Data Acquisition System in High-Speed Rotating Frame for New Mexico Alpha-Omega Liquid Sodium Dynamo Experiment

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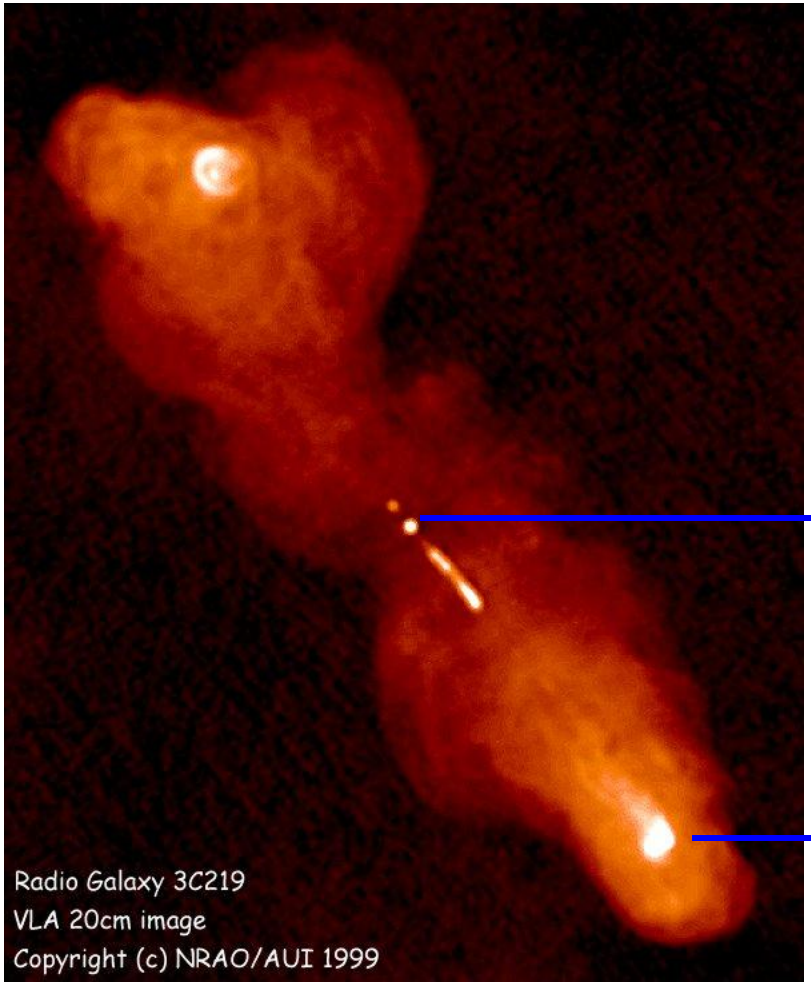
NO LABORATORY ASTROPHYSICAL DYNAMO HAS YET BEEN DEMONSTRATED, only constrained flows.

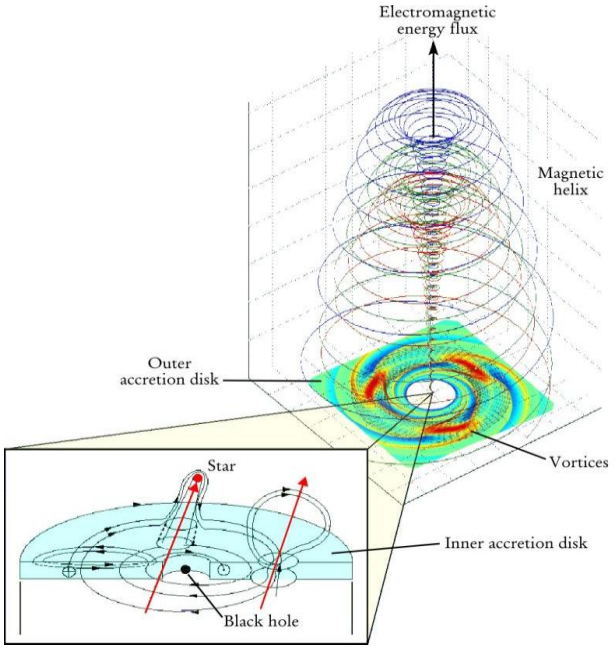
3C219 Radio Lobe, (intergalactic)
~ 1% of free energy of black hole, ~10^{60} ergs.



the dynamo

the radio lobes

The accretion disk dynamo (plumes and differential rotation) and helical jet.



New Mexico Liquid Sodium Experiment is for demonstrating how magnetic field is generated by flowing conducting fluids base on a Star-disk collision model

Seed poloidal field —ω-effect: differential rotation→ Toroidal field

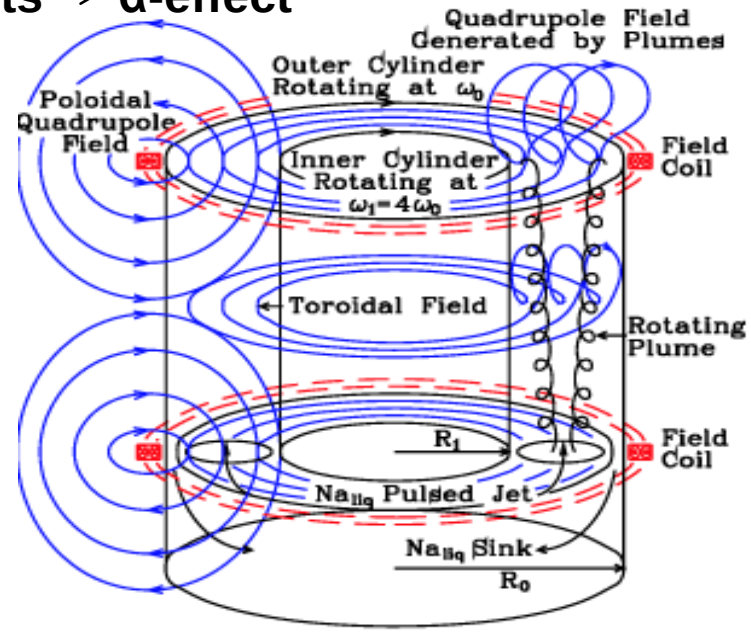
↑ α-effect: plumes created by star-disk collisions

