L.11 Locking of external resonant cavity to 1064nm using HCD scheme

We have developed a frequency locked External Resonant Cavity (ERC) with a SLM 1064nm laser using Hansch-Couillaud Detector (HCD) scheme and the necessary control electronics. We also have built the SLM source laser of 50 mW of power at 1064 nm with 1.3% power stability to characterize the locking performance. The transmitted laser beam through the frequency locked cavity was used to see the locking stability. We found that the system operated for more than 1hour (1 hour and 4 minutes) with an output power stability of 0.76%. We used a home-built hybrid PI controller and a PZT driver as the control electronics for locking.

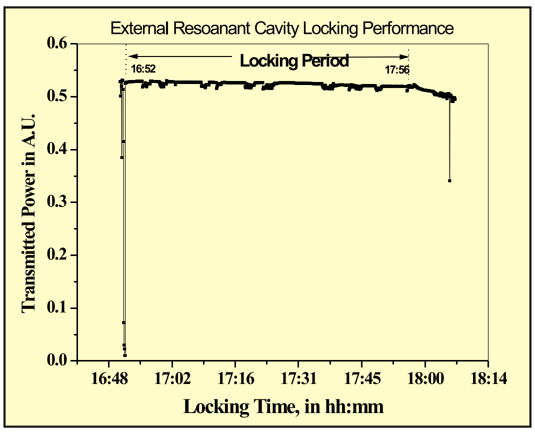

Fig. L.11.1 *Power transmission through the frequency locked bow-tie-ring ERC recorded as a function of time*

The cavity was based on Bow-Tie-Ring (BTR) cavity geometry with a Brewster plate for frequency discrimination through polarization. The BTR consists of two curved mirrors with 100mm radius of curvature (M_1 and M_2) with an inter-mirror separation of 115mm between M_1 and M_2. Mirror M_1 acted as the output coupler with 85% reflectivity at 1064nm and M_2 was HR coated at 1064nm. Two other plane mirrors (M_3 and M_4) completed the ring cavity design. A PZT was attached to the plane-mirror M_1 and other plane-mirror M_2 acted as the input coupler with 85% reflectivity at 1064nm. In order to mode match the ERC with the input beam, we matched the virtual waist outside the resonator with the input beam with a mode-matching lens. A half-wave plate was inserted in the path of the 1064nm input beam to rotate the polarization with respect to that of the ERC and hence to optimize the error voltage required for locking. The transfer efficiency of the frequency locked resonant cavity was 20%. We are trying to achieve better transfer efficiency.

(Contributed by: T.P.S. Nathan; nathan@cat.ernet.in)

L.12 End plate cutting of nuclear fuel bundle

The extraction of nuclear fuel from defective fuel bundles or from spent fuel bundles requires a lot of effort due to cutting requirements in hot cell with high level of radioactivity. Cutting with conventional methods such as mechanical, gas or plasma has their own disadvantages. With a view on Nd:YAG Laser cutting advantages in terms of flexibility, easy remote handling, long life of cutting tool and less amount of material loss, an industrial Nd:YAG laser with 200Watt average power and 30mm.mrad beam quality having dual fiber optic beam delivery configuration has been commissioned at PIED, BARC for end plate cutting of fuel bundles. This laser system with dual fiber optic beam delivery has been specifically developed with one fiber outside hot cell for optimization of cutting process and another fiber delivery with cutting nozzle has been kept in hot cell for actual cutting of fuel bundle end plates. Both ‘the fibers have 600µm core diameter and 90% transmission efficiency at the fiber exit end. The laser beam transmission through any of the fibers on time-sharing basis can be selected by means of a self-aligning mechanical arrangement of fiber coupling optics.

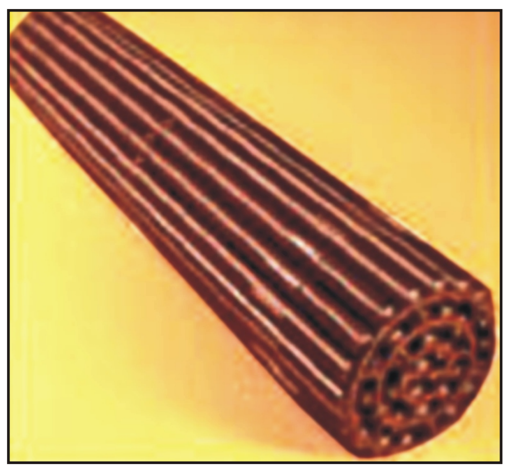

Fig. L.12.1

Fuel bundle end plates have thickness of about 2mm and fuel pins are welded at several positions with end plates on both of the sides. In order to extract fuel pins it is required to cut the end plates at several locations. End plate cutting kerf width of about 700µm with a cutting speed of 180mm per minute has been achieved with this laser system. This operation of end plate cutting of fuel bundles to extract fuel pellets is being done remotely by means of manipulators to handle the cutting nozzle. Fig.L.12.1 shows a view of fuel bundle with end plate at both the ends.

(Contributed by: T.P.S. Nathan; nathan@cat.ernet.in)