



Low Radioactivity Techniques based on ICP-MS at Peking University *

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On Behalf of PandaX-III Collaboration

Low Radioactivity Techniques 2017 , Korea

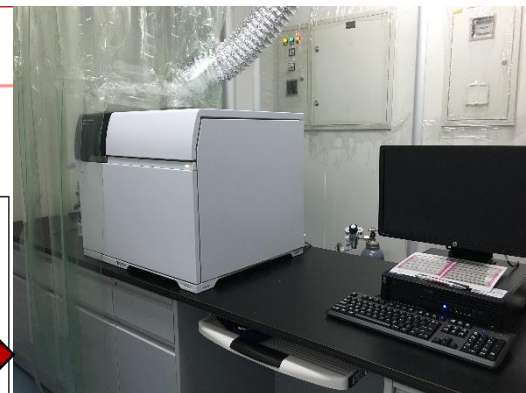
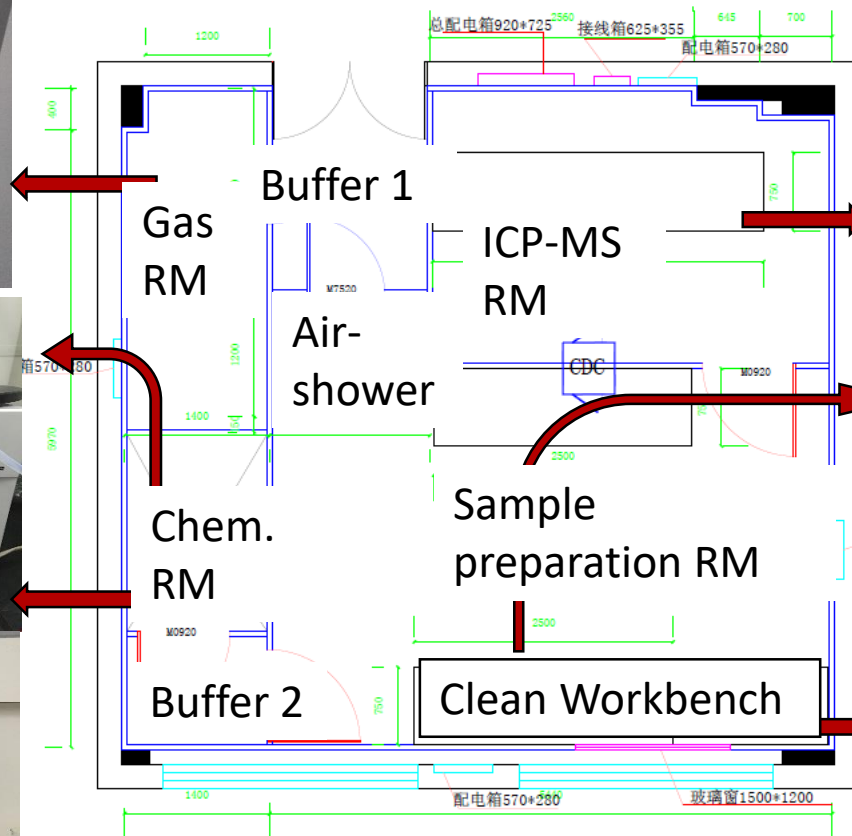
*Supported by Center for High-Energy Physics, PKU



