DF 2010 MEM'T

Complete system for brake discs and drums to guarantee the traceability of the parts:

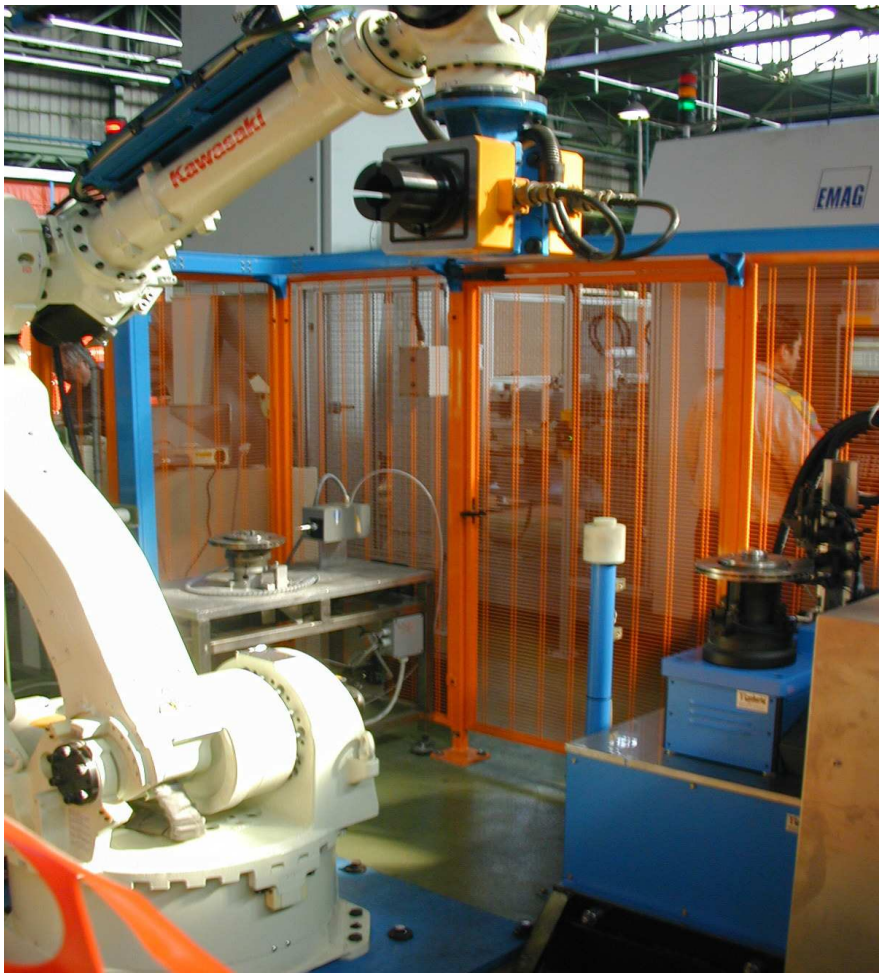
Measurement - dimensional and geometrical

Eigen Frequencies control

Cracks detection control – Eddy Current

Marking

Traceability



TQM ITACA TECHNOLOGY srl has for many years been producing sophisticated brake discs control systems, integrated with the mechanical production line and constantly updated to meet market requirements.

TQM ITACA TECHNOLOGY srl proposes the integrated system DF 2010 MEM'T for the dimensional and geometrical control, the Eigen frequencies test, the Cracks control with E.C. technology, the marking of brake discs. We guarantee the complete traceability of the products during their entire production cycle.

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Registro Imprese di Brescia/Codice Fiscale/Partita IVA: 03138930981 - Capitale sociale: € 10 000 i.v. - REA: BS-508432

Dimensional and Geometrical Measuring

The Principles

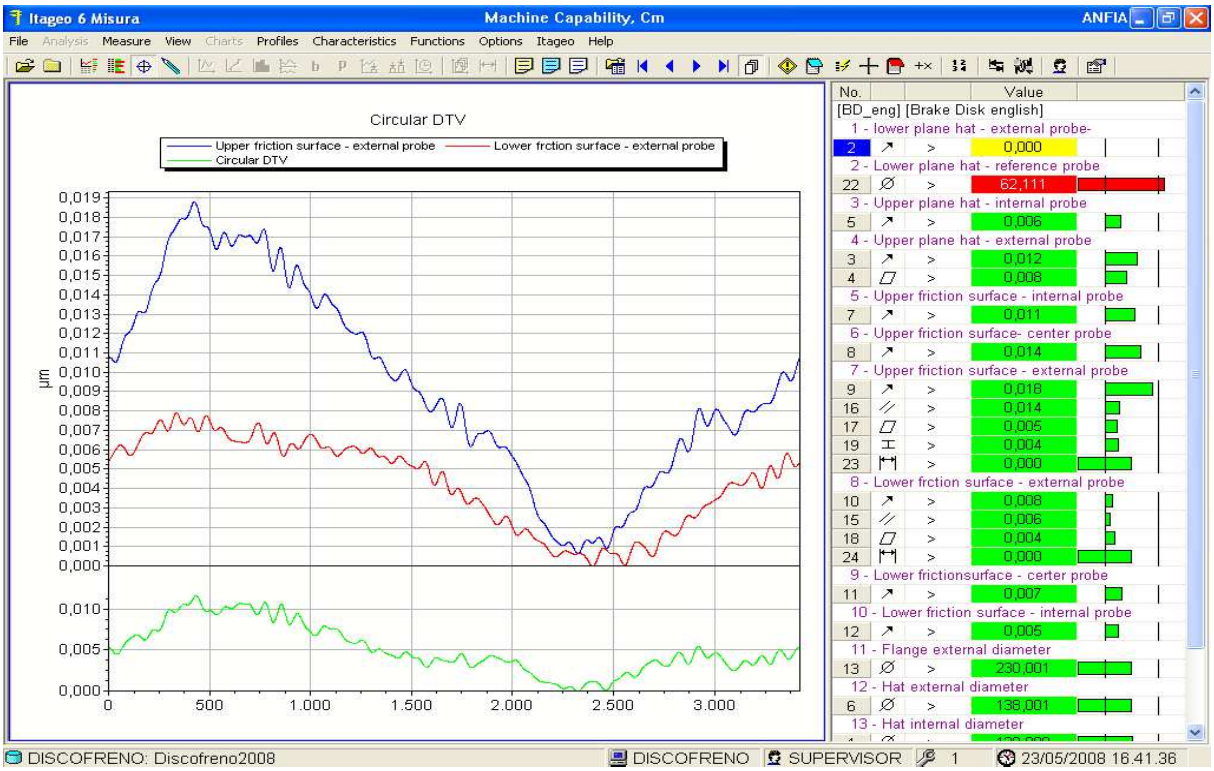
The new measuring software, dedicated to the control of brake discs, Itageo 6©, is optimized for the dynamical control, and allows controlling section with a single probe. The result is the simplicity of mechanical configuration and type change.

To guarantee the highest precision and reliability of the measurement, the DF 2010 MEM'T works on the same measurement principle as laboratory roundness measuring instruments: a part turning on a precision mandrel, angular control via encoder, contact probe on the section to be measured, acquisition of at least 3.600 points/turn, reconstruction and analysis of the obtained profile.

Moreover, Itageo 6© allows the real time display of the profiles, very helpful to find out the possible causes of manufacturing problems.

Some of the main features of our new generation of brake disk and brake drums measuring machines:

- DTV measurement with 5 Microns tolerance.



- Gauge retooling is simple and fast.
- Handling of several probes at the same time: a complex control plan has no influence on the cycle time.
- The cycle time for medium dimension discs, load/unload included, is approximately 15/20 seconds.
- The measuring cycle is completely automatic; also in the version with manual load/unload.
- Automatic calibration and gauge stability control.
- Different fixture configurations, to install the machine in any type of production line.

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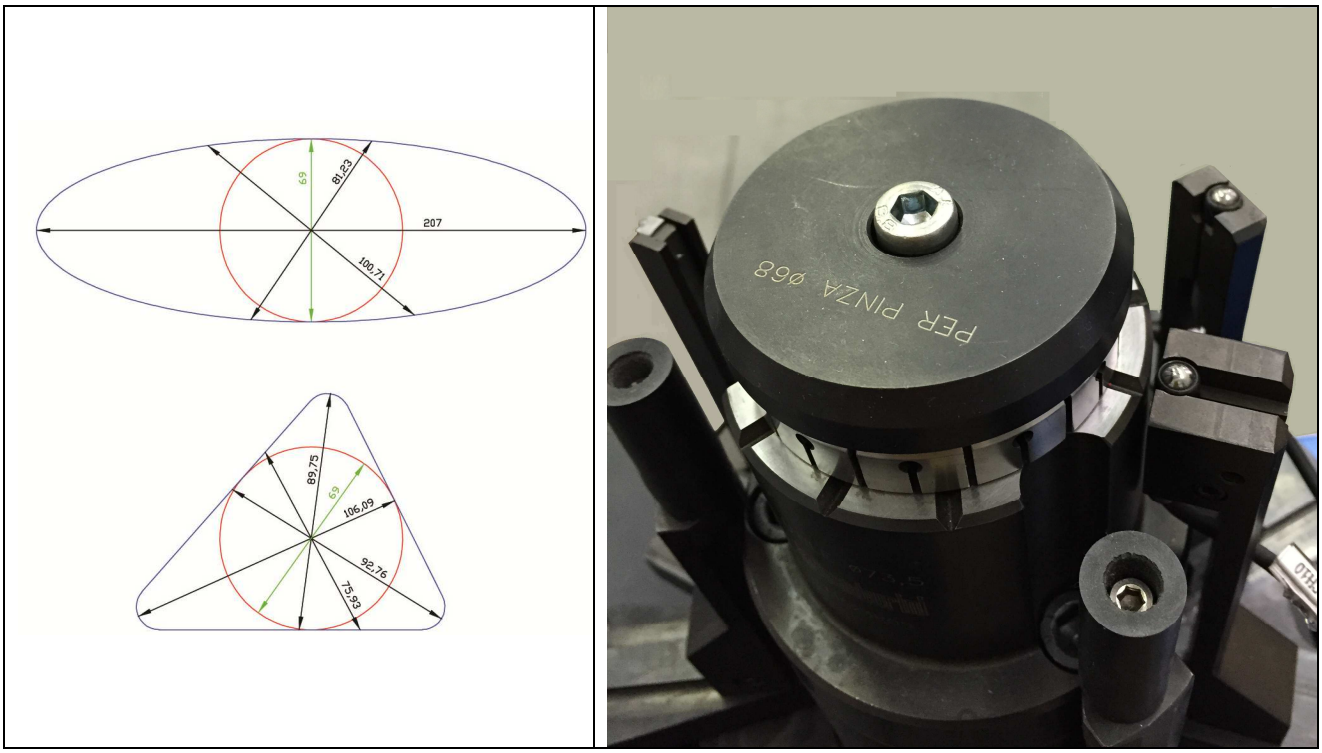
The Mechanics for brake discs measuring station

During measurement, the disc is positioned on a **precision mandrel**.

