Fibre laser development for use in accelerators

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Use of lasers in accelerators

Beam diagnostics - laserwire, Shintake monitor, polarisation measurement.

Photoinjectors.

Laser wakefield acceleration.

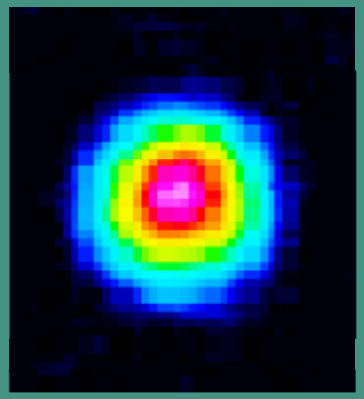
THz radiation generation by laser modulation of electron beams.

X-ray generation by Compton scattering.

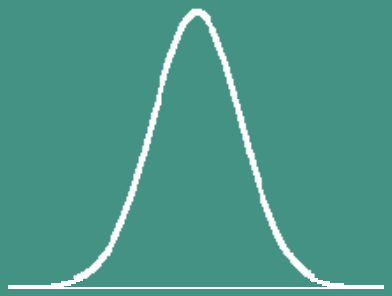
Selective ionisation and ion stripping.

Laser-wire requirements

< 1 μm spot size



Excellent Gaussian spatial mode quality



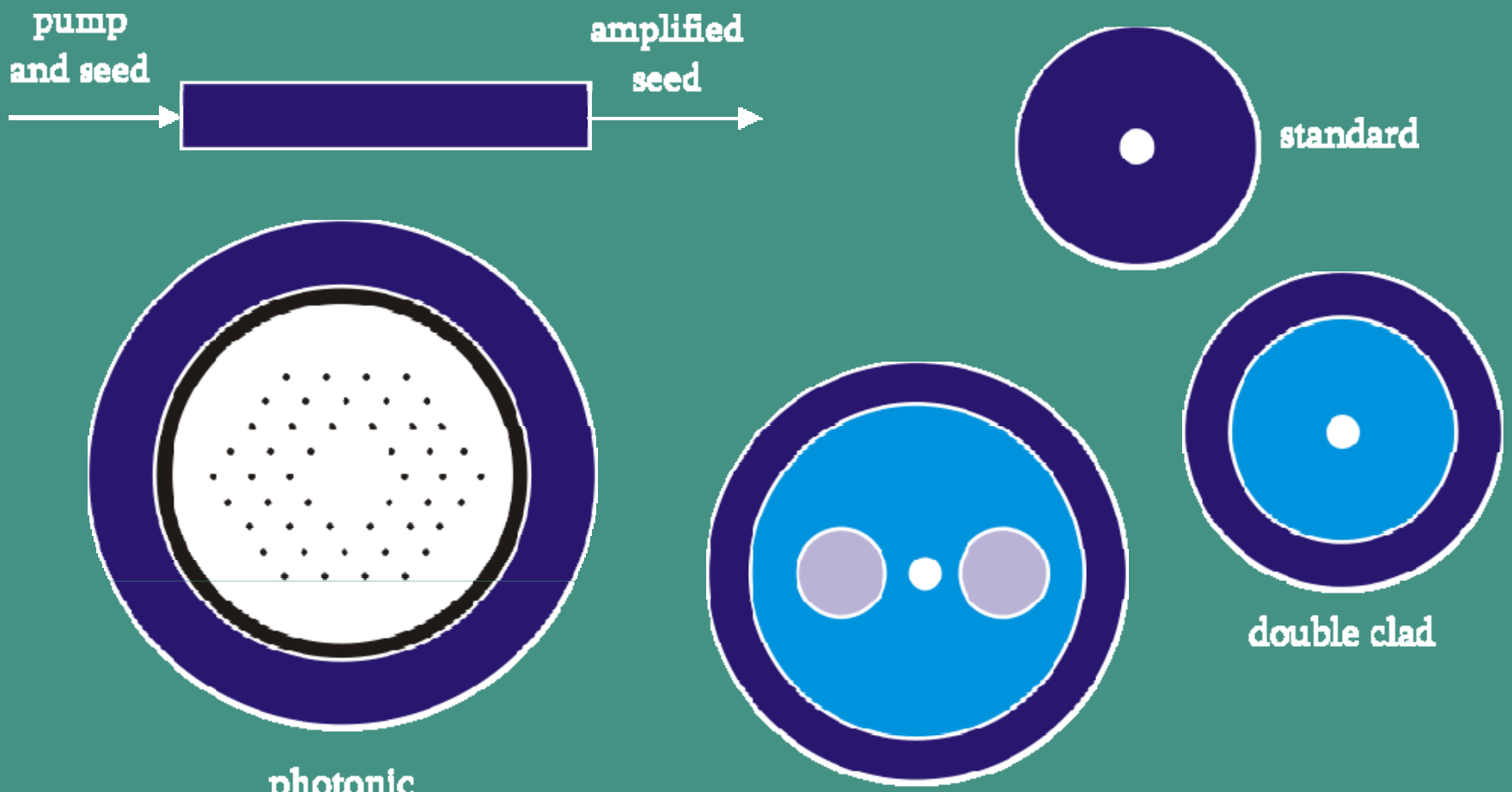
Narrow spectral width (< 2 nm)

