Notes on MD1 2003 27/06/2003

With a first superficial analysis

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Goal for this MD

This (unexpected) MD time was dedicated to re-commissioning the BBLR and debugging the two new features of this 2003 run:

- Local correction of the linear dipole kick by a new dipole corrector.
- Measurement of the diffusion with a scraper

Schedule

This run lasted from 10:00 to 18:15; it took over an hour for the PS to deliver the low-intensity LHC beam needed. The target total intensity value of 3 10^{11} protons could not be reached.

SPS Set-up

This MD was carried out on the P2 cycle at 26 GeV/c. The LHC beam was injected in batches of 12 bunches. The total intensity was the minimum that could be delivered by the PS to minimize risks to the BBLR. The intensity of 6 to 8 10^{11} protons was about twice what could be delivered last year.
The orbit and the tunes were not checked at this stage.

Check of the BBLR

The interlocks were verified with the BBLR at 20 A. The temperature rise (BA5) versus excitation was checked. At 270 A, the temperature increased from 24 to 27 degrees within 5 minutes.
This demonstrate that the cooling is active.

Calibration of the BBLR BPM

The BBLR was set to 10 A (negligible effect). The local closed orbit at the BBLR was zeroed by interpolation. The residuals were: H: -0.07mm, V: +0.29 mm
The BBLR BPM signals were logged at 12225 for various bumps (timing??) by S. Jackson program.
The cycles just before and just after a change are not guarantied to correspond to the given bump amplitude.
The reproducibility from cycle to cycle was measured to be 0.1 mm.
The logged file was processed by Stephen into an XL file now in jpk\LRBBC\MD\2003\Bpm-calib

During the MD, it was noted that the signal is often too small to be detected and that the position readings does not seem to show trends and might not be reproducible from cycle to cycle. We made the hypothesis that the position was not normalized.

Cycle number	Bump amplitude at BBLR (mm)
295741	+1
49	+2
55	+3
60	+4
65	+5
73	0
79	-1
86	-2
92	-3
99	-4
04	-5
295810	-6
18	-7
25	-8
30	-9
38	-10
48	-11
55	-12

Test of the local correction of the BBLR dipole kick

The standard orbit interface had been modified to include the new magnet and a single micado iteration for the correction (forcing MICADO to use the “BBLR corrector”), after disabling the BPM’s inside the BBLR Pi bump. The BBLR was set to -270 A. Its timing was: ramp up between 1000 and 1500 ms, ramp down between 3600 and 4200 ms. The nominal beam wire distances (I_w=0) were chosen nominal (19+2.54/2mm) and -5mm (14 +2.54/2mm).
The timing of the closed orbit correction was the whole P2 cycle, i.e. the injection could be disturbed by the BBLR orbit correction. This situation can be improved next time.

At the nominal position, the BBLR orbit perturbation is 2.4 mm rms, corrected down to 0.1 mm rms in three iterations of the same corrector (effect of the non-linearity).
At the position -5 mm, the beam is actually at -10 mm before correction. We did not try beyond.
This new facility was shown to allow in a few cycles a restoration of the initial orbit with great precision. Given the very low vertical aperture, this makes the BBLR experiment in a much better position for un-ambiguous data taking.

Test of the scraper

The BCV appeared stuck from the control room (after disabling the scraper interlock). It had been checked in local mode the day before. It will be checked again in the tunnel and in remote control next Thursday.

Test of the PMT recording (cmonJPK)

After a successful launching, cmonJPK changes by itself its parameters at regular intervals. We could thus not use the loss recordings as observed by the PMT's and BCT's.
The hypothesis is that somebody else must have accessed the PMT's remotely. The instrument is now reserved for next Friday.

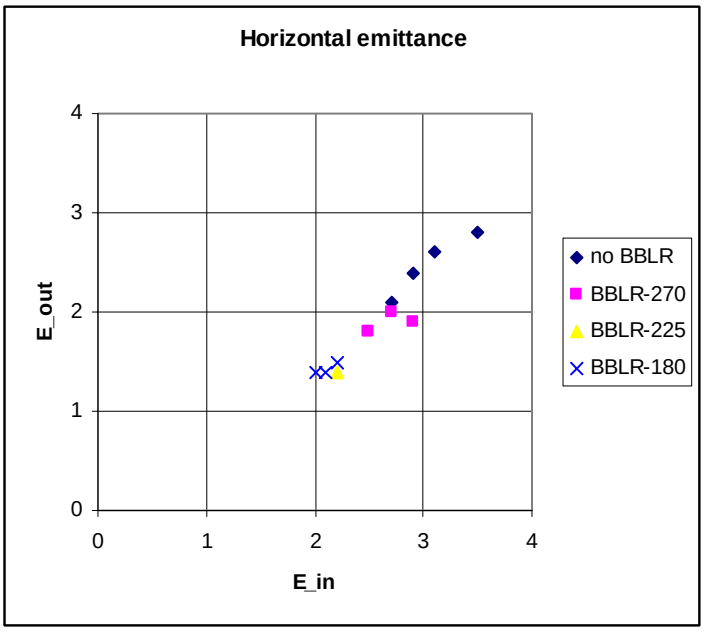
Measurement of the consequence of diffusion

