Carlos Paz-Soldan

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Professional History

Founding Director — 2025-present
Columbia Fusion Research Center

Associate Professor — 2021-present
Applied Physics and Applied Math Department — Columbia University, New York NY

Staff Scientist — 2014-2020
Post-doctoral Fellow — 2012-2014
DIII-D National Fusion Facility — General Atomics, San Diego CA

Education

Ph.D, Physics — University of Wisconsin-Madison, 2007–2012

M.Sc, Engineering Physics — University of Wisconsin-Madison, 2007–2009

B.Sc.E, Engineering Physics — Queen's University at Kingston, Canada 2003–2007

Scientific Leadership

Founding Director, Columbia Fusion Research Center — 2025-present
Aligning the academic program to a new era of commercialization and industry engagement

Principal Investigator, Plasma Stability, Disruptions, & Control Research — 2021-present
Lead a research team of over a dozen scientists and graduate students as well as dozens of undergraduates conducting research in these areas in support of the public and private fusion program

Co-Leader, Negative Triangularity Working Group at DIII-D National Fusion Facility — 2019-2023
Organized research program for negative triangularity reactor scenarios, culminating in a dedicated experimental campaign that led to full special journal issue worth of high-impact scientific results

Co-Leader, ELM Control Research Area at DIII-D National Fusion Facility — 2016-2023

Principal Investigator, Genaral Atomics Internal R&D Project: DIII-D New Capabilities — 2020
Identify capability upgrade opportunities and develop physics and engineering assessments

Principal Investigator, GA Internal R&D Project: Non-Planar Superconducting Coils — 2019-2020
Develop advanced winding and fabrication techniques to mitigate strain in HTS tape conductor

Member, International Tokamak Physics Activity (ITPA) Pedestal and Edge Physics — 2017-present

Expert, International Tokamak Physics Activity (ITPA) MHD, Disruptions, Control — 2015-present

Community Leadership

President, University Fusion Association (UFA) — 2025-present
Serving a two-year term advocating for universities and launching mentorship activities

Member, Fusion Energy Sciences Advisory Committee (FESAC), *US Dept of Energy* — 2022-2025
Member of the only group that provided official advice to DOE Fusion Energy Sciences (FES)

Chair, FESAC Decadal Plan Subcommitee, *US DOE* — 2024-2025
Led subcommittee to consensus on aligning the DOE-FES program with the FESAC LRP

Vice-Chair, FESAC Facilities Construction Projects Subcommitee, *US DOE* — 2023-2024
Co-led the subcommitee to identify which future major facilities would best serve US fusion

Co-Chair, Workforce Accelerator for Fusion Energy Technology Development — 2023-2025
Assembled experts from academia, labs, and industry to drive fusion workforce development

Inaugural Chair, User Board, DIII-D National Fusion Facility — 2024-present
Provide strategic advise to program leadership and improve quality-of-life for facility users

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Professional Honors

Fellow, *American Physical Society* (APS) 2024
"For groundbreaking contributions and scientific leadership in the understanding and optimization of tokamak plasmas for fusion energy, including non-axisymmetric magnetic fields, plasma shaping, and control of relativistic electrons."

Thomas Stix Award for Early Career Contributions to Plasma Physics, *APS* 2021
"For groundbreaking contributions and scientific leadership in the understanding of non-axisymmetric magnetic fields and relativistic electrons in tokamak plasmas."

Marshall Rosenbluth Outstanding Doctoral Thesis Award, *APS* 2013
"For experimental research that conclusively demonstrated effective stabilization of the deleterious resistive wall mode in a linear plasma column by rotating conducting shells, and for perceiving how error fields affect kink mode stability asymmetrically for differentially rotating walls."

National and International Conference Invited Talks and Honors

Nuclear Fusion Prize, Co-author for *"Shattered pellet injection experiments at JET in support of the ITER disruption mitigation system design"* by S. Jachmich et al 2025
Nuclear Fusion Prize Shortlist, First-author for *"A novel path to runaway electron mitigation via deuterium injection and current-driven MHD instability"* 2024
Nuclear Fusion Prize, Co-author for *"Experimental conditions to suppress edge localised modes by magnetic perturbations in the ASDEX Upgrade tokamak"* by W. Suttrop et al 2021
Invited Talks at the IAEA Fusion Energy Conference 2016, 2018, 2021
Invited Talks at the APS Division of Plasma Physics Annual Meeting 2011, 2013, 2017

Full Publication List

Over twenty first-author and over 170 peer-reviewed journal publications, see below links and pages: Google Scholar (H-index 49), ORCiD, Publons, Scopus

Selected Publications (Organized Thematically)

Negative Triangularity (NT) Tokamak: The NT tokamak concept promises enhanced edge stability which facilitates integration of a high-performance plasma core with power exhaust needs.

C. Paz-Soldan et al, Simultaneous access to high normalized density, current, pressure, and confinement in strongly-shaped diverted negative triangularity plasmas, Nucl. Fusion 64 094002 (2024)
This publication cataloged the core operating space and plasma performance properties of the NT tokamak plasma in DIII-D, revealing access to conditions compatible with a fusion pilot plant.

