PETRA III Review November 2006

K. Balewski

Wednesday							
Time	**Duration**	**Topic**	**Speaker**				
09:00	00:30	Executive Session					
09:30	00:30	Project Overview	E. Weckert				
10:00	00:30	Exp. Hall	H. Franz				
10:30	00:30	"Coffee"					
11:00	00:45	Machine Design Overview	W. Decking				
11:45	00:45	Technical Systems Overview	K. Balew ski				
12:30	01:30	Lunch					
14:00	04:00	**Breakout 1**	**Group 1**	**Speaker**	**Group 2**	**Speaker**	
			Geometry and Optics	W. Decking	Magnets	A. Petrov	
			non-linear dynamics	Yongjun Li	Damping w igglers	E. Levichev	
			current limitations	R. Wanzenberg	Vacuum	K.Zapfe	
			beam diagnostics	K. Wittenburg	RF	M. Ebert	
18:00							

Thursday						
Time	**Duration**	**Topic**				
08:30	04:00	**Breakout 2**	**Group 1**	**Speaker**	**Group 2**	**Speaker**
12:30			closed orbit correction and stability	G. Sahoo	insertion devices	M. Tischer
			feedback systems	J. Klute	pow er supplies	H.-J. Eckoldt
			controls	R. Bacher	mechanical structure	M. Schloesse
			injection system	J. Maidment	reconstructi on schedule	K. Balew ski
12:30	01:30					
14:00	01:30	Executive discussion general				
15:30	00:30	"coffee"				
16:00	01:00	Preliminary conclusions				
17:00	01:00	Report structure and partition od w ork				
18:00						

Friday		
Time	**Duration**	**Topic**
08:30	03:00	Finalise report
11:30	01:00	Closeout
12:30		END

Teilnehmer

MAC Mitglieder	**Zusätzliche Experten**
C. Bocchetta (Elettra) (1)	R. Walker (DIAMOND) (2)
J. Galayda (SLAC) (2)	J. M. Filhol (SOLEIL) (1)
M. Harrison (BNL) (2)	M. Eriksson (MAXLAB) (1)
L. Rivkin (PSI) (1)	G. Decker (APS) (1)
N. Toge (KEK) (2)	Sushil Sharma (BNL) (2)
S. Meyers (CERN) (1)	S. Krinsky (BNL) (1)

Geometry and Optics and Non-Linear Dynamics (1)

- The alignment tolerances for placement of the quadrupoles and the sextupoles in the old 7/8 of the ring seem loose by modern standards … 0.25 mm ➔ geht das besser (0.1mm)
- when switching the RF OFF the beam is not going on a resonance that would result in a complete loss in the vertical plane (on the small aperture vacuum vessels). Beam dump

Geometry and Optics and Non-Linear Dynamics (2)

- **The results of ON momentum dynamic aperture that were presented were not considered convincing. It is the feeling of the committee that there might be no or very little margin, which does not look safe for the day 1 injection. We were not sure the errors which were taken into account in the dynamic aperture calculations …**
- **Energy acceptance: It looked unusual to the committee not to try to have "on paper" an energy acceptance larger that 1.5%. On many existing machines the energy acceptance actually achieved is smaller that the one initially anticipated. Considering that this has dramatic impact on the Touschek lifetime, the committee encourages further work on this subject.**
- **The sextupole optimisation was not totally convincing.**
- **Injection: Due to the large emittance from the injector, injected particles may have horizontal betatron amplitudes as large as 2 cm. …Serious consideration should be given to developing a septum design with thickness significantly less than 5 mm; the APS storage ring injection septum is 2 mm thick. Collimation schemes in the high energy transport line may be helpful to reduce the effective emittance of the injector,**

Current Limitations

- The vacuum chamber impedances of PETRA-III have been carefully studied by the PETRA-III team … Simulations should be carried out to determine the longitudinal and transverse instability thresholds resulting from the geometric and the resistive wall wakefields. In particular it is interesting to investigate the effectiveness of positive chromaticity in stabilizing the transverse single and coupled bunch motion. (influence on dynamic aperture…see above).
- **Measurements of the collective effects in PETRA II** should continue. In particular, the threshold of turbulent bunch lengthening and the energy spread evolution as a function of single bunch current in the present machine may deliver some clues as to the possible energy broadening in PETRA III at the design current.
- At the moment the multi-bunch feedback system is the only solution proposed. The use of higher harmonic **Landau cavities** (possibly passive and superconducting) to stabilize the multi-bunch instabilities should be investigated. Some examples where the Landau cavity will have an impact are:
  - the increased bunch length might have an impact on time-resolved experiments;
  - intra-beam scattering(IBS);
  - Touschek life-time;
  - damping of longitudinal as well as transverse coupled bunch instabilities. (The latter in combination with positive chromaticity which shifts the power spectrum to higher frequencies and the elongation will decrease the width of the power spectrum thus avoiding power at unstable negative frequencies);
  - resistive wall effect.

