Polarization rectification of two red polarization coupled broad area ECDL's

Optikexpertisen
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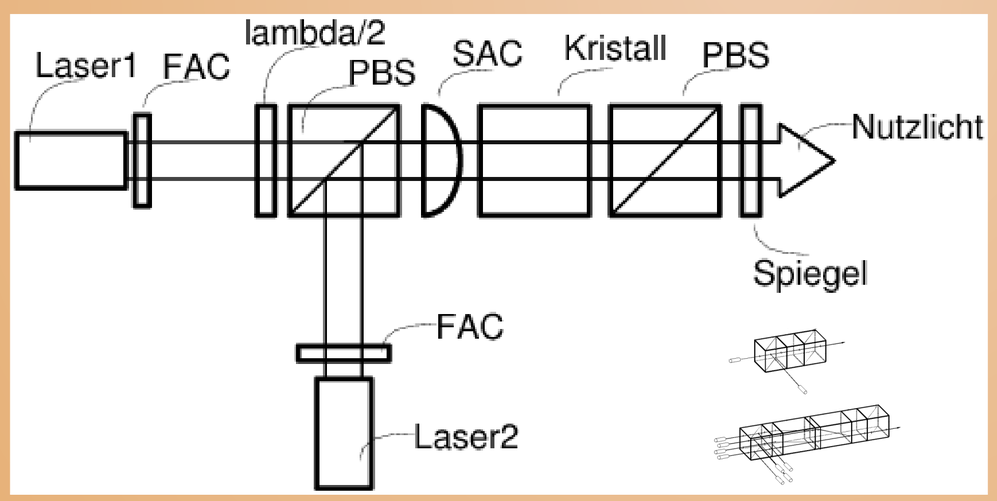
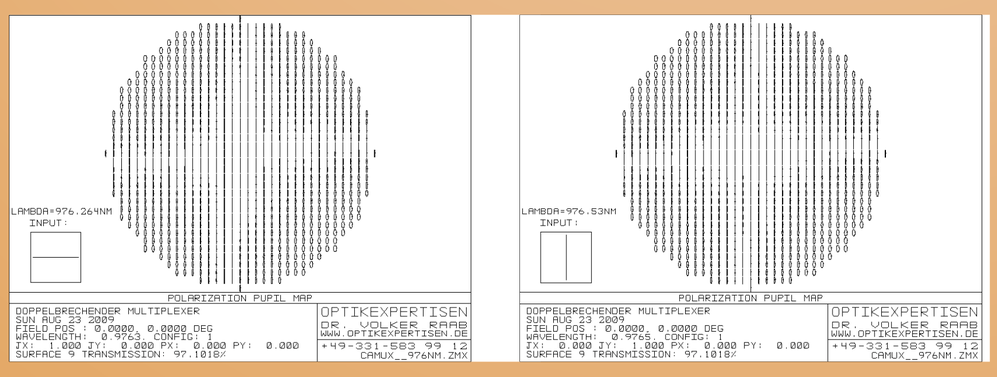
A novel coupling scheme for spectral multiplexing of laser sources is presented.
Two broad area diode lasers in the visible red spectral range are being polarization coupled for power scaling to achieve a total output in excess of 1W. The resulting radiation carries the power of both semiconductor lasers with the beam parameter product of a single emitter only. The resulting radiation has approximately the same spectral breadth as each single laser alone and is polarized again as to enable a second step of polarization coupling.
Conceptionally, both lasers are subject to an external feedback so that they oscillate on slightly different wavelengths spectrally separated by about 80pm. By means of a suitable spectral filter the orthogonal polarization can be rectified almost completely. Experimental results show that the fraction of rectified light is of the order between 80% and 95% of the total emission. The coupling scheme is very robust with respect to power densities and thermal drift.
A spectral coupling of two laser sources with a spectral separation of less than 0.1nm with coupling efficiencies around 90% can be valuable for powerful pump applications and material processing, particularly because, theoretically, it should be possible to scale it up to four or even eight polarization coupled emitters.

