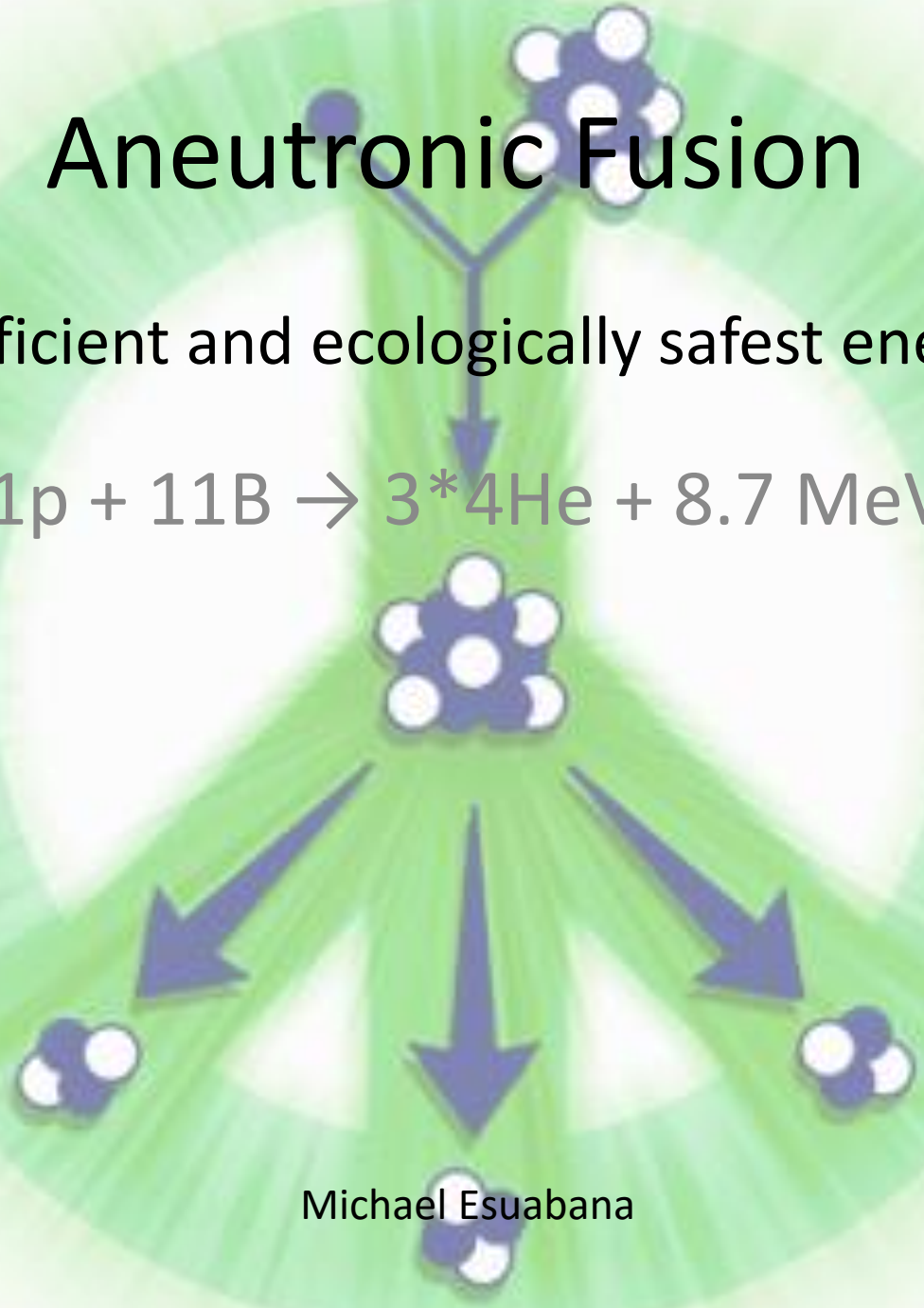
Aneutronic Fusion

The most efficient and ecologically safest energy source

$$1p + 11B \rightarrow 3*4He + 8.7\ MeV$$

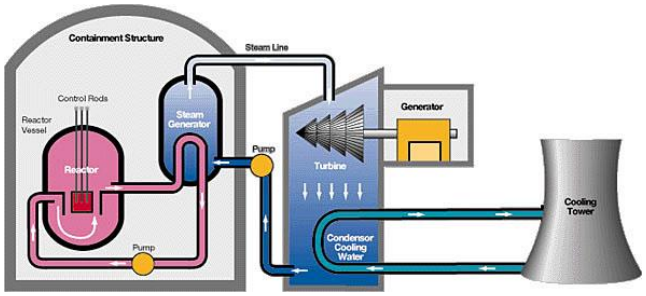


Michael Esuabana

Agenda

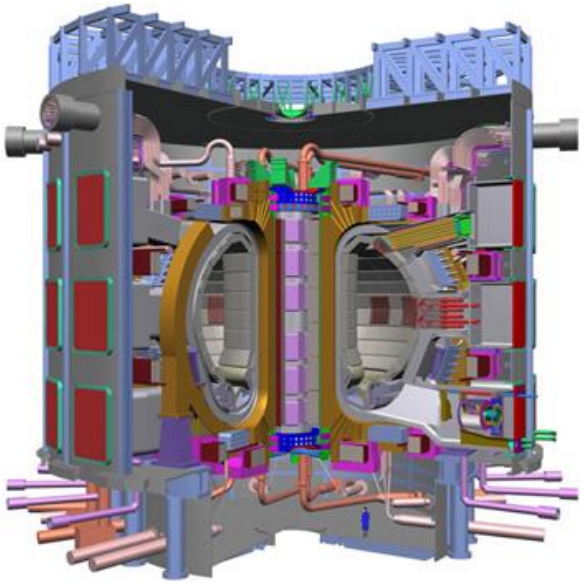
- Why Aneutronic
- Theory
- LPP
- TriAlpha
- Polywell
- Space propulsion

