

# 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.

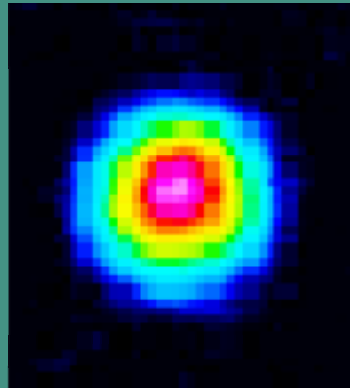
X-ray generation by Compton scattering.

Selective ionisation and ion stripping.

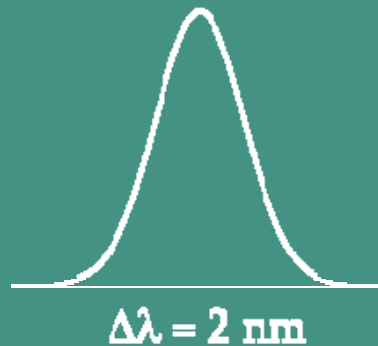


# Laser-wire requirements

< 1  $\mu\text{m}$  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  $\mu\text{J}$ ) @ high rep. rate (6.49 MHz)

Fibre laser

# Fibre lasers and amplifiers

pump  
and seed



amplified  
seed



standard



photonic  
crystal fibre

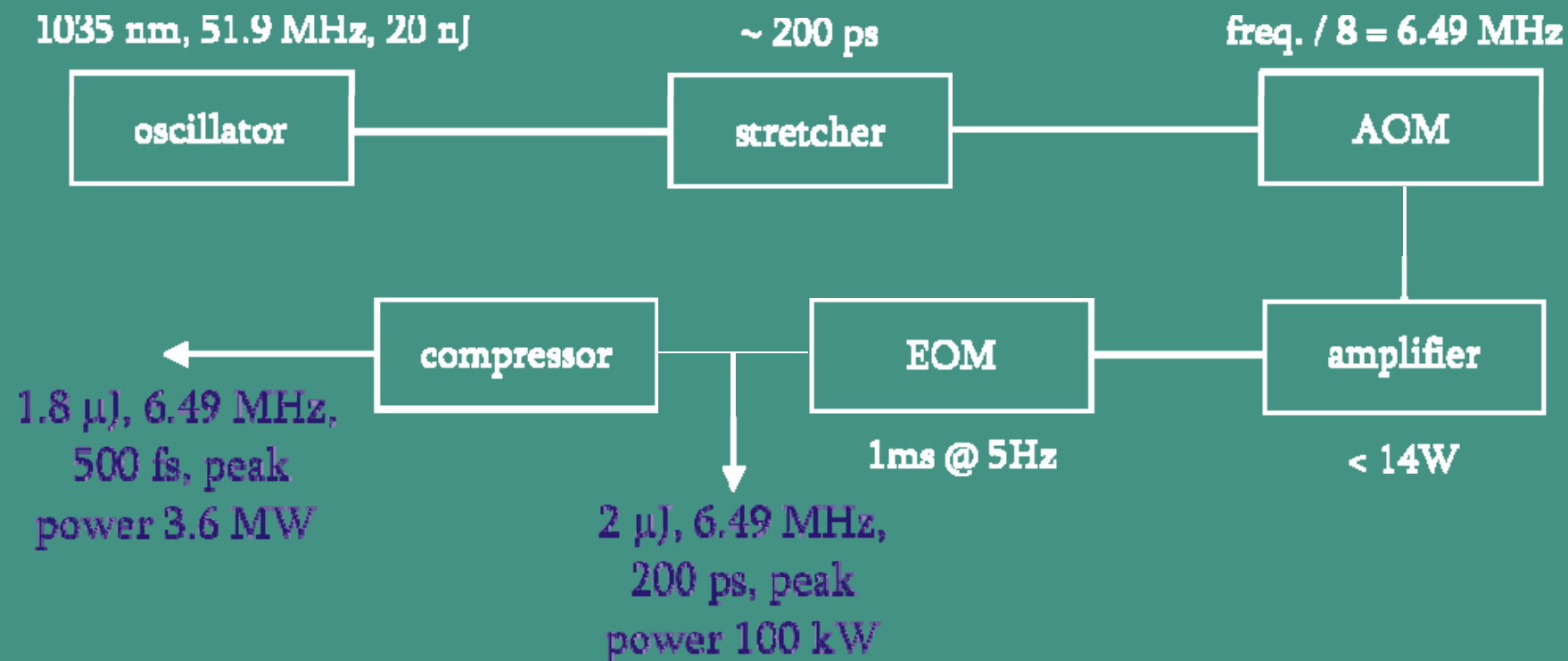


polarisation maintaining  
double clad



double clad

# Oscillator and pre-amplifier



Oscillator solid state cavity lockable to external frequency reference

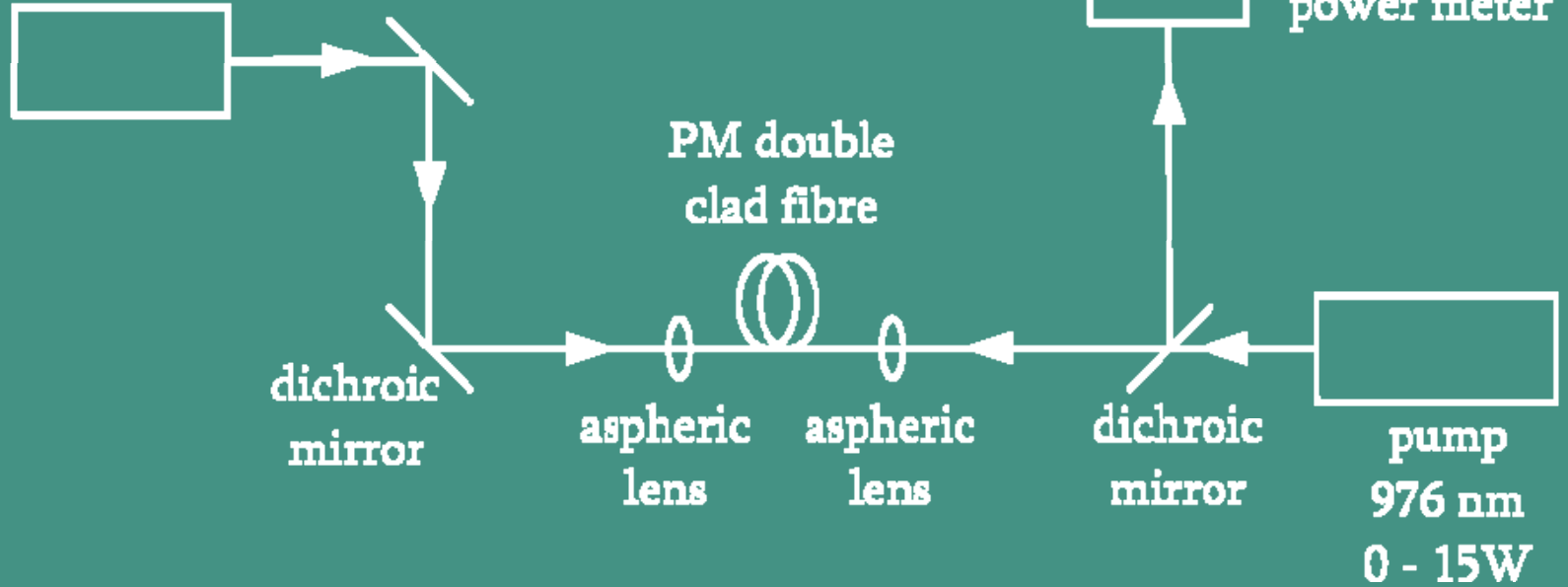
AOM, amplification, EOM, compressor all adjustable

