Suggestions for Development Strategy of MFE and the Next Device in China

“FAST”

Y. Shimomura

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First Workshop on MFE Development Strategy in China

Fast

-Fast start and fast progress of the project is essential to increase momentum and public support.

(Cost of a fusion project is very high and its time scale is very long.)

-Fast utilization of fusion energy is essential to meet requirements.

(The conventional scenario is too slow.)

The next device in China must be a big and fast step.

Must be more advance than ITER

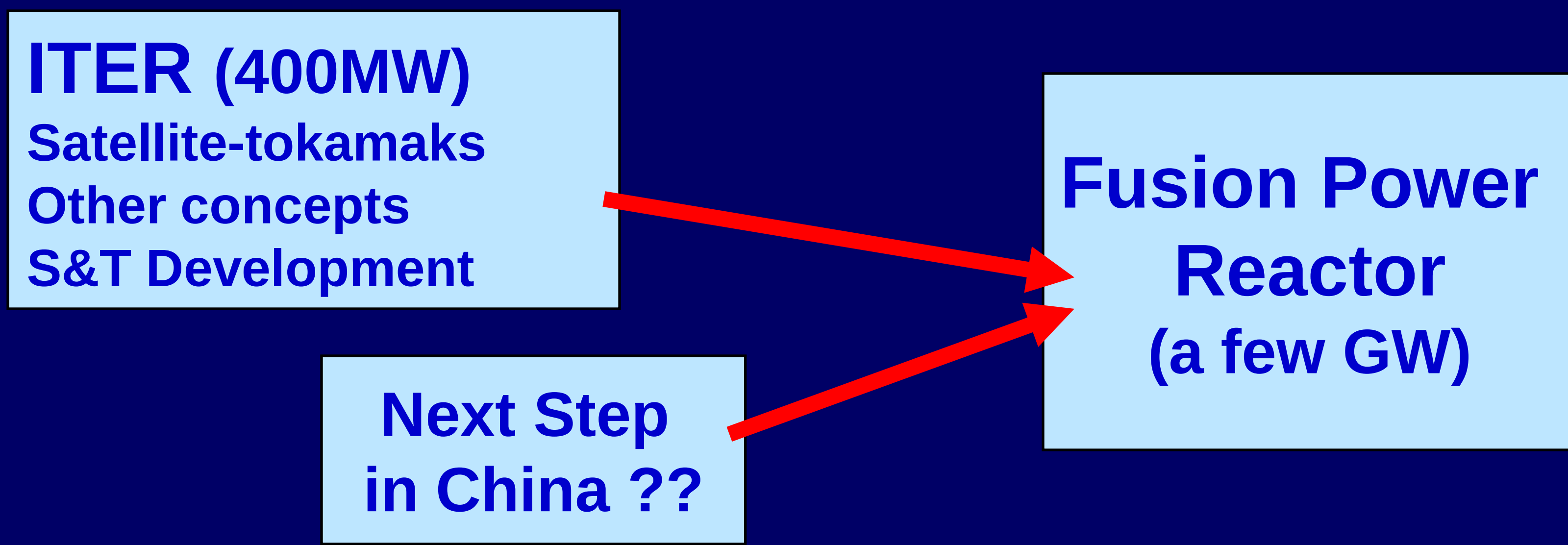
It must include at least one of the following features:

1. higher performance
2. more reactor relevant system
3. demonstrating feasibility of faster utilization of fusion energy

Must be fast

1. cannot be largely based on physics & technology to be developed
2. must use existing experience efficiently
3. must not be after ITER

