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# *Using the Dielectric Barrier Discharge Detector in an Electron Capture Mode*

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# The ECD Detector

- Uses radioactive source emitting high energy Beta
  - Typically Ni-63 or Tritium
- Beta particles collide with detector gas generating "thermalized" electrons
- Electrons in detector set up a standing current
  - Generally high background signal
- Constituents of interest enter detector and capture electrons
  - Results in a decrease in standing current forming the basis of the chromatographic response

# The ECD Detector: Advantages

- Highly sensitive to selective constituents
  - Halogenated hydrocarbons, especially multiply substituted
  - Nitro compounds, especially multiply (DNT, TNT, etc....)
  - Disulfides, diketones
- Selective
  - Take advantage of differences in sensitivity to simplify the chromatography
- Can be very stable
  - Constant temperature/flow conditions

# The ECD Detector: Disadvantages

- Radioactive source:
  - Subject to licensing requirements/shipping restrictions
  - In US, subject to annual monitoring for escape
  - Long term liability (custody, disposal, etc...)
  - Very difficult to get it clean without sending it in, cannot clean in the field
  - Prevent thermal runaway: migrate Ni into foil
  - Hydrogen exchange (for tritium foils)
- Limited linear range, widely varying responses
- Needs reasonably high purity gases/no leaks
  - Oxygen and water suppress signal

# DBD-ECD detector: use DBD plasma to replace radioactive source

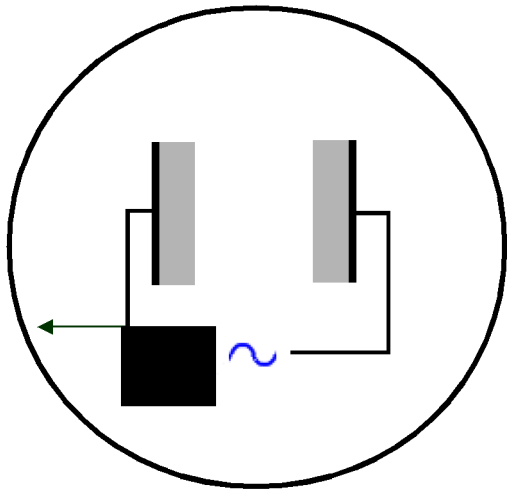
- DBD = Dielectric Barrier Discharge plasma
  - A/C discharge across a dielectric barrier
  - Non-thermal discharge
  - Low electrode wear
  - Ability to operate without getters/purging
- Simple design
  - Non-radioactive, windowless
  - Simple, robust power supply
  - Conventional (modified) electrometer
  - Low valve disturbance, packed column compatible

