

CURRENT STATUS OF JINR-IAP EXPERIMENT

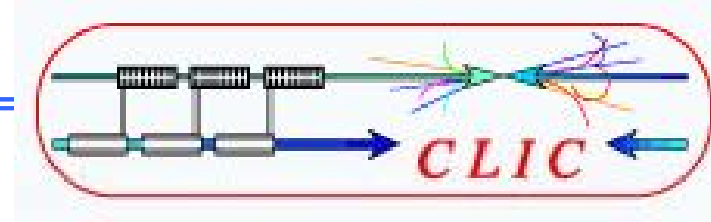
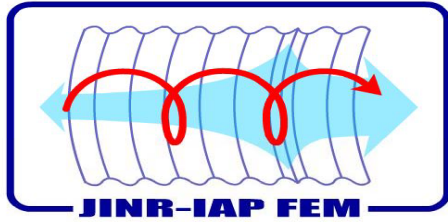
ON 30 GHZ CAVITY HEATING

Kaminsky A.K., Perelstein E.A., Sedykh S.N.

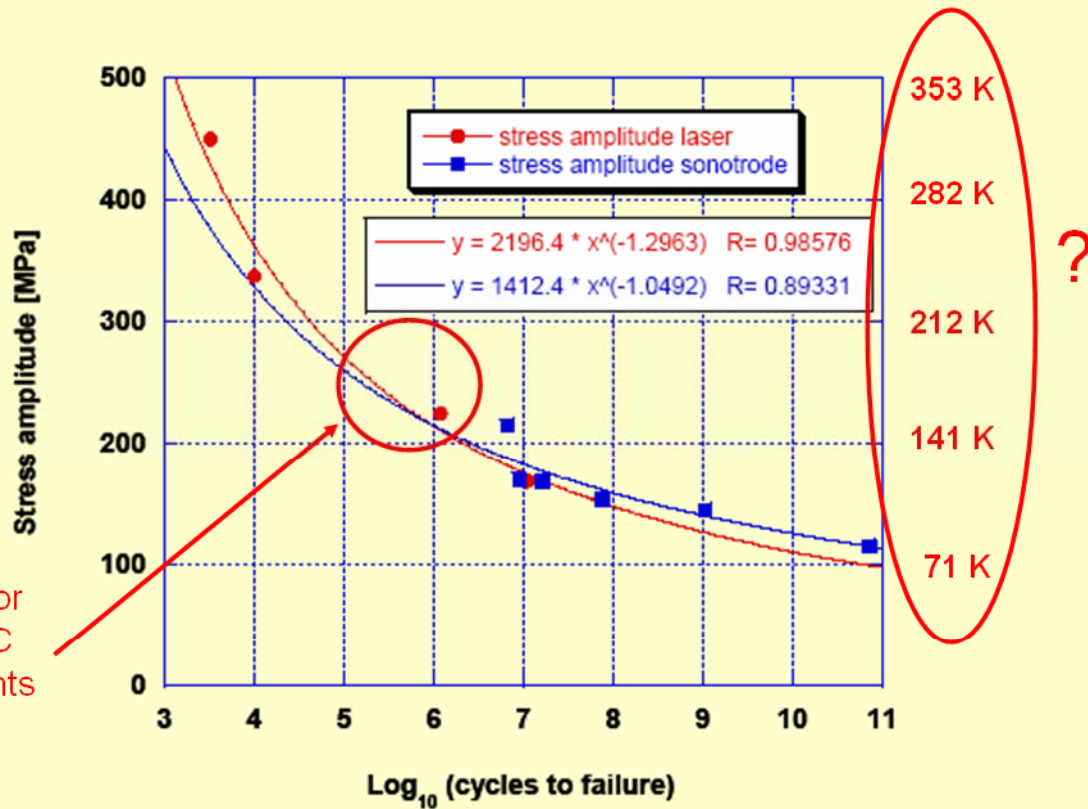
JOINT INSTITUTE FOR NUCLEAR RESEARCH, Dubna

Kuzikov S.V., Peskov N.Yu., Petelin M.I.

*INSTITUTE OF APPLIED PHYSICS RUSSIAN ACADEMY OF
SCIENCES, Nizhny Novgorod*

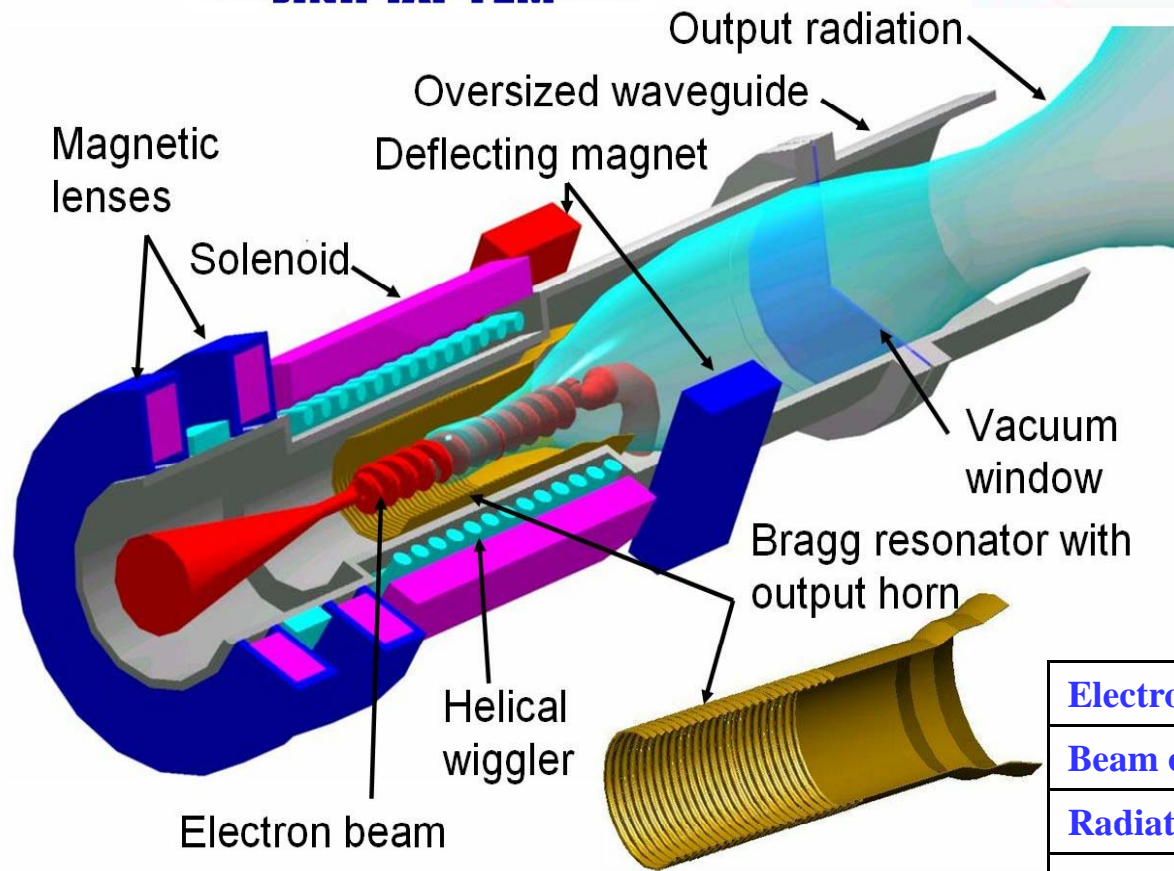
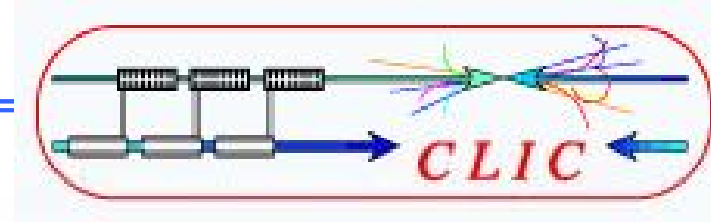
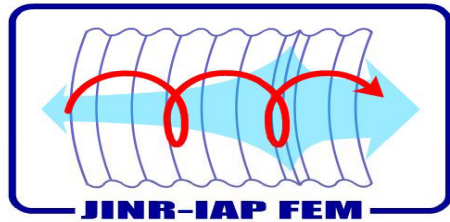


