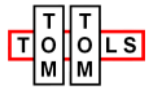


Measurement Tools For The Cement Industry

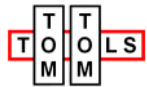


Mechanical condition monitoring on rotary kilns



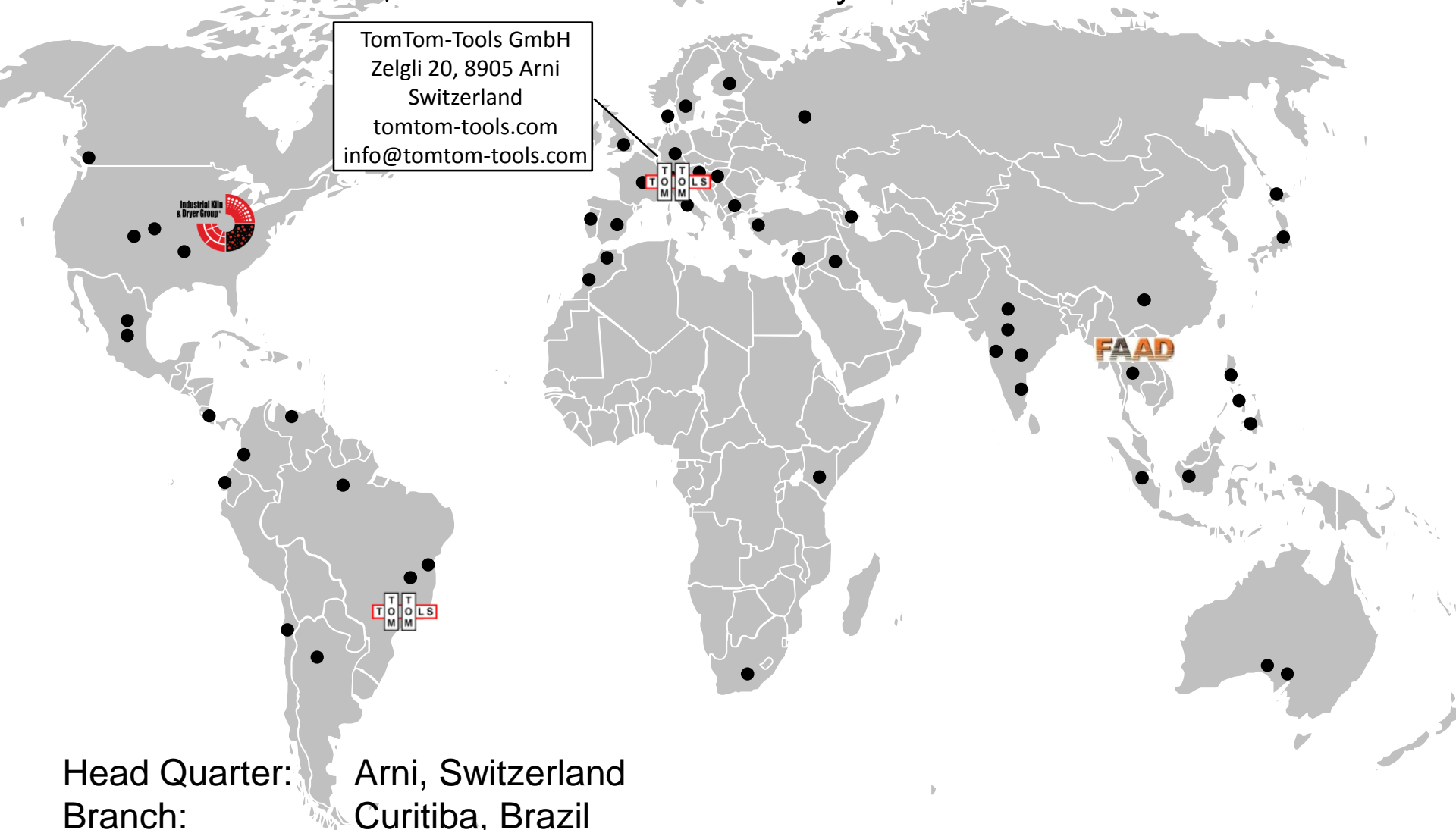
Agenda

- About TomTom-Tools GmbH
- Ovality Sensor
- Inductive Distance Measurement (IDM) Tool Kit
 - Gear Run-Out Measurement
 - Roller Shaft Bending Measurement
- Mechanical Kiln Monitoring (MKM) System
- Measuring Wheel
- Rotary Inclinometer
- Kiln Shell Laser + Rotation Trigger
- Measurement PC with Long Range Bluetooth
- Kiln Axis Alignment System (soon available)
- Telescopic Contact Thermometer



About TomTom-Tools GmbH

Founded in 2007, now the tools are already in almost 40 countries in use



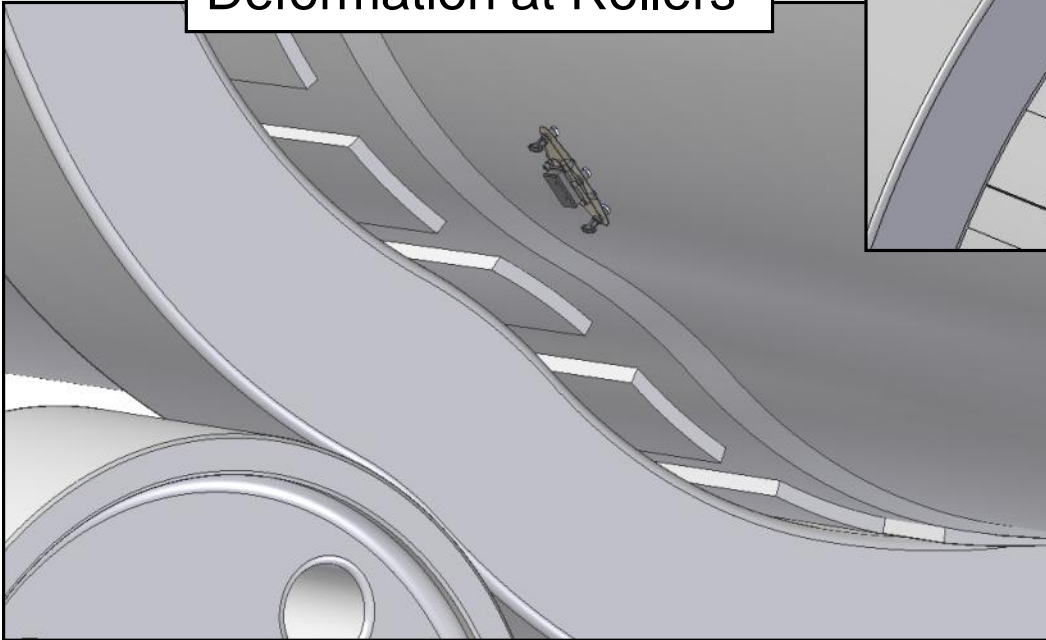
Head Quarter: Arni, Switzerland

Branch: Curitiba, Brazil

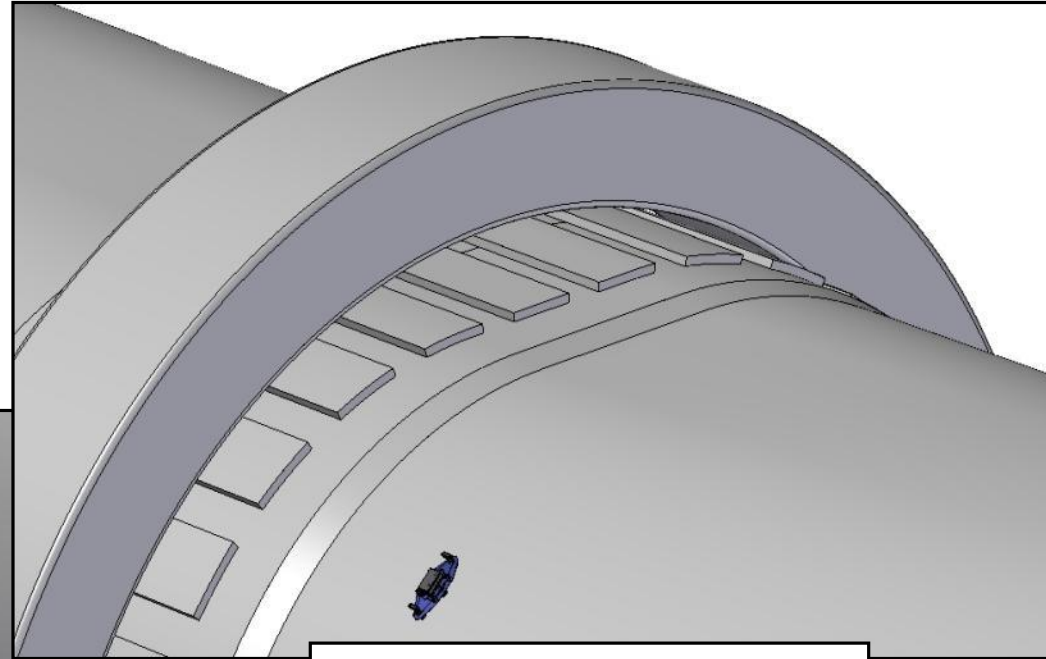
Team: 5 engineers, 2 technicians, 3 in administration

Ovality on Kiln Shell, Focus Areas

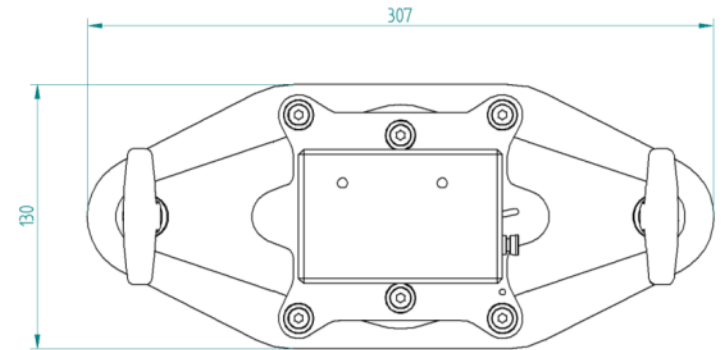
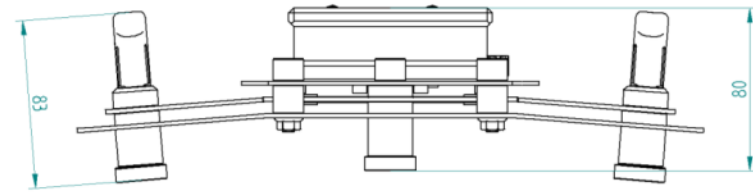
Deformation at Rollers



