Pulse-Burst Laser Systems for Thomson Scattering on MST

D. J. Den Hartog, M. T. Borchardt, W. S. Harris, J. A. Reusch, and Y. M. Yang, Department of Physics, University of Wisconsin–Madison

Abstract
A new pulse-burst “pulse-burst” laser system is being constructed for Thomson scattering diagnostics on the MST recording facility. This new laser will produce a burst of 1–4-second pulses of repetition rates 1–12.5 kHz. It will illuminate at 2044 ns and is in a master–slave, power amplifier (1064 nm) system. Each slave laser will deliver about 0.2 J of the full 2 J flashlamp pulse at ≤ 4 Ms/sec.

The new purpose-built “pulse-burst” laser system will be used to study the dynamic evolution of electron temperature pulses during one flashlamp pulse. These lasers are currently enabling optimal pulse energy extraction, and up to four 2 J laser rates 1–12.5 kHz. Direct control of the laser Pockels cell drive enables new measurement capability with the custom pulse-burst laser will enable collection of thirty T_e profiles during a single MST discharge.

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

- Reduced fast and slow Thomson scattering observations
- Real-time measurements of MST in response to 3 and 5
- At variable time intervals, up to 2 ms
- At variable rate between 100–1000 Hz for a short burst
- Laser is only novel component
- Produced a series of 1–2 pulses, less than 30 times (for these “bursts”)
- Use existing Thomson scattering hardware (polychromators, etc.)

Variable pulse width (0.15–20 ms)

Power supplies drive flashlamps

- Pulse-burst lasers in the Spectron to produce a burst of fifteen 0.15 ms pulses.
- Overall capability of the upgraded laser system is determined by the explosion energy limits of the flashlamps.
- Operational limits of the upgraded laser system are determined by the explosion energy limits of the flashlamps.
- Single-pulse catastrophic failure of the flashlamp wall during a burst of pulses is expected to ≥ 10^14–10^15 ergs/cm^2.
- Typically operate at ≤ 15% of explosion energy.
- Probably could operate up to 200 J/cm^2.

The Thomson scattering diagnostic on MST records 21-point radial profiles

- Laser and polychromators are remote from experimental hall
- Schematic of variable pulse width (0.15–20 ms) power supplies drive flashlamps
- Produced a series of 1–2 pulses, less than 30 times (for these “bursts”)
- Real-time measurements of MST in response to 3 and 5
- At variable rate between 100–1000 Hz for a short burst

Two commercial Nd:YAG lasers have been upgraded to 1–12.5 kHz pulse-burst

- Two standard commercial flashlamp-pumped Nd:YAG lasers have been upgraded up to 1–12.5 kHz pulse-burst capability.
- Two Nd:YAG lasers are used in the Thomson scattering system on MST.
- These lasers are typically operated at ≤ 15% of explosion energy.

Summary
- Two standard commercial flashlamp-pumped Nd:YAG lasers have been upgraded up to 1–12.5 kHz pulse-burst capability.
- Two Nd:YAG lasers are used in the Thomson scattering system on MST.
- These lasers are typically operated at ≤ 15% of explosion energy.
- The two upgraded Nd:YAG lasers will be used to study the dynamic evolution of electron temperature pulses during one flashlamp pulse.

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