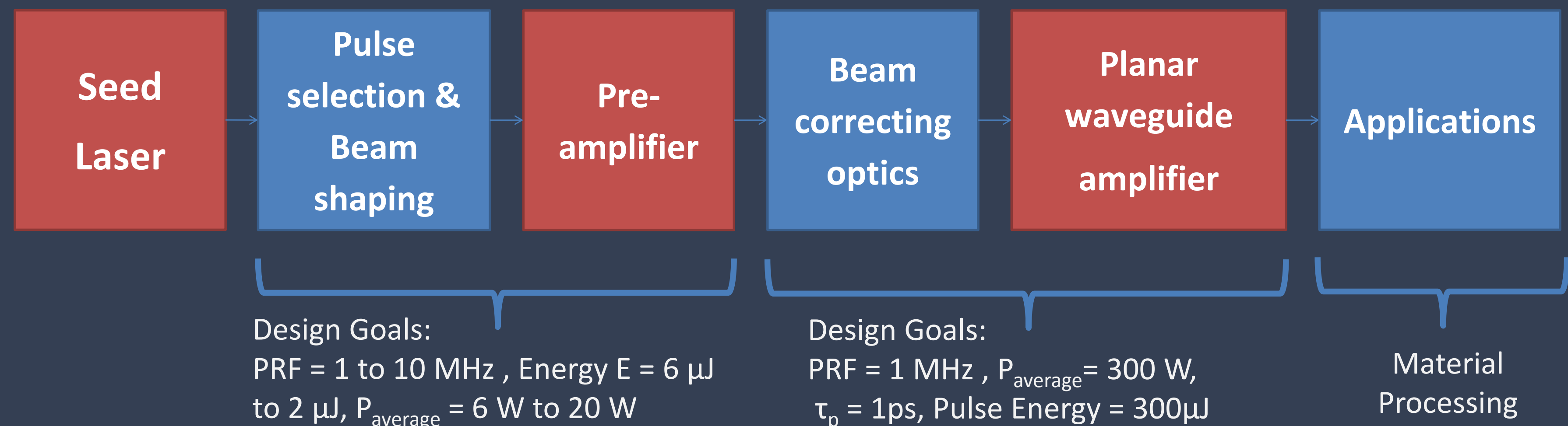


High Energy Amplifiers for 1 μ m Ultrafast Lasers

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Project Goals

- Use existing amplifier device architectures developed at Heriot-Watt to scale commercial ultrafast systems to >300W average power at 1 MHz repetition rate
- Investigate thermal, gain and parasitic processes in amplification stages
- Material processing applications for Heriot-Watt and RoFin-Sinar UK



Experimental design

Spectrophysics Femtotrain Seed Laser stage

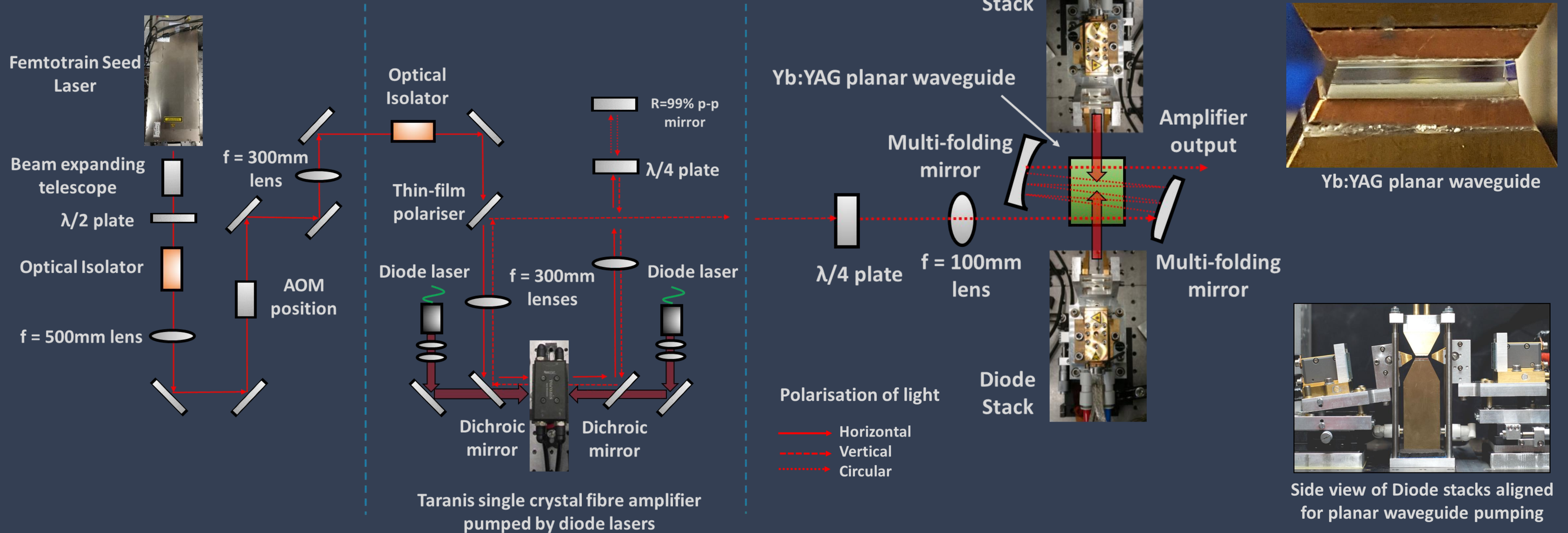
- P_{average} = 3.06W, PRF = 10.3 MHz
- τ_p = 0.4 ps, E_p = 0.250 μ J
- λ_l = 1030 nm, $M^2 \sim 1.3$

