Report of

Nuclear Fusion Section,

National Committee for Nuclear Science and Application,

Science Council of Japan

On the New Way of Nuclear Fusion Research

Presented by

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Background of the study

(i) **Cabinet agreed to promote hosting ITER to Japan on May 31, 2002,**
while governmental negotiation is being undertaken concerning technical site assessment addressing construction of ITER.

(ii) **In the past, for about 30 years, it was required to pursuit various concept developments in parallel and competitively. However, it is time to reconsider research subjects and structure.**

(ii) **It is essential to develop plans for success of ITER and early realization of fusion power.**

subcommittee on *the new way of developing nuclear fusion under the new circumstances* (chair: Prof. A. Koyama) under the Nuclear Fusion Section of National Committee for Nuclear Science and Application (chair: Prof. K. Miya), the 18th Term of Science Council of Japan was charged to investigate the new way.

Reviews of confinement concepts & Survey of activities in laboratories

Through 11 Subcommittee meetings:
(May 2001 - Jul. 2002)

* ***Analyses of confinement concepts for evaluating possibilities for energy development:***
  - i) achieved plasma performances relative to the reactor requirements, & remaining physics issues
  - ii) reactor design studies on the same basis, & remaining engineering issues
  - iii) future research objectives & strategy
* ***Survey of activities of fusion laboratories / institutes for future organization of the fusion community:***
  - budget, scientific achievements, number of researchers, papers, patents,education, etc.

Evaluated possibilities for energy development

(i) Plasma Performance

1) Tokamak: 1/5 of the ignition condition
2) Helical System: 1 / a few hundreds
3) Spherical Tokamak: 1 / a few thousands
4) Other magnetic confinement systems: ~ 1 / 10^5

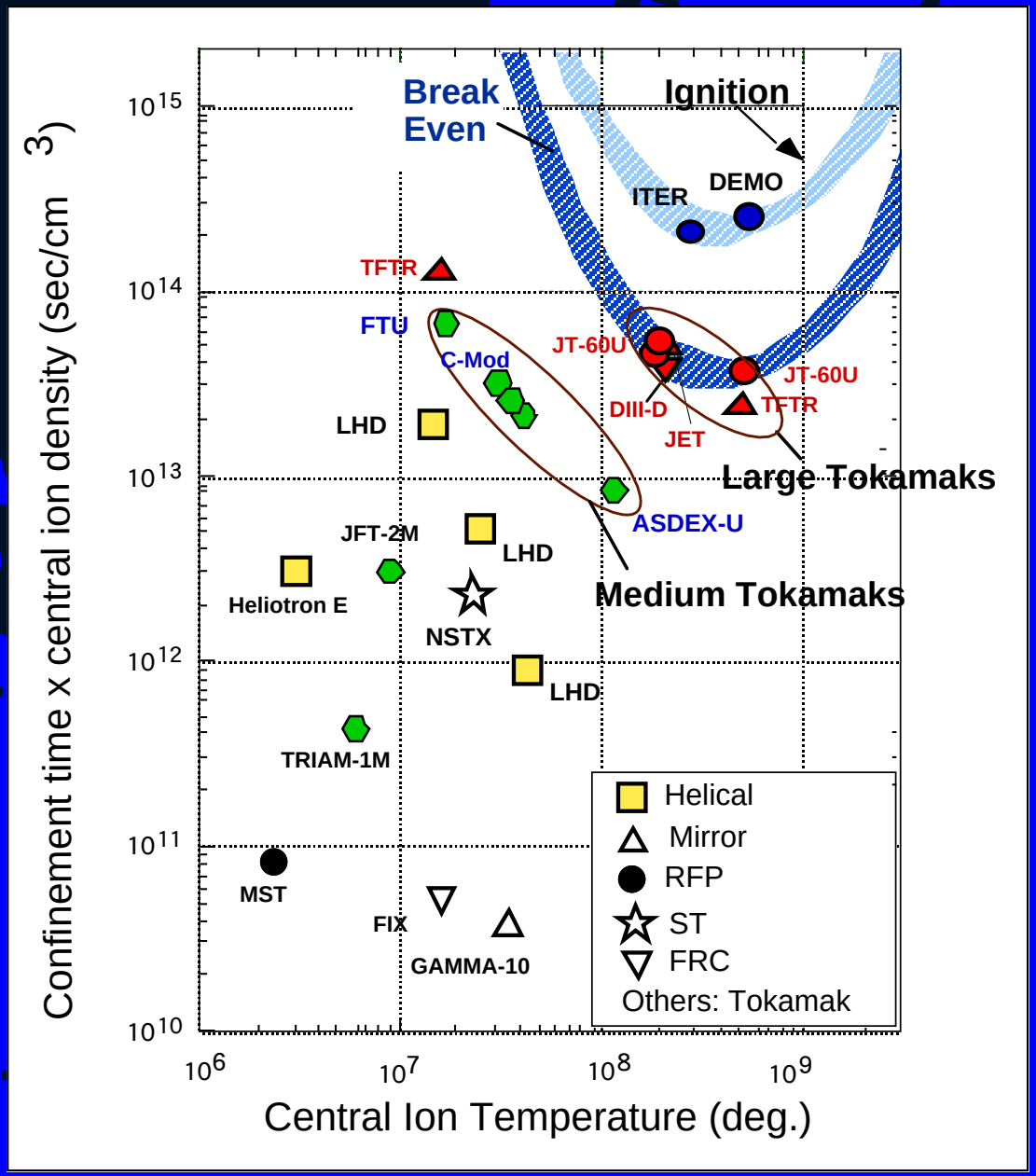
(ii) power plant concept & engineering prospect

