Canadian Nuclear Society – Société Nucléaire Canadienne

E-mail: yelmorb7@nrtco.net, Website: http://www.cns-snc.ca

"Supporting nuclear science and technology for 25 years"
"25 ans de promotion de la science et de la technologie nucléaires"

November 9, 2009

Dear Canadian Researcher,

Greetings! My name is Blair Bromley. I am a Member-at-Large on the national council of the Canadian Nuclear Society (CNS). Recently, I volunteered to assume the role of the chair of the **Fusion Science and Technology Committee of CNS.** Due to various reasons, including the general downturn in Canadian participation in research and development (R&D) in fusion science and technology within the international community over the last several years, this committee has become dormant, to point where consideration has been given to disbanding it altogether. However, we would like to re-vitalize it.

Considering the long-term potential and value of the development of fusion energy, it is vital that there be a sustained effort to preserve and hopefully grow the fusion S&T knowledge base and R&D activities in Canada. Such sustained activities will help contribute to the eventual development of fusion energy as a power source to complement others.

It is realized and fully understood that the goal of developing fusion energy is apt to be very difficult and long-term, as it has been for the last 60 years. Making continual progress towards reaching that goal will depend on long-term public support and private investment. It will also likely require more collaboration between nations on existing and potential future projects.

Therefore, I would like to invite you to become a member of the CNS Fusion Science and Technology Committee, a broad network through which researchers and entrepreneurs across Canada can continue to communicate and exchange ideas and information in long-term support of developing fusion energy in Canada.

As a member of this committee, you will get out of it what you put into it, as it is a purely volunteer activity, but we may have the opportunity to make a long-term difference by re-building and growing fusion research in Canada. Shown on the following page is a short list of tentative goals for this committee. Perhaps you might like to help contribute to achieving one or more of those goals as part of a group effort.

If you would like to be a part of the ***CNS Fusion Science and Technology Committee,*** please contact me. If you know of a colleague who might be interested, please forward this letter to them.

Thank you for your time and consideration. I look forward to hearing from you soon.

Sincerely,

Blair P. Bromley

Dr. Blair P. Bromley,
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Tentative Goals of CNS Fusion Science and Technology Committee

(Last Update: November 9, 2009)

1. To develop a position paper by the CNS for long-term Canadian strategy for Fusion S&T R&D.

2. Encourage Canada-wide participation and sharing of information on research in fusion, plasma physics, and related sciences and technology through participation in technical sessions / conferences at Canadian Nuclear Society annual meetings (yearly or every 2nd year), or at other meetings co-sponsored by the CNS.

3. To promote Canada-wide co-operation and collaboration between universities, various research laboratories, and private companies.

4. To get co-sponsorship with various societies (e.g. Canadian Association of Physics, etc.)

5. To provide resources / information to all stakeholders (e.g. federal and provincial governments, universities, industry, associations, societies) to encourage their long-term, continued and sustained support on Canadian R&D in fusion science and technology.

Supplementary Information and Commentary

Blair Bromley: Who Am I?

For those of you who don't know me, let me tell you a little about myself. I have a B.A.Sc. in Mechanical Engineering from the University of Toronto (1993), an M.S. in Aerospace Engineering (1998) and a PhD. in Nuclear Engineering from the University of Illinois at Urbana-Champaign (2001).

While working on my masters and doctoral degrees, I studied plasma physics and fusion technology (eg. electromagnetic confinement systems, inertial confinement, alternative concepts, etc.), and did my dissertation research on particle-in-cell (PIC) direct simulations of inertial electrostatic confinement (IEC) fusion neutron devices, along with some work on other alternative fusion concepts, such as the dense plasma focus (DPF) and Penning Traps. I spent a number of summers while I was in graduate school working in the plasma physics groups (T-15, P-24) at Los Alamos National Laboratory (LANL), where some exploratory work was being done on Magnetized Target Fusion (MTF).

I have had a long-term interest in fusion energy, probably dating back to when I was in high school, and was contemplating the energy supply and power systems needed for deep-space propulsion systems.

Today, I work in the field of nuclear fission, as a reactor physicist at Atomic Energy of Canada Limited (AECL) – Chalk River Laboratories. The reality for me has been that there is more commercial and government financial support to further develop and improve nuclear fission technology, which has been a proven success for generating economical electricity with a relatively low environmental impact. However, I still maintain an interest in the long-term development of fusion energy.

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A Qualitative Review of Fusion Science and Technology

Many of you may recall early predictions of "commercial fusion power plants within 10, to 20, to 50 years", and this statement has been repeated for the last 50 years. It would now seem that there is no definite time frame for if and when fusion power plants will become a reality. Clearly, it is quite probable that there are many remaining physics and engineering obstacles to overcome in fusion science and technology before the ultimate goal of fusion-based electric power plants become a reality.

Many research groups at various universities and laboratories across the world have been working over the last several decades on developing various fusion concepts, many which since have been abandoned due to limited progress and success. In a numbers of situations, there was a failure to meet early expectations and promises, many which were grossly unrealistic. These failures were followed by the subsequent drying up of funds to carry out further research.

