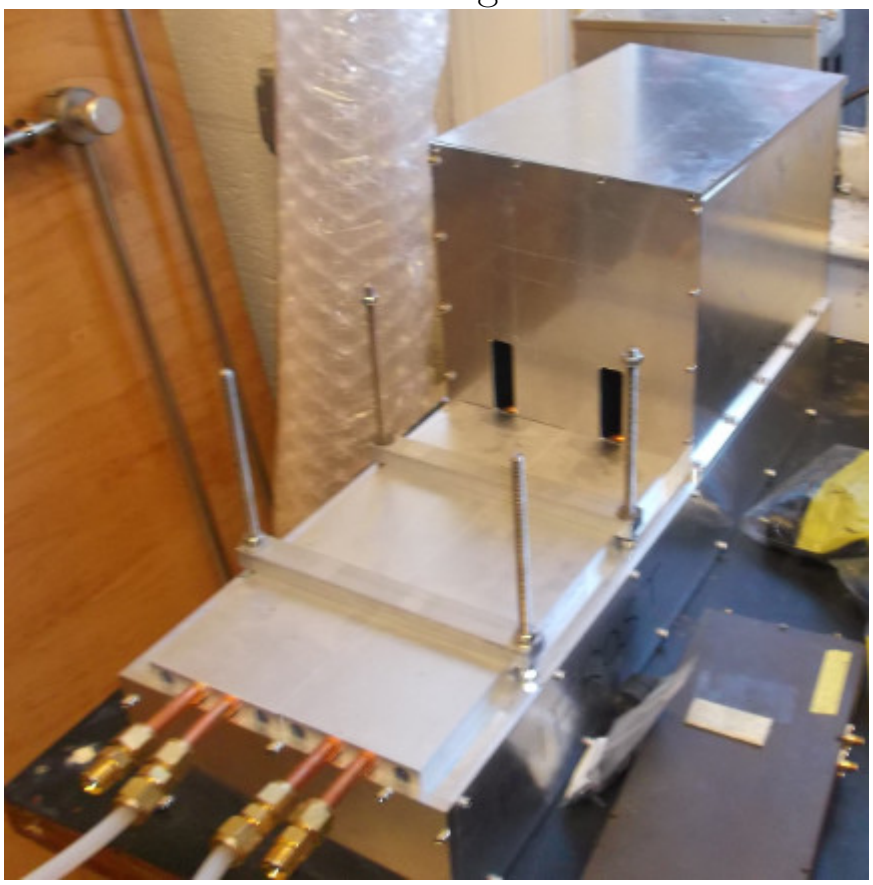
Yale Card Housing Installation



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Abstract

This document is meant as a guide for physically and electronically installing a Yale Card for use with a polarized target NMR system. We call the installation assembly a **Yale Card housing**, or sometimes *NMR housing* or even just *housing*. Some implementation-specific details are left out, e.g., chilled water plumbing, but we include the details that we think future researchers will find helpful.

1 Wiring Information Source

The original Liverpool documentation for Yale Cards exists, but we found it difficult to distill practical installation instructions from it. Instead, we traced the electronics of a so-called "Liverpool Yale Card Box", a gold plated enclosure resembling a QMeter that contains a Yale Card and necessary feedthroughs.

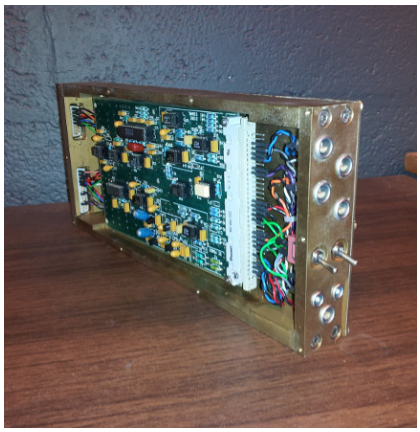

Figure 1: Liverpool Yale Card Box

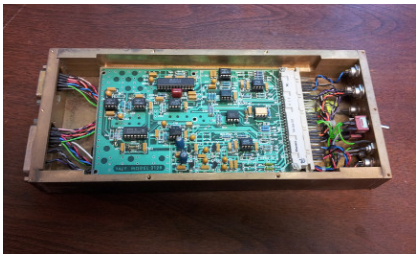

Figure 2: Liverpool Yale Card Box

There are certainly other valid ways to hook up a Yale Card, but we have only tried to do it by modeling our system after Liverpool's.

