Interaction chamber design for the Astra Gemini project

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Introduction

The Astra Gemini project will deliver two focused 0.5PW beams into a specifically designed interaction chamber which provides a unique environment in which to study interactions covering a broad range of experimental topics. The provisional design of the interaction chamber, reported in this document, is crucial to the project as it must address stability, vacuum, usability and radiological issues, whilst still retaining the flexibility to house a wide range of experimental arrangements.

Design Philosophy

A number of different target chambers exist within the CLF and we have tried to take into consideration all the successful ideas and lessons learned from Astra Target Area 2 and Vulcan Target Areas Petawatt and West. These ideas include[1]:

- The interaction point should be movable so it can be located to give maximum experimental benefit to each required geometry.
- Internal optics should be mounted from vibration isolated breadboards.
- Experimental set-ups should be mounted on removable breadboards to facilitate ease of external set-up and the set-up storage facility that has proved so successful in Astra.
- Good chamber experimental and diagnostic access must be available and the design must allow the maximum flexibility to meet new experimental configurations.
- The compressor and interaction chambers should be vacuum isolated using a gate valve, which can accommodate a full aperture alignment beam when access the interaction chamber is required.

Experimental Requirements

After an extensive user consultation exercise, four distinct focusing requirements for the main 150 mm diameter CPA beams were identified. These were: -

a) Maximum possible intensity (On-axis)

b) Off-axis with maximum possible intensity

c) Travelling wave line focus

d) Long Raleigh range

The target chamber is being designed to incorporate all of the different experimental target geometries. An example experimental layout can be seen in Figure 1.

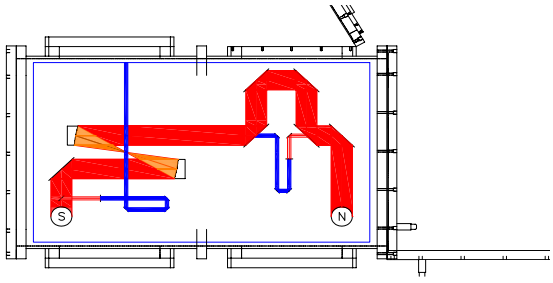

Figure 1. Opposing double sided target illumination with two F/2 beams. Potential probe options are shown in blue.

Design Details

The current chamber design is shown below in Figure 2. The rectangular structure is made from 60 mm thick Aluminium and is designed modularly in two pieces for installation.

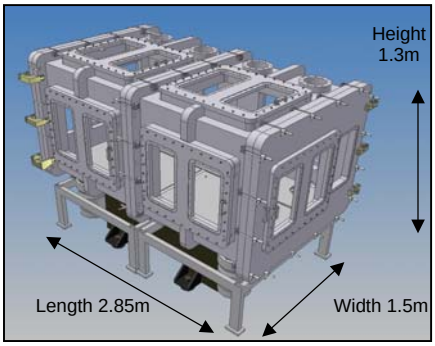

Figure 2. The current target chamber design.

Exchangeable hinged doors on each side of the chamber allow easy access for experimental set-up. These doors have been designed to mount two rectangular flanges that are currently standard to Astra TA2 and Vulcan target areas West and Petawatt.

The Gemini beams are brought into the chamber from above so as to maximise diagnostic access around the possible interaction points. Chamber centre is at 1.3m above floor level, which is standard beam height in all the Vulcan target areas. This ensures diagnostic compatibility across the facility.

The internal breadboard is located at 200mm above the bottom of the chamber. This will provide a minimum of 100mm clear space for any electrical cabling require during experiments. Low level ports for permanent electrical and mechanical connections have been included leaving the chamber doors available for experimental access and diagnostics.

Mounting and Stability

Relative movement between the two beam lines will compromise experiments where the two focal spots are overlapped. Angular vibrations of 2 micro radians between the beams will be the upper limit for such experiments. For this reason an internal breadboard will be separately vibrationally isolated by being mounted off a composite granite block to isolate vibrations from the chamber walls and vacuum systems. The chamber is designed to hold a vacuum pressure of 10^{-6}mB.

Radiological Requirements

Gemini will have the capability to fire at least 1 PW every minute so the choice of materials is extremely important in order to minimise activation of the target chamber and associated components. Aluminum has been selected as its half-life is very short-lived and so the emission will be negligible by the time experimental personnel access the area.

The new chamber is scheduled for delivery in February 2006.

References

1. Neely *et al*,. 'Astra Gemini Target Area Specification' CCLRC Astra Gemini Project Management Board (2004)