# Update on the APMMN and Progress on Wet Deposition Sample Analysis

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# Update on the APMMN: Center for Environmental Monitoring and Technology

# Background

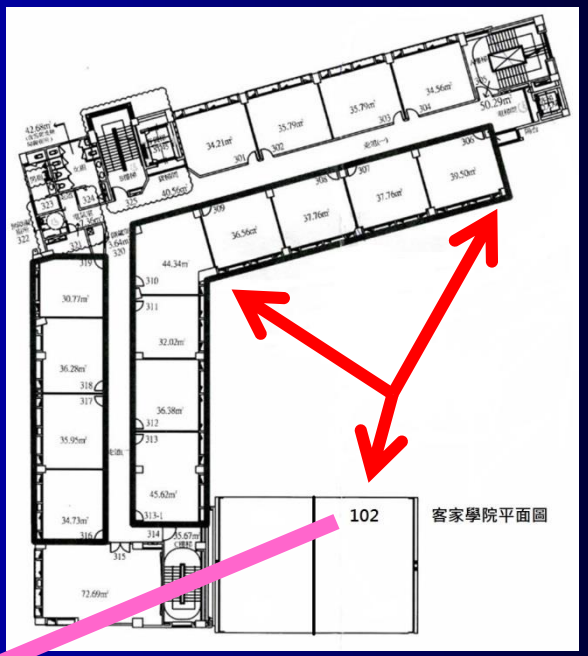
- NCU has been working closely with Taiwan EPA, USEPA and NADP since 2012 to establish the collaborative Asia-Pacific Mercury Monitoring Network (APMMN).

# Background

- NCU Hg Lab serves as the center for ultra-trace level Hg analysis and training
  - To help analyze rainwater samples, and to train researchers from other Asian countries for capacity building of ultra-trace level Hg sampling and analysis
  - However, lab space and analytical equipment are limited
  - Establishment of the Center for Environmental Monitoring and Technology on NCU campus in 2016
    - Administrative offices and lab expansion to support the operation of Asia-Pacific Mercury Monitoring Network

# Center for Environmental Monitoring and Technology

# Administrative Area: Hakka Studies Building




| | Area ($m^2$) |
|---|---|
| Room 102 | 66.14 |
| Room 306 | 39.50 |
| Room 307 | 37.76 |
| Room 308 | 37.76 |
| Room 309 | 36.56 |
| Total | 217.22 |

