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Calibration of Secondary Emission Monitors in TT60 and the West Hall

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The calibration of secondary emission monitors (SEM) in TT60 and the West Hall was done on two different dates: 15 April and 8 August 1977. SEM's used for the slow extracted beam to the West Hall (targets T1, T3, T5) were calibrated versus SEM's located upstream of TT60. These monitors (BSPV 610307 and BSI 610316) are also used for the fast extracted beam to the Neutrino cave (targets T7, T9, T11) and can then be calibrated versus the fast extracted beam measured by beam current transformers (BCT 610307 and BCT 680062). A schematic layout of the monitors is given in fig. 1.

To avoid unknown losses on the splitter, the calibration of the target lines TT63, TT64 and TT65 is made by sending the beam at once on one target only (T1 or T3 or T5) by changing the focusing parameters of the TT62 line ('beta' value at the splitter = 50 m instead of 15 km). This calibration cannot be done during physics runs where the beam is currently shared between the three targets. It is also necessary to remove the targets themselves to calibrate the BSI foils located in the TBID boxes downstream of the targets.

Results

1. Cycle-to-cycle variations

Cycle-to-cycle variations were found to be very small over ten consecutive cycles. Figure 2 gives the average value of the ratio in percent (SEM/BSPV 610307 in the same cycle) and the standard deviation of this ratio over ten cycles. During the test, the signal given by the BSPV 610307 was of the order of 900 mV corresponding to 90 bits for a slow extracted beam of $\sim 1.3 \times 10^{12}$ protons.

The standard deviation is of the order of 1% corresponding to one bit.

All 24 SEM's gave signals between -12% and +21% of the BSPB 610307.

2. Parameters influencing the calibration factors

At stable machine conditions similar sets of measurements were repeated over ten cycles and gave stable calibration factors. But the calibration factor appeared to be dependent on the size and position of the beam.

Figure 3 gives average calibration factors for 5 SEM's in TT62 and the corresponding beam sizes for the two different settings (β = 50 m and β = 15 km). The normal setting being for β = 15 km, the change in calibration could be due to the ageing of the SEM. The calibration factors are greater when the beam passes through a new area of the foil.

The steering program gives a 'tolerance box' for the target steering. No significant changes in calibration factors were observed when the beam was inside the 'tolerance box', but the calibration factors increased when the whole beam hit the targets outside the 'tolerance box'.

Further measurements have to be made to confirm this change of calibration factor by up to 20% more for a 'new' area. Variations of up to 30% have been observed in FNAL[1)] and BNL[2)].

The calibration factors (SEM/BSPV 6103) were measured on 15 April and 8 August for targets T1, T3 and T5, in good steering conditions. These are given in fig. 4. They were all within $\pm$ 2%, except for TBID in T1 which was 10% less on 15 April.

Nevertheless, it is worth noting that the beam sizes, as given in fig. 4, are slightly different for the two cases (β = 50 m and β = 15 km) hence the calibration factors could also be slightly different for the two cases.

3. Correspondence between SEM signals and number of protons

This calibration was performed during a fast extraction between BSPV 6103 and BCT 6103.

On 15 April, it was not possible to make such direct calibration. At that date all SEM's of T1, T3, T5 lines were normalized to the upstream BSI 610306. This detector has a buffer amplifier in the tunnel between the detector and its integrator providing an analog signal for the RF servo-spill, therefore its calibration could be slightly altered by a long-term change in the characteristics of the amplifier. It has been decided to better normalize against BSPV 610307. Calibration between BSI 6103/BSPV 6103 was measured on the 2nd of May and found to be 0.94 ± 0.01. This factor has been incorporated in the results given in paragraph 2. The same day calibration between BSPV 6103/BCT 6103 was measured at 400 GeV and found to be $(0.749 \pm 0.010)\ V/10^{12}$ protons.

