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- ► **Measure rates from 0.1 to 10,000 Å/sec**
- ► **Monitor up to 8 optical emission inputs**
- ► **Control co-deposition of up to 8 materials**
- ► **Compatible with existing Sentinel® EIES sensors**
- ► **Ideal for CIGS PV materials**

EIES-IV Guardian™

Electron Impact Emission Spectrometer

Thin Film Deposition Controller

Electron Impact Emission Spectroscopy (EIES) is a thin film measurement technique that is applicable to a wide range of vacuum thin film processes including MBE, superconducting thin films, OLEDs, and CIGS solar cells.

In EIES, the material being deposited is excited by a thermionic emitter, which results in the creation of photons. The light from these photons is directed through an optical filter to a photomultiplier (PMT) detector. The detector measures an optical emission spectra unique to the material of interest. The intensity of the emission is a measure of deposition rate. Additional detectors, with appropriate optical filters, can be used to measure multiple materials simultaneously.

Working with Dr C (Larry) Lu of C Lu Laboratories, and using the latest electronic and optical components, Sigma Instruments has developed the EIES-IV Guardian™. The Guardian system offers features and performance far exceeding previous generation EIES instruments, at a significantly lower cost.

By digitizing measurement data in each detector, the Guardian offers improved sensitivity, S/N ratio, linearity, and dynamic range. PMT gain of each detector may be adjusted individually to optimize performance for different materials.

The Guardian controller operates 1 or 2 thermionic emitters (sensors), and up to 8 optical detectors and source control outputs, to control deposition rates of up to 8 materials simultaneously.

The Guardian controller is integrated with Sigma's proven thin film control software for simple setup and operation of multi-layer deposition processes. The software also integrates Sigma's SQM-242 QCM card for alternate deposition control, or for calibration of the EIES to a QCM reference. The SAM-242 option card integrates control of other analog process variables, such as temperature and pressure.

The EIES-IV Guardian's ability to control co-deposition of up to 8 materials, at rates from 0.1 to 10,000 Å/s, make it ideal for applications such as MBE, fabrication of OLEDs, superconducting thin films, and photovoltaics.

