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Magnet portable mass spectrometer with membrane inlet system

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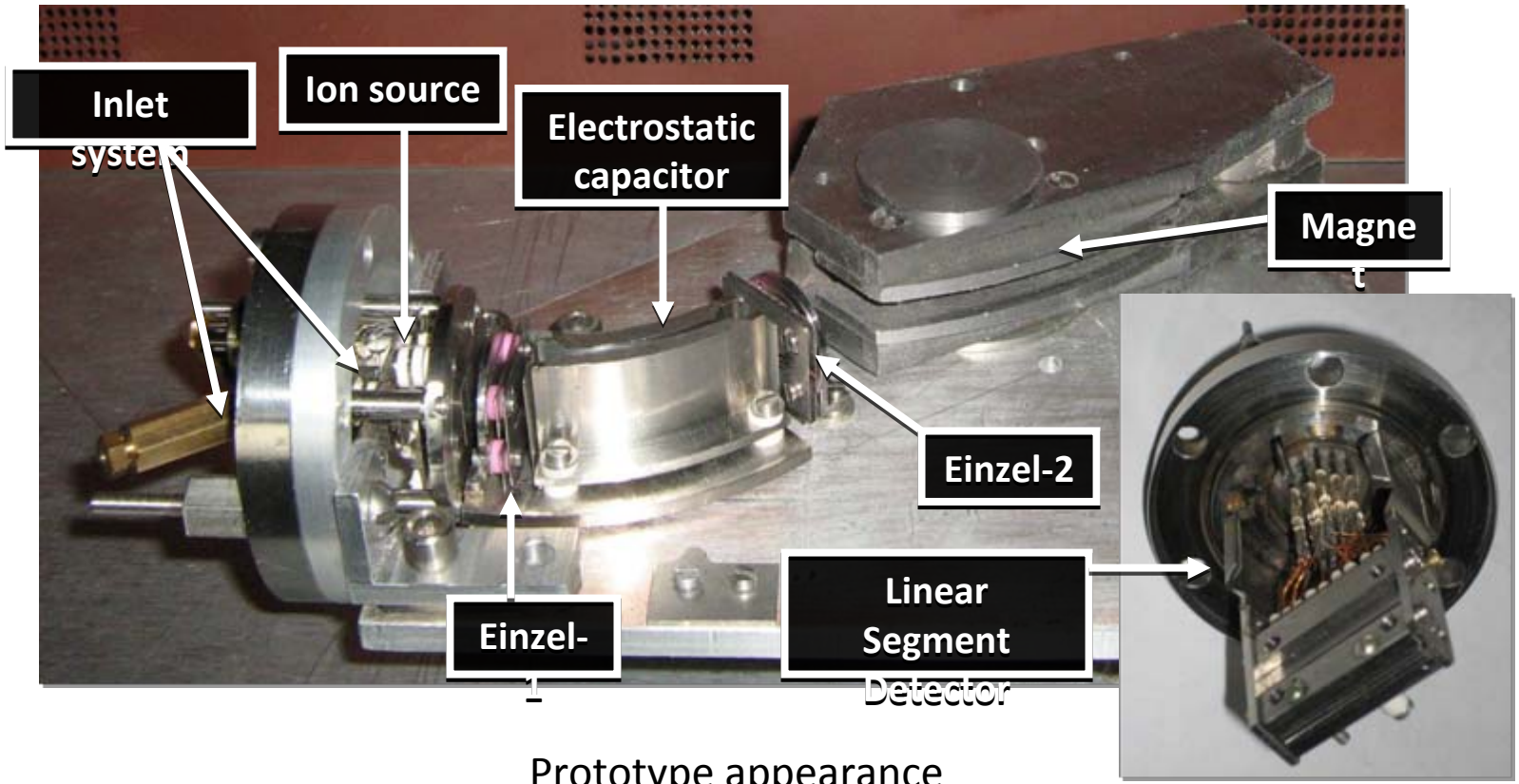
Portable system for *in situ*, *on-line* analysis

reliability, precision	mass analyzer system type static magnet sector
precision	mass analyzer mode independent scanning of the separate mass subranges
low detection limit	inlet system membrane

Inlet system, ion source and mass analyzer

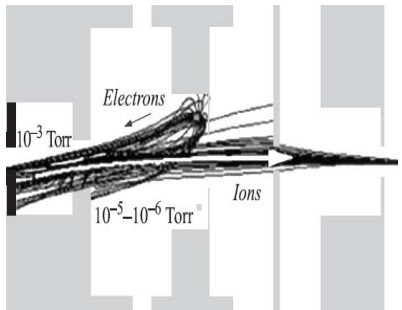


Prototype appearance

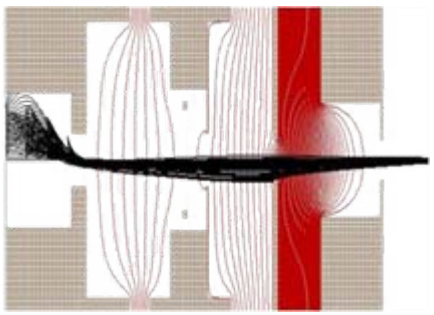
Ion optic scheme of mass analyzer with ion source

