SP-AMS: Main Issues for Quantification

1. rBC mIE calibration (laser only)
   - Determination of laser beam and particle beam widths and overlaps
   - mIE_rBC calibration independent of CE issues

2. R_{BC} and NR-PM quantification (laser only; both vaporizers)
   - Is this dependent on particle beam – laser beam overlap?
   - Do RIE's work across vaporizers?

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Atmospheric Measurement Techniques
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Collection efficiency of the soot-particle aerosol mass spectrometer (SP-AMS) for internally mixed particulate black carbon

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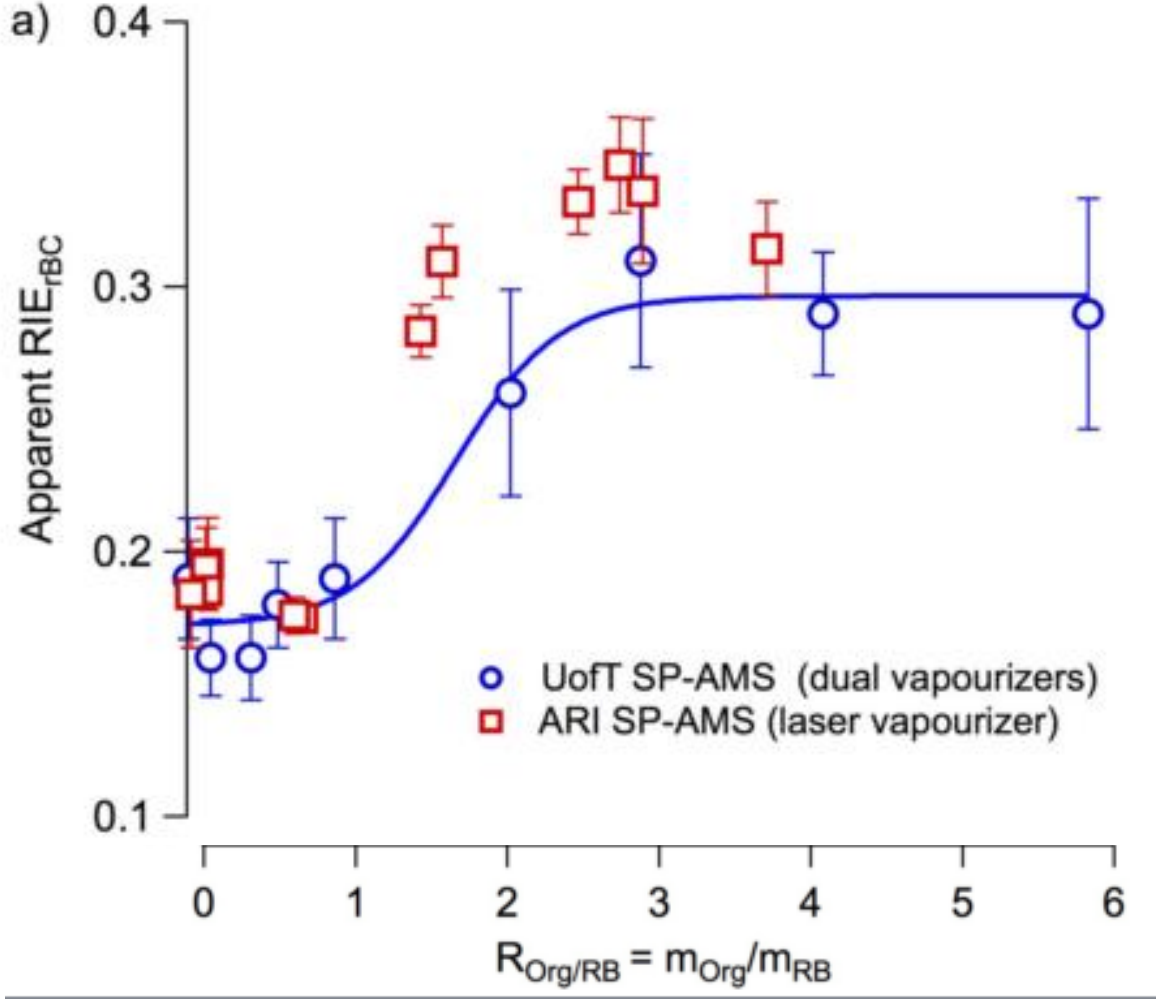
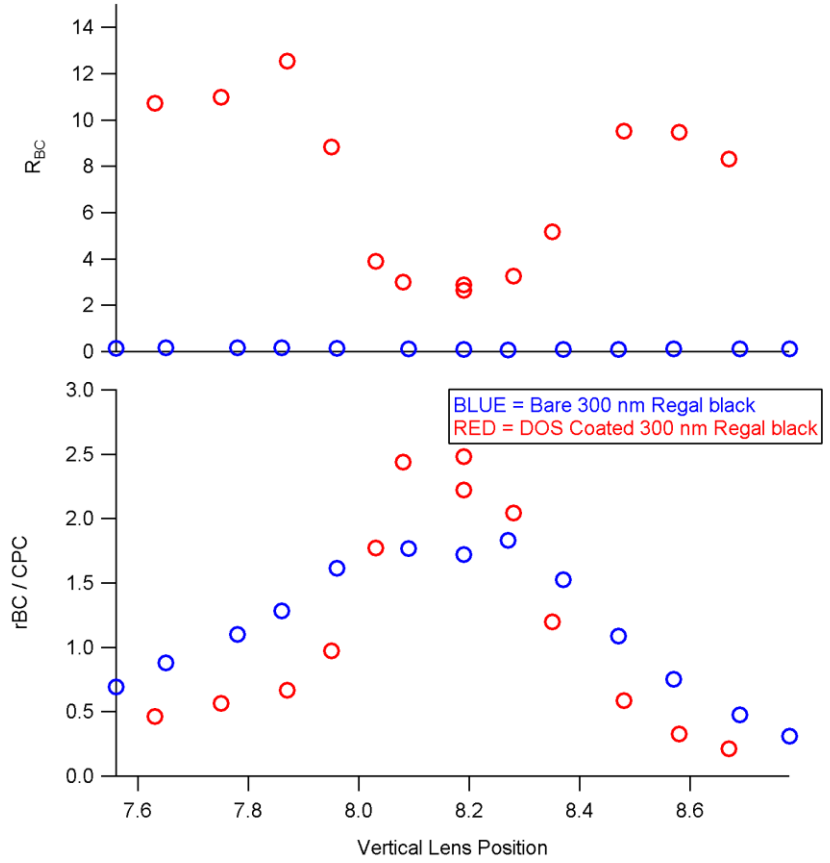
DOS coated Regal black



