# Technical REVIEW on using UELR-10-10S E-beAM accelerator for industrial application

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In 2014 Ural Federal University created the R&D Center of radiation sterilization with UELR-10-10S linear electron accelerator. This is Russian e-beam accelerator produced by CORAD Ltd, St.-Petersburg, Russia. This accelerator is based on Thales klystron and typically has following parameters: 1mA beam current, 10 MeV electron energy, 10 kW output power.

In everyday work it is quite stable accelerator, but in everyday work with 2 or 3 shifts per day there are as usual some components which need to be paid more attention to prevent long-term repairing and to provide more reliable, more stable working parameters. In UELR-10-10S a few systems can be highlighted, for example cooling system, power modulator unit and waveguide.

In Ekaterinburg, Russia, we have the outside temperature range from -35°C to +35°C. Typically for cooling in industrial application two or three circuits with heat exchangers are used. To keep the klystron and the accelerator temperature stable at 33-35°C we use chiller with dry cooling (or chiller with condenser and winter kit can be used not to freeze it in winter). One of modification we implemented for our accelerator is the possibility to reconfigure external cooling circuits not to use the chiller in winter and to keep it working resource, this modification can be considered as safe and effective only if you control heat carrier temperature in all circuit. We added blocking system to stop circulation in external circuit with propylene glycol solution when we reach too low temperature in inner circuit with distilled water.

Another modification of cooling system was developed to prevent klystron from destruction when water circulation stops and the small water volume boils inside the klystron. If you have quite stable electrical power supply it can happen 1-2 times per year, or 1-2 per month with heavy loaded electrical network. We added unit for backup power to keep water circulation in klystron and pulse transformer for some time in power failures.

Power modulator unit was modified to achieve more stable degaussing current in pulse transformer, which allowed to prevent periodical faults in charging circuits leaded to electrical damage of capacitors and pulse form deviations. This modification allowed us to save a few weeks per year needed for repair after power modulator failures.

All work done with waveguide allowed to obtain more stability and to exclude the effect of broken ceramic window separating vacuum tube and waveguide with filling of SF6 under the pressure inside.

In 2021 we started modification of our accelerator to install another klystron (not compatible with Thales). This modification will allow to use Toriy (Moscow, Russia) klystron on UELR-10-10 accelerators worldwide. The main component to change is the pulse transformer, but also some changes in power modulator like pulse form, pulse width are needed.

All these modifications were performed in consultations with CORAD Ltd and can be realized in new accelerators of this company.