Work Request Status
DSG-HDIce

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HDIce Experiment

- Frozen spin target made of hydrogen and deuterium.
  - Aluminum wires remove heat from target.

See [HDice Target](#) talk June 2015 in the DSG website DSG/Talks
Original Work Request

• Hardware:
  – Search for semi-flexible NMR cables, with low loss and low or controlled temperature variation.
  – Construct 2 sets of duel cables with lengths adjusted to operate on $\lambda/2$ resonance, with tuned NMR circuit ($R_L, C_L$).
  – Build 2 low-noise variable-capacitance RF tuning ($R_L, C_L$) boxes.
  – Install a precision (temperature-stabilized) shunt to directly read the current from Oxford supplies that drives the magnets used for NMR-2 shunts, one for each NMR rack.
  – Debug and finish existing NMR control codes.
Original Work Request

Software:

- Finish RF distribution and attenuation control to display current settings on attenuator box, and integrate into NMR control codes so that changes are reflected in display.
- Incorporate precision shunt into field controls.
- Re-activate component-ID key portion of NMR control codes to allow VI to distinguish between different cables.
- Modify NMR control program to run NMR scans with both positive and negative currents in magnet power supply.
- Re-activate online noise analysis VI.
- Write VI to control 2 power supplies to rotate HDIce target polarizations (by varying currents in both solenoid and saddle coils).
Examples of Additional Work Requests

- Insulate Rack 1 and Rack 2.
- Redo grounding wires in Rack 1 and Rack 2.
- Replace and test Pump Cart cRIO.
- Incorporate Mercury iPS power supply into RTP program.
  - Code had to be re-written for VISA drivers. Mercury iPS did not have GPIB, which is what old Oxford supplies had.
- Make T-down and T-up variable times in NMR program.
- Add T-bot and T-wait to NMR program.
- Add synchronization to NMR program.
Examples of Additional Work Requests

• Incorporate temperature and liquid helium level sensors into NMR program.
• Update all programs to latest version of LabVIEW.
• Update Rack #1 PC to Windows 10.

NMR Racks Built by DSG

- Isolated racks.
- Fabricated and installed RF cables.
  - Low-noise
  - Semi flexible
- Built RF Attenuation and Distribution Box.
- Incorporated CAENels CT-Box.
  - Installed in Rack #1.
- Upgraded Rack #1 computer to Windows 10.
  - Rack #2 computer is Windows 7.
  - Needs to be updated to Windows 10.
- Created documentation for both racks.
RF Attenuation and Distribution Box Built by DSG

- Two boxes upgraded, one box built new.
- Upgraded existing boxes to display current settings and integrated into NMR control so that changes are reflected in display.
- Redesigned
  - RF Attenuation Daq modules interface for component-ID key reading.
  - Redesigned and rewired modules’ connections.
Controls nitrogen and helium for In-beam cryostat (IBC).

- Replaced and tested cRIO.
- Created flow chart of Pump Cart program.
Software Work Done by DSG

• Developed Rotation of Target Polarization program.

• Modified programs.
  – Fast Resonance Scanner.
  – Nuclear Magnetic Resonance.

• Updated to latest version of LabVIEW.

• Developed documentation for all programs.
  – Flow charts in Visio.
  – Instrumentation manuals.
Rotation of Target Polarization

• Rotates spin direction for target polarization.
• Varies currents in both solenoid and saddle coils.
• Created and demonstrated RTP program.

• Features:
  – Controls two power supplies (axial and transverse [saddle]).
  – Includes Automatic mode and Manual mode.
  – Program developed for Mercury iPS (new supplies, no GPIB).
    ▪ Updated drivers to VISA.
Rotation of Target Polarization

![User Interface Diagram](image_url)

**Program Control**
- Exit Program: Off
- Manual/Automatic Mode: Automatic Mode
- Transverse Ramp Hold: Off
- Axial Ramp Hold: Off

**Transverse Power Supply Status**
- **LOC/REM**: Local & Locked, Remote & Locked, Remote & Unlocked
- **Mode**: At Rest, Sweeping
- **System Status**: Normal, Out of Limits