2 Interfaces

The housing interfaces are how we hook up electronics and plumbing. They consist of the following:

- a 15-pin DSub connector for the power supply
- 2 standard plumbing connectors for circulating chilled water
- a 25-pin DSub connector for a Q-Meter
- DC monitor coaxial outputs
- "phase out" detector coaxial output
- "diode out" detector coaxial output
- 2 manual switches for gain (optional, see Section 7)
- an optional DIO connector (implementation dependent, controls DC convert, reed relay, electronic gain switches)

One complete set of connectors must be installed for each QMeter/Yale Card pair, excepting the power supply and water connectors which can serve the whole box if routed properly. There may be only one DIO connector depending on how the DAQ and control is designed.

3 Housing Frame

We do not give drawings or details of actual housing construction. Instead, here are photos of the two-card Hifrost housing (also see title page) and the six-card PTGroup housing. Actual dimensions will depend on how many QMeters/Yale Cards will be installed. Approximate size is 12 x 24 inches.

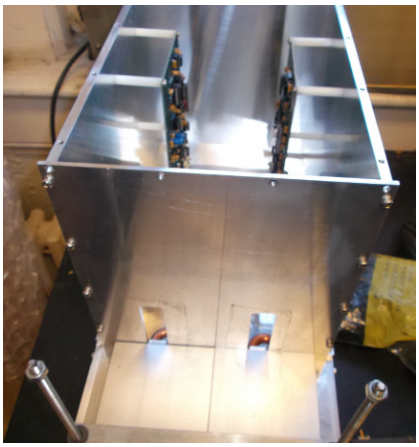

Figure 3: Hifrost housing

Figure 4: PTGroup housing

The housing must have the following characteristics:

- metal (we used aluminium)
- entirely encloses Yale Card to keep out RF noise
- copper plumbing for circulating chilled water to flow and cool a (horizontal) plate
- room for a QMeter to sit on said chilled plate
- mechanism to anchor down the QMeter (see threaded rods in photos above)
- room for DSubs and coaxial feedthroughs
- a thermistor nearby the QMeters (monitoring temperature stability)

We recommend designing the lid to secure with just a few screws or latches to prevent lazy lab workers from leaving it open.

4 Yale Card Installation

As shown in Figures 5 and 6, the Yale Card is installed inside the housing and secured with standoffs for electronic and thermal isolation from the aluminium walls.

The Yale card interface is a 64-pin, two row DIN style “Burndy” connector. Its mating receptacle is an obsolete part identified by the following:

