

100 kW MODULAR LINEAR ACCELERATOR FOR INDUSTRIAL APPLICATIONS WITH ELECTRON ENERGY OF 7.5–10 MeV

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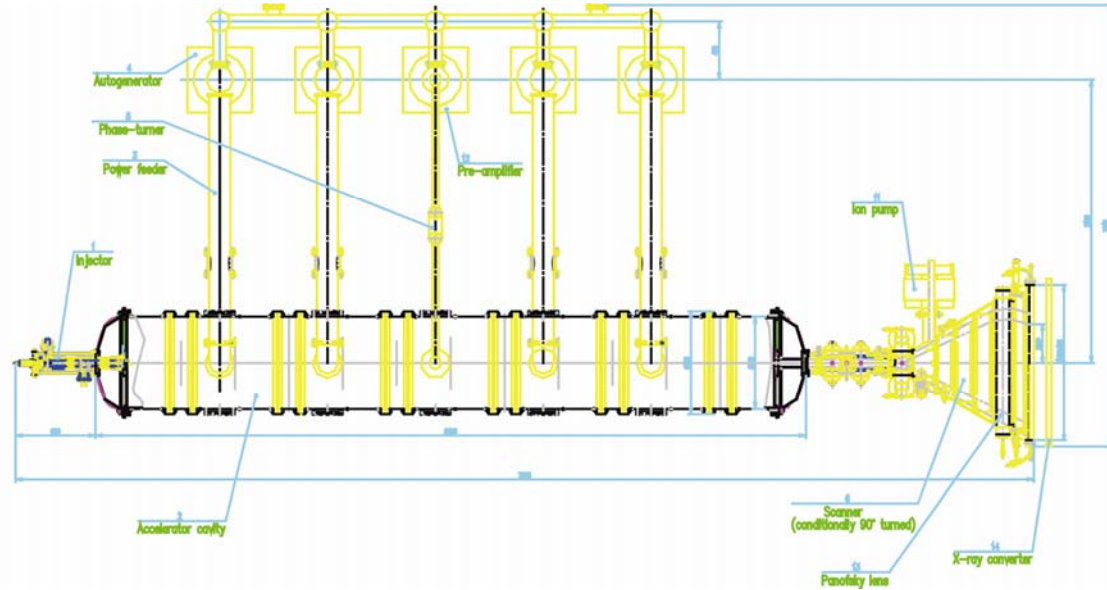
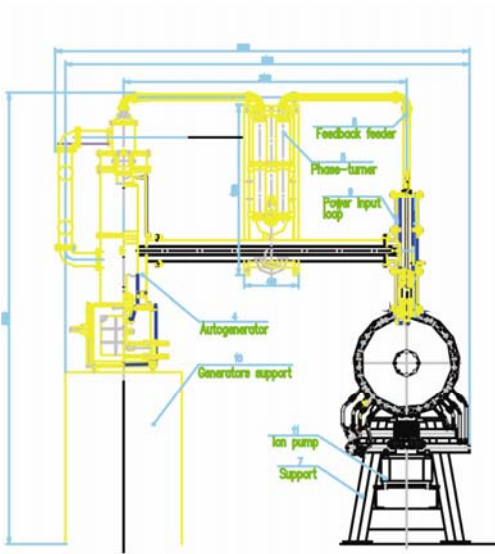
Abstract

- At Budker INP SB RAS, a single module for a new 100 kW industrial accelerator with electron energy of 7.5–10 MeV has been successfully tested in pulsed operating regime. The accelerator operates at 176 MHz, expected wall plug to electron energy efficiency is 32%.
- The obtained structure electron efficiency of 67% and average electron beam current are close to the expected values. Improvements of beam transportation and energy spectrum due to the injection regime optimization were experimentally proven.

