Software Tool Leverages Existing Image Analysis Results to Provide In-situ Transmission of the NIF Disposable Debris Shields

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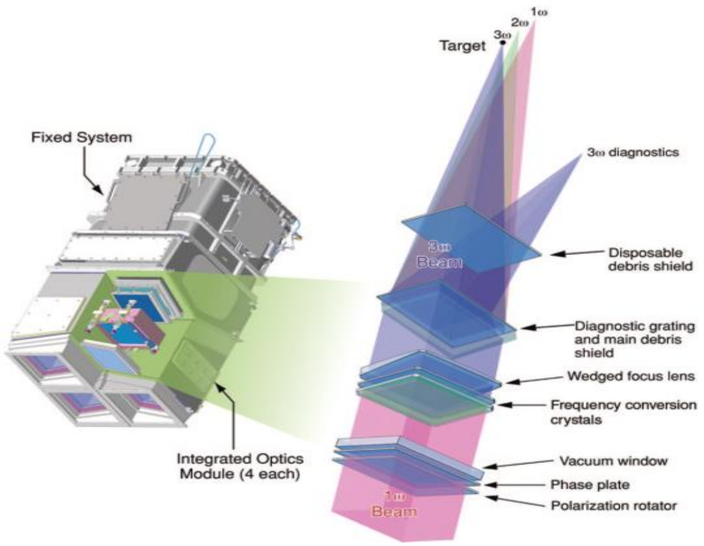
Abstract

The Disposable Debris-Shield (DDS) Attenuation Tool is software that leverages Automatic Alignment image analysis results and takes advantage of the DDS motorized insertion and removal to compute the in-situ transmission of the 192 NIF DDS. The NIF employs glass DDS to protect the final optics from debris and shrapnel generated by the laser-target interaction. Each DDS transmission must be closely monitored and replaced when its physical characteristics impact laser performance. The tool was developed to calculate the transmission by obtaining the total intensity of transmitted light with the debris shield inserted and removed. These total intensities are calculated in the Automatic Alignment image processing algorithms. The tool uses this data, adding the capability to specify DDS to test, moves the DDS, performs calculations, and saves data to an output file. It operates on all 192 beams of the NIF in parallel. The tool has discovered a discrepancy between models and actual measurements. The software was qualified with DDS of known transmissions as supplied by the vendor. This demonstrated the tool capable of measuring in-situ DDS transmission to better than 0.5% rms.

Automatic Disposable Debris Shield (ADDS)

NIF has expensive optics in the Final Optics Assembly (FOA) that have strict focusing and frequency conversion criteria. Debris shields are inserted between these optics and the target chamber to protect the FOA optics.
The Debris shields are disposable, but are also high quality optics fabricated from borosilicate glass with anti-reflective coatings.
Each beamline has a cassette with 10 separate shields.

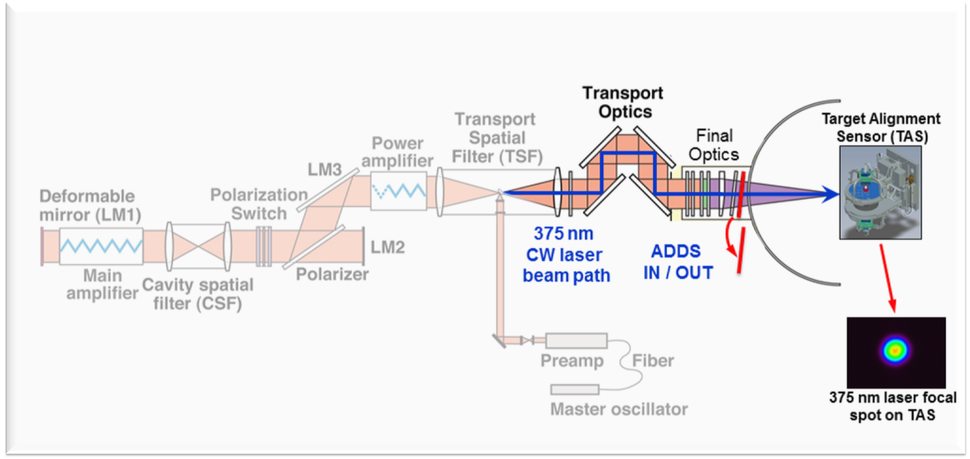


Measuring on-line transmission of shield in beam path necessary to understand laser performance

- Need was identified to measure in-situ ADDS transmissions to verify model predictions
- Software developed in Java to use existing control interfaces
- GUI allows for input file to identify beamline shields to test
- GUI also shows feedback and calculated results for each beamline
- Software tests, with shields with known transmission, have proven accuracy of 0.5% rms

