A Brief Overview of

Inertial Confinement Fusion

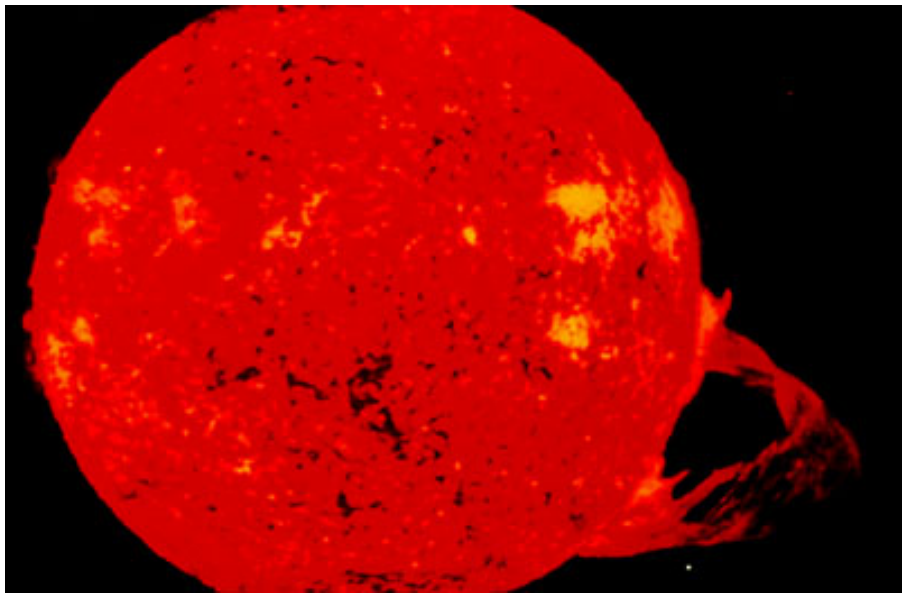

Image courtesy of Los Alamos National Laboratory

22.012 Final Presentation

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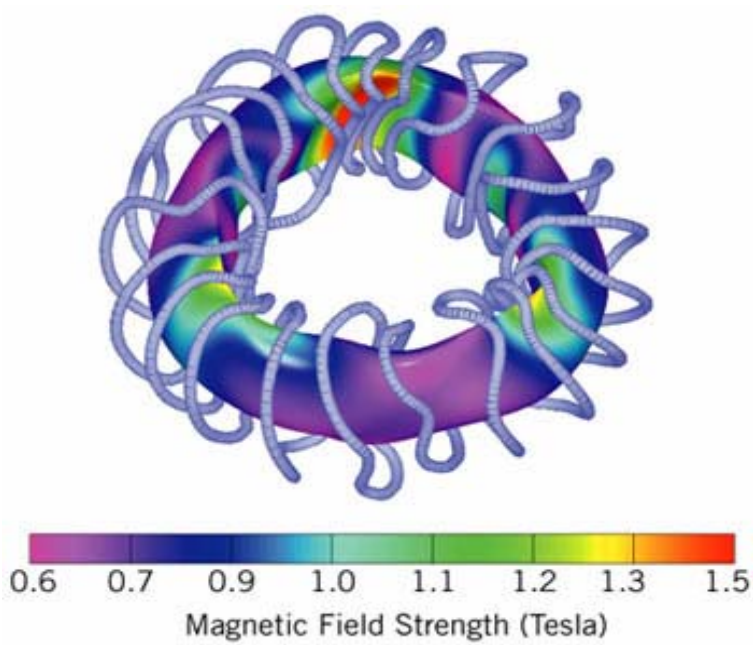
Magnetic Confinement

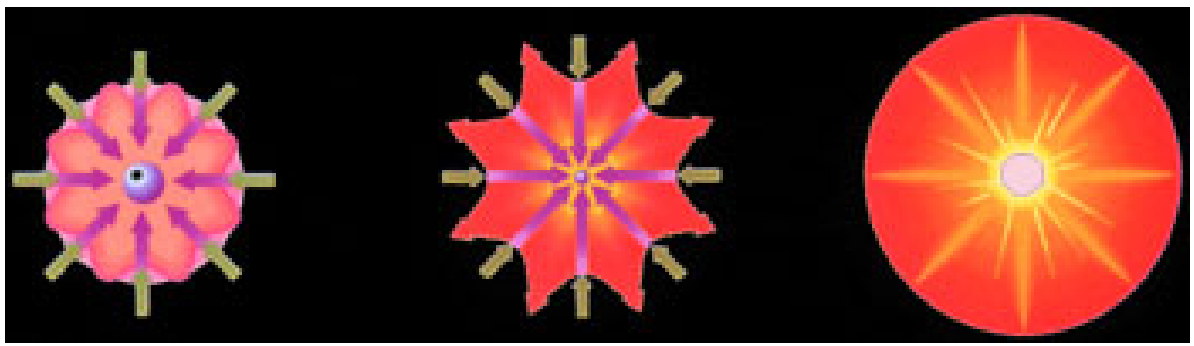
- Ions held together along magnetic field lines long enough for collisions to occur and fusion to ignite



Courtesy of Oak Ridge National Laboratory.

