Superlaser Development in Germany

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"Superlasers," also called "petawatt lasers," are ultrapowerful lasers with intensities higher than 10^{19} W/cm^2, and powers up to 1000 TW = 1 PW (i.e, one petawatt). Such lasers are capable to generate nuclear reaction directly, i.e., they can directly fission heavy nuclei such as uranium, initiate thermonuclear fusion reactions, create antimatter, generate intense well-focussed ion beams, etc.

The invention of the superlaser, which enabled a factor of one million increase in the instantaneous power of table-top lasers, is possibly the most significant advance in military technology of the past fifteen years. This increase is of the same magnitude as the factor of one million difference in energy density between chemical and nuclear energy.

Superlasers have many actual and potential applications in nuclear weaponry, either offensive (in warheads)[1] or defensive (in warhead/decoy discrimination systems for ballistic missile defence).[2]

The whole subject of superlaser research and development is presently a domain of very intense activity. In the past few years, new institutes and specialized laboratories have been created in several countries. For example, the Max-Born-Institut für Nichtlineare Optik und Kurzzeitspektroskopie (MBI) in Berlin Adlershof, Germany. All the most advanced industrialized countries have now superlasers with powers of at least 10 TW in operation, and 100-1000 TW superlasers under construction (see Table 4.1 in the report *Fourth Generation Nuclear Weapons*).

In Germany, the atomic and plasma physics departments of GSI Darmstadt have started a petawatt high-energy ND:glass laser project – PHELIX – as a joint venture together with the Lawrence Livermore National Laboratory and the Max Born Institute in Berlin. Offering pulse energies up to 5 kJ in nanosecond pulses or alternatively petawatt peak power in pulses of less than 500 femtoseconds PHELIX will be among the world leading superlaser facilities.

Since Germany is a non-nuclear-weapon state, it is politically very disturbing that PHELIX will be built in collaboration with the Lawrence Livermore National Laboratory (LLNL), and that there will be a "cooperation agreement" between GSI and LLNL that will be similar to those LLNL has with the French and British nuclear weapons laboratories.

These events can be seen as very dangerous steps towards post-nuclear weaponization of Germany, and a reminder that the possibility of building fourth generation nuclear weapons in any technologically advanced countries is a reality.

In the following overview, a few comments are made on four documents, two of German and two of American origin. It is troublesome to see that in the two American documents Germany is listed as the prime foreign partner of LLNL for the development of superlaser technology.

1 A. Gsponer, J.-P. Hurni, *Fourth Generation Nuclear Weapons*, INESAP Technical Report No.1, seventh edition, Darmstadt, 2001.

2 A. Gsponer, *U.S. National Missile Defense: Looking at the whole package*, Science, 28, 8 September 2000, p. 1688.

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1 *PHELIX design report*, December 1998.
Document GSI-98-10, December 1998, is the basic design report describing the German project PHELIX to build a 1-5 kJ, 0.5-10 ns, petawatt superlaser at GSI.
The "cooperation agreement" between GSI and Lawrence Livermore National Laboratory is mentioned on page 60.

2 *First PHELIX Status report*, March 2000.
The GSI Annual Report 1999 (Document GSI 2000-1, March 2000) p. 203-204 contains a number of details on the ground-breaking ceremony of the PHELIX superlaser on December 7th, 1999, the month that the construction of the laser building has started.

3 *Science and Technology Review*, March 2000, p. 3-12.
The cover story of the March 2000 issue of the Lawrence Livermore National Laboratory magazine Science and Technology Review is dedicated to the LLNL superlaser named Petawatt that was the most powerful laser in the world between 1996 and 1999.

In the abstract (back cover page), the commentary by the Associate Director for National Security (page 3), and the main article (page 12), the word Germany appears three times, and each times at the beginning of a list of country names ("Germany, France" etc. and "Germany, England" etc.) with which the Lawrence Livermore National Laboratory is collaborating on superlaser science and technology.

4 *Science and Technology Review*, May 2000, p. 25-27.
The LLNL superlaser Petawatt was closed down in May 1999. Superlaser research at LLNL will continue with JanUSP. Although JanUSP has only a fraction of the power and energy of Petawatt, it will enable research begun on Petawatt to continue in a different regime of laser matter interaction, until one (or several) new much more powerful superlasers will be installed on one (or several) beamlines of the National Ignition Facility (NIF).

JanUSP is open to researcher from other nations. However, Germany is the only country cited on p. 27 as an example.