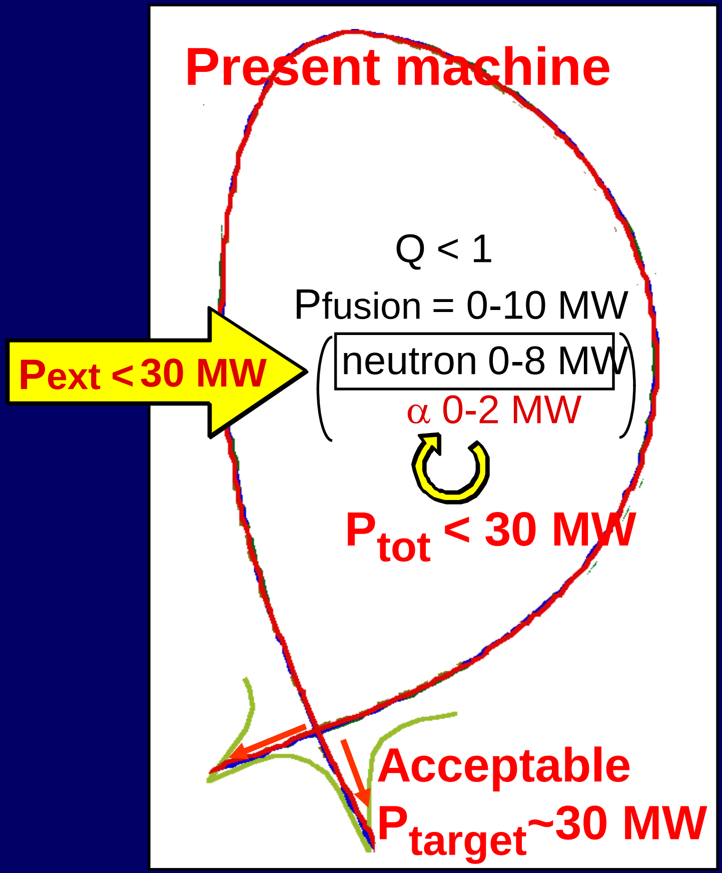
Can the next step of ITER fit into the program in China?

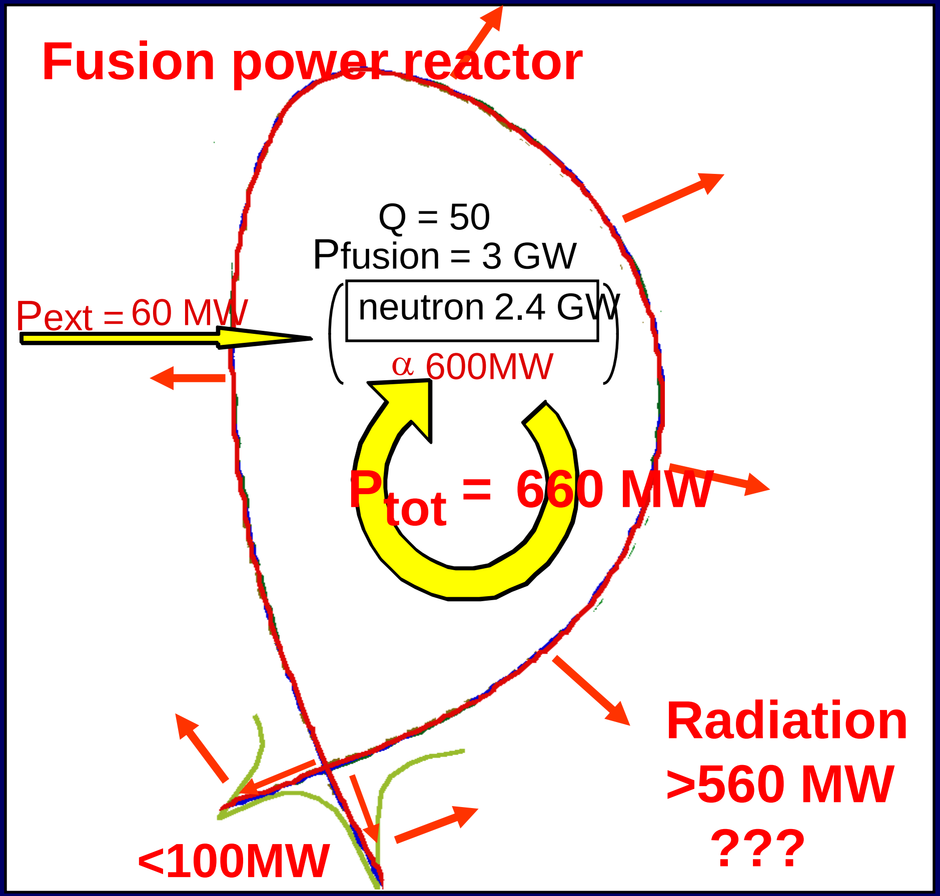


Progress beyond ITER physics-base at this moment is not enough for starting a next step of ITER.

