# Status of ILU-14 electron accelerator

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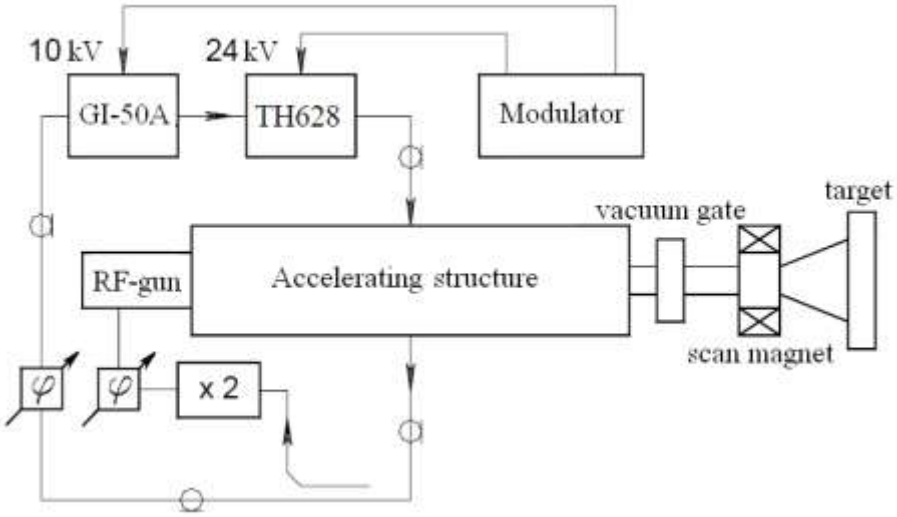
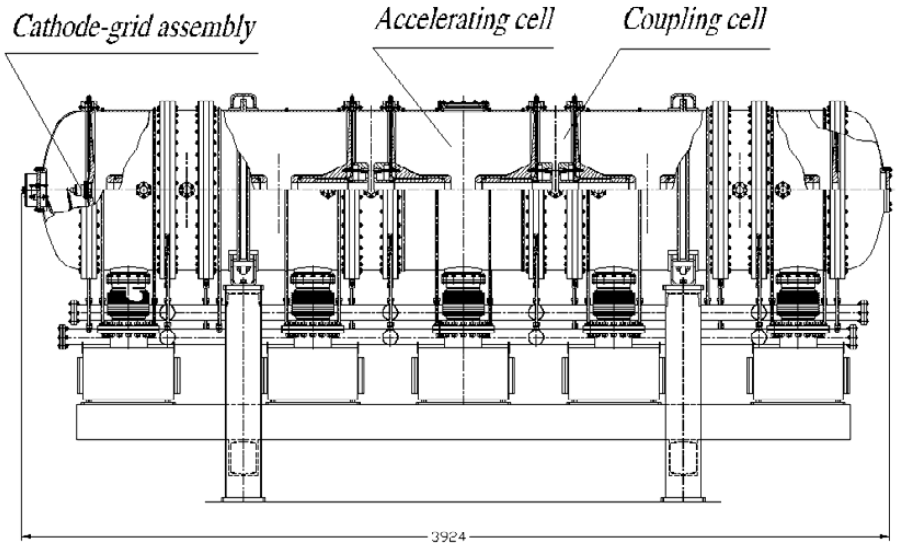
# Abstract


- A new high power (up to 100 kW) industrial linear electron accelerator ILU-14 for energy of 7.5–10 MeV is under construction at Budker INP.
- The accelerator operates at 176 MHz with total efficiency of 26 %, its modular structure allows the electron energy and beam current to be varied within certain limits by changing the modular arrangement.
- The 5 MeV prototype of the accelerator was created and successfully tested in 2009. The designed average beam current of 600 mA with pulsed power of 2.5 MW and accelerating structure electron efficiency of 68 % were obtained during experiments.
- Applying an additional RF voltage to the electron gun cathode-grid gap allowed a beam current passing of 96 % with minor beam energy spread.
- The paper presents results of the numerical and experimental study of the accelerator systems together with the latest tests on the accelerator prototype.


# ILU-12 (ISTC grant 2550) (since 2003)




Pulse cathode current 350 mA

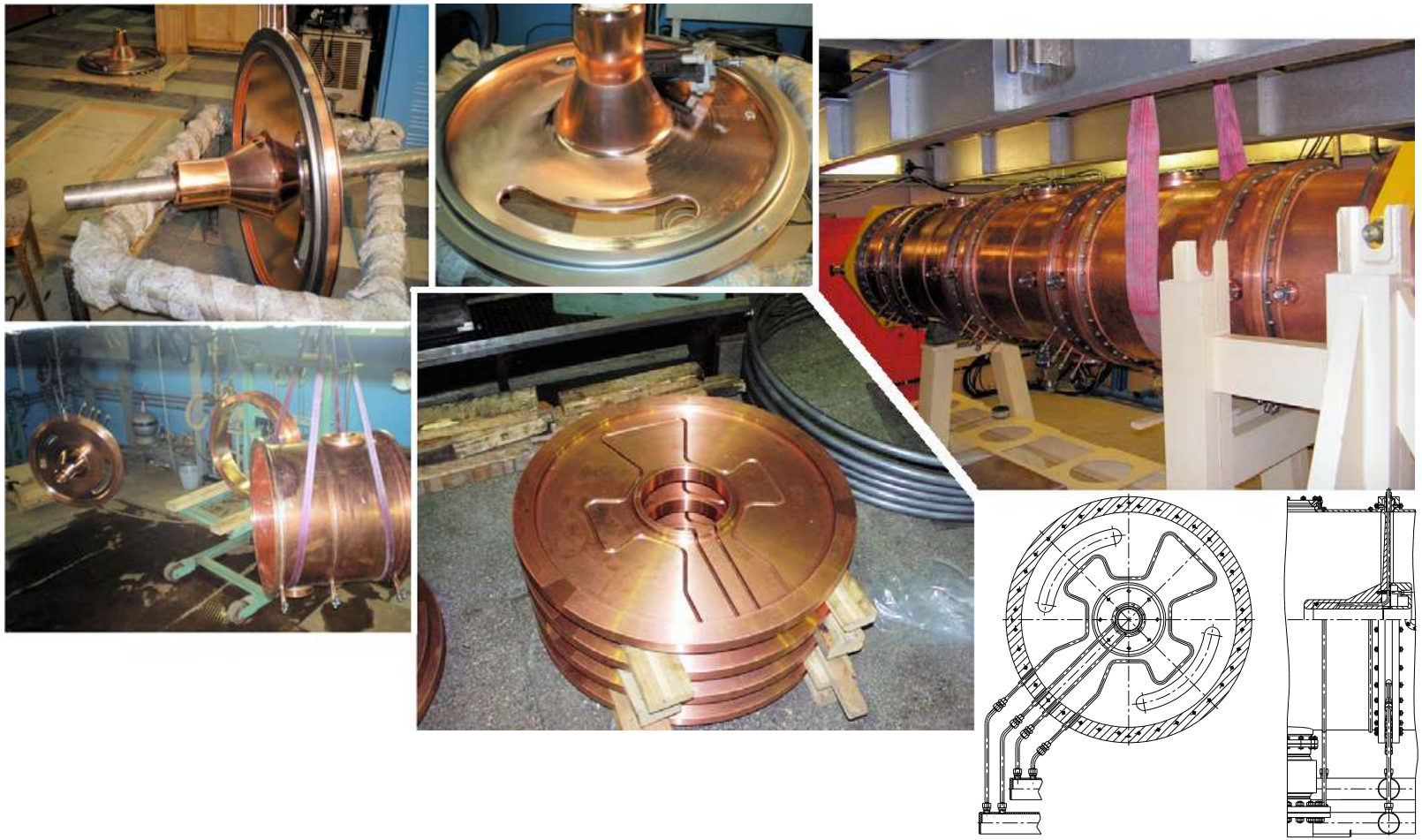
Beam current transmission through accelerating structure 95%

