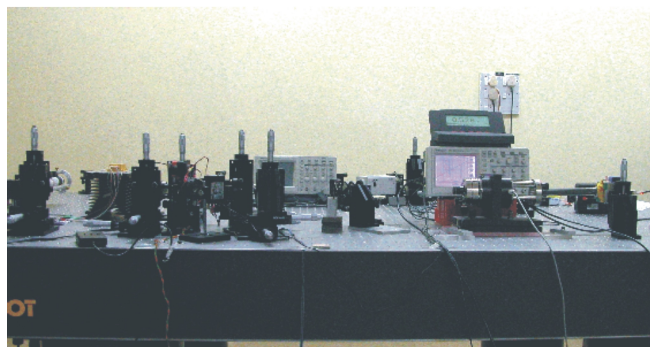


SLM output power was 535mW corresponding to an optical-to-optical efficiency of 30% with respect to the absorbed pump power.



**Fig. L.17.1** Experimental setup of DEPPSS laser operating with 535mW of SLM output power at 1064nm

(Contributed by: Jogy George; jogy@cat.ernet.in, V. Agnihotri, T.P.S. Nathan)

## L.18 Development of laser based system for cutting and welding of bellow lip of a coolant channel in a pressurized heavy water reactor

It is generally necessary to replace pressure tubes in a pressurized heavy water reactor (PHWR) after a life of around 15 years. This replacement is performed en masse on all channels with in the permissible MANREM dose. There are about 306 coolant channels in Indian PHWR which are bounded to the core of the reactor by means of two shrink fit welded bellow attachment rings, one on each face of reactor core located at a distance of about 945mm from E-face of end fittings. These coolant channels can be replaced, if the welded bellow rings are detached at the welding point on each end. This requires grooving at the welding point up to the depth of welding and then pulling the channel. Although, single point mechanical cutters, are utilized for this operation, such cutters suffer from bulkiness and entail large time consumption.

To speed up this process, a multi-port fiber coupled industrial Nd:YAG laser with 250 W average power has been developed along with fixture and tooling for coolant channel

replacement in Indian PHWR in collaboration with NPCIL. The fixture for cutting of bellow lip consists of a motorized circumferential rotary arrangement, which can be mounted on E-face of coolant channel and can be fixed on E-face just by tightening of a single screw. A miniature fiber coupled laser cutting head with 0.5 inch diameter is mounted on the fixture in such a way that it takes care of position tolerance of bellow lip and diameter of coolant channel. Fig. L.18.1 shows the fixture mounted on coolant channel for cutting of bellow lip. The time required for cutting of one bellow lip is typically 5 minutes. Using the multi-port fiber optic beam delivery, time-sharing can be utilized to further reduce cutting time. This laser based bellow lip-cutting tool has been field tested by NPCIL and found to be very satisfactory. The same fixture with a fiber optic beam delivery and welding nozzle can also be utilized for welding. The time required for welding one of the bellow lips is about 8 minutes.



**Fig. 18.L.1** Bellow lip cutting demonstration

The fixing of tool on any of the coolant channel requires about one minute and the cutting process can be controlled remotely. With this laser based cutting and welding tool, there is an enormous scope for time reduction, for en-masse coolant channel replacement (EMCCR) operations of our PHWR's. This system is being made ready for deployment for EMCCR at NAPS in 2005-06.

(Contributed by: B.N. Upadhyaya; bband@cat.ernet.in, S.C. Viswakarma, R.K. Jain, A. Chaubey, Sabir Ali, T.P.S. Nathan)