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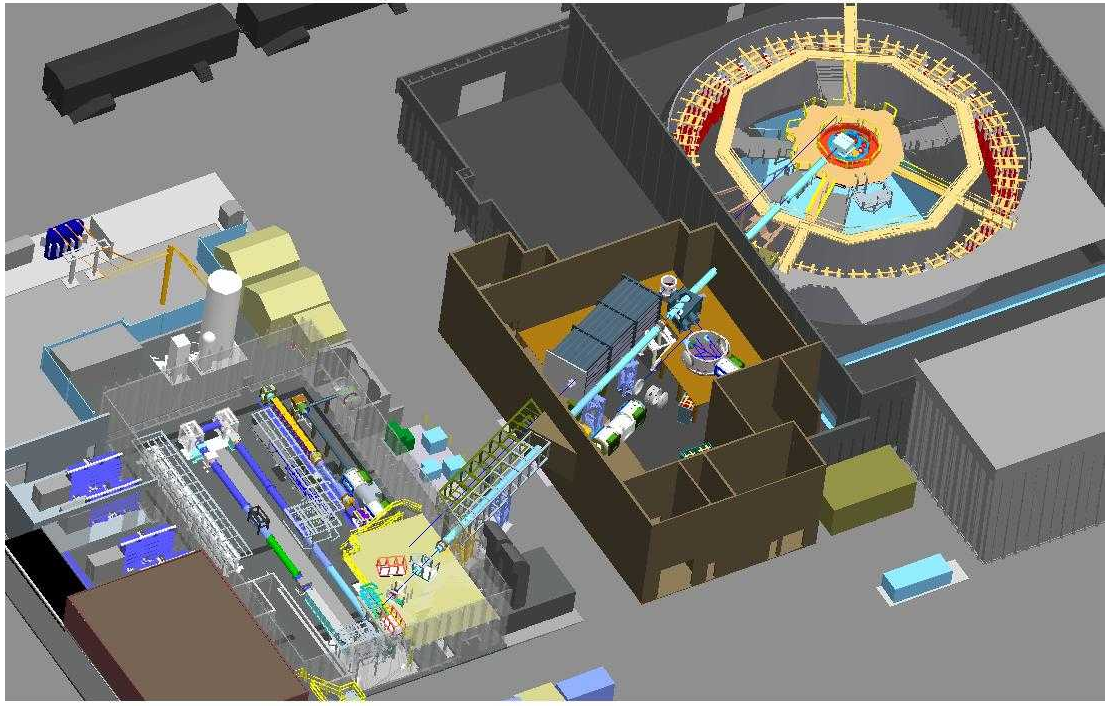
ZBacklighter



ZBacklighter

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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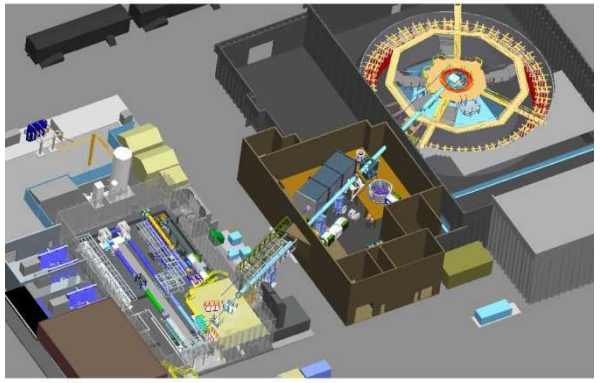
ZBacklighter Developments- ZPetawatt

- At the last ILOW meeting we showed pictures of the rebuilding of “phase C” the portion of the Z building where the new large CPA compressor was to be housed.



- The building work is now complete and the compressor chamber is installed. The installation required the removal of several parts of the ZBeamlet laser train making ZBeamlet unavailable to Z. This necessitated synchronizing the work to the refurbishment of Z.

