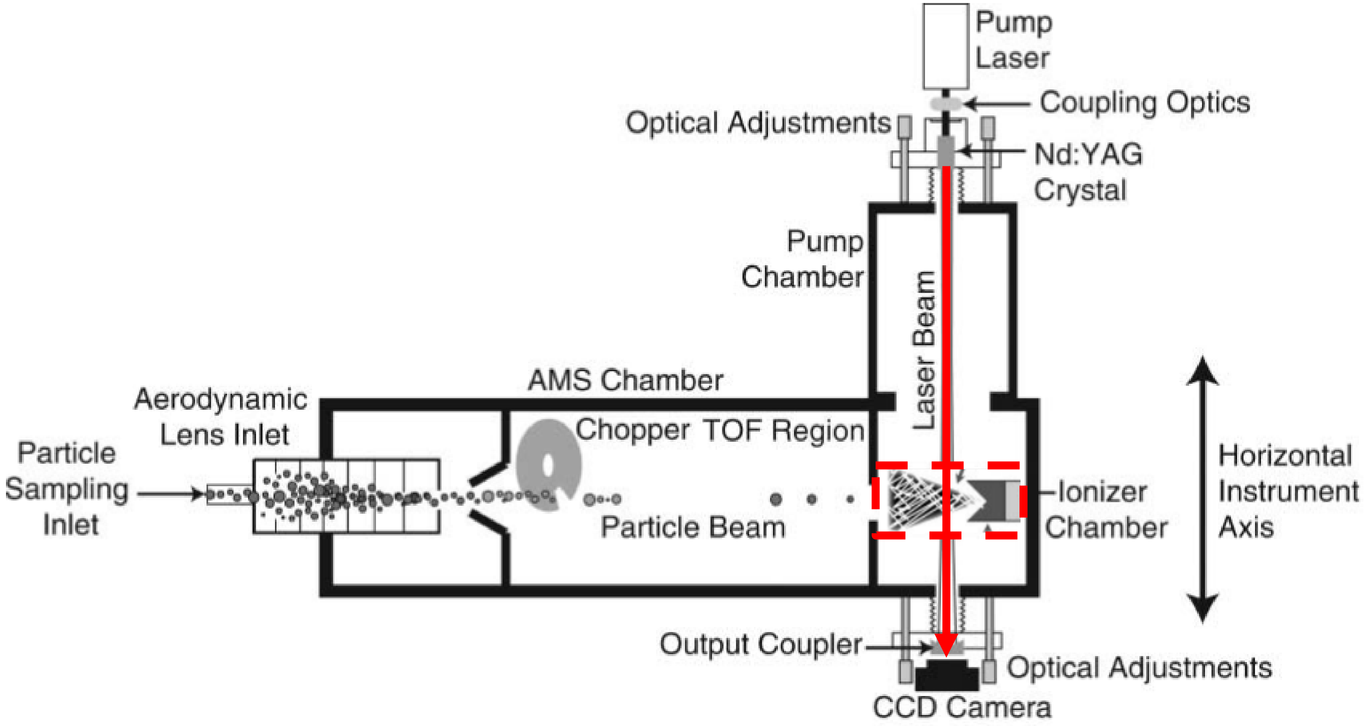
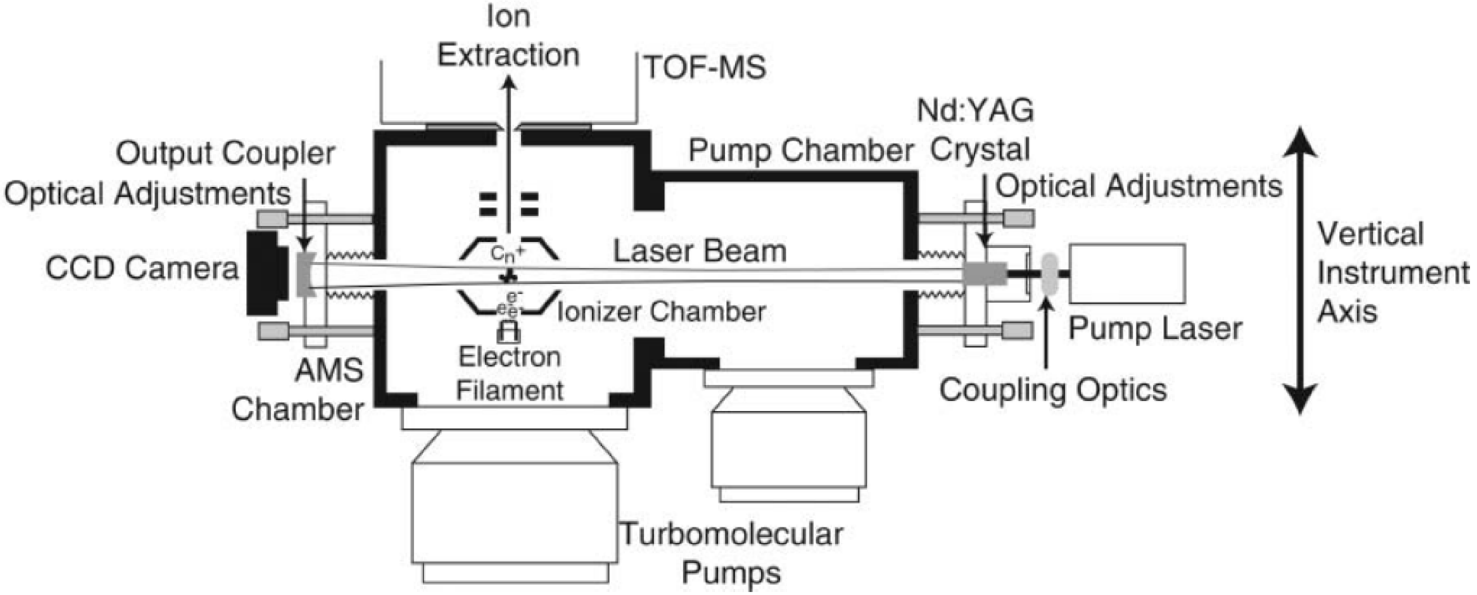
Particle Detection Using the Dual-Vaporizer Configuration of the Soot Particle Aerosol Mass Spectrometer (SP-AMS)

Anita Avery
(Leah, Tim, Ed, Bill, Wade)

