MOLLER Laser Table Isolated Ground – Requirement Document

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When conducting PV experiments it is vital to prevent electronic cross-talk that could transmit real-time helicity information to the "outside world" (e.g., experiment hall counting house, polarimeter DAQs), including via ground loops, that could produce false raw (detector) asymmetries. In designing the helicity-control board and laser table devices, the following precautions were taken (with many illustrated in Figure 1):

1. The helicity-control board is located within an electrically-isolated VME crate at the Injector Service Building, powered by an isolation transformer.
2. The helicity-control board generates two real-time helicity signals called Helicity Flip and its opposite, nHelicity Flip. In this manner, the current drawn by the board does not depend on the helicity state.
3. The Pockels cell and IA charge-asymmetry HV controllers at the injector laser table are the only devices that receive the real-time helicity signal (Helicity Flip). The setpoint voltages for these devices pass through a galvanic-isolation card and there are no readbacks of these setpoint voltages. This card uses a precision isolation amplifier (ISO-124) to isolate signals from -10 V to +10 V with a bandwidth of up to 50 kHz.
4. The helicity magnets are powered using an independent electrically-isolated VME crate powered by an isolation transformer that receives one of the two real-time helicity signals (nHelicity Flip).
5. The beam helicity signal is generated by a pseudo-random bit generator, to prevent a correlation between the helicity signal and any other signal at the accelerator or experiment hall.
6. The "outside world" receives only a delayed helicity signal (Delayed Helicity) so there is no knowledge of real time helicity.

During the experiment, all helicity-correlated beam asymmetries (position, angle, charge, energy, and size – and thus beam scraping) are minimized so that helicity is the only real-time property of the beam that is changing.

Current Grounding Scheme

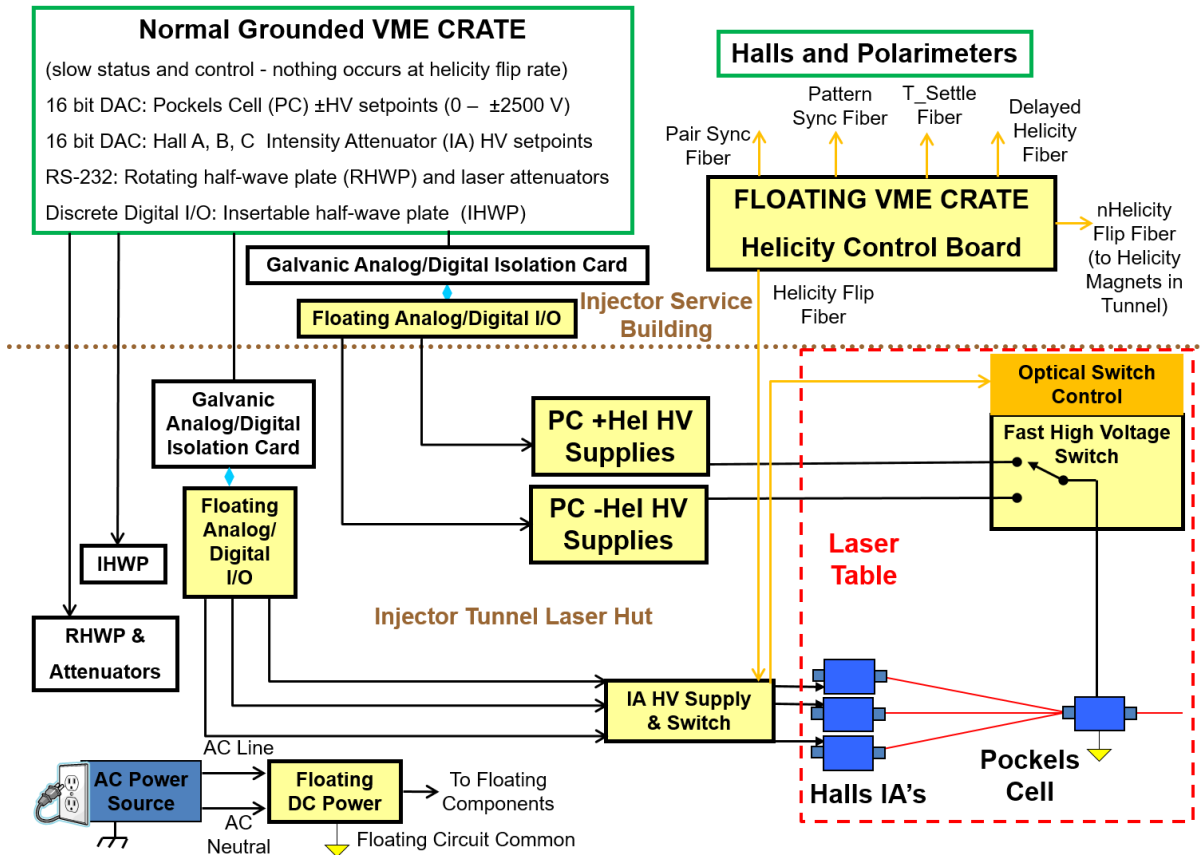Figure 1 shows the current grounding scheme of the laser table systems.

