



**Thermo Scientific SIPRO**  
Simultaneous Profile Gauge

# profile measurements for world class quality

Thickness Profile. Contour. Crown.  
Wedge. Width. Temperature Profile.  
Flatness. Ridges.

**Thermo**  
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# Thermo Scientific SIPRO simultaneous profile gauge

Simultaneously measure centerline and transverse thickness, temperature, profile, width, edge drop and shape of a steel strip at the exit of a hot rolling mill. Improve operating practices with this wealth of process control data, thereby increasing mill throughput and yield.

## Raw materials savings

Off-gauge and off-tolerance product results in the downgrading or even scrapping of coils. High-speed, accurate dimensional measurements allow for in-bar correction of off-gauge product, resulting in raw materials savings and mill optimization.



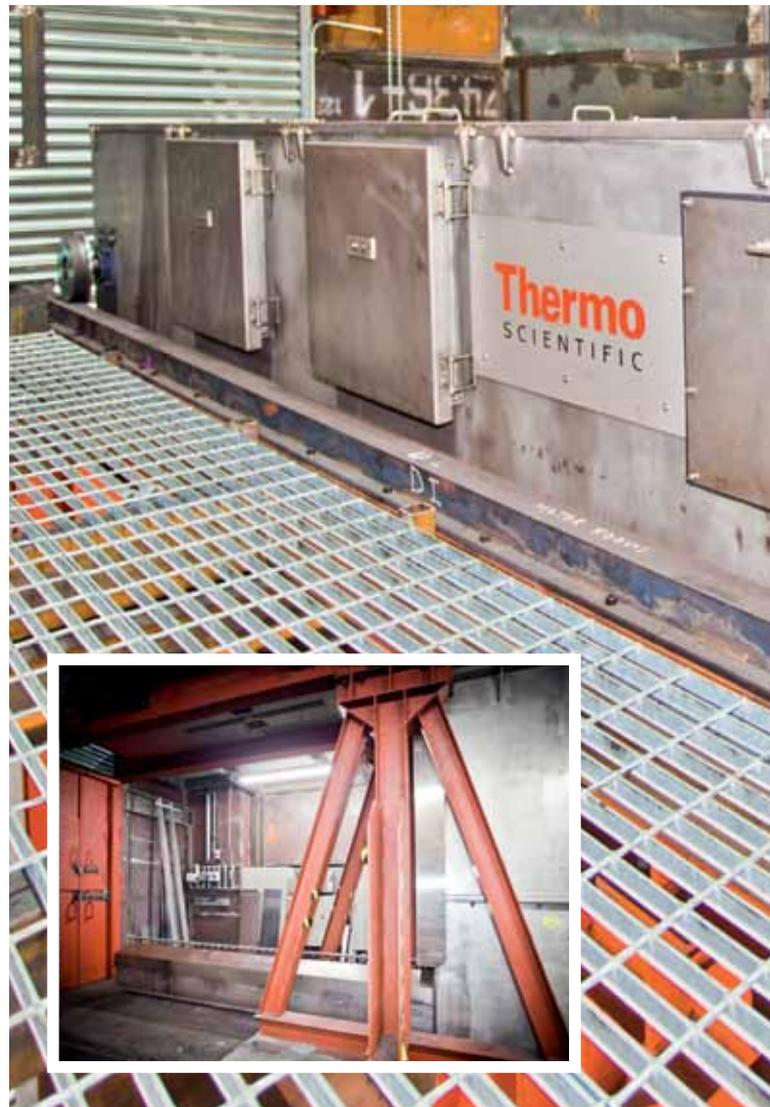
## The importance of uptime

Production demands require permanent uptime and scheduled outages are limited to just a few days each year. Reliable sensors and the built-in redundancy of SIPRO ensure measurement values are there when needed.



## Protection in harsh environment

Designed to last, SIPRO is built with a robust stainless steel frame. Water cooled jackets on all strip facing surfaces protect sensor components from heat, steam and other challenges that exist in the hot rolling environment.



### Features

- Alloy compensation
- 5mm cross profile resolution
- Fast centerline AGC channel
- Accurate width measurement
- Temperature profile data
- Length profile
- Strip position
- Optional strip flatness

### Benefits

- Raw material savings
- Scrap reduction
- In coil profile control
- World class quality assurance
- Process optimization

SIPRO demonstrates excellence in non-contact total strip measurement. While it is aimed primarily at mills producing hot steel strip, it may also be used on non-ferrous applications. Owing to the fast acquisition time of an accurate cross profile, SIPRO is ideally suited to automatic profile, flatness control systems, mass flow computations and other control systems.



