EMPA News

GD-MS activities at lake Thun, CH

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Pulsed rf-gd-TofMS

- MS complementairy information
  - Better detection limits
  - Molecular information
- TOFMS
  - Simultaneous
  - Large mass range m/z > 1000
  - Mass resolution
  - price

•Glow Discharge
-Fast
-Versatile
-Quantification
-« Easy to use »
-Surface and interface

•Radio Frequency
-Non-conductors

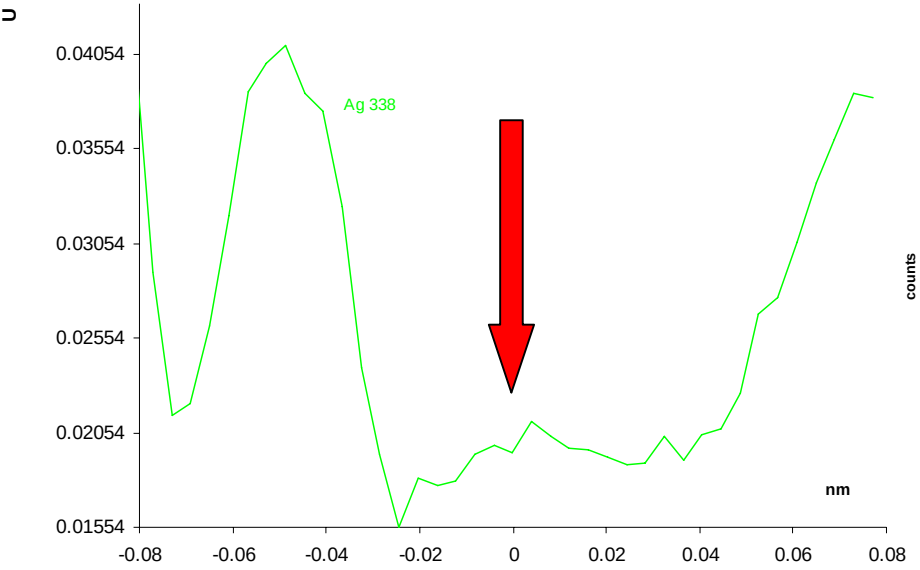
•Pulsed
-Hard and soft ionisation

OES versus MS

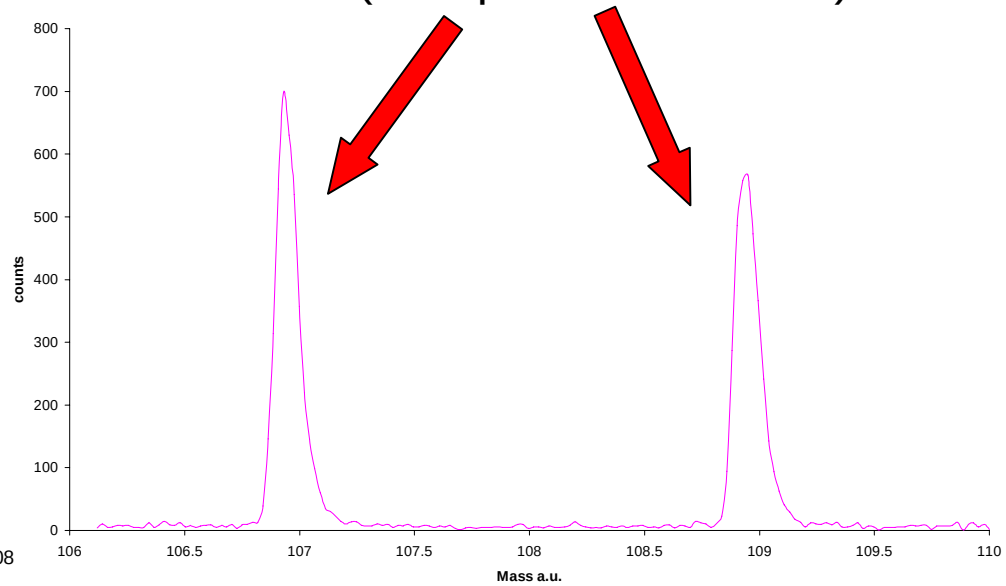
GD-**OES**, spectral scan around 338 nm

GD-**MS**, mass spectrum

8ppm Ag



8ppm Ag
(Isotopes 107 and 109)



The BEC for Ag in Cu is 60ppm

Accumulated mass spectra for 100s acquisition time

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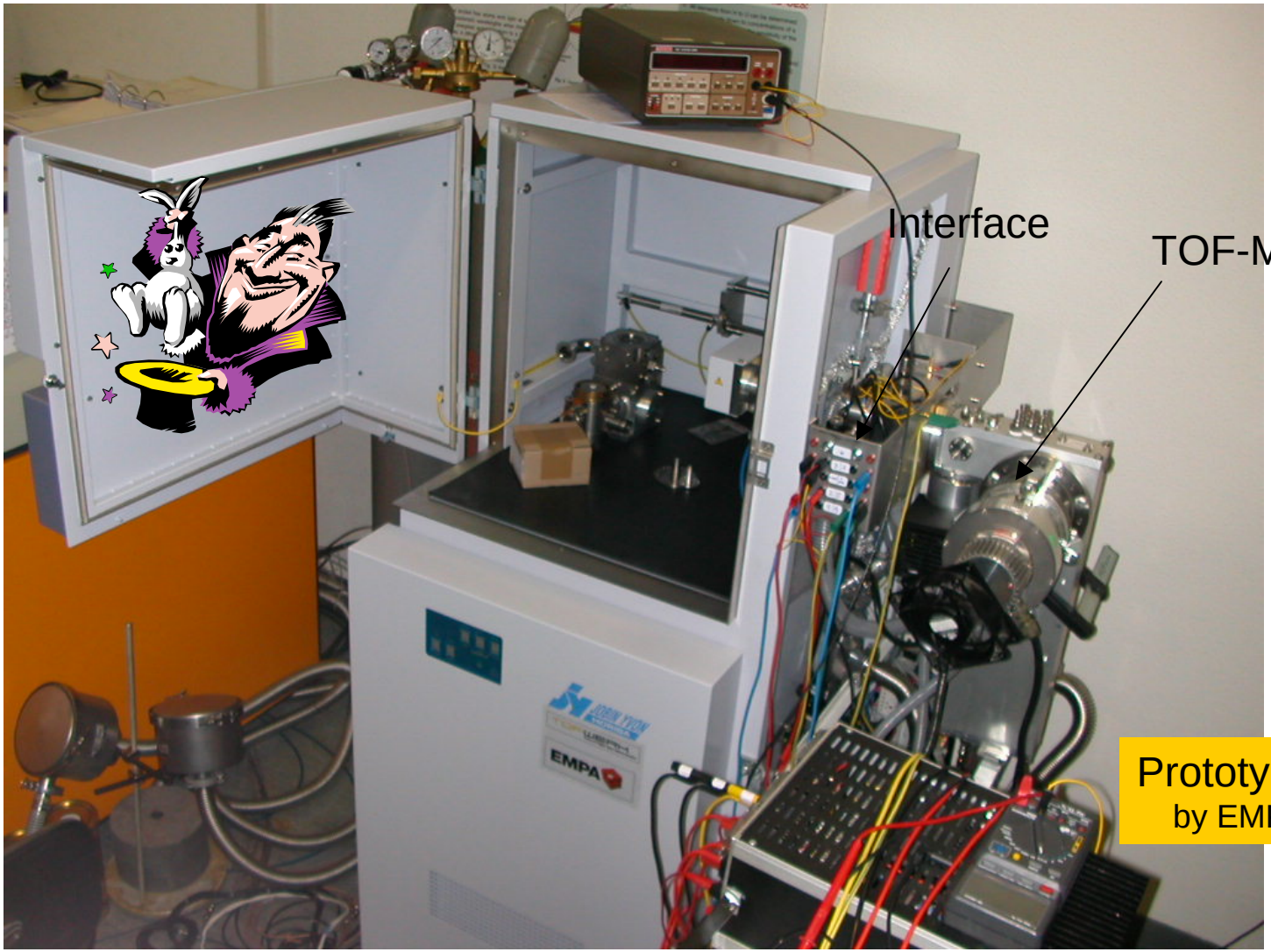
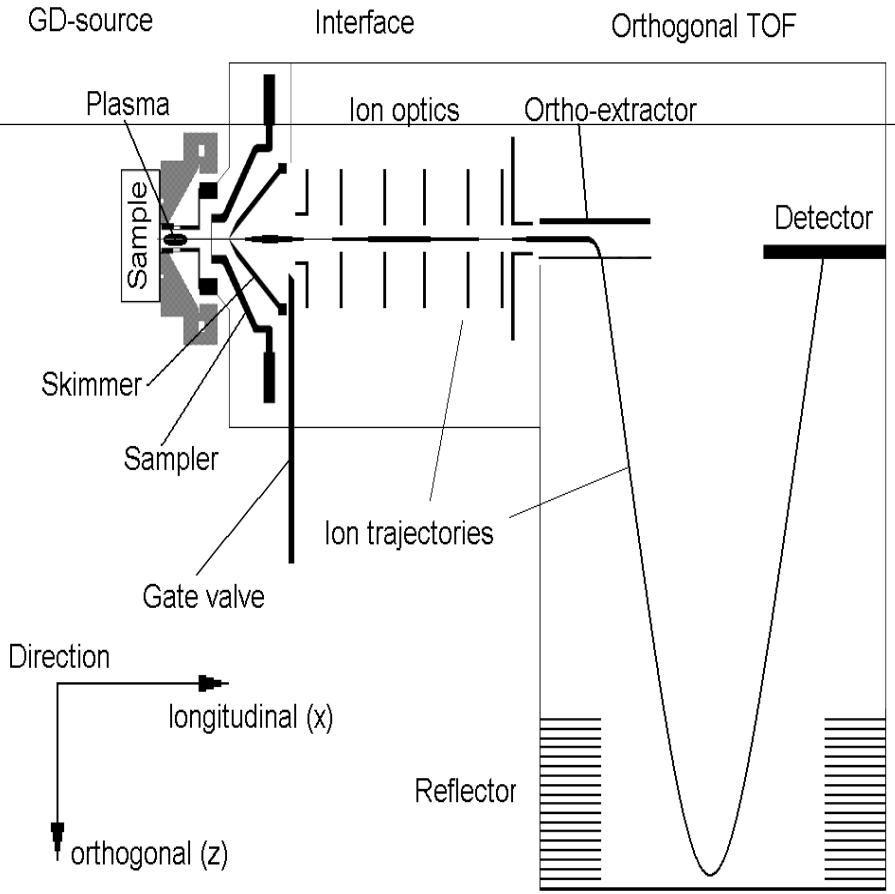
1rst Prototype



