High reliable operation of the pre-accelerator chain for PETRA III

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ABSTRACT

PETRAIII is a 3rd generation sychrotron light-source starting operation in 2009. The annual availability usually reaches a level over 97%. For this level of availability a high reliable preaccelerator is mandatory. The pre accelerator complex for PIII includes a Linac (LINACII), an accumulator ring (PIA) und a booster synchrotron (DESYII). With the constant-current ("topup") operation mode of PETRA III, the pre accelerators must deliver beam every few minutes. As a consequence they have to run continuously. Maintenance periods are rather limited. At the same time, the reliability and operation stability must be very high. To fulfill this goals several technical systems are designed redundant and the complex runs in a completely automated operation mode.

Pre-Accelerator chain for PETRA III

LINAC2 / PIA / DESY2

Linac II and PIA are at the beginning of the accelerator chain for electrons at DESY. A electron gun generates a direct current of electrons at a beam energy of 150 keV. This electron beam is prepared in the subsequent injector so that it can be accelerated to an energy of 450 MeV in six accelerator sections.

PIA (Positron Intensity Accumulator) is the smallest storage ring at DESY with a circumference of 28.8m and is used for the intermediate storage of electrons - and earlier also for positrons bunch trains.



DESY 2 is an electron or positron synchrotron with a circumference of 292.8m, which has a fixed cycle of 12.5 Hz. The injection energy is 450 MeV. In a half period of the cycle time, acceleration is on a sinusoidal energy curve and then extracted at time tr. DESYII is used as a booster for PETRA 3, and the extraction energy is 6 GeV.



Booster Sychrontron DESYII

35 years of DESYII beam operation

From spring 1987 on, DESY II delivered beam to DORIS, PETRA and detector test areas. PETRA was used in this time as a preaccelerator for the collider HERA. With the recontruction of PETRA into a sychrontron light source in the year 2009 some infrastructur renovation were realized. One important measure was the renewal of all six main power supplies (dipole DC, dipole AC, QD, QF, SD and SF) including the regulation concept. The beam intensity variation could thus be significantly reduced.

To further reduce possible downtime, a second independent HF station was build. It came into routine operation in summer 2011. Also the injection kicker has a redundant design.

Since 2011 only minor additional renewals were done.



DESYII also houses the 3 beamlines of the DESY testbeam facility which are used for detector tests and development - testbeam.desy.de

Maintenance periods a very limited but all technical system of course follow a well defined maintenance schedule. Despite rather old systems with long operating times the machine runs quite well with a very high availability.

> Beam intensity versus time for a typical situation today. The beam intensity in DESY II (light green) follows the delivered intensity from LINAC II (dark green) without breakdowns.

LINAC2 / PIA

The beginning of the accelerator chain

Since 1987 the LINAC2 and the small associated storage ring PIA delivers beam to DESYII.

The LINAC2 has 12 S-band accelerator sections. The associated RF stations are based on old PFN modulators, only modern HV power supplies and PLC controllers were installed in the year 2000. Of the 12 accellerator sections, 4 are running as hot spare, ensuring high operational reliability.

To ensure further operational reliability, a second redundant electron gun was commissioned in 2013.





Conclusion

With the constant-current ("top-up") operation mode of PETRA III, the pre accelerators must deliver beam every few minutes For the last several years, the pre-accelerator chain has been running in a fully automated operation mode without manual actions by the operators.

PETRA's pre-accelerators are very robust and deliver very high availability, despite some aging components. For example, the availability of DESYII is regularly above 99%. The preaccelerators thus contribute significantly to the successful operation of PETRA III.



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