

## DACAPO TYRE MEASUREMENT STATION

### Quality control

- automatic operation
- check for misaligned tread and ovality error
- measure the tyre profile in several positions
- generate error codes
- store all measurements in a database

### Verification / Traceability

- retrieve each individually stored tyre from the database
- view measurements and result on-line
- view / print graphics

### Production statistics

- compile statistical data for all tyres or for a selected size
- view / print graphics (bar graphs, diagrams, etc.)

### Suitable for retreads and new tyres

A tyre can be controlled up to three times as

- buffed casing
- cushion gum covered casing
- built tyre

### Measuring

The tyre is measured using a machine vision system. While the tyre is rotating on the inflatable hub, it will be measured 10 or 20 times (user selectable).

### Quality control

The tyre is checked for tread movement sideways, tread off-center and ovality. If any of these values exceeds the set tolerances, an error code will be generated.

The tyre profile is also measured and the profile is presented as 10 individual profiles (every 36°) and as an average profile.

### Production traceability

The tyre data is stored with an id. This will make it possible to retrieve the data for each individual tyre.



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## Control functions

The TMS includes functions for on-line control of the tyre. The following features are checked automatically:

- The tyre circumference is compared with a datum circumference for size error.
- The tyre is checked for out-of-round error.
- The shoulder position is checked regarding width, wobbling and symmetry errors.

The above control is done automatically using tolerances set by the user.

An alarm is generated if any of the values are out of tolerance and the alarm information is stored with the tyre data.

## Measurement functions

- Measuring the tyre profile. Each tyre could be measured three times: After being buffed, after being covered with cushion gum and after being built. The complete tyre profile from shoulder to shoulder is measured at steps of 36° around the circumference.
- Analysing data. After being measured, the measurements could be compared to the datum tyre and “average” tyre for the selected size.
- Printing of data. All graphs, tyre profiles, data etc can be printed.

## Data storing

Before measuring, the tyre ID must be entered either from the keyboard or by a bar code scanner or similar device.

All data is stored in a database after measuring.

Using the tyre ID, all data could be retrieved later.

