

A photograph of an industrial facility, likely a power plant or refinery, featuring a long row of large blue pumps mounted on concrete bases. The pumps are connected to a complex network of large yellow pipes. The scene is illuminated with a warm, yellowish light, creating a high-contrast, industrial atmosphere.

FLUKE.

Fluke 831 Laser Shaft Alignment

**Best Practices
learned from other
maintenance teams**

Meet the speakers



John Bernet, CMRP
Application Specialist,
Fluke Reliability
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- Reliability Application Specialist at Fluke Corp. (11 years)
- Previously worked at Azima DLI for 18 years
- Served 12 years in U.S. Navy on cruiser & aircraft carrier as electrical technician & maintenance supervisor
- Certified Maintenance Reliability Professional (CMRP)
- Has 40+ years of experience in preventive and predictive maintenance



Jonathan Gough
Senior Product Manager,
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- Senior Product Manager at Fluke Reliability (3 years)
- Previously worked for:
 - Pruftechnik Ltd, England (2 years)
 - Pruftechnik South East Asia, Singapore (3 years)
 - Prüftechnik Dieter Busch, Germany (19 years)
- Has 30+ years of experience in both the Alignment and Vibration condition monitoring sector

Agenda

- **Team challenges / solutions**
 - Maintenance workflow
 - Why keep replacing the same bearings and seals

- **Alignment principles**
 - Why alignment / parameters / symptoms / methods

- **Fluke 831– value / benefits**
 - Shaft and belt alignment
 - Why needed for all machines
 - Key features / technology

- **Fluke 831– how to use it**
 - 3 easy steps

- **Questions and Answers**

Every organization is somewhere on this journey ...



3 challenges confronting today's maintenance leaders



1

How do we grow a reliability program
... when we are 100% busy?

We have no time to collect/analyze data and generate reports.

2

How do we make the best decisions
... when we have incomplete information?

We don't have time to conduct all the necessary routes, nor can we have access to all machines

3

How do we monitor all critical assets
... with limited resources?

We must allocate/balance resources needed for planned/calendar-based maintenance, repairs, and emergencies, etc.

Predictive equipment vendors have been developing and improving tools / software

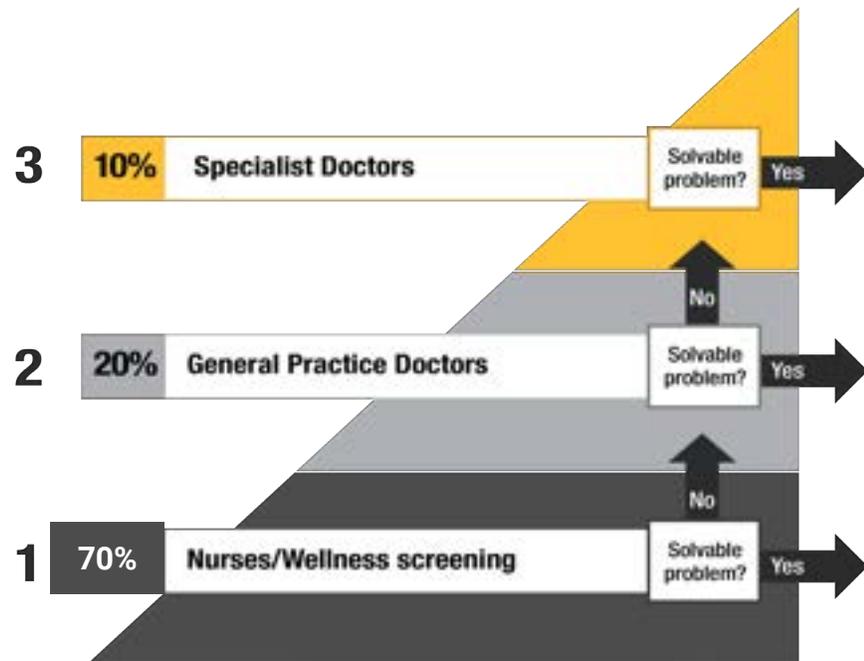
So why are most companies (in almost all industries) still mainly using reactive and preventive methods?

Today's tools are the most advanced, and training has never been easier, but the problem is always time and resources.

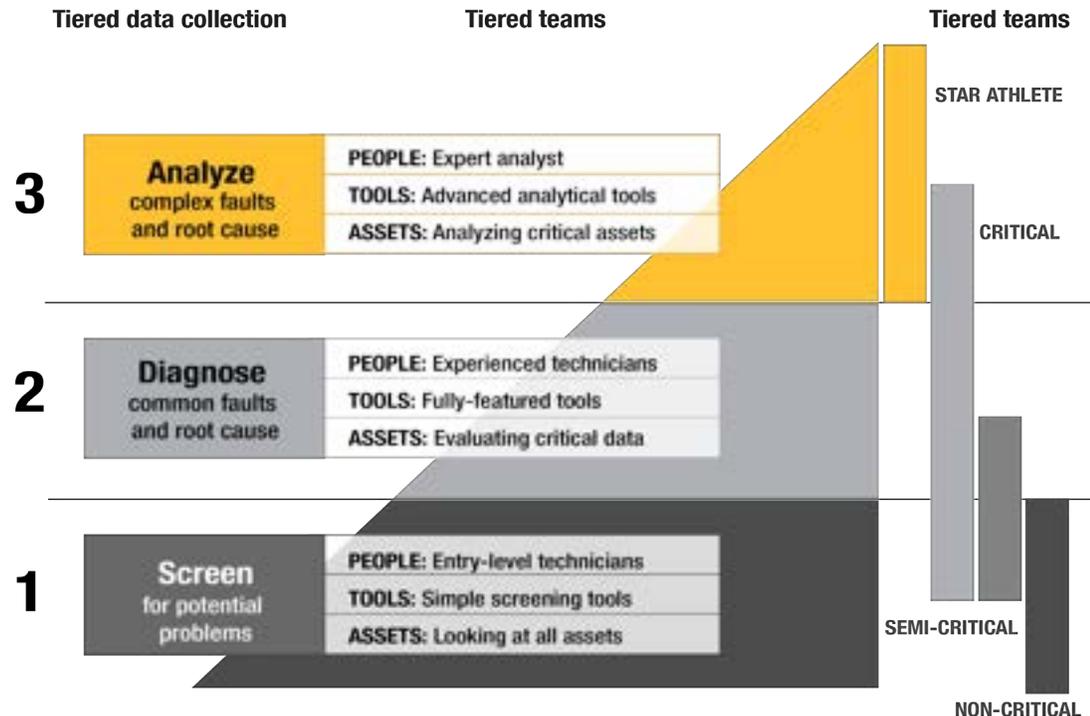
The criticality dilemma – a healthcare parallel

Everyone is **EQUALLY** important **AND** resources are limited. What to do?

- 1) Create a cut-line and only serve the critical people? → UNACCEPTABLE
- 2) Build-up the vast resources needed to give everyone 100% care? → UNSUSTAINABLE



- Tiered levels of training and certification
- Tiered levels of workers
- Tiered volume of visits / inspections
- Tiered amount of time spent on each person



Condition-based screening helps relieve workload at each level of care

Total condition maintenance in four simple steps: To keep your plant up and running

Automated tools for common faults on standard machines by technicians - no advanced training

SCREEN

805 FC
Vibration Meter



DIAGNOSE



810 Vibration Tester

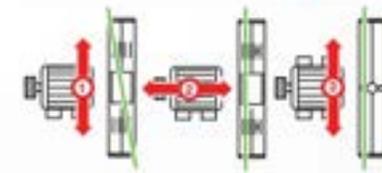


Fluke 835 Laser Belt Alignment

CORRECT

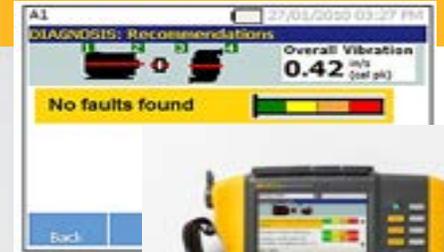


831 & 835 Laser Alignment Tools



VERIFY AND REPORT

805 FC
Vibration Meter



810 Vibration Tester

820-2 LED
Stroboscope



Why do teams keep replacing the same bearings and seals?

Need to find root cause of the problem – fix the root cause don't just fix the symptom



50% of rotating machine damage is directly related to misalignment



Flexible couplings just transfer forces to bearings and seals



Most teams just replace bearings and seals because alignment takes too much time

Diagnose the root cause

Diagnostic tester reports all faults – don't ignore the root cause (misalignment, imbalance, looseness)

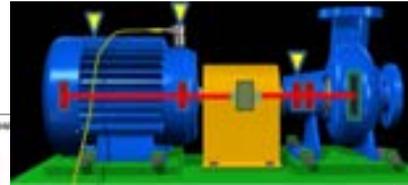


330 Vibration Tester Diagnosis

Diagnosis:	Fault Severity	Severity Score	Severity Scale
Pump Drive End Ball Bearing Wear	Extreme	82/100	Red
Motor Drive End Bearing Wear	Extreme	81/100	Red
Pump Free End Ball Bearing Wear	Serious	72/100	Orange
Motor Free End Bearing Wear	Serious	63/100	Yellow
Parallel Misalignment	Moderate	48/10	Green
Angular Misalignment	Moderate	34/100	Green

Recommendations:

Recommendation	Priority	Priority Description
Replace Pump Bearings	4	Mandatory
Replace Motor Bearings	4	Mandatory
Monitor For Increased Vibration	2	Desirable



Correct the root cause on most machines

Step-by-step alignment tools provide quick, easy precision alignment to fix root cause on most machines in the plant (not just a few)



"We electricians would replace the motor bearings and mechanics would replace the pump bearings and seals, and we'd slap it all back together. In a few months we would do it all over again. Then we learned to perform precision shaft alignments, and the bearings would last for years and years."

Maintenance Supervisor from US Navy

And yet ...



Alignment is easier, but there are still obstacles

- Changing workforce – knowledge is lost
- Less time available
- More complex machines with less technical support

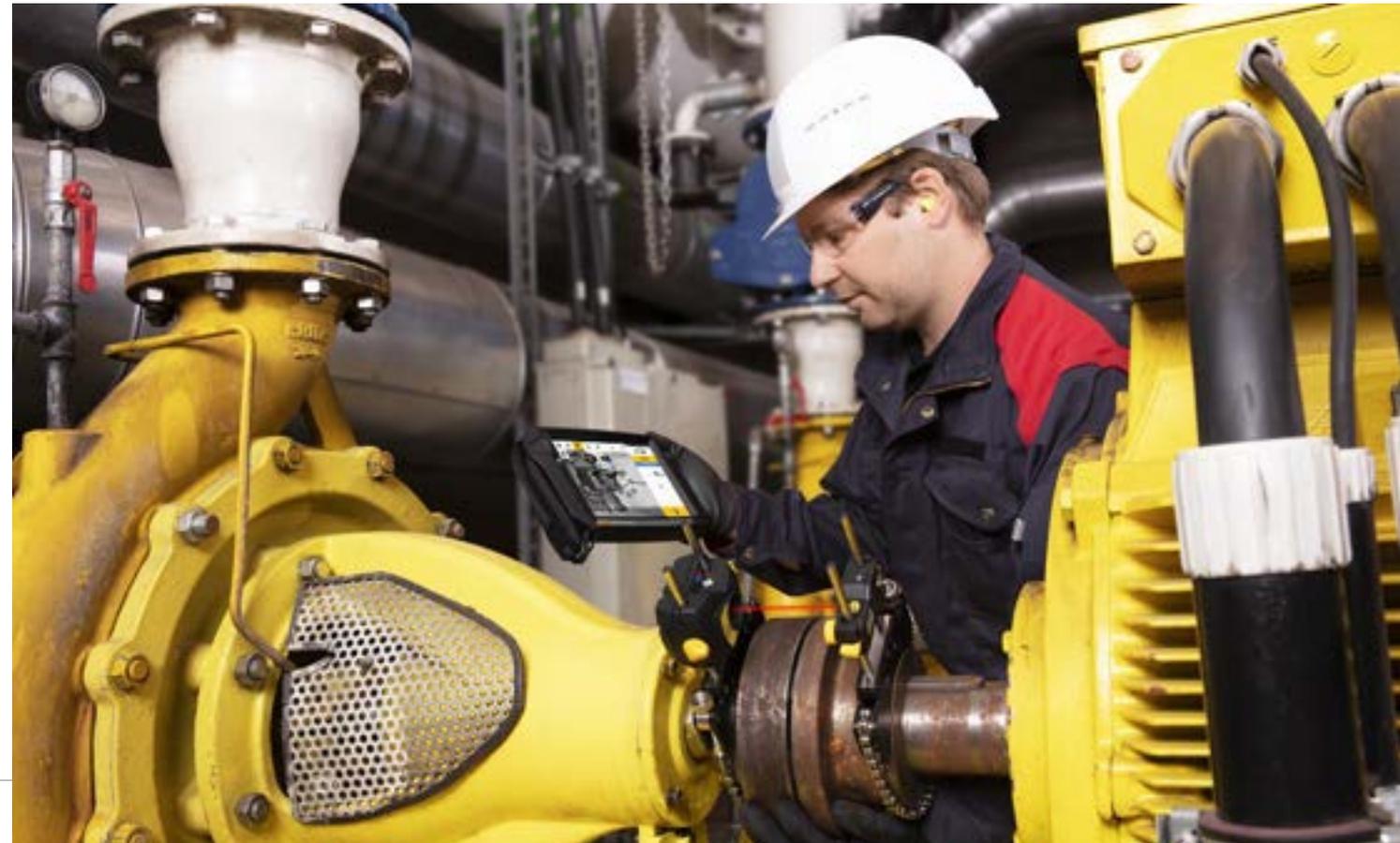
How to succeed when you're always being asked to do more with less?

The answer =>
The next generation of laser alignment technology – adaptive alignment.

Adapt to the asset - Single-laser technology adapts to virtually all rotating assets.

