

The Open Source model for research projects: The LPP Fusion case

Datto Engineering

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Agenda

- What is nuclear fusion
- Why is it important
- The hard and slow way
- Scams and delusions
- The new fusion companies
- The EPP case

What is fusion?

- Nuclear reactions produce a lot of energy
- Nuclear fission is the breakdown of heavy atoms (e.g., uranium) into lighter elements
- Nuclear fusion is the merging of light atoms (e.g., hydrogen) into heavier elements

Fusion is hard

- Fusion is much more energetic than fission, but much harder to achieve
 - An unattended pile of natural uranium can undergo fission, as in Oklo (Gabon)
 - An unattended pile of hydrogen just laughs at you.
- Bomb A: Just squish fissionable material together
- Bomb H: First, let's get an A-bomb
 - Add some tritium nearby
 - With clever design, the temperature and pressure will trigger fusion of the tritium.
 - Sometimes hard to control: The 1954 Castle Bravo test aimed for a 5-MT yield, got 15 MT.



Oklo natural uranium reactor (Gabon)

Why is it important

- **Mankind needs cheaper energy...**
 - To grow food (fertilizer plants are energy hogs)
 - To build safe houses (cement plants are energy hogs)
 - To get water (reverse osmosis plants are... you know the drill)
 - To depolute (plasma lances)
- **Energy is the key to higher standards of living**
- **Some Westerners ask developing countries to reduce their energy demands**
 - Do they think that developing countries enjoy their slums, famines and epidemics?

The hard and slow way: Big govt-funded projects

- National Ignition Facility (Livermore, CA) - \$3.5B
 - Uses inertial fusion: lasers shoot at small hydrogen pellets
 - Blew its deadline, suffers big from budget cuts (-14% in latest budget!)



The hard and slow way: Big govt-funded projects (cont'd)

■ Various Tokamaks (e.g., MIT)

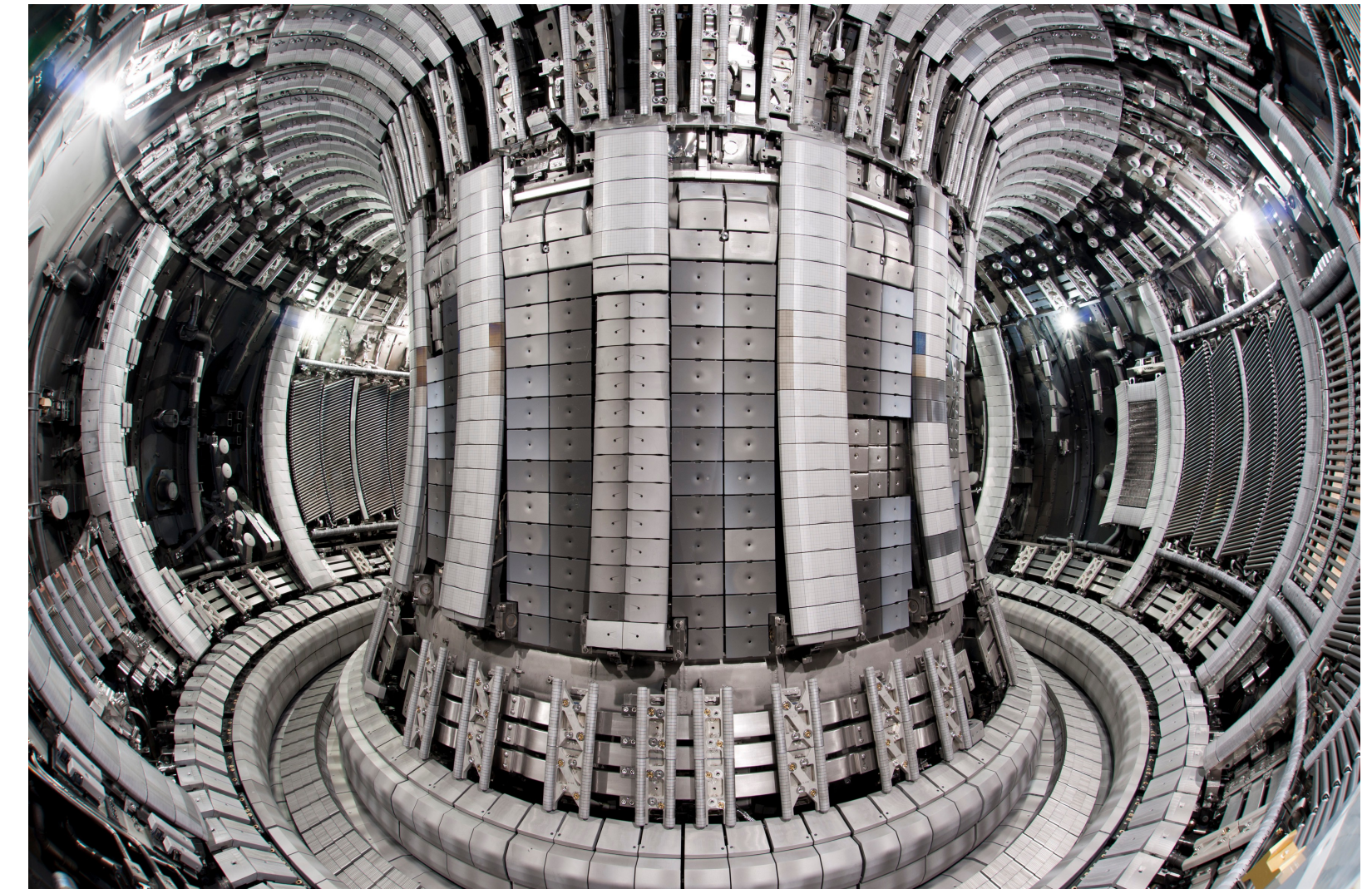
- Magnetic confinement - Torus chamber contains hot plasma in magnetic field
- Most of them are idle due to lack of funding