# Administrative Area: Hakka Studies Building

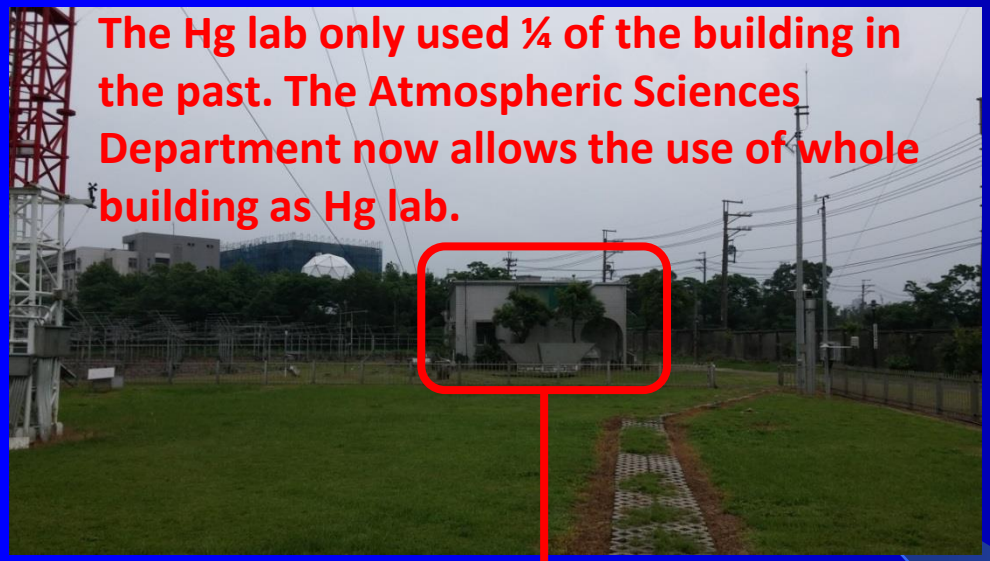
3rd floor offices and meeting rooms

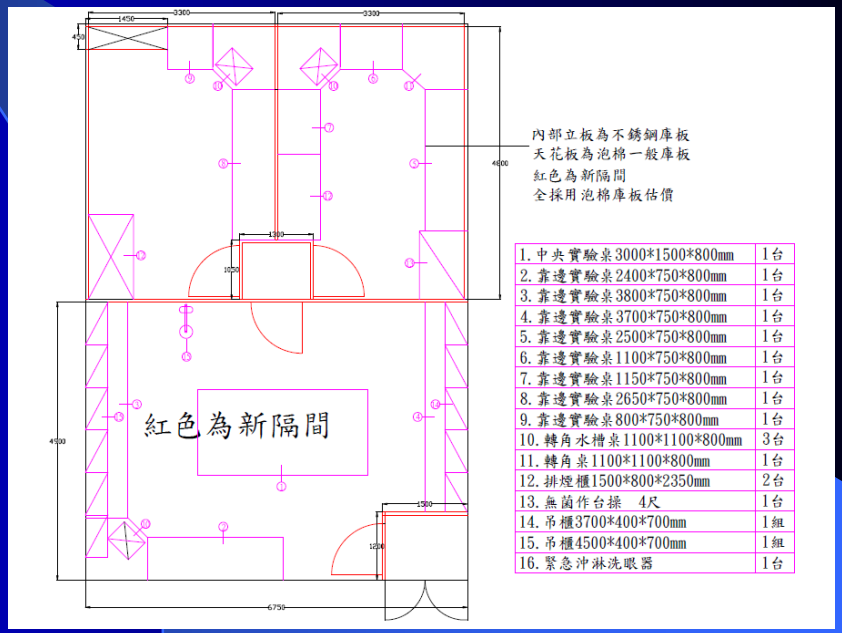
Meeting room

Visitor's office

Staff's office

# Lab Space and Equipment Expansion





# Lab Space and Equipment Expansion

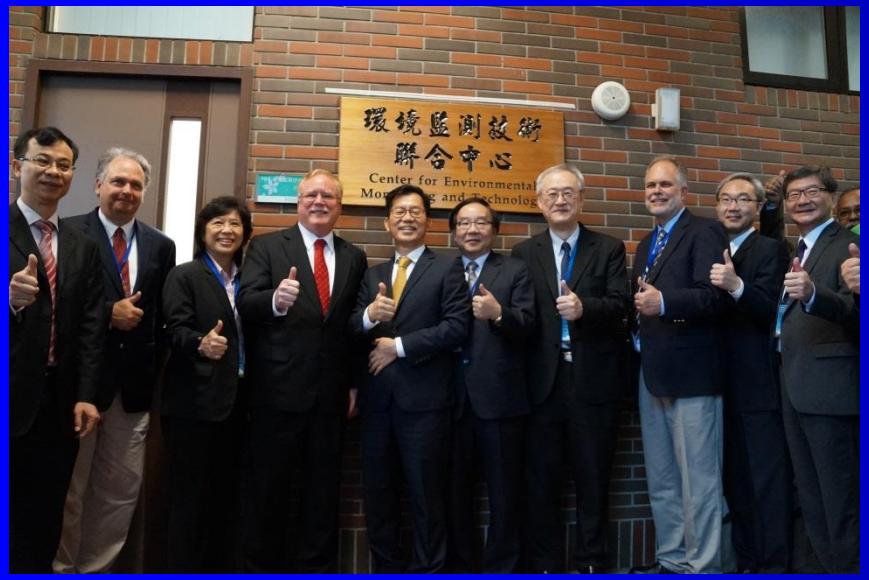
**Area of the new analytical lab = 145.35 $m^2$**

