# Control of the plasma transversal losses, caused by MHD instabilities, in open mirror magnetic traps of the ECRIS: recent experiments on SMIS 37 setup

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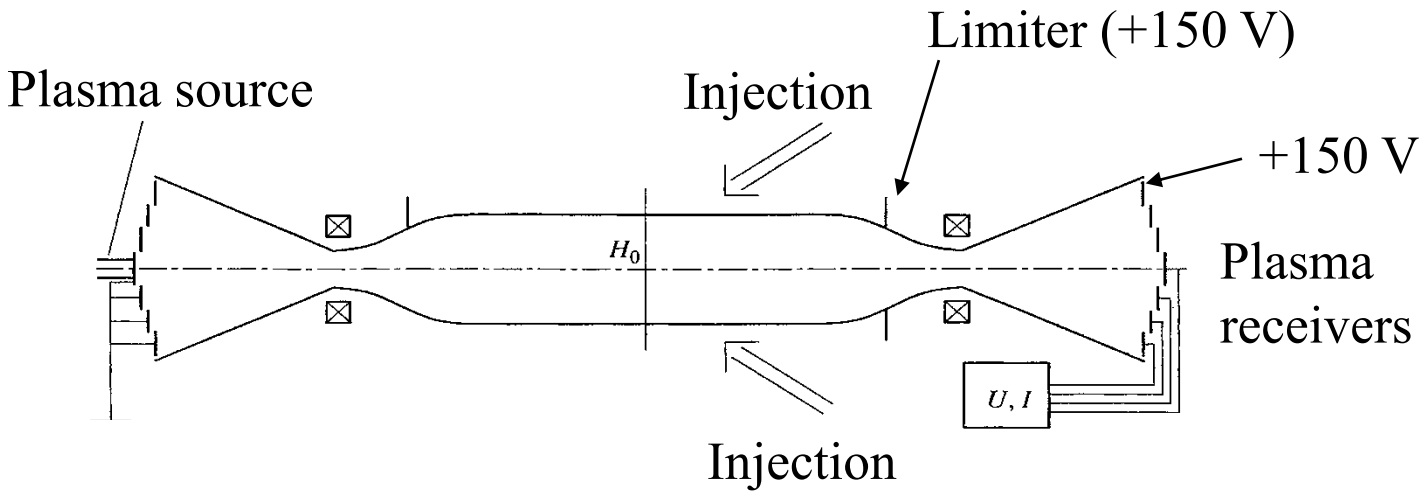
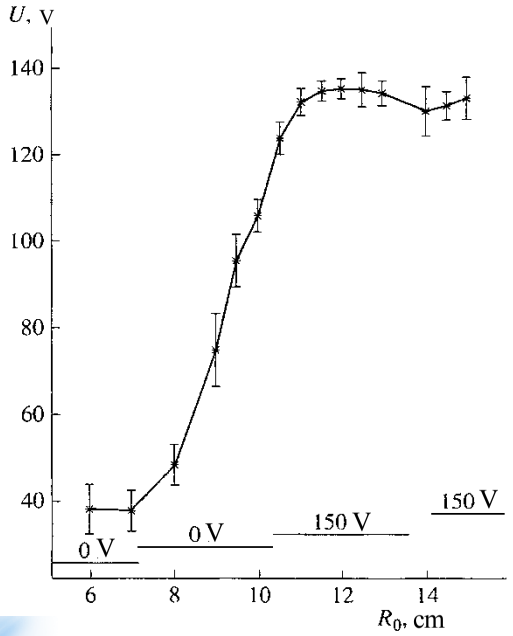
# Vortex confinement: potential profile control in Gas Dynamic Trap



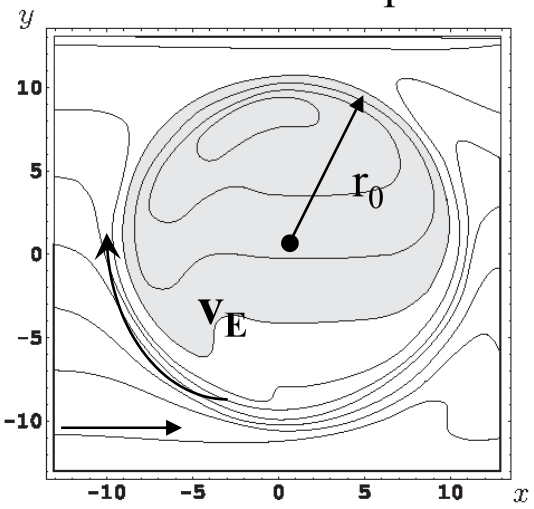

Potential profile

$\beta = N_e T_e / (B^2/8\pi) \sim 0.6!!$

E. I. SOLDATKINA, P. A. BAGRYANSKY and A. L. SOLOMAKHIN. *Plasma Physics Reports*, **34**, 259 (2008).

# Conditions of the “vortex” creation

View of the plasma core in the transversal plane




$\otimes \vec{B}$

$\mathbf{v_g}$ - velocity transversal flow caused by flute instability

If $v_E >> v_g$ then the closed streamlines appears and the existence of the vortex like structures is possible

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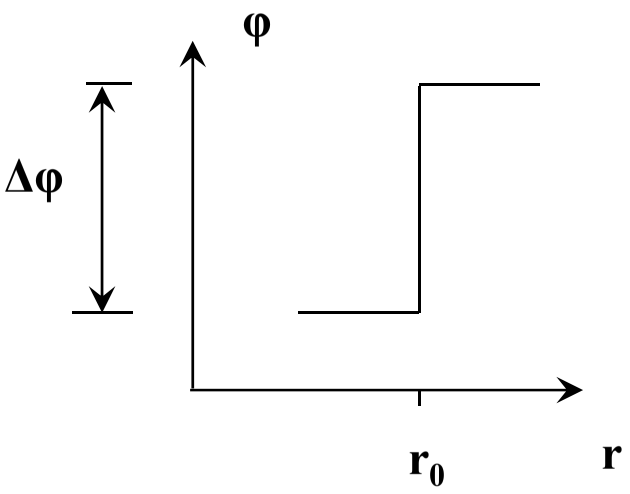


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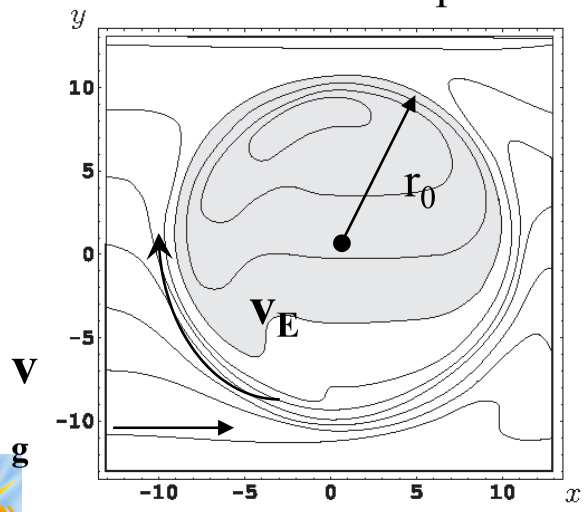


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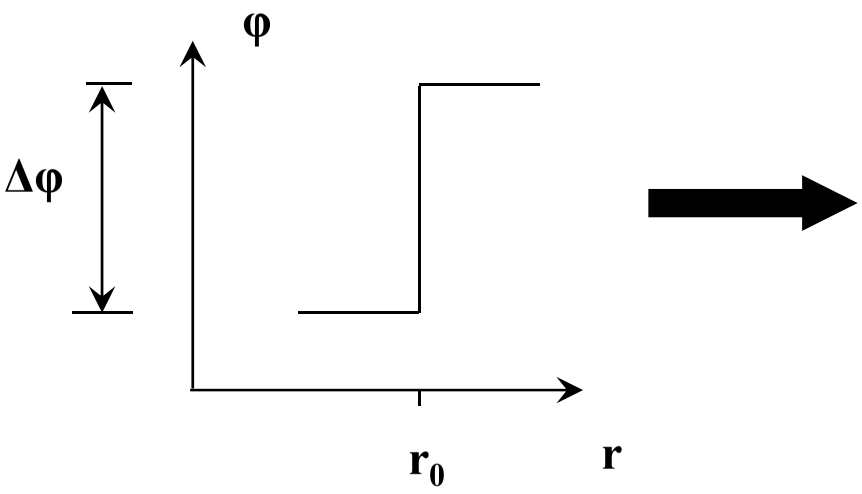


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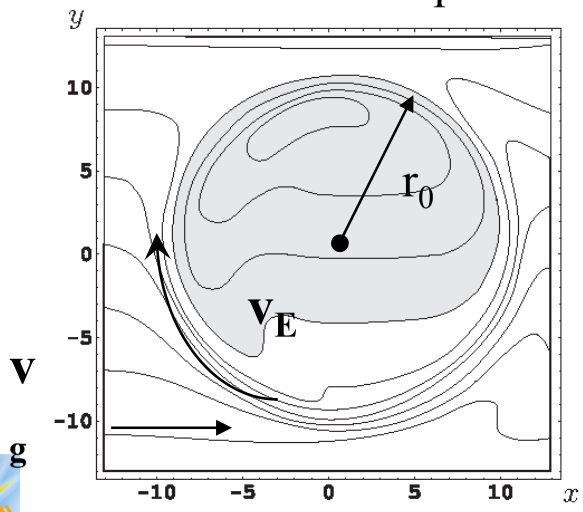


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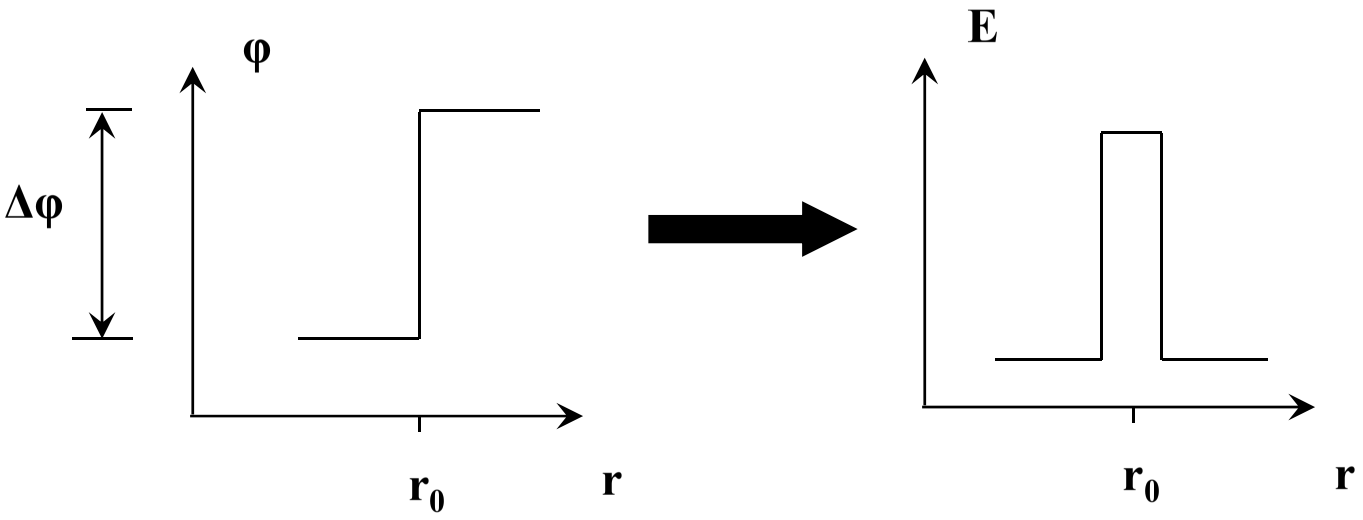


