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# [Invited] Assembly and Test of the world's first conduction-cooled NbTi Magnet System for Magnetic Density Separation

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We present the integration and initial test of the world's first superconducting magnet system for Magnetic Density Separation, from coil winding to cryostat assembly as well as first cool-down and energizing. Magnetic Density Separation is a relatively new separation technology that allows the simultaneous sorting of multiple non-magnetic materials based on their mass density by combining a ferrofluid with a strong vertical magnetic field gradient. To maximize the field gradient in the ferrofluid, the distance between the NbTi coils operating at 4.5 K and the room-temperature ferrofluid is minimized. This is made possible by two design choices: conduction-cooling allowing for a single-wall cryostat; and vertical 'stay rods'that support the flat top plate of the D-shaped cryostat from the stiff bottom, allowing for a relatively thin wall.
The magnet system is designed, engineered and assembled at the University of Twente and comprises 3 side-by-side 0.3 m $\times$ 1.4 m racetrack coils that are shrink-fitted in an aluminum alloy cassette, which provides thermal pre-stress to balance the Lorentz forces. The vertical magnetic field gradient at the bottom of the ferrofluid reaches 20 T/m. The coils are cooled to 4.5 K with a 1.5 W @4.2 K GM cryocooler. A particular design challenge is to minimize the cryogenic load to enable conduction cooling by meeting competing requirements imposed by the support structure, the heat load from the cold mass with a large surface area, and a significant attraction force between coils and ferrofluid.

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