THE FIRST DESIGN OF MEDIUM RESOLUTION MASS SPECTROMETER (MRMS) HIGH VOLTAGE PLATFORM IN A SPES PROJECT

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Abstract

A new project of 130 kV high voltage platform (HVP) is developed in a Laboratori Nazionali di Lagnaro as part of SPES (Selective Production of Exotic Species) project for the production of the multiply charged rare ion beams (RIB). The HVP will be located after ECR ion source charge breeder [1]. Medium resolution mass spectrometer (MRMS) is installed at the platform to provide high purity beams with mass resolution about 1/1000. The Draft of platform design including all beamline elements is discussed. It is proposed a several way of equipment feeding on HVP, required engineering services parameters (vacuum system, cooling system, power system and etc) were defined. Some safety measures are proposed.

MRMS IN SPES FACILITY

Selective Production of Exotic Species (SPES) project is under development. The result of SPES operation should be production of the multiply charged rare ion beams (RIB) by ISOL technique which using the proton induced fission on a Direct Target of UCx. The proton driver is a Cyclotron with variable energy (15-70 MeV) and a maximum current of 0.750 mA. The RIB separate in HRMS platform and transport to charge breeder. The charge breeder is a device that accepts RIB ions coming from the Target-Ion source complex with charge state *+1* and it transforms their charge states to *+n*. The last separator (MRMS) will be installed after the charge breeder to avoid the contamination of the selected beam by the stable contaminant introduced by the charge breeder itself [2].

The beam will transport from charge breeder to 130 kV MRMS platform, which will separate ions with mass resolution about 1/1000. The Potential of 130 kV is necessary for high mass resolution.

The beam will be transported to MRMS high voltage platform (HVP) through an 130 kV accelerate tube, ions will be focused by electrostatic lenses and after that, the ions with different mass will be selected by magnetic dipole. The beam orbit will be rotated at 90 degrees by each dipole. Separated ions will be refocused ones more in electrostatic lenses and then slows down to the initial speed (same ions speed before MRMS platform) by deaccelerating tube.

The beam line elements will be located on the platform according figure 1. MRMS platform will be enclosed in Faraday cage and will set on insulators columns.

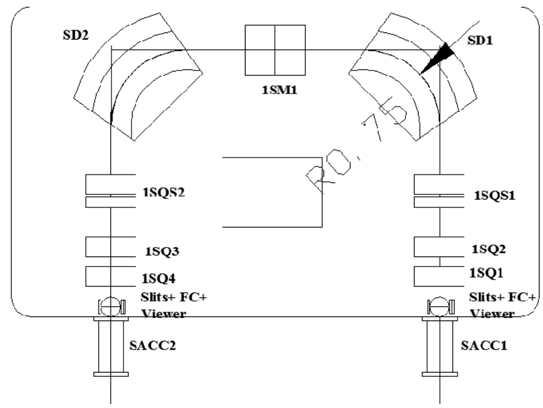

Figure 1: layout of main elements on the MRMS platform. SD1, SD2- magnetic dipoles; 1SQS1, 1SQS2 - sestupole electrostatic lenses; 1SQ1, 1SQ2, 1SQ3, 1SQ4 - quadrupole electrostatic lenses, SACC1 –accelerating tube, SACC2 – deaccelerating tube.

The platform should be located in experimental hall with sizes according figure 2 and further than 0.9 m to the nearest surface of the building. It is important to avoid electrical breakdowns. The Platform height will be 5 meters or less it for the crane movement will be free over the HVP.

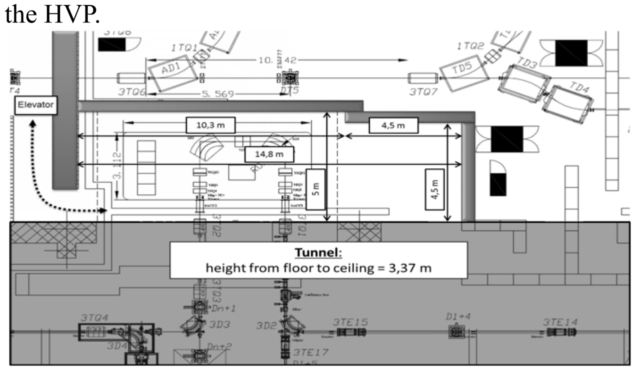

Figure 2: layout of experimental hall.