■ ITER

- Huge multinational project - \$20B and counting
- Demonstrator being built in Southern France - Still at foundations stage

■ Joint European Torus

- Interesting results, limited design



The JET tokamak

Scams and delusions

■ Are there faster ways?

- Problem: fusion requires a very hot plasma which is hard to create and control
 - Plasma physics is in infancy
 - Surprises at every turn
- Some methods create neutrons, harsh radiations or useless neutrinos.
- Cold fusion is a big hope, but physics is a bitch
- Failed past attempts have given a bad rep to the field

■ Fleischmann and Pons (1989)

- Simple palladium electrodes in deuterium were producing way too much heat
- Detected fusion byproducts – or did they?
- Nobody could replicate their results
- Their problem: calorimetry
 - Hardest of all measurement sciences
 - F&P made mistakes in measuring heat in their closed system

The Rossi scam

- Andrea Rossi, an Italian entrepreneur, has patented a device called e-cat
- Claimed container-sized e-cat generates 1 MW by cold fusion of nickel into copper with a secret catalyst
 - If true, this would revolutionize physics. Forget fusion: Quantum physics is wrong!
- This is Nobel material, and yet he refuses independent verification
- He has abused scientists supposed to verify the machine works, but...
 - A physicist is not trained to detect legerdemains
 - Assumes instruments are working as advertised and data is correct
- I'll accept Rossi's claims when he publishes his findings and accepts his \$1 million Nobel prize.

The fast and cheap players

■ EMC2, Inc.

- Inertial confinement, heating by pumping electrons into small sphere, a.k.a Polywell fusion
- Funded by Navy, then by other.

■ Tri-alpha Energy

- Secretive, has been operating since 1998
- 150 employees, well funded
- Pursues aneutronic fusion
 - 1 atom of Boron-11 + protons \rightarrow 3 atoms of Helium-4 + lots of energy
 - No radioactive residues

Fast and cheap players (cont'd)

■ Lockheed

- Surprise announcement from a firm not known for high-energy physics
- Claim new confinement method avoids the tokamak problems
- Plan prototype in 5 years
- Either they are up onto something...
- Or they need a red herring to divert attention from a military-related hard-to-hide project.

