

Rugged and Compact Mid-infrared Solid-state Laser for Avionics Applications

IASSA 2009

M. J. Daniel Esser, D. Preussler, A. Sharma, C. Jacobs and C. Bollig

National Laser Centre, CSIR, South Africa

&

Stellenbosch University, South Africa



Overview

Objectives

- Mid-IR laser system - 2.3 μm & 4.0 μm
- Rugged design for use in field & flight
- Modulation of Mid-IR output



Overview

Objectives

- Mid-IR laser system - 2.3 μm & 4.0 μm
- Rugged design for use in field & flight
- Modulation of Mid-IR output

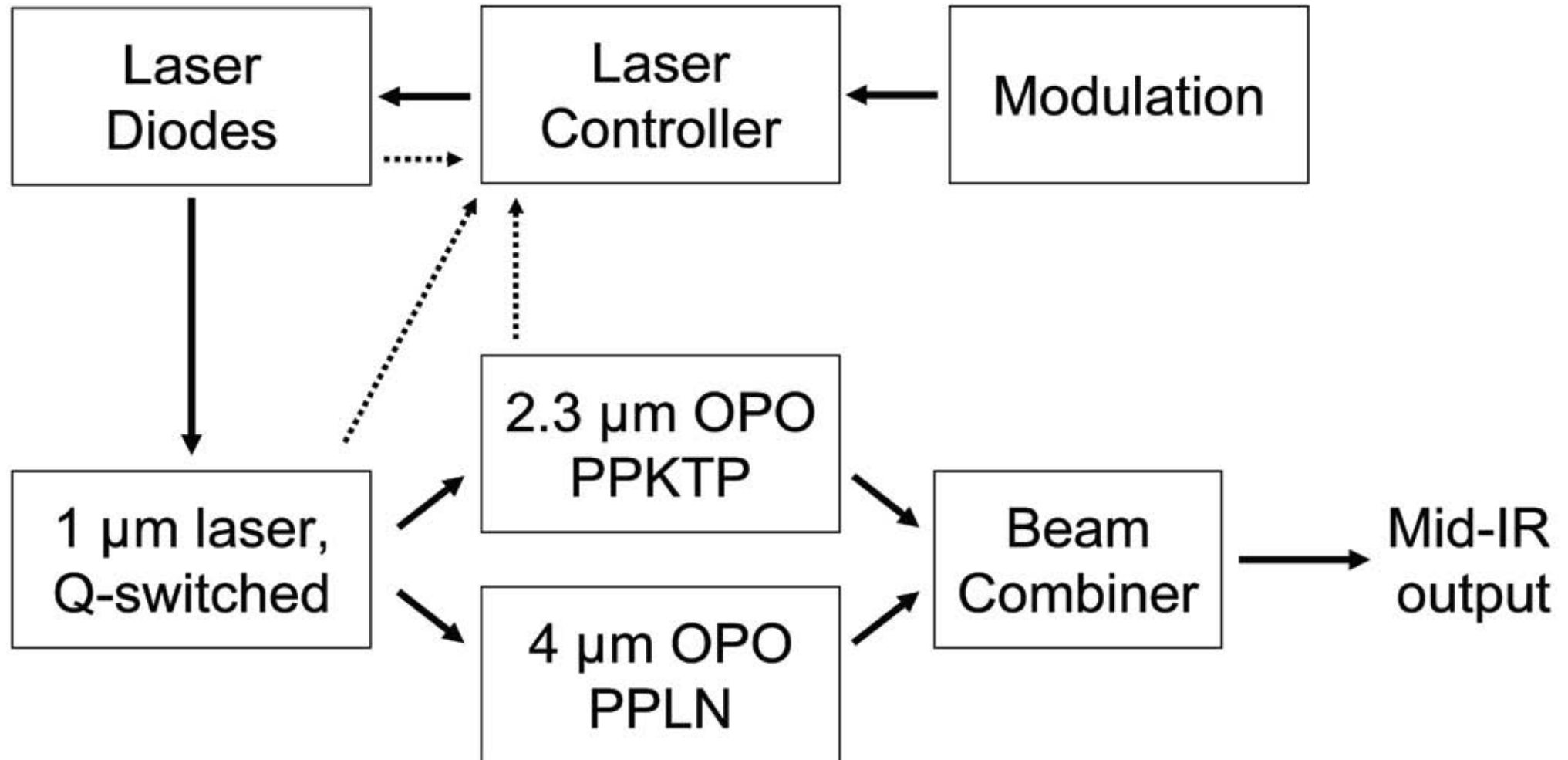
Optical layout

Challenges solved

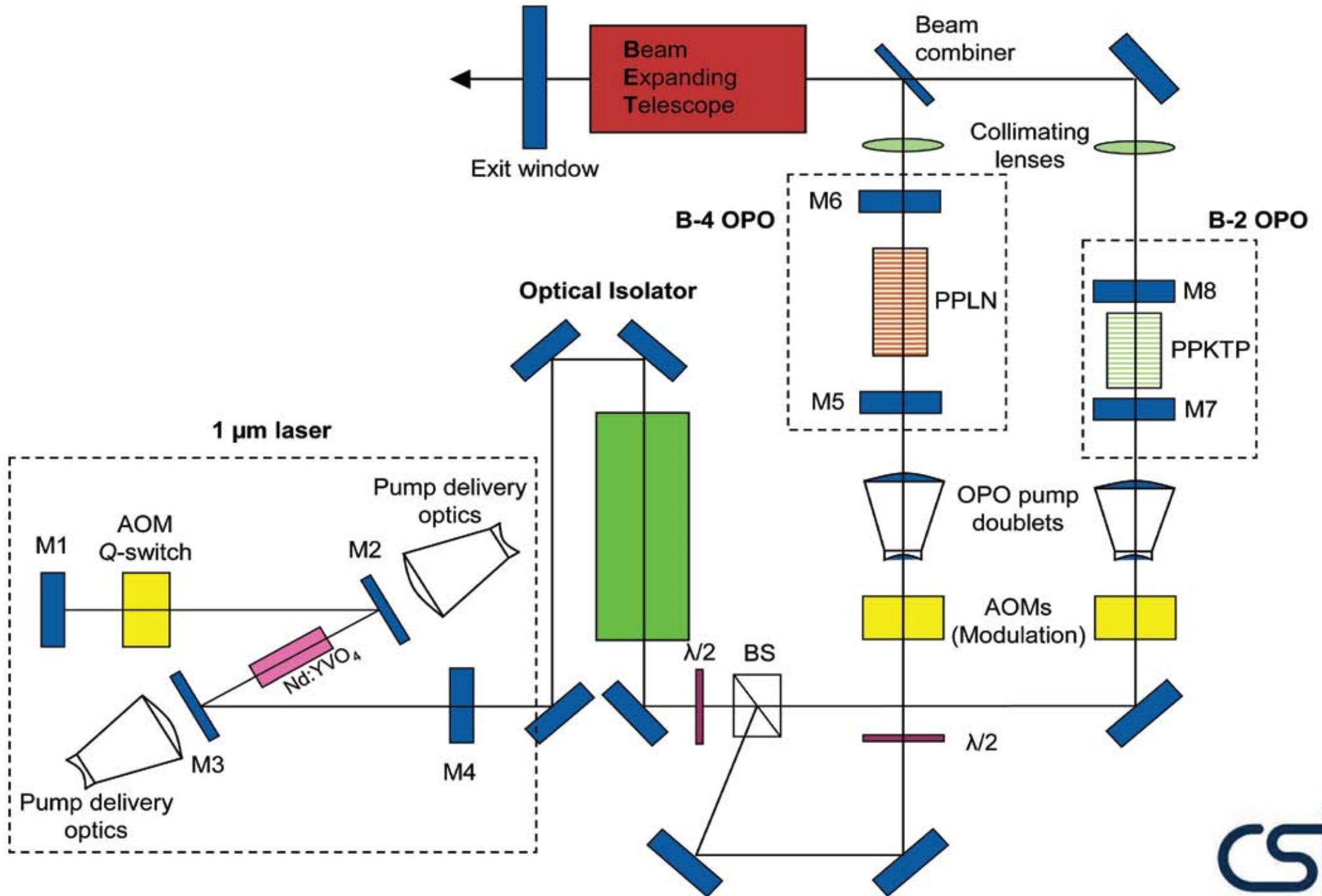
- **Modulation**
- **Synchronisation**
- **Ruggedness**



