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Implementation of the Spherical Tokamak MEDUSA-CR

The low aspect ratio spherical tokamak MEDUSA (Madison Educational Small Aspect Ratio Tokamak) built by the University of Wisconsin-Madison (USA) and donated to *Instituto Tecnológico de Costa Rica* is currently being re-commissioned at *PlasmaTEC*. The main characteristics of this device (renamed MEDUSA-CR) are: plasma major radius $R_0 < 0.14$ m, plasma minor radius $a < 0.10$ m, toroidal field at the geometric center of the vessel $B_T < 0.5$ T, plasma current $I_p < 40$ kA, $n_e(0) < 2.00 \times 10^{20} \text{ m}^{-3}$, central electron temperature $T_e(0) < 140$ eV, discharge duration is < 3 ms, top and bottom rail limiters, and D shaped plasma volume [1]. Although MEDUSA was initially constructed for educational purposes, some interesting topics may be addressed with it despite its relatively small size. It serves mainly to merge elementary synergic knowledge between the physics and the engineering involved in controlled plasma discharges and fusion related topics, which in turn could address relevant design concepts for spherical and conventional tokamaks safeguarding the cost-benefit ratio of the device operation [2]. Several topics were addressed on a first stage of engineering of MEDUSA-CR. A new vacuum system design was developed with a corresponding new design of a stainless-steel vacuum vessel instead of the original glass chamber. In addition, a new injection system was entirely developed and tested accomplishing MEDUSA's requirements. The possibility of upgrading the electric current control to an AC mode is being considered. Finally, MHD equilibrium simulations for MEDUSA-CR have been carried out using a free-boundary solver code named Fiesta (created by Geoffrey Cunninham from CCFE). This code allows to explore among other things, the best plasma-shaping scenarios regarding the *beta* ratio by changing the elongation and triangularity parameters [3].

References:

- [1] G. D. Garstka, doctoral thesis, University of Wisconsin at Madison, September 1997.
- [2] V.I. Vargas et al., Progress on Re-commissioning of the Spherical Tokamak MEDUSA in Costa Rica, 23rd IAEA Technical Meeting on the Research Using Small Fusion Devices (23rd TM RUSFD), March 29-31 2017, Santiago, Chile.
- [3] V.I. Vargas et al., Re-commissioning the Spherical Tokamak MEDUSA in Costa Rica, 26th IAEA Fusion Energy Conference (FEC IAEA), 17-22 October 2016, Kyoto, Japan.

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