

# NIST tools to characterize resist outgas and analyze stepper contaminants

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# Elements of the NIST Methods

## **A. Resist qualification, two characteristics to be determined:**

1. Total resist outgassing rate (molecules/cm<sup>2</sup>)
  - Mechanical measurement of pressure rise in sealed chamber
2. Identification of molecular components
  - Cryotrap outgas products from sealed chamber
  - Subject cryotrapped sample to GC/MS

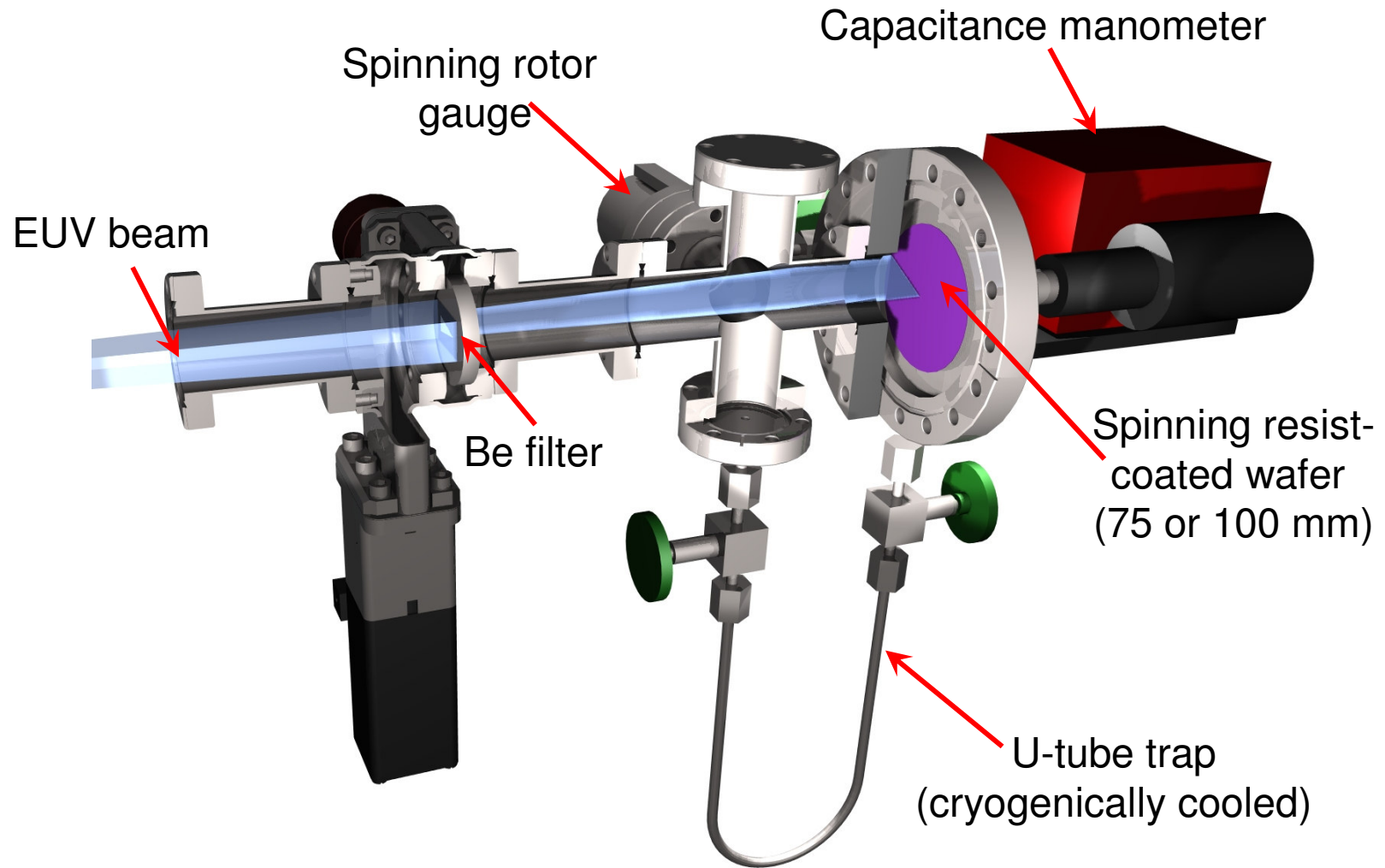
## **B. Stepper contamination**

- Cryotrap contaminants in trap filled with inert, high surface area material
- Identification of molecular components by subjecting trapped sample to GC/MS