Axisymmetric ion source

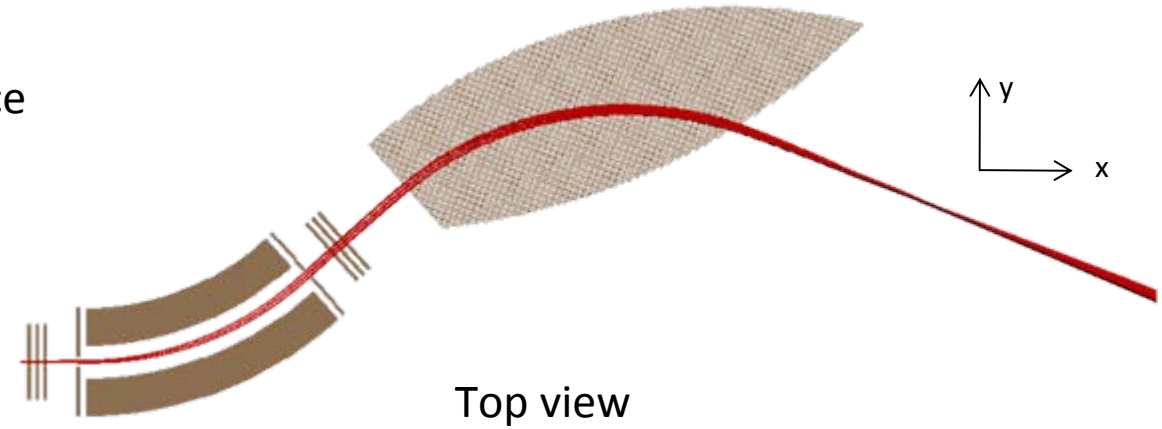
(large scale)



