



Optimized use of PostgreSQL in real world production

Dr. Roland Sonnenschein

Hesotech GmbH, Diez, Germany



- Physicist: Optics, solid state physics
- Process engineering
- Bridging gap: Real world $\leftrightarrow$ Modern software



Some of our Customers

Automobile Manufacturers

- Volkswagen
- Audi
- Fiat
- BMW
- Mercedes
- Daimler
- Peugeot
- Ford
- Lada



Location

Hesotech GmbH

Wilhelm-von-Nassau-Park 11
65582 Diez
Germany



Developing Solutions

- Documentation of technical processes
- manufacturing, testing, bio-science,
- landslide monitoring
- Computer-Vision



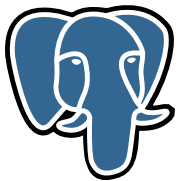
The job!



The job ! But whre is Slony ? 



The job! Slony helps!



Document annealing process
of each subplot of a order

SQL capabilities used to fullify the job

SQL

array

trigger

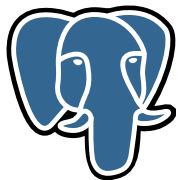
json / jsonb

xml / xpath

tstzrange

plpgsql

plv8



Document annealing process
of each subplot of a order

More skills needed

SQL

array

trigger

json / jsonb

xml / xpath

tstzrange

plpgsql

plv8

Skills

Programming

Web: html5, css, js, svg

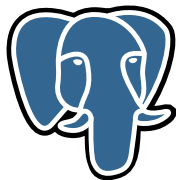
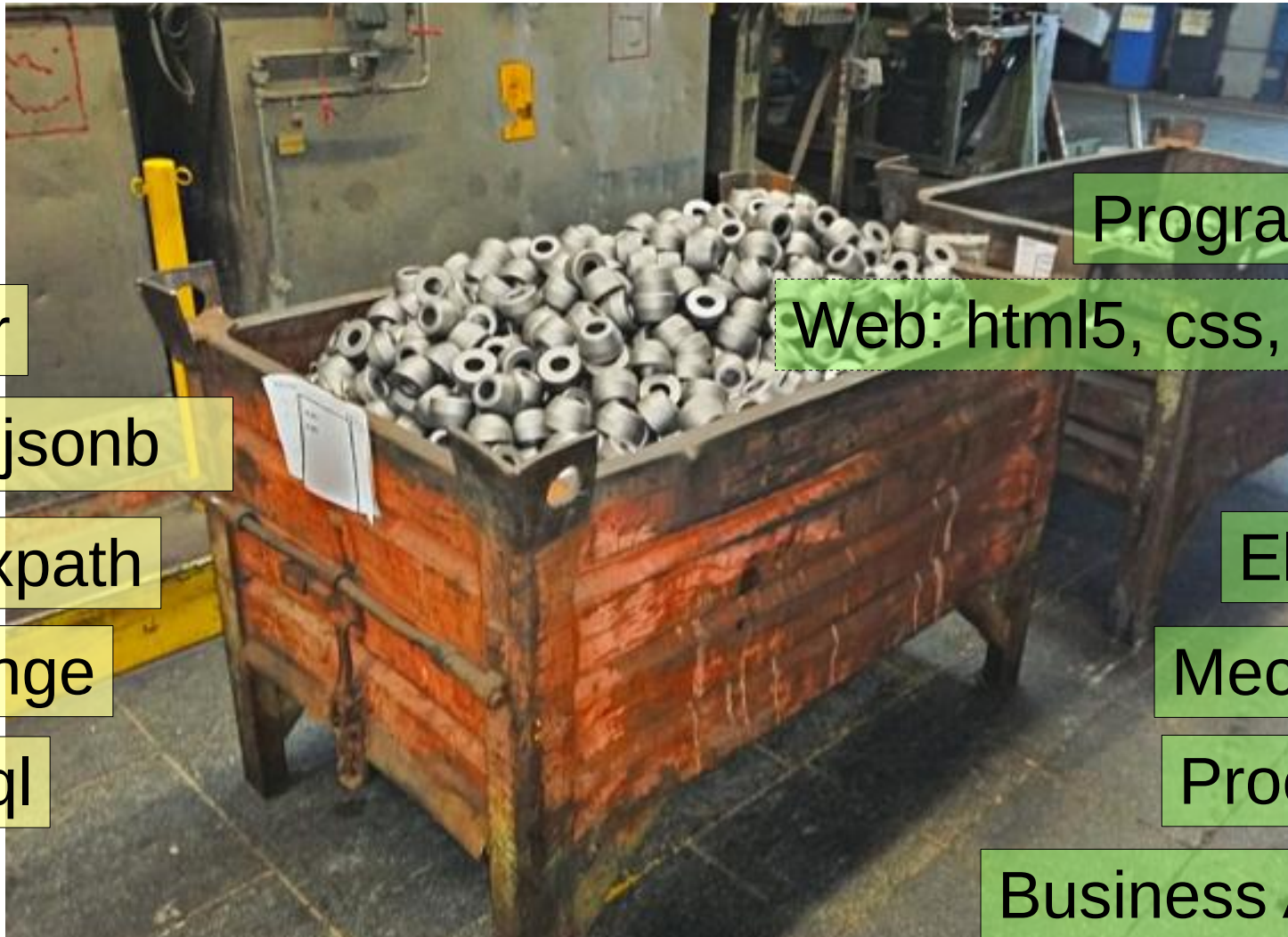
PLC

Electrics

Mechanics

Processes

Business Admin.



Document annealing process
of each subplot of a order

Mix it up to get a good result !

SQL

array

trigger

json / jsonb

xml / xpath

tstzrange

plpgsql

plv8

Skills

Programming

Web: html5, css, js, svg

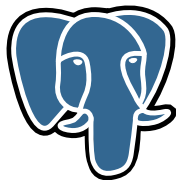
PLC

Electrics

Mechanics

Processes

Business Admin.



Document annealing process of each subplot of a order

Links

Simulator	D:\Metaldyne\Durchstoss-Simul\Durchstoss-Simul\bin\Debug\Durchstoss-Simul.exe
PgStorage	D:\Hesotech\IMaster\PgStorage.exe
iMaster	http://localhost/web/iMaster/build/index.aspx
DbGate	D:\CentralDb\DbGate\Start-DbGate-forever.cmd
DbEditor	http://localhost:3000/DbEditor/source/index.html

Like baking a cake ...



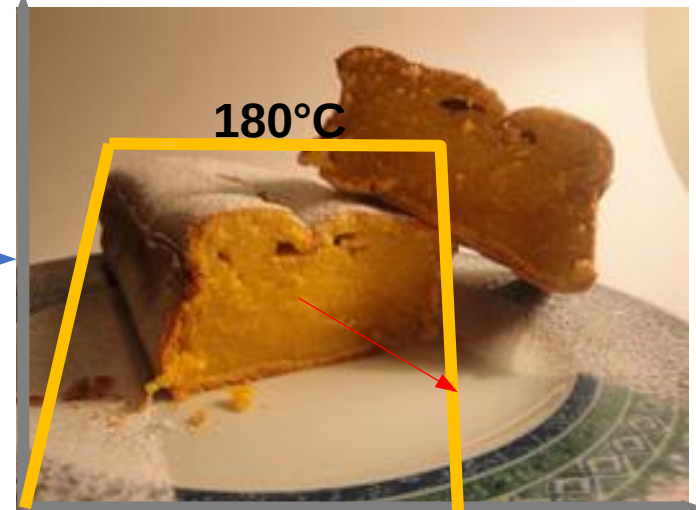
Temp.



time



Temp.