### Flatness measurement

SIPRO provides the highest cross-strip measurement resolution of any on-line hot mill profile gauge. This granularity allows proprietary algorithms to calculate strip flatness, head to tail and strip edge to strip edge.



### In bar control

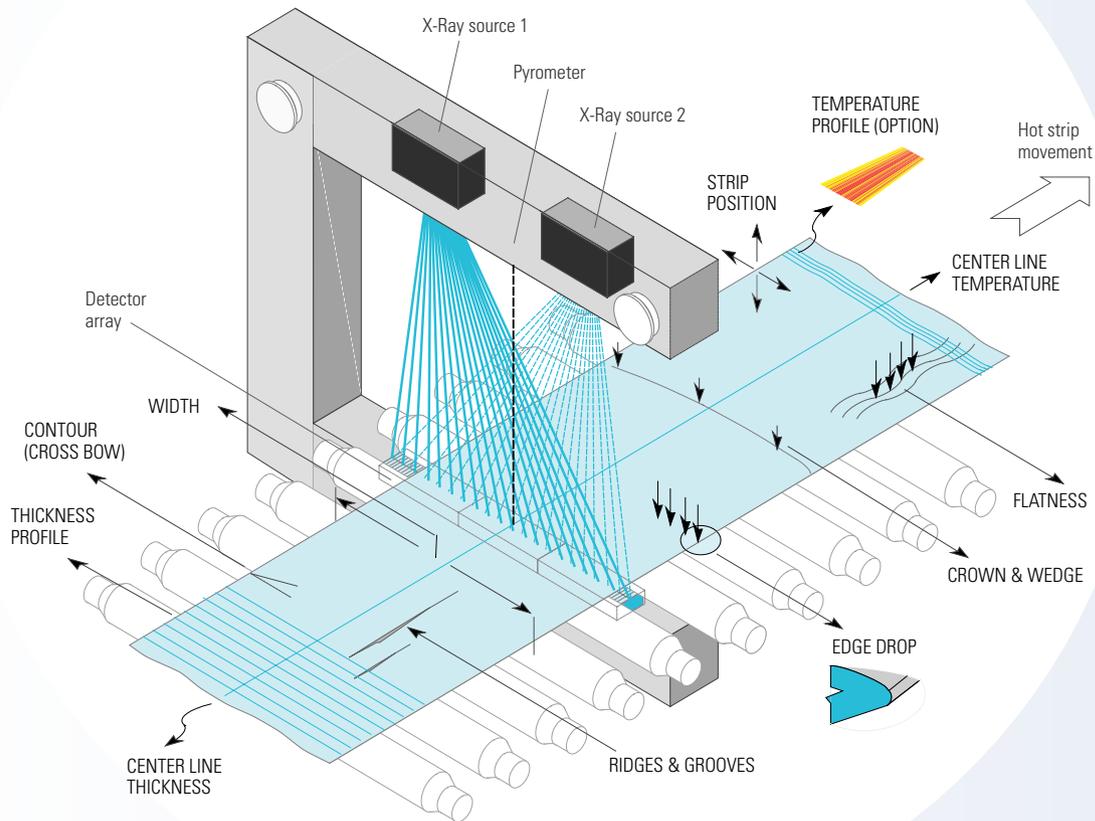
By providing stereoscopic, full profile measurements every 5 milliseconds, the advanced profile control software can make corrections within the same bar. This increases mill yield, product quality and overall profitability.



### World class quality = high profits

Accuracy and reliability conceals the impressive technology behind the SIPRO measurements. With the highest speed and resolution available, SIPRO assures the quality of your products and the quality of your products assures your profitability.

# Measurements and user interface



## Thickness and Profile Measurement

The ability to fully characterize width, centerline thickness, thickness profile, and temperature profile over 100% of the length of the product, as it exits the finishing mill, offers a wealth of process control and quality assurance data never previously available.

Immediate benefits in product quality will accrue from mill operators and quality inspectors developing and applying new insights into the hot rolling process. Analysis of data will lead to new and improved operating practices in several areas including roll grinding, roll changes, guide practices and roll scheduling. These new practices will result in improvements in dimensional quality with a corresponding increase in mill throughput and yield.

