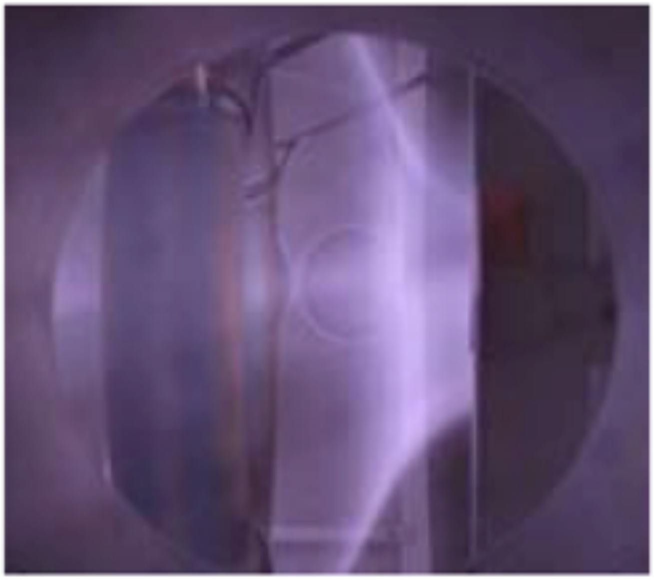
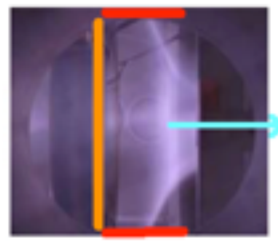
Skunk Works Cusp Fusion Rocket

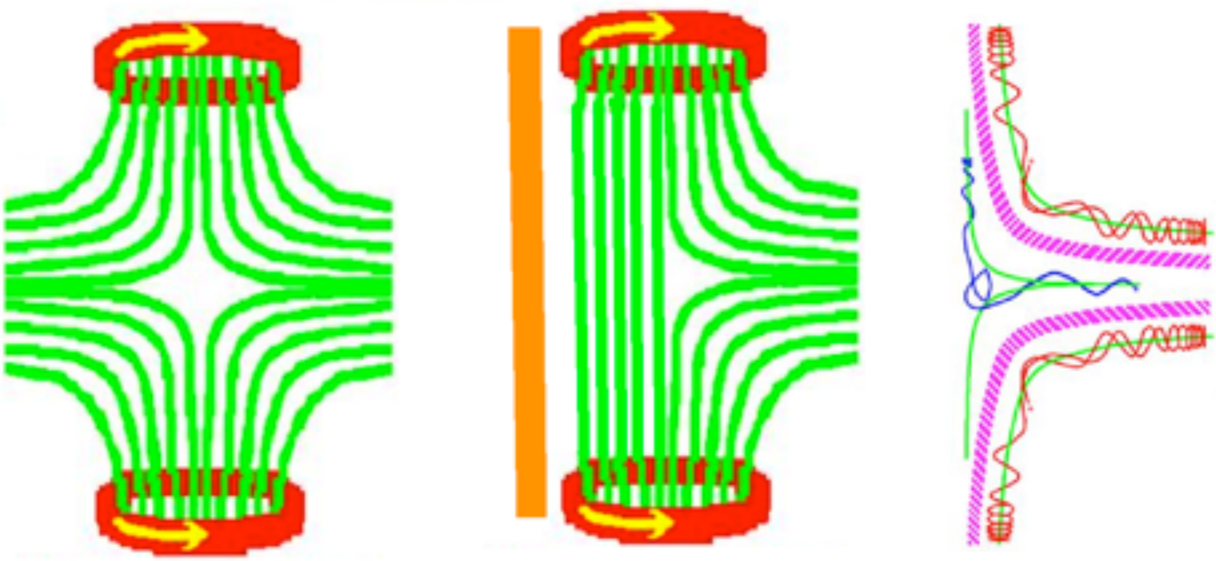
Frank Dodd (Tony) Smith, Jr. - 2013

Charles Chase of Lockheed Martin SkunkWorks made a presentation at a February 2013 Google "Solve for X" event in which his slides stated:

"... Nuclear Fusion ... Tritium + Deuterium ...[to]... Helium + Neutron + 17.6 MeV
... Cheap, Safe, Compact 100 MW Fusion Power Plants ...
New magnetic configuration ... High Beta ... Plasma Pressure / Magnetic Pressure ...".