Fatigue limit: laser & ultrasound



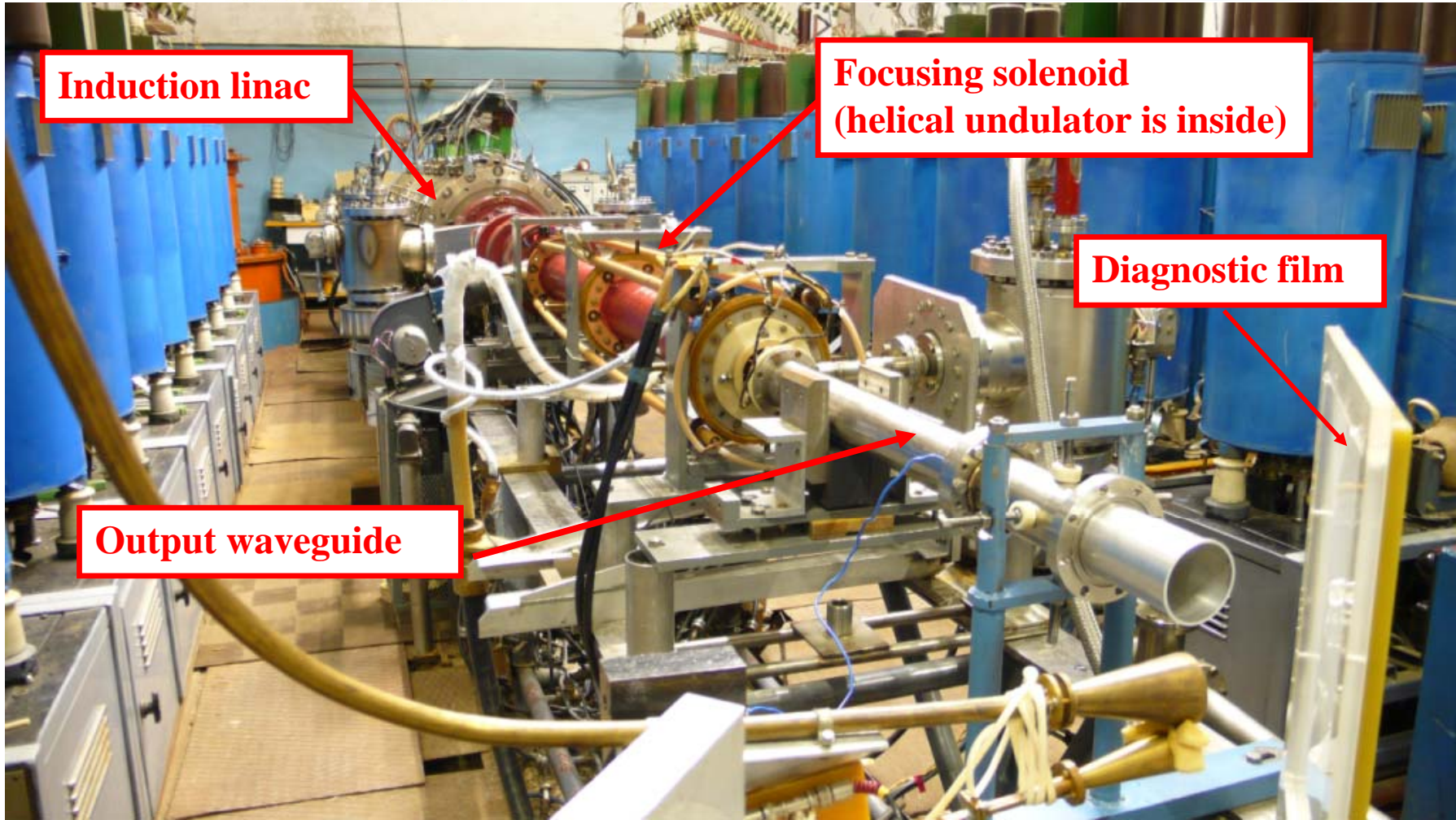
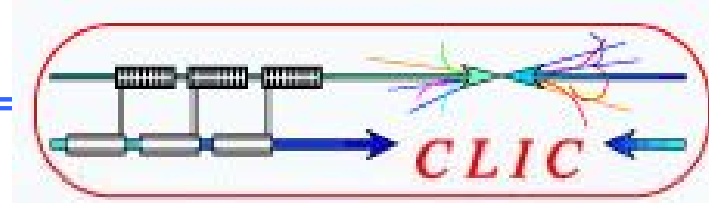
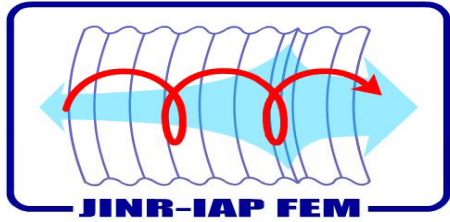
Parameters planned for JINR-IAP experiment



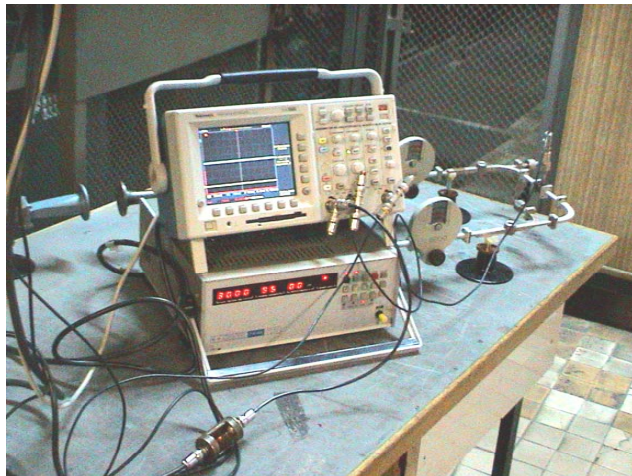
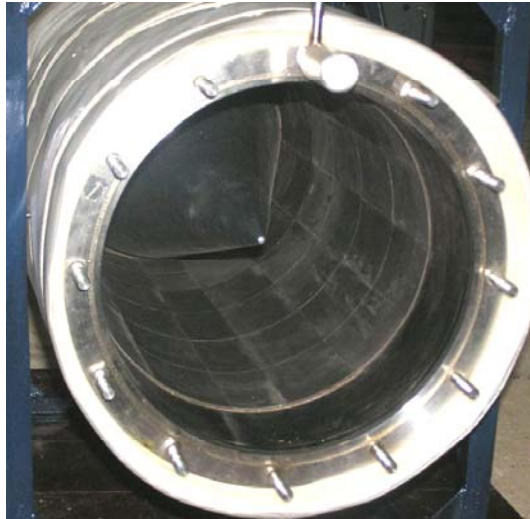
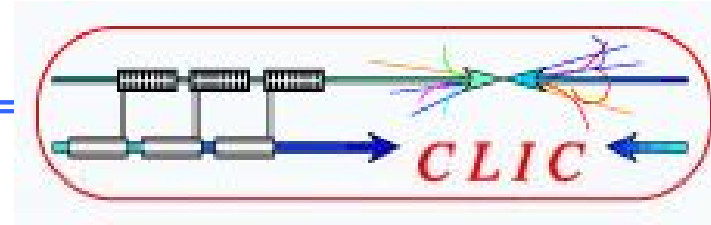
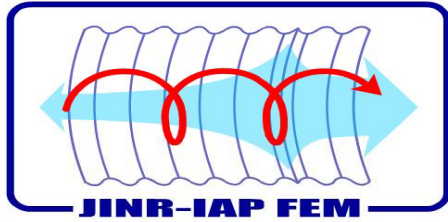


Electron energy	0.8 MeV
Beam current	200 A
Radiation power	15 – 25 MW
Pulse length	150 ns
Radiation frequency	30 GHz
Spectrum width	< 0.1%
Repetition rate	0.5 – 1 Hz

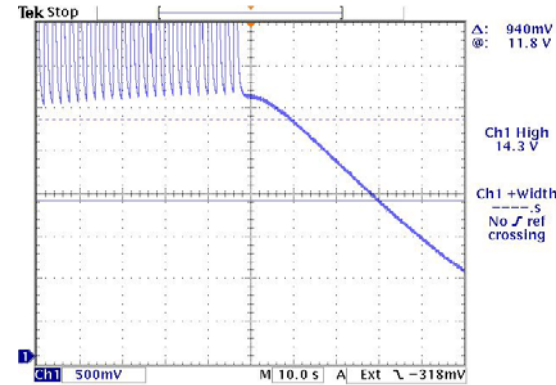
JINR-IAP FEM oscillator with Bragg resonator



