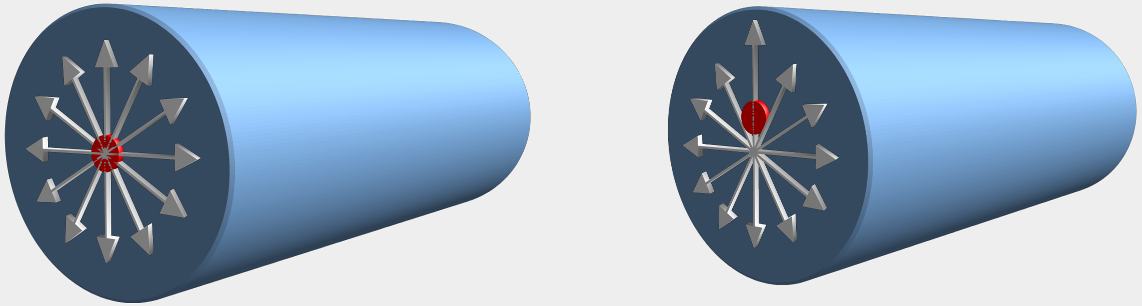
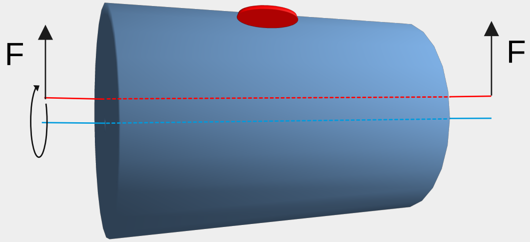
Rotor Balancing with the VM100 Vibration Analyzer

Introduction

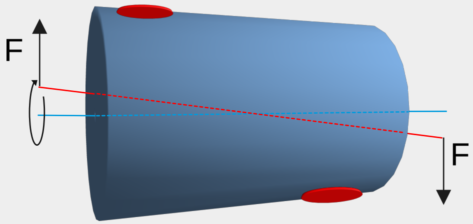
A rotating mass, or rotor, is said to be out of balance when its center of mass is out of alignment with the center of rotation. A centrifugal force is generated in the direction of the unbalanced mass. This centrifugal force increases with the square of the rotational speed.



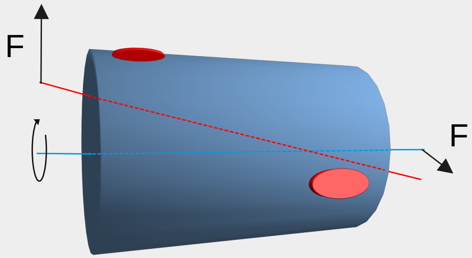
Types of Unbalance



Static unbalance:
Mass axis parallel to rotation axis



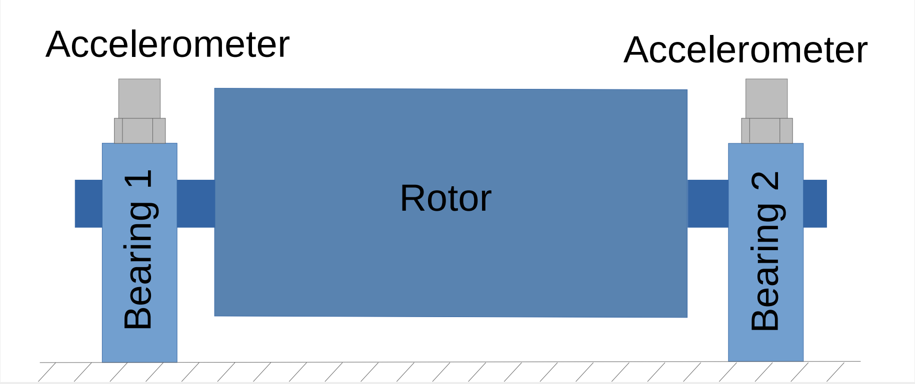
Couple unbalance:
Mass axis intersects rotational axis at center of gravity



Dynamic unbalance:
Mass axis not parallel and not intersecting rotational axis at center of gravity

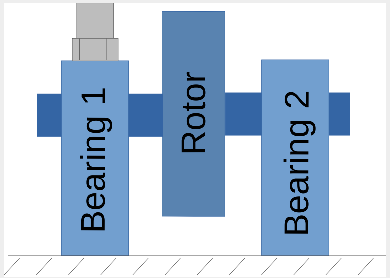
Balancing Planes

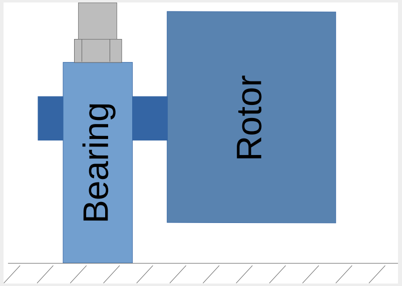
The rotating centrifugal force is transmitted to the rotor bearings and can be measured there with accelerometers. Depending on whether measurements are made on one or two bearings, this is referred to as one- or two-plane balancing.



One or Two Planes?

For disc-shaped rotors at speeds below 1000 min^{-1} and overhung rotors one-plane balancing is often sufficient, while longish rotors should be balanced in two planes. As a rule of thumb, rotors with a length greater than twice their diameter require two-plane balancing.



