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Forensic olfactronics and human scent signatures created from GC×GC-MS data

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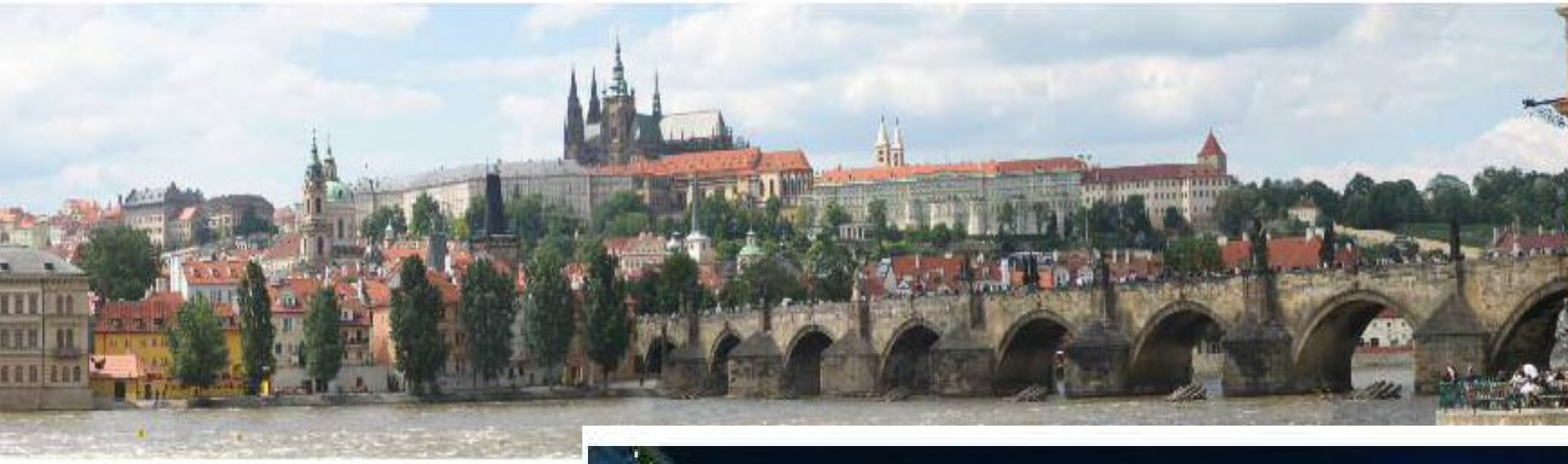

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Forensic Olfactoric

2013 The Czech police asked me, to try analysis of human scent samples (collected from a crimescene), with an aim to support, so called, the olfactoric identification of persons that is performed in many countries by means of specially trained canines (dogs).

Forensic Olfactronics

At first, we refused, this police request to analyse the human scent samples, since I did not know what such a human scent evidence (trace) means!

However, this police requirement was repeated with a promise of financial support…. and than I started to study

Forensic Olfactronics

However, this police requirement was repeated with a promise of financial support…. and than I started to study available papers in this field, on chemical composition of the human scent.

However, I found relatively small amount of papers, I expected thousands papers and I have found only tens of papers…

Forensic Olfactronics

However, I found relatively small amount papers about human scent, I expected thousands and I have found only tens of papers.

We can define the human scent as the large mixture of thousands (probably more than 100000) variant compounds in dramatically different relative concentrations in the gaseous phase

Forensic Olfactronics

We can define the human scent as the large mixture of thousands (more than 100 000) distinct compounds in dramatically different relative concentrations in the gaseous phase

The scent compounds can be formally divided in three groups:

a) **Primary scent compounds**
b) **Secondary scent compounds**
c) **Tertiary scent compounds**

Forensic Olfactronics

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a) **Primary scent compounds**
b) **Secondary scent compounds**
c) **Tertiary scent compounds**

The Primary Scent Compounds are genetically conditioned!

Forensic Olfactronics

The Primary compounds are genetically conditioned!

Relative concetrations of the primary compounds are roughly constant!!!!!

The **primary scent** is individual and **it creates the basis for the scent identification of persons**

Forensic Olfactronics

The Secondary Scent

Chemical compositions of the secondary scent is very flexible, depends from diet, meals, lifestyle, weather, daytime, drugs (used) etc.

The primary as well as the secondary scent compounds pass through the human skin. Tertiary not.

Forensic Olfactronics

The primary as well as the secondary scent compounds pass **through the human skin**!

Tertiary scent does not pass through the skin.

Tertiary scent is a scent of other peoples, scent of animals, cosmetics, generally scent of nature, things, matter ……

SCENT AND SCENT EVIDENCE

(recapitulation)

The scent is produced by nearly everything (people, animals, fruits, vegetables, mushrooms,……), since there is only one requirement …..**non zero volatility of chemical** compounds, non zero vapour pressure**.**

This volatility of chemical compounds depends on many circumstances, above all, on the **atmospheric pressure and temperature**.

If the volatile chemical compounds is a liquid , we speak about an **evaporation.** In the case of the solid state, we are speaking about a **sublimation.**

Human scent

An average human body lets out about

1.5g of scent molecules per day,

it is about 2 .10^{21} molecules per day -

2 000 000 000 000 000 000 000

molecues per day, it means

about 9.10^{19} molecules per one hour, thus

90 000 000 000 000 000 000 mols per hour

Human scent

It means that human body emits about 5 x 10^{16} molecules per second and it means about

7x 10^{14} molecules per second

from one open palm

700 000 000 000 000 mol/s

from one open palm

7×10^{14} molecules per sec

How to study human scent?

Spectroscopy (IR, MW, VIS, UV)

No, relatively low sensitivity, necessity to use extremly long optical trajectory (more than 10 km)