- Repetition rate locked to accelerator.
- Low beam jitter - pointing stability.
- Linear polarisation.

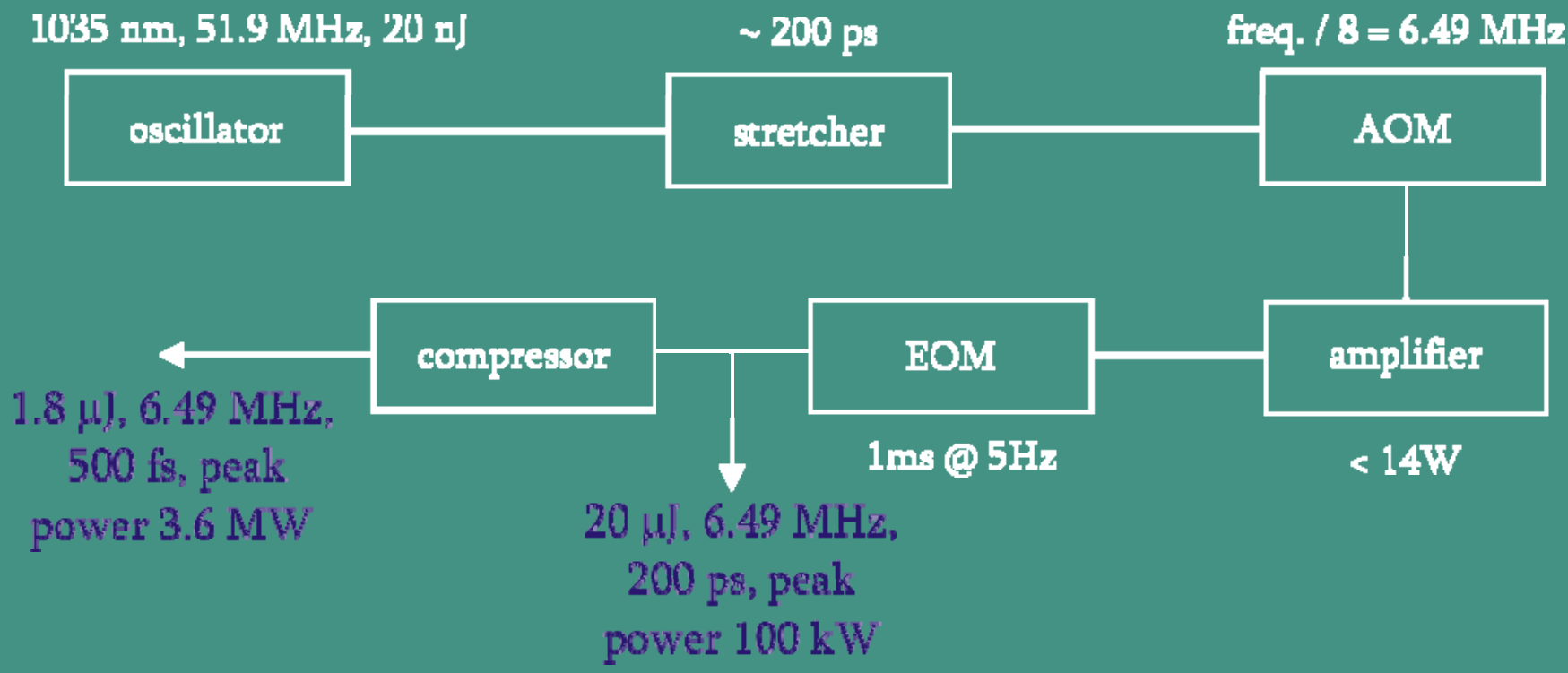
High energy (> 100 μJ) @ high rep. rate (6.49 MHz)