The disc is locked to the mandrel by a **patented expansion clamp**, which also performs the centring, the locking of the brake disc and the measurement of the minimum diameter of the bore – i.e. **the effective mounting diameter (Patent N° PCT/IT2004/000361)).**

It is known that the measure of a diameter with two opposite probes (differential measurement) is highly influenced by form errors. In case of oval form, or with even number of lobes, the measure is correct. In case of triangular form, or with odd number of lobes, the measure is wrong.
Here below an example explaining the situation.

It is evident that with triangular form error, the diameter measured with two opposite probes is greater than the minimum effective diameter, with the risk of mounting problems.



The solution patented by TQM ITACA TECHNOLOGY srl simulates the mounting condition; so the measurement made is correct and independent from the bore form.

An electronic probe on the inner surface of the hub-side is used for the **compensation of errors in perpendicularity** of the mandrel, so they do not change the result of the **measurements of the run-out** of the friction surfaces. The other probe on the inner surface is used for the construction of the inner surface and for the flatness → concavity / convexity of the support plane.

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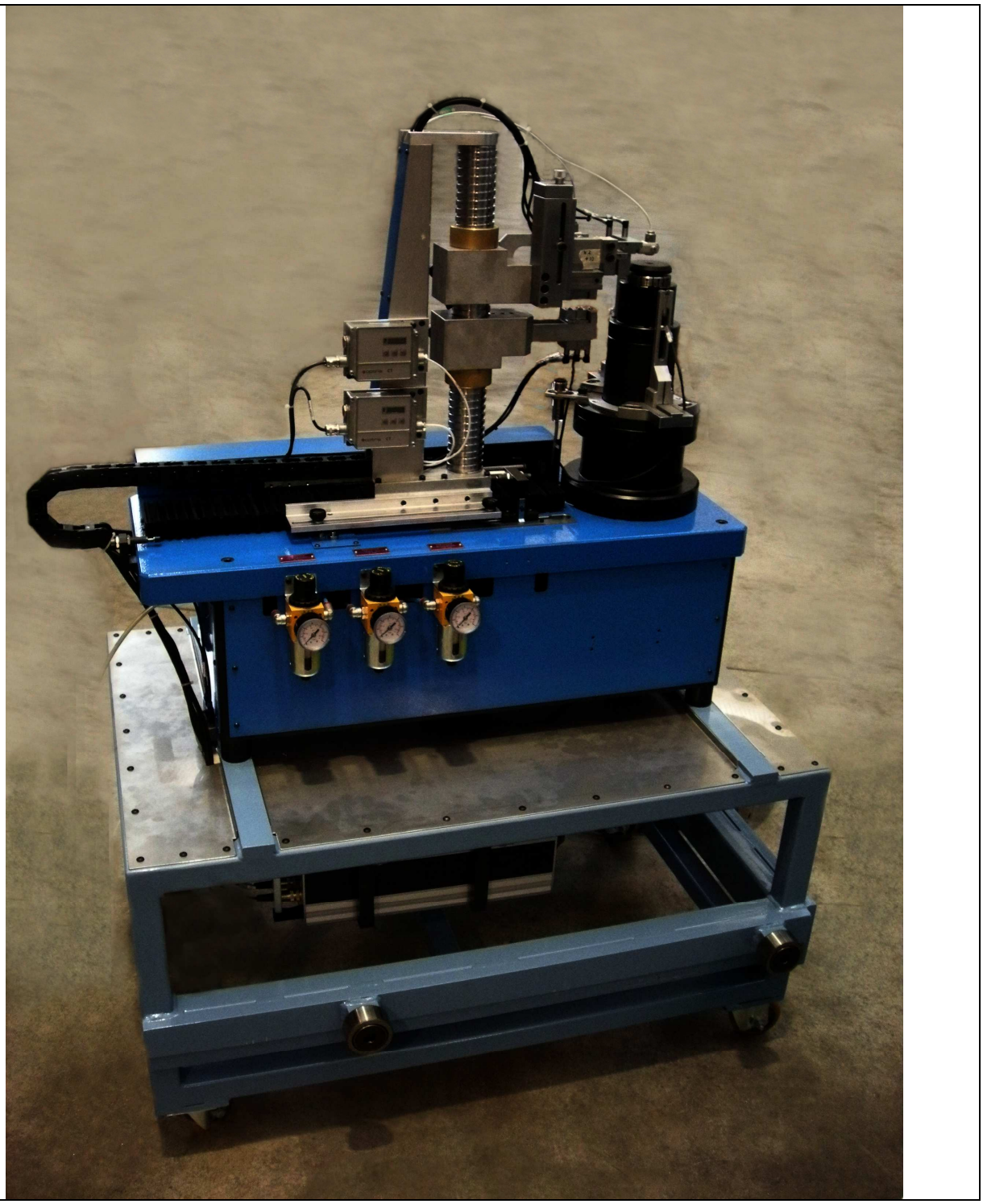
The probes for the measurement of the friction surfaces and of the opposite surface are mounted on an automatic feed carriage managed by the PLC of the bench. The carriage is equipped with an anti-collision safety system.

All the mounted probes are fully adjustable, so fast and easy retooling of the measuring station is guaranteed.



It is possible to manage the temperature variations of the pieces and of the measuring system.

The software – ITAGEO 6©

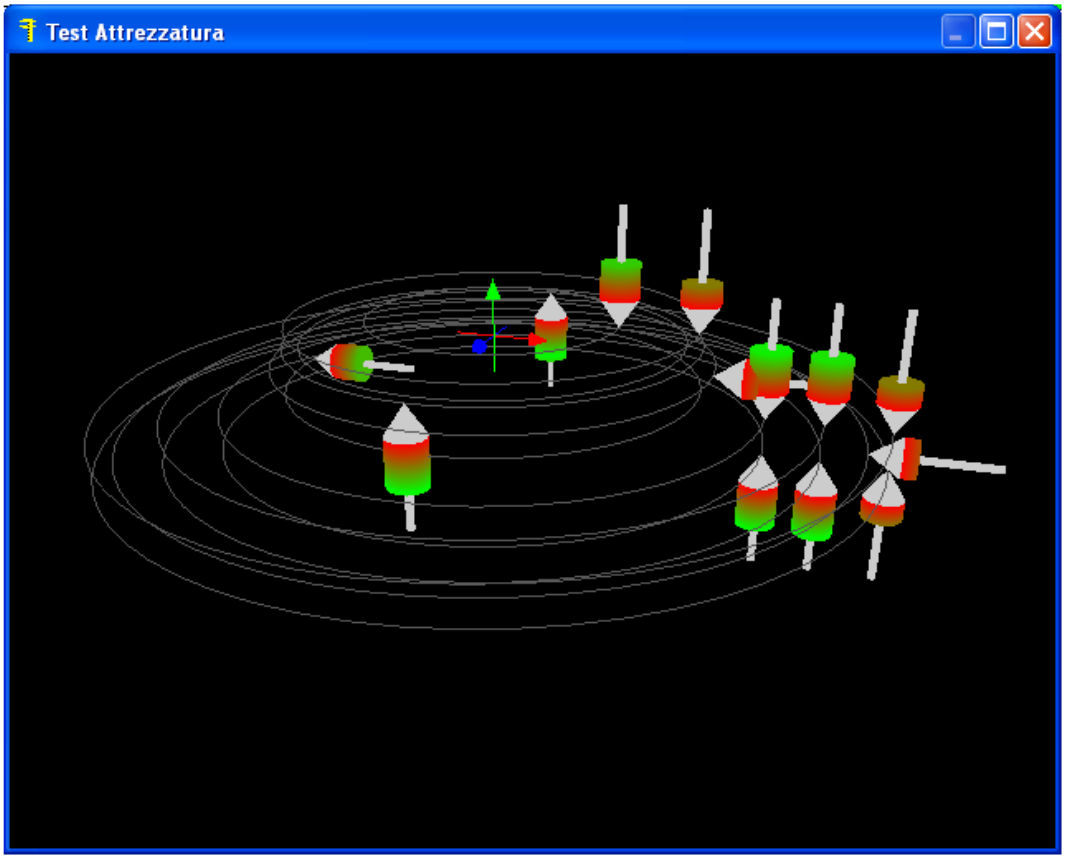
Itageo 6© is the most advanced software for the management of automatic workstation for brake discs control. It allows the management of the following functions:

1. Dynamical, geometrical and dimensional measurements of brake discs and drums.
2. Control of the production process.
3. Data saving in SQL database, with full network capability.
4. Possibility of remote real time monitoring.
5. Remote assistance.
6. Dialogue with external devices (Loading robots, marking machines, processing machines, etc.).
7. Marking and traceability of the parts.

1. Brake disc dynamical measurement

Itageo 6©, Native Windows Application, includes the following special functions:

- Immediate and visual configuration of the workstation.



