OPENING REMARKS

Presented to:

1999
Fusion Summer Study

by

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July 23, 1999

1999 Fusion Summer Study
Opportunities and Directions in Fusion Energy Science for the Next Decade

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The results of world-wide fusion research during the last decade indicate that fusion can be an energy source. A key challenge for fusion energy science research in the next decade is to optimize the science and technology to make fusion practical and affordable.

…individuals involved with fusion research are invited to come together to interact with each other and to develop a scientific and technical basis for consensus on:

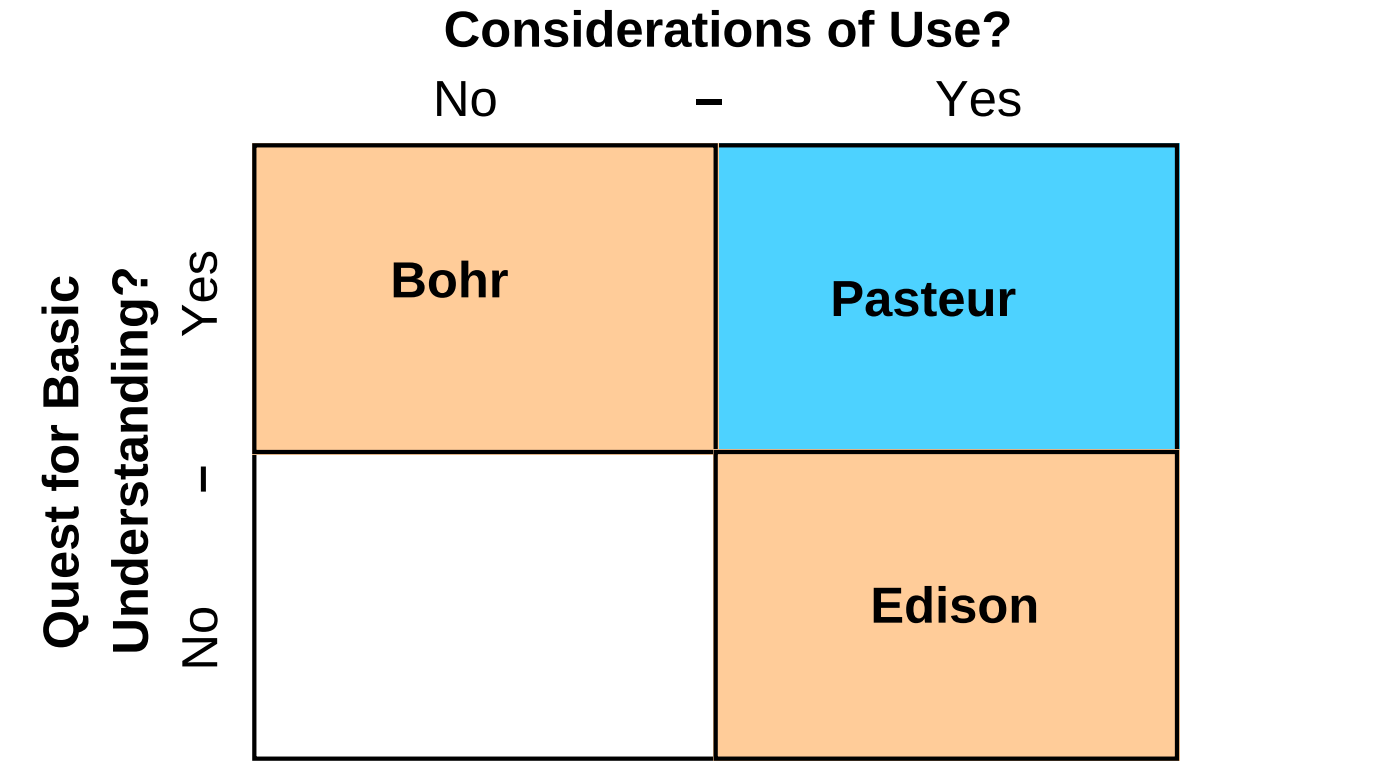
- **The key issues for plasma science, technology, and energy and environment for fusion energy development.**

- **The opportunities and potential contributions of existing and possible future facilities and programs to reduce fusion development costs and achieve attractive economic and environmental features.**

Meeting Representative of the Diversity of Fusion Community

- **MFE & IFE**
- **Science & Technology**
- **Basic Understanding & Energy Applications**

Fusion Energy Science Sits in Pasteur's Quadrant



The Grand Challenge:
Excellent basic scientific research enabling theinnovations that will make fusion energy practical.

