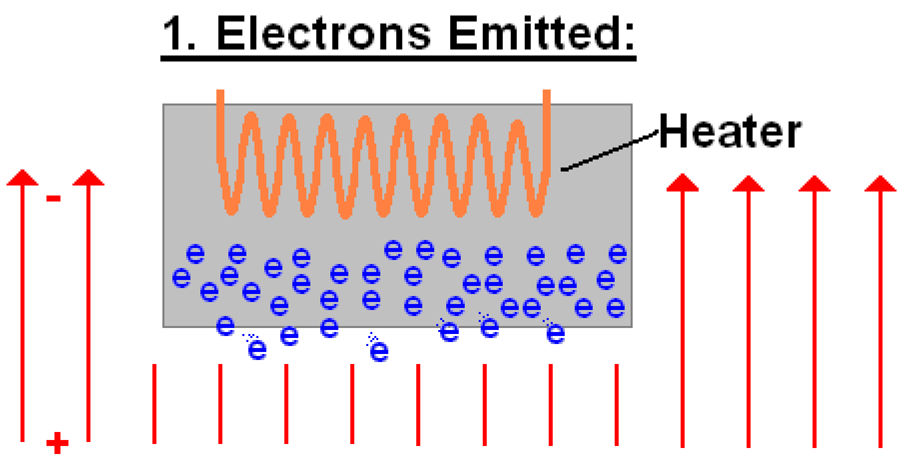
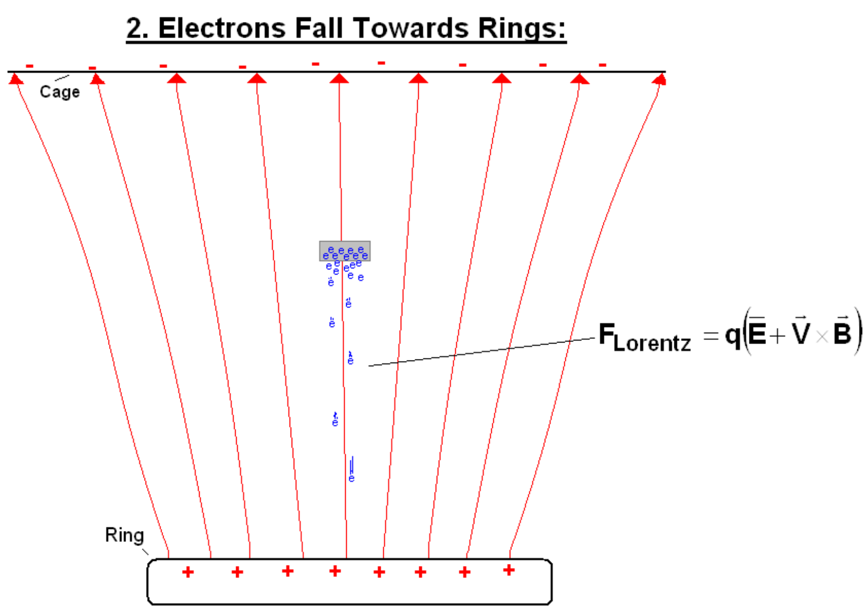
Purposed Polywell Mechanism

A short YouTube Cartoon explaining the mechanism is needed. It has to be simple and informative. Explaining the mechanism is really important. Is there an animator that is willing to help? Deciding on the right amount of detail will be hard. We could almost make three videos with increasing levels of details. However, for the general public a simple video will suffice. Here is an example of what is needed: http://www.youtube.com/watch?v=60QX5RY_ohQ. Since this is still new idea, there may be changes to add later. But, we need a movie out there now, so new Polywellers can quickly understand the mechanism. Enumerated below are the nine purposed steps for Polywell fusion.

