

# VOODOO FUSION ENERGY

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## **Abstract**

During the last 15 years a host of fusion energy “startups” have declared that their systems will put net electrical power on the grid or serve as a portable electric power generator within a decade. But only 10% of these myriad ventures have given evidence of any fusion-neutron production whatever. This paper defines “voodoo fusion energy” as those plasma systems that have never produced any fusion neutrons, but whose promoters make the claim of near-term electric power generation. With representations analogous to those of the notorious Theranos blood-diagnosis sham, the voodoo-fusion practitioners have cast a spell over credulous journalists, investors and politicians.

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## **Modern Fusion Fantasies**

During the last decade a host of fusion energy “startups” have captured the attention of the technology press and blogosphere. These startups promise to develop practical fusion electric power generators in 5 to 15 years, and incidentally will achieve ITER’s planned performance in a fraction of the time at 1% of the cost. With few exceptions, journalists have accepted these claims without criticism and propagated them with enthusiasm.

But these projects are nothing more than modern-day versions of Ronald Richter’s arc discharges of 1948-51, the inaugural fusion fraud [1]. Just as Richter’s contraption could not generate a single fusion reaction, only a tiny minority of the current projects has given evidence of any fusion-neutron production.

It was principally the absence of neutron emission that doomed claims of “cold fusion”, so why should more elaborate assemblies get a free pass, just because they use plasmas heated beyond room temperature? A tepid plasma of deuterium cannot produce measurable levels of fusion neutrons because one or more of the ion temperature, ion density or plasma volume is too small. As far as energy production is concerned, such systems are the *functional equivalent* of cold fusion but cost orders of magnitude more.

Robert Park was the longtime director of the Washington office of the American Physical Society, and author of the book “Voodoo Science” [2]. In his book and numerous

columns under the heading “What’s New,” Park demolished “cold fusion” but never mentioned any of the failed “warm plasma” fusion schemes of his era. Unlike cold fusion, plasma-based fusion attempts are generally not voodoo science but most of these enterprises can be classified as voodoo technology.

For present purposes, we define “voodoo fusion” as those plasma systems that have never produced any fusion neutrons, but whose promoters claim will put net electrical power on the grid or serve as a portable electric power generator within a decade or so. As in Richter’s pioneering fiasco, all the modern voodoo schemes offer perfect examples of one axiom of fusion energy R&D:

The Inverse Timescale Axiom states that *for any fusion concept, the smaller the achieved fusion neutron production, the shorter the predicted time to a working power reactor.*

The total absence of any fusion neutron production has an inexplicable psychological effect: It encourages both promoters to predict and onlookers to believe that tinkering with a tepid plasma can result in commercial fusion electric power generators within a decade.

Voodoo incantations are necessary both to induce a trance in journalists, investors and politicians in order to procure financing, and eventually to command the fusion neutrons to materialize by witchcraft as those neutrons cannot be produced by the touted plasma concepts. Today the messianic incantations of the voodoo priest-promoters invoke the aura of “the energy source that powers the sun and stars” as well as the myth that terrestrial fusion energy is “clean and green” in order to cast a spell over credulous investors and politicians.

### **Fusion Neutrons are Critical**

Unlike solar fusion reactions that produce no neutrons, in the most favored Earthbound fusion reaction (deuterium-tritium) 80% of the energy is released in streams of high-energy neutrons. Because of the difficulty in handling radioactive tritium, experimenters commonly use deuterium alone, and 50% of D-D reactions produce high-energy neutrons. Some enterprises propose to use the neutron-free D-3He reaction, but neutrons are still produced in unavoidable D-D reactions. In all cases, *no neutrons means no fusion*. Finally, some ventures propose to use the aneutronic proton-boron reaction, but the only convincing way to discern progress in reaching reactor conditions is by doping the plasma with deuterium and measuring D-D neutron output.

Numerous fusion “startups” promise a practical fusion reactor delivering net electric power in 5 to 10 years, but *have never produced a single D-D fusion reaction*. The

currently most notorious (in alphabetical order) are General Fusion [3], Helion Energy [4], Lockheed-Martin Compact Fusion [5], and Tri-Alpha Energy [6], all of which have made that promise for the last 5 to 15 years.

For reference, one watt of D-D fusion power is accompanied by approximately one trillion neutrons per second. Examples of fusion concepts that can attain some level of fusion activity are the tokamaks in numerous labs worldwide, laser-compressed pellets at Livermore (NIF) and U. Rochester, MagLIF at Sandia, and the dense plasma focus (DPF). Neutron production by itself has various practical uses such as isotope production and radiography [7]. More than 90% of fusion concepts have never produced measurable levels of fusion neutrons, which means those systems probably have no practical value at all.