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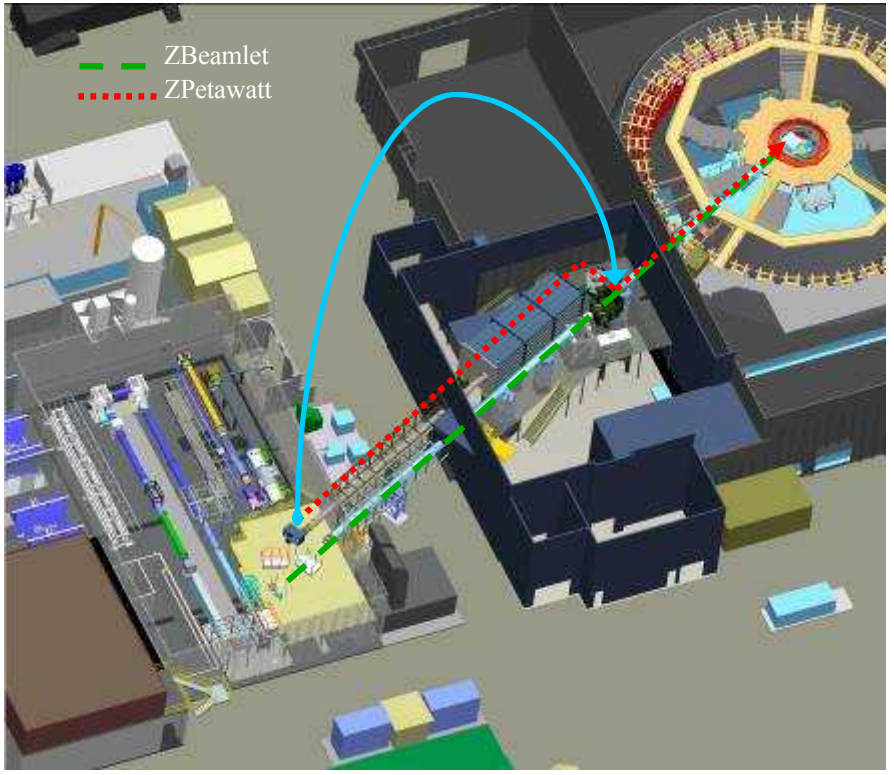
ZBacklighter Developments- ZPetawatt

- Construction work finished early this year and the optic installation is almost complete, with commissioning shots commencing soon.



- The foot print of the additional parallel beam line for ZPetawatt forced the move of the ZBeamlet target chamber over to the new area.
- Experiments in the ZBacklighter target chamber have recently restarted with a run to validate the operation of a x-ray diagnostic (gated MCP) for Z.

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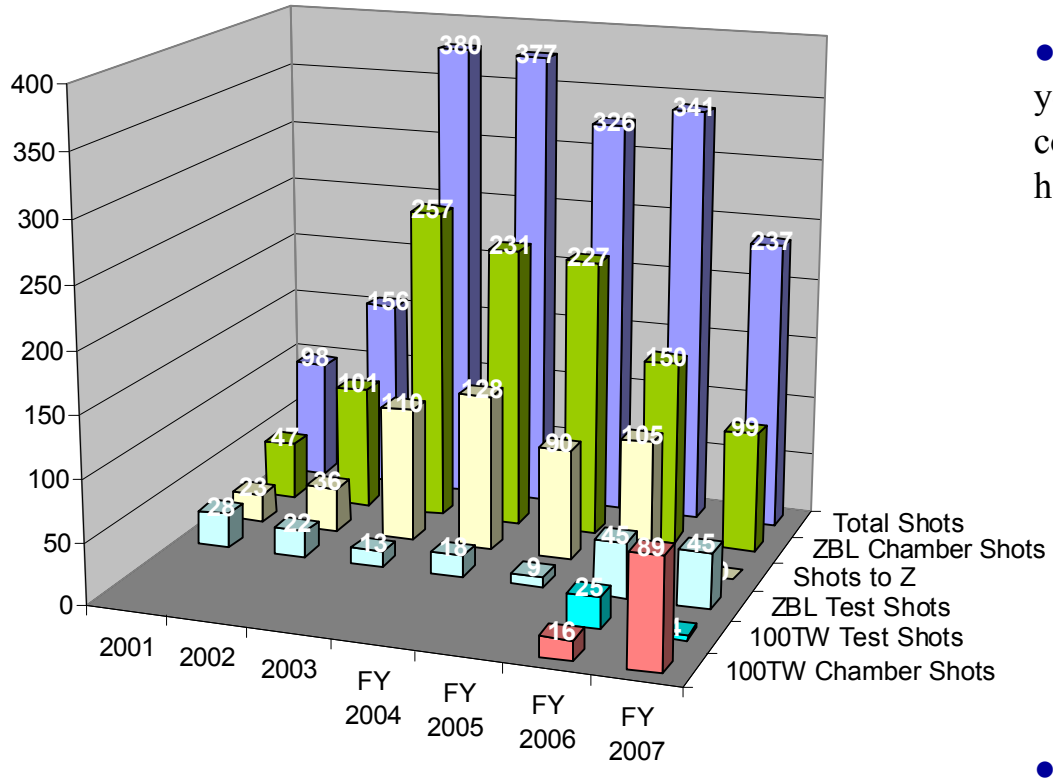
ZBacklighter Shot Statistics-Shot Numbers



