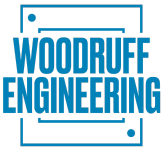


High Temperature Superconducting Solenoid Magnet System

Model WE-HTS-5T · 5 T Bore Field · YBCO Pancake Coil · Closed-Loop Cryocooled · 60 mm Free Bore



AVAILABLE FOR QUOTATION YBCO 2G HTS tape · 5 T bore / 8.2 T on conductor · Closed-loop cryocooled to 20 K · UHV compatible · 18–24 week lead time

Doc Ref: WE-HTS-DS-001 · Rev 01 · 2026-03-09

The Woodruff Engineering WE-HTS-5T is a cryocooled, high-temperature superconducting solenoid magnet system delivering 5 T in the bore and 8.2 T peak field on the conductor, within a 60 mm free bore suitable for in-vessel machine mounting. The system is built on YBCO (YBa₂Cu₃O₇) second-generation HTS tape—wound in pancake coils and stacked into a short solenoid—selected for its record engineering current density of over 1,000 A/mm² at 20 K, 20 T, as demonstrated in large-volume commercial production (Molodyk et al., Scientific Reports, 2021). Coils are housed in a stainless steel or aluminium vacuum jacket operating at $\leq 10^{-3}$ Torr (UHV-compatible to 10^{-6} Torr), insulated with multi-layer super insulation, and cooled to 20 K by a closed-loop two-stage cryocooler thermally coupled via OFHC copper—eliminating the need for liquid cryogens. Dual-technology cryogenic temperature sensors provide redundant monitoring; a resistive heating system enables controlled warm-up and in-vessel adjustment. Current feedthroughs are thermally optimised across the ambient-to-20 K gradient. A waveform-controlled high-current power supply is available on request. Delivered as a complete, factory-tested system pair including vacuum jacket, cryocooler, and power supply, priced at \$500k–\$750k USD including fabrication, test, and shipping.

KEY PERFORMANCE FIGURES

5 T BORE FIELD	8.2 T PEAK CONDUCTOR FIELD	60 mm FREE BORE DIAMETER	20 K OPERATING TEMPERATURE
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CONDUCTOR & COIL SPECIFICATIONS

Conductor Type	YBCO 2G HTS tape	YBa ₂ Cu ₃ O ₇ on Hastelloy C276 substrate
Tape Width	12 mm	Wound into pancake coils; production-slit from 12 mm master
Substrate	Hastelloy C276, 40 µm	Cold-rolled; biaxially textured IBAD-MgO buffer
HTS Layer	YBCO via PLD, ~2.4 µm	Y ₂ O ₃ nanoparticle pinning centres; no nano-columns
Eng. Current Density	J _E > 1,000 A/mm ²	At 20 K, 20 T (B//c); >2,000 A/mm ² at 4.2 K, 20 T
Critical Current	I _c ~175 A / 4 mm	At 77 K, self-field; averaged over production lot
Bore Field	5 T	Central axial field in 60 mm free bore

CRYOGENIC SYSTEM

Operating Temp.	20 K	Cryocooler-cooled; no liquid cryogens required
Cryocooler Type	Two-stage closed-loop	Options: SRDK-500B-F70LP; CH-110L series; KDE400SX
Cooling Capacity	>60 W @ 25 K	Min 100 W @ 77 K; min 20 W @ 20 K; target 60 W @ 25 K
Thermal Link	OFHC copper	High-conductivity oxygen-free copper from cryocooler to coils
Warm-Up System	Resistive heating elements	Sized for controlled warm-up and in-vessel adjustment
Temp. Sensing	Dual-technology sensors	Two independent sensor technologies for redundancy

Peak Conductor Field	8.2 T	Maximum field experienced by HTS tape
Coil Architecture	Pancake coil stack / solenoid	Stacked pancakes; mechanically restrained vs magnetic forces
Free Bore	60 mm	Clear inner bore for machine or experiment mounting