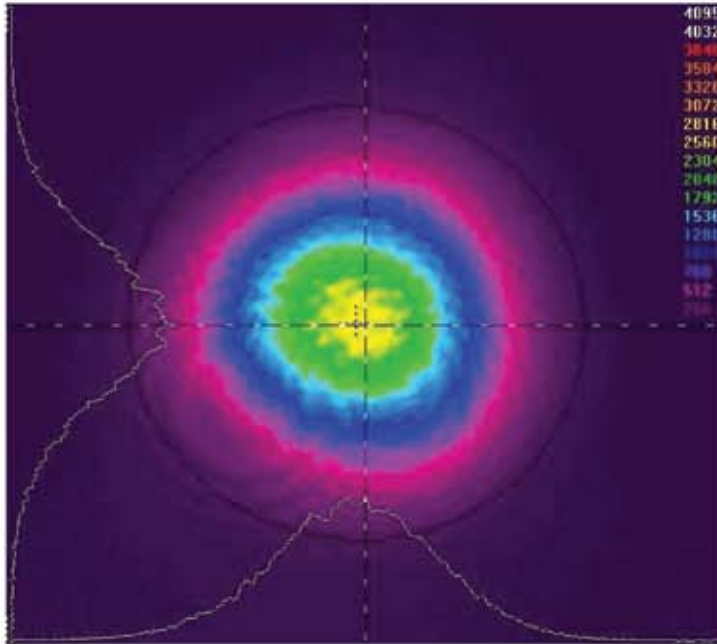
Laser System Concept



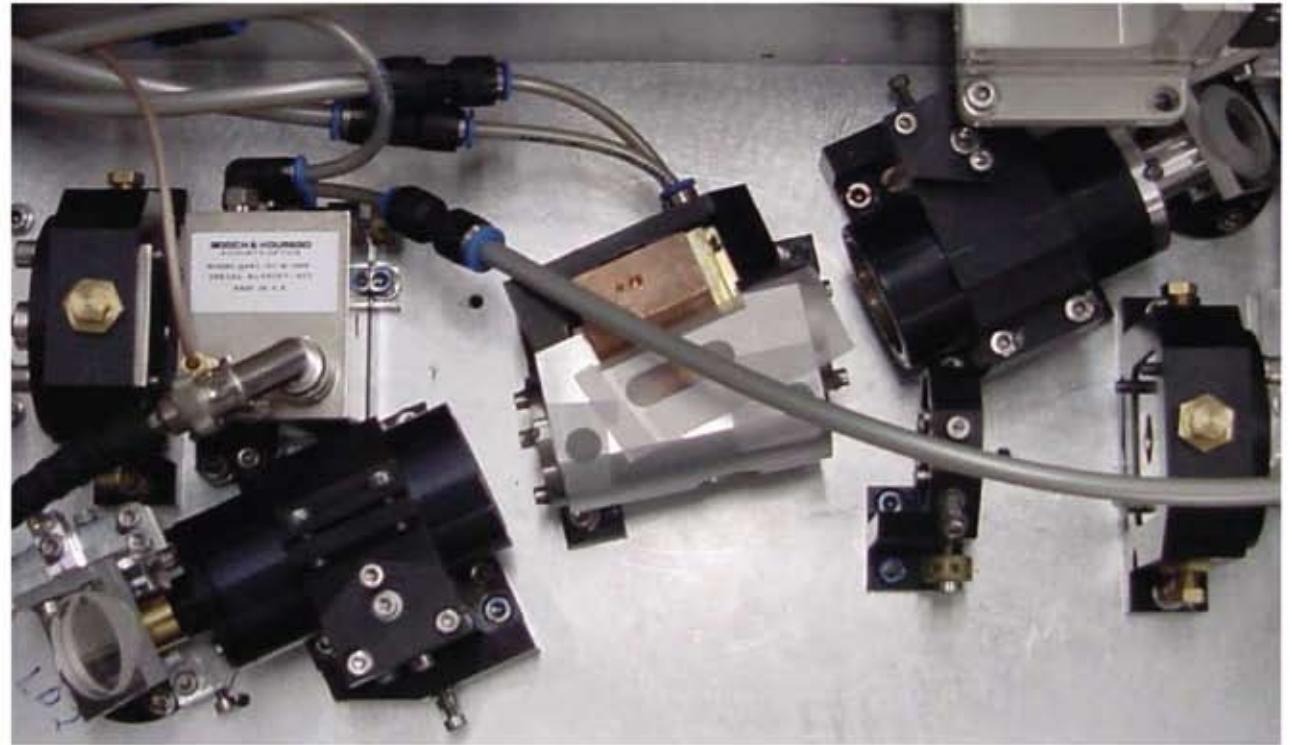
Optical Layout



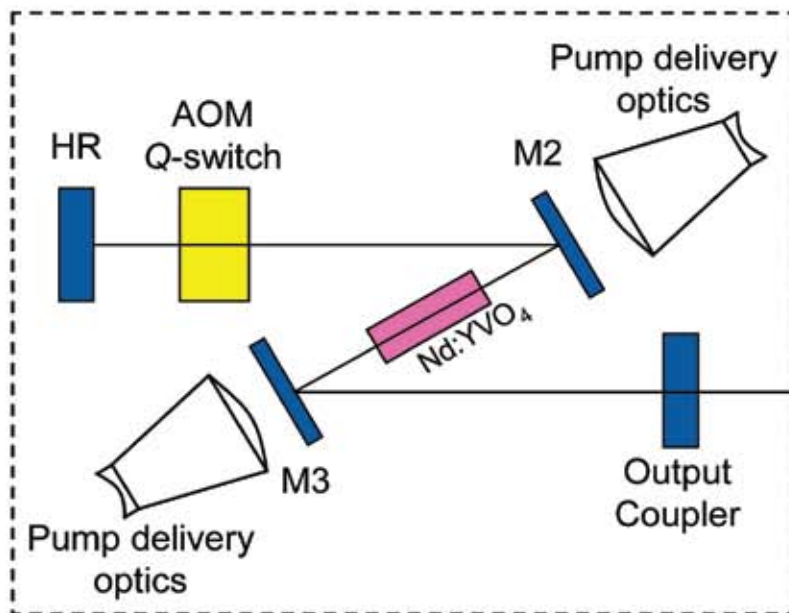
Opto-mechanical Layout



1 μm laser



1 μm laser



- Diode-end-pumped (fibre-coupled) @ 808 nm
