External Optical Probes

EOP-xxx and ISP 40

Product highlights

- Versions with different cosine correction and light throughput
- Flexible fiber optic cable to the spectroradiometer
- Special version with fixed field-of-view of 5.7°

Instrument Systems supplies a series of different optical probes for measuring irradiance and illuminance. They are also used for general coupling of light into the spectrometer. The optical probes differ primarily in the light throughput, degree of cosine correction and the spectral range. All optical probes in the EOP-xxx series include a diffuser for scattering incident light. The type of diffuser determines the overall quality of cosine correction and this in turn exerts an effect on light throughput. Almost perfect cosine correction can only be achieved with an integrating sphere. Instrument Systems therefore supplies the ISP 40 integrating sphere for universal light input from light sources.

Adjusted optical probes are supplied for specific applications, such as measurements with defined fields-of-view or for measurements in the infrared range.

The optical probes are connected to a spectroradiometer using either fiber bundles or thick-core fibers. The precise selection of the optical fiber and the fiber plug adapter depends on the available spectral range.

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External Optical Probes supplied

This table shows an overview of the available optical probes and provides a qualitative assessment of their cosine correction and light throughput.

Model	Cosine correction	Light throughput	Spectral range	Application
With fiber bundle connector				
EOP-120	medium	good	190 - 1700 nm	Universal
EOP-121	medium	good	190 - 1700 nm	Universal, very flat design
EOP-140	low	high	190 - 2500 nm	Weak light
EOP-146	good	medium	190 - 2500 nm	For extended light sources
EOP-542	n/a	high	190 - 2500 nm	5.7° field-of-view
With SMA fiber connector				
EOP-350	very low	good	1000 - 5000 nm	IR spectral range
Integrating sphere				
ISP40	very good	low	220 - 2500 nm	Solar irradiation

Cosine correction

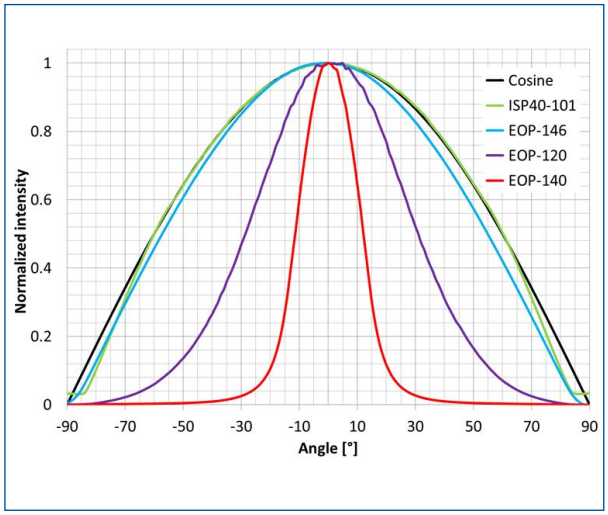
Assuming that the light source is arranged normal to the detector surface, photometric fundamentals indicate that irradiance can only be correctly determined for extended sources if the signal sensitivity of the detector changes with the cosine of the angle of incidence.

$E = E_0 \cdot \cos(\alpha)$

E : Irradiance measured at the incident angle
E_0 : Irradiance at normal incidence
α : Angle between the incident light beam and the detector normal

As a general rule, the better the cosine correction, the lower the light throughput.
The photometric integral was always measured for the cosine behavior of different optical probes shown below. This means that the curves displayed only apply to the visual range. The table shows the “acceptance angle” as a rule of thumb for individual EOPs. The assumption is that the deviation from the ideal cosine behavior must not be greater than 5%. The “~” sign is due to minor deviations in the symmetry of the optical probes.

	Acceptance angle for deviation < 5%	Largest dimension of an object at a distance of 1 meter
EOP-140	+/-3°	10 cm
EOP-120	+/-8°	28 cm
EOP-146	~ +/-38°	156 cm
ISP40-101	~ +/-65°	430 cm