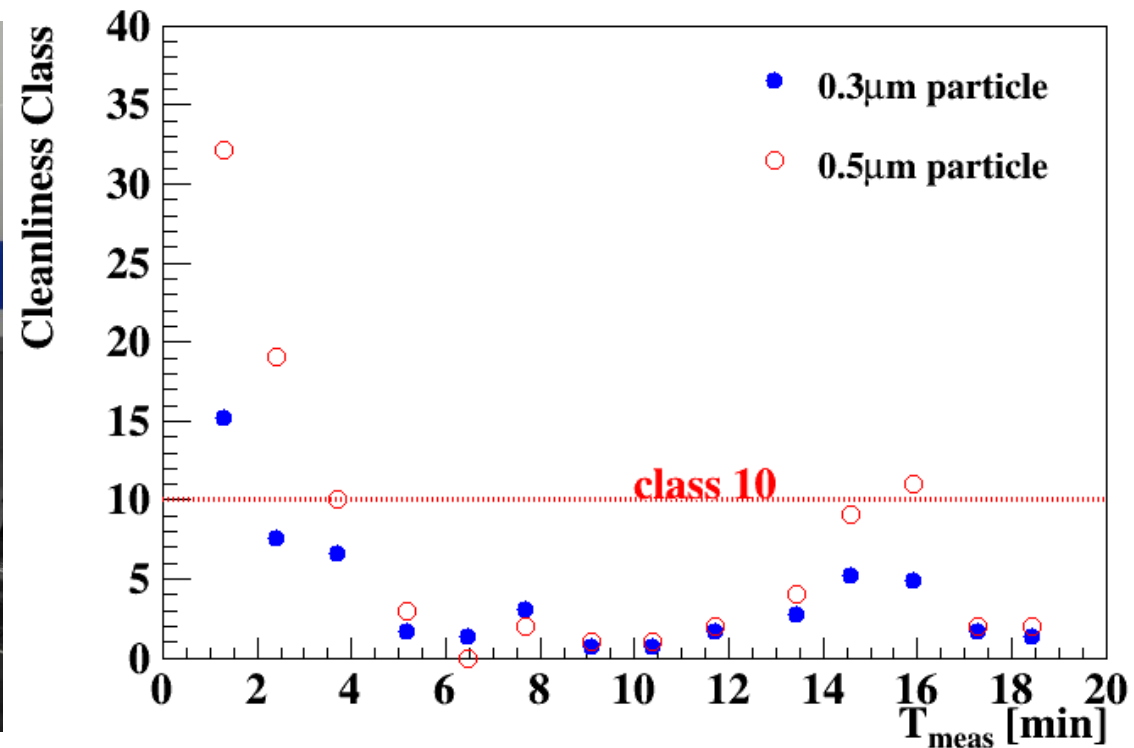
Outline

- 1. Brief introduction to Trace determination Lab**
- 2. ICP-MS & Sample Preparation System**
- 3. Experiments**
- 4. Summary**

Floor Plan



Cleanliness Measurement in Sample Preparation Room (Apr. 16, 2016)



Outline

1. Brief introduction to Trace Analysis Lab

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ICP-MS (Agilent 7900)

The injection port:

Class 10 laminar flowhoods



mass fraction (-100)	
$m(^{233}\text{U})/m(\text{U})$	98.020 1(58)
$m(^{234}\text{U})/m(\text{U})$	0.918 3(02)
$m(^{235}\text{U})/m(\text{U})$	0.216 0(56)
$m(^{236}\text{U})/m(\text{U})$	0.024 4(03)
$m(^{238}\text{U})/m(\text{U})$	0.821 2(20)

2.3539(42)ppm ^{233}U

mass fraction (-100)	
$m(^{230}\text{Th})/m(\text{Th})$	99.849(50)
$m(^{232}\text{Th})/m(\text{Th})$	0.151(50)

0.5691(42)ppm ^{230}Th

mass fraction (-100)	
$m(^{234}\text{U})/m(\text{U})$	0.035 9(02)
$m(^{235}\text{U})/m(\text{U})$	99.941 4(18)
$m(^{236}\text{U})/m(\text{U})$	0.009 6(10)
$m(^{238}\text{U})/m(\text{U})$	0.013 1(03)

0.9999(25)ppm ^{235}U

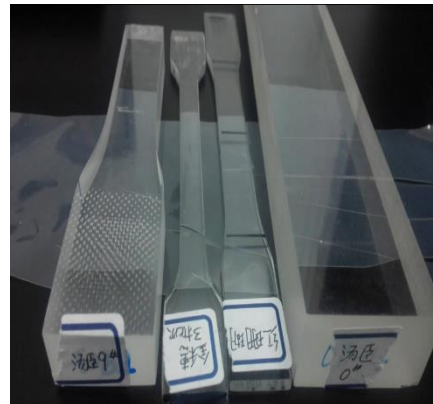


Isotope dilution analysis using radioactive tracers for U and Th

Sample Preparation

Sample Digestion (analytikjena TOPwave)

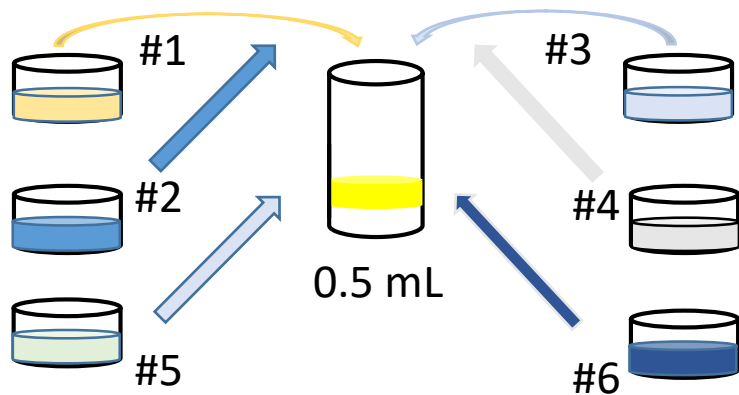
A microwave digestion method was used in treatment of acrylic and circuit boards.



