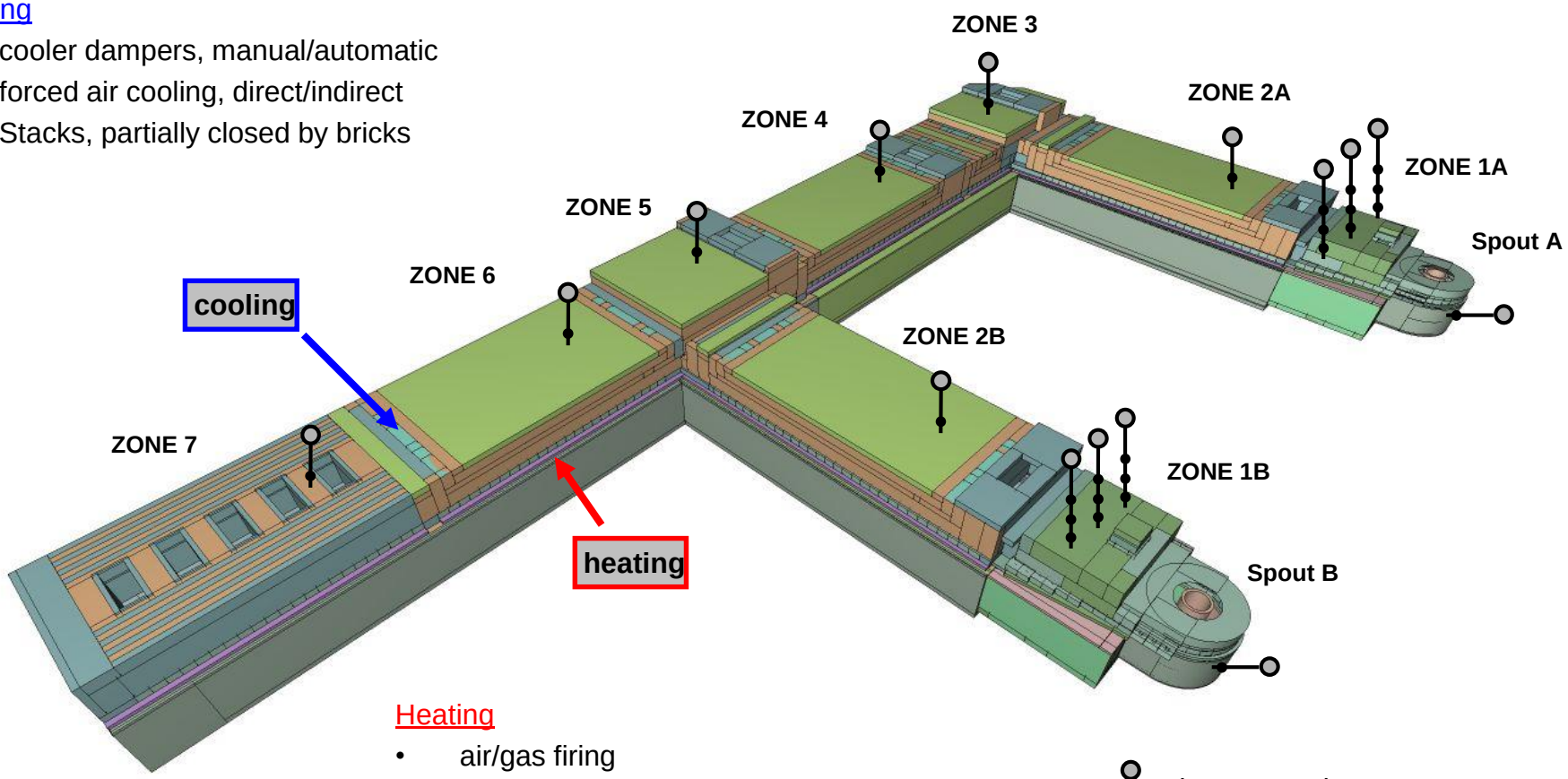
Question: Can we help with Advanced Process Control?

Answer: Yes, we can!

Heating, cooling and thermocouples in a feeder

Cooling

- cooler dampers, manual/automatic
- forced air cooling, direct/indirect
- Stacks, partially closed by bricks



