PROGRESS OF ECRF ANTENNA DEVELOPMENT FOR JT-60SA

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Progress of antenna development of the Electron Cyclotron Range of Frequency (ECRF) system for JT-60 Super Advanced (JT-60SA) is presented. Four antennas are installed into four upper oblique ports of the JT-60SA tokamak. Two of them are installed before the first plasma discharge (initial research phase) which is planned in 2016. The others are installed for the integrated research phase which is started a few years after the first plasma discharge. Capability of pulse length of 100 s, which requires active cooling for mirrors, and flexibility of beam injection angles in both poloidal and toroidal directions are required for the antenna with high reliability. The conceptual design of the antenna based on a linear motion (LM) antenna concept had been carried out up to 2008 [1]. This antenna is featured by a simultaneous realization of a wide poloidal injection angle range only by a linear motion of a small mirror and a reduction of the risk of water leakage in the vacuum vessel by eliminating flexible tubes for coolant. Mechanical and structural design works of the launcher (antenna and its support with steering structure) are in progress.

Figure 1 shows a model of the launcher with two waveguide lines. Here, realistic sizes of commercially available components are assumed. A port depth between the flange at the cryostat port and the stabilising-baffle plate (first wall) is about 3 m and the total length of the launcher is about 7 m. The launcher has to be installed from outside of the cryostat after assembling of the vacuum vessel, super conducting magnets, and the cryostat, and it is possibly uninstalled between operation campaigns for maintenance. Consequently, a guiding rail with the length of about 8 m is required on an inclined stage which is standing beside the tokamak independently of the cryostat and the vacuum vessel. In Fig. 1, positions of the base of the launcher, which can be moved on the rail, before and after installation are shown. The launcher is supported on the inclined stage as a cantilever. The total weight of the launcher (not including the inclined stage) is about 3 tons and the weight of the part of cantilever is about 1 ton. The weight is much smaller than that of the lower-hybrid launcher in JT-60U of which the weight was several tons and the length of the part of cantilever was about 3 m.

The key component of this launcher is the long-stroke bellows which enables to alter poloidal injection angle and a bellows which enables to alter toroidal injection angle. Using a newly fabricated mock-up of the steering structure, it was confirmed that the LM-antenna was mechanically realized for poloidal and toroidal injection angle ranges of -10° to +45° and -15° to +15°, respectively. Those angles are consistent with angles required in JT-60SA. The results of thermal and structural analyses of the launcher performed by a finite-element-method are also presented.

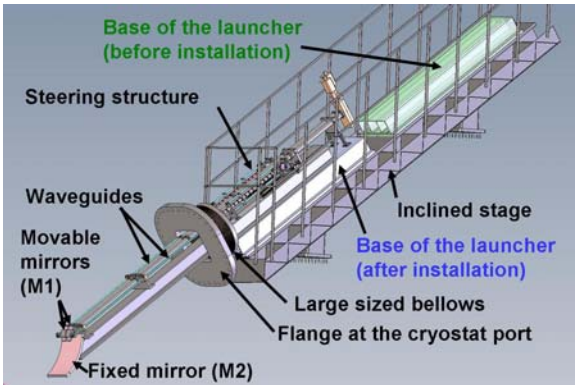

Figure 1: ECRF launcher model for JT-60SA.

[1] T. Kobayashi et al., Fusion Eng. Des. **84** (2009) 1063.