SC Magnet Division – S&T Committee Program Review

BES – Basic Energy Science

G. Ganetis

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BES – Basic Energy Sciences

BES Programs that the SMD has supported and is in the process of supporting:

- **NSLS:**
  - Low temperature superconductor (LTS) & high temperature superconductor (HTS) magnet design & testing support
- **NSLS II:**
  - Room temperature magnet design for CDR
  - HTS magnet design
  - Power Supply design for CDR
- **Summary**

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- **NSLS – Magnet Testing Support**
  - In the past SMD has supplied cryogenic support for a LTS wiggler.
  - The magnet was tested in the 902 high bay in a small dewar.
- **SMD is presently supporting the Superconducting Undulator Vertical Test Facility "Fixture"**
  - Used to make cold Hall probe measurements on a LTS undulator.
  - Mounted in SMD's medium sized portable vertical dewar.
  - SMD is supplying cryogenic support, power supply and quench protection for the fixture
  - Mechanical Engineering support is also being supplied for future upgrades to the fixture.

NSLS – VuV ring Dipole magnet coil replacement:

- SMD, NSLS and HTS 110 (a New Zealand company) are working on a project to replace the room temperature water cooled copper coils with HTS coils.
- The goal is to have the HTS coils smaller in size than the room temp. coils.
- This will allow a larger opening angle so more infrared radiation can be collected for experiments.
- HTS 110 will be responsible for the design and construction of the coils. This includes the cryostat and cooling equipment (cryo-coolers).
- SMD will help with the design by doing 3-D field calculation of the end region of the HTS coil.

NSLS – VuV ring Dipole magnet coil replacement:

- NSLS will supply the final magnet specifications. SMD will measure the field of an existing magnet to confirm the field specifications.
- SMD is constructing a Hall probe array translation device to measure the field of the room temperature magnet. This device will also be used to measure the magnet when the coils are replaced with HTS coils.
- SMD will also assemble the HTS coils in the magnet iron and setup the cooling system.
- SMD will provide the power supply, quench protection, and all instrumentation systems for the HTS magnet test.

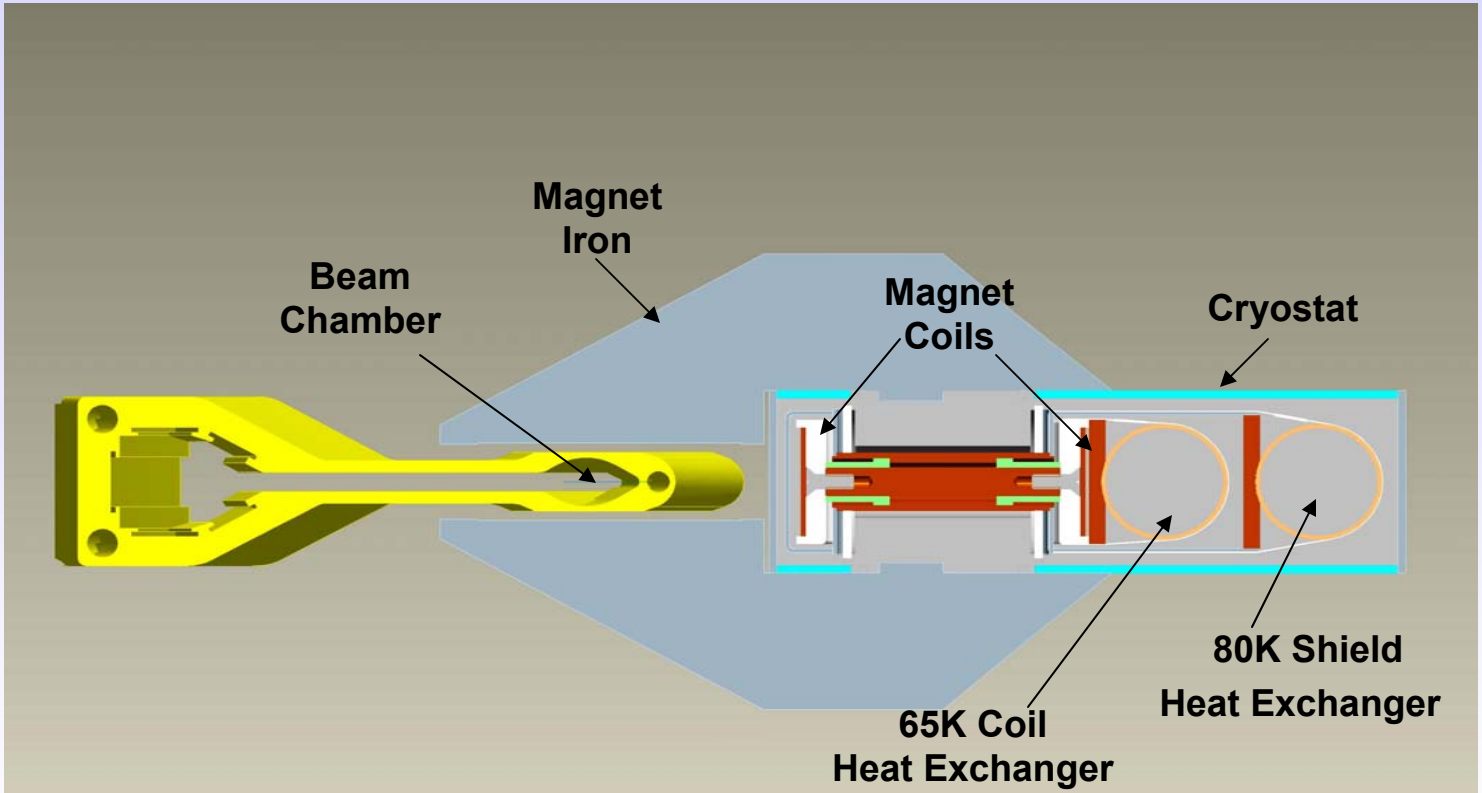
NSLS II – Room Temp. Storage Ring Dipole Magnet:

- SMD is doing the magnet design and writeup that will describe this magnet for the NSLS II CDR.
- These C-shaped magnets are low field (0.5 Tesla) and have a low current density in the water cooled copper conductor.
- SMD has done magnetic field modeling to get the magnet's iron dimensions.
- The mechanical design is now being done to develop 3-D models where cross section drawings can be made for the CDR.

NSLS II – HTS Storage Ring Dipole Magnet CDR: (1)

- SMD is to develop a conceptual design for a HTS magnet system that will be used for the dipole magnets for NSLS II.(A magnet that uses less energy is the motivation for this design study.)
- Using this conceptual design, SMD will produce an initial cost estimate for R&D, construction, and operations for this magnet system.
- R. Gupta has developed a warm iron C type magnet design where the field on the HTS coil is relatively low and uniform. The design has the coil on the back leg of the magnet. This design requires only one cryostat.
- The HTS coils are designed to operate at 65K.

  Alternate designs that operate at 35K will also be explored.



NSLS II Storage Ring HTS Dipole
Design Concept for LN2 Cooling

NSLS II – HTS Storage Ring Dipole Magnet CDR: (2)

- Magnet coils – SMD is investigating these design concepts:
  - Can HTS conductor be 1st or 2nd generation tape?
  - Conduction cooled coils operating in a vacuum.
  - Kapton insulated conductors.
  - Overall coil assembly vacuum impregnated with epoxy.
  - Interface to cooling system.
  - Interface to power leads.
  - Minimize temperature gradients along coil.
  - Minimize stresses of coil assembly during cool down and powering.

NSLS II – HTS Storage Ring Dipole Magnet CDR: (3)

- **Cryostat - design concepts:**
  - Low cost and low heat loss design
  - 80K shield with thermal intercepts on supports
  - Low heat loss coil support structure
  - Super insulation design
  - Power leads – conduction cooled or gas cooled ?
  - Cooling system interface
- **Cooling system - design concepts:**
  - 65K coil cooling system using sub-cooled liquid nitrogen heat exchanger.
  - 80K liquid nitrogen heat exchanger for heat shield cooling.
  - Vacuum pump requirements for sub-cooled nitrogen.
  - Nitrogen usage – cool-down and operation

NSLS II – HTS Storage Ring Dipole Magnet CDR: (4)

- **Cooling system – design concepts (cont'd):**
  - Individual magnet – piping, valves, and instrumentation.
  - Nitrogen distribution system – piping, valves and storage.
  - Safety Concerns – ODH, Low pressure cryogens, & ?
  - Controls for cool-down, warm-up, and operations.
  - Explore alternative 35K cooling system – Cryo-coolers
- **Magnet Iron - design concepts:**
  - Design of iron that meets beam & HTS magnetic field requirements.
  - Manufacturability – low cost design
  - Fringe field shields ?

NSLS II – HTS Storage Ring Dipole Magnet CDR: (5)

- **Magnet Tooling - design concepts:**
  - Coil winder, coil forms, vacuum impregnation tooling, etc.
  - Handling fixtures and assembly fixtures.
  - Test fixtures – mechanical, electrical, and magnetic.
- **Magnet Electrical - design concepts:**
  - Quench Protection
  - Power supplies
  - Instrumentation & interlocks
- **Manufacturing Plan**
- **Production QA Tests**
- **Installation Plan**
- **Cost Estimates**

NSLS II – Power supply Design for CDR:

- SMD is supplying an electrical engineer to work on power supply designs for both storage ring and booster.
- This work will also include the interfaces to the accelerator control system.

Summary :

- SMD is going to apply the design and construction experience of the many LTS magnet programs, and the newer HTS programs, to the BES tasks.
- We have a very broad range of design capabilities that can be used to develop new types accelerator magnets using HTS.