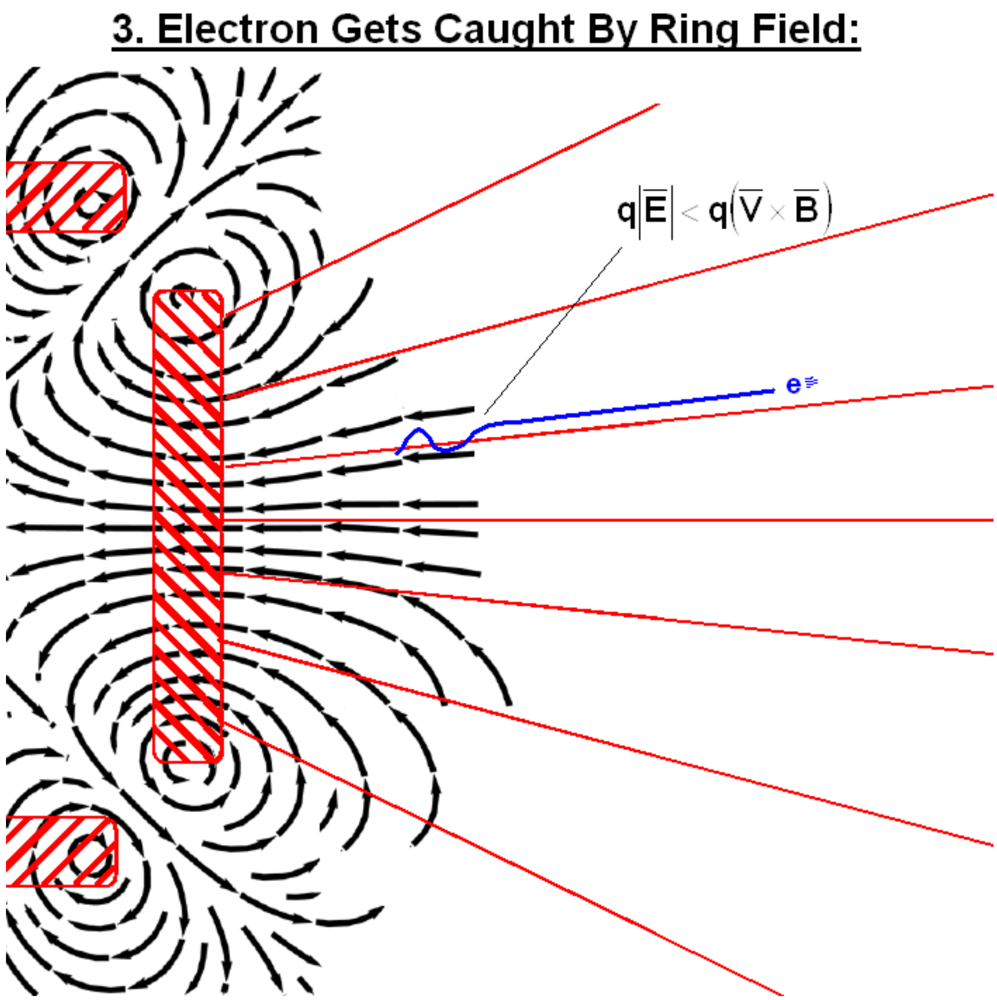
1. ELECTRON EMITTED: The electron can be generated using thermionic emission [3, 21] from a metal surface.



2. ELECTRON FALLS TOWARDS RINGS: There is a voltage drop between the outside cage and the rings. In WB6 this was 12,500 volts [4]. The electron is emitted some distance from the device. The electron "falls" down the voltage drop towards the rings. It moves this way because it is experiencing the electric component of the Lorentz force [5, 6].