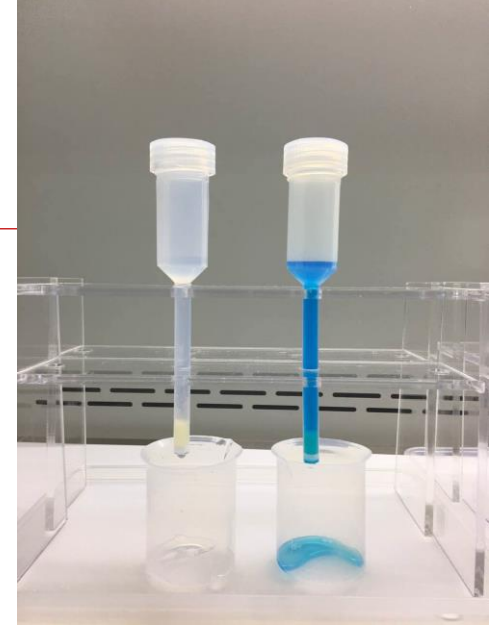
Sample Preparation

Separation & Preconcentration

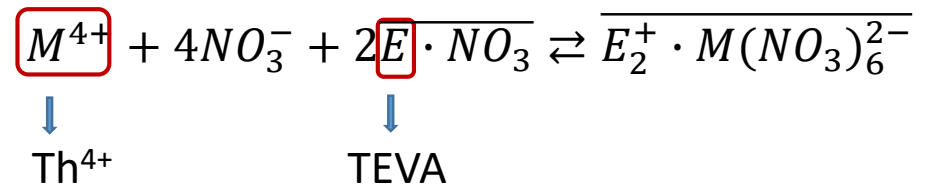
Pre-cleaning:



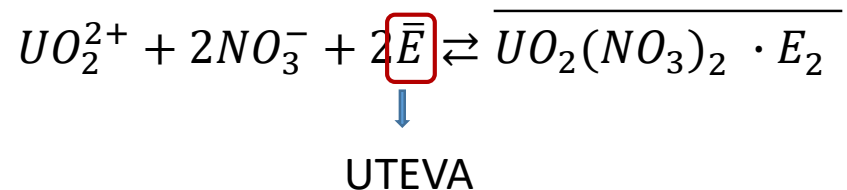
- #1: 2ml 3 M HNO₃
- #2: 2ml UPW
- #3: 2ml HCl (37%)
- #4: 2ml 5 M HCl
- #5: 8ml 0.02 M HCl
- #6: 10ml UPW



Extraction Chromatography Column: TEVA:



UTEVA:



Outline

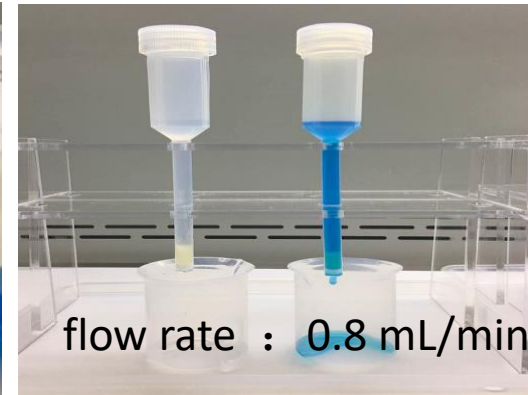
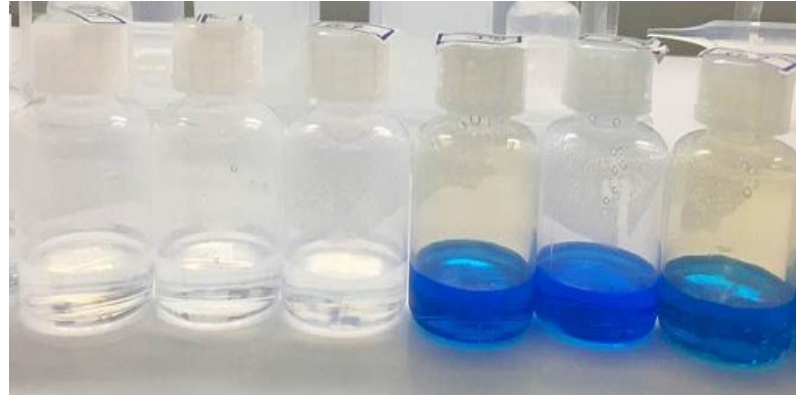
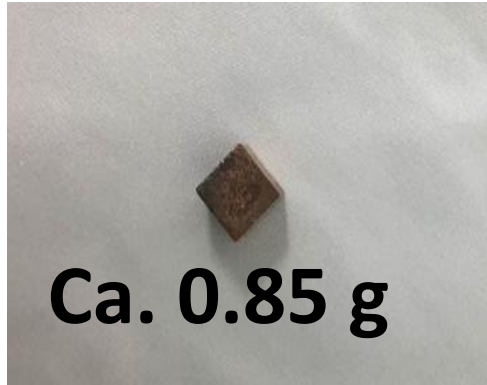
1. Brief introduction to Trace Analysis Lab