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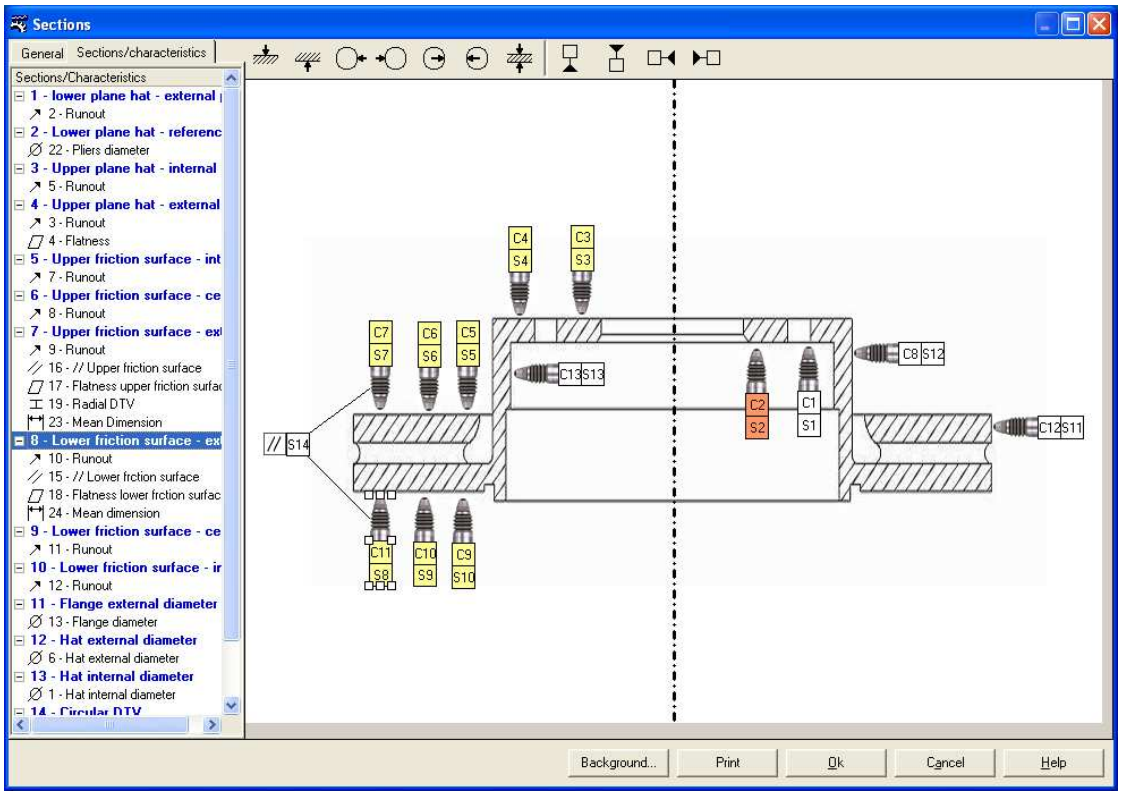
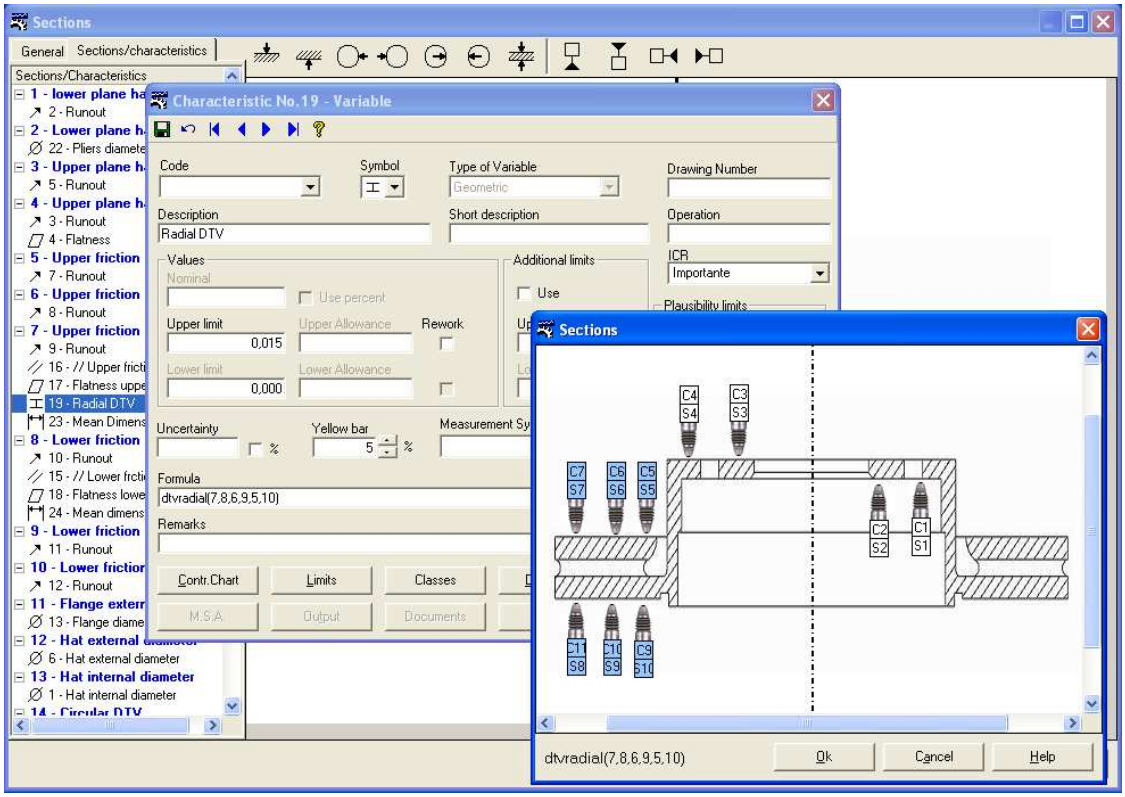
- Creation of the control plans with fast and intuitive graphic support.



- Definition of complex characteristics through probe selection on pictures.



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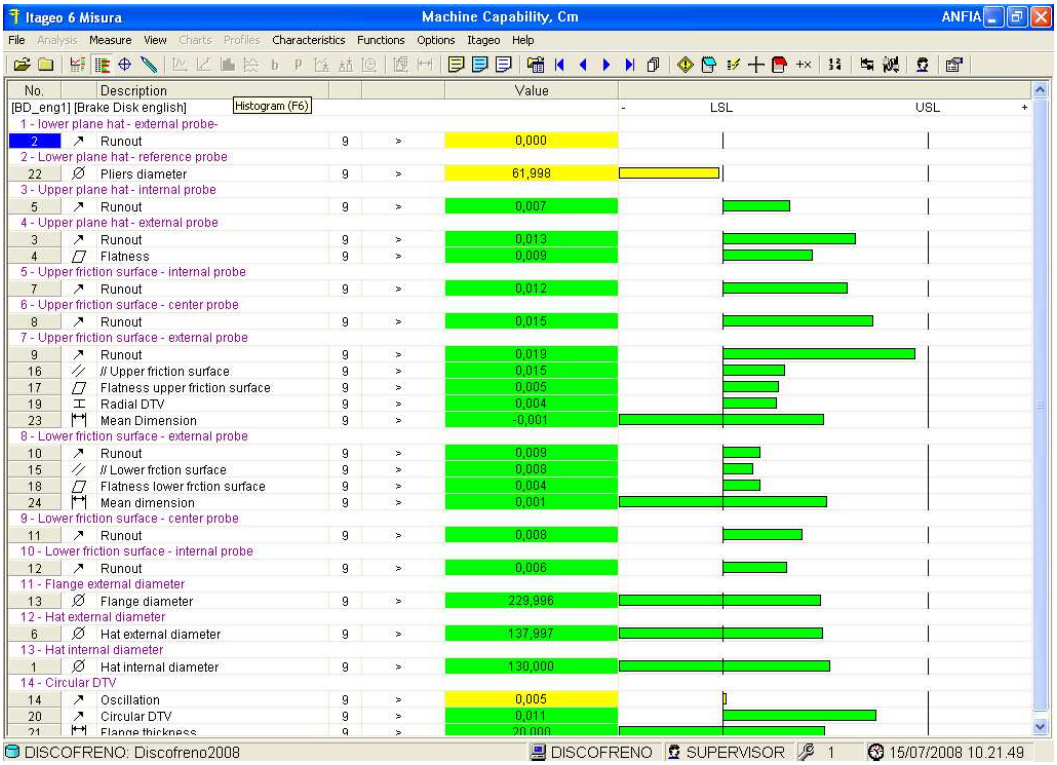
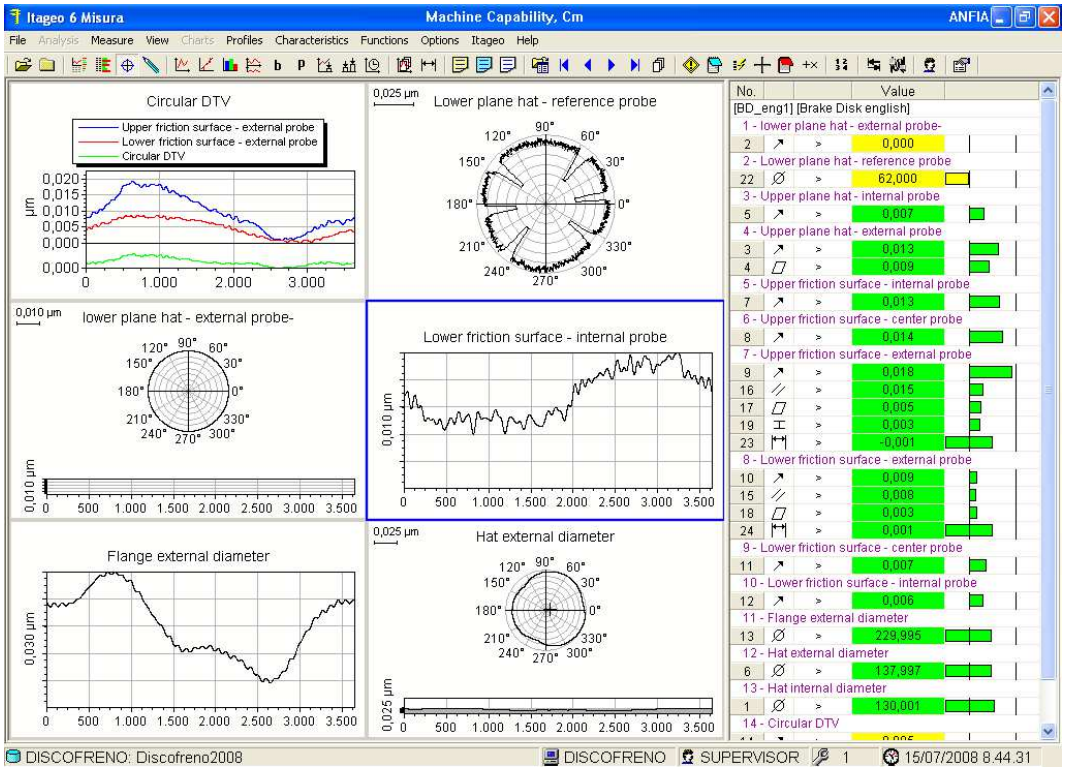
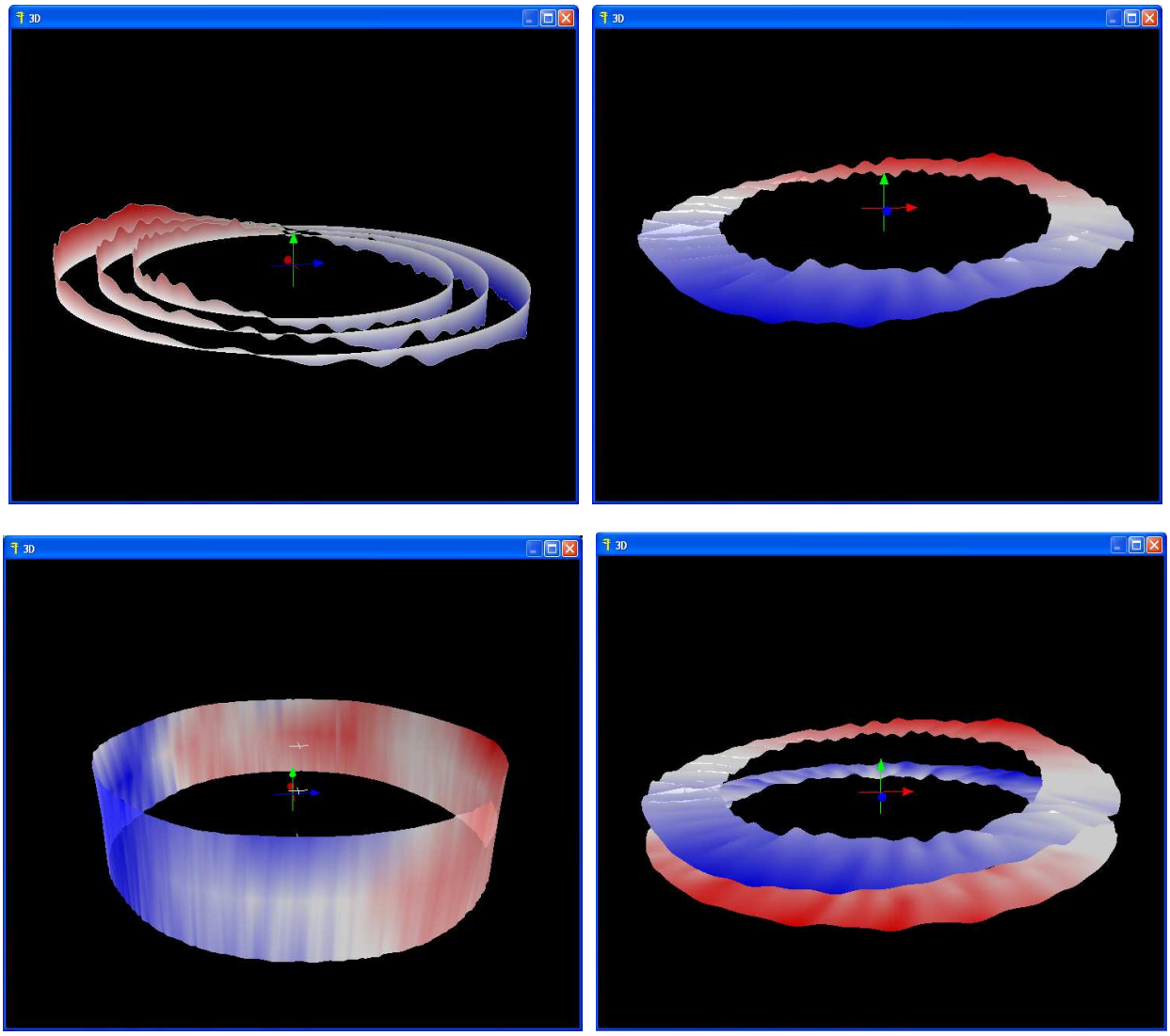
- Fully configurable user interface: easy and immediate, with the global result of the test (green for Good, red for Reject, yellow for uncertain) and the punctual values of each characteristic of the control plan.



