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Air Sampling Equipment

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Module 2.18

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July 2018

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Agenda

July 2018

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- **Objectives:**
- **2.18.01: Factors affecting choice of air sampler**
- **2.18.02: Identify features, characteristics and limitations of portable air samplers**
- **2.18.03 Identify features, characteristics and limitations of motor air pumps**
- **2.18.04 Preoperational checks of portable air samplers**
- **2.18.05 Identify features, characteristics and limitations of beta-gamma constant air monitors (CAMs)**
- **2.18.06 Identify features, characteristics and limitations of alpha constant air monitors (CAMs)**

2.18.01: Factors to consider in choice of portable air sampler

- Type of radiation emitted by the airborne contaminant of interest.
  - Affects filter selection
  - Others ?
- Physical state of airborne contaminant
  - Gas
  - Particulate (particle size)
- Type and duration of job
  - Short or long term monitoring (affects pump selection)
  - Environmental conditions
  - Sampling rate (cfm)
  - Sampling method (filtration or absorption or impaction)
  - Others ?

2.18.02: Staplex (LV1 and LV2 air samplers)

Standard Models
Model LV-1, LV-2 Line-powered Models

LV-1: 110-125 Volts AC, 50-60 Hz, (15-35 LPM)

Features: Staplex Models LV-1 and LV-2 are capable of continuous use. The sampling efficiency will cover up to 35 LPM of air with resistance pressure of 40 " WG (3 " Hg). Extremely compact and rugged.

Standard Components: Motor, pump, built-in flowmeter (rotometer), 1-1/8" diameter Filter Holder Assembly, convenient carrying handle.

Maintenance: Staplex® Models LV-1 and LV-2 Air Samplers are equipped with a brush type motor and special self-lubricating bearings, requiring a minimum of attention. A few drops of No. 1 0 motor oil should be put into the unit every 200 working hours in the two small holes provided for in the carrying handle. If used continuously over an 8 hour period, it should be oiled daily after each run.

Weight: 6 pounds (2.7 kg)

Dimensions: 4" x 4" x 7" (10.2 cm x 10.2 cm x 17.8 cm)

2.18.02: Radeco (H-809V)

Features:
•Lightweight and compact
•Rugged construction
•Easily removable sample heads
•Individually calibrated to customer specifications
•Supplied with rotometers guard and spring loaded face guard
•Fused overload protection
•Calibration certified traceable to NIST
•NOW UL LISTED for US and CANADA
The Model H-809V is a lightweight rugged grab sampler designed specifically for heavy duty industrial applications **sampling airborne particulates or combination particulates and radioiodines.**
The Model H-809V may be used with RADēCO sample holders that house selected filter discs and high quality RADēCO radioiodine cartridges. The unit may be re-calibrated using one of the RADēCO NIST traceable Air Flow Calibrators (sold separately) to give the user a fully qualified air sampling system. The **H-809VI** has a small, sintered metal exhaust diffuser and is normally used with combination filter and cartridge holders **(typical flow range from 1-8 CFM).** The **H-809VII** has a large diffuser and is normally used with 4" diameter filter holders (**typical flow range from 1-30 CFM**).
Standard features of the H-809 series include a spring-loaded face guard which protects the switch, fuse, and flow adjust knob and a top mounted eye bolt with carrying strap.

Dimensions: 8" High X 10" Wide X 7" Deep, 30.3 cm X 25.4 cm X 17.8 cm
Weight: 10.5 lbs (4.8 kg)
Power Requirement: 115V, 50-60Hz, 8 Amps, 1ø, 230V, 50-60Hz, 4 Amps, 1ø
Power Cable: Three wire cord six feet 10 Amp rating; British and European available.
Air Flow Indicator: Individually calibrated, easy reading protected rotometer.
Air Mover: Two stage turbine blower with peripheral exhaust.
Motor: One horsepower; self-cooling universal type.
ALSO AVAILABLE: Model H-809C 12/24VDC or H-809B2 with integral battery pack.

