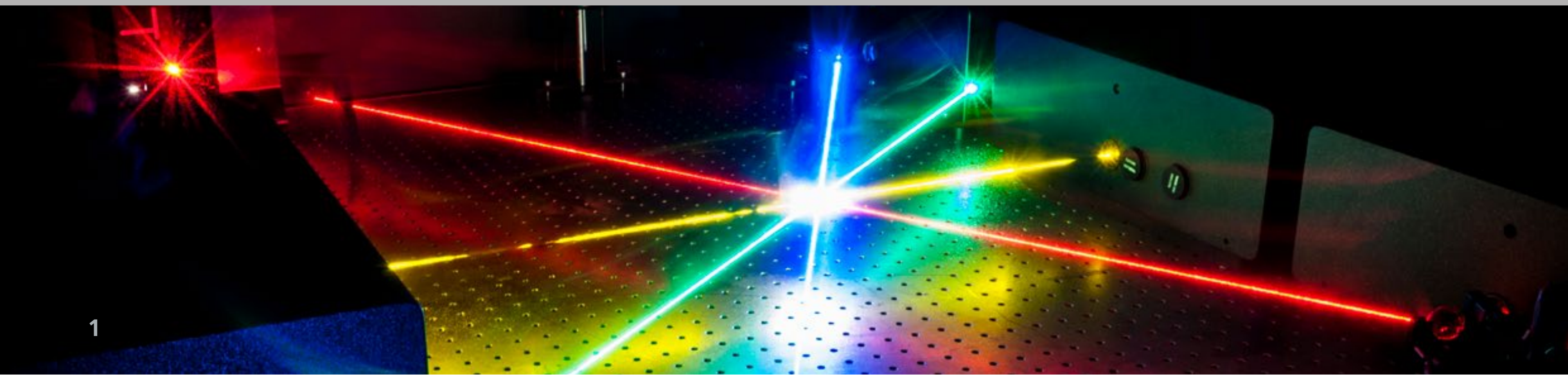
FRAUNHOFER INSTITUTE FOR PHYSICAL MEASUREMENT TECHNIQUES IPM



1 *Nonlinear optics for tailormade light output, developed and built at Fraunhofer IPM: crossed beams of four continuous-wave optical parametric oscillators tuned to different wavelengths in the visible range.*

OPTICAL PARAMETRIC OSCILLATORS

CONTINUOUS-WAVE, SINGLE FREQUENCY

Continuous-wave, single-frequency lasers are powerful tools for a wide range of applications such as spectroscopy, gas analysis, holography, or interferometry. Depending on the task, wavelengths between ultraviolet and far-infrared are needed. Suitable laser materials are required for generating the desired wavelengths. Depending on the availability of such materials, gaps in the spectrum occur where direct generation of laser light is difficult or even impossible. This is especially true for power levels above 100 mW or for wavelengths in the visible (VIS) and mid-infrared (MIR) spectral ranges.

Nonlinear-optical frequency conversion opens a way to generate the desired wavelengths via second harmonic generators (SHG), sum and difference frequency generators (SFG, DFG), and optical parametric oscillators (OPOs). Especially periodically poled nonlinear-optical materials offer a high degree of flexibility since they allow the whole transparency range of the respective material to be used.

Our expertise

Fraunhofer IPM has specialized in frequency conversion of continuous-wave lasers. Based on more than 15 years of experience in the field of nonlinear optics and materials, a technology platform has been developed for different converter modules, delivering light with narrow linewidth, excellent beam profile, and low amplitude noise. These modules are distinguished by mechanical robustness, reliable operation and high conversion efficiencies based on in-house solutions for optics, mechanics and electronics.

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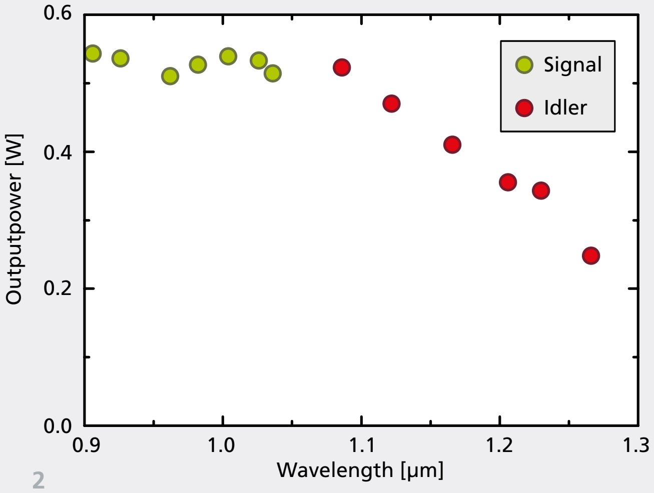

