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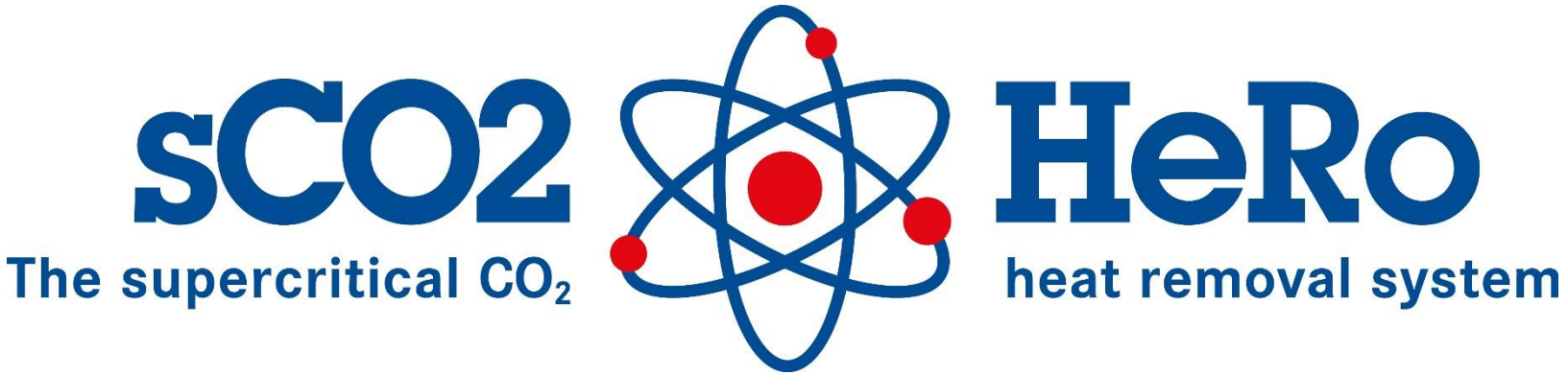
This project has received funding from the Euratom reseach and training programme 2014-2018 under grant agreement No 662116.

