Bharat Singh Rawat, Ph.D.

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LinkedIn
Online Dossier
PY-BEMCS

Expert in charged particle beams with over 7 years of experience in the design of ion sources, beam diagnostics, and transport systems.

Employment

10/2026 – Present

Accelerator Physicist: Basilisk Industries

(a) Design of Linear Induction Accelerator for rock cutting applications.
(b) Responsible for electron injector design, electron optics analysis and optimization.
(c) Development of plasma and beam diagnostics such as Bdot probes, Faraday Cups, langmuir probes, current monitors.

06/2026 – 10/2026

Scientific Consultant

Provided scientific consultancy services to startups and labs in the areas of electric propulsion, ion sources , plasma based systems and other cross disciplinary areas in terms of **modelling , design and optimization**.

03/2026 –06/2026

Independent Researcher

(a) Developed **PY-BEMCS**, a Python-based multiphysics suite for simulating ion beam extraction and Monte Carlo Collision (MCC) physics in Ion Sources/Thrusters and Fusion Neutral Beam Injectors (NBI).
(b) Developed a self consistent **Poisson solver** integrating Bohm criterion based extraction.
(c) Implemented dynamic **sputter erosion and structural failure logic** using probabilistic Charge-Exchange (CEX) scattering models and in-situ mesh erosion to predict grid End-of-Life (EOL).

2023 - 2026

Research Associate: University of Liverpool / Cockcroft Institute / CERN.

Responsibilities:

(a) Led **ballistic antiproton transport optimization studies** during the annual shutdown, utilizing a **3D CST Penning Trap model** to validate the new Positronium target design and determine critical operational settings **to achieve antiproton velocities below 2000 m/s**.

(b) Developed **Reduced Order Models (ROMs)** for a **Digital Twin** of the Penning Malmberg trap apparatus, integrating first principles physics with Machine Learning (ML) models to **predict trap behavior and optimize particle confinement.**

(c) Executing **critical on shift responsibilities** during beam time, including **real-time data acquisition and the management of cryogenic systems for superconducting magnets**.

2018-2018

Radiation Protection Engineer: Nuvia India Pvt Limited.

Responsibilities:

(a) Managed occupational radiation exposure for plant personnel at Kakrapar Atomic Power Station, ensuring **strict adherence to weekly, monthly, and annual regulatory dose limits**.

(b) Developed an **automated dose tracking spreadsheet to monitor exposure trends and identify personnel approaching threshold limits**, enabling proactive safety interventions.

Education

2018 - 2024 **Ph.D., Homi Bhabha National Institute / Institute for Plasma Research** in Engineering Sciences.

Thesis title: *Studies on extraction of an ion beam and its transport from a multicusp gridded ion source.*

Contribution:

(a) Designed, developed and characterized a **ring cusp ion source** for space propulsion and fusion research, capable of producing Ar^+ ion beams with energies of **1–2 keV** and currents up to 100 mA. Achieved an average beam current of **0.23 mA per aperture**.

(b) Engineered a nine-channel **Parallel Wire Array (PWA)** and a **Faraday Cup array (FCA)** for real-time, in-situ monitoring of ion beam profiles.

(c) Utilized **CST Studio for magnetic cusp optimization** and **OPERA-3D for ion optics design**, achieving a low beam divergence of 6.5°. Conducted transient thermo-structural analysis in **ANSYS** to design a grid mounting system that **limited thermal deformation to <0.1 mm.**

2015 - 2017 **M.Tech., Pandit Deendayal Petroleum University** in Nuclear Engineering.

Thesis title: *Design and Development of 10 kW Faraday cup for Ion beam intensity measurement .*

Contribution:

(a) Designed, developed, and characterized a Faraday Cup to handle a **thermal load of 10 kW** and a beam current of **20–30 mA**, a significant upgrade from the existing 1000 W and 500 µA system.

(b) Engineered a **water-cooling system** capable of maintaining a maximum temperature of **350.6°C**, well below the 1085°C melting point of copper.

(c) Optimized the device geometry with a 30° cone angle, which was found to **reduce the total secondary electron yield by a factor of 1.15** compared to larger angles.

2009 - 2013 **B.E., Gujarat Technological University** in Mechanical Engineering.

Thesis title: *Long Chain Beamer-Braking system and troubleshooting.*

Contribution:

(a) Calculated that replacing Hardened Mild Steel with **Cast Iron reduced the temperature rise** per stop by $1.39C$ (from $18.39C$ to $17C$), significantly improving safety for heat-sensitive materials like cotton.

(b) Identified and **mitigated critical operational difficulties**, including **overheating of adjacent assemblies, brake fluid vaporization, and thermal judder**, ensuring the integrity of textile materials during the beaming process.

Project title: *Synchronizing Ice Cream cup Packaging machine.*

Contribution:

(a) Analyzed and **resolved critical underperformance issues** in a four-track pneumatic packaging machine, restoring lost production capacity caused by internal mechanical misalignments.