Lead Time	22-24 weeks (cryocooler)	KDE400SX: 3 months + He compressor; check current availability
Compressor	He compressor required	Supplied with SRDK-500B-F70LP and CH-110L options

VACUUM & MECHANICAL

Operating Vacuum	$\leq 10^{-3}$ Torr	Coil system operates within evacuated jacket
UHV Compatibility	$\leq 10^{-6}$ Torr	Full UHV-compatible design and outgassing specification
Jacket Material	SS 304/316 or Al 6000/7000	Customer-selectable grade; standard ASTM-compliant finishes
Insulation	Super insulation / MLI	Multi-layer super insulation or equivalent
Fasteners	Vacuum-compatible (ASTM E595)	All internal fasteners meet ASTM E595 outgassing spec
Mounting	Flexible / thermal-isolating	Allows movement due to thermal contraction and expansion

ELECTRICAL & POWER SUPPLY

Current Feedthrough	Ambient to 20 K	Thermally optimised; sized for available cryocooling budget
Heat Load (leads)	Minimised by design	Low-heat-load current leads specified per coil operating point
Power Supply	Waveform-controlled HV PSU	Available on request; configurable ramp, flat-top, ramp-down
PSU Reference	842010V06	18-20 week lead time; confirm availability at time of order
Supply Price	\$500k-\$750k USD (pair)	Includes coils, vacuum jacket, cryocooler, PSU, FAT & shipping
Delivery	FAT + shipping included	Factory Acceptance Test performed prior to shipment

KEY SYSTEM PARAMETERS

>1,000 A/mm² J _E @ 20 K, 20 T	>2,000 A/mm² J _E @ 4.2 K, 20 T	~175 A/4 mm I _C @ 77 K, S.F.	12 mm TAPE WIDTH	~2.4 μm YBCO THICKNESS	>60 W@25 K CRYOCOOLING	20 K OPERATING TEMP.
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Conductor performance per Molodyk et al., Scientific Reports (2021) 11:2084. J_E values on 40 μm substrate with 5 μm Cu stabiliser per side (56 μm total wire thickness). · Ref: WE-HTS-DS-001

KEY FEATURES

YBCO Pancake Coil Architecture 12 mm YBCO 2G HTS tape wound in pancake coils and stacked into a solenoid, mechanically restrained against magnetic forces and bonded for structural integrity.	No Liquid Cryogenics Required Closed-loop two-stage cryocooler (>60 W @ 25 K) replaces liquid helium or nitrogen, eliminating cryogen logistics and enabling long-duration unattended operation.	Record Engineering Current Density YBCO conductor with Y ₂ O ₃ nanoparticle vortex pinning delivers J _E > 1,000 A/mm ² at 20 K, 20 T in high-volume commercial production — exceeding SPARC fusion targets.
UHV-Compatible Construction Metal-jacketed vacuum system rated to $\leq 10^{-6}$ Torr with ASTM E595-compliant fasteners, MLI super insulation, and	Dual-Technology Temperature Sensing Two independent cryogenic sensor technologies provide fully redundant	Waveform-Controlled PSU Option Factory-matched waveform-controlled high-current power supply with programmable ramp, flat-top, and

flexible mounts for thermal expansion management.

temperature monitoring, with resistive heaters for precise temperature control and fast warm-up.

ramp-down profiles available on request (ref: 842010V06).

TARGET APPLICATIONS

Fusion Research

High-field solenoid magnets for magnetised plasma confinement, magnetised liner inertial fusion, and compact tokamak / spherical torus experiment inserts.

Beam Physics & Accelerators

Solenoid focusing and beam steering magnets for particle accelerators, free-electron lasers, and charged-particle transport lines requiring sustained high fields.

High-Field Science & Industry

NMR spectroscopy, MRI research magnets, materials characterisation in high field, and industrial process applications requiring cryogen-free superconducting solenoids.

Woodruff Engineering Inc.

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Available for quotation. \$500k–\$750k USD per pair incl. vacuum jacket, cryocooler, PSU, FAT & shipping.

Contact WE for custom bore, field, or geometry requirements.

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