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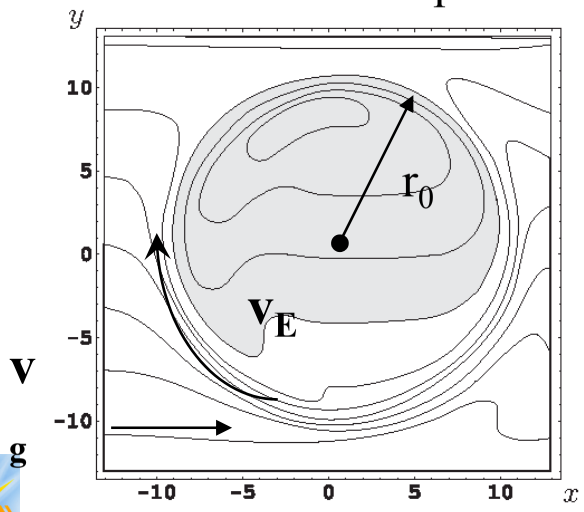


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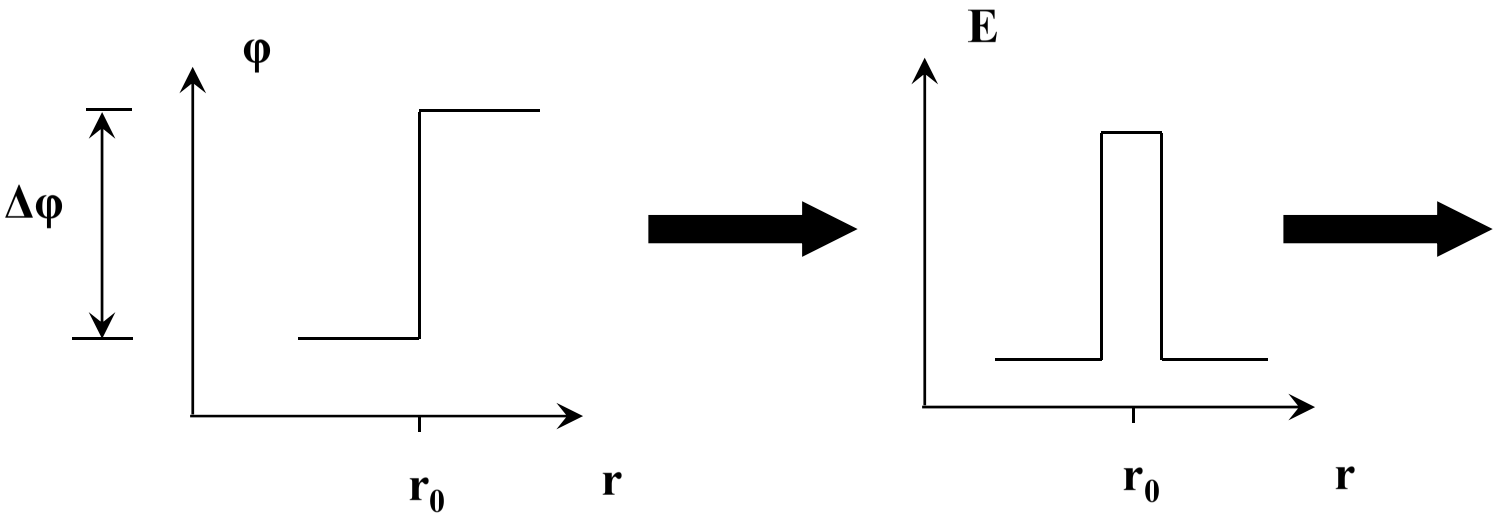


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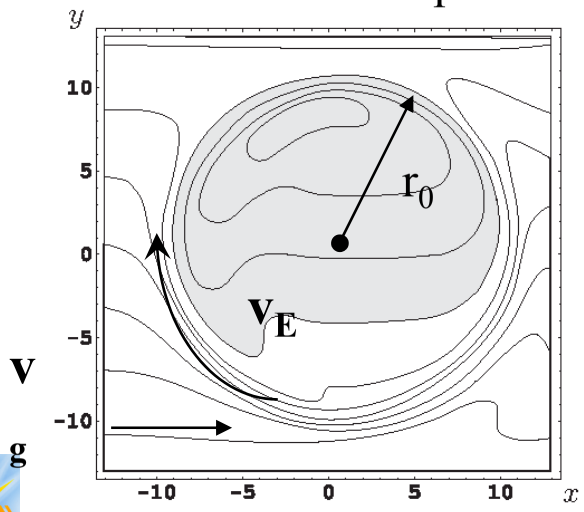


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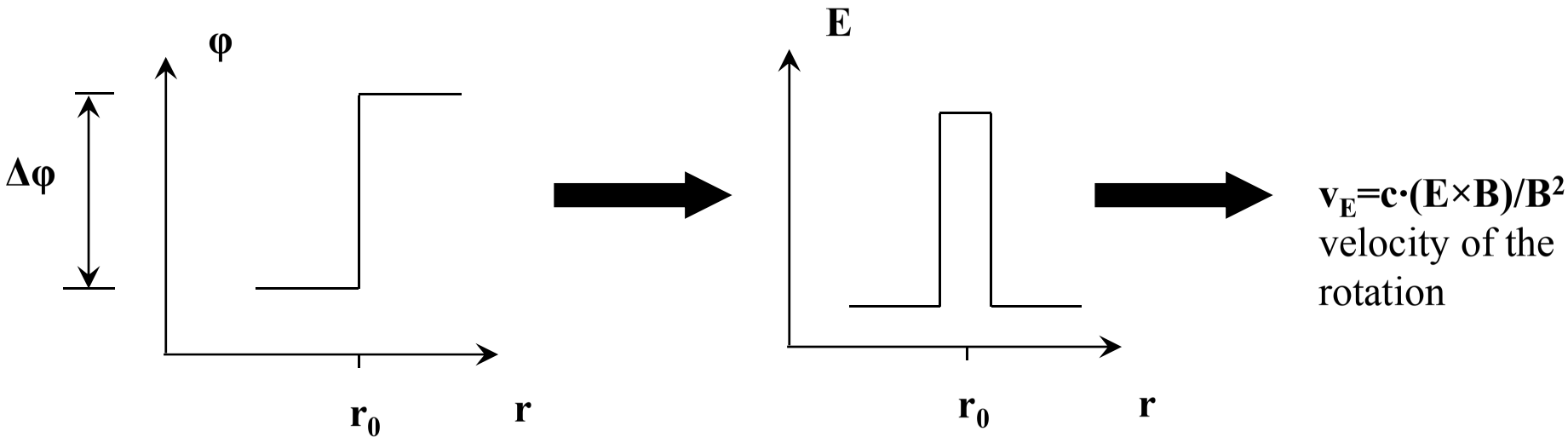
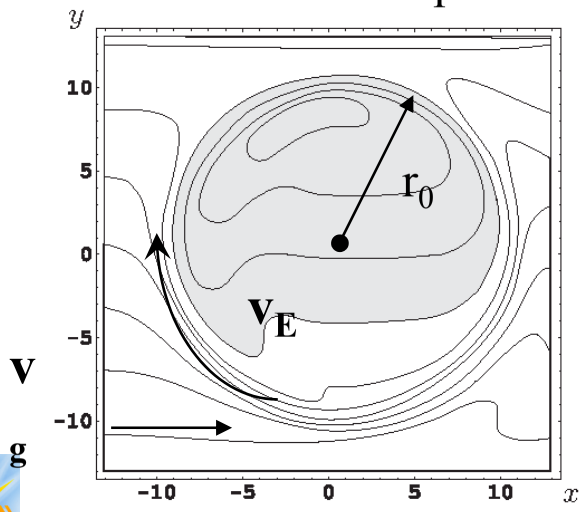



$v_E = c \cdot (E \times B)/B^2$ velocity of the rotation

View of the plasma core in the transversal plane

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# The threshold of the vortex confinement: analytical estimations

threshold of the vortex confinement

$$\frac{e\Delta\varphi}{T_e} \geq 10\sqrt{\frac{T_e M}{Z}}\frac{\kappa c}{eBL}$$

According to the SMIS 37 parameters
(L=30 cm, B=0.5 T, κ=6, Te=100 eV) one can get:

$$\frac{e\Delta\varphi}{T_e} \geq 0.45\sqrt{\frac{A}{Z}}$$

For the helium and nitrogen ions:

$$e\Delta\varphi \geq 1.2T_e$$

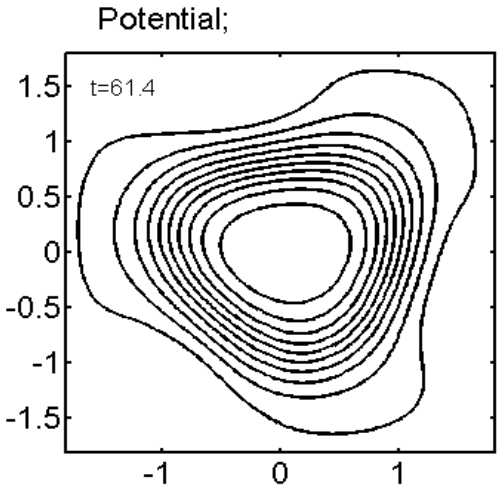
So, the value of the limiter
Voltage has to be in order of
100 V according to the estimations

Beklemishev, A. D. Shear Flow Effects in Open Traps. Theory of Fusion Plasmas, AIP Conference Proceedings. V. 1069. P. 14 – 25 (2008)

# Finite larmor radius (FLR) effect

**GDT** $T_i >> T_e$ $\longrightarrow$ $\rho_i L / a^2 >> 1$

$\rho_i$ - ion gyroradius, L – trap length, a – plasma radius.
At $\rho_i L/a^2 >> 1$ m=1 mode dominates in spatial spectrum of the flute instability