Why Aneutronic



Fission reactor 1M x more efficient than coal but!

- Expensive (Mining, Turbine, Cleanup/Storing)
- Large amount of Highly Radioactive byproducts
- Proliferation (Thorium doesn't help either U232)



ITER

D-T Fusion reactors Tokamak /(Laser not shown)

- 3-4 times more efficient than a Fission reactor
- Produces high number of Neutrons
- Still requires expensive Turbine system.
- Storing problem, irradiated from Neutrons.

Pros

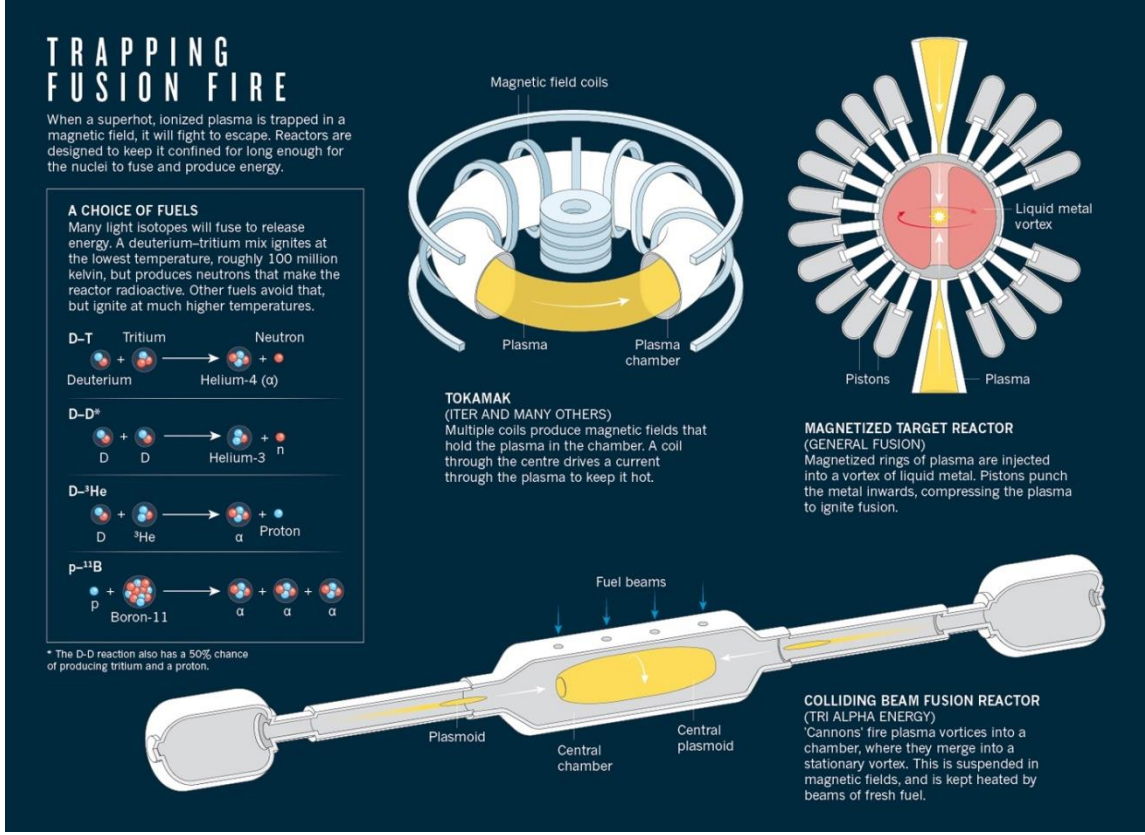
- Lower temperature to ignite 400MK
- Higher Cross section

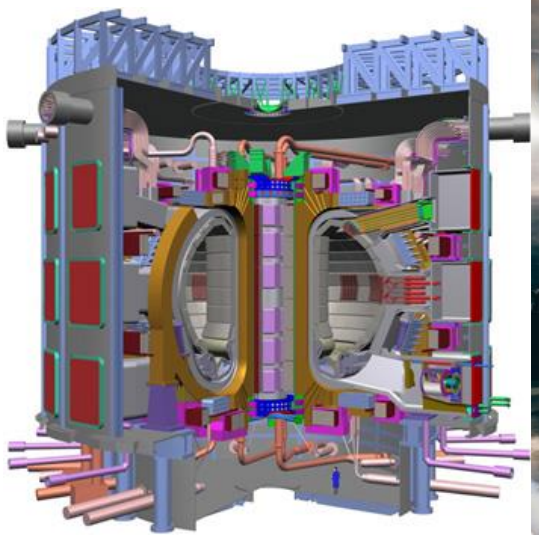
Proton + 11Boron Fusion Pros

- Has no Neutron emission < 1%, just Helium Ions.
- Energy can be directly converted without Turbine
- No Storage worry
- Still 10:1 input output ratio as D-T fusion reaction.
- Cheaper

