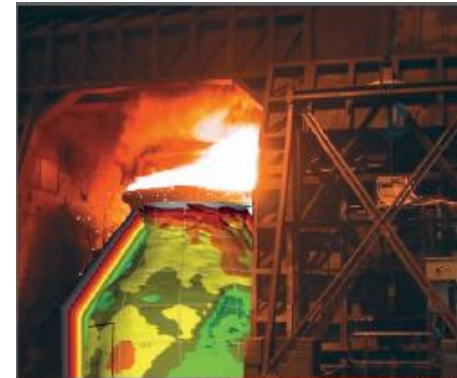




# LaCam<sup>®</sup> LI-Explorer



Rolf Lamm  
October 2018



**MiNTEQ**



**FERROTRON**  
A **MiNTEQ** DIVISION

# Laserprofile Measurement in the Steel Industry

## LaCam® - Mobile



Mobile version  
for converters  
and ladles

## Fixed installation for:



Converters



Ladles



EAFs



Torpedo Ladles



Open Die Forging



# Motivation of Laser Measurement in Ladles

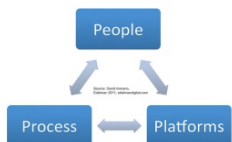
## Why Laserscanner for Hot Ladles?



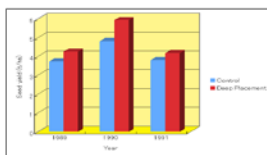
Increase of safety in a steelplant



Reduction of refractory and maintenance cost



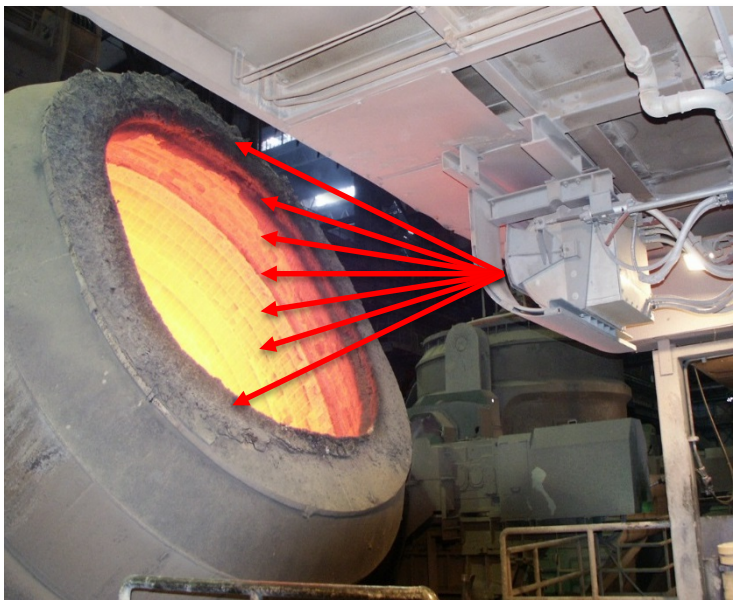
Optimization of process and logistics



Increase of yield



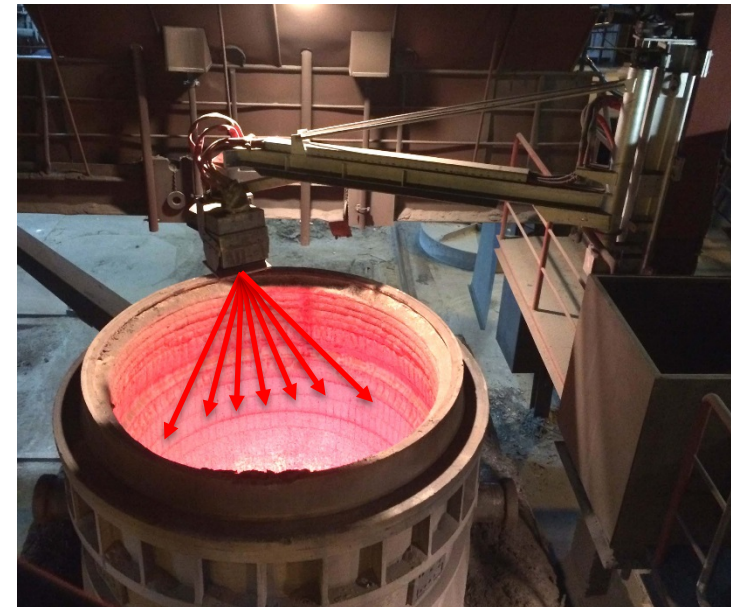
# Examples of Current Laser-Ladle Inspection



fixed or tiltable ladle stand



bridge over ladle transport car



swinging arm above ladle

If the mouth of the ladle is “clean” and no skull is built up you can have good results from the entire Ladle-Refractory lining although the laserscanner is in front of the ladle mouth. But hidden areas cannot be measured and leads to a remaining risk.



# New Developed LaCam® LI-Explorer



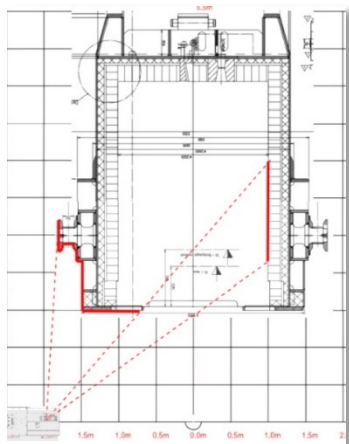
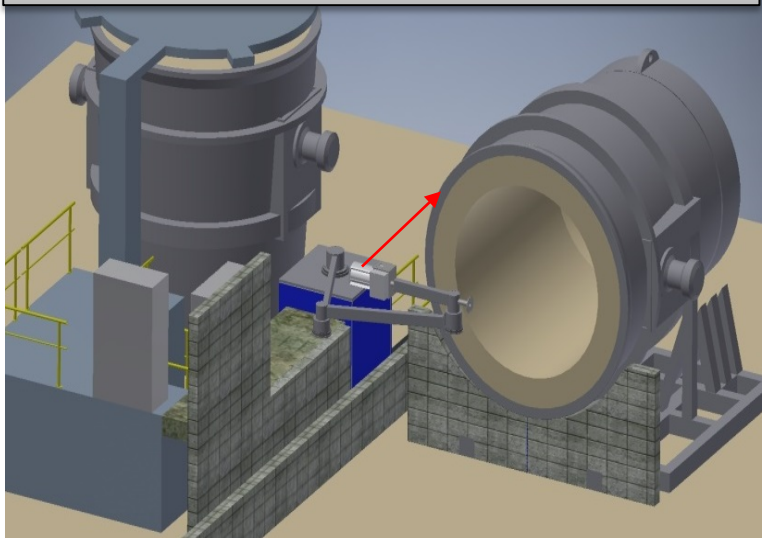
Patented measurement method was further developed to measure ladle refractory lining in hot condition directly after tapping from inside the ladle

The method of immersing a laserscanner into a hot confined space was already introduced with the LaCam®-Torpedo which measures inside the hot torpedo ladle.

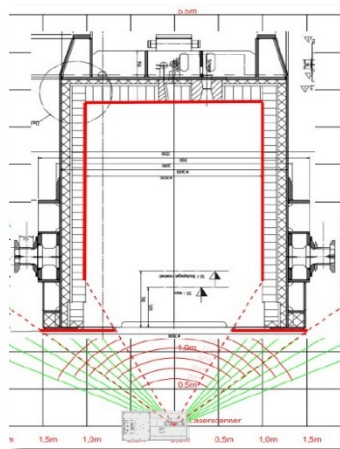
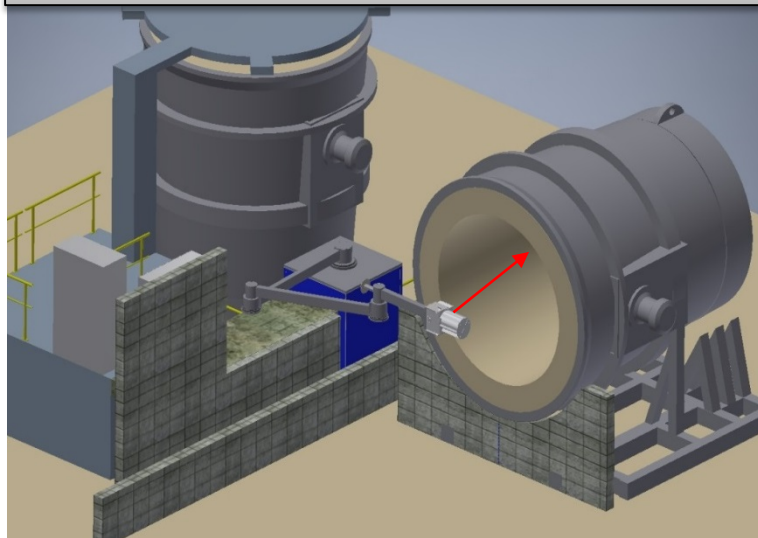


# Measurement Procedure

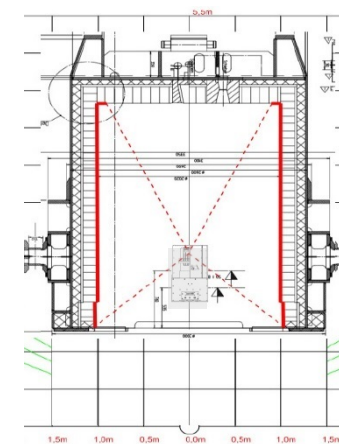
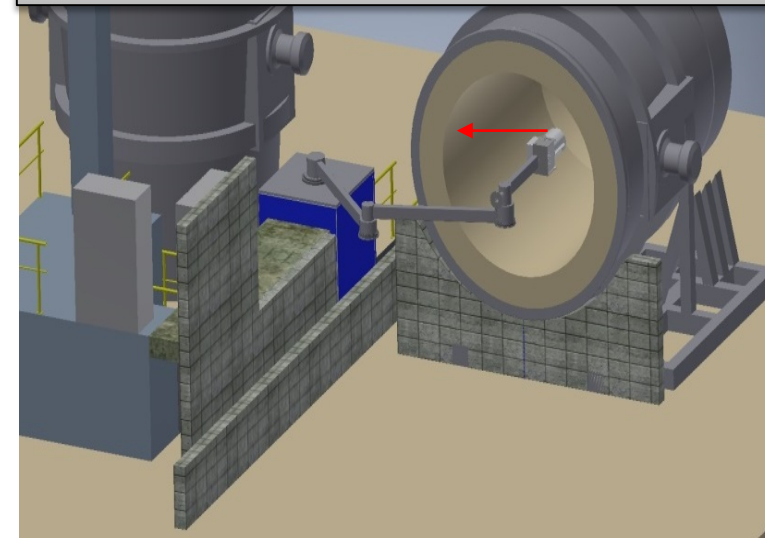
Positioning-Scan on outer ladle shell



