Summary of session 2: Experience with large systems

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1. Introduction

The purpose of this session was to review the experience gained during operation of large systems. All contributions except the one of T. Marshall about the D0 muon system described central tracking devices. The observations discussed are ranging from "no indication of aging" for the L3 vertex drift chamber up to an almost textbook-like collection of aging effects seen by H1. The most relevant parameters of the five detectors are summarized in Tab. 1.

2. Summary of the five presentations

As discussed by Botio Betev, the L3 vertex drift chamber did not show any aging effects after 11 years of operation at the LEP storage ring. This was demonstrated by the fact that the anode pulse amplitude did not degrade and that the drift-time space relation remained stable at the 0.1% level over this time period. Most likely, the successful chamber operation was due to the small amount of background produced by LEP as well as the great care taken to construct a clean gas system. The irradiation of the anode wires corresponds to 10^{-4} C/cm; an integrated dose of 2300 rad was measured.

The ZEUS central drift chamber had been operated reliably at HERA for 8 years without any visible aging effects. However, during the year 2000 the two outermost layers suffered from high voltage instabilities which were unrelated to beam conditions or to other environmental factors. According to David Bailey, they suspect these problems to be due to the Malter effect. A small quantity of water was added to the chamber gas which appeared to be the appropriate solution.

Carsten Niebuhr reported on the H1 central jet chambers. Both inner (CJC1) and outer (CJC2) chambers are made of similar materials and share the same gas system. Therefore, is was quite astonishing to observe in total 48 broken wires in CJC1 due to corrosive remnants in the crimp parts, but none in CJC2. Consequently, all sense wires in CJC1 were replaced. Two years later, a gain drop due to deposits on sense wires in the lower part of CJC2 was detected. The aging observed at moderate irradiation (< 0.01 C/cm) was attributed to impurities in the gas in combination with temperature gradients in the chambers. All wires were replaced and the gas distribution was improved. Afterwards, increased background levels at HERA led to about two times larger chamber currents consistent with the Malter effect so that the water additive was replaced by 0.8% of Ethanol.

Thomas Marshall reported on a method to restore contaminated wires of the D0 muon system. After one year of operation they found inefficient cells in high radiation areas. Outgassing of the cathode pads had produced a shell of "crud" coating the wires. They managed to clean the wires by quickly heating up the wires close to the melting point of gold. This procedure broke the contaminating sheath into little pieces and blew them away from the wire.

The central drift-chamber of CDF presented by Morris Binkley suffered from a severe gain drop (1000% / C/cm) after an irradiation of only 0.02 C/cm. This was confirmed by inserting monitor chambers in the gas system. After cleaning the gas system and reducing the amount of aerosols emanating from the alcohol bubbler, the aging rate could be reduced to an acceptable level.

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Speaker	Exp.	Detector	Operation	Gas	Irradiation	"Aging effects"	Remedy
B. Betev	L3	Vertex drift chamber, TEC	LEP: 11 years	CO_2 / iso-C_4H_{10} 80:20	10^{-4} C/ cm	none	No background, clean gas system
D. Bailey	Zeus	Central tracker, DC	HERA: 1992 - 1999	Ar / CO_2 / C_2H_6 83:5:12 + 0,5% Ethanol	0,1 C/ cm	none	
			HERA: 2000	add H_2O		HV trips not correl. to beam, Malter effect	Add 0,15% H_2O
C. Niebuhr	H1	2 central jet chambers; inner CJC1, outer CJC2	HERA: 1992 - 1993	Ar / C_2H_6 50:50 + 0,1% H_2O		48 broken wires in CJC 1 due to corrosive remnants in crimp parts; no damage in CJC2	New wires for CJC1
			HERA: 1994 - 1995			none	
			HERA: 1996 - 1997		< 0,01 C/cm	Gain drop in CJC2; deposits on sense wires. ΔT=15 …C	New sense wires for CJC2; improve gas distribution
			HERA: 1998 - 2000		Increased background	Increased chamber currents: "Malter" effect	Replace H_20 by 0,8% Ethanol
T. Marshall	D0	Central Muon: prop. drift tubes	Fermilab: 'Run I '	Ar / Freon / CO_2 90:6:4	1st year	Inefficient cells; outgassing of pads gives sheath of crud	Clean wires in place by heating up quickly
		Forward Muon: stainless steel tubes	Fermilab: 'Run I '	CF_4 / CH_4 90:10		none	
		"	Test tubes	CF_4 / CH_4 90:10	5 C/ cm	none	
		Muon: mini drift tubes	Fermilab: 'Run II '	Ar / Freon / CH_4 84:8:8			double gas flow
M. Binkley	CDF	Central tracking CTC	Fermilab: 'Run I '	Ar / C_2H_6 50:50 + 1% alcohol	0,05 C/ cm	Gain drop up to 1000 % / C/ cm; deposits on wires	Cleaning of gas system, add Cu-wool filters, reduce alcohol
		Central tracking prototype			0,4 C/ cm	none	
		Gas monitors with ^{90}Sr	Fermilab: 1995-2000			Gain drop up to 100k % / C/ cm; deposits on wires	
		Central tracking COT	Fermilab: 'Run II '	Ar / C_2H_6 50:50 + 1% alcohol		Gain drop < 5 % / C/ cm	

Table 1
Session 2: Experience with large systems – summary of aging effects and relevant parameters.