2.18.02: Radeco (TRU-DAC)

Features:

•Ultra Portable & Light Weight

•Personal Alpha/Beta Air Sampler

•Acoustic And Optical Alarm

•24 Hours Of Operation, Only 1 Hr Recharching Time

•Fully Radon Compensated

•Software For Data Analysis And Archiving

The TRU-DAC Personal Air Sampler determines the inhalation dose obtained from the exposure to long living Alpha and Beta nuclides (LLRD) in the breathing air.

The aerosols will be accumulated on the surface of a membrane filter by an internal pump. The collected activity is analysed by a semiconductor detector with subsequent **Alpha spectroscopy and Beta gross counting.**

The influence of natural occurring Radon daughters is fully compensated.

An accurate determination of the obtained dose without any additional equipment is possible by a special filter analysis mode. The small filter paper (17.5 mm diameter) can be used for preservation of evidence.

The lightweight (less than 1 lb) instrument can be worn on the body without impairment of the mobility. Sampling head, battery and electronics have been integrated into rugged metal enclosure of the size of a mobile phone. Therefore, no additional cables and hoses are required.

Dangerous doses will be detected within 60 Seconds and signalized by an acoustical and an optical alert. The display, equipped with a with bright back-light shows the recent dose values (µSv or mrem) as well as the over all count rates. The internal rechargeable battery allows approx. 24 hours of autonomous operation – it takes only one hour to recharge the battery.

No other maintenance is required than the battery recharging and a monthly and easy to perform filter replacement.

2.18.02: Radeco (RAD-H-2000)

Features:
•System Scaleable To Any Flow
•Conforms To ANSI N13.1 1999
•Portable Cart
•500-2000 Cfm Range
•Sample Pump With Totalizer
•**Sample Range 20-100 Lpm**
•Portable ANSI N13.1 1999 Air Sampling for Release Monitoring

A portable air sampling system that conforms to ANSI N13.1 (1999) and 40 CFR 61.93 requirements for representative sampling of discharges. Intended to operate with portable ventilation units in the range of **500 to 2000 CFM** with 8” flex hose connection.

May be scaled up to sample discharge flow rates as high as 72,000 CFM

Self contained package contains compact air mixer, discharge duct, exhaust flow meter, shrouded air particulate sampling probe, sample line, filter holder, 20-100 lpm sample pump, and sample volume totalizer.

Optional features include weather housing, inlet/outlet size adapters, discharge elbow, and automatic sample flow rate management.

Documented quality control verification, certificate of conformance, and velocity profile tests on each unit.

Less than 1 psig (0.14 psig) pressure drop at 2000 CFM with a 10” diameter duct

2.18.02: Hi-Q (Iodine collection cartridges)

The "AGX" Series, Silver impregnated Zeolite Cartridges contain a highly efficient inorganic adsorbent for the collection and removal of elemental and organic forms of radioactive Iodine. Laboratory test indicate that radioactive Xenon, Krypton, and other Noble Gases are not retained to any significant degree by Silver impregnated Zeolite cartridges (approximately 1/15,000th, or less, than that retained by activated Carbon). The media is nonflammable and operates at a very high efficiency at elevated temperatures. These cartridges are the preferred and specified type for use in post accident standby monitoring systems.

TEDA (triethylene di-amine) impregnated Carbon filter media has a high affinity for the adsorption, chelation and retention of the various species of Iodine. The HI-Q Environmental Products Company manufactures a number of configurations of activated carbon cartridges to fit almost all industry standard cartridge holders.

2.18.03: Hi-Q (Continuous duty portable air samplers)

This low cost pump is ideal for indoor or outdoor sampling of Air Pollutants such as Radioactive Particulate. The standard TFIA unit comes complete with a rotometer scaled up **to 70 CFM** and a 4" diameter filter holder assembly which accepts the "CF" series 8" x 10" paper only holders. TFIA options include: Motor Speed Control, N.I.S.T. Traceable Side Mounted Rotometer, Elapsed Timer, Tri-Pod, and TFIA Motor Mounting Plate.