Bottom-Scan from outside



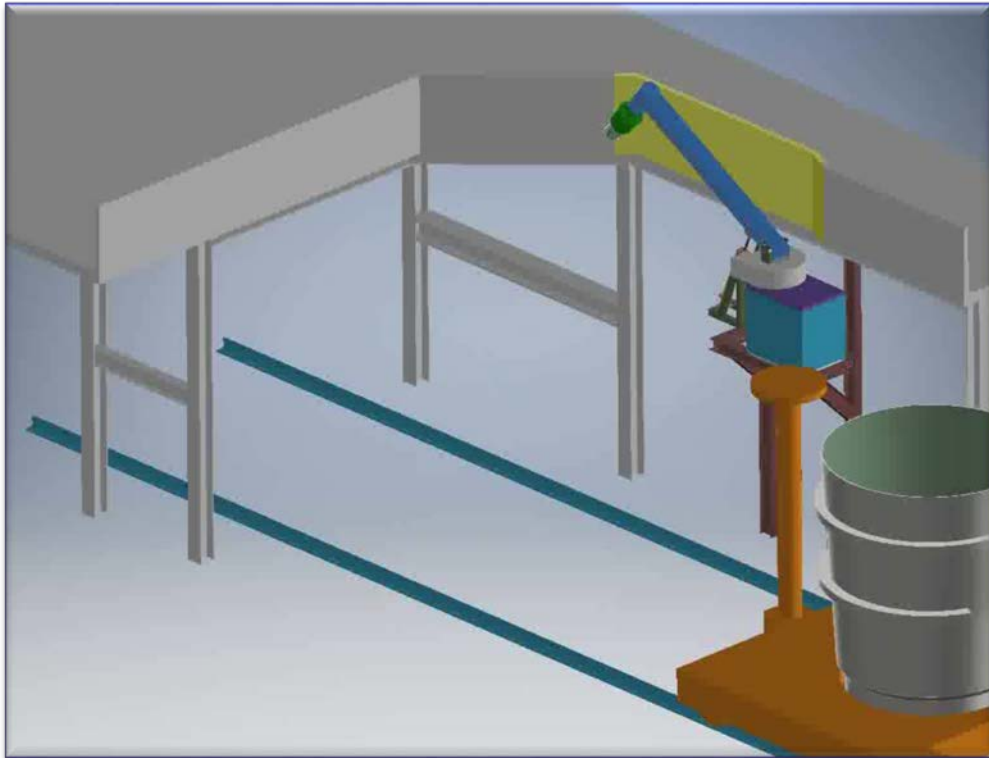
Centerposition-Scan 360° inside ladle



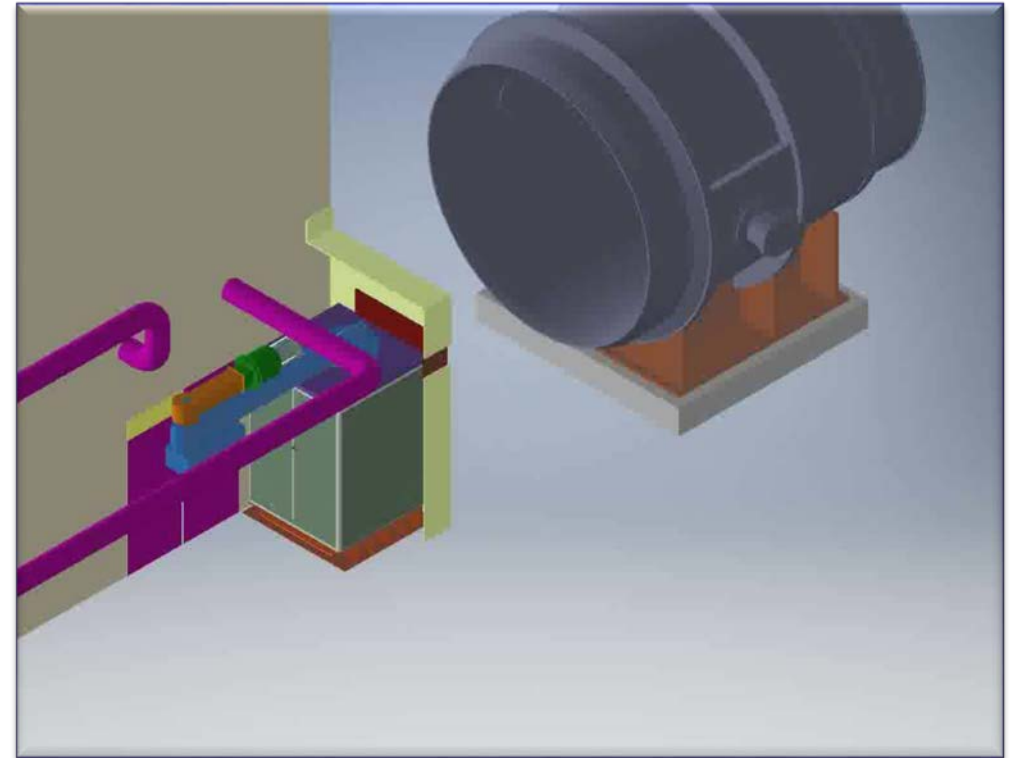


# Examples of LaCam LI-Explorer Applications

Ladle in Vertical Position



Ladle in Horizontal Position

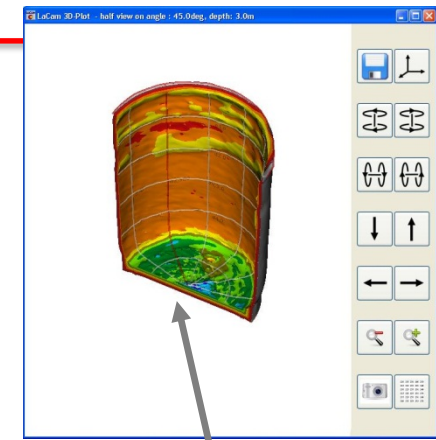
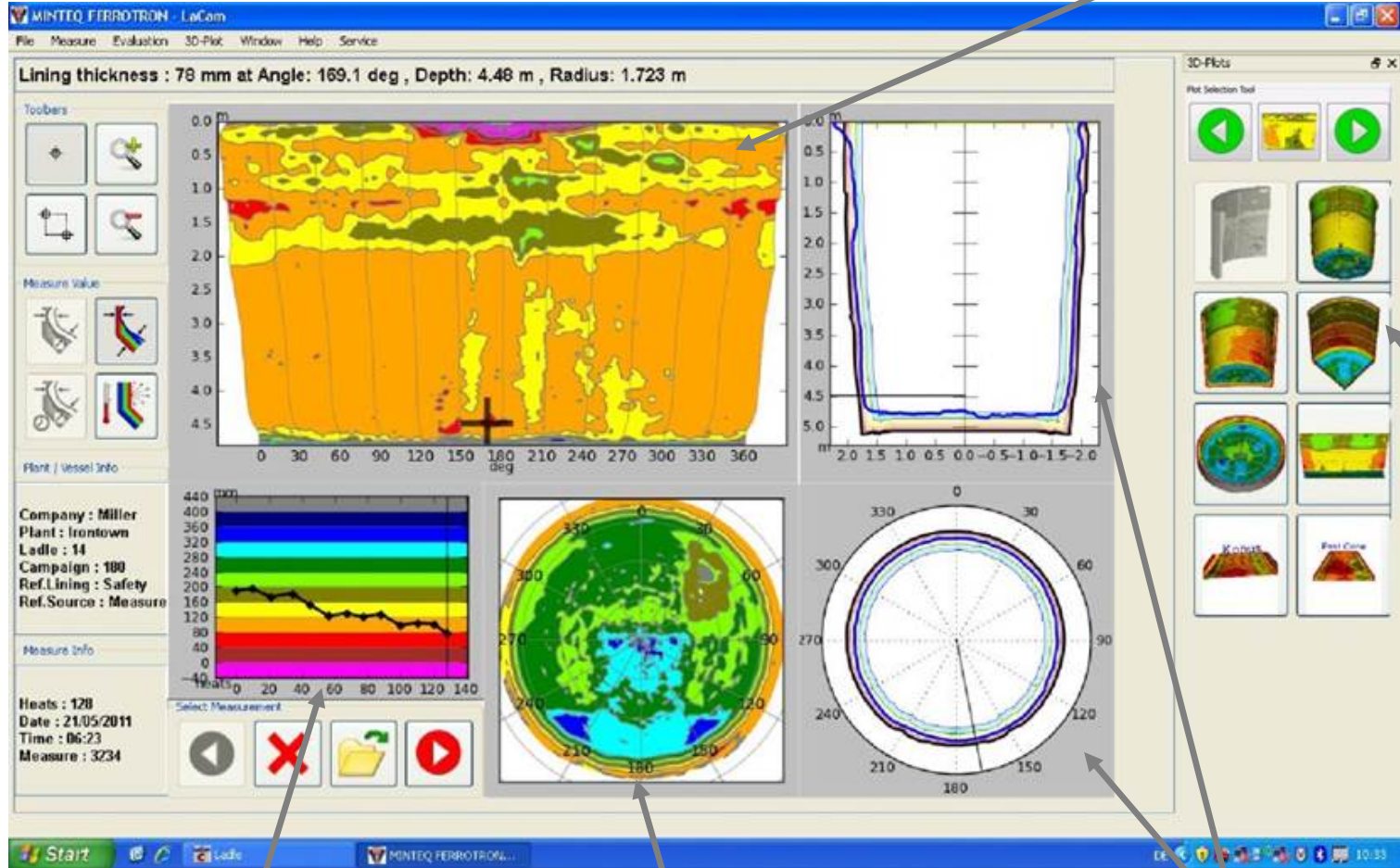


