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ISR-OP/TV/FL/svw CM-P00072460 26th July, 1979

PHYSICS RUN ANALYSIS NO. 2 - 1979

Periods 2 and 3 (24th April - 16th July, 1979)

I. INTRODUCTION

The high luminosity physics running at 31.4 GeV/c continued during all of period 2 (10 runs).

The physics program for Period 3 required running exclusively at 15 GeV/c (3 runs) and 22 GeV/c (10 runs) with high currents and luminosities. This report reviews these two running periods which extended from run 1025 to 1056. The ISR long summer shutdown started after run 1056 (16th July).

II. SUMMARY OF OPERATIONS

Much running time was lost during Period 2 due to power supply problems in the SFM system, and during Period 3 due to vacuum valve interlock problems and to a pressure rise which appeared suddenly at high current in ring 1, sector 51.

The remaining running loss time was caused by 18 kV perturbations due to frequent thunderstorms during the months of May and June. Run 1039 had to be cancelled due to high 18 kV activities.

On May 25th (run 1037) the Solenoid, after a long breakdown caused by cryogenic problems, could finally be put into operation again.

From 14th May onwards (run 1033) the ISR operated with a single dedicated power transformer and capacative filter (except during the 15 GeV/c runs). The benefit has been a noticeable reduction in background spikes and noise from sources outside the ISR (mainly booster or PS supercycle pulsing). On the other hand, the main disadvantage of the scheme is that the ISR is now more sensitive to power surges coming from our own magnet changes (main magnets, experimental magnets, ...).

a) Ring set-up and filling

Table 1 shows the main filling parameters used and performances achieved. Working lines used for 31.4, 15.4 and 22.5 GeV/c were always of the ELSA type with steel low beta on.

No major problems were experienced with 15 and 22 GeV/c fills although these energies have not been used in the ISR for a long time (more than 2 years for 22 GeV/c). Four to six hours were needed at these energies to set up the rings and fill to high currents. Generally good longitudinal densities were achieved (.35 A/mm at 15 GeV/c and .5 A/mm at 22 GeV/c) except for some runs in ring 1 when a density fall off with large spill-out occurred after stacking 12-15 Amps. The use of the RF "missing bunch phase lock" scheme partly cured this problem.

In order to reduce the beam-beam effects during the first 22 GeV/c runs, stacking by separating the beams vertically as for 31.4 GeV/c

runs was tried. This method was abandoned, due to the long time taken for steering, in favour of head-on colliding beam stacking which gave the same performances with time savings for filling.

Centering the beam at 22 GeV/c after stacking gave rise to unexplained high current losses. By adjusting the top of the stack position less close to the chamber protector scraper (<~+35>mm instead of <+40> mm) beam centering was no longer needed.

At the end of period 3, three runs (1054, 55 and 56) were affected by the pressure rise in Sector 51. Current in Ring 1 had to be limited to about 20 Amps.

b) Physics running conditions and behaviour

The total stable beam time and integrated luminosity for the three energies is given in the table below.

Momentum GeV/c	Stable beam time (hours)	lums x time x 10^{35} cm^{-2}
15.4	112	21.8
22.5	355	192.1
31.4	404	214.7

Background rates, as seen by the experimenters, do not show a drastic difference between the use of a single transformer or three transformers for the ISR power.

Background conditions were good on average but the presence of sudden dI/dt spikes with small current losses in both rings have still not been explained and make clean-ups necessary.

The mysterious ring 2 background structure was still present during the whole of period 2. After a partial ring 2 power supply exchange with the ring 1 counterpart, a surprising event occurred during run 1047 when the periodic structure appeared very clearly in ring 1. Nevertheless, the structure was still present later in ring 2. Until now, no final conclusion has been reached on the cause of this strange beam behaviour.

On the other hand, a new program for fast scanning of suspected power supplies giving beam spikes is now operational. Also the improved beam diagnostic FFT device has been put into operation with new computer programs and has provided a convenient and rapid way of measuring working lines and beam stability limits and also providing better information on beam statistics.

A fast and automatic vertical beam steering program has been developed and the time taken to steer an intersection to its optimum position could be reduced by a factor of 3.

Background levels have been reduced for I-2, I-6 and I-8 by means of the collimation system. The efficiency of collimation is largely dependent on the amplitude of the horizontal and vertical closed orbit distortion. Due to non-reproducibility of the orbits, compromises often had to be found in ring 2 between intersections 1 and 4.

Physics running at 15 and 22 GeV/c with the OAFM and Solenoid switched on did not cause any major problem. Beam spikes, however, seemed to be more visible to I-8 physicists when the OAFM was powered.