NIF schematic highlighting systems utilized in ADDS Transmission calculations

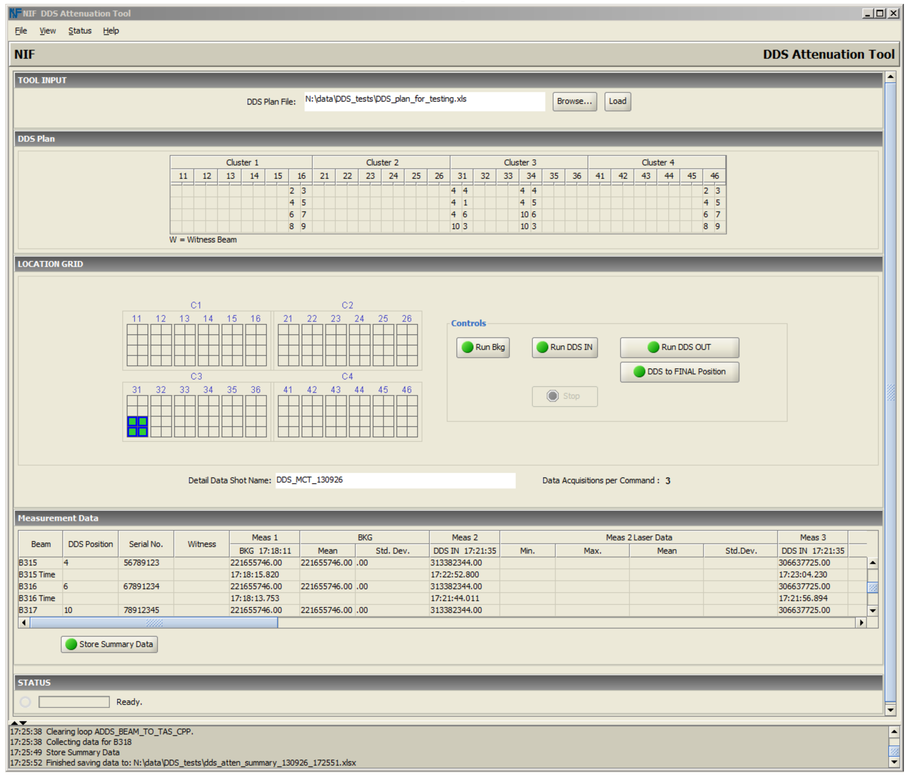
375 nm laser is propagated through beam path and TAS images are analyzed with ADDS Inserted and Removed



ADDS Attenuation Tool Software performs multiple steps to obtain results

- Moves ADDS motorized shields to specified position
- Initiates Automatic Alignment (AA) command that processes TAS images
- Retrieves Total Image Intensity results from AA software
- Calculates Attenuation and displays to Operator
- Executes on 192 beamlines in parallel for most efficient operation
- Provides functionality to save data to Excel for post-acquisition analysis

ADDS Attenuation Tool Graphical User Interface

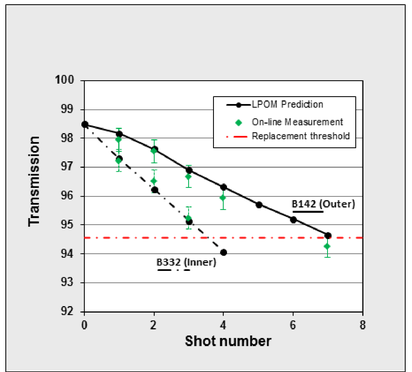


Transmission Measurements

Set of 3 Image Acquisition/Processing executions by AA to determine mean value used in calculation. Ratio of Total Image Intensities are used to calculate the Transmission

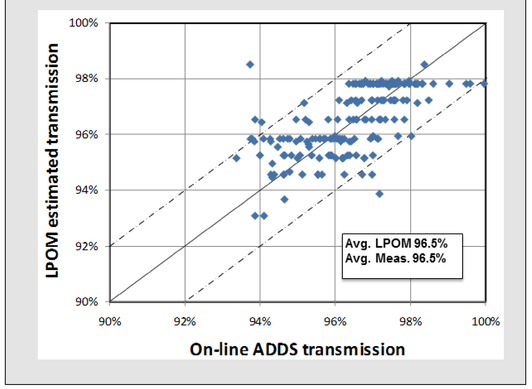
$$Atten = \frac{IN\ Total\ Intensity\ -\ Background\ Total\ Intensity}{Out\ Total\ Intensity - Background\ Total\ Intensity}$$

Comparison between LPOM predicted ADDS transmission and on-line measurement by the tool



ADDS are changed when T<94.5%
(4% loss from pristine state)

On-line (ADDS Attenuation Tool Software) transmission measurements for 192 beamlines as compared to the Laser Performance and Operations Model (LPOM) values after 1.3 MJ experiment



Summary

The ADDS Attenuation Tool software was developed taking advantage of existing software functionality to provide transmission data important for efficient NIF operation. Prior to tool, the only shield transmissions were from laser performance modelling. While the modelling is a very crucial component, it was enhanced by on-line measurements to validate and improve certain model parameters. Its ability to execute in a parallel manner on all 192 beamlines concurrently has made it a useful tool for NIF operations and planning activities, while still minimizing the use of NIF facility time.

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