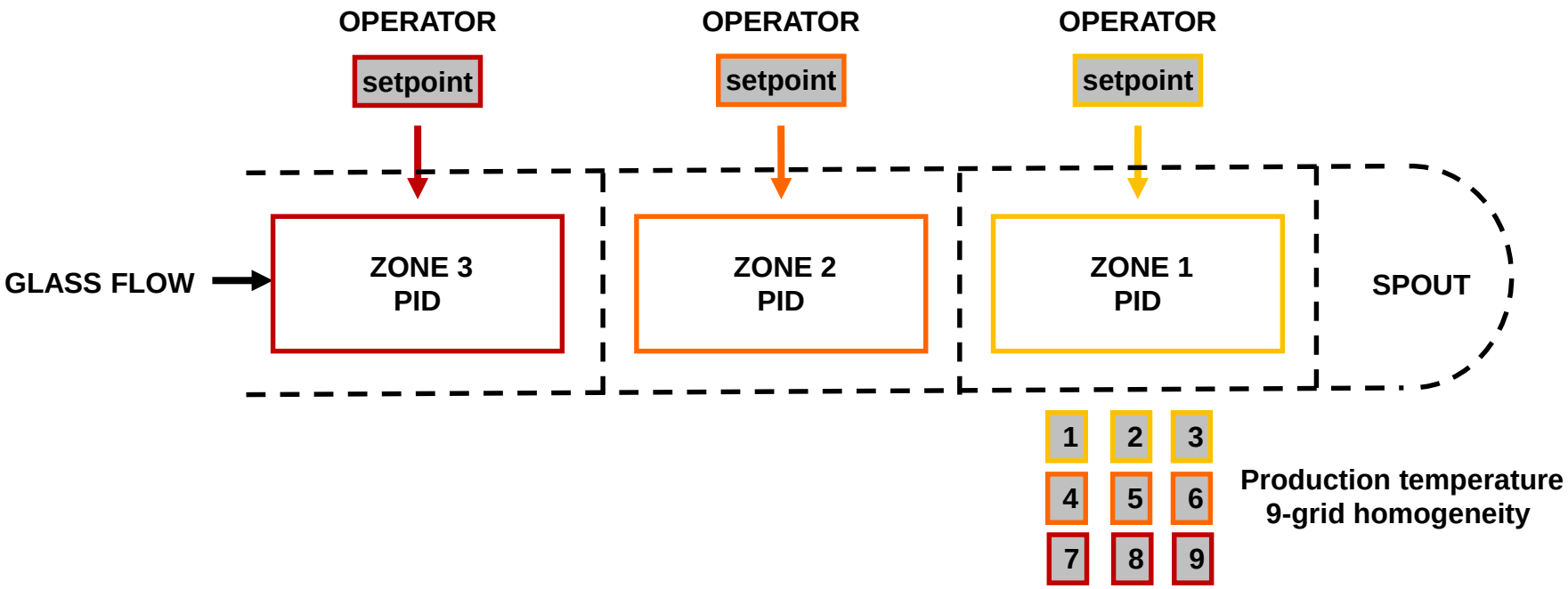
Heating

- air/gas firing
- oxy/gas firing
- electric boosting
- separate left/right heating or combined

1 thermocouple per zone

3x3 thermocouples
'9 grid' before spout:
glass homogeneity

‘Classical’ approach: operator sets zone setpoints



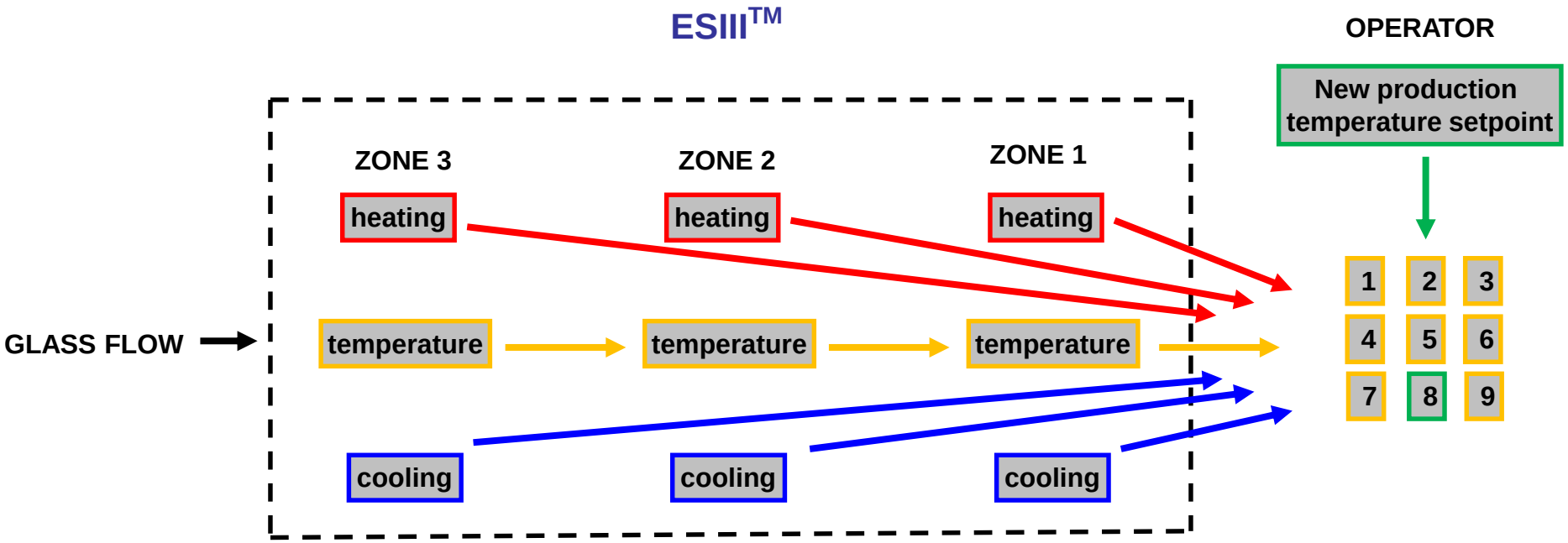
- Production temperature depends on article (gob) weight
- Targets for 9-grid temperatures & homogeneity
- Operator sets zone setpoints based on experience: previous runs with same article.
- PID controls each zone <u>separately</u> to required setpoint

