The Public Plea

"This is a once in a generation holy shit idea." – Justin Timberlake

The Dream:

In his viral TED talk: "How great leaders inspire action", Simon Sinek argues that to inspire action around an idea, you must start with why. This blog has reasons for publicizing the Polywell: we believe it will change the world. But, we wanted to know what the Polywell community thought. Why is there so much interest? Why are there 394,713 email addresses registered on talk-polywell? Social scientists use quantitative surveys and focus groups to answer questions like this. We aimed to do something similar. For our "focus groups": we re-read 409 conversations on the implications thread, going back to July 2010. This informal survey asked the question: does the poster believe that the impact of the Polywell would be good or bad?

This was fascinating reading. This community has some strongly viewed individuals. We all agree that the Polywell has far reaching implications. One interesting argument was between ChrisMB, Charles Kramer and skipjack over wither abundant energy will ultimately lead to the destruction of the worlds' resources. Another common theme was cheap energy's connection to other frontier technologies: laser weapons, hovercrafts, space exploration. The Polywells' impact on warfare was also debated. It was agreed that fusion could be a powerful tool for mankind; both creating and eliminating many problems. But, our success will depend on how mankind wields this tool. Below is a summary of the survey.

The Polywells' Impact On…			
	Good	Bad	No Position
World Resources	32	36	37
Global Pollution	5	8	10
Frontier Technology	10	8	14
American Influence	13	8	15
Warfare	7	18	23
Existing Energy Systems	12	1	21
Space Exploration	28	5	33
Food Production	10	5	39
Shipping	9		
Computers	1		
Human Health		1	

We attempted to group the posts into topics. There was allot of noise in the data; the most common post has no position. Occasionally, many posts came from the same person – analogous to someone shouting the loudest. The fact is: this technology is screaming to be researched. We have been saying this for years and we will continue to say it: the Polywell is really important.

In Their Own Words:

In the survey, we collected fifteen quotes from people that reflected their take on the technology, these are included below:

1. "…Biggest advantage? No oil…" –cgray45
2. "…and ostracizing those who don't agree, pretending they know--they KNOW--when in fact, they just accepted what they were told, by others who accepted what they were told, and so on, and so on, and so on… Let's face it, sometimes its best to say "I don't know…" – GIThruster
3. "…I think that with unlimited cheap energy, everything is possible..." – Skipjack
4. "…but I don't see fusion causing identifiable problems. It will cause unforeseeable problems…" – CharlesKramer

5. “…research enabling the quick application of such systems in space is important to overall fusion research and development…” – Zapkitty

6. “…A Polywell, like a gas turbine or diesel engine, will probably have a throttle that allows for a range of power outputs to meet demand. It could be idled, and with direct conversion, be throttled up…” – Dan Tibbets

7. “…You nonchalantly declare that interstellar travel will be easy because we'll have free energy soon. That is just total madness….” – ChrisMB

8. “…Monitors and televisions, too, would now only be limited by size and less by how much power they consume. Productivity all over the board could rise drastically…” – bennmann

9. “…I would love to see the destruction of the terrain of West Virginia stop or at least slow down to a crawl. All for the mining of coal...” – rjaypeters

10. “…We need to stop taking anything out of the ground that we can avoid, and we need to do it now…” – ChrisMB

11. “…With sufficient energy, there are no pollutants, only resources ... With sufficient energy, there are no pollutants except energy…” – KitemanSA

12. “…The critical point that we are at is not whether cheap electricity from fusion may compensate for disappearing fossil fuels, but whether humanity will learn to understand its true impact on others as it produces and consumes all that energy...” – ltgbrown

13. “…I think this ties into another implication for the social environment. I think that, in general, people don't trust technology, and view it as a force for evil in the world…” – MirariNefas

14. “…What if Polywell, or Focus Fusion, or some other source of "clean" and cheap energy is discovered? Are we "ready" for it? … By cheap, I mean so inexpensive, that people can begin to discount the cost of energy in doing any and everything…. By clean I mean it is essentially nonhazardous material producing, no radiation … and no CO2… Would having such a "cheap and clean" source of energy reduce war or increase it? …will cheap and clean energy be a catalyst to achieving peace?... While technically speaking, we cannot destroy the environment …we sure as hell can make it not as nice…” – ltgbrown

