6.3 Concept for a possible optimisation of Hot Fusion

Introduction to the fusion process:

Hot fusion – the process in the sun

The fusion processes in the sun have been modelled using the Bethe-Weizäcker cycle, which takes place at a pressure of around 300 billion bar and a temperature of approx. 15 million °C. Initial fusion processes promote the production of hydrogen ^{1}H to helium ^{4}He with radiation ɣ and heat:

$$^{1}H^{+} + {}^{1}H^{+} \rightarrow {}^{2}H^{+} + e^{+} + e^{-} + 0{,}42\ \text{MeV} \qquad (6.01)$$

$$^{2}H^{+} + {}^{1}H^{+} \rightarrow {}^{3}He^{2+} + \gamma + 5{,}49\ \text{MeV} \qquad (6.02)$$

$$^{3}He^{2+} + {}^{3}He^{2+} \rightarrow {}^{4}He^{2+} + {}^{1}H^{+} + {}^{1}H^{+} + 12{,}86\ \text{MeV} \qquad (6.03)$$

Hot fusion – state of the art

Hot fusion is being researched at the Cadarache nuclear research centre in southern France and at the Tokamak or Wendelstein 7x in Greifswald. Here, the elements deuterium and tritium are heated to approx. 100 million °C in a microwave-like process to form a fusion-capable plasma. Plasma is a state of matter in which positively charged fions, negatively charged electrons and neutral particles with high entropy move randomly in relation to each other. They can be manipulated electrically or magnetically. The elements are supplied with energy by the microwaves of the so-called gyrotron as an external energy source. The multiple microwave frequencies couple to the coupling frequency of the electron, which sets the electron in motion and continuously heats the plasma. With sufficient heat, a threshold is exceeded that is sufficient for a fusion reaction. The plasma is guided in a twisted magnetic field and accelerated linearly. In the narrow plasma jet, the atoms lean against each other to such an extent that the fusion process begins. Helium and a neutron are produced, releasing heat. The neutron and the heat released are captured on a reactor wall. The heat is transferred to a water boiler, which conventionally drives a generator via a high-pressure turbine to generate electricity.

The hot fusion process was selected using the elements deuterium ^{2}H and tritium ^{3}H to form helium ^{4}He, which is largely radiation-free and heat-generating:

$$^{2}H^{+} + {}^{3}H^{+} \rightarrow {}^{4}He^{2+} + \text{neutron} + 14{,}1\ \text{MeV} \qquad (6.04)$$

Framework for this model:

Within the framework of FSM, the optimisation of hot fusion and a concept for the economic utilisation of cold fusion will be presented below. The multiple frequency of all fusion elements is the coupling frequency of the proton. The required radiation energy of the external energy source must only correspond to a multiple of the proton.

Possible optimisation of hot fusion :

To optimise hot fusion, a similar process based on the state of the art should be found, in which more energy is generated than is added. In this case, the elements should be hydrogen ^{1}H, which is converted to helium ^{4}He with heat radiation of:

[0,42 MeV + 5,49 MeV + 12,86 MeV = 18,77 Mev]

The fusion threshold is reached through constant coupling with a suitable coupling frequency between the external energy source and the hydrogen over a period of time that is yet to be determined.

Technical concept for optimising hot fusion:

Technically, the design of the Wendelstein 7x can be used. The difference in using the gyrotron as an external energy source is that it is no longer the electrons, but the protons that are directly excited to start the fusion process. For this purpose, the coupling frequencies of the proton for the 5th dimensional family are used.

Energy enrichment with suitable coupling frequency for the hot fusion process with hydrogen ^{1}H to helium ^{4}He:

A plasma mass of 50 g = 0.05 kg is to be used.

$f_e = 1{,}2356\ 10^{-20}\ \mathrm{Hz}\ ;\ M_e = 9{,}1094\ 10^{-31}\ \mathrm{kg}\ ;\ h = 6{,}626\ 10^{-34}\ \mathrm{Js}\ ;\ c = 299792458\ \frac{\mathrm{m}}{\mathrm{s}}$

$M_{obj}\ k_{obj} = 4{,}0396\ 10^{35}\ \frac{\mathrm{kg}}{\mathrm{s}}$

$$\lambda_{proton} = \frac{c}{1845{,}28125\ f_e} = \frac{299792458\ \frac{\mathrm{m}}{\mathrm{s}}}{1845{,}28125 \cdot 1{,}2356\ 10^{20}\ \mathrm{Hz}} = 1{,}315\ 10^{-15}\ \mathrm{m} \qquad (6.05)$$