Prototype GD-TOF
by EMPA / Tofwerk

Current Status: Schematics V-mode

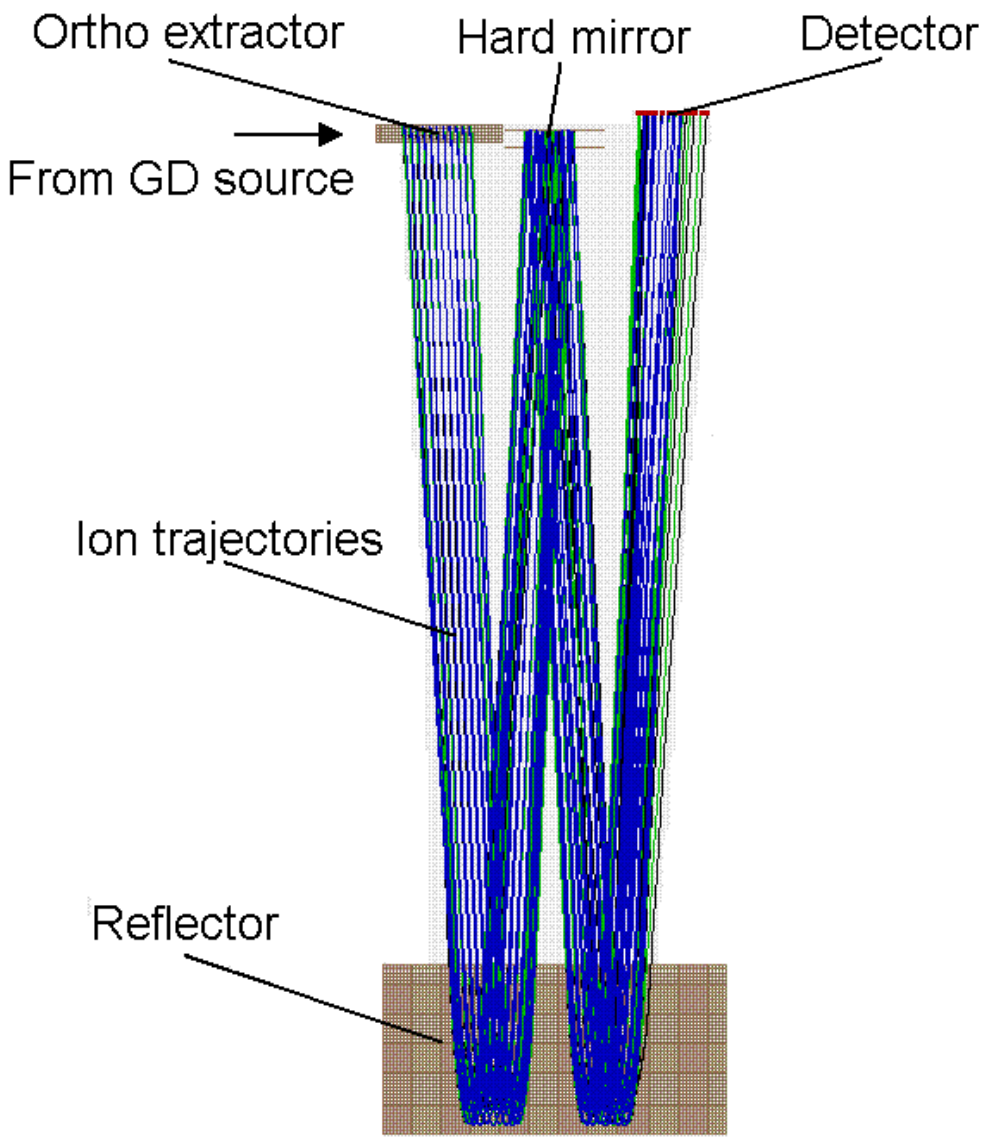


W-ToF

Mass resolution

m/dm = 6000

Sufficient for most applications



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2nd Proto type

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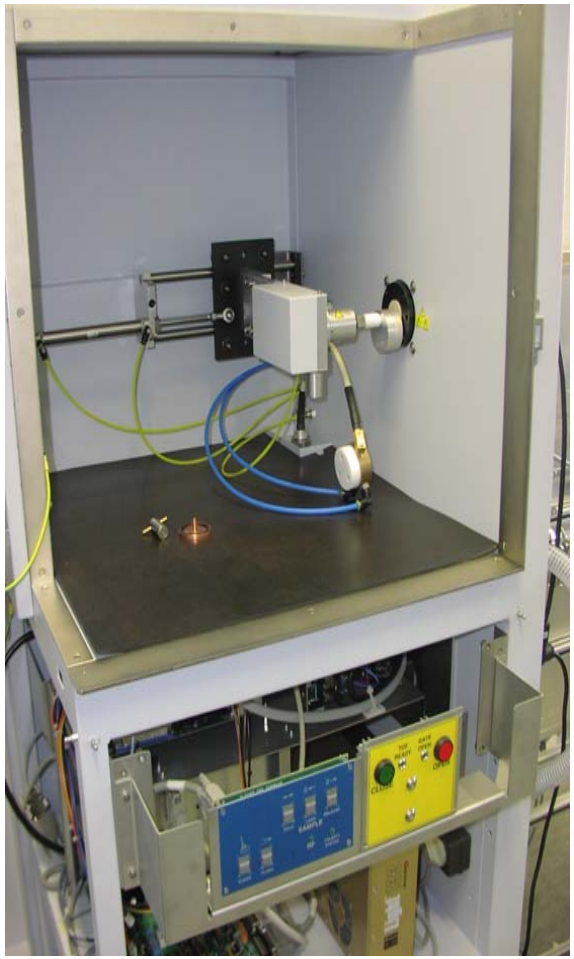
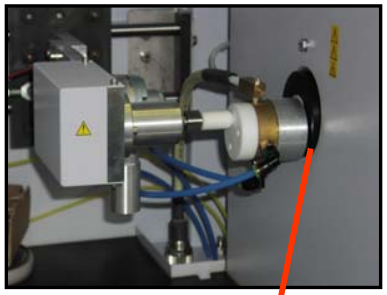
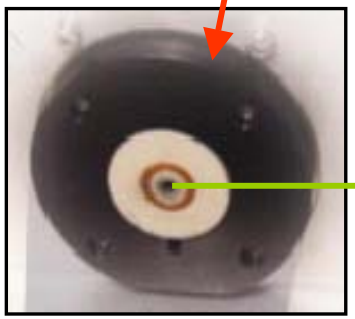
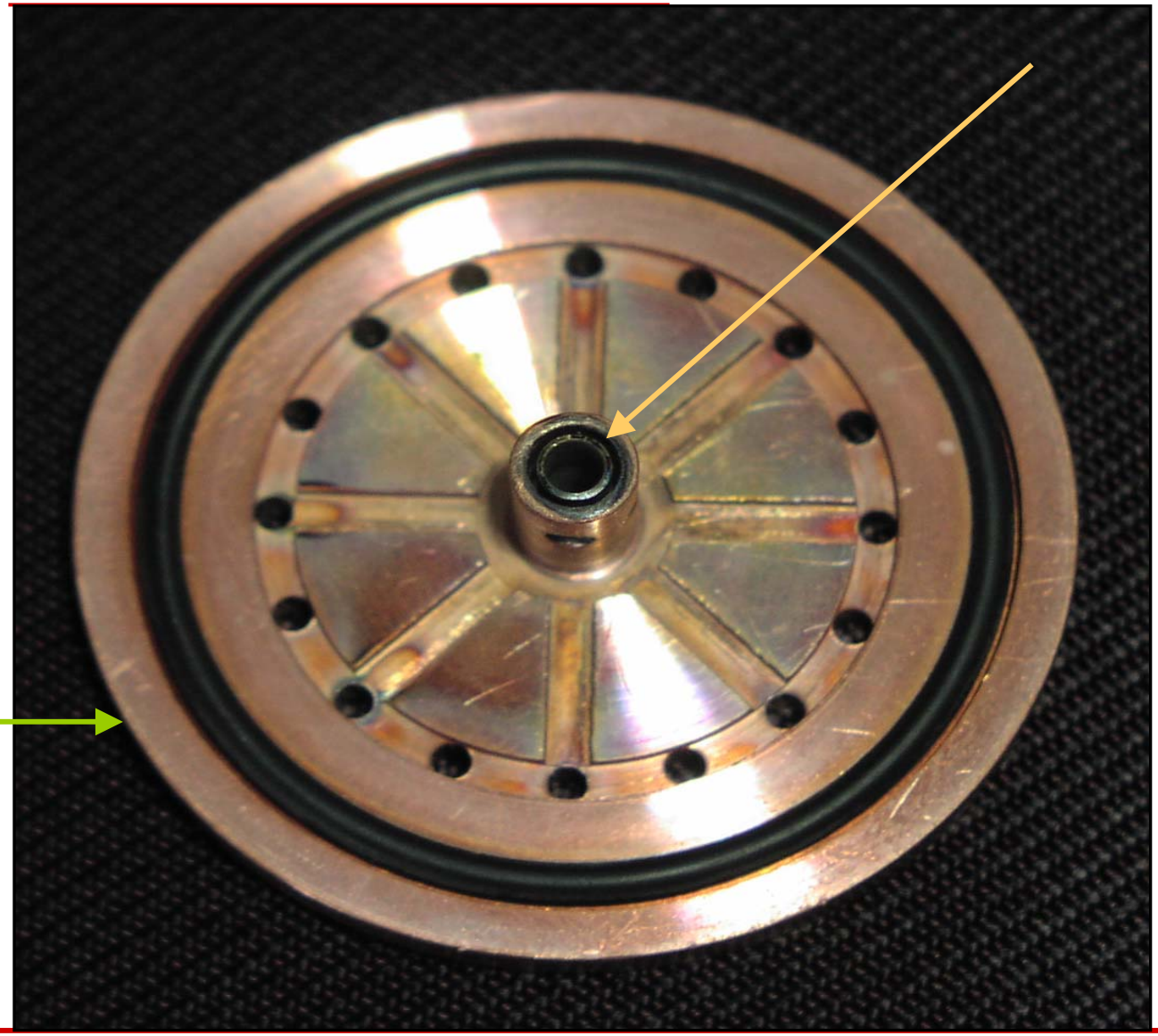
Oviedo GDMS: sample stage



