

A brief presentation of

## ASELT In Process Control

The HBU induction heating for hardening needs to be monitored very strictly in order to reach a product in conformance.

The ASELT IPC is a new generation system for monitoring based on the classical ideas for this kind of systems, but strongly renewed in:

- number and nature of tests
- program visual layout
- recipe tuning procedure
- help to operator during resetting
- production data management

The key-words which have driven to this new IPC are the following:

- ✓ **Visual** all possible data are immediately translated to graphics in real time
- ✓ **Autolearning** the system can calculate by itself the target for all of its parameters
- ✓ **Autotuning** the system can calculate by itself target and tolerance for all of its parameters
- ✓ **Usability** no need at all for the operator to type in numbers
- ✓ **Safety** it's never possible to forget the alarms disabled
- ✓ **Integrity** new test for checking inductor and probes integrity
- ✓ **Positioning** new tests for a better evaluation of inductor positioning
- ✓ **Resetting** new management for helping in repositioning the

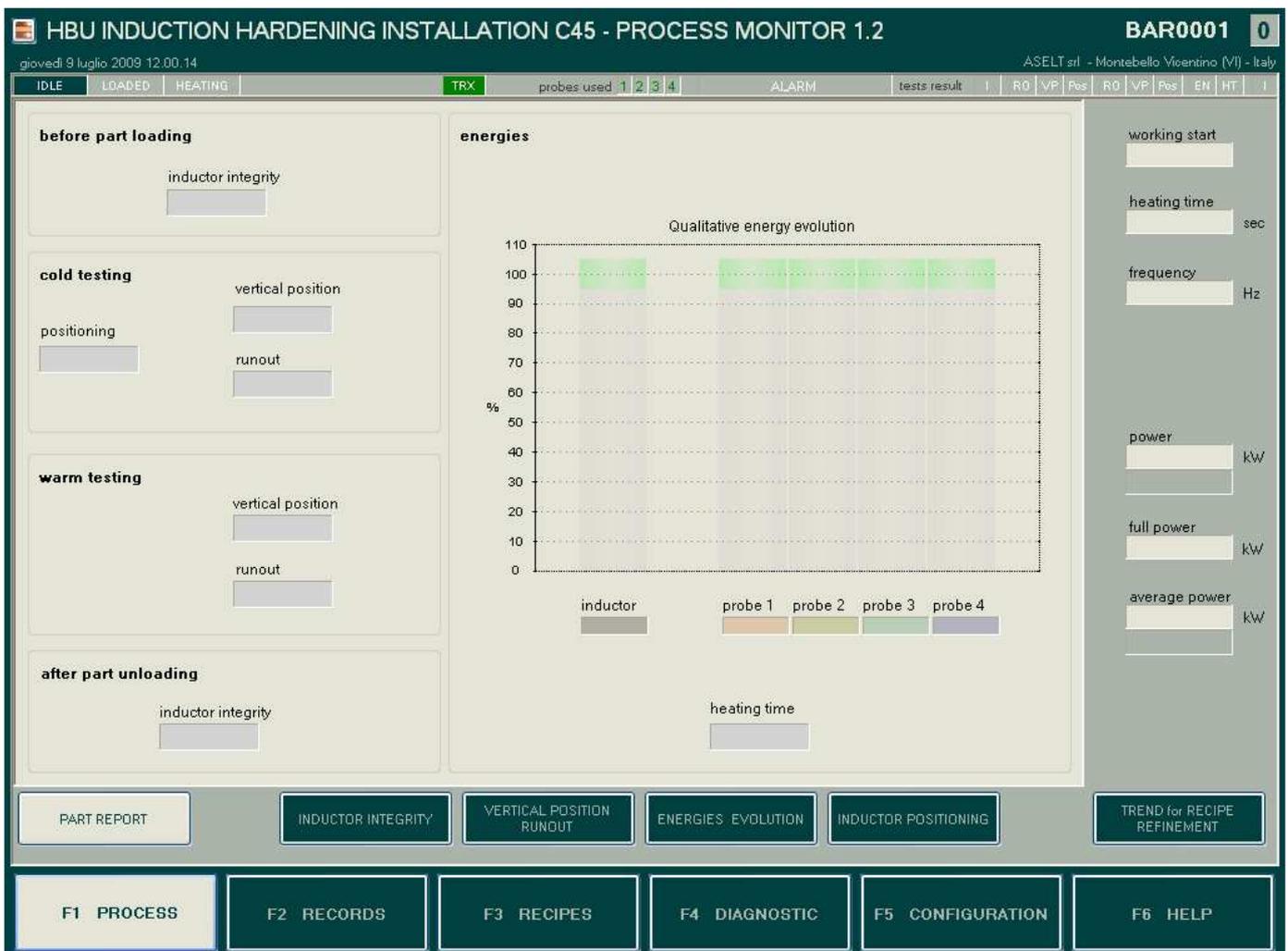
ASELT IPC system is made by

1. one industrial computer running the IPC supervisor program
2. one mainboard with Texas last generation DSP for industrial control (plus some secondary boards all in the IPC board rack) running the IPC firmware
3. proper connectors on inductor and one Rogowski coil (for current picking up) with cables

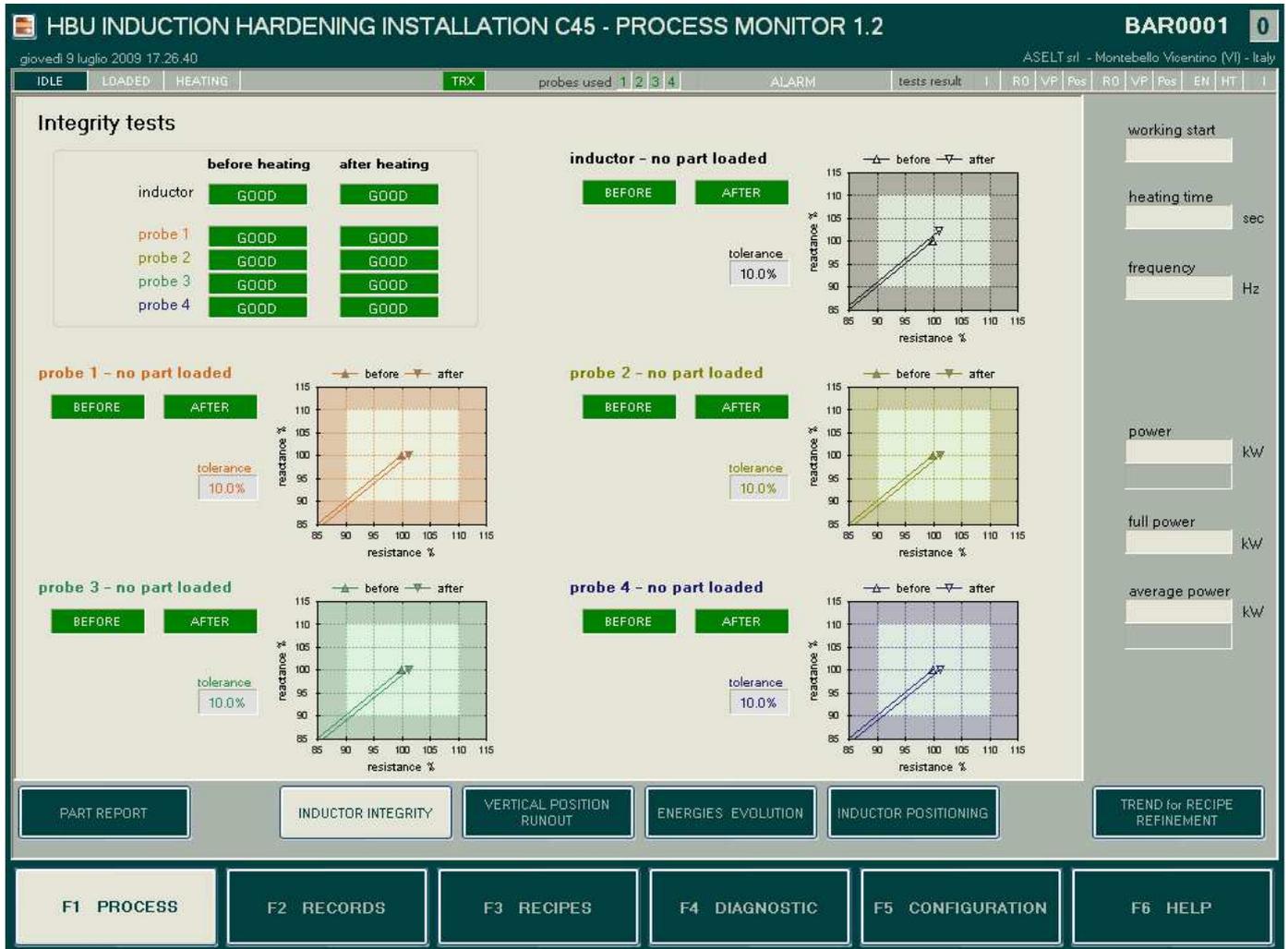
The system can be easily linked to the PLC of the machine.