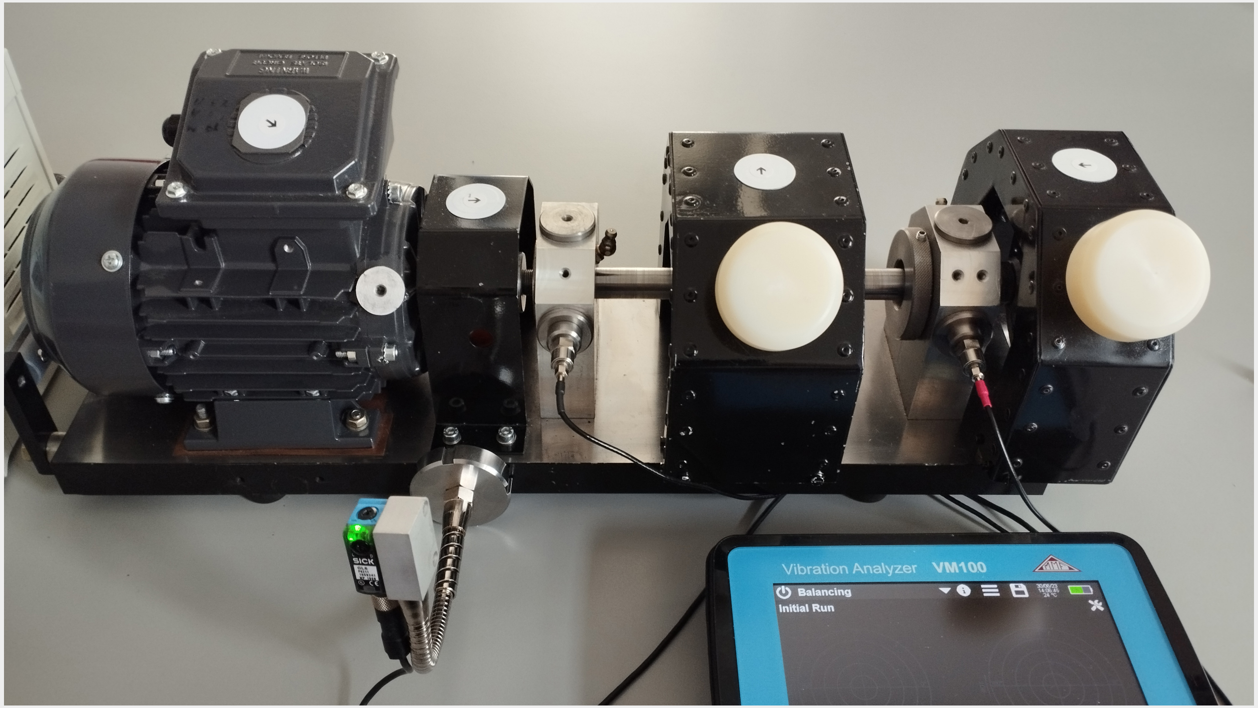


Balancing with the VM100

This Demonstration uses a model machine with a motor, a shaft and two steel disks carrying the unbalance.

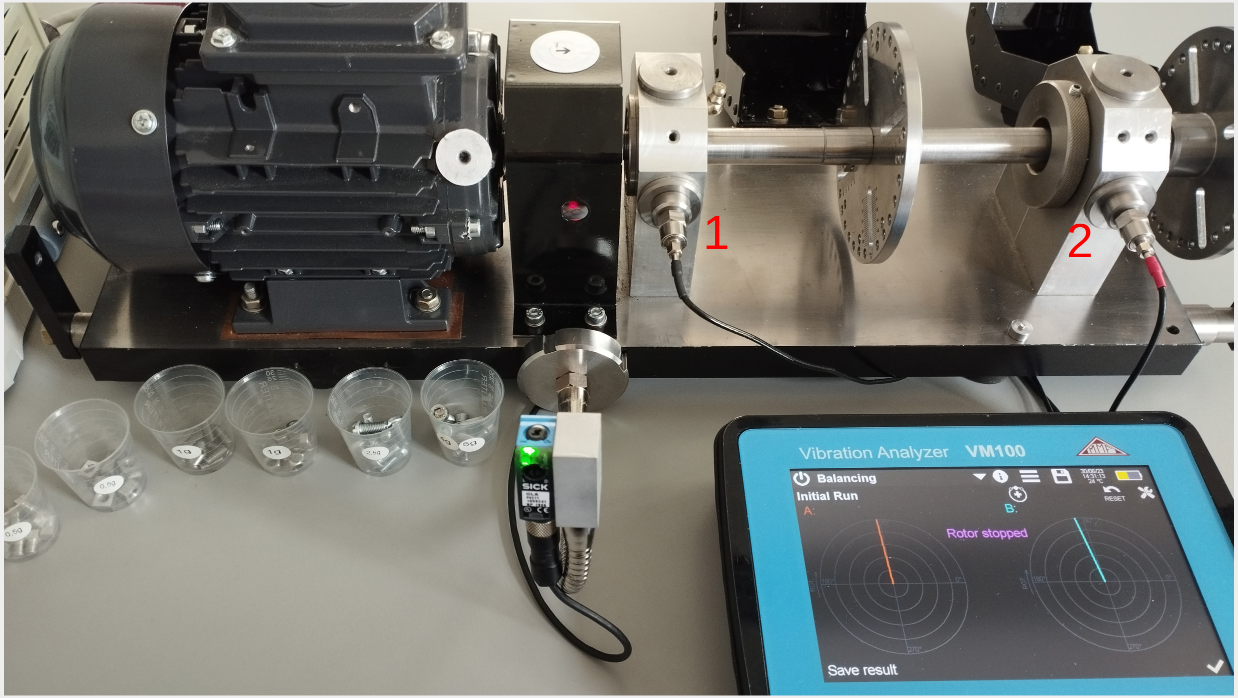
This is a field balancing example with two planes.

Field balancing means that the rotor remains in its normal operating state.



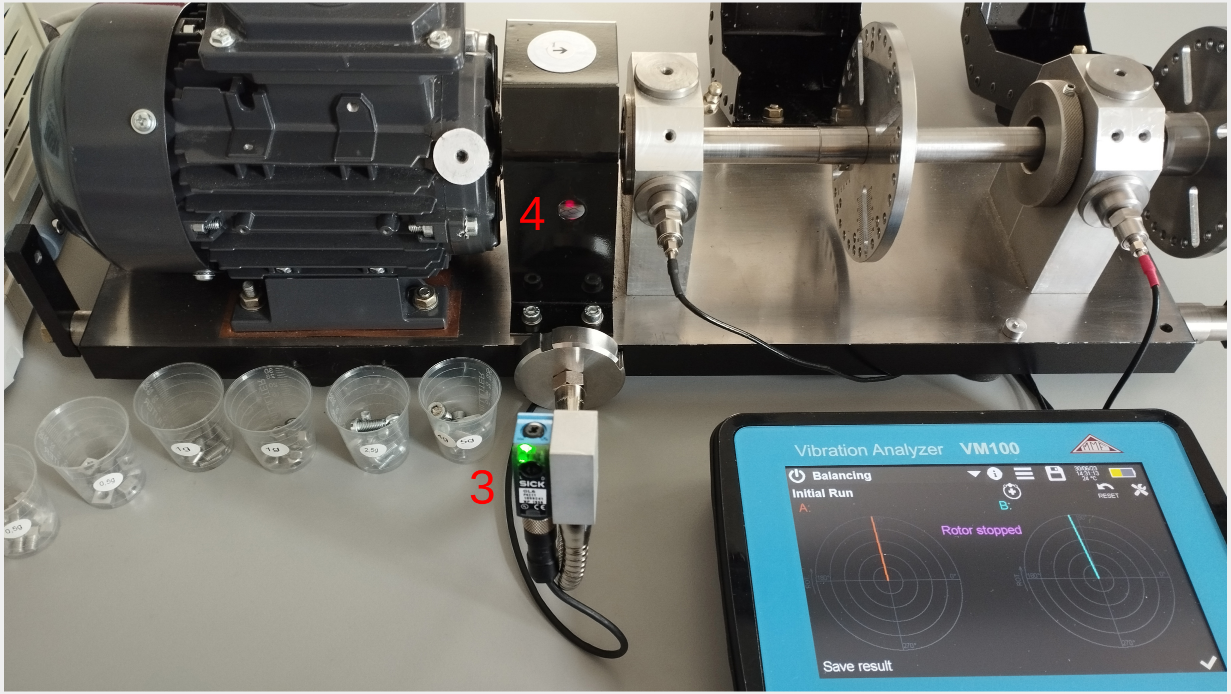
Preparations
Install the accelerometers (1) and (2) at the two bearing pedestals

