International Committee for Future Accelerators

Sponsored by the Particles and Fields Commission of IUPAP

Beam Dynamics Newsletter

No. 45

Issue Editor:
R. Wanzenberg

Editor in Chief:
W. Chou

April 2008

4.7 The Impedance Model of PETRA III

K. Balewski, R. Wanzenberg, O. Zagorodnova
Deutsches Elektronen-Synchrotron, A Research Centre of Helmholtz Association
Notkestr. 85, 22603 Hamburg, Germany
Mail to: rainer.wanzenberg@desy.de

4.7.1 Introduction

The PETRA ring was built in 1976 at DESY as an electron - positron collider and was operated from 1978 to 1986 in this collider mode. From 1988 to 2007 PETRA II was used as a preaccelerator for the HERA lepton hadron collider ring. The PETRA ring is currently being converted into a dedicated 3rd generation synchrotron radiation facility called PETRA III [1]. The planned facility aims for a very high brilliance of about 10^{21} photons /sec /0,1%BW /mm^2/ mrad^2 using a low emittance (1 nm rad) electron or positron beam with an energy of 6 GeV. One octant of the PETRA ring is completely redesigned to provide space for 14 insertion devices in nine double bend achromat (DBA) cells. The location of the new hall is shown in Fig. 1. A photo of the new experimental hall is shown in Fig. 2.

Figure 1: Ground Plan of the DESY site with the PETRA ring. The new experimental hall (red) is situated between the PETRA halls North-East and East.

Nearly the entire vacuum system of the existing storage ring PETRA will be replaced during the conversion into a synchrotron radiation facility. This includes the vacuum chamber in the seven “old” octants, where the new chambers in the dipoles and quadrupoles of the FODO lattice have recently been installed, and also the so called “new” octant between the halls North-East and East, where several undulator chambers with a small vertical gap of about 7 mm will be installed. The positron or electron beam will interact with its vacuum chamber surroundings via electromagnetic fields. These wake fields in turn act back on the beam and can lead to instabilities, which limit either the achievable current per bunch or the total current or even both. The total impedance of PETRA III depends on the RF cavities, undulator chambers, bellows, beam position monitors, kickers, pump ports, the finite resistivity of the chamber and many other objects [2]. In collaboration between DESY, the University of Darmstadt, the Otto-von-Guericke University of Magdeburg, CANDLE (Yerevan University, Armenia), and the Budker Institut, BINP (Novosibirks, Russia) an impedance model of PETRA III has been built which includes more than 25 objects. The impedance due the resistivity of vacuum chambers, the impedance of the wiggler section, of feedback cavities and of the beam position monitors are discussed in the contributions [3,4,5,6] of this Beam Dynamics Newsletter. An overview of the considered objects is provided in section 4.7.3 of this article.

Figure 2: The new experimental hall of PETRA III. The photo shows the construction site from inside the ring. This photo is taken from the webcam: http://petra3.desy.de/webcam .

4.7.1.1 Parameters

The main parameters of PETRA III are summarized in Tab. 1. The standard bunch filling pattern will consist of a large number of equally spaced bunches with a low bunch population. Additionally a special operation mode is required for time-resolved experiments with a higher charge per bunch (2.5 mA per bunch) in 40 equally spaced bunches.

Table 1: PETRA III parameters

Parameter		***PETRA III***	
Energy	GeV	6	
Circumference	m	2304	
RF Frequency	MHz	500	
RF harmonic number	-	3840	
RF Voltage	MV	25	
Momentum compaction	-	1.22×10^{-3}	
Synchrotron tune		0.049	
Total current	mA	100	
Number of bunches		960	40
Bunch population	10^{10}	0.5	12
Bunch separation	ns	8	192
Emittance (horz. / vert.)	nm	1 / 0.01	
Bunch length	mm	12	
Damping time H/V/L	ms	16 / 16 / 8	