- Nd:YVO₄ gain medium @ 1064 nm
- Q-switched at ~30 to 100 kHz (50kHz typical)
- Rugged & Compact
- Good beam quality

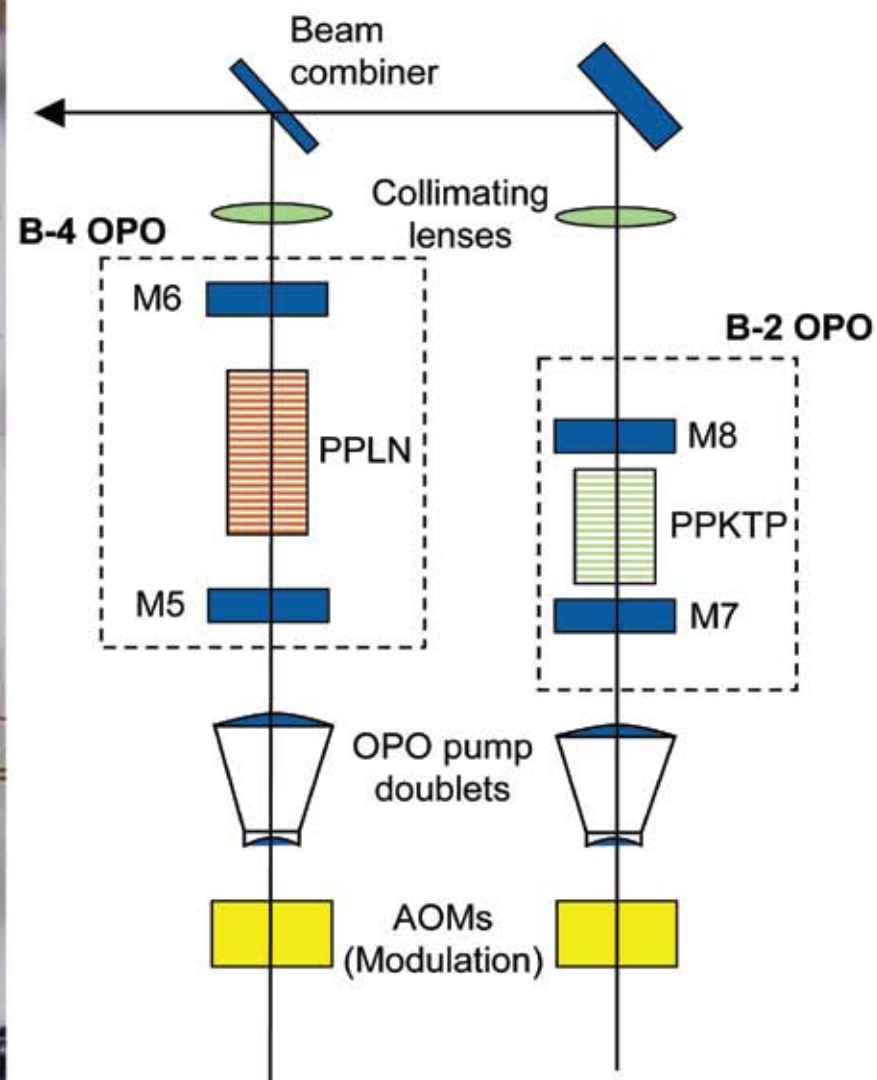
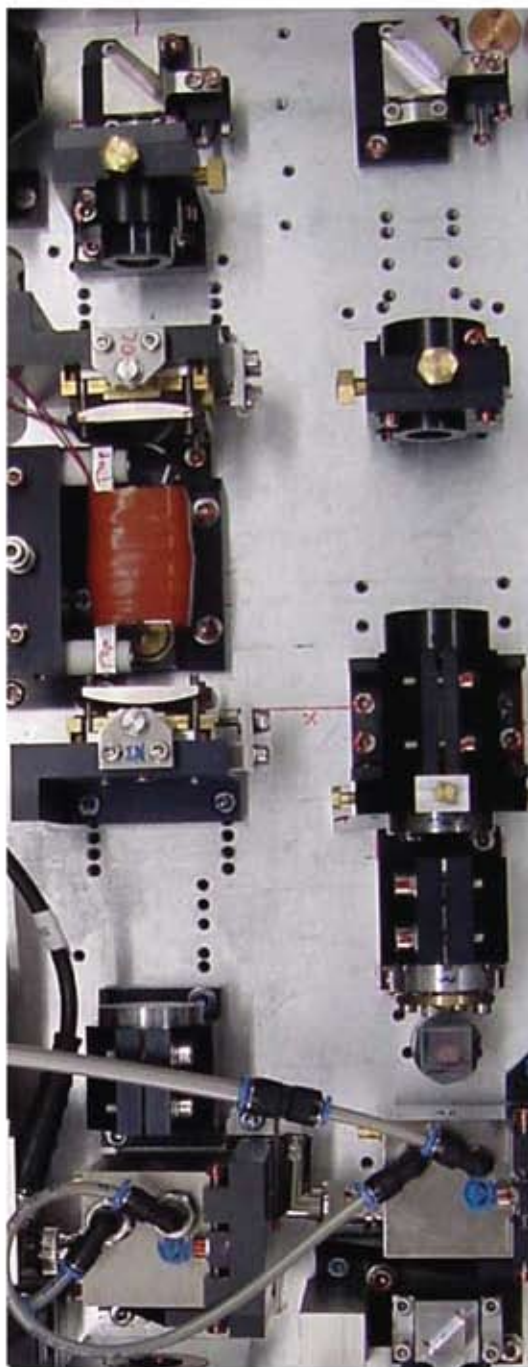
Opto-mechanical Layout