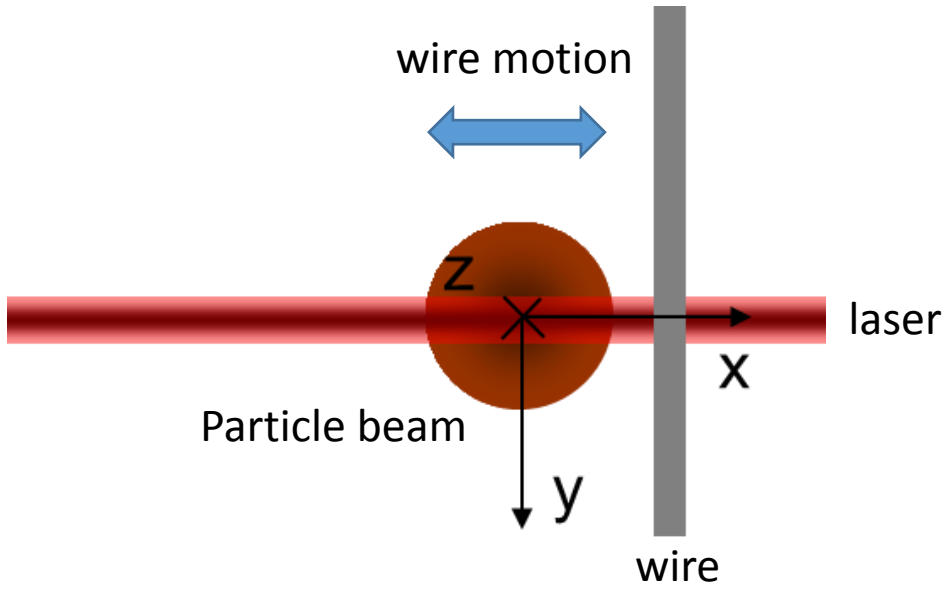
- Coated Regal black particles with DOS to make spherical
- With thicker coatings, RIE_rBC increased as the particle beam narrowed down closer to laser beam width
- NOTE: Low RIE_rBC << 1 was initial observation of deviation of RIE's possibly due to molecular velocity in ion formation chamber!

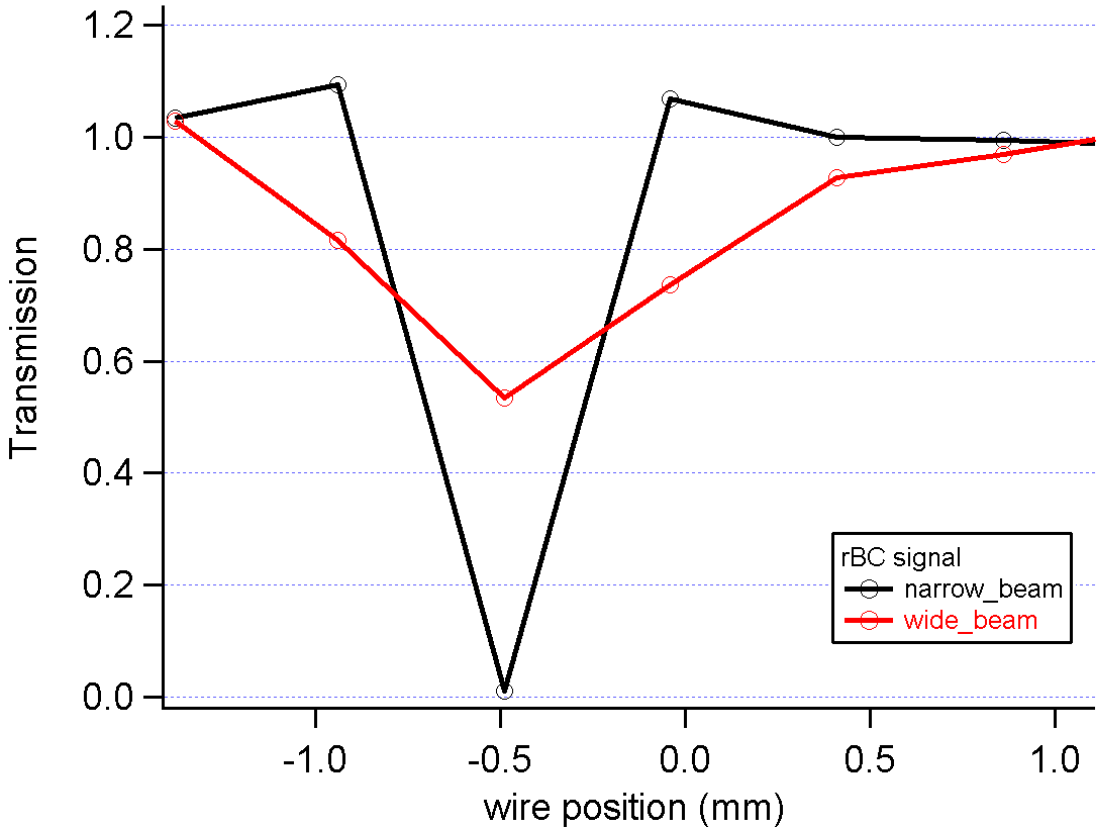
Particle Beam Vertical Walk
Bare RB and DOS Coated



