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Comprehensive Debris Mitigation Technique for a Petawatt Laser Shot into Sandia's Z-Accelerator

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During the last seven years, the Z-Backlighter laser facility at Sandia National Laboratories has successfully provided x-ray radiography for the adjacent Z-Accelerator. Due to the violent nature of Z-pinch experiments the final focusing optics have to be properly shielded from Z-target debris. For long pulse (~1ns) lasers such as Z-Beamlet, a 1 cm thick fused silica AR coated window can adequately protect the focusing lens.

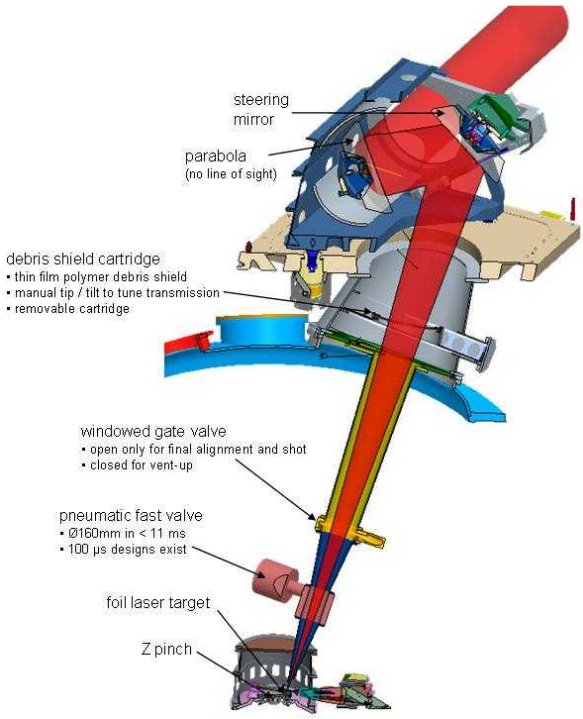

Figure 1: Schematic overview of the final focusing assembly on top of the Z-Accelerator lid.

As the new 500 J, 500 fs Z-Petawatt laser (ZPW) comes online, the debris shield thickness is limited by the accumulated B-integral that the laser acquires in transmission. In our case, this sets an upper limit of 500 micron for the debris shield thickness if the added B-integral is to stay below 1.5. Therefore we have investigated the optical properties of various thin films such as Nitrocellulose, Mylar, and Polyimide with respect to their application as laser debris shields [1]. Studies on optical and spectral transmission quality, absorption, stress induced birefringence, and damage threshold have been performed. Nitrocellulose shows a damage threshold of 1 J/cm^2 at a laser pulsewidth of 500fs. Furthermore we have verified its feasibility as a debris shield by successfully using it in our 100TW laser target experiments. Scalability to large apertures (up to 50 cm diameter) has also been investigated.

We will show how focusing geometry, target alignment, fast valves, and mechanical components can help mitigating target debris traveling back to the focusing optic (see Fig 1).

References:

[1] J. Schwarz, P. Rambo, M. Geissel, D. Headley, M. Ramsey and B. Atherton. "Studies on thin films as short pulse laser debris shields". **Laser-Induced Damage in Optical Materials**, vol.: 6720, pp. 67200Q-10, 2007.

Acknowledgments

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