



Radar-Based Non-Contact Glass Level Measurement

A New Approach for Accurate and Reliable Furnace Control

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glassservice.it

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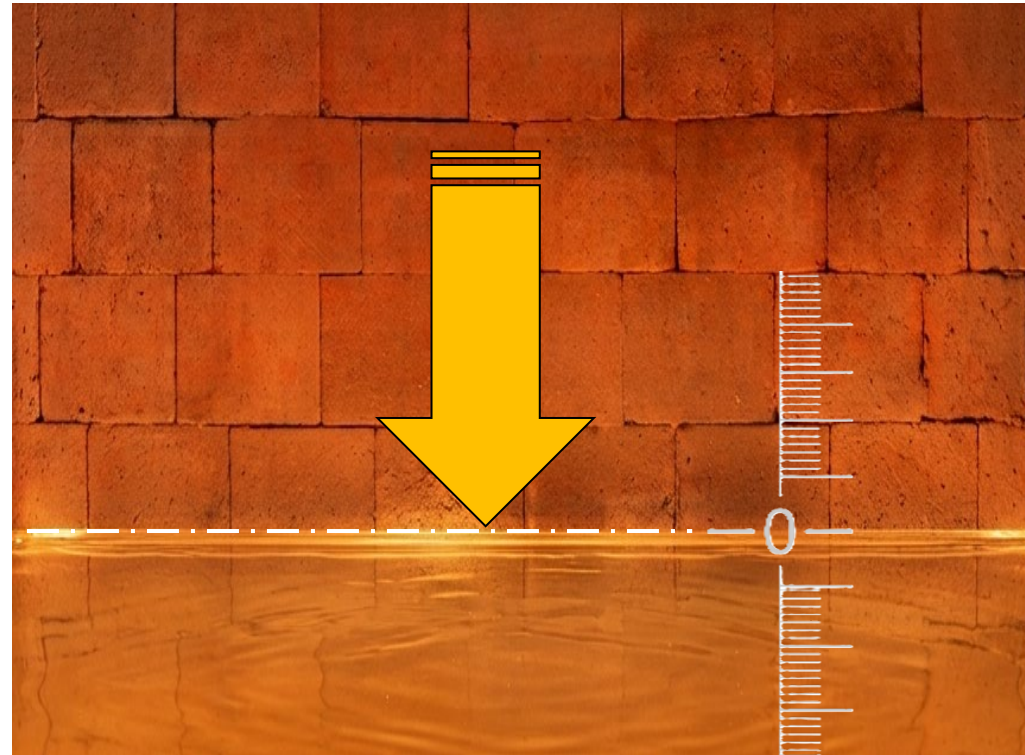
Why glass level measurement is critical?

Every furnace control strategy starts from one fundamental parameter:

Glass Level

The glass level directly influences:

- Furnace basin stability
- Glass quality
- Temperature profile
- Glass homogeneity
- Energy consumption
- Pull rate control



Why glass level measurement is critical?

An accurate glass level control:

- Reduces fluctuations in the batch charger speed



- Reduces carryover



- Stabilizes the gas/fuel flow



- Stabilizes the furnace temperature pattern



- Reduces the energy consumption



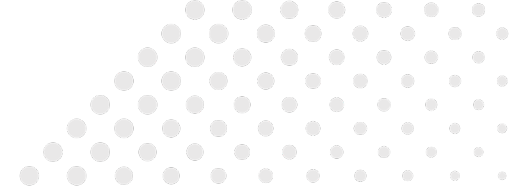
- Increases the glass quality



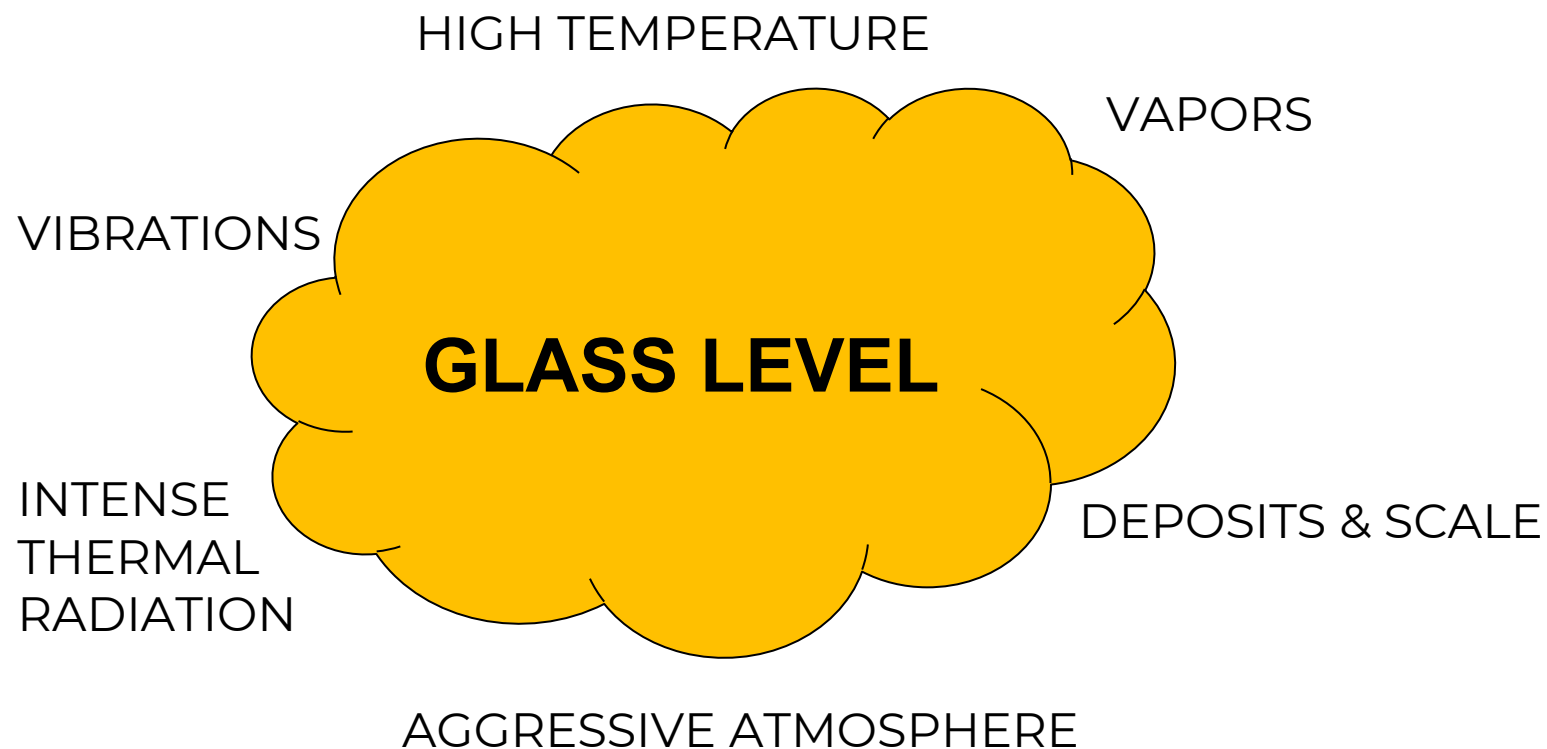
- Increase the production efficiency



Why glass level measurement is critical?