AMS Users' Meeting

9/8/18



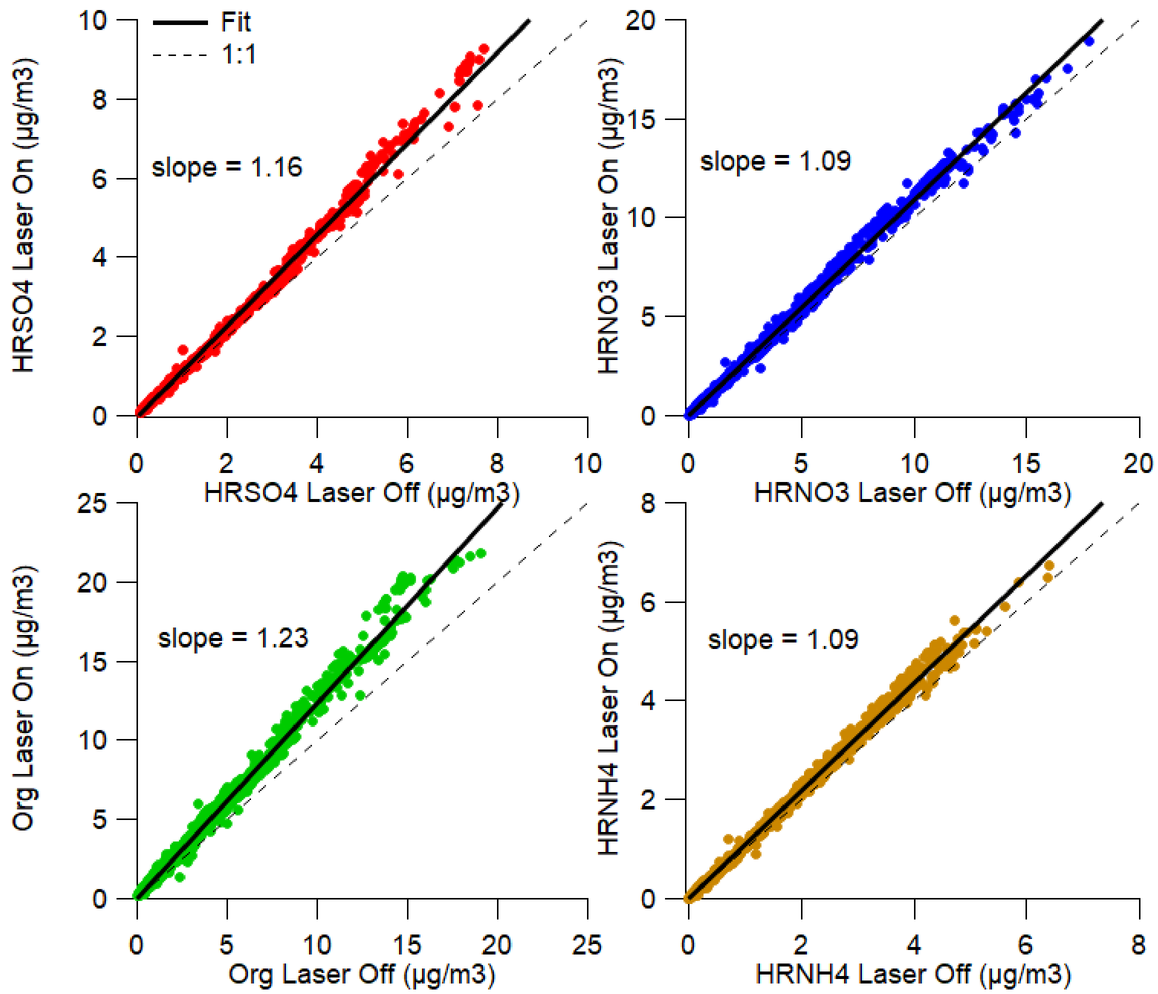


SP-AMS Vaporizer(s)

- Standard vaporizer + laser vaporizer
  - Fundamentally different mechanisms
  - Used in tandem, to what effect?

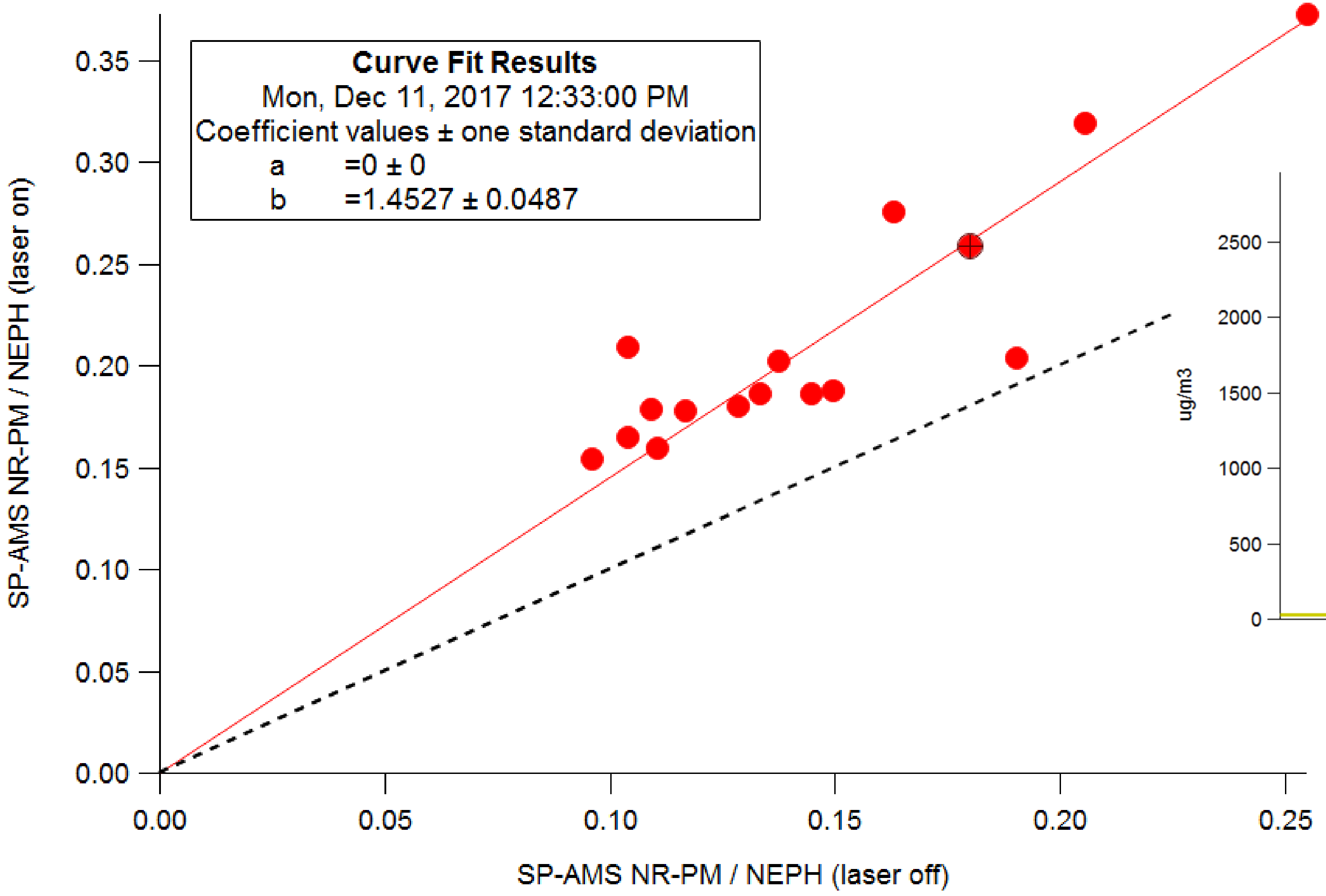
Theory vs Practice

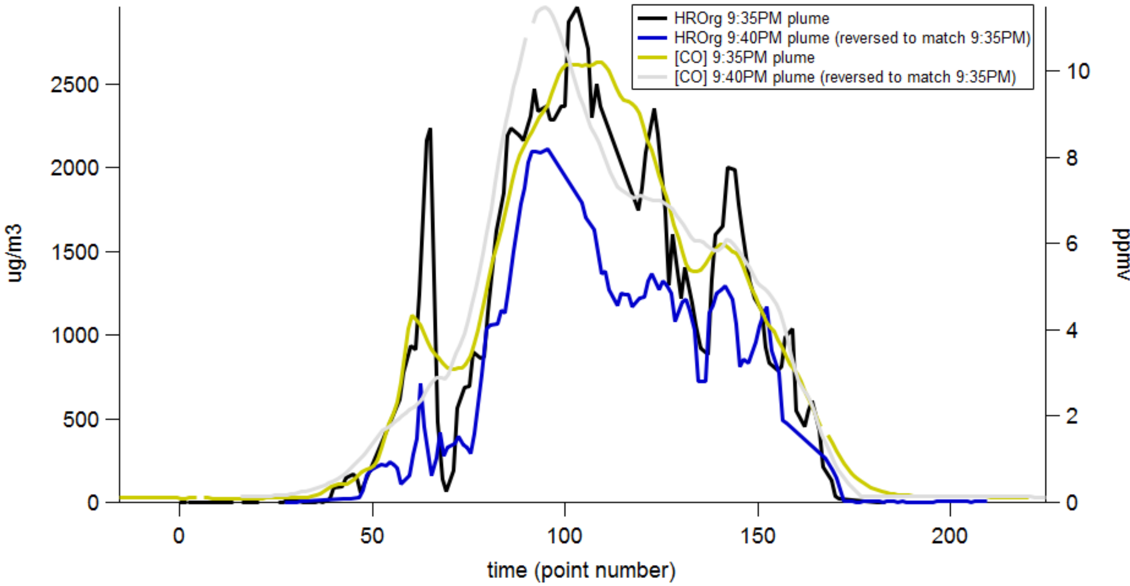
- Theory
  - Tungsten-only = NR
  - Laser-only = R+Coating
  - Together= NR+R+Coating
  - Switching allows to do all at once!
    - Subtract NR from Total to get coating
    - Mostly organics, source/age dependent
- Practice
  - Laser ON/Laser OFF >1,
    - Species-dependent
  - Not always in line with theory