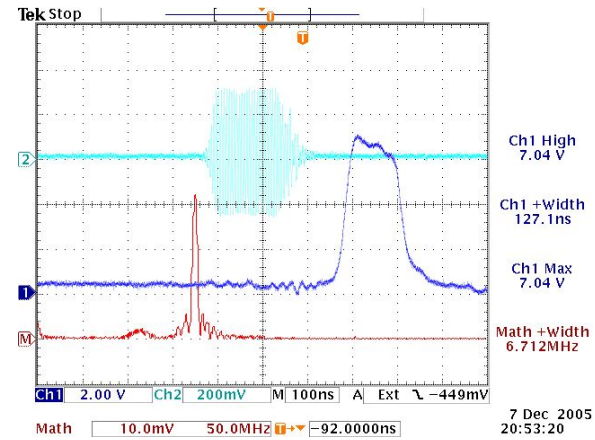
General layout of JINR-IAP FEM oscillator based on induction linac



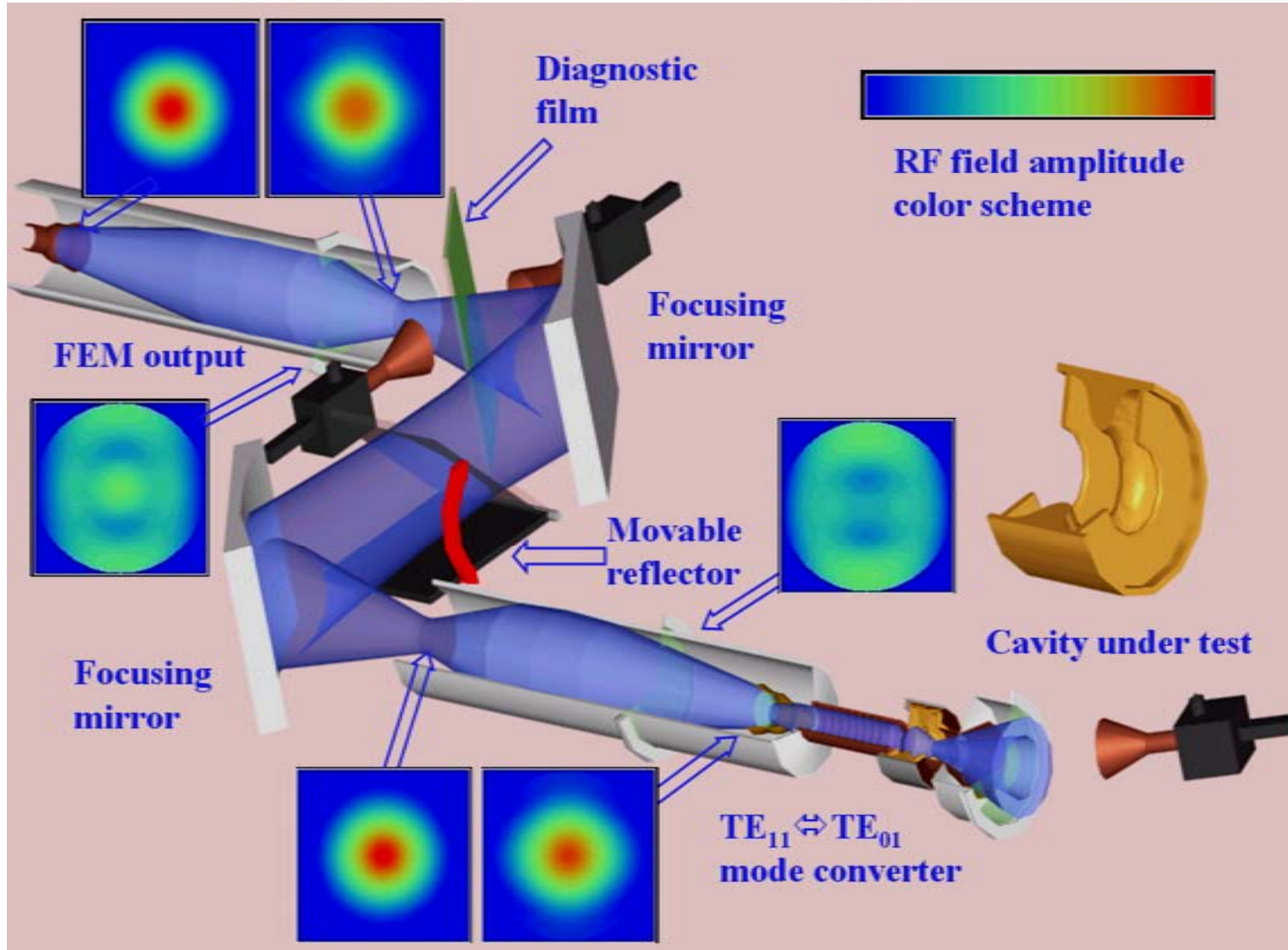
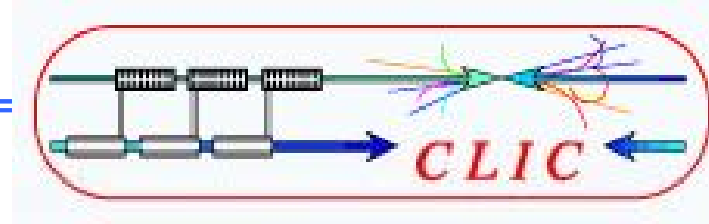
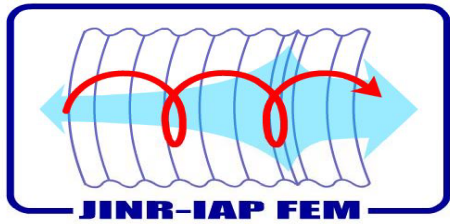
Calorimeter and heterodyne spectrum meter.



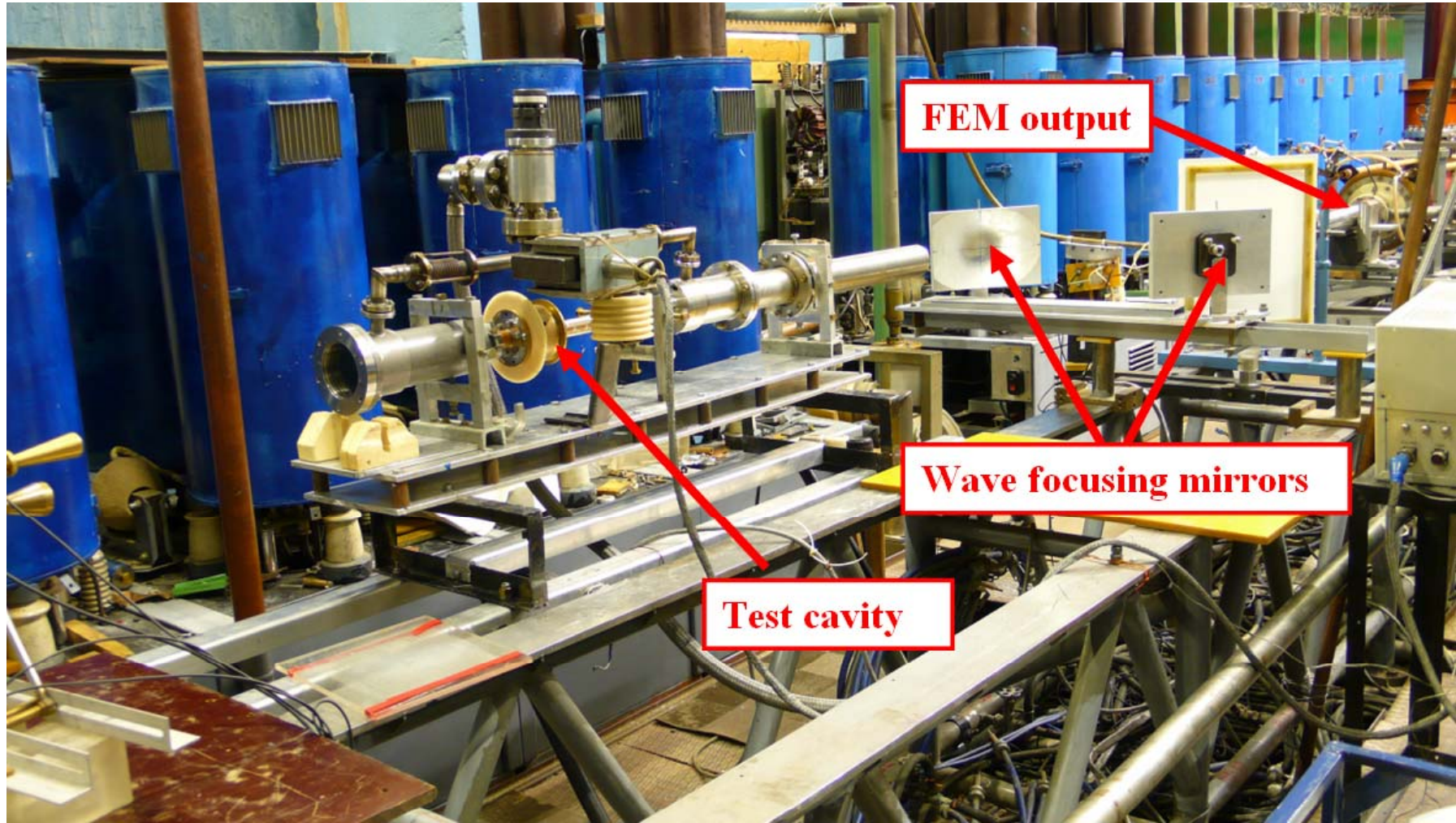
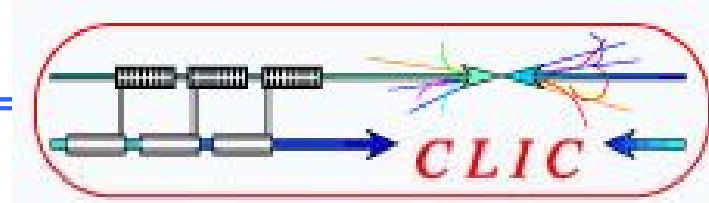
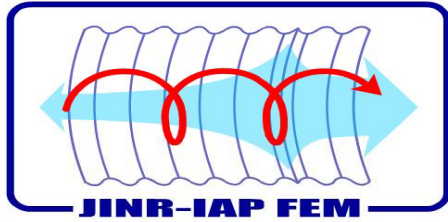
Typical output parameters of FEM radiation.
Pulse energy 2.2J



