Superconducting Magnet R&D at Muons, Inc

Muons, Inc.
Innovation in research

Program Goals.

NATIONAL INSTRUMENTS

BROOKHAVEN NATIONAL LABORATORY

NCS

Fermilab

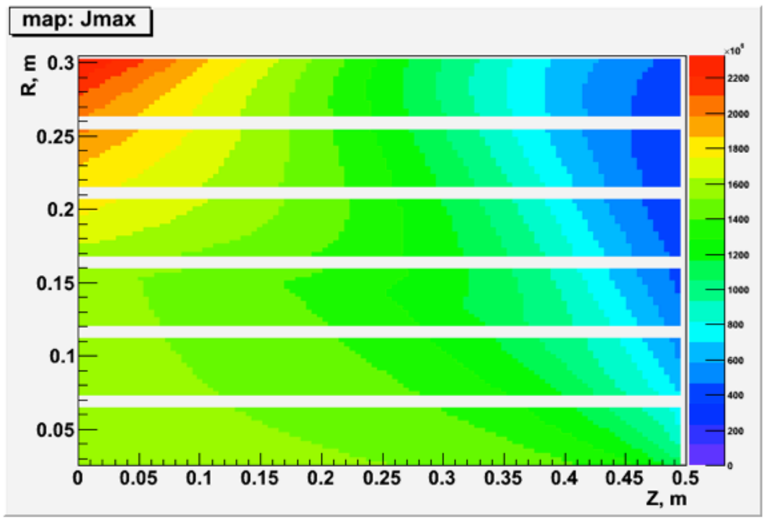
With our collaborators we are developing the enabling technologies for the next generation of energy and intensity frontier accelerator facilities.

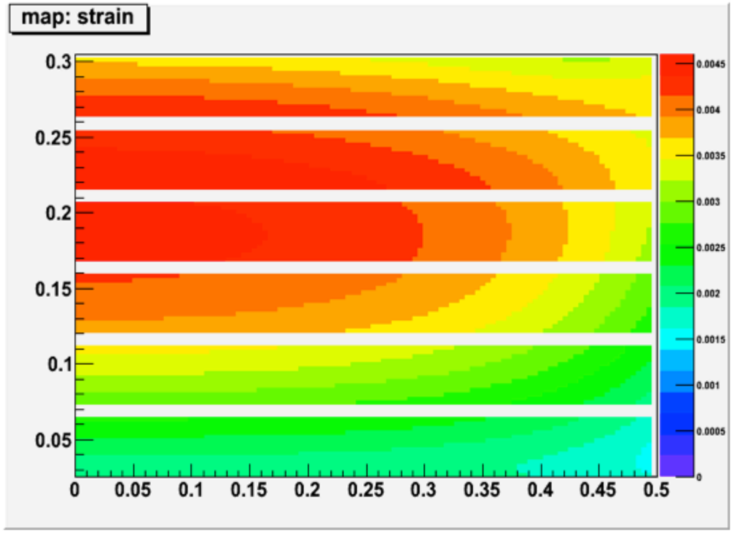
A Muon Collider (MC) is arguably the ultimate goal for any particle physics frontier program. The realization of a MC depends, in part, on the development of muon cooling techniques. Muon cooling requires cooling channels such as a Helical Cooling Channel and a high field final cooling solenoid.

The technologies we develop have significant importance to the energy sector via SMES and ADSR. The following slide show presents a brief summary of our R&D program.

High Field Solenoid Design

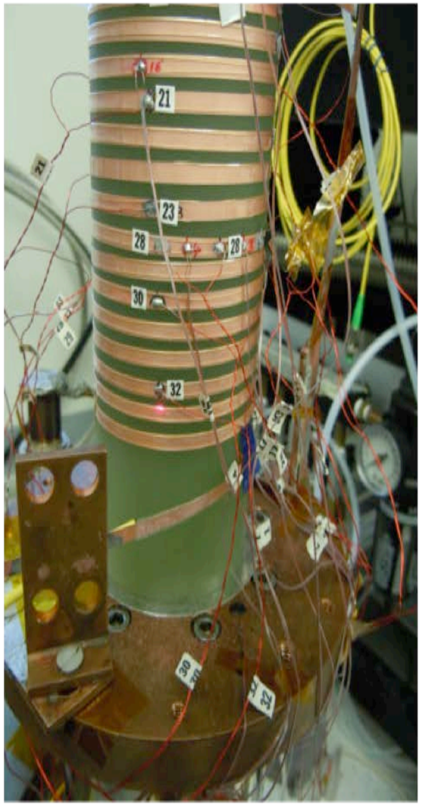
We have a conceptual design of a YBCO based insert for a solenoid achieving a 50 T magnetic field. We realize that this is an ambitious goal and that there may be issues that limit the performance below that value. Thus, we have examined magnet designs in the 30 T to 50 T range, all of which would be a significant improvement in magnetic field generation.