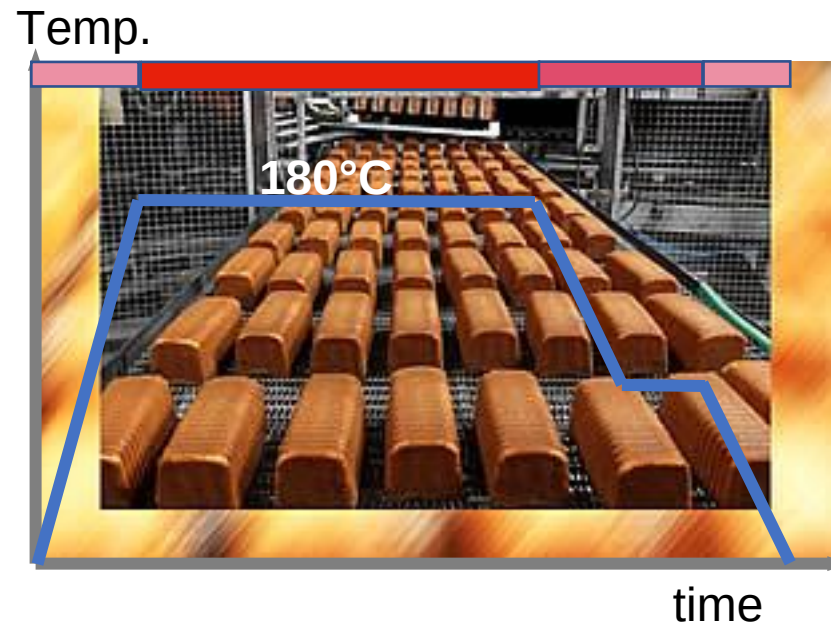
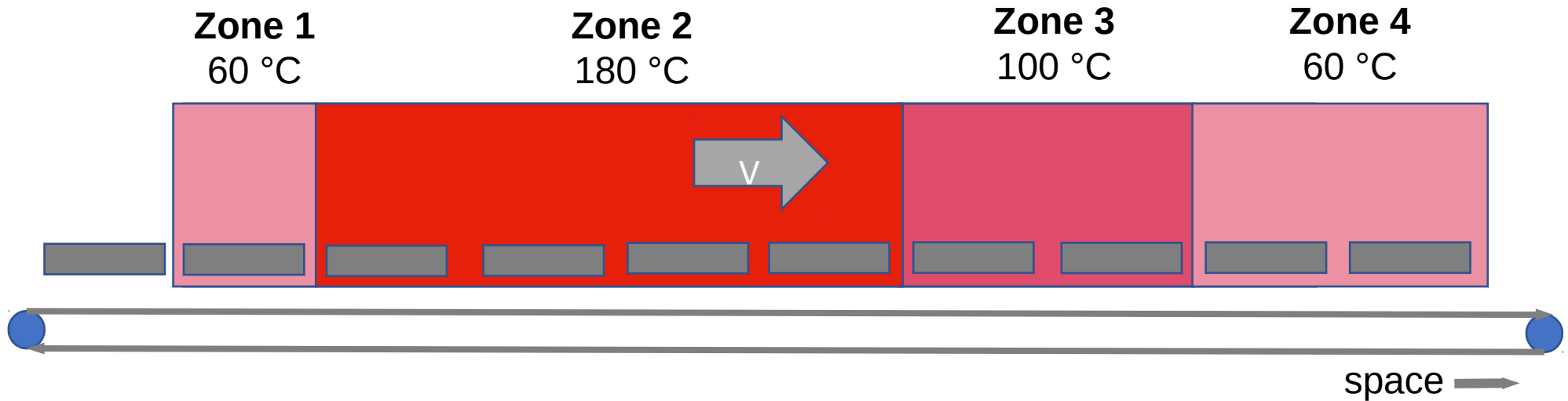


time

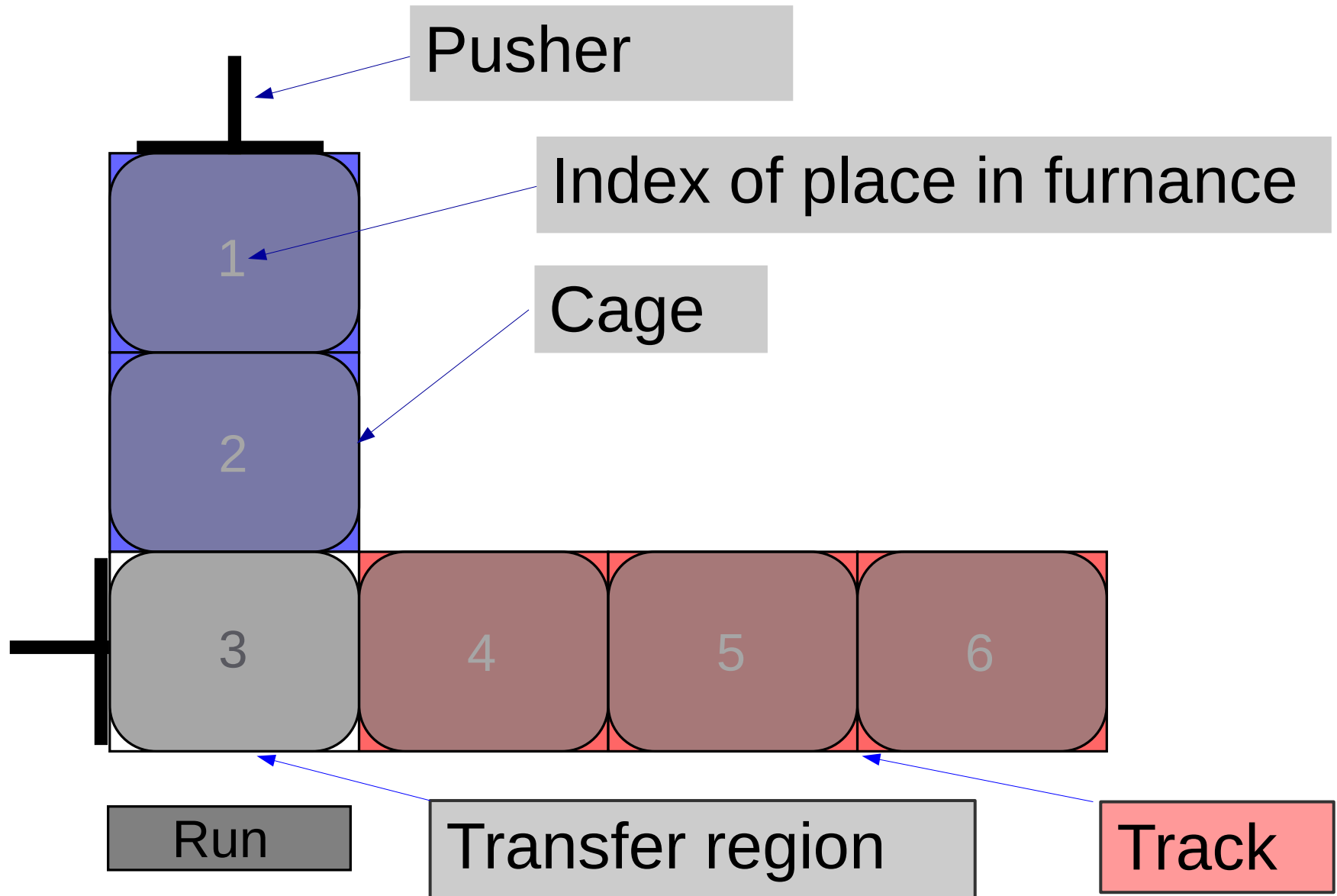


10 000 per day ?