GC-MS

is allowing to observ hundreds as far as thousands compounds

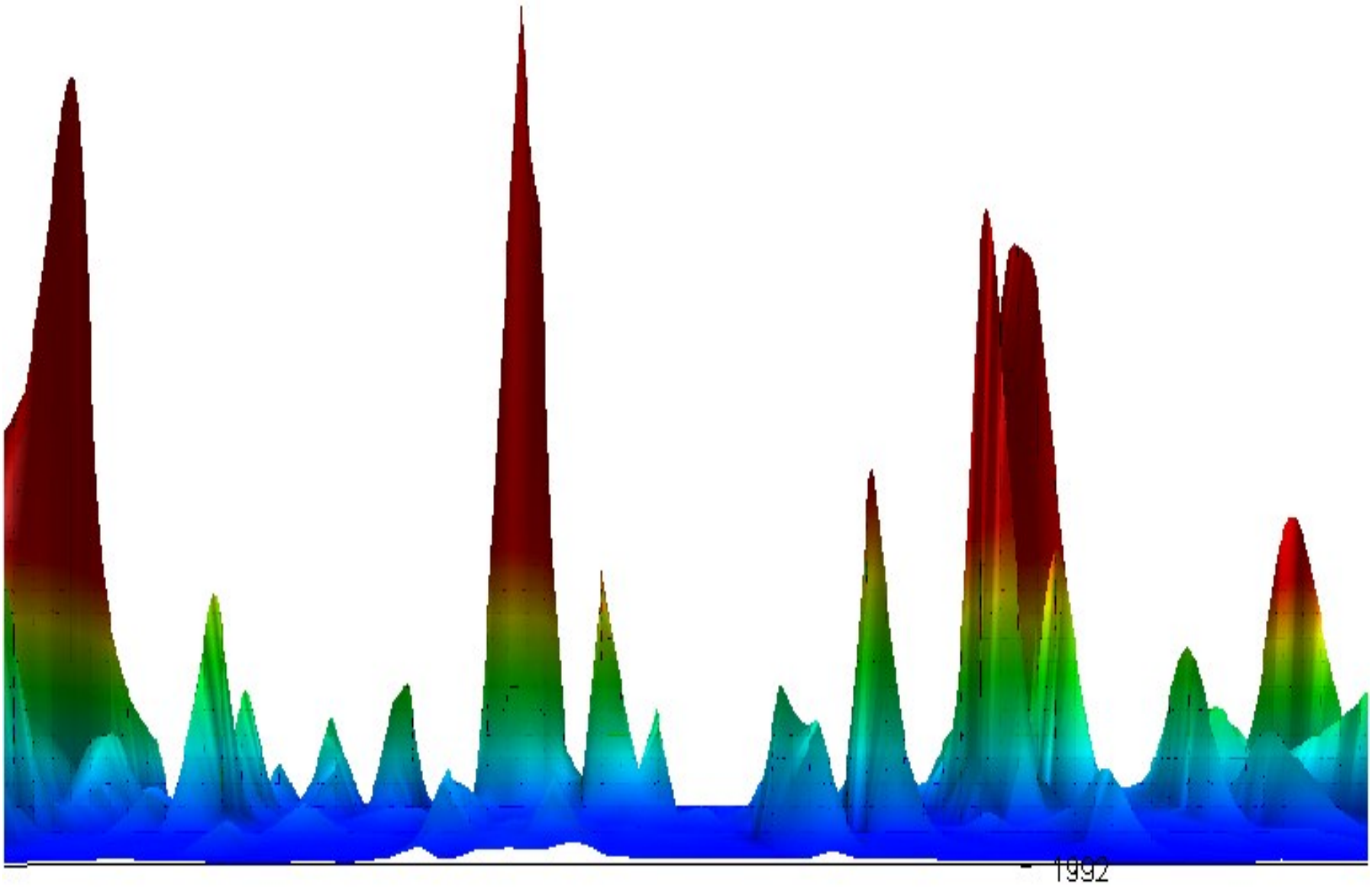
How to study human scent?

Spectroscopy (IR, MW, VIS, UV)

No, relatively low sensitivity, necessity to use extremly long optical trajectory (more than 10 km)

GC-MS

is allowing to observ hundreds as far as thousands compounds in the scent samples


1992

FORENSIC OLFACTRONICS

High quality GC/MS(QQQ) but our effort to be able to identify people was not quite successful.

We started to look more sensitive instruments, if exists, and we found,

comprehensive two dimensional gas chromatography, GCxGC-TOF

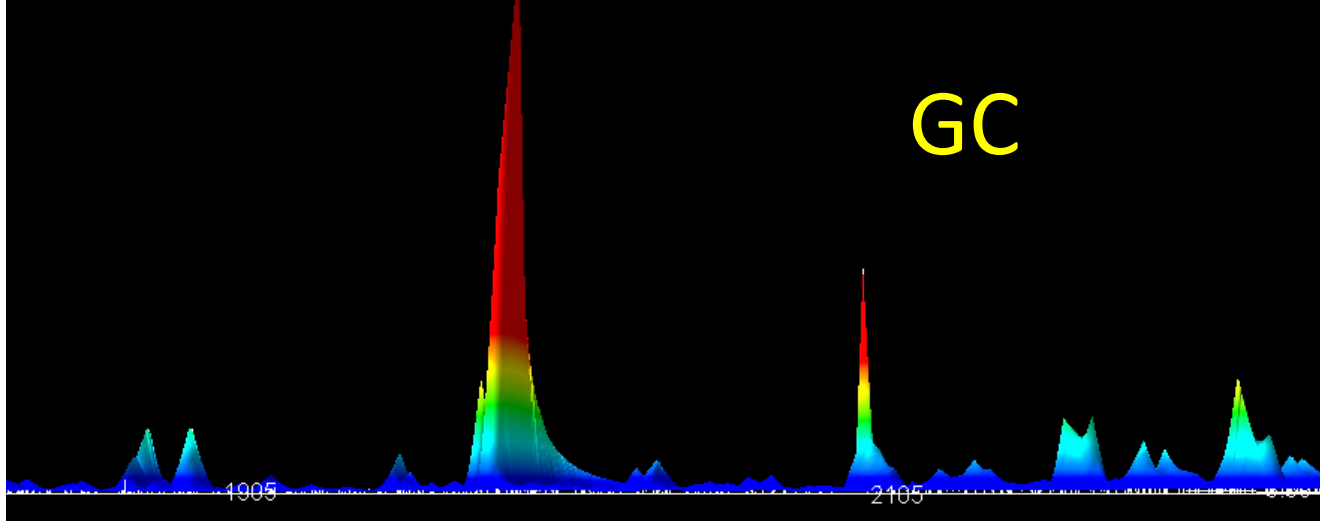
Therefore, it was necessary to obtain money

