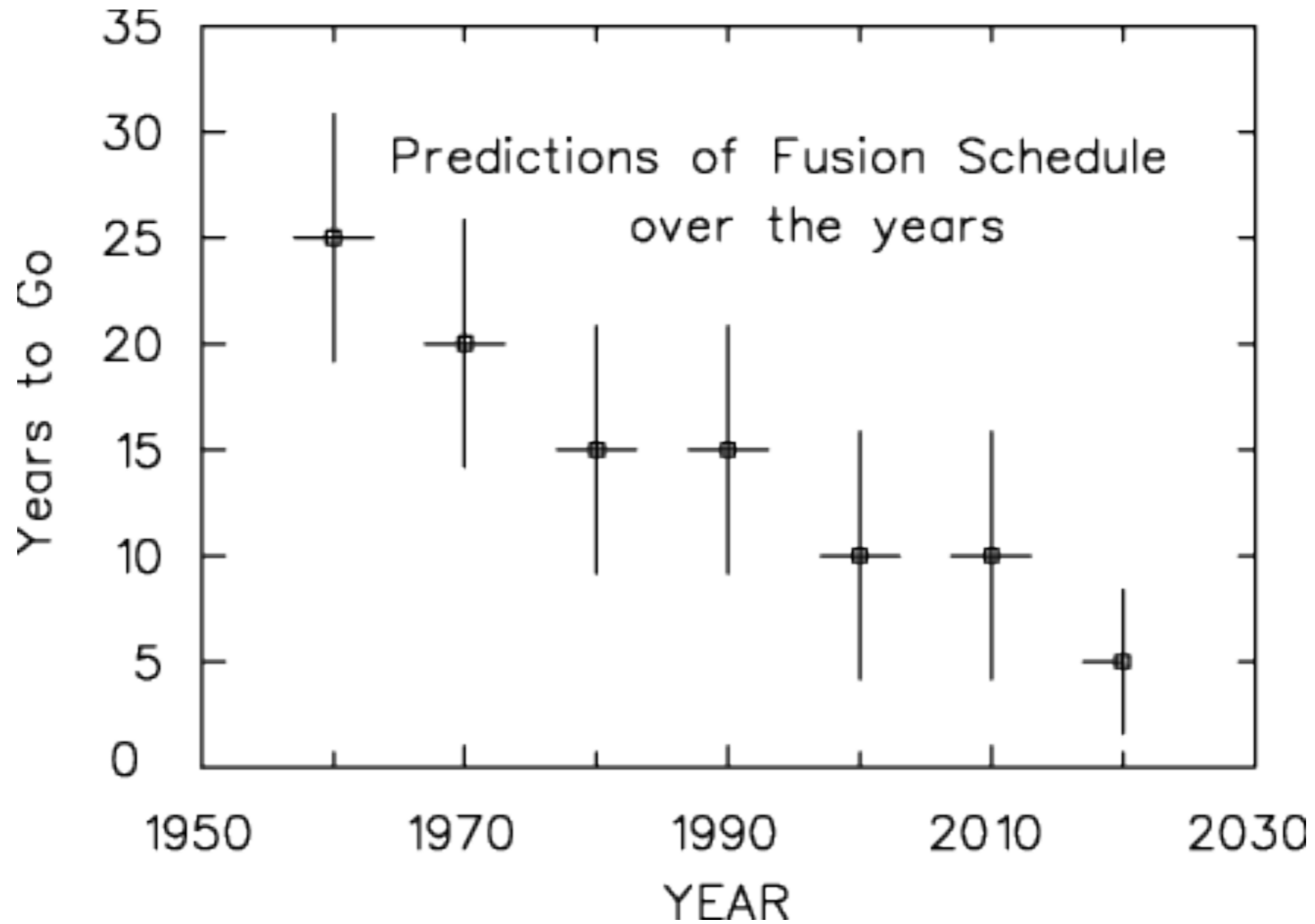


What About **FUSION?**

Answer to all the world's energy needs?

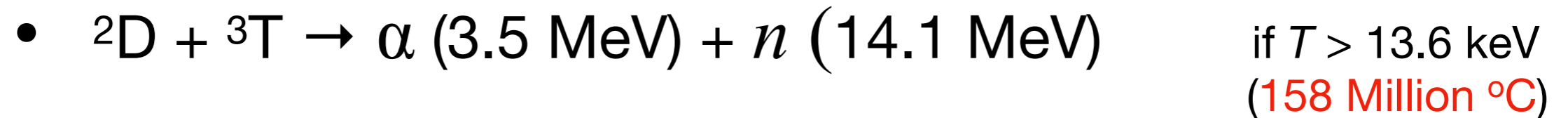
Or “forever 20 years in the future”?

When will we have Fusion Power?



How “Clean” is Fusion?

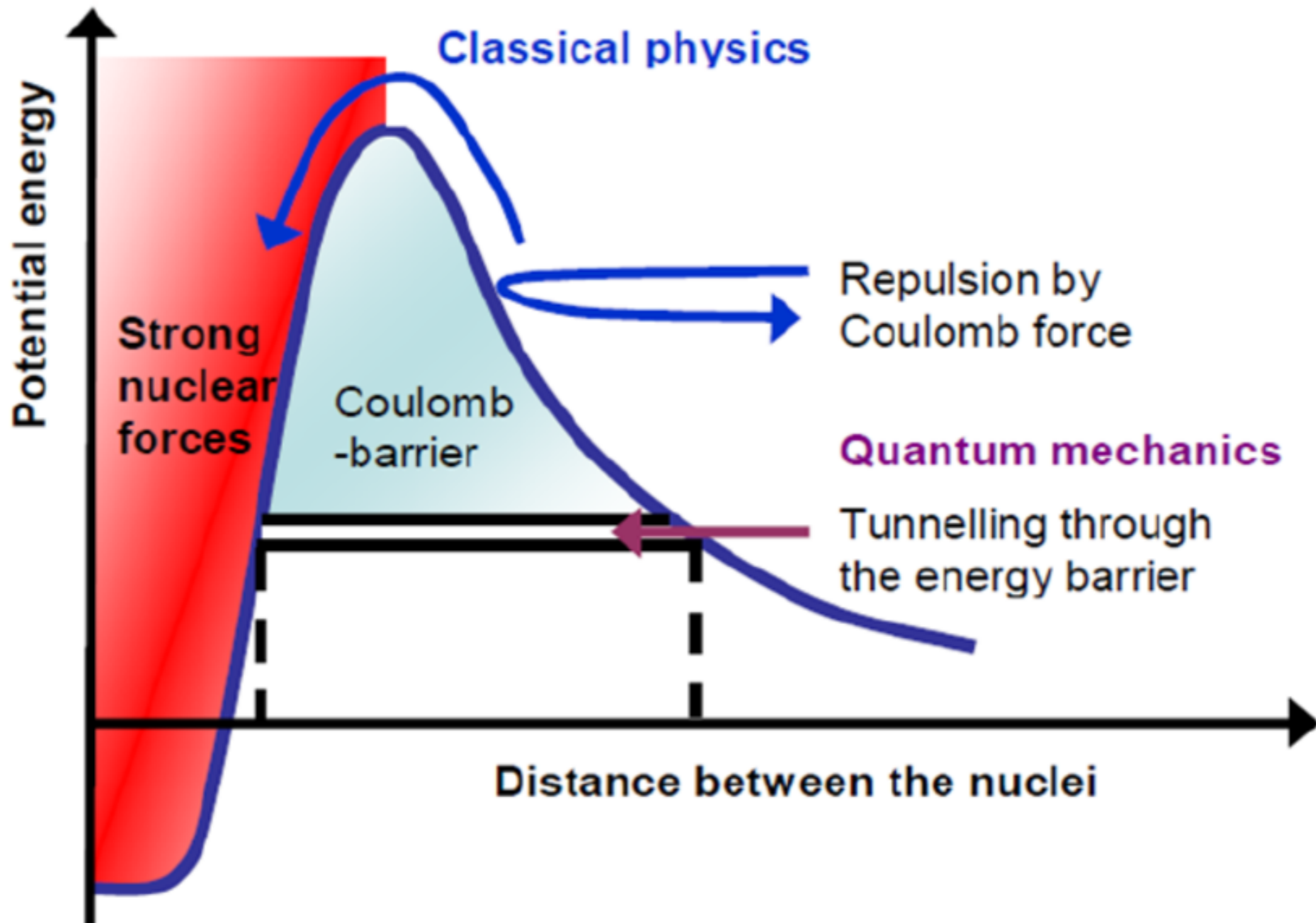
* Basically, for *d-t* fusion, as clean as a “neutron bomb”:



* “Aneutronic” fusion is *possible* but requires **much** higher temperatures and densities, *e.g.*

- ${}^2\text{D} + {}^6\text{Li} \rightarrow {}^8\text{Be} \rightarrow 2\alpha + 22.4 \text{ MeV}$ if $T > 60 \text{ keV?}$
- ${}^2\text{D} + {}^3\text{He} \rightarrow {}^1\text{p} + \alpha + 18.3 \text{ MeV}$ if $T > 40 \text{ keV?}$
- ${}^1\text{p} + {}^7\text{Li} \rightarrow {}^8\text{Be} \rightarrow 2\alpha + 17.2 \text{ MeV}$ if $T > 60 \text{ keV?}$
- ${}^1\text{p} + {}^{11}\text{B} \rightarrow 3\alpha + 8.7 \text{ MeV}$ if $T > 123 \text{ keV}$

The $d-t$ Potential



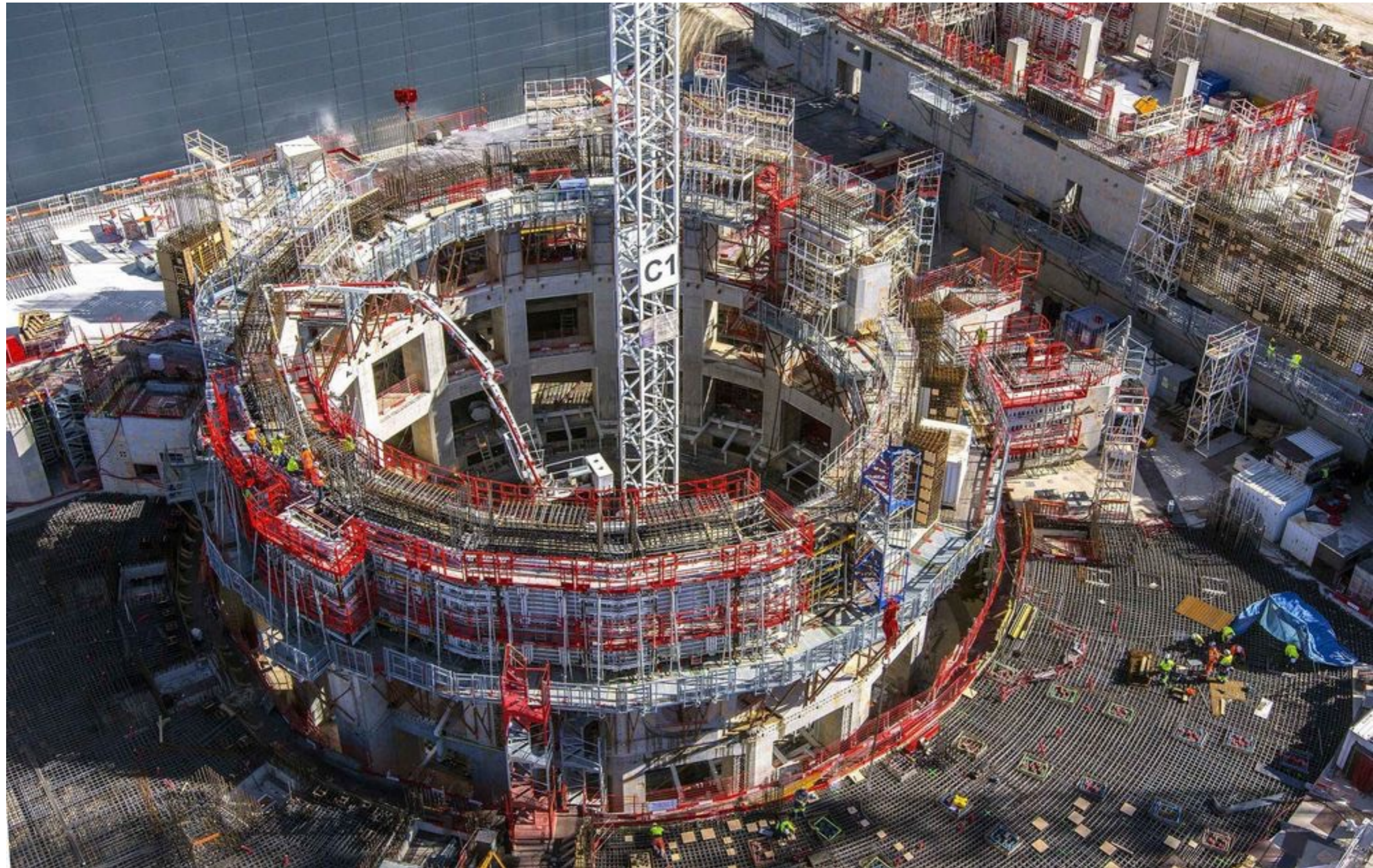
Types of *Proposed* Fusion

- Magnetic Confinement (e.g. Tokamaks & Stellarators)
- Inertial Confinement (miniature H-bombs)
- Laser-driven 1p into laser-generated ^{11}B plasma (HB11 Energy)
- Self-colliding Beams (e.g. Bogdan Maglich's *Migma cell*)
- Sonoluminescent Bubbles (dubious)
- Muon Catalyzed Fusion (forever frustrating)
- "Cold Fusion" (completely bogus)

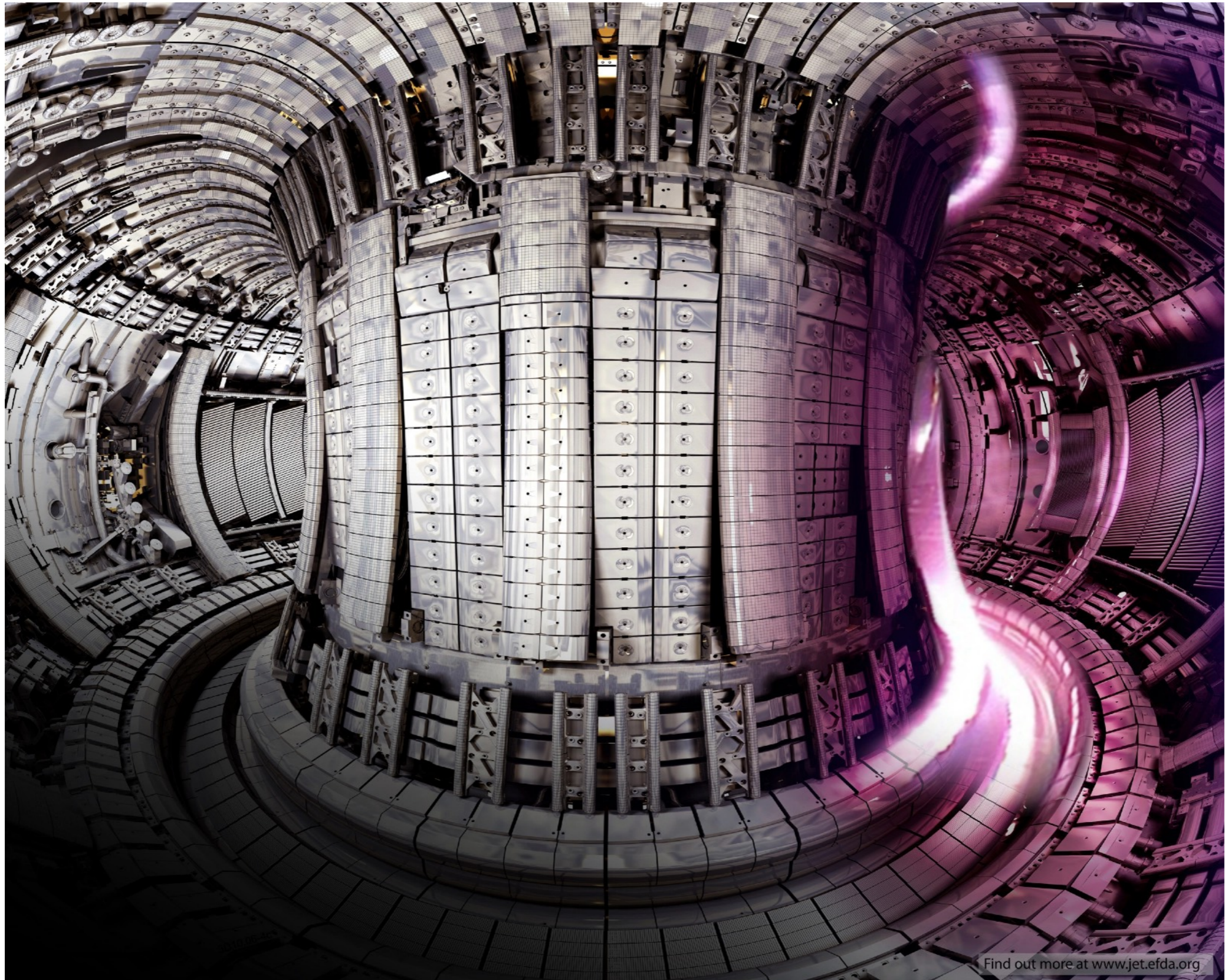
International *T*hermonuclear *E*xperimental *R*eactor



