

## **Universities are the future for providing human capital in MFE**

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Just as in regular life, things are easy to replace, people are not. The current demographic in the US MFE community is very top heavy. In fact the announcement of the 2013 presidential budget has already had a disastrous effect and will worsen the situation. More precisely, where generally a few open post-doc positions are available at all times in the MFE community (mostly at National Laboratories), there is currently not a single opening. It is frightening to know that students, in which our community has already invested on average 5 years of time, knowledge and money, will be lost to us. The same situation exists for junior scientist positions, so not only are we losing recently graduates, but moreover we are losing people that are currently in post-doc positions.

It is time we start investing in human capital, or there will be no future. The US is in a leadership position, because of the high quality of very experienced researchers and we should not let this knowledge go to waste. We need to actively make sure that every single senior member of our community can pass on his or her knowledge to a junior member (saving us from reinventing the wheel). Universities are the only institutions that are suited to train and recruit the next generation of scientists for MFE and by advising graduate students and exposing undergraduate students to the exciting field of fusion science.

Therefore my personal view on how to address these 3 questions posed by DOE to FESAC is as follows. Note that this view is independent of what research to emphasize:

1. Assuming that we will be funded to the level of the 2013 presidential budget, I strongly recommend that funding would be prioritized based on the *potential* for human capital. Concrete suggestions are, delaying upgrades and experimental time in favor of collaborations that address ITER and burning plasma needs (national or international) and analysis of previous experiments. These cuts should allow us to minimize the loss of human capital. Although we can not discriminate against age (or any others) and we should not minimize the contributions of our senior scientists, it would be beneficial in the long run for our community if priority would be given to younger scientists. Unfortunately, we will not be able to depend on our senior scientists in the ITER area and beyond, so in order for the US to continue to being a leader in MFE research, we should not cut into programs that train the next generation of scientists. Therefore, cuts to any program where training the next generation of scientists is a priority should be limited to an absolute minimum.
2. Even if the 2013 budget would be funded at the same level as 2012 and no cuts would be made, I strongly suggest that DOE starts thinking about restructuring the budgets in order to maximize the influx of new scientists. Due to the top heavy demographics in MFE, we will be facing a strong outflow of senior scientists due to retirements in the next 10 years. Without an increased effort to attract and retain new scientists, the US will not be able to continue its national program, let alone actively participate in ITER. We need to retain the current students, post-docs and young scientists, since they will be in an ideal position when ITER becomes operational to provide leadership. They will have the experience and expertise to put the US at the international forefront of MFE research in the ITER area and beyond. They will also have the responsibility to train the generation that comes after them that will have the responsibility to make fusion power generation a reality. Currently, there is no funding opportunity that

focuses on the educational aspect of MFE research (DOE fellowships for US citizens excluded). Similarly as the NSF-DOE collaboration on basic plasma research, we need something similar that focuses on MFE, in order to train the next generation of scientists.

3. Since the only way to increase the amount of scientists is through university program, part of the increase in funding should go to universities. Other parts should go to programs at National Labs to increase the amount of young scientist positions (we need to offer the increased number of students a future in fusion). Currently, most universities that had or have a research program in plasma physics with very senior faculty are in the process of closing that program in favor of physics programs that they perceive to have a higher potential for visibility and revenue for the university. This is a vicious cycle that needs to be broken as quickly as possible in order for MFE to continue being a vibrant research field with a bright future. We need to train our post-docs and young scientists in order to be eligible for tenure-track positions, by providing them the opportunity to assist with advising of students and writing of grants. Universities need to be convinced that having a research program in MFE will be of benefit to them and this can only be achieved through more funding for university programs and prestigious fellowships/prizes for our scientists.

In short, we need to invest in human capital first and foremost and in institutions that promote opportunities for young scientists in plasma physics. Without human capital our community will not be able to reap the investments made in our senior scientists and experimental hardware.