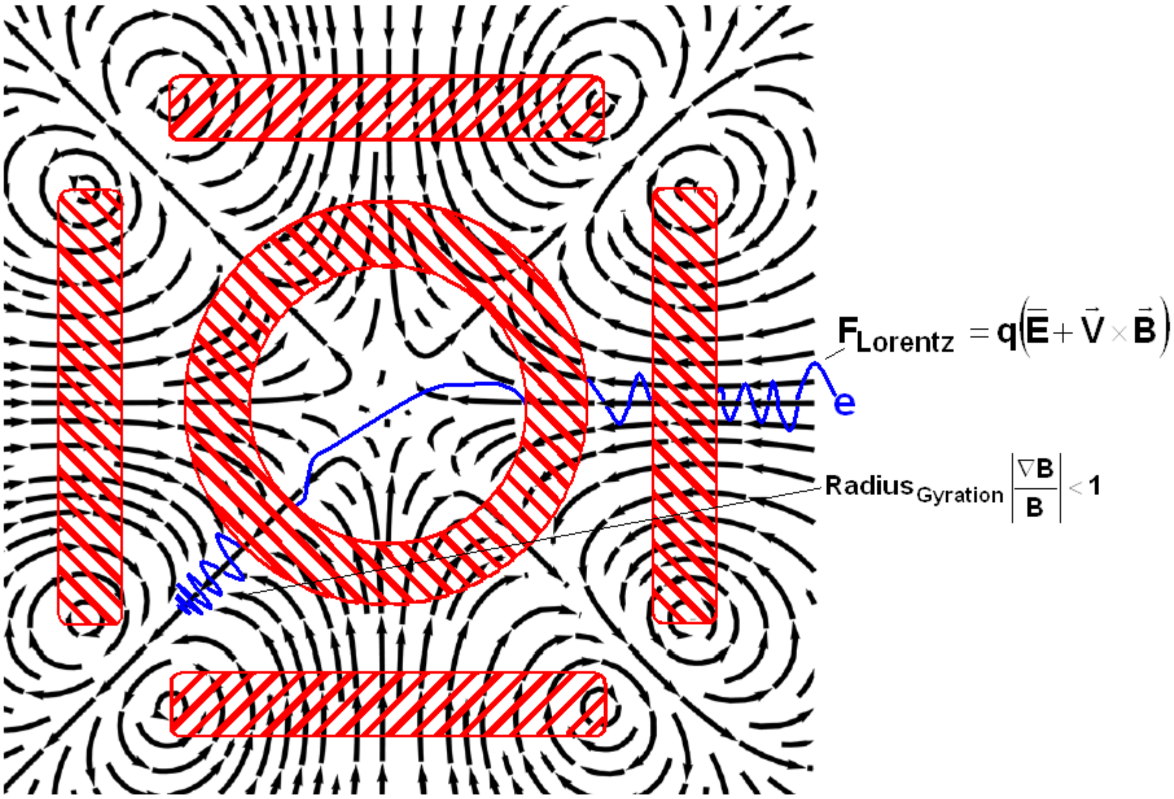


3. ELECTRON GETS CAUGHT BY RING FIELD: When the electron gets close it starts to feel the magnetic fields. Specifically, the magnetic component of the Lorentz force becomes stronger than the electric force [5]. The electron starts following the magnetic fields generated by the rings. The electron oscillates around one of these magnetic field lines, following it towards the center, giving off cyclotron radiation [7].



