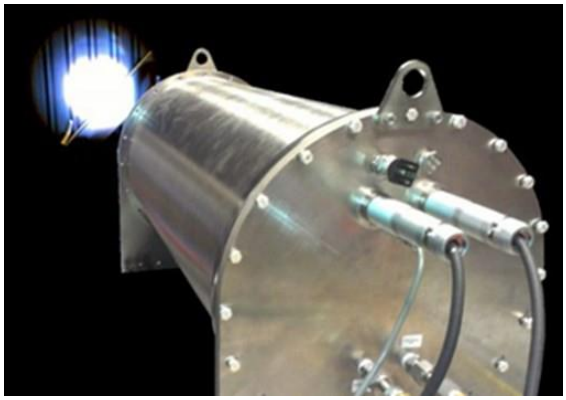
SOLAR SIMULATORS FOR SPACE RELATED RESEARCH

1. Highly collimated Fresnel Solar simulator for space environment simulation

A world-renowned space agency requested SCIENCETECH to create a highly collimated solar simulator. It needed to be placed within a vacuum chamber. The solar simulator was part of a bigger system that simulated extraterrestrial settings in a controlled laboratory setting.



Main Characteristics of the system

The illumination area was designed as a 36 cm diameter target area, and the solar spectrum had an AM0 spectral match to mimic solar irradiance in space. The target plane received 1360 W/m_2 of irradiation, meeting the required levels of optical power on target. This solar simulator was developed to illuminate with great spatial non- uniformity of irradiance and temporal instability of irradiance in accordance with ASTM E927-10 standard.

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If you have any questions or would like to discuss with one of our engineers about your special requirements, do email us at:
sales@Sciencetech-Inc.com

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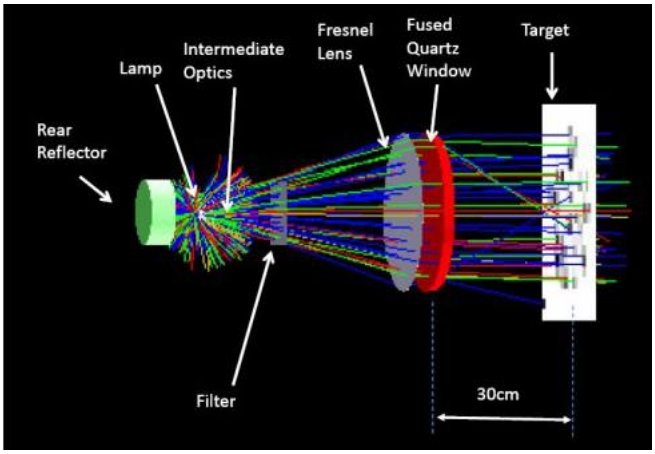
Complex ray tracing models were developed to evaluate the optical properties of the proposed solar simulator system. After developing the optical design, we achieved over 85% optical power within ±0.7° of the collimation full angle. This was more than sufficient to deliver the necessary power on target.

The solar simulator has to be installed inside a vacuum chamber. A competent vacuum system engineering business designed and constructed the solar simulator housing, which was guaranteed to be leak-proof.

The system underwent on-site acceptance testing at the end user's facilities before being successfully installed by Sciencetech's service engineers.



Ray tracing model of the Fresnel Solar Simulator

2. Highly Collimated Solar Simulator with automated beam angle movement

This solar simulator was also developed for a major national space agency to test sensors installed on satellites. Several years ago, personnel of the client agency gained firsthand experience with Sciencetech's highly collimated sun simulators. They contacted Sciencetech and requested whether we should supply a solar simulator with an extremely near match to the sun.

The customer had precise guidelines for:

- Irradiance: 1 sun (AM0 spectral match)
- Collimation angle: 0.7°
- Spatial non-uniformity: Class A
- Attenuation: down to 10% in increments
- Clean-room compliance: ISO Class 5
- Automated beam angle movement

The system was developed to move the solar simulator in X, Y, Z, and two rotation angles, allowing the incident light angles to be adjusted. The entire system was sealed for usage in a clean room, with an isolated air-cooling system to prevent contamination of the clean room environment.

