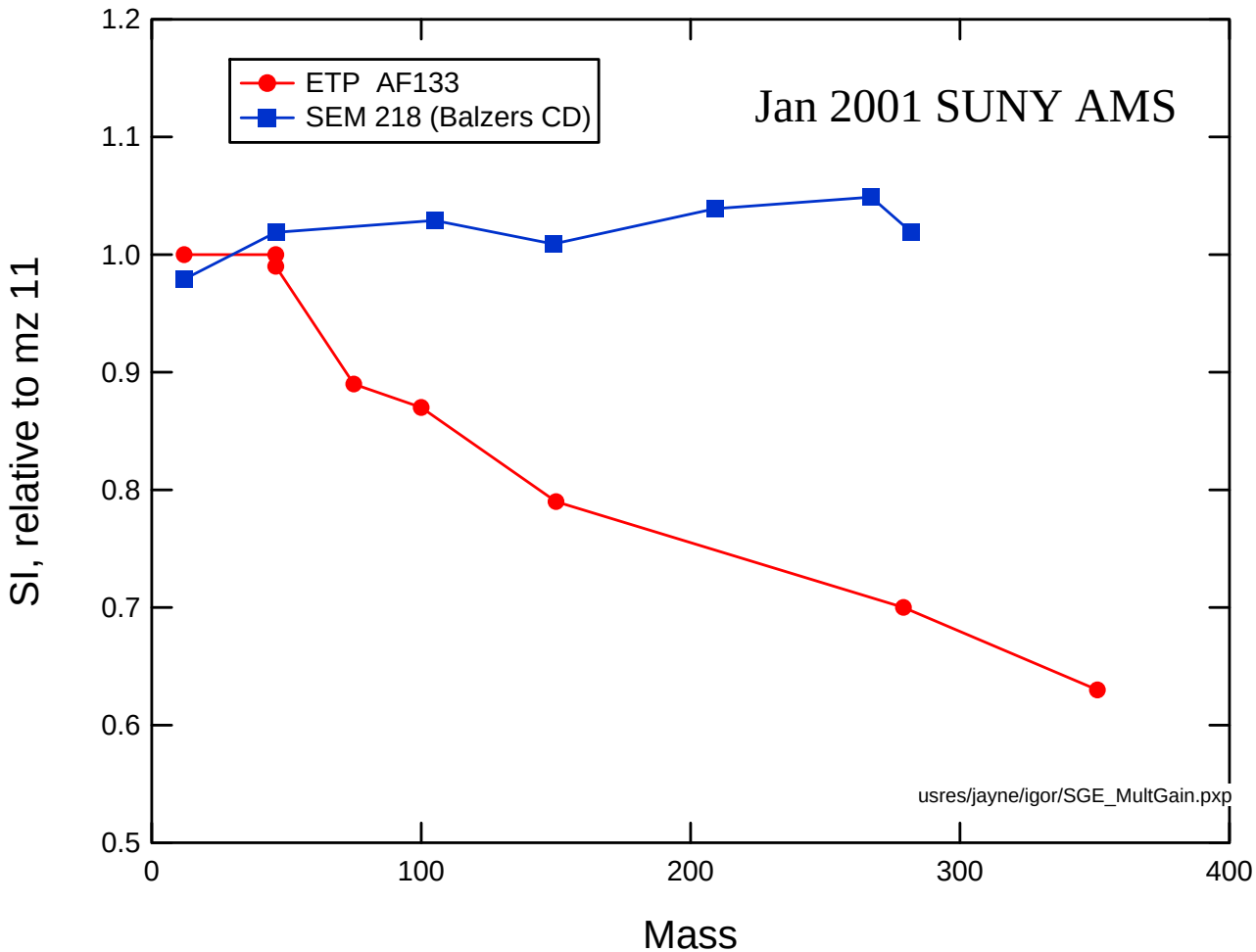
# Calibration Issues

John Jayne

5th AMS User's Meeting

10/11/04

# Decrease in multiplier efficiency with ion mass and effect of conversion dynode

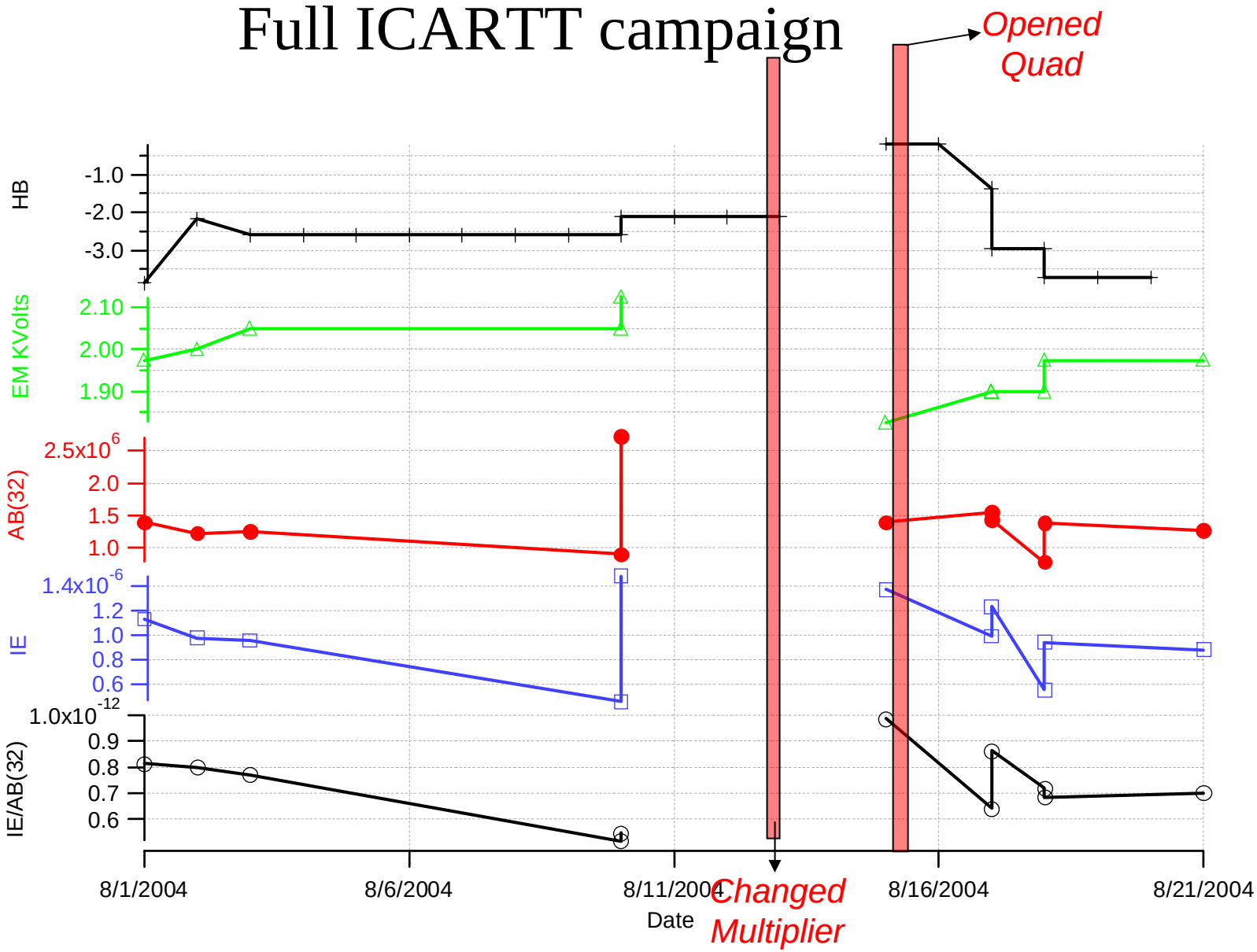



*Collection efficiency (EM/FC) of ions w/CD multiplier is ~3x lower than standard multiplier*