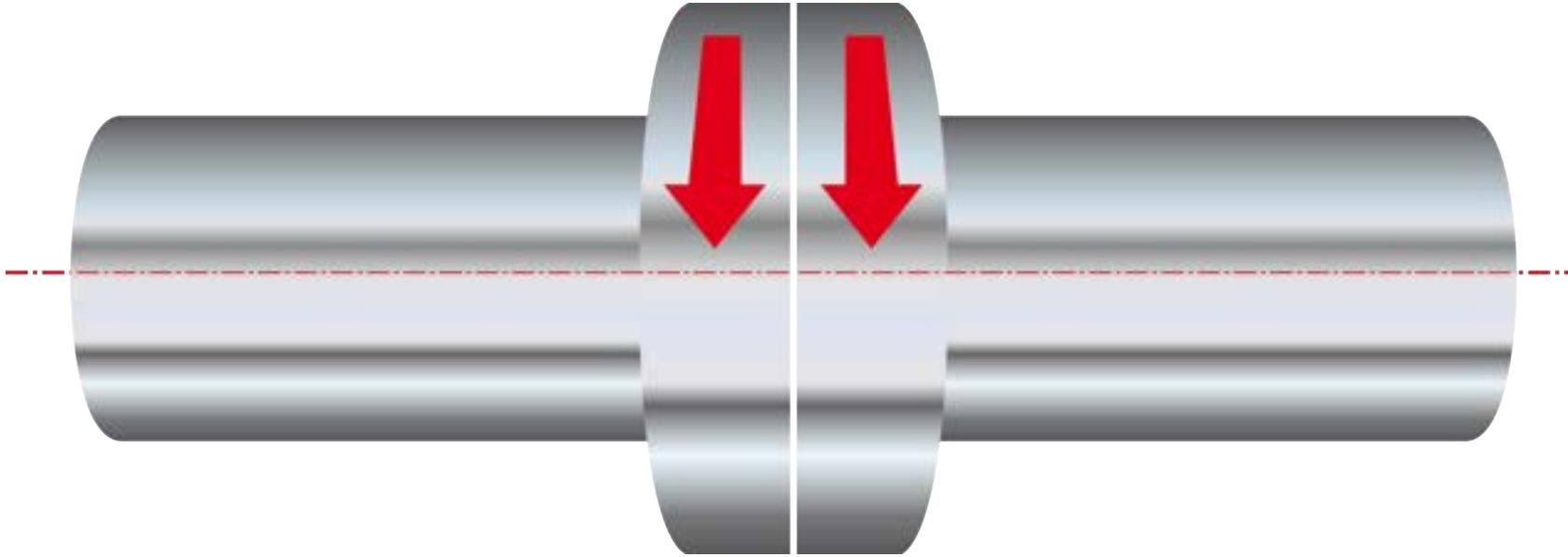
Adapt to the situation - Automatically adjust in real-time for challenges such as initial gross misalignment.

Adapt to the team - Support every technician's level of experience by eliminating user errors and enabling team collaboration through the Cloud.



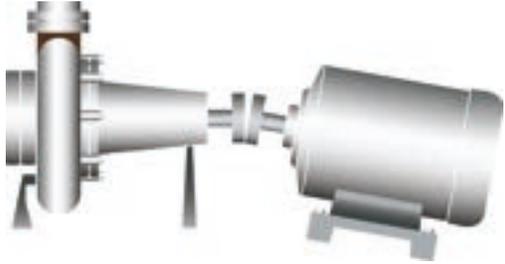
Alignment Principles and Methods

What is shaft alignment ?

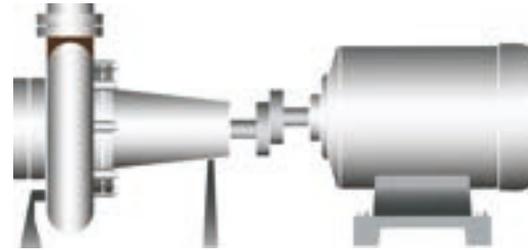


at the point of power transfer from one shaft to another, the axes of rotation of both shafts should be colinear when the machine is running under normal operating conditions

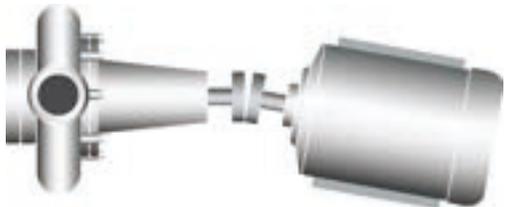
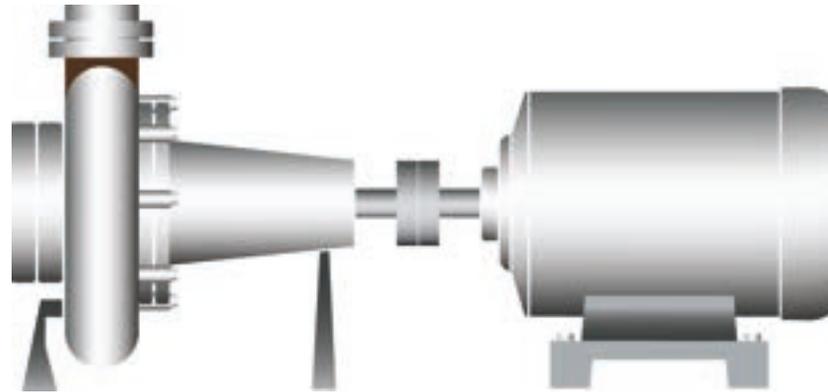
The 4 alignment parameters



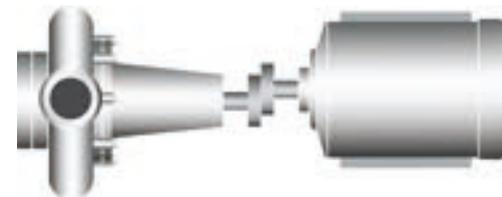
Vertical angularity



Vertical offset



Horizontal angularity

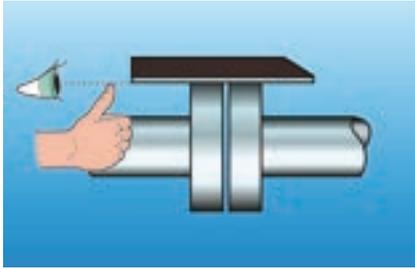


Horizontal offset

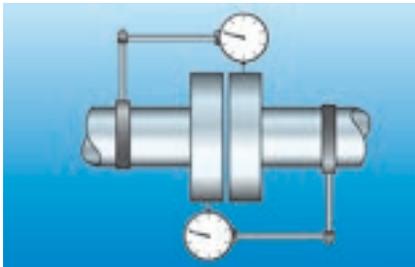
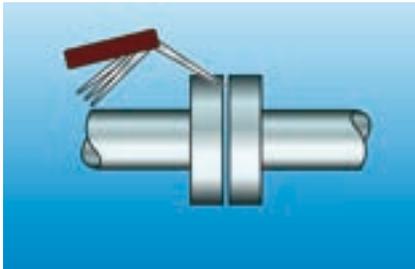
Symptoms of misalignment

- Excessive radial and axial vibration.
- High casing temperatures at or near the bearings or high discharge oil temperatures.
- Excessive amount of oil leakage at the bearing seals.
- Loose foundation bolts, shim packs or dowel pins.
- Loose or broken coupling bolts.
- Some flexible coupling designs run hot under misalignment conditions. If it is an elastomeric type, look for rubber powder inside the coupling shroud.
- Similar pieces of equipment are vibrating less or seem to have a longer operating life.
- Unusually high number of coupling failures or they wear quickly.
- The shafts are breaking (or cracking) at/or close to the inboard bearings or coupling hubs.
- Excessive amounts of grease (or oil) on the inside of the coupling guard.

Common alignment methods



Straightedge/Feeler gauge
Resolution 1/10 mm

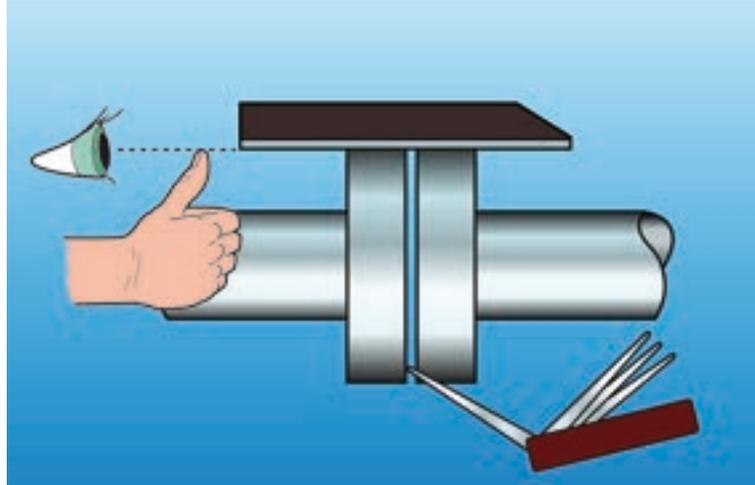


Dial indicator
Resolution 1/100 mm



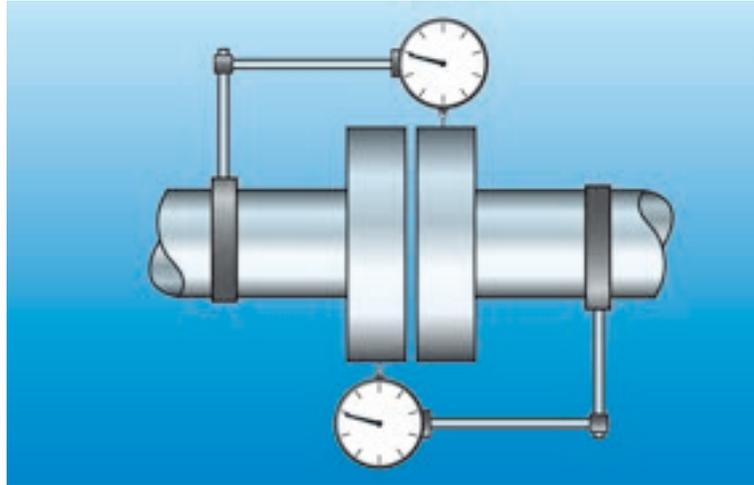
Laser-optical alignment
Resolution 1/1000 mm

Straightedge and feeler gauges



- Limited resolution of the human eye:
0.1 mm / 0.004"
- Coupling alignment - not shaft alignment
- Prone to coupling fitting errors
- Trial and error corrections
- No documentation
- Far too inaccurate for most machines

Dial indicators



- Resolution (typical): 0.01 mm /0.0004”
- Bracket sag
- Mechanical play
- Possible sign error
- Calculations complicated
- Requires high user experienced.

How accurate are dial indicator readings?

Sagging Indicator brackets

Sag should always be measured before actual alignment readings are taken irrespective of how solid the bracket appears.



Low resolution

Up to 0.005 mm rounding error may occur with each reading – which easily results in an error of up to 0.04 mm in the calculated results.



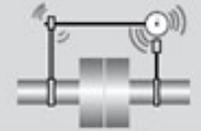
Sticking/jumping dial hands

Sometimes the indicator must be tapped in order for the needle to settle on its final value.



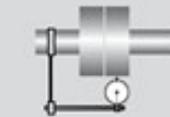
Play in mechanical linkages

Slight amounts of looseness may not be noticed, yet produce large errors in results.



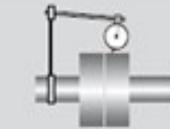
Reading errors

Human errors occur all too often when dials must be read under cramped, poorly-lit conditions and severe time constraints.



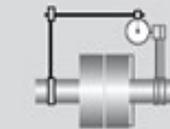
Tilted dial indicator

The indicator may not be mounted perpendicular to the measurement surface so that part of the displacement reading is lost.

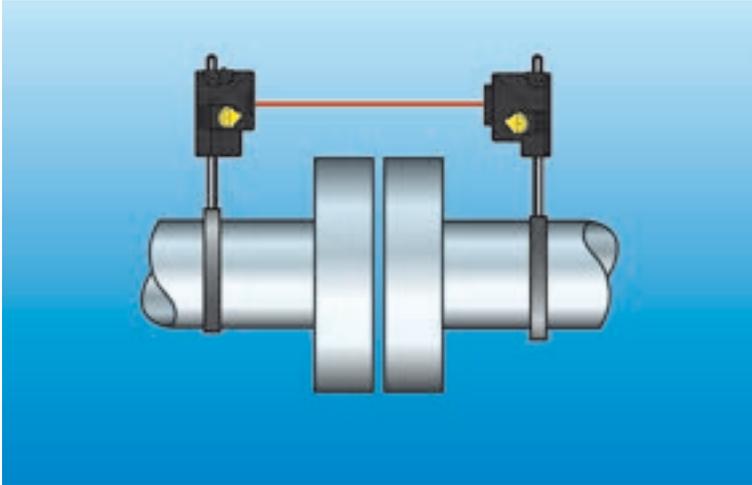


Axial shaft play

This can affect face readings taken to measure angularity unless two axially mounted indicators are used.