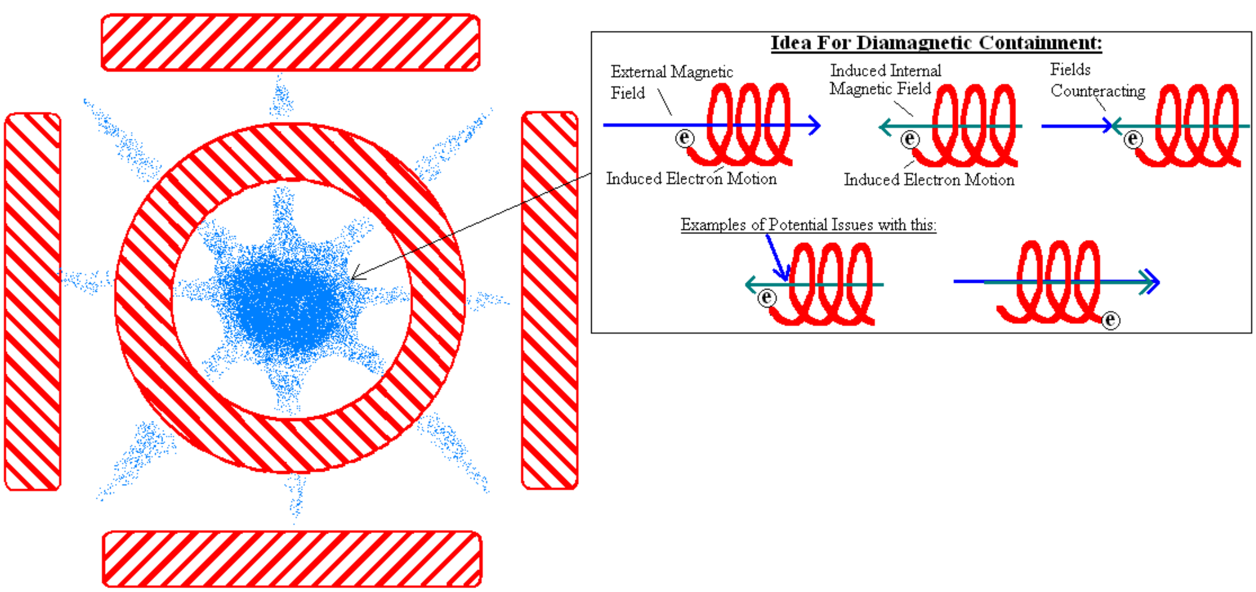
4. ELECTRON MOTION INSIDE CENTER: When the electron reaches the center, its' motion becomes straighter as it passes through the null point [8]. This is the point of no magnetic fields in the middle of the rings. As it heads out the other side, it starts oscillating again. This oscillation get tighter as the electron gets farther away from the center [14, 11]. The radius of oscillation is the electron gyroradius [9]. The electron follows the magnetic field lines. These lines are drawn together, tighter and tighter at the corners. The magnetic field gets denser. The electron oscillation gets smaller and tighter. At some point, the field gets so tight that the electron hits a magnetic mirror at the cusps [9, 10, 11, 14]. The electron turns around. It heads back toward device center and repeats the motion [11, 14]. An electron should be lost after a given period of time [11].