Operating conditions:



CONTACT SENSORS



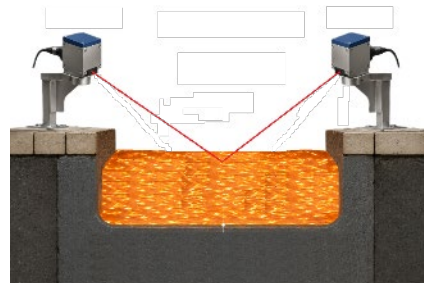
The most traditional technology on the market. Simple and cost-effective

ELECTRICAL/CAPACITIVE PROXIMITY SENSING



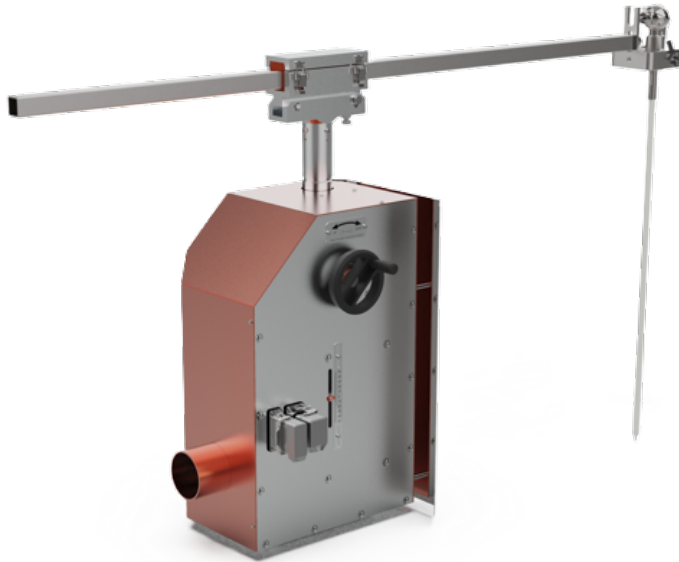
Measurement affected by the liquid's dielectric properties and conductivity

LASER SYSTEMS



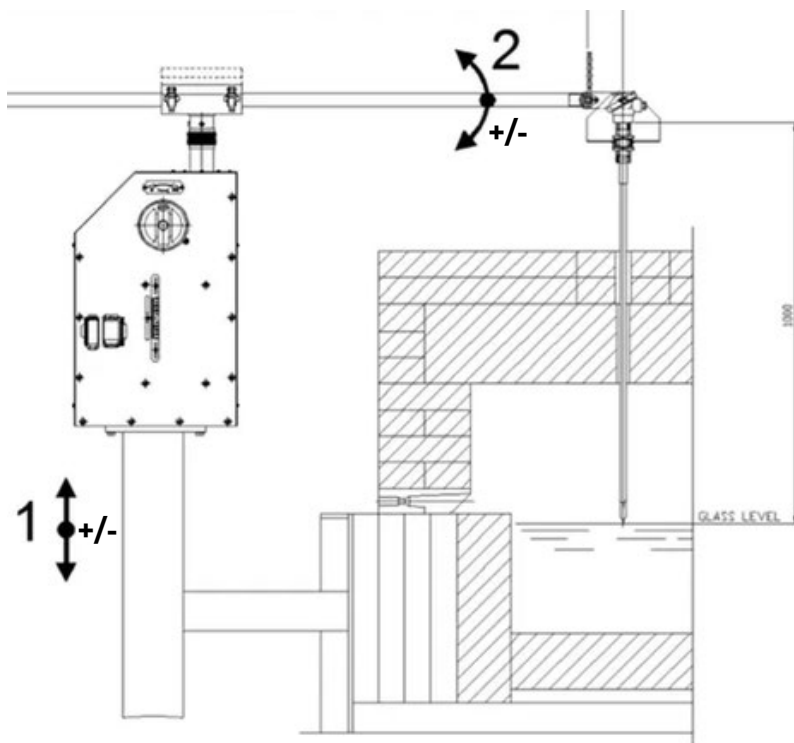
They have not become the industry standard due to cleaning, reflection, and dust-related issues

CONTACT SENSORS



- Low Capex
- Reliable mechanical mechanism
- Horizontal and vertical installation
- Short vertical stroke (limit for installation)
- Glass sticking
- Low sampling frequency due to the mechanical cycle
- With water-cooled probe, issues with water temperature and pressure variations

