Session VIII   Future concepts, Issues

Makoto Katsurai
University of Tokyo
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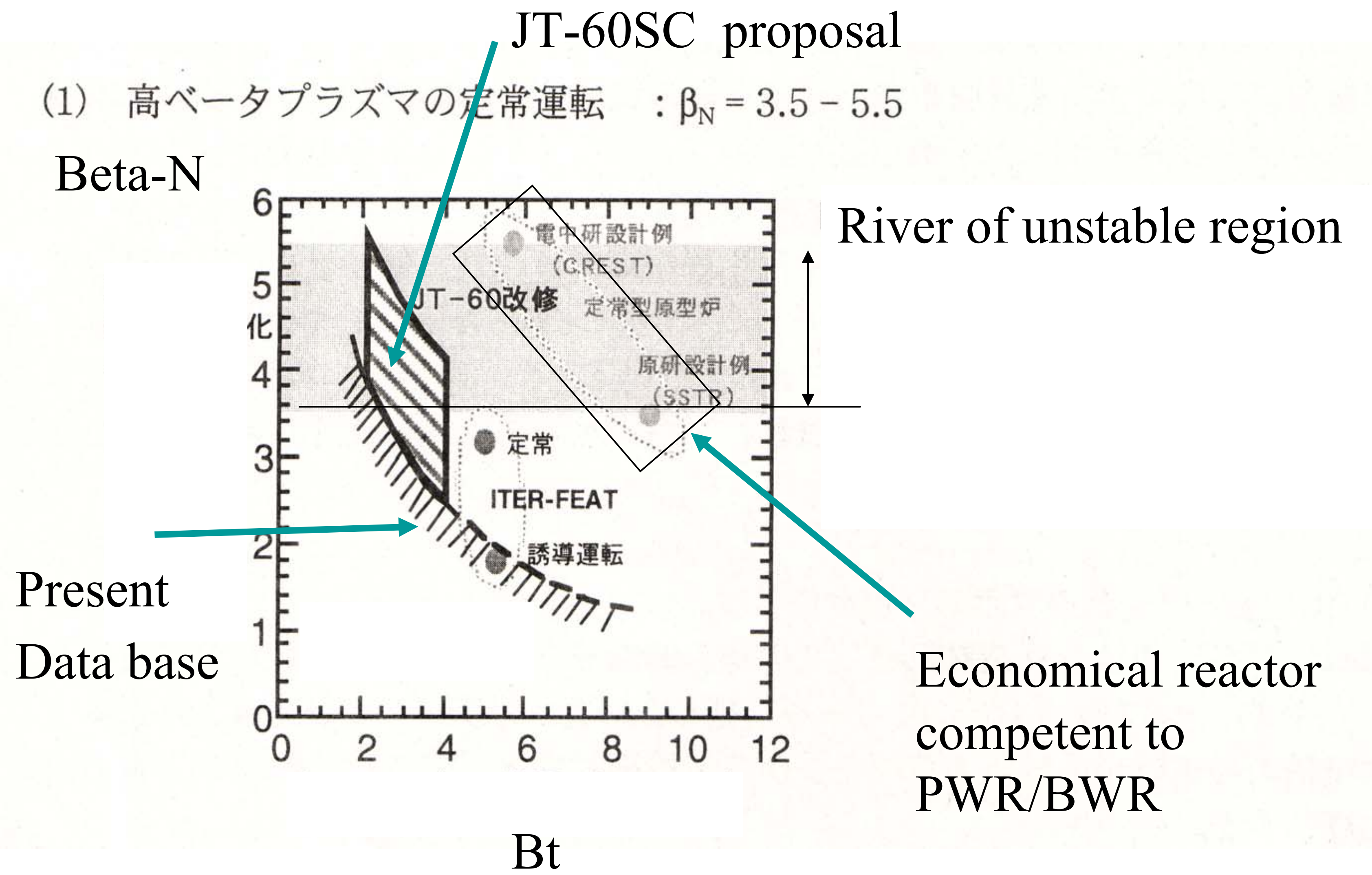
JT-60SC proposal
(1) 高ベータプラズマの定常運転 : βN = 3.5 - 5.5
Beta-N
River of unstable region
電中研設計例
(CREST)
JT-60改修
定常型原型炉
原研設計例
(SSTR)
定常
ITER-FEAT
誘導運転
化
6
5
4
3
2
1
0
0
2
4
6
8
10
12
Present
Data base
Economical reactor
competent to
PWR/BWR
Bt

Five Presentations

- **Physics requirements for future ST's.**
  - **By M. Gryaznevich**
- **NSST(Next Step ST)**
  - **By M.Ono**
- **ST's without solenoid**
  - **By A. Sykes**
- **CTF(Component Test Facility)**
  - **By M. Peng**
- **Current ramp up in D-He3 reactors**
  - **By T. Mitarai**

Personal comments are presented on the common issues relevant to the engineering aspects of these presentations.