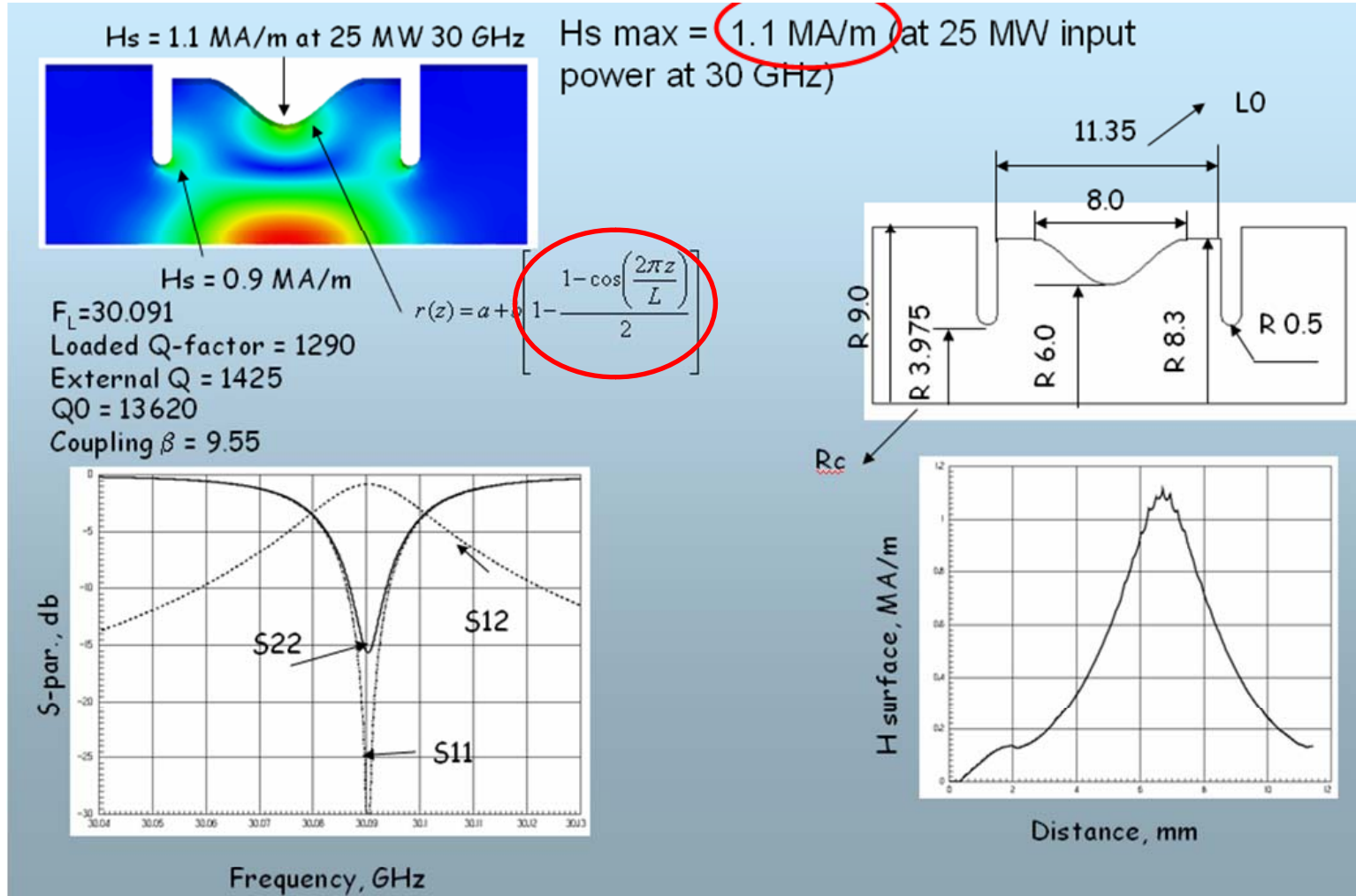
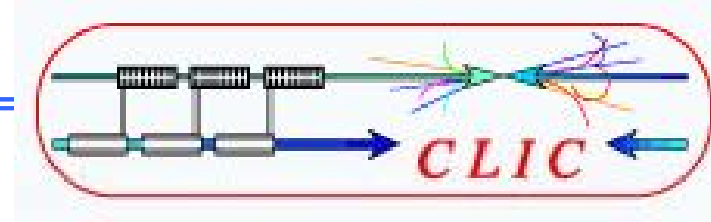
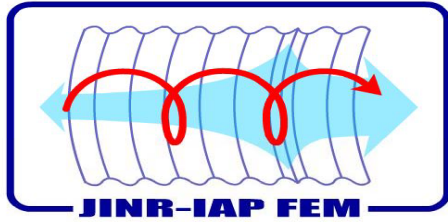
Typical output parameters of FEM radiation



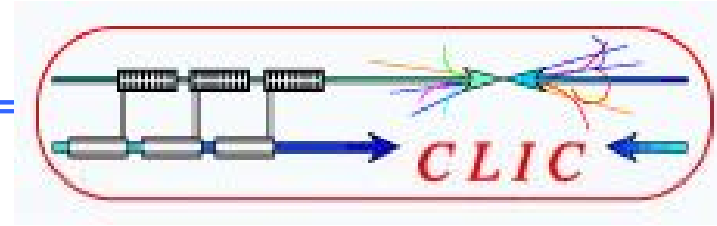
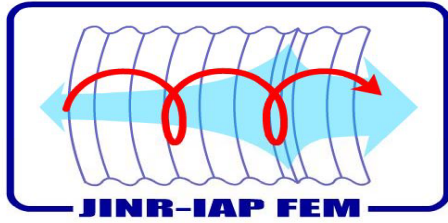
Layout of the experiment on 30 GHz copper cavity heating



