

Beyond Nuclear!

The Chinese, once again, show us their outstanding ability to tackle great challenges together, all as one.

However, they are not the only ones who count in all this. Of course not. The nuclear fusion race is a global race and a global race is being settled.

Many countries have experimental facilities whose objective is to generate knowledge on the path that will lead us to the Holy Grail of [nuclear fusion](#) : Germany, Australia, Brazil, Canada, China, Costa Rica, Spain, United States, France, India, Italy, Japan, Mexico (discontinued project), Pakistan, Portugal, United Kingdom, Czech Republic, Russia, Switzerland and Ukraine. And probably a few other countries have been left in the pipeline.

And to these must be added those projects in an international consortium such as the European Union's JET or the most ambitious of them all, ITER. One of the largest projects that human beings have ever undertaken and in which dozens of nations participate.

[Related Topic: China's artificial sun takes the lead in nuclear fusion race](#)

But this is not what will concern us in this article, but an even more singular and remarkable fact:

To date, all the merger projects had been state-owned. But this has just stopped being the case.

The company [North American Helion](#) , from Redmond (also the small homeland of Microsoft), announced a few days ago that they are, by right, a broker to take into account in the merger race.

Specifically, through their [statement on June 22](#) , they have made public that Trenta, their sixth fusion electric generator prototype , has concluded a successful 16-month uninterrupted testing period with the milestone of having achieved plasma at temperatures of 100 million degrees centigrade .

And the entry of a corridor from the private sector is something to applaud. Innovation thrives on competition and there is much that the private sector can contribute there.

Helion's business pragmatism has been translated into an innovative approach that could be an enriching twist to the technology strategy hitherto dominant in the field of fusion.

Let's move on to unravel what its new technological vision is and why, indissolubly to it, it is a healthy proposal for purely business innovation.

The conventional technological approach

As we discussed in the previous article, the quantum mechanical description of the nuclear fusion process as a mechanism that explains the “normal” life of stars was published by the physicist Hash Bethe in 1939.

And it was already in the 1950s that attempts to bring this theoretical knowledge to technological reality began.

This is how the design called 'tokamak' appeared, even today almost omnipresent in the field of fusion technologies:

A donut-shaped machine inside which superheated plasma moves in a circular motion, trapped by magnetic forces exerted by the powerful electromagnets that cover the donuts. (The term 'tokamak' is a Russian acronym that describes, as is, such a configuration).

The objective of all this, the one we already know:

Create a self-sustaining energy fusion reactor (an 'artificial Sun'). Generating so much energy that it not only nourishes itself with the high energies necessary to produce a chain of fusion events, but also produces a large surplus of energy that we can take advantage of.

Well, the key here is the starting postulate : the requirement of continuous operation (in a regime of 'ignition' or self-sustained chain reaction).

Such a requirement implies designing a machine that is capable of taming hyperheated plasma (to keep it in place without interruption) and that, simultaneously, is capable of withstanding the immense heat stress (millions of degrees centigrade) and radiation (electromagnetic radiation, light, high energy and neutron storm) that this entails.

Dozens of years after great experimental projects, there we are.

We are on the right way. Everything indicates that we will be able to create such a “resilient tamer”, a powerful (magnetic) whip at the ready and well-tempered (anti-stress) nerves:).

But, probably, that colossal technological achievement still has to delay us a few years. Maybe even quite a few.

It's time for a 'what if?'

Great business ventures are the chronicle of a 'what if?' The same as the great adventures of thought. Not surprising given that the 'what if?' they are the backbone of innovation.

What if... (we say) we ignore the requirement for continuous operation?

Or, in other words:

Is the ignition regime essential to creating surplus energy through nuclear fusion (which, after all, is the ultimate purpose of the whole thing)?

And indeed, it may not be so.

And that is, in my opinion, the central intuition behind the Helion company and what has allowed them to reformulate the problem of the merger to bring it to the realm of what is possibly viable in the short or medium term, as well as profitable business.

Helion's approach, a bit different

Therefore, the starting point of Helion has been to imagine a fusion energy generator that, instead of operating in an uninterrupted regime (like our 'resilient tamer:'), would work in a pulsating way (come on ... a 'fusion heart':).

Such a contraption, assuming it were capable of generating surplus energy, would avoid many of the major technological problems encountered by fusion. Those mentioned above: continuously control the hyperheated plasma and withstand the immense and also continuous thermal and radiation stresses.

And six generations of prototypes later, the "Helionites" tell us that their vision is yielding promising results.

Now, to this we could respond: "You cheat, gentlemen ... You really haven't created a 'fusion reactor'!"

And it is true. They have not created a 'reactor' for the simple fact that they have not created a vessel in which a reaction takes place continuously (which is nothing else a 'reactor').

But what the hell does that matter if they still achieve the purpose, to produce large amounts of energy.

We could call them inelegant for not solving the problem completely. But in doing so we will be losing our ability to appreciate the beauty that is contained in the pragmatism of his approach.

After all, if they have overlooked the solution in its entirety (continuous operation), it is because their chances of success were slim.

How could a newly created private company be able to achieve what dozens of large state projects have not achieved in decades !?