Laser alignment methods



- Resolution of 1/1000 mm (0.00004")
- Universal bracket
- No bracket sag influence
- Human error free
- Accurate measurement
- Graphical result display:
No misinterpretation
- Alignment evaluation
- “Live” corrections
- Documented results

Laser Shaft Alignment Tool

- Value / Benefits**
- Overview**

Laser Shaft Alignment Tool

Get more out of your rotating machines through proper alignment

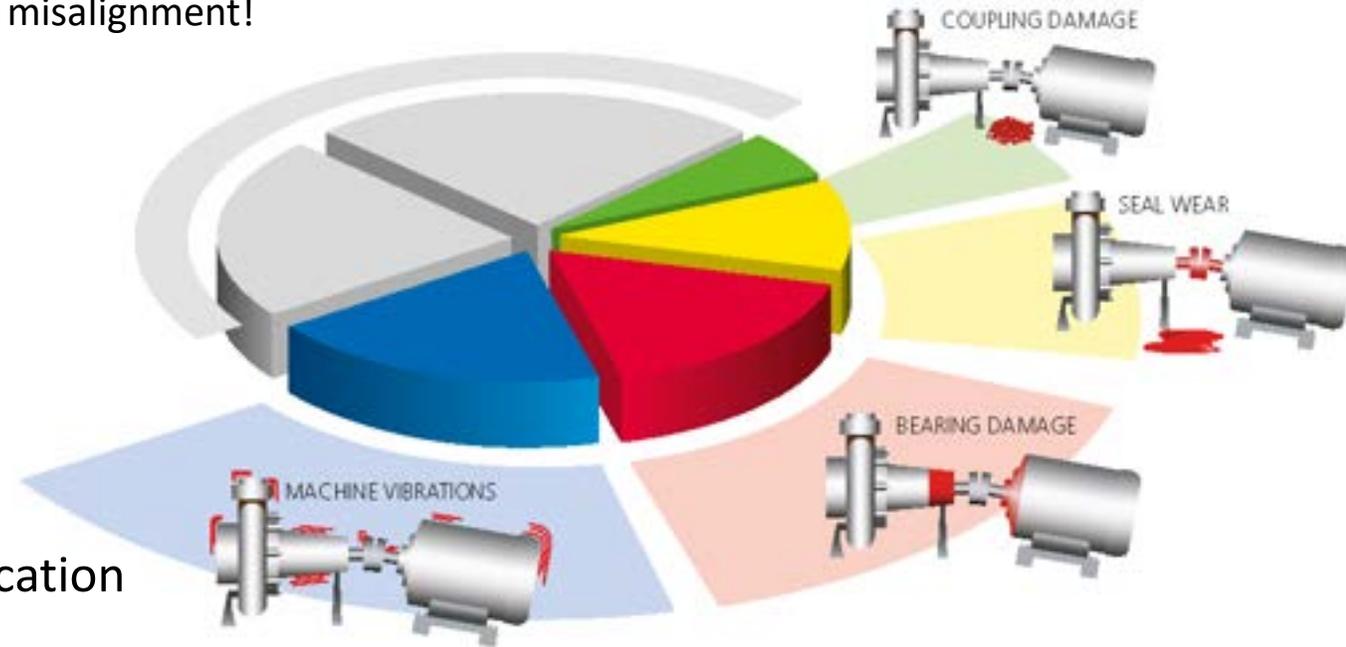
- An aligned coupled system reduces bearing and coupling wear, and vibration of machinery, which in turn leads to improved machine performance.
- See the benefits of precision alignment on most of your machines not just a few of the most critical

Benefits: Cost savings:

- Up to 50% of damage to rotating machinery is directly related to misalignment!
- Well aligned machines reduce operating and maintenance costs
- Reduced bearing and mechanical seal repairs

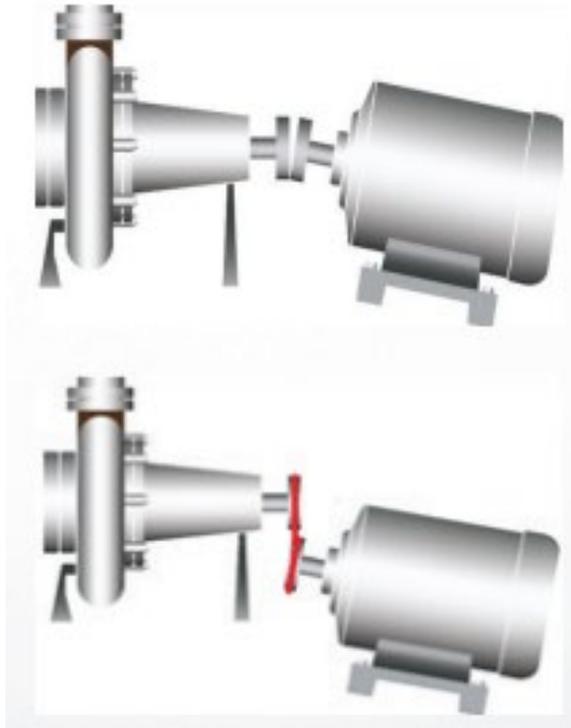
Benefits: Why precision alignment is so crucial:

- Decreased power consumption
- Longer machine lifecycle
- Less vibration leading to less wear (other faults)
- Lower temperatures on bearing, coupling and lubrication
- Reduced costs for storing spare parts



ANSWERS not just data— easy to read report

Combine the laser shaft & belt alignment tools to align both coupled and belt-drive machines



- ✓ You could be losing thousands of dollars per year in replacement bearings and hours of unnecessary repair time
- ✓ Today's maintenance departments can't afford crippling unplanned downtime and wasted energy
- ✓ See the benefits of precision alignment on most of your machines not just a few of the most critical

Precision alignment can provide

UP TO **65 %**
Reduction in seal repairs

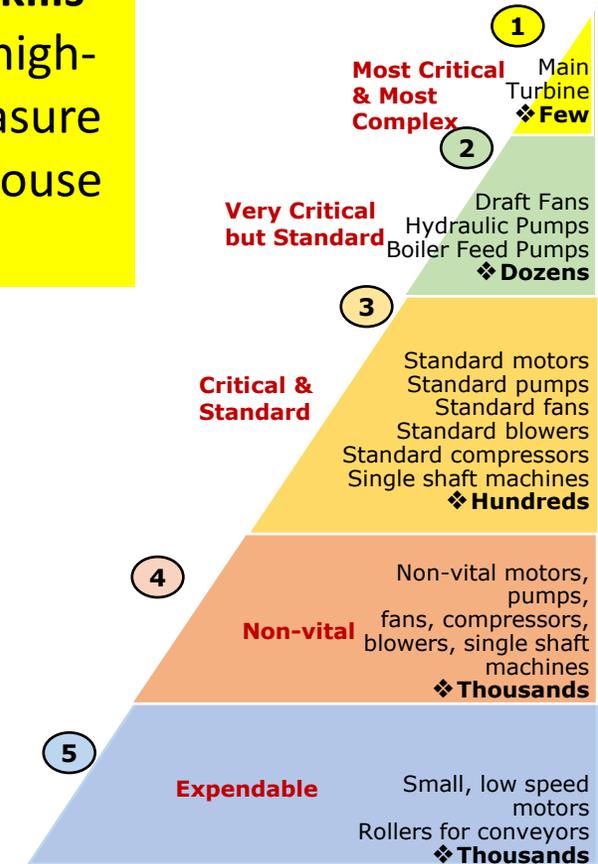
UP TO **50 %**
Longer bearing life

UP TO **10 %**
Reduction in energy waste

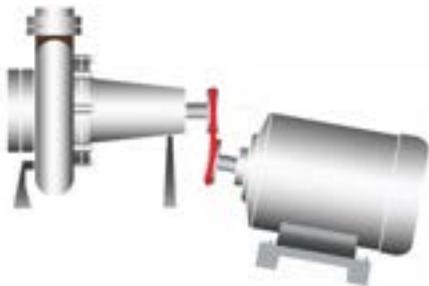
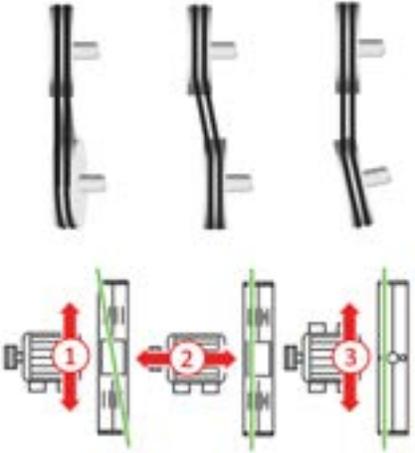
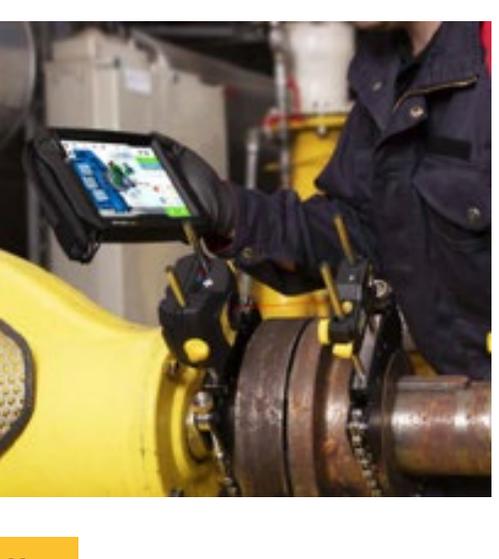
How to justify the cost of alignment for more than a few critical machines?

More complex applications typically require more advanced tools/skills
→ e.g., Long Spacer-shaft applications, Cardan shaft alignment and high-speed critical turbo machine trains (with gearboxes) additionally measure dynamic machine positional change (Live-Trend), typically not for inhouse technician/millwright, but more commonly OEM Service engineers

- The standard laser shaft alignment tool allows technicians to conduct quick, easy precision alignments that get to the root cause of the alignment issues of most machines in a plant.
- You should align EVERY machine that is overhauled or repaired because the savings from bearings, seals, production loss, energy waste, etc. can be multiplied by hundreds of machines to save thousands of dollars a year.



Applications: Shaft & Belt driven rotating machinery

Alignment Tool	Application	Stationary - Moveable	3 quick, easy steps	Corrections to moveable
	<p>Laser Belt Alignment Tool for Belt-Drive Machines</p>			
	<p>Laser Shaft Alignment Tool for Coupled Machines</p>			

Best Practice Solution

Fluke 831 Laser Shaft Alignment Tool

PRECISION SHAFT ALIGNMENT MADE EASY

A simple three step process provides machine condition answers without difficult analysis.

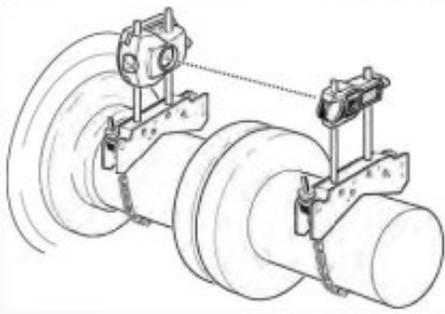
✓ **Intuitive guided user interface for quick and complete alignments without extensive alignment education or complicated programs that customers won't use**

✓ Up to 50 % of damage to rotating machinery is directly related to misalignment— most customers ignore it and simply replace the bearings and seals

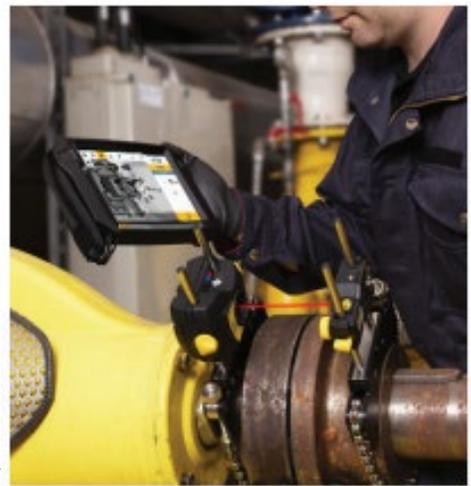


✓ Flexible couplings do not make up for the misalignment in a machine they simply transfer the forces to the bearings and seals causing rapid wear and failure

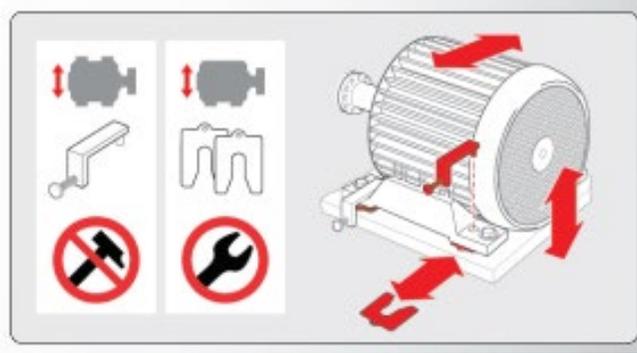
1 Dimensions



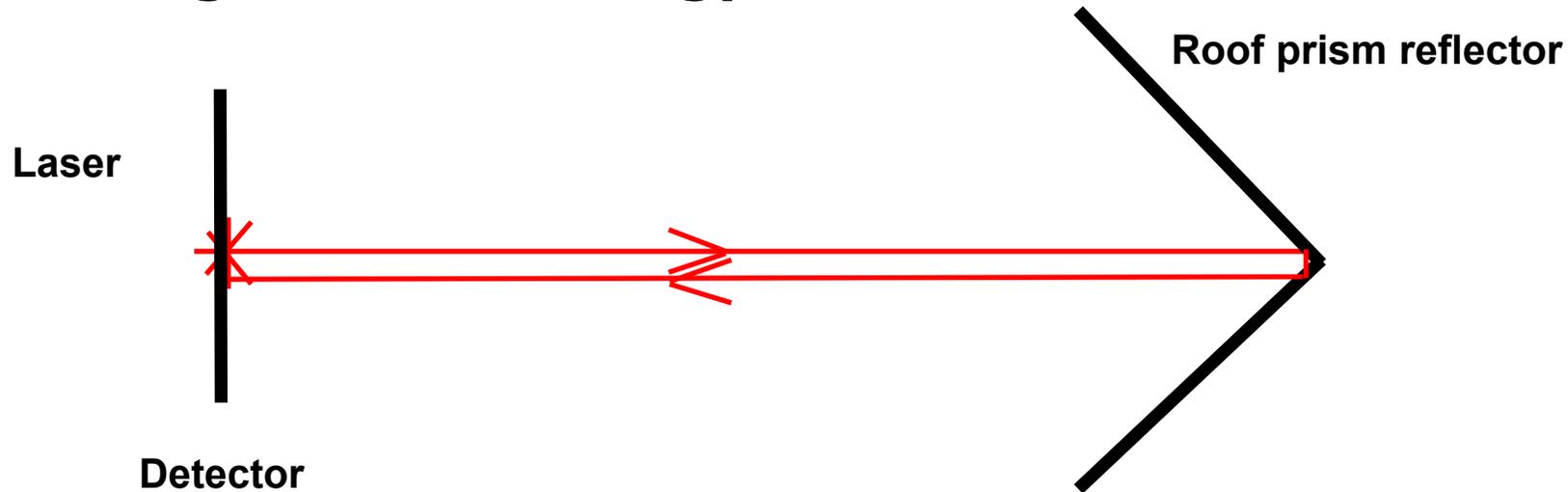
2 Measure



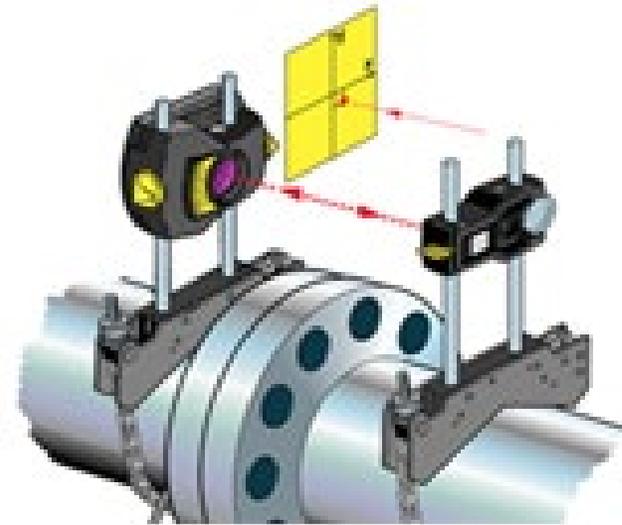
3 Results



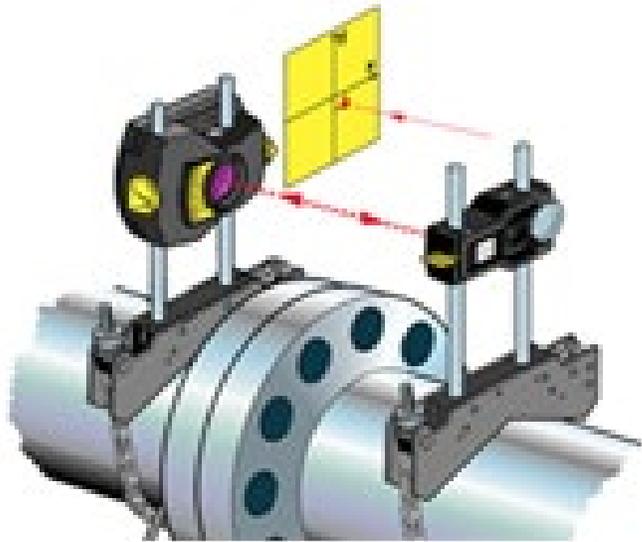
Laser Alignment technology



- The single laser beam technology is easier, quicker, and more accurate than two lasers.
- The laser head is mounted on the left side of the coupling and the prism is mounted on the right.
- The beam comes out of the transducer eye across the distance of the coupling, strikes the precision prism and is reflected back to through the transducer eye to the sensor
- The **auto-collimating laser optics system** is less susceptible to backlash