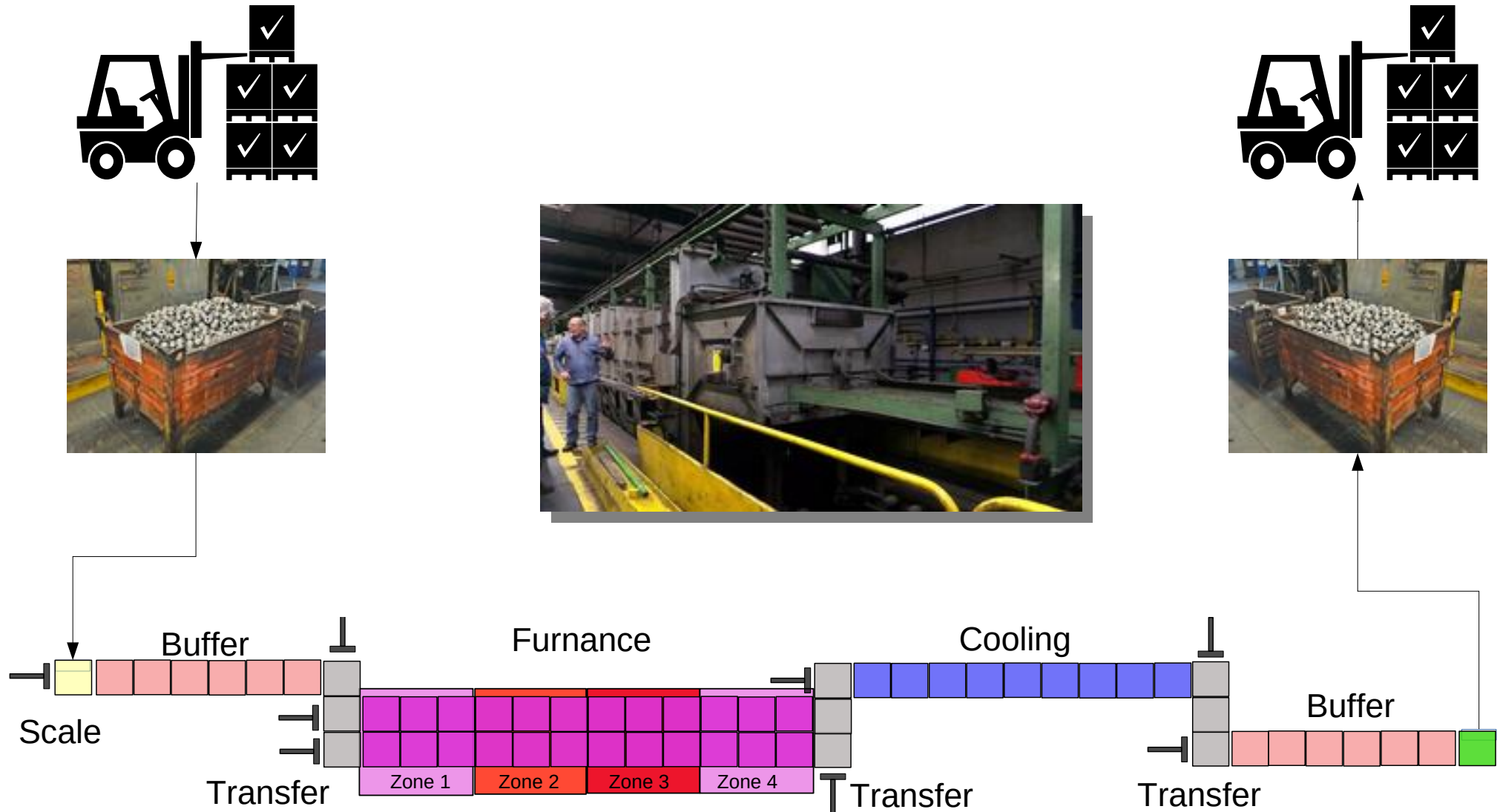
Industry: Batch $\rightarrow$ Continuous process



High Temperature: Conveyor → Pusher



Material flow



Fill into cages + measuring mass



Cages on buffer track



Pusher

Some numbers

- Up to approx. 10 orders / lots per day
- Up to several 100 cages/ sublots per order
- Approx. 400 kg per cage
- Approx. 15 min per push

- 365d / 24h
- 71 Places
- 11 Tracks
- 8 Zones

- 250 Process-Points
 - Read once per sec
- 170 Alarm / Events

The job: part 1

- Document the temperatures of each zone
 - Setpoint and process value
 - Furnance: 4 zones
 - Cooling: 2 zones
- Document for each cage of each order
 - Mass
 - For each place timestamp of
 - Occupation
 - Leaving

The job: part 2

- Document alarms
 - If measured values are outside limits
 - Temperatures
 - Oxygen content inside the furnace
 - Residence time outside limits

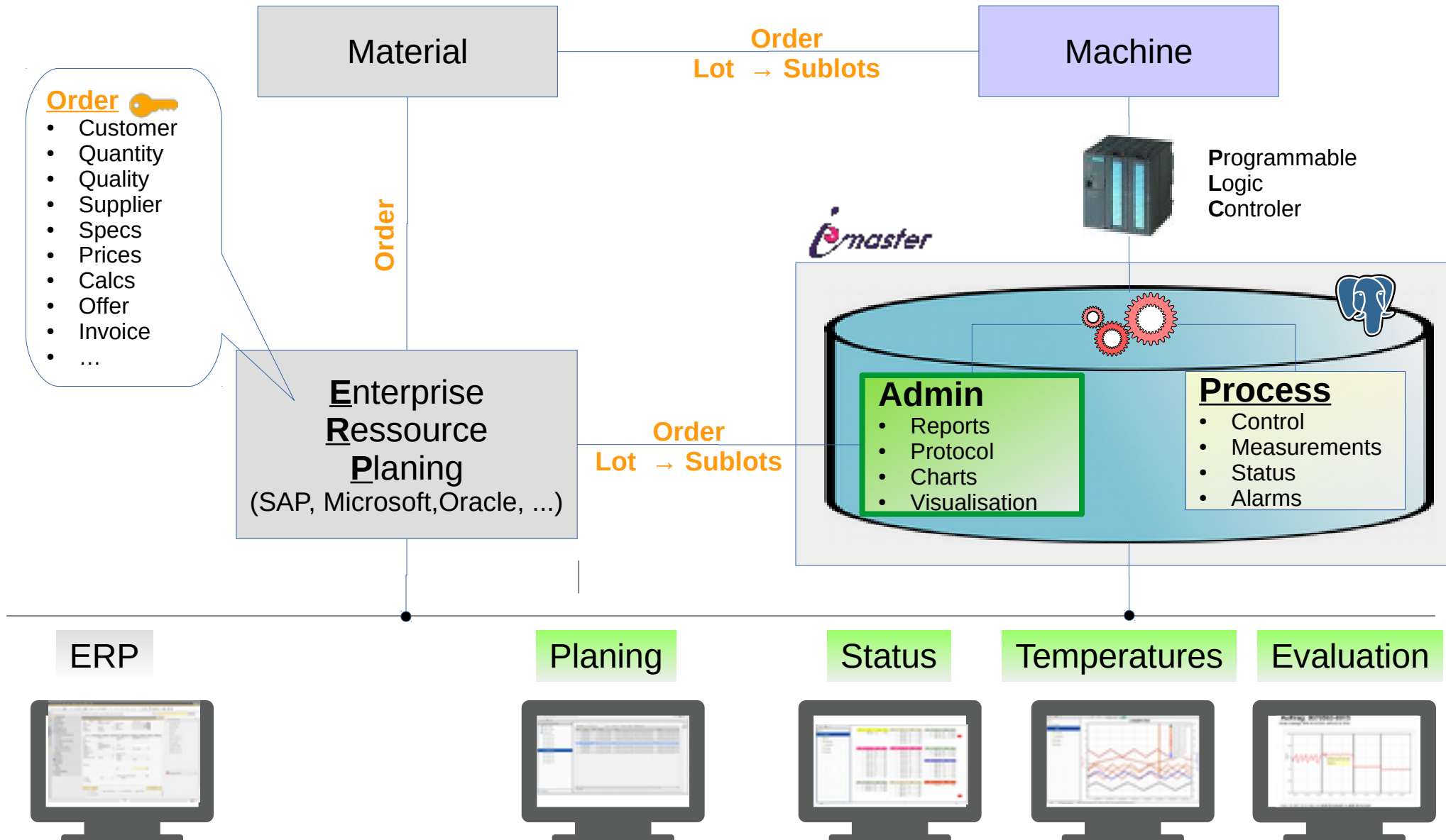
The job: part 3

- Merge for each cage of each order
 - Temperature curve
- Calculate for each cage of each order
 - Duration in each zone
- Generate Report for each order
 - Statistics
 - Alarming
- Transfer data to ERP system

The job: part 4

- Operation via browser
 - At machine site
 - In office
 - On standby duty

Business + Process Enviroment



How we started: Simulation



occupancy_online

 machine_id	integer	« pk »
 datetime	timestamp with time zone	
 lot_id	text[]	
 subplot_id	integer[]	
 subplot_attributes	jsonb[]	
 event_occupancy_update_bu	trigger	« bu »

