STATUS OF PETRA III

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Abstract

PETRA III is a new hard x-ray synchrotron radiation source which will be operated at 6 GeV with a extremely low horizontal emittance of 1nmrad. This new light source will be the result of a conversion of the existing accelerator PETRA II into a light source. The conversion comprises the complete rebuilding of one eighth of the 2304 m long storage ring, which will then house 14 undulator beam lines and the modernisation and refurbishment of the remaining seven eighths. In addition two 100m long damping wiggler section will be installed which are required to achieve the small design emittance. During the last four years extensive design work, construction and production as well as procurement of components have been carried out to prepare for the conversion. Since the 2nd of July 2007 the construction activities have started when PETRA II was no longer needed as a pre-accelerator for HERA. At present the project is still on track so that operation with beam is foreseen for January 2009 and first user experiments in the second half of 2009. In this report a brief overview of the project and the status of the constructional work, the different components including the damping wigglers and the installation in the tunnel will be given.

INTRODUCTION

Details of the PETRA III project have been presented in [1], [2]. The basic paraemters are summarized in table 1.

Table 1: PETRA III parameters

Parameter	**PETRA III**	
Energy / GeV	6	
Circumference /m	2304	
Total current / mA	100	
Number of bunches	960	40
Lifetime / h	24	2
Emittance (horz. / vert.) /nm	1 / 0.01	
Number of insertion devices	14	

The conversion of PETRA II into a new light source started on the 2nd of July 2007. It comprises the complete refurbishment of 7/8 of the existing storage ring, the so-called old octants and the replacement of 1/8, the so-called new octant, by a new hall which will house the 14 insertion devices.

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Commissioning of the technical equipment will start in autumn 2008 and commissioning with beam is foreseen at the beginning of 2009.

EXPERIMENTAL HALL

The main building works started in August 2007. Figure 1 shows a recent view of the outer facade and the interior of the hall.

In order to maintain the high brilliance of the undulator radiation to the sample position special measures have to be taken to reduce the impact of vibrations and cultural noise and to guarantee the positional stability of the radiation. To avoid that any motion of the walls of the hall, for example caused by wind and crane motion, is coupled to the experimental floor the walls rest on 99 piles of 1m thickness. These piles are rigidly anchored at 20 m depth and the upper half of the piles is insulated from the surrounding by a 2 cm thin elastic foil to ensure decoupling of the walls and the floor. The work on the piles, the building shell was finished in November 2007 and this event was celebrated during the topping-out ceremony on the 26th of November.

Figure 1: upper half: Facade of the hall; lower half: view into the new hall with the concrete shielding blocks on the left

Another important element in the context of stability is the correct layout of the experimental floor. The slab of the new hall consists of a 1m thick monolithic steel fibre

enforced concrete block. The slab was produced within 3 days starting from the 15th of December. First measurements show that the slab fulfils the requirements on stability.

Meanwhile basic parts of the new hall have been hand over to DESY and the surveying of the hall and the building of the shielding wall started. The final handover is foreseen end of June 2008.

STATUS OF MACHINE COMPONENTS

Magnet System

For the new octant 18 dipoles (l=1m), 16 long quadrupoles (l=0.72m) and 68 short quadrupoles (l=0.44m) have been built by the Efrimov institute in St. Petersburg. For orbit correction and orbit feedback more than 70 iron core corrector magnets and more than 80 air coils have been produced by Efrimov. All magnets have been delivered to DESY till the end of 2007. The properties of these magnets, which are described in reference [3], have been checked and are in accordance with the specifications. For accurate alignment of the quadupole and dipole magnets a precise transfer of the magnetic axis to the alignment monuments is necessary. This has been achieved by applying a novel method with is described in reference [4]. The transfer measurements were carried out during the first half of 2007.

The existing PETRA II quadrupole, sextupole and dipole magnets will be reused for the old octants. To replace the radiation damaged coils the Efrimov Institut, BINP Novosibirsk and Scantitronix built about 600 new coils. In case of the sextupoles also the iron yoke has to be replaced because of corrosion. The replacement procedure started at the beginning of July 2007 and was finished at the end of 2007. The procedure included a check of the magnet field by a rotating coil and also transfer-measurements of the mechanical axis to alignment monuments.

The impact of the magnetic field errors of the new and refurbished magnets on dynamic aperture is presented in a contribution to this conference [5].

Girders

Similar to other third generation light sources the demand on magnet alignment is rather stringent. To fulfil these requirements the magnets in the new octant will be mounted on 34 girders of 4.2 m length.

The DESY girder system does not require a precisely machined surface of the girder nor does it involve keys and shims to align the quadrupole axis with respect to the girder since the final or fine adjustment of the magnets is done only with respect to each other and not to the girder. Only the pre- or coarse alignment of the magnets within half a millimetre is done with respect to the girder axis which can be determined with an accuracy of better than 0.5 mm. Details of the system as well as results of dimensional, deflection and vibration tests can be found in reference [6].