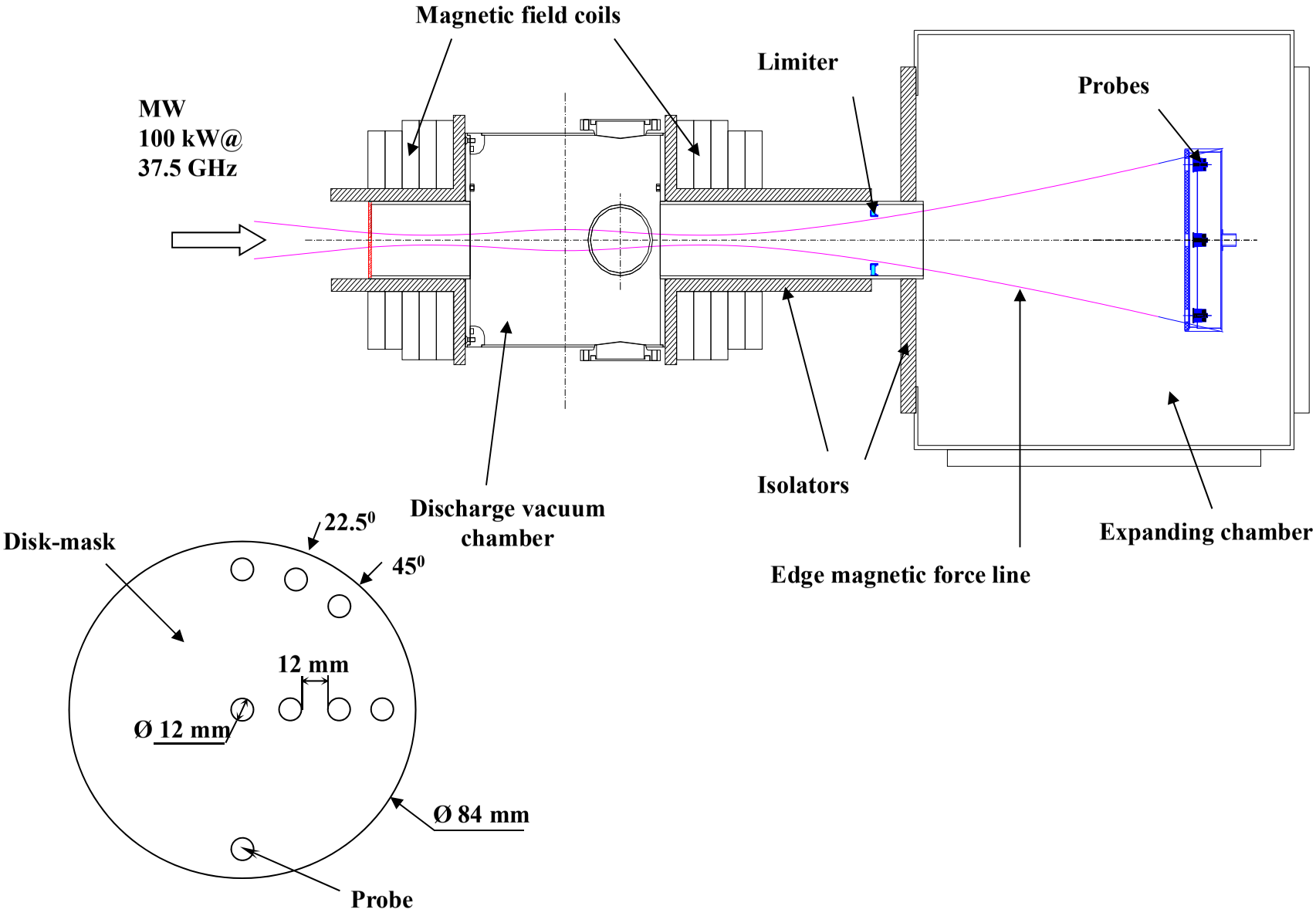



**SMIS 37**

$T_i << T_e$ , FLR effects are negligible and higher modes (m=2, 3) exists in spatial spectrum

A.V. Sidorov, P.A. Bagryansky, A.D. Beklemishev, I.V. Izotov, V.V.Prikhodko, S.V.Razin, V.A. Skalyga and V.G. Zorin, *ECR Plasma Confinement Improvement in the Axisymmetric Mirror Magnetic Trap*, Preprint IAP RAS № 804, 2010 (in russian).

# Scheme of the experiments (SMIS 37)



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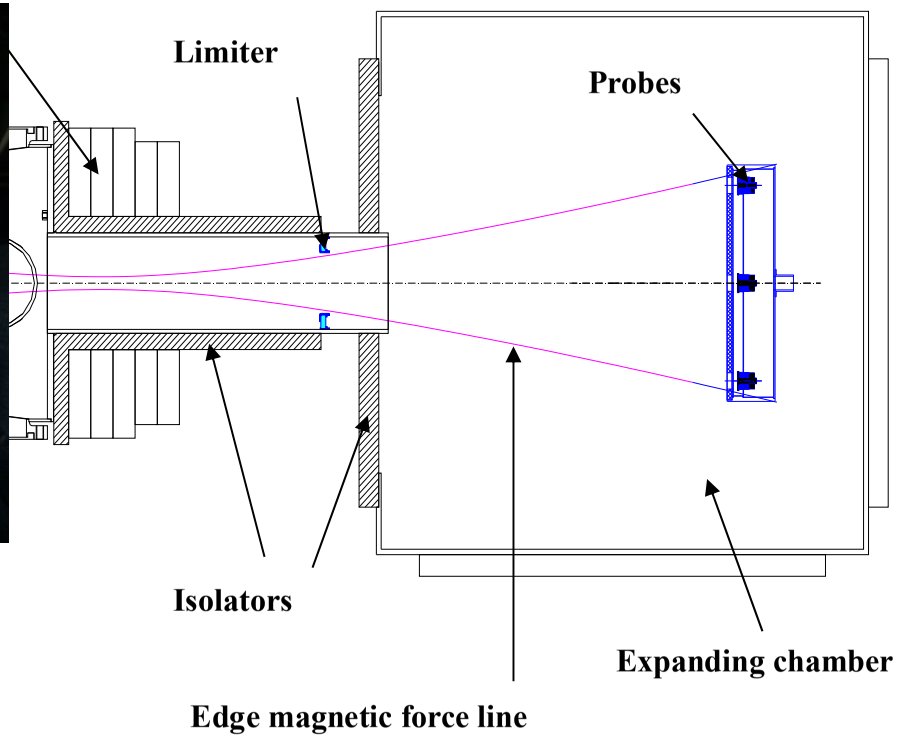


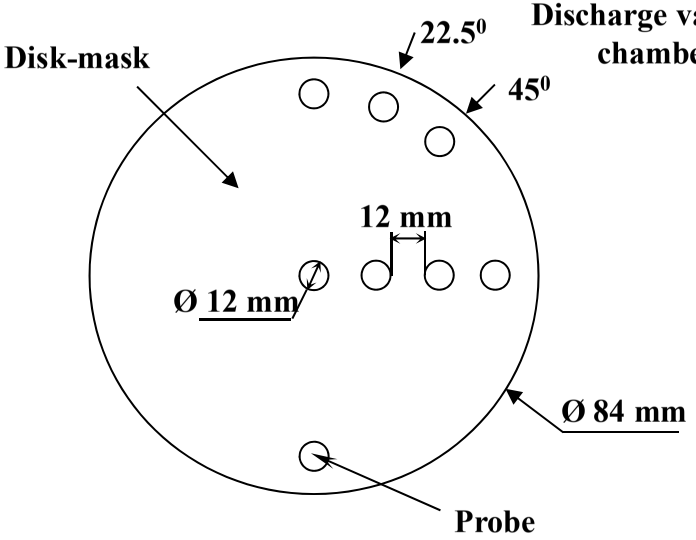

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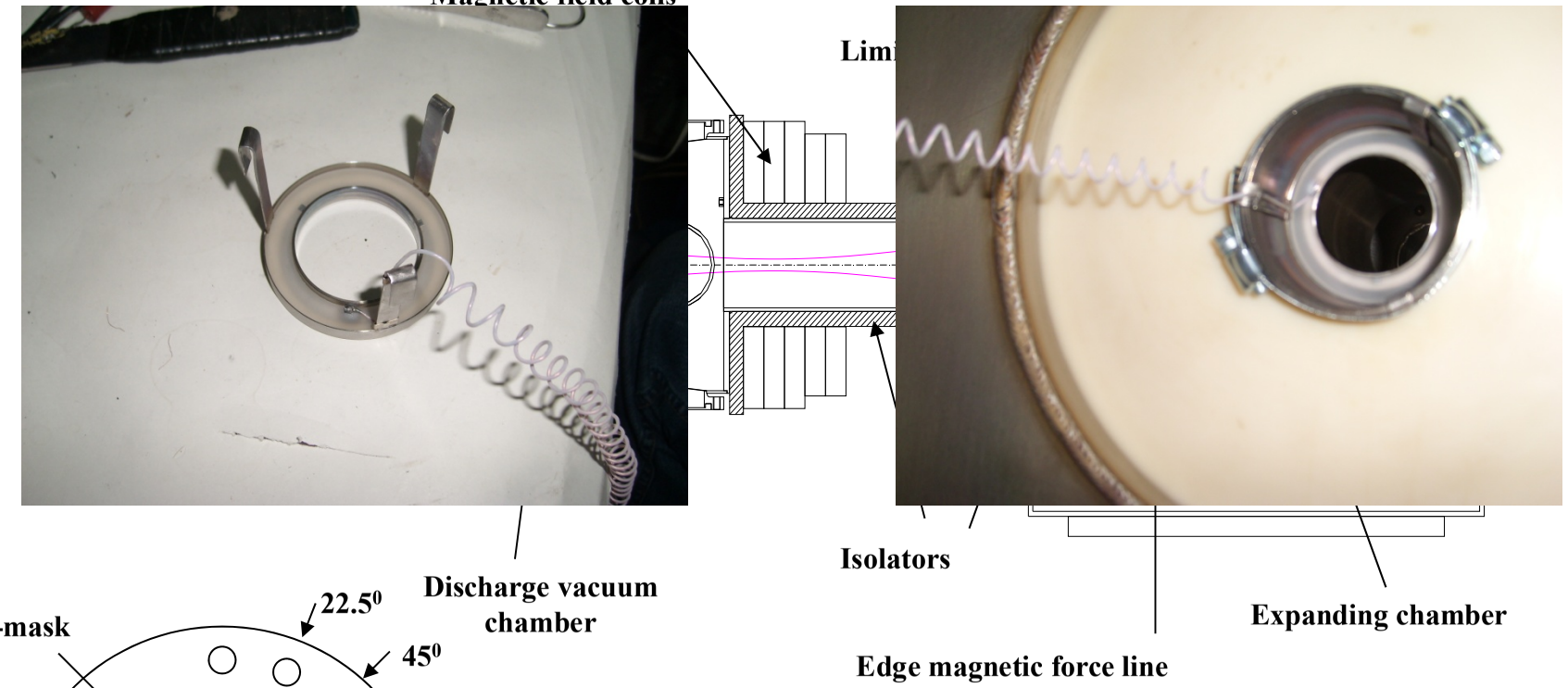