# Principle of Operation

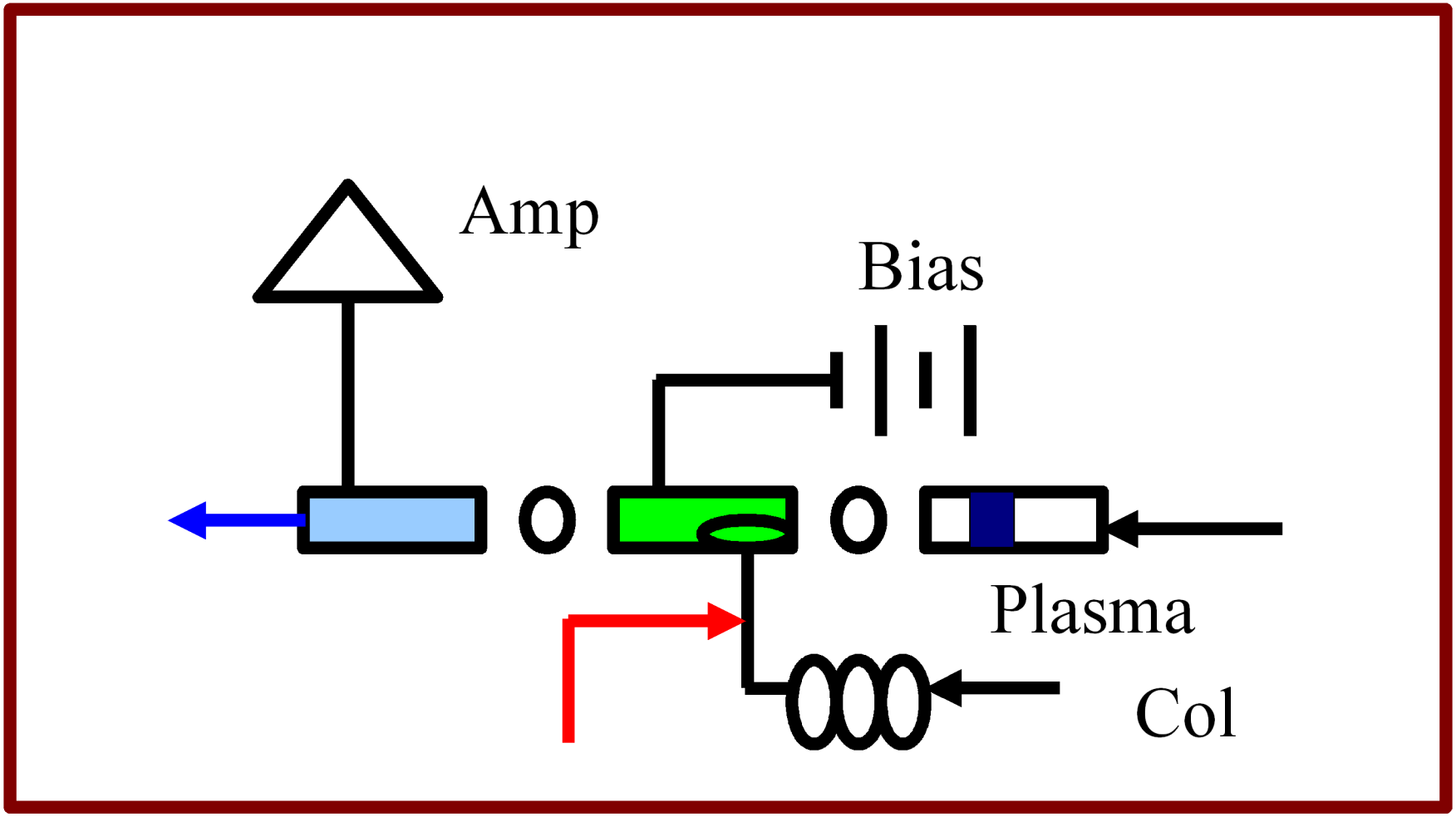
- Helium mode discharge in DBD tube
- Small stream of dopant hydrogen as electron source
- Stacked electrode configuration
  - Constant bias applied to “upper” electrode
  - Collect electrons at “lower” electrode with modified FID electrometer
- Constituents of interest capture electrons, yields a negative peak in the data system

