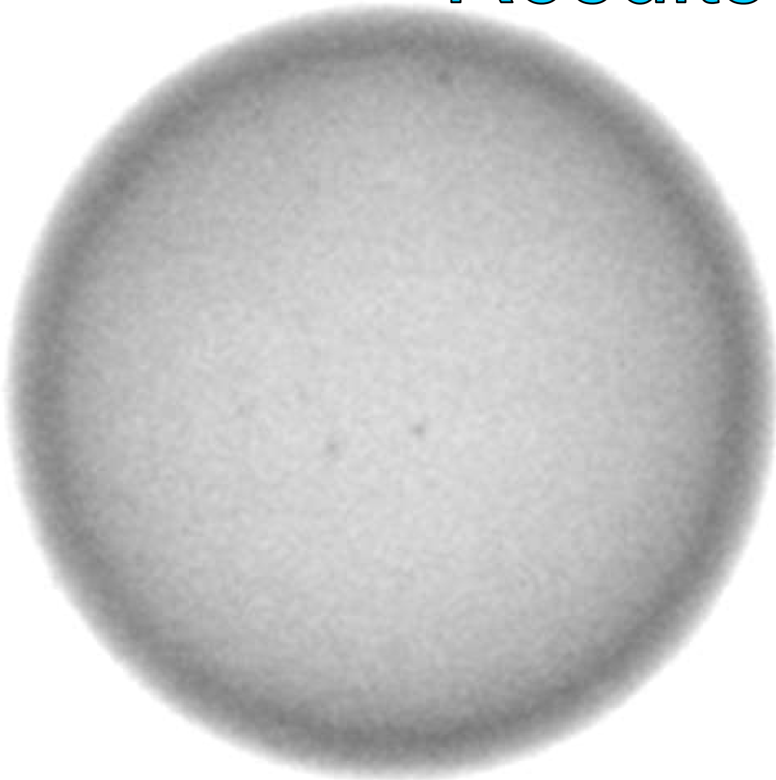
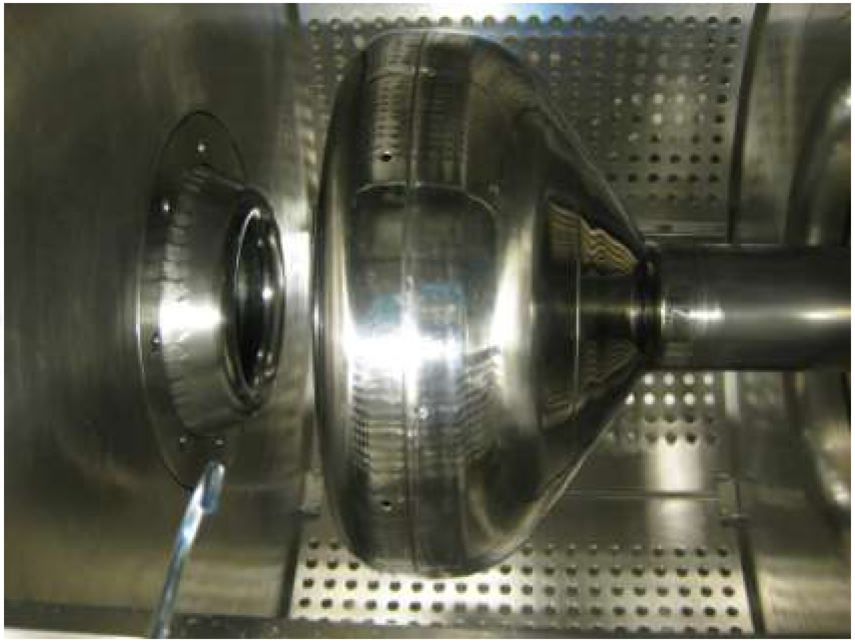
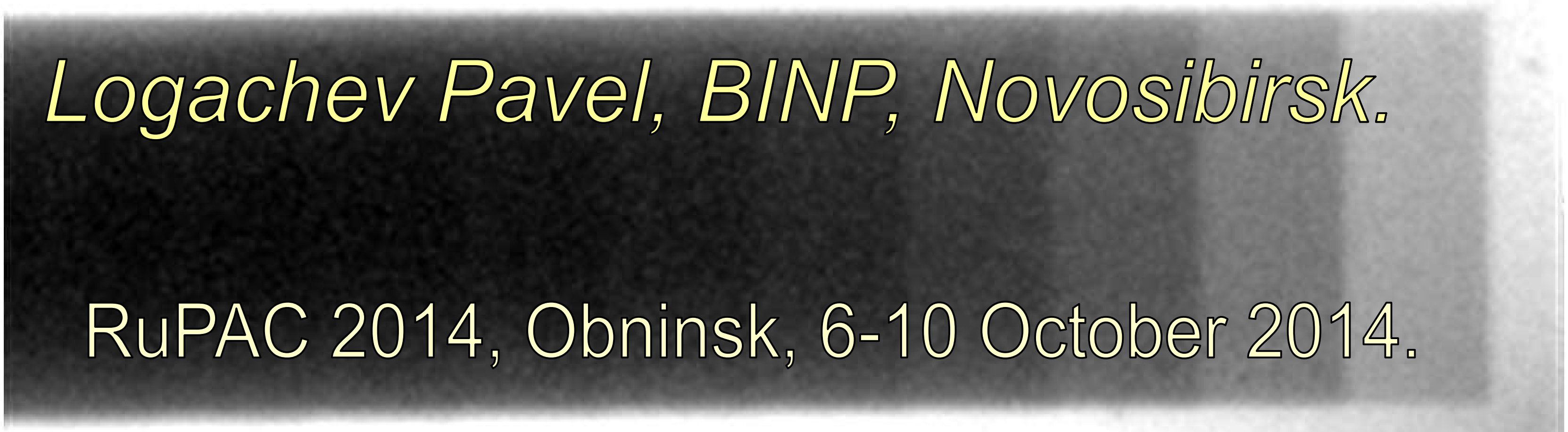
Results of LIA-2 operation.





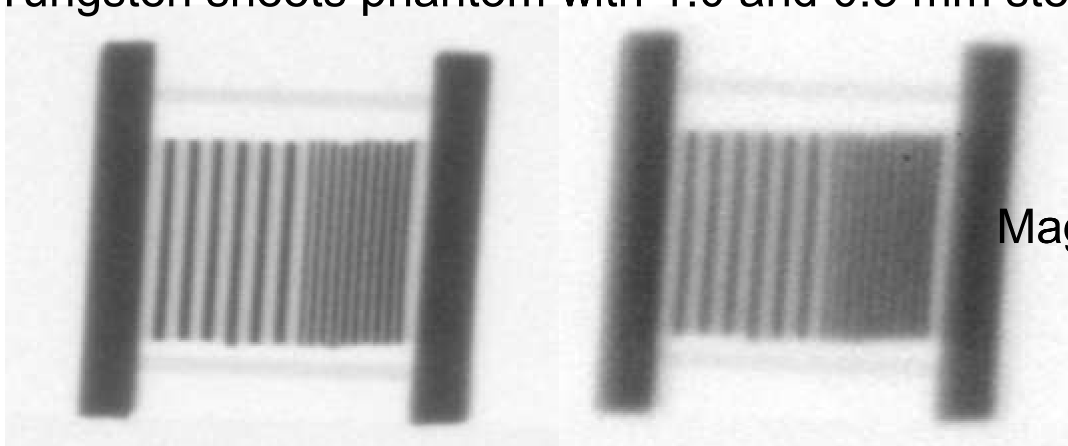


Logachev Pavel, BINP, Novosibirsk.