Laser alignment measurement principle

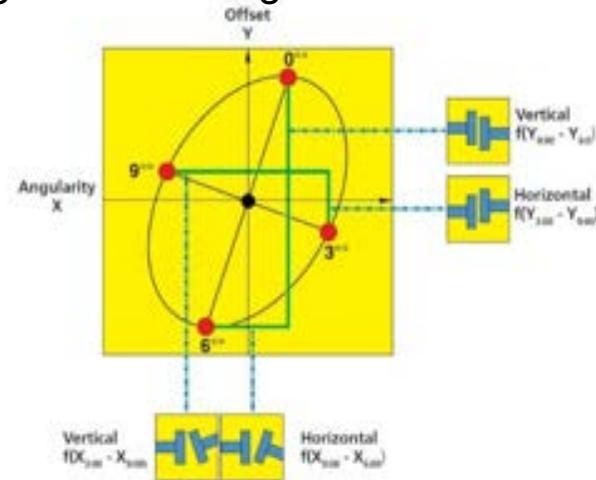
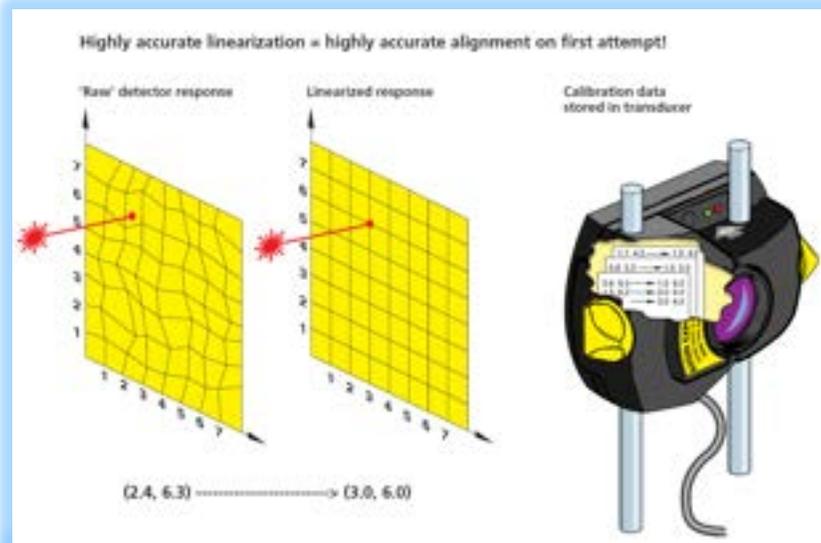


Single laser principle

- One sensor / prism
- One roof prism as reflector
- Quick setup and laser beam adjustment
- Built-in electronic inclinometer

By measuring the laser beam as the heads rotate with the shaft, the sensor measures/plots the laser movement.

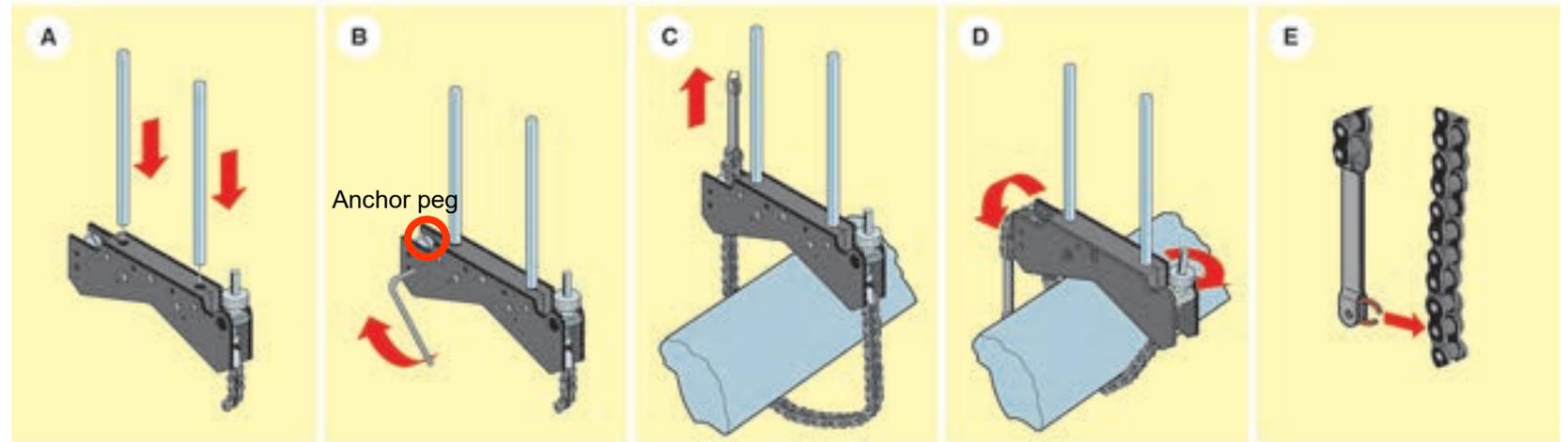
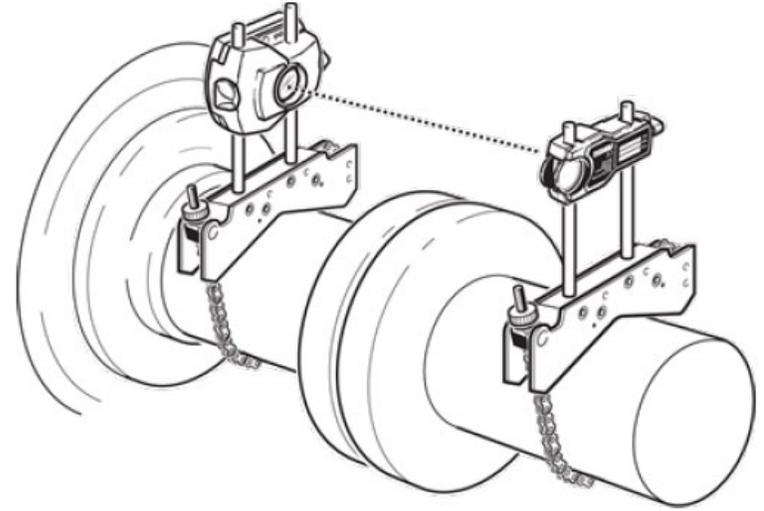
A calculation is then made by the shape of the ellipse to get misalignment readings for both shaft offset and angularity



How to use the Laser Shaft Alignment Tool – Follow guided workflow

Mount brackets on shaft in preparation

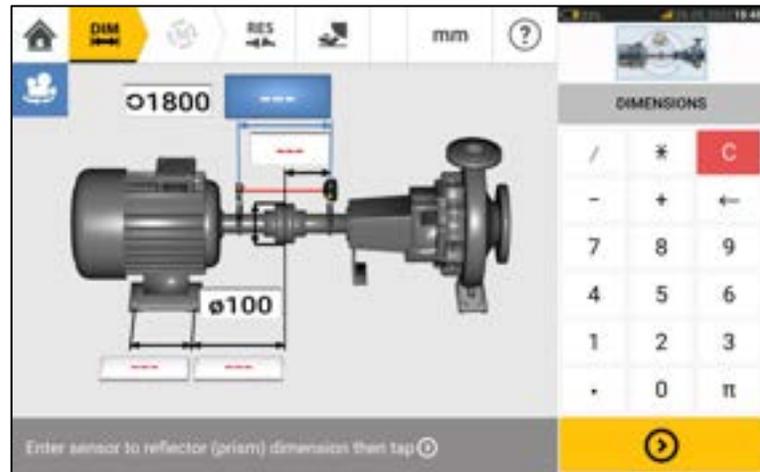
Mount the brackets on either side of the coupling on either the shafts or on the solid coupling hubs, and both at the same rotational position.



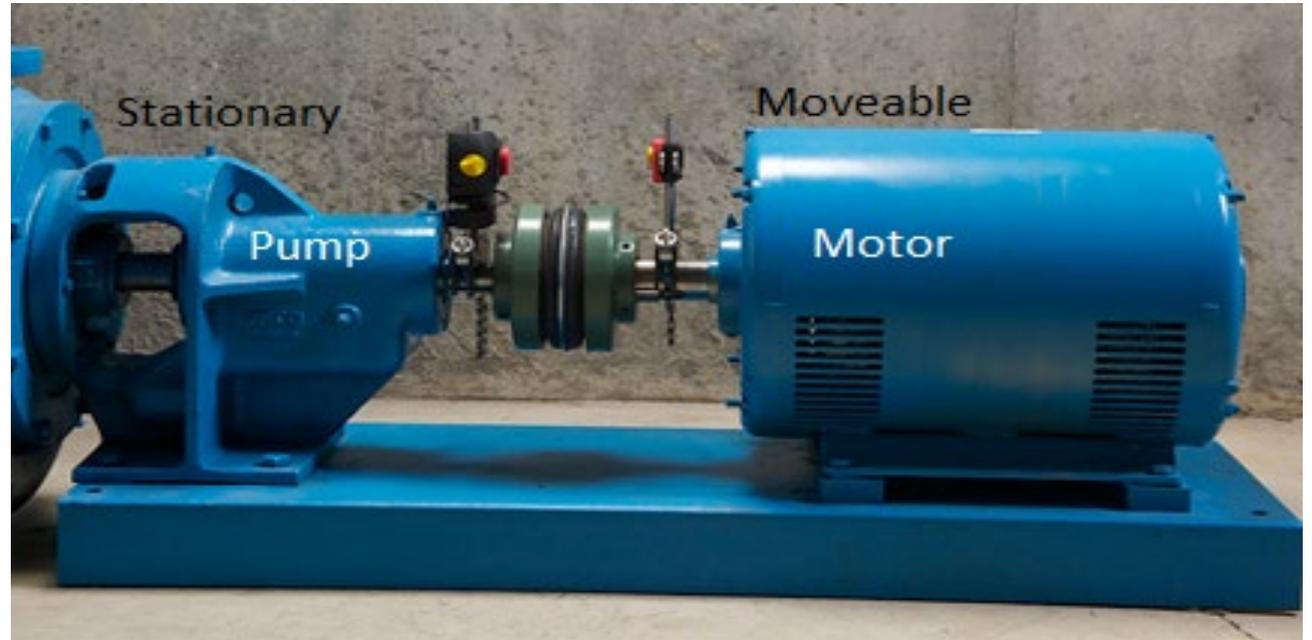
Machine configuration



Confirm machine configuration matches your machine
- if not, switch view and change machine images



Typical setup

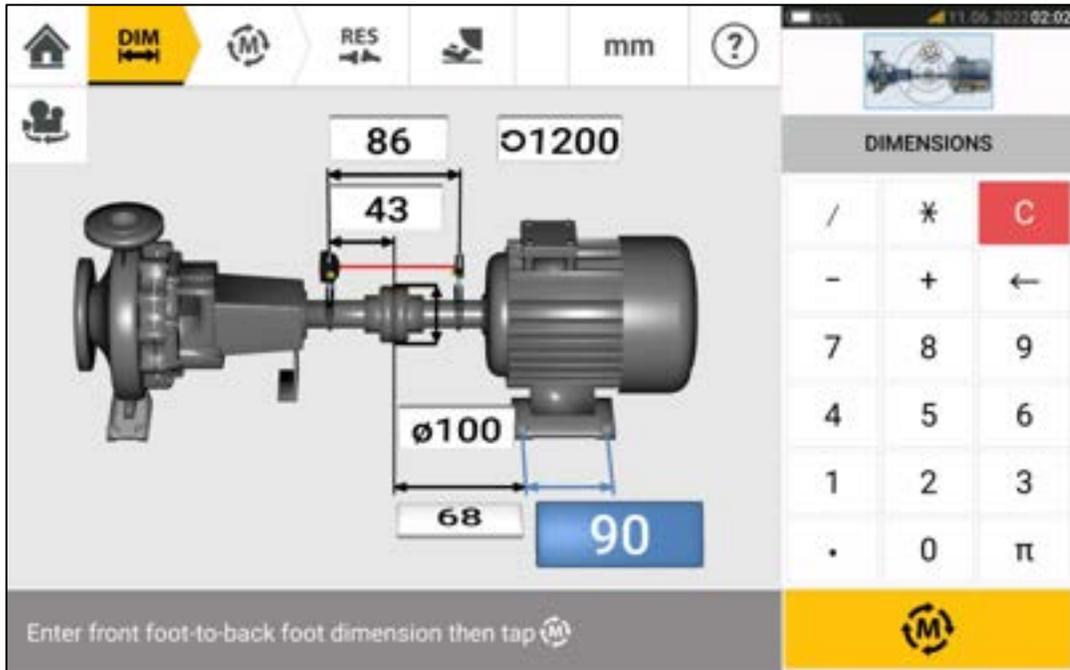


Typically: Mount sensor on "Left machine" – usually Stationary (pump)

