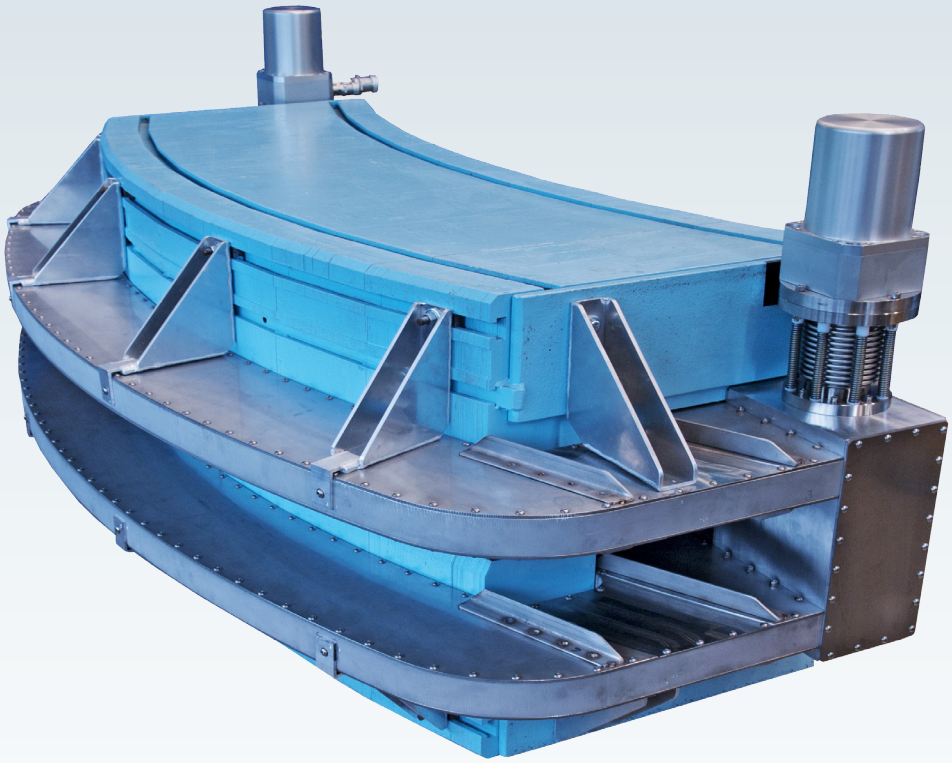
HTS Synchrotron Dipole Magnets

- Reduce energy usage by up to 90%
- High field possibilities: 1 - 3 tesla +
- Retrofit or new site options
- Payback in less than 5 years



Brookhaven National Lab Dipole Retrofit

Reverse-bend 22.5° angle dipole from NSLS VUV storage ring, using 60,000 amp-turns to deliver 1.4 tesla with 55 mm pole gap.

- Copper coils replaced with HTS
- Power usage reduced from 15kW to less than 7kW
- Significant reduction in cooling water required

HTS SYNCHROTRON DIPOLE MAGNETS

HTS-110

HTS - Less Electricity

With electricity prices continuing to rise, synchrotron owners face pressure on operating budgets. HTS-110's superconducting storage ring dipoles allow synchrotron owners to reduce their electricity bill by as much as 90%, potentially saving millions of dollars per year.

System overview

HTS dipoles look and operate much like conventional copper dipoles.

Traditional bulky copper windings are replaced with a low-profile vacuum chamber ("cryostat") that houses the HTS coils. In place of water cooling pipes, a liquid nitrogen circuit runs between groups of magnets. A centralised cryogenic cooling system can be used instead of a centralised water chilling system, and a small power supply replaces the traditional large, high powered resistive supply.

HTS dipoles can be utilised by synchrotrons in a number of scenarios, from retrofitting in place of copper coils in an existing dipole, through to a "cleansheet" approach, with full integration of HTS into new synchrotrons.

Energy Savings

The largest energy consumer in an HTS magnet is for the cryogenic system. A typical centralised cryogenic recirculation system suitable for a ring of 50 or more synchrotron dipole magnets, including cooler, pumps and other ancillary equipment, uses up to 50 kW. Power supplies suitable for the low voltage, high current requirements of HTS magnets add a further 5-10 kW.

The total energy requirement of an HTS system, at around 60 kW, is less than 10% of the energy requirements of a typical copper dipole magnet ring, which can consume upwards of 600 kW and up to 3 MW, continuous.

Other Benefits

In addition to substantial power savings, HTS dipole magnets allow synchrotrons the potential to use smaller magnets, providing more space for insertion devices. Also, HTS magnets provide the potential for much higher field dipoles, reducing storage ring size or increasing energy levels.

Reliability

HTS-110 knows that synchrotrons require ultra-reliable magnets that will last the lifetime of the synchrotron. Our designs integrate these requirements into all facets of the magnet and cooling system design.

Inside the magnets, HTS-110 has designed in reliability, using long-life vacuum seals, advanced monitoring electronics to prevent quenches from occurring, modular construction to allow user exchange of parts and mechanical design to predict the lifetime stresses.

HTS-110: Technology Leaders

HTS-110 has over 12 years of cutting-edge HTS magnet design and manufacture, with installations of custom and standard HTS products at premier research institutions around the world.

Brookhaven National Lab

HTS-110 engaged with the internationally renowned National Synchrotron Light Source at Brookhaven National Lab (New York, USA) to investigate the feasibility of replacing the copper coils in synchrotron dipoles with high temperature superconducting coils. A dipole from the NSLS VUV ring was chosen as the retrofit candidate.

The 55 mm pole gap dipole used a water-cooled 60,000 Amp-turn sagittal (reverse bend) copper coil pack consuming 15 kW to deliver the 1.4 tesla required for operation.

HTS-110 designed, manufactured and retrofitted HTS coils into an existing iron yoke, successfully testing at 1.4 tesla. Mechanical cryocoolers were used for the demonstration. As a result power savings of only 50% were achieved; in a commercial HTS installation a centralised nitrogen based cooling system would deliver substantially improved efficiency and cooling system reliability.

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