4.7.1.2 Wakefields, Kick and Loss Parameters, Instabilities

The interaction of the beam circulating with its vacuum chamber surroundings via electromagnetic fields can be characterized with a wake potential. The wake potential of a point charge q_1 is defined as [7]:

$$\vec{W}^{\delta}(\vec{r}_2,\vec{r}_1,s) = \frac{1}{q_1}\int dz\ (\vec{E} + c\ \vec{e}_z \times \vec{B})_{t=(z+s)/c}\ , \tag{1}$$

where r_2 is the transverse coordinate of the witness charge q_2. The impedance is the Fourier transform of the point charge wake potential. The wake potential of a bunch is the convolution of the point charge wake potential with the line charge density $\lambda(s)$:

$$\vec{W}(\vec{r}_2,\vec{r}_1,s) = \int d\bar{s}\ \ \lambda(s-\bar{s})\ \vec{W}^{\delta}(\vec{r}_2,\vec{r}_1,\bar{s})\ . \tag{2}$$

We will express the impedance of PETRA III in terms of the so-called loss and kick parameters, which are defined via the wake potential and the normalized beam line charge density. The loss parameter $k_{\|}$, $k_{\|}(1)$ and the kick parameter $k_{\perp}$ are defined as:

$$k_{\|} = \int ds\ \ W_{\|}(s)\ \ \lambda(s) \tag{3}$$

$$k_{\|}(1) = \int ds\ \ W_{\|}(s)\ \ \frac{d}{ds}\lambda(s) = -\int ds\ \ \lambda(s)\ \ \frac{d}{ds}W_{\|}(s) \tag{4}$$

$$k_{\perp} = \int ds \;\; W_{\perp}(s) \;\; \lambda(s) \,. \tag{5}$$

A transverse instability has been observed in PETRA when the storage ring was operated in the collider mode [8]. Single bunch currents of 10 mA could be stored in PETRA II without any evidence of transverse or longitudinal instabilities. The instability threshold for mode coupling instabilities can be estimated from the tune shifts of the lowest order modes in the longitudinal and transverse planes [2, 9] using the loss and kick parameters:

$$\Delta Q_{S} = Q_{S} \frac{I_B \, R \, T_0}{2hV_{rf}} k_{\|}(1), \qquad \Delta Q_{\beta} = \frac{I_B \; T_0}{4\pi \, E / e} \, \langle\beta\rangle \, k_{\perp} \,, \tag{6}$$

where I_B is the single bunch current, R = 367 m is the mean machine radius, T_0 = 7.685 μs is the revolution time, h = 3840 is the harmonic number, V_{rf} is the total acceleration voltage, E = 6 GeV the energy and $\langle\beta\rangle$ is the average beta-function. Instead of the kick parameter $k_{\perp}$ often an effective transverse impedance $Z_{\perp}^{eff}$ is used [10, 11]. They are related in the following way:

$$k_{\perp} = \frac{1}{2\pi} \, \frac{\sqrt{\pi}}{\sigma_z / c} \, Z_{\perp}^{\mathrm{eff}} = 7.05 \frac{\mathrm{V}}{\mathrm{pC\,m}} \, \frac{Z_{\perp}^{\mathrm{eff}}}{\mathrm{k\Omega / m}} \,, \tag{7}$$

where σ_z = 12 mm is the rms bunch length.

4.7.2 The Impedance Model of PETRA III

The impedance model of PETRA III is based on numerical calculations, analytical estimates of the wakefields and on measurements of instability growth rates at PETRA II. Many objects, including the RF cavities, undulator chambers, bellows, beam position monitors (BPMs), kickers, and pumping ports, have been studied in detail. At DESY mainly the code MAFIA [12, 13] has been used to obtain the loss and kick parameters. Furthermore the codes ECHO [14] and GdfidL [15, 16], mainly for the wiggler section, and PBCI [3, 17] have been used. All objects can be categorized into four different sections of PETRA III, which are summarized in Table 2. All insertion devices will be installed in the new experimental hall, which is located between the hall North-East and East. The damping wigglers will be installed in the (long) straight section West and North, while the RF-cavities are being reinstalled in the straight section South. Fig. 3 shows the location of the different sections around the PETRA ring. There are four long straight sections (108 m long) and four short straight sections (64.8 m long). Each “old” arc consists of 14 FODO cells, while the “new” octant consists of 9 DBA cells.