Maximum electron energy on the accelerator output 5 MeV

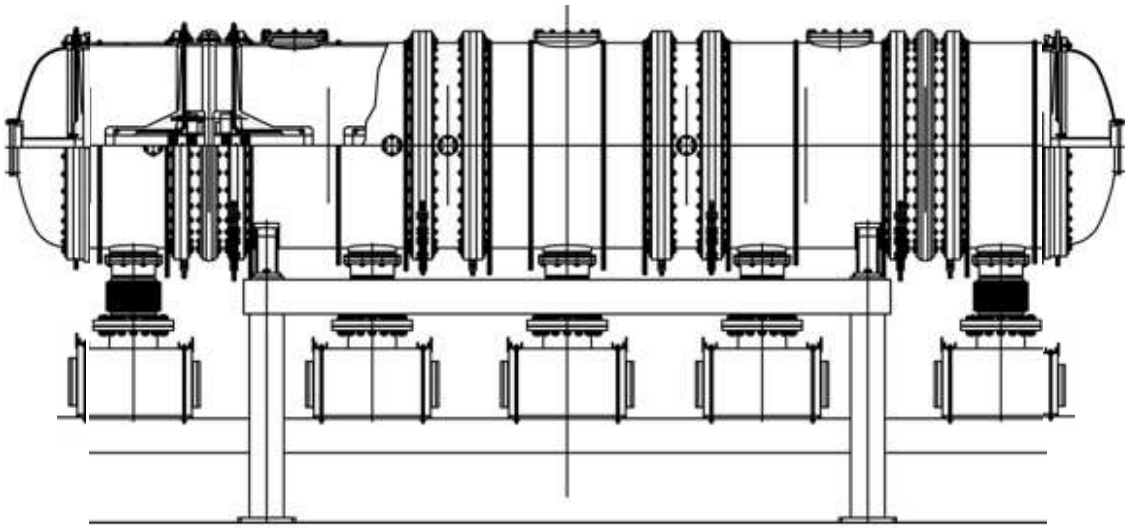
# Key Features

- 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.