Agenda

Opening Remarks	**R. Hawryluk**
Magnetic Fusion Concepts	**T. Taylor**
Inertial Fusion Concepts	**C. Olson**
Emerging Fusion Concepts	**D. Baker**
Break	
Plasma Science Issues	**A. Kritz**
Technology Issues	**M. Abdou/S. Milora**
Energy Issues	**F. Najmabadi/R. Stambaugh**
Concluding Comments	**G. Logan**

It is my pleasure to open the summary session of the 1999 Fusion Summer Study. We have just participated in two weeks of intense and interesting discussions. Today, I will make a few introductory comments on what we attempted to achieve and where we are headed. The working group leaders in the subsequent talks will summarize the conclusions of the workshop.

Let me begin by reminding you what we set out to do. At this meeting, we set out to define the opportunities and directions in Fusion Energy for the Next Decade. Fusion offers immense potential and substantial challenges to meet our long term goals and aspirations.

During these two weeks, it was not possible to, using Herrman Grunder's phrase, develop an "innovative integrated plan" with detailed costs and schedules. However, what we sought to make progress on and accomplished was to address was the key challenge for fusion energy science research in the next decade, which is to optimize and develop the science and technology necessary to make fusion practical and affordable.

We worked hard to identify the scientific and technical basis on :

- **The key issues for plasma science, technology, and energy and environment for fusion energy development.**
- **The opportunities and potential contributions of existing and possible future facilities and programs to reduce fusion development costs and achieve attractive economic and environmental features.**

To address this challenge, we brought together a group of individuals from all facets of our program to address the scientific and technical issues and opportunities of our field. Its scientific and technical breadth distinguishes our work on fusion. We have a range of concepts varying from magnetic to inertial fusion. Within both approaches we have concepts ranging from mature concepts to those just now being explored. At this meeting, we addressed both the scientific issues in our field and the opportunities for resolving them. In our discussions, two recurring themes are apparent that of developing the underlying understanding and their impact on our long term energy goal.

A useful conceptual framework for both our field and what we sought to accomplish here can be found in Don Stokes' book, "Pasteur's Quadrant."[1] In a strong departure from the science policy model of Vannevar Bush, Stokes characterized the development of science and technology by the "Quest for Basic Understanding" and "Consideration of Use." As an example of the quest for basic understanding, consider Bohr's quest for understanding the spectrum of hydrogen light. This in many ways is a classic example of curiosity driven basic research. On the other hand, Edison's many inventions and innovations are a clear example of technology research and development with little interest in developing fundamental understanding. However, Stokes noted that many research activities have a strong element of a quest for basic understanding with a use in mind. The example he cites is Pasteur who did fundamental work in microbiology but with the goals of curing

rabbis and fermentation. Fusion research, with its emphasis on developing plasma science and the goal of developing an attractive reactor, is clearly in Pasteur's quadrant. Throughout this meeting and today's summary talks, the issues of doing forefront science are addressed. The development of plasma science is a high priority on all of our facilities from both the smallest to the largest facilities. In support of our goal of making an attractive energy source, we need to develop the technology to both advance the science and support our long-term goals. The grand challenge of our field and the focus of this meeting is doing excellent basic scientific research enabling the innovations that will make fusion energy practical.

At this meeting, the working groups in the morning have been organized to address the magnetic fusion, inertial fusion, and emerging concepts, which are the approaches we use to explore the science and technology. In the afternoon, the working groups have been crosscutting: addressing the plasma science issues, technology, and energy. Each group had many subgroups addressing specific issues. Today, we will hear from the working group organizers providing a summary of the discussions which took place.

As you will hear, we have had a vigorous discussion of the key issues and opportunities to optimize and develop the science and technology necessary to make fusion practical and affordable. During this meeting, I have learned a great deal about our science and technology but perhaps most importantly about the passion of our community for doing first rate science and technology with the long term goal of making fusion practical.

1. Donald E. Stokes, Pasteur's Quadrant, Brookings Institutional Press, Washington D. C. (1997)