iii. Instrumentation and Control System

The layout of the RHIC vacuum instrumentation and control is depicted in Fig. 4-3. The heart of the system is a network of Allen-Bradley programmable logic controllers (PLCs). There are eight vacuum PLCs, one each at the six ring service buildings and at the two AtR houses. Each PLC consists of a 520/540 CPU, several input and output (I/O) modules, and two sets of coprocessor modules. Each coprocessor set has four serial communication ports, which can be connected through the multi-drop RS-485 serial bus to the vacuum instruments (e.g., vacuum gauge controllers, ion pump controllers, etc.), located either in the service buildings or in the tunnel. Up to 32 instruments of the same protocol can be addressed and connected on the same RS-485 serial bus. Communication driver software is used by the coprocessor's OS-9 real time operating system to communicate with each type of instrument. The transaction time between the driver and each instrument is less than 30 milliseconds, and the total time to update each coprocessor's database is less than 10 sec.

The coprocessors interface with the RHIC control system front-end computers (FEC) located in the service buildings through the Ethernet links. The accelerator device object (ADO) code running in the FEC does most of the data processing before forwarding the information to the high-level application codes for control, display and logging. For faster display and logging, the analog outputs of a few selected vacuum gauges are fed directly into dedicated MADC channels for conversion. During startup or trouble-shooting, portable PCs using vendor-provided software can be connected to an RS-485 bus to operate and diagnose the vacuum instruments.

The RHIC vacuum systems are protected from catastrophic failures by beam vacuum gate valves, which are interlocked by vacuum gauges and sputter ion pumps. Gauges and pumps on both sides of the valves are used in a voting scheme that minimizes valve closure due to false triggering. The gate valves and the set point relay contacts of the gauge controllers are hardwired to the PLC I/O modules. Ladder-logic software in the PLC is used to open and close the gate valves and generates the beam permit link (BPL) signal, either by the FEC or through a man-machine interface (MMI). Valve status and control information is copied from the PLC to the coprocessor by means of data block transfers, and then exchanged with the FEC via the coprocessor Ethernet port. The MMI software runs independently from the PLC software and resides on a PC connected to the PLC Data Highway network that links all eight PLCs.

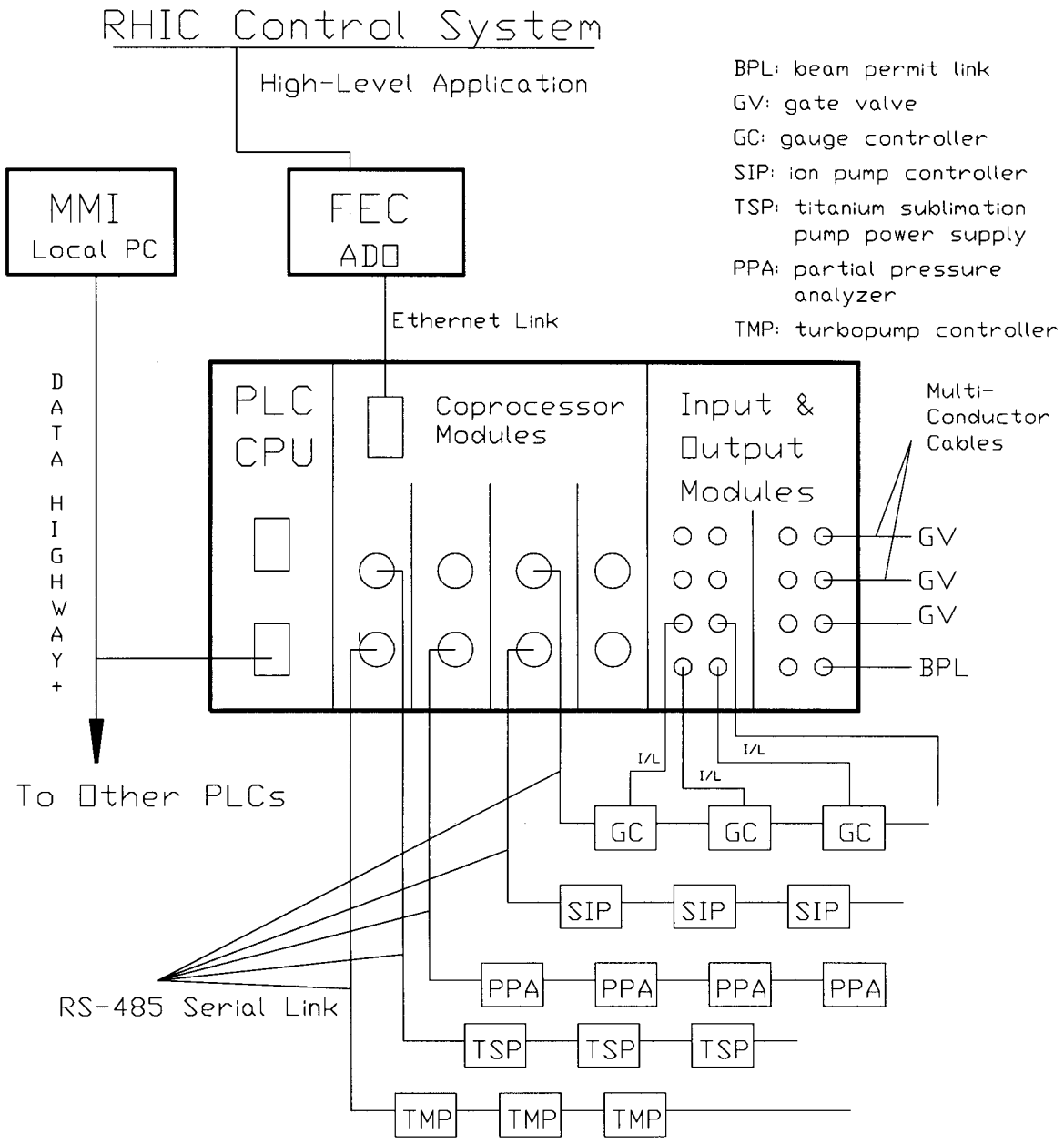

Fig. 4-3. Vacuum instrumentation and control block diagram.