Network Analysis: Prof. Yakov Krasik

1. Role and Significance

Professor Yakov E. Krasik of the Technion-Israel Institute of Technology is a foundational academic pillar in the international pulsed power and plasma physics community. His strategic significance is best understood not through direct involvement in military or large-scale commercial programs, but through his prolific and decades-long role as a producer of elite human capital. Analysis of his academic lineage, professional network, and the career trajectories of his students indicates that his Plasma and Pulsed Power (P4) Laboratory at the Technion functions as a critical and highly efficient node for the transfer of specialized knowledge from the post-Soviet research ecosystem into the Western scientific establishment. Prof. Krasik's career path created a multi-decade, multi-generational conduit for the diffusion of a specific and high-value scientific tradition, making his network a primary subject of interest for mapping the global landscape of expertise in high-energy-density physics.

Prof. Krasik's academic and early professional foundation was forged entirely within the premier institutions of the former Soviet Union, a state that invested immense resources into pulsed power and plasma physics for strategic applications. He received his M.Sc. in physics from Tomsk Polytechnic Institute in 1976 and his Ph.D. in physics from the Joint Institute for Nuclear Research (JINR) in Dubna in 1980, a leading international center for nuclear science within the Soviet sphere. His subsequent career at the Nuclear Research Institute in Tomsk from 1980 to 1991, culminating in his position as Head of the High Power Ion Beam Laboratory, placed him at the heart of the USSR's advanced research in this field. This background is of paramount importance; the Soviet school of thought on pulsed power and high-energy-density physics developed unique theoretical and experimental approaches, often in parallel to and isolated from Western efforts. His emigration to Israel in 1991, first to the Weizmann Institute of Science and then to the Technion in 1997 to establish his own laboratory, created a critical bridge. This move allowed a valuable and often insular body of knowledge to cross-pollinate with Western research methodologies and funding structures. At the Technion, he trained a new generation of students, imbuing them with this hybrid Russo-Israeli approach to experimental physics. Many of these students have since migrated to top-tier laboratories in the United States and Europe, completing a multi-stage transfer of expertise that continues to this day.

The scale of this human capital production is substantial. As of early 2025, Prof. Krasik has supervised at least 23 Ph.D. students and 26 M.Sc. students, creating a significant global network of specialists trained in his specific methodologies. The quality and destination of these graduates underscore the strategic importance of this network. Official Technion publications note that graduates of the P4 laboratory have been accepted as postdoctoral researchers at world-leading scientific institutions, including Imperial College London and the Princeton Plasma Physics Laboratory (PPPL), the U.S. Department of Energy's flagship center for fusion energy science. This demonstrates a consistent and successful pathway for injecting high-caliber talent, trained in the demanding field of experimental pulsed power, directly into the heart of the Western R&D establishment.

2. Academic & Mentorship Network

The core of Prof. Krasik's influence and the primary vector for knowledge transfer is his

extensive academic and mentorship network. This network maps the flow of specialized expertise from its origins in the Soviet research complex, through the crucible of the P4 laboratory at the Technion, and out into the global scientific community, particularly in the United States and Europe.

2.1 Mentors and Formative Institutions (The Soviet Lineage)

Prof. Krasik's expertise is deeply rooted in the Soviet Union's advanced scientific and technical education system. His formative years were spent at institutions that were central to the USSR's efforts in nuclear physics, accelerator technology, and pulsed power.

