LEP-IOP/TV/svw

21st February, 1983

ISR PERFORMANCE REPORT
Physics Run Analysis No. 3 - 1982
Periods 4 and 5 (1st September - 20th December, 1982)

1. Summary

After the long summer shutdown, the ISR started operating for physics early in September. This report reviews the last two periods of the year (4b, 5a, 5b) which extended from run 1287 to run 1317. A complete summary of all 1982 physics runs are attached.

The physics program for these two periods mainly required running at 31 GeV/c. Throughout period 5, special running requests for 22 and 15 GeV/c were completed. In addition, four runs were devoted to optimising the operational procedures at 3.5 GeV/c for the gas-jet experiment in I-7; successful results were obtained.

A significant milestone was achieved during a high intensity run (1315) with the double low-β scheme in operation: a record luminosity of $1.4 \times 10^{32} \text{cm}^{-2}\text{s}^{-1}$ at 26 GeV/c was attained in I-8 with the superconducting low-β in operation. The currents stacked were just above 30 Amps.

A further step was made in a two weeks p-bar running at the end of the year. A total of 6.6 mA was accumulated in R2 with three successive AA stack transfers and a luminosity of $3.10^{28} \text{cm}^{-2}\text{s}^{-1}$ was reached in I-8 with the superconducting low-β in operation.

The anti-protons from the initial transfer circulated for just over two weeks.

Throughout these last two running periods, machine operation was often delayed due to reduced availability of the FS operating most of the time at a full rate for AA. Hence, with the complex PS super cycles used in addition, refills after accidental beam losses were difficult to negotiate and resulted, in the end, in a significant increase in lost physics time (runs 1293, 1310, 1311).

2. Operation Review

2.1 Start-up, filling acceleration

Although the majority of runs were at 31 GeV/c, these two periods provided the opportunity to complete several commitments for physics at various lower energies. Two runs were at 15 GeV/c and three at 22 GeV/c, including a further Terwilliger calibration run for I-2 (run 1304). For these energies beam optics computer files had to be revised and were tested during machine preparation periods. Fillings and beam centering were very straightforward, stable beams were given with currents of the order of 20 Amps at 15 GeV/c and 30 Amps at 22 GeV/c.
The start-up for most of the 31 GeV/c runs proceeded very smoothly. Higher speeds for power supply settings were tried and a new faster cycling program to reduce the main magnets cycling time by a factor of 3 gave good results. For several runs, however, the precision in orbit measurements was affected due to aging components. Hence, the orbit distortions, mainly in the vertical plane, were difficult to reduce. Nevertheless, up to 40 Amps could easily be stacked at 26 GeV following the well established standard procedures on LB optics. The acceleration files which were updated after the shutdown resulted in improvements in the working line control during phase displacement acceleration. Only small corrections were needed in order to avoid a persistent ring 2 working line curvature at the bottom of the stack. This problem is still under investigation. The RF cavities and the beam load compensators, after maintenance during the shutdown, were more reliable and low and constant current losses per RF sweep were obtained. Only one cavity could not be tuned as expected in R2. Remaining currents after acceleration were of the order of 30-35 Amps.

2.2 p-pbar operation

Preceding a comparison run with protons (run 1316) the last two weeks of running were dedicated to p-bar physics. Three successive transfers brought the antiproton current to a record 6.6 mA. This current could have been much higher if the antiproton transfers still scheduled had not been cancelled due to hardware problems in the PS and later in AA.

Considered as the standard tune for p-p̅ runs, the new rematched double low-B (DL) scheme with the WL placed above the diagonal QH = QV gave very good results. The best beam behaviour was, however, obtained by removing the WL from higher order resonances (8th order horizontal) and surprisingly the beam quality was not affected when 6th order resonances were crossed. The proton stack was renewed four times and the current successively increased from 10.6 Amps to 21 Amps; the peak luminosity attained in I-8 was of the order of $3 \times 10^{28} \text{cm}^{-2}\text{s}^{-1}$ with a proton current in R1 of 21 Amps. Both cooling systems, the momentum and the vertical betatron cooling, were successfully used on beam 2. The stack width was reduced from 15 mm to 4 mm in less than 10 days of running. About 300 hours were used for physics data taking. Unfortunately, after a huge 18 kV dip, the run was interrupted and advanced by 30 hours the end of year shutdown.