Cons

- Higher Temperature required to fuse 1.6BK
- Lower cross section than D-T

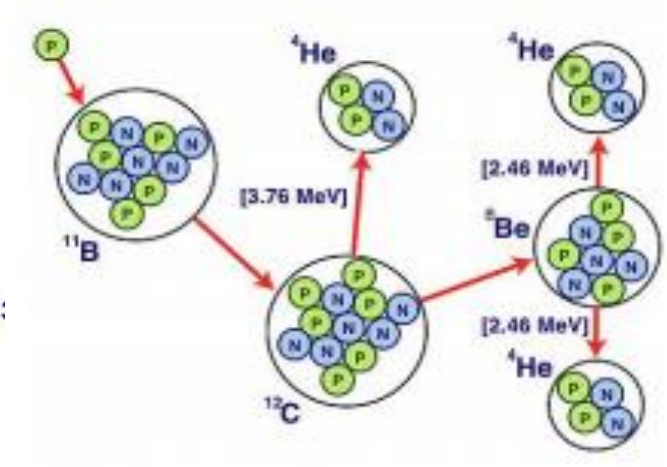


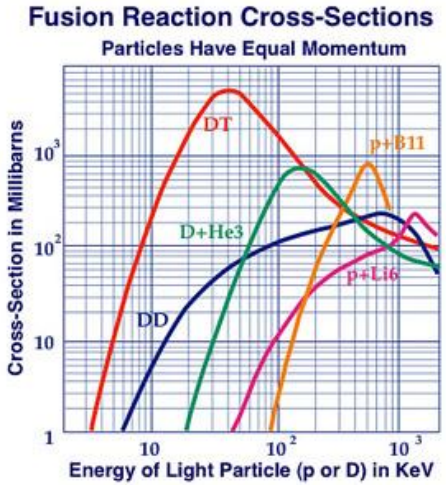


Deuterium–helium-3 fusion	^{2}D	+ ^{3}He →	^{4}He	+ ^{1}p	+ 18.3 MeV
Deuterium–lithium-6 fusion	^{2}D	+ ^{6}Li → 2	^{4}He		+ 22.4 MeV
Proton–lithium-6 fusion	^{1}p	+ ^{6}Li →	^{4}He	+ ^{3}He	+ 4.0 MeV
Helium-3–lithium fusion	^{3}He	+ ^{6}Li → 2	^{4}He	+ ^{1}p	+ 16.9 MeV
Helium-3-helium-3 fusion	^{3}He	+ ^{3}He →	^{4}He	+ 2 ^{1}p	+ 12.86 MeV
Proton–lithium-7 fusion	^{1}p	+ ^{7}Li → 2	^{4}He		+ 17.2 MeV
Proton–boron fusion	^{1}p	+ ^{11}B → 3	^{4}He		+ 8.7 MeV
Proton–nitrogen fusion	^{1}p	+ ^{15}N →	^{12}C	+ ^{4}He	+ 5.0 MeV[2]

He3 is scarce on earth, must mine in space(moon) Li7 has no advantages to B11, and has lower cross section!

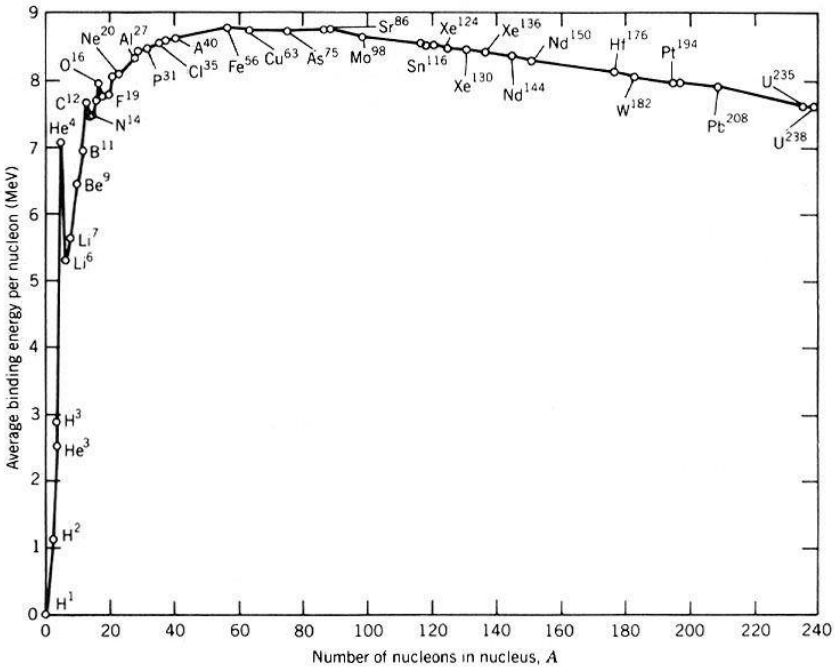
Theory





- No γ rays, no neutrons. Ideal for everday use around populace.
- Z=6 is large state of electric charge, easy to convert directly into electricity. By cyclotron or reverse linear accelerator.
- Can recover energy 13 times larger for every 675 keV used 8.7 MeV is produced.