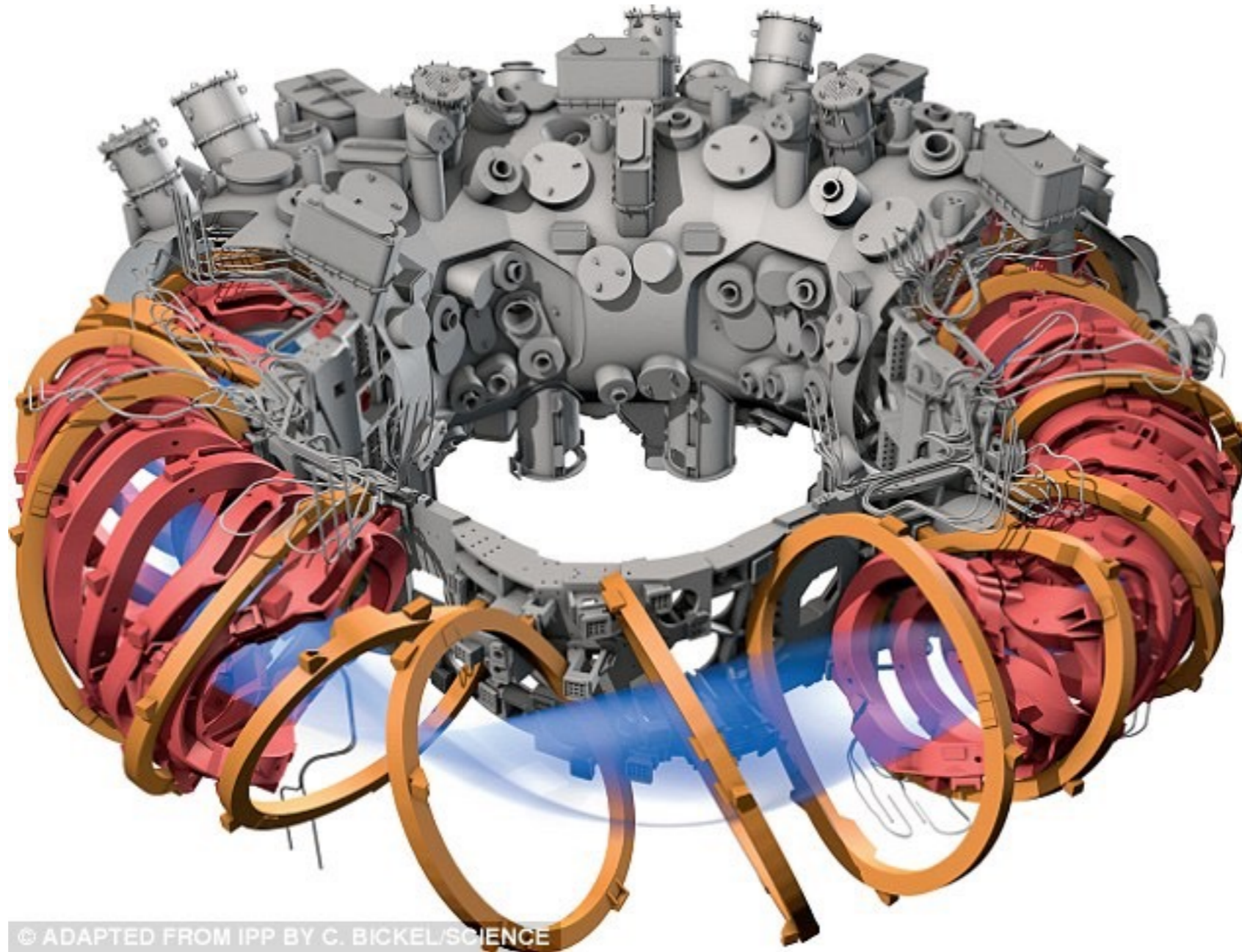
International *T*hermonuclear *E*xperimental *R*eactor