1. ST power reactor: ***GW(e) level***

1. Even if all of the physical and technological issues of ST reactors; non-OH current ramp up, current sustainment, etc., are solved, economical issues still remain .

2. In principle, even if the energy confinement time becomes long enough, fusion reactors can not be compact because its size mainly depends strongly on the material properties, specifically, on the limit of the first wall heat loading.

3. When the first wall loading and total fusion power are assumed to be the same, the larger the aspect ratio, the smaller the volume of the plasma vessel. The ST reactor with A~1 has the largest vessel volume among toroidal systems over a range of aspect ratios.

4. Therefore, the statement that “ST reactor can be compact.” is misleading. The major merit of ST is that the total cost of the toroidal field coil that provides q-edge ~5 is about 1/10 of normal A designs, so that its construction cost is very much reduced .

5. The evaluation of the power loss of the center rod and the associated increase in recirculating power in the generation plant (the values have not been shown in the presentations) is a key issue, compared to the advanced CvT reactor designs. ST power reactor design has not yet shown clear advantage over advanced CvT reactor in terms of CoE (Cost of Electricity), mainly because of the large amount of the circulation power in the power generation plant.

7. The application of the superconducting magnet with 1m thick neutron shield brings about the 4~5m major radius. Advanced fuel reactors, that require the energy confinement time of about 20sec, could be one of the directions that utilize the potential for ST power reactors and that give ST power reactors relative competence to other types of fusion reactors.

8. DHe^3 reactor which could be almost neutron free would have more severe problems on the heat removal from the diverter than neutron dominating DT reactors, unless radiation power loss on the first wall accounts for a large fraction of the fusion power.

9. For DT reactors with shielded superconducting toroidal coils, the selection of A~2 could be an optimal through the trade off between merits and demerits of ST and advanced CvT.

2. CTF *The power loss by Itfc is not so crucial issue as for the power reactor, however:*

1. Necessity of CTF in the course of fusion reactor development needs to be widely recognized. The material researchers are likely to comment that the IFMIF can do the majority of material tests that are required for the development of DEMO reactor materials. The development of reliable CTF is not easily realized because of the requirement that it should be operated for more than several years stably and reliably.

2. CTF could become the key facility in the newly developed field called "NEUTRON INDUSTRY" where the cost-effective energetic 14MeV neutrons could be used in material processing and other applications.

3. In the development of CTF, the cooperation with the fission energy industry would be beneficial for both communities.

4. Historical survey on the necessity of the equivalent CTF in the fission reactor development would be persuasive.

3. Ignition Test Machine

1. ST device with sustained burn and technology integration might become a viable option to the ITER project to realize a compact and economical burning test machine or an ignition demonstration machine, if the ITER project is delayed.

4. Speculative expectations for ST research

(Ignited ST reactor as a basis of further evolution)

1. Compact Tori (CT) with q-edge=0, namely, spheromak and FRC, seem to be superior to ST in terms of CoE if their confinement properties become as good as those of ST and CvT.
2. However, their present performance is very poor. Their researchers have been commenting that once the temperature becomes very high, their performance will become very good; however, it seems quite difficult to get a high temperature with a present poor confinement time. The transformation from a high temperature ST plasma to a high temperature CT plasma by artificial reduction of Itfc that is accompanied with some stabilization mechanisms for various instabilities is challenging subject for future ST researches.

3. In future, once the ignited ST is realized, its self generated thermal energy could be utilized to transform the original configuration to an improved configuration.

4.. For example, the flux core spheromak reactor, equivalent ST reactor without a center metal conductor(rod), should have more than about 1keV electron temperature in their center flux core section if its conductivity is required to be larger than that of the pure copper. Once the ignition is achieved, such high electron temperature in the open flux core could be sustained by virtue of the internal heating.

5. As another expectation, the burning plasma might drive internal plasma currents resulting in the helicity generation. Therefore, the helicity "extraction" could serve to generate dc current directly from the helicity injection electrodes.

Conclusion.

There seems to be high potential for presently unknown, hidden, unconceivable growing possibilities for future ignited ST reactors.