4. Electron Motion Inside Center:

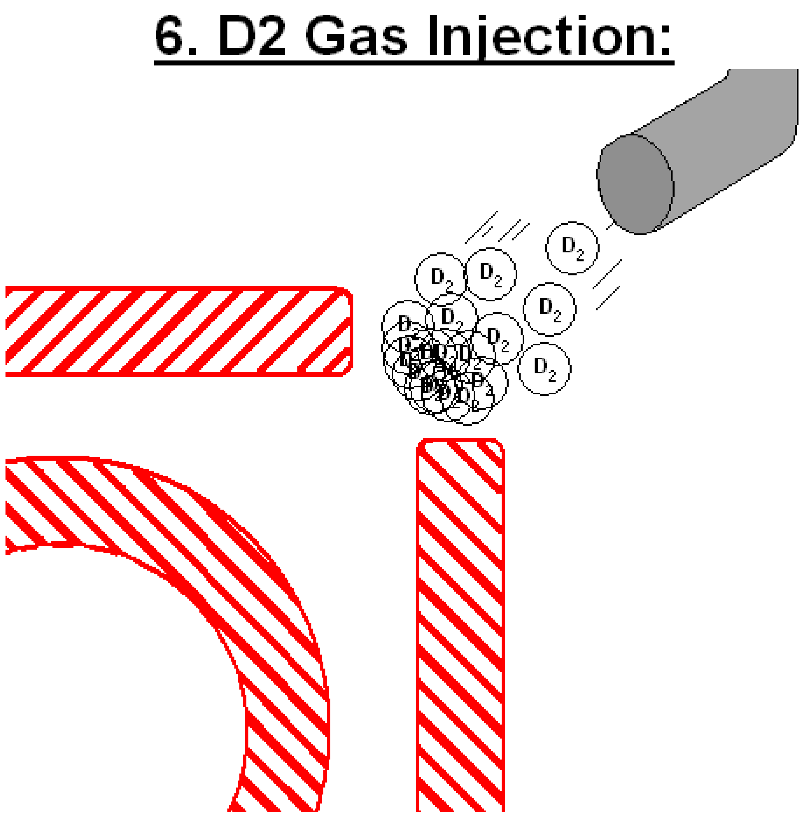


5. ELECTRON CLOUD BEHAVIOR: When a large number of electrons are inside the rings, they should appear as a pulsating swarm where material swirls around and moves forward and back to the cusps. This electron motion generates mini magnetic fields [12]. It has been purposed [4]: that these mini fields resist the rings fields. This is not proven. This would be analogous to the electron cloud going diamagnetic [22, 23]. If this were true, the electrons may occupy spherical cloud in the center, with 14 "spikes" pointed towards the cusps along the 8 corners and the 6 sides. If true, this may positively affect conduction losses.

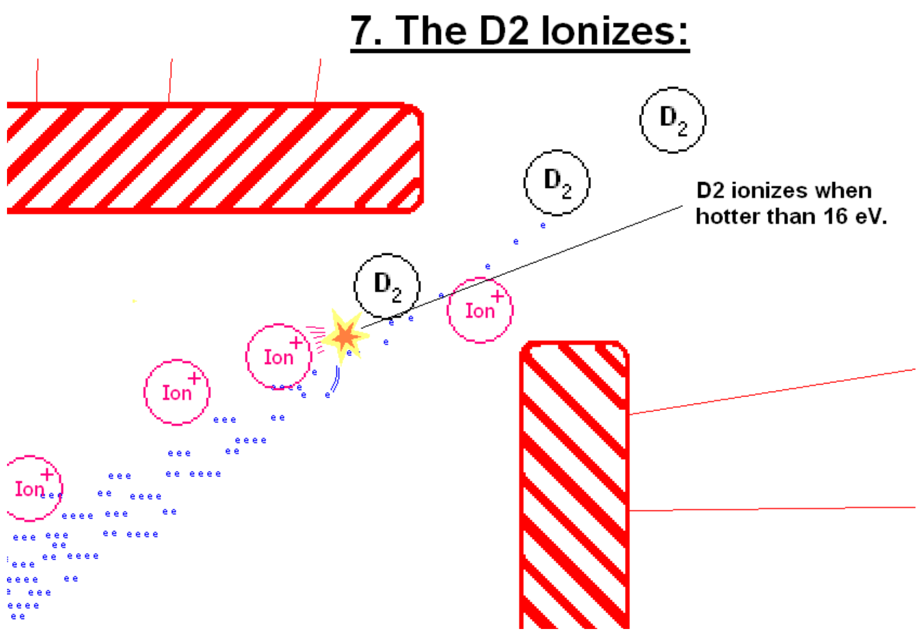
5. Electron Cloud Behavior:



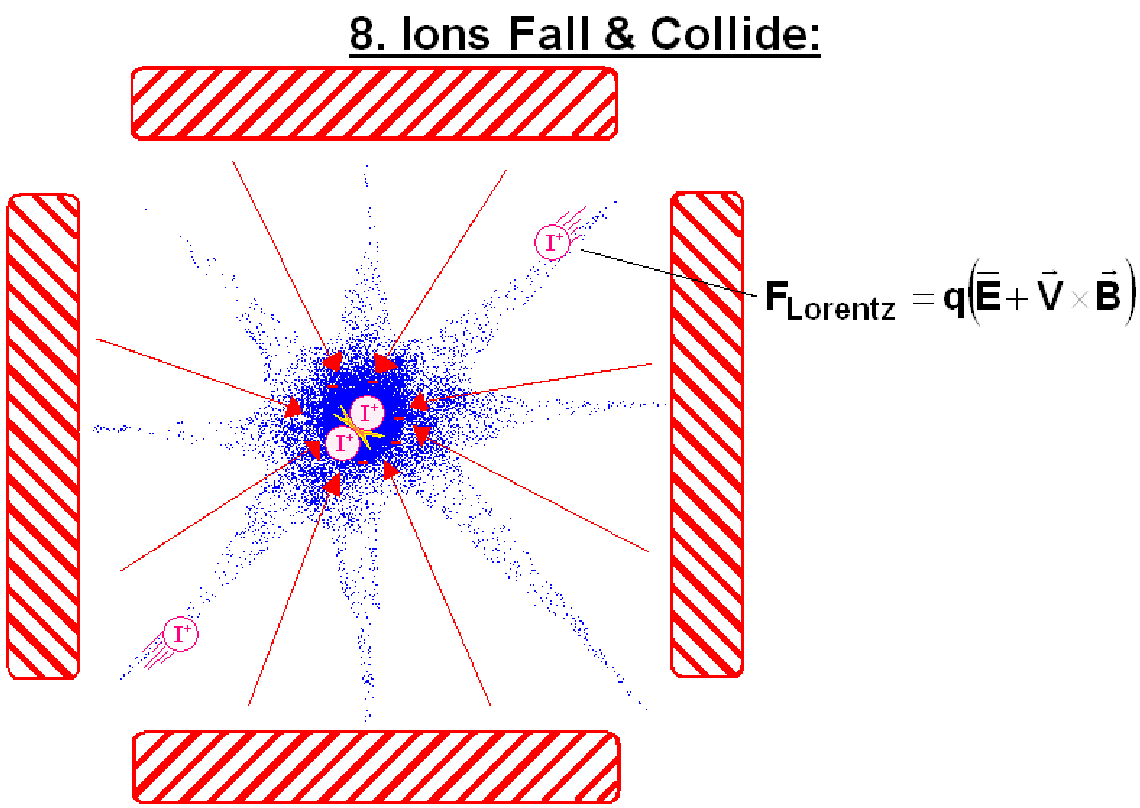
6. D2 GAS INJECTION: The D2 gas is puffed towards the rings [4]. This is the uncharged D2 gas. This means that the gas is less affected by the electric fields. Hence, it can make it to the edge of the rings. Bussard puffed the gas in at the relatively high pressure of 3E-4 torr against vacuum pressure of 1E-7 torr [4].



7. THE D2 IONIZES: When the D2 reaches the edge of the rings it is hit by an electron. If the electron is hotter than 16 eV [1] the D2 will become an ion. Bussard estimated that the typical electron in his device had 2,500 eV [4] at the beta=1 condition [13]. This collision heats up the deuterium and it ionizes.   The deuterium loses an electron to become the ion. The ion is positively charged and is attracted to the cloud of electrons in the center. In WB-6, this attraction created a 10,000 volt drop for the ions to "fall down"[4].



