Can Fusion Research be Revitalized by Embracing a Fission Fusion Hybrid Reactor?

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A study has recently be undertaken to re-examine the entire question of whether fission fusion is a viable approach to revitalizing fusion research in the United States[1]. This study examined not only the science and technology, but also attempted to figure out what would and would not be salable to the American government, the source of fusion research funding in the United States. Some of the conclusions of this study are

1. It is unlikely that the American Government will continue to support fusion research at the multi-hundred million dollar level per year with a goal so distant in the future.
2. Large international projects such as ITER are unlikely to be the salvation of fusion research, at least as far as the American Government is concerned.
3. The use of fusion reactors for anything but energy generation is unlikely to be salable to the American government.
4. It is very likely that fission power will make a comeback, probably in the United States, almost certainly in the world[2].
5. Fission and fusion are more likely allies than competitors.

Based on these conclusions, the idea of fission fusion was reviewed and re-examined. Some conclusions are

1. Fusion reactors can be used as fission breeders, but with a very large advantage over fission breeders. One fusion breeder can support perhaps 10 satellite fission reactors, whereas one fission breeder can support more like a single additional reactors. Any breeder is a large proliferation hazard and would have to be in a secure area with close government oversight. A fusion breeder greatly reduces the number of breeders.
2. Even pure fusion has a significant proliferation hazard in that a rogue country or reactor operator could slip ^{238}U in the blanket and breed plutonium. This potential proliferation hazard of a pure fusion reactor has received very little attention.
3. Fusion could be used to help put the world on a much safer and proliferation resistant nuclear energy cycle, namely the breeding of ^{233}U from Thorium. This could be mixed with ^{238}U in a sub-critical, proliferation resistant mixture.

4. Tokamaks are now producing about 10^{19} neutrons per second in a D-T plasma. Operating such a tokamak steady state would produce enough nuclear fuel to power a 200-400 MW fission burner.
5. A viable approach to the American fusion project could be to build a high duty cycle tokamak of the size of say TFTR. This tokamak would have a thorium blanket and a D-T plasma. Breeding ^{233}U would be an important research goal.
6. The construction of such a tokamak would mean that the fusion project would enter mainly a technology demonstration phase, rather than a plasma physics phase.
7. The tokamak might be of interest to the Navy as a producer of nuclear fuel for ship propulsion.
8. This tokamak could also be used for other purposes such as spallation neutrons, burning nuclear waste, etc. However fuel production would be its main purpose.
9. If the project is successful and captures the interest of the country, a follow on phase could be to build a much larger tokamak, say with 100 MW of beam power and Q=10. This could supply a large number of satellite burner reactors, and might be economically viable.

It is hoped that this study will stimulate discussion in the American fusion community.

References

1. W. Manheimer, Back to the Future, the Historical, Scientific, Naval, and Environmental Case for Fission Fusion, Fusion Technology, 36, 1. July, 1999
2. IEEE Spectrum, November, 1997. An entire issue making the case that fission will come back as a viable power supply.