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Laser Desorption-Ion Mobility Spectrometry As a Useful Tool For Surface Analysis

Martin Sabo and Štefan Matejčík

MINISTERSTVO ŠKOLSTVA SR
SLOVAK RESEARCH AND DEVELOPMENT AGENCY
MaSaTECH

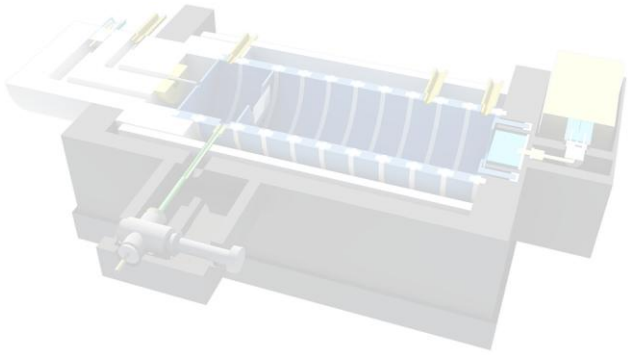
Introduction

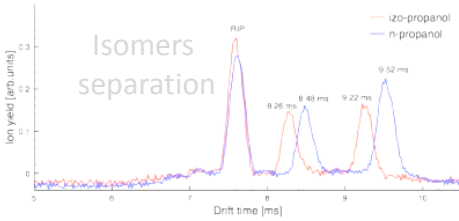
- Instrumentation & Experiment

- Explosives detection

- Isomeric β–Blockers separation

- TLC+IMS





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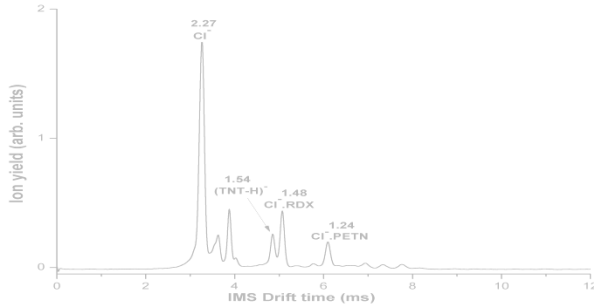

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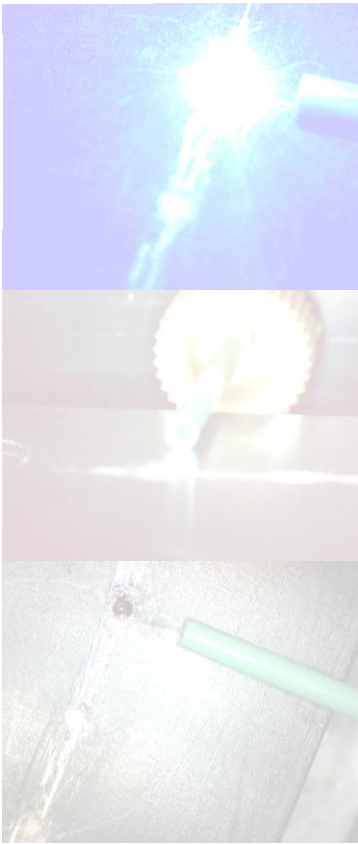

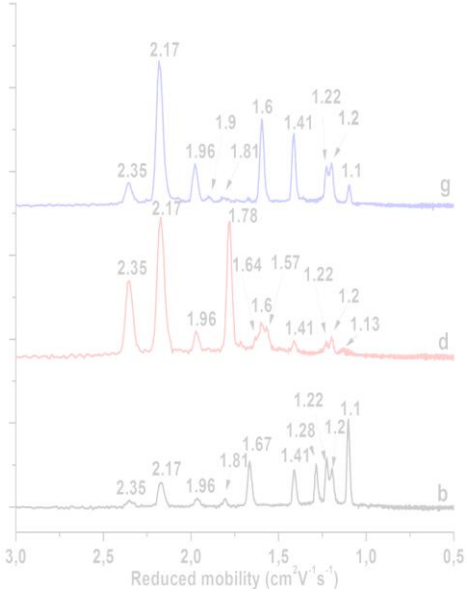

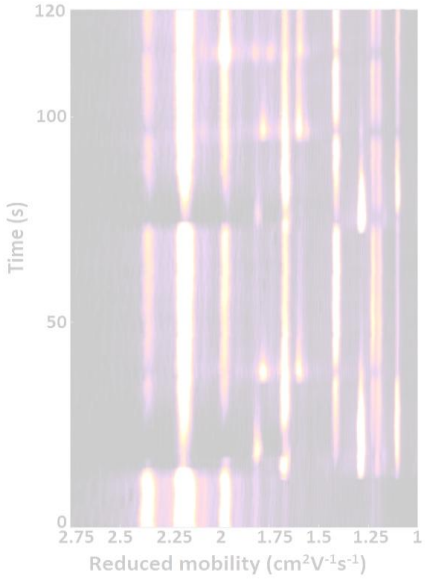

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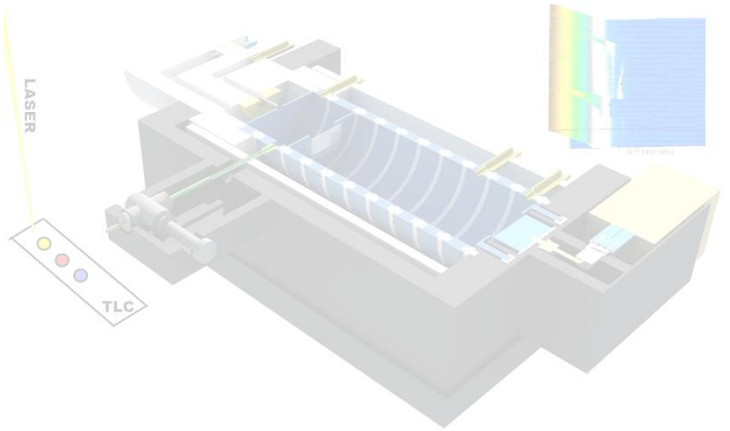
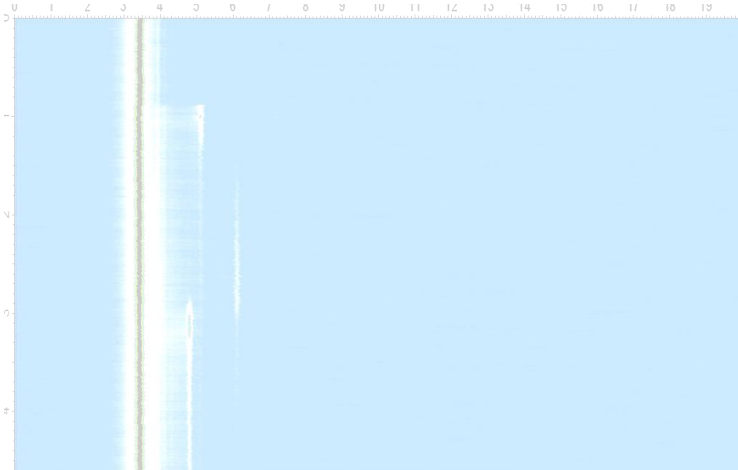
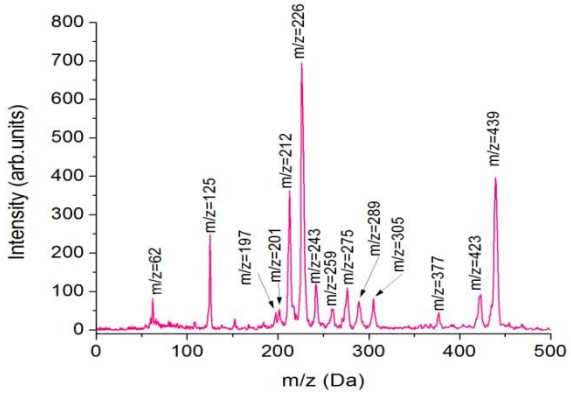
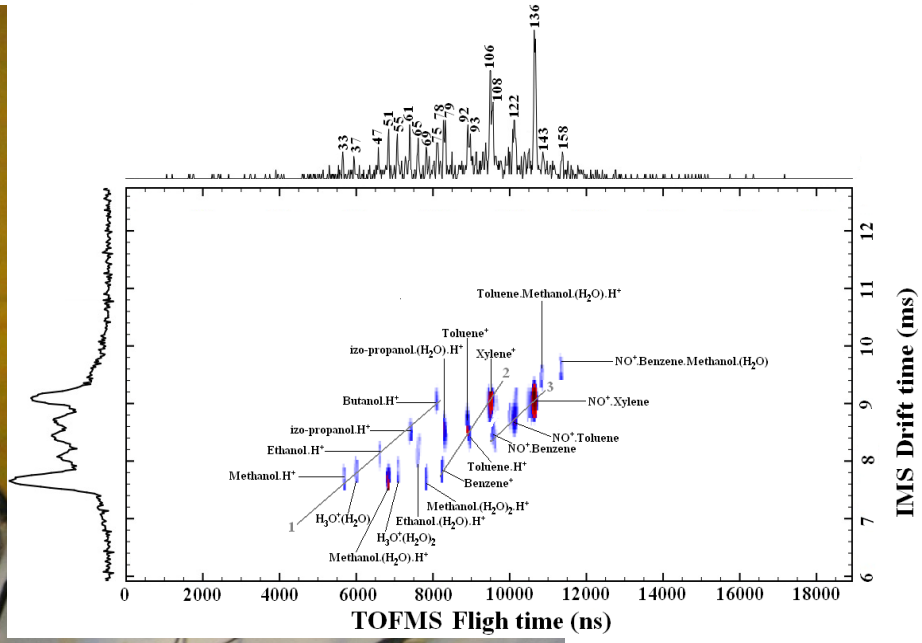
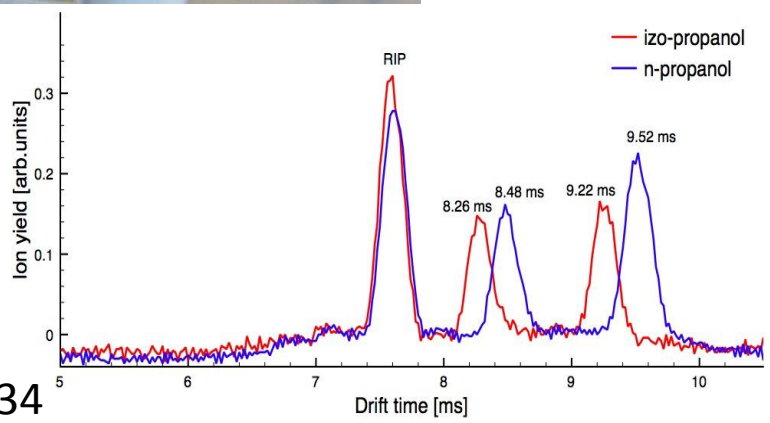




IMS-MS Laboratory - DEP - FMFI-UK

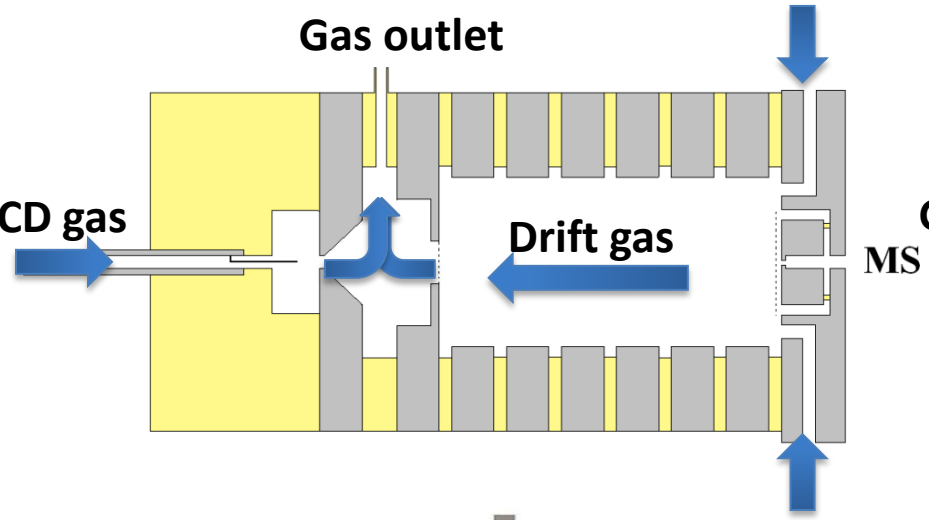


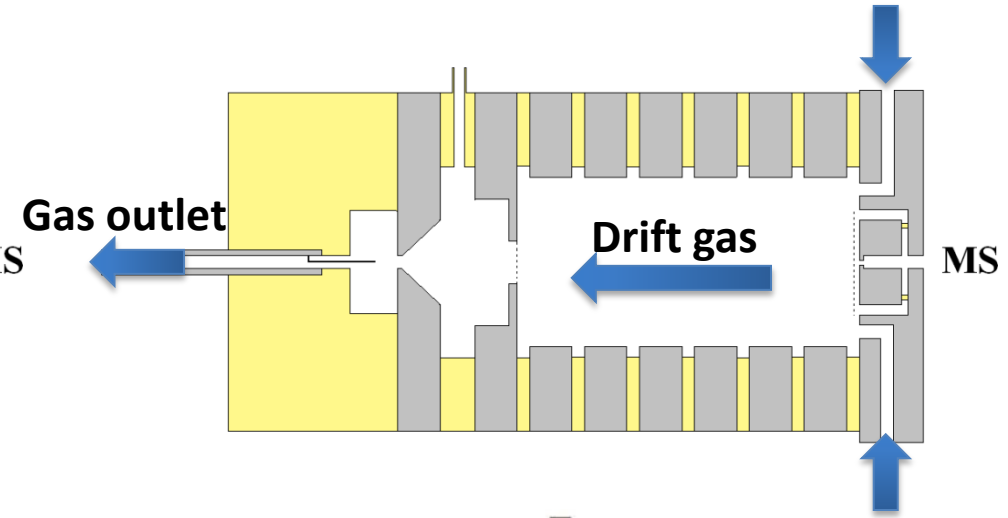




M.Sabo, Š. Matejčík; *Analytical Chemistry*; 84; **2012**; 5327-34

CD-Selective reactant ions generation





Standard gas flow mode

Ions direction

CD gas flow

O, O_3, N_xO_y

$N_2O_2^-$, NO_3^-, $NO_3^-.HNO_3$
Stable RI

Reverse gas flow mode

Ions direction

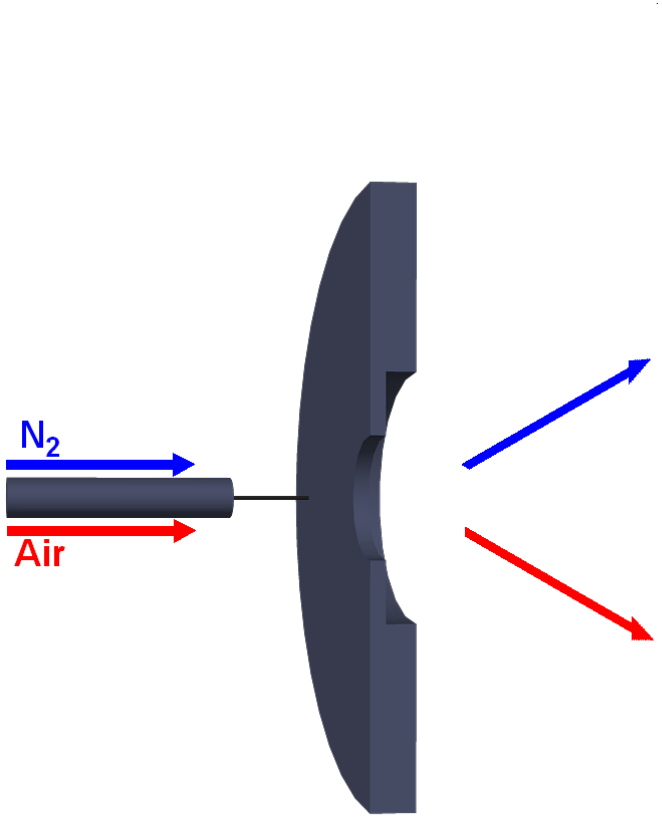
CD gas flow

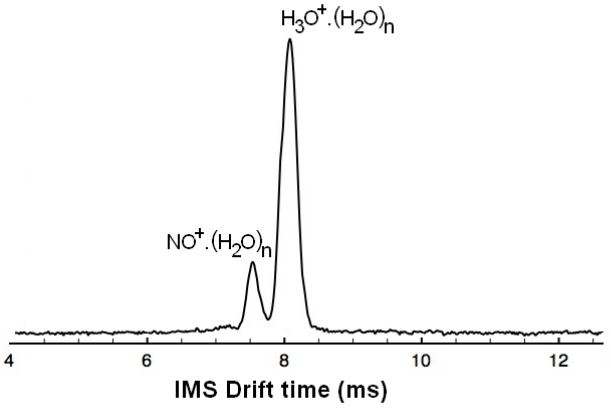
O, O_3, N_xO_y
Removed

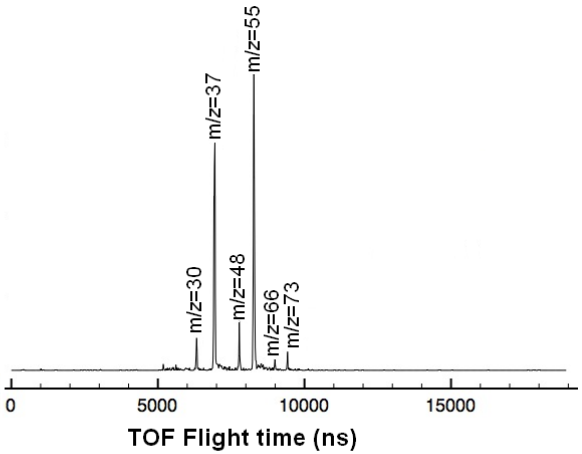
$O_2^-.(H_2O)_n$
Stable RI

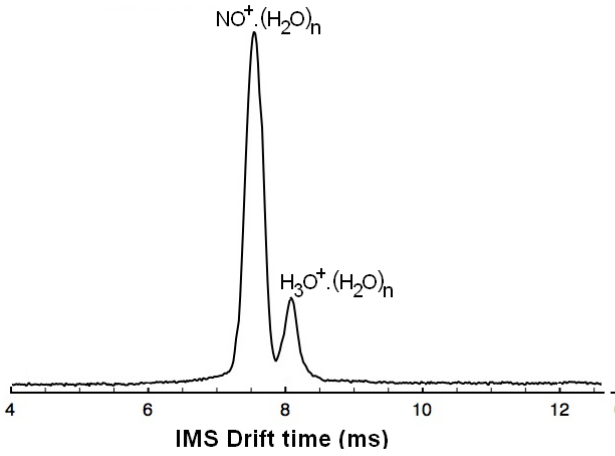
Martin Sabo, Ján Matúška, Štefan Matejčík, 85, *Talanta,* ***2011***, 400

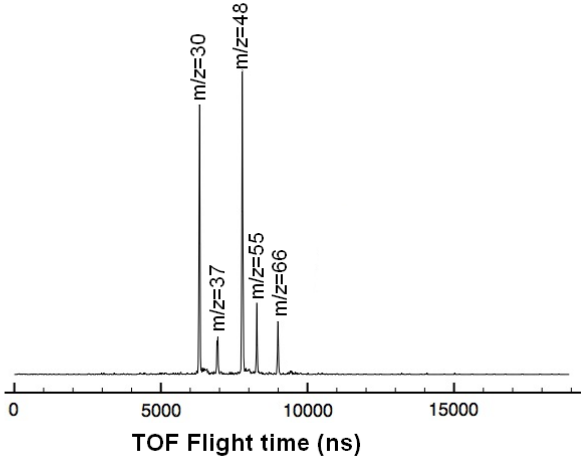
Positive ion chemistry and optimization of CD