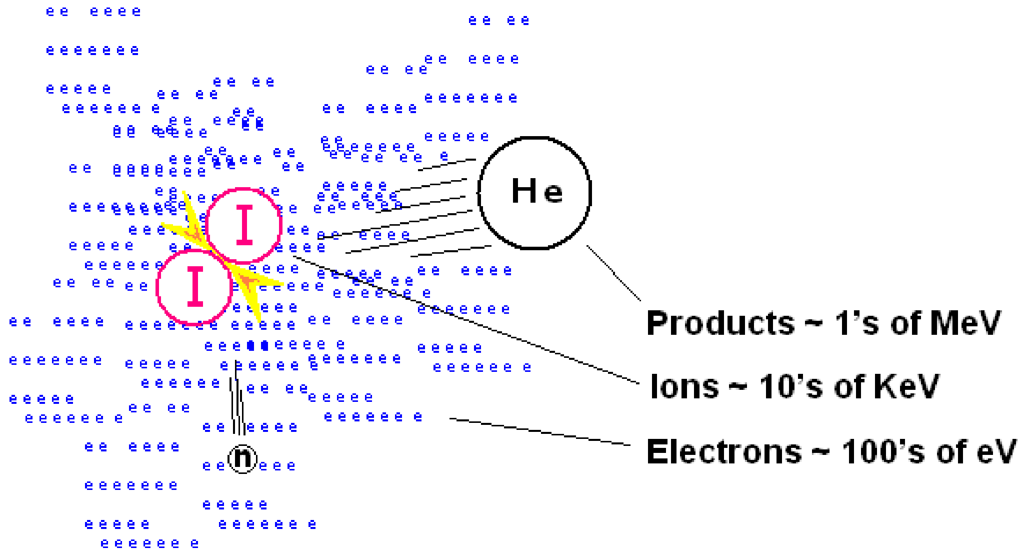
8. ION FALLS & COLLIDES: The charged deuterium is attracted to the electrons in the center. It is attracted by the 10,000 volt drop. It "falls down" this hill towards the center [4]. The ion builds up 10,000 eV as it falls. Note that the deuterium ion is about 3,670 times more massive than the electron [16, 1].



9. FUSION: If two ions do collide at 10,000 eV, they can fuse. The product will be have on the order of 1 MeV [19] of energy and cannot be held by the electric or magnetic fields. It should therefore rapidly exit the rings. As the voltage increases the odds of fusion typically improves. This is measured by a fusion

reactions' cross section [19]. The stated goal of NIF was to get the average plasma temperature over 10,000 eV under confinement [2].

9. Fusion:



Inside WB-6, the deuterium could have collided with 10,000 electron-volts of kinetic energy. This would give a fusion cross section of 1E-4 Barns [19]. This cross section is entered into the volumetric fusion rate equation [20]. This equation is shown below with typical numbers for WB-6 [4, 24, 25]. The ion density is estimated from experimental estimates [4].

$$\frac{\text{Energy From Fusion}}{\text{Hot Volume}} = \left(\frac{\text{Number of Deuterium Atoms}}{\text{Volume of Space}}\right)^2 * \text{Relative Velocity} * \text{Rxn Cross Section} * \text{Ave Energy From Rxn}$$

$$\frac{\text{Energy From Fusion}}{\text{Hot Volume}} = \left(\sim 1\text{E}15\ \text{Ion}/\text{M}^3\right)^2 * \sim 1{,}384{,}000\ \text{M}/\text{S} * \sim 1\text{E}-32\ \text{M}^2 * \sim 2.92\text{E}-13\ \text{Joules}/\text{Ion} = 4.0\text{E}-9\ \text{Joules}/\text{Second}$$

Many other things can happen as the ions fall towards the device center. The ion can interact with other electrons or ions. They interact if the distance between these objects falls below the Debye screening length [17]. These interactions can create x-rays, repulsion or collision without fusion [18]. Three main criticisms against this idea are: x-rays sap away too much energy, the electron and ion temperature cannot vary more than 5% and a bell curve of ion energy keeps most of them too cold to fuse [18].