## Examples, PC screen dumps

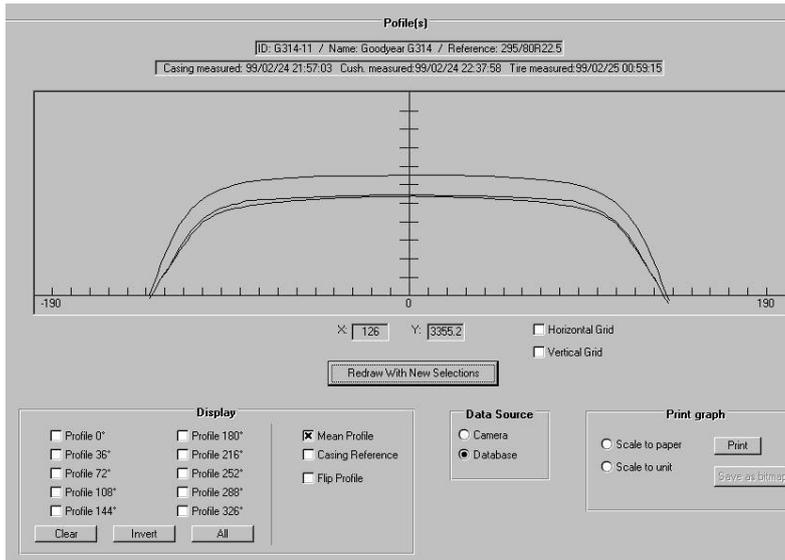
Pos	36	24	22	20	18	16	14	12	10	8	6	4	2	0	2	4	6	8	10	12	14	16	18	20	22	24	
0°	530.9	530.8	531.0	531.0	531.0	531.1	531.0	531.0	531.0	531.1	531.3	530.8	530.9	530.9	530.9	530.9	530.8	530.8	530.8	530.9	530.9	530.9	531.1	531.2	530.7	530.7	53
36°	531.1	531.3	531.0	531.1	531.1	531.1	531.0	531.0	531.0	531.0	531.0	531.0	531.2	531.2	531.2	531.2	531.2	530.8	531.2	531.1	531.3	531.3	531.3	531.3	531.0	530.8	53
72°	531.2	531.3	531.2	531.3	531.3	531.3	531.4	531.1	531.1	531.2	531.2	531.2	531.2	531.2	531.2	531.2	530.8	531.2	531.1	531.3	531.3	531.1	531.3	531.3	531.0	530.8	53
108°	530.6	530.8	531.0	531.1	531.1	531.1	531.0	530.9	530.9	530.9	530.8	530.9	530.9	530.8	530.8	530.7	530.8	530.7	530.8	530.7	530.8	530.7	530.7	530.8	530.5	530.5	53
144°	530.6	530.9	530.8	530.8	531.0	530.8	531.1	531.0	531.0	530.9	530.9	531.0	530.8	530.7	530.8	530.9	530.7	531.1	530.8	530.8	530.7	530.8	530.7	530.8	530.3	530.2	53
180°	530.8	530.9	530.9	531.0	531.1	531.1	531.1	531.1	530.9	530.8	530.8	530.8	530.8	530.8	530.6	530.7	530.5	530.4	530.3	530.5	530.3	530.3	530.3	530.5	530.3	530.1	53
216°	530.7	530.8	530.9	531.0	531.1	531.0	531.2	531.1	531.0	531.0	531.0	531.0	531.0	531.0	530.9	530.8	530.8	530.7	530.7	530.6	530.5	530.7	530.6	530.6	530.7	530.7	53
252°	531.2	531.2	531.2	531.5	531.5	531.5	531.2	531.4	531.4	531.4	531.3	531.0	531.0	531.0	530.9	530.9	530.8	530.8	530.9	530.8	530.8	530.8	530.8	530.7	530.7	530.7	53
288°	531.2	531.2	531.4	531.4	531.5	531.5	531.4	531.4	531.4	531.4	531.2	531.2	531.4	531.4	531.2	531.2	531.2	531.2	531.3	531.3	531.0	531.3	531.3	531.0	531.1	530.9	53
324°	531.3	531.5	531.5	531.7	531.4	531.5	531.5	531.2	531.4	531.5	531.4	531.5	531.4	531.4	531.3	531.3	531.4	531.4	531.2	531.3	531.2	531.1	531.1	531.0	531.0	531.0	53
Mean	531.0	531.1	531.1	531.2	531.2	531.2	531.2	531.2	531.1	531.1	531.1	531.0	531.1	531.0	530.9	530.8	530.8	530.9	530.9	530.9	530.9	530.9	530.9	530.9	530.8	530.6	53
Ref	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ref	-0.1	-0.3	0.0	-0.2	-0.2	-0.1	-0.2	-0.2	-0.1	0.0	0.2	-0.2	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.1	0.0	0.1	0.0	0.1	0.3	0.0	0.1

Picture 2: Measurement table, Tyre ID #1-07.

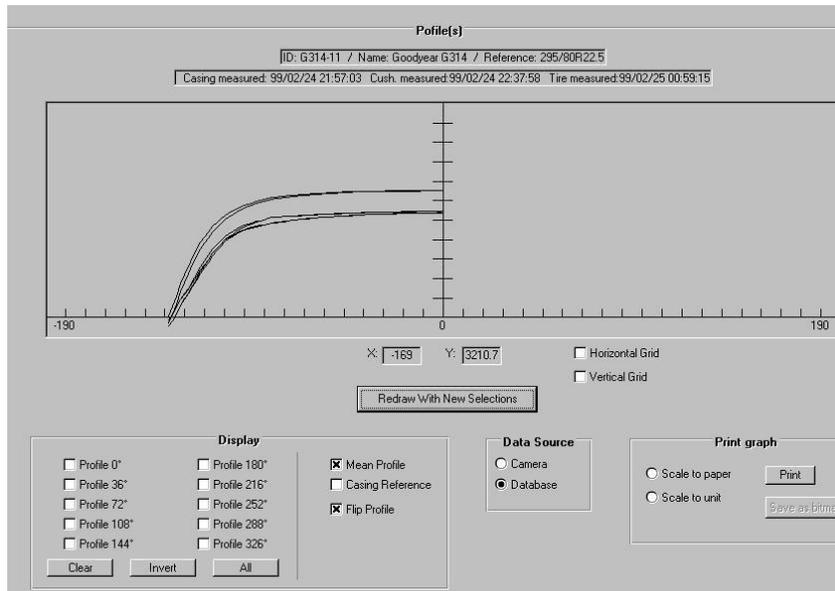
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**Picture 3: Profile graph. Buffed casing, cushion gum and built tyre.**