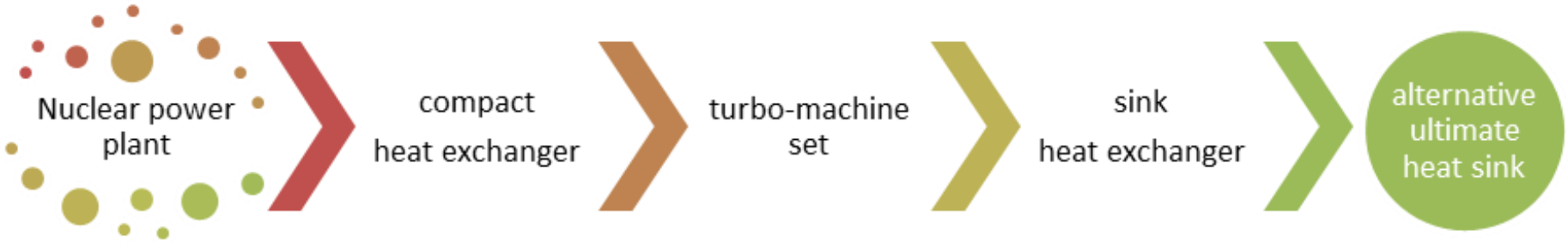


A supercritical CO_2 low temperature Brayton-cycle for residual heat removal

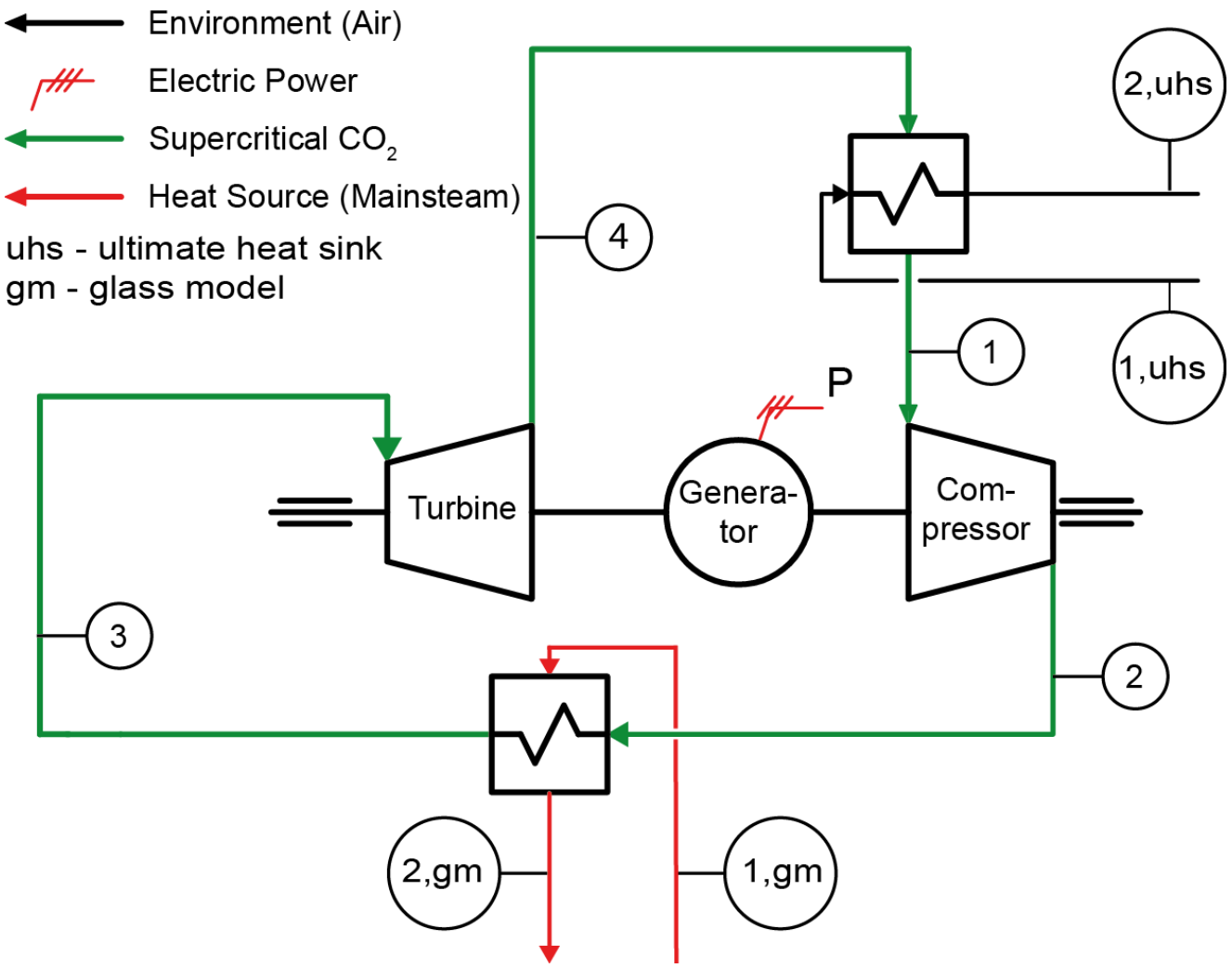
F.-K. Benra, D. Brillert, O. Frybort, P. Hajek, M. Rohde