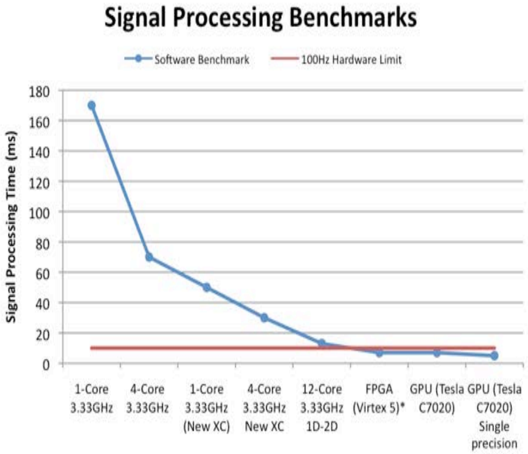


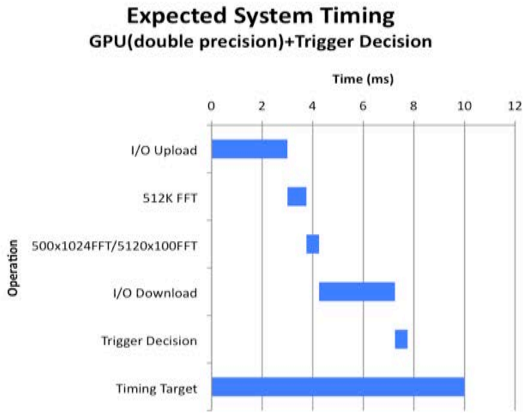


Maximum current density for the YBCO conductor as a function of of position in the coils in the 50T model (left), Tensile stain on the conductor as a function of coil position in the 50T model (right). Our design includes a Nb_3Sn & NbTi “outsert”.