Fibre laser

Fibre lasers and amplifiers



Oscillator and pre-amplifier

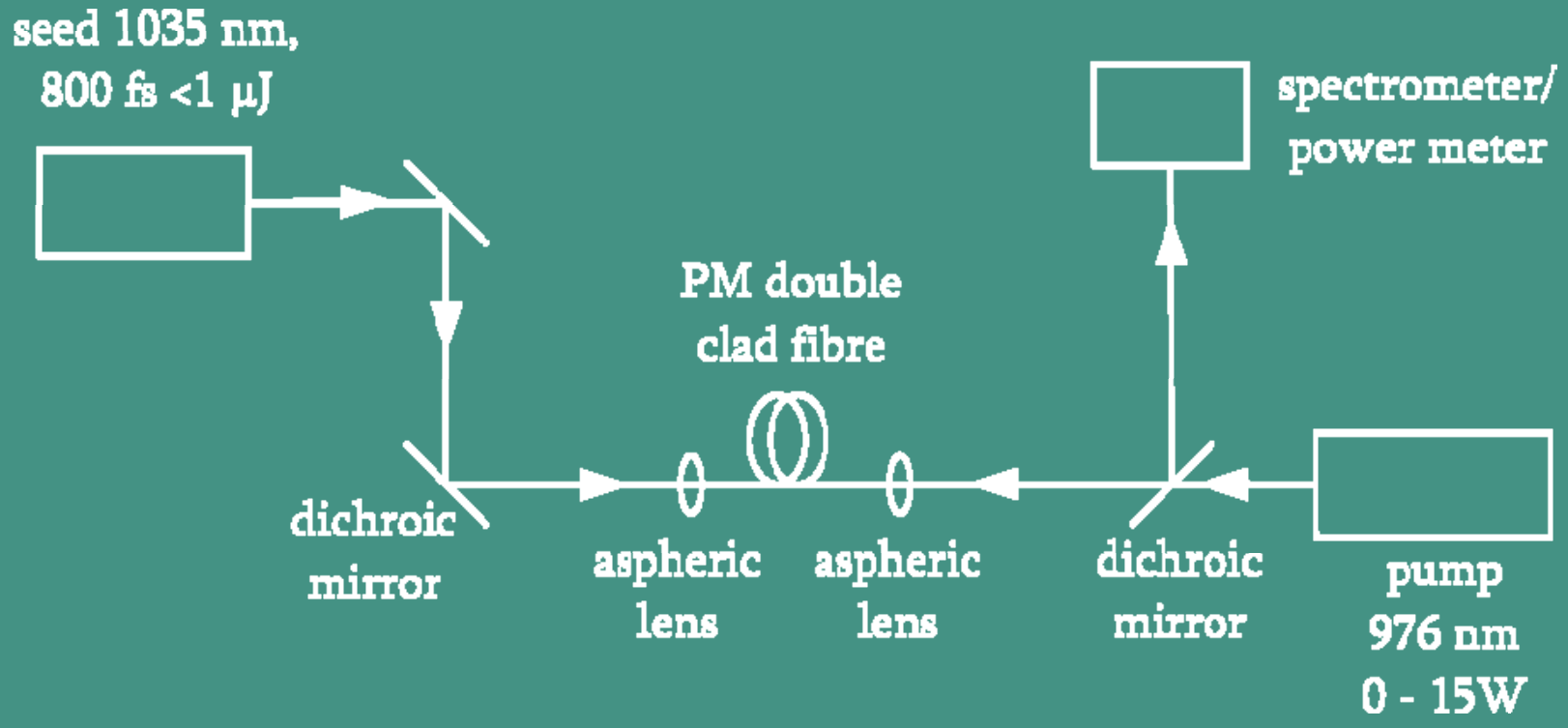


Oscillator solid state cavity lockable to external frequency reference

AOM, amplification, EOM, compressor all adjustable

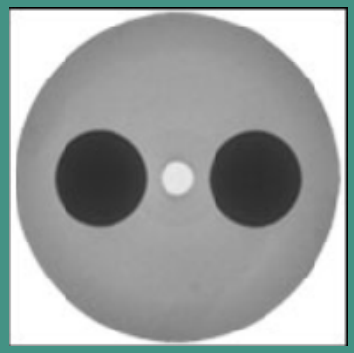
Very flexible system in 1 m x 1.2 m footprint

