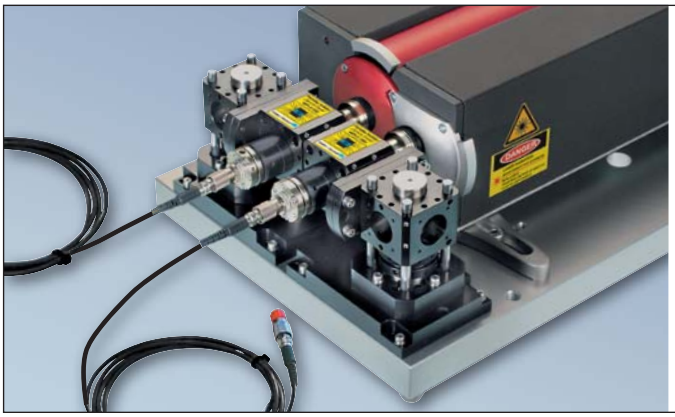
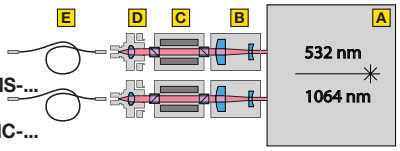
Customized Solutions

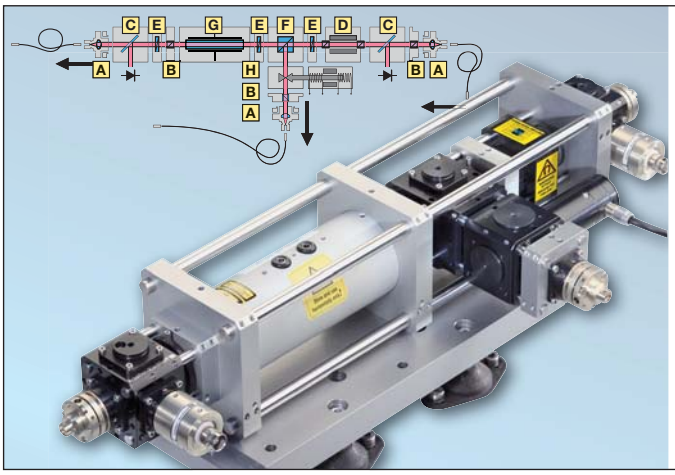


Fiber Coupling with Beam Shaping and Feedback Protection

Sensitive laser resonators must be protected against back-reflections of the emitted laser light. Schäfter+Kirchhoff can couple singlemode and polarization-maintaining fibers to a customer laser source and integrate a Faraday Isolator to prevent laser feedback. A complete system could have additional power monitors, as shown. To guarantee the highest coupling efficiencies, different kinds of beam-shaping optics can be used, e.g. beam expansion.

- A Innolight Prometheus
- B Beam expansion **48EO-...**
- C Faraday isolator **48FI-...**
- D Laser beam coupler **60SMS-...**
- E Polarization-maintaining singlemode fiber cable **PMC-...**

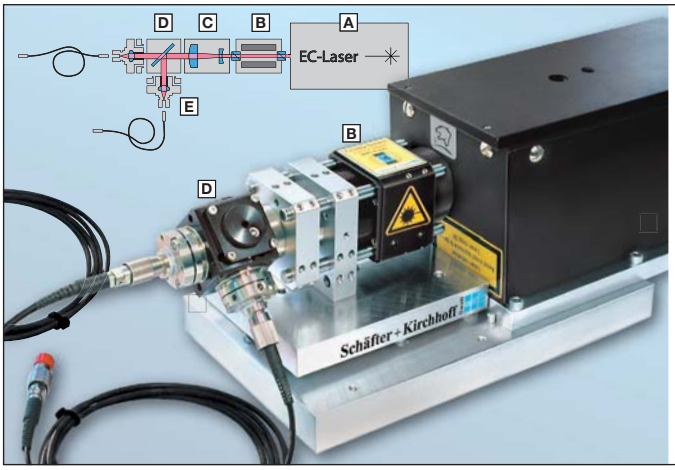




Cascadable Fast Laser Switch with Back-Reflection Protection

Applications such as LIDAR need a laser source with a relatively high frequency stability in combination with a fast switching operation (compare apparatus with optical scheme below). The Faraday Isolator protects the laser beam source from disturbing back-reflections, while the EOM provides a fast pulse operation. A polarization beam splitter together with retardation optics offers a stepless splitting of the laser power. This additional channel allows a cascading of the beam and can be automatically connected to an electromagnetic shutter. Power monitors at the input and the output ports provide complete control.

