FUSION ENERGY:
SPHEROMAK TURBULENT PLASMA EXPERIMENT (STPX)

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Kyron Williams, Joseph Johnson III, and Charles Weatherford, "Nuclear Fusion: The Real Solar Power and Renewable Energy Source", Proceedings of the Florida Energy Systems Consortium: 2010 FESC Summit, p. 9, University of Central Florida, September 28-29, 2010.

James B. Titus, Alonzo B. Alexander, Kyron Williams, Charles Weatherford, and Joseph A. Johnson III, "FAMU Spheromak and the Turbulent Physics Experiment—STPX", Technology and Innovation 14, 1-11, 2012.

Earl Scime, West Virginia University
Ed Thomas, Auburn University
Simon Woodruff, Woodruff Scientific

The FAMU-STPX stands approximately 4 meters high and 2 meters wide at the vacuum vessel.

- The STPX achieves plasma temperatures of 300 eV,
- plasma currents of approx 600 kA
- with a pulse duration of 5ms.
- Elec den $10^{19}/m^3$

Measurements of electron and ion temperature and magnetic field fluctuations.
Manipulation of the stable Taylor state with pulsed RF and TeraWatt femtosec laser pulses.
Controlling impurity content including the physics of microparticle transport in fusion plasmas.

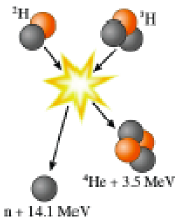
- **The primary goal was to build the world's largest spheromak reactor.**
- **The research studies the scaling (both in space and time) of turbulent processes influences the loss of particles from the core to the edge of the spheromak plasma.**

- **The Spheromak was successfully constructed and first plasma was achieved July 17, 2012.**
- **The STPX is the world's largest Spheromak reactor.**

Laser-Assisted Muon Catalyzed Fusion

Charles A. Weatherford (FAMU)

Two types of nuclear energy
1. Fission=Dirty=> splitting nuclei apart
2. Fusion=Green (Clean)=> forcing nuclei together



Fusion of deuterium (D) and tritium (T) forming an alpha particle and a neutron and 17.59 MeV (million electron volts)

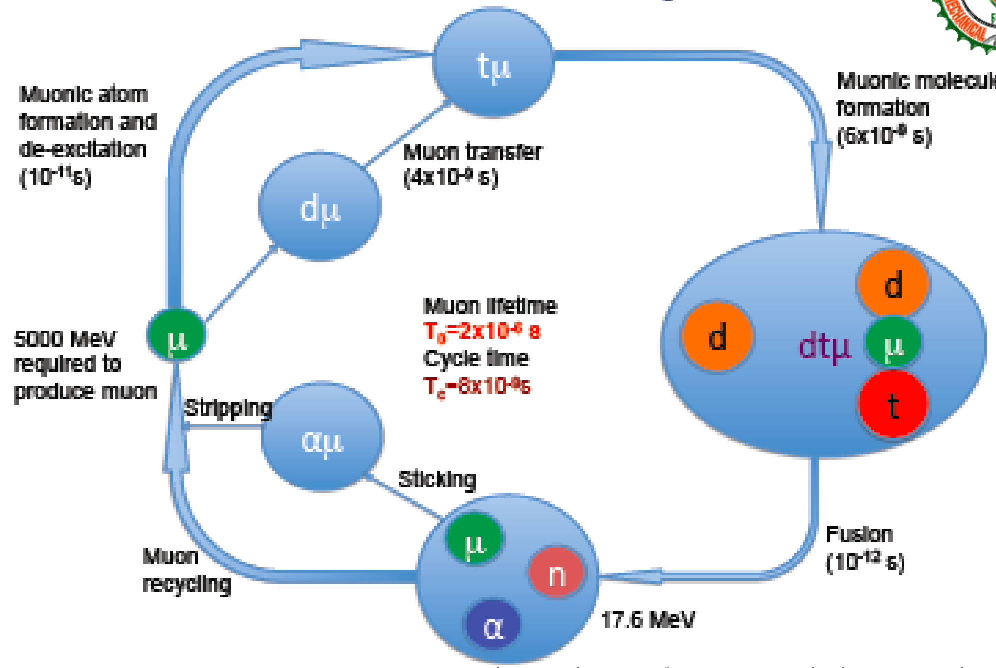
D-T separation (confinement) must be small for sufficient time for fusion to occur (Lawson criteria) so as to release energy.

Currently two confinement methods:
1. Magnetic—ITER (international theromonuclear reactor) in Cadarache, France;
2. Inertial—NIF (national ignition facility) at LLNL (Lawrence Livermore National Laboratory, Livermore, CA).

Neither have produced more output energy than input energy.

- I am proposing a third confinement method—a muonic molecule [(dtμ)+d].
- The dtμ is similar to H_2^+ but since the mass of μ is 207 times the mass of an electron, the separation of the d and t is .009 bohr instead of 2.003 bohr => confinement=>fusion.

Standard D-t MCF Cycle



250 fusions are possible in the lifetime of the muon with this cycle time.
3125 fusions per muon are required to break even.
150 fusions have been produced experimentally.

- SOLUTION
  - Use Quantum Control with intense (10^{12} W/cm^2) ultraviolet (UV) lasers.
  - Reduce
    - Muonic atom and de-excitation time to 10^{-12} s
    - Muon transfer time to 10^{-12} s
    - Muonic molecule formation time to 10^{-12} s.
- RESULT
  - 1 million fusions are possible in the lifetime of the muon.
- QUESTION
  - How much energy input is required for the lasers?
  - My current simulation results => better than breakeven by three orders of manitude