Vulcan operational statistics

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Vulcan has completed an active experimental year, with 69 set up and experimental weeks allocated to target areas TAE, TAW and TAP between March 2007 and March 2008.

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 977 with 98 of these failing to meet user requirements. The overall shot success rate to target for the year is 90%, compared to 85%, 86%, 94% and 90% in the previous four years. Figure 1 shows the reliability of the Vulcan laser to all target areas over the past five reporting years.

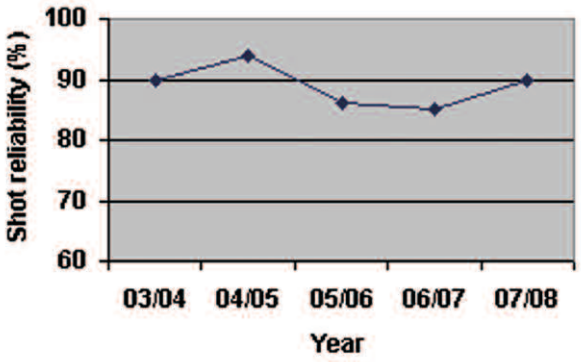
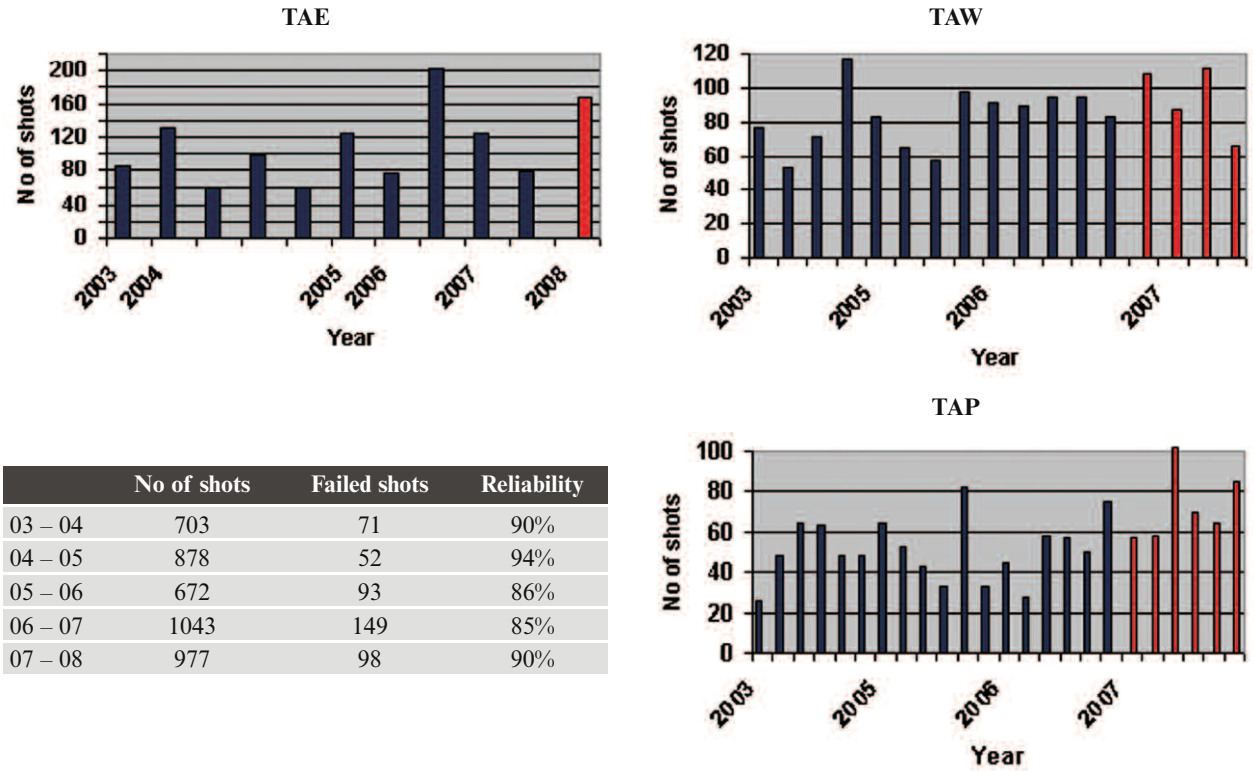


Figure 1. All areas shot reliability for each year 2003-4 to 2007-8.

