The vacuum interlock and monitor systems of Taiwan Photon Source are designed to maintain the ultra-high vacuum condition and to protect the vacuum devices. The pressure readings of ionization gauges are taken as the judgment logic to control the opening and closing of sector gate valves so as to protect the ultra-high vacuum condition. Monitors of the water-cooling system and the chamber temperature serve to protect vacuum devices from radiation hazards. The preparation, installation and status of the interlock and monitor systems are presented in this paper.

Abstract

The vacuum interlock and monitor systems of Taiwan Photon Source are designed to maintain the ultra-high vacuum condition and to protect the vacuum devices. The pressure readings of ionization gauges are taken as the judgment logic to control the opening and closing of sector gate valves so as to protect the ultra-high vacuum condition. Monitors of the water-cooling system and the chamber temperature serve to protect vacuum devices from radiation hazards. The preparation, installation and status of the interlock and monitor systems are presented in this paper.

TPS Vacuum system

- The storage ring (circumference 518.4 m) is divided into 24 sections, including 24 bending and 24 straight sections.
- The bending sections, which were prebaked to ultra-high vacuum in a laboratory, have been installed in the TPS tunnel during 2013 October to 2014 March.
- The straight sections, six of length 12 m and 18 of length 7 m are assembled continually, including injection and diagnostic sections, three PETRA cavities and five insertion devices in vacuum, and will be completed in phase I.
- The triangularly shaped vacuum chamber in a bending section was designed for localized pumping
- Exhaust pumping systems with turbo-molecular pumps will be installed to increase the pumping performance during machine commission.

Vacuum control system

- TPS uses EPICS to control and monitor the accelerator machine.
- NI Compact-RIO PAC (programmable automation controller) serves for the vacuum safety interlock, data acquisition and monitor systems
- The interface of I/O communication is used between the PAC and the vacuum system
- Each PAC is in charge of all signals from one section, including 46 analogue input signals, 96 digital input signals and 64 digital output signals, roughly.
- Besides the storage ring, vacuum signals of the booster ring, LTB (linac to booster ring) and BTS (booster to storage ring) are connected to adjacent PAC, depending on the location, for safety interlock and monitors.

SGV logic control system

(a) Pressure issue
- Manual on and fail-safety principle was used.
- All three gauges are installed between two SGV. If any two gauges are over the setting or malfunctioning, the logic trigger outputs; SGV are then closed.
- Vacuum gauges become switched off automatically when the vacuum pressure increases suddenly to more than 1x10⁻³ Pa (self-protection)
- Two front-end (FE) vacuum systems associated with this vacuum system additionally ensure the completeness of the safety interlock system.

(b) Emergency trip
- The emergency trip of neighbouring valves is added to the interlock system to decrease the risk of a spread of poor vacuum.
- When any neighbouring valve is out of control or malfunctions, the emergency trip signal becomes triggered; the SGV then becomes closed to prevent the spread of the poor vacuum in advance.

FEV protection consideration

- A photon stopper with a cooling channel is designed and installed upstream of the FEV to avoid the FEV becoming irradiated directly with synchrotron light.
- When a FEV is in an open status, a photon absorber can be opened to allow synchrotron light to pass. If a FEV is not in an open status, the opening of the FEV is inhibited.
- The vacuum status behind the FEV requires also an interlock to prevent erroneous human operation.

Exhaust pumping system

(a) The emergency trip of a PGV is interlocked with the neighbouring vacuum system to prevent the spread of a poor vacuum from the backsteam of the exhaust pumping system.
- The mechanism for the time delay serves to provide a buffer period for the judgement of the UPS signals to avoid a transient blackout or a sudden fluctuation of the line power system.
(b) The diaphragm type of fore-line pumping unit is chosen because of the smaller rate of increase of pressure when its power is interrupted. This mechanism not only protects the turbo-molecular pump by preventing inrushing air at a great speed of rotation, but also provides a buffer period for the closing of the PGV.