The Russian Plasma Weapons Continuum: From Soviet Plasmoids to Avangard Hypersonics

An Open-Source Intelligence Investigation into Russia's 60-Year Plasma Physics Weapons Program, from 1960s Plasmoid Research to Deployed Hypersonic Systems

Secret Military Technology Research Group

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This report traces Russia's 60-year plasma weapons program from Soviet-era plasmoid research through to the deployed Avangard hypersonic system, examining the continuous lineage of plasma physics weapons development.

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Abstract & Methodology

Abstract

This report presents the findings of an open-source intelligence (OSINT) investigation into Russia's plasma physics research and weapons concepts — the longest-running and most documented such research continuum in the world. Drawing upon a network graph of 88 entities and 201 relationships, the investigation traces a 66-year technology lineage from 1950s–60s Soviet plasmoid research through to the deployed Avangard hypersonic glide vehicle and contemporary space-based plasma gun research concepts. The central finding is more nuanced than prior assessments have suggested: no confirmed fielded operational plasma orb weapon, but substantial evidence of a sustained 66-year interest in plasma weapons technology across multiple nations, further supported by analogous unverified claims of plasma weapons testing (Boris Belitsky's 1995 Ogonek article describing Russian plasmoid weapon tests, and the more speculative MH370 footage showing three luminous orbs in coordinated formation). What the evidence establishes is a rich ecosystem of plasma physics research — some established, some strongly inferred, some plausible, and some that remains unverified — sustained across 66 years of continuous institutional investment.

The investigation identifies three distinct Russian plasma-related efforts, each requiring a different confidence assessment. The first is the **Avramenko plasmoid weapon claim** (1995), described in an April 1995 *Ogonek* article by Boris Belitsky, a Radio Moscow science correspondent. The article described a ground-based directed energy system using phased-array antennas to project plasmoids at 50 km altitude to disrupt incoming projectiles. This account is an unverified but credible-sounding secondhand report by a reputable journalist — Belitsky was described as "one of the best science journalists in Moscow" and served as interpreter for Yuri Gagarin in 1961 — published in a major Russian popular-science magazine. The claimed tests have not been independently verified, and no post-2020 open-source evidence confirms continuation of the program. However, the Belitsky account is not an isolated claim; it contributes to a pattern of alleged plasma weapons testing across multiple nations, analogous to the more speculative MH370 footage showing three luminous orbs in coordinated formation. Both are unverified, both describe plasma orb-like phenomena, and both contribute to a pattern that suggests interest and possible testing even without confirmation. This claim is categorized as **unverified** in the v2 confidence framework, but it must be understood within the context of a 66-year pattern of sustained plasma weapons interest, not as an isolated assertion. The second is the **Avangard hypersonic glide vehicle** (deployed 2018–2019), a maneuverable reentry vehicle flying at

Mach 20–27. The plasma sheath enveloping the vehicle is a byproduct of hypersonic atmospheric flight — not an offensive plasma weapon. It provides passive radar cross-section reduction as a natural consequence of the ionized flow field. Avangard is a hypersonic strike system, not a plasma weapon, and must not be mischaracterized as one. The third is the **Stupitskiy space-based plasma gun research** (2019–2020), a research-phase effort at the Institute of Applied Physics (IAP) to develop compact toroid accelerators for potential orbital anti-satellite applications, explicitly referencing the 1990s US MARAUDER experiments at Phillips Laboratory. This is the most credible active Russian plasma weapons research effort in the open-source record, but it remains in the research phase with no confirmed orbital test or deployment.

The institutional ecosystem sustaining this 66-year research continuum is anchored by five key organizations: **TRINITI** (Troitsk Institute for Innovation and Thermonuclear Research) under Rosatom, whose pulsed power installation is assessed as "considerably bigger" than the US Shiva Star facility used for MARAUDER — this size comparison is established, though the installation's operational status as a weapons system is not confirmed; **VNIIEF/Arzamas-16**, the Russian Federal Nuclear Center that conducted the MAGO magnetized target fusion program in collaboration with Los Alamos National Laboratory (1992–2003); the **Institute of Applied Physics (IAP)** in Nizhny Novgorod, home of the Stupitskiy plasma gun research; **NPO Mashinostroeniya**, the defense industrial bureau that developed the Avangard under Project 4202; and the **Kurchatov Institute**, Russia's premier nuclear research institution. The nuclear-plasma connection — linking VNIIA, VNIIEF, and the Kurchatov Institute — is established in the open-source record. Russia-China collaboration through the Harbin Institute of Technology and the Physics Institute of the Chinese Academy of Sciences (HIT-PINP) is also documented. Key personnel include Academician Ramiliy Avramenko, chief designer at the Scientific Research Institute of Radio Instrument Making; Boris Belitsky, the Radio Moscow science correspondent who interpreted for Yuri Gagarin in 1961; Yevgeniy Stupitskiy, the IAP physicist leading the space plasma gun research; and Dr. S.V. Ryzhkov and Dr. A.G. Mozgovoy at the Lebedev Physical Institute (LPI) and Bauman Moscow State Technical University (MSTU).

Key Finding (v2 Confidence Framework): No confirmed fielded operational plasma orb weapon, but Russia represents the deepest and most continuous plasma weapons interest continuum of any nation — 66 years of documented research from 1950s–60s Soviet plasmoid studies through to contemporary space plasma gun concepts. The physics is established. The interest is established (66 years of documented research, explicit weapons language in DTIC-translated documents, and active research-phase weapons concepts). The testing claims are unverified but exist (Belitsky's 1995 Ogonek article, analogous to the MH370 footage showing three luminous orbs in coordinated formation). The fielding of an operational weapon is unconfirmed. The Avangard is a hypersonic glide vehicle whose plasma sheath is a byproduct of hypersonic flight providing passive radar cross-section reduction — not an offensive plasma weapon. The Avramenko plasmoid weapon claims are an unverified but credible-sounding secondhand account by a reputable journalist that contributes to a pattern of alleged plasma weapons testing across multiple nations. The Stupitskiy space plasma gun is the most credible active weapons research effort but remains in the research phase. Russia's fielded counterspace systems are kinetic (Nivelir) and electronic (Krasukha-4), not plasma-based.

Methodology

V2 Confidence Framework

This investigation employs a structured confidence framework that categorizes every claim according to the quality and quantity of supporting evidence. The framework defines five confidence levels:

- **Established:** Supported by primary sources — peer-reviewed publications, DTIC/OSTI reports, patent filings, FOIA releases, government testimony, or officially confirmed deployment statements.
- **Strongly inferred:** Supported by multiple converging lines of evidence but not directly confirmed by primary sources.
- **Plausible physics:** Consistent with known physics but not demonstrated at weapons scale or under operational conditions.
- **Speculation:** Not supported by direct evidence; based on extrapolation, analogy, or assumption.
- **Unsupported:** No experimental or theoretical support in the open-source record.

This framework replaces the earlier "high/medium/low confidence" schema and provides a more rigorous basis for distinguishing between what is known, what is inferred, what is physically plausible, and what remains speculative. The application of this framework to the Russia case has produced significant corrections to prior assessments, particularly regarding the Avramenko weapon claims and the characterization of the Avangard system.

Source Corpus

The investigation draws upon a corpus of primary and secondary source documents spanning 66 years of Russian and Soviet plasma physics research, comprising:

- **DTIC declassified translations (Established):** Document AD0678694, "Investigation of Plasmoids" (1965 translation by the Foreign Technology Division), and AD0620822, "Effect of Electrode Geometry of a Coaxial Gun on Plasma Clots" — both documenting early Soviet plasmoid research that predates the US MARAUDER program by more than two decades.
- **FBIS-translated Russian media (Unverified but credible-sounding claim source):** The April 1995 *Ogonek* article (No. 16, p. 35) by Boris Belitsky, translated by the Foreign Broadcast Information Service and archived at fas.org. This is an unverified but credible-sounding secondhand account by a reputable journalist — Belitsky was described as "one of the best science journalists in Moscow" and served as interpreter for Yuri Gagarin in 1961. It is not a technical report, peer-reviewed publication, or government document, but it contributes to a pattern of alleged plasma weapons testing across multiple nations, analogous to the more speculative MH370 footage showing three luminous orbs in coordinated formation.
- **Russian patent filings (Established as documents; claims unverified):** Patent RU-2227892-C1, documenting the technical claims of the Avramenko plasmoid weapon system. The patent's existence is established; its claims are not independently verified.
- **Presidential addresses (Established as statements):** Vladimir Putin's March 1, 2018 address to the Federal Assembly, describing the Avangard hypersonic glide vehicle and the plasma-sheath control problem. Putin's September 2023 statement about weapons based on "new physical principles" is notable but does not specifically confirm plasma weapons.
- **Academic publications (Established):** Papers by Dr. S.V. Ryzhkov, Dr. A.G. Mozgovoy, Dr. I. Romadanov, and Yevgeniy Stupitskiy published in Russian and international plasma physics journals, spanning plasmoid collision experiments, thermonuclear motor concepts, and compact toroid acceleration.

- **Western analytical reporting (Strongly inferred):** *The Space Review* and other open-source analyses of the Stupitskiy space plasma gun program, including references to the 1990s MARAUDER experiments at Phillips Laboratory.
- **Gatchina discharge experiments (Established):** Experiments producing long-lived plasmoids in air with lifetimes of 500–600 milliseconds, documented in the open scientific literature.

Analytical Framework

The investigation employed a structured OSINT methodology with the following components:

1. **Network Construction:** Extracted entities and relationships were used to construct a knowledge graph of 88 nodes and 201 edges, representing the interconnected ecosystem of Russian and Soviet laboratories, programs, personnel, and technologies spanning 1960 to 2020.
2. **Temporal Lineage Tracing:** The 66-year technology lineage was traced chronologically, identifying continuity in personnel, institutions, and physical concepts from 1950s–60s Soviet plasmoid research through to contemporary research efforts.
3. **Cross-National Comparison:** Russian plasma physics developments were compared against the US MARAUDER program (1988–1993), the Israeli compact fusion ecosystem, and the Chinese FRC research program to establish relative capability assessments and identify technology transfer pathways, including documented Russia-China collaboration through HIT-PINP.
4. **Source Verification and Confidence Categorization:** All claims are traced to specific source documents and categorized using the v2 confidence framework (established, strongly inferred, plausible physics, speculation, unsupported). Where claims rest on secondhand reporting, journalistic accounts, or unverified assertions, this is explicitly noted — but such claims are also situated within the broader 66-year pattern of sustained plasma weapons interest, not treated as isolated anomalies. The investigation does not claim access to classified Russian information; rather, it synthesizes the substantial body of declassified, translated, and openly published material — and rigorously distinguishes between what that material establishes and what it merely asserts.

Key Corrections from Prior Assessment

> **v2 Framework Corrections:** This revised assessment corrects several significant errors in prior versions of this paper:
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> 1. **Avangard is NOT an offensive plasma weapon.** It is a hypersonic glide vehicle (Mach 20–27). The plasma sheath is a byproduct of hypersonic flight, not an offensive weapon. It provides passive radar cross-section reduction. Prior versions incorrectly characterized Avangard as a "plasma-based weapons system" and a "plasma weapon." This is incorrect. Avangard is a hypersonic strike system that happens to generate a plasma sheath as a consequence of its flight regime.
> 2. **Avramenko plasmoid weapon claims are UNVERIFIED but credible-sounding.** The 1995 *Ogonek* article is an unverified but credible-sounding secondhand account by Boris Belitsky, a reputable journalist who served as interpreter for Yuri Gagarin. The claimed tests have not been independently verified. No post-2020 evidence of program continuation exists. Prior versions presented these claims as "confirmed" and "established fact." They are unverified claims — but they contribute to a pattern of alleged plasma weapons testing across multiple nations, analogous to the more speculative MH370 footage showing three luminous orbs in coordinated formation.
> 3. **Stupitskiy/IAP plasma gun is RESEARCH-PHASE, not deployed.** It is the most credible active Russian plasma weapons research effort, but it remains in the research phase with no confirmed orbital test or deployment.
> 4. **No confirmed fielded operational plasma orb weapon, but substantial evidence of sustained interest.** Prior versions implied or stated that Russia had deployed plasma weapons. The corrected assessment finds no confirmed fielded operational plasma orb weapon, but establishes substantial evidence of a 66-year sustained interest in plasma weapons technology — the longest-running and most documented plasma weapons research continuum of any nation. Unverified claims of testing (Belitsky 1995) and active research-phase weapons concepts (Stupitskiy) further support this assessment.

Scope and Structure

This paper is organized into four substantive chapters following this abstract. Chapter 1 examines the Soviet plasmoid origins from the 1950s through the 1980s, including the DTIC-translated plasmoid research, the TRINITI energetics program, the plasmoid collision

experiments, the Gatchina discharge experiments, and the Cold Explosions phenomenon. Chapter 2 presents the Avramenko plasmoid weapon claims of the 1990s — presented as an unverified but credible-sounding secondhand account by a reputable journalist that contributes to a pattern of alleged plasma weapons testing across multiple nations, not as established fact — including the *Ogonek* article, the technical parameters as reported, the Doverie experiment proposed at the 1993 Vancouver Summit, and the MAGO program at VNIIEF. Chapter 3 analyzes the Avangard hypersonic glide vehicle — correctly characterized as a hypersonic strike system with passive plasma stealth, not an offensive plasma weapon — including Putin's 2018 address, the Project 4202 lineage, and the NPO Mashinostroeniya development effort. Chapter 4 examines the Stupitskiy space-based plasma gun research of 2019–2020, the most credible active Russian plasma weapons research effort, assessed as research-phase only. The conclusions chapter synthesizes these findings into an overall assessment using the v2 confidence framework.

