# *New front end for the Gemini facility*

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**Introduction**

Analysis of operational statistics last year showed that the oscillator and kHz preamplifier of the Gemini system were the principal causes of lost experimental time. The reasons varied from tripping of the pump lasers to instability in the energy output of the oscillator, but overall nearly 50% of the lost time was attributable in one way or another to the front end. With the increasing demand for access to Gemini, reliability has become one of the most important factors in laser operations, so it was decided to replace the front end with a more modern version.

**System choice**

A range of options for updating the front end was considered and evaluated. These included replacing only the oscillator, the oscillator/preamplifer combination and indeed the whole of Astra up to the second amplifier. None of the commercial 100mJ-level oscillator-amplifier systems could meet the required contrast specification, and they were in any case too expensive, so the decision taken was to replace the oscillator alone with a new, turn-key system (Integral Element Pro) from the same manufacturer (Femtolasers). After consultation, Femtolasers advised that instead of only buying a new oscillator, significantly better performance would be achieved by using it together with the spare Compact Pro preamplifier (purchased several years previously). Their proposal was to install a new custom-made water-cooled breadboard in the laser housing, and mount both the new oscillator and the preamplifier on that breadboard. This would offer maximum stability and freedom from the beam movement, energy fluctuations and other problems that we had experienced with the original system. The oscillator from the spare Compact Pro would be installed in a new housing with space for the Verdi pump laser, to serve as a backup in the event of a failure in the new system.

This proposal had the important advantage that the existing front end would remain operational until the new system was ready to install, as the spare preamplifier could be returned to Femtolasers for refurbishment and later testing of the complete system. It also paved the way for the original front-end system to be released for use as the primary laser source in the new R&D laboratory.

A check of the inventory of components for the spare system confirmed that everything was present, and the equipment was shipped back to Femtolasers at the end of December 2013.

**Exchanging old for new**

The new front end was delivered in March 2014, scheduled for installation early in April. The existing set-up in Astra was photographed and documented carefully before being dismantled. The Compact Pro and its oscillator plus Verdi pump laser were moved out of the Astra laser area on rolling platforms, which were low enough for the laser to be moved under the main laser tables to the door. Other components were moved separately. The laser was transported into the R&D lab and placed in its intended position on the table there.

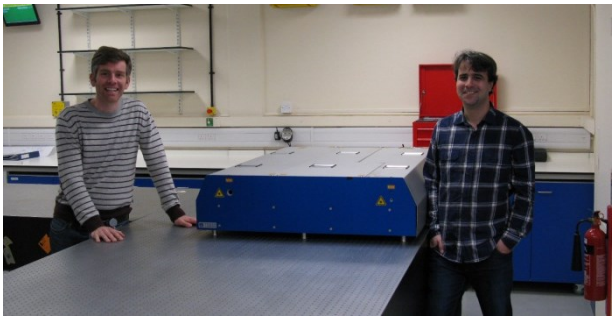

Figure 1. The former Astra Compact Pro in its new location in the R2 R&D lab.

With the space on the table in the Astra laser room cleared, the new Compact Pro (minus the oscillator) was brought to R7, moved into the Astra laser area under the main tables, and lifted into the place where the old system had been.


Figure 2. The new Compact Pro on its way to Astra.


Figure 3. The new Compact Pro in position on the laser table, with helpers.

The new preamplifier required water cooling for the breadboard carrying the oscillator and components of the amplifier itself. The original chiller used for the purpose in the previous system was very old and had become less reliable in recent years, so the opportunity was taken to replace it with a new model. The new unit was moved into the lab and plumbed into the breadboard once the laser had been positioned.

**Installation**

The installation was carried out by Femtolasers engineers over a period of three days after the new laser had been moved into place. The oscillator was delivered separately, and was fitted into position inside the Compact Pro by the engineers. During the course of the work some problems were discovered with the Compact Pro pump laser, which required a service visit to resolve. However, the front end installation was completed satisfactorily, and the performance demonstrated the expected improvements. A contrast scan of the output from the new preamplifier is shown in Figure 4 below, and demonstrates a good contrast level with no significant pre-pulses, although there is a slight shoulder on the rising edge of the pulse. It is not clear whether this is genuine or a Sequoia artefact.

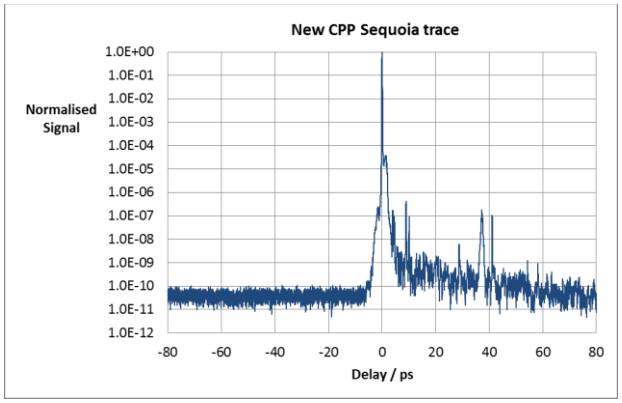


Figure 4. Sequoia scan of the new Compact Pro output.

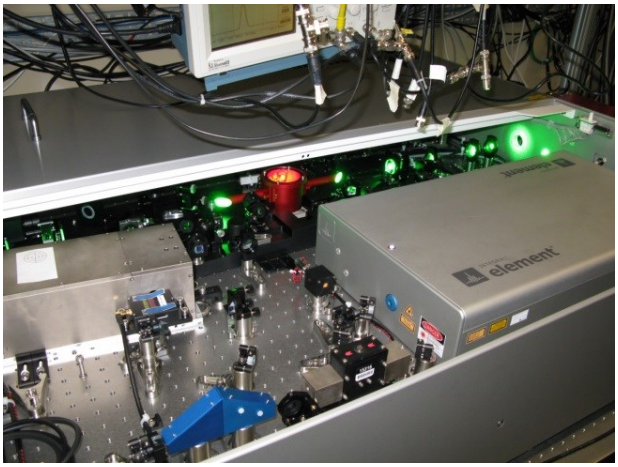


Figure 5. The Element Pro oscillator in its place inside the new Compact Pro housing.

The main difference that was immediately noticeable with the new system was the faster start-up in the mornings. The new oscillator does not require a half-hour warm-up period, unlike the old one, and this results in the laser being available to the users roughly half an hour earlier than previously. Other differences include an increased bandwidth of approximately 110nm FWHM, which in principle will allow for shorter pulses to be delivered to target provided the reduction in bandwidth due to gain narrowing in the amplifier chain can be reduced to a lower level.

**Conclusions**

The refurbishment of the spare oscillator/preamplifier was carried out successfully, and the exchange of the old system for the new one was completed on schedule. The new system is performing well and has reduced the start-up time of the laser, which is already benefitting operations. Although the new oscillator is expected to be highly reliable, we intend to set up the spare oscillator (taken from the spare Compact Pro) as a backup on a nearby table, as described above. This oscillator has been installed in a customized case with its Verdi pump laser head. In the event of a failure of the primary oscillator, the spare system will be available as a back-up to allow Gemini operations to continue with a minimum of disruption.

**Acknowledgements**

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