Fiber Optics for Quench Protection





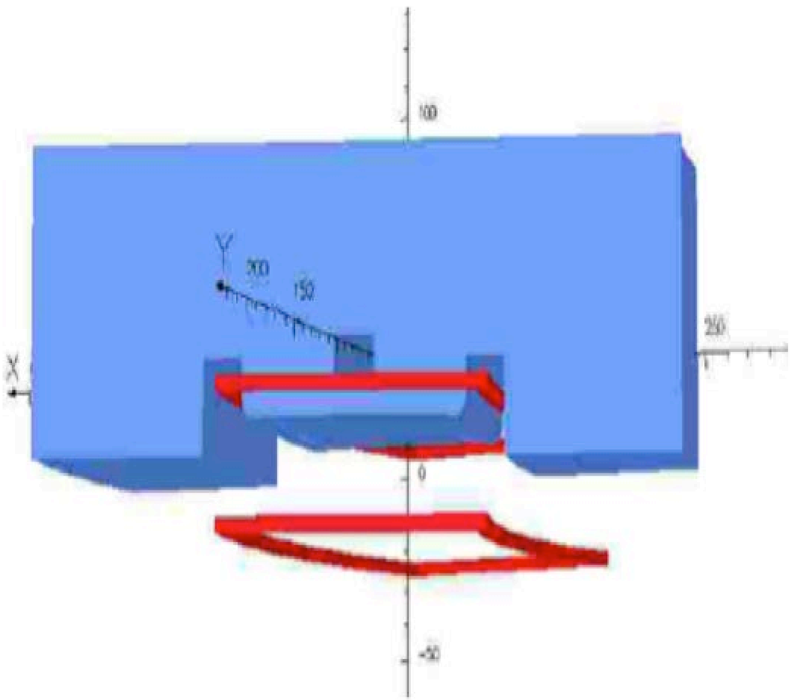


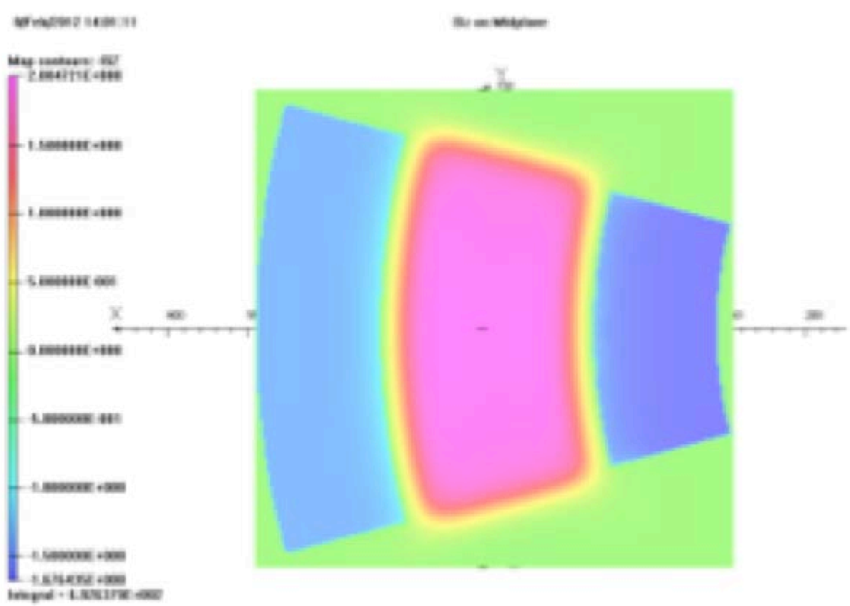
HTS magnets are well suited to applications which require the capability of generating large fields under stringent structural constraints. These magnets are however vulnerable to quench occurrence during operation.

Temperature and strain sensors based on fiber optics are being developed as a countermeasure to this contingency. Rayleigh Scattering based systems offer a promising solution to the HTS quench detection problem.

High Radiation Environment Nuclear Fragment Separator Dipole

We are developing magnets for the fragment separator region of the Facility for Rare Isotope Beams (FRIB). These magnets will be subjected to extremely high radiation and heat loads. Critical elements of FRIB are the dipole magnets which select the desired isotopes.



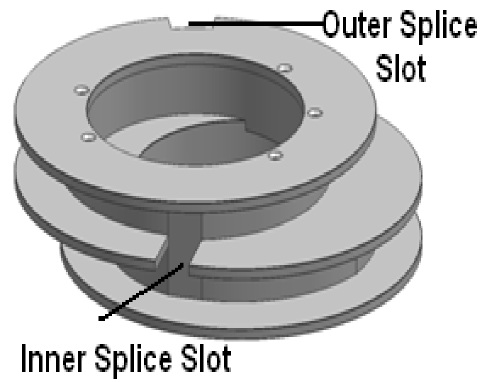


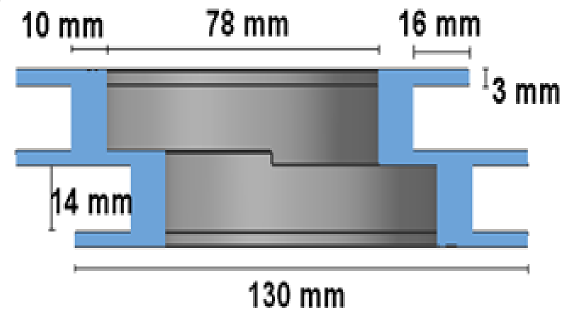
Helical Solenoids For Muon Beam Cooling

Muon beam cooling channels require complicated coils and high fields.

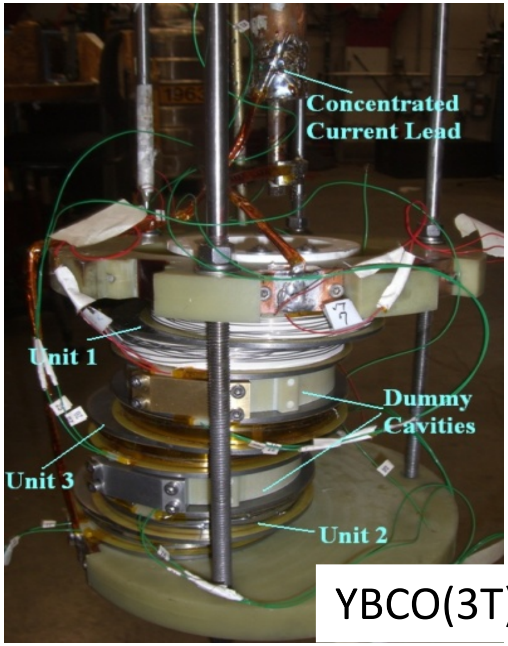
In out helical solenoid demonstration coils we explore the complexities of design and fabrication of coils that superimpose solenoid, helical dipole, and helical gradient fields that are needed to constrain the muon beams of the next generation energy and intensity frontier machine, the Muon Collider.