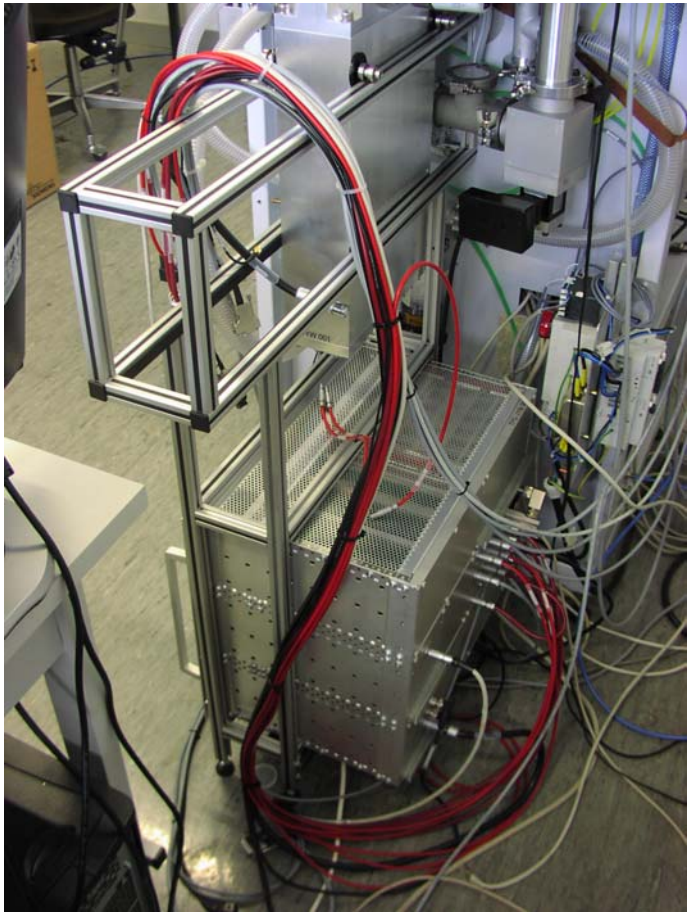
Flow Tube ?