Cosine behavior of different EOPs

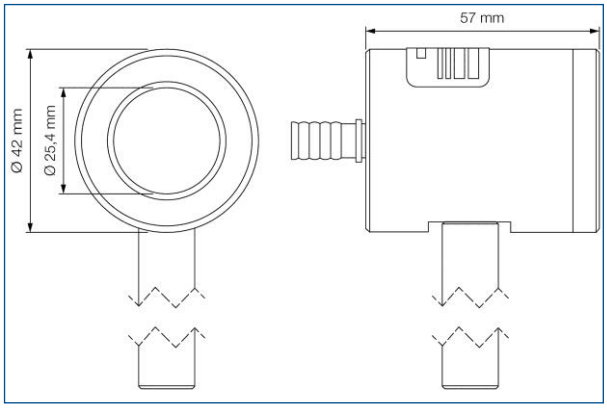
Throughput

The same OFG-465 fiber bundle was used to measure the throughput of all optical probes for the wide spectral range and the halogen lamp (spectral range 300 nm - 2100 nm).
ISP40-102 has the lowest throughput in the entire measured wavelength range. The values were therefore standardized on 1. Higher values therefore entail higher throughput.

	300 to 380 nm	380 to 1000 nm	1000 to 1650 nm	1650 to 2100 nm
ISP40-101	1	2	3	4
ISP40-102	1	1	1	1
EOP-120	13	16	23	46
EOP-140	41	49	70	161
EOP-146	3	3	5	8

The range of models EOP-120 and EOP-121

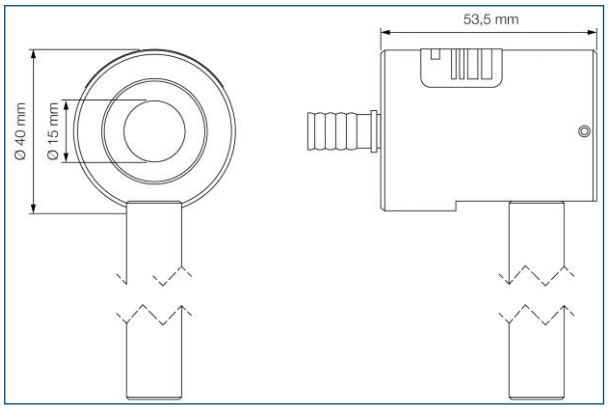
For general applications we recommend the optical probes from the EOP-120 and EOP-121 series (the latter with fiber bundle connector on the side) since these offer the best compromise between average cosine correction and good light throughput.



The diagram shows technical drawing EOP-120

EOP-146

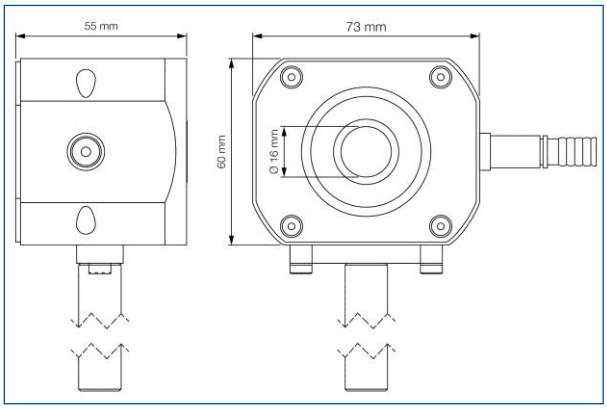
Good or very good cosine correction is necessary for analyzing extended light sources. However, this entails a loss in light throughput. The EOP-146 optical probe provides the best characteristics for this type of application.



The diagram shows technical drawing EOP-146

ISP 40

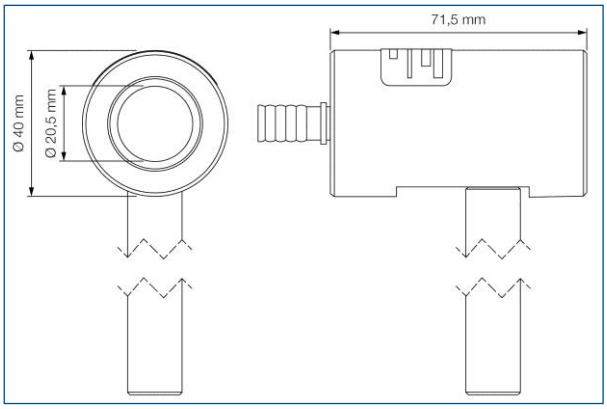
Integrating spheres offer ideal cosine correction together with broad spectral range. Instrument Systems has developed the ISP 40 with 44 mm internal diameter to meet this requirement. The integrating spheres are either coated with Spectralon (ISP40-101) or barium sulfate (ISP40-102). The ISP 40 can also be used for universal light input and for lasers. The rectangular shape provides easy handling and the internal cavity is naturally spherical in shape.



