

## HTS/LTS Hybrid Dipole Magnets by the US Magnet Development Program

Paolo Ferracin<sup>3</sup>, Giorgio Ambrosio<sup>1,2</sup>, Kathleen Amm<sup>2</sup>, Michael Anerella<sup>2</sup>, Douglas Araujo<sup>4</sup>, Diego Arbelaez<sup>3</sup>, Maria Baldini<sup>1</sup>, Lucas Brouwer<sup>3</sup>, Marika D'Addazio<sup>3</sup>, Emanuela Barzi<sup>1</sup>, Lance Cooley<sup>5</sup>, John Cozzolino<sup>2</sup>, Laura Garcia Fajardo<sup>3</sup>, Stephen Gourlay<sup>1</sup>, Ramesh Gupta<sup>2</sup>, Mariusz Juchno<sup>3</sup>, Vadim Kashikhin<sup>1</sup>, David Larbalestier<sup>5</sup>, Vittorio Marinuzzi<sup>1</sup>, Igor Novitski<sup>1</sup>, Soren Prestemon<sup>3</sup>, Emmanuele Ravaioli<sup>6</sup>, Etienne Rochepault<sup>7</sup>, Jose Luis Rudeiros Fernandez<sup>1</sup>, Tengming Shen<sup>3</sup>, Reed Teyber<sup>3</sup>, Giorgio Vallone<sup>3</sup>, George Velev<sup>1</sup>, Ben Yahia<sup>2</sup>, Alexander Zlobin<sup>1</sup>, Xiaorong Wang<sup>3</sup>

<sup>1</sup>FNAL, Batavia, Illinois, USA

<sup>2</sup>BNL, Brookhaven, New York, USA

<sup>3</sup>LBNL, Berkeley, California, USA

<sup>4</sup>PSI, Villigen, Switzerland

<sup>5</sup>NHMFL, Tallahassee, Florida, USA

<sup>6</sup>CERN, Geneva, Switzerland

<sup>7</sup>CEA, Paris-Saclay, France

E-mail: [pferracin@lbl.gov](mailto:pferracin@lbl.gov)

**Abstract**—The next generation of High Energy Physics particle accelerators is expected to require superconducting dipole magnets with very high magnetic field. For some of the different scenarios under study, arc magnets capable of generating up to 20 T in the bore are considered to maximize the energy of colliding beams. This magnetic field level goes beyond the limits of the traditional superconducting materials used in accelerator magnets, namely the Low Temperature Superconductors Nb-Ti and Nb<sub>3</sub>Sn, and requires the use of so-called High Temperature Superconductors, like REBCO and Bi2212. The US Magnet Development Program (MDP) is currently designing and fabricating superconducting dipole magnets in hybrid configuration, i.e. characterized by HTS coil inserts surrounded by Nb<sub>3</sub>Sn inserts, with the ultimate goals of reaching a bore field of 20 T. In this paper we discussed the challenges of hybrid magnets in terms of magnetic design, mechanical integration, and quench protection, and we summarize the recent activities carried by the MDP collaboration aimed at the construction of HTS inserts and LTS inserts, first tested in stand-alone configuration, and then assembled and powered in hybrid configuration. In addition, the conceptual study of a future 20 T hybrid magnets is presented, and different possible lay-outs are analyzed.

**Keywords (Index Terms)**—Superconducting magnets, dipole magnets, Nb<sub>3</sub>Sn magnets, HTS magnets, hybrid magnets

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