
A Broadly Tunable, All-Solid-State, Mid-IR Source

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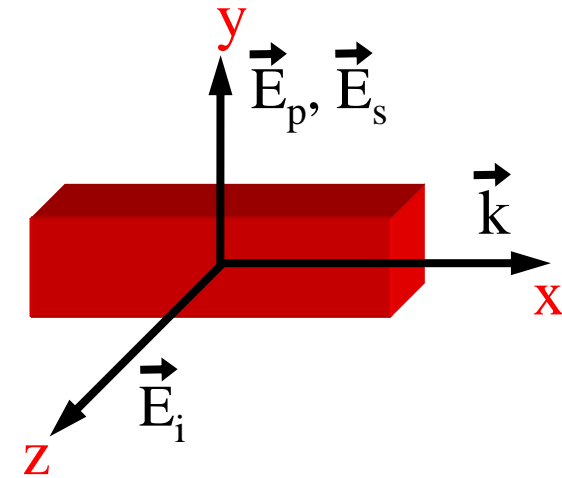
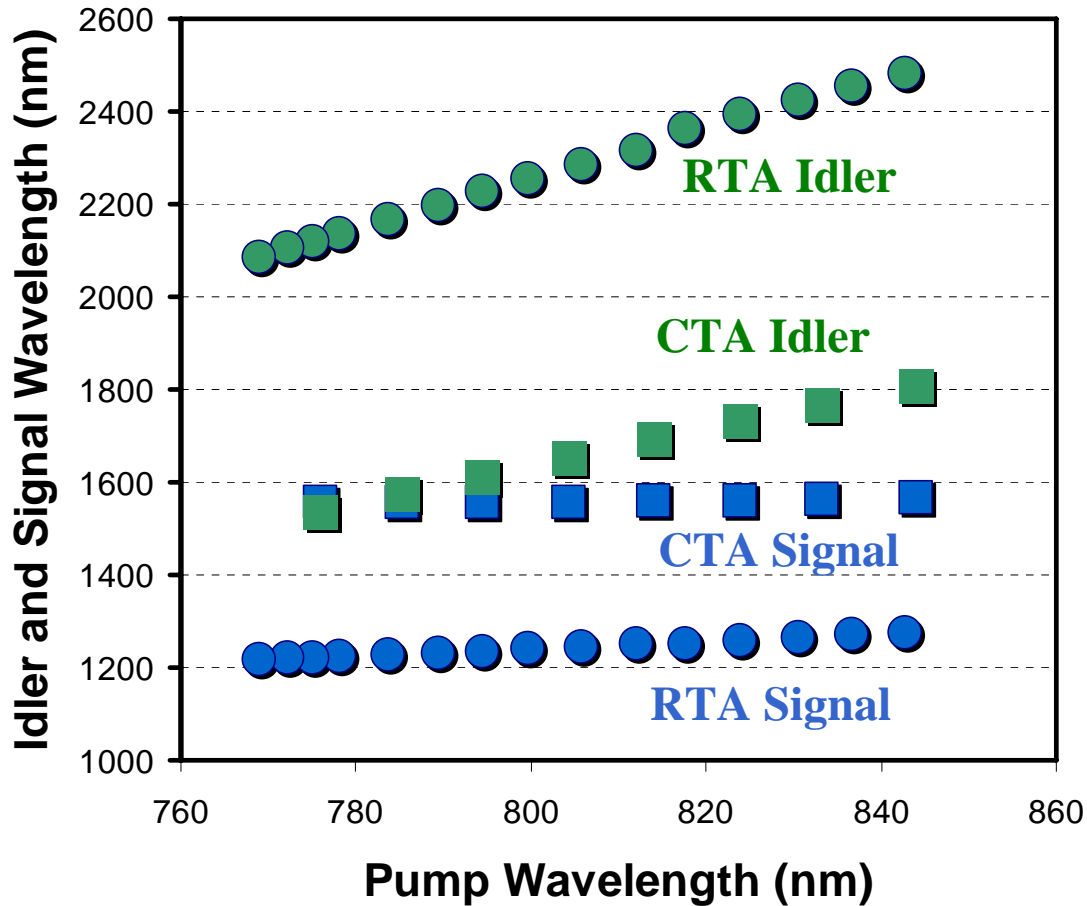
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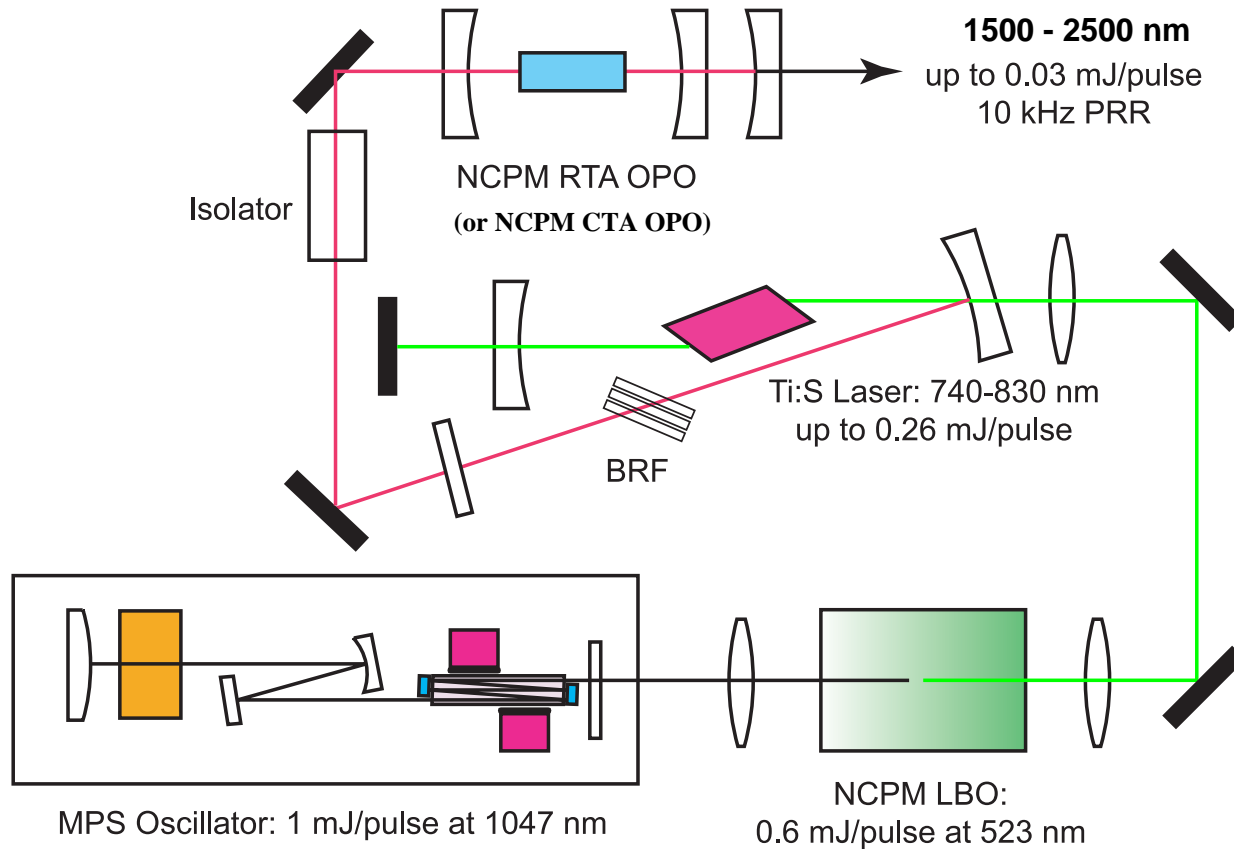
INTRODUCTION