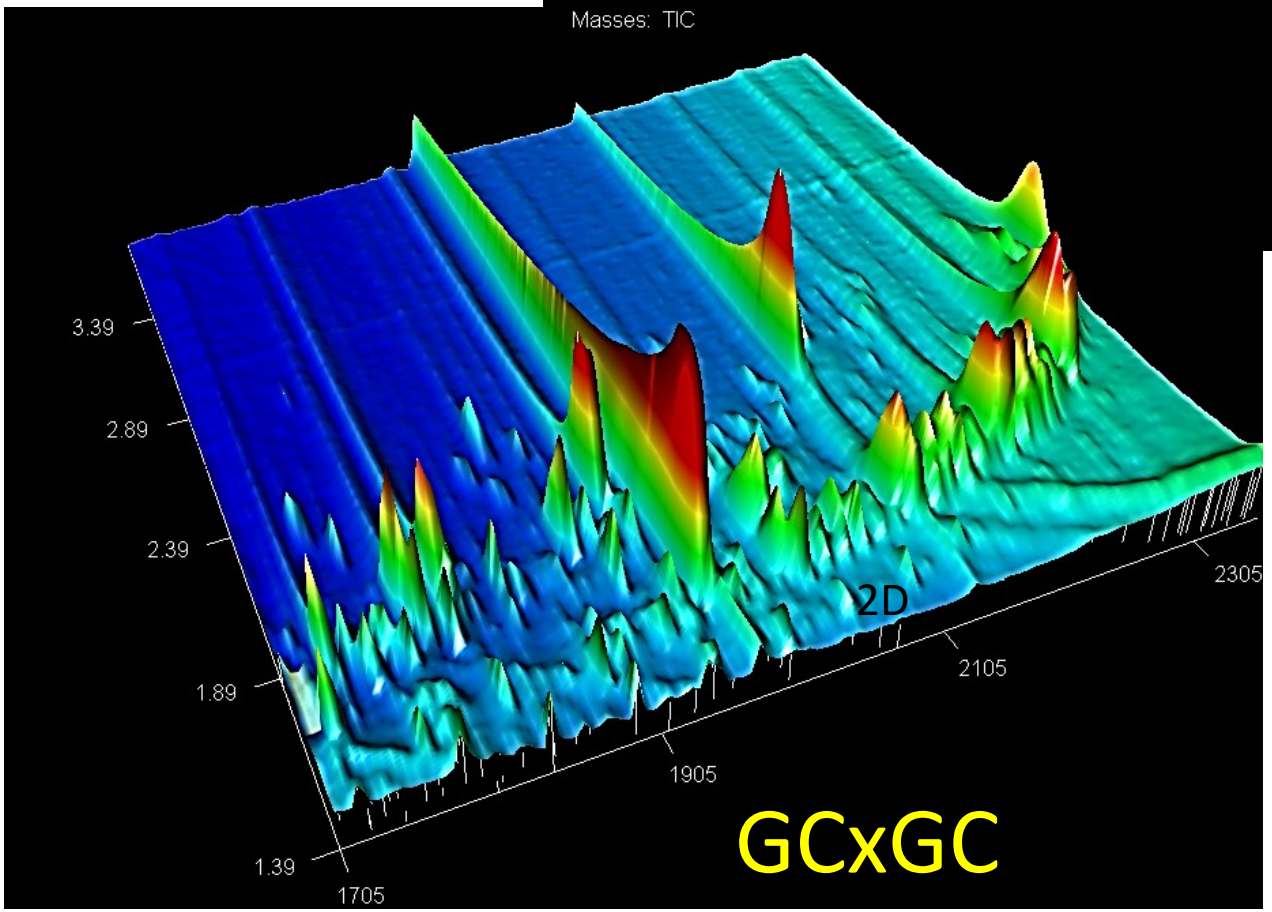
FORENSIC OLFACTRONICS

Comprehensive two dimensional gas chromatography, GCxGC-TOF

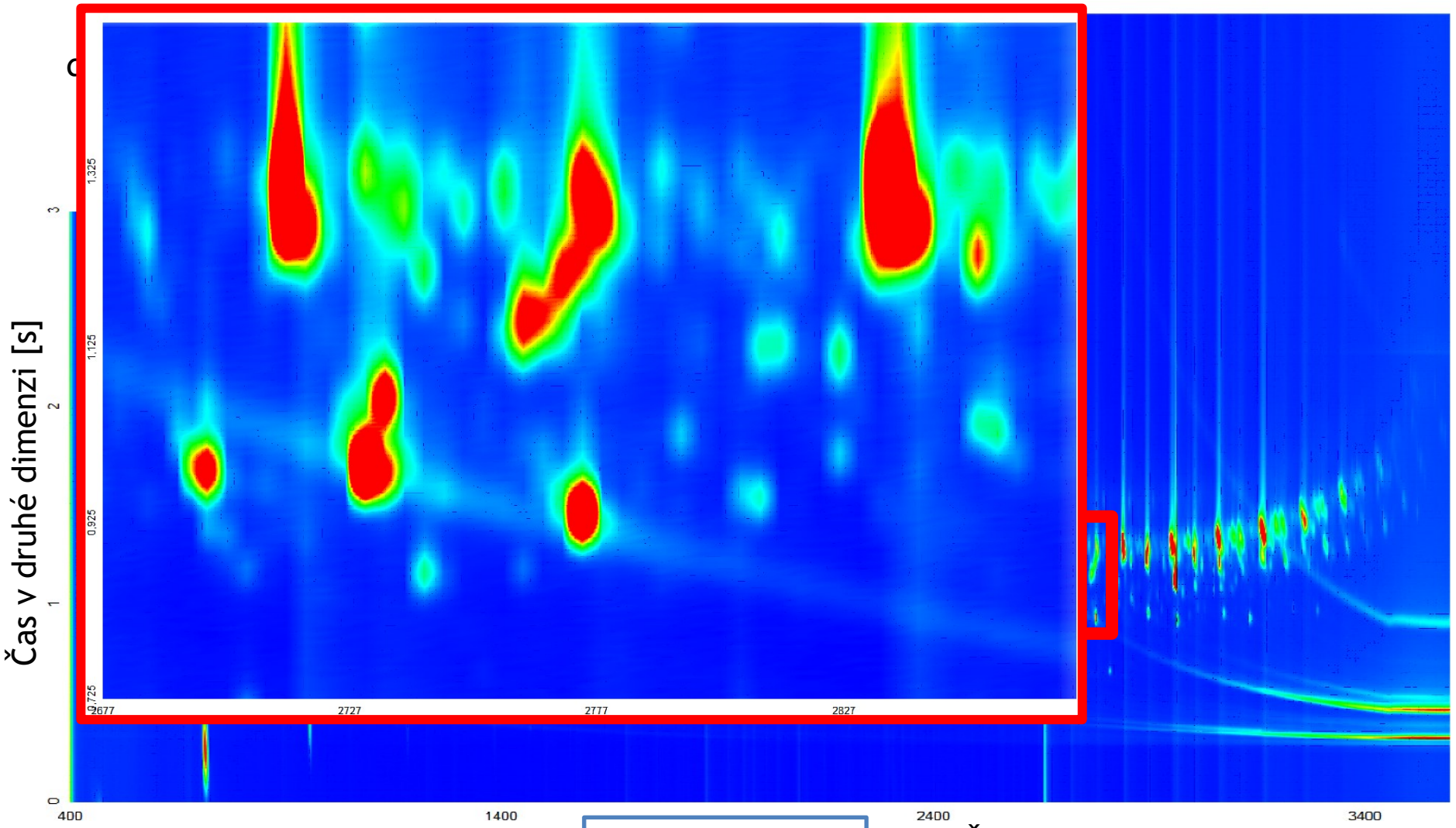
is probably **only one order worse** then the specially trained canines, we are able to detect **more than 60 000 different compounds** in the single scent sample. And with a such sensitivity, we are able to gain a lot information about people from their scent …….