## MAIN PAGE OF THE PROGRAM

The program layout consists in five main pages, divides in many subpages for convenience. The following is the main page appearing on the computer monitor, representing the real time report of the piece now on working:



# NEW TEST: INDUCTOR and PROBES INTEGRITY



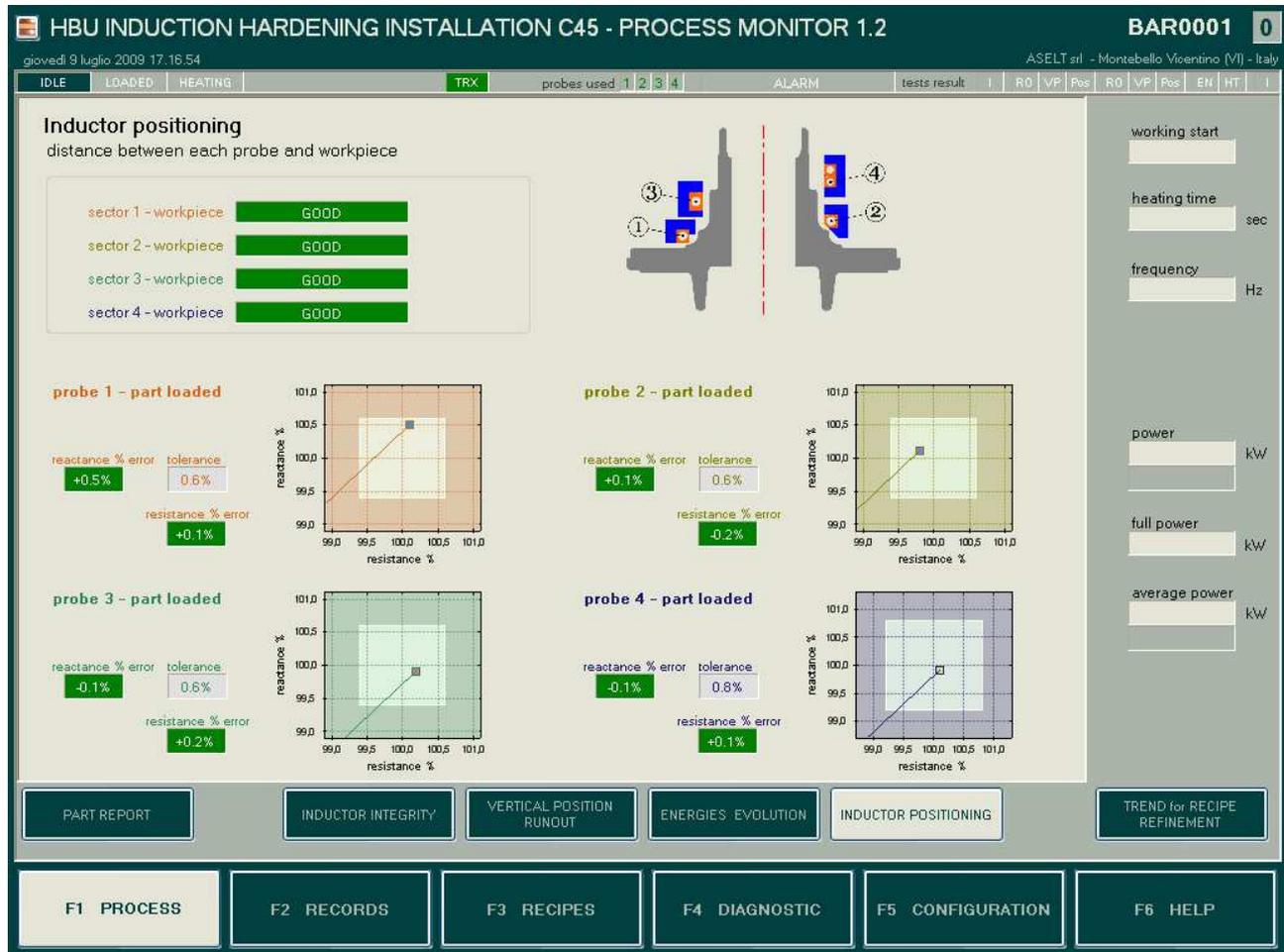
This test can be done twice: before and/or after heating.