We are currently in the design stage of a 10T Nb3Sn demonstration coil (2013)





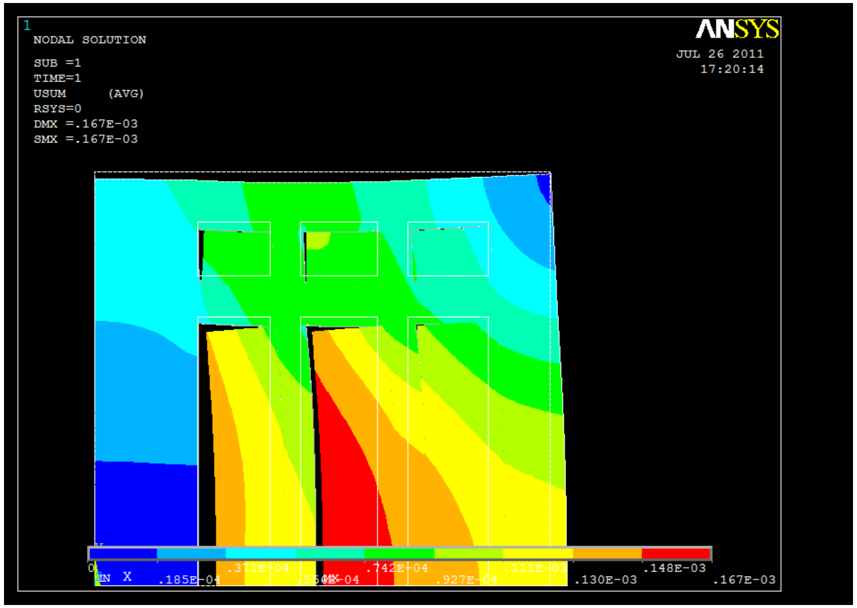

NbTi (5T)



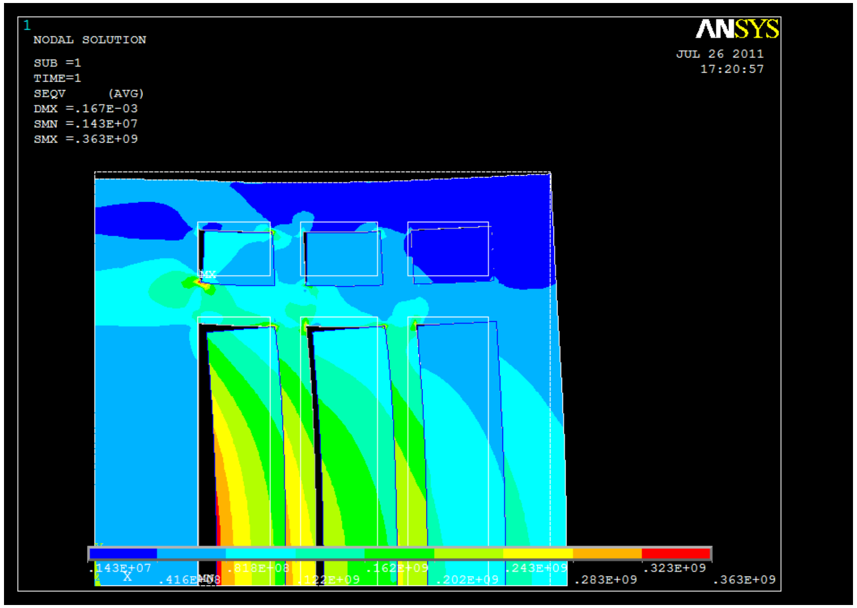
YBCO(3T)

Super Conducting Magnetic Energy Storage Devices

High field solenoid magnets may have an application as an energy storage device. Arrays of these magnets could store many mega-joules of energy. These high field magnets would be subjected to large Lorentz forces and these magnets would need to be designed to withstand these forces. Muons, Inc. has researched the mechanical design of a 25 T magnet for this purpose.



Distortions from Lorentz forces were less than 200 μm



Peak equivalent stress was less than 370 M Pa.