Drawback of classical approach

This ‘classical’ approach of feeder control by operator is used in practically all container glass feeders worldwide, with a few drawbacks:

- Operator sets zone setpoints based on previous run with same article, but conditions might be different (e.g. feeder pull, furnace pull, furnace temperatures, neighbor feeder pull, thermocouple aging) so previous setpoints might not be applicable.
- Sometimes PID control loops need to be set to manual mode.
- Proper feeder setup needs full attention and experience of operator, especially during the job change.
- Human mistakes can delay the feeder stabilization after job change.
- Incorrect setting of heating and cooling.
- Trial and error to find new temperatures for new products.

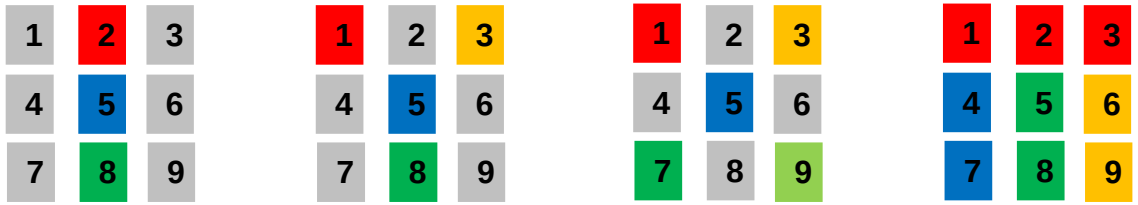
ESIII™ Control Of Glass Feeders



- Goal: Operator only needs to specify new production temperature for the article at the feeder end (9-grid or spout).
- **ESIII™** controls simultaneously all heatings and coolings of entire feeder in <u>one</u> MPC controller, also during the job changes, to reach required new setpoint at optimal homogeneity.
- **ESIII™** takes into account variations in upstream temperatures and various residence time of glass in feeder at different pulls to control 9-grid temperatures.

Advantages

- ***ESIII*™** controls automatically feeder temperatures during <u>stable production and job changes</u>, no operator intervention is needed.
- Operator only needs to specify new production temperature setpoint for new article (this could also be linked to article number via special library), ***ESIII*™** will do the rest.
- ***ESIII*™** optimizes homogeneity after job changes and during stable production, depending on feeder hardware layout and customer requirements, e.g.:



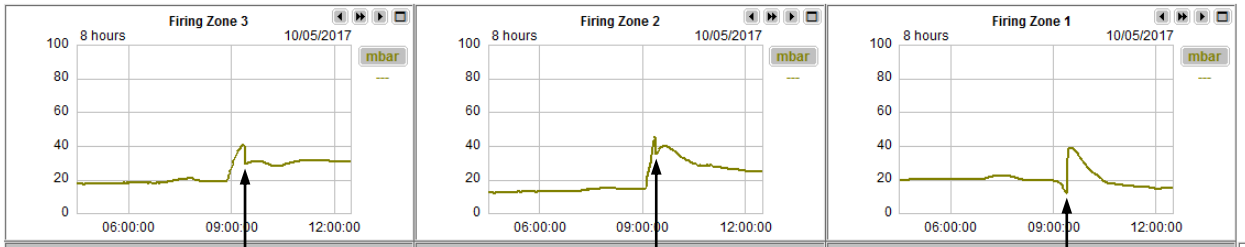
3 temperatures **4 temperatures** **5 temperatures** **4 temperatures combined**

- Besides temperature and homogeneity control, ***ESIII*™** also optimizes the ratio between firing and cooling in each zone -> save energy.
- ***ESIII*™** optimizes the distribution of the firing: smooth reduction of temperature and homogeneous firing along the feeder to prevent reboil -> glass quality.
- ***ESIII*™** is even able to handle situations where operator adjusts manual cooling dampers (e.g. during huge pull changes).