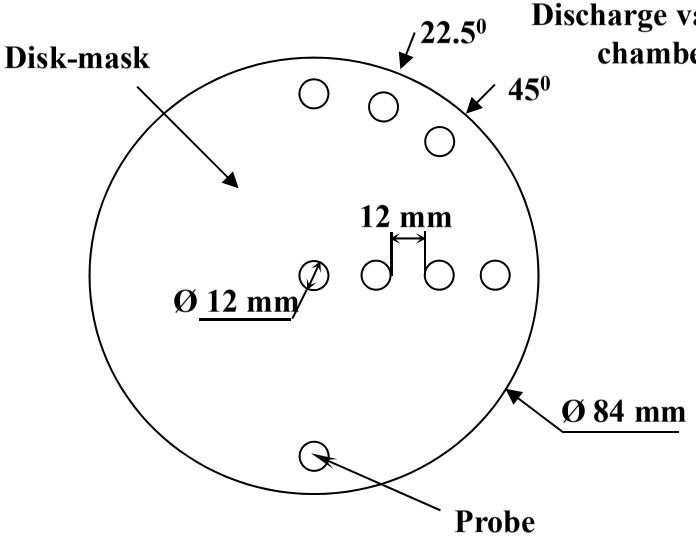

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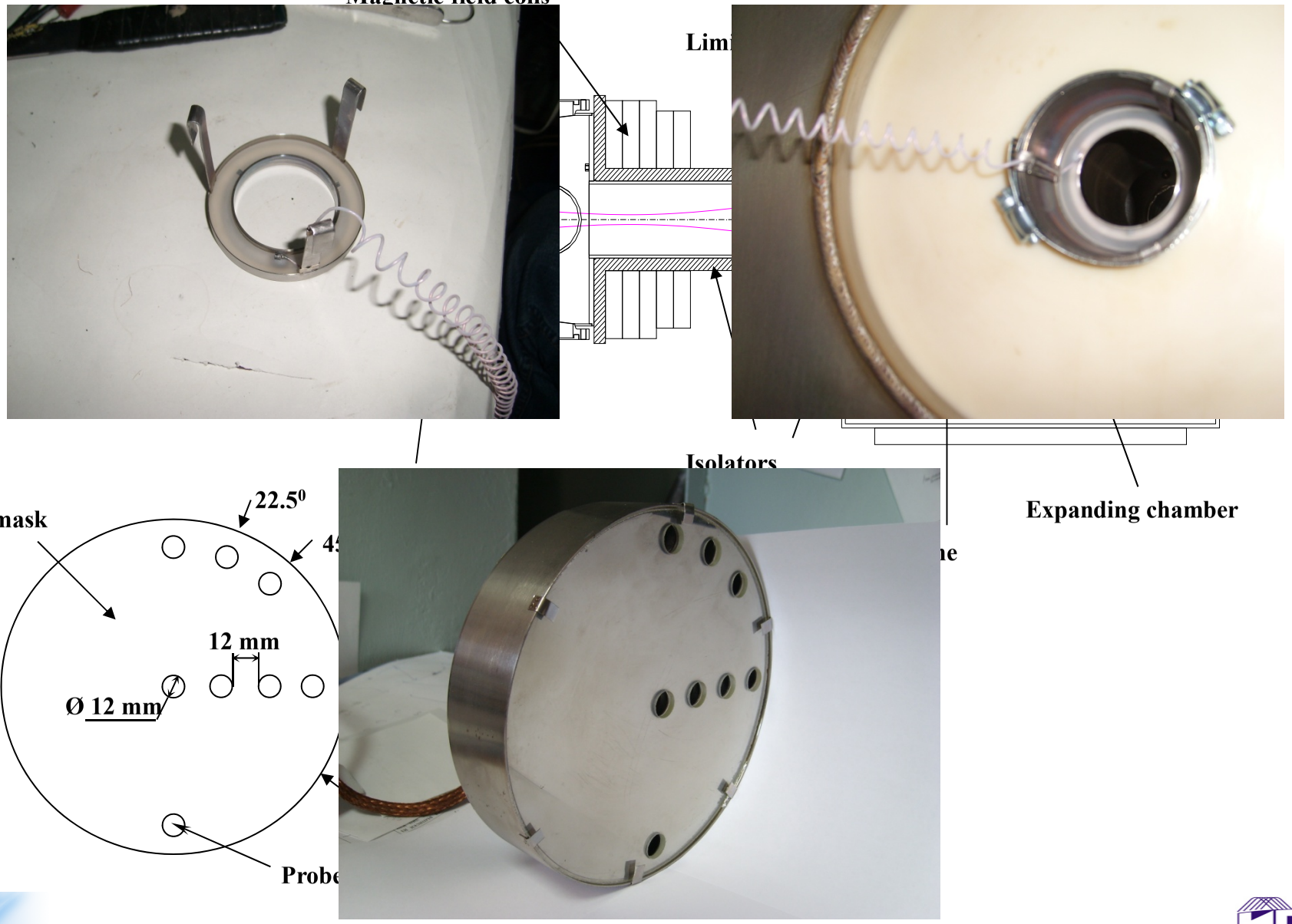
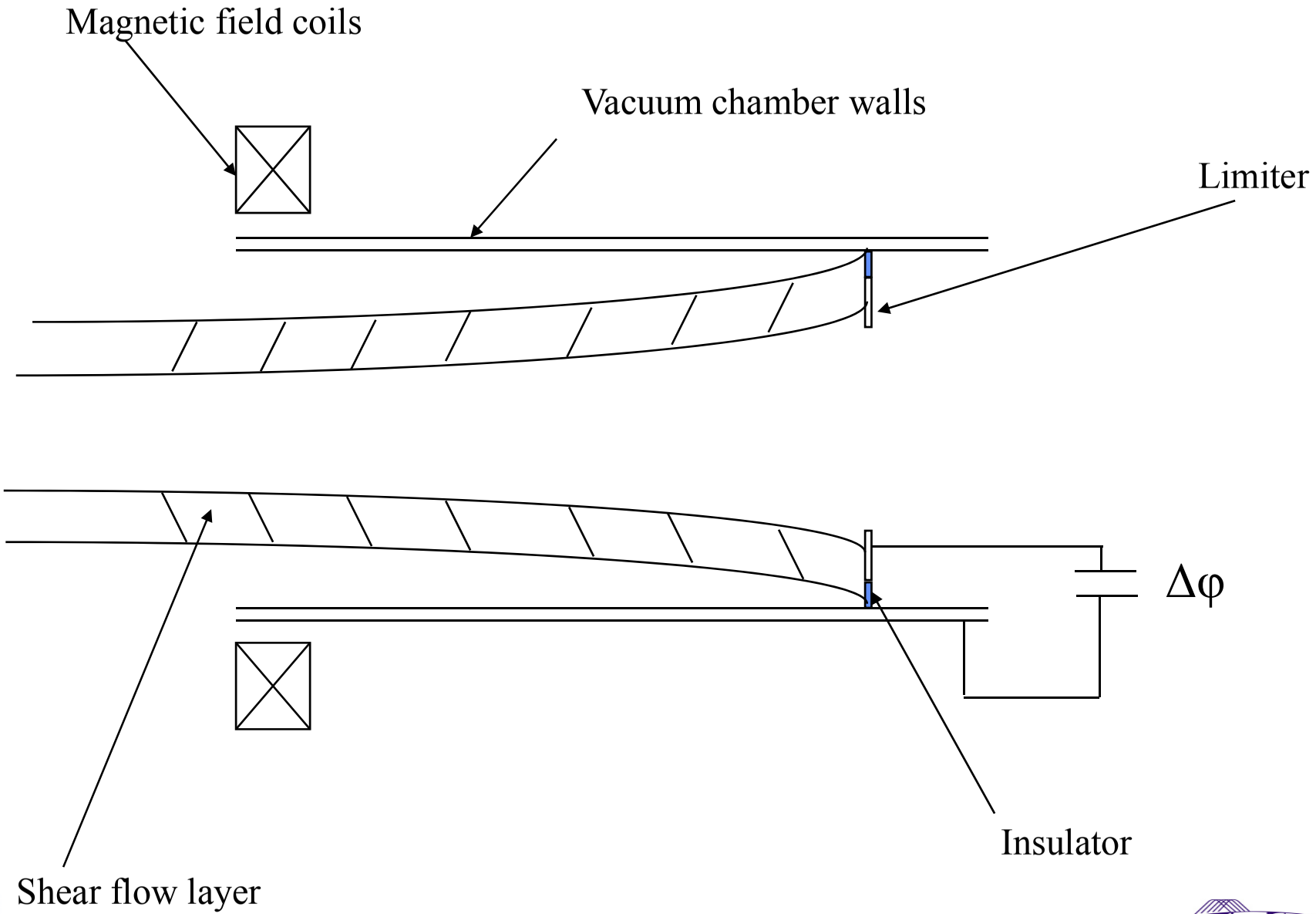
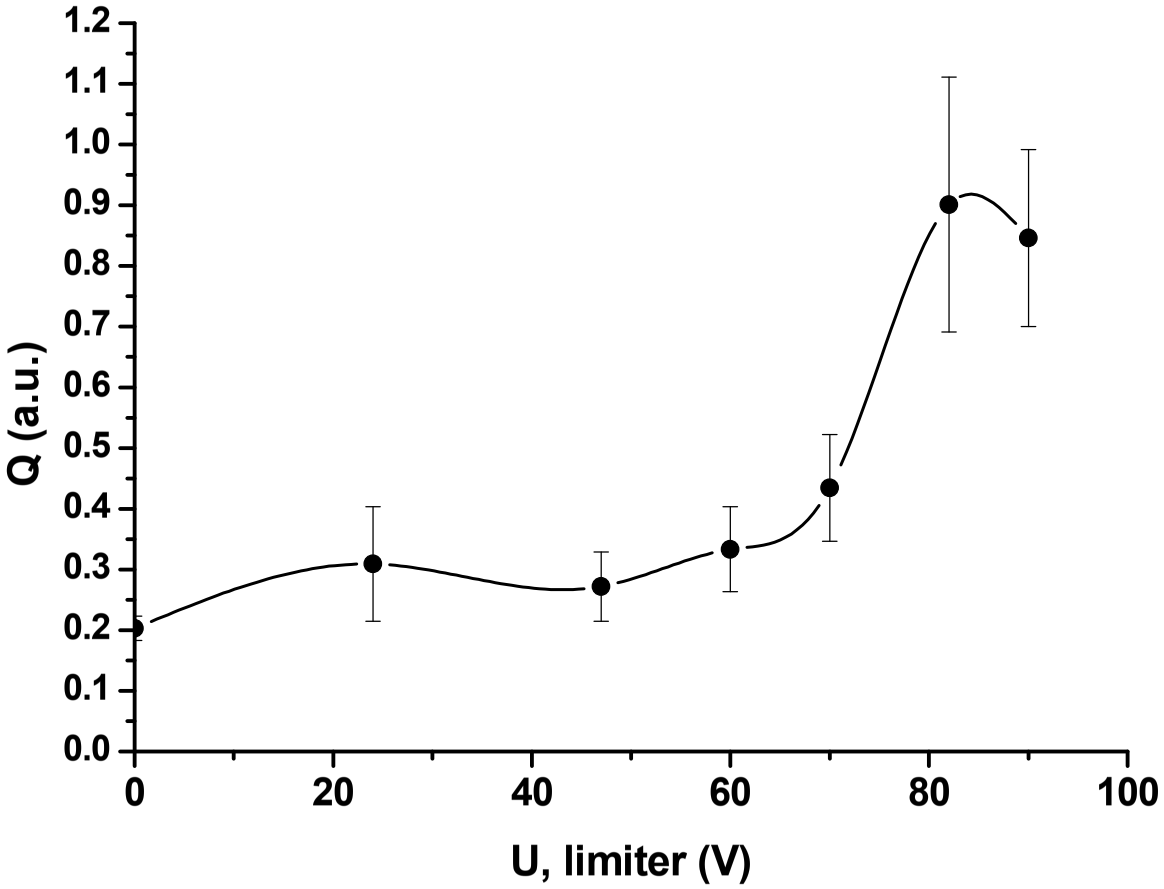


