Thin Film PRODUCTS OVERVIEW

k-Space Associates, Inc.

k-space.com

Leaders in Thin Film Metrology

Putting Light to Work
Since 1992

k-Space
Associates, Inc.

Leading manufacturer of in-line, in situ, and ex situ metrology tools for semiconductor, thin-film, photovoltaic, automotive, glass, and architectural materials.

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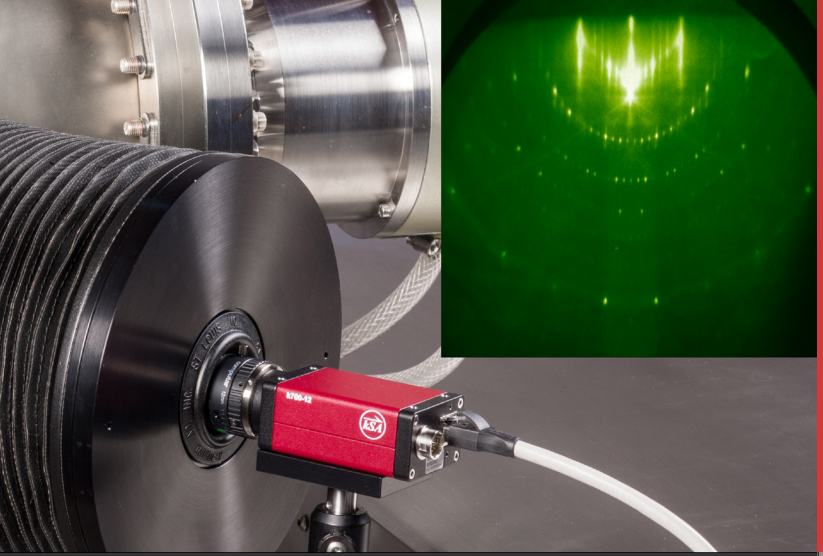

- Growth rate
- Lattice spacing/strain
- Surface coherence
- Structural analysis

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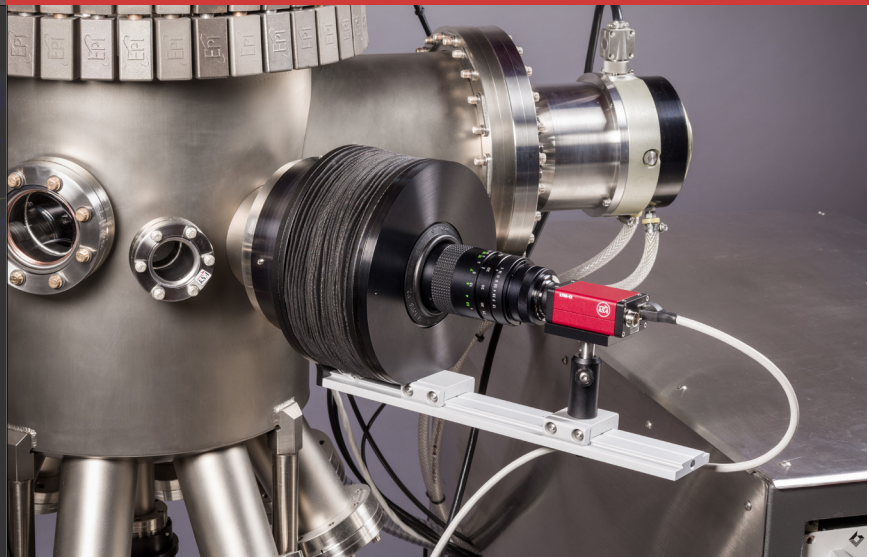
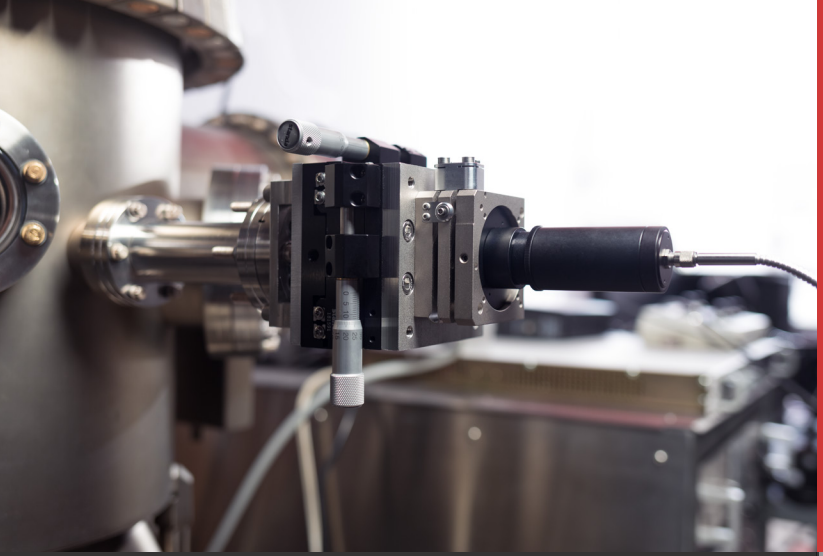


