Gas support systems for New High–Rate Detectors: The Example of the Inner Tracker of HERA–B

(title assigned)

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The challenge to avoid aging in the new generation of hadronic high-rate detectors at DESY and CERN does not only need adequate and partly new detector materials but also force the gas support systems to be of previously not needed material qualities and cleanliness. The effort which is necessary to test materials for detectors must be extended to all parts which are touched by gas; detailed and critical investigations also in a lot of traditionally used parts are necessary. It turned out that some of these contain small parts of out-gassing material, which were so far negligible, but can cause fast aging under high rate conditions. In addition, for some detectors new quenchers that are chemically reactive were proposed, which caused the number of usable gas system components to shrink even further. Finally, the traditional way of mounting gas systems in workshop-like environments is history by now; in the future clean-room-like environments become more and more necessary.

Summary of Talk: HERA–B – recently started – is the first of a number of hadronic high-rate experiments which will be operated or will start in the next ten years. As well as for detector technology, HERA–B was also a pioneer in gas system technology; not only for gas system automation and flow regulation but in particular also for investigations into pipes and other parts related to gas systems that are usable at high detector rates, for which approximately three man years were necessary. The work was done in parallel with the detector development and frequent aging tests could also be used for excluding inadequate gas system components. All potential candidates for parts such as valves, flow controllers and pressure transducers etc. were completely dismantled and the origin and material of their parts were determined and checked up to traces of glue used somewhere. Only the small number of accepted types of materials which had passed the aging tests could be accepted to be used inside the parts and everything else had to be replaced if possible. Consequently, those candidates for which this didn't work had to be rejected. It was interesting to learn that also parts which had a so-called 'complete material list' contained often surprises neglected in the documents. The list of gas system compliant components for HERA–B was split into two branches; one being the inner tracker gas components and the other outer tracker, muon system and high–P_T chambers components (The RICH gas system with completely different purpose is neglected here). Originally, the list for the inner tracker was especially small because the inner tracker gas system was completely designed for the use of DME which is known to be reactive and aggressive, e.g. when used with many sealing elastomers. The use of DME had finally to be canceled after a last minute discovery which proved gas aging caused by the DME itself. Another discovery independent from the use of DME had big influence on the gas system design, namely the fact that CERN tests showed in 1997 that Teflon somewhere in the system even if touched by gas only at small surfaces starts aging in MSGC's. As a consequence, all Teflon parts had to be removed from the inner tracker system (and as a preventive measure also from the rest of the tracker). The bad thing here was that Teflon is used more or less everywhere in commercial products. Concerning the pipes with their big surfaces a special cleaning procedure with acetone and ethanol was done routinely. This was also applied to the outer surface because this is usually covered with suppliers inscriptions which can accidentally have contact with the gas inside fittings. This cleaning procedure fails of course for ring corrugated tubes which cannot be easily cleaned. In HERA–B, approximately 2.5 km of ring corrugated tubes are used for gas support and a suitable oil-free method of production and chemical-free method of cleaning had to be found which took several month. At least one company was able to do so but nevertheless the inner tracker ring corrugated tubes were in addition cleaned and dried with some hundred cubic meters argon before use. The meaning of pumps gets also a new quality when trying to build a closed loop system for high hadronic rates. In HERA–B, large gas flows of up to 22 m^3/h have to be compressed to a pressure of 2.5 bar (abs). Elastomer membrane pumps as well as rotary slide pumps were excluded a priory because they enforce the contact of gas with rotating sealing material or elastomer membranes. The finally chosen metal bellow pumps tend to develop leaks at the bellows, which is still a subject of investigation. The mounting of gas system components finally was performed under stricter conditions compared to the usual practice. To avoid grease from hands on fittings and pipes the mounting was performed with latex gloves and fittings were routinely or especially if potentially contaminated with dirt severely cleaned in ultra-sonic acetone and ethanol baths and afterwards stored in special dust-free clean boxes. It should be pointed out that such precautions need an enormous amount of discipline on part of the technical personnel because the meaning of clean environment and parts in all areas not directly related to detector production are usually underestimated. In addition, it can never be avoided that some of the work has to be done on the fly in the experimental hall where conditions are worse than in the labs. Finally, it should be mentioned that the cost of the HERA–B gas systems due to the tough conditions exceed by far what is known from the other experiments at HERA. In the end, one can only hope that the effort was sufficient because it is clear that aging coming from impurities in the gas support systems can take some time. What we can say so far is that we have put an enormous effort into the attempt to avoid it and that after one year of HERA–B running we have absolutely no indications for gas aging and we have hopes for this condition to stay.