The Institute for Fusion Studies in Southern Italy: Simulation Results for the Design Parameters of the First Prototype Fusion Reactor

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BACKGROUND

- **On March 7, 2003 a Memorandum of Understanding has been signed between FRT and the Township of Ferrandina, Southern Italy**
- **The Township will provide the land, and all the infrastructure necessary for the project**
- **FRT will provide the Intellectual Property for the development of the First Fusion Prototype Reactor**
- **On July 14, 2004 an Agreement of Cooperation has been signed between the local State University (“University of Basilicata”) and FRT**
- **An Italian Company “FRT International” is now being incorporated**

Map of Italy

Township of Ferrandina

Map of Southern Italy.

The Institute will be built in the Township of Ferrandina, in Southern Italy.

The Nature and Extent of the Fusion Problem

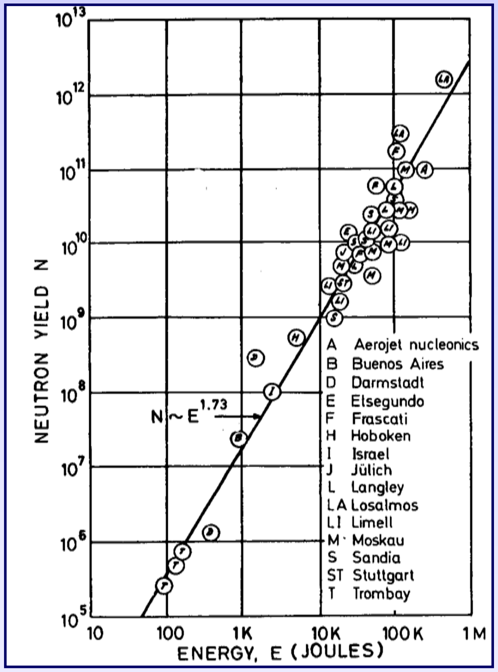


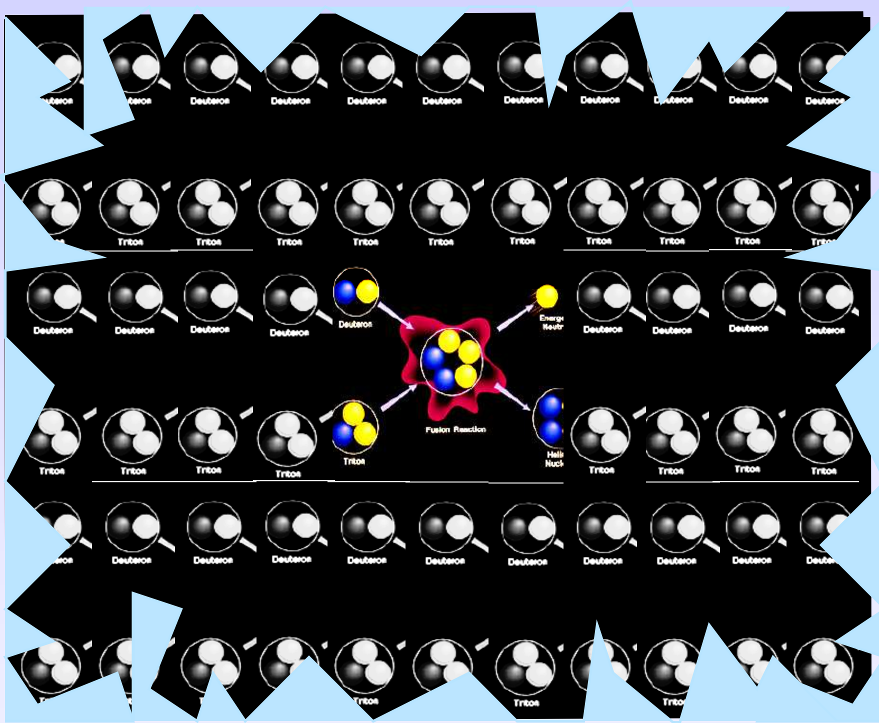
Fig. 2 – Neutron yield *N* as a function of energy *E*

Input energy E (*J*)	Number of neutrons produced (N_{prod})	Number of neutrons required for breakeven (N_{br})	Ratio (N_{prod}/N_{br}) or (E_{prod}/E_{br})
(1)	(2)	(4)	(6)
1.00×10^{2}	1.53×10^{7}	1.07×10^{14}	1.43×10^{-7}
1.00×10^{3}	8.21×10^{8}	1.07×10^{15}	7.67×10^{-7}
1.00×10^{4}	4.41×10^{10}	1.07×10^{16}	4.12×10^{-6}
1.00×10^{5}	2.37×10^{12}	1.07×10^{17}	2.21×10^{-5}
1.00×10^{6}	1.27×10^{14}	1.07×10^{18}	1.19×10^{-4}

Table 1 – Tabulation of the experimental data

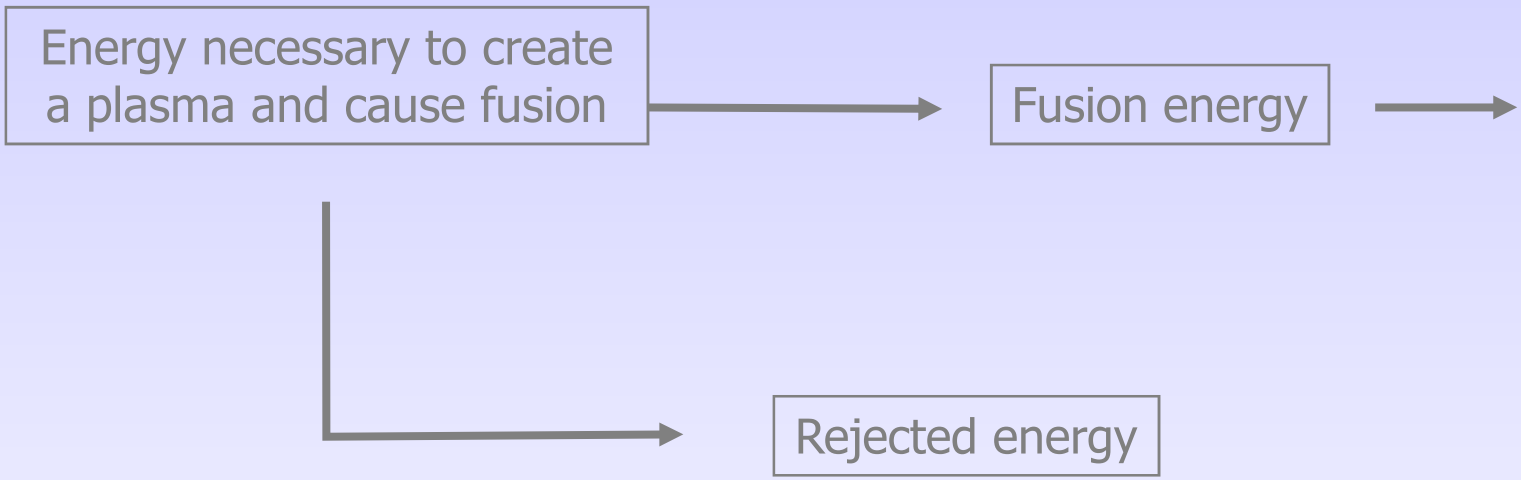
Column 6 points out to the seriousness of the fusion problem. We are in fact from 4 to 7 orders of magnitude away from reaching breakeven conditions.