We describe a **rapidly tunable** high-repetition-rate (**10 kHz**), all-solid-state **mid-IR** source. The system is built around our commercial, **diode-pumped**, frequency-doubled **MPS-523** Nd:YLF laser pumping a highly efficient **tunable Ti:sapphire** laser. The Ti:sapphire output is then used to pump either a **RbTiOAsO₄ (RTA)**, or a **Cs(TiO)AsO₄ (CTA)** -based **OPO**. By tuning the output of the Ti:sapphire laser, we can change the OPO **idler** wavelength from **1.5 to 2.5 μm** while keeping the average output power **over 100 mW**. The OPO crystals are **non-critically phase-matched** and tuning is achieved by simply changing the pump wavelength.

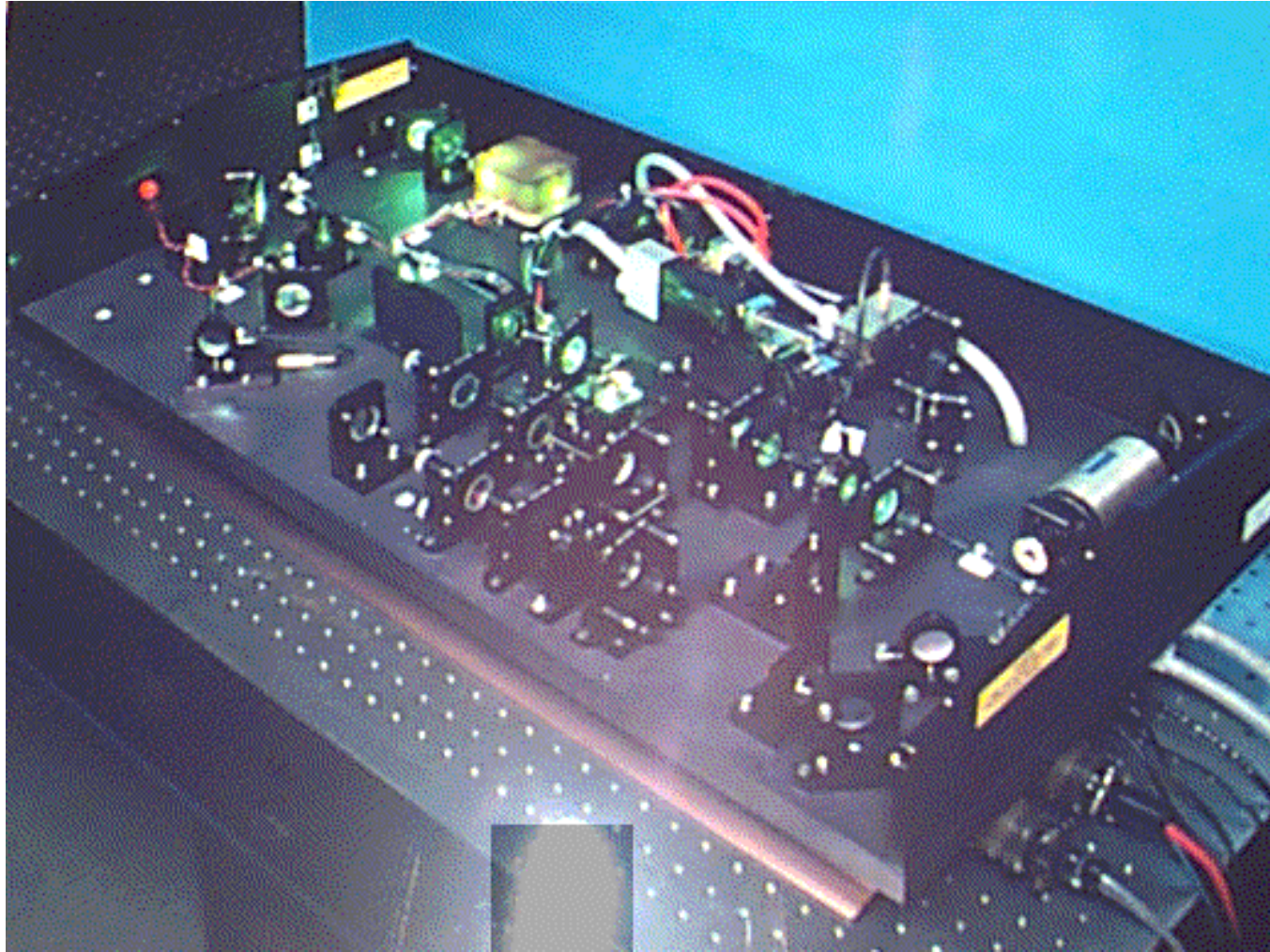
RTA and CTA can be Non-Critically Phase-Matched over Ti:sapphire Emission Spectrum