# Accelerating structure assembling

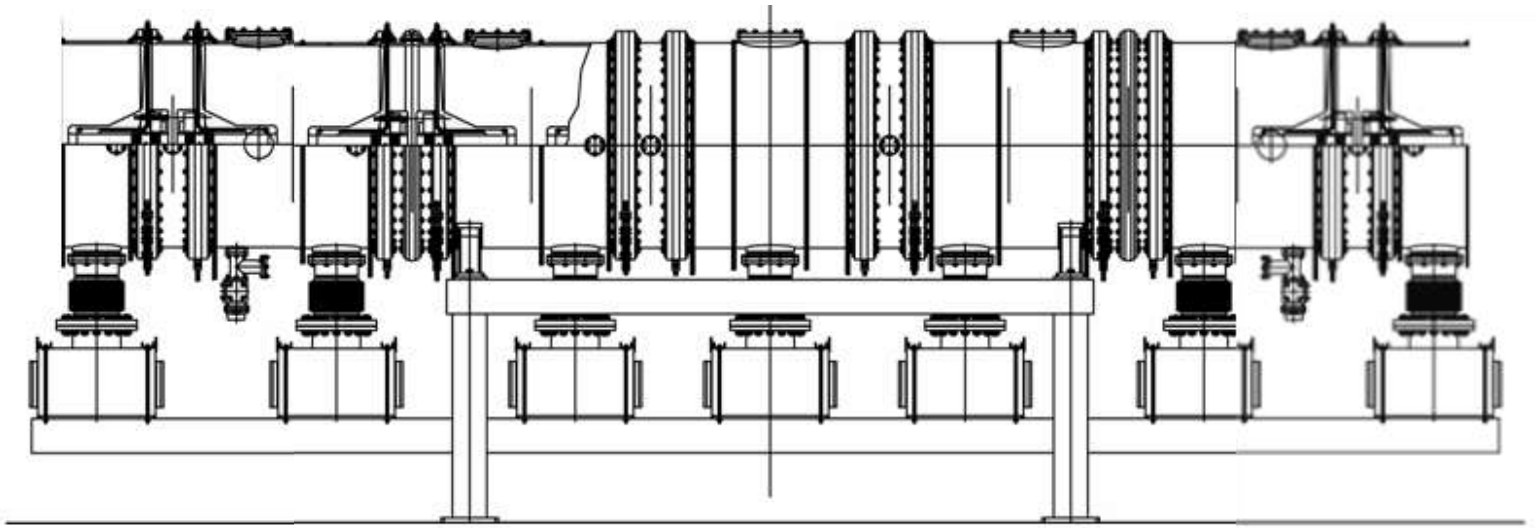


# ILU-12 ➡ ILU-14 changing



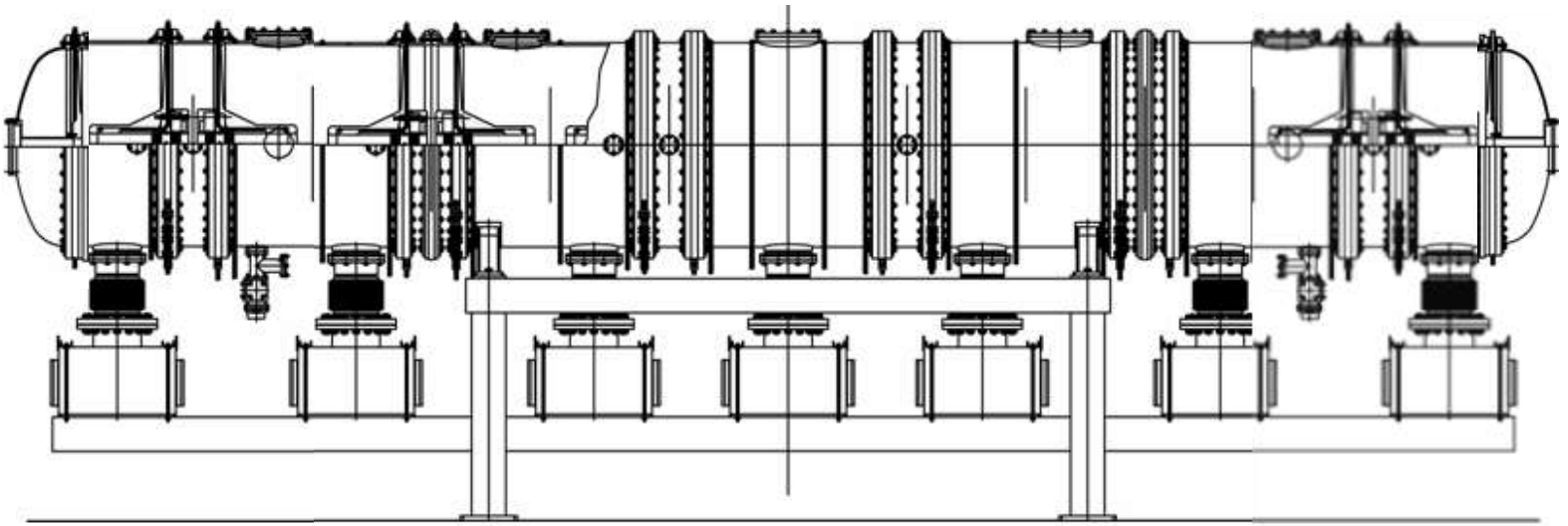
***Covers removal***

# ILU-12 ➡ ILU-14 changing



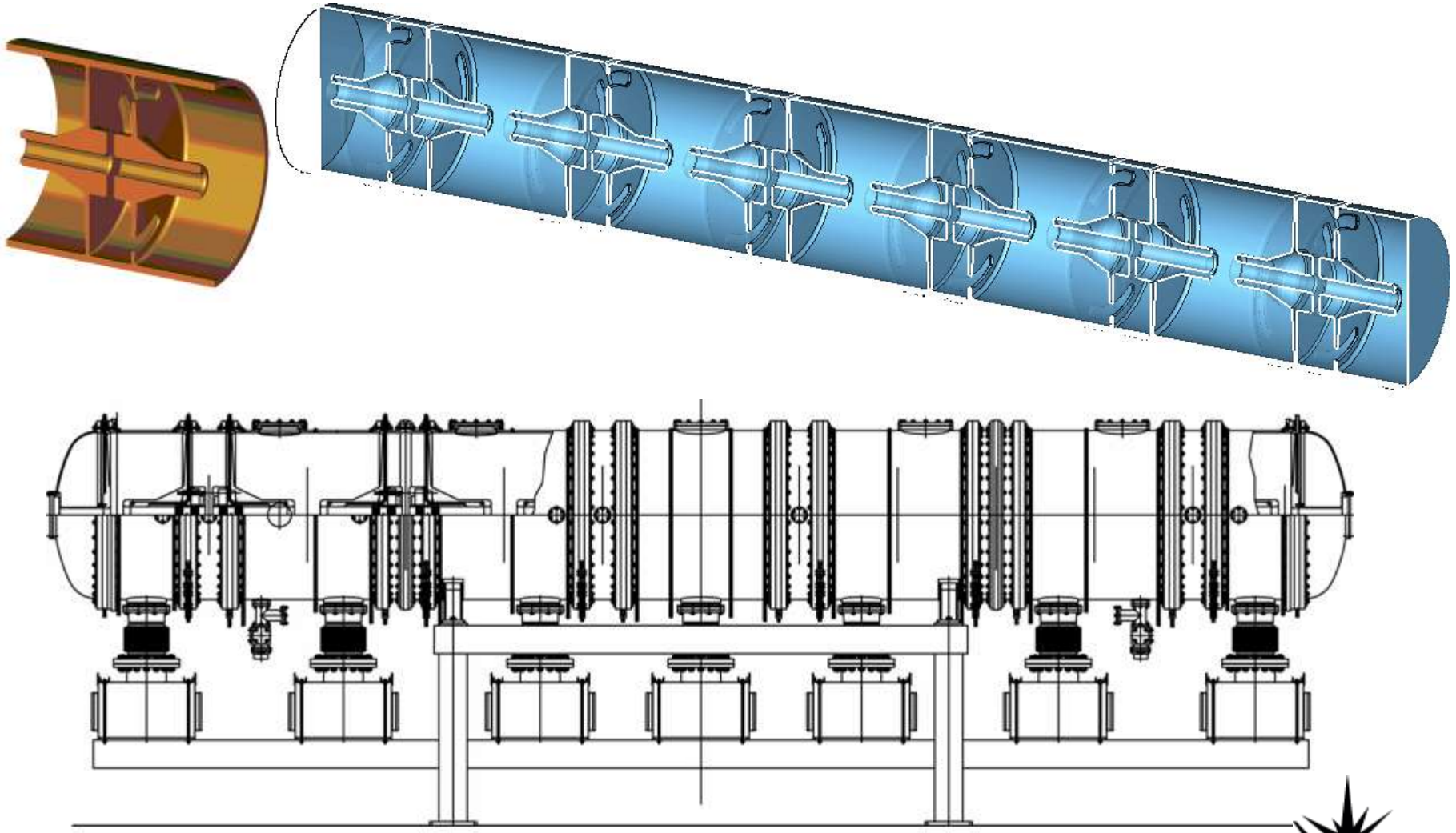
***Two modules addition***

# ILU-12 ➡ ILU-14 changing

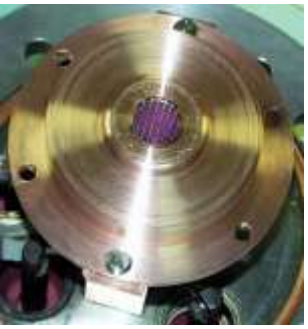


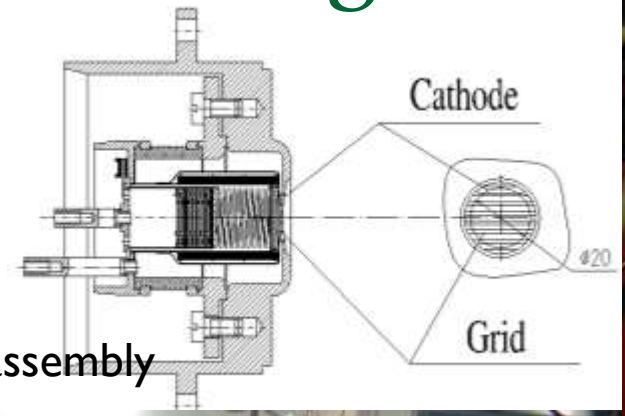
***Two modules addition***

# Accelerating structure



# Triode RF-gun



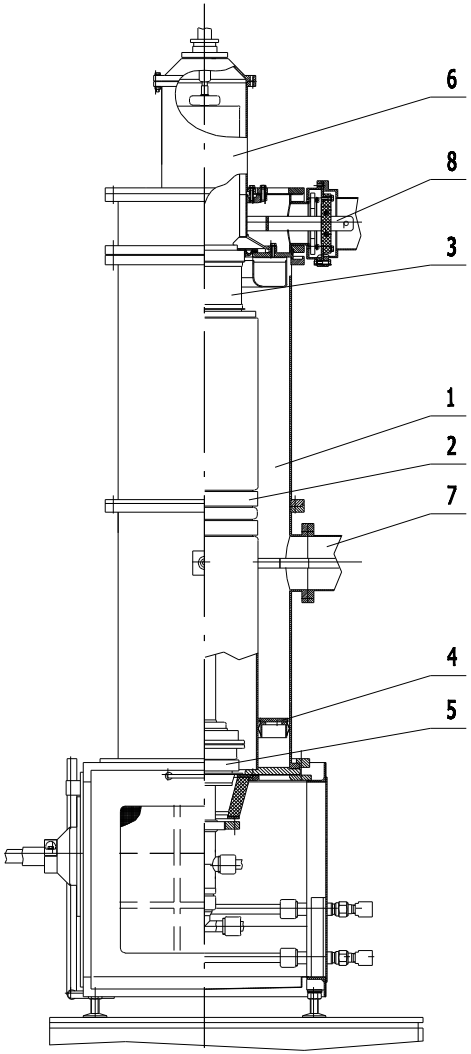