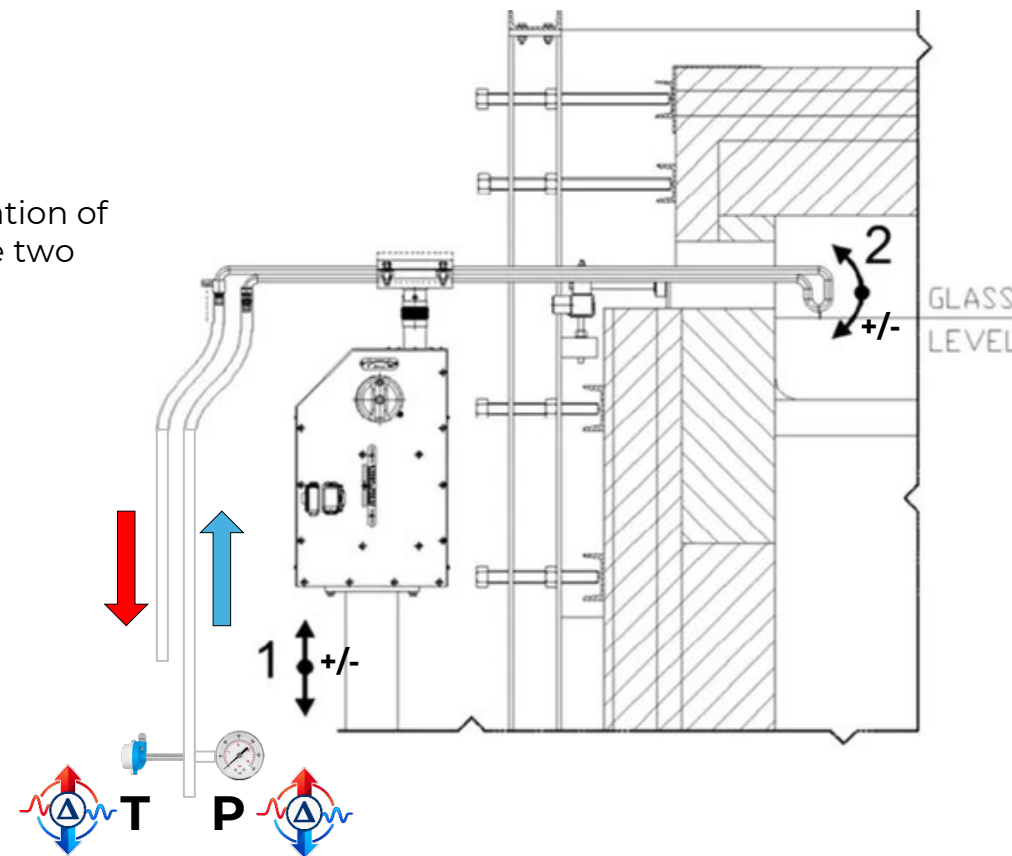
THERMAL DEFORMATION WITH PROBE



In both case the thermal deformation of the machine and its support have two main directions:

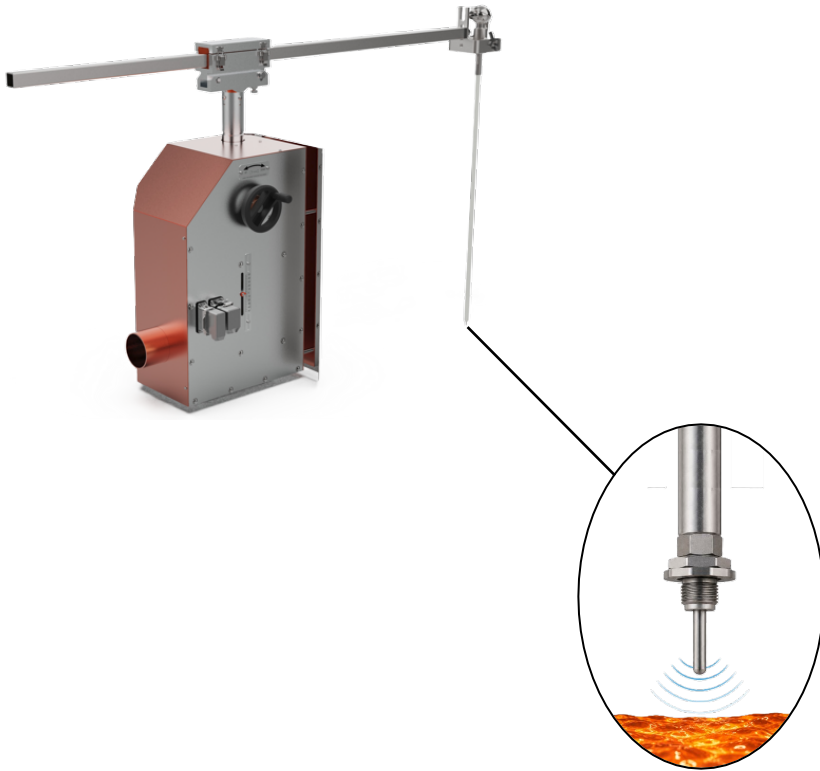
- Linear deformation "1"
 - Bending deformation "2"
- This values are not negligible.**

A carbon steel support column and the machine body, with a total length of 1500 mm, undergo a thermal expansion of approximately 0.18 mm for a temperature variation of 10°C, which is greater than the instrument measurement accuracy. Considering also the bending of the support probe (item 2 in the figure), the overall displacement becomes significantly larger than the required measurement accuracy



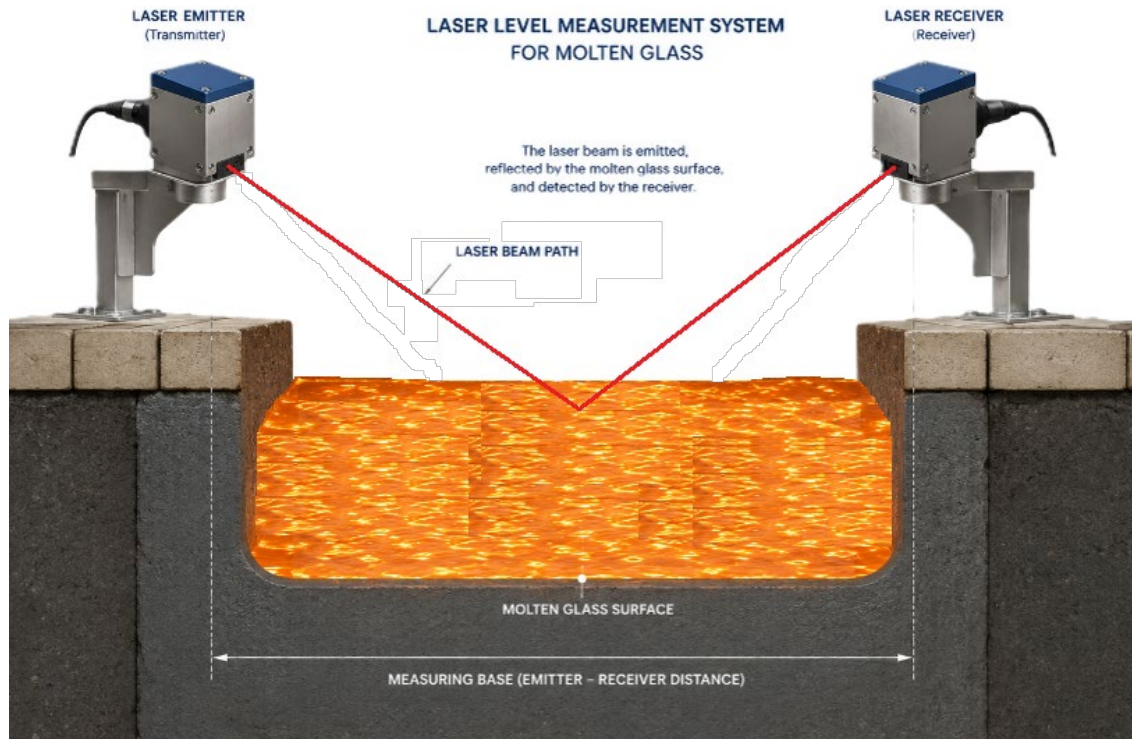
In the water-cooled machine, the thermal deformation of the probe (item 2 in the figure) is also affected by the water temperature and pressure

ELECTRICAL/CAPACITIVE PROXIMITY SENSING



- Sensitivity to chemical composition (change dielectric properties)
- Vapors disturb micro electrical field between probe and glass
- Low sampling frequency due to the mechanical cycle
- With water-cooled probe, issues with water temperature and pressure variations

