MTW 15-cm Nd:glass Disk Amplifier

Upon exiting the rod amplifier (RA), the pulse energy is up to ~3 J. Before the beam is injected into the disk amplifier (DA), it is expanded to 26 × 26 mm^2 by a three-lens zoom telescope, which has a vacuum spatial filter (ZOOM VSF)between two first lenses. This final stage of amplification consists of four 15-cm Nd:glass (Hoya LH-8) disks. It is powered by an LLE-designed power conditioning unit capable of delivering up to a total of 275 kJ when charged 52-in. flashlamps to a maximum voltage of 14.8 kV. The peak current in each circuit is approximately 7 kA with a pulse width of 550 μs (FWHM). A preionization and lamp check circuit allows for reliable operation even at reduced capacitor bank voltages. Ignitron vacuum tubes are used to switch the high voltage and current. Since flashlamp pumping deposits a significant amount of heat in the amplifying glass disks, thermally induced changes in refractive index as well as thermal expansion can affect the beam profile and pointing if the laser is fired too soon after a previous shot. For this reason, a 20-min delay between shots is enforced for 10-kV shots and 45 min for 13-kV shots.

The amplifier housing is shown in Fig. 1. The beam is folded in a four-pass geometry to maximize the amount of energy extracted to use more space in the available aperture and to maintain beam uniformity. There is the 2× up-collimation telescope with the DA VSF between the second and the third passes. The cross-section alignment diaphragm with the numbers and orientations of passes is also shown in Fig. 1. A 45-mm-diam Faraday isolator is located between the second and the third passes to protect the laser from back-reflections. Mirrors between the passes rotate the beam up–down, left–right, and by 90° to minimize the effects of any gain nonuniformity across the disks.

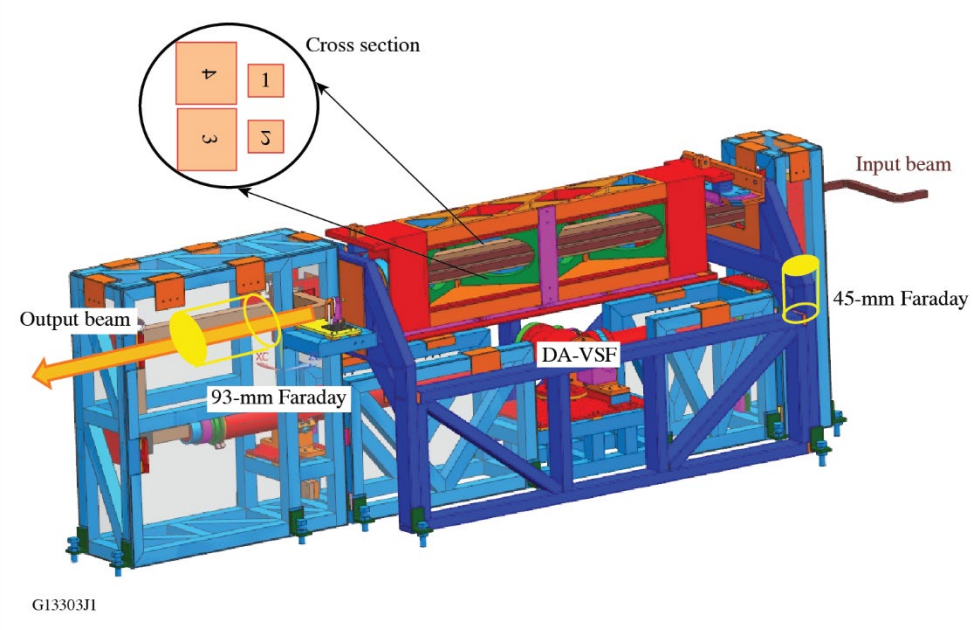

Fig. 1. DA structure. Pass numbers (1–4) showing beam rotations.

Although the flashlamps may be fired at voltages as high as 14.8 kV, the maximum used in operations is 13.5 kV and they are usually operated at 10 kV to lengthen their lifetimes. Under these conditions, the small-signal gain from a single pass is ~3. After four passes through the amplifier, the final energy of the laser is >120 J. In general, the RA and DA voltages are kept at the modest levels (2 kV and 10 kV, respectively) to maintain the same time between shots and to minimize thermal effects of RA and DA. There are two half-wave plate/polarizer throttles between the optical parametric chirped-pulse–amplification stage and RA that are used to vary the MTW output energy if necessary.

Similar to the RA, the DA is also limited in spectral gain and has a higher small-signal gain for a narrowband input signal than for a broadband one Fig. 2(b).

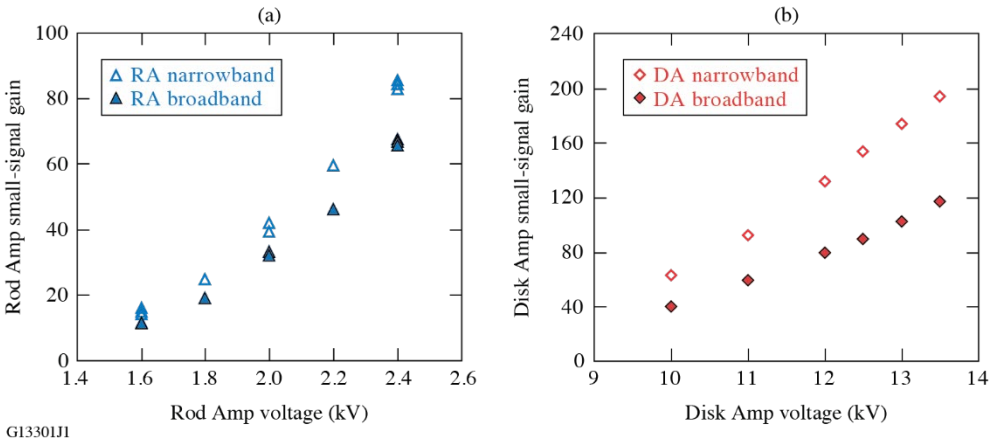

Fig. 2. Small-signal gain of (a) the double-pass RA and (b) the four-pass DA for narrowband (open symbols) and broadband (solid symbols) signals.