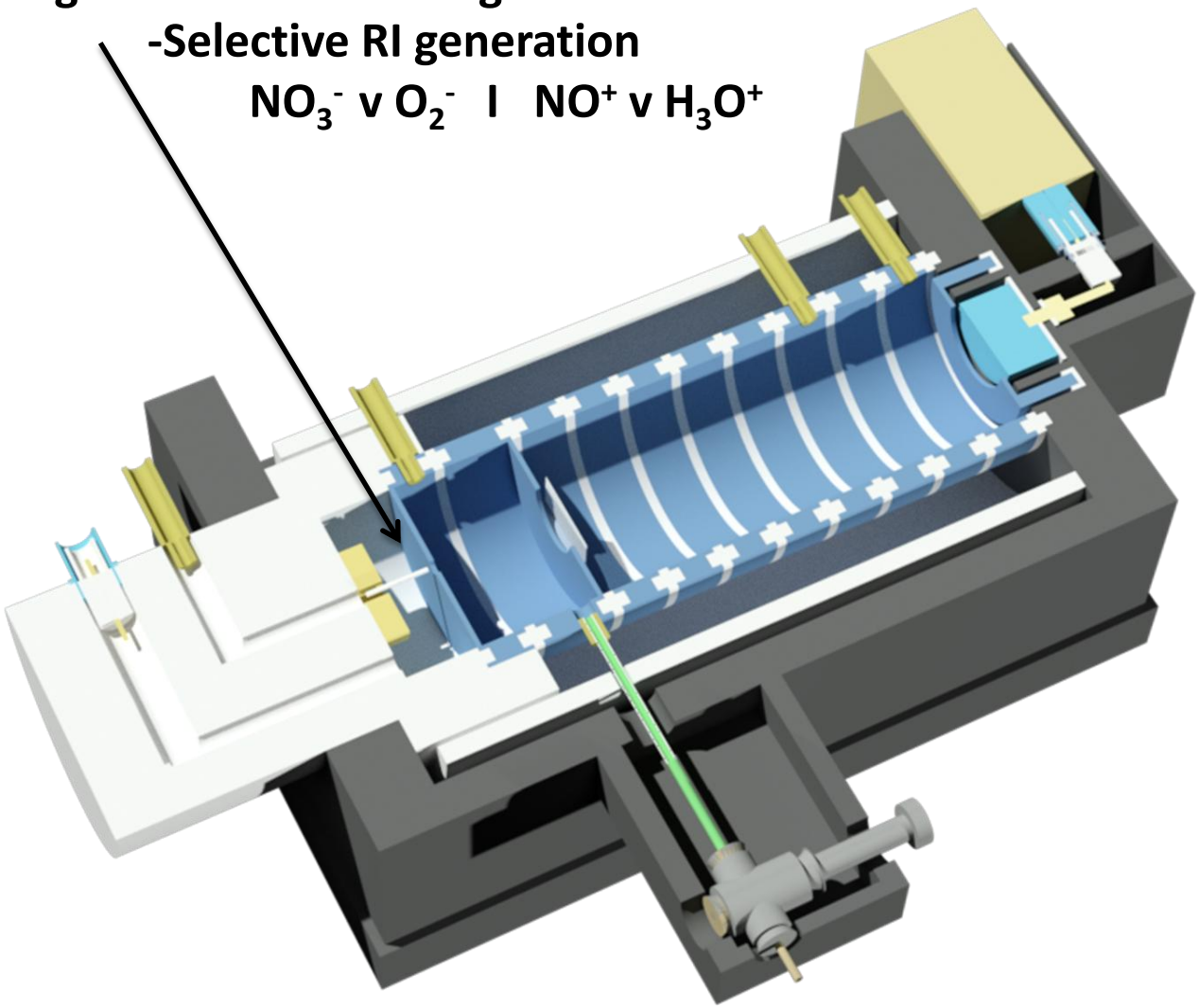
Martin Sabo, Štefan Matejčík, 138, *ANALYST*, **2013,** 6907

Ion Mobility Spectrometer

Ionization Region-Corona Discharge

-Selective RI generation

NO_3^- v O_2^- I NO^+ v H_3O^+



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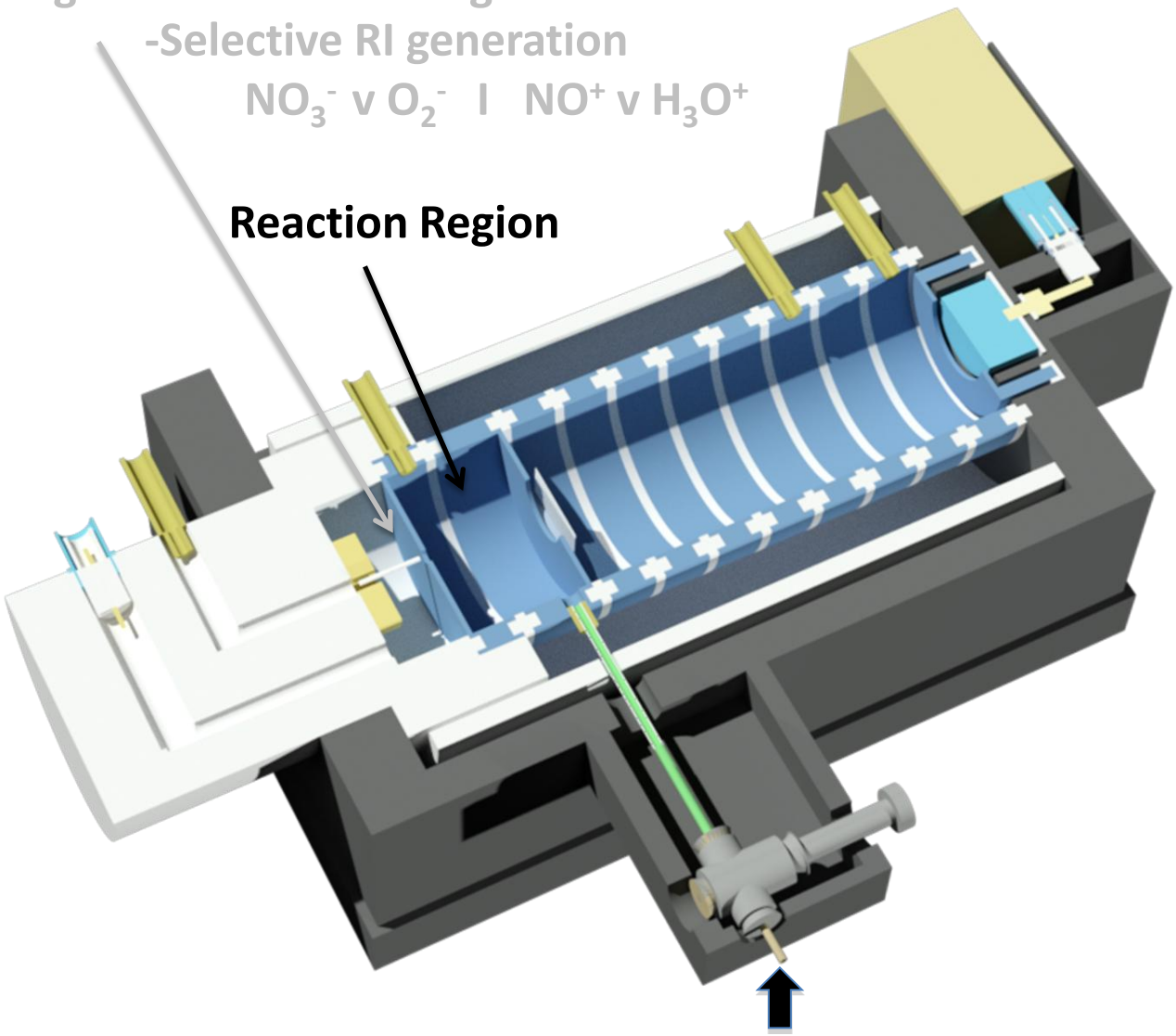


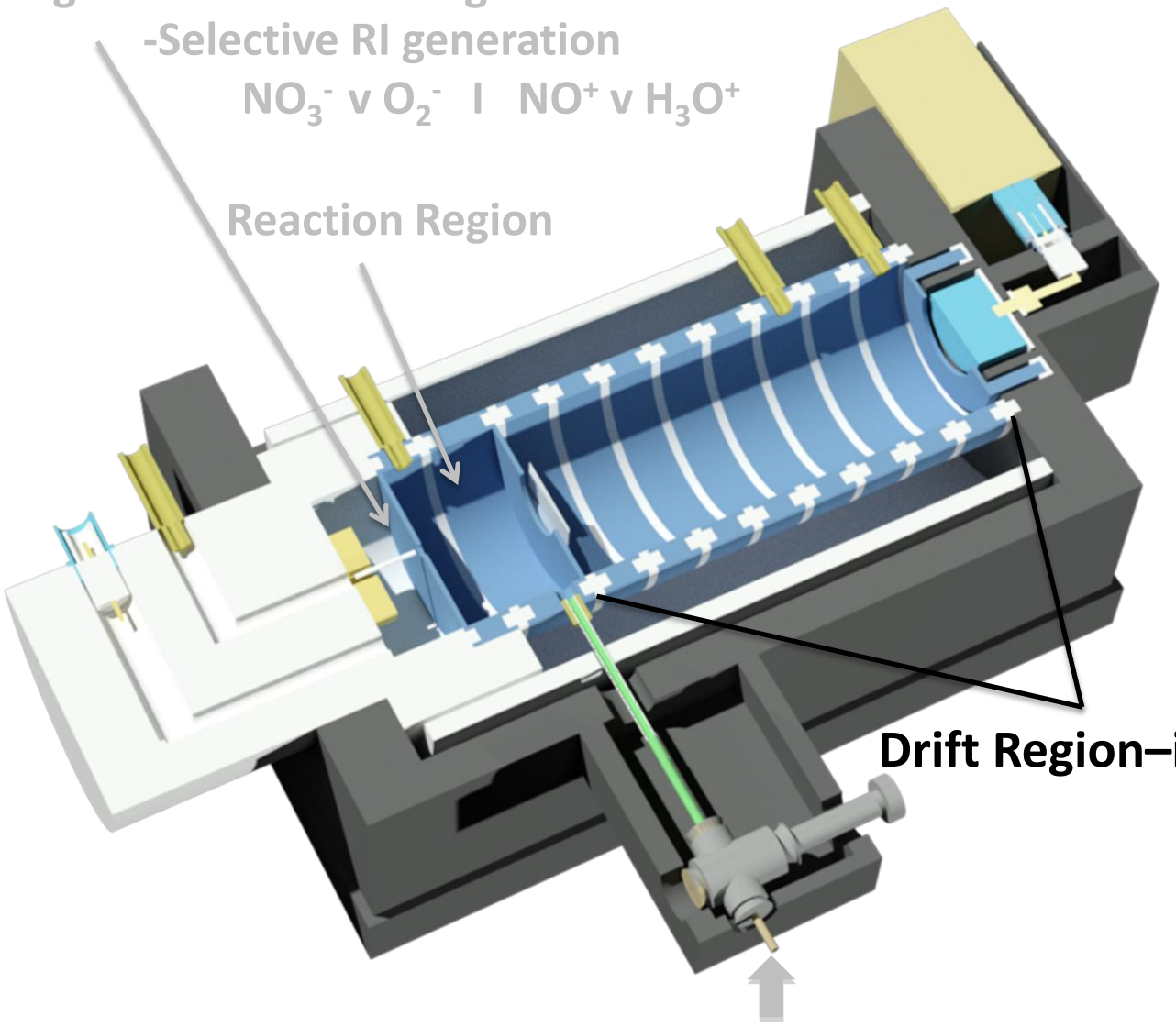
Ion Mobility Spectrometer

Ionization Region-Corona Discharge

-Selective RI generation

NO_3^- v O_2^- I NO^+ v H_3O^+

Reaction Region

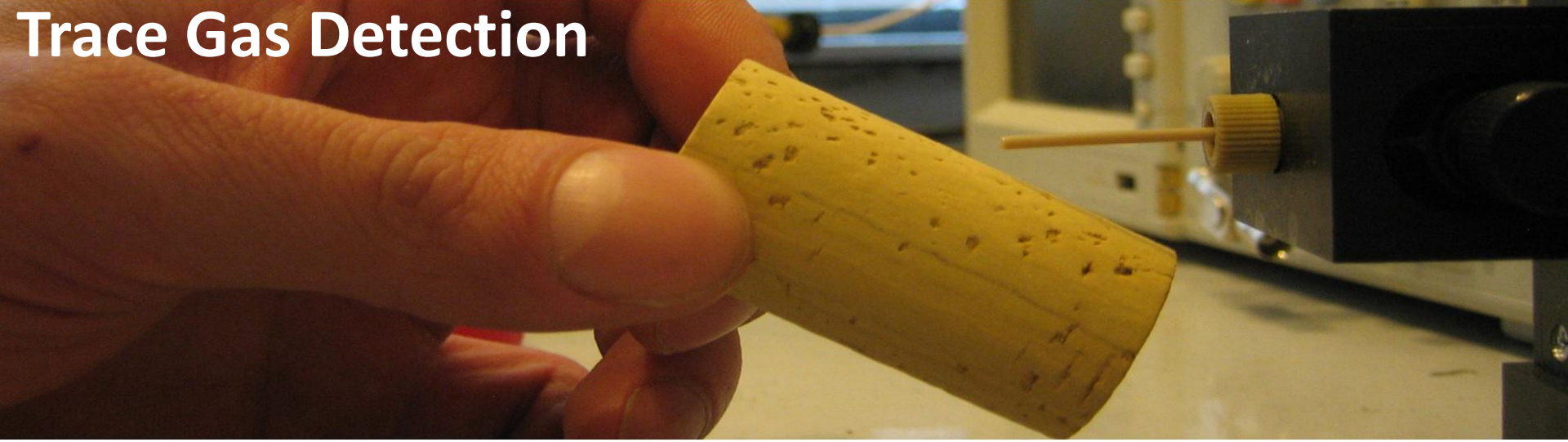


Drift Region–ions separation

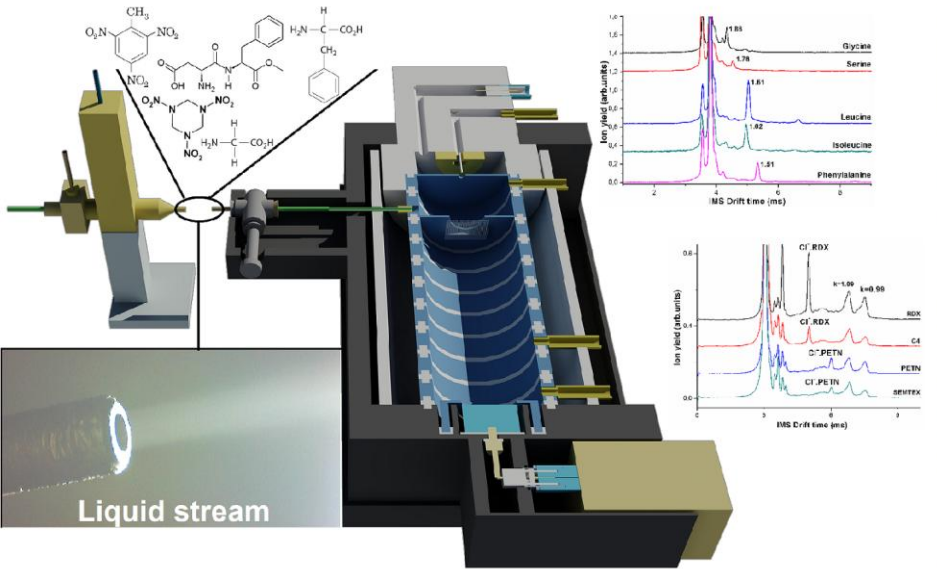
Sample inlet

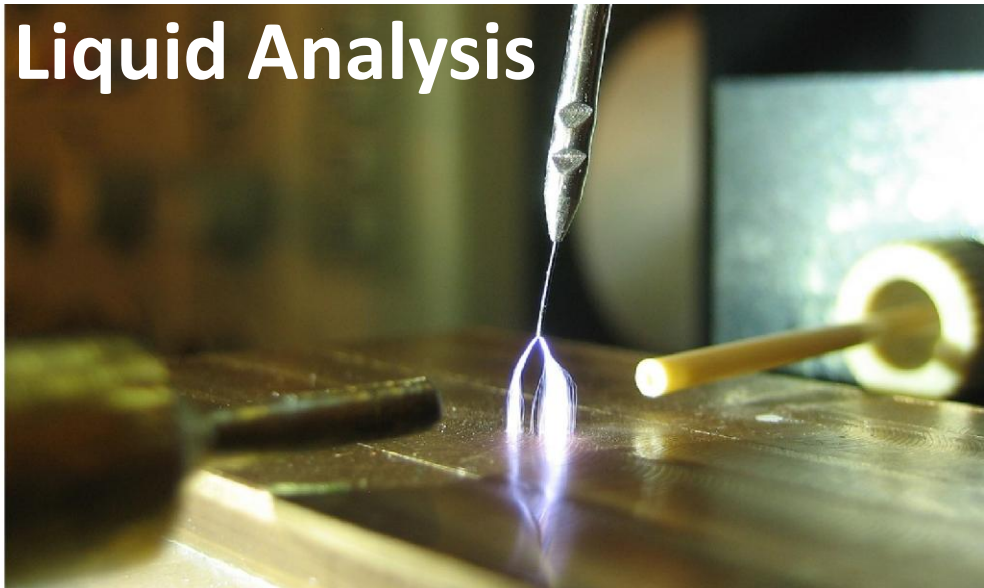

Ion mobility spectrometry
Pressure sensor
Drift gas inlet
Sample inlet
MaSaTECH
Because we live for science

Trace Gas Detection

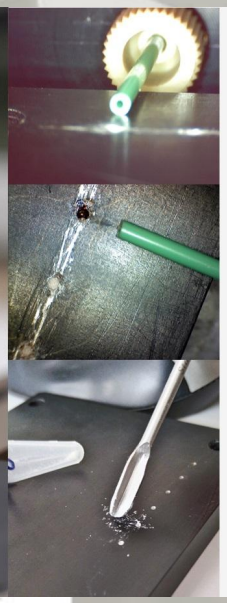


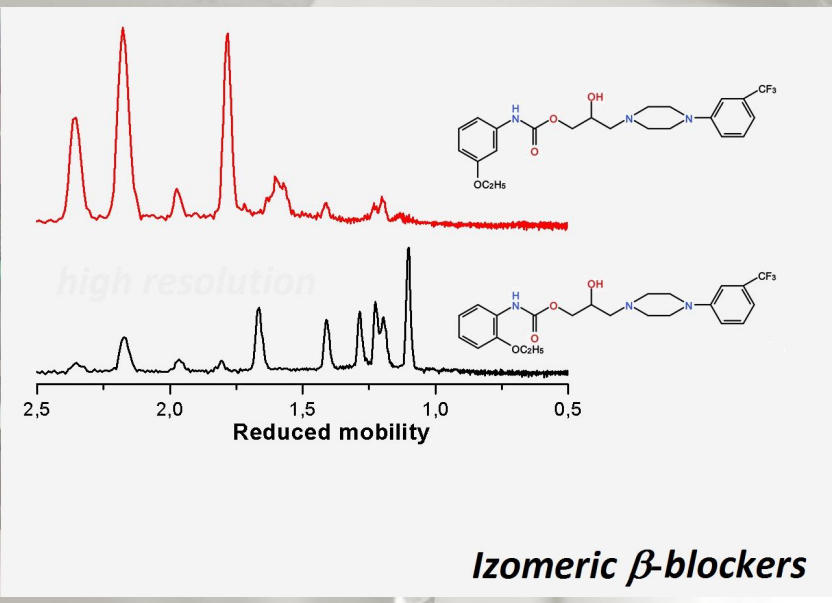
M.Sabo et al.; *Analytical Chemistry* ,87, **2015**, 7389−7394