- The overall shot levels have fallen this year mainly due to the amount of construction and installation work that has interfered with regular operations
  - ZBL chamber shots fell in FY06 due to the time taken to install the Multi Frame backlighting system.
  - ZBL chamber shots remained low for this year due to the relocation of the target chamber.
  - The number of shots to Z fell to zero as the Z Refurbishment project (ZR) closed down Z operations for the year.
- 100TW chamber shots have increased sharply as the system was commissioned last year and transitioned into routine operation. Although much of the systems crews efforts are now focused on ZPetawatt.

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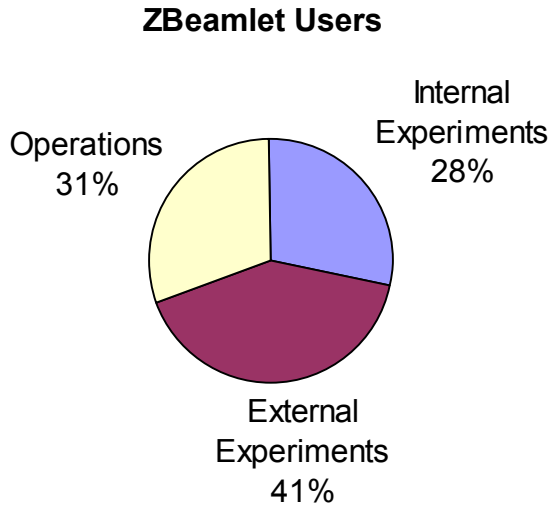
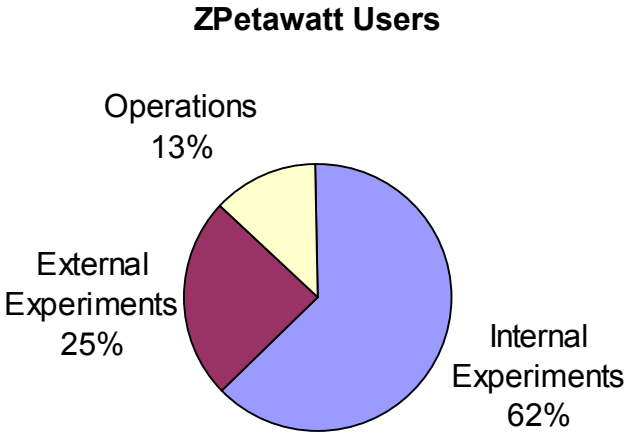
ZBacklighter Shot Statistics-Users

- With the refurbishment of Z effectively shutting down Z operations for FY2007 all ZBacklighter shots have been for other users, although many of the internal users have been supporting development of techniques or equipment for future Z experiments.