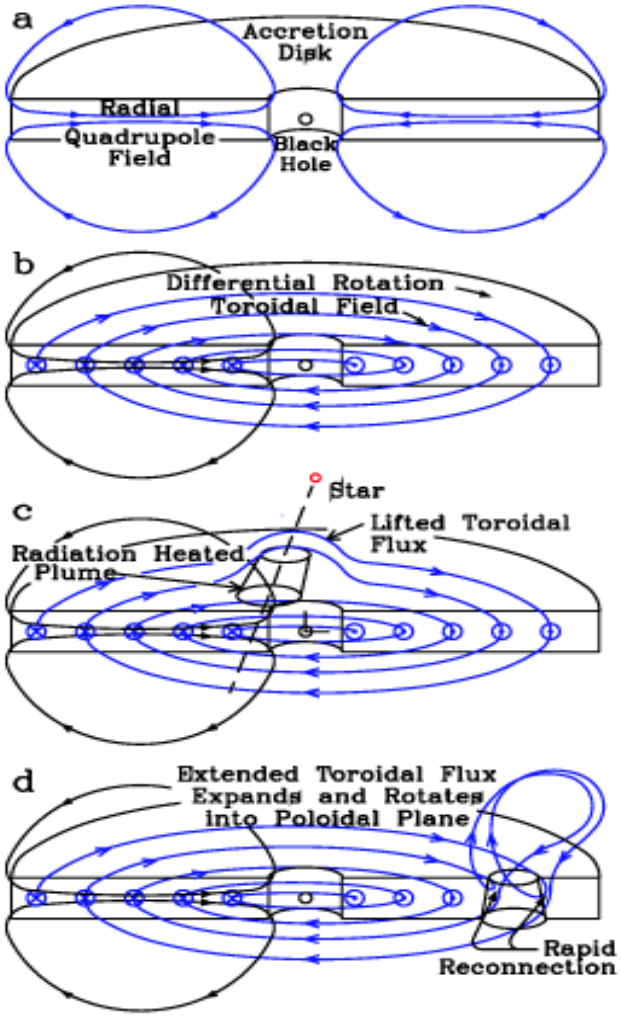
Liquid Sodium → plasma

Taylor-Couette flow → ω-effect

Plumes created by Jets → α-effect

A

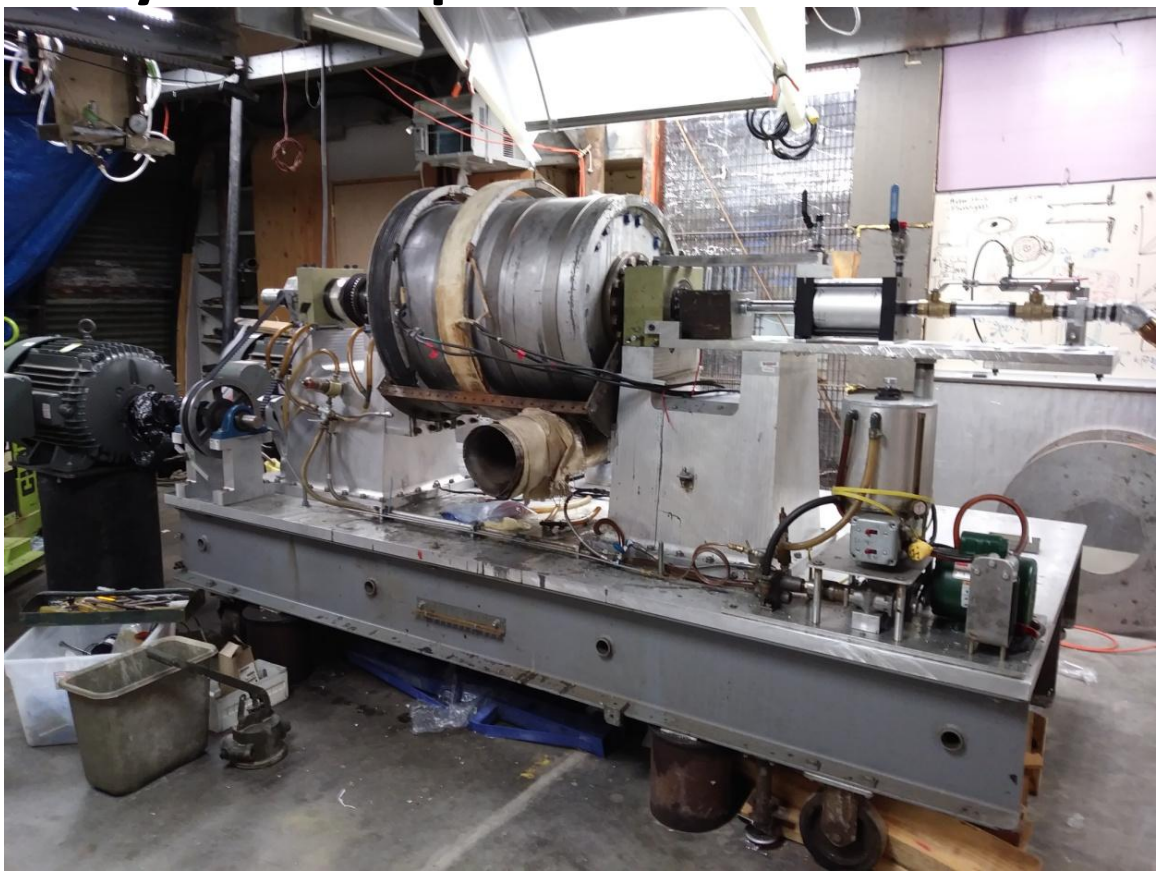




New Mexico Liquid Sodium Dynamo

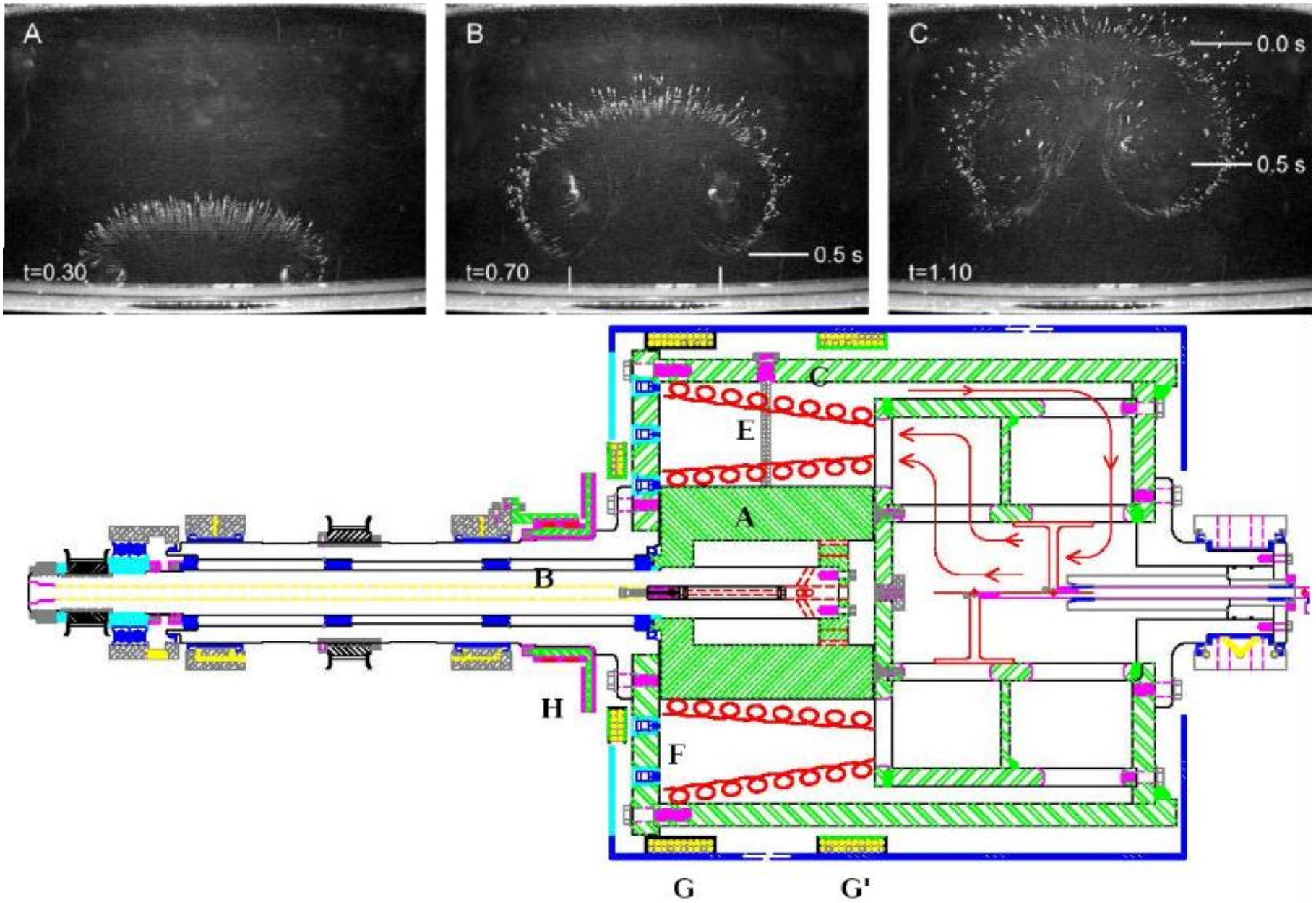
Key parameters of the NM dynamo experiment

Outer cylinder: 0.6 m
Inner cylinder: 0.3 m (in diameter)
Working fluid: liquid sodium.
Speed: 17.5 (inner) & 70 Hz (outer)
Stable Couette flow, Re = 1.0×10^7,
Rm = 94 at T = 110°C.