- **Tomsk Polytechnic Institute & Nuclear Research Institute, Tomsk:** Tomsk was a major Siberian center for pulsed power and accelerator physics within the Soviet system. Krasik's M.Sc. thesis, "High-current electron beam propagation across external magnetic field in low pressure gas," completed in 1976, demonstrates his early focus on the fundamental physics of charged particle beams, a cornerstone of his subsequent research. His work at the Nuclear Research Institute from 1980 to 1991 further solidified this expertise.
- **Joint Institute for Nuclear Research (JINR), Dubna:** JINR was the Soviet bloc's premier international nuclear physics center, analogous to CERN in Western Europe. Completing his Ph.D. there in 1980 with a thesis on "High power ion beam generation in reflex systems" placed him at the forefront of this research area. This early work on high-power ion beams is directly relevant to plasma heating, materials science, and certain concepts for inertial confinement fusion.
- **Weizmann Institute of Science (1991-1996):** His first position after emigrating to Israel was at the Weizmann Institute, one of the country's top multidisciplinary research centers. This period served as a crucial transition, allowing him to integrate his Soviet-era expertise into the Israeli and broader Western scientific environment before establishing his own laboratory and research agenda at the Technion in 1997.

2.2 Protégés: The Human Capital Production Line

The most significant output of the P4 laboratory is the cadre of highly trained specialists who now occupy key positions in Western academic and industrial institutions. Their migration represents the most direct and highest-fidelity pathway for the transfer of complex, hands-on experimental knowledge. The following dossier details the career paths of his most prominent protégés, identifying them as key human capital vectors.

Protégé Name	Degree/Role under Krasik	Key Research Area at Technion	Current Affiliation (Vector Destination)	Significance of Vector
Dr. Shurik Yatom	Ph.D. (2013)	Nanosecond discharges, runaway electrons	**Princeton Plasma Physics Laboratory (PPPL)**, USA (Staff Research Physicist)	Direct vector into a premier U.S. Department of Energy fusion energy research center. Expertise in advanced plasma

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				diagnostics is critical for fusion experiments.
Dr. Vladislav Vekselman	Ph.D. (2012)	Heaterless hollow cathodes, plasma sources	**Princeton Plasma Physics Laboratory (PPPL)**, USA	Reinforces the PPPL pipeline. Expertise in plasma sources is foundational for creating the initial plasma in fusion devices and for neutral beam injectors.
Dr. Alexander Rososhek	Ph.D. (2021)	Underwater wire explosions, Z-pinches, shock waves	**Cornell University**, USA (Postdoctoral Researcher, Laboratory of Plasma Studies)	Direct vector into a top-tier U.S. university's plasma physics lab, working on high-current Z-pinch implosions with the COBRA generator.
Dr. Dmitry Levko	Co-author/Collaborator	Numerical simulations of discharges	**Lam Research Corporation**, USA (Lead Computational Plasma Scientist)	High-value industrial vector. Transfers advanced plasma simulation expertise into the U.S. semiconductor manufacturing industry.
Dr. Alon Grinenko	Ph.D.	Underwater wire explosions, shock waves	**University of Bristol / University of Warwick**, UK	Key vector into the UK academic research community, particularly in shock physics, acoustics, and high-energy-density matter.
Daniel Maler	Ph.D. Student	Underwater wire explosions, supersonic jets	**Technion**, Israel (as of 2024)	Represents the current generation of talent being

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				cultivated in the P4 lab; a candidate to monitor for future migration to Western institutions.
Dr. Antonina Dunaevsky	Postdoc/Researcher	Ferroelectric plasma sources	Formerly **Technion**; current affiliation unconfirmed in open sources	Represents an earlier generation of talent. The lack of a clear current vector is also an intelligence finding, indicating potential career paths outside of public-facing research.

2.3 Key International Co-authors: The Institutional Network

Beyond direct mentorship, Prof. Krasik has built a robust network of institutional bridges through sustained, long-term research collaborations. These partnerships, particularly those funded by U.S. defense agencies, are not merely academic exercises; they are officially sanctioned channels for knowledge exchange, allowing the U.S. to leverage foreign expertise and unique experimental facilities to solve specific technical problems relevant to its own national programs.

Collaborator Name	Primary Institution	Country	Nature of Collaboration	Significance
Prof. Edl Schamiloglu	**University of New Mexico**	USA	High-power microwaves (HPM), relativistic magnetrons. Jointly funded by **ONR Global**.	Direct, long-standing collaboration with a leading U.S. HPM research center, with explicit U.S. Navy funding, indicating high strategic relevance.
Dr. John Luginsland	**AFOSR**	USA	Pulsed power, HPM. Luginsland is a Program Officer for the U.S. Air Force Office of Scientific Research.	Direct link to a key U.S. military science funding and oversight body, confirming the strategic alignment of the research.

