Kether Fusion Reactor
Initial Concept

Kristijan Kljajić 25.2.2025.

Kether reactor is a nuclear fusion reactor design made by deducing the optimal natural shape for a nuclear fusion reactor from inherent natural laws. The design aims to make a compromise free reactor vessel that will enable humanity to start using fusion power with relatively little effort.

It utilizes all the best from: Field reversed configuration, Stelarators, Magnetic mirrors, Pollywells, Ion gun fusors, Tokamaks and Magnetic pinch, all that while significantly reducing the overall complexity of the vessel and making the plasma much more stable and defined while having naturally beneficial design geometry that not only allows for easier and more affordable manufacturing but also has convenient diverter geometry and eliminates weak points like center pillar of the tokamak or diverter that is caged inside coils by design geometry of a tokamak and enables for better coil design. The design takes in consideration plasma reflow and mixing while focusing it all in the center focal point where the most reactions happen. It is the design that all the other designs lead to if exaggerated with intuition about magnetic fields.

With its multiple application optimized variants it will enable affordable, relatively simple and compact power generation and rocket engines for space travel that will enable humanity to expand and grow in peace and abundance like never before.

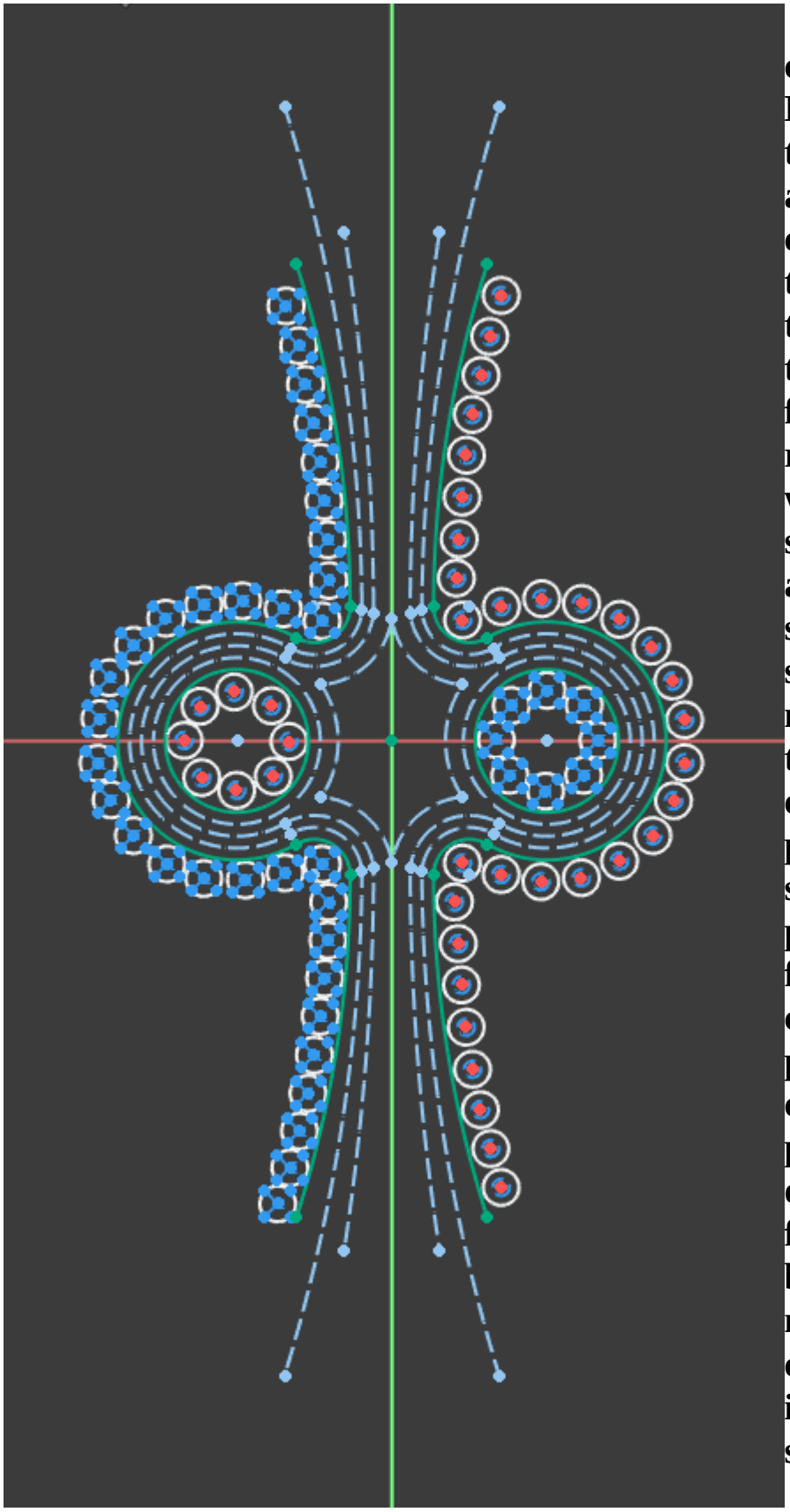

Figure 1. Main concept diagram for Kether configuration, this diagram shows an abstraction of coil configuration and the target magnetic field that they are supposed to produce, magnetic field is primarily a Field reversed configuration which is designed in such a way to allow for a symmetric star shaped plasma structure free of magnetic field lines, that plasma in the center can then be pinched inwards symmetrically by pulsing the magnetic field rapidly. Some configurations would be pulsed, other continuous and some possibly oscillated. This design is very favorable for pulsed fusion because a rapid rising magnetic field compresses plasma inward with great symmetry.