electrons and ions traces



ions traces and equipotential lines

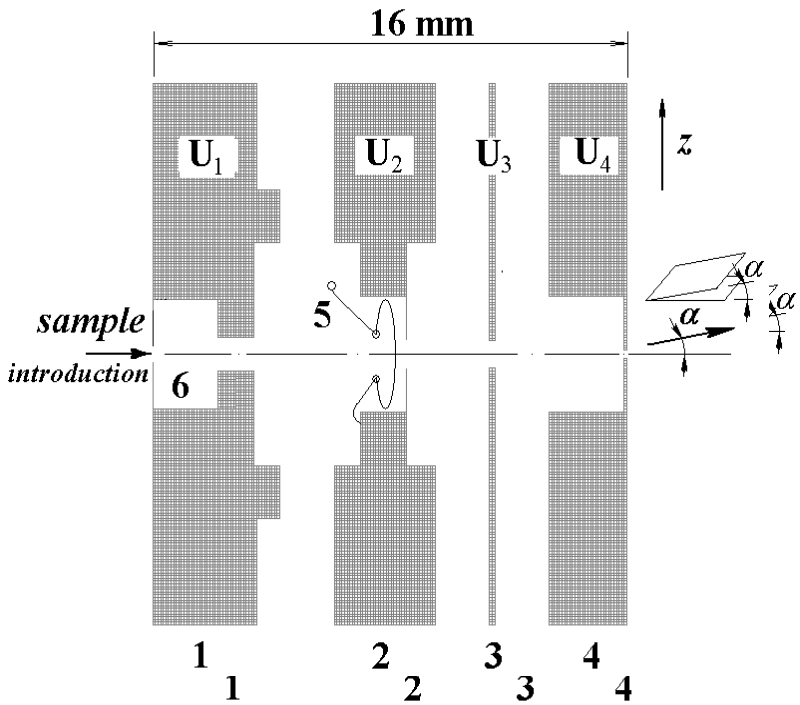


Top view

Front view

Axisymmetric Ion source

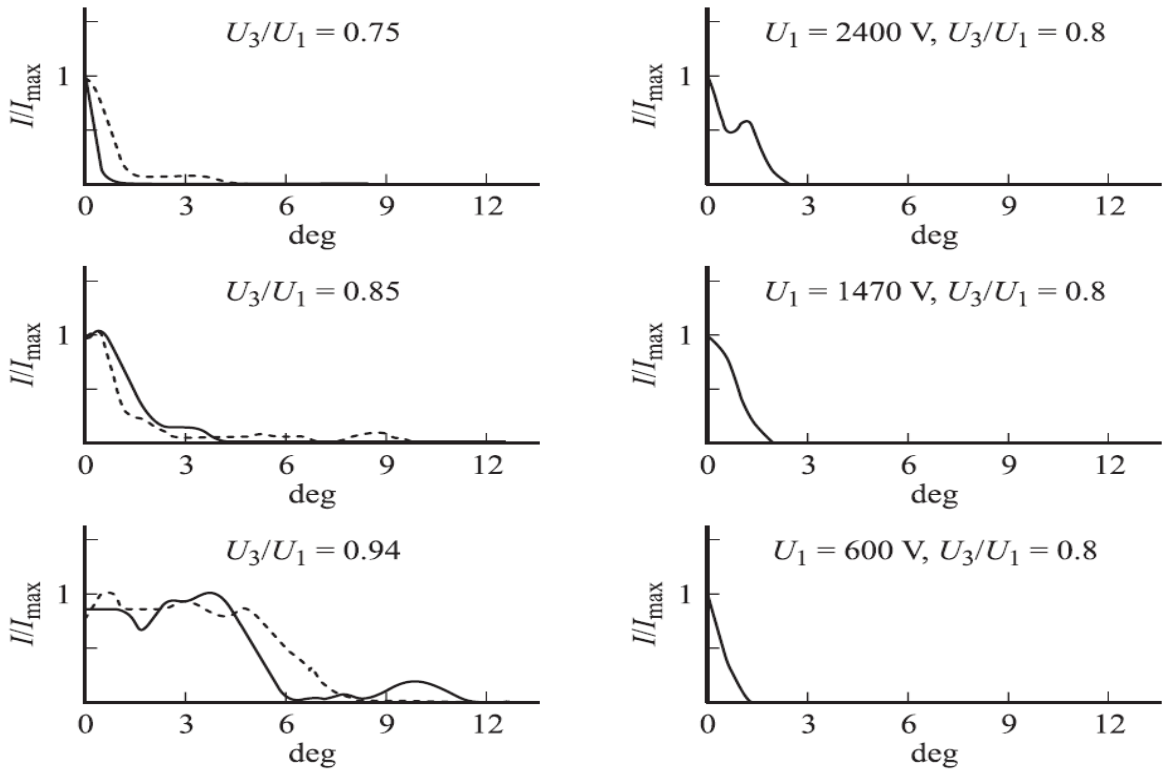
Ion source appearance



Ion source scheme

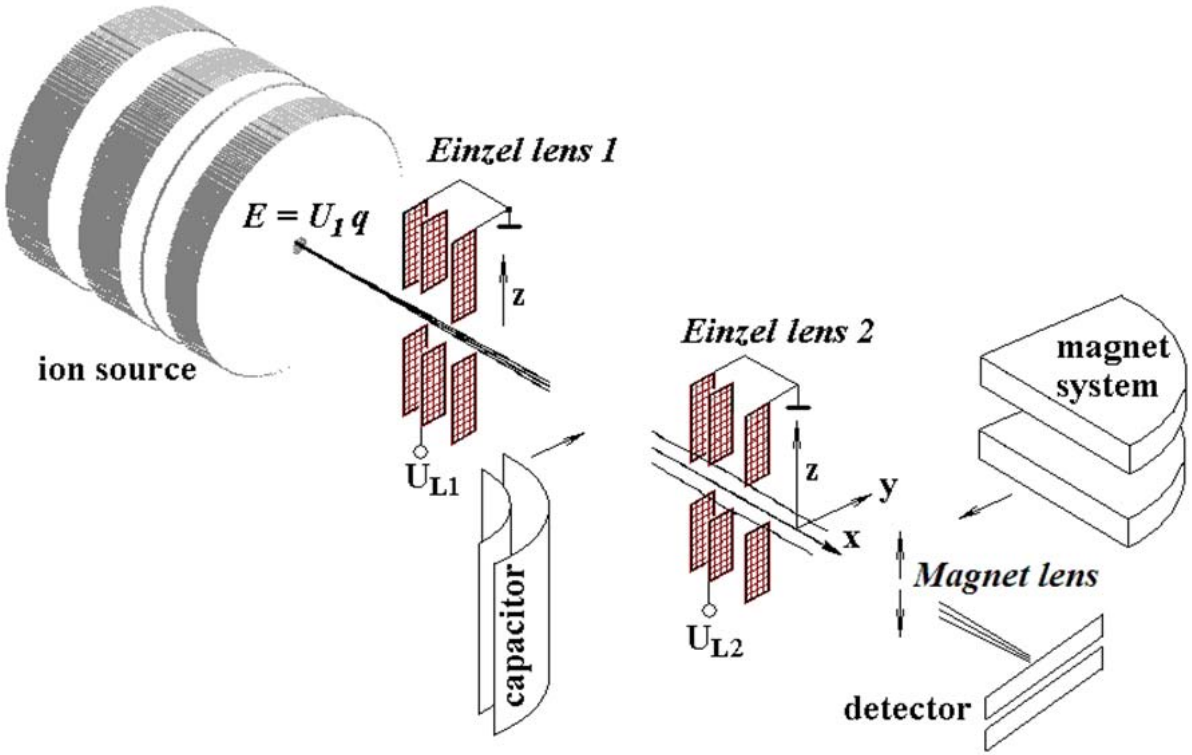
Axisymmetric Ion source

Emittance and electrode potentials of the ion source (U_1 - U_2 = 80V and U_4 = 0V)
— calculation results
- - - experimental results