Therefore, they have done the only business wise thing (and, indeed, generally sensible): Break with the prevailing methodological dogma to find, if their intuition was correct, a workable shortcut.

An uncertain but unexplored path offers more possibilities to make a difference than a busy and difficult path. The difficulty of the second and the unexplored nature of the first are the factors that determine that there is a niche of Darwinian opportunity. Beautiful divergent pragmatism. Good example of business innovation as God intended. Don't you think?

The 'fusion heart': a closed loop pulsed fusion generator

Ultimately, what these people have proposed is to reformulate the problem:

Stop conceiving a fusion generator as a 'reactor' (continuous machine) and envision it more as an 'accelerator' (discontinuous machine).

And with this they have designed an energy generator that generates it by pulses, through a repeating cycle.

To illustrate this without esotericism, we can resort to its resemblance to something much more mundane: the internal combustion engine of a car.

Such an engine works by generating continuous (circular) movement from the discontinuous (linear) movement that occurs in its cylinders and that operate in a four-stroke cycle that is repeated over and over again.

These times are named for what is done in each of them with the fuel: 1) intake, 2) compression, 3) explosion and 4) expansion-exhaust.

(As a reminder, a pill on combustion engines: 1) at the 'intake' the fuel is introduced into the cylinder; 2) during 'compression' it is prepared for combustion; 3) in the 'explosion' said combustion takes place, that is, the conversion of the chemical energy contained in the fuel into thermal agitation of the combustion products; and 4) in the 'explosion-escape', first, the conversion of this thermal agitation into mechanical energy is carried out in the form of a discontinuous linear movement of the piston which, thanks to the transmission system, turns into a circular movement. continuous and, later, the return of the cylinder to its initial state so that the cycle can begin again).

Well, the machine proposed by Helion works in an analogous way. Remarkably, very analogous!

Although, let us bear in mind that we are not talking here about a machine that, like the combustion engine, converts chemical energy (stored in the quantum states of the electrons of the molecules) into mechanical energy, but rather one that converts nuclear energy (stored in the quantum states of the particles of atomic nuclei) into electricity. And that, in addition, it does this with zero CO₂ release and minimal production of other pollutants.

That said, it turns out that Trenta, his fusion electric generator, operates through a repeated cycle that also happens to consist of four strokes.

What's more, its functional parallelism with the times of a combustion engine is so great that it is fun.

Specifically, Trenta consists of a container in the shape of an hourglass with a widening in its central part (therefore, formed by three connected spaces).

In this container a cycle is repeated whose times, depending on what we do with the plasma in each of them, are: 1) formation, 2) acceleration, 3) collision-compression-fusion and 4) expansion.

Author's elaboration from a collection of images extracted from [the animation on the Helion website](#) (used with his permission).

And to all this they have even added two elements, by way of crucial technological salt and pepper. The second of them, by the way, clearly innovative.

First, in the 'training' phase they use a magnetic configuration called the Field Reversed Configuration (FRC). This consists in achieving that, to a large extent, the plasma self-confines itself (by virtue of its own magnetic field) and, with this, allows reducing the complexity and thermal stress of the machine.

For its part, it is in the 'expansion' phase that they convert the energy that resided in the plasma of light atoms (in the form of nuclear energy, as we have already said). And, for this, they do not resort to the usual method, but to one that they have taken from the hat (or, rather, from what they have inside it) .

The usual thing is to resort to a water circuit that the reaction heats up and that, after that, we first use to generate mechanical energy (movement of a turbine) and then, finally, to generate electrical energy from that mechanical energy (by means of a coil, an electric motor running backwards).

On the contrary, what Trenta does is convert the energy that plasma acquires by virtue of fusion, directly , into electrical energy . And thanks to that, they say, they get spectacular energy efficiencies of 95% (!).

This is based on the fact that plasma is a fluid of charged particles and, therefore, its sudden expansion movement (powered by the energy produced in fusion) produces a violent change in the magnetic field that can be directly converted into electrical energy (as dictated by the almost bicentennial Faraday Induction Law), without the intermediation of water.

Time to be vigilant

Of course, innovation in business differs from innovation in academia in its knowledge management. While in the second premium the publication and reproducibility of the investigations, in the first the knowledge is subordinate to the business income statement and, therefore, is protected.

Consequently, it goes without saying, we must be cautious and not give blind credibility to Helion's statements. That said, it is my firm wish that your results are true and lead to success.

It would be great if they became the first to patent the world's fully functional nuclear fusion electric generator .

Its assembly will most likely give us less energy power than what we will be able to obtain by means of a fusion reactor with ignition (the “complete solution”, the continuous reaction).

But it will be a great intermediate state to start using fusion as a power source as we continue to investigate how to build our 'resilient tamer'.

And that will allow us to reduce the brutal fossil dependence of our mix current energy (80% of the total) and gradually replace it with energy without a carbon footprint and infinitely more environmentally sustainable.

Because depending on fossil fuels is like smoking, maintaining a human civilization in chronic and carcinogenic smoking, while nourishing ourselves with nuclear fusion would be like getting energy by making vapors.