# Guest House on NCU Campus

- All double rooms with three room sizes: 17.8 $m^2$, 22.4 $m^2$, and 36.4 $m^2$.

| Type | General Price | Discount Price |
|---|---|---|
| 17.8 $m^2$ | NT 1100/D | NT 550/D |
| 22.4 $m^2$ | NT 1200/D | NT 600/D |
| 36.4 $m^2$ | NT 1800/D | NT 900/D |

# 2016 Atmospheric Mercury Monitoring Workshop at NCU in June



# Progress on Wet Deposition Sample Analysis

# Commonly Used Units for Trace and Ultra Trace Components

| *Name of concentration unit* | *Part per thousand* | *Part per million* | *Part per billion* | *Part per trillion* | *Part per quadrillion* | *Part per quintillion* | *Part per sextillion* |
|---|---|---|---|---|---|---|---|
| Volume/volume concentration | vpth (ppth v/v) | vpm (ppm v/v) | vpb (ppb v/v) | vpt (ppt v/v) | vpq (ppq v/v) | $vpq_{ui}$ ($ppq_{ui}$ v/v) | vps (pps v/v) |
| Mass-mass concentration | ppth | ppm | ppb | ppt | ppq | $ppq_{ui}$ | pps |
| Percentage (%) | $10^{-1}$ | $10^{-4}$ | $10^{-7}$ | $10^{-10}$ | $10^{-13}$ | $10^{-16}$ | $10^{-19}$ |
| Amount of analyte in 1 g sample | 1 milligram (1 mg) | 1 microgram (1 µg) | 1 nanogram (1 ng) | 1 picogram (1 pg) | 1 femtogram (1 fg) | 1 attogram (1 ag) | 1 zeptogram (1 zg) |

**Concentration of major ions in rainwater.**

**Concentration of Hg and MeHg in rainwater and ambient air.**

# Analytical Methods and Detection Levels

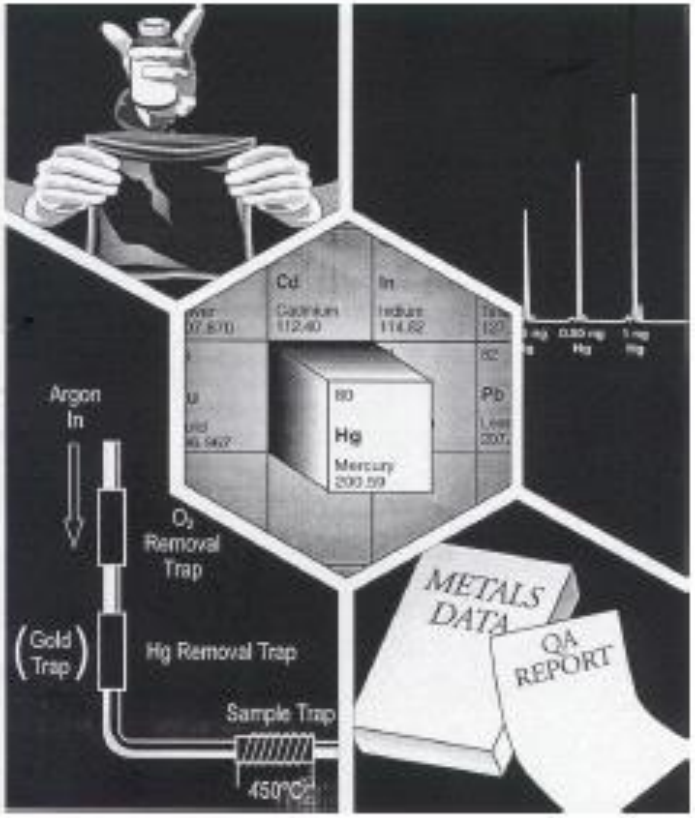
| Method Source | Method Number | Media Name | Instrumentation | Detection level |
|---|---|---|---|---|
| EPA-NERL | 245.1 | WATER | CVAA | 0.2 ug/L |
| EPA-NERL | 245.2 | WATER | CVAA | 0.2 ug/L |
| EPA-OSW | 7470A | VARIOUS | CVAA | 0.2 ug/L |
| USGS | I-2462 | WATER | CVAA | 0.1 ug/L |
| USGS | I-1462 | WATER | CVAA | 0.5 ug/L |
| USGS | I-5462 | OTHER | CVAA | 0.5 ug/L |
| USGS | I-7462 | WATER | CVAA | 0.5 ug/L |
| USGS | I-3462 | WATER | CVAA | 0.5 ug/L |
| NOAA_NST | 131.01 | ANIMAL TISSUE | CVAA | 0.012 ug/L |
| NOAA_NST | 131 | SOIL/SEDIMENT | CVAA | 0.012 ug/L |
| EPA-EAD | 1631 | WATER | CVAFS | 0.0002 ug/L |
| EPA-OSW | 6010 C | VARIOUS | ICP-AES | 17 ug/L |
| EPA-NERL | 200.7 | WATER | ICP-AES | 7 ug/L |
| EPA-NERL | 200.8 | WATER | ICP-MS | 0.2 ug/L |
| ASTM | D6502 | WATER | XRF | 1 ug/L |