Example 1
ESIII™ Control Of Feeder Job Change

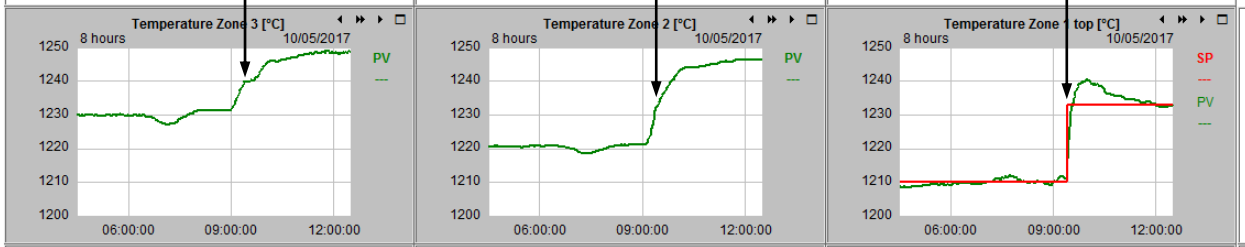
Zone 3 **Zone 2** **Zone 1**

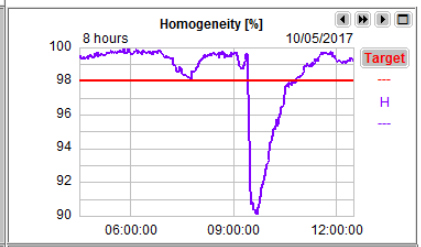
Mixing pressure [mbar]



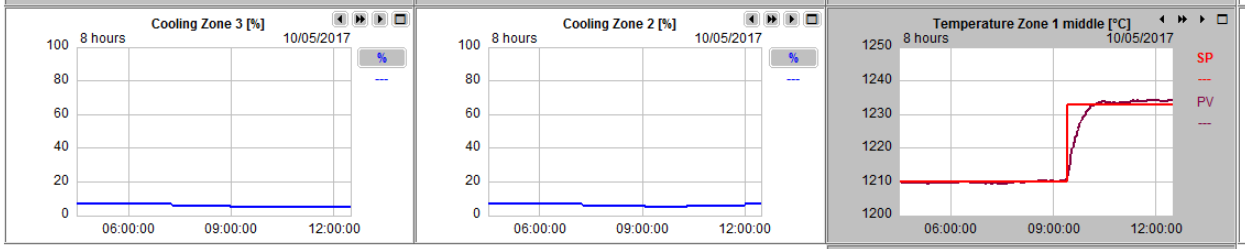
ESIII™ optimizes homogeneity above target after job change.

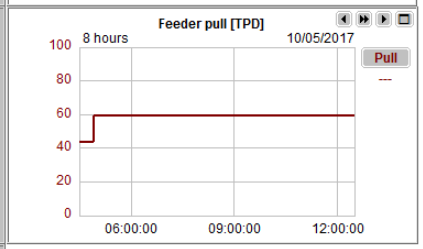
Temperature [°C]

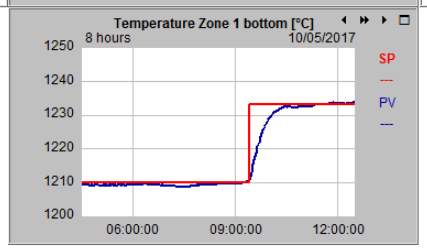




Cooling [%]







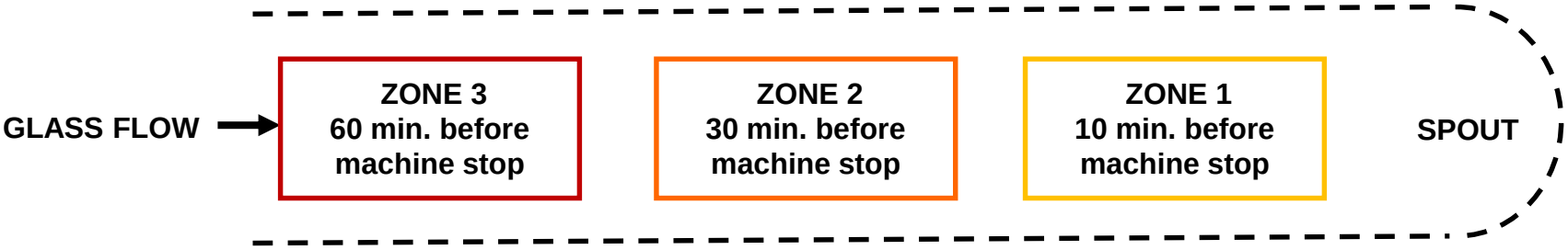
<u>Job change (flint glass):</u>
Production SP: 1210 °C -> 1233 °C
Feeder pull: 43 tpd -> 59 tpd

Zone 1 temperatures reach new setpoint in time after SP change due to preheating in Zone 3 and Zone 2, prior to actual job change:

ESIII™ Feeder Preconditioning.