Deformation on Top

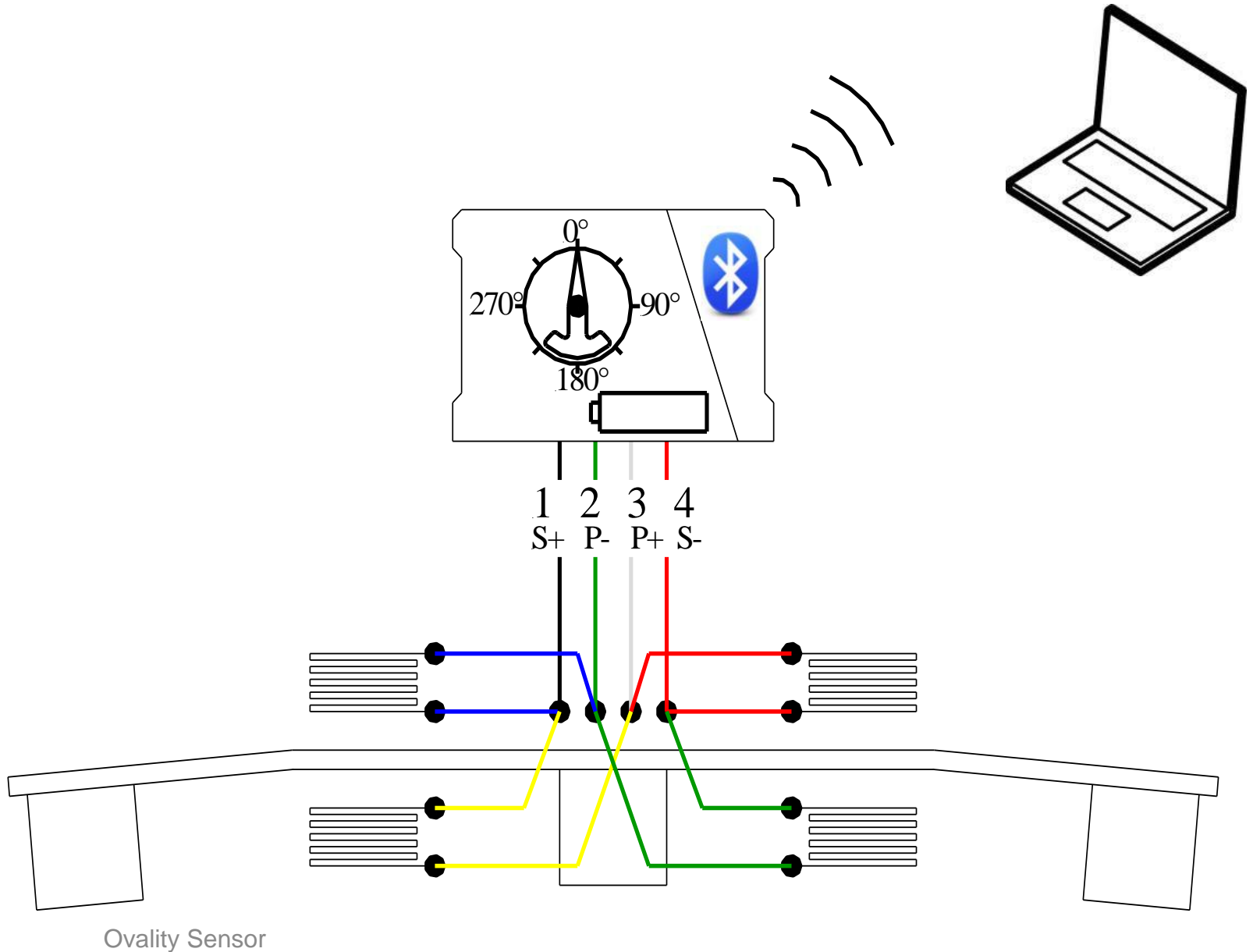


Ovality Sensor



Ovality Sensor

Ovality Sensor Working Principle



Ovality Sensor



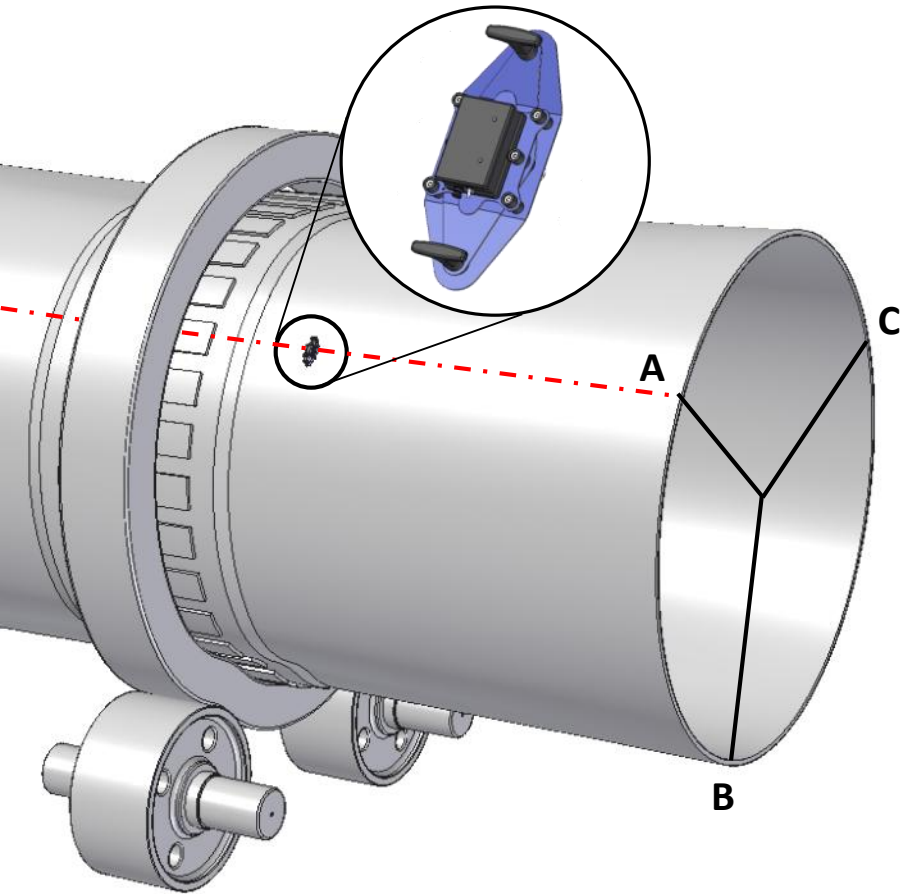
Ovality Sensor

The Ovality Sensor is a measurement tool for rotary kilns, which measures the changes of the roundness / curvature in the kiln shell during operation.

This elastic deformation is called Ovality and is primarily present in the area of a kiln tire.

The measurement gives accurate information about the degree of mechanical loads in the refractory / kiln shell and allows defining the countermeasures in advance to increase the lifetime of the kiln components.

Measurement Positions Along the Kiln



The Ovality typically is measured at 3 positions on both sides of each tire

The position “A” typically is in line with the reference of the kiln, often the manhole is used as reference

The Ovality Sensor should be placed close to the tire, where the ovality is the highest

Make sure the contact surface is clean enough that the magnets are able to keep the tool in position

Measurement Studio / Ovality

2009-12-16 Abnahme Intervaz.tms - TomTom-Tools Measurement Studio

File Measurements Reports Window Help

Overview

- Measurements
 - 2009-12-16 Abnahme Intervaz.tms
- Devices
 - DAQmx
 - Ovality Sensor

Events

Log

Main Function Buttons

Kiln Overview

Ovality Piers

Pier 1 Pier 2

Ø[m]: 4.7 Ø[m]: 4.7

	Uphill	Downhill	Uphill	Downhill	Uphill	Downhill	Uphill	Downhill
A	<input checked="" type="radio"/> 0.17%	<input type="radio"/> 0.29%	<input type="radio"/> 0.28%	<input type="radio"/> 0.36%	<input type="radio"/> 0.15%	<input type="radio"/> 0.19%	<input type="radio"/> --	<input type="radio"/> --
B	<input type="radio"/> 0.22%	<input type="radio"/> 0.16%	<input type="radio"/> 0.25%	<input type="radio"/> 0.26%	<input type="radio"/> 0.22%	<input type="radio"/> 0.27%	<input type="radio"/> --	<input type="radio"/> --
C	<input type="radio"/> 0.23%	<input type="radio"/> 0.33%	<input type="radio"/> 0.27%	<input type="radio"/> 0.25%	<input type="radio"/> 0.28%	<input type="radio"/> 0.14%	<input type="radio"/> --	<input type="radio"/> --
Average	0.21%	0.26%	0.2			0.20%	--	

Measurement Results

Ovality Polar Diagramm

Radar Chart

- Pier 1 Uphill A
- Pier 1 Uphill B
- Pier 1 Uphill C
- Pier 1 Downhill A
- Pier 1 Downhill B
- Pier 1 Downhill C
- Pier 2 Uphill A
- Pier 2 Uphill B
- Pier 2 Uphill C
- Pier 2 Downhill A
- Pier 2 Downhill B
- Pier 2 Downhill C
- Pier 3 Uphill A
- Pier 3 Uphill B
- Pier 3 Uphill C
- Pier 3 Downhill A
- Pier 3 Downhill B
- Pier 3 Downhill C

Ovality Polar Diagramm Ovality Line Diagramm

Ovality Measurement Settings

Plant Name: Example

Kiln Number: 1

Measured by: Wilhelm Tell

Date: 20.01.2010

Tool ID No: 09256027

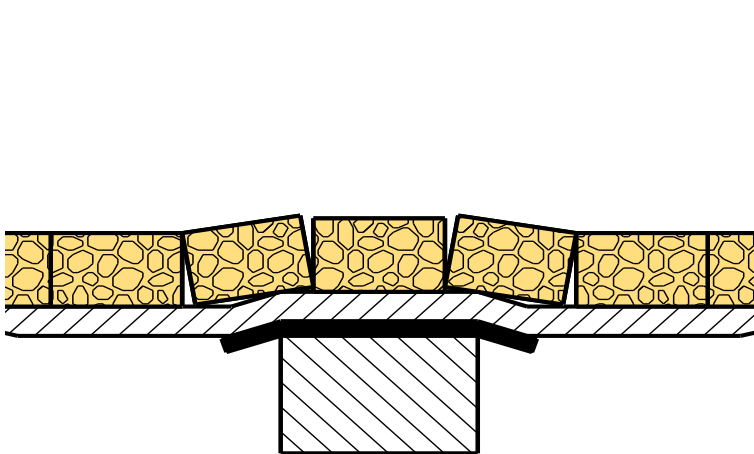
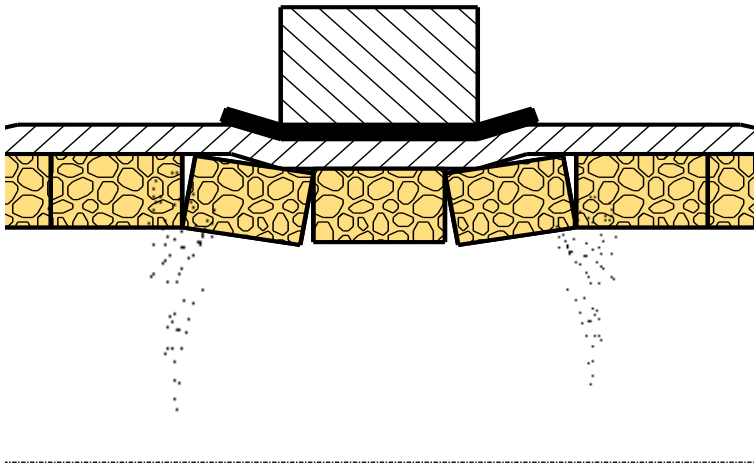
Remarks: Kiln in normal operational condition, no abnormalities

Tool: TomTomToolsMeasurementS

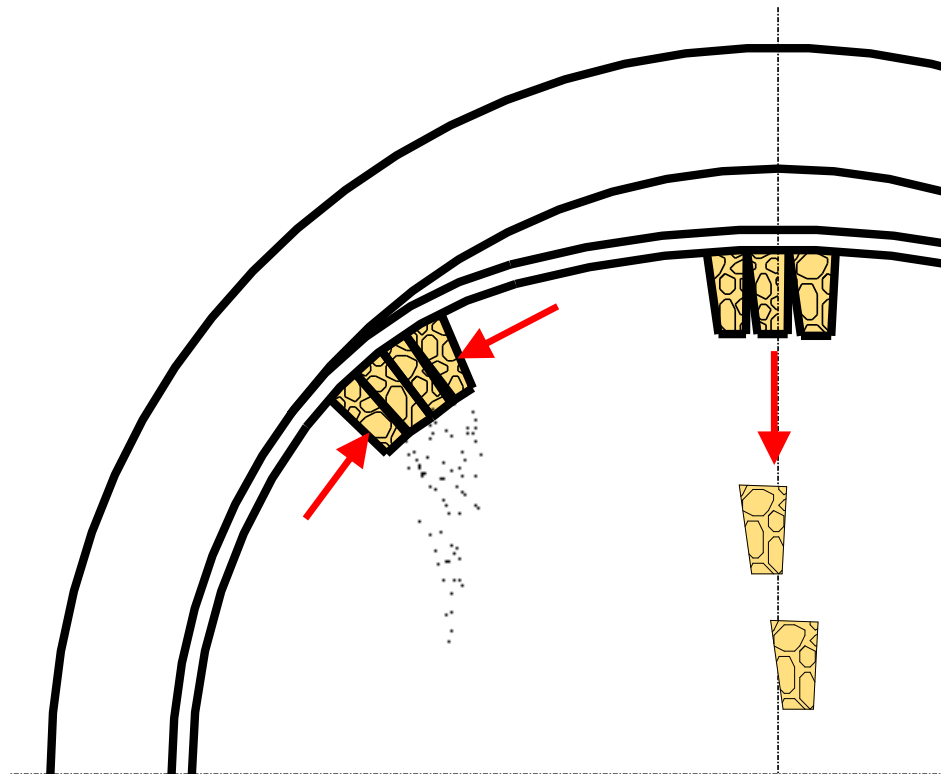
Correct Shimming of the Tire is the Key

Too thick shims can lock the tire → Shell constriction

Too thin shims increase the ovality → Brick failures



Ovality Sensor



Inductive Distance Measurement (IDM) Tool Kit

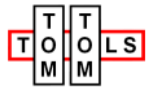


The IDM Tool Kit is a multi purpose measurement tool.

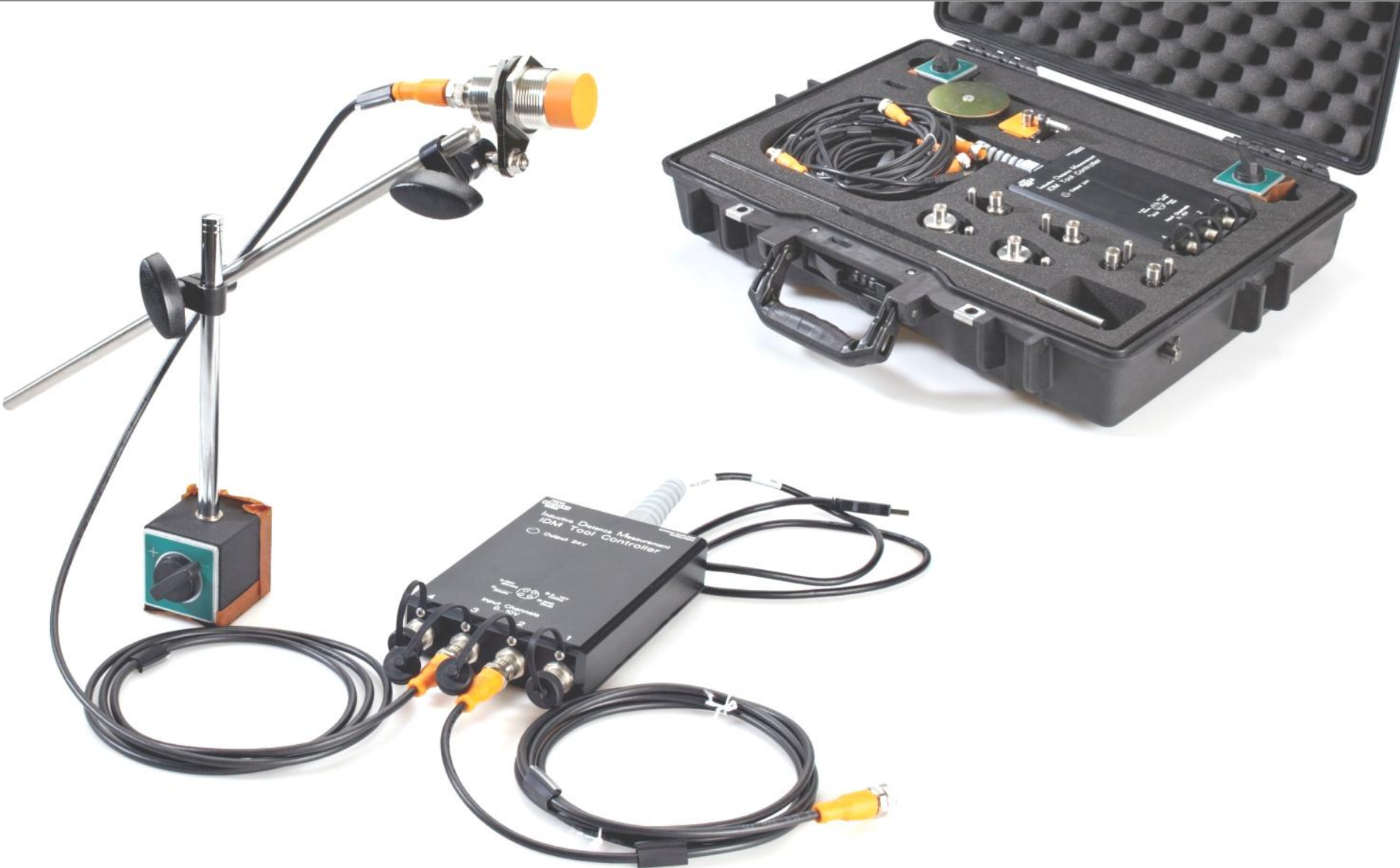
Typically it is used to check the condition of rotating parts during operation (e.g. on Rotary Kilns, Dryers, Ball Mills).

It measures variation of distances of moving metal surfaces without contact with high accuracy and high speed.

