

**FLUKE®**

**Reliability**

# Best Practices for Roll Alignment

**Rollers play an integral role in industrial paper machines. Learn the best practices for roll alignment and how laser alignment simplifies the process.**

**db**® PRÜFTECHNIK

Connected Reliability ebook

# Introduction to industrial paper machines

Modern paper machines are based on the principles of the Fourdrinier Machine, which uses a moving mesh to create a continuous paper web. The fibers held in a paper stock, are filtered out on a woven mesh producing a continuous wet mat of fiber. Much of the water is removed in the press section where rollers pressing against each other nip the wet mat. The removed water is absorbed by press felts that also serve to support the paper sheet. The drier section of the machine uses internally heated cylinders to vaporize the remaining moisture. In the final section, calendar rollers impart the desired smoothness and gloss to the paper. The continuous nature of production necessitates that paper is produced in the form of rolls. Paper webs are wound onto a core to produce large rolls that can be easily handled and transported for further processing.

Value addition to paper rolls through coating, printing, slitting, laminating and converting, is invariably also performed on web lines. Rollers play an integral role in conveying paper webs through web processing machines. They apply tension, guide, support and drive the web from one end of the machine to the other while the machine carries out the desired value-addition process. The number of rollers in a single web processing machine can be surprisingly large. Just the dryer section of a paper machine can have more than 100 rollers!

## What is roll alignment

Good web handling ensures that the essential properties of the web are preserved during processing and transport. The web must be available in an optimal condition after processing for subsequent value-addition steps. Wrinkling or uneven stretching of the web during processing can ruin the product making it impossible to perform any further value addition. The large number of rollers in a web line are connected by the web being processed. It is therefore imperative that these rollers drive or guide the web in a common direction. To achieve this objective, the rotational axes of the rollers must be parallel to each other. If successive rollers are not parallel, the web between the two rolls will have differing lengths at the two ends of the roll as shown in Figure 1. Uneven spacing between rolls, can lead to degradation of the web during processing, or worse, cause web breaks and machine jams.

### Some common symptoms that signal a misalignment of machine rollers are:

- Uneven tension in the web
- Poor tracking of web (Web moves to one side)
- Excessive guide roll compensation reaching adjustment limit
- Wrinkling or stretching of the web at one end of the roller
- Uneven or inconsistent coating
- Inadequate bonding between layers in a lamination process
- Frequent web Breaks
- Excessive roller wear
- Frequent need for wire/felt replacement
- Excessive bearing and coupling wear
- Reduction in operating speed
- Increased machine vibration

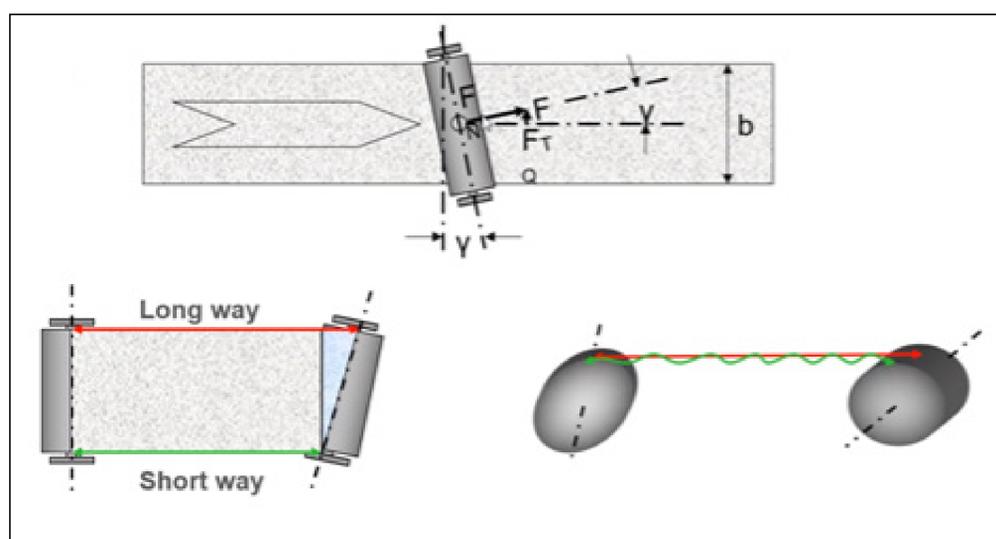


Figure 1: Misaligned rolls lead to different lengths of the web at the two ends of the roll