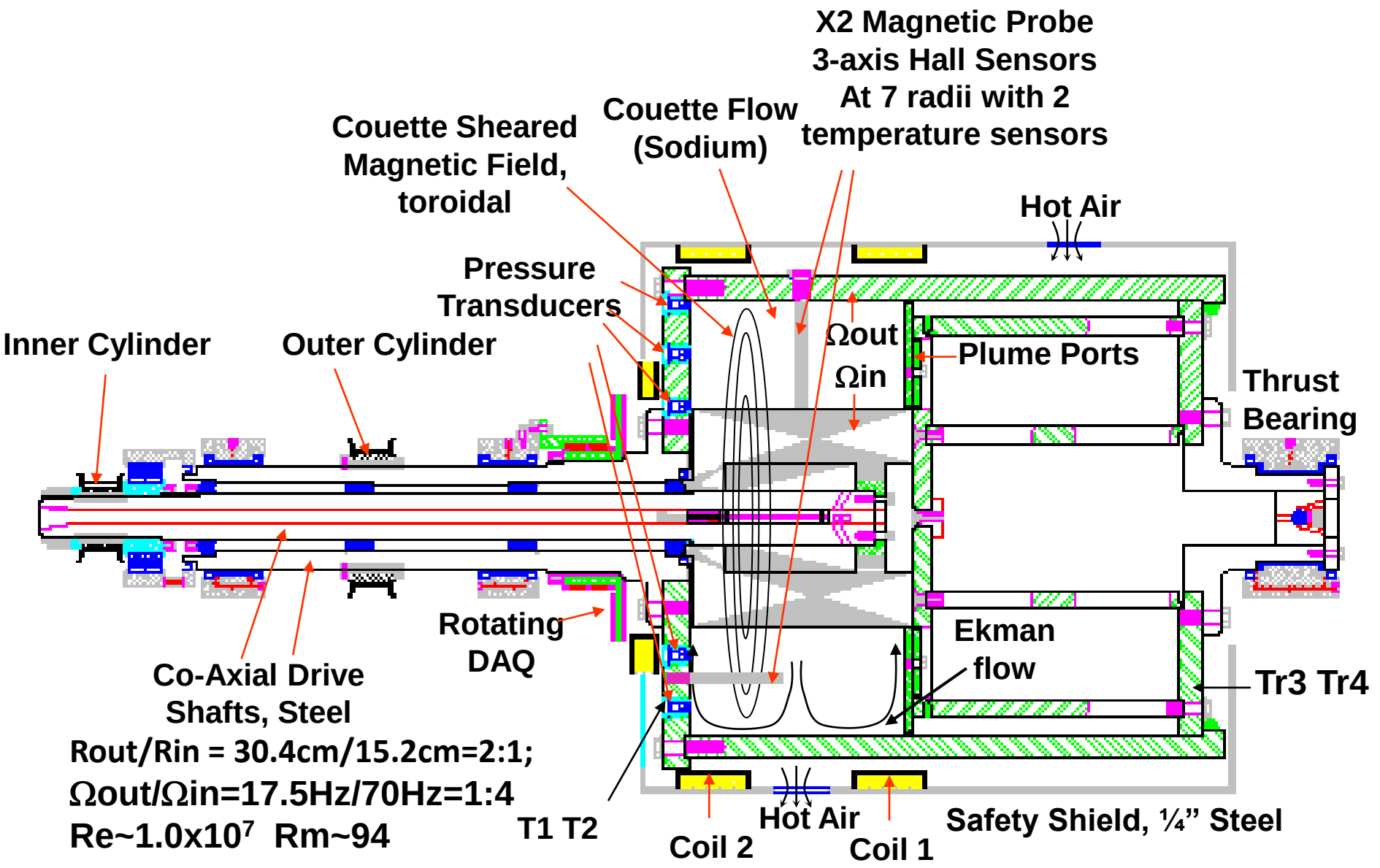


$$\mathrm{Re} = (\omega_{in} - \omega_{out})(R_{in} - R_{out})^2 / \nu \qquad Rm = (\omega_{in} - \omega_{out})(R_{in} - R_{out})^2 / \eta_m$$

α-phase



Sensors in Rotating Frame



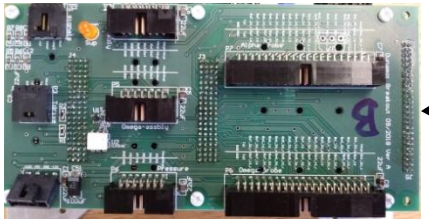
Data Acquisition for rotating frame will use WiFi technique to obtain 160kS/sec overall sampling rate

20VDC in stationary frame

Or

X10 AA Li Battery

Rotating Frame



Interconnection board
~54 magnetic sensors
~8 temperature sensors
~9 pressure sensors
~3 voltage input
~Optocoupler to turn on/off sensors