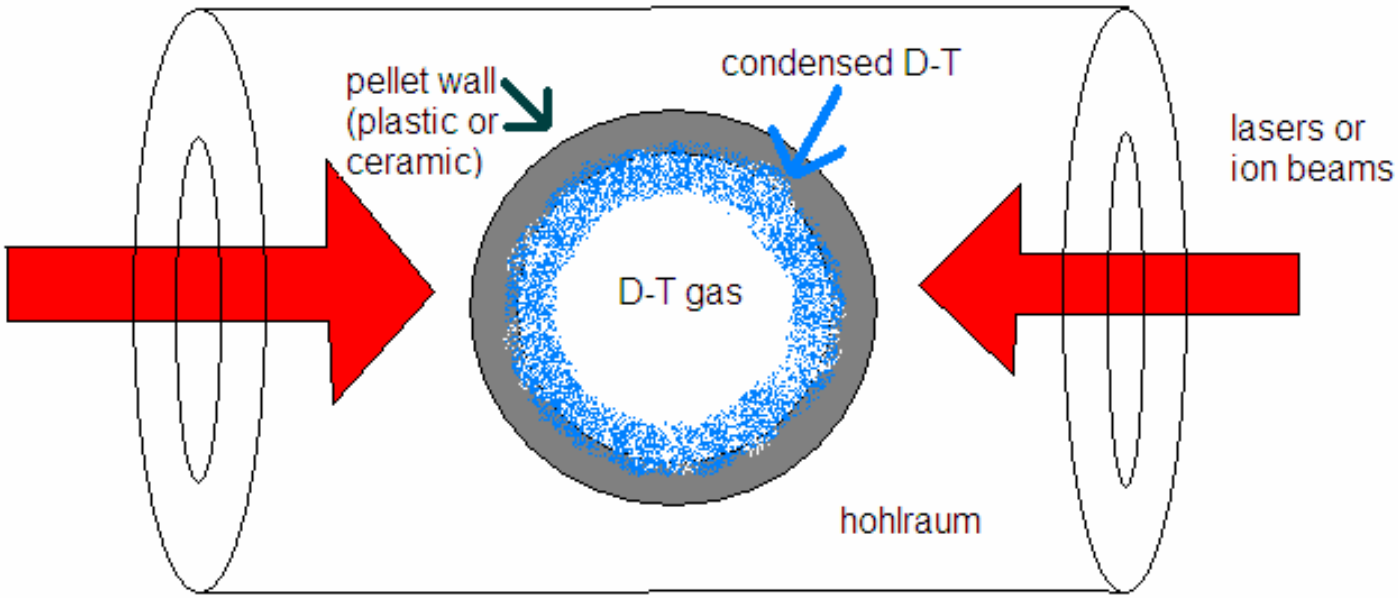
Inertial Confinement

- Ions compressed into a pellet and heated so quickly that fusion ignites before inertia of ions is overcome



Picture from Los Alamos Inertial Confinement Fusion Webpage:
http://www.lanl.gov/ICF/intro.shtml

Detailed view of target



Fusion Ignition Step by Step

- Capsule cryogenically cooled, then bombarded with lasers or ion beams
- Outer shell of capsule turns to plasma and starts to expand
- D-T ice is compressed, accelerates inward
- D-T gas reaches temperatures of about 100 million °C
- Fusion ignites and spreads throughout pellet
- 70 times the input energy is released

Animation from UC Berkeley Inertial Fusion Energy Tutorial:
http://www.nuc.berkeley.edu/thyd/icf/IFE.html

Picture from National Ignition Facility website:
http://www.llnl.gov/nif/index.html

National Ignition Facility

- Located at Lawrence Livermore National Labs
- Due to come online in 2010, costs $1.2 billion
- NIF Laser animation

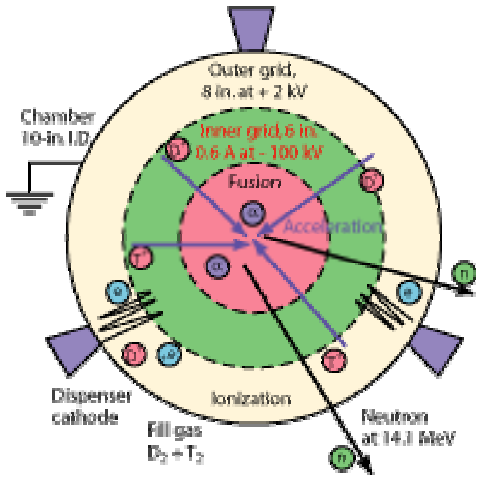
Goals:

- Determine minimum energy input required to ignite fusion
- Demonstrate fusion ignition via inertial confinement
- Provide information needed to evaluate future inertial confinement efforts
- Further research into high energy density physics, hydrodynamics, material properties, nuclear stewardship applications, etc.

Remaining Obstacles

- Lasers
- Coolant
- High repetition/steady state
- Neutrons
- X-rays
- Debris
- Energy capture

Another Possibility:
Inertial Electrostatic Confinement



Courtesy of Los Alamos National Laboratory.

- Ions confined via inertia and electrostatics
- Concentric grids of decreasing potential cause ions to accelerate towards center, where fusion ignites
- Grid can be physical grid or electron cloud
- Could burn advanced fuels such as D-^{3}He, ^{3}He-^{3}He, or p-^{11}B
- Still in very early stages of research and development

Conclusion

- Inertial confinement fusion is possible, but not soon
- Commercial power from inertial confinement fusion? Probably not until after power from magnetic confinement
- Research possibilities are most promising for now, hopefully will keep NIF funded

Works Consulted

- National Ignition Facility Website: http://www.llnl.gov/nif/
- LANL Inertial Confinement Website: http://www.lanl.gov/ICF/intro.shtml
- UC Berkeley Inertial Fusion Energy Website: http://www.nuc.berkeley.edu/thyd/icf/IFE.html
- Inertial Electrostatic Confinement: http://www.lanl.gov/ICF/intro.shtml