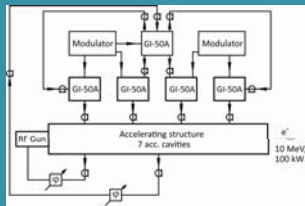
Introduction

A new modular high-energy (up to 10 MeV) and high-power (up to 100 kW) multi-gap accelerator has been developed by BINP to widen the range of irradiated products by the use of both e-beam and X-ray irradiation modes. The accelerator keeps all basic features of ILU type accelerators, such as internal beam injection and self-excited RF power source. This work will allow us to create a new family of reliable simple RF accelerators, destined mainly for sterilization and pasteurization markets. Also they may make good replacement for ^{60}Co sources.

ILU-14 accelerator, 7.5-10 MeV, 100 kW



Block diagram



Key features

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Parameters

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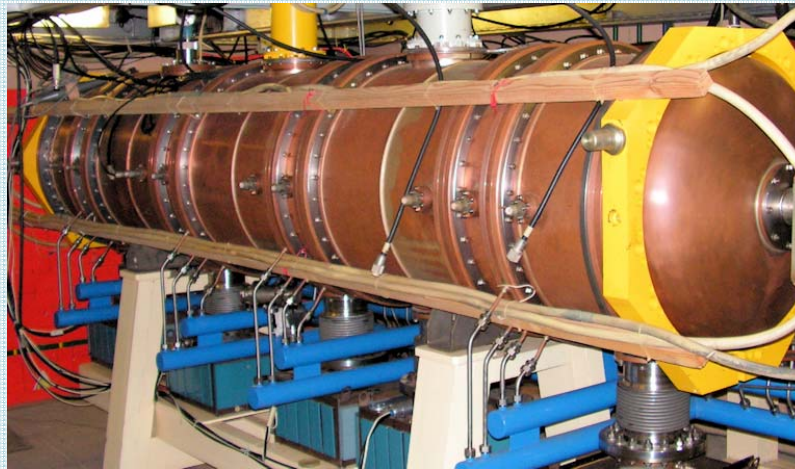
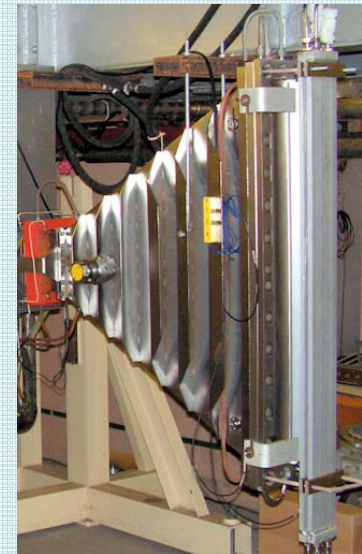
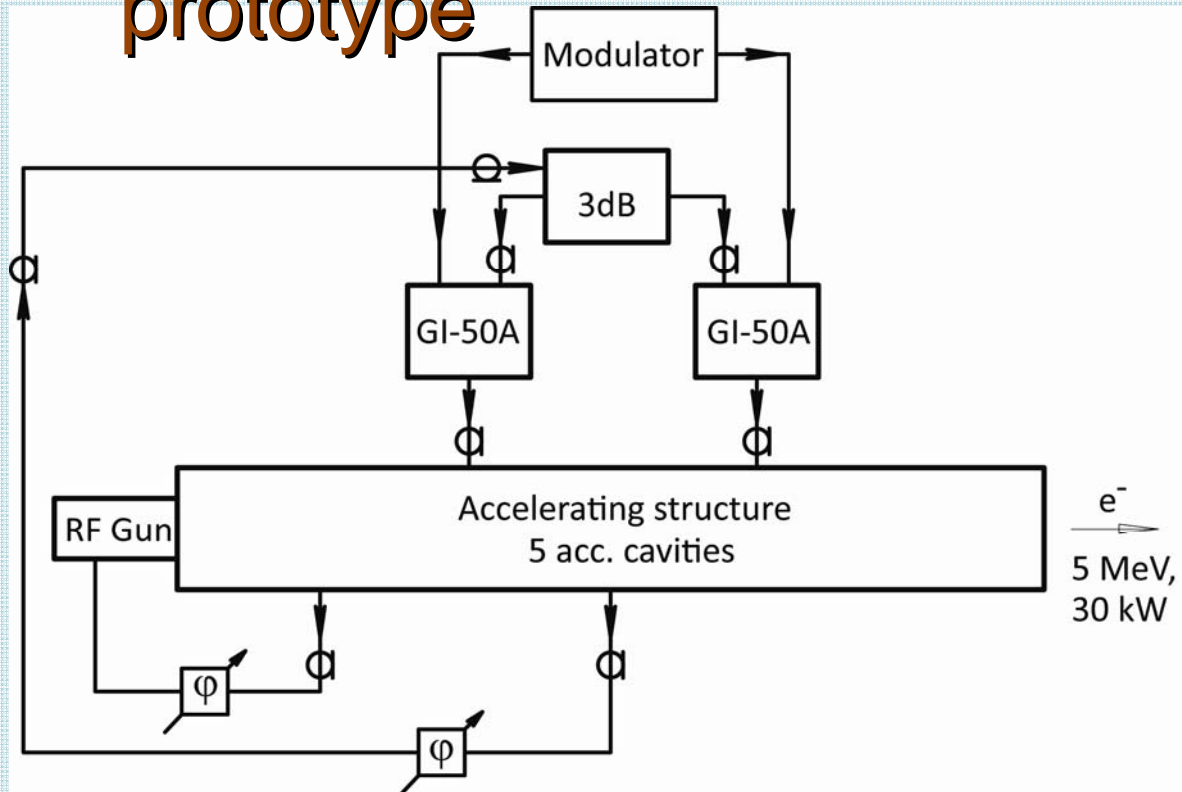
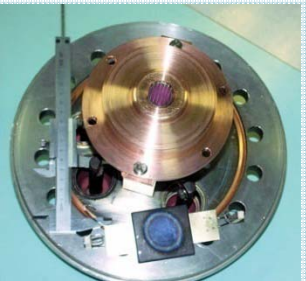
5 MeV accelerator prototype