Very flexible system in 1 m x 1.2 m footprint



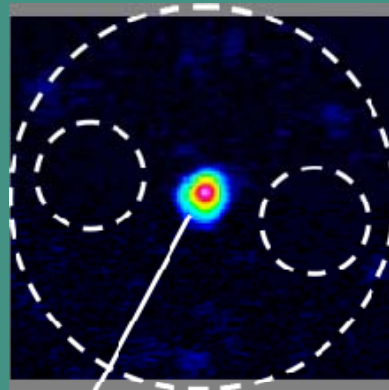
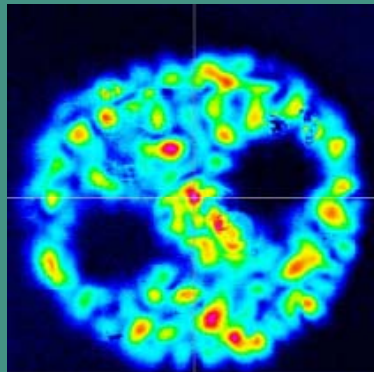
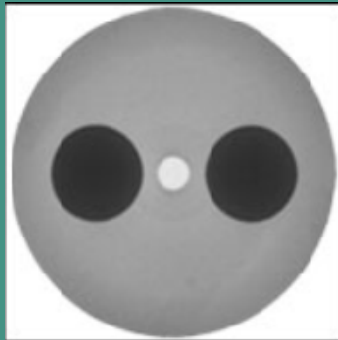
# Experimental arrangement

seed 1035 nm,  
800 fs <math>1 \mu\text{J}</math>



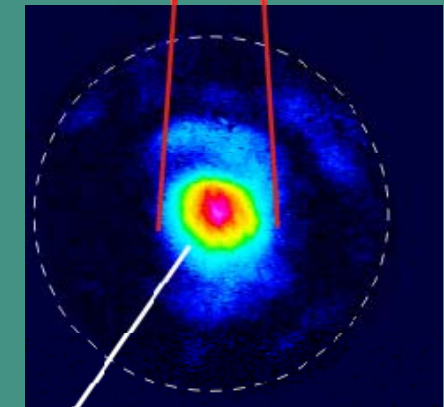
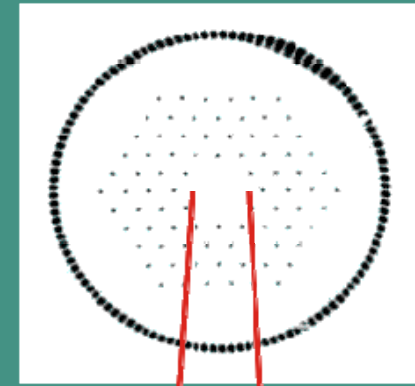
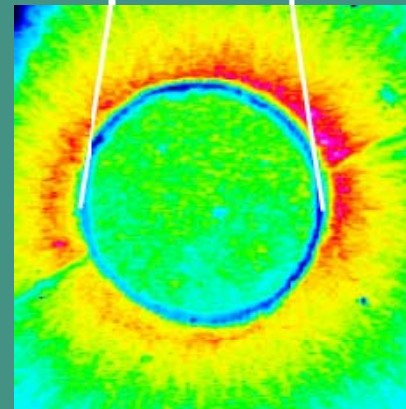
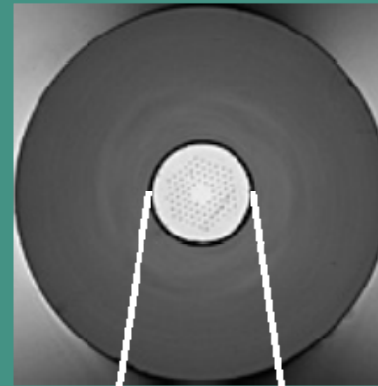
# Fibre coupling