Demo: Simulation Program

**Simulation of
furnance and PLC**

C#

PLC

write

occupancy_online

 machine_id	integer	« pk »
 datetime	timestamp with time zone	
 lot_id	text[]	
 subplot_id	integer[]	
 subplot_attributes	jsonb[]	
 event_occupancy_update_bu	trigger	« bu »

**Visualisation
in the browser**

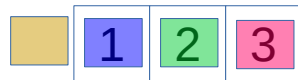
read

HTML5 / AJAX

Position ↔ Array-Index



Place



Index in Array

↓

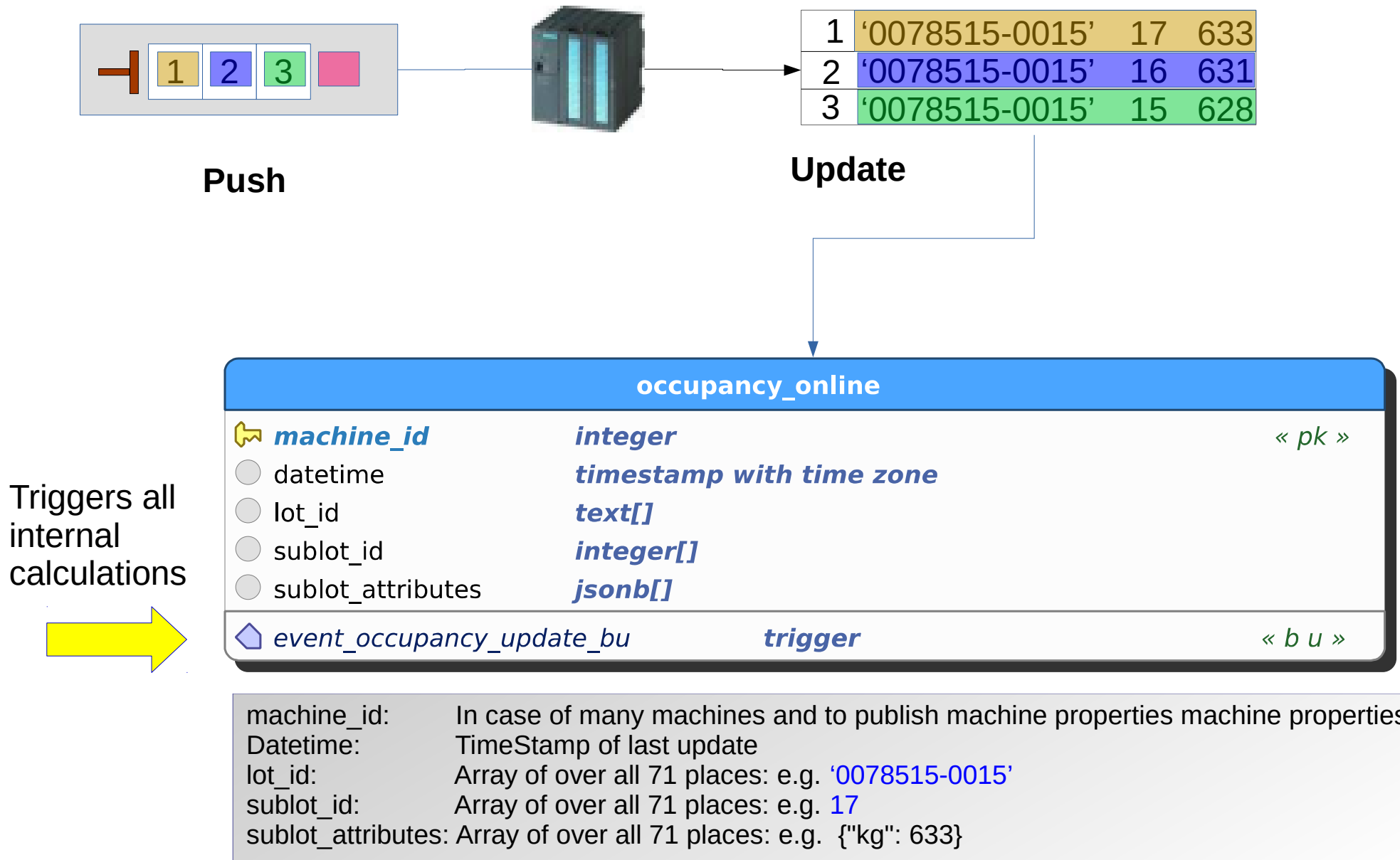
1	'0078515-0015'	17	633
2	'0078515-0015'	16	631
3	'0078515-0015'	15	628

1	'0078515-0015'	16	631
2	'0078515-0015'	15	628
3	'0078515-0015'	14	633

database

mirrors and enforces
process logic

Only Updates of one row!



Machine-Config: Tracks

machine		
 id	<i>integer</i>	« pk »
 name	<i>text</i>	« uq »
 status	<i>integer</i>	
 position_zone_map	<i>integer[]</i>	
 config	<i>jsonb</i>	
 memo	<i>text</i>	

jsonb

```
{
  tracks:
  [
    {name: "Scale",    numPlaces: 1 , type: "Queue",  next: ["Buffer1"] },
    {name: "Buffer1",  numPlaces: 6 , type: "Buffer",  next: ["Transfer1"] },
    {name: "Transfer1", numPlaces: 3 , type: "Transfer", next: ["Furnance1", "Furnance2"] },
    {name: "Furnance1", ... },
    {name: "Furnance2", ... },
    {name: "Transfer2", ... },
    {name: "Cooling", ... },
    {name: "Transfer3", ... },
    {name: "Buffer2", ... },
    {name: "Out", ... },
    {name: "Done", ... }
  ]
  ...
}
```