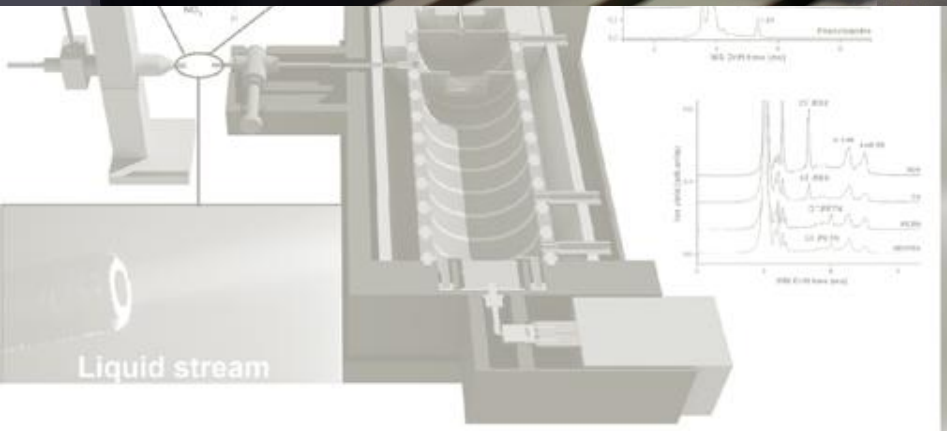


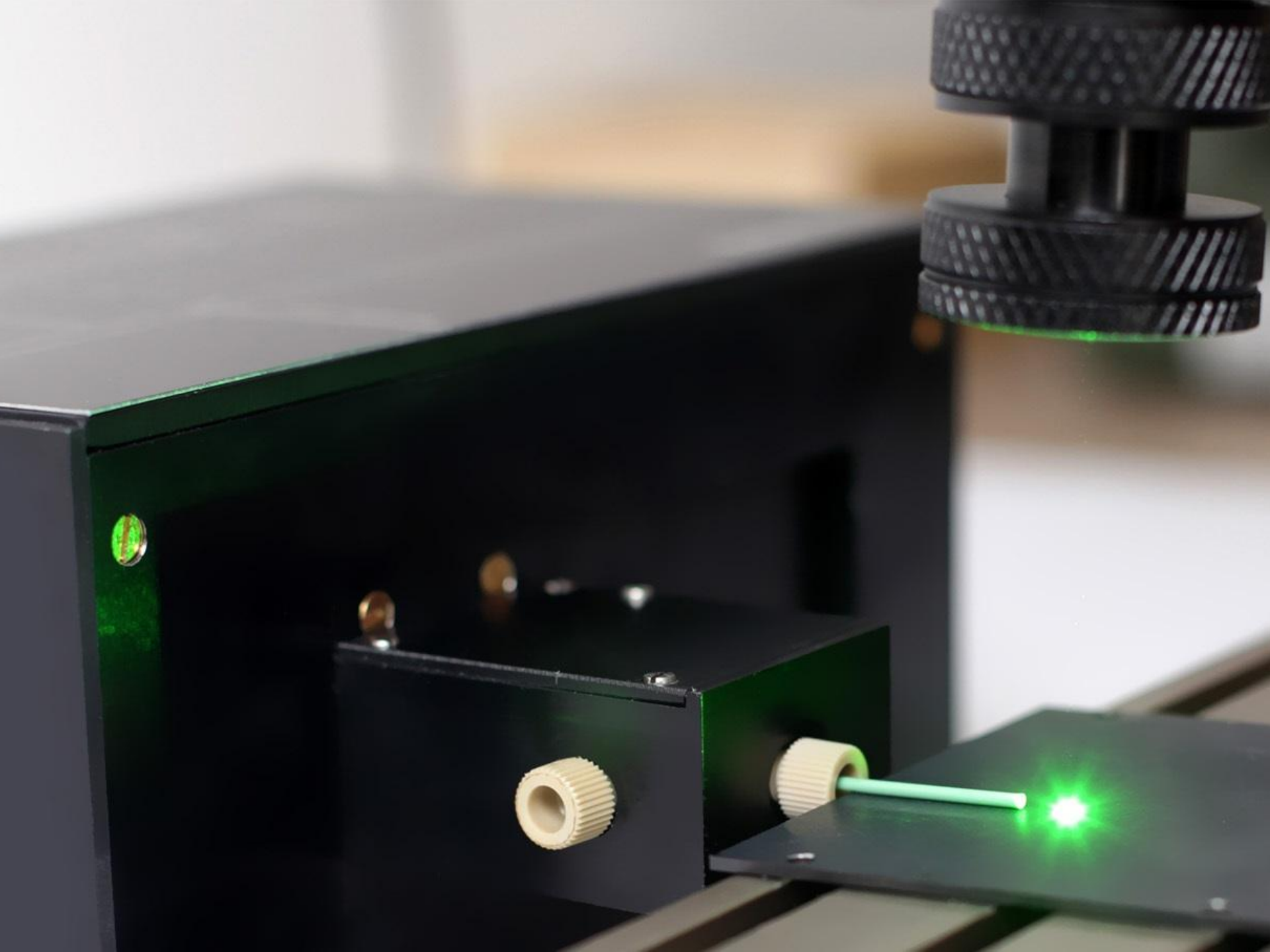


Surface Analysis





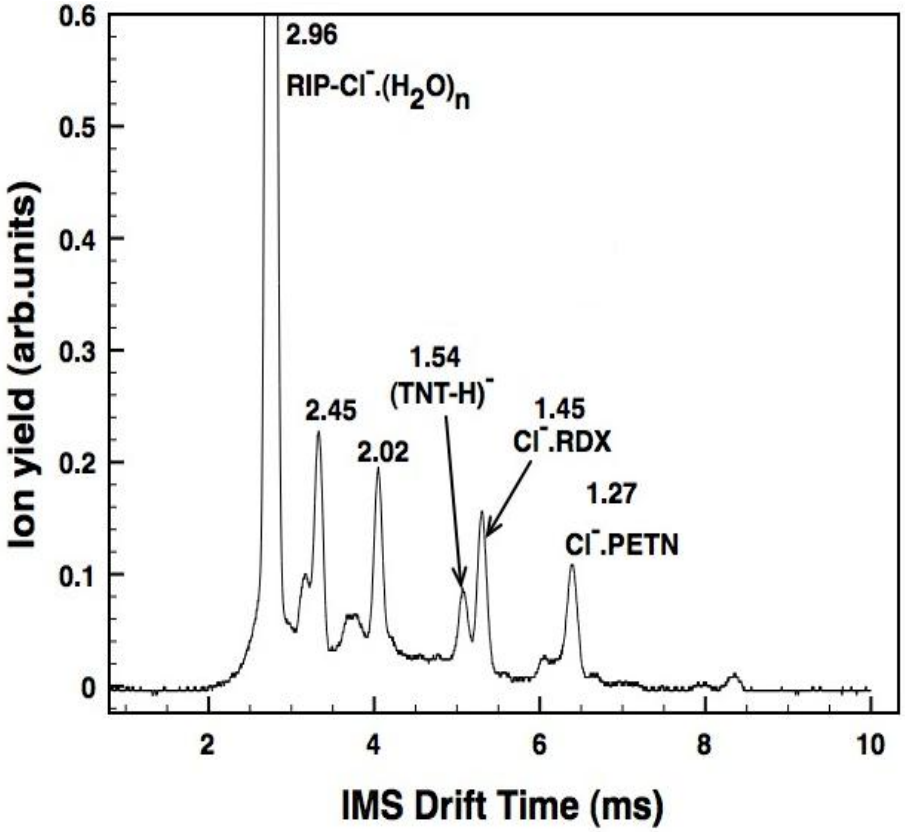


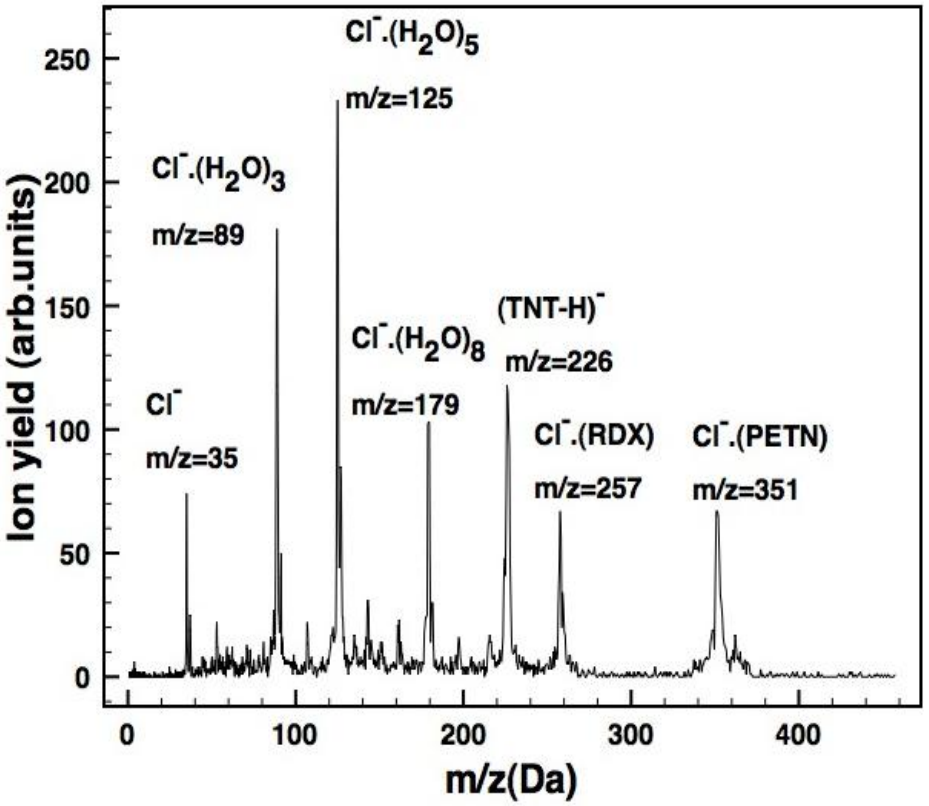


Explosives detection

M.Sabo, Š. Matejčík, 139,
ANALYST .2014, 5112

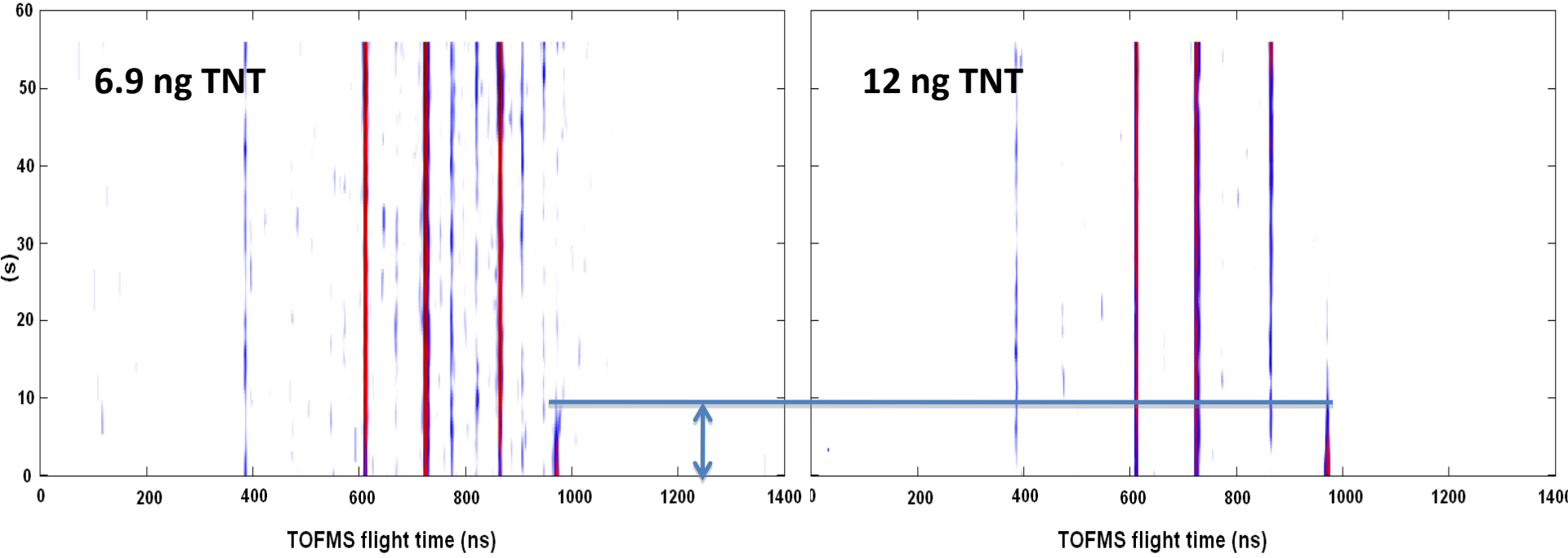
Explosives detection

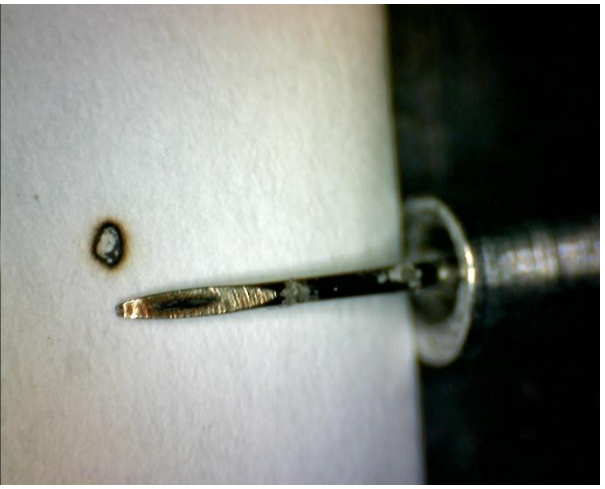




	532 nm (300 mW)	445 nm (500 mW)	635 nm (300 mW)
TNT	**86 pg**	675 pg	520 pg
RDX	**305 pg**	6,5 ng	3,32 ng
PETN	1,41 ng	5 ng	**1,22 ng**

TNT evaporation profile - 532 nm (300mW) Laser





LOD

TNT 86 pg

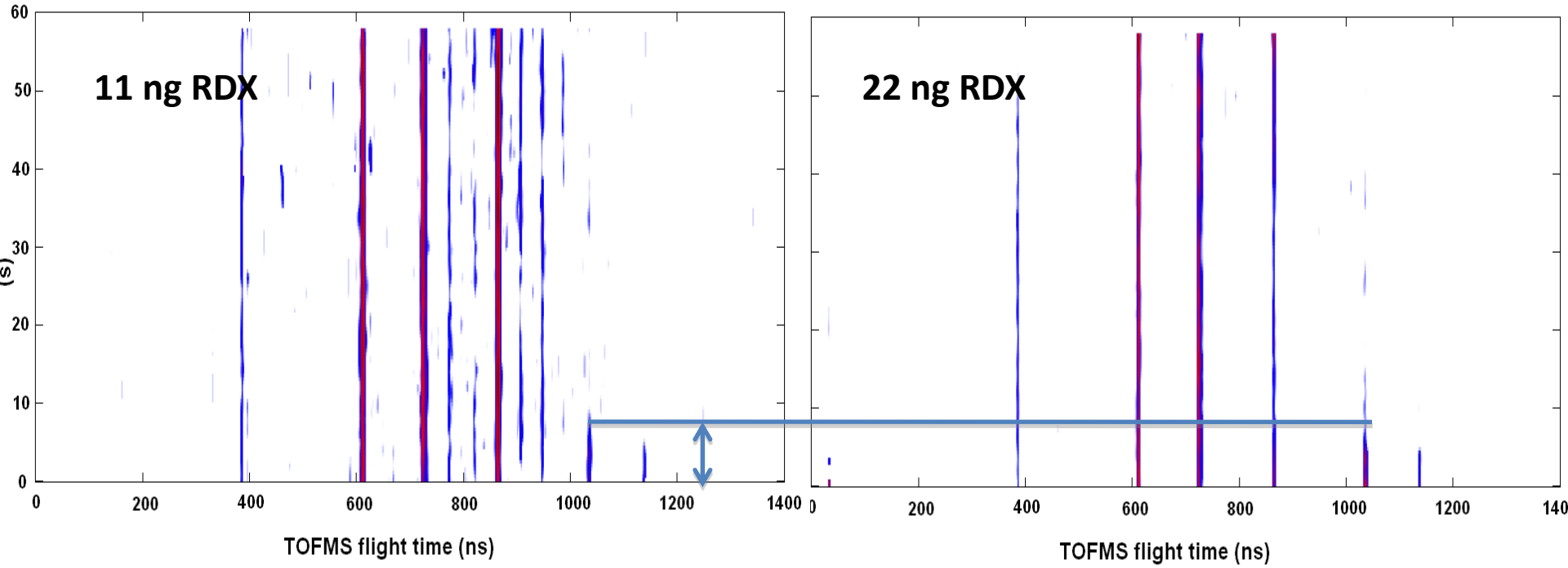
Evaporation time : 8s IMS duty cycle 0.272 s