Table 2: PETRA III Sections

Section	***Objects***
RF-Section	12 rf-cavities, 8 feedback cavities
Damping Wigglers	20 wigglers, several absorbers
Insertion Devices	14 undulators, tapered transitions, absorbers
Arcs, “Old Octants”	196 dipole chambers, 203 quad chambers, 105 BPM’s

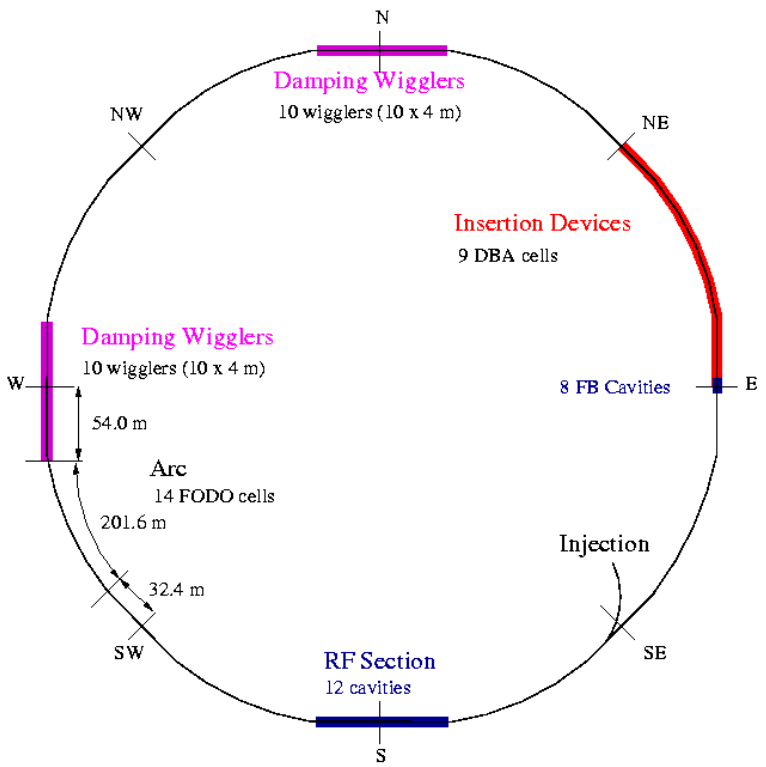

Figure 3: The PETRA III ring. The location of the Insertion Devices, the Wiggler section, and the RF-Sections are shown.

4.7.2.1 Coupled Bunch Instabilities

The long range wake field is dominated by higher order modes (HOMs) in the 7 cell 500 MHz cavities. In PETRA II sixteen cavities were installed. The effective shunt impedance could be determined from measurements of threshold currents and instability growth rates at PETRA II. The results are summarised in Table 3.

Table 3: Measurements at PETRA II related to coupled bunch instabilities

Effective Impedance	***Petra II (total) 16 x 7 cell cavities***
$Z_{\|\|eff}$ (MΩ)	3.6
$Z_{\perp\, eff}$ (MΩ/m)	50

The growth rates for longitudinal and transverse coupled bunch instabilities for PETRA III can be estimated from the measured effective impedance of PETRA II according to:

$$\frac{1}{\tau_{||}} = \frac{2\pi Q_S}{T_0} \frac{I_{tot} Z_{||eff}}{2 V_{rf}}, \qquad \frac{1}{\tau_{\perp}} = \frac{2\pi}{T_0} \frac{I_{tot} \beta_{cav} Z_{\perp eff}}{4\pi E/e}, \qquad (8)$$

The longitudinal growth rate of 360 Hz and the transverse growth rate of about 1100 Hz is significantly larger than the radiation damping rates of 125 Hz (longitudinal) and 62.5 Hz (transverse). Therefore a powerful feedback system is required to provide additional damping. The longitudinal feedback system is based on eight one cell cavities with a total voltage of 12 kV. The cavity design is based on the DAFNE feedback cavity [18] and has been adopted from the SLS [19]. The transverse feedback system will utilize in total four 1 m long strip-line kickers to damp the transverse coupled bunch instabilities. The required damping is 1/τ = 800 Hz for the longitudinal and 1/τ = 1400 Hz in the transverse plain (see Table 4) and the required bandwidth is 62.5 MHz for a bunch to bunch spacing of 8 ns.