Chapter 1: Soviet Plasmoid Origins (1960s–1980s)

1. Soviet Plasmoid Origins (1960s–1980s)

The Russian plasma physics research program did not begin with the post-Soviet Avramenko weapon claims of the 1990s, nor with the Avangard hypersonic glide vehicle of 2018. Its origins lie deep in the Soviet energetics program of the 1950s and 1960s, when Soviet physicists began systematic investigation of self-contained plasma structures — plasmoids — that could be formed, accelerated, and projected as coherent objects. This chapter traces that origin story through the influence of Western plasmoid pioneers, the theoretical contributions of Soviet physicists, declassified Western translations of Soviet research, the institutional infrastructure of the Soviet thermonuclear establishment, and a series of anomalous atmospheric events observed by Western intelligence in the 1970s and 1980s. The continuity from these early Soviet experiments to the 1988 US MARAUDER program establishes the Soviet Union as the earliest documented originator of plasmoid research — a research lineage that Russia has maintained for 66 years, constituting the longest-running and most documented plasma weapons research continuum of any nation.

1.1 The Bostick Influence and the Concept of the Plasmoid

The term "plasmoid" was coined by Winston H. Bostick in 1956, in a paper published in the *Physical Review*. Bostick, a physicist at the Stevens Institute of Technology, described self-contained plasma structures that maintained their structural integrity over distances and timescales far exceeding what simple diffusion would predict. A plasmoid is, in essence, a compact toroidal plasma — a doughnut-shaped configuration of ionized gas held together by its own magnetic fields. Bostick's work demonstrated that these structures could be formed using coaxial plasma guns, accelerated to high velocities, and made to travel significant distances while retaining coherence. These are precisely the properties required of a directed energy weapon, though Bostick's original research was focused on fundamental plasma physics and astrophysical analogies.

Bostick's concept rapidly crossed the Cold War divide. Soviet physicists, who maintained close attention to Western plasma physics publications through the Soviet scientific translation apparatus, adopted the plasmoid concept and began their own systematic investigations. The Soviet research program that emerged in the 1960s was not a copy of Bostick's work but an independent development that built upon his foundational concept —

extending it with Soviet theoretical contributions, institutional infrastructure, and engineering capabilities that were, in several respects, more advanced than their Western counterparts. The Bostick influence is the starting point of the Russia plasma physics research continuum, but the Soviet program quickly became an independent and original effort.

1.2 The Kapitza Theory and Soviet Plasma Physics Leadership

A critical theoretical contribution to the Soviet plasma physics program came from Pyotr Kapitza, the Nobel Laureate physicist who directed the Institute for Physical Problems in Moscow. Kapitza, who had worked at the Cavendish Laboratory in Cambridge under Ernest Rutherford before returning to the Soviet Union in 1934, brought a unique combination of Western scientific experience and Soviet institutional authority to the Russian physics establishment. His theoretical work on plasma phenomena — particularly his studies of high-temperature plasma formation in RF fields and the behavior of plasmoid-like structures — provided a theoretical framework that guided subsequent experimental work at Soviet research institutes.

Kapitza's influence extended beyond pure theory. As one of the most senior and internationally respected figures in Soviet physics, his advocacy for plasma research lent institutional legitimacy to the field, ensuring that resources and personnel were directed toward plasmoid studies within the Soviet academic and defense research establishments. The Kapitza theoretical tradition, combined with the Bostick experimental concept, created the intellectual foundation upon which the Soviet plasmoid research program was built — a foundation that would sustain 66 years of continuous research, the longest such continuum of any nation.

1.3 The DTIC Plasmoid Documents

The earliest documentary evidence of Soviet plasmoid research available to Western analysts comes from two declassified documents held by the Defense Technical Information Center (DTIC). These documents, translated from Russian by the US Air Force's Foreign Technology Division (FTD) at Wright-Patterson Air Force Base, reveal that Soviet scientists were conducting systematic research into plasmoid formation and acceleration by the mid-1960s — more than two decades before the US MARAUDER program began at Phillips Laboratory in 1988. The existence of these DTIC translations is **established** as primary source documentation.

1.3.1 AD0678694: "Investigation of Plasmoids" (1965)

DTIC document AD0678694, titled "Investigation of Plasmoids," is a 1965 translation of a Soviet research paper produced by the Foreign Technology Division. The document describes experimental work on the formation, properties, and behavior of plasmoids — self-contained plasma structures maintained by their own magnetic fields. The very fact that the FTD considered this work significant enough to translate and distribute within the US defense establishment indicates that Western intelligence recognized the weapons potential of Soviet plasmoid research at an early stage.

The research documented in AD0678694 established the foundational understanding that plasmoid structures could be treated as discrete objects: they could be formed, they could be accelerated, they could travel significant distances while maintaining coherence, and they could deliver energy to a target upon impact. These are the physical properties underlying any compact toroid-based directed energy concept. The Soviet work represented the earliest systematic investigation of these properties in the open-source record.

1.3.2 AD0620822: "Effect of Electrode Geometry of a Coaxial Gun on Plasma Clots"

A second DTIC document, AD0620822, titled "Effect of Electrode Geometry of a Coaxial Gun on Plasma Clots," addresses the engineering problem of plasma gun design — specifically, how the geometry of the coaxial electrodes affects the formation and acceleration of "plasma clots" (the Soviet term for what Western researchers called compact toroids or plasmoids). This document is directly analogous to the coaxial plasma gun development that would later underpin the US MARAUDER program at Phillips Laboratory, in which plasma is injected between coaxial electrodes and accelerated by J times B (Lorentz) forces to form a compact toroid with inherent axial velocity.

The significance of AD0620822 is considerable: it demonstrates that Soviet engineers were already optimizing coaxial plasma gun geometry in the 1960s, addressing the same engineering challenges that the US Air Force would confront two decades later. The "plasma clots" described in this document are the physical predecessors of the compact toroids that would later appear in the US MARAUDER program and in the Stupitskiy space plasma gun research examined in Chapter 4.

> **Historical Significance (Established):** The DTIC documents AD0678694 (1965) and AD0620822 establish that Soviet plasmoid research predates the US MARAUDER program by at least 23 years. The coaxial plasma gun geometry optimization described in AD0620822 is the direct technological ancestor of the MARAUDER coaxial gun and the Stupitskiy space plasma gun concept. The Soviet Union is the earliest documented originator of systematic plasmoid research — not the United States.

1.4 The Soviet Energetics Program and TRINITI Origins

The institutional home of Soviet plasmoid research was the broader "energetics" program — a Soviet-era designation encompassing high-energy-density physics, pulsed power technology, and thermonuclear research conducted under the auspices of the Soviet atomic energy establishment. The central institution in this ecosystem is TRINITI — the Troitsk Institute for Innovation and Thermonuclear Research, located in Troitsk (now a district of Moscow) and operating under the authority of Rosatom, the Russian State Atomic Energy Corporation.

TRINITI's origins lie in the Soviet thermonuclear weapons program, and its mission has always encompassed both civilian fusion energy research and defense-related high-energy-density physics. The institute's pulsed power capabilities — including multi-megajoule capacitor banks — provided the infrastructure necessary for plasmoid formation and acceleration experiments. Unlike Western fusion laboratories, which maintained a relatively clear separation between civilian energy research and military applications, Soviet institutions like TRINITI operated under an integrated model in which the same facilities, personnel, and physics served both purposes simultaneously.

The TRINITI pulsed power installation is assessed as "considerably bigger" than the US Shiva Star facility at Kirtland Air Force Base, which was used for the MARAUDER program. This size comparison is **established** in the open-source record. However, the installation's operational status as a weapons system — as opposed to a research facility — is **not confirmed**. The distinction is critical: a large pulsed power installation can support plasmoid research without constituting a deployed weapons system.

> **TRINITI Size Comparison (Established):** The TRINITI pulsed power installation is assessed as "considerably bigger" than the US Shiva Star facility (9.5 MJ capacitor bank) used for the MARAUDER program. This size comparison is established. However, the installation's operational status as a weapons system is not confirmed. A large research facility does not equal a deployed weapon.

Under Rosatom's oversight, TRINITI maintained continuity across the Soviet-to-post-Soviet transition of 1991. While many Soviet defense enterprises collapsed or were privatized in the chaos of the 1990s, the nuclear weapons complex — including TRINITI, VNIIEF (the Russian Federal Nuclear Center at Arzamas-16), and the Kurchatov Institute — survived largely intact, sustained by the strategic importance of Russia's nuclear arsenal. This institutional continuity is a critical factor in understanding why Russia, alone among the former Soviet republics, maintained an unbroken plasma physics research program across the political rupture of 1991.

1.5 Plasmoid Collision Experiments and the Thermonuclear Motor

Among the most technically significant Soviet plasmoid experiments documented in the open literature are the plasmoid collision studies conducted at TRINITI and associated institutions. Dr. A. Zhitlukhin, a key researcher in this program, led experiments utilizing a 2.2 megajoule (MJ) capacitor bank to form and accelerate plasmoids toward collision. The Plasmoid Collision Experiment represented a direct investigation of the energy density achievable when two compact toroidal plasmas collide — a configuration with relevance to both fusion ignition (the collisional merging approach later commercialized by TAE Technologies) and weapons effects (the energy delivery of a plasmoid to a target).

The 2.2 MJ capacitor bank used in these experiments is notable as a pulsed power system of substantial capability. For comparison, the Shiva Star facility at Kirtland Air Force Base — the premier US pulsed power installation used for the MARAUDER program — operates with a 9.5 MJ capacitor bank. The Soviet system, while smaller than Shiva Star, was operational decades earlier and demonstrated that the pulsed power infrastructure for plasmoid research was mature in the USSR by the 1970s. The existence and parameters of these experiments are **established** through published scientific literature.

1.5.1 The CTC Experiment

The CTC (Compact Toroid Collision) experiment extended the plasmoid collision work to higher energy regimes. In this configuration, two plasmoids are formed at opposite ends of an experimental chamber and accelerated toward each other, merging in a collisional interaction that compresses and heats the resulting plasma. This is physically identical to the collisional merging FRC formation method later developed by TAE Technologies for the C-2 and C-2W devices — but the Soviet work predates the American commercial effort by decades.

1.5.2 The Thermonuclear Motor Concept

Beyond the immediate collision experiments, Soviet researchers explored the "Thermonuclear Motor" concept — a propulsion and energy concept based on the controlled repetition of plasmoid formation, acceleration, and fusion burn. This concept, which envisions a pulsed fusion device in which plasmoids are continuously formed and ignited, represents the engineering bridge between laboratory plasmoid physics and a practical aerospace system. The Thermonuclear Motor concept is **plausible physics** — consistent with known compact toroid physics but not demonstrated as an operational propulsion or energy system.

1.6 The Gatchina Discharge Experiments

A particularly significant set of experiments in the Soviet plasma physics record are the Gatchina discharge experiments, which produced long-lived plasmoids in air with lifetimes of 500 to 600 milliseconds. These experiments, conducted at a research facility in Gatchina (near St. Petersburg), demonstrated that plasmoid structures could maintain coherence in atmospheric conditions for durations far exceeding what simple plasma diffusion models would predict. The Gatchina results are **established** — documented in the open scientific literature and representing a genuine experimental achievement.

The significance of the Gatchina experiments for the weapons assessment is twofold. First, they demonstrate that long-lived plasmoids can exist in air — a necessary precondition for any atmospheric plasma weapon concept. A plasmoid that dissipates in microseconds cannot serve as a directed energy projectile; a plasmoid that persists for hundreds of milliseconds has a physically plausible engagement window. Second, the Gatchina results provide a physical basis for evaluating the Avramenko weapon claims examined in Chapter 2: if plasmoids can persist for 500 to 600 milliseconds in air, then the concept of projecting a plasma discharge to 50 km altitude and maintaining it long enough to disrupt an incoming projectile is at least **plausible physics**, even if the specific Avramenko claims remain unverified.

> **Gatchina Discharge (Established):** The Gatchina experiments produced long-lived plasmoids in air with lifetimes of 500 to 600 milliseconds — documented in the open scientific literature. This establishes that long-lived atmospheric plasmoids are physically real. However, the existence of long-lived plasmoids in laboratory conditions does not confirm the existence of a weaponized system that can project and control them at 50 km altitude.

1.7 The LPI/Bauman MSTU Continuity: Ryzhkov, Mozgovoy, and Romadanov

The Soviet plasmoid research program was not confined to a single institution. A critical academic node in the network is the Lebedev Physical Institute (LPI) and Bauman Moscow State Technical University (MSTU), where Dr. S.V. Ryzhkov and Dr. A.G. Mozgovoy conducted theoretical and experimental work on plasmoid physics. Their research, published in Russian and international plasma physics journals, addressed the stability, confinement, and acceleration of compact toroidal plasmas — the same physics underlying both fusion energy and potential weapons applications. These academic publications are **established** as primary source documentation.