Plasma from the recirculation section of the vessel would be squeezed into the center at great force during a pulse. However during continuous operation with static magnetic field recirculation sections would conduct plasma that flows out of the core back into the core, this part of the concept is especially useful when the vessel is looked at as a polywell.

Additional coils can be placed around the gates of the diverter to control outflow of the plasma. Ions can be injected into the reactor vessel through diverter section or additional ion gun tubes that are pointed at each other through the center of the plasma core, they would be positioned symmetrically around the diverter gates in between the recirculation channels and they would be pointed through the center of the vessel at their opposite peer at the other diverter gate. Needless to say ion guns would have their own gate magnetic field in the tube that would connect them to the main vessel, that field would most likely be in the same direction as their side of the recirculation tube to retain the same magnetic field configuration as on diagram. Those ion guns themselves would form ion gun fusor reactor within the rest of the reactor that would act as a chamber that would facilitate recirculation of ions and possible compression depending on configuration.

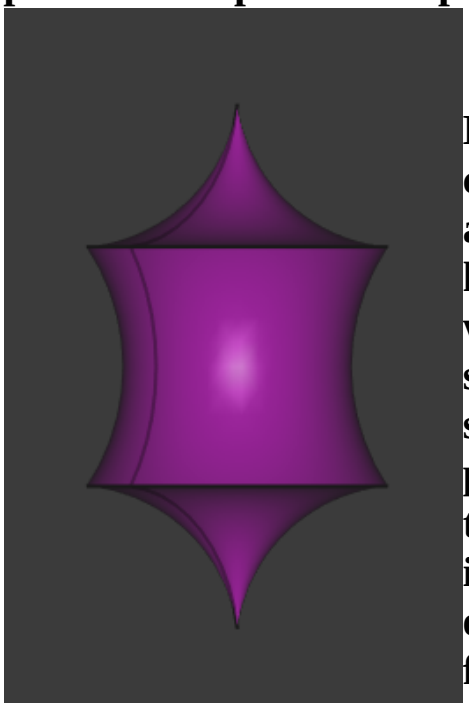

Figure 2. Shape of the central plasma in the Kether vessel, ions would flow in and out of it controlled by the field of the magnetic gates, also shape would slightly change inward during high confinement field where the diverter gates would throttle up the magnetic fields and squeeze the plasma more into six sided star shape. During a extremely high power pulse the plasma would be compressed in such a manner that it would implode inwards similar to how implosion style fission device does using explosives. There can be a static confinement field that can be pulsed and oscillated.