Cathode-grid assembly

***Accelerator triode RF-gun assembled***

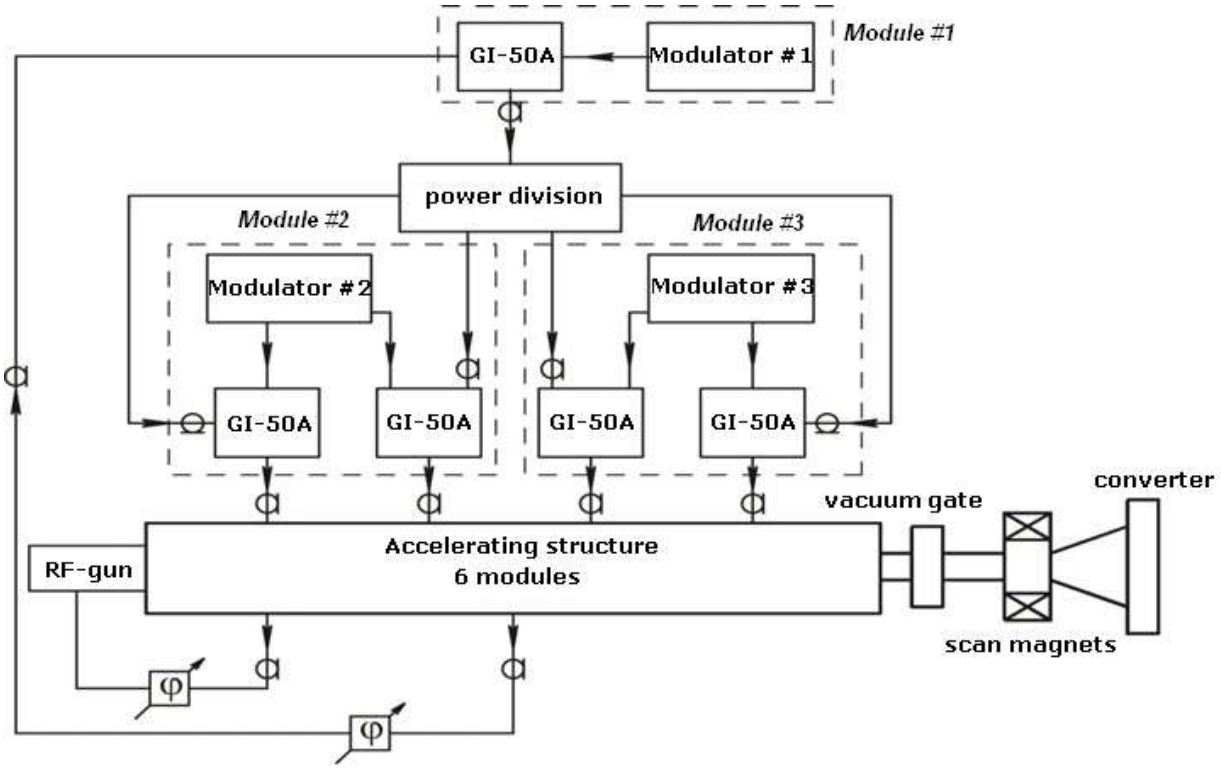
Electron gun cold tests

# Generator cascade



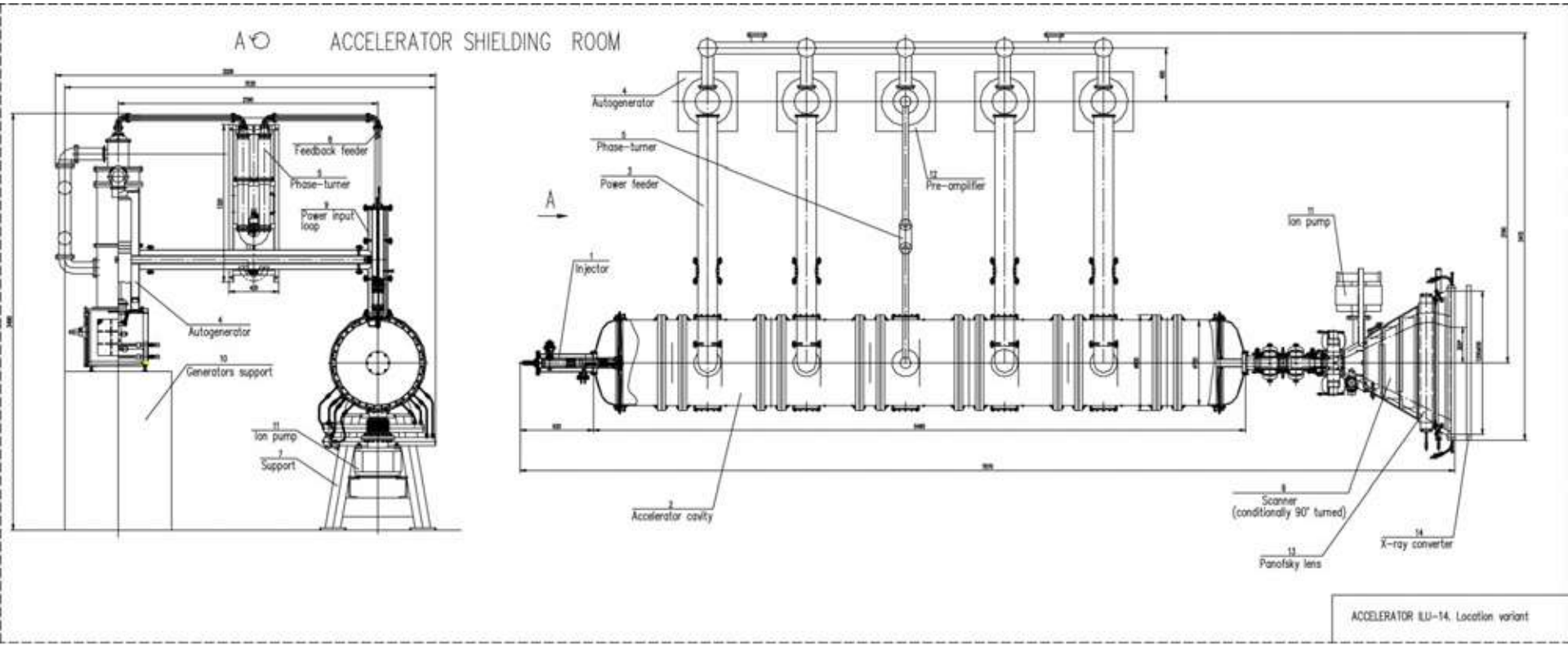

***1**- anode-grid contour, **2**- anode separating capacitor, **3**-generator GI-50A triode tube, **4–** shorting plunger, **5**- anode LC filter, **6**- cathode contour, **7–** output device connection, **8**- input of generator tube heat*