The mass of the proton according to the FSM photon model:

$$M_{proton} = \frac{h\ c^2}{G\ \{M_{obj}\ k_{obj}\}\ \lambda_{proton}} = 1{,}681\ 10^{-27}\ \mathrm{kg}$$

The mass of the proton according to the FSM particle model:

M_{proton} = 1845,28125 M_e = 1,681 10^{-27} kg (calculated proton mass)

M_{proton} = 1836,15 M_e = 1,6726 10^{-27} kg (measured proton mass)

In order to obtain two possible settings, we will now continue with the measured and calculated masses.

Coupling frequency for protons:

For the calculated proton mass:

$$f_{proton} = \frac{1}{2} [\frac{4}{3} (\frac{3}{2})^3]^5 \frac{6}{3} f_e = 1845{,}28125\, f_e = 1845{,}28125 \cdot 1{,}2356\ 10^{20}\ \text{Hz}$$

f_{proton} = 2,28003 10^{23} Hz

$E_{proton} = h\, f_{proton}$ = 6,626 10^{-34} Js · 2,28 10^{23} Hz = 1,51075 10^{-10} J

For the measured proton mass:

$$f_{proton} = \frac{1}{2} [\frac{4}{3} (\frac{3}{2})^3]^5 \frac{6}{3} f_e = 1836{,}15\, f_e = 1836{,}15 \cdot 1{,}2356\ 10^{20}\ \text{Hz}$$

f_{proton} = 2,268747 10^{23} Hz

$E_{proton} = h\, f_{proton}$ = 6,626 10^{-34} Js · 2,268747 10^{23} Hz = 1,5033 10^{-10} J

Number of protons in a hydrogen ^{1}H mixture of 50 g:

$$n_{protons} = \frac{m_{proton\ mass}}{m_{proton}} \qquad \text{with: } n\ \varepsilon\ \mathrm{N} \qquad (6.06)$$

For the calculated proton mass:

$$n_{protons} = \frac{0{,}05\ \text{kg}}{1{,}681\ 10^{-27}\ \text{kg}} = 2{,}974\ 10^{25}$$

For the measured proton mass:

$$n_{protons} = \frac{0{,}05\ \text{kg}}{1{,}6726\ 10^{-27}\ \text{kg}} = 2{,}989\ 10^{25}$$

The multiple energy equivalent to be provided for $n_{protons}$ in order to enrich the gas mixture:

For the calculated proton mass:

$$E_{50g} = E_{proton}\, n_{protons} = 1{,}51075\ 10^{-10}\ \mathrm{J} \cdot 2{,}974\ 10^{25} = 4{,}493\ 10^{15}\ \mathrm{J} \qquad (6.07)$$

For the measured proton mass:

$$E_{50g} = E_{proton}\, n_{protons} = 1{,}5033\ 10^{-10}\ \mathrm{J} \cdot 2{,}989\ 10^{25} = 4{,}4934\ 10^{15}\ \mathrm{J}$$

Since the frequencies to be set and the respective energy equivalents are not technically feasible, they are factored by two. Halving the frequency is permissible in communication technology because halving the frequency of an electromagnetic wave does not change the form of its comprehensive original frequency. It should be noted that scaling also scales the deviations and tolerances accordingly. Fine adjustment of the frequency will probably have to be inversely proportional to the scaling.

The coupling frequency and radiation energy are scaled by a factor of 2:

Proposal for scaling with: 2^{40}

For the calculated proton mass:

$$\underline{\underline{f_{proton,scaled} =}} \frac{2{,}28003\ 10^{23}\ \mathrm{Hz}}{2^{40}} = \underline{\underline{207{,}368\ \mathrm{GHz}}} \qquad \text{(coupling frequency)}$$

$$E_{proton,scaled} = \frac{1{,}51075\ 10^{-10}\ \mathrm{J}}{2^{40}} = 1{,}374\ 10^{-22}\ \mathrm{J} \qquad \text{(energy content per proton mass)}$$

$$E_{50g,scaled} = \frac{4{,}493\ 10^{15}\ \mathrm{J}}{2^{40}} = 4086{,}4\ \mathrm{J} \qquad \text{(Energy content for 50 g proton mass)}$$

$$\underline{\underline{P_{input,scaled} =}} \frac{4086{,}4\ \mathrm{J}}{\mathrm{s}} = \underline{\underline{4086{,}4\ \mathrm{kW}}} \qquad \text{(frequency-dep. input for 50 g plasma mass)}$$