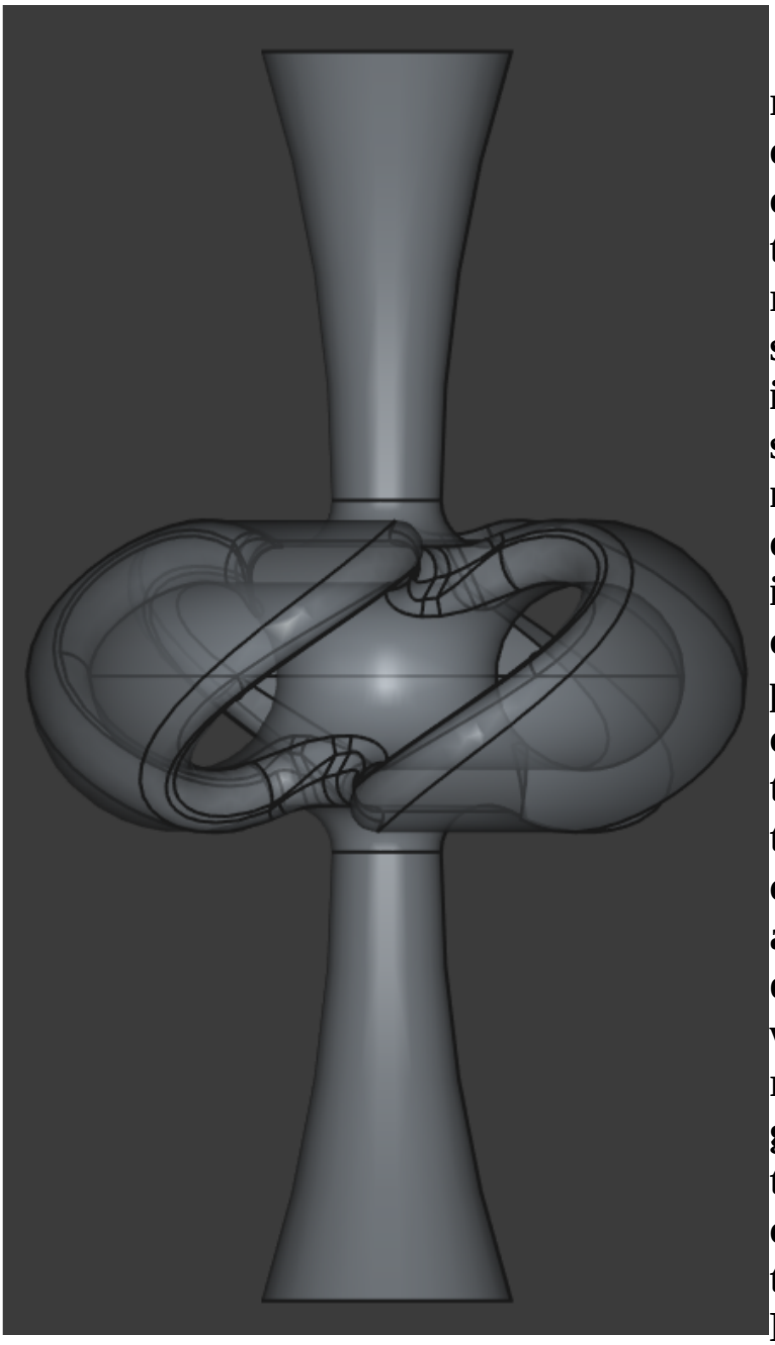

Figure 3. Kether reactor vessel shape concept, recirculation channels that are twisted by 60 deg relative to where they start from that is to insure proper stellarator twisting and mixing trough the center of plasma core, it would form one continuous strip of plasma that would cross and collide three times through itself in the very center of the core, that would be accomplished because of the 60 deg twist it would cause the lower recirculation channel gate would align with the upper recirculation channel gate through the center of the core. Not to mention the possible ion gun tubes that would be shooting the ions into the core perpendicular to the plasma ribbon.