PERIOD	TAE	TAW	TAP
19 March - 29 April		G. Gregori	K. Lancaster
		Ultrafast thermal radiation	*Fast electron energy transport*
		(108,9)	(57,3)
		(91.7%)	(94.7%)
4 June - 15 July		G. Tallents	M. Borghesi
		EUV lasing	*Relativistic electron transport*
		(87,16)	(58,8)
		(81.6%)	(86.2%)
23 July - 2 September			P. McKenna
			Electron transport in foil targets
			(102,16)
			(84.3%)
17 September - 28 October		Z. Najmudin	
		High Drive-Energy Laser	
		Wakefield Acceleration	
		(112,4)	
		(96.4%)	
5 November - 16 December		R. Smith	D. Neely
		High-energy scaling of cluster	*Ion acceleration studies*
		blast wave physics	(70,3)
		(66,6)	(95.7%)
		(90.9%)	
14 January - 30 March*	J. Wark		P. Norreys
	X-ray Diffraction Studies		*Fast electron beam divergence*
	(168,16)		(64,12)
	(90.5%)		(81.3%)
			R. Edwards
			AWE
			(85,5)
			(94.1%)

Table 1. Experimental schedule for the period March 2007 – March 2008 (*Experiments had staggered finish dates)

(Shots fired, failed shots)
(Reliability)



	No of shots	Failed shots	Reliability
03 – 04	703	71	90%
04 – 05	878	52	94%
05 – 06	672	93	86%
06 – 07	1043	149	85%
07 – 08	977	98	90%

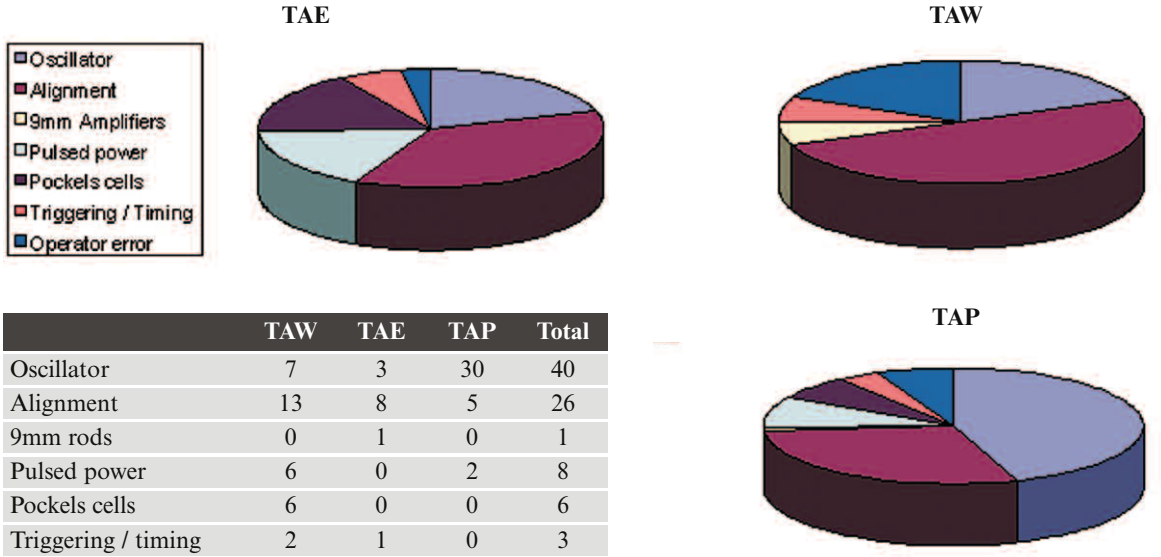
Figure 2. Total number of shots for each experiment to each target area over the past five years.

The reliability of Vulcan has increased over the past three years whilst maintaining a high shot rate (figure 2). There are a number of reasons for this increase including automatic turn-on of the oscillators at 7:30am (which means that the average time at which the laser is made available to users is earlier than in previous years), firing full energy shots earlier in the experiment and operating in 'blocks' to target areas – whereby each target area has access to the laser for a 2-3 hour period.

The overall shot success rate to TAP for the period is 89.2%, which is comparable to TAE (90.5%) and TAW (90.6%). Analysis of the reasons for failure of the individual shots enables a breakdown of the causes into specific categories. Figure 3 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 (35 failed shots, or 74%), which is primarily due to issues with the OPCPA pump laser. This was identified as an issue last year and a corrective plan implemented, including ordering a custom laser. For TAE+TAW, oscillators and alignment have accounted for 31 failed shots, or 60%, of all failures – a major improvement on last year (80 shots, or 81%). Other significant contributions this year have been due to large optic degradation which is difficult to diagnose as under vacuum, and pulsed power – rod and disc amplifiers – accounting for 8 failed shots (8% to all target areas). This compares with 15 failed shots last year and reflects improvements made to the capacitor bank.

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 target areas for 81.9% of the time during contracted hours and 120.2% overall. These figures compare with 77.7% and 103.5% in 2006-2007 to all target areas. However, over the past twelve months, each experiment has also experienced an average of 7.1 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).



	TAW	TAE	TAP	Total
Oscillator	7	3	30	40
Alignment	13	8	5	26
9mm rods	0	1	0	1
Pulsed power	6	0	2	8
Pockels cells	6	0	0	6
Triggering / timing	2	1	0	3
Operator error	1	3	2	6
Other (inc automation)	0	0	8*	8
Total	**35**	**16**	**47**	**98**

*Failed shots due to large optic degradation.

Figure 3. Total numbers of failed shots and their causes 2007-2008.