POWER SUPPLIES FOR TTF2

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Abstract

For TESLA a lot of equipment will be installed inside the accelerator tunnel which is not accessible during the four week run periods. During the following maintenance day time consuming trouble shooting is not possible and equipment will be exchanged instead of being repaired in place. Therefore the equipment has to be installed in electronic racks inside a container frame. This container will have a docking system to allow a quick exchange of the whole assembly via a monorail that will be installed inside the tunnel. In the TESLA Test Facility this principle will be investigated. The magnet power supplies will be installed in the tunnel. For this purpose the container frames with the electronic racks and a special docking system for quick exchange have been designed, and prototypes are being developed. The power supplies are modified to fit in the electronic racks.

1 INTRODUCTION

So far the designer of power supplies (PS) for particle accelerators is used to the fact that the PS are reachable in case a repair is needed. In general the power supplies are installed in areas that are accessible and the power supply is constructed in a way that an easy and fast repair can be done. From this central area the magnets are connected via cables. For TESLA this will no longer be possible for multiple reasons. The distance between service halls is up to 5 km. The cabling for the magnets will become to expensive, the electric losses on the cable will be to high, the heat load for the tunnel will become to high and finally there is not enough space available at the entrance of the tunnel to fit the cable. For these reasons power supplies and other equipment will be installed inside the tunnel along the accelerator. To get experience with this new situation and to learn about potential problems some of the new power supplies for TESLA will be installed into the TEST FACILITY phase 2 (TTF2) accelerator tunnel.

2 DESIGN OF THE TUNNEL

The extension of the accelerator tunnel for TTF2 is designed according to the tunnel layout mentioned in the Technical Design Report of TESLA. The diameter is 5.2 m. The length of the complete TTF2 tunnel is 262 m of which 136 m have the same cross section as in the TESLA design. As described in the TDR the heavy components will be transported via monorail into the tunnel which can be seen in Fig. 1

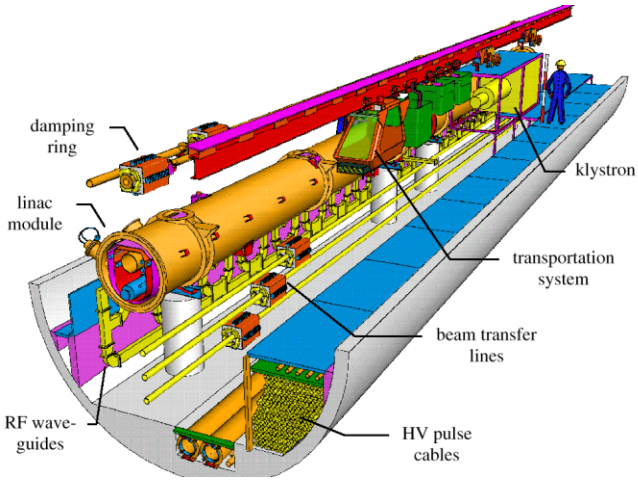

Fig. 1 Design of the TESLA tunnel

3 NUMBER OF PS

Overall more than 212 power supplies are foreseen for TTF2. The quantities and the different sizes are given in Tab.1. The undulator steerers and the small buck converters have already been installed in TTF1 and can be used again.

Table 1: PS of TTF2

Magnets	Current	Voltage	Qtty.	Type
QP, DP	200	60/120	25	Buck converter
QP, DP	400	Up to 120	48	Buck converter
Sc. Magnets	Up to +/- 100	+/-10	48	New design
Undulator steerers	+/- 30	+/- 10	30	Linear H-bridge
Steerers	+/-3,5	+/-120	68	Switched on primary
Dump	+/-100	+/-100	3	H-bridge bipolar

4 POSITION OF THE POWER SUPPLIES

The PS will be installed at three different locations. The main part of the PS will be installed in a hall that was already used for the PS of TTF1. This room is located at midpoint of the TTF2 accelerator. From here the cabling is directed to both sides. The max. distance between power supply and magnet is about 140 m. However due to the number of magnets it is a problem to install this amount of cable due to the concrete blocks shielding.

The steerer PS of the undulators (30 units) will be positioned near the undulators at the end of the tunnel in a radiation shielded position.
15 PS will be installed inside the accelerator. Another 15 PS will be installed in app. 3 years for the next upgrade.

5 NEW CHALLENGES

The idea of installing PS into the tunnel requires a new philosophy of construction. The following problems have to be solved and shall be discussed in more detail:

- How can the PS be installed ?
  - racks
  - container
  - cooling
- How can the PS be commissioned?
  - test of equipment
  - test of cabling
  - system test
- What happens in case of failure
  - accessibility
  - fast replacement,
  - failure detection, accessibility?
- How are the interfaces
  - connection of power cables
  - water system
  - controls

6 DEVELOPMENTS

The above mentioned questions led to a number of new developments.