CVAFS: Cold Vapor Atomic Fluorescence Spectrometry

EPA
United States
Environmental Protection
Agency

# Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry

**August 2002**



# Rainwater Hg Analysis

- Total Hg is quantified by dual amalgamation CVAFS after BrCl oxidation, $NH_2OH \cdot HCl$ neutralization, and $SnCl_2$ reduction.

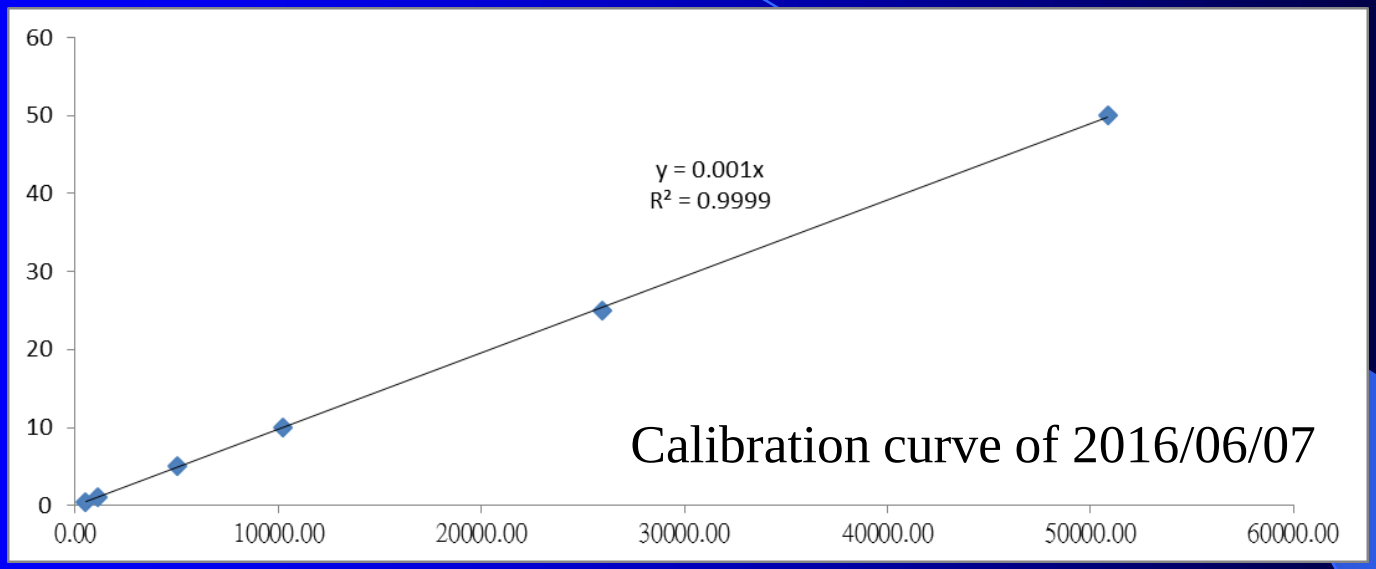
# QA/QC: Method Detection Limit

The detection limit and minimum level of quantitation in this Method usually are dependent on the level of interferences rather than instrument limitations. The method detection limit (MDL; 40 CFR 136, Appendix B) for Hg has been determined to be 0.2 ng/L when no interferences are present. The minimum