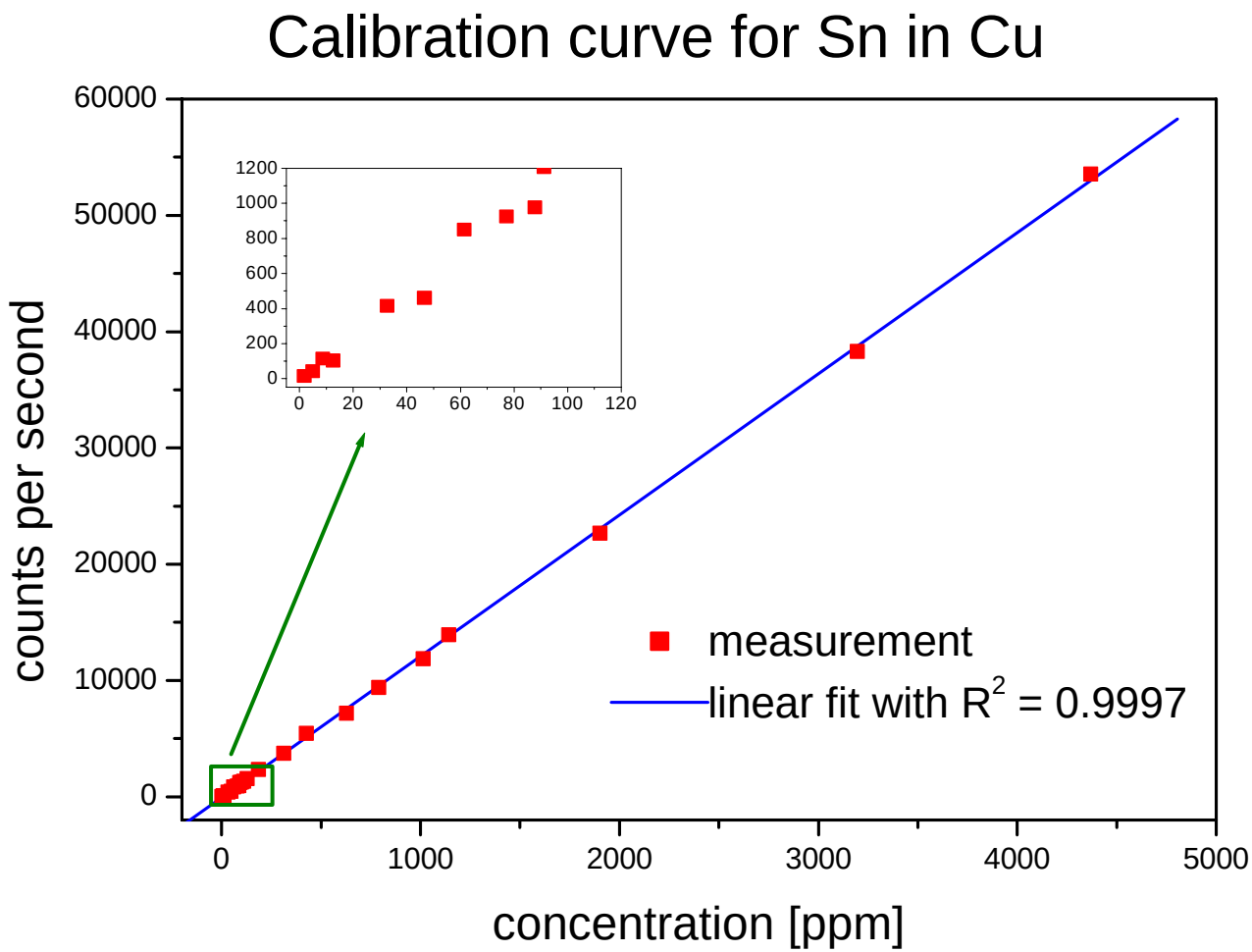




2nd rf GD TOFMS: fully integrated Electronics



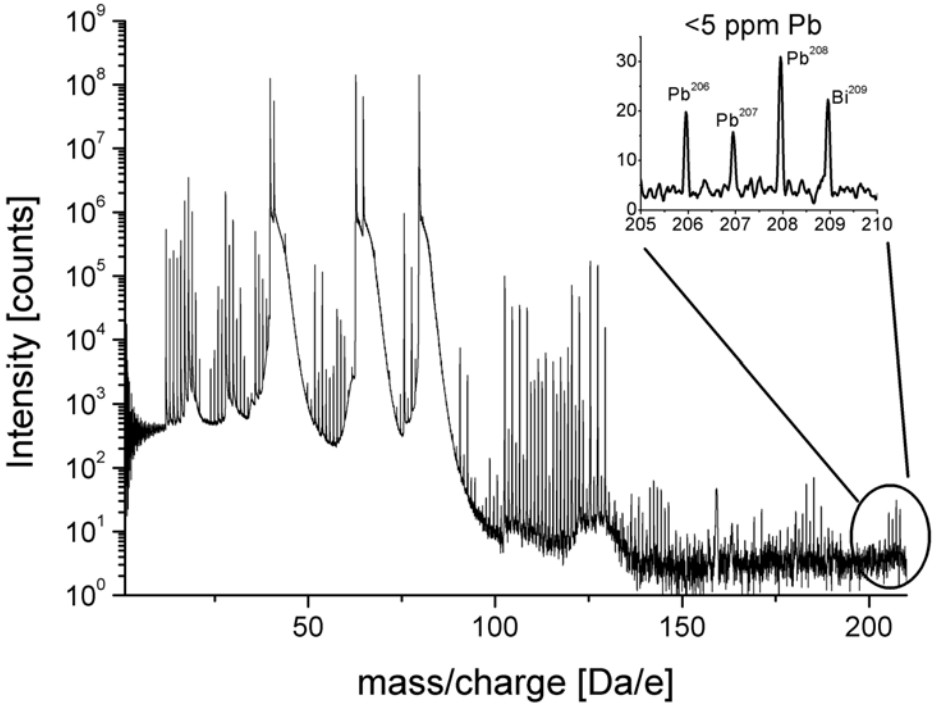
Bulk Analysis



Detection limits ?

Current Status: High purity Cu

With higher amplification:
Sub ppm
BUT:
saturation problems too solve!
Too much information?



LOD (Cu):
PB: < 2 ppm
SN: < 3 ppm
Bi: < 1 ppm

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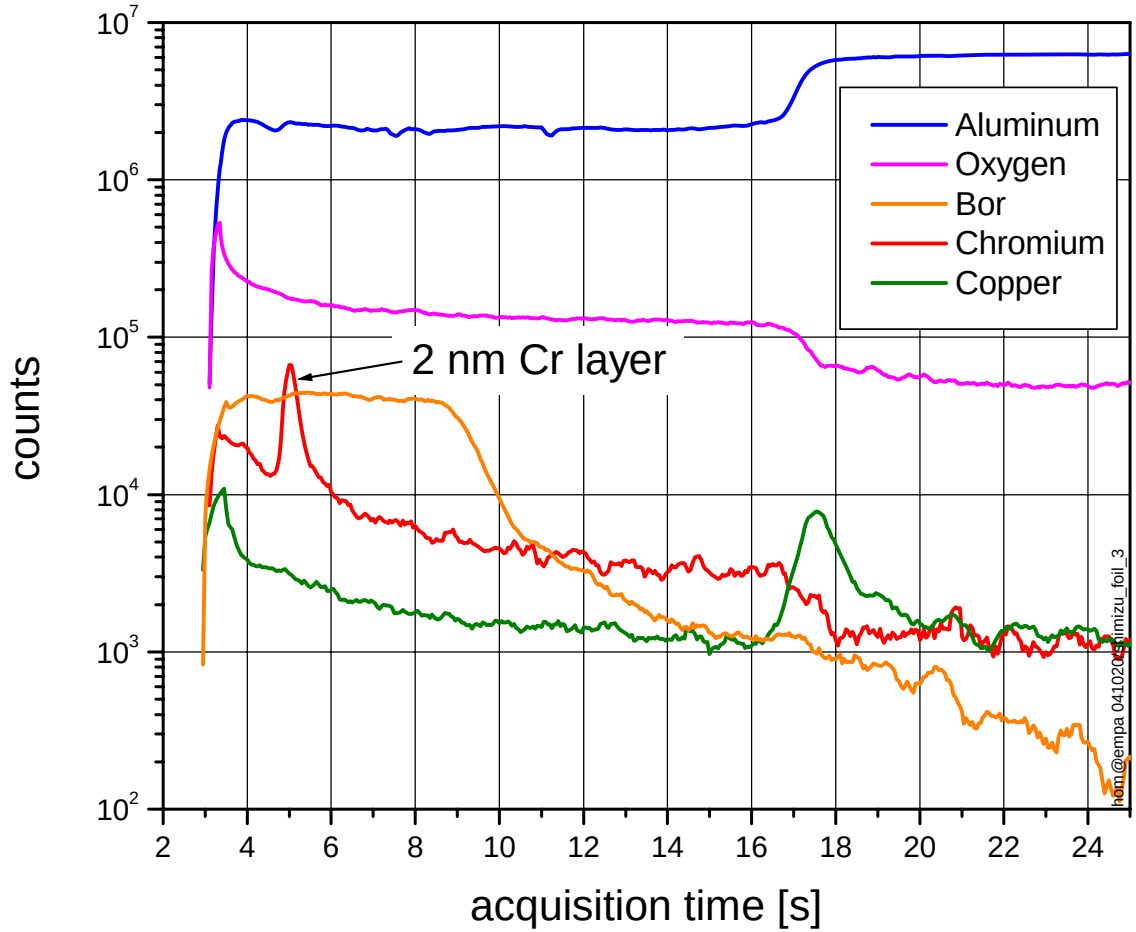
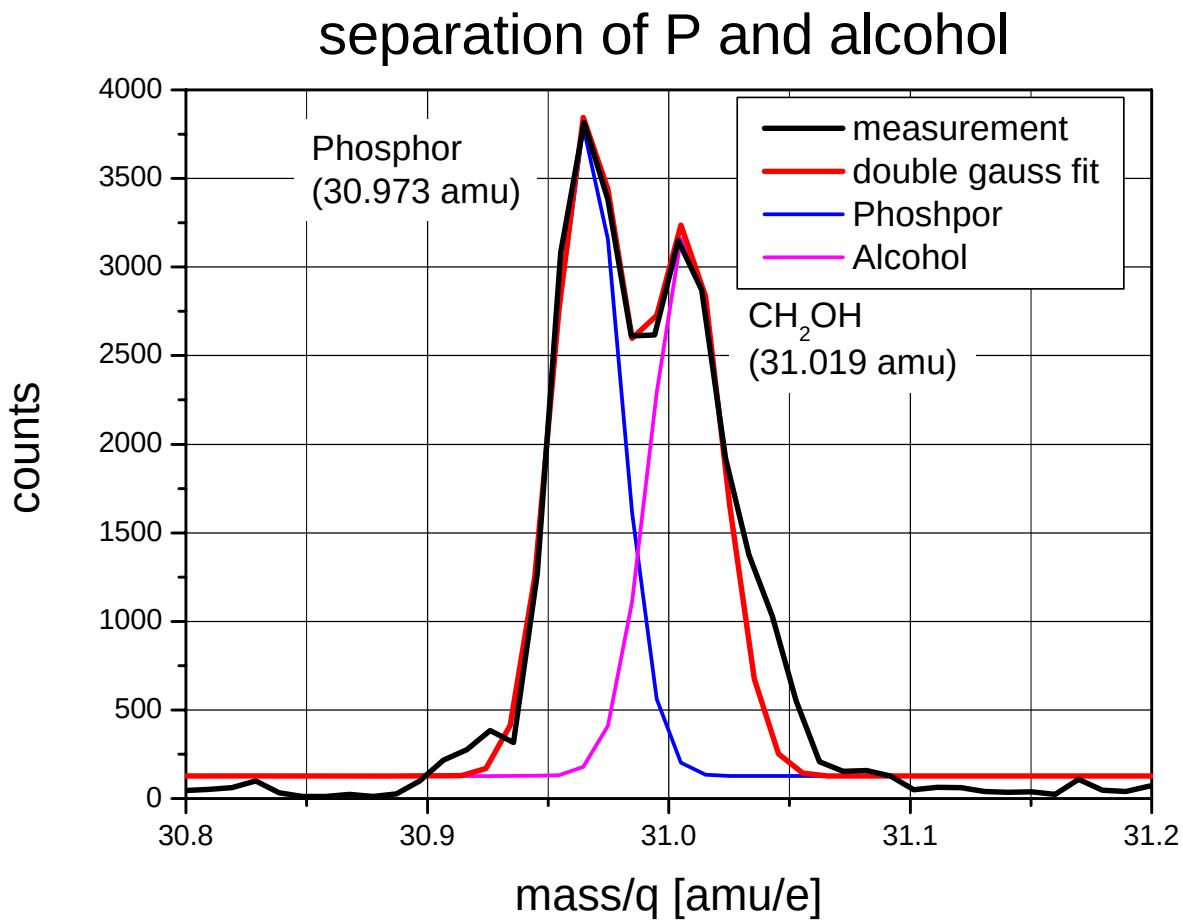
Depth profiling

