CONTROL OF THE TRISTAN VACCUM SYSTEM

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ABSTRACT

The TRISTAN vacuum system is controlled by computers and program controllers. All components for the system were miniaturized as possible. Four types of ion pump made from aluminum alloy were used at the pressure range less than 10^{-4} Pa. Pressure measurement from an atmospheric pressure to 10^{-10} Pa were made by pirani gauges, convectron gauges, inverted magnetron gauges, and modulating ion current gauges. (MIC)

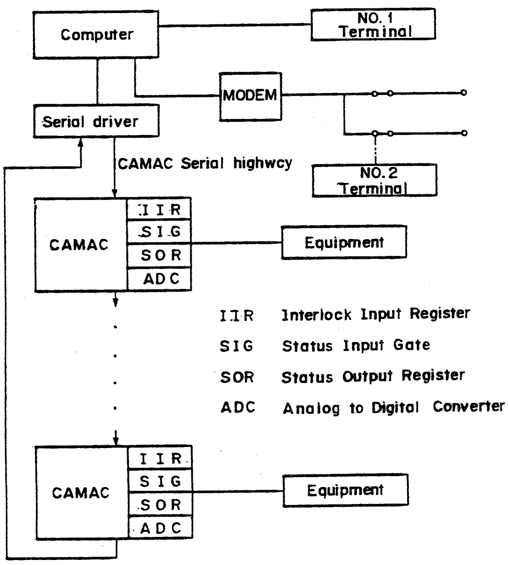

Fig. 1 Utilized states of the computer.

INTRODUCTION

For the vacuum system of the TRISTAN accumulation ring (AR) the required base pressure is 10^{-8} Pa without beam and 10^{-7} Pa with beam. The beam life time is dependent not only on the total pressure but also on the atomic and molecular species in the residual gases. It is therefore very important to analyze residual gases as well as to measure the total pressure. Gauges to measure the total pressure are required to have a wide dynamic range from 10^{-9} Pa to an atmospheric pressure which is utilized to a safety interlock for system protection. The dynamic range is covered by four types of gauge in our control system. The control and the data aquisition are made using computers and a programmable controllers (PC).

CONTROL SYSTEM

Principles of the design for the system are:
1 Controls and measurements are all made by computers,
2 Interlock by hardwires is made by a programmable controller,
3 Power supplies and gauges are miniaturized as possible without meters.

Fig.1 shows utilized states of the computer. CAMAC is used as an interface. Significant signals for the maintenance of the system were connected to Interlock Input Resister (IIR) which can be always interrupted. Many connectors from data terminals make it possible to use computers in the AR tunnel and the auxiliary rooms. Fig.2 shows an example of interlock system by hardwires.

The vacuum chambers in electron storage rings are cooled to suppress temperature rise due to synchrotron radiation. A sensor of a water turbine type is used to check the flow rate of cooling water. Beam can be stopped at the value less than 80 % of the flow rate. Platinum resistors are used to measure the temperature of the chambers.

