

Beam Tap I & II

Uniform S & P Polarization

Laser Beam Sampler

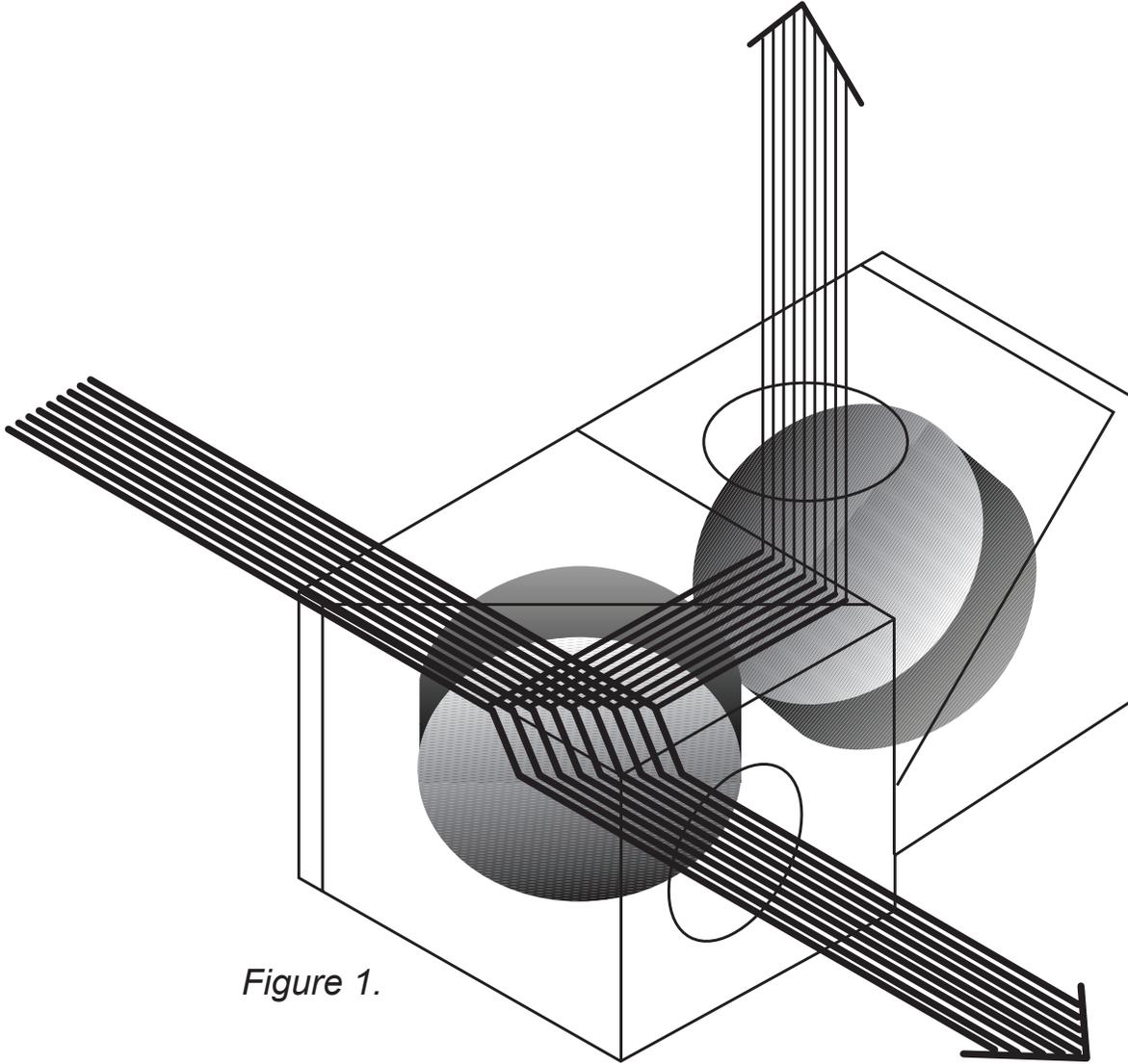


Figure 1.