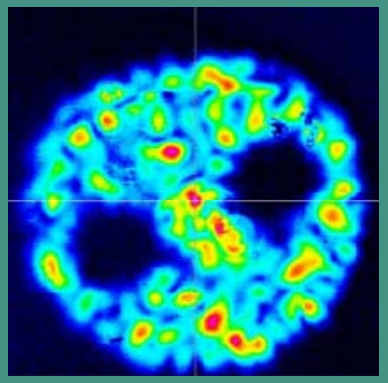
Experimental arrangement

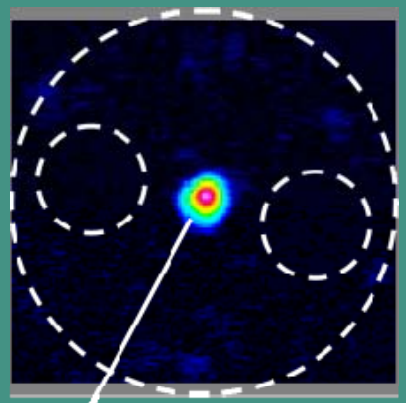


Fibre coupling

Double clad conventional fibre

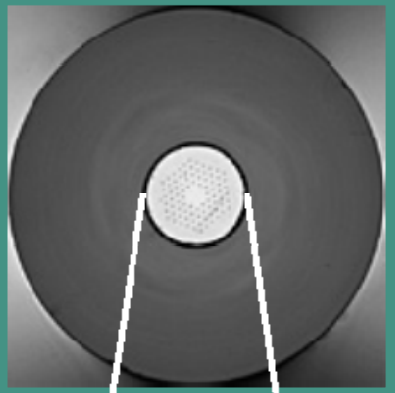


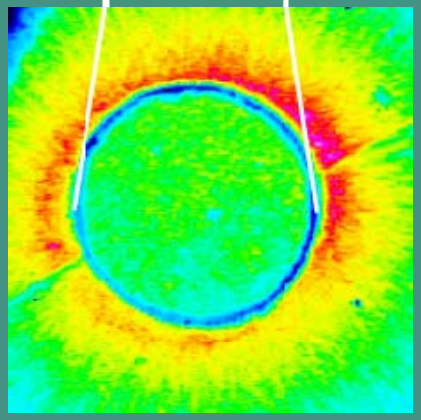


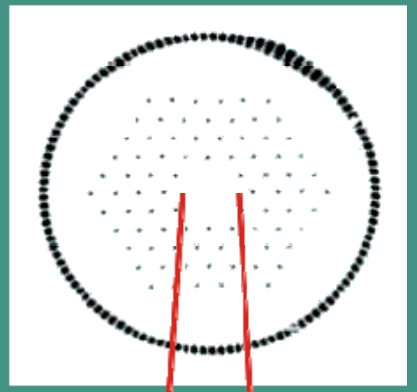


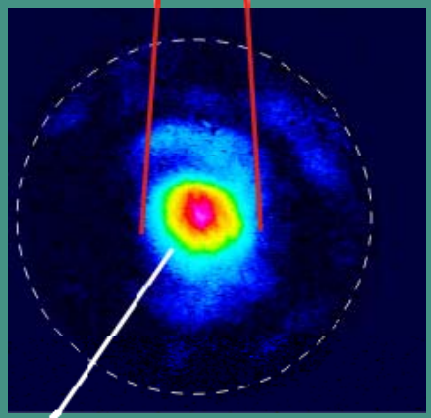
15 µm

Photonic crystal fibre