3. Physics Review

3.1 Statistics

The main physics parameters are reviewed in Tables 1 and 2. The total data taking time used for physics and the total integrated luminosity as measured in I-5 are given in the following table.
The total integrated luminosity and the total hours dedicated to physics in 1982 reached $1.1 \times 10^{38} \text{cm}^{-2}$ (in which $3.7 \times 10^{33} \text{cm}^{-2}$ for p-pbar running) and 3,003 hours respectively.

The total running hours are given in fig. 1.

3.2 Background and working conditions

Very good running conditions were reported for most of the 31 GeV/c physics runs. For example, run 1313 was considered as the best physics run achieved so far; with currents of $36 \times 37 \, \text{A}^2$ at 31 GeV/c and a luminosity of $31 \times 10^{37} \text{cm}^{-1} \text{s}^{-1}$, excellent beam conditions could be maintained for more than 60 hours.

Although background levels were extremely low and the experimenters in general were very satisfied, in the majority of runs unexplained small and large current losses were regularly experienced in both beams after 20 to 30 hours of data taking. A total of nine runs were very much affected and up to 4 Amps were lost in ring 2 (run 1297). Much effort was put into trying to understand and find the cause of these beam instabilities. Experience has shown that observation of the phenomena using transient recorders is not sufficient. More statistics with different trigger rates are needed and studies are being pursued.

Other normal factors which deteriorated beam conditions were 18 kV disturbances (runs 1297, 1298, 1309, 1313) and power supply fluctuations (1287, 1288, 1293, 1314); the latter resulted mainly in persistent and intermittent instabilities detected on tuning quadrupoles (QT) power supply chain. Thanks to conscientious follow-up, their influence on beam background could be reduced.

There was considerable background perturbation on beam 2, when the newly installed movable calorimeter in I-6 was brought close to the beam pipe. As a result both beams were lost during a detector movement in run 1299. After some tests, and although no important orbit variations could be detected, displacement of the calorimeter was only allowed with all beam limitations fully withdrawn.

For a few runs (runs 1306-1308) the unexplained background stucture in R2 reappeared, however, due to tight collimation, the experimenters were not unduly disturbed.
3.3 Beam losses

For these last two periods, thirteen runs were affected by accidental beam losses during stable beam physics. The following table gives the list of runs with the reasons, if known. Refills could not always take place and/or were often delayed due to the non-availability of the PS.

<table>
<thead>
<tr>
<th>Run</th>
<th>Beam affected</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1287</td>
<td>R2</td>
<td>2PFD 10 faulty</td>
</tr>
<tr>
<td>1288</td>
<td>R2</td>
<td>2QT7 faulty</td>
</tr>
<tr>
<td>1291</td>
<td>R2</td>
<td>Unknown</td>
</tr>
<tr>
<td>1293</td>
<td>R2</td>
<td>2QT2 faulty</td>
</tr>
<tr>
<td>1295</td>
<td>R1+R2</td>
<td>Unknown</td>
</tr>
<tr>
<td>1298</td>
<td>R1+R2</td>
<td>18 kV failure</td>
</tr>
<tr>
<td>1299</td>
<td>R1+R2</td>
<td>I-6 detector</td>
</tr>
<tr>
<td>1306</td>
<td>R2</td>
<td>Unknown</td>
</tr>
<tr>
<td>1307</td>
<td>R1</td>
<td>Vertical transverse feedback</td>
</tr>
<tr>
<td>1308</td>
<td>R2</td>
<td>Unknown</td>
</tr>
<tr>
<td>1309</td>
<td>R1+R2</td>
<td>18 kV dip</td>
</tr>
<tr>
<td>1311</td>
<td>R1</td>
<td>Water cooling fault main magnets</td>
</tr>
<tr>
<td>1317</td>
<td>R1</td>
<td>18 kV dip</td>
</tr>
</tbody>
</table>

T. Verbeeck

References

1) PR 7.2.83 - 3.5 Gev/c R2 - S. Baird.