This discussion excludes Tokamak Energy and Commonwealth Fusion from the voodoo class despite their preposterous and insupportable declarations of near-term electrical power production [8], solely because their schemes are based on tokamaks. For 50 years many tokamak facilities have demonstrated that they are capable of producing a significant level of D-D fusion reactions, increasing from  $1 \times 10^8$  n/s in T-3 in 1969 to more than  $2 \times 10^{16}$  n/s in TFTR in 1988 [9] and later in JET and DIII-D [10]. We also exclude LPP Fusion, because its DPF does produce meaningful levels of D-D fusion neutrons ( $3 \times 10^{11}$  n/pulse), as the DPF has done since the 1960's.

### **Naked Emperors Flaunt Their New(tronless) Clothes**

One sketchy way to track the predicted dates for each player's commercial power plant is to review the articles issued periodically by Brian Wang on *nextbigfuture.com* [11]. For the last dozen years, Wang has quoted uncritically predictions of future accomplishments with dates furnished by project promoters. Wang treats all projects and unjustified claims seriously, but you, dear reader, will merely take note of the dates promised for commercial fusion reactors.

Here are samples of the more recent predictions for energy breakeven and commercial powerplants from the currently most notorious voodoo fusion enterprises. The symbol NBF denotes the website *nextbigfuture.com*.

#### General Fusion (GF)

"GF targets prototype by 2015 and a working reactor by 2020," from NBF 5/19/2012.

"GF will demonstrate DD-equiv. net (energy) gain in 2016," and "GF targeting commercial reactor for 2020," from NBF 5/24/2013.

GF will demonstrate net gain in 2018 and "GF targeting commercial reactor for 2023," from NBF 8/18/2015.

“GF Demo nuclear fusion plant around 2023”, quoting C. Mowry, CEO of GF, from NBF 5/23/2018.

### Helion Energy

“The Helion Fusion Engine will enable profitable fusion energy in 2019,” from NBF 7/18/2014.

“If our physics holds, we hope to reach that goal (net energy gain) in the next three years,” D. Kirtley, CEO of Helion, told The Wall Street Journal in 2014.

“Helion will demonstrate net energy gain within 24 months, and 50-MWe pilot plant by 2019,” from NBF 8/18/2015.

“Helion will attain net energy output within a couple of years and commercial power in 6 years,” Science News 1/27/2016.

“Helion plans to reach breakeven energy generation in less than three years, nearly ten times faster than ITER,” from NBF 10/1/2018.

### Lockheed-Martin Compact Fusion

“Lockheed will have a small fusion reactor prototype (powerplant) in five years...and a commercial application within a decade,” from MIT Technology Review, 10/20/2014.

“Net energy gain in 2020 and commercial powerplant targeted for 2024,” from NBF May 3, 2016.

### Tri-Alpha Energy (now TAE Technologies)

“Tri Alpha says it will produce a working commercial reactor between 2015 and 2020,” from NBF 8/16/2011.

“Tri Alpha Energy now likely 2020 - 2025..... for commercial nuclear fusion,” from NBF 10/16/2015.

“Tri-Alpha Fusion to develop commercial fusion by 2027,” from NBF 1/19/2017.

“The company will generate net energy from fusion.... in about five or six years,” from K. Bourzac [8], 8/6/2018.

TAE once planned to exploit the aneutronic p-11B reaction, but tacitly abandoned that goal when it dropped “Tri-Alpha” from the company name.

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Another collection of postings describing plasma fantasies masquerading as practical energy sources along with projected commercialization dates can be found on The Polywell Blog [12], maintained by Matthew Moynihan.

There are also numerous wannabe fusion scams that have popped up in the last 5 years or so, making the usual preposterous claims on the basis of nothing but hot air or cold plasma, but these outfits are not yet sufficiently well-known to warrant more than a mention. Examples are Dynamak, First Light, HyperJet, and numerous members of the delusional Fusion Industry Association.

Journalists and promoters rarely mention neutrons, because most journalists have never heard of them, while the promoters assume that neutrons can eventually be made to issue from their contraptions by the appropriate voodoo recitation. Wang and Moynihan, our indefatigable monitors of press releases, have probably heard of fusion neutrons but they care not a whit about their absence— in their eyes *any* gaseous plasma is the basis of a working fusion reactor simply because its promoters claim that it is. But you, dear reader, will actually search for reports of fusion neutron production and you will find *nothing* !