International *T*hermonuclear *E*xperimental *R*eactor

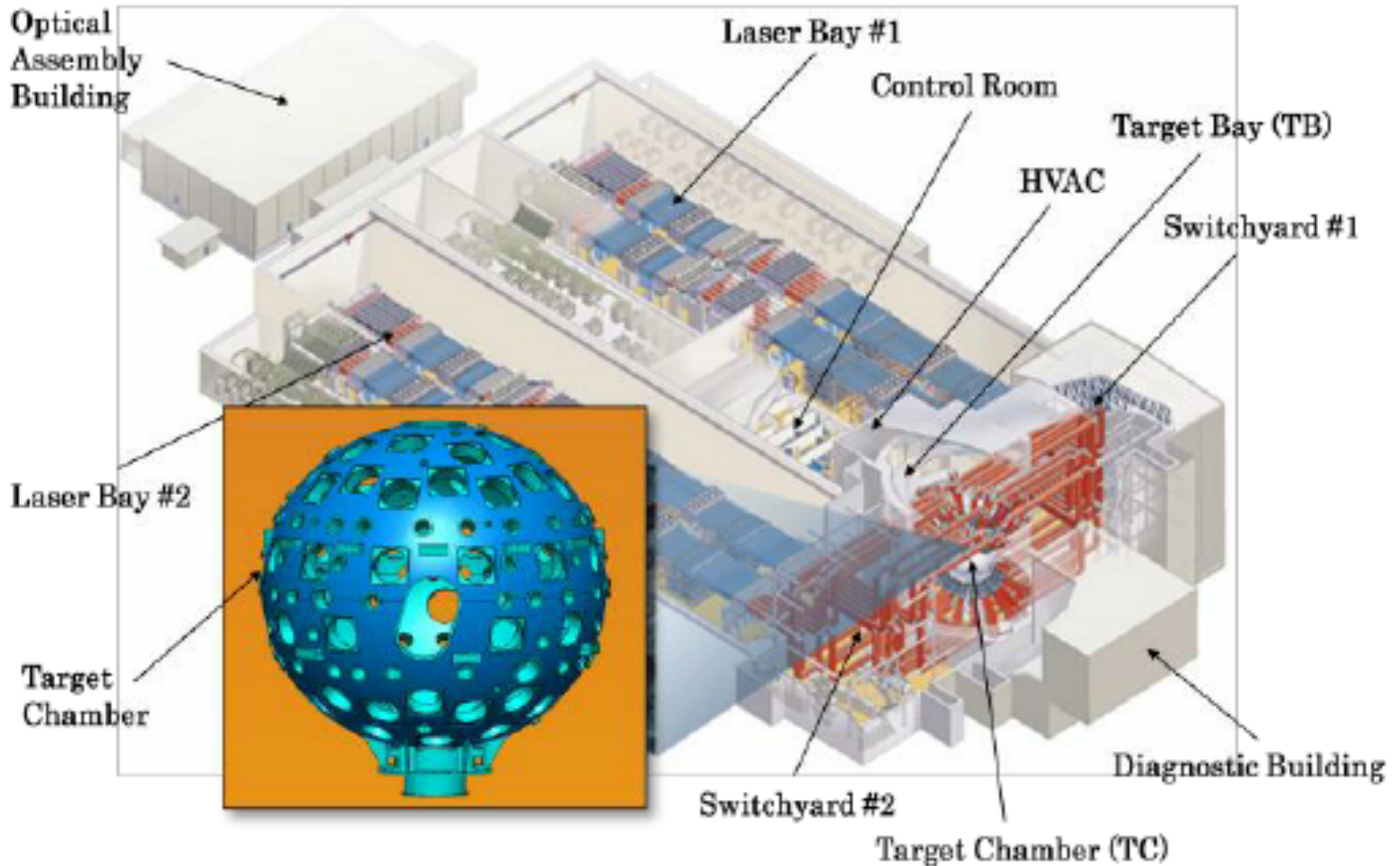


Stellarator

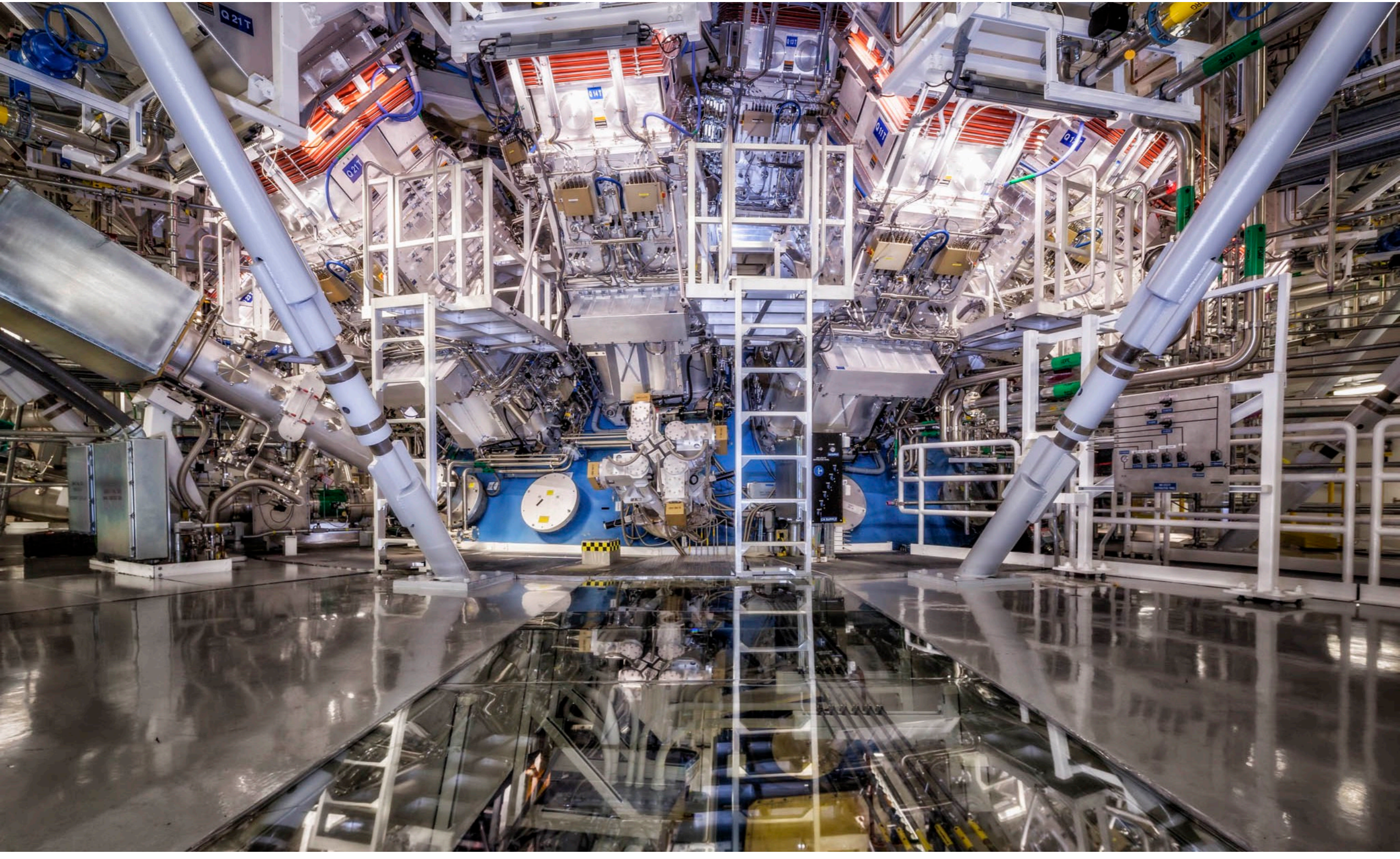


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National Ignition Facility