- Emittied n is < 1% of total energy emitted from fusion.
- Q value is 3.07 MeV amount of energy released from decay C12
- P colliding Boron11 A=11 Z=5 produces radioactive ion C12 A=12 Z=6.
- C12's half life 20 minutes, decays into stable He4 ions.
- With boron at rest, proton needs large velocity to fuse. Resonance at 675 keV has large cross section 0.9 barn.
- Low energy and High cross section ideal for Fusion.
- Direct conversion to electricity can be obtained from 8.7 MeV of 3 α part



B11 as stationary source is impractical

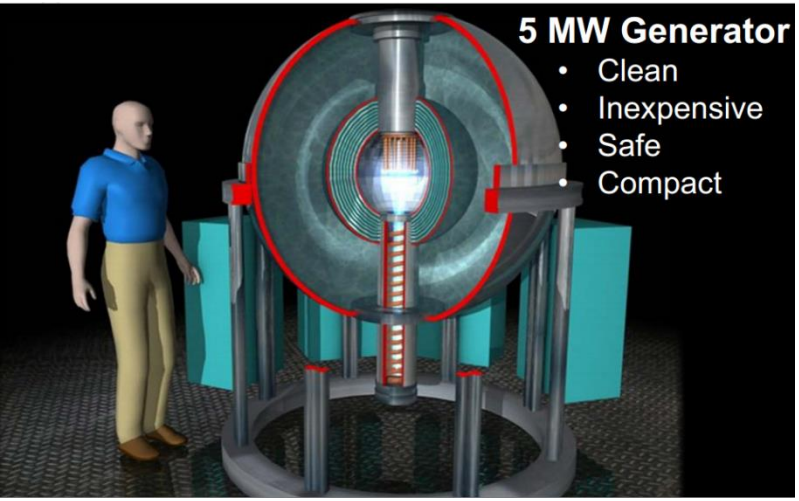
- With 10^18 events, on average the proton must travel 8cm.
- Proton loses all of its energy traveling 10 microns in the target
- Loss from ionization and excitation of atoms in the target.
- Too many electrons on the way before proton can hit nucleus of Boron

C12 is in the realm of fusion, not much higher from He4.
Fe56 is like an ash for fusion, (equal energy to fuse or to split)
Above Fe only fission releases energy.

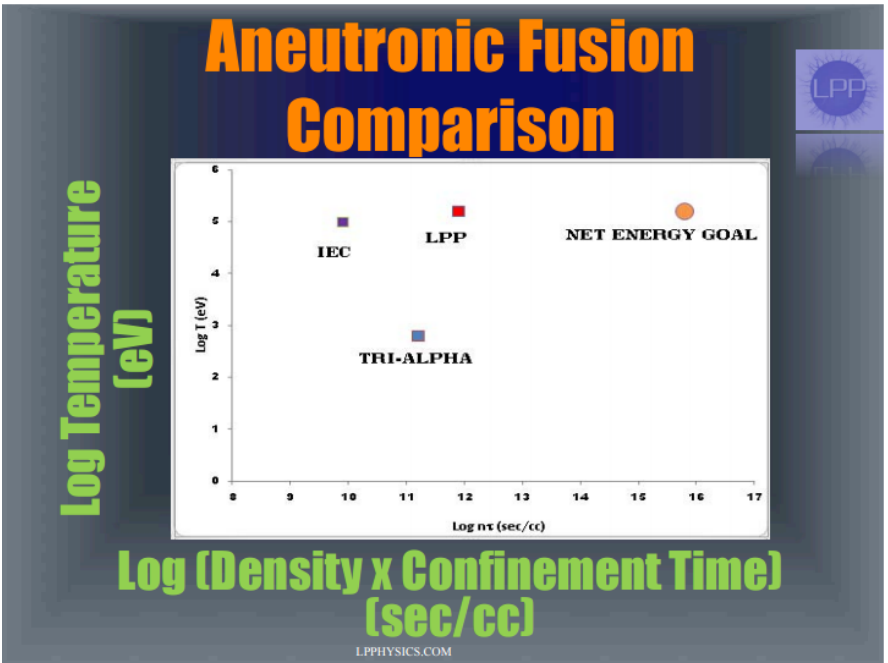
Method colliding beams is promising

- Don't have to overcome electric force in order fuse them
- Two beams with same velocity Tp=56 keV, Tb = 619 keV
- Tp+Tb=657keV < W
- W = 8.7 MeV, the reaction from fusing the proton with B11 ion.