Mounted on

Multiplexing daughter board With 80 analog channels

Mounted on

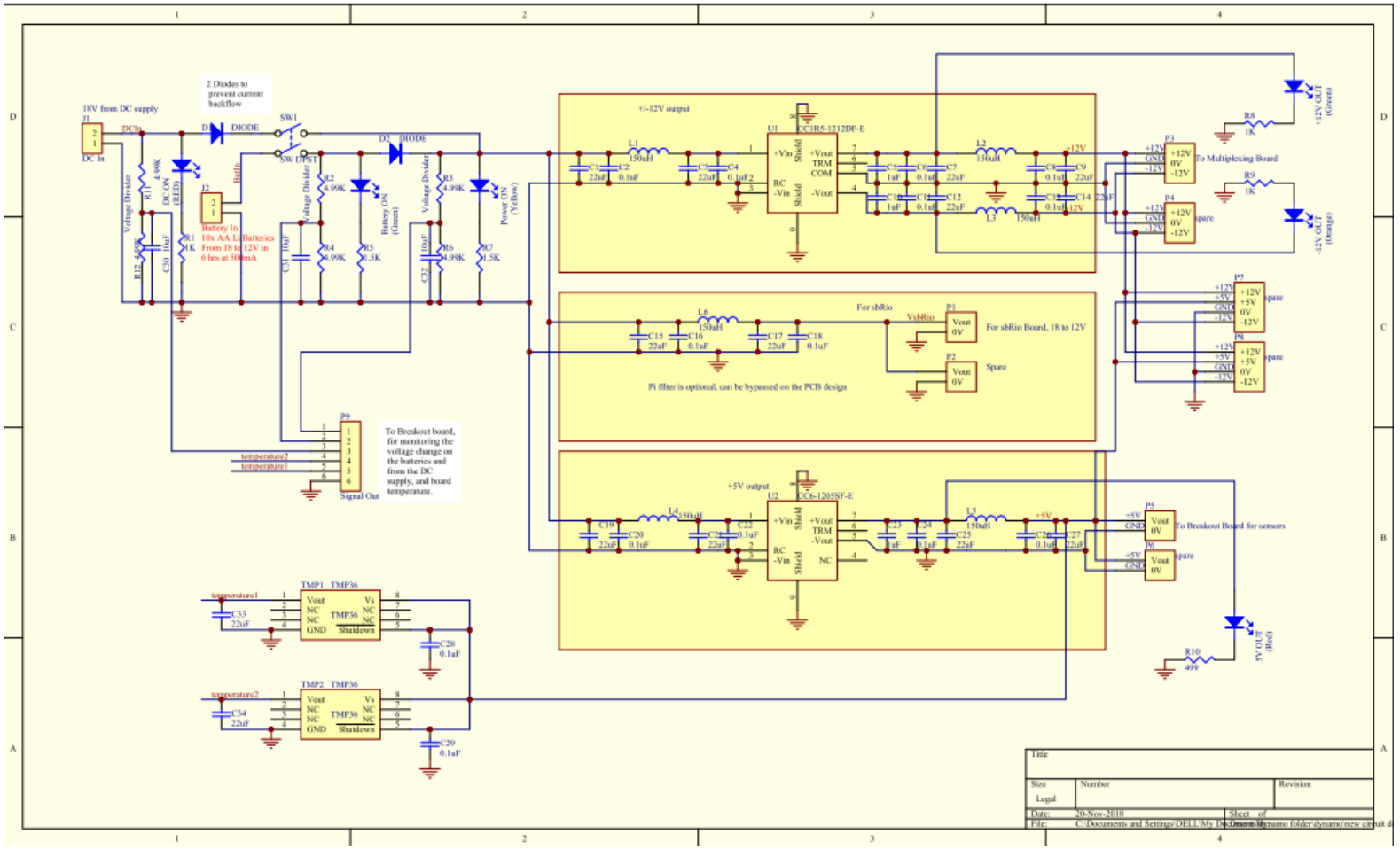
Power module with ±12, +5V output

NI sbRio-9637 single board computer with Real-Time Linux OS

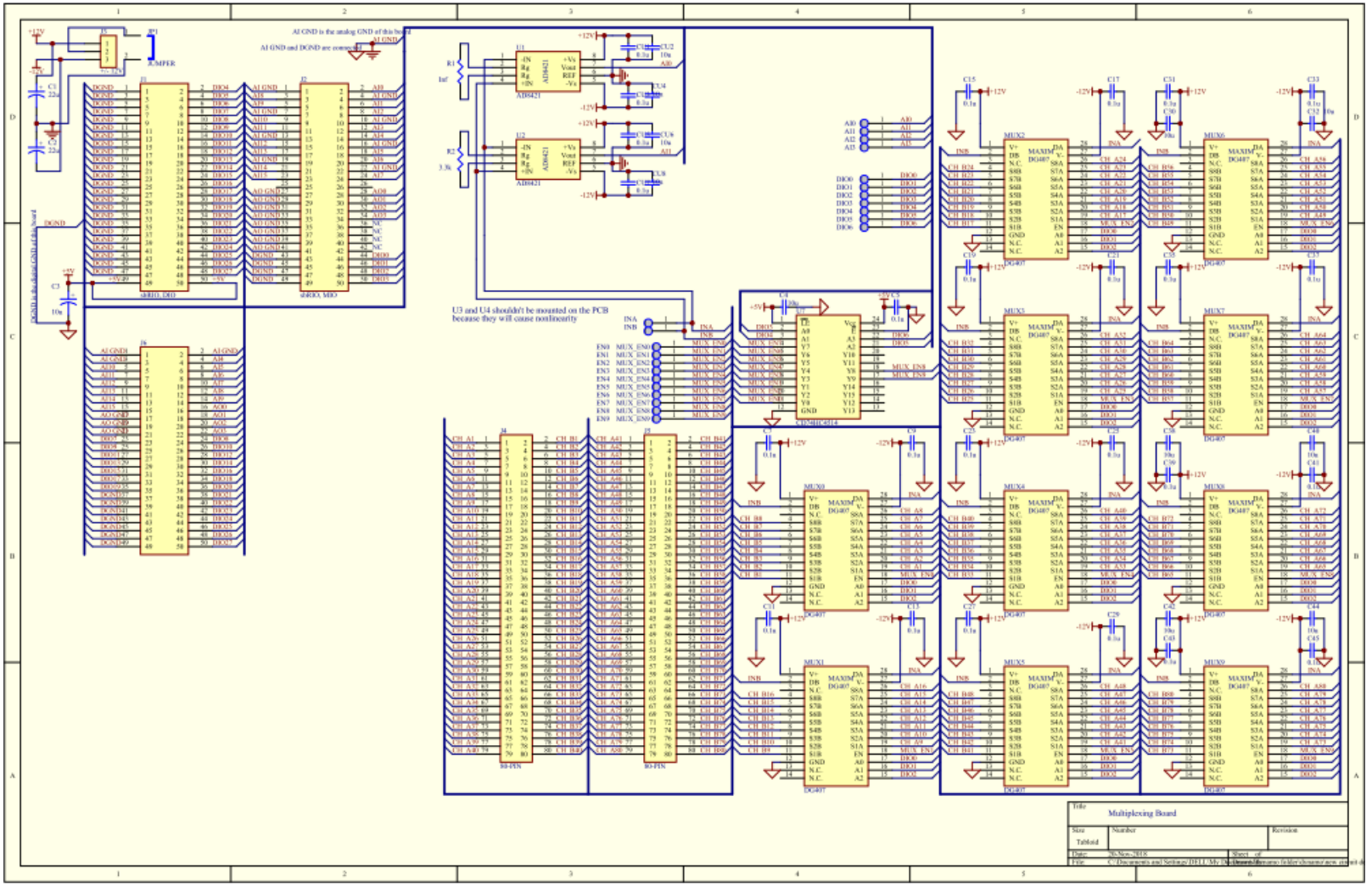
Wifi Module Transmitting data to DAQ computer through Router