level of quantitation (ML) has been established as 0.5 ng/L. An MDL as low as 0.05 ng/L can be achieved for low Hg samples by using a larger sample volume, a lower BrCl level (0.2%), and extra caution in sample handling.

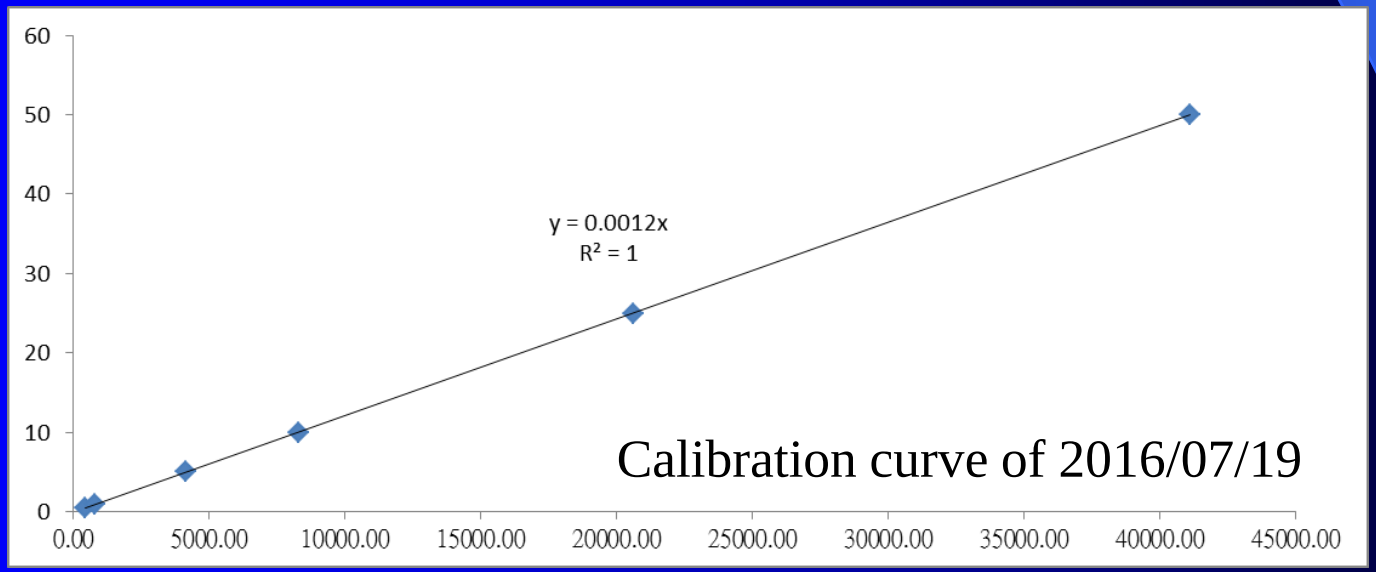
MDL of the NCU lab is 0.16 ng/L

# QA/QC: Calibration Curve

$R^2$ of calibration curve > 0.999




Calibration curve of 2016/06/07




Calibration curve of 2016/07/19

# QA/QC: Blanks of Jan.-April 2016

| | Freqency | Mean (ng $L^{-1}$) | Min. (ng $L^{-1}$) | Max. (ng $L^{-1}$) | 1631 rev. E |
|---|---|---|---|---|---|
| System blank | 12/12 | 0.01 | 0.00 | 0.08 | < 0.5 ng $L^{-1}$ |
| Bottle blank | 12/12 | 0.09 | 0.00 | 0.4 | < 0.5 ng $L^{-1}$ |

