PS/AA/ME/Note 15 March 29, 1982

EYPERIMENT : Reduction of the 1-2 GHz Phase Difference between the vertical Sidebands of the Stack Core System by Means of a Filter Line.

DATE : 9.3.1982 (Installation) to 16.3.1982

EXPERIMENTERS: C.S. Taylor, L. Thorndahl

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1. Description of the Experiment

In the original AA design the PU to K distance chosen for the betatron HF cooling was a compromise since the phase advances for the V + H system were different, resulting in 0.71 λ vertically and 0.79 λ horizontally, the aim being odd quarter wavelenths in both cases. This should have resulted in the sideband phases being ± 15^{0} from the revolution harmonic in both planes. The actual phase differences measured are greater, of the order of ± 45^{0} for the vertical, and ± 30^{0} for the horizontal, the upper sideband lagging in phase in the vertical case and leading for the horizontal. To compensate for their differences, Thorndahl proposed a filter line as used in the low frequency system, and it was decided to try this for the vertical system, the most seriously affected. Fig. 1 shows the phase and amplitude relations at a notch. Preliminary tests showed that the standard 40 mm, 50 Ω, copper co-axial line used in the ISR and AA had acceptable precision of notch frequency in the stack core frequency band 1-2 GHz.

2. Installation

For the nominal stack core centre frequency of 1.855 MHz, a half-wave line short circuiting the main signal path at this frequency and at its harmonics needs to be 80.86 m long, i.e. half the ring circumference. On Tuesday 9.3.1982, a large crew cleaned, straightened and assembled the 6 m lengths of copper tubes into 40 mm coaxial line, and a General Radio line lengthener was fitted at the end to fine-tune the length to 1.855 MHz.

With a simple T connection to the signal line (standard Type N tee-piece) the filter was seen to give about 10 db suppression of thermal noise at the notch frequency, and a phase correction of ± 23° at the sidebands, not enough to correct fully but adequate for the experiment. The layout of the V_{β} circuit is shown in Fig. 2. The measured notch caracteristics in amplitude and phase are shown in Fig. 3. M. Wright wrote a program for the HP 9845 B and confirmed that the measured r.m.s. deviations in notch frequency was around $5 \cdot 10^{-5}$, for samples of 10 notches at 100 MHz intervals over the 1-2 GHz band. Temperature sensitivity is 1.3 mm per $^{\circ}$C.

3. Beam Tests

During stacking the Δp distribution is weighted towards the low frequencies and the notch appears to be assymetric, (see Fig. 4, V_{β} Schottky with H_{β} as background) but when the core has been cooled at the end of stacking the notch becomes fairly symmetrical (Fig. 5).

Beam transfer functions indicated that the phase difference had decreased from 90° to 25° at 1.2 GHz and 45° at 1.5 GHz, with a suggestion, however, of less constant behaviour than before over the 1.2 GHz band, due presumably to notch errors (it was interesting to find in passing that beam transfer traces were observable with circulating beam as low as $8.5\ 10^{9}$). The open and closed loop signals showed that the vertical cooling was effective.

4. Conclusions

The use of a filter at the higher frequencies is feasible, and such a line can be installed and set-up with a days' work. Further work will include:

(i) the decoupling of the filter line from the signal line in order to get a higher loaded Q, and hence greater effect on the amplitude and phase, and better correction;

(ii) the refinement of the beam transfer phase measurement, possibly by further development of the computer controlled measurement used at the AA start-up but put aside because of doubts about the interaction of the measurement with the beam.