- As the final construction of ZPetawatt approaches the short pulse system concentrated on addressing backlighting and radiological issues relevant to its use with Z (the 100TW system being a small aperture sub set of ZPetawatt)

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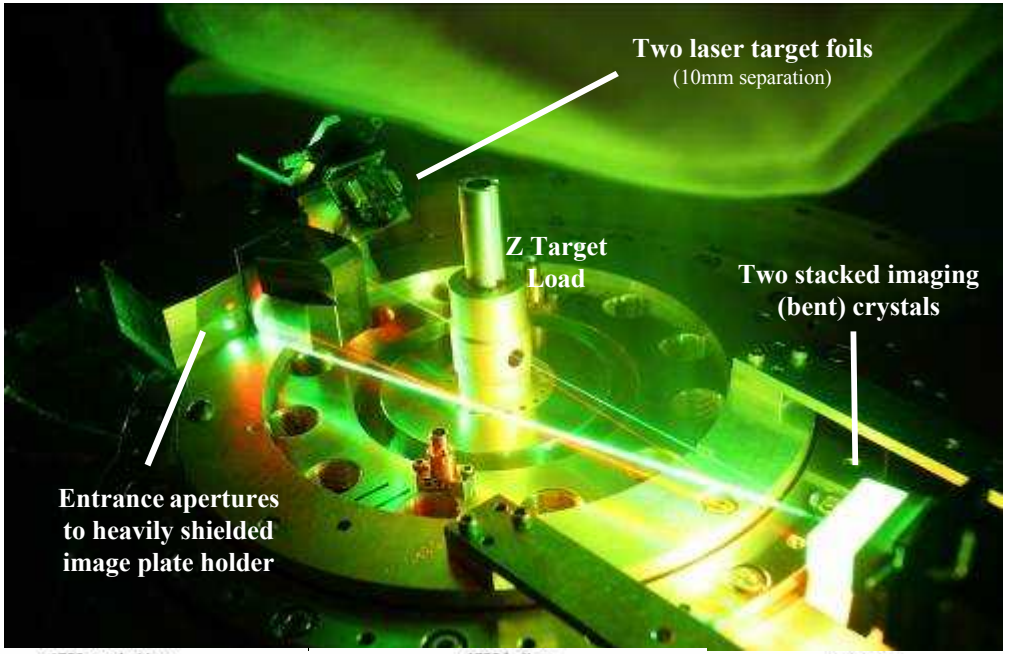
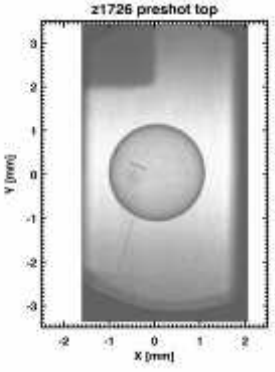
ZBacklighter Developments- ZBeamlet MFB

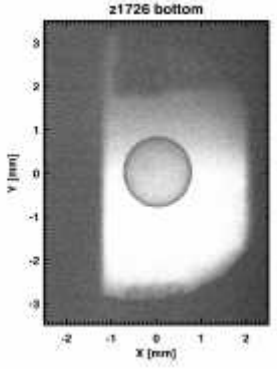
- At the last meeting we reported on the design work for a Multi Frame Backlighting system (MFB). The system is now incorporated into ZBeamlet and was used on several experiments towards the end Z operations in 2006. The success of those early shots have lead to almost all of the currently scheduled Z experiments using this system (starting in early February).

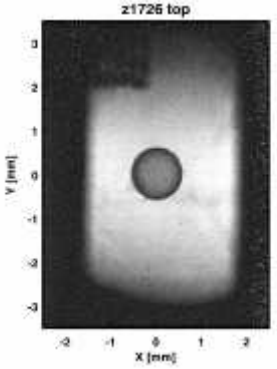
- Further enhancements have been planned including a "Two Color" approach using different foil materials and crystals in each path to efficiently image two wavelengths of x-rays.

- The 3 images to the right form a data set from Z shot #1725. The first (left) is a pre-shot radiograph, a image taken of the loaded target with ZBeamlet (without Z firing). The next two images are the two frames taken with the MFB system of the Z driven experiment with a 8ns inter frame time









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ZBacklighter Developments- ZBeamlet Upgrades

- One persistent failure mode that has been a problem for several years has been false triggers of the “fail safe” system for the 4 pass rod section of ZBeamlet.