Table 4: The PETRA III multi-bunch feedback system.

Feedback	*Required Damping*	*Devices*
Longitudinal	800 Hz	8 cavities (12 kV)
Horizontal	1400 Hz	2 kickers (1 m)
Vertical	1400 Hz	2 kickers (1 m)

4.7.2.2 Mode Coupling Instabilities – Impedance Budget

The impedance budget for longitudinal and transverse mode coupling instabilities is determined from the formula (6) for tune shifts of the lowest order modes. Assuming that a total tune shift of $\Delta Q_s / Q_s = 0.5$ and $\Delta Q_\beta / Q_s = 0.5$ is acceptable, one obtains limits for the parameters $k_{||}(1)$ and $k_{\perp}$. The results are summarized in table 5 for single bunch beam current of 2.5 mA and a reference beta-function of 20 m.

Table 5: The PETRA III single bunch impedance budget.

	Impedance Budget
Longitudinal	10900 V/pC/m
Transverse	4800 V/pC/m

The total kick parameter of all elements is a weighted sum:

$$k_{\perp \text{total}} = \frac{1}{\langle \beta \rangle} \sum_n \beta_n \, k_{\perp n} \,, \tag{9}$$

where $\langle \beta \rangle = 20\ \text{m}$ is the reference beta-function. The transverse impedance budget as an effective impedance is 681 kOhm/m.

4.7.3 Wakefield Calculations

A list of all components which have been studied via numerical wakefield calculations is given in table 6. The list contains the horizontal and vertical beta functions and the number or total length of the component.

The synchrotron light absorbers in the wiggler section are discussed in more detail in [6]. The element “Wiggler Absorber (9 mm mask)” corresponds to cell type “A” while “Wiggler Absorber (17 mm mask)” corresponds to cell type “B” in reference [6]. A photo of one wiggler cell in the PETRA III ring is shown in Fig. 4.

Figure 4: One wiggler cell in the PETRA III tunnel. The synchrotron light absorbers are installed downstream of the wiggler and in front of the quadrupole magnet (WL 12 QA).

Table 6: Components of PETRA III

Name	***Horz. Beta funct. / m***	***Vert. Beta-funct. / m***	***Length / m***
Undulator (Resitive wall)	20	5	55
Wiggler (Resitive wall)	15	15	80
Arc (Resitive wall)	20	20	1411
Straight Section (resistive wall)	20	20	248
			Number
7 -cell cavity	14	13.5	12
Feedback cavity	10	7	8
Dipole chamber	15	15	196
Quadrupole chamber	15	15	203
Shielded bellow	15	15	203
BPM - Arc	7	25	105
Pumping ports (cylindrical)	20	20	50
Pumping ports (elliptical)	20	20	100
BPM straigth section	18	13	55
Collimator	13	30	2
Injection Kicker	24	12	3
Horz. Feedback Kicker	27	13	2
Vert. Feedback Kicker	13	30	2
Synchroton light absorber	5	30	9
Standard chamber new octant	5	30	9
Undulator Taper	15	6	16
Bellow Undulator (11 mm gap)	15	6	16
Taper 2 mm transition	15	6	16
BPM Undulator	15	6	16
Wiggler Absorber (9 mm mask)	22	6	8
Wiggler Absorber (17 mm mask)	6	19	8
Dipole magnet mask (17 mm gap)	20	20	2

The results for the wakefield calculations of the beam position monitors (BPMs) and the feedback cavities are summarized in the references [4, 20, 21, 22, 23]. The resistive wall wakefields and the wakefields of the injection kicker are discussed in more detail in references [6, 24]

The transition from the standard vacuum chamber of the “New Octant” to the small gap (7 mm) undulator chamber is shown in a schematic way in Fig. 5. Pumping ports are integrated in the long taper. The wakefields of the long taper have been calculated with PBCI and MAFIA, see ref. [3, 25].

Furthermore many other components including the feedback kickers, collimators, shielded pumping ports, synchrotron light absorbers, have been analyzed using the codes MAFIA [13] and ECHO [14].