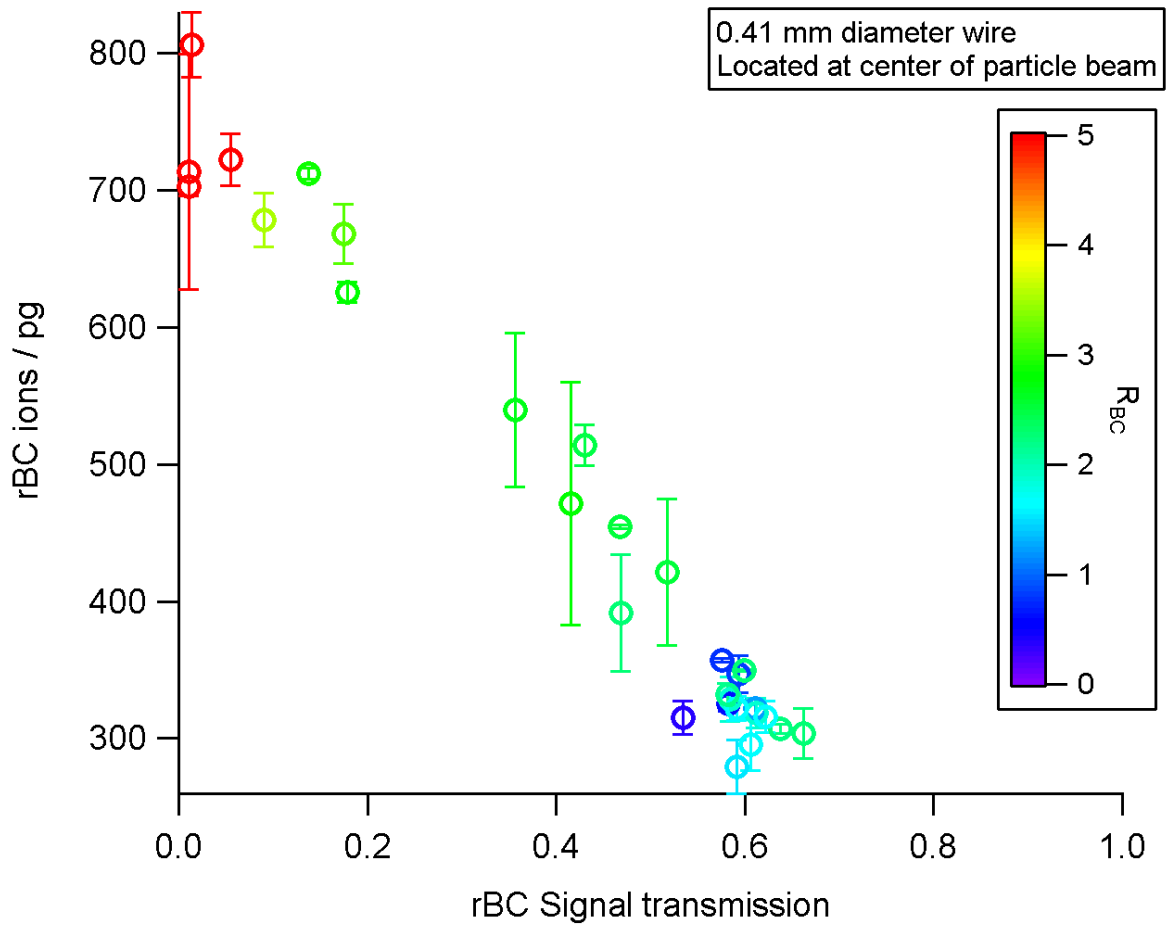
- DOS coated Regal black particle beam walk is narrower than bare RB
- R_{BC} definitely depends upon overlap of laser and particle beam

Beam Width Probe (Huffmann et al./Salcedo et al.)





