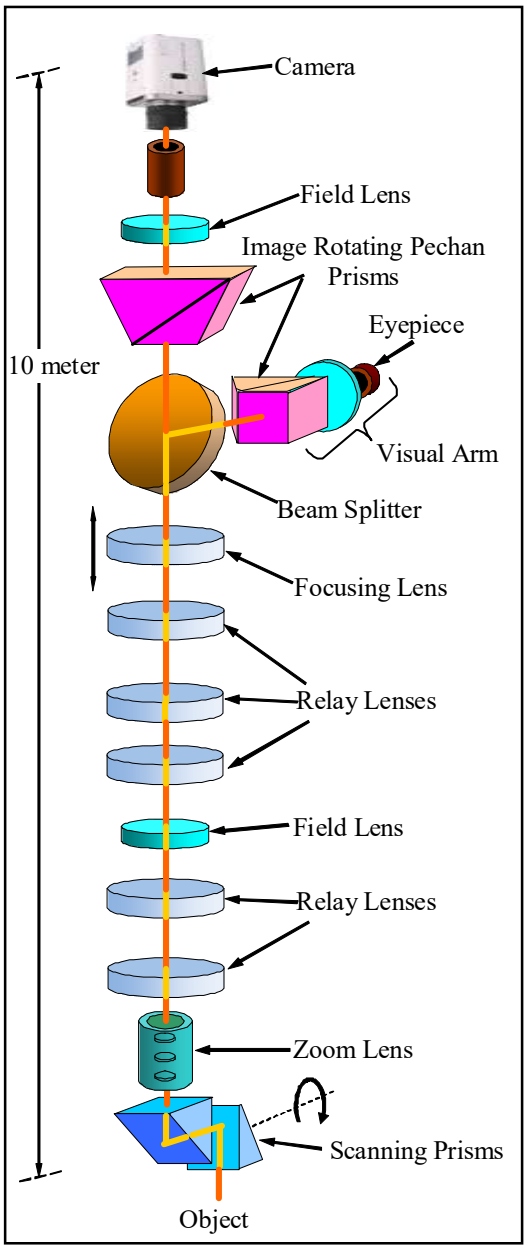
Design and development of a 10 m long optical periscope for Prototype Fast Breeder Reactor (PFBR)

A 10 meter long optical periscope (Fig. 2) has been indigenously designed and developed as a mandatory requirement for pre-commissioning and periodic in-service visual inspection of reactor vessel internals under shut down condition for Prototype Fast Breeder Reactor (PFBR) at Kalpakkam. The periscope will be used for inspection of the main reactor vessel under shutdown condition in presence of the reactor cover gas (argon). The main design features of the periscope are as follows:

- Length of the periscope: 10 meter
- Object distance from the periscope end: 2 – 4 meter
- Spatial resolution: 2 mm without zoom (3X) and 0.2 mm with zoom (9X)
- The maximum field of view: 15 arc degrees
- Operating temperature: 150 °C (Cover gas temperature)
- Object space scanning in the vertical plane: from 0° (vertical) to 115°
- Horizontal scanning: 360° by rotating the periscope on vertical axis.
- The periscope provides the facility of video recording in addition to visual inspection.
- Final image formed by the periscope is erect with no lateral inversion.

The periscope was developed in collaboration with Division of Remote Handling & Robotics (DRHR), Centre for Design & Manufacture (CDM) of BARC and Reactor Engineering Group (REG) of IGCAR.