# QA/QC: Duplicate Analysis and Matrix Spike

| | Results of Jan.-April 2016 |
|---|---|
| Duplicate analysis | 0.1% - 1.9% |
| Matrix spike recovery | 99.3 - 104.4% |

# QA/QC: Percent Recovery of CRM

## ORMS-5

*Elevated mercury in river water*

ORMS-5 is a river water spiked with inorganic mercury. The material is packaged in 50 ml glass ampoules stabilized with 0.5% BrCl.

**Table 1: Certified quantity value for ORMS-5**

| Element | pg/g |
|---|---|
| Hg | 26.2 ± 1.3 |

| | Frequency | Recovery(%) |
|---|---|---|
| Before 2015/11 | 9 | 88 ± 4 |
| After 2015/11 | 8 | 100 ± 4 |

# Rainwater Samples Received and Analyzed

Until 07/19/2016:

| Site | Number of Samples |
|---|---|
| Indonesia | 9 |
| Korea-GIST | 7 |
| Korea-NIER | 9 |
| Thailand | 68 |
| Vietnam | 20 |
| Total | 113 |

4 samples from Korea and 1 sample from Vietnam received last week will be analyzed soon.

# Data Summary of Analyzed Samples

| Number of Samples | Mean (ng/L) | Median (ng/L) | Min. (ng/L) | Max. (ng/L) |
|---|---|---|---|---|
| 113 | 15.3 | 6.6 | 0.4 | 147.1 |

# Summary of Rainwater Hg Conc. Worldwide

| Location | Site characteristic | VWM conc. (ng $L^{-1}$) | References |
|---|---|---|---|
| 12 sites in Taiwan | Various | 7.3-12.1 | Lin et al., 2016 |
| Equatorial Pacific Ocean | Open ocean | 2.9 | Mason et al., 1992 |
| North Pacific Ocean | Open ocean | 14.3 | Laurier et al., 2003 |
| Bermuda | Island | 4.7 | Gichuki and Mason, 2014 |
| Long Marine Lab, CA, USA | Coastal (Pacific) | 6.0 | Steding and Flegal, 2002 |
| Monterey Bay, CA, USA | Coastal (Pacific) | 5.8 | Conaway et al., 2010 |
| CBL, MD, USA | Coastal (Atlantic) | 11.4-15.0 | Mason et al., 2000 |
| Nam Co, China | High elevation | 4.8 | Huang et al., 2012 |
| Mt. Leigong, China | Mountain | 4.0 | Fu et al., 2010 |
| Chuncheon, Korea | Rural | 8.8 | Ahn et al., 2011 |
| Pensacola, FL, USA | Urban/suburb | 17.3 | Landing et al., 2010 |
| 4 sites in Xiamen, China | Urban/suburb | 11.4-14.0 | Xu et al., 2014 |
| Seoul, Korea | Urban | 10.1-16.3 | Seo et al., 2012 |
| Nanjing, China (9 months) | Urban | 52.9 | Zhu et al., 2014 |
| Chongqing, China | Urban | 30.7 | Wang et al., 2012 |
| Moffett Field, CA, USA | Urban | 11.6 | Steding and Flegal, 2002 |
| EMEP (2013) | Various | 2.6-12.5 | EMEP, 2015 |
| 107 sites in USA (MDN/NADP) | Various | 1.6-25.8 | NADP 2014 Annual Summary |
| 10 sites in Japan (estimate) | Various | 5.2-9.5 | Sakata and Marumoto, 2005 |
| 10 sites in UK | Various | 1.6-5.1 | Rowland et al., 2010 |
| 2 sites in South Africa | Various | 10.6-15.8 | Gichuki and Mason, 2013 |
| 2 sites in Mexico | Various | 7.9-8.2 | Hansen and Gay, 2013 |

# THANK YOU!

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