LPP



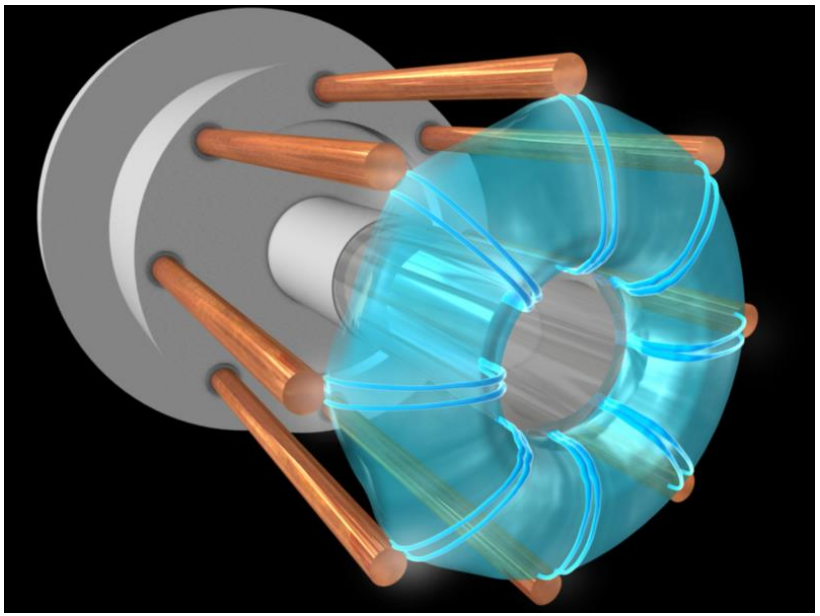
Natrual Instabilities of fusion to capture energy
Cost effective $.08 - $.2/W to generate. Can sell for $.3/W vs $.6/W of today conventional energy cost.
Successfully raise ion temperature to 1.8 BK
Confinement 20 ns so far



Density required is not achieved, any where near
Must increase by the order of 10,000 for it to be feasible.

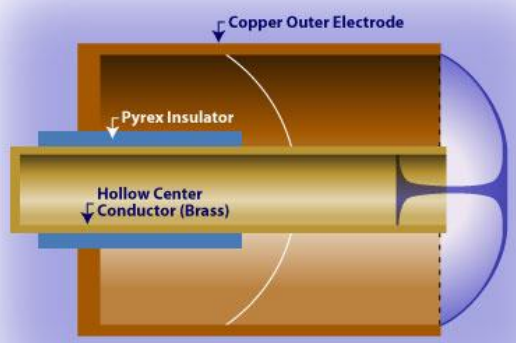
Middlesex NJ LPPFusion Company

LPP



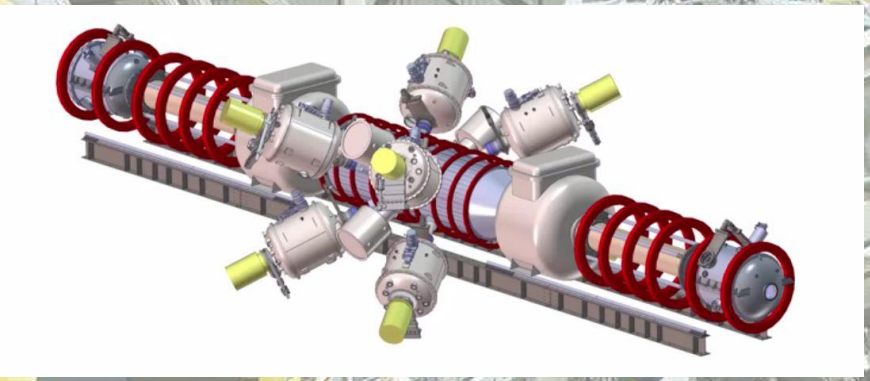
DPF = Dense Plasma focus

- Charged bank of electric capacitors switch to anode
- Rising electric current flows across the insulator axisymmetrically
- The plasma rise from surface of insulator axisymmetrically because of interaction of current with its own magnetic field accelerating axially.
- Releases ions and Xray



The beam (B11 ions) from the opposite smashes into the plasma to induce fusion.

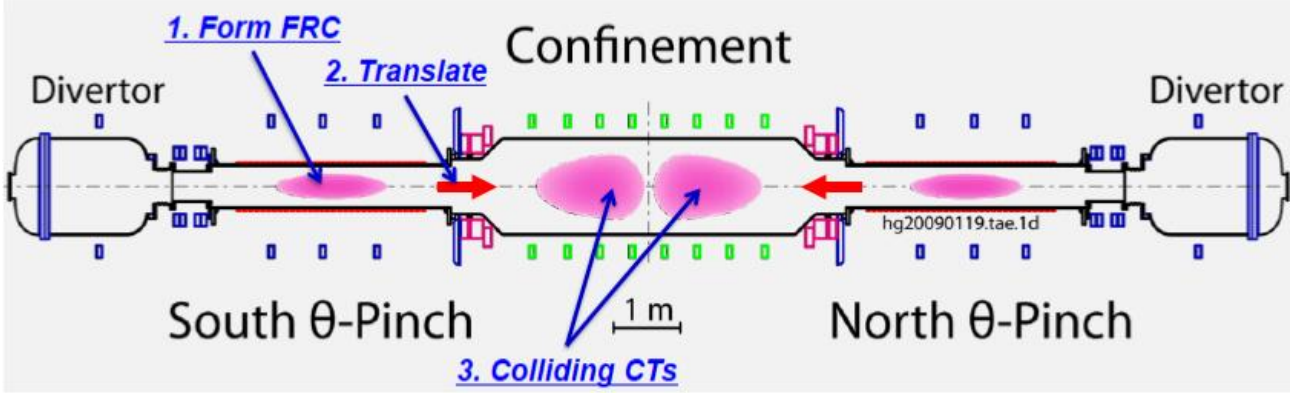
TriAlpha



$$^{1}p + {}^{11}B \rightarrow {}^{12}C$$
$$^{12}C \rightarrow {}^{4}He + {}^{8}Be$$
$$^{8}Be \rightarrow 2\,{}^{4}He$$