There are large uncertainties of plasma with very high fusion power.

Example: In a fusion power reactor, the major power must be widely radiated on the wall.





Is it compatible with the core confinement and fuel density?

Research in ITER is indispensable for tackling this issue

-ITER will study radiation-cooling with a reactor relevant core plasma at a level of P_{tot}=200MW. Only ITER can study this.
-But ITER cannot cover all. The present experiments and next generation of SC machines (EAST, KSTAR, JT-60SA- -) as well as theoretical and basic researches are needed for understanding physics, and developing/validating integrated models/codes.

PSI 2006 Hefei

When ?

Full DT Operation in ITER will not start earlier than 2028.

Will the result be good enough for a reactor with a few GW?

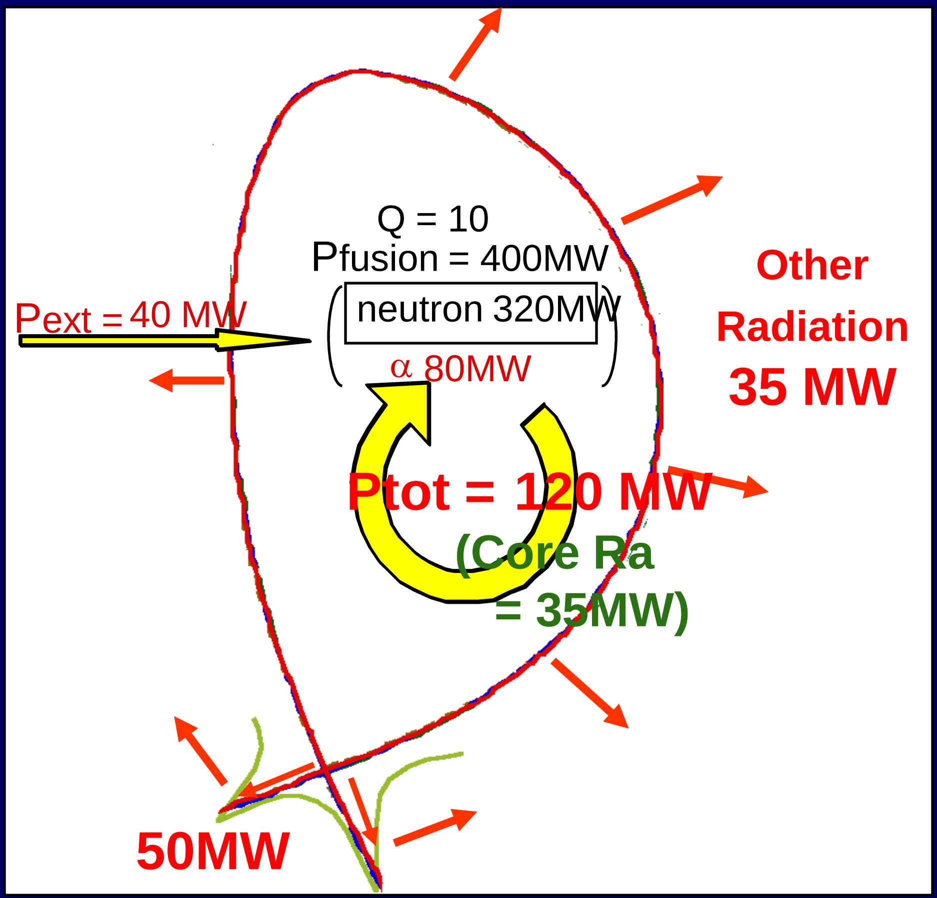
If yes, start a demo.

If not, ?

Whichever the case, it will be too slow for the program in China.