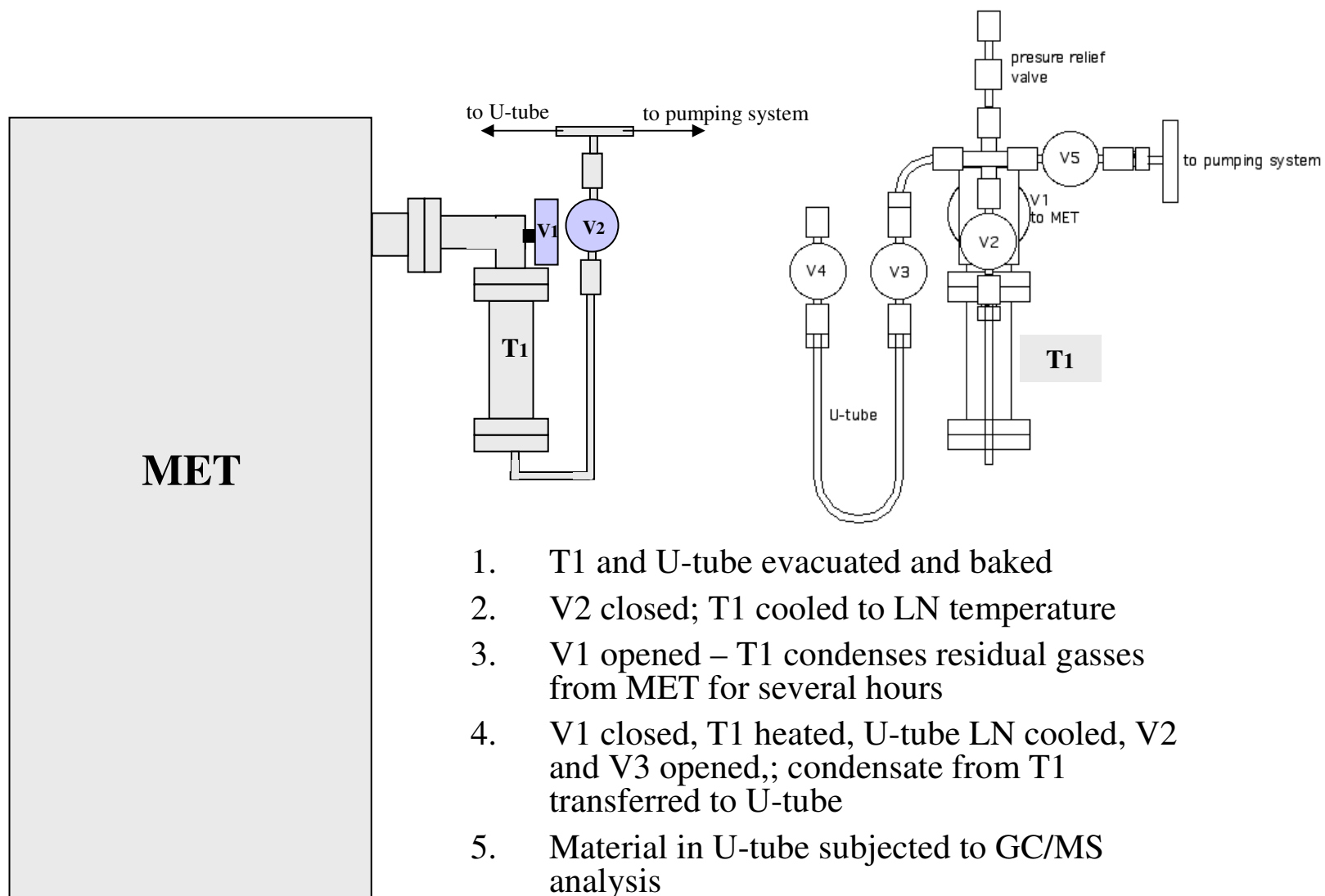
## **Advantages:**

1. Measurement of pressure is independent of molecular species (for **A.1**)
2. Cryotrapping indiscriminate – traps practically everything of interest except CO
3. GC/MS removes much of the ambiguity connected with fragmentation in the MS
4. Cryotrapping + GC/MS can be made fairly quantitative