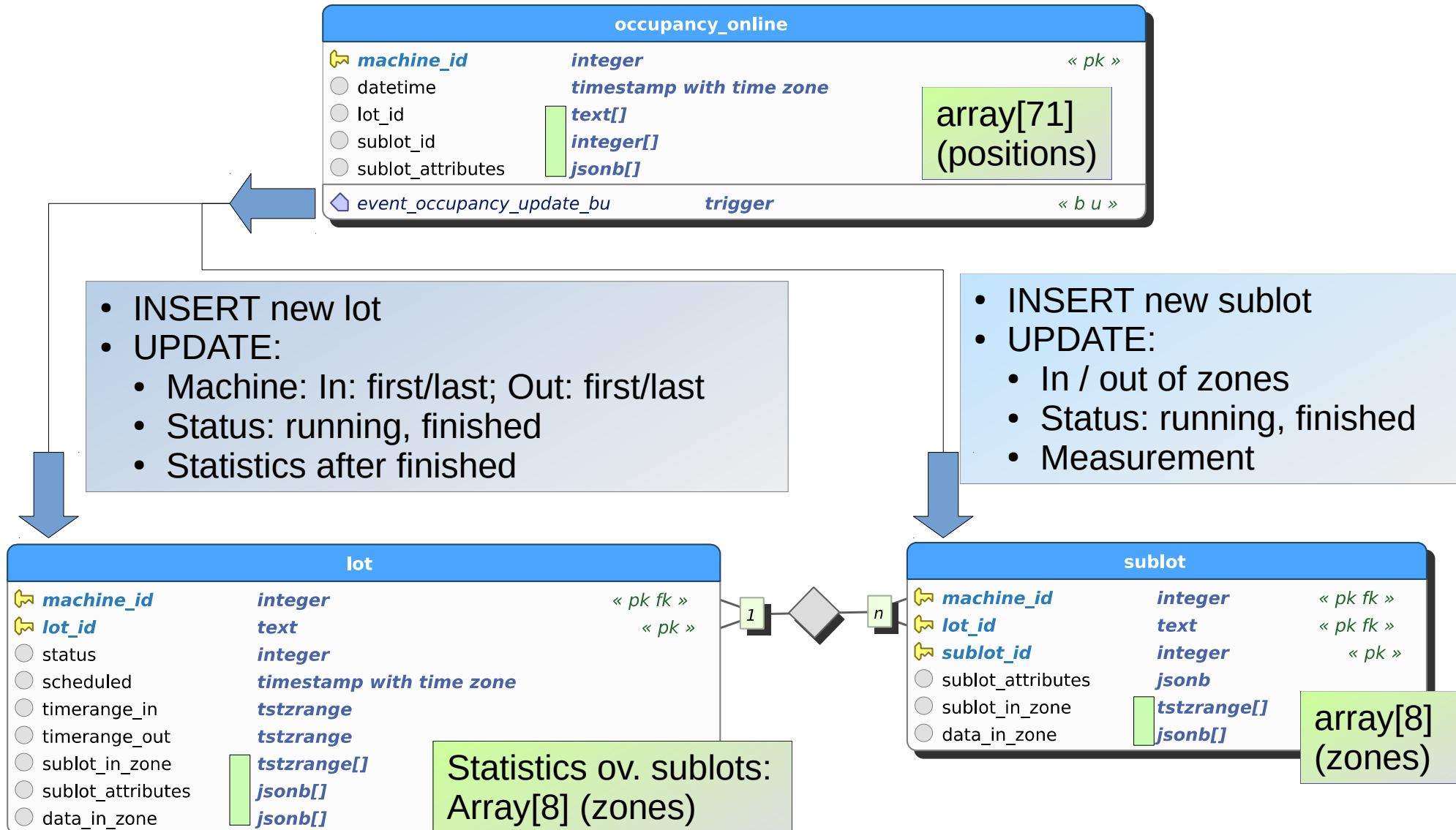

Machine-Config: Zones + misc

machine		
 id	integer	« pk »
 name	text	« uq »
 status	integer	
 position_zone_map	integer[]	←
 config	jsonb	
 memo	text	

Calculated mapping
zone = position_zone_map[place]

```
...
"zones": [
  { "name": "Aufgabe", "positions": { "Waage": [1]}, "channels": [] },
  { "name": "HZ1", "positions": { "Bahn1": [1,2,3], "Bahn2": [1,2,3] },
    "channels": [ "Temp_HZ1_1", "Temp_HZ1_2", ... ] },
  { "name": "HZ2", ... },
  { "name": "HZ3", ... },
  { "name": "HZ4", ... },
  { "name": "KZ1", ... },
  { "name": "KZ2", ... },
  { "name": "Entnahme", ... }
],
"params": {
  "entrancePosition": 1,
  "exitPosition": 56,
  "tableName": "ludwig524"
}
}
```

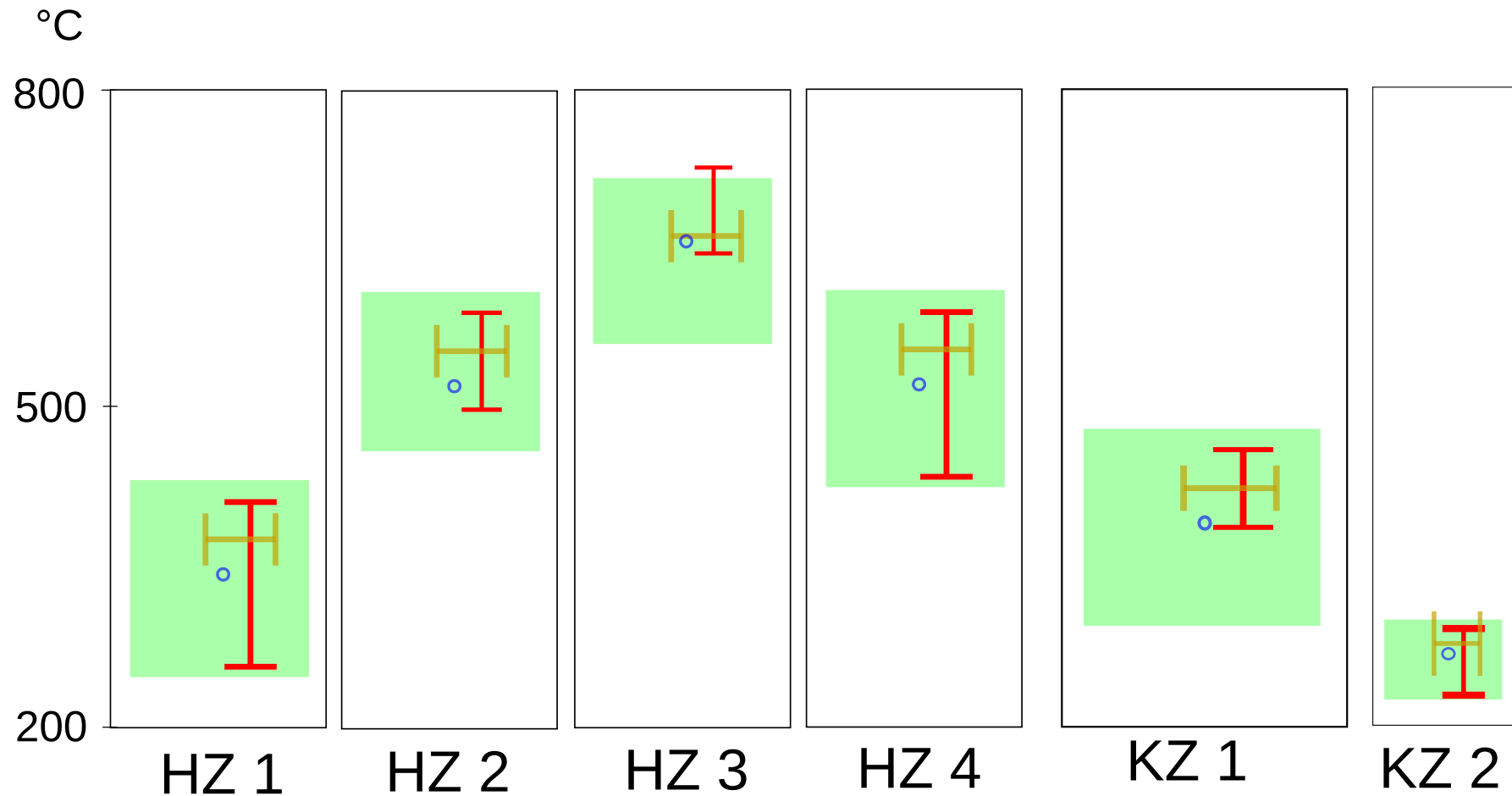
Before Update Trigger



Summary of order

Auftrag 75641

2016-03-02 14:04 -> 2016-03-02 21:03



master - Demo: Occupancy

Login de All Ludwig5205240 EventList Chart ALLE Hz1 Hz2 Hz3 Hz4 Kz1 Kz2 Schuebe Messungen Belegung TableReport NaechsterAuftrag	Waage <table> <tr> <th>(1)</th><th>Lot</th><th>Sub</th><th>Kg</th></tr> <tr> <td></td><td>170311-1455</td><td>4</td><td>781</td></tr> </table> Ofen Bahn 1 <table> <tr> <th>(4)</th><th>Lot</th><th>Sub</th><th>Kg</th></tr> <tr><td></td><td>170311-1453</td><td>11</td><td>771</td></tr> <tr><td></td><td>170311-1453</td><td>9</td><td>769</td></tr> <tr><td></td><td>170311-1453</td><td>7</td><td>767</td></tr> <tr><td></td><td>170311-1453</td><td>5</td><td>765</td></tr> <tr><td></td><td>170311-1453</td><td>3</td><td>763</td></tr> <tr><td></td><td>170311-1453</td><td>1</td><td>761</td></tr> <tr><td></td><td>170311-1452</td><td>5</td><td>759</td></tr> <tr><td></td><td>170311-1452</td><td>3</td><td>757</td></tr> <tr><td></td><td>170311-1452</td><td>1</td><td>755</td></tr> <tr><td></td><td>170311-1451</td><td>4</td><td>753</td></tr> 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	170311-1448	7	730																																																																																																																																																																																																																																																																								
	170311-1448	6	729																																																																																																																																																																																																																																																																								
	170311-1448	5	728																																																																																																																																																																																																																																																																								
	170311-1448	4	727																																																																																																																																																																																																																																																																								
(3)	Lot	Sub	Kg																																																																																																																																																																																																																																																																								
	170311-1454	3	774																																																																																																																																																																																																																																																																								
	170311-1454	2	773																																																																																																																																																																																																																																																																								
	170311-1454	1	772																																																																																																																																																																																																																																																																								
(6)	Lot	Sub	Kg																																																																																																																																																																																																																																																																								
	170311-1450	6	747																																																																																																																																																																																																																																																																								
	170311-1450	5	746																																																																																																																																																																																																																																																																								
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(7)	Lot	Sub	Kg																																																																																																																																																																																																																																																																								
	170311-1450	3	744																																																																																																																																																																																																																																																																								
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	170311-1450	1	742																																																																																																																																																																																																																																																																								
	170311-1449	8	741																																																																																																																																																																																																																																																																								
	170311-1449	7	740																																																																																																																																																																																																																																																																								
	170311-1449	6	739																																																																																																																																																																																																																																																																								
	170311-1449	5	738																																																																																																																																																																																																																																																																								
	170311-1449	4	737																																																																																																																																																																																																																																																																								
	170311-1449	3	736																																																																																																																																																																																																																																																																								
(10)	Lot	Sub	Kg																																																																																																																																																																																																																																																																								
	170311-1448	3	726																																																																																																																																																																																																																																																																								