It can be considered as a contactless dial gauge



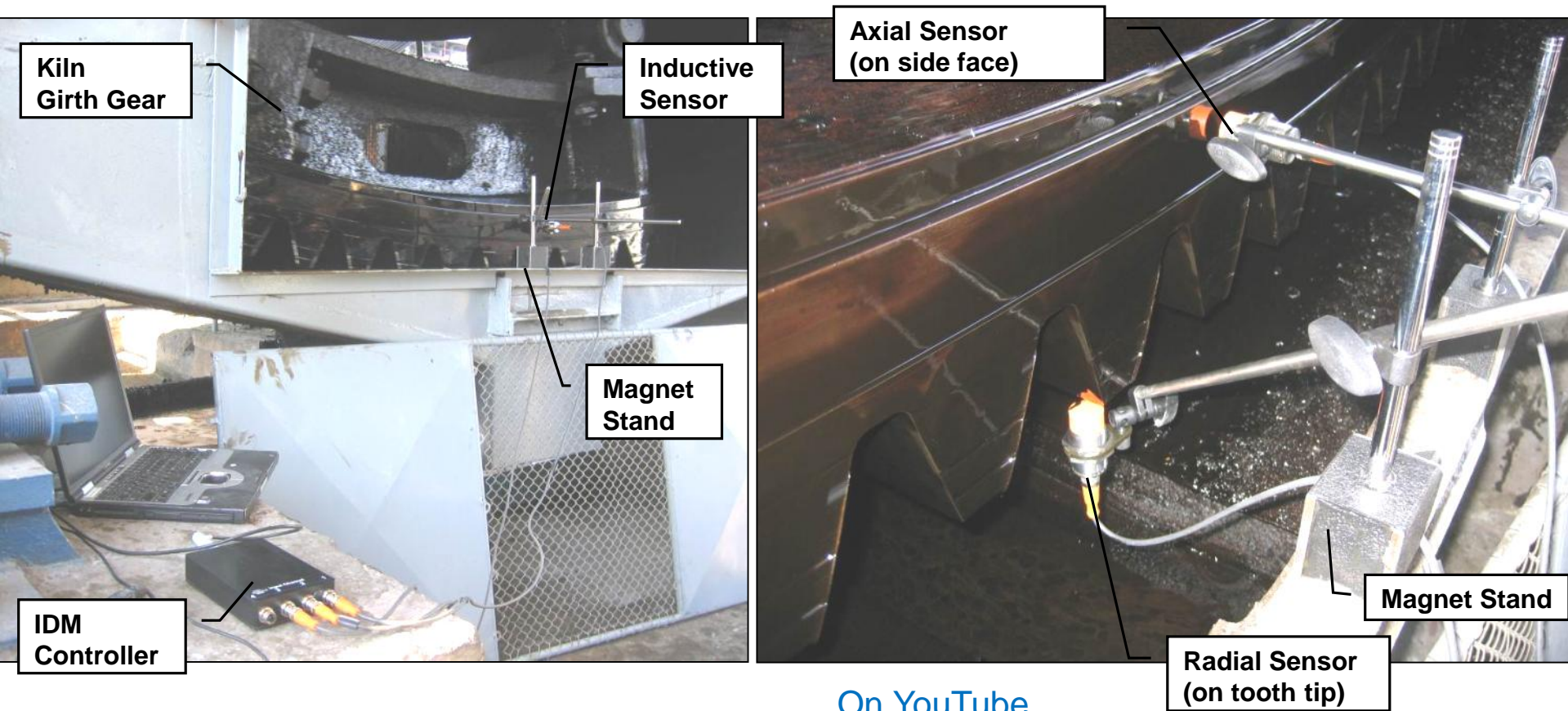
Inductive Distance Measurement (IDM) Tool Kit



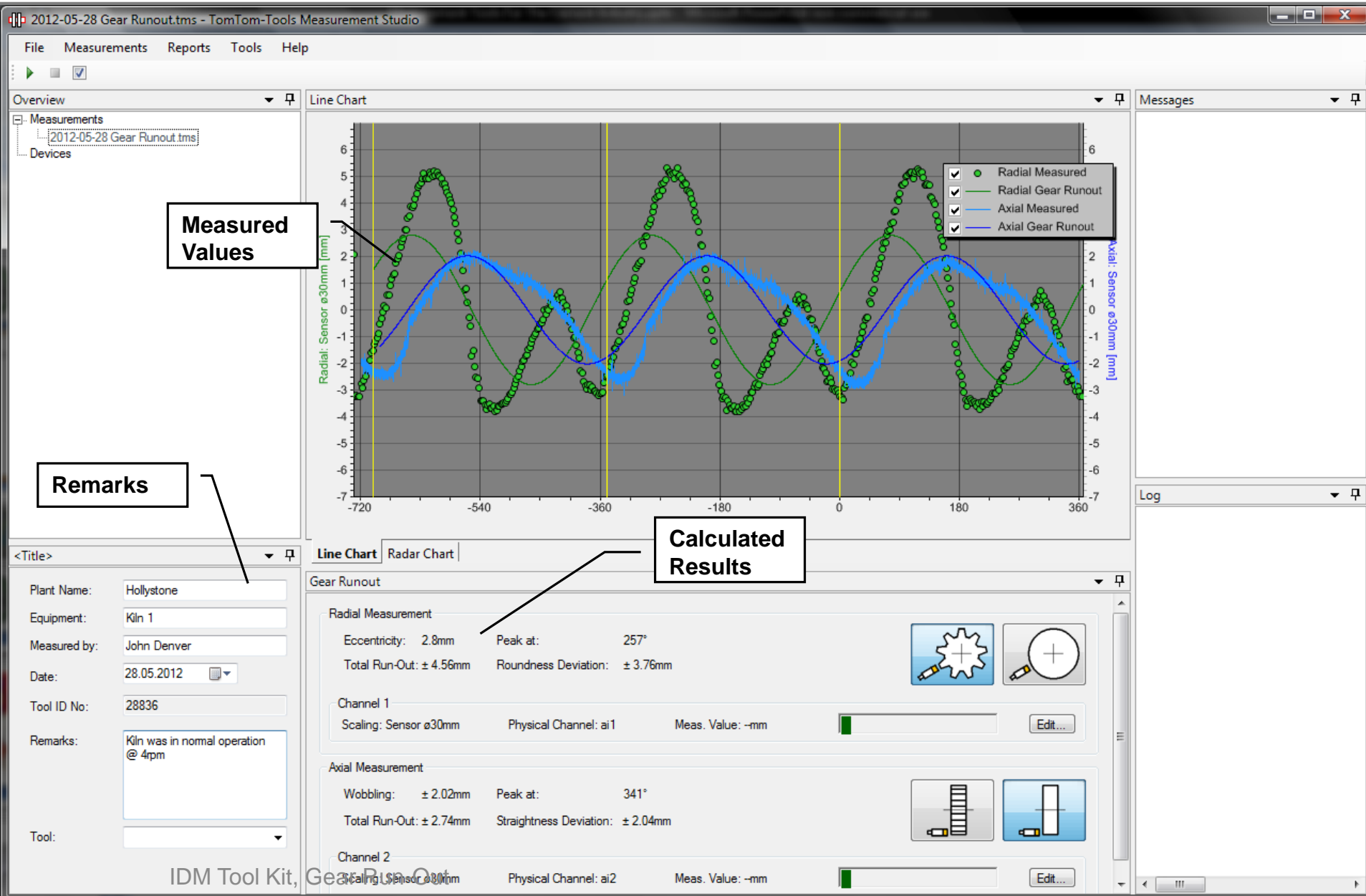
IDM Tool Kit, Gear Run-Out

Run-Out Measurement of Girth Gear

- The measured values are not affected by oil, grease or dust
- Continuous as well as interrupted surfaces can be measured
(**Note:** Sampling rate has to be adjusted according to rpm and surface type)



Line Chart: Axial + Radial Values



Radar Chart: Radial Values

2012-05-28 Gear Runout.tms - TomTom-Tools Measurement Studio

File Measurements Reports Tools Help

Overview Measurements 2012-05-28 Gear Runout.tms Devices

Radar Chart

Centre of rotation

Ideal Circle (with eccentricity)

Centre of Girth Gear

Measured Values

Remarks

Log

<Title>

Plant Name: Hollystone
 Equipment: Kiln 1
 Measured by: John Denver
 Date: 28.05.2012
 Tool ID No: 28836
 Remarks: Kiln was in normal operation @ 4rpm
 Tool:

Line Chart Radar Chart

Gear Runout

Radial Measurement

Eccentricity: 2.8mm	Peak at: 257°
Total Run-Out: ± 4.56mm	Roundness Deviation: ± 3.76mm

Channel 1

Scaling: Sensor ø30mm Physical Channel: ai1 Meas. Value: -mm

Axial Measurement

Wobbling: ± 2.02mm	Peak at: 341°
Total Run-Out: ± 2.74mm	Straightness Deviation: ± 2.04mm