# ILU-14 accelerator block diagram

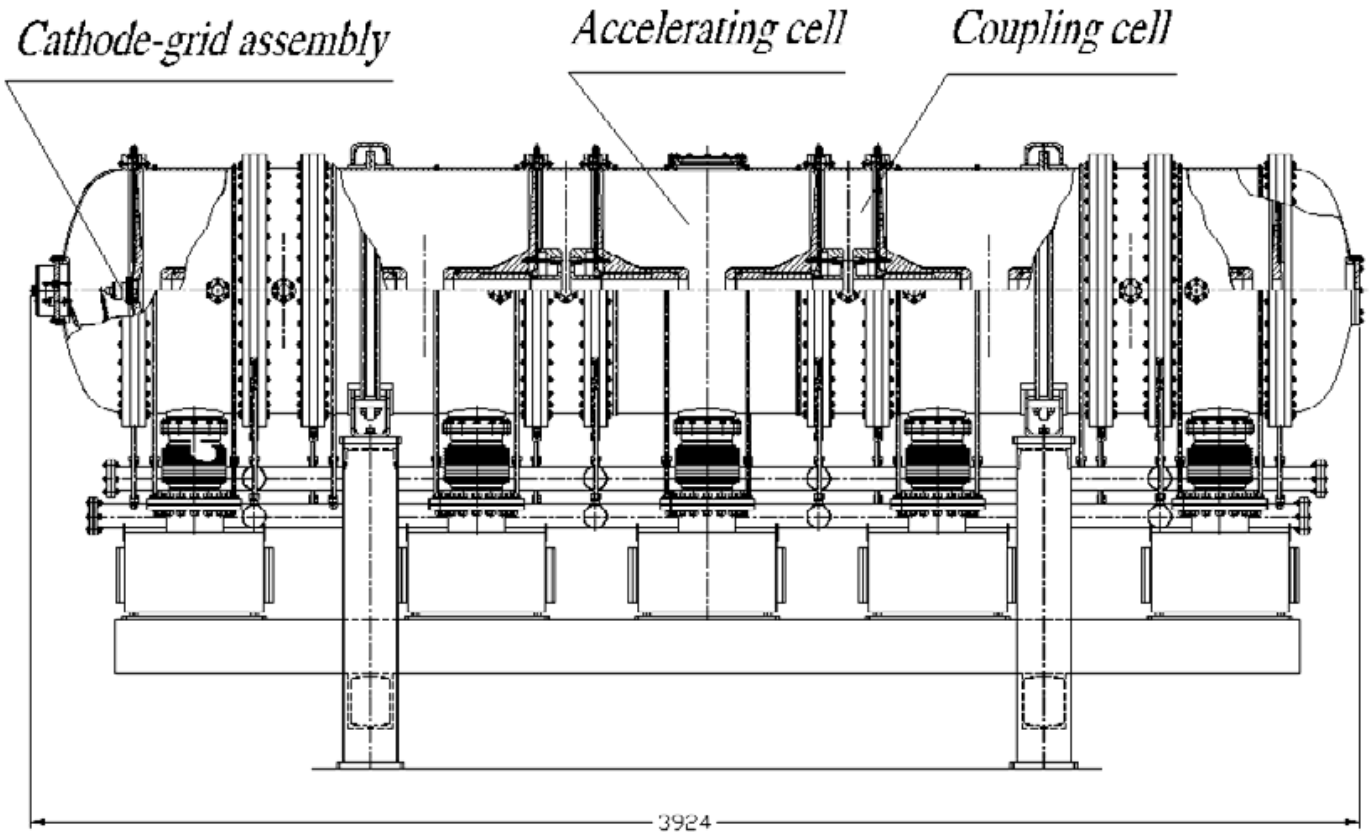



| | | | |
|---|---|---|---|
| ***Operating frequency, MHz*** | ***176*** | ***Full efficiency, %*** | ***26*** |
| ***Electron energy, MeV*** | ***7,5-10*** | ***Modulator pulse duration, μs*** | ***500*** |
| ***Average beam power, kW*** | ***100*** | ***Repetition rate, Hz*** | ***Up to 50*** |