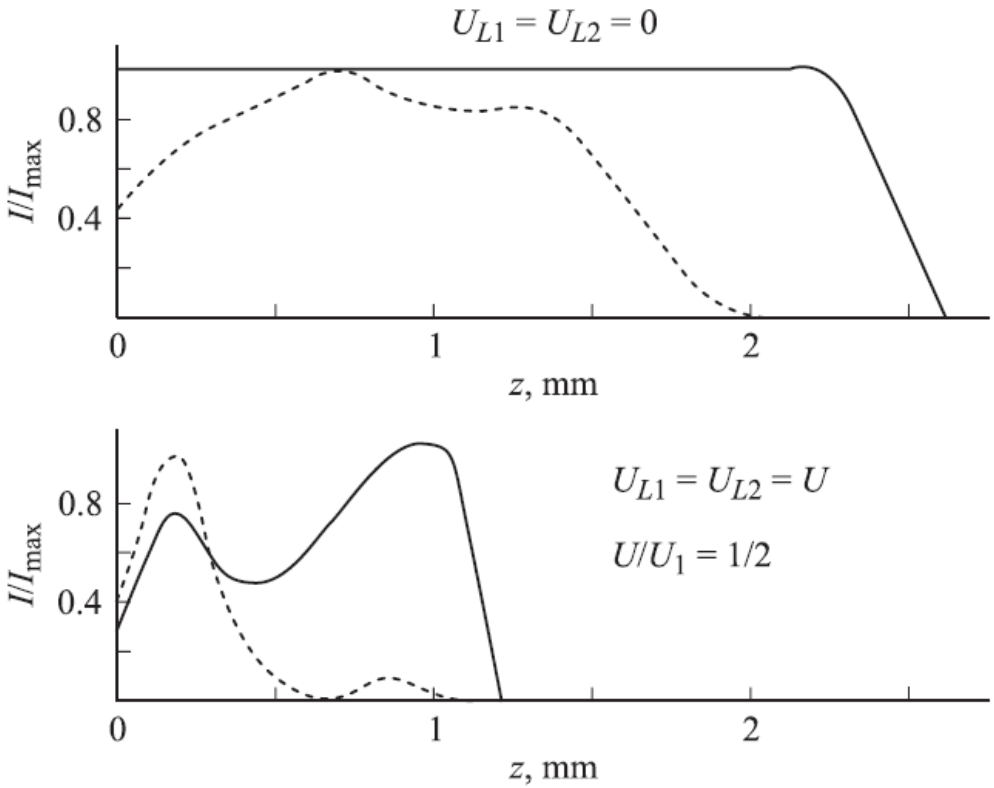
focusing **small focus point shift**

Z – focusing system of the mass spectrometer



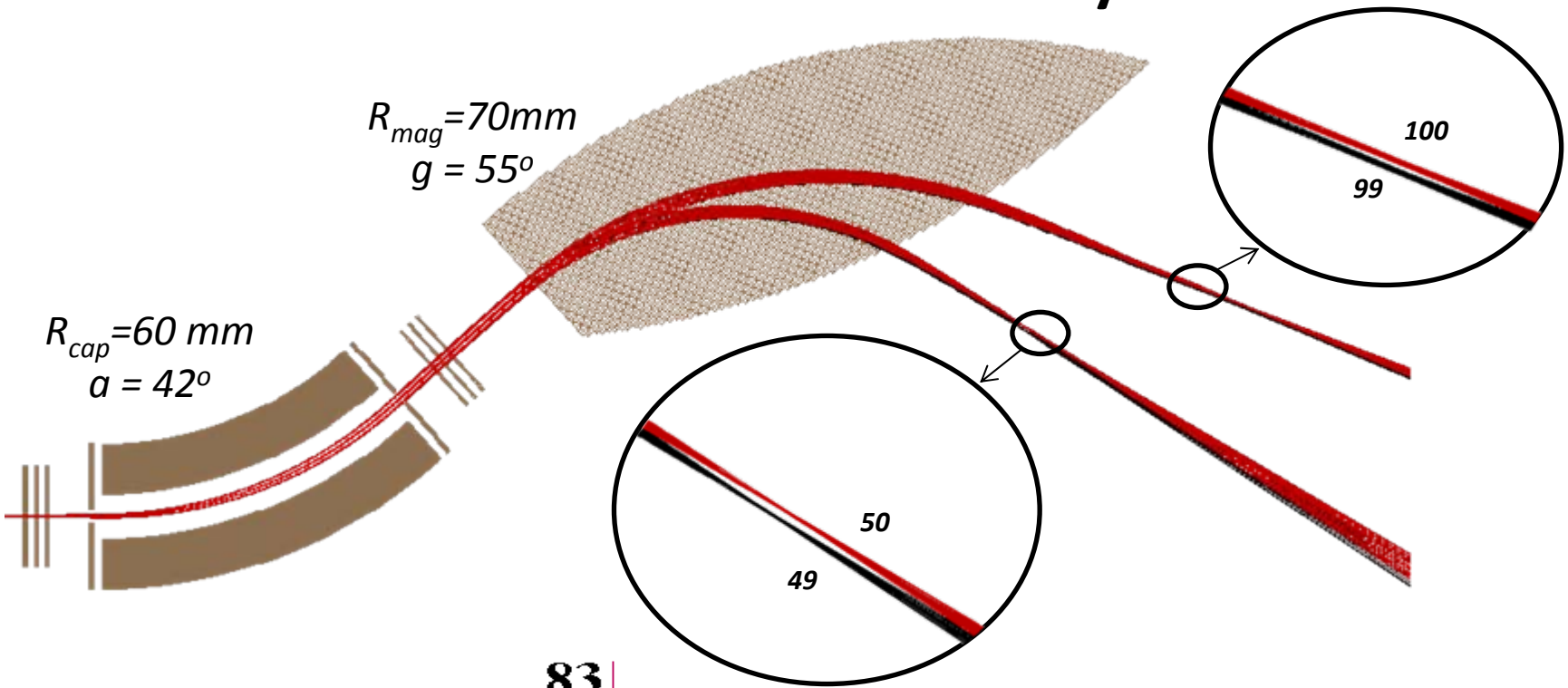
Ion-optic scheme

Z – focusing system of the mass spectrometer



Ion beam intensity in z-direction near x-y focus line of the mass spectrometer
— calculation results
- - - experimental results