Beam Diagnostics

- **Suggestion**: Beam Loss monitors.
- In general diagnostics looks to be in good shape.

Magnets

- The question of whether the refurbished magnets will all be re-measured, including checking/re-alignment of the magnetic axis, was not clear to the MAC. Clearly this has an implication for timescales and resources.
- The MAC notes that the closed orbit dipole correction elements are of a solid core design operating at relatively low fields, and as such could exhibit non-negligible hysteretic properties. The Committee recommends that AC field measurements be performed on these elements as soon as they become available.
- The mechanical layout of the insertion girder results in magnets in **close physical proximity** which will result in some magnetic cross-talk. While the MAC does not expect this to produce any dramatic effects we suggest it would be prudent to perform measurements across the full operating range of the magnets 'in situ' when the prototype girder becomes available next year.
- The **good field region of the correction dipoles (3mm)** appears somewhat restrictive. The Committee wonders whether such a specification will be sufficiently flexible to allow for all eventualities.
- **The MAC notes that a significant fraction of the project's inventory of new magnets is scheduled for delivery in the next 6 months. The Committee recommends that DESY keeps close scrutiny of the production schedule during this period. Frequent visits to the magnet suppliers during this crucial time are encouraged.**

Damping Wigglers

- ***Comments and Recommendations***
- Regarding the SR absorbers, the MAC recommends considering a **larger tolerance on the position of the absorbers: 0.5 mm** would appear to be a bit optimistic, considering realistic manufacturing, alignment and stability tolerances. Closed orbit errors should be added on top of this. The MAC was reassured to hear that fluorescence from the Copper absorbers had been taken into account in modelling the heat transport.
- For the Al-extrusion vacuum vessels, the question of whether there is sufficient distance between the cooling water channel and the beam vacuum was raised. Regarding the NEG coating, the MAC was reassured that BINP has sufficient experience in this area, but nevertheless considers that only one month to set up a new rig and achieve reliable coating appears too short. Progress on this aspect, as well as of the production of the wigglers themselves, should be monitored closely.
- The MAC was concerned whether the **vacuum performance** of the damping wiggler straights has been adequately modelled. Although no details were presented, the MAC was given assurances that it had been modelled and that performance was acceptable.
- **In general, the number of meetings between BINP and DESY staff did not appear to us to be frequent enough at this stage of what is quite a large project, and the MAC strongly recommends that more regular technical meetings, for example on engineering/integration, vacuum and production issues, should take place.**

Vacuum

- *Comments*
- *The design of the explosion ring copper absorber appears to be quite complex and expensive. It is not obvious to the MAC that the functional requirements of the absorber require a design of this complexity.*
- *VAT type seals were selected for vacuum connection in the new octant as opposed to Conflat flanges in the standard octants. It was not made clear why Conflat flanges could not be used in the new octant also.*
- *The designs of discrete absorbers for both the standard and the new octants were briefly discussed. Although ray-tracings and thermal analyses were not presented, especially with off-orbit beam, the MAC is given the impression that this work was done with sufficient rigor and thoroughness. In this regard, the MAC believes that a miss-alignment tolerance of 0.5 mm for the absorbers is too optimistic. Another concern about the absorbers' design is that they are permanently attached to the vacuum chambers by brazing or explosion bonding. This would complicate their inspection or replacement in the future.*
- *A concern was raised if there were enough pressure sensors in the vacuum system to allow quick diagnosis of any vacuum related issue.*

- *Recommendation*
- *The procurement of most of the vacuum system components appears to be on schedule. The MAC recommends expediting the fabrication of the prototype undulator chamber and the design of the bellows assemblies for the new octant to ensure timely delivery of these components. The MAC also recommends that the design and/or procurement of the remaining special vacuum vessels should also proceed as quickly as possible since these may take a long time to procure, especially the kicker ceramic chambers. Suitable make-up pieces for items that are not essential for machine start-up should also be prepared as a fall back solution.*

RF

- ***Comments***
- ***The Committee was impressed with the work presented and did not identify any issues of significant concern. The great improvements in performance of the RF couplers suggest that it might be possible to remove more than two cavities, so as to further reduce the impedance driving the coupled-bunch instabilities. The longitudinal feedback system must have high performance to achieve its performance requirements; the risetime of the instability is about 12 synchrotron periods. The Committee was told that there are no higher-order mode dampers in the PETRA cavities. Damping or detuning the modes could give the feedback system more performance margin; however serious consideration could be given to alternatives only if a detailed model of the HOM impedance of the RF system were available to make reliable predictions.***