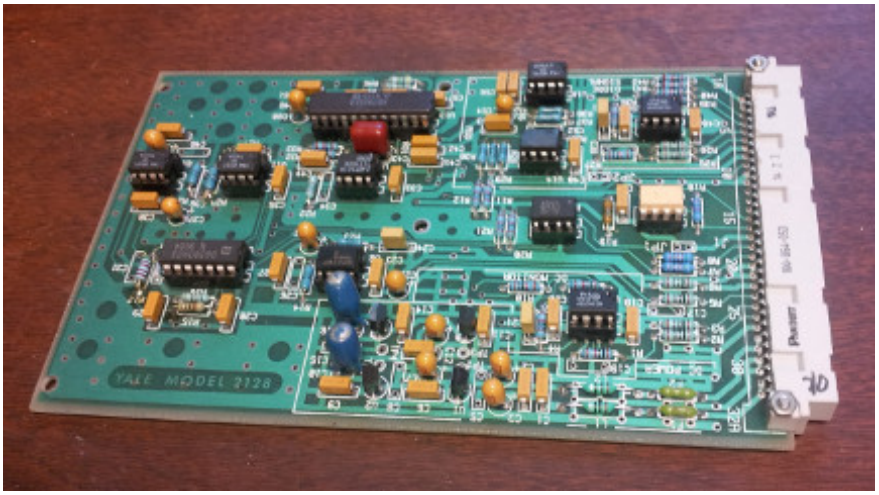

Figure 5: Yale Card

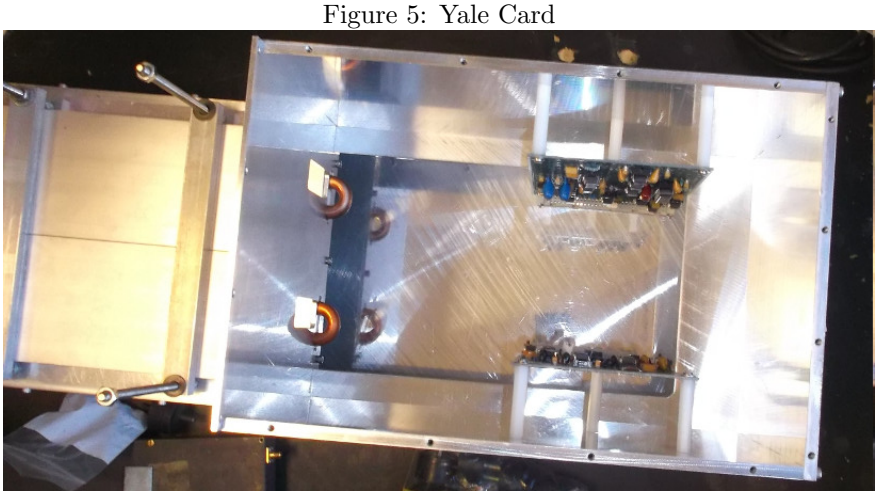

Figure 6: A look down the Hifrost housing installation; Yale Cards mounted with struts to aluminium walls; copper tubing can be seen coming from under the chilled QMeter plate.

- Manufacturer: FCI
- Part Number: 86092646114755E1LF
- Description: DIN 41612 Connector 64P 2ROW A+B STRAIGHT RECEPTACLE
- Number of Rows: 2
- Pitch: 2.54 mm
- Termination Style: Solder
- Mounting Angle: Straight
- Current Rating: 1.5 A

Make the connections from the Yale Card to housing according to the following table:

Pin #	**goes to**	**color**
YC1	NC	
YC2	NC	
YC3	25D20	black
YC4	25D8	gray
YC5	Diode out	black
YC6	Diode out	blue
YC7	NC	
YC8	25D23	black
YC9	25D11	purple
YC10	NC	
YC11	NC	
YC12	NC	
YC13	NC	
YC14	NC	
YC15	DC Convert	black
YC16	DC Convert	red
YC17	Reed relay	black
YC18	Gain switch Hi	green
YC19	Gain switch Lo	green
YC20	NC	
YC21	NC	
YC22	Phase out	black
YC23	Phase out	orange
YC24	DC monitor	black
YC25	DC monitor	gray
YC26	NC	
YC27	25D4	blue
YC28	NC	
YC29	25D17	black
YC30	25D16	black
YC31	25D3	red
YC32	NC	

Note that appropriate black/color pairs are in twisted-wire configuration (See Figure 7). The coloring convention came with the Liverpool boxes and we kept them for our setup - they are here for our reference only.

Figure 7: Yale Card Wiring

5 QMeter Connector

The QMeter interfaces with the housing via a 25-pin DSub. Connect it according to the following table:

Pin #	goes to	color
25D1	15D1	pink
25D2	15D2	orange
25D3	15D3, YC31	red
25D4	15D4, YC27	blue
25D5	15D5, RRs	green
25D6	NC	
25D7	NC	
25D8	YC4	gray
25D9	NC	
25D10	NC	
25D11	YC9	purple
25D12	NC	
25D13	NC	
25D14	15D9	black
25D15	15D10	black
25D16	15D11, YC30	black
25D17	15D12, YC29	black
25D18	RR	white
25D19	NC	
25D20	YC3	black
25D21	NC	
25D22	NC	
25D23	YC8	black
25D24	NC	
25D25	NC	

The solder side of the QMeter DSub is shown on the left in Figure 8.