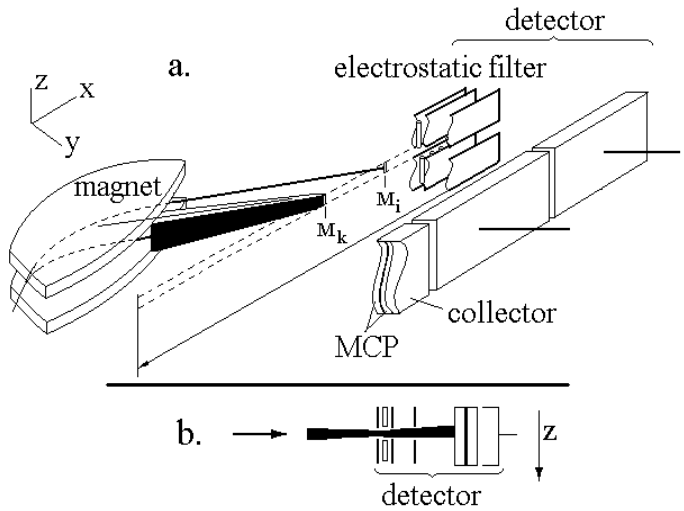
Resolution of the mass analyzer

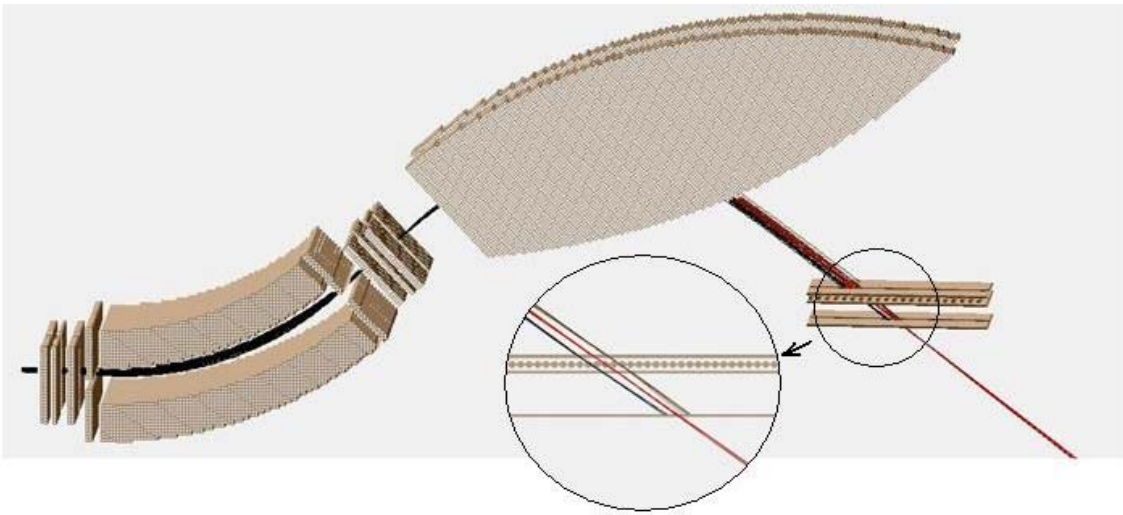


SIMION simulation result: **M/ΔM ~ 140**

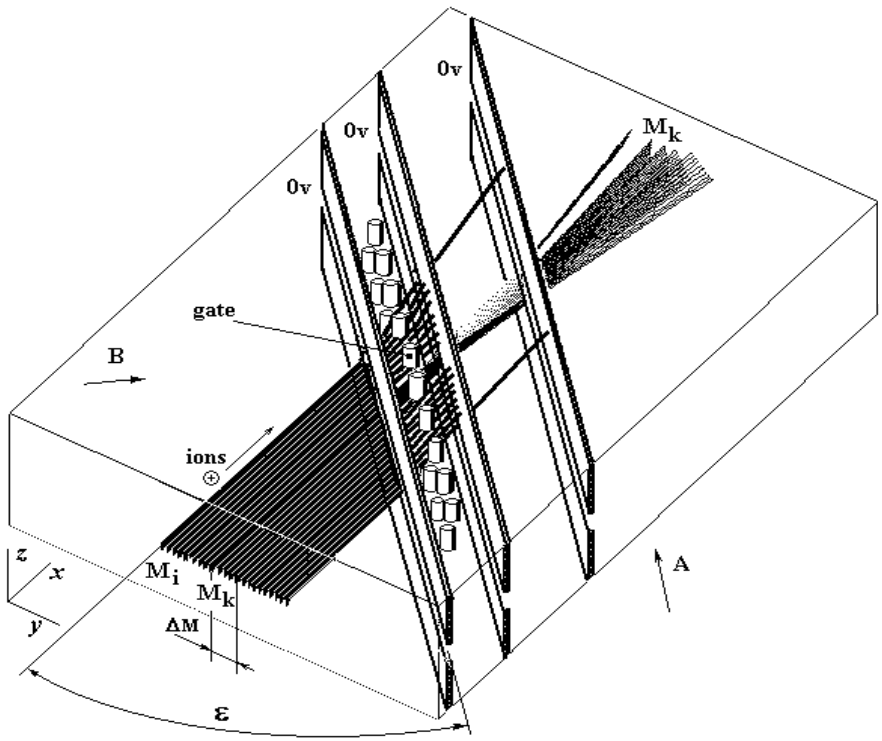
experimental result: **M/ΔM ~ 110**

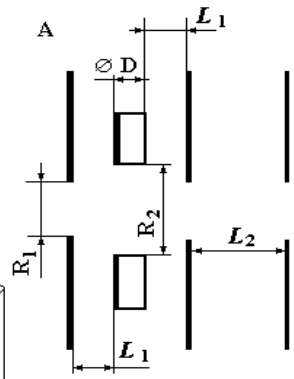
Detector system

