LANSCE VACUUM SYSTEM REFURBISHMENT PLAN AND VACUUM ALERT SYSTEM IMPROVEMENTS FOR PREDICTIVE MAINTENANCE*

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Abstract

The Los Alamos Neutron Science Center (LANSCE) accelerator, an 800-MeV H+/H- LINAC with a storage ring, has been operated over 30 years since early 1970s. A refurbishment project named LANSCE-R was approved and started in 2007. This paper describes our plan for vacuum system refurbishment as well as an update on the ongoing vacuum email alert system improvement project, which will eventually notify workers of the need for predictive maintenance of particular devices like ion pumps.

INTRODUCTION

Figure 1 schematically shows the LANSCE accelerator [1] and experimental areas together with the number of various vacuum pumps in red. A detailed description of the vacuum system has been shown in [2]. The main vacuum pumps are ion pumps and there are a total of ~235 ion pumps, mostly 500 L/s ones throughout the linac. Our objectives for the LANSCE-R project are summarized in Fig. 2, i.e., 1) install fast-closing valves to protect the linac from experimental areas to increase the reliability, 2) replace ~40 years old ion pump power supplies with new modern power supplies to increase the maintainability, 3) install independent chiller system for the cryopumps in the drift-tube linac (DTL) section to increase the reliability by avoiding the shut down due to cooling water problems connected to other systems, 4) increase the number of turbo pumping carts to shorten the time of action in case of failure, and 5) increase the number of ion gauges in the coupled-cavity linac (CCL) to have better monitoring of vacuum in the beam line instead of relying on the ion pump currents.