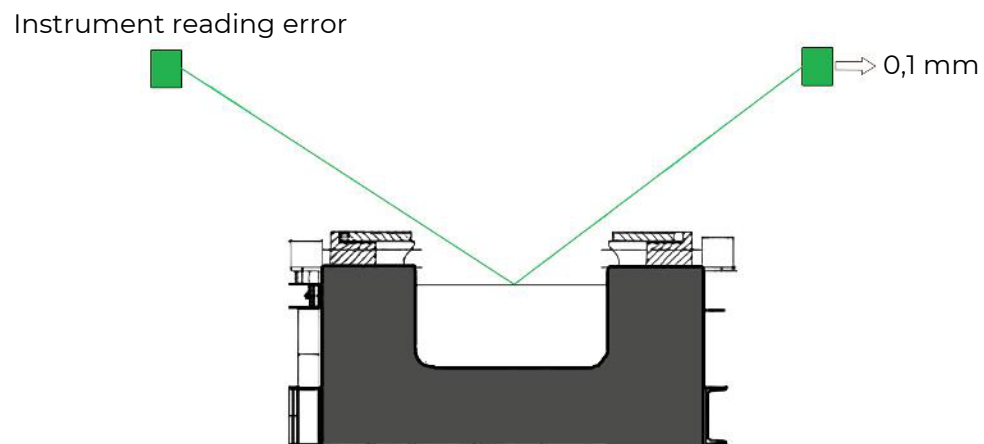
LASER SYSTEMS



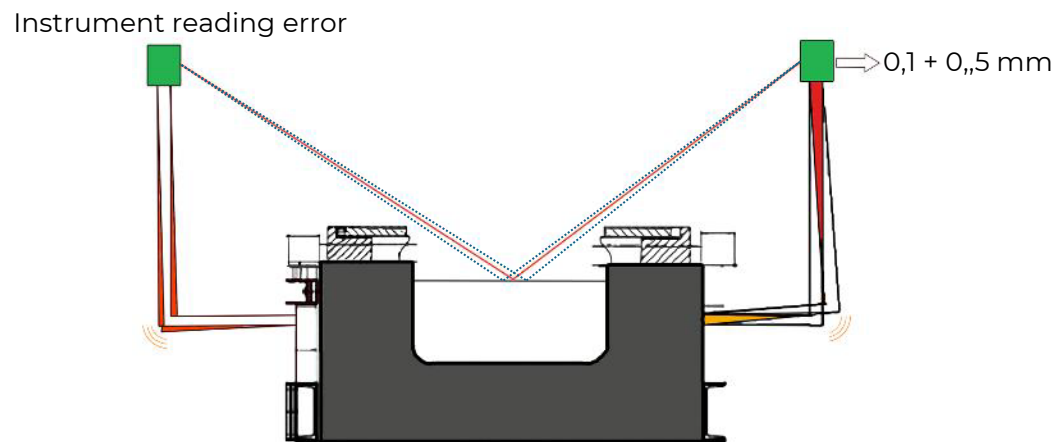
- Optical systems (light emitter/receiver):
the long distance between emitter and receiver amplifies measurement errors.
- At 3000 mm and 15° inclination, a support deformation of only **0.01° causes a 0.5 mm deviation**
- Temperature effect on accuracy

THERMAL DEFORMATION WITH LASER SYSTEMS

**THEORETICAL
ERROR**



**REAL
ERROR**
reading + support



SMALL DEFORMATION OF
THE SUPPORT ($\Delta 0,01^\circ$)



HIGH ERROR IN READING
(+0,5 mm)

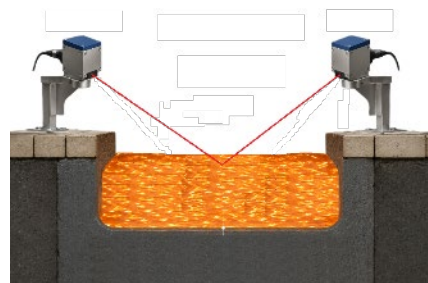
CONTACT SENSORS

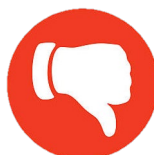


ELECTRICAL/CAPACITIVE PROXIMITY SENSING



LASER SYSTEMS



NO CONTACT	SENSITIVITY FUMES	MAINTENANCE
		
		
		

RADAR Technology:



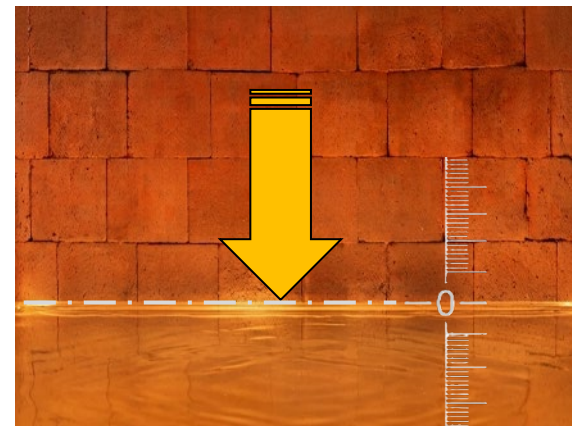
Electromagnetic
Waves



Echo
Generation



Distance
Computation



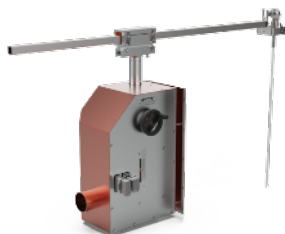
Glass Level
Calculation

Dust
Vapor
Fumes

do not affect the
measurement

NO CONTACT	SENSITIVITY FUMES	MAINTEN.
		

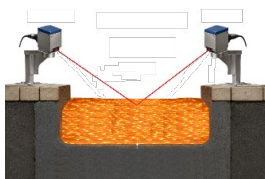
CONTACT SENSORS



ELECTRICAL/CAPACITIVE PROXIMITY SENSING



LASER SYSTEMS



RADAR



NO CONTACT	SENSITIVITY FUMES	MAINTENANCE
		
		
		
		

Why radar is particularly suitable for glass furnaces?

The radar is virtually insensitive to :

- vapors
- dust
- fumes
- Vibrations
- Temperature variations

Radar is not just a new sensor technology. It is a new source of reliable process information that supports smarter furnace operation, enabling a more stable, more efficient and more predictable production process.



- Process Stability → **Better level stability, better furnace stability**
- Maintenance
- Product Quality
- Digitalization
- Economic Benefits

Stable glass level means:

- constant hydrostatic pressure
- uniform glass flow
- reduced process oscillations
- improved feeder stability
- more repeatable production conditions

- Process Stability
- Maintenance → **Maintenance reduction**
Continuous operation → planned maintenance only
 - Elimination of mechanical wear
 - No components immersed in the glass
 - Fewer spare parts
 - Reduction of interventions
- Product Quality
- Digitalization
- Economic Benefits

- Process Stability
- Maintenance
- Product Quality
- Digitalization
- Economic Benefits

Stable level contributes to stable glass quality

A more reliable level measurement provides the control system with more consistent information, contributing to improved process stability.

