

## Eliminating 5-axis machining errors: Real-time verification for Aerospace precision

Aerospace and Defence machining pushes tolerances to the single-digit-micron range on certain critical features (commonly  $\pm 1\text{--}10\text{ }\mu\text{m}$ ), while many blade geometry parameters elsewhere are specified at  $\pm 0.1\text{ mm}$  scales. Both ends of this spectrum have real performance and yield consequences. Static verification (e.g., touch-probe systems) can miss true dynamic tool-center-point (TCP) error that appears under synchronised 5-axis motion. The Rotary Inspector performs ISO 10791-6-based dynamic measurements in  $<1$  minute and delivers Q/P KPIs (geometric vs dynamic errors) as a digital quality report, enabling rapid correction and audit-ready proof.

### 5-axis machining in Aerospace and Defence

5-axis machining of turbine airfoils, casings and structural parts requires both geometric accuracy and dynamic stability. While lasers or interferometers are precise, they are slow, expert-intensive and often unsuited to frequent shop-floor checks; touch-probe routines are static and can't reveal dynamic controller/servo or axis alignment effects that hurt surface and form in production.

Deviations affect engine efficiency, air flow capacity and even vibratory response. Recent studies quantify measurable losses from tolerances issues, reinforcing the need to monitor and control them tightly during manufacturing.



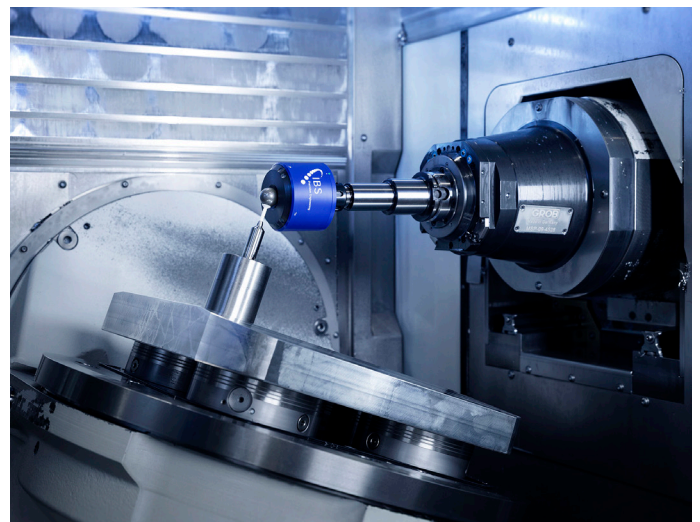
### Hidden dynamic errors in 5-axis motion

In synchronized 5-axis motion, pivot-line and squareness errors, controller instabilities and bearing or spindle dynamics combine to generate TCP error that emerges as profile shift, form deviation and surface finish problems. These issues may pass a static point-probe routine yet show up clearly on finished parts. Because aerospace materials like Ti-6Al-4V and nickel

superalloys are costly and slow to cut, discovering errors after value has been added is the worst-case scenario. Scrap and rework erode margins and consume schedule. What's required is a verification step that is quick enough to run often, sensitive enough to see sub-micron changes and presented in a way that drives fast, unambiguous action.

### Rotary Inspector (dynamic, fast, quantified)

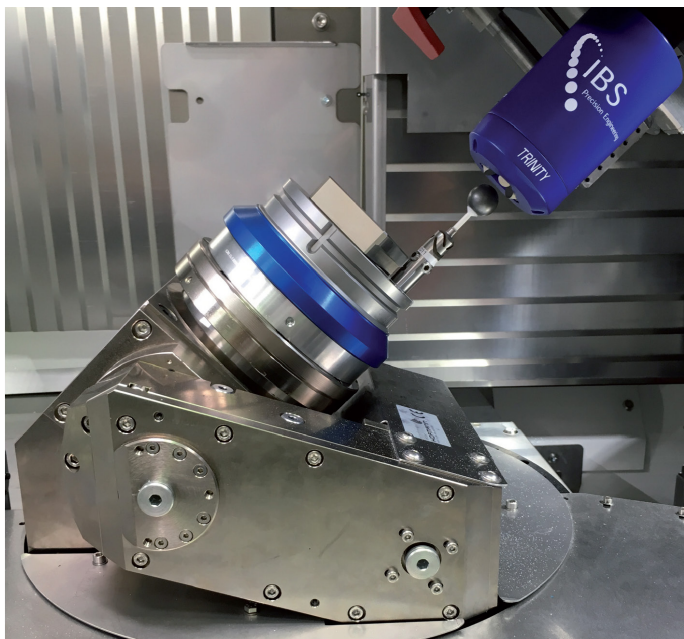
The Rotary Inspector, developed by IBS Precision Engineering, executes dynamic 3-, 4-, and 5-axis tests consistent with ISO 10791-6 motion and measures the actual TCP path against a calibrated masterball using a wireless, non-contact Trinity probe. The measuring system's sub-micron uncertainty and high sampling rate capture the geometric and dynamic behavior of the machine in well under a minute. Because cycles are so short, teams can check at start-up, after a crash or service event and before critical lots, building a time series that exposes drift and thermal behavior before it becomes scrap.



