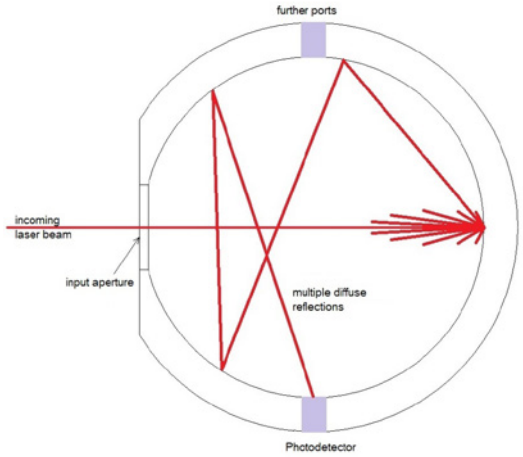
Artifex Engineering

Considerations on Design Parameters

Preliminary Considerations:

An integrating sphere collects light through its input port and reflects this light from its diffuse, but highly reflective surface.
In this manner, the beam is spatially homogenized and it loses all polarization properties. This makes the integrating sphere an ideal instrument for preparation of a laser beam for power measurement.
In addition, the total power exiting a given port is proportional to the size of that port. In this manner, the integrating sphere can be used to attenuate the power of a laser beam making measurement with a photodiode accessible.
Since photodiodes are high speed devices, an integrating sphere is a much faster power measurement device than a thermopile.



The power reaching the photodetector mounted in an integrating sphere is given by:

$$P_{pd} = P_{laser} \times \frac{A_{pd}}{A_{sphere}} \times \frac{\rho}{1-\rho(1-a)}$$

Whereby:

P_{pd} = power onto the photodiode
P_{laser} = power entering the sphere
A_{pd} = surface area of the photodiode
A_{sphere} = surface area of the sphere
ρ = reflectivity of the sphere surface
$a = \frac{\text{combined surface area of all ports}}{\text{surface area of the sphere}}$

From this we see that a small value of „a“ increases the sensitivity of the sphere. It also has the effect of improving the homogenizing property of the sphere leading to more reproducible measurements.

The ratio $\frac{A_{pd}}{A_{sphere}}$ allows us to adjust the sensitivity of the measurement system to match a particular application.

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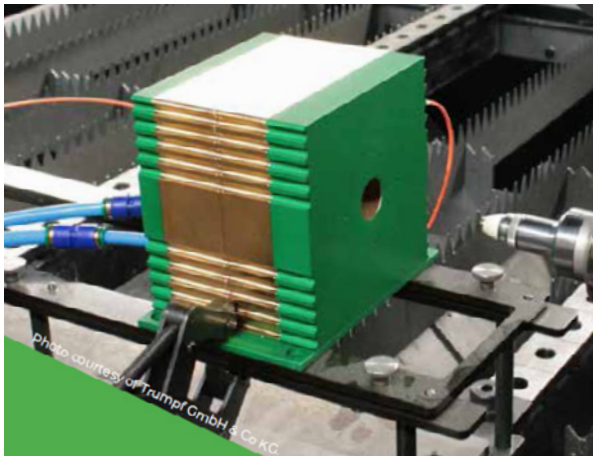
Light may be coupled from the integrating sphere to an external photodiode via an optical fibre.
This further attenuates the power allowing measurement of much higher laser powers.
Furthermore, since the photodiode is not mounted in the integrating sphere, it will not heat up at high power. This conserves the integrity of the calibration of the system.
Artifex Engineering calibrates such systems as a complete chain to ensure accuracy of the measurement system.