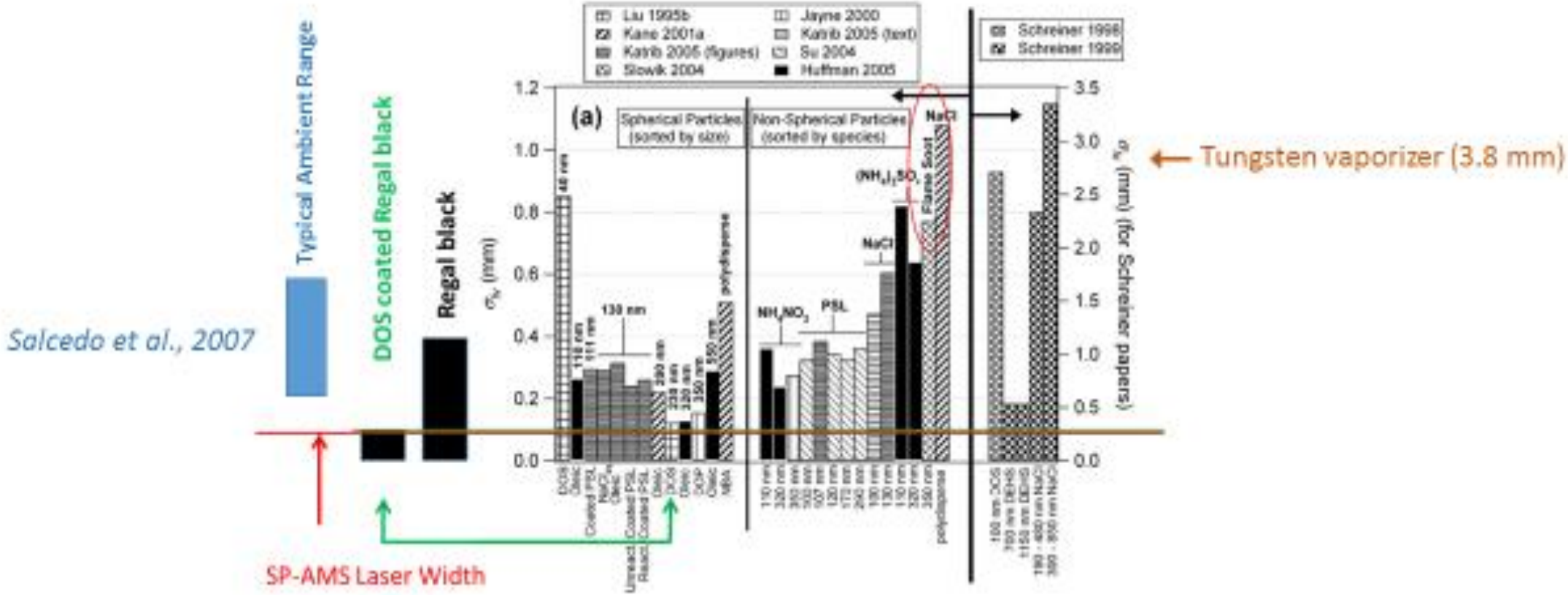
BWP Results



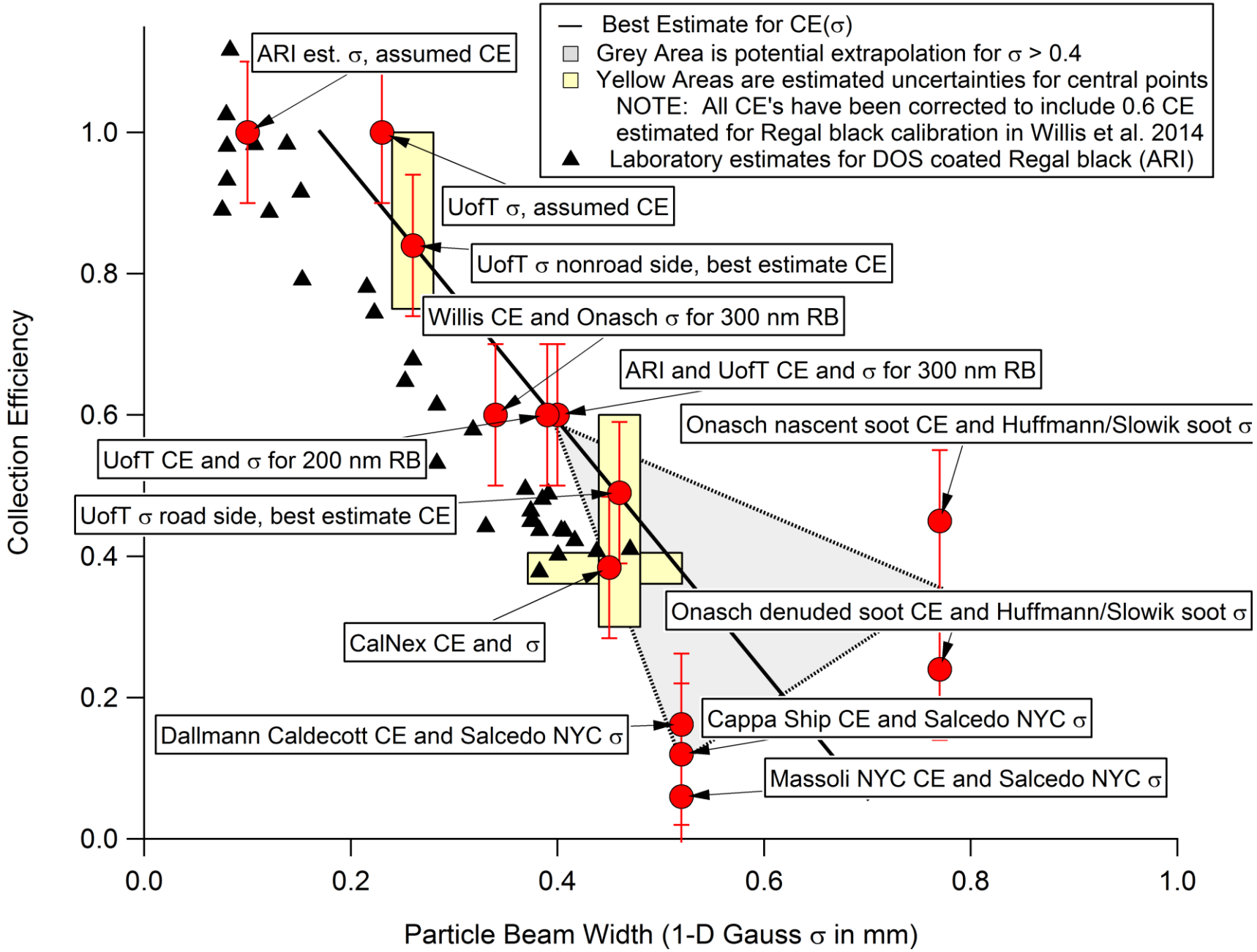
- Two independent measures of narrowing of particle beam with coating
- Decreasing particle beam width increases particle-laser beam overlap

Willis et al., 2014 – U Toronto

Laser and Particle Beam Widths



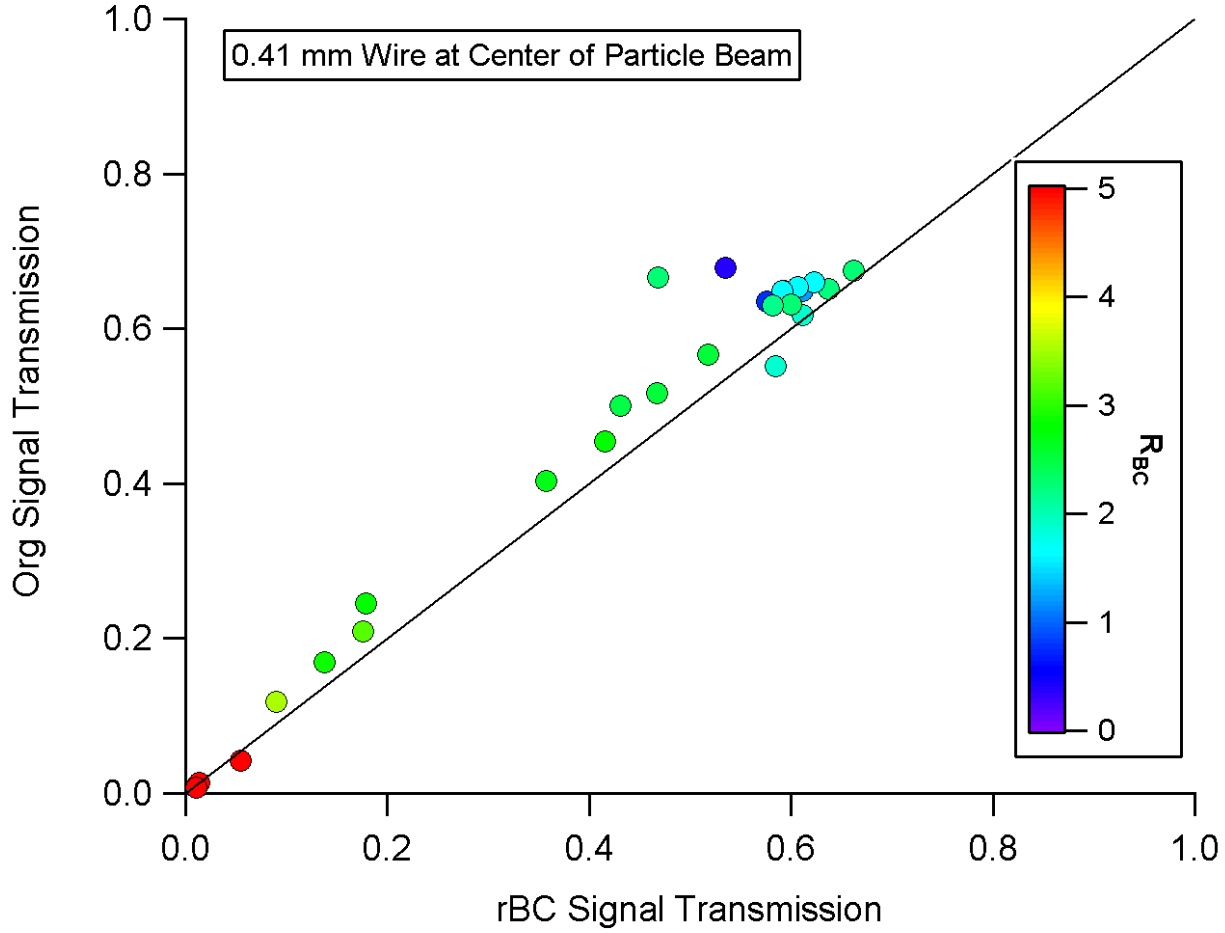
- Particle beam widths: DOS coated Regal black ~ pure DOS particles
- Laser beam width (σ) is ≤ ~ 0.1 mm
- Use BWP for CE determination in future