National Ignition Facility



National Ignition Facility

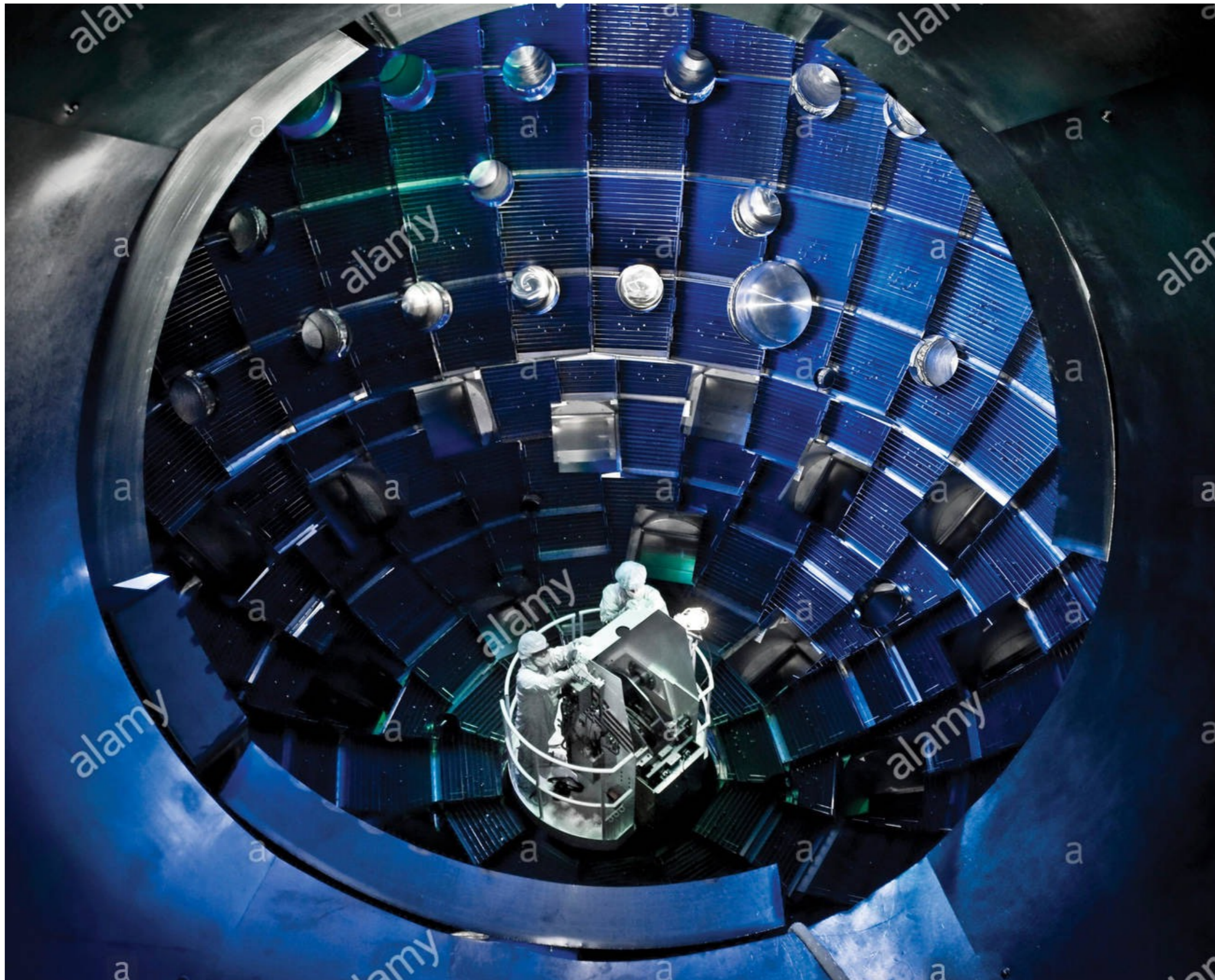


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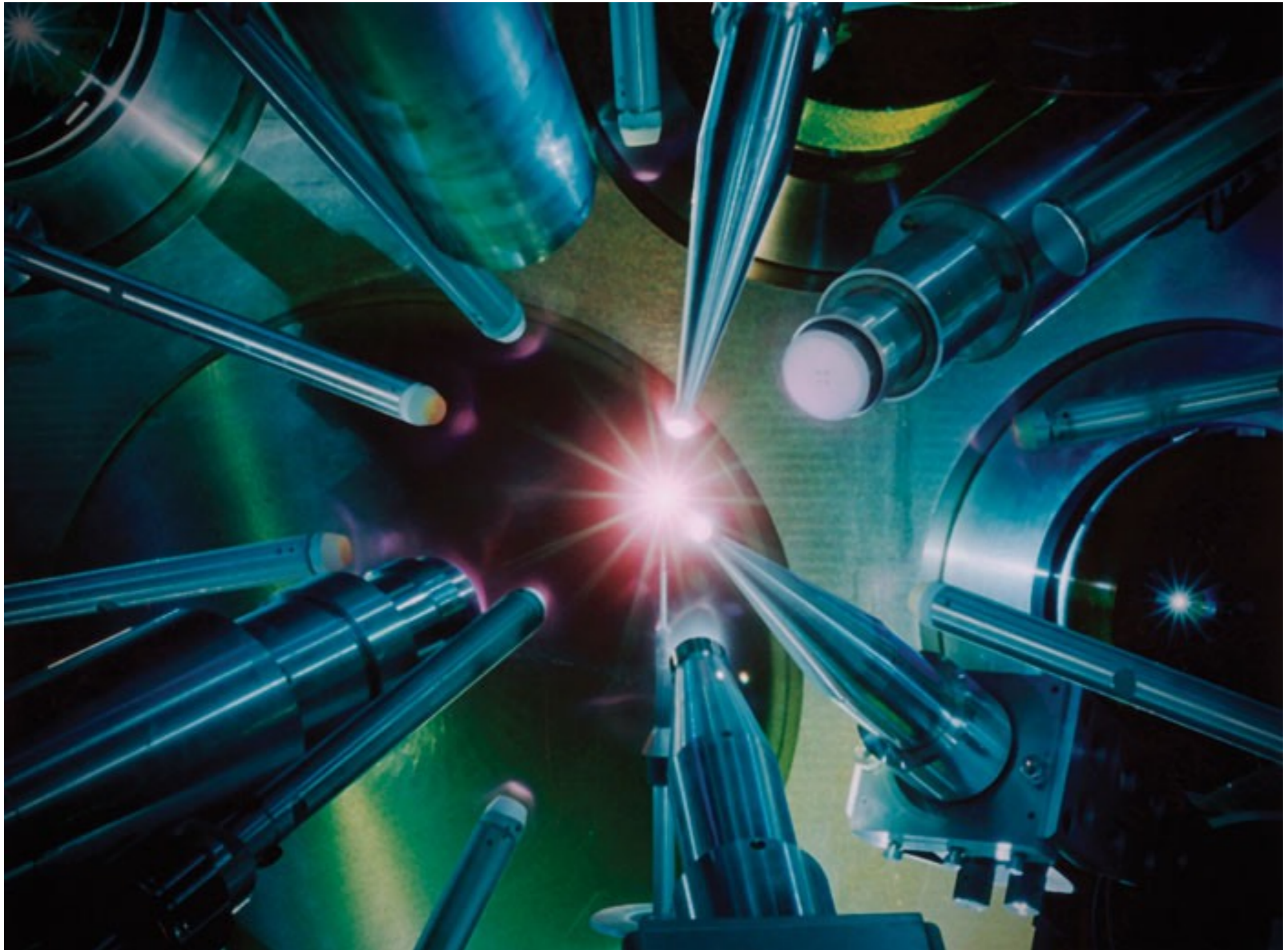
Laser Bay