- Possibility to display up to 6 graphs for critical sections.



- Display of complex geometric characteristics in 3D mode.



- Control of the **interrupted surfaces** (e.g. in correspondence of locking bores). It is enough to insert the parameter “number of interruptions” and Itageo 6© finds out the interruption areas and excludes them from the analysis.

- The Itageo 6© uses a **compensation algorithm for verticality errors** of the mandrel. In this way run-out and waviness values of the braking faces are real and not influenced by the rotation system.

- **Analysis of the harmonics** (Fourier analysis) with possibility to control the single harmonics, each with own tolerances.

- Settable high frequency harmonics **cut-off filters** (typically 0 - 50 Hz).

- Settable **“dirt filter”**.

- Possibility to configure the harmonic and dirt filters for each section of the control plan.

- Creation of **univocal serial numbers** (only for positively tested parts) and transmission of the same to the marking machine for the printing on the disc.

- Storage in the db of **measurements** + **profiles** + **serial number** to guarantee 100% **traceability**.

2. Statistical process control

Fully configurable management of the **statistical alarms**, in function of the statistical configuration activated in Itageo 6© Analysis, complying with the ANFIA guidelines (ISO 16949) and to the ones of the main manufactures of the Automotive sector. Signalling through lamp and indication on the display of the characteristics in alarm.

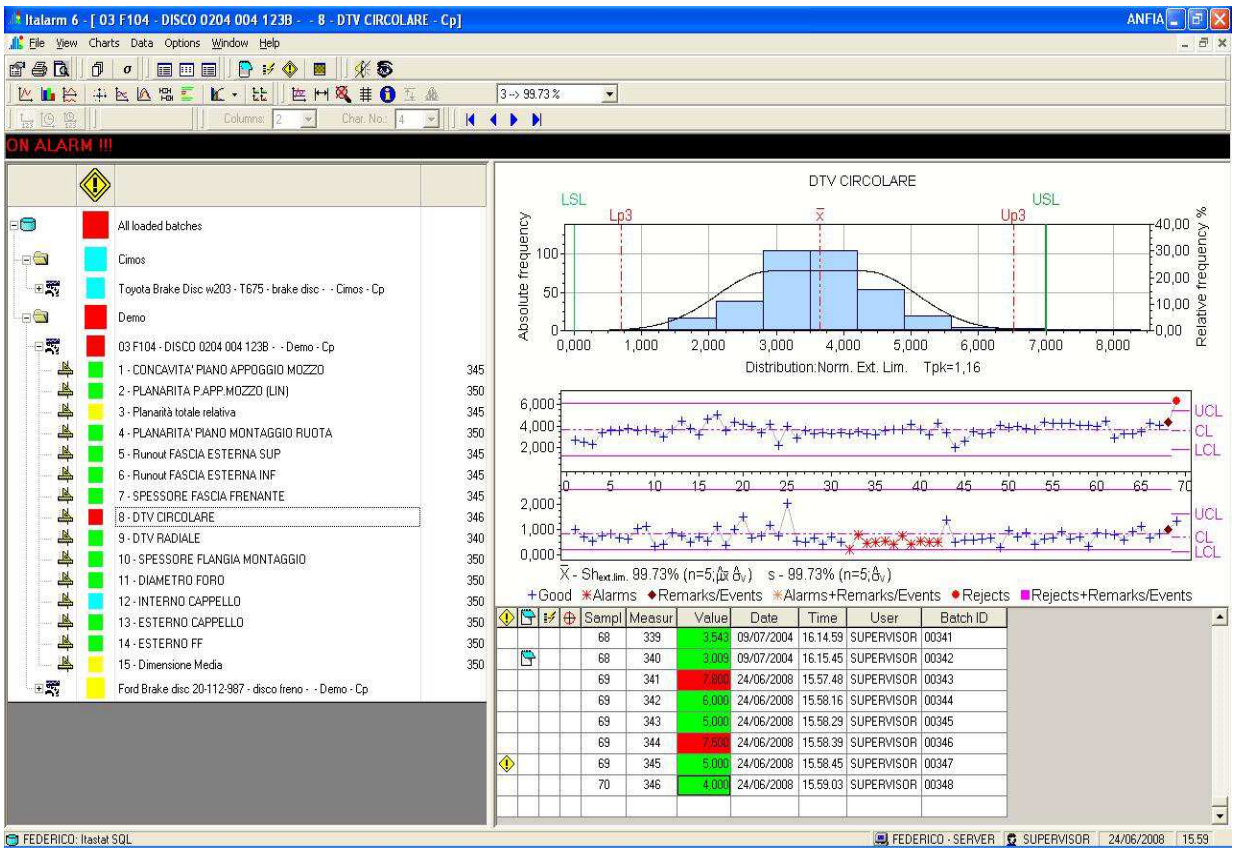
Management of the Master verification cycle and automatic Master zero setting. The verification and zero setting data are stored with date and time and are used for the **measuring system stability control**, in compliance with the guidelines of the automotive sector (ANFIA, VDA, AIAG) and with the ISO 10012 norm. This control is made at each zero setting of the machine. The stability tolerance can be freely set up by the user.

3. Data saving in Database, with full network capabilities

Itageo 6© saves the data in the SQL database, that can be local or in network.

4. Remote Real Time monitoring

It is possible to make a Real time monitoring of all the stations connected in the network from any PC having the Italarm software installed.