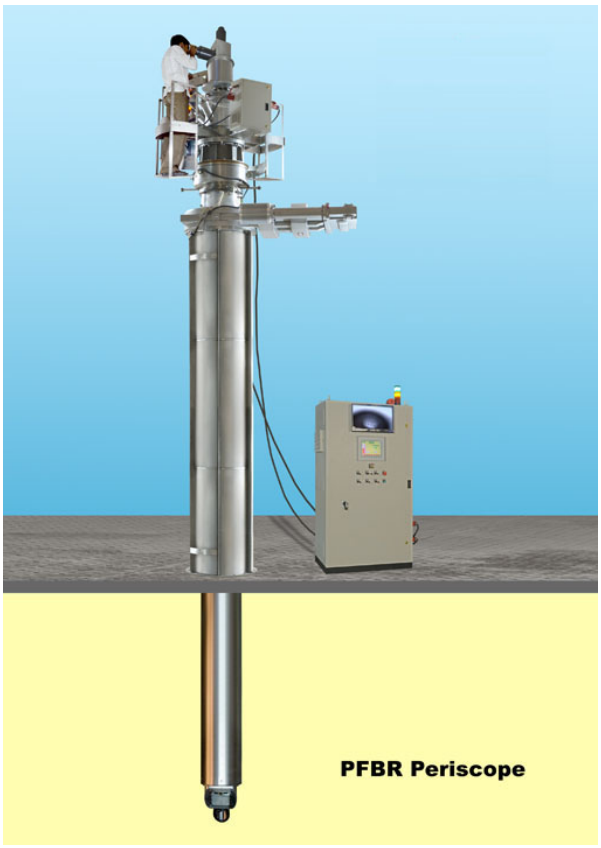


Fig. 2: (a) Optical design layout of PFBR periscope and (b) Photograph of the optical periscope

(ii) Design and development of an optical periscope for remote viewing of core of Fast Breeder Test Reactor (FBTR)

An optical periscope, shown in Fig. 3, has been designed and fabricated indigenously for viewing / photography and video recording the objects in the core of Fast Breeder Test Reactor (FBTR). The periscope consists of a scanning prism mechanism, zoom lens objective, a system of relay lenses and an eyepiece sub-assembly for viewing the objects. The objective of the periscope is a zoom lens system for obtaining a continuously varying magnification from 2X to 5X. Zoom lens objective system has a variable focal length from 100 mm to 250 mm with an aperture varying from 10 mm to 25 mm respectively. This covers a semi-field angle of 3^0 for the objective lens of focal length of 250 mm and 4^0 for the objective of focal length of 100 mm.

Two prisms of 45^0-90^0-45^0 types are used for scanning the object space in vertical direction. One prism is fixed, whereas the prism facing the object can be rotated about the horizontal axis through an angle of 110^0. The rotation of the entire periscope assembly along the vertical axis scans the object space on the horizontal plane. The combination of these two rotations is used for visual examination of the field of interest. Linear resolution of the instrument is 0.7 mm at a distance of 2.5 m for 5X zooming. Fig. 4 represents an image of a line target as viewed through the periscope.