Alternative pass with lower fusion power

ITER reference operation



Sub ITER plasma with lower P_f and lower Q

More margin
More reliable operation

Alternative Fast Pass: Hybrid Fusion-Fission Reactor

(long study in China)

Small uncertainties of ITER-class plasma

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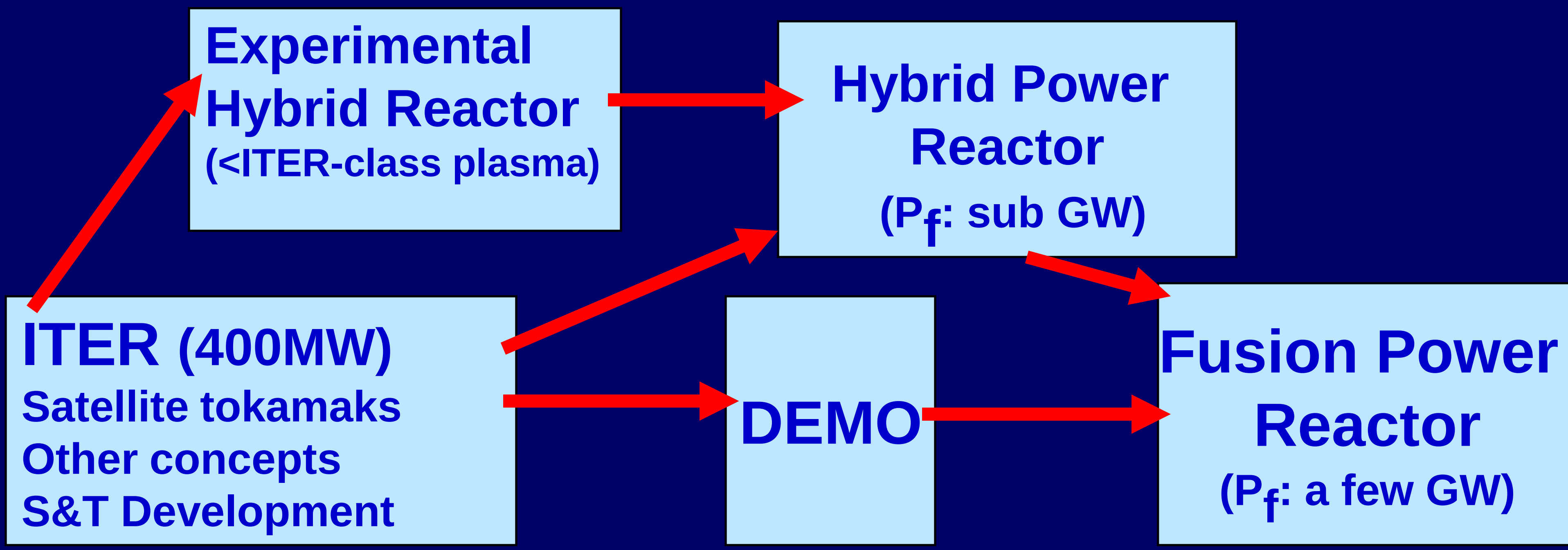
Fast start of the program

Possibility of faster utilization of fusion energy



A possible concept of Experimental Hybrid Reactor to be studied.

ITER-like Basic Machine

1. Use design, technology, fabrication line, etc. of ITER as much as possible.
2. Limited modifications:

   Increase reliability, pulse length & duty factor with lower Q & P_f

   Increase space for blankets

   Further optimization with Nb_3Al

New blanket and divertor

Fusion-fission hybrid blanket

Remote replacement

Major areas to be developed

Plasma

1. Base operation: conventional mode

reliable longer pulse and control of ELM/disruption

smaller I_p, lower Q, lower P_f , higher q, higher vs for flat top - - -
shape optimization, e.g., lower/upper x-point, q, δ, κ - - -

2. Advanced/high performance operation

Flexibility must be included for better performance.

Blanket

1st   Stage: shield blankets & test blankets
2nd Stage: hybrid blankets and test blankets
Remote replacement of large blanket modules must be developed.