## Why roll alignment is important in paper machines?

According to estimates, misalignment of rollers is the underlying cause of around half of all machine failures. These failures can lead to significant unplanned downtime causing production losses. The repairs necessary to resume production can have staggering costs. Misalignment in web lines can be detrimental to machine performance even if it does not lead to immediate machine failure. The product from a line with misaligned rollers will be of sub-optimal quality. The operator might be forced to run the production line at a reduced speed to manage the misalignment leading to reduced production. In addition, web breaks during production or production of sub-standard material with an uneven thickness profile can lead to excessive wastage.

Parallelism of rolls assumes even greater significance in paper machines which run at very high speeds and have rolls in close proximity to each other. Misaligned rolls can cause asymmetrical winding of the web, frequent paper breaks or lead to the production of wrinkled material that is unsuitable for further processing. In printing machines, misaligned rollers can cause print registration issues. In a lamination process, misalignment causes uneven application of the adhesive which may lead to delamination.

Machines with misaligned rolls require a longer startup time and demand an increased number of scheduled downtimes for maintenance. Over the long run, misaligned rollers reduce machine durability due to uneven bearing stresses and excessive roller surface wear. Parts such as wires and felts wear out faster when moving over misaligned rolls; the ensuing replacement downtime reduces machine availability and productivity.

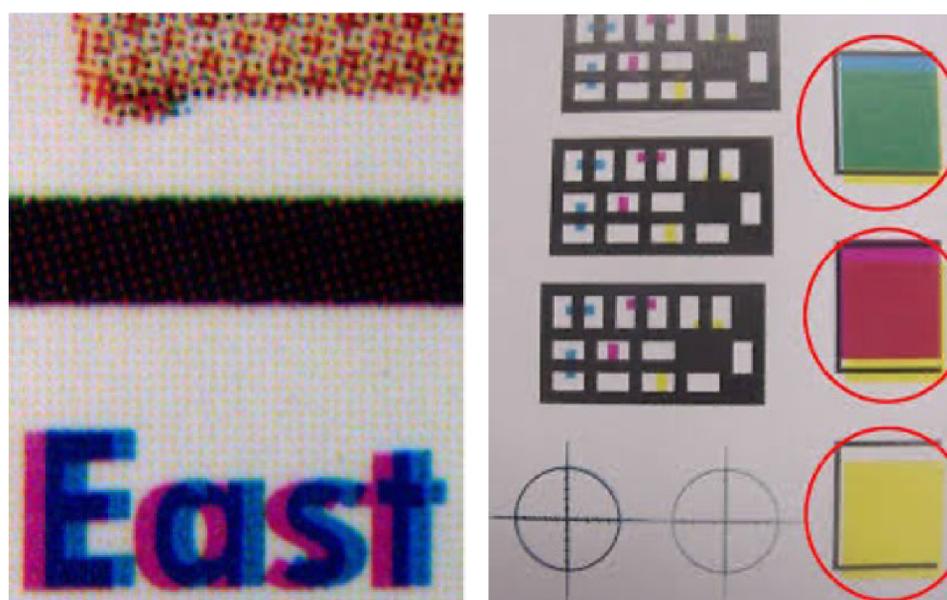


Figure 2: In printing machines, roll misalignment can cause print registration issues.

## **Causes of misalignment**

Most manufacturers of paper and allied machinery ensure that the rollers in their equipment are properly aligned before the machines are shipped out to their clients. Rollers that are installed onsite are generally checked for alignment with preinstalled rollers to ensure smooth startup and operation of the machine.

**Overtime, however, machine rollers can become misaligned due to one or more of the following reasons:**

- Roll or bearing change outs
- Addition of equipment to existing line
- Machine vibration
- Web breaks, machine jams or malfunctions
- Cumulative effect of a cracked or settling foundation
- Routine wear and tear of high-speed machines running at high tension
- Coupling misalignment
- Use of Inadequate roll-alignment technology for maintenance



## Alignment methods currently in use

**Roll alignment methods have evolved over time, increasing in precision, to match the requirements of high-speed lines and more complex machines.**

### Plumb Bob

The simplest and perhaps the oldest method of roll alignment is the plumb bob which is simply a mass hanging from a string. It is currently used as a rough alignment tool to determine or set the centerline of rolls. It is also used to set the horizontal alignment of a pair of rolls that are vertically on top of each other. A plumb bob is a handy tool but not suitable for complete alignment of complex machines.

