A Pulse-Burst Laser System for Thomson Scattering

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Abstract

A pulse-burst laser system is being constructed for Thomson scattering on the MST reversed-field pinch. The laser will produce a burst of up to 300 shots at 1 kHz with a 0.2–0.4 ms square pulse, 0.3–20 ms width, to flashlamp. The insulated-gate bipolar transistor (IGBT) supplies will drive flashlamps delivering up to 20% of the explosion energy of the flashlamp. The laser will operate at 1000 Hz and is a master oscillator, power amplifier (MOPA) system. Variable pulse-width drive (0.3–20 ms) of the flashlamps is accomplished by IGBT switching of large electrolytic capacitor banks. In the near term, these flashlamp power supplies will be adapted to drive the flashlamps in the two existing commercial Nd:YAG lasers used for Thomson monitoring on the MST reversed-field pinch. As currently configured, Thomson scattering diagnostic records a 21-point radial profile four times each shot. As pulse repetition rates fall below about 50 kHz, Nd:YAG is increasingly able to re-pump a burst of 10–30 pulses at pulse repetition rates of 50–250 kHz. Slowly rising pulse energy ~65 mJ/pulse. a) Individual pulse width ~70 ns. Also amplified a burst of 20 pulses at 250 kHz pulse rep rate, average pulse energy ~250 mJ/pulse. a) Individual pulse width ~70 ns. Also amplified a burst of 20 pulses at 250 kHz pulse rep rate, average pulse energy ~250 mJ/pulse. b) Individual pulse width ~70 ns. Also amplified a burst of 20 pulses at 250 kHz pulse rep rate, average pulse energy ~250 mJ/pulse.

Fast Thomson scattering diagnostic with pulse-burst laser will enable new measurement capability

- Quick fast repetition rate changes, turbulence, electron density fluctuations.
- Goal for system on MST is to measure 75 points.
- Laser will be novel component, developed over a 20 month period.
- Laser pulse repetition rate can be varied from 50 to 250 kHz.
- Laser pulse energy is varied as a function of pulse repetition rate.
- Laser is only novel component.
- Polychromators and data system are able to accept much more data at a higher rate than current four laser pulses.
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Successfuly operated Nd:YAG amplifier chain with compact diode-pumped Nd:YVO4 oscillator

- Nd:YVO4 oscillator is of burst of 10 pulses at 20 kHz pulse rep rate, average pulse energy ~65 mJ/pulse. Nd:YAG diode-pumped pulse width ~70 ns. Also amplified a burst of 20 pulses at 250 kHz pulse rep rate, average pulse energy ~250 mJ/pulse. b) Individual pulse width ~70 ns. Also amplified a burst of 20 pulses at 250 kHz pulse rep rate, average pulse energy ~250 mJ/pulse.

Variable pulse width (0.3–20 ms) power supplies will drive flashlamps

- Nd:glass-grown q-switched mode to maximize inversion for production of a burst of 10–20 pulses. a) Nd:glass q-switched mode produces a burst of 10 pulses at 50 kHz. Approximately 30% of the stored energy is delivered to the flashlamp.
- Variable pulse width drive (0.3–20 ms) of the flashlamps is accomplished by IGBT switching of large electrolytic capacitor banks.
- The flashlamp supplies are controlled and monitored by a system based on single-board computers and expansion cards.
- Each flashlamp drive circuit is independently controllable for pulse width, delay, and energy from a single display screen.
- Each flashlamp drive circuit has two redundant control channels.
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For near-term operation, variable pulse width power supplies have been adapted to drive existing Spectron Nd:YAG lasers at 1 kHz.

Construction is proceeding on a pulse-burst laser system for fast Thomson scattering on MST

- Laser is a master oscillator, power amplifier (MOPA) architecture
- Single-board computer control system.
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