Aluminum with 240 nm Al_2O_3 and 2 nm Cr



Comparable to GD-OES

Mass resolution and molecues



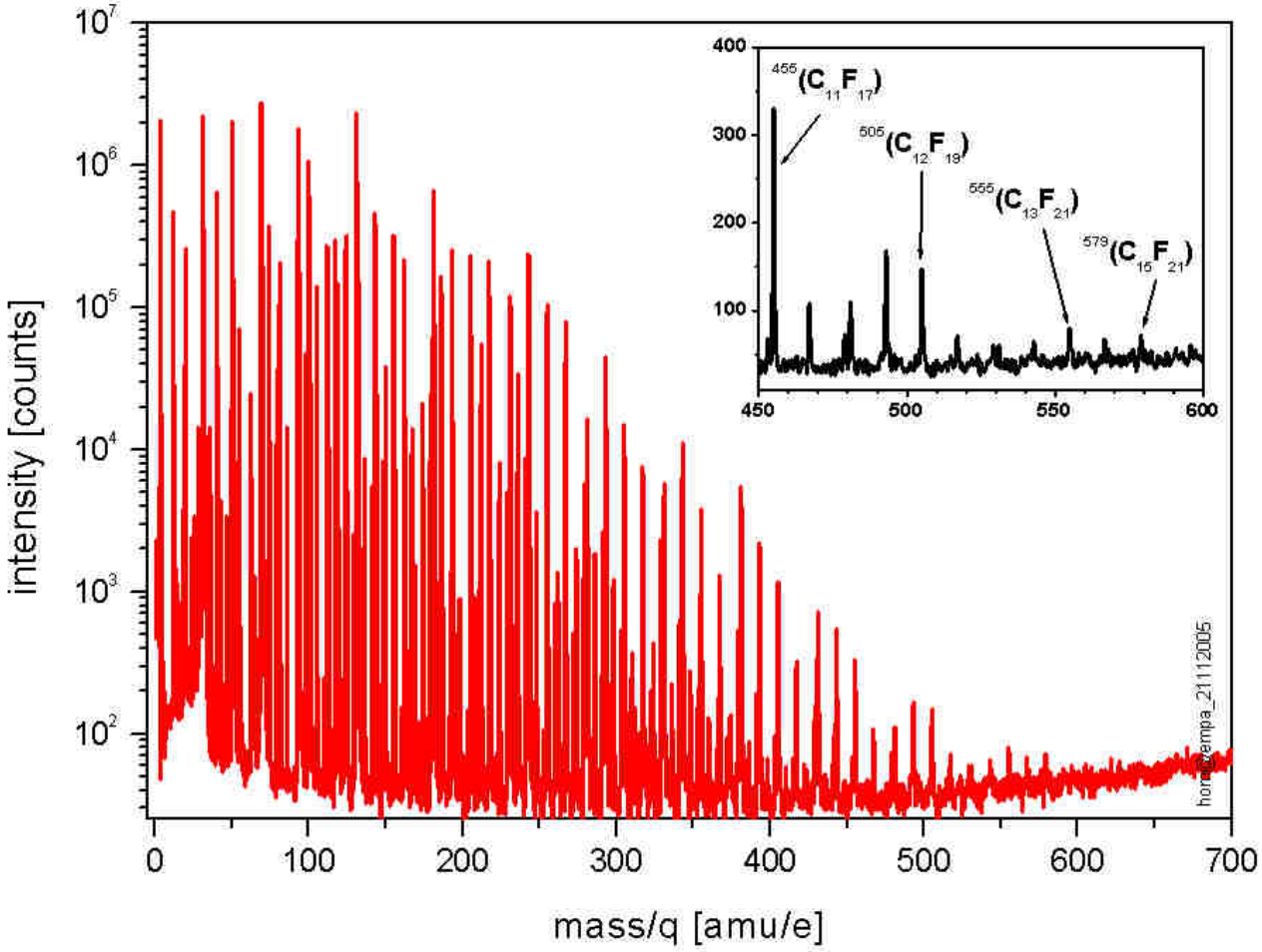
1rst Proto type:

M/dm = 1200

W-ToF

M/dm = 6000

Molecular Species: Teflon



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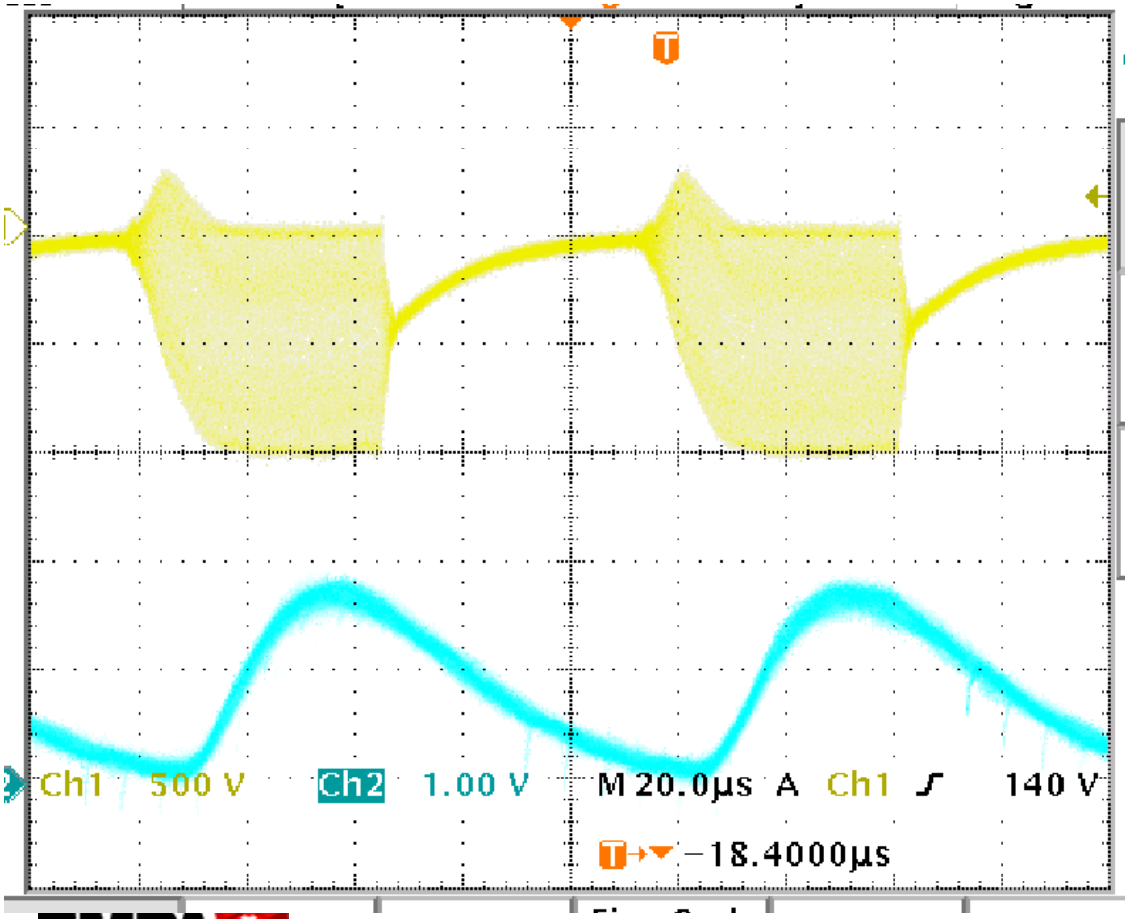
Fundamentals