Klick on picture to run animation clip

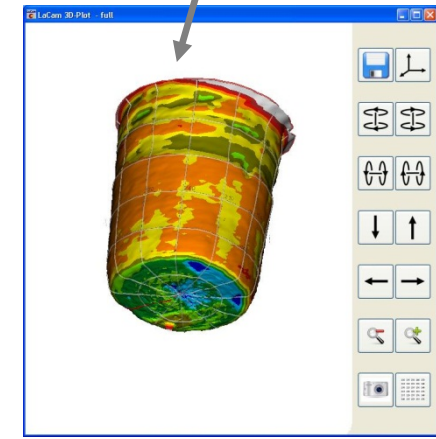
# Versatile 2D and 3D Result presentation for Ladle Application

Ladle Refractory Thickness- ,Wear- and Wearspeed- Measurement

Wall



Examples of 3D presentation



Trend and Tendency Analysis

Bottom

Sectional and Horizontal 2D Cut

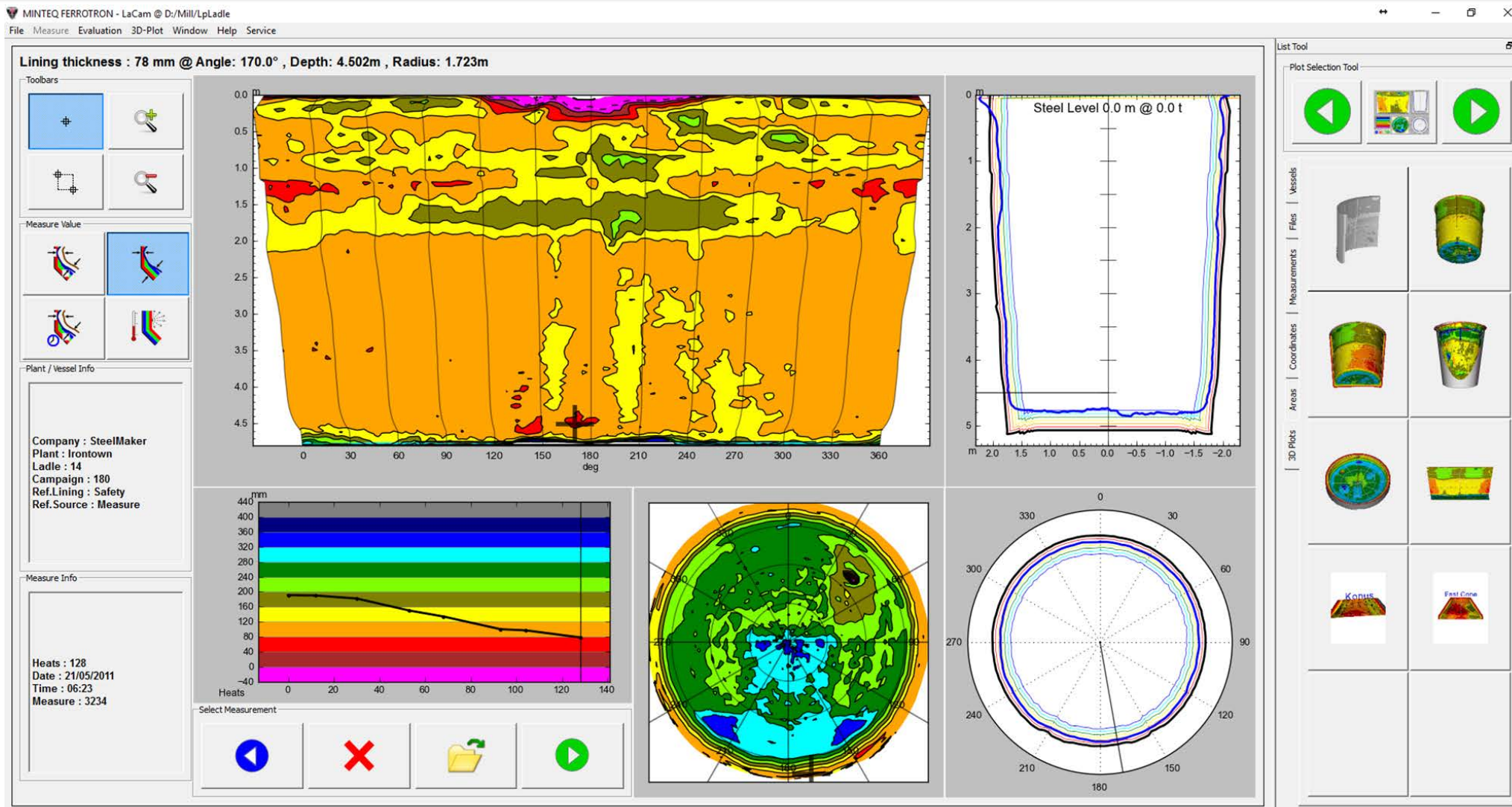


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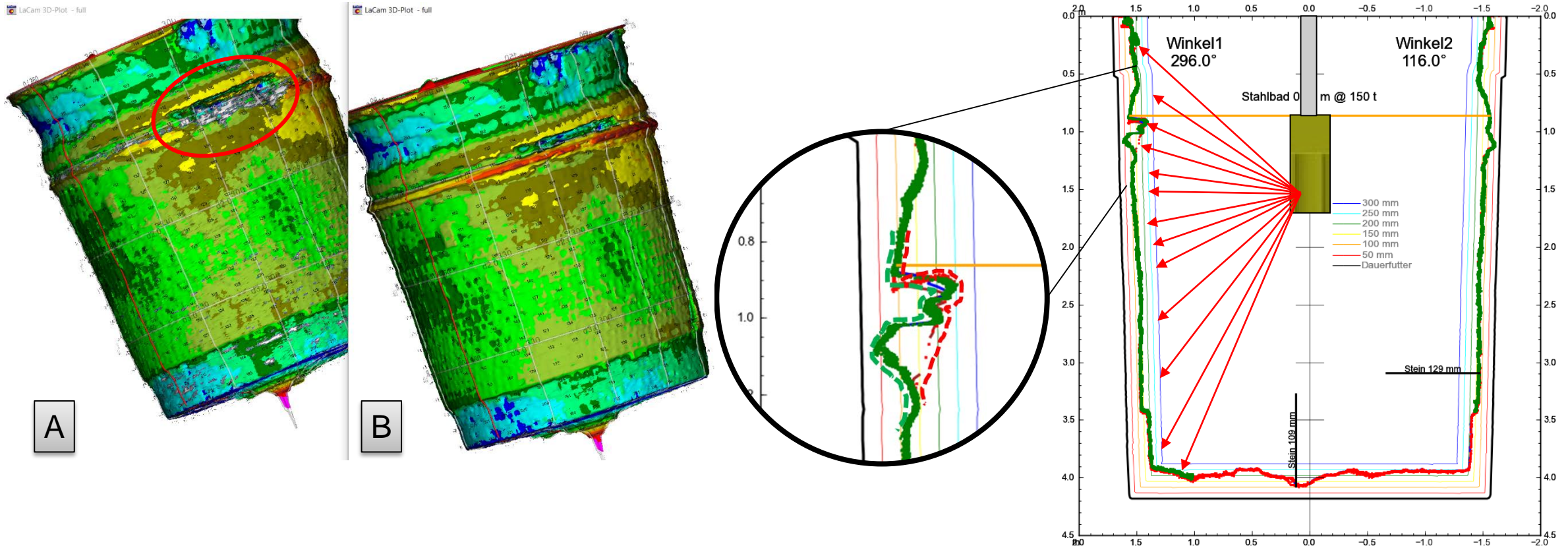
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# Evaluation and presentation of the results



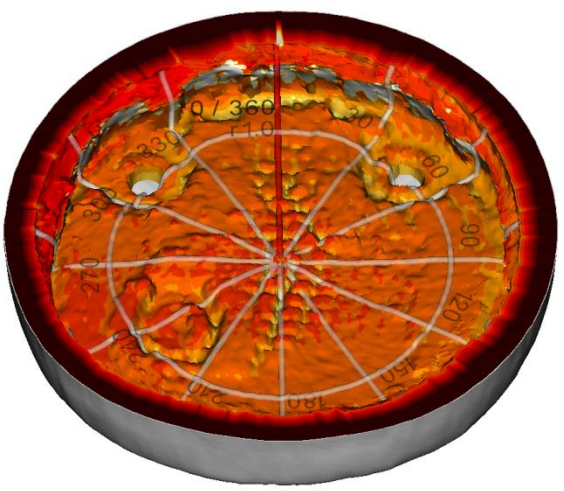
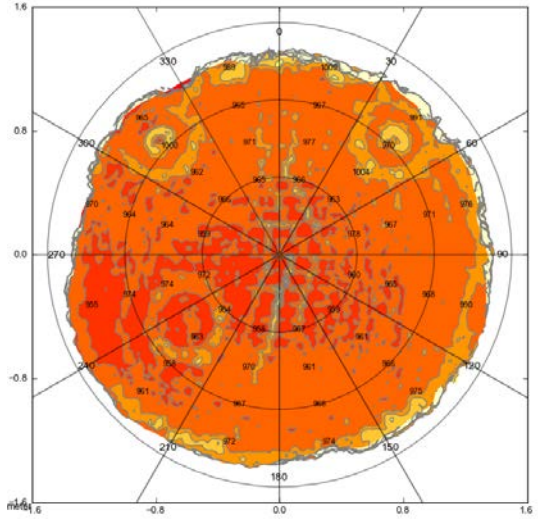
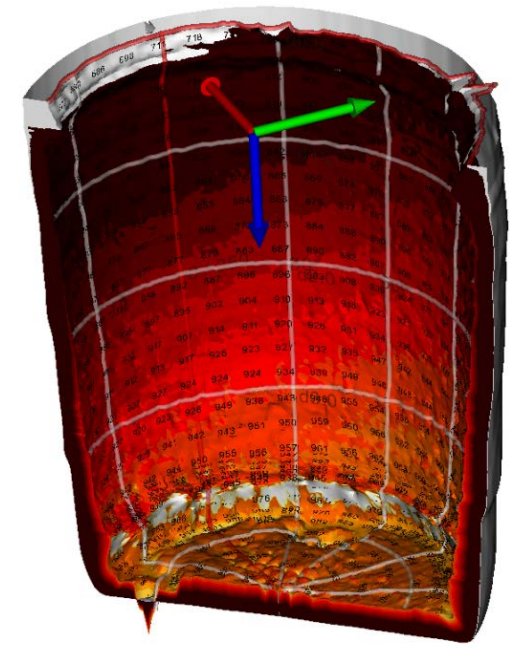
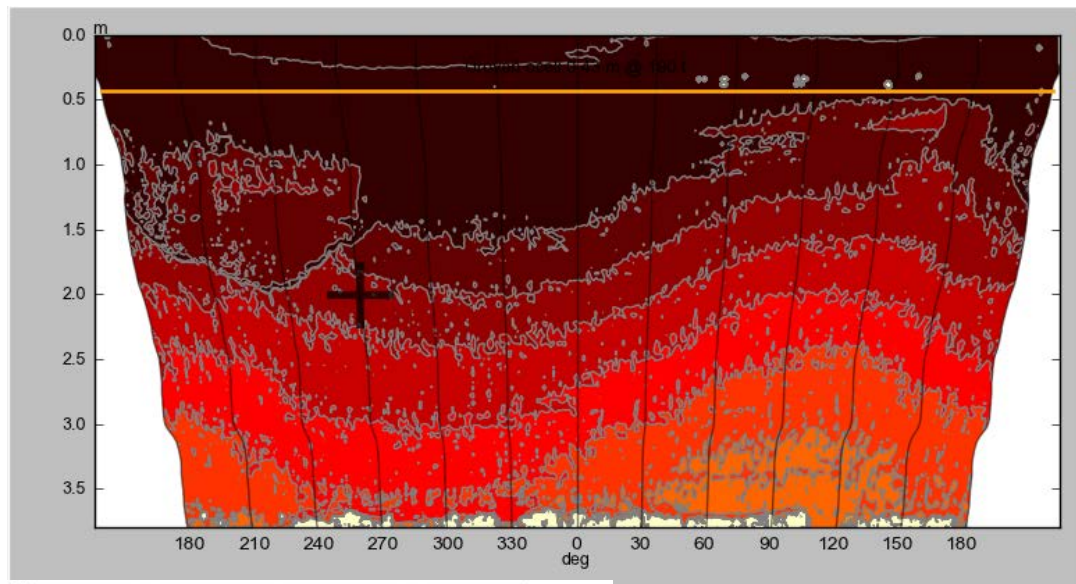
# Measurement from outside vs. inside