For the measured proton mass:

$$\underline{\underline{f_{proton,scaled} =}} \frac{2{,}268747\ 10^{23}\ \text{Hz}}{2^{40}} = \underline{\underline{206{,}341\ \text{GHz}}} \qquad \text{(coupling frequency)}$$

$$E_{proton,scaled} = \frac{1{,}5033\ \ 10^{-10}\ \text{J}}{2^{40}} = 1{,}367\ 10^{-22}\ \text{J} \qquad \text{(energy content per proton mass)}$$

$$E_{50g,scaled} = \frac{4{,}4934\ 10^{15}\ \text{J}}{2^{40}} = 4086{,}7\ \text{J} \qquad \text{(energy content for 50 g proton mass)}$$

$$\underline{\underline{P_{input,scaled} =}} \frac{4086{,}7\ \text{J}}{\text{s}} = \underline{\underline{4{,}0867\ \text{kW}}} \qquad \text{(frequency-dep. input for 50 g plasma mass)}$$

If the correct coupling frequency of the external energy source in the GHz range resonates with that of the proton, then the reactor requires a constant radiation power of only approx. 4,1 kW for a plasma mass of 50 g. The irradiation time for fusion remains open for the time being.

Compared to Wendelstein 7x, which operates at approx. 140 GHz and 1–15 MW, electromagnetic excitation takes place using the FSM concept at a coupling frequency of approx. 206 GHz and a power of 4,1 kW. Plasma generation would be 1000 times more efficiently if the coupling frequency were selected via protons rather than electrons.

Energy output :

The energy enrichment must only be continued until the plasmatic state is sufficient ($E(t) = h\, f_{proton} \frac{1}{\sin(kt)}$), to start the fusion process. However, the effect is comparable to the relativistic energy increase without an object velocity. Per total process for the fusion of

$6\ ^{1}H \rightarrow\ ^{4}H +\ ^{1}H +\ ^{1}H$

18,77 MeV is generated. If the entire plasma mass were to fuse, the following heat energy could be generated for electricity production.

For the calculated proton mass:

$n_{protons} = 2{,}974\ 10^{25}$

$$E_{output} = 18{,}77\ \text{MeV} \cdot 2{,}974\ 10^{25}\ \frac{1}{6}$$

$$\underline{\underline{E_{output\ ø} = 9{,}3\ 10^{26}\ \text{MeV}}}$$

For the measured proton mass:

$n_{protons} = 2{,}989\ 10^{25}$

$$E_{output} = 18{,}77\ \text{MeV} \cdot 2{,}989\ 10^{25}\ \frac{1}{6}$$

$$\underline{\underline{E_{output\ ø} = 9{,}35\ 10^{26}\ \text{MeV}}}$$

Comparison with the hot fusion process in the Wendelstein 7x:

$^{2}H^{+} + {}^{3}H^{+} \rightarrow {}^{4}He^{2+} + \text{neutron} + 14{,}1\ \text{MeV} \qquad n_{protonen} = 2{,}989\ 10^{25}$

$$E_{output} = 14{,}1\ \text{MeV} \cdot 2{,}989\ 10^{25}\ \frac{1}{5}$$

$$\underline{\underline{E_{output\ ø} = 8{,}43\ 10^{26}\ \text{MeV}}}$$

The output appears to be similar for both processes. The main difference lies in the generation of fusion with its ignition. By exciting protons instead of electrons, the input power is reduced by a factor of 1000. The comparison assumes that the temporal excitation of a plasma is modelled to be approximately the same length with the same pressure and temperature. The classic hot fusion process could start sooner here because it already contains higher elements. Another economic advantage of the optimized process, however, is that it now uses hydrogen—which is available in large quantities—instead of tritium. Natural tritium causes environmental damage during extraction. When produced artificially, it requires additional energy input, and its use necessitates more extensive shielding.

6.4 Concept for Cold Fusion

A possible concept for the technical implementation of cold fusion is to be provided for this model, which, like hot fusion, also enables energy to be gained. The concept presented is intended to be an initial approach.

A common coupling frequency is sought for the excitation to be set in the fusion process, which favours the process for a field-space shift. When a particle is shifted in the field-space, it automatically generates a quark-fion plasma. In the intermediate state between two field-space levels, the elements reach over 1000 times their mass and correspondingly strong interaction properties, which favours the fusion process even at lower temperatures. The fusion process no longer requires hot gas when it takes place in the field-space-shifted state.

