COSY VACUUM SYSTEM AND REMOTE OPERATING ELEMENTS

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Abstract

At the COSY Vacuum System the point of special interest has advanced to the design and reliability tests of specialised components, so as a multi foil stripper target facility able to change targets in a short time by the use of a magazine without braking the vacuum. Another speciality is a bended vacuum chamber with tangential beam port, which can be closed by a movable hinged bridge acting as current conductor and rf-shield. Problems by friction at moved components in UHV-vacuum is given extra interest in design and prototypical tests.

Introduction

The progress in work for the vacuum system is within the time frame of scheduling for the COSY project. Approximately 90 % of the vacuum chambers for the 184 m long COSY ring are being manufactured at present and will arrive at the site by the end of the year.
A more detailed description of COSY and the present status of the project is given in ref. [1].

In planning the manufacture of the vacuum chambers from the selected material 1.4429 (SS 317 LN) the COSY project stored the needed quantities of cold- and hot rolled plates, forgings and precision tubes in the special electro slag remelted quality to fullfill the specified vacuum requirements of a design pressure of $< 10^{-10}$ mbar for a system bakeable at 300 °C [2].

Current work comprises the structural detail definition in the working drawings for the remaining special vacuum chambers. These are in particular the vacuum chambers for beam injection, the rectangular chambers with extraction side channel and the extraction branch chamber. A further component in the phase of detail definition is the remote-controlled multi-stripper target with a 8-fold multimagazine.

Current hardware production also comprises the bake-out control system of the entire COSY ring and for the transition regions to the injection and extraction beam lines.

Vacuum Chamber Test Section

An approx. 7 m long prototype section of the COSY ring vacuum chambers was constructed last autumn and has since been measured and tested in the new facility for vacuum component testing. This test section was built in order to verify the structural detail solutions meanwhile evolved and to check the production, welding, cleaning and annealing specifications defined in preparation of series manufacture [3]. For this purpose, a typical section of the COSY ring was selected which forms the transition from the linear telescope section of circular cross-section to the curved bending chambers of rectangular cross-section (see Fig. 1). This section contains the smooth transition from the circular to the rectangular cross-section, a pump nozzle with RF shielding, a housing for a rectangular position pick-up, circular and rectangular straight chambers as well as circular and rectangular flanges for flat metal gaskets. The metal gaskets are the flat VATSEAL (reg. trade mark) gaskets specifically selected for COSY.

Fig. 1: COSY test section under preparation for the bake-out test at 300 °C

Fig. 1 shows the test section under preparation for the bake-out test at 300°C with the position pick-up, bending chamber and pump housing being already provided with the heating jackets specifically developed and tested for COSY. A requirement for the

heating jackets was to find a thin, but effective insulation for the 10 mm thick heater jecked in order to prevent the epoxy-resin bond from overheating in the confined area of the magnet yokes during the 48-hour bake-out process.
The rack shown in the centre contains a laboratory version of the regulating and control unit for the bake-out system based on a programmable open-loop controller (Simatic S5). This control system has been extended with a display operating and monitoring system for use in COSY. Testing was successful. An end pressure of 5×10^{-12} mbar was achieved.

Multi-Foil Stripper Target

The life time of a stripper target foil is expected to be about 10 days beamtime. The replacement of a defective target foil means long downtimes if a single stripper target system is used due to the inward and outward transfer of the foils. Moreover, the new foil and the lock chamber must be thoroughly baked and pumped out during the inward transfer procedure in order to avoid an excessive increase of the vacuum operating pressure in the beam tube system. Finally, the time at which this outage occurs is not foreseeable.

In order to circumvent this problem, COSY will be equipped with a multi-foil stripper target providing a stock of 7 target foils within the area of the beam tube vacuum. This makes it possible to insert a new foil in the beam tube within a few minutes in the event of a target foil becoming defective.