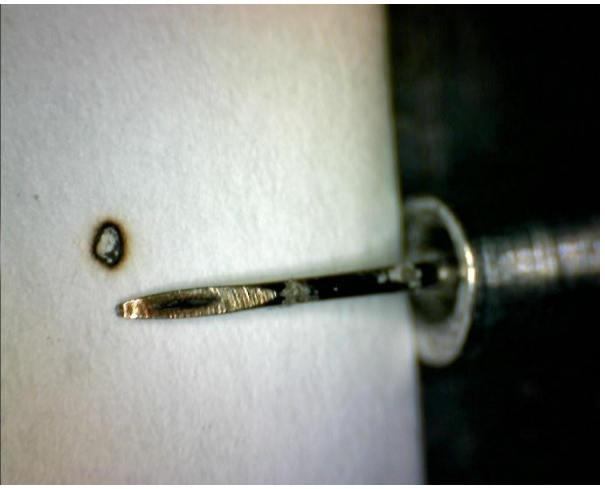
30 time higher sensitivity

Desorbed area **20%**

Real sensitivity of IMS ≈ **500 fg**

RDX evaporation profile - 532 nm (300mW) Laser





LOD

RDX 305 pg

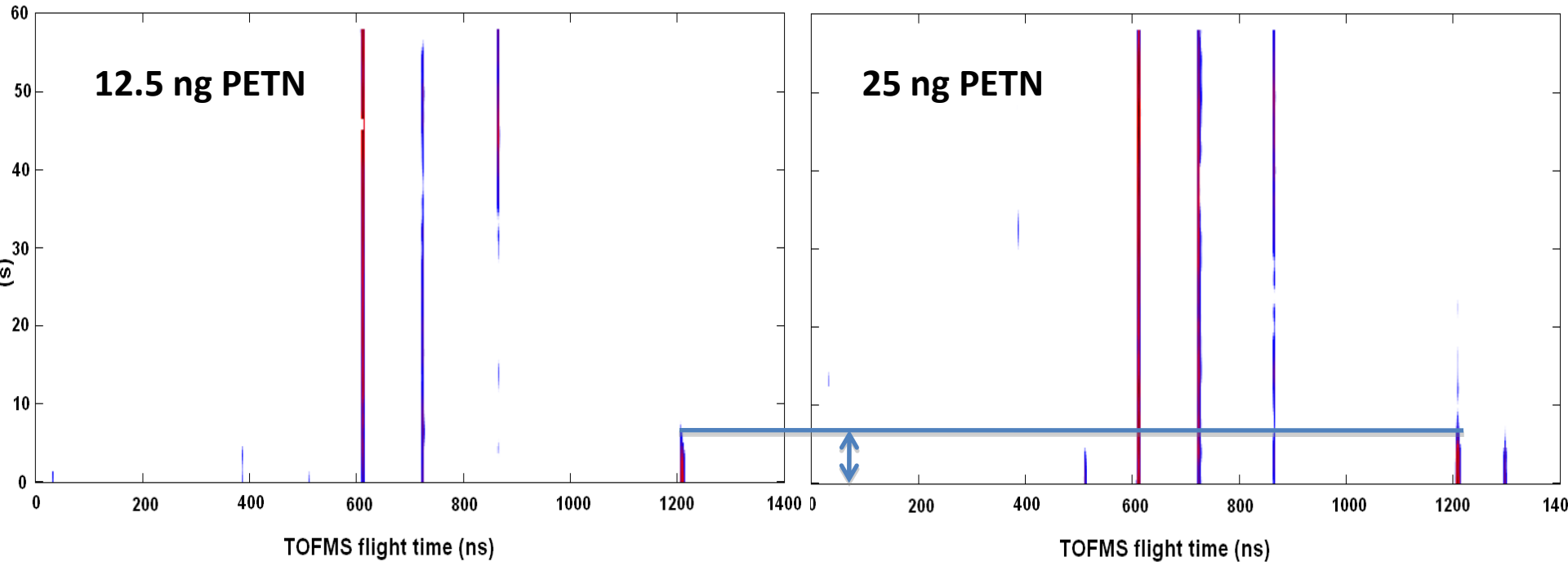
Evaporation time : 6s IMS duty cycle 0.272 s

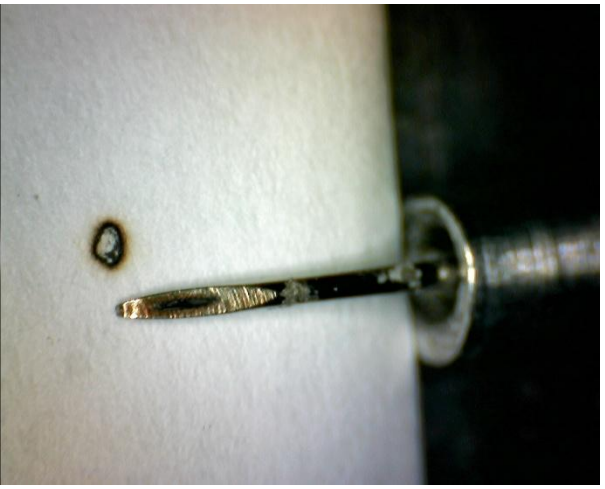
22 time higher sensitivity

Desorbed area **20%**

Real sensitivity of IMS ≈ **3 pg**

PETN evaporation profile - 532 nm (300mW) Laser





LOD

PETN 1,22 ng

Evaporation time : 5s IMS duty cycle 0.272 s

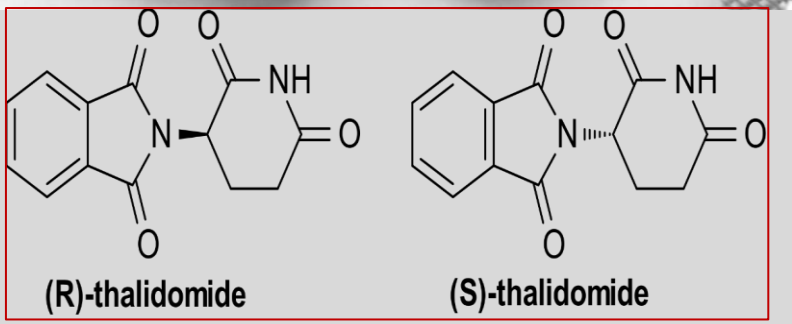
18 time higher sensitivity

Desorbed area **20%**

Real sensitivity of IMS ≈ **13 pg**

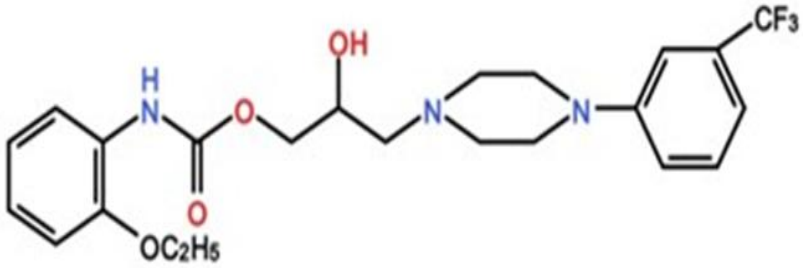
Isomers in pharmacy

Teratogenic effects - S-thalidomide

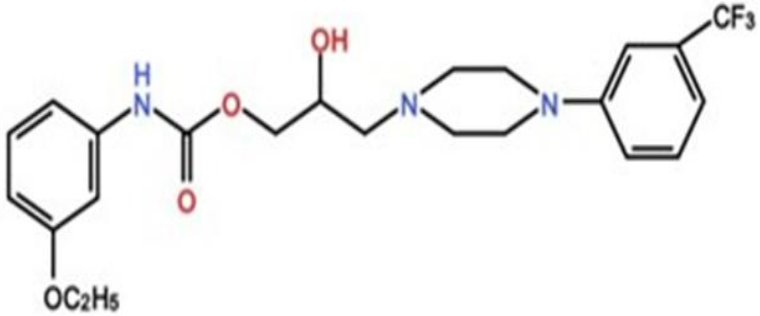


Isomeric β-Blockers separation

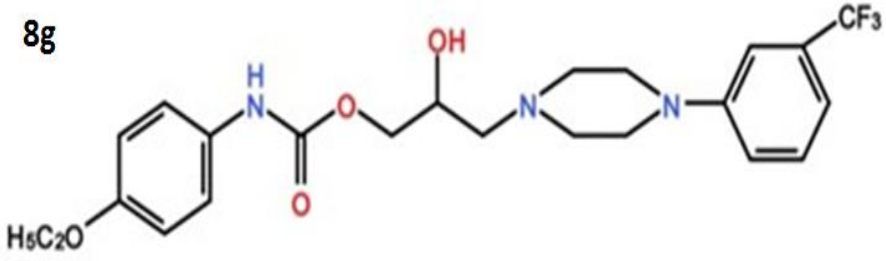
8b



8d



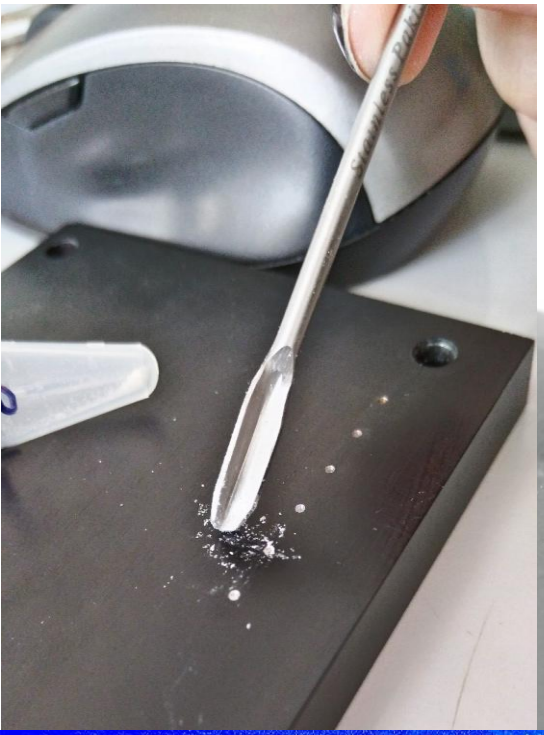
8g



	R^1	R^2
8b	2-OC_2H_5	3´-CF_3
8d	3-OC_2H_5	3´-CF_3
8g	4-OC_2H_5	3´-CF_3

$C_{23}H_{29}O_4N_3F$, mass = 503.95 g/mol

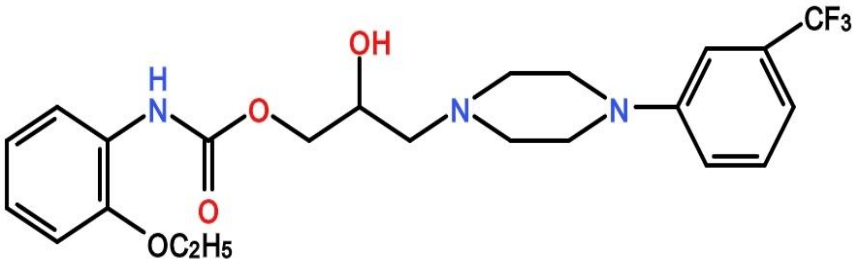
Isomeric β-Blockers separation





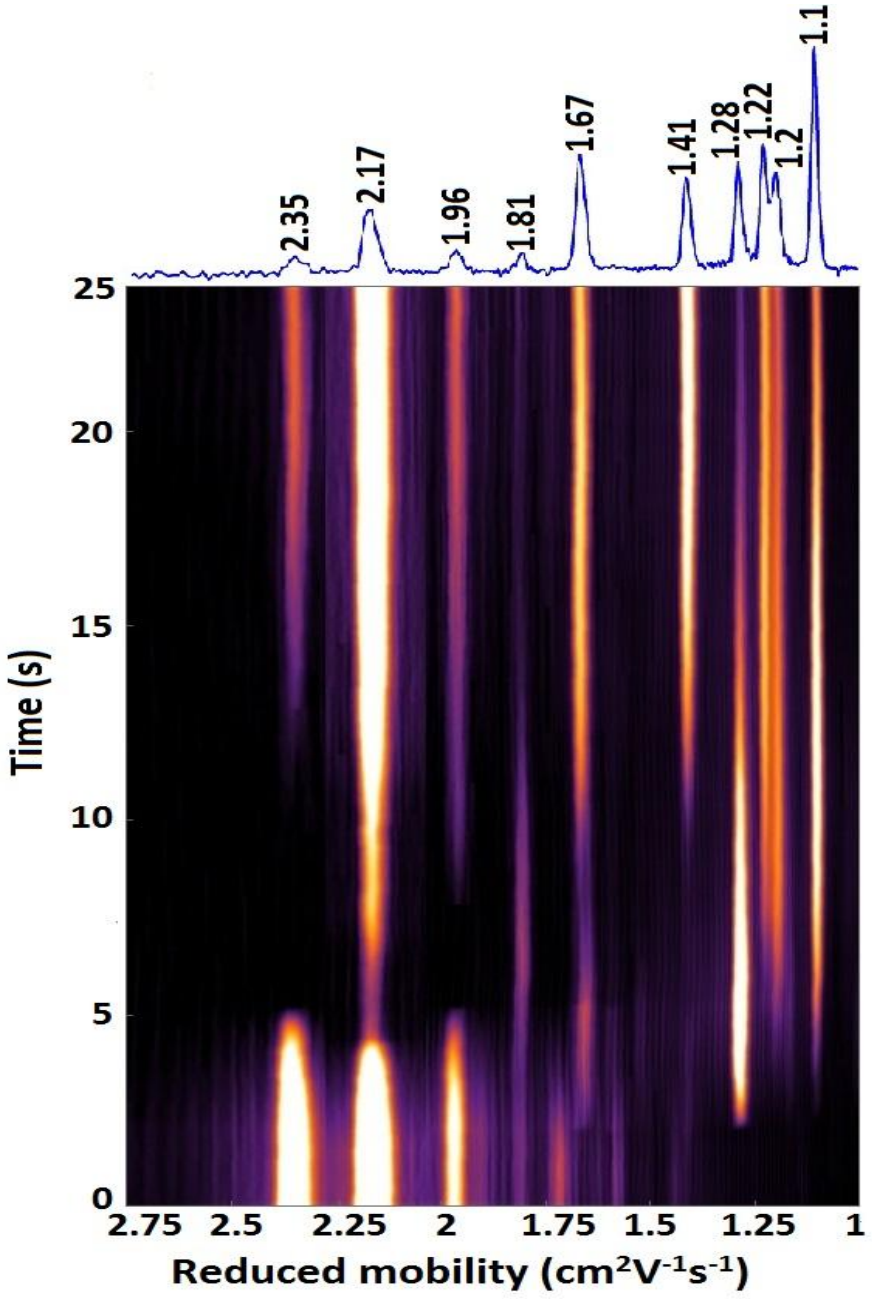
Isomeric β-Blockers separation

Sample 8b



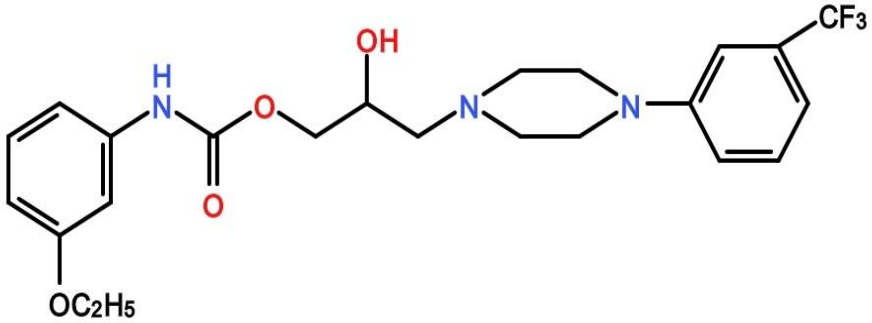
RI : 2.35; 2.17; 1.96;

8b response : 1.81; 1.67; 1.41;
1.28; 1.22; 1.2; 1.1



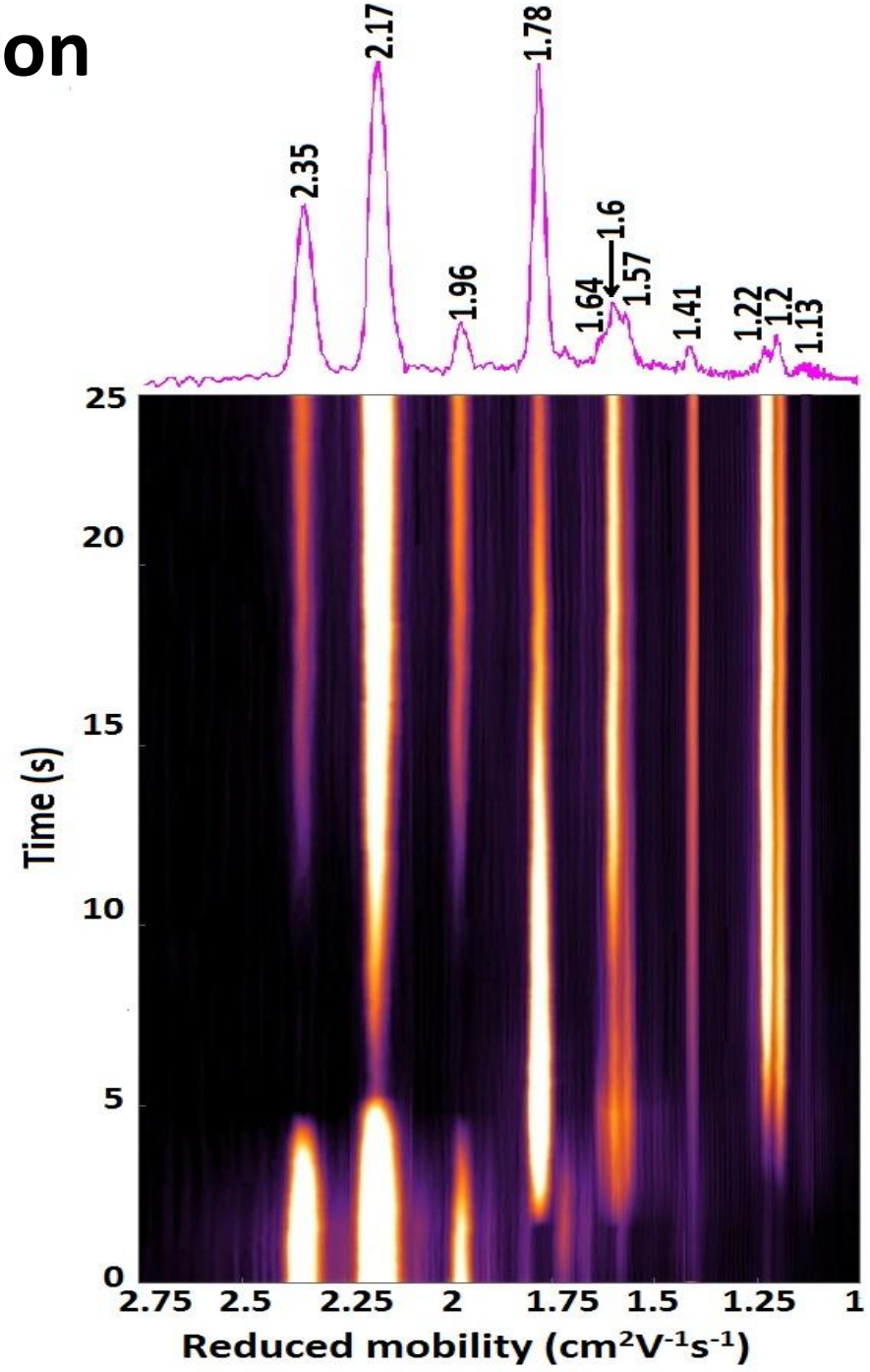
Isomeric β-Blockers separation

Sample 8d



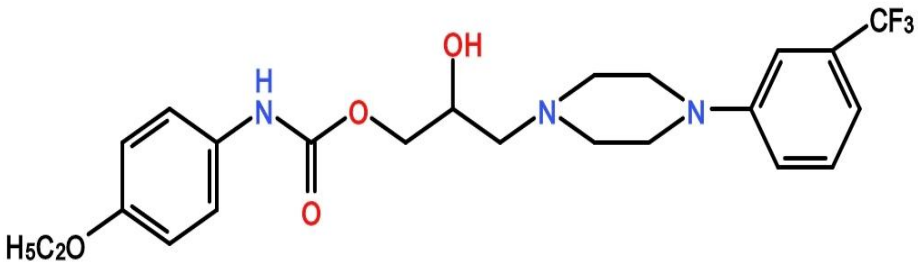
RI : 2.35; 2.17; 1.96;