### The “integrity check” idea



The integrity of global inductor and of each one part of inductor is checked: loss of efficiency in magnetic concentrators or other damages can be easily detected.

# NEW TEST: INDUCTOR POSITIONING



This test has been developed mainly for supporting in case of inductor resetting.



### The “inductor positioning” idea

ASELT IPC system can easily check the relative distance between piece and each one inductor sector and can so provide a real time diagnostic on the inductor positioning.

Through impedances and energy metering, the ASELT IPC system gives a full control on:

- |   |                  |                                |  |
|---|------------------|--------------------------------|--|
| ✓ | “ <b>WHAT</b> ”: | TOTAL AMOUNT OF ENERGIES       | to each one nominal location               |
| ✓ | “ <b>WHERE</b> ” | ACTUAL DESTINATION OF ENERGIES | each single part is in the proper position |
| ✓ | “ <b>HOW</b> ”   | SYSTEM INTEGRITY               | of each one magnetic concentrator          |

## ASELT IPC – CONCEPTUAL INNOVATIONS

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1. the operation is full based on IPC **autolearning** and **autotuning** of all recipe parameters
2. introduction new impedance parameters: Reactance, Module and Q factor
3. inductor can be identified for future use using recipe settings
4. operator has **no need to type in numerical values** for recipe targets and tolerances (only to click buttons)
5. it is actually impossible to work with PC recipe **misaligned** with board recipe
6. many **new tests** are implemented (integrity, all cold tests, positioning, heating duration)
7. total power information is added
8. probes are built more **robust** (ASELT IPC can work with old probes too)
9. classical tests (VP and RO) are fully **customizable** for quantity type and gain
10. system measures the **actual impedances** and the **actual energies** (not proportional values)
11. all meaningful operations are **traced** for one year with date, time and the name of operator
12. a two-level password protection is implemented for all important change requests
13. data of each produced piece are stored **one by one**, with all recipe and ipc settings too
14. real time graphs for all collected data (not only for historic data)
15. alarm can never remain disabled (alarm capability is automatically restored)

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## ASELT IPC – MAIN USABILITY IMPROVEMENTS