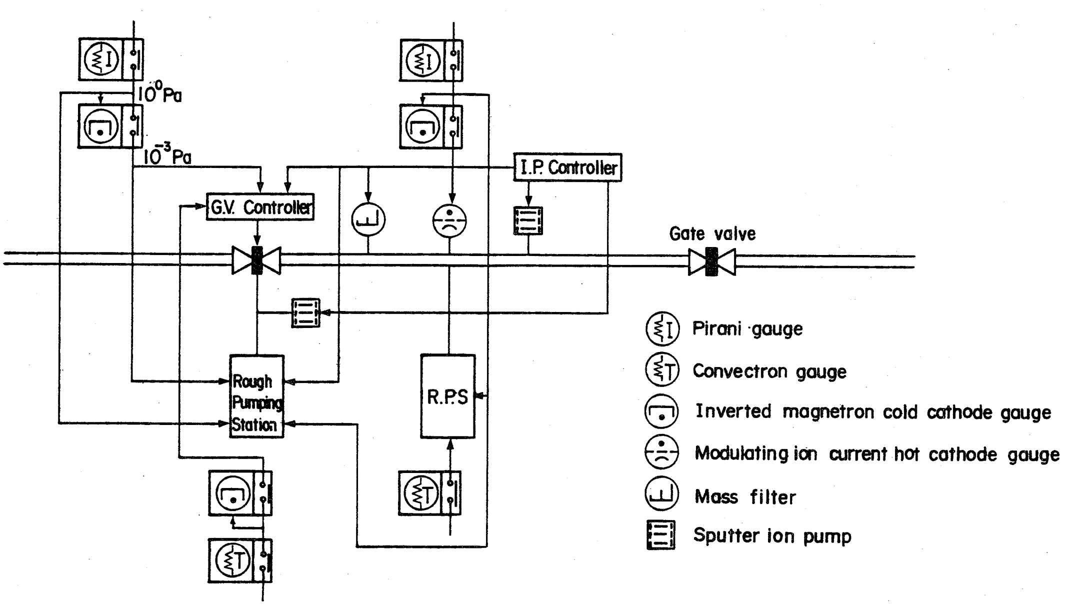

Fig. 2 Example of interlock system by hardwires.

CONTROL OF THE PUMPS

Four types of pump are used in the TRISTAN AR: Rotary pumps and turbomolecular pumps (TMP) for roughing, sputter ion pumps (SIP) for ultra high vacuum, and non-evaporable-getter (NEG) for evacuation of hydrogen.

Roughing pumps are used for the evacuation from an atmospheric pressure, to start up SIP and for the gas desorption due to synchrotron radiation. Only the roughing pumps are manually controlled in the AR. Four types of SIP are 500 l/s, 30 l/s, 10 l/s, and 250 l/s distributed ion pumps (DIP).

Power supplies for SIP are very small because start up pressure is set at less than 10^{-4} Pa. There are two types of the power supply, 5.5 kV, 20 mA type for the pumps 125 l/s or more and 5 mA type for those less than 125 l/s. A NIM 2 unit module contains one 20 mA type or two 5 mA types. Type of the power supplies is a DC-DC converter. Fig.3 shows the power supply.

Only discharge current of DIP can be measured because both an anode and a cathode of the pump are insulated from the chambers. The current can be utilized to measure the pressure.

Roughing pumps and SIP are controlled with computers and PC. The NEG pump can evacuate only hydrogen in room temperature mode. Activation is manually controlled.

CONTROL OF THE GATE VALVES

The dual flat mirror surface seals with differential pumping type gate valves are used not to disturb wall current and not to excite parasitic mode losses. To operate the valves a roughing pump and a SIP (10 l/s) are required. The valves, the roughing pump, and the SIP are automatically controlled by PC.

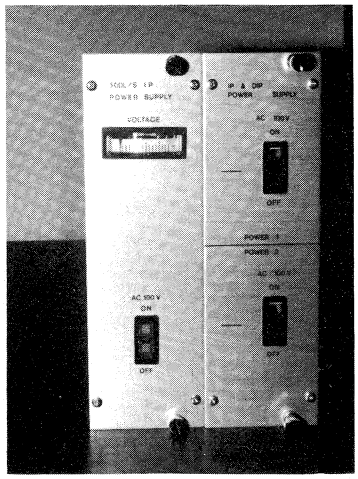

Fig. 3 Power supply for SIP, 20 mA (left) and two 5 mA.

TOTAL PRESSURE MEASUREMENT

Low vacuum range (10^5 - 10^{-1} Pa)

Gauges to cover the low pressure range are a convectron gauge (GP) and pirani gauge of constant current type. A convectron gauge is chosen because the pressure around atomosphere can be measured. The gauge is set at the back of a TMP. Contact output of the gauge is used to an interlock of a roughing pump. A pirani gauge of constant current is set to a chamber and sends an interlock signal less than 1 Pa.

Controllers of the 2 types of gauge are mounted on a NIM 2 unit module which can operate 4 gauges. Figs.4 and 5 show output characteristics of the two gauges.

