

Vulcan Operational Statistics

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Vulcan has completed an active experimental year, with 14 full experiments taking place in target areas TAE, TAW and TAP between March 2006 and March 2007. This was the fourth complete operational year for the Petawatt target area (TAP).

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 1043 (an increase of 55% compared with the previous year) with 149 of these failing to meet user requirements. The overall shot success rate to target for the year is 85%, compared to 86%, 94%, 90% and 80% in the previous four years. Figure 1 shows the reliability of the Vulcan laser to all target areas over the past five years.

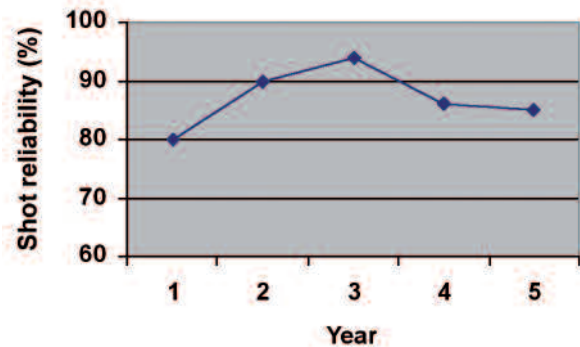


Figure 1. All areas shot reliability for each year 2002-3 to 2006-7.

PERIOD	TAE	TAW	TAP
6 March - 23 April*		<i>G. Gregori</i> Electron and heat transport (91, 12) (86.8%)	<i>M. Zepf</i> Energetic protons and ions (45, 8) (82.2%)
17 April - 30 April		Proton acceleration (28, 2) (92.9%)	
8 May - 18 June		<i>P. McKenna</i> (89, 7) (92.1%)	<i>Z. Najmudin</i> Wakefield (58, 9) (84.5%)
3 July - 13 Aug		<i>N. Woolsey</i> Stellar jets (94, 10) (89.4%)	<i>P. Norreys</i> Energy transport (57, 11) (80.7%)
28 Aug - 8 Oct	<i>D. Riley</i> (76, 11) (85.5%)	<i>O. Willi</i> EU – Proton focusing (94, 16) (83.0%)	
13 Nov - 24 Dec		<i>M. Borghesi</i> (83, 17) (80%)	<i>P. Norreys</i> (50, 7) (86%)
15 Jan - 11 Mar	<i>J. Wark</i> (125, 19) (84.8%)		<i>K. Krushelnick</i> (75, 14) (81.3%)
	<i>AWE</i> (78, 6) (92.3%)		

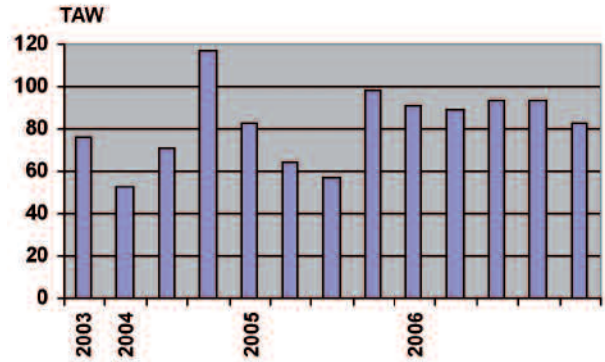
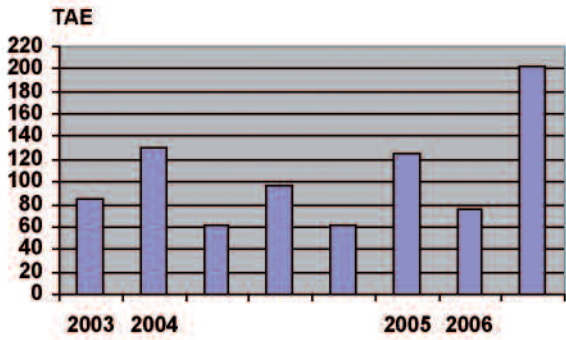
(Shots fired, failed shots)
(Reliability)

Table 1. Experimental schedule for the period March 2006 - March 2007 (*experiments had staggered start)

Although the reliability of Vulcan has dropped over the past two years, the number of shots delivered has increased to a five year high of 1043 shots (Figure 2). There are a number of reasons for this increase:

- Automatic turn-on of the oscillators at 7:30am means that the average time at which the laser is made available to users is (on average) 30-60 minutes earlier. This corresponds to an extra 1-2 shots being fired per day.

- Firing full energy shots earlier in the experiment (Figure 3).
- Operating in 'blocks' to target areas - whereby each target area has access to the laser for a 2-3 hour period.
- A full experimental programme has meant that, unlike previous years, there has not been a prolonged shutdown period.



	No. of shots	Failed shots	Reliability
02 – 03	852	172	80%
03 – 04	703	71	90%
04 – 05	878	52	94%
05 – 06	672	93	86%
06 - 07	1043	149	85%

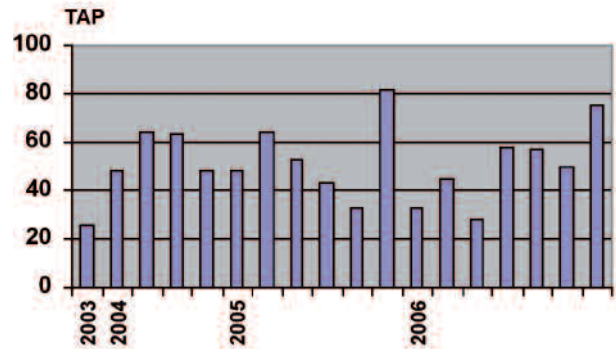


Figure 2. Total number of shots for each experiment to each target area over the past five years.