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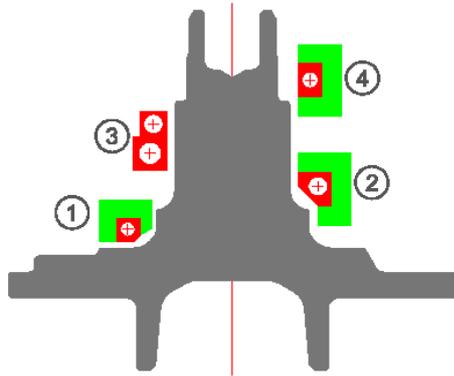
1. entire program layout has been redesigned in order to be easy to use and to understand
2. no need for adjusting the signs of the probes
3. automatic setup of inductor parameters with “*Trend for recipe refinement procedure*”
4. mechanical re-positioning of already used inductor is aided in case of resetting (with need for cutting only one piece)
5. one or more probes can be disabled to go on with production (only in case of serious need)
6. the production navigation is on time basis (and not on piece number basis)
7. more than one year of production can be stored in pc hard disk
8. production graphical records can automatically follow production trend
9. the system automatically deletes the oldest data when the disk is full
10. visual feedback on the mechanical state of the machine
11. each single test may easily be enabled or disabled
12. production data are easy to export and to understand (text files)
13. waveforms for diagnostic are easy to save, export and analyze (excel worksheets)
14. log files for diagnostic and documentation are easy to export and understand (text files)
15. visual navigation in historical data is easy and rich in graphical options
16. probes numbering is reminded to operator for convenience
17. operator must only think on percentage basis for each analyzed quantity
18. many statistic information is added
19. Option “mark piece as Met Lab” for documentation
20. Function “deactivate the alarms for one piece only”
21. Strongly modified background color in case of alarm disabling

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## IPC WORKING PRINCIPLE – brief explanation

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The inductor is made by **several sectors** behaving as independent inductors: each **one sector** of the inductor is arranged with **one probe**:



**Sector 1** → **Probe 1**  
is for heating seal location.

**Sector 2** → **Probe 2**  
is for heating groove.

**Sectors 3** → **Probe 3**  
are for heating the cylindrical body.

**Sectors 4** → **Probe 4**  
is for heating spindle.

Only **destructive tests** in the met-lab are reliable.

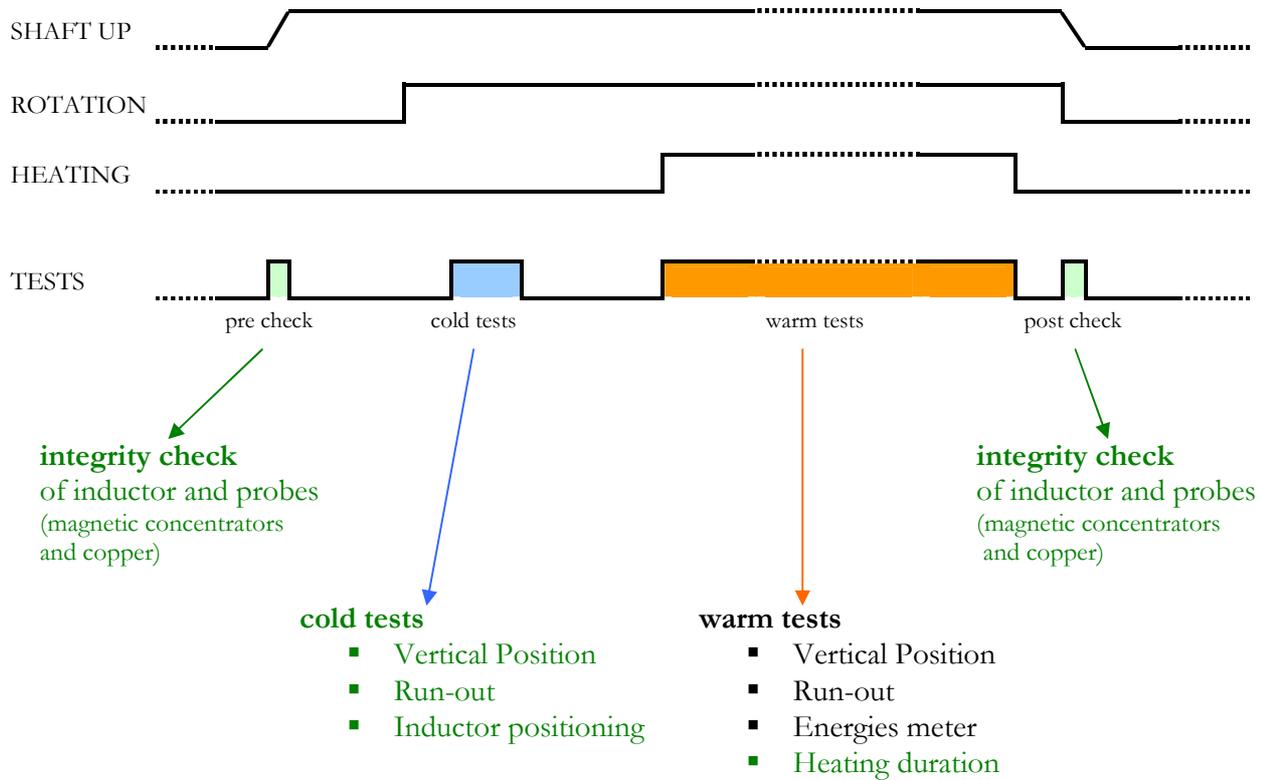
The basic idea is to **check the process** instead of checking the product, so the behaviour of each one sector of the inductor has to be checked in real time for evaluation of:

- ✓ Impedances
- ✓ Energies

The purpose of the digital calculations based on impedances is to check whether the measured energies are actually heating the “**proper locations in the ring**”.

## OVERVIEW OF ASELT IPC's TESTS

Up to 24 different tests are executed in different moments during each one piece treatment:



Tests in green color are **ASELT innovations** with respect to old IPC

	TEST NAME	PERFORMED THROUGH	ASELT INNOVATION
PRE TEST	Inductor and probes integrity	IMPEDANCES METER	✓ yes
COLD TESTS	Vertical Position	IMPEDANCES METER	✓ yes
	Run-Out	IMPEDANCES METER	✓ yes
	Inductor positioning	IMPEDANCES METER	✓ yes
WARM TESTS	Vertical Position	IMPEDANCES METER	-
	Run-Out	IMPEDANCES METER	-
	Inductor Positioning	IMPEDANCES METER	✓ yes (possible by request)
	Energies	ENERGY METER	-
	Heating duration	TIME METER	✓ yes
POST TEST	Inductor and probes integrity	IMPEDANCES METER	✓ yes

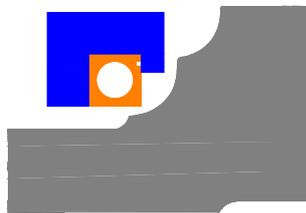
## INFORMATION GAINED THROUGH THE IMPEDANCE CALCULATION

The impedance is an elettrotechnical quantity that is associated to each pair of realted voltage and current periodic signals.

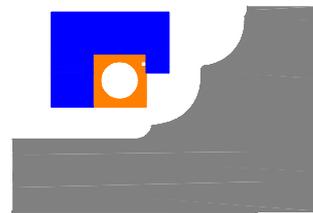
The impedances of the probes are evaluated **many times** during each piece working.

The **impedance** value shows remarkable variations

- with the **distance** variation between the piece and the inductor
- in case of **damaged** magnetic concentrator



Nominal situation (detail)



Inductor shifted a little up and left

Through the impedances analysis, the system is able:

- to notice a **distance** modification of about **100 μm** (**vertical and lateral position**)
- to notice a bad piece **rotation** (**run-out**)
- to detect **in advance** a reduced efficiency in a damaged **magnetic concentrator**

Tests possible only through IMPEDANCES analysis are:

- ✓ INDUCTOR AND PROBES INTEGRITY (new test)
- ✓ Vertical Position (vertical position) (new cold test)
- ✓ RUN-OUT mechanical rotation (new cold test)
- ✓ INDUCTOR POSITIONING (new test)