8b response : 1.78; 1.64; 1.6;
1.57; 1.41; 1,22; 1.2; 1.13



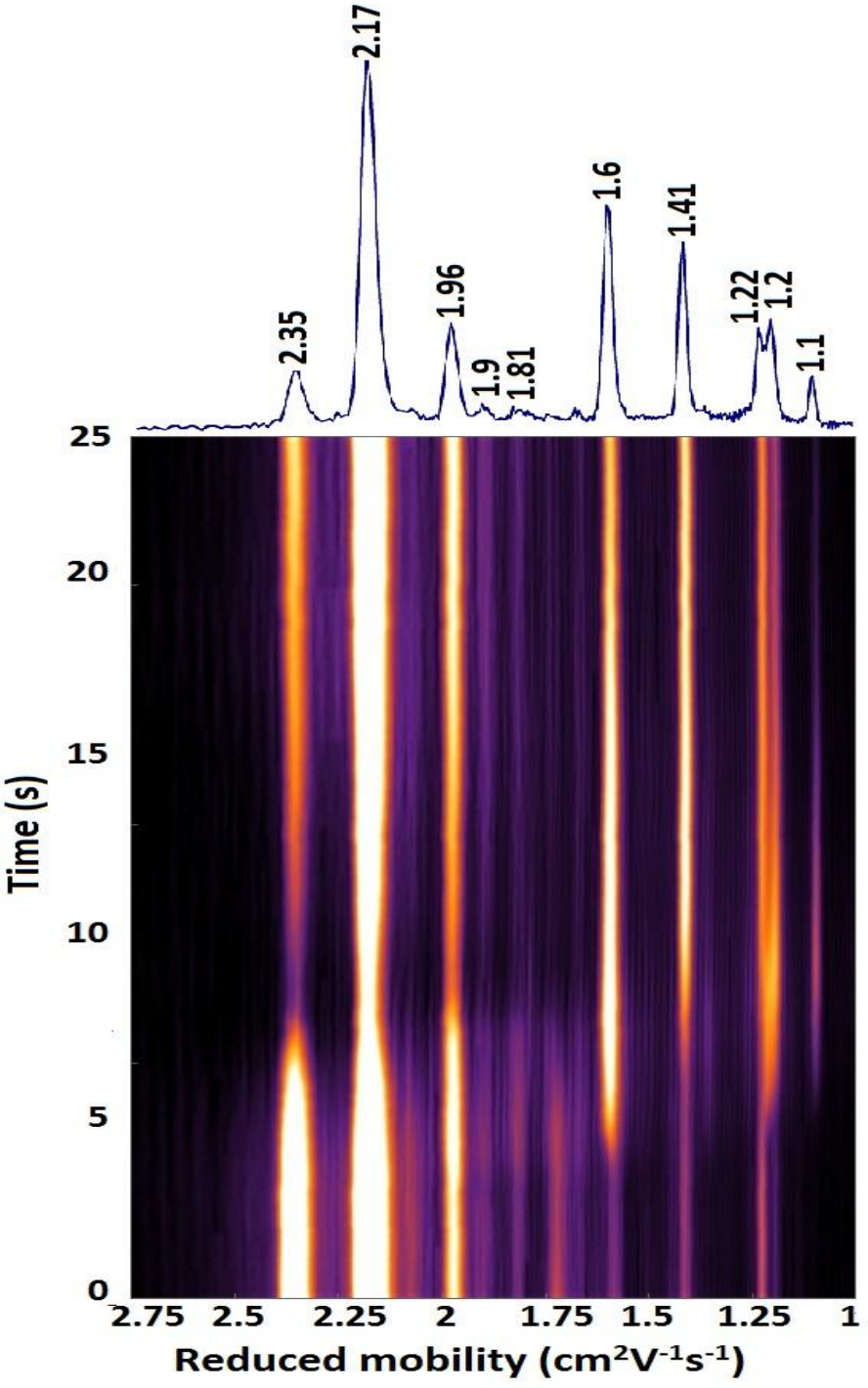
Isomeric β-Blockers separat

Sample 8g



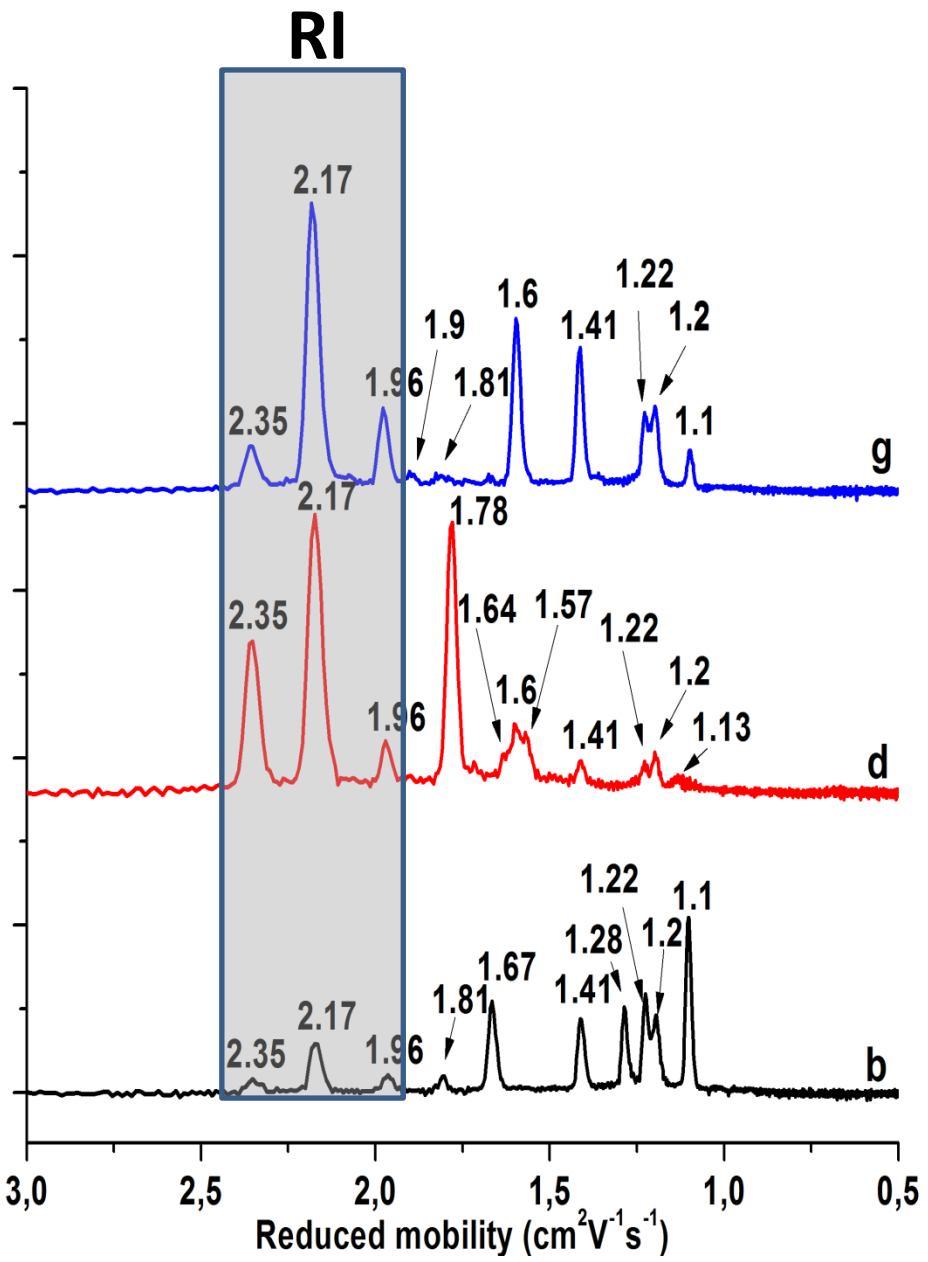
RI : 2.35; 2.17; 1.96;

8b response : 1.9; 1.81; 1.6;
1.41; 1,22; 1.2; 1.1



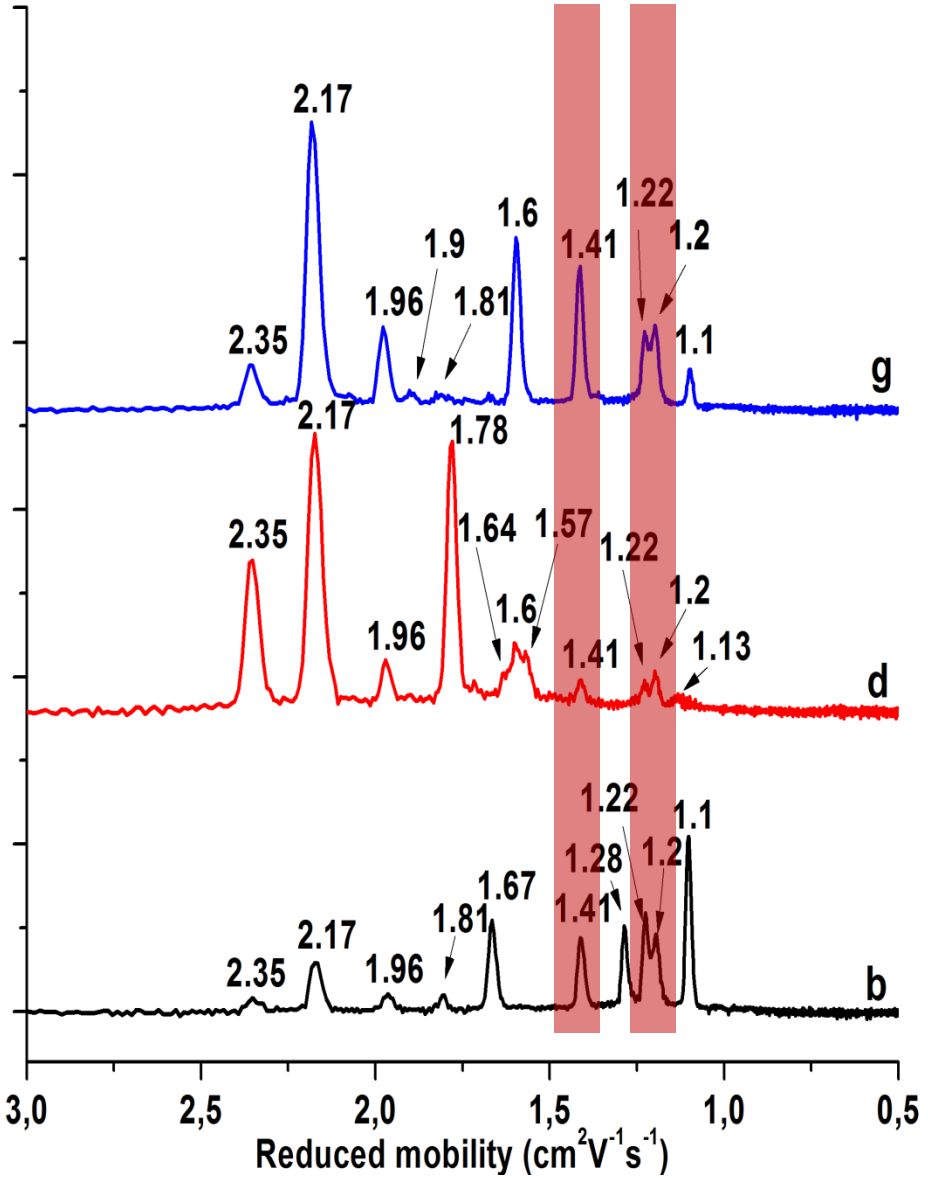
Isomeric β-Blockers separation

K_0 8b [$cm^2V^{-1}s^{-1}$]	K_0 8d [$cm^2V^{-1}s^{-1}$]	K_0 8g [$cm^2V^{-1}s^{-1}$]
1,81	1,78	1,9
1,67	1,64	1.81
1,41	1,60	1,60
1,28	1,57	1,41
1,23	1,41	1,22
1,20	1,22	1,20
1,10	1,20	1,10
-	1,13	-



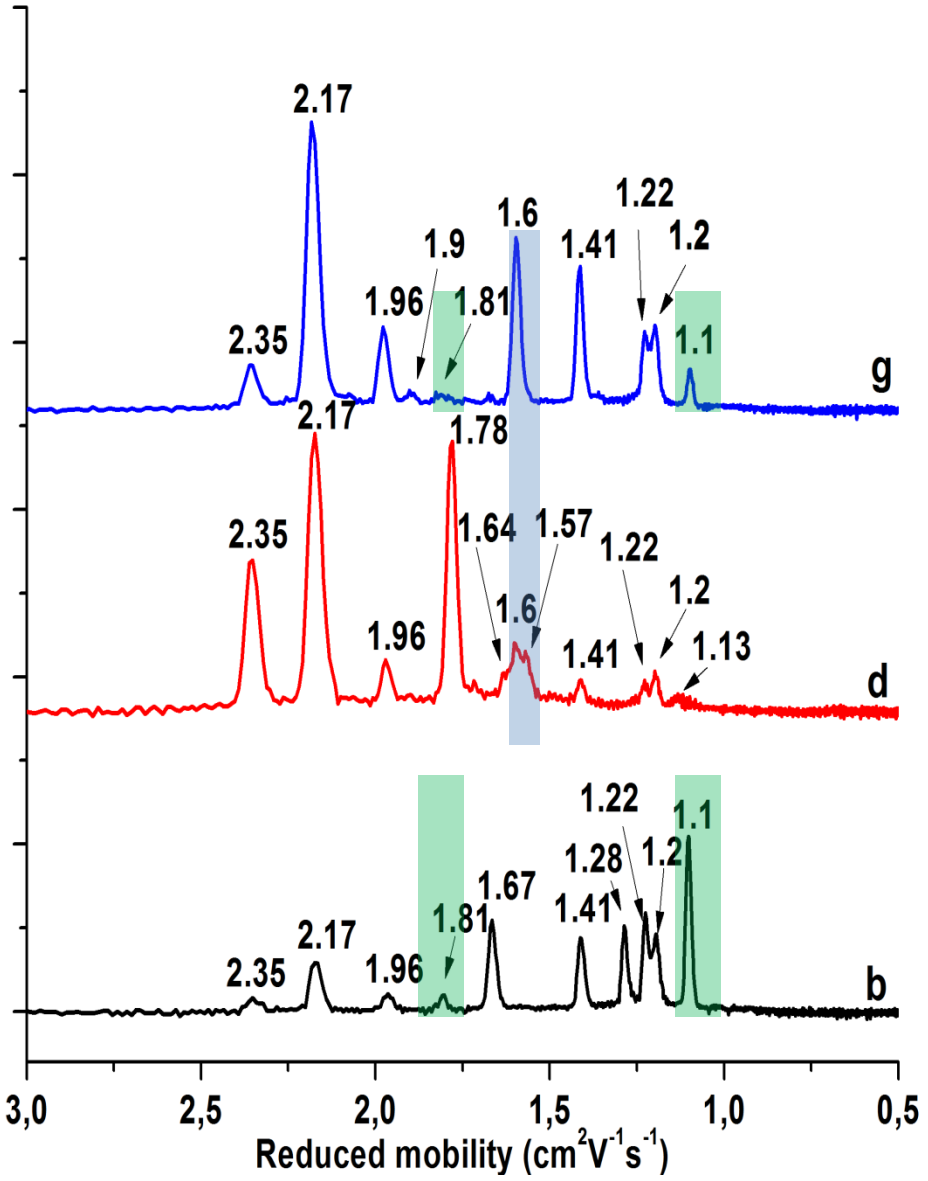
Isomeric β-Blockers separation

K_0 8b [$cm^2V^{-1}s^{-1}$]	K_0 8d [$cm^2V^{-1}s^{-1}$]	K_0 8g [$cm^2V^{-1}s^{-1}$]
1,81	1,78	1,9
1,67	1,64	1.81
1,41	1,60	1,60
1,28	1,57	**1,41**
1,22	**1,41**	**1,22**
1,20	**1,22**	**1,20**
1,10	**1,20**	1,10
-	1,13	-



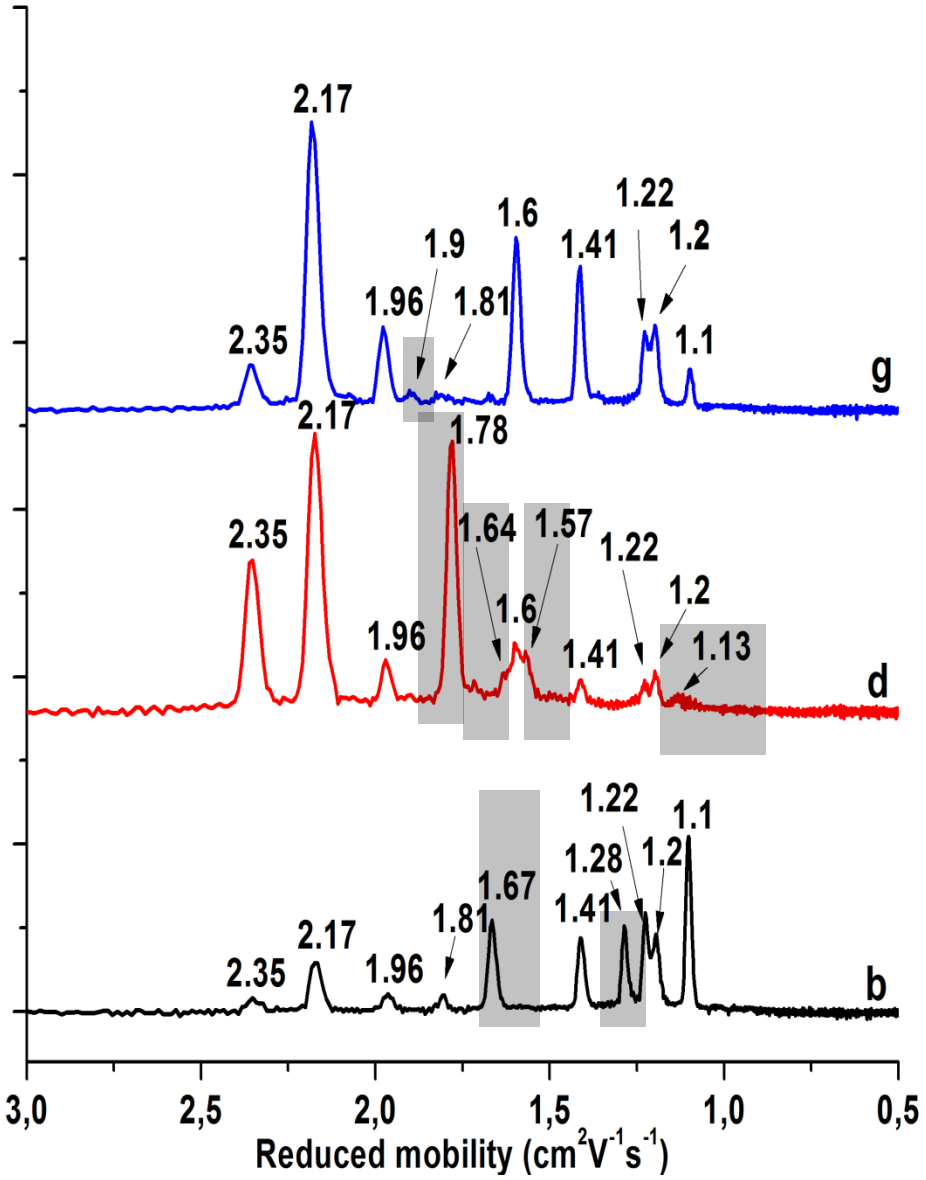
Isomeric β-Blockers separation

K_0 8b [$cm^2V^{-1}s^{-1}$]	K_0 8d [$cm^2V^{-1}s^{-1}$]	K_0 8g [$cm^2V^{-1}s^{-1}$]
1,81	1,78	1,9
1,67	1,64	1,81
1,41	1,60	1,60
1,28	1,57	1,41
1,22	1,41	1,22
1,20	1,22	1,20
1,10	1,20	1,10
-	1,13	-