15. “….even if electricity becomes much more cheap and much more safe and universal … other resource constraints will still necessitate a change in how we live…” – CharlesKramer

The Supporters:

In his RSA talk, Michael Lima, explains how a network of people can collaborate to get things done. The Polywell needs to do this. This community is growing and we need to connect it better. Why? We will stop duplicating our work. For example, William Flint – over at http://polywellnuclearfusion.com/ - has written an aggressive argument for the polywell. Bills website is impressive. His enthusiasm for this project is contagious. Bill is a baby boomer who had a career as a high school physics teacher. His twitter account lists him as an advocate for the polywell since 2007. Since 2007, Bill has generated power point presentations, built a website, and written several e-books on the Polywell, including:

1. "Safe, Green, Clean - the p-B Polywell: A Different Kind of Nuclear Energy"[22] – Copyright 2008 – This book is 293 pages long! It draws support from M Simons blog and

2. "Earth's Big Energy Problem and How to Fix it" [21] – Copyright 2009 - This is a children's book. It covers our dependence on carbon based fuels and the downsides and advocates for the polywell.

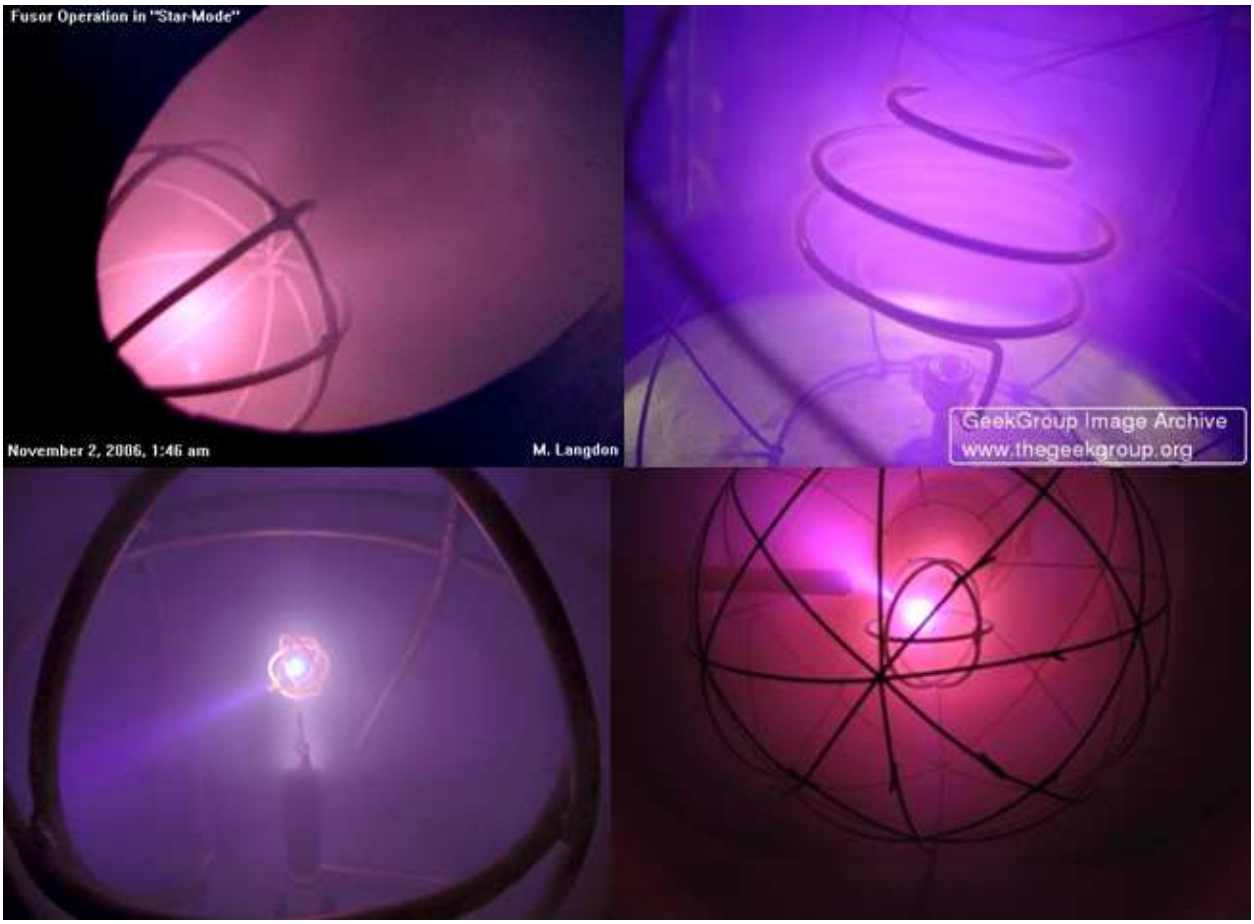
We agree the polywell is important. However, it is not proven. There is a real danger of pathological science. We can only be convinced by verifiable and repeatable evidence. We must always be skeptical.