Fibrecrest Yb:YAG Taranis Pre-amplifier Stage

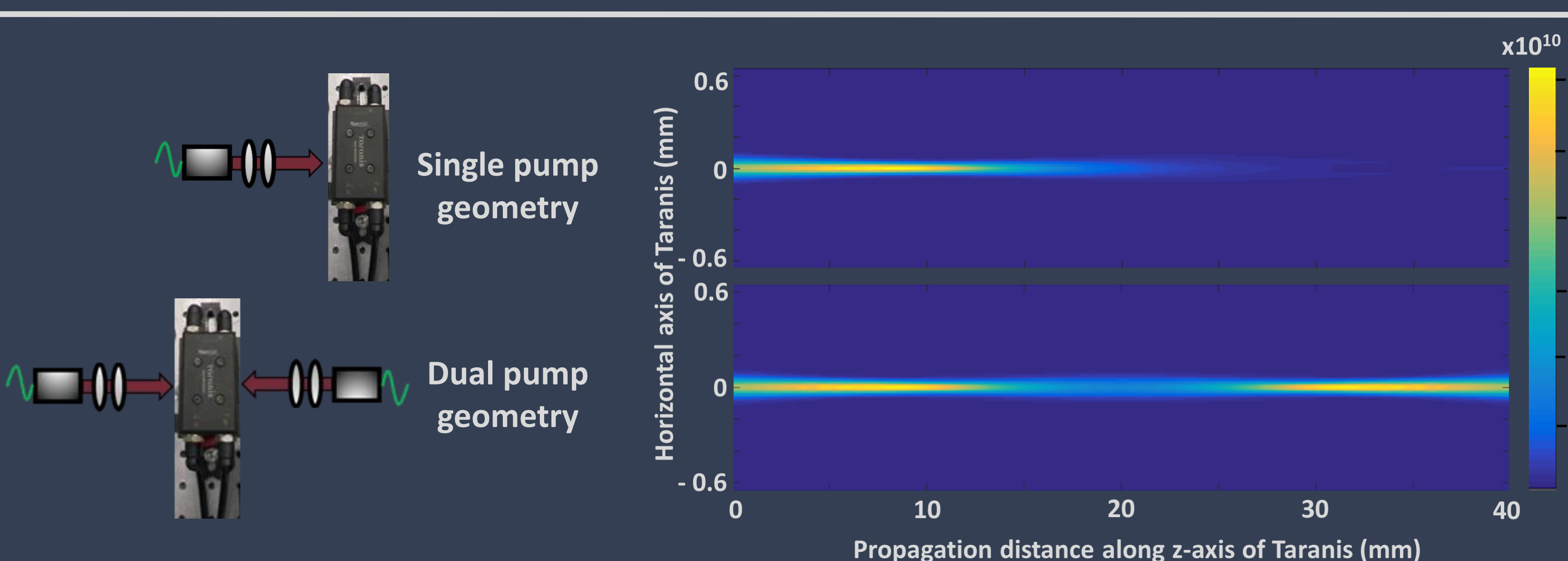
- \varnothing = 1 mm, 40 mm long, 1 at.% Yb:YAG single crystal fibre module (SCF)
- Dual-end pumped by 2 x 100W 940 nm fibre-coupled diode lasers, NA = 0.22