System Architecture

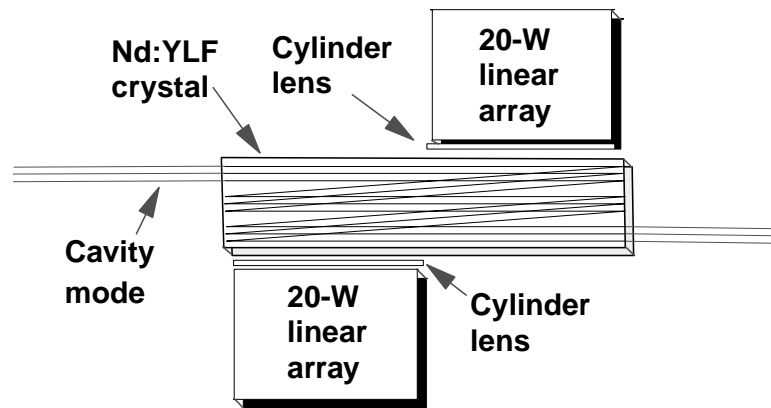


“The Real Thing”

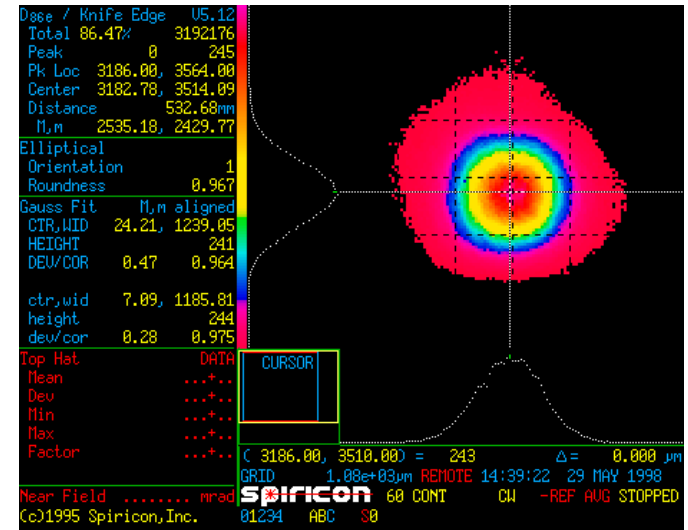


Technology: Diode-Pumped Nd:YLF Laser

Gain Module

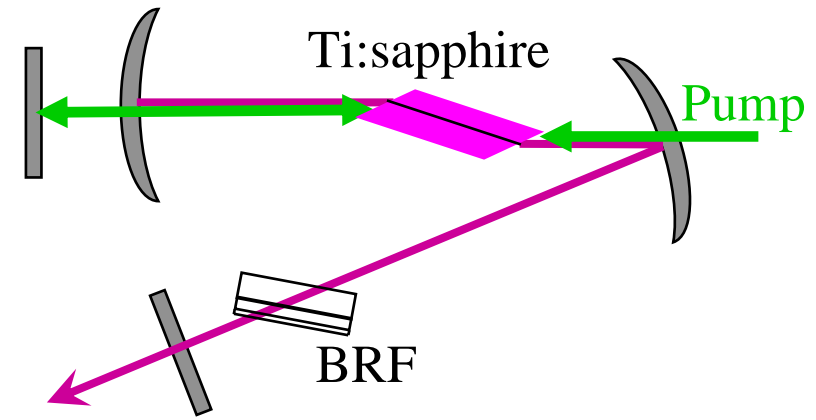
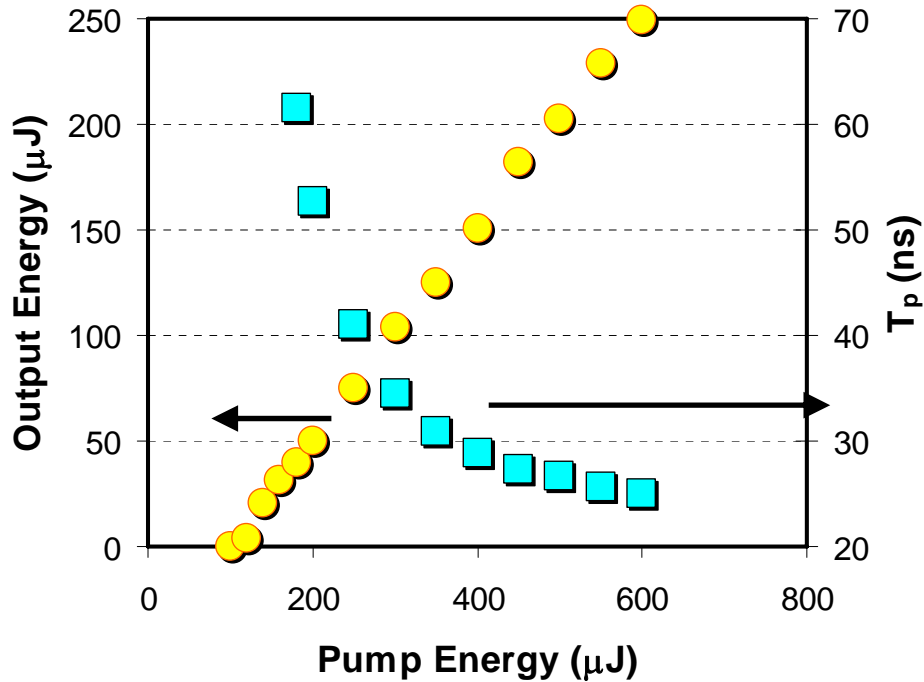