The loss parameters $k_{||}$, $k_{||}(1)$ and the kick parameter $k_{\perp}$ for these components and other components are summarized in table 7. Using the data from table 6 and 7 we obtained the total vertical and horizontal kick parameter using Eq. (9), and the sum of the parameter $k_{||}(1)$. The results are summarized in table 8 and are well within the impedance budget (table 5).

Table 7: Loss- and Kick- Parameters of PETRA III

Name	$k_{\|\|}$ / V/pC	$k_{\|\|}(1)$ / V/pC/m	Horz. $k_{\perp}$ / V/pC/m	Vert. $k_{\perp}$ / V/pC/m
Undulator (Resitive wall), for L = 1 m	-0.00459	0.28	0.10	32.79
Wiggler (Resitive wall), for L = 1 m	-0.00312	0.11	0.02	3.39
Arc (Resitive wall), for L = 1m	-0.00080	0.05	0.01	0.18
Straight Section (resistive wall), for L = 1m	-0.00200	0.05	0.05	0.05
7 -cell cavity	-3.76900	127.60	35.80	35.80
Feedback cavity	-0.47000	17.50	13.20	13.20
Dipole chamber	0.00000	0.00	0.00	0.00
Quadrupole chamber	-0.00001	-0.01	0.00	0.05
Shielded bellow	-0.00054	-0.27	0.14	0.25
BPM - Arc	-0.00035	-0.09	0.00	0.03
Pumping ports (cylindrical)	-0.00002	-0.02	0.00	0.01
Pumping ports (elliptical)	-0.00005	-0.05	0.00	0.05
BPM straigth section	-0.00035	-0.09	0.00	0.03
Collimator	-0.01900	-21.60	11.70	75.40
Injection Kicker	0.00000	0.00	1.60	1.60
Horz. Feedback Kicker	-0.34000	6.13	31.60	1.30
Vert. Feedback Kicker	-0.30800	5.34	31.70	4.10
Synchroton light absorber	-0.00001	-0.01	0.05	0.00
Standard chamber new octant	-0.00001	-0.01	0.10	0.00
Undulator Taper	-0.00520	-4.60	0.00	62.80
Bellow Undulator (11 mm gap)	-0.13700	-0.98	0.10	14.90
Taper 2 mm transition	-0.00440	-0.73	0.00	32.60
BPM Undulator	-0.00016	-0.05	0.00	3.87
Wiggler Absorber (9 mm mask)	-0.01780	-14.10	15.20	80.60
Wiggler Absorber (17 mm mask)	-0.01730	-11.20	7.56	33.50
Dipol magnet mask (17 mm gap)	-0.03250	-13.10	4.10	31.70

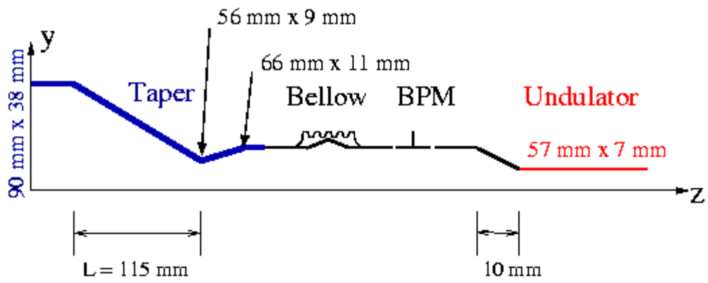

Figure 4: Transition from the standard vacuum chamber (height 38 mm) of the "New Octant" to the small gap (7 mm) undulator chamber.

Table 8: The total loss and kick parameters of PETRA III based on the wakefield calculations of the components of table 5 and 6.