On the 8th of August the same calibration factor BSPV 6103/BCT 6103 was measured at 350 GeV and found to be $(0.637 \pm 0.010)\ V/10^{12}$ protons.

Between May and August no mechanical change nor electrical modifications were made on BSPV 6103. BCT 6103 has been changed, but according to previous calibrations,a maximum variation of 1% could be due to the BCT calibration.

The good stability of the relative calibration SEM/BSPV 6103 and the 15% change in the BSPV 6103/BCT 6103 could be explained by a global ageing of the SEM's, the averaged secondary emission coefficient per foil passing from 4.68×10^{-2} on 15 April to 4.00×10^{-2} on 8 August.

Further measurements have to be pursued to follow this evolution, at least once in a period of 5 weeks. They can be done parasitically with physics runs for TT62 and the neutrino lines during fast extraction. For the T1, T3, T5 lines the same MD time has to be foreseen if the TBID calibration had to be made with targets off.

The steering of T1, T3, T5 lines when β= 50 m is not a trivial operation and N. Siegel and R. Lauckner have to be thanked for having performed the steering efficiently.

REFERENCES

1. F. Hornstra, FNAL TM 542.

2. V. Agoritsas, AGS Tech.Note/136, 28 June 1977.

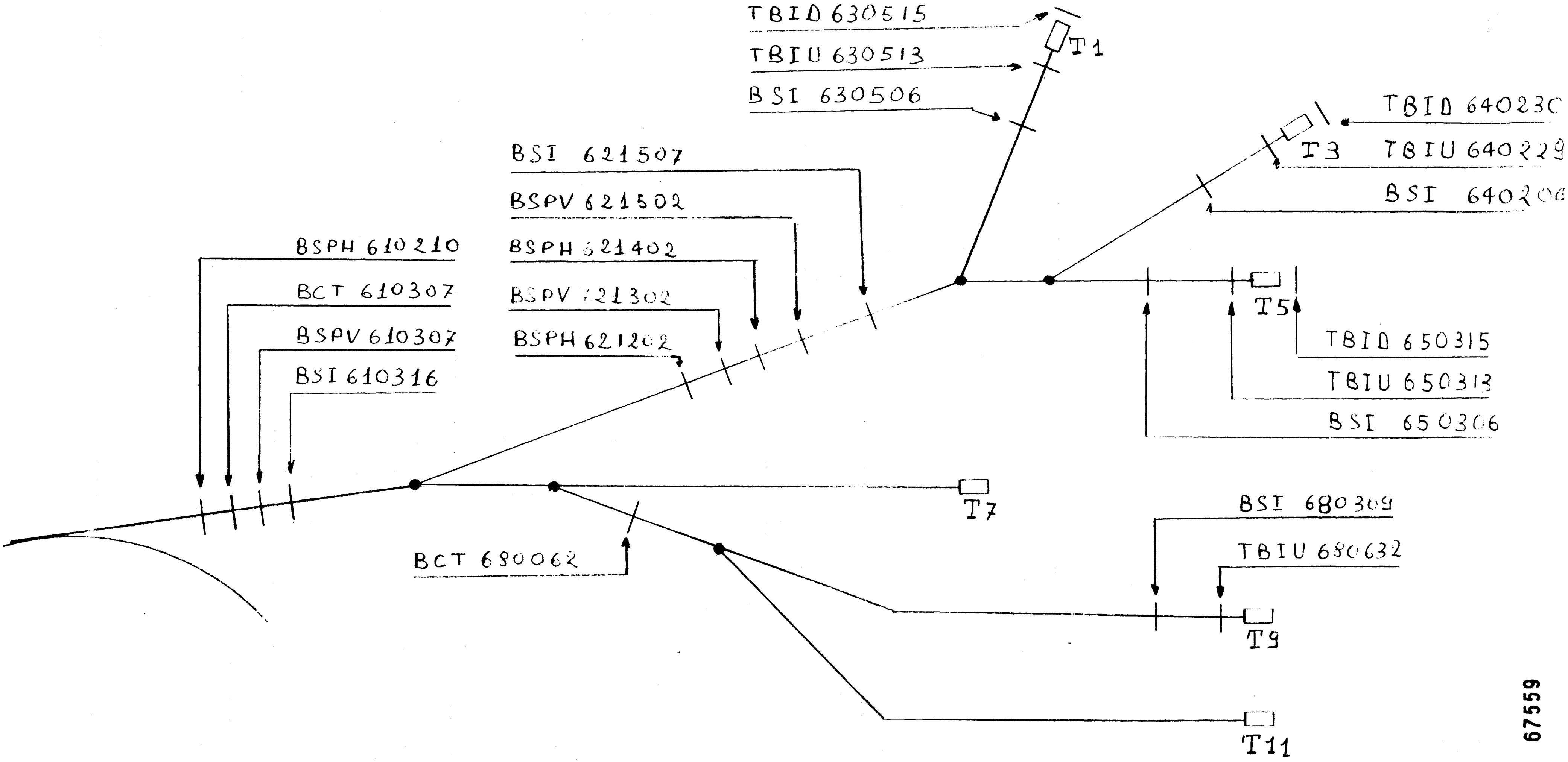

Figure 1 - Schematic layout of monitors

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Fig. 2

Typical SEM/BSPV 6103

CALIBRATION FACTOR IN %

(measured on 8.8.1977)

Type	Layout	Averaged over 10 cycles	Std deviation