, S. Schuster, M. Seewald, J. Starflinger

The idea …

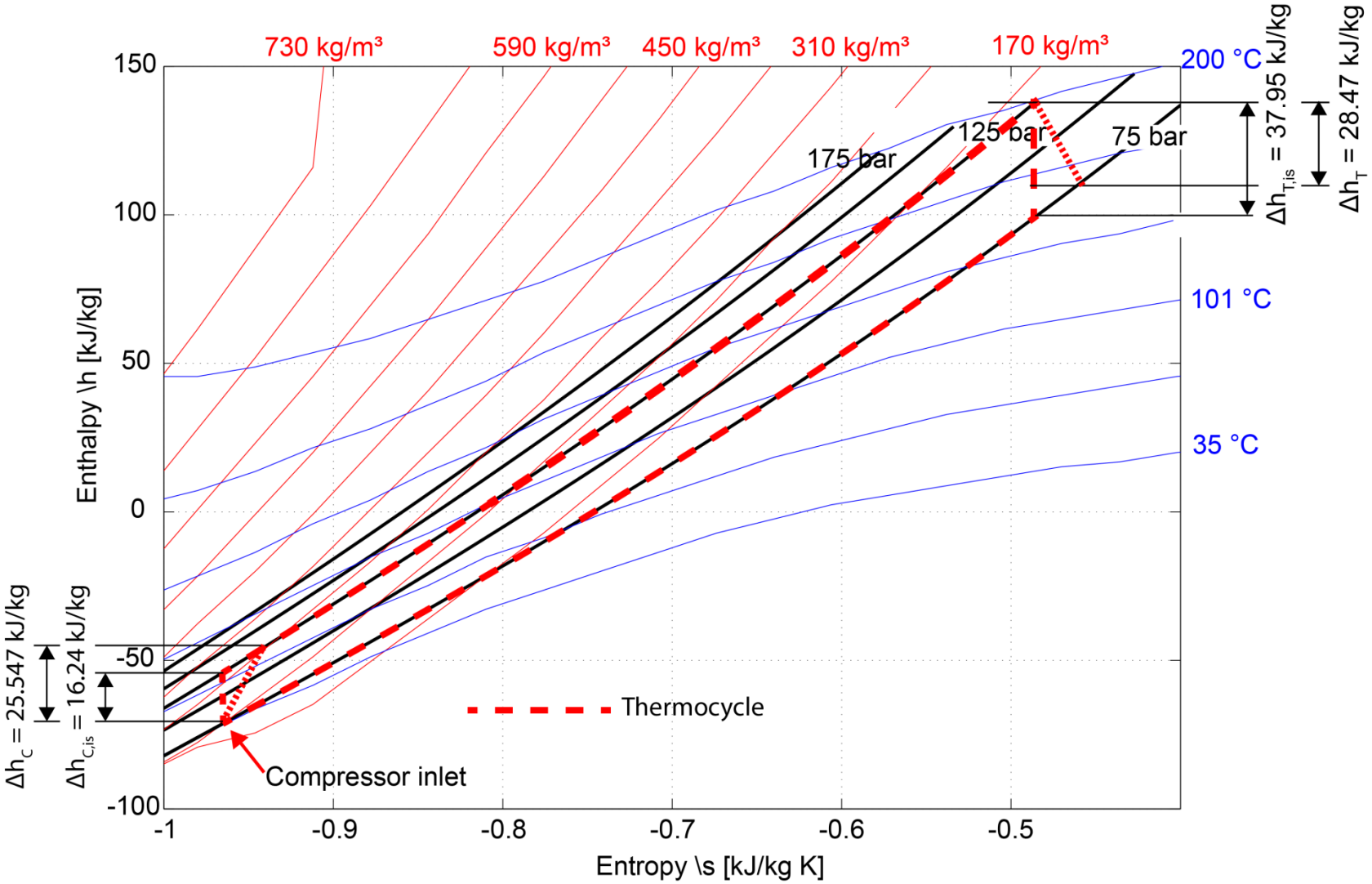
http://www.spreadnews.de/wp-content/uploads/2013/11/artikelbild-offizielles-foto-kkw-akw-fukushima-daiichi-tepco.jpg