**Beam Tap II Dual Surface Reflector for Equalizing
S & P sampled polarization.
(The two planes of reflection are orthogonal.)**

SPiRiCON
Laser Beam Diagnostics

 Member of the Ophir Group

Single Surface Polarization Problems

A single surface reflection at 45° is often used to sample a laser beam for profile measurements or for monitoring power or energy. However, as shown in Figure 2, at 45° a single surface reflects the S polarization component at more than 10 times the reflection of the P component. Depending on the laser polarization content, or stability, this sampling can provide very misleading and unreliable measurements. (However, the BT-I-YAG has both surfaces A/R coated for 1064nm so the reflection for both polarizations is equal at 0.5%. At other wavelengths far from 1064nm the above discussion applies.)

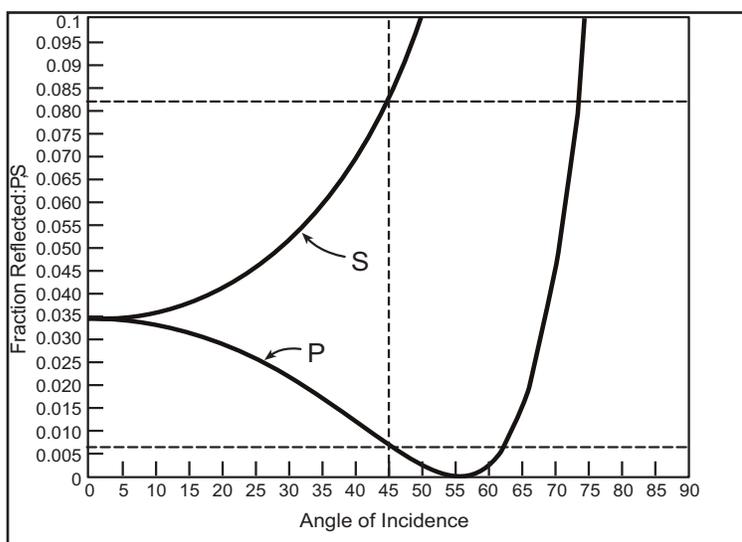


Figure 2. Individual S & P polarization reflection vs. angle of incidence.

Equalizing S & P Reflected Polarization

As shown in Figure 3, any arbitrary polarization component can be broken into equivalent S & P components. With complimentary sampling surfaces any given component gets reflected once as the S polarization, and the second time as the P polarization. Thus using 2 surfaces, the total reflected

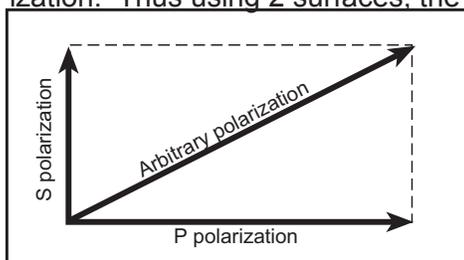


Figure 3. S & P polarization components of any arbitrary polarization.

energy for all polarization components is the sum of the S reflectance and the P reflectance. This causes the sampled beam to have S & P components that are identical to the original beam.

The Beam Tap II uses two reflecting surfaces such that the two planes of reflection are orthogonal. (Refer to Figure 1 on the cover.) With attenuation of 5.5×10^{-4} from the Beam Tap II, lasers with CW power of up to 10^4 Watts/cm², or pulsed lasers of up to 5×10^5 joules/cm², can be monitored without damage to the ND filters placed after the Beam Tap optics.

An additional advantage of the two surface beam sampler is that additional attenuation is obtained, which reduces the load on ND filters following the sampling. (The BT-I, with a single reflecting surface, can be used when the beam polarization effects are not important in a specific application.)

Beam Tap I & II Components

The BT-II Beam Tap is composed of two identical BT-I Beam Taps with coupling tubes to join the two together. Each Beam Tap I or II comes with a complete set of adapters to connect the Beam Tap to a variety of other measurement components, as shown in Figure 4.

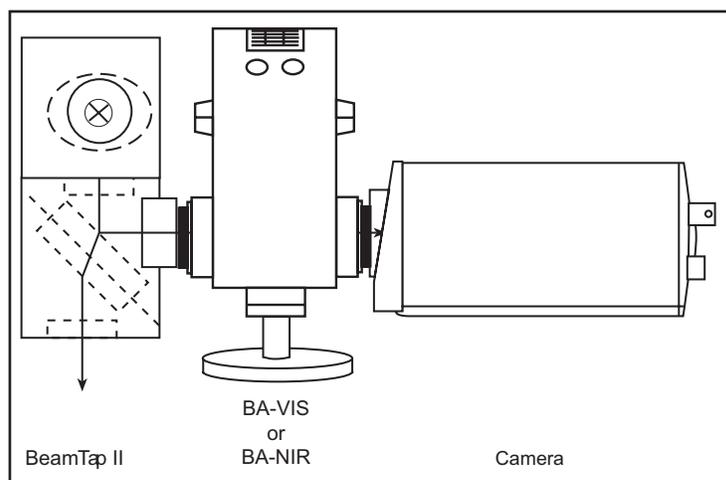


Figure 4. Accessory connectors to adapt a Beam Tap to a number of other optical instruments. (Connectors have c-mount, 1"-32, thread for connection to standard cameras and other optical components.)