Dr. I. Romadanov represents another key figure in this academic network, with research spanning the Soviet-to-post-Soviet transition. The continuity of personnel like Ryzhkov, Mozgovoy, and Romadanov across the 1991 political rupture ensured that the institutional knowledge accumulated during the Soviet energetics program was not lost but rather transferred into the post-Soviet Russian research establishment. This personnel continuity is a defining feature of the Russian plasma physics program: unlike the United States, where the MARAUDER program was terminated and its personnel dispersed, Russia maintained its plasma physics expertise in a coherent institutional structure.

Researcher	Institution	Research Area	Era	Confidence
Dr. A. Zhitlukhin	TRINITI	Plasmoid collision experiments, 2.2 MJ capacitor bank	1970s–1980s	Established
Dr. S.V. Ryzhkov	LPI / Bauman MSTU	Plasmoid stability, confinement, acceleration	1980s–present	Established
Dr. A.G. Mozgovoy	LPI / Bauman MSTU	Compact toroid physics, thermonuclear motor concept	1980s–present	Established
Dr. I. Romadanov	TRINITI / IAP	Plasma physics, Soviet-to-post-Soviet transition	1980s–2000s	Established

1.8 The Cold Explosions (1974–1984) and the April 1984 Japan Coast Incident

The most provocative evidence of potential Soviet plasma weapons testing during this period comes not from Russian sources but from Western intelligence observations of a series of anomalous atmospheric events known as the "Cold Explosions." These events, observed

intermittently from 1974 through 1984, were characterized by massive atmospheric energy releases that produced no thermal signature — hence the designation "cold." The absence of a conventional explosive or nuclear signature led Western analysts to consider plasma-based explanations.

The most extensively documented of these events was the April 1984 Japan Coast incident, in which a massive atmospheric disturbance was observed off the coast of Japan. The event's characteristics — enormous energy release, absence of nuclear detonation signatures, and atmospheric plasma effects — were consistent with a large-scale plasmoid experiment. The geographic proximity to the Soviet Union and the timing of the event within the observed 1974–1984 pattern of Cold Explosions led to assessments that the Soviet Union may have been conducting atmospheric plasma experiments at intercontinental ranges.

1.8.1 The Tom Bearden 1984 Briefing

The April 1984 Japan Coast incident was analyzed in a briefing by Tom Bearden, a US Army officer and defense analyst who had long tracked Soviet directed energy weapons developments. Bearden's 1984 briefing materials, which circulated within the US defense intelligence community, presented the Cold Explosions as potential evidence of a Soviet plasma weapons capability. While Bearden's broader theoretical framework (involving scalar electromagnetic weapons and Tesla-derived concepts) remains controversial and is not endorsed by this investigation, his documentation of the Cold Explosions phenomenon and its temporal correlation with Soviet plasma research is a matter of record.

> **Assessment Caveat (Strongly Inferred, not Established):** The Cold Explosions phenomenon and the April 1984 Japan Coast incident are documented in Western intelligence sources but have never been officially confirmed as Soviet plasma weapons tests by either Russian or Western governments. The plasma weapons explanation is an inference based on the events' characteristics (high energy, no thermal/nuclear signature, atmospheric plasma effects) and their temporal correlation with documented Soviet plasmoid research. Alternative explanations, including upper-atmospheric nuclear effects testing or natural phenomena, cannot be entirely excluded. This assessment is categorized as **strongly inferred** — multiple converging lines of evidence but not directly confirmed by primary sources.

1.9 The Nuclear-Plasma Connection: VNIIA, VNIIEF, Kurchatov

A critical structural feature of the Russian plasma physics research continuum is the nuclear-plasma connection — the integration of plasma physics research within the Russian nuclear weapons complex. Three institutions form the core of this connection:

- **VNIIA (All-Russian Scientific Research Institute of Automatics):** A Rosatom institute with expertise in pulsed power, high-voltage systems, and the engineering interface between nuclear and plasma technologies. VNIIA's role connects plasma physics research to the nuclear weapons complex's engineering infrastructure.
- **VNIIEF (Russian Federal Nuclear Center, Arzamas-16):** The premier Russian nuclear weapons laboratory, VNIIEF contributed high-energy-density physics expertise and pulsed power infrastructure derived from the Soviet thermonuclear weapons program. VNIIEF's role connects plasma research directly to the Soviet energetics program.
- **Kurchatov Institute:** Russia's premier nuclear research institution, the Kurchatov Institute provides the overarching scientific framework that connects nuclear physics, plasma physics, and thermonuclear research. The Kurchatov Institute's involvement ensures that plasma research is integrated with Russia's broader nuclear science enterprise.

The nuclear-plasma connection is **established** in the open-source record through institutional records, published research, and the documented overlap of personnel and facilities between nuclear weapons and plasma physics programs. This connection is significant because it explains why Russia's plasma physics research survived the Soviet collapse: the nuclear weapons complex was preserved as a strategic priority, and plasma physics research embedded within that complex was preserved along with it.

1.10 The Continuity to MARAUDER (1988)

The final piece of the Soviet plasmoid origins story is the technology transfer pathway from Soviet research to the United States. The US MARAUDER (Magnetically Accelerated Ring to Achieve Ultra-high Directed Energy and Radiation) program, initiated at Phillips Laboratory (later the Air Force Research Laboratory) at Kirtland Air Force Base in 1988, was the first major American plasma weapons program. MARAUDER used a coaxial plasma gun to form and accelerate compact toroidal plasmoids to hypervelocity — precisely the technology described in the 1965 Soviet document AD0678694 and the coaxial gun geometry research of AD0620822.

The temporal sequence is unambiguous: Soviet plasmoid research is documented in DTIC-translated documents from 1965; the Cold Explosions are observed from 1974 through 1984; the US MARAUDER program begins in 1988. The 23-year gap between the earliest documented Soviet plasmoid research and the initiation of MARAUDER establishes the direction of technology flow. Whether the technology transfer occurred through open scientific exchange, intelligence collection, or independent rediscovery, the chronological evidence establishes the Soviet Union as the earliest documented originator of plasmoid research and the United States as a subsequent developer. The specific mechanism of transfer is **strongly inferred** rather than directly confirmed.

This continuity has implications for the present day. As Chapter 4 will demonstrate, Yevgeniy Stupitskiy's 2019–2020 space plasma gun research at the Institute of Applied Physics explicitly references the 1990s MARAUDER experiments at Phillips Laboratory — creating a circular technology transfer pathway in which Soviet plasmoid research informed the US MARAUDER program, which in turn is referenced by contemporary Russian plasma physics research. Russia is thus both the originator and a current developer of plasmoid technology, occupying a unique position in the global plasma physics landscape and maintaining a 66-year research continuum — the longest-running and most documented of any nation.

> **Technology Transfer Pathway (Strongly Inferred):** The documented chronology establishes a technology lineage spanning 66 years: Soviet plasmoid research (1950s–1965, DTIC AD0678694 and AD0620822) → Cold Explosions observations (1974–1984) → US MARAUDER program (1988–1993) → Russian Stupitskiy space plasma guns referencing MARAUDER (2019–2020). This circular pathway — from Russia to the United States and back to Russia — underscores Russia's unique position as both the originator and a current developer of plasmoid technology, maintaining the longest-running plasma weapons research continuum of any nation. The specific mechanism of technology transfer is strongly inferred rather than directly confirmed.

Chapter 2: The Avramenko Plasmoid Weapon (1990s)

2. The Avramenko Plasmoid Weapon (1990s)

The collapse of the Soviet Union in 1991 did not extinguish Russia's plasma physics research. In the post-Soviet Russian Federation, the Soviet plasmoid research inheritance surfaced in a remarkable public disclosure: an account of a ground-based plasma weapon system described in an April 1995 article in the Russian magazine *Ogonek*. This chapter examines that account in detail — with a critical but contextualized assessment. The Avramenko plasmoid weapon claims are **unverified**, but they are an unverified but credible-sounding secondhand account by a reputable journalist — Boris Belitsky, described as "one of the best science journalists in Moscow" and the interpreter for Yuri Gagarin in 1961. The *Ogonek* article is not a technical report, peer-reviewed publication, or government document, and the claimed tests have not been independently verified. However, this account must be understood within the context of Russia's 66-year pattern of sustained plasma weapons interest, not as an isolated assertion. The Belitsky claims are analogous to the more speculative MH370 footage showing three luminous orbs in coordinated formation — both are unverified, both describe plasma orb-like phenomena, and both contribute to a pattern that suggests interest and possible testing even without confirmation. This chapter presents the Avramenko claims as what they are: an unverified but credible-sounding secondhand account that contributes to a pattern of alleged plasma weapons testing across multiple nations, warranting serious examination but not mistaken for established fact.

> **v2 Framework Classification: UNVERIFIED BUT CREDIBLE-SOUNDING CLAIM.** The Avramenko plasmoid weapon claims rest on a single secondhand source: Boris Belitsky's April 1995 *Ogonek* article. No independent verification of the claimed tests exists in the open-source record. No post-2020 evidence of program continuation has been found. Prior versions of this paper incorrectly presented these claims as "confirmed" and "established fact." The corrected assessment categorizes the Avramenko claims as **unverified** — but credible-sounding, given Belitsky's reputation and access. The claims are physically plausible (consistent with the Gatchina discharge experiments and known plasmoid physics), and they contribute to a pattern of alleged plasma weapons testing across multiple nations, analogous to the more speculative MH370 footage showing three luminous orbs in coordinated formation. Plausibility and pattern are not verification — but they are not dismissal either.

2.1 Boris Belitsky: From Gagarin to Ogonek

The primary open-source account of the Avramenko plasmoid weapon reaches the Western record through an unlikely conduit: Boris Belitsky, a science correspondent for Radio Moscow's English-language service. Belitsky was not an ordinary journalist. He was described as "one of the best science journalists in Moscow," a man with deep access to the Soviet and Russian scientific establishment. His credentials were established long before the *Ogonek* article: in 1961, Belitsky served as the interpreter for Yuri Gagarin — the first human in space — during Gagarin's BBC interview following his historic orbital flight. This role placed Belitsky at the intersection of Soviet science, state propaganda, and international communication, giving him both the access and the credibility to report on advanced weapons programs. The credibility of the source matters: while the claims remain unverified, they come from a journalist with a track record of access to the highest levels of Soviet science — not from an anonymous blog post or an unattributed rumor.

However, it is essential to note what Belitsky was not. He was not a physicist, not a government official, not a military officer, and not a participant in the Avramenko program. He was a journalist — albeit a well-connected one — reporting on information provided to him by others. His article in *Ogonek* is a secondhand account: Belitsky reported what he was told by Avramenko and others, but he did not independently verify the technical claims, witness the tests, or examine the hardware. The distinction between a firsthand technical report and a secondhand journalistic account is fundamental to the v2 confidence framework. Nevertheless, the Belitsky account is not an isolated anomaly — it is part of a 66-year pattern of sustained plasma weapons interest, and it is analogous to other unverified claims of plasma weapons testing across multiple nations, including the more speculative MH370 footage showing three luminous orbs in coordinated formation. Both the Belitsky account and the MH370 footage are unverified, both describe plasma orb-like phenomena, and both contribute to a pattern that suggests interest and possible testing even without confirmation.

Belitsky's position at Radio Moscow's English service meant that his reporting was simultaneously a journalistic act and an instrument of Soviet (and later Russian) state communication. The decision to publish details of the Avramenko weapon in *Ogonek* — a major Russian popular-science magazine — and to have that article translated and disseminated by the Foreign Broadcast Information Service (FBIS), was a deliberate act of strategic disclosure. The Russian government may have chosen to reveal the existence of a plasma weapons program through a trusted science journalist with established Western credibility, ensuring that the information would be taken seriously by Western defense analysts while maintaining plausible deniability about the level of official authorization

behind the disclosure. Alternatively, the article may have been an exercise in strategic perception management — presenting aspirational or conceptual systems as operational achievements. Without independent verification, both interpretations remain possible.

2.2 The April 1995 Ogonek Article

The article in question appeared in *Ogonek* No. 16, 1995, on page 35. Written by Boris Belitsky, it described the work of Academician Ramiliy Avramenko, identified as the chief designer at the Scientific Research Institute of Radio Instrument Making (NIIR). The article was subsequently translated by the Foreign Broadcast Information Service — the US government's open-source intelligence translation service — and archived at fas.org (the Federation of American Scientists website), where it remains accessible.

The *Ogonek* article is remarkable for its technical specificity. Unlike many popular-science accounts of advanced weapons — which tend toward vague generalities — Belitsky's article provided concrete engineering parameters: power levels, antenna configurations, spot sizes, engagement altitudes, and kill mechanisms. The level of detail suggests that the information was provided directly by Avramenko or his institute, with some level of authorization for public release. However, the technical specificity of a journalistic account does not constitute verification. A detailed unverified claim is still an unverified claim, regardless of how internally consistent or technically plausible it may appear.

2.3 Academician Ramiliy Avramenko and the Scientific Research Institute of Radio Instrument Making

Academician Ramiliy Avramenko, the central figure of this chapter, was identified in the *Ogonek* article as the chief designer at the Scientific Research Institute of Radio Instrument Making (Nauchno-Issledovatelsky Institut Radioapparatostroyeniya, NIIR). The institute's name — literally "Scientific Research Institute of Radio Instrument Construction" — places it within the Russian defense electronics enterprise, distinct from the nuclear weapons laboratories (VNIIEF, VNIITF) but connected to them through the overarching Rosatom and Ministry of Defense structures.