RuPAC 2014, Obninsk, 6-10 October 2014.

Tungsten sheets phantom with 1.0 and 0.5 mm step.

LIA-2 pictures:

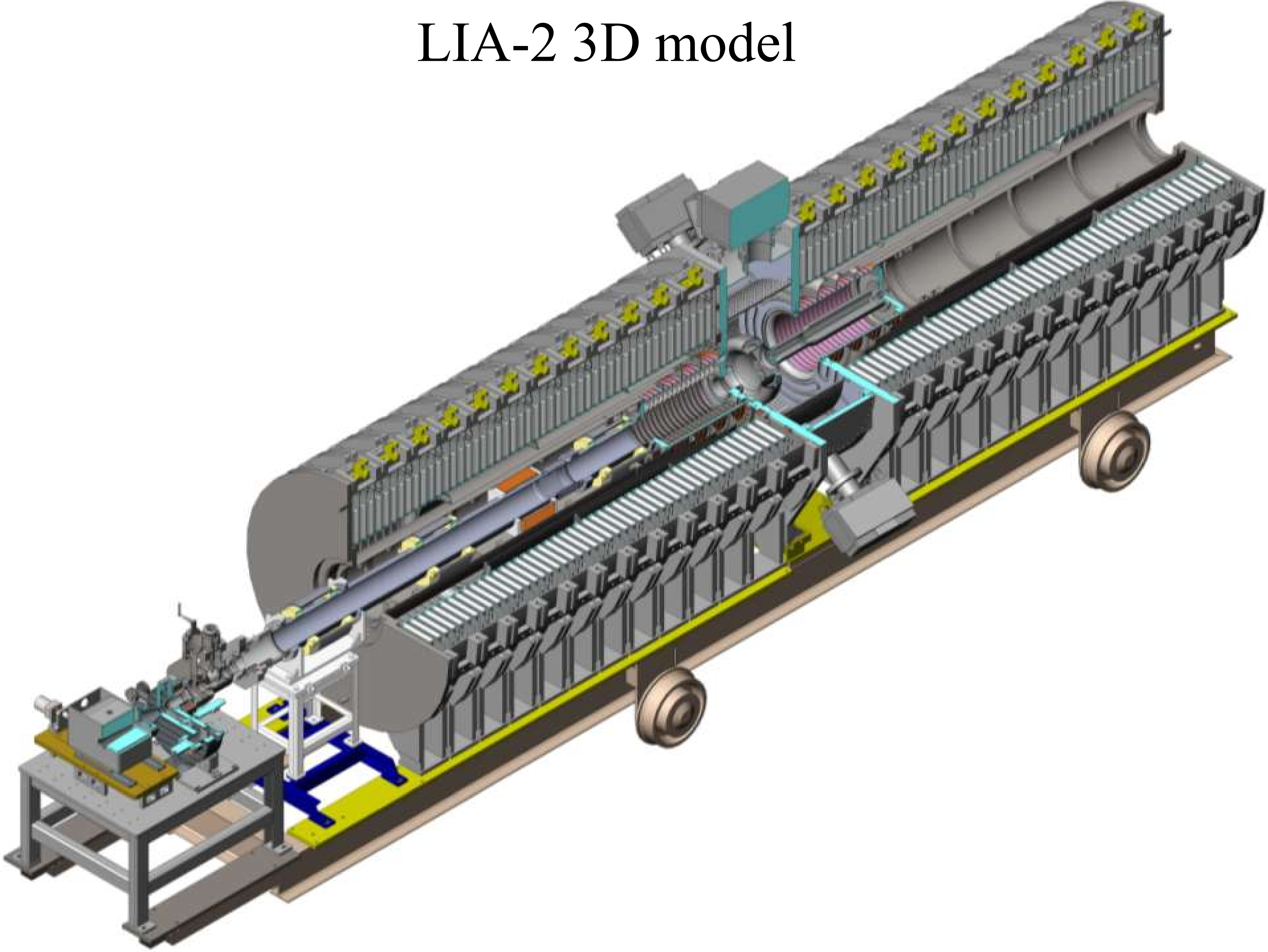


Magnification factor =1.3

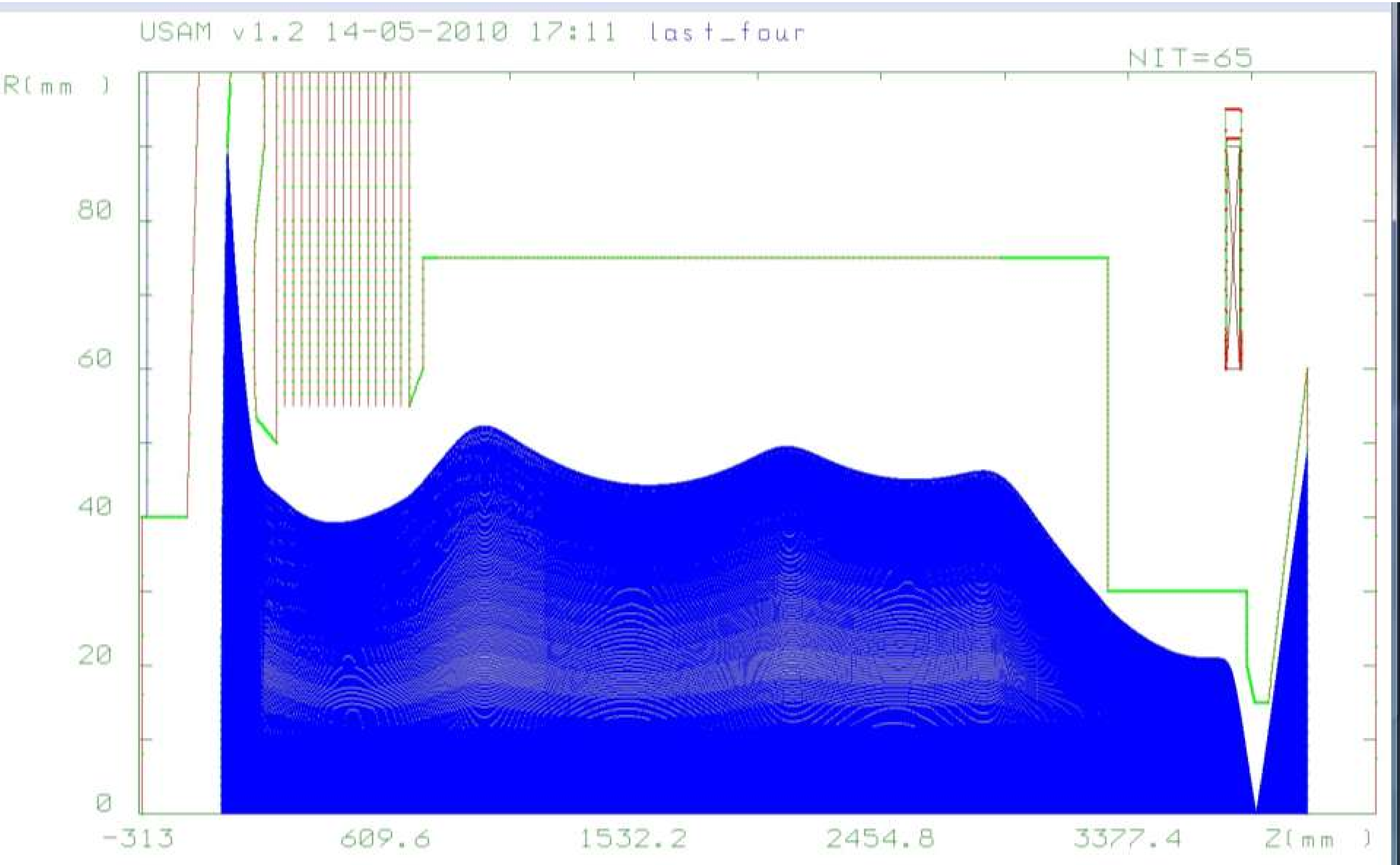
+ 20 mm of aluminum shockwave shielding

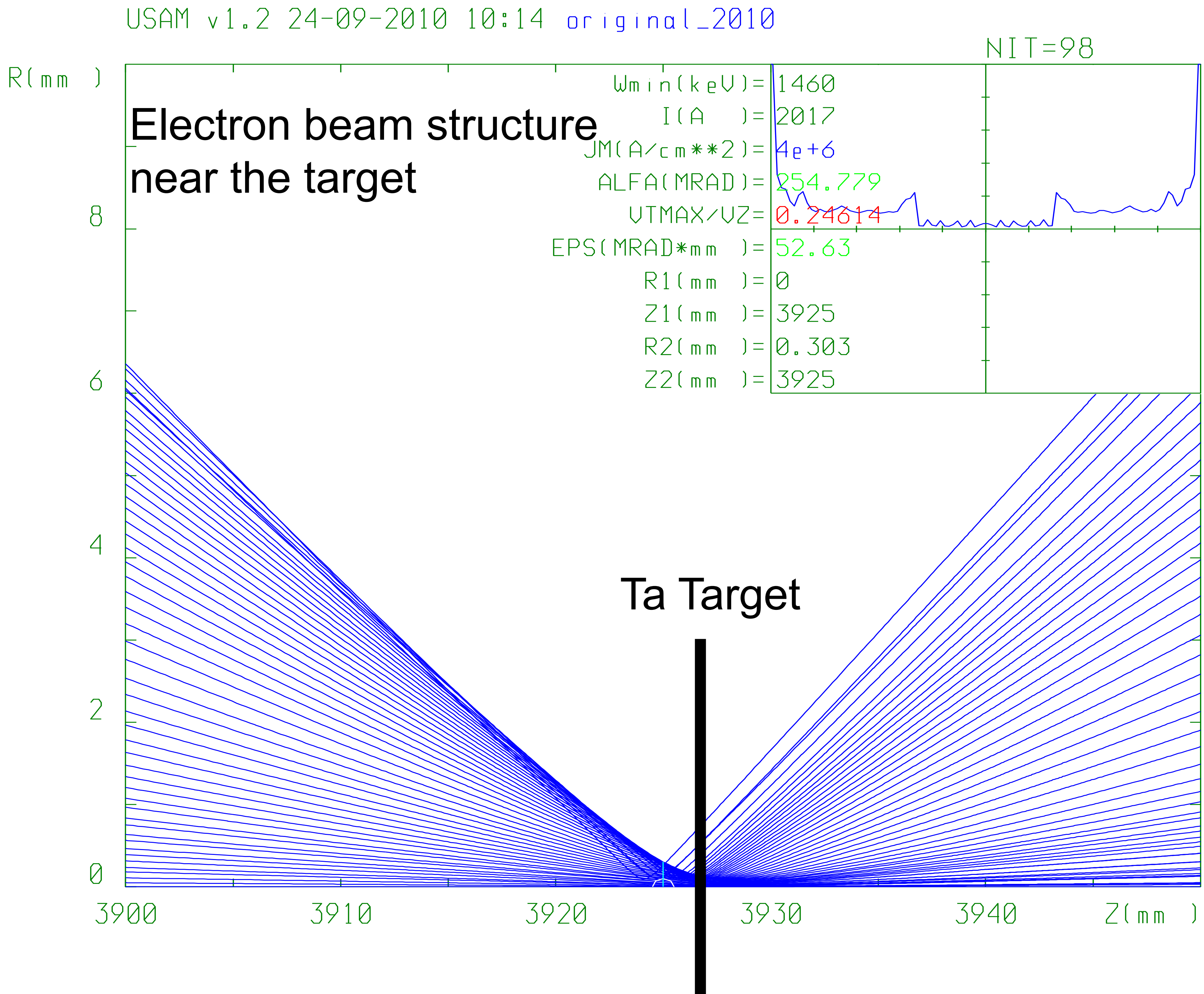
Parameter (Units)	**Value**
Maximum electron beam energy (MeV)	2.0
Maximum electron beam current (kA)	2.0
Number of pulses in the burst	2
Cathode heater DC power (kW)	2.5
Time interval between pulses in the burst (μs)	2 - 30
Pulse duration, flat top 4% (ns)	200
Maximum repetition rate (Hz)	0.1
Min. beam spot size FWHM on the target (mm)	0.7