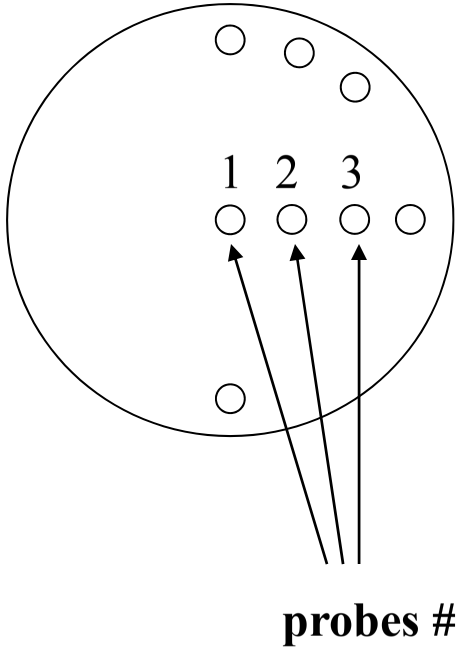
# Scheme of the experiments (shear flow drive)



# Total charge registered by probes #1-3, Helium

Magnetic field at the plug: 1.7 T



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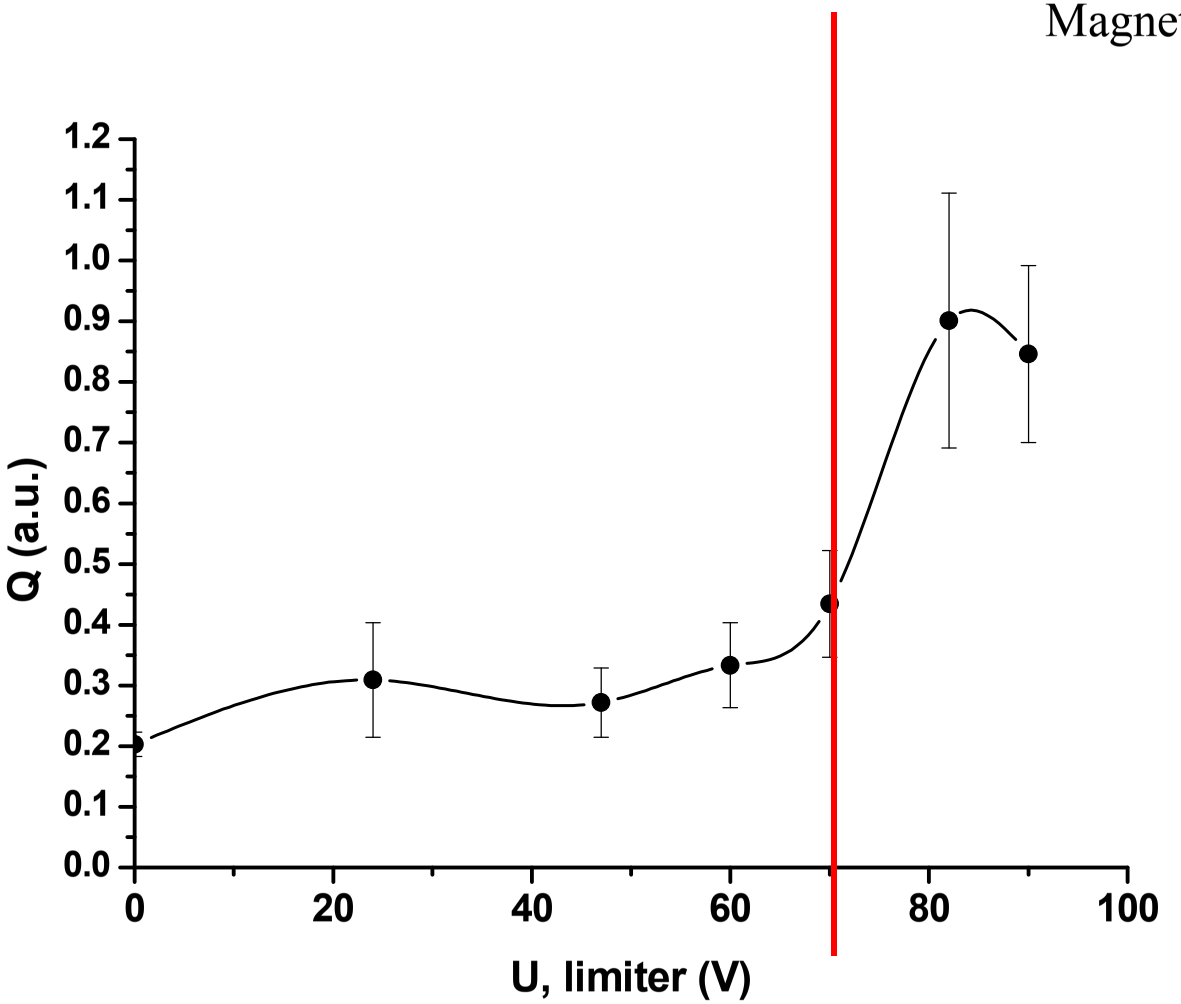
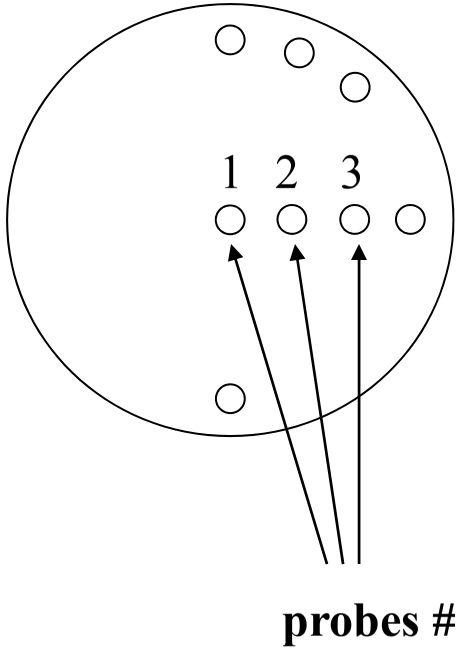
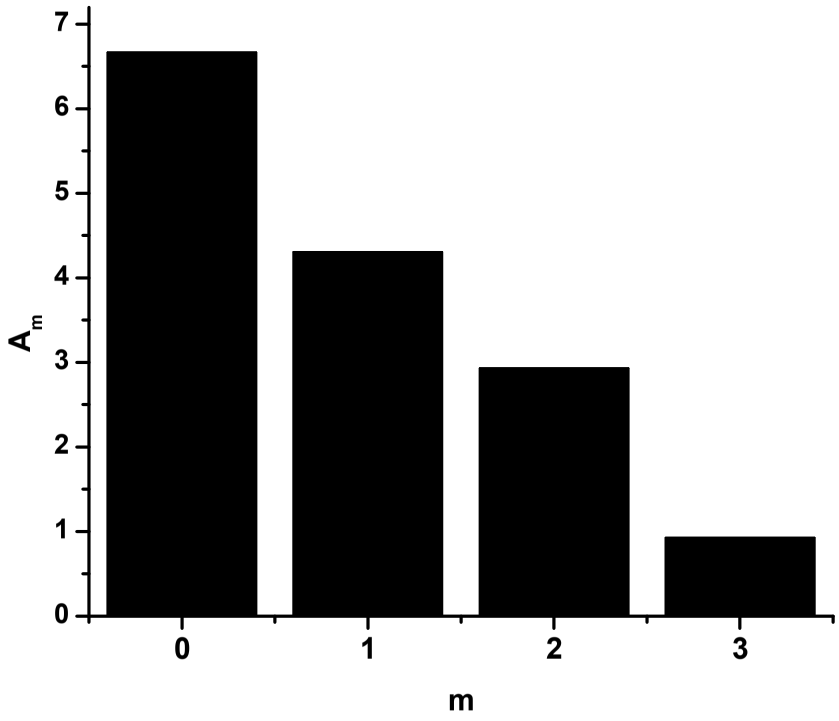



probes #1-3

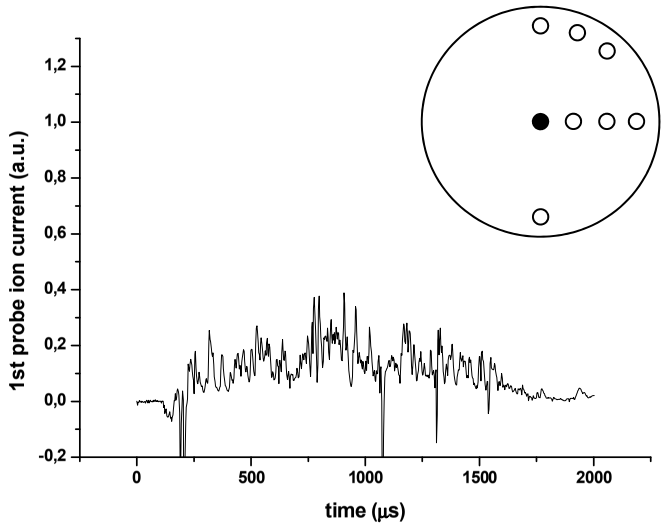
# Mode structure in azimuthal direction: experiment