The fast decrease in luminosity at these energies resulted in more frequent refills. A maximum of 40 hours continuous physics running could be achieved, whereas 60 hours and more can be maintained at 31.4 GeV/c.

c) Beam losses

During stable beam physics, beams were lost due to "hardware" problems on 10 occasions:

Run 1028 - Both beams lost due to 18 kV dip
1036 - Both beams lost : SFM fault
1037 - Beam 1 lost : 18 kV disturbance
1039 - Run cancelled due to thunderstorm
1043 - Both beams lost : Solenoid fault, refill with Solenoid
1045 - Both beams lost : vacuum sector valve fault
1048 - Both beams lost : vacuum sector valve fault
1050 - Both beams lost due to OAFM interlock fault
1052 - Solenoid shunt fault : both beams lost
1054 - Beam 1 lost due to pressure rise in Sector 51.
1055 - Beam 1 lost due to pressure rise in Sector 51.

These beam losses affected not only the physics running conditons but also necessitated many refill negociations with the PS.

III. CONCLUSIONS

High performances obtained in the past at 31.4 GeV/c continued with luminosities of the order of 20 x 10^{30} $cm^{-2}s^{-1}$, whilst those achieved presently at 15.4 and 22.5 GeV/c have been substantially improved. Luminosities of about 7 at 15.4 GeV/c and 20 x 10^{30} $cm^{-2}s^{-1}$ at 22.4 GeV/c were achieved from the start.

Current in Ring 1 was limited for some runs due to density drop and to vacuum pressure problems.

dI/dt spikes are still not understood nor are the several minute structures on background present since a few runs in both rings.

Important time was lost not only due to 18 kV perturbations (thunderstorms) but also due to various interlock system faults (OAFM, vacuum valves) dumping the beams.

F. Lemeilleur T. Verbeeck

FILLING PARAMETERS
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RUN	P1 P2 GEV/C	WL1 WL2	SHAVING %		DENSITY A/MM		STACK TOP		STACK BOTTOM		I.INITIAL AMP.		HEFF MM		DH/DT %/H	L.INIT 10F30
			R1	R2	R1	R2	R1	R2	R1	R2	R1	R2	IN.	FIN.	INIT.	
1041	15/15	LB LB	25	25	.35	.32	33	30	-25	-29	20.66	19.50	6.4	8.2	.7	6.3
1042	15/15	LB LB	30	30	.30	.30	26	28	-38	-31	23.15	19.64	6.0	7.5	.8	7.6
1043	15/15	LB LB	30	30	.30	.32	32	38	-24	-22	18.92	19.10	6.3	7.3	.7	5.7
1043	15/15	LB LB	20	20	.33	.35	38	38	-14	-10	17.04	16.97	6.0	6.7	.8	4.8
1045	22/22	SB SB	20	20	.50	.52	34	29	-30	-29	32.05	30.07	4.0	5.9	2.5	24.1
1045	22/22	SB SB	25	25	.48	.52	35	30	-28	-28	29.92	30.04	4.0	6.6	2.5	22.5
1047	22/22	SB SB	25	25	.36	.39	37	41	-17	-21	19.40	23.93	4.3	6.3	2.9	10.8
1048	22/22	SB SB	25	25	.52	.53	33	33	-26	-29	30.86	32.95	5.1	6.7	1.3	19.8
1049	22/22	SB SB	20	20	.48	.50	37	32	-26	-31	30.22	31.43	5.2	7.4	1.3	18.0
1050	22/22	SB SB	20	20	.47	.50	40	40	-26	-28	30.96	33.95	5.2	6.0	1.2	20.2
1050	22/22	SB SB	20	20	.46	.54	33	33	-32	-33	29.49	35.80	4.9	7.1	1.3	21.7
1050	22/22	SB SB	25	25	.50	.51	40	40	-22	-21	31.09	31.28	5.4	6.1	.9	18.0
1052	22/22	SB SB	25	25	.44	.48	40	39	-24	-24	27.99	30.05	4.6	5.8	1.4	18.2
1054	22/22	SB SB	20	20	.48	.53	37	37	-25	-25	29.92	33.19	4.6	6.0	1.8	21.5
1054	22/22	SB SB	30	30	.40	.51	33	38	-12	-22	18.45	30.75	4.5	5.4	2.2	12.7
1055	22/22	SB SB	25	25	.35	.51	36	40	-20	-24	19.56	32.24	4.5	6.4	1.4	14.1
1056	22/22	SB SB	35	20	.42	.50	38	38	-11	-24	20.51	31.17	4.1	6.5	2.4	15.5
1025	31/31	AC AC	30	30	.55	.55	34	34	-32	-35	26.64	30.04	4.6	7.0	.7	17.5
1026	31/31	AC AC	30	30	.45	.39	35	38	-36	-34	31.84	27.90	4.8	6.0	.7	18.3
1028	31/31	AC AC	30	30	.38	.40	36	35	-38	-35	27.67	27.72	5.3	5.6	.6	14.5
1029	31/31	AC AC	25	25	.36	.47	26	35	-38	-34	22.90	32.40	4.7	5.2	.7	15.6
1030	31/31	AC AC	15	15	.36	.45	35	37	-37	-34	25.56	32.21	6.0	6.7	.6	13.8
1033	31/31	AC AC	20	20	.45	.47	33	34	-34	-35	30.49	32.48	4.7	5.6	.7	21.0
1034	31/31	AC AC	20	20	.46	.49	34	33	-37	-34	32.62	32.86	4.7	7.2	.7	22.5
1036	31/31	AC AC	25	25	.42	.44	33	36	-37	-34	29.49	30.83	4.8	5.0	.7	18.6
1036	31/31	AC AC	25	25	.44	.47	32	35	-36	-32	30.24	31.98	4.7	5.5	.7	20.4
1037	31/31	AC AC	25	25	.40	.44	33	28	-27	-30	23.73	25.26	6.6	7.2	.6	9.1
1038	31/31	AC AC	30	30	.46	.49	34	36	-35	-26	32.14	31.08	4.4	5.1	1.1	22.7
1038	31/31	AC AC	20	20	.40	.48	34	36	-35	-27	27.97	30.66	4.7	6.0	.7	18.3

