DON JOYCE

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Power requirements for Hall B

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Abstract

This report will discuss AC input power requirements for the Hall B spectrometer. The instrumentation for the spectrometer will be divided into subsytems in order to define power requirements for each electronics service platform. Recommendation for power distrubution and conditioning will be given as well as a price schedule.

1 Crate Power Definitions

Each major subsytem will require equivalent type readout and control instrumentation crates. These crate systems require AC power rated in KVA. KVA equals the RMS AC voltage multiplied by the current required by the device, divided by one thousand. For three phase KVA, multiply volts, load current, and 1.73(square root of 3), then divide by one thousand.

AC input power requirements for the following crate systems:

1. FASTBUS CRATE ———— 3 Phase 208V 10Amps ———— 3.5KVA
2. CAMAC CRATE ———— 120V 15Amps ———— 2.0KVA
3. VME CRATE ———— 120V 6 Amps ———— 1.0KVA
4. VXI CRATE ———— 120V 10Amps ———— 2.0KVA
5. HV MAINFRAME ———— 3 Phase 208V 15Amps ———— 5.5KVA

2 Hall B Subsytems

I. MAGNETS

A. Superconducting Toroidal Magnet ———— 3 Phase 480V 60Amps ———— 50.0KVA
B. Mini-Toroid ———— 3 Phase 480V 120Amps ———— 100.0KVA
C. Photon Tagger Magnet ———— 3 Phase 480V 180Amps ———— 150.0KVA
D. CAMAC Control/Status Crate ———— 120V 15Amps ———— 2.0KVA

The CAMAC control crate will provide enough status and control channels for the three magnet systems, and will be located on the East service platform near all three magnet power supplies.

II. DRIFT CHAMBERS

A. Preamplifier Power Supplies

Three power supplies per sector. ____ 2KVA per supply. ____ 36.0KVA

B. High Voltages (Sense wires, Field wires)

Distribute 128 HV Channels per Sector.
Total of six High Voltage Mainframes. ____ 5.5KVA per supply. ____ 33.0KVA

C. Front End QTC and Discriminator Boards

Sixty four boards per sector – 384 boards total.
Region one – 96 Boards
Region two – 144 Boards
Region three – 144 Boards
Assume 9U type card cage.
Region one – 8 Crates. ____ 1.0KVA per crate ____ 8.0KVA
Region two – 24 Crates. ____ 1.0KVA per crate ____ 24.0KVA
Region three – 24 Crates. ____ 1.0KVA per crate ____ 24.0KVA

D. TDC Commercial Board

Total number of boards is 192.
Region one – 48 Boards ____ 2 FASTBUS Crates ____ 7.0KVA
Region two – 72 Boards ____ 4 FASTBUS Crates ____ 14.0KVA
Region three – 72 Boards ____ 4 FASTBUS Crates ____ 14.0KVA

E. Slow Controls

Preliminary layout of equipment location in Hall B shows the Drift Chamber system divided into the three electronics platforms. Each platform will require a CAMAC crate for the control and query of High voltages, Preamplifier power, Calibration, Gas sytem status, Temperature probes, etc.

One CAMAC crate for each of the three service platforms. ____ 6.0KVA

III. TIME OF FLIGHT SCINTILLATION COUNTERS

The scintillation counters will be mounted on moveable suppport platforms. The forward 22 counters per sector will be mounted on the support platform for the shower counter and cerenkov counters. The rear 26 counters per sector will be split into North and South support platforms. The North and South platorms will hold three sectors each.

A. High Voltage

Forward support platform requires two HV mainframes. ——— 11.0KVA
South support platform requires one HV mainframe. ——— 5.5KVA
North support platform requires one HV mainframe. ——— 5.5KVA

B. Discriminators, Control and status, Calibration
Forward support platform requires two CAMAC crates. ——— 4.0KVA
North and South platforms require one CAMAC crate each. ——— 4.0KVA

C. Readout electronics. (TDC's, ADC's)
Forward support platform requires two FASTBUS crates. ——— 7.0KVA
North and South platform require one FASTBUS crate each. ——— 7.0KVA

IV. TRIGGER SYSTEM
The trigger electronic crates will be located on the forward support platform.

A. Level One, Level Two Trigger Boards
D size VXI 13 slot crate. ——— 3 crates ——— 6.0KVA

V. PHOTON TAGGER SCINTILLATION COUNTERS

A. High Voltage
384 E counters ——— 48 T counters ——— Pair Spectrometer Counter
Total absorbtion counter
Two High Voltage Mainframes ——— 11.0KVA

B. Readout Electronics
Discriminators, Splitters, Pattern Units, Scalers, CAMAC or VME?
TDC's, ADC's? Budget 1 CAMAC crate and 1 FASTBUS crate. ——— 5.5KVA

VI. CERENKOV COUNTERS
The Cerenkov counters will be located on the forward support platform.

A. High Voltage
150 Burle five inch PMT's. ——— One HV mainframe ——— 5.5KVA

B. Readout electronics. ——— One FASTBUS crate ——— 3.5KVA
Discriminators, gas system control, etc. One CAMAC crate. ——— 2.0KVA