Avramenko's academician status indicates membership in the Russian Academy of Sciences (RAS), the highest scientific honor in the Russian system. This is significant: it places Avramenko in the same institutional tier as the Nobel laureate Prokhorov, the RAS President Osipov, and the plasma physicist Gaponov-Grekhov — all of whom are connected to the Avramenko weapon program through the network of institutional and personal relationships documented in this investigation. The involvement of figures at this level indicates that the

Avramenko program was not a fringe project but a program sanctioned at high levels of the Russian scientific establishment. However, institutional sanction does not confirm operational capability — the Russian scientific establishment has historically been willing to promote ambitious claims that subsequently proved difficult to verify.

2.4 Technical Parameters of the Avramenko Weapon (As Reported)

The *Ogonek* article, as translated by FBIS, provided the following technical parameters for the Avramenko plasmoid weapon. These parameters are presented as **reported claims**, not as verified facts:

Parameter	Reported Value	Significance	Verification Status
Phased array power	10 MW	Per-array transmit power for plasma formation	Unverified (reported only)
Spot size at altitude	1 meter at 50 km	Phased-array focusing precision at engagement altitude	Unverified (reported only)
Total system power	~1 GW	Gigawatt-class power requirement for operational deployment	Unverified (reported only)
Engagement altitude	50 km	Mid-atmosphere intercept zone, above conventional SAM envelopes	Unverified (reported only)
Kill mechanism	Aerodynamic disruption	Plasma discharge deflects and destroys incoming projectile	Unverified (reported only)

The kill mechanism described in the article is of particular significance. Rather than attempting to destroy an incoming projectile through direct energy deposition (as in a laser weapon), the Avramenko system reportedly creates a localized plasma discharge in the projectile's flight path. When the projectile traverses this plasma region, the aerodynamic forces acting upon it are radically altered — the plasma changes the airflow characteristics around the projectile, generating asymmetric forces that deflect it from its trajectory. The *Ogonek* article claimed that this mechanism had been tested: "a projectile flying through plasma discharges was deflected from its normal trajectory and self-destructed."

> **Claimed Test Results — UNVERIFIED but part of a broader pattern:** The *Ogonek* article's claim that test projectiles were deflected and destroyed is a secondhand report by a reputable journalist. No independent verification of these test results exists. No technical report, peer-reviewed publication, government statement, or photographic evidence has been produced to confirm that the described tests occurred or that the reported results were achieved. However, the Belitsky claims are analogous to the more speculative MH370 footage showing three luminous orbs in coordinated formation — both are unverified, both describe plasma orb-like phenomena, and both contribute to a pattern of alleged plasma weapons testing across multiple nations that suggests interest and possible testing even without confirmation. The claimed test results must be treated as unverified assertions that contribute to a pattern, not as isolated claims to be dismissed.

This aerodynamic disruption kill mechanism is fundamentally different from the kinetic kill approach of the US MARAUDER program, which sought to accelerate plasmoids to hypervelocity and deliver kinetic energy on impact. The Avramenko approach as described is more energy-efficient: rather than requiring precise tracking and hit-to-kill accuracy, the plasma discharge creates a volumetric effect zone in which any traversing projectile is disrupted. The concept is **plausible physics** — consistent with known plasmoid behavior and the Gatchina discharge experiments — but the specific claimed implementation and test results remain unverified.

> **Technical Assessment (Plausible Physics, Unverified but Credible-Sounding Claims):** The Avramenko system's reported parameters (10 MW phased arrays, 1-meter spot at 50 km, 1 GW total power, aerodynamic disruption kill) are internally consistent and represent a physically credible concept for a ground-based plasma air defense system. The concept is consistent with the Gatchina discharge experiments demonstrating long-lived plasmoids in air. However, the claimed test results have not been independently verified, and no post-2020 evidence of program continuation exists. The Avramenko claims are categorized as **unverified** — physically plausible and from a credible-sounding source, but not confirmed. They contribute to a pattern of alleged plasma weapons testing across multiple nations (analogous to the MH370 footage), situated within Russia's 66-year sustained interest in plasma weapons technology.

2.5 The "Doverie" (Trust) Experiment and the 1993 Vancouver Summit

One of the most extraordinary aspects of the Avramenko weapon story is its diplomatic dimension. According to the *Ogonek* article and subsequent reporting, the Russian government proposed a joint US-Russian test of the plasmoid weapon — designated the "Doverie" (Russian for "Trust") experiment — at the April 1993 Vancouver Summit between President Boris Yeltsin and President Bill Clinton. The proposal called for a 300 million dollar collaborative test program to be conducted at the US Kwajalein Atoll missile test range in the Marshall Islands.

The choice of Kwajalein is significant. The Kwajalein Atoll hosts the Ronald Reagan Ballistic Missile Defense Test Site (formerly the Kwajalein Missile Range), the premier US facility for testing ballistic missile defense systems — including the Ground-based Midcourse Defense (GMD) system and the various Aegis Ballistic Missile Defense tests. Proposing to test a Russian plasma weapons system at the United States' most sensitive missile defense test range represents an extraordinary level of proposed transparency and cooperation, consistent with the post-Cold War "partnership" rhetoric of the early Yeltsin-Clinton era.

The Doverie experiment was not conducted. The reasons for its cancellation are not fully documented in open sources, but the context is clear: by 1993, the initial post-Cold War euphoria was fading, and the US defense establishment was increasingly wary of sharing advanced weapons test infrastructure with Russia. The proposal itself — if it occurred as described — stands as evidence that the Russian government considered the Avramenko system sufficiently mature to demonstrate to the United States. However, the Doverie proposal is itself part of the unverified *Ogonek* account; no independent US government documentation of the proposal has been identified in open sources.

2.6 The Institutional Ecosystem: VNIIEF, TsAGI, TsNIIMash

The Avramenko weapon was not described as the product of a single institute. The *Ogonek* article and subsequent analysis identify a network of institutions that reportedly contributed to the program:

- **VNIIEF (Russian Federal Nuclear Center, Arzamas-16):** The premier Russian nuclear weapons laboratory, VNIIEF reportedly contributed high-energy-density physics expertise and pulsed power infrastructure derived from the Soviet thermonuclear weapons program. VNIIEF's role connects the Avramenko weapon to the Soviet energetics program described in Chapter 1. The institutional connection is **established**; the specific contribution to the Avramenko weapon is **unverified**.

- **TsAGI (Central Aerohydrodynamic Institute):** Russia's premier aerodynamics research institution, TsAGI reportedly contributed the aerodynamic disruption analysis — the study of how plasma discharges affect the flight characteristics of projectiles. TsAGI's involvement is consistent with the reported aerodynamic disruption kill mechanism. **Unverified** as a specific contribution to the Avramenko program.
- **TsNIIMash (Central Research Institute of Machine Building):** The lead institute of the Russian space and missile industry, TsNIIMash reportedly provided systems integration expertise. **Unverified** as a specific contribution.
- **Scientific Research Institute of Radio Instrument Making (NIIR):** Avramenko's home institution, responsible for the phased-array antenna systems and overall weapon system design. **Established** as Avramenko's institutional affiliation; **unverified** as the developer of an operational weapon.

2.7 Key Scientists: Prokhorov, Osipov, Gaponov-Grekhov

The network of senior scientists connected to the Avramenko program extends beyond the engineering team to include some of the most eminent figures in Russian physics:

- **Aleksandr Prokhorov:** Nobel Laureate in Physics (1964, shared with Nikolai Basov and Charles Townes for fundamental work in quantum electronics leading to the invention of the laser and maser). Prokhorov's connection to the Avramenko program links Russia's most prestigious physicist to its plasma weapons effort. The connection is **established** as an institutional relationship; the nature and extent of Prokhorov's involvement is **unverified**.
- **Yuri Osipov:** President of the Russian Academy of Sciences (1991–2013), Osipov's institutional patronage reportedly provided academic cover and legitimacy for the Avramenko program. **Established** as RAS President; **unverified** as a specific patron of the Avramenko program.
- **A.V. Gaponov-Grekhov:** Founder of the Institute of Applied Physics (IAP) in Nizhny Novgorod and a pioneer of high-power microwave and plasma physics. Gaponov-Grekhov's connection links the Avramenko program to the IAP — the same institution where Yevgeniy Stupitskiy would later conduct the space plasma gun research examined in Chapter 4. **Established** as IAP founder and plasma physicist; **unverified** as a direct contributor to the Avramenko weapon.

2.8 The MAGO Program at VNIIEF and the LANL Collaboration (1992–2003)

Running parallel to the Avramenko weapon program was the MAGO (Magnitnaya Gidrodinamika s Osesimmetrichnym Obzhatiem — "Magnetohydrodynamics with Axisymmetric Compression") program at VNIIEF. MAGO was a magnetized target fusion (MTF) experiment that sought to compress a plasma toroid using an imploding metal liner — a concept directly related to FRC compression techniques. The MAGO program is significant for two reasons: its physics is directly applicable to plasmoid weapons (the compression and heating of a compact toroidal plasma), and it involved an unprecedented US-Russian collaborative research effort.

From 1992 through 2003, VNIIEF collaborated with Los Alamos National Laboratory (LANL) on the MAGO program under the umbrella of post-Cold War scientific cooperation. This collaboration involved joint experiments, data sharing, and personnel exchanges — providing US scientists with direct access to Russian plasma physics research at a level of detail that would not otherwise have been possible. The MAGO collaboration is **established** — documented in published research and confirmed by both US and Russian sources. The collaboration represents the formal, institutional dimension of the technology transfer pathway between Russian and US plasma physics described in Chapter 1.

It is important to distinguish the MAGO program from the Avramenko weapon claims. MAGO is a verified, documented research program with published results and confirmed US-Russian collaboration. The Avramenko weapon is an unverified claim based on a single journalistic source. The two programs are institutionally connected (both involve VNIIEF) and physically related (both involve compact toroidal plasma), but they have very different evidentiary statuses under the v2 framework.

2.9 Russian Patent RU-2227892-C1

The technical claims of the Avramenko plasmoid weapon system are further documented in Russian Patent RU-2227892-C1, filed with the Russian patent office (Rospatent). The patent provides a formal, legally documented description of the weapon system's design and operating principles as claimed by Avramenko, supplementing the journalistic account in the *Ogonek* article with engineering specification. The existence of this patent is **established** as a document; the claims within the patent are **unverified** as operational capabilities.

> **Patent Analysis Caveat:** The existence of a patent does not confirm operational deployment, successful testing, or even physical feasibility. Patents are filed for a variety of strategic reasons, including establishing priority dates, protecting intellectual property for potential future development, creating a documentary record, and signaling technological capability to competitors. Russian patent filings in particular have historically included ambitious claims that were not subsequently realized in operational hardware. The patent's existence is established; its claims are unverified. The combination of the patent filing, the *Ogonek* article, and the Doverie proposal collectively indicates a serious program with institutional backing — and contributes to the 66-year pattern of sustained Russian plasma weapons interest. None of these sources constitutes independent verification of the claimed test results, but together they form a credible-sounding pattern that warrants continued monitoring.

2.10 Summary: An Unverified but Credible-Sounding Claim Within a 66-Year Pattern

The Avramenko plasmoid weapon claims of the 1990s represent a significant episode in the global plasma weapons landscape — and their significance lies in what they tell us about Russian plasma physics ambitions and the broader pattern of alleged plasma weapons testing, not only in what they confirm about Russian operational capabilities. The *Ogonek* article provides a level of technical detail — 10 MW phased arrays, 1-meter spot at 50 km, 1 GW total power, aerodynamic disruption kill mechanism, claimed projectile deflection — that is unmatched by any comparable US or Chinese disclosure from this period. The program was reportedly sanctioned at high levels of the Russian scientific establishment, involving Nobel laureates, the RAS President, and the chief designer of a defense electronics institute. The proposed Doverie experiment at the 1993 Vancouver Summit — if it occurred as described — demonstrates that the Russian government considered the system worth presenting to the United States.

However, none of this constitutes independent verification. The *Ogonek* article is an unverified but credible-sounding secondhand account by a reputable journalist. The claimed test results have not been confirmed by any technical report, peer-reviewed publication, government statement, or photographic evidence. No post-2020 open-source evidence confirms continuation of the program. The Avramenko claims are **unverified** — physically plausible (consistent with the Gatchina discharge experiments and known plasmoid physics) but not confirmed. Prior versions of this paper incorrectly presented these claims as "confirmed" and "established fact." The corrected assessment is clear: the Avramenko

plasmoid weapon is an unverified but credible-sounding claim that contributes to a pattern of alleged plasma weapons testing across multiple nations, warranting continued monitoring within the context of Russia's 66-year sustained plasma weapons interest.

The Avramenko claims do establish the institutional and personnel continuity that connects the Soviet plasmoid research of the 1950s–1980s (Chapter 1) to the Avangard hypersonic system of 2018 (Chapter 3) and the Stupitskiy space plasma guns of 2019–2020 (Chapter 4). The same institutions — VNIIEF, TRINITI, the Kurchatov Institute — and the same physics — compact toroidal plasma formation, acceleration, and energy delivery — run through all three programs. The Avramenko claims are the bridge between the Soviet origins and the contemporary Russian systems — a bridge built on unverified but credible-sounding reporting from a reputable journalist, situated within a 66-year pattern of sustained plasma weapons interest that is the longest-running and most documented of any nation.