2.3 μm OPO

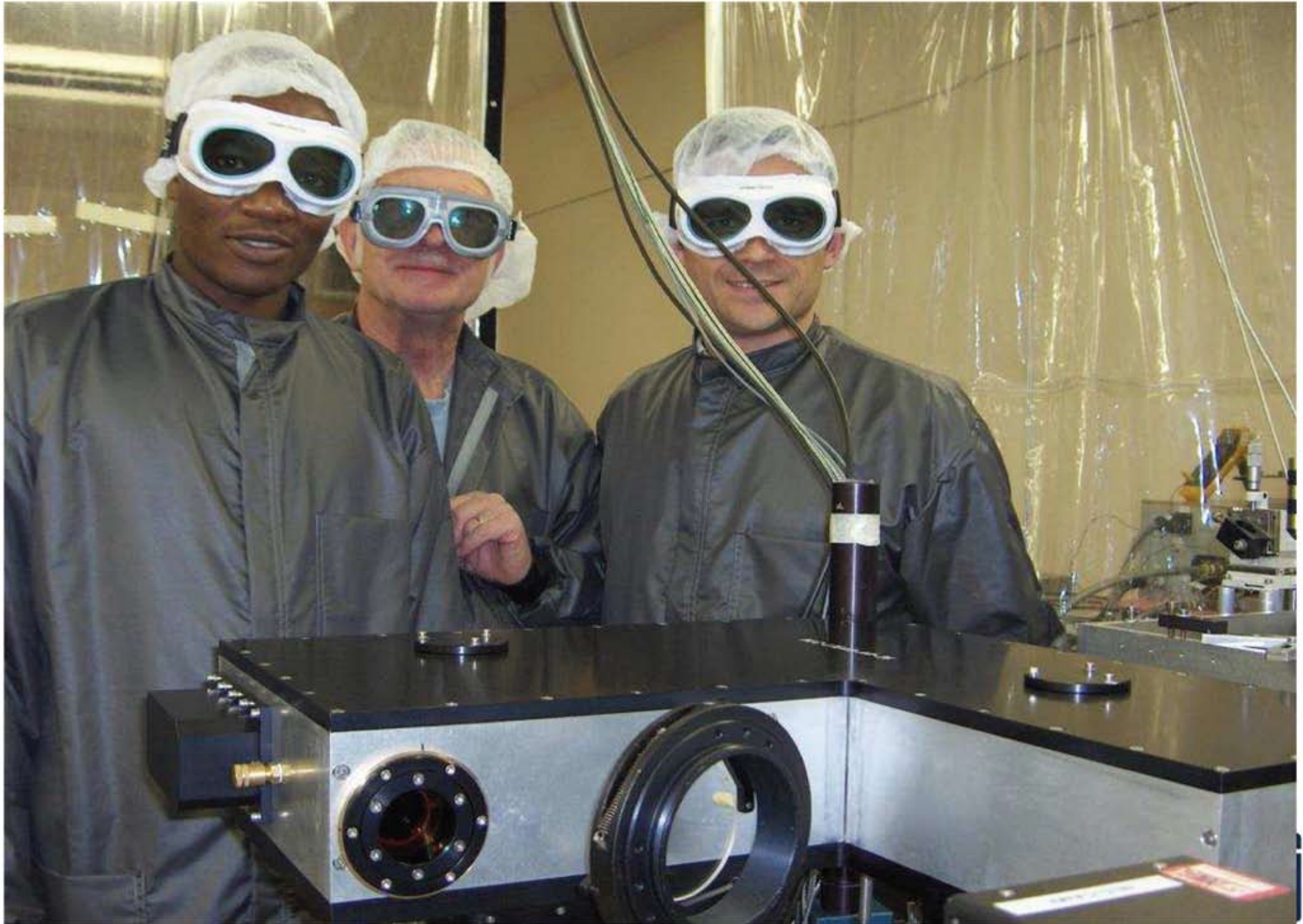
- Signal resonant & pump reflection
- Non-linear medium: PPKTP
- Idler output @ 2.3 μm

4 μm OPO

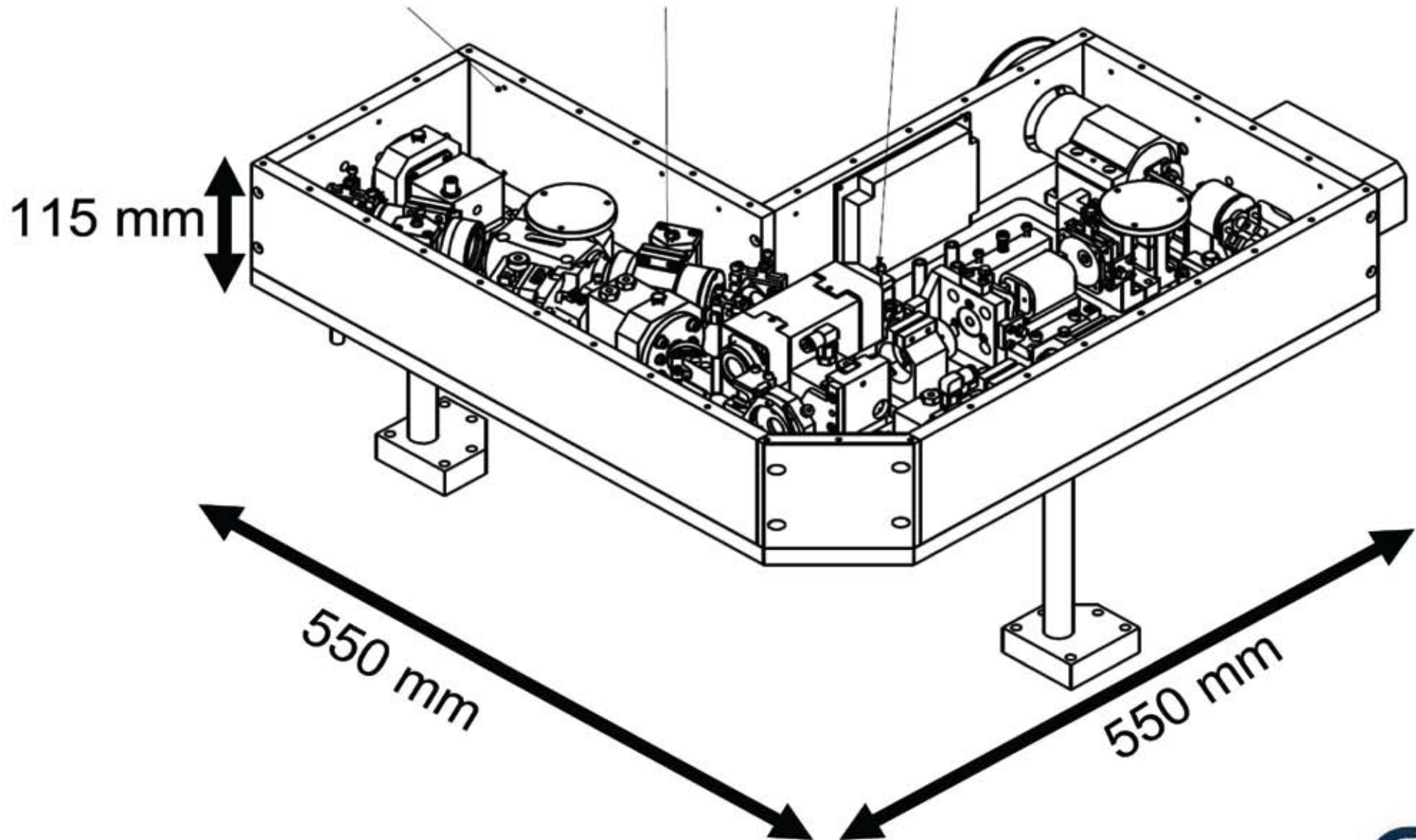
- Signal resonant & pump reflection
- Non-linear medium: PPLN
- Idler output @ 4 μm



