Plasma Technologies To Build A Truly Human Society

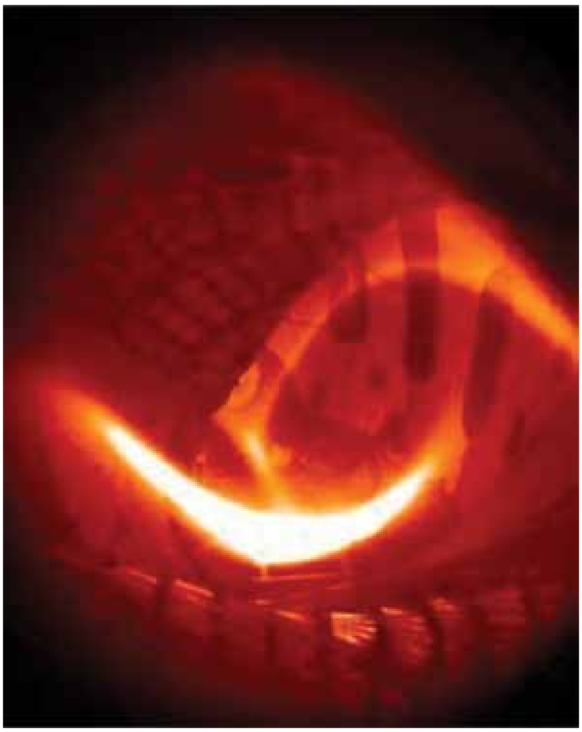
by Stephan Ossenkopp

Feb. 8—Mankind can make a leap into an entirely new world. Recent breakthroughs in German plasma physics deliver a key to open up that possibility.

The discovery and general use of technologies are activities closely related to the unique creativity of the human soul, a characteristic which separates us, in principle, from the domain of other forms of life, including apes and other highly-developed animals.

In the ever-changing course of human development, there are those critical moments when, aided by the use of technologies, man improves his environment of interaction in a fundamental way; and there are those other times, when he neglects his moral progress and falls into a state of decadence. In these latter instances it is not the technologies which are "dangerous," but the evil projects of those who abuse the power of technology to destroy.

Today we are situated in a particularly momentous time, because the technologies which powerful nations or international alliances are able to put into effect, present us with the choice of either a new and unexplored summit of our development, or of unprecedented suffering and likely self-annihilation. If we abhor the thought of our civilization ending up as a gruesome tragedy, we have to muster our strength of will to make the necessary leap into a happy future.



Max Planck Institute for Plasma Physics

The first hydrogen plasma in the Wendelstein 7-X stellarator, the fusion device at Max Planck Institute for Plasma Physics in Greifswald, Germany. This historic event, on Feb. 3, 2016, marked the start of the device's scientific operation. Wendelstein 7-X, the world's largest fusion machine of the stellarator type, will investigate the suitability of the stellarator configuration for use in a power plant.