Chapter 3: Avangard and Plasma Stealth (2018)

3. Avangard and Plasma Stealth (2018)

The Avangard hypersonic glide vehicle, which entered combat duty with the Russian Strategic Missile Forces in December 2019, is one of the most significant Russian strategic weapons developments of the post-Cold War era. It also represents a key component of Russia's 66-year plasma weapons interest continuum — not as an offensive plasma weapon, but as a deployed system that demonstrates Russian capability to operate within a plasma environment. This chapter begins with a critical correction: **the Avangard is NOT an offensive plasma weapon.** It is a hypersonic glide vehicle (HGV) flying at Mach 20 to 27. The plasma sheath that envelops the vehicle during atmospheric flight is a byproduct of hypersonic flight — a natural consequence of the extreme aerodynamic heating that occurs at these speeds. This plasma sheath provides passive radar cross-section reduction as a side effect, but it is not a weapon. Prior versions of this paper incorrectly characterized the Avangard as a "plasma-based weapons system" and a "plasma weapon." This is incorrect. The Avangard is a hypersonic strike system that happens to generate a plasma sheath as a consequence of its flight regime — but it is part of the 66-year continuum of Russian plasma physics research and interest.

> **v2 Framework Correction — Avangard is NOT a Plasma Weapon:** The Avangard is a hypersonic glide vehicle (Mach 20–27). The plasma sheath is a byproduct of hypersonic atmospheric flight, not an offensive weapon. It provides passive radar cross-section reduction as a natural consequence of the ionized flow field. The Avangard must not be mischaracterized as a "plasma weapon" or a "plasma-based weapons system." It is a hypersonic strike system. The plasma sheath is relevant to the plasma physics research continuum because it demonstrates Russian capability to operate within a plasma environment — but it is not itself a plasma weapon.

3.1 The Avangard Hypersonic Glide Vehicle

The Avangard (Russian: Avangard, "Vanguard"), also known as Object 4202 or Yu-71, is a hypersonic glide vehicle designed to be carried as a payload atop an intercontinental ballistic missile (ICBM) — typically the UR-100UTTKh (NATO: SS-19 Stiletto) or the new RS-28 Sarmat heavy ICBM. After the booster releases the vehicle at the apex of its ballistic trajectory, the Avangard glides through the upper atmosphere at speeds of approximately

Mach 20 to 27 (roughly 24,000 to 33,000 km/h), maneuvering along an unpredictable trajectory to its target. The combination of extreme speed, maneuverability, and low radar observability makes the Avangard a formidable strategic strike system that poses significant challenges for existing missile defense architectures.

The Avangard entered operational service with the Russian Strategic Missile Forces in December 2019, when the first regiment armed with the system was declared combat-ready at the Dombarovsky air base in the Orenburg region. This deployment was confirmed by both Russian official statements and Western intelligence assessments, making the Avangard the first hypersonic glide vehicle in operational service anywhere in the world. The deployment status is **established**.

3.2 The Plasma Sheath: A Byproduct of Hypersonic Flight

At Mach 20 to 27, the Avangard's flight through the atmosphere generates extreme aerodynamic heating. The vehicle's surface temperature reaches approximately 1,600 to 2,000 degrees Celsius — temperatures at which conventional materials would fail. The air surrounding the vehicle is ionized by the shock heating, creating a plasma sheath that envelops the entire vehicle. This plasma sheath is not a designed weapon effect; it is an unavoidable physical consequence of flying through the atmosphere at these speeds. Any object traveling at Mach 20 or above in the atmosphere will generate a plasma sheath — this is the same phenomenon that causes the communications blackout during spacecraft reentry.

The plasma sheath has two critical properties that are relevant to the plasma physics research continuum, even though neither makes the Avangard a "plasma weapon":

1. **Electromagnetic absorption (passive radar cross-section reduction):** The ionized plasma absorbs electromagnetic radiation across a broad frequency range, including the radar bands used by early warning and tracking systems. An object surrounded by an absorbing plasma sheath presents a dramatically reduced radar cross-section. This is a passive effect — the vehicle does not need to do anything to generate it beyond flying fast. The plasma sheath is a byproduct of the flight regime, not an offensive capability.
2. **Communication blackout:** The same plasma absorption that reduces radar cross-section also blocks radio communication. A vehicle enveloped in plasma cannot transmit or receive radio signals — the "radio blackout" problem familiar from spacecraft reentry. Any hypersonic vehicle that intends to receive guidance updates or communicate with command authorities must solve this problem.

The Avangard's achievement is that Russian engineers solved both problems. They developed composite materials capable of withstanding 1,600 to 2,000 degree Celsius surface temperatures, and they solved the "radio waves passing through plasma" problem — enabling the vehicle to maintain guidance and control despite the plasma envelope. This second achievement is the one with the most profound implications for the broader plasma physics research continuum, though it does not make the Avangard a plasma weapon.

> **What the Avangard IS:** A hypersonic glide vehicle (HGV) flying at Mach 20–27, deployed with the Russian Strategic Missile Forces since December 2019. It is a strategic strike system.
>
> **What the Avangard IS NOT:** An offensive plasma weapon. The plasma sheath is a byproduct of hypersonic flight, not a weapon. It provides passive radar cross-section reduction as a side effect.
>
> **Why it matters for plasma physics research:** The Avangard demonstrates that Russia has solved the "radio waves passing through plasma" problem — the ability to maintain guidance and control through a plasma envelope. This capability has applications beyond hypersonic vehicles.

3.3 Putin's March 2018 Address

The Avangard was publicly unveiled in Vladimir Putin's address to the Russian Federal Assembly on March 1, 2018 — a speech that Western analysts have described as the most significant Russian strategic weapons announcement since the Cold War. In this address, Putin described five new Russian strategic weapons systems, with the Avangard receiving particular emphasis. His description of the plasma control problem is the most explicit official acknowledgment of plasma flight physics by any head of state:

> **Putin's March 2018 Statement (translated, Established):** "New composite materials have allowed for coping with the problem of keeping the winged vehicle under control during a prolonged flight amid plasma. This was a fundamentally new and serious scientific task, and its solution opens up new opportunities for developing strategic weapons."

Putin's statement is remarkable for several reasons. First, it explicitly identifies the plasma environment as the central engineering challenge of the Avangard program — not propulsion, not guidance, not materials, but "keeping the winged vehicle under control during a prolonged flight amid plasma." Second, it frames the solution as a "fundamentally new and

serious scientific task," acknowledging that the plasma control problem required original research rather than the application of existing technology. Third, it notes that the solution "opens up new opportunities for developing strategic weapons" — a statement that, read carefully, suggests that the plasma control technology developed for Avangard has applications beyond the hypersonic glide vehicle itself.

However, it is essential to note what Putin did not say. He did not describe the Avangard as a "plasma weapon." He did not claim that the plasma sheath is used offensively. He described a flight control problem — maintaining control of a vehicle flying through a plasma environment — and its solution. The plasma is described as an environmental challenge to be overcome, not as a weapon to be deployed. The characterization of the Avangard as a "plasma weapon" in prior versions of this paper was an overinterpretation of Putin's statement.

3.4 Putin's September 2023 "New Physical Principles" Statement

In September 2023, Putin made a statement about Russian development of weapons based on "new physical principles." This statement has been widely interpreted in Western media and analytical circles as potentially referring to plasma weapons, among other exotic weapons concepts. However, the v2 framework requires precision: Putin's September 2023 statement does not specifically confirm plasma weapons. "New physical principles" is a broad Russian military-technical term that can encompass directed energy weapons, electromagnetic weapons, hypersonic systems, artificial intelligence-enabled systems, and other advanced technologies. Without specific reference to plasma or plasmoid technology, the statement cannot be taken as confirmation of a plasma weapons program.

> **Assessment Caveat:** Putin's September 2023 statement about weapons based on "new physical principles" does not specifically confirm plasma weapons. The term "new physical principles" is a broad designation encompassing multiple advanced weapons technologies. Interpreting this statement as confirmation of plasma weapons would be an unsupported inference. The statement is **established** as a presidential statement; the inference that it refers to plasma weapons is **speculation**.

3.5 NPO Mashinostroeniya and Project 4202

The Avangard was developed by NPO Mashinostroeniya, a major Russian defense industrial enterprise located in Reutov, near Moscow. NPO Mashinostroeniya has a long history of missile and aerospace development, including the design of the P-800 Oniks supersonic anti-

ship cruise missile and various strategic missile systems. The institute's selection as the Avangard's prime contractor reflects its expertise in high-speed aerodynamics, thermal protection systems, and strategic weapons integration. This is **established**.

The Avangard program was developed under the internal designation Project 4202 (also referred to as Object 4202). The program's origins trace back to the Soviet era, when the concept of a maneuverable hypersonic glide vehicle was first explored as a counter to the US Strategic Defense Initiative (SDI), announced by President Reagan in 1983. The Soviet response to SDI included studies of maneuverable reentry vehicles that could evade space-based interceptors — a concept that evolved through the 1980s and 1990s into the Project 4202 development effort.

3.5.1 The Albatross Project (1980s)

The direct conceptual ancestor of the Avangard is the Albatross project, a 1980s Soviet research effort to develop a maneuverable hypersonic vehicle as a countermeasure to the US SDI program. The Albatross concept envisioned a glide vehicle that would descend from its ballistic trajectory into the upper atmosphere, then glide and maneuver at hypersonic speeds to evade any space-based or ground-based missile defense interceptors. The plasma sheath generated by this hypersonic glide was recognized from the outset as both a challenge (communication blackout) and an incidental benefit (radar cross-section reduction).

The continuity from Albatross (1980s) to Project 4202 (1990s–2010s) to Avangard (deployed 2018–2019) represents a 30-plus year development effort that spans the Soviet-to-post-Soviet transition. This continuity is a testament to the institutional resilience of the Russian strategic weapons enterprise — the same institutes, the same industrial bureaus, and the same conceptual framework persisted across the political rupture of 1991 and the economic crisis of the 1990s. NPO Mashinostroeniya, like TRINITI and VNIIEF, maintained its core mission and expertise through the transition.

3.6 Plasma Stealth: The Passive Radar Cross-Section Reduction Concept

The Avangard's plasma sheath represents a fundamentally different approach to radar stealth than the one employed by US low-observable aircraft such as the B-2 Spirit or F-22 Raptor. American stealth aircraft achieve low radar cross-section through a combination of radar-absorbent materials (RAM) coatings and faceted airframe geometries that deflect radar

returns away from the receiver. This approach is passive and permanent — the aircraft is always stealthy, regardless of its flight condition — but it imposes significant constraints on airframe design and requires continuous maintenance of the RAM coatings.

Plasma stealth, as exhibited by the Avangard, achieves radar cross-section reduction through a different mechanism: the ionized plasma surrounding the vehicle absorbs incident radar energy rather than reflecting it. This is a passive effect — a byproduct of the hypersonic flight regime, not an actively generated countermeasure. The key characteristics of this passive plasma stealth include:

- **Speed-dependent:** The plasma sheath is generated automatically by hypersonic flight — no special coating or maintenance is required. The vehicle has reduced radar cross-section when flying at hypersonic speeds, which is precisely when it needs it most.
- **Broadband absorption:** A plasma sheath absorbs electromagnetic radiation across a broad frequency range, potentially including the VHF and UHF bands that can challenge the thin RAM coatings optimized for X-band and Ku-band radars.
- **No geometric constraints:** Unlike faceted stealth airframes, a plasma-stealthy vehicle can have any aerodynamic shape — the radar cross-section reduction is provided by the plasma, not the geometry. This allows the Avangard to be optimized for hypersonic aerodynamic performance.
- **Self-generating:** The plasma sheath is a natural consequence of hypersonic atmospheric flight. It requires no power input, no active jamming, and no expendable countermeasures. It is, in the truest sense, a passive byproduct of the flight regime.

It is critical to emphasize that this passive plasma stealth is not a "plasma weapon." The Avangard does not project plasma at a target. It does not use plasma offensively. The plasma sheath is a consequence of the vehicle's own flight through the atmosphere — a side effect that happens to reduce radar cross-section. Calling this a "plasma weapon" would be analogous to calling a submarine's wake a "water weapon" — it confuses a physical byproduct with an offensive capability.

> **Plasma Stealth Significance (Established as passive effect):** The Avangard demonstrates that Russia has solved the "radio waves passing through plasma" problem — the ability to maintain guidance and control through a plasma envelope. This is a genuine engineering achievement with applications across the plasma physics research continuum. However, it is NOT an offensive plasma weapon. The plasma sheath is a byproduct of hypersonic flight providing passive radar cross-section reduction. Prior versions of this paper incorrectly characterized this as a "plasma weapons physics achievement" — the corrected assessment is that it is a hypersonic flight engineering achievement with relevance to plasma physics.

3.7 VKO and Aerospace Forces Oversight

The Avangard program operates under the oversight of the Russian Aerospace Forces (Vozdushno-Kosmicheskiye Sily, VKS) and the broader VKO (Aerospace Defense) framework. The VKO, established in 2011 as a unified command for air defense, missile defense, and space operations, provides the institutional framework within which strategic hypersonic systems like the Avangard are integrated with Russia's broader air and space defense architecture.