Tri Alpha Energy, Inc
Private company(stealth company for 17 years with no website)
Foothill ranch, Lake Forest, California

TriAlpha



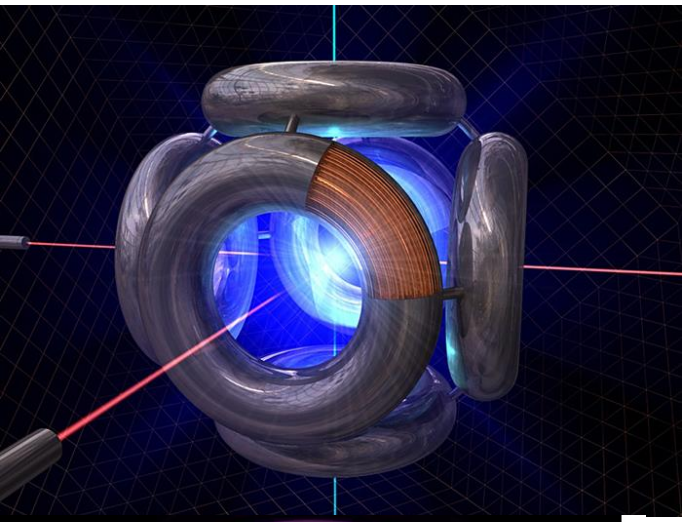
Divertors shoot plasmoids toward each other where they collide inside the confinement. Uses magnetic topology of plasma rather than containing it. More stable than tokamak reactors.

Colliding beams create FRC a field reversed configuration where a toroidal cylindrical current is induced inside a cylendrical plasma

Not shown, beams at angle then further stabilize the plasma.

Uses inverse cyclotron converter ICC for direct fusion to electric power. 100MW potential (Truck sized)

PolyWell



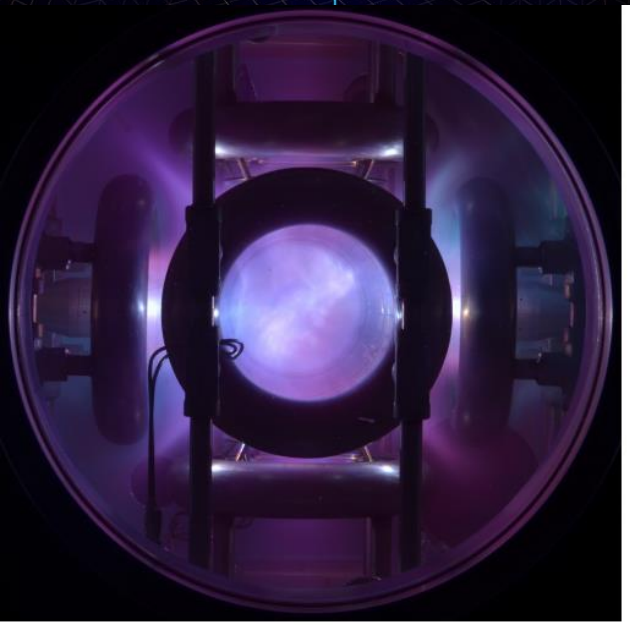
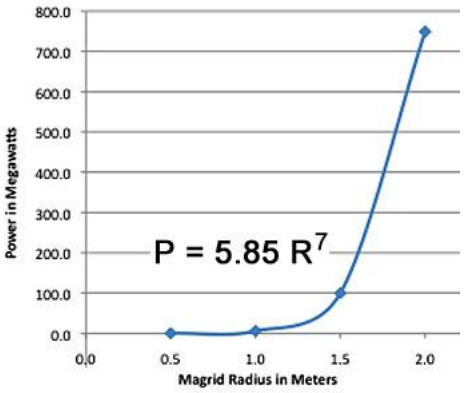


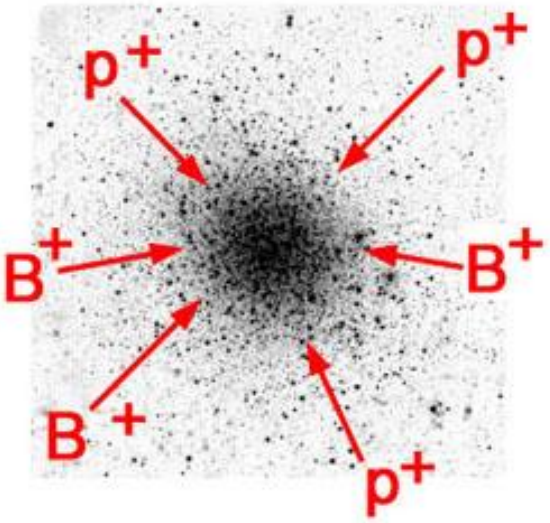
FIG. 3. Time integrated raw visible light image of plasma from a high β shot (#15640).

