Backyard Nuclear Fusion

(or, High-energy Deuterium Plasmas)

Raymond Jimenez

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Contents

Chapter 1

Nuclear fusion—what is it?

Despite sounding rather scary and ominous (not to mention incredibly dangerous), nuclear fusion is a rather simple process. It is basically smashing certain types of atoms together and seeing whether they stick together or not.

This being said, there are two main ways to achieve this goal of accelerating particles into one another:

1. Large magnets
2. Large amounts of electricity

With my project, I am doing the latter; I'm quite literally using a neon sign transformer to push/attract atoms toward a central core where they collide with one another.

Chapter 2

Dangers and risks

There isn't a whole lot of risk involved in the operation. The main enemies are:

1. High voltage
2. Neutron radiation
3. Minute amounts of X-ray radiation

High voltage is a well-studied field, and there's no reason for it to go out of control when proper procedures are followed. The levels of electricity I'm working at can be found in old TVs (the cathode-ray-tube–based ones) as well as neon signs, the both of which operate around us every day without incident.

Neutron radiation is relatively benign, and the flux from a homebuilt reactor is small compared to other sources, such as a professional particle accelerator. It can be stopped by a foot of paraffin wax, but the amounts that I would be producing are harmless and would most likely not affect people at all. Moreover, the reactor can also be operated with very fine level of control over how much of this radiation is produced (if at all); it would be hard, if not impossible to get neutron flux levels high enough to injure or kill a human being.

X-ray radiation is something that's well known to cause problems, but as is the case with neutron radiation, the levels are insignificant or extremely small. Unlike professional X-ray machines, the X-rays emitted by this fusor are at a very low voltage (several magnitudes less), and have much less penetrating power and means of causing damage. Moreover, these X-rays only come from specific points in the fusor chamber, and can be isolated with shielding easily. Most of the X-rays are blocked by the stainless steel chamber itself.

Moreover, I have discussed this project with several others (including a professor emeritus at Caltech and someone who's built their own fusor before), and they know that the risks are managable and that there wouldn't be any problem with someone my age building one. In fact, Brian McDermott from Massachusetts began building his fusor in freshman year in high school and was completed by the time he graduated.

Chapter 3

Benefits

The benefits far outweigh any possible risks.

Naturally, I'll present this in its operational form to science classes, and if possible, show them how it works as well as do small test runs (the majority of which have *highly* reduced voltages and X-ray fluxes). It's a first-hand experience of how nuclear fusion works; instead of being an alien concept in a textbook, they'll finally have something to visualize and look at.

Moreover, it shatters the misconception that serious science can only be done by professionals with six or seven figure budgets—there is nothing from preventing them from embarking on their own curious endeavors (say, particle accelerators of the likes of cyclotrons).

Chapter 4

Why fund it?

Right now, the total project has a budget of around two thousand dollars, which can probably be reduced by surplus shopping. Despite the fusor's basic premise of operation, vacuum equipment is precision equipment, and therefore relatively pricy.

I would be glad to present it to Chandler students and show them the inner workings, as well as guide them through how I did it/what similar projects they can attempt if they're interested in this type of particle physics. It's a stepping stone to a grander world—and when built, this will be one of the few portable systems in the country (less than 50 fusors exist in the US, with half of them being demonstrator types unable to actually fuse, the other half being regular lab-based stationary setups). As far as I know, only one other portable cart-like fusor remains in operation: Brian McDermott's on the east coast.

It's a unique project that provides a once-in-a-lifetime experience for students and teachers alike, and it's a project broadens horizons and ignites imaginations.