- Multi-pass design extracts large fraction of available power in TEM₀₀ mode, has high gain
- Low average excitation density minimizes stress, beam distortion
- Simple, single-element pump optics

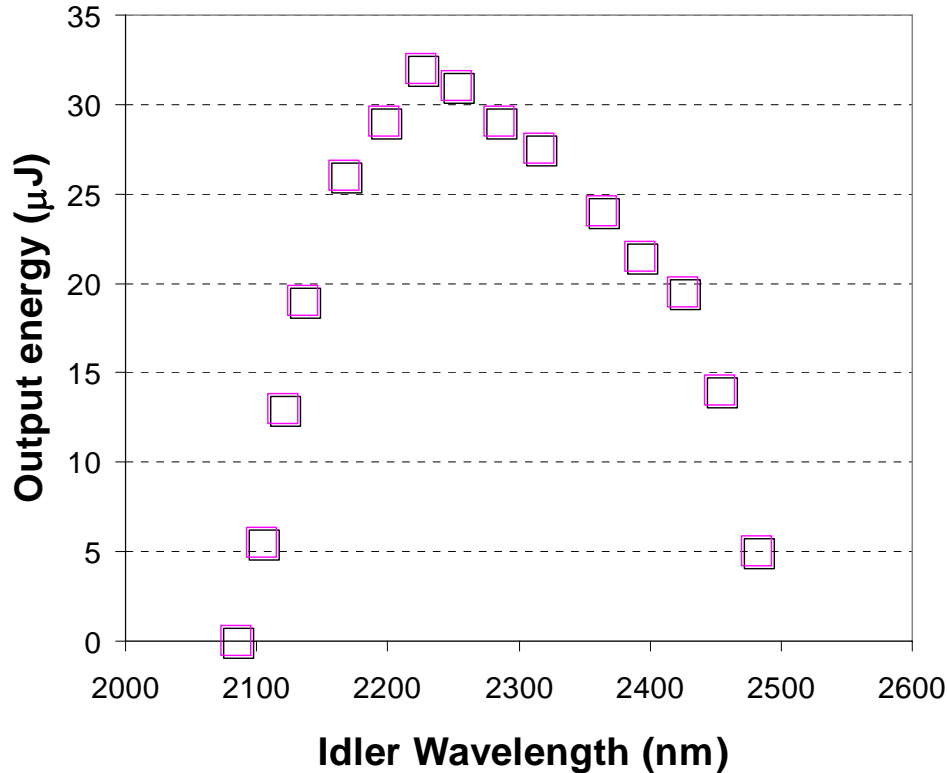


Technology: Highly Efficient Ti:sapphire Laser

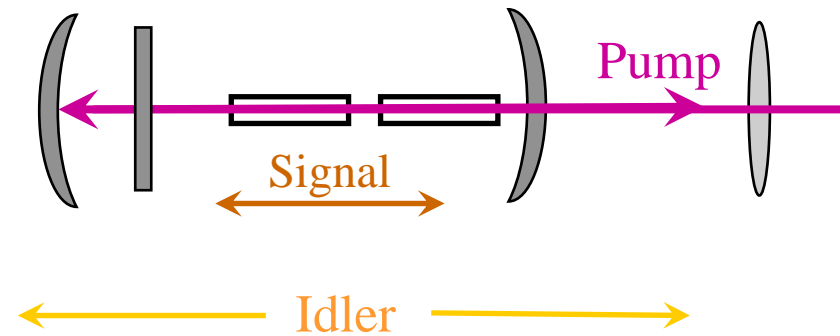
$\eta_{\text{slope}} > 50\%$ (no BRF in the Cavity)