BBOP study

Non-Refractory Collection Efficiency

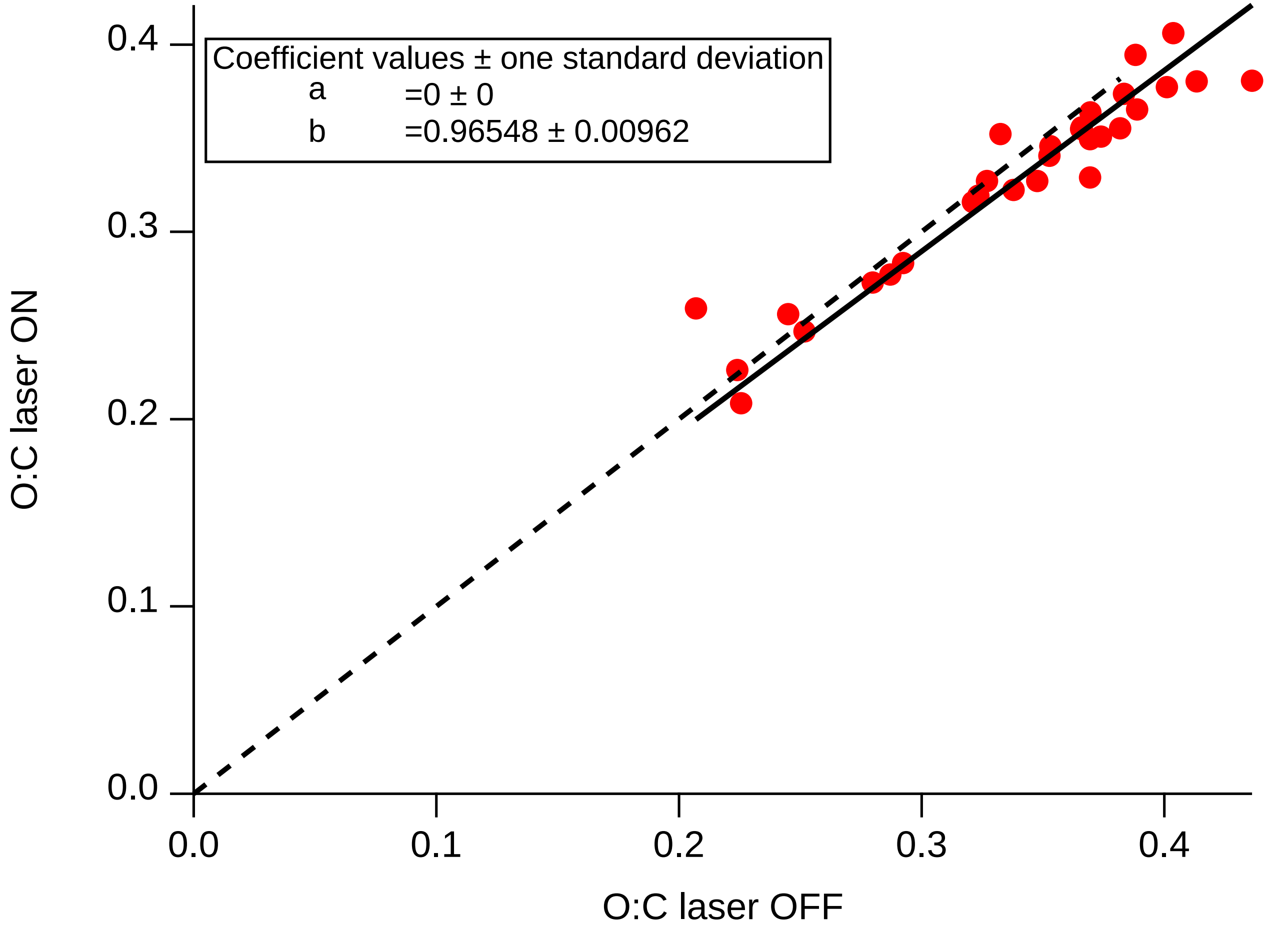




SP-AMS laser OFF CE = 0.5

SP-AMS laser ON CE = 0.76 ± 0.07

Non-Refractory Chemical Differences

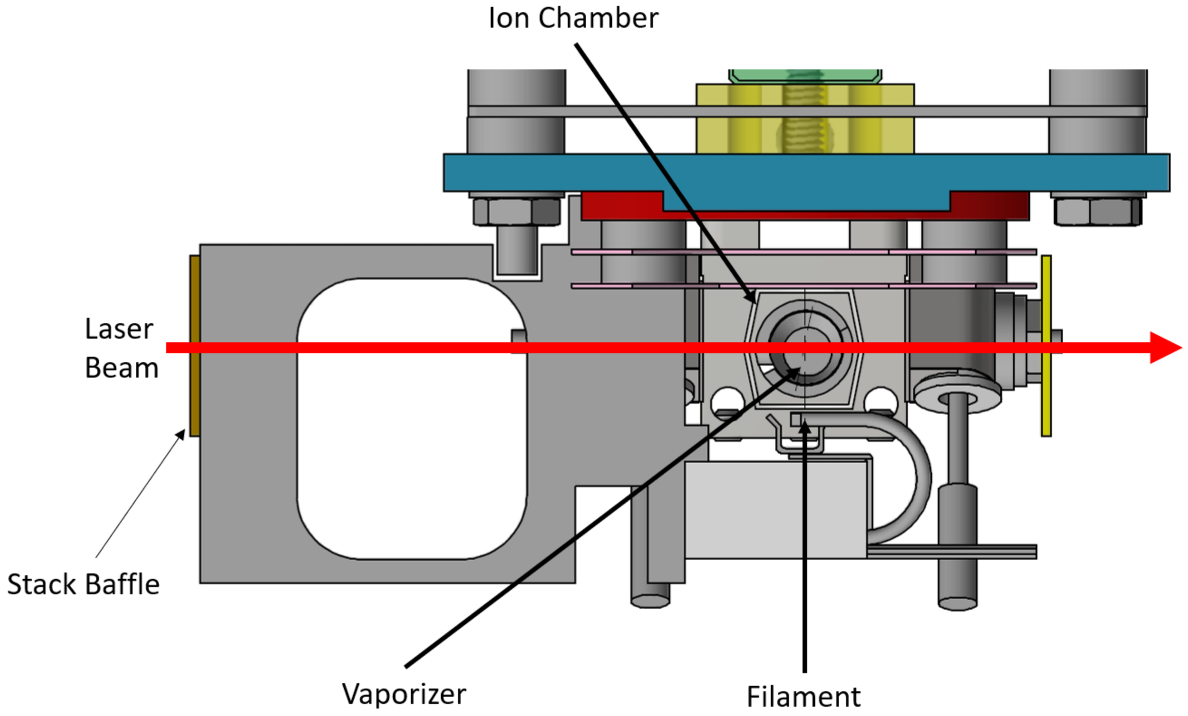


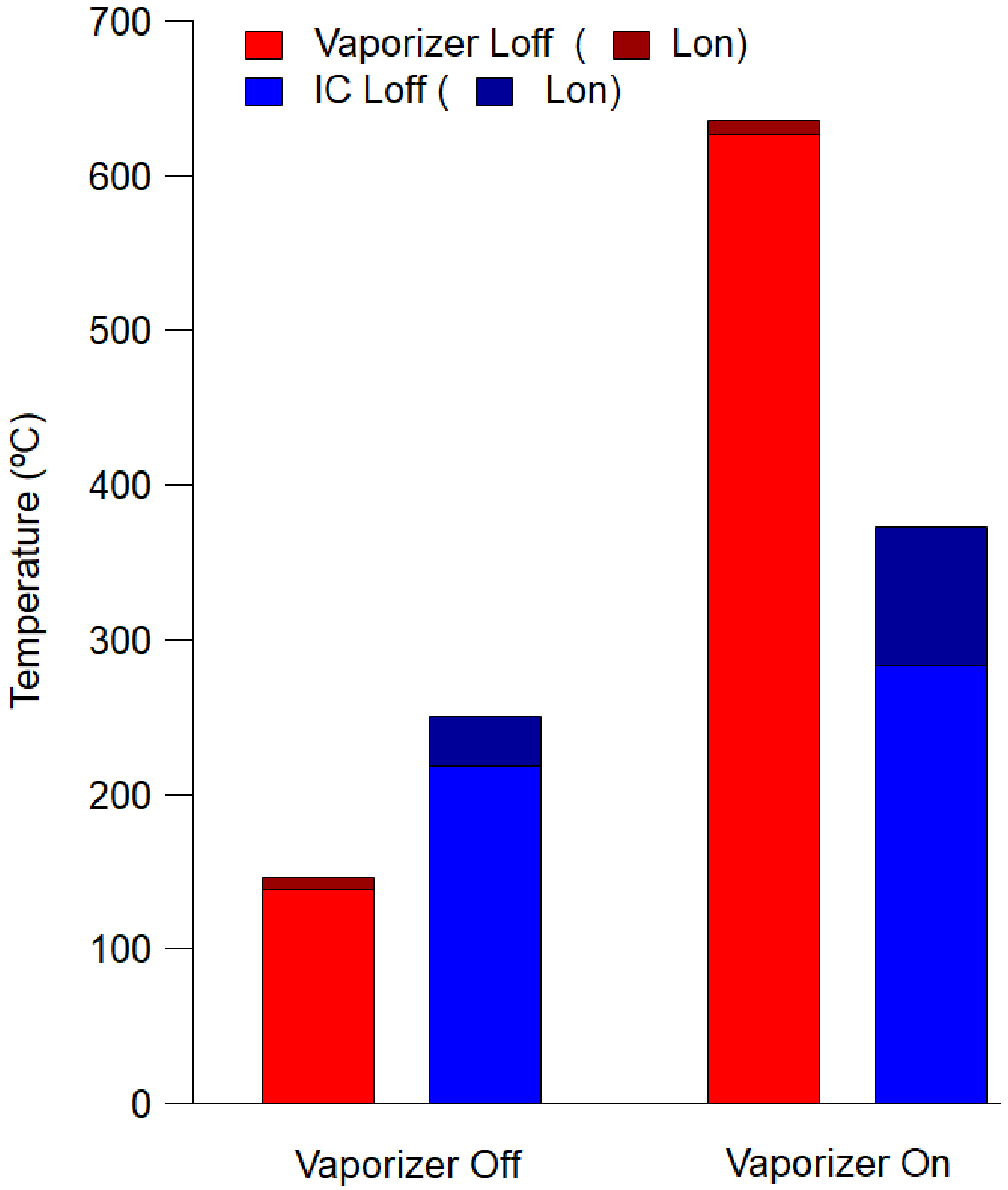
SP-AMS laser ON/OFF O:C Ratio
~0.97 ± 0.07