Opto-mechanical Layout



Opto-mechanical Layout



Overview

Objectives

- Mid-IR laser system - 2.3 μm & 4.0 μm
- Rugged design for use in field & flight
- Modulation of Mid-IR output

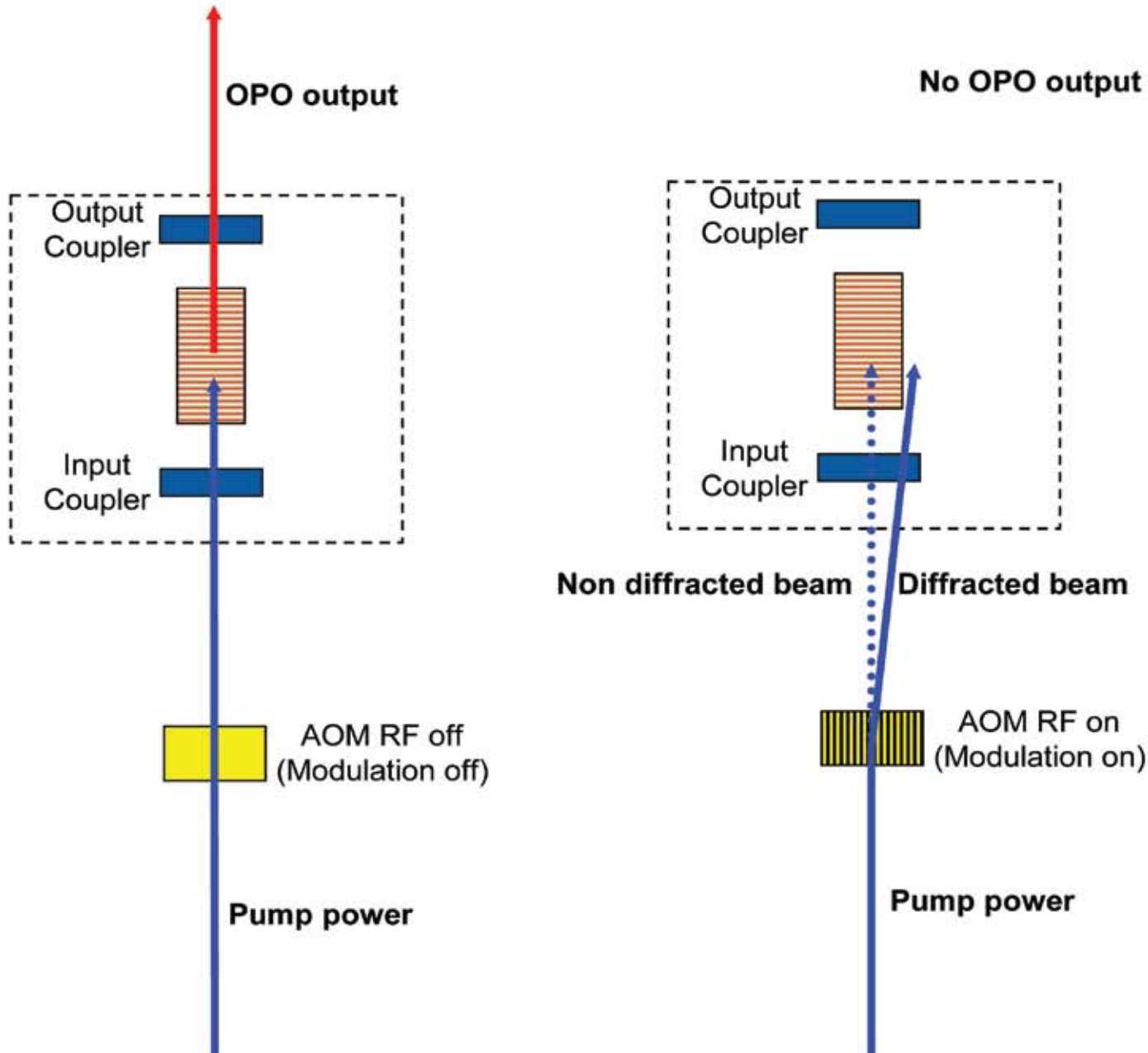
Optical layout

Challenges solved

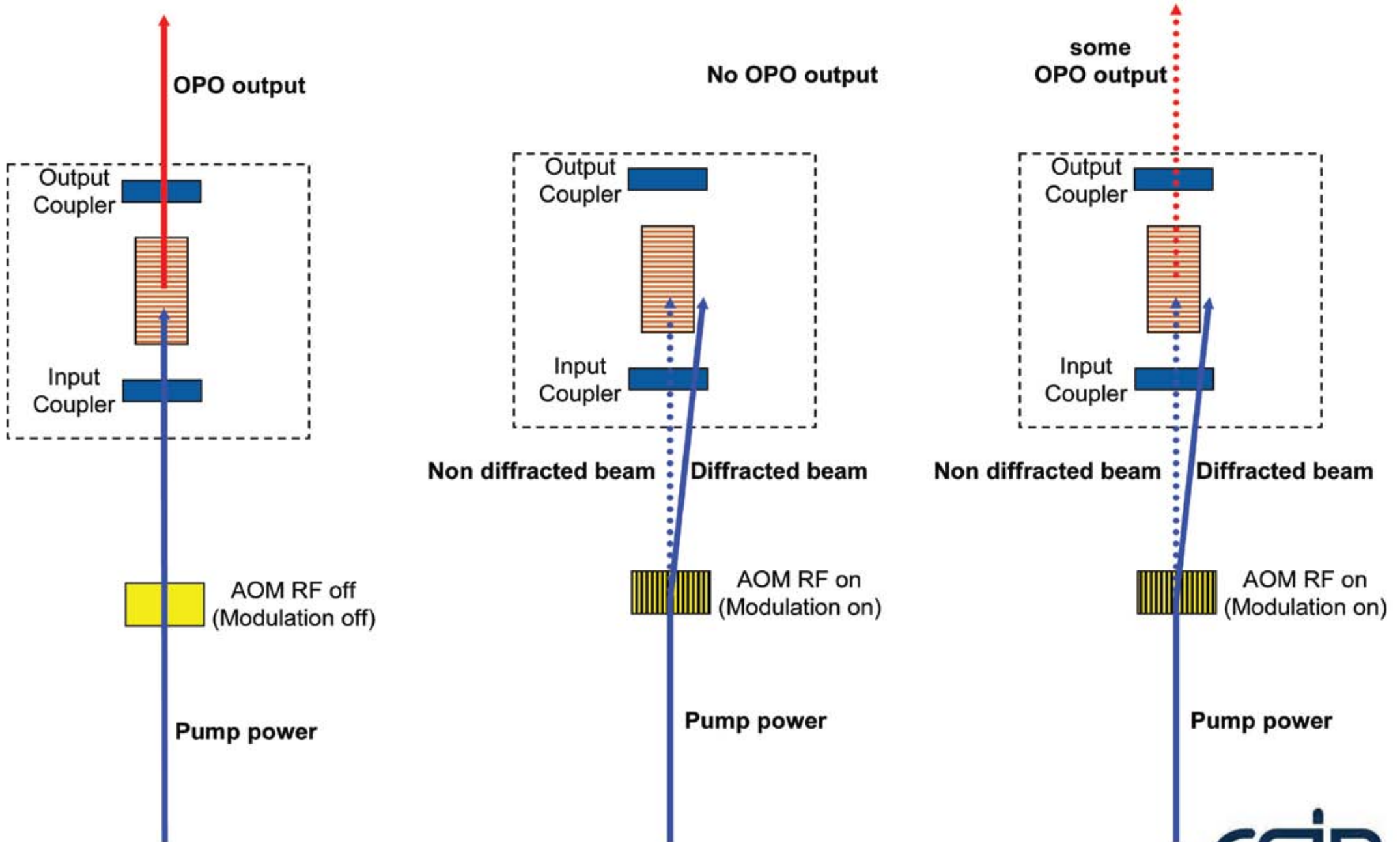
- **Modulation**
- **Synchronisation**
- **Ruggedness**