6.1 Electronic racks

When reviewing available space in the tunnel, a new type of electronic rack had to be chosen with a height of 1200 mm. The heat losses introduced into the tunnel will be minimized. This can be realized with an internal air cooling. The circulating air is cooled via an air/water heat exchanger. By this losses of 2 kW can be taken out of the rack.
A rack combination of three racks with a width of 700 mm each and a depth of 800 mm was chosen. By this even space-consuming connectors at front or rear side of the electronic can be installed inside this racks. A combination of 19 inch technology and other construction is possible.

6.2 Container structure

The transportation of the equipment shall be done via monorail. The electronic racks shall be installed into a container being a metal support structure. The size of the containers is chosen 1200 * 1300 * 3000 mm (W*D*H). The width and depth is according to the TDR. The length of 3000 mm derives from the length of the electronic rack including the air/water heat exchanger and the docking system for the cable connection. To get an impression of sizes a wooden mock up was build (Fig. 2). The first prototype of the metal structure and the tests for mechanical stability in combination with the monorail is aimed for December 2002.

Fig. 2 Electronic rack with wooden mock up

6.3 Docking system

For the fast exchange of the containers an automatic docking system is needed. This will be the only interface between the container and the magnets, water system, control system etc.. It will work simply by lifting or lowering the container. The required contact pressure is given by the weight of the container. This interface has high current contacts of 400 A, water couplings and signal contacts with plugs and BNC connectors. With different manufacturers designs of this docking system have been developed. Cost estimates have been made for TTF2 and for the mass production for TESLA.

6.4 Internal construction of the racks

The internal construction of the racks was developed and can be seen in Fig. 3.
Inside the racks are:

- one input circuit breaker and main contactor
- one transformer 400 V/ 45 V, 45 kW
- one diode rectifier
- five power supply units
- five regulation electronics
- ten DC current transformers
- five Power Supply Controller
- one Programmable Logic Controller
- four 400 A switches for disconnecting/connecting spare PS
- busbars
- wiring
- auxiliary components

6.5 New Buck converter power part

The buck converter that had been developed for HERA has been redesigned to minimize the volume. The current is 400 A, the output voltage is 50 V. The screwing connections for power cables of the old design have been

Fig. 3 Internals of the electronic racks

replaced by fast connectors and busbars (Fig. 4). For replacement the PS can be pulled and pushed. The overall repair time is reduced. Additionally it leaves the freedom of exchanging just the power part in the tunnel without exchanging the entire container.

6.6 Redundancy system

Although the above mentioned measures enable a fast component exchange, the overall repair time will be quite long since the technicians would have to go into the tunnel and with the help of the monorail exchange the containers. Therefore redundancy is built into the containers. Each container will have five power supplies of which four are in use. The fifth power supply is spare. Switches are installed to disconnect the tripped PS and connect the spare.

6.7 PLC

The interlocking of the PS as well as the communication with the power supply controller is done via a PLC. A new type for the controls of the container is in development. It based on Siemens S7 and is programmed in STEP 7. There will be one PLC surveying all five power supplies.

Fig. 4: Buck converter with fast connectors

6.8 Digital/Analog Converter

Since the prices of DAC 1136 keep on rising a DAC was built at DESY. The temperature stability is at 1.5 ppm/°C. The new DAC is pincompatible to the Analog Devices DAC AD 1136. It consists of a DAC AD669SQ with an external voltage reference AD688BQ. A production of 85 units started

6.9 New power supplies for superconducting magnets

New power supplies for superconducting magnets have been designed and are in the prototype state. These PS are built in a high redundant way. Due to the built in redundancy of the power part it will be failure tolerant. In case of a trip in the power part the redundancy ensures that the PS will continue operation. For further information see [2]. Although these PS are prototypes for TESLA the first series will not be installed inside the tunnel.

7 COMMISSIONING

Usually before commissioning the PS are installed in their final position being connected to the magnets. The power tests can either be done with a test load with time consuming changes of the cable for each PS or the technicians have to wait till the construction in the tunnel is completed and the tunnel has been secured. By this the PS commissioning crew is permanently working under time pressure since the end of this work determines the moment of turning on the accelerator. With respect to TESLA this procedure will no longer be possible. The container solution with the automatic docking system gives the possibility to change these procedures.
The test of connections of the tunnel part of the docking system can be done with low voltage signal generators not disturbing other constructions going on inside the tunnel.
For the power supplies all necessary tests including heat runs or burn ins can be performed on a test stand. When the container has passed all tests it can be transported to the tunnel. Via monorail it will be transported to the final location. When lowered into position all necessary contacts are made automatically and the PS is ready for use. A short final check has to be done to ensure that no damage has occurred during transportation.

8 SUMMARY

TTF2 is a good training field for TESLA. Principle questions of how to install electronics like power supplies into the tunnel are investigated and solutions are ready. A set of 15 PS will be installed into three containers with electronic racks. Via an automatic docking system the connection of the container is done.

9 REFERENCES

[1] Magnet power supplies for TESLA, Hans-Jörg Eckoldt, TESLA Report 2000-37
[2] Correction magnet power supplies, Niels Heidbrook, EPAC 2002, Paris