Double clad conventional fibre



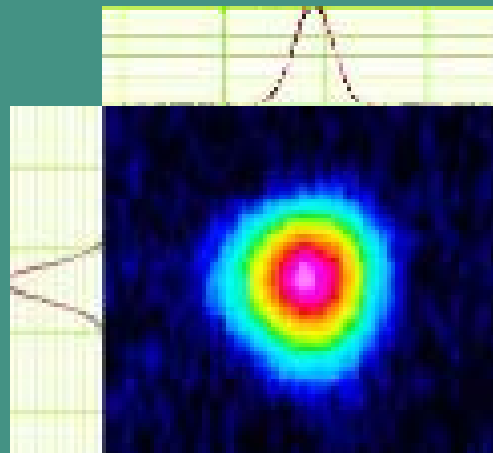
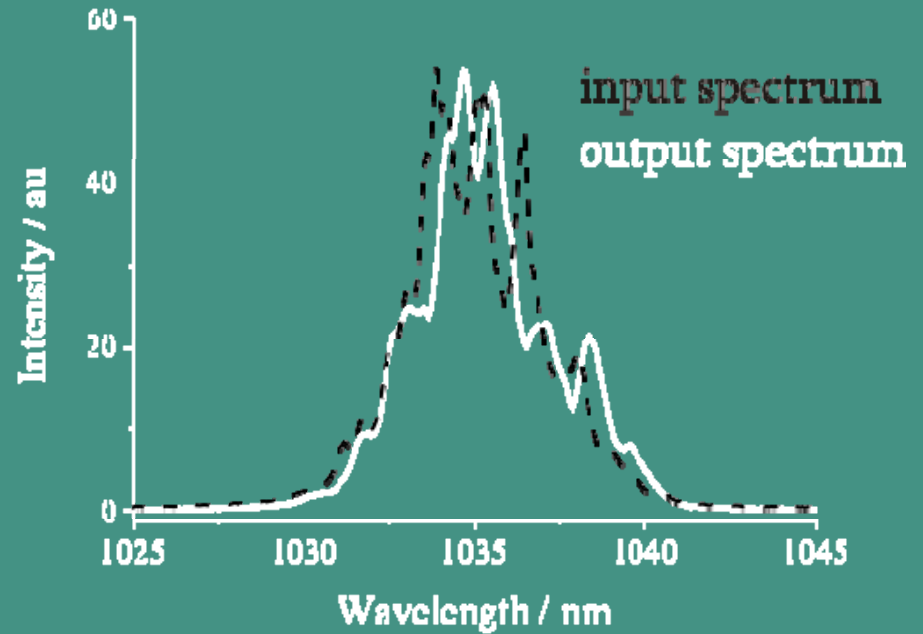
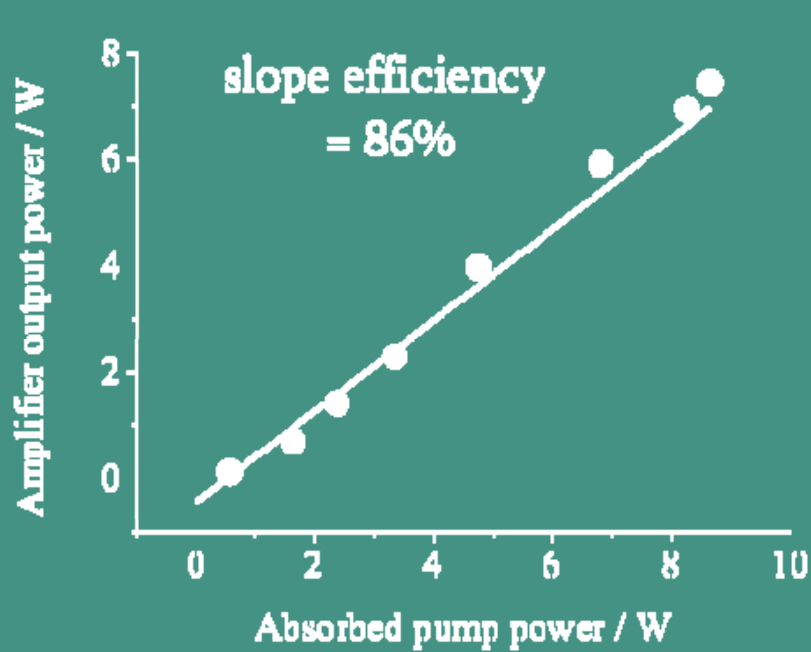
15 µm