Table : 1

PHYSICS PARAMETERS
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RUN	P1 P2 GEV/C	I.INIT AMP R1	I.INIT AMP R2	I.FIN AMP R1	I.FIN AMP R2	DI/DT PPM/MN R1	DI/DT PPM/MN R2	L.AVE 10E30	TIME HOURS	WORKING CONDITIONS FOR EXPERIMENTERS RING 1 INTERSECTIONS I1	I2	I4	I5	I6	I7	I8	RING 2 INTERSECTIONS I1	I2	I4	I5	I6	I7	I8
1041	15/15	20.66	19.50	19.44	18.53	8	2	5.4	38	2	2	2	2	1	0	2	2	2	2	2	1	0	2
1042	15/15	23.15	19.64	21.39	17.99	11	4	6.1	37	2	2	2	2	1	0	2	2	2	2	2	1	0	2
1043	15/15	18.92	19.10	16.80	16.74	10	4	4.8	29	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1043	15/15	17.04	16.97	16.70	16.60	4	3	4.4	8	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1045	22/22	32.05	30.07	0.00	0.00	5	3	19.1	24	2	2	2	2	1	0	2	2	2	2	2	1	0	2
1045	22/22	29.92	30.04	28.91	29.07	10	9	17.5	31	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1047	22/22	19.40	23.93	18.31	23.30	8	5	8.8	36	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1048	22/22	30.86	32.95	0.00	0.00	12	5	16.8	20	3	2	2	2	2	0	2	3	2	2	2	2	0	2
1049	22/22	30.22	31.43	28.80	30.56	8	4	15.0	36	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1050	22/22	30.96	33.95	0.00	0.00	9	4	18.8	15	1	1	1	1	1	0	1	1	1	1	1	1	0	1
1050	22/22	29.49	35.80	28.30	33.30	8	15	17.0	38	3	2	2	2	2	0	2	2	2	2	2	2	0	2
1050	22/22	31.09	31.28	30.55	31.10	5	4	17.0	15	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1052	22/22	27.99	30.05	0.00	0.00	4	3	16.5	13	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1054	22/22	29.92	33.19	0.00	32.60	10	2	18.5	17	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1054	22/22	18.45	30.75	17.95	29.84	20	5	11.2	10	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1055	22/22	19.56	32.24	18.52	31.19	20	8	11.5	31	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1056	22/22	20.51	31.17	20.05	29.72	5	8	12.3	36	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1025	31/31	26.64	30.04	23.20	28.13	22	2	12.9	56	3	3	3	2	2	0	2	3	3	3	2	2	0	2
1026	31/31	31.84	27.90	29.76	25.97	11	7	15.6	57	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1028	31/31	27.67	27.72	27.27	27.31	12	5	13.8	14	2	2	2	2	2	0	2	2	3	2	2	2	0	2
1029	31/31	32.90	32.40	32.40	31.64	4	1	14.0	25	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1030	31/31	25.56	32.21	22.12	29.50	21	2	11.3	39	1	2	2	2	2	0	1	2	1	2	2	2	0	1
1033	31/31	30.49	32.48	29.65	31.72	8	1	18.4	42	1	1	1	1	1	0	1	1	1	1	1	1	0	1
1034	31/31	32.62	32.86	30.57	30.03	13	4	17.4	58	1	1	1	1	1	0	1	1	1	1	1	1	0	1
1036	31/31	29.49	30.83	0.00	0.00	11	2	18.5	4	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1036	31/31	30.24	31.98	0.00	0.00	12	2	18.5	27	3	3	2	2	2	0	2	2	2	2	2	2	0	2
1037	31/31	23.73	25.26	23.13	23.72	8	19	8.2	43	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1038	31/31	32.14	31.08	31.76	30.98	8	1	21.0	6	2	2	2	2	2	0	2	2	2	2	2	2	0	2
1038	31/31	27.97	30.66	27.37	25.90	7	6	15.1	33	4	2	4	2	3	0	3	4	2	4	2	3	0	3

