Pulse Shape Correction for RF Pulse Compression System

S.Y.Kazakov
142284, Branch INP, Protvino, Russia

Abstract

The RF power pulse feeding accelerating structure of Multibunch Linear Collider must has a flat top and stable phase. Up date three type of RF pulse-compression system providing quite flat top pulse are known - BPC [1], SLED II [2], VPM [3,4]. The next scheme allowing to have a flat output pulse with stable phase is presented in this paper .

1 PULSE SHAPE CORRECTION

One of the method to provide a flat pulse is to use several coupled cavities for RF power storage. The coupled cavities operate like a delay line. VPM uses this method [3,4]. But one can look at the coupled cavities from another point of view: the difference between single cavity and a chain of coupled cavities is that the coupled cavities have a more dense spectrum of modes near operating frequency. These modes are coupled between each other by the hole (holes) of feeding waveguide (if cavities is not coupled with waveguide these modes are orthogonal). During RF energy storing (in pulse compression process) only one mode tuned at operating frequency works. Other modes practically do not contain RF energy up to phase reversion. They start to work only after 180 degree phase shifting. Because of coupling through waveguide holes they take part of RF energy and re-emit one making a pulse flat.

Main ideas of new approach:

1) To separate these modes in space using individual cavity for each mode.

2) Since all modes,except only one of them,work relatively short time only after phase shifting, their quality factor can be more less then quality factor of the energy storage mode. So the dimensions of cavities for these modes can be noticeably smaller.

The code for simulation several travelling-wave cavities coupled with common waveguide (Fig.1) was made. In this code the cavities are described with basic quality factor (Q_0), factor of coupling β ($\beta = Q_0/Q_l - 1.$, Q_l - loaded quality factor), frequency (F).

The parameters were chosen similar to the VPM's ones: duration of input pulse is 500 ns, reverse phase time is 400 ns, duration of phase switching is 20 ns, operating frequency is 14000 MHz. The quality factor of storage cavity (SC) was taken $2. \times 10^5$ - measured value for VPM open cavity. For all cases of simulation the basic Q-factors of "correction" cavities (CC) were 2.5×10^4. Q_l of SC was 9.4×10^3 Tuning of CC were as $F = F_0 + 10MHz \times i, i = 1, ..., N-1$ for symmetrical spectrum and $i = \pm 1, ..., \pm(N-1)/2$ for nonsymmetrical spectrum; N is number of cavities. Other parameters are gathered in Tab1. Results of simulation are shown at and Fig.2

Table 1

Picture	a	b	c	d	e	f	g	h
Numb.of cav.	1	9	2	3	3	5	7	9
Spectrum	-	S	N	S	N	S	S	S
$(Q_l$ of CC$)\times 10^{-3}$	-	5.0	3.6	6.2	3.6	7.2	7.2	7.2
Efficiency %	69	65	66	67	66	67	66	66

Where S - symmetrical spectrum and N - nonsymmetrical spectrum.

These results show that quality factor of CC can be nearly 2.5×10^4 without any noticeable reducing of efficiency of pulse-compression system (in our cases when all cavities have $Q_0 = 2. \times 10^5$ the efficiency is 69%). If the frequencies of CC are placed symmetrically around operating frequency there are no phase deviation (Fig. 2b,d,f,g,h). One can construct desired shape of pulse by choosing frequencies and coupling coefficients of cavities. For instance the pulse with increasing to end amplitude can by useful to compensate energy losses in multibunch regime (Fig. 2b). As one can see (Fig. 2g,h) that the output signal look lake a pulse of SLED II system. The reason is that spectrums in these cases are similar to spectrum of modes of long pipe.

2 SUMMARY

The described method permits to have a flat pulse or pulse with another desired shape and with stable phase after conventional SLED-type pulse compression system by adding several TW cavities with relatively low quality factor and small size. Each of TW cavities can be tuned regardless of others. In practice TW cavity can be fabricated like a VPM TW cavity or like a SLED [5] cavity by using two cavities or by another way. One can try to re-collect all low quality factor modes into one structure.

3 ACKNOWLEDGEMENTS

The author thanks Dr. I.V.Syrachev for useful discussions.

4 REFERENCES

[1] Z.D.Farcas,"Binary Peak Power Multiplier and Its Application to Linear Accelerator Design", IEEE, Trans. MTT-34(1986), p. 1036-1043.

[2] P.B. Wilson, Z.D. Farkas, R.D. Ruth, "SLED II: A New Method of RF Pulse Compression", SLAC-PUB-5330, Sept. 1990.

[3] V.E.Balakin "VLEPP Status", in Proc. of 2nd Int. Workshop on Next-Generation Linear Collider, March 1990, Tsukuba, Japan, KEK, 90-22.

[4] V.E.Balakin, I.V. Syrachev, "Status of VLEPP Power Multiplier", in Proc. of 3rd Int. Workshop on Next-Generation Linear Collider, Sept. 1991, Protvino, Russia, to be published.