Photonic crystal fibre



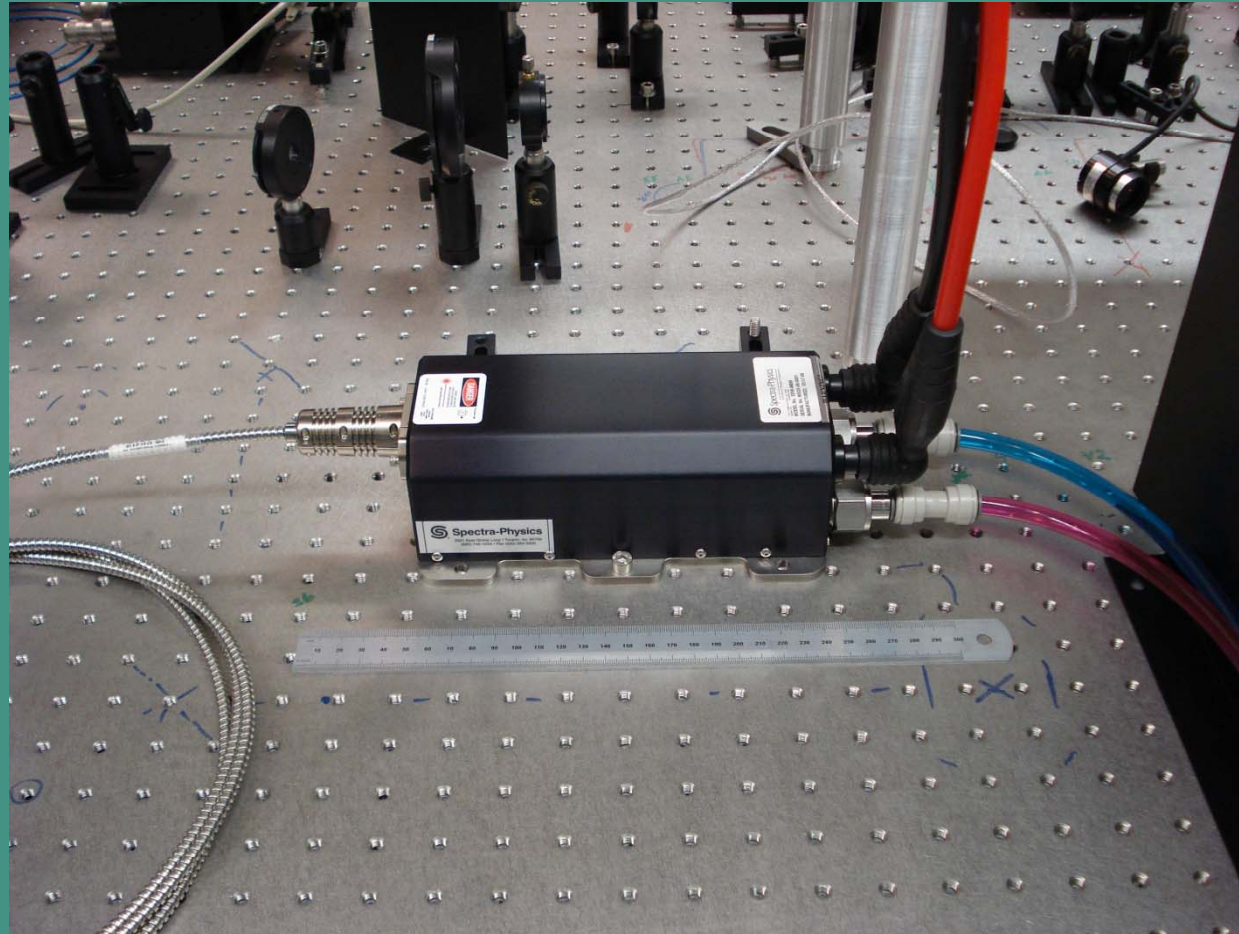
80 µm

# Results





# 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  $\mu$ J/pulse, burst mode, 6.49MHz, Gaussian mode.