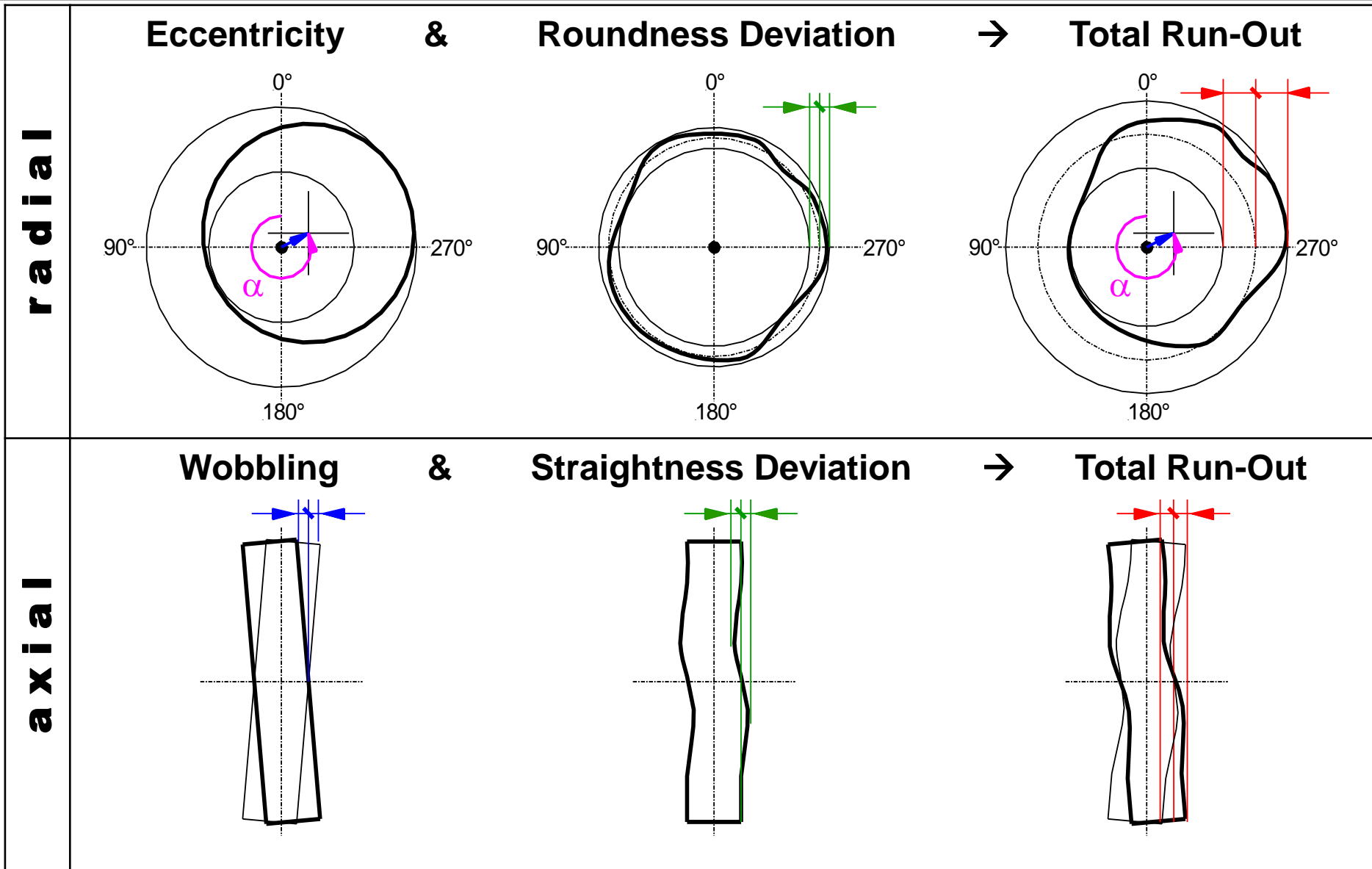
Channel 2

Scaling: Sensor ø30mm Physical Channel: ai2 Meas. Value: -mm

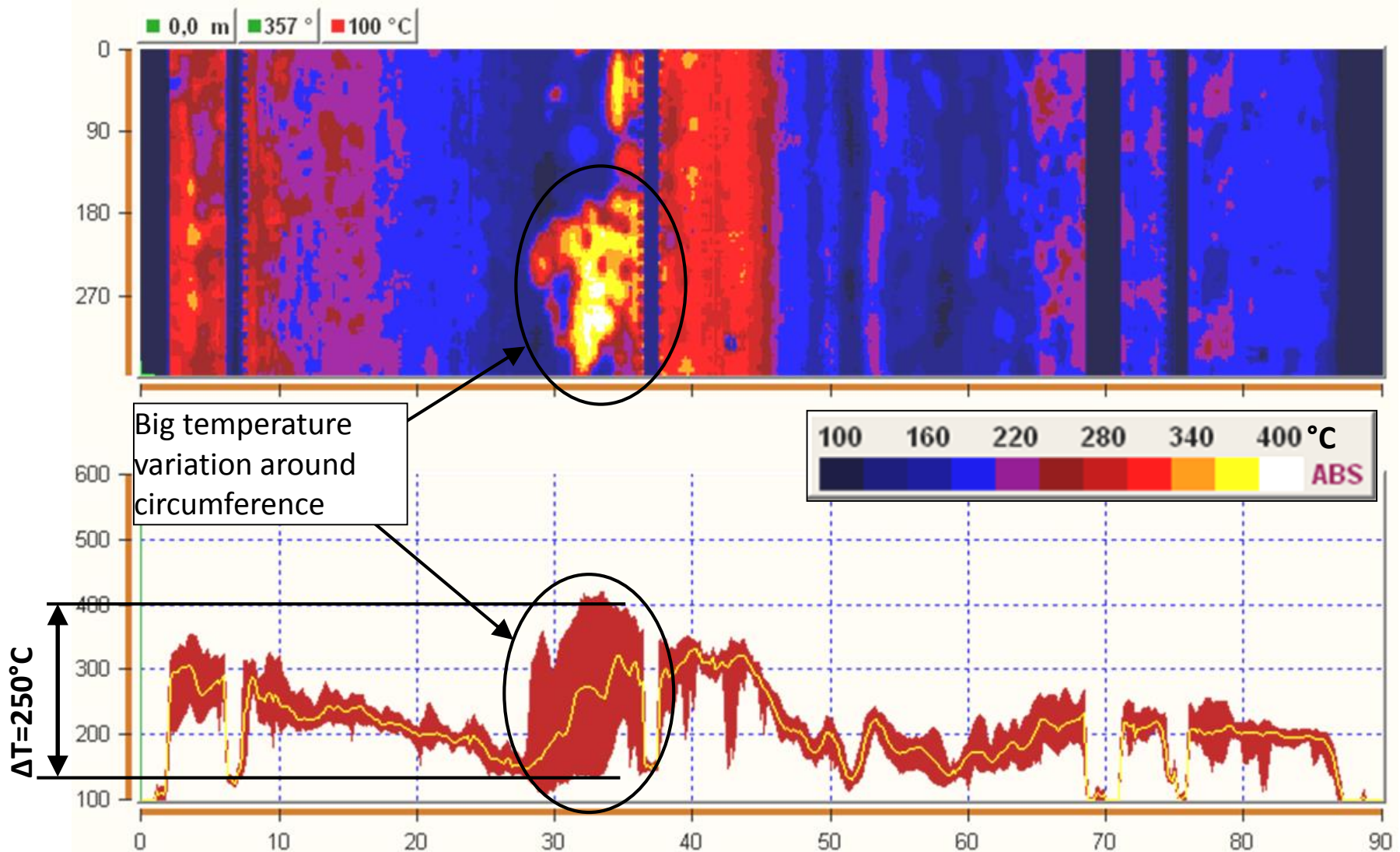
Calculated Results

IDM Tool Kit, Gear Runout

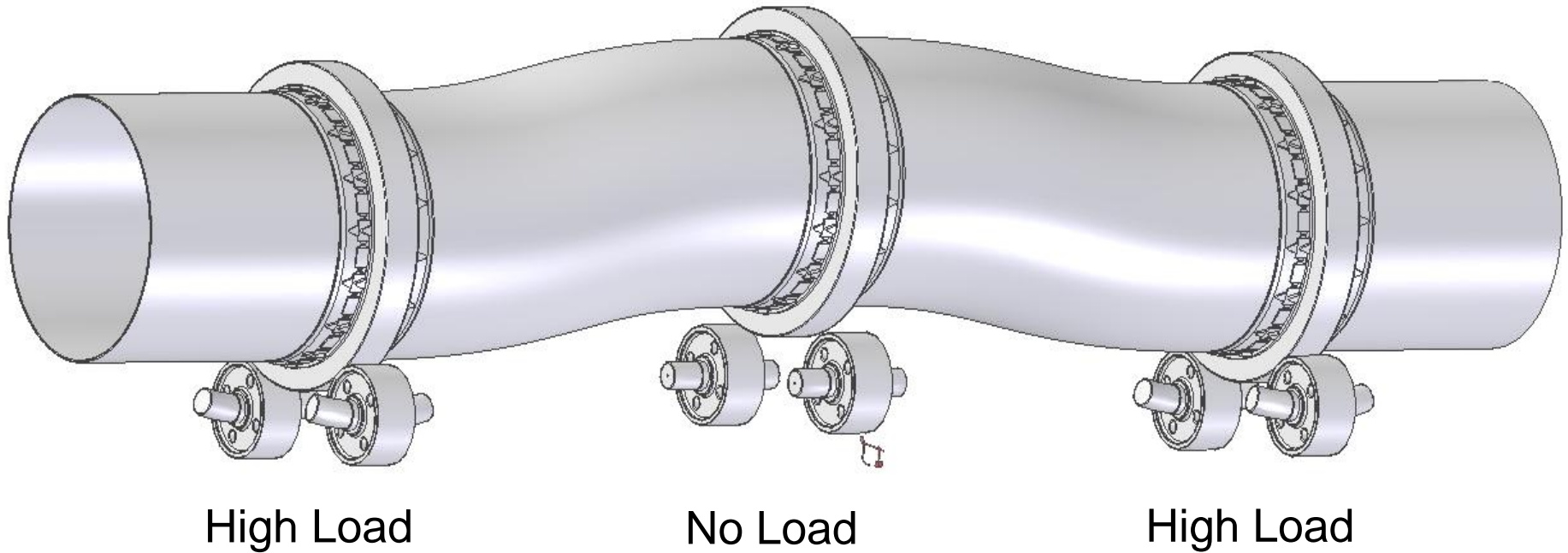
Run-Out Definition



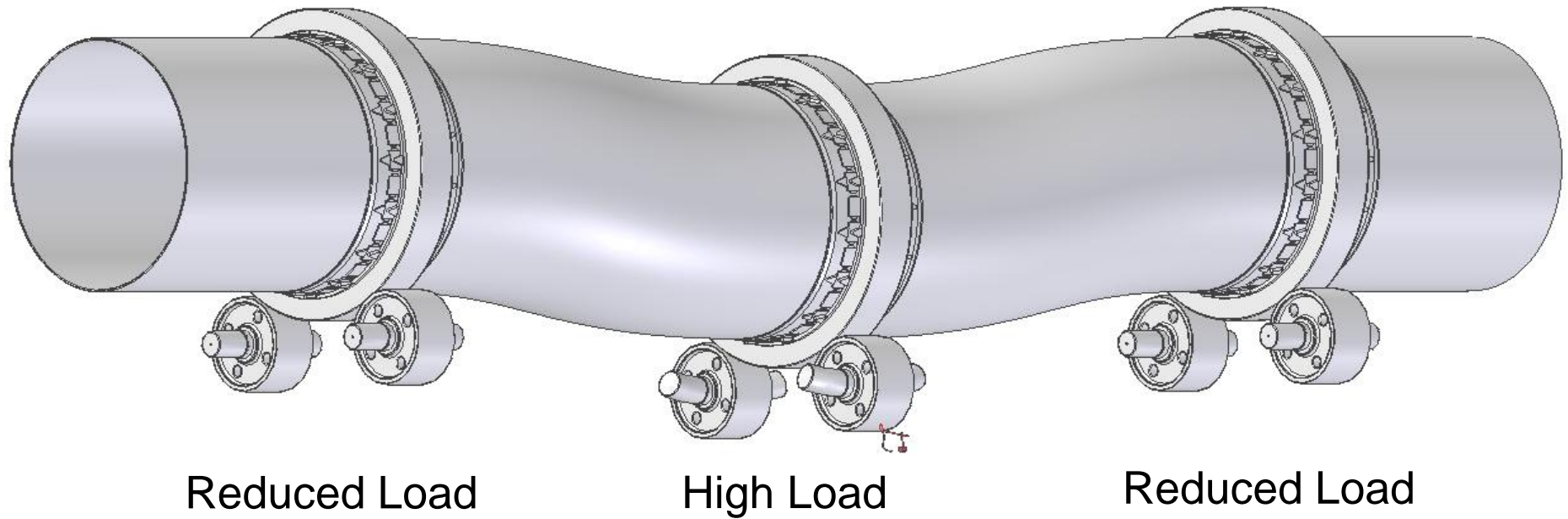
Uneven Shell Temperature → Thermal Crank



Crank In Tire Area (up)



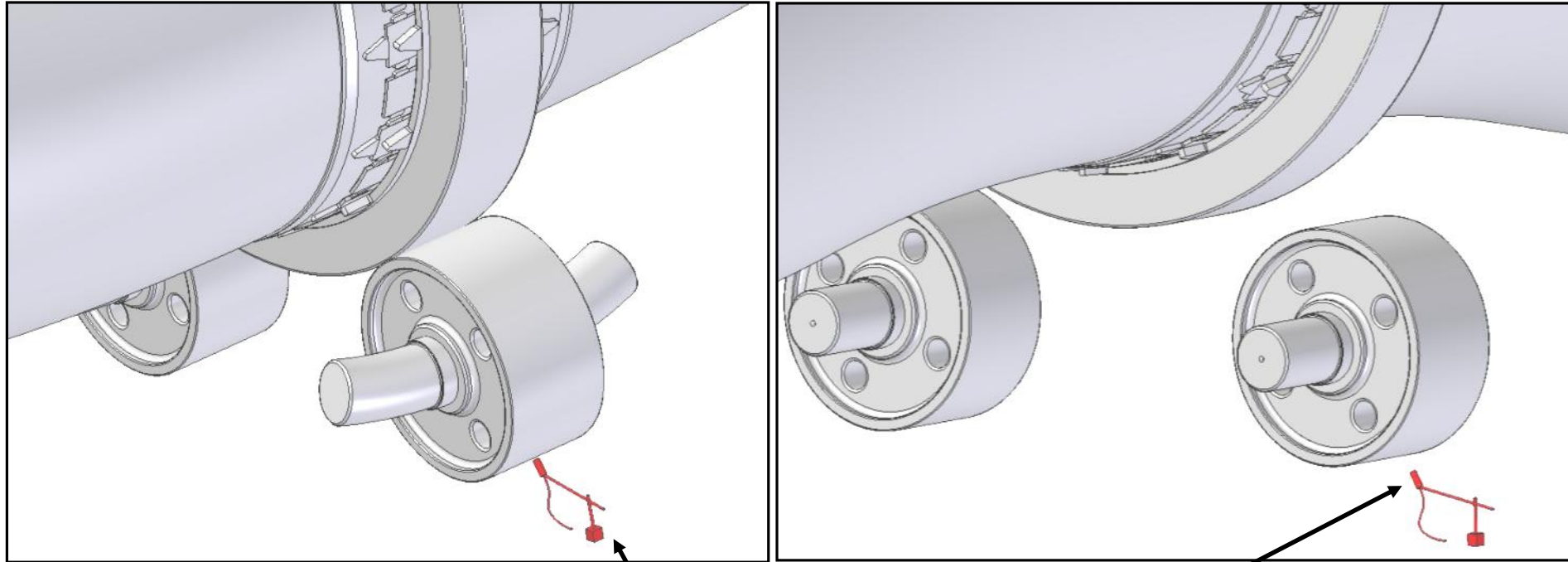
Crank In Tire Area (down)



IDM Tool Kit makes crank visible

High load on roller

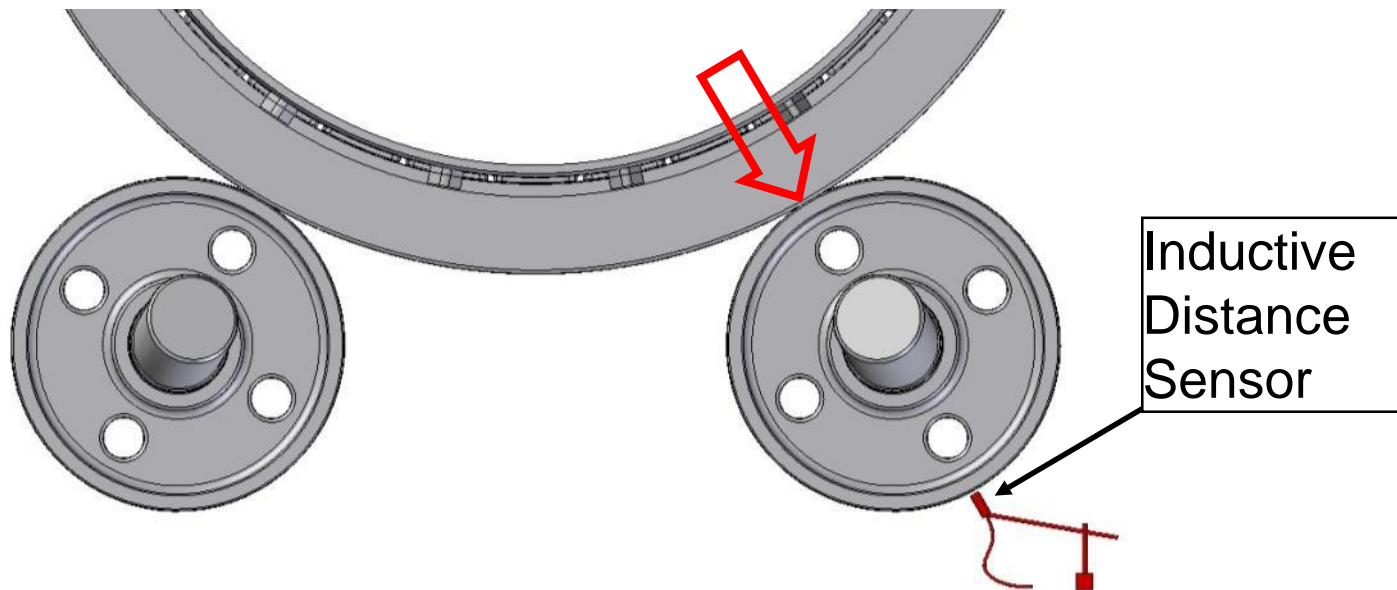
No or low load on Roller



Inductive Distance Sensor

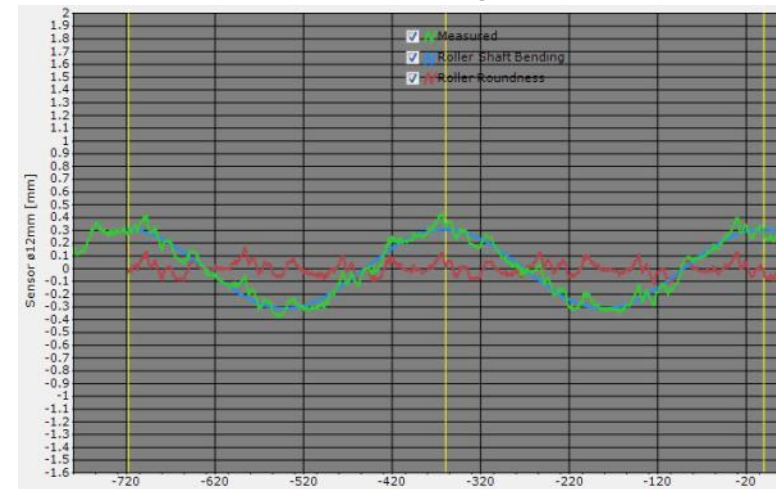
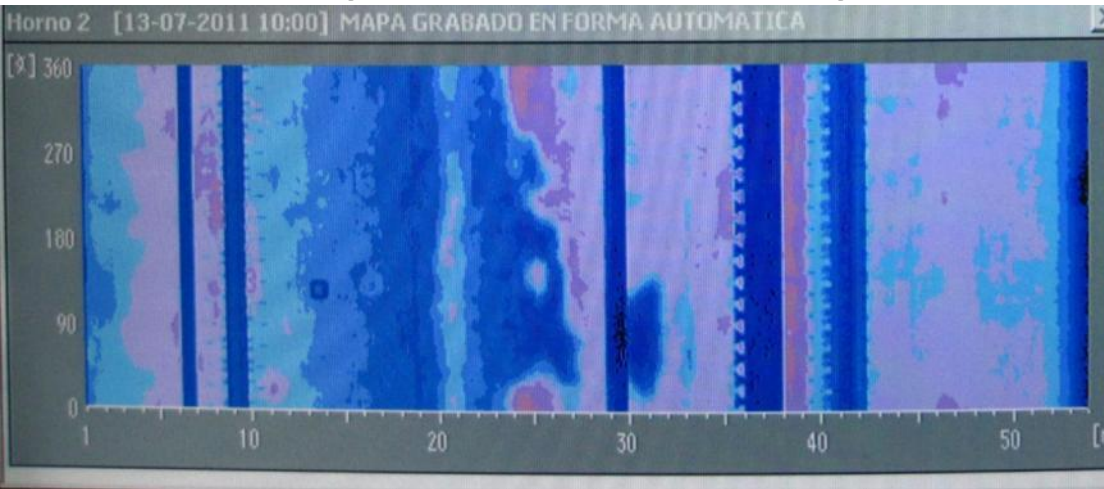
Roller Bending Measurement