Present Status of Research in Fusion



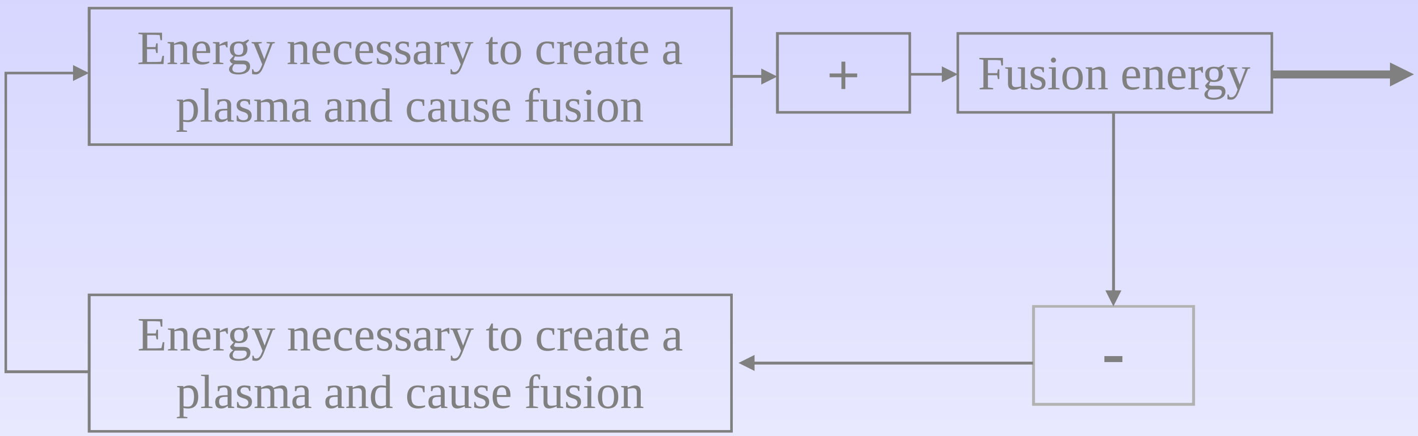
- **Presently, in order to have two atoms of D and T fused, we spend an energy 10^4 times higher than the energy returned to us. This is because many atoms do not fuse, and therefore we have wasted energy just to heat them.**
- **The energy that has been used for creating a plasma and obtain those fusion reactions is presently discarded.**
- **If we were able to retain this energy and reuse it, we would have a net energy gain**

Present Status of Research in Fusion



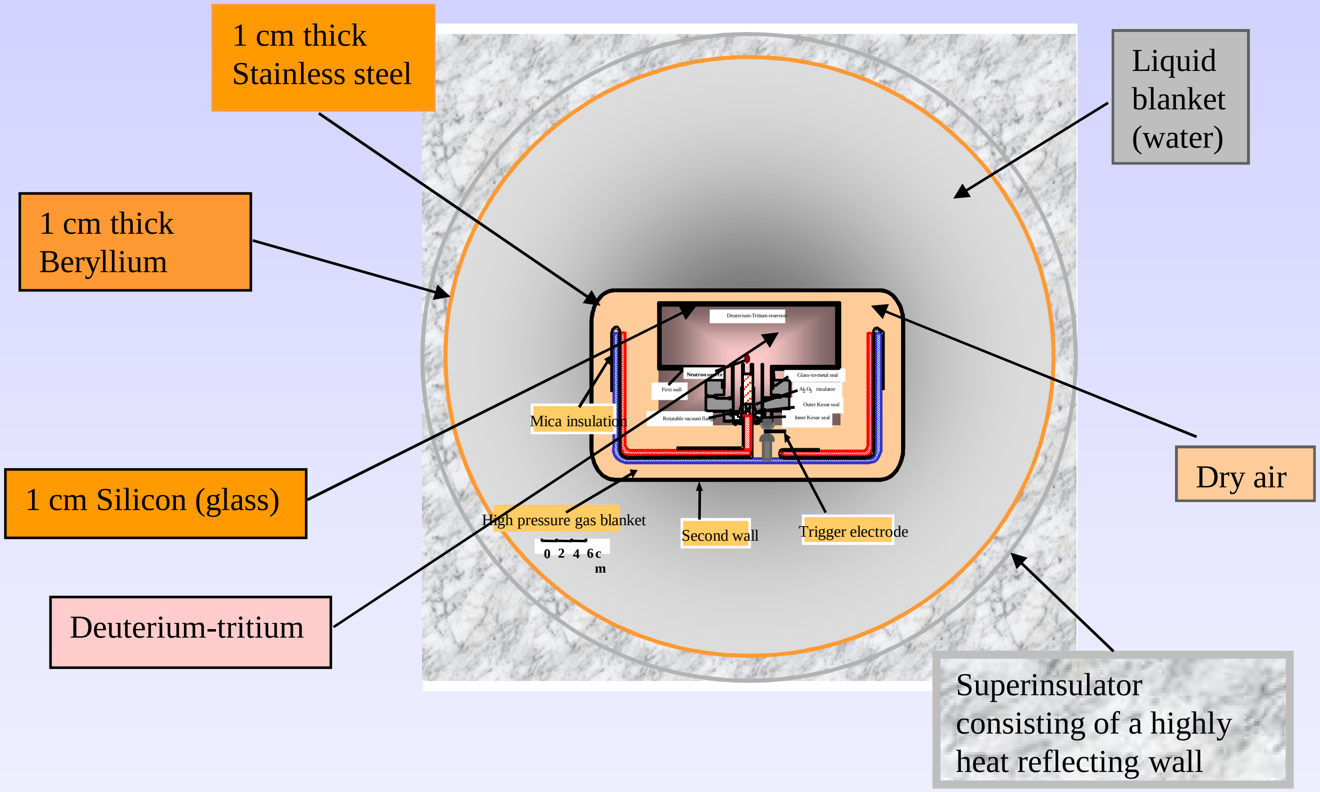
Presently, there is no energy gain because of the rejection of the energy necessary to create a plasma and cause fusion. Only if the fusion energy were much higher than the energy used to obtain the fusion reactions, then it would be justified to reject this energy.