(b) Successfully increased production output **from 9,600 cups per hour to 11,200 cups per hour, a recovery of approximately 1,600 units/hr** that brought the machine to near-maximum design capacity.

Key Research Publications

1. Butcher, W.; Kumar, N.; Patel, M.; Rawat, B.S.; Stringer, O.; Parambil, F.T.M.; Zhang, H.; Welsch, C.P, "**Invasiveness study of supersonic gas-curtain-based ionization profile monitor for medical accelerators**," *Instruments*, vol. 10, 3 2026. DOI: https://doi.org/10.3390/instruments10030035.

2. Thesni, Farhana ,Patel M., Kumar N., Rawat B.S.,Butcher W, Price T, Welsch C.P., "**Characterization of the extraction system of supersonic gas curtain-based ionization profile monitor for flash proton therapy**," *Instruments*, vol. 10, 1 2026. DOI: 10.3390/instruments10010004.

3. Rawat, B. S., Kumar, N., Ghosal, D., Aflyatunova, D., Rienäcker, B., Welsch, C. P., "**Faraday cups: principles, designs, and applications across scientific disciplines—a review**," *Instruments*, vol. 9, no. 3, 2025, ISSN: 2410-390X. DOI: 10.3390/instruments9030020.

4. Rawat B.S., "**Studies on Extraction of an Ion beam and its Transport from a Multi-Cusp Gridded Ion Source**," Ph.D. dissertation, Homi Bhabha National Institute, 2024. DOI: 10.13140/RG.2.2.14806.25929.

5 Rawat B.S., Sharma, S. K., Prahlad, V., Choksi, B., and Baruah, U. K., "**Experimental Studies on the Roles of Space Charge Neutralization in a Ring Cusp Ion Source**," *IEEE Transactions on Plasma Science*, vol. 51, no. 8, pp. 2218–2224, 2023. DOI: 10.1109/TPS.2023.3302419.

6 Rawat, B.S., Sharma, S. K., Choksi, B., Prahlad, V., and Baruah, U. K., "**Measurement system for ion beam profiles using fixed parallel wires and Faraday cup array**," *AIP Advances*, vol. 12, no. 12, p. 125 103, Dec. 2022, ISSN: 2158-3226. DOI: 10.1063/5.0117836.

7 Rawat, B.S., Sharma, S. K., Choksi, B., Bharathi, P., Sridhar, B., Gupta, L. N., Thakkar, D., Parmar, S. L., Prahlad, V., and Baruah, U. K., "**Characterization of a Multicusp Ion Source With Two-Grid Extraction System for Studying Extraction and Transport of Ion Beam**," *IEEE Transactions on Plasma Science*, vol. 49, no. 11, pp. 3537–3547, 2021. DOI: 10.1109/TPS.2021.3121519.

8 Rawat, B.S., Vala, S., Abhangi, M., Kumar, R and Chauhan, S, "**Design and simulation of 10kW Faraday cup for ion beam current**," in *Proceedings of the 25th International Conference on Nuclear Engineering ICONE25, Shanghai, China*, 2017, pp. 2–6. DOI: 10.1115/ICONE25-67589.

Skills

Languages	Strong reading, writing, and speaking competencies for English, Native in Hindi and Gujarati. Learning Spanish (B2) and Russian (A1).
Coding	Python, Matlab, C++
Software Expertiese	CST Studio (Particle tracking, ES/EM-PIC), Solid Works, OPERA3D, SIMION, COMSOL, RF Track, ANSYS (Thermal/Structural/CFD), ASTRA, MAD-X, Geant4/G4Beamline, TRAK,G4Beamline, BDSIM, IBISIMU, PY-BEMCS.
Outreach	Designed interactive web games related to antimatter physics for outreach demonstrations.
	Conducted interactive demonstrations showcasing superconductivity and magnetic levitation during outreach events.
Misc.	Teaching/Tutorials (Introduction to Beam diagnostics (Co-Instructor), HPC Computing, Doctoral student supervision.

Presentations and talks

1) Invited talk titled "**Design tutorial on FC design for low energy antimatter research using CST studio.**" at CST User day, October 2025, Nottingham, United Kingdom.

2) Contributed talk titled "**Digital Twin-Enabled Modeling of Antimatter Beam Control: Insights from AEgIS to EuPRAXIA**" at EuPRAXIA-DN Camp II: Science, July 2025, Lisbon, Portugal.

3) Contributed talk titled "**Trapping Antiprotons: Modeling Penning-Malmberg Traps for AEgIS at CERN**" at SIMULIA Euronorth Regional User Meeting, June, 2025, Manchester, United Kingdom.

4) Contributed talk titled "**Design and Simulation of 10 kW Faraday Cup for Ion Beam Current Measurement**" 25th International Conference on Nuclear Engineering 2017, Shanghai, China.

Hobbies

Playing chess, learning languages, musical instruments, and traveling.