- The roller shaft bending is measured via the radial displacement of the roller surface (run-out)
- The sensor is located in the line of force under the roller
- It is measured during normal operation (no stop required)
- Only the variations are measured due to a crank, the static load due to weight and possible alignment errors are not measured

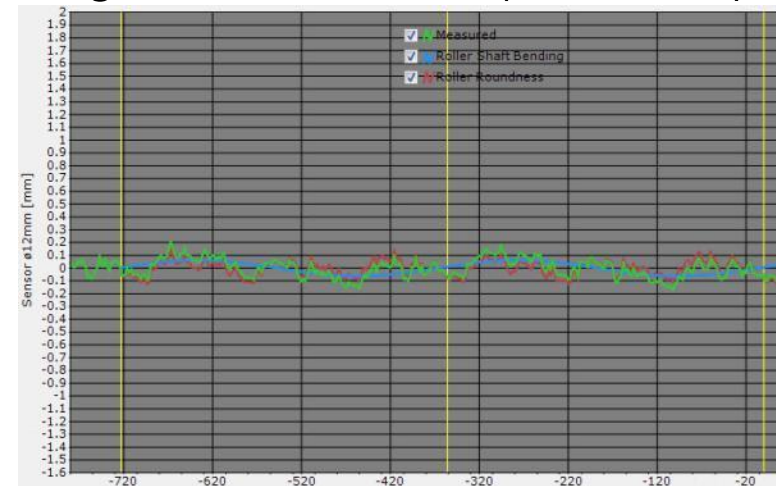
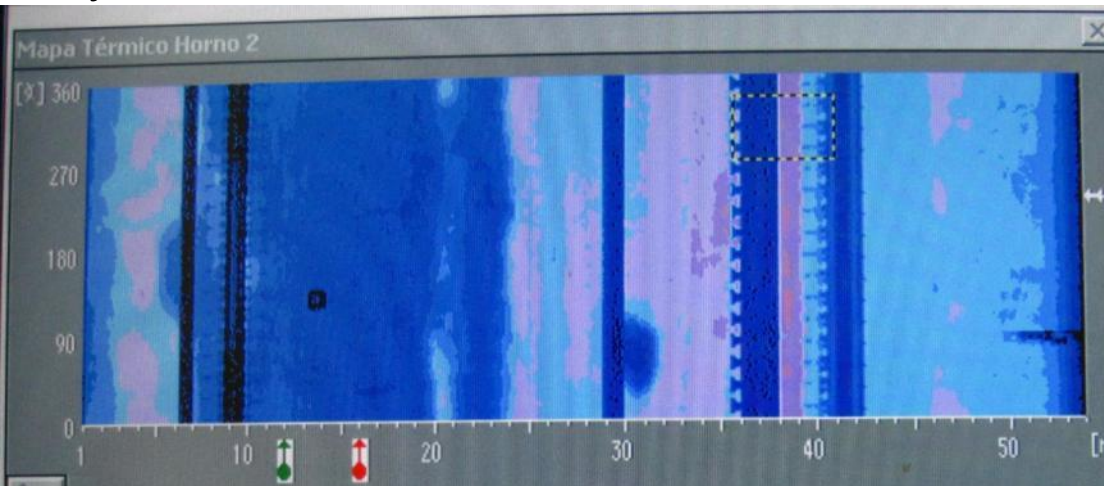


Thermal Crank (example 3 station kiln)

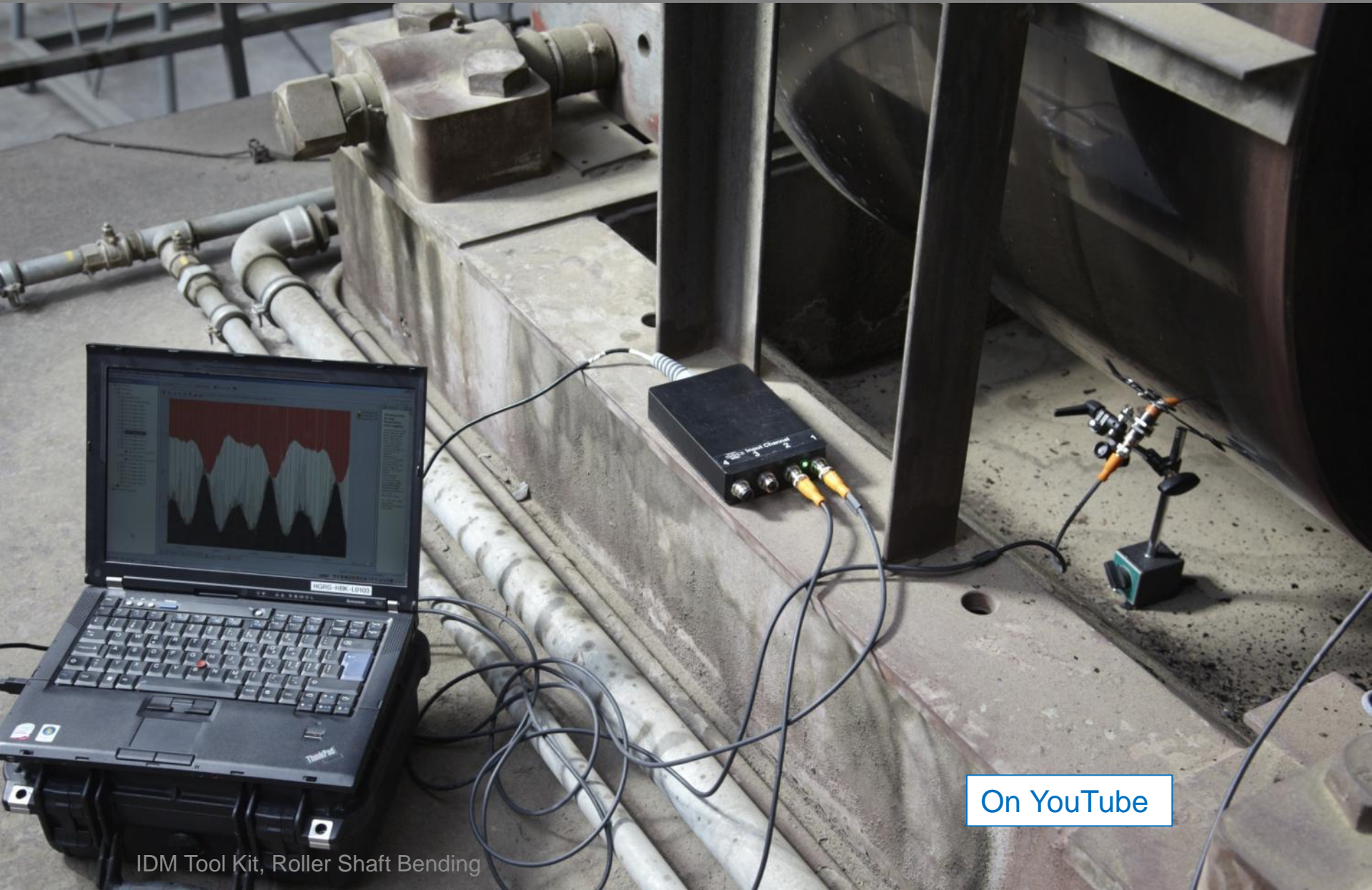
July 13: strong thermal crank → high variation in roller shaft bending ($\pm 0.3\text{mm}$)



July 15: no thermal crank → low roller shaft bending value ($\pm 0.08\text{mm}$)

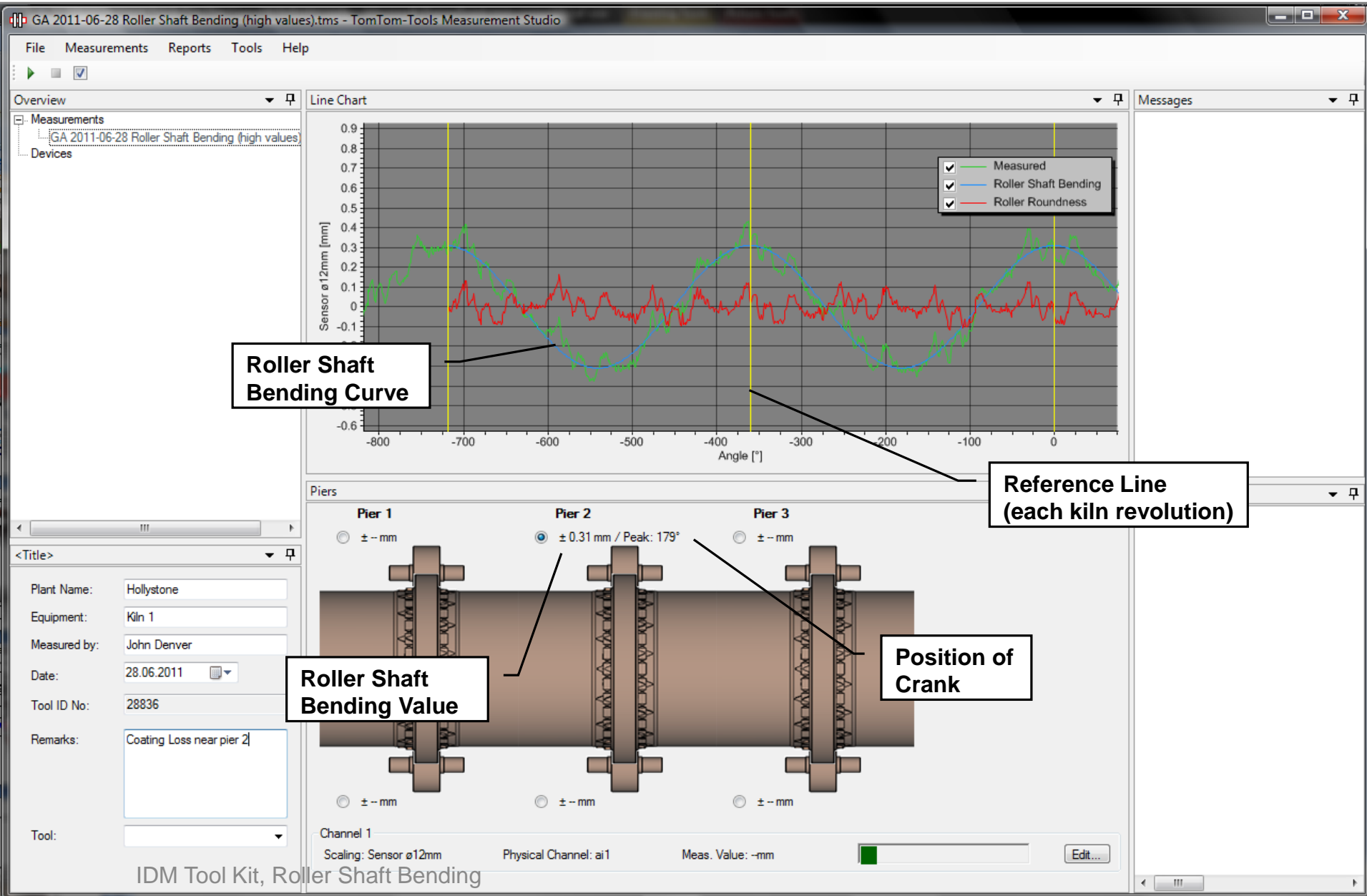


Roller Shaft Bending Measurement

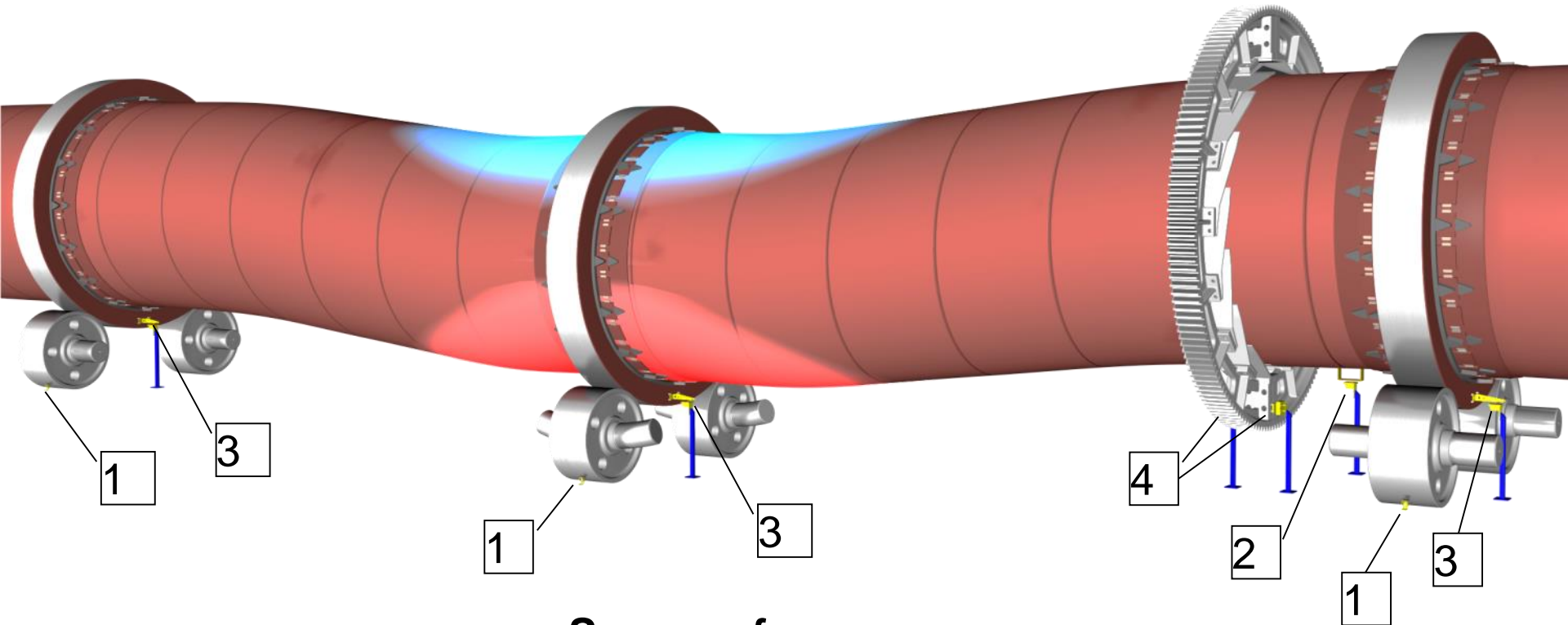


[On YouTube](#)

