EMCal/HCal Electronics & Readout

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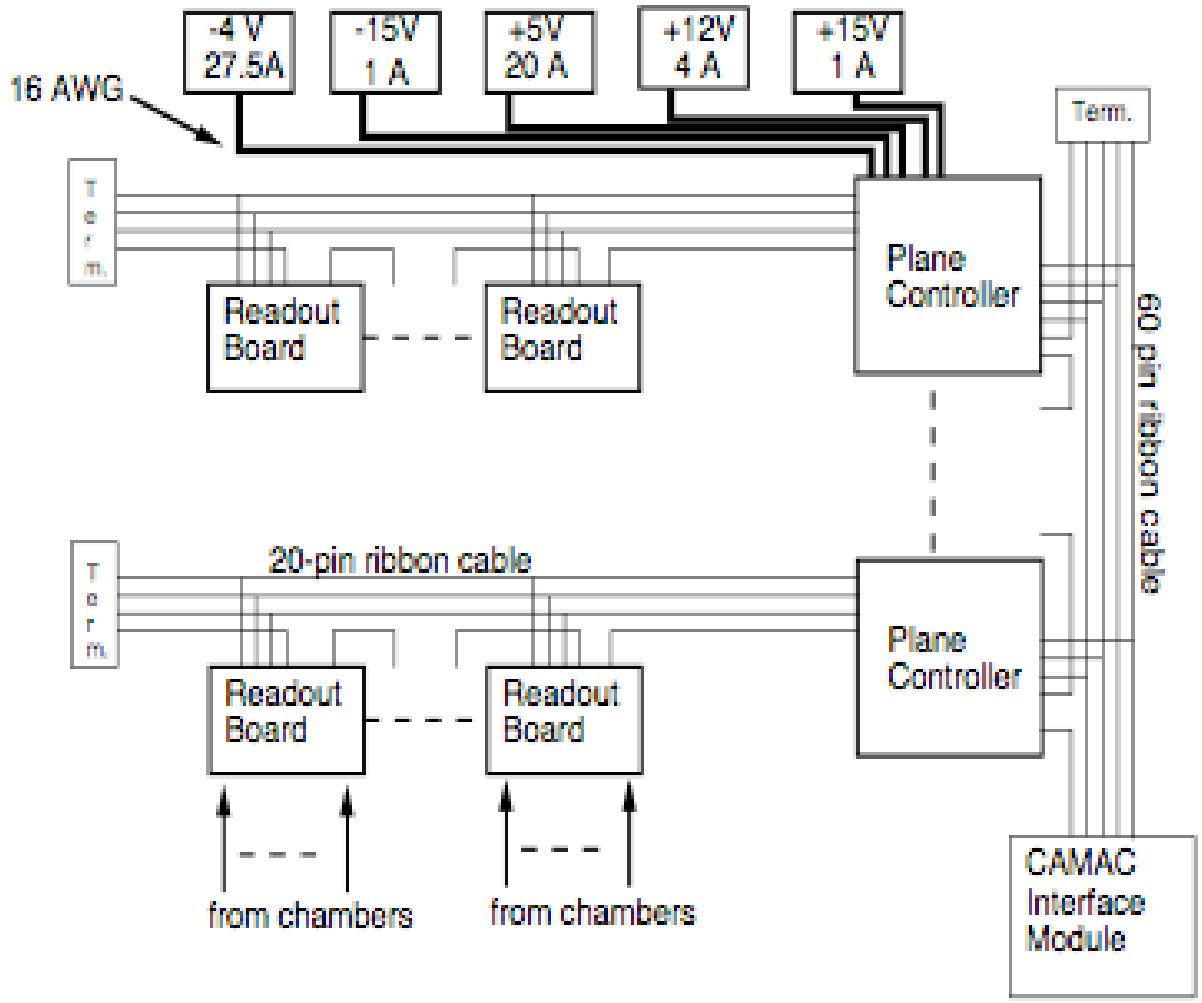
EMCal Readout System

- 10 planes of alternating X and Y wires
- 8 chambers (8 wires ea.) per plane = 640 channels
- Signals are amplified by amplifier/multiplexer boards (1 board = 32 channels, 20 boards total)
- Amplified signals are digitized by “plane controllers” (160 channels each) = 4 controllers total.
- The 4 controllers digitize in parallel (the 160 channels within each controller are digitized in series).
- Digitized data are read out serially via CAMAC.

EMCal Readout System Sketch



EMCal DAQ Rate

- Currently the EMCal electronics can read out at a rate of ~150Hz.
- Digitization time per controller(160 wires) is: >= 10μs x 160 = 1.6ms (ADC774)
- In addition there is significant CAMAC overhead for reading: 640x2 = 1280 reads.

Handling Higher EMCal Readout Rate (the easy way)

- Having a selective EMCal/HCal readout trigger will allow us to readout only events of interest, *e.g.* forward-going neutrons and photons
- ~40% of all triggers have EMCal energy > ~1 GeV, so a selective readout would give a factor ~2
- In addition to a CAL trigger, we could prescale the calorimeter readout so as to not limit the overall DAQ rate.
- Note: the DAQ should be capable of selectively reading out – *i. e.*, read CALs only if CAL trigger is satisfied.
- Need to understand what effect this will have, if any, on the physics from the EMCal. So far, no one has shown any interest in inclusive photon spectra with high statistics.

Handling Higher EMCal Readout Rate (other ways)

- Double the number of plane controllers – this will give a factor of 2.
- If we read out all channels, it would be possible to reduce the number of CAMAC reads by 2 (forego the address word) = ~factor of 2.
- Doing CAMAC reads via 2 interface modules in parallel would increase rate by ~2
- Build new "plane controllers" that would do channel-by-channel pedestal subtraction (similar to the current TPC pedestal loading). We would then load pedestals at beginning of run and read out only channels nominally over pedestal. (Can FNAL do this?)

Using FERA 4300 ADCs

- Without a CAL trigger or prescale, the only way to increase EMCal readout rate is to completely redo the electronics.
- Using the FERA 4300 ADC system called for in the proposal is not trivial.
- The FERA ADCs are 11 bit (current ADCs are 12 bit). The full-scale is also higher than for our current system. Hence significant loss in sensitivity and dynamic range.
- The amplifier boards and cabling would have to be completely replaced to feed the FERA ADCs.

HCal Electronics

- HCal readout can remain unchanged for the upgrade. Rate is not an issue.
- However, there is one cell(east side, most downstream) which appears to have lower efficiency. It is not clear if this is an ADC issue or if it's related to the PMT. This would need to be fixed.
- We should open up the HCal and inspect and fix any bad/crazed fibres.

Conclusions

- EMCal electronics can currently readout at a rate of ~150 Hz. Require a factor of ~20 to keep up with projected MIPP2 DAQ rate (3kHz).
- With implementation of a selective CAL DAQ trigger and doubling the number of controllers, we can gain a factor of at least 4 in rate.
- New “plane controllers” to do pedestal subtraction and enable readout of only “hit” channels, will further increase the rate. (Fermilab time and resources?)