Chapter 5

Pictures of other fusors

Figure 5.1: Brian McDermott's fusor parts prepped and ready for assembly

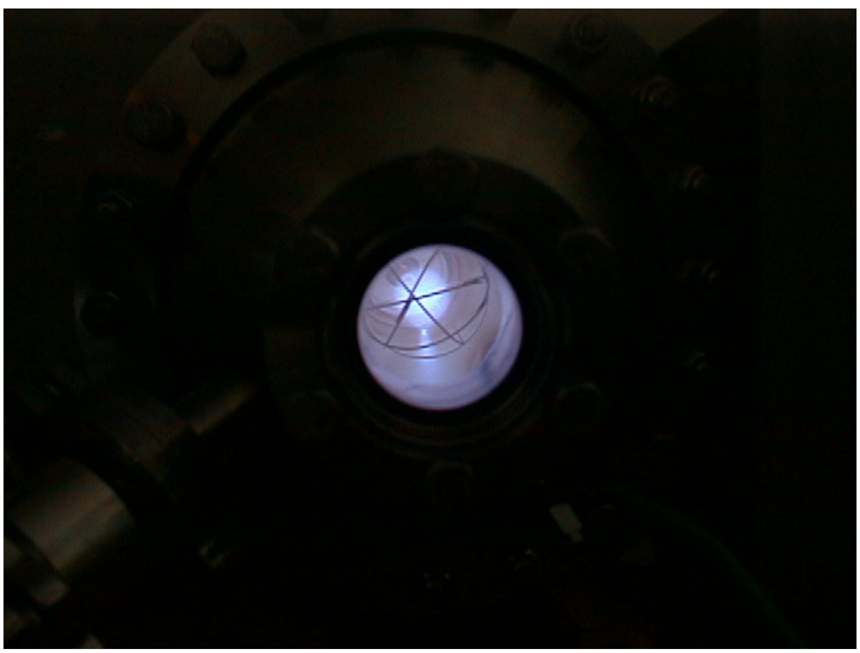

Figure 5.2: The first plasma in the fusor

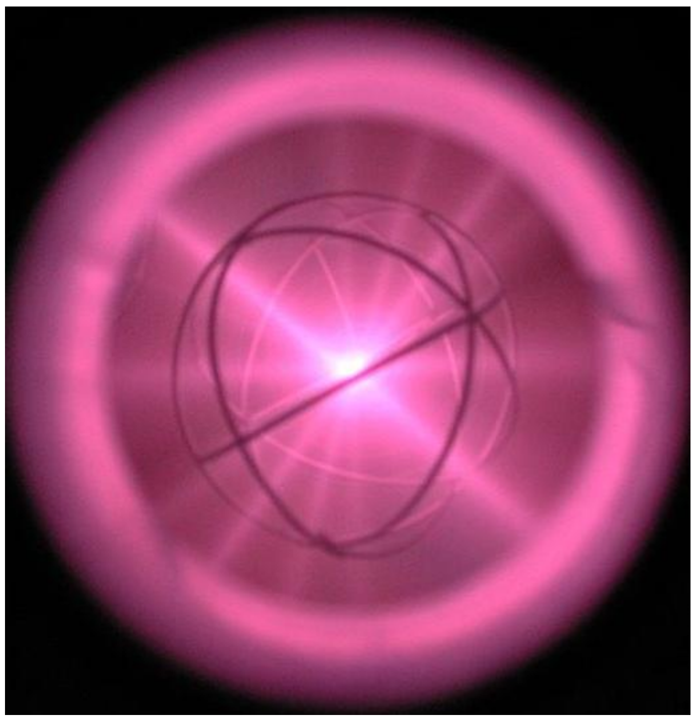

Figure 5.3: A fusing, star-mode plasma

Figure 5.4: Brian McDermott with his fusor in its entirety

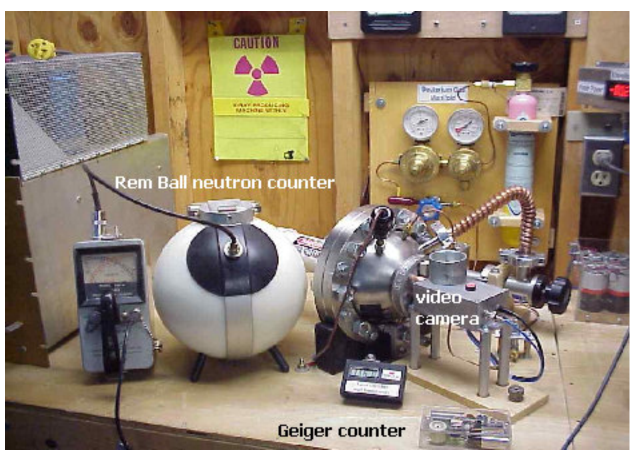

Figure 5.5: Richard Hull's fusor setup

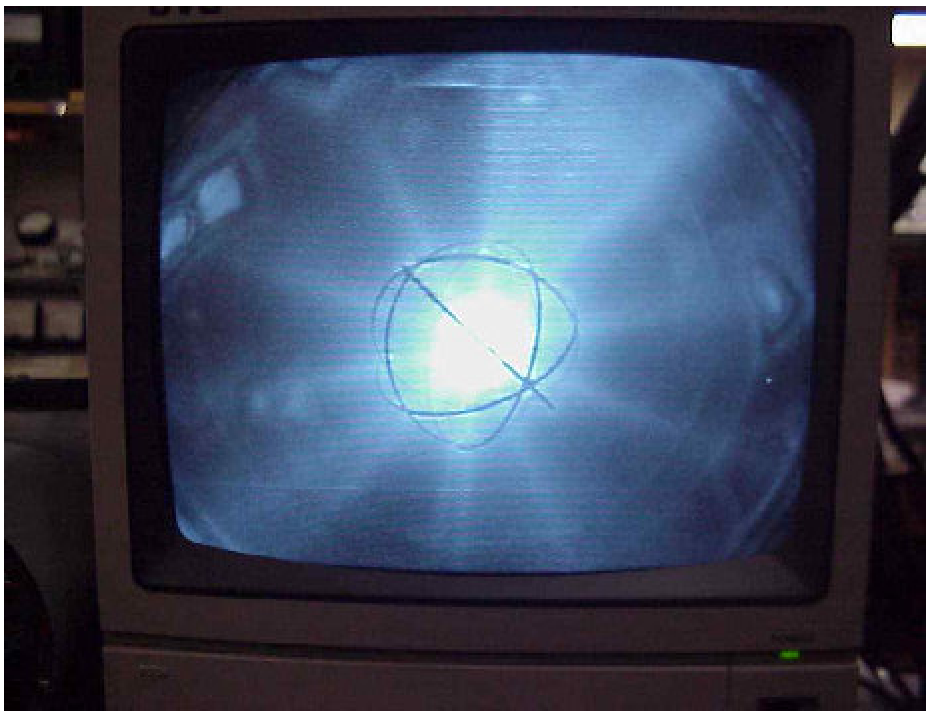

Figure 5.6: Richard Hull's fusor in star-mode (possibly fusion) operation