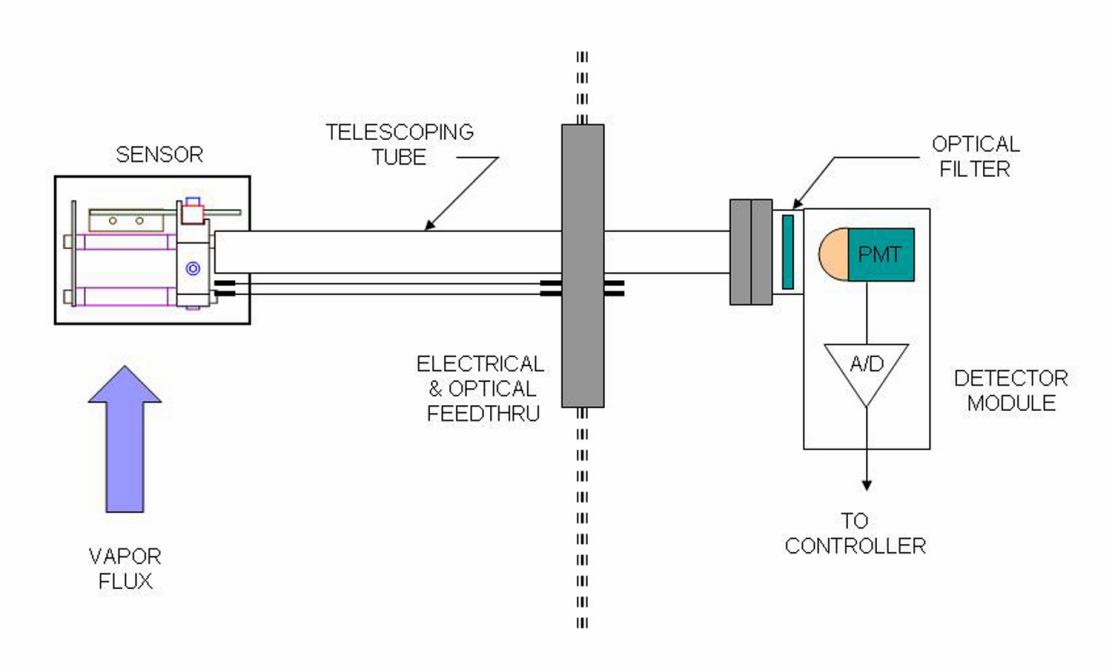
Sigma instruments

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System Configuration

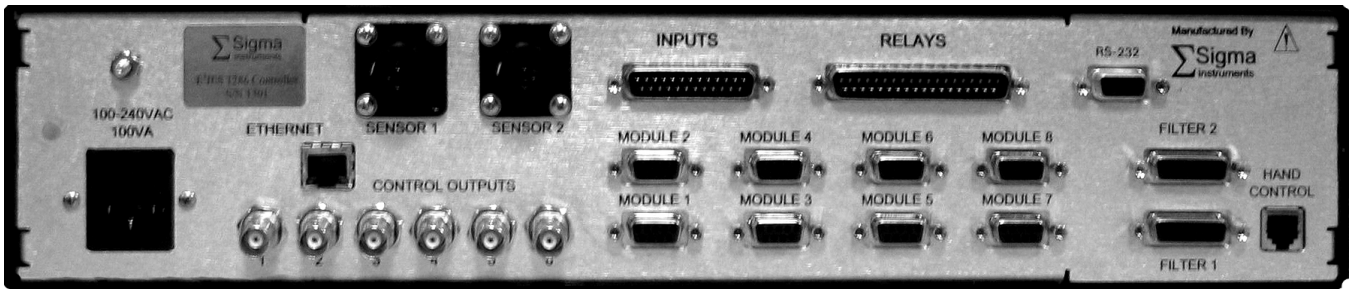
An EIES-IV Guardian™ system consists of 4 basic components:

Sensor / Feedthrough Assembly
The sensor is positioned in the vapor stream of the materials being deposited. It contains a thermionic emitter which produces a low-energy electron beam to optically excite the vapors. The sensor is connected to a vacuum feedthrough by a rigid or flexible tube, containing a light guide and lens.



Detector Module
The detector module consists of a photomultiplier tube (PMT) and electronics that convert the PMT signal into a high resolution digital signal. The mounting bracket includes a filter for selecting the specific wavelengths of interest. For a single material system the optical detector module can mount directly on the feedthrough. For multiple materials, a beam splitter couples the optical signal from one sensor into 2 to 4 optical detectors.

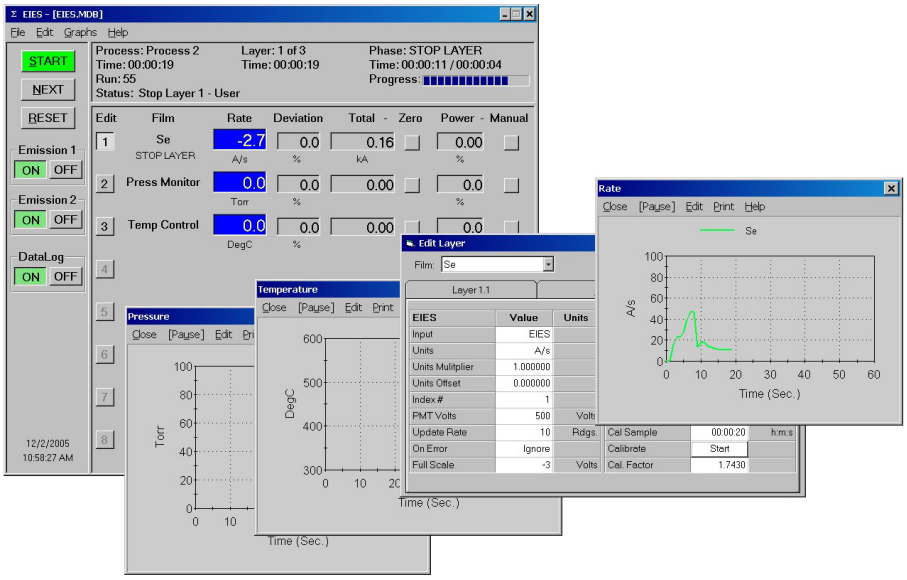
Controller & I/O Interface Unit
The controller provides power for 1 or 2 sensors, up to 8 optical detectors, 8 control output signals, and digital I/O functions (12 relays, 12 logic inputs).



