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SECONDARY ELECTRONS MONITOR FOR CONTINOUS ELECTRON ENERGY MEASUREMENTS IN UHF LINAC

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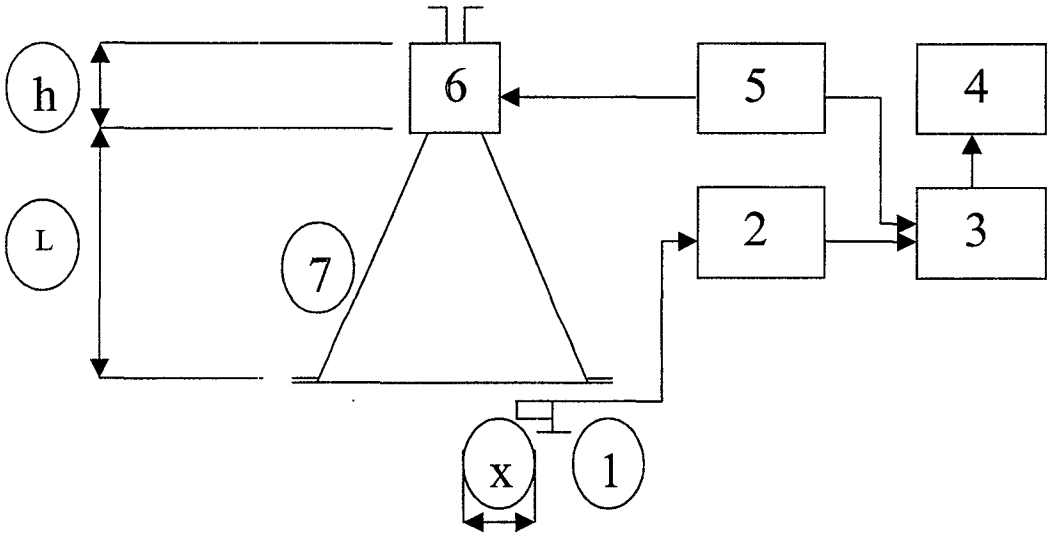
A continuos energy measurements became now an obligatory in accelerator facility devoted to radiation sterilization process. This is one of several accelerator parameters like dose rate, beam current, beam scan parameters, conveyor speed which must be recorded as it is required condition of accelerator validation procedure. Electron energy measurements are rather simple in direct DC accelerator, where the applied DC voltage is directly related to electron energy. High frequency linacs are not offering such opportunity in electron energy measurements. The analyzing electromagnet is applied in some accelerators but that method can be used only in off line mode before or after irradiation process. The typical solution is to apply the non direct method related to control and measurements certain accelerator parameters like beam current and microwave energy pulse power. The continuous evaluation of electron energy can be performed on the base of calculation and result comparison with calibration curve.



A secondary electrons monitor for continuous electron energy measurements described in this paper is based on application of scanned electron beam which is typically used in industrial facilities devoted to radiation sterilization process. The principal idea of the measurements is

presented on included figure which shows schematic block diagram. The measuring circuit consists of following components:
1 – secondary electrons monitor,
2 – analog digital interface,
3 – computer control system,
4 – display,
5 – sweeping current generator,
6 – scanning electromagnet,
7 – scanning horn.

The secondary electrons monitor is made of thin strip of foil shielded by two additional foils to reduce distortions level. The monitor is located under accelerator window on certain distance from the center of the scanner. The pick up signal on central electrode is related to the electrical charge of secondary electrons, which escaped from strip of foil. The secondary electrons are initiated by electron beam passing through the foil and its amplitude is proportional to the beam current level.

The electron beam is sweeped along the distance x according to current change in the scanning magnet coil. If some distortions of magnetic field on pole edges will be omit the distance x can be calculated for low deflection angles according to following equation:

$$x \approx \frac{E_o e \mu_o}{m_o c} \frac{h(L+h)\,In}{d\sqrt{E_k(E_k+2E_o)}}$$

where:
I - current in magnet winding,
n - number of turns,
μ_o - permeability,
d - distance between scanning magnet poles,
h - hight of scanning magnet poles,
L - distance between scanning magnet and surface of scanning,
E_o - electron energy in state of rest,
E_k - electron kinetic energy,
m_o - electron rest mass,
c - speed of light.

When the monitor position is fixed the measured signal is related to the electron energy for certain scanning coil current level. Due to current level is function of time there is possibility to found the energy distribution of the electron beam at the output of the UHF linac.

The computer control system was applied to process the data coming from the monitor and sweeping current generator. Averaging procedure was used to improve the signal to noise relation and sensitivity of detection system. Interlock system was incorporated to interrupt irradiation process when electron energy is above acceptable range. The detail parameters of the secondary electrons monitor was described in the paper. The accuracy of the measurement has been evaluated as well.