SP-AMS laser ON/OFF H:C Ratio
~1.02 ± 0.07

Thermal connectivity

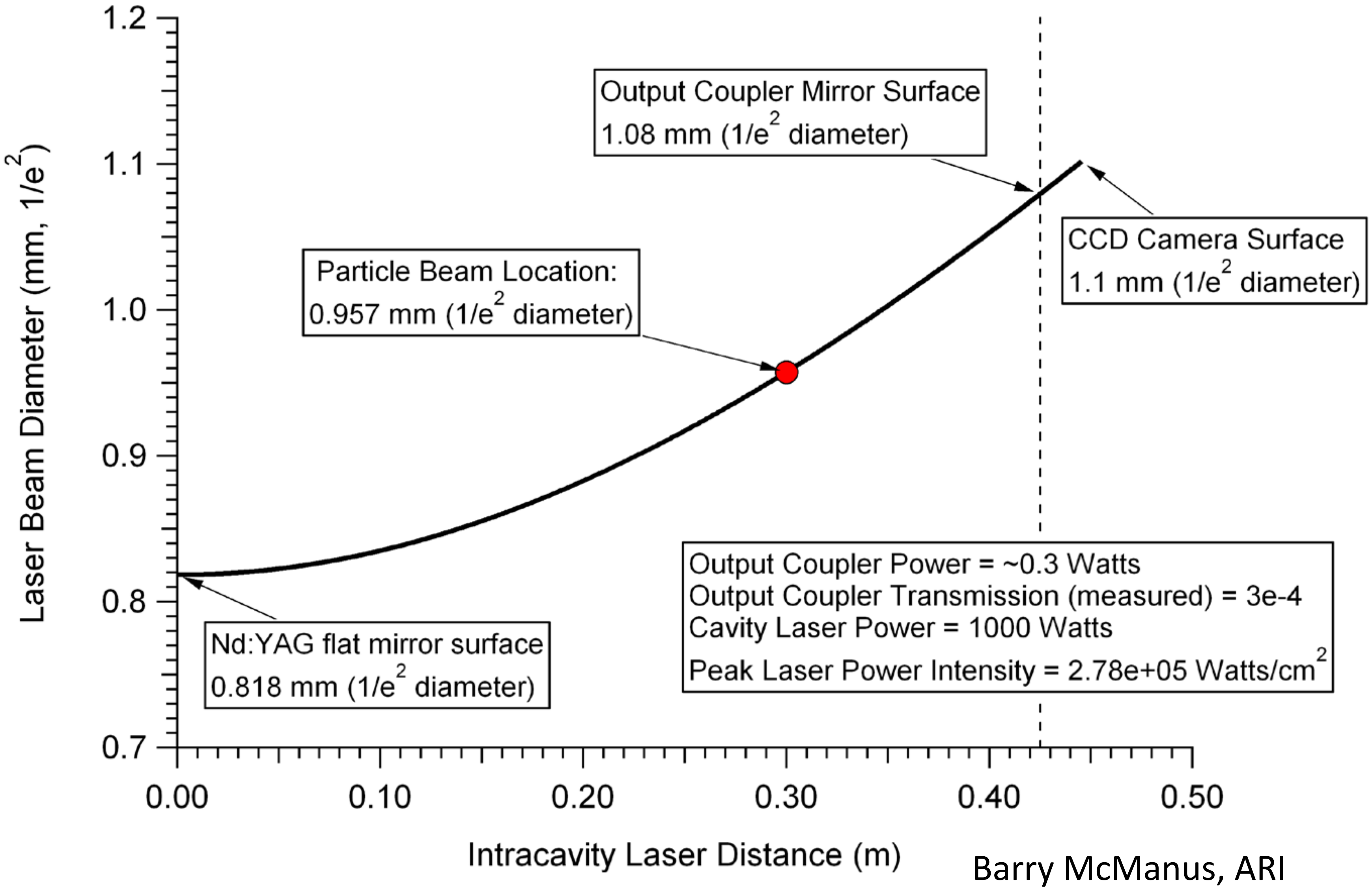
- Vaporizer, filament, laser all heat internal components