# Discharge on a Detector

Side View Cross Section



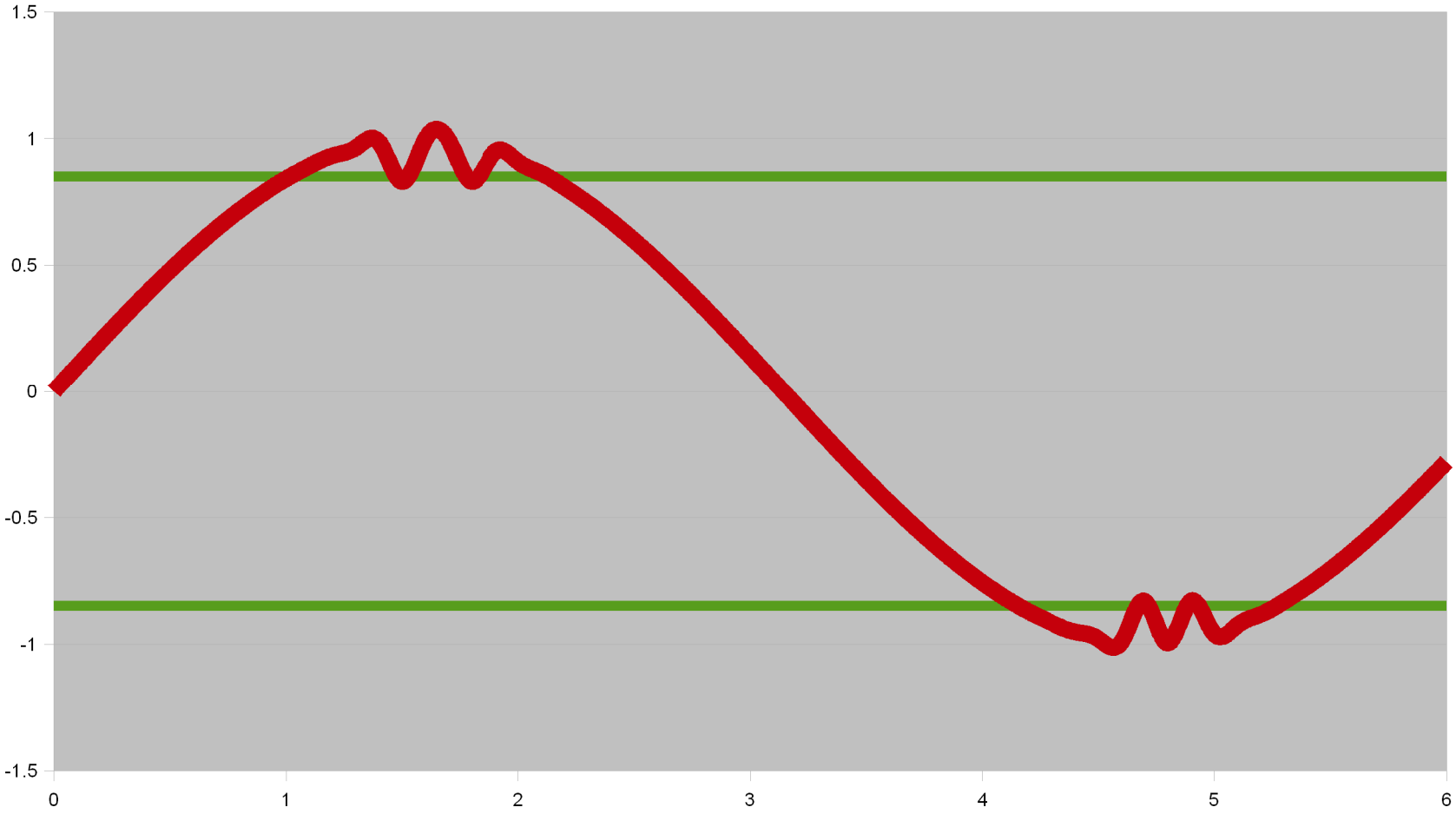
# ECD Schematic



# DBD-ECD Advantages/Disadvantages

- Advantages:
  - Non-radioactive
  - Highly sensitive
  - Can be stable (less fussy than Helium mode -large standing current)
- Disadvantages
  - Widely varying sensitivity
  - Requires two gas supplies (helium and very low flow hydrogen)
  - Limited linearity
  - Clean gases, leak free