The sensors can be oriented vertically or horizontally



Preparations

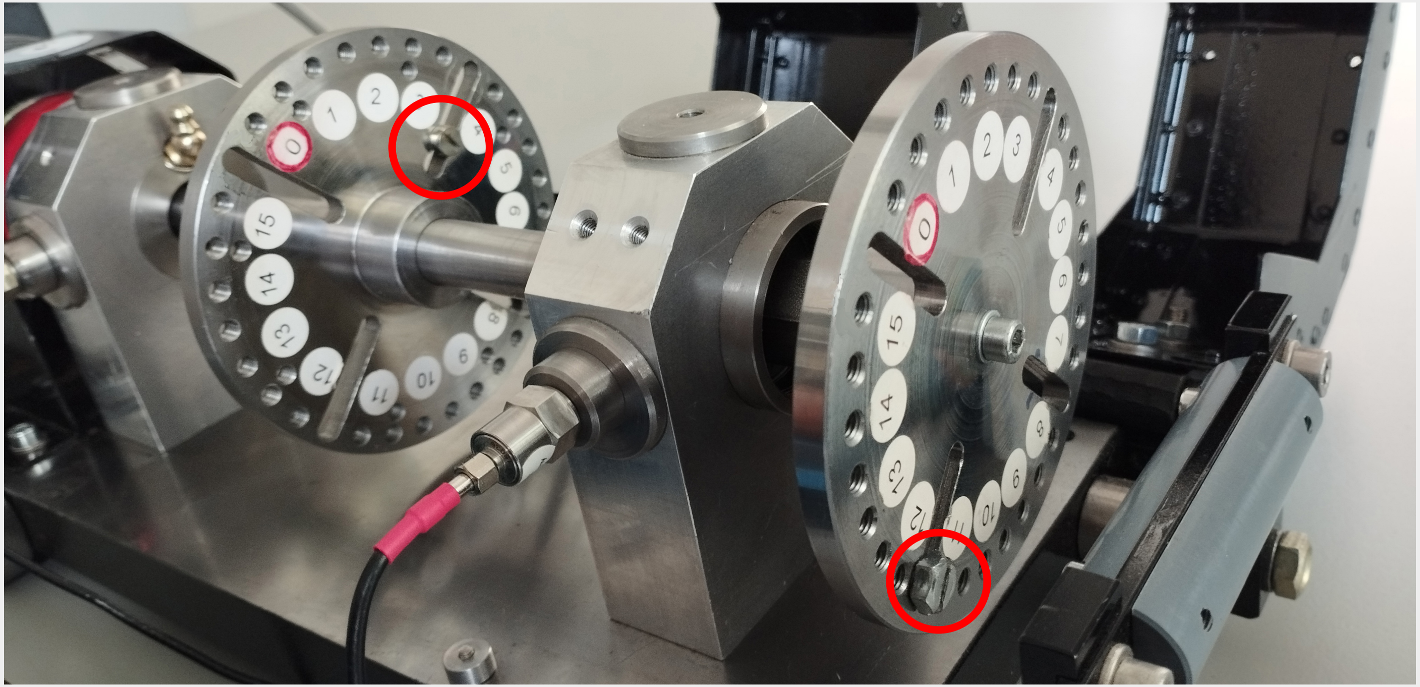
Install the photoelectric reflex switch (3) so that the red beam (4) hits a piece of reflective material on the rotor



Balancing with the VM100

The machine has weights (screws) on both disks which form an unbalance.

Our goal is to compensate it.

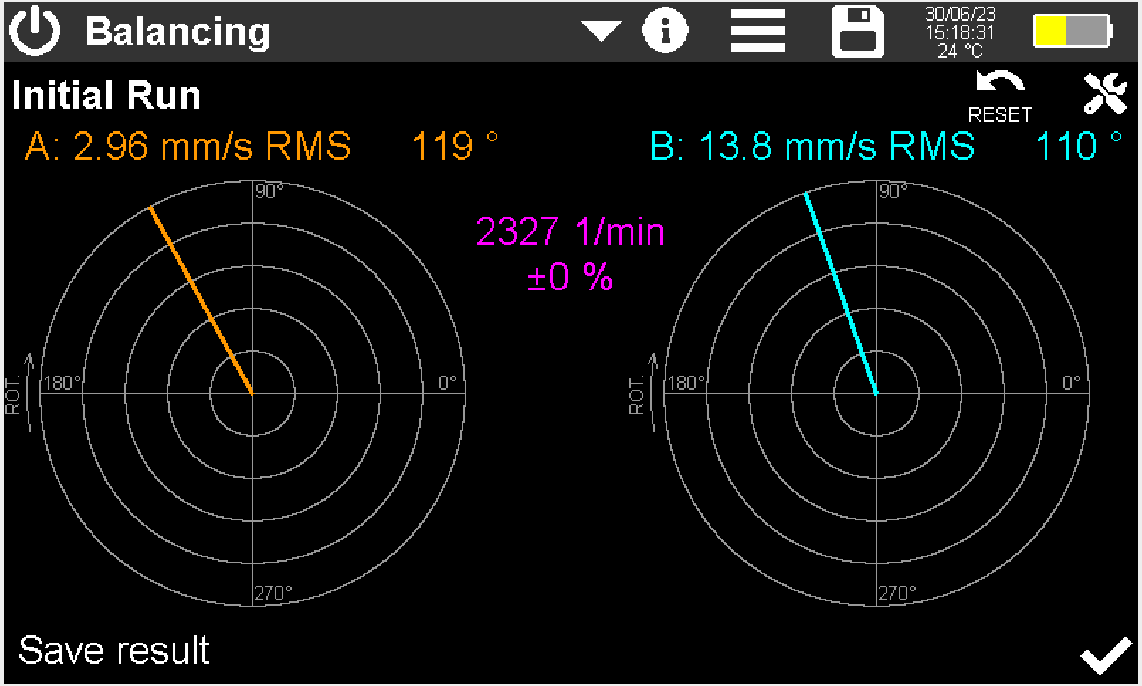


Initial Run

Start the rotation.

The measured unbalance is indicated as amount and angle and as pointer. Press OK when the pointers are stable.

Important: Rotation speed has to be kept constant during the entire balancing process.