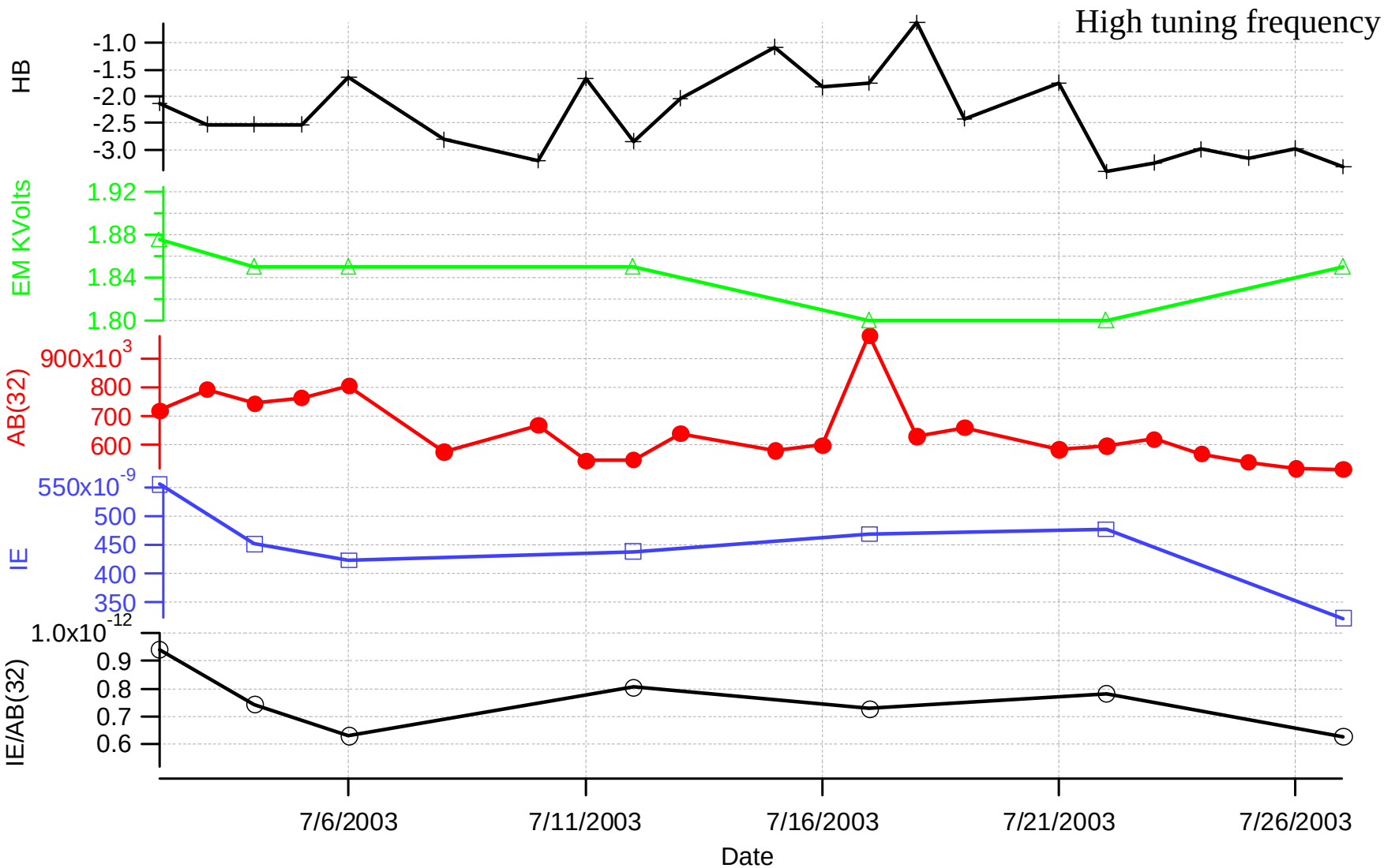
# Calibration Histories
# How well are we doing

- Ground based
- Aircraft based

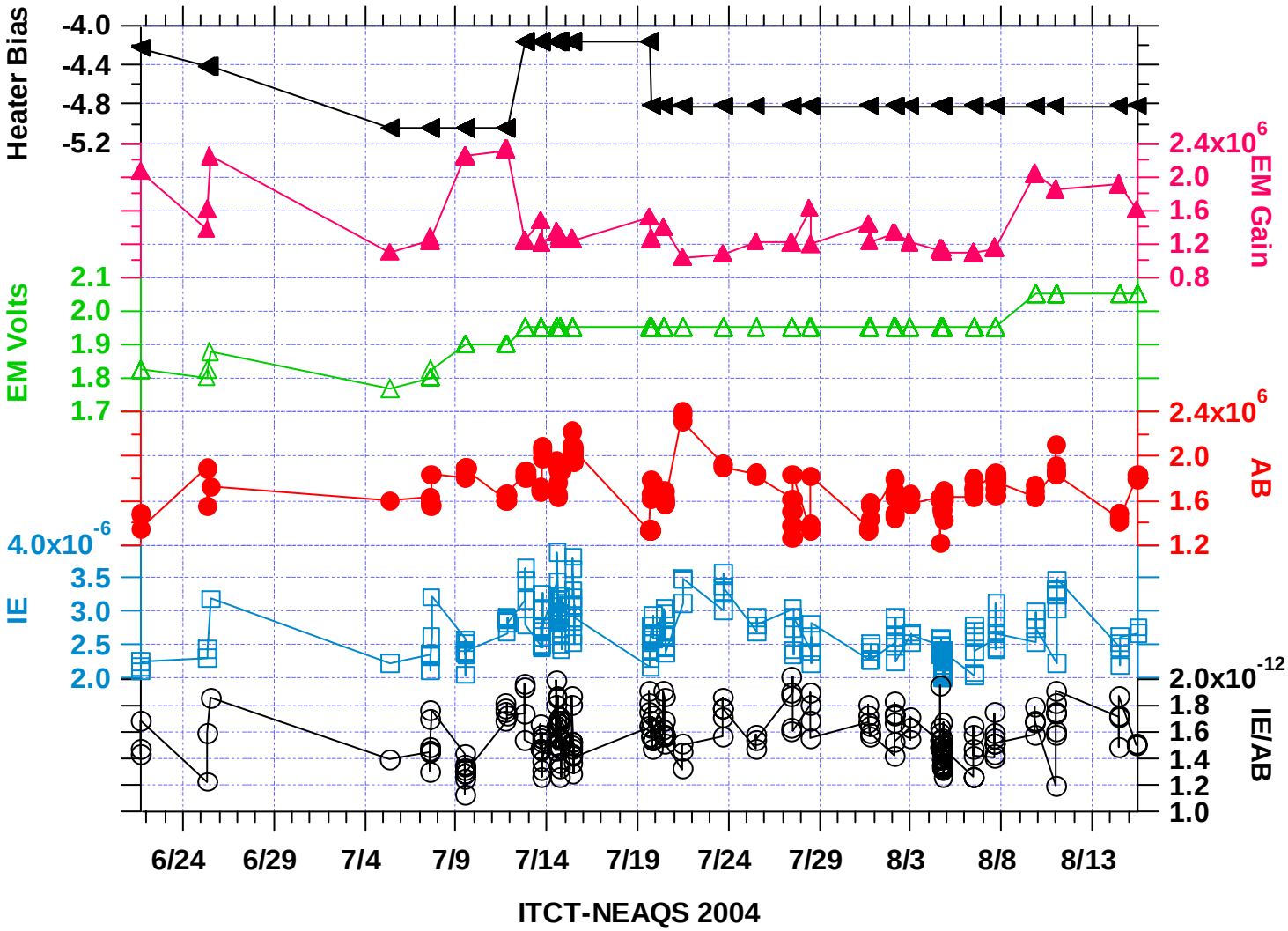
# Twin Otter Aircraft
# Basic AMS calibration/diagnostic parameters
# Full ICARTT campaign

