Giant Pulse Phenomena in a High Gain Erbium Doped Fiber Amplifier

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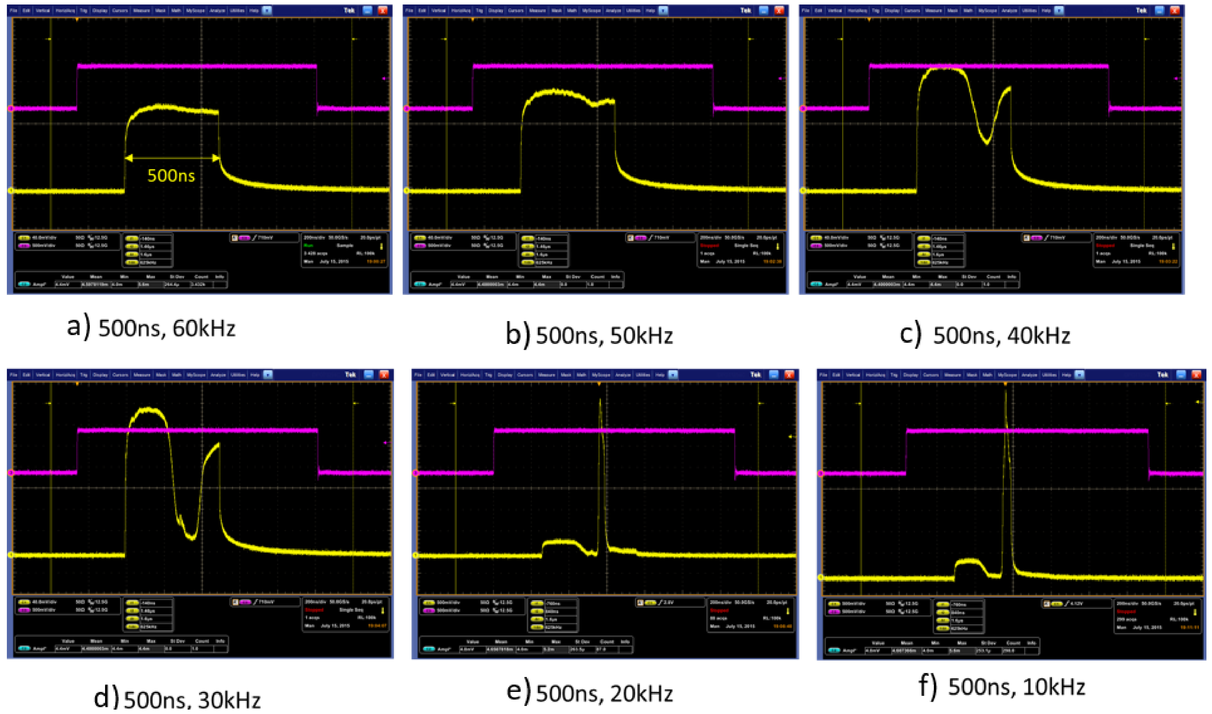
Abstract

High gain Erbium Doped Fiber Amplifiers (EDFAs) are vulnerable to optical damage when unseeded, e.g. due to nonlinear effects that produce random, spontaneous Q-switched (SQS) pulses with high peak power, i.e. giant pulses. Giant pulses can damage either the components within a high gain EDFA or external components and systems coupled to the EDFA. We explore the conditions under which a reflective, polarization-maintaining (PM), core-pumped high gain EDFA generates giant pulses, provide details on the evolution of normal pulses into giant pulses, and provide results on the transient effects of giant pulses on an amplifier's fused-fiber couplers, an effect which we call Fiber Overload Induced Leakage (FOIL). While FOIL's effect on fused-fiber couplers is temporary, its damage to forward pump lasers in a high gain EDFA can be permanent.