Main structural vessel should be constructed out of NON-feromagnetic materials like aluminum for the continuous variants and out of electrical isolator materials like ceramic or glass for pulsed designs.

The primary field forming coils should be intentionally wound around the vessel in a tight HELICAL pattern THIS IS VERY IMPORTANT FOR THE PROPER PLASMA CONTAINMENT AND COMPRESSION AND OVERALL PLASMA STABILITY. The reason why is because that makes a twisting mechanic similar to if you connected a string between each corresponding finger on your hands and then twisted your hand around the axis of the strings it would form a helical pattern although each individual string is still straight, that would make the lines much denser and you could for example easily hold a pencil like that by rotating your hands around the axis, try archiving that sort of stability without the twist. Same thing applies to the plasma and magnetic fields, helical twist in the coils directly translates to the magnetic field which becomes more denser around the edges of the vessel than on the center and that is important for high stability plasma containment, I believe that it is almost impossible to archive that kind of stability with only modular coils like on tokamaks.

Primary field forming coils should be wound around the entire vessel starting from one side of the diverter winding to the gate then winding around one of the recirculation channels till the other gate then winding around the core until arriving at the gate on the starting side then winding around other recirculation channel and then continuing to the other side of the diverter, there should be at least three electrically parallel coils that start from the diverter and they are intentionally wound next to each other to improve helical aspect of them when they come to the first gate then they each wound around their respective channel keeping the space for the next coil that will come on the return as described, when the coils come to the gate they once again get wound parallel to each other to insure helicity then when they come to the gate of the starting side then they start winding around neighboring channel to the one they wound in the first place, that is where the place left comes into play, when they come to the gate they wind to the end of the diverter the same way as on the staring side.

I suggest these coils should be copper tubes isolated with kapton tape around them, sections of the vessel could be produced with coils wound around them already an they would be connected with the next segment using compression fittings. Coils would be cooled using flowing water or other similar liquid.

This is the coil that would either be powered from a high current power supply in a simple continuous variant or pulsed using extremely high power capacitors or both. What can be done is connecting a continuous power supply to the coils over a diode and when pulse is initiated a switch is closed connecting a high power capacitor to the coil in parallel to the constant supply and spiking the magnetic field without interfering with the constant power supply, and when the pulse is over coils return to normal currents from constant supply. It may be possible that the plasma would recoil the magnetic field and end up producing a higher amount of energy in the coil than the one that capacitor imputed then that would form a LC circuit that would be going exponential in amplitude with each pulse therefor allowing for energy extraction from "overhead voltage" using circuits that would ensure stable capacitor voltage and output everything else.

Superconducting coils can be added as modular coils around the Field forming coils to enhance the intensity of the magnetic field.

Furthermore superconducting coils could be extremely beneficial if we take into consideration that these reactors can be used in rockets, then it opens up a possibility that the same field of the engine could be used as a MAGNETIC HEAT SHIELD to deflect plasma on reentry.

While the thrust may be too little to lift the rocket of the ground and radiation too intense to operate near ground it will be crucial for interplanetary transport and may be for radiation protection from charged particles by inducing super string magnetic field around the spaceship similar to Earth.

Figure 4. Partially complete rocket engine variant concept, full version would have six ion guns pointing all in the center of the core three up three down and they would be put in between the channels. The straight tube up would go all the way through the rocket and would be a superconducting magnet that would channel plasma through the center of the engine during reentry.