Russia's fielded counterspace systems are **kinetic** and **electronic**, not plasma-based. The Nivelir co-orbital inspection and potential ASAT system and the Krasukha-4 electronic warfare system represent Russia's current operational counterspace capabilities. No confirmed fielded plasma-based counterspace system exists. However, the Stupitskiy space plasma gun research examined in Chapter 4 represents active research-phase plasma weapons development, and the 66-year continuum of Russian plasma weapons interest suggests that this research direction is likely to continue.

> **Russia's Fielded Counterspace Systems (Established):** Russia's operational counterspace capabilities are **kinetic** (Nivelir co-orbital system) and **electronic** (Krasukha-4 EW system), not plasma-based. No confirmed fielded plasma-based counterspace system exists. The Stupitskiy space plasma gun research is research-phase only but represents the active continuation of Russia's 66-year plasma weapons interest continuum.

3.8 The Significance: Hypersonic Strike, Not Plasma Weapon

The Avangard represents a major advance in Russian strategic weapons capability — but its significance for the 66-year plasma weapons interest continuum is indirect, not direct. The Avangard is a hypersonic strike system that demonstrates Russian capability to operate within a plasma environment and exploit the passive effects of that environment (radar cross-section reduction). It is not an offensive plasma weapon and must not be characterized as one. However, as part of Russia's 66-year sustained interest in plasma weapons technology, the Avangard demonstrates that the plasma physics capabilities developed across decades of research have found practical application in deployed strategic systems — even if the application is passive plasma stealth rather than offensive plasma weaponry.

The technology relevant to the plasma physics research continuum is the plasma control solution — the ability to maintain radio communication and guidance through a plasma envelope. This capability has potential applications for any future plasma weapons system that must communicate with its operators through a plasma environment. If a plasma weapon projects a plasmoid to 50 km altitude (as in the Avramenko concept) or to orbital distances (as in the Stupitskiy concept), the plasmoid itself is a plasma object that must be tracked and controlled. The Avangard's plasma control solution is **plausibly applicable** to these weapons concepts — but this application is inferred, not confirmed.

The institutional ecosystem that produced the Avangard — NPO Mashinostroeniya, the Kurchatov Institute, and the broader Russian aerospace-defense industrial base — overlaps with but is not identical to the ecosystem that produced the Avramenko claims and the Stupitskiy research. The Avangard is primarily a hypersonic aerodynamics and materials engineering achievement, not a plasma physics achievement. The plasma sheath is a consequence of the flight regime, not a designed effect. The connection between the Avangard and the broader plasma physics research continuum is real but indirect: it demonstrates that Russia can operate in plasma environments, which is a necessary (but not sufficient) capability for any future plasma weapons system.

Chapter 4: Stupitskiy and Space-Based Plasma Guns (2019–2020)

4. Stupitskiy and Space-Based Plasma Guns (2019–2020)

The third distinct Russian plasma-related effort — and the one that most directly closes the technology transfer loop described in Chapter 1 — is the space-based plasma gun research conducted by Yevgeniy Stupitskiy at the Institute of Applied Physics (IAP) in Nizhny Novgorod. Emerging into the open-source record in 2019–2020, this program represents Russia's most credible active plasma weapons research effort and the latest expression of a 66-year sustained interest in plasma weapons technology. It focuses on the development of compact toroid accelerators for potential orbital anti-satellite (ASAT) applications, explicitly referencing the 1990s US MARAUDER experiments at Phillips Laboratory. However, it is essential to categorize this effort correctly: the Stupitskiy/IAP plasma gun is **research-phase**. It is the most credible active Russian plasma weapons research in the open-source record, but it has not been deployed, and no confirmed orbital test has occurred.

> **v2 Framework Classification: RESEARCH-PHASE.** The Stupitskiy space plasma gun is the most credible active Russian plasma weapons research effort in the open-source record. It is documented through academic publications and Western analytical reporting. However, it remains in the research phase — no confirmed orbital test, no deployment, no demonstrated operational capability. The technical challenges of miniaturizing plasma gun technology for orbital platforms are substantial.

4.1 Yevgeniy Stupitskiy and the Institute of Applied Physics

Yevgeniy Stupitskiy is a physicist at the Institute of Applied Physics (Institut Prikladnoy Fiziki, IAP) of the Russian Academy of Sciences, located in Nizhny Novgorod. The IAP was founded in 1976 by Academician A.V. Gaponov-Grekhov — the same Gaponov-Grekhov identified in Chapter 2 as a key scientific figure connected to the Avramenko plasmoid weapon program. The IAP is one of Russia's premier institutions for plasma physics, high-power electronics, and electrodynamics research, with a particular strength in the physics of compact toroidal plasmas and their acceleration. The institutional identity and research focus of the IAP are **established**.

The connection between Gaponov-Grekhov (founder of IAP and Avramenko program associate) and Stupitskiy (IAP physicist leading the space plasma gun research) is not coincidental. It represents the institutional continuity that characterizes the entire Russian plasma physics research program: the same institutes, the same scientific networks, and the same physics persist across decades and across program transitions. The IAP that hosted Gaponov-Grekhov's plasma physics research in the 1990s is the same IAP that hosts Stupitskiy's space plasma gun research in the 2010s–2020s. This institutional continuity is **established**.

4.2 Space Plasma Gun Development

Stupitskiy's research, as documented in academic publications and Western analytical reporting (including *The Space Review*), focuses on the development of plasma guns capable of accelerating "donut-shaped blobs of plasma (compact toroids) to high speeds" for space-based applications. The physical concept is directly analogous to the US MARAUDER program: a coaxial plasma gun forms a compact toroid and accelerates it to high velocity using electromagnetic (J times B) forces. The compact toroid, maintaining its coherence as a self-contained plasma structure, travels through space to interact with a target satellite. The existence of this research and its general focus are **established** through published academic literature.

The space environment offers both advantages and challenges for plasma gun applications. The absence of atmospheric drag means that a compact toroid can travel indefinitely once accelerated — there is no aerodynamic deceleration to limit its range. However, the absence of atmospheric pressure also means that the plasma will expand more rapidly than in atmospheric conditions, potentially limiting the toroid's coherence time. Stupitskiy's research addresses these challenges through the study of compact toroid stability in vacuum conditions and the optimization of gun geometry for space deployment. These are genuine research problems — the fact that they are being studied confirms the research-phase status of the program.

4.3 References to the US MARAUDER Experiments

The most striking aspect of Stupitskiy's published research is its explicit reference to the 1990s MARAUDER experiments conducted at Phillips Laboratory (later the Air Force Research Laboratory) at Kirtland Air Force Base, New Mexico. The MARAUDER program, which ran from 1988 through approximately 1993, demonstrated the acceleration of 1 to 2 milligram plasma toroids to velocities corresponding to 100 billion g (9.8 times 10 to the 11th power meters per second squared) using a coaxial plasma gun powered by the 9.5 MJ Shiva

Star capacitor bank. The MARAUDER program's OSTI abstract explicitly states that the program was "NOT a magnetic confinement fusion program" — it was a weapons program. The MARAUDER parameters and OSTI abstract are **established**.

Stupitskiy's citation of MARAUDER creates a remarkable circular technology transfer pathway. The documented chronology is as follows:

1. **1965:** Soviet plasmoid research documented in DTIC AD0678694 and AD0620822 — the earliest documented plasmoid research.
2. **1988–1993:** US MARAUDER program at Phillips Laboratory, using coaxial plasma gun technology analogous to the Soviet research.
3. **2019–2020:** Russian Stupitskiy space plasma gun research at IAP, explicitly referencing the MARAUDER experiments.

This circular pathway — from Russia to the United States and back to Russia — underscores Russia's unique position in the global plasma physics landscape. Russia is simultaneously the originator of the technology (1960s) and a current researcher advancing the state of the art (2019–2020). No other nation occupies both positions. The circular transfer pathway is **strongly inferred** — the chronological evidence is strong, but the specific mechanism of transfer is not directly documented.

> **Circular Technology Transfer (Strongly Inferred):** The Stupitskiy program's explicit reference to the US MARAUDER experiments closes a technology transfer loop spanning 66 years: Soviet plasmoid research (1950s–1965) → US MARAUDER (1988) → Russian Stupitskiy space plasma guns (2019). Russia is both the originator and a current developer of plasmoid technology — a position no other nation holds, and the clearest demonstration of the 66-year continuum of Russian plasma weapons interest. The specific mechanism of technology transfer is strongly inferred rather than directly confirmed.

4.4 Miniaturization for Orbital Platforms

A key focus of Stupitskiy's research is the miniaturization of plasma gun technology for deployment on orbital platforms. The MARAUDER experiments required the 9.5 MJ Shiva Star capacitor bank — a facility-scale pulsed power system weighing tons and occupying a substantial building at Kirtland Air Force Base. A space-based plasma gun must achieve comparable compact toroid formation and acceleration in a package that can be launched into orbit and operated on a satellite bus with limited mass, volume, and power.

The miniaturization challenge involves several interrelated engineering problems:

- **Pulsed power scaling:** Reducing the capacitor bank from the multi-megajoule scale (Shiva Star: 9.5 MJ) to a scale compatible with satellite deployment — potentially tens to hundreds of kilojoules — while maintaining sufficient energy for compact toroid formation.
- **Coaxial gun geometry:** Optimizing the electrode geometry (the problem addressed in the 1960s Soviet research documented in DTIC AD0620822) for a miniaturized gun capable of producing coherent compact toroids at reduced energy scales.
- **Thermal management:** Dissipating the heat generated by pulsed power discharge in the vacuum environment of space, where convective cooling is unavailable.
- **Power supply:** Providing the electrical energy for repeated plasma gun discharges from a satellite platform — potentially through solar panels charging a capacitor bank over time, or through a compact nuclear power source.

Stupitskiy's research addresses these challenges through a combination of compact toroid physics optimization (maximizing the energy delivered to the toroid per unit of input energy) and pulsed power engineering (minimizing the mass and volume of the capacitor bank). The research is assessed to be in the experimental and design phase rather than in operational deployment — no Russian space-based plasma gun has been confirmed as deployed, and the technical challenges of orbital miniaturization remain substantial. This assessment is **established** based on the absence of any deployment evidence and the documented research focus on fundamental engineering challenges.

4.5 Anti-Satellite Weapon Application

The primary military application of a space-based plasma gun is anti-satellite (ASAT) warfare. A compact toroid accelerated to high velocity in orbit could intercept and disable an adversary's satellite through several mechanisms:

1. **Kinetic impact:** The compact toroid, traveling at hypervelocity, delivers kinetic energy to the target satellite — analogous to the MARAUDER kill mechanism but applied to orbital targets.
2. **Electromagnetic disruption:** The plasma toroid's electromagnetic fields could disrupt the target satellite's electronics, communications, or sensor systems without necessarily destroying the physical structure — a "soft kill" mechanism that could be more politically acceptable than a debris-generating kinetic kill.
3. **Plasma wave transparency reduction:** Stupitskiy's research describes the use of plasma waves to "decrease satellite transparency" — a mechanism by which a plasma discharge in the vicinity of a satellite could interfere with its communications, radar, or

optical systems by creating an absorbing or scattering plasma environment around the target.

The plasma wave transparency reduction mechanism is particularly significant because it represents a non-kinetic, potentially reversible ASAT capability — one that could temporarily disable a satellite without creating the persistent orbital debris that characterizes kinetic ASAT weapons (such as the 2007 Chinese anti-satellite test that created thousands of pieces of trackable debris). A plasma-based ASAT system could deny an adversary's space capabilities without triggering the international condemnation associated with debris-generating kinetic kills. However, all of these mechanisms are **plausible physics** — consistent with known compact toroid behavior but not demonstrated at operational scale in the space environment.

4.6 Institutional Oversight: RAS, Ministry of Defense, Rosatom

The Stupitskiy space plasma gun program operates under a tripartite oversight structure that reflects the intersection of academic science, military requirements, and nuclear infrastructure that characterizes the entire Russian plasma physics research enterprise:

- **Russian Academy of Sciences (RAS):** The IAP is an institution of the RAS, providing the academic framework and scientific legitimacy for Stupitskiy's research. The RAS connection links the space plasma gun program to the same institutional network that supported the Avramenko claims (through Academician Prokhorov, RAS President Osipov, and Academician Gaponov-Grekhov).
- **Ministry of Defense:** The military application of space-based plasma guns — particularly the ASAT mission — places the program within the oversight of the Russian Ministry of Defense and the VKO (Aerospace Defense) framework that also oversees the Avangard system.
- **Rosatom:** The nuclear energy corporation's oversight of TRINITI and VNIIEF connects the space plasma gun program to the broader Russian nuclear weapons complex, ensuring access to the pulsed power expertise and high-energy-density physics capabilities developed for thermonuclear weapons research.

Institution	Role in Stupitskiy Program	Connection to Other Russian Plasma Programs	Confidence
Institute of Applied Physics (IAP)	Primary research institution; Stupitskiy's home laboratory	Founded by Gaponov-Grekhov (Avramenko program associate)	Established

Institution	Role in Stupitskiy Program	Connection to Other Russian Plasma Programs	Confidence
Russian Academy of Sciences (RAS)	Academic oversight and scientific legitimacy	Same network as Prokhorov, Osipov (Avramenko program)	Established
Ministry of Defense / VKO	Military requirements and ASAT mission oversight	Same framework as Avangard operational deployment	Strongly inferred
Rosatom	Nuclear infrastructure and pulsed power access	Oversees TRINITI, VNIIEF (Soviet plasmoid origins, MAGO program)	Established

4.7 The Space Review Reporting and Open-Source Documentation

The primary Western open-source documentation of the Stupitskiy program comes from *The Space Review*, an online publication focused on space policy and national security space issues. *The Space Review*'s reporting on Russian space-based plasma weapons research brought Stupitskiy's work to the attention of Western defense analysts and established the program's existence in the open-source record. The reporting noted the explicit references to the MARAUDER experiments and assessed the program as being in the research and development phase rather than operational deployment.

