# Executive Summary

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# Booster

# Linac, Damping Ring and Sources

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## Linac Technical Systems

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### Control System

(Error! – this section needs to be re-written. It is not acceptable in its present form for the TDR, which is a construction-ready document.)

#### Introduction

The injector of CEPC is an electron/positron linear accelerator. The equipments controlled are distributed along with about the 1.8 km gallery. The Linac accelerator will produce the e+ and e- beam to be transferred into the booster ring. The control system allows the operators to monitor and control the equipment in the local and central control rooms. There is a machine protection system to keep the devices in a safe condition. All of the useful parameters are stored in a database for later retrieval.

Considering the construction period of CEPC, CEPC will commissioning the beam while building. Therefore, a temporary central control room is required, and at the same time, global control systems such as timing systems, MPS , data service systems, etc., will also enter the state of commissioning and trial operation.

Operators will be able to adjust the current and choose the operating mode of the electron/positron gun.

Parameters of klystrons and modulators will be monitored and displayed. These include the high voltage, the output power, the RF phase and the amplitude of the output envelope. There are interlock loops for klystrons and modulators. In case the pressure outside a vacuum klystron window exceeds a specified limit, the HV of corresponding modulator will be turned off.

#### Magnet Power Supply Control

There are 325 varieties of magnet power supplies in the Linac of CEPC, including the power supplies of dipole, quadruple, solenoids and correctors etc. These power supplies are distributed along a linac gallery. The power supply control systems for Linac and Collider are similar, seeing chapter 4.

According to the user requirements the power supply control system should have the following functions:

1. Turning on/off all power supplies locally and remotely.
2. Monitoring current and status of the power supplies, such as the status of on/off, local/remote, normal/alarm, etc.
3. Setting values

There are three kinds of mode to make settings.

* + 1. Direct setting mode: In this case, a single setpoint is given and the current will ramp linearly to the setpoint. This mode is often used to initialize, test and maintain the power supplies
		2. Standardization mode: Ramping power supplies resets the hysteresis of the magnetic field to the standard position, in which the current is set along the standard hysteretic loop
		3. Knobs - adjusting individual power supplies.
1. Interlock system for protection of magnets and power supplies

The system patrols inspection for cooling waters, temperatures of magnets and power supplies. And if anything goes wrong, the system must treat the problems locally and send out an alarm message to the local and central control stations.

The control system provides graphic control panels for operators. The majority panels are provided to display the current, setpoint, and status of all power supplies in Linac. The control panel allows user to operate the power supplies e.g. make settings directly, standardization and on/off etc. The other screen shows diagnostic information such as the alarm report or the interlock trips. The knob screen is for adjustment of current for one or a set of power supplies. Operators can assign a knob to a process variable (PV) and set the PV up and down.

#### Vacuum Control

There are total about 30 vacuum valves, 1310 pump and 611 gauges distributed in the Linac tunnel.

Vacuum control system will measure the vacuum pressure for vacuum chamber and the outside window of klystrons, and close valves of Linac sections to to protect the machine from being damaged due to vacuum leak in a chamber.

Based on EPICS, the vacuum control system has three levels: operator interfaces (OPI), input output controllers (IOC) and device controllers. The IOCs will interface with device controllers via RS-485 and RS-232 serial buses and PLC via Ethernet.

The ion pump controllers are connected to the IOCs through RS-232/485 serial communication to turn on/off the pump high voltage and to read back pump current and voltage. The gauge controllers communicate with IOC through RS-232/485 interface and directly provide setpoint outputs as interlock signals to the vacuum interlock system.

The programmable logic controllers (PLCs), the heart of the vacuum protection interlock system, will be used to monitor gauge setpoint outputs and IOC interlock outputs and to provide control of the sector gate valves. The PLCs will also output interlock signals to the RF system and other subsystems and receive interlock signals from other subsystems.

#### Integration of Other Sub-systems Control

Linac control system includes not only klystrons and modulators, electron gun, positron target and microwave system but also power supply and vacuum devices. The functions of the Linac control system should be:

 (1) Klystron/modulator monitor and interlock

* There are interlock loops for klystrons and modulators. In case of the vacuum pressure of the outsides or inside window of a klystron exceeds a specified limit, the HV of corresponding modulator has to be turned off.
* Parameters of klystron and modulator will be monitored and displayed on the console, such as the high voltage, the output power, the RF phase and the amplitude of output envelop and so on.

(2) Phase - shifter control

Adjusting and monitoring the stroke of electromotor of phase-shifters and attenuators

 (3) Electron gun system

Operator can adjust the current and choose the operation mode of the electron gun. The parameters of filament current and vacuum pressure of the cavity should be measured and displayed on the console.

(4) Positron target control

Monitoring and adjusting the position of the target

Displaying the beam parameters in the local and central control rooms, such as the beam position, the beam loss, the beam current and the emittance, etc.