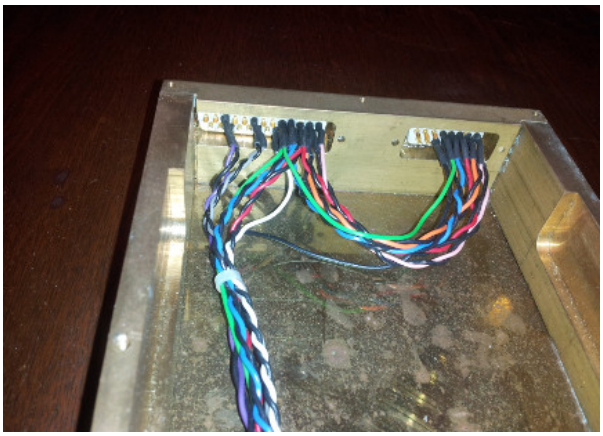

Figure 8: 25-pin DSub and 15-pin DSub connectors

6 Power Supply Connectors

The power supply is connected through a 15-pin DSub receptacle (right side of Figure 8). All pins connect directly to the QMeter's 25-pin DSub except for the reed relay. Connections and pin voltages as follows:

Pin #	**goes to**	**color**	voltage
15D1	25D1	pink	+24 V RF
15D2	25D2	orange	+15 V RF
15D3	25D3	red	+15 V LF
15D4	25D4	blue	-15 V LF
15D5	25D5	green	+5 V (switching)
15D6	NC		
15D7	NC		
15D8	NC		
15D9	25D14	black	
15D10	25D15	black	
15D11	25D16	black	
15D12	25D17	black	
15D13	Reed relay	black	
15D14	NC		
15D15	NC		

NB: nobody seems to know what RF and LF mean. If you ask around, somebody will invariably suggest "radio frequency" and "low frequency", which doesn't really make sense given they're all DC voltages.

7 Gain Switching Connections

Except for the gain switches, every connection between the QMeter, Yale Card and power supply is very straightforward. There are a few cases where two wires go to a single pin, e.g. 25D4 connects to both 15D4 and YC31, but that's as complicated as it gets.

The gain switches are the exception and require some attention. Their topology is shown in Figure 9.

The manual gain switches (MGS) and coaxial gain switches (CGS) are in parallel so gains are controlled with either. PTGroup does not use (or even have installed) MGS; we exclusively control gains from PDP.

8 Coaxial Feedthroughs

For coaxial connections, the Liverpool box uses 3-pin Lemos, of which two pins are connected. Hifrost uses BNC connectors and PTGroup uses 2-pin Lemo connectors. Choose which coaxial connector to use based on shielding requirements and how much space there is available on the housing.

9 Final Design Thoughts

Figure 10 shows the final NMR setup and demonstrates some pitfalls.