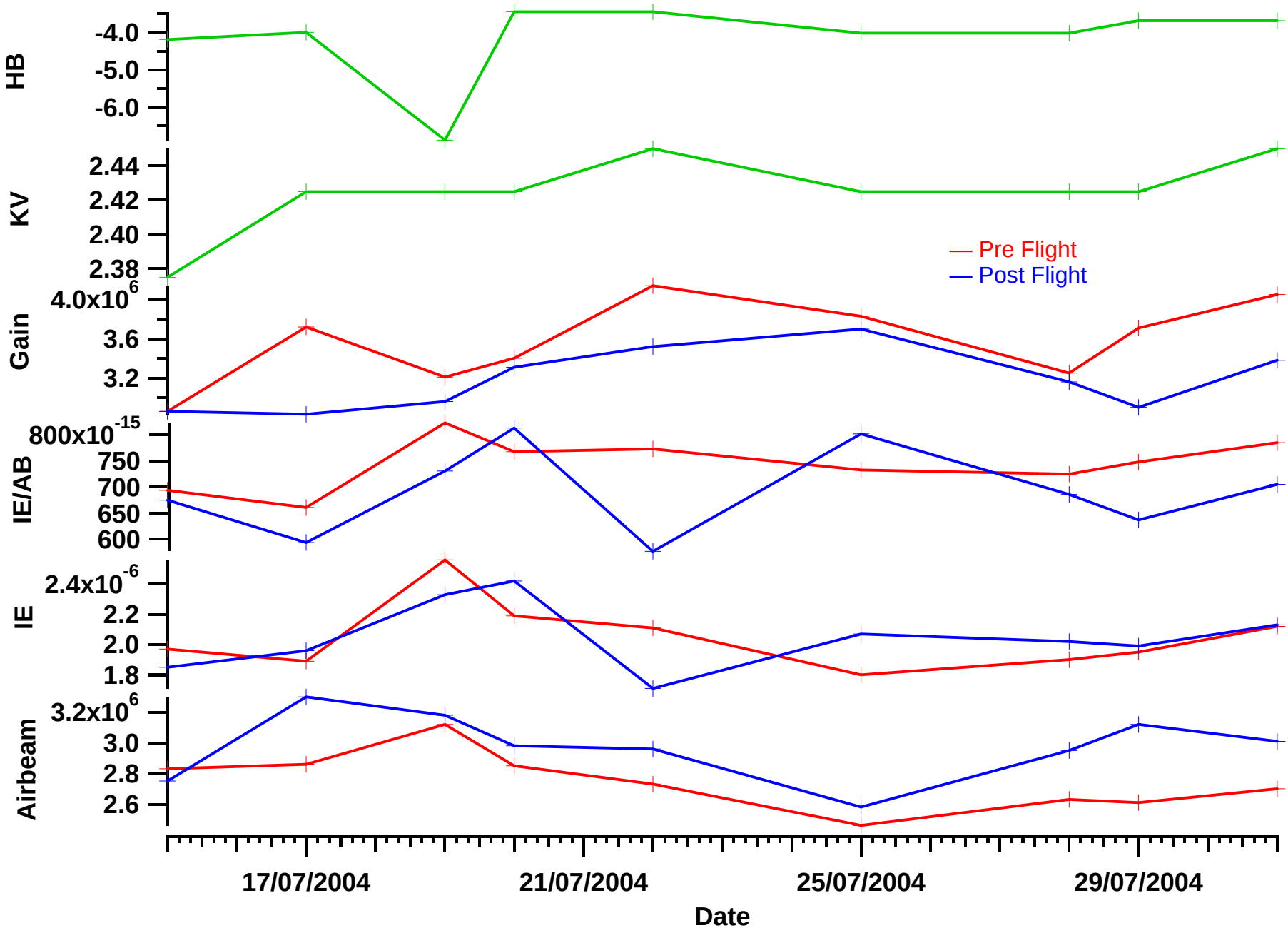


# Twin Otter Aircraft
# Basic AMS calibration/diagnostic parameters
# Full CSTRIPE campaign Roya/Shane

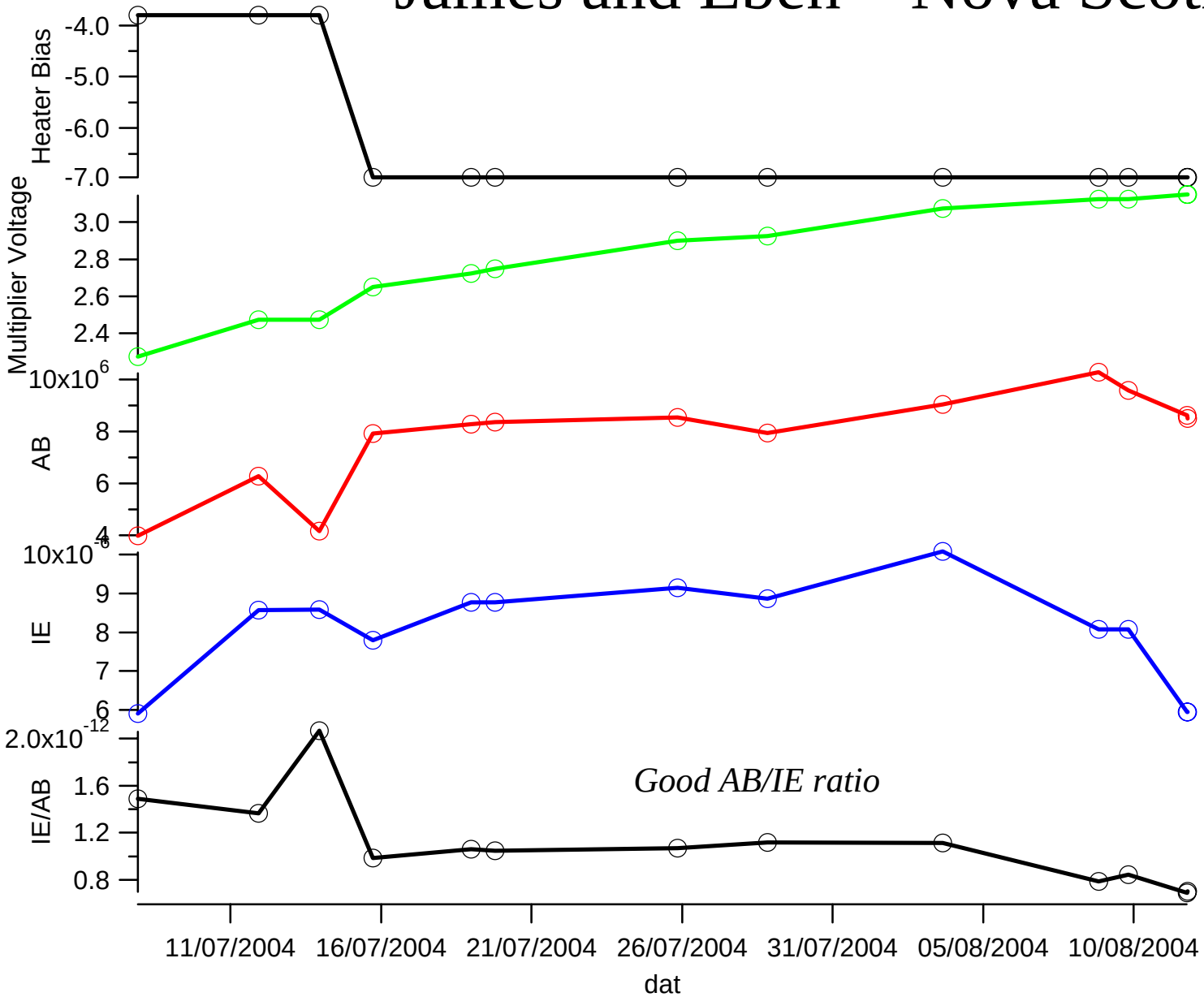


# P3 Aircraft Polydisperse calibrations
# Basic AMS calibration/diagnostic parameters
# NOAA AL for ITCT-NEAQS 2004 Ann/Brendan