The diagram shows technical drawing ISP 40

EOP-140

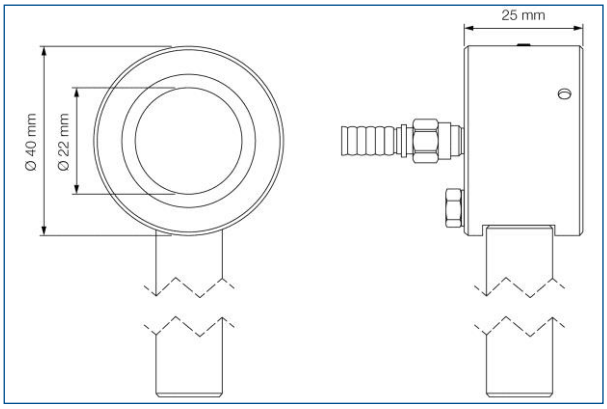
The EOP-140 optical probe is only suitable for applications requiring a high light throughput because the cosine correction is correspondingly low.



The diagram shows technical drawing EOP-140

EOP-350

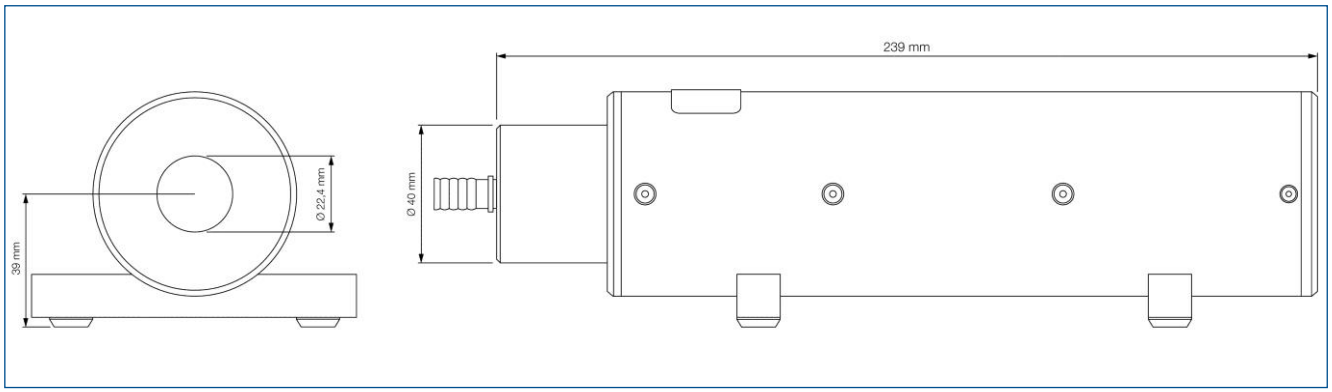
The EOP-350 model with SMA fiber connector is supplied for special applications in the infrared range.



The diagram shows technical drawing EOP-350

EOP-542

The EOP-542 model is supplied for measurements with defined field-of-view of 5.7°. This probe is mainly used to analyze direct sunlight.



The diagram shows technical drawing EOP-542

Ordering information

Order no.	Description
Optical probes with diffuser	
EOP-120	Good light throughput and medium cosine correction in the spectral range 190 - 1700 nm; connector for fiber bundle
EOP-121	Good light throughput and medium cosine correction in the spectral range 190 - 1700 nm; connector at the side for fiber bundle
EOP-140	High light throughput over wide spectral range of 190 - 2500 nm; connector for fiber bundle
EOP-146	Good cosine correction over wide spectral range of 190 - 2500 nm; connector for fiber bundle
EOP-350	High light throughput in IR; spectral range 190 - 5000 nm; incl. connector socket for flushing with nitrogen and adapter for SMA plug
EOP-542	Fixed field-of-view of 5.7°; spectral range 190 - 2500 nm; connector for fiber bundle
ISP40 Integrating sphere with 44 mm internal diameter	
ISP40-101	Reflecting material made of Spectralon; spectral range 220 – 2500 nm; fiber bundle connector at 90° to the measuring port;
ISP40-102	Reflecting material made of BaSO4; spectral range 240 – 2600 nm; fiber bundle connector at 90° to the measuring port;
ISP40-110	Quartz glass dome for ISP40

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