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Prof. Simon N. Bland	**Imperial College London**	UK	Pulsed power, shockwaves, wire array explosions. Joint experiments on the MACH generator.	Strong, ongoing collaboration with a top-tier UK university's shock physics group, a key NATO ally.
Dr. Alexander Rack	**European Synchrotron Radiation Facility (ESRF)**	France	Use of synchrotron for ultra-high-speed X-ray diagnostics of wire explosions.	Demonstrates access to and collaboration with premier European advanced diagnostic facilities, essential for studying high-energy-densit y matter.
Prof. Joshua Felsteiner	**Technion** (Emeritus)	Israel	Frequent domestic collaborator on numerous projects since the lab's inception.	Represents the foundational local collaborator and a key figure in the P4 lab's history and development.
Dr. Evgeny Stambulchik	**Weizmann Institute of Science**	Israel	Co-author on spectroscopic diagnostics.	Link to another of Israel's premier research institutions, indicating a strong domestic network.

3. Professional & Institutional Network

Prof. Krasik's influence extends well beyond his direct academic lineage. He is an active and respected leader within the global plasma science and pulsed power communities, leveraging professional societies, conferences, and editorial roles to shape the direction of the field and maintain a wide network of contacts.

3.1 Primary Affiliation: Technion Plasma and Pulsed Power (P4) Laboratory

Established by Prof. Krasik in 1997, the P4 laboratory is the central hub of his network. The lab's research is focused on the physics of current-carrying pulsed plasma, including the generation of high-current relativistic electron beams, the study of warm dense matter via underwater electrical wire explosions, the generation of converging strong shock waves, and the production of high-power microwaves (HPM).
A key aspect of the P4 lab is its unique hardware and experimental capabilities. It is equipped with a suite of high-power pulsed generators capable of producing peak powers up to tens of gigawatts (GW) and current amplitudes up to 1 Mega-Ampere (MA) on timescales ranging from

nanoseconds to microseconds. This specialized, high-energy-density hardware is not commonly available in university laboratories. This capability is a primary driver for international collaboration, as it allows researchers from other institutions to conduct experiments that cannot be easily replicated elsewhere, making the P4 lab a destination for leading scientists in the field. It is important to distinguish the P4 lab from the Technion's Aerospace Plasma Laboratory (APL). The APL was founded in 2015 by Asst. Prof. Igal Kronhaus and focuses on a different domain of plasma physics: innovative, miniaturized, lower-power plasma devices for applications such as nanosatellite electric propulsion and aeronautical flow control. Prof. Krasik's P4 lab, in contrast, is squarely focused on the high-power, high-energy-density physics relevant to pulsed power systems, directed energy, and the conditions required for nuclear fusion.

3.2 Secondary Affiliations and Global Influence

Prof. Krasik's status as a leader in his field is solidified by his active participation and recognition within its most important professional organizations.