Pulsed RF: Emission



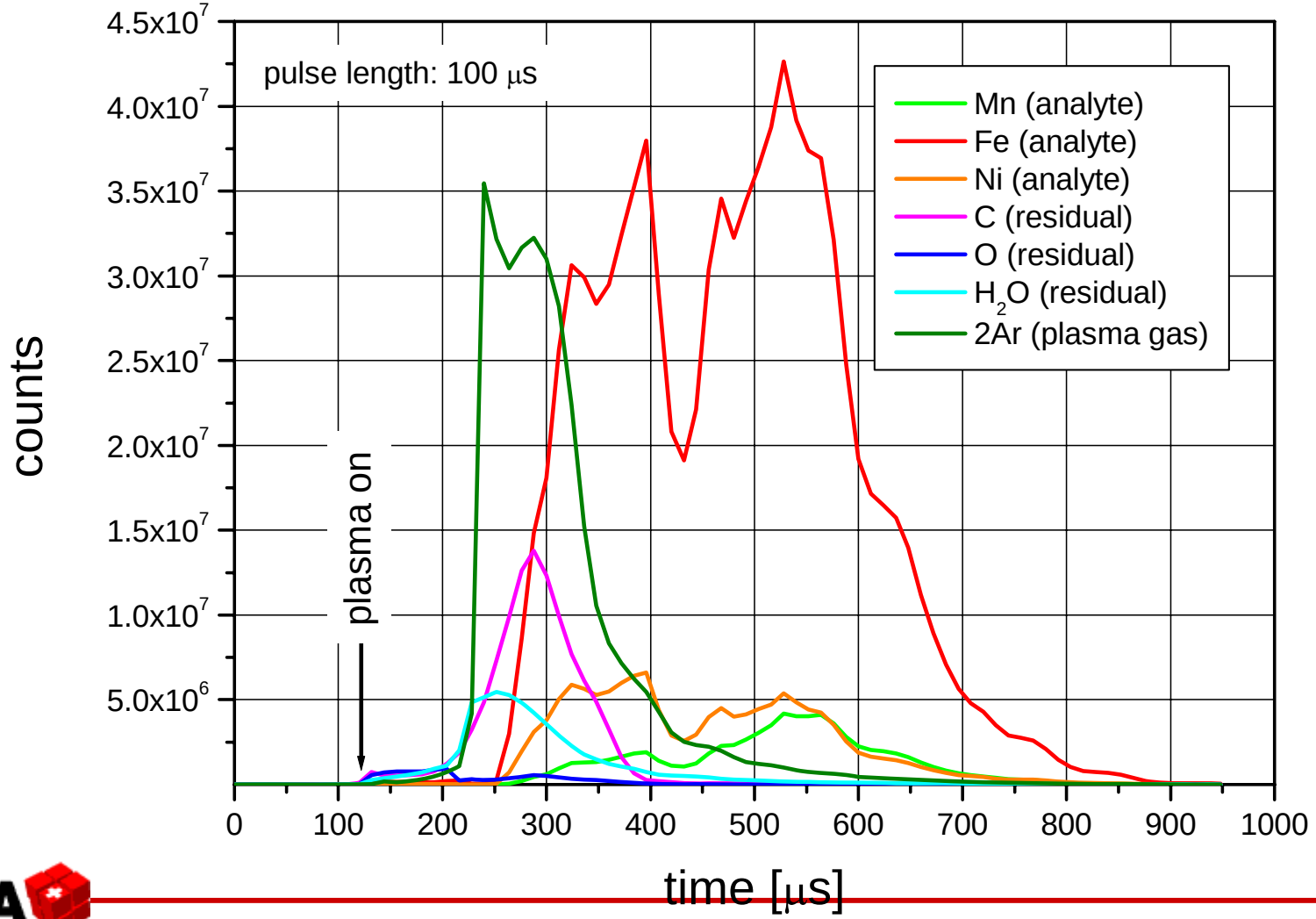
Pulse width 50µs
Freq. 10000Hz

Al Signal

Boosted Mono

Pulsed source operation

Analyte peaks versus residual gas peaks



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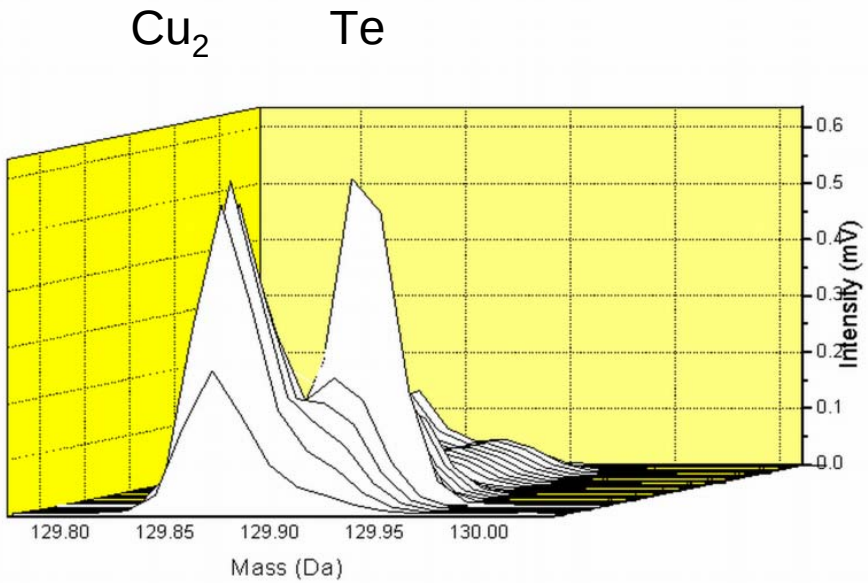
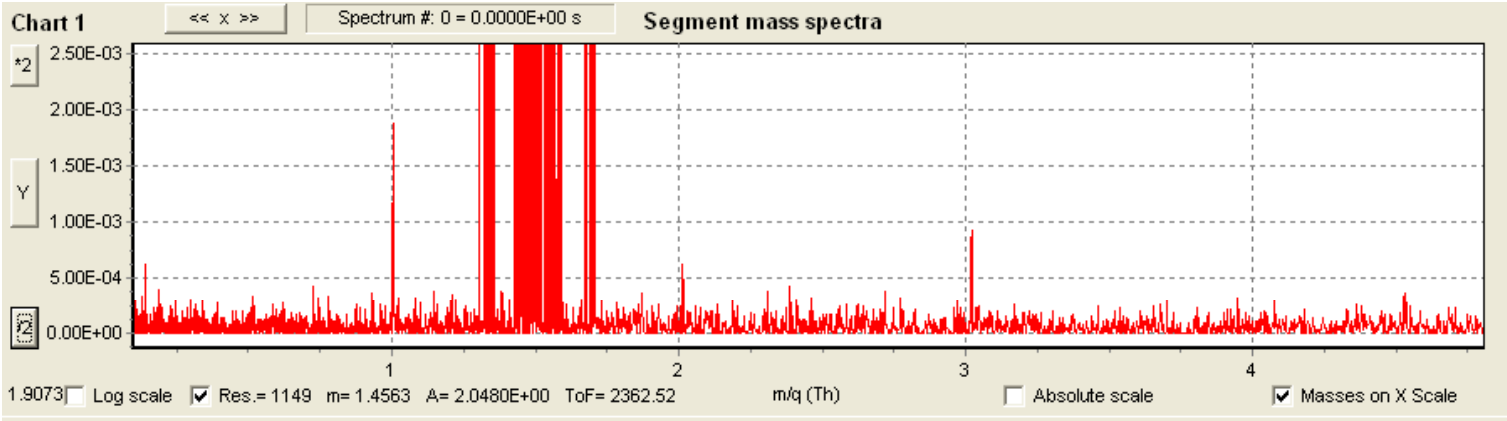
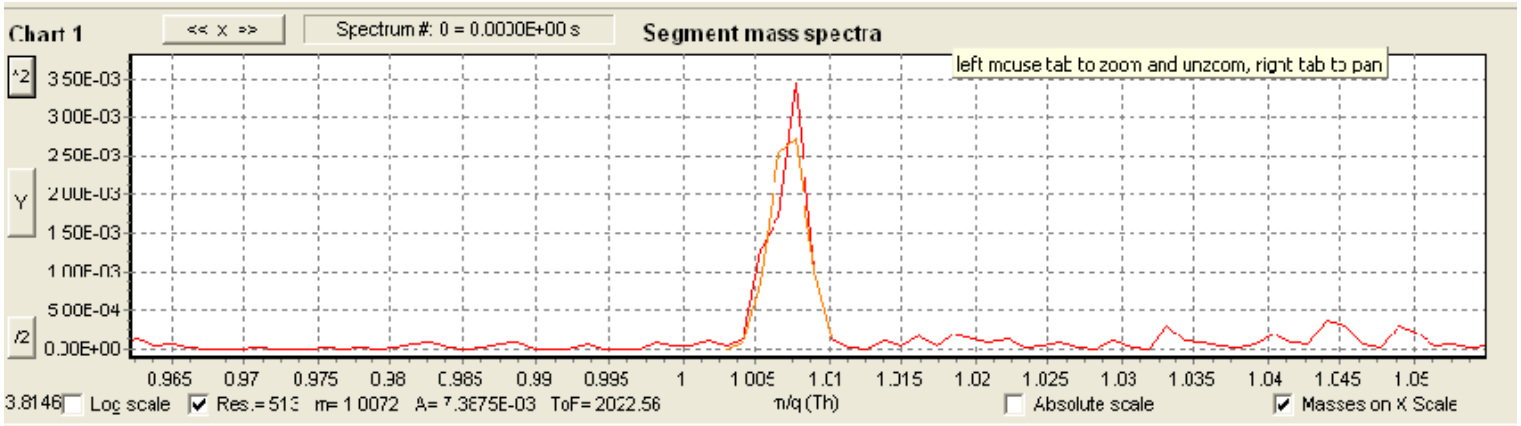
Current Status: Pulsed mode