RTA OPO Idler Wavelength can be Rapidly Tuned between 2 and 2.5 μm

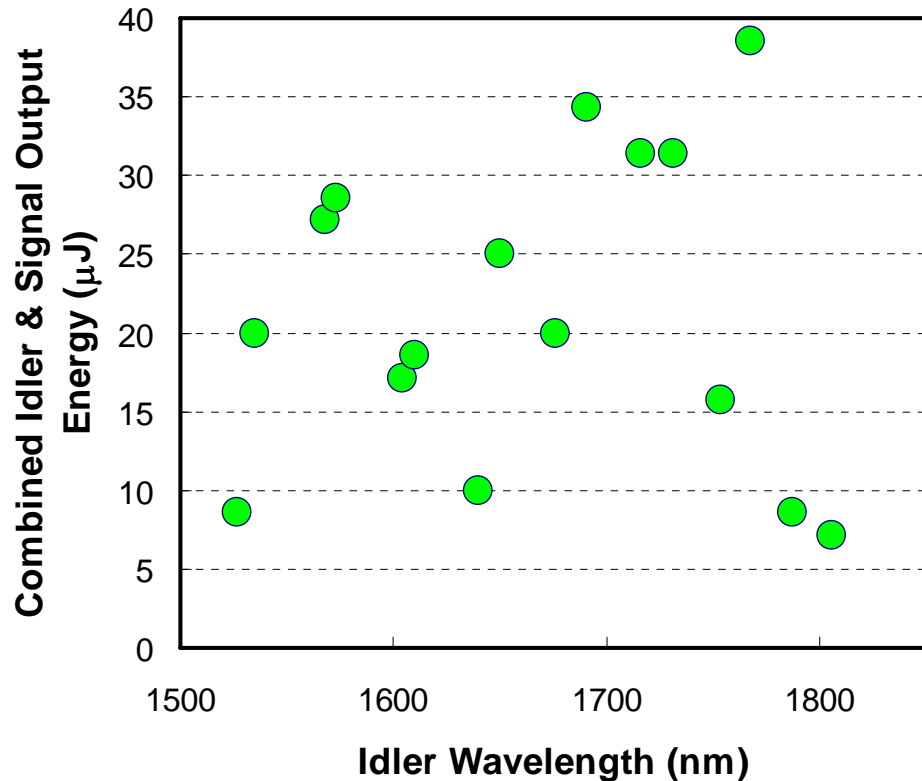


Two 15-mm long RTA crystals are AR-coated for pump, signal, and idler λ

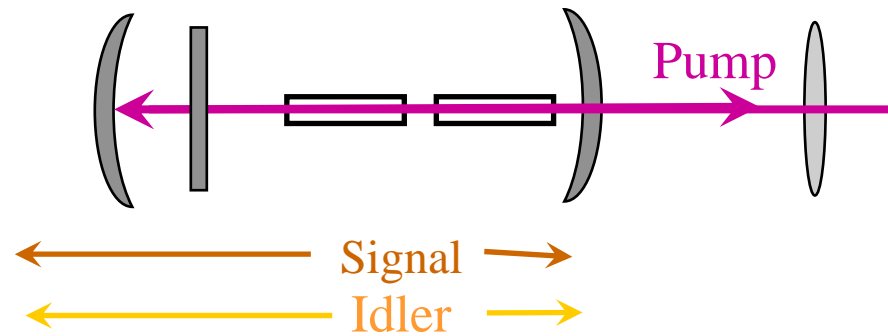


The OPO cavity is designed to resonate signal and reject the idler wave. The resonator consists of a flat and a curved (R=50 mm) mirror, placed 65 mm apart.

