LIA-2 Upgrade

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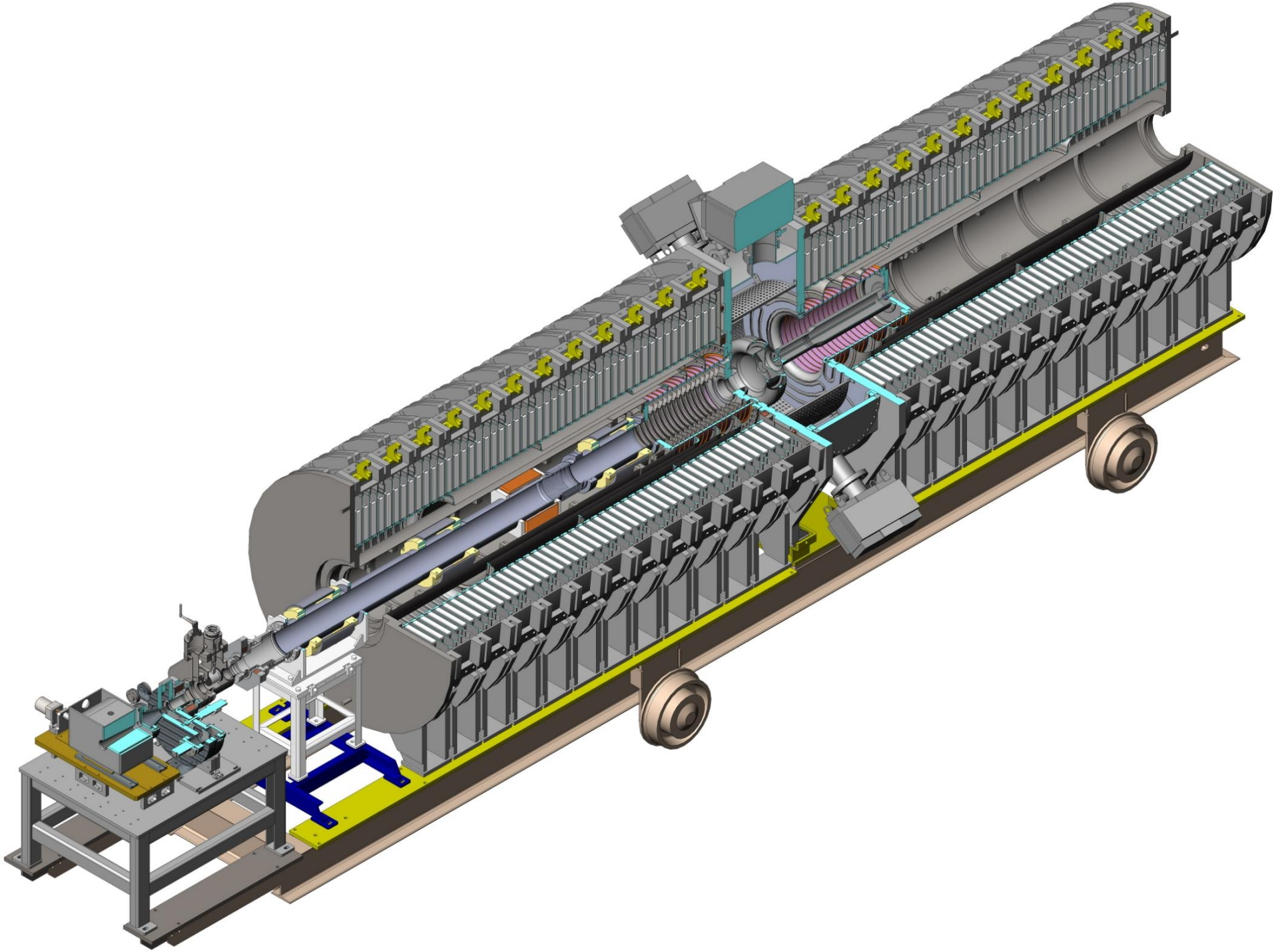
Outline

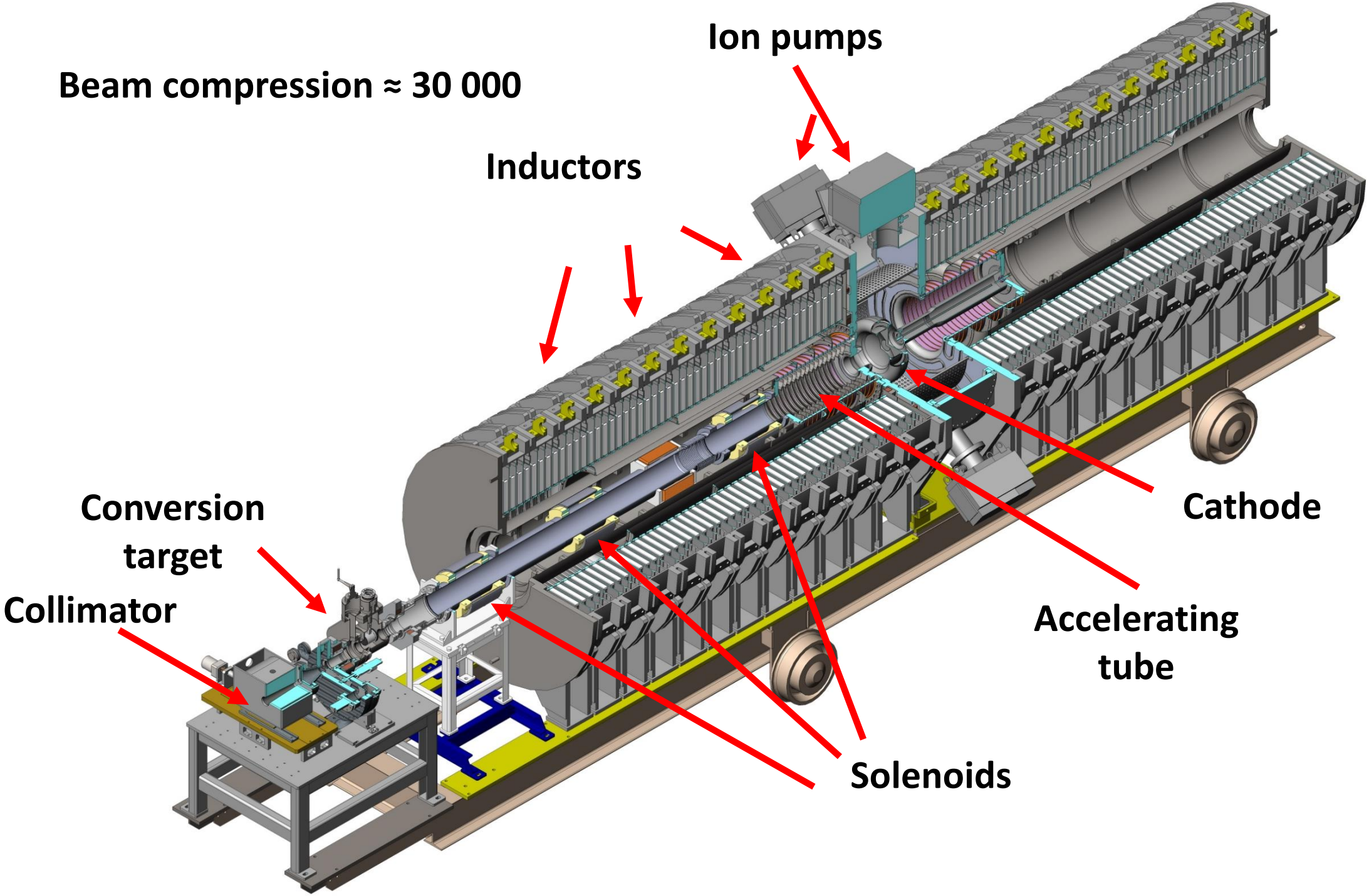
- **LIA-2 Project development history**
- **New version of cathode manufacturing**
- **Vacuum system upgrade**
- **Beam dynamics simulation**
- **Radiation losses control system manufacturing**
- **Current status**



