PRESENT STATUS AND A PLAN OF IMPROVEMENT ON TARN II VACUUM SYSTEM

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Abstruct

Vacuum system of cooler ring, TARN II, was operated at a mean pressure of about 5×10^{-10} Torr. This paper describes basic design, present status and a plan of improvements .

Introduction

Vacuum system of the cooler/synchrotron,TARN-II[1],was designed based on TARN-I[2] and was constracted in 1988. This ring has mean radius of 12.4 m and circumference of 78 m that is about 2.5 times longer than that of TARN-I. Vacuum pumps used at TARN-I were applied to the ring. First beam from SF sychrotron had been circulated in 1988. Electron cooling devaice was joined into the ring in 1989 and the cooling experiment was performed. The chambers for the beam extraction were connected in 1990 and alfa beam of 40 MeV was extracted in 1991. TARN-II had been operated in the condition of the vacuum pressure of about 5×10^{-10} Torr.

Beam experiments such as injection, acceleration,beam monitoring, electron cooling and beam extraction were performed. At present, a plan of reinforcement of titanium sublimation pumps and ion pumps is in progress.

Present status

Basic design

The operation as the storage ring for light heavy ions is one of the important aspect of TARN-II, so a pressure of better than 10^{-10}Torr is required keeping long beam life. The design of the vacuum system is based on the following points,

(1) All vacuum chambers are bakable at 350° C, so organic free materials such as stainless steel and pure alumina ceramics are used.

(2) All metal gaskets are used and elastmer is not used.

(3) Ion pumps, titanium sublimation pumps and turbo-molecular pumps are employed.

Vacuum chamber

The vacuum chambers of dipole magnets and quadrupole magnets are made by 316L stainless steel plate of 4mm thickness, because the operating mode of TARN-II is rather slow (acceleration period of 0.1 Hz). The vacuum chamber which correspond to two stages of the dipole magnets have a length of 3 m and a cross sectional area of 240 mm (horizontal) x 53 mm (vertical). Large size flanges of 325 mm in diameter are used at both side of the chamber and stainless steel O-ring gaskets coated with silver are applied. The pump port and the auxiliary port in which beam monitor is equipped are located in the midle of the chamber.

Pump system

The parameters and the arrangement of the pump system of TARN-II are shown in Table 1 and Fig. 1. The ion pumps of 800 l/s, 400l/s and the titanium sublimation pumps 1500 l/s are installed at the pump ports of the dipole magnet chambers. The pumping capacities of the inflector chamber, S1 and a chamber which crossed the beam transport and main ring are augumented by the ion pumps of 800 l/s, respectively.