Mount prism on "Right machine" – usually Moveable (motor)

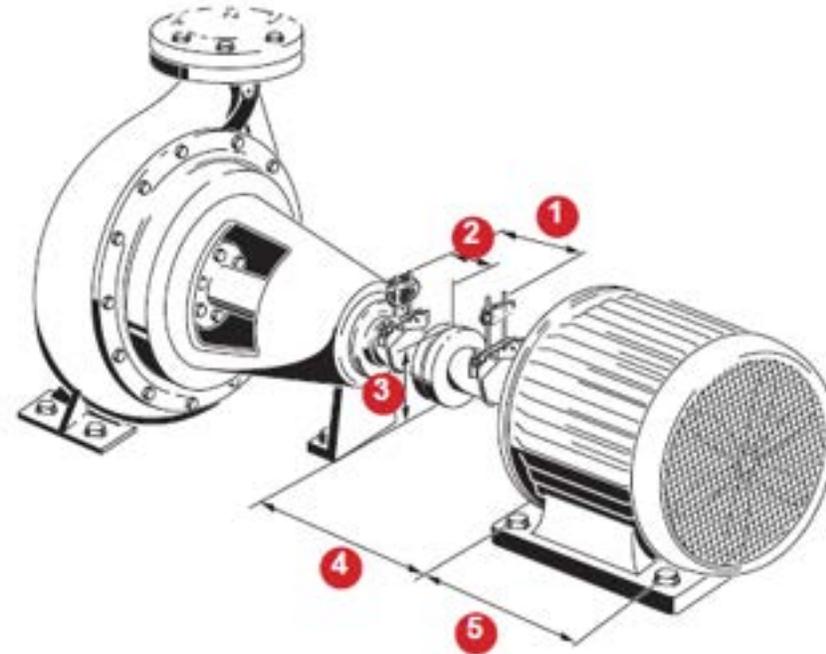
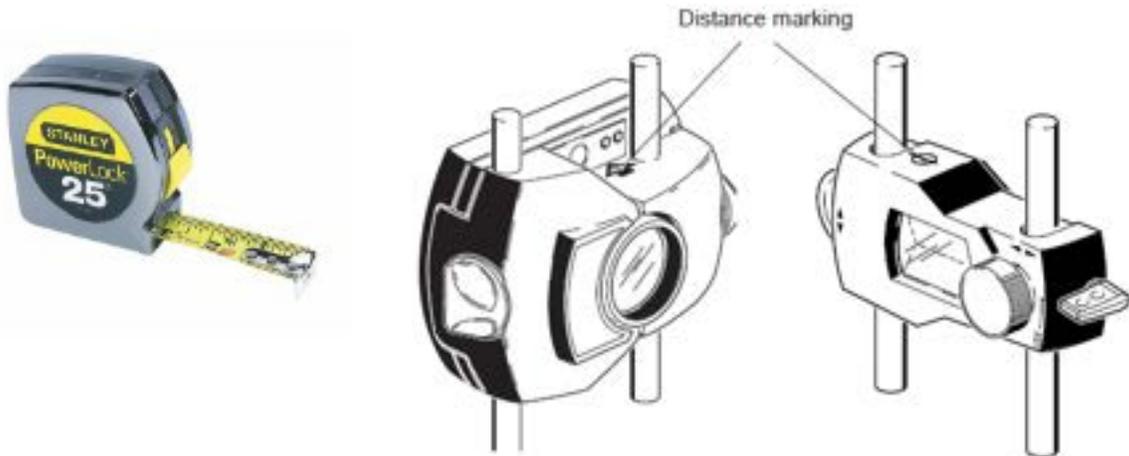


Dimensions



Tap the dimension fields and enter all required dimensions.

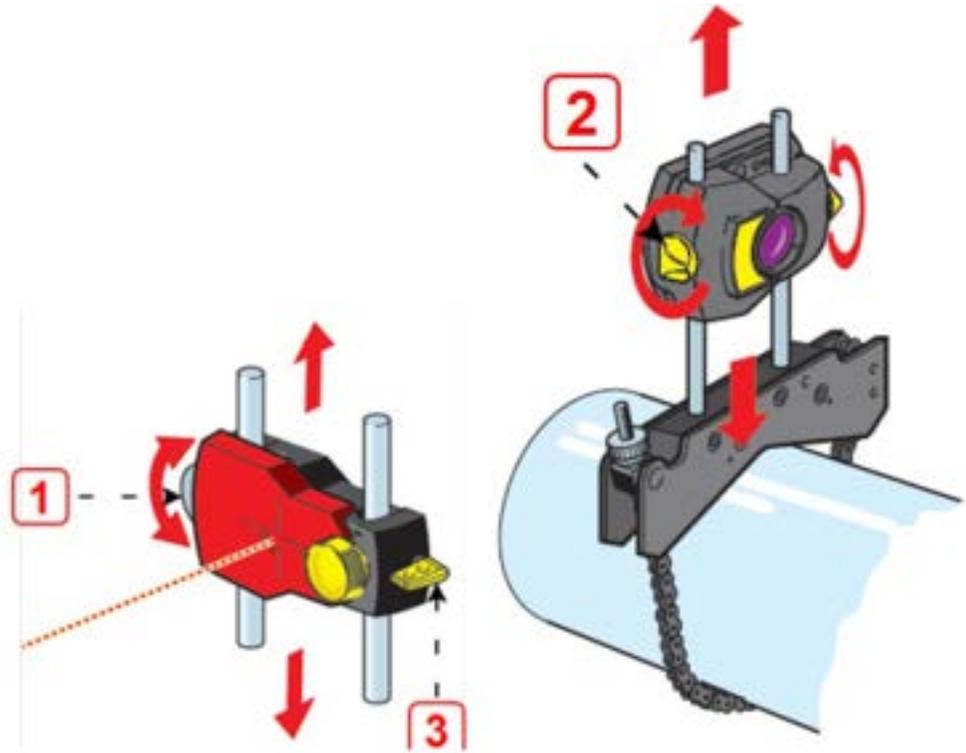
When all required dimensions have been entered, the 'Measure' icon appears.



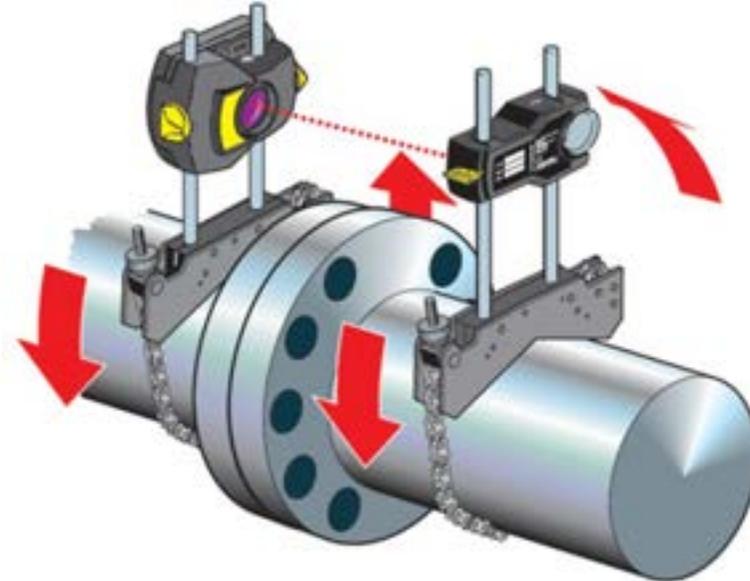
Laser beam adjustment

3. With the reflector dust cap still in place, reposition the components until the laser beam strikes the center of the target on the reflector dust cap

Slide the reflector or sensor up and down along the support posts. To move the sensor, use the yellow knobs.



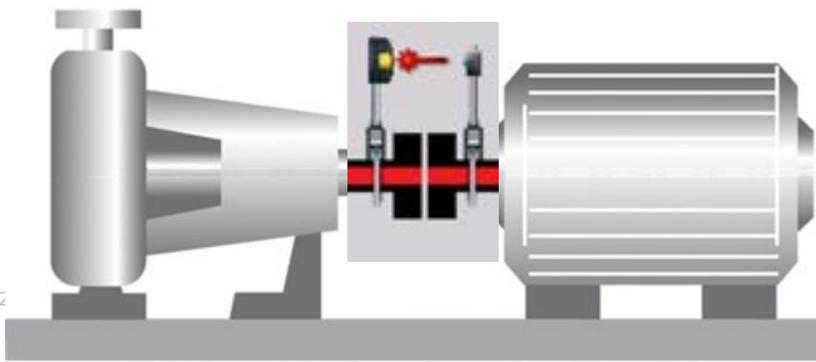
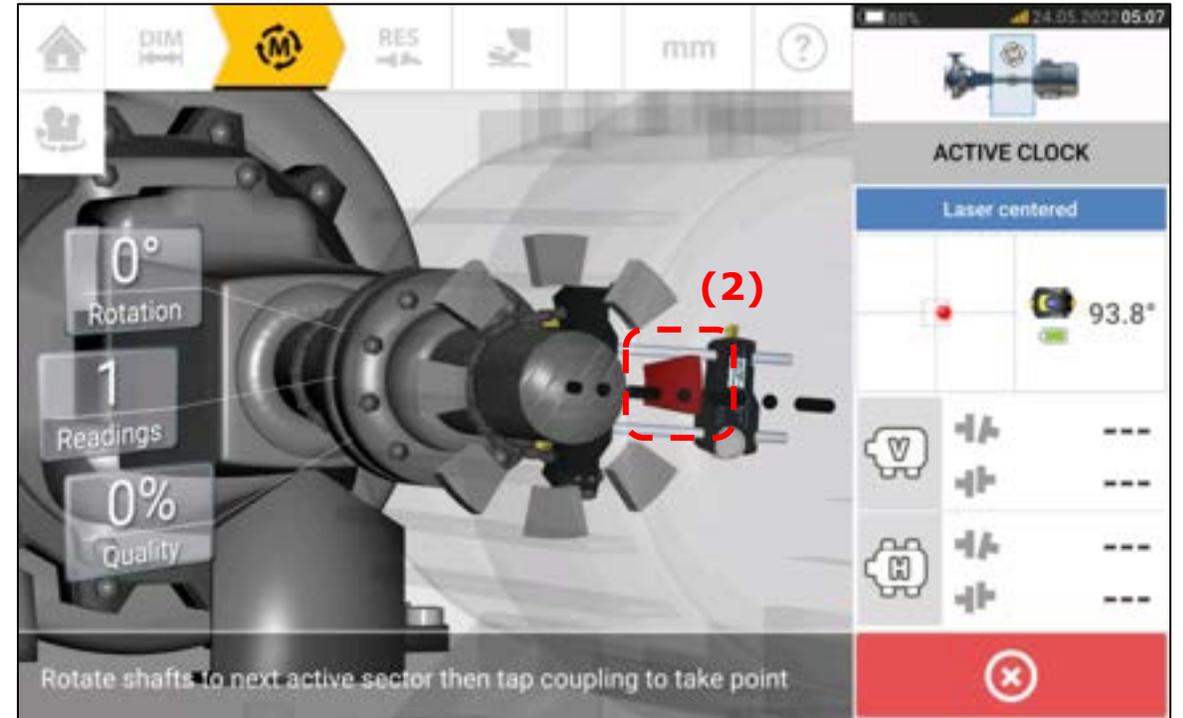
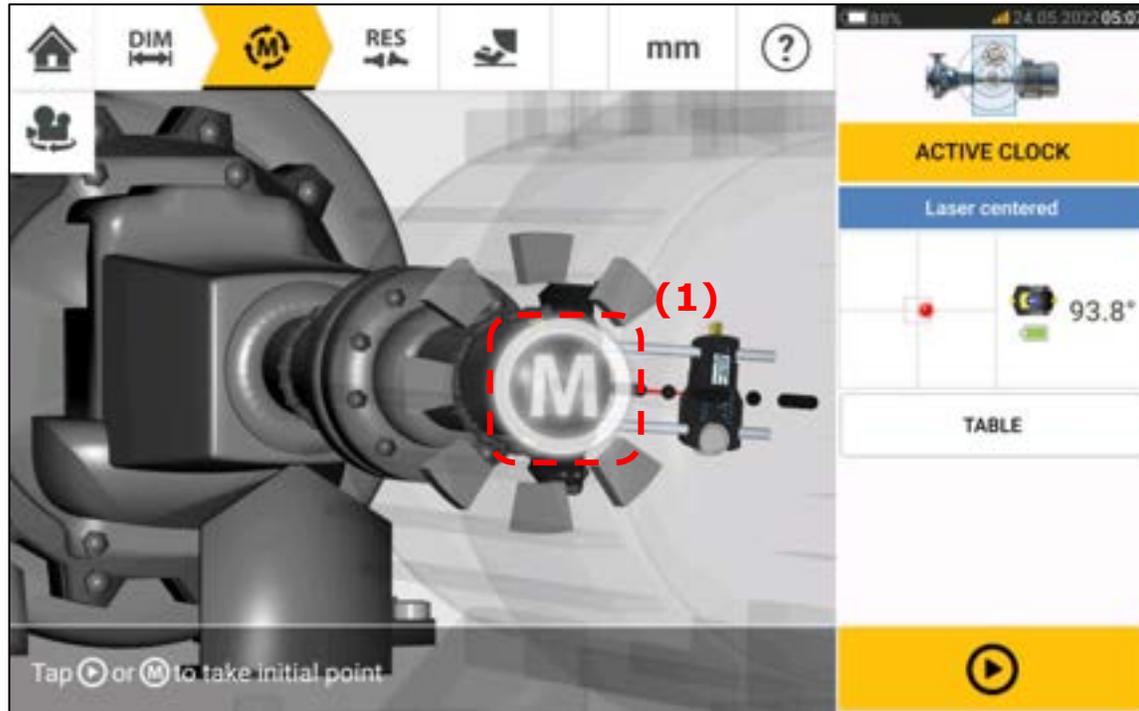
4. Remove the reflector dust cap so that the laser beam strikes the reflector and is reflected back to the sensor. The sensor laser beam adjustment LED will indicate the beam adjustment condition.