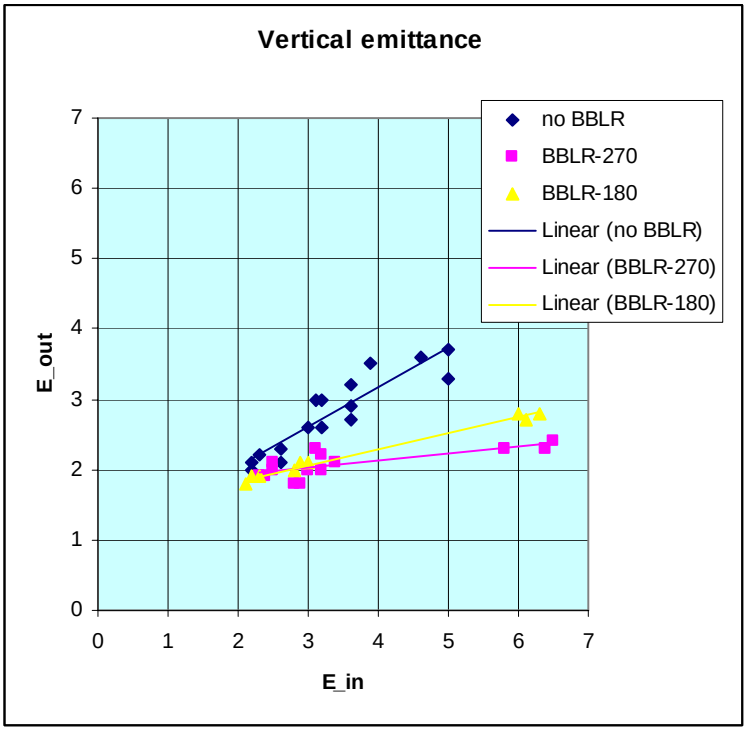
While testing the scraper program, Jorg noticed that the beam emittance 'shrinks' when the BBLR is on (actually it shrinks more than without the BBLR).
In the remaining time, we did dedicated measurements. In all cases, the orbit perturbation caused by the BBLR was carefully corrected to let the beam at -5.6mm at the BBLR (separation of 14.7 mm). We did not check nor correct the betatron tunes.
The timing for this experiment was as follows:

- BBLR: ramp up 1000 -> 1500, ramp down 3600 -> 4200 ms.
- BBLR orbit correction: whole P2 cycle
- WS: IN at 100 ms; OUT at 3000 ms.

Situation	Iw	$\varepsilon_{x,in}$	$\varepsilon_{x,out}$	$E_{y,in}$	$E_{y,out}$
	A	10^-6 m rad			
No BBLR	10	3.5	2.81	3.6	2.9
		2.7	2.1	3.9	3.5
		3.1	2.6	2.2	2.1
		2.9	2.4	2.3	2.2
				2.6	2.1
				2.2	2.0
BBLRmax Loss 88 to 54 10^10	-270	2.9	1.9	2.8	1.8
		2.5	1.8	2.9	1.8
		2.7	2.0	3.1	2.3
		2.5	1.8	3.0	2.0

	-180	2.1	1.4	2.1	1.8
		2.0	1.4	2.3	1.9
		2.2	1.5	2.2	1.9
Loss 80 to 72 10^10	-225	2.2	1.4	2.4	1.9
		2.2	1.4	2.5	2.1
				2.4	2.1
	-250			2.4	2.0
				2.2	1.9
				2.6	2.2
	-270			2.5	2.1
				2.4	1.9
				2.3	1.9
No damper	-270			2.5	2.0
Injection detuned	-270			3.4	2.1
				3.2	2.2
				3.2	2.0
	-180			3.0	2.1
				2.8	2.0
				2.9	2.1
	-90			2.7	2.0
				2.4	2.1
				3.2	2.3
				2.9	2.3
No BBLR	0			2.6	2.3
				3.0	2.6
				3.6	2.7
				3.2	2.6
Same timing on WS IN and OUT	0			3.1	3.0
				3.2	3.0
				3.6	3.2
Injection badly detuned	0			5.0	3.7
				5.0	3.3
				4.6	3.6
Profile in profile_v_100ms.data	-270			6.5	2.4
				5.8	2.3
				6.4	2.3
	-180			6.3	2.8
				6.0	2.8
				6.1	2.7





Both emittances shrink between the IN and OUT scans, even in the absence of BBLR. A systematic of the WS was excluded. Tune problem, coherent oscillation at injection (plausible, as the intensity loss- not recorded- was not large or negligible)? poor aperture on top? The final emittance depends linearly on the initial emittance and was equal or larger than 3 in 50% of the cases.

There seems to be a clear effect of the BBLR (-270A) limiting the emittance to about 2.2 in the vertical plane. When excited at -180 A, the BBLR restricts the emittance to about 2.8.
The horizontal emittance data are less complete. There seems to be no correlation between the horizontal emittance decrease and the excitation of the BBLR.

If the observation is the diagnostics of a BBLR enhanced diffusion, the maximum stable amplitude is about at 2.5 sigma (?) of an emittance of 2.2, i.e. about 4 mm for a beam separation of about 15 mm at -270 A.
This would be in good agreement with Frank's latest simulations, actually a bit worse than simulated. Of course, one need to reflect on the 2.5 sigma's, i.e. to the relation diffusion-equilibrium emittance.

Acknowledgments

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