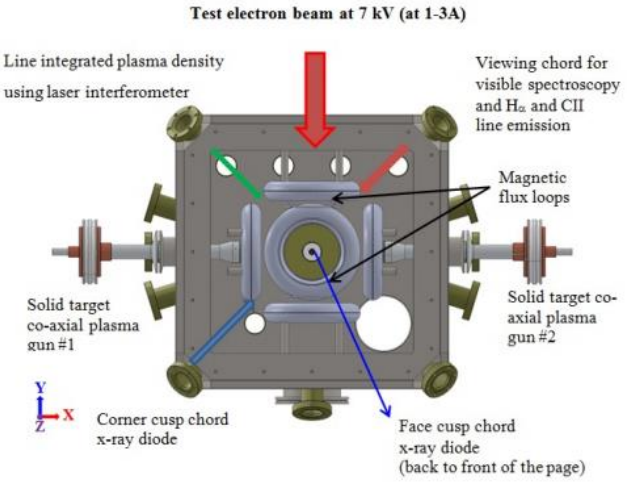
- Uses for four magrids to contain the plasma inside.
- 2 Tesla is produced by each donut
- Red is ions and turquoise beam is an electron, they converge to produce most stable arrangement
- Without electrons you get leakage through magrids' gaps
- The power out put of polywell is proportional to R^7 where R is the radius of the magrid.
- Optimum radius to achieve self sufficiency is 1.5 meters.



At 60% efficiency a 3 meter radius polywell, will supply 7.68GW
Meaning around a little more than 840 of these reactors to power all of the earth electricity usage 12.9TW

PolyWell

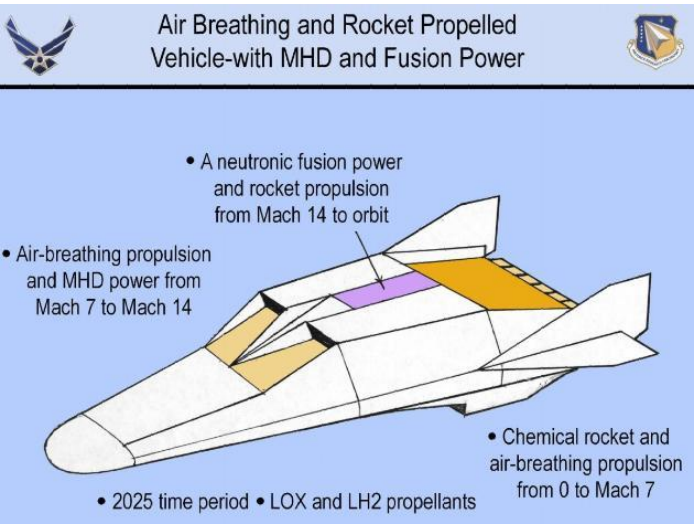


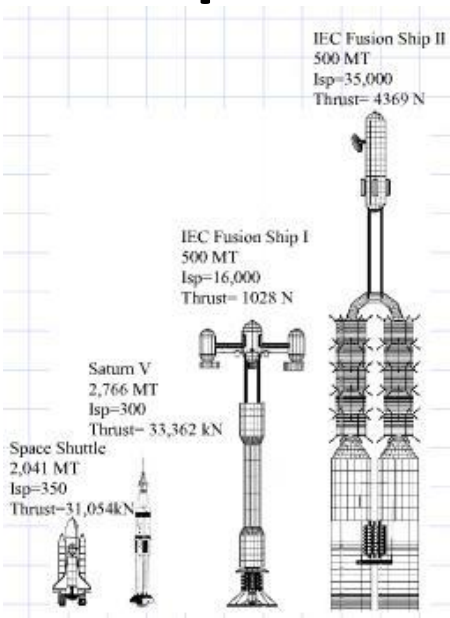


IG. 2. Experimental setup of high β plasma confinement study used in the present article using hexahedral cusp configuration.

- The negative cloud creates a well, hence the name PolyWell.
- Electron cloud Attracts protons and B11 ions, accelerating them in the process helping the fusion process
- The well has 50000 volt potential of incoming ions p and B. The outgoing α have 2.46MeV
- Spherical metal shell +1.22 million volt will slow the α, this will push electrons through cable connected to the shell.