Cables

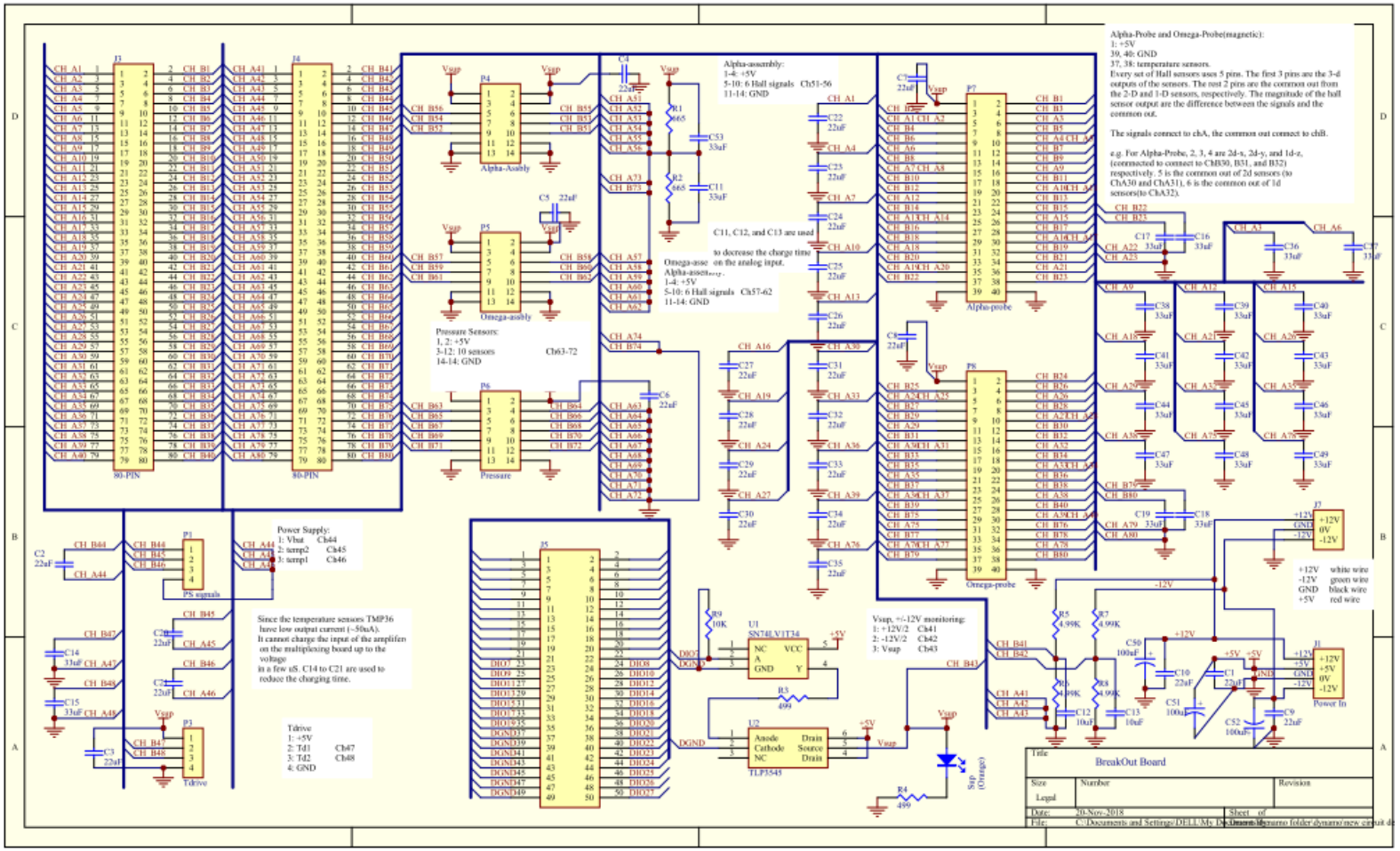
Switch-mode power modules are used to converty voltage of 10xAA Li Battery to +/-12V, +5V for electronics