	Parameter	*Impedance Model*
Longitudinal	$k_{\|\|}(1)$	1350 V/pC/m
Horizontal	$k_{\perp\,total}$	750 V/pC/m
Vertical	$k_{\perp\,total}$	2610 V/pC/m

4.7.4 Conclusion

Taking into account the different beta functions at the different vacuum components one obtains a total scaled (vertical) kick parameter of 2610 V/pC/m which is well below the impedance budget of 4800 V/pC/m (20 m beta function). The impedance of the planned X-ray light source PETRA III has been estimated based on measurements for the existing storage ring PETRA II, numerical calculations and analytical results for discontinuities in the beam pipe. Small gap chambers in the insertion devices will contribute significantly to the transverse impedance of PETRA III. But we expect no mode coupling instabilities for the operation mode with 40 bunches which requires a single bunch current of 2.5 mA since tune shifts in units of the synchrotron tune are small. Multi-bunch instabilities are mainly driven by parasitic modes in the RF cavities. The effective impedance has been determined from measurements at PETRA II. The expected growth rate of coupled bunch instabilities in PETRA III is much larger than the radiation damping rate. Therefore a powerful longitudinal and transverse multi-bunch feedback is required to provide the additional damping.

4.7.5 Acknowledgment

We would like to thank Mark Lomperski for carefully reading the manuscript.

4.7.6 References

1. PETRA III: A low Emittance Synchrotron Radiation Source", Technical Design Report, DESY 2004-035
2. K. Balewski, R. Wanzenberg, "Beam Current Limitations in the Synchrotron Light

Source PETRA III", 9th European Particle Accelerator Conference, EPAC04,5 to 9 July, 2004 Lucerne

3. E. Gjonaj, T. Lau, T. Weiland, R. Wanzenberg, "Computation of Short Range Wake Fields with PBCI", this ICFA Beam Dynamics Newsletter, April 2008
4. A.K. Bandyopadhyay, A. Joestingmeier, A.S. Omar, R. Wanzenberg, "Wake Computations for Selected Components of PETRA III", this ICFA Beam Dynamics Newsletter, April 2008
5. M. Ivanyan, E. Laziev, V. Tsakanov, A. Vardanyan, A. Tsakanian, R. Wanzenberg, "PETRA III Storage Ring Resistive Wall Impedance", this ICFA Beam Dynamics Newsletter, April 2008
6. V. Smaluk, R. Wanzenberg, "Geometrical Impedance of the PETRA III Damping Wiggler Section", this ICFA Beam Dynamics Newsletter, April 2008
7. T. Weiland, R. Wanzenberg: "Wakefields and Impedances", in M. Dienes, M. Month, S. Turner (Eds.) Proceedings US-CERN School, Hilton Head 1990, Springer-Verlag, Berlin , 1992
8. R. D. Kohaupt, "Transverse instability in PETRA", Proc. 11th Int. Conf. in High Energy Acc., CERN (1980) EXS Vol. 40, Birkhauser Verlag, p. 566
9. K. Balewski, "Analyse der transversalen Moden-Kopplungsinstabilitaet fuer lokalisierte HF-Strukturen und ihre Kompensierbarkeit durch Rueckkopplungssystemen", DESY 89-108, Aug. 1989
10. T. F. Günzel, "Transverse coupling impedance of the storage ring at the European Synchrotron Radiation Facility", Phys. Rev. ST Accel. Beams **9**, 114402 (2006)
11. N. S. Sereno, Y.-C. Chae, K. C. Harkay, A. Lumpkin, S. V. Milton, B. X. Yang, A Potpourri of Impedance Measurements at the Advanced Photon Source Storage Ring, Particle Accelerator Conference, PAC 97, Vancouver, 12-16 May 1997
12. T. Weiland, "On the Numerical Solution of Maxwell's Equations and Applications in the Field of Accelerator Physics", Part. Acc. 15 (1984)
13. MAFIA Version 4.106, CST GmbH, Büdingerstr. 2a, D-64289 Darmstadt, Germany (2002).
14. I. Zagorodnov and T. Weiland, "TE/TM field solver for particle beam simulations without numerical Cherenkov radiation", Phys. Rev. ST Accel. Beams 8, 042001 (2005).
15. W. Bruns, "Improved GdfidL with Generalized Diagonal Fillings and Reduced Memory and CPU Requirements", International Computational Accelerator Physics Conference, ICAP 98, Monterey, Sep. 14-18, 1998.
16. W. Bruns, "The GdfidL Electromagnetic Field simulator", http://www.gdfidl.de
17. E. Gjonaj, X. Dong, R. Hampel, M. Kärkkäinen, T. Lau, W. F.O. Müller, T. Weiland, "Large Scale Parallel Wake Field Computations for 3D-Accelerator Structures with the PBCI Code", International Computational Accelerator Physics Conference, ICAP 06, Chamonix, France, Oct 2-6, 2006
18. R. Boni, A. Gallo, A. Ghigo, F. Marcellini, M. Serio, M. Zobov, "A waveguide overloaded cavity as longitudinal kicker for the DAFNE bunch-by-bunch feedback system," Particle Accelerators, Vol. 52, pp. 95–113, 1996.
19. M. Dehler, "Kicker design for the ELETTRA/SLS longitudinal multi-bunch feedback," in 8th European Particle Accelerator Conference (EPAC 02), Paris, France, pp. 2070–2072, 2002.
20. A.K. Bandyopadhyay, A. Joestingmeier, A.S. Omar, K. Balewski, R. Wanzenberg , "Wake Computations for the Beam Positioning Monitors of PETRA III", Proceedings of European Particle Accelerator Conference, EPAC 06, Edinburgh, Scotland, 26-30 Jun 2006
21. A.K. Bandyopadhyay, A. Jostingmeier, A.S. Omar, R. Wanzenberg, "Computations of Wakefields for Beam Position Monitors of PETRA III", Internal Report DESY-M-06-02, Jul 2006