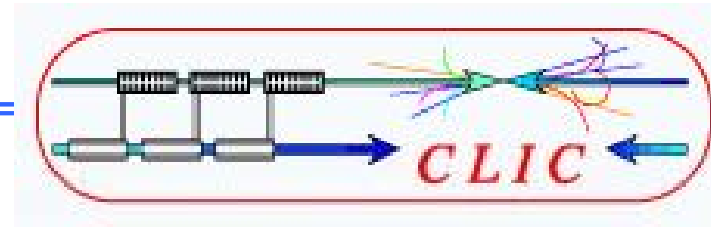
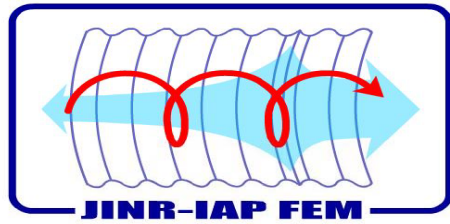
Overview of experimental setup



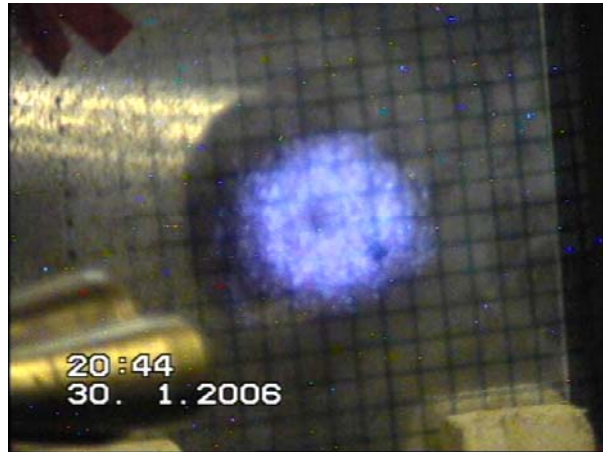
Parameters of test cavity for preliminary JINR experiments



Details of test cavity – vacuum box, central ring and input diaphragm

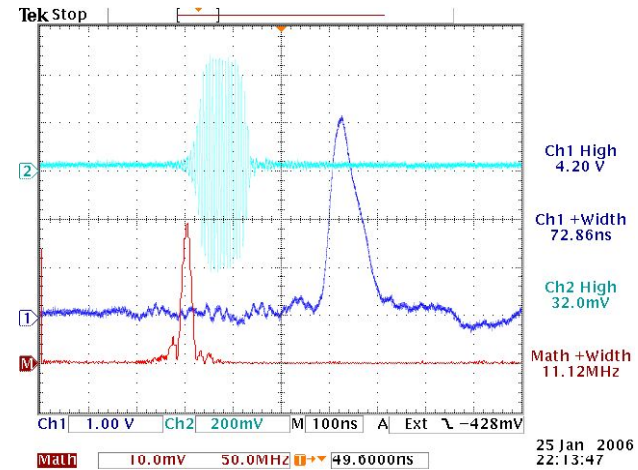
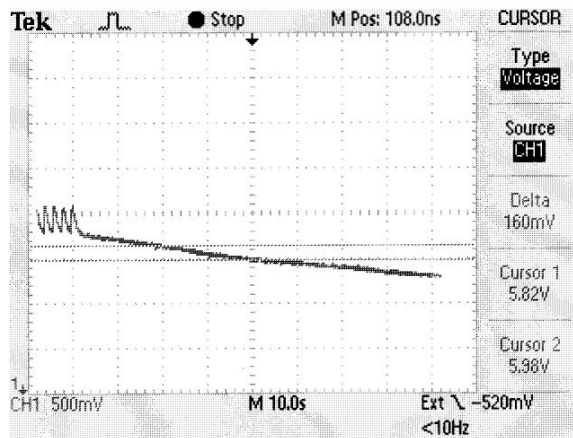
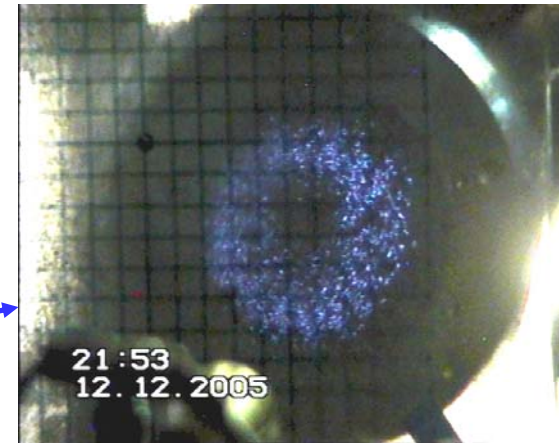


Wavebeam
visualisation:

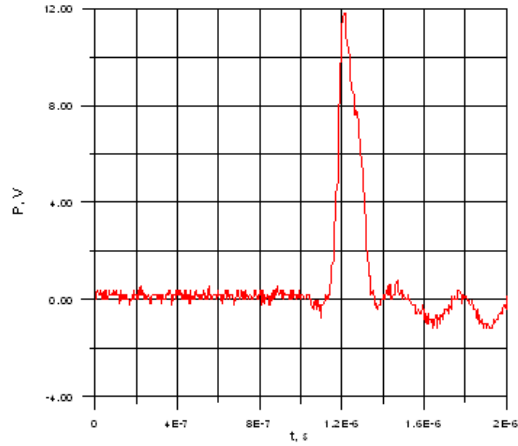
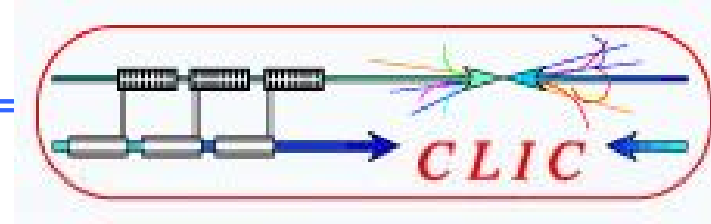
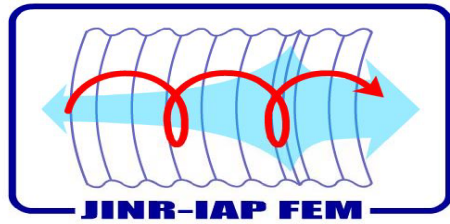


at the FEM output
(Gaussian beam)

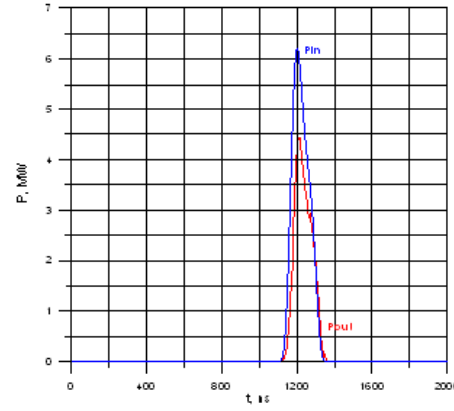
after the test cavity
(H01 mode)



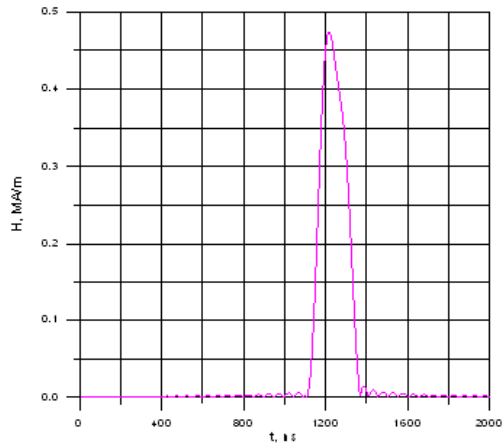
Pulse energy after test cavity was 0.4J, pulse duration was 70 ns