Conceptual solution of the energy problem

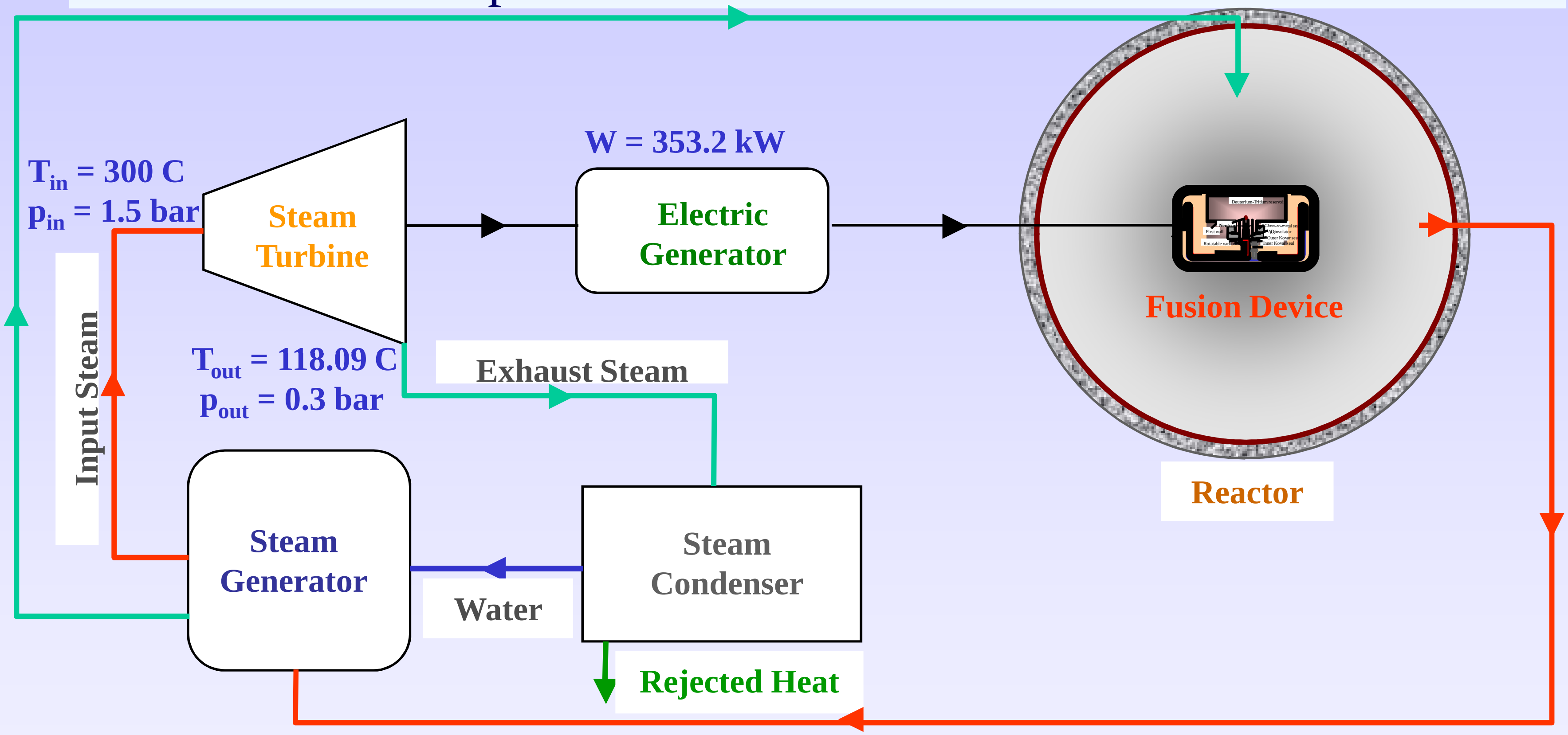


In this case we have net energy gain because the initial energy is recovered and re-used.