Indirect effects:

- more stable gob weight
- improved feeder performance
- reduced process variability
- improved repeatability

- Process Stability
- Maintenance
- Product Quality
- Digitalization
- Economic Benefits

A sensor designed for industry 4.0

The radar does not only produce a level value. It produces a large amount of data.

Indirect effects:

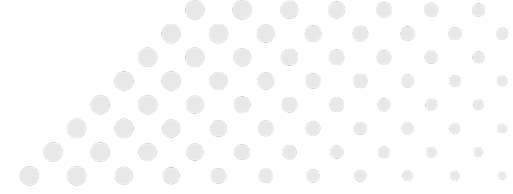
- more stable gob weight
- improved feeder performance
- reduced process variability
- improved repeatability

The data can be used for:

- trend analysis
- anomaly detection
- furnace diagnostics
- predictive maintenance



- Process Stability
- Maintenance
- Product Quality
- Digitalization
- Economic Benefits → **Operational Benefits**
 - Less maintenance
 - Higher measurement availability
 - Stable process
 - Continuous measurement
 - Reduced downtime
 - Improved process reliability



FMCW principle (*Frequency Modulated Continuous Wave*)



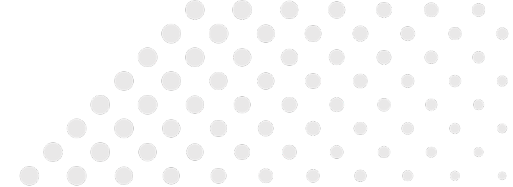
Continuously transmits a radio signal while constantly modulating its frequency (not pinging)

Simple continuous wave radar devices without frequency modulation have the disadvantage that it cannot determine target range because it lacks the timing mark necessary to allow the system to time accurately the transmit and receive cycle and to convert this into range

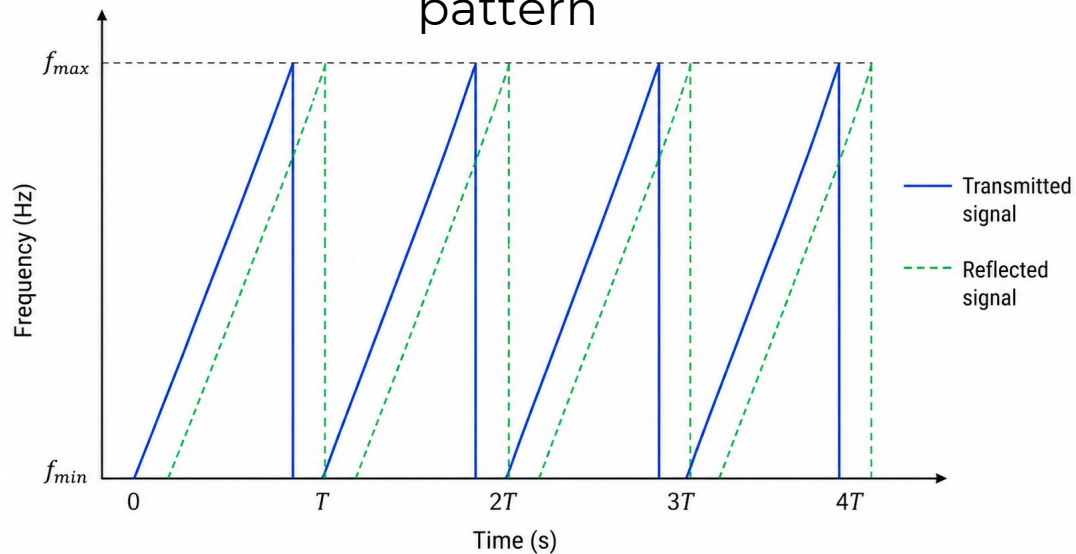
In FMCW radar a signal is transmitted, which increases or decreases in the frequency periodically and then they are measured the differences in phase or frequency between the actually transmitted and the received signal