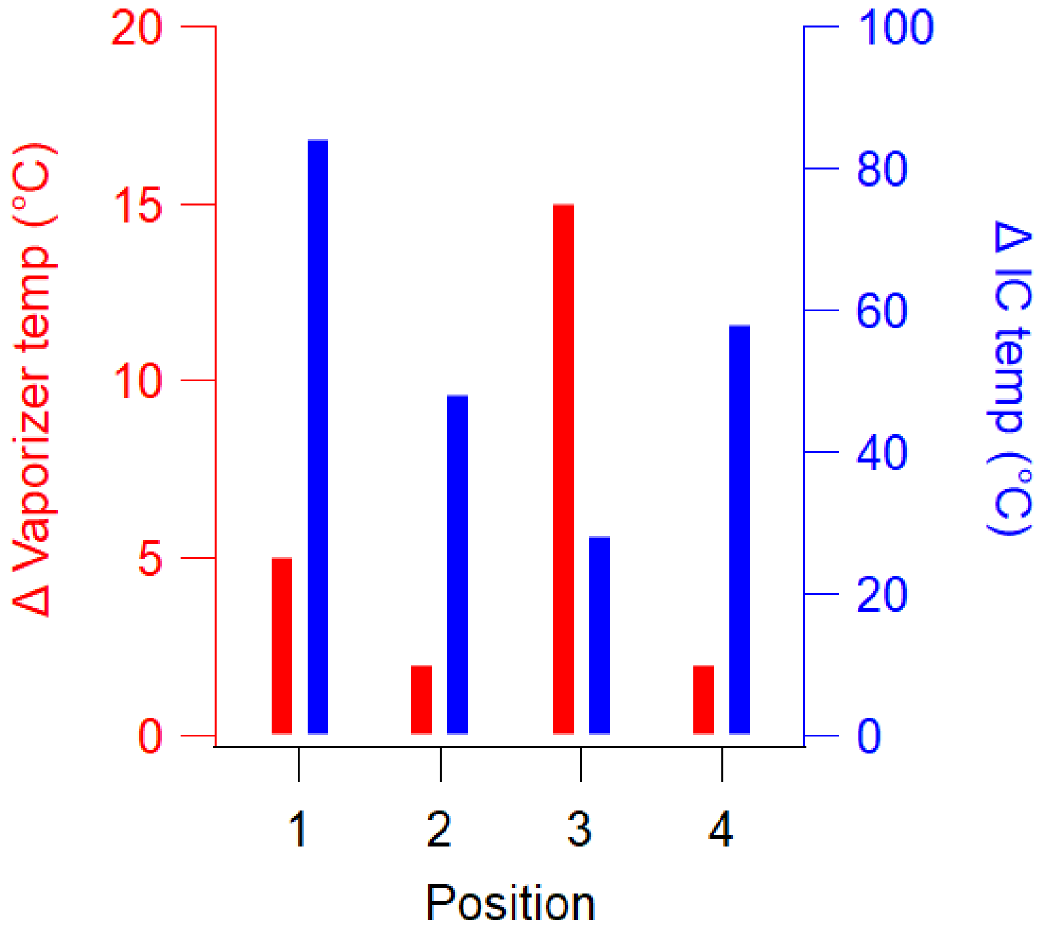
Laser specifics and intervention

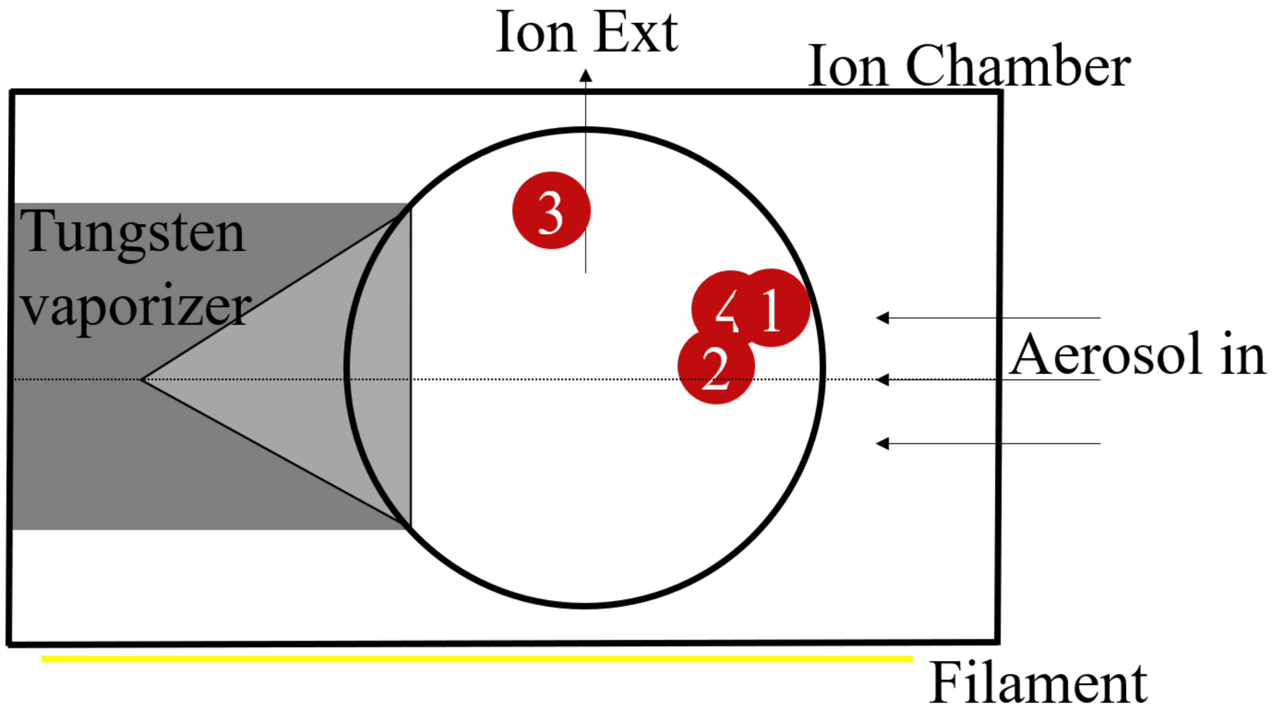
- Laser is ~ 1mm, but wings of heating are wide
- Laser diameter < ion chamber space so moveable in space
- Add baffles at various points along the air beam
    - 3 points, multiple diameters
    - Limit lasing position
    - Limit heating