[5] Z.D.Farkas et al., "SLED: A Method of Doubling SLAC's Energy" ,in Proc. of 9th Int. Conf. on High Energy Accelerators , 1976.

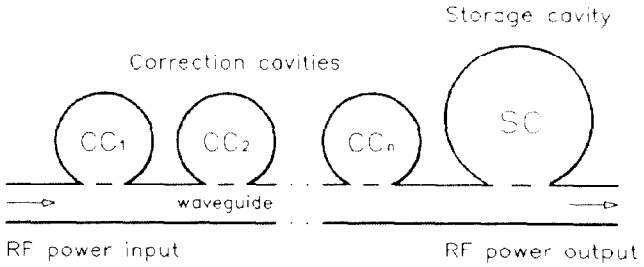

Figure 1. Scheme of pulse compression sistem with correction cavities.

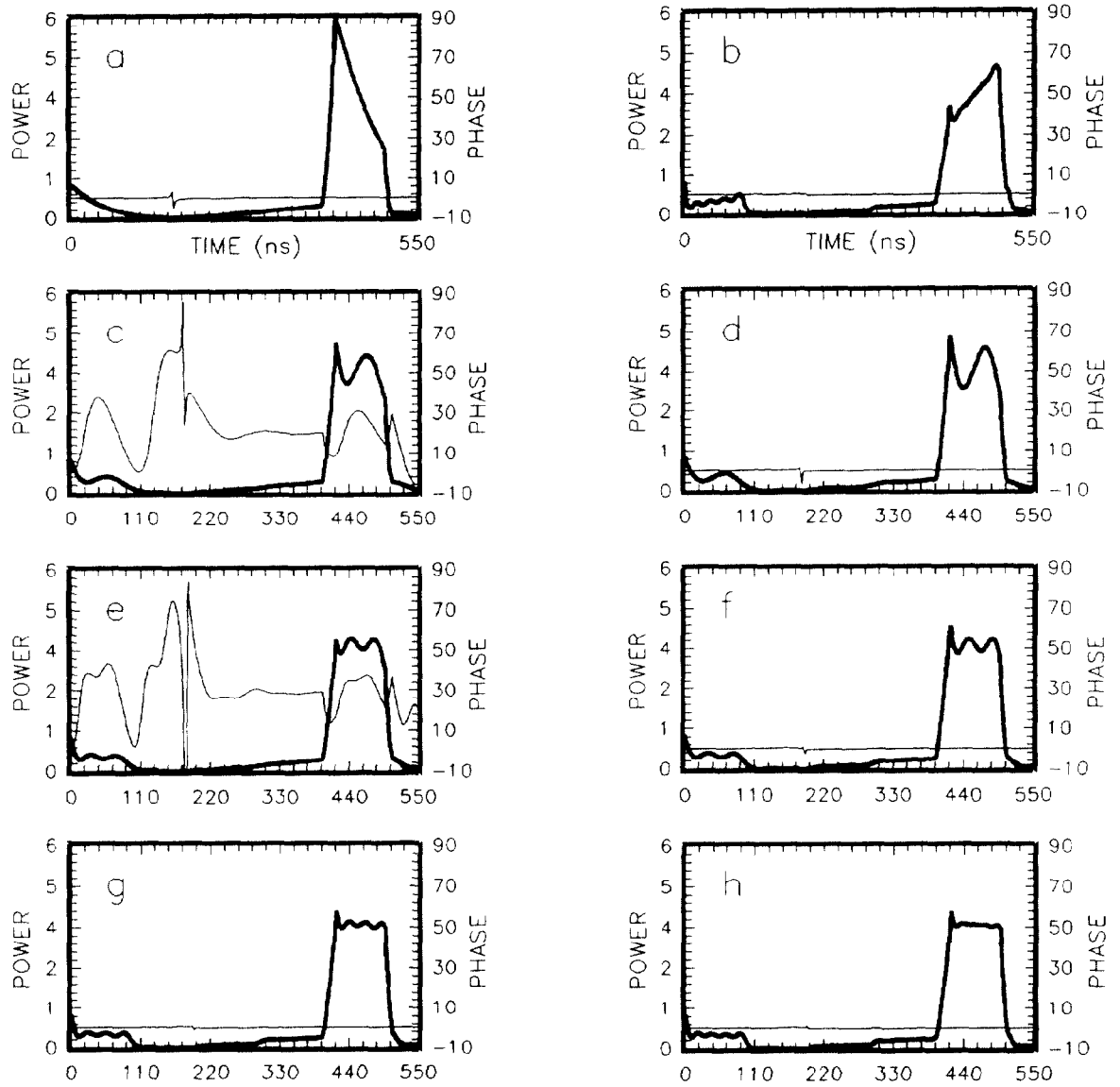

Figure 2. Shapes of output pulses for different parameters of correction cavities.