This "Golf Cart" (aka Giraffe) type unit can be used for the assay of both particulates and gaseous radioiodine. Its telescoping "Goose Neck" allows for industry standard breathing zone air sampling. There is a 3/8" female Quick Disconnect fitting at the sampling inlet which accepts all "RV" series filter holders.

2.18.04: Checklist for portable air samplers

- Check that calibration is current

- Physical damage checks:
  - If applicable, check power cord in good condition
  - Seals and gaskets are in good order
  - Housing in good condition
  - Any controls are in working order

- Working condition:
  - No unusual sounds, smells or vibrations
  - Air flow is appropriate
  - Cartridges or filters are in place

2.18.05: Comments on gamma/beta CAMs

- Particulates on filter media counted using a GM pancake or gas proportional detector
  - Usually a 2nd detector acts as a gamma compensator
- Often Pb shielded to reduce gamma background
  - Therefore can be very heavy to move
  - Pb shielding less effective for high-energy gammas
- Alarms for activity and for operational faults such low flow rates
- Low energy beta response is poor (due to thickness of detector entrance window)
- Interference from naturally occurring Rn/Tn progeny can be problematic
- Placement is an important consideration i.e. should not be upstream of potential release site

2.18.06: Real-time Alpha/Beta continuous air monitors (CAMs)

- Various types of CAMs
  - Area monitors (alpha or beta or alpha/beta)
    - Highest sensitivity but often located far from work activity
    - ~ 30-60 lpm
    - Semi-conductor detector

  - Personal monitors
    - Low sensitivity but located in proximity of worker
    - 6– 0 lpm

  - Lapel samplers
    - Low sensitivity but co-located with breathing zone
    - ~ 3 lpm

2.18.05-06: Checklist for CAMs

- Check calibration sticker for flow rate and detection efficiency are current
- Check CAM housing and power cords for any damage
- Check that any switches and knobs are in working order
- If using a remote CAM head, check that the communication cable to the control unit is securely tightened
- Check alarm parameters are appropriate and that the DAC value is correct
- Prior to startup, verify that a filter is loaded in filter cartridge and that access door is shut.
- After startup, verify that air is being drawn through the sample head.
  - Can be an external pump or house vacuum
- Check status lights and display for any abnormal conditions (e.g. low flow rate)

2.18.05-06: Principal CAM components

- A filter to efficiently collect particles of most concern inhalation-wise.
  - 0.001 -10 µm physical diameter particles of most concern to lungs
  - Can be a single use size (37 and 47 mm diameter most common) or on a spool to allow unattended operation
  - Single use filters typically changed weekly
- A pump to draw air thru the filter
- A CAM head design that promotes the passage and collection of particle sizes of most concern on the filter and not on the detector
- A calibrated mass flow meter to monitor air volume thru the filter
- A detector to monitor the activity on the filter
  - Typically a semiconductor for alpha and alpha/beta CAMs
  - Semi-conductor, GM pancake or sealed gas proportional for beta CAMs
  - GM pancake or sealed gas proportional for beta/gamma CAMs

2.18.05-06: Some applications of continuous air monitors (CAMs)

- Monitoring for transuranic alpha emitters such as ^{241}Am and ^{239}Pu in particulate form collected on filter media
- Monitoring for particulate beta emitters on filter media
  - Some CAMs also simultaneously monitor for alpha particulates
- Monitoring for radioactive Iodine releases using charcoal and zeolite cartridges.
- Monitoring for noble gas releases (e.g. ^{85}Kr and ^{133}Xe fission products)
- Monitoring natural airborne activity from ^{222}Rn and ^{220}Rn progeny