# Layout of the accelerator structure with RF-generator

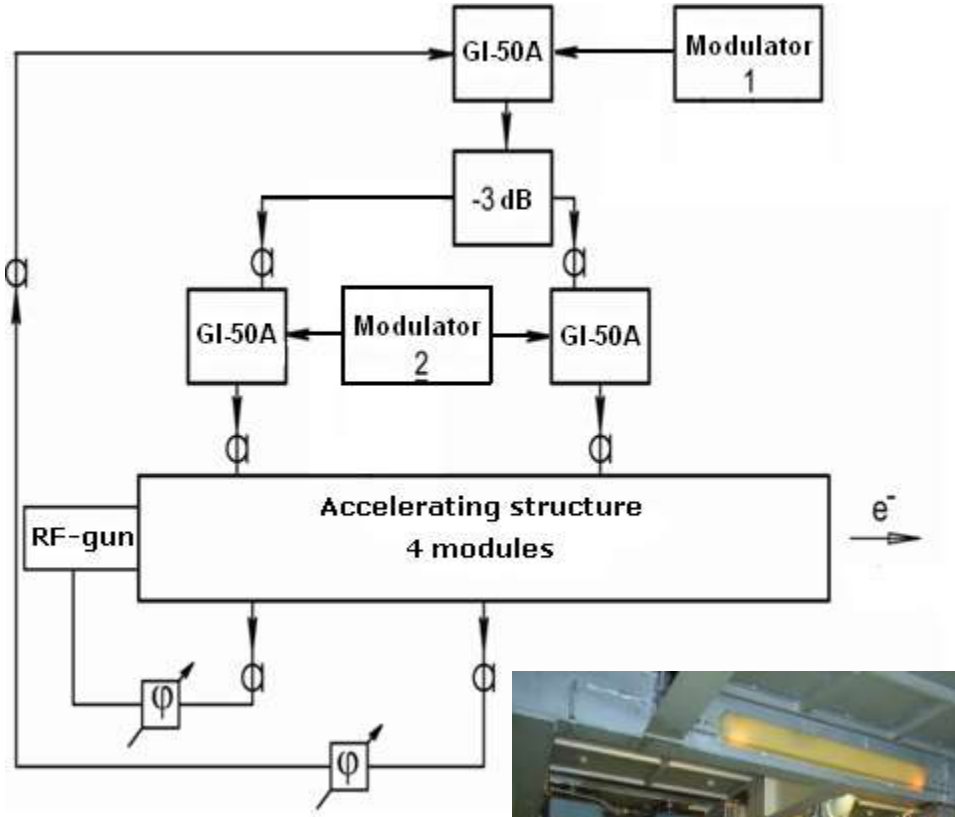


# ILU-14 accelerator prototype

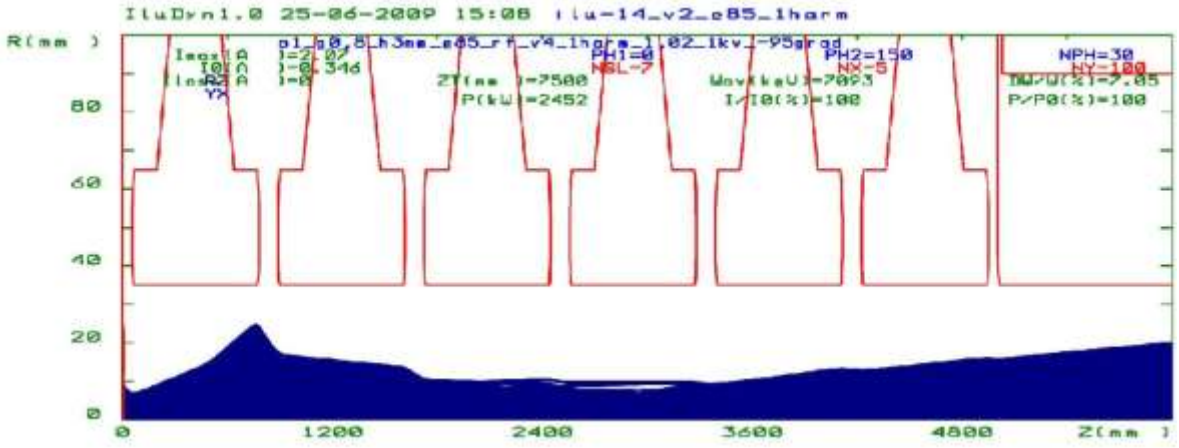


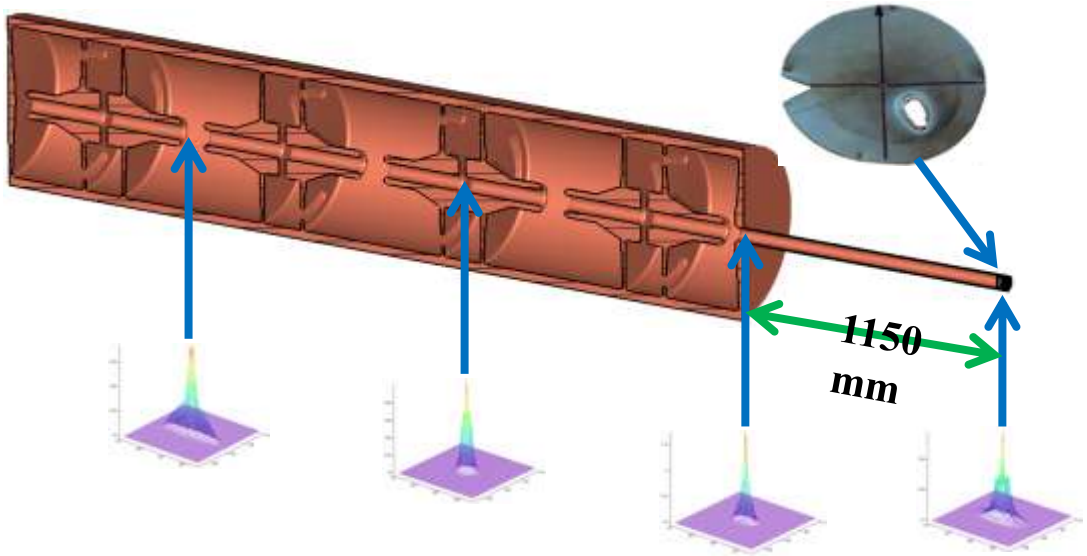

***Accelerating structure of the prototype***

# ILU-14 accelerator prototype

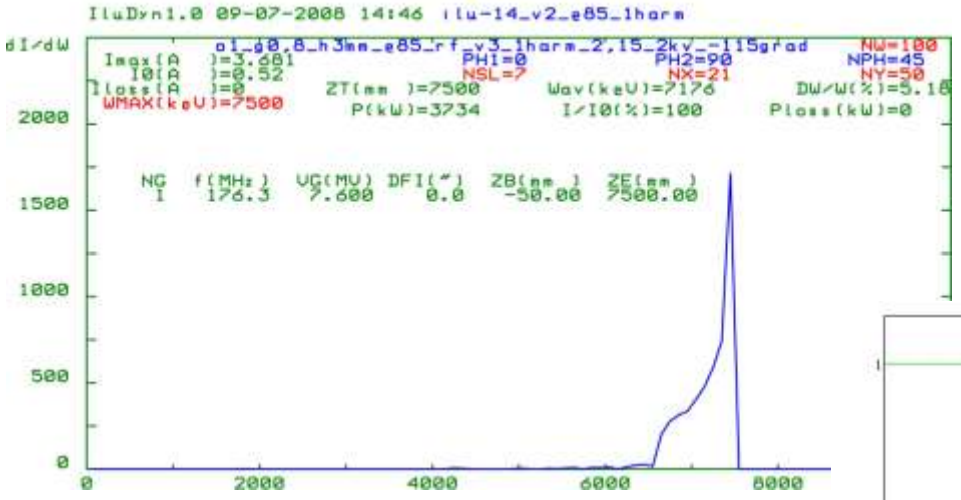



# Beam conducting through accelerating structure. Beam cross-size measurements at accelerator

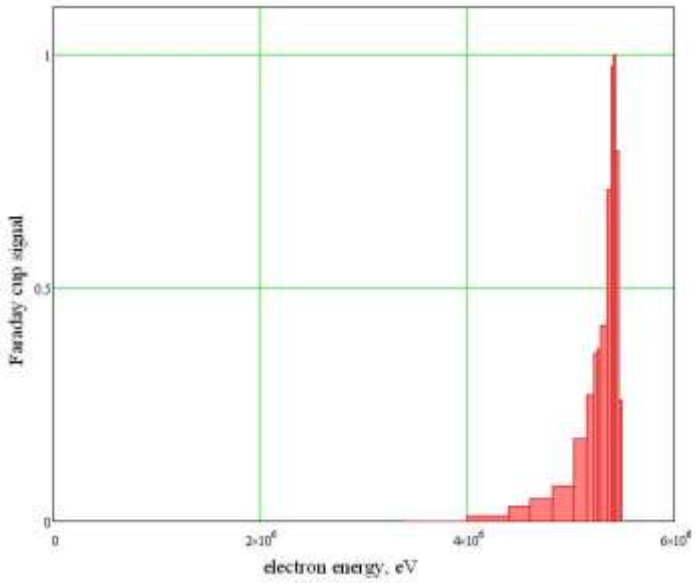


# Theoretical spectrum and its measurements




***Theoretical electron spectrum***




***Measured electron spectrum***

# Pulse parameters, obtained during prototype tests

- Maximum accelerating voltage **7.5 MV**
- Maximum beam pulsed current **500 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.**
- Electron energy **6.7 MeV** at beam pulse current of **300 mA**
  **(at repetition rate of 50Hz beam power wiil be of 50 kW)**