Typical Assembly

Figure 5 shows a typical application. A Beam Tap I or II is connected to the model BA Laser Beam Attenuator, which is in turn connected to a CCD camera, all in one fully enclosed assembly.

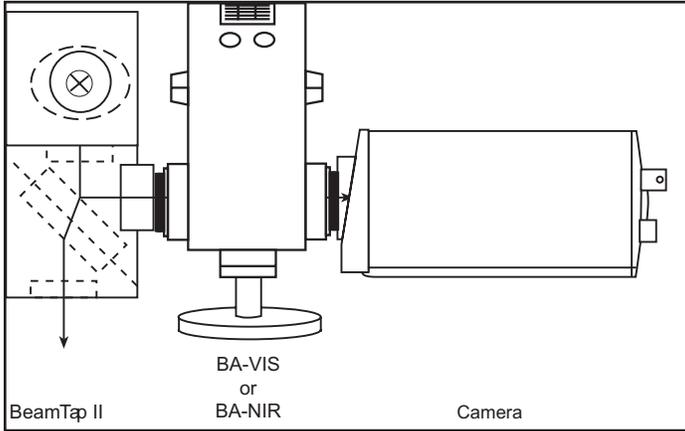


Figure 5. Typical application of a Beam Tap II with a BA attenuator and a CCD camera.

Beam Path Through Beam Tap

Figure 6 shows the 6mm offset of the through beam that is created by the reflecting optic. The deflection angle of the output beam is less than 0.007 degrees. The rear surface of the flat is AR coated to maximize the throughput of the main beam. The standard Beam Tap rear surface is AR coated for 400nm-700nm. The YAG version is AR coated for 1064nm on both surfaces.

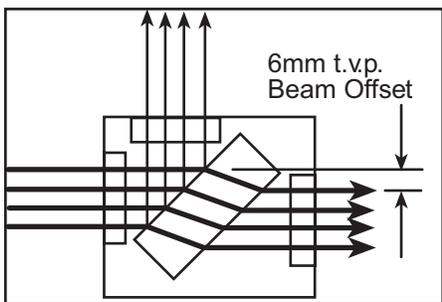


Figure 6. Optical path through a Beam Tap.

Beam Tap Reflection VS Wavelength

Figure 7 shows the Beam Tap II final sampled reflection vs. wavelength. As shown both the S & P reflection are nearly constant at 0.05% from the UV to the infrared.

Beam Tap II Reflection vs. Wavelength

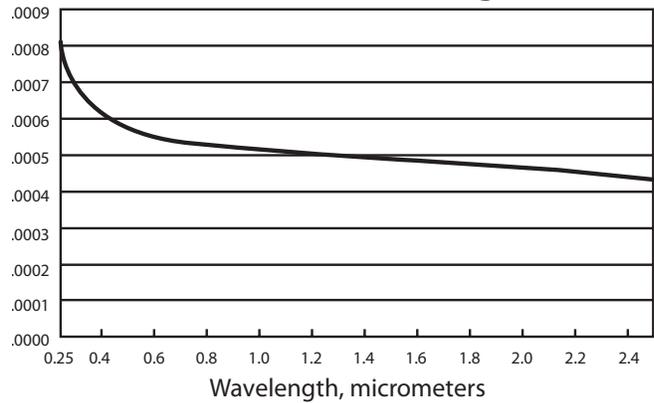


Figure 7. Beam Tap II reflection as a function of wavelength.

Through Beam Transmission of Beam Tap

Figure 8 shows the transmission of fused silica and BK-7 glass versus wavelength with the incident beam normal to the surface. Fused silica is used for Beam Tap I and BK-7 is used for Beam Tap I-YAG. The attenuation over most of the range is for the reflection of one surface since the rear surface is AR coated. The incident power capability at the two absorbing wavelengths in fused silica (1.4 μ m and 2.2 μ m) would be lower than at other wavelengths.