Part of a chromatogram of a women, 21years



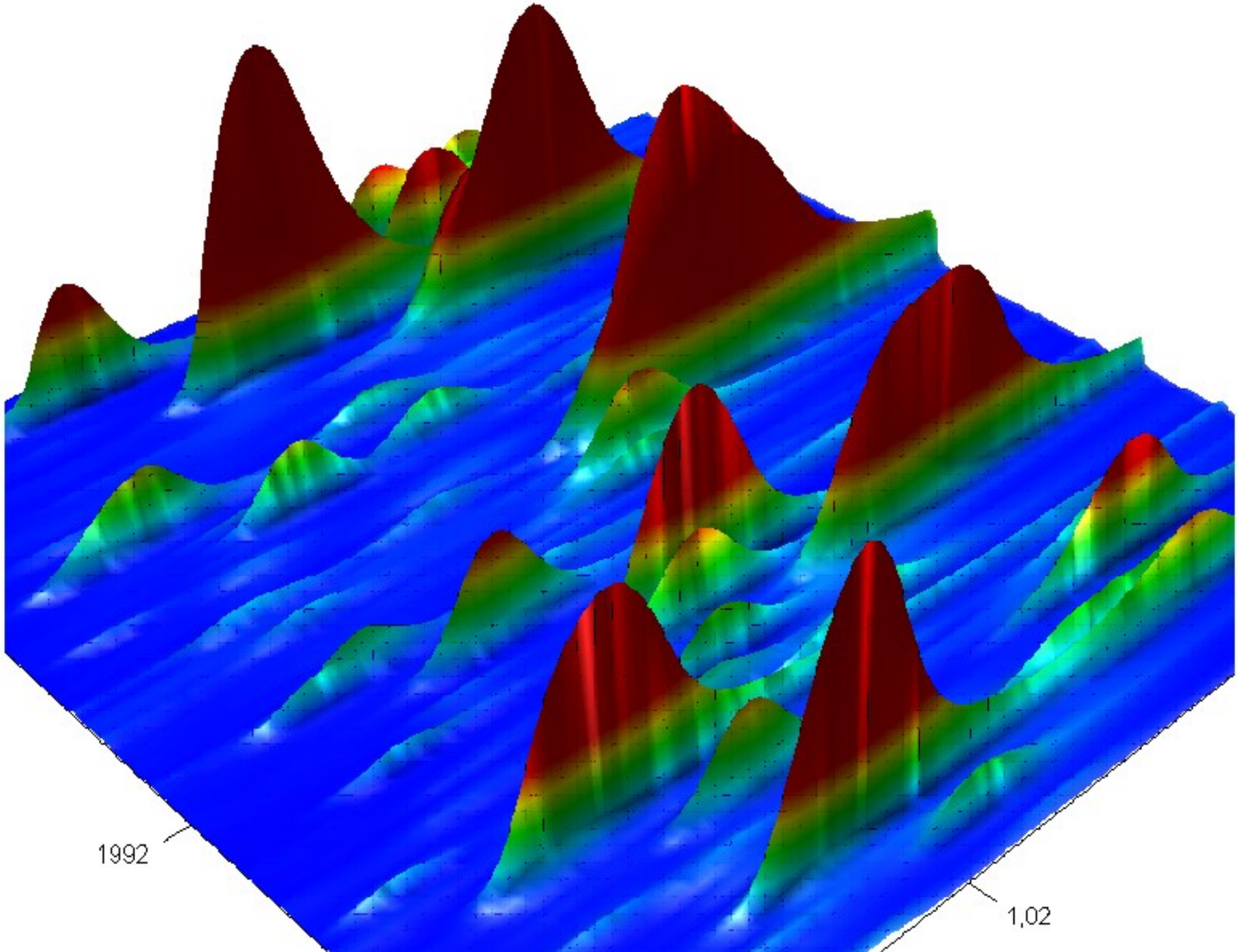


2D GCxGC/MS - chromatograph



Vzorek VV_1.8

Čas v první dimenzi [s]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FORENSIC OLFACTRONICS

We are able to resolve more than 60 thousands different chemical compounds. The sensitivity of GCxGC/TOF still is worse than small of the speciál trained canines, but now we are able to **create the digital human scent signatures from concetration ratios of selected primary compounds**

FORENSIC OLFACTRONICS

The **individual identification** based on these concetration ratios of our **primary scent compounds**

is working!!!

FORENSIC OLFACTRONICS

We created a database of these digital scent signatures of different persons.

Then an **unknown scent sample** is compared **by computer** with the digital **signatures in our database.**

FORENSIC OLFACTRONICS

The individual identification of persons is based on the digital scent signatures that are created by the ratios of the concentrations of the selected primary scent compounds.

FORENSIC OLFACTRONICS

The **individual identification** is **working!!!**

What about a class identification??

Now, I will present an overview of results of our research which are focused on the