Reactor Design

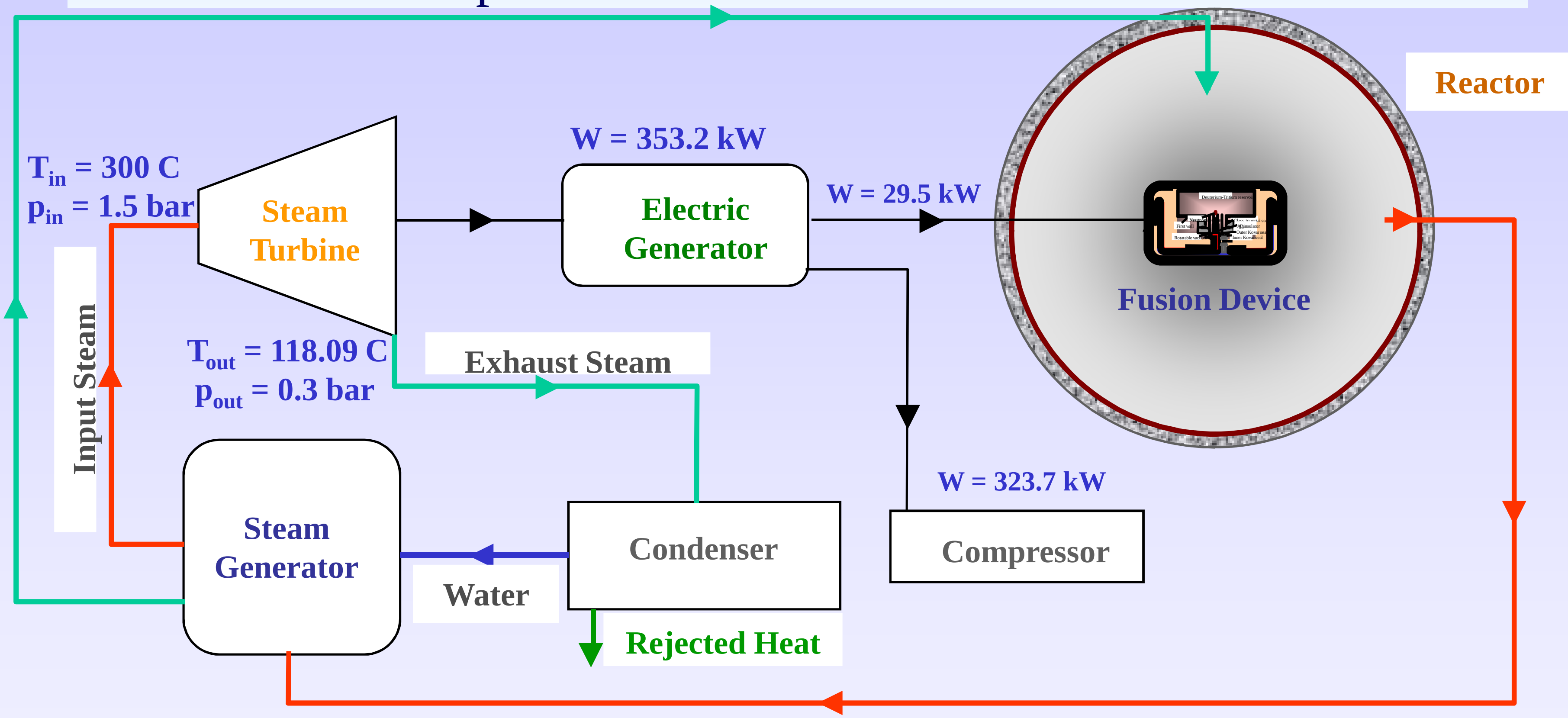


Conceptual Solution of the Fusion Problem



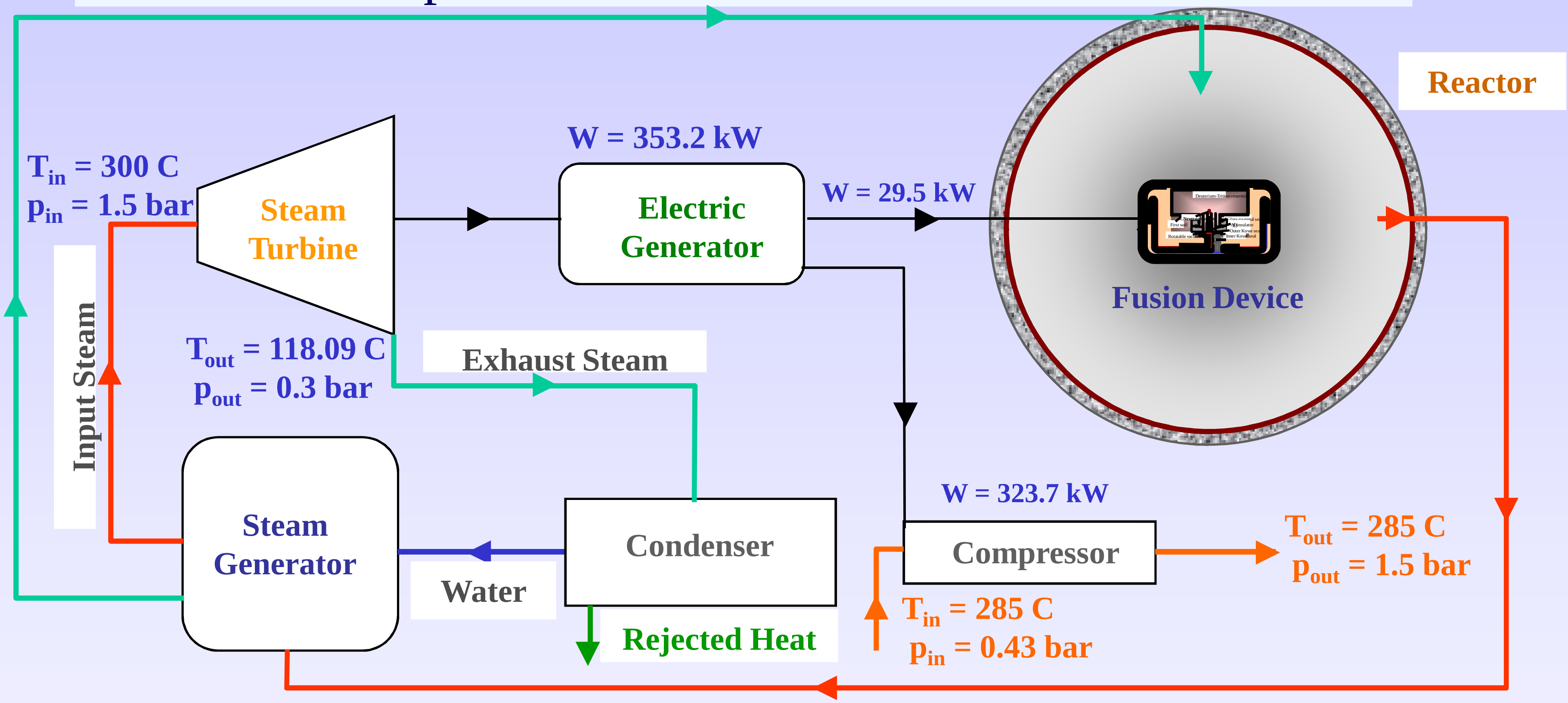
All the heat content of the exhaust steam is rejected in a conventional system.

Conceptual Solution of the Fusion Problem



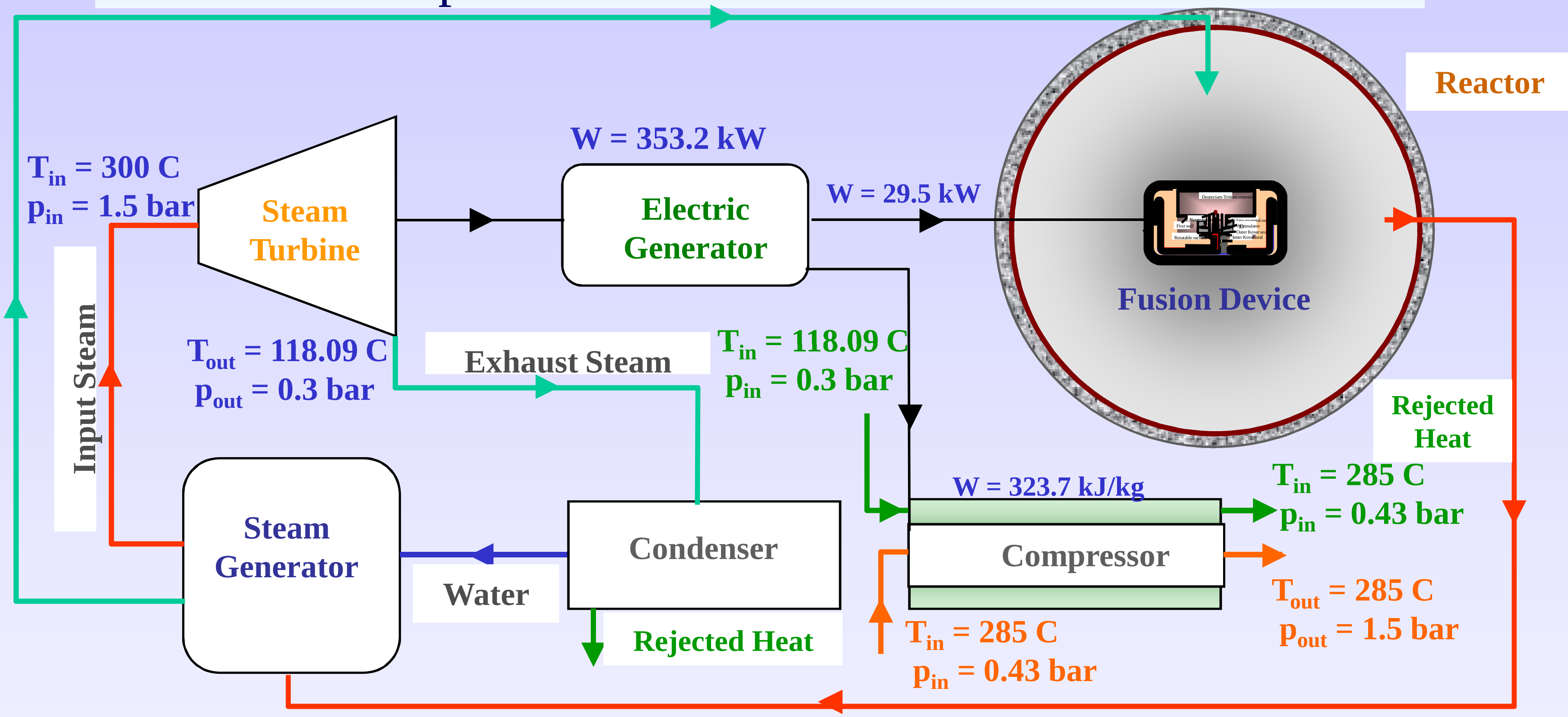
The Electric Generator can also drive a Compressor, without affecting the system.

Conceptual Solution of the Fusion Problem



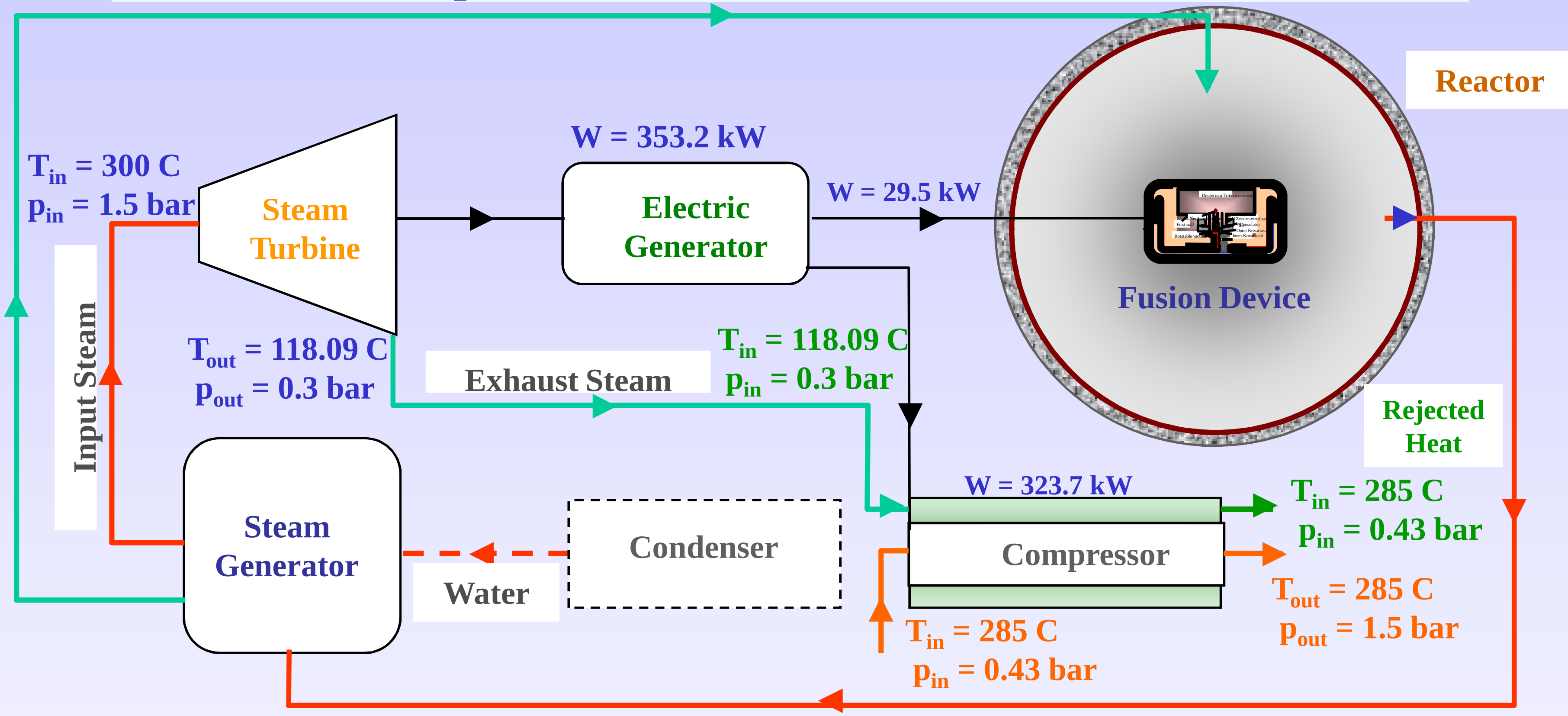
The Compressor is used to compress steam isothermally.