- **Professional Societies:** He is a Fellow of both the **Institute of Electrical and Electronics Engineers (IEEE)** and the **American Physical Society (APS)**. Fellowship in these organizations is a high honor reserved for members with extraordinary records of accomplishment. His elevation to IEEE Fellow, effective January 1, 2021, was specifically "for contributions to plasma-based electron sources," a critical technology for HPM generation and particle accelerators. This status places him in the top tier of his field and provides a platform for influence and networking at the highest levels. He has also served as Chairman of the Israeli Plasma Society, demonstrating leadership within his national community.
- **Conference Leadership and Participation:** He is a central figure in the international conference circuit that defines the pulsed power and plasma science community. He served on the technical committee for the 2024 International Conference on Plasma Science (ICOPS), chairing the topic area on "Charged Particle Beams and Sources," and was an invited lecturer for the conference's Minicourse. His stature is further highlighted by his reception of the 2023 IEEE Nuclear and Plasma Sciences Society (NPSS) Plasma Science and Applications (PSAC) Award, a major career honor presented at ICOPS 2023 for his lifetime of contributions. He is a frequent invited and plenary speaker at the most important conferences in his field, including the International Conference on High-Power Particle Beams (BEAMS), ICOPS, and the IEEE Pulsed Power Conference (PPC).
- **Editorial and Reviewer Roles:** Prof. Krasik plays a significant role in the peer-review process that vets and validates new research. He is an exceptionally active reviewer for top journals in the field. Notably, he was recognized by the editors of *Physics of Plasmas* for reviewing more than ten manuscripts in 2022 alone. He also received an Outstanding Reviewer award from *Plasma Sources Science and Technology* in 2017. This gatekeeping role provides him with early and comprehensive insight into emerging research trends, challenges, and breakthroughs across the entire international community.
- **Sabbaticals and Visiting Professorships:** Extended stays at foreign institutions are prime opportunities for deep knowledge transfer and the establishment of lasting collaborative ties. Prof. Krasik has engaged in several such visits, including a sabbatical stay at the Institute of Plasma Physics (IPP) of the Czech Academy of Sciences in Prague during August 2019, and a "Thinker in Residence" position at Deakin University's Institute

of Frontier Materials in Australia in 2016.

4. Inferred Knowledge Transfer Vectors

Synthesizing the network map of personnel, institutions, and professional activities allows for a clear assessment of the most probable pathways for the transfer of knowledge and technology relevant to compact fusion concepts, pulsed power systems, and related advanced propulsion technologies. The vectors can be prioritized based on the fidelity and depth of the knowledge being transferred.

4.1 Primary Vector: Human Capital Migration to U.S. National & Academic Labs

The most effective and highest-fidelity vector for knowledge transfer is the migration of Prof. Krasik's top Ph.D. graduates and postdoctoral researchers into premier U.S. research centers. This channel is superior to publications or conferences because it transfers not just explicit knowledge (data, equations, schematics) but also deep tacit knowledge—the invaluable, hands-on expertise related to experimental techniques, diagnostic interpretation, hardware troubleshooting, and the intuition for what makes a complex experiment work.
A compelling pattern has emerged in the form of a sustained pipeline of talent from the P4 lab directly into the U.S. Department of Energy's fusion research ecosystem. The consecutive placement of two of Krasik's Ph.D. graduates, Dr. Shurik Yatom (Ph.D. 2013) and Dr. Vladislav Vekselman (Ph.D. 2012), at the **Princeton Plasma Physics Laboratory (PPPL)** is a powerful indicator of this successful pathway. PPPL is the leading U.S. national laboratory for magnetic confinement fusion research. The specific skills these individuals brought from the Technion—advanced plasma diagnostics (Yatom) and novel plasma source development (Vekselman)—are not peripheral but are directly applicable to the core challenges faced in major fusion experiments, such as tokamaks and stellarators.
This vector extends to top-tier U.S. academic centers as well. The placement of Dr. Alexander Rososhek (Ph.D. 2021) as a postdoctoral researcher in the Laboratory of Plasma Studies at **Cornell University** is another key example. This move places his Technion-honed expertise in high-current implosions and shockwave physics directly into an environment with premier experimental hardware, such as the 1-MA COBRA pulsed-power generator. This represents a direct injection of talent and specialized knowledge into the heart of the U.S. high-energy-density physics community, which has strong ties to the national security establishment and the nuclear weapons stewardship program.