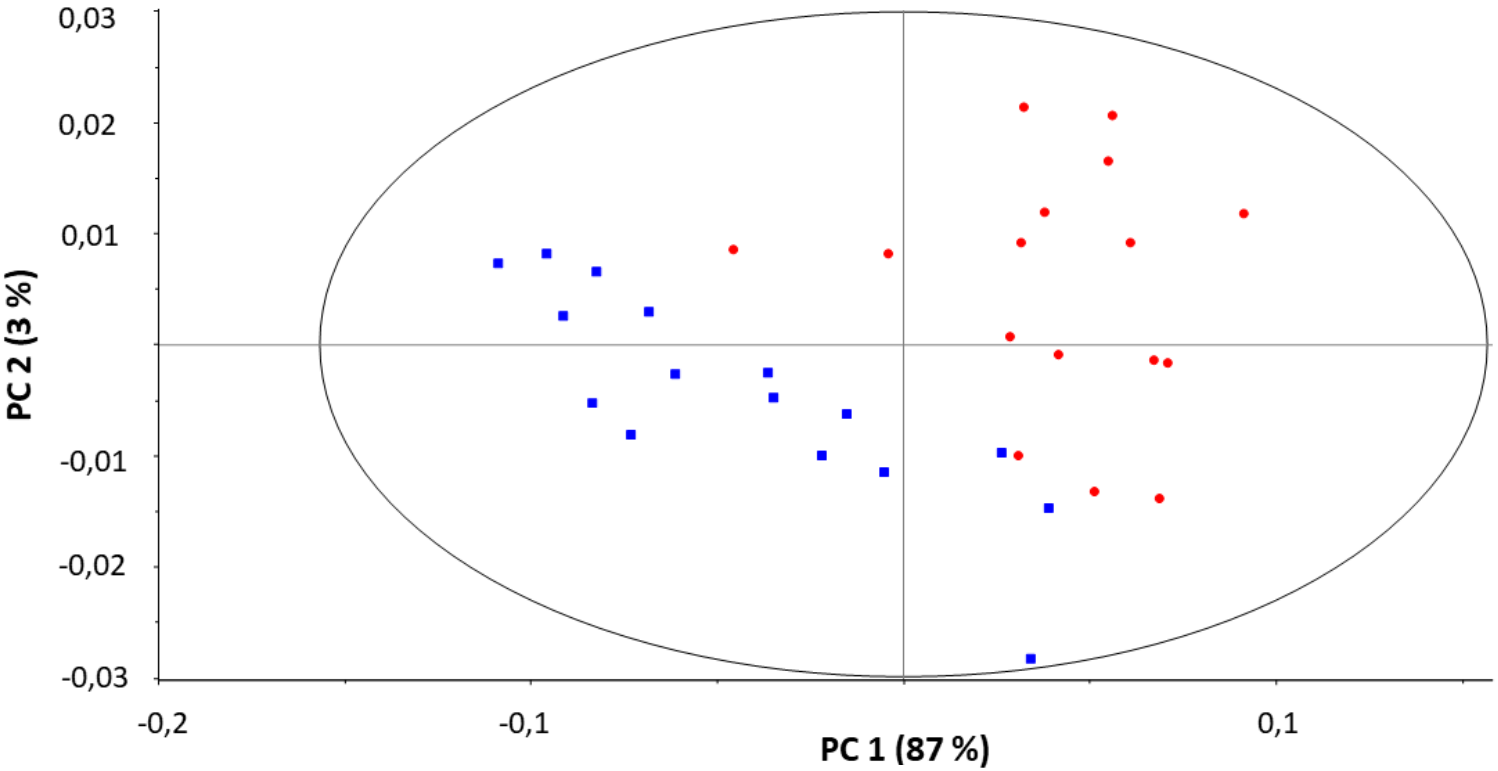
class identification

Differences between men and women

gender determination

glass beads
GC-MS analysis

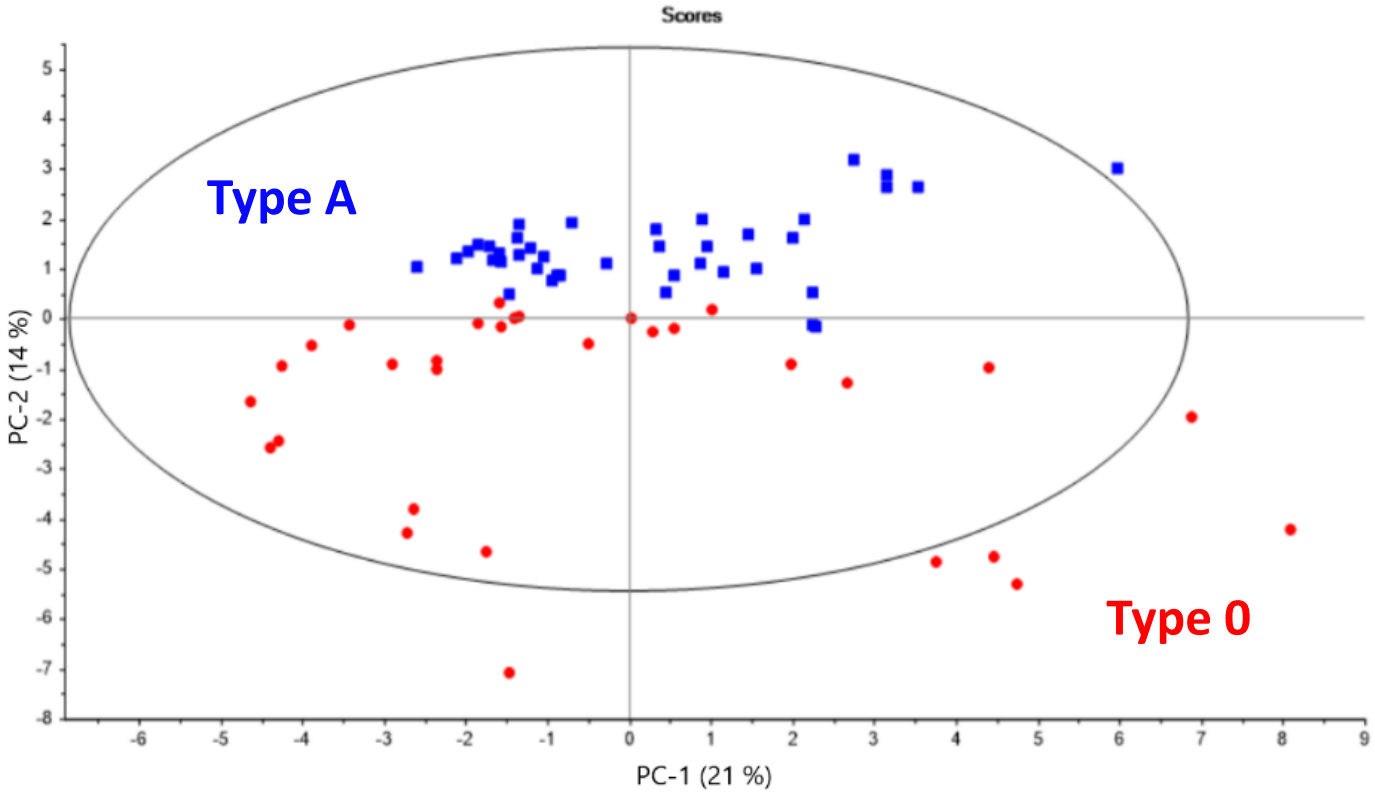
model obtained using 15 odorants (important by Kruskal-Wallis test)