LIA-2 3D model



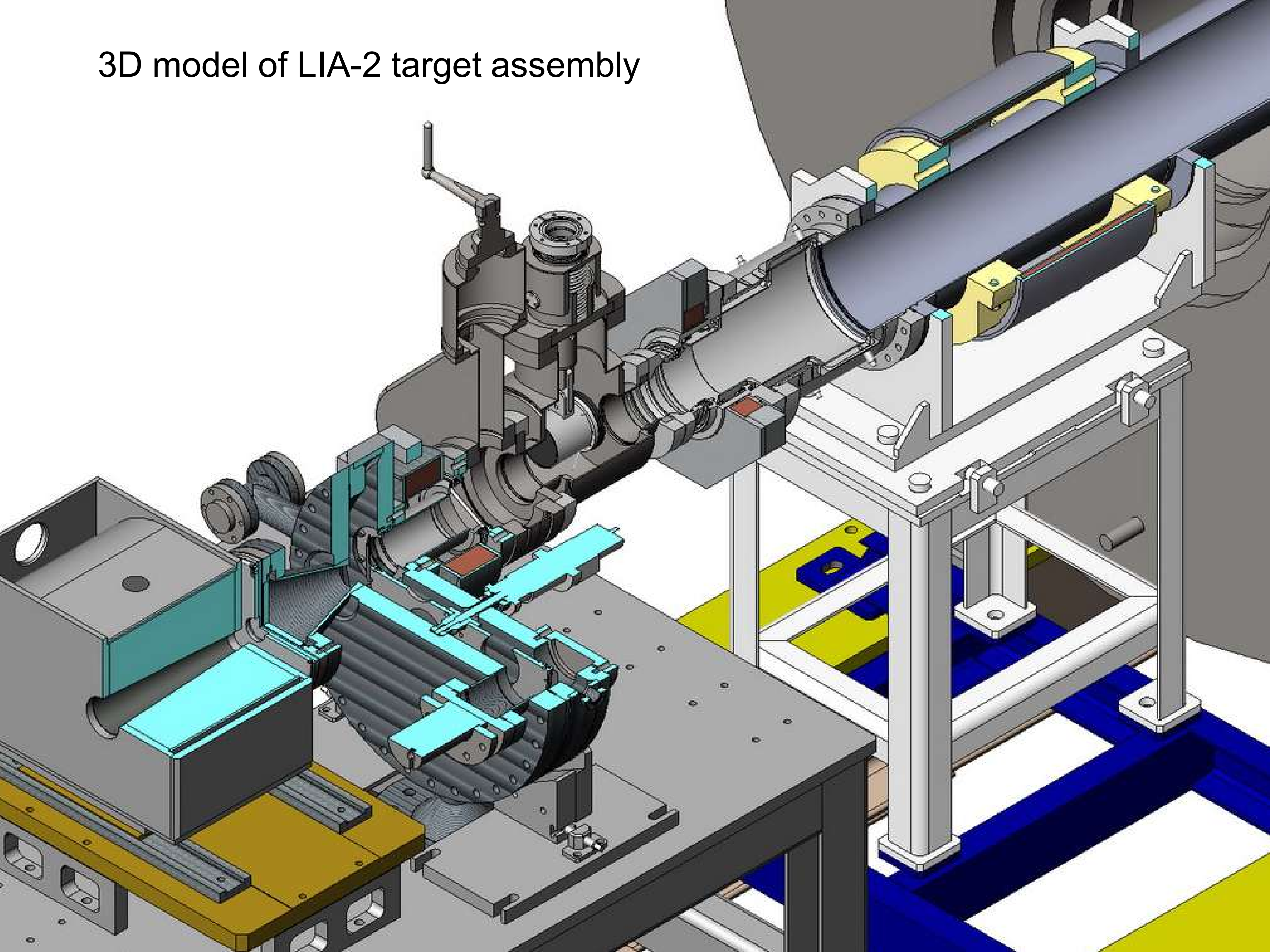
Electron beam envelope at 2 MeV, 2 kA from cathode up to beam dump.