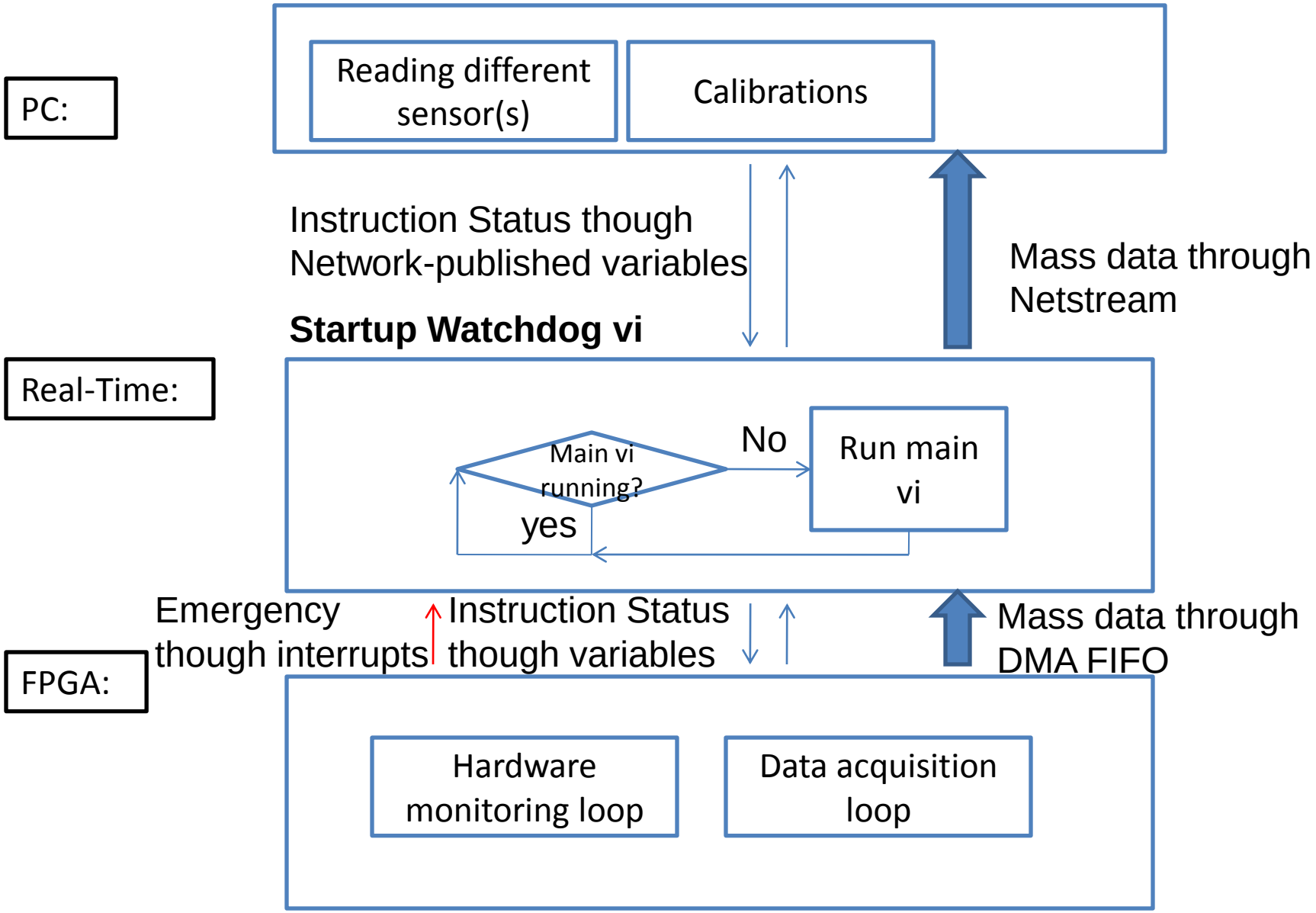
80 channels of analog inputs are multiplexed by a daughter board to the analog input of sbRio single-board computer



An interconnection board provides connectivity to sensors.