Refractory thickness measurement with laserhead position outside (A) and inside (B)  
 Not measured areas in the slagzone are white spots (A)  
 fully measured slagzone (B) shows dangerous thin lining in red



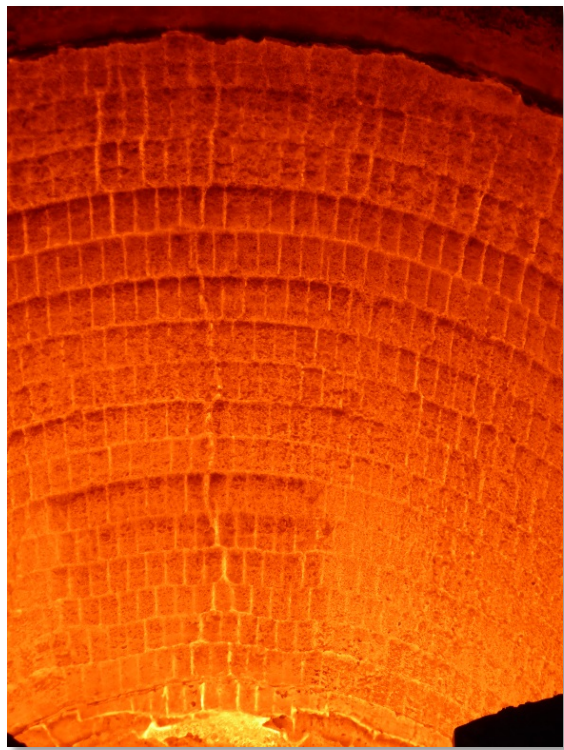
# Pyrometric Temperature Measurement



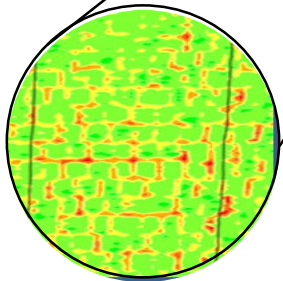
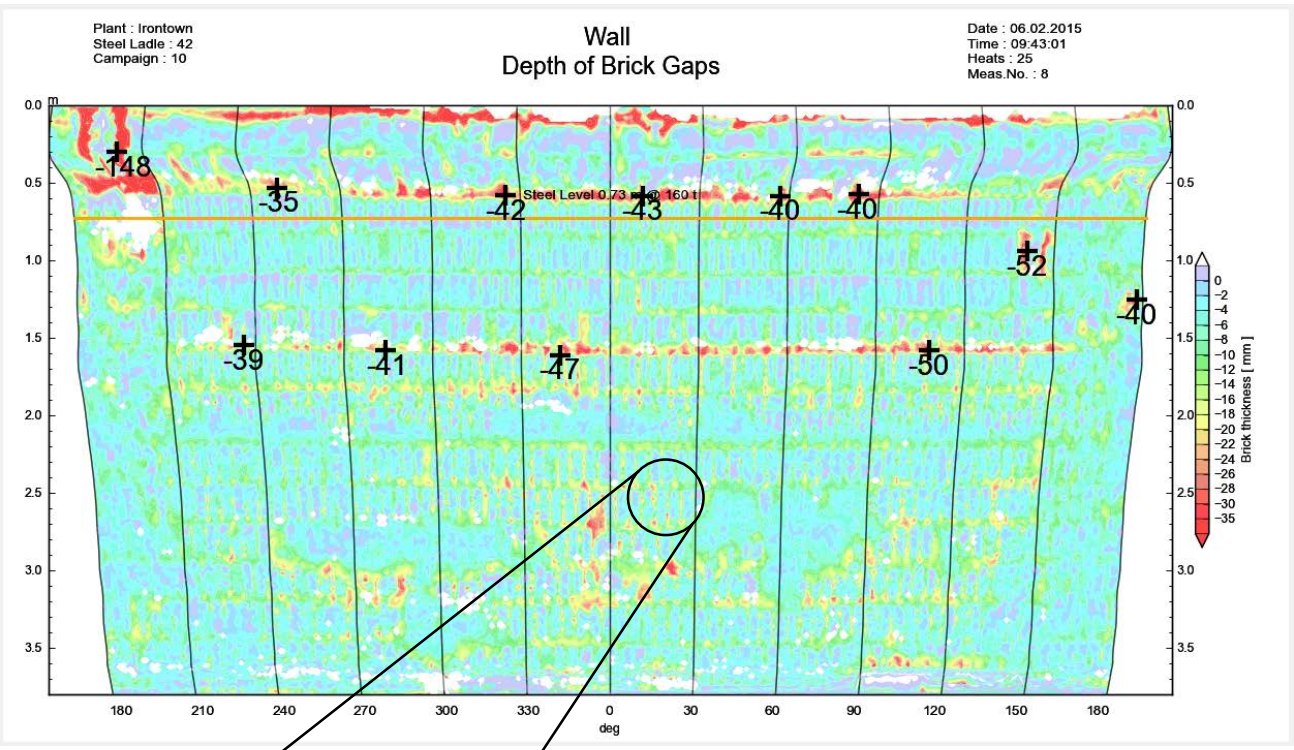
Simultaneously to the lining thickness the system measures the surface temperature of the lining with a high density of data collection (one measure point per laser shot). With this additional temperature profile information the system provides non-uniform temperature distribution of the ladle-lining and hot spots.