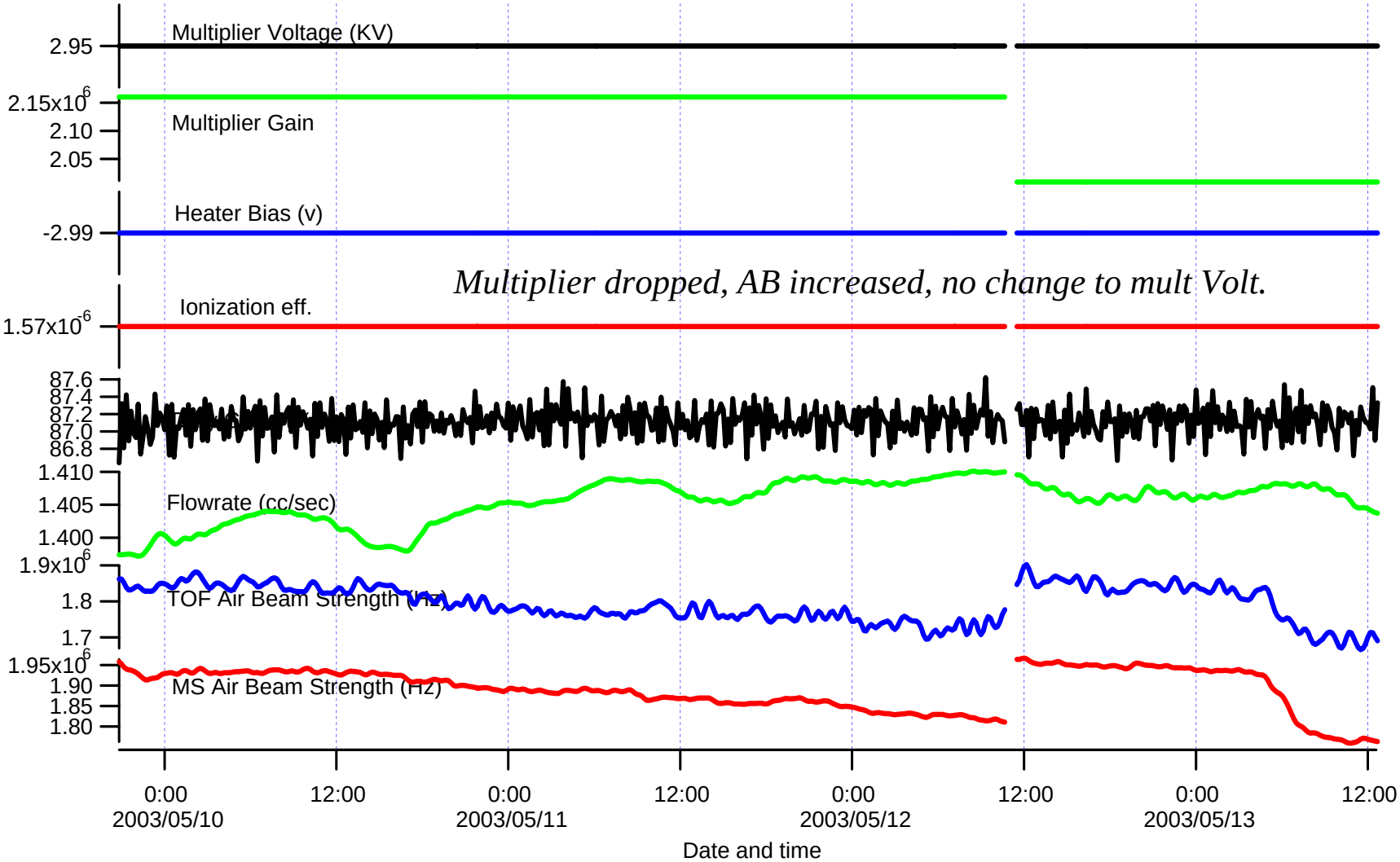



HB
-4.0
-5.0
-6.0
KV
2.44
2.42
2.40
2.38
Gain
4.0x10^6
3.6
3.2
IE/AB
800x10^-15
750
700
650
600
IE
2.4x10^-6
2.2
2.0
1.8
Airbeam
3.2x10^6
3.0
2.8
2.6
Pre Flight
Post Flight
17/07/2004
21/07/2004
25/07/2004
29/07/2004
Date