# Schematic of NIST System

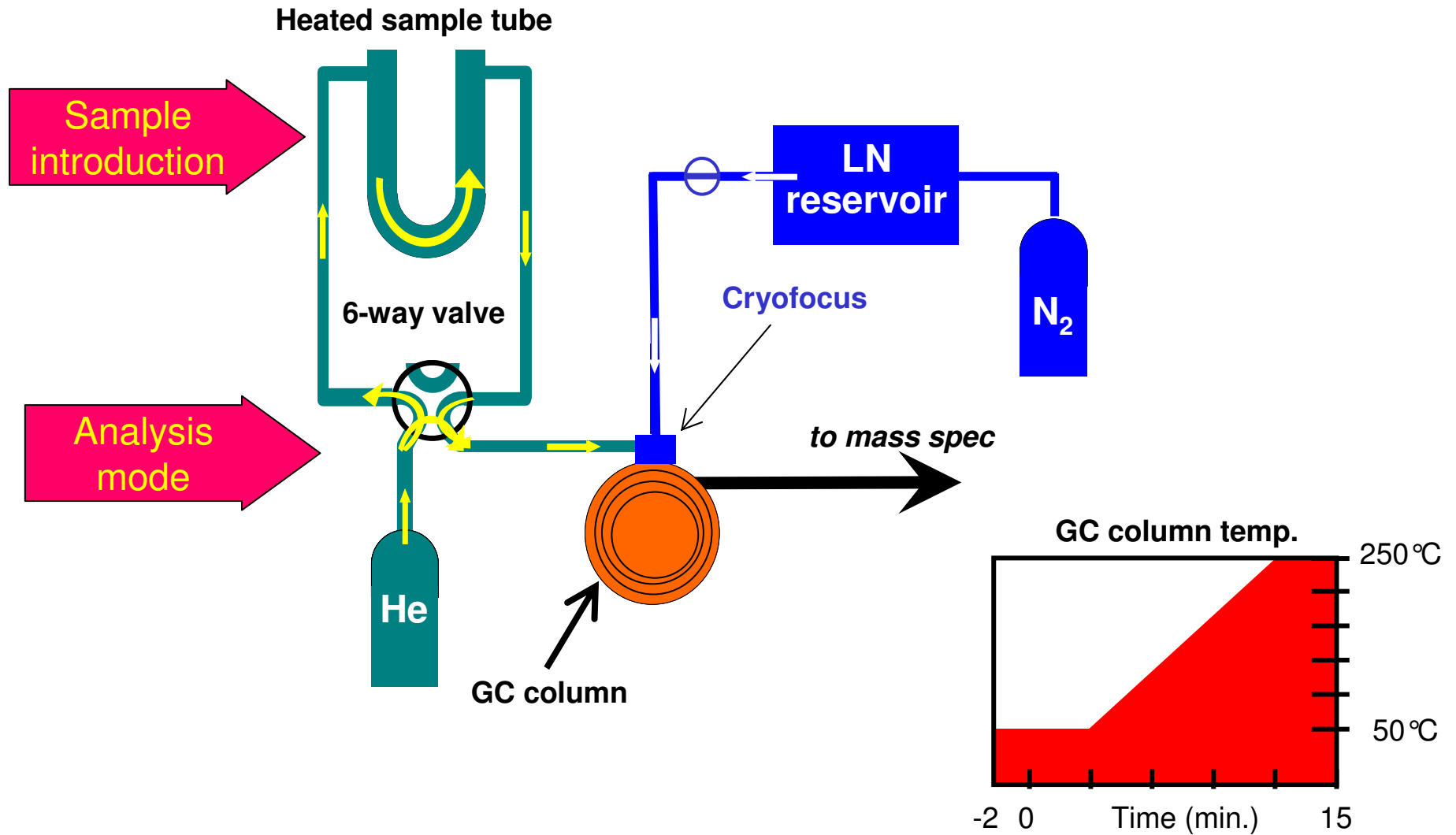


## Schematic of Cryotrapping Method

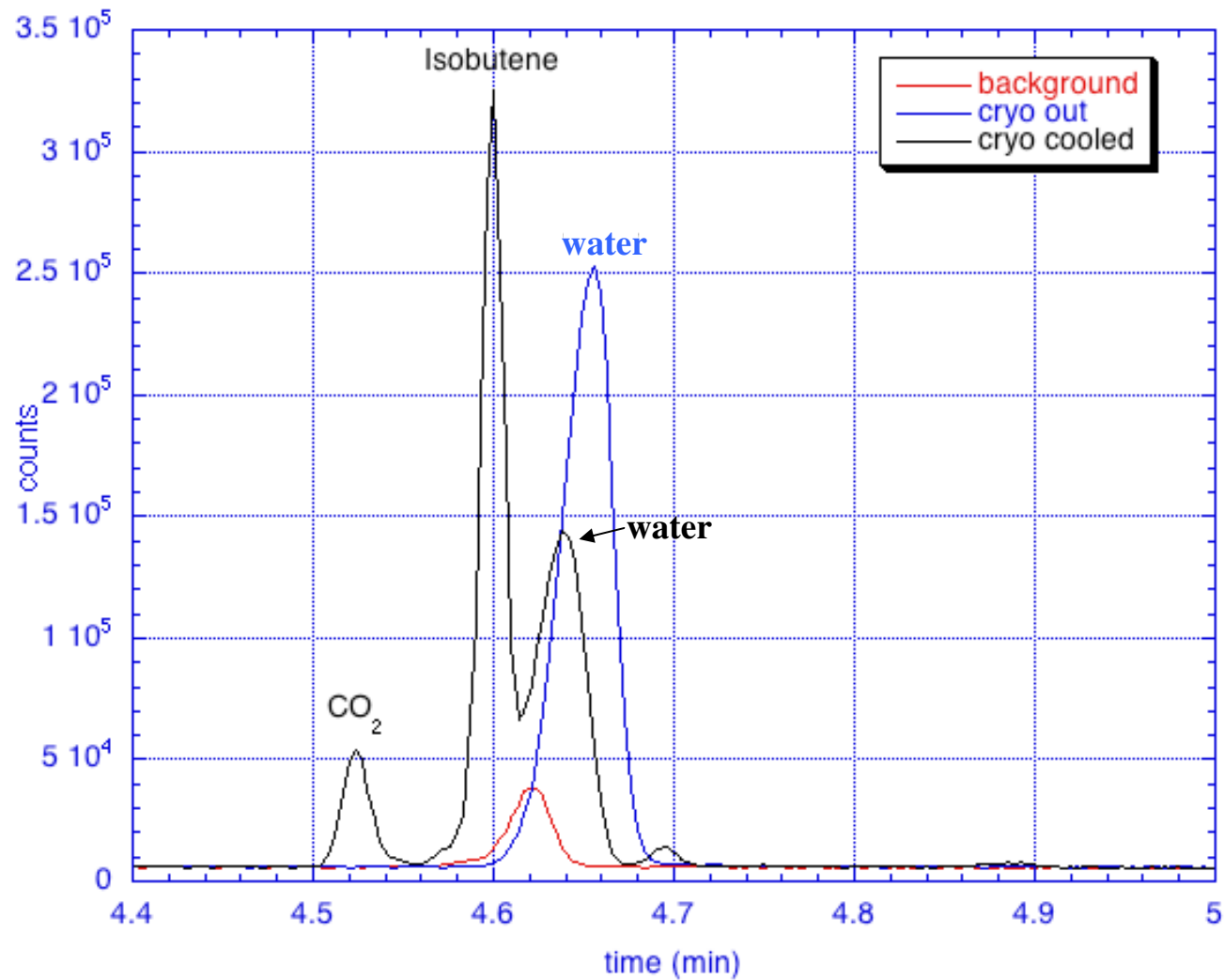


T1 filled with high surface area inert material

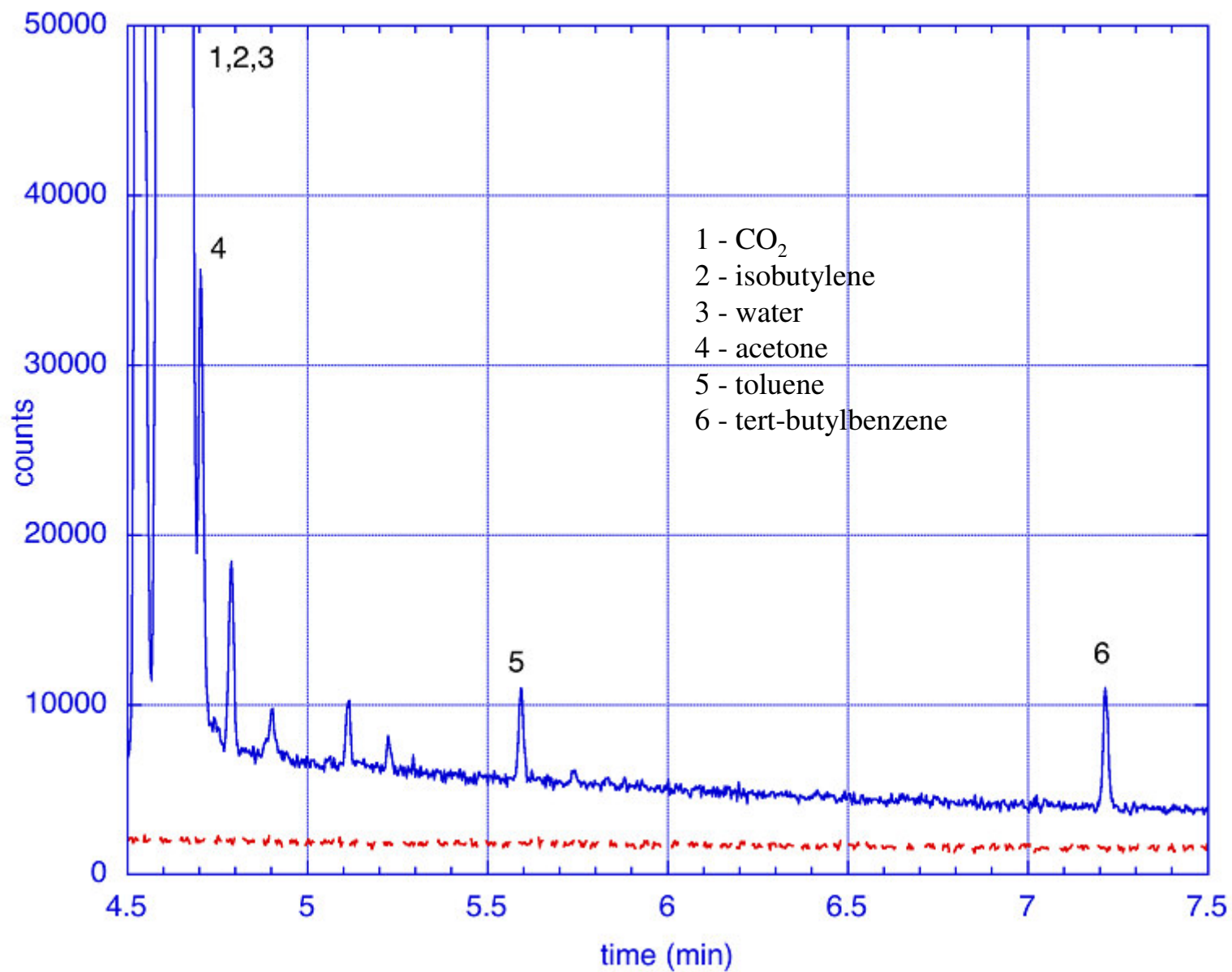
# GC/MS with cryofocus



# Cryofocus advantage



# Total ion chromatogram



# Summary

- Mechanical measurement of absolute pressure rise provides stable, repeatable measurements of resist area outgassing rate without further calibrations
- GC/MS with cryofocus well suited to analyze samples with species having widely varying volatilities
- Cryotrapping of resist outgas components and of stepper vacuum systems provides representative samples with informative relative abundances for GC/MS
- Efforts underway at NIST to make method of cryotrapping + GC/MS analysis more quantitative