Conceptual Solution of the Fusion Problem



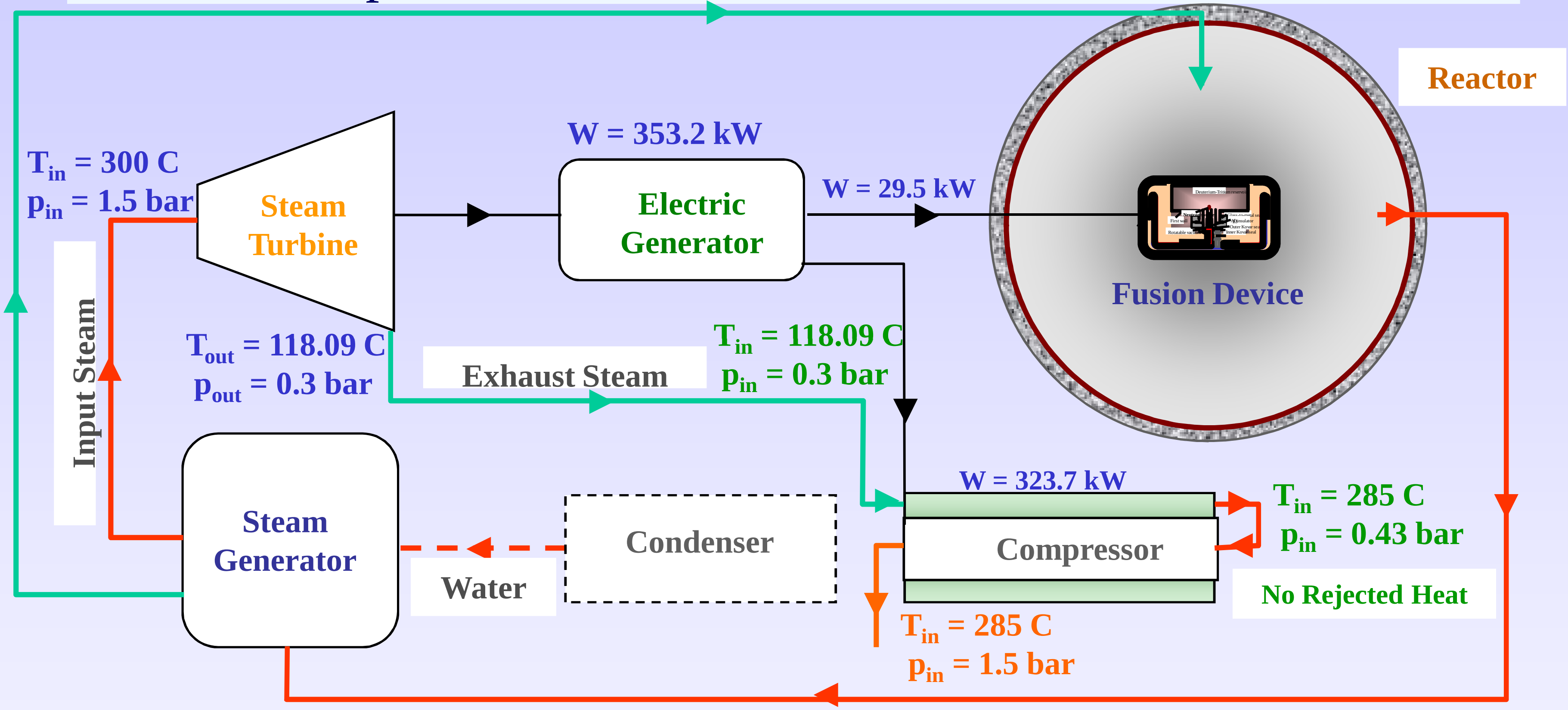
As long as we reject heat, the conventional system is acceptable and understood.

Conceptual Solution of the Fusion Problem



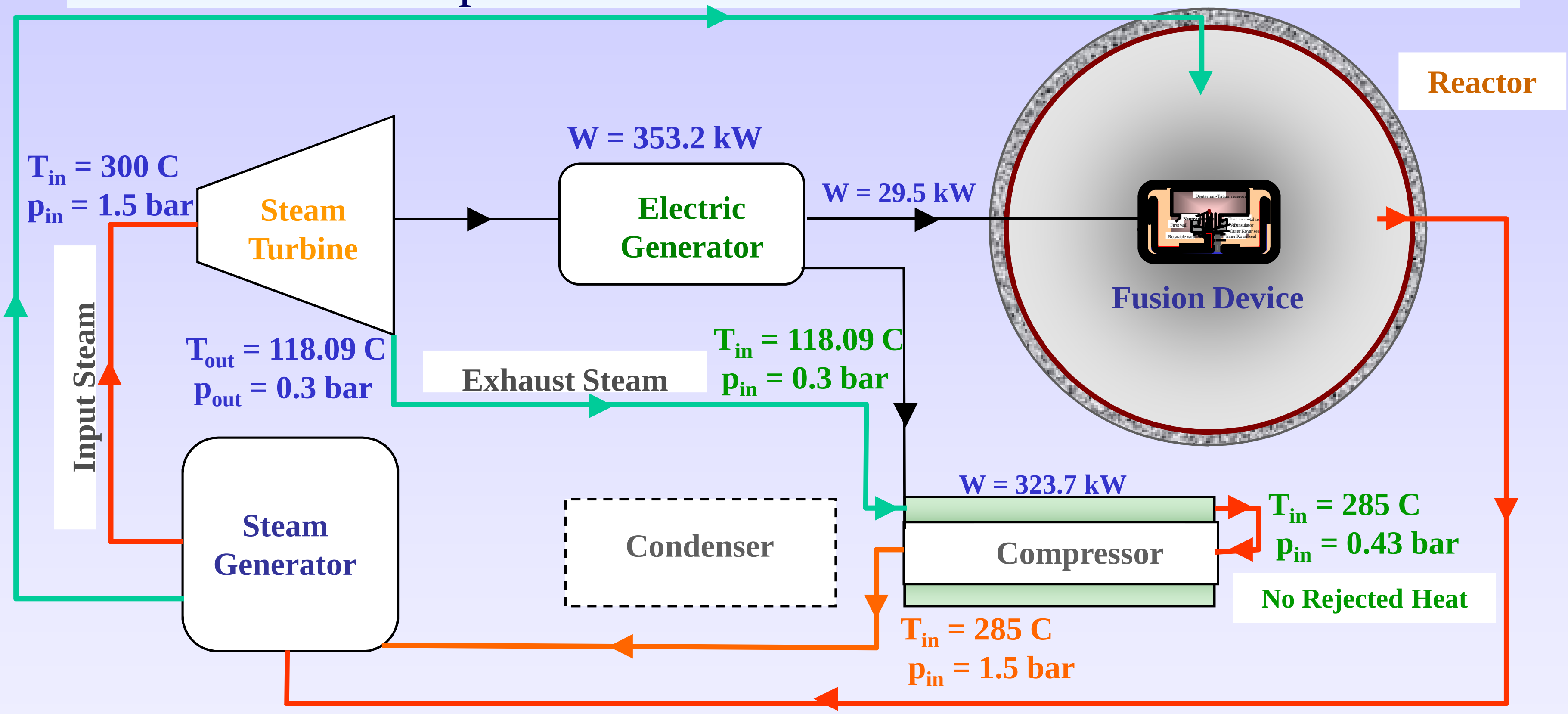
The exhaust steam is now channeled to cool the Compressor.