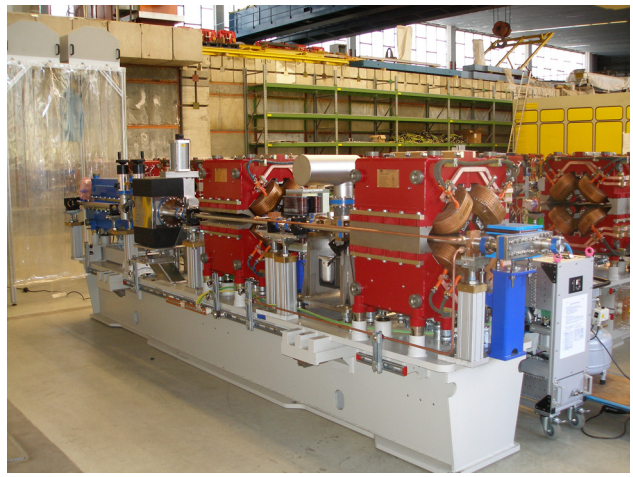

Figure 2: First fully equipped girder

A test girder has been fully equipped to check the overall concept and the installation procedure. Meanwhile all magnets were mounted and coarsely aligned on the girders and the installation of the remaining components will start in June.

To align the girders with respect to each other they rest on four motorized cam blocks which allow alignment within in a tenth of a millimetre. This system is very similar to those being in operation at SLS and DIAMOND [7]. The girder pedestals, the cams and stepper motors have been delivered till the end of 2007.

Vacuum System

PETRA III will be equipped with a completely new vacuum system [8], [9].

The production of almost all components of the vacuum system for the old octants has been finished. The production of special elements such as ceramic kicker chambers, the septum and kicker magnets and cavities of the feedback system is progressing and the components will be ready in time.

The manufacturing of the vacuum system for the new octant is continuing. Unfortunately the delivery of components is considerably delayed for several reasons. Since the time for installation of components on the girders was overestimated it will still be possible to prepare the girders for fine adjustment and installation in the new octant on time.

Damping Wigglers

In order to achieve the small horizontal design emittance 20 four meter long damping wigglers are installed in PETRA III [10]. The work on the damping wigglers and the vacuum systems for the two damping wiggler sections is done in close collaboration between DESY and BINP. Twenty damping wigglers have been delivered to DESY and only one spare wiggler is missing. The wigglers have been tested at DESY and the results and the impact of non-linear field errors on dynamic

aperture are presented in two companion papers to this conference [5], [11].

The vacuum system of the two damping wiggler sections is rather complex since it includes a large number of absorbers of different dimensions to safely remove up to 800 kW from the machine. The vacuum system consists of 20 regular cells each consisting of a quadrupole chamber, a wiggler chamber and an 82 cm long copper absorber as well as some standard elements like flanges and bellows. Close to the end of both sections two 4.5 m long absorbers and at the very end one 6 m long absorber will be installed.

The wiggler chamber is an extruded aluminium profile which has a NEG coated inner surface. After some initial problems with the coating the production of the chambers went well and all of them have been delivered as well as the other above mentioned components. In November 2007 one regular cell was installed in PETRA III to verify the installation concept and the mechanical tools for opening and closing the wigglers. In July the four 4.5 m long absorbers will be delivered and in October the two so-called final absorbers which are currently in production.

Diagnostic and Control System

To achieve and maintain the high beam quality sophisticated diagnostic is necessary. In particular a reliable and accurate beam position system including the electronics is required. The electronic modules have already been delivered by I-Tech and been tested. The results are within specifications. Prototypes of the fast orbit feedback such as power-supplies, signal combiners and timing units were tested with beam in the first half of 2007 and found to be accordance with requirements. Parts of the new multibunch feedback systems have also been successfully tested in 2007. More details on diagnostics can be found in a recently puplished paper and a contribution to this conference [12], [13].

A completely new control system will be developed for PETRA III and its pre-accelerators. The structure and conceptual layout is described in reference [14].

The hardware components are either ordered or in production and will be ready in time.

Control room applications are basically written in Java to ensure platform independence. Software development is progressing but is on a critical path. To relief the problem work has been outsourced and some of the high level applications such as beam based alignment, orbit response matrix measurements will be developed by the accelerator physics group in MatLab and should be integrated firmly into the control system later.

A decisive test of the new system will be the commissioning of the pre-accelerators in July 2008.

STORAGE RING INSTALLATION

At the beginning of the shut down in July 2007 the tunnel had to been emptied in particular the part for the new experimental hall so that the dismantling could start in August ‘07.

The other seven eighth of the tunnel were emptied till September. After the lowest layer of the bus bars has been moved to the ceiling of tunnel the new water cooling system consisting of four pipes was installed.

Shortly after the first octant has been equipped with the new pipes the refurbished dipoles, quadrupoles and sextupoles were reinstalled. The magnets were pre-aligned to prepare the installation and connection of the vacuum chambers in the arc. This work was finished in April 2008 and in May the commissioning of the vacuum systems started.

In May 2008 the regular cells of the two damping wiggler section were assembled. In addition two damping wigglers were installed to check the alignment of components.

Other work like cabling and installation of temperature and water flow is progressing well so that the installation in the old octants will be ready on time at the end of September.

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