5. Remote control management

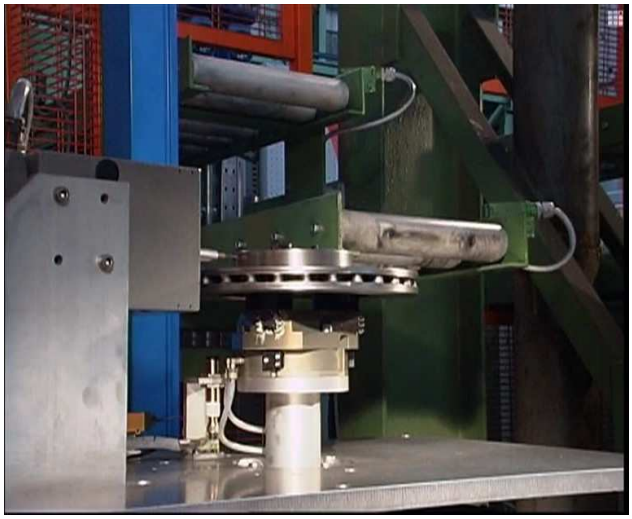
Thanks to the software TQM Control it is possible to grant the remote assistance of the measuring stations using internet adsl, LAN, umts. TQM Control presents the most advanced security standards: once the program is launched, it generates ID and password, which allows to "take control" of the station in order to make all the necessary service operations. Each time the program is launched, TQM Control generates a new dynamic password for the current session, which expires at any access end.

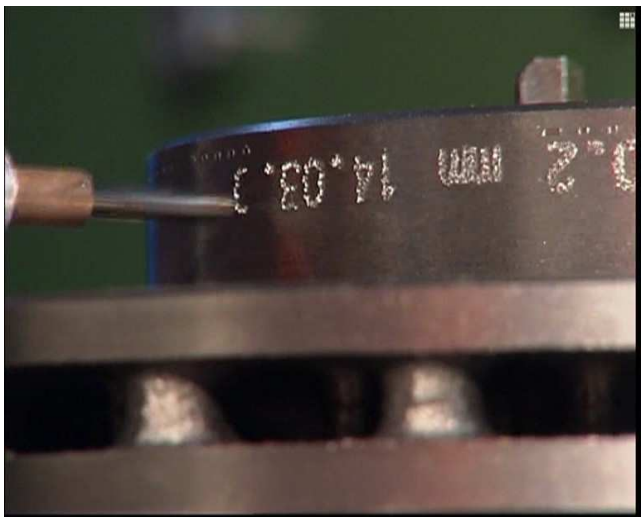
6. Connection with external devices

Itageo 6© dialogues with other systems: this allows interacting with loading / unloading devices, in order to manage for example the Master verifications and zero settings, interacting with machining machines, in order to send corrections (with a fully configurable logic), or with marking machines, in order to manage the traceability of the discs.

7. Traceability management

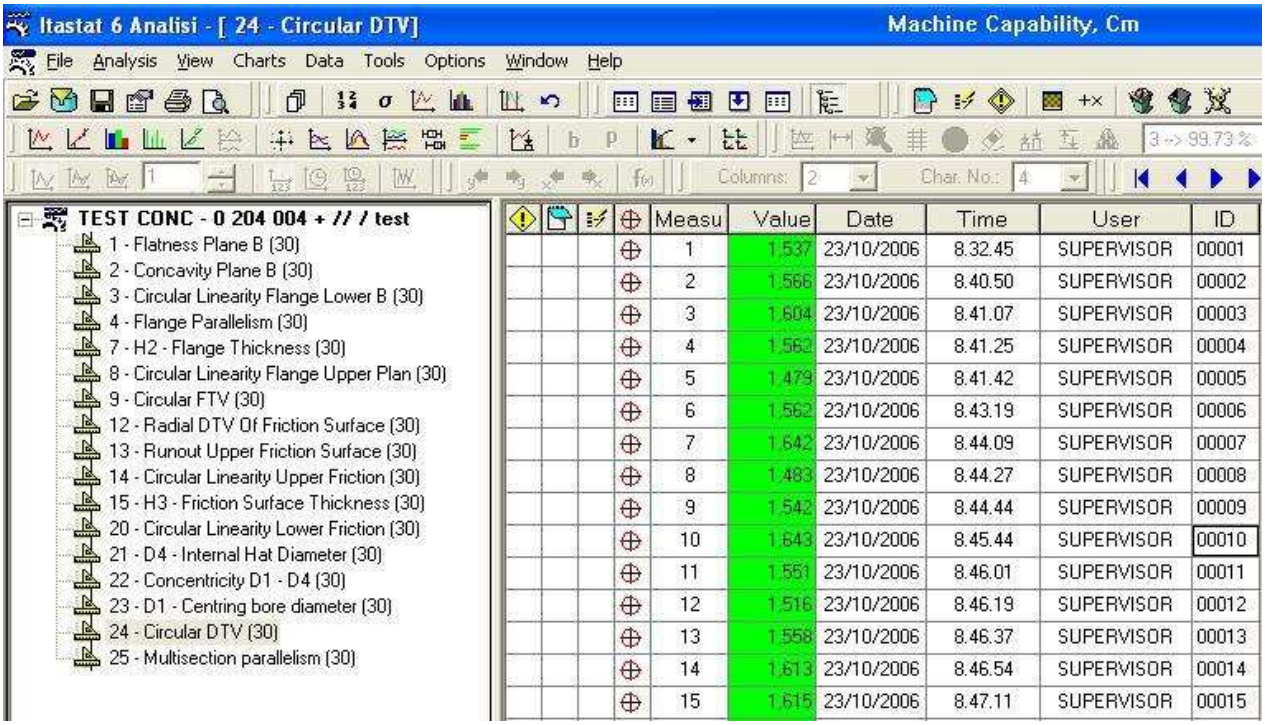
The basis concept of the traceability is to mark only the parts which passed the dimensional control with positive result, and to insert in the marking string a serial number connecting univocally the part with the results obtained on the bench.





The serial number (ID-number) is stored in the Itageo 6© database with all the measurements made on the part, than it is sent to a marking machine and marked on the disc. In this way, it is possible to search in the database, the univocal code and so to recover all the related information (measurements, date and time of the control, etc.), but also to do searches by period, day, etc. in order to individuate an ID-numbers interval with possible problems, avoiding the intervention on the entire batch of the parts.

Here below the single characteristic table, in this example the “circular DTV”, of 30 measured parts, with date, time and part ID.



Measu	Value	Date	Time	User	ID
1	1,537	23/10/2006	8.32.45	SUPERVISOR	00001
2	1,566	23/10/2006	8.40.50	SUPERVISOR	00002
3	1,604	23/10/2006	8.41.07	SUPERVISOR	00003
4	1,562	23/10/2006	8.41.25	SUPERVISOR	00004
5	1,479	23/10/2006	8.41.42	SUPERVISOR	00005
6	1,562	23/10/2006	8.43.19	SUPERVISOR	00006
7	1,642	23/10/2006	8.44.09	SUPERVISOR	00007
8	1,483	23/10/2006	8.44.27	SUPERVISOR	00008
9	1,542	23/10/2006	8.44.44	SUPERVISOR	00009
10	1,643	23/10/2006	8.45.44	SUPERVISOR	00010
11	1,551	23/10/2006	8.46.01	SUPERVISOR	00011
12	1,516	23/10/2006	8.46.19	SUPERVISOR	00012
13	1,558	23/10/2006	8.46.37	SUPERVISOR	00013
14	1,613	23/10/2006	8.46.54	SUPERVISOR	00014
15	1,615	23/10/2006	8.47.11	SUPERVISOR	00015

The following example is a report relative to disc S/N 00010, controlled on 23/10/2006 at 08:45:44. The disc was produced on the Kitako 2 production line and checked using the measuring station DF 2003 MMT S/N 00012-03.

TQMitaca

Machine Capability, Cm

Page 1
Date 31/10/2006

Batch name	Program name	Line : Kitako 2
TEST CONC	*0 204 004 + //*	Fixture : DF 2003 MMT S/N 00012-03

Serial Number: 00010

Date and time *23/10/2006 8.45.44*
Measure Number 10

Remark / Event

Char.	Description	Value	Nominal	LSL	USL	Result
1	Flatness Plane B	3,021	0,000	0,000	50,000	
2	Concavity Plane B	0,002	0,000	0,000	0,100	
3	Circular Linearity Flange Lower B	1,452	0,000	0,000	30,000	
4	Flange Parallelism	1,326	0,000	0,000	100,000	
7	H2 - Flange Thickness	6,264	6,000	6,000	6,500	
8	Circular Linearity Flange Upper Plan	1,794	0,000	0,000	50,000	
9	Circular FTV	2,644	0,000	0,000	40,000	
12	Radial DTV Of Friction Surface	1,575	0,000	0,000	50,000	
13	Runout Upper Friction Surface	2,733	0,000	0,000	25,000	
14	Circular Linearity Upper Friction	1,596	0,000	0,000	15,000	
15	H3 - Friction Surface Thickness	25,956	26,000	25,800	26,100	
20	Circular Linearity Lower Friction	0,767	0,000	0,000	15,000	
21	D4 - Internal Hat Diameter	141,989	142,000	141,700	142,300	
22	Concentricity D1 - D4	1,865	0,000	0,000	500,000	
23	D1 - Centring bore diameter	62,034	62,000	62,010	62,056	
24	Circular DTV	1,643	0,000	0,000	5,000	
25	Multisection parallelism	0,609	0,000	0,000	100,000	

EIGEN FREQUENCIES CONTROL

The newest request of the automotive industry is the 100% control of the Eigen frequencies, because a variation of the values compared to the nominal ones can influence important quality parameters of the car braking system (e.g. noise).

