New short pulse diagnostics for the Target Area West

Contact marco.galimberti@stfc.ac.uk

M. Galimberti, P. N. Anderson, S. P. Blake, C. Burton, S. Bandyopadhyay, B. Costello, A. J. Frackiewicz, C. Hernandez-Gomez, A. K. Kidd, I. O. Musgrave, B. T. Parry and W. Shaikh

Central Laser Facility, STFC, Rutherford Appleton Laboratory, HSIC, Didcot, Oxon OX11 0QX, UK

Introduction

Within the upgrade of the Target Area West[1], it was necessary to redesign and enhance the laser diagnostics on the 2 CPA beams.

It was required as part of the upgrade to completely redesign completely the diagnostics after the new compressor, in addition we planned to improve the existing diagnostics in the laser areas (LA3) for both pulses before compression to fully characterize the pulses.

Pre-compression diagnostics

It is important to monitor the characteristics of the pulses prior to compression. For that purpose, we aimed to acquire during each shot near field, far field and spectrum in addition to energy which is routinely monitored for all beams. We have also maintained some additional lines for future development of other possible diagnostics. In addition to the shot diagnostics we need to retain the capacity to check the nearfield and farfields with the cw alignment beams.

The layout of the diagnostics that we installed in LA3 is shown in fig. 1.

Both designs are similar with the beams incident from the right. In both cases the light leaking through a turning mirror is collected using a long focal length lens.

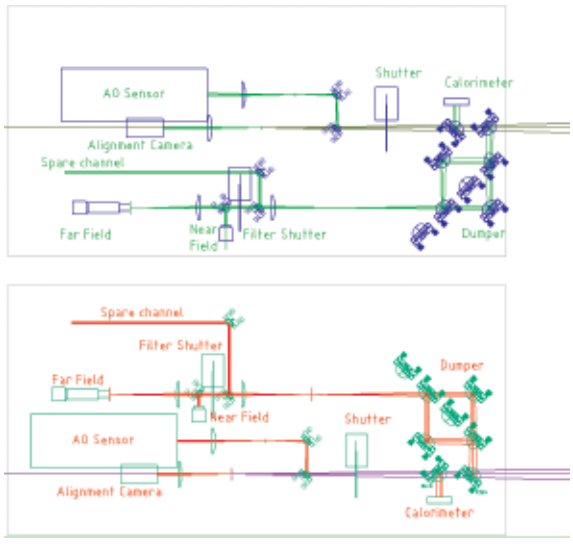

Figure 1. Pre-compression diagnostics layout.

The diagnostics in LA3 are located on a two tier table. The lower tier houses the diagnostics that have been installed for beam 8. The converging beam is incident from the right and it is split into two by a beam splitter. The transmission of the beam splitter is directed to the calorimeter and the alignment line. The reflection is directed to the on shot diagnostics.

On the alignment line we installed a line for a video camera to monitor the near field of the CW and a line dedicated eventually to a phase sensor for the deformable mirror. This beam line is protected during a shot by a nitrogen controlled shutter.

For the on the shot diagnostics line only a fraction of the light is used and most of the energy is dumped using a combination of optics. The energy dumper comprises of an arrangement of 4 mirror mounts in a square. In shot mode, i.e. the configuration shown in the figure 1, the beam was reflected by the first mirror to a glass plate, which is AR coated on the second surface. The reflected part is then directed by another mirror to the diagnostics. In CW mode the first and the third mirror are removed and the beam directly hits the fourth mirror and is redirected to the diagnostics.

After the dumper the beam was recollimated by a lens and reflected to the spare line by a mirror. The transmission on that mirror was used to take the near field and the far field images. A shutter with some neutral filters was used to avoid the saturation of the images. Currently the spare channel is used for the spectrometer.

Post-compression diagnostics

The new compressor arrangement was built on two levels in order to make best use of space, we decided to also put the post-compression diagnostics on two levels (fig. 2).

The beams are collected from two different leakages through two mirrors that are used to direct the light into the interaction chamber, one for each compressor. After the mirrors two lenses (one for each beam) are used to focus the beam down as part of a de-magnifying telescope. These two large lenses are inside the compressor vacuum chamber and the collimating lenses are located in the diagnostics table. The reflectivity of the two mirrors are 99% on beam 8 and 98% on beam 7, in order to keep the B-integral less than 1.