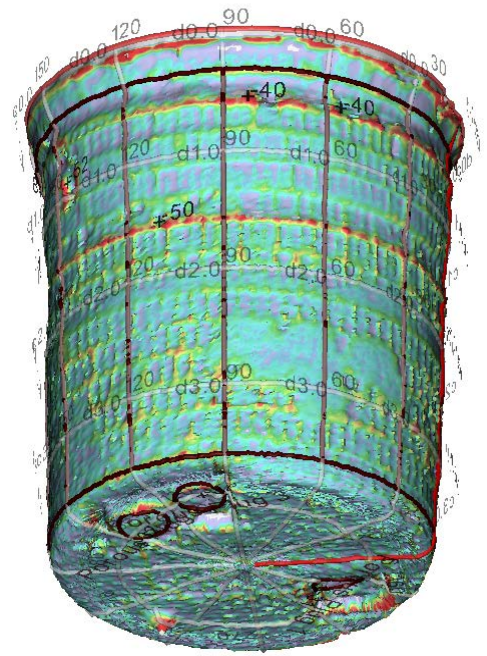
# Gap and Crack Detection



Crack and Gaps in a ladle



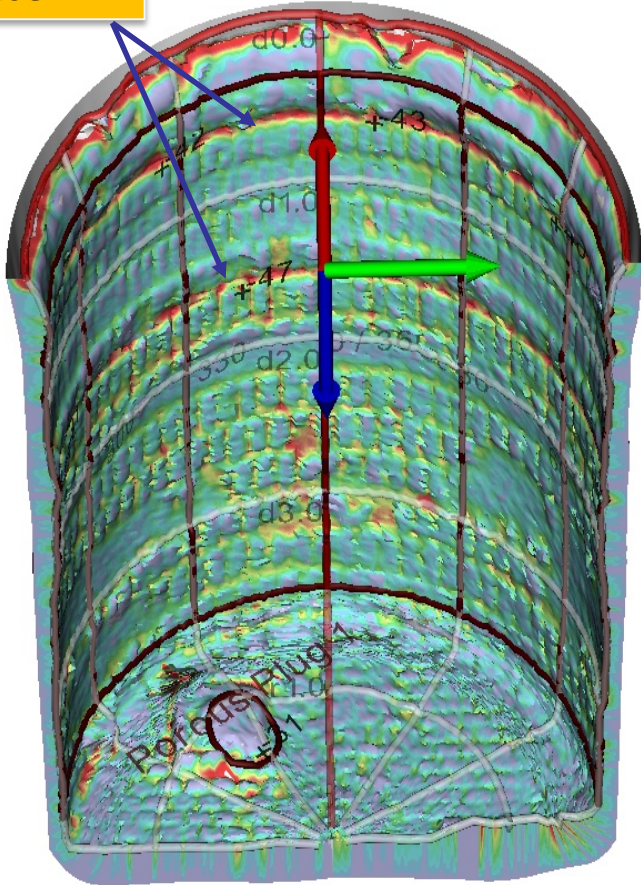
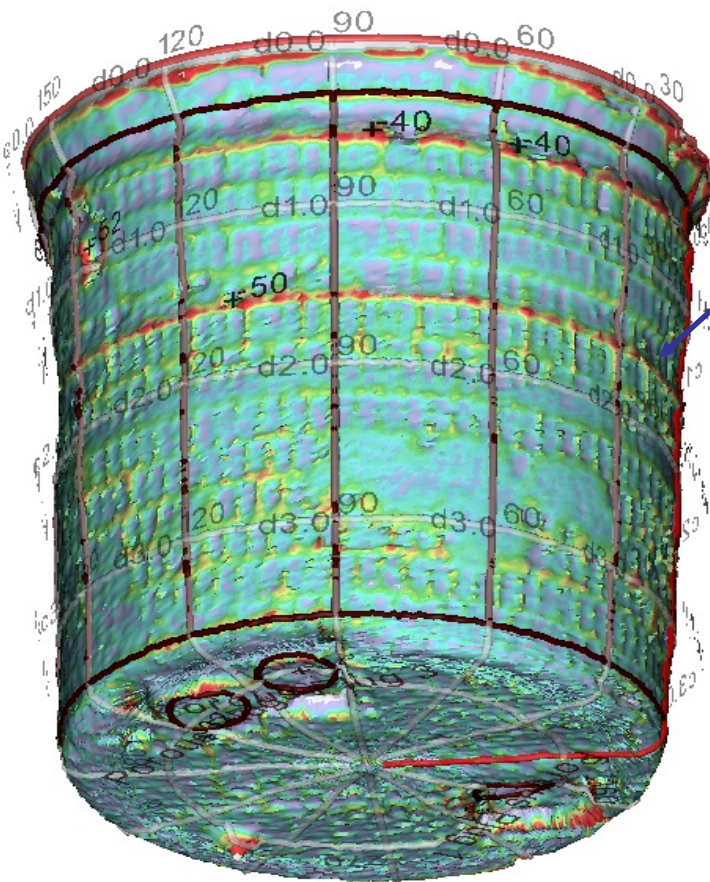
Performed data processing is a special 2D peak finding algorithm which has some similarities to image processing functions. In a combined evaluation of brick thickness-, surface temperature and Laser Echo Amplitude a gap or crack in the lining can be determined





# 3D - Gap contour plot of ladle / view from outside w/o steel shell and cut in half from inside

Ladle wall with gaplines (red) and gap values

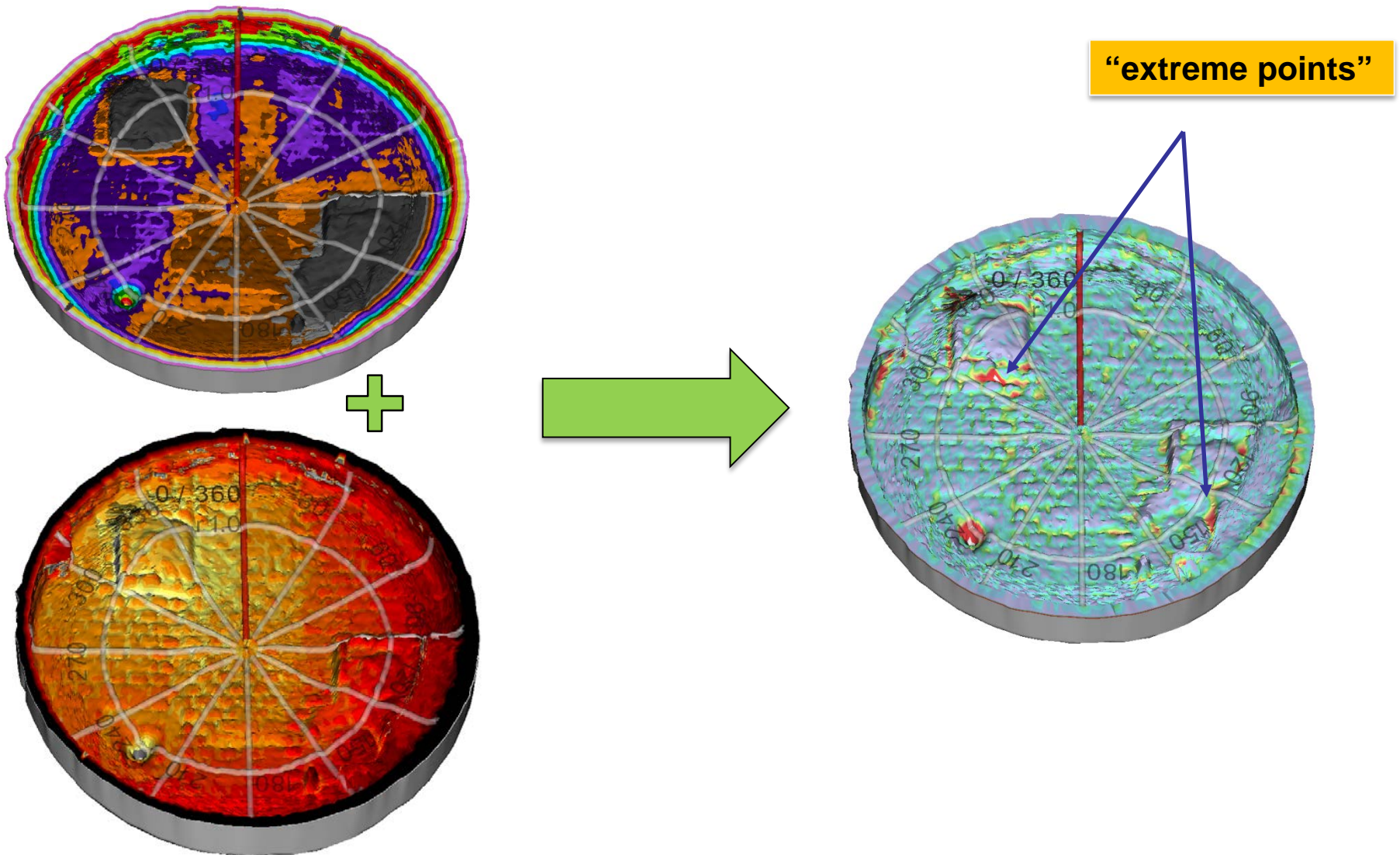


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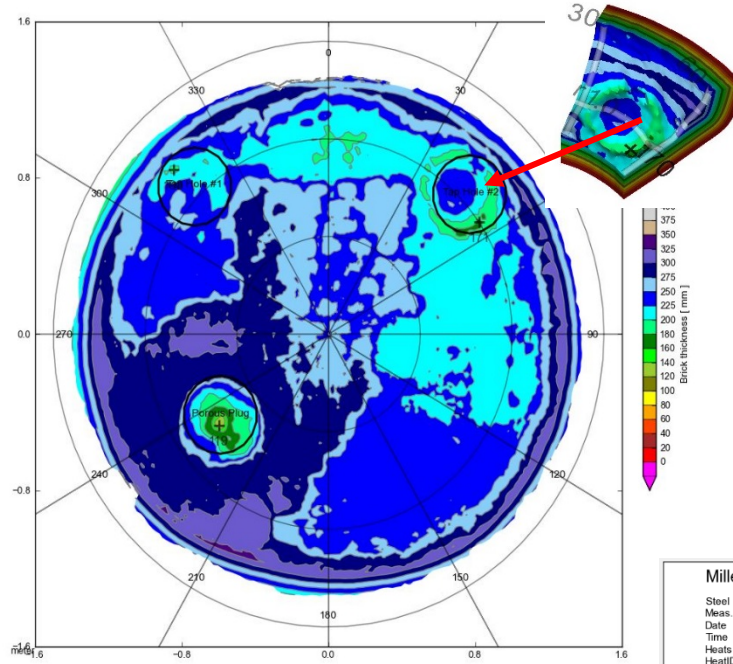
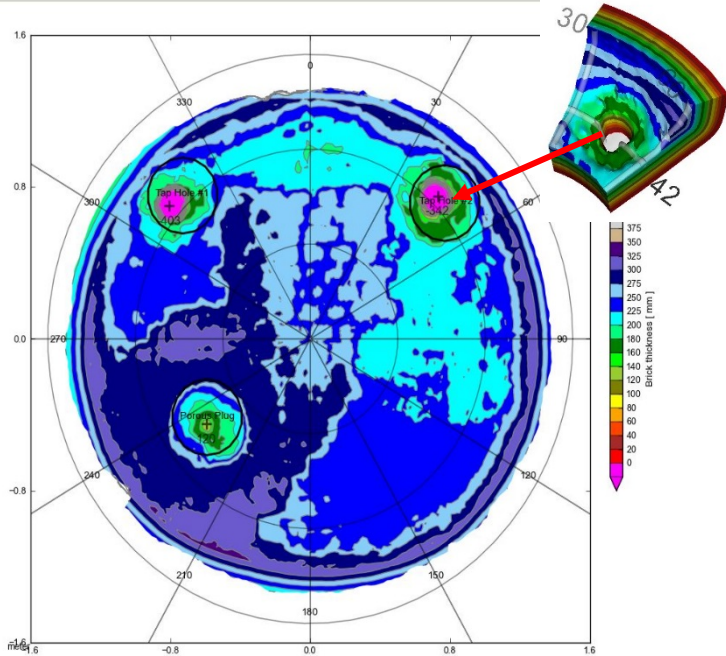
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# 3D - Gap contour plot and Temp. plot of ladle bottom result in automatic detection of extreme points



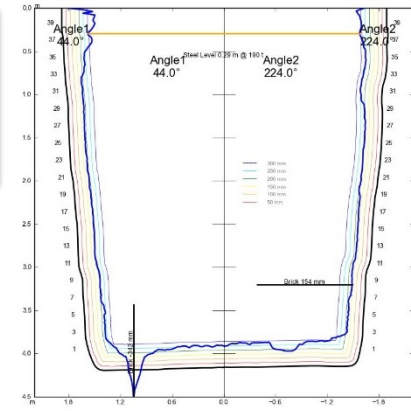


# Taphole Condition and Sandfilling

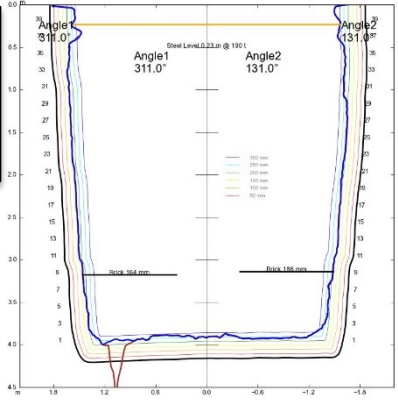


Detection of “Open slider”, Debris above slider, optimum amount of sand mass, optimum sand filling by controlled x-y position, optimum sand profile shape