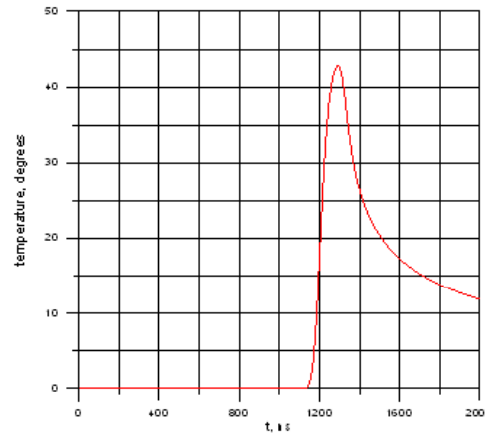
Measured signal from output detector



Output pulse and the recovered input pulse envelopes

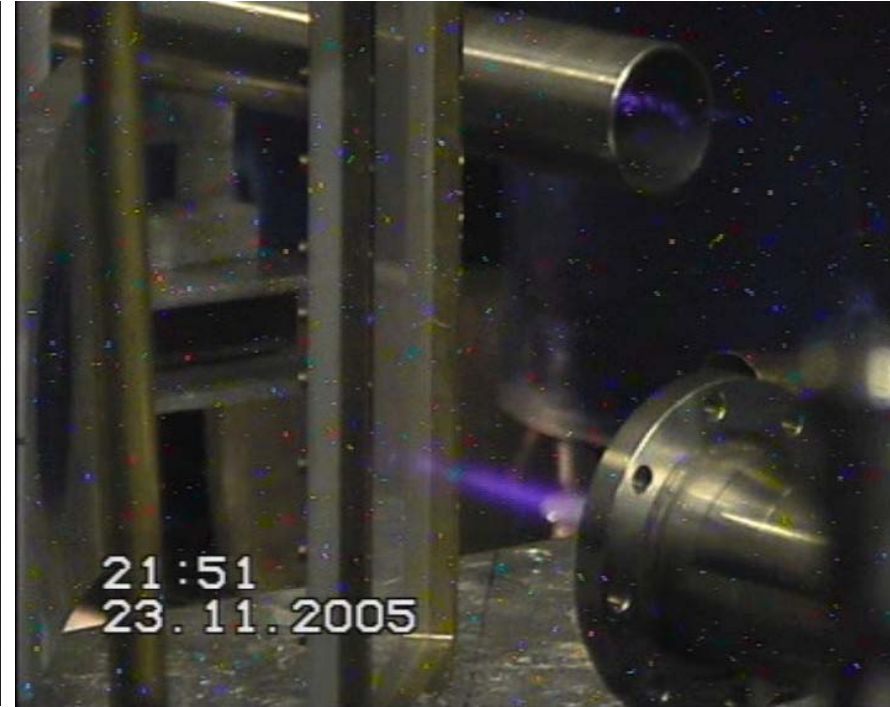
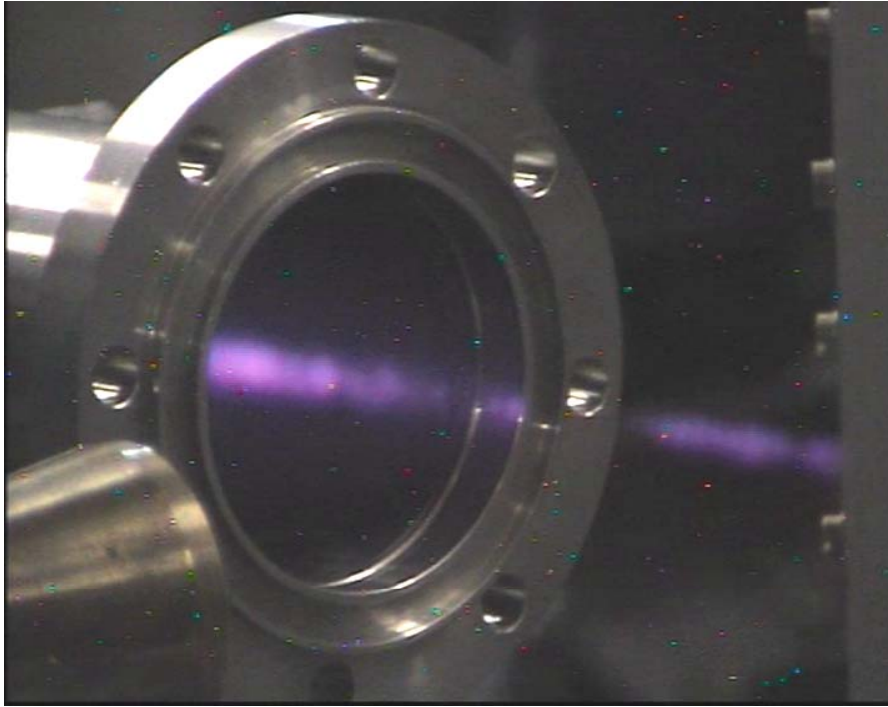
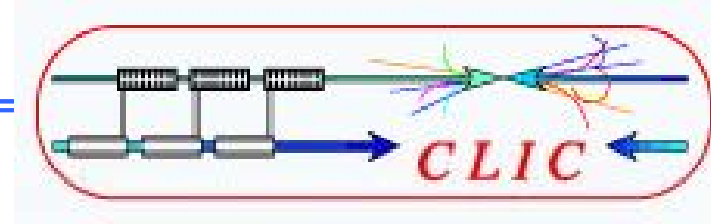
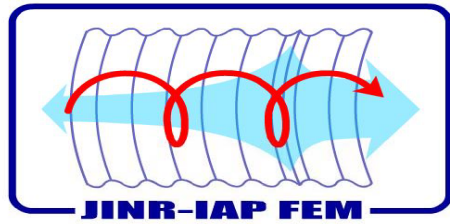


Maximum magnetic field in test cavity surface

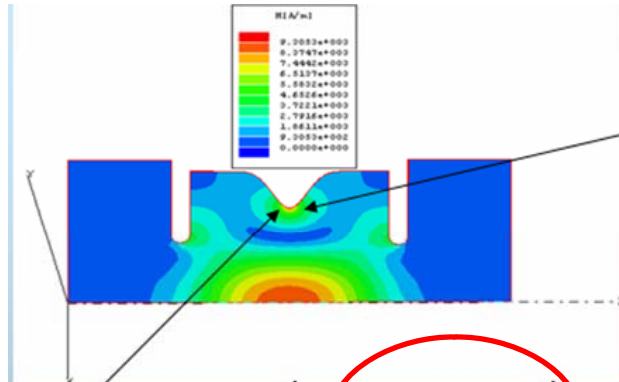
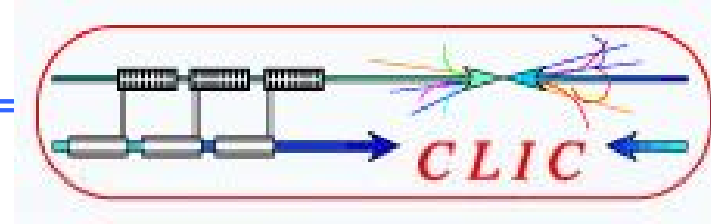
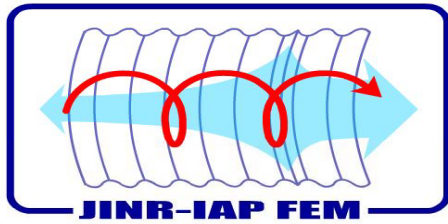


Temperature rise

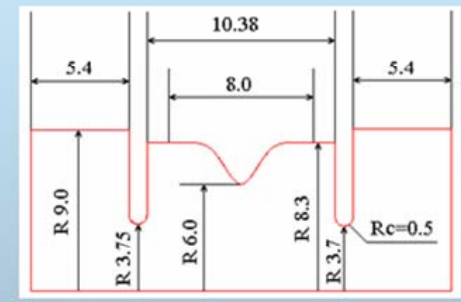
Temperature rise is 43°C.



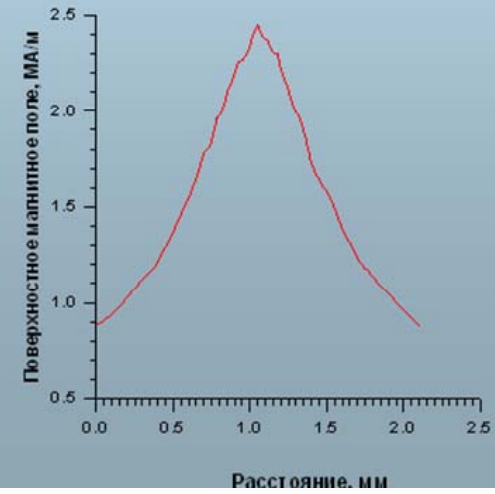
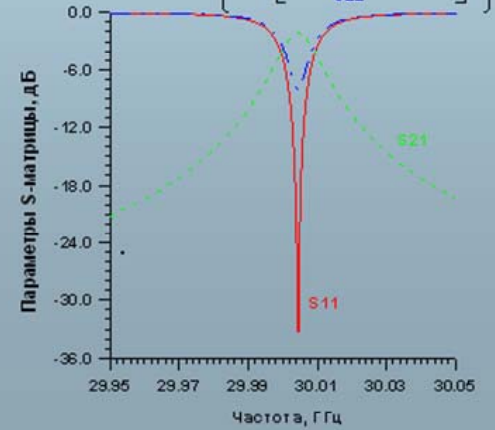
Air breakdown at the FEM output waveguide and at the input of test cavity module