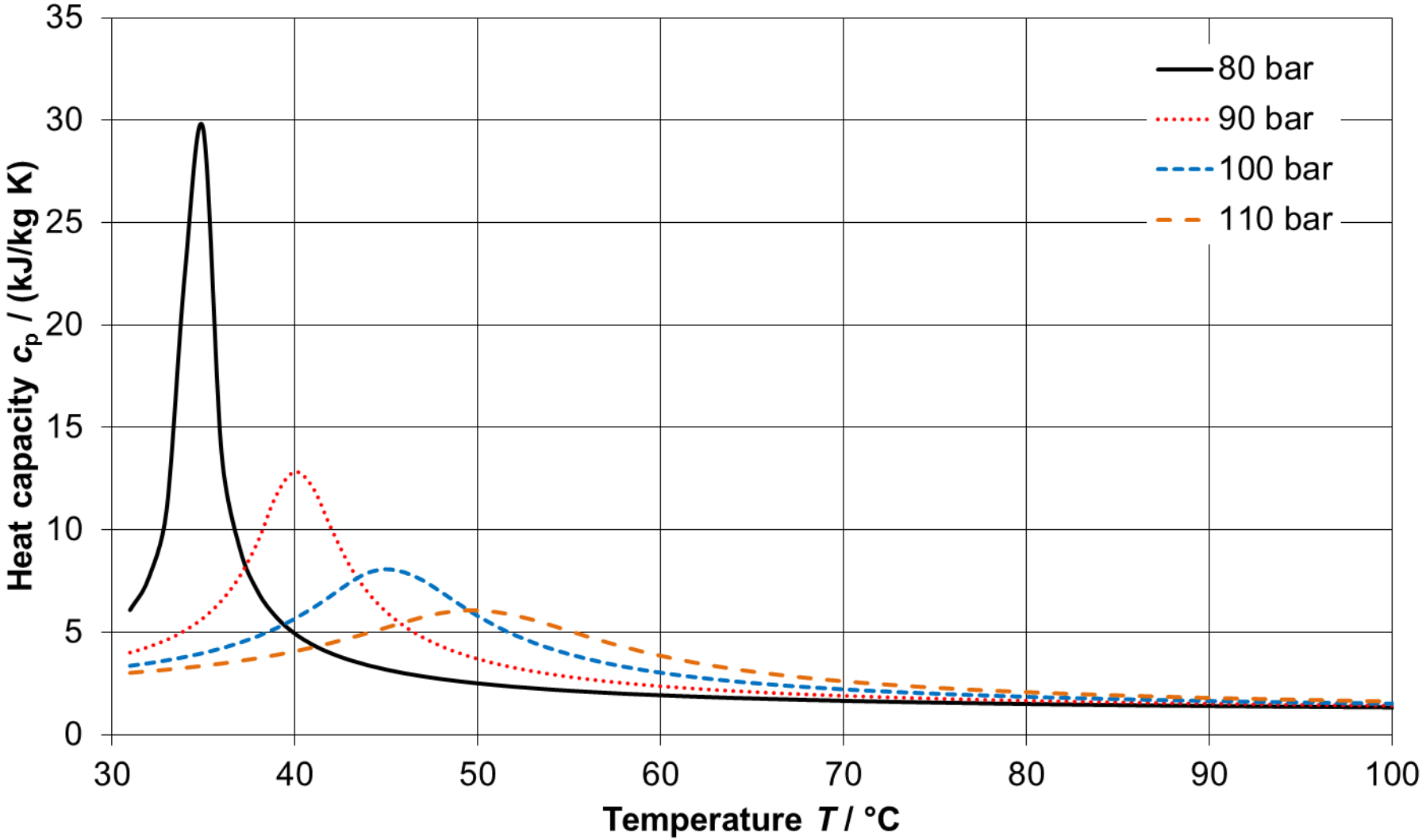
The technical realisation …



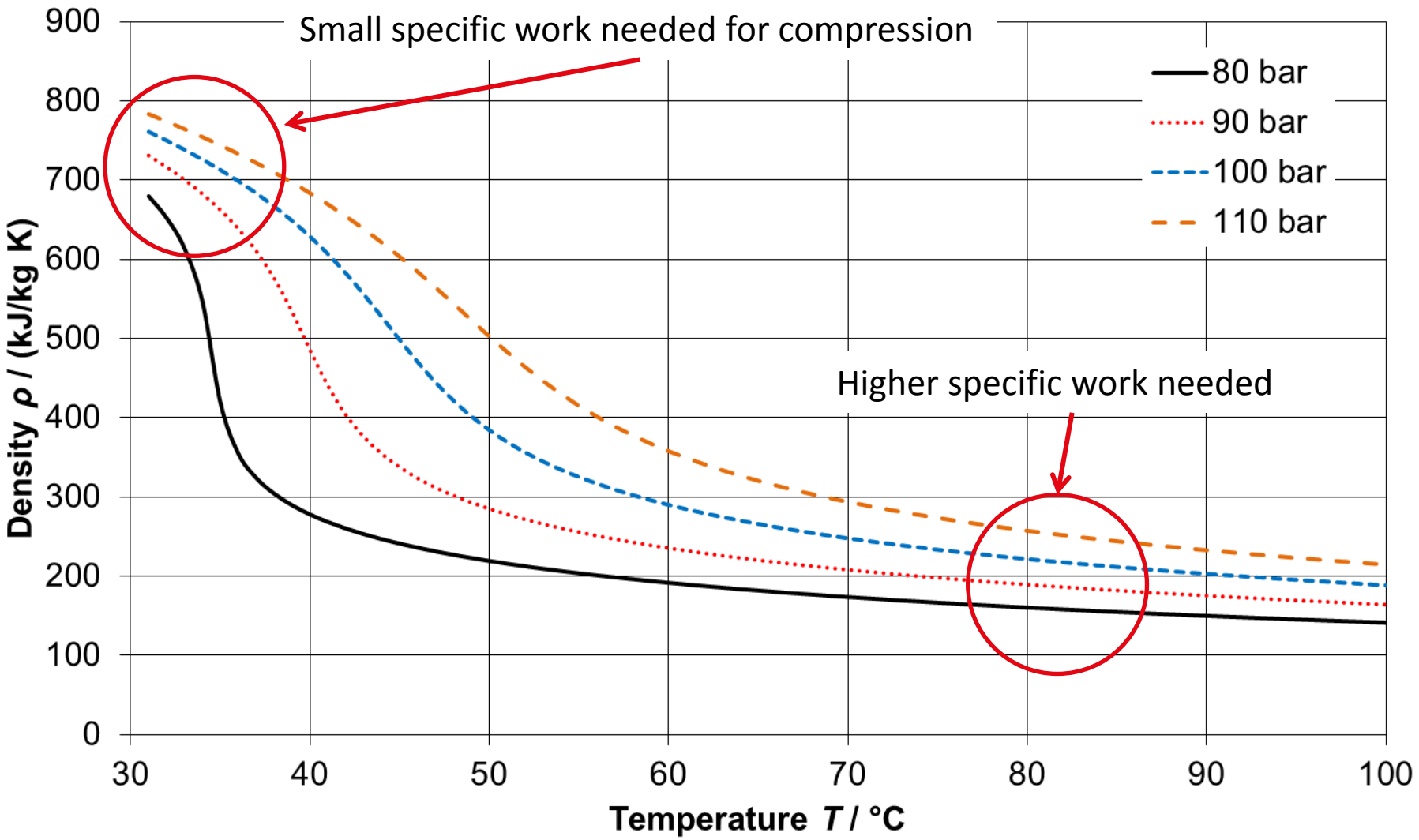
The thermodynamics behind …



Fluid properties …

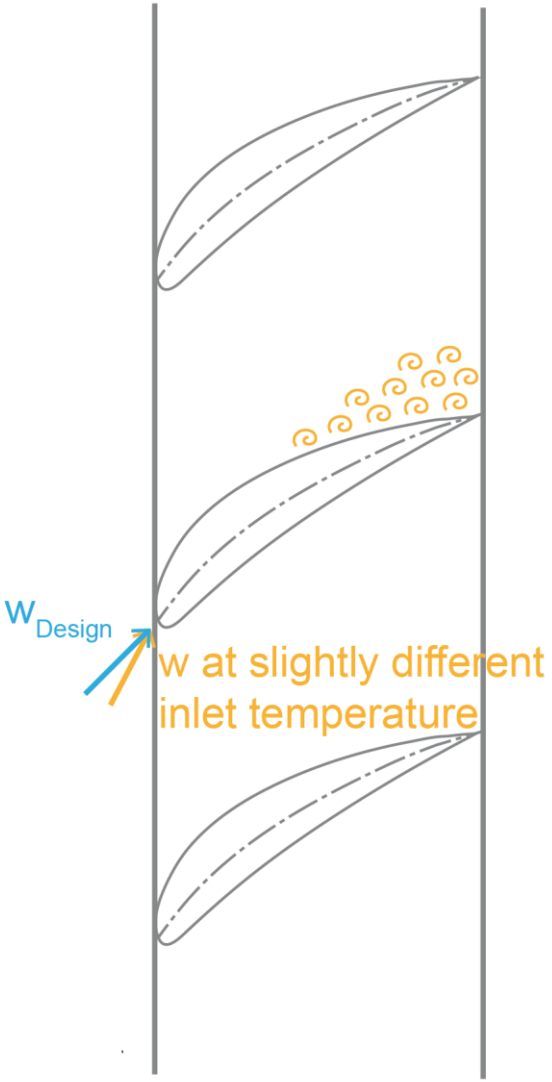


Density …

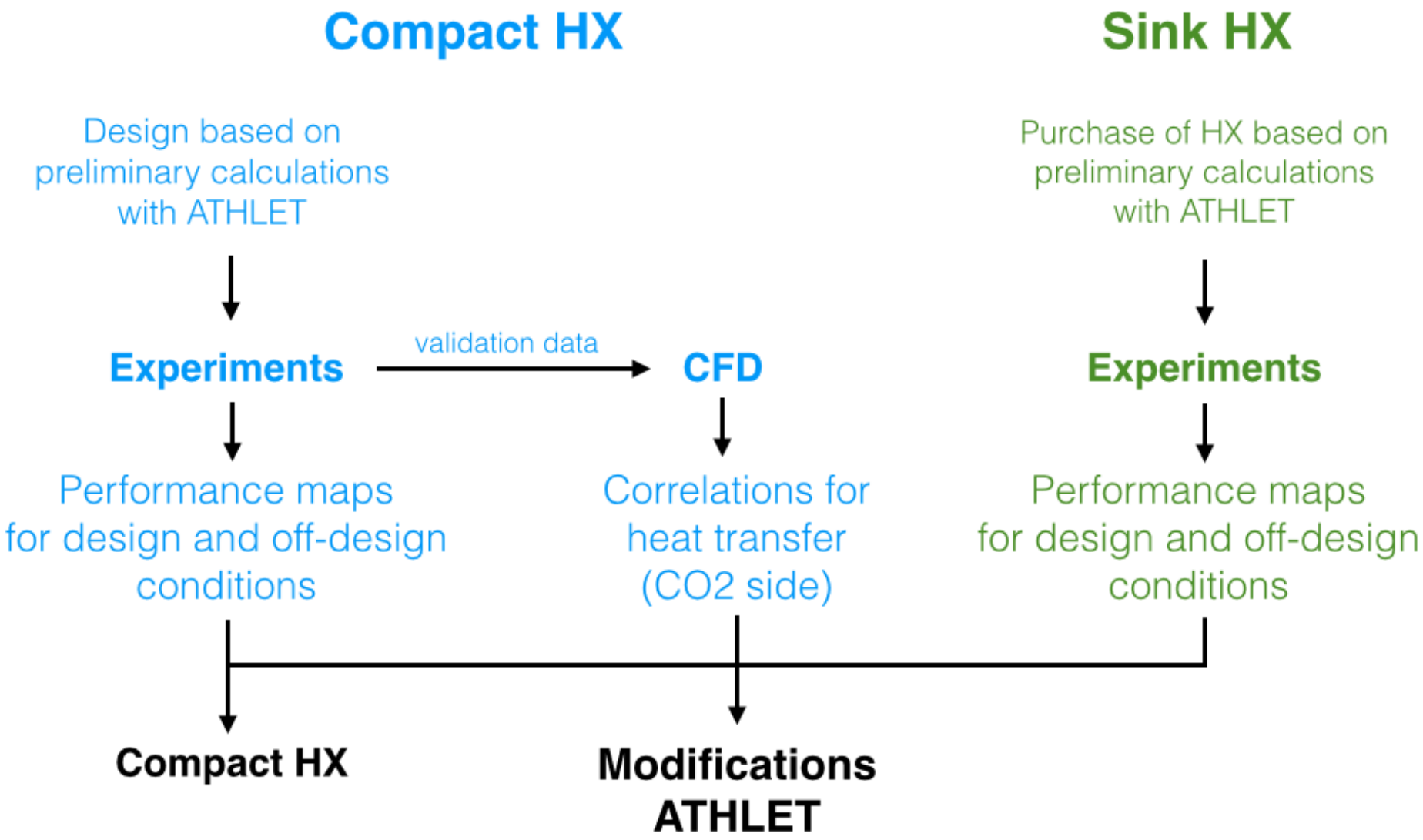