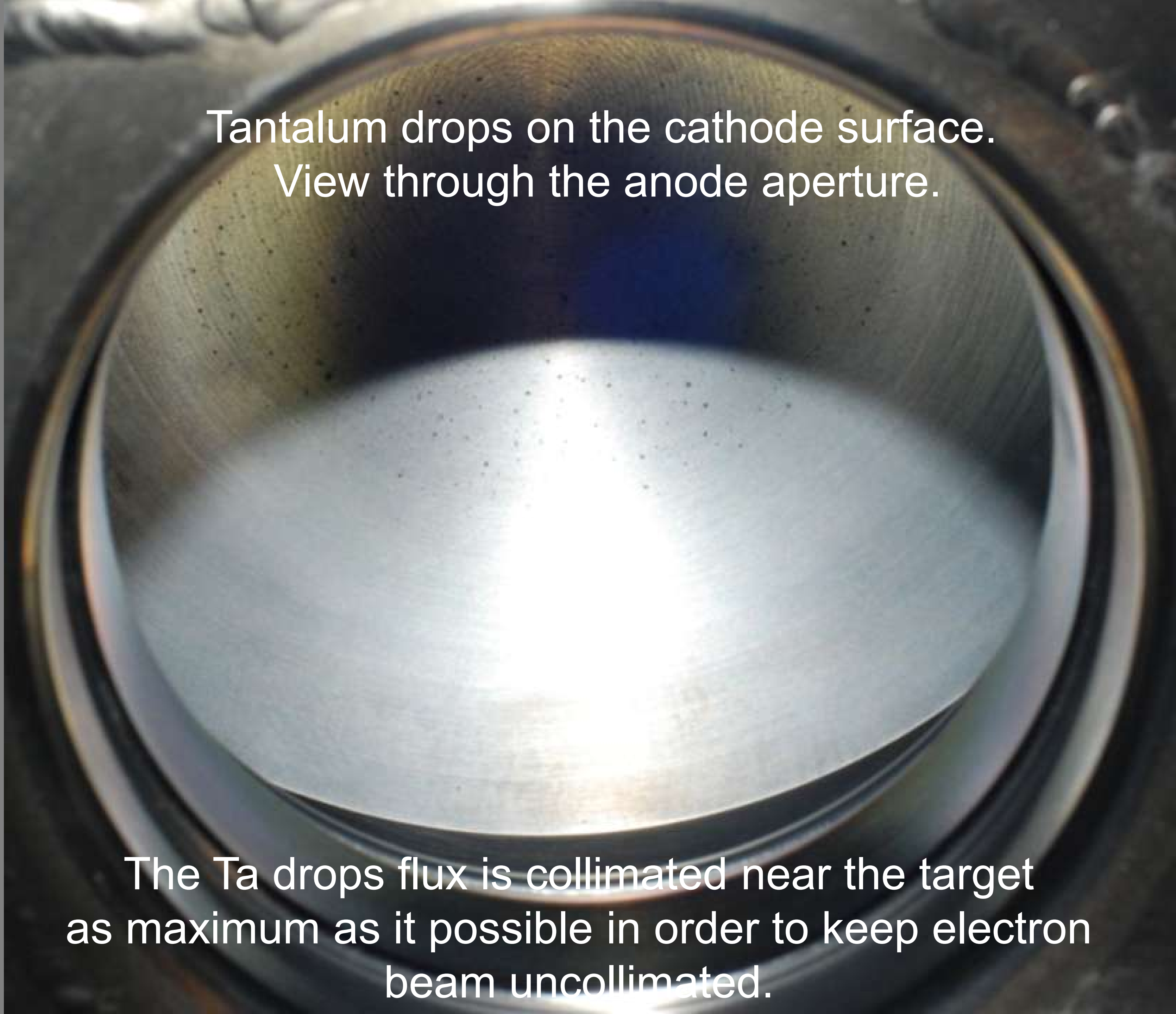


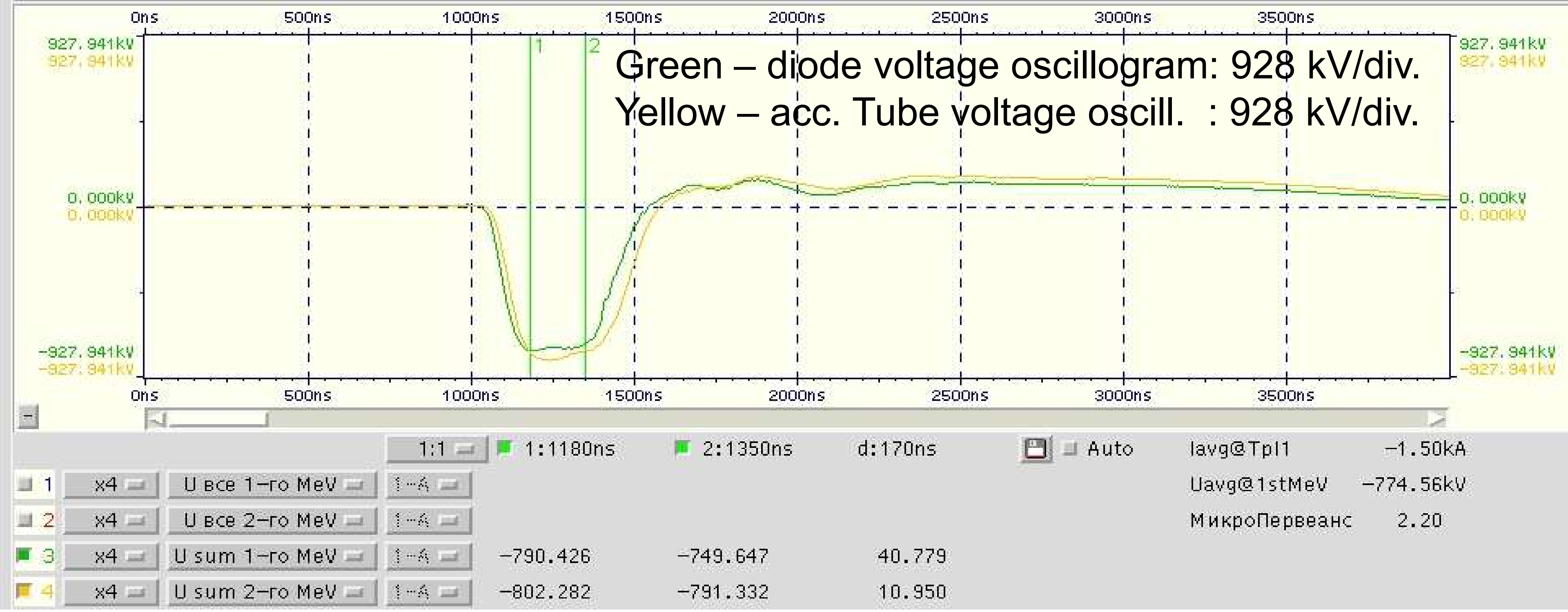
USAM v1.2 24-09-2010 10:14 original_2010
NIT=98
R(mm)
Electron beam structure near the target
Wmin(keV)= 1460
I(A)= 2017
JM(A/cm**2)= 4e+6
ALFA(MRAD)= 254.779
VTMAX/VZ= 0.24614
EPS(MRAD*mm)= 52.63
R1(mm)= 0
Z1(mm)= 3925
R2(mm)= 0.303
Z2(mm)= 3925
8
6
4
2
0
Ta Target
3900
3910
3920
3930
3940
Z(mm)

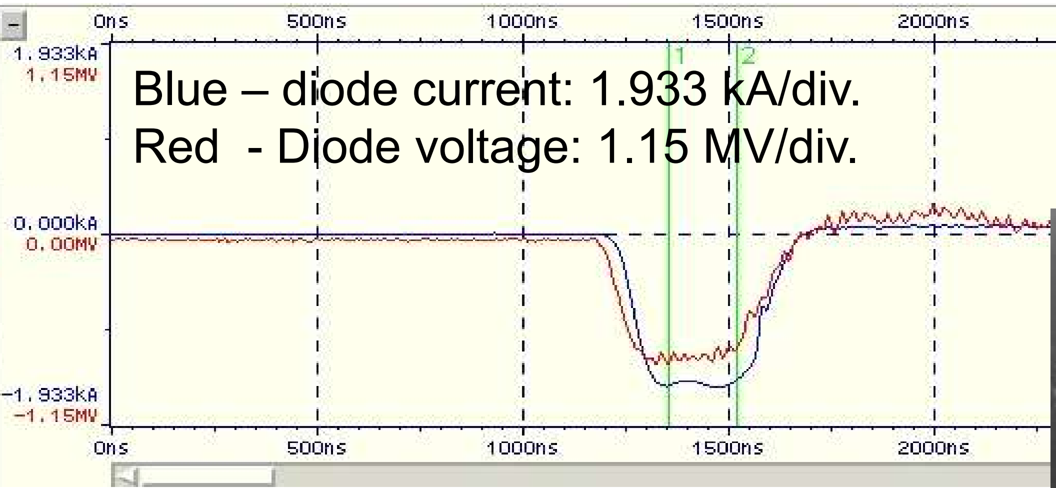
3D model of LIA-2 target assembly



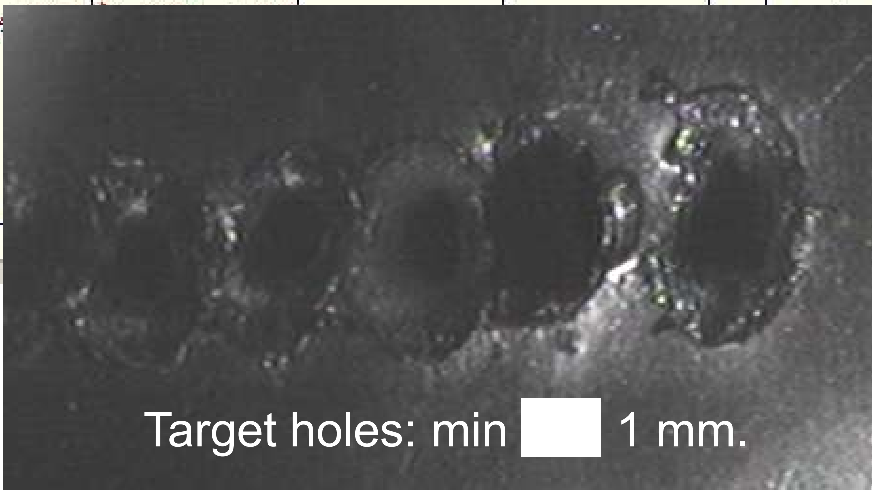
Target explosion due to electron beam energy deposition generates tantalum drops with very high velocity (up to few km/s). These drops damage the emission ability of the cathode and reduce the electric breakdown strength of diode and further accelerating tube electrodes. This is why LIA-2 can reliably operate 2 MeV, 2 kA without target explosion and only 1.6 MeV, 1.5 kA with target explosion.