- ILU 14 has specially designed modular structure of the RF system and accelerating structure that allowed us to carry out the tests of all the main accelerator units at 5 MeV accelerator prototype.

The prototype was manufactured at BINP workshop and tested in pulsed mode in 2008. The test results allowed us to prove and measure the following:

- a) accelerating structure electric strength by modeling the accelerating rate that corresponded to ILU-14 operation conditions (7.5 MeV and 10 MeV);
- b) accelerating structure cooling system efficiency;
- c) obtaining the required pulsed beam current from the RF gun;
- d) beam transmission coefficient and energy spectrum;
- e) serviceability of RF system elements (power inputs, feeders etc.).

5 MeV accelerator prototype

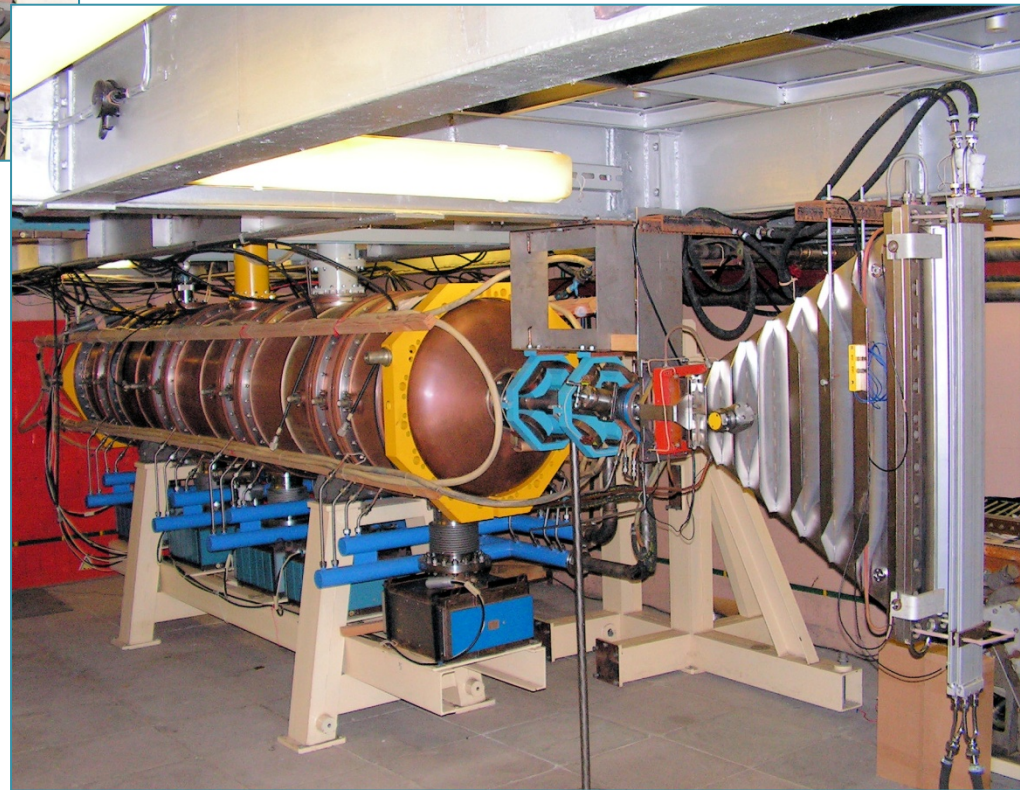


Accelerator prototype in radiation bunker

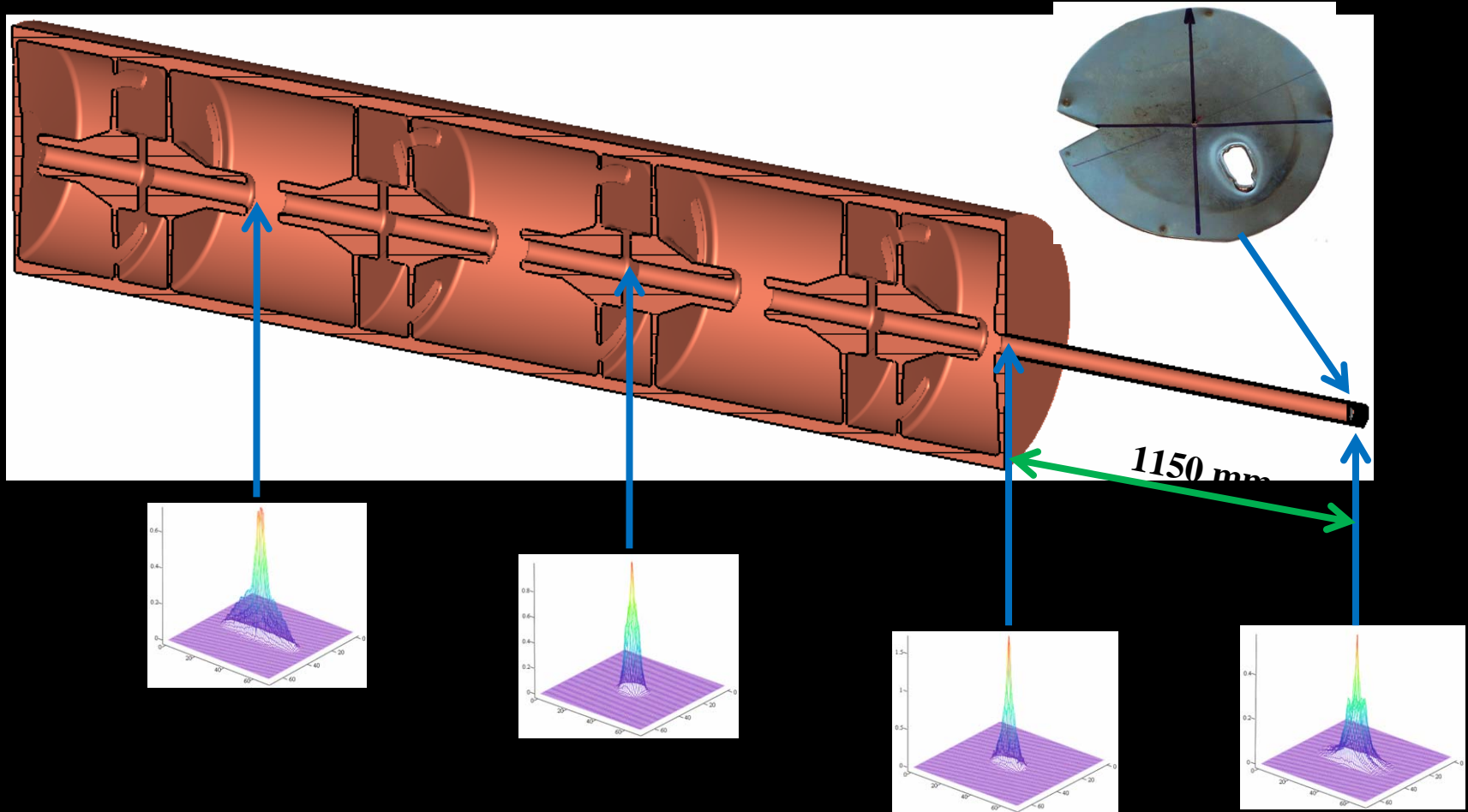


Two generators with feeders

Accelerating structure with beam scanning system