Itasonic 2010©, entirely developed by TQM ITACA TECHNOLOGY srl, is fast and based on high-performing and extremely reliable electronic components. It presents technical characteristics of absolute importance:

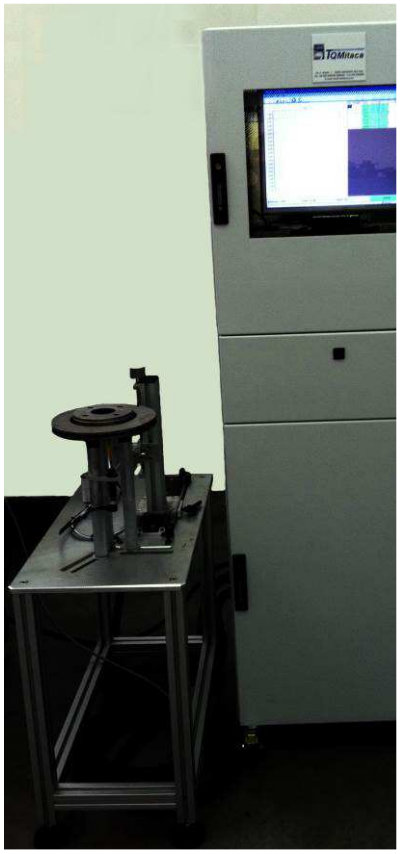
- Sensor Box iDaq4Sonic with 4 independent channels, 24 bit resolution and 125 KHz sampling frequency.
- Microphone for use in industrial area:
  - Standard: 20 – 20.000 Hz
  - Special: 6 – 80.000 Hz
- Scanning range: from 1 Hz to 50.000 Hz.
- Resolution and measuring time, on all the scanning range :
  - Resolution 2 Hz control time 0,5 sec.
  - Resolution 1 Hz: control time 1 sec.
  - Resolution 0,5 Hz: control time 2 sec.
  - Resolution 0,25 Hz control time 4 sec.
- Minimum distance between two frequencies: 2 Hz.
- Correct management of overlapping tolerances.
- FFT, FRF and FRF with congruence calculation analysis, configurable.
- Functions of “repeat measure on rejected” and “repeat measure if not congruent”.

The management software Itasonic 2010©, is very easy to use and generates a univocal code which guarantees the traceability, and which is saved in the db with the data related to the frequencies. Then the code is sent to the marking station.

The mechanical part is developed on the specific requirement of the customers, depending on the lay-out of the control station and on the load/unload system.

In the pictures by side there are 2 different kinds of stations for FRF control for brake discs and brake drums suitable for their insertion in production lines with manual load/unload or with robot.

The stations are completely independent, provided with dedicated PC. The dialogue with the line is made by the I/O board integrated in the sensor box.



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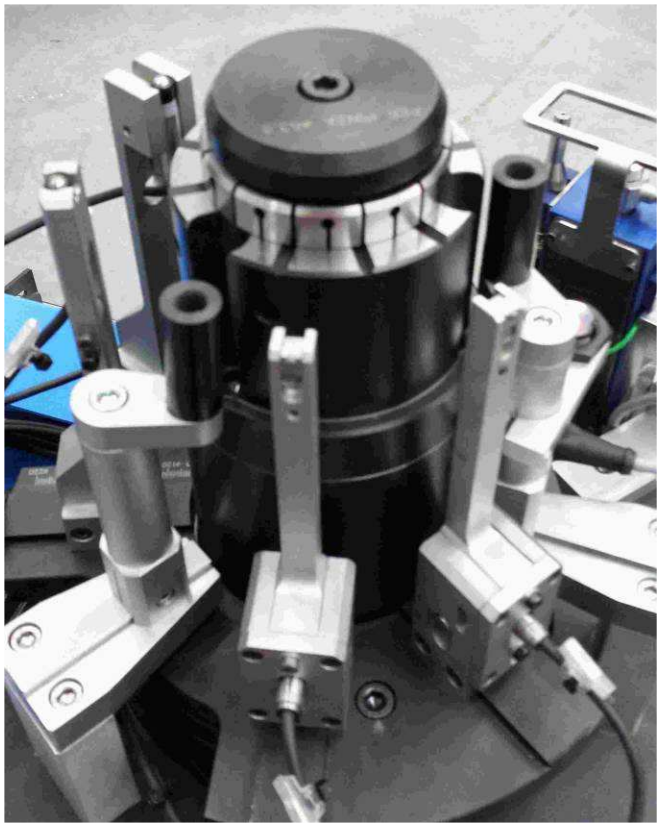
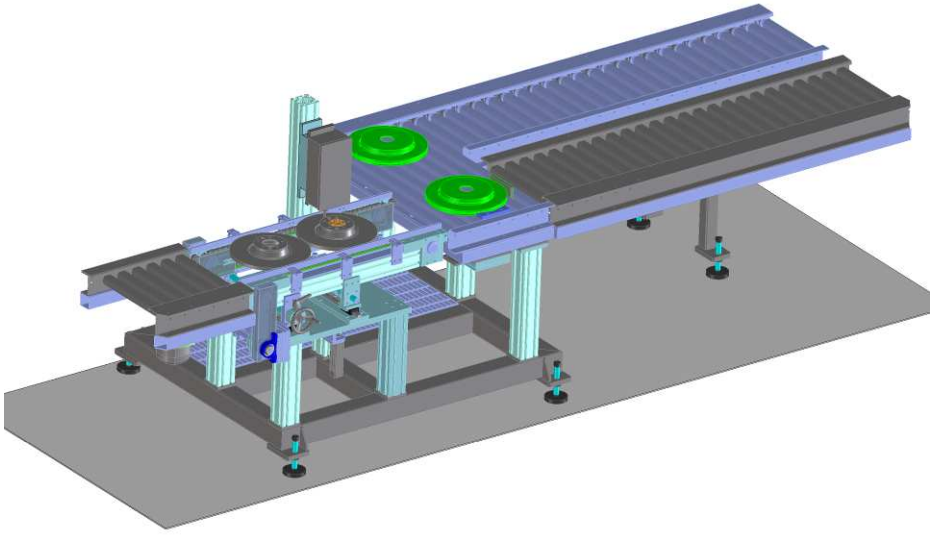
There are also available stations for FRF control directly integrated in the Itageo 6© gauge: there is an elevator which has the function of release the disc from the gauge for the control of frequencies and, in the meanwhile, it allows to avoid the direct load of the disc on the precision mandrel made by the load/unload robot.



There are available also solutions for the insertion of the FRF control in production lines of discs with handling by roller conveyors:



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Cracks detection

More and more manufacturers require the 100% integrity control (absence of cracks). Today the most efficient method is the control by induced currents (Eddy Current) which allows to find surface or “under skin” discontinuities with very small dimensions. TQM Itaca Technology srl has developed an innovative cracks detection bench, based on Eddy Current technology but with a management of the probe, which allows the maximum flexibility, and simplicity of use. The probe is mounted on the wrist of an adjustable Cartesian manipulator: the disc is put in rotation and the surfaces to be controlled are scanned by the probe. The modifications of the control plan need only a new program for the manipulator. The type change needs the load of a new part program, expensive mechanic modifications are not necessary. The benches are available in different configurations; it’s also possible to integrate them in lines with powered roller conveyors.

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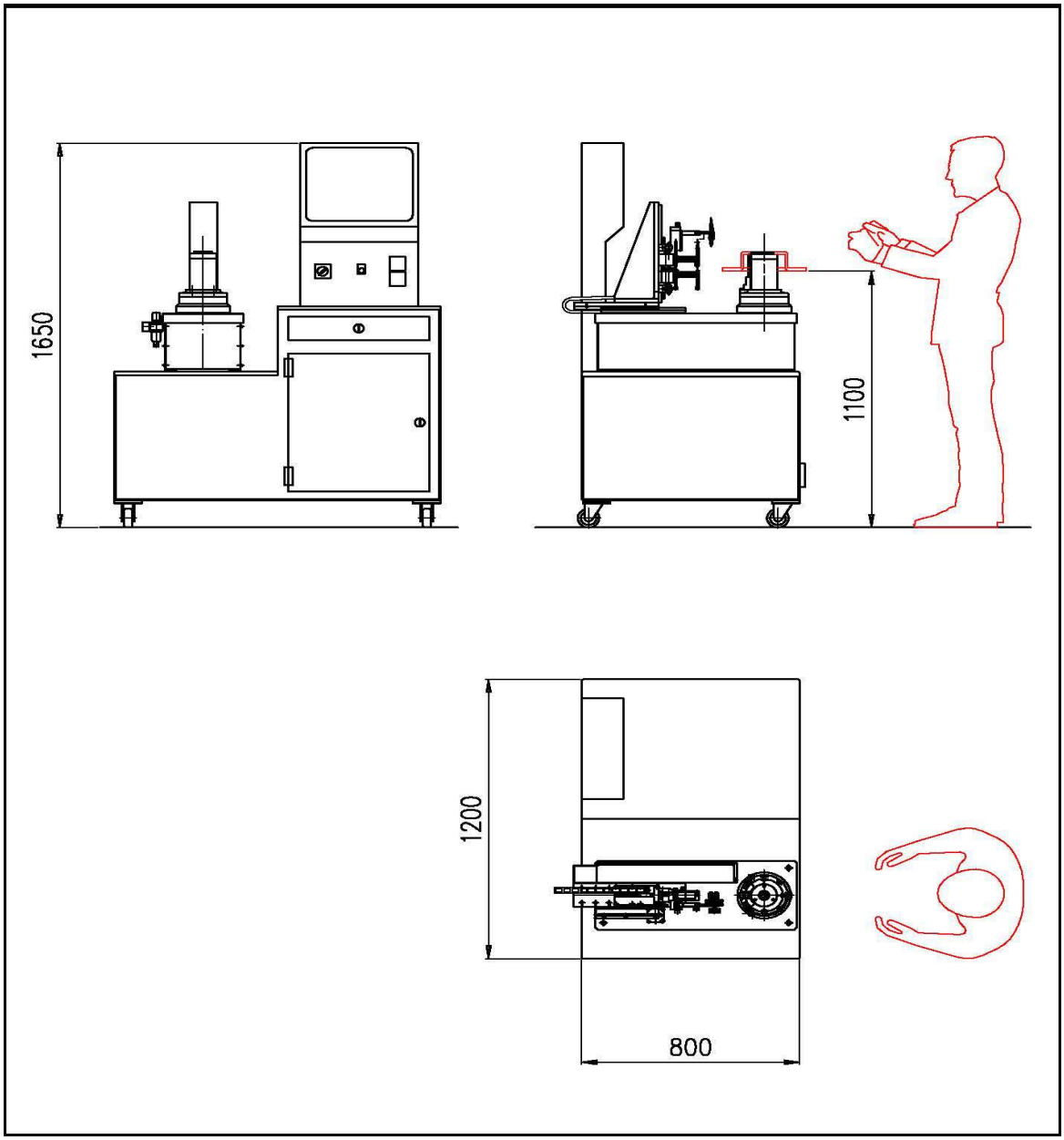
DF 2010 with manual load/unload and automatic measuring cycle

In this configuration, the station consists of:

- A workbench (available in different sizes), containing the PC and all the electronic devices.
- A measuring gauge

The load/unload is manual, while the measuring cycle is fully automatic. The operator uses a dedicated, easy-to-use keyboard, which allows the station management without using keyboard and mouse.