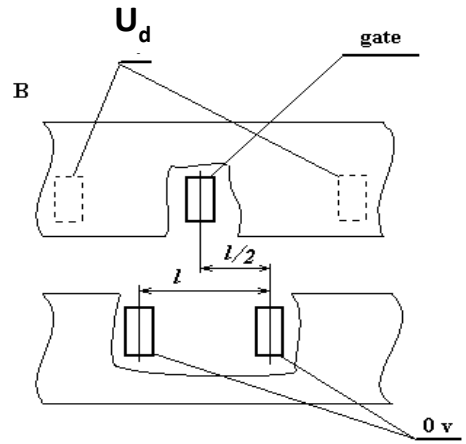




Segment geometry



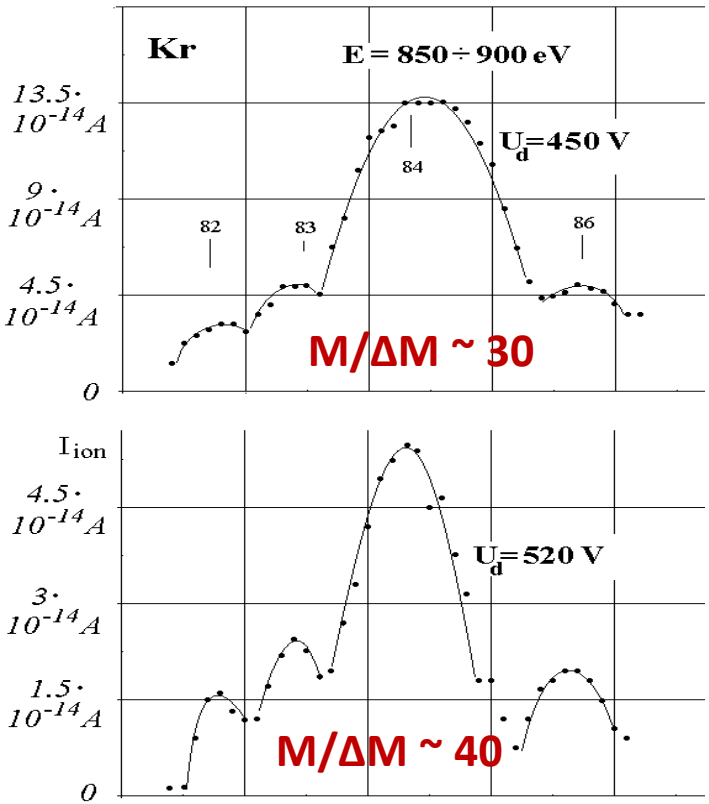




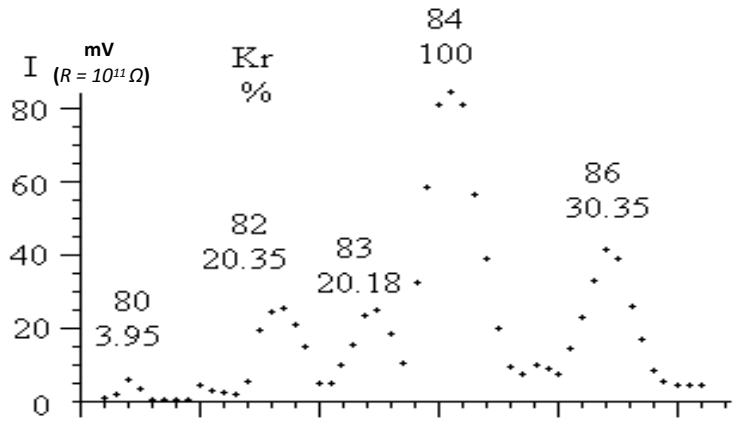
	light ions	heavy ions
L_1	***1 mm***	***0.25 mm***
L_2	4 mm	4 mm
R_1	1 mm	0.7 mm
R_2	1.5 mm	1 mm
D	0.6 mm	0.3 mm
l	***1.4 mm***	***0.5 mm***

Kr–mass spectrum (one electrode gate)