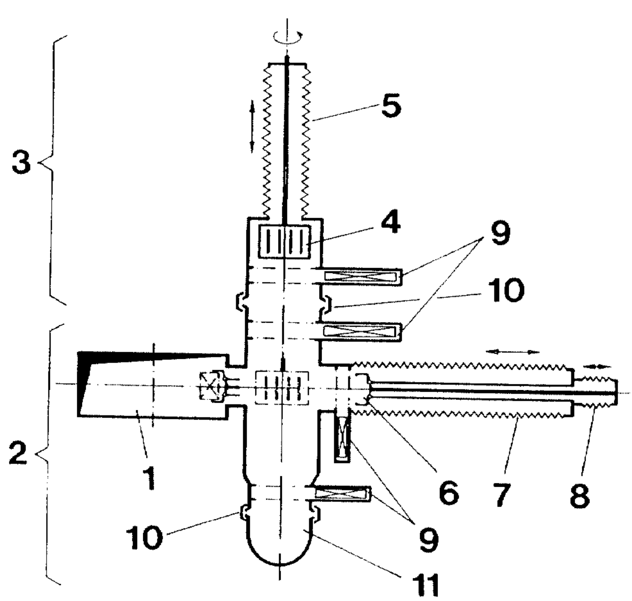

Fig. 2: Multi-foil stripper target for COSY-Injection
1 COSY beam line, 2 permanetly installed manipulator system, 3 mobile magazine system, 4 revolving magazine for 7 targets plus 1 viewer foil, 5 lowering/lifting and rotating drive, 6 manipulator grab, 7 long-stroke drive, 8 short-stroke cycle drive, 9 gate valve, 10 quick flange, 11 foil dump

Fig. 2 shows a functional diagram of this multi-foil stripper target. It consists of a target foil manipulator permanently installed in the COSY beam line and a flanged-on mobile revolving target foil magazine. The revolving magazine can accommodate 7 target foils held in U-shaped frames and 1 viewer foil. The foils are inserted manually in the laboratory where the target foil magazine can then also be baked out and evacuated. The UHV-prepared magazine is then transported to the COSY ring with closed gate and flanged onto the transfer gate of the target foil manipulator.

After a short bake-out and evacuation procedure both transfer gates can be opened and the revolving magazine lowered to the level of the target foil manipulator. The manipulator grabs a foil by the U-frame and withdraws it from the magazine which is then moved up again.

The manipulator has two separate linear drives, and it uses the long-stroke linear drive to move the foil up to the edge of the rectangular COSY beam chamber. The short-stroke linear drive can now be used to rapidly insert the foil 30 mm into the COSY beam chamber and withdraw it again. Insertion and withdrawal take 0.2 seconds each and the cycle time is 3 seconds.

If a foil becomes defective, the long-stroke linear drive moves to an intermediate position above the container for defective targets where the grab drops the U-frame into the foil dump. The grab is then moved back into its original position so that the revolving magazine can be lowered again for a new target transfer.

The target condition is monitored by a video camera.

Additional vacuum pumps, which are not shown in Fig. 1, evacuate the area of the revolving magazine, manipulator and container for defective targets.

The multi-stripper target is currently in the detailed design phase. Relevant testing of major components is being prepared.

Wall-Current Bridge

There are two positions at the COSY ring where laser beams can be launched in or neutrals launched out. For this purpose, a tangential beam outlet port is provided in front of or behind the straight cooler telescope section in each of the curved bending chambers.

Since these beam ports are not used all the time, it should be possible to close them by hinged wall-current bridges. These wall-current bridges are 0.25 mm thick sheet metal strips which partly replace the outer chamber wall in the rectangular chamber cross-section.

Fig. 3 shows a top view of a rectangular vacuum chamber with tangential beam port which is clear for beam exit due to the wall-current bridge being swung back. The wall-current bridge is moved by a bellows-sealed crank mechanism in the UHV vacuum.

The only mobile component in this arrangement producing friction within the bakeable vacuum area is the roller at the front end of the crank. In order to avoid problems due to friction and seizure, this roller is made of ceramics.