Only the SIPRO system provides the necessary measurement performance to enable on-line refinement of rolling process models, with virtually instantaneous feedback of the results of changes without disruption to the rolling program. The first requirement for a hot-strip mill gauging system is to provide a fast low-noise centerline thickness output for automatic gauge control (AGC) purposes. This is achieved by averaging each 5 ms profile across a section of the center portion, 100mm typically being used. A running average is made of the last three samples before making the output. This gives better than 0.2 percent thickness noise, with the digital equivalent of an analog 10 ms response time. If a longer or shorter response time is required, this can be adjusted by the user.

## Compensation Features

To optimize the accuracy of the SIPRO system when measuring materials with different compositions of alloys, there is a range of alloy compensation functions available as standard. Since strip edges are often significantly cooler than the center, it is necessary to utilize a scanning pyrometer, so that the correct temperature compensation may be applied to the measurement of each detector element. Shortly after the hot material leaves the exit of the rolling mill, the vertical position and orientation of the strip is not sufficiently defined to allow consistent, accurate profile measurement in the absence of strip position compensation.

The stereoscopic design of the SIPRO system overcomes this obstacle. By providing two transversely-separated sources of radiation, and rapidly switching between them in antiphase, the single detector array receives two distinct images in quick succession of the strip edge transition, taken from different positions.

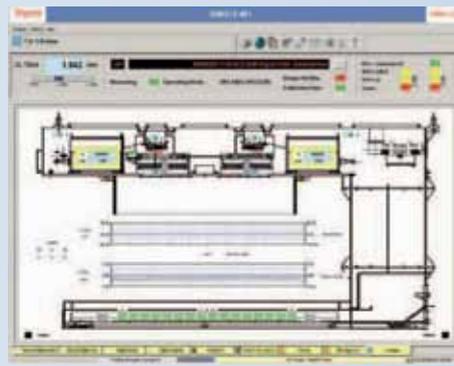
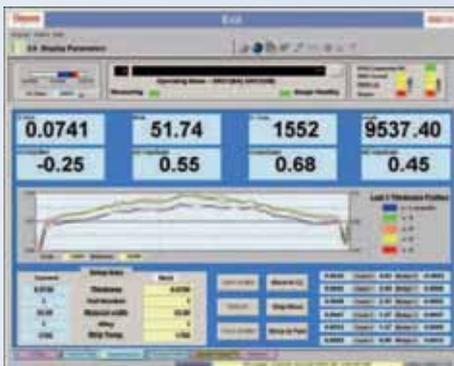
From the system geometry, the edge positions can be calculated by suitable software, originally developed for computer tomography. Having determined both the absolute position in space of each point across the strip, both scattering and angle-related errors can be automatically corrected - the first from calibration data and the second by computation from the strip angle.

## System Displays

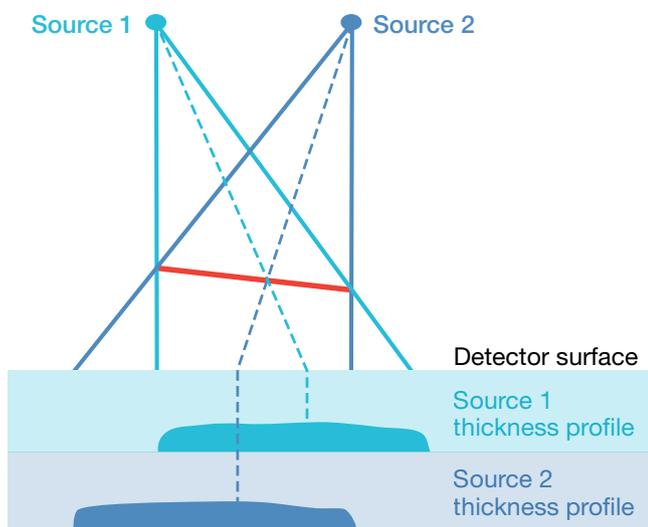
The SIPRO system provides a number of graphical display pages for the mill operator and/or quality control inspector. Measurement data is processed in real time to produce the following displays:

- Graduated color maps of thickness and temperature cross-strip profiles.
- Graduated color maps of thickness and temperature length profiles.
- Graphical presentation of cross-strip thickness and temperature profiles.
- Point display of thickness, crown, wedge and edge drop.
- Graphical and numeric statistics on measured and calculated parameters.

In addition to the listed displays, the system also provides analog and digital signals for the mill control computer and for process analysis.



## Measurement principle



For every 5 ms exposure, the computer calculates an apparent thickness for each detector giving a raw thickness profile. It then analyzes the results of the current and previous scans to locate the edges of the strip in space.