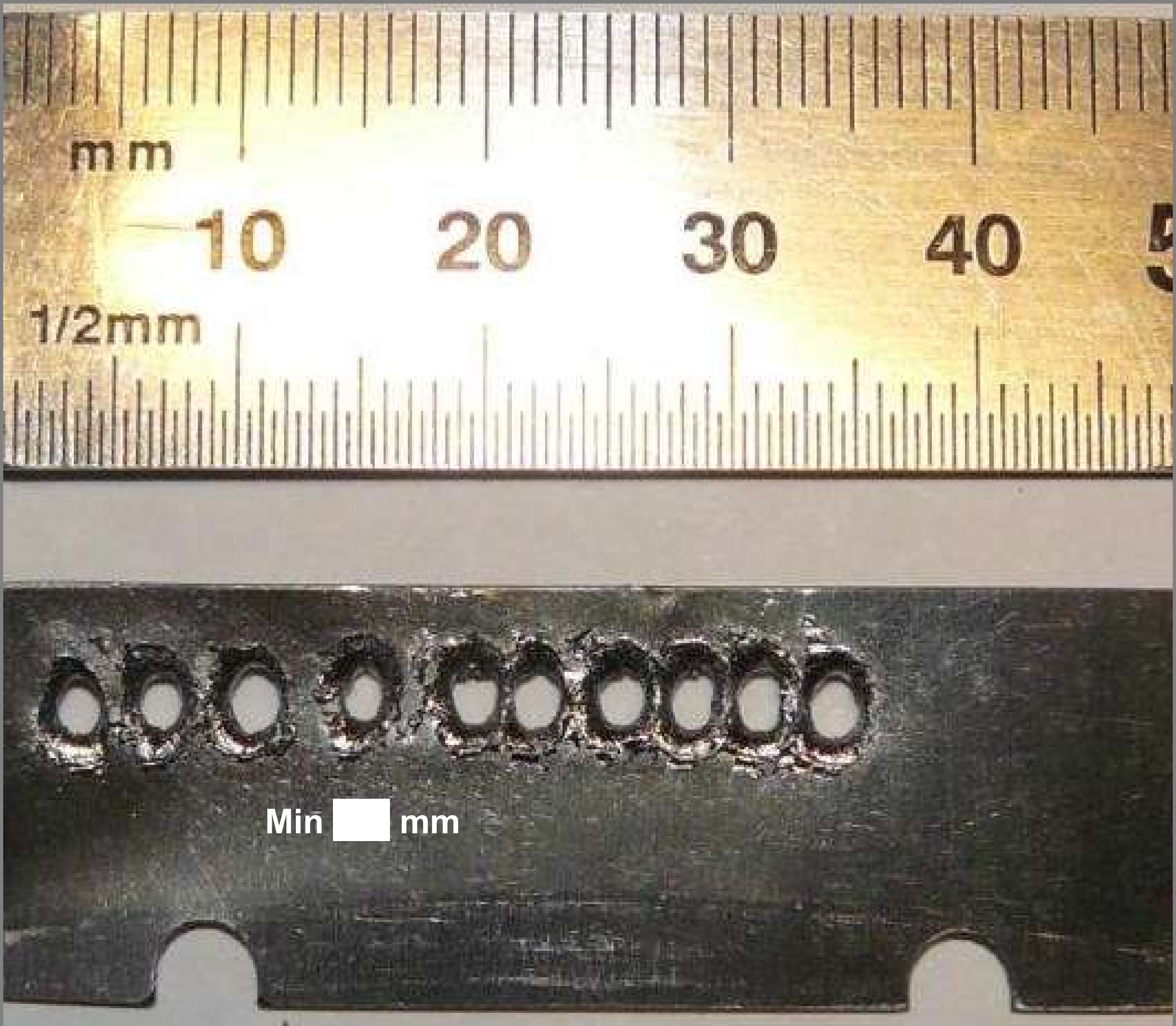

Tantalum drops on the cathode surface.
View through the anode aperture.
The Ta drops flux is collimated near the target
as maximum as it possible in order to keep electron
beam uncollimated.