Conceptual Solution of the Fusion Problem for b ≃ 1



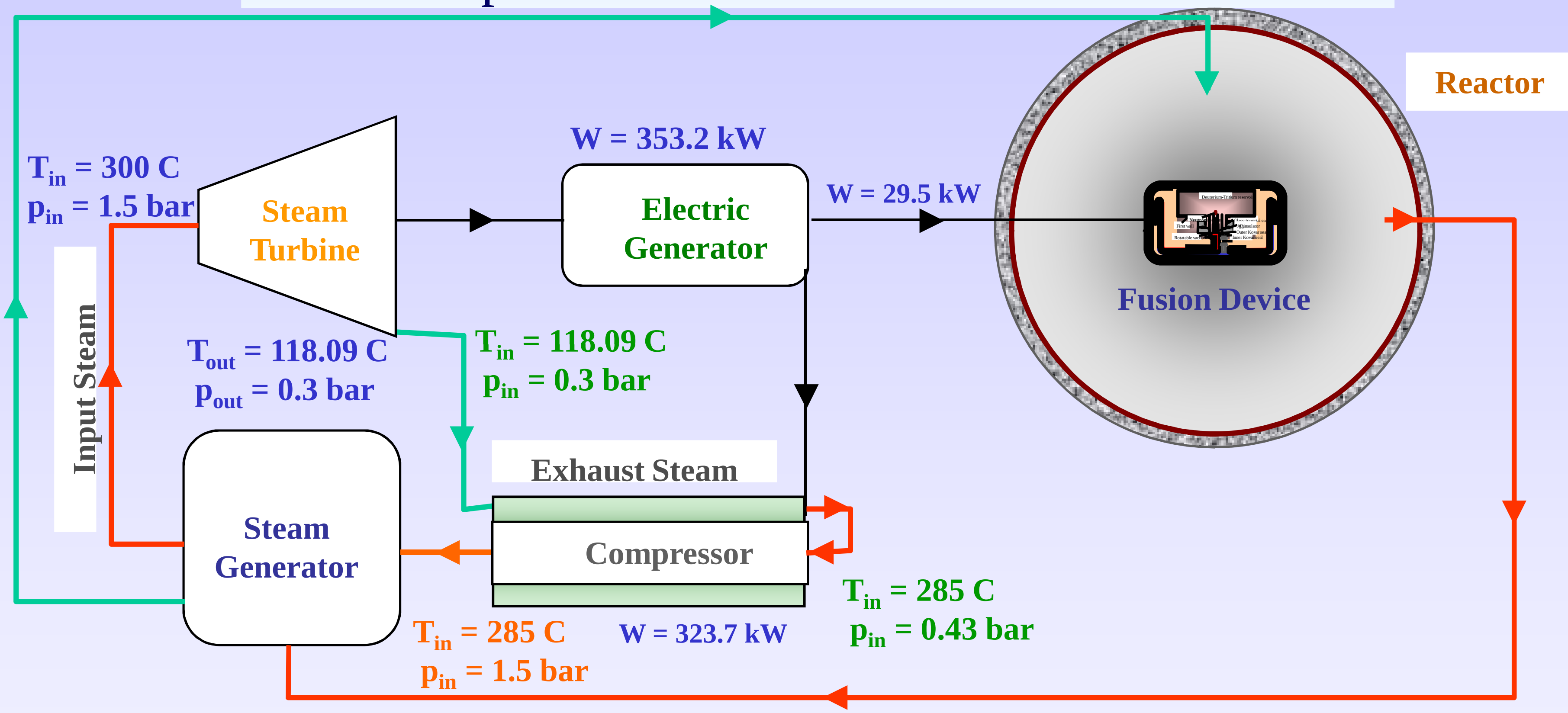
The cooling steam is now entering the Compressor

Conceptual Solution of the Fusion Problem



The compressed steam can now re-enter the Steam Generator. There is no rejected heat.

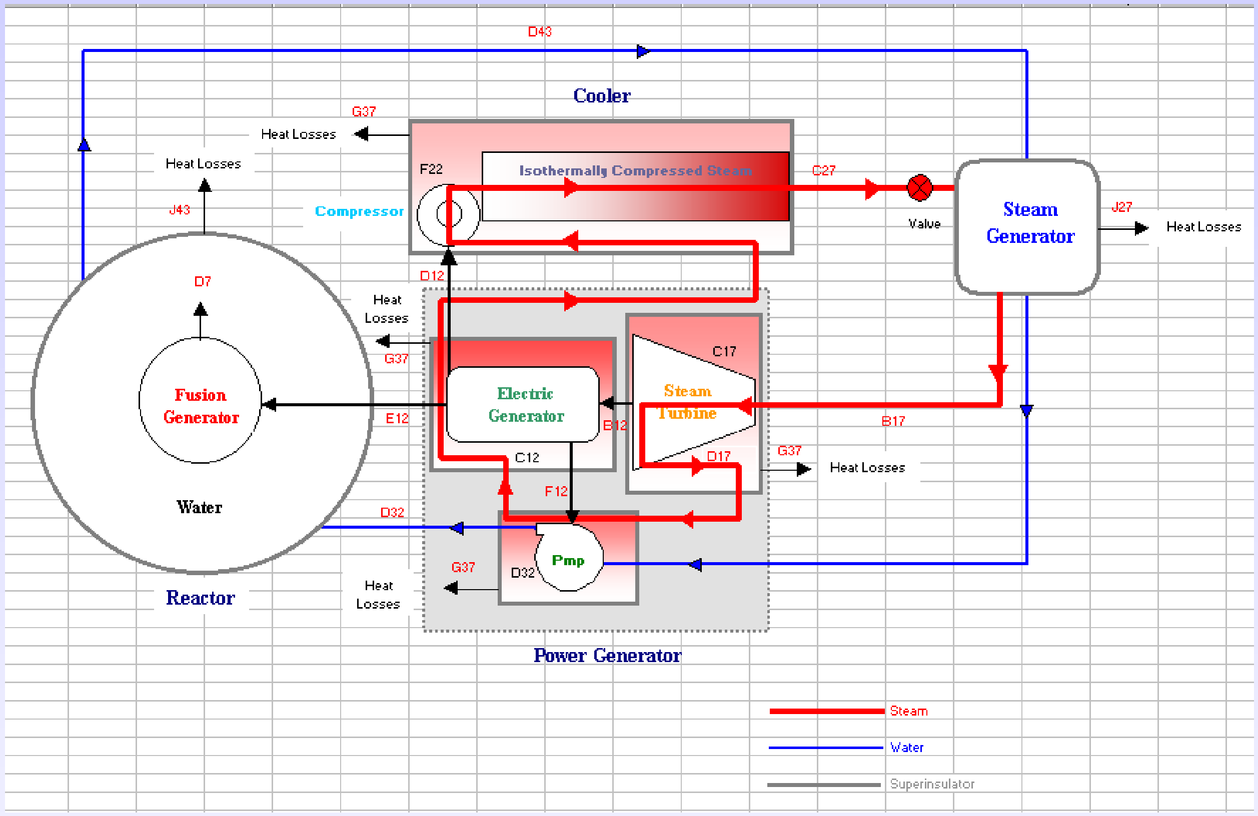
Conceptual Solution of the Fusion Problem