The LIA-2 first stage upgrade was completed in 2019-2020

- New version of cathode was manufactured.
- Vacuum system upgrade, residual gas analyzer was installed.
- Radiation losses control system was manufactured.
- K-V envelope code was created (A. Petrenko, D. Nikiforov, V. Fedorov).

Beam compression ≈ 30 000

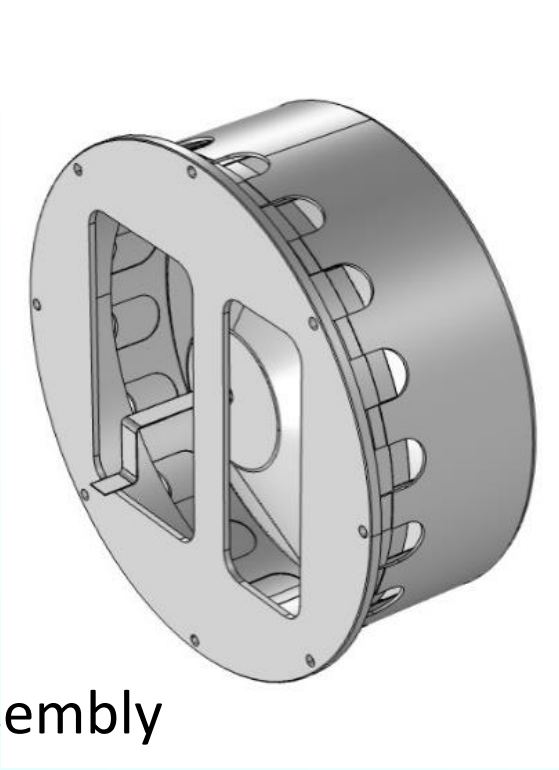


LIA-2 main parameters	
Max. energy, MeV	2
Max. current , kA	2
Pulses quantity	2
Time delay between pulses, μs	2 ÷ 100
Current flat top, ns	200
Beam spot size, mm	2
Average number of pulses	150

New version of cathode

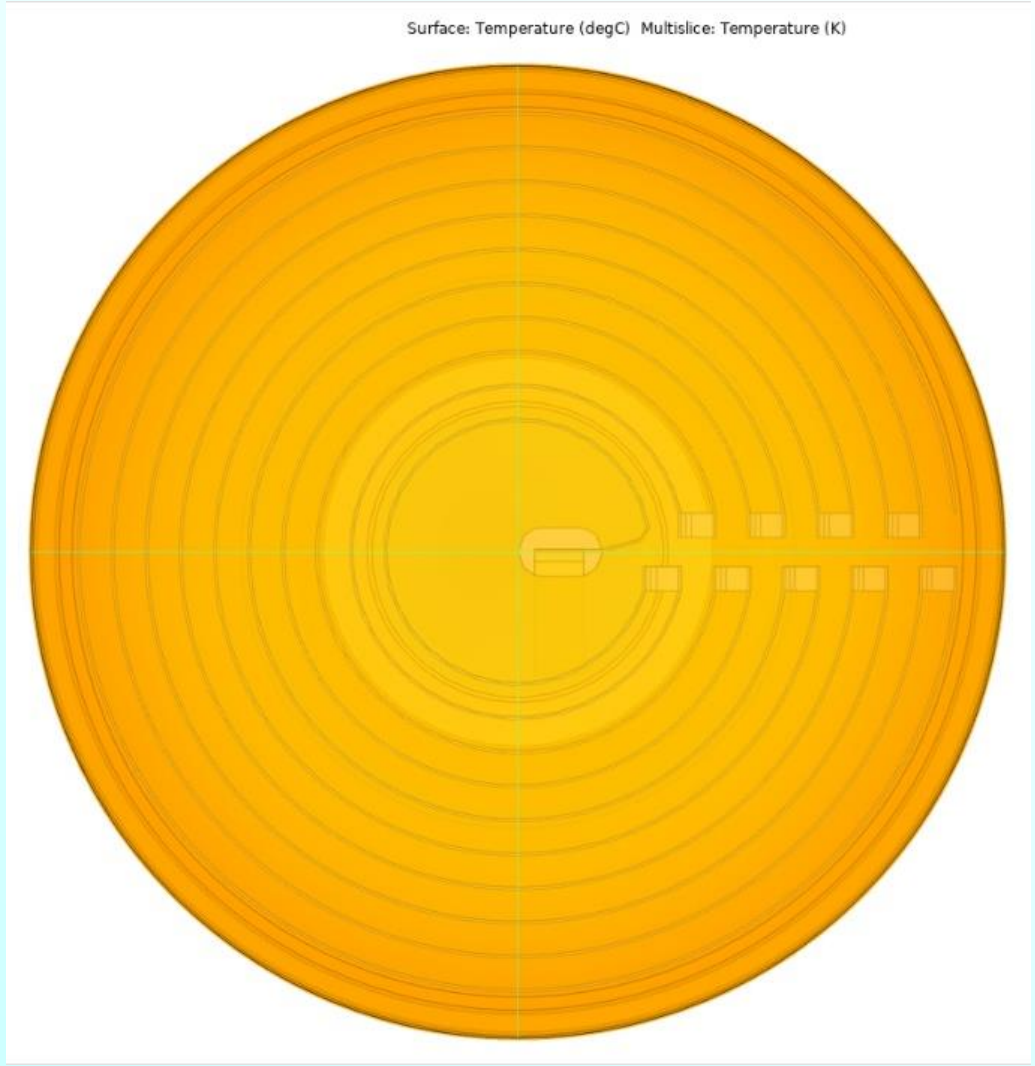
- the design of the heater mount was changed
- number of heat shields were increased
- welding technology was changed
- the new cathode has an extended lifetime and reliability