# Back-up details

# Capabilities available at NIST

## **Electron and Optical Physics Division**

- SURF III EUV radiation source – well suited for radiometry, lifetime studies, etc.
- Expertise in UHV
- Extensive knowledge of EUVL metrology issues
- GC/MS instrument outfitted with cryofocus sample injection

## **Process Measurements Division**

- Expertise in pressure measurement and vacuum system design

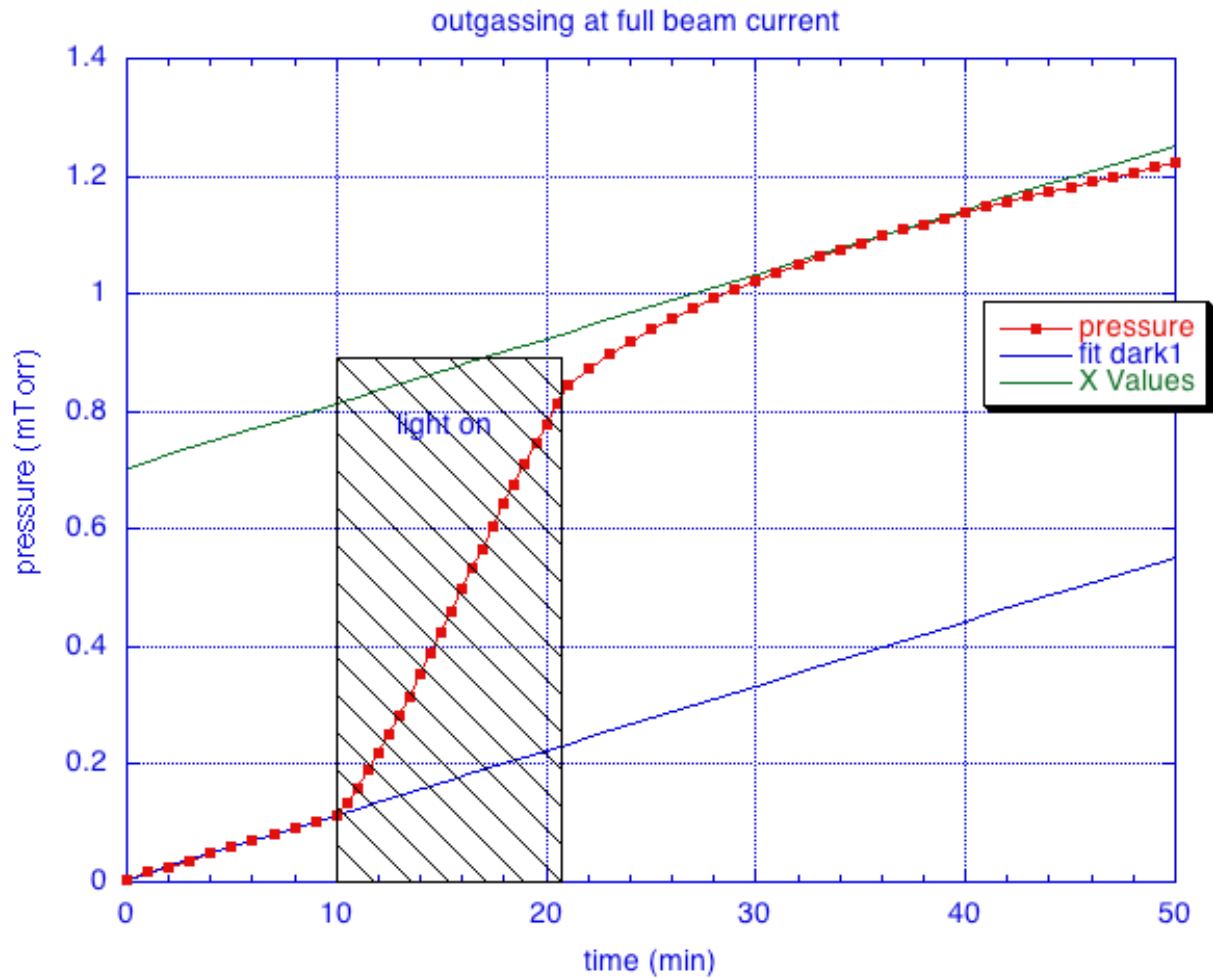
## **Physical and Chemical Properties Division**