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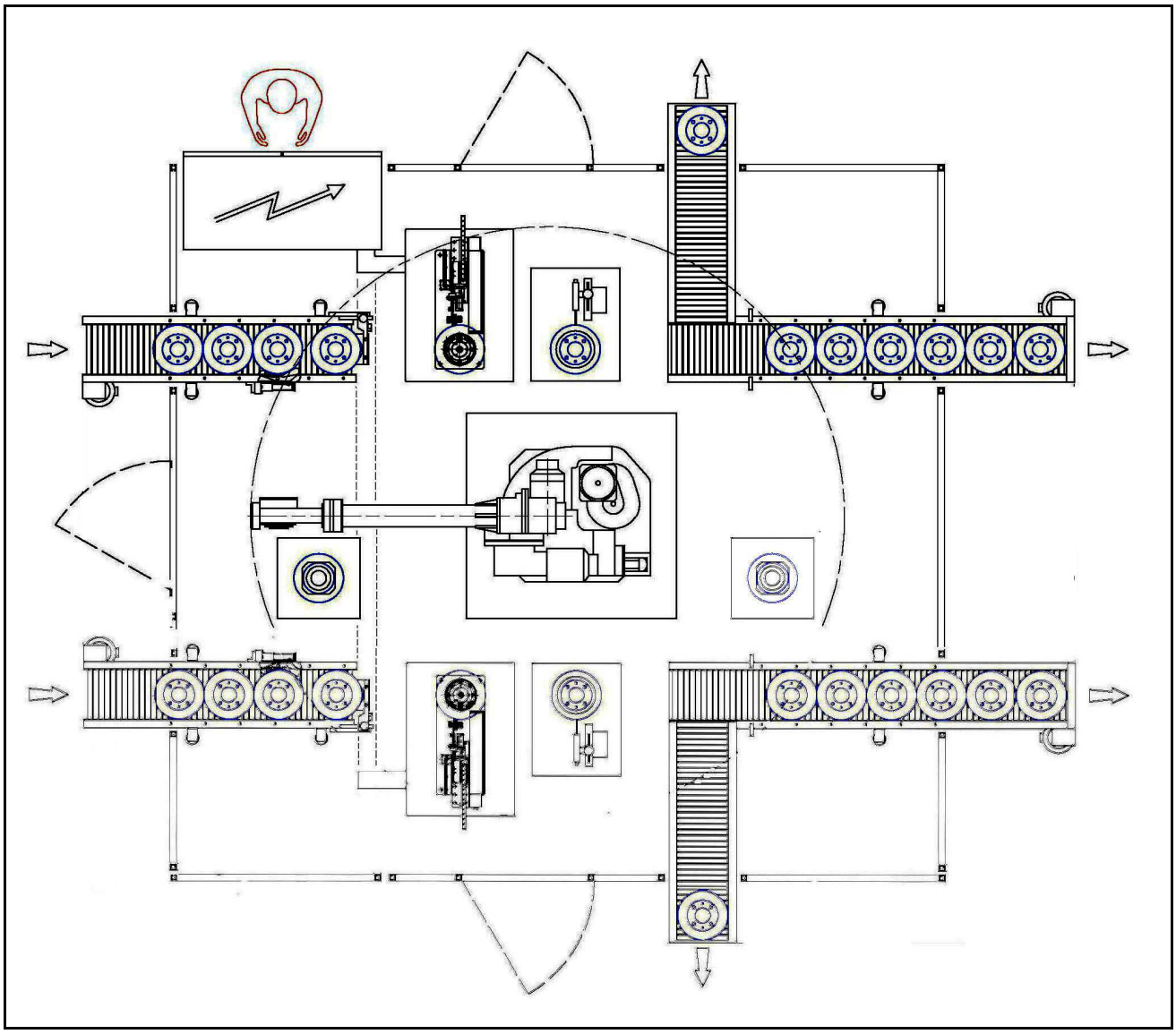
DF 2010 MEM'T in automatic line served by articulated robot

In case of use of an articulated robot for the loading/unloading of the parts, the gages are mounted on special benches with wheels and a specific locking devices, while the main part of the electronics is located in an electrical cabinet outside the working area: that allows intervention on the Itageo 6© without stopping the line.

In the example, here below the DF 2010 MEM'T is composed of an automatic gauge, a Eigen Frequencies control station integrated on the marking machine and an electrical cabinet: the measuring station lay-out is defined according to the space available in the production line. The use of a robot allows the serving of 2 adjacent working lines.



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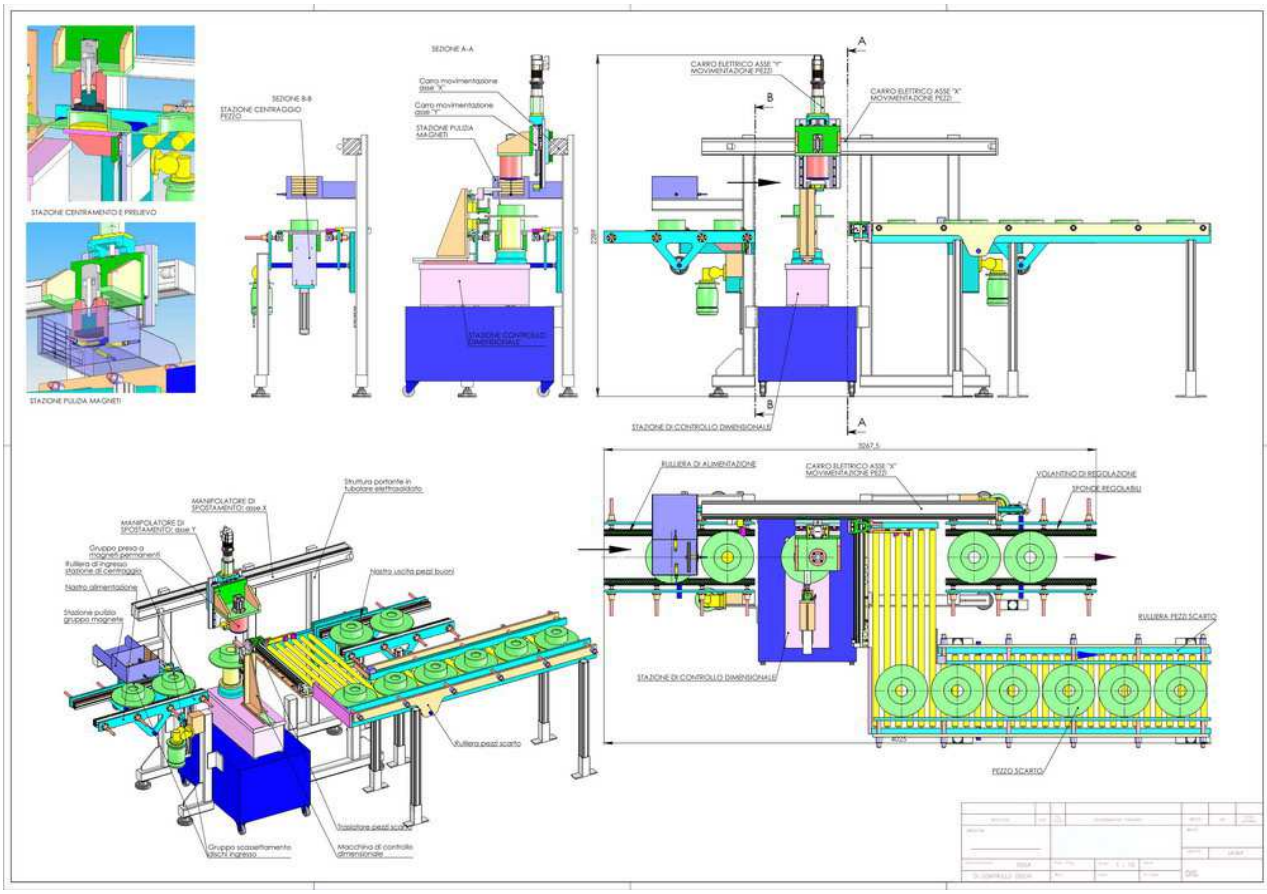
DF 2010 MME'T with powered roller conveyor and feed linear system.

This solution is studied in order to integrate the fixtures in a production line with part handling through a roller conveyor belt without articulated robot. All the dimensions and the positioning of the single components are to be defined according to the available spaces.

It is a modular solution extremely flexible. It is possible to add different stations, as cleaning station at the entry, dimensional measuring station, cracks control, Eigen frequencies control, *True Position* bore control through a camera, roughness control station and marking unit.

The pictures below show an automatic line with powered roller conveyor at the entrance, elevator, 4-position gantry with magnetic plier, dimensional control station, good/reject separation.



N.B.: The addition of integrative modules does not affect the cycle time.