Barry McManus, ARI

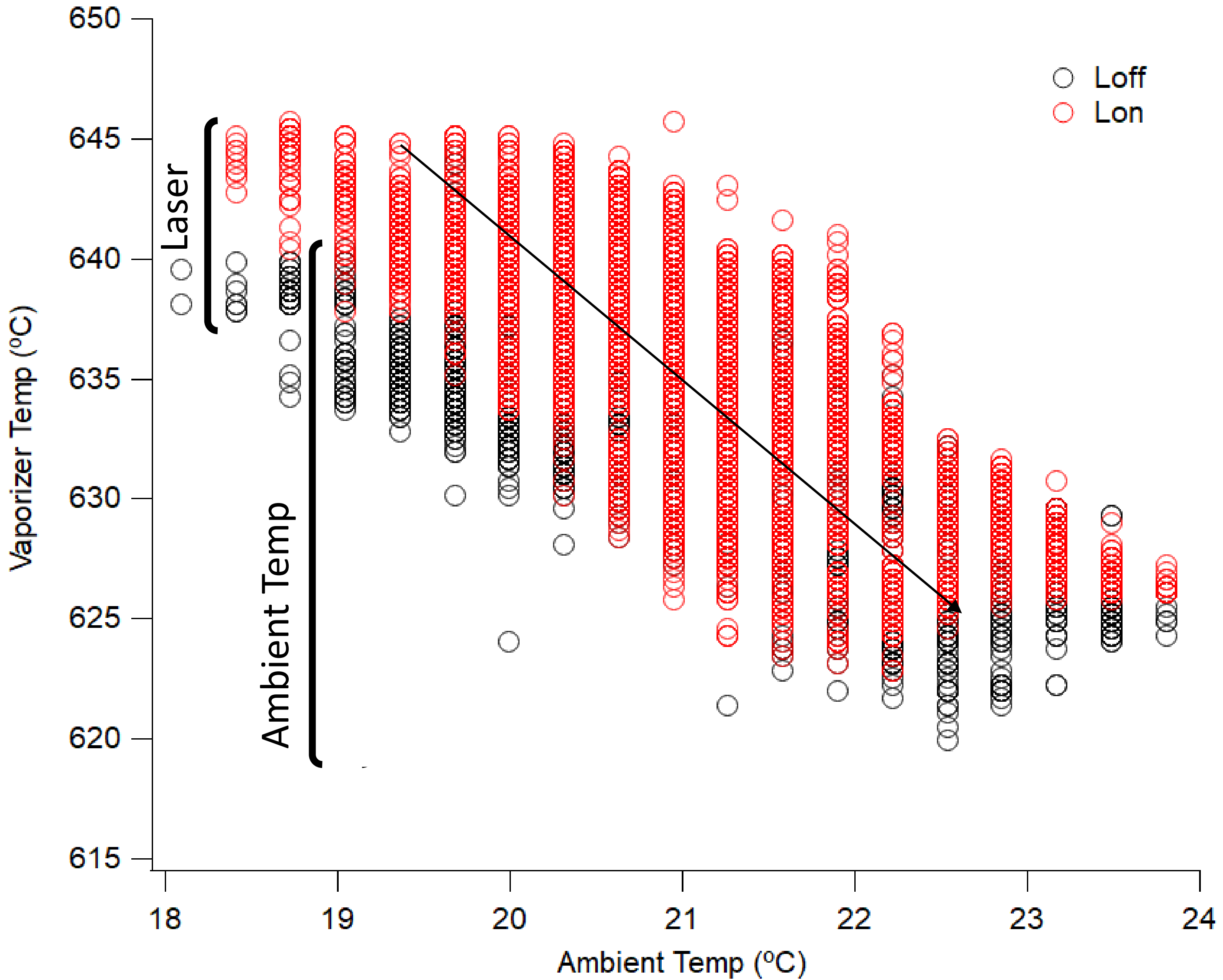
Laser position



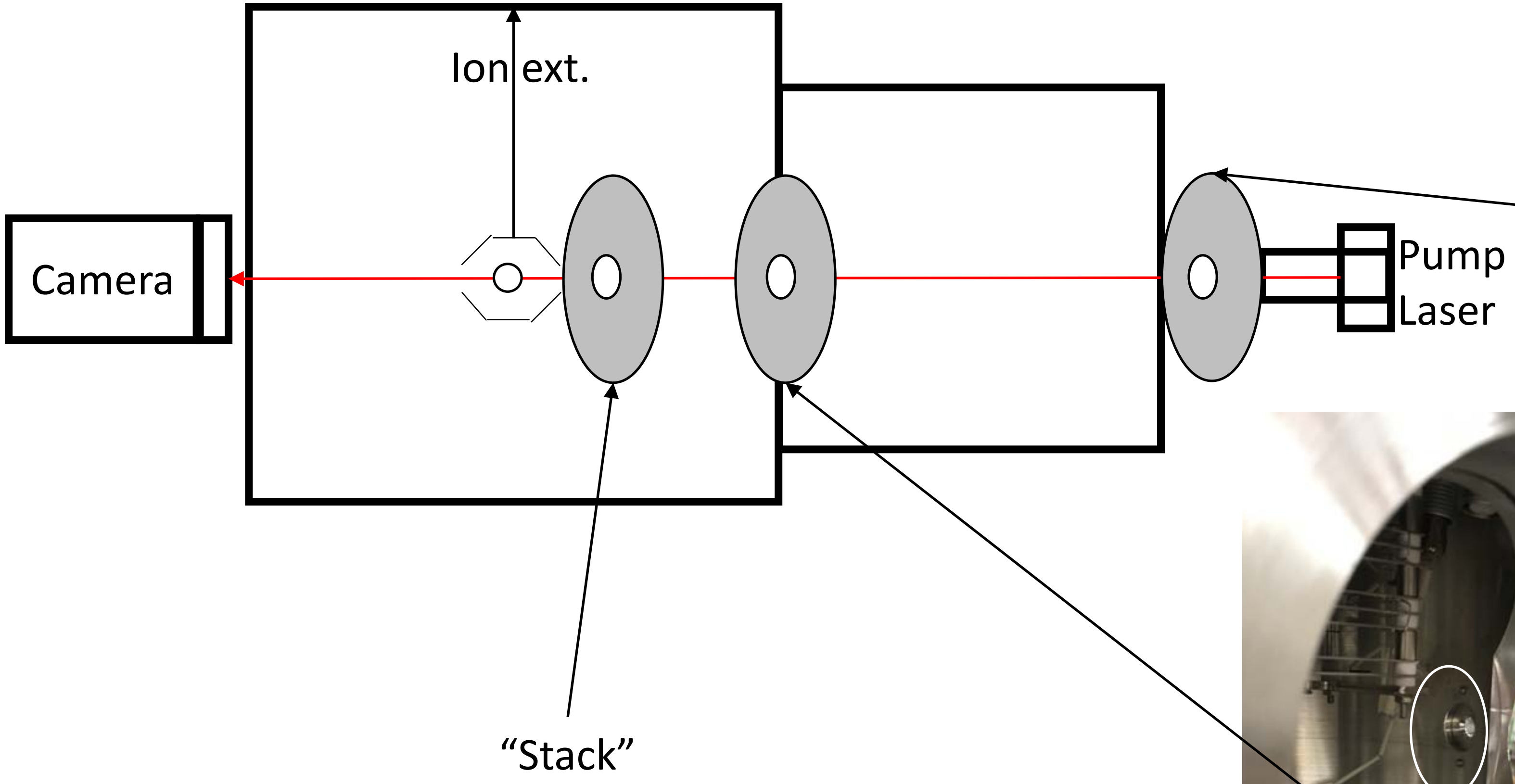


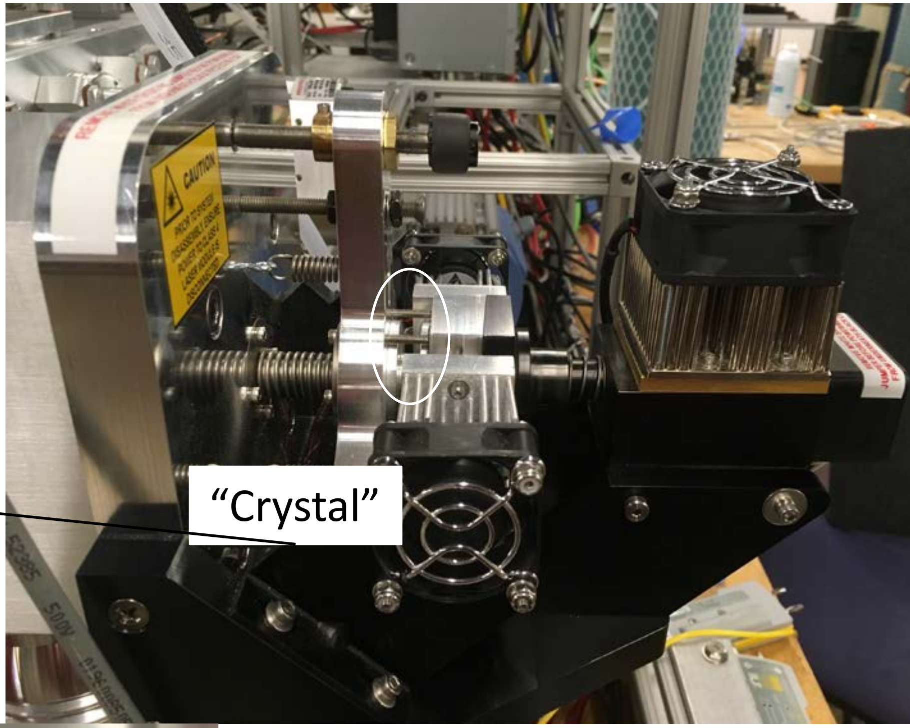
Other factors: vaporizer/ambient temp

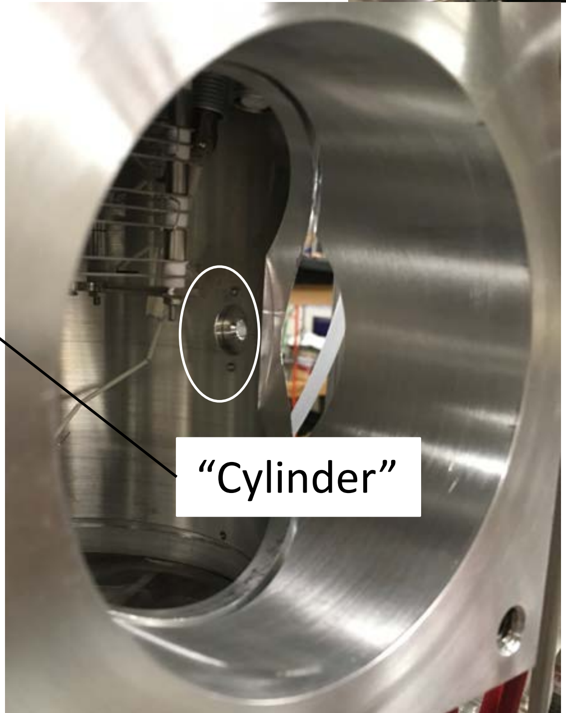
- Inverse relationship
  - For vaporizer, effect of ambient temp > laser
  - Lesser effect on IC temp but some
  - Observed across instruments to different degrees
- Counter-intuitive
  - Not on stack
  - Repeatable