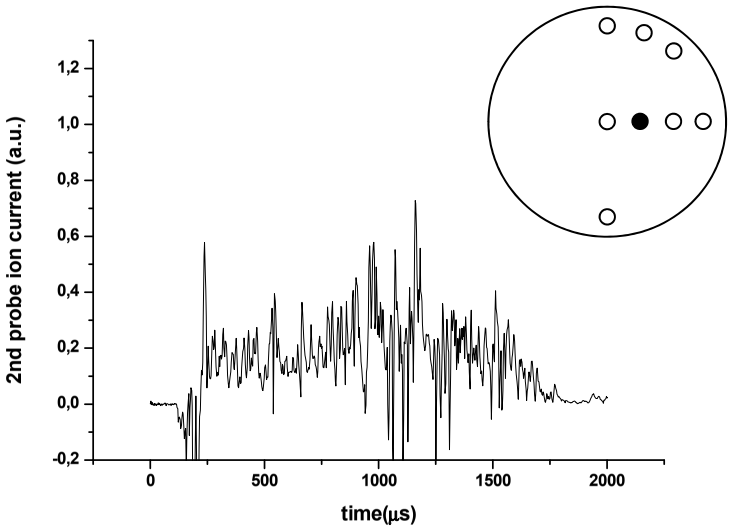


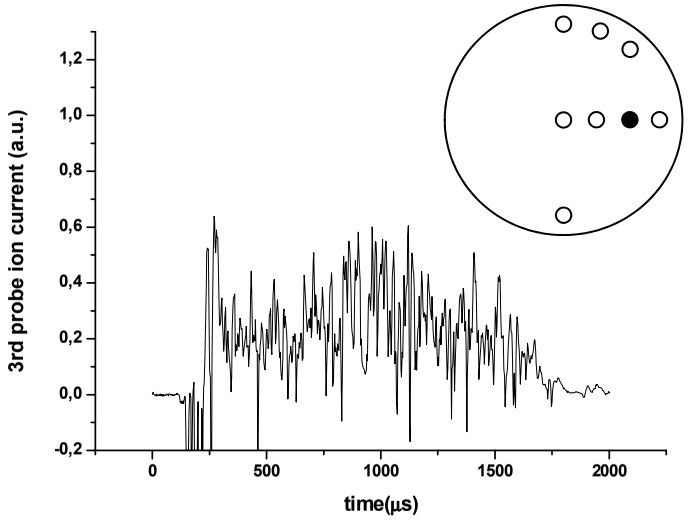

$$N_e = \sum_{m=0}^{\infty} A_m \exp(im\varphi)$$

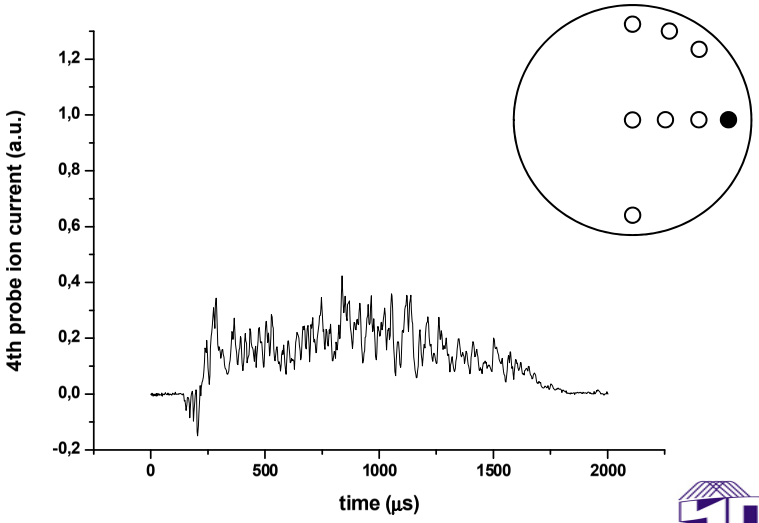
It was experimentally demonstrated that there are modes with indexes m=1,2 in the azimuthal structure of the plasma core