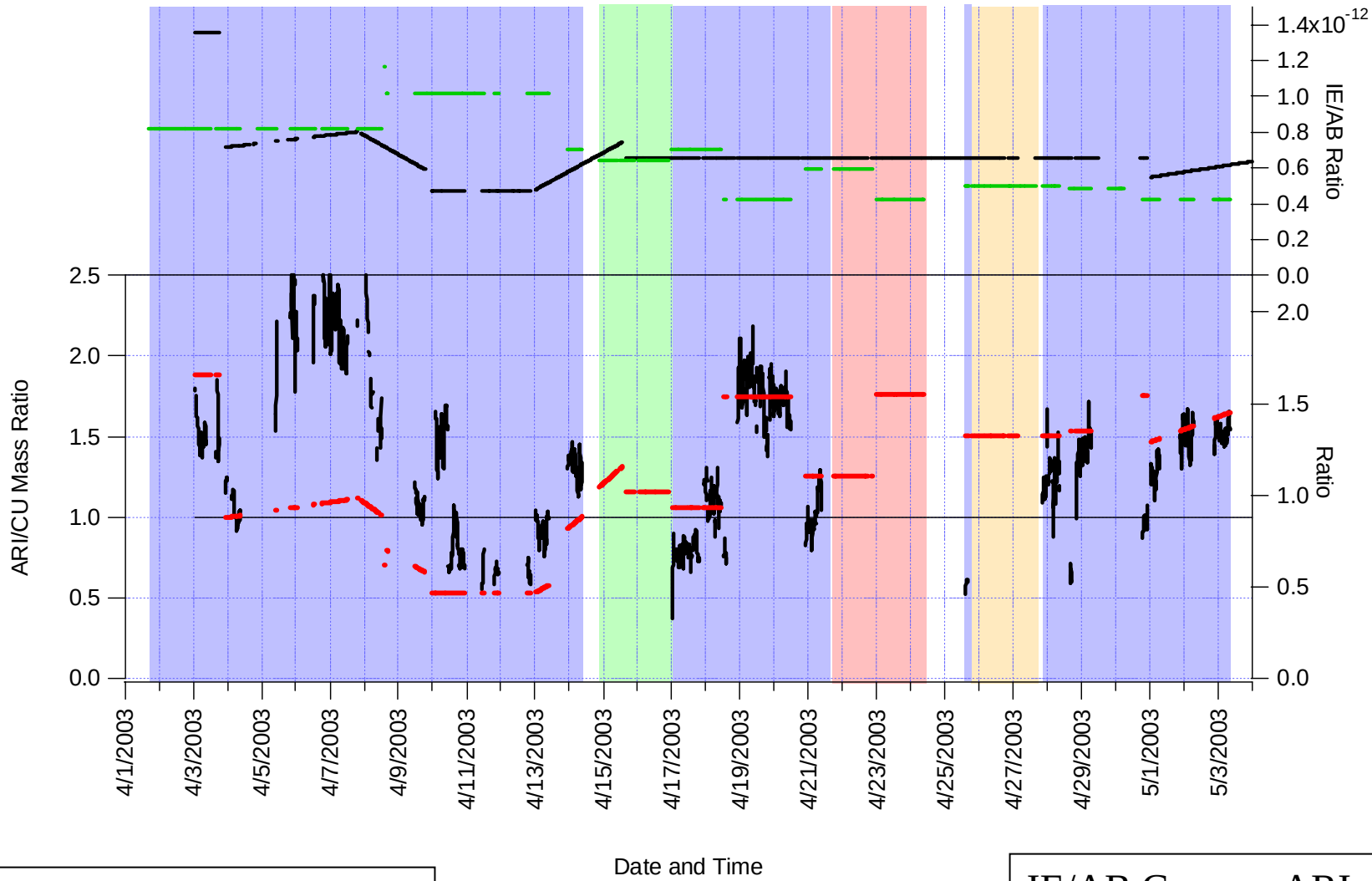
# James and Eben – Nova Scotia



# AMS calibration/diagnostic parameters - Nobu



# ARI/CU Ratio – Using ‘best’ calibrations



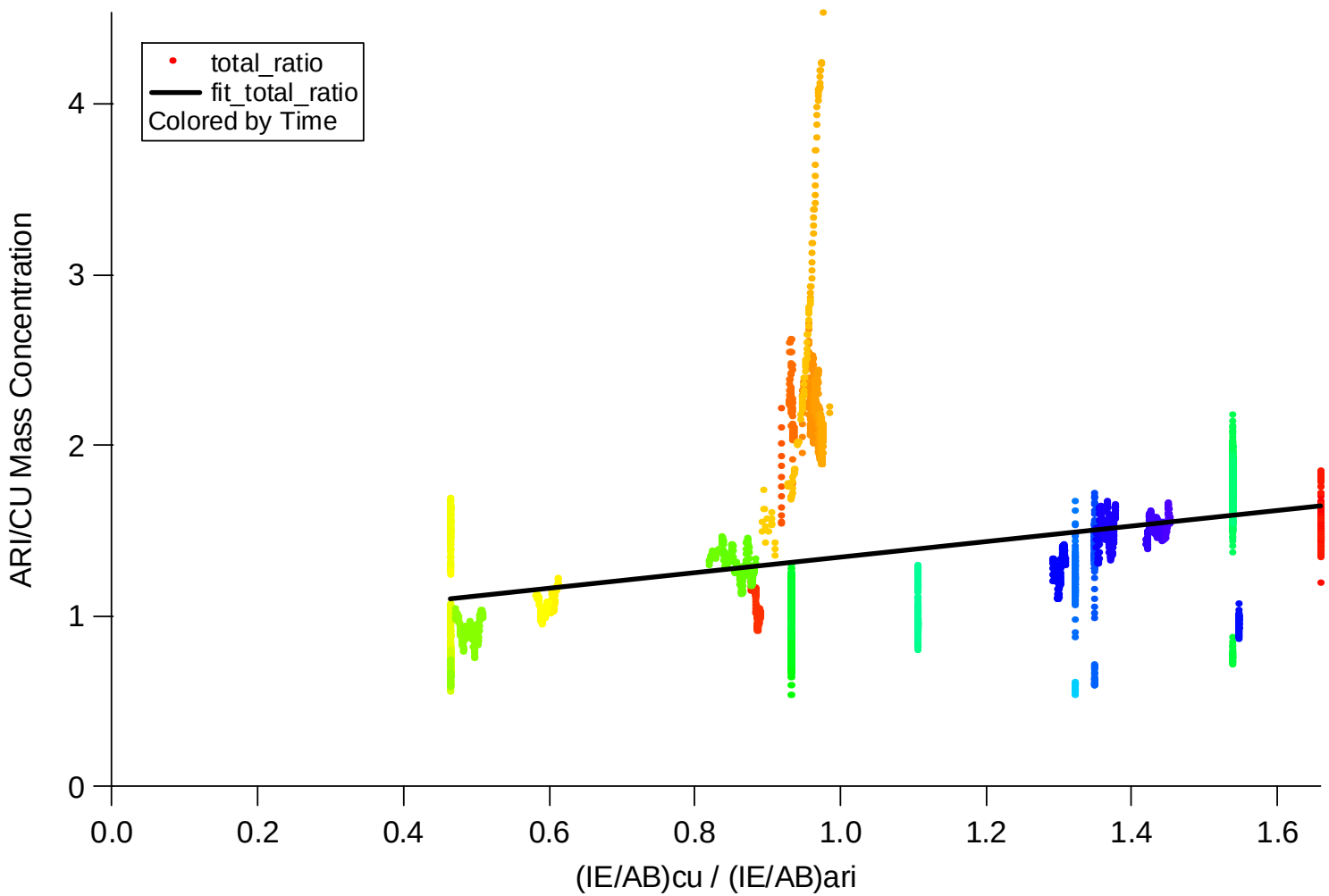

Ratio lines = AMS colors

IE/AB Green = ARI

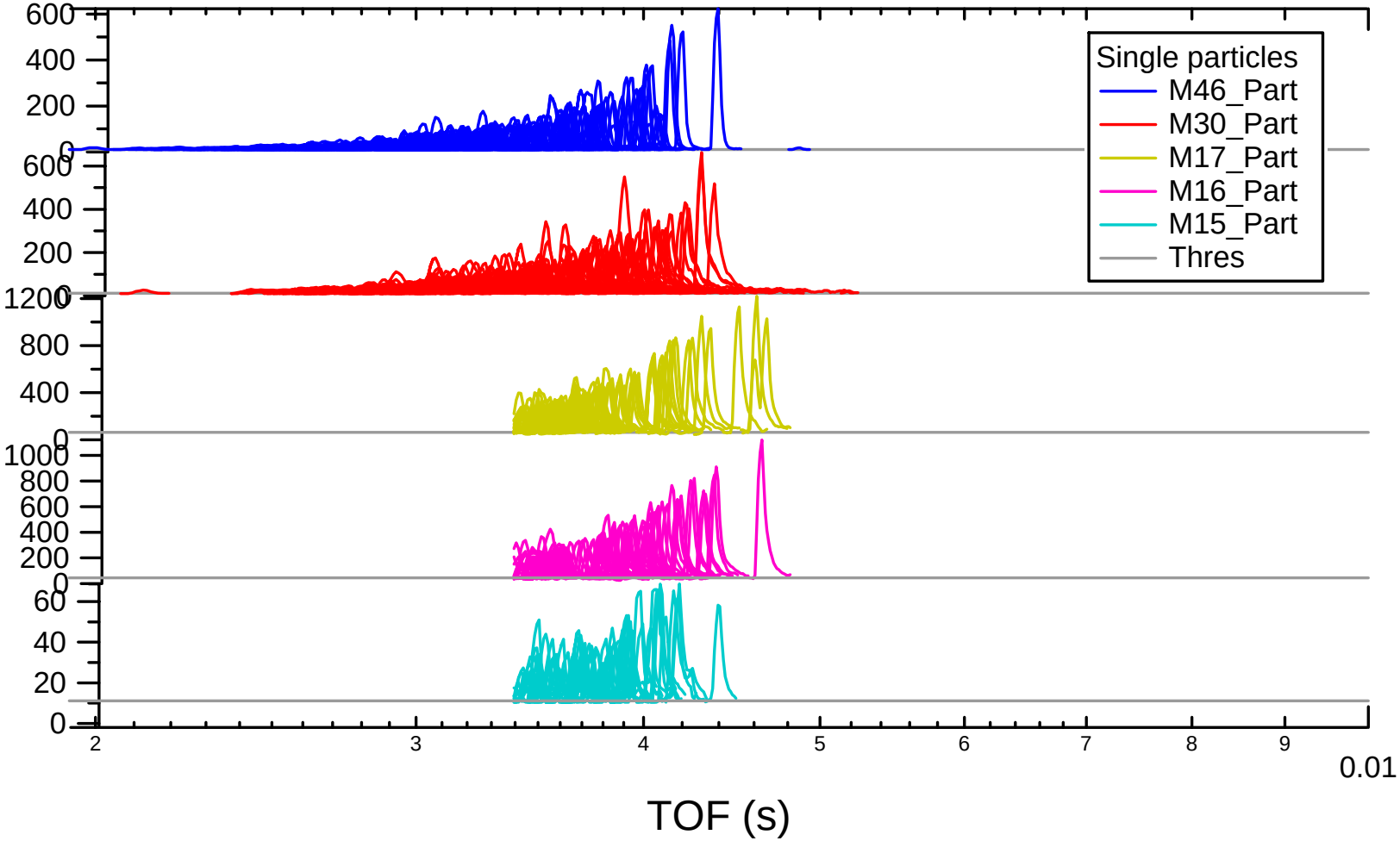
IE/AB Black = CU

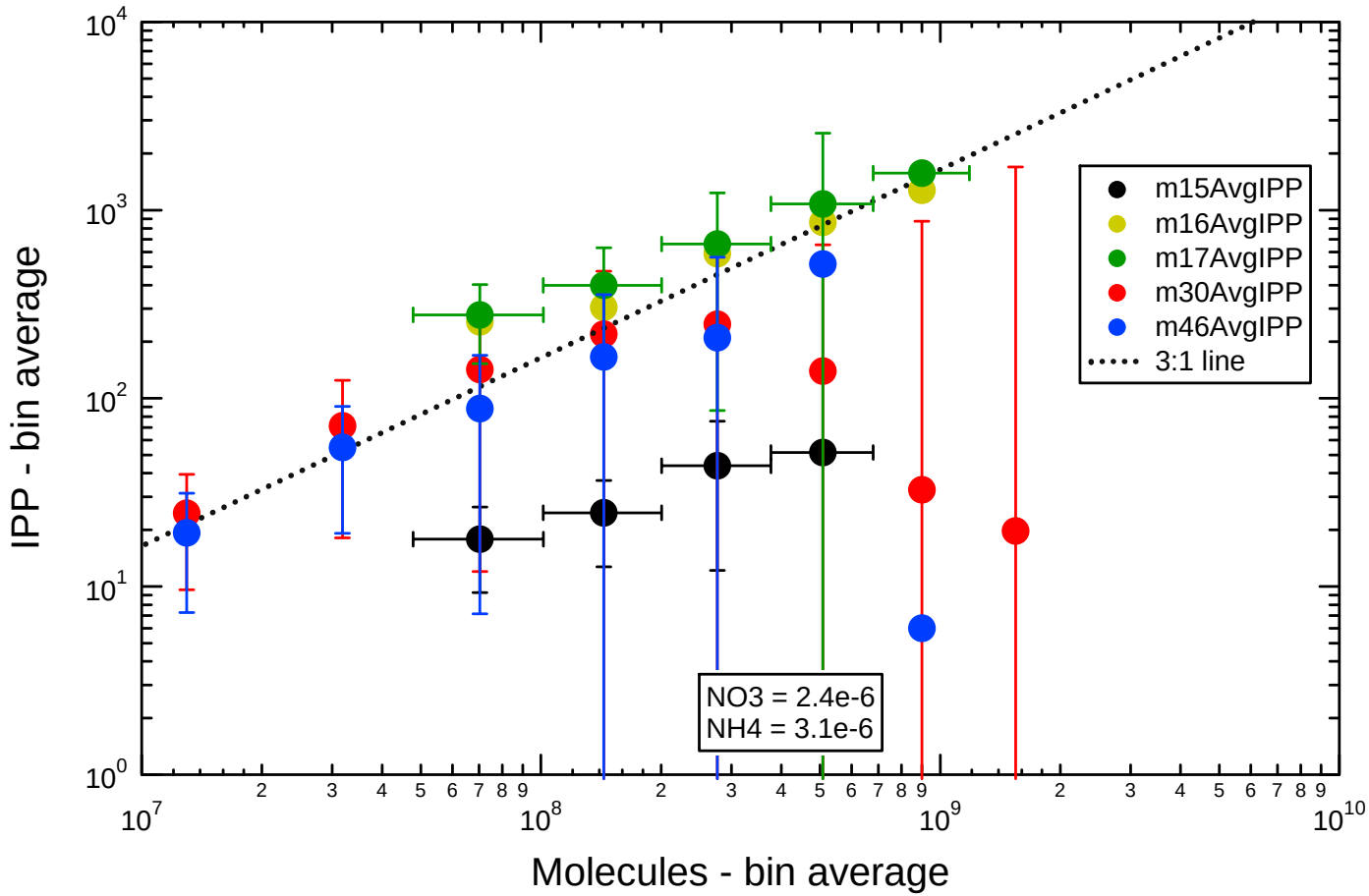