kSA 400

Save time and gain insight into your thin-film growth with industry-leading RHEED analysis – your window into RHEED

The kSA 400 is an analytical Reflection High-Energy Electron Diffraction (RHEED) system that combines a high-resolution, high-speed, and high-sensitivity camera with sophisticated RHEED-specific acquisition and analysis software. This flexible system enables users to analyze virtually any image feature. And with the optional electron gun control feature, users can also operate the electron gun for such tasks as acquiring RHEED rocking curves.

This easy-to-use instrument is straightforward to install and designed with convenience in mind – it is ready to go, right out of the box. The software seamlessly integrates with the hardware and provides visually driven RHEED pattern analysis, making it simple for users at all levels to operate. Incorporating extensive customer feedback with each iteration of the design has helped k-Space make the kSA 400 the most powerful analytical RHEED system in the industry and an integral part of MBE, PLD, PVD, and surface science chambers worldwide. Now in its fifth generation, the goal of the kSA 400 is to provide you with the widest variety of information from your RHEED pattern.



- Real-time source flux monitoring
- Real-time growth rate
- Real-time composition control
- Simultaneous measurement of up to three atomic species

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kSA ACE

Atomic flux control with accurate and high-resolution source flux and growth rate monitoring – Atomic Control for Epitaxy

The kSA ACE (Atomic Control for Epitaxy) is an optically based metrology tool that measures the in situ flux rate of atomic species using the principle of atomic absorption spectroscopy (AAS). The kSA ACE system uses conventional hollow cathode lamps (HCLs) to generate the atomic emission for the elements of interest. It also utilizes a high-sensitivity, UV-optimized solid-state spectrometer to monitor the absorption and a second spectrometer to monitor signal drift from the HCLs. Because the technique is inherently material-specific, the signal does not respond to other species or radiation in the chamber.

The kSA ACE can measure each material of interest independently with high accuracy, providing precise material-specific flux control in multi-source evaporation or co-sputtering processes. With its high sensitivity and long-term repeatability under continuous operation, the kSA ACE has applications in the fabrication of III-V and II-VI compounds, semiconductor devices, thin-film sensors, solar cells, optical coatings, x-ray optics, flat-panel displays, and more.

- Band Edge Thermometry (BET)
- Blackbody temperature
- Film thickness and roughness
- Multi-wafer and full platen scanning options

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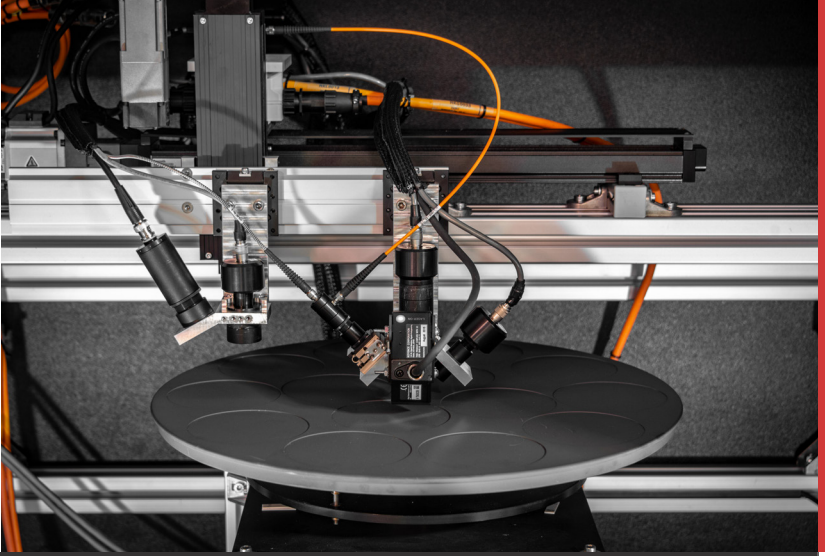
kSA BandiT