### Precision level

A precision level is useful for setting the horizontal level of rolls. The accuracy of levelling achieved depends on the sensitivity of the precision level. Precision levels are available in a range of sensitivities, graduated from 0.5 to 5 thousandths of an inch per foot. They need to be calibrated properly to achieve acceptable results. Precision levels are only suitable for the correction of vertical alignment errors of rollers but another tool is needed for horizontal alignment

### Pi tape

Pi tapes are commonly used to measure the diameter of rolls and to ensure the uniformity of the cross-width diameter profile. To check roller parallelism, the pi tape is wrapped around two adjacent rollers creating a two-roller belt. A Pi tape is designed for the measurement of a single diameter and therefore this method measures the alignment error twice. The tape readings need to be adjusted to obtain the misalignment value. Before using a pi tape, the roll must first be levelled using a precision level. They are available in limited lengths and therefore multiple tapes are required for the alignment of a single machine. Pi tapes are useful only in certain configurations; an adjacent roller is not always available for alignment.

## Optical methods

A *Precision Sight Level* is used to measure the vertical offset of rollers. An optical tooling scale is positioned at each end of the roll. The sight level is used to look down the roll from each end. It uses a coincidence vial to level the optic. The difference between the readings taken from the scales at the two ends indicate the vertical alignment of a roll.

*The Theodolite / Transit square method* allows measurement of the tram or horizontal misalignment of rolls. One optic is set at an offset from the center so that it is precisely parallel to the machine centerline. A second optic is collimated such that it is parallel to the first optic. It is used to measure the optical tooling scales positioned at the two ends of the roll.

### Optical roll alignment methods have the following limitations:

- Require significant setup time with multiple setups for each roll
- Rolls have to be visible (line of sight)
- Alignment over several levels is very difficult
- Results can be influenced by temperature variations
- Susceptible to user error as there is no feedback for erroneous measurements
- Manual reporting of results
- Extremely time consuming to get full alignment baseline

## Laser Tracker

A laser tracking system consists of a laser tracker head mounted on a tripod or magnetic base and a spherically mounted retroreflector (SMR). The tracker head shoots a laser which hits the SMR, acting as a target. The laser is reflected back into the head which collects alignment data by precisely measuring the position of the center of the SMR. All measurement data is captured and exported into a 3D CAD/CAM software which enables good reporting. The device triangulates its position using stable reference points. This means that the device can be repositioned by reshooting the reference points. A laser tracking system is a great tool with some limitations. It requires a skilled operator as the measurement and reporting system can be quite complex. There is a maximum measurement distance before the device must be repositioned. Multiple device positions are required to measure an entire line and with each move the measurement error can accumulate.



Figure 3: A Laser tracking head and SMR



## PARALIGN Technology

PARALIGN employs inertial roll alignment technology enabled by three ring laser gyroscopes that measure angular rotation in terms of pitch, roll and yaw. The highly-reliable inertial measurement technology evolved in the aerospace industry and has long been used for the navigation of spacecrafts, the international space station and orbiting satellites. The three high-precision ring laser gyroscopes, inside a PARALIGN device, are mounted horizontally, vertically and axially. The gyroscopes keep their rotational axis unchanged due to mass inertia, even when moved in space (Figure 5). This allows the measurement of the angle of inclination with reference to the axis of rotation. The measurements from the three gyroscopes allow the device to constantly calculate its relative position in space. The inertial measurements are so precise that the PARALIGN device must account for the rotation of the earth to ensure reliability of results.

The use of a PARALIGN device is relatively simple when compared to other roll alignment technologies. The device is placed on a roll and swept along the curved surface in either direction to cover a central angle of at least 20 degrees. The sweeping action records the roll's relative position in space. The measurement is taken twice to ensure repeatability. The next roll is analyzed with a further sweep and any deviation from the reference roll is calculated in a matter of seconds.