# Results of the recent experiments: signals from the 1-4 probes for U=0 V, B=1.9 T, Helium

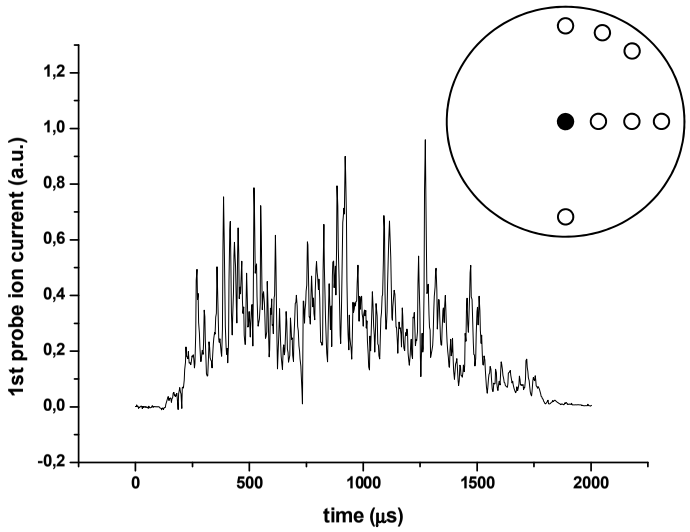


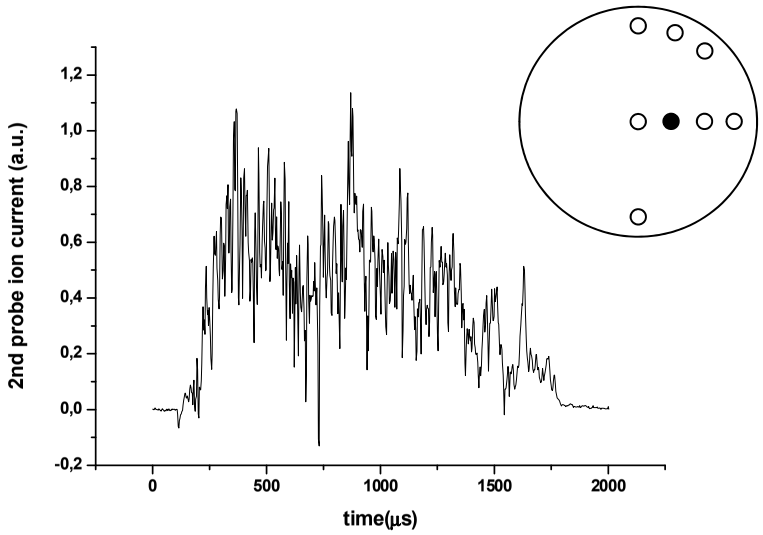



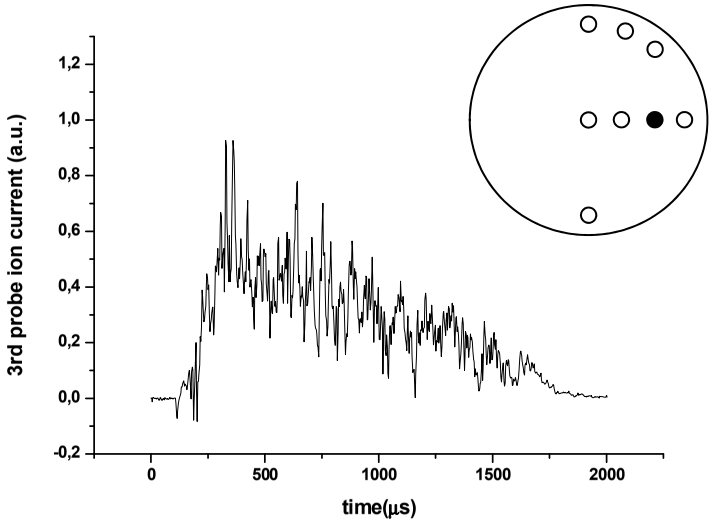



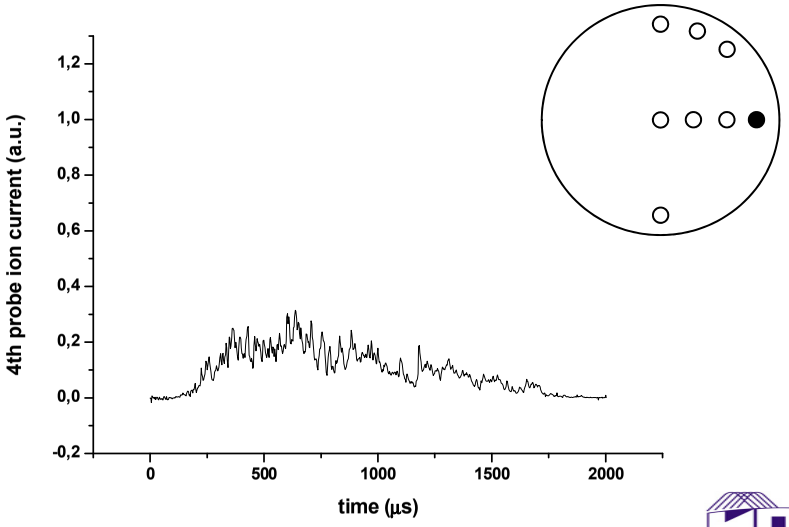



# Results of the recent experiments: signals from the 1-4 probes for U=170 V, B=1.9 T

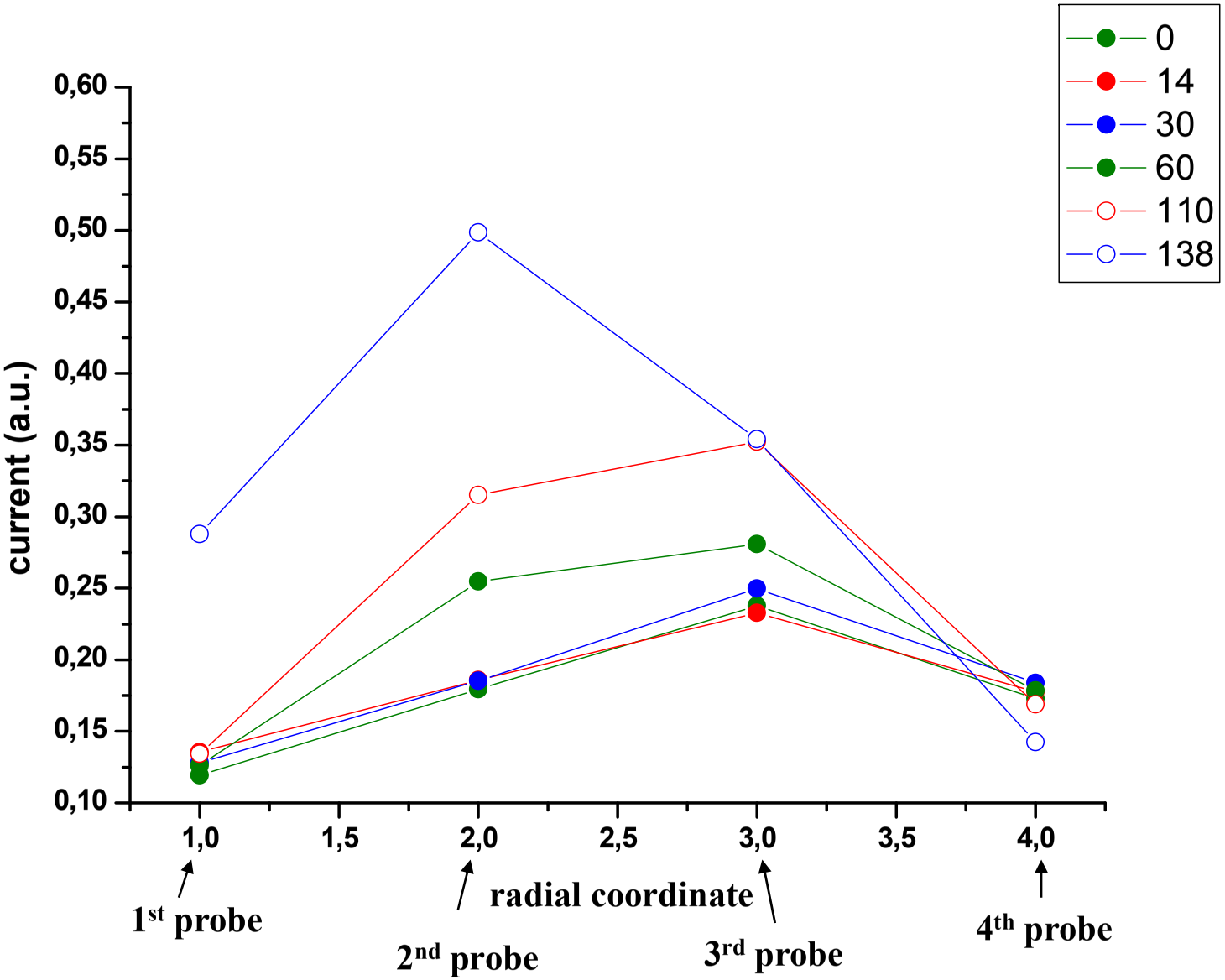


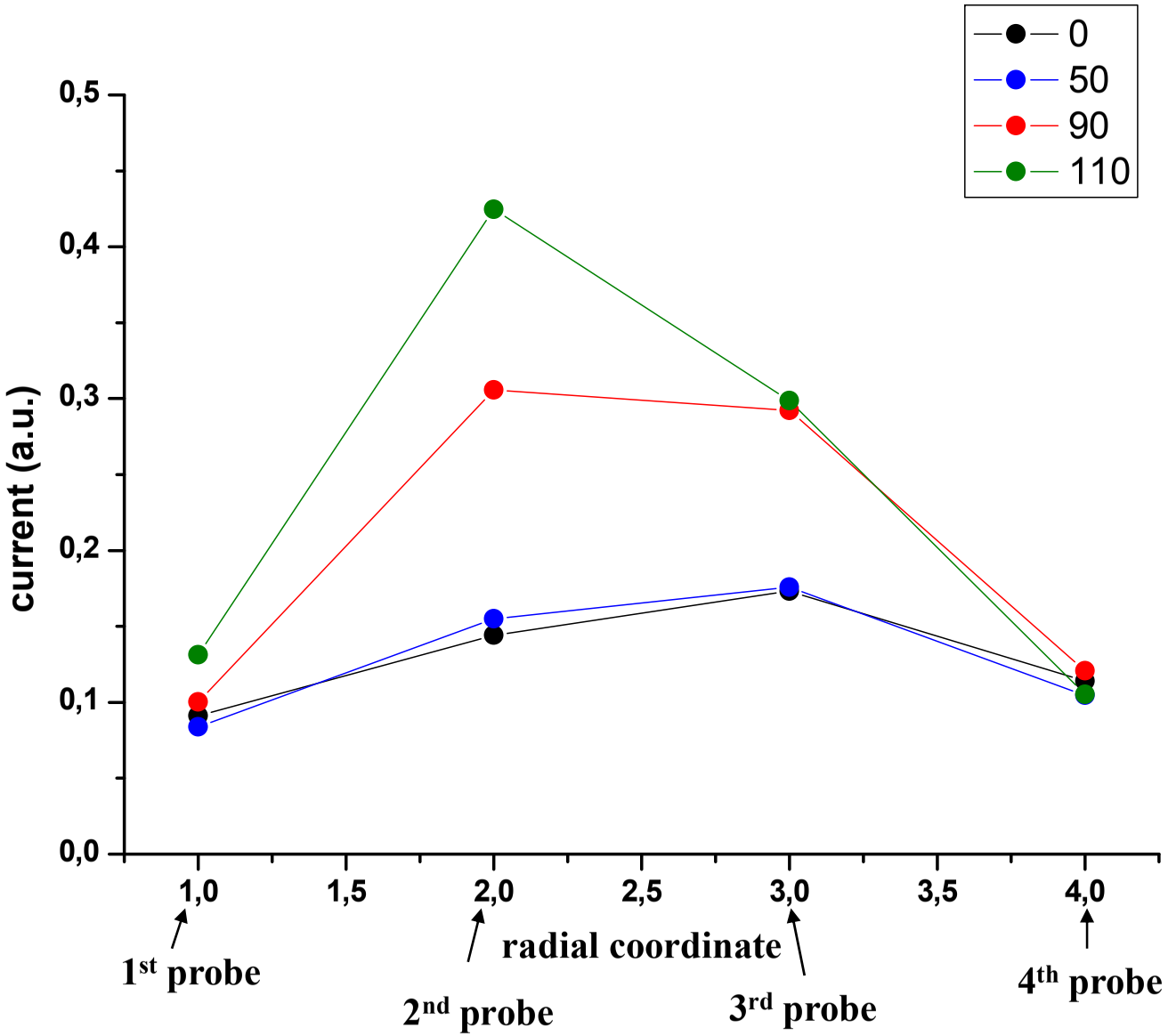



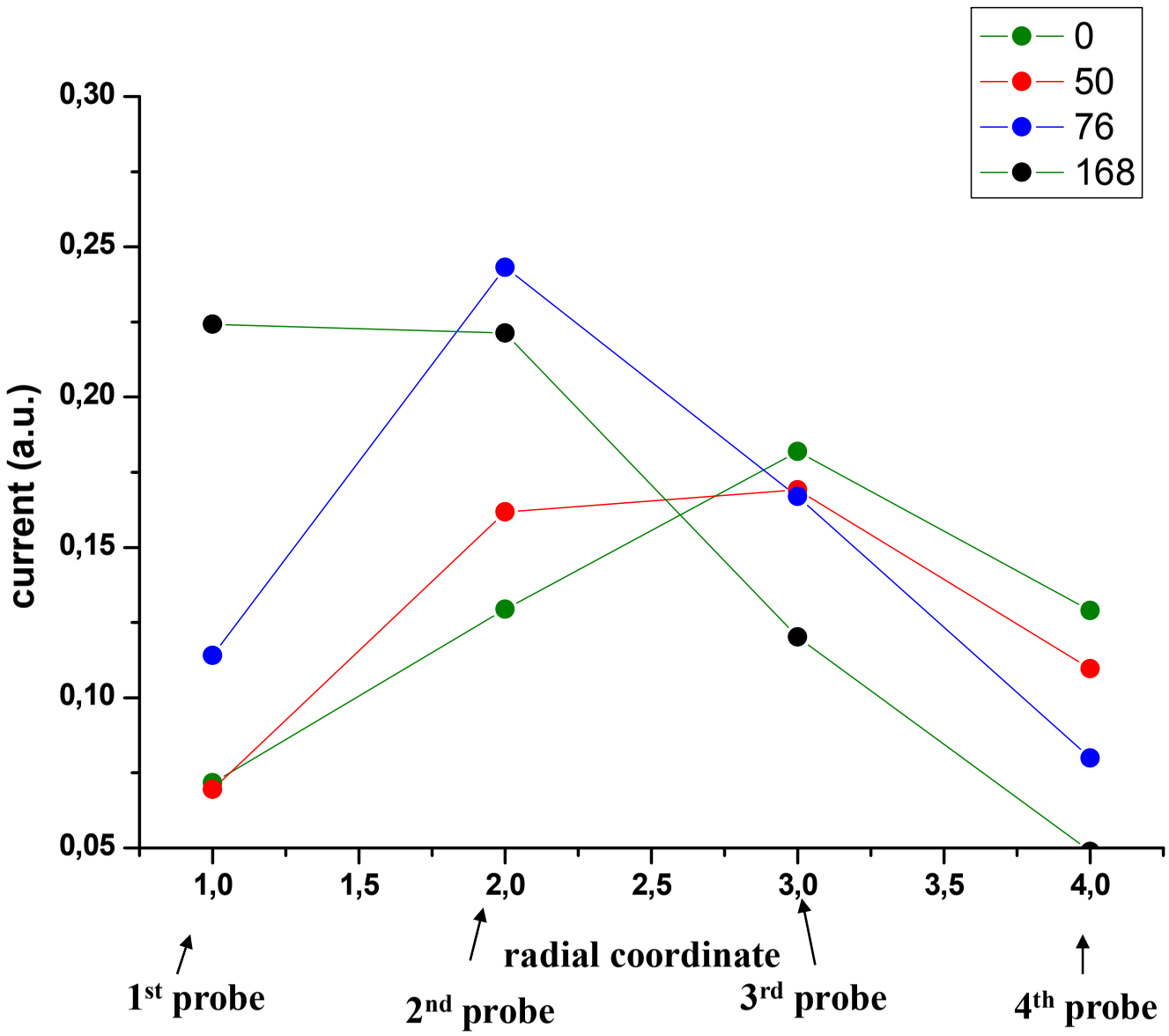
# Results of the recent experiments: ion current density profiles, B=1.7 T