- Creators and maintainers of the NIST MS data base
- GC/MS expertise

## **Polymers Division**

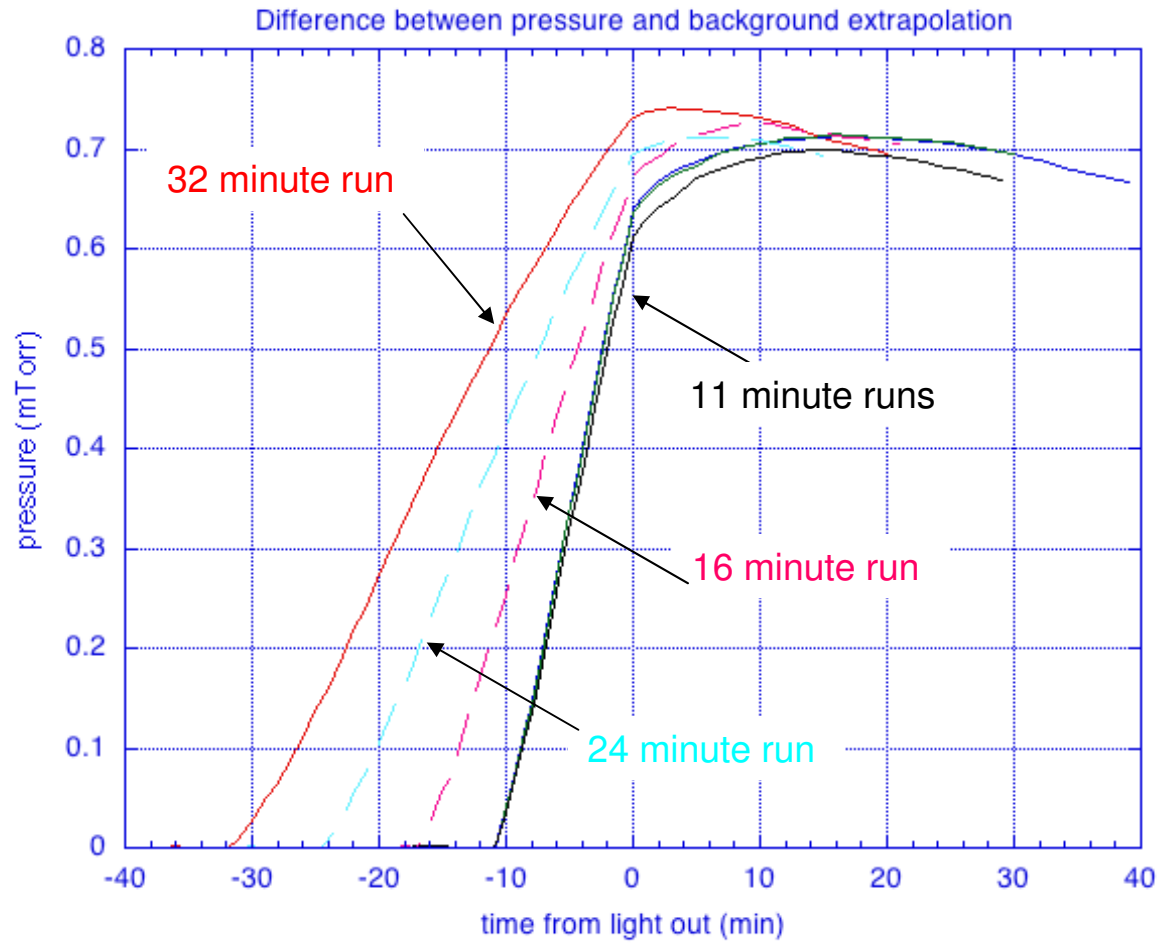
- Photoresist expertise
- DUV radiation source

# Outgassing at SURF III



Outgassing remains elevated for several minutes

# Outgassing at SURF III



Data from several runs made under varying conditions

## Data Analysis (10+ runs)

post-exposure time (min)	average ( $10^{14} \text{ cm}^{-2}$ )	Std. dev. ( $10^{14} \text{ cm}^{-2}$ )	Std. dev.
0	2.77	0.20	7.2%
5	2.99	0.13	4.3%
10	3.11	0.06	1.9%
20	3.20	0.18	5.6%