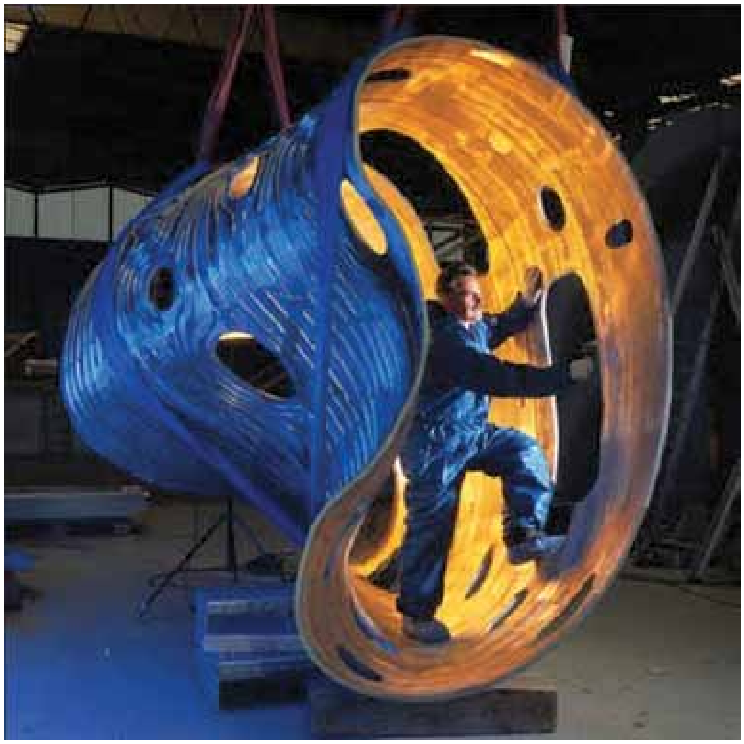
Technology of the Future

The seed of those technologies with which we are able to create our future and increase our happiness, has already been sown. The general public has just not been adequately informed about the gigantic efforts made by physicists, developers, technicians, and engineers worldwide, to thrust mankind into a new millennium of seemingly boundless opportunities. The German Physical Society has therefore taken steps to showcase some of its most advanced technical equipment to the public.

Not far from Greifswald, a small, beautiful maritime city in northern Germany, lie the extensive facilities of the Max Planck Institute for Plasma Physics, whose staff has worked for roughly ten years to build a one-of-a-kind complex apparatus. They named it simply the Research Facility for High-Temperature Plasma Physics, but it is a unique undertaking, unparalleled in the world, which was realized after intensive international discussions. The aim of this machine is to prove experimentally that the motion of extremely hot gases can be contained and controlled. A gas which is heated above a few thousand degrees Celsius (centigrade), reorganizes itself into a new state of matter called plasma. Thereby scientific man recreates an action that already exists in the universe and has been observed by astronomers, including for example in our Sun. The research facility at Greifswald will be able to keep within its experimental container a plasma of 100 million degrees Celsius, making those physical processes of nature controllable by the human mind, which are otherwise the "daily business" of the stars.

These experiments are being conducted to prove that the construction of plasma power plants, in which extremely high amounts of energy can be harvested out of the minute components of a hydrogen atom, is possible. Where there is water there is always hydrogen, a fraction of which shows a different atomic structure. These hydrogen isotopes have the characteristic that, when exposed to such a hot plasma environment, they will "melt together" the fusion process.

The fusion process gives birth to a new physical element, which in this case is helium. The crux of the matter is this: When this action takes place, a neutron is shot out of the nucleus of the hydrogen isotopes, carrying with it an astonishing amount of energy. The energy of these neutrons can be converted into heat, which can be used to put turbines and generators into motion to produce electricity. Just 80 grams of hydrogen isotopes can generate the same amount of energy as one billion grams (or 1,000 metric tons), of coal. This energy, obtainable from an element that surrounds us everywhere, has an energy-flux density 12 million times higher—when carried by the neutrons shooting out of the fused nuclei—than coal, which we have to dig out of the earth with immense physical effort, and load into hundreds of freight cars.



Max Planck Institute for Plasma Physics/Wolfgang Filser

Part of the plasma vessel during fabrication. Construction of the device in time-lapse video is shown here.

Of course, society has to invest significant resources into the realization and general use of newly discovered technologies; however, once these technologies become a common tool in our spectrum of applications, mankind enters a new world. The proper term for a mode of operation by society which consciously drives this process forward, is scientific culture, or progress.

How the Plasma Is Contained

Plasmas move in a circle in most containment devices. Nature has however somehow decreed that a plasma, bounded by its characteristics, will not choose a perfect circle, but rather a more complex, ring-shaped form. Because of its electromagnetic charge, the containment of the plasma in the vessel can be achieved by strong magnets, which will also prevent the plasma from touching the walls of the container. The Greifswald fusion project has been named Wendelstein 7-X, and its machine is called a stellarator. In a recent public presentation, its scientific director, Professor Thomas Klinger, described it as an "optimized torus with curves and bumps." He then compared the shape of the stellarator's magnetic field with that of a solar protuberance, whose ejections resemble complex curved structures, as if nature were "looking to follow a suitable magnetic field form." The shape and arrangement of the Wendelstein 7-X magnets determine the shape of the magnetic field. This guarantees that the plasma will take the optimal shape for achieving the required long-lasting stability.

