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Engineering overview of the Fusion Research in Costa Rica: SCR-1 Stellarator and Spherical Tokamak MEDUSA-CR

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As of this day, two major magnetic fusion research projects are held at the Plasma Laboratory for Fusion Energy and Applications at Instituto Tecnológico de Costa Rica (Costa Rica Institute of Technology. The current status of both devices is summarized.
On June 29, 2016, the Stellarator of Costa Rica 1 (SCR-1) produced its first hydrogen plasma, becoming the first Stellarator of Latin America and one of the few operatives in the world. This fusion research device was fully designed, constructed and implemented in Costa Rica. SCR-1 is a 2-field small modular Stellarator (R=0.247 m, <a>=0.040 m, R/a=6.2, plasma volume ≈ 0.0078 m3, 10 mm thickness aluminum torus shaped vacuum vessel) [1]. Plasma is confined using a magnetic field of 43.8 mT generated by 12 modular coils with 6 turns each. The SCR-1 plasmas are heated by ECH second harmonic at 2.45 GHz with a plasma density cut-off value of 7.45 × 1016 m-3. Two magnetrons with a maximum output power of 2 kW and 3 kW are used. Currently, the SCR-1 is at a validation process with magnetic mapping tests, set to determine the quality of the magnetic field confinement, and the plasma shape. The different tests performed are, oscillating rod mechanism, fluorescent screen, and in house developed method combining the last two.
Furthermore, different vacuum tests have been performed on the toroidal vacuum vessel to optimize the pressure levels. Validation results for the modular coils, vacuum vessel, and an explanation of the construction process of each component are presented. Also, the design and implementation of the coils´ electric current regulator, and the acquisition and control system are detailed.
The low aspect ratio spherical tokamak (ST) MEDUSA (Madison EDUcation Small Aspect ratio tokamak), donated by the University of Wisconsin-Madison, USA. is currently being re-commissioned at Instituto Tecnológico de Costa Rica. The major characteristics of this device are: plasma major radius Ro < 0.14 m, plasma minor radius a < 0.10 m, plasma vertical elongation 1.2, toroidal field at the geometric center of the vessel BT < 0.5 T, plasma current Ip < 40 kA, ne (0) < 2 x 1020 m-3, central electron temperature Te (0) < 140 eV, discharge duration is < 3 ms, top and bottom rail limiters, natural divertor D-shaped ohmic plasmas). As part of the recommissioning process, several technical tasks are being performed, such as the re-design and implementation of the gas injection, vacuum systems, and the re-design of the coils´ electric current control system. Progress in some of these topics will be presented in this work.
References
1. V.I. Vargas, et al. Implementation of stellarator of Costa Rica 1 SCR-1, in: 26th IEEE Symposium on Fusion Engineering (SOFE), 31 May –4 June 2015, Austin, TX (USA), IEEE Conference Publications, 2016, pp. 1–6, ISBN: 978–1-4799–8264-6
2. V.I. Vargas, et al., Re-commissioning of the Spherical Tokamak MEDUSA in Costa Rica, 26th IAEA Fusion Energy Conference (FEC IAEA), 17–22 October 2016, Kyoto, Japan.

Eligible for student paper award?

No

Authors: VARGAS, V.I. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa

Rica, Cartago, Costa Rica); MORA, J. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); OTAROLA, C. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica)

Co-authors: ARIAS-BRENES, J.M. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); SOLANO-PIEDRA, R. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); ASENJO, J. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); LÓPEZ-RODRÍGUEZ, L.D. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); MONGE, J.I. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); COTO-VÍLCHEZ, F. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); ROJAS, J.F. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); ARAYA-SOLANO, L.A. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); ROJAS-LOAIZA, A.M. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); ROJAS-QUESADA, M.A. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); PIEDRA-QUESADA, N. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); BARILLAS, L. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica); SANCHEZ-CASTRO, J. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica)

Presenter: OTAROLA, C. (Plasma Laboratory for Fusion Energy and Applications, Instituto Tecnológico de Costa Rica, Cartago, Costa Rica)

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