



High-Performing Neutral-Beam Injection Systems and Their Development at TAE Technologies

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10th International Symposium on Negative Ions, Beams, and Sources –
NIBS'26
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About TAE Technologies

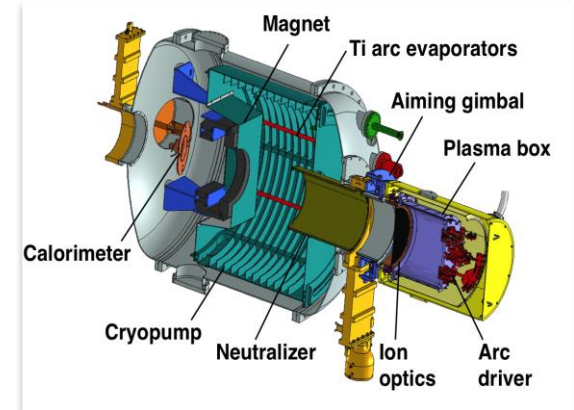
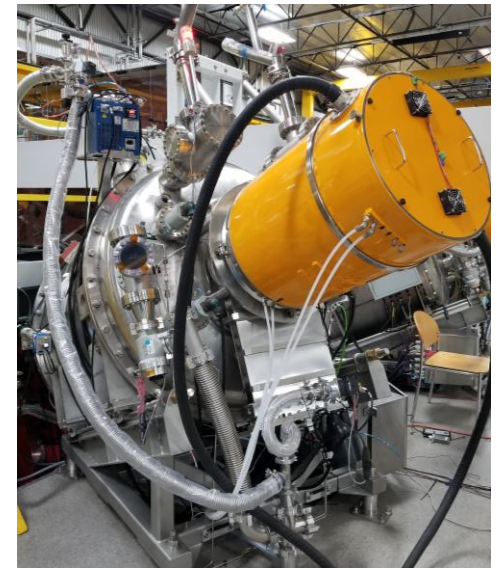
- Mission: To deliver clean and economically viable fusion power and fusion-derived technologies to solve existential human challenges
- Founded in beautiful Orange County, CA in 1998
- 550+ employees globally (US, EU, UK)
- National lab-scale fusion device
- Technology spin-offs
- Collaboration with academia and industry to accelerate progress: PPPL, ORNL, LBNL, LLNL, UCI, UCLA, UCSD, Univ. of Wisconsin, Univ. of Washington, U. of Pisa, Nihon U., Google, and more



TAE has developed proprietary NBs with unparalleled accuracy and precision

TAE has led the world in short-pulsed NB R&D for over a decade

- TAE spent 15+ years on-shoring this technology, the R&D and supply chain
- NB team comprised of world-leading experts in the field with decades of NB R&D experience
- NBs feature centrally into a number of fusion configurations, in addition to being core to TAE's Da Vinci and commercial power plant in guaranteeing superior confinement to enable higher temperatures for $p\text{-}^{11}\text{B}$ fuel
- TAE Beam UK (joint venture with UKAEA) has recently been established for long pulse, positive ion NB R&D and manufacturing



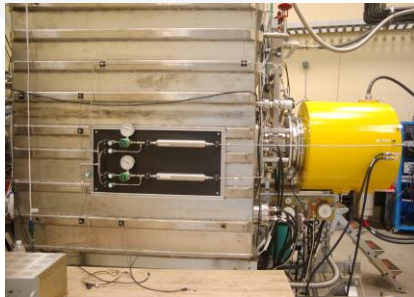
TAE has a long history of NB research and development

Short-pulse and tunable-energy beam technologies

	C-2		C-2U	C-2W (Norman/Norm*)	
Number of NBs	2	6	6	4	4
Plasma source	Arc	RF	Arc	Arc	Arc
Voltage control	Static	Static	Static	Static	Tunable
Accelerating voltage	20 kV	40 kV	15 kV	15 kV	15 – 40 kV
Ion current	40 A	40 A	150 A	150 A	up to 150 A
Pulse duration	5 ms	1 s	8 ms	40 ms	40 ms
Beam energy composition (full:half:third)	84:10:6	72:20:8	84:10:6	84:10:6	84:10:6
Power in neutrals (per beam)	0.6 MW	1 MW	1.6 MW	1.6 MW	1.6 – 3.5 MW

