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High Current Positive Ion Source for Copernicus NBI Based on a Cold-Cathode Arc Plasma Generator

At TAE Technologies, a next-generation Field-Reversed Configuration (FRC), known as Copernicus, is being built. The current device, C-2W, has achieved steady-state beam-driven FRCs up to 30 ms using four 15 kV and four 40 kV NBIs(neutral beam injector)[1]. In order to increase FRC performance in the next generation device, both beam energy and beam power will be increased beyond these values.
The positive ion source in development is composed of 8 arc drivers [2] and a 720x360x300 mm expansion chamber. The arc plasma initiated by the spark at the cold cathode needle tip grows up to 600 A of arc current and is emitted to the expansion chamber. The duoplasmatron type arc driver emitted highly ionized plasma jet is collisionless and travels toward the plasma grid (PG) within the expansion chamber. The arc driver can produce high proton ratio, low transverse ion temperature, and high ion current density plasma regardless of the chamber dimensions. Plasma uniformity is one of the big challenges in this type of ion source since the produced plasma naturally has a peak at the center of the driver axis [3,4]. To improve spatial uniformity especially in the peripheral region, the expansion chamber is surrounded by NdFeB magnets along the beam axis to reflect positive ions [2, 5]. For the uniformity estimation, a three-dimensional proton trajectory calculation considering the initial ion velocity was adopted and could reproduce the previous configuration. The new arc driver's layout for Copernicus has been optimized using the developed method, and the calculated uniformity is 85% over the extraction area.
In this paper, improvement of the source uniformity for the large high current ion source of Copernicus NBI and relevant diagnostics development will be discussed.
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[2] P.Deichuli et al., RSI 75,1816(2004).
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Email Address

yshimabukuro@tae.com

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Presenter if not the submitter of this abstract

Primary author: Dr SHIMABUKURO, Yuji (University of California, Irvine)

Co-authors: Mr CAMPBELL, Christopher (TAE Technologies); Dr BONDARENKO, Anton (TAE Technologies); Mr KNAPP, Kurt (TAE Technologies); Dr MATSUMOTO, Tadafumi (TAE Technologies); Dr KOREPANOV, Sergey (TAE Technologies)

Presenter: Dr SHIMABUKURO, Yuji (University of California, Irvine)

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