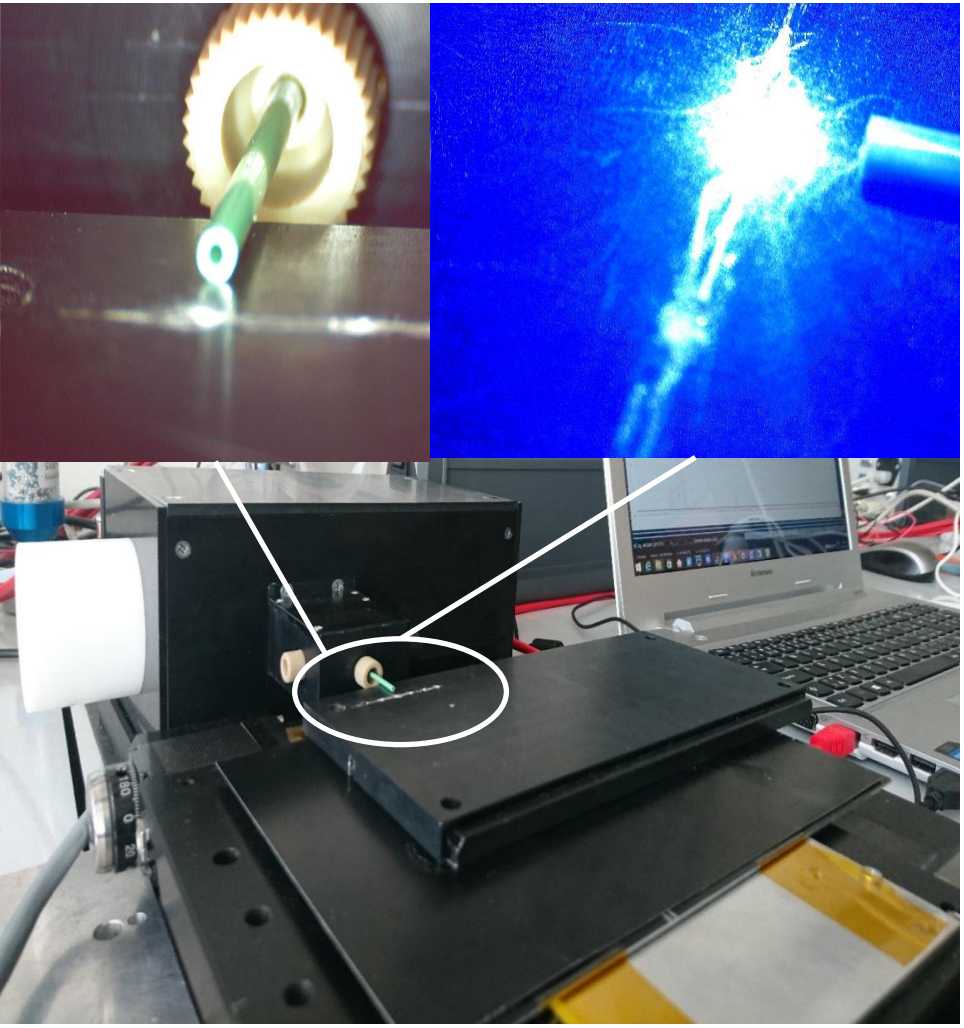
Isomeric β-Blockers separation

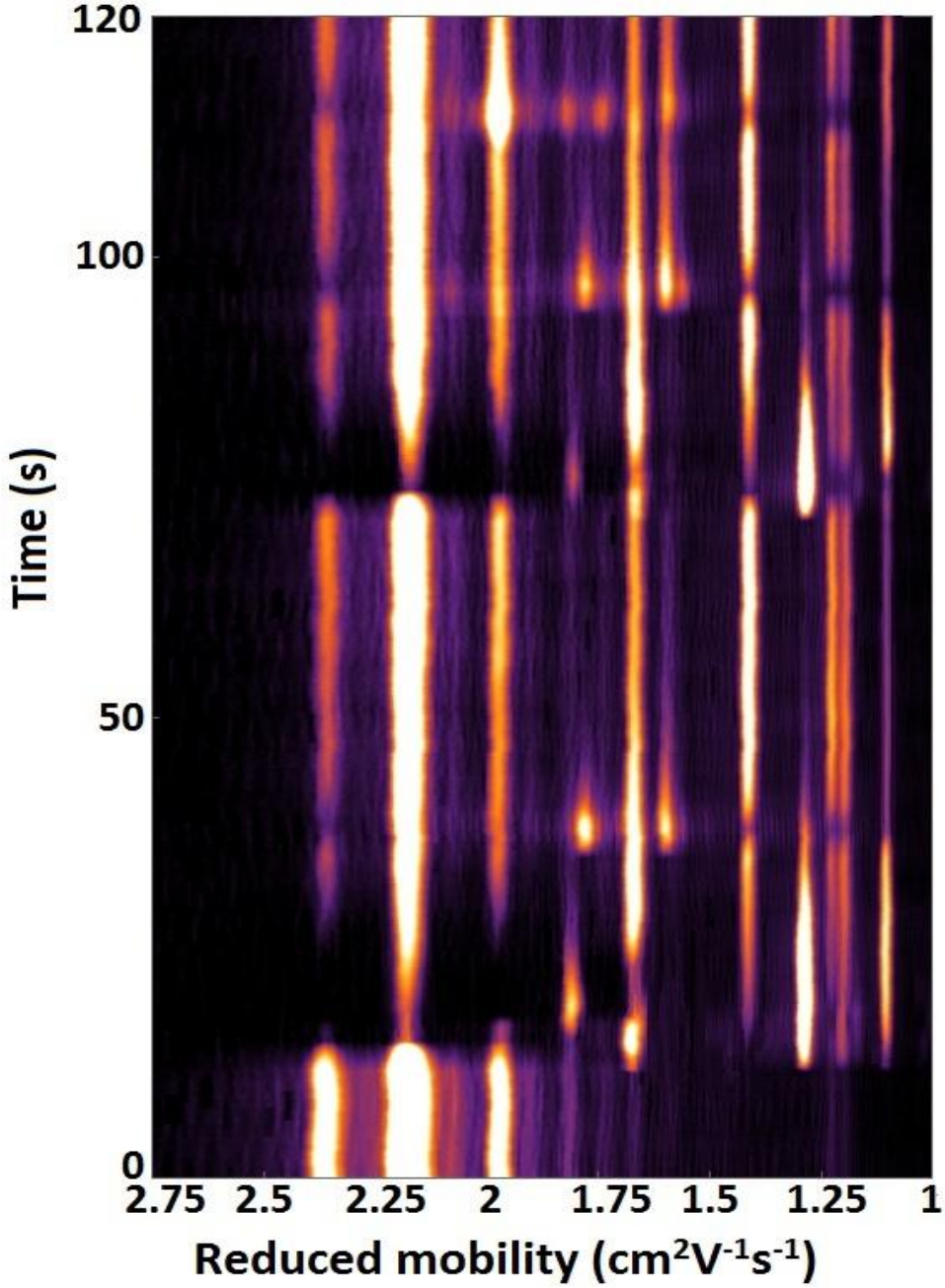
K_0 8b [$cm^2V^{-1}s^{-1}$]	K_0 8d [$cm^2V^{-1}s^{-1}$]	K_0 8g [$cm^2V^{-1}s^{-1}$]
1,81	1,78	1,9
1,67	1,64	1,81
1,41	1,60	1,60
1,28	1,57	1,41
1,22	1,41	1,22
1,20	1,22	1,20
1,10	1,20	1,10
-	1,13	-



Isomeric β-Blockers separation

Sample 8b-8d-8b-8d-8g

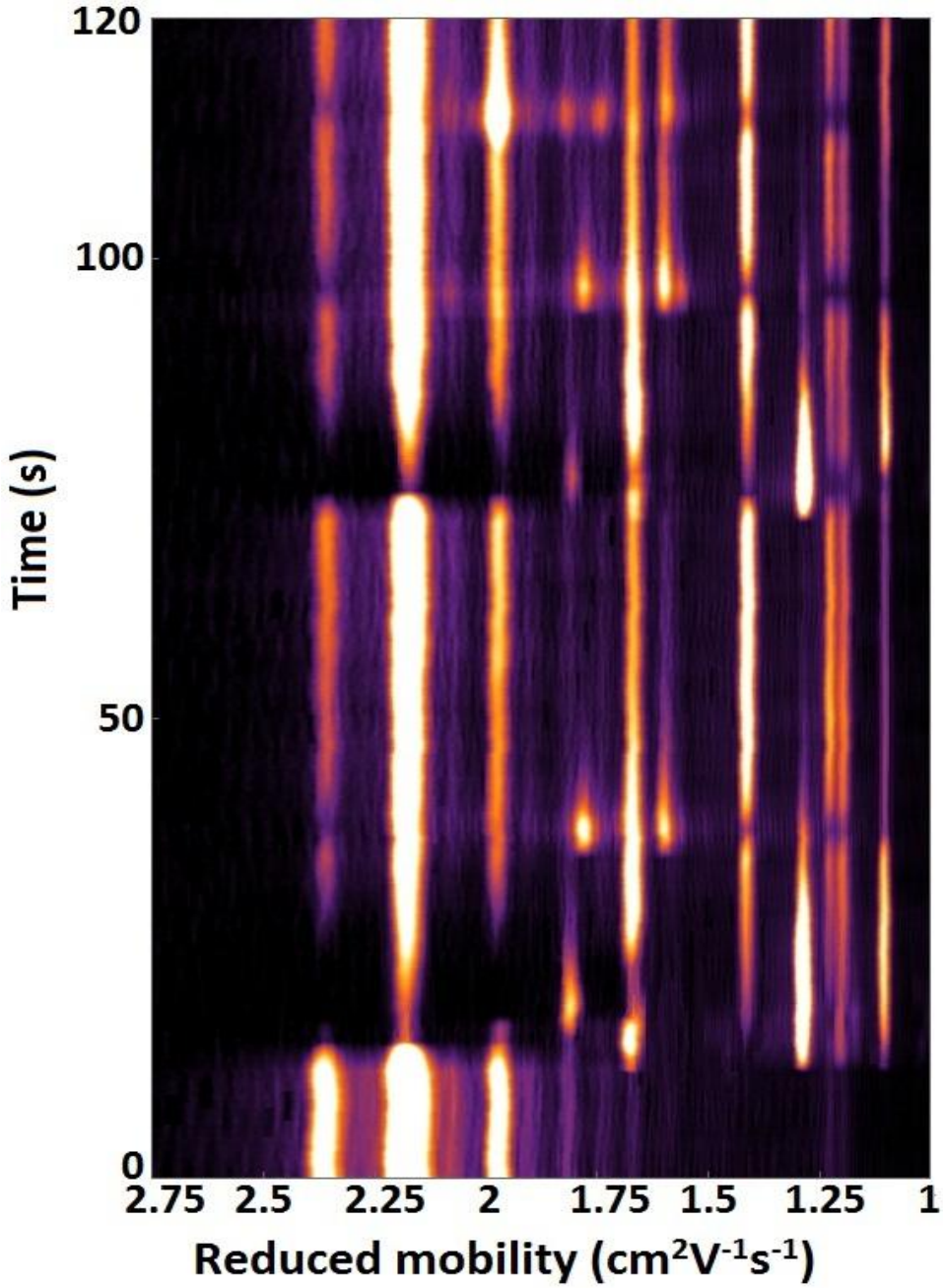




Isomeric β-Blockers separation

Sample 8b-8d-8b-8d-8g

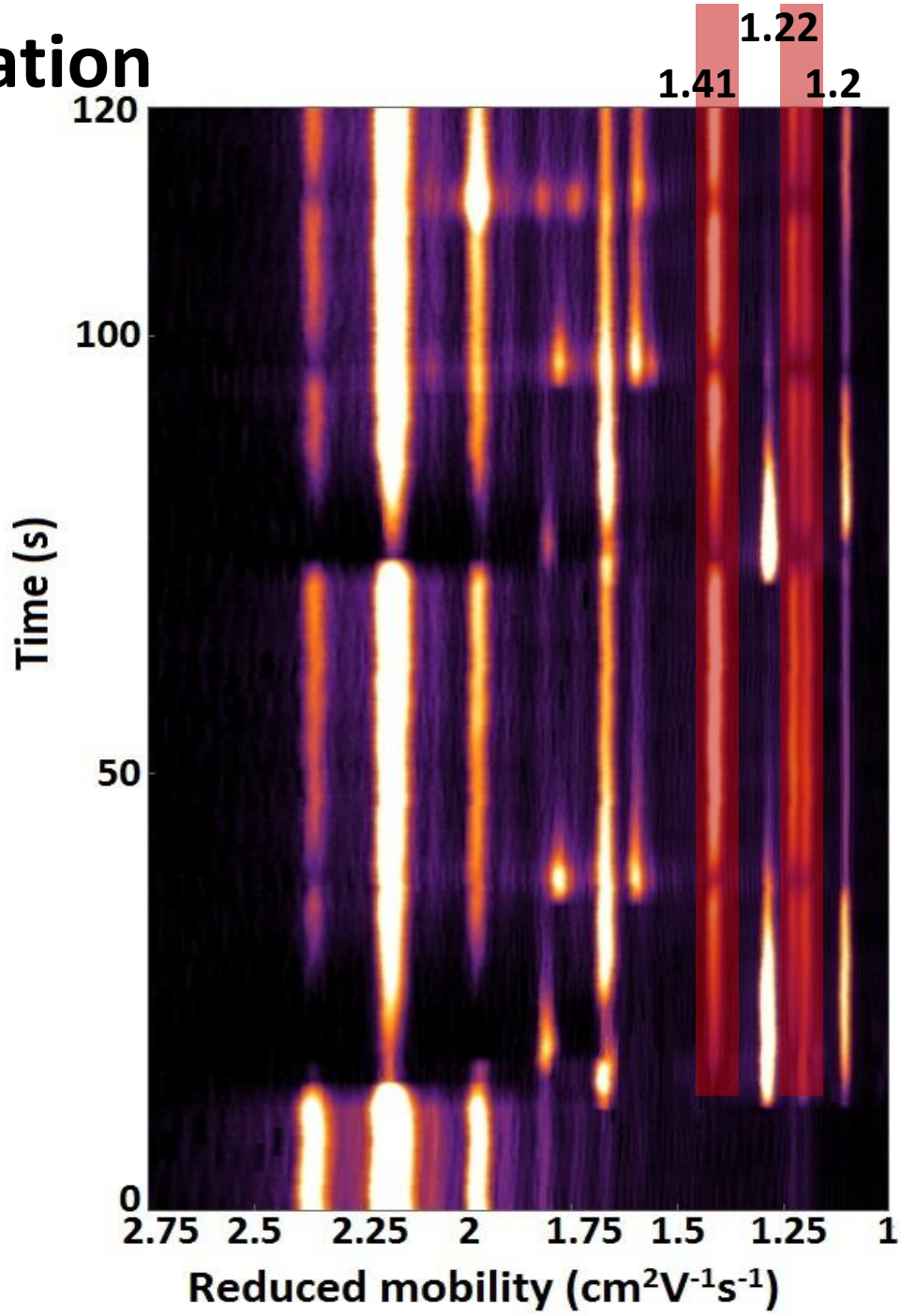
K_0 8b [$cm^2V^{-1}s^{-1}$]	K_0 8d [$cm^2V^{-1}s^{-1}$]	K_0 8g [$cm^2V^{-1}s^{-1}$]
1,81	1,78	1,9
1,67	1,64	1,81
1,41	1,60	1,60
1,28	1,57	1,41
1,22	1,41	1,22
1,20	1,22	1,20
1,10	1,20	1,10
-	1,13	-



Isomeric β-Blockers separation

Sample 8b-8d-8b-8d-8g

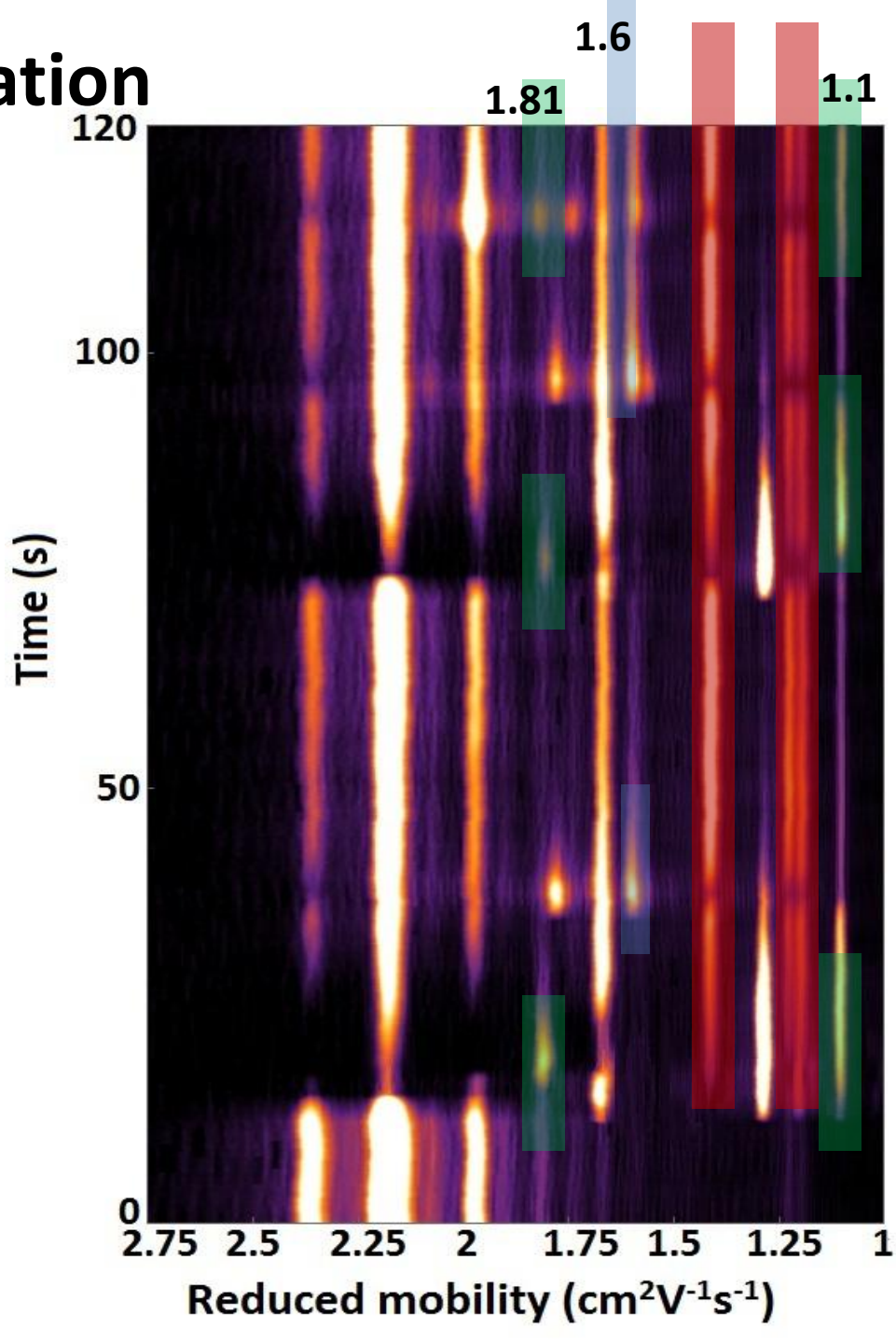
K_0 8b [$cm^2V^{-1}s^{-1}$]	K_0 8d [$cm^2V^{-1}s^{-1}$]	K_0 8g [$cm^2V^{-1}s^{-1}$]
1,81	1,78	1,9
1,67	1,64	1,81
1,41	1,60	1,60
1,28	1,57	1,41
1,22	1,41	1,22
1,20	1,22	1,20
1,10	1,20	1,10
-	1,13	-