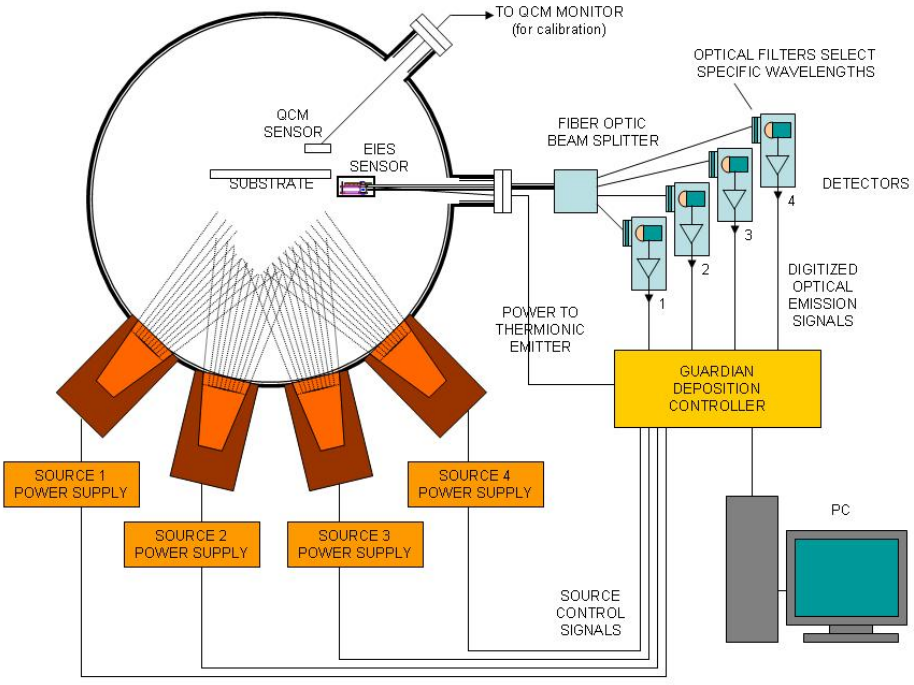
Guardian Controller & I/O Unit - Rear Panel

PC Data Acquisition and Processing Unit
The fourth and final component of a Guardian system is your PC, which provides the user interface, using the setup and operating software supplied with the system. The screen shots shown below illustrate some of the setup, data logging, and graphing capabilities of the software.

Guardian™ Software



Typical thin film deposition system using a Guardian™ to control deposition rates



In this system, a single EIES sensor is installed near the substrate in the vapor stream. The optical signal generated by the sensor passes through the feedthrough, then through a fiber optic beam splitter, to multiple detectors (up to 4), each monitoring a different wavelength. Using the measured deposition rate for each material, the Guardian controller sends a control signal to each material's source, to control individual and total deposition rates. A QCM is commonly used to calibrate the deposition rates measured by the EIES, but may also be used to control deposition rates for materials that do not require EIES measurement. Guardian software seamlessly integrates QCM and EIES functions for calibration and control.

Specifications

Sensor / Feedthrough		
Operating Pressure		< $5x10^{-4}$ Torr
Temperature		operation: 450°C maximum bakeout (non-operating): 450°C maximum
Size		1" x 1" x 2" (25 x 25 x 50 mm) approximate
Filament Life		1000 hours typical
Sensor-Feedthrough Linkage		rigid ss tube, or rigid ss tube with quartz light guide and collimating lens, or flexible metal bellows with fiber optic cable and collimating lens
Feedthrough		one optical and two electrical feedthroughs
Flange		1" bolt or 2-3/4"CF (NW35CF) Conflat®
Optical Detector		
Photomultiplier Tube (PMT)		Hamamatsu R7518 or equivalent
Spectral Response		185 to 730 nm
Detection Limit		better than 5 fW of optical input power
PMT Gain		10^3 to 10^7 (detectors are independently adjustable)
Output Resolution		20-bit
Optical Entrance Port		built-in filter holder, for filters up to 1" (25mm) diameter and 0.2" (5mm) thickness
Size		2" x 5.5" x 2.75" (50 x 140 x 70 mm) mounting holes on 3 sides (optional mounting brackets available)
Controller		
Inputs		8 optical detector channels
Outputs		8 source control 0 to ±10 VDC programmable
Digital I/O		12 relay outputs and 12 logic inputs
Power		100-240 VAC, 50/60Hz, 150W
Size		19" x 3.5" x 12" (483 x 89 x 305 mm)
Compliance		CE pending
User Interface		software: Windows® based setup program included with Controller
Displays	deposition rate:	4-digit numeric display of all channels, from 0.001 to 999.9 Å/s, and graphical X-Y scrolling plot with selectable scales.
	thickness:	5-digit numeric display with range selection, from 000.01 to 999.99 KÅ
Computer		user-supplied - any PC with Windows®xP or Windows®2000 operating system, and Ethernet or RS-232 interface

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