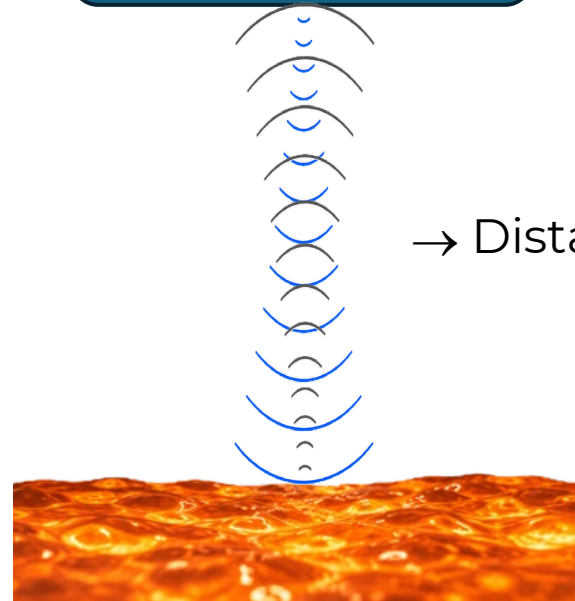
Distance calculation



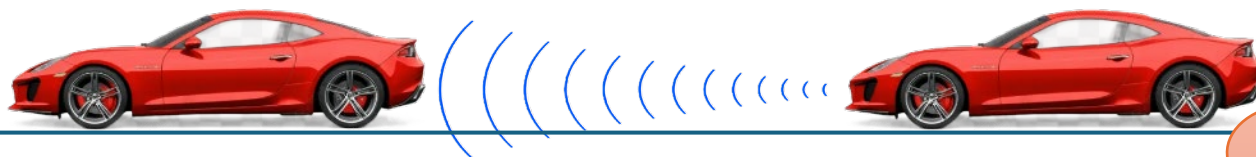
Typical modulation pattern



RADAR ANTENNA

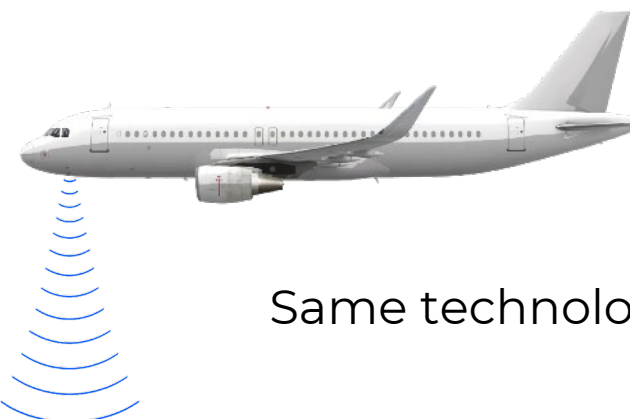


→ Distance calculation



Same technology

SAFE &
RELIABLE
TECHNOLGY

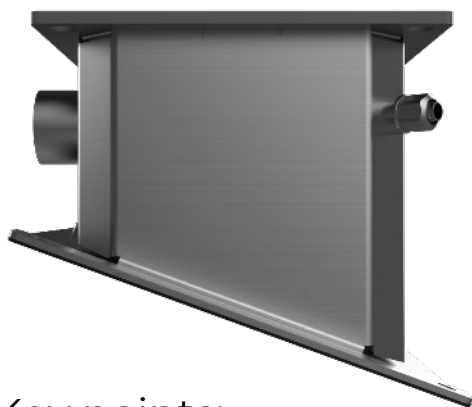


Same technology

Glass Service 2° Generation Radar

The current Radar Level Machine represents the evolution of the interferometric radar developed in 2012

Antenna box



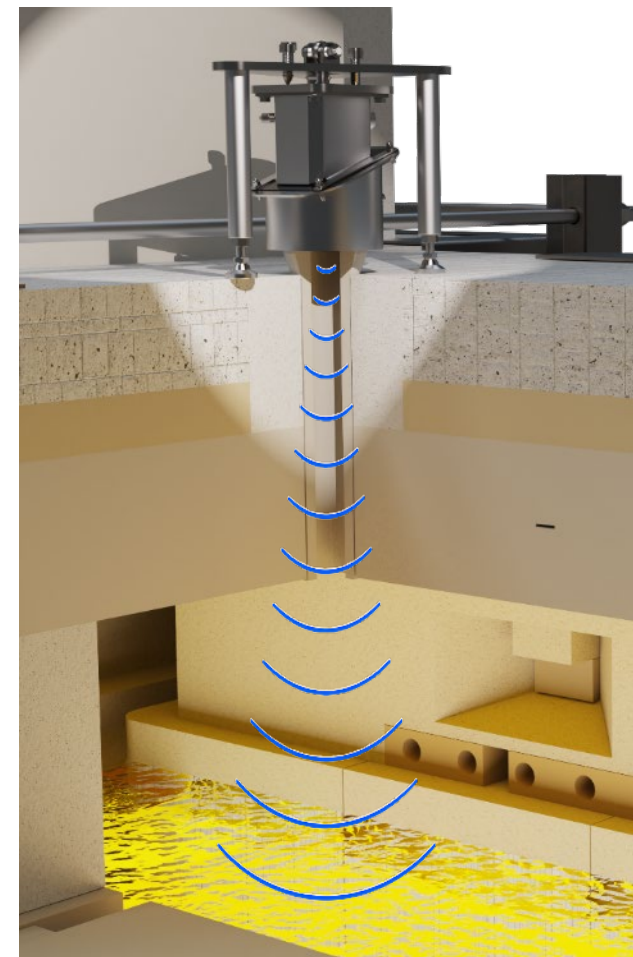
Radar machine



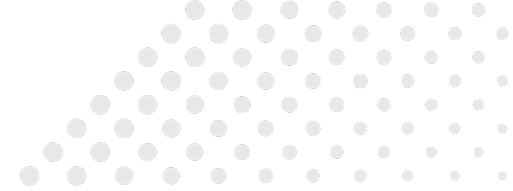
Key points:

- non-contact
- no moving parts
- continuous measurement
- reliable
- suitable for glass furnaces
- Compact → reduced thermal deformation

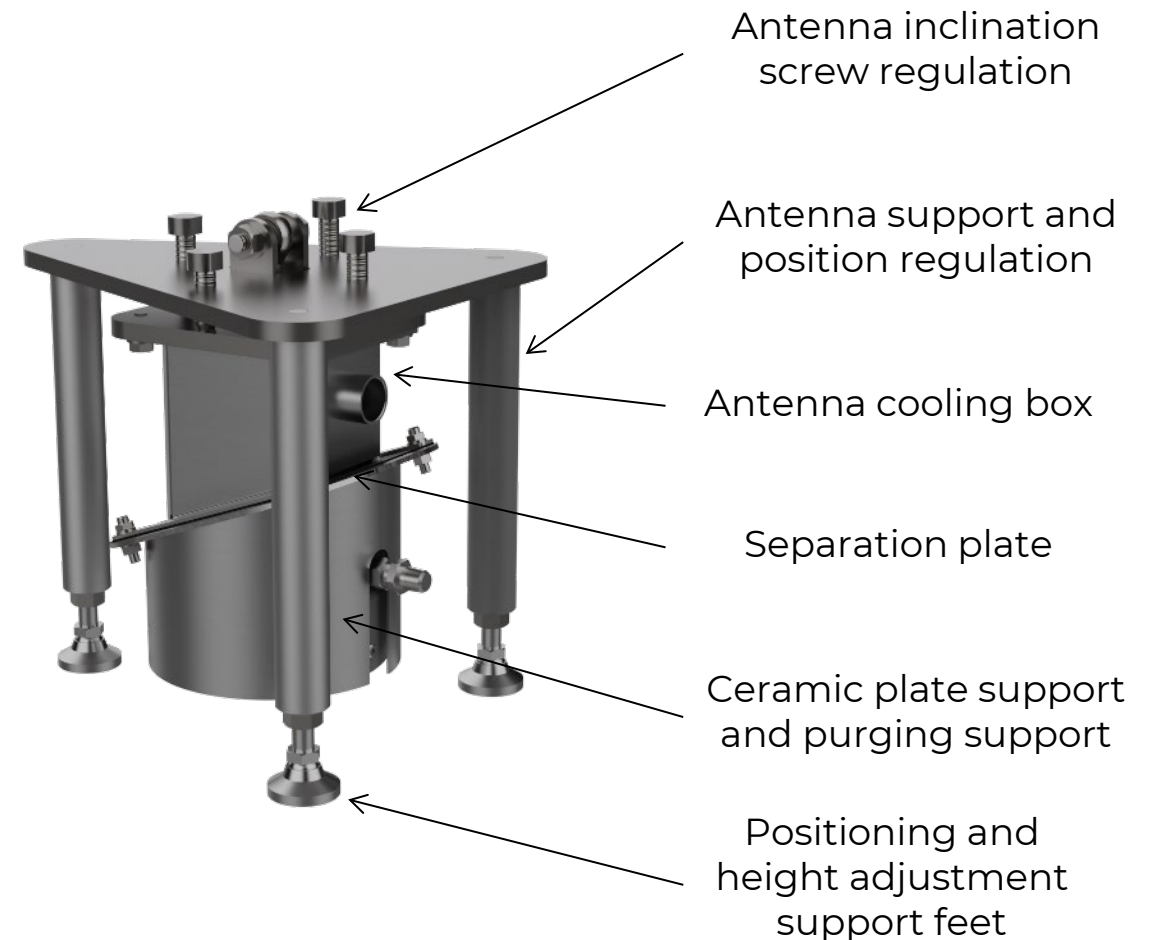
The challenge was not to build a more accurate sensor. The challenge was to build a more reliable measurement system.