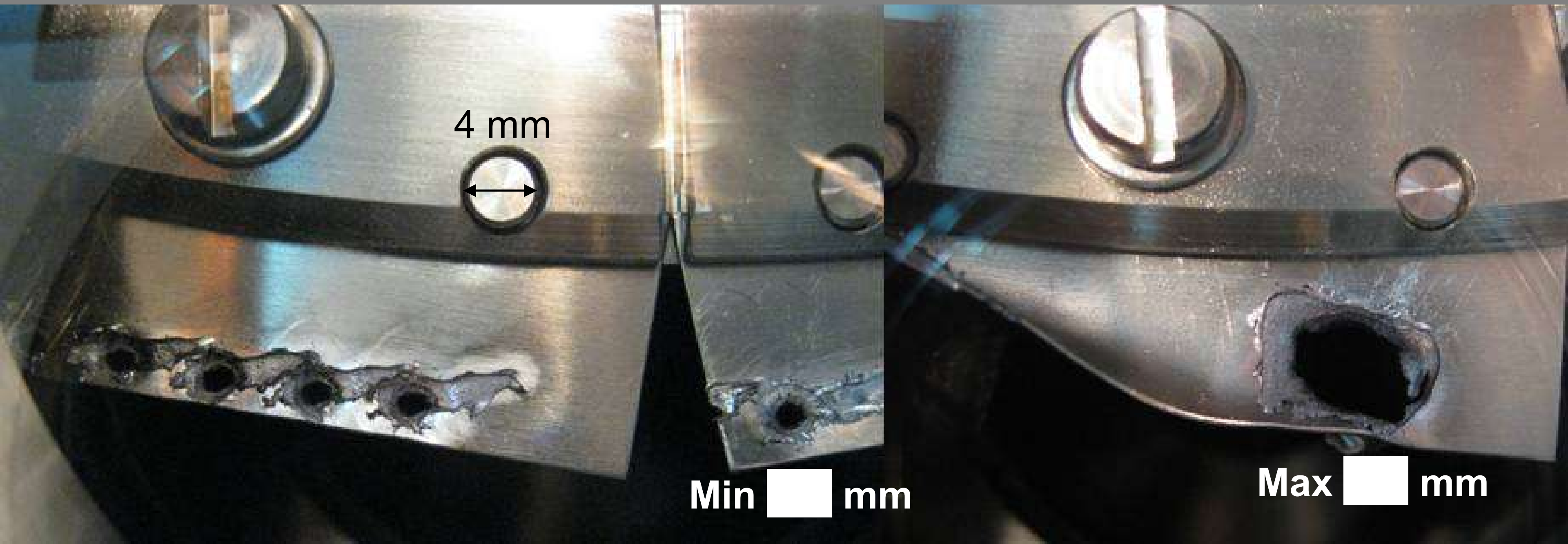


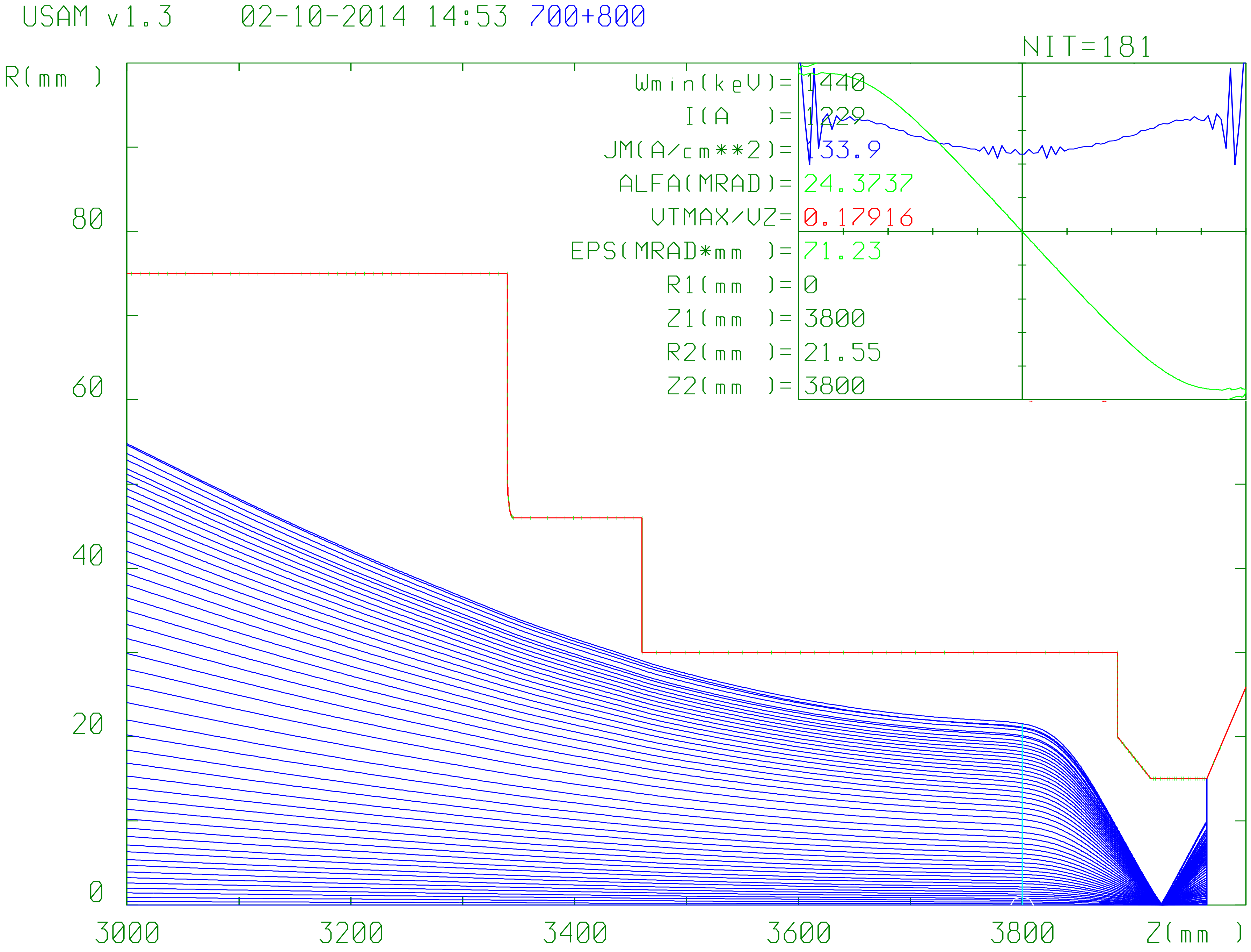
Reliable operation regime with target explosion




mm
10
20
30
40
1/2mm
Min
mm

For fixed beam energy and current the hole diameter in the target can be changed by final lens strength regulation (from minimum possible to maximum possible value).
These two values help to perform the beam emittance estimation.




USAM v1.3 02-10-2014 14:53 700+800
NIT=181
R(mm)
Wmin(keV)= 1440
I(A)= 1229
JM(A/cm**2)= 133.9
ALFA(MRAD)= 24.3737
VTMAX/VZ= 0.17916
EPS(MRAD*mm)= 71.23
R1(mm)= 0
Z1(mm)= 3800
R2(mm)= 21.55
Z2(mm)= 3800
80
60
40
20
0
3000
3200
3400
3600
3800
Z(mm)

For Gaussian transverse distribution of power dissipation in the target:

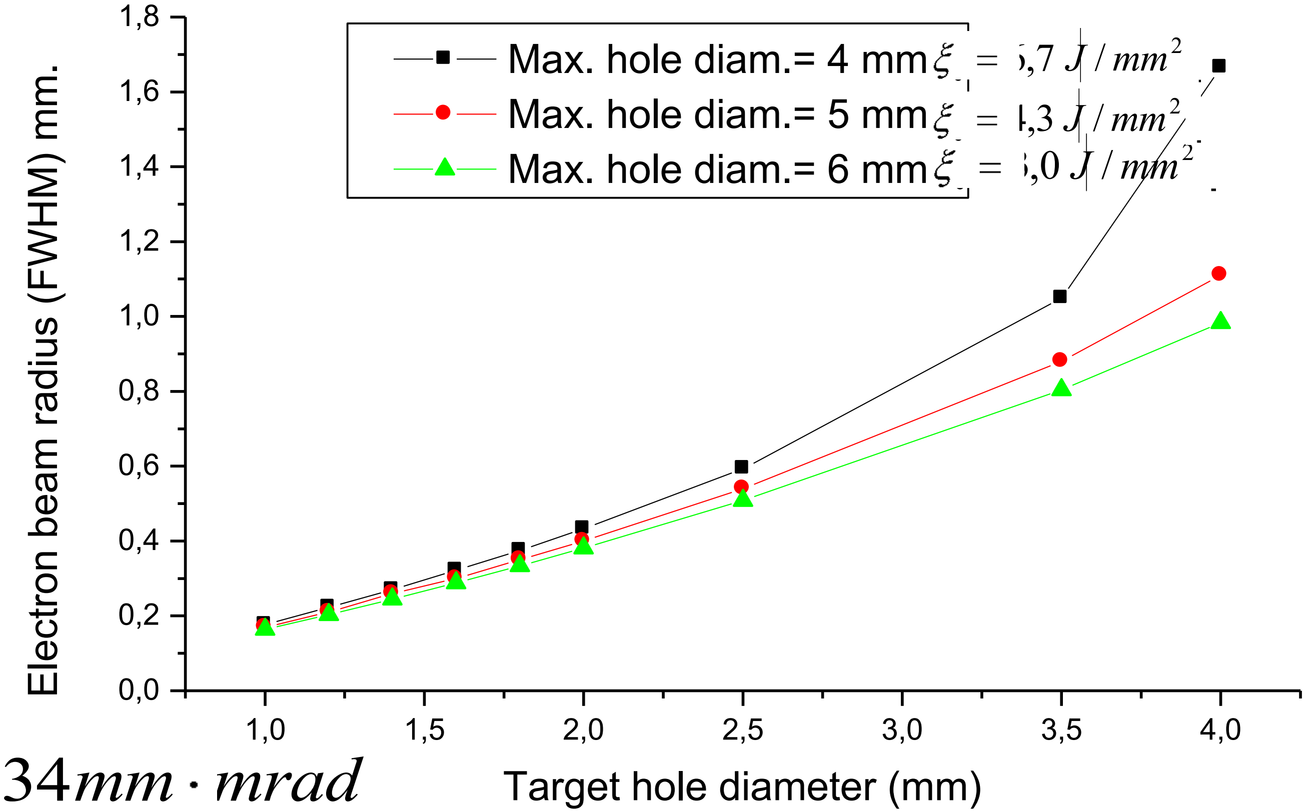
$$\xi = \xi_0 e^{-\frac{r^2}{2\sigma_r^2}} \qquad Q_0 = 2\pi\sigma_r^2 \xi_0 \qquad \xi_e = \xi_0 e^{-\frac{r_e^2}{2\sigma_r^2}} = const$$