- This fault, detection of a apparent failure of the pulsed Faraday isolator, dumps the rod amplifier pulsed power, to protect from potentially damaging back reflections.

- This problem has affected about 1 in 200 shots and has been very difficult to trouble shoot.

- We have therefore taken the brut force approach and have just received a 10 cm aperture permanent magnet isolator to replace the pulsed unit.

ZBacklighter Developments- ZBeamlet Upgrades

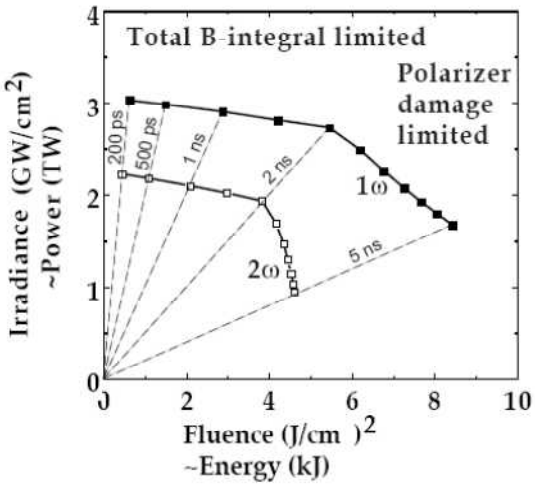
- ZBeamlet was originally optimized for working in the 0.2 to 0.5ns range. This lead to two significant design decisions;
  - The omission of pulse shaping and SBS suppression systems.
  - The reapplication of the original Beamlet frequency doubling crystal.

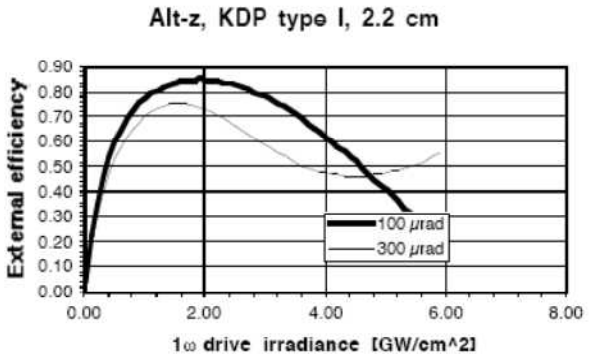
- ZBeamlet users have pushed towards longer pulses, we are now almost exclusively operating at 1ns, with some requests > 2ns.

- As can be seen from the CDR performance chart, above 2 ns the 2w output falls rapidly.

- Several alternative crystal designs where considered in the CDR. Thicker designs push the peek efficacy to lower powers and improves long pulse and multiple pulse performance. A new 2.2 cm crystal has been delivered and should be available for the MFB shots on Z in the new year.

- Along with a general modernization of the MOR, pulse shaping and SBS suppression are being installed to allow longer pulse operation. The new MOR design will act as a common platform for several lasers throughout the ZBacklighter facility.





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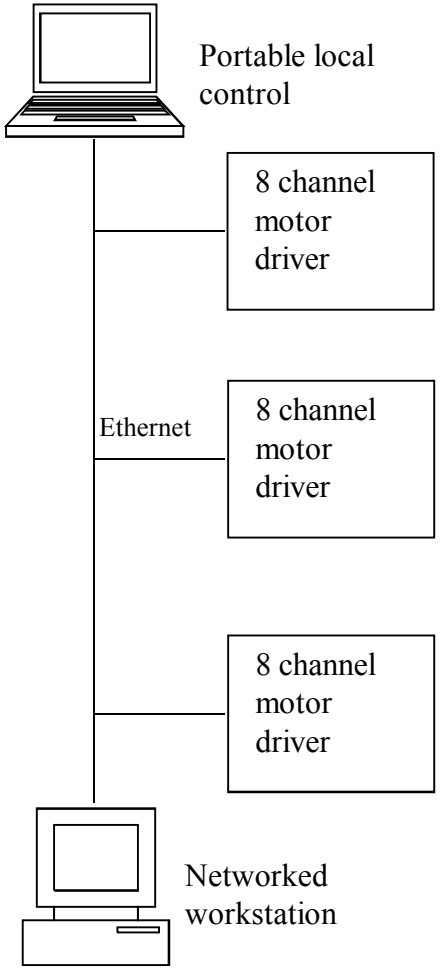
ZBacklighter Developments- Control System Update