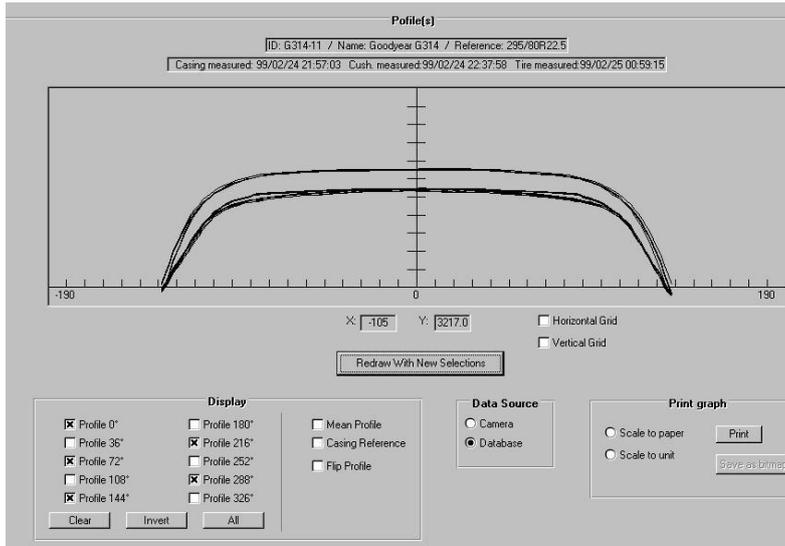


**Picture 4: Control using the flip function. The right half is flipped over the left.**

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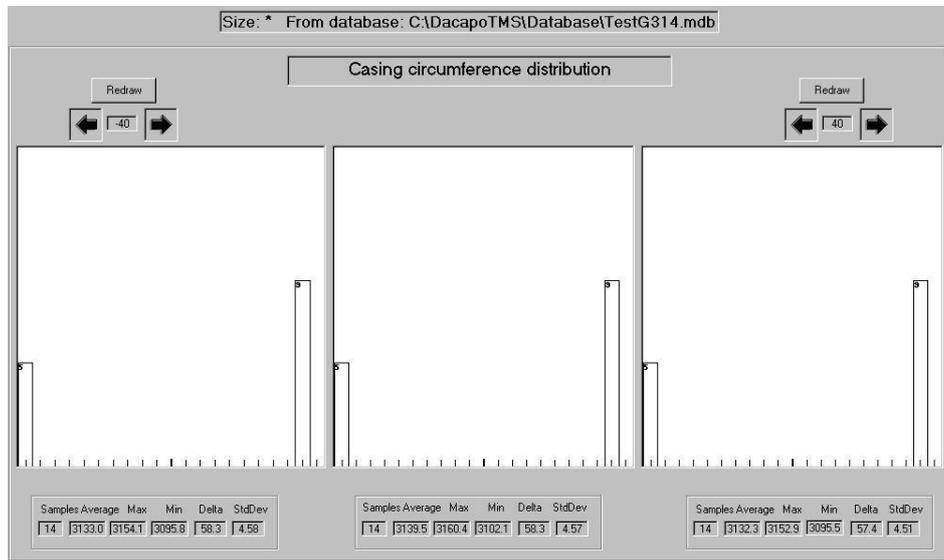
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**Picture 5: Profile overlay. Comparing the profile at every 72°.**

## Examples, PC screen dumps of statistical data information

(Please note: These examples contain too few samples to give a good statistical distribution. The more tyres measured, the more useful is the information about the distribution.)