Real-time temperature measurement of thin films and semiconductor substrates – go where pyrometers can't!

The kSA BandiT is a non-contact, non-invasive, real-time, absolute wafer and thin-film temperature monitoring tool used during thin-film deposition and thermal processing. The instrument uses the temperature-dependent optical absorption edge that is inherent in semiconductor materials to provide semiconductor temperature monitoring in ranges that pyrometers cannot measure. This system is proven for substrates transparent in the infrared (including GaN, SiC, ZnO, AlN, Ga_2O_3, and $SrTiO_3$), as well as low-temperature monitoring, e.g., low-temperature GaAs, InP, and Si deposition.

Furthermore, the kSA BandiT is immune to changing viewport transmission, stray light, and signal contribution from substrate or source heaters, which are all sources of measurement error for pyrometers. Combined with its patented blackbody emission monitor, the kSA BandiT can monitor the full range of temperatures for most substrate materials, including low bandgap substrates and metal films. Finally, because the kSA BandiT acquires full wavelength spectra from the wafer, it can also measure real-time film thickness and surface roughness.



- Carrier emissivity, specular reflectance, diffuse reflectance, and photoluminescence
- Defect and microcrack detection
- Web/pocket height profiles
- Full carrier maps

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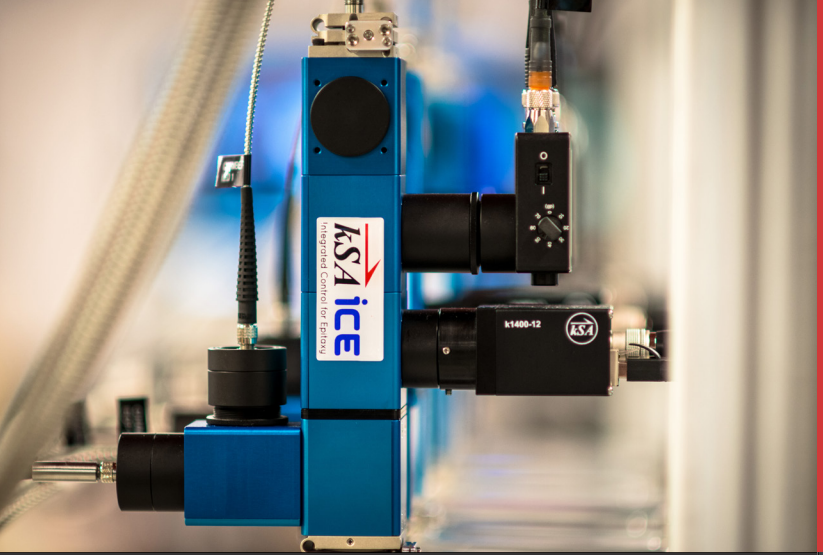
kSA Emissometer

Emissivity, reflectance, and photoluminescence mapping for MOCVD wafer carriers – open the door to quantitative characterization

The kSA Emissometer quickly and easily generates high-resolution diffuse and specular reflectance and total emissivity maps of MOCVD carriers. Variations in carrier emissivity result in non-uniform temperatures, which can lead to reduced device yield – or worse, complete growth run failure. The kSA Emissometer can track emissivity changes to determine carrier end-of-life, without wasting growth runs. It also detects unwanted residual deposits after baking and easily identifies carrier surface defects, scratches, microcracks, and pits that are not visible to the eye.