Demo

*i*master-Demo: Measurements

Login  de

All

▼ Ludwig524

- Chart
- Messungen**
- Umlaufarme
- Schuebe
- Belegung

Bezeichnung	Wert	Einheit	
Atmosphaere_Ofen	36		
Temp_HZ1_1	69		
Temp_HZ1_2	89		
Temp_HZ2_1	59		
Temp_HZ2_2	79		
Temp_HZ3_1	110		
Temp_HZ3_2	110		
Temp_HZ4_1	96		
Temp_HZ4_2	96		
Temp_KZ1	69		
Temp_KZ2	69		

11 Zeilen

Admin of channels in iMaster

```
CREATE TABLE history.pgchannelsets  
(  
  chnsetid serial      NOT NULL,  
  mapobjectid         character varying(36) NOT NULL,  
  tablename           character varying(80),  
  validfrom           timestamp with time zone DEFAULT now(),  
  validto             timestamp with time zone,  
  xmlconfig           xml,  
  CONSTRAINT pgchannelsets_pkey PRIMARY KEY (chnsetid)  
)
```

See 2016.pgday.ru

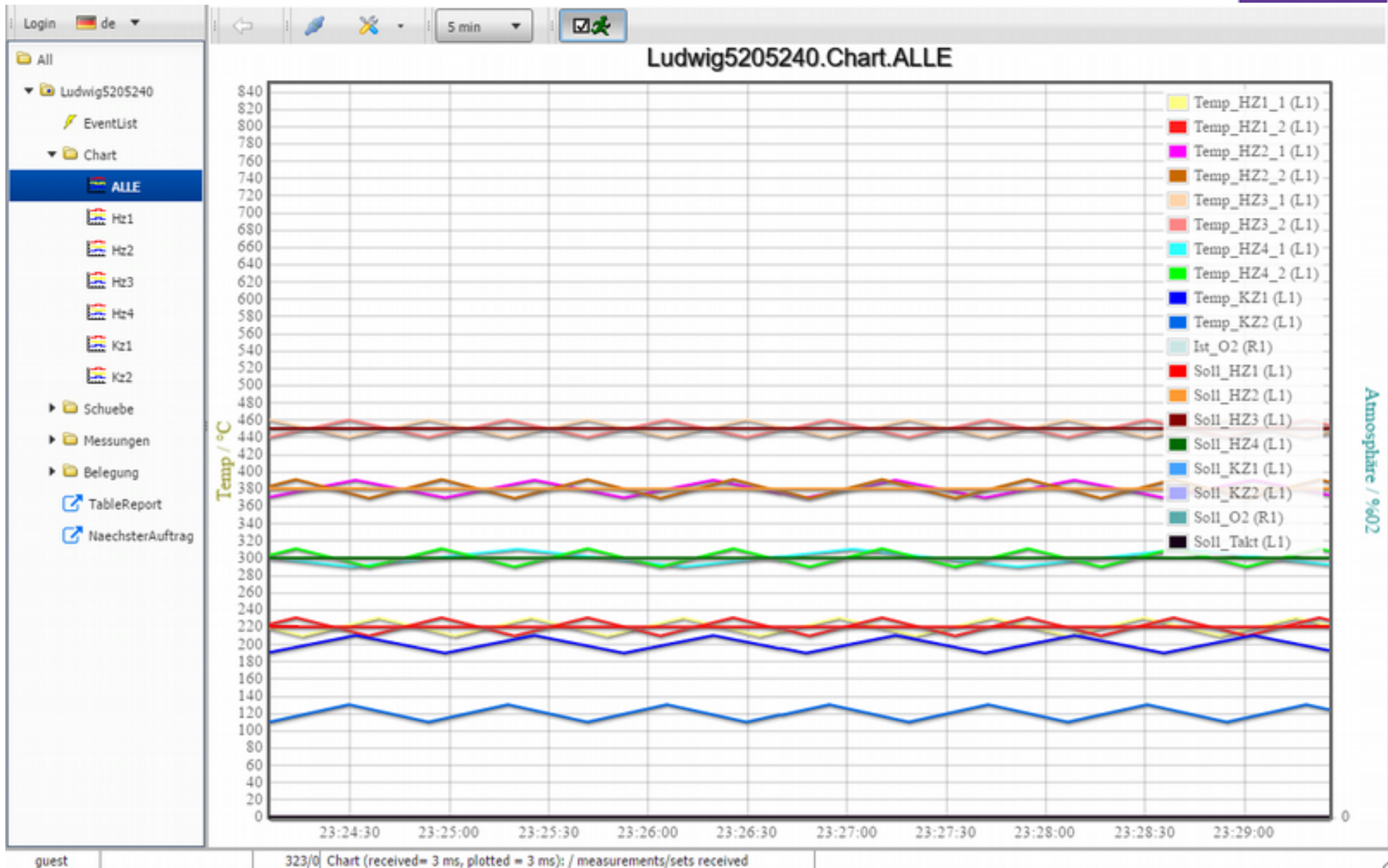
Why industrial manufacturing
data need special
considerations