- The development of the 100 TW and ZPetawatt systems required a large number of new controls points. To address this need a new motion control system has been developed over the last few years. The new system takes advantage of improved network communications to distribute the motor drivers throughout the laser system, shortening the motor drive cable lengths. The trade off for shorter motor cables being increased length of communication and control cables, however this is easily, and robustly, achieved using fiber Ethernet.



ZBacklighter Developments- Engineering Updates

- The ZPetawatt development has required lots of complex engineering, however a few items stand out.

- In past designs we have used commercial mounts for large optics however we have had some stability and resonance issues and prohibitive costs for vacuum preparation. These considerations lead us to design our own large optics mounts. This mount for 94cm mirrors has tip/tilt and horizontal x/z translation.

- To help with the stability of the large vacuum vessel we decided to make the internal optic tables a structural member that help support the walls of the vessel and reduce the over all flexure under vacuum. The tables are mounted from rails on the walls, for adjustability and when correctly positioned are clamped to the walls.

- Like the chamber the bulk of the tables is aluminum but they have a stainless top surface.

ZBacklighter Developments- Engineering Updates

- The tables themselves, like the mirror mounts, are fabricated from bolted plate. Bolting the structure, not welding, avoids the problem of stress deformation by the welding that would require post machining of the complete table. Skip welding would also have left the stretches of open joint very dirty and difficult to clean.

- Throughout the design of the vessel and its internals great care was used to make cleaning effective and easy and also avoiding any trapped volumes, venting all screw holes and even captive trough holes.

- This attention to detail seems to have paid off. The 163m^3 chamber, internal tables and mounts roughs to 50mT in around 1hour 30 mins the three 20”cryo pumps then get to 2e-5 in 15mins. So shot pressure can easily be reached in 2 hours. When left to pump the chamber reaches 4e-7 over a few days.

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ZBacklighter Developments- Coating Chamber

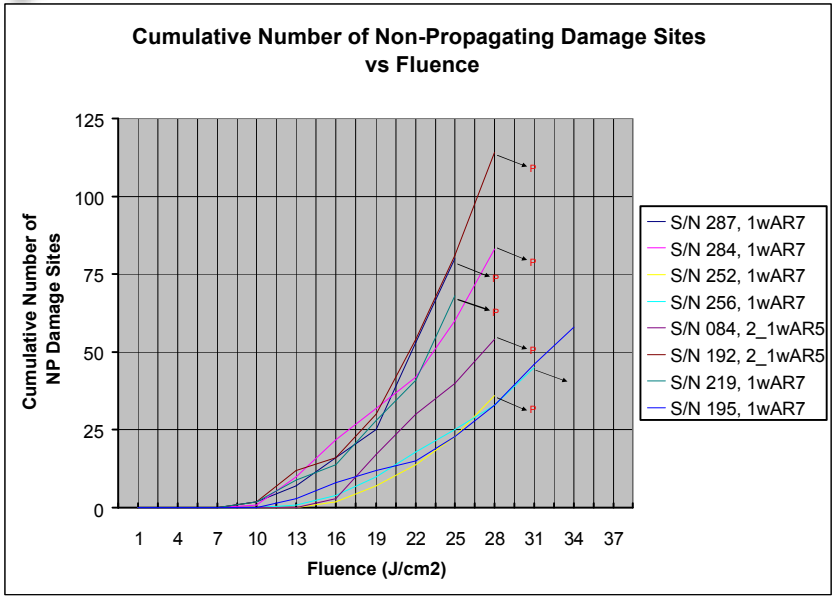
- At the last meeting in LLNL John Bellum reported on the development of a large optical coating chamber and its commissioning and installation at SNL.
- In the interim newsletter we reported on the successful coating of many AR coating required for ZBeamlet operation, mainly debris shields (42) for use with Z and some (3) spatial filter and FOA lenses for ZBeamlet, 40 to 60cm scale optics.