Technical concept for implementing cold fusion:

For particles to be displaced between two field-space levels, there must be a surrounding potential field that encloses them and enriches them with energy. The Wendelstein 7x with its gyrotron is likely to be only partially suitable for this purpose. An alternative reactor design is proposed for the cold fusion concept. The hydrogen is electrolysed from H_2 to ^1H and introduced into a reactor chamber at room temperature. In the reactor chamber, an electromagnetic radiation field exists between two radiation surfaces. A static helical magnetic torsion field as shown in **Figure 6.5** is generated by means of a suitable torsion coil. Since the magnetic torsion field inside follows a 45° angle, an exactly orthogonal electric torsion field is present. At this location, the negative charge carriers are separated from the positive hydrogen $^1H^+$ and accelerated. The gas mixture of hydrogen $^1H^+$ and electrons e^- moves mechanically separated from each other along the electric torsion field. At the same time, the gas mixture is excited by microwave radiation from an external energy source at a suitable coupling frequency. The energy introduced is increased in a targeted manner with an efficiency of nearly 100%. At the centre of the torsion coil is a constriction through which the hydrogen atoms must pass during their orbit. At the constriction, the probability of fusion increases. The torsion field performs the same task as the superconducting coils in the Wendelstein 7x. The radiation surfaces replace the gyrotron, which continuously transfers its power to the reactor. After the fusion process, the heat generated is also removed conventionally at the reactor wall.

Figure 6.6 shows the structure and **Figure 6.7** shows the functioning of a torsion coil that generates a magnetic field inclined at 45° in the centre. Currently, there is no device that can build such a coil.