Isomeric β-Blockers separation

Sample 8b-8d-8b-8d-8g

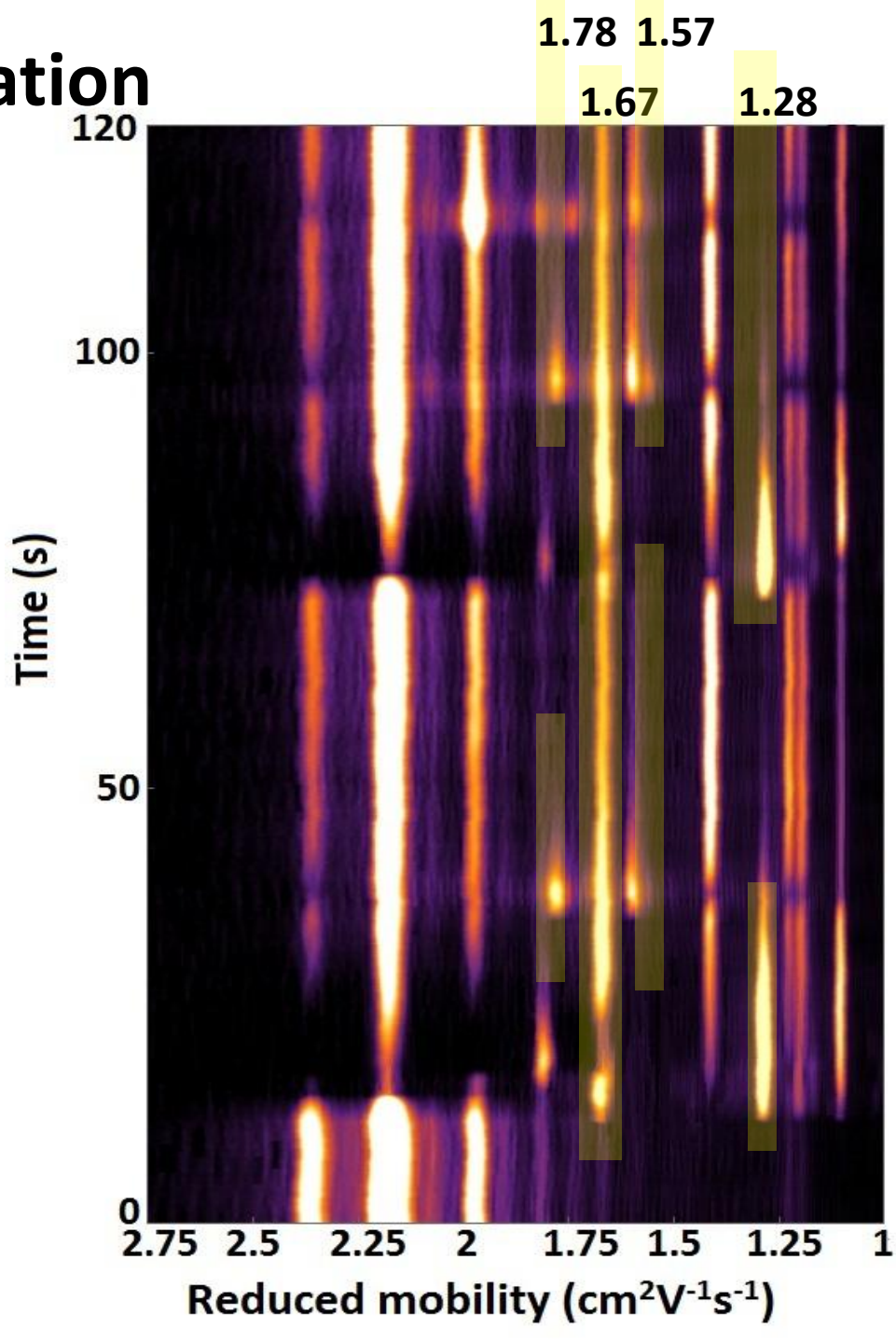
K_0 8b [$cm^2V^{-1}s^{-1}$]	K_0 8d [$cm^2V^{-1}s^{-1}$]	K_0 8g [$cm^2V^{-1}s^{-1}$]
1,81	1,78	1,9
1,67	1,64	1,81
1,41	1,60	1,60
1,28	1,57	1,41
1,22	1,41	1,22
1,20	1,22	1,20
1,10	1,20	1,10
-	1,13	-



Isomeric β-Blockers separation

Sample 8b-8d-8b-8d-8g

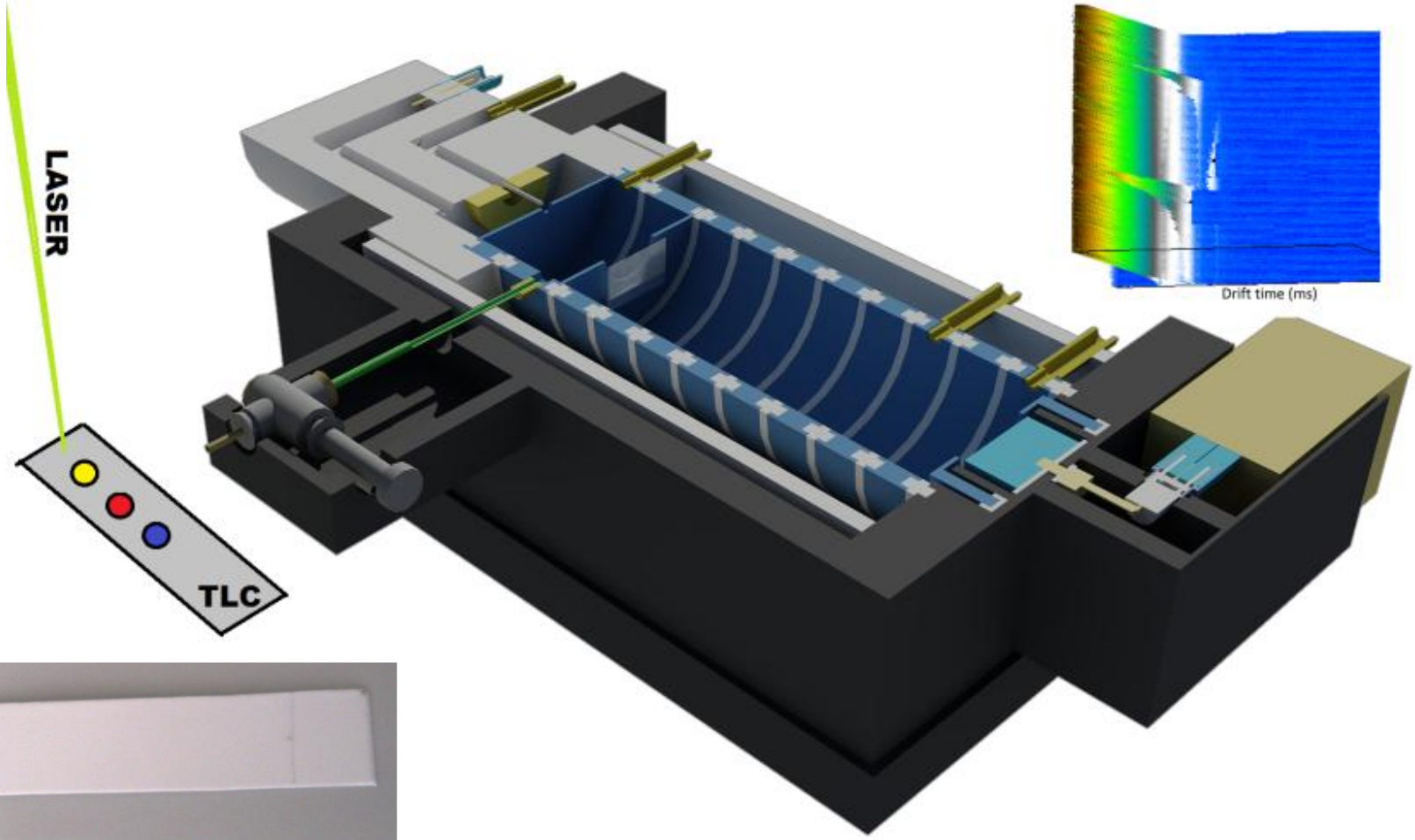
K_0 8b [$cm^2V^{-1}s^{-1}$]	K_0 8d [$cm^2V^{-1}s^{-1}$]	K_0 8g [$cm^2V^{-1}s^{-1}$]
1,81	1,78	~~1,9~~
1,67	~~1,64~~	1,81
1,41	1,60	1,60
1,28	1,57	1,41
1,22	1,41	1,22
1,20	1,22	1,20
1,10	1,20	1,10
-	~~1,13~~	-



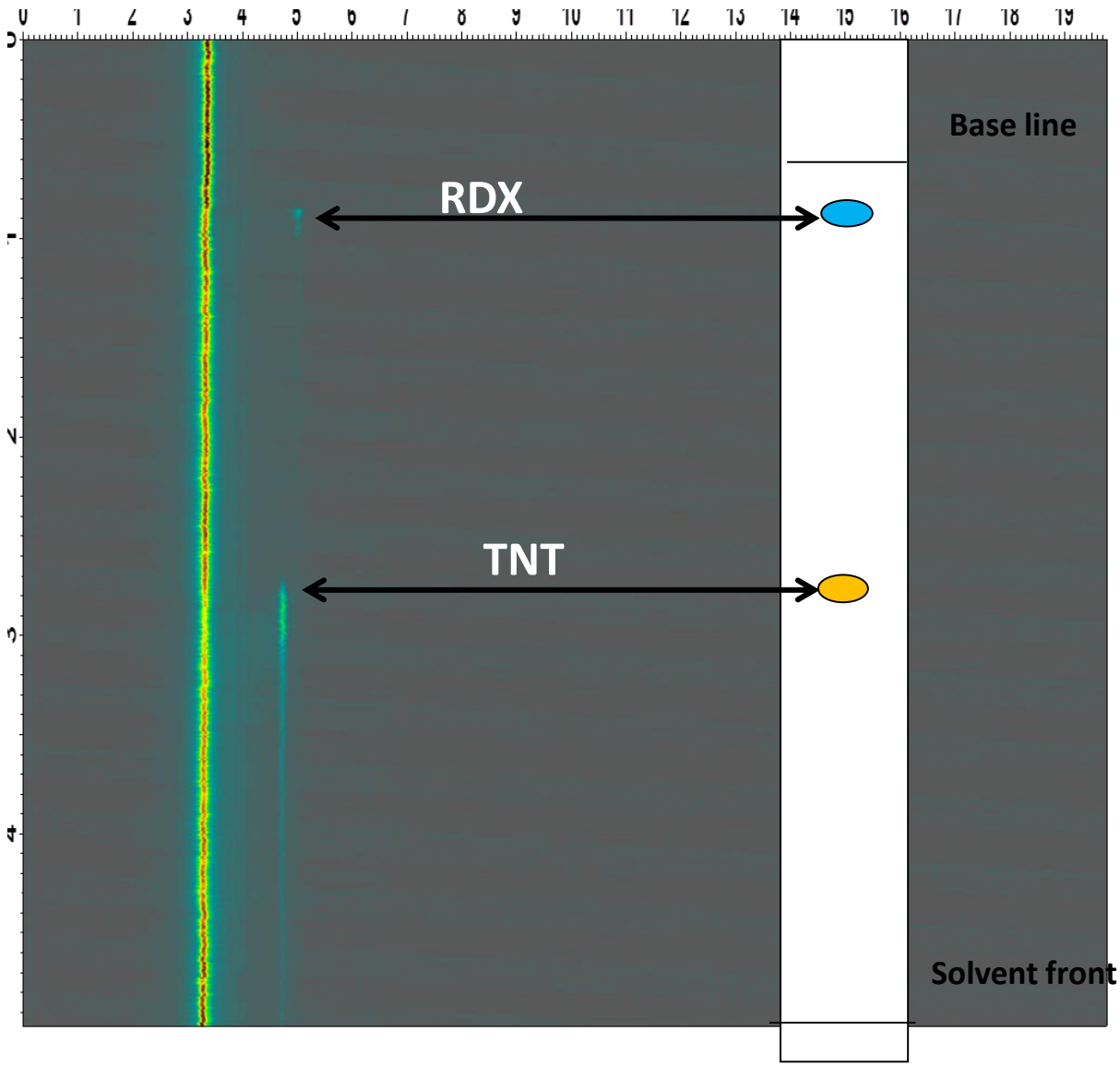
TLC-LD-IMS 2D Separation

Prof. Tabrizchi
Dr. ILbeigi

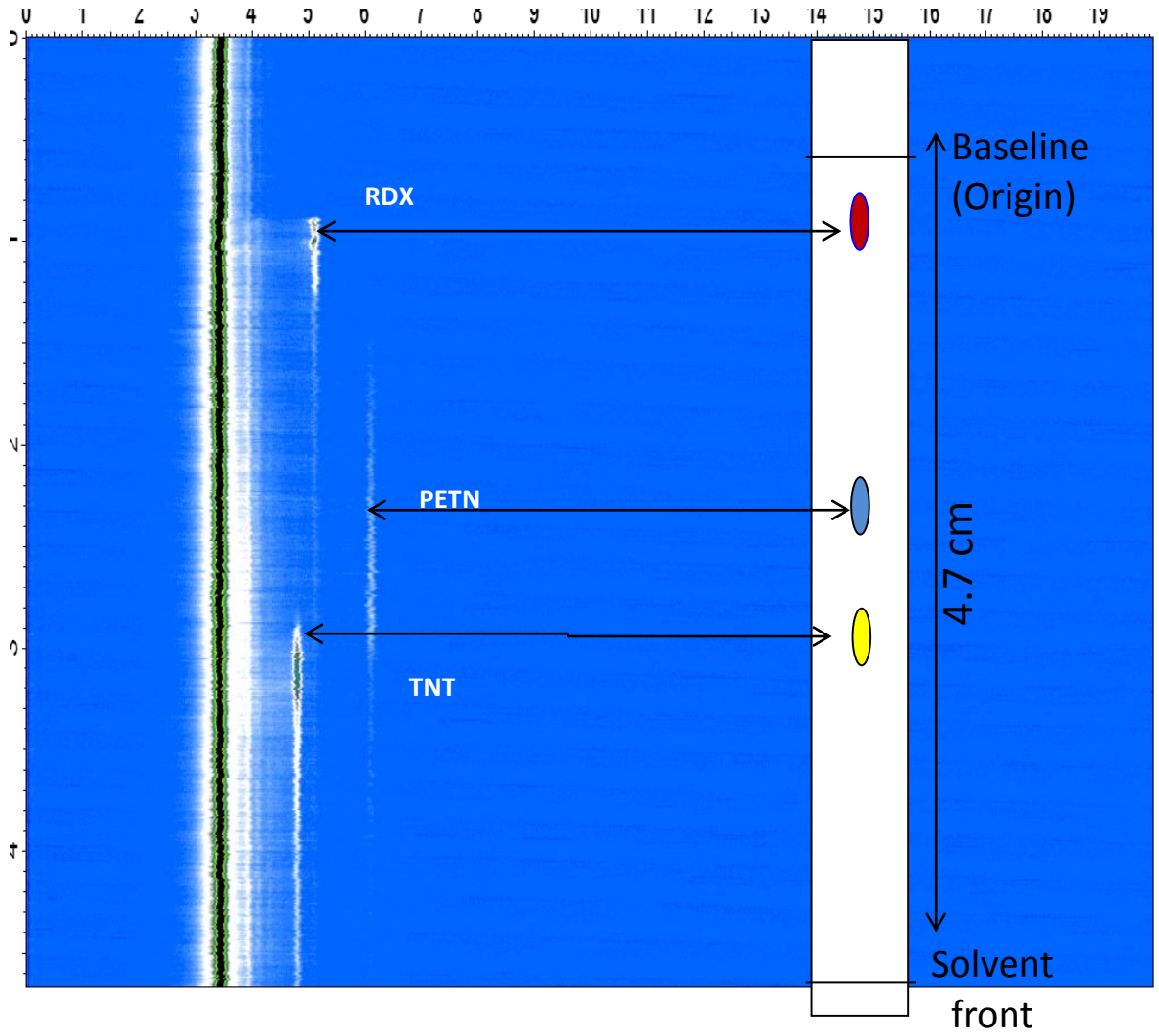
V.Ilbeigi, M.Sabo, Y.Valadbeigi, S.Matejcik, M.Tabrizchi
J.of Chromatography A, 1459, 2016, 145-151



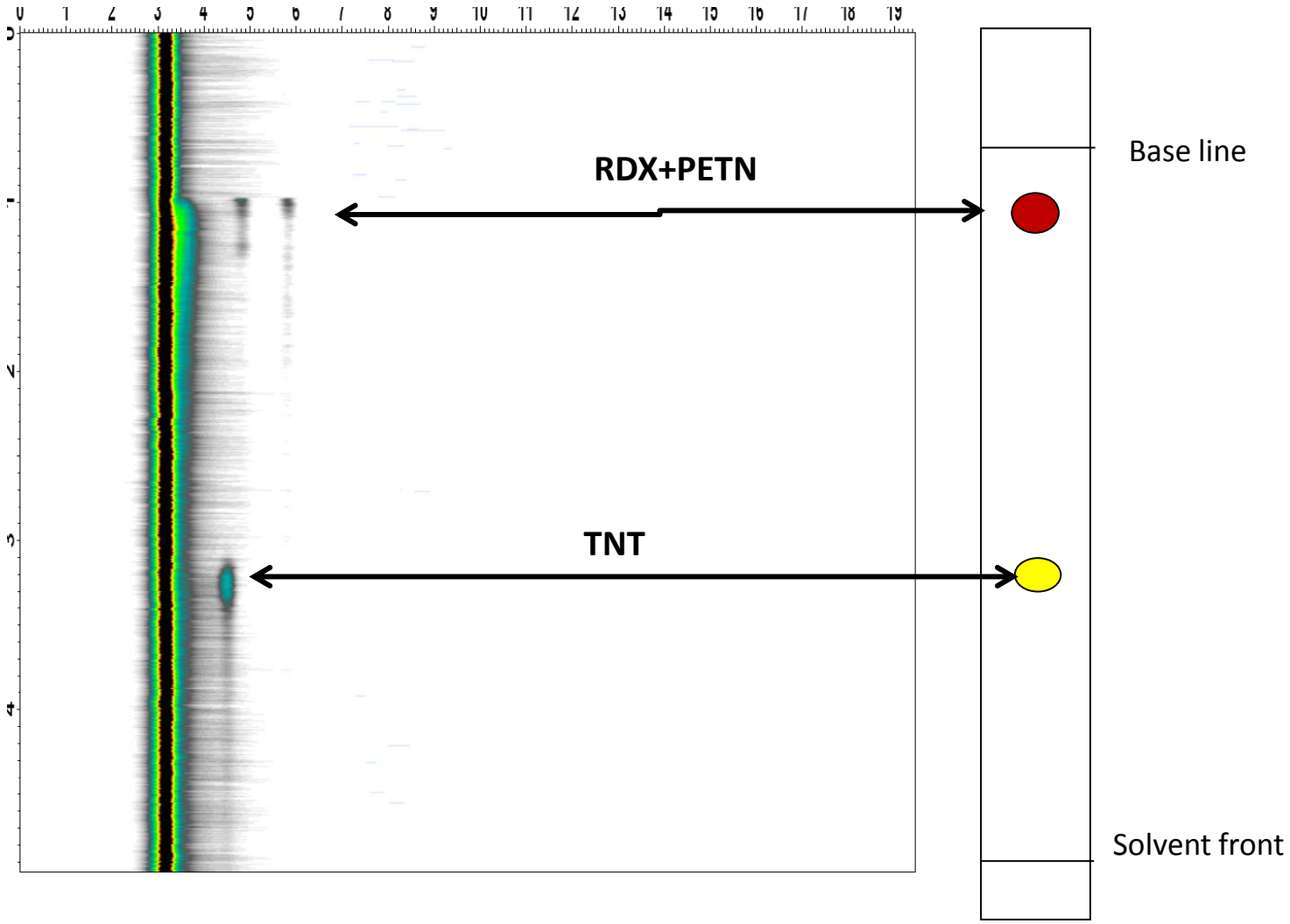
Speed of scanning TLC surface= 0.6 mm/s
Total time= 80 S