Best Estimate for CE(σ)
Grey Area is potential extrapolation for σ > 0.4
Yellow Areas are estimated uncertainties for central points
NOTE: All CE's have been corrected to include 0.6 CE estimated for Regal black calibration in Willis et al. 2014
Laboratory estimates for DOS coated Regal black (ARI)
ARI est. σ, assumed CE
UofT σ, assumed CE
UofT σ nonroad side, best estimate CE
Willis CE and Onasch σ for 300 nm RB
ARI and UofT CE and σ for 300 nm RB
Onasch nascent soot CE and Huffmann/Slowik soot σ
UofT CE and σ for 200 nm RB
UofT σ road side, best estimate CE
Onasch denuded soot CE and Huffmann/Slowik soot σ
CalNex CE and σ
Cappa Ship CE and Salcedo NYC σ
Dallmann Caldecott CE and Salcedo NYC σ
Massoli NYC CE and Salcedo NYC σ
Collection Efficiency
Particle Beam Width (1-D Gauss σ in mm)
0.0
0.2
0.4
0.6
0.8
1.0

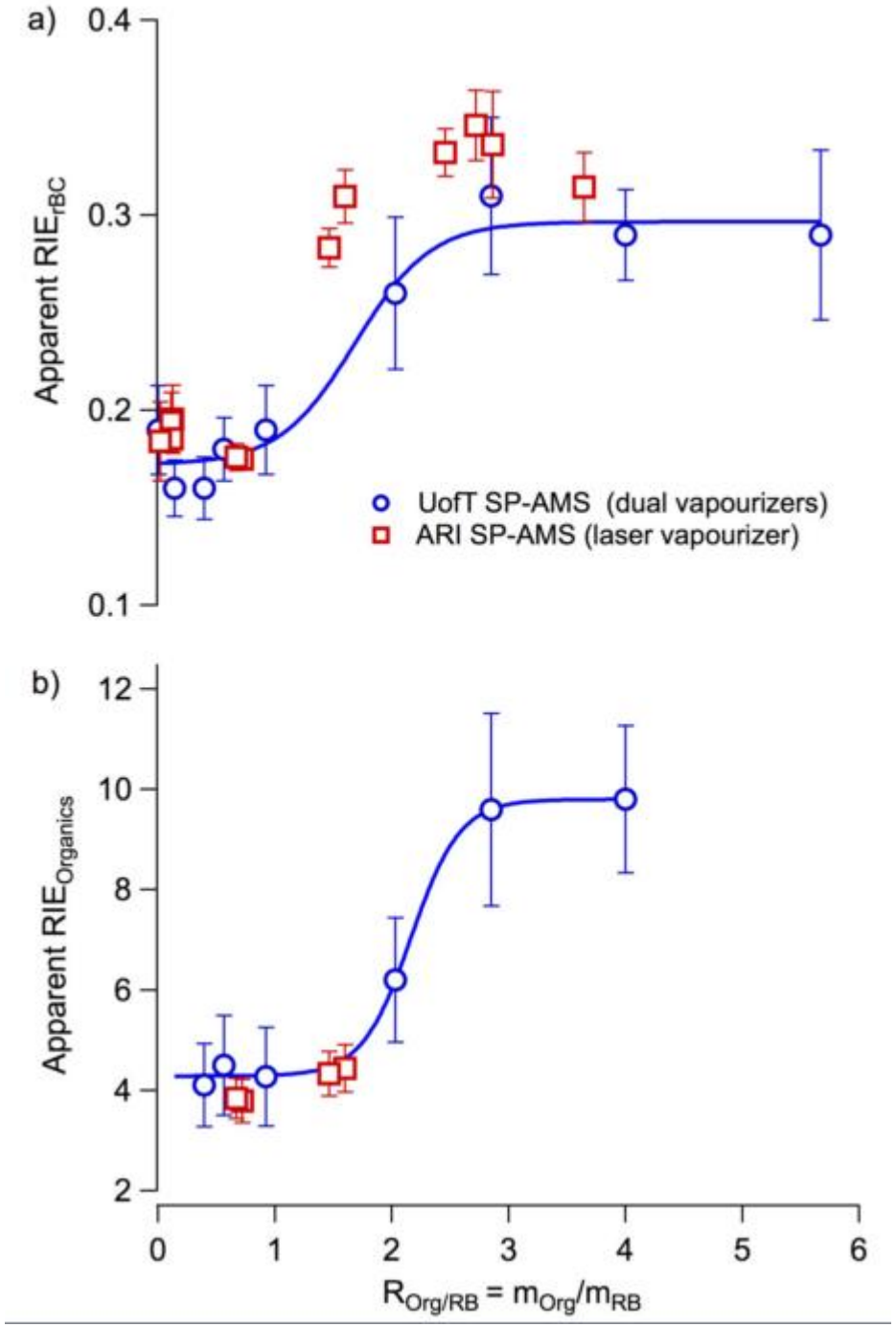
Summary 1

- rBC quantification is dependent upon laser alignment and power and overlap with particle beam.
  - BWP will provide internal measurement of particle beam width and, therefore, CE
  - We have new version of BWP hardware!
  - Qualification is that the CE is a strong function of particle beam width, making accurate measurements difficult