For start the entire inside of the vessel could be lined with graphite tiles and possible ceramic spaces for electrical insulation so they don’t get crushed during a pulse by induced currents. Aluminum vessel could have cooling channels in the walls. Also the aluminum vessel could even be used for pulsed operation if it had longitudinal segment of ceramic that would prevent the currents from closing.

However later in reactors a tritium breeding blanket could be used it would be made out of interlocking tiles that would look like bricks in the wall and the tiles would be made out of graphite, beryllium and lithium, beryllium would be solid under it would be sintered lithium powder and the plasma facing material would be a layer of graphite over beryllium, the graphite may be sputtered onto beryllium of cast together.

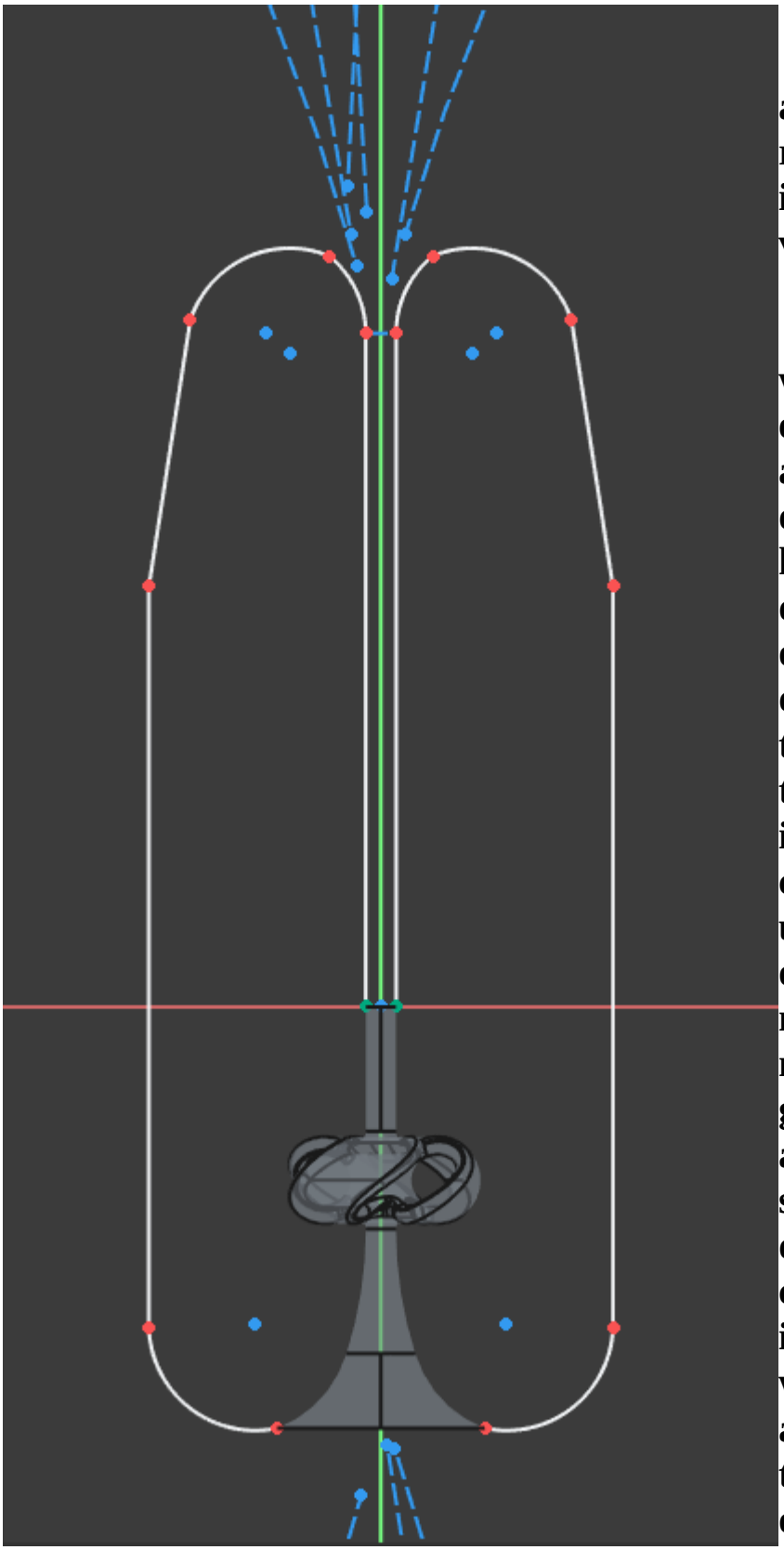

Figure 5. An abstract example of a rocket engine integration onto a vehicle.

The center tube would have a electromagnet wound around it to generate deflection field and to help close upper gate during operation in order to focus thrust downward. However if this method of directing thrust proves to be inefficient a big ion gun can be put in place of upper diverter instead of magnetic tube, it may not need upper mentioned six axial ion guns in that situation, and magnetic field may still be used as particle deflection. Magnetic center pipe can still be installed only now coils would have to wind around the ion gun an the continued, majority of the particle don’t travel all the way into

the tube but the ones that do the would have to hit some sort of striker plate on the top of ion gun.