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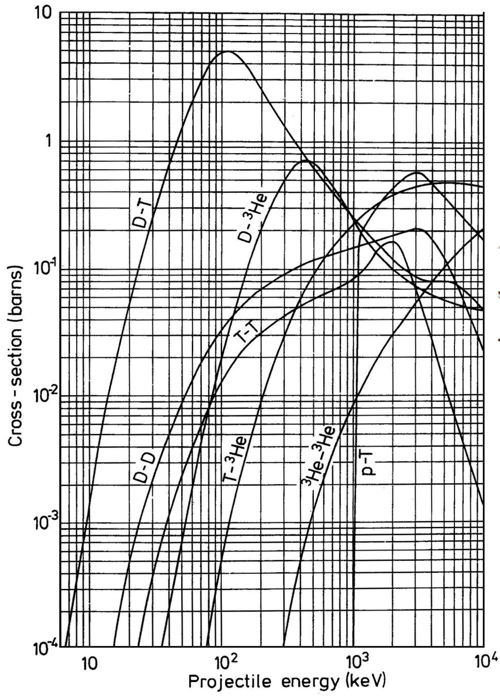
SCALE UP: Here is the volumetric rate equation for different machines. The first example is a machine fusing deuterium and tritium with a 64,000 volt drop. If the fusing gas has the same density, then the equation predicts 0.003 joules per second will emanate from the cloud [25].

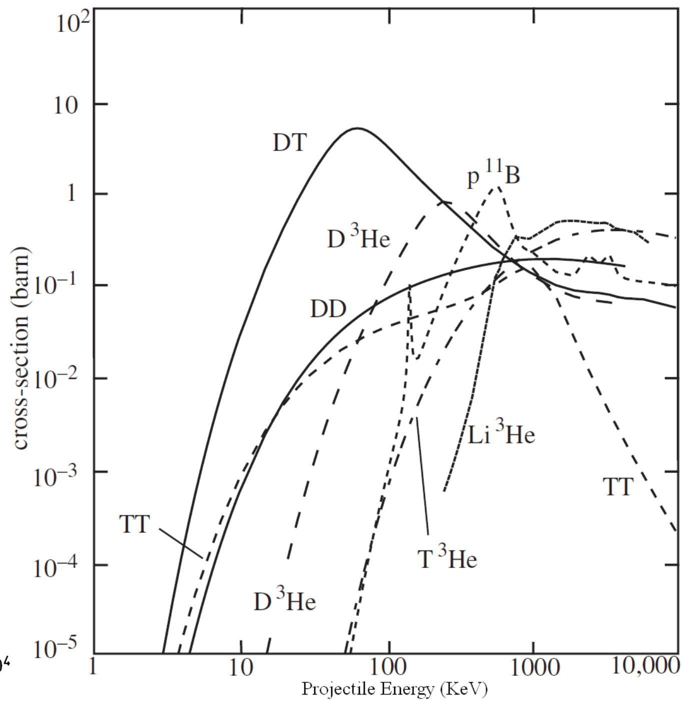
$$\frac{\textbf{Energy From Fusion}}{\textbf{Hot Volume}} = \left(\sim 1\text{E}15\ \text{Ion}/\text{M}^3\right)^2 * \sim 2{,}215{,}000\ \text{M}/\text{S} * \sim 5\text{E}-28\ \text{M}^2 * \sim 2.82\text{E}-12\ \text{J}/\text{Ion} = 0.003\ \text{Joules}/\text{Second}$$

If the machine is fusing boron-11, then the reactor can exploit the fact that the boron has a charge of five. Because of this, the boron experiences five times the Lorentz force for the same electric field. The equation predicts that this reactor, with a 110,000 volt drop would produce 0.0005 joules per second [25].

$$\frac{\textbf{Energy From Fusion}}{\textbf{Hot Volume}} = \left(\sim 1E15 \, {}^{Ion}\!/\!_{M^3}\right)^2 * \sim 3{,}105{,}000 \, {}^{M}\!/\!_{S} * \sim 1.2E-28 \, M^2 * \sim 1.39E-12 \, {}^{J}\!/\!_{Ion} = 0.0005 \, {}^{Joules}\!/\!_{Second}$$

Cross sections for different fusion reactions are shown below [19, 25].





<u>Citations:</u>

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