ESIII™ Feeder Preconditioning

- Use residence time of glass in feeder to prepare glass temperature upstream prior to actual job change: minimize time for job change.
- Implementation of special algorithm in ***ESIII***™ to enable this kind of feeder preconditioning automatically.
- Operator needs to specify planned machine stop only -> ***ESIII***™ starts feeder preconditioning automatically in advance.
- Feeder preconditioning times are set automatically in relation to the actual feeder pull
- Example:



ESIII™ User Input – Production planning

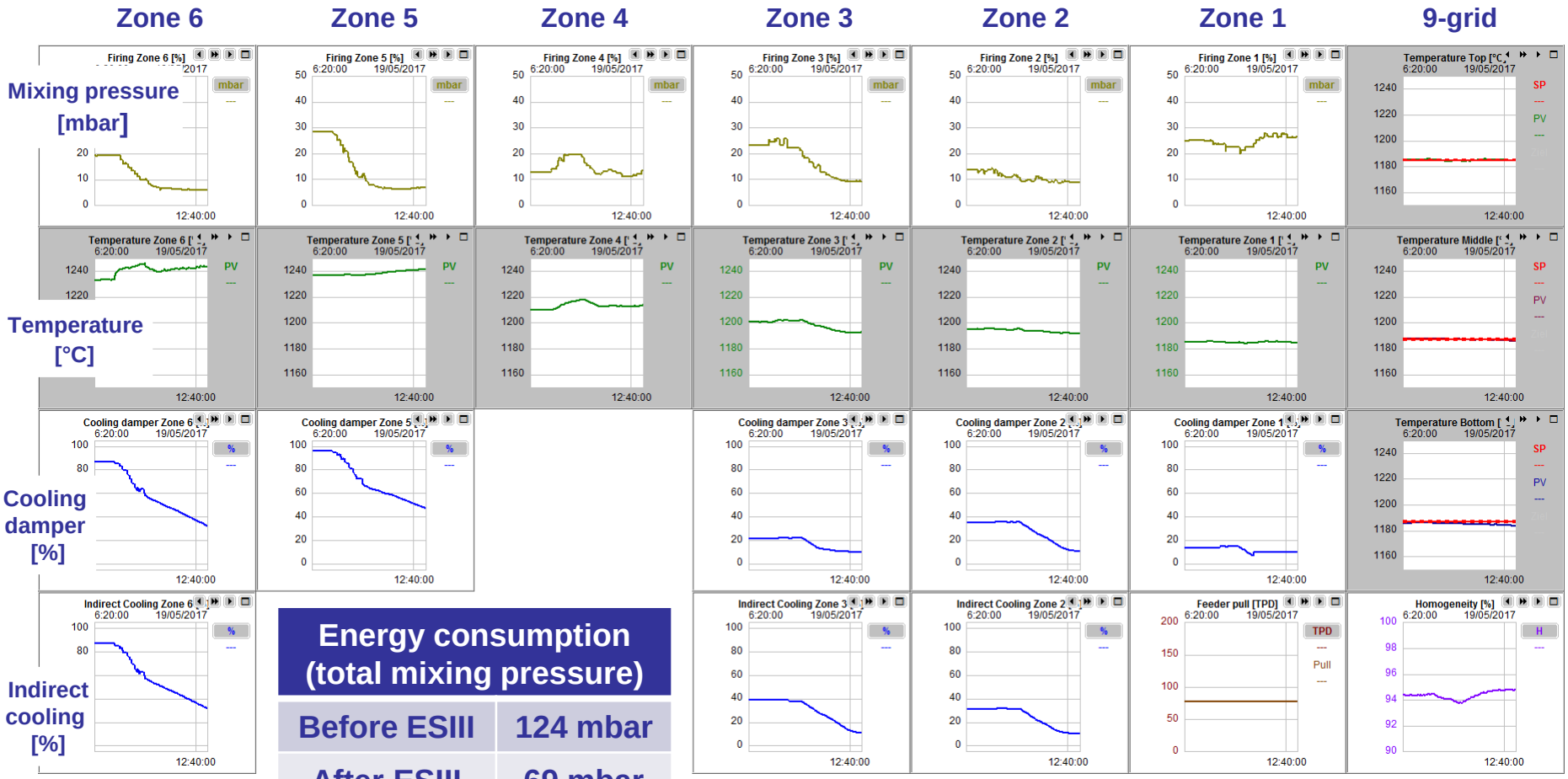
	Feeder 1	Feeder 2	Feeder 3	Feeder 4
	ESIII ON	ESIII ON	ESIII ON	ESIII ON
Article nummer	1264	3259	6358	2534
Feeder Pull	80.6 t/d	43.5 t/d	60.3 t/d	52.8 t/d
Production Setpoint	1200 °C	1190 °C	1194 °C	1210 °C
Temperature	1200.1 °C	1189.8 °C	1194.2 °C	1210.0 °C
New Feeder Pull	70.5 t/d	51.6 t/d	84.6 t/d	58.9 t/d
New Production Setpoint	1187 °C	1238 °C	1220 °C	1174 °C
Job Change	25.05.2017 07:00	25.05.2017 09:30	24.05.2017 06:00	26.05.2017 08:45
	Start	Start	Start	Start
Preconditioning	30 min.	56 min.	45 min.	51 min.