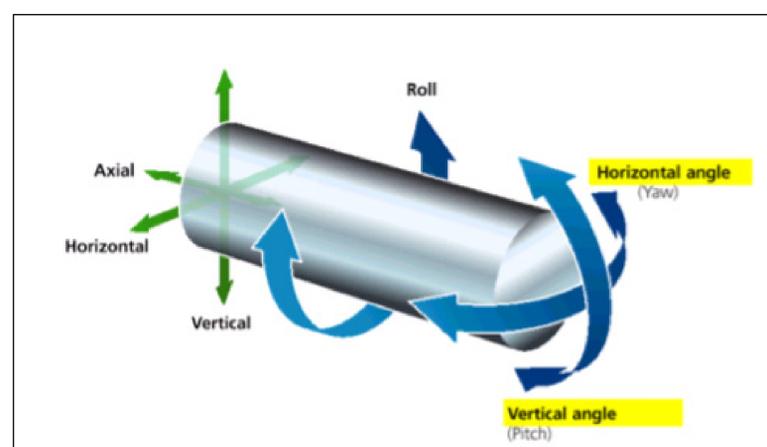
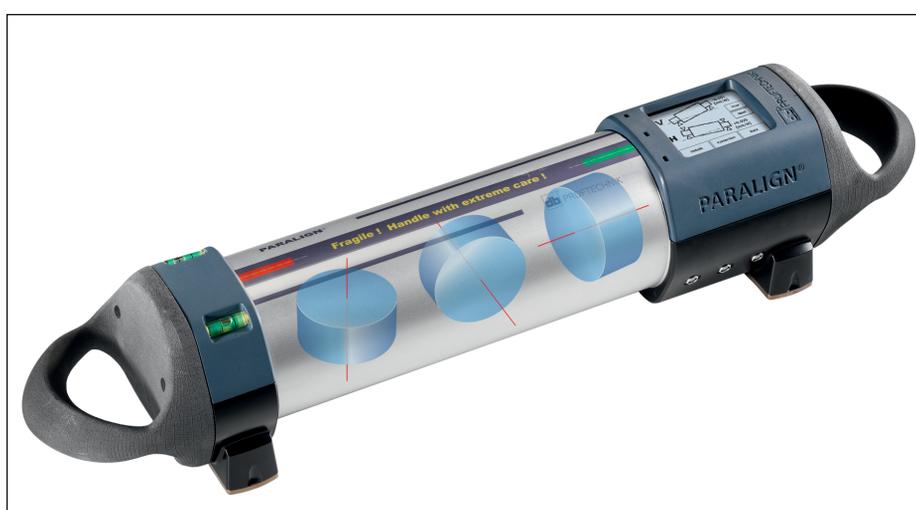


Figure 4: A PARALIGN device has three ring laser gyroscopes oriented along the three axes

The initial setup required for the PARALIGN service involves fixing of a calibration plate which takes less than an hour to install. The plate is used to calibrate the PARALIGN device through measurement of the change in orientation during a 5-minute period due to earth's rotation. This calibration is used to account for the impact of earth's rotation on measurements during the next 20-minute window. After the calibration, the device is used to measure a link roll which puts the device in the correct coordinate system. The device can be used to measure as many rolls as possible during the following 20 minutes, after which the link roll is measured again to account for any drift in the gyroscopes. The relative offset data for measured rolls is transferred to a PC via bluetooth which displays the results in clear graphics instantly. The vertical and horizontal offsets for each roller are presented graphically and numerically (Figure 6) and can be used to make the necessary adjustments. After the adjustments, the adjusted rolls are remeasured to ensure that the misalignment has been rectified.