The kSA Emissometer is an essential instrument for performing the following tasks and more:

- Determine wafer carrier post-bake quality and a carrier's suitability for the next production run.
- Quantitatively determine real surface emissivity and necessary temperature set-point adjustments for a particular wafer carrier post-bake.
- Detect presence and severity of microcracks in SiC coatings to determine the end of its useful lifetime.
- Examine emissivity uniformity within a wafer carrier and its batch to provide quality control and qualification of a supplier's incoming wafer carriers.
- Prevent wasted MOCVD growth runs.
- Obtain high-resolution carrier web and pocket height profiles.



- Temperature – emissivity-correcting pyrometry (ECP), blackbody temperature
- Film thickness, growth rate, and optical constants
- Film stress and wafer curvature

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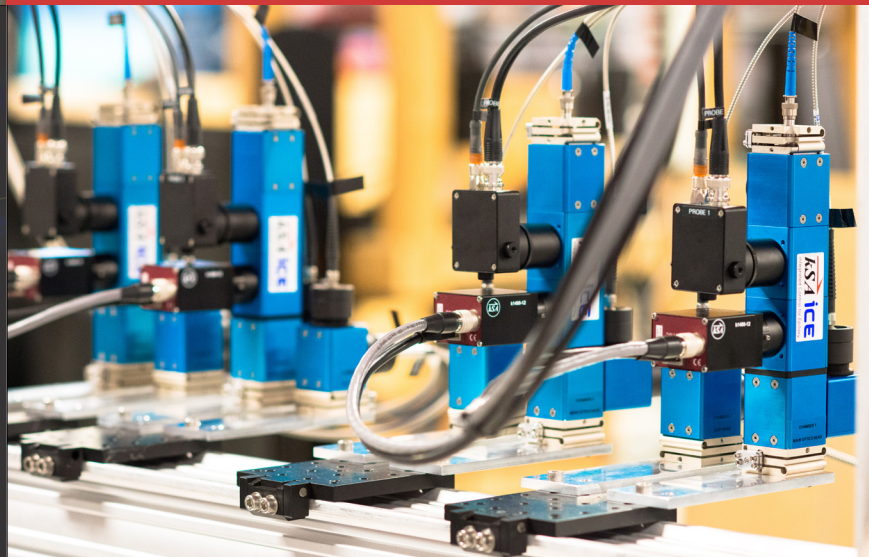

kSA ICE

Real-time multi-parameter measurement of thin films and semiconductor substrates – keep cool with Integrated Control for Epitaxy

The kSA ICE (Integrated Control for Epitaxy) system is a modular in situ metrology tool designed for today's MOCVD, MBE, and sputter deposition tools. It combines patented technologies from the kSA MOS and kSA RateRat metrology tools, along with an Emissivity Corrected Pyrometry and Reflectivity (ECPR) module. The modular design of kSA ICE allows k-Space to build each system based on user-specific needs by including only the applicable modules.

By integrating these various measurement modules into a single optics head, kSA ICE can simultaneously measure real-time temperature, reflectivity, growth rate, film thickness, substrate curvature, and film stress. The kSA ICE can handle wafer-resolved measurement for rotation speeds up to 1,500 RPM.

- Simultaneous 2D wafer curvature
- Simultaneous 2D film stress
- Wafer bow
- Reflectivity
- Growth rate

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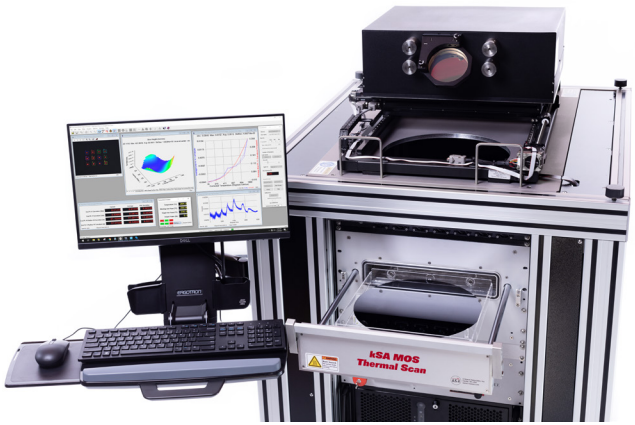
kSA MOS

In situ 2D curvature and thin-film stress monitoring – control your stress!