Yb:YAG Planar Waveguide Slab Amplifier Stage

- 150 μ m high, 13mm long, 12mm wide 2 at.% Yb:YAG / sapphire planar waveguide
- Dual-pumped by 2 x 450W 941 nm diode stacks
- Seed beam folded through amplifier for multi-pass amplification



Pre-amplifier modelling



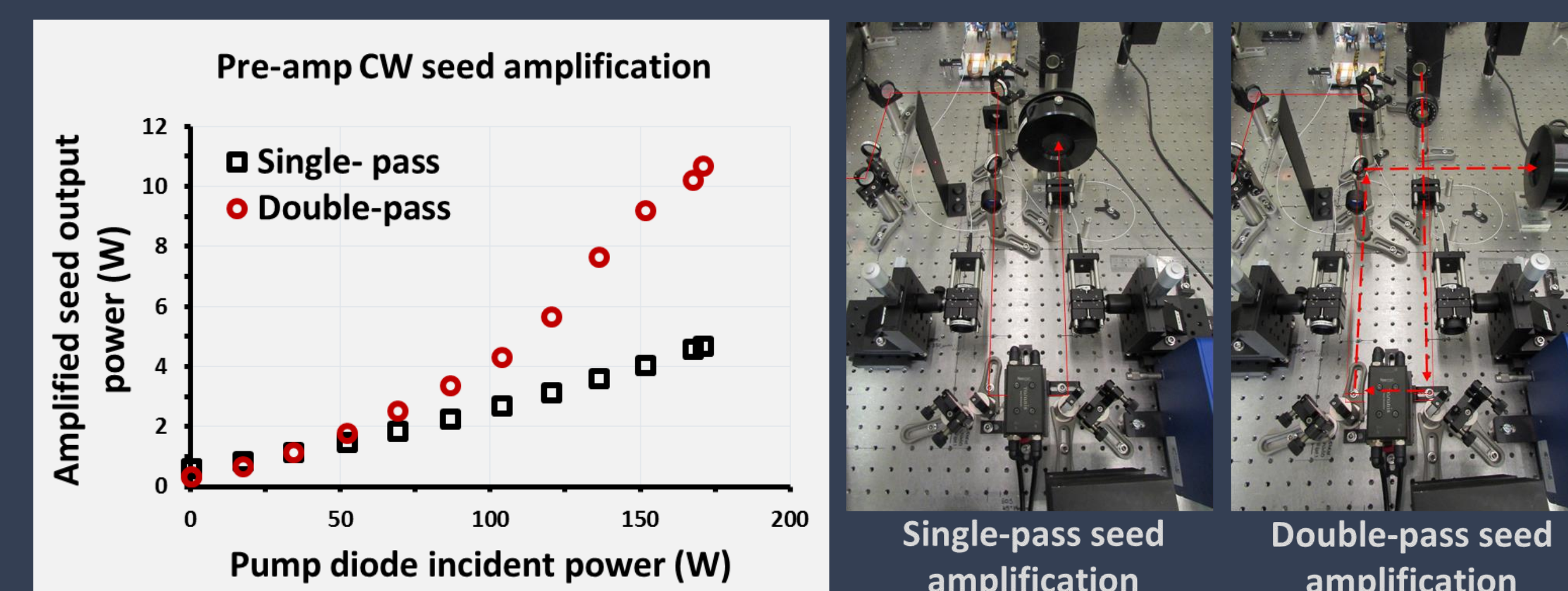
Pump absorption in Taranis pre-amp can lead to detrimental heat load-related processes

Absorbed intensity of pump propagation along Taranis Yb:YAG medium modelled for single and dual end-pumped geometries to assist experimental design

Model combines

- Fourier Propagation through SCF
- Wave guiding and Free space analysis
- Single and dual end-pumped solution
- Pump saturation

Experimental results



CW pre-amplification of $P_{\text{seed}} = 1.16$ W at PRF = 10MHz

- 4.7W and 11W achieved in single and double pass operation, corresponding to a gain of 4.05 and 9.48 respectively.
- Work ongoing to examine pre-amplification for mode-locked seed operation and to implement amplifier section

Outlook

With seed, pulse picking, pre-amp and main amp we aim to achieve average powers of over 300 W at a PRF of 1 MHz and a pulse duration of 1 ps after amplification with Yb:YAG planar waveguide.