"Nothing arises completely of its own power" –Buddhist saying

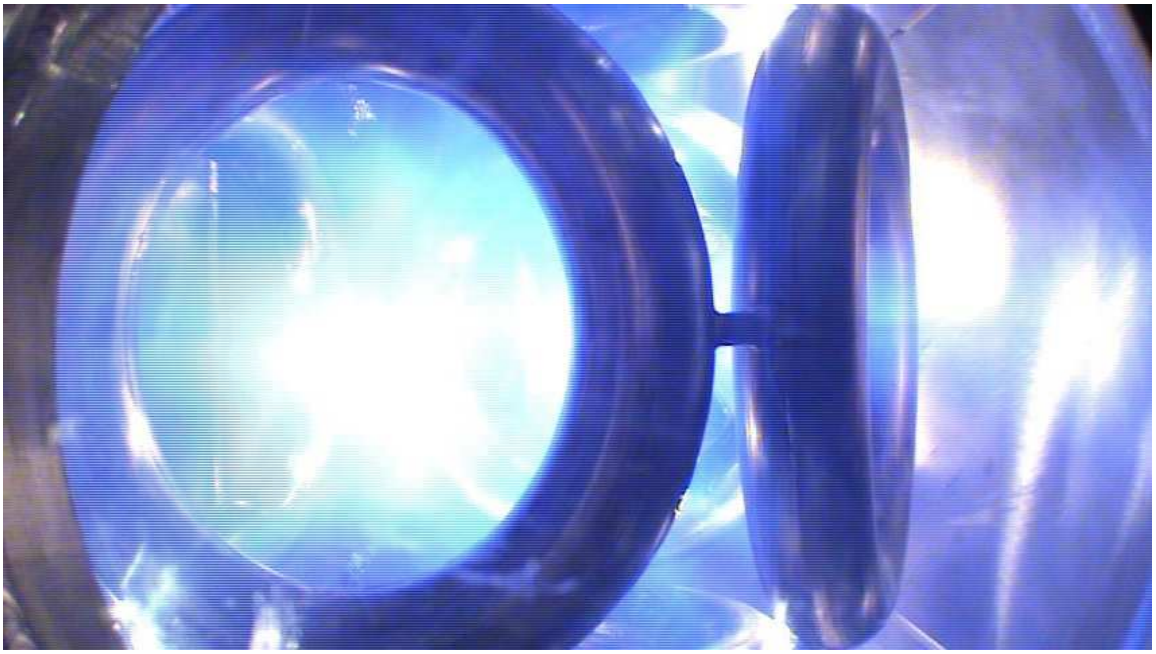
The History:

There is a simple way to fuse atoms. It is called a fusor. It uses metal cages in a vacuum. Put a voltage drop across these cages and puff in hydrogen gas and you get fusion. Here are pictures of fusor devices over the years:


Sat Mar 3 10:41:30 PST 2007

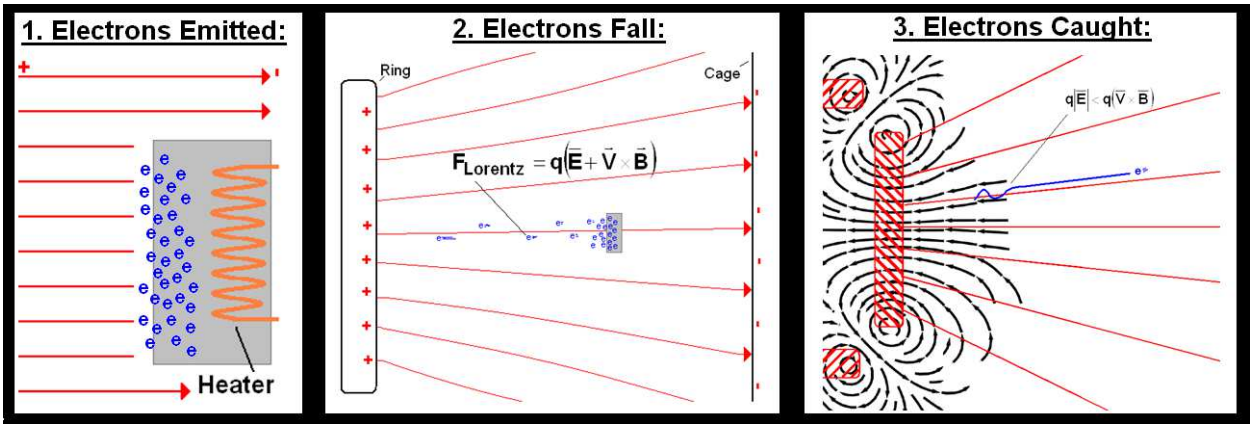


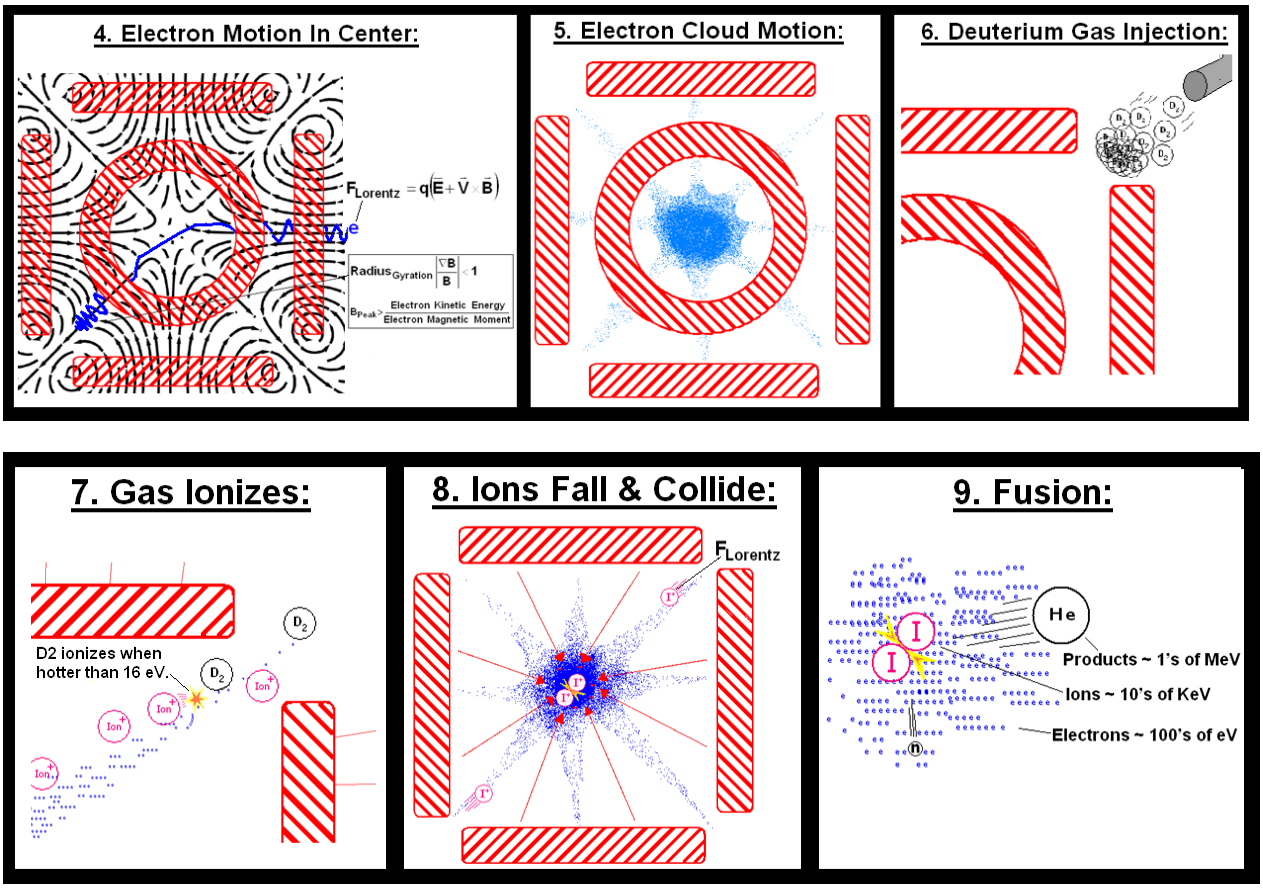
The Fusor has been around since 1964 [13]. High school students have built fusors [5]. One even presented at TED. It is an old technology. It works. It fuses material. It will never make power because of ions touch the metal cages and are conducted away. Conduction losses kill the machine. The fusor works because it uses a metal cage to attract ions. The polywell is the next generation fusor. It uses a cloud of electrons to attract the ions. But, can the polywell someday make net power?