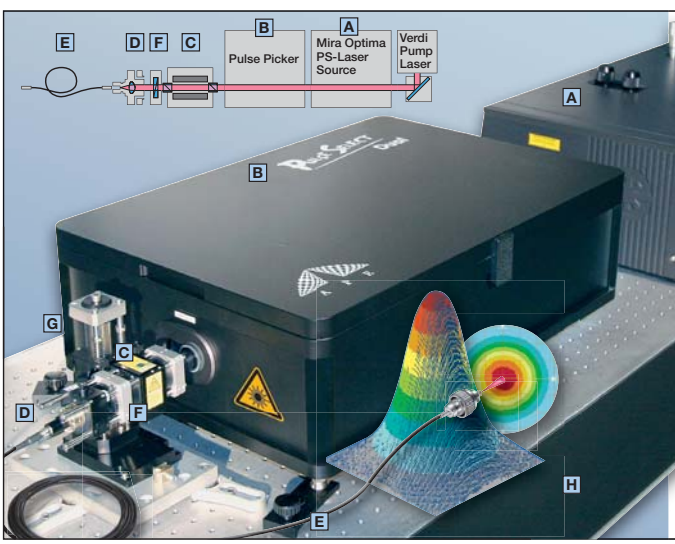
- A Laser beam coupler **60SMS-...**
- B Polarizer **48PM-...**
- C Beam splitter with photodiode **48BS-...** and **48PD-...**
- D Faraday Isolator **48FI-...**
- E λ/2 plate **48WP-...**
- F Polarization beam splitter **48PM-...**
- G EOM
- H Electrical shutter **EMS-...**



External Cavity (EC) Laser with Polarization-maintaining Fiber Optics

- A Diode laser at 820 nm with external resonator in Littman configuration, single frequency configuration.
- B Faraday Isolator 48FI-5-820 to prevent unwanted back-reflections into the incident laser source.
- C Anamorphic beam-shaping optics 5AN-3-V-05 reduce ellipticity and astigmatism of the laser beam.
- D Beam splitter 48BS-..., mounted in "multicube" 48MC-SM-19.5, diverts 1% of the beam intensity for monitoring wavelength or power.
- E The two laser beam couplers 60SMS-... each transfer one beam into polarization-maintaining singlemode fibers PMC-... F. Both beams emerge as divergent, axially symmetric Gaussian beams.

A beam inclined to the housing can be accommodated using the common mounting bracket, with its numerous adjustment possibilities, together with retention of the Faraday Isolator and adjacent optical elements.



Fiber Coupling of a Picosecond Singlemode Pulse Laser System

Single laser pulses from a Mira Optima 900-P laser with Verdi V5 pump, emitting picosecond pulses at a repetition rate of 76 MHz, are selected by an acousto-optical pulse selector. Opto-mechanics and fiber optic components from Schäfter+Kirchhoff are used to couple the beam to a polarization-maintaining optical fiber cable. Laser back-refelctions arre prevented by use of a Faraday Isolator. The fiber coupling is solidly mounted on an adjustable 4-axis translational and rotational stage.

- A Mira Optima 900-P picosecond laser
- B Acousto-optical pulse picker
- C Faraday Isolator **48FI-5-830**
- D Laser beam coupler **60SMS-...**
- E Polarization-maintaining singlemode fiber cable **PMC-...**
- F λ/2 Plate **48WP-...**
- G 4-axis translation and rotation stage from Schäfter+Kirchhoff
- H Breadboard

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Customized Fiber-Optical Solutions

