A dedicated beamline for the Petawatt facility

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Introduction

The operation of Target Area Petawatt (TAP) has been characterized by high demand and as such a fast turn around time is essential between shots and target areas. The implementation of the Petawatt Beamline[1)] was carried out in such a way that the disruption to operations of the Vulcan Laser system was minimized. This was achieved by utilizing the existing beam 8 layout with two additional sliding mirrors to direct the beam into TAP. Unfortunately, this required an apodizer to match the output of beam 8 to that required by the 208s and the sliding mirrors introduced alignment instability. During a Vulcan experimental period two target areas operate simultaneously with it being common for both Target Area West (TAW) and TAP to be using beam eight as their CPA beamline. The limiting factor determining the time between shots is the 20 minute cooling cycle of the common 108 and 150 disc amplifiers[2)]. Therefore when TAP and TAW run simultaneously one way to greatly reduce the turnaround time between areas and to increase the throughput of the laser is to operate the CPA line for TAW and TAP on different beams. This report discusses the design and implementation of a dedicated beamline to TAP.

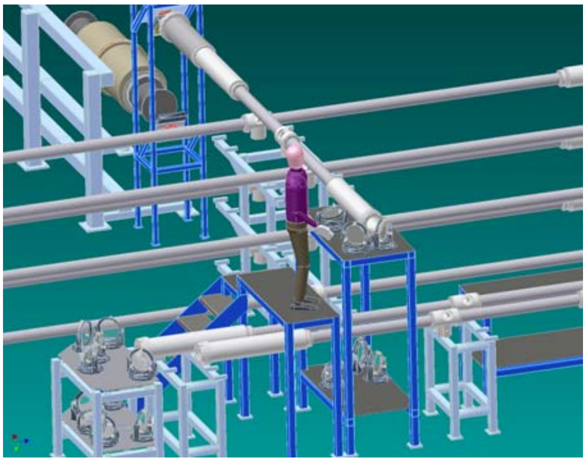

Figure 1. Three dimensional design drawing of the beamline changes.

Implementation of Petawatt beamline

The design for the TAP beamline that has been implemented is shown in Figure 1. It is novel in that it uses the vertical space available within Laser Area 3 to take the beam over the beamlines of the six-beam system. It also eliminates the sliding mirrors, so that the TAP beamline now utilizes fixed mirrors improving the alignment stability.

After passing through the 150 lower amplifier the beam is sent up to the high level by a 98% reflective mirror. The leakage of this mirror forms the diagnostics channel for the beam to this point. The beam is then injected into a vacuum spatial filter (VSF) where it was expanded to 180 mm diameter using a combination of a 2825 mm and a 3767 mm focal length lenses.

One of the major design drivers was that due to its relative inaccessibility the VSF needed a large viewing window to aid alignment. This was achieved by making one side of the centre section of the VSF a glass window. The installed pinhole assembly was also a new design utilizing vacuum compatible motors to give 25 mm of drive, which is sufficient to move the pinhole out of the path of the beam.

The collimated beam is then returned to a height of 1.3 m using two 350 mm by 260 mm mirrors. It was decided to use an existing mirror mount design for these mirrors. There proved to be issues with the alignment of the system because the heavy mirrors (~20 kg) made it more difficult to adjust the angle than expected. It was also found that there was a large degree of ‘cross talk’ between the tip and tilt motions. This is unfortunate because the lower of these mirrors is used to match the alignment between the laser and the Laser Area 4 alignment system. To solve this injection issue, alternative mirror mounts are being investigated.

Target Area East and West operations

The introduction of this beamline to TAP required alteration to the injection of the final VSFs for beams 7 and 8 for Target Areas East and West. These alterations enabled the separation of the common CPA and TAP amplifiers. This was achieved by configuring the upper back lighter amplifiers to seed beam 8 into TAE and TAW and the back lighter lower amplifiers feeding beam 7 and TAP. To maintain the horizontal polarization needed for beam 8 in TAW a half waveplate was installed in front of the TAW beam 8 shutter.

These changes to the beam 8 layout into TAE and TAW resulted in the laser pulses arriving earlier by approximately 8 ns than the previous arrangement. To reduce this timing change to 4ns an extra delay has been introduced in the upper beam.

Beam 8 into TAW has had the option of using the TAP adaptive optic to improve the focal spot quality[3)]. With the change of beam layout this will not initially be available, although a new adaptive optic has been sought. In the mean time the static aberration corrector[4)] mirror has been installed in this beamline.

Conclusion

The Petawatt Facility has had a beamline installed that should greatly reduce the possibility of near field misalignment. Thereby increasing the stability of the beamline and reducing the time required to change the laser system from one target area to another. The issues with the ‘cross talk’ of the tower mirrors is being addressed by investigating alternative mirror mount designs.

References

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