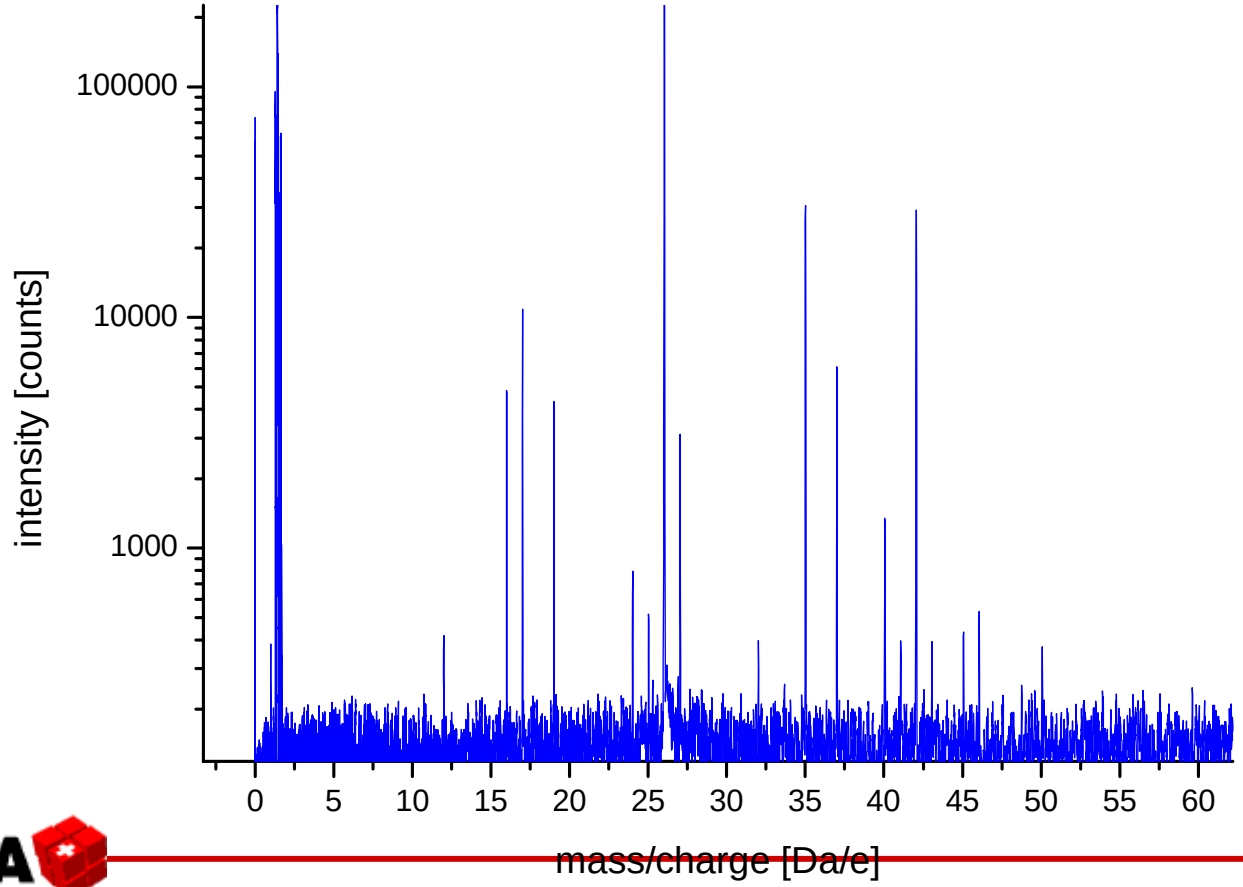
Current Status: Hydrogen





Very last news

Current Status: Negative ion mode



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Where are we now ?

- First prototype built by EMPA and Tofwerk AG (KDI financed)
- Second prototype built and shipped to Oviedo University (HJY financed)
- Third prototype at EMPA/Tofwerk in preparation
- European Project STREP EMPDA
  - Elemental and Molecular Depth Profile Analysis.

EMDPA

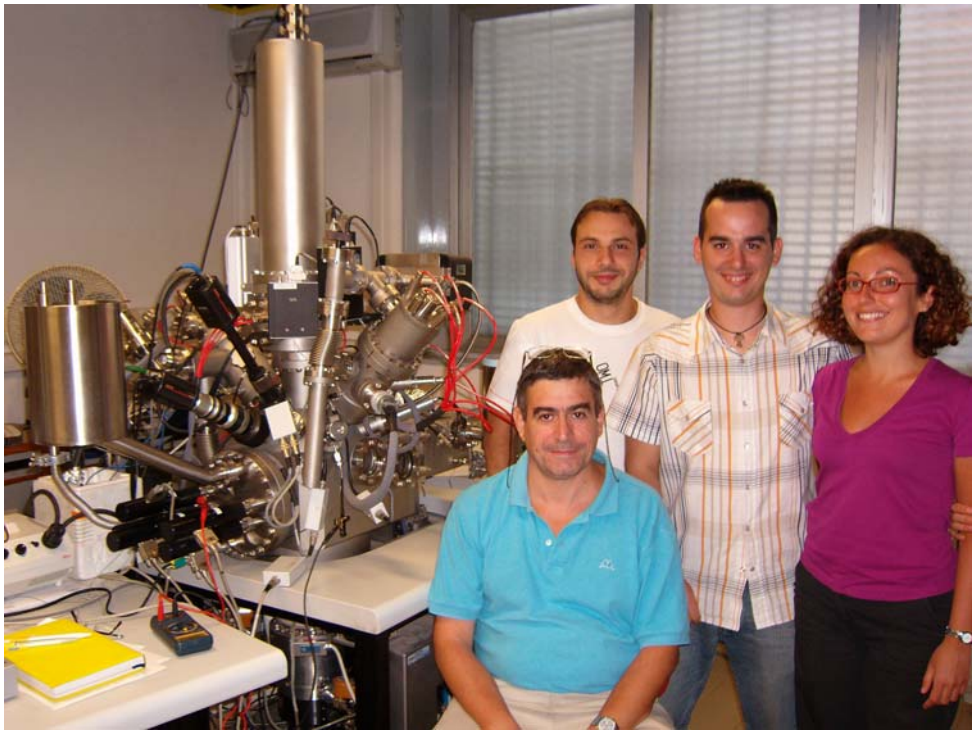
- **Elemental and Molecular Depth Profiling Analysis of Advanced Materials by Modulated Radio Frequency Glow Discharge Time of Flight Mass Spectrometry**

- 10 partners
- 7 countries

Consortium

Role	Participant N°	Participant name	Participant short name	Country
CO	1	HORIBA Jobin Yvon	HJY	France
CR	2	University of Manchester	UoM	United Kingdom
CR	3	National Institute of Lasers, Plasma and Radiation Physics	NILPRP	Romania
CR	4	Gesellschaft zur Foerderung der Analytischen Wissenschaften e.V.	ISAS	Germany
CR	5	Swiss Federal Institute for Materials Science and Technology	EMPA	Switzerland
CR	6	Centre de Physique des Plasmas de Toulouse	CPAT	France
CR	7	TOFWERK AG	TW	Switzerland
CR	8	University of Oviedo	UNIOVI	Spain
CR	9	Università degli Studi di Catania	UNICT	Italy
CR	10	ALMA Consulting Group	ALMA	France

University of Catania (ToF-SIMS)



People involved in the project:

Antonino Licciardello
Prof. of Physical Chemistry, scientific responsible

Ivan Delfanti
BSc (materials science)

N. Tuccitto
Post-Doc fellow (Chemistry)

V. Torrisi
Ph.D. Student (Materials Science)

Other people (permanent positions at UNICT) that will give support to the project:

Prof. G. Marletta, Professor A. Torrisi, Prof. A. Grassi

National Institute for Lasers, Plasma and Radiation Physics, Bucarest, Rumania

Group directly involved in EMDPA project:

Dr. Rares MEDIANU (director of NILPRP) – **Thin film deposition**
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Dr. Mihai GANCIU-PETCU – **Pulsed transient plasmas**
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Dr. Agavni SURMEIAN – **Diagnostics of afterglow plasmas**
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Dr. Constantin DIPLASU – **Pulsed discharges and modulated RF plasmas**
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Dr. Andreea GROZA – **Structural modifications of organic compounds in nonequilibrium discharges**
andreea@infim.ro

Mihai Marin – **Technical assistance**

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EMDPA

EMDPA will provide research laboratories and industry with a unique "multi-dimensional" analysis tool of all types of layered materials, allowing direct, simultaneous elemental and molecular quantitative measurements with a sensitivity down to 100 ppb in the depth profiling mode for all elements of the Periodic Table, in observed zones of millimetre dimensions, through the development of a Micro Modulated or Pulsed Radio Frequency Glow Discharge Time of Flight Mass Spectrometer.

Such instrument represents a major breakthrough as it will change the way surface and depth profiling analysis is regarded, being ultra fast, easy to use and low cost.

The instrument is dedicated to the depth profiling of advanced materials made of conductive and/or non-conductive thin layers down to the nanometre scale.