**Axial Power Supply Status**
- **Activity**: Hold, To Set Point
- **Axial Current**: 13.899 Amps
- **Axial Field**: 0.0172 T
- **Axial Ramp Rate**: 3 Amps/Min
- **Axial Ramp Rate**: 0.004 T/Min

**Automatic Mode**
- **Rate**: 3 Amps/Min
- **Wait Time**: 10 Sec

**Expert Controls**
- **Step % of Completion**: 0%
- **Ramp Type**: Negative

**Diagram Description**
- Ramping Axial Supply to 10.2 Amps at R1 Ramp Rate
- Axial Current Diagram
Fast Resonance Scanner Program

• Sweeps RF frequency at constant magnetic field.
  – Determines RF parameters for setting up NMR run conditions and calibration constants.

Resonance peak at 2857 KHz

• Incorporated into LabVIEW NMR program file.
NMR Program

• Sweeps magnetic field at a constant RF frequency.
  – Measures actual NMR signals for monitoring and analyzing polarization.

• Rewritten to include
  – Varying T-up, T-down, T-bottom, and T-wait times.
  – Varying field ranges (original range was fixed at 300 G).

• Implemented signal averaging.

• Modified to run scans with positive and negative current.

• Features added to program with option to enable and disable:
  – Synchronization Mode.
  – Sensors for temperature and liquid He level.
NMR Program

- Signal averaging.
  - Red lines in graphs.
  - Averaged over cycle number.

- X-values and Y-values from lock-in amplifier.
  - Auto-scale to ensure signal is visible.
Synchronization of CT-box with Lock-in Amplifier

• Synchronization incorporated into NMR program.
  – Provides an independent and accurate ( <0.01%) magnet current measurement.
  – Current measurements are synchronized with lock-in amplifier measurements.
  – CT-Box maximizes number of acquisition points for variable NMR sweep lengths (up to 16,000 points, limited by memory of lock-in amplifier).
  – Stores measurements in NMR data files.

  – See Synchronization Status talk in March 2018 in the DSG website DSG/Talks
CAENels CT-Box Current Shunt

- New product by CAENels.
- Required extensive development of library of LabVIEW device drivers (55 to 60).
- LabVIEW Daq code developed using DSG device driver library to test CT-Box.
Synchronization Programs

- CT-Box data acquisition program.
  - Created to measure current from output of power supply.
  - Tests CT-Box’s frequency-dependent data acquisition and CT-Box’s triggering.

![DAq Program](image)
Synchronization Programs

• Lock-in amplifier test program.
  – Used with CT-Box data acquisition program to test following:
    ▪ Lock-in amplifier data acquisition.
    ▪ Data buffer storage and read-out.
    ▪ Lock-in amplifier dual data stream.
    ▪ Lock-in amplifier external triggering capabilities and limitations.
Mathematica

- Program originally from Brookhaven.
- Creator of program no longer employed.
  - Could not obtain needed information to further program.
- Cancelled.
HD Ice Current Problems

• Rack #1 upgraded Windows 10 PC would not update to version 1809.
  – Computer center is performing update.

• Dilution fridge card tripping off power supply.
  – DSG looking at problem.

• Quench occurred in transfer cryostat magnet.
  – Caused damage to magnet winding.
  – Magnet winding not yet started.
    ▪ Will take ~6 weeks.
Work Requests Pending Approval

• Upgrade of Rack #2.
  – Procurement of second CT-Box.
  – Update of existing PCs to Windows 10.
  – Waiting for CT-Box analysis so second CT-Box can be ordered?

• Create NMR program that varies frequency with fixed current.

• Look into development method for beam position monitor.
Conclusion

All requests completed as of July 2018.

• Rack #2 completed July 2016.
• Rack #1 completed July 2018.
  – Since August 2018, DSG has been addressing issues presented by HDIce as they are requested.
    ▪ These requests are listed as Additional Work Requests.

DSG staff involved in this project:

Mary Ann Antonioli, Peter Bonneau, Pablo Campero,
Brian Eng, Amanda Hoebel, Mindy Leffel, and Tyler Lemon