- ***Recommendations***
- ***The Committee suggests that some effort be devoted to development of a detailed model of the effects of cavity HOMs on longitudinal stability of the beam. Such a model can be checked against experience in PETRA-II, and used to better understand the performance of the feedback system and perhaps to assess the effects of damping HOMs or other countermeasures.***
- ***The Committee suggests that a phase stability specification be developed for the RF system.***

Closed Orbit Correction and Stability

- *Recommendation: A strategy for handling the frequency dead-band must be developed, either by increasing the slow correction sample rate to 10 Hz or more, using feed forward schemes to precisely power insertion device compensation coils, or some combination thereof.*
- *Note that the planned dedicated slow corrector magnets have solid cores, which severely limits their achievable AC performance. It is likely impossible (and undesirable) to increase the speed of secondary windings on the main dipoles to even 1 Hz for use in a faster slow correction scheme.*
- *The arrangement of steering correctors in the DBA portion of the lattice allows for local steering (with 4 correctors confined to each straight section) in the vertical plane only. An additional horizontal corrector near the ends of the insertion device straight section is highly desirable to allow a horizontal 4-bump without involving the main dipoles, and to provide direct compensation of insertion device steering effects. The main ring dipole secondary windings should be used rarely, and with trepidation.*
- *For the canted undulators, it is very important to have a beam position monitor located between the two devices.*
- *The capability to displace magnet girders remotely is included in the design, but no detailed strategy for their use was presented. It is recommended that this issue be carefully studied, taking into account planned beam-based alignment activities, which also were not described in detail.*

Feedback Systems

- *The presentation on feedback systems covered three systems: multi-bunch and fast orbit feedback, as well as the timing system for the experiments. The existing system of machine timing distribution may need to be improved, considering the present timing jitter of 100 – 200 ps.*
- *The hardware for the fast orbit feedback system is well advanced, with nearly all major components prototyped and tested. Software development should proceed with a focus on commissioning requirements. High level software functional specifications should be developed to allow for AC response matrix measurement and diagnostic capabilities to allow rapid localization of noise sources. Access to simultaneous waveform records of selected system inputs and outputs can be useful for quantifying beam stabilization effectiveness.*

Controls

- ***Good overview of the controls situation for PETRA-III (and other accelerators) was given. MAC was informed of the "legacy" situation at DESY with control systems (e.g. SEDAC and TINE) and the need to be able to incorporate different front-end electronics from other groups or Users. The MAC agrees with no further development of SEDAC. MAC appreciates the use of industrial systems and standards (CANopen and IVI) and takes note that front end electronics development is progressing as planned.***
- ***Although informed that personnel resources have been assigned, the MAC perceives that application development is on the critical path. The MAC recommends rapid re-evaluation of the number of people required for this and to prioritize DESY controls activities and hiring. Out-sourcing should be used already from the beginning to mitigate risks.***
- ***The MAC recommends minimizing the amount of system integration and controls administration by strongly suggesting to client groups to follow recommended practices and adopt standard device server applications and electronics' interfaces. The controls systems for experiments and beam line end station need good integration, especially with regard to undulator control. TANGO developments at other European laboratories should be followed even if PETRA-III personnel are unable to implement parts of this system now.***

Injection System

- *Assuming 20 h beam life-time and an allowed current variation of 0.1%, 1 shot per minute is needed in the first case with one bunch injected from the synchrotron. Only 1 nC is needed at each injection so the safety margin to the maximum booster current is a factor of 5.*
- *In the latter case, assuming 2 h life-time, 1 nC could be injected each 7th s. (This is likely unacceptable to the user community, since injection transients are unavoidable at some level due to kicker waveform mismatch, septum field leakage etc.).*
- *The specified value of 350 nm rad of the extracted beam from the synchrotron is uncertain. The value of today is rather around 700 nm rad. The larger value makes the situation even more serious.*
- *One could of course tailor the electron beam in the transfer path synchrotron-PETRA III, rather than induce radiation in the PETRA III ring. This method has its limitations as well.*

Insertion Devices

- *Comments and Recommendations*
- *The ID programme seems to be well underway, for the most part using designs that have benefited from previous experience in building IDs at DESY. The MAC believes that the decision to build the APPLE2 device in collaboration with BESSY is also a good choice given the heavy work load of preparing 11 IDs for installation by Sep. 2008. Nevertheless the timescales are still not generous, and attention needs to be paid to ensuring that the prototypes are not delayed further and the call for tender and subsequent contract for the production modules proceeds in a timely manner.*