Tap Holes before sand filling



Tap Holes after sand filling



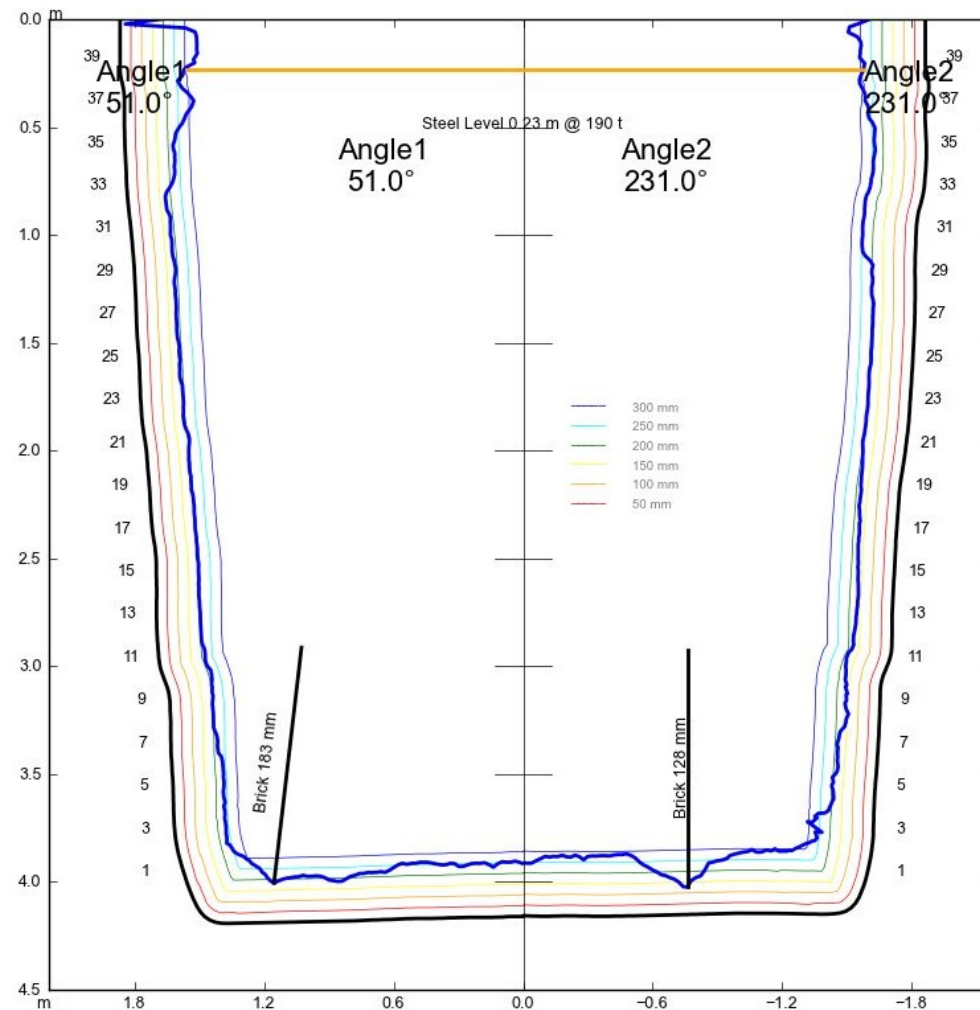
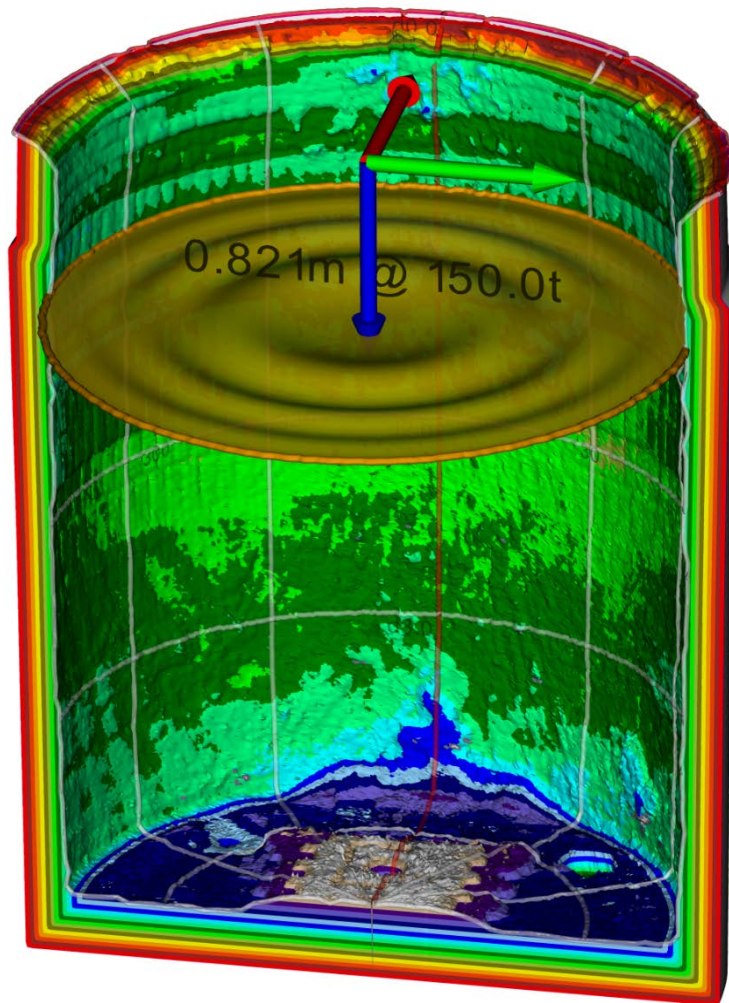
Miller Irontown LaCam LI : Condition of Wear Lining and Sand Filling

Steel Ladle	11	Area Name	Angle ( )	Depth ( m )	Limit( mm )	Minimum( mm )	Average( mm )
Meas No.	0	Wand_0	[ 315-45 ]	[ 0.3-4.0 ]	50	79	161
Date	09.04.2014	Wand_90	[ 45-135 ]	[ 0.3-4.0 ]	50	40	113
Time	11:05:41	Wand_180	[ 135-225 ]	[ 0.3-4.0 ]	50	21	100
Heats	109	Wand_270	[ 225-315 ]	[ 0.3-4.0 ]	50	64	145
HeatID	49753						

Area Name	X, Y( m )	Diam. ( mm )	Limit( mm )	Minimum( mm )	Average( mm )
Lochstein	[ 3.2, -3.2 ]	[ 0.5 ]	100	244	299

# Bathlevel Determination and Freeboard



Bathlevel determination based on exact profile and volume calculation and input from steel and slag mass