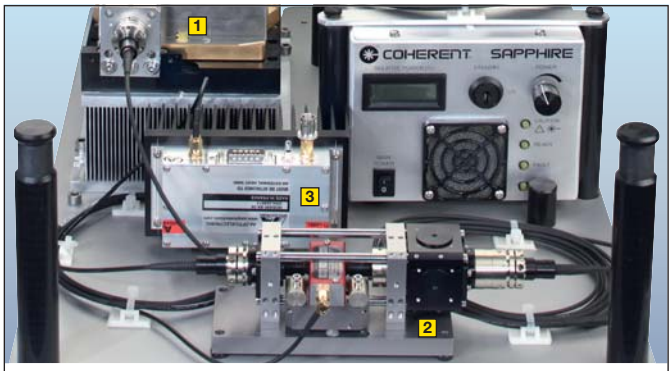


Figure 1: External **fiber-coupled acousto-optical modulator (AOM)** with fiber-coupled Sapphire HP laser:
1 COHERENT Sapphire 488 HP, 100 mW, coupled to a polarization-maintaining fiber cable
2 **AOM**: Acousto-optical modulator, fiber coupled using the "multicube"components from **Schäfter+Kirchhoff.** For more details see page 54.
3 Driver for the acousto-optical modulator
- Overall coupling ≥50 % of the intrinsic power
- Polarization extinction ratio ≥23 dB

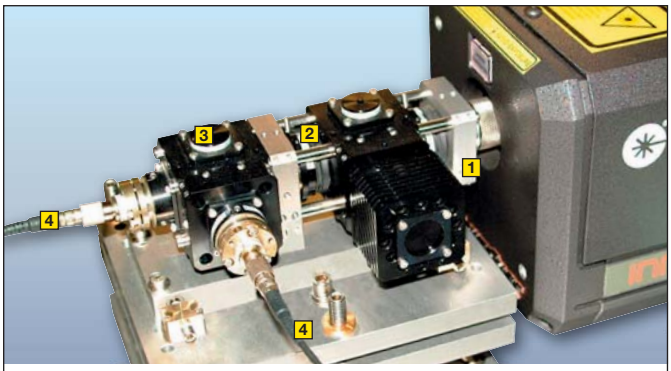
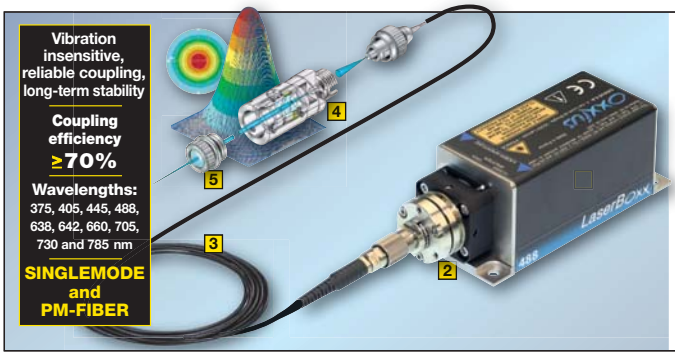


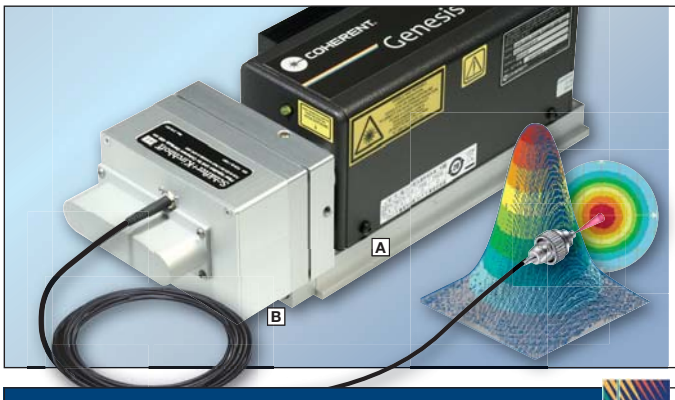
Figure 2: Fiber coupling of a COHERENT Innova Laser 1
The fiber-coupling system depicted is with a power dump 2 and an adjustable power-splitting unit 3, with the laser power launched into two polarization-maintaining fiber cables 4.
- Innova I-30x for the visible range
- Innova I-32x for the UV range (wavelengths 364 nm and 351 nm)
- Coupling ≥70 % of the intrinsic power
- Polarization extinction ratio ≥23 dB