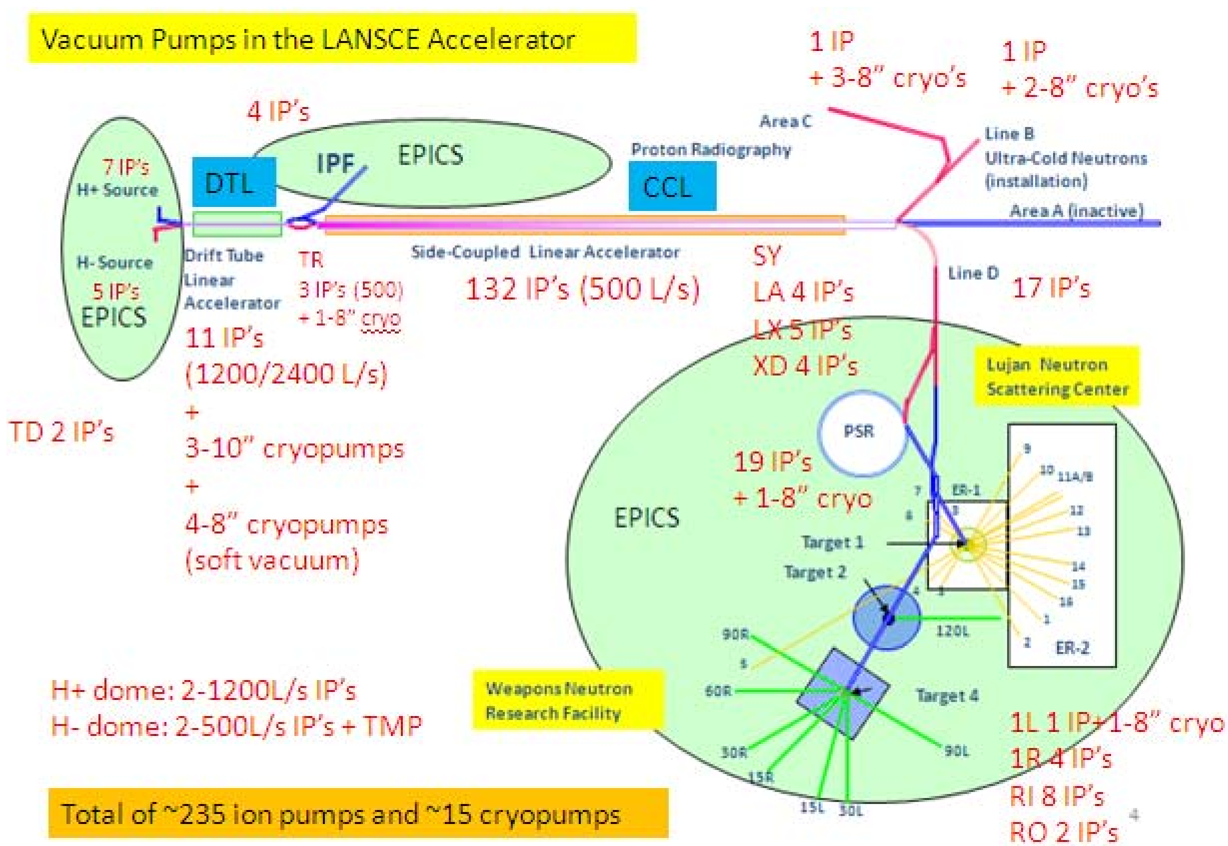

Figure 1: Schematic representation of LANSCE accelerator and experimental areas. The numbers of various vacuum pumps are shown in red.

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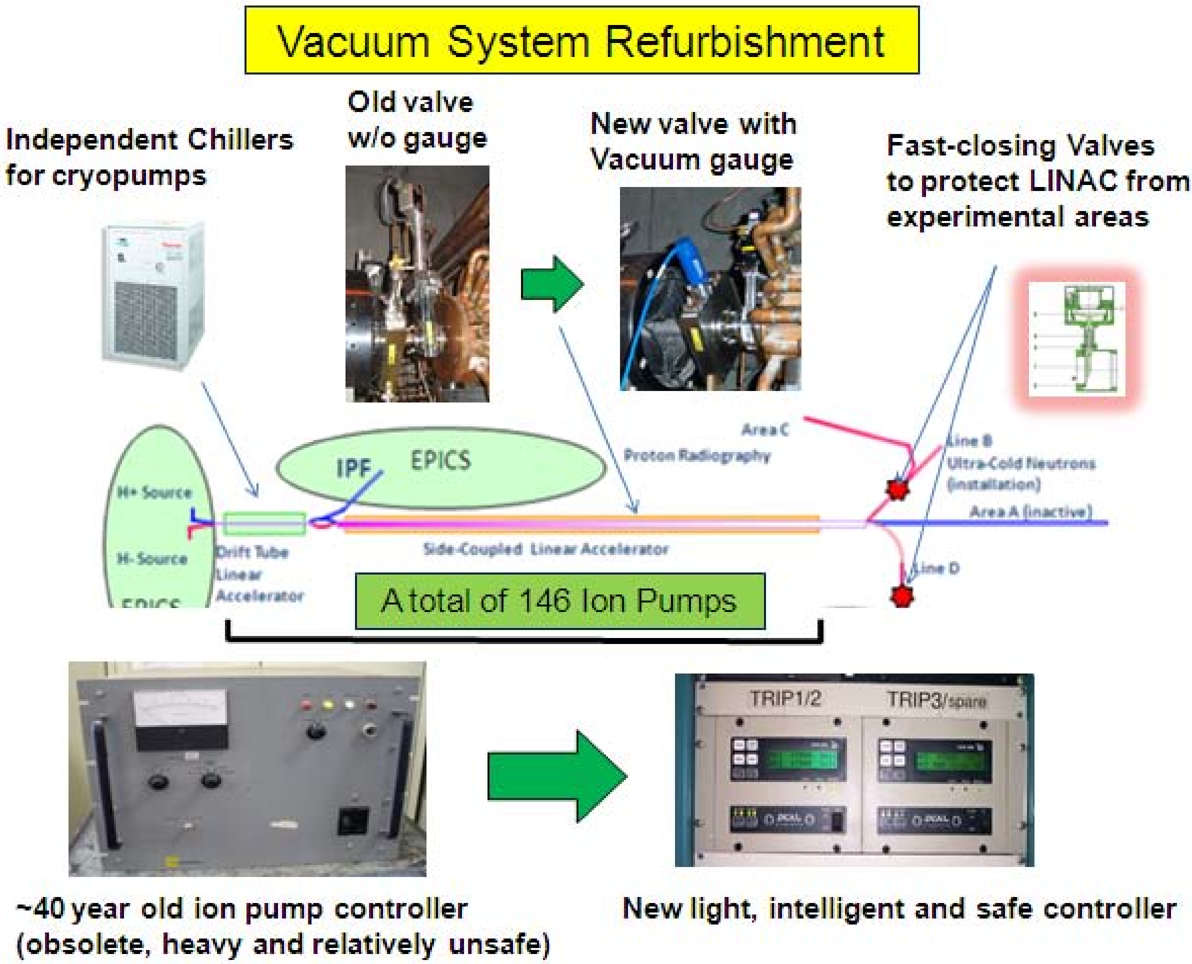

Figure 2: Summary of LANSCE vacuum system refurbishment project.