2.18.05-06: CAM alarms

- CAMs typically analyze for airborne releases using a short and long time window
  - CAM design and filter media optimized to efficiently collect particle sizes of most concern – those that enter and remain in lungs
  - Alarms can set based on DAC-h and/or DAC values

- The short time window (~$\Delta t = 1$ min.) is used to detect a large release as quickly as possible

- The longer time window (~$\Delta t = 20$ min.) is designed to alarm at lower DAC-h values using better statistics and a more rigourous algorithm
  - The presence of background peaks from Rn/Tn progeny poses a particular problem for the detection of lower-energy transuranic activity (TRU)
  - Various approaches have been used by vendors

- But, CAMs are not designed to give quantitative DAC and DAC-h measurements but rather to alarm when set points are exceeded.

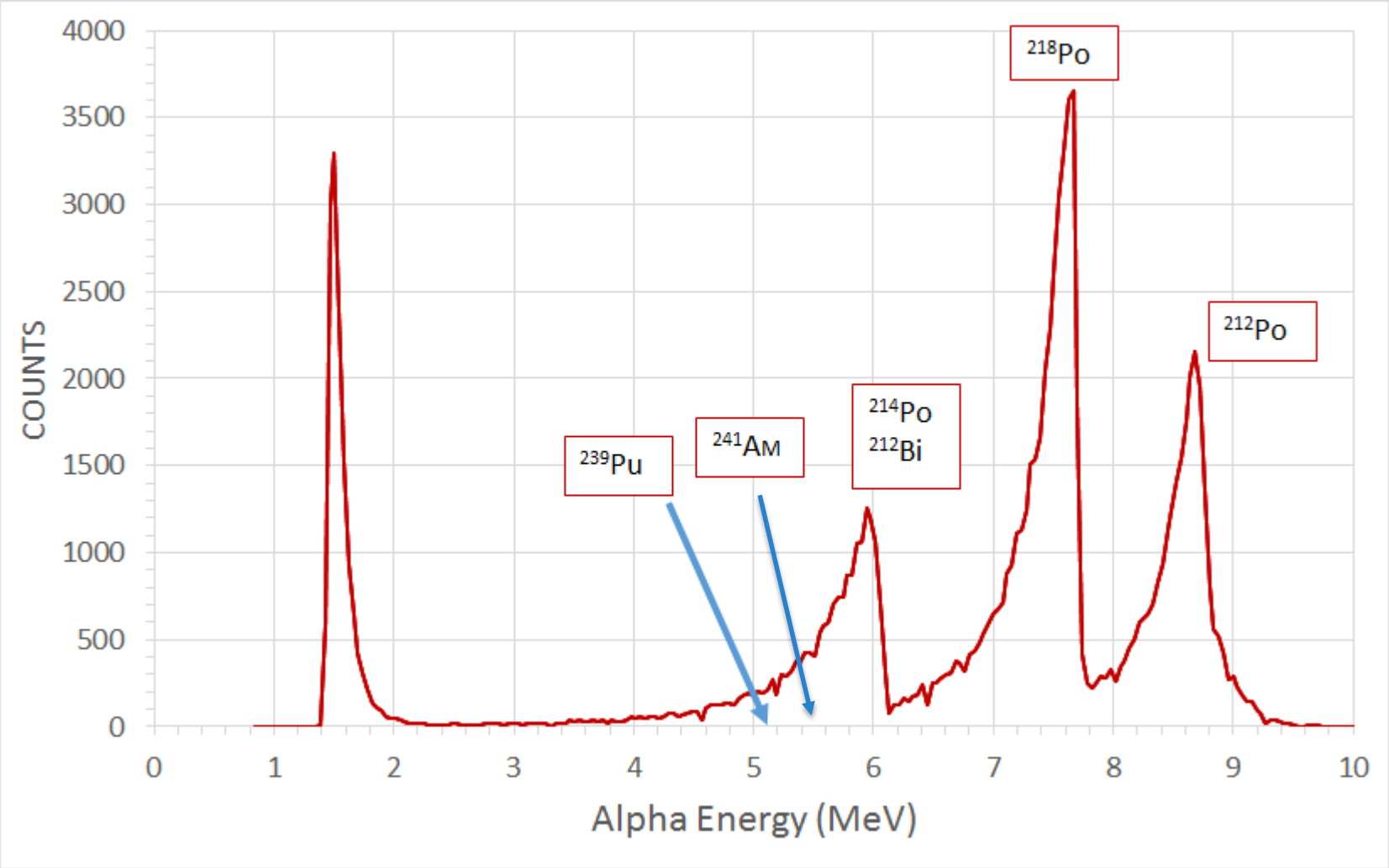
2.18.05-06: CAM filter media

- Can be single use or on a continuous roll for unattended operation
- Selection criteria include:
  - Spectral resolution (alpha)
  - Minimal pressure drop
  - Static cling – makes handling difficult
  - Collection efficiency for particle sizes of most concern for inhalation dose
  - Cost
- Typically changed weekly but more often in “dirty” environments
- Often one side of filter gives a better performance than the other
  - But not always easy to tell one side from the other
- Fixed air sampler (FASs) or retrospective samplers are less demanding in filter choice as do not rely on real-time analysis (i.e. Rn/Tn progeny allowed to decay prior to counting)

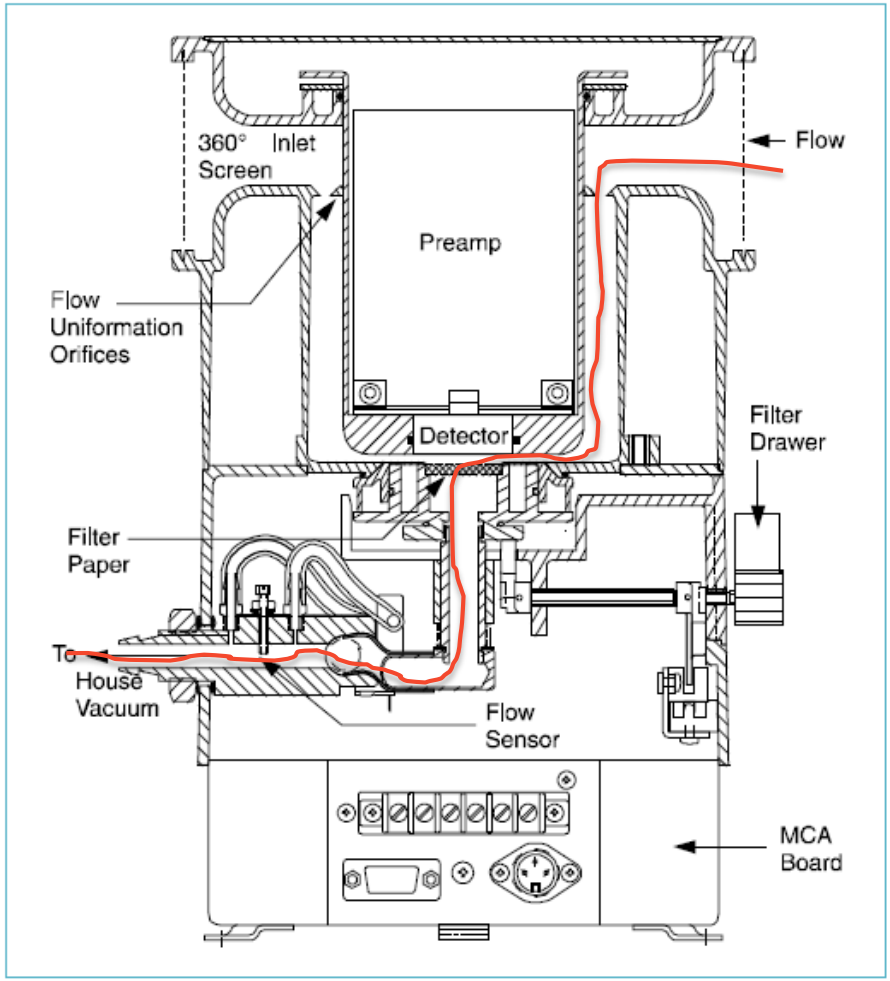
2.18.05-06: Derived air concentration (DAC) definition