Operator only needs to fill in the yellow fields related to production planning per feeder.

ESIII™ use this information to control all feeders, but also the furnace.

Example 2
ESIII™ Feeder Optimization

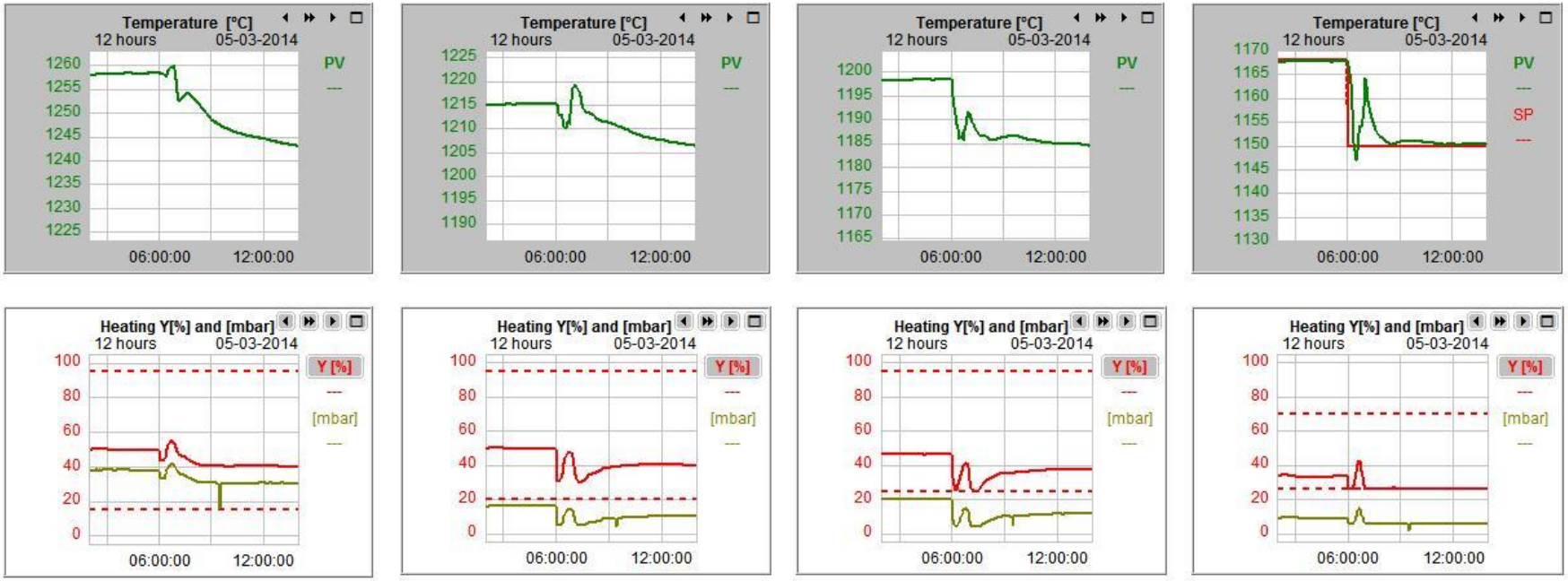
ESIII™ optimization tools: minimize cooling and equalize firing to save energy



Energy consumption (total mixing pressure)	
Before ESIII	124 mbar
After ESIII	69 mbar
Energy saving	44%

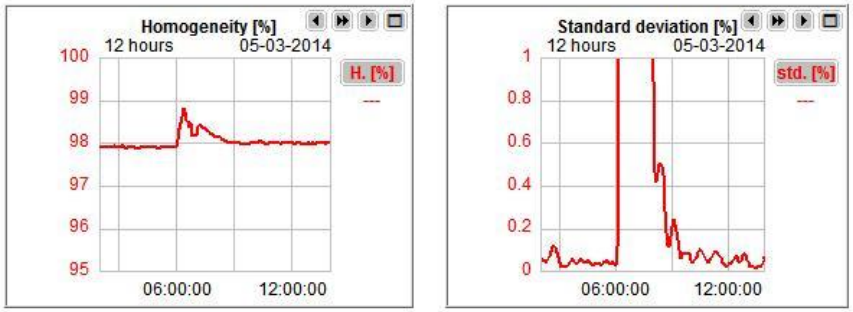
Example 3
ESIII™ Control Change of Spout Ring