Figure 1: Electrical ground isolation. Devices that receives the real-time helicity signal (Helicity Flip) are isolated with floating ground.

Figure 2 shows detailed schematics of the grounding scheme of the RTP and IA HV systems. The isolated ground is floating at ~10 mV relative to earth ground (i.e. measured voltage between floating-ground and earth-ground, voltmeter reads a fluctuating value at the mV level). If by accident the ground is not floating, then the voltage readback is stable below 1 mV. In terms of resistivity, the floating ground is about 10 MOhm relative to the earth ground and when it is not floating, it is less than few Ohms. More details about the laser table isolated ground is shown in Figure 2.
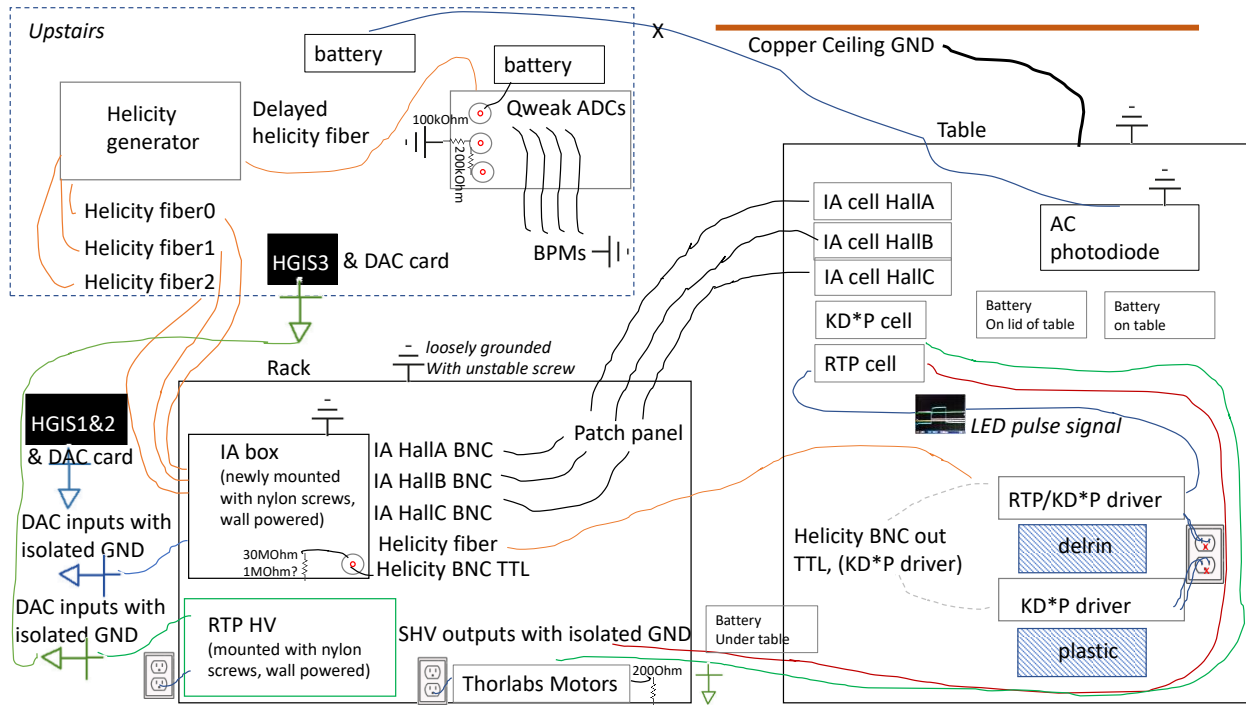
Figure 2: Details of laser table isolated ground.

