The Astra Gemini Project
A High Repetition Rate Dual Beam Petawatt Laser Facility

J L Collier, O Chekhlov, R J Clarke, E J Divall, K Ertel, B D Fell,
P S Foster, S J Hancock, C J Hooker, A Langley, B Martin, D Neely, J Smith, B E Wyborn
Central Laser Facility,
CCLRC Rutherford Appleton Laboratory, Chilton, Oxon OX11 0QX UK
Principle contact email address j.collier@rl.ac.uk

In July 2004, the CCLRC embarked on a 3 year long major upgrade programme to this *Astra* ultra-high intensity Titanium Sapphire laser facility. This project, known as the Astra *Gemini* Project will, by its completion in June 2007, see Astra transformed from a single beam, 10 TW system into a dual beam facility, with each beam delivering a power of 0.5 PW. It will be internationally unique. Two beams will allow access to a far wider range of science compared to the single beam facilities being developed elsewhere. Each beam will be independently configurable and focusable to ~10^{22} to 10^{23} Wcm^{-2}, some 3 to 4 orders of magnitude above the current operating point of Astra. A crucial aspect of the design is that the system will be capable of firing one shot per minute, offering a completely new experimental approach to ultra high intensity physics research.

The two 0.5 PW 30 fs pulses will be synchronised to high accuracy, and because of the use of adaptive mirrors in the amplifiers, they will be virtually diffraction limited. The expected intensities, coupled with the repetition rate of the system, mean that extensive radiation shielding will be required. The experience of operating the Vulcan Petawatt facility, and radiation measurements obtained from it, has allowed us to develop an optimised shielding design. It is envisaged that the interaction facility itself will be a large high density concrete "bunker" with 1 m thick walls and a 0.6 m thick concrete roof, housed within the confines of the new target area.

An important parameter for some of the anticipated science is optical pulse contrast. Currently on Astra the pulse peak to ASE ratio is ~10^6 : 1 which is insufficient to prevent target breakdown well ahead of the arrival of the main pulse. A new system for temporal pulse cleaning using a combination of Kerr gating and saturable absorbers recently developed at the CLF will be will be installed in the front end of the existing amplifier chain. We anticipate a contrast increase to 10^{10} : 1 which will be sufficient to prevent pre-plasma formation.

In this submission we will describe in more detail the design philosophy of this system and highlight some of the new science that we expect to be able to undertake.