Beam cross-size measurements at accelerator prototype



Pulsed parameters obtained at the accelerator prototype

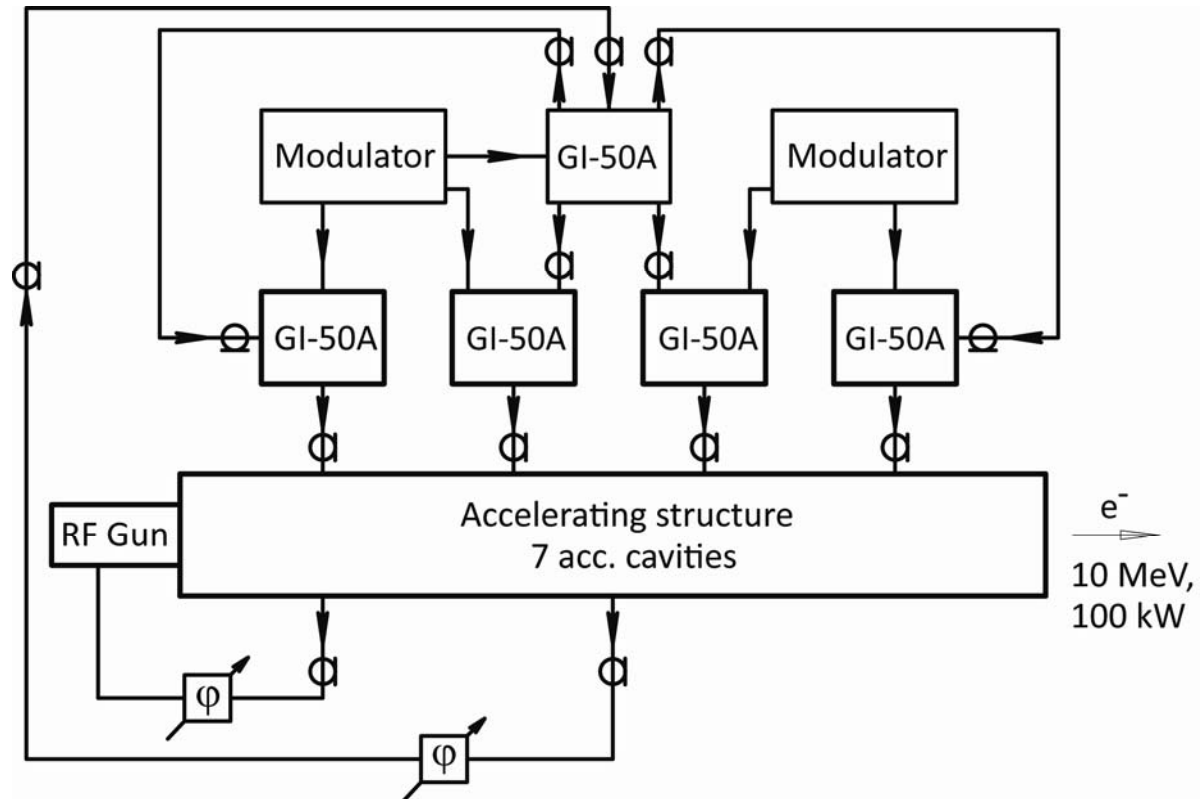
- Maximal accelerating voltage **7.5 MV**
- Maximum beam pulsed current **600 mA** at electron energy of **5 MeV**
- **96%** beam passing through the structure
- Structure electron efficiency of **73%** at electron energy of **5 MeV**
- Beam average power **37.5 kW** at pulse repetition rate **35 Hz**.