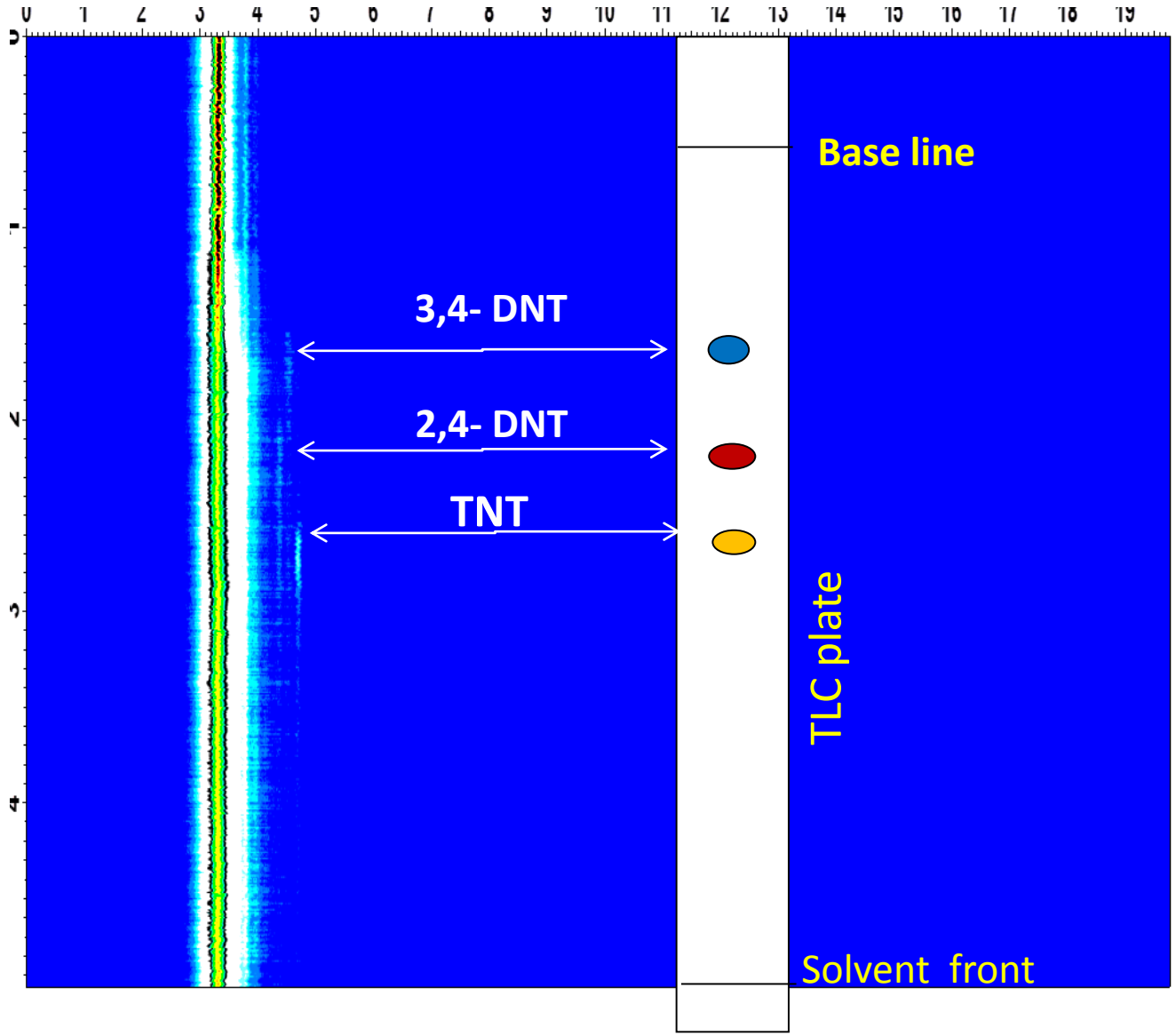
Speed of scanning TLC surface= 0.6 mm/s
Total time=71 S



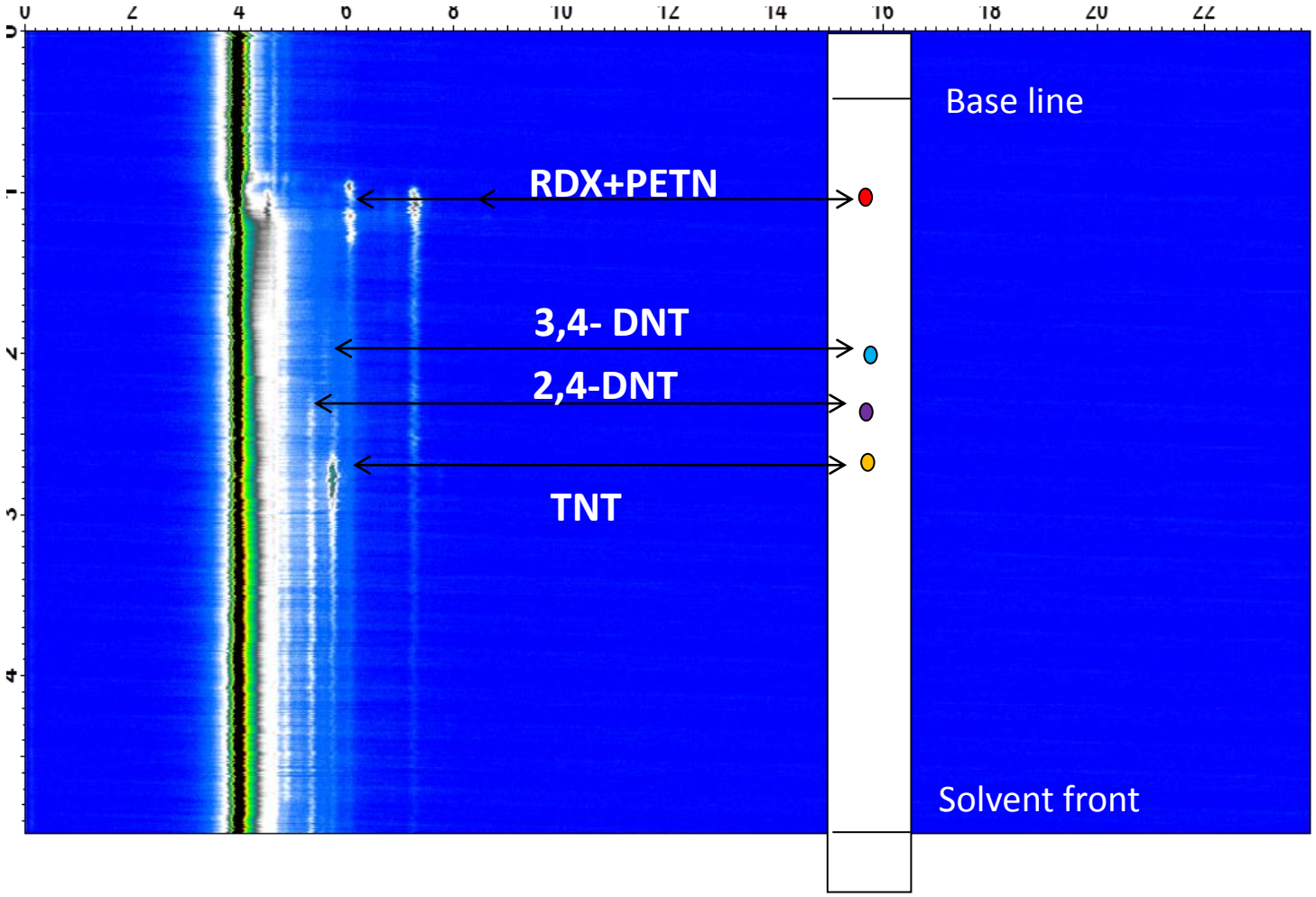
Speed of scanning TLC surface= 0.6 mm/s
Total time=83 S



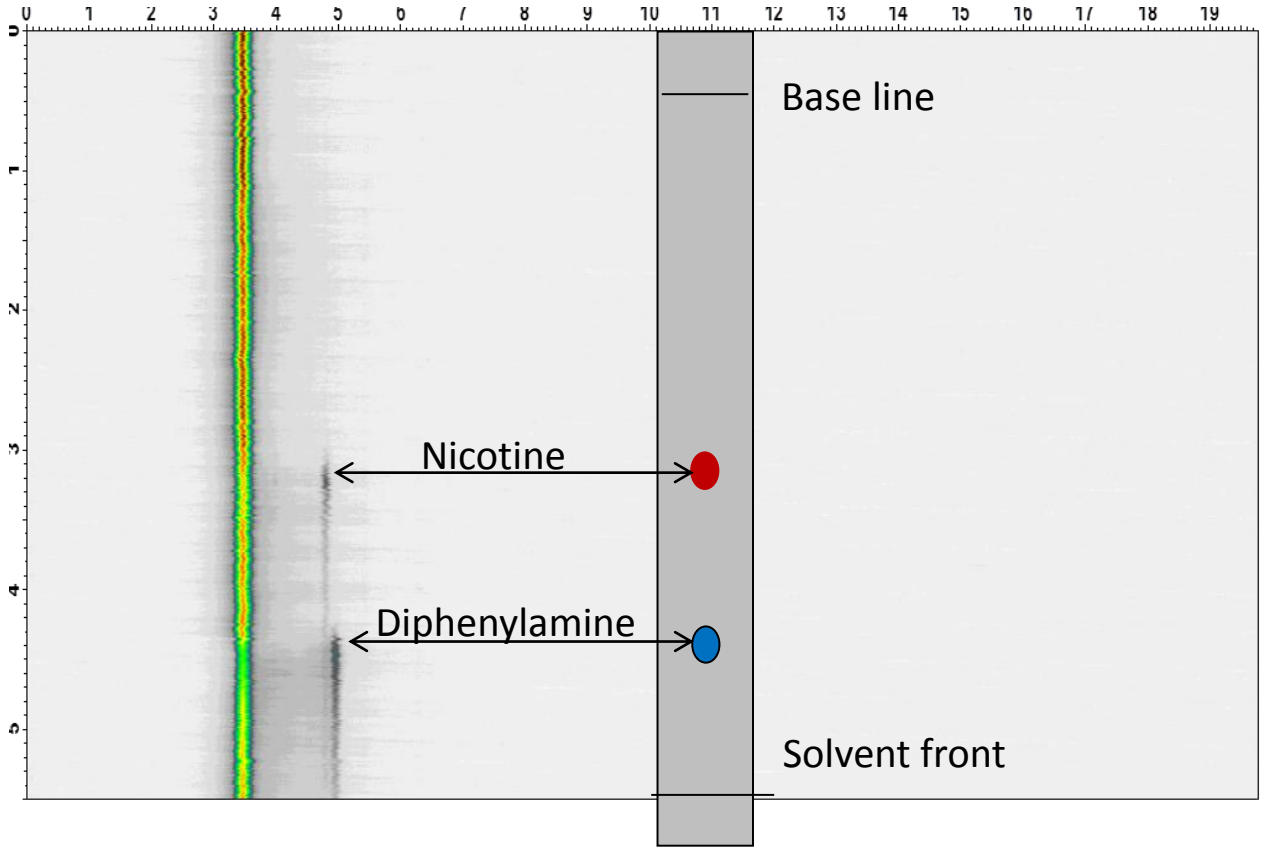
Speed of scanning TLC surface= 0.6 mm/s
Total time=85 s



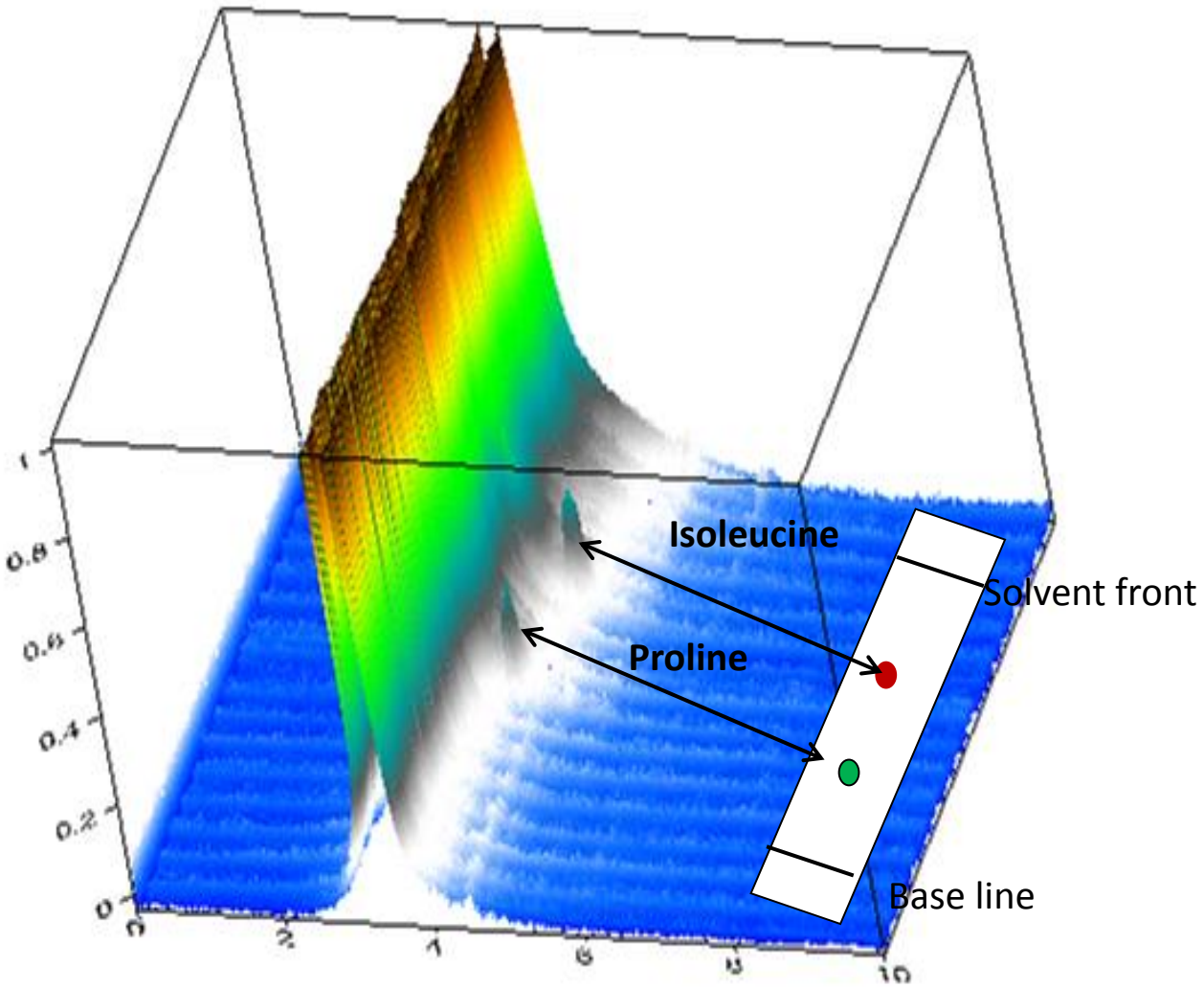
Speed of scanning TLC surface= 0.6 mm/s
Total time=85 s



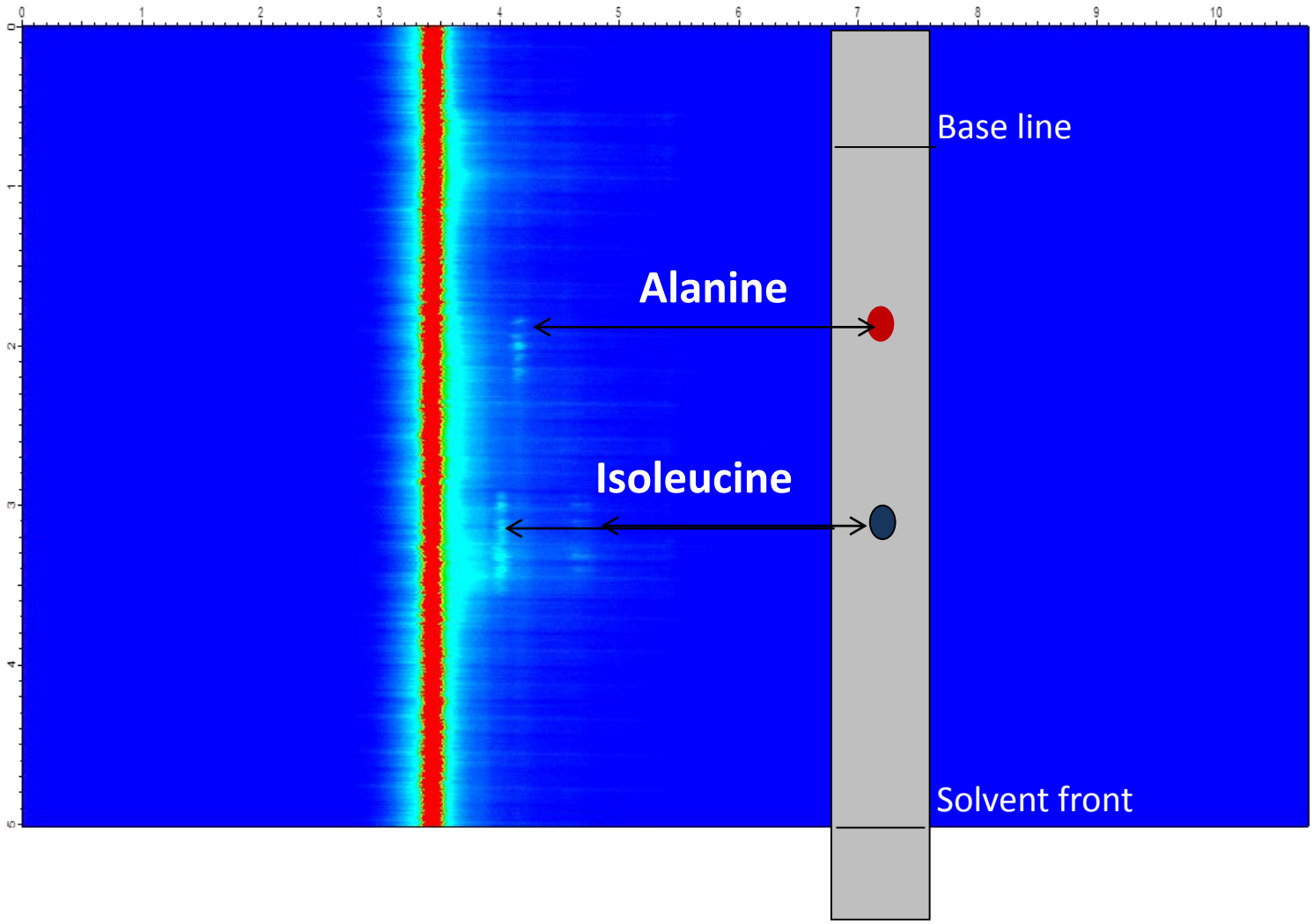
Speed of scanning TLC surface= 0.6 mm/s
Total time=91 s



Stationary phases = SiO2
mobile phases = CHCl3: CH3OH:H2O = 1.5:1.2:0.3



Speed of scanning TLC surface= 0.6 mm/s
Total time=83 s



Summary

Laser Desorption –IMS

-LD-IMS-Explosives detection

-LD-IMS-Pharmacy

-TLC-LD-IMS new 2D separation technique

Acknowledgement

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Slovak ministry of education

MINISTERSTVO ŠKOLSTVA SR

Thank you for your attention