TT60			
BSPH	610210	99	± .6
BSI	610306	100	± .7
TT62 BSPH	621204	115	± 1.5
V	1304	111	± .9
H	1402	105	± .5
V	1502	121	± 1
BSI	1507	118	± .9
TT68 BSI	680207	120	± 1.4
TBIU BSI	680632	105	± 1.3

Type	Layout	Averaged over 10 cycles	Std deviation
T1 BSI	630506	92	± .6
TBIU BSI	630513	88	± .7
TBID BSI1	630515	100	± .5
2	630515*	1010	± 33
3	630515*	1080	± 30
T3 BSI	640204	111	± .9
TBIU BSI	640229	99	± 1.4
TBID BSI1	640230	105	± 1
2	640230*	1110	± 30
3	640230*	1050	± 30
T5 BSI	650306	98	± 1
TBIU BSI	650313	94	± 1
TBID BSI1	650315	108	± 1
2	650315*	1070	± 35
3	650315*	1130	± 50

*) these monitors have an integrator capacitance of 10^5 pF instead of 10^4 pF for the others.

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Figure 3 - TT62 SEM/BSPV 6103 : Calibration factors for β= 50 m and β= 15 km (measured on 8.8.1977)

Type	Layout	Beta = 50 m H mm	Beta = 50 m V mm	Beta = 50 m SEM/BSPV	Beta = 15 km H mm	Beta = 15 km V mm	Beta = 15 km SEM/BSPV
BSPH	621204	7.4	1	107	2.2	2	115
V	1304	3.3	2.1	102	2.2	3.7	109
H	1402	4.6	3	94	5.8	1.3	13
V	1502	6.4	5.5	108	1.3	7.2	126
BST	1507	6.5	5.4	103	1.3	7.4	121

Figure 4 - Comparison of calibration factors (SEM/BSPV 6103) at 2 different dates

		15.4.1977		8.8.1977	
T1 BSI	630506	93	± 1.1	92	± .6
TBIU	13	87	± 0.8	88	± .7
TBID	15	90	± 1.1	100	± .5
T3 BSI	640204	110	± 2.5	111	± .9
TBIU	29	101	± 0.8	99	± 1.4
TBID	30	107	± 1.9	105	± 1
T5 BSI	650306	99	± 1.1	98	± 1
TBIU	13	95	± 0.8	94	± 1
TBID	15	103	± 1.5	108	± 1

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