*Better practice not to ‘fiddle’ too much?*

# ARI/CU vs (IE/AB)cu/(IE/AB)ari



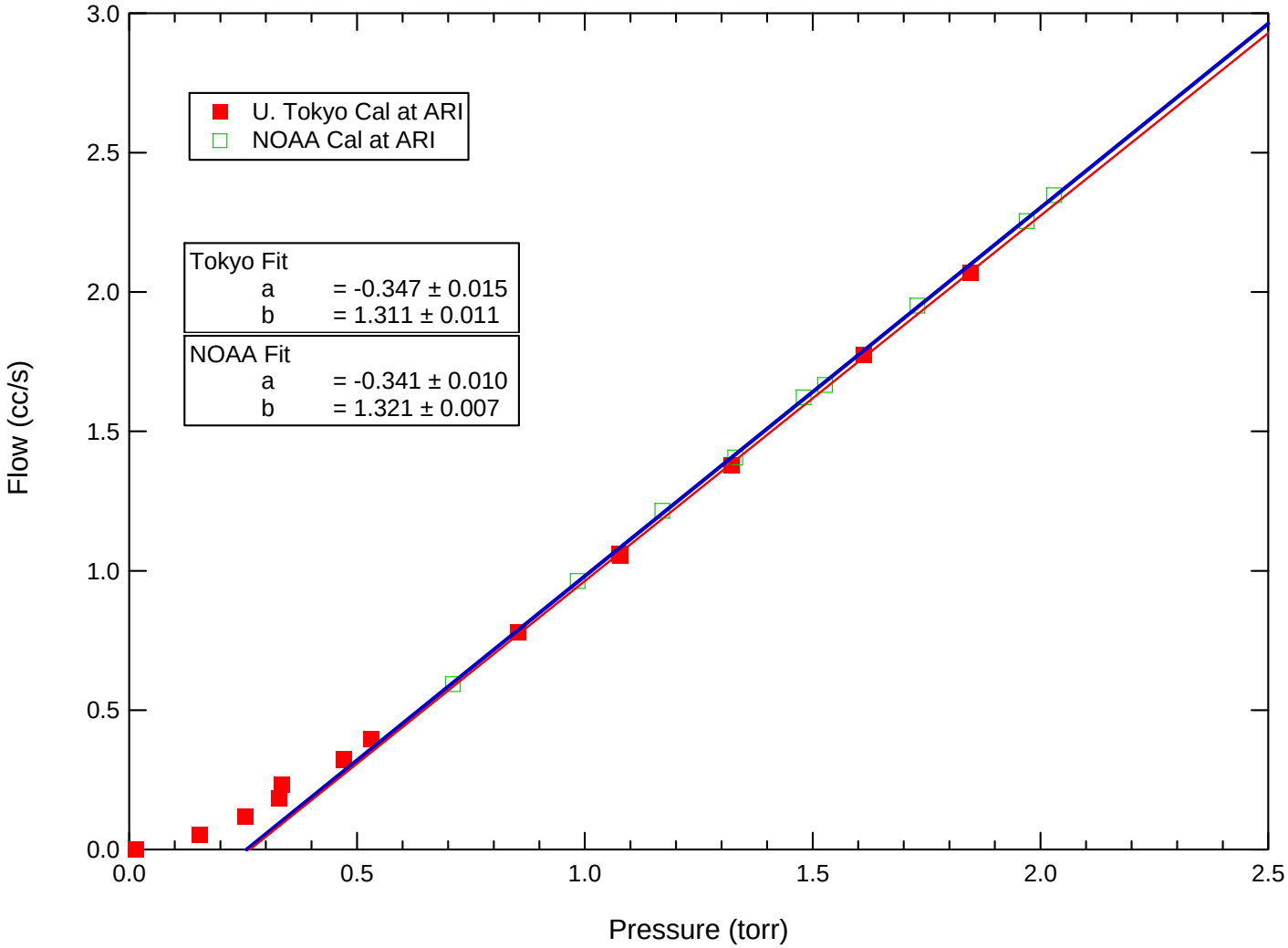
IGOR Procedure under development to analyze single particles to get a multi-point calibration for ionization efficiency




IPP - bin average
Molecules - bin average
m15AvgIPP
m16AvgIPP
m17AvgIPP
m30AvgIPP
m46AvgIPP
3:1 line
NO3 = 2.4e-6
NH4 = 3.1e-6