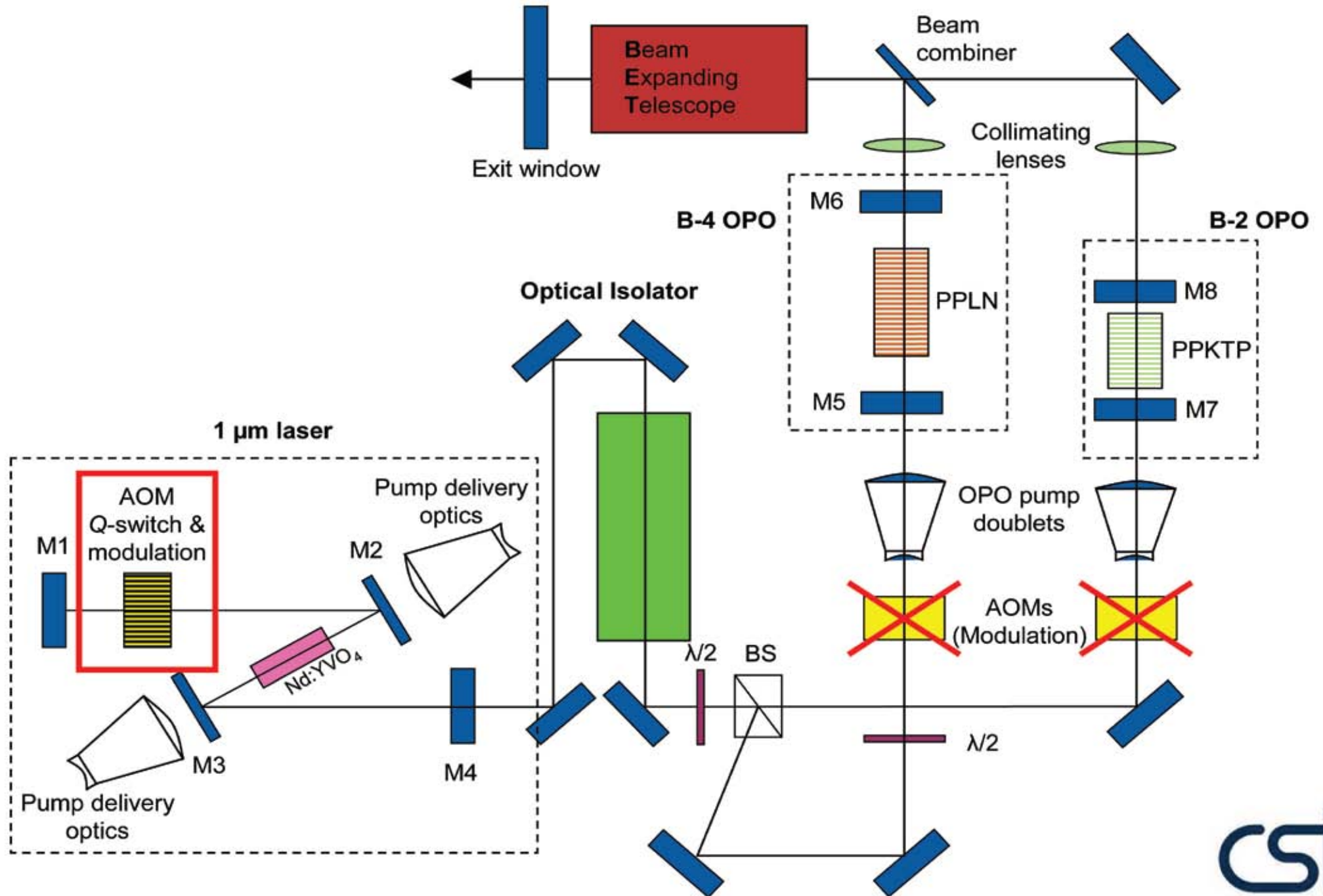
Modulation of OPO output



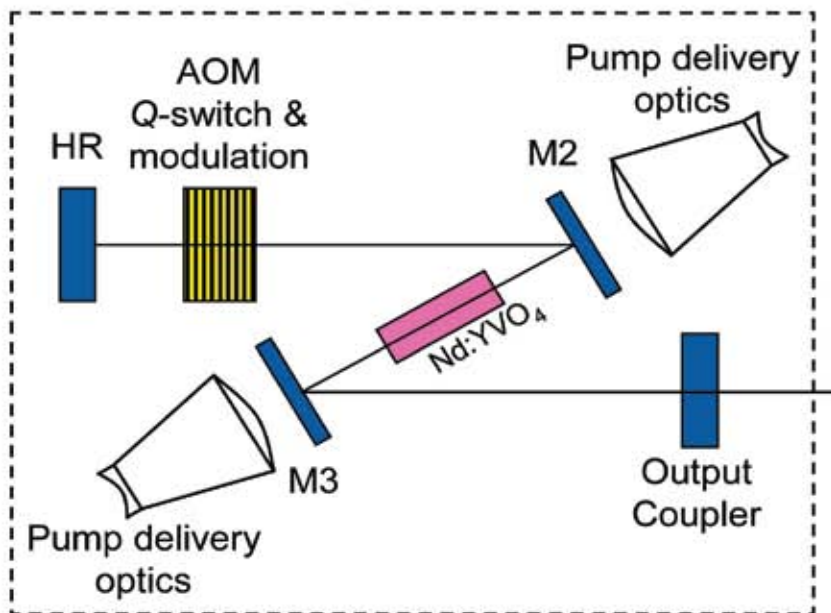