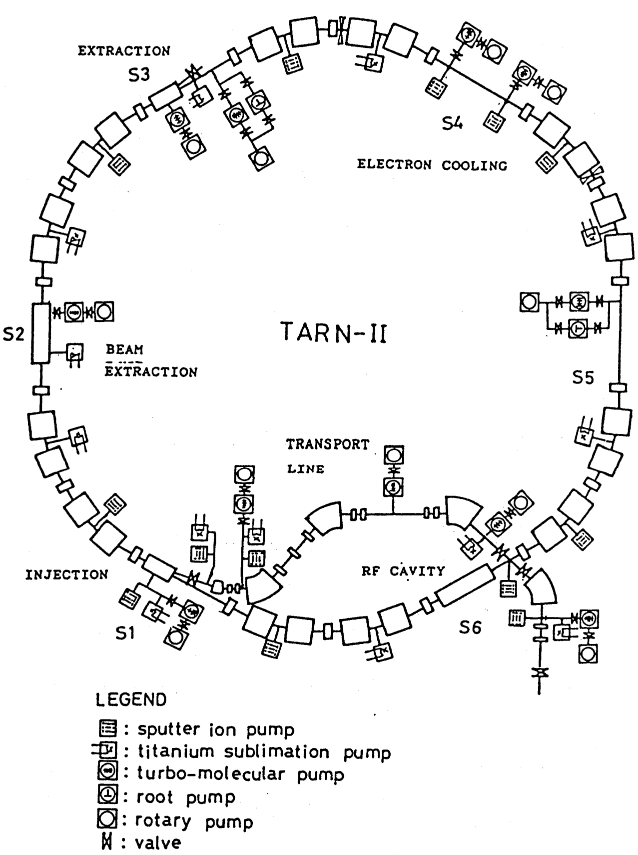

Fig.1 The vacuum system of TARN II

Table 1

Parameters of the TARN II vacuum system

Circumference	78	m
Total surface area	$5x10^{5}$	cm^{2}
Required vacuum pressre	$<1x10^{-10}$	Torr
Total pump speed	$1.7x10^{4}$	l/s
Titanium sublimation pump	1500x7	"
Sputter ion pump	800x5	"
"	400x3	"
Turbo-molecular pump	500x3	"
Out gassing load (Required)	$<2x10^{-6}$	Torr·l/s
Out gassing rate (Required)	$<4x10^{-12}$	Torr·l/s·cm^{2}

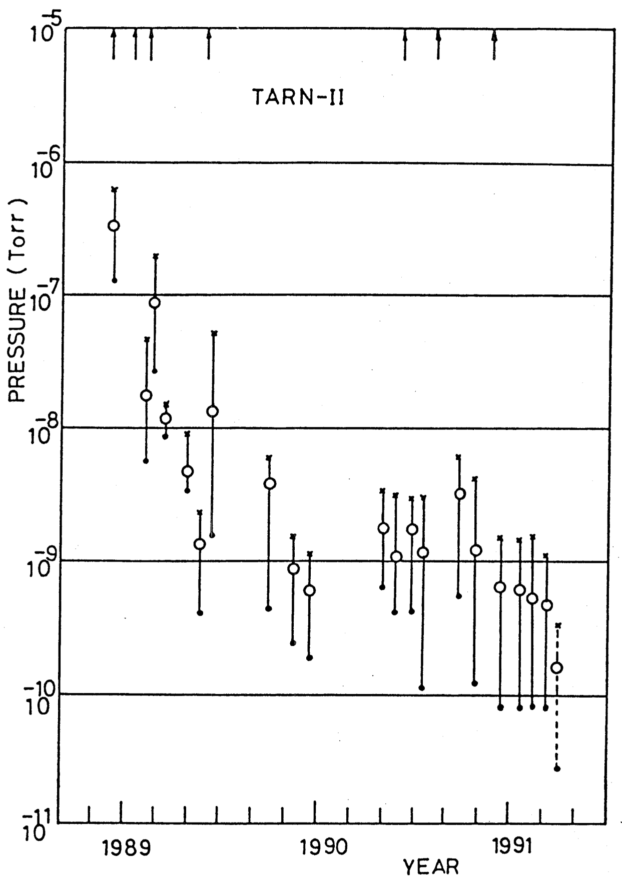

Fig.2 Mean pressures at machine times from the first beam experiments. Good and bad values at the measuring points are indicated by black dots and crosses respectively. The last point (indicated by the dotted line) is the based pressure for the condition of without a beam.

Baking

The chambers of the dipole magnets are baked by supplying DC current of about 1300 A through themselves. Temperature of the chambers reached up to 300°C in the midle position. The chambers of the quadrupole magnets, beam ducts and titanium sublimation pumps are heated by theath heaters and temperature reached from 200°C to 350°C. Baking for ion pumps is performed by mantle heaters up to 250°C. Glass wool sheat of 25 mm thickness are used as heat insulation.