New Grounding Scheme

Figure 3 shows the proposed new isolated ground scheme. The scheme will implement these new improvements:

1. The DAC with the HV setpoints is on fibers.
2. There will be fiber readback of the HV switch status
3. The IA HV supply and switch to be placed on the laser table
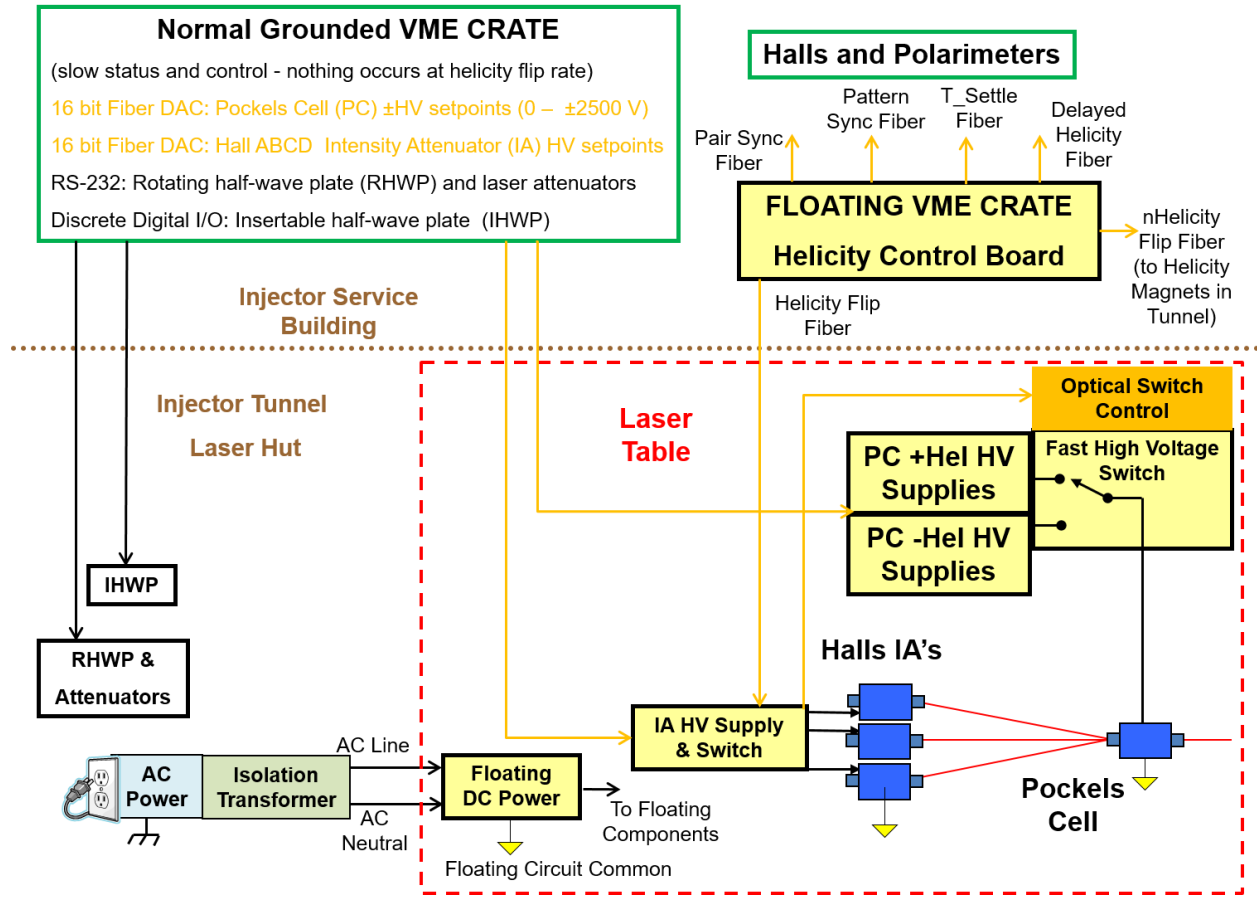4. The RTP HV supply, SHV/HV cable box, and opto-switch will be integrated in one box on the laser table.

Figure 3: New isolated ground scheme.