MAINTENANCE AT HERA

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Abstract

HERA is an electron proton collider with a circumference of 6.3km at the DESY laboratory in Hamburg, Germany. The machine was commissioned in 1991. The age of the machine and the big number of components make it necessary to add some preventive maintenance to the usual scheme of event-triggered repairs.

The way maintenance is organized at HERA will be described in this paper.

1 HERA

HERA (Hadron Electron Ring Accelerator) is an electron proton collider for high energy physics. Two accelerator rings are built in one tunnel of 6.3km circumference: The proton ring with superconducting magnets reaches an energy of 920GeV with a beam current of 100mA, distributed in 180 bunches. The normalconducting electron ring reaches 27.5GeV with a beam current of up to 50mA in 189 bunches.

Two of the four experiments at HERA (ZEUS and H1) use colliding beams to probe the structure of the proton, whereas the HERA-B detector uses a wire target in the halo of the proton beam for fixed target physics. The fourth experiment, HERMES, uses a polarized gas target and the polarized electron beam to investigate the spin structure of the proton.

2 HERA OPERATION

HERA is operated 24 hours per day, 7 days per week, 8-11 month per year. In the year 2000 HERA has reached an operational efficiency of roughly 60%. Here efficiency is defined as the ratio between luminosity operation time and scheduled luminosity operation time. One of the reasons for this relatively low efficiency is the long fill time of HERA. Both HERA and its preaccelerator PETRA are slow cycling machines. Therefore it takes 2-3 hours from the end of a luminosity run until the beginning of the next luminosity run. Apart from this relatively long fill time the efficiency is determined by the failure rate and repair time. Breaks due to component failures add up to about 18% of the scheduled luminosity operation time. This down time cannot be compared to that of a synchrotron radiation source, being operated at fixed energy and having only a low number of components. HERA has for example 1500 superconducting magnets, 2500 normalconducting magnets, 1220 magnet power supplies, 16 klystrons (500MHz) with 1MW output each, 6 proton RF transmitters, 500 normalconducting cavity cells with 82 couplers, 80 superconducting RF cells with 16 couplers, 550 beam position monitors, 470 beam loss monitors and a quench protection system with some 20000 cable connections. Another reason for delays is the time it takes the repair crew to reach the faulty component. From the accelerator control room it takes approximately 15 minutes to reach the most distant hall of HERA. Afterwards the repair crew may have to walk up to 750m through the tunnel, depending on the location of the faulty component.

3 MAINTENANCE

3.1 Preventive Maintenance

Every first Thursday of the month HERA operation is interrupted for a service day. The tunnel is open for access from 6am to 3pm, the experimental areas are open from 6am to 10pm. During 9 hours access to the tunnel there is time for new installations, for regular service work, for preventive maintenance and for a lot of not so urgent repairs, which have piled up during the previous month. Regular service work is for example the regeneration of NEG pumps and titan sublimation pumps. Examples for preventive maintenance are the cleaning of feedthroughs on superconducting magnets, checks for water leaks on magnets and RF or the regular switching of relays in safety circuits to prevent them from getting stuck in the same position when never operated. Not so urgent repair work in the tunnel is collected on a white board in the accelerator control room and is scheduled either on short notice in parallel to urgent repairs or shifted to the next service day. Last but not least the access to the tunnel is used for ‘tunnel tourism’. As there are only about ten opportunities per year to enter the tunnel, there is always a need to show new colleagues or guests the tunnel.

Every access to the tunnel has to be announced in advance to the technical coordinator. The work in the tunnel is planned and coordinated in order to minimize disturbances between different tasks in the same area, avoid rush hours at the tunnel gates and check for consequences of certain actions for other components (i.e. repairs on cooling water or mains power). The work scheduled for the next service day is published on a web page.

The experiments get 16 hours access to their detectors, while the tunnel is closed after 9 hours. The remaining time is used for a thorough search of the tunnel, to switch on all power supplies and for component tests.

Problems occur either during a service day (test of the ‘emergency off’ buttons without prior notice,…) or at the end of a service day, when everything is switched on again (remote control switched to ‘local’,…). Now it is useful to have a list of the work that was foreseen and a list of the people that were in the tunnel. This helps for example to locate a ground fault in a 6.3km dipole circuit.

3.2 Event-triggered Maintenance

If an accelerator component breaks unexpectedly during operation, the shift crew is able to respond relatively quickly, because the shift crew is recruited from 20 different technical support groups of the DESY machine department [1]. Due to this mixture of hardware experts on shift, chances are high that there is either a system expert on shift or there is at least one colleague in the shift crew who has taken part in a similar repair before.

All power supply failures are handled by the two power supply experts on shift and the mixture of people from different groups on shift helps to solve almost all other problems without external help. However, several groups have people on call (quench protection, vacuum, RF, superconducting cavities, cooling water, power distribution), who can give advice on the phone, check their systems from their computers at home or come to DESY and help to solve the problem. Although most shift crews take pride in solving problems themselves, the shift leaders do not hesitate to call even people who are not 'on call' to solve severe problems and get the machines running again.

If a quick repair is impossible (broken magnet, broken 10kV mains power cable,…) the repair is scheduled for the next working day. In most cases HERA is still able to deliver at least one beam (p+ or e+/e-), which can be used by the experiments for calibration runs. If the repair takes several hours, some of the not so urgent repair work listed at the white board in the control room is scheduled in parallel. However, the amount of work done during such breaks should be limited to the necessary minimum in order to reduce the aftermath of such an unscheduled service day.

Repairs of broken components are generally managed by the shift leader. The shift leader will call in experts, if necessary, and will discuss the situation with the physicist on shift, the shift leaders of the four experiments, the technical coordinator of HERA, the coordinator of HERA or the head of the machine department, depending on the severity of the problem. If the shift leader is convinced that all necessary support is available and the repair just takes time, there is no need for the shift leader to call any group leaders or coordinators, no matter how long the repair takes.

4 REFERENCES

[1] M. Bieler, "How we do Business at DESY," these proceedings.