PEAK NANOPLEX™ HDC CAPACITOR FILMS FOR INERTIAL CONFINEMENT FUSION

NanoPlex HDC At a Glance

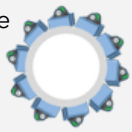
- **100% engineered** in the U.S. and sourced from allied nations
- **4x** more energy storage than conventional BOPP
- **Up to 50%** smaller capacitor bank footprint
- Engineered for **nanosecond-precision** pulse delivery
- Supports **ICF and IMG** architectures

IMG Pulse Power Architecture With NanoPlex HDC

E&P capacitors using **NanoPlex HDC film** build the core power block

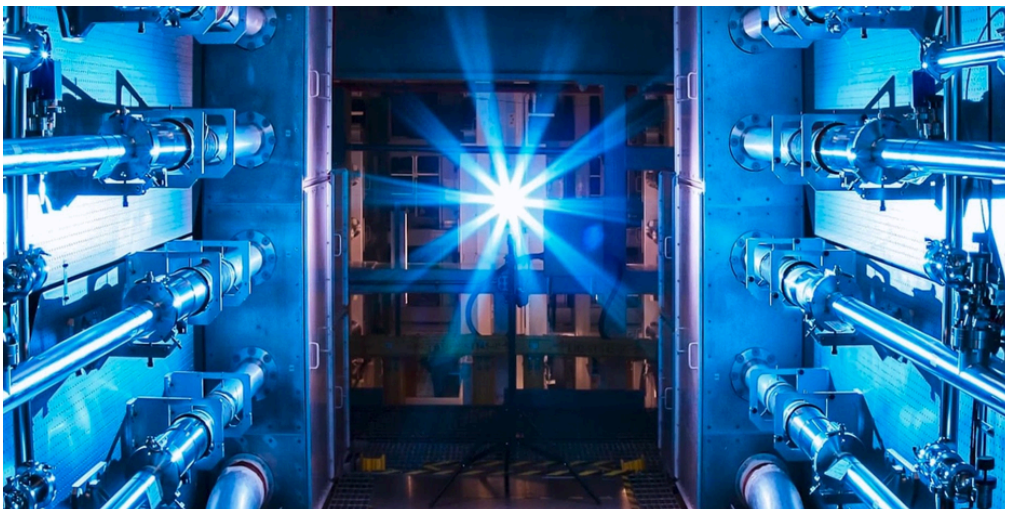
Two caps are **added to a switch** to form the full power block

The power blocks are arranged around chamber cylinder to form a **power stage**



Up to 150 stages are combined to form an **IMG power module**

The power modules are incorporated into the overall **fusion machine**



Commercial inertial confinement fusion drivers demand capacitor technology engineered for nanosecond pulse delivery at scale.

NanoPlex HDC Supports the Future of Inertial Confinement Fusion

Alongside magnetic confinement approaches, inertial confinement fusion (ICF) is one of the leading pathways to commercial fusion power. It uses precisely timed, high-energy pulses delivered by lasers or electrical drivers to compress a small fuel target with enough force to trigger a fusion reaction. Each shot demands a synchronized energy burst discharged within nanoseconds, repeated thousands of times per second. The commercial ICF sector is accelerating rapidly. Private fusion investment now exceeds $15 billion globally, with impedance-matched Marx generator (IMG) architectures emerging as the leading modular approach to commercial ICF.

The Pulse Power Challenge Behind ICF

Most commercial fusion roadmaps underestimate one component: the capacitor. ICF capacitor banks must store massive energy reserves and discharge energy with nanosecond precision, shot after shot. Conventional capacitor film struggles under that duty. It fails sooner than the system can tolerate and requires more modules, more interconnects, more cooling infrastructure, and more frequent replacement cycles. This produces a system that is harder to scale, more expensive to operate, and less capable of delivering the precision commercial ICF demands.

"Capacitors sit at the heart of many fusion approaches – especially IMG. We're talking about storing megajoules of energy and discharging it within nanoseconds of precision, repeating that over and over to power cities and beyond."

Caroline Sorrick | Founder & CEO
E&P Technologies

ICF and the Rise of the Impedance-Matched Marx Generator

NanoPlex HDC is purpose-built for the architectures leading commercial ICF development:

Indirect Drive
High-energy laser beams enter a small cavity called a hohlraum, where they convert to X-rays that compress the fuel target symmetrically.

Direct Drive
High-energy laser beams illuminate the fuel target directly, ablating its outer surface to drive compression. Removing the X-ray conversion step couples more of the laser energy into the target.

Impedance-Matched Marx Generator (IMG)
A modular, scalable architecture in which standardized capacitor-and-switch modules fire in precise synchronization to deliver high-energy pulses directly at the load. This eliminates pulse compression stages and reduces cost per shot.

ICF and IMG rely on the same component, the capacitor bank, and that is precisely where NanoPlex HDC delivers measurable advantages.

Advanced Materials for Fusion Energy

Peak Nano is a U.S.-based manufacturer of nanolayered metamaterial films engineered for high-energy and high-reliability applications across the power grid, fusion, electric vehicles, aerospace, and defense. Our NanoPlex™ films are designed and engineered in the U.S., with a secure supply chain from allied nations, strengthening the U.S. materials supply chain for fusion research and next-generation energy infrastructure. NanoPlex HDC films are optimized for inertial confinement fusion and pulse power applications, delivering 4X greater energy storage, up to 50% smaller capacitor footprints, and pulse durability for the high shot-rate demands of commercial ICF systems.

5 Ways NanoPlex HDC Supports ICF

Peak Nano built NanoPlex HDC film for these conditions, driving superior energy density and pulse precision, and it's backed by a secure U.S. and allied nation-based supply chain. NanoPlex HDC delivers across five critical performance dimensions:

1 | **Energy Precision: High-Speed Pulse Delivery Without Signal Drag**

As shot rates increase, delivering clean, high-energy pulses at nanosecond speed becomes harder. NanoPlex HDC films store 4X more energy in half the space, shortening current paths, reducing signal interference, and simplifying layouts.

2 | **Power Density: More Energy, Smaller Footprint**

Traditional capacitor film requires oversized banks to hit energy targets. These consume space, block access, and make fast-moving fusion systems harder to scale. NanoPlex HDC's 4X energy density advantage allows fusion teams to shrink pulse banks by up to 50%.

3 | **Shot Life: Extended Service Life Across High-Duty Cycles**

Repeated high-current pulses and the internal heating they create cause drift, degradation, and premature failure in conventional capacitors, forcing frequent maintenance and reducing system stability. NanoPlex HDC maintains performance under intense shot cycles and elevated heating from high-current discharge.

4 | **Lower Cost: Compact Power That's Easier to Deploy**

To meet high-energy demands, traditional capacitor banks must be oversized and frequently replaced, driving up component count, installation time, and lifetime operating costs. NanoPlex HDC enables smaller, high-capacity modules that reduce the total number of racks, interconnects, and mounting hardware.

5 | **Secure Supply: Fusion Without Foreign Dependence**

Fusion programs rely on a fragile supply chain dominated by overseas producers. Around 70% of BOPP capacitor film comes from China, exposing fusion developers to unpredictable lead times, geopolitical risk, and costly delays for mission-critical components. NanoPlex HDC films are 100% U.S.-engineered and backed by an allied-nation supply chain, ensuring dependable delivery and long-term supply chain resilience.

Peak Nano Films, LLC
7700 Hub Parkway, Ste 8
Valley View, OH 44125

sales@peaknano.com
www.peaknano.com

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