Small specific work needed for compression
Higher specific work needed
80 bar
90 bar
100 bar
110 bar
Density ρ / (kJ/kg K)
900
800
700
600
500
400
300
200
100
0
30
40
50
60
70
80
90
100
Temperature T / °C

Incidence caused by density variation

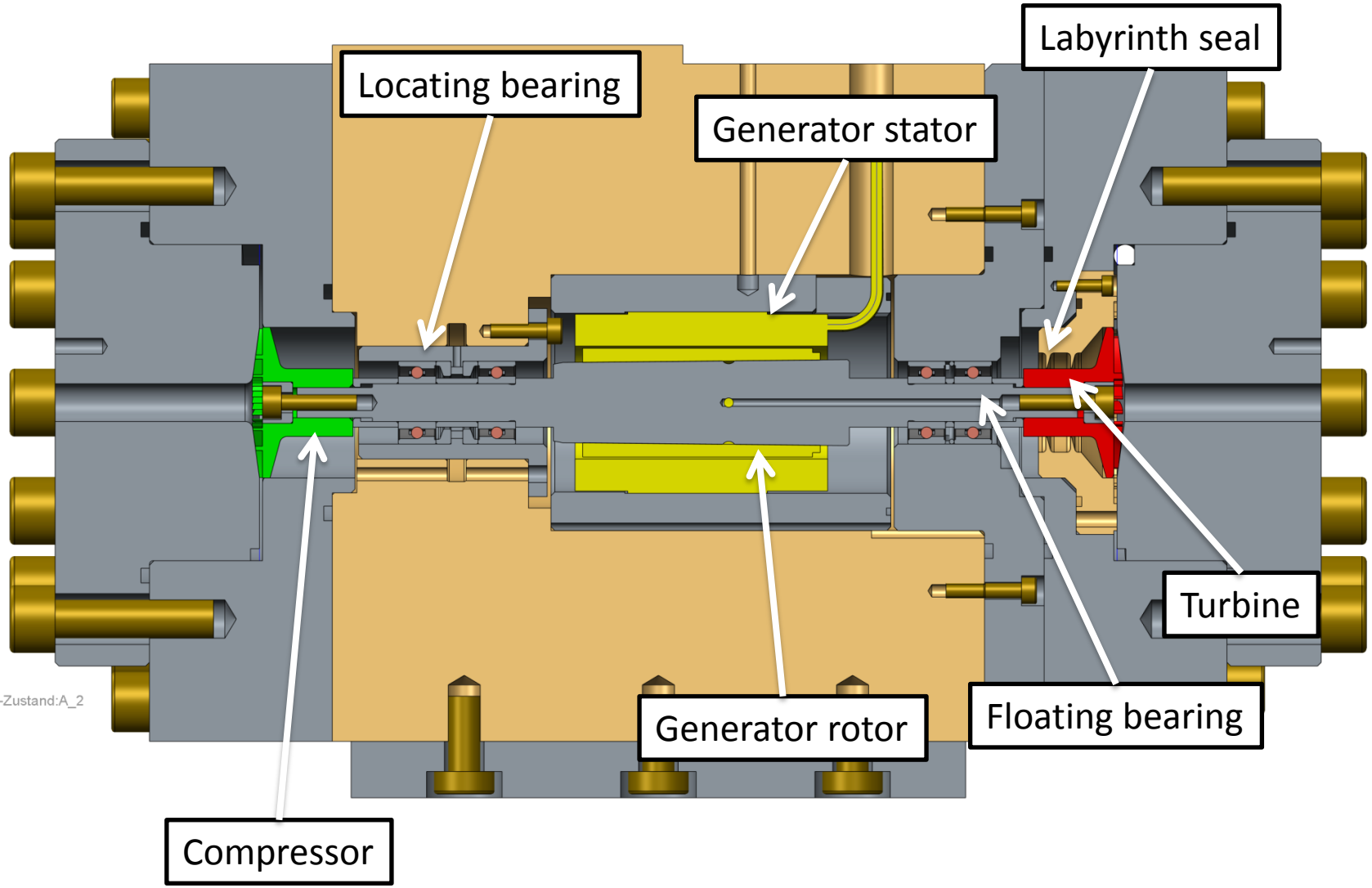
- **Inlet close above the critical point**
- **Changes of the inlet temperature will have a strong impact on the density**
- **Induced variation of inlet conditions requires a special blade shape design**
- **To preserve a wide range of operation and to sustain the efficiency on a high level**