Liquid helium in an oversized refrigerator called a cryostat is used to cool the magnets, so that they are super-conductive even under high voltage. A generator of 10-million watt microwaves is used to heat the hydrogen gas until it ionizes, becoming hydrogen plasma. The stellarator has a diameter of 16 meters, weighs 725 tons, and has 50 specially arranged, ring-shaped magnets, as well as 20 more flat magnets. The plasma vessel has a volume of 30 cubic meters.

This highly complex machine is being operated by specially trained personnel in a control center, whose system consists of a great number of monitors showing the temperature—approximately minus 270 degrees Celsius—and the electrical current—about 13,000 Amperes—in the magnetic coils. Other monitors show the state of the vacuum pump and the security system.

In July 2015, a series of tests of the magnets was successfully completed. Further experiments confirmed that the computer-simulated magnetic field lines and the actual field lines in the machine were congruent. After some readjustments by the engineers, the first test plasma was produced on December 10, 2015, when about one milligram of helium was fed into the evacuated plasma vessel. On Feb. 3, the first hydrogen plasma was produced, which marked the start of the series of scientific investigations which will run until 2020. The aim of the final tests will be to produce a stable hydrogen plasma for 30 minutes without interruption. A visibly excited German Chancellor Angela Merkel (PhD in quantum chemistry) pushed the button to initiate a 60-second countdown sequence, after she spoke about the need for fundamental research and scientific breakthroughs as a basis for a progressing living standard. The audience on Feb. 3 was made up of many leading scientific, industrial, and academic institutions, including a representative of the U.S. Department of Energy, which had contributed $20 million to this enterprise.

Project Stellarator

Initially there was a lot of controversy surrounding the stellarator concept, says project director Professor Klinger, because the first models and tests with the optimal shape of the magnetic field were a failure. Almost all the laboratories in the world "threw their stellarators in the garbage," he continues. Only the "stubborn Germans" and the Japanese continued their research. The mathematics and physics of the complex systems were extraordinarily difficult, until faster computers made the simulation of their magnetic field lines possible.

Today it is generally acknowledged that it was right to pursue parallel scientific avenues, and not to abandon the development of the stellarator, despite all the setbacks, because it offers advantages when compared with the other major fusion device, the doughnut-shaped Tokamak model,— such as the continuous operation of the plasma. Says Klinger: "We had split from the commonly available concepts for the magnetic coils. Then we looked into the computer and asked what the shape of the magnetic field should be, for one that the plasma actually would like to have. We got the result, and calculated backwards to determine the shape of the magnets. We don't have to call into question the shape of the magnetic coils any longer, because they are now determined by the physics of the plasma."

The construction of the buildings in Greifswald began in 1996, and the first magnet was delivered in 2004. Between 2005 and 2013, all of the approximately one million parts of the system were assembled, the coils were tested, and the final welding was done. With costs a little higher than one billion Euros, the stellarator is an official major project of the German industrial and scientific community. Most of the 200 engineers, 200 physicists, and 60 additional staff are driven by idealism and excitement about this project, says Professor Klinger. Eighty percent of the financial support came from federal and local state funds, and only 20% from the European Commission.

Some international experts claim that this machine could only have been built by Germans with their "clockmaker mentality," as their distinctive sense of precision is whimsically labeled. Nevertheless, the Wendelstein 7-X is not a particular German path, but an international lead project, where scientists from all over the world will be working.

A New Paradigm

The stellarator is a groundbreaking concept, which poses a fundamental question to us: Will human civilization seize this opportunity to turn wholeheartedly towards rational progress, or will we end up in certain tragedy by dismissing or even refusing it altogether? The reorganization of of our productive economy to the level of a plasma-fusion based economy, demands of us a dramatic shift to an entirely new direction in our cultural outlook. We have to let go of a society driven by irrational entertainment and anti-technological hysteria.

Plasma research will open up the possibility of an unprecedented thrust of innovation in machine-tool design, micro-electronics, medicine, and many more fields of activity which still have to be defined. The "green technologies" with their extremely low energy-flux density have maneuvered our society into an obvious dead-end. We have to force nothing less than a complete change in paradigm, while all of our popular convictions, which have gotten us into this mess today, have to be brought into question. A broad and open discussion about this must be initiated now, because this is about the future of our human species.