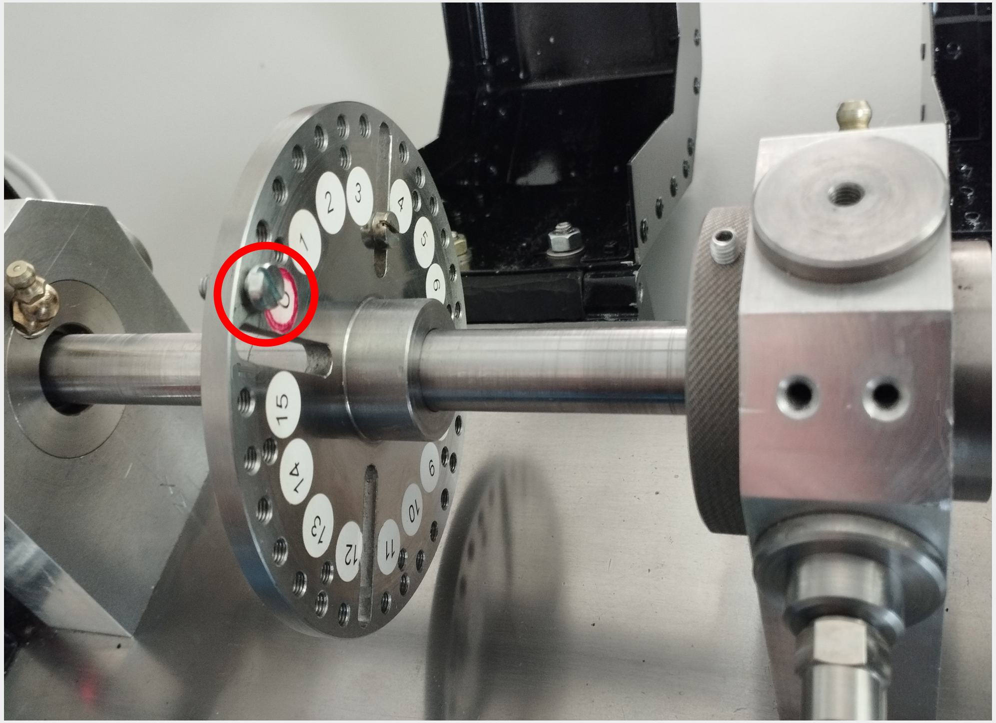


Test Run Plane A

Stop rotation.

Attach a test weight to plane A
The angle position of the test weight is the 0° reference for angle measurement.

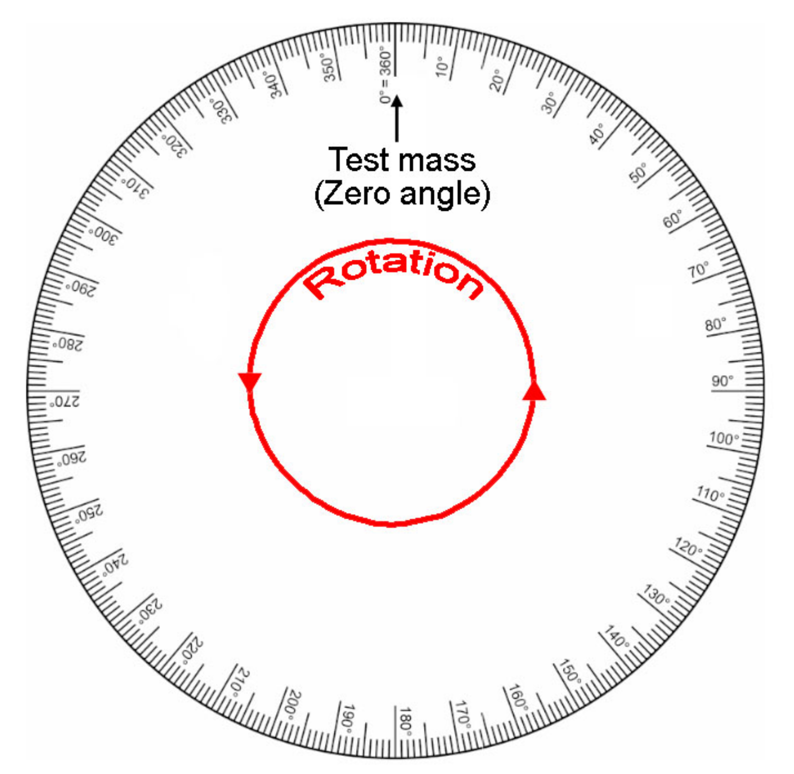
Finding a good test weight may require some experience.



Conventions for Angles

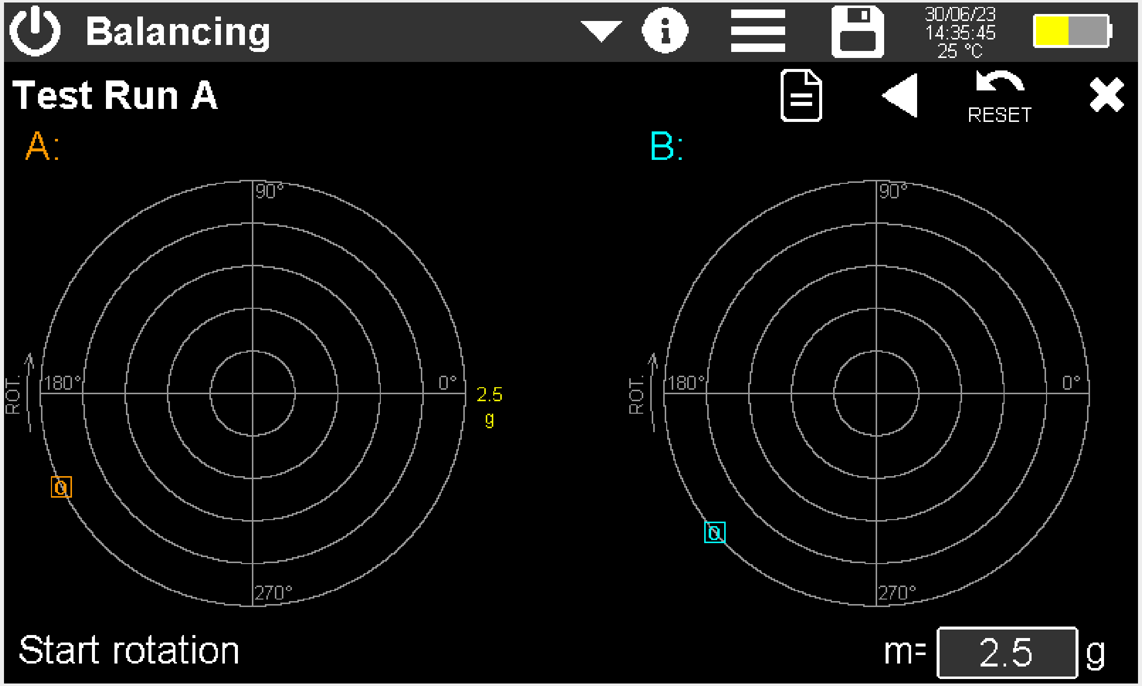
The test mass position defines 0°.

Angles are measured against the direction of rotation.