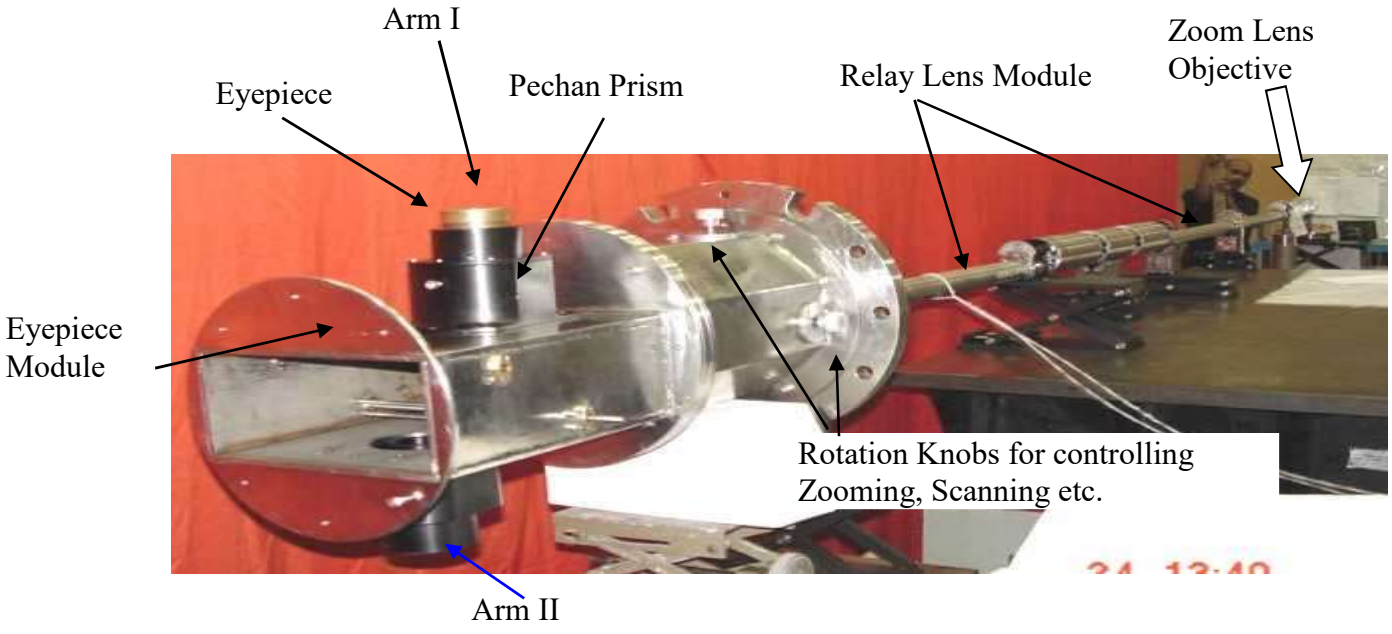


Fig. 3. The photograph of the assembled Fast Breeder Test Reactor (FBTR) periscope

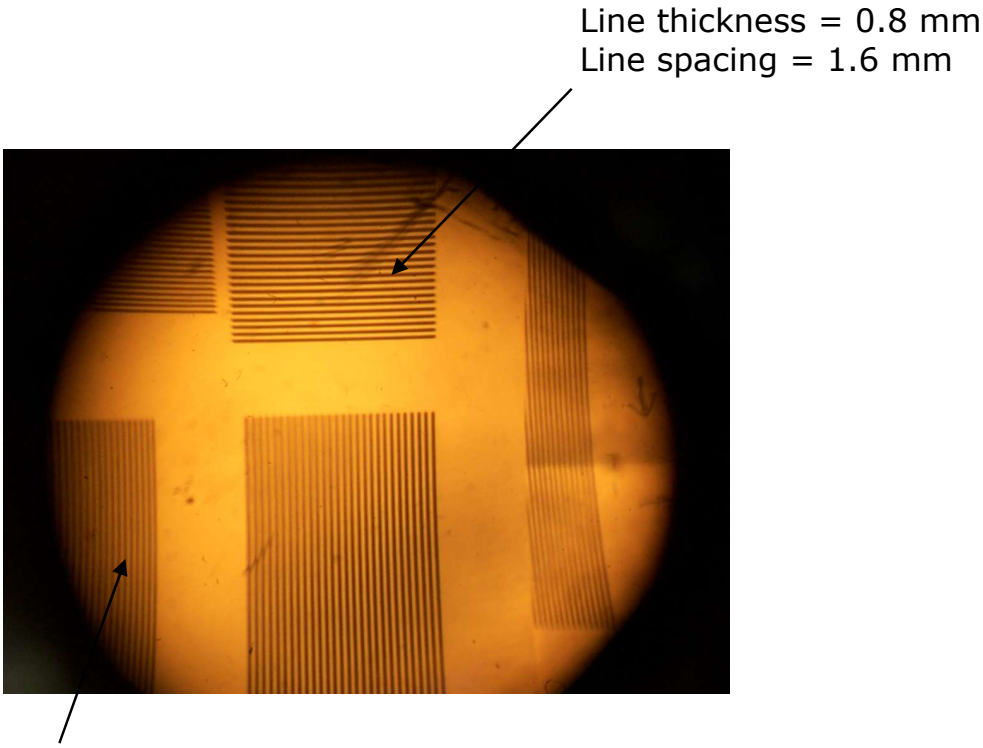


Fig. 4: Photograph of a line target as viewed through the FBTR periscope.