NO DATA...0
VERY GOOD.1
GOOD.....2
FAIR.....3
BAD.....4

Table: 2

SPECIAL COMMENTS
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RUN	
1041	LB+SOL.FAILY GOOD COND.CLEAN-UPS FOR I4.SOME SPIKES IN R1.
1042	LB+SOL+AFM.QUITE GOOD WORKING CONDITIONS.
1043	LB+SOL+AFM.^GOOD RUNNING COND.BEAMS LOST DUE TO SOL FAULT.REFILL.
1043	LB+AFM.VERY GOOD CONDITIONS.LOW BACKGROUNDS.
1045	LB+SOL+AFM.VERY STABL.BEAMS LOST DUE TO VACUUM VALVES CLOSURE.REFILL
1045	FAILY GOOD COND.SPIKES.BEAMS BLOWN-UP AT THE END.
1047	LB+SOL+AFM.QUITE GOOD WITH SOME SPIKES.BG STRUCTURE IN R1.
1048	GOOD COND AFTER CLEAN UPS.BG INCREASING RAPIDELY.BEAMS LOST DUE TO VACUUM.
1049	LB+SOL+AFM.QUITE GOOD COND. CLEAN-UPS IN R1 FOR I1+I2.
1050	LB+SOL+AFM.VERY GOOD COND.BEAMS LOST DUE TO OAFM INTERLOCK FAULT.REFILL.
1050	GOOD COND EXCEPT FOR I1 R1.SPIKY AT THE END.BEAMS BLOWN-UP.REFILL.
1050	LB+SOL+AFM.QUITE GOOD COND.LOW BACKGROUNDS.
1052	LB+SO.STABLE AND GOOD COND.BEAMS LOST DUE TO SOLENOID FAULT.REFILL.
1054	LB+SOL+AFM.VERY QUIET BG.R1 LOST DUE TO PRESSURE RISE IN S51.REFILL.
1054	GOOD COND.HIGH LOSS RATE IN R1 DUE TO PRESSURE BUMP.R2 LOST AT THE END.
1055	GOOD COND.BG STRUCTURE IN R1.LIMITED CURRENT IN R1 DUE TO PRESSURE BUMP.
1056	GOOD AND QUIET COND WITH FEW CLEAN-UPS.AT THE END BEAM 2 ONLY FOR I1.
1025	OAFM+LB GOOD TO FAIR I1+I4 IN R2.LARGE AND REGULAR SPIKES IN R2.
1025	GOOD AFTER CLEAN-UP.
1026	OAFM+LB.SPIKES FROM TIME TO TIME IN R1+R2,DISTURBING I2+I4.R2 STRUCTURE.
1028	OAFM+LB.GOOD COND AFTER CLEAN-UPS.BOTH BEAMS LOST DUE TO 18KV(THUNDERSTORM)
1029	OAFM+LB.HIGH BG IN R2 FOR I2.VERY STABLE CONDITIONS.
1030	LB+OAFM. GOOD AND STABLE WORKING CONDITIONS.
1033	LB.VERY GOOD COND FOR ALL INTERSECTIONS.ISR POWER FROM SINGLE TRANSFO.
1034	LB ON. GOOD AND STABLE WORKING CONDITIONS.
1036	LB ON.GOOD COND.BOTH BEAMS LOST DUE TO SFM FAULT. REFILL
1036	LB.REFILL.GOOD TO FAIR COND FOR I1+I2.MANY 18KV SPIKES.R1+R2 LOST.SFM FAULT
1037	SOL+LB ON. QUITE GOOD AND STABLE CONDITIONS.
1038	SOL+LB ON.GOOD COND.R1 HAD TO BE DUMPED FOR SFM COMPENSATOR REPAIR
1038	SOL+LB.REFILL R1.FAIR TO BAD COND IN I1+I4.MANY CLEAN-UPS+BEAM ADJUSTEMENTS