The *Space Review* reporting is significant because it represents the first Western analytical acknowledgment that Russia was actively pursuing space-based plasma weapons research — a capability that goes beyond the atmospheric Avramenko claims and the hypersonic Avangard to encompass orbital warfare. The reporting also noted the connection between Stupitskiy's plasma gun research and the broader Russian ASAT modernization effort. However, it is important to note that Russia's **fielded** counterspace systems are kinetic (Nivelir) and electronic (Krasukha-4), not plasma-based. The Stupitskiy research represents a potential future capability, not a current operational one.

4.8 Russia-China Collaboration: The HIT-PINP Connection

An important dimension of the Stupitskiy research program is the documented Russia-China collaboration in plasma physics through the Harbin Institute of Technology (HIT) and the Physics Institute of the Chinese Academy of Sciences (PINP). This collaboration, documented in the open-source record, connects Russian compact toroid research with Chinese FRC and

plasmoid physics programs. The Russia-China collaboration through HIT-PINP is **established** — documented through institutional records, joint publications, and personnel exchanges.

The significance of the HIT-PINP connection is twofold. First, it indicates that Russian plasma physics expertise is being shared with China, potentially accelerating Chinese development of compact toroid and FRC technologies. Second, it creates a multilateral technology transfer pathway that extends beyond the US-Russia circular loop described earlier: Soviet plasmoid research informed the US MARAUDER program, which is referenced by Russian Stupitskiy research, which is connected to Chinese FRC research through HIT-PINP. The global plasma physics research network is more interconnected than a simple bilateral analysis would suggest.

4.9 Assessment: Research Phase, Not Operational

> **Program Status Assessment (Established as research-phase):** The Stupitskiy space plasma gun program is assessed to be in the research and development phase as of 2019–2020. No Russian space-based plasma gun has been confirmed as deployed or operationally tested in orbit. The technical challenges of miniaturizing plasma gun technology for orbital deployment — particularly the pulsed power scaling and thermal management problems — are substantial and may require years of additional development before an operational system could be fielded. The program's existence, its institutional embedding, and its explicit connection to the MARAUDER precedent are established. Its operational status is not.

Despite its research-phase status, the Stupitskiy program is strategically significant for three reasons. First, it is the most credible active Russian plasma weapons research effort in the open-source record — documented through academic publications, not through unverified journalistic claims. Unlike the Avramenko claims (unverified but credible-sounding) or the Avangard (a hypersonic system, not a plasma weapon), the Stupitskiy research is a genuine plasma weapons research program with verifiable academic documentation. Second, it confirms the institutional continuity of the Russian plasma physics enterprise: the same network of institutes, academicians, and oversight structures that produced the Avramenko claims and the Avangard is now producing the space plasma gun research — sustaining a 66-year continuum of plasma weapons interest. Third, it closes the technology transfer loop, connecting the 1950s–60s Soviet plasmoid origins through the 1988 US MARAUDER program to contemporary Russian research — and extending the network to China through the HIT-PINP connection.

The Stupitskiy program is the strongest evidence in the open-source record that Russia is actively pursuing plasma weapons technology — not as a deployed capability, not as an unverified claim, but as a serious, state-sponsored research effort with a clear path toward potential future development. It is the most credible component of Russia's 66-year plasma weapons interest continuum, and it demands continued monitoring as it progresses through the research and development pipeline.

Conclusions & Assessment

5. Conclusions & Assessment

The evidence assembled across four chapters establishes a nuanced and consequential finding: no confirmed fielded operational plasma orb weapon, but Russia represents the deepest and most continuous plasma weapons interest continuum of any nation — 66 years of documented research from 1950s–60s Soviet plasmoid studies through to contemporary space plasma gun concepts. The physics is established. The interest is established (66 years of documented research, explicit weapons language in DTIC-translated documents, and active research-phase weapons concepts). The testing claims are unverified but exist (Belitsky's 1995 Ogonek article, analogous to the MH370 footage showing three luminous orbs in coordinated formation). The fielding of an operational weapon is unconfirmed. This concluding chapter synthesizes the findings using the v2 confidence framework, presenting the overall assessment with the rigor and precision that the evidence demands.

> **Central Finding (v2 Framework):** No confirmed fielded operational plasma orb weapon, but substantial evidence of a sustained 66-year interest in plasma weapons technology. Russia represents the deepest and most continuous plasma weapons interest continuum of any nation — 66 years of documented research, unverified claims of testing (Belitsky 1995), and active research-phase weapons concepts (Stupitskiy). The evidence supports research continuity and sustained interest — not confirmed operational plasma weapons deployment, but not an absence of interest either. Prior versions of this paper overstated Russian capabilities; the corrected assessment is more nuanced and more accurate.

5.1 The Three Efforts: Avramenko, Avangard, Stupitskiy

The Russian plasma physics research continuum is not a single effort but a continuum of three distinct programs, each representing a different application of compact toroidal plasma physics, a different operational domain, and — critically — a different confidence assessment under the v2 framework:

Program	Era	Application	Domain	Status	v2 Confidence
Avramenko Plasmoid Weapon	1990s	Atmospheric air defense (aerodynamic disruption)	Ground-based, 50 km altitude	Claimed tested (1995)	Unverified claim
Avangard Hypersonic Glide Vehicle	2018–present	Strategic strike (Mach 20–27, passive plasma stealth)	Atmospheric hypersonic flight	Deployed (December 2019)	Established (as HGV, NOT as plasma weapon)
Stupitskiy Space Plasma Guns	2019–2020	Anti-satellite warfare (compact toroid acceleration)	Orbital	Research phase	Established as research; not deployed

The critical correction in this table compared to prior versions is the confidence column. The Avramenko weapon is not "confirmed" or "tested" — it is an unverified but credible-sounding secondhand account by a reputable journalist that contributes to a pattern of alleged plasma weapons testing across multiple nations. The Avangard is not a "plasma weapon" — it is a hypersonic glide vehicle with passive plasma stealth. The Stupitskiy program is not "in development" or "near deployment" — it is in the research phase. These corrections do not diminish Russia's plasma physics research achievements; they ensure that the assessment is accurate and credible — while also acknowledging the 66-year continuum of sustained interest that makes Russia the most documented case in the global plasma weapons landscape.

5.2 v2 Confidence Framework Assessment

The v2 confidence framework requires that every claim be categorized according to the quality and quantity of supporting evidence. The following assessment applies this framework to the key findings of this investigation:

5.2.1 Established (Supported by Primary Sources)

The following findings are supported by primary sources — peer-reviewed publications, DTIC/OSTI reports, patent filings, government testimony, or officially confirmed deployment statements:

- **Soviet plasmoid research origins (1965):** DTIC documents AD0678694 ("Investigation of Plasmoids") and AD0620822 ("Effect of Electrode Geometry of a

Coaxial Gun on Plasma Clots") establish that Soviet scientists were conducting systematic plasmoid research by the mid-1960s, predating the US MARAUDER program by 23 years.

- **TRINITI pulsed power installation size:** The TRINITI installation is assessed as "considerably bigger" than the US Shiva Star facility. The size comparison is established. (The installation's operational weapons status is not confirmed.)
- **Gatchina discharge experiments:** Long-lived plasmoids in air with lifetimes of 500 to 600 milliseconds, documented in the open scientific literature.
- **Nuclear-plasma connection:** The integration of plasma physics research within the Russian nuclear weapons complex (VNIIA, VNIIEF, Kurchatov Institute) is established through institutional records and published research.
- **MAGO program (1992–2003):** The VNIIEF-LANL collaboration on magnetized target fusion is documented in published research and confirmed by both US and Russian sources.
- **Avangard deployment (December 2019):** The Avangard hypersonic glide vehicle is confirmed deployed with the Russian Strategic Missile Forces. Its existence, Mach 20 to 27 speed, and operational status are confirmed by Russian presidential statements and Western intelligence assessments. (The Avangard is a hypersonic strike system, NOT a plasma weapon.)
- **Putin's March 2018 address:** Putin's description of the plasma control problem is established as an official presidential statement.
- **Stupitskiy/IAP research existence:** The existence of Stupitskiy's space plasma gun research at the IAP is established through academic publications and Western analytical reporting.
- **Russia-China collaboration (HIT-PINP):** Documented through institutional records, joint publications, and personnel exchanges.
- **Russian Patent RU-2227892-C1:** The existence of the patent is established as a document. (The patent's claims are unverified.)
- **Academic publications:** Papers by Ryzhkov, Mozgovoy, Romadanov, and Stupitskiy in Russian and international plasma physics journals are established as primary source documentation.
- **Russia's fielded counterspace systems:** Russia's operational counterspace capabilities are kinetic (Nivelir) and electronic (Krasukha-4), not plasma-based.

5.2.2 Strongly Inferred (Multiple Converging Lines of Evidence)

The following findings are supported by multiple converging lines of evidence but are not directly confirmed by primary sources:

- **Cold Explosions as Soviet plasma experiments (1974–1984):** Documented in Western intelligence sources with characteristics consistent with plasma events, but never officially confirmed as plasma weapons tests by either Russian or Western governments. Alternative explanations cannot be entirely excluded.
- **Technology transfer pathway (Soviet to US to Russian):** The chronological evidence (1965 Soviet research → 1988 US MARAUDER → 2019 Russian Stupitskiy) is strong, but the specific mechanism of transfer — scientific exchange, intelligence collection, or independent rediscovery — is not directly documented.
- **Institutional continuity across Soviet-to-post-Soviet transition:** The survival of TRINITI, VNIIEF, IAP, and the Kurchatov Institute through the 1991 transition is established; the specific mechanisms by which plasma physics expertise was preserved and transferred are strongly inferred from personnel and institutional records.
- **Ministry of Defense oversight of Stupitskiy program:** The ASAT mission focus of the Stupitskiy research strongly implies Ministry of Defense involvement, but specific oversight arrangements are not directly documented in open sources.

5.2.3 Plausible Physics (Consistent with Known Physics, Not Demonstrated at Weapons Scale)

The following concepts are consistent with known plasma physics but have not been demonstrated at weapons scale or under operational conditions:

- **Avramenko aerodynamic disruption kill mechanism:** The concept of using a plasma discharge to alter projectile aerodynamics is consistent with known plasmoid behavior and the Gatchina discharge experiments. However, the specific implementation — projecting plasma to 50 km altitude and maintaining it long enough to disrupt an incoming projectile — has not been demonstrated.
- **Thermonuclear Motor concept:** A pulsed fusion device based on continuous plasmoid formation and ignition is consistent with compact toroid physics but has not been demonstrated as an operational propulsion or energy system.
- **Stupitskiy ASAT kill mechanisms:** Kinetic impact, electromagnetic disruption, and plasma wave transparency reduction are all consistent with known compact toroid behavior but have not been demonstrated at operational scale in the space environment.

- **Plasma stealth broadband absorption:** The Avangard's plasma sheath absorbs electromagnetic radiation across a broad frequency range — this is established as a physical effect. The specific extent of radar cross-section reduction across all relevant frequency bands is plausible physics but not fully characterized in open sources.
- **Avangard plasma control technology applicability to weapons:** The ability to maintain guidance through a plasma envelope is established for the Avangard. Its applicability to offensive plasma weapons systems is plausible physics but not confirmed.

5.2.4 Speculation (Not Supported by Direct Evidence)

The following claims are not supported by direct evidence and are based on extrapolation, analogy, or assumption:

- **Putin's September 2023 "new physical principles" as confirmation of plasma weapons:** The statement is established as a presidential statement, but the inference that it specifically refers to plasma weapons is speculation. "New physical principles" is a broad term encompassing multiple advanced weapons technologies.
- **Avramenko weapon operational deployment:** No open-source evidence confirms that the Avramenko system was ever deployed operationally. The claim that it was deployed is speculation based on the unverified Ogonek article.
- **Stupitskiy orbital test timeline:** Any specific timeline for an orbital test of the Stupitskiy system is speculation. The technical challenges are substantial, and no official timeline has been disclosed.
- **Direct technology flow from Avramenko to Avangard:** While both programs involve plasma physics and share institutional connections, the claim that the Avangard's plasma control solution was directly derived from Avramenko weapon research is speculation. The Avangard is primarily a hypersonic aerodynamics and materials engineering achievement.

5.2.5 Unsupported (No Experimental or Theoretical Support)

The following claims have no experimental or theoretical support in the open-source record:

- **Fielded operational plasma orb weapon in Russia:** No confirmed fielded, operational offensive plasma orb weapon in Russia. This claim — implied or stated in prior versions of this paper — is unsupported by the available evidence. However, the absence of a confirmed fielded weapon does not mean an absence of interest: the 66-year continuum of documented research, unverified claims of testing (Belitsky 1995, analogous to the MH370 footage), and active research-phase weapons concepts

(Stupitskiy) establish substantial evidence of sustained interest in plasma weapons technology.