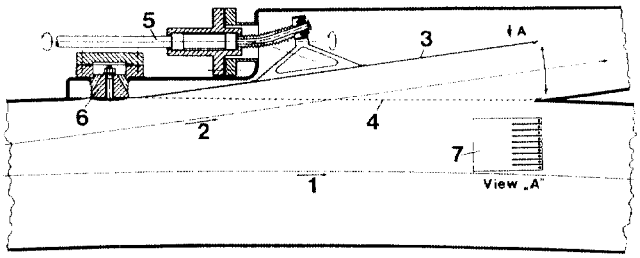

Fig. 3: Tangential beam outlet through swung back wall current bridge
1 COSY beam in curved chamber with rectangular cross section, 2 tangential lounched out beam, 3 wall current bridge in swung open position, 4 wall current bridge swung in closed position, 5 bellow sealed crank mechanism, 6 bridge mounting clamp, 7 top view detail of the slitted contact-comb end at the bridge

The wall-current bridge is designed to transfer the current tracking on the walls without any disturbances. For this purpose, the sectionally profiled sheet metal strip is clamped at one end to the vacuum chamber. The other mobile end is provided with point-type contact rivets for better electrical contacting.

Functioning of the hinged wall-current bridge, the crank mechanism with ceramic roller and the electrical transition resistance has been extensively tested at 300 °C under vacuum. The test has been successfully completed. The electrical resistance by the use of copper rivets was measured to 12 mΩ.

Bake-out system

All components of the COSY vacuum beamlines can be heated up to 300 °C. There are two different types of heat jackets used. Inside of magnet joke areas the totaly 10 millimeter thick heater jacket is composed by a insulation sandwitch of a mineral paper layer followed by an aluminium foil and a 6 millimeter layer of a microfiber felt, all surrounded by glass textile fabric. Outside of the narrow magnet areas the heater jackets have a total thickness of 25 millimeters, using normal glass fiber for thermal insulation.

The total of the COSY beamline ring can be devided by vacuum valves into eigth separate sections. To keep the effort for the heating control system limited the bake-out procedure can be done at only one of this sections at the same time. The bake-out control system is a selfcontrolling subsystem linked to the COSY main control system. It consist of (i) a programmable logic controller (PLC), (ii) a data bus-system, (iii) one portable rack containing extern programmable heater regulators and power supplies and (iv) for each section a terminal box as head-end for the distribution of heater power cables and thermocouple lines. Fig. 4 shows a diagram of COSY bake-out system.

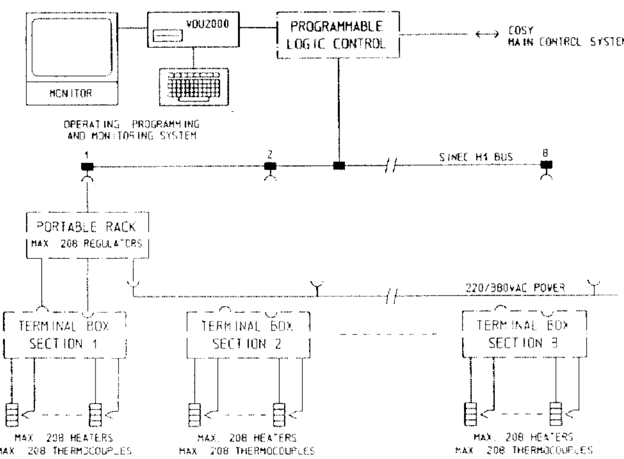

Fig. 4: Diagram of COSY bake-out system

In order to limit the length of the cables the terminal boxes are installed close to each beam line section. The portable regulator and supply rack is capable for a maximum of 208 heater and thermoelements.

To bake one of the sections the portable rack is moved to the appointed terminal box and connected by inserting some multipole plugs. There are different heating programms for each section available at the PLC. They are assigned to the selected section by coded connectors. Modifications of a section heating programm can be easily done by the use of an attached operating programming and monitoring system at the PC.

References

[1] U. Pfister and R. Theenhaus for the COSY-team, The COSY-Jülich Project, this conference.

[2] H. Stechemesser et.al., "Design and technical features of the Vacuum System at COSY", European Particle Accelerator Conference, Rome, June 7-11, 1988

[3] User Guide, Cooler Synchroton COSY Jülich