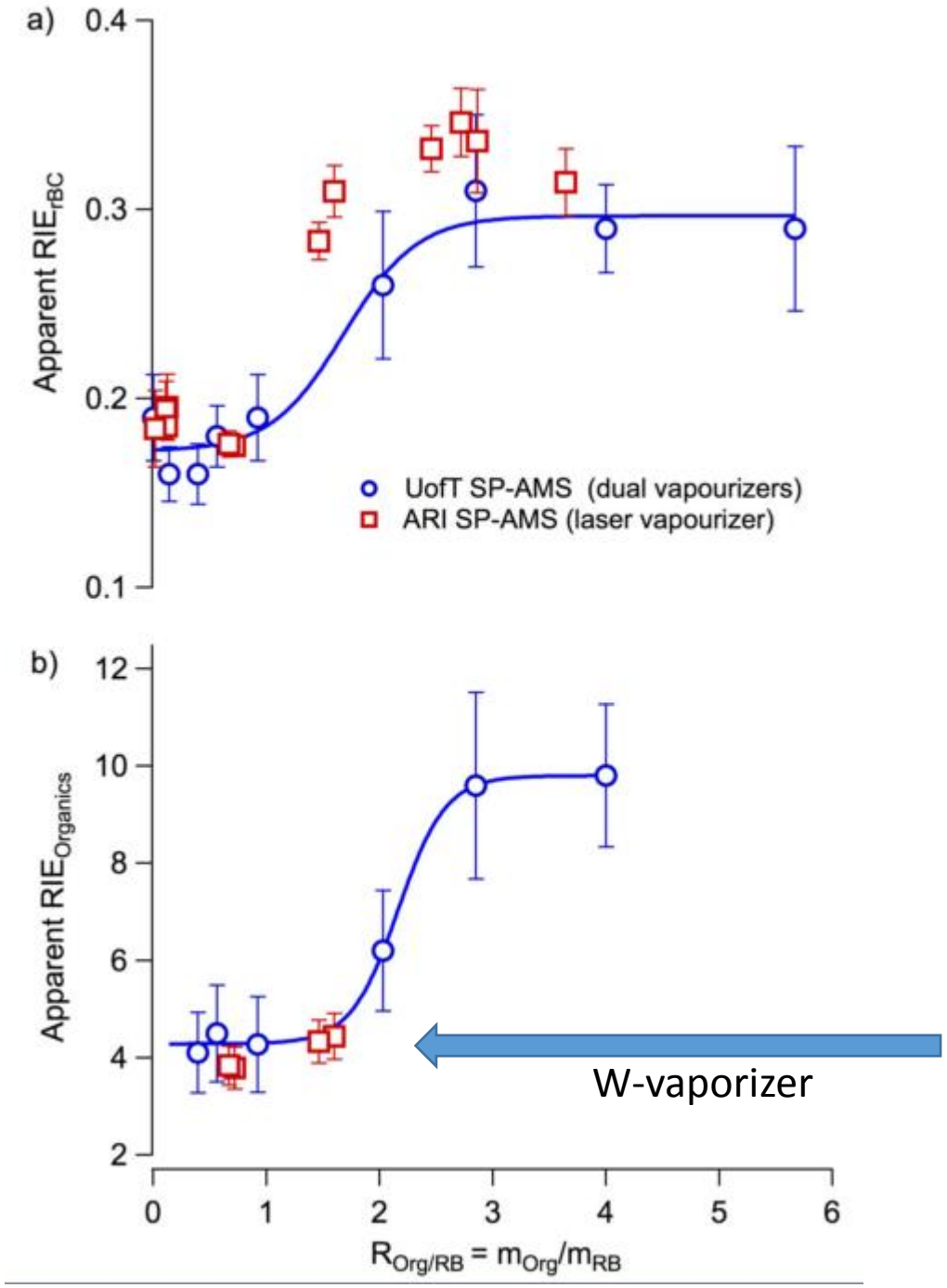
NR-PM_{BC} observations



- ORG and rBC signal transmissions decrease together with increasing DOS coating and narrowing of particle beam
- Suggesting that the effective particle beam widths for rBC and DOS are similar

