

Vulcan Operational Statistics

A K Kidd, C N Danson

Central Laser Facility, CCLRC Rutherford Appleton Laboratory, Chilton, Didcot, Oxon., OX11 0QX, UK

Main contact email address: a.k.kidd@rl.ac.uk

Vulcan has completed an active experimental year, with 12 full experiments taking place in target areas TAE, TAW and TAP between March 2004 and March 2005. This was the second complete operational year for the Petawatt target area (TAP) and again it has proved very productive. From mid-February until the end of March, the Vulcan laser was shut down to enable improvements to the infrastructure to be made.

Table 1 below shows the operational schedule for the year, and illustrates the shot rate statistics for each experiment. Numbers in parentheses indicate the total number of full energy laser shots delivered to target, followed by the number of these that failed. The total number of full disc amplifier shots that have been fired to target this year is 878 with 52 of these failing to meet user requirements. The overall shot success rate to target for the year is 94%, compared to 90% for the previous year and 80% two years ago. Figure 1 shows the improvement in reliability over the past two years; over the past twelve months, the reliability for each experiment has consistently been in the 90-100% range.

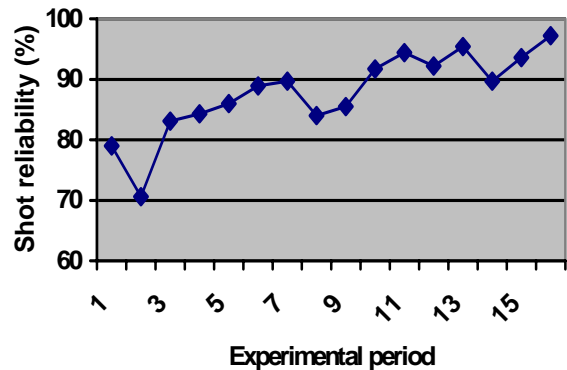


Figure 1. All areas shot reliability for each experimental period for 2002-3 (periods 1-5), 2003-4 (6-11) and 2004-5 (12-16).

PERIOD	TAE	TAW	TAP
1 Mar – 25 Apr (including overrun)	<i>I Ross</i> OPCPA development (131, 6) (95.4%)		<i>K Krushelnick</i> Electron acceleration (64, 5) (92.2%)
10 May – 4 July (experiments had staggered start)		<i>R Snavely</i> NIF (53, 5) (90.6%)	<i>Z Najmudin</i> Electron acceleration (63, 4) (93.7%)
19 Jul – 29 Aug	<i>D Riley</i> X-ray scatter (61, 6) (90.2%)	<i>M Borghesi</i> Electric fields (71, 0) (100.0%)	
13 Sep – 24 Oct	<i>J Wark</i> Shocks (97, 9) (90.7%)		<i>R Edwards</i> AWE (48, 5) (89.6%)
8 Nov – 19 Dec	<i>G Tallents</i> Opacity (61, 5) (91.7%)		<i>M Key</i> LLNL (48, 2) (95.8%)
10 Jan – 20 Feb		<i>K Krushelnick</i> Magnetic fields (117, 3) (97.4%)	<i>P Norreys</i> Solid targets (64, 2) (96.9%)
Shutdown March 2005			

Table 1. Experimental schedule for the period March 2004 – February 2005.

(Shots fired, failed shots)
(Reliability)

This was the second full year of operations for the Petawatt target area, with 5 full experiments. The total number of full disc amplifier shots that have been fired to TAP is 287 with 18 of these failing to meet user requirements. The overall shot success rate to TAP for the period is 93.7%. Figure 2 shows the reliability of the individual experimental campaigns as the year progressed. Over the last two experiments, there have been only 4 failures in 112 full energy shots (96.4% reliability).

Analysis of the reasons for failure of the individual shots enables a breakdown of these causes into specific categories. Figure 3 shows the individual failure rates for the identified failure modes, and compares these with the figures for 2003-2004. For the past 12 months, the most serious causes of failed shots are the oscillators (31 failed shots, or 60%) and alignment (14 shots, 27%). The numbers of failed shots in each category has remained roughly the same, but the major difference is the elimination of any failures due to the 9mm amplifiers. The 9mm amplifiers have been the primary cause of failure for the past two years, accounting for between 30 and 40% of all failures. The problem was targeted during the infrastructure shutdown period when the 9mm power supplies were replaced. There has not been a single failure attributable to this cause since the shutdown and this is the primary reason for the increase in overall shot reliability this year from 90% to 94%.

There is a requirement which was originally instigated for the EPSRC FAA that the laser system be available, during the four week periods of experimental data collection, from 09:00 to 17:00 hours, Monday to Thursday, and from 09:00 to 16:00

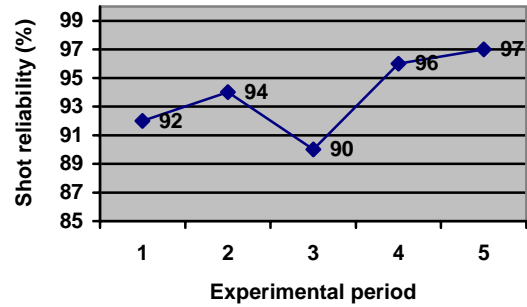


Figure 2. TAP shot reliability for each experimental period.

hours on Fridays (a total of 156 hours). The laser has not always met the startup target of 9:00 am but it has been common practice to operate the laser well beyond the standard contracted finish time on several days during the week. In addition, the introduction of early start times on some experiments has led to improvements in availability.

On average, Vulcan has been available for each experiment for 77.3% of the time during contracted hours (compared with 74.8% in 2003-2004) and 104.3% overall (103.9%). However, each experiment has also experienced an average of 5.0 hours of laser downtime. For experiments which have had an overrun, the overall availability has been on average 133.9%.

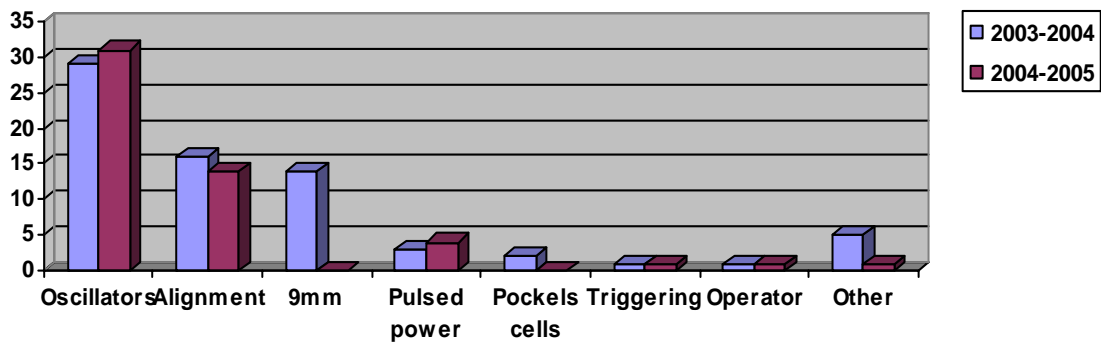


Figure 3. Comparison of Vulcan failure modes over the past two years.