Zone 3 | Zone 2 | Zone 1 | Spout



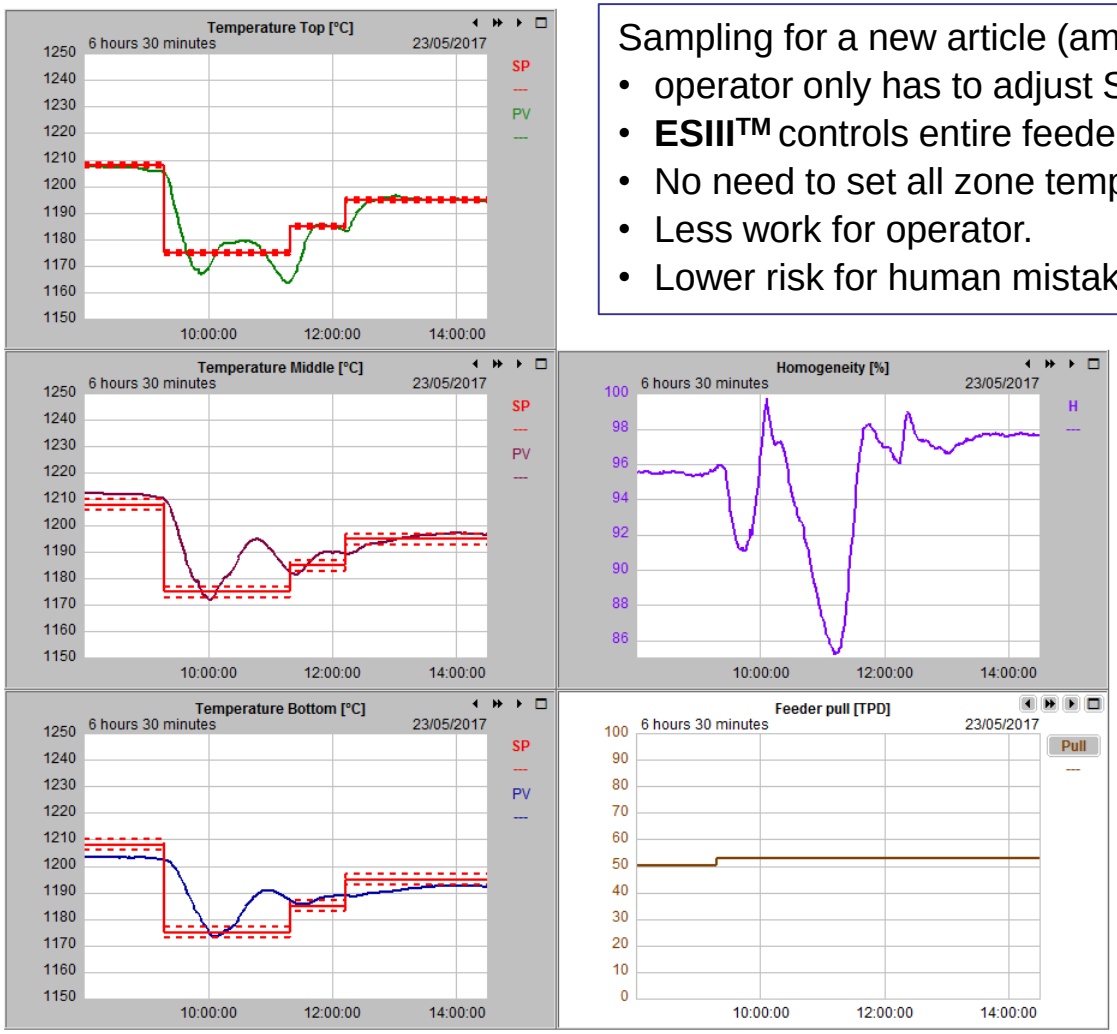
For some job changes operator has to change the spout ring. A temporary stop of the feeder glass flow is directly observed by a strong drop in temperature, followed by a sudden increase in temperature as soon the glass flow is restarted. **ESIII**™ is able to control the process also during such strong disturbances in the feeder.

Homogeneity | Stability



Example 4
ESIII™ Control of 'Sampling'

ESIII™ control during 'sampling' ('Musterung') for a new article



Sampling for a new article (amber glass):

- operator only has to adjust SP of production temperature.
- **ESIII™** controls entire feeder (heatings and coolings).
- No need to set all zone temperatures individually.
- Less work for operator.
- Lower risk for human mistakes.

Closing – remarks from our customers

Production manager after his training:

‘… so it means from now on I only have to specify 1 production temperature in stead of all zone temperatures, great I like it, it means much less work for me (big ☺)’

Another Production Manager:

‘How does somebody get the idea to develop such a helpful tool for us, wonderful!’