The compressed steam can now re-enter the Steam Generator. There is no rejected heat.

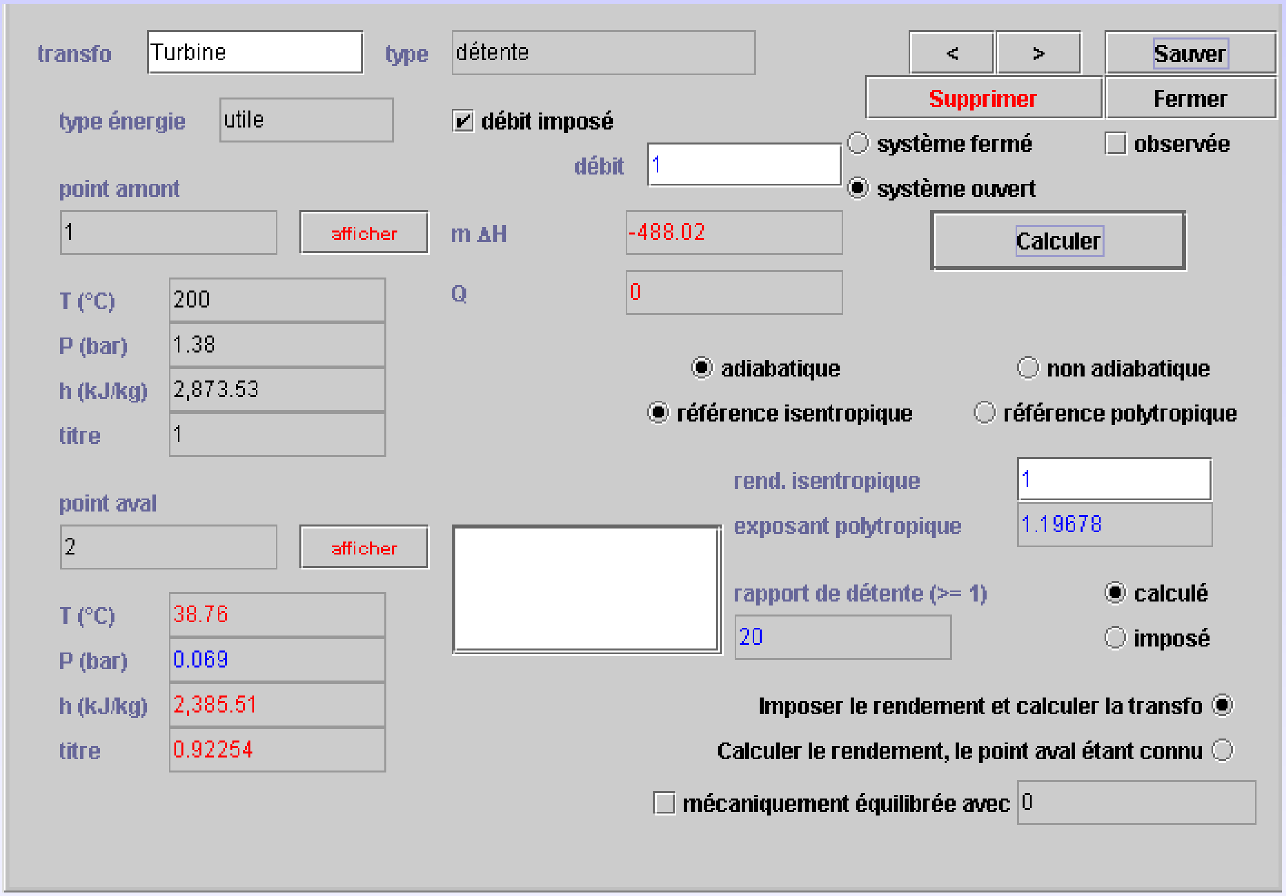
Simulation Results

The simulation has been done with the software Thermoptim available commercially and extensively used for optimization of power plants.