As many of you may have experienced and observed, funding for fusion R&D has been going through periods of ups and downs throughout the international community. The early excitement, enthusiasm, and promises of fusion dating from the early 1950's have since given way to a more subdued and reserved approach. This has occurred due to the technical difficulty in achieving break-even and net fusion power production, coupled with the reality that there are numerous alternative sources of energy that, in the foreseeable future, will be much easier and more economical to exploit (e.g. fossil fuels, nuclear fission, and various renewable resources).

Thus, it may be considered by many governments that there is no immediate or urgent need to massively invest in developing fusion energy. It may be expected by many countries that reserves of fossil fuels and the growing exploitation of nuclear fission and renewable energy resources (e.g., wind, photo-voltaics, solar-thermal, geothermal, biomass, tidal systems, ocean wave, etc.) will be adequate to meet the world's energy needs for the next several centuries.

Nevertheless, it is realized that the potential energy resources for nuclear fusion are enormous by comparison to all other current sources. Therefore, it would be prudent, in the long-term interests of ensuring energy supplies, to take the necessary steps to develop the science and technology to enable the harnessing of the vast energy resource of fusion fuels available on Earth (e.g., deuterium extracted from water, tritium bred from lithium extracted from the earth's crust).

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Some Current Mainstream Fusion Projects

Today, there are two mainstream fusion concepts that are under investigation with substantial government support.

One is Inertial Confinement Fusion (ICF), which is largely supported by defense spending due to the commonality of its physics with that of nuclear weapons (http://en.wikipedia.org/wiki/National_Ignition_Facility). Construction of the National Ignition Facility (NIF), sited at Lawrence Livermore National Laboratory (LLNL), which is a large laser-based ICF experiment, was completed in early 2009, and ignition test experiments are expected to start in mid-2010.

The other fusion device is the well-known "Tokamak" concept for electromagnetic confinement of plasmas, with several variants having being built and tested around the world over the last 40 years. Currently, the world's latest and largest test facility for the Tokamak concept is being built in Cadarache, France as part of an international project, ITER (International Thermonuclear Experimental Reactor, www.iter.org). ITER (~500 MW_{th}, Q~10) is expected to become operational by approximately 2020 and will operate for 20 years. ITER is to be followed by DEMO (~2,000 MW_{th}), which is planned to be the first demonstration magnetic fusion-electric power plant.

On first glance, it might appear that a demonstration fusion electric power plant may become a reality in the next 30 to 40 years based on two mainstream concepts.

Potential for Alternative Concepts

The current world emphasis on supporting the Tokamak and ICF fusion concepts does not mean that other fusion device concepts have no potential. Alternative means for confinement of fusion fuels at high enough densities and temperatures to achieve net power production may be possible. Although many early fusion concepts may have lost out on financial support for further R&D or have much smaller-scale budgets (e.g. stellarators, reversed-field pinches, magnetic mirrors, field-reversed configurations (FRC), magnetic cusps, Z-pinches, theta-pinches, dense plasma focus (DPF), Penning Traps, electrostatic confinement, radio-frequency confinement, etc.), the alternative concepts may still have the potential to work, and to have some practical and economical advantages over the mainstream concepts. Further R&D may help may help uncover physics and engineering solutions to enhance performance.

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In addition to pure-fusion systems, another possibility for the not-too-distant future is the development of hybrid fusion-fission systems (e.g., see http://web.mit.edu/fusion-fission/), where a low-Q fusion reactor (Q~1) would be used to provide 14-MeV neutrons from the D-T fusion reaction to drive a sub-critical fission reactor made of thorium or depleted uranium. Such a system could serve as both a burner and breeder for fission fuels, and may act as a technology bridge to developing practical and economical full-fusion systems. A hybrid fusion-fission system may also be more economical than an accelerator-driven sub-critical reactor system, and it would have the ability to burn conventional fissile isotopes and fertile heavy actinides, such as those found in spent fission reactor fuels.

Competition for Funding

Historically, there has tended to be a very competitive environment for getting funding for fusion research. With limited government budgets allocated fusion R&D, at times there have been fierce competitions between various research groups to win funding, sometimes resulting in indirect attacks to discredit each other's work. Thus, a number of research groups have resorted to "fighting over the pie" with the "winner takes all" approach rather than "increasing the size of the pie".

In a number of cases, demonstrated successes, indication of good scaling outcomes, effective technical marketing and clever salesmanship has convinced some government programs and wealthy benefactors to focus their investments on very limited number of R&D projects, leaving other proposals to wither.

In the long-term, it may be better to "hedge one's bets" and take a multi-prong approach to investing in fusion R&D. By historical example, the Manhattan Project to develop nuclear weapons during World War II had taken a multi-prong approach to find ways to enrich uranium and also develop a plutonium-based nuclear explosive. The urgency and necessity of success during war-time helped open up government coffers to support R&D to investigate and test numerous approaches, many which failed, but ultimately resulting in finding solutions that did work.

Thus, while mainstream activities go on in fusion R&D, there is an opportunity and a prudent necessity to investigate as many avenues of fusion research and concepts as reasonably possible, to improve the long-term chances of developing practical and economical fusion-based electric power.