Power Supplies

– *Conclusions*

- *For bipolar power supplies to use with steering magnets the time needed to switch the polarity was reported to be of an order of a fraction of a second (0.4s?). While MAC feels that a confirmation concerning the requirement on the switching time and trimming time of these power supplies from the parties responsible for beam commissioning might be worthwhile MAC also recommends reconfirmation of stability performance for steerer power supplies near zero current in conjunction with specifications from the beam dynamics standpoint.*

- *In the area of the power supplie proper, however, it was mentioned that an issue has been encountered regarding the scarcity of the competent and willing vendors to take the DESY II power supplies contract which is therefore something of a concern. The expected 14 month delivery time for these supplies also seems to be rather optimistic. Power commissioning is shown taking place between May and July 2008, which would not appear to leave much time for installation.*
- *The timescales for the 625 PETRA III power supplies would also not appear to be overgenerous.*
- *It was reported that the power supply group recognizes the importance of maintaining a good contact with the vendor and closely monitoring the progress, which the MAC wholeheartedly endorses.*

Mechanical Structure

- *Comments*
- *The girder support design is cost efficient and appears to meet all alignment and dynamic stability requirements. The stack-up of measured alignment tolerances (magnetic axis, revolving target circle, survey monument, etc) was shown to be less than 37 μm. This is very impressive since in some facilities that the MAC is familiar with, a ~ 50 μm intra-girder alignment would be considered somewhat optimistic in production phase.*
- *The assembly, alignment and installation procedures are well developed with assembly and rough alignment in Hall-1, final adjustments in the air-conditioned P3-Hall and transportation of the girder assembly with a crane. The MAC notes however that it is critical to programme that the new Hall is available on time in order to set up the area for final alignment. To mitigate the effect of a possible delay to the building, the MAC recommends forming a contingency plan, by identifying an alternative location where the final alignment can be done as well as the implication of checking the alignment, and possibly making adjustments, in the tunnel. The MAC also recommends taking the opportunity during girder assembly to also perform a hydraulic check on the water circuits, to minimise subsequent work in the tunnel.*

- *Recommendations*
- *The transfer function between the middle of the girder and the bearing show magnifications of 8.3 and 5.3 at 5 and 8 Hz, respectively. Since there is a substantial ambient ground/floor motion at these low frequencies, the MAC recommends that their impact on the vibrational stability should be carefully evaluated. Thermal stability of the support structure under ± 0.1℃ tunnel temperature transient should also be investigated.*

Reconstruction Schedule

- *The Project is scheduled for beam commissioning in early 2009 and is currently engaged in component specification and procurement. Installation activities will start at the end of HERA operation next year with the refurbishing of 7 octants of PETRA and the removal of the 8th. A significant amount of the required manpower (100 man-years) will involve temporary labour. The Project is starting to address the procurement of this manpower now. The MAC encourages this step. A detailed project schedule exists together with a manpower profile. Agreements have been negotiated with DESY departments for the completion of various project tasks. The Project currently is showing 3 months of schedule contingency in the tunnel work associated with PETRA, however any use of this contingency will presumably take resources from work on the new octant and possibly cause delay there.*
- *The completion of the experimental hall is one of the main project milestones scheduled for beneficial occupancy in April 2008. This is crucial date since many activities cannot be started before this milestone. The schedule is demanding (out for tenders now, construction start in July, occupancy the following April, and completed with utilities 3 months later.) The period after 1/4/08 when machine assembly going on in-parallel with building services works is also very critical. The MAC believes that maintaining this schedule will require a co-coordinated effort from both DESY and the Project.*
- *The major uncertainty at this point would appear to be the installation work associated with the insertion octant and the experimental region. Five months for this period seems quite tight. There is at this time no detailed choreography involving the beamline installation and the associated experimental equipment.*
- *No information was presented about beamline front-ends, which are not under the direct control of the PETRA III project. The MAC heard that all 14 front-ends are expected to be delivered in time for installation in the tunnel before the end of Sep. 2008, However the MAC considers it would be prudent to prepare a contingency plan to allow an absorber and valve to be installed on the X-ray arm, to allow the machine to be commissioned in the event of a delay to any of the front-ends. The installation of the front-ends also needs to be carefully integrated into the overall assembly schedule, because of the risk of trying to carry out too many activities in the same congested area.*
- *The possibility of a manpower shortage if the tunnel work is delayed for any reason is a concern. Girder assembly is an important element of the planning and there is some uncertainty associated with the manpower needed for a girder assembly. The first girder assembly will be started in March 2007 and should be monitored closely.*