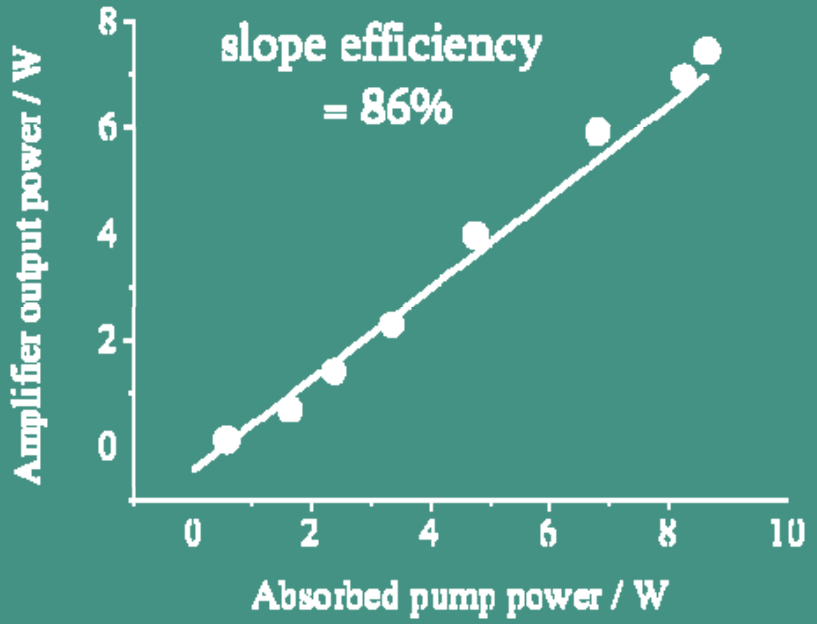


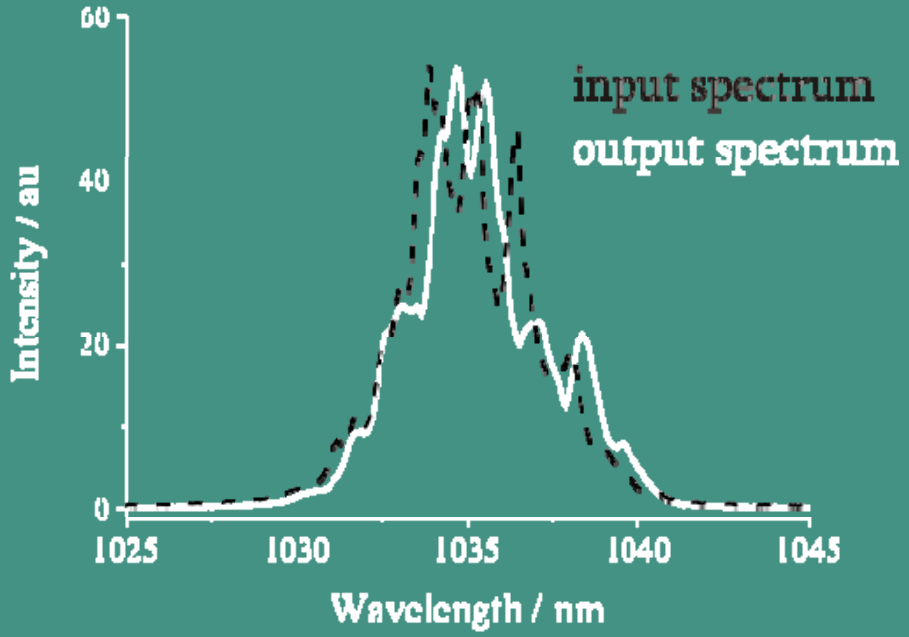


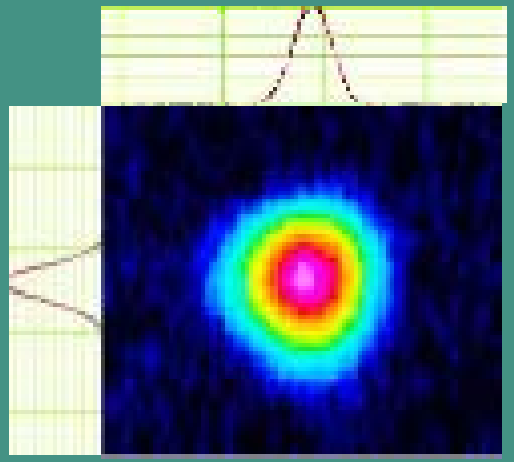


80 µm

Results







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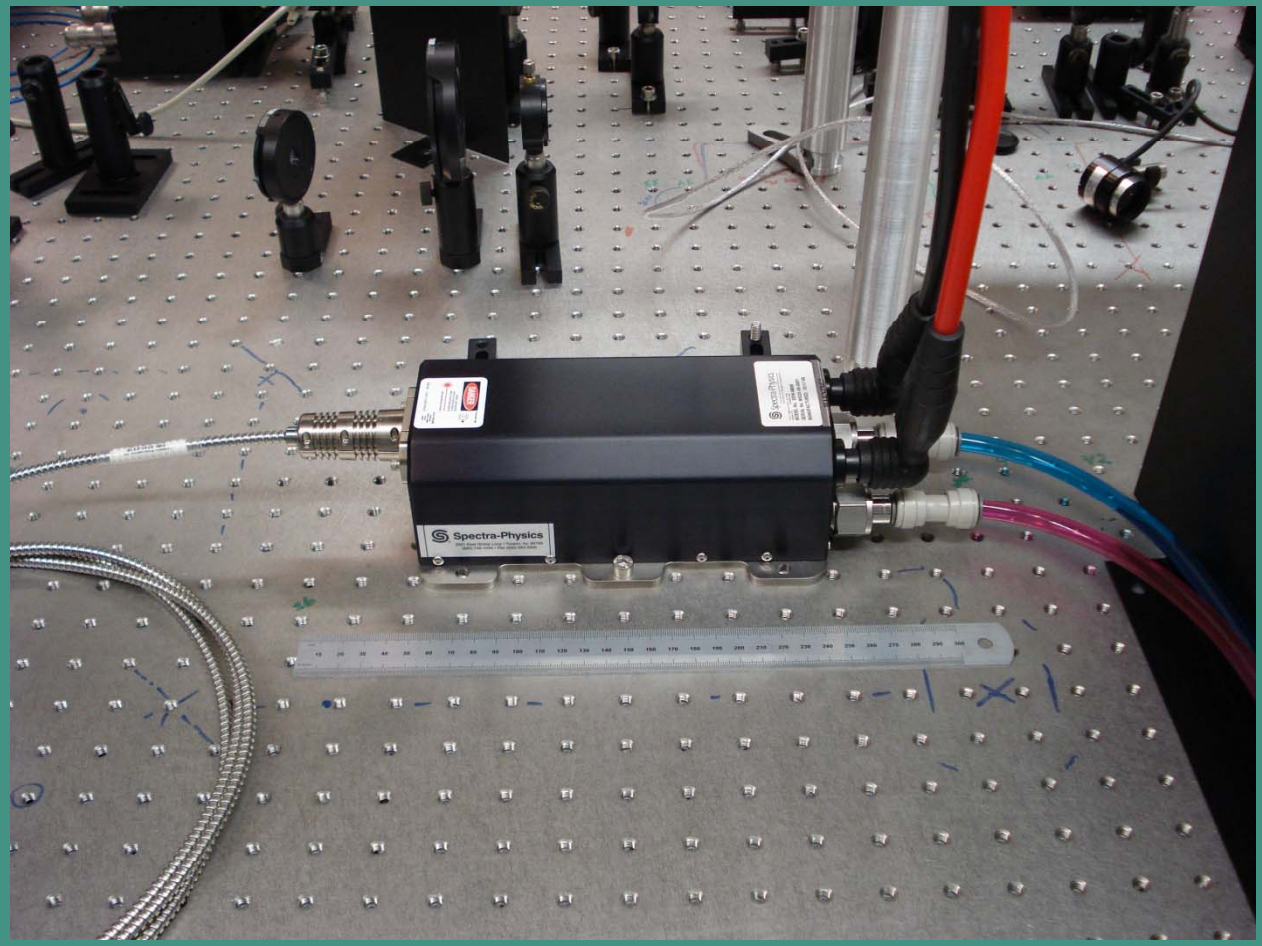
Photonic fibre amplifier



Progress and future work

Amplification: double clad fibre, low power pump.
8W average power @ 8.49MHz (pump limited).
Excellent spatial mode quality, ~ 200ps pulse length.
No spectral distortion or thermal effects.

Future work:
Burst mode amplification - timing issues, energy extraction efficiency.
High power pumping - 400W diode pump installed.
Photonic crystal fibre - large area single spatial mode.
Compression - 1 - 10 ps.

Aim: 100 μJ/pulse, burst mode, 6.49MHz, Gaussian mode.