Measurement

Once the laser beam has been centered, rotate shafts to the first measurement position:

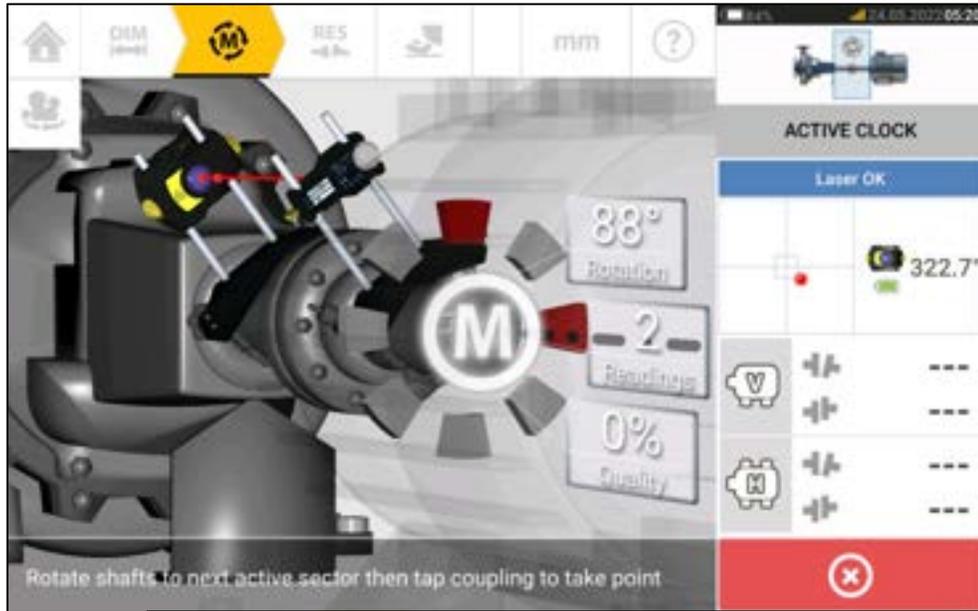
When the sensor and reflector are within the sector range, a pulsating **M** (1) appears. Tap the pulsating **M** or  to take the first measurement position.



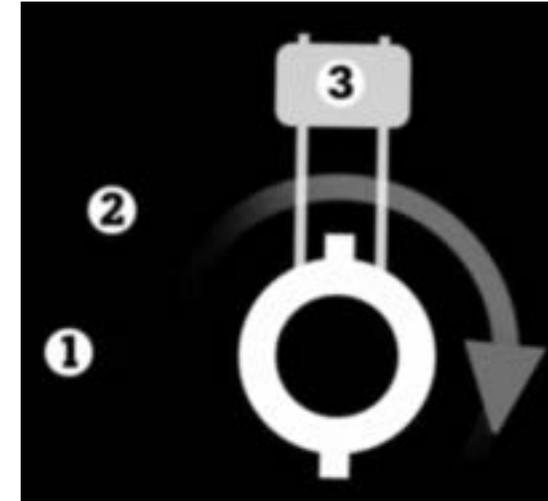
After measurement is taken, the sector is highlighted red. (2) This is an indication of the measurement quality.

Measurement

Rotate shaft to next active sector then tap coupling to take point.



- ✓ Measure - 1
- ✓ Rotate to another sector
- ✓ Measure - 2
- ✓ Rotate to another sector
- ✓ Measure - 3

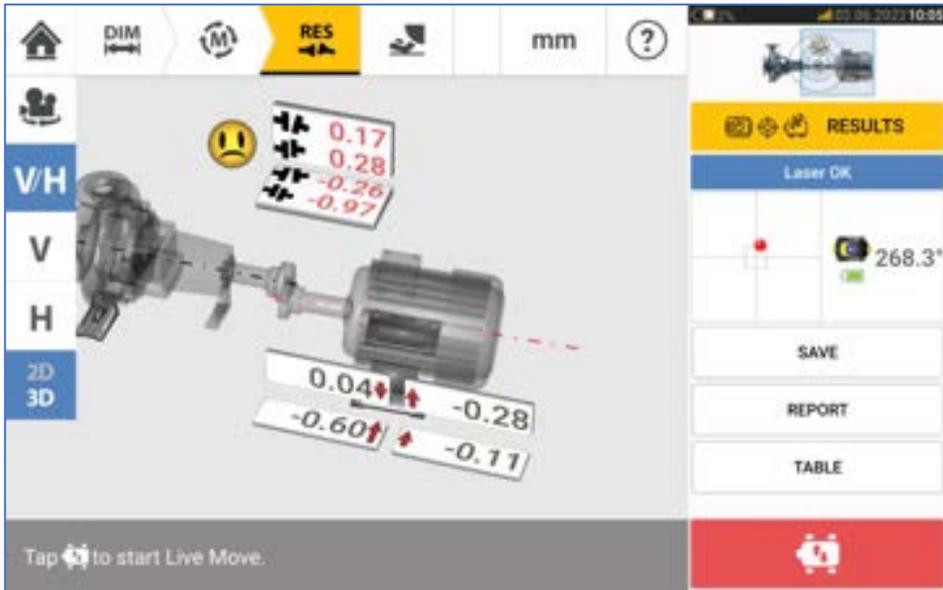


Once the set number of measurement points is attained, Tap **RES** to view machine foot results

TIPS

- ✓ Turn the machine shaft in the same direction
- ✓ Move in one direction
- ✓ Rotate the shaft manually, by holding onto the shaft itself or the coupling

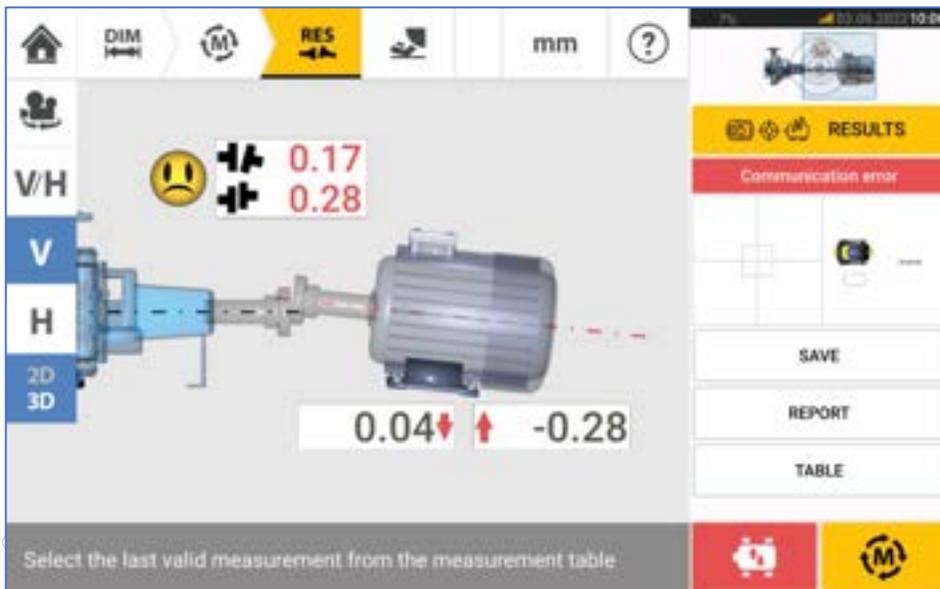
Results: 3D view



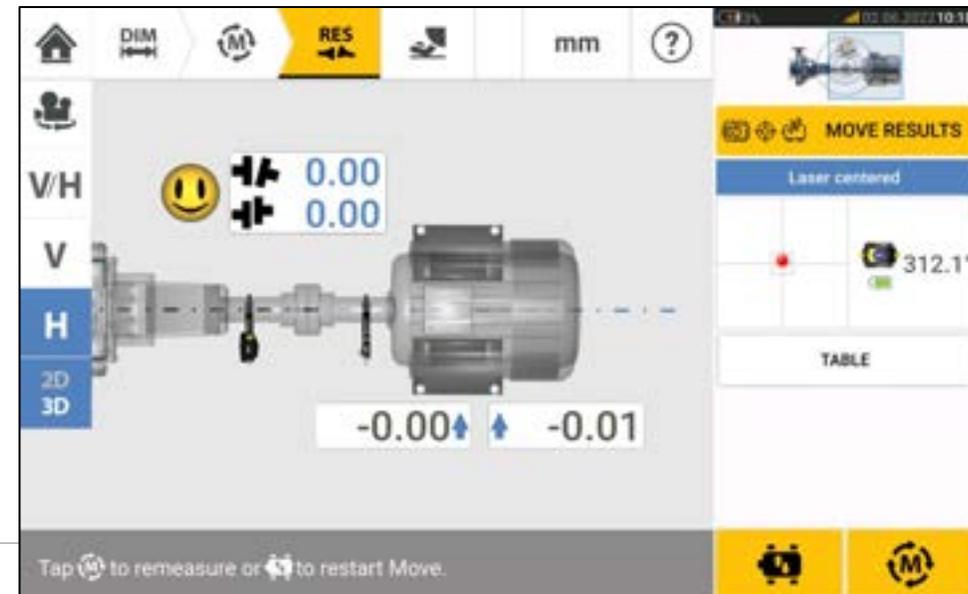
The colors of the bold arrows next to the feet correction values are directly related to the coupling alignment condition as follows:

- Blue** – excellent (foot should not be moved)
- Green** – acceptable (if possible, foot should remain unaltered)
- Red** – poor (foot requires moving to attain a better alignment condition)

Results: Vertical view



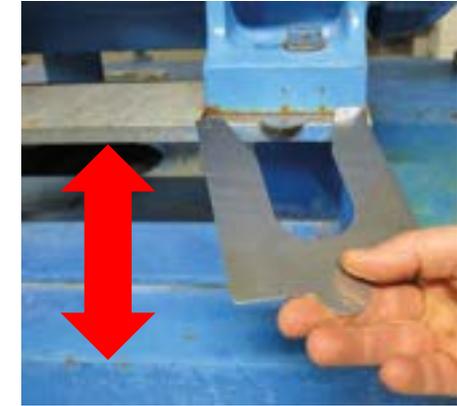
and Horizontal view



Make vertical corrections first

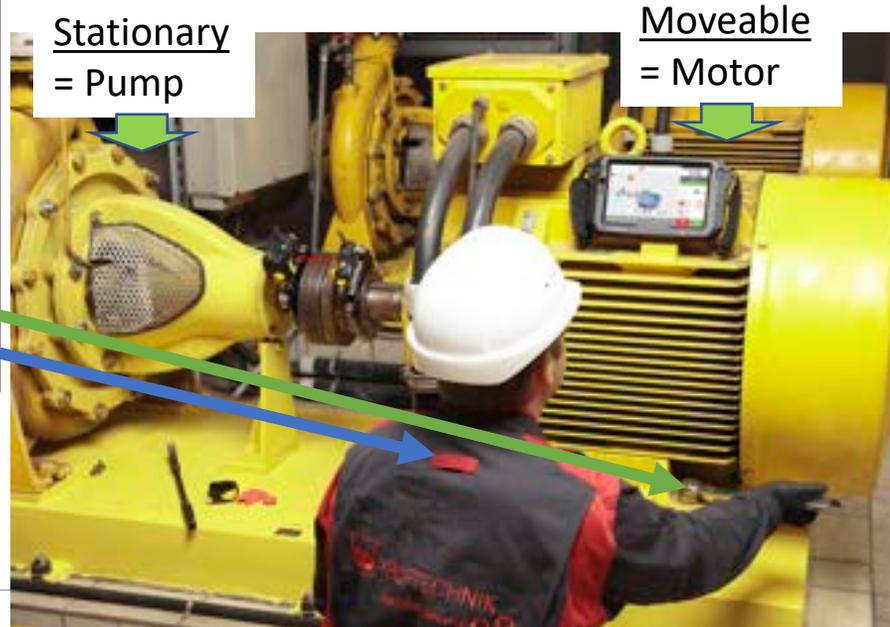
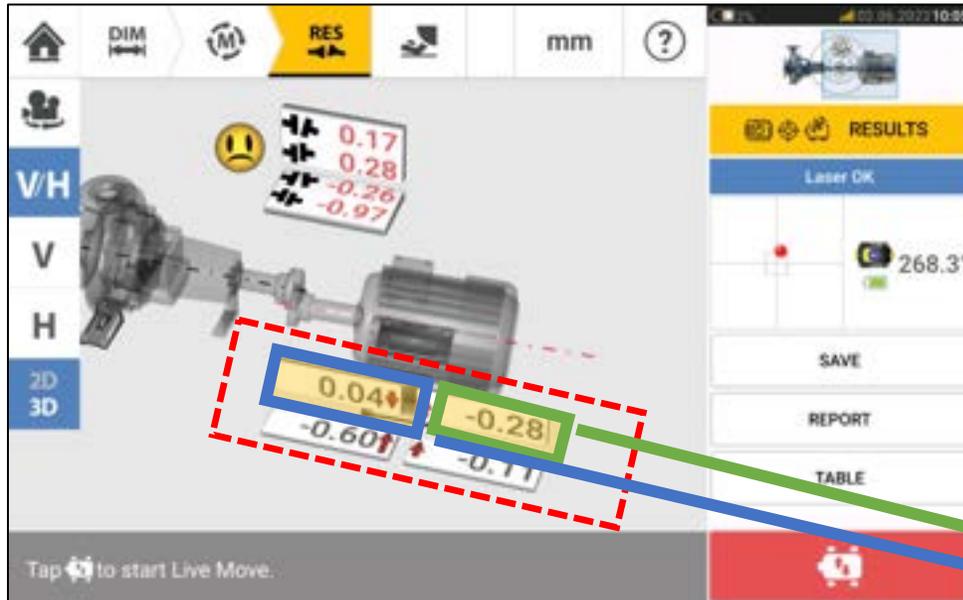
Once alignment condition is found, a correction is recommended:

- Loosen bolts and shim **first** for vertical correction
- Jack up machine and insert or remove shims of known thicknesses
- Use vertical foot correction values to shim BOTH front and back feet
- Up arrows suggest addition of shims
- Down arrows indicate feet are high and remove shims

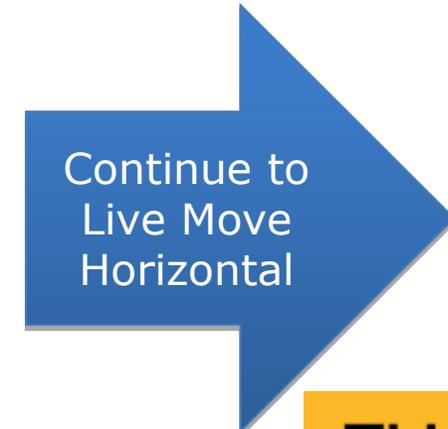


If color of bold arrows is **Red**, then action is needed.

