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PhD PROPOSAL 2010

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Title : Design of metrical high power Fabry-Perot cavity

Summary :

The ITER program includes the development of a neutral beam injector designed to provide 34 MW of D° at 1 Mev, which is significantly higher than those used up to now in positive ions D^+ based injector. In fact, neutralisation of positive ions by charge exchange becomes ineffective, so the plan is to prepare the energetic neutral beams from accelerated D^- ions.

Negative ions can also be neutralised by photodetachment which offers the possibility to get rid of the gas injection for neutralisation purposes. However, to reach interesting neutralisation efficiency, few tens of MW of laser power are needed.
With the injector geometry , such a power can only be reached in a refolded high finess Fabry-Perot cavity, in which the intracavity laser beam crosses the ion beam several times to cover its whole width. In the ITER conditions, the laser beam shall be 2 cm width which make the Fabry-Perot cavity close to the threshold of instability.
Therefore, the real challenge would be to control thermal effects which the mirrors coatings shall feel under the high intracavity power.
The topic of this PhD thesis belongs to a larger project aiming at the development of a new injector concept in which non neutralised ions energy is recovered to increase the whole system efficiency, which becomes possible while using photoneutralisation. The PhD student shall design an experimental device which accommodates :

- A laser system in which a master laser is modulated then amplified in an Yb doped fiber. The modulation is used to increase the Brillouin threshold which is responsible of the gain saturation. The entire frequency comb shall be resonant with the cavity. Hence, the system should be able to provide a power of 1 kW
- A few meters cavity long in which we shall load 10 MW of laser power. All mirrors shall accommodated thermal compensation systems in order to control the intracavity wave front, which will allow an optimum coupling of the energy within the cavity to reach the anticipated laser power.

This project shall be conducted within the ARTEMIS group who has a long experience in the field of high stability lasers and high power cavities. Indeed, the group is engaged in the Virgo project and more recently in the advanced Virgo project, in which the giant cavities shall undergo 1 MW laser power.
This project is conducted under the supervision of « la Fédération de Recherche CEA-CNRS sur la fusion ». The CEA involvment in the thesis is linked to the acceptation of the project submitted to ANR (Agence Nationale de la Recherche).

Skills : Atomic physics, Optics and laser, simulation…