2) PR 24.11.82 - J. Poole, K. Dahlerup-Petersen, R2 WL curvature during acceleration to 31.4 GeV/c.

3) PR 23.9.82 - Set-up, stacking and beam observation with new DL scheme - J. Poole, T. Risselada, A. Verdier.
FIG: 1
SPECIAL COMMENTS

RUN
1306 GOOD AT THE START, BG STRUCTURE IN R2, R2 LOST DUE TO UNKNOWN REASON REFILL.
1307 MANY DIAM. R2 LOSSES FAIR, COLD DUE TO SPIKES.
1308 GOOD COND. BOTH BEAMS LOST DUE TO 130KV FAILURE, REFILL.
1298 FIRE COND., LARGE SPIKES IN R1
1299 GOOD COND., BOTH BEAMS LOST DURING 16 DETECTOR DISPLACEMENT.
1296 TEST WITH NEW CL. L 18=32, 16E30, VERY GOOD IN 18
1315 GOOD FOR DL MACHINE. L 16=1.4, 10E32.
1316 COMPARISON RUN FOR A PLAIN GOOD EXCEPT FOR 12.
1287 STABLE R2, R1 SPIKY, THE R2 LOST DUE TO 2P+10.
1288 GOOD COND., R2 LOST DUE TO 2P-7, REFILL.
1288 GOOD COND., SOME SPIKES DUE TO 18KV.
1291 GOOD COND. 2 AMPS LOST IN R2, R2 LOST DUE TO CORONA FOUND REFILL.
1292 FAST BLOK-UP IN R1, MANY CLEAN-UPS + STEERINGS FOR 14.
1292 L0L, BG, LARGE CURRENT LOSSES IN R2.
1293 R2 LOST DUE TO 2P+7, REFILL.
1293 GOOD AND STABLE, TWO LARGE CURRENT LOSSES IN R2.
1294 GOOD COND., GOOD, BOTH BEAMS LOST DUE TO CORONA FOUND.
1295 GOOD COND. L0L, LARGE CURRENT LOSSES, BOTH BEAMS, REFILL.
1295 FAIR TO GOOD COND., LARGE CURRENT LOSSES, REFILL.
1297 GOOD COND., SOME 18KV SPIKES.
1307 GOOD AT THE START, MANY SPIKES IN R1, R1 LOST DUE TO FEEDBACK SYSTEM.
1308 MANY SPIKES IN R1, BG STRUCTURE IN R2, R2 LOST DUE TO CORONA FOUND.
1309 GOOD COND., SOME SPIKES, BOTH BEAMS LOST 18KV, REFILL.
1309 NO SOL, FAIR COND. AT THE END, GOOD AFTER MANY BEAM ADJUSTS, SPIKES ON R2.
1310 NO SOL, VERY GOOD COND., LOW BG, SOME SPIKES IN R2.
1311 GOOD COND., PARTIAL CURRENT LOSSES IN R2, R1 LOST DUE TO COOLING PUMP FAULTY.
1312 VERY LOW BG, SMALL BEAM LOSSES IN R2.
1313 GOOD COND., SPIKES DUE TO 18KV.
1314 GOOD COND. FAIR FOR 14 SMALL SPIKES + BS FLUTUATION.
1317 F, F-BAR RUN, L 18=1.4, 10E28, BEAM 1 LOST 18KV, REFILL.
1317 FAST BLOK-UP IN R1, MANY CLEAN-UPS + STEERINGS FOR 14.
1317 F, F-BAR. L 18=1.3, 10E26, GOOD COND. R1 REFILLED.
1317 F, F-BAR. L 18=2.3, 10E26, GOOD COND. R1 REFILLED.
1317 F, F-BAR. L 18=2.5, 10E26, GOOD AT THE START, BECOMING FAIR, R1 LOST=0-SHIFT.
1317 F, F-BAR. 4 AMPS LOST DURING LUMS, FAIR COND. IN 12+14.
SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.

SPECIAL \#18-\#20 PLTS-L Extract LEAPS MUST BE CHECKED FOR POSSIBLE FAULT REVERSION.