Would you like to read more about these projects? Do contact us for more details at: sales@sciencetech-inc.com

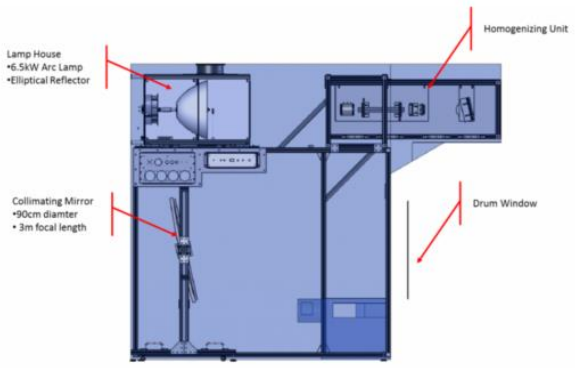
3. UV Solar Simulator for Air-pollution Studies in the Upper Atmosphere

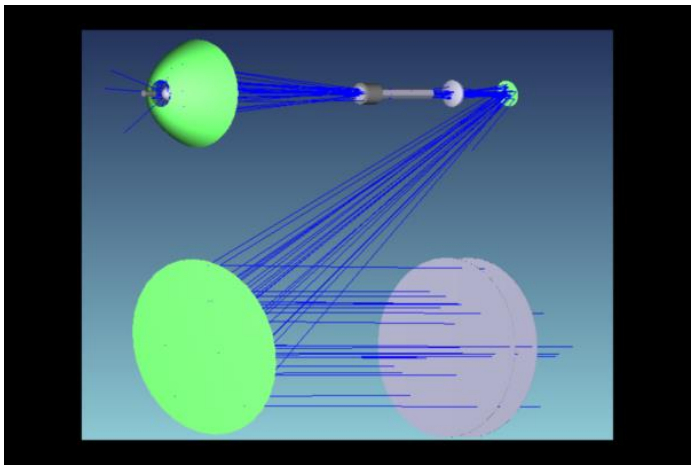
- This Solar simulator illuminates a rotating cylindrical drum designed to test aerosols suspended in the upper atmosphere.
- We used a 6.5 kW Xenon Light Source to illuminate a 0.5 m^2 target area with a beam collimation of 1° half angle.
- AM0 spectral match with variable attenuation from 0.25 - 1 sun was provided and ambient room temperature was to be maintained at 23º C.
- All equipment in the system were to fit within a room of dimensions 3 m x 5 m x 2.5 m.
- The intensity, cross sectional area, room size, and cooling requirements made the system a significant engineering challenge which Sciencetech was able to successfully overcome.

Designing the System

During the initial concept designing phase, a few different ray tracing models were produced to assess the most effective optical design. Finding the correct geometrical positions of the optical elements also required several alterations to the optical designs. Multiple ray tracing simulations were conducted to assess the collimation and irradiance profile

At the heart of the system is a 6500 W xenon short-arc lamp and deep elliptical reflector to produce and redirect the maximal optical power into the homogenization system. A custom specified and highly purified fused silica homogenizing rod was used to achieve the required spatial uniformity in the sample drum. The homogenized light was directed through a Koehler lens configuration, folded back by a turning mirror, and again folded back and directed into the sample drum by the collimating mirror. The almost one-meter diameter collimating mirror with a 3 m focal length was specially produced by one of Sciencetech's lens suppliers and tested by Sciencetech to confirm that the target irradiance profile was achieved.





4. Large Area IR Solar Simulator with High Spatial Uniformity

- This solar simulator was specially requested to be hung from the ceiling in order to accommodate the testing setup at the end user's laboratory.

- The system was designed so that the simulated sunlight directed downwards towards a vertical target plane from top of a 2m distance at a 30-degree angle.

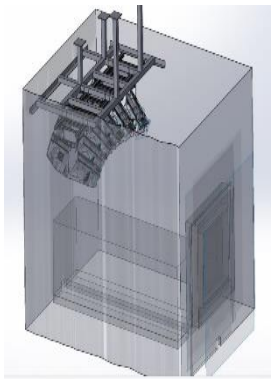
- This system incorporated five projector systems with the ability to upgrade to 6 units based on power requirements of the end user.

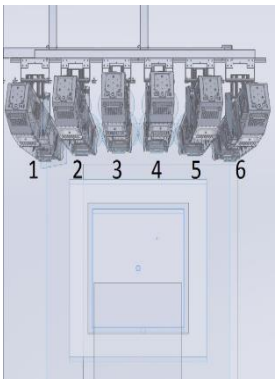
- Each projector system contained 2kW QTH lamps with specialized filters to create the necessary spectral output.

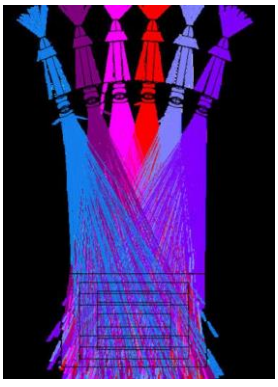
Specifications:

The customer had precise guidelines for:

- Target Area: Illuminates a 1.5m ² area
- Work distance: 2.1m above floor, 0.8m above center of target plane
- Spectrum: Class A, (ASTM E927)
- Wavelength: 700nm to 1100 nm
- Depth of Field: ± 15cm, with change ≤ ± 5% intensity (ASTM E927)
- Uniformity: 1m²: ± 5% (ASTM E927), 1.5m: ± 30% (ASTM E927)
- Attenuation: 10 steps, 0.1 suns to 0.6 suns
- System Warm Up: ≤ 15 seconds
- Intensity: Equivalent to 0.6 suns irradiance in the range of 700nm to 1100nm wavelength spectrum
- Temporal Instability: Class A (ASTM E927)







5. High Flux Solar Simulator for Solar Thermal Testing

The contract, awarded by the French government, underscores Sciencetech's exceptional capabilities in the field of solar simulation. Working with specifications outlined by the team of researchers, our team developed, manufactures, and assembled a custom system to match the experiments proposed for research. This system is at the cutting edge of research and includes many innovative features.

