Civil and military nuclear power: related research

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The development of nuclear power in France is the result of political choices that have established a close link between military research and research on civilian applications. The consequences of this link are numerous and have led physicists to question their role.

The development of civil and military nuclear power in France is closely linked. From the outset, particularly throughout the history of the CEA, the study of nuclear physics has developed through the constant interaction between basic research and industrial, civil and military applications[(a)]. Even today, civilian nuclear research is still tackling some key problems whose solution is of interest to the military in order to improve, diversify and better control their nuclear arsenal. Similarly, military research on nuclear weapons is seen as dual-use by policy-makers, i.e. it should have benefits for civilian research, not just nuclear, as well as for industry in general (particularly, but not only, the arms industry). As such, the State gives a substantial budget to the military, justified to the people by claiming that part of it is used for civilian research, and boosts our industry through technological excellence[(b)]. This was the thrust of two recent parliamentary reports [1, 2].

Many overlaps

In addition to the in-depth knowledge of nuclei and nuclear reactions, many research fields are common to both military and civil nuclear power. Examples include isotope separation, waste treatment and equipment dismantling, safety and cyber security issues, sustainable fuel supply, miniaturization of components, understanding seismology, etc. Nuclear medicine has long benefited from better resourced military equipment, in particular regarding the supply of radioactive products from enriched weapons-grade uranium. Similarly, the military has

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benefited from the expertise of nuclear doctors for the radiation protection of soldiers and public health in nuclear test zones. Today there is justification for cooperation in the medical field because of the impact of so-called dirty bombs and depleted uranium weapons.

There has always been a cross-fertilization of knowledge and innovation back and forth between civilian and military applications of nuclear power. For example, it is likely that the potential near doubling of the budget for nuclear deterrence (from 3.5 to 6 billion euros per year), due to the dismantling and modernization of nuclear-powered ballistic missile submarines, will have repercussions on civil nuclear research and industry. The 2016 parliamentary report [1] details the industrial duality in many areas, for example in ballistics, with the parallel between the Ariane program and the M51 missile.

The example of the "Simulation" program

To illustrate the duality within the world of university research, we can take as an example the « Simulation » program. Since France committed itself to no longer causing nuclear explosions by signing the Comprehensive Nuclear Test Ban Treaty (CTBT), it has been improving its equipment through simulation[c]. It has equipped itself with supercomputers: the Tera 100 was co-developed with the CEA's Military Applications Directorate (DAM) in 2010, then the Tera 1000 in 2017 and an even more powerful one is expected by 2023. These are used to test and numerically verify certain theories involved in the operation of nuclear bombs and missiles. The "Simulation" program, managed by the DAM, is based on data taken during past explosions. It is also based on new data taken using a very high-powered laser, the MegaJoule Laser (LMJ) recently built in Bordeaux. By focusing a beam of light energy of more than a million joules on a target of a few millimeters in a few billionths of a second, matter is transformed to a state comparable to that of an atomic bomb.

The Center for Scientific and Technical Study of Aquitaine (Centre d'Etudes Scientifiques et Techniques d'Aquitaine, CESTA), like its American and British counterparts, respectively the National Ignition Facility (NIF) and the Atomic Weapons Establishment (AWE), with its Orion laser is available for academic research purposes. It has an entirely smaller-scale civilian laser facility, PETAL, which cost 54 million euros, compared with 3 billion euros over 15 years for the LMJ. Its purpose is to acquire knowledge on laser-matter interaction and plasmas for research related to astrophysics, such as stellar plasmas, or civilian energy using fusion. According to those responsible for academic collaboration at NIF and AWE, who have more experience than at the LMJ, this cooperation is mutually beneficial [3]. The military benefits from fresh perspectives and new ideas from the facility on a small part of their work, the rest being "military secrets". Academics are able to use the laser equipment of the military center of Bordeaux, but only for about 10% of the time. This complements the powerful lasers of the laboratory of the École Polytechnique (the LULI) in Palaiseau.

Do we need a nuclear weapon?

One may wonder about the relevance of dual technologies for nuclear power. Wouldn't it be much more efficient to directly finance the needs of civilian research and industry in the nuclear field (as is the case, for example, in Germany or Japan, which do not have nuclear weapons), without having to resort to crumbs of military funding? Moreover, military nuclear power may cease: the 2012 Senate report on the "future of French nuclear forces" [4] already stated: "If we had to design a new army format from scratch today, it is highly likely that the need to acquire a nuclear strike force [...] would not be part of our defense ambitions." The dual system of research funding is only justified if we want to develop nuclear weapons, which is a political decision. However, there are political reasons for the decline and eventual cessation of funding for nuclear weapons in view of the recent Nuclear Weapons Treaty that the UN opened for States to sign in July 2017.

Some scientists, including ourselves and the global Pugwash [5] movement, do not want civilian nuclear research to contribute directly to military applications. They also believe, along with the International Campaign to Abolish Nuclear Weapons (ICAN), the 2017 Nobel Peace Prize winner, that nuclear deterrence is not a lasting solution for world peace. They are aware of the risks associated with the development of these weapons, which are increased through the risk of their proliferation, computer hacking, maintenance accidents or the outbreak of nuclear war through misunderstanding [6], or by the creation of small "dirty" bombs from radioactive materials, etc. Not to mention the horror and immorality that a nuclear war, even a small one, would represent. ▮

References

1. « Les enjeux industriels et technologiques du renouvellement des deux composantes de la dissuasion », National Assembly Report No. 4301 (December 2016).
2. « La nécessaire modernisation de la dissuasion nucléaire », Senate Report No 560 (May 2017).
3. See examples of cooperation in: « Bilan 2015 des publications et de la vie scientifique de la Direction des applications militaires », Chocs Avancées, **10** (June 2016).
4. «Rapport d'information sur l'avenir des forces nucléaires françaises », Senate Report No. 668 (July 2012).
5. J.Bordé, N.Delerue, A.Suzor-Weiner, « Pugwash: les physiciens, l'arme nucléaire, la responsabilité des scientifiques », *Reflets de la Physique* **43** (2015) 51-53.
6. On the very many past technological accidents involving nuclear weapons and the false alarms that nearly triggered nuclear wars see, for example, J. Villain, « Le livre noir du nucléaire militaire », Fayard (2014).

a. See the article by H. Bercegol (p. 34).

b. It should be noted that the military sector is pushing to develop systems with superior technical requirements but which go beyond the requirements for civilian use (the average person's car does not need to meet Formula 1 specifications).

c. The parliamentary reports referred to above state that "the fact that France has a high-performance computing sector is due to deterrence".