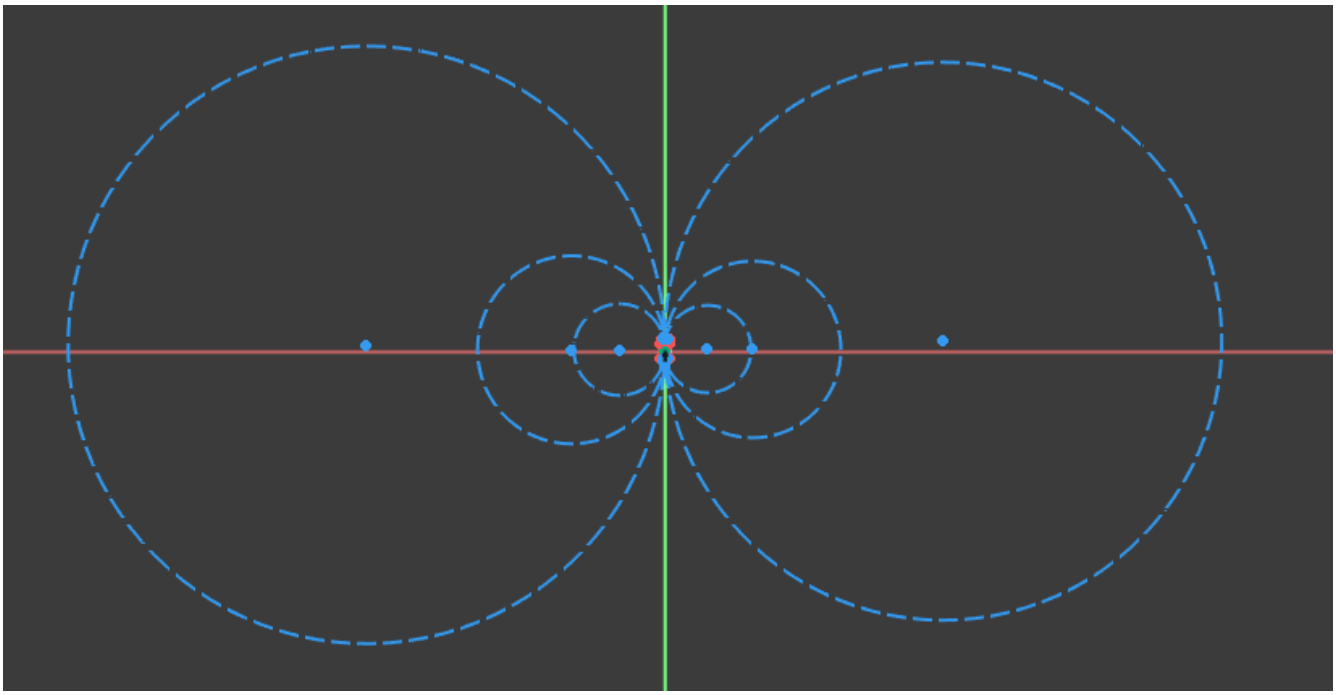

Figure 6. Abstract depiction of what the magnetic field in space around the vehicle in space may look like, similarly to magnetic field around planets particles would get redirected to the poles and here that would be the front and back end of the ship.

Radiation shielding from the reactor itself is critical, for the ordinary power generation on the surface a clear choice is water, and for the spaceship it also seems like using a water tank to absorb the radiation might be the best choice. The convenient thing about radiation shielding from the spaceships engine is that the engine is at the very end of the vehicle so your shield however thick it must be it only really needs to cover one direction so this may not be an inconvenience at all for an interplanetary ship that would have to carry large amounts of water anyways.