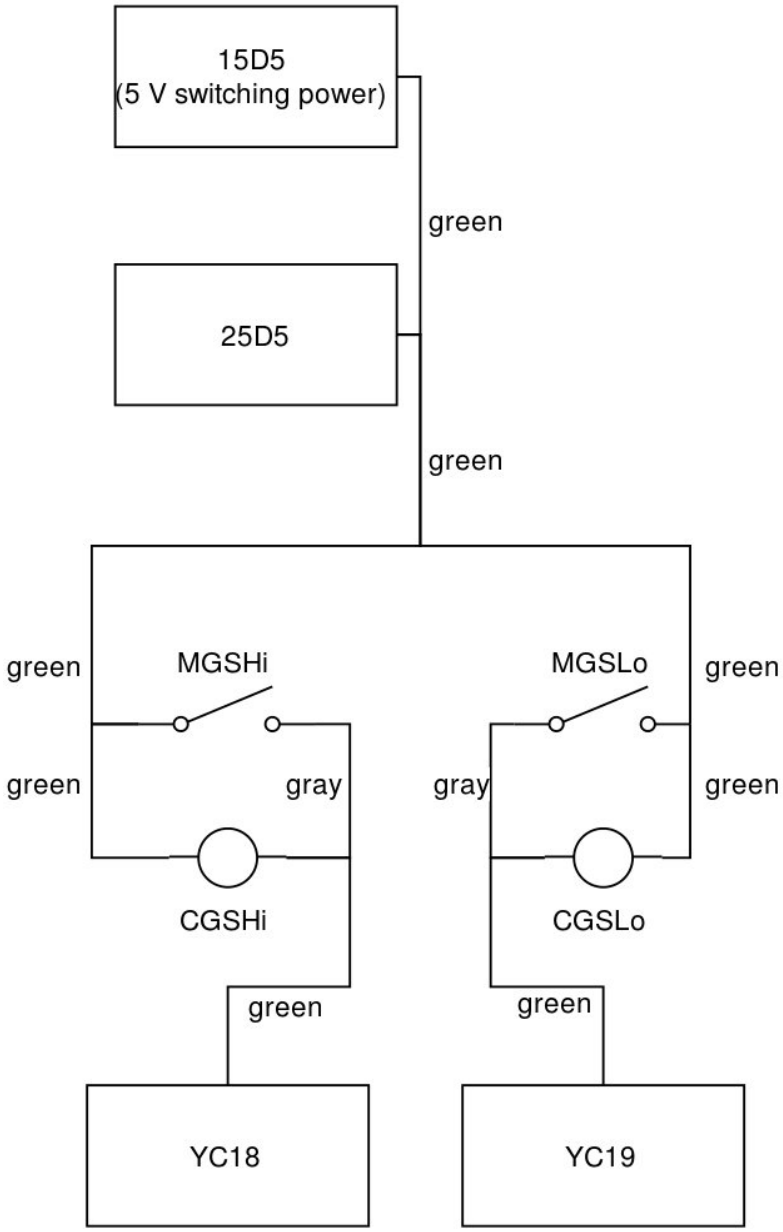

Figure 9: Gain switching electrical topology

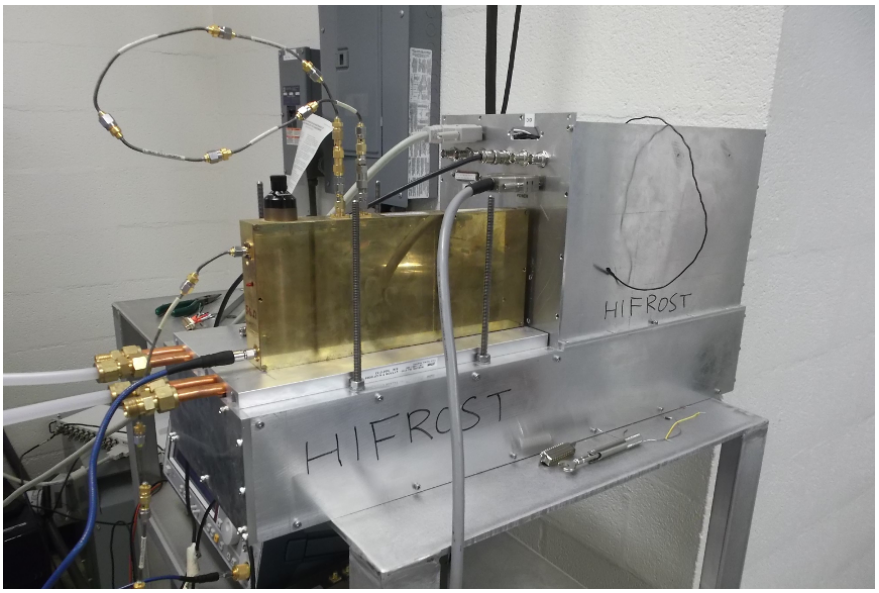

Figure 10: Finished system with QMeter during NMR tune.

- Make sure the housing has a platform big enough to sit on during development.
- Design the water connections to face a convenient direction (in the back back would have been better, as seen above).
- Our coaxial connections are too close to other connectors and each other.
- If you install a DIO connector (see general NMR technical writeup), make sure it is a different connector than the power supply connector.