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Copper



- Surface treatment
- Dissolved in 8 M HNO₃ (spiked with ²³⁰Th and ²³⁵U)
- Loaded on the Extraction Chromatography Column
- Analyze

Detection Limits:

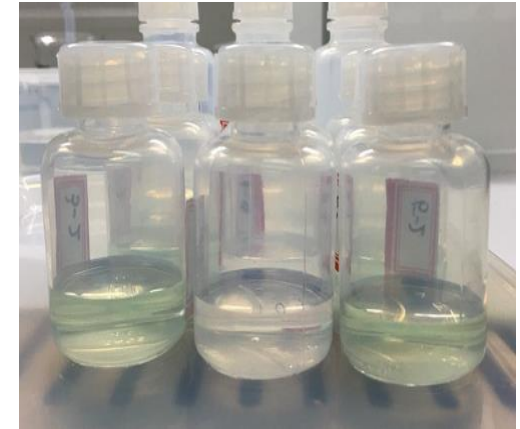
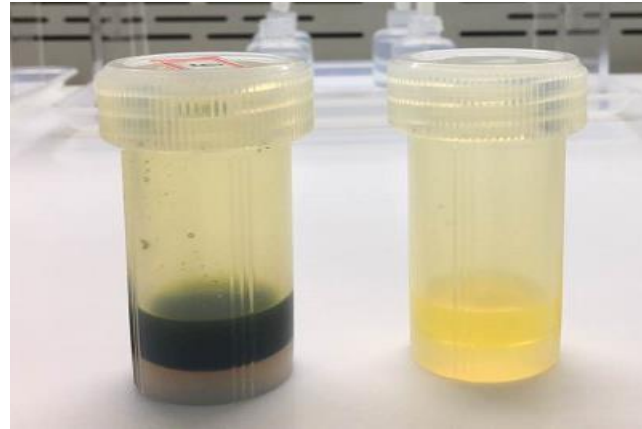
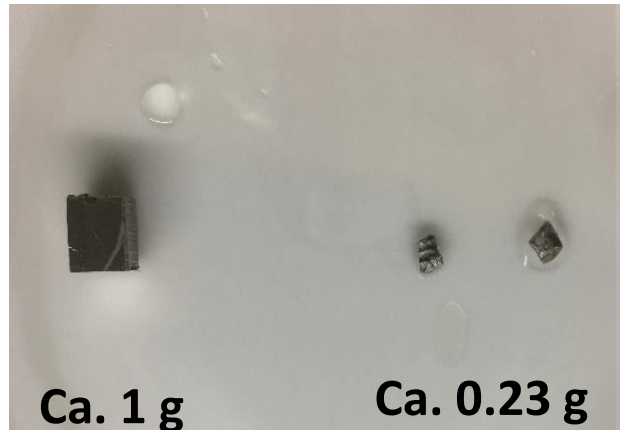
0.035 pg ²³²Th/g (0.14 μBq ²³²Th/kg)

0.073 pg ²³⁸U/g (0.90 μBq ²³⁸U/kg)

Preliminary

Sample	²³² Th pg/g	²³⁸ U pg/g
Cu 1	0.22(0.07)	0.37(0.08)
Cu 2	0.28 (0.14)	0.37(0.07)
Cu 3	0.27(0.07)	0.59(0.19)
Cu 4	0.16(0.07)	0.576(0.033)
Cu 5	0.14(0.07)	0.54(0.15)

Stainless Steel



- Surface treatment
- Dissolved in aqua regia (spiked with ^{230}Th and ^{235}U)
- Diluted
- Analyze(Using standard addition method)