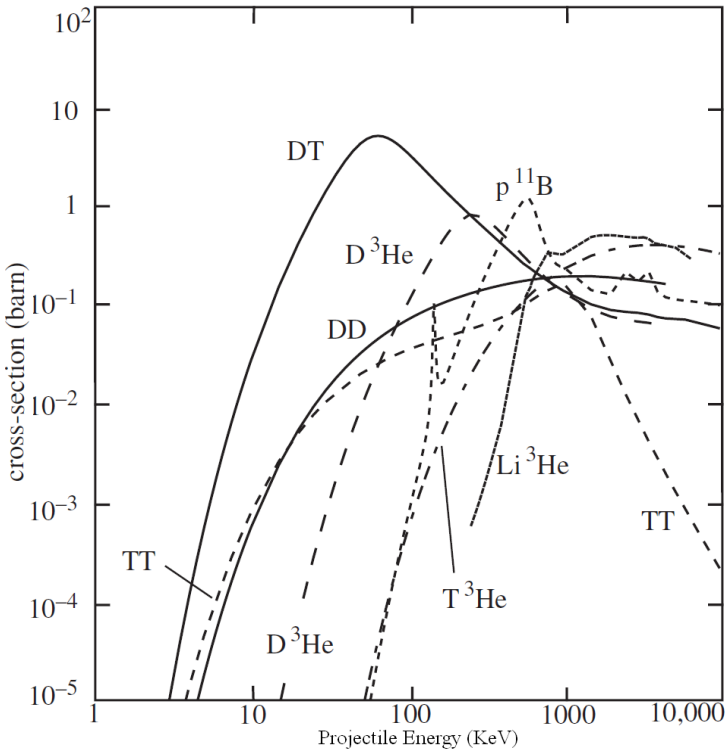
The How:

We have a mechanism for how this machine works. Check out this post for a detailed description. We need to make this into a YouTube movie. The mechanism needs to be is verifiable and understandable for the general public. Shown below is a cartoon summarizing the nine steps for Polywell fusion.





The biggest question we always hear from people is: they cannot believe that a collision of two deuterium ions at 10 KeV would lead to fusion. It can; but not with high reliability. NIF's stated goal was to get the plasma to 10 KeV, under a dense confinement [18]. The "reliability" is measured by the reaction cross section. The cross section is a measure of the "fusibility" of two atoms. The way cross sections have been measured, for decades, is by accelerating particles in an electric field – in much the same manner as the Polywell will attempt fusion power. The cross section is shown below [19].



"The optimism of youth is really underrated." – Larry Page.