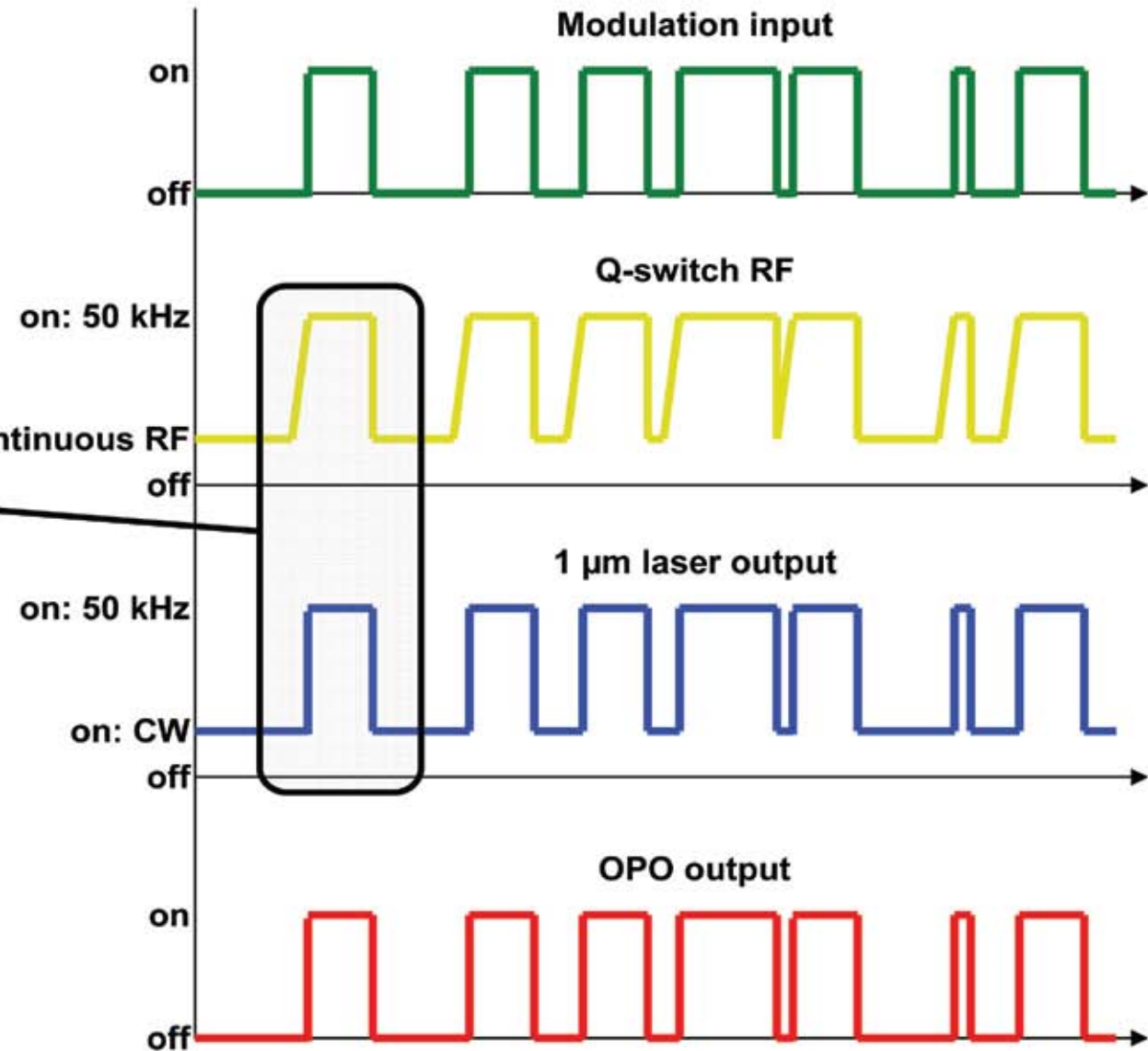
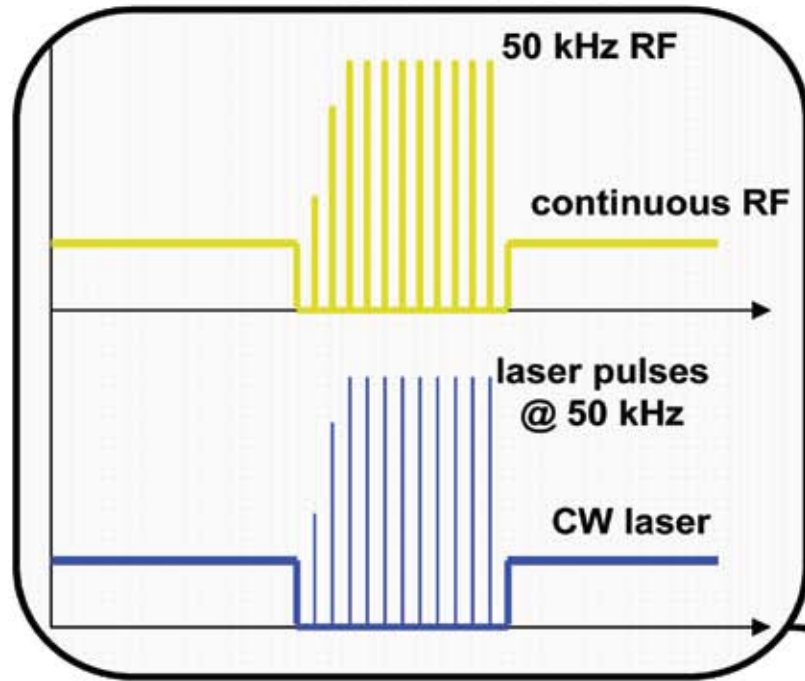
Modulation of OPO output – high power