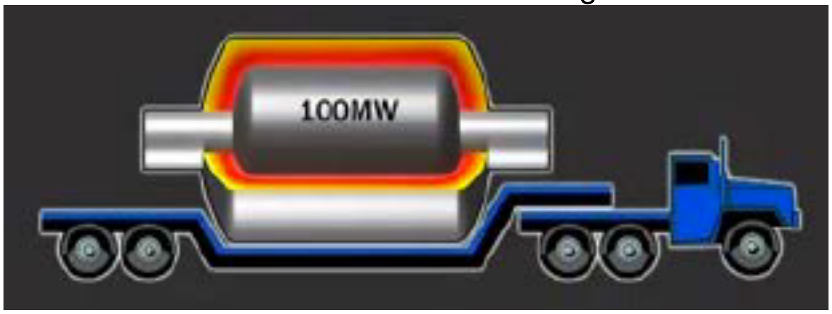






The upper left image is from the slides showing the SkunkWorks T4 experiment.
The lower series of 3 images are adapted from Wikipedia on "Biconic cusp"
The upper right image shows T4 setup structure in tems of Biconic cusp
with red tori loops setting the field into the cusp configuration
and the orange torus directing the cusp to the direction perpendicular to its plane
causing a rocket jet of particles (blue arrow) to be emitted in that direction.

SkunkWorks' Charles Chase said that the size of a 100 MegaWatt Fusion Device would be about 2 x 2 x 4 meters as indicated in this image from his slides



100 MegaWatts = 100 x 10^6 Joules / second = 10^8 Newton-meter / second
Saturn V peak thrust was 34 x 10^6 Newtons.
Note the similarity to the scale of an aircraft engine,
and the fact that SkunkWorks has traditionally produced advanced aircraft / spacecraft.

According to the Wikipedia entry "Bionic cusp":

Cusp Plasma Fusion "... devices were explored theoretically by **Dr. Harold Grad** at NYU's Courant Institute in the late 1950s and early 1960s. Because the fields were planar symmetric this plasma system was simple to model. ... [as shown on the bottom right image on the first page there are]... three classes of particles.
The first class [thin red lines] moved back and forth far away from the null point ... reflected close to the poles of the [red - top and bottom] electromagnets and the plane cusp in the center. This reflection was due to the magnetic mirror effect.
These are very stable particles, but their motion changes as they radiate energy ...
The second particle [thin blue line] moved close to the null point in the center. Because particles passed through locations with no magnetic field, their motions could be straight, with an infinite gyroradius. This straight motion caused the particle to make a more erratic path through the fields.
The third class of particles [magenta bands] was a transition between these types. ...".

In their paper "**Cusped Geometries**" Berkowitz, Friedrichs, Goertzel, Grad, Killeen and Rubin of NYU (Proceedings of the Second United Nations International Conference on Peaceful Uses of Atomic Energy, Geneva, 1958, Vol 31, Paper 23, Session A-5, P/1538 (171-176)) said:
"... The major advantage of **the cusped configuration** is its **stability**.
The chief disadvantage ... is the **large rate of loss of particles** ...
the **particle losses increase rapidly with temperature** ...
Particles can be lost from a system by ... nonadiabatic-dominated cusp losses ...
At thermonuclear temperatures the mean free path is essentially infinite compared to the dimensions of the apparatus. A particle trajectory consists of straight lines joined by cycloidal arcs ... **particles ... aimed close enough to the cusp axis are lost** ...
One property of cusp losses is that ... **high speed particles are lost more quickly** ...".

The loss at cusp of high-speed particles
is not good for using Cusp Fusion for Fusion Power Plants
(Pd/D Cold Fusion or Spheromak Plasma Fusion would be better for that)
but
is good for making a Cusp Fusion Rocket (a likely project for SkunkWorks).