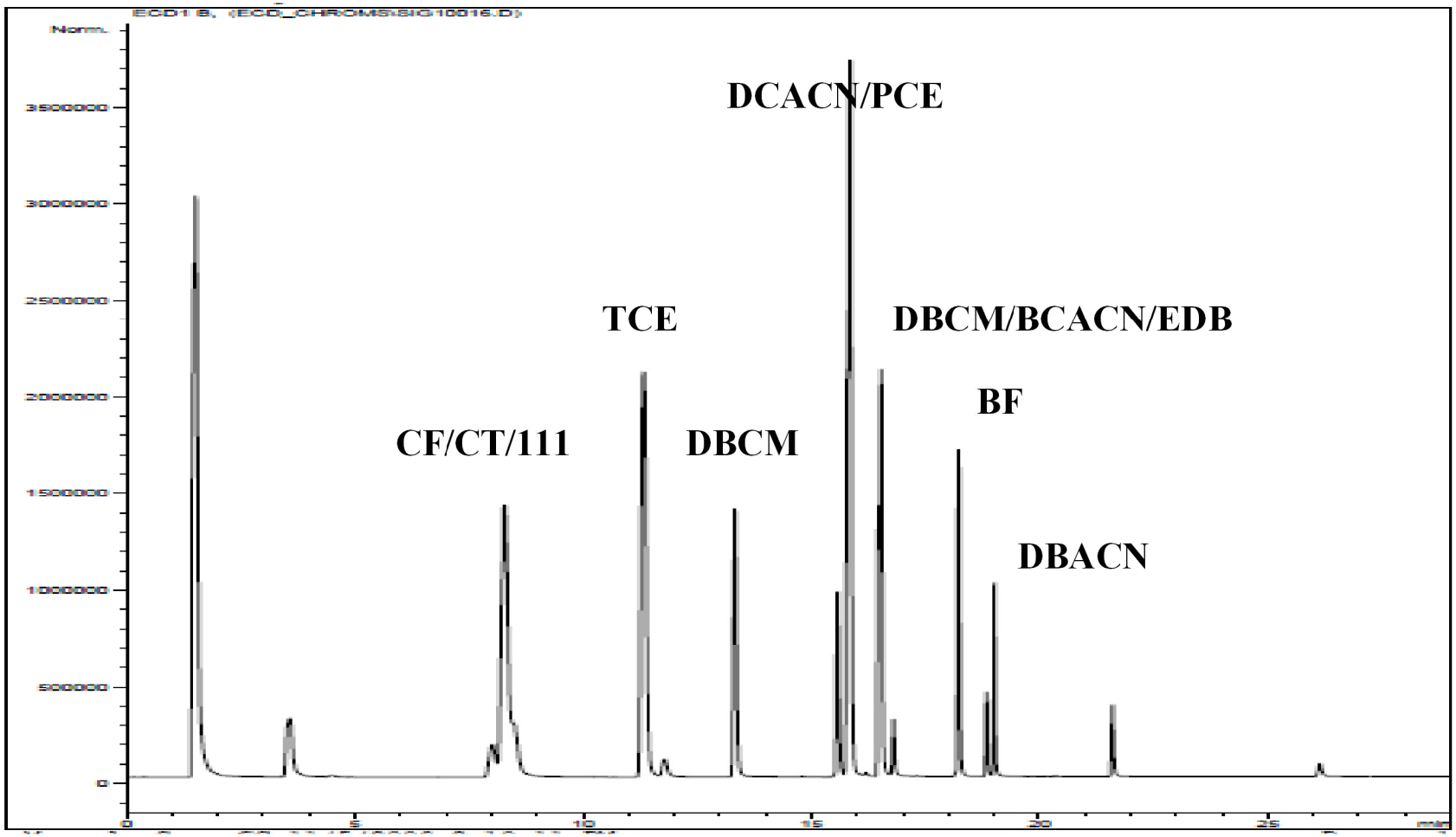
# Discharge Cycle



# EC Detector Mechanism's

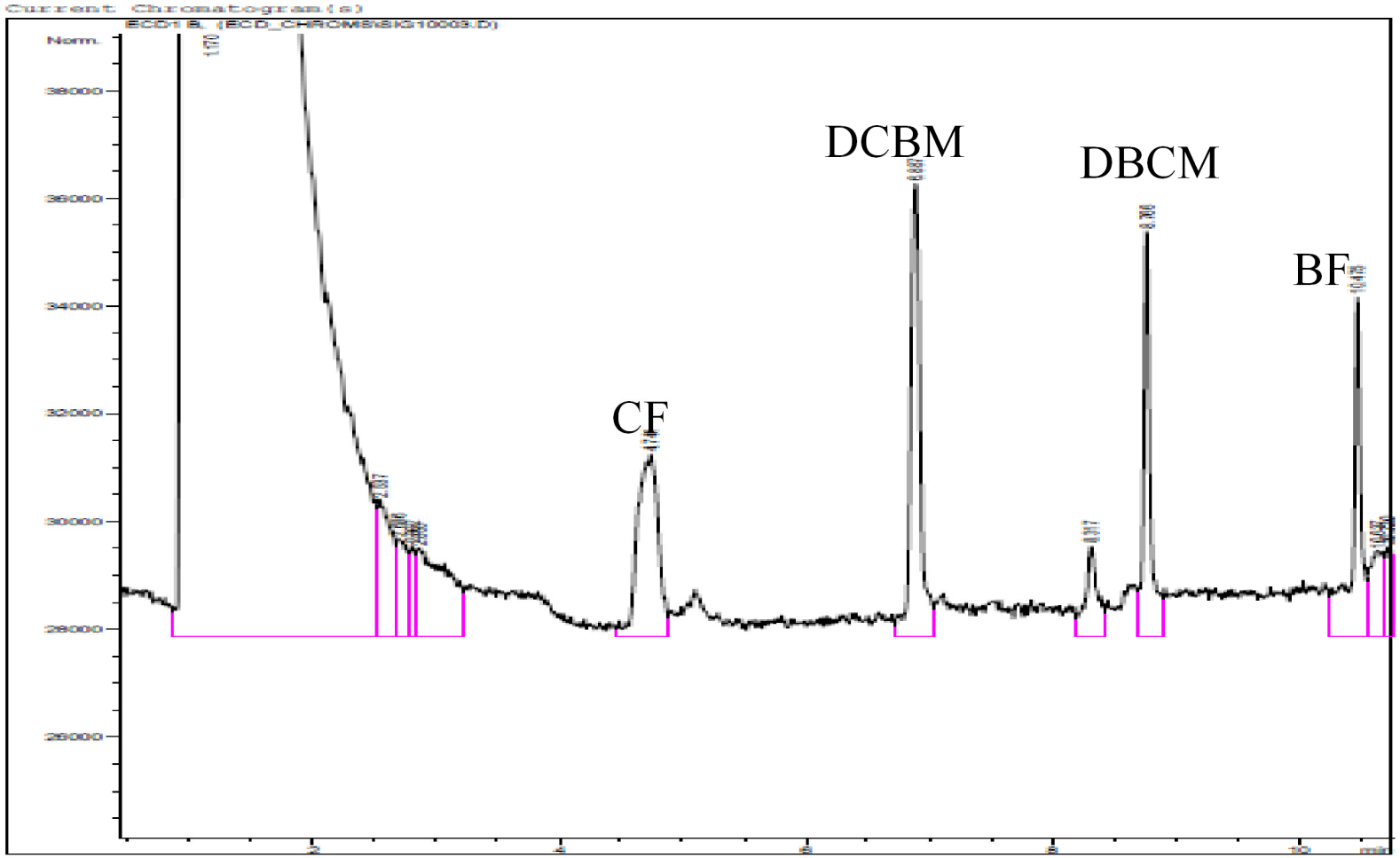
- **Associative electron capture:**
  - **AB + e(-) <=> AB(-)**
  - **Response decreases with temperature (subject to TED)**
  - **Example: Azulene (C10H8)**
- **Dissociative electron capture:**
  - **AB + e(-) > A + B(-)**
  - **Response for some compounds will increase with temperature, i.e. Chloroform**
  - **Up to a maximum, i.e. Carbon tetrachloride**