# Flow calibration

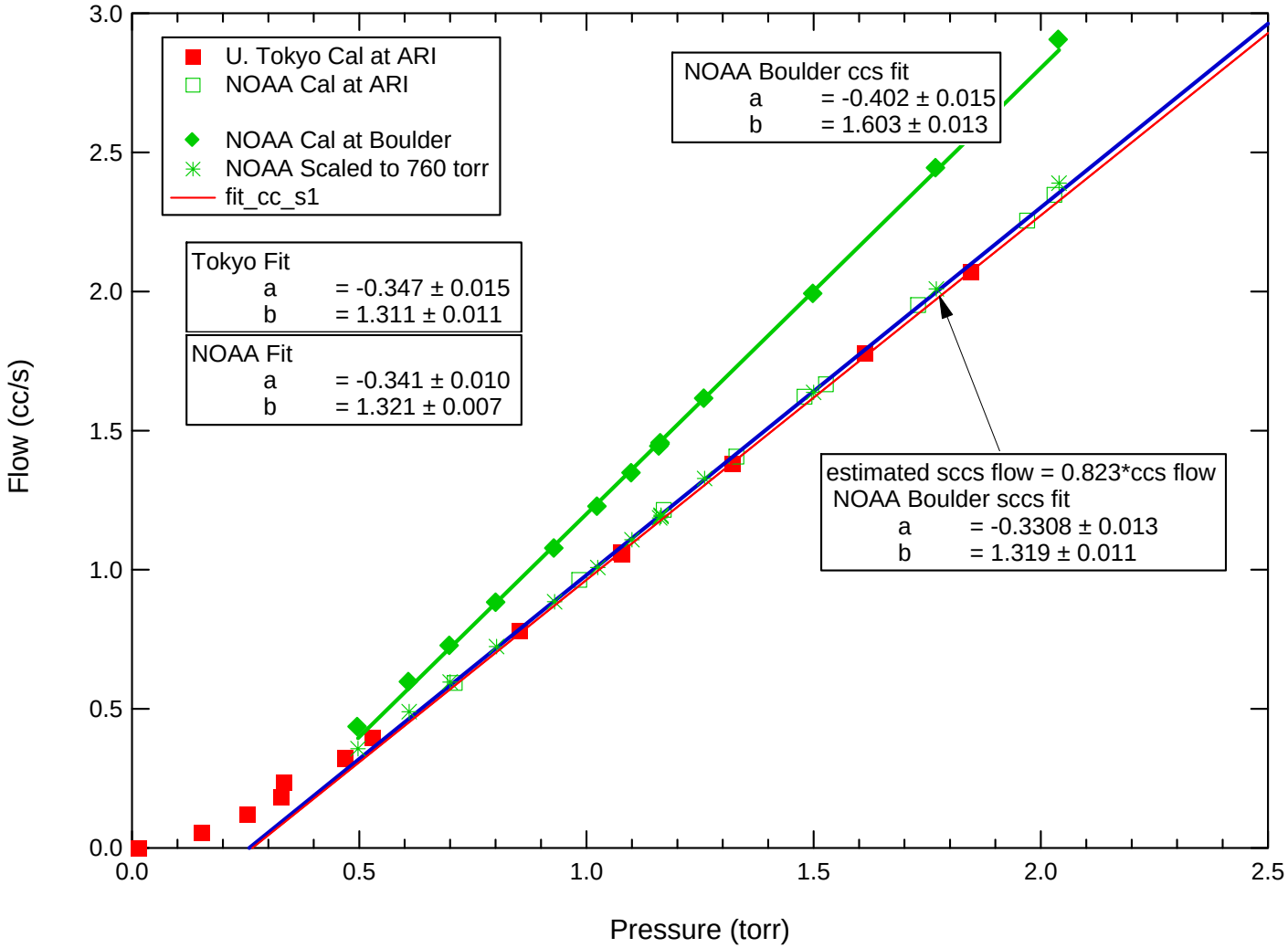
A volumetric flow meter




Absolute pressure gauge

# Flow calibration

A volumetric flow meter




Absolute pressure gauge

# Particle Mass Loading

From quad (IE calibration)

$$\frac{\mu g}{m^3} \rightarrow \frac{\text{mass}}{\text{volume}}$$

From volumetric flow rate

*Should the air volume we sample be referenced to STP?*

# If the ambient pressure changes:

The value for the flow rate in the data file will also change via the flow-pressure calibration curve.

However the volumetric flow has not changed…

Should not let this fold into the AB correction since the sensitivity of the quad system has not actually changed.

*James, is this what we are doing?*

Should we routinely measure T and P

Absolute pressure and temperature so we can determine the mass flow into instrument?

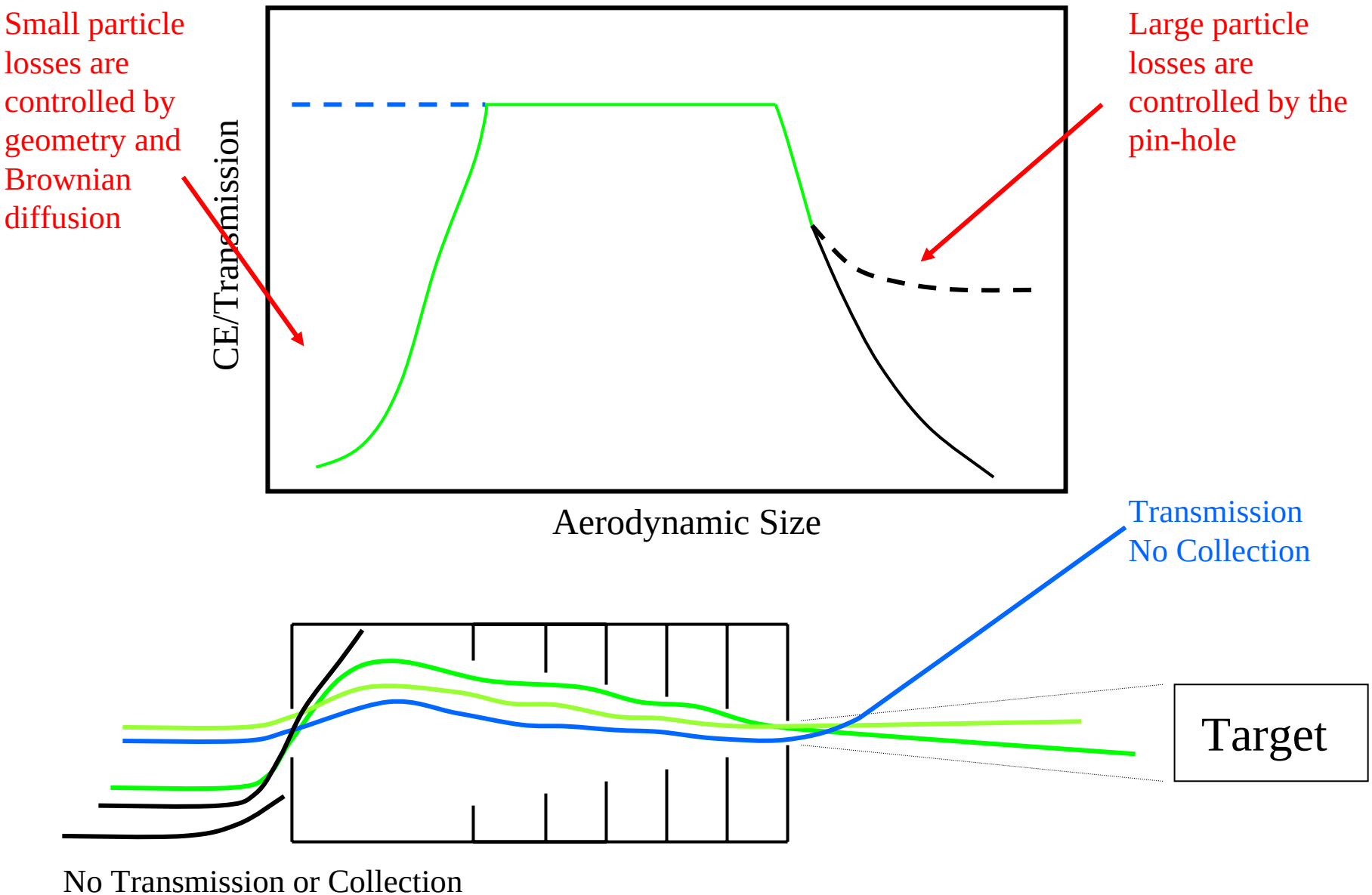
# Current Calibration and Quantification Issues