Conclusion

The prototype of high-power industrial electron accelerator ILU-14 has been successfully tested in pulsed mode at BINP SB RAS. The results obtained proved the possibility to create the series of linear accelerators with electron energy up to 10 MeV and beam power up to 100 kW on the base of RF modules designed by BINP. Rather narrow accelerated electron beam energy spectrum makes it possible to use the accelerators in both e-beam and X-ray modes that widen their field of application. Also, accelerators of that type may be a good replacement for ^{60}Co sources.

Thank you for your
attention

100 kW ILU-14 accelerator



Key Features

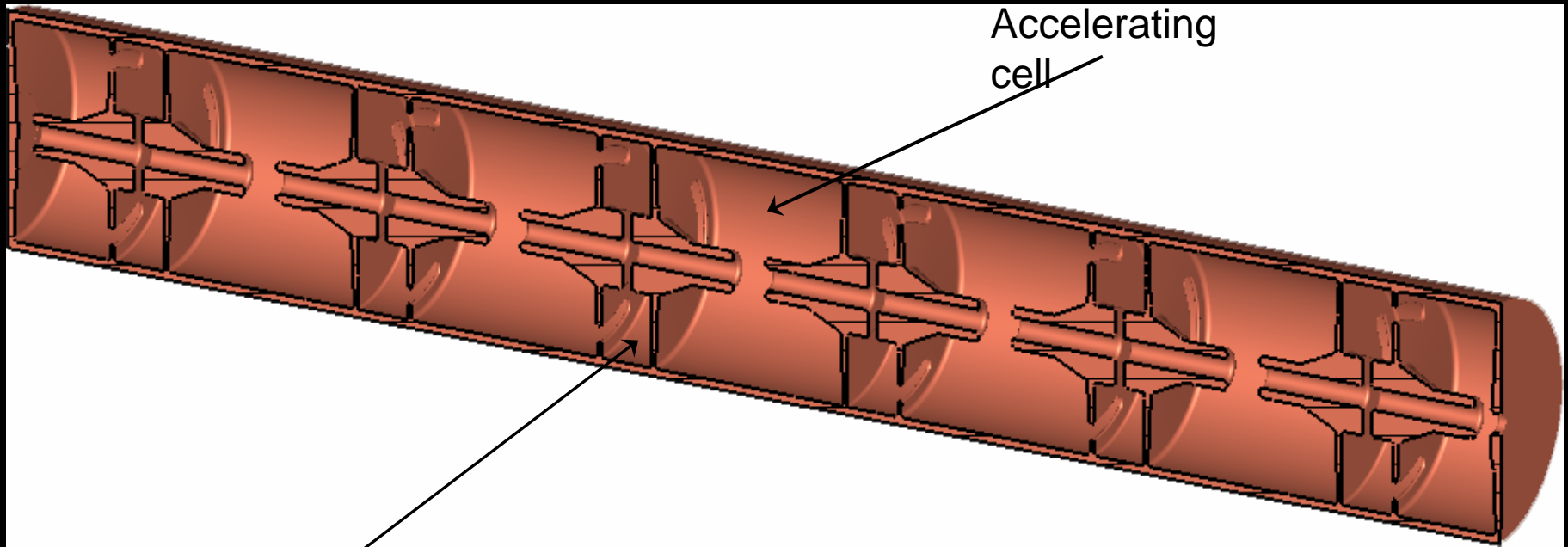
- Multi-cell low-frequency accelerating structure with on-axis coupling cavities, which operates in standing wave mode. The structure is driven by active oscillator based on five triodes GI-50A, that provides the high plug-to-electron beam power efficiency.
- Triode RF gun, placed directly into the first accelerating gap, serves as the electron source. Additional RF voltage applied to the cathode-grid gap provides the narrow energy spectrum of the high-power electron beam (required for efficient electron beam power transformation into X-rays)
- Two-stage generator with feedback loop closed via the accelerating structure. There is no need in frequency (thermo) stabilization of the structure or generator that simplifies the generator and accelerator control system.