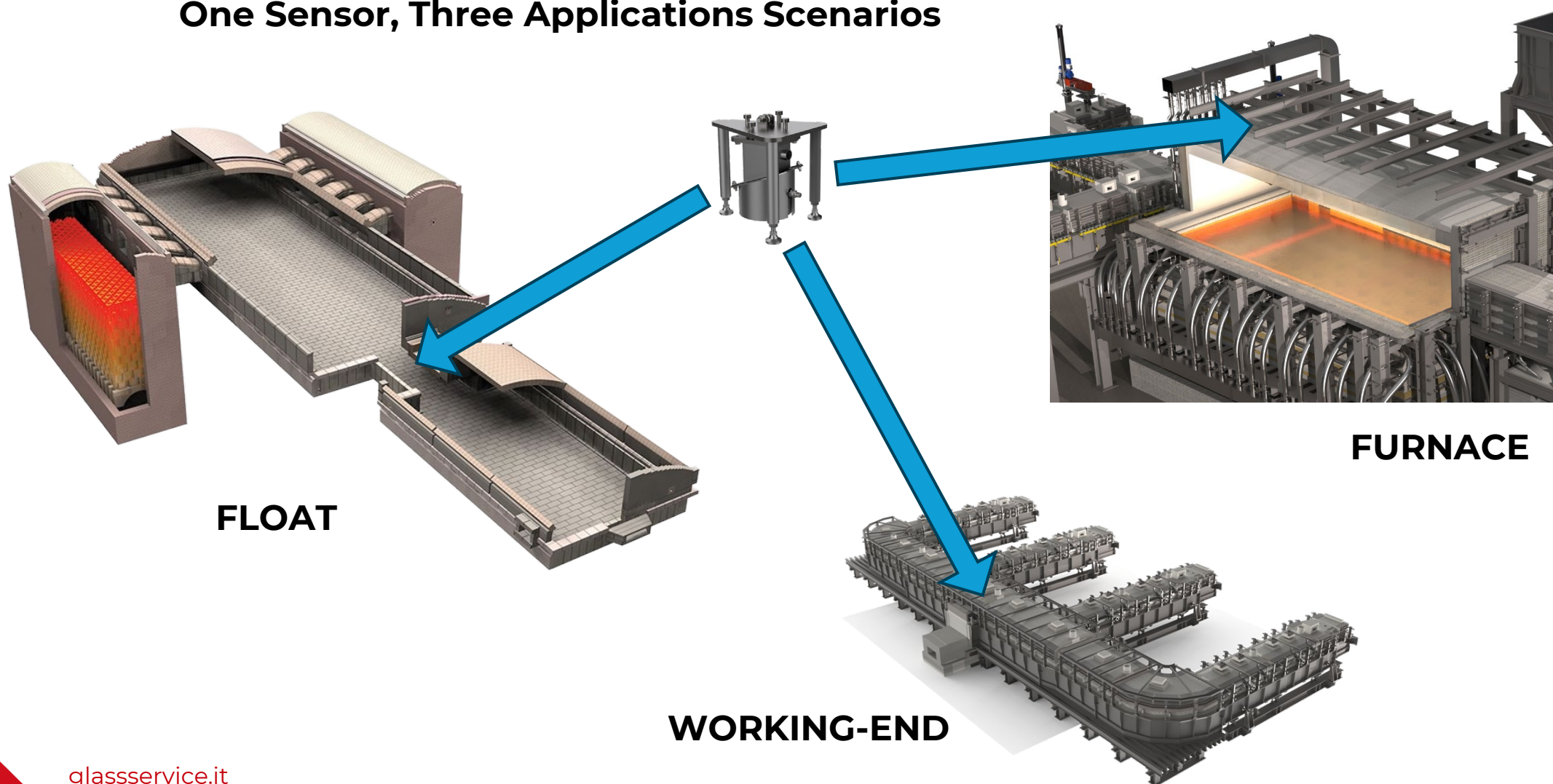
Typical installation on forehearth



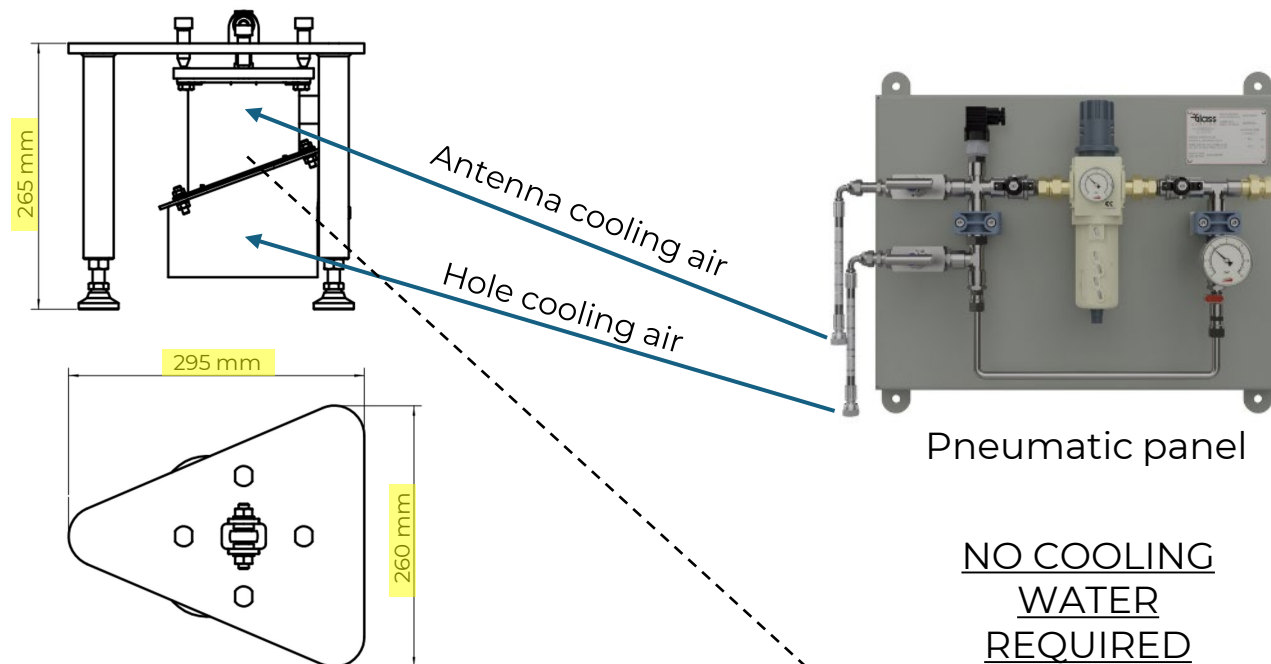
Specifications	
CONFIGURABLE 4-20 mA OUTPUTS FOR GLASS LEVEL READING	4
DIGITAL INPUT (COMPRESSED AIR PRESSURE SWITCH)	1
COMUNICATION LINKS	MODBUS RTU TCP/IP
OPTIONAL LINK COMUNICATION	PROFINET
HMI INTERFACE	15"
QUANTITIES CONTROLLED AND RECORDED ON LOG FILE	GLASS LEVEL, ANTENNA TEMPERATURE
EMITTED POWER	<100 mW
CABLE LENGHT BETWEEN ANTENNA AN PANEL MAX	35 mt
ANTENNA BEAM ANGLE	±2°
DISTANCE MEASUREMENT RANGE	0,3-5 mt
MEASUREMENT SAMPLING	100 Hz
READING ACCURACY	0,05 mm