Measurement Studio / Roller Shaft Bending



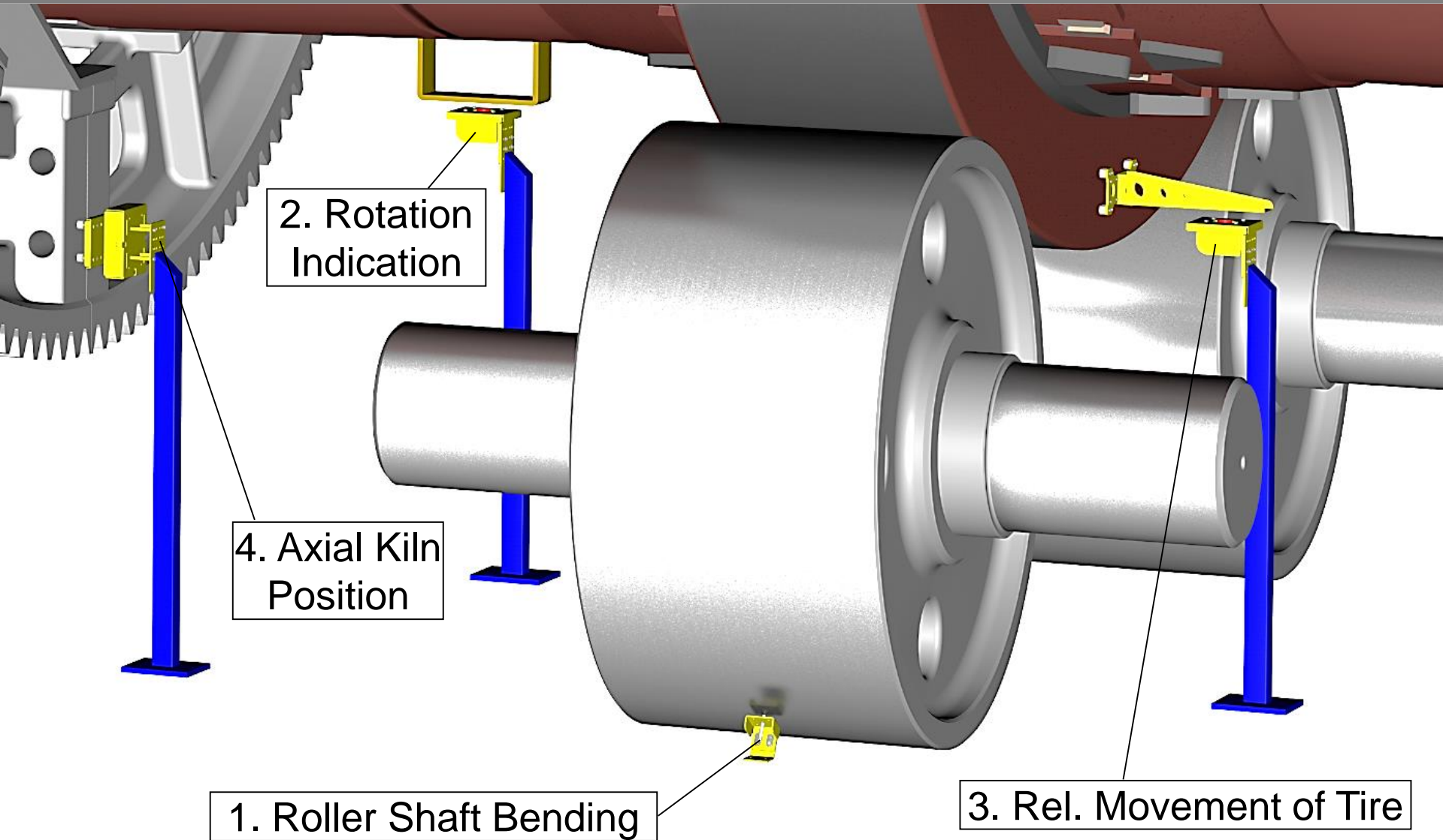
MKM-System (Mechanical Kiln Monitoring System)



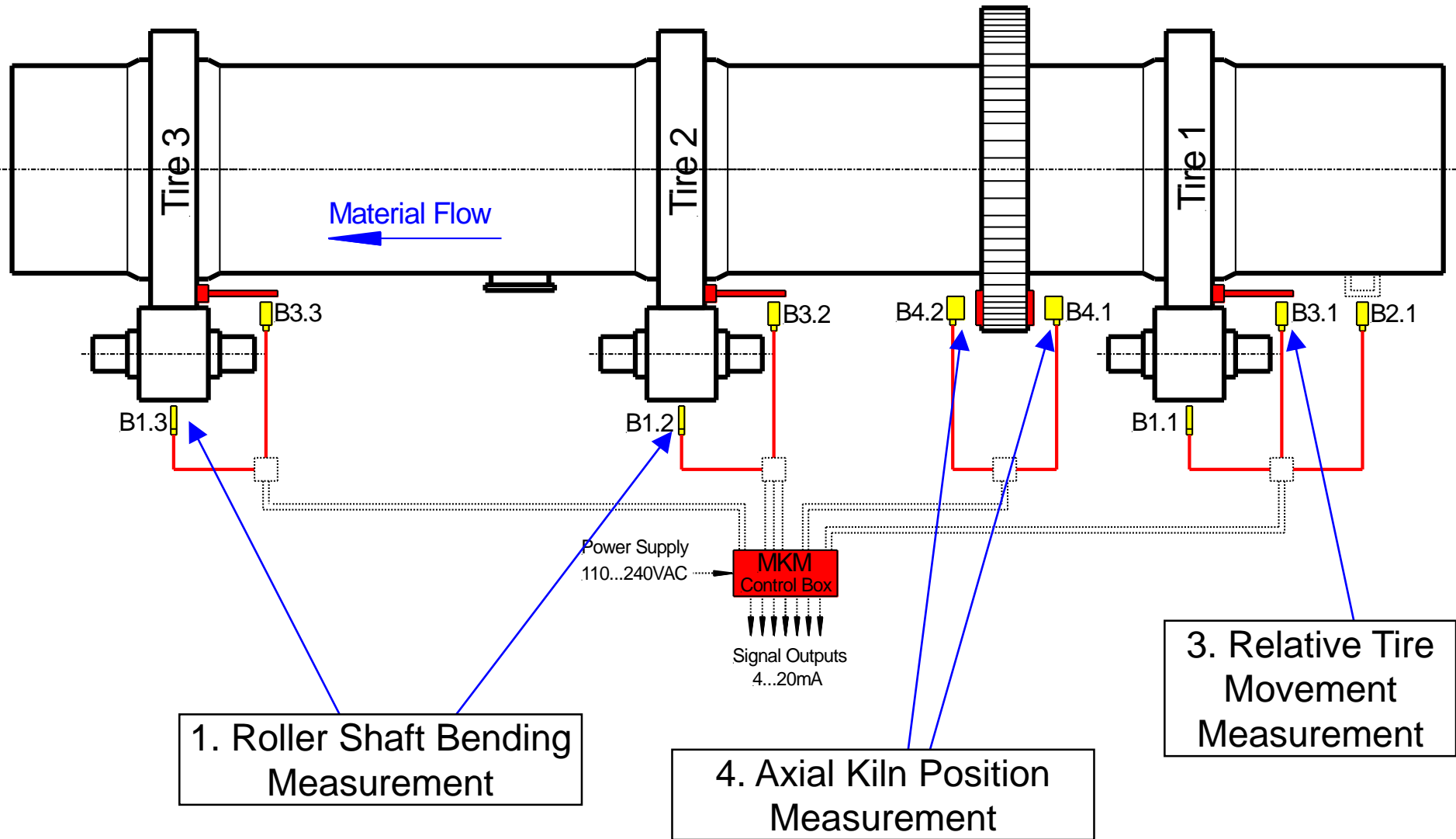
Sensors for:

1. Roller Shaft Bending Measurement
2. Rotation Indication
3. Relative Movement of Tires
4. Axial Kiln Position

MKM-System (Mechanical Kiln Monitoring System)



MKM-System (Mechanical Kiln Monitoring System)



MKM Sensor Installation



Kiln Speed Sensor



Axial Kiln Position Sensor



Axial Kiln Position Sensor



Roller Shaft Bending Sensor

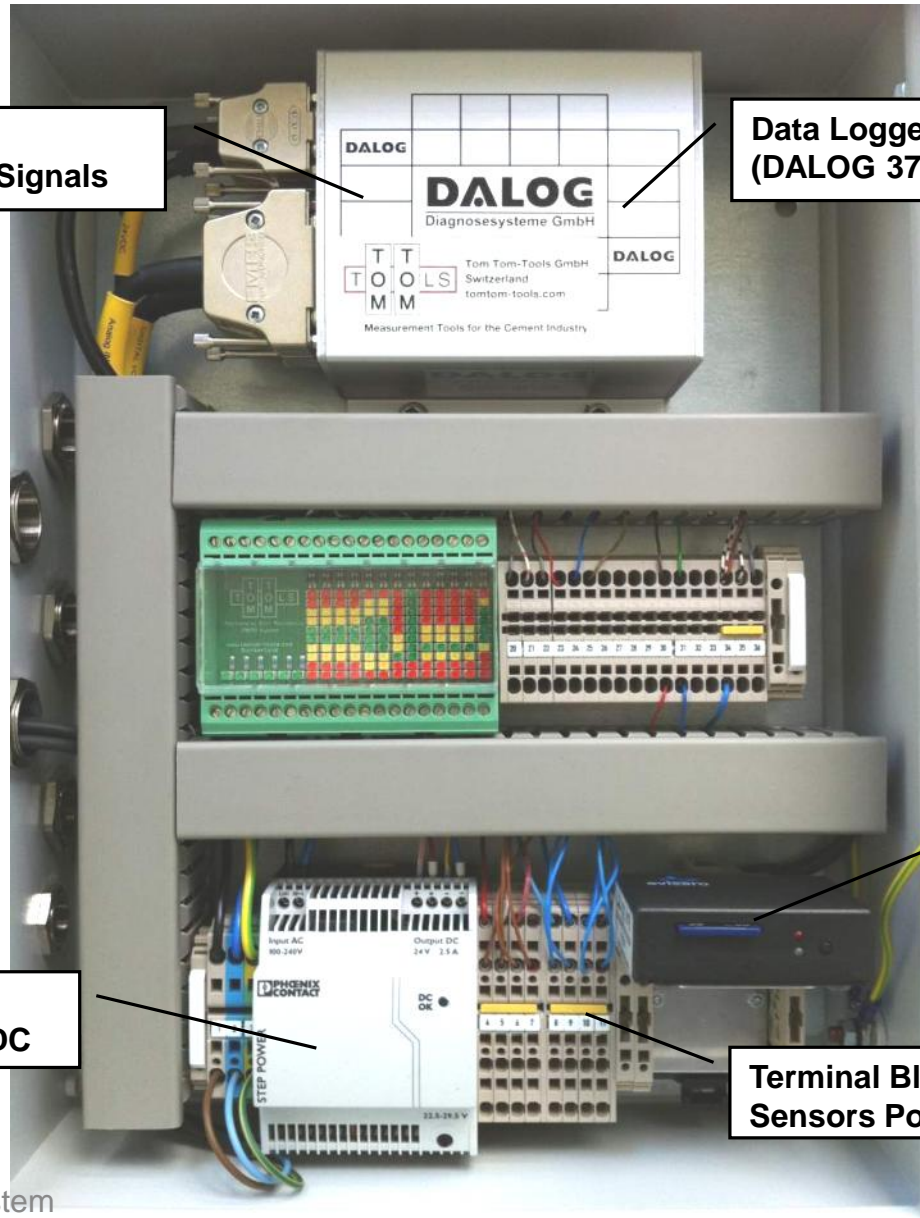


Relative Tire Movement Sensor

MKM Controller / Data Logger

**LED Terminal Block
for Sensor and Output Signals**

**Data Logger
(DALOG 376)**



**Power supply
100...240VAC → 24VDC**

**SD Card
Reader**

**Terminal Block
Sensors Power Supply**

Measuring Wheel



The Measuring Wheel is a measurement tool, which measures the diameter of slow rotating cylinders during operation; for example on support rollers or tires on rotary kilns or dryers.

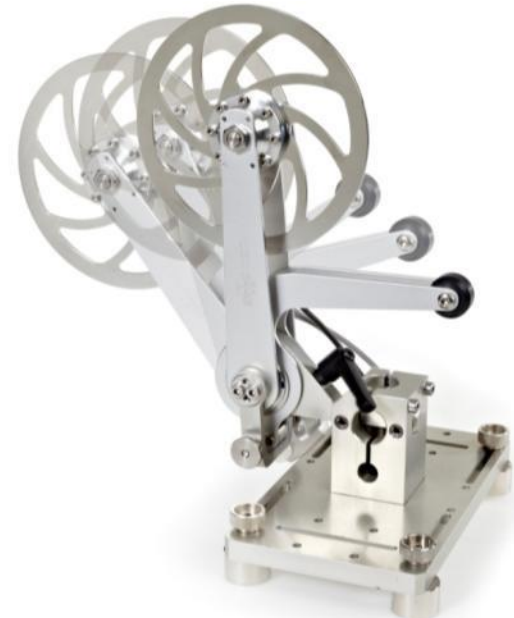
These components are typically subject to a certain amount of wear and have to be re-machined or replaced after some time of operation

In order keep the kiln or drier axis aligned; it is essential to know the changes of the diameters and to compensate them by adjusting the roller positions

