THE COMPUTER DIAGNOSTICS OF LINAC UNIT FAILURES

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1 CONTROL SYSTEM

Computers is electron linac Control Systems, aside from performing the operation control and linac parametr adjustment, allow to cope with problems of automated diagnostics of systems malfunctions.

KIPT has developed and commissiored over the resent years a member of electron linacs: LUE-60, KUT, LIK,EPOS. To exercise control over operation of these accelerators a system [1] was made which monitors election beam entrant and energy, controls beam parameters and protections of the acceleratind structure from its effects, locks up the modulator and klystron amplifier during inadmissible operation modes, adjusts currents in magnetic system power supplies, tunes rf-signals phase and power in the injection system. The program-technical complex comprises a PC/AT, fitted out with a CAMAC crate or measurement channels in the PC standard, a synchronization unit, microprocessor arrays for klystron amplifirr operation control, heat exchangers and target operation-support devices. The measurement devices provide for signal reception from analog pulse detectors with discretion 50 or 100 ns simultaneously over two or four acceleration structure and the electron beam scanning diagnostics from beam effects. The program package CSL (Control System Linac) provides for accelerator control, written in C langvage. The system accumulates digital symbols in the computer memory, unit that characterize the signal amplitnde and shape in the linac pulse-forming systems.

2 MALFUNCTION SEARCH ALGORITM

The linac functional structure can be represented as a tree-like chart the apex of which is node determining the charged particle beam output parameters. The presence of check points (detectors) and criteria for detection of malfunctions allows to perform a “dissecting” diagnostics, i.e. check-up on system parameters in a certain refuence “dissecting away” the operating brancher of the tree. It is clear that the control system capable to maintain such an algorithm must have no less than two channels. For a single - section linac that has a functional chart with a small number of apex it is evident that the simplest algorithm of systems sampling should be taken. For a multi-sectional linac selection of the sampling method is not so explicit already. By may of illustration , done by computer simulations, comparison of the efficiency of employing the half - integer and dynamic programming iteration methods for a 50-sector LU-2000 showed that the iteration method is more efficient by factor of 1.2. However, this method is more difficult to work, since it pre-supposes the knowledge of a priori probabilities for acceleration system malfunctions.

3 CRITERIA FOR MALFUNCTION SEARCH

A great number of malfunctions in linac systems is characterized. by amplitude instabilities of pulse signals in these systems which, in the outcome, leads to .unstable beam parameters at the accelerator exit. Making use of signal frequency spectra in accelerator systems as the criteria for malfunction search will give information useful for recognizing the malfunction type and allow to locate the propagation path and the source of perturbing action. The perturbing action of j-th system on i-th system in a linac can be represented by the signal spectral density relationship:

$$G_i(\omega) = G_{oi}(\omega) + \sum_j g_{ij}(\omega) \cdot G_j(\omega),$$

where $g_{ij}(\omega)$ – is the linear responce function ;

G_{oi} – are the spectral density components, not associeted with the perturbing action of other systems.

If $G_i(\omega_k) >> \sum_j g_{ij}(\omega_k) \cdot G_j(\omega_k)$,

then, the malfunction causing perturbation at the frequency is inside the very i-th system.

4 RESULTS AND PROSPECTS FOR FUTURE WORK

Studies made on the base of above methods have come out with locations of perturbing action in the systems of a multi-sectional electron linac with frequencies 0.5Hz , 2.7Hz and 25 Hz. At present, research is under way to create the data base on images of electron linac malfunction for the CSL program package.

Data analysis concerning operation of the control system indicates that automated methods employed for malfunction diagnostics on charged particle linear accelerators allow to locate malfunctions at early stages of their development.

5 REFERENCES

1. V.N.Boriskin et al. Control system for a linear resonance accelerator of intense electron beams. Nucl. Instr. and Meth. in Phys. Res A 352 (1994) 61-62.