Experimental Hybrid Reactor as the next step in China

Demonstration of feasibility of hybrid reactor

-faster utilization of fusion energy

Fast start and progress of the project

1. Small uncertainties of < ITER-class plasma
2. Efficient use of ITER design, technology, fabrication lines, etc.
3. Staged blanket program

1st Stage: shield blankets & test blankets

2nd Stage: hybrid blankets and test blankets

Big effort for

1. Reliable longer pulse and higher duty operation
2. Fusion fission hybrid blanket
3. SAFTY

Good combination with ITER

(not after ITER)

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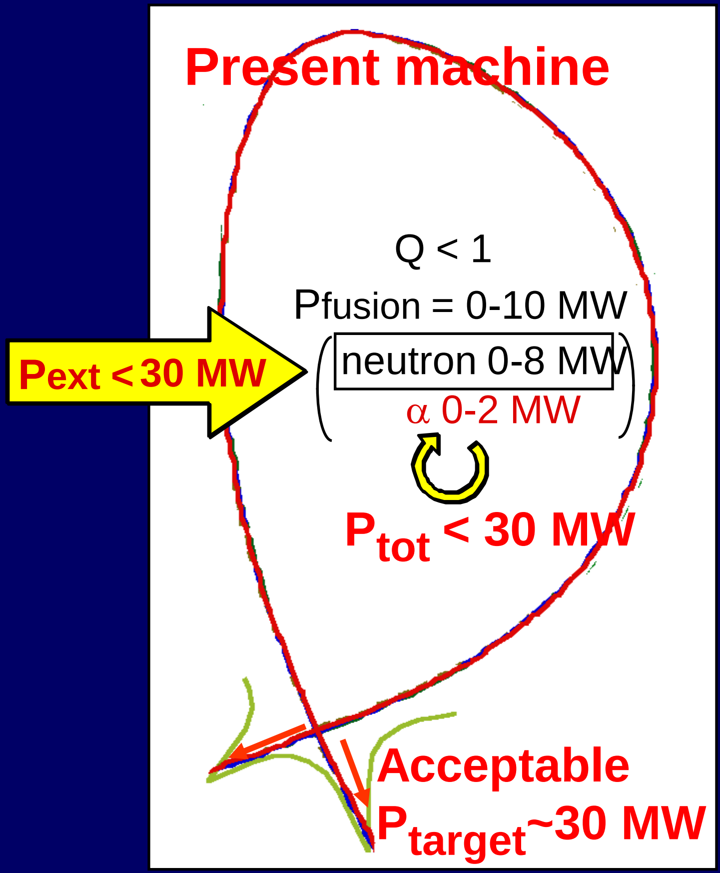