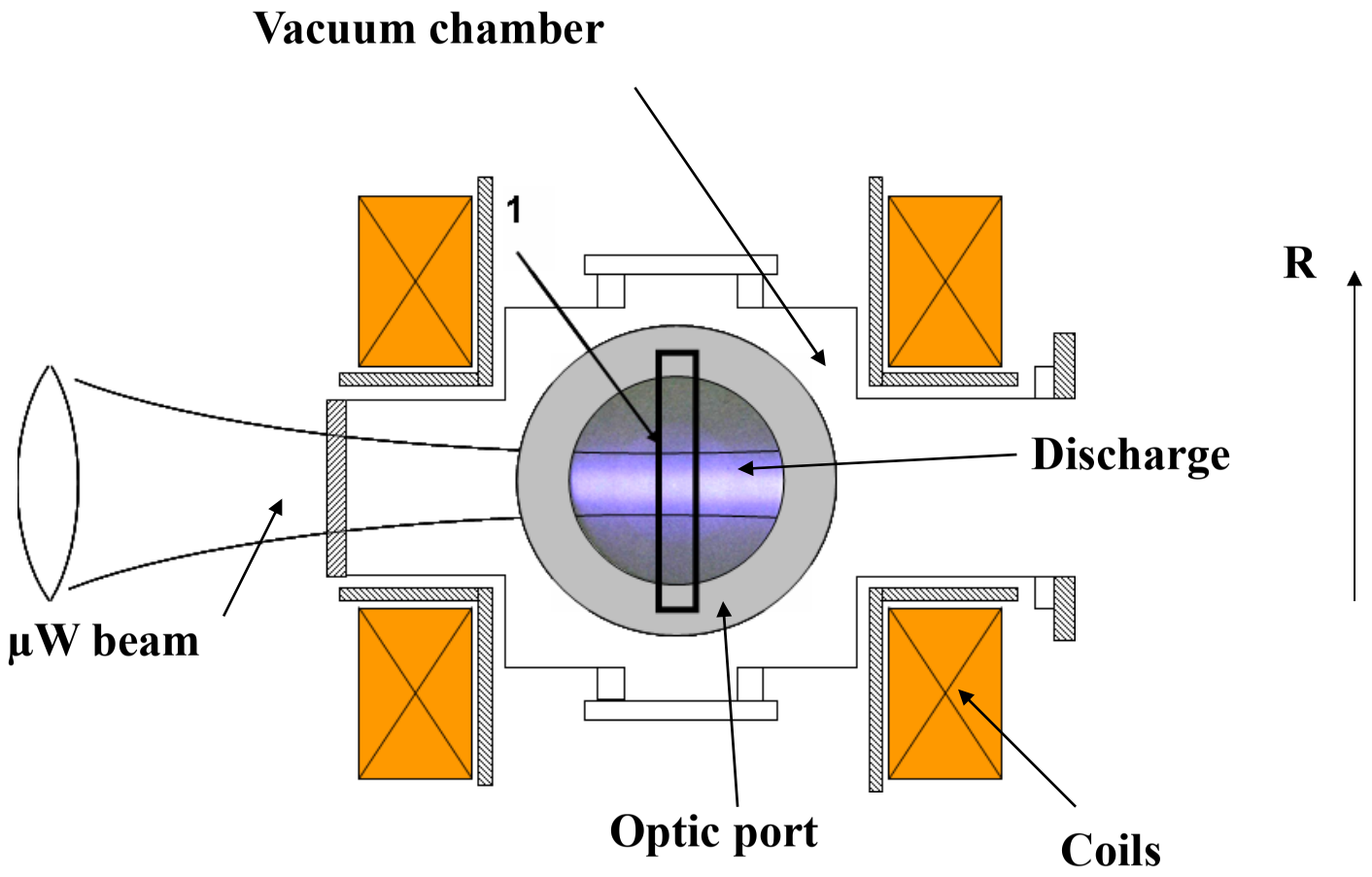
# Results of the recent experiments: ion current density profiles, B=1.5 T



# Results of the recent experiments: ion current density profiles, B=1.3 T

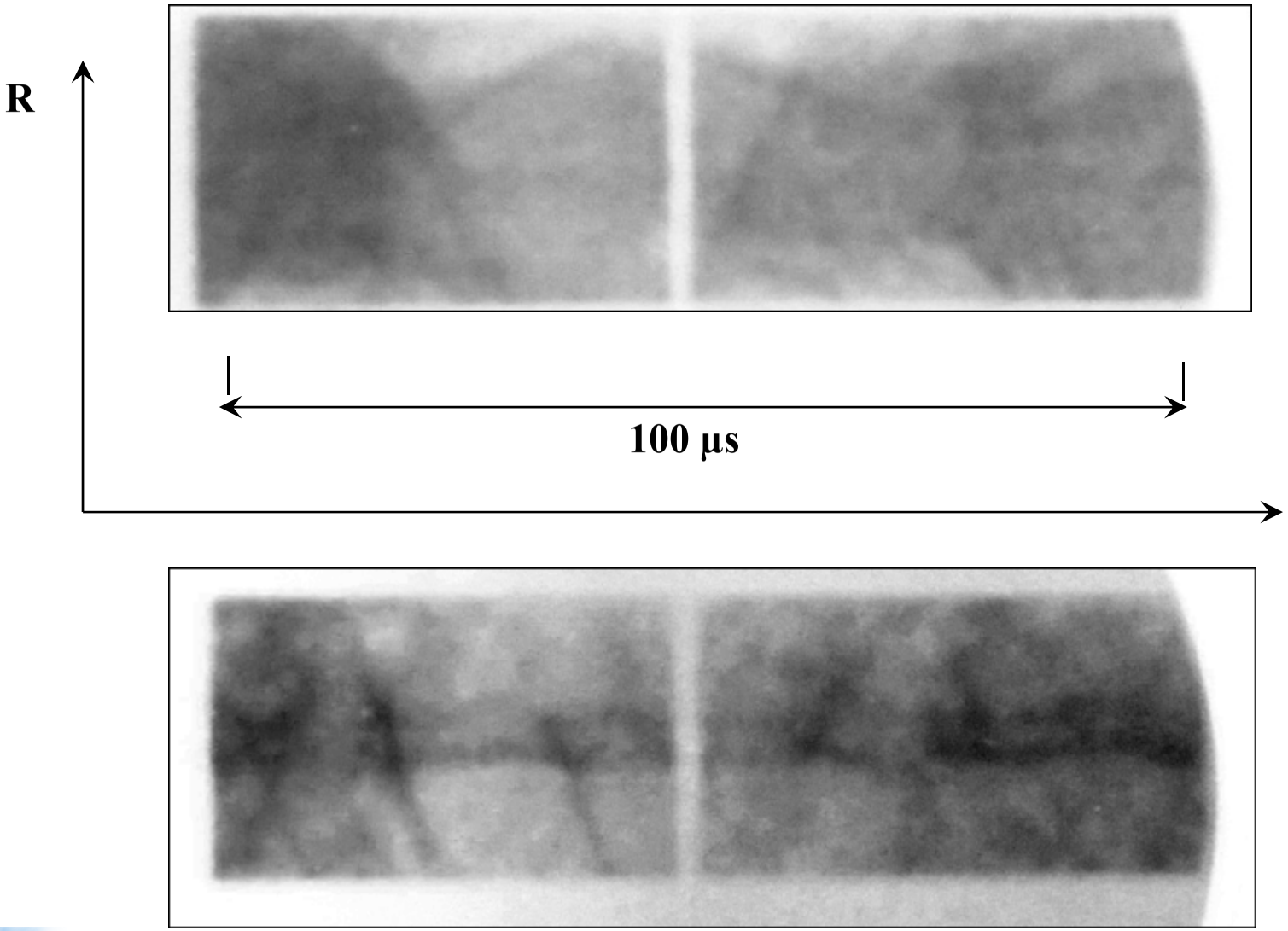


# Results of the experiments with streak camera: scheme

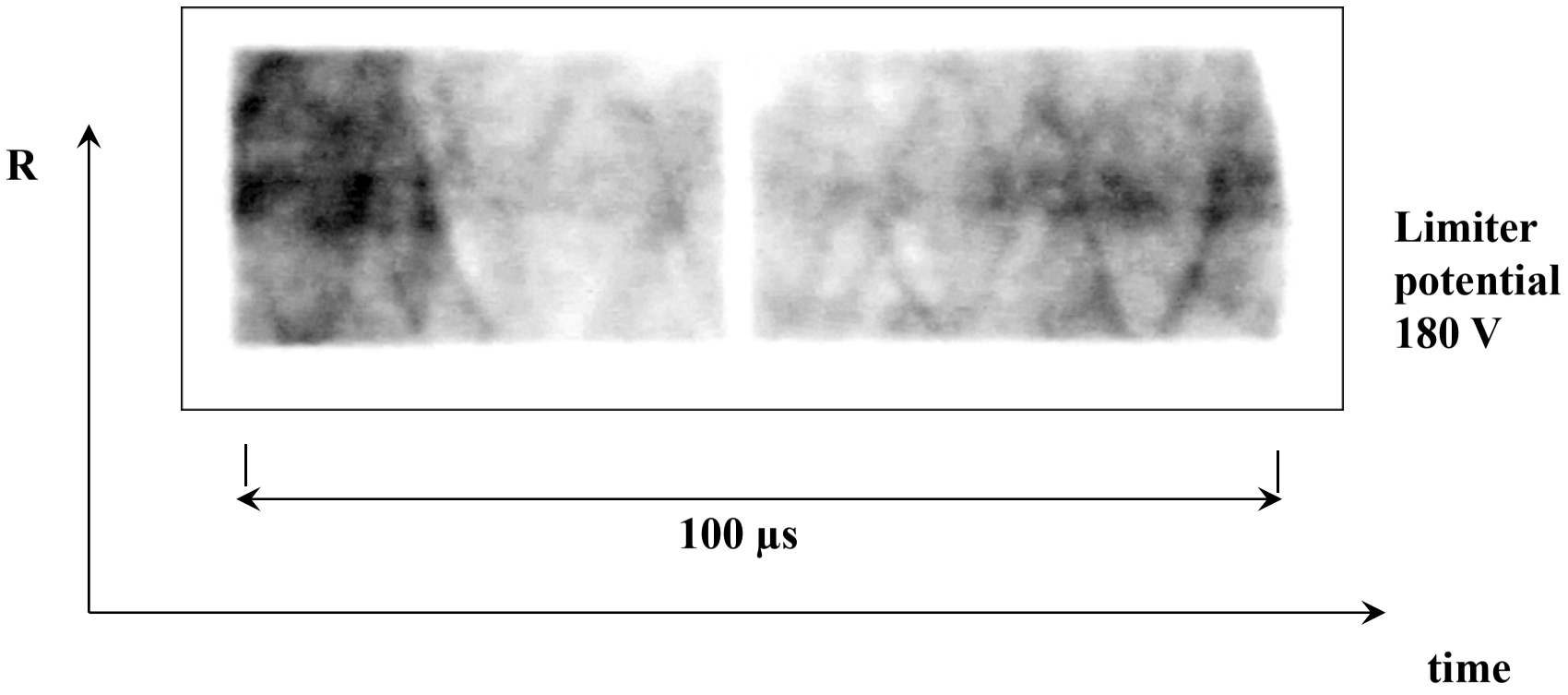



1 – projection of the streak camera slit

# Results of the experiments with streak camera: photos, B=1.7 T



# Results of the experiments with streak camera: photos, B=4.1 kV



**Thank you for your attention!**