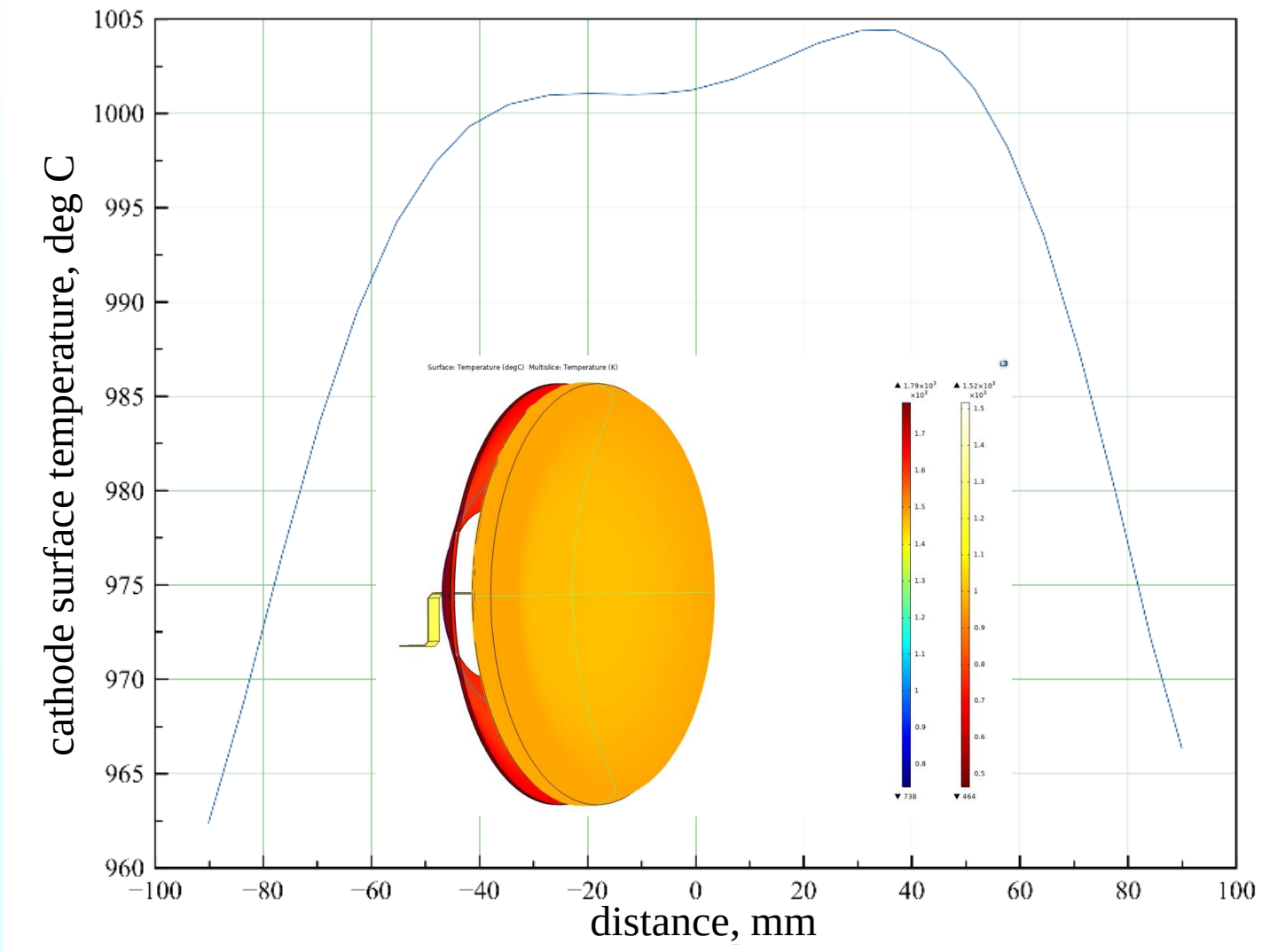
heater



Cathode assembly

Temperature distribution on the cathode surface at 2.5 kW.





Dispenser cathode conditions

Cathode lifetime depends on:

- residual gases composition in the vacuum chamber;

- evaporation rate of active substances from the cathode surface.

Evaporation rate of barium oxide:

$$\lg(w) = 7{,}7 - \frac{20000}{T(K)}$$

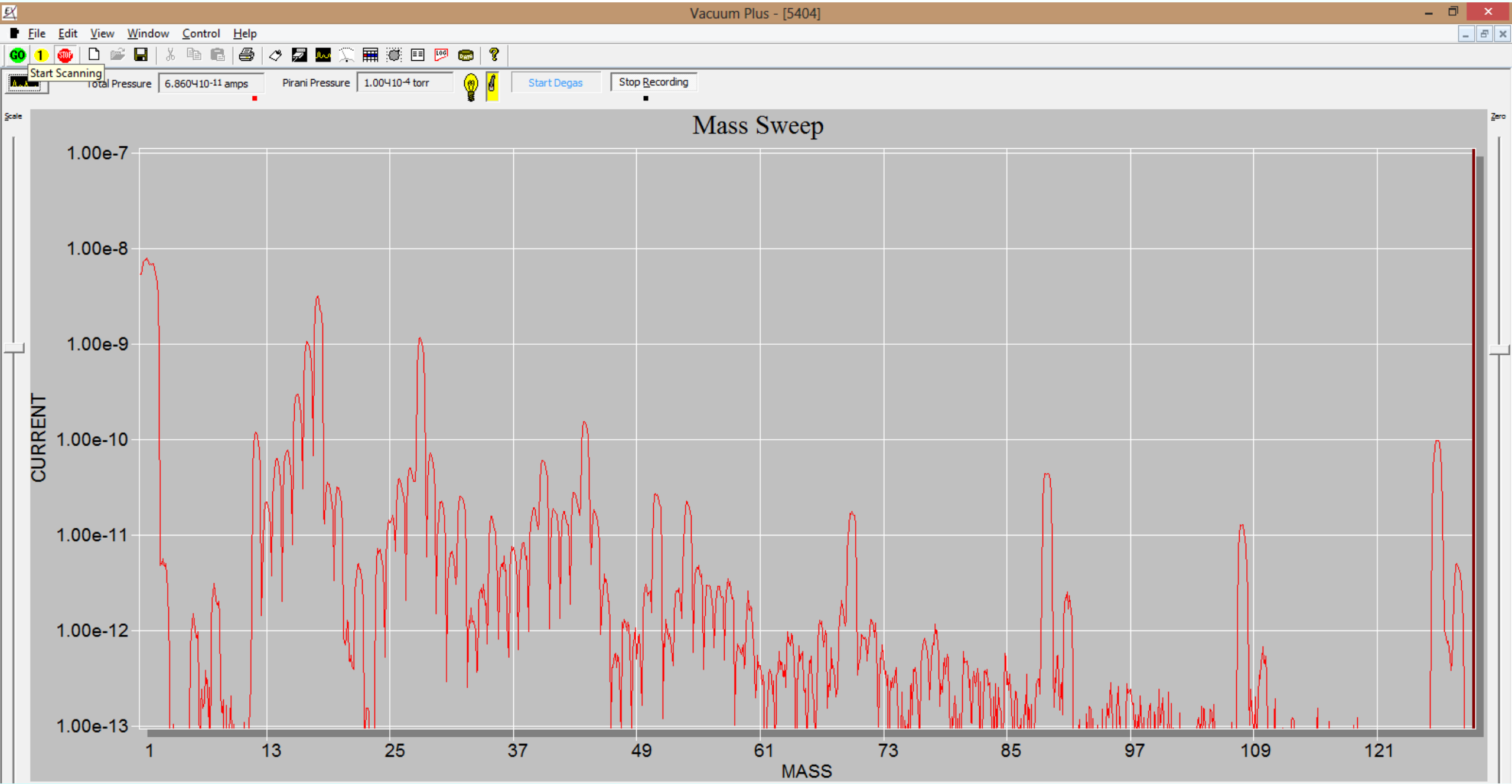
$$\text{At } 1300\ K \text{ evaporation rate } w \approx 2 \cdot 10^{-8}\ \frac{g}{cm^2 \cdot sec}$$

$$\text{At } 1400\ K \text{ evaporation rate } w \approx 2{,}6 \cdot 10^{-7}\ \frac{g}{cm^2 \cdot sec}$$

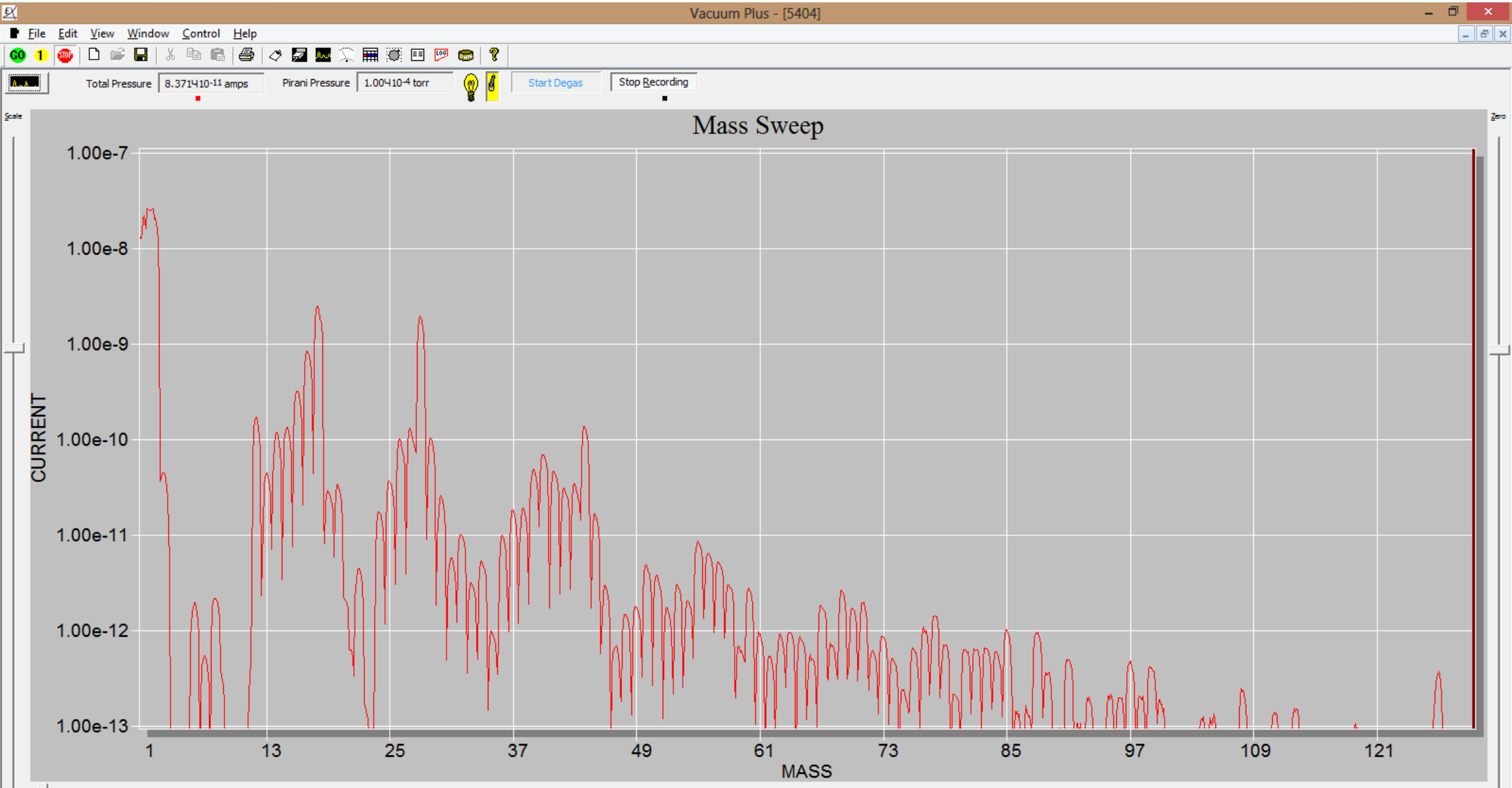
Vacuum system upgrade

- residual gas analyzer was installed
- Ion pumps were replaced
- additional pump was installed