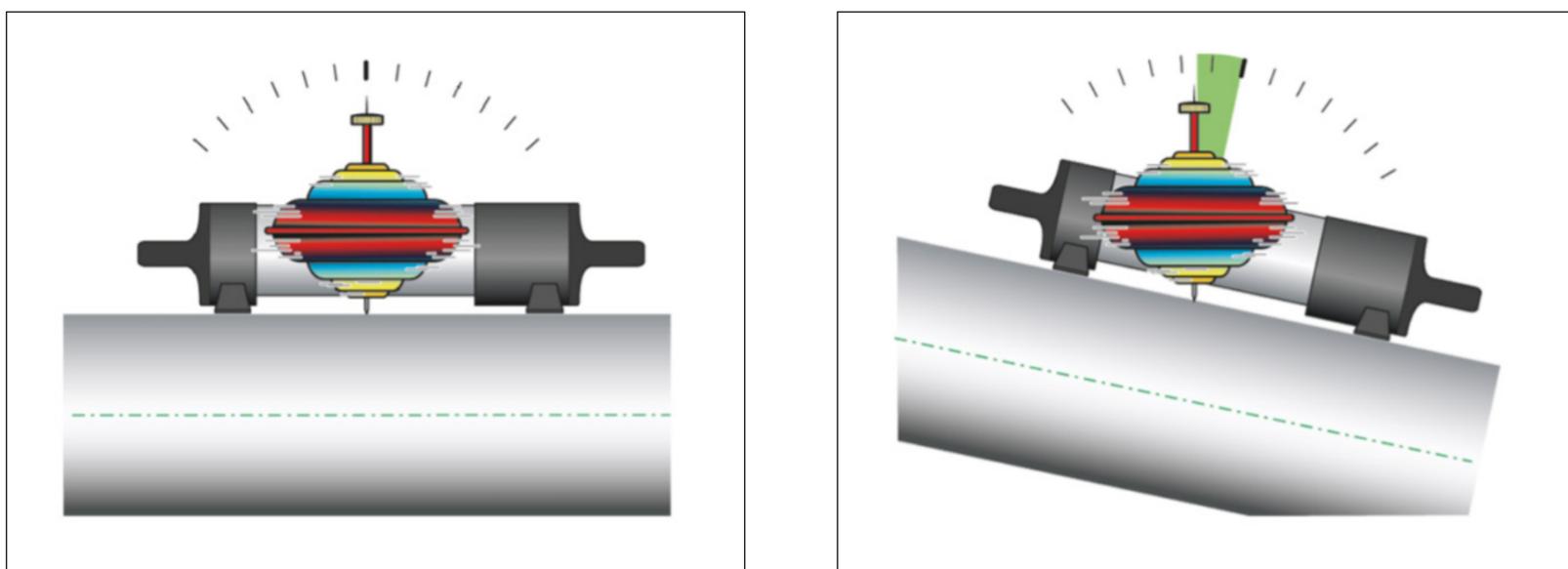


Figure 5: The gyroscope retains its axis of rotation despite a change in orientation of the device which allows measurement of the angle of inclination

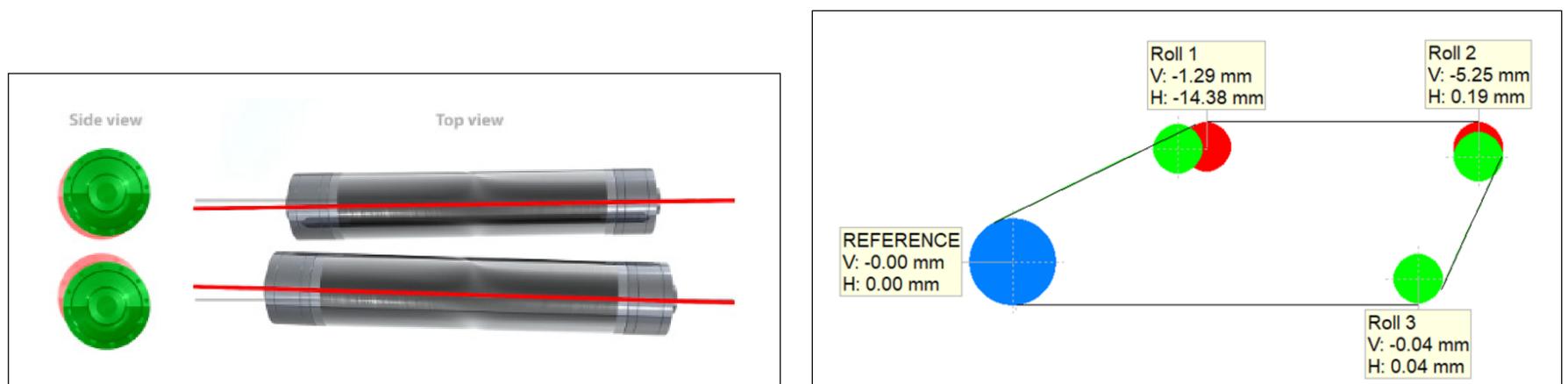


Figure 6: PARALIGN software displays the vertical and horizontal offset values graphically and numerically on a Bluetooth-connected PC to simplify the adjustment process