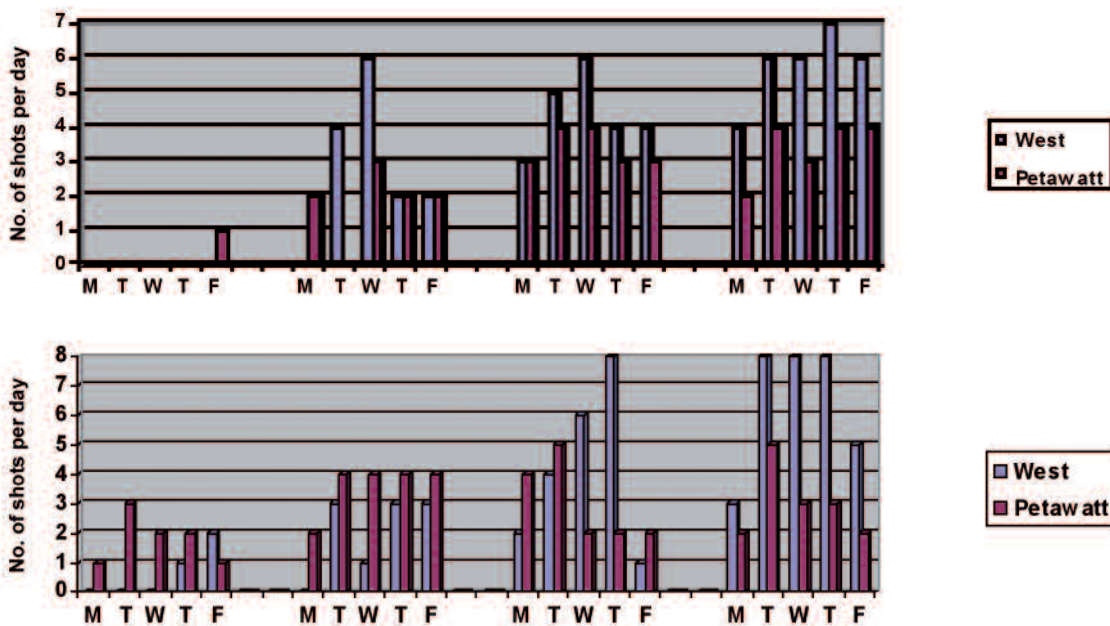


Figure 3. Number of shots per day to each target area over the course of an experiment 2004-5 (upper) and 2006-7.

This was the fourth 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 285 with 49 of these failing to meet user requirements. The overall shot success rate to TAP for the period is 82.8%. Figure 4 shows the reliability of the individual experimental campaigns as the year progressed.

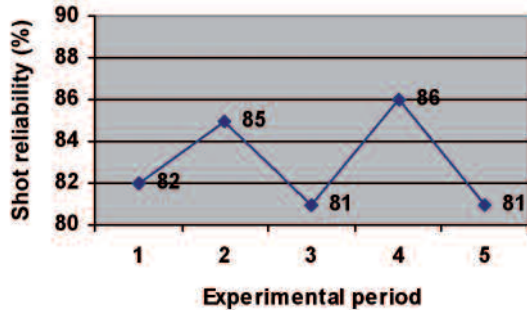


Figure 4. TAP shot reliability for each experimental period.

Analysis of the reasons for failure of the individual shots enables a breakdown of these causes into specific categories. Figure 5 shows the individual failure rates for the identified failure modes, and compares these with the figures for TAP, TAE and TAW. For the past 12 months, the most serious causes of failed shots to TAP are the oscillators and alignment of the OPCPA beam through the rod chain (46 failed shots, or 92%). For TAE+TAW, oscillators and alignment have accounted for 80 failed

shots, or 81%, of all failures). The only other significant contribution this year has been pulsed power (10% to all target areas). The dramatic improvement in the failure rate of the 9mm amplifiers due to installation of new power supplies two years ago continues with just one failed shot to either area since the commissioning. This compares with the 9mm amplifiers accounting for between 30 and 40% of all failures prior to the installation.

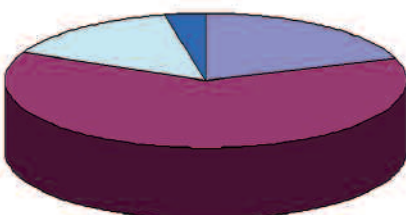
There is a requirement which was originally instigated for the EPSRC FAA that the laser system be available, during the four week periods of experimental data collection, from 09:00 to 17:00 hours, Monday to Thursday, and from 09:00 to 16:00 hours on Fridays (a total of 156 hours). The laser has not 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 continues to lead to improvements in availability.

On average, Vulcan has been available for each experiment to TAP for 77.7% of the time during contracted hours and 103.5% overall. For TAE+TAW the availabilities are 82.9% and 118.0%. These figures compare with 83.3% and 117.9% in 2005-2006 to all target areas. However, over the past twelve months, each experiment has also experienced an average of 7.0 hours during the standard working week when the laser has been unavailable, or just under one and a half hours per day (primarily this is the time taken for beam alignment at the start of the day).

TAE



TAW



TAP



- Oscillator
- Alignment
- 9mm Amplifiers
- Pulsed power
- Pockels cells
- Triggering / Timing
- Operator error

	TAW	TAE	TAP	Total
Oscillator	12	19	36	67
Alignment	38	11	10	59
9mm rods	0	0	0	0
Pulsed power	9	2	4	15
Pockels cells	0	0	0	0
Triggering / timing	0	0	0	0
Operator error	2	3	0	5
Other (inc automation)	1	1	1	3
Total	62	36	51	149

Figure 5. Total numbers of failed shots and their causes 2006-2007.