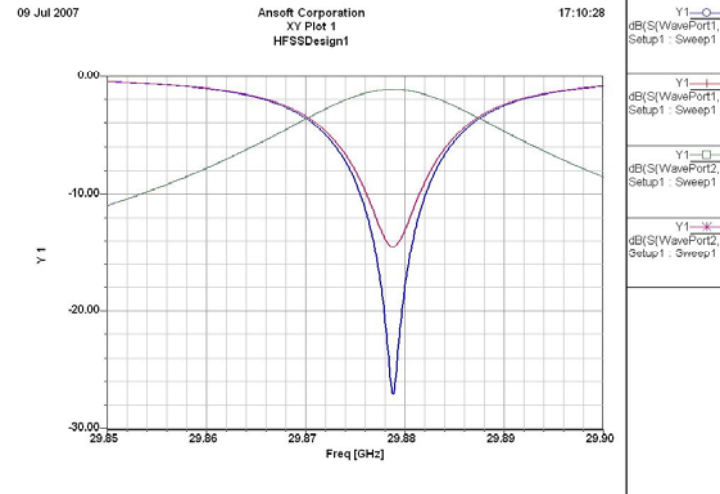
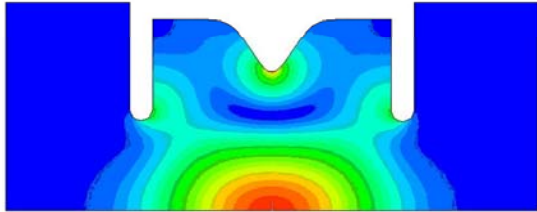
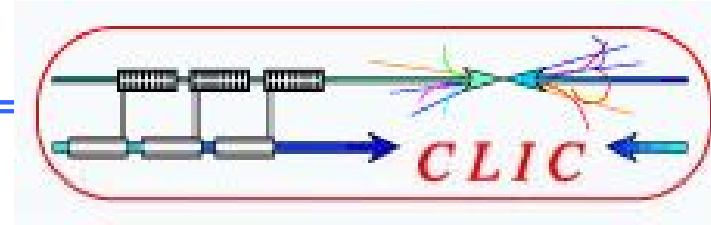
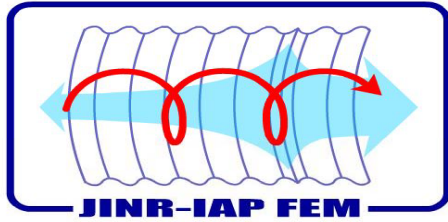
$f_L = 30.004(\text{GHz})$ $Q_0 = 12150$ $Q_L = 2400$
 $H_{s,max} = 2.45(\text{MA/m})$ $P_{in} = 25(\text{MW})$



$$r(z) = R_0 + (R_1 - R_0) \left[1 - \frac{1 - \cos\left(\frac{2\pi z}{L_1}\right)}{2} \right]^4, \quad (L_0 - L_1)/2 < z < (L_0 + L_1)/2$$



Parameters of improved test cavity



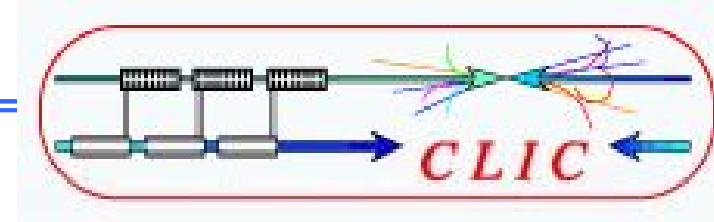
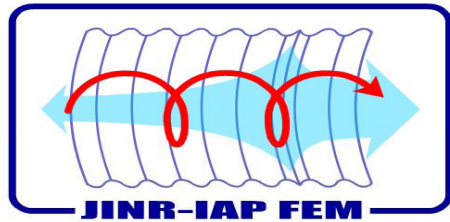
Test cavity with sharp edges and quality factor about 1500.

Frequency - 29,8788 GHz

Quality factor - 1500.

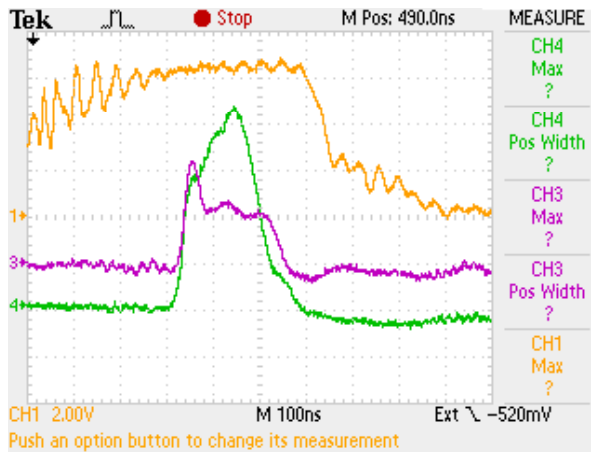
H z,max - 1,98 MA/m when Win = 25MW

Improved test cavity with Q-factor about 1500

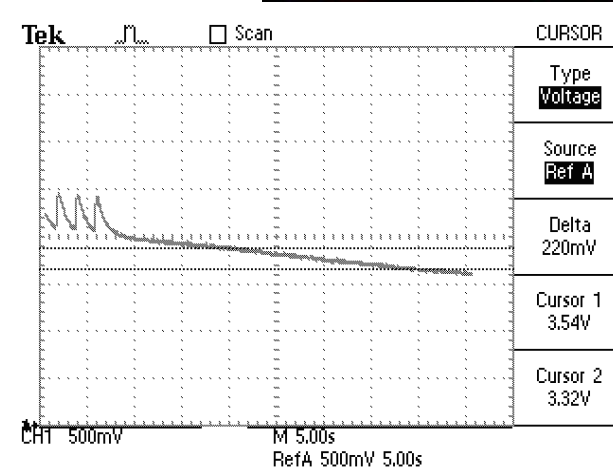


Wavebeam
visualisation:
after the test cavity
(H_{01} mode)