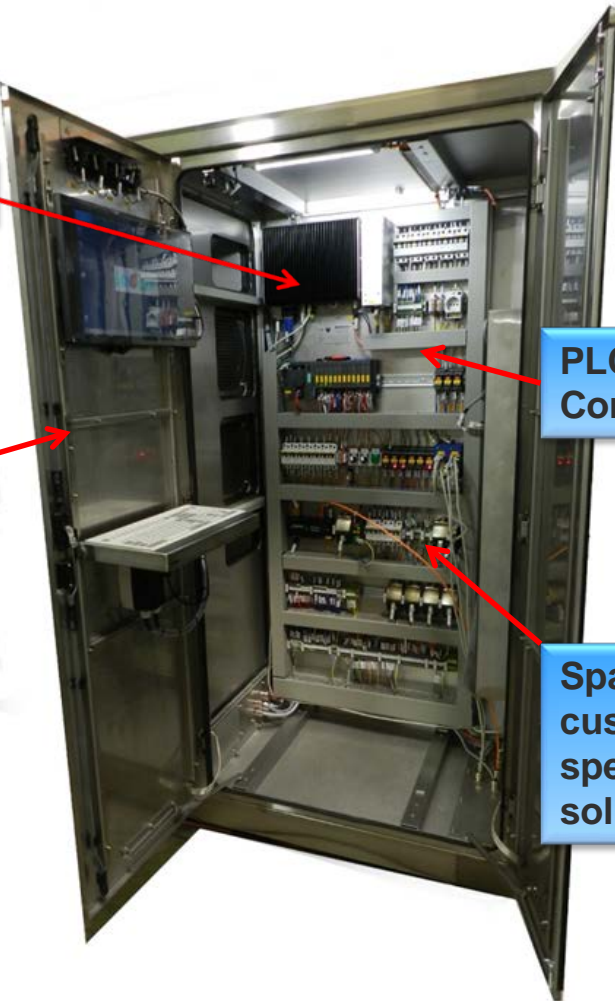


# Cooling and Control Unit



IPC COMPUTER

SERVICE monitor and keyboard



PLC Control unit

Space for customer specific solutions



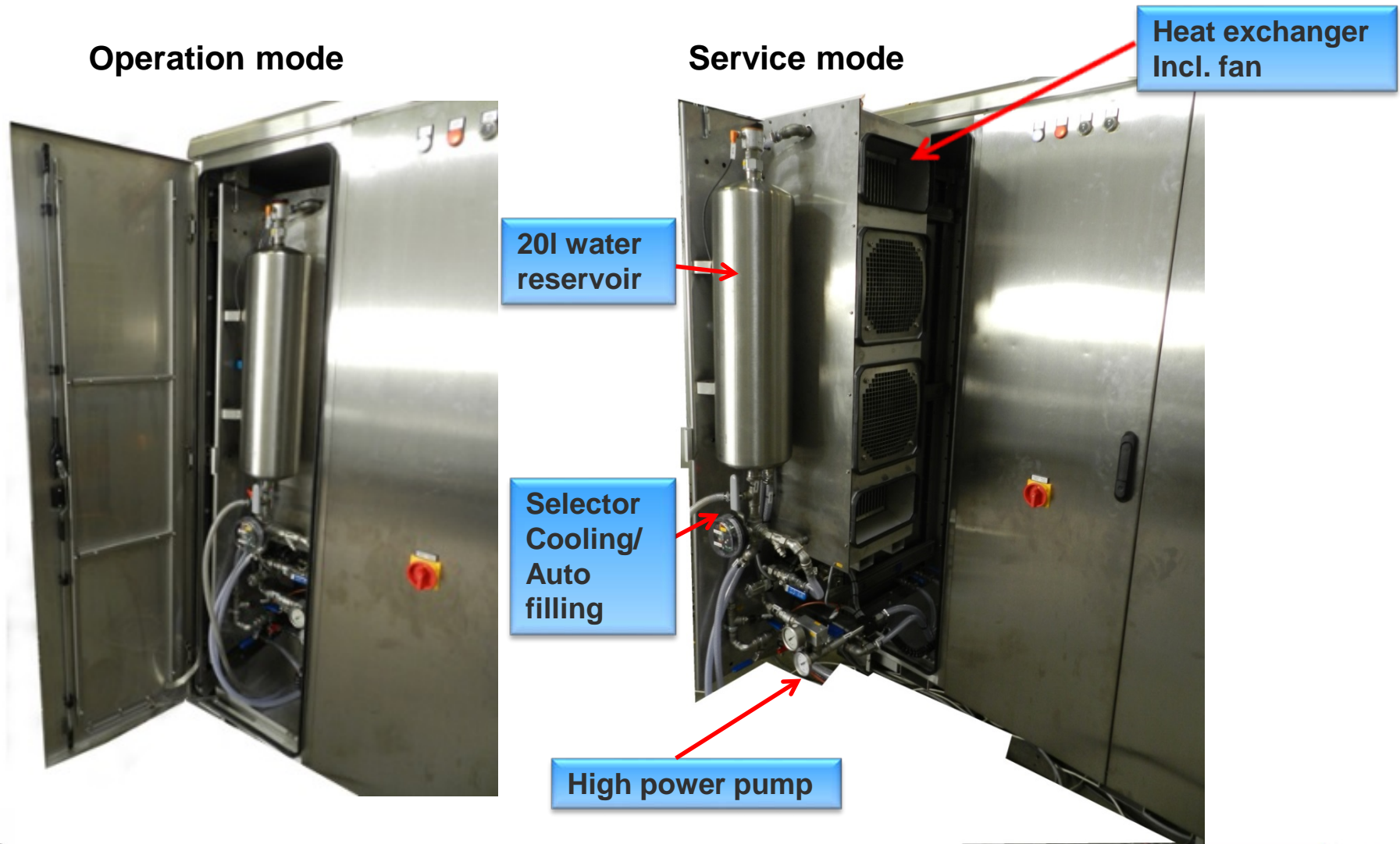
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# Cooling and Control Unit

## User friendly solution and easy to maintain



Operation mode

Service mode

Heat exchanger  
Incl. fan

20l water  
reservoir

Selector  
Cooling/  
Auto  
filling

High power pump



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# Conclusion

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- By immersion the laserscanner into the ladle you achieve better results by means of
- Higher measurement accuracy in all areas - covering 100% of the ladle surface
  - Scanning areas e.g. slagzones which are often hidden if you are using laserscanner from outside
  - Very high resolution scan due to small laserbeam and better viewing angle
  - Detection of gaps and cracks due to combination of thickness measurement and surface temperature
  - Additional advantages like taphole analysis and controlled sandfilling
  - Precise determination of bathlevel and freeboard

# SCANTROL® - Intelligent Control Module between Laser Wear Measurement System LaCam® and Automatic Spraying Manipulator

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LaCam® M



LaCam® CI, Converter



LaCam® - EAF



LaCam®, LI Ladles



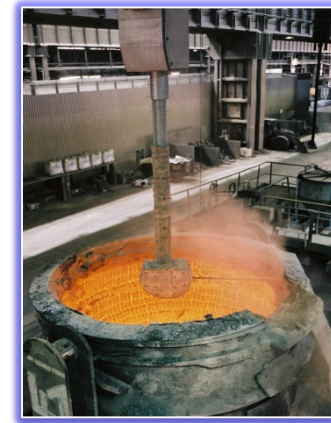
scantrol®



Tornado Shooter



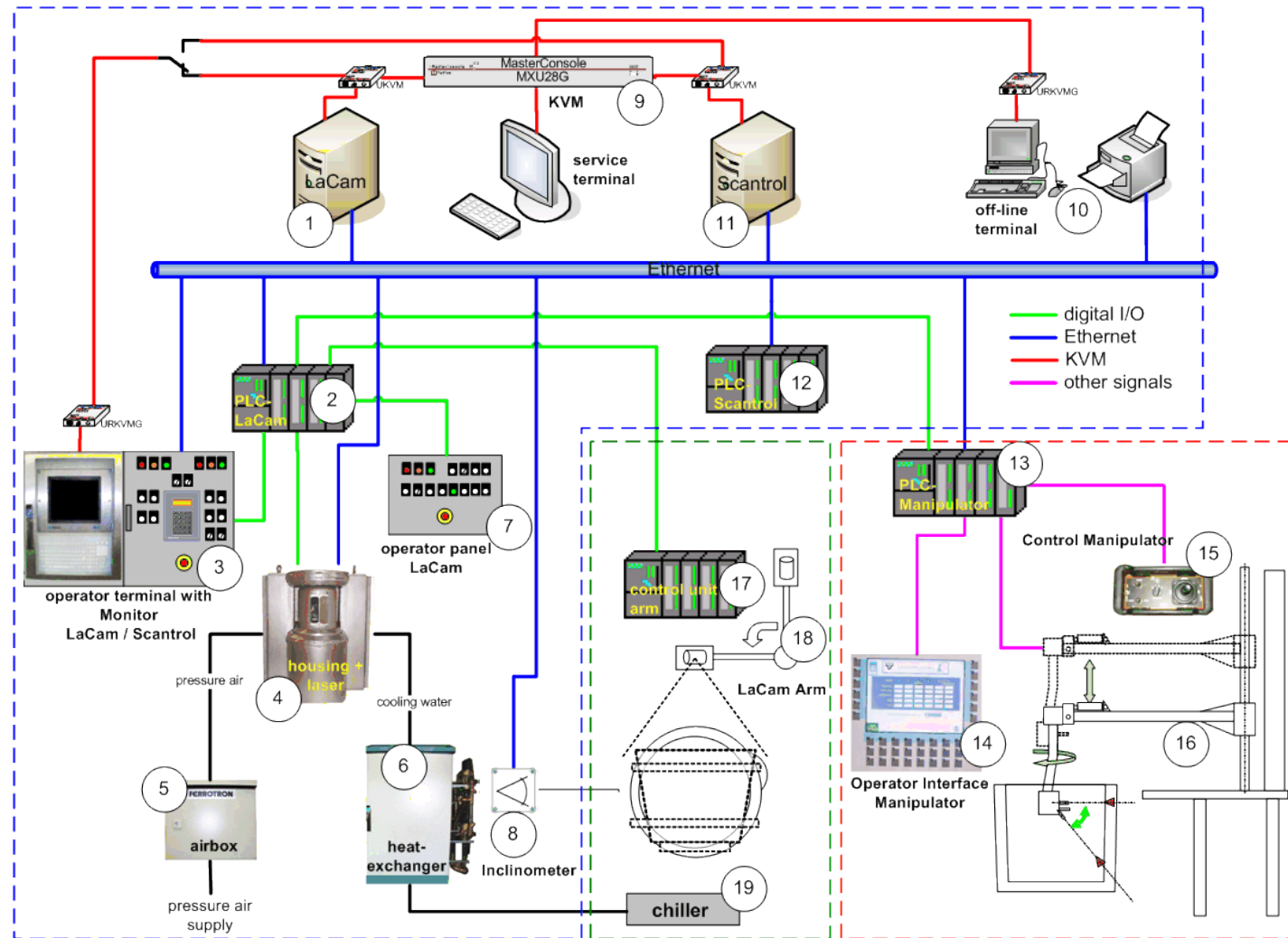
Minscan



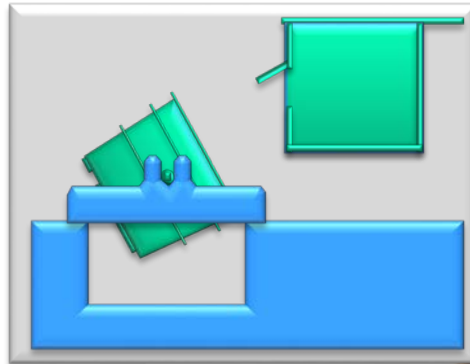
Lego Manipulator



# System overview Scantrol for Ladle (example)



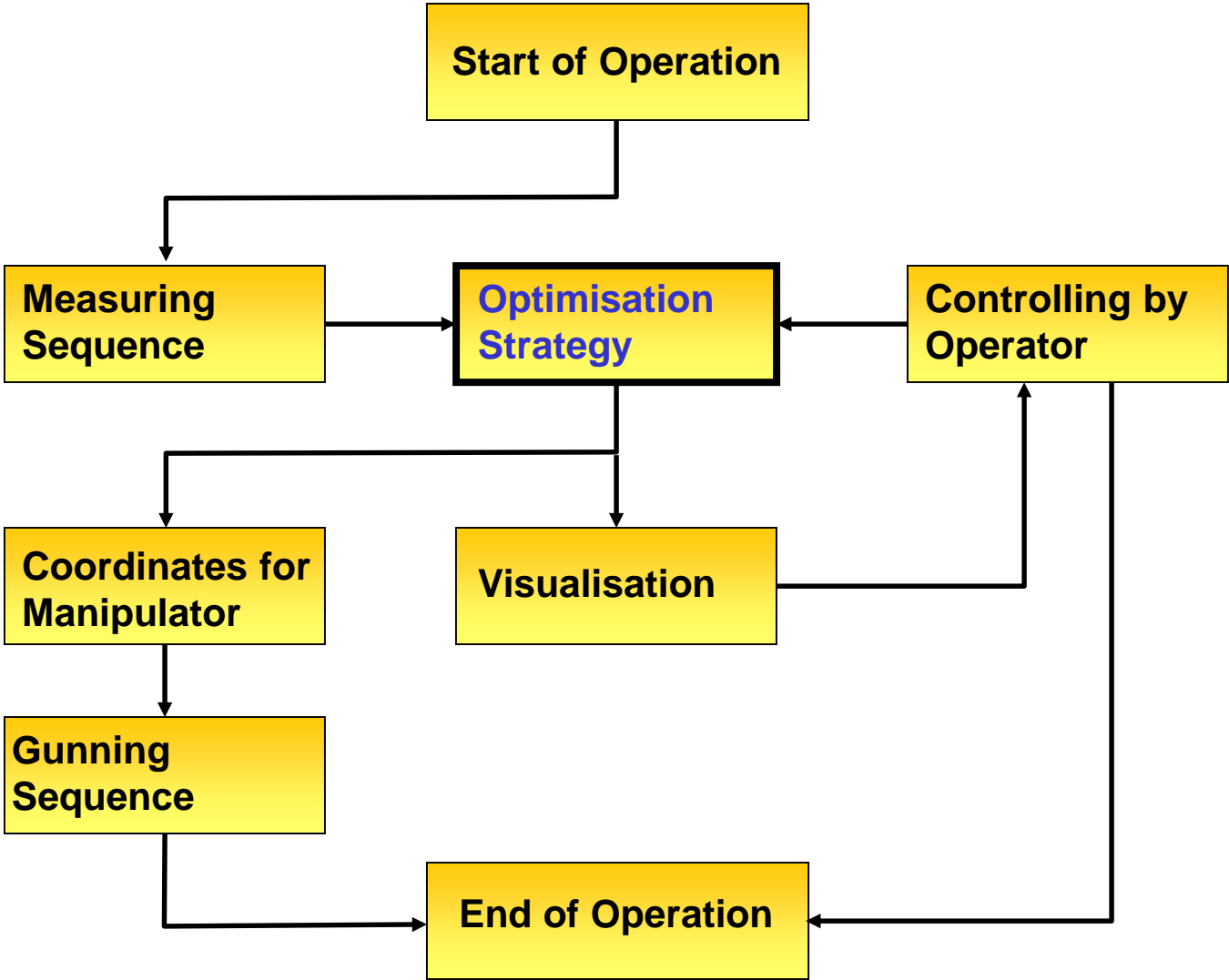
# Planning in realisation of the complete system