Testing the Onset of Giant Pulses

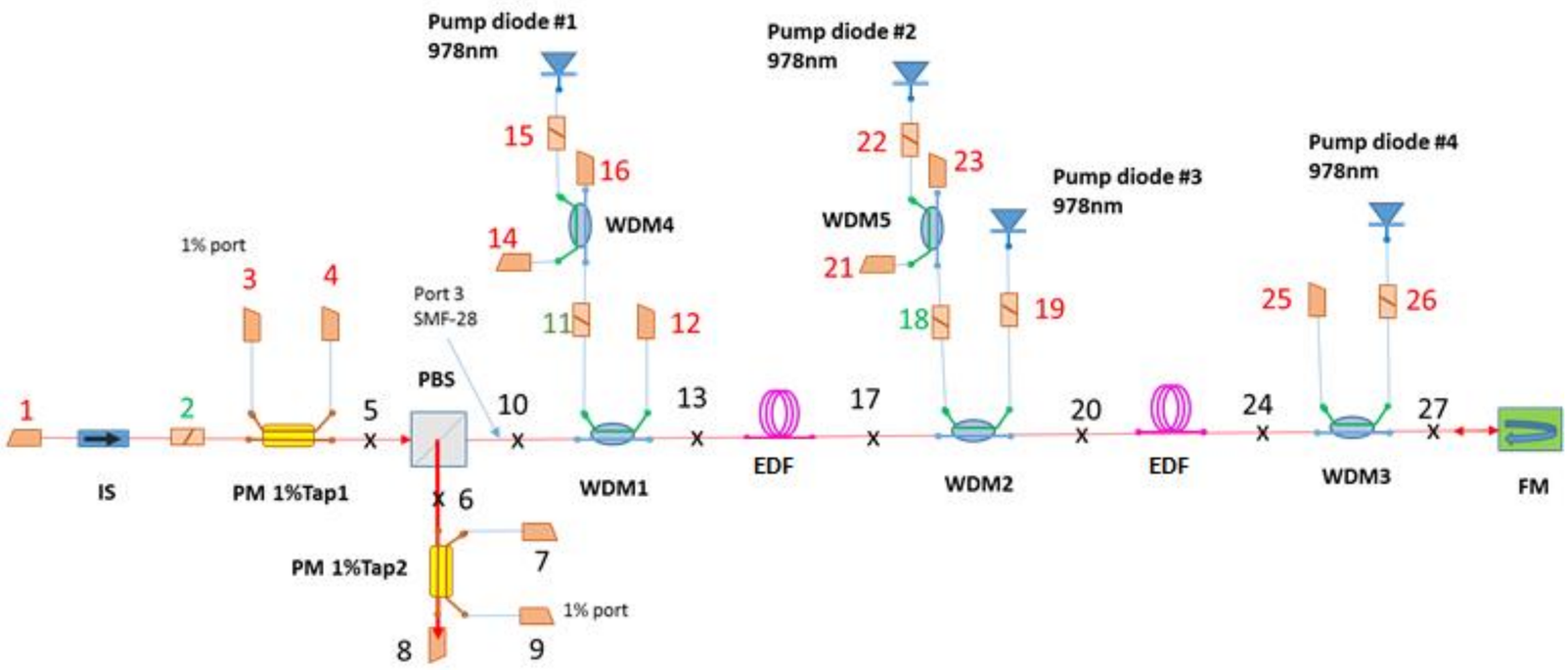


a) 500ns, 60kHz b) 500ns, 50kHz c) 500ns, 40kHz

d) 500ns, 30kHz e) 500ns, 20kHz f) 500ns, 10kHz

Dependence of output pulse shape (lower trace in each screenshot) on the repetition rate of the seed pulse. The scale of the lower trace is 40 mV/div for traces a), b), c) and d) and 500 mV/div for traces e) and f), which exhibit giant pulses of up to 1 kW.

High Gain EDFA



Conclusions

We tested the susceptibility of a reflective PM fiber amplifier to generate giant, self-Q-switched (SQS) pulses by injecting designed seed pulses over a range of inter-pulse intervals that spanned the amplifier's SBS threshold. We find that the onset of pulse break-up (using a fixed seed pulse width and decreasing PRF) as shown in Figures 4c) and 4d) provides a leading indicator of the reflective amplifier's likelihood of generating SBS-induced giant pulses in unseeded operation. We used these results to produce "designed" giant pulses to test amplifier components, including pump-protective WDMs, for fiber overload induced leakage (FOIL) phenomena.

References

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