# Haloacetic acids in air
## (evidence of difference in sensitivities)



# Trihalomethanes in Water

## (2 ppb by headspace)

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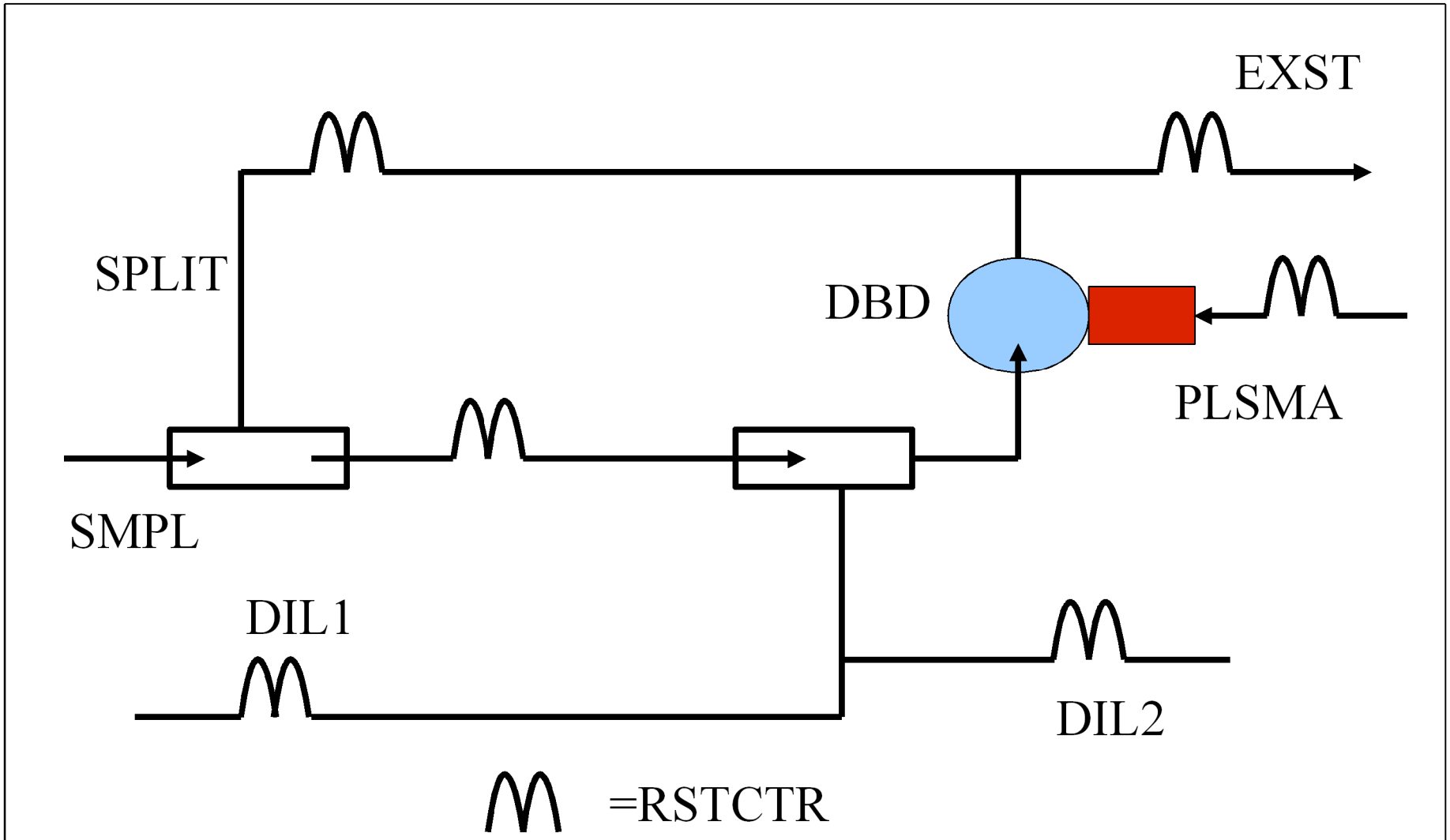
# Compound ID's

