

Outsourcing Fusion: recruitment and retention of women

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This white paper is in response to Dr. Brinkman's charge letter dated April 13, 2012.

Regarding an assessment of priorities within and among the different elements of the US magnetic fusion energy research program, recruitment and retention of excellent scientists must be a priority.

Universities have a critical role to play in establishing a vibrant and world-leading fusion energy research program. The "outsourcing" of all (or a majority of fusion funding) to ITER or other machines abroad makes it more difficult generally to advise students, since face-to-face interactions between student and advisor are critical.

In addition to this overarching challenge for education of students that accompanies international collaborations, I also wish to call your attention to the fact that "outsourcing" a STEM field will potentially decimate the number of women scientists in that field, with the most notable impact occurring at the post-doc or early career level.

There are three points I discuss below -- Mobility, Productivity and Gender Bias - which I believe to be issues worthy of consideration by FESAC and FES when discussing the future of the field.

Mobility: A recent study found that women in science have difficulty "being mobile" as post-docs and early career researchers (Ackers 2004). The post-doc phase of one's career is arguably the most important stage for a young scientist. **If fusion research will occur outside the U.S. (especially experiment), then female post-docs will have fewer opportunities for career advancement because they are less mobile than men.**

Productivity: A study, on gender bias and discrimination (Towers 2008), found that women have to develop more socialization than men in order to be equally successful. Socialization is a measure of how connected each researcher is within the collaboration; quantitatively, it is related to the number of people with whom they typically co-author papers (Towers 2008). Towers also finds that **women must be three times more productive (productivity means more first author papers) to be as equally successful as men.** Towers also finds, that women are systematically overlooked for conference presentations; and that this has a ripple effect: limiting both socialization and productivity. **The result of off-shoring fusion would remove avenues for both male and female US scientists to socialize and to write first-author papers (especially in plasma experiment).** For men, statistically, as Towers finds, this has little to no impact on career advancement; but for women, the loss of connectedness will damage their professional advancement in the field.

Gender bias: Gender bias against women is a known issue for recruitment and retention of female scientists in the U.S. across all STEM fields (Hill 2010). Studies have identified that the workplace environment as a "masculine" and "manly" arena seems to have a large impact on the number of women in plasma physics (Pettersson 2010). One potential measure of the "equality" of the workplace environments of the ITER partners, and how welcoming these countries will be for female plasma and fusion scientists, can be taken from report "The Gender Gap" from the World Economic Forum (WEF 2011). In this report, 135 countries are ranked according to their gender equality: 1 being the most equitable and 135 the least equitable. The U.S. ranks 17. Russian Federation ranks 43. France ranks 58. China ranks 61 and Japan

ranks 98. Korea Republic (South Korea) ranks 107 and India ranks 113. The laboratories and universities in the U.S. still have problems with gender equality and gender bias. **Female scientists are likely to encounter more negative gender bias when they travel in countries and collaborate on-site in countries that are low on the list for Gender Equality.** This will hinder women scientists' ability to develop long-term (career developing) socialization opportunities, if not turn them away from the field entirely. This has the potential to further increase the difference in number of men and women in plasma physics and fusion; this is likely an issue to be considered when outsourcing *any STEM field*.

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