LANSCE-R FOR VACUUM

Installation of fast valves

As shown in Fig. 2, we will install two 4 inches ID fast-closing valves to protect the linac from experimental areas called Area B, Area C and Line D.

These valves will completely close in 15 ms after receiving the trigger signal. To keep the wave front from hitting the valve before it closes, the vacuum gauge to trigger the valve action will be installed at least ~5 m away from the gauge.

Replacement of old ion pump power supplies

Most of our existing power supplies were installed in early 1970s. They weigh ~60 lbs. and the stored energies are 4-25 joules. We plan to replace these with ~20 lbs. with stored energy of 0.5 joules, i.e., much safer. Figure 3 shows the old and new power supplies. As you can see, it is more compact as well.

Figure 3: Comparison between a new ion pump power supply for 500 L/s ion pumps and our old one.

Portable pumping carts

Figure 4 shows our typical pumping cart for the CCL section. We plan to have 2-3 more pumping carts that can be strategically distributed along the linac to respond to vacuum failures more efficiently.

Figure 4: Our existing portable pumping cart consisting of a 1000 L/s air-cooled turbo pump, a dry scroll pump, an ion gauge and a Convectron gauge.

Installation of air-cooled chillers for cryopump compressors in the DTL section

In the last few years, there have been occasions where water supply stopped for several reasons such as a break of water hose for DTL tuners. We had to recover the cryopumps whose compressors are connected to the same cooling water line. If the recovery of water supply is not soon enough, we need to regenerate the cryopumps and that takes a few hours.

To reduce this sort of incidents and operate our cryopumps more reliably, we decided to install 2 air-cooled chillers dedicated for the cooling of our 4 cyopumps in the DTL section.

More ion gauges for monitoring beam line vacuum in the CCL section

Presently, we monitor only ion pump currents of 2 out of 3 ion pumps attached to each coupled-cavity module. Although we can predict the beam line vacuum from the ion pump current if there is no beam, they are less sensitive to the dynamic change of pressure during beam operation. Also, when ion pumps get worn out, they do not show the current from which we can calculate the pressure.

To improve this situation, we started to add an ion gauge between each module in 2004. So far, we added 20 gauges out of 44 needed. Our plan is to complete the installation of all the gauges and connect them to the data taking system so that we can monitor them constantly during the beam operation.

THE VACUUM ALERT EMAIL SYSTEM

In June 2006, we first implemented a system that sends an email to vacuum team members and others interested when a pump current exceeds a set point, typically 5 mA for a 500 L/s ion pump. This set point corresponds to approximately 7E-7 Torr for a typical 500 L/s ion pump. The detail of the system is described in Ref. [2].

The problem of too many emails due to the noisy signal crossing the set point has been addressed by reducing the frequency of emails from 1 minute to 1 hour when this noisy signal is detected, which made it less annoying.

Has this system helped us in terms of the reduction of down time? Table 1 shows the downtimes due to vacuum failures from 2003 through 2007. It is difficult to determine if this system has been effective from this data, but we feel that it has been very useful and at least it has reduced the time for people checking the ion pump currents.

Table 1: Downtime due to vacuum failures during run cycles from 2003 through 2007.

Year	Total operation time (hrs)	Vacuum Downtime total (hrs)	% of ops time	No. of down-times	Mean outage dur. (min)
2003/ 2004	4509.1	191.2	4.24	42	273
2004/ 2005	3826.5	15.4	0.40	17	54
2006	4540.3	24.3	0.54	24	61
2007	3476.7	23.5	0.68	32	44

REFERENCES

[1] P. Lisowski and K. Schoenberg, “The Los Alamos Neutron Science Center,” Nucl. Instrum. Methods 562 (2006) 910.

[2] F.R. Olivas et al., PAC’07, Albuquerque, June 2007, MOPAS053, p. 557 (2007); http://www.JACoW.org.