National Ignition Facility

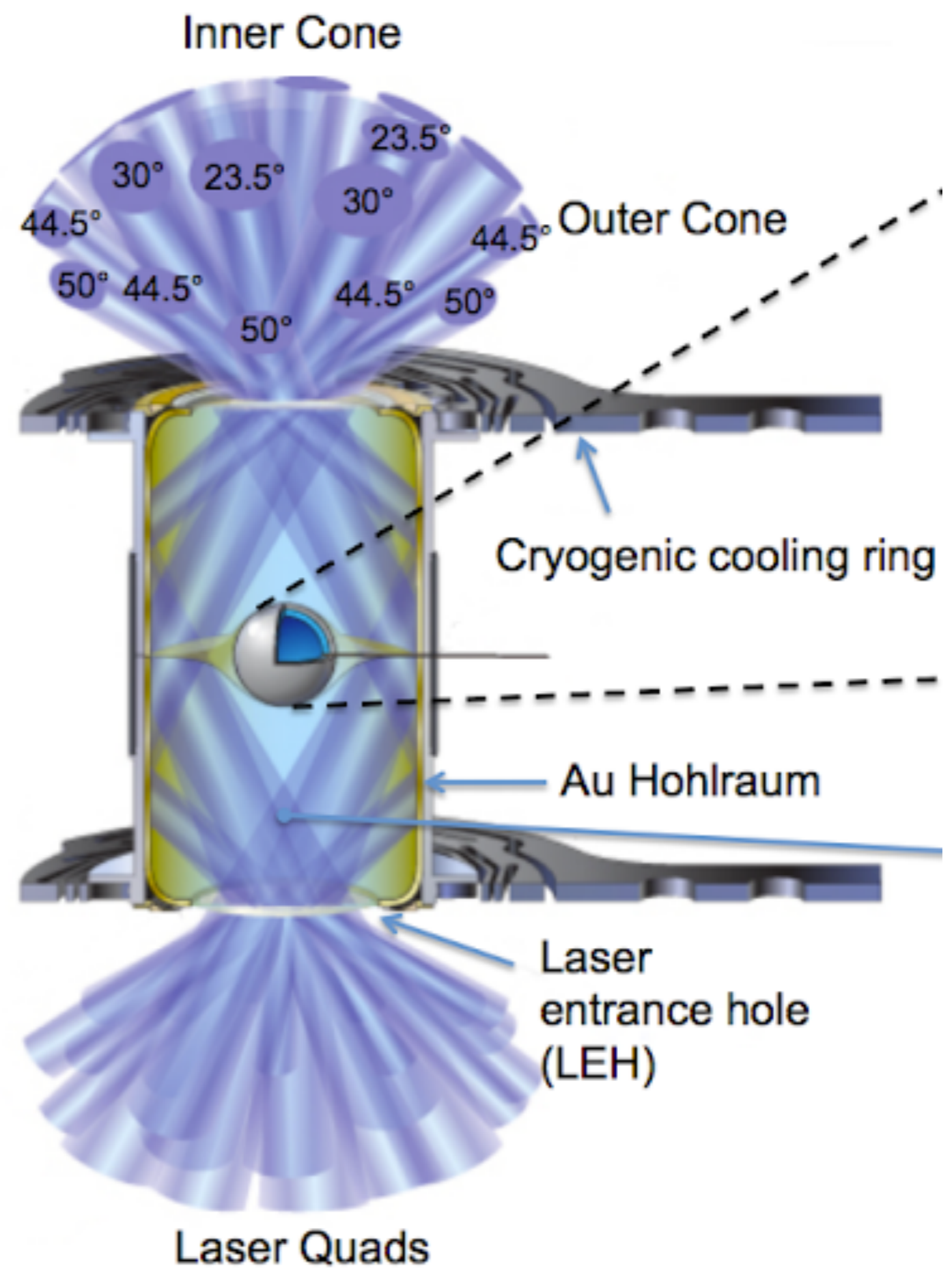


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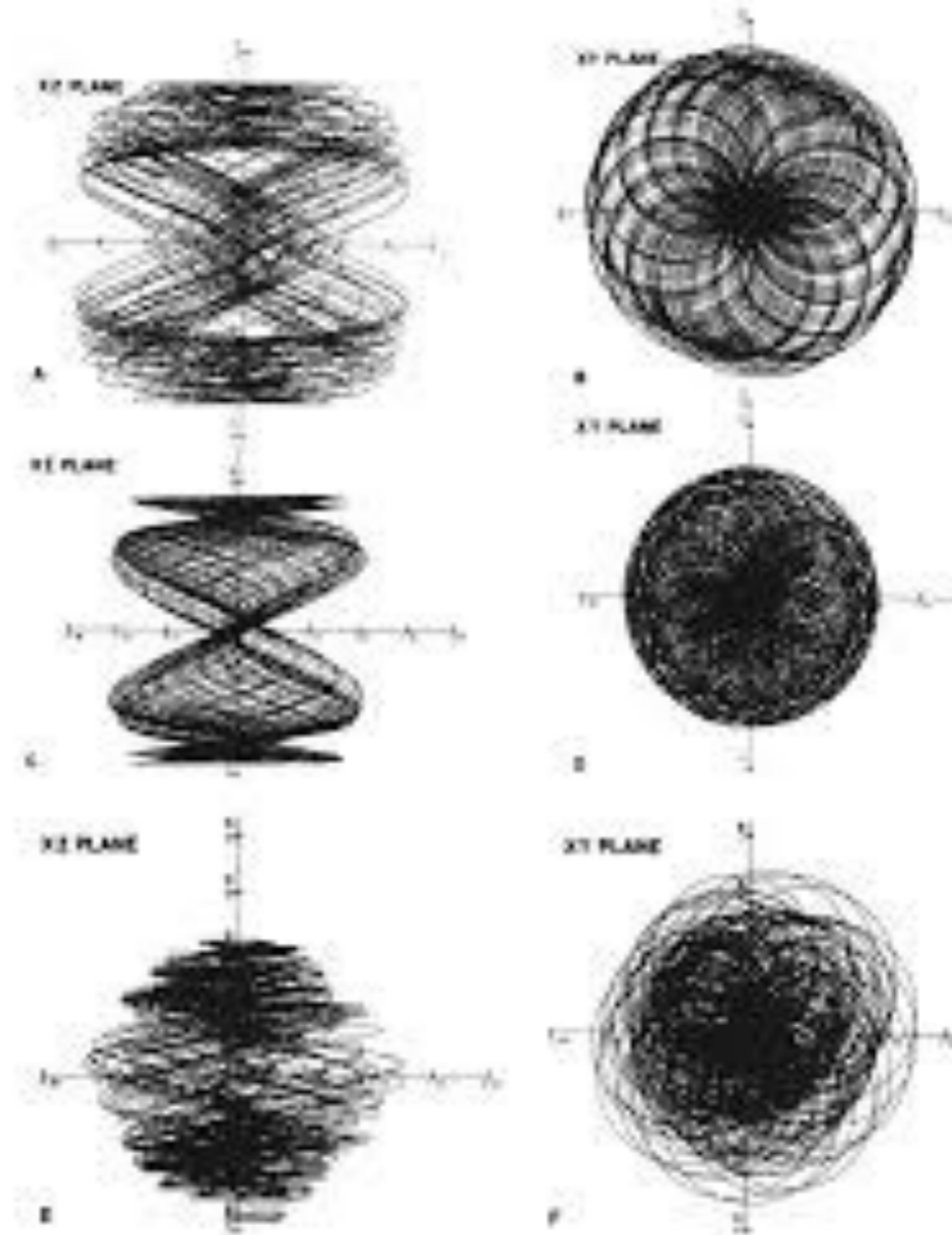
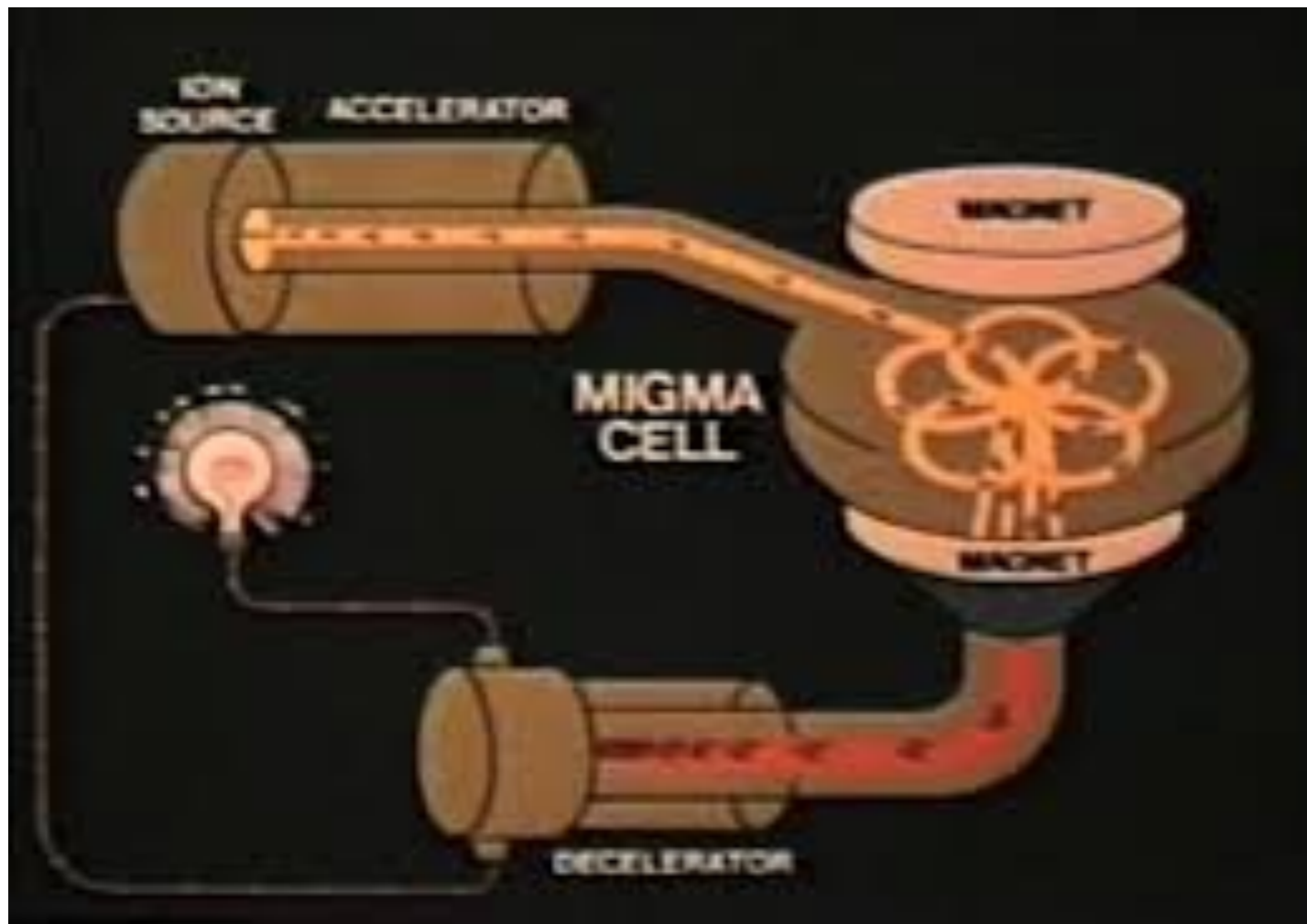
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HOHLRAUM



The *Migma* Cell

- Self-Colliding Beam
- Invented by Bogdan Maglich in 1975
- World record “confinement”: 24 s

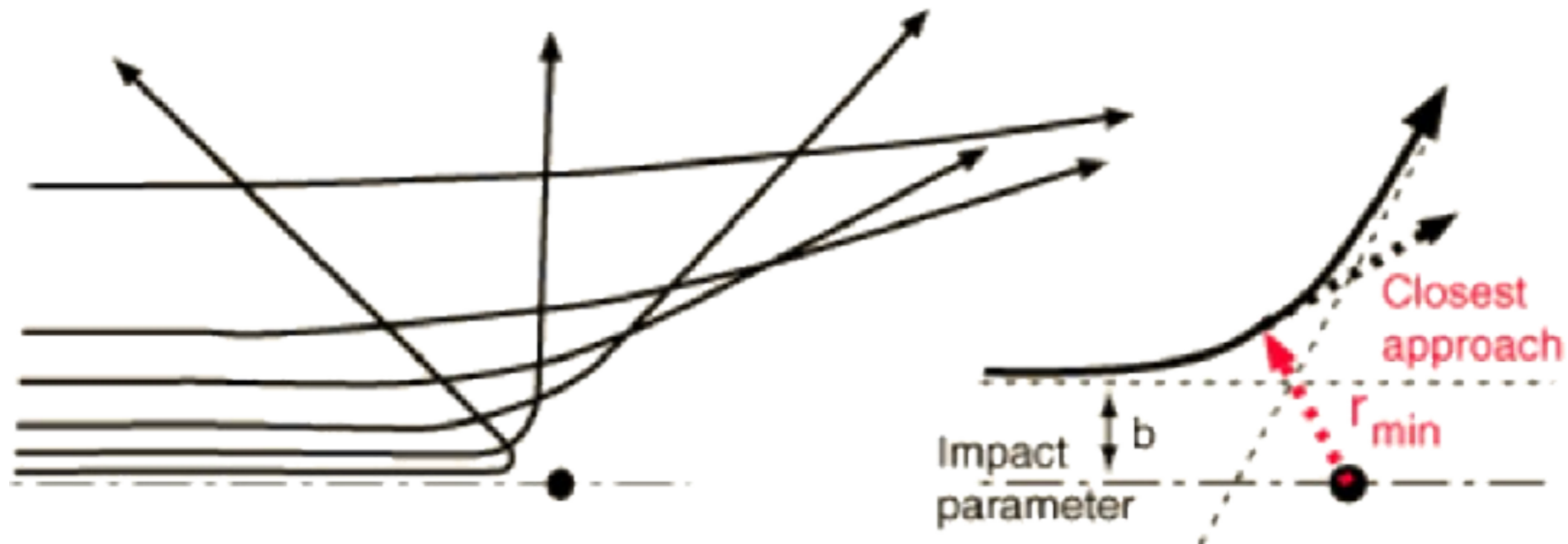


The *Aiming* Problem

- To make a ${}^1\text{p} + {}^{11}\text{B} \rightarrow 3\alpha + 8.7 \text{ MeV}$ reaction, in principle all you need is to accelerate your proton to 123 keV and hit a boron target with it, right?