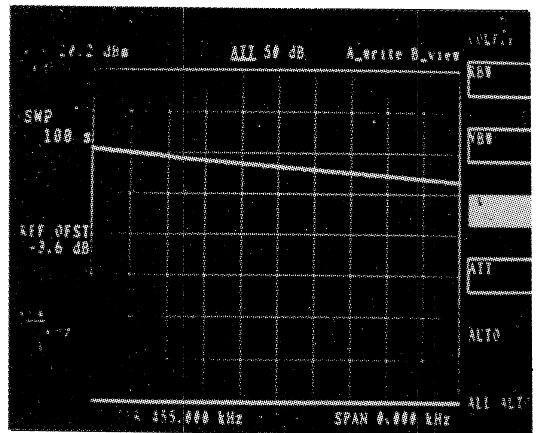

Fig.3 Beam intensity. V: 10 dB/div
H: sweep 100 s/FS

Beam Extraction

In August 1990, vacuum chambres of beam extraction are installed in the ring. Electric septum located in long straight section (S2) is evacuated by 200 l/s turbo-molecular pump and 1600 l/s cryo pump. Septum magnet chamber located in next long straight section (S3) is evacuated by 450 l/s turbo-molecular pump and cryo pump of 800 l/s is equipped nerby. The vacuum pressures of $1x10^{-10}$Torr at S2 and $3x10^{-10}$Torr at S3 were obtained.

Operational characteristics

The mean pressure values measured by Bayard-Alpert gauges at machine times from the first beam experiment are shown in Fig. 2. The arrows at the upper position indicate the times of pump-down from atomospheric pressure. Recent beam experiments have been carried out at a mean pressure of about $5x10^{-10}$Torr. Fig.3 shows the beam life time of about 100 sec measured at alfa beam of 40 MeV. Fig.4 shows the vacuum pressures measured at ten points without a beam. A mean pressure of $1.7x10^{-10}$Torr and a good point pressure of $3x10^{-11}$Torr were obtained.

A plan of improvement

We desired more better vacuum pressure for experiment of electron cooling. The electric septum chamber and the septum magnet chamber located in long straight section S2 and S3 respectivly were removed to obtain space of beam monitor temporally.

Reinforcement of ion pumps and titanium sublimation pumps are in progress. Ion pumps of 800 l/s is placed in straight section S3 and ion pumps of 400 l/s are settled in S2 and S 5 respectively. Ion pumps of 4 units of 160 l/s are equipped to auxiliary port of dipole magnet chambers. Titanium sublimation pumps

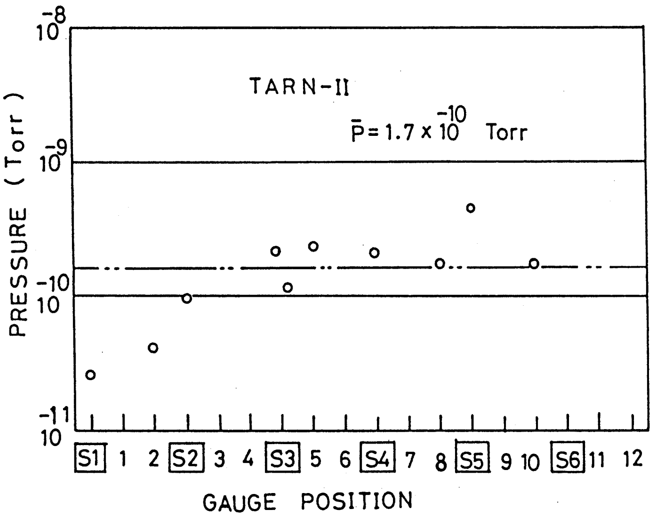

Fig.4 The vacuum pressure measured at ten points around the ring without a beam.

of 3 units (1000 l/s), 2 units (700 l/s) and 10 units (400 l/s) are equipped in the ring. Pump speed by reinforcement is 16000 l/s and total pump speed by titanium sublimation pumps and ion pumps for the new pump system is 26000 l/s. The pump speed by titanium sublimation pump and ion pumps for TARN-I is 16800 l/s. We expected that mean vacuum pressure of around 5×10^{-11}Torr will be obtained by high temperature baking process.

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