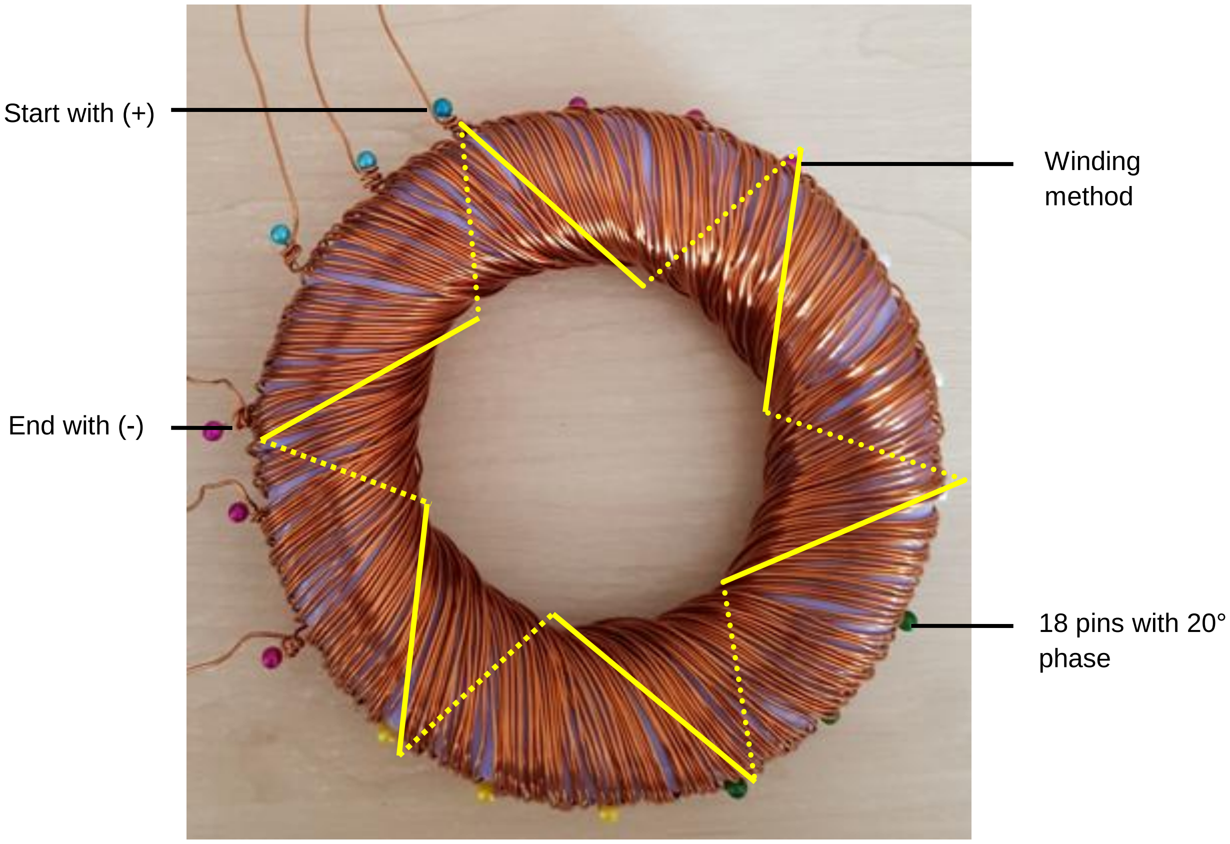

Figure 6.6: Structure of a torsion coil

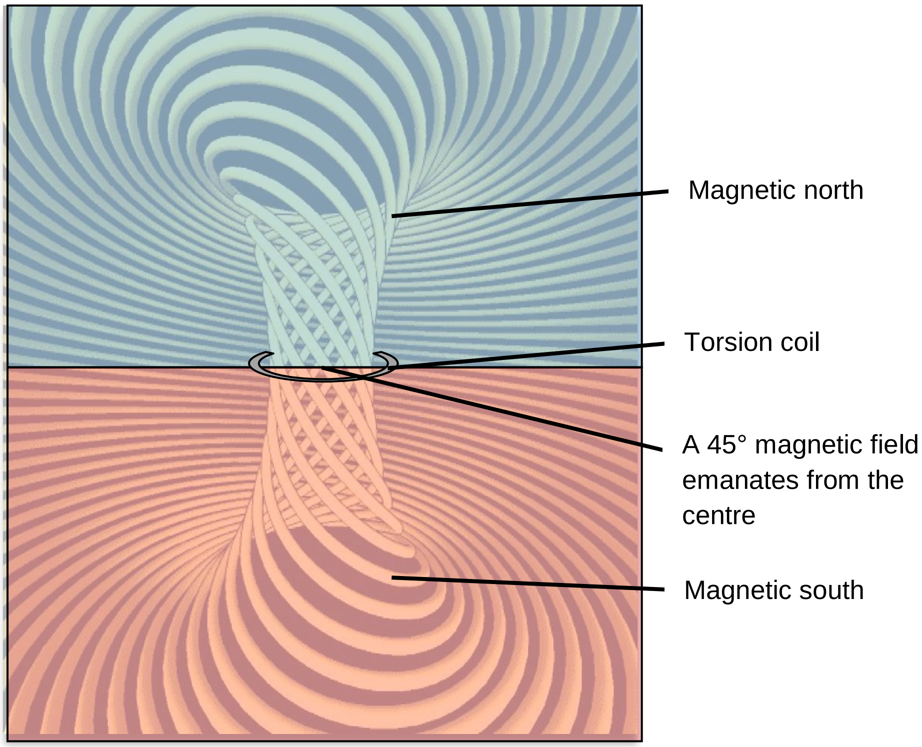

Figure 6.7: How a torsion coil works

Figures 6.8 and **6.9** show a conceptual design and the associated operating mechanism of a possible cold fusion reactor. The charge carriers separate within the torsion field, causing the hydrogen to undergo a mechanical periodic cycle.