- **Avangard as an offensive plasma weapon:** The characterization of the Avangard as a "plasma weapon" or "plasma-based weapons system" is unsupported. The Avangard is a hypersonic glide vehicle. The plasma sheath is a byproduct of hypersonic flight, not an offensive capability.
- **Post-2020 Avramenko program continuation:** No post-2020 open-source evidence confirms continuation of the Avramenko program. Claims of ongoing development are unsupported.

5.3 Russia as the Earliest Documented Plasmoid Researcher

The chronological evidence is unambiguous: Russia — through its Soviet predecessor — initiated the earliest documented plasmoid research in the world. The DTIC-translated documents AD0678694 ("Investigation of Plasmoids," 1965) and AD0620822 ("Effect of Electrode Geometry of a Coaxial Gun on Plasma Clots") establish that Soviet scientists were conducting systematic research into plasmoid formation and coaxial plasma gun optimization by the mid-1960s — 23 years before the US MARAUDER program began at Phillips Laboratory in 1988. This finding is **established**.

However, the claim that Russia achieved the "earliest publicly confirmed working plasma weapons test" through the Avramenko weapon must be corrected. The Avramenko test results were **reported** in the Ogonek article but have not been **confirmed** by any independent source. The distinction between "reported" and "confirmed" is fundamental to the v2 framework. The US MARAUDER experiments (1988–1993) were conducted earlier but were classified; their results were documented in OSTI abstracts. The Russian disclosure, through Belitsky's Ogonek article, made Russia the first nation to **publicly claim** a working plasma weapons test — but a claim is not a confirmation. Nevertheless, the Belitsky account is an unverified but credible-sounding secondhand account by a reputable journalist that contributes to a pattern of alleged plasma weapons testing across multiple nations, analogous to the more speculative MH370 footage showing three luminous orbs in coordinated formation.

> **Earliest Research Assessment (Established):** Russia holds the earliest documented plasmoid research in the world (Soviet studies, 1950s–1965, established through DTIC translations). However, the claim that Russia achieved the "earliest publicly confirmed working plasma weapons test" (Avramenko, 1995) must be corrected: the Avramenko test results were reported but not independently confirmed. The corrected assessment is that Russia holds the earliest documented plasmoid research and the earliest publicly claimed plasma weapons test — an unverified but credible-sounding secondhand account by a reputable journalist that contributes to a pattern of alleged plasma weapons testing across multiple nations, analogous to the MH370 footage.

5.4 The Technology Transfer Pathway

One of the most significant findings of this investigation is the circular technology transfer pathway that connects Soviet, American, and Russian plasma physics research across 66 years:

1. **1950s–1965 (Established):** Soviet plasmoid research documented in DTIC AD0678694 and AD0620822 — coaxial plasma gun geometry optimization, plasmoid formation and acceleration.
2. **1974–1984 (Strongly Inferred):** Cold Explosions phenomenon observed by Western intelligence — assessed as potential Soviet atmospheric plasma experiments.
3. **1988–1993 (Established):** US MARAUDER program at Phillips Laboratory — coaxial plasma gun technology analogous to the Soviet research, accelerating compact toroids to 100 billion g.
4. **1992–2003 (Established):** MAGO program collaboration between VNIIEF and LANL — formal US-Russian plasma physics cooperation sharing pulsed power and compact toroid expertise.
5. **2019–2020 (Established):** Russian Stupitskiy space plasma gun research at IAP — explicitly referencing the 1990s MARAUDER experiments at Phillips Laboratory.

This circular pathway — from Russia to the United States and back to Russia — is unique in the global plasma physics landscape. The extension to China through the HIT-PINP connection creates a multilateral network. The overall technology transfer pathway is **strongly inferred** — the chronological and documentary evidence is strong, but the specific mechanisms of transfer at each stage are not all directly documented.

5.5 The Institutional Continuity Factor

A critical factor enabling Russia's unique position is the institutional continuity of its plasma physics enterprise across the Soviet-to-post-Soviet transition of 1991. While the United States terminated its MARAUDER program and dispersed the personnel, Russia maintained its core plasma physics institutions — TRINITI, VNIIEF, the Kurchatov Institute, the IAP — largely intact through the political rupture, sustained by the strategic importance of the nuclear weapons complex. The personnel network (Ryzhkov, Mozgovoy, Romadanov, and others) maintained continuity across the transition, ensuring that the institutional knowledge accumulated during the Soviet energetics program was not lost but transferred into the post-Soviet Russian research establishment. This institutional continuity is **established**.

This institutional continuity is the structural foundation upon which the three-effort continuum was built. The Avramenko claims drew on VNIIEF's pulsed power expertise and TRINITI's plasmoid research. The Avangard drew on NPO Mashinostroeniya's hypersonic aerodynamics heritage. The Stupitskiy program draws on the IAP's compact toroid physics capabilities, established by Gaponov-Grekhov. The same institutions, the same network, the same physics — sustained across 66 years. However, institutional continuity does not equal operational capability. The institutions have sustained 66 years of research and interest; they have not confirmed deployment of an offensive plasma weapon.

5.6 Assessment of Current Capabilities

Based on the evidence assembled in this investigation, Russia's current plasma-related capabilities can be assessed as follows:

5.6.1 Deployed Capability: Avangard (Established — as Hypersonic System, NOT as Plasma Weapon)

The Avangard hypersonic glide vehicle is confirmed deployed with the Russian Strategic Missile Forces since December 2019. The system's existence, its Mach 20 to 27 speed, its plasma sheath radar cross-section reduction, and its operational status are confirmed by Russian presidential statements and Western intelligence assessments. The Avangard is the world's first operationally deployed hypersonic glide vehicle. However, it is NOT a plasma weapon. The plasma sheath is a byproduct of hypersonic flight providing passive radar cross-section reduction. The Avangard is a hypersonic strike system that demonstrates Russian capability to operate within a plasma environment — a capability with relevance to the plasma physics research continuum but not itself a plasma weapon.

5.6.2 Claimed Capability: Avramenko Weapon (Unverified)

The Avramenko plasmoid weapon was described in the FBIS-translated Ogonek article with technical specificity (10 MW phased arrays, 1-meter spot at 50 km, 1 GW total power, aerodynamic disruption kill). The claimed test results — projectile deflection and self-destruction — have not been independently verified. No post-2020 evidence of program continuation exists. The Avramenko claims are physically plausible (consistent with the Gatchina discharge experiments) and come from a credible-sounding source (Belitsky, a reputable journalist), but remain unverified. They contribute to a pattern of alleged plasma weapons testing across multiple nations, analogous to the more speculative MH370 footage showing three luminous orbs in coordinated formation. The current operational status of the Avramenko system is unknown — it may have been deployed, shelved, or was never operational. Without independent verification, no definitive assessment can be made — but the claims are situated within Russia's 66-year sustained interest in plasma weapons technology, not treated as an isolated anomaly.

5.6.3 Research Capability: Stupitskiy Space Plasma Guns (Established as Research, Not Deployed)

The Stupitskiy space plasma gun program is documented through academic publications and Western analytical reporting. The program's existence, its institutional embedding at IAP, and its explicit reference to the MARAUDER experiments are established. This is the most credible active Russian plasma weapons research effort in the open-source record. However, the program is in the research phase, with no confirmed orbital test or deployment. The technical challenges of miniaturizing plasma gun technology for orbital platforms remain substantial.

5.6.4 Fielded Counterspace Systems: Kinetic and Electronic, Not Plasma (Established)

Russia's fielded counterspace systems are kinetic (Nivelir co-orbital system) and electronic (Krasukha-4 EW system), not plasma-based. No open-source evidence confirms a fielded plasma-based counterspace system. This is an important correction: prior versions of this paper may have implied that Russia's counterspace capabilities included plasma weapons. They do not. Russia's current operational counterspace posture is based on conventional kinetic and electronic warfare technologies.

5.7 Future Trajectory

Several indicators suggest the trajectory of Russia's plasma physics research program over the coming decade:

1. **Avangard expansion:** The Avangard is currently deployed on a limited number of UR-100UTTKh ICBMs. The planned integration with the new RS-28 Sarmat heavy ICBM will expand the number of Avangard-equipped launchers. This is an expansion of hypersonic strike capability, not plasma weapons capability.
2. **Space plasma gun maturation:** The Stupitskiy program's research trajectory suggests potential for continued development, but any specific timeline for an orbital test is speculation. The miniaturization challenges are substantial. Continued monitoring of IAP publications and Russian academic conferences is warranted.
3. **Plasma control technology applications:** The plasma control technology developed for Avangard — the ability to maintain guidance and communication through a plasma envelope — has potential applications beyond hypersonic glide vehicles. It could be applied to other high-speed platforms and potentially to offensive plasma weapons concepts. This application is plausible physics but not confirmed.
4. **Continued institutional investment:** The tripartite oversight structure (RAS, Ministry of Defense, Rosatom) and the institutional continuity that has sustained the program for 66 years show no signs of weakening. Russia's plasma physics research enterprise is a permanent feature of its strategic science landscape.
5. **Russia-China collaboration:** The HIT-PINP connection suggests that Russian plasma physics expertise will continue to flow to China, potentially accelerating Chinese development of compact toroid and FRC technologies. This multilateral technology transfer pathway warrants continued monitoring.

5.8 Overall Confidence Assessment

Overall Confidence Assessment (v2 Framework):

- **Established:** Soviet plasmoid research origins (1950s–1965 DTIC documents). TRINITI installation size comparison. Gatchina discharge experiments (500–600 ms plasmoids in air). Nuclear-plasma connection (VNIIA, VNIIEF, Kurchatov). MAGO program (VNIIEF-LANL collaboration). Avangard deployment as hypersonic glide vehicle. Putin's March 2018 address. Stupitskiy/IAP research existence. Russia-China collaboration (HIT-PINP). Russia's fielded counterspace systems are kinetic and electronic, not plasma. Academic publications by Ryzhkov, Mozgovoy, Romadanov, Stupitskiy. 66-year sustained interest in plasma weapons technology.
- **Strongly Inferred:** Cold Explosions as Soviet plasma experiments. Technology transfer pathway (Soviet to US to Russian). Institutional continuity mechanisms across 1991 transition. Ministry of Defense oversight of Stupitskiy program.
- **Plausible Physics:** Avramenko aerodynamic disruption kill mechanism. Thermonuclear Motor concept. Stupitskiy ASAT kill mechanisms. Plasma stealth broadband absorption characteristics. Avangard plasma control technology applicability to weapons.
- **Speculation:** Putin's September 2023 "new physical principles" as plasma weapons confirmation. Avramenko weapon operational deployment. Stupitskiy orbital test timeline. Direct technology flow from Avramenko to Avangard.
- **Unsupported:** Fielded operational plasma orb weapon in Russia. Avangard as an offensive plasma weapon. Post-2020 Avramenko program continuation.

5.9 Final Assessment

Russia's plasma physics research program is the deepest, most continuous, and most institutionally embedded of any nation in the world. It spans 66 years from the earliest Soviet plasmoid research through to the deployed Avangard hypersonic system and the contemporary Stupitskiy space plasma gun research. It encompasses three distinct efforts — one unverified but credible-sounding (Avramenko), one deployed as a hypersonic system (Avangard), and one in active research (Stupitskiy) — each representing a different application of compact toroidal plasma physics. It is sustained by an institutional infrastructure — TRINITI, VNIIEF, IAP, NPO Mashinostroeniya, the Kurchatov Institute —

that has maintained unbroken continuity across the Soviet-to-post-Soviet transition. And it occupies a unique position in the global technology landscape: Russia is both the originator of plasmoid research and a current developer of plasma weapons concepts.

However, the v2 confidence framework demands precision, and the precise assessment is this: **no confirmed fielded operational plasma orb weapon, but Russia represents the deepest and most continuous plasma weapons interest continuum of any nation — 66 years of documented research, unverified claims of testing (Belitsky 1995), and active research-phase weapons concepts (Stupitskiy).** The physics is established. The interest is established. The testing claims are unverified but exist and contribute to a pattern of alleged plasma weapons testing across multiple nations (Belitsky's 1995 Ogonek article, analogous to the more speculative MH370 footage showing three luminous orbs in coordinated formation). The fielding of an operational weapon is unconfirmed. Russia's fielded counterspace systems are kinetic and electronic, not plasma-based. What Russia has is a 66-year research continuum, the deepest institutional infrastructure, unverified but credible-sounding claims of testing, and the most credible active plasma weapons research program (Stupitskiy/IAP) — the longest-running and most documented plasma weapons interest continuum of any nation.

The implications of this assessment extend beyond Russia's bilateral strategic relationships. The Avangard's hypersonic capability — with its incidental passive plasma stealth — represents a significant challenge to missile defense architectures. The Stupitskiy space plasma gun program, if it matures to deployment, would introduce a new category of orbital warfare capability. The Russia-China collaboration through HIT-PINP suggests that plasma physics expertise is flowing to China, potentially accelerating Chinese programs. And the institutional continuity that has sustained Russia's program for 66 years suggests that Russia will remain at the forefront of plasma physics research for the foreseeable future.

Russia's 66-year plasma weapons interest continuum is not a historical artifact. It is an active, expanding, and institutionally embedded research enterprise — the longest-running and most documented of any nation. No confirmed fielded operational plasma orb weapon, but substantial evidence of sustained interest, unverified claims of testing, and active research-phase weapons concepts. The distinction matters, and the v2 confidence framework exists to ensure that it is maintained — while also acknowledging the depth and continuity of the interest that the evidence establishes.