The patented kSA MOS (Multi-beam Optical Sensor) metrology tool is an extremely sensitive in situ laser-based multi-beam optical sensor system that measures and provides feedback on thin-film curvature, stress, reflectivity, and growth rate. Understanding and controlling stress in thin-film deposition and thermal annealing processes is critical for achieving the desired optical, electronic, and mechanical properties. Today's high-performance electronic devices rely on – or must be designed with – intrinsic stress within the individual layers to ensure specific device characteristics. However, unwanted changes in thin-film stress may be introduced into the fabrication process, leading to a reduction in device performance or film delamination and cracking.

Traditional ex situ stress/strain measurement methods such as X-ray diffraction (XRD) or surface profiling measure the overall stress only after the process is done, completely missing the dynamic changes occurring during the process. The kSA MOS makes it possible to measure the film stress in situ, providing valuable insight into mechanisms and methods for controlling and targeting the overall stress induced into the sample during every step.



- Thin-film curvature and stress
- Absolute reflectance
- Wafer bow, tilt, and warp
- Spectral reflectance and film thickness options
- Full wafer maps

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kSA MOS UltraScan and kSA MOS ThermalScan

Full sample mapping of curvature, stress, tilt, bow height, and warp

The kSA MOS (Multi-beam Optical Sensor) UltraScan and kSA MOS ThermalScan systems are ex situ high-resolution scanning systems that map curvature, bow, tils, warp, and stress.

Based on proven and patented kSA MOS technology, the kSA MOS UltraScan and kSA MOS ThermalScan systems use a laser array to map 2D wafer curvature, bow, tilt, warp, and stress of semiconductor wafers, optical materials, and practically any polished surface. Our MOS systems measure two in-plane surface dimensions simultaneously – something that single- and dual-beam curvature and stress tools simply cannot do. Simultaneous detection of the laser array also makes the measurement inherently less vibration-sensitive compared to systems that rely on scanning a single laser spot on a localized sample surface to measure local curvature. This leads to the kSA MOS's increased curvature resolution capability.

The integrated XY scanning stage allows for line scans and full area scans on samples as small as 15mm x 15mm up to full 300mm diameter wafers. kSA's patented automated servo-controlled mirror tracking and auto-intensity laser control, ensures MOS signal continuity during thermal expansion of the hardware and variation in wafer surface reflectivity, curvature, or tilt during thermal cycling. For room temperature measurements, explore the kSA MOS UltraScan. To determine how a sample changes with temperature, explore the kSA MOS ThermalScan.

- Absolute spectral reflectance
- Film thickness and growth rate
- Identification of custom spectral features

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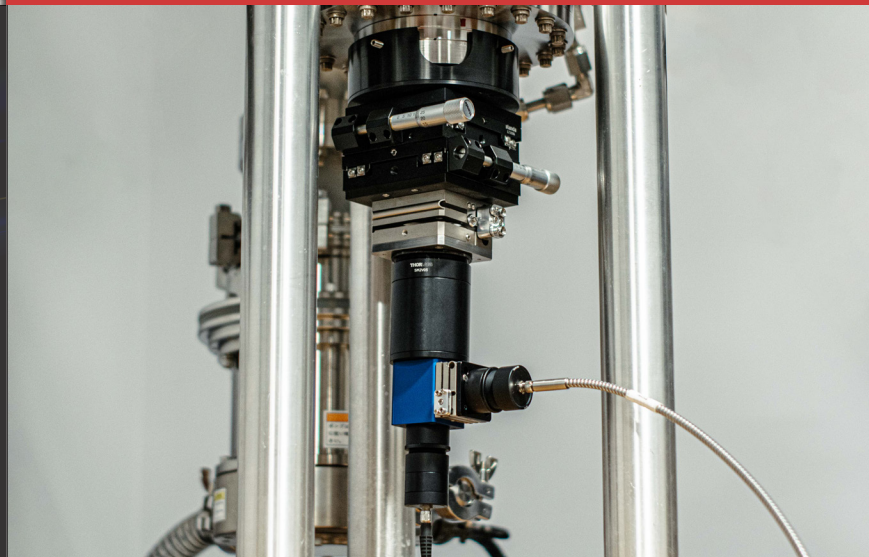

kSA SpectR

In situ spectral reflectance measurement for semi-transparent thin films – expect more with SpectR