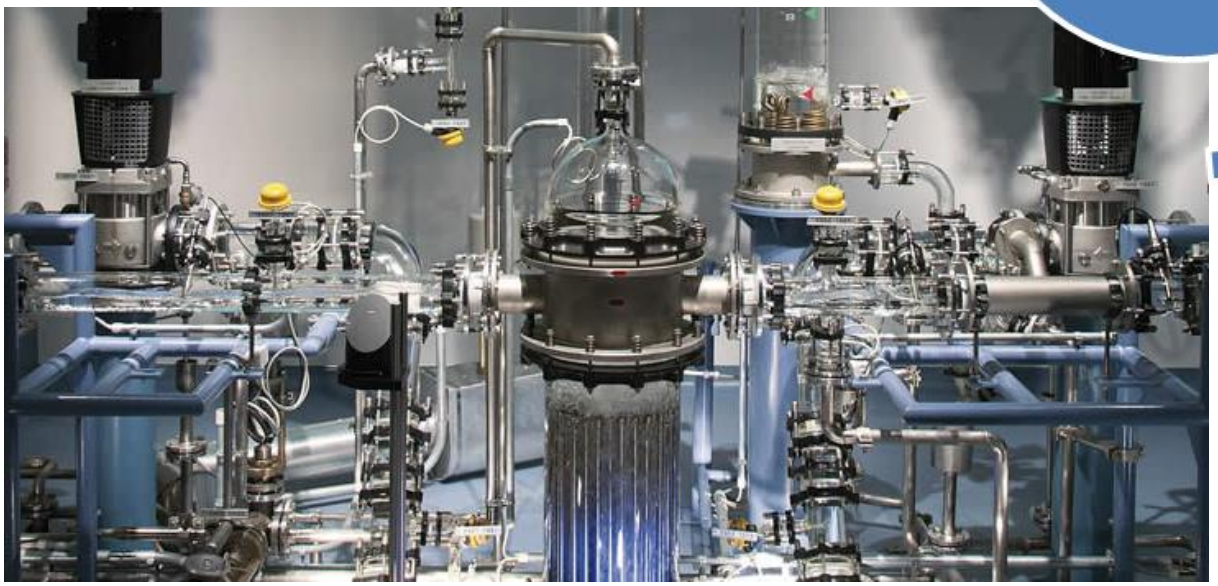
Consequences for heat transfer



The driving unit …



Properly implement the action…



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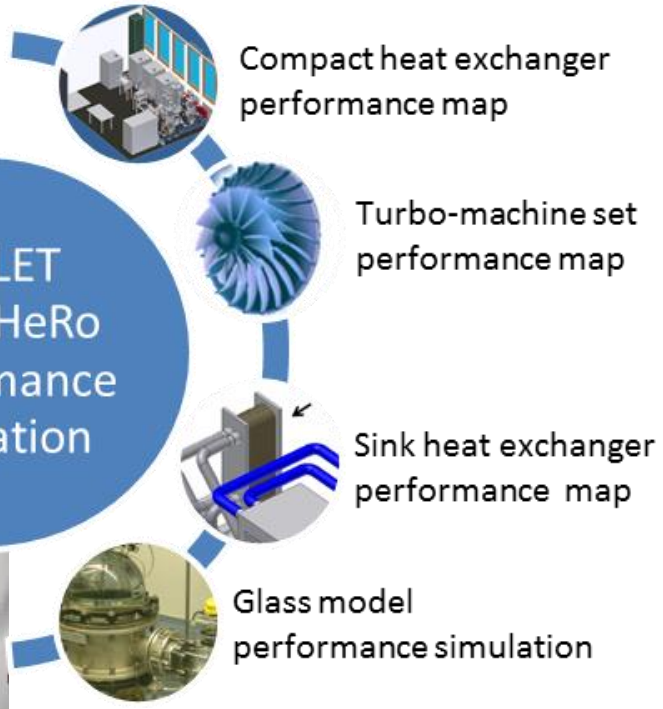
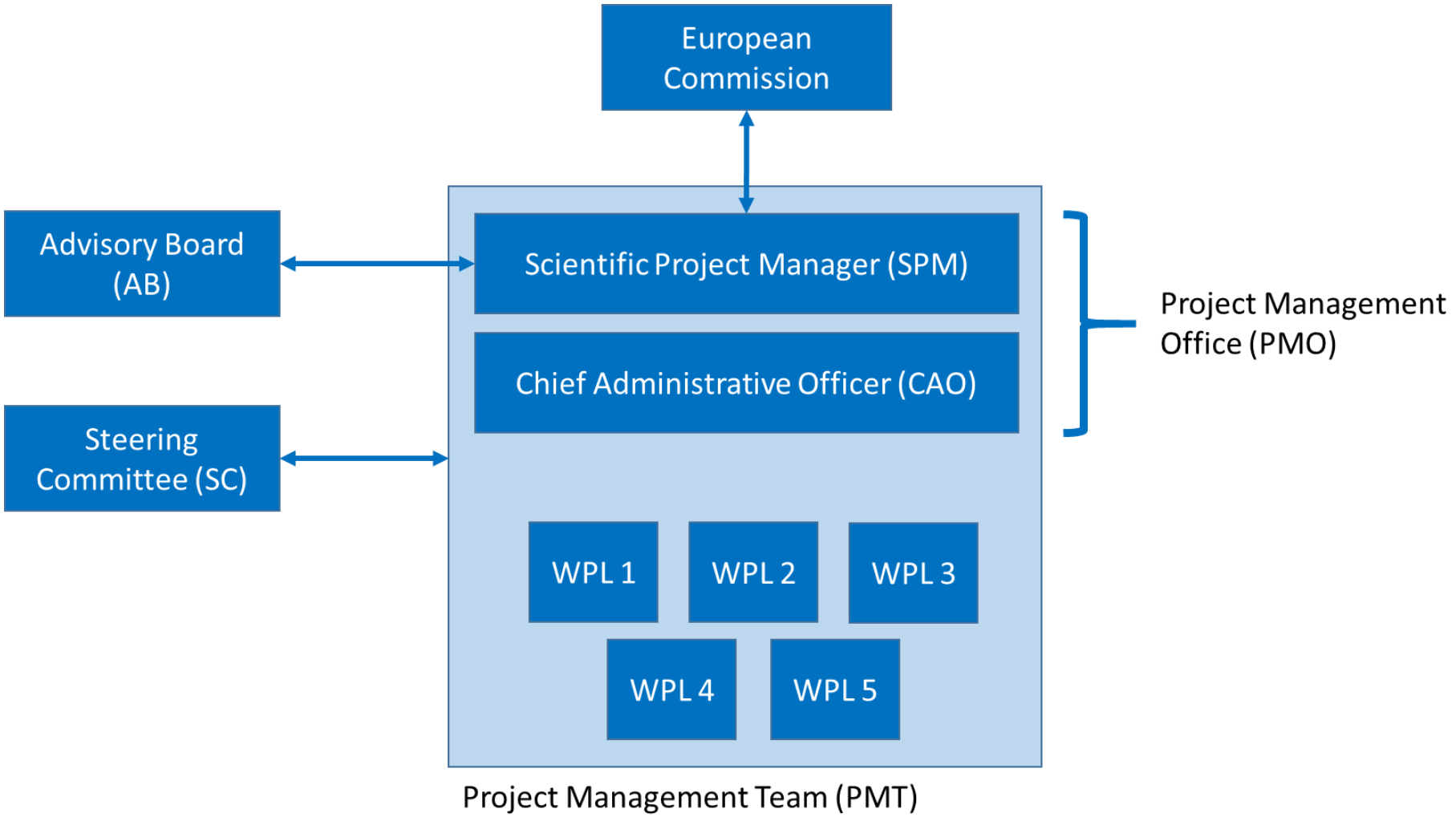


The team…


European Commission
Advisory Board (AB)
Scientific Project Manager (SPM)
Chief Administrative Officer (CAO)
Project Management Office (PMO)
Steering Committee (SC)
WPL 1
WPL 2
WPL 3
WPL 4
WPL 5
Project Management Team (PMT)

Properly implement the action …

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- **Further develop sCO2-HeRo from TRL2 to TRL3**

- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment
- TRL 6 – technology demonstrated in relevant environment
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

Ground breaking aspects…

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- **Development of a self-propellant safety system for heat removal in nuclear power plants**
- **Fundamental knowledge about heat transfer in turbulent, supercritical flows, and its translation to practical heat transfer correlations**
- **The application of diffusion welded compact heat exchanger to nuclear reactors**
- **Design criterions for the turbomachines working in the supercritical regime close to the critical point**
- **Advanced blade contouring for operation in the supercritical regime close to the critical point**
- **Autarkic start-up system (self-launching)**

Impact…

- **TRL9 - system provides more time for additional severe accident scenarios**
- **Increases acceptance of NPPs within population**
- **Reduces CO2 emissions**
- **Increase competiveness of industry**

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sCO2 HeRo

The supercritical CO_2 heat removal system

Thank you for your attention!