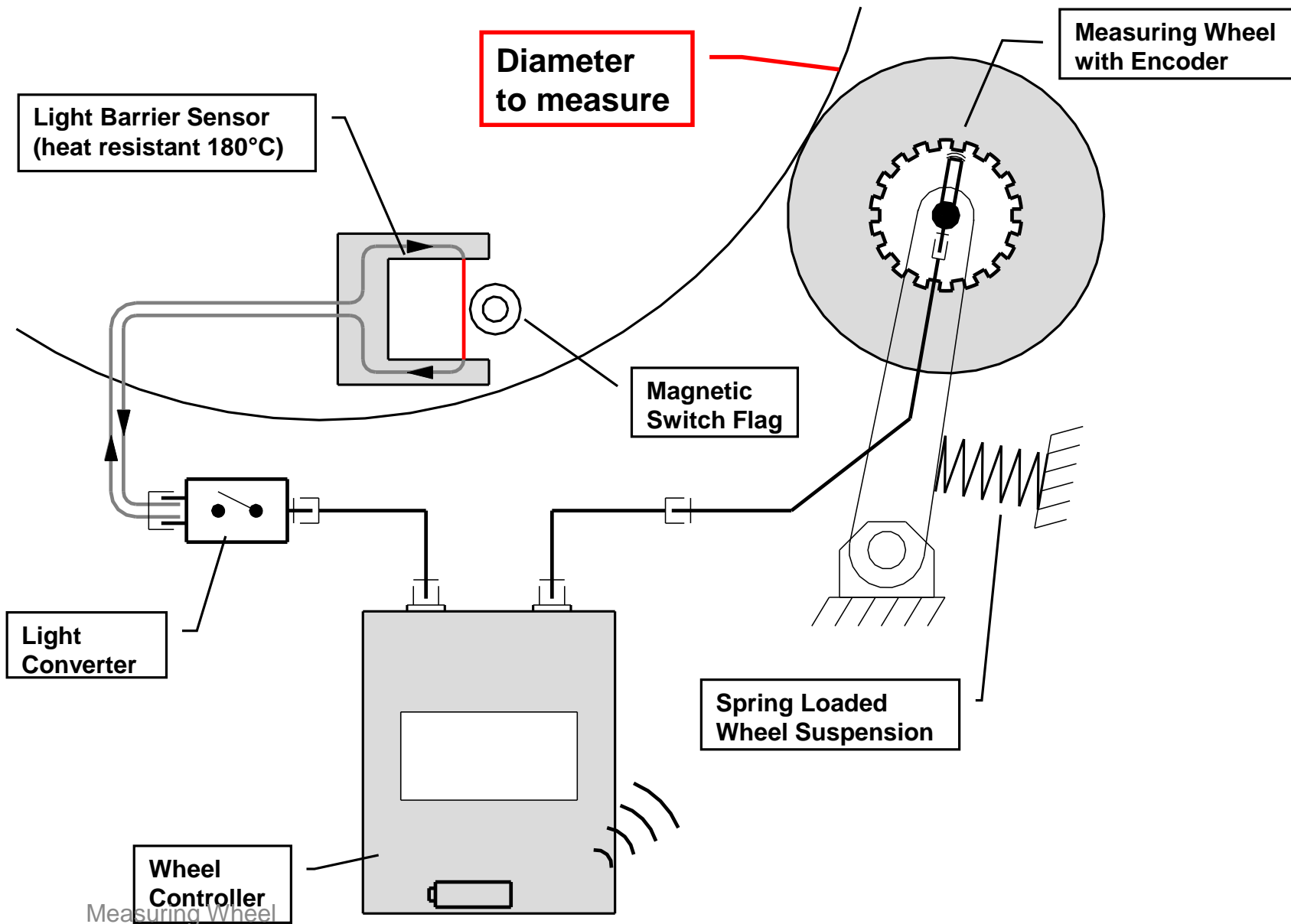
Measuring Wheel



Measuring Wheel



Measuring Wheel Schematic

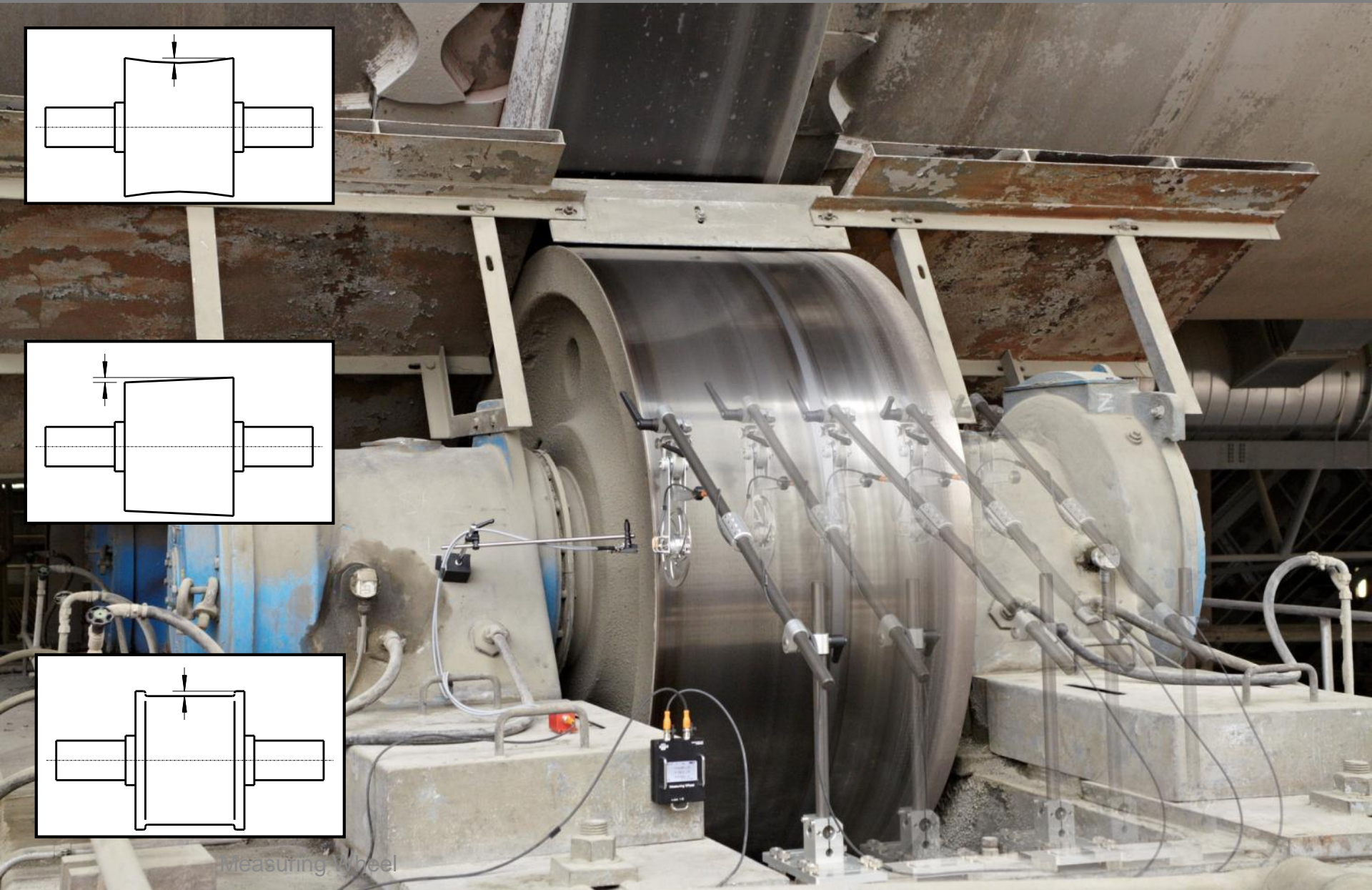
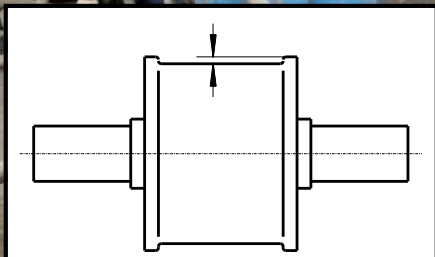
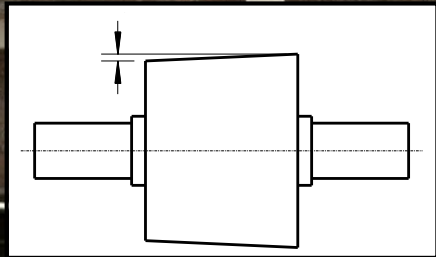
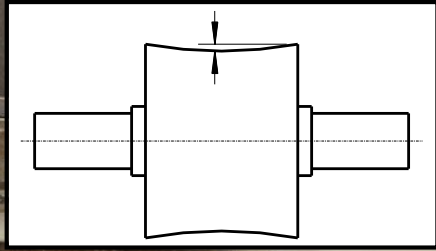


Measuring Wheel



[On YouTube](#)

Measurement of Cylindricity



Rotary Inclinometer



The Rotary Inclinometer is a measurement tool, which measures the axle inclinations of slow rotating parts during operation (e.g. Rotary Kilns, Dryers, Ball Mills in barring mode).

It measures deviations in vertical direction with a high accuracy, which makes the alignment work much easier.

It can be considered as a water level for slow rotating parts.

Rotary Inclinometer

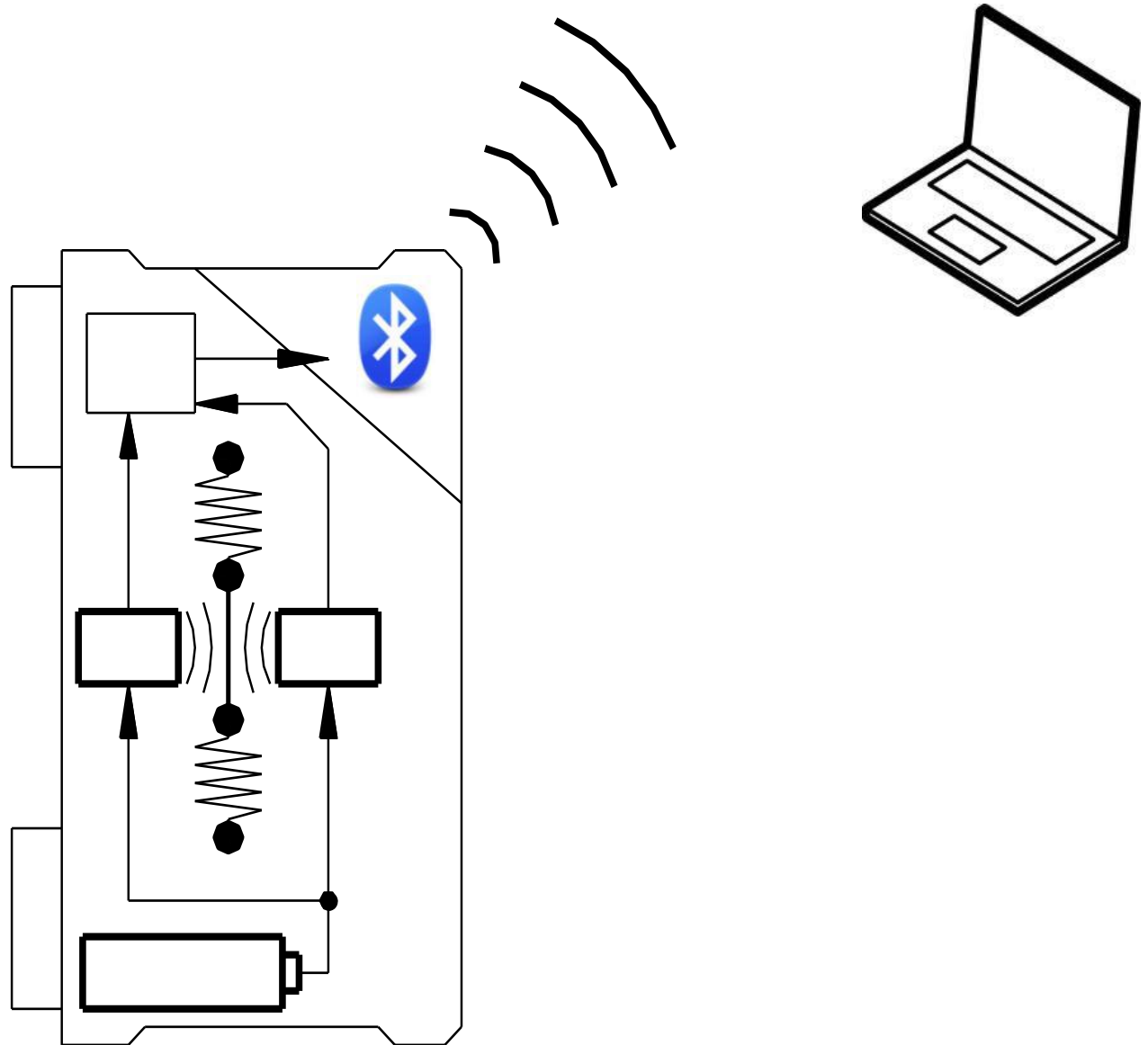


Inclinometer with heat shield to measure hot kiln tires



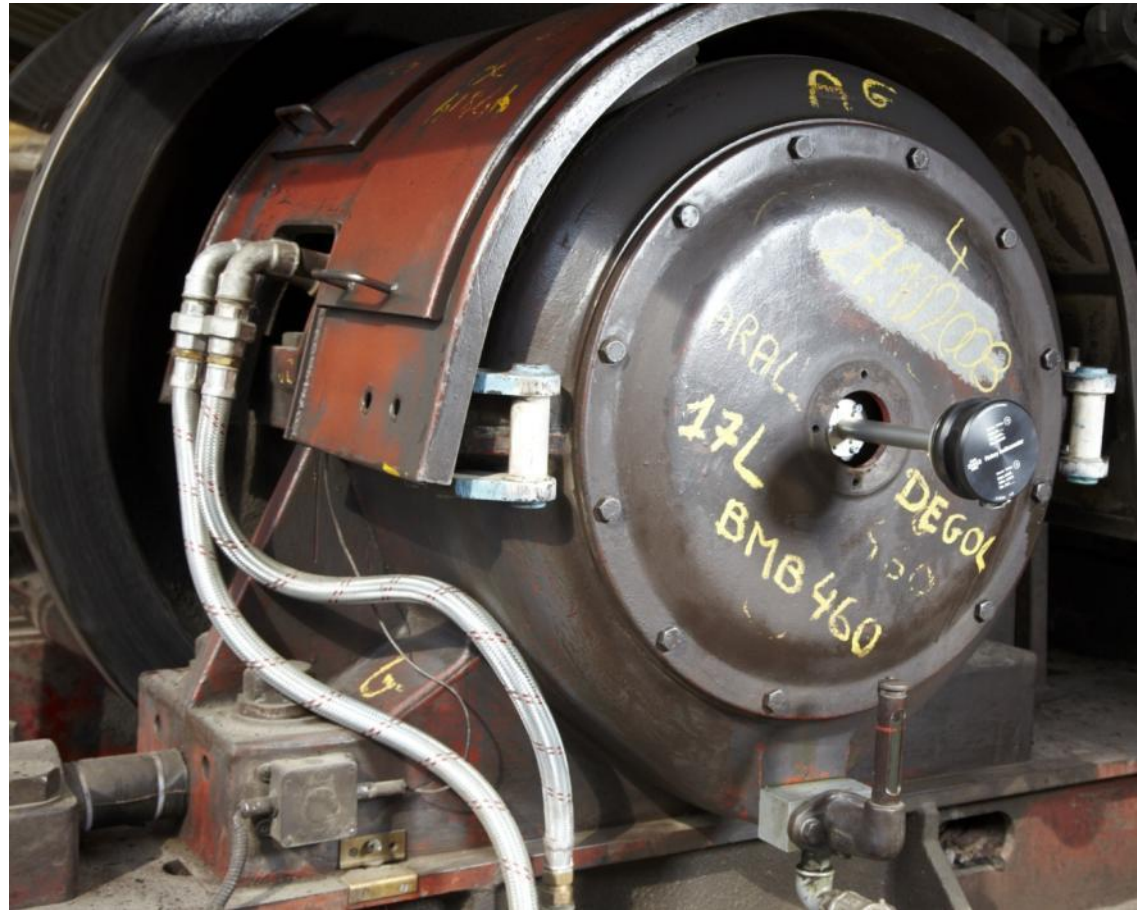
Inclinometer with shaft adapter to measure support rollers at the shaft center

Rotary Inclinometer Working Principle



Rotary Inclinometer

Roller Inclination Measurement



[On YouTube](#)

Rotary Inclinometer

Measurement Studio: Inclination

CR 2011-02-03 Kiln Inclination 1.tms - TomTom-Tools Measurement Studio

File Measurements Reports Tools Help

Overview

- Measurements
 - CR 2011-02-03 Kiln Inclination 1.tms
 - Devices

Measured Values

Line Chart

Inclination [mm/m]

Angle [°]

Inclination Values per Revolution

Inclination

Rotation Nr.