4.2 Secondary Vector: U.S. Defense-Funded Institutional Collaboration

Formal research collaborations that are directly funded by U.S. military research agencies, such as the Office of Naval Research (ONR) and the Air Force Office of Scientific Research (AFOSR), constitute explicit, sanctioned channels for knowledge transfer. These are not passive academic exchanges but active, mission-oriented efforts by the U.S. Department of Defense to acquire foreign expertise and capabilities to address specific technological requirements.
The long-standing collaboration between Prof. Krasik's lab and the research group of Prof. Edl Schamiloglu at the **University of New Mexico** is a prime example of this vector. This partnership focuses on high-power microwaves (HPM), a critical technology for directed energy weapons and advanced radar systems. The collaboration is explicitly funded by **ONR Global** and involves direct engagement with Dr. John Luginsland, a program officer at **AFOSR**. This

triangular relationship between the Technion, a leading U.S. university research group, and two separate U.S. military science funding bodies demonstrates a coordinated strategy. The U.S. DoD is directly paying to access the unique expertise and experimental capabilities resident at the P4 lab. This represents an active acquisition of knowledge to advance U.S. military technology programs.

4.3 Tertiary Vector: Industrial Application and Commercialization

While Prof. Krasik himself does not appear to be directly involved in commercial ventures, the migration of his protégés and collaborators into the private sector represents a significant, if less direct, pathway for knowledge transfer into industrial applications.

The career of Dr. Dmitry Levko, a computational plasma physicist and frequent Krasik collaborator, is a clear example. His current role as a Lead Computational Plasma Scientist at **Lam Research Corporation**, a leading U.S. manufacturer of semiconductor fabrication equipment, places his deep expertise in plasma modeling directly into a high-value industrial setting. The physics of plasma etching and deposition, which are fundamental to modern microchip manufacturing, has significant overlap with the physics of the pulsed discharges he studied in collaboration with the P4 lab. This represents a transfer of advanced modeling capabilities from the pulsed power domain into a critical U.S. technology sector.

It is also important to note a significant negative finding: there is no open-source evidence linking Prof. Krasik or his direct protégés to the major commercial fusion energy companies, such as Helion Energy or TAE Technologies. This suggests that the knowledge and human capital flowing from his network are primarily being absorbed by foundational government laboratories, academia, and adjacent high-tech industries (like semiconductor manufacturing) rather than directly into the U.S. commercial fusion startup ecosystem. This may indicate that the skill set is perceived as more valuable for fundamental, government-led research and defense applications than for the specific engineering pathways currently being pursued by venture-backed fusion companies.

4.4 Relevance to FRC and Compact Fusion Programs

Prof. Krasik's network is of extremely high relevance to any nation-state or corporate entity pursuing compact fusion, including Field-Reversed Configurations (FRCs). While the P4 laboratory does not publish research directly on FRC physics, it is a world-leading center for the *critical enabling technologies* upon which any successful FRC program must be built. An FRC is fundamentally a high-density, current-carrying plasma toroid that must be formed, sustained, heated, and controlled using intense, rapidly-switched magnetic fields. These fields are, in turn, generated by sophisticated pulsed power systems.

The P4 laboratory can be viewed as a foundry for solving the "hard problems" inherent to this domain. Building a viable FRC device requires:

1. **High-Performance Plasma Sources:** To create the initial high-density plasma that will be formed into the FRC. This is a core competency of the P4 lab.
2. **Advanced Pulsed Power:** To drive the massive, rapidly rising currents (hundreds of kiloamperes to mega-amperes in nanoseconds) needed for theta-pinch formation and magnetic compression.
3. **Sophisticated Diagnostics:** To measure the parameters of the hot, dense, transient plasma with high spatial and temporal resolution.
4. **Validated Computational Models:** To simulate and understand the complex

magnetohydrodynamic (MHD) behavior of the plasma.

These four areas are the exact core competencies of the P4 laboratory and its personnel. Therefore, the lab is not peripheral to FRC research; it is a foundational training ground for the skills and personnel required to solve the hardest engineering and physics challenges that all FRC programs face. The knowledge being transferred via Prof. Krasik's network is not a specific FRC design, but the far more valuable and broadly applicable expertise on *how to make the underlying high-energy-density physics work*. This makes the human capital emerging from his laboratory a strategic asset for any entity seeking to achieve a breakthrough in compact fusion.

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