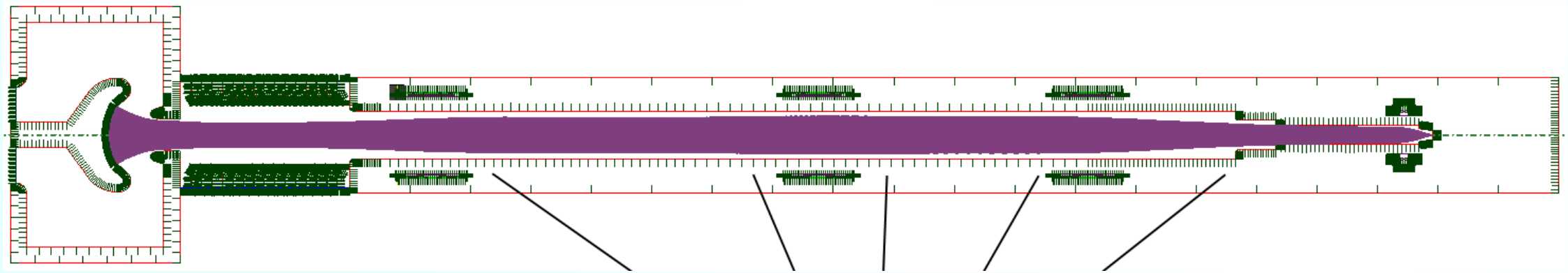
SF6 was detected



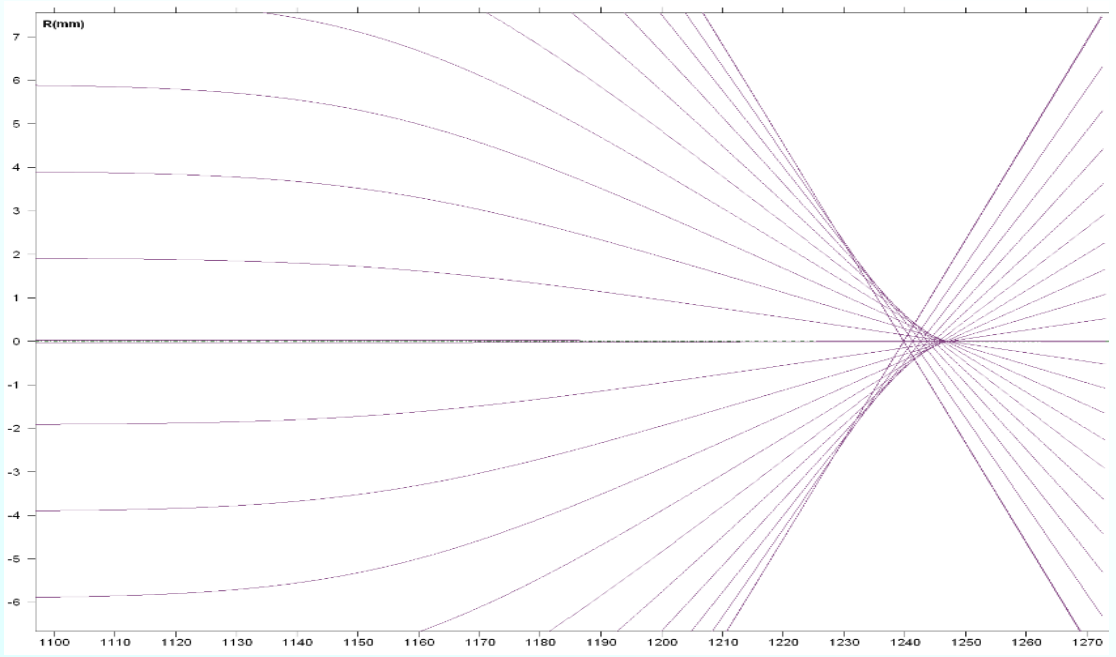
SF6 was deleted from inductors



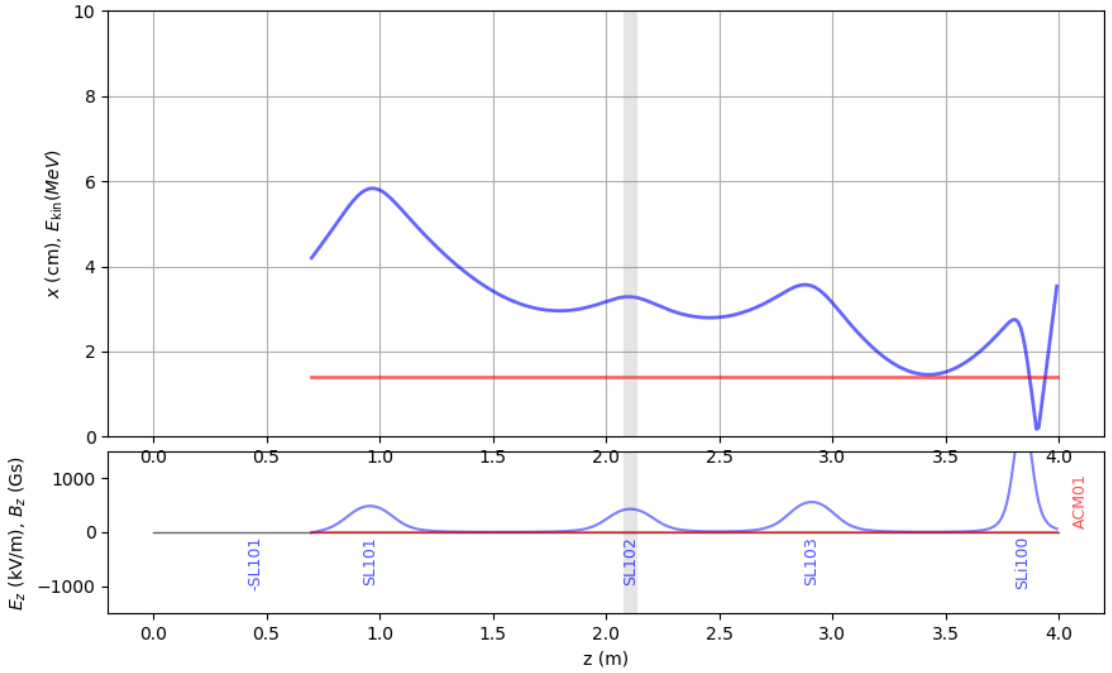
UltraSAM simulate



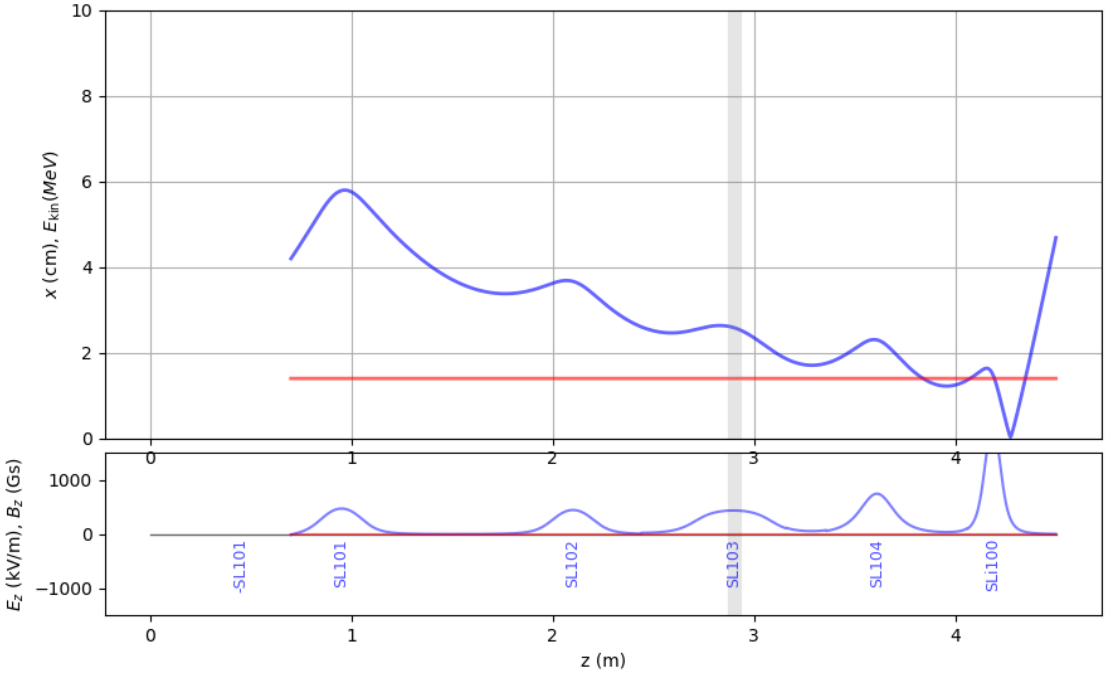
Final beam spot size 1 mm