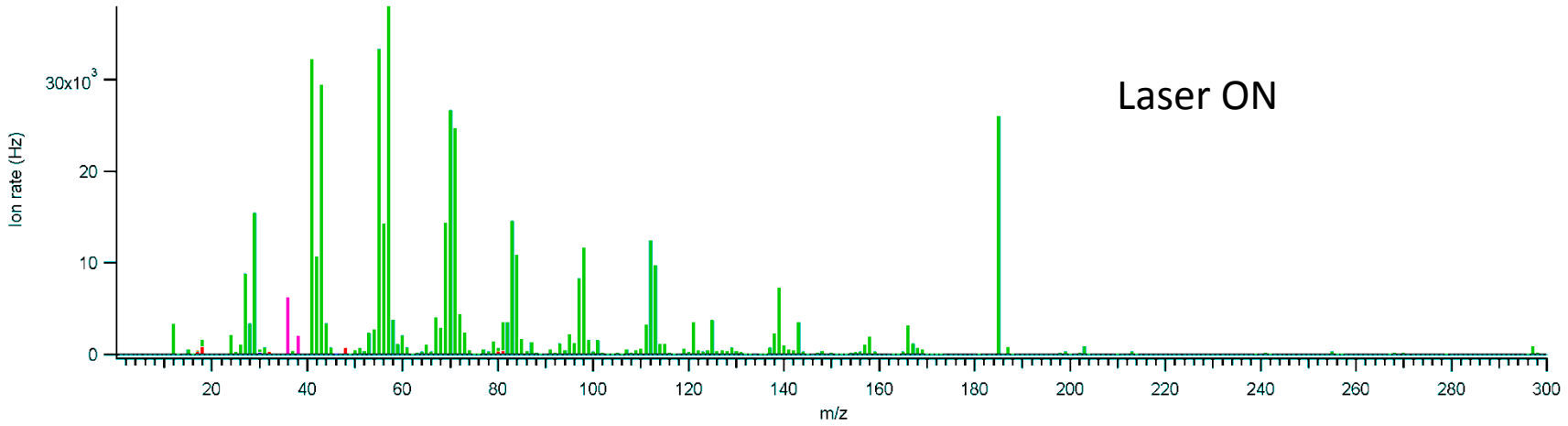


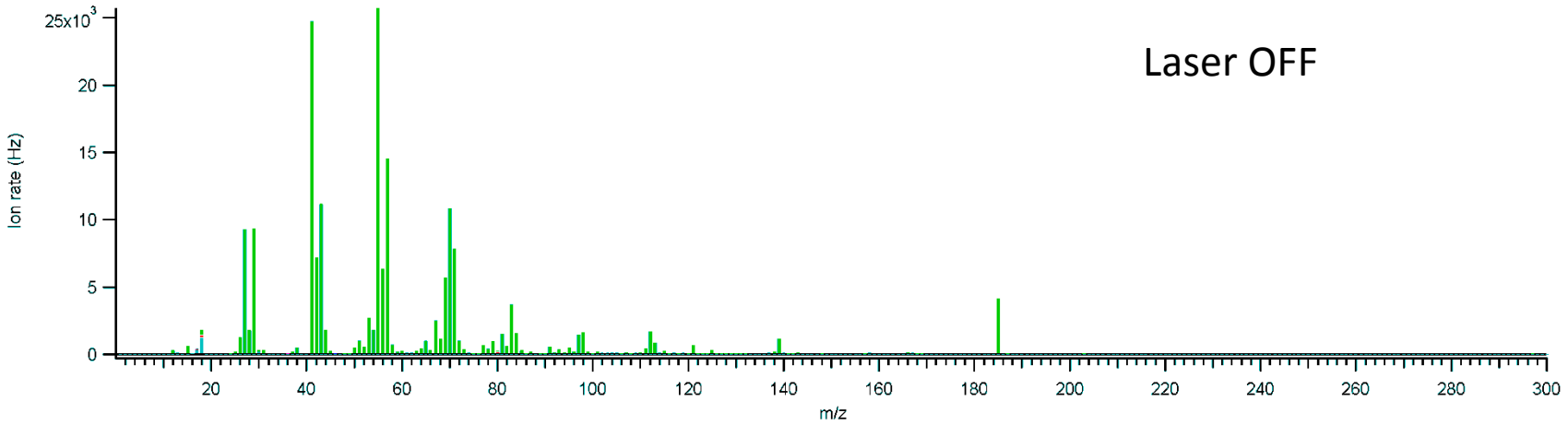
- Coated Regal black particles with DOS to make spherical
- With thicker coatings, RIE_rBC increased as the particle beam narrowed down closer to laser beam width
- Dual laser/tungsten vaporizer setup
- *Both* rBC and Org ion signals increased



- Question, why did the RIE_org start at ~4??

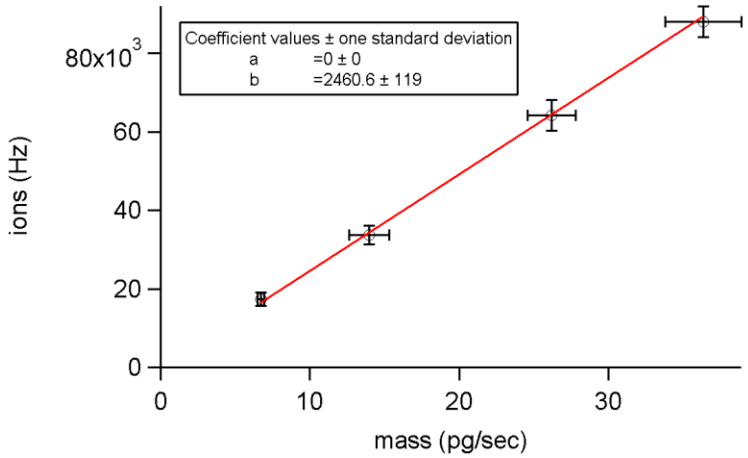
DOS


Laser ON
Ion rate (Hz)
30x10^3
20
10
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
m/z

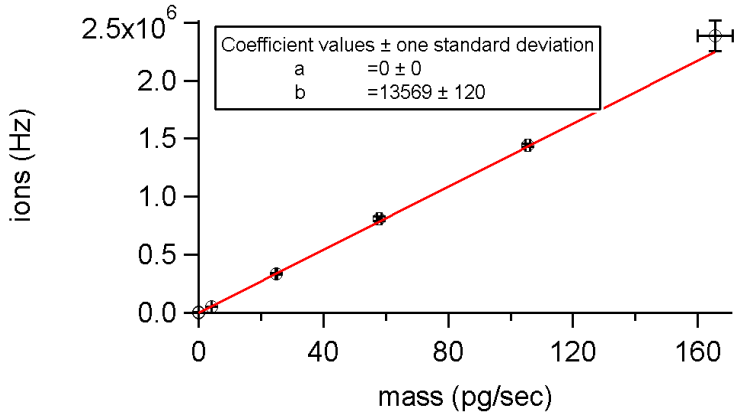

Laser OFF
Ion rate (Hz)
25x10^3
20
15
10
5
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
m/z