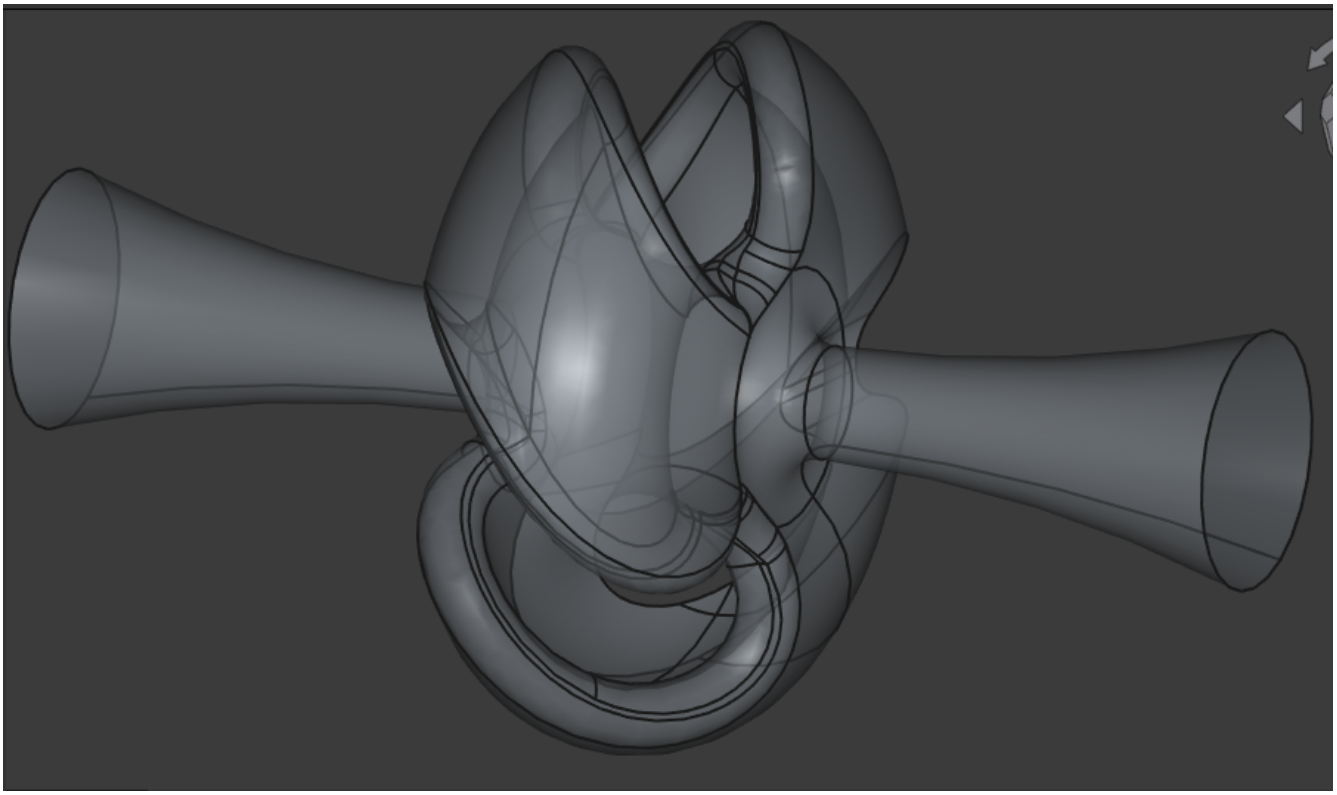

Figure 7. Another angle at the base concept Kether reactor vessel.

Power generation reactors may be put horizontally and the diverters may be made wider in order to spread the output plasma in order to reduce the target heat load, and the target may be liquid metal like lithium, flowing over the surface like a thin film.

Ordinary diverter target material may be entirely sufficient because diverters can be made longer and spread wider and it may not be a challenge at all to design a good diverter.

Overall geometry may be varied slightly, this is just a bare bone basic concept that I know will produce results in one form or another.

Summary

Kether reactor is a conceptual shape for a nuclear fusion reactor that has not jet been explored, it has multiple aligned mechanisms of confining the plasma and multiple possible variant for experiments, power production, space propulsion, heat shielding “force field”, variable source of radiation…

There are also multiple modes of operation that the reactor can be designed for: continuous, pulsed and oscillated.

Power can either be extracted from the diverter output or may be even from the recoil of the plasma expansion after a pulse. That would be inductive power generation.

Either way this is a very efficient and convenient way to compress plasma if used in pulsed mode, orders of magnitude more efficient than laser target fusion or anything else more indirect especially methods that may require fuel pellet for every pulse… Kether keeps it simple, straight forward, scalable, and relatively inexpensive compared to other methods.

It can be pulsed which means that there is no reason for an ultra expensive setup for the theory to be tested, instead a prototype can be constructed using coper pipes wrapped in kapton tape as insulation.

