Presentation 29

Improved Diagnostics

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SL-BI organised a "Journée de l'Instrumentation du LEP 1990" last October, where the performance of most instruments was presented and discussed with the users. Since then, an extensive improvement programme has been implemented the main items of which can be seen in Table 29.2. The most relevant points will be explained in more detail below.

29.1 Improvements relevant to beam-beam studies

29.1.1 Emittance measurements

Four wire scanners are used to measure the emittances of the two beams. All of their wires had been burned and were replaced during last June shutdown. Since then, no further problems have occurred and even tests with beam could not reproduce the melting of a wire! Recording of electrical resistance of the wire at rest and during beam traversal has allowed the contribution of electromagnetic induction to be distinguished from the collision heating. The forks holding the wires have been redesigned to reduce induction, final power circuit cards for driving the wire through the beam have been produced and bremsstrahlung detectors are now installed downstream of each beam so that the four instruments will be fully operational. Further data analysis is being conducted to better understand the effect of beam blow-up during the wire traversal. A proper de-convolution will then be possible, leading to the determination of the genuine emittances.

The four synchrotron light telescopes BEUV have been working steadily in TV mode during last year and their single shot triggering by means of an image intensifier/shutter has unveiled the ultimate resolution of the instrument when UV light at 250 nm is used. Two more intensifiers will be available for the next running period and a new software package will allow recording emittances at regular intervals. Vertical emittances can also be observed for each passing bunch by the use of a hard X-ray detector (BEXE) made of a dense array of CdTe photoconductors. These have a pitch of 100 μm and cover a span of 6.4 mm. They can be read continuously and displayed to show a mountain range of four bunches.The new electronics will provide 64 channels and the multiplexing of the signals will be re-arranged to cope with up to eight bunches per beam.

Table 29.1 compares the performance of the three instruments described above. The first one gives an accurate absolute reading of the transverse position through an optical ruler with a resolution of a few microns, but the wire scan interferes slightly with the measured beam size. The second shows a true two-dimensional image of the beam cross-section and can separate bunches and record a sequence of ten of them. The third measures only in the vertical plane but has got a full time resolution (it can trace each bunch for thousands of revolutions).

Instruments	Measurements	Trigger	Integration time	Frequency
Wire scanner	H- or V-profile	separate bunches	$\approx$ 50 revol.	0.2 Hz
BEUV				
a) CCD in TV	beam cross-section	TV asynchronous	18 ms	50 Hz
b) CCD in digital	digitized image + projections	asynchronous	18ms	0.5 Hz
c) fast shutter	digitized images + projections	selected bunch	1 to 200 revol.	0.5 Hz
d) fast shutter	digitized images + projections	8 bunches at pre-selected intervals	single passage	0.1 Hz
BEXE	V-profile	separate bunches	single passage	44 kHz

Table 29.1: Instruments for transverse emittance measurement

29.1.2 Luminosity measurement

All sixteen Bhabha monitors are being displaced together with the BIMO collimators from 15 m to 8.5 m distance from the IP's, following the installation of smaller vacuum chambers for the experiments. In this alternate position the detectors will have to be recommissioned and their data taking rate is expected to be slightly increased because some space has been gained on the local shielding. An improved version of event analysis, taking into account the total energy measured in each mini-calorimeter, will soon be available and should hopefully provide for a better rejection of accidental events due to electron background.

29.1.3 Excitation of dedicated beam-beam modes

For beam-beam tune shift measurements at LEP, the Q-meter has been used in its FFT-mode until now, with a random frequency excitation directed on one particular bunch. The result is that both π- and 0-modes of transverse coherent oscillation of this bunch and the corresponding modes in the other beam are excited simultaneously. Under most circumstances the anti-symmetric mode was marginally observable rendering difficult the measurement of ξ_x and ξ_y.

It is proposed that such measurements should be done in the future by using the swept frequency mode of the Q-meter. This mode will be provided with a new facility to excite four bunches at a time (the two of one beam and the two of the other beam which meet at the even points). This excitation will be given with appropriate phases to each bunch in order to enhance only one mode of oscillation at a time.

29.2 Other important improvements

29.2.1 BOM

The Wide Band electronics (used for 6 to 8 BPM's near each IP) is being fitted with new amplifiers/attenuators in order to suppress the numerous relays which were providing erratic readings.

Two hardware modifications are made in the Narrow Band part of the system: i) All generators used for the calibrations are modified to provide shorter pulses which will simulate the real beam in a closer way and therefore leave us with smaller offsets and more accurate gain assessment, ii) longer connection cables between each button electrode and the normaliser box will avoid some signal reflections which were seen to perturb the measurements.