The thickness profile is then calculated by working along a straight line between the two edge positions. For every 5mm of strip width, the measurements from the two source views are combined, taking into account the known strip angle, to give a strip thickness profile measurement insensitive to position or tilt. For profile control systems that require real-time crown and wedge outputs, the system provides these by further analysis of each 5 ms thickness profile. This analysis is made using configurable sections of profile width to obtain the crown position required (e.g. C40, C50, etc.).

# System benefits

## System Performance

The SIPRO system is designed to provide 100% characterization of the material edge position and transverse thickness and temperature profiles throughout the entire length of the product. Installation close to the last mill stand enables dynamic control of transverse thickness profiles by means of roll shifting or bending.

Derivation of the AGC signal is made by calculating the position of the actual center of the material relative to the gauges, determining the thickness of this point, and deriving a signal proportional to the deviation from the target. A number of detector element signals, comparable to a discrete thickness gauge, are automatically combined to give a low noise, rapid response AGC output. Strip width measurements are taken at the same frequency as the thickness profile and, unlike other profile gauges, can be directly related to the thickness profile measurement, independent of the product tilt or lift. Transverse temperature profile measurements are taken 40 times per second with a typical measurement accuracy of  $\pm 5^{\circ}\text{C}$  ( $\pm 9^{\circ}\text{F}$ ).

Wedge, crown, edge drop and the strip position relative to the roller table are calculated and displayed every 100 ms. Outputs are available to alert the operator and mill computer to the presences of out-of-tolerance thickness, ridges, etc. The gauge features built-in redundancy, both in X-ray generation and the detection systems. It will operate with a single source functioning or defective detector element. In the event of a detector element being defective, it is automatically identified and eliminated from both profile and AGC outputs. Furthermore, measurement errors due to the build-up of dirt and drift effects are cancelled out by a standardization that is carried out automatically at the end of each coil.

## Diagnostics

The system software includes a thorough diagnostic program, which can be accessed remotely via dial up modem or internet if the customer's firewall permits.

All digital and analog I/O values may be exercised and monitored via a built-in maintenance screen. Alarms are generated for inputs going out of preset bounds or in an unexpected state. Separate screen pages allow monitoring of the x-ray sources, pyrometer and detector array. Network and serial data links can be monitored and traffic logged for analysis.

Additionally, a full measurement diagnostic facility allows on line logging of all the signals, reference sample checks, intermediate calculation stages and final measurement results. Any of this data can be imported into Excel™, allowing the end user to create and present personalized reports for quick identification of any faults.



# Support you can depend on

Thermo Scientific products are supported by our extensive network of qualified application engineers who will work closely with you to understand and evaluate your specific production parameters. Our experts will help you choose the right instruments for your application, then keep them performing to spec. Their goal is to optimize your process today, and also lay the foundation for easy upgrades in the future.

## Product Maintenance

Our comprehensive service offering is based on corrective and preventative maintenance that not only reduces downtime, but also helps you improve your process. We offer multiple levels of support agreements, with varying degrees of access and response, including:

- System calibration
- On-site repair
- Depot repair
- Preventative maintenance
- System commissioning

Some options feature complete cost predictability, with all travel, labor, spare parts, and consumables included.

## Professional Services

Our certified engineers are available to review your process, perform benefit analysis and recommend improvements to help you meet your best-practice goals. We will develop an implementation plan that integrates all Thermo Scientific systems, as well as third-party components including:

- System layout and connectivity
- Software implementation, configuration and support
- Site modifications

You can rely on us to manage the entire installation and start-up if you choose, including serving as a liaison with licensing agencies where necessary.

## Education and Training

We offer multiple training options to help you increase productivity by optimizing the use of your instruments and expanding the skills of your operators. You can receive hands-on instruction in your plant or at one of our training facilities in the USA, Europe and Asia. Our range of courses covers:

- Basic operation
- Calibration
- Routine maintenance
- Troubleshooting
- Certification

We will also work with you to develop a custom program that meets your specific training objectives, often incorporating your own operating procedures.

## Parts and Upgrades

Our spare parts are designed specifically for your Thermo Scientific system, and we make it easy for you to secure high-quality, low-cost replacements by maintaining offices around the world that respond quickly to your phone or on-line requests. You can also extend the lifetime of your older instruments through our add-on system enhancement and retrofit packages, which adapt your instruments for new uses and eliminate the time and cost to retrain operators on new equipment.



## Profile measurements for world class quality

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Width. Temperature Profile. Flatness. Ridges.



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