The permanent fusion R&D organizations, mainly government-supported labs, are the silent spectators of the naked emperors, only occasionally challenging their insupportable assertions and predictions. One feature that voodoo fusion schemes do share with their neutron-producing rivals is that while they will never put electricity onto the grid, all of them take plenty of energy *from* the grid. The *voracious consumption* of electricity is an inescapable feature of all terrestrial fusion schemes.

### **The Theranoses of Voodoo Fusion Energy**

So how will these ballyhooed boondoggles end up? For guidance let's look at the fate of an analogous voodoo technology scam, that practiced by the notorious Theranos (a contraction of THERApy diagNOSis). Theranos is a California-based company that purported to have a revolutionary blood-testing system, garnered nearly a billion dollars of investment, and stacked big names on its Board of Directors. The company's claim is that with only a tiny drop of blood it could run hundreds of tests and detect diseases early. Over the past few years it was exposed as a total fraud, principally by the investigative work of John Carreyrou, which culminated in his book "Bad Blood" [13]. In mid-2018 the company and its founder, Elizabeth Holmes, were charged with fraud by federal prosecutors.

Theranos and fusion energy enterprises are both centered on fluids called "plasma," liquid in the case of Theranos, and gaseous for the others. But Theranos and the so-called fusion energy startups have a lot more in common than the name of their working fluid. It's striking how the characteristics of the Theranos fraud are similar to those of the phantom fusion enterprises that promise a practical fusion reactor delivering substantial net electric power in 5 to 10 years, but have never produced a single D-D fusion reaction.

Here are some of the features of the Theranos fraud, derived from Carreyrou's book and published interviews with Carreyrou [13]. The voodoo fusion analogs are in parentheses.

- Holmes preached that the Theranos device was “the most important thing that humanity has ever built.” (That's the same refrain made by fusion technologists about their beloved contraptions.)

- Theranos's technology was either not ready or unworkable during the initial period of bombast, and when put into service was never validated. (Today's much-heralded voodoo fusion equipment cannot produce fusion neutrons, and to the end of time will be capable only of phantom energy production.)

- Holmes hoodwinked high-profile people to serve as directors or investors. They ignored or could not recognize all indications that they were being conned. (Clueless billionaires and celebrities serve as investors or board members in General Fusion, Helion, TAE Tech., etc.)

- Holmes' game was always that the ends justify the means. She thought the technology would eventually catch up with all the promises she made, and practiced “fake it till you make it.” (Fusion promoters assume that high-energy neutrons will magically show up when needed for promised electricity generation.)

## **Blood Brothers**

The pin-pricks of blood plasma extracted by Theranos could not produce enough usable data for meaningful tests. It was voodoo diagnosis. Similarly, the tepid plasmas of the voodoo fusioners can never produce enough fusion neutrons, if any at all, to have practical use.

Theranos is a Silicon Valley company, and until recently the news media covered the Valley uncritically. Company founders have always been glorified, and worshipful journalists helped deceive investors and regulators. While the fusion Theranoses highlighted herein are not located in Silicon Valley, they are all located on the West Coast, apparently close enough to the Valley to merit immunity from close scrutiny.

Like Theranos's Elizabeth Holmes, the priests of voodoo fusion have cast a spell over journalists, investors and politicians. If Ronald Richter, the first practitioner of voodoo fusion energy, has been resurrected in the founders and CEO's of General Fusion, Helion Energy, Lockheed Fusion and Tri-Alpha, the Richter reincarnations are also the soul-mates of Elizabeth Holmes. Very recently, Theranos announced that it would

dissolve and its investors will receive at most one cent on the dollar. At best, that same outcome awaits the voodoo fusion ventures when it becomes apparent that their powerplant foolishness, fantasies and deception have zero factual basis. And at worst? Follow the Theranos case.

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1) Some years ago when “sonofusion” was a short-lived obsession, General Fusion applied an electrically driven shock wave to a sphere of deuterated water and claimed to have produced up to 50,000 neutrons per shot. That was never confirmed and in any case has nothing to do with the company’s fusion reactor concept.

2) TAE Technologies is pursuing another venture that uses ion beams striking solid targets to produce neutrons for cancer therapy. This technique is real, having been pioneered by cyclotron inventor Ernest Lawrence and his physician brother in 1938 and used for eight decades.

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