No alternative system can be comparable to Tokamak system.

Tokamak system is the unique solution for the early realization of fusion power generation.

iii) Inertial confinement fusion

The fast ignition concept may be very attractive and potential option to ignite burning plasma with a relatively compact device inexpensive way in a short time. Together with engineering development, if accomplished, this could be another energy option for the early realization scenario.


Break Even
Ignition
ITER
DEMO
TFTR
FTU
C-Mod
JT-60U
JT-60U
TFTR
DIII-D
JET
LHD
Large Tokamaks
ASDEX-U
JFT-2M
LHD
Heliotron E
NSTX
Medium Tokamaks
LHD
TRIAM-1M
MST
FIX
GAMMA-10
Helical
Mirror
RFP
ST
FRC
Others: Tokamak
Confinement time x central ion density (sec/cm 3)
Central Ion Temperature (deg.)
10^{15}
10^{14}
10^{13}
10^{12}
10^{11}
10^{10}
10^{6}
10^{7}
10^{8}
10^{9}

New view point

1) Early realization of fusion power

Fusion research provides energy sources which burden less damage to the environment; mitigation of the global warming problem.

The middle of this century is a time limit by which fusion energy will succeed in entering into commercial market.

→ ***demonstration of electricity production in the first half of 21st century***

= The first power plant starts operation around 2030.

demonstration of economical feasibility in the middle of this century.

2) Tokamak power plant as the unique option for the early realization

The unique solution to realize fusion power realistically along the scenario is Tokamak.

Unrealistic to consider non-Tokamak system as a fusion power plant.

New view point-2

3) Change of high priority subjects in fusion R&D

The core subjects and the structure of development should be changed depending on the research progress.

Facing near-term construction of ITER, aspect of system engineering becomes more important and should be strengthened,

while previous fusion research was focused on element/component studies.

4) Change of Research Structure

ITER project provides a quite good opportunity to realize the change.

In addition, reconstruction of governmental structure and drastic changes in large institutes and national universities also provide good opportunities.

a) improvement of researcher's attitude

b) mobility of researchers among organizations

c) organizational scrap & build in institutes

Suggestions

Structural reform for the success of ITER and proper response towards the early commercialization of fusion are the most important issues:
the time constraint of power production in the first half of 21st century,
demonstration of economical feasibility in the middle of this century.

1) Decision of responsible route and execution of central issues.
Make the strategy clear that Tokamak to be the unique option for the early realization of fusion energy in a plant level.

⇒ Promote four important subjects, in parallel with ITER,
* material development using intense neutron source,
* construction of blanket integrated technology,
* high beta steady-state high performance research,
* development of system integration technology

intensively with high priority in budget and man power allocation while keeping cooperation with basic research

Suggestions-2

2) Evaluation of other routes

Inertial fusion should concentrate on demonstration of fast ignition concept and study of the engineering feasibility, while, helical system should be studied as a science research for various helical configurations and physics of toroidal confinement.

⇒ *Researches except tokamak, helical and inertial fusion should address their own research programs to get funded.*

3) Desirable system reconstruction

* Autonomous organization of the university researchers,
* "Network" for planning research programs and organizing groups.
  new research subjects, generation change, cooperation among various fields, & personal mobility.
* competitive fund to support system reform.

JAERI should accomplish critical role in the principal participation to ITER & execution of the four important subjects with strong cooperation with autonomously organized universities.

Suggestions-3

4) Autonomous formation of non-governmental evaluation group

It is desirable to form a neutral autonomous group independent from national research organization for the transparency and fairness and to notify the public of the importance of the research.

Evaluation by such a group will contribute to *the break through from the current isolation of fusion research from public* and *the improvement of the circumstance to form a healthy and stable fusion research*.