Concept



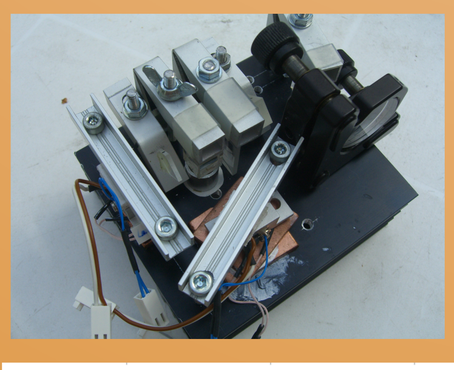
Two (semiconductor) laser are polarization coupled. The combination of a birefringent crystal between two polarizers operates as a narrow bandwidth Lyot-filter. The laser lines lock to their respective wavelengths by means of a feedback-mirror. Due to the polarization beamsplitter the two laser emissions are orthogonal on the side of the semiconductors and parallel on the side of the outcoupling mirror.
Usually, the gain bandwidth is broader than the free spectral range of the Lyot-filter. Therefore the two lasers oscillate on entangled frequency combs.

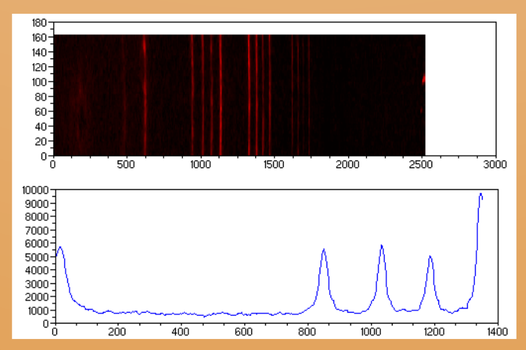
Simulation



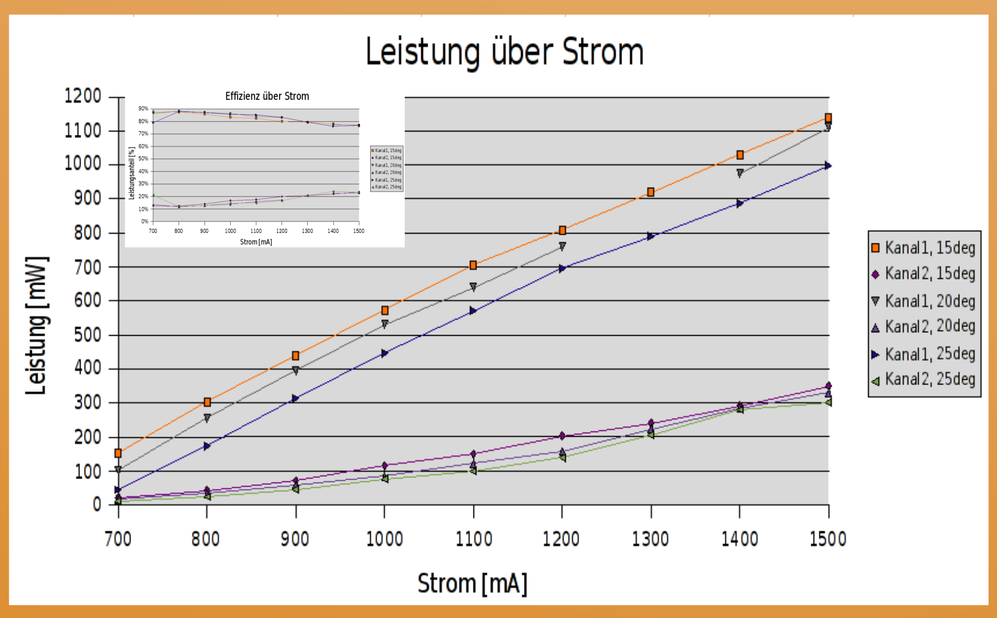
A simulation of the filter characteristic of a 10mm long calcite crystal is shown. On the left light of 976.264nm with horizontal polarization is incident; on the right 976.530nm with vertical polarization. Both beams exit with vertical polarization.
The degree of rectification is decreasing with increasing divergence. The extension of the plot is about ±40mrad.
For red light the dispersion is about twice as large.

Experiments





A demonstrator (ca. 10x10cm²) with two broad area diodes (150µm width) has been set up.
A Fabry-Perot-Image of the emission of one such laser with Lyot-filter is shown. The etalon has an FSR of 1THz from which one calculates the spectral separation of the lines as 122MHz or 165pm for light around 635nm.
Rotating the halfwave plate does not change the output power but shifts the emission lines.
Upon a shift of the gain curve (e.g. by thermal influence) ¨new¨ lines appear on one side of the spectrum and ¨disappear¨ on the other.



For three different temperatures of the heat sink the combined output power has been determined. It reaches more than 1W for temperatures below 20°C. Also given is the power in the ¨loss channel¨ out of the second PBS. The relative powers define the coupling efficiency.
Despite its mechanical and thermal insufficiencies coupling efficiencies up to 90% could be achieved.

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