One Sensor, Three Applications Scenarios



GLASS SERVICE 2nd Generation Radar



COMPACT SIZE



REDUCED
THERMAL
DEFORMATION



Compact control cabinet with HMI Touchscreen da 15"

- Visualization
- Configuration
- Diagnostics



Installation on field

We've introduced a new approach to monitoring the furnace

Radar is not just a new sensor technology.
It is a new source of reliable process
information that supports smarter furnace
operation.

Reliable Measurement
↓
Stable Process
↓
Better Production Control
↓
Higher Operational
Efficiency

The future of furnace control will not depend on a
single instrument, but on the integration of
multiple high-quality measurements.

**Radar technology represents one of the key
building blocks of this evolution.**

PAST

Sensor
↓
Level value

TODAY

Radar
↓
Continuous level
profile

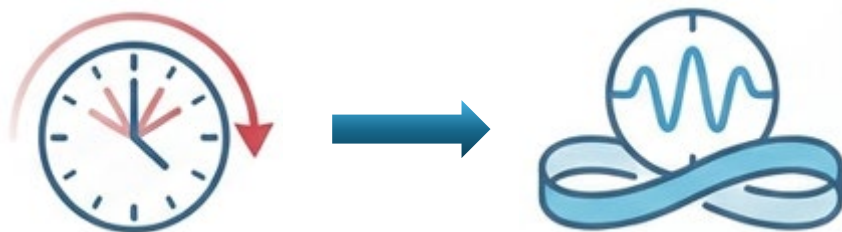
TOMORROW

Radar
↓
Continuous process
information
↓
Smart Furnace



Continuous Data Opens New Opportunities

Continuous measurement turns a snapshot of the level into a view of its evolution.



We are no longer measuring only the level.
We are observing the dynamics of the molten glass.

A continuous and reliable measurement allows instead to:

- Reduce signal noise
- Increase control system reliability
- Make process regulation more effective

Radar as an Enabling Technology

Radar Technology



Reliable Continuous
Measurements



Advanced Process Control



Predictive Analytics



Optimization

Glass level is one of the critical process variables



Traditional technologies have intrinsic limitations



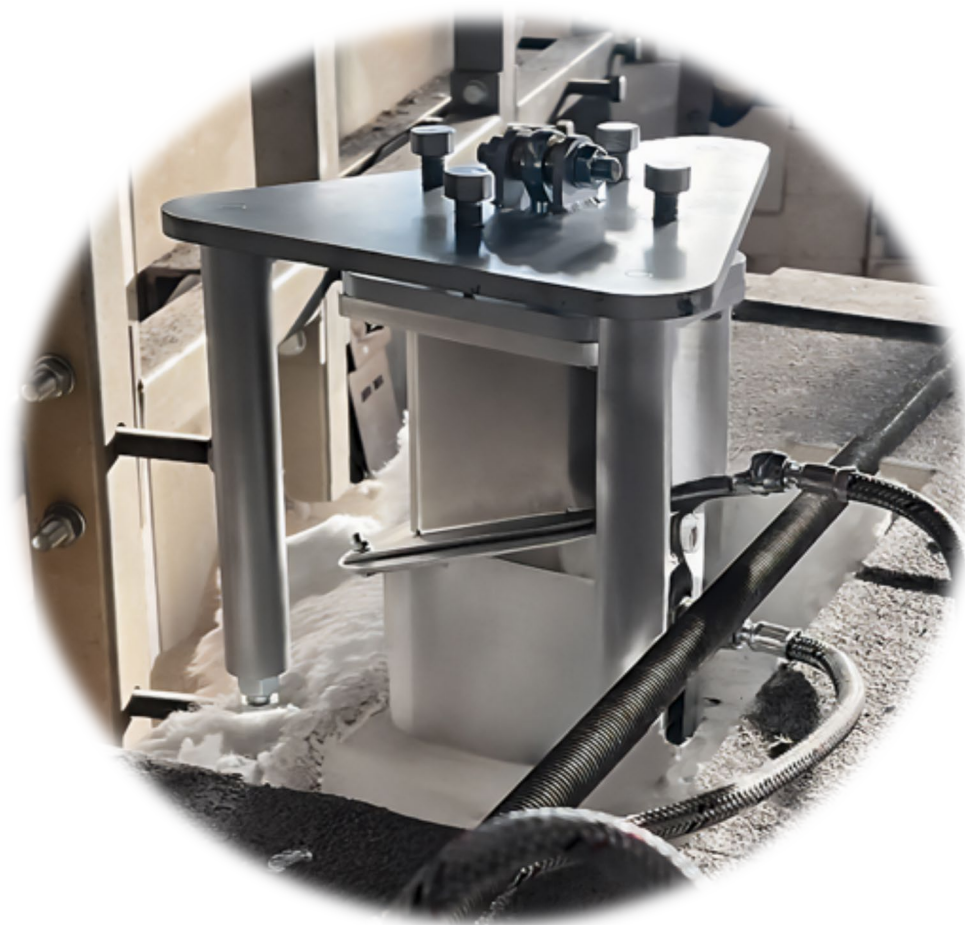
Powered by proven FMCW radar technology, Glass Service's new glass level gauge delivers reliability, precision, and safety



Continuous measurement creates new opportunities for process optimization and digital integration



This is not only a new sensor. It is a new generation of process information for the glass industry



Installed radar glass level
10 months of trouble-free operation



Thank you for your attention!

For more information, contact us at: info@glassservice.it

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ENGINEERED AND MADE IN ITALY