The kSA SpectR is a non-contact, non-invasive, real-time absolute spectral reflectance tool. Knowing and controlling film thickness, growth rate, and optical constants is critical for achieving production quality standards. To help accomplish this, the kSA SpectR provides real-time spectral reflectance measurements for in-line and in situ deposition applications, such as sputtering, MBE, and MOCVD. The integrated kSA SpectR software includes film thickness monitoring for single- and multi-layer (film-stack dependent) films from the acquired reflectance spectra.

When monitored as a function of time during deposition, the instrument can determine film growth rate and *n* and *k* values, which are critical for applications such as vertical cavity surface emitting lasers (VCSELs), transparent conductive oxides (TCOs), avalanche photodiodes (APDs), and more

The kSA SpectR is available as a stand-alone tool or as an in situ module integrated into the kSA ICE optics technology.

- Absolute temperature measurement via patented blackbody fitting routine
- Multiple probes easily added

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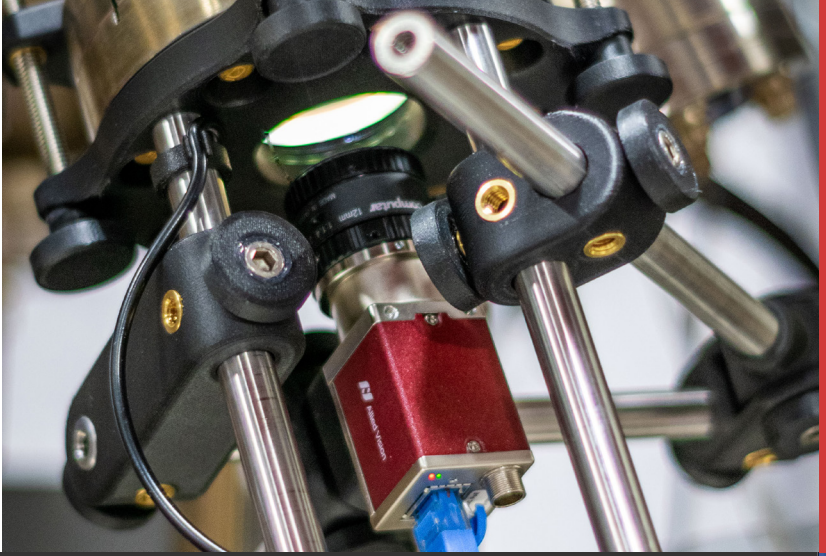
kSA SpectraTemp

Real-time blackbody spectral fitting for absolute temperature measurements – absolute temperature made absolutely easy

The kSA SpectraTemp is an easy-to-use, non-contact, optically based temperature measurement and calibration instrument that measures absolute temperature. Using patented techniques to analyze the spectral radiation profile, the kSA SpectraTemp can determine absolute temperature without any prior temperature calibration or knowledge of the material emissivity.

It's an easy solution for pyrometer calibration, blackbody sources, and kSA ECP module calibration at the beginning of each growth with no system downtime. Within seconds, the absolute blackbody temperature is available. With this simple but powerful metrology tool, you can achieve improved accuracy and repeatability in your temperature measurements.



- Rotation Monitoring and Triggering (RMAT)
- Laser Triggering Module (LTM)
- kSA Pulse Control Triggering
- kSA Insight Viewport Light and Camera
- RHEED Screens
- Beam Alignment Substrates

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kSA Accessories

Gain more from your deposition process

From viewport cameras to triggering hardware and RHEED accessories, k-Space offers a variety of options to enhance your system and make it work better for you. Explore the benefits of triggering options that can be based on rotation position, rotation stage, or home pulse input. Gain more from your deposition process with viewport cameras, RHEED screens, and beam alignment substrates.

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