

SiPro-FA (UTA edition)

Fully-Automatic Silicon Photonics Measurement Probe System



Overview

Omega SiPro-FA is a fully-automatic, integrated silicon-photonics measurement platform that delivers engineering- and production-proven optical results immediately after installation—no custom development required.

Powered by SPARC and its Autonomous Metrology Assistant, the system self-calibrates the optical positioning stack to the probe station and verifies end-to-end performance with traceable logs.

The SPARC and enclosure enable hands-free calibration and re-calibration across multiple temperatures, an anti-condensation environment for stable measurements. Rapid tool-less changeover supports everything from single PM fibers to fiber arrays, as well as from grating to edge coupling.

A modular architecture unifies RF, DC, and optical paths in one platform—In short: install, calibrate, and measure—then scale from research to pilot production without changing your workflow.



Why SiPro-FA

- Fully-automatic chip handling, alignment, test, and reporting.
- Purpose-built for Silicon Photonics: grating couplers (GC) and microring resonators (MRR), and all passive components.
- Recipe-driven workflow for repeatable, auditable measurements at scale.
- Open, scriptable software SPARC with unified instrument control.
- Lab-ready + production-aware: compact footprint, safety interlocks, calibration and logs.

What it measures

- Grating Couplers (GC): IL/PDL, SOP-optimized; single fiber or fiber array
- Microring Resonators (MRR): Q/FSR/ER; continuous/step sweep; optional thermal tuning
- Splitters (Y / MMI / Directional): ratio, excess loss, uniformity
- MZI / RAMZI / Filters: extinction ratio, 3-dB bandwidth, ripple
- AWG / Echelle Gratings: channel center λ , IL, crosstalk, uniformity
- Bragg / Contra-DC Gratings: reflection/stopband, center λ , bandwidth
- Edge Couplers / SSC: coupling loss vs. λ , alignment tolerance, (opt.) return loss
- Mode (De)Mux / Converters: modal IL, extinction, inter-mode crosstalk
- Plus: wafer maps, site statistics, batch reports, CSV.

Automation you can trust

- Wafer map & lot management: define dies, sites, and recipes; auto-index and log.
- Closed-loop alignment: sub- μm resolution stages.
- Polarization synthesis & PDL scan: fixed SOP or randomized SOP for robustness.
- Recipe engine: GC $\rightarrow$ MRR $\rightarrow$ thermal sweep $\rightarrow$ export — repeatable every time.

What starts here changes Silicon photonics.

Mechanical Performance

Precision Alignment Platform 7 DOF (XYZ + $\theta_x/\theta_y/\theta_z$ [fiber] + ψ_z [chip]), sub-micron precision

XYZ Max Velocity	20 mm/s (unloaded)
XYZ Min Increment	0.2 μm
XYZ Unidirectional Repeatability	$\pm 0.2 \mu\text{m}$
XYZ Bidirectional Repeatability	20 μm
θ_x Range	360° coarse; 8° fine
θ_x Resolution	2° readout; $\sim 1 \mu\text{rad}$ actuator
θ_y/θ_z Range	$\pm 5^\circ$ total
θ_y/θ_z Resolution	$\sim 1 \mu\text{rad}$
ψ_z Range	360° coarse; 8° fine
ψ_z Resolution	5' readout; $\sim 1 \mu\text{rad}$ actuator

Temperature control

TEC Temperature Range	-25 °C to +85 °C (non-condensing)
TEC Stability	0.004 °C (1 h)
TEC Resolution	0.01 °C
TEC Modes	Temperature ramping & constant temp

Vibration damping system

Vibration Isolation Resonance	3.5 Hz
Vibration Isolation Loss @ Resonance	24 dB
Vibration Transmission @ 10 Hz	-16 dB (0.15 ratio)

Software

The SiPro system is equipped with the SPARC integrated probe station control software. The operating system is Windows 11.

- **1. Measurement Automation**

- Supports recipe-driven automated test flows, enabling multi-site, multi-channel, and multi-temperature sequence measurements.
- Provides automated Grating Coupler (GC) alignment and Microring Resonator (MRR) spectral sweep processes to ensure measurement consistency.
- Built-in Resonance Peak-Shift Tracking Algorithm automatically identifies resonance peaks and tracks shifts under temperature or bias variations.

- **2. Test and Alignment Control**

- Chip-to-chip movement and alignment time: a few seconds to tens of seconds (depending on pattern complexity and travel distance).
- Supports pattern-based wafer map for fast definition and execution of full-wafer test plans.
- Provides live spectral plots and real-time parameter display.

- **3. Data Processing and Analysis**

- Features automated data acquisition, baseline subtraction, signal averaging, and yield statistics.
- Supports generation of insertion loss distribution maps, wavelength drift charts, and wafer-level yield maps.
- Provides multi-channel data comparison and overlay functions to facilitate process variation analysis.

- **4. Report Generation and Data Export**

- Automatically generates complete test reports after measurement, including test conditions, spectra, and statistical data.
- Report formats supported: Excel (.xlsx) and CSV (.csv), enabling easy post-processing and publication.
- Supports auto-naming and batch storage to ensure data traceability.

- **5. User Interface**

- Unified instrument control interface with abstracted driver management.
- Built-in wafer map editor and recipe runner (process controller) for visualized wafer test progress and results.
- Provides user access management, supporting administrator and general user modes to ensure system security and data integrity.