April 24, 2014
SP-AMS #2

300 nm AN



300 nm DOS



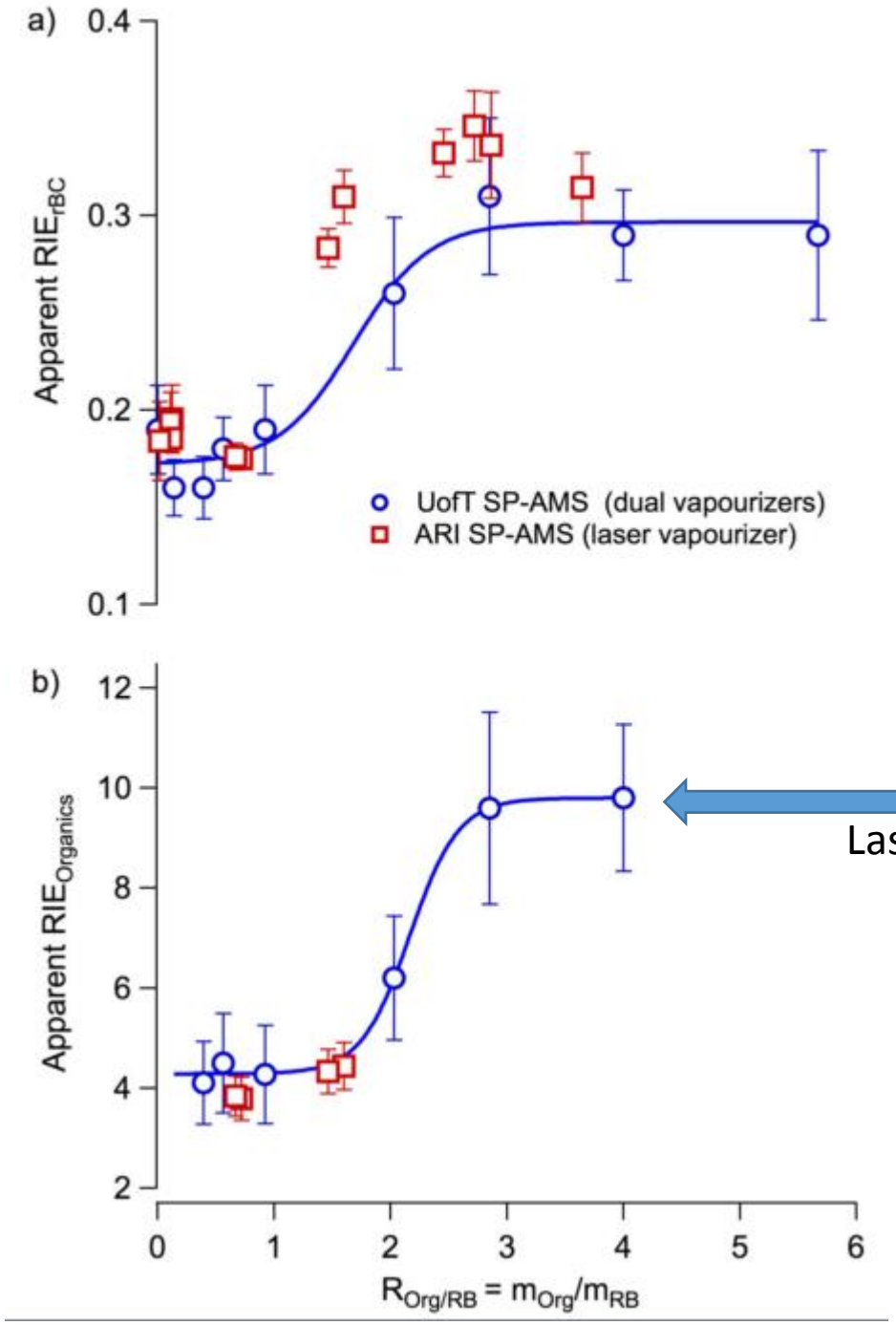
- RIE_DOS = 13569 / 2460.6 = 5.51

Results

- RIE_DOS = 5.46 ± 0.18

- Varying:
  - Two different instruments
  - Several different Pulser Frequencies
  - 200 and 300 nm DOS mobility diameters
  - 4 separate measurements

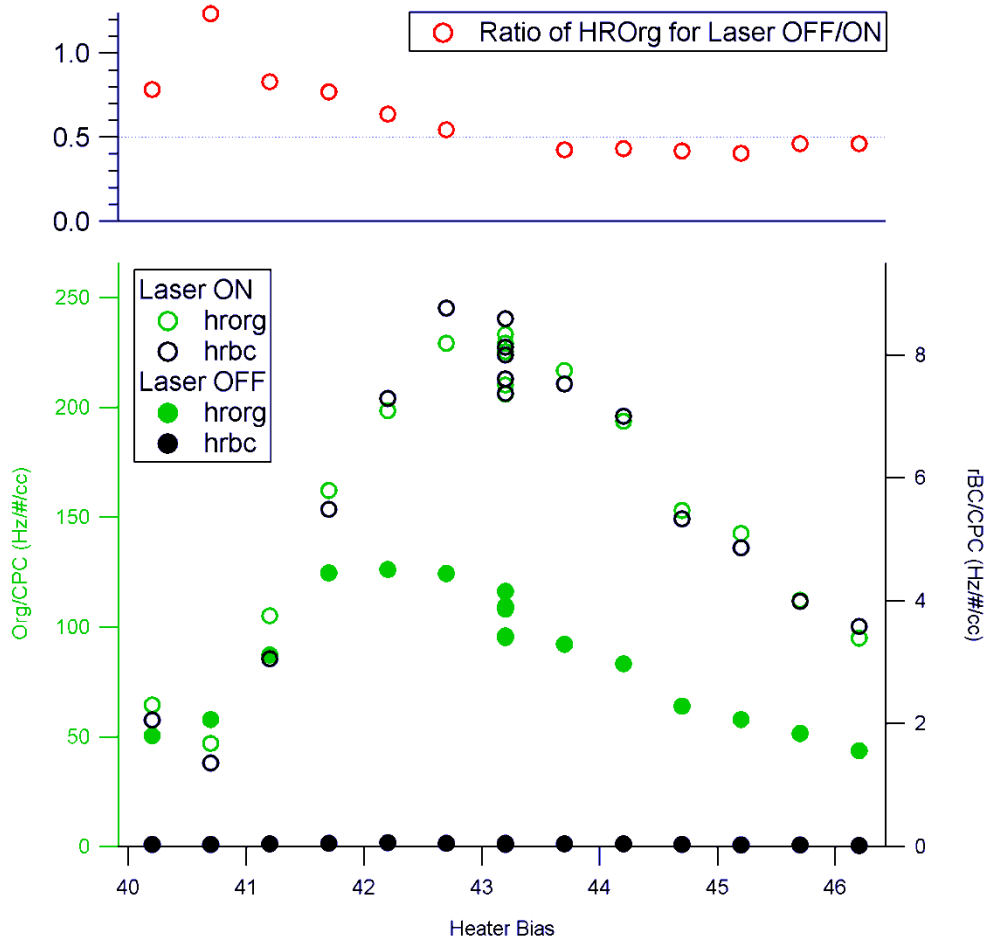
- High precision (~4%), but >> 1.4 for standard Org RIE



- RIE_org for DOS on laser vaporizer is ~10!?!
- RIE_org laser vaporizer >> W vaporizer??

Laser-vaporizer

DOS coated RB Laser OFF/ON Heater Bias Walk



- Similar observations as Toronto!
- More DOS ions generated from laser-RB than tungsten vaporizer

Summary 2

- NR-PM_{BC} sensitivity shows some evidence (lab) for ~2x increase compared with tungsten vaporizer, though it this is NOT yet definitive.
  - DOS has less fragmentation in laser vaporizer than W-vaporizer
  - DOS vaporizing at lower temperatures from soot surfaces than W-vaporizer, thus moving slower in ion chamber
  - DOS is not representative of ambient observations

  - *Need* more measurements of other materials coated on rBC particles!