- ★ Don't tighten the motor locking bolts yet.
- ★ Wait until both vertical and horizontal corrections are complete.



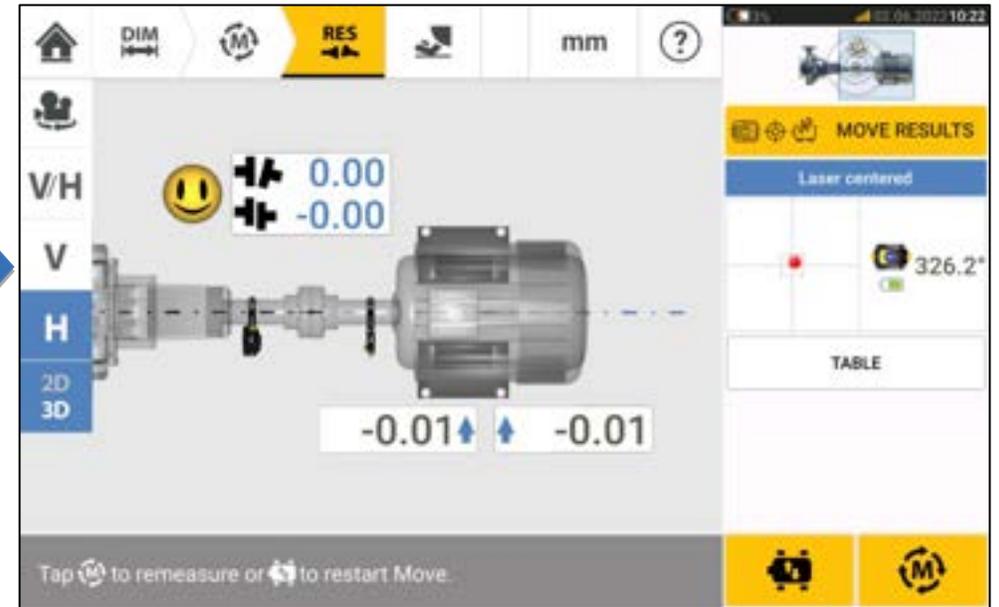
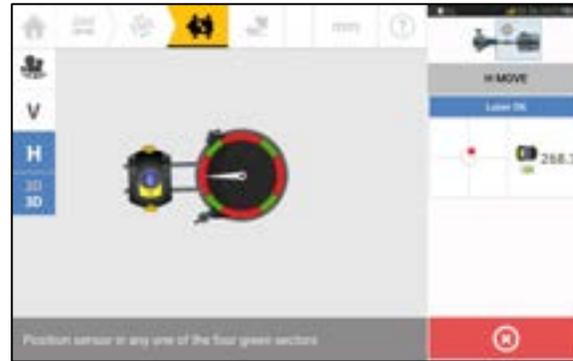
Tap  to start Live move



Live move – correct the misalignment

A screen prompting the positioning of the sensor and reflector in any one of the four designated positions appears.

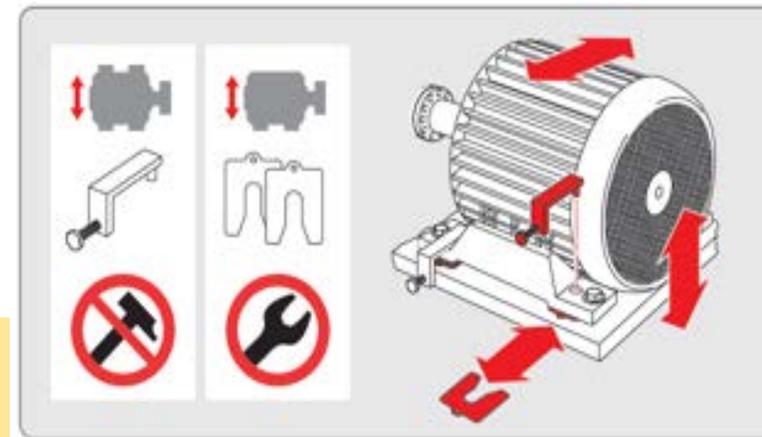
Rotate shaft until in any 45° position



- With the anchor bolts loose, correct the alignment condition by moving the machine feet in the direction of the color-coded bold arrows, keeping an eye on the smiley on the display screen.
- The smiley on the display screen gives an indication of the alignment status as the machine is moved.
- Machines should be moved to within acceptable tolerances (😊) or excellent tolerances (OK) while observing shaft alignment best practices.

CAUTION

Do NOT attempt to move the machine using heavy sledgehammer blows. This can cause bearing damage, and also produce inaccurate Live Move results. Jack bolts on the feet or other mechanical or hydraulic devices are recommended for moving machines.



After moving machines to within tolerance, tighten the foot bolts then tap  to remeasure.

Fluke 831 Alignment PDF Report

FLUKE

Machine alignment information

Location: Basement
Asset ID: Demo rig
Operator: John Bennett
Notes: New Demo rig

Dimensions



Measurements

AS FOUND:

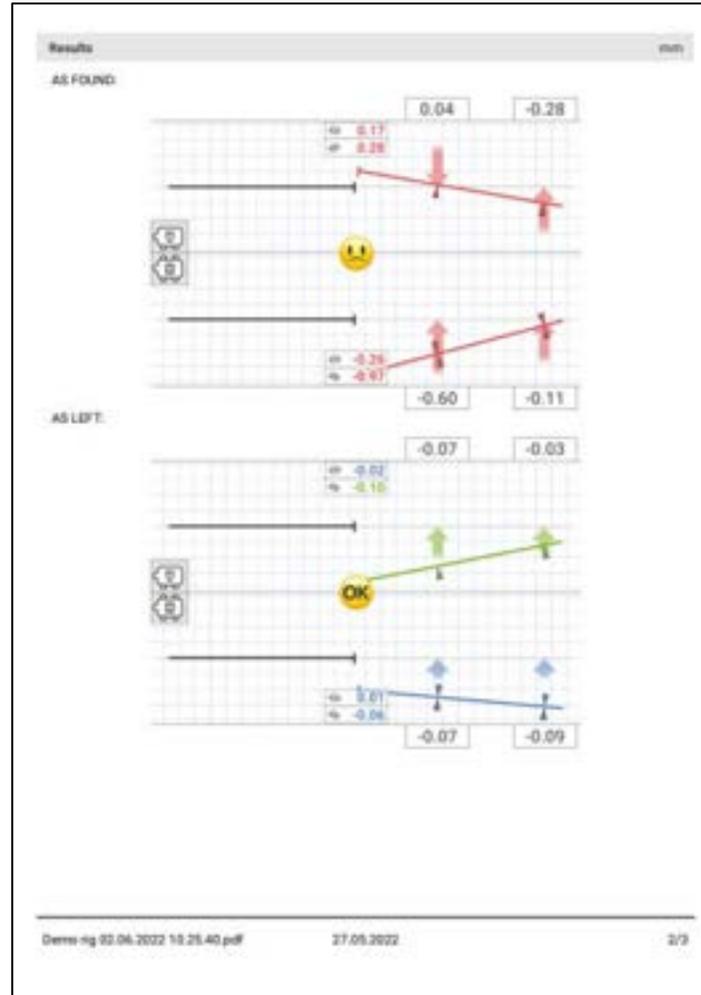
Date	Type	V	H
02.06.2022 10:00:40	Active Clock	0.17 0.28	-0.28 -0.97

Measurements

AS LEFT:

Date	Type	V	H
02.06.2022 10:22:34	Active Clock	-0.02 -0.10	0.01 -0.06

Demo rig 02.06.2022 10:25:40.pdf 27.05.2022 1/3



Report at the beginning 'Before' or 'As Found' and 'After' or 'As Left'. This will document the correction that was made compared to the misalignment at the start.

➔ Email → expert for review

➔ Copy to eMaint CMMS

Fluke 831 Key Takeaways

- **Premium, upper entry laser alignment system**, fully featured for standard shaft alignment applications
- **Adaptive Alignment features**, such as Single Laser Technology and certain Active Situational Intelligence capabilities such as Extend Range (aka Freeze-Frame Measurement)
- **Ruggedized touch device**, large touch screen, Camera with flash/torch, Bluetooth, Wi-Fi with Cloud transfer using included ARC 4.0 PC software and RFID machine identification
- **Graphical User Interface** for easy operation, Real 3D machine graphics with selectable machine colours
- **Single laser technology** for quick setup and adjustment, one sensor with 2-axis HD PSD position detector
- **Compact chain-type brackets** for quick, rigid mounting of the measurement components

Adapt to the asset - Single-laser technology adapts to virtually all rotating assets.

Adapt to the situation - Automatically adjust in real-time for challenges such as initial gross misalignment.

Adapt to the team - Support every technician's level of experience by eliminating user errors and enabling team collaboration through the Cloud.





FLUKE®

Reliability

Questions?

THANK YOU!

FLUKE.

Appendix

FLUKE. 831 Hardware features



sensALIGN 3 sensor



Key Hardware features:

- Large touch screen tablet
- **Capacitive display (glove enabled)**
- Touch GUI: DIM > MEAS > RES
- **Camera with flash/torch**
- Wi-Fi
- **RFID**
- Long run-time Li-Ion rechargeable battery
- **Ruggedized and shockproof IP protection**

Single laser/sensor technology with:

- Integrated Bluetooth communication
- **Rechargeable Li-Ion battery**
- Simple set-up
- **Increased high accuracy over increased distances**
- Freeze-Frame (Extend) measurement range



sensALIGN 3 sensor

**ALIGNMENT**

RELIABILITY CENTER 4.0

Key Shaft features/functionality/advantages:

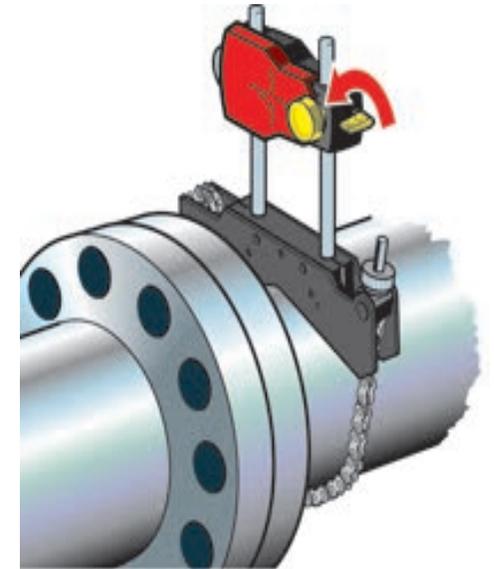
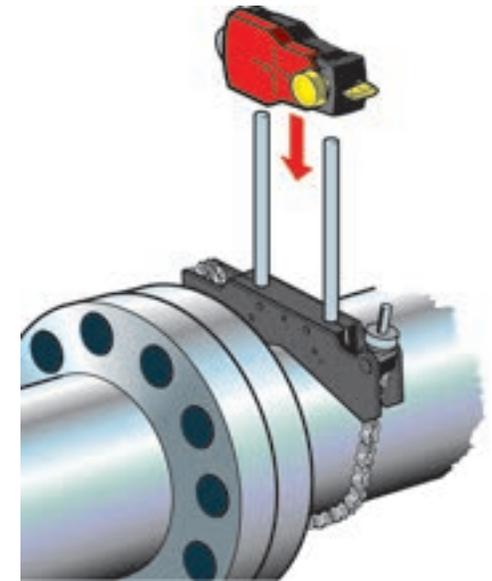
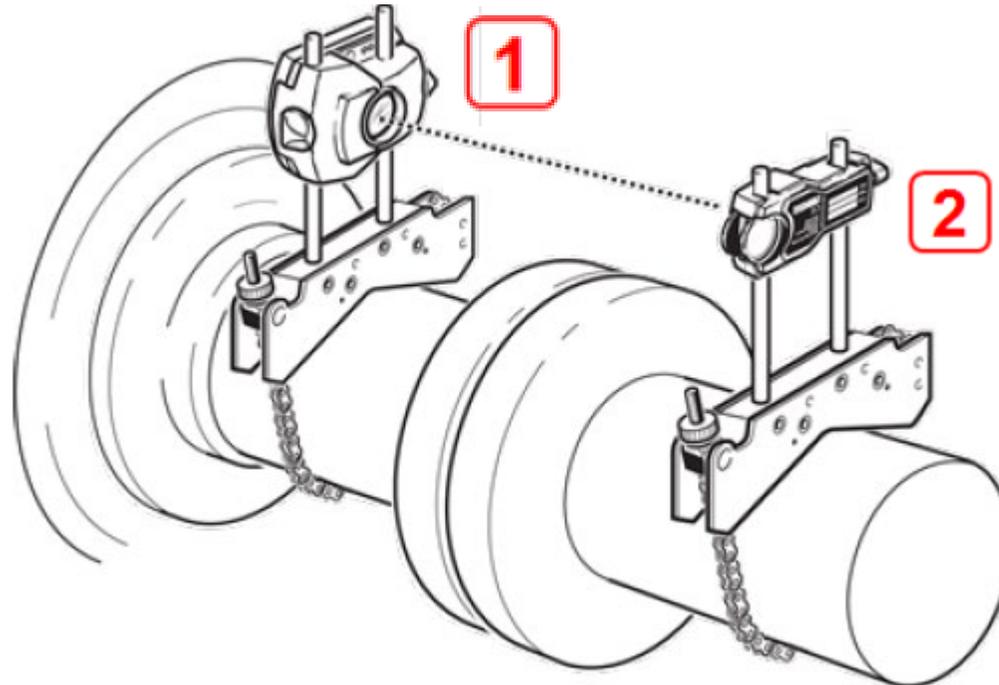
- Rotatable, non-rotatable, coupled/uncoupled shafts:
 - **Active Clock 3→5 points; Static mode 8 points**
- Coupling types:
 - **Short-flex, Spacer, Single plane, No-coupling**
- Real-time Measurement Quality factor:
 - **Standard Deviation**
- Machine pre-sets
 - **Machine Thermal growth and Coupling targets**
- Static feet
 - **Over and under constrained**
- **Vertical alignment application**
- **ARC 4.0 Windows Software** for cloud collaboration, archiving and analysis:
 - **RFID** Asset Identification
 - **Wi-Fi** cloud transfer