Results are delivered as a digital quality report with two production-friendly KPIs:

- Q-value (geometric/volumetric error, linked to form finish)
- P-value (dynamic error, linked to surface finish).

These KPIs make acceptance decisions unambiguous and provide a compact signal for trend analysis over days and weeks.



### Rotary Inspector software

The Rotary Inspector software offers a short and easy installation process which includes automated masterball position determination via the NC-codes. Combined with an automatic spindle alignment function, this allows the operator to run the measurement fully automated.

With an extended machine database to a total of 23 standard configurations, the software accommodates even the most complex inclined machines. In addition, an inclined axis calculator is now fully built into the software, enabling simple determination of compensation data. The same goes for integrated manuals and automated measurements reports via email for remotely checking the outcome.

The Rotary Inspector's analysis layer computes pivot-line and squareness errors and reports 5-axis volumetric and dynamic errors over the usable 3D volume. The workflow is fully

automated, supports machine-specific tolerance settings, and optionally writes axis-error compensation where enabled, closing the loop from detection to correction within the same session.



### Benefits for Aerospace and Defence manufacturing

In the Aerospace and Defence sector, where costly materials like titanium or nickel alloys are machined to single-digit micron tolerances, the Rotary Inspector offers a significant advantage by enabling early detection and correction of dynamic Tool Centre Point (TCP) errors before any cutting occurs. This not only safeguards critical  $\pm 1-10 \mu\text{m}$  features from drift or controller-induced deviations but also improves first-pass yield by eliminating downstream rework and scrap.

By embedding a sub-1-minute, ISO-based verification routine into daily workflows, teams can run checks during production with minimal downtime or right after setup or a crash. The masterball can be integrated on a pallet and the probe in the toolchain for a 100% automated measurement. The system generates traceable digital quality reports with clear geometric and dynamic values, supporting AS9100 and ISO-compliant audits and making it easier for engineers to meet growing demands.

With such fast cycles, operators can check machines often, without halting production, making dynamic verification a practical, daily tool instead of a time-consuming exception. This transforms quality from a bottleneck into a real-time asset.

### Fleet-level oversight and predictive maintenance

In Aerospace and Defence manufacturing, it is common to operate multiple machines of the same type. The Rotary Inspector supports this reality with its optional Data Manager module, which provides management oversight across an entire machine base. Performance data from each machine is collected and visualized at group, cell or factory level, giving instant feedback on the status of all installed 5-axis machines. This enables cross-machine comparison, supports predictive maintenance strategies, improves scheduling, reduces errors and strengthens compliance with customer and regulatory requirements.

### Use case: Rolls-Royce and IBS

IBS has been Rolls-Royce's trusted partner in machine tool measurement and inspection since 2007. The collaboration began with spindle metrology for their high-precision grinding machines and quickly expanded to include inspection and analysis software that enhanced the performance of 5-axis machines used in the production of high-pressure turbine blades. Today, IBS metrology systems are the global standard for manufacturing these blades across multiple Rolls-Royce facilities. Most recently, our Rotary measurement solutions have played a key role in ensuring the dimensional accuracy and process stability of complex 6-axis machines used in the production of carbon fibre turbine blades for next-generation jet engines.

### Read more

- [Rotary Inspector in Aerospace industry](#)
- [Rotary Inspector product page](#)
- [Machine qualification webpage](#)
- [Machine qualification brochure](#)

### Siemens Product Partner

IBS Precision Engineering is a Siemens Product Partner for 5-axis machine tool qualification with the Rotary Inspector. The Siemens Product Partner program recognises companies whose expertise complements Siemens solutions and adds value in demanding applications. As a partner to the SINUMERIK portfolio IBS provides a dynamic verification tool that aligns with premium CNC machine concepts and supports fast shop floor qualification of multi-axis performance.

### Testimonials

*"I'm a big fan of the probe"*

**James Tingle**  
Automation Technical Specialist  
Rolls-Royce

*"Employing the IBS Rotary Inspector we can manufacture products with consistently high quality and precision."*

**Matthias Scherm**  
Plant Services-Engineering  
MTU Aero Engines, Munich

**Contact IBS Precision Engineering today to find out how our proven metrology solutions can help you achieve tighter tolerances, higher first-pass yields and greater confidence in your multi-axis machining operations.**



For over 30 years IBS has been helping customers address unique problems. With our expert foundation in metrology, we understand the true meaning of ultra precision engineering and how to help you achieve it. Please visit our website for more information: [www.ibspe.com](http://www.ibspe.com)

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