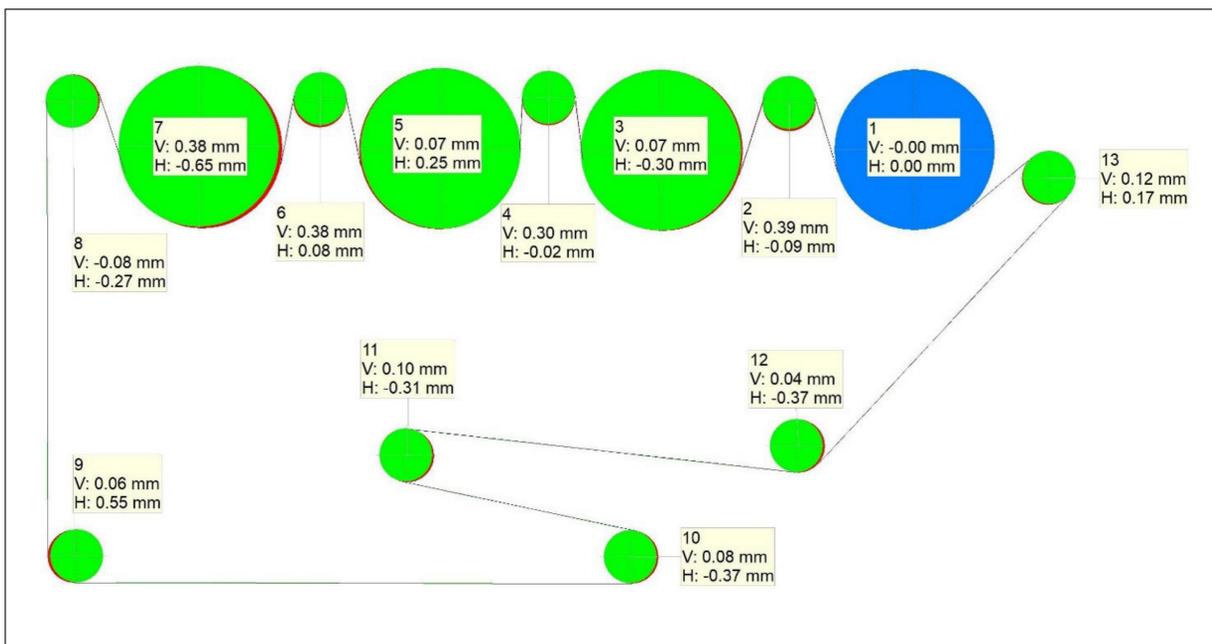
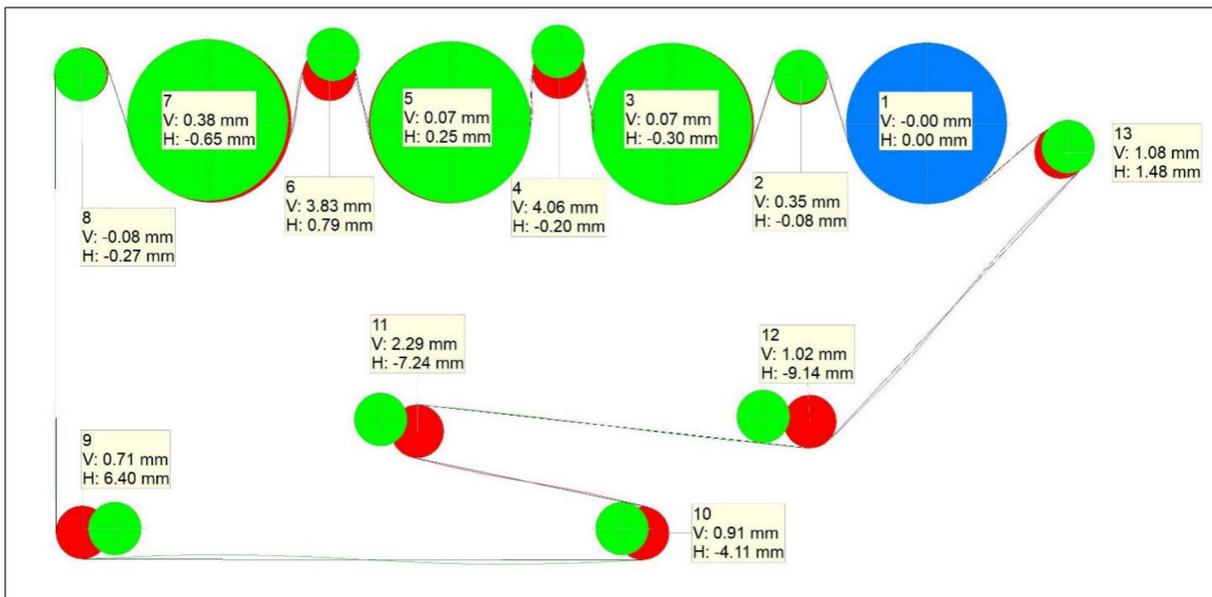