Test Run Plane A

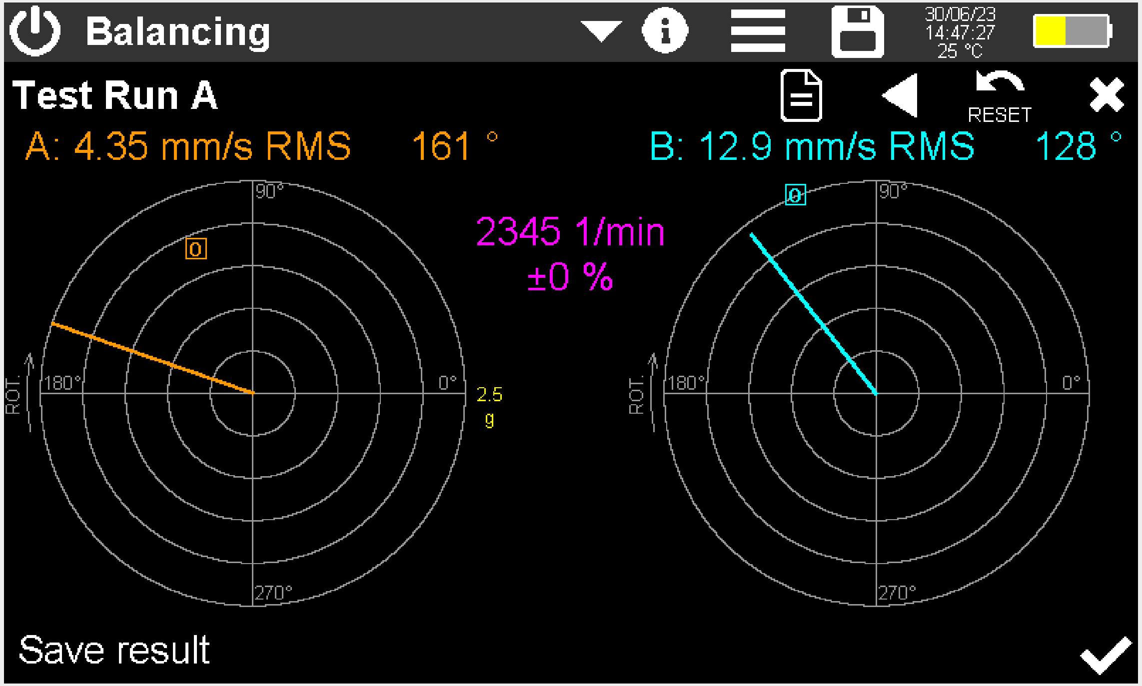
Enter the mass of the attached test weight and start rotation.



Test Run Plane A

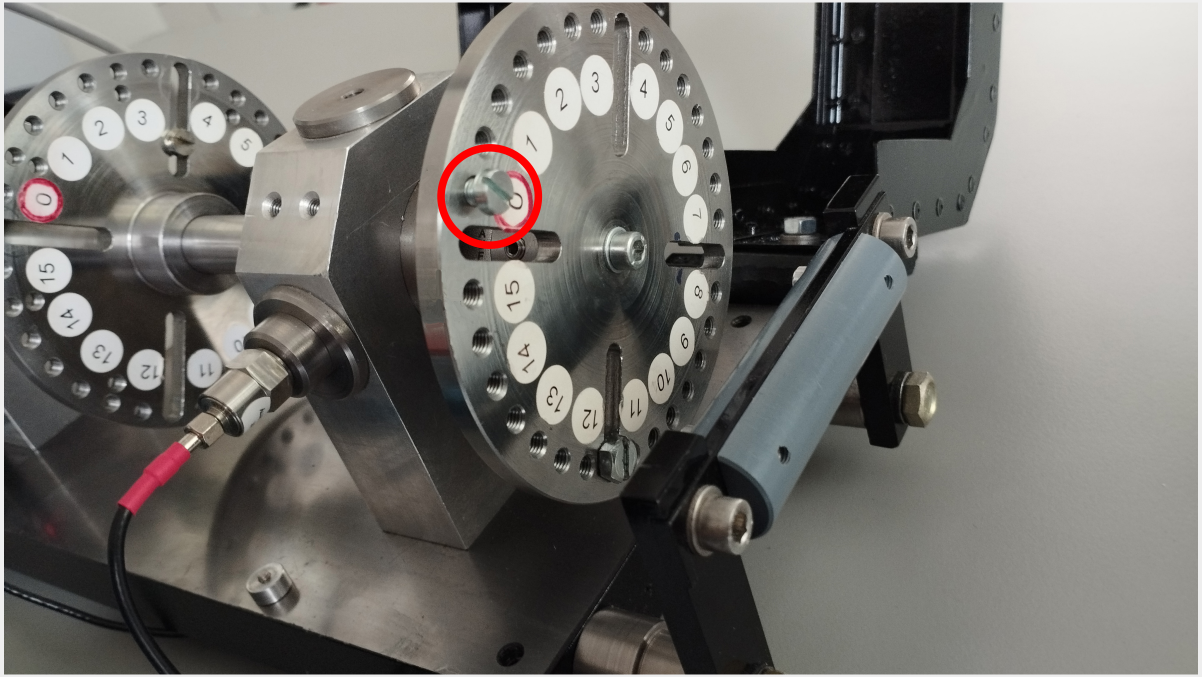
Now vibration with test weight A is measured. “O” indicates the initial unbalance. We see a significant change of amplitude and angle. Otherwise a warning will be issued.

Press OK when the pointers are stable.



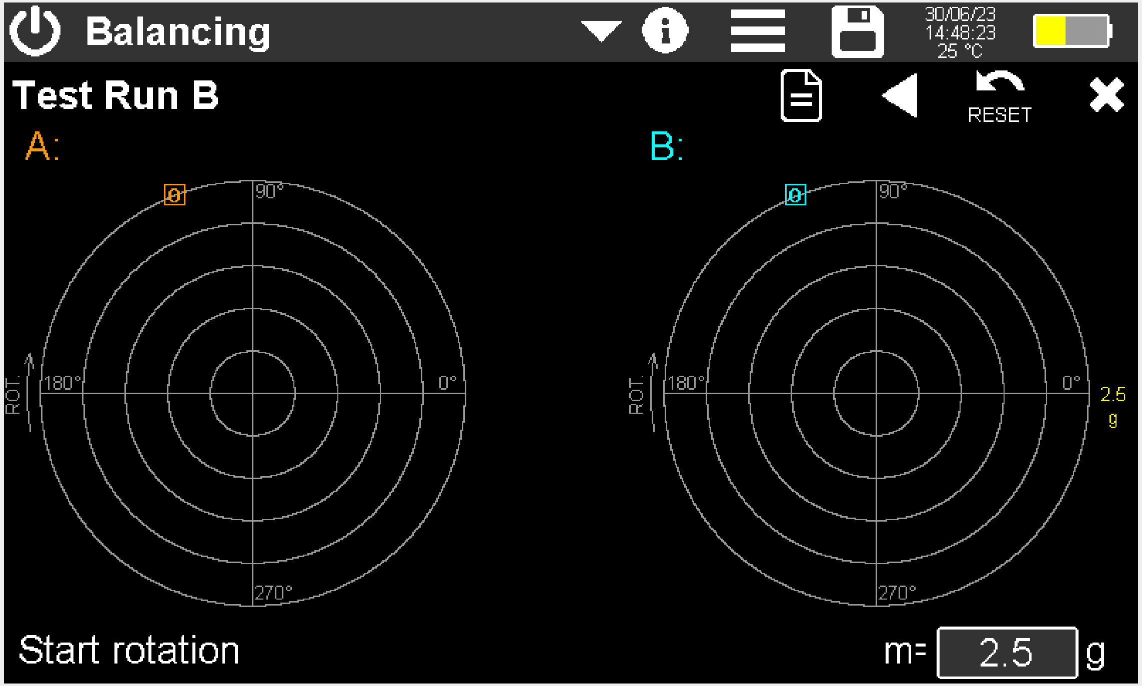
Test Run Plane B

Remove test weight A and attach a test weight at plane B.