(scanning mode with linear segmented detector)



segment geometry for light ions with different dispersive potential

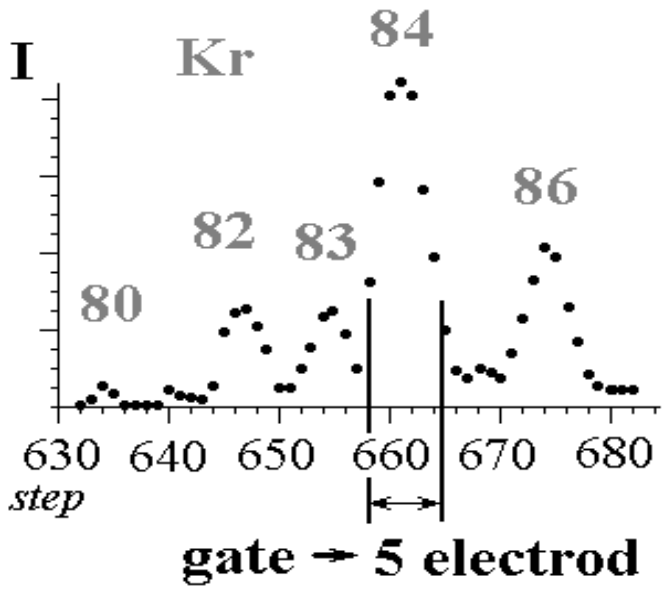


M/ ΔM ~ 80

segment geometry for heavy ions

electrode distance *l*	1.4 mm	1.4 mm	0.5 mm
dispersive potential U_d	450 V	520 V	500 V
width of the window (one electrode gate)	**1.4 mm**	**1.1 mm**	**0.4 mm**

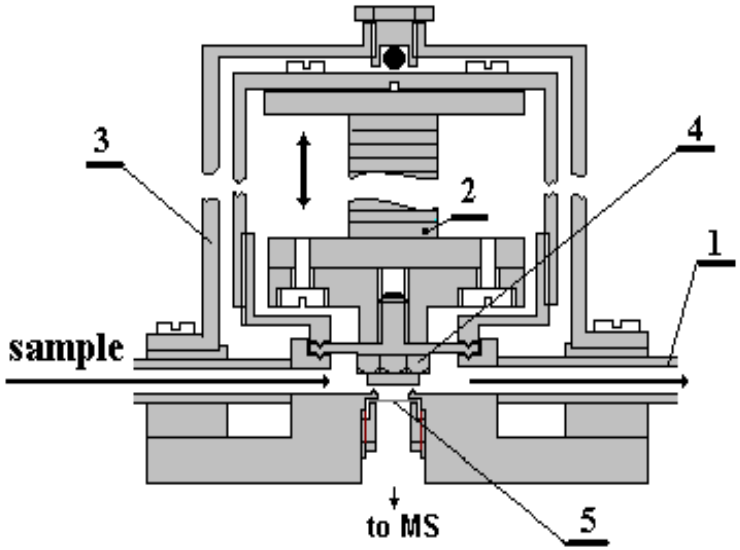
Matching of gate width to voltage steps



to register peak integral intensity in non-scanning mode up to 100 Daltons our system requires usage of 5 electrodes gate to provide correlation with scanning mode.

Membrane inlet systems for VOC's analyzing

diffusion system with a sheet membrane SSP-M100



Schematic design of the membrane inlet system.
(1) A tube with a flow of a sample, (2) a piezo-electric lock, (3) a body, (4) vacuum compression, (5) membrane.

Idle volume in front the membrane about 2-3 cubic millimeters.