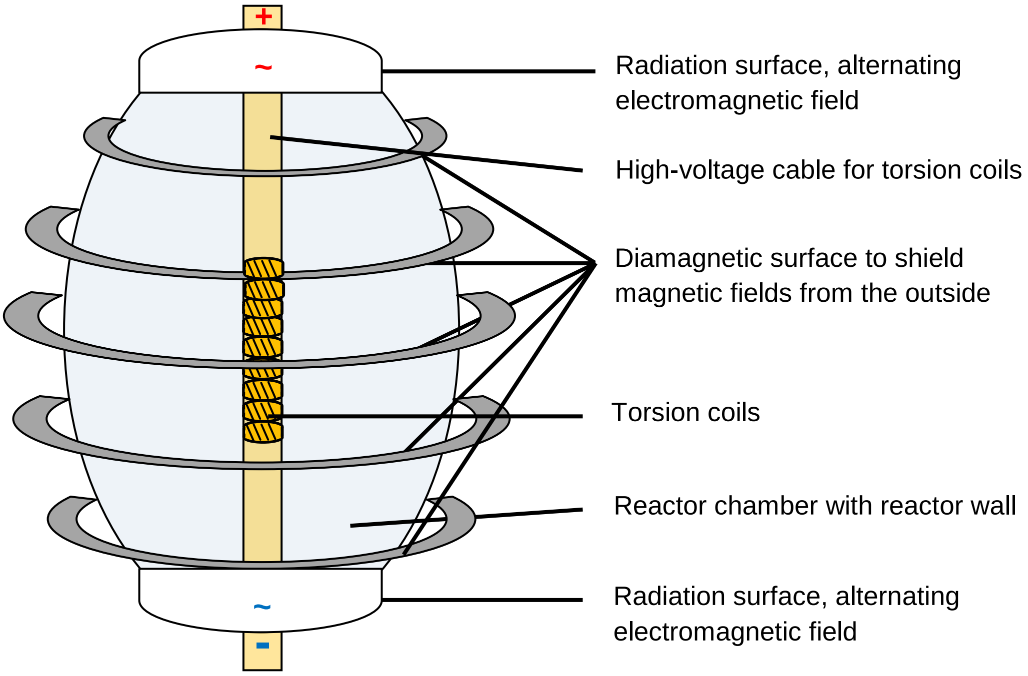

Figure 6.8: Principle design of a reactor for cold fusion

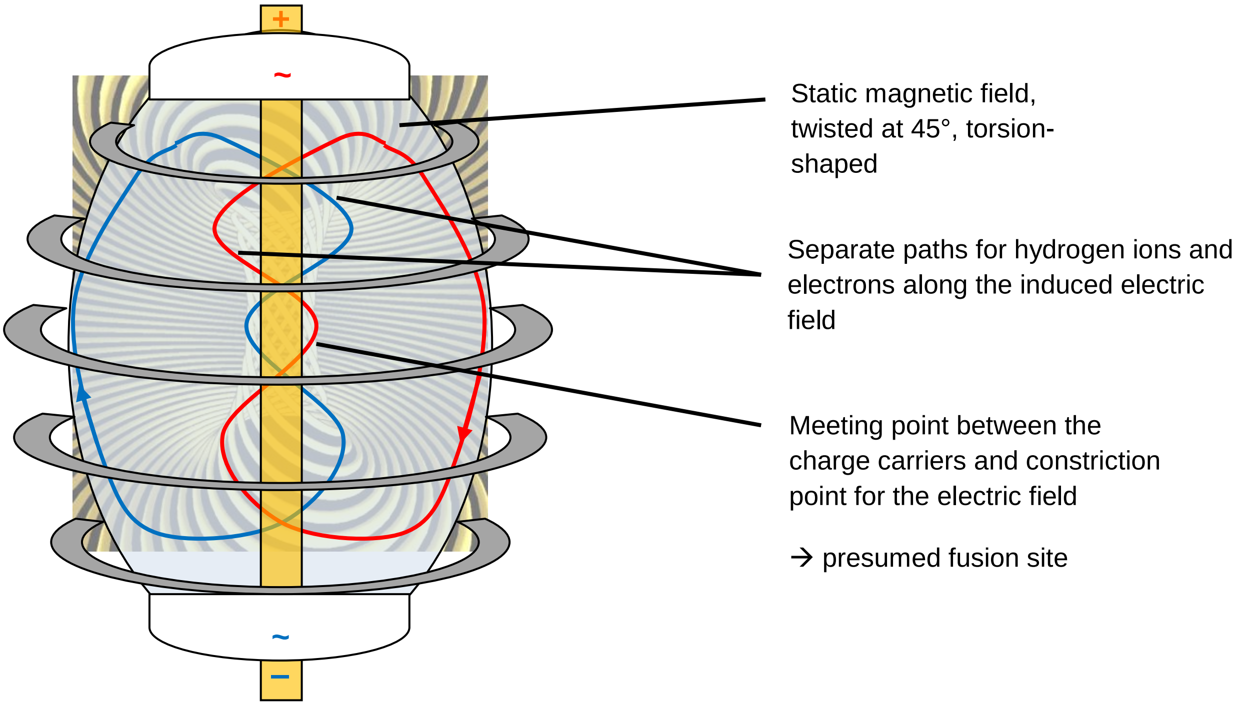

Figure 6.9: Mechanism of action of the magnetic and electric torsion field on the hydrogen mixture

Energy enrichment with suitable coupling frequency for the cold fusion process with hydrogen ^{1}H to helium ^{4}He:

The calculation follows the same pattern as for hot fusion. The main change now lies in the coupling frequency for protons at a field-space shift with the 10th dimensional family.