*Biggest Issue is the factor of 2 or CE=0.5*

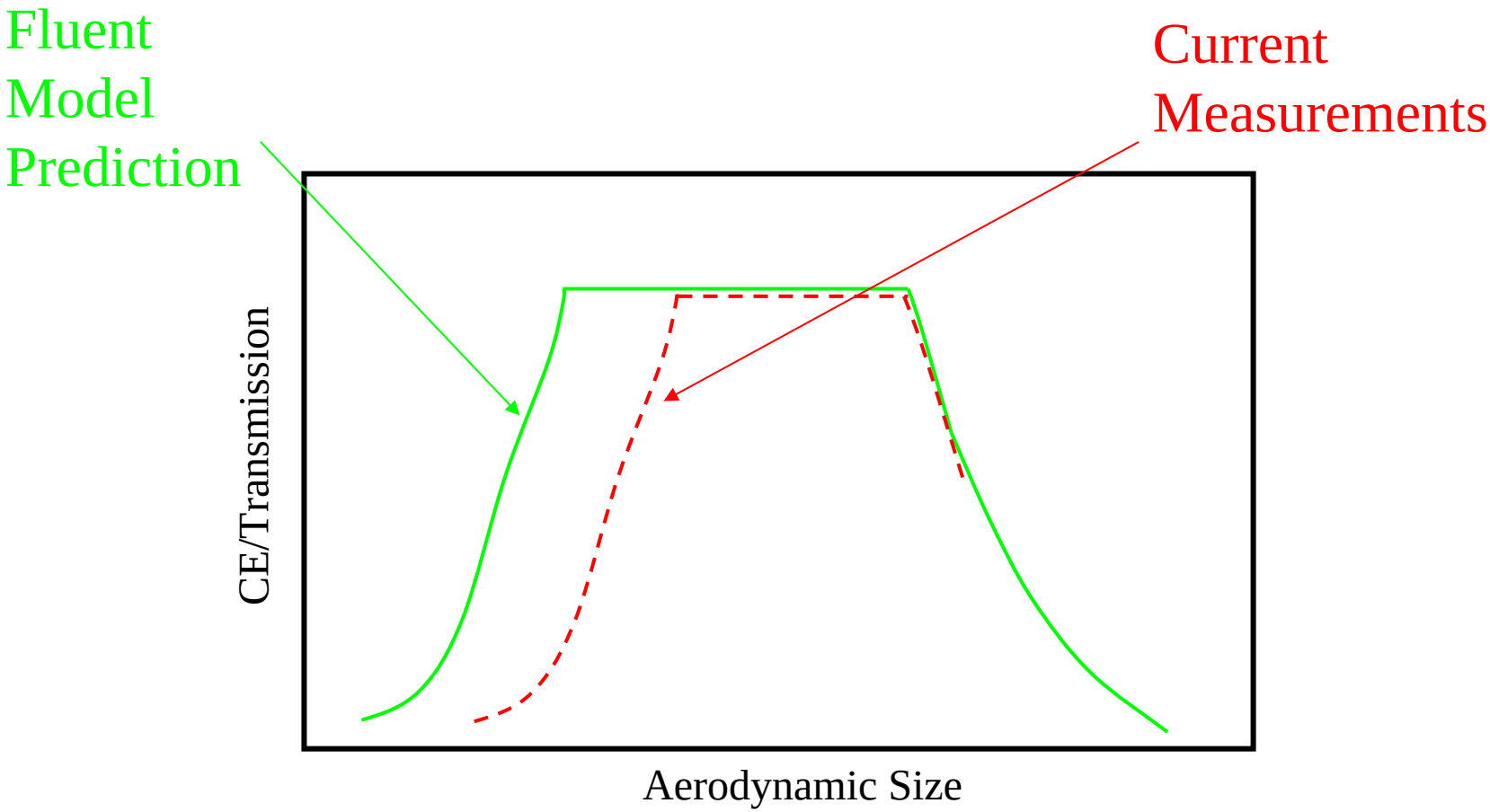
- Particle focusing/divergence?
  - Improved Beam Width Probe
  - Shortened length of chamber by 10 cm

- Particle Bounce?
  - Light scattering probe and BWP results
  - Is there a better design for the vaporizer?
  - Can we directly a “bounce” event?

# Particle Transmission versus Collection in Aerodynamic Lens



# Can we measure and verify the predicted lens transmission?



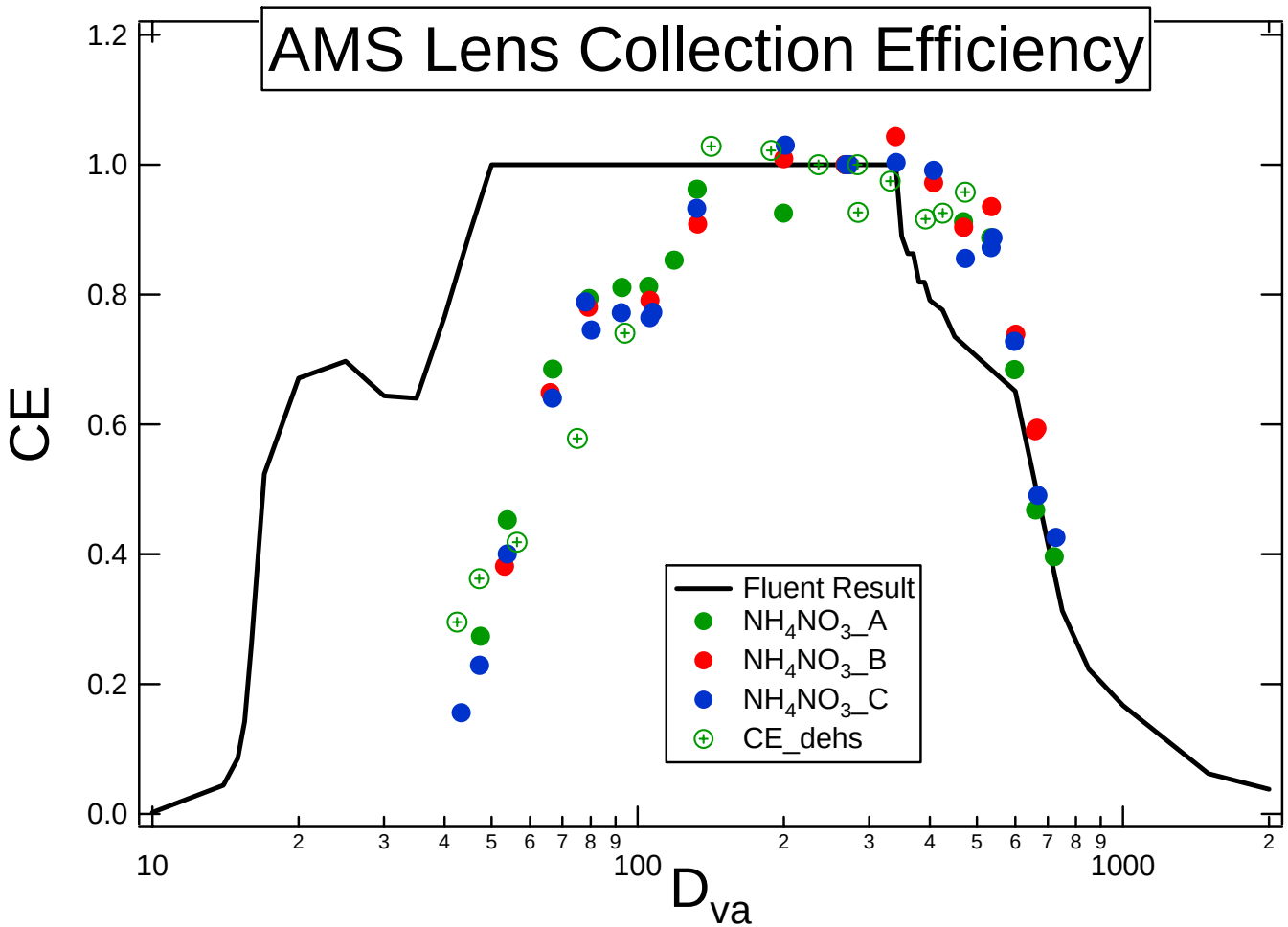

*Peter Decarlo's model vs Peter Liu's measurements*

# Lens Transmission/Collection Dilemma

- Pittsburgh AMS/SMPS data set suggests that AMS transmission is as good as the predicted value.