Detection Limits:

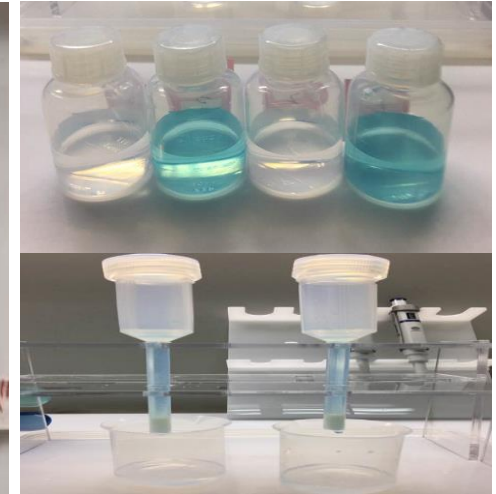
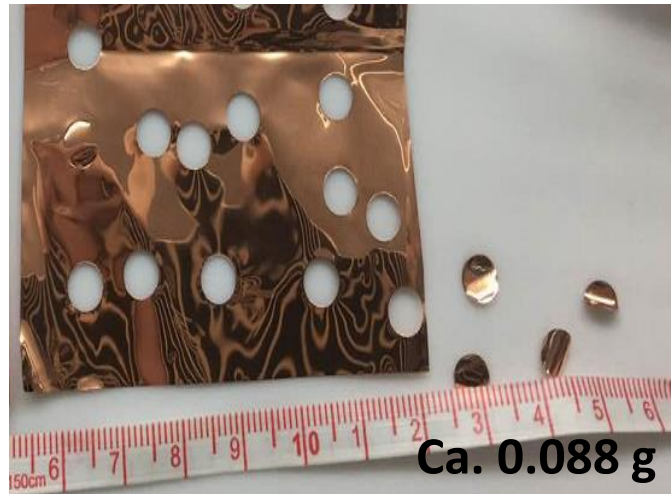
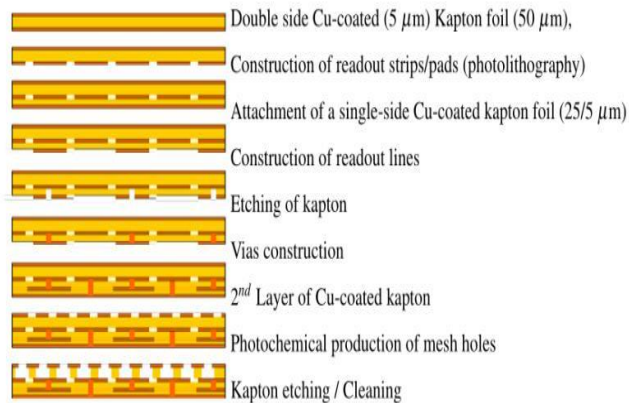
0.001 pg $^{232}\text{Th}/\text{g}$ (0.05 $\mu\text{Bq } ^{232}\text{Th}/\text{kg}$)

0.019 pg $^{238}\text{U}/\text{g}$ (0.24 $\mu\text{Bq } ^{238}\text{U}/\text{kg}$)

Preliminary

Sample	^{232}Th pg/g	^{238}U pg/g
SS 1	558(12)	1052(24)
SS 2	446(9)	967(22)
SS 3	734(16)	1200(30)
SS 4	734(16)	1200(30)

MicroMegas



- Surface treatment
- Microwave Digestion with concentrated HNO_3 (spiked with ^{230}Th and ^{235}U)
- Loaded on the Extraction Chromatography Column
- Analyze

Detection Limits:

0.24 pg $^{232}\text{Th}/\text{g}$ (0.97 μBq $^{232}\text{Th}/\text{kg}$)

0.14 pg $^{238}\text{U}/\text{g}$ (1.73 μBq $^{238}\text{U}/\text{kg}$)

Preliminary

Sample	^{232}Th pg/g	^{238}U pg/g
mm 1	36 (16)	273(7)
mm 2	34 (13)	308(42)
mm 3	118(25)	292(34)

Summary

1. Method Detection Limits (preliminary results)

Sample	MDLs ^{232}Th pg/g	MDLs ^{238}U pg/g
Copper	0.035	0.073
Stainless Steel	0.001	0.019
MicroMegs	0.24	0.14

2. A nice experimental environment and operating procedures for trace determination have been established. We hope that we can bring more reliable data in the near future.

Thanks

Any suggestion or question will be thankful!

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