The key difference that sets apart this concept from others is that this concept contains all the semi working concepts and combines them into one extremely simple and elegant solution where all of the working mechanisms of fusion combine themselves into one it is almost as all the designs emerged as parts of a puzzle that none was even aware existed.

It is an extremely simple stellarator, yet it is also in the same vessel a pollywell that has been upgraded to allow for plasma recirculation, it is also a way to localize magneic pinch, it works both as continuous and pulsed design, it truly is a more primal design.

Kristijan Kljajić 2025.

Public Invitation To Start The Project Development

I openly invite everyone that is interested to collaborate in some way even if just promoting it publicly, to mention it, to exchange ideas to build parts of the project, to try these to experiment on these concepts themselves, to provide professional support and so on.

Some of the individual that I would like specifically see and get to know the concept are:

Drake Anthony (styropyro)
Chris Boden
Tyler Folse (t.folse nuclear)
Cody (CodysLab)
Improbable Matter
Sabine Hossenfelder
Niel deGrasse Tyson
The Thought Emporium
Kyle Hill
Plasma Channel
The Action Lab
Everyday Astronaut
Marcus House
SmarterEveryDay
What about it!?
Anton Petrov
Hyperspace Pirate
Applied Science
Mahesh Shenoy (FloatHeadPhysics)
PBS Space Time
Scott Manley
BreakingTaps

These are some of the people who I think would be interested.

In my opinion the biggest upfront value of this vessel its ability to pinch the plasma evenly in the center during a pulse, I believe this alone if done properly can make fusion more than break even.

This is just an initial concept so no scale models have been constructed yet, but I am very interested to see for myself what sort of properties would an actual electromagnet configuration like that have.

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Freecad and LibreOffice were used in making of graphics for this document, big thanks to the developers!