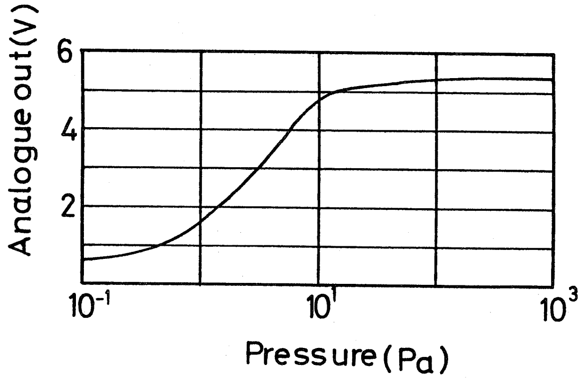

Fig. 4 Output characteristics of the Pirani gauge.

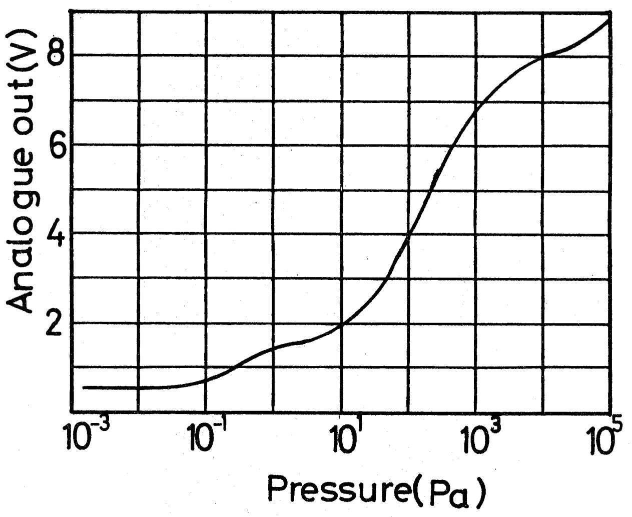

Fig. 5 Output characteristics of the Convectron gauge.

Medium and high vacuum ranges (10^{-1} - 10^{-7} Pa)

An inverted magnetron gauge is used to cover the vacuum range because the gauge has a wide dynamic range and less mode jump[2] than other cold cathode gauges. The output characteristics is shown in Fig.6. Though it can be operated in an atmosphere, the operation less than 1 Pa is prefered. The reason is that a long operation in low vacuum accellerates contamination. The gauge controller is mounted in a NIM 2 unit module which can control 2 gauges.

UHV range (10^{-7} - 10^{-10} Pa)

A Modulating Ion Current (MIC) gauge is used to cover this range. Merit of the gauge is that the signal component and the desorbed gas bombarded by electrons or secondary particles excited by electron beam can be separately detected. A guage head is shown in Fig.8. The gauge controller can be operated at the distance closer than 200 m from the gauge head.

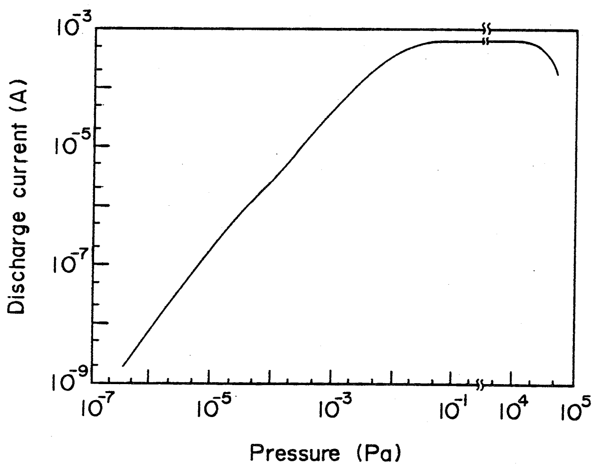

Fig. 6 Output characteristics of the cold cathode gauge.