The development of such a radically new analytical instrument requires the understanding of key-phenomena:

- Understanding/modelling of the sputtering mechanisms and ionization processes
- Characterization of sputtered surfaces and understanding/modelling molecular chemistry in plasmas
- Ion transport phenomena and detection methods
- Assessment of performance properties

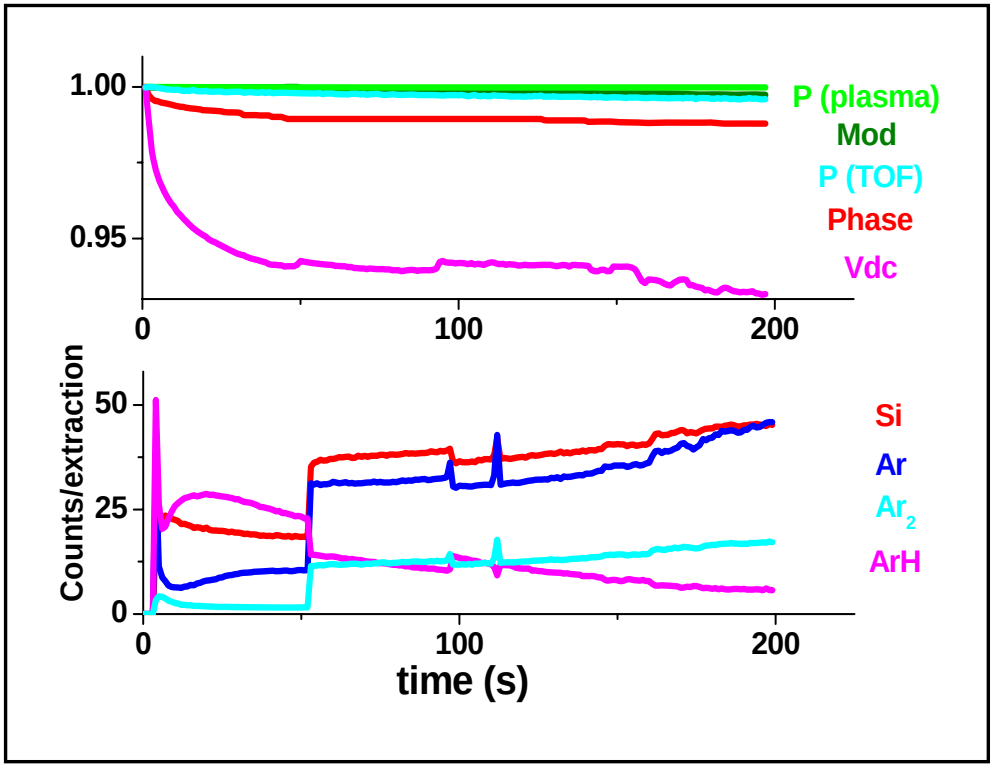
The END

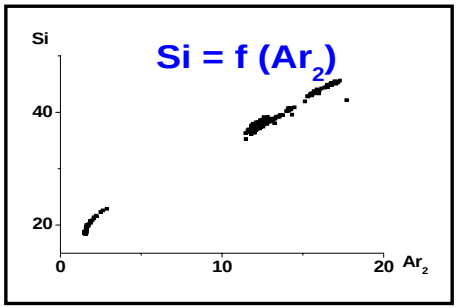
Ladies and Gentlemen

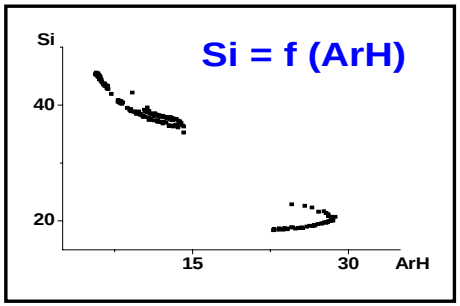
It's time now

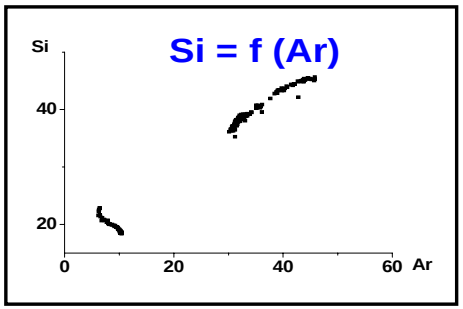
Last orders please!

Instabilities

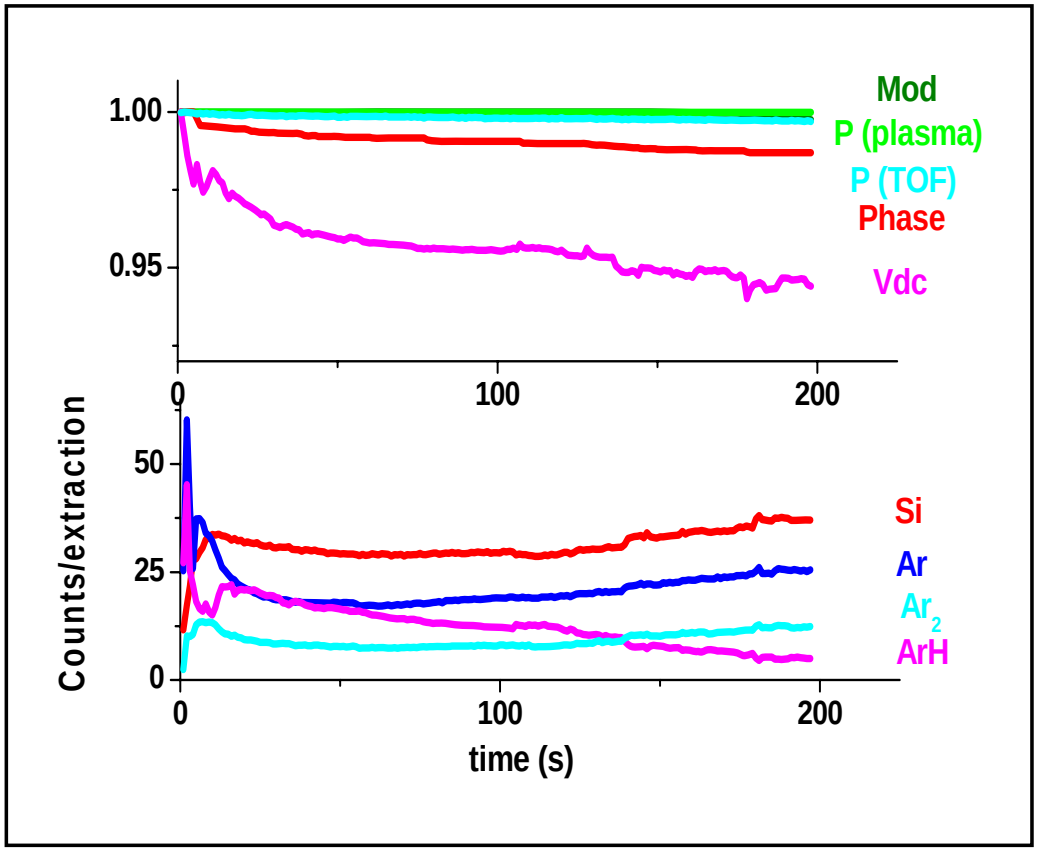


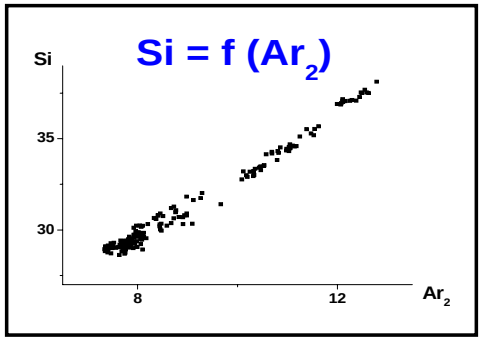


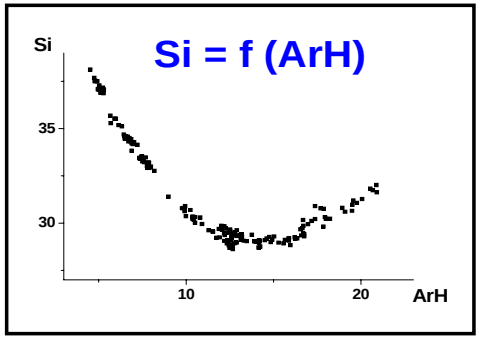


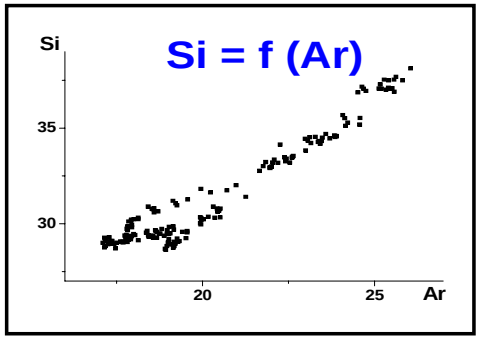


H-Pollution ?


1.00
0.95
0
100
200
Mod
P (plasma)
P (TOF)
Phase
Vdc
Counts/extraction
50
25
0
0
100
200
time (s)
Si
Ar
Ar2
ArH


Si = f (Ar2)
Si
35
30
8
12
Ar2


Si = f (ArH)
Si
35
30
10
20
ArH


Si = f (Ar)
Si
35
30
20
25
Ar