- A DAC is based on the annual limit of intake (ALI)
- An ALI is the amount of radioactivity that would need to be inhaled to receive the limiting dose (e.g. 5 rem) in one year
- Based on an assumed breathing rate of 20 lpm and 2000 work hours per annum the total volume of air breathed at work per year is:
  - 20 l/min x 10^{-3} m^3/l x 60 min/h x 40 h/week x 50 weeks = 2400 m^3
  - therefore, 1 DAC = 1 ALI/(2400 m^3) = 1 ALI/(2.6 x10^6 l) and
  - 1 DAC x 2000 h = 2000 DAC-h = 1 ALI
- DAC values are tabulated in 10CFR835 and 10CFR20 for airborne particulates
  - the most restrictive are for ^{241}Am and ^{239}Pu at 5E-12 µCi/cm^3 (or 0.011 dpm/l)
- A CAM "breathes" at a different rate (F) than standard man and the calculation of DAC-h activity based on the activity on the filter must reflect this:
  - DAC-h = A_{filter} (dpm) x 20 (lpm)/F(lpm) * 2000 DAC-h/ (0.011 dpm/l x 2.4x10^6 l)

2.18.05-06: Typical CAM background spectrum



2.18.05-06: Canberra Alpha-Sentry Alpha (CAM)



Typical parameters:

- 2cfm flow rate
- 32% detection efficiency
- Acute and chronic alarms
- 4 DAC-h sensitivity

2.18.05-06: Other area CAMs

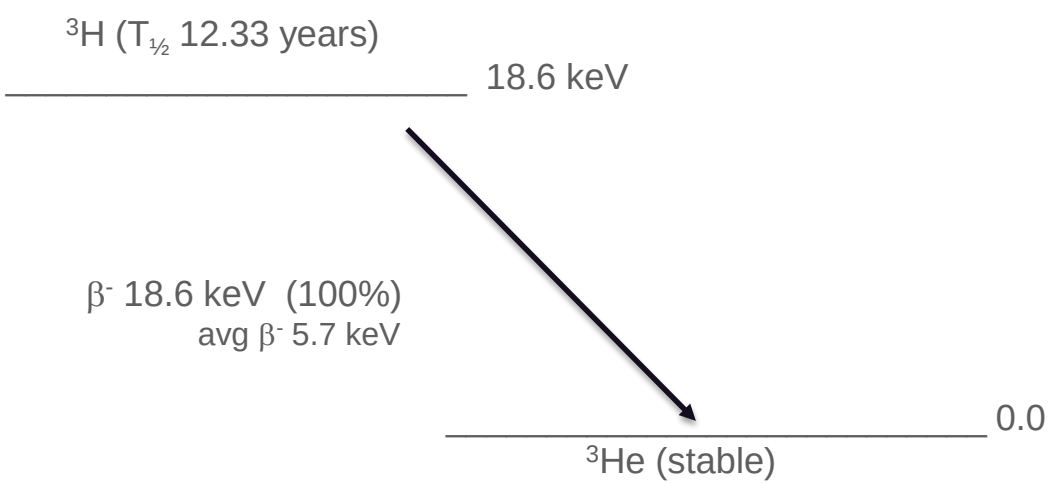
Thermo Alpha-7 (alpha)

Lab Impex Smart CAM (alpha/beta)

Thermo AMS-4 Beta CAM (gas proportional detector)