Preliminary CTA OPO Tuning Spectrum



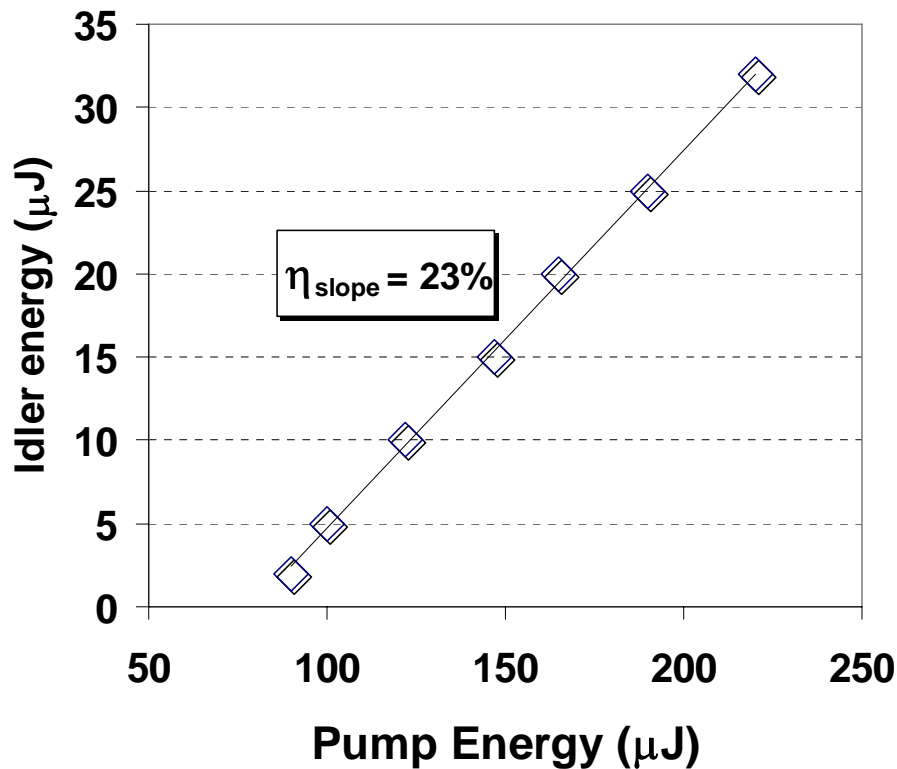
30-mm long CTA crystal is AR-coated for pump, signal, and idler λ



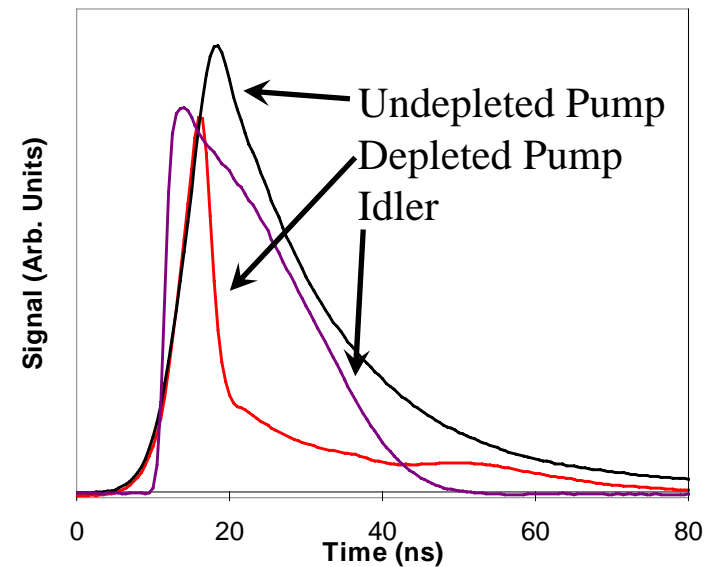
The resonator consists of a curved ($R=50$ mm) broadband mid-IR HR mirror and a flat output coupler, placed 65 mm apart.

Output Pulse Energies > 30 μJ

$\lambda_{\text{idler}} = 2226 \text{ nm}$ (RTA)



Typical Photodiode Traces



CONCLUSION

- ❑ Low pulse energy (**over 30 μJ**) and high repetition rate (**up to 10 kHz**);
- ❑ Broad spectral tunability (**1.5 - 2.5 μm**);
- ❑ No variation of output beam direction with wavelength;
- ❑ The entire system is driven by a **diode-pumped** laser, providing compact and reliable operation;
- ❑ **Rapid tunability**;
- ❑ Ideal for **remote sensing applications**.

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