Reported by C.S. Taylor

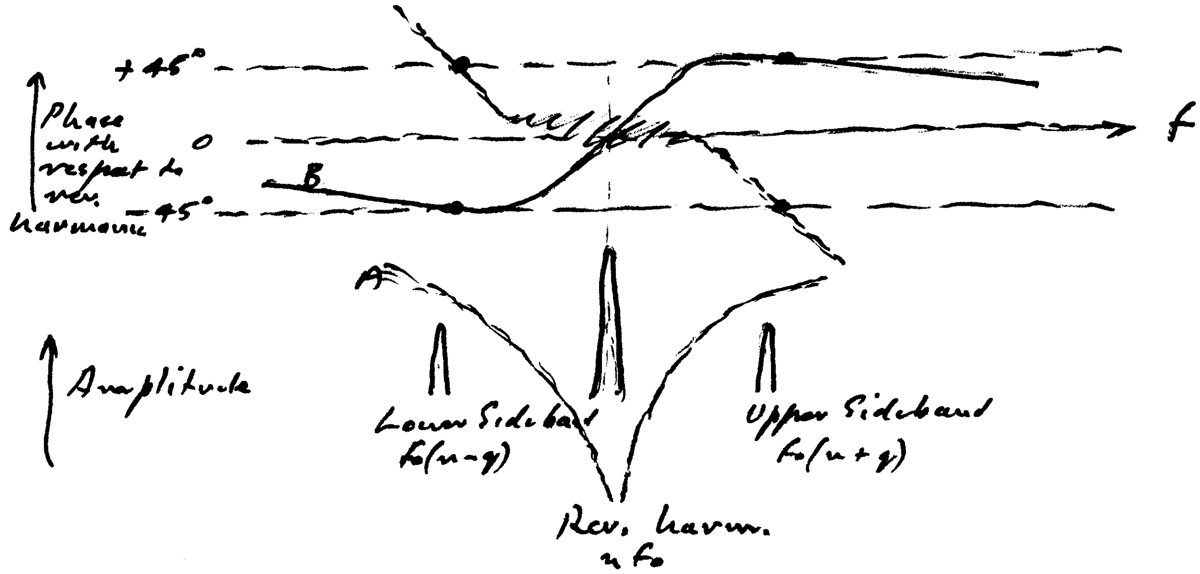

Fig 1 Amplitude A and Phase response B of a short-circuited line in the vicinity of a revolution harmonic, showing complete correction of sideband phases.

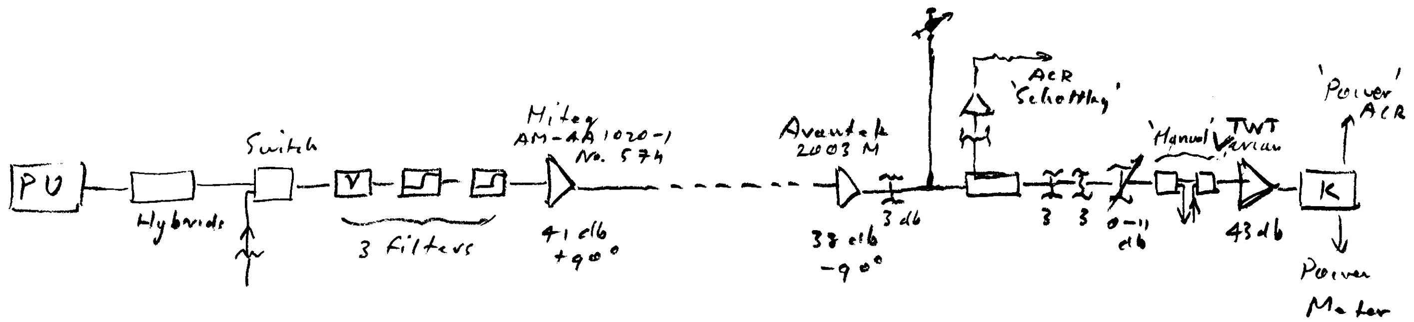

Fig 2 Vertical System layout

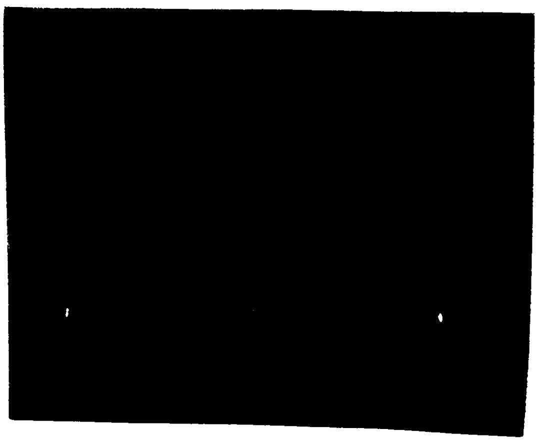

Fig 3 Phase & amplitude at a notch.

Phase

Amplitude

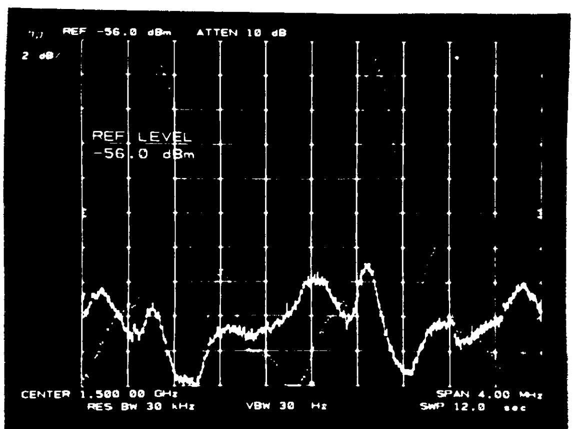

Fig 4 Assymetry during stacking (background H_β)

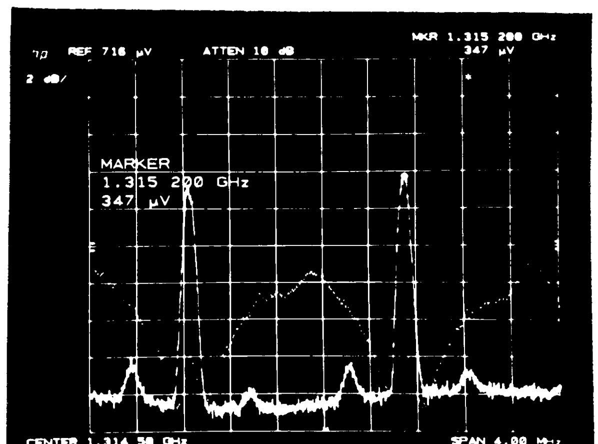

Fig 5 Cooled beam V_B background