Baffle Setups

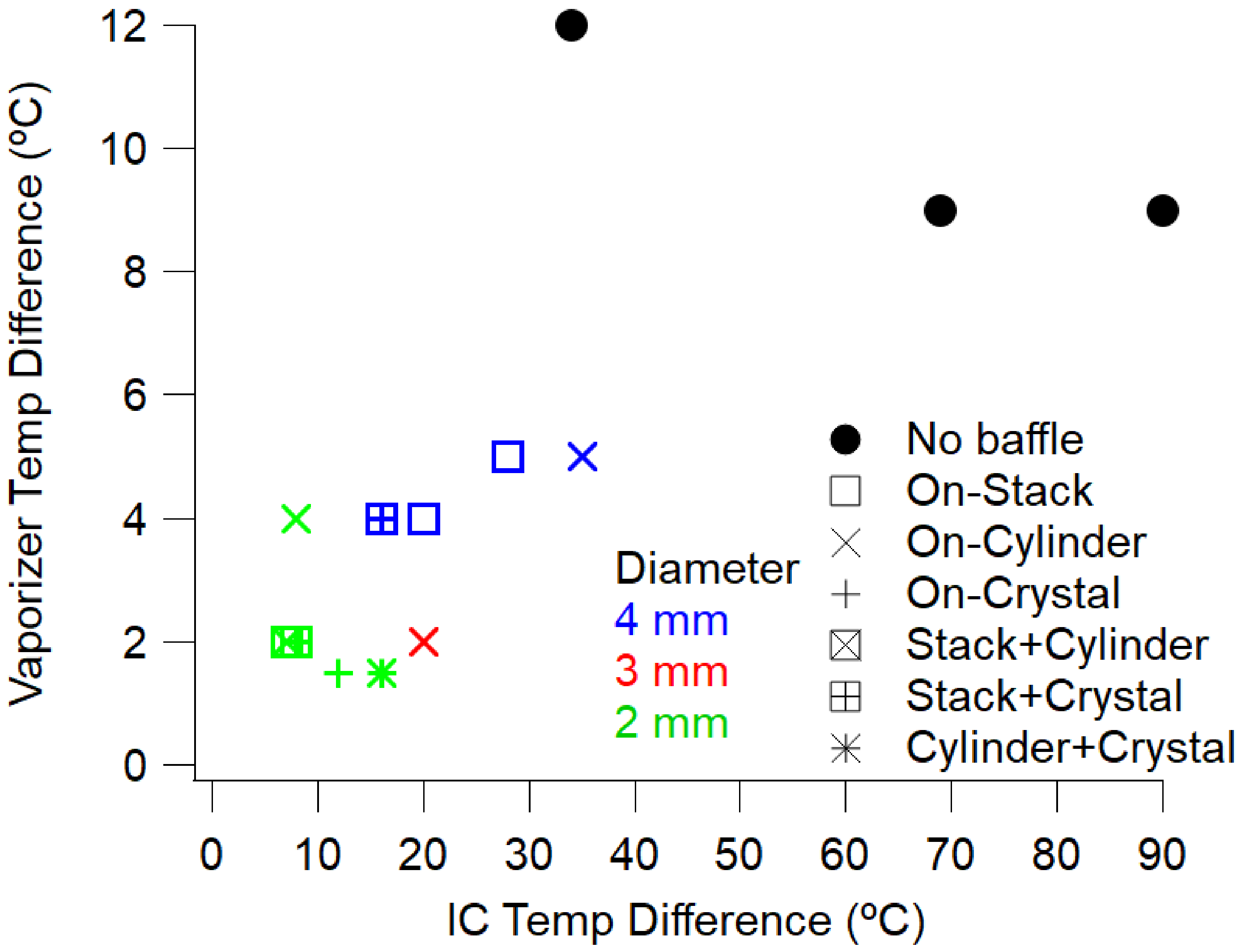




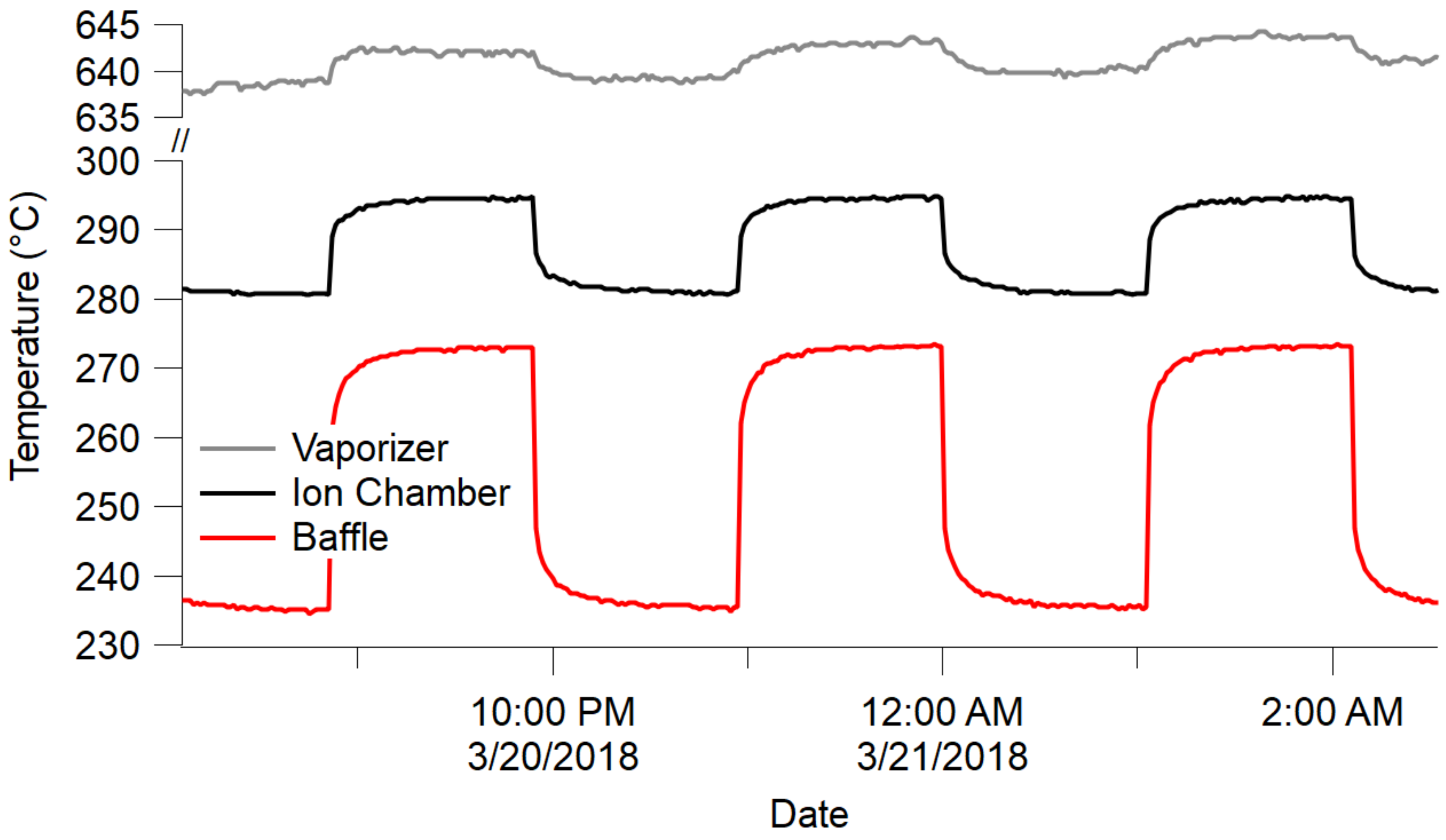


Results: are the baffles effective?

- Vaporizer and IC temp somewhat related
  - Position-dependent
  - Not necessarily correlated with power
- Smaller diameter baffles do better
- <20C temperature differences reasonably achievable



Implementation considerations: time for temperature change

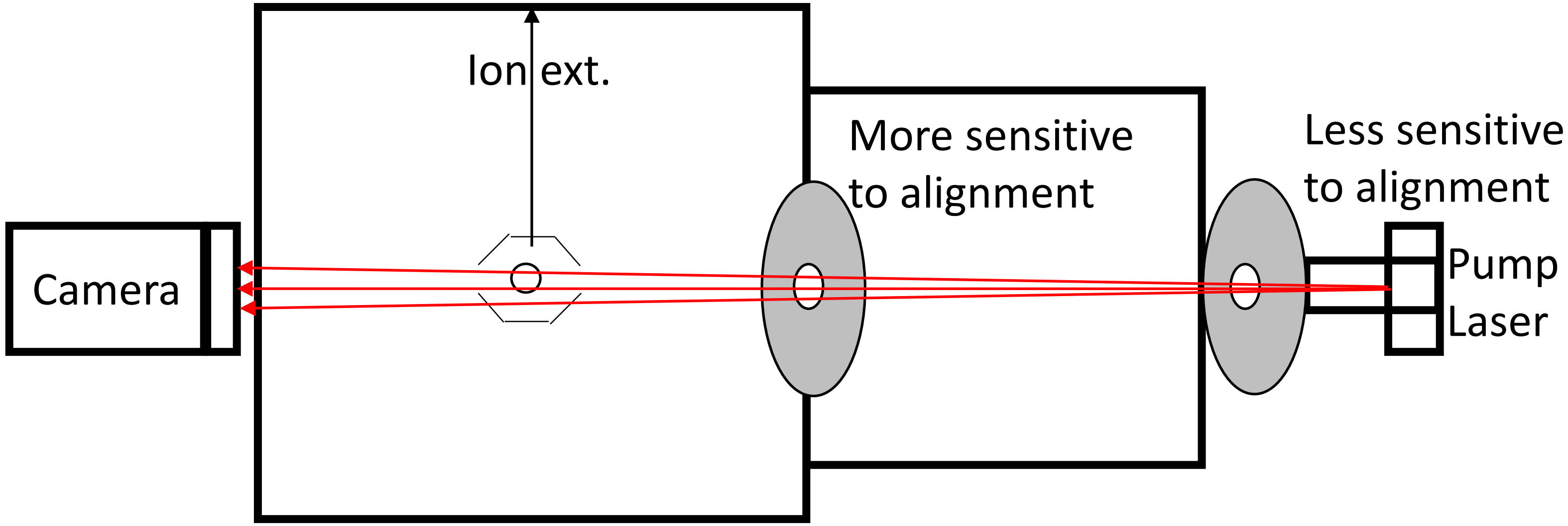


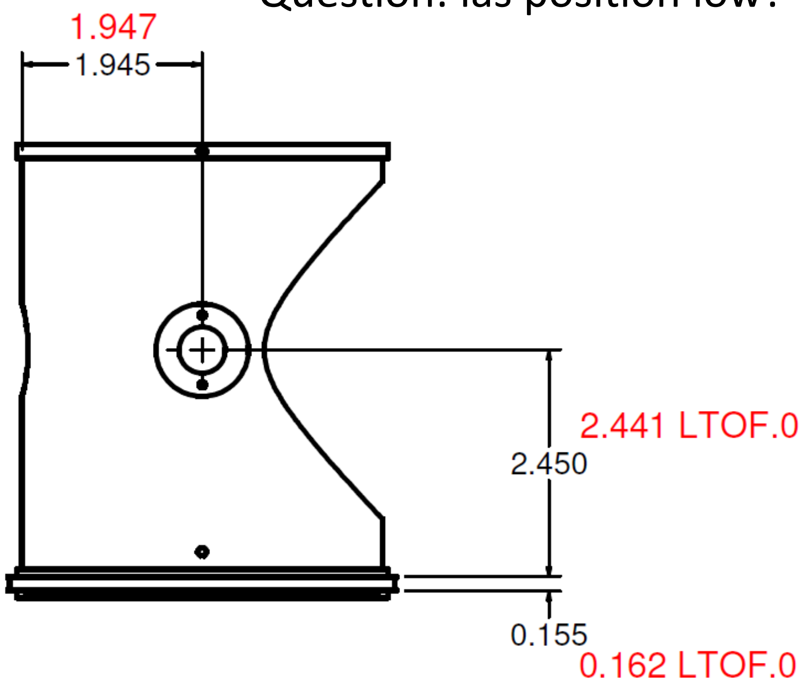
Baffle	Time (s)
No Baffle	387
Cylinder	375
Crystal	518
Stack+Crystal	692
Stack	1007