master-Demo: alarms / events

Login de				2016-03-07 12:00:00		2017-03-11 23:26:23	
Prio	ID	Name	Beschreibung	Gestartet	Beendet		
3	5725	LW0524.5.4	35KF2 Brenner 26 Störung	2016-09-28 11:56:40	2016-09-28 12:09:07		
3	5726	LW0524.5.12	43F2 Brenner 34 Störung	2016-09-28 11:56:40	2016-09-28 12:09:07		
3	5727	LW0524.5.14	45KF2 Brenner 36 Störung	2016-09-28 11:56:40	2016-09-28 12:09:07		
3	5728	LW0524.5.15	46KF2 ZBrenner 1 Störung	2016-09-28 11:56:40	2016-09-28 12:09:07		
3	5729	LW0524.5.16	46KF2 ZBrenner 2 Störung	2016-09-28 11:56:40	2016-09-28 12:09:07		
3	5733	LW0524.5.4	35KF2 Brenner 26 Störung	2016-09-28 12:22:43	2016-09-28 18:17:27		
3	5734	LW0524.5.12	43F2 Brenner 34 Störung	2016-09-28 12:22:43	2016-09-28 18:17:27		
3	5735	LW0524.5.14	45KF2 Brenner 36 Störung	2016-09-28 12:22:43	2016-09-28 18:17:27		
3	5736	LW0524.5.15	46KF2 ZBrenner 1 Störung	2016-09-28 12:22:43	2016-09-28 18:17:27		
3	5737	LW0524.5.16	46KF2 ZBrenner 2 Störung	2016-09-28 12:22:43	2016-09-28 18:17:27		
3	5743	LW0524.4.9	24KF2 Brenner 15 Störung	2016-09-28 18:22:52	2016-09-28 18:23:52		
3	5744	LW0524.5.1	32KF2 Brenner 23 Störung	2016-09-28 18:23:00	2016-09-28 18:23:52		
3	5742	LW0524.5.5	36KF2 Brenner 27 Störung	2016-09-28 18:22:00	2016-09-28 18:23:52		
3	5745	LW0524.4.4	19KF2 Brenner 10 Störung	2016-09-28 18:24:00	2016-09-28 18:24:34		
3	5746	LW0524.5.1	32KF2 Brenner 23 Störung	2016-09-28 18:24:00	2016-09-28 18:24:34		
3	5747	LW0524.5.14	45KF2 Brenner 36 Störung	2016-09-28 18:24:00	2016-09-28 18:24:34		
3	5748	LW0524.5.1	32KF2 Brenner 23 Störung	2016-09-28 18:24:42	2016-09-28 18:25:21		
3	5749	LW0524.5.15	46KF2 ZBrenner 1 Störung	2016-09-28 18:25:00	2016-09-28 18:25:21		
3	5750	LW0524.5.15	46KF2 ZBrenner 1 Störung	2016-09-28 18:25:29	2016-09-28 18:25:35		
3	5751	LW0524.5.15	46KF2 ZBrenner 1 Störung	2016-09-28 18:25:42	2016-09-28 18:25:50		
3	5754	LW0524.5.1	32KF2 Brenner 23 Störung	2016-09-28 18:27:00	2016-09-28 18:29:11		
3	5753	LW0524.5.5	36KF2 Brenner 27 Störung	2016-09-28 18:26:00	2016-09-28 18:29:11		
3	5752	LW0524.5.15	46KF2 ZBrenner 1 Störung	2016-09-28 18:25:58	2016-09-28 18:29:11		
3	5759	LW0524.4.8	23KF2 Brenner 14 Störung	2016-09-28 19:13:00	2016-09-28 19:22:12		
3	5755	LW0524.5.1	32KF2 Brenner 23 Störung	2016-09-28 18:29:19	2016-09-28 19:22:12		
3	5756	LW0524.5.5	36KF2 Brenner 27 Störung	2016-09-28 18:29:19	2016-09-28 19:22:12		
3	5758	LW0524.5.10	41KF2 Brenner 32 Störung	2016-09-28 19:06:00	2016-09-28 19:22:12		
3	5757	LW0524.5.15	46KF2 ZBrenner 1 Störung	2016-09-28 18:29:19	2016-09-28 19:22:12		
3	5760	LW0524.5.1	32KF2 Brenner 23 Störung	2016-09-28 19:22:20	2016-09-28 19:22:33		
3	5761	LW0524.5.5	36KF2 Brenner 27 Störung	2016-09-28 19:22:20	2016-09-28 19:22:33		
3	5762	LW0524.5.15	46KF2 ZBrenner 1 Störung	2016-09-28 19:22:20	2016-09-28 19:22:33		

575 Zeilen

master-Demo: alarms / events



Demo: Orders → machine

Login  de

All

Ludwig5205240

EventList

Chart

ALLE

Hz1

Hz2

Hz3

Hz4

Kz1

Kz2

Schuebe

Messungen

Belegung

TableReport

NaechsterAuftrag

Aufträge in Anlage

Aufträge	Anzahl Körbe	Gewicht [kg]	Startzeit	Beginn Endezeit
170311-213	13	12766	2017-03-11 17:31:36	2017-03-11 17:33:49
170311-278	9	6093	2017-03-11 17:51:32	2017-03-11 17:53:37
170311-307	13	12298	2017-03-11 18:00:27	2017-03-11 18:02:40
170311-380	3	1950	2017-03-11 18:20:47	2017-03-11 18:22:40
170311-627	11	10505	2017-03-11 19:30:56	2017-03-11 19:33:05
170311-714	11	8976	2017-03-11 19:56:21	2017-03-11 19:58:30
170311-914	11	8525	2017-03-11 20:55:05	2017-03-11 20:57:14
170311-954	9	1890	2017-03-11 21:06:18	2017-03-11 21:08:23
170311-994	5	2610	2017-03-11 21:16:47	2017-03-11 21:18:44
170311-995	8	4228	2017-03-11 21:16:57	2017-03-11 21:19:00
170311-1112	5	3080	2017-03-11 21:49:58	2017-03-11 21:51:55

[Gehe zu Fertige Aufträge](#)

[Zurück](#)

guest2017-03-11 23:31:531372/0Visu (NaN ms): Received 4 measurements ; 1 sets

master-Demo: Running orders

Login de

All

Ludwig5205240

EventList

Chart

ALLE

Hz1

Hz2

Hz3

Hz4

Kz1

Kz2

Schuebe

Messungen

Belegung

TableReport

NachsterAuftrag

Geplant

Auftrag

Lot1-0015	▶
Lot2-0015	▶
Lot3-0015	▶
-	▶
-	▶
-	▶
-	▶
-	▶

Anlage

	Auftrag	Körbe	kg	
	LOT_id			vorbereitet
in Anlage	170311-213	13	12766	↗
	170311-278	9	6093	↗
	170311-307	13	12298	↗
	170311-380	3	1950	↗
	170311-627	11	10505	↗
	170311-714	11	8976	↗
Fertig	0078515-0015	101	34931	↗

guest | 2017-03-11 23:31:53 | 1372/0 Visu (NaN ms): Received 4 measurements ; 1 sets

DbExplorer : Planing Orders

Login Logout

Produktions-Daten-Verwaltung

- ▼ Auftrag: Geplant
 - Lot1-0015
 - Lot2-0015
 - Lot3-0015
- Auftrag: In Anlage
- Auftrag: Fertig

Metaldyne

Refresh + Metaldyne Del Apply Diagramm

Status	Auftrag	Körbe	Geplant	Eintritt
	Lot1-0015	0	2017-03-11 23:34:27	
	Lot2-0015	0	2017-03-11 23:34:39	
	Lot3-0015	0	2017-03-11 23:35:23	

3 rows

Table
Text

DbExplorer : Evaluating orders

Login Logout

Produktions-Daten-Verwaltung

- Auftrag: Geplant
- Auftrag: In Anlage
- Auftrag: Fertig
 - 0078159-0015
 - 0078167-0015
 - 0078168-0015
 - 0078507-0015
 - 0078515-0015**
 - 0078563-0015
 - 0078577-0015
 - 0078597-0015
 - 0078630-0015
 - 0078632-0015
 - 170311-1
 - 170311-10

Metaldyne

Refresh 0078515-0015 Metaldyne Del Apply Open Site

Status	Auftrag	Körbe	Geplant	Eintritt
	0078159-0015	9	2016-10-12 15:56:20	["2016-10-12 16:46:08.319+02", "2016-10-12 20:1
	0078167-0015	6	2016-10-14 11:28:50	["2016-10-15 08:50:15.35+02", "2016-10-15 10:59:5
	0078168-0015	57	2016-10-13 16:15:27	["2016-10-14 08:19:06.328+02", "2016-10-15 08:27
	0078507-0015	53	2016-10-10 11:16:35	["2016-10-10 17:05:32.264+02", "2016-10-12 16:26
	0078515-0015	101	2016-10-07 09:50:40	["2016-10-07 10:36:33.160201+02", "2016-10-10 16
	0078563-0015	47	2016-10-12 16:59:32	["2016-10-12 20:39:48.321+02", "2016-10-13 18:31
	0078577-0015	27	2016-10-13 07:37:06	["2016-10-13 19:22:00.329+02", "2016-10-14 07:41
	0078597-0015	34	2016-10-14 12:15:53	["2016-10-15 23:00:57.368+02", "2016-10-16 13:25
	0078630-0015	23	2016-10-14 12:15:35	["2016-10-15 11:21:37.351+02", "2016-10-15 22:24
	0078632-0015	21	2016-10-14 12:22:11	["2016-10-16 13:46:34.366+02", "2016-10-16 22:17
	170311-1	8	2017-03-11 16:33:57	["2017-03-11 16:33:57.292259+01", "2017-03-11 16
	170311-10	7	2017-03-11 16:36:17	["2017-03-11 16:36:17.280379+01", "2017-03-11 16
	170311-100	5	2017-03-11 16:59:49	["2017-03-11 16:59:49.274168+01", "2017-03-11 16
	170311-1000	5	2017-03-11 21:18:25	["2017-03-11 21:18:25.619785+01", "2017-03-11 21
	170311-1001	8	2017-03-11 21:18:35	["2017-03-11 21:18:35.669505+01", "2017-03-11 21
	170311-1002	8	2017-03-11 21:18:52	["2017-03-11 21:18:52.68007+01", "2017-03-11 21