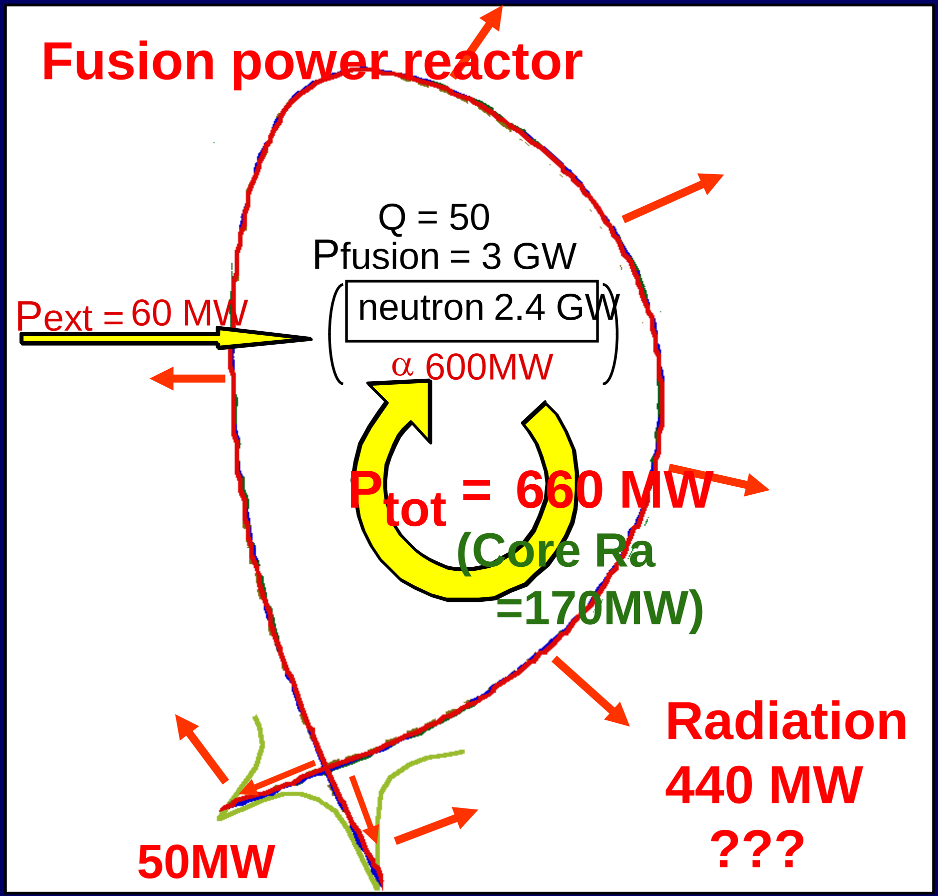

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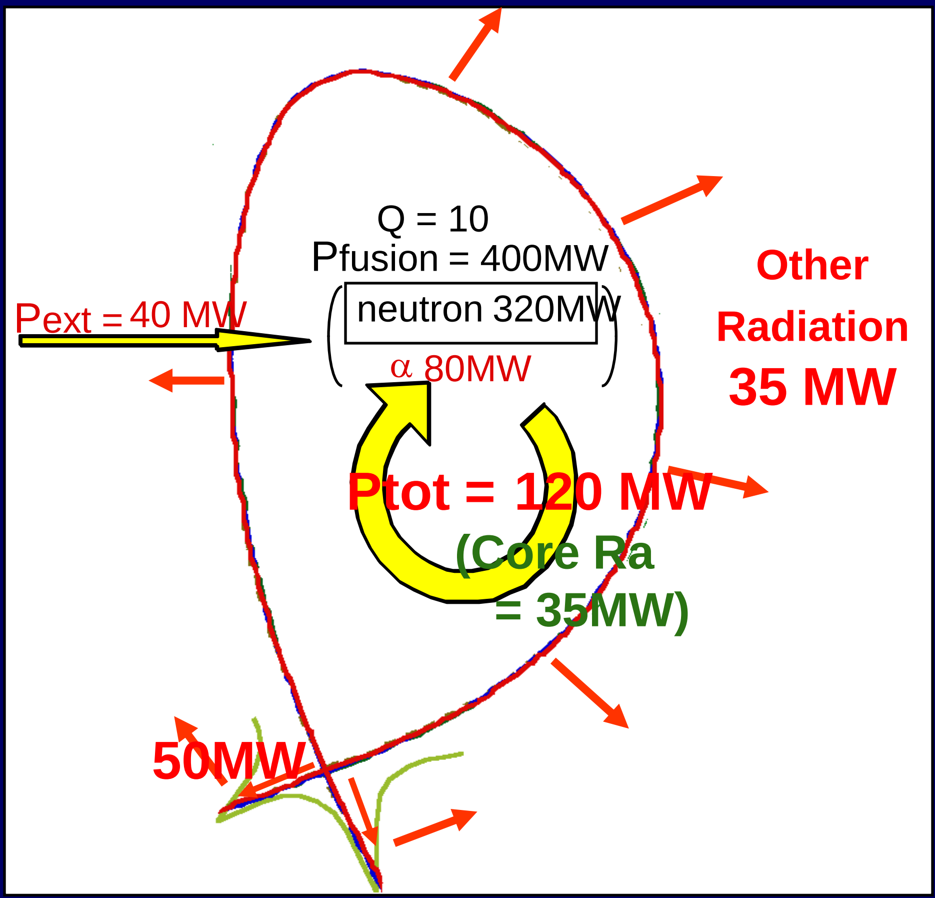
ITER reference operation



Compatibility with core confinement & fuel density?

-ITER will study radiation cooling with a core plasma at a level of P_{tot}=200MW.
(e.g., P_{ext}=100MW,P_{fusion}=500MW)

-Only ITER can study this.

-But a gap will be left.

Research in ITER is indispensable for tackling this issue

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