- Having for filled the requirements for regular ZBeamlet operation the coating efforts have now focused on the optics necessary for ZPetawatt , including 94cm truncated HR mirrors.

FY 07 Optics	30cm	60cm	94cm
ZBeamlet		4AR	
ZPetawatt	6AR & 4HR	3AR	3HR

- Including the test and development runs the coater averages around 10 coating runs per month (or a run every other day).

ZBacklighter Developments- Coating Chamber



- Independent damage testing has shown good results from the AR coatings. Using a definition of 25 cumulated damage sites (non-propagating) gives thresholds in the range of 19-28 J/cm^2 *
- Damage test results from the HR coatings have not yet come in. However several small (30cm) HR optics have been installed in the 100TW system and appear to behave well under vacuum and typical laser exposure conditions.
- The design of the HR coatings accommodates the future upgrade to MLD gratings by ensuring performance at both S and P polarizations.

- IAD coatings have not yet been performed but testing looks good. Uniform etch tests to full aperture (94cm) have demonstrated, providing confidence in the ion gun set up.

* 1064nm, 3.5ns pulse, 1.06mm spot scanned to fill 1cm^2 with 2300 shots for each of 13 levels from 1-37 J/cm^2

ZBacklighter Summary

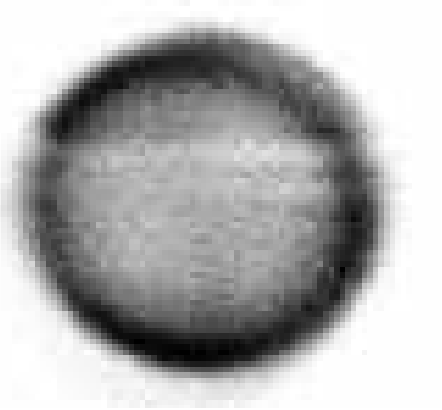
- The facility's name has been changed to reflect the expanding capabilities that have, and continue to be, added (the short pulse lasers and other probe lasers).

- We are nearing the completion of the ZPatawatt short pulse laser and are planning demonstration shots in the near future.

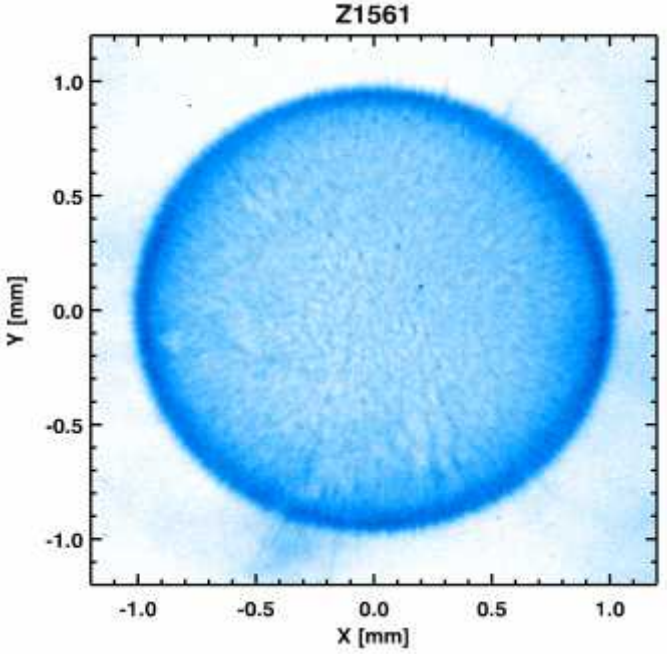
- Refinements are being made to ZBeamlet both to add flexibility (extended pulse width and multi pulses) and improve performance at its regular operating point.

- Z is come back up after a major refurbishment and improved backlighting support will be provided for up coming experiments. Continuing to improve the data quality from Z experiments.
(top capsule image from 2001, the lower from 2006)

Z-767



Z1561



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