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The conceptual design for the modification of HL-2A tokamak

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The medium-sized tokamak HL-2A, based on the former ASDEX's main components has approached its rating operational parameters with Ip=450kA and BT=2.8T so far. The HL-2A was originally designed to operate under an axisymmetrical double-null configuration by two triplets of shaping coils located in the vacuum vessel. Because the shaping coils were set very close to the plasma column, the nulls are normally fixed and the plasma has a nearly circular cross-section. It is difficult to increase the parameters further and obtain a preferable plasma shape with certain values of trangularity and elongation. Due to the defects on upper shaping coils' electrical insulation, the HL-2A is presently just operated with lower single null divertor configuration. Additionally, the experiment has to occasionally terminate due to incidental damages of the weak parts. With the experimental progress on HL-2A, the plasma stored energy and auxiliary heating power is being increased, a more efficient, compact and tight divertor is needed.

Based on present status of HL-2A tokamak and for satisfying the requirements of the experiment, the modification of HL-2A tokamak device will be carried out. The modification design of HL-2A intents to obtain optimized plasma parameters, e.g., aspect ratio, Ip, b, plasma volume, certain plasma shaping with preferable elongation and trangularity, a stable vacuum vessel easy to be maintained and an advanced divertor.

The primary consideration of the modification is to take all of the shaping coils out of the vessel to enlarge the plasma volume. The elongated and triangular cross section with double null of plasma is to be obtained by composite distribution of eight sets of poloidal coils. Because all poloidal coils will be located between the TF coil and the vessel, the vacuum vessel will be remade with a smaller size to make rooms for the poloidal coil system. With an optimized operation mode, the volt-second of the plasma may be increased a little even if the ohmic coil is kept. The elongation and triangularity of plasma shape will be above 1.6 and 0.3 respectively. The plasma volume can be increased by about 30%. The plasma current IP and the poloidal beta betap will reach 800kA and 1.5 respectively. The divertor is to be changed from closed configuration to an open one.

The construction period and the cost are critically taken into account, so the TF and the ohmic coils will be kept. In this case, the HL-2A experiments in SWIP won't be paused while the new vessel and coils are being manufactured and tested off-line. So remaking a new vessel can shorten the modification construction period. The detailed calculations and analyses on the plasma parameters, operation regime, control mode, configuration, engineering feasibility, stress force, divertor, first wall material, pumping, cooling, etc. are being performed. Further physical calculation and engineering design will be stressed for better plasma performance.