The Frontier of Ultrahigh Power Lasers in Europe
「欧州における超高出力レーザーの最前線」

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Around the world ultrahigh intensity lasers have been planned and developed of late. This is particularly the case in Europe. Since the first TW laser[1] and first multi-10TW laser[2] it took only several years to witness the first PW laser[3]. The fs PW laser emerged in 2003[4] and ever since then there have been many PW-class lasers. The science of high fields[5] is driving this development, such as laser acceleration[6),7] and fast ignition[8]. The world organization ICUIL (International Committee for Ultrahigh Intensity Lasers)[9] was founded in 2003, reflecting such a scientific trend.

Europe is taking leadership in the recent years to extend this frontier beyond PW and even toward EW, dreaming about the physics of EW (and ZW) high fields[10]. The high field science of atoms and chemistry ensued, followed by that of plasma. We are now scoping the physics of nuclei and even vacuum by intense lasers. Simultaneously ultrafast science has developed, now transiting from fs to as[11]. The high field science and ultrafast science are intertwined, as it was discovered that the pulse duration is directly proportional to the inverse of the pulse intensity, i.e. in order to make the pulse shorter, one must increase the laser intensity[12].

At the forefront of European high field science projects is that of Extreme Light Infrastructure (ELI)[13]. This is in addition to numerous national centers of intense lasers in Germany, France, UK, Italy, Sweden, Spain, Poland, Czech, Greece, Russia, etc. To begin with, ELI is the first multi-10 PW laser endeavor. It should usher in the first multi-10 GeV electron acceleration as well as the first dedicated nuclear physics experiments based on lasers. Furthermore, its billion dollar facilities encompass three pillars of Czech Republic, Hungary, and Romania, all former Eastern Block countries of Europe and first major scientific installations east of Elbe (except for Russia). This means that not only the high field science is rapidly propagating to Eastern Europe, but also it symbolizes the rapprochement of the Cold War and reconciliation in that part of the world, a significant development of world science and politics. A catchphrase "Youngman (and woman), go East" has been invented. This development should be remembered as a shining example of an international goodwill inspired by scientific cooperation. The bug seems to be spreading further, as Russia is now proposing a laser facility beyond 100PW (approaching EW) in XCELS[14]. (This might constitute as the fourth and final pillar of ELI).

It should not escape our attention, however, that Europe is also dedicating itself to the technology development of high average power (and high efficiency) lasers with high intensity. The consortium of CAN (Coherent Amplification Network)[15] has developed the method of coherently adding short pulses of fiber lasers that are inherently of high repetition and highly efficient to turn them into a more intense coherent pulse[16]. Such lasers enable the realization of a future high luminosity high energy collider[17] and other fundamental physics applications; the slow but steady confluent tendency of the interests of laser and high-energy physicists is evidenced, for example, by the participation of Professor Peter Higgs in the recent IZEST Conference (2012)[18]. These lasers, furthermore, open the door toward a variety of societal impacts. This is because many of such applications need both intensity and a large number of photons at an affordable efficiency. For example, CAN laser-driven gamma rays may be able to develop nuclear pharmacology and to provide a portable diagnosis devise for the exposed spent radioactive isotopes (Fukushima).

Finally, we note that these significant developments have been espoused by the spirit and hard work of European pioneers. At the same time these were spurred by the societal vision of Europe to make laser as one of the cornerstones of their future science and high technology supported by the innovative policy advancement scheme (such as ESFRI). The world cannot afford not noticing their initiative.

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