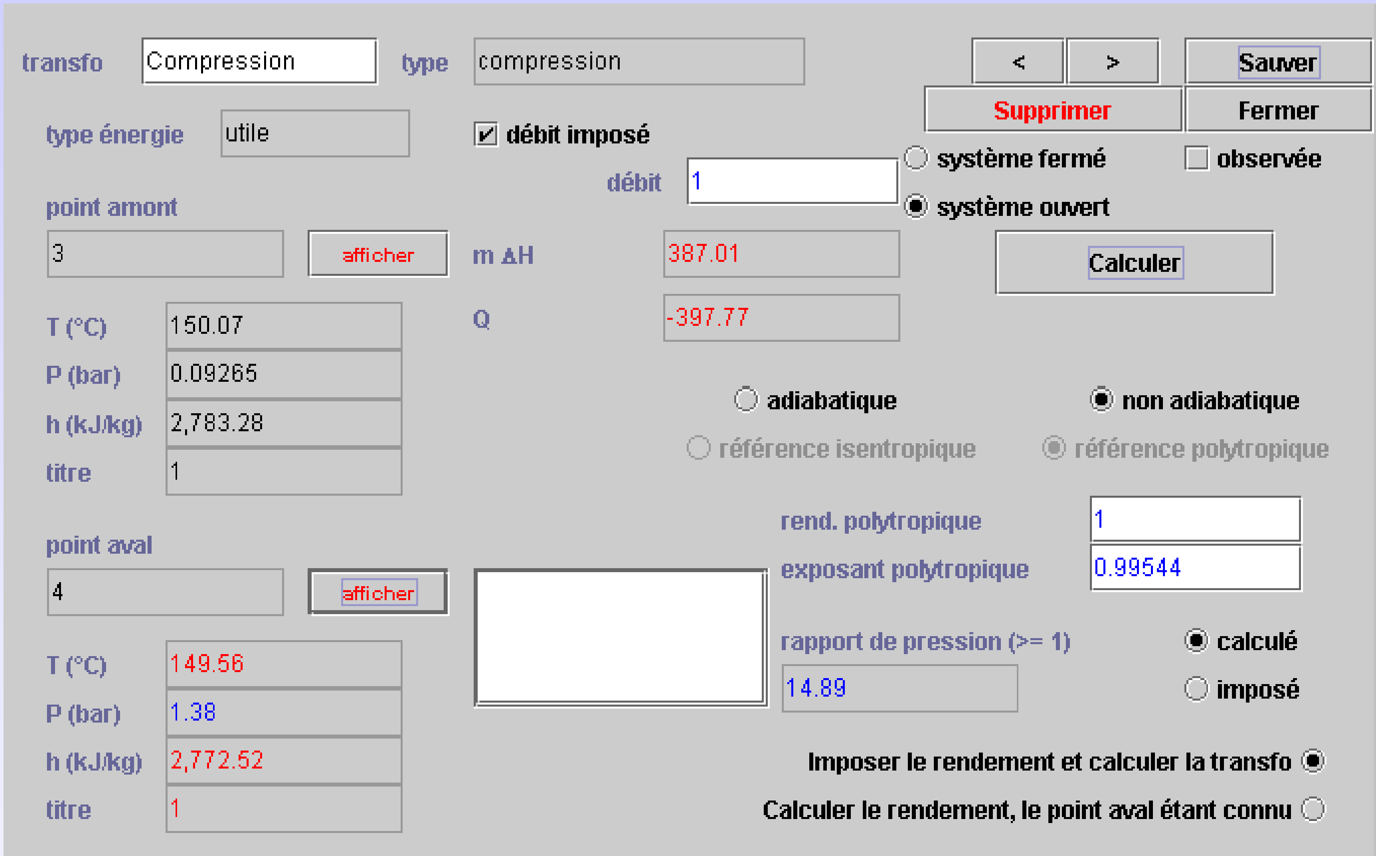


Basic schematic showing the steam cycle and the water cycle

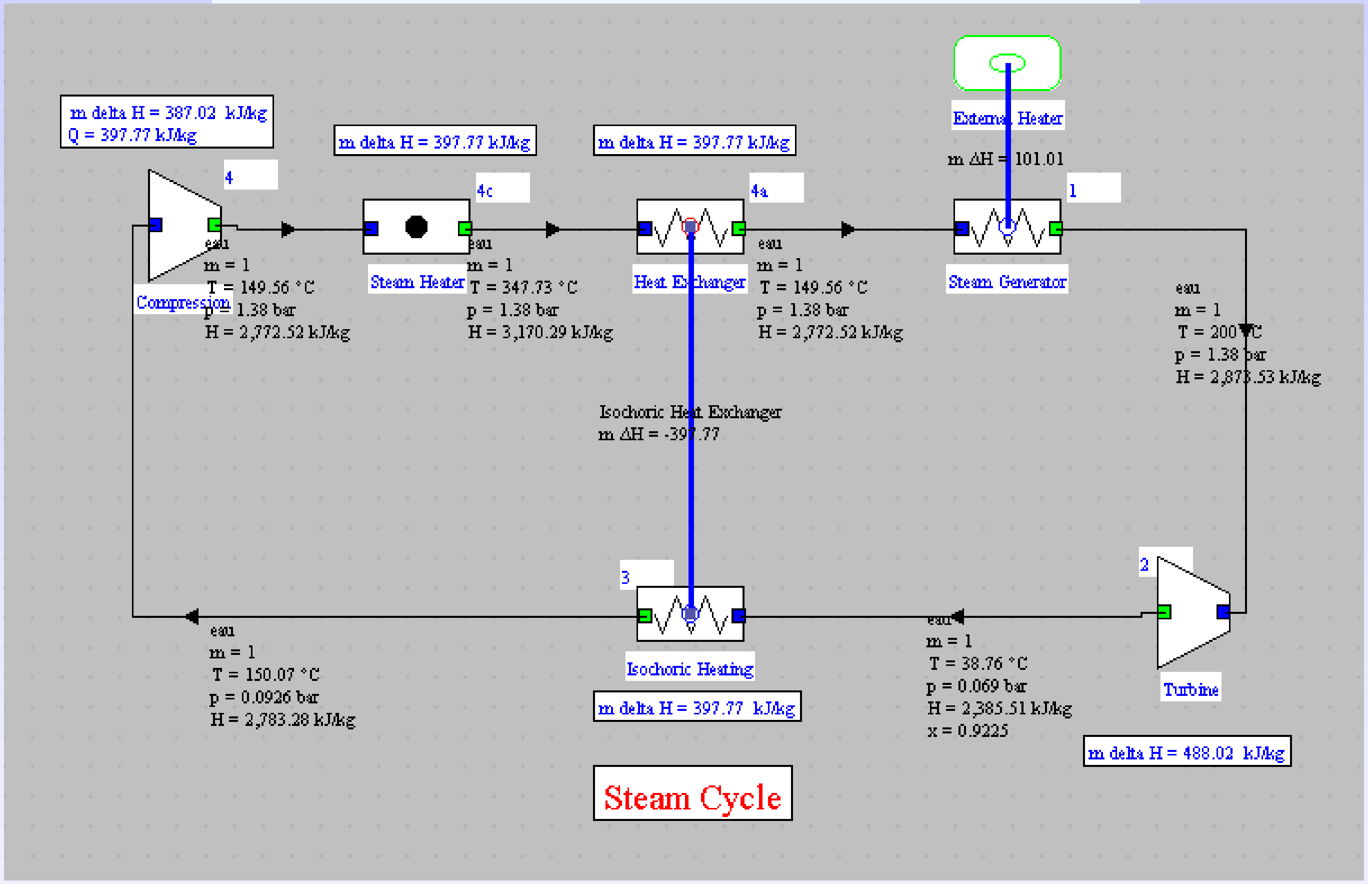
Simulation Results



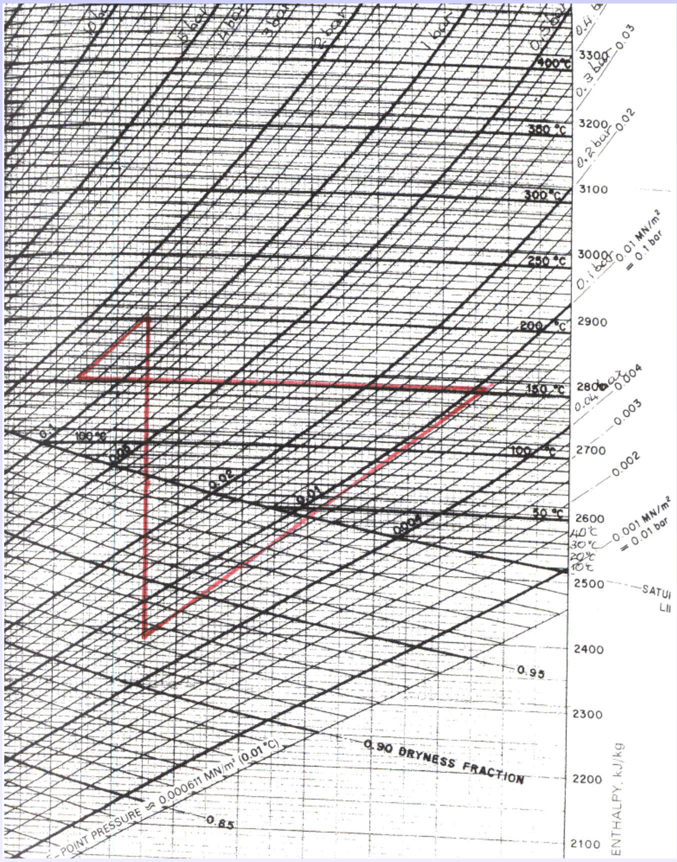
Simulation Results



Simulation Results



Simulation Results



The novel cycle is shown in the Mollier diagram.

Conclusions

- Breakeven is possible now, provided we recover the energy that we have used to generate a fusionable plasma.
- Through the use of a thermodynamic cycle that recycles the steam rather than rejecting its heat content, such energy can be recovered.
- This is confirmed both by a study done with conventional Steam Tables, and through a simulation study done with a software extensively used in the optimization of Power Plants.
- The achievement of the breakeven milestone would set the proper stage for work towards energy gain.