The 6.5kW xenon lamp housing and support is an innovative custom design that allows for fine adjustments of lamp position including adjustable travel along the optical axis(+/-5cm). Housing rotation and tilt adjustment of (+/-30) degrees allowing these housings to be integrated for larger systems.

An XYZ stage system for positioning the solar furnace or sample that allows for displacement as small as 10cm and can support samples up to 30kg in weight and up to 80cm cubed in size.
A measurement system to measure the spatial irradiance of a 20cm x 20cm target. This is performed in two ways.

- XYZ movements of a calibrated Gardon gauge measuring each point as it travels the specified target area.
- An industrial camera calibrated to measure the intense light reflected off a custom water cooled; alumina coated Lambertian plate. The benefit of this is the ability of lamp alignment in real time knowing the exact power distribution that the final device under test will be subjected to.

After successful completion of the single lamp system, we were contracted to build a seven lamp HFSS system.

Seven Lamp High Flux System

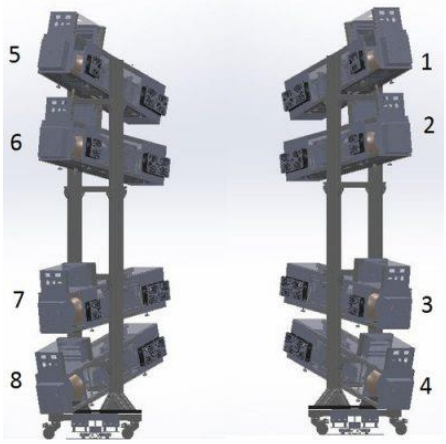
6. Large Area IR Solar Simulator for Illumination in the Infrared Wavelength

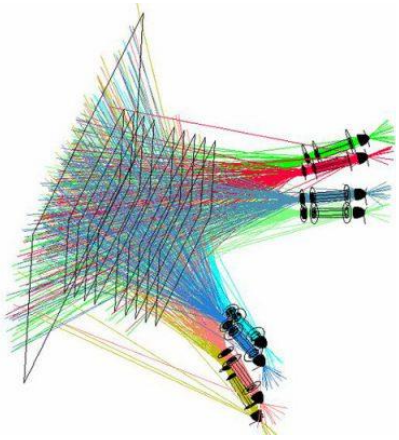
- This solar simulator was required to match the solar spectrum with a Class A spectral match in the near infrared region from 700 nm to 1100 nm.
- The optical system was required to produce a uniform field of light over a relatively large 3-dimensional volume (1.5x1.5x0.5 m3).
- The customer required the light to illuminate a vertical target plane from an off-axis angle.
- The necessary output irradiance had to be attenuated in increments down to 10% of the maximum power output.

Specification

The customer had precise guidelines for:

- Target Area: Illuminates a 1.5m ² area
- Spectrum: Class A, (ASTM E927)
- Wavelength: 700nm to 1100 nm
- Intensity: Equivalent to 1 sun irradiance in the range of 700 - 1100 nm
- Uniformity: 1m²: ± 10% (ASTM E927), 1.5m²: ± 30% (ASTM E927)
- Attenuation: 10 steps, 0.1 suns to 1.0 suns
- System Warm Up: ≤ 15 seconds
- Temporal Instability: Class A (ASTM E927)





ABOUT US

SCIENCETECH INC. has been designing and manufacturing optical spectroscopic instruments and solar simulators in Canada since 1985.

During the past 39 years, we have supplied spectroscopic instruments, among them, solar simulators, far infrared Terahertz spectroscopy systems, photovoltaic testing equipment, and custom-made instruments to distinguished institutions around the world like:

- The National Aeronautics and Space Administration (NASA),
- The European Space Agency (ESA),
- The Jet Propulsion Laboratory (JPL),
- The Max Planck Institute for Solid State Research,
- The Max Planck Institute for the Structure and Dynamics of Matter,
- The Brookhaven National Laboratory,
- The Herzberg Institute of Astrophysics,
- The Argonne National Lab,
- Over 2,000 top universities plus many synchrotron and accelerator facilities, and government institutions.

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