Technical Plant Manager:

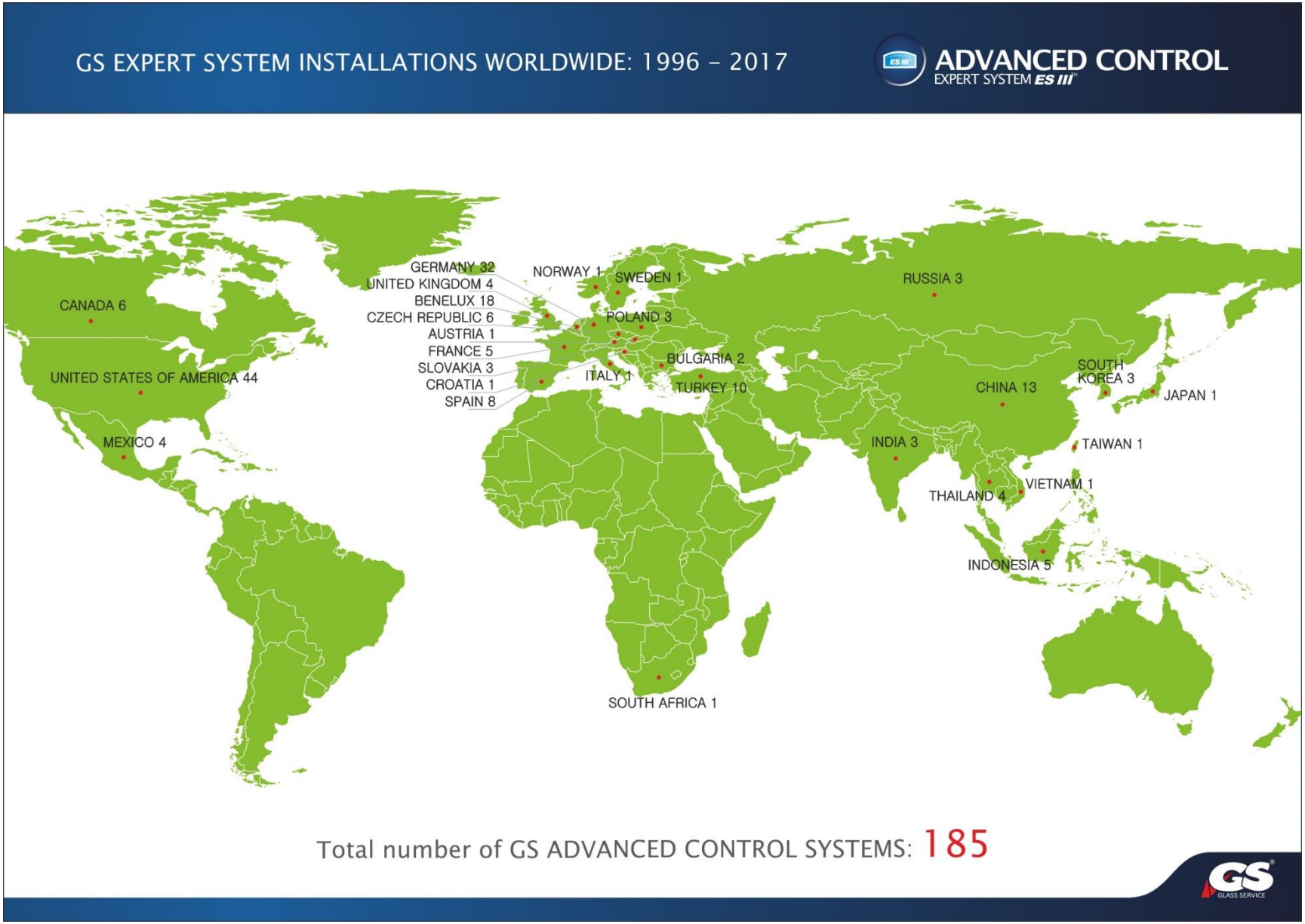
‘We have installed **ESIII™** now on all our 9 feeders. Usually we have over 26 job changes per week, so operators had to set and check many zone temperatures, clearly **ESIII™** is an enormous relief for them. In past this kind of work was even done by a feeder specialist, but most plants do not have them anymore.
We see following benefits:

- The reproducibility of the system, less human interaction and risks for human mistakes.
- The system reaches our targets for temperature and stabilization after job changes.
- Stable and homogeneous temperatures at the feeder end have a positive impact on the gob weight and bottle formation so finally on product quality.
- Energy savings.
- Less risk for reboil and feeder corrosion due to homogeneous firing.
- More time operator for other tasks (feeder maintenance).’

How does a happy GS customer look like?

Dietmar Pfeufer, Batch and Furnace manager Gerresheimer Lohr
with 11 feeders in full automatic job change control

ESIII Reference Map



Could ESIII™ have helped here? – ‘Modern Times’

Thank you for your attention!

GLASS SERVICE, a.s.
Rokytnice 60, 755 01 Vsetin
Czech Republic

www.gsl.cz

GS®
GLASS SERVICE

Could ESIII™ have helped here? – ‘Modern Times’

Thank you for your attention!

GLASS SERVICE, a.s.
Rokytnice 60, 755 01 Vsetin
Czech Republic

www.gsl.cz

GS®
GLASS SERVICE