■ General Fusion

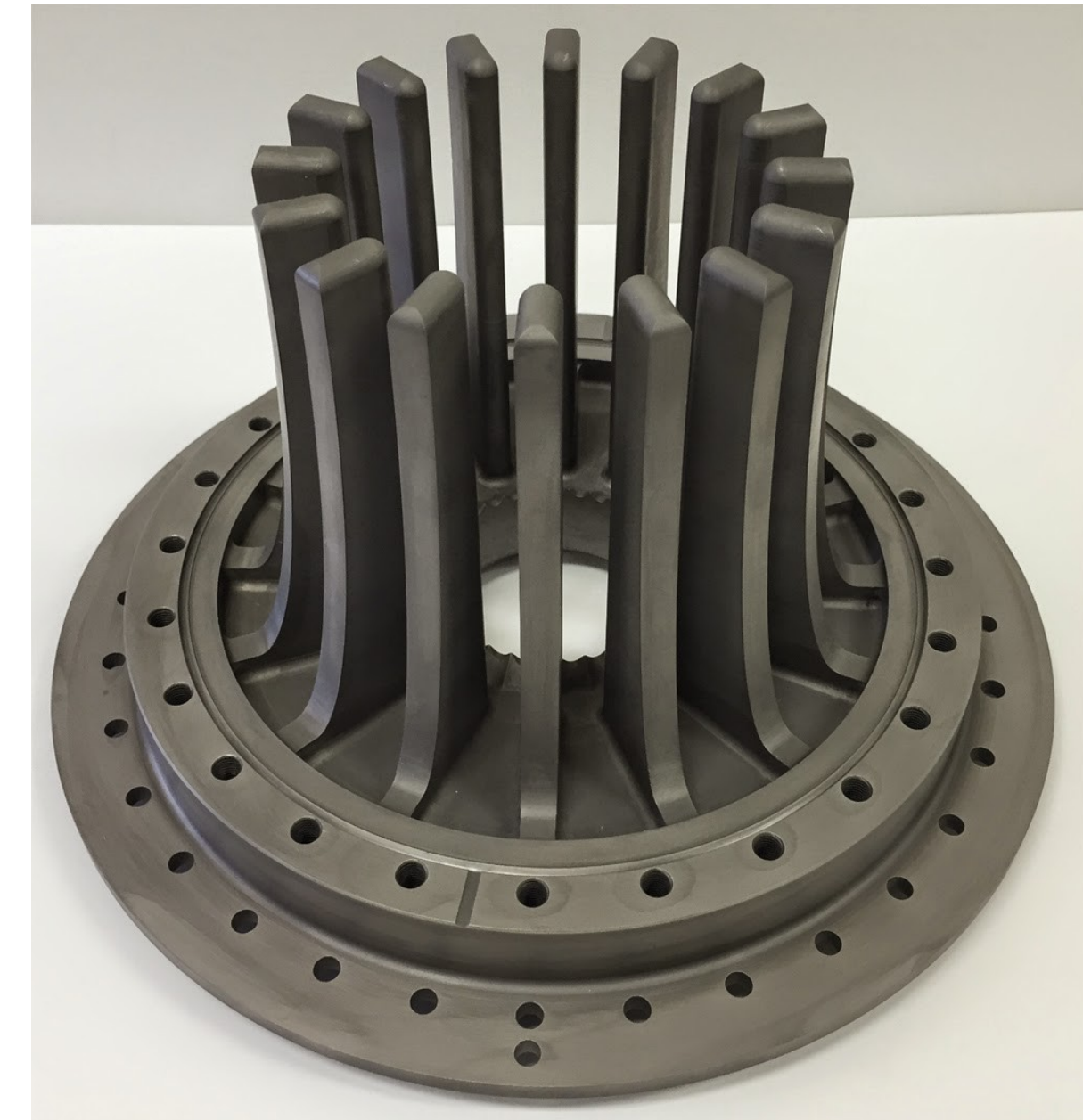
- VC-funded
- Pistons create a shock wave that briefly induces fusion

And the most original entry...

LPPFusion

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- Lawrenceville Plasma Physics is a small shoe-string company
- Very open in their designs and schedules whereas most others are secretive. Truly an open-source company!
- Partially funded through Indiegogo
- Publish their results, peer reviewed
- Original path: Production of fusion through a special-shaped electrode with aneutronic boron+neutron reaction
- They even show their "secret sauce", the tungsten electrode, and explain why their supplier is late
- Expected to move to beryllium electrodes this year
- They produce lots of X-rays which will have to be converted into heat
- They plan to use magneto-hydro-dynamism to convert the plasma directly into power



Questions?