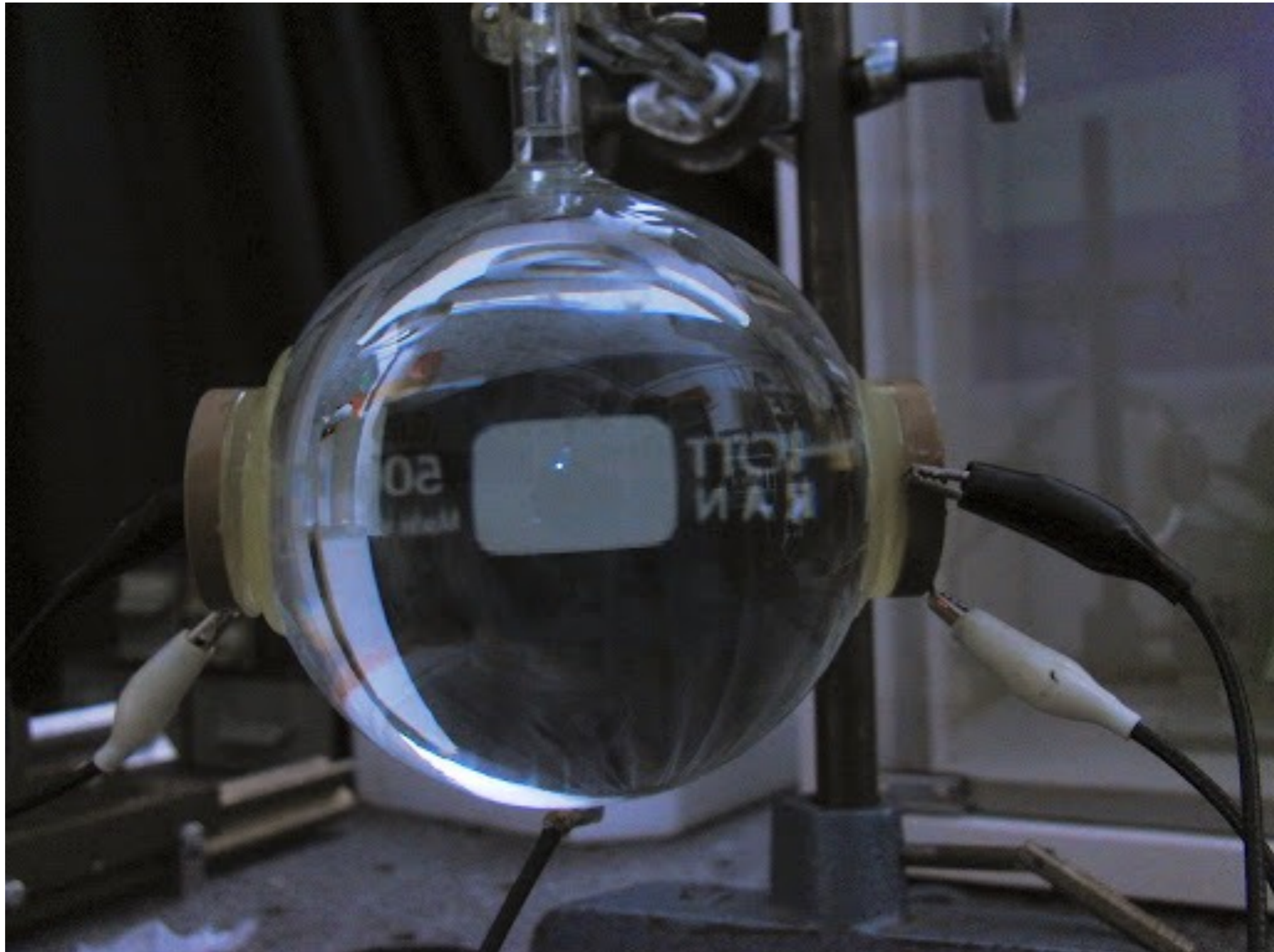


- But this requires exquisite *aim* to get close enough to tunnel in!

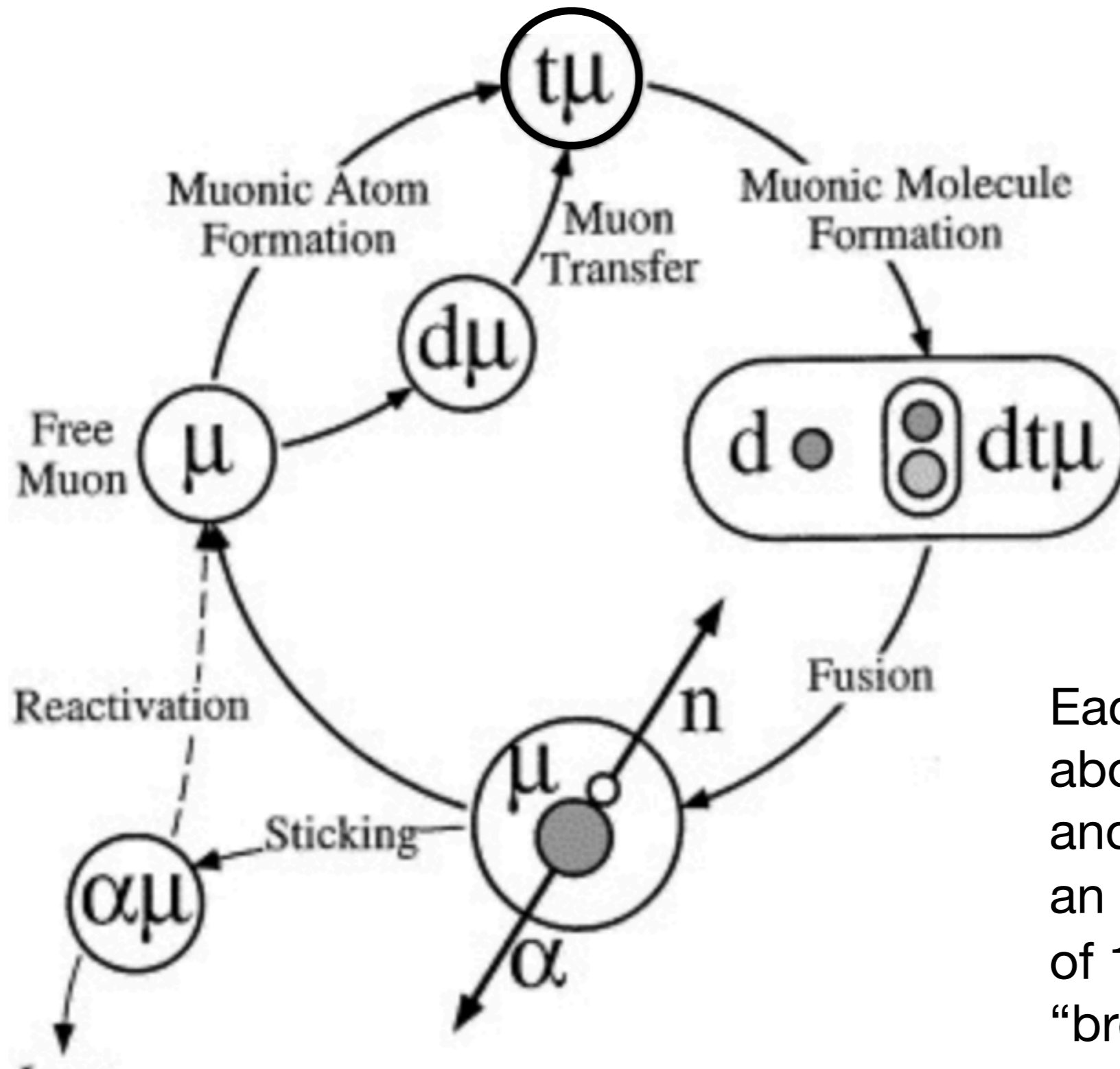


- This renders all “colliding beams” ideas implausible, IMO.