Fiber coupling of a OXXIUS LaserBOXX LBX-xxx Laser Diode Module: Singlemode and Polarization-maintaining

Figure 3: Fiber coupling of an Oxxius Laserboxx
- Coupling efficiency >70 %
- Polarization extinction ratio ≥ 27 dB
- Vibration insensitive, persistently stable

1 Oxxius Laser Boxx laser diode module
2 Laser beam coupler **60SMS-...**
3 Polarization-maintaining fiber **PMC-...**
4 Fiber Collimator **60FC-...**
5 Micro focus optics **5M-...**



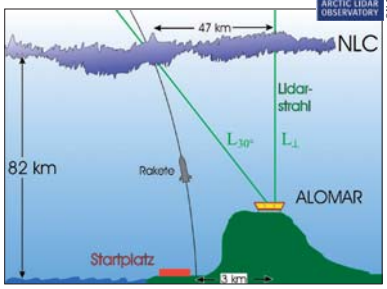
Fiber coupling of a COHERENT Genesis MX-Series Singlemode • Polarization-maintaining

Figure 4: Optically pumped laser system consisting of:
A High Power Optically Pumped Semiconductor Laser (OPSL) type COHERENT Genesis MX, 488 nm.
B Fiber coupling from **Schäfter+Kirchhoff.**
- Optical power 650 mW ex fiber
- Singlemode, mode field diameter 4.0 µm.
- Polarization extinction ratio ≥ 23 dB.

To guarantee the highest long-term stability, the fiber-coupling system is completely enclosed in a protective housing. A fiber cable feed-through acts as additional strain relief for the fiber cable.

Triggered Laser-Seeding for LIDAR

RMR-LIDAR (Rayleigh-Mie-Raman Light Detection and Ranging) is used by the ALOMAR (Arctic LIDAR Observatory for Meso-Atmospheric Research) facility in Norway for measuring the temperature and wind velocity in high altitudes.
Laser radiation from two pulsed power lasers is directed into the atmosphere. The radiation scattered back by aerosols (due to Rayleigh, Mie or Raman scattering) is collected by two 1.8 m terrestrial telescopes.
A frequency-stabilized seed laser is used to meet the stringent experimental restrictions for pulse length and spectral stability. The power lasers are alternately seeded, pulse-by-pulse, using two EOMs. The demanding specifications of the seeding process require the power lasers to emit extremely short pulses (~12 ns) of high spectral stability at a repetitive rate of 30 Hz.



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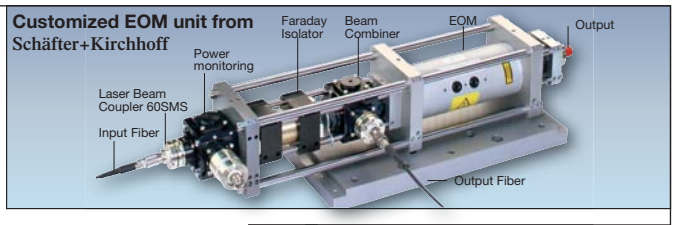
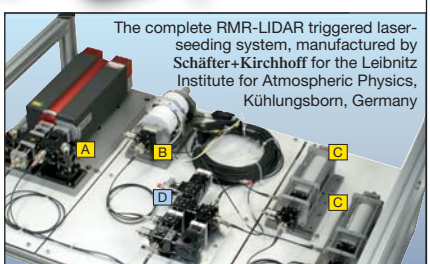


A 532 nm / 1064 nm seeding laser A, iodine reference cell B and the electro-optical modulator units C are connected by the fiber port cluster D, which combines and distributes the laser beams. All are assembled using **Schäfter+Kirchhoff** components and polarization-maintaining optical fibers around our proprietary "multicube" system. This robust, adaptable and modular system is a major improvement on conventional, but bulky, optical breadboards.



The complete RMR-LIDAR triggered laser-seeding system, manufactured by **Schäfter+Kirchhoff** for the Leibnitz Institute for Atmospheric Physics, Kühlungsborn, Germany