**Norm NBs to be upgraded in Norm-U (w/ higher energy & longer duration)*

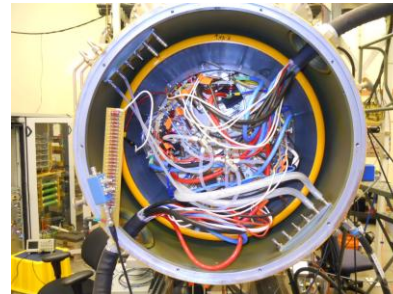
C-2 NB (RF Source)



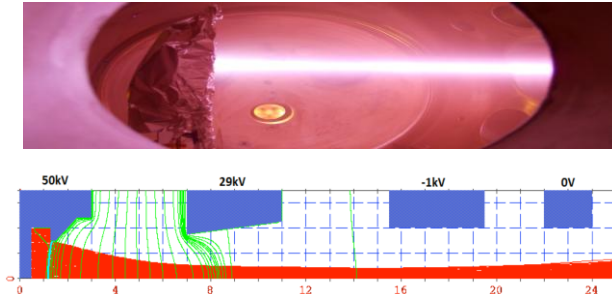
C-2 NB (Arc Source)



C-2U/W Static NBs



C-2W Tunable NB

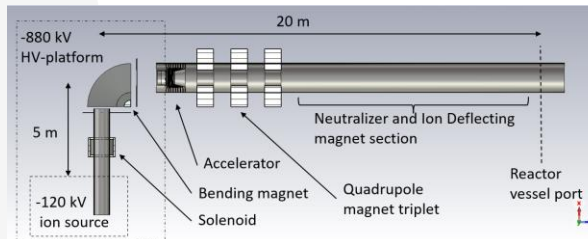


Da Vinci negative-ion-based NB injection system

R&D underway for next generation NBs

Target Specs for Da Vinci:

- Accelerating voltage, up to 1 MV
- Ion current per source, ~ 10 A
- Continuous operations (>1000 s)
- Neutral power, 5 MW per beamline



Distinct Features:

- Ion source is separated from accelerator section
- Low energy beam transport (LEBT) line includes beam deflecting magnet, pumps and Cs-traps
- Single-aperture accelerator is utilized
- Plasma or photon neutralizer is employed

NIBS'26 Presentations:

- 73. Operation, Performance, and Modeling of a Cesium-Free Negative Hydrogen Ion Source for a BNCT Accelerator (Poster – Session 1)
 - Vladislav Vekselman 9/21/26, 5:00 PM
- 66. Numerical Analysis of the Da Vinci project negative ion-based Neutral Beam Injectors (Poster – Session 2)
 - Ken Franzen 9/22/26, 5:00 PM
- 72. Conceptual design of a negative-ion-based neutral beam module for an FRC reactor prototype (Talk – S1)
 - Alexandr Ivanov 9/22/26, 8:55 AM

References:

- A.A. Ivanov *et al.*, Rev. Sci. Instrum. **85**, 02B102 (2014).
A.A. Ivanov *et al.*, AIP Conf. Proc. **1771**, 030012 (2016).

In Conclusion: We are Hiring!

- **Senior Design Engineer – Neutral Beams**

- Focus on designing high-energy ion sources, beamline components, used to heat and sustain plasma.

- **Accelerator Physicist – Medical Beams**

- Focus on developing, commissioning, and operating components, subsystems, and complete particle accelerators for medical and industrial applications.