Sonoluminescence

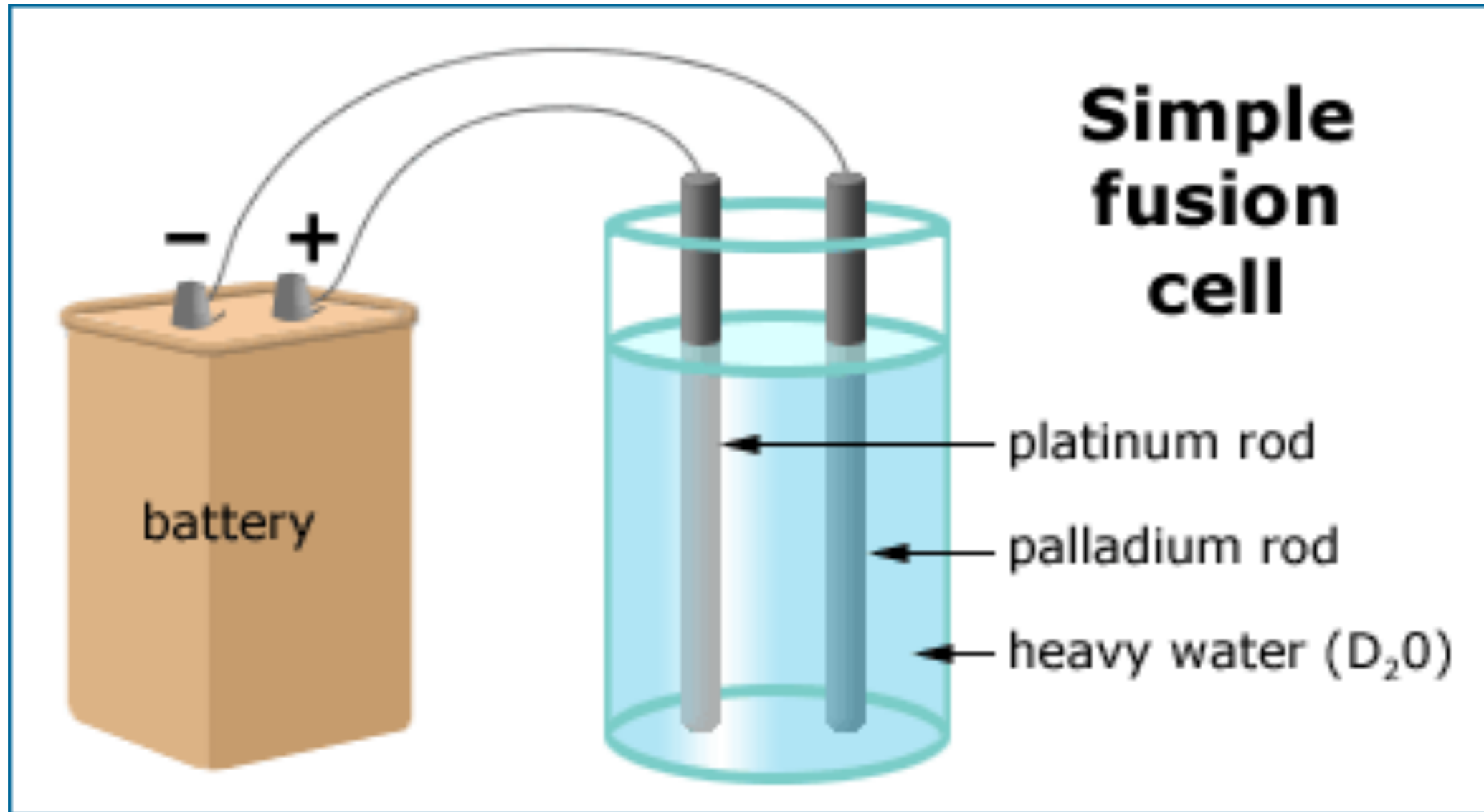


μCF = Muon Catalyzed Fusion

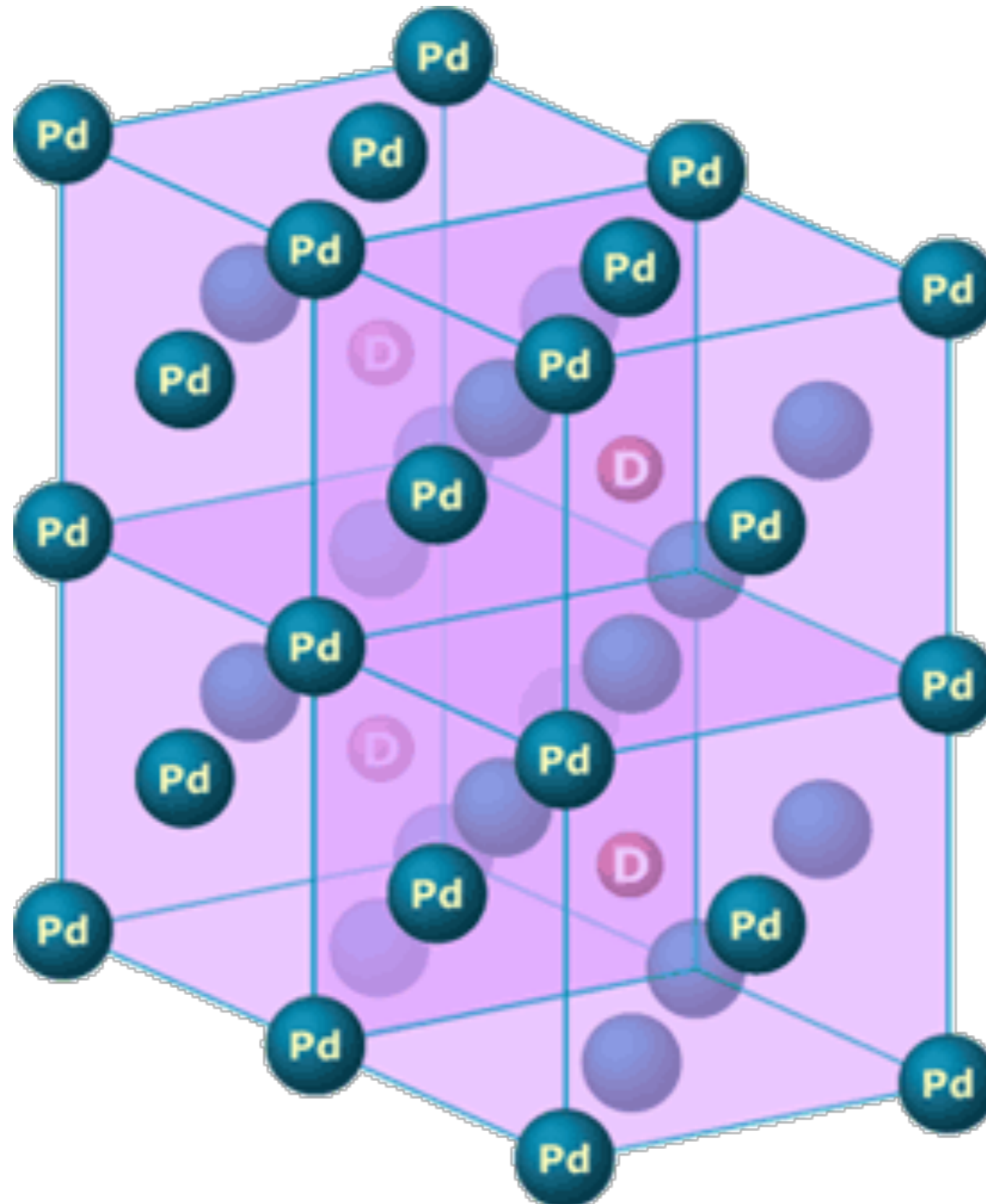


Each μ^- catalyzes about 200 d-t fusions and then “sticks” to an α^{++} . Another factor of 10 is needed for “break-even”. :-)

“Cold Fusion”



Palladium Deuteride



“Cold Fusion”