On the software side the introduction of the new DSC's which will happen soon after start-up for the Wide Band part of BOM and during the June shutdown for the Narrow Band part, will bring three major advantages: i) faster processors at the ECA level, ii) better transmission through the controls system by the suppression of the PCA layer and iii) more flexibility for local software

running under OS9.

29.2.2 Q-METER

An additional system is planned to be introduced at the start-up to provide a permanent display of the frequency spectrum observed from coherent transverse oscillations (without exciting the beam via the Q-shaker). The first implementation will be done with an existing microprocessor 68020 and a new VME card to create an RGB picture in US15. This display will be refreshed at 1 Hz and will be enhanced later by the introduction of a DSP. This display will be cheaply converted to PAL for transmission to PCR.

Improvement Programme for LEP Beam Instrumentation (11.1.91)			
Items	**Work** *(software work is written with italic letters)*	**Responsible**	**Date**
BOM	Wide band electronics: new HP attenuators	D.Cocq	March 91
	Narrow Band electronics: modified pulse generators	G. Vismara	March 91
	longer cables anti-reflections	G. Vismara	March 91
	Software version 1(NB) + version 0 (WB) from start-up on		
	• *trajectories of each selected bunch*	A. Burns	March 91
	• *selected closed orbits of e+ or e-*	A. Burns	March 91
	Installation of 8 DSC's allowing:	SL-CO	April 91
	• *version 2 for WB, incluiding:*	G. Morpurgo	April 91
	• *x,x',y,y' for PCR and experiments*	J. Miles	April 91
	Progressive implementation of DSC's allowing:	SL-CO	June 91
	• *version 2 for NB, including:*	G. Morpurgo	June 91
	• *harmonic analysis of coherent trans. oscil. : phases*	G. Morpurgo	June 91
	• *harmonic analysis of coherent synch. oscil. : dispersion*	G. Morpurgo	June 91
Analogue signal observation	Transverse coherent signals up to 2 MHz at PCR	L. Vos	June 91
	Longitudinal signals up to several GHz: tunnel, klystron gallery, or optical laboratory ?	J. Borer	March 91
Q-Meter	Displace shaker to better bV/bH ratio	K.D. Lohmann	March 91
	Improve pick-up sensitivity	M. Desroziers	March 91
	Extend Q-loop feed-back range	J. Pett	March 91
	Permanent FFT display on TV screen in PCR	K.D. Lohmann	March 91
	2Hz refresh programmed on 68020	H. Schmickler	March 91
	interface for new DSP	M. Desroziers	June 91
	100 Hz refresh programmed on DSP	H. Schmickler	June 91
	Four bunch excitation in swept frequency (p- or s-mode)	H. Schmickler	March 91
BCT	Generate trigger on dI/dt	B. Halvarsson	March 91
	Improve life-time computation	van den Eyden	March 91
Injec.Mon.	Install new screens and split foils to allow steady observation of injected beams during stacking	G. Burtin	March 91
Wire scanner	New forks to reduce E.M. induction heating the wires	J. Camas	March 91
	Four set-ups complete and operational	J. Koopman	March 91
	Improve analysis of profiles to deduce emittances	C. Fischer	
BEUV	New amplifier/shutter for single-/multi-shots at 250 nm	R. Jung	June 91
	Recording of emittance history on file	SL-CO	
BEXE	Install new vessel with Be window	E. Rossa	March 91
	Install more electronic for 64 vertical channels	E. Rossa	March 91
	Install new prototype of autocorrelator	E. Rossa	March 91
	New software: • *calibration of vertical channels*		June 91
	• *detector automatic retracted position*		June 91
	• *continous mountain range display*		June 91
Streak camera	New trigger modules for ARP system	J.-J. Savioz	March 91
	Realize a combined data taking and image treatment for STREAK&BEBE	Y. Solberg	92
Bhabha	Recommissioning of all 16 monitors moved from 15m to 8.5m from IPs	G.P. Ferri	March 91
	New and more complete event analysis in OS9	J. de Vries	June 91
Polarimeter	Improve polarimeter performance:	M Placidi	March 91
	• laser optics and light control	B. Dehning	March 91
	• detector dynamics	G.P. Ferri	March 91
	• data acquisition (OS9)	L. Knudsen	March 91
	• connection to PCR	L. Knudsen	March 91

Table 29.2: Improvement Programme for LEP Beam Instrumentation (11.1.91)