STATUS OF THE PETRA III UPGRADE

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Abstract

Since 2010 PETRA III, a third generation light source at DESY, has been running as a user facility, with all 14 undulator beam lines operational since autumn 2011. In order to fulfill the request for additional beam lines in order to partially compensate the shutdown of DORIS at the end of 2012, it was decided to add two new halls at PETRA III, each housing 5 additional beam lines [1], [2]. Next to these new halls about 100 m of the accelerator will be completely remodeled to install additional undulators. The upgrade should be accomplished during a short 6 month shut down in 2013 in order to minimize the interruption of user operation. Therefore, it was decided to keep the existing accelerator tunnel in place. This has impact both on the mechanical connection between the accelerator and the experimental floor and on the design of the optical beam lines in the tunnel. In this paper the layout of the upgraded accelerator will be shown. The design status of the major components for the upgrade will be presented.

GENERAL LAYOUT

Figure 1 shows the DESY site with PETRA III (in red), the damping wiggler sections (DW, light blue), the planned new experimental halls North and East and possible sites for further extensions (purple). The positions for the two new halls were chosen because here the existing tunnel is near to the surface, making construction easier compared to the possible sites in the western part, where the tunnel is located 10 m below the surface. Both new halls are limited in size by existing buildings, roads and the DESY campus area.

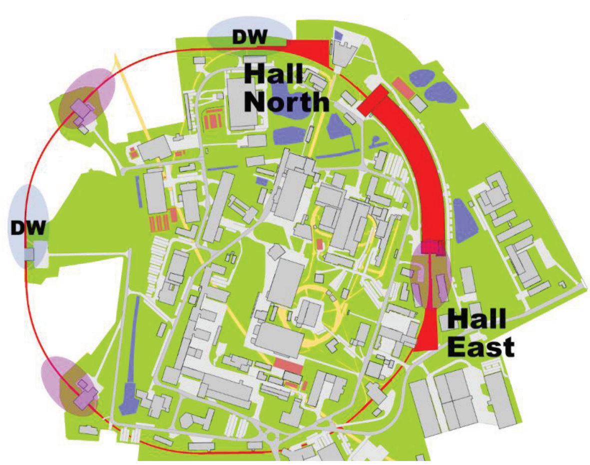

Figure 1: The DESY site with PETRA III.

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The existing damping wigglers in the straight section North will be used as the source for one new beam line, along with four undulators in the first sections of the following arc as the source for four more beam lines. A new long undulator in the straight section East and four undulators in the following arc will serve as sources for the five beam lines in hall East. For each of the new halls about 100 m of the existing machine have to be modified.

LAYOUT OF THE HALLS

Both halls have a very similar layout. They differ mainly by the way the access for heavy loads is realized. Figure 2 shows a sketch of the layout of hall North.

The Slab

For the experimental hall a thick slab is planned, providing a stable foundation for the experimental setups. This slab will be mechanically insulated from the walls and the roof of the hall to prevent movements of the building due to wind or crane work from disturbing the experimental ground. The slab has to be poured early in the shutdown, because it has to support the new radiation shielding for the tunnel. As the existing accelerator tunnel will stay in place, the connection between the slab and the tunnel will not be as stiff as the slab itself. This means that there will be no common slab for the undulators and the optical beam lines. A stretched wire system is envisaged to detect movements of the tunnel relative to the slab of the hall.

Radiation Shielding

For the existing tunnel with a wall thickness of only 20 cm the radiation shielding is provided by at least 3 m of soil covering the tunnel. As this soil will be removed in the area of the new halls and as the tunnel wall itself will not be strengthened, a new radiation shielding wall outside of the existing tunnel becomes necessary. The front end components of the optical beam lines will be placed between the undulators and this new shielding wall, partly inside the existing tunnel and partly between the tunnel and the radiation shielding wall. Two chicanes in the shielding wall give access to the front end components. Above the existing tunnel the radiation shielding will be provided by an additional layer of concrete, 1.3 m thick. Outside the tunnel, above the front end components, there will be a removable ceiling, made from a double layer of concrete beams. Away from the front end components the ceiling will be made from cast-in-place concrete.

