

TECHNICAL ADDENDUM: EMERGENT DATA & PLASMA SHEAR

System Designator: SPERS-MK1

Module: FPGA Control Logic / Magnetic Driver

Subject: Rotational Plasma Shear ("The Twist")

Status: Emergent Behavior Validation

Date: November 24, 2025

1.0 CONCEPT: FIELD-REVERSED CONFIGURATION (FRC) SHEAR

The "Twist" is an emergent operational mode discovered during the analysis of the Pentagonal Coil Array geometry. By altering the pulse timing of the existing magnetic drivers, we can induce **Counter-Rotating Toroidal Currents** within the plasma sphere.

1.1 The Mechanism

Instead of a simple compressive Z-Pinch (all coils firing simultaneously), the system utilizes **Phased Induction**.

- Upper Hemisphere Coils ($N=6$):** Fired in a Clockwise (CW) sequence ($\phi = 0^\circ, 120^\circ, 240^\circ$).
- Lower Hemisphere Coils ($N=6$):** Fired in a Counter-Clockwise (CCW) sequence ($\phi = 0^\circ, -120^\circ, -240^\circ$).

1.2 The Result: The Shear Plane

This creates two opposing magnetic vortices.

- Equatorial Shear:** At the center of the sphere (the equator), the two spinning plasma fields grind against each other.
- Effect:** This friction creates a zone of **hyper-turbulence** and **magnetic reconnection**, significantly increasing the ion collision rate (Fusion Burn Efficiency) without requiring higher input power.

2.0 HARDWARE COMPATIBILITY

NO HARDWARE MODIFICATION REQUIRED.

The existing **CORE-A1** hardware features a **Pentagonal Litz Wire Array** (Spec 1.1.2). This geometry is naturally conducive to generating rotating magnetic fields (similar to a 3-phase electric motor stator).

- Drivers:** The 3x Parallel Circuits are already independently addressable.
- Implementation:** The upgrade is strictly a **Firmware Patch** (v2.1) to the FPGA controller to alter the microsecond firing delays.

3.0 PHYSICS OF SEPARATION (THE CENTRIFUGE EFFECT)

The "Twist" provides a secondary benefit: **In-Chamber Isotope Separation**. As the plasma spins violently ($>100,000\text{ RPM}$ equivalent), centrifugal forces act on the ions based on their atomic mass.

3.1 Mass Segregation

- $F_c = m \cdot \omega^2 \cdot r$
- **Heavy Ions (Waste):** Iron (Fe), Arsenic (As), and fission products have high mass (m). They are flung to the **Outer Wall** of the plasma torus.
 - **Light Ions (Fuel):** Helium (He) and Lithium (Li) have low mass. They remain in the **Stable Center**.

3.2 Extraction Logic

- When the magnetic field collapses and the exhaust valve opens:
1. **First Exit (Outer Layer):** The heavy waste sludge is ejected first, driven by centrifugal momentum directly into the cyclone separator wall.
 2. **Second Exit (Inner Core):** The clean Helium ash follows, remaining gaseous and easily separated by the PSA unit.

4.0 FPGA PULSE SEQUENCE (FIRMWARE v2.1)

The new "Punch, Pinch, Twist" firing table.

Step	Time (t)	Action	Component	Effect
1. PUNCH	$t=0$	Pulse	PZT Acoustic Drivers	Cavitation Nucleation.
2. WAIT	$t=50\mu s$	Delay	-	Bubble Collapse (R_{max} to R_{min}).
3. PINCH	$t=55\mu s$	Discharge	All Coils (Base Load)	Plasma Ignition (10^8 K).
4. TWIST	$t=60\mu s$	Phase Shift	Upper/Lower Coils	Rotational Shear Induction.
5. EJECT	$t=100\mu s$	Open	Flap Valve	Centrifugal Exhaust.

5.0 SUMMARY OF BENEFITS

1. **Higher Burn Rate:** Shear friction increases fusion probability.
2. **Self-Sorting Waste:** Centrifugal force pre-separates heavy metals from clean gas.
3. **Zero Cost Upgrade:** Achieved entirely through software timing adjustments on existing

hardware.