2.18.05-06: Tritium portable and area monitors

$^{14}N_7 + n \rightarrow {}^{15}N_7 \rightarrow {}^{12}C_6 + {}^{3}H_1$



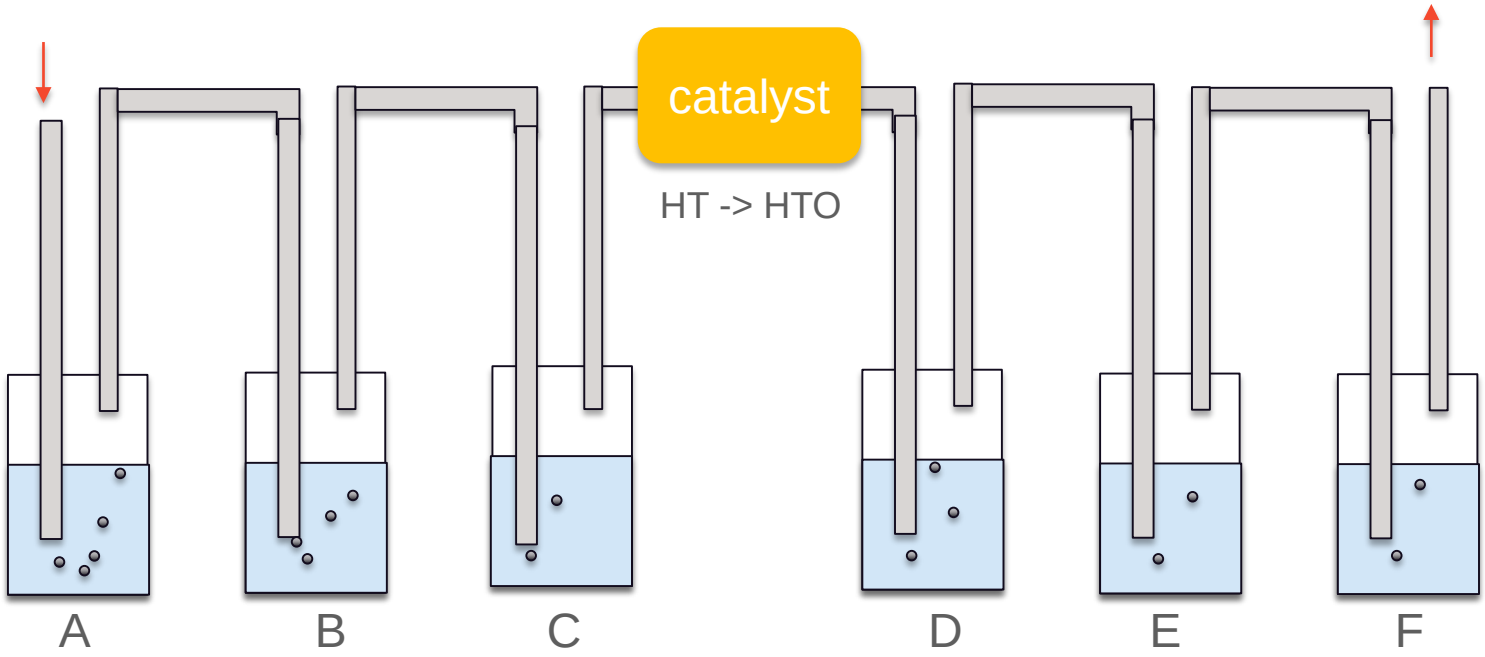
Femto-TECH PTM-1812
Ion chamber
0-20 mCi/cm^3

Complications using ion chambers for ^{3}H measurements:

- Gamma sensitivity of ion chamber
- HTO vs HT from dose perspective (10^5 difference in DAC values !)

2.18.05-06: Tritium stack monitoring using bubblers

- Tritium stack releases must be monitored as required by EPA code 40CFR61 subparts A and H



- Bubbler samples a known fraction of total flow thru stack.
- ^{3}H as HTO captured in vials of gylcol
- Total flow through bubbler is also monitored.
- Aliquots from each vial are counted using LSC.

Questions ?