Test Run Plane B

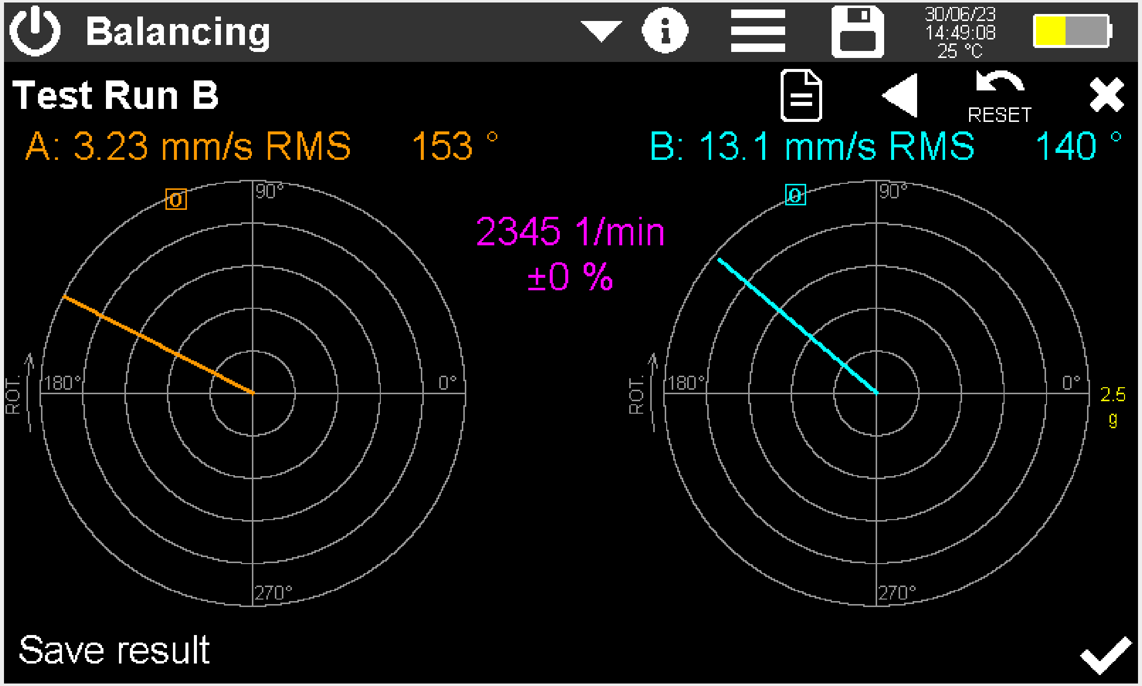
Enter the mass of test weight B and start rotation.



Test Run Plane B

Now vibration with test weight B is measured.

Press OK when the pointers are stable.

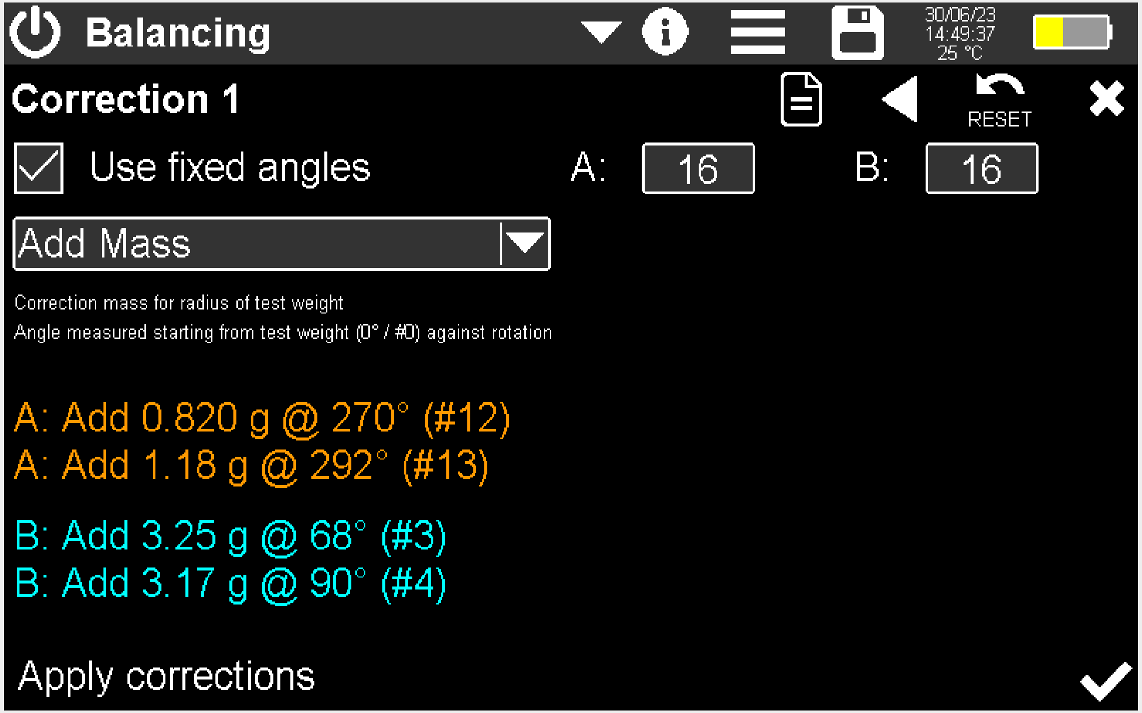


Corrections

The VM100 can now calculate correction weights for unbalance compensation.