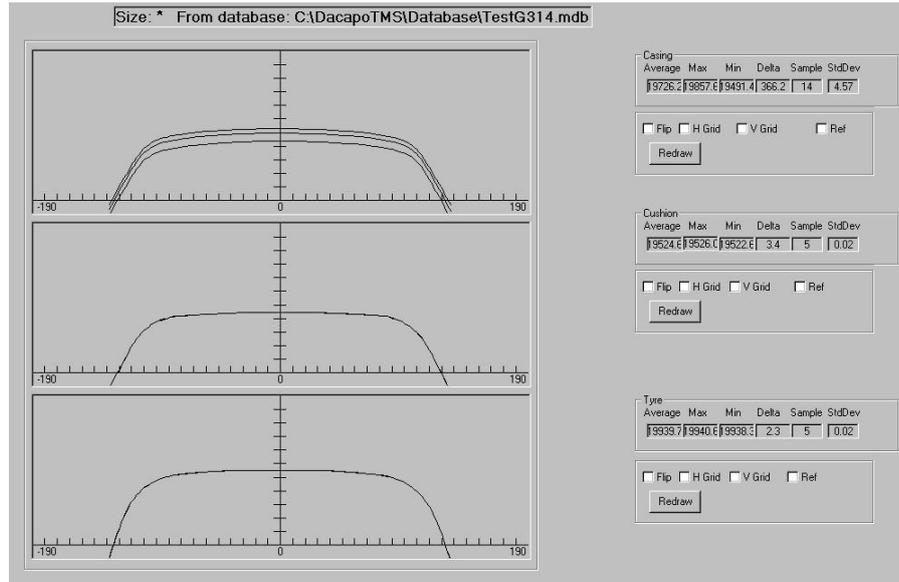


**Picture 6. Bar graph showing circumference distribution for all tyres of a certain size.**

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**Picture 7. Compilation of all data for tyres at a certain size. Max/min/average profiles and max/min/average/delta/standard deviation for centre circumference.**

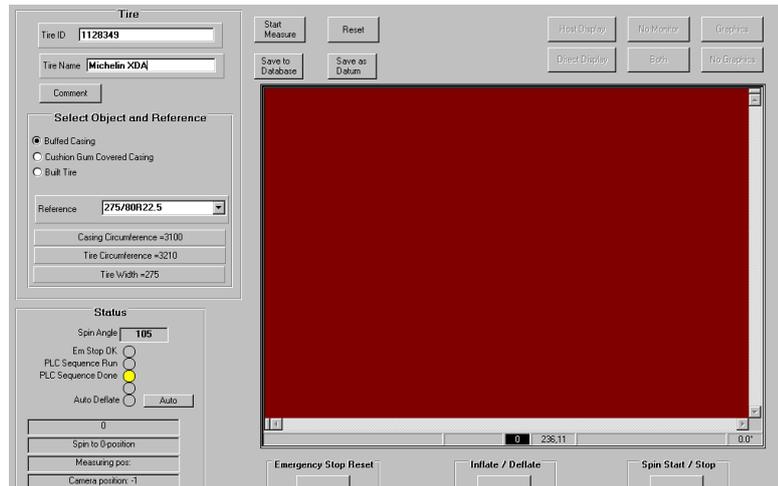
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## Operating the TMS

- The tyre is mounted on the expandable rim.
- The tyre ID and reference tyre is entered on the PC.
- The cycle is started by clicking on *START* on the PC.
- The tyre is measured while rotating on the hub and the values are checked against tolerances.
- After the cycle is finished, a window with measurement data and error message appears. The operator has to acknowledge the error and save the data before proceeding.
- If no error is found or after the error has been acknowledged, the tyre is deflated and all tyre data are stored on the PC.



Picture 8: Main Operator Window

## Comments

- A measurement cycle will take about 20-35 seconds plus the time to inflate/deflate and change tyre.
- The tyre profile is measured at every 36° or 18° (user selectable) while rotating.
- The tyre is measured from shoulder to shoulder in up to 200 positions.
- The accuracy when measuring the average radius in a position is better than  $\pm 0.15$  mm, depending on the surface.
- By using a CCD camera, the full profile of the tyre will be measured.
- Due to the parallax when using a single CCD camera, the edges of a wide tyre looks more rounded when measured down the edges. This will have an affect on the absolute value of the shoulder radius but will not affect the comparison with the datum tyre and average tyre. As an option two cameras can be used to minimize this effect.
- As an option a laser device could be used for an automatic calibration.
- When measuring tyres with precured tread, the pattern could affect the result. In this case, a parameter for each tread pattern must tell the TMS where to look for the “center” circumference.
- The TMS could be networked to a server or another computer.

## Specifications

- The power supplied to the TMS should be 3x400VAC+PE, 16A.
- The TMS should be connected to air supply, min 8 bar.

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