Mount laser/sensor and prism bracket assembly



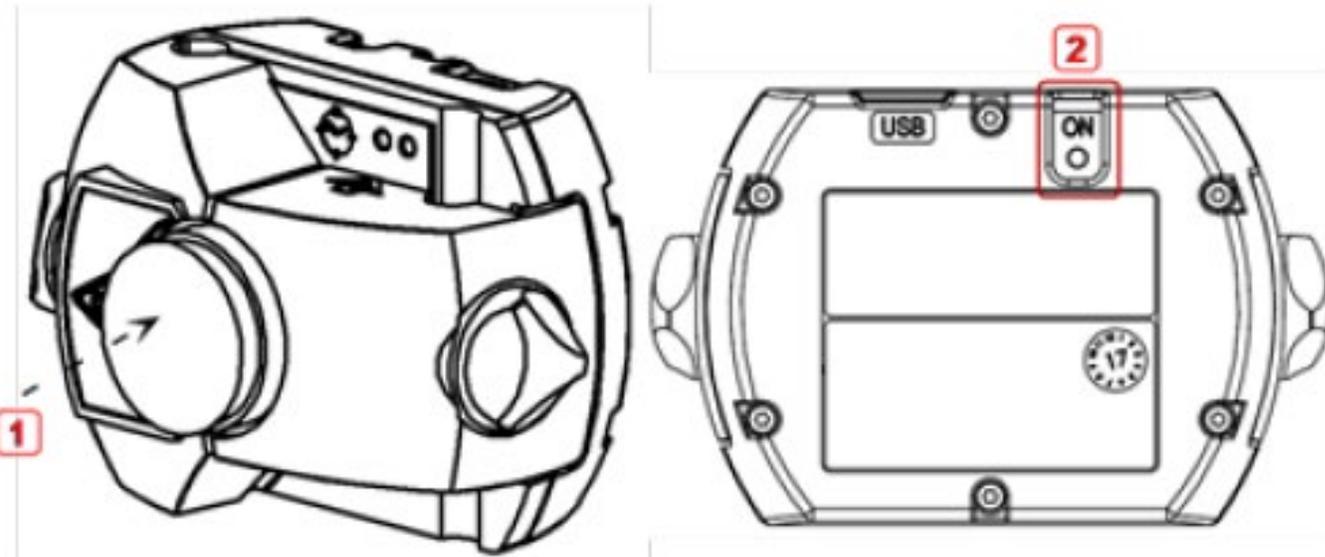
1. Mount Sensor on “Left machine” – usually Stationary - Mount as low as possible but high enough for beam to clear coupling flange

2. Mount prism on “Right machine” the same height as sensor.



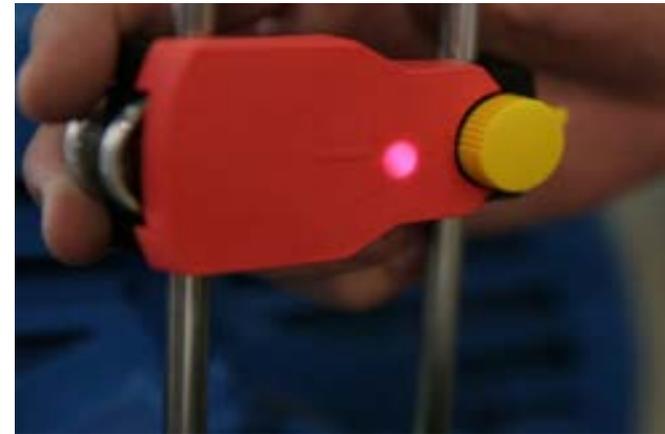
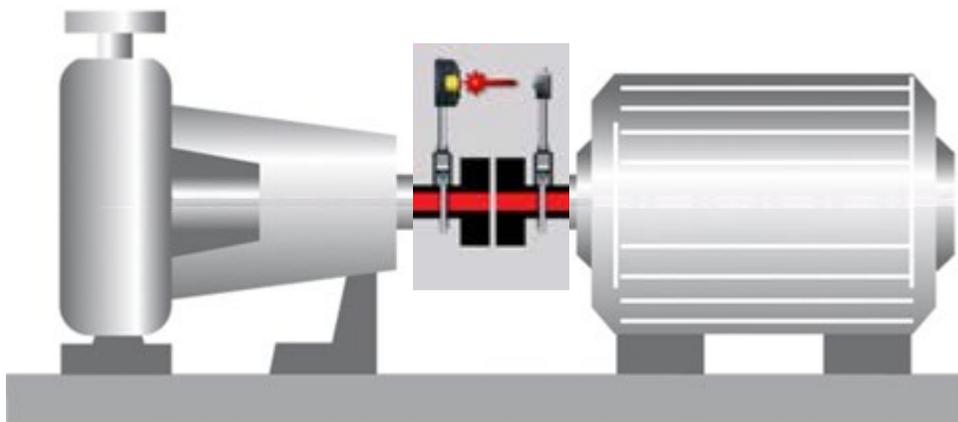
Laser beam adjustment

The sensor and reflector need to be adjusted so that the laser beam strikes the reflector and is reflected back into the sensor.



1. Remove the sensALIGN 3 dust cap (1) and then switch the sensor on by pressing its On/Off switch (2).

2. Leave the reflector dust cap on. If the sensor and reflector have been roughly positioned to each other during mounting, the laser beam should strike the reflector dust cap and is readily visible.



Quick Reference Guide - take with you in the field: follow the easy steps

Mount Brackets, Power on, Dimensions, Measure, Results

1

2

3

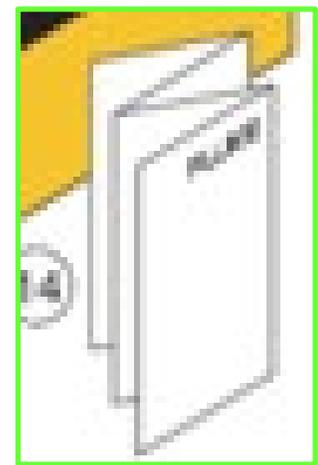
4 DIM

5

6 RES

S	/100mm		/10"	
	OK (mm)	NA (mm)	OK (mil)	NA (mil)
600	0.15	0.10	14.9	10.0
750	0.12	0.08	12.3	8.3
900	0.10	0.07	10.5	7.0
1200	0.10	0.06	9.6	6.4
1200	0.08	0.05	8.2	5.4
1500	0.07	0.04	6.7	4.5
1800	0.06	0.04	5.7	3.8
3000	0.04	0.02	3.7	2.5
3600	0.03	0.02	3.1	2.1
6000	0.02	0.01	2.0	1.3
7200	0.02	0.01	1.7	1.1

S	(mm)		(mil)	
	OK (mm)	NA (mm)	OK (mil)	NA (mil)
600	0.23	0.13	9.0	5.1
750	0.18	0.10	7.3	4.1
900	0.16	0.09	6.1	3.6
1000	0.14	0.08	5.5	3.1
1200	0.12	0.07	4.6	2.8
1500	0.09	0.05	3.7	2.1
1800	0.08	0.04	3.1	1.8
3000	0.05	0.03	1.9	1.1
3600	0.04	0.02	1.6	0.9
6000	0.02	0.01	1.0	0.6
7200	0.02	0.01	0.8	0.5



Quick Reference Guide

Live move, Make corrections, Soft foot check, Save results, Print report

QRG **FLUKE**

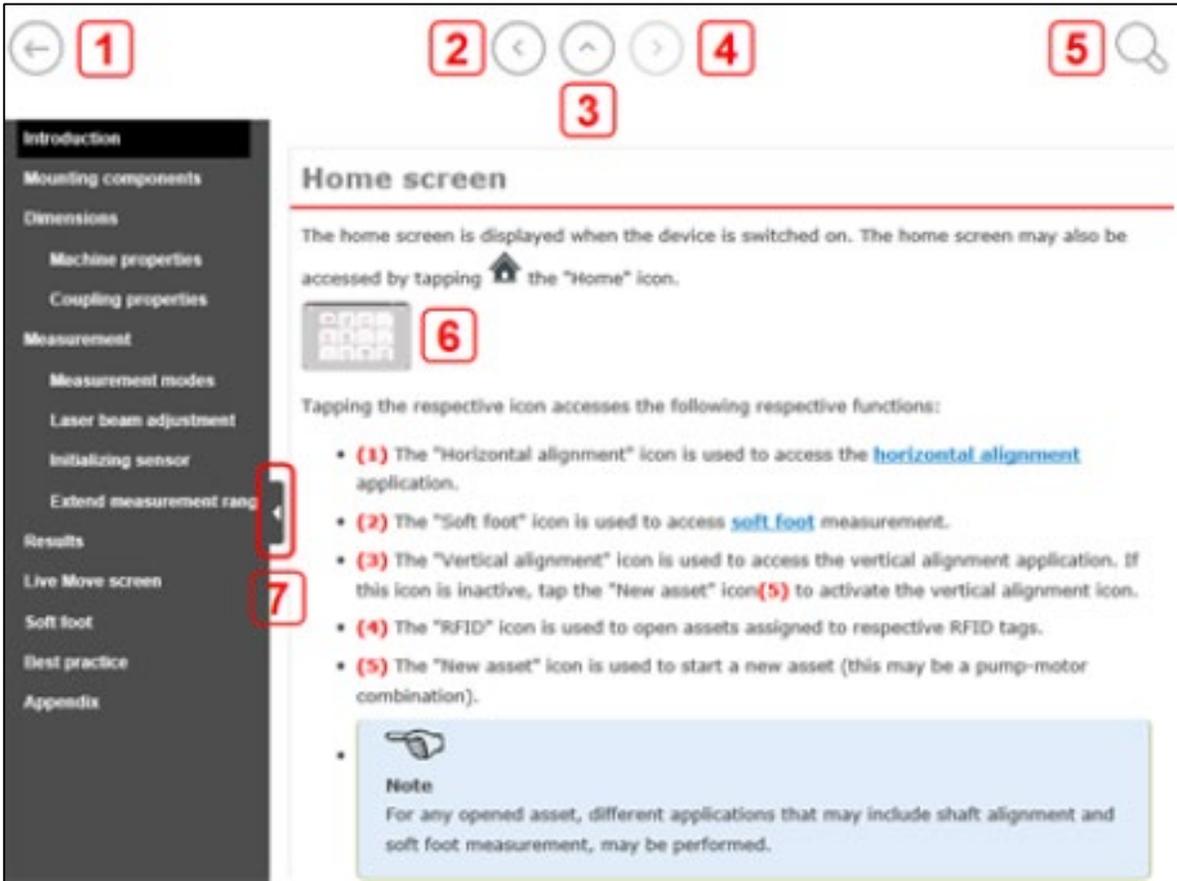
831
Laser Alignment Tool

www.fluke.com

PN 5346772 April 2022
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On-board help provides information to support users

 Context sensitive help may be accessed from specific screens by tapping the question mark icon



1 Home icon, **2** Back icon, **3** Home icon, **4** Forward icon, **5** Search icon

Home screen

The home screen is displayed when the device is switched on. The home screen may also be accessed by tapping  the "Home" icon.

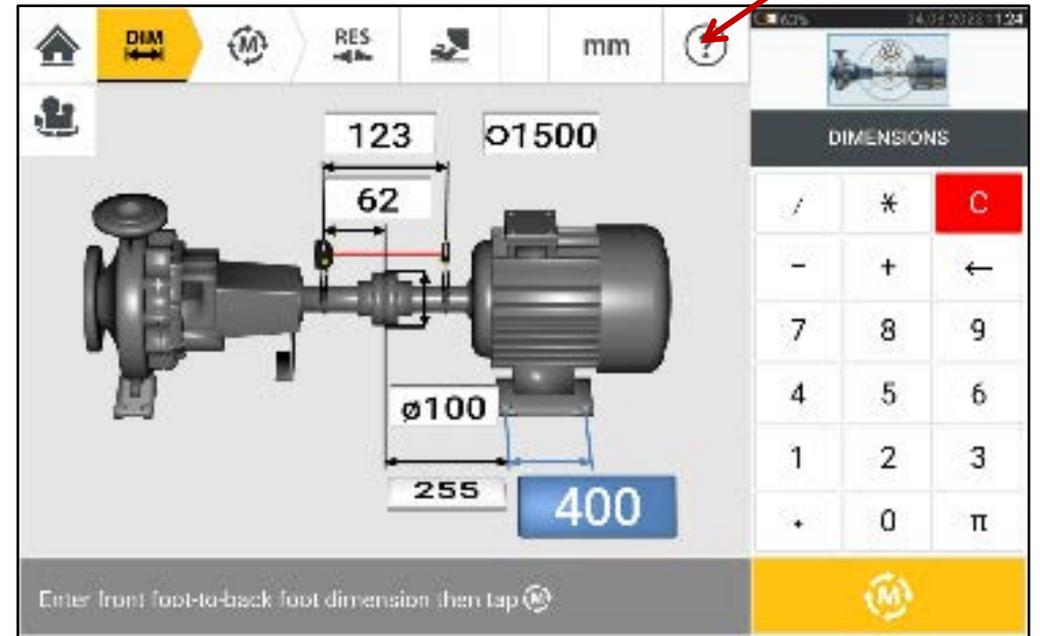
6 

Tapping the respective icon accesses the following respective functions:

- (1)** The "Horizontal alignment" icon is used to access the [horizontal alignment](#) application.
- (2)** The "Soft foot" icon is used to access [soft foot](#) measurement.
- (3)** The "Vertical alignment" icon is used to access the vertical alignment application. If this icon is inactive, tap the "New asset" icon **(5)** to activate the vertical alignment icon.
- (4)** The "RFID" icon is used to open assets assigned to respective RFID tags.
- (5)** The "New asset" icon is used to start a new asset (this may be a pump-motor combination).

7 

Note
For any opened asset, different applications that may include shaft alignment and soft foot measurement, may be performed.



DIM RES mm 

123 62 255 400 $\varnothing 1500$ $\varnothing 100$

Enter front foot-to-back foot dimension then tap 

DIMENSIONS		
/	¥	C
-	+	←
7	8	9
4	5	6
1	2	3
+	0	π