Secondary Faraday cage locating around the platform at a distance for 0.9 m.

Successful HVP design is necessary several calculations and circuits:

- power system calculations and circuit of power board;
- water cooling and ventilation system should be provided;
- radioactive and fire security should be provided;
- vacuum scheme and appropriate calculation, residual pressure should be less than 10^{-8} mbar;
- HV power supply will be defined according leakage currents;

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- way of equipment feeding on the HVP should be defined.

The platform needed following locks: doors, power supplies and secondary Faraday cage around the HVP (HVP zone) for safe operation.

PLATFORM DESIGN AND PLACEMENT OF EQUIPMENT ON IT

130 kV high voltage platform have one level, with sizes 5400x3110 mm. 130 kV is made HV power supply which will locate in HVP zone. Power of HV power supply should be more than leakage currents. Total leakage current from HPV will be less than 1.3 mA.

The Faraday cage will be installed around HVP area with height 2800 mm. This cage must be made of light and strong materials, with a door and removable upper cover for easiness of installation of different equipment's. The cage consists of aluminums panels, which must be mounted on frame. HVP shape must be a rounded (on all corners), we use a 14 cm radius for sides and vertices. This radius calculated by formula 1 [3].

$$R := \left(\frac{\sqrt{8} \cdot V2}{3 \cdot E}\right)^3 \cdot \frac{1}{b^2} \quad (1)$$

The false floor will be located under floor with equipment. Electrics and others cables should be located in false floor as is shown in figure 3.

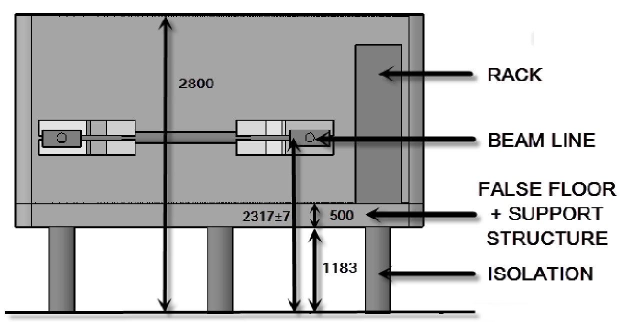

Figure 3: The front view of model HVP.

Height of beamline is 2317±7 mm (over floor of experimental hall). Height of insulation column should be less than 1200mm because false floor and beam line base necessary about 1150mm. The HVP will be standed on 9 insulating support columns, withstand 130 kV+20% Voltage. Metallic ring should be mounted in the middle of the insulator and bottom side isolators. It is important that the equipotential V=0 and half-potential (V/2) will be defined by metal rings, potential is distributed along the columns by two 750 MΩ resistors. Bottom part of insulators should be grounded.

Electrostatic and magnetic components are located along beam line. These components must be mounting on adjustable supports. Equipment inside racks must be located on a HVP. As well other engineering services must be locating on a HVP: vacuum pumps, diagnostic boxes, water cooling, lighting, interlocks and different alarms. Description thereof will be in the following chapters.

POWER SYSTEM

Equipment (load about 50 kVA) on a HVP can be powered by three ways:

1. Indoor Isolating transformer:

In case of dry type isolating transformer will be purchased, it will enable to install transformer in the experimental hall.

2. Outoor Isolating transformer:

In case of isolating transformer with oil will be purchased, it should be located on the outside of the building in the up special room. Transformer will be supplied power through the high voltage cables to HVP.

3. Motor-generator (figure 4).

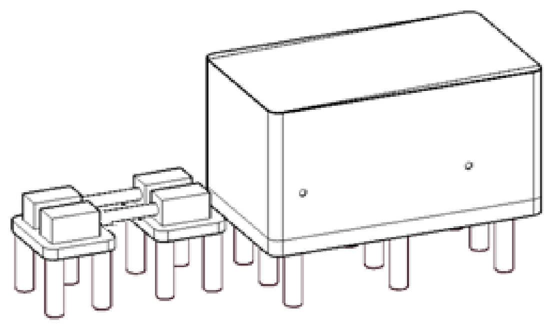

Figure 4: The front view of model HVP.

2 motors and 2 generators installed horizontally and connected by plexiglass shaft (1 motor-generator is spare), which acts as insulator. Motor and generator will be located on 2 platforms at the same level. Platform with generators will be connected to the main high-voltage potential platform. The generator will be located on a separate platform with insulating columns to eliminate vibrations.