Pojmanová, Dissertation

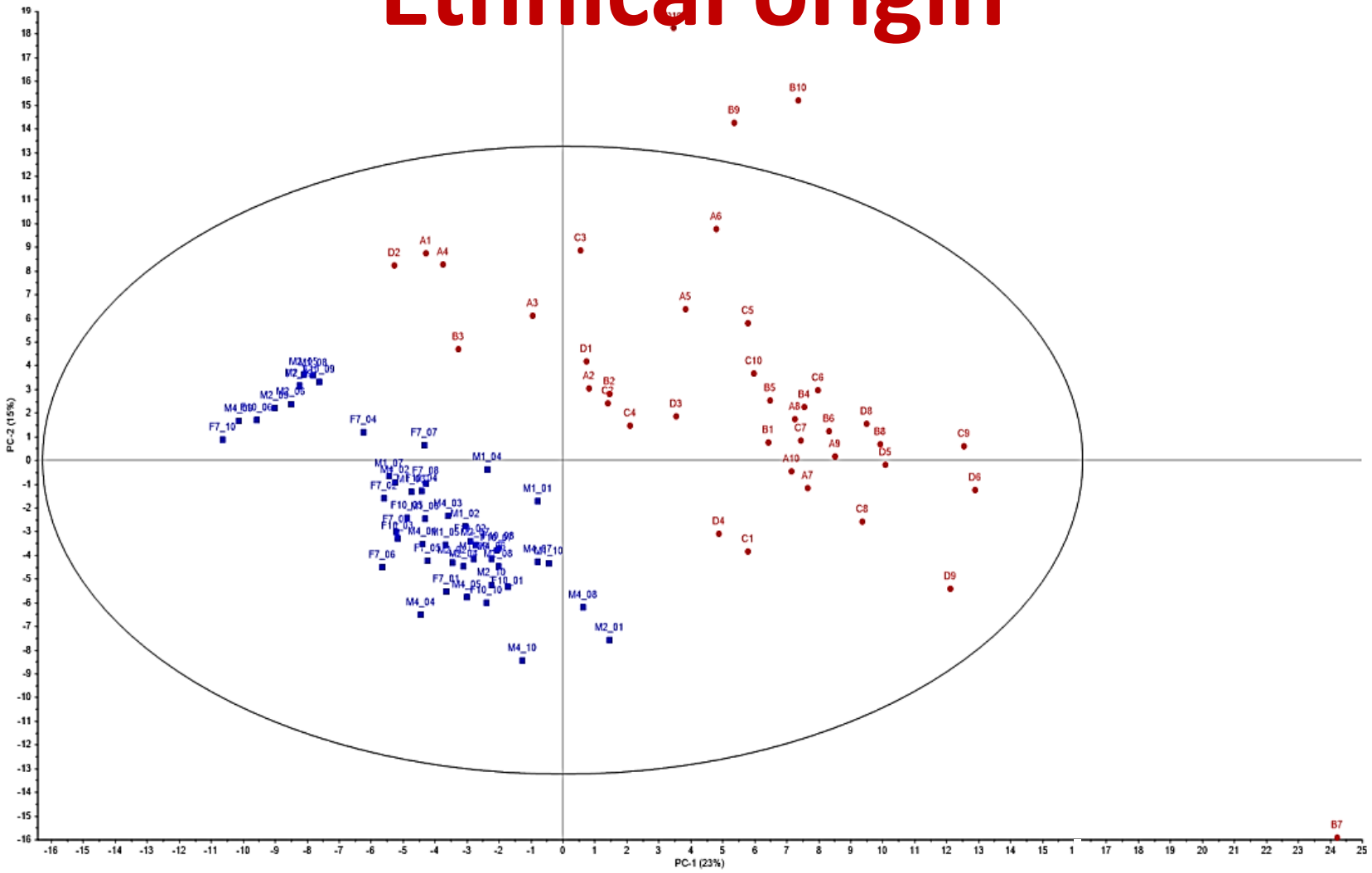
FORENSIC OLFACTRONICS

PCA model – blood type A versus type 0

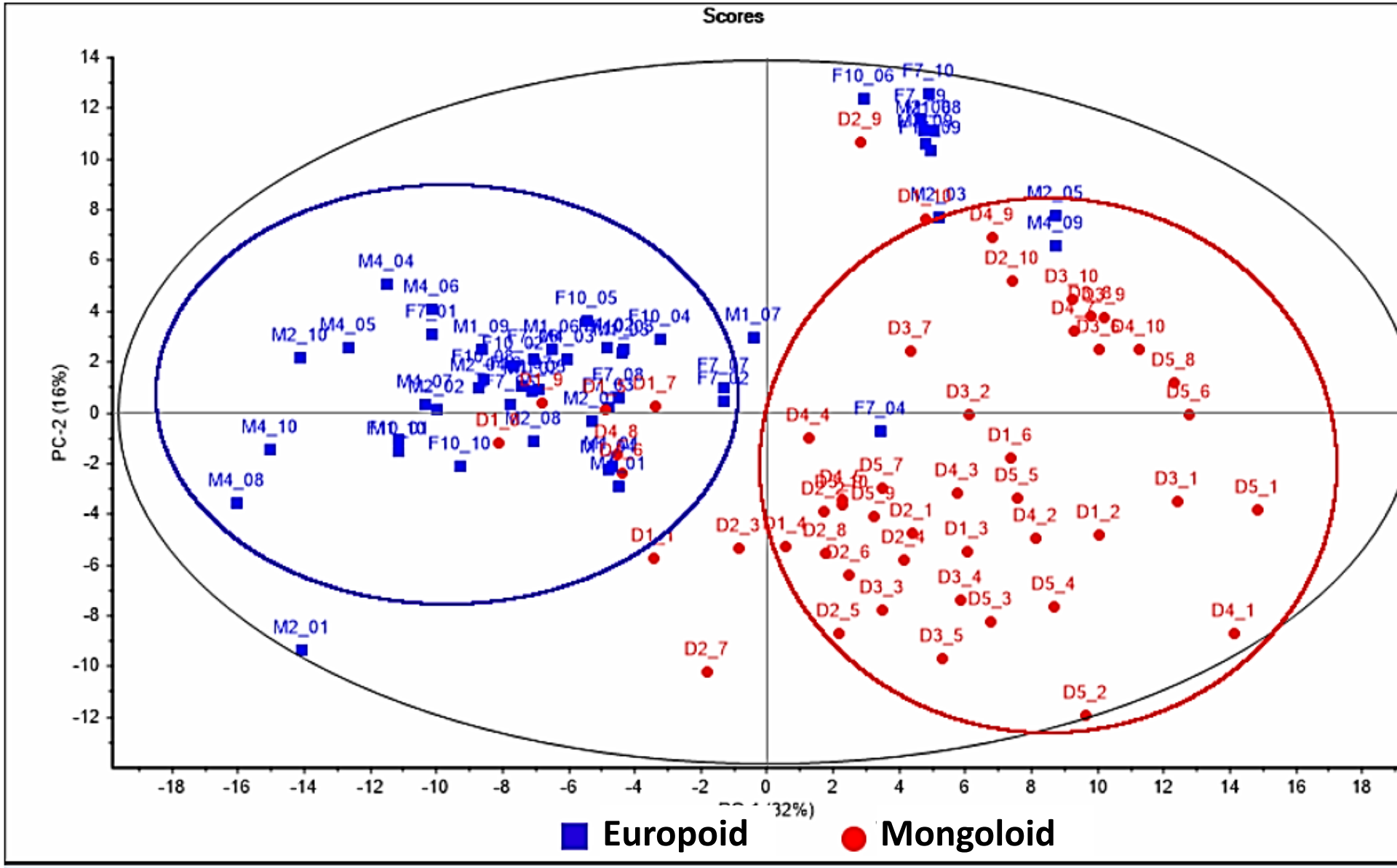


Brom, Bachelor thesis

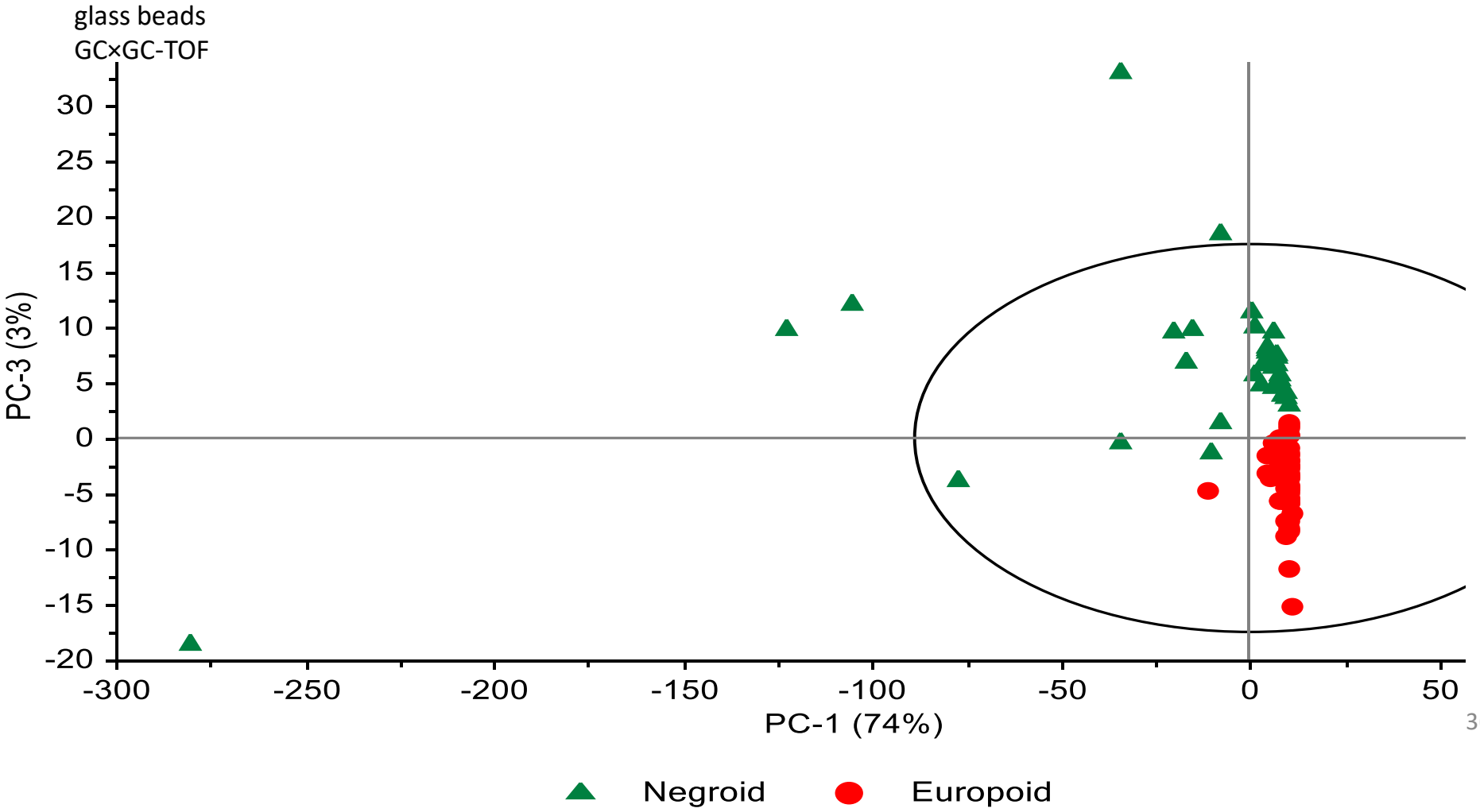
Ethnical origin



■ Czech volunteers samples, ● Indian volunteers samples

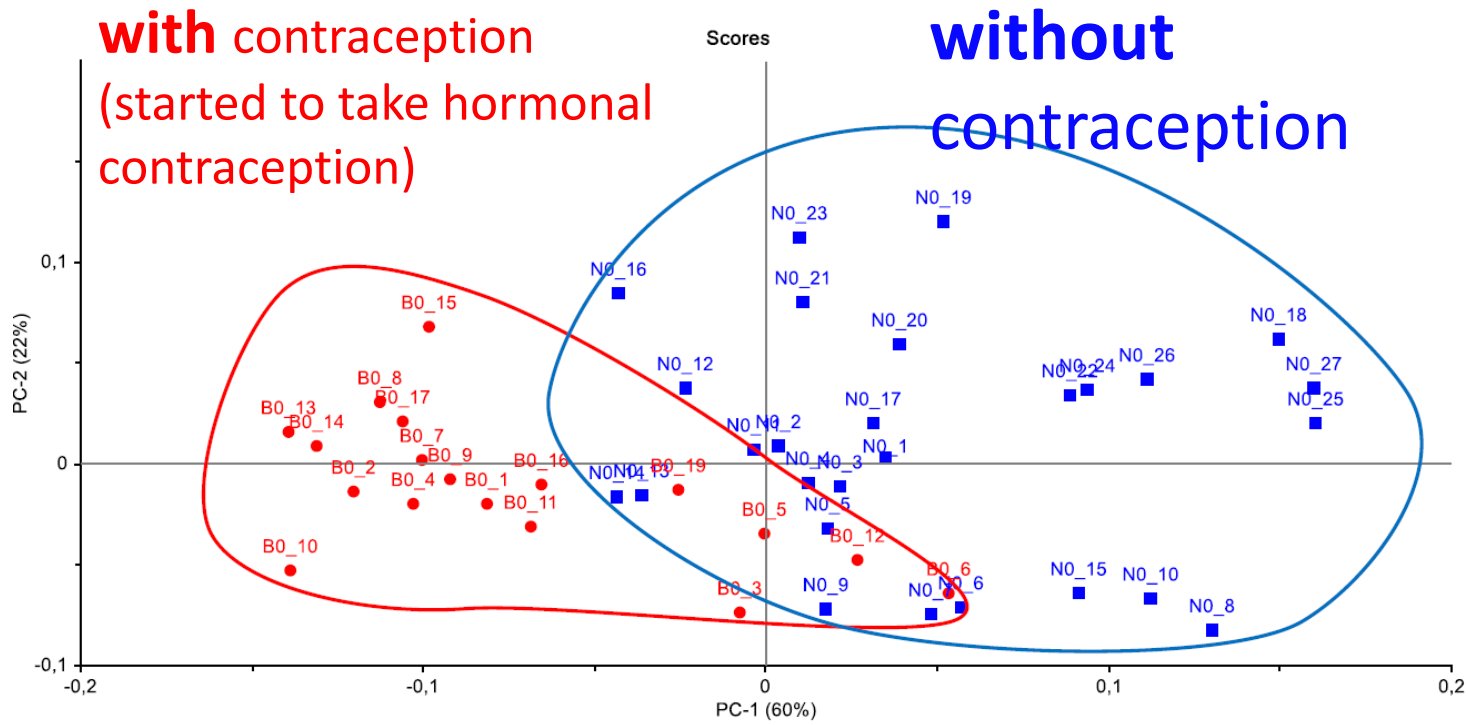

Scores
PC-2 (16%)
Europoid
Mongoloid

Negroids versus Europoids (2021)



Effect of hormonal contraception

- differences with and without contraception
- differences mainly in the amount of cholesterol and its derivatives

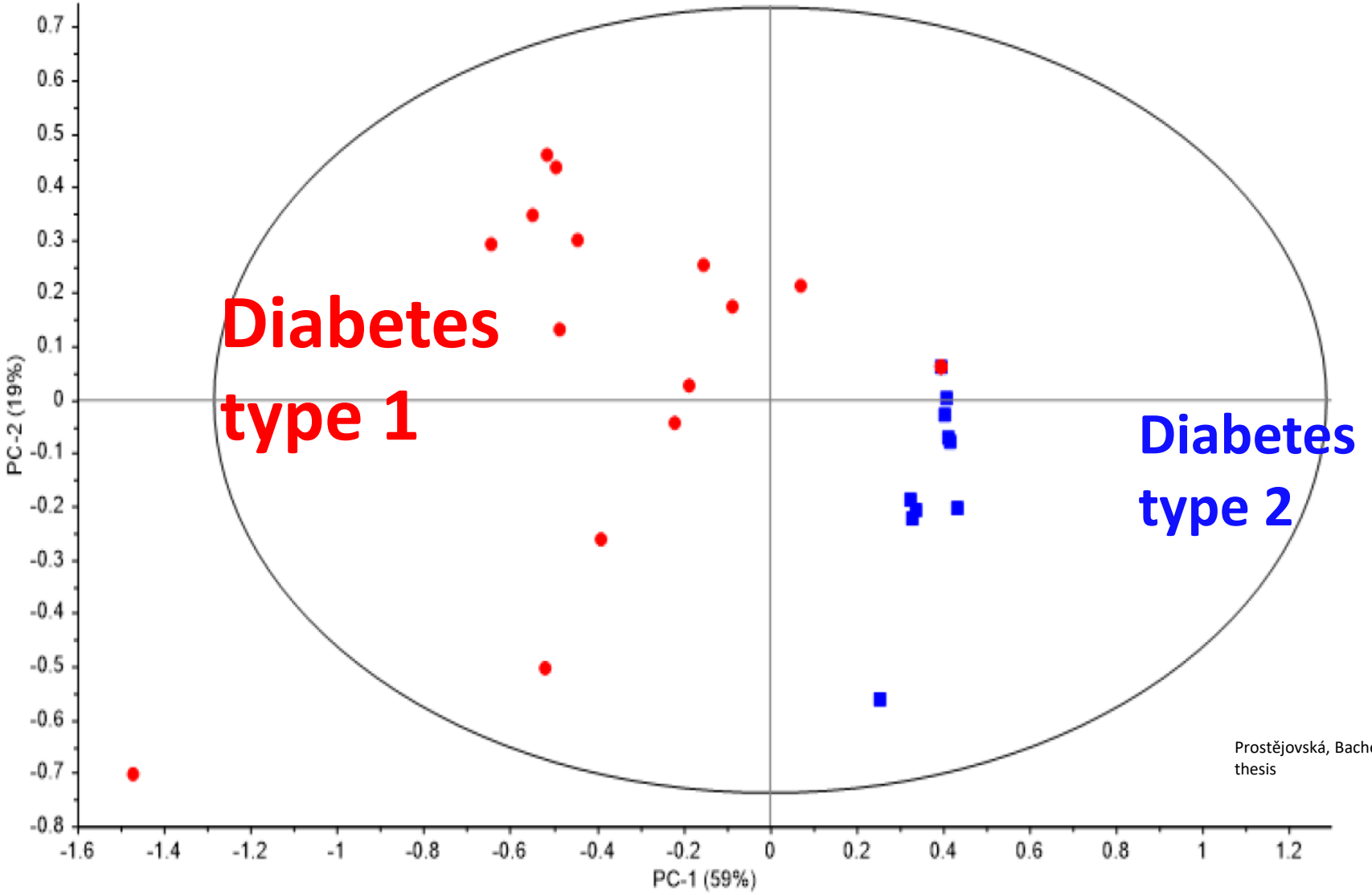


Linhartová, Diploma thesis

Diseases according to smell:

diabetes

glass beads
GC×GC-TOF



Prostějovská, Bachelor thesis

Medical olfactronics

New research project in collaboration Prague hospitals is oriented to diagnostics of degenerative diseases

Since the primary scent molecules are genetically determined, then any changes of DNA have its specific reflection in the detailed composition of the primary scent

Medical olfactronics

Since the primary scent molecules are genetically determined, then any changes of DNA have its specific reflection in the composition of the primary scent .

Since the degenerative diseases (eg. all the cancers, Alzheimer, Huntington as well as Parkinson diseases, diabetes mellitus etc.) are influencing DNA, we are looking for the specific influence (affection) of the these illnesses to the composition of the primary scent.

3rd February 2:20 – 2:30 PM FL05 **Oleksii Kaminskyi - Development and testing of a non contact scent collection device on real human scent**

4th February 1:50 - 2:00 PM FL12 **Ulrika Malá - Analysis of the human scent on the cartridge cases using GC×GC-MS/TOF**

4th February P-22 **Jana Čechová Challenges in data processing and evaluation of scent samples analyzed by GC×GC-TOF**

4th Feb. P-28 **Veronika Skerikova Sorbents for forensic olfactronic**

Forensic and Medical Olfactronics

Thanks for your attention