- **Sr. Scientist – Neutral Beams**

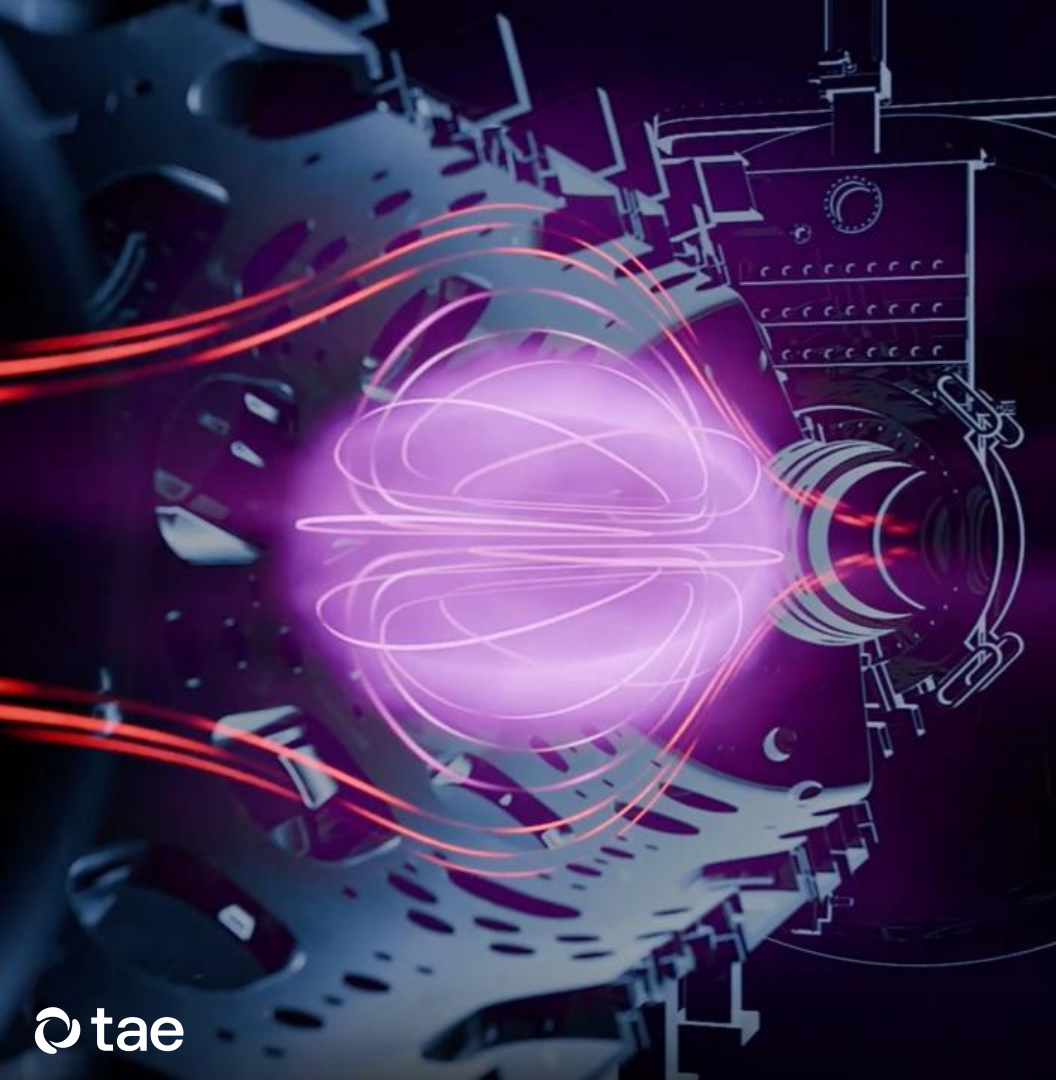
- Participate in development of the long pulse plasma sources (CW), extracting and accelerating systems, beamline components; conduct experiments with the plasma source and beam characterization, along with plasma generation and beam transport simulation.

- **R&D Engineer – Neutral Beams**

- Develop and design NB systems in collaboration with scientists and design engineers. Oversee NB manufacturing.



Thank You

A stylized illustration of a mechanical device, possibly a turbine or engine, with a glowing purple sphere in the center. Red energy lines or light trails swirl around the sphere and extend towards the left. The background is dark blue with faint mechanical outlines.

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