ILU-14 parameters

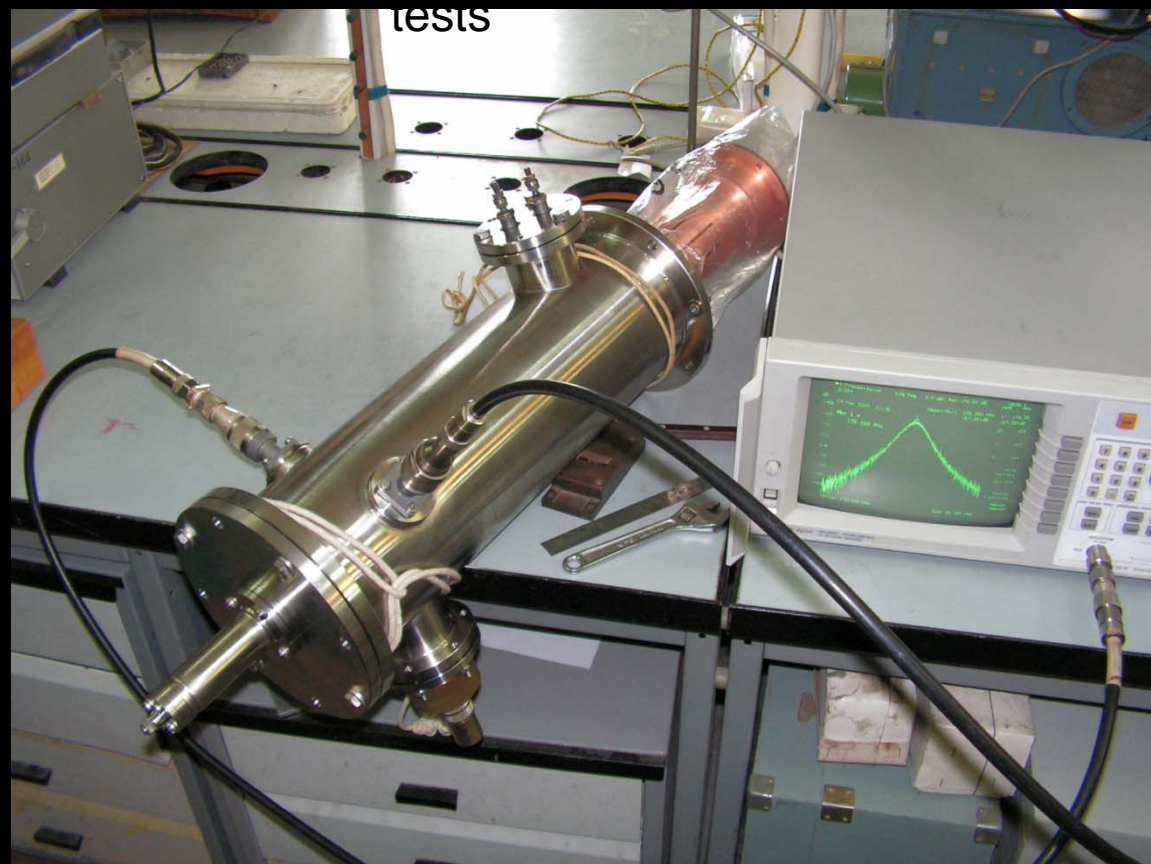
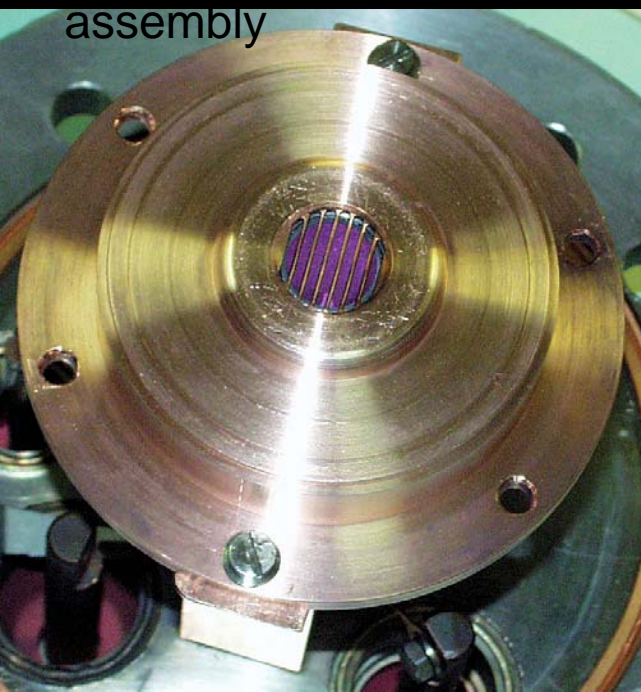
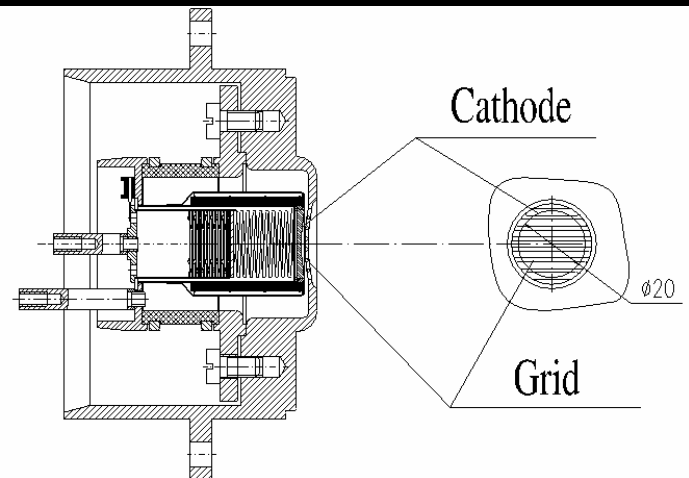
Variant	1	2
Generator tube	5xGI-50A	5xGI-50A
Energy, MeV	10	7.5
Beam power, kW	100	100
Accelerating structure efficiency, %	61	77
Total efficiency, %	26	32



Accelerating structure with 7 accelerating cells



Triode RF gun



Single generator module with feedback