22. A.K. Bandyopadhyay, A. Joestingmeier, A.S. Omar, K. Balewski, R. Wanzenberg, "Computation of Wakefields and Impedances for the PETRA III Longitudinal Feedback Cavity", Asian Particle Accelerator Conference, APAC 07, Indore, India, Jan 29-Feb 02, 2007
23. A.K. Bandyopadhyay, A. Joestingmeier, A.S. Omar, R. Wanzenberg, "Wakes and Impedance Computations for the PETRA III Longitudinal Feedback Cavity", Internal Report, DESY-M-07-02, Nov 2007
24. M. Ivanyan, E. Laziev, V. Tsakanov, A. Vardanyan, A. Tsakanian, R. Wanzenberg, "Investigation of the PETRA III Resistive Wall Impedance, Intermediate Report of the PETRA III - CANDLE COLLABORATION", Internal Report, DESY-M-07-01, Sep 2007
25. K. Balewski, E. Gjonaj, T. Weiland, , R. Wanzenberg, "Wake Computations for Undulator Vacuum Chambers of PETRA III", Particle Accelerator Conference, PAC07, Albuquerque, New Mexico, 25 to 29 June, 2007

4.8 PETRA III Storage Ring Resistive Wall Impedance

M. Ivanyan, E. Laziev, V. Tsakanov, A. Vardanyan
CANDLE, Acharyan 31, 375040 Yerevan, Armenia
Mail to: ivanian@asls.candle.am
A. Tsakanian, Hamburg University, Hamburg, Germany
Mail to: tsakania@mail.desy.de
R. Wanzenberg, DESY, Notkestr. 85, Hamburg, Germany
Mail to: rainer.wanzenberg@desy.de

4.8.1 Introduction

The article presents the results of the resistive wall impedance study for the PETRA III storage ring [1] vacuum chamber that consists of different parts with various geometrical (circular and elliptical cross sections) and structural (single layer and laminated) configurations conditioned by the technical solutions for high brightness synchrotron light sources.

The study is based on the impedance calculation for a laminated vacuum chamber with circular-cylindrical geometry using the field matching technique [2,3]. The field transformation matrix concept is introduced to evaluate analytically the longitudinal and transverse impedances for a layered vacuum chamber with arbitrary materials and thicknesses [4,5]. The results are applied to calculate the impedances for various parts of the vacuum chamber listed in Table 1: the finite thickness standard vacuum chamber, the metallic wiggler chamber with NEG coating and the injection kicker ceramic – metallic vacuum chamber. Impedances are evaluated for chambers with circular and elliptical cross sections. Horizontal and vertical geometrical correction factors [6] are used for the impedances calculations of vacuum chambers with elliptical cross section. The kick factor and the integrated gradient of the longitudinal wake potential are also given.