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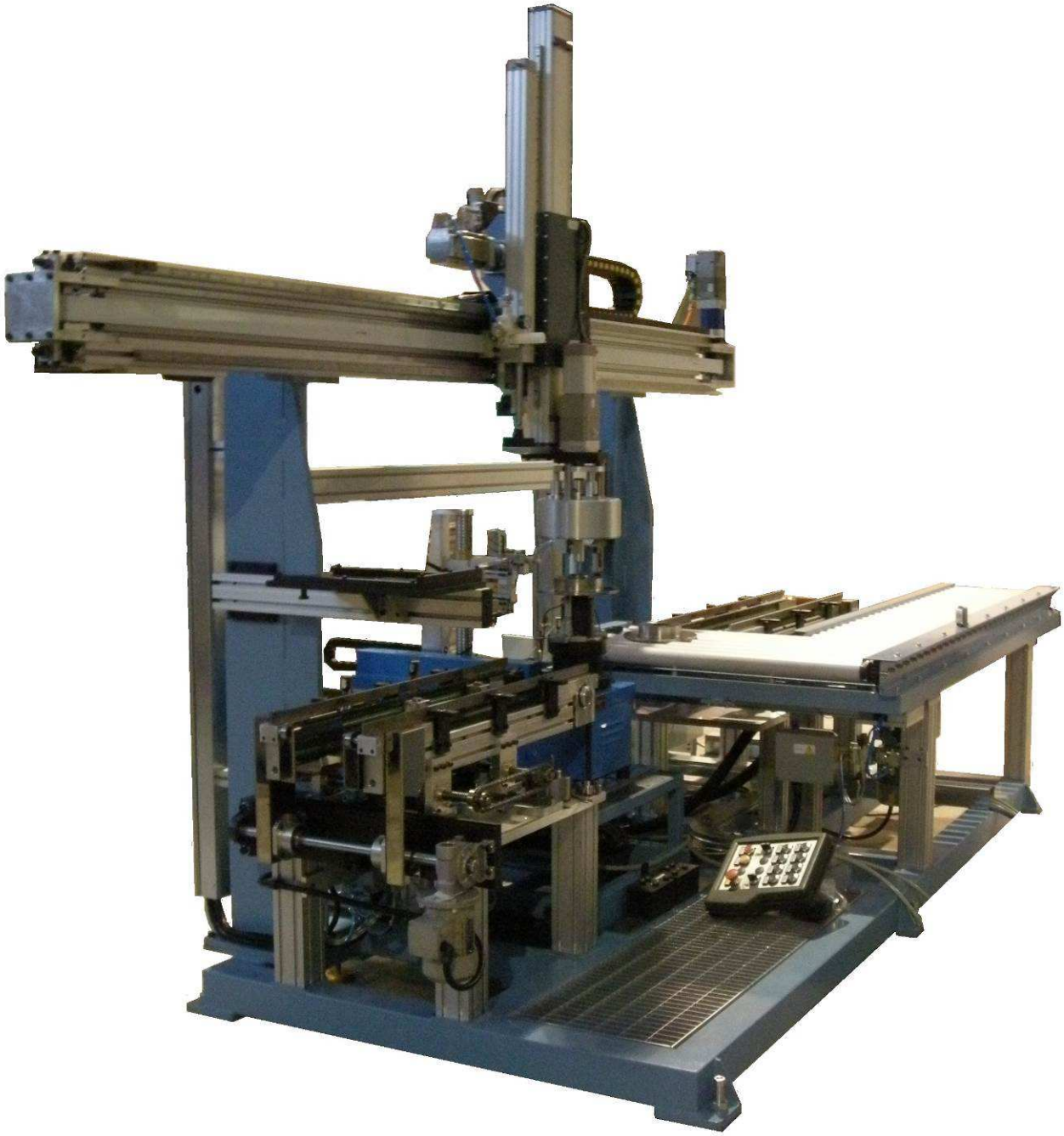

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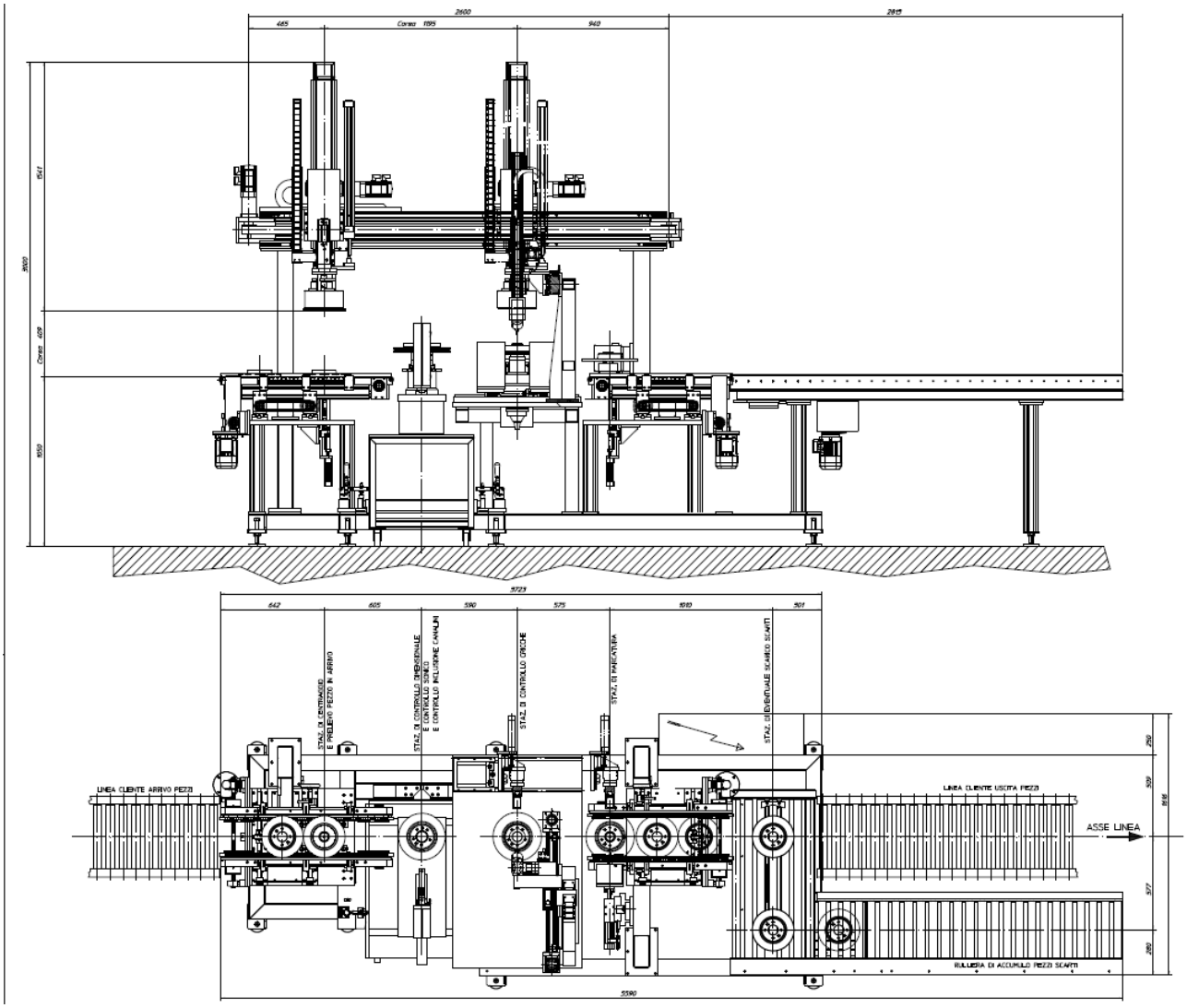
Example of an automatic line with powered roller conveyor at the entrance, elevator**,** 4 position gantry with magnetic plier, dimensional control station with FRF control integrated, ND station for the cracks detection with Cartesian manipulator, marking station, good/reject separation.



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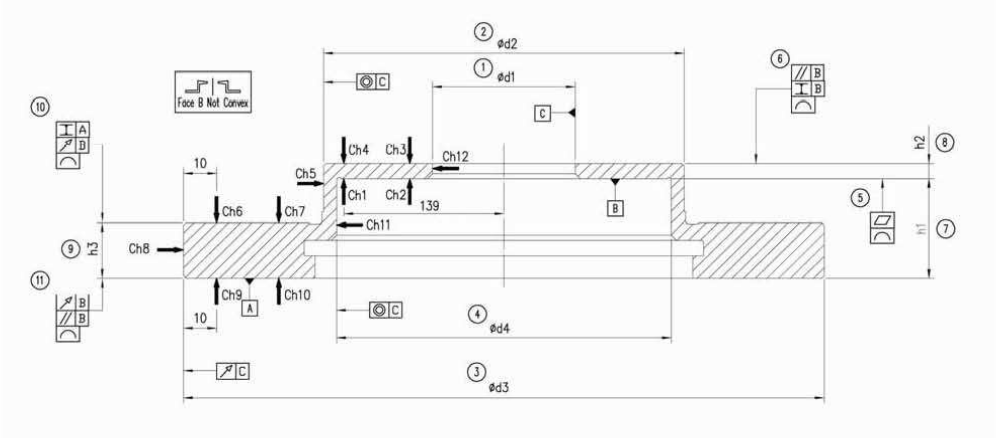
DF 2010 MEM'T – brake disc's control plan

	BRAKE DISK CONTROL	
TQMitaca	*Document type*	*Drawing nr*
	SPECIFICATIONS	



Ref.	*Description*	*Specification*	*Remarks*
1	ø d1 – Centring bore diameter	62 $^{+0,056}_{+0,01}$	
2.1	ø d2 – Outer hat diameter	152 ±0,3	
2.2	◎ Concentricity d1 - d2	0,5 C	
3.1	ø d3 – Outer rotor diameter	273 ±0,2	
3.2	↗ Runout outer rotor border	0.5 C	
4.1	ø d4 – Internal Hat Diameter	142 ±0,3	
4.2	◎ Concentricity d1 – d4	0,5 C	
5.1	▱ Flatness plane B	0.05	Not convex
5.2	⌒ Circular linearity flange lower plane B	0,03	
6.1	// Flange parallelism	0,1 B	
6.2	⌶ Circular FTV	0,04 MAX	
6.3	⌒ Circular linearity flange upper plane	0,05	
7	h1 – Height between plane B and plane A	43 $^{+0,1}_{-0,15}$	
8	h2 – Flange thickness	6 $^{+0,5}_{0}$	
9	h3 – Friction surface thickness	26 $^{+0,1}_{-0,2}$	
10.1	⌶ Circular DTV of friction surface	0,005 MAX	
10.2	⌶ Radial DTV of friction surface	0,05 MAX	
10.3	↗ Runout upper friction surface	0,025 B	
10.4	⌒ Circular linearity upper friction surface	0.015	
11.1	↗ Runout lower friction surface	0,025 B	
11.2	// Parallelism plane A with plane B	0,1 B	Radial
11.3	⌒ Circular linearity lower friction surface	0.015	

- ⌒ Circular linearity = ▱ Flatness on the same circumference (waviness).
- DTV / FTV: Disk / Flange thickness variation during a complete rotation.

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References

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- Brembo S.p.A.
- Metelli Group S.p.A.
- Quinton Hazell
- Autoindustrial Spartan PTY
- Xuming Yuan
- Eurac Hradec s.r.o.
- Streparava S.p.A.
- Egyptian Axles Company
- Intercar S.p.A.
- Egyptian German Automotive Company