# Contracts

**Contract #09-10 (8.12.2009)**

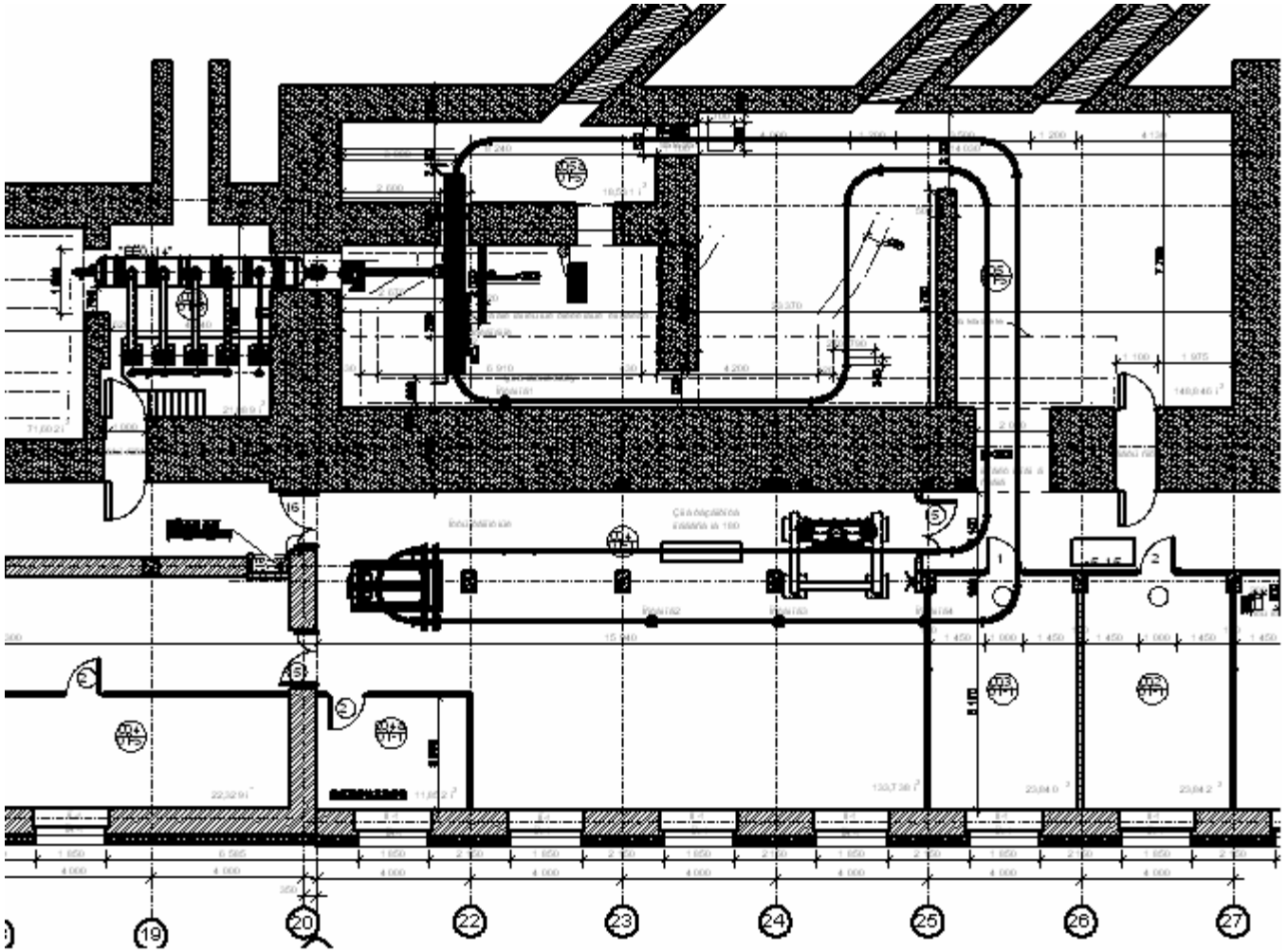
***ILU-14*** delivery to ***Burnazyan Federal Medical Biophysical Centre***

Contract cost – **105 000 000 rub.**

Delivery date – **31.12.2010.**

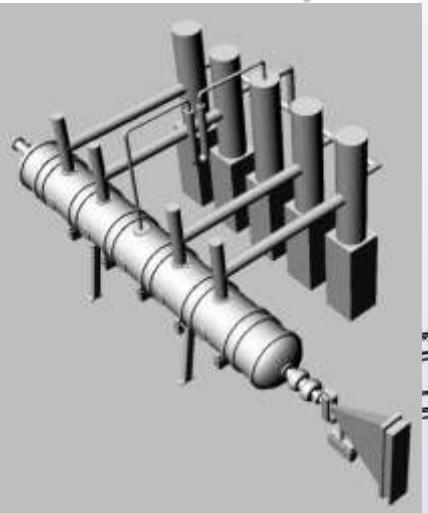
Федеральный медицинский
биофизический центр
имени А.И. Бурназяна