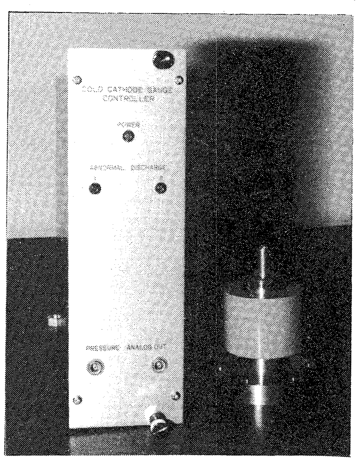

Fig. 7 Cold cathode gauge and the controller.

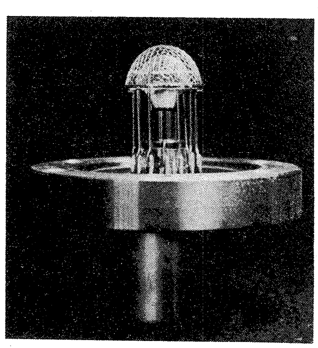

Fig. 8 Head of the Modulating Ion Current gauge.

RESIDUAL GAS ANALYSIS

In storage rings, it is very important to know the composition of the residual gas species to estimate the life time. A mass filter with SEM is used for a residual gas analyser. The mass filter for ultra high vacuum has a function of electron bombarded degassing. Distance between a gauge head and a controller is about 100 m. Output of six species can be selected by a peak detecter and read with analogue values. Typical mass patterns with beam and without beam are shown in Fig.9 and 10. Fig.11 shows partial pressure at before injection, during injection, and after injection. 70 % of residual gases is H_2 and the quality of the vacuum has been improved.

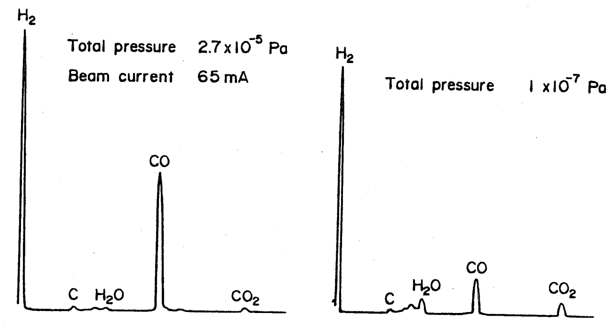

Fig. 9 Mas patterns with beam.

Fig. 10 Mass patterns without beam.

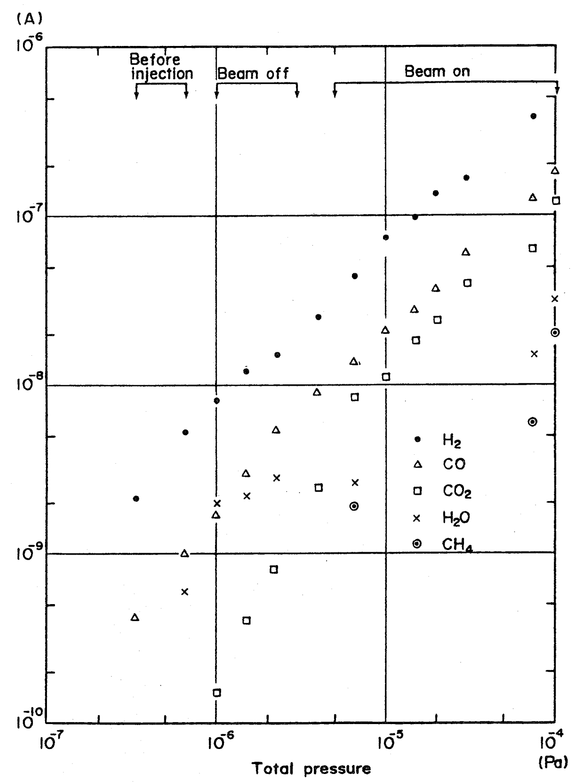

Fig. 11 Partial pressure change with beam conditions.

CONCLUSIONS

Gauges and power supplies of pumps of the AR are developed under a new idea of all computer control and miniaturization. The gauges, power supplies, and computer controlled system have been operated without any significant trouble. Simpler and more reliable control system for the main ring has now been designed including computer controlled roughing system.

REFERENCES

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