VII. ELECTROMAGNETIC SHOWER COUNTER
The Shower Counter will be located on the forward support platform.
A. High Voltage 1400 PMT's
Six HV mainframes. ——— 33.0KVA

B. TDC's and ADC's Readout electronics.
Four FASTBUS crates. —— 14.0KVA

C. Discriminators,Control and Status, N2 Laser calibration.
Four CAMAC crates. —— 8.0KVA

VIII. BEAMLINE and TARGET INSTRUMENTATION and CONTROL
The control crate for the Beamline and Target instrumentation will be located on the East service platform.
A. One CAMAC crate —— 2.0KVA

IX. SAFETY, ALARMS, and AREA INTERLOCKS

A. One Status and Control CAMAC crate —— 2.0KVA

3 Discussion

The total AC power requirement for instrumentation and control of the Hall B Spectrometer is 297.5KVA. The three magnet power supply systems require an additional 300KVA.

Refer to CEBAF drawing number 66880-E-00676 which shows how the total of 297.5KVA is distributed to each of the electronic service platforms. The distribution is as follows:

1. EGN, TOF and Trigger Support Platform —— 113KVA
2. East Service Platform —— 60.5KVA
3. Southwest Electronics Tower —— 51KVA
4. Northwest Electronics Tower —— 51KVA
5. TOF North "Clamshell" —— 11KVA
6. TOF South "Clamshell" —— 11KVA

AC power is distributed through the use of tranformers which reduce the voltage from the power company distribution network to a voltage that is normally used for equipment and utilities. These step down transformers are nothing more than two coils of wire concentrically wound around an iron core. The primary coil is connected to the source and the secondary coil provides the proper voltage to the load. The capacitive coupling that exists between the primary and secondary windings permits transient voltage spikes caused by lightning, motor operations, welding operations, or a host of other devices, to pass to the load.

A shielded isolation transformer prevents the transients from passing between the primary coil and the secondary coil by adding a Faraday Shield and connecting it to the grounded power input. The capacitive path between the primary and secondary is reduced significantly. Transient voltage spikes do not pass to equipment on the secondary winding.

Shielded isolation transformers are available in power ratings up to 500KVA. (3 phase, 480VAC primary voltage). This type of transformer would be mounted at each electronics service platform and provide isolated, transient free, AC power to the intrumentation and control crates described in Section 2.

Another device which prevents unwanted noise and transient voltage spikes is an AC power conditioner. As the name implies, the conditioner has an active regulator circuit which will maintain specified output voltages in case of overvoltage or undervoltage conditions from the input power mains. Further, the power conditioner has a shielded isolation tranformer which provides attenuation of capacitively coupled transients from the primary coil to the secondary output coil. This type of unit is available up to 45KVA, with an efficiency of 94%. (3 phase, 480VAC primary voltage). The shielded transformers provide up to 97% efficiency.

Both types of tranformers will provide excellent isolation from transients produced by lightning, pumps and motors, and beamline vacuum equipment. In addition, a centralized power distribution transformer for each electronic service platform will provide even further isolation from transients generated from the other service platforms.(eg. Noisy power supplies, relay closures, solenoid control valves)

4 Cost Estimates

The cost estimates are based on the best price quotes received from four vendors. The first estimate is the cost of shielded isolation transformers for each electronics service platform.

The second estimate is the cost to use power conditioners for each electronics service platform. To date I have been unable to locate a vendor which offers a power conditioner above 45KVA (3 phase, 480VAC primary voltage). In order to satisfy the power requirements for each service platform, several units would have to be used on the ECAL platform, Southwest platform, Northwest platform, and East platform.

As a safety margin the KVA rating is approximately 15% larger than the power required for the platforms.

I. Cost Breakdown ** Shielded Isolation Transformers **:

1. ECAL service platform	150KVA	$3778.00
2. Southwest service platform	75KVA	$2254.00
3. Northwest service platform	75KVA	$2254.00
4. East service platform	75KVA	$2254.00
5. North "Clamshell"	15KVA	$980.00
6. South "Clamshell"	15KVA	$980.00
TOTAL		$12,500.00

II. Cost Breakdown ** Power Conditioners with Shielded Transformers **:

1. ECAL service platform	135KVA	$35,520.00
2. Southwest service platform	60KVA	$22,640.00
3. Northwest service platform	60KVA	$22,640.00
4. East service platform	60KVA	$22,640.00

5. North "Clamshell"	15KVA	$10800.00
6. South "Clamshell"	15KVA	$10800.00
TOTAL		$125,040.00

5 Conclusion

From the point of providing isolation from transients occuring on the AC power mains, the shielded isolation transformer should perform very well. The shielded transformer cannot correct for power mains surges, or undervoltage conditions, and will not solve every power mains problem. Preventing unwanted transients from potentially damaging sensitive electronics, or ruining signal quality from detector components, is justification for this type of power distribution design.

Clearly from a cost stance, the power conditioner scheme is a factor of ten more expensive. The extra provision to maintain a constant output voltage may be desired, but not affordable. A study of power mains stability may need to be performed once the AC mains power is established in Hall B.