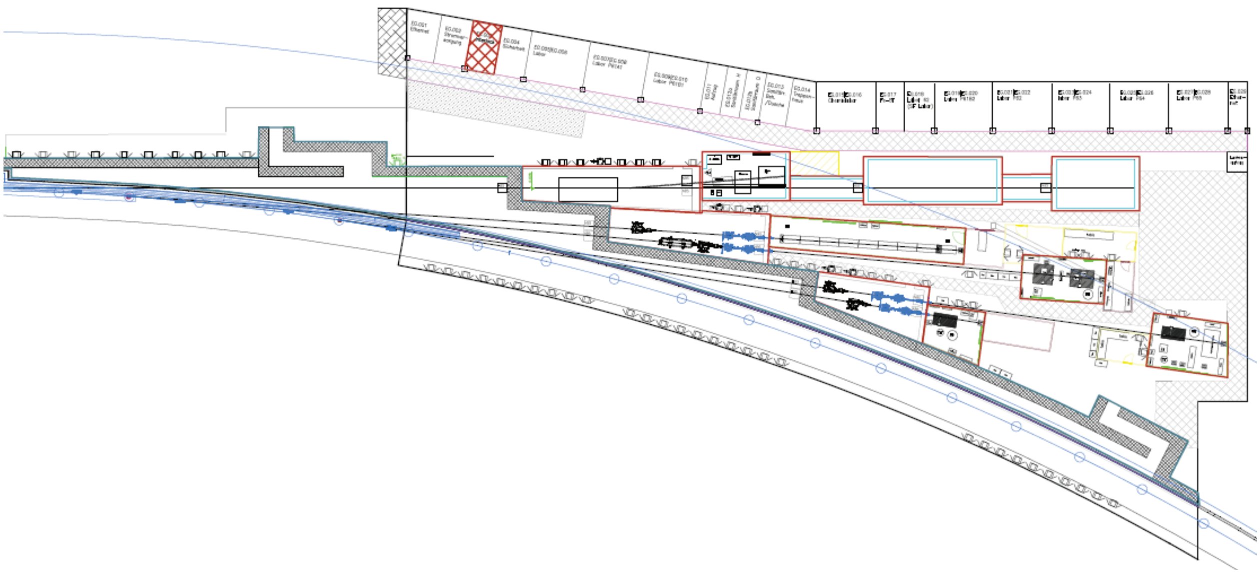

Figure 2: Rough sketch of hall North. From bottom to top: The existing tunnel with the unchanged machine (blue circles and line) and the remodelled part of the machine (thick blue line), the new beam lines (black lines), and in shaded black the new radiation shielding wall with room for the front end components. Outside the radiation shielding wall are the optics hutches and the experimental hutches.

Front End Components

The maximum total length of the optical beam lines is given by the size of the new halls, which is limited by surrounding buildings and roads. Therefore, it becomes necessary to install some front end components inside the accelerator tunnel, between the storage ring and the outer tunnel wall. Here ways have to be found to insure the serviceability of these components.

Optics Hutches and Experimental Hutches

As seen in Fig. 2, the optics hutches, containing the monochromators, are directly connected to the radiation shielding wall. The experimental hutches are located at the end of the beam lines further down the hall.

LAYOUT OF THE TUNNEL

Figure 3 shows the layout of the accelerator tunnel in the new undulator section. On the left side one of two undulators can be seen, their optical axes canted by 20 mrad. The two optical beam lines are separated from the accelerator vacuum system downstream from the following dipole magnet. As the tunnel wall behind the optical beam lines has to stay intact, the components of the optical beam lines will obviously be hard to service. Therefore the components in the optical beam lines have to be interleaved with the accelerators main magnets to provide as much access as possible to these components.

Behind the next pair of undulators the optical beam lines reach the tunnel wall. Here, the wall has to be slit for a length of 3 m at each beam line. At these cut-out sections, the tunnel has to be strengthened by an additional support structure in order to sustain the weight of the concrete shielding on top.

Inside the tunnel the components of the optical beam lines will be carried by the same supports as the accelerator magnets. Fig. 4 shows a cross section of the outer tunnel wall, looking with the beam. The outer wall of the tunnel is covered with cable trays and water pipes, as these utilities have to be distributed along the storage ring. In Fig. 4 a quadrupole magnet is shown with its concrete support. On the left side of the magnet the optical beam line with some front end components is visible. Above and below the optical beam line are cable trays. To the left the tunnel wall is shown with the new support structure carrying the weight of the concrete shielding. The optical beam line is going through a slit in the wall (the slit is not shown here). Cooling water pipes and more cable trays are mounted on the outside of the tunnel wall.