Initial beam radius 20 mm
spherical aberration $\Delta r_{min} = 0.41$ mm



K-V envelope code simulate

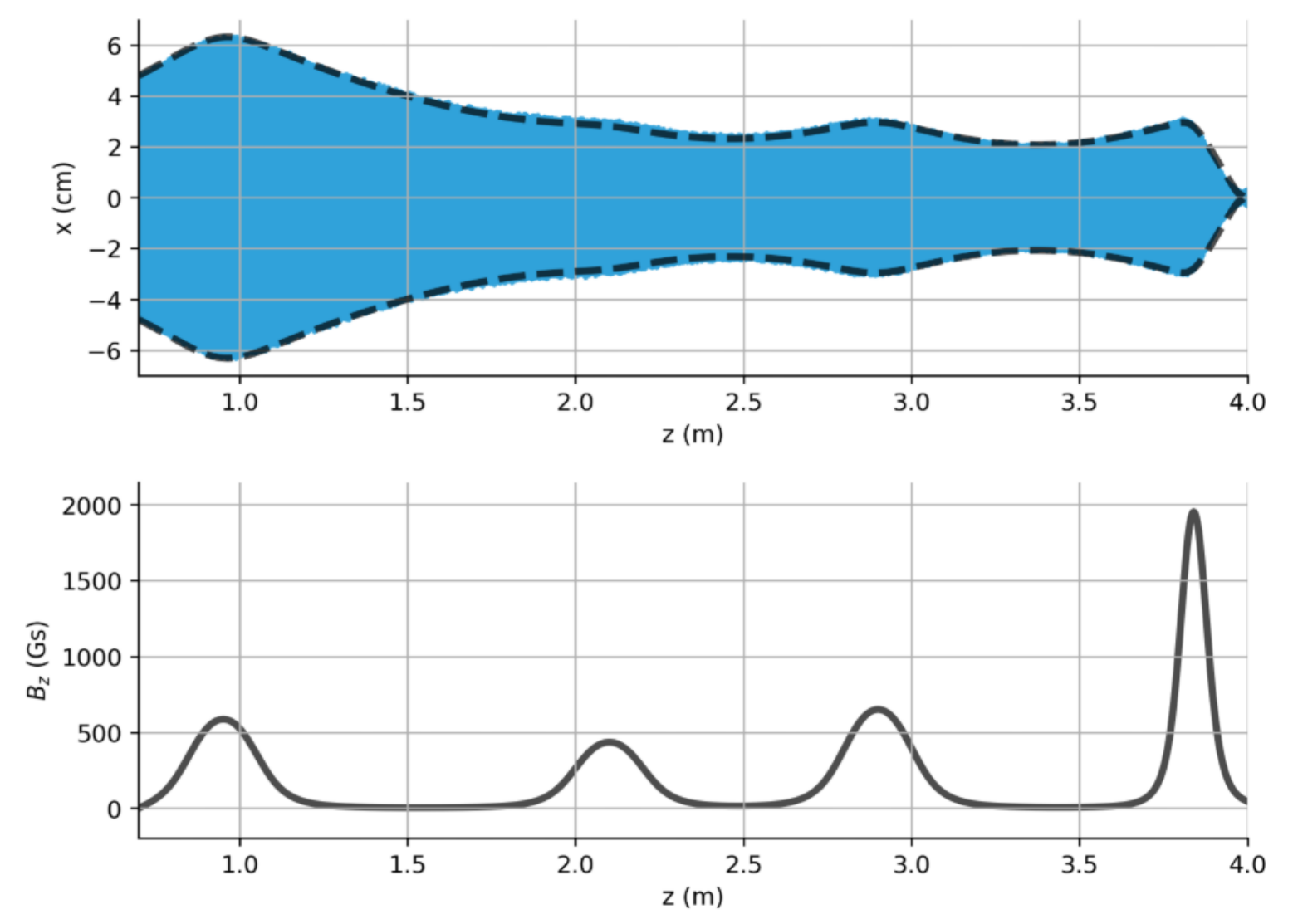


Beam envelope at 1.4 MeV, 1.3 kA.
Beam radius before the final focus lens 28 mm.
Beam spot size more than 1 mm.