I_{sample} ~(5÷30) ml/min

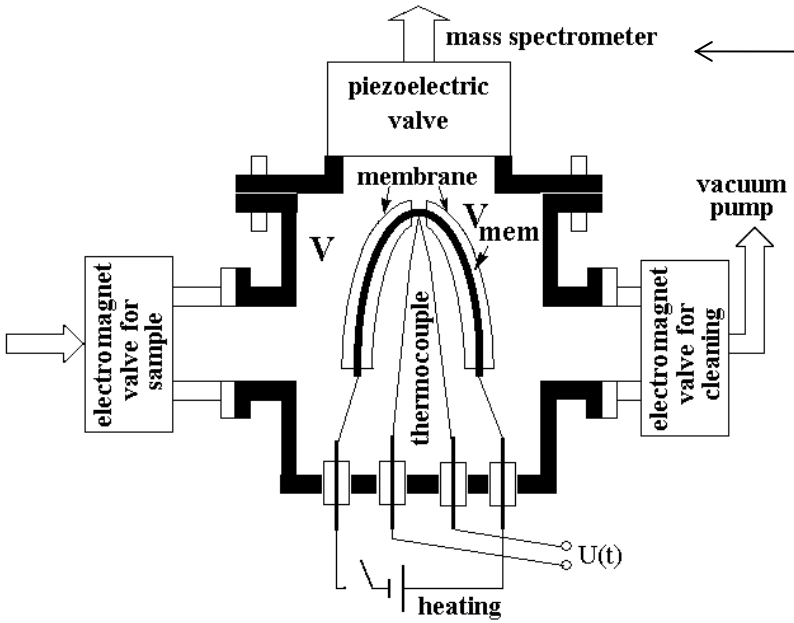
t_{resp} ~ (1÷10) sec

$k_{enrich}(C_7H_8/N_2) \sim 130$

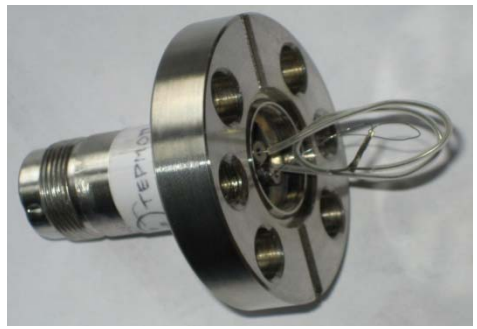
$k_{enrich}(C_4H_{10}/N_2) \sim 40$

Accumulating system with tube membrane

*(*Graham Cooks «Single-Sided Membrane Introduction»*)*



laminar flow
(0.2mbar; 0.1 mm)

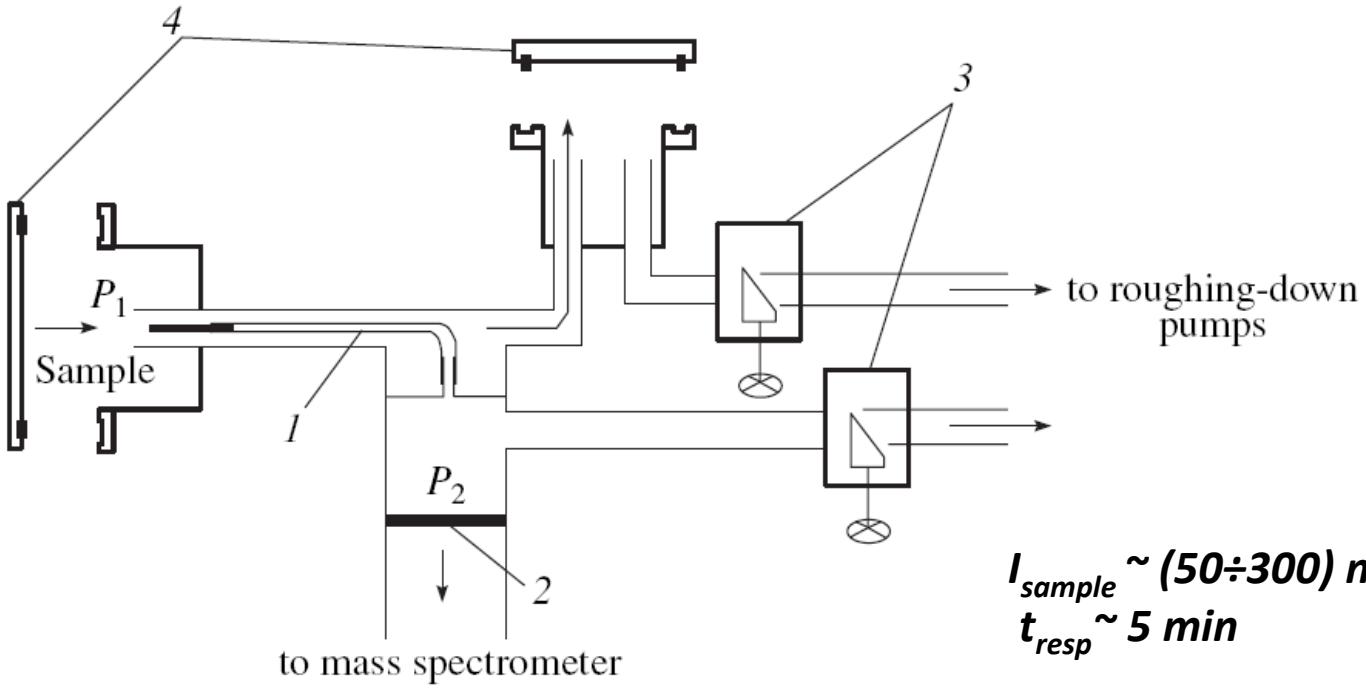


P_{start} < 0.001 mbar, t^{o}_{start} = 200°C,
V = 40 ml, V_{mem} = 0.08 ml,
P_{sampl}=1 bar, t_{expos}=10 min,
t_{pump} = 5 s, P_{clean}<0.001 mbar,
t^{o}_{ext} = 200°C, P_{ext} ~ 0.2 mbar

V = 40 ml
t_{resp} ~ 10 min

$k_{enrich}(C_7H_8/N_2)$ ~ 1000
$k_{enrich}(C_4H_{10}/N_2)$ ~ 170

Diffusion system with sheet and tube membranes
(Llewellyn)



Block diagram of the sample inlet system: (*1*,*2*) the first and second membranes; (*3*) controllable gates; and (*4*) flanges

I_{sample} ~ (50÷300) ml/min
t_{resp} ~ 5 min

$k_{enrich}(C_7H_8/N_2) > 10^5$
$k_{enrich}(C_4H_{10}/N_2) > 10^3$

Conclusions

The instrument gives the possibility of simultaneous and independent scanning of the separate mass sub ranges and supplies high dynamic range up to 100 Daltons.

- new ion source - efficiency of ion production
- Z focusing - mass analyzer transmission
- membrane inlet systems for VOC detection

The work is still in progress…

Thank you!
Questions…