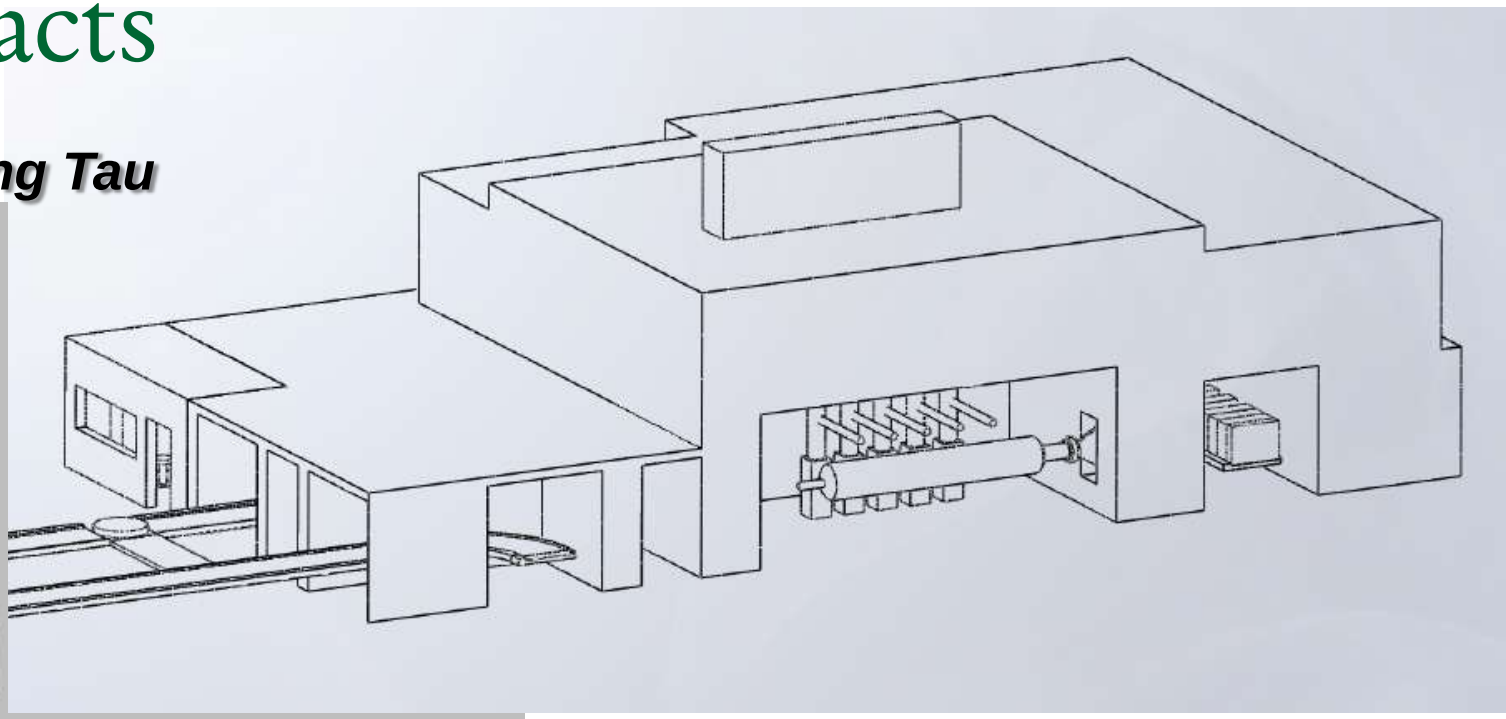
# Contracts

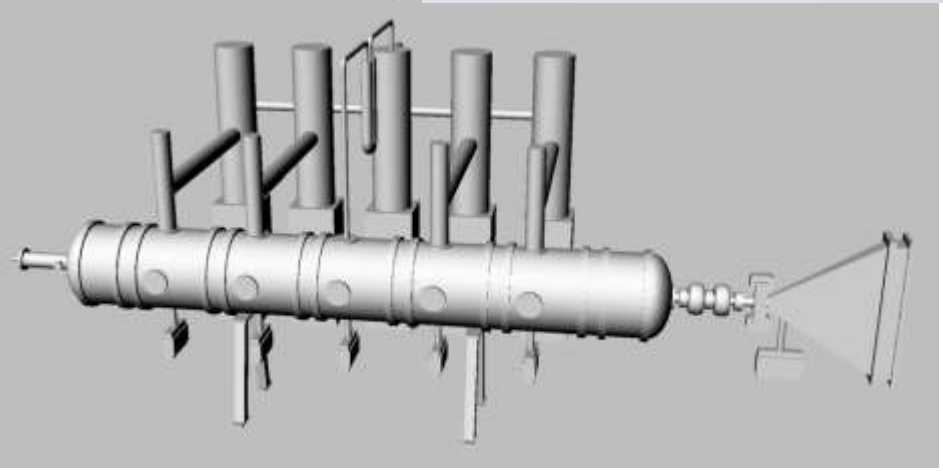


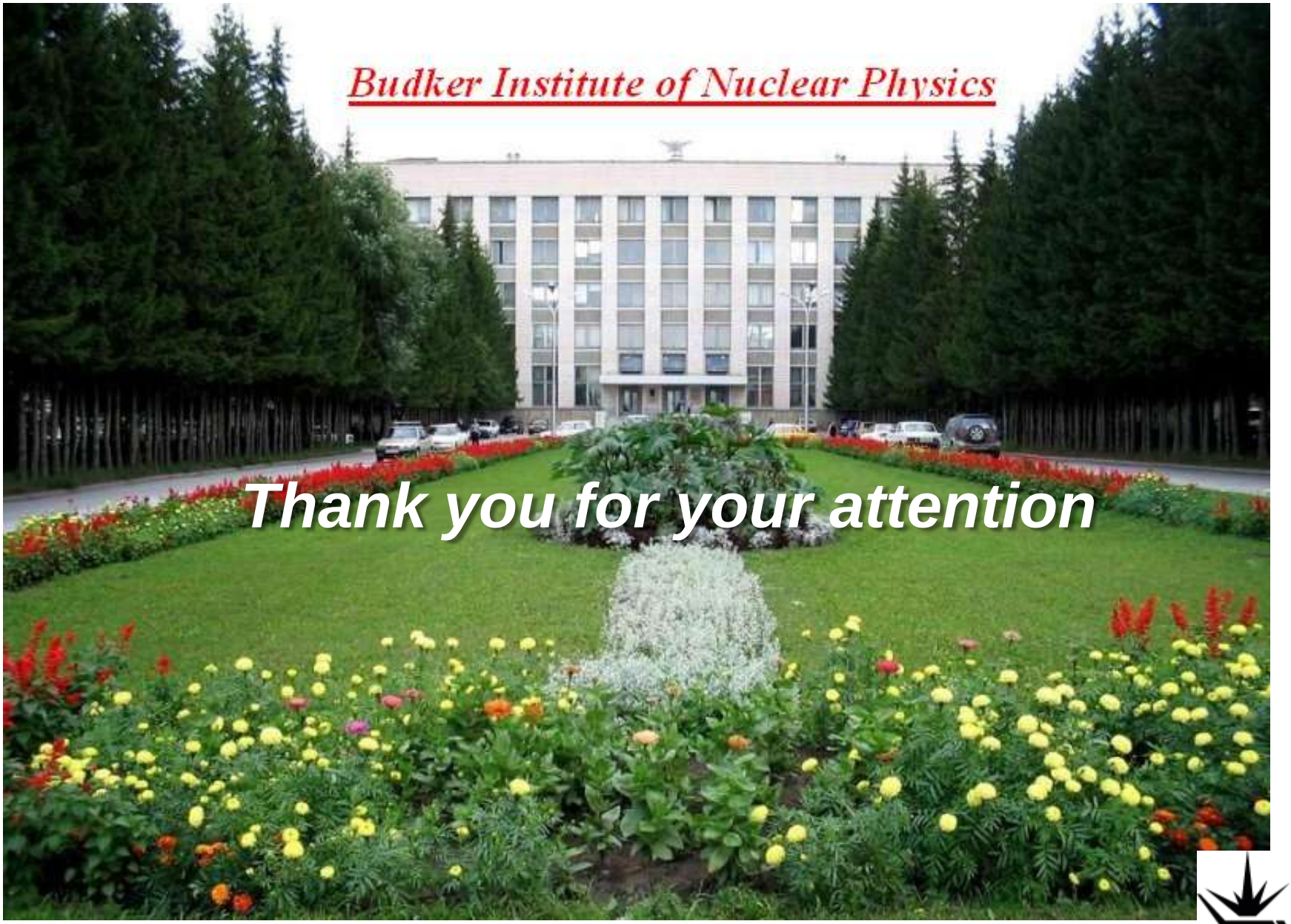
# Contracts

***Vietnam, Vung Tau***








Budker Institute of Nuclear Physics
Thank you for your attention