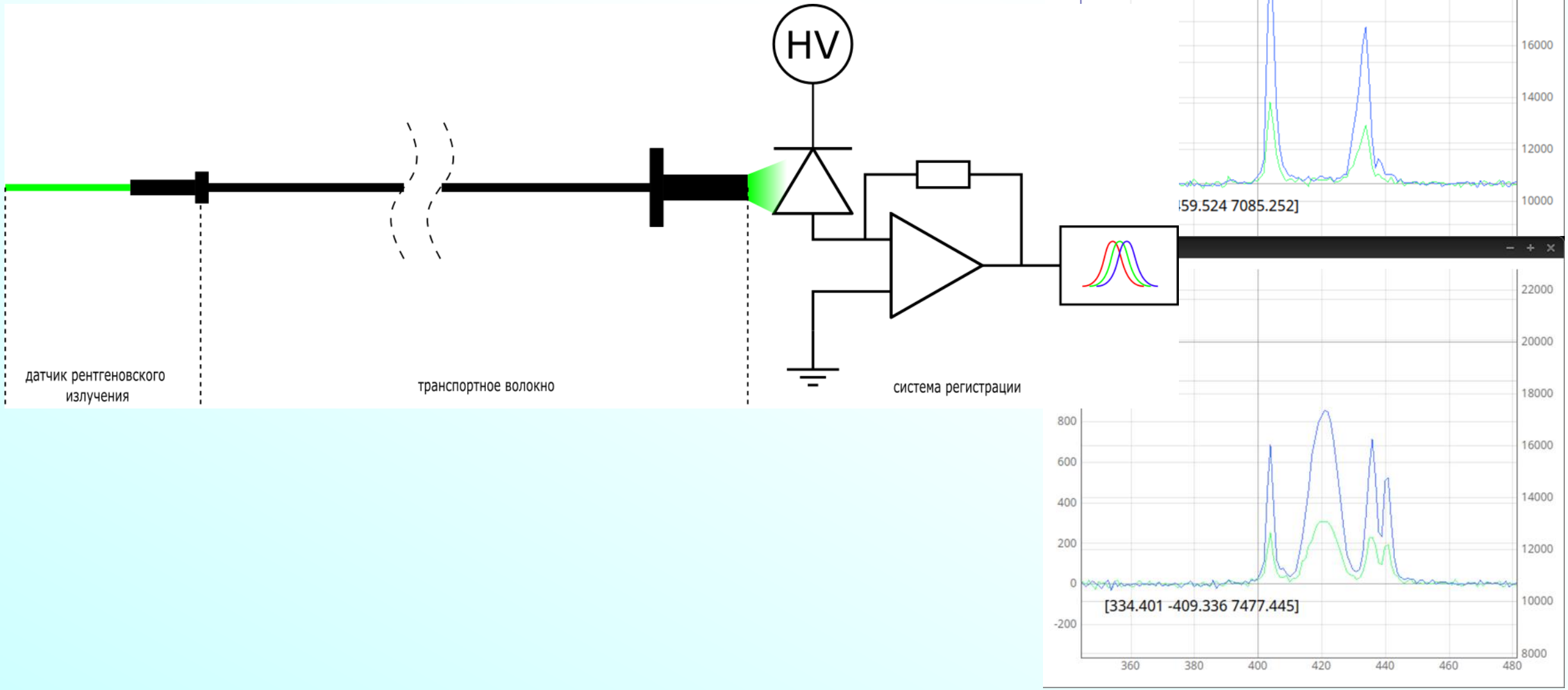


Additional lens 100 mm
Beam envelope at 1.4 MeV, 1.3 kA.
Beam radius before the final focus lens 16 mm.
Beam spot size 0.5 mm.

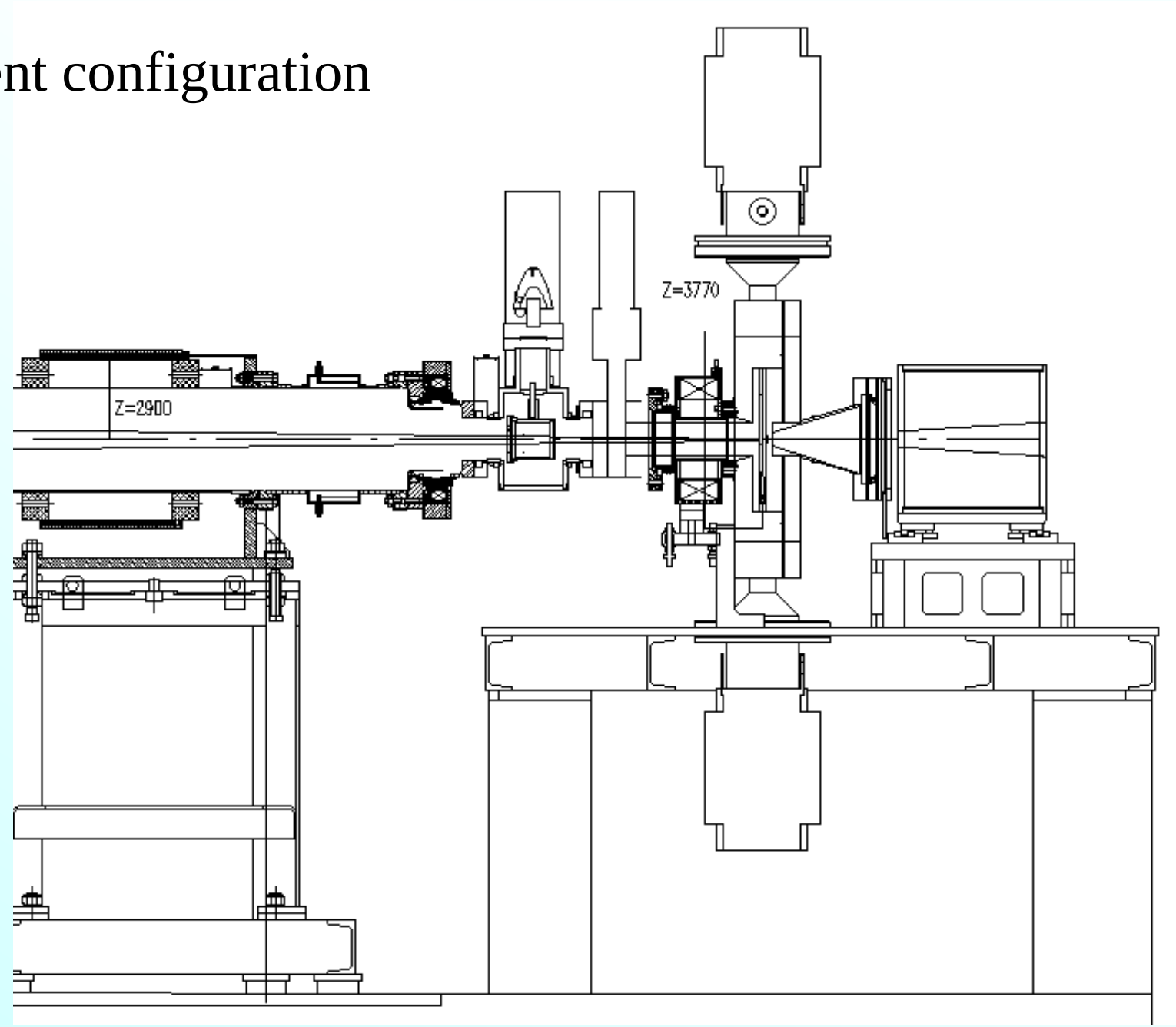
K-V envelope code simulate (dashed line) vs ASTRA simulate with 1 million particulate