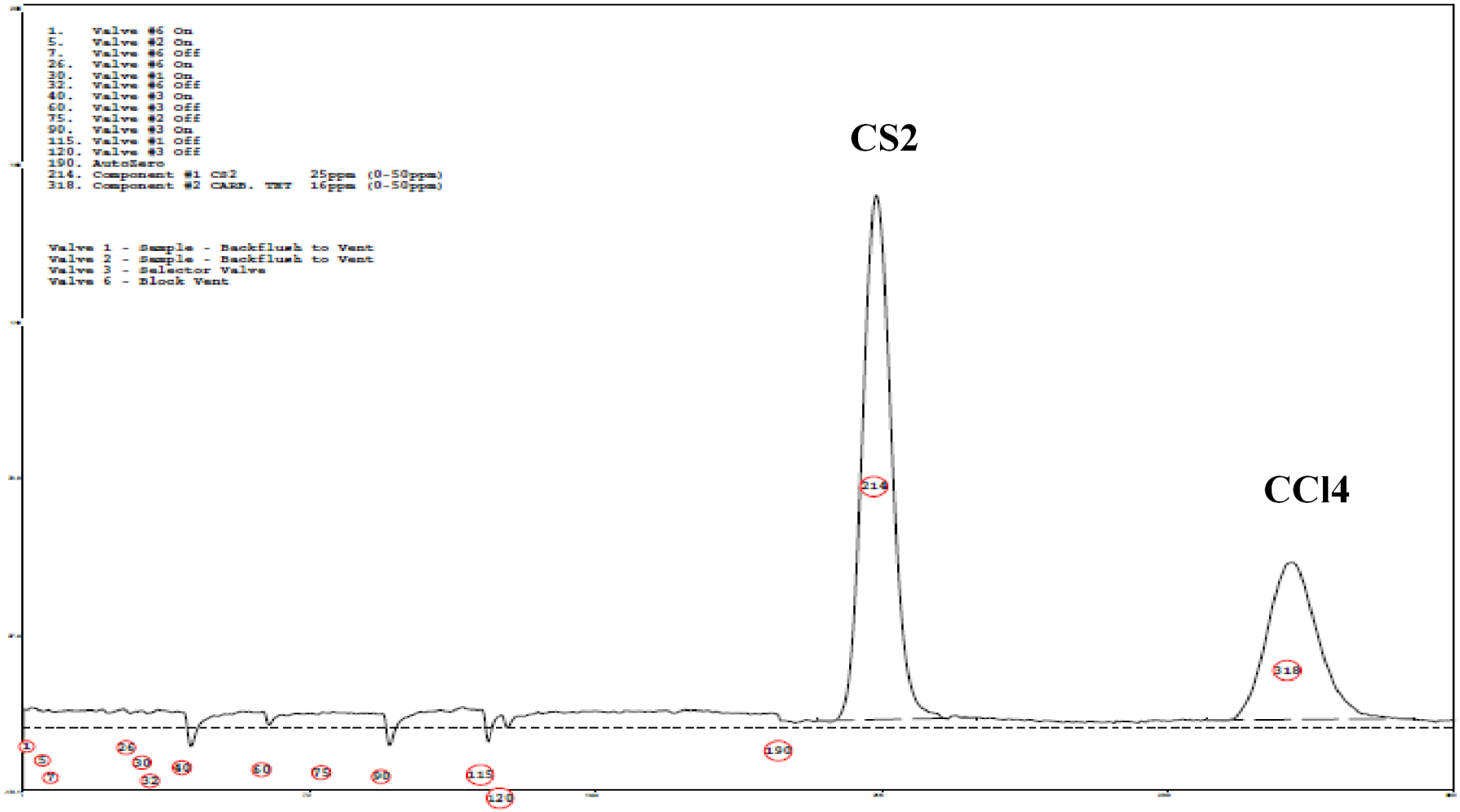
- **Trihalomethanes:**
  - **CF, chloroform; DCBM, dichlorobromomethane, DBCM, dibromochloromethane, BF, bromoform**

# Splitter for CS2/CCl4



# Carbon Disulfide and Carbon Tetrachloride in air

## (using variable dilution, 2 loop volumes)

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# Questions?