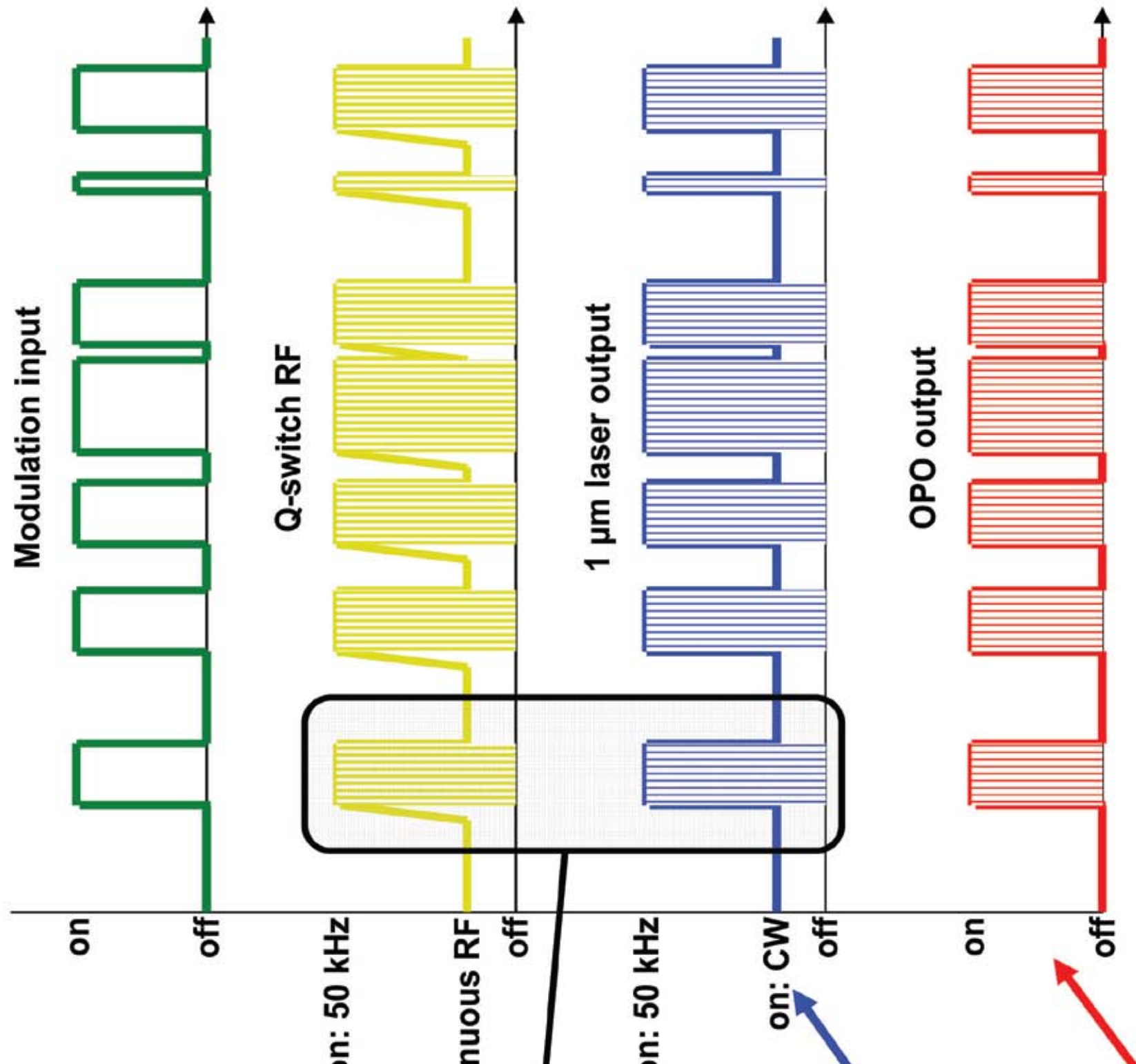
Solution: Modulation of 1 μm laser



Solution: Modulation of 1 μm laser



Modulation of 1 μm laser



aged design

Environmental tests

- While operational

Temperature chamber

- Temperature range 10 to 40 °C

Vibration table

- Vibration spectra of helicopter
- x 10 amplitude!



Field tests



B-2 & B-4 radiation

System resistant to:

- ✓ Hot South African sun
- ✓ Dust
- ✓ Truck transport

Flight tests

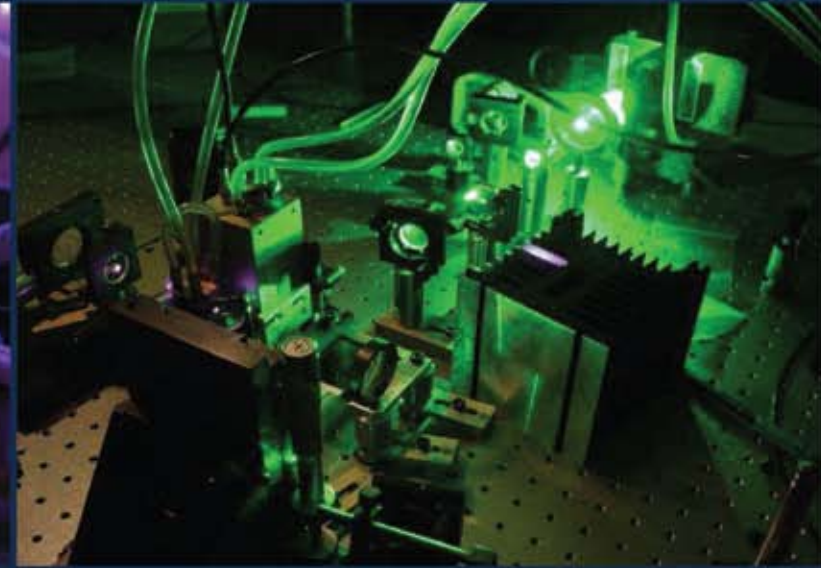
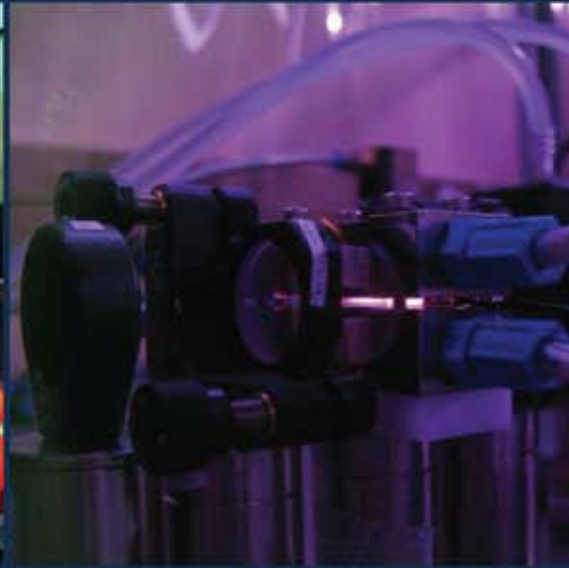


Conclusions

Mid-IR laser

- Diode-end-pumped
- 1 μm solid-state laser Nd:YVO₄
- Modulation imposed on Q-switch
- Two OPOs with simultaneous modulation
- Synchronised output at 2.3 μm & 4.0 μm
- Rugged, compact design
- Several field tests
- Extended flight tests

Thank you for your attention!



Laser Source Development
National Laser Centre, CSIR
South Africa

CSIR
our future through science