

PLS 2-GeV Linac Vacuum System

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I. Introduction

We started commissioning of the PLS 2-GeV linac on January 7, 1994. The extracted beam energy reached 1.5-GeV without the energy doubler system on March 9, 1994 and 2-GeV with 9-SLED system on May 10, 1994. The vacuum system of the PLS 2-GeV linac consists of forty two 3.07-m long accelerating columns and rectangular waveguides of about 400-m long with stainless steel flanges. In order to prevent electrical breakdowns in high rf fields, the vacuum system is providing a base pressure in the medium range of 10^{-7} Torr and a working pressure in presence of electron beams in the low range of 10^{-8} Torr.

II. Description of the vacuum system

The PLS 2-GeV linac of 150-m long consists of ten 14-m long modules and a 100-MeV preinjector unit. Each module contains four 3.07-m long accelerating columns composed of a string of 86 S-band copper cavities. The module of the main linac is shown in Fig.1. The E3712 klystron feeds the rf power into four 3.07-m long structures via SLED cavity and 40-m long rectangular waveguides. The peak rf power and the rf pulse width from the klystron are 80-MW and 4.5 μ s. Each module is pumped down by four 60 ℓ /s triode sputter ion pumps in tunnel and two 120 ℓ /s in gallery. Pressure is monitored by the usual cascade of commercial penning gauges, ion pump current reading, and BA hot-filament ion gauges. We adopt the distributed pumping layout without manifolds to utilize the several advantages such as the simplicity of system layout, the good accessibility of assembly work, the minimization of virtual leaks and cost saving. However, the large number of individual vacuum components are still related to the scale of the PLS 2-GeV linac. More than 1300 construction components are required for 10-module assembly. More than 60 sputter ion pumps, 12 isolation gate valves, 50 gauges are permanently operated. The vacuum control rack is separately integrated into three local stations in gallery. The primary vacuum interlock is used to protect the klystron and modulator system. Interlock vacuum levels are set to 2×10^{-8} Torr for klystron window and 3.5×10^{-8} Torr for accelerating column.

III. Installation and Commissioning

513 conflat and 749 skarpass flange pairs were assembled in the whole system. The critical alignment of waveguide gaskets during the assembly work was achieved by a special clamping tool with two precision dowels. The leak rate for joined flanges was tightly controlled to be less than 1.5×10^{-12} Torr \cdot ℓ /s. Most leaks were mainly

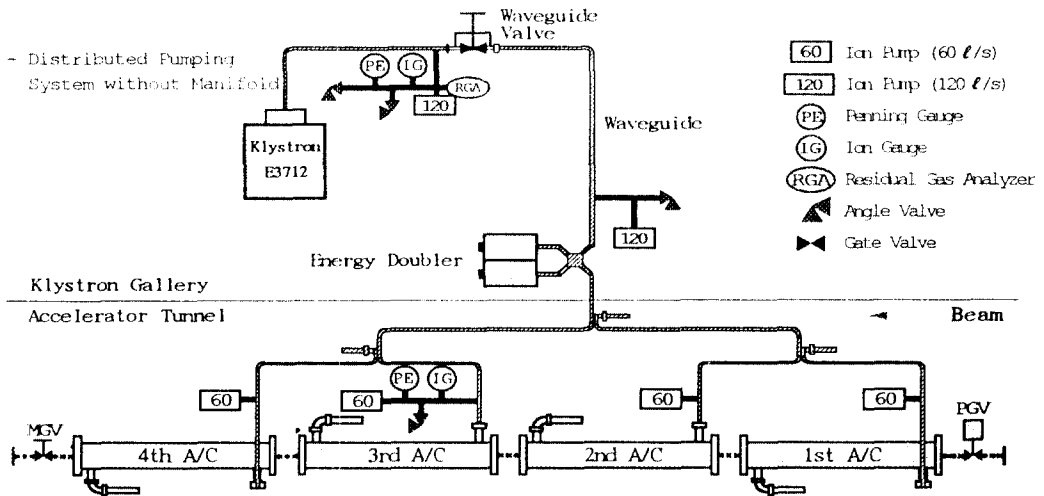


Fig. 1 Schematic Diagram for Regular Module Vacuum System

originated from the fabrication defect, flawed edge and uneven torque. The initial pumping from an atmospheric pressure was performed by two 220 ℓ/s turbomolecular pump units. The microwave power conditioning for whole linac system has been continued since December 7, 1993. Presently, the applied power level from klystron is about 64-MW. During the rf conditioning, the steady outgassing at pressures between 10^{-8} and 10^{-7} Torr and rf breakdown events accompany. The effective outgassing rate is measured to be approximately 5×10^{-12} Torr \cdot $\ell/s \cdot \text{cm}^2$ using the rate-of-rise technique. The average base pressure remains around 4.5×10^{-9} Torr or lower with H_2 , comprising more than 90% of residual gas, the balance being CO , CO_2 , CH_4 , and molecules of water vapours. However, when the microwave power is loaded, the pressure increases by several times of magnitude due to rf assisted desorption from the vacuum chamber wall. Before stable operation with required beam parameters, enough MW-Hours of conditioning time has to be accumulated to desorb the gas from the wall. The time required to accomplish this depends on the initial cleanliness of the vacuum system, the installed pumping speed, and the sophisticated power loading procedure.

IV. Conclusion

The vacuum system of the PLS 2-GeV linac has been installed and commissioned. The system has been working without any trouble. The system pressure has been improved by uninterrupted operation, and now it is approximately 1.39×10^{-7} Torr in the electron gun, 1.14×10^{-8} Torr in the accelerating columns, 7.85×10^{-9} Torr at the klystron window, and 1.27×10^{-8} Torr in the SLED system under 64-MW rf power loading.