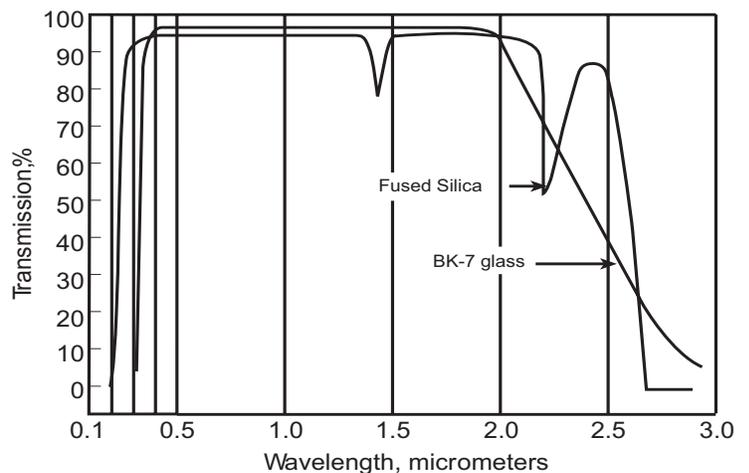


Figure 8. Transmission of Fused Silica and BK-7 glass versus wavelength.

Performance Characteristics

- Optical Material, Beam Tap I: Fused Silica
Beam Tap I-YAG: BK-7 glass
 - Wavelength Range, Beam Tap I: 250nm-2000nm
Beam Tap I-YAG: 400nm-2600nm
Rear Surface AR Coating:
Beam Tap I: 400nm-700nm
Beam Tap I-YAG: A/R coated for 1064nm
 - Typical Beam Reflection:
Beam Tap I: 0.67% P Polarization (0.0067)
8.19% S Polarization (0.0819)
Beam Tap II: 0.055% Total (0.00055)
Beam Tap I-YAG: 0.5% (only @ 1064nm)
Beam Tap II-YAG: 2.5×10^{-5} (only @ 1064nm)
 - Reflection Angle:
90° from incident beam
 - Typical Through Beam Transmission:
99% P Polarization
91% S Polarization
BT-I-YAG: 99.5% P and S
 - Transmitted Beam Path:
6mm typical offset from input beam
<24 arcsec deflection (0.007 degrees)
 - Clear Aperture: 20mm (Maximum input beam width: 8mm)
 - Damage Threshold:
1MW/cm² CW, or 1MJ/cm² pulsed
 - Operating Beam Power: 1000 watts,*
 $\lambda = 400\text{nm}$ to 700nm for BT-I
 $\lambda = 1064\text{nm}$ for BT-I-YAG
 - Operating Beam Power: 250 W,
 λ outside above limit
 - Surface Quality:
Scratch/Dig: 20/10
Flatness: $\lambda/10$ @ 632.8 nm
Parallelism: <30 arcsec
 - Optical Path Length: BT-I = 2.02", BT-II = 4.04"
 - Mounting: 1/4"-20, 2 surfaces
 - Weight: Beam Tap II 40oz.
- *An external beam dump should be used with a Beam Tap II whenever 8% of the input power (transmitted through the second Beam Tap I) exceeds a safe level for the environment.



Figure 9. Photograph of assembled Beam Tap II.

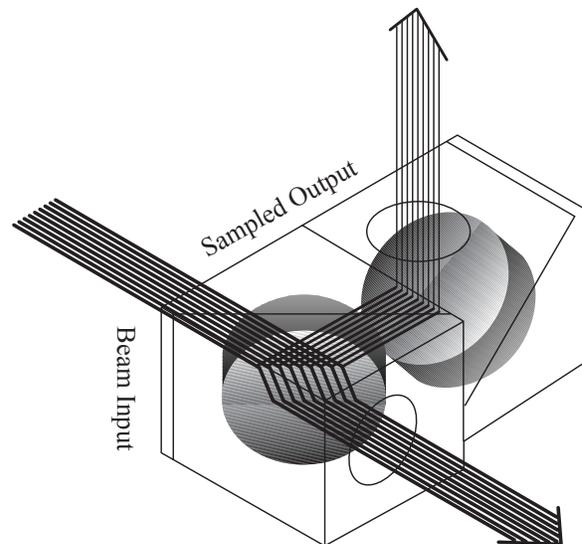


Figure 10. Dimensions of Beam Tap I.