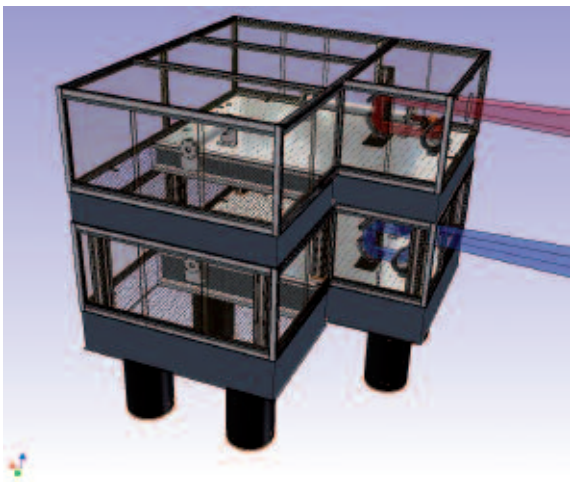

Figure 2. Post compression table arrangement.

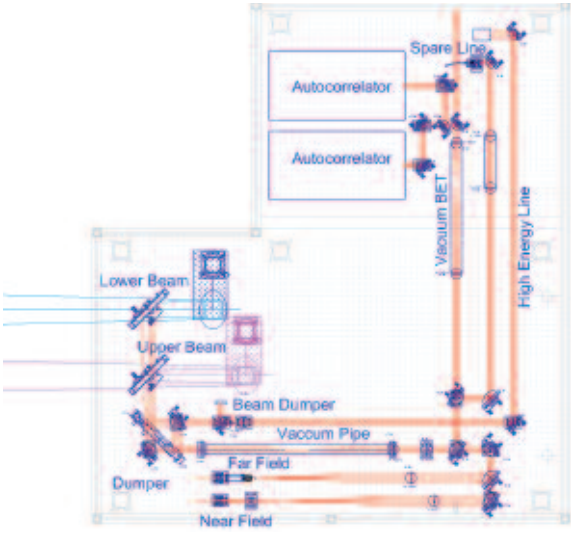

Figure 3. Post-compression layout.

Whilst the two beams had the same characteristics, we designed the diagnostics to have the same layout, except just for the first three mirrors. The used layout is shown in fig. 3.

Both tables are positioned so that they are slightly lower than the beam heights. Looking at just the lower beam (beam 7), the incoming beam from the left was reflected down and then backward by two mirrors. Another mirror directs the beam to the energy dumper. The layout of the dumper is exactly the same to the one used in LA3. However, we now collect part of the dumped beam which is recollimated by a negative lens and sent to a high energy line which is useful for diagnostics like the nanosecond contrast monitor.

The attenuated beam was focused in vacuum and then re-collimated using a negative and a positive lens. In this way it is possible to obtain a better image of the gratings and it simplifies the alignment procedure. A mirror redirects the beam to two lines, one with a relay imaging system under vacuum and the other with just a reducing beam expander. The first line is used for the autocorrelators while the second one is for other diagnostics that don't require a good quality near field, like streak camera or spectrometer.

The transmission through that mirror is used to obtain the near field and far field, focusing and reimaging the beam with some lenses.

The only difference on the upper table is that the first three mirrors are located in a different place, fixed by the position of the incoming beam.

Current status and future plan

During the first 3 experiments the diagnostics have run quite well. In this period the diagnostics in operation were primarily near fields, far fields, a spectrometer on beam 8 in LA3 before compression, a spectrometer on beam 7 in TAW and two single shot autocorrelators, one for beam 7 and one for beam 8.

The most reliable diagnostics were the near fields. However, in LA3 there has been an issue with diffused light, which is now under investigation.

With regards to the far field, there have been some issues with the limited field of view used. By reducing the magnification the issue has been partially resolved. For the diagnostics in TAW the pointing precision and long term stability are additional issues. To make the day-to-day repointing of the diagnostics easier, one or more mirrors will be motorized to allow remote control and it is under investigation the possibility to improve the point accuracy and automatic alignment system.

The autocorrelator used on beam 7 was already in use in TAW and it was working well. On beam 8 a new one was in use, showing encouraging results.

Some other diagnostics are under development, like a contrast monitor and a wide temporal window single shot autocorrelator.

Other possible improvements include use of phase sensor in LA3, more spectrometers, installation of filter wheels primarily in front of the autocorrelators, etc.

Conclusions

A new layout and improved layout for the diagnostics in LA3 and TAW was designed and implemented. These was chosen to be flexible and to allow future upgrade and to add more diagnostics.

References

1. C. Hernandez-Gomez *et al.*, *An overview of the Target Area West Short pulse upgrade*. CLF annual Report (2007-2008).