Future Plans:

Going forward, there are two classical equations which will drive Polywell research. The first is the volumetric rate equation. This uses the reactions' cross section as described above. The cross section is entered into the volumetric rate equation, which predicts the fusion power from a hot cloud [1].

$$\frac{\text{Energy From Fusion}}{\text{Hot Volume}} = \left(\frac{\text{Number of A Atoms}}{\text{Volume of Space}}\right) * \left(\frac{\text{Number of B Atoms}}{\text{Volume of Space}}\right) * \text{Relative Velocity} * \text{Cross Section} * \text{Rxn Energy}$$

If you use typical numbers for WB-6, this equation predicts a tiny 4E-9 joule per second [20]. It is a start. The polywell may be improved by raising the cross section and reaction energy. It may be improved by increasing the voltage drop. This will raise the cross section, velocity and number density. The Polywell may also work by increasing machine size. A larger hot volume means more energy output.

The equation also tells us that raising the density will have a big impact. This is due to the squared term. Hence, for last 55 years laser fusion has tried to compress material. The problem is: you need lots of money, energy and equipment to do that.

The polywell cannot win, if it heads in that direction. We also have to raise the machine efficiency.

We recognize this because of the Lawson criteria. John Lawson laid this out in his 1957 paper on fusion [1]. This has become the standard by which we measure all reactors. Any reactor fusing using a hot plasma cloud is subject to the following equation.

Net Power = (Power Made - Power fed in - Conduction losses - Xray losses) * 33%

In this equation, the losses are what are important. They are special to plasma clouds. Conduction losses are when atoms touch the walls and are conducted away. X-ray losses are when energy is bled away as x-rays. The Polywell will need to reduce these losses to reach net power; it needs to be more efficient.

Net power is the goal. There is a worldwide race to get there: from the tokamak, NIF and a collection of smaller projects. In this race, the smallest, simplest and cheapest devices have the best chance of being commercial. That is not just common sense - it is scientific precept known as Occam's razor. It states that: among complete solutions, the one which makes the fewest assumptions should be selected. So which system would you bet on: a giant 196 laser system costing $3.54 billion [23] or a new untested reactor?

Research Plan:

Using simulations, can a polywell operational “sweet spot” be found? Simulations are by definition, simpler than the real world. This makes analysis of a simulated reactor clearer and cleaner than an experimental one. Ideally, one would use details from WB6 and previous simulation work from the University of Sydney [7], happyjack [26], indrek [27] as the starting point. Our hope is to use the MCNP code [24] from LANL to do this simulation. We would like to couple simulations with dimensional analysis to test a wide range of Polywell operating conditions. For example, it may work better with 10:1 electrons to ion ratio or if the magnetic field is tuned to a specific strength. Our goal would be to find a resonance condition, a sweet spot or just modes of operation for this machine. Dimensional analysis means varying a set of dimensionless numbers to see what effect they have on operations. By grouping variables this way, research can be significantly accelerated. Here is list of groups we would like to try:

1. $$\text{X - ray Reflection} = \frac{\text{X} - \text{rays Reflected Back In}}{\text{X} - \text{rays Sent Out}}$$

2. $$\text{Whiffle Ball Number} = \frac{\text{Magnetic Field Generated by Electron Cloud}}{\text{Number of Rings} * \text{Ring Circumfrence} * \left(\frac{\text{Magnetic Field}}{\text{Section Of Ring}} \right)}$$

3. $$\text{Ion To Electron Ratio} = \frac{\text{Number Of Ions Inside Device}}{\text{Number Of Electrons Inside Device}}$$

4. $$\text{Beta Ratio} = \frac{\text{Number Density} * \text{Boltzmann Constant} * \text{Plasma Temperature}}{\text{MagneticField}^2 \Big/ 2 * \text{Permability Of Free Space}}$$

5. $$\text{Energy Ratio} = \frac{\text{Energy Produced By Machine}}{\text{Energy Fed Into Machine}}$$

7. $$\text{Conduction Loss Ratio}_{\text{Electron}} = \frac{\text{Number of Electrons Retained Per Transit In Machine}}{\text{Total Number of Electrons Per Transit In Machine}}$$

8. $$\text{Conduction Loss Ratio}_{\text{Ions}} = \frac{\text{Number of ions Retained Per Transit In Machine}}{\text{Total Number of Ions Per Transit In Machine}}$$

This may not work. The idea may be a flop. If that is the case we as a community must be willing to accept this. But, if we find a resonance condition: we patent it. That would be the intellectual property needed for a startup.

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