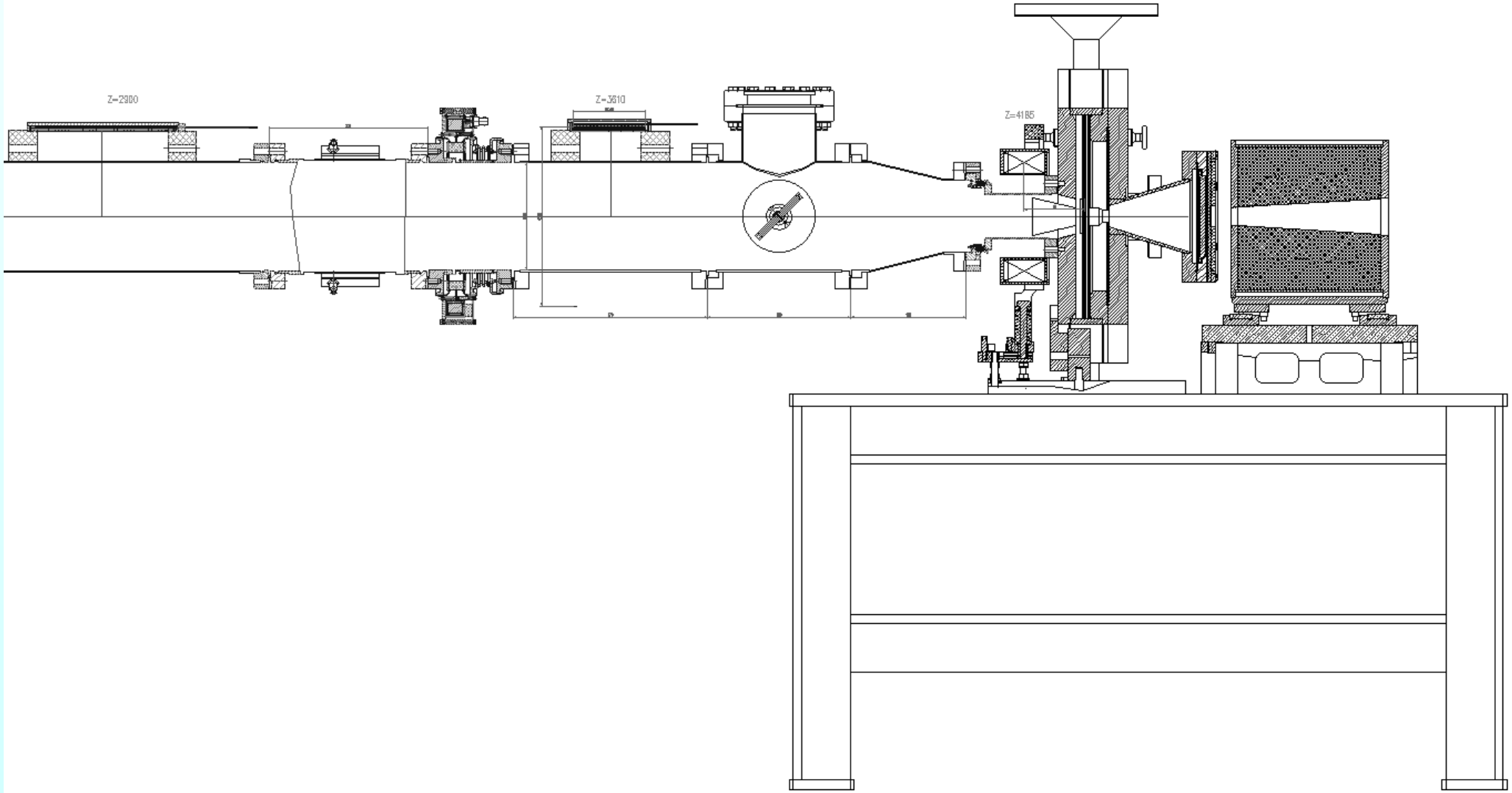
Radiation losses control system



Current configuration



Future configuration



Summary

- Vacuum system was upgraded and productivity increased ~ 25 times
- New version of cathode was manufactured and installed
- Beam envelope simulation was performed taking into account the spherical aberration of the final focus lens
- Radiation losses control system was manufactured and installed
- K-V Envelope code was verified by using of the radiation losses control system
- Simultaneous accelerator tuning and simulation was realized
- A new configuration of the transport channel with additional lens and new diagnostics is proposed

Current status

- 2021-2023 years
- manufacture of modulators for three-pulse mode
- Pulse flat tope 90 ns

- 2024-2026 years
- Manufacture of new version inductors
- Manufacture of new diagnostics