The choice of power system depends on the power of finite resources of the project.

In any cases electric power should be distribute in power board with differential and overload breakers.

Grounding circuitry on HVP will be carried out by IT scheme [5]. In an IT system neutral of power supply should be isolate from earth or earthed via instruments or apparatus having high resistance, and the exposed conductive parts are earthed.

CONTROL UNITS

Control units should be operating the equipment on HVP remotely from the console. Also they will be indicated important values for safe operations on the HVP like leakage currents, pressure, powerboard status etc.

Two consoles will be used to control the platform and equipment installed on it:

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- A main console will be located in the main control room;
- Service console will be located closed to the platform, outside the secondary Faraday cage

Consoles will be connected with a platform by optical cables.

COOLING SYSTEM

Water from the central water delivery system can use for cooling equipment on HVP. The central conduit pressure is 8 bars. The equipment on the platform requires a cooling water flow about 40 l/min. Leakage currents by plastic tubes should be less than 1 mA. Tubes with L=20 m d=0.03 m provide necessary level of leakage currents and water flow at same time. Calculation of water flow by Darcy-Weisbach formula [6] is satisfying the requirements.

Racks will be cooled by air flow. Roof of HVP consist of grid blocks, for good heat air outlet.

SAFETY SYSTEM AND INTERLOCKS

HVP must have several locks and alarms for safe startup and operation of theplatform. For safety start up the HV power supply it must have positive status of doors interlocks, disconnectors interlocks, vacuum interlocks and ronda.

The ronda is a system of protection the presence people on the platform from HV generator startup. When you perform a technique (until 5 min) to bypass the platform, Ronda set a positive status and enables HV generator.

HV automatically disconnector position depends on the HV generator.

All equipment and RACK must be grounded to the housing platform. Also be placed on the platform and fire alarm sensors.

Emergency stop button should be installed near to console. This button can turn off all equipment on the platform, including UPS.

Also radioactive and fire security should be involved on the HVP.

VACUUM SYSTEM

The residual gas in the beam line will be removed by a small number of Turbo Molecular Pumps (TMPs). A rough estimation on the pumps installed is 4 TMPs assisted by 2 Primary Pumps (PP) (see. Figure 4).

Additional Ion Pumps (IPs) are planned as extension of the system to increase further the performance of the line. This type of pumps use the principle of the evaporable getters, i.e.

Compressed air is used to operate the vacuum valves, whereas nitrogen is used for venting the beam line before opening. Both these fluids are distributed to the valves on the HVP from a unique pressure gas panel (PGP).

The PNG collects the air compressed and nitrogen inlet lines from the III Experimental Hall. For the former there is one tank positioned below the PNG (approx. 10 lt) that is used as a reservoir for closing the valves even if the inlet is out of service. For the nitrogen line there is a pressure reducer. A mechanical sensor for gauging the pressure is installed in both the lines of the PNG.

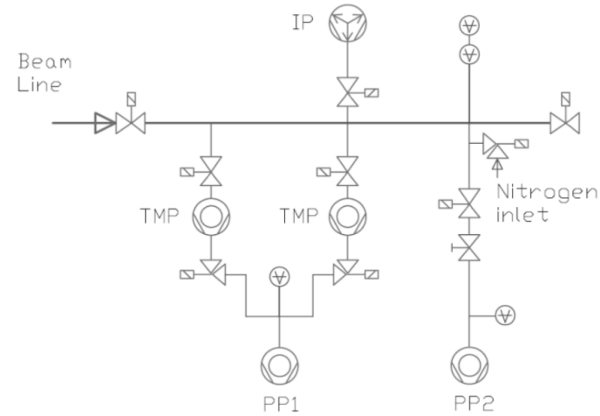

Figure 5: Diagram of the beam pipe with two pumping stations. The pumping station is composed of a TMP a Gate Valve (GV) and a Ion Pump (IP) as further option. The Primary Pumps (PPs) send the gas to the exhaust line.

The gas from the two PPs have the different contamination level. Thus two different pumping lines are used.

Indeed, the pumping of the exhaust gases with low contamination level can be achieved keeping into account the precaution that all the flow is sent to the air ventilation pipe, but for a gas with high contamination level this is no longer true. The gas must be stored in a tank since the radiation level is decreased and afterwards released to the air ventilation pipe.

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