Figure 7: Application example of roll alignment in a drying group which restored the lifetime of a wire back to 12 months after it was reduced to half its usual life.

# Advantages of PARALIGN

PARALIGN is the fastest and the most accurate roll alignment technology on the market today. It offers several advantages over traditional methods of roll alignment. A short setup time means that a PARALIGN service can be performed during a scheduled maintenance window. Unlike optical measurement systems, PARALIGN does not require a line of sight to function. This allows measurement of rolls in enclosed sections or across multiple levels of a machine. In addition, no baseline is necessary for measurement since the offset is defined in relation to a reference roll, however baseline data can be incorporated in to the software easy. PARALIGN results are displayed instantaneously which allows necessary corrections to be made quickly and adjusted rolls to be re-measured immediately.

## The advantages of PARALIGN over other alignment technologies can be summarized as follows:

- Measurement time is cut short by 50% or more
- Results are very accurate and not influenced by external factors such as temperature
- No human reading and reporting error
- A sweep angle of only 20 degrees is sufficient for a measurement
- Immediate reporting of results
- Provides feedback when results are inaccurate due to surface irregularities or bad bearings
- Ability to measure both cylindrical and crowned or tapered rollers
- No line of sight required; allows measurement in several planes and over multiple stories
- Allows quick checking of adjustments
- Optical data from a baseline can be incorporated in the software, if required
- Measurement error is not a function of distance
- Limitations of the system can be removed through pairing with a laser tracker
- Ideal for measuring and adjusting entire machines



In the paper industry, PARALIGN helps increase machine availability and improves product quality. Regular alignment of paper machines increases the life time of parts and reduces maintenance costs; wires, felts, bearings and rollers last longer and web breaks, wrinkles, folds, and creases are minimized. The smooth and even movement of the web through the line ensures a uniform moisture profile in the final product. In the printing industry PARALIGN technology can measure more than 300 cylinders in a single day of service. In corrugated production, the technology can be used to align more than 130 cylinders in a day.



## About Fluke and PRUFTECHNIK

Founded in 1948, Fluke Corporation is the world leader in compact, professional electronic test tools and software for measuring and condition monitoring. It serves engineers, maintenance managers, technicians, electricians, and metrologists who install, troubleshoot, and maintain industrial equipment and calibration processes. Fluke is a multi-national corporation headquartered in Everett, Washington, USA with manufacturing centers located in the USA, the UK, Asia and The Netherlands. In 2019, Fluke acquired the global maintenance technology supplier, PRUFTECHNIK.

PRUFTECHNIK offers a wide range of products, services and training programs tailored to the needs of maintenance professionals in the areas of shaft alignment, vibration analysis, condition monitoring and nondestructive testing. Manufacturing organizations worldwide trust PRUFTECHNIK solutions for condition-based maintenance of rotating machinery. PRUFTECHNIK has more than 600 employees worldwide with 18 sales and service subsidiaries and distributors in 70 countries.