# Control Flow SCANTROL®


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# Scantrol<sup>®</sup> mask: Wall Areas

File Tools Help


**FERROTRON<sup>®</sup>**



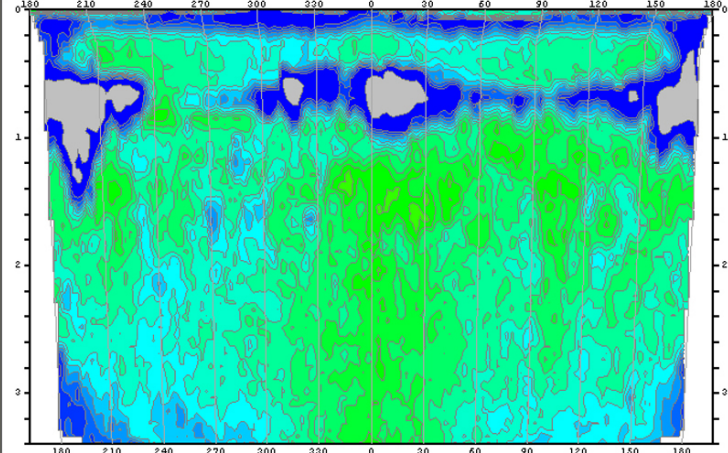
**scantrol<sup>®</sup>**

04.08.2006 11:04:57

MINERALS TECHNOLOGIES<sup>®</sup>

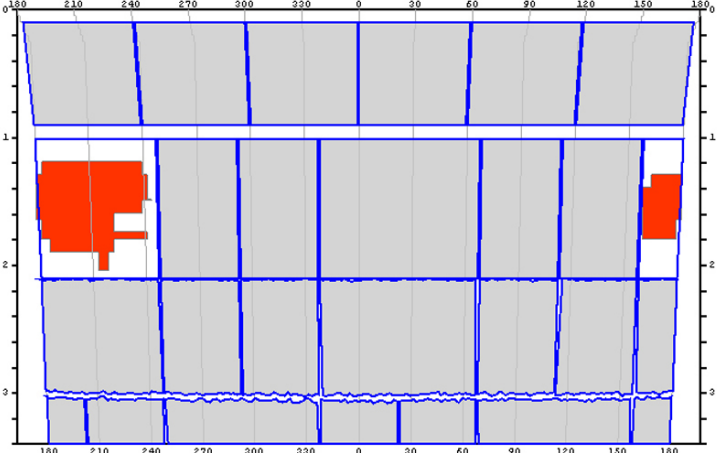


### Lining Thickness (2006/06/30 11:43)



Campaign :331; W-Heats :95; B-Heats :95; M-Num :5; AngCorr[°] :0

### Calculated Maintenance



Screen:0179/0422,Vessel:----°/----m,Matrix:-001/-001,Thick:----mm

Thickness [mm]

- higher values
- 200 - 250
- 180 - 200
- 170 - 180
- 160 - 170
- 150 - 160
- 140 - 150
- 130 - 140
- 120 - 130
- 110 - 120
- 100 - 110
- 90 - 100
- 80 - 90
- 70 - 80
- 60 - 70
- 50 - 60
- 40 - 50
- 30 - 40
- 20 - 30
- 10 - 20
- 0 - 10
- 100 - 0
- missing data

View V Wall Bottom

```

2006-08-04 11:04:44.149 <1501> PLC: Connecting to 192.168.10.9:2001.
2006-08-04 11:04:44.249 <602> Scantrol calculation finished Material Num.: 1
2006-08-04 11:04:44.299 <601> Scantrol calculation DISABLED for Material N
2006-08-04 11:04:44.329 <601> Scantrol calculation DISABLED for Material N
2006-08-04 11:04:46.051 <1504> PLC: Error in connection to 192.168.10.9.
2006-08-04 11:04:51.058 <1501> PLC: Connecting to 192.168.10.9:2001.
2006-08-04 11:04:52.020 <1504> PLC: Error in connection to 192.168.10.9.
2006-08-04 11:04:57.027 <1501> PLC: Connecting to 192.168.10.9:2001.
2006-08-04 11:04:57.928 <1504> PLC: Error in connection to 192.168.10.9.
                    
```

Temperature Nozzle head [°C] --

Maintenance time [mm:ss] 03:39 - +

Required material quantity [kg]

**Ladleshot SP3** 0 99 - +

**SP2** 0 - +

**SP3** 0 - +

Refractory
Back
OK

Ladle number Default Ladle 31

Automatic maintenance START STOP



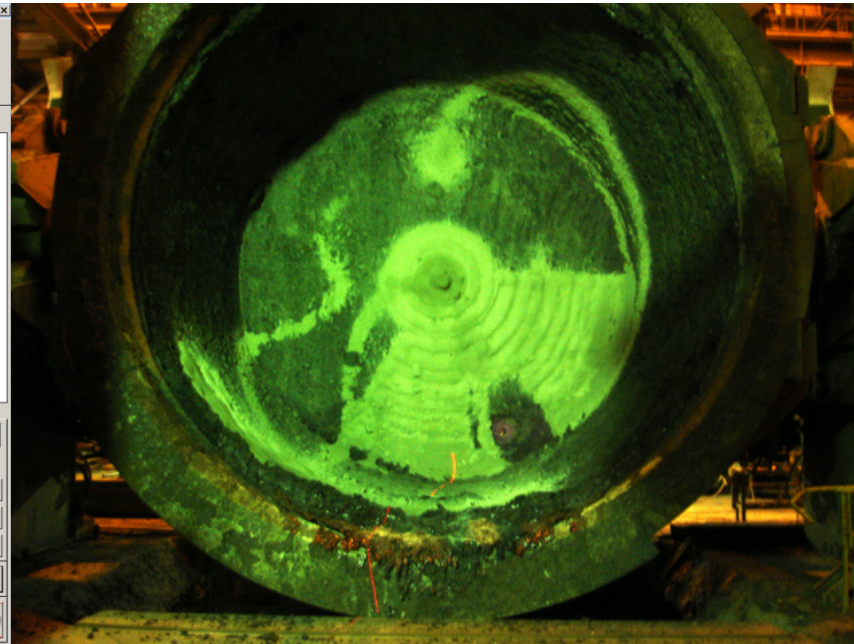
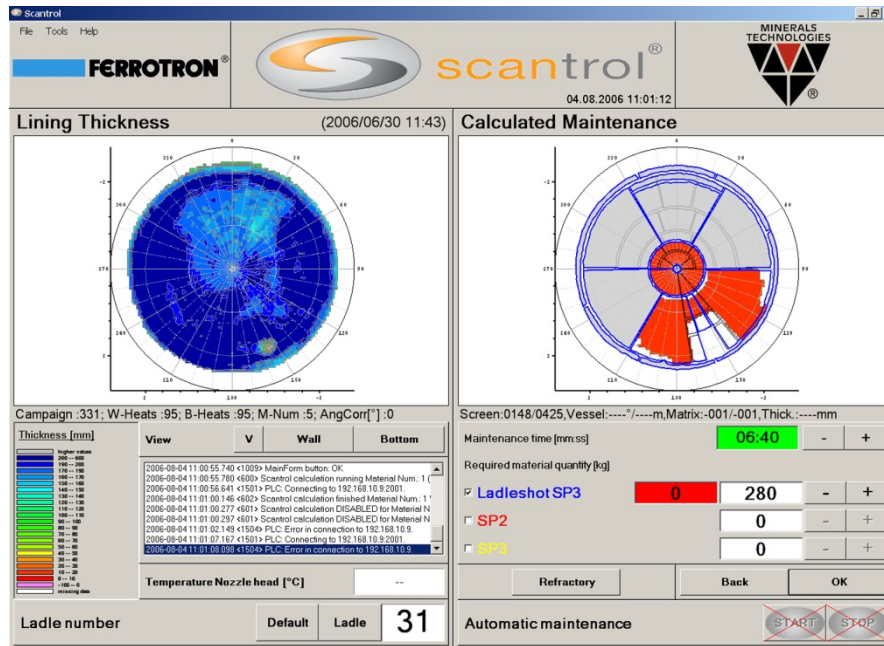
# Controlling by Operator

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- **Operator can adjust the optimisation strategy parameters**
  - **gunning time (optional)**
  - **quantity of material**
  - **degree of lining rebuilding**
- **Operator can decide whether to start the gunning sequence either**
  - **immediately,**
  - **later on,**
  - **or whether to cancel the gunning sequence**

# Coordinates for Manipulator

The gunning areas calculated by the optimisation strategy are transformed into control commands which can be interpreted by the manipulator



Scantrol® mask: Bottom Areas

Gunning Result