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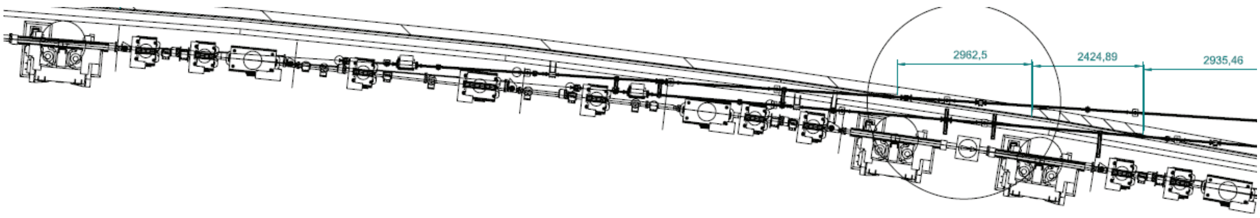

Figure 3: Layout of the accelerator tunnel. From bottom to top: The storage ring with vacuum components, magnets and undulators, the optical beam lines, cable trays below the beam lines and the outer wall of the existing tunnel.

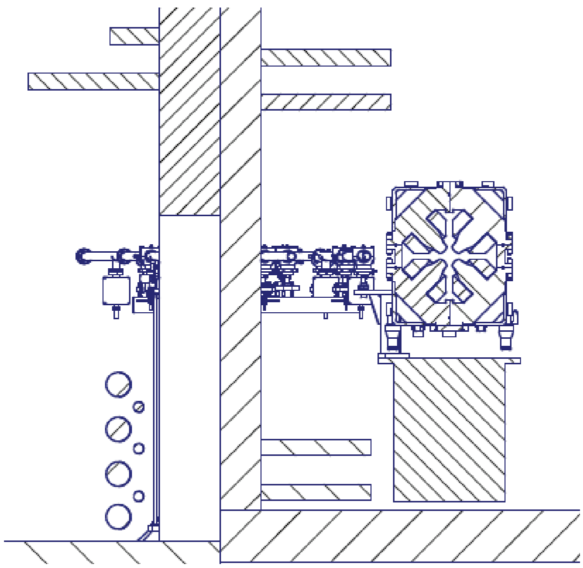

Figure 4: Cross section of the modified PETRA III tunnel wall in the new undulator section.

STATUS OF MAYOR COMPONENTS

Most of the components for the PETRA III Upgrade are in the final design phase or already ordered.

Magnets

All magnets are specified and ordered. Delivery is scheduled between January and March 2013. Most of the tools for the fabrication of the magnets are at hand, because most magnets are similar to magnets fabricated for the new octant of PETRA III.

Magnet Supports and Alignment

The magnet supports are designed, but need fine tuning to give room for cabling and water hoses. Alignment of the storage ring components is no problem, whereas for the components of the optical beam lines in the tunnel the lines of sight have to be verified.

Magnet Power Supplies

All magnet power supplies have been specified. Subunits like power electronics and DCCTs are ordered. Details of the cabling are currently being worked out along with the detailed design of the civil construction.

Vacuum System

The design of the vacuum system for the arcs north and east is completed. The new straight section east for long undulator devices was not been designed yet, but can mainly be copied from the existing 10 m PU01 undulator section in PETRA north-east. The ordering process for the standard components of the vacuum system has started.

Diagnostics

The beam diagnostic components are nearly identical to those used in the new octant of PETRA III and need only minor modifications. Mechanical components and 30 Libera Brilliance BPM electronics modules will be ordered soon. New positions for beam current monitors in the straight section east have to be identified. Details about cabling and positions for electronics racks depend on the final layout of the civil construction.

Air Conditioning

A new air conditioning system for the tunnel section east will be installed and tested in summer 2012. A new system for the tunnel section north will follow in 2013.

Civil Construction

The request for the legal approval for the civil construction will be made end of May 2012, which should, after the call for tenders in summer 2012, allow for ground breaking in mid-April 2013.

ACKNOWLEDGMENT

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REFERENCES

[1] K. Balewski et al., "PETRA III Upgrade," IPAC'11, San Sebastian, September 2011, THPC020, p. 2948 (2011); http://www.JACoW.org
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