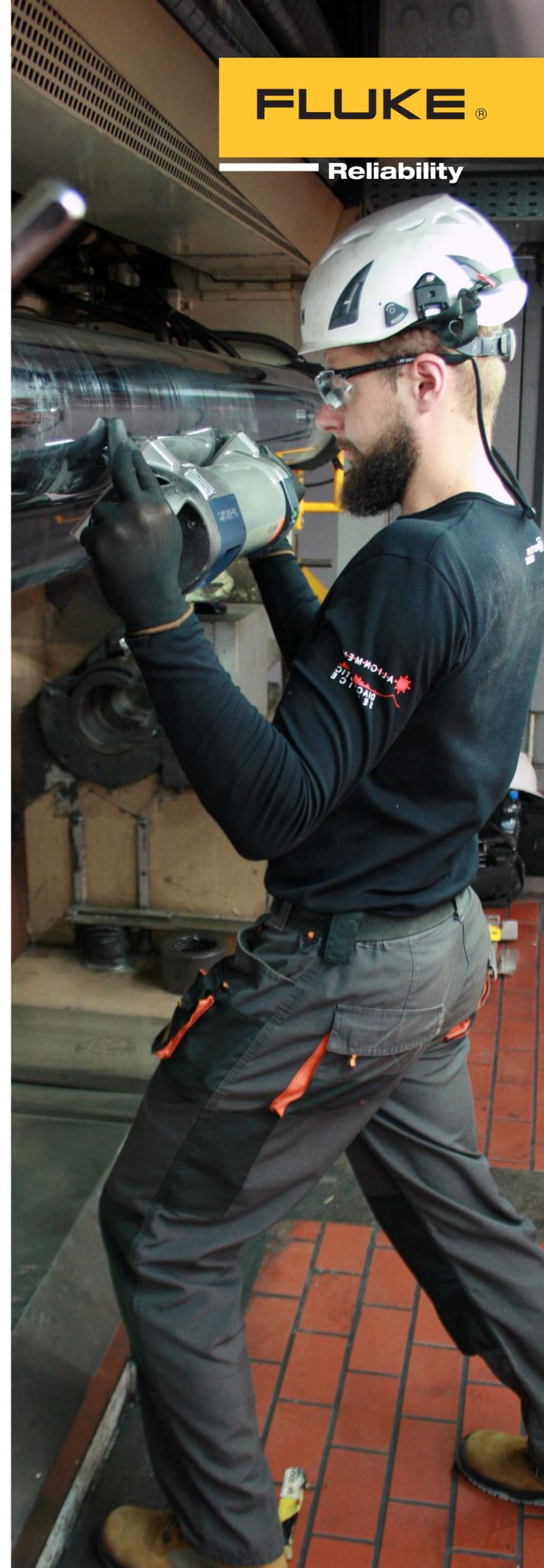
Through PRUFTECHNIK, Fluke offers Peak Roll and Geometrical Alignment (RGA) service based on the PARALIGN technology. Peak RGA service provides fast, reliable alignment results that allow necessary adjustments to be made to the machine in a timely manner, leading to decreased downtime. PARALIGN is offered only as a service and is not sold as an independent product due to governmental restrictions on the sale of proprietary technology.

## Conclusion

In the paper industry, well-aligned rolls are the key to achieving consistent product quality and high productivity. Good roll alignment significantly increases machine availability and production output. In addition, wastage is minimized, unscheduled downtime is reduced and unexpected maintenance costs are avoided.

PEAK RGA is a complete roll alignment service offered by Fluke Reliability that delivers results faster than any other service, without compromising accuracy. The service is designed for plants with complex roll machines that need to maintain highest product quality without loss of productivity due to unscheduled maintenance downtime. PARALIGN combines both gyroscopic and laser tracker technology. The unique ring laser gyroscopes, employed by PARALIGN, work without the need for clear line-of-sight to the rolls. Its rapid visual reports give in-depth feedback, pinpointing rolls that are compromising quality. The clear, actionable reports cut down the time required for making the necessary adjustments, minimizing the scheduled maintenance time.

PARALIGN is available in most countries worldwide through PRUFTECHNIK regional offices. With its global presence, PRUFTECHNIK has the ability to support multiple plants in different geographical locations. It offers immediate assistance in case of an emergency through its global teams which are available to travel on short notice. Suppliers in the paper industry that wish to deliver the highest product quality with maximum reliability must consider roll alignment an integral part of their scheduled maintenance.



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**Fluke Deutschland GmbH**  
Freisinger Str, 34  
85737 Ismaning, Germany

**For more information:**  
Phone: +49 89 99616-420  
Email: [salesupport.frs@fluke.com](mailto:salesupport.frs@fluke.com)  
Web access: [www.pruftechnik.com](http://www.pruftechnik.com)

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