$$\xi_e = \frac{Q_0}{\pi r_{\max}^2 e}$$

(1.6 MeV, 1.5 kA, 200 ns, 0.5 mm Ta target)

$$Q_0 = 230J$$

$$r_{FWHM} = \sqrt{2\ln 2}\,\sigma_r$$

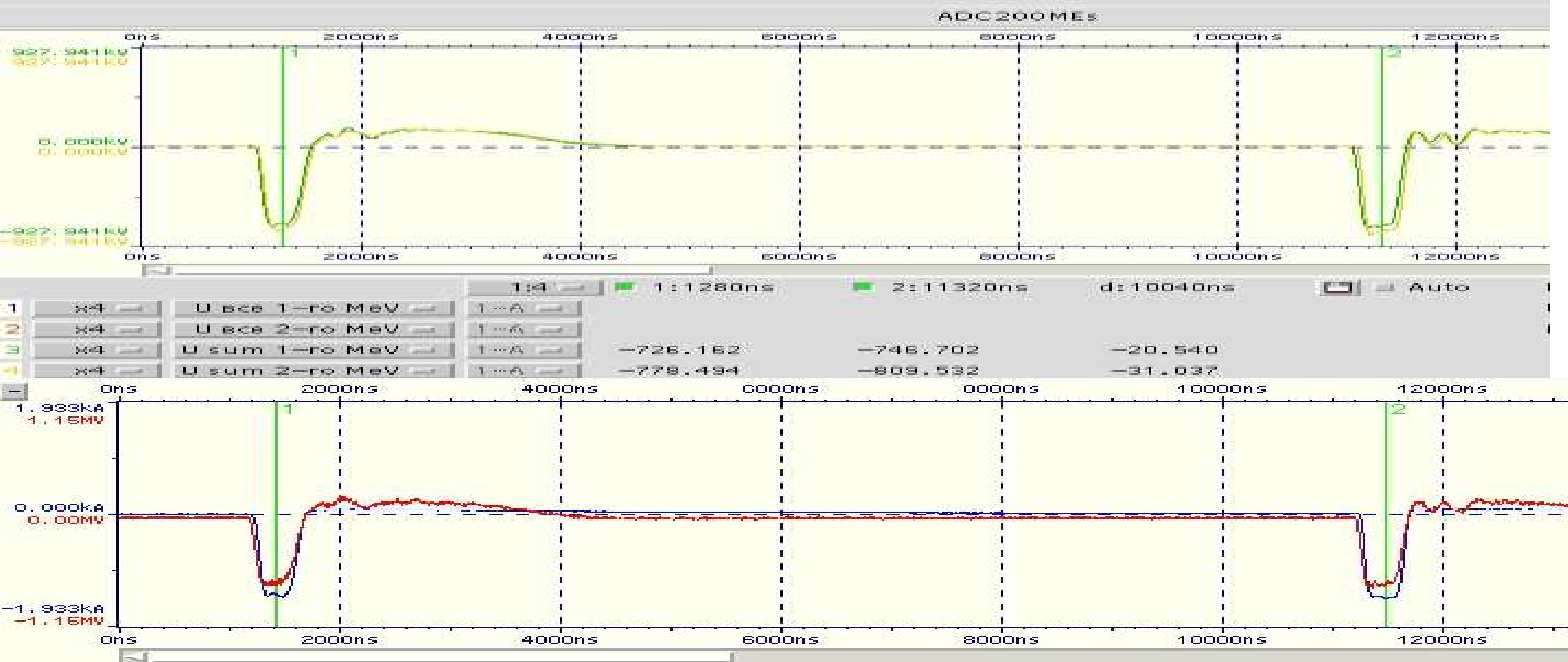


$$r_e = 0.5mm$$

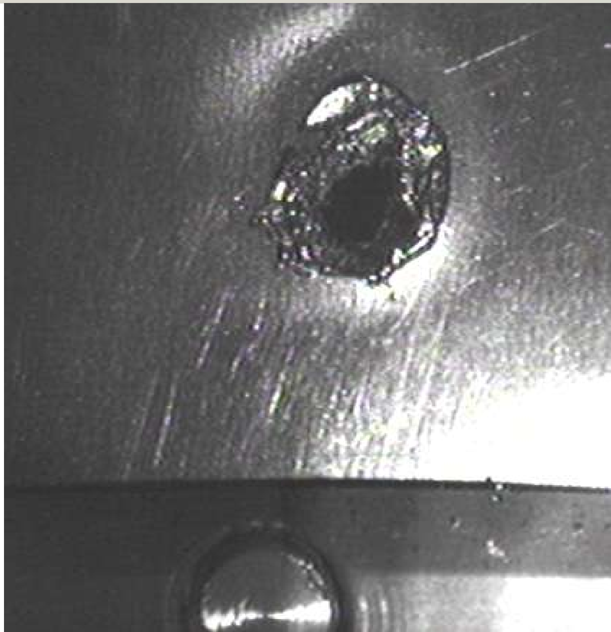
$$r_{\mathrm{FWHM}} = 0.17mm$$

$$\alpha_{\mathrm{target}} = 200mrad$$

$$\varepsilon = \alpha_{target} \cdot r_{FWHM} = 34mm \cdot mrad$$



Two pulse operation of LIA-2, 1 mm thick Ta target.
1.6 MeV, 1.5 kA.
10 μs between pulses.
Normalized beam emittance: 110 π mm•mrad.



Results

- Max reliable regime with target explosion: 1.6 MV, 1.5 kA.
- Max reliable regime without target explosion: 2.0 MV, 2.0 kA.
- Minimum normalized beam emittance:

110 π •mm•mrad

- Two pulse operation: OK on 1 mm Ta target with the same normalized emittance.

Thank you for your attention!

Results of LIA-2 radiographic application have been presented yesterday at the poster session «B» № 51.