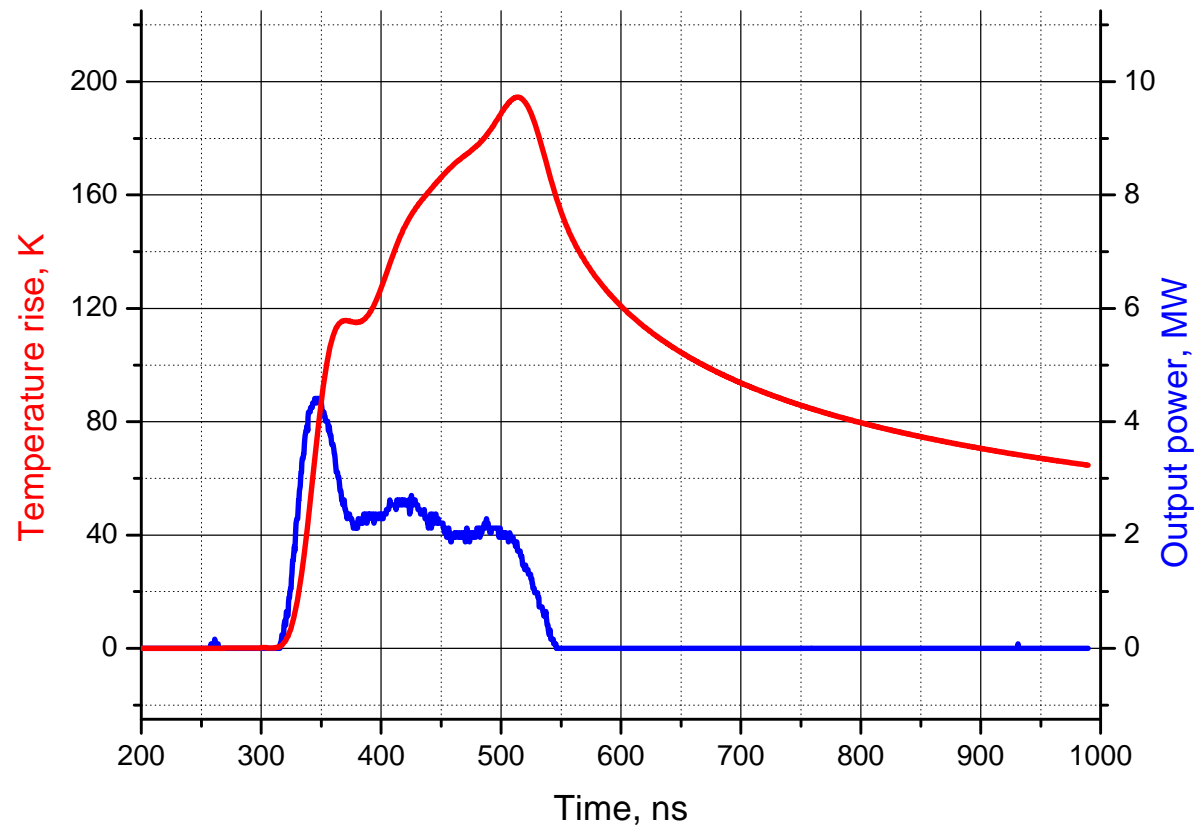
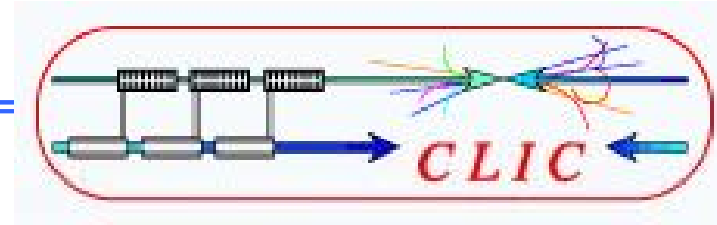
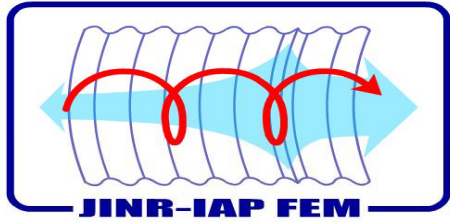
Vacuum breakdown
in the test cavity



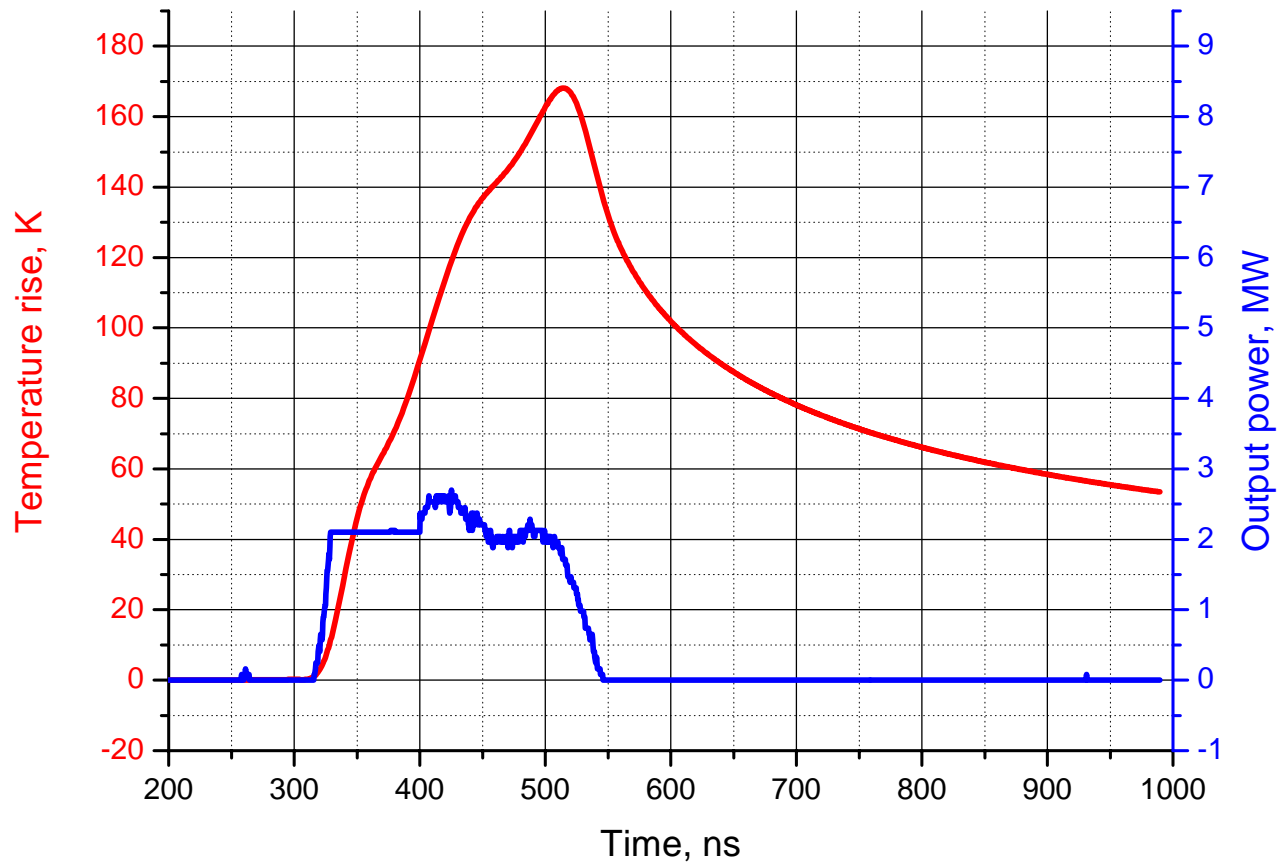
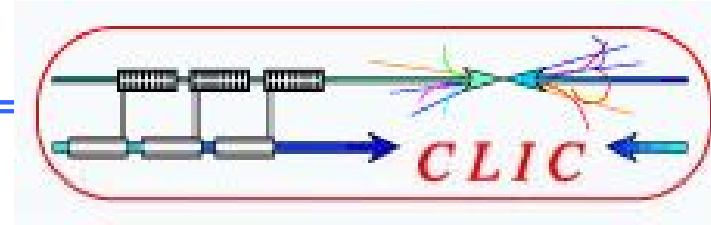
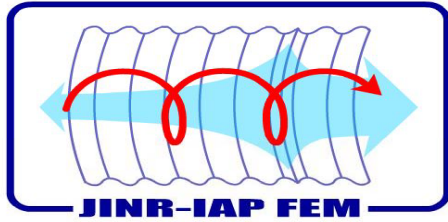
RF power behind the FEM (green trace)
and after the test cavity (violet trace)



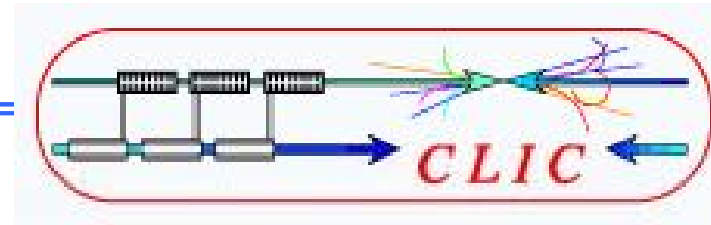
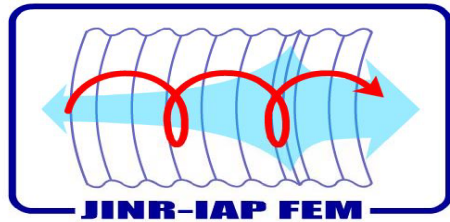
Pulse energy after test cavity is 0.51 J,
pulse duration is about 200 ns



RF signal measured by crystal detector behind the test cavity (blue trace) and pulse temperature rise (red trace).



We suppose that more stable operation will correspond to the pulse heating about 150-160 K.



CONCLUSION

Feeding of several variants of test cavity at the frequencies 29.87-30.17 GHz have been realized in JINR-IAP RAS experiments during 2005-2007.

Pulsed heating at the level of 35-45 K have been obtained in 2006 with variant of test cavity with Q-factor about 1300. Statistics of $1.0^4 \cdot 10^5$ pulses have been registered and showed ability of the facility for long-time heating experiments. Surface of central ring was not damaged.

Pulsed heating at the level of 150-160 K have been obtained in 2007 using new variant of test cavity with Q-factor about 1500 and modified shape of central ring.