Standard Options (Polymer Spheres):

Spheres with integrated photodiode and SMA fibre port:

Polymer Integrating Spheres P10

Polymer Integrating Spheres P20

- High reflectivity from 250-2500nm
- Very homogeneous
- Power handling up to 100W

Polymer Integrating Spheres SP20

Polymer Integrating Spheres SP50

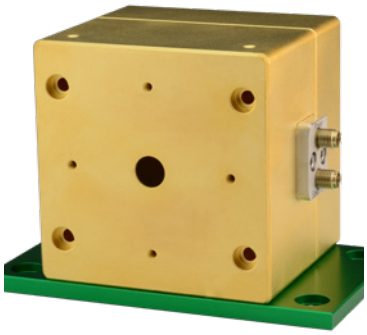
Polymer Integrating Spheres SP100

Standard Options (Gold Spheres):

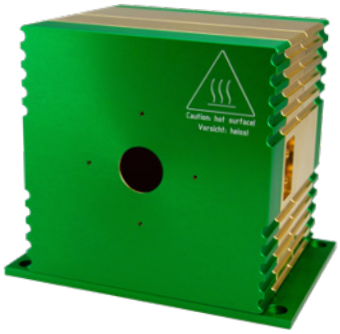
- High reflectivity from 700-12000nm
- Power handling up to 12kW

25mm Gold Integrating Spheres G25

65mm Gold Integrating Spheres G65

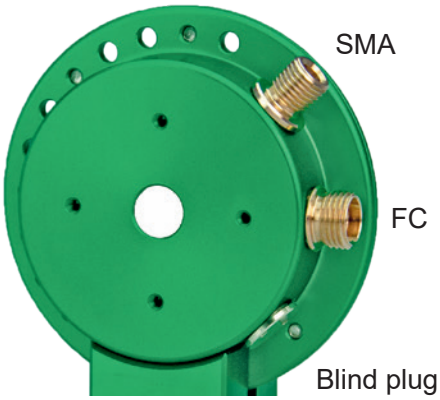


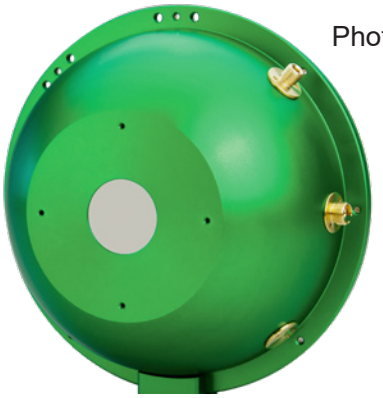
Liquid Cooled, 100mm Gold Integrating Spheres G100L



Liquid Cooled, 200mm Gold Integrating Spheres G200L

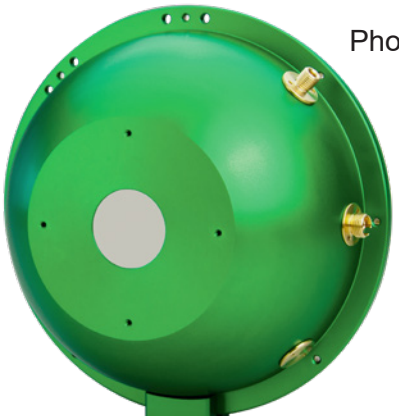
Standard Options (Detector Ports):





SP- Series with rotatable Azimuth

Standard Options (Photodiode Ports):



Photodiode

Choices of Photodiodes

• UVS (Si):	250-1100nm 250-950nm preferred
• VIGA (InGaAs):	400-1600nm
• x2.0IGA (x-InGaAs):	800-2000nm
• x2.2IGA (x-InGaAs):	1000-2200nm
• x2.5IGA (x-InGaAs):	1300-2500nm

Standard Options (Entrance Ports):

- Proprietary design for very low back reflection. This means the adapter will not influence the calibration.
- FC and SMA available.

Take Aways:

- Integrating spheres fitted with photodiodes are accurate power measurement devices.
- Integrating spheres are much faster than thermopiles.
- Spheres can be configured for almost any application.
- Power measurement over 8 decades possible with a single device.
- Power range: 1µW (min.) up to 12kW (max.).
- Wavelength range (calibrated):
  250-2490nm (max. 100W)
  or
  700-2490nm (max. 12kW).