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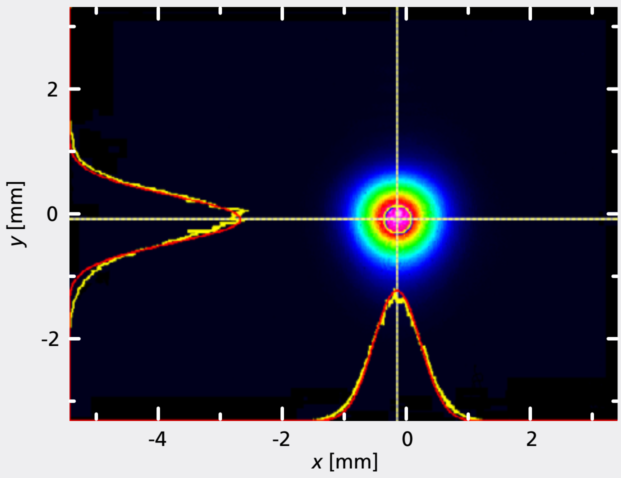

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Optical parametric oscillator

Continuous-wave OPOs are the first choice in nonlinear-optics when narrow linewidth, wavelength flexibility or wide tunability and high output powers are required, e.g. in atomic or molecular spectroscopy, quantum optics or trace gas analysis.

By selecting the proper crystal and phase-matching conditions and applying suitable tuning mechanisms and frequency stabilization methods, the emission can typically be set across several hundred nanometers in the mid-infrared with MHz precision. The coherence properties of the pump wave are preserved or even enhanced in the conversion process.

Features

Optomechanics

- Sealed and stable optics platform
- Customer-tailored wavelength range
- Alignment-free operation
- Integration of pump laser
- Lock to external reference

Electronics

- Low-noise electronics
- Fully automated wavelength setting, tuning and locking

Control

- User interface or libraries for customer programs
- System control via Ethernet

2 Typical wavelength coverage and output power for an OPO pumped at a wavelength of 532 nm with a power of 1.5 W.

3 Typical output beam profile of the non-resonant wave.

4 Top: Schematic illustration of optical parametric generation – the underlying process for optical parametric oscillators: A pump wave generates signal and idler waves within a nonlinear-optical crystal. Bottom: Examples for OPO configurations and possible tuning ranges. Blue: pump waves, green: signal waves, and red: idler waves.

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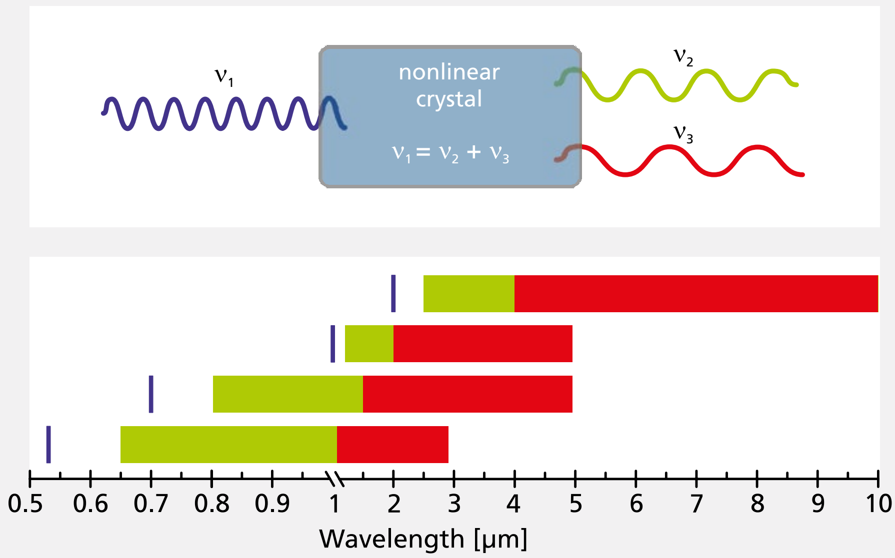

EXAMPLE SPECIFICATIONS

for a MIR OPO pumped at 1064 nm

- ***Tuning range*** *1.35 – 1.8 µm, 2.6 – 5.0 µm*
  Mode-hop-free tunability *> 10 GHz*
- ***Linewidth*** *< 1 MHz (depending on the pump-laser linewidth)*
- ***Output power*** *up to several Watts*
- ***Power noise*** *< 1 %*
- ***Beam profile*** *TEM_{00}*
- ***M²*** *< 1.2*
- ***Linear polarization*** *> 1000:1*

OUR PORTFOLIO

- ***Customized OPOs and frequency converters***
- ***Widely-tunable and Single-line OPOs***
- ***Product development for OEM***
- ***End-user-specific solutions***