Remarks

Rotary Inclination Measurement Settings

Plant Name: Hard Rock

Equipment: Kiln 1

Measured by: Bill Clinker

Date: 03.02.2011

Tool ID No: 10249057

Remarks: Kiln was in normal operation condition

Tool:

Calculated Results

Piers

Pier 1 Material Flow ← Pier 2 Drive Pier 3

Tire	39.4 mm/m *	Tire	40.5 mm/m *	Girth Gear	41.7 mm/m *	Tire	41.5 mm
ΔRoller (f)	1.5 mm/m	ΔRoller (f)	1.7 mm/m	ΔPinion (b)	0.4 mm/m	ΔRoller (f)	-0.5 mm
ΔRoller (b)	1.2 mm/m	ΔRoller (b)	1.2 mm/m			ΔRoller (b)	0.8 mm

Kiln Shell Laser



The Kiln Shell Laser is a measurement tool, which measures the deformations (roundness, straightness, eccentricity) in shells of rotary kiln and dryer during operation.

It measures continuously the distance to the shell and records the deviations. The tool is placed in various positions along the kiln.

For evaluation, the shape of the kiln shell is displayed in line and radar charts as well in 3d.

Kiln Shell Laser



**Kiln Shell Laser
on Tripod**

Kiln Shell Laser



**Kiln Shell Laser
on G-Clamp**



Rotation Trigger



**Kiln Shell Laser
in transport case**

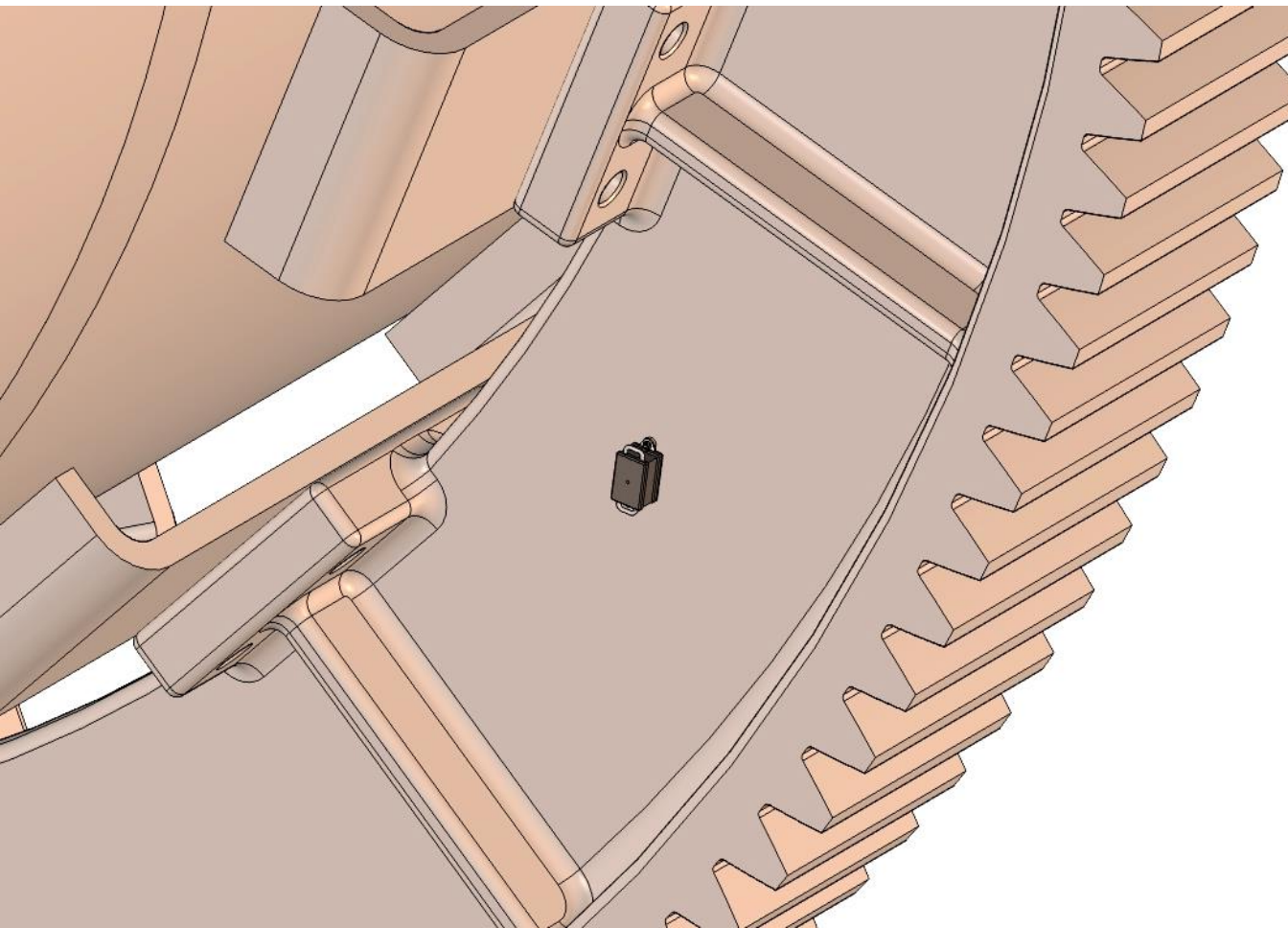
Kiln Shell Laser

placed in various positions along the kiln



The Rotation Trigger synchronizes the Kiln Shell Laser with the kiln rotation

- It is attached to the girth gear and provides continuously the rotation position of the kiln via Bluetooth to the measurement computer



Kiln Shell Laser in the Measurement Studio offers different display options for evaluation

Overview

- Measurements
 - 2014-04-02 Shell Runout SG
- Devices
- 3D Kiln View
 - 2014-04-02 Shell Runout SG

Shell Runout

Laser
Distance: no value received

Measurements

Position [m]	Eccentricity [mm]	Peak at [°]	Total Run-Out [mm]	Roundness Deviation [mm]
1	4	49	± 6	± 4
8	0	102	± 8	± 8
9	2	160	± 12	± 12
19	1	327	± 10	± 10
20	2	268	± 9	± 9
			± 10	± 9
			± 84	± 84
			± 8	± 6
			± 12	± 9
			± 16	± 11
			± 16	± 8
			± 14	± 6
			± 12	± 7

Chart

Legend:
 ● Measured Values
 — Ideal Circle
 X Geometrical Center

3D View

Chart Radar Chart

Tool ID No:

Remarks:

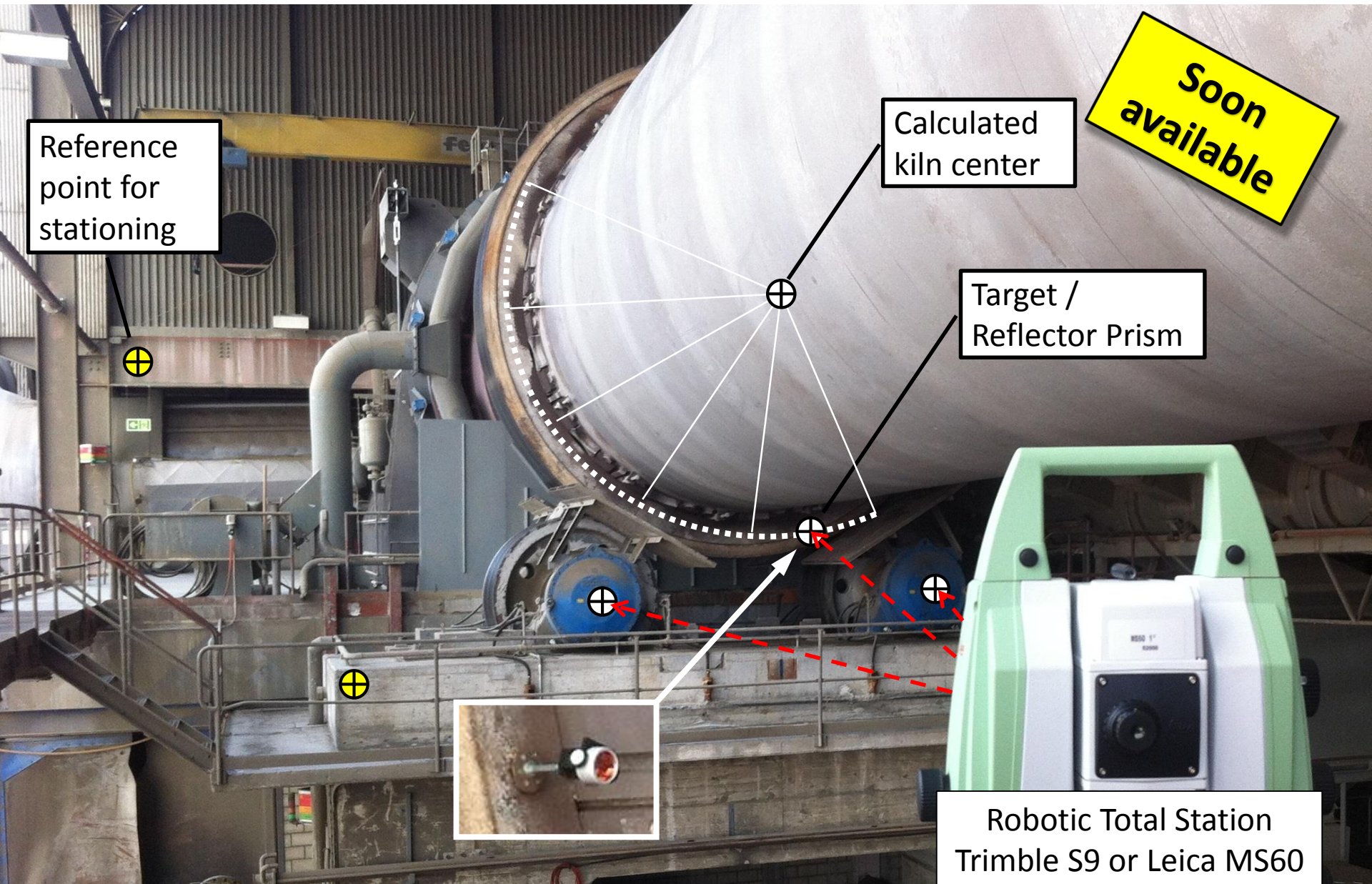
Tool:

Industrial Tablet PC, Panasonic TOUGHPAD FZ-G1 with Long Range Bluetooth

- The special Bluetooth Adapter makes the Tablet PC to match perfectly to the TomTom measurement tools



New system uses the target tracking function the reflector is attached to the kiln tire



Reference point for stationing

Calculated kiln center

Soon available

Target / Reflector Prism

Robotic Total Station
Trimble S9 or Leica MS60



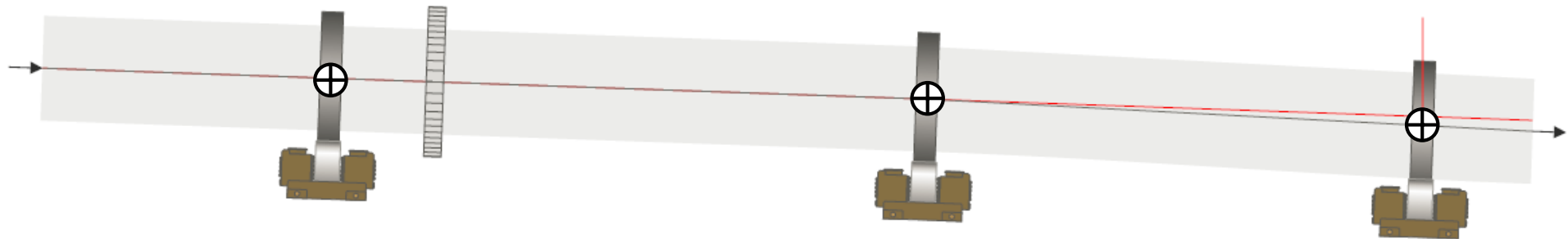
The results of the measurement is the value how much to move the rollers to get the kiln straight

Kiln Axis deviation:

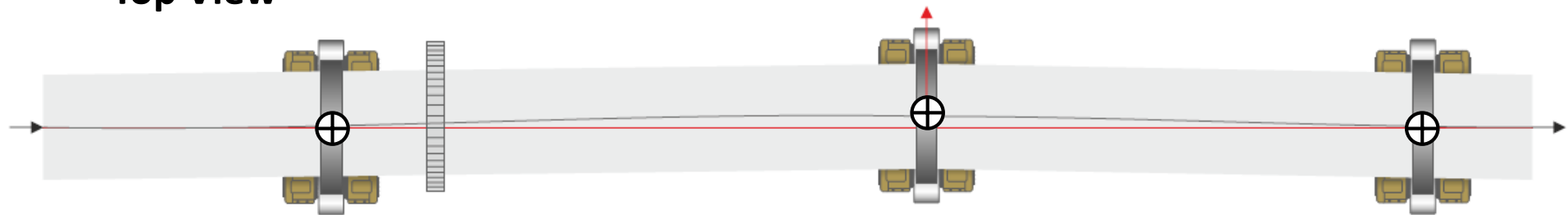
desired center determination accuracy: $\pm 1\text{mm}$

Soon available

Side View



Top View



The advantage of the new method with the **Arc Path Center Determination** software

- Easy to measure
 - no specialized geo survey engineer required
 - 1...2 days training is sufficient (possible with own personnel in cement plant)
 - Much less sources for errors
- Fast
 - A kiln with 3 piers can be measured easily within one day, traditional methods require up to one week
 - Diameter of rollers and tires have not to be measured
- Easy to analyze
 - The results are immediately visible in the PC
 - Possible erroneous measurements can be repeated at the spot
 - No transfer to other software required
 - Unmistakable visualization

**Soon
available**

Telescopic Contact Thermometer

- To measure the shaft temperature of the support rollers
- It helps to evaluate the condition of the bearings and the thrust load
- The telescopic handle makes it easy to reach the roller shaft
- It is much more precise than pyrometers and not affected by the oil film



T **T** **T** **L** **S**
O **O**
M **M**