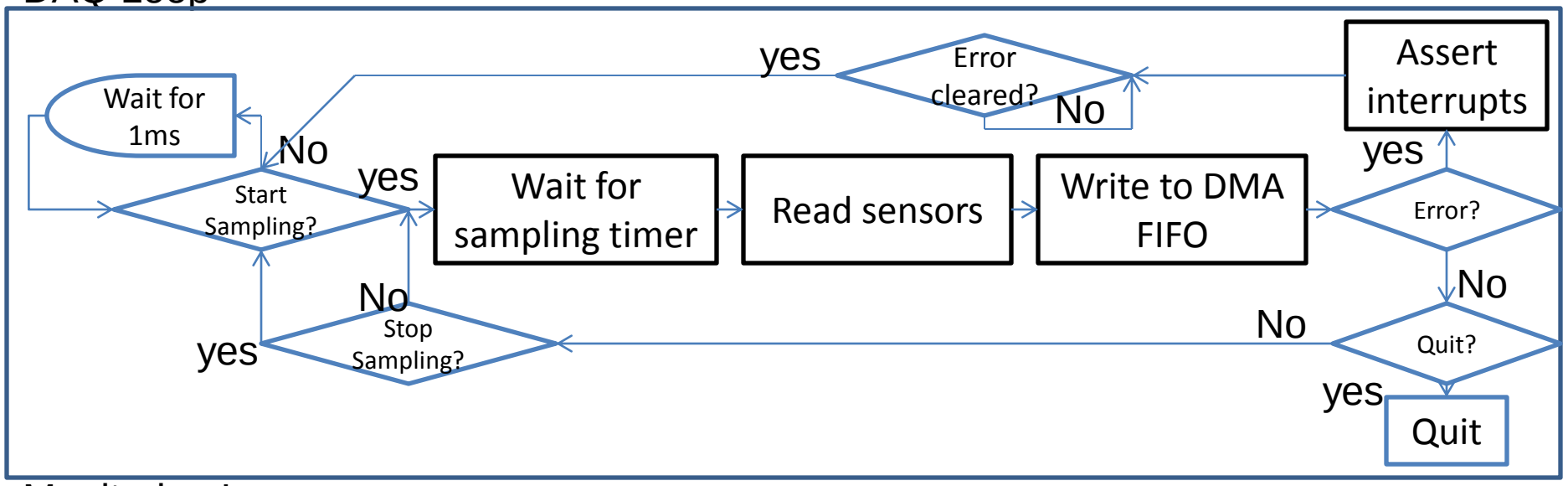


DAQ software is written in NI labview

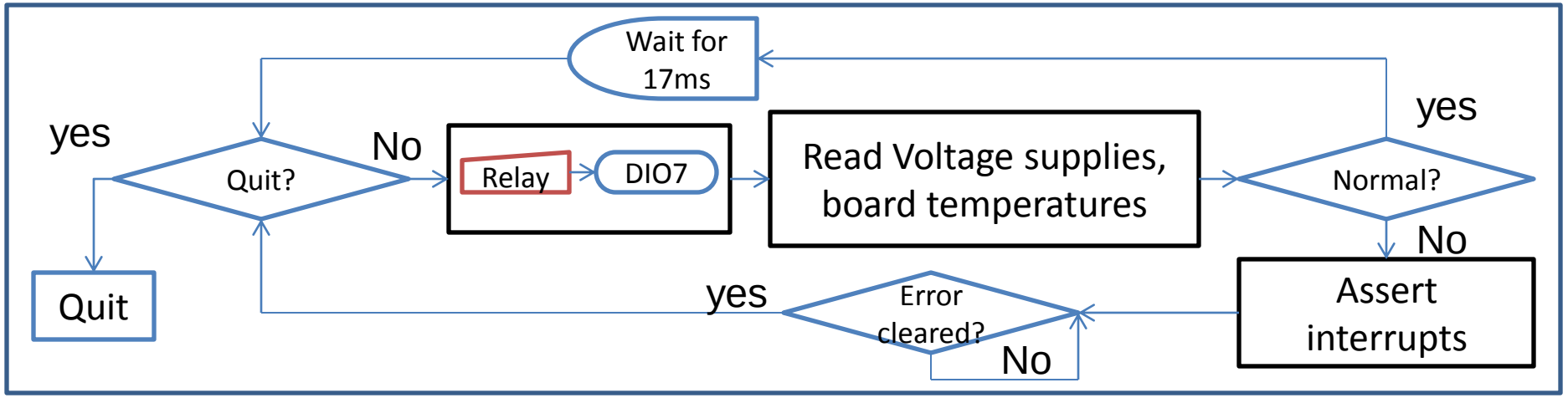


FPGA module

DAQ Loop

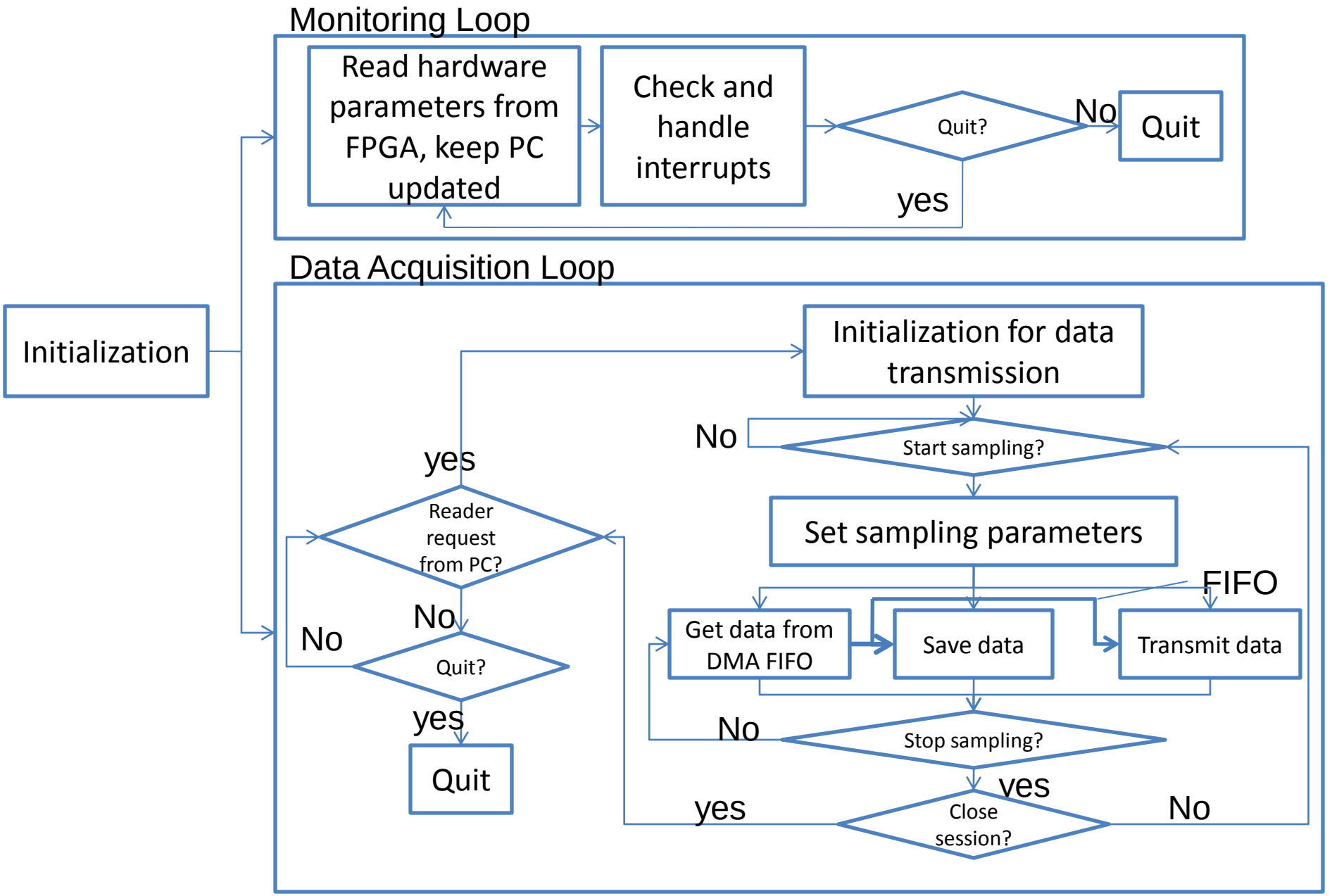


Monitoring Loop



•When any interrupts is asserted, both loops will be suspended until it is cleared by host VI.

Real-Time DAQ



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http://kestrel.nmt.edu/~dynamo/
Or search 'New Mexico Dynamo'