A.O. Nelson, L. Schmitz, **C. Paz-Soldan**, et al, Robust Avoidance of Edge-Localized Modes alongside Gradient Formation in the Negative Triangularity Edge, Phys. Rev. Lett. 131 195101 (2023)
This publication demonstrated the robust edge stability across the expanse of parameter space, and presented a candidate mechanism to explain the observation.

MANTA collaboration et al, MANTA: a negative-triangularity NASEM-compliant fusion pilot plant, Plasma Phys. Contrl. Fusion 66 105006 (2024)
This publication presented the student-led MANTA tokamak design, a NT fusion pilot plant that meets all the criteria of a first-of-a-kind FPP according to the National Academies.

Workforce Development: A growing fusion sector requires enhanced workforce programs.

C. Paz-Soldan et al, Accelerating the fusion workforce in the USA, Plasma Phys. Control. Fusion 67 083701 (2025)
This publication documented the final report of the Fusion Workforce Accelerator initiative.

Carlos Paz-Soldan

Relativistic Electrons (REs): REs in tokamaks are both fascinating and problematic as their impact on material surfaces can produce significant melting, thus they require control and study. My contributions have been to initiate research lines in the use of instability and non-axisymmetric field effects, as well as plasma waves, to provide alternative pathways to control the RE populations.

C. Paz-Soldan, C. Reux, et al, A novel path to runaway electron mitigation via deuterium injection and current-driven MHD instability, Nucl. Fusion 61 116058 (2021)

C. Reux, **C. Paz-Soldan**, et al, Demonstration of Safe Termination of Mega-Ampere Relativistic Electron Beams in Tokamaks , Phys. Rev. Lett. 126 175001 (2021)

C. Paz-Soldan, et al, Kink Instabilities of the Post-Disruption Runaway Electron Beam at Low Safety Factor, Plasma Phys. Contrl. Fusion 61, 054001 (2019)

These three publications form the original work describing the 'benign termination' approach to RE mitigation, which is now broadly considered the primary approach to RE control in the ITER tokamak. The 2019 paper is the first to present the phenomenon.

D. Weisberg, **C. Paz-Soldan**, et al, Passive deconfinement of runaway electrons using an in-vessel helical coil, Nucl. Fusion 61, 106033 (2021)

This publication presented the first design of a passive deconfinement system for REs applied to an real tokamak, building on the pioneering work of Boozer. Subsequent systems were designed for five other tokamaks including SPARC, but it is currently implemented only on Columbia's HBT-EP.

D. Spong, W. Heidbrink, **C. Paz-Soldan** *et al*, First Direct Observation of Runaway-Electron-Driven Whistler Waves in Tokamaks, Phys. Rev. Lett. 120, 155002 (2018)

C. Paz-Soldan, C.M. Cooper, P. Aleynikov, *et al*, Spatiotemporal Evolution of Runaway Electron Momentum Distributions in Tokamaks, Phys. Rev. Lett. 118, 255002 (2017)

These publications describe the use of hard X-rays to identify the RE dynamics that enable energy-limiting plasma-wave generation, leading to exploitation of waves to control the REs.

Non-axisymmetric fields and Edge Stability: Repetitive edge instabilities can preclude long-term operation of a fusion device, which can be controlled by the use of non-axisymmetric fields.

C. Paz-Soldan *Plasma Performance and Operational Boundaries without ELMs in DIII-D*, Plasma Phys. Control. Fusion 63 083001 (2021) Topical Review

This review compared the various flavors of stable edge operating modes in the DIII-D tokamak and advanced metrics to quantify success and extrapolation to fusion pilot plans.

C. Paz-Soldan, R. Nazikian, *et al*, *Observation of Multimode Plasma Response and its Relationship to Density Pumpout and Edge-Localized Mode Suppression*, Phys. Rev. Lett. 114, 105001 (2015)

R. Nazikian, **C. Paz-Soldan**, *et al*, *Pedestal Bifurcation and Field Penetration at the Threshold of Edge-Localized Mode Suppression in the DIII-D Tokamak*, Phys. Rev. Lett. 114, 105002 (2015)

These two paired publications demonstrated the change of edge state when instability control is achieved, and the macroscopic nature of the non-axisymmetric field used to achieve control.

Research in Support of Industry: Research directly contributes to fusion commercialization in partnership with fusion developers by advancing the state-of-the-art of their confinement concepts.

I.G. Stewart, R.S. Granetz, C.E. Myers, **C. Paz-Soldan**, et al, Optimization of the equilibrium magnetic sensor set for the SPARC tokamak, Nucl. Fusion 63, 126014 (2023)

A.O. Nelson, D.T. Garnier, D.J. Battaglia, **C. Paz-Soldan** et al, Implications of vertical stability control on the SPARC tokamak Nucl. Fusion 64 086040 (2024)

A.F. Battey, C. Hansen, D. Garnier,D. Weisberg, **C. Paz-Soldan** et al, Design of passive & structural conductors for tokamaks using thin-wall eddy current modeling Nucl. Fusion 64 016010 (2024)

These three publications present recent research in support of the SPARC tokamak currently under construction, advancing the physics basis of several equilibrium and control phenomena.