Space Propulsion

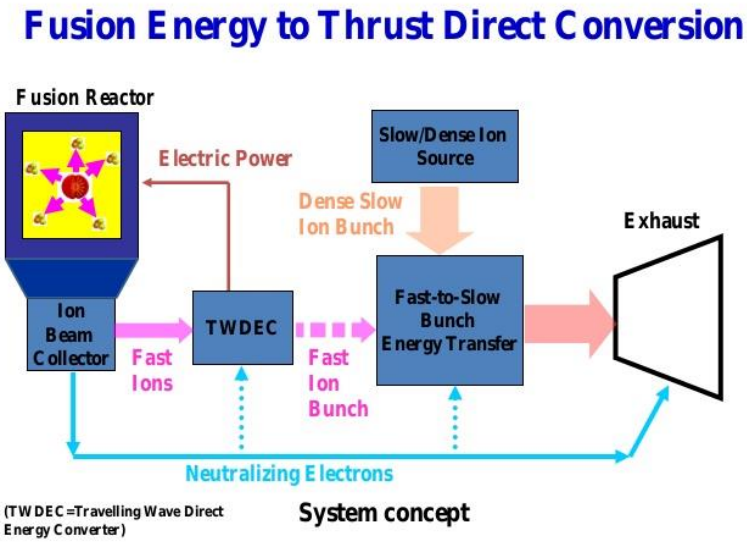


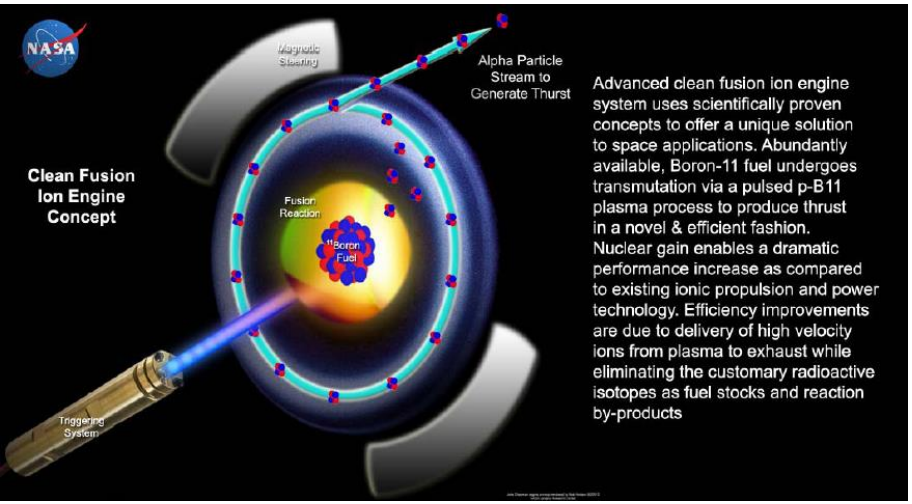


- While fusion ship II deminsions are much large than for a Saturn rocket it must be remembered that Fusion ship II is for a much more demanding Jupiter round trip.

P-B11 fusion engine makes movie instastellar spaceships possible.
Or Star Wars X-Wing or 2001 Space oddessey Pan-Am space plane.

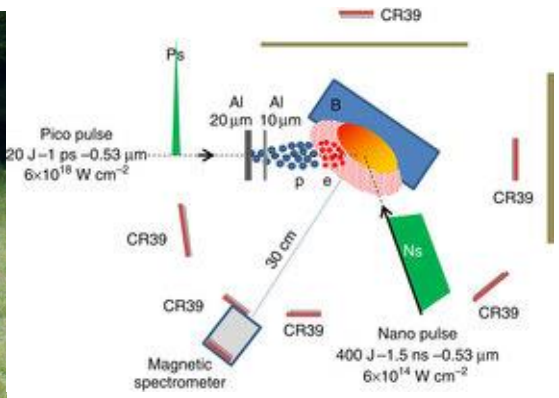
Space Propulsion



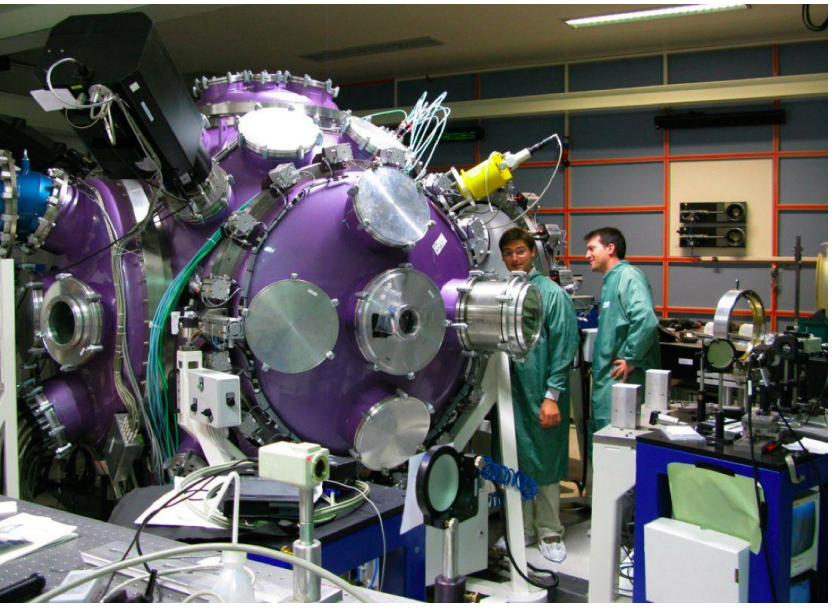


- Fusion of 2 tsp of Boron makes enough energy to send an F-16 to the moon
- Can achieve speed up to 116 320.687 miles per hour
- Which will take 49.7545068 days to go to Mars with 5332 s of Maximum specific impulse.
- Higher specific impulse means lower amount of propellant used to achieve certain momentum.
- Less exposure to the dangers of space
- Outposts and space stations can be powered similarly

Milka



Successfully fused proton with Boron11 using laser
Fusion techniques. (short lived plasma)
Still not viable for commercial productions
Success means that it is no longer a theory but a reality
That is coming to us in the near future.



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