Again, a plasma mass of 50 g = 0,05 kg should be used for the calculation.

$f_e = 1{,}2356\ 10^{-20}$ Hz

$$\lambda_{proton} = \frac{c}{1845{,}28125\ f_e} = \frac{299792458\ \frac{\mathrm{m}}{\mathrm{s}}}{1845{,}28125 \cdot 1{,}2356\ 10^{20}\ \mathrm{Hz}} = 1{,}315\ 10^{-15}\ \mathrm{m}$$

The mass of the proton using the FSM particle model

$M_{proton} = 1845{,}28125\ M_e = 1{,}681\ 10^{-27}$ kg (calculated proton mass)

$M_{proton} = 1836{,}15\ M_e = 1{,}6726\ 10^{-27}$ kg (measured proton mass)

Mass and coupling frequency of the proton:

With protons, the following coupling frequency must be used for a shift between two field-space levels with the 10th dimension family and the corresponding dimension reduction factor for the maximum velocity V_{max}.

For the calculated proton mass:

$$f_{proton,5.} = \frac{1}{2}\left[\frac{4}{3}\left(\frac{3}{2}\right)^3\right]^5 \frac{6}{3}\ f_e = 1845{,}28125\ f_e = 1845{,}28125 \cdot 1{,}2356\ 10^{20}\ \mathrm{Hz}$$

$f_{proton,5.} = 2{,}28003\ 10^{23}$ Hz

$$f_{proton,10.} = \frac{1}{2}\left[\frac{4}{3}\left(\frac{3}{2}\right)^3\right]^{10} \frac{5}{10}\,\frac{6}{3}\ f_e = 1702531{,}4458 \cdot 1{,}2356\ 10^{20}\ \mathrm{Hz}$$

$f_{proton,10.} = 2{,}10365\ 10^{26}$ Hz

$E_{proton,5.} = h\ f_{proton} = 6{,}626\ 10^{-34}\ \mathrm{Js} \cdot 2{,}28\ 10^{23}\ \mathrm{Hz} = 1{,}51075\ 10^{-10}\ \mathrm{J}$

$E_{proton,10} = h\ f_{proton,10.} = 6{,}626\ 10^{-34}\ \mathrm{Js} \cdot 2{,}10365\ 10^{26}\ \mathrm{Hz} = 1{,}394\ 10^{-7}\ \mathrm{J}$

For the measured proton mass:

$$f_{proton} = \frac{1}{2}\,[\,\frac{4}{3}\,(\,\frac{3}{2}\,)^3\,]^5\,\frac{6}{3}\,f_e = 1836{,}15\,f_e = 1836{,}15 \cdot 1{,}2356\;10^{20}\text{ Hz}$$

$$f_{proton} = 2{,}268747\;10^{23}\text{ Hz}$$

$$f_{proton,10.} = \frac{1}{2}\,[\,\frac{4}{3}\,(\,\frac{3}{2}\,)^3\,]^{10}\,\frac{5}{10}\,\frac{6}{3}\,f_e = \frac{1836{,}15}{1845{,}28125}\,1702531{,}4458 \cdot 1{,}2356\;10^{20}\text{ Hz}$$

$$f_{proton,10.} = 2{,}09324\;10^{26}\text{ Hz}$$

$$E_{proton} = h\,f_{proton} = 6{,}626\;10^{-34}\text{ Js} \cdot 2{,}268747\;10^{23}\text{ Hz} = 1{,}5033\;10^{-10}\text{ J}$$

$$E_{proton,10.} = h\,f_{proton,10.} = 6{,}626\;10^{-34}\text{ Js} \cdot 2{,}09324\;10^{26}\text{ Hz} = 1{,}387\;10^{-7}\text{ J}$$

Number of protons in a hydrogen ^{1}H mixture of 50 g:

For the calculated proton mass: with: $n \in \mathrm{N}$

$$n_{protons} = \frac{0{,}05\text{ kg}}{1{,}681\;10^{-27}\text{ kg}} = 2{,}974\;10^{25}$$

For the measured proton mass:

$$n_{protons} = \frac{0{,}05\text{ kg}}{1{,}6726\;10^{-27}\text{ kg}} = 2{,}989\;10^{25}$$

The multiple energy equivalent to be provided for $n_{protons}$ in order to enrich the gas mixture:

For the calculated proton mass:

$$E_{50g} = E_{proton,10.}\;n_{protonen} = 1{,}394\;10^{-7}\text{ J} \cdot 2{,}974\;10^{25} = 4{,}145756\;10^{18}\text{ J}$$

For the measured proton mass:

$$E_{50g} = E_{proton,10.}\;n_{protonen} = 1{,}387\;10^{-7}\text{ J} \cdot 2{,}989\;10^{25} = 4{,}145743\;10^{18}\text{ J}$$

The coupling frequency and radiation energy are scaled by a factor of 2:

Suggestion for scaling with: 2^{50} (comparison to hot fusion: 2^{40})

For the calculated proton mass:

$$\underline{\underline{f_{proton,10.,scaled} =}} \frac{2{,}10365\ 10^{26}\ \text{Hz}}{2^{50}} = \underline{\underline{186{,}842\ \text{GHz}}} \qquad \text{(coupling frequency)}$$

$$E_{proton,10.,scaled} = \frac{1{,}394\ 10^{-7}\ \text{J}}{2^{50}} = 1{,}238\ 10^{-22}\ \text{J} \qquad \text{(energy content per proton mass)}$$

$$E_{50g,10.,scaled} = \frac{4{,}145756\ 10^{18}\ \text{J}}{2^{50}} = 3682{,}2\ \text{J} \qquad \text{(energy content for 50 g proton mass)}$$

$$\underline{\underline{P_{input,scaled} \approx}} \frac{3682{,}2\ \text{J}}{\text{s}} \approx \underline{\underline{3{,}6822\ \text{kW}}} \qquad \text{(frequency-dep. input for 50 g plasma mass)}$$

For the measured proton mass:

$$\underline{\underline{f_{proton,10.,scaled} =}} \frac{2{,}09324\ 10^{26}\ \text{Hz}}{2^{50}} = \underline{\underline{185{,}917\ \text{GHz}}} \qquad \text{(coupling frequency)}$$

$$E_{proton,10.,scaled} = \frac{1{,}387\ \ 10^{-7}\ \text{J}}{2^{50}} = 1{,}232\ 10^{-22}\ \text{J} \qquad \text{(energy content per proton mass)}$$

$$E_{50g,10.,scaled} = \frac{4{,}145743\ 10^{18}\ \text{J}}{2^{50}} = 3682{,}16\ \text{J} \qquad \text{(energy content for 50 g proton mass)}$$

$$\underline{\underline{P_{input,scaled} \approx}} \frac{3682{,}16\ \text{J}}{\text{s}} \approx \underline{\underline{3{,}68216\ \text{kW}}} \qquad \text{(frequency-dep. input for 50 g plasma mass)}$$

If the correct coupling frequency of the external energy source resonates with the correct excitation frequency of the displaced proton, then the reactor requires a constant radiation power of only ~ 3,68 kW for a plasma mass of 50 g. The irradiation time for fusion remains open for the time being. Presumably, due to the scaling, irradiation during cold fusion takes 1000 times longer than during hot fusion. However, a 1000-times lower temperature is required for the plasma in favour of the irradiation time. The pressure can be increased, which reduces the time required for conditioning the plasma. Once ignition has been successfully initiated, the process can be sustained by supplying additional hydrogen. The specific modelling must be designed technically.

In this case, too, the energy enrichment must only be continued until the plasma state is sufficient ($E(t) = h\, f_{proton} \frac{1}{\sin(kt)}$), to start the fusion process. The cold fusion process ignites in a controlled manner and burns continuously, while hot fusion in the spiral reactor is associated with statistically difficult-to-predict ignition and explosive combustion of the entire material.

The coupling frequency to be set and the radiation power are of the same order of magnitude as in hot fusion. The energy output for the cold fusion process could be similar to that of hot fusion. The difference that leads to cold fusion lies in the fact that the protons are shifted between two field-space levels with the 10th-dimensional family. The protons fuse to form helium as a matter/antimatter particle. During a shutdown process, some of the energy introduced could also be recovered through a matter/antimatter annihilation reaction by means of thermal radiation, which was previously used for energy enrichment. Key advantages of this concept include controlled ignition, efficient control of the input, a sustained fusion process, and safety due to low temperatures

It remains unclear for the present concept how long the torsion coils and the external energy source must be active before a fusion process is successful. The duration of the irradiation could be regulated via the scaling between the coupling frequency and the energy input. The dimensioning of all components remains open for this concept. The concrete design of a concept with all technical and legal requirements would go beyond the scope of this paper.