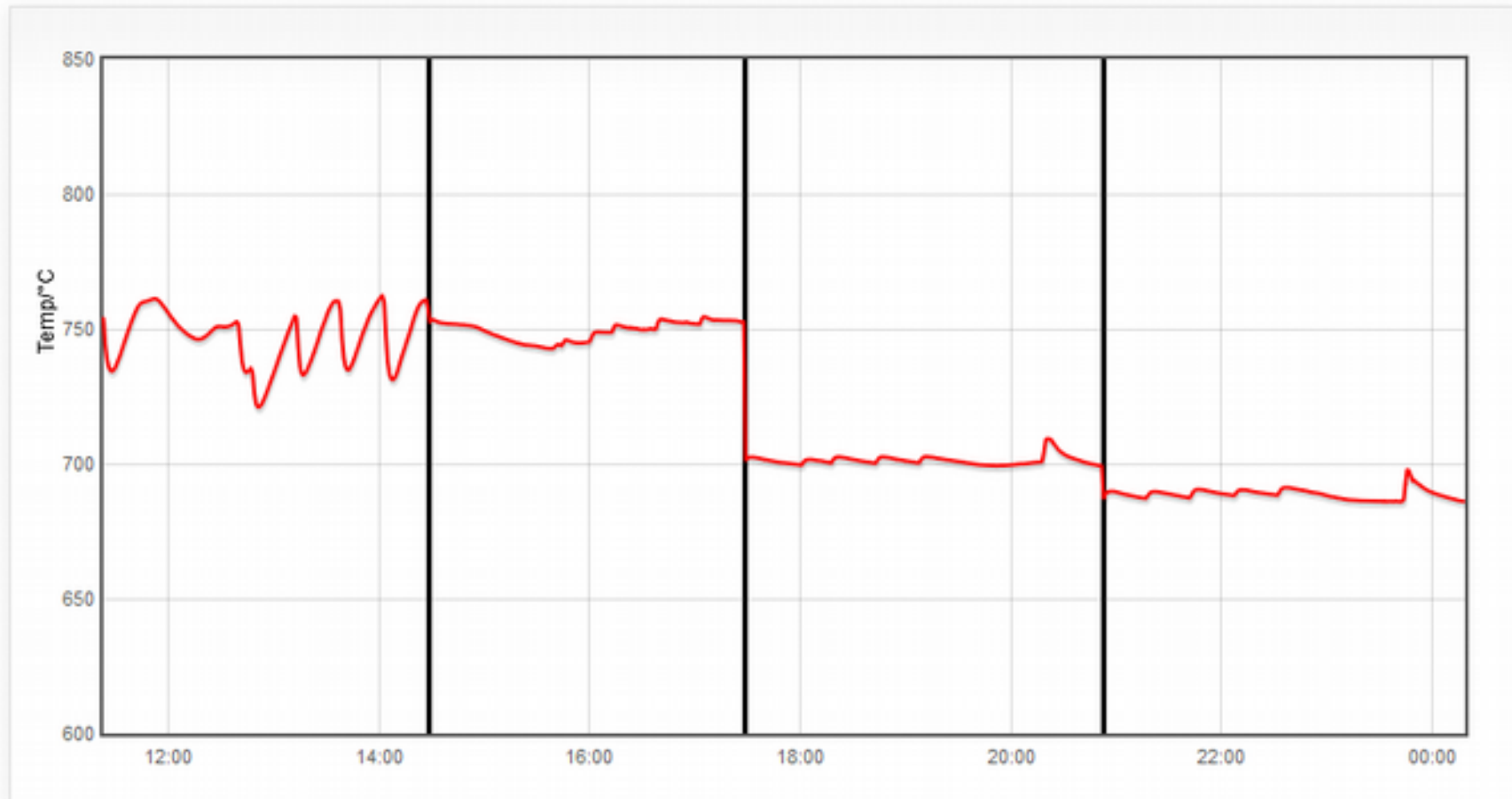
1 of 1493 rows

Table
Text
Diagram
Tabelle

DbExplorer 🗡️ : Evaluating cages

Auftrag: 0078515-0015

Körbe in Anlage: 2016-10-07 09:36 - 2016-10-12 05:49



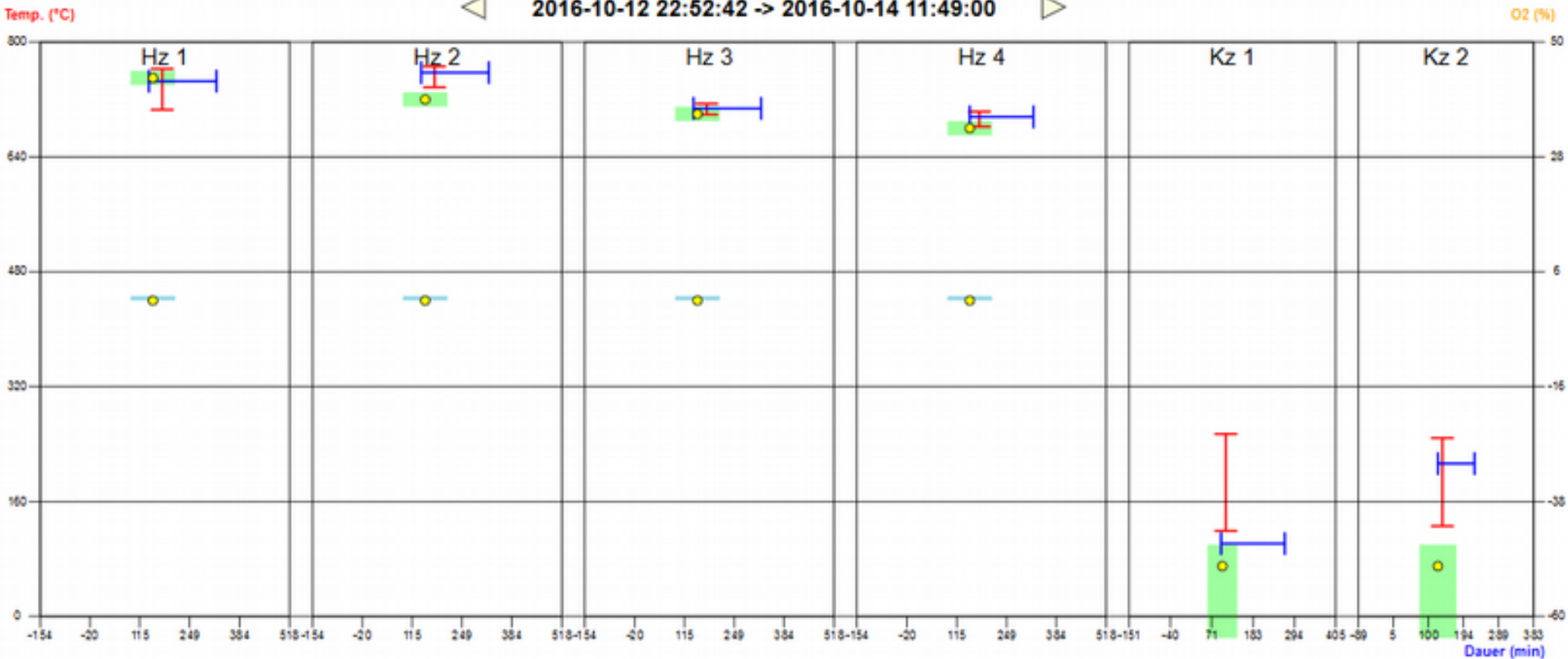
Korb: < 51/101 > Im Ofen von 2016-10-09 06:56 bis 2016-10-10 03:05

DbExplorer : Reporting Orders

Auftrag 0078563-0015

Korb-Nr: Alle

◀ 2016-10-12 22:52:42 -> 2016-10-14 11:49:00 ▶





Спасибо За внимание

Thank's for your
attention

Spasibo sa wni ma ni je