Implementation considerations: alignment and usability

- Small spatial changes make a BIG difference
  - Change in stack height of 0.015” (0.38mm) causes misalignment
  - Smaller baffles are more difficult to align

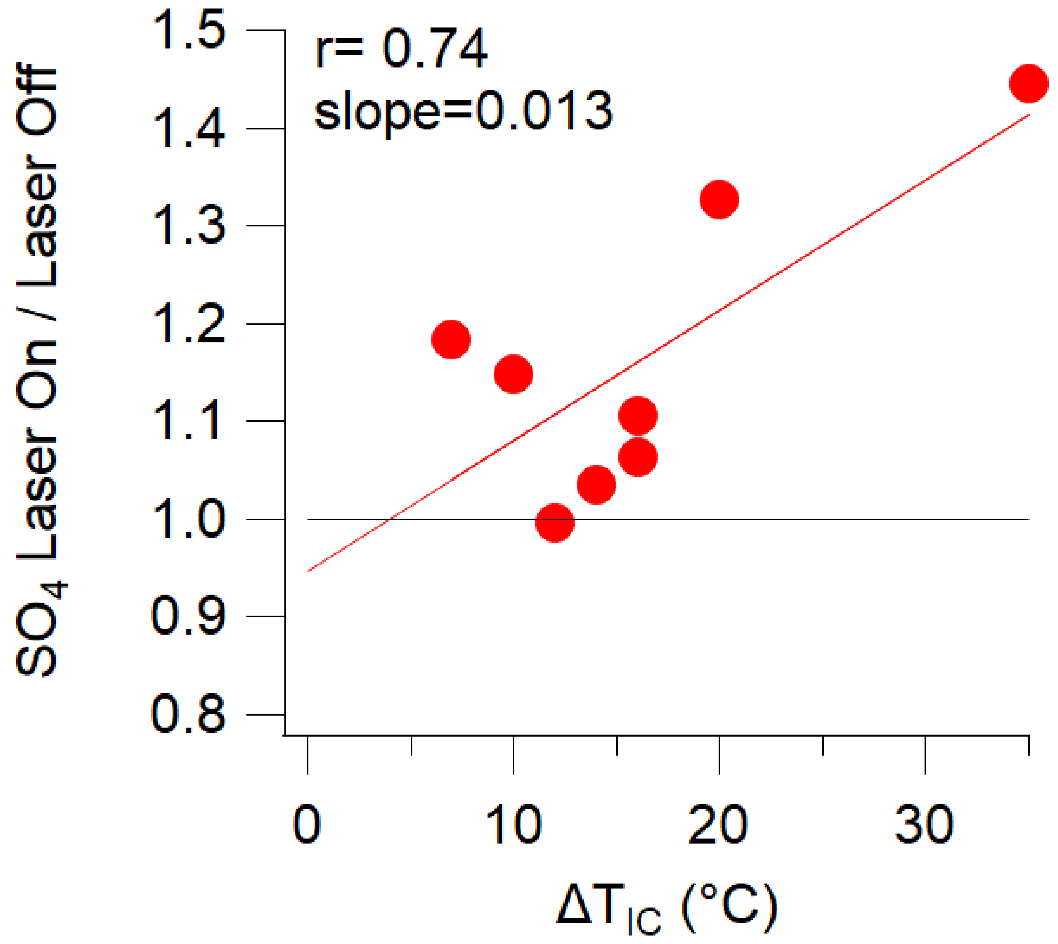
Question: las position low?





Bringing it back to quantification

- Is this temperature reduction making a difference?
  - Yes, based on ambient data
    - This data still has position effects
  - …..but I'm going to make sure in the lab
  - Organics are more complicated (of course), need to analyze more systematically



Summary/ Recommendations

- Baffles
  - Stack baffles remove minimal heat, increase transfer time
  - Cylinder baffles effective, but suffer from alignment
  - Crystal baffles hard to reproduce, provide more freedom of movement
- Stack alignment: 0.015” low
- One baffle or multiple
- Consider laser position

Next steps

- Making peak lasing, sensitivity to BC reproducible
- Atomize sulfate, nitrate, organics, BC with select baffles
- Design considerations for implementation
  - Reproducibility
  - Sufficient Power (BC signal vs power)
  - User ability

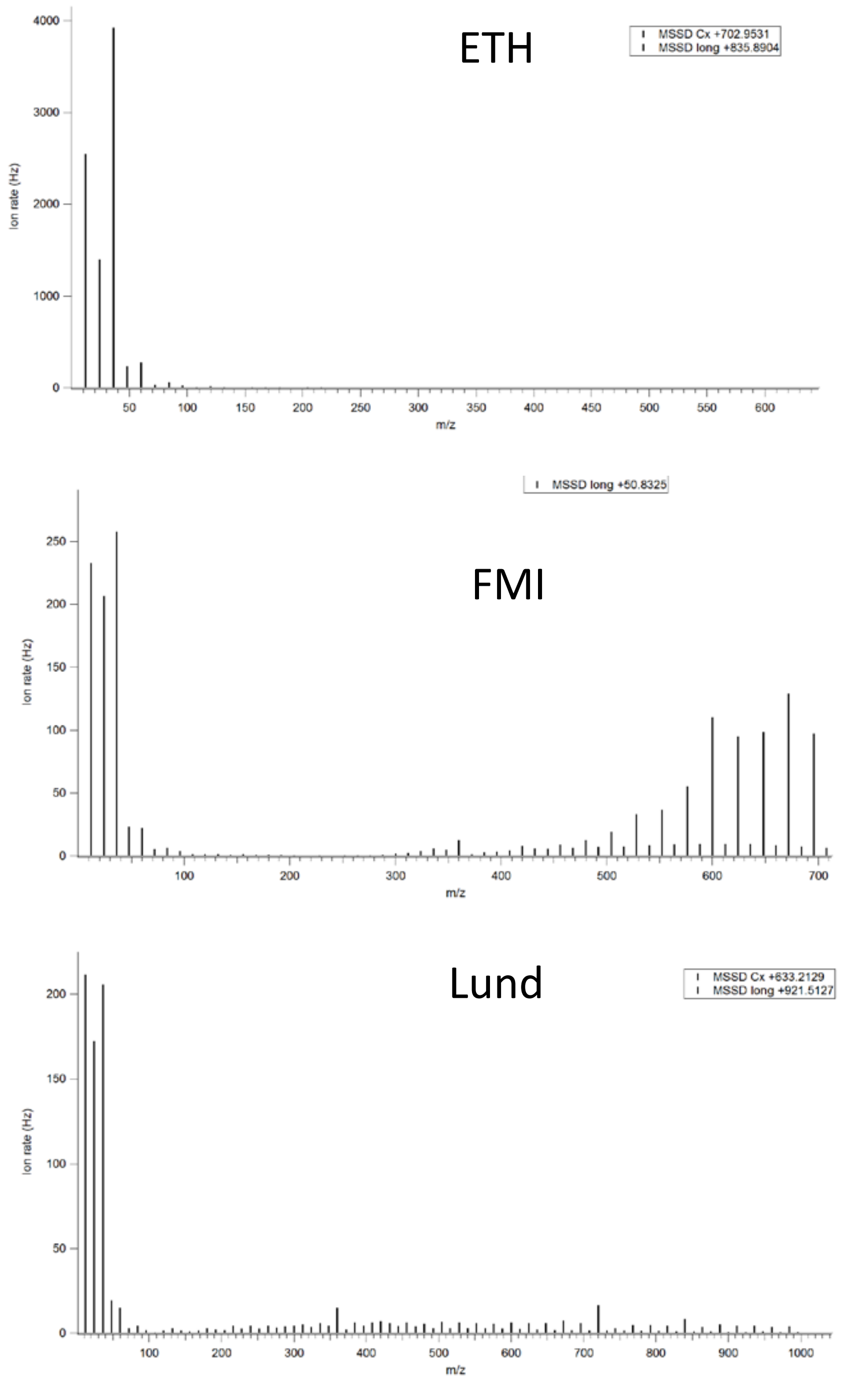
Switching topics (a preview)

rBC ion distributions

Experiment #51
(ETH sample fullerene soot)

Amewu Mensah et al.

- Three independent SP-AMS instruments sampling the same fullerene soot sample showing different carbon ion distributions!



Measuring mirror reflectance

Mirror Reflectance

- Newport mirrors via DMT
- Relate to intracavity power