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# Conventional Magnet Measurement System Upgrade - Overview

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# Overview Outline

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- Current Capabilities
- Future Needs
- Requirements
- Context
  - Current Projects and Programs
  - Current Resources
- Summary

# Current Capabilities

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- Room Temperature “Conventional” Magnet Test Stands

[See link to review materials on Indico web page]

- 3 Stands for all styles Room Temperature Accelerator Magnets
  - Rotating Coil (strength, harmonics); Flat Coil; 1,2 Wire Stretched Wire
  - NMR, Hall probe 3-axis Point Scan (field mapping)
- “CHISOX” Framework
  - Sybase RDB on SunOS 4 (frozen)/Sparc20 [c1995]
  - Captures all installed instruments, probes, procedural steps, data
  - Scripted analysis tools
  - Measurement Archive since FMI production
- VME/VXI electronics [c1994], Sparc5 and Force bd controllers
  - Metrolab Precision Digital Integrators (not available)
- Variety of Power Supplies, up to 10 kA
  - Unix/NIM Power Supply Control; precision DCCT, DMM readout
- >30-year-old Mechanical Motion Stages, Motor Control
  - Thompson rails & bearing blocks, Whedco motors and drivers

# Current Capabilities

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- Other Deployed Magnet Measurement Systems
  - Mobile systems, including for SC and specialized magnet R&D
  - Rotating Coil Magnetic Measurements
    - EMS Framework [c2002]
      - Java, C/C++, Python, xml, OODB
    - PDI Cart [c2002], VME/vxWorks, Metrolab PDI
    - DSP Cart [c2004], VME/VxWorks, Fast ADCs+DSP
    - DSA Cart [>2010] Under Development, NI DSA+FPGA
  - Single Stretched Wire & Vibrating Wire System
    - EMMA Framework, completed system [2016]
    - Metrolab FDI; modern Aerotech Motion control & stages
    - Keyence fast precision wire position sensors
  - Voltage Spikes, Inductance, Splice Resistance
    - Stand Alone LabView; PXI chassis, NI DAQ, Windows OS

# Future Needs

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- Three Room Temperature test stands
  - Ongoing Accelerator Support < ~50 magnets/year >
  - Proton Improvement Plans (PIP-I+, PIP-II, PIP-III)
  - LBNF/DUNE Beamline ~100 magnets
  - Historically the right number of stands
    - to handle the volume of measurements
    - with special features distributed to manage the diversity
      - Range of DC currents, AC magnets, field mapping, thermal tests
    - to provide redundancy and moderate schedule risk
- HL-LHC Test Stand 4 Production Measurements
- High Field SC Magnet R&D
- Preservation of all archived data and results
  - Traceability

# Requirements

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- Replace CHISOX, Sun Systems, VME/VXI electronics, Unix PS Control, Motion systems as soon as possible: goal by 2021
  - This is an identified Enterprise Risk and longstanding concern
  - The system is quite complex, replacement must meet same criteria
  - Diagnostics and Repairs have become increasingly costly
  - Component replacement has become increasingly difficult
- Vision for the Magnet Test Facility
  - Modernize other unix/VME and LabView-based control and monitoring systems with a common technological foundation
  - Integrate all the test & measurement systems into a common software framework to assure reliable, efficient operation, maintainability and quality
  - Ensure adequate skilled staff to support ongoing test & measurement operations, system maintenance over anticipated >10 year life cycle

# Current Magnet Sector DOE Projects

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- Command Significant MSD, T&I Resources, Schedule Priority
  - Mu2e Solenoids [2014 through ~2020]
    - Transport Solenoid Production Field Angles (SSW)
    - Field Mapping System
    - TS Test Stand, Production Test Support, HTS Leads testing
    - All Instrumentation, Controls & Monitoring, Quench Protection
  - HL-LHC Magnets [2019 - 2024]
    - Magnet Cryo Assembly, Instrumentation
    - Measurement System (Rotating Coil), production measurements
  - HL-LHC Test Stand 4 [2019 - 2024]
    - Measurement System, Controls & Monitoring, Quench Protection
  - LCLS-II CM Instrumentation [2015 through 2020]
  - PIP-II CM Instrumentation [starting now]
  - LBNF [starting now]

## Other Programs

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- Accelerator operation support, old data analysis
- High Field Magnet R&D
  - VMTF Operation and Upgrades
  - Expansion of facilities for Magnet Development Program
- Support, maintenance, upgrades of critical systems
  - SELVA coil winding machine for HL-LHC
  - Databases, Servers, Backups, DAQ Computers, Security



- Magnet Systems
  - Measurement & Analysis Group – 4 + 1G
    - Requirements, Measurement Probes, DAQ Development, Analysis Tools
    - Magnet & Instrumentation Devel., Tests, Analysis, Project Management
- Test & Instrumentation Department
  - Computing and Software Development
    - System operations, maintenance and improvements – 2.5
    - Software development – 1.5 + new CE-I hire
  - Instrumentation and DAQ Systems
    - Electronics/Electrical Engineering – 3 Senior, 3 Junior
    - Electrical Technical Support – 3+2C (Magnets), 5+2C (CM)
  - Mechanical Systems
    - Mechanical Engineering – 2 + ME-II opening
    - Mechanical Technical Support – 4 + 2C

## Summary

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- Our goal is replacement by 2021 of the Room Temperature Measurement Systems with new electronics, computers, DAQ and data management software, mechanical components
- The systems we must replace are complex, and we have been developing the solution for a number of years
- Our road map is based on a software framework that is flexible and extensible to other aging and new magnet test and measurement systems
- Progress has been driven by outside projects, and ongoing operations that compete with high priority for limited resources (all categories), and slowed by shortage of resources in particular skill areas (software development)