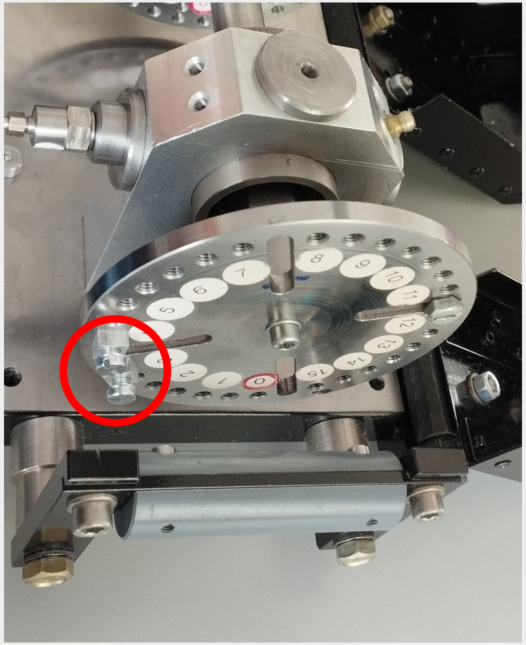
We have 16 holes in the steel disks for mounting correction weights (fixed angles).

Corrections are shown for two adjacent positions on each disk.



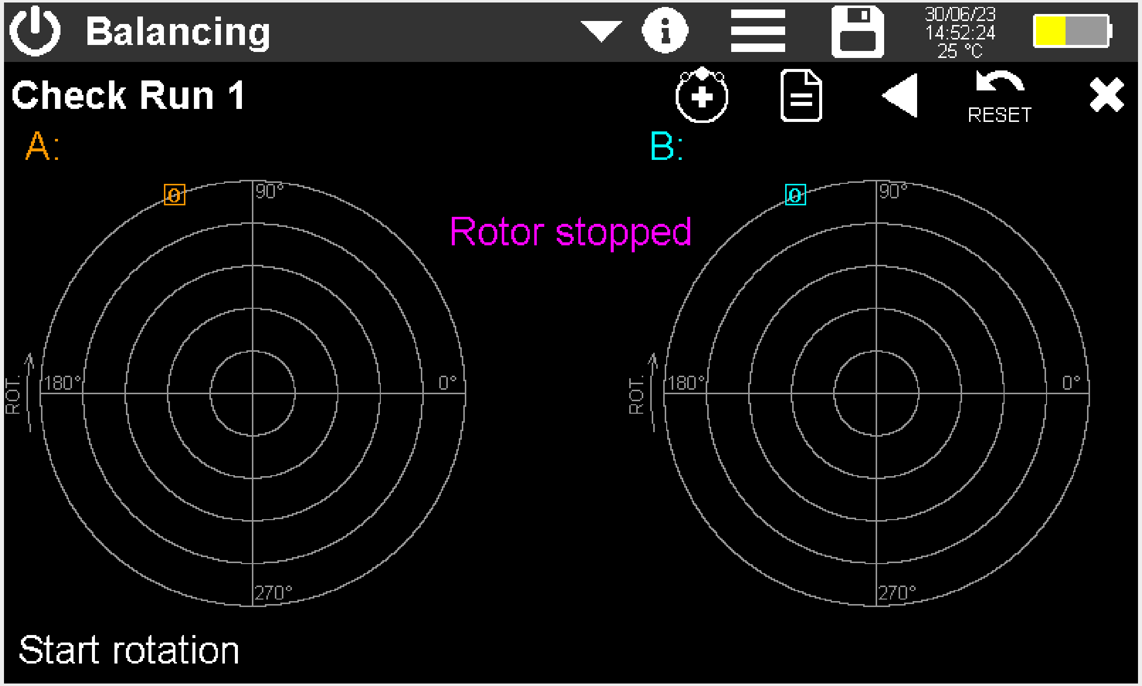
Corrections

Install the calculated mass pieces for both planes.



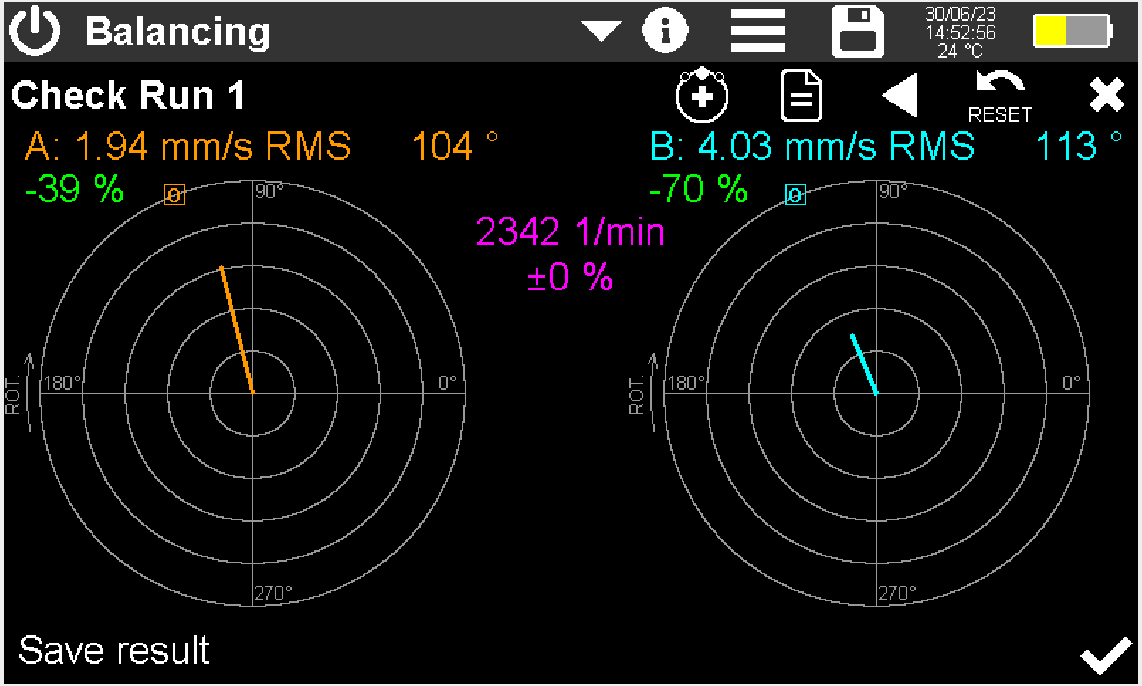
Check Run

Start rotation to see the result of the corrections made.



Check Run

We see improvements in both planes. Plane A is 39 % better and plane B 70 % better.

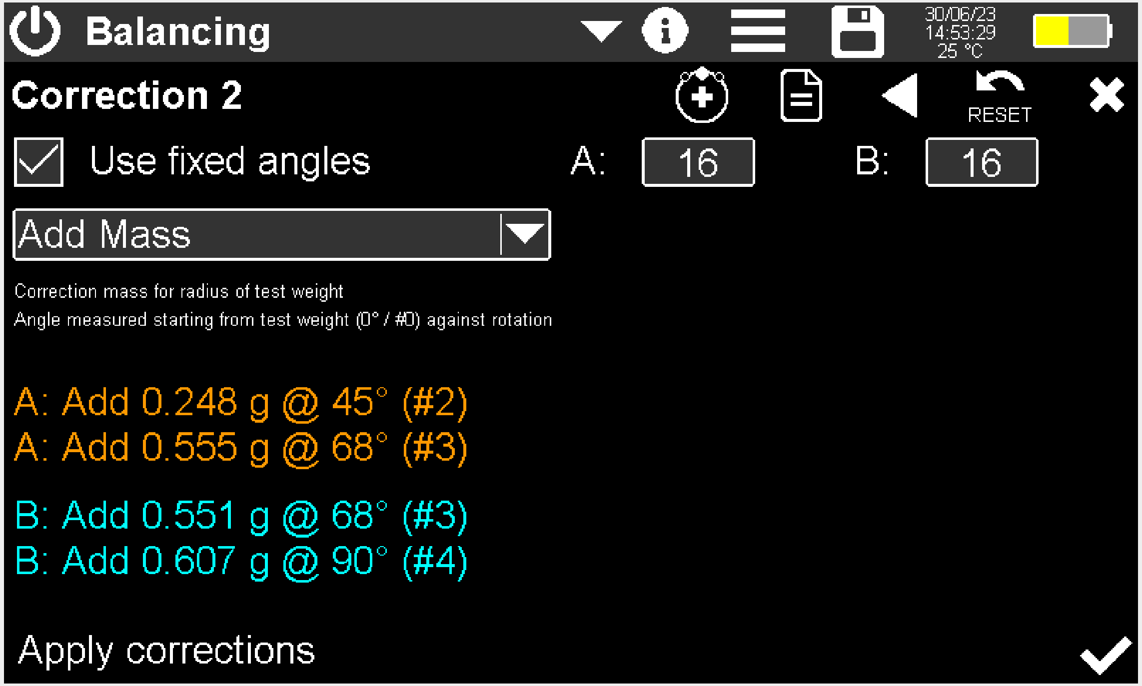


Correction 2

Usually we will not reach the optimum result at the first try.

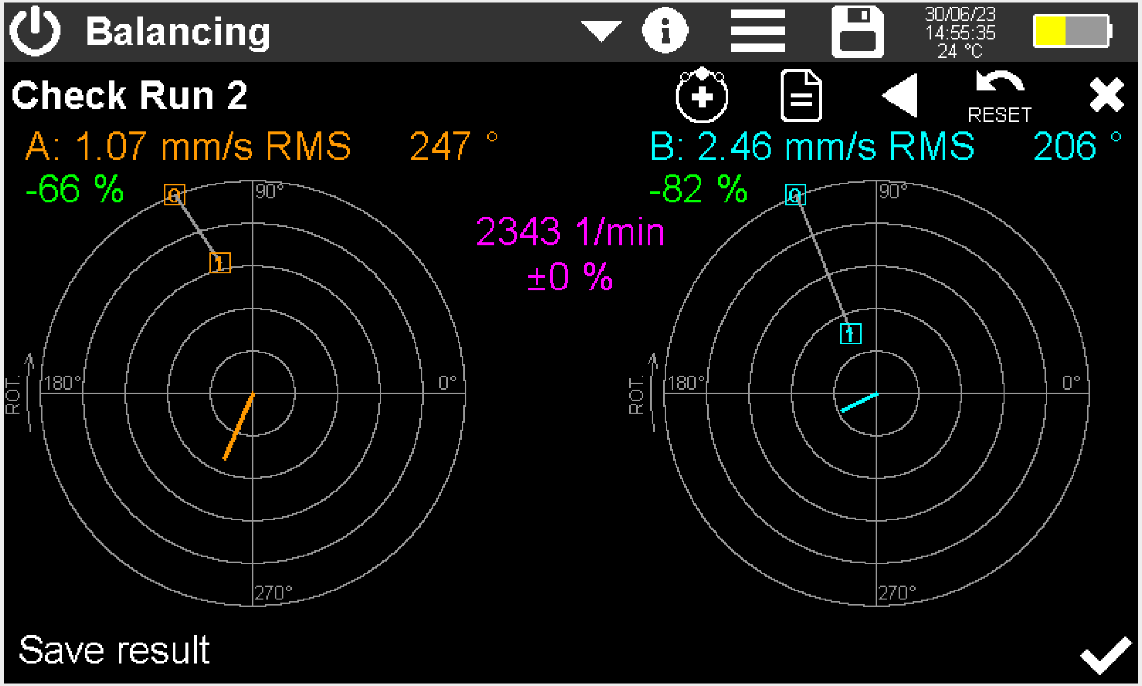
We can decide to continue.

The instrument suggests additional corrections.



Check Run 2

We see further improvements in both planes. Plane A is 66 % better and plane B 82 % better.



Some Useful Hints for Balancing (1)

- Accelerometers should be mounted as close as possible to the bearings.
- All balancing runs must be performed at the same rotary speed.
- The rotary speed must not be at the resonance frequency of the rotor. If possible, the acceleration amplitudes at different speeds should be measured in advance to rule out resonance excitation.
- Do not change the measuring setup (sensors, reflective label) during the balancing process.

Some Useful Hints for Balancing (2)

- If the position of the calibration mass is defined as 0°, all other measurements and correction measures are to be referred to this point.
- The angle positions of VM-BAL are always measured against the rotary direction.
- It may be necessary to repeat the balancing procedure a few times to obtain good results.
- The FFT and Amplitude/Time mode of the VM100 can be used to check whether machine vibrations result from unbalance or other sources.

Balancing Report

Press the “Save” button to save csv report including all measurements and changes made.

Sensor A:		Ser.:		Sensit.:	10.0	mV/ms^-2
Sensor B:		Ser.:		Sensit.:	10.0	mV/ms^-2
Date & Time:	30/06/23	15:00:25				
Temp:	25	°C				
Comment:						
NFC Id:						
Balancing mode: Two planes (sensors 1X/1Y)						
Rotary speed: 2345 RPM <1 %						
Rotor weight: ?						
Balancing radius A: ?						
Balancing radius B: ?						
Initial Run A: 3.16 mm/s RMS 111°						
Initial Run B: 13.5 mm/s RMS 112°						
Test weight A: 2.50 g 0°						
Test Run A-A: 4.36 mm/s RMS 161°						
Test Run B-A: 12.9 mm/s RMS 128°						
After test run: remove						
Test weight B: 2.50 g 0°						
Test Run B-A: 3.20 mm/s RMS 153°						
Test Run B-B: 13.1 mm/s 140°						
After test run: remove						
Correction A 1-1: +0.820 g 270°						
Correction A 1-2: +1.18 g 292°						
Correction B 1-1: +3.25 g 68°						
Correction B 1-2: +3.17 g 90°						
Check Run A 1: 2.00 mm/s RMS 104°						
Check Run B 1: 4.03 mm/s RMS 113°						
Correction A 2-1: +0.248 g 45°						
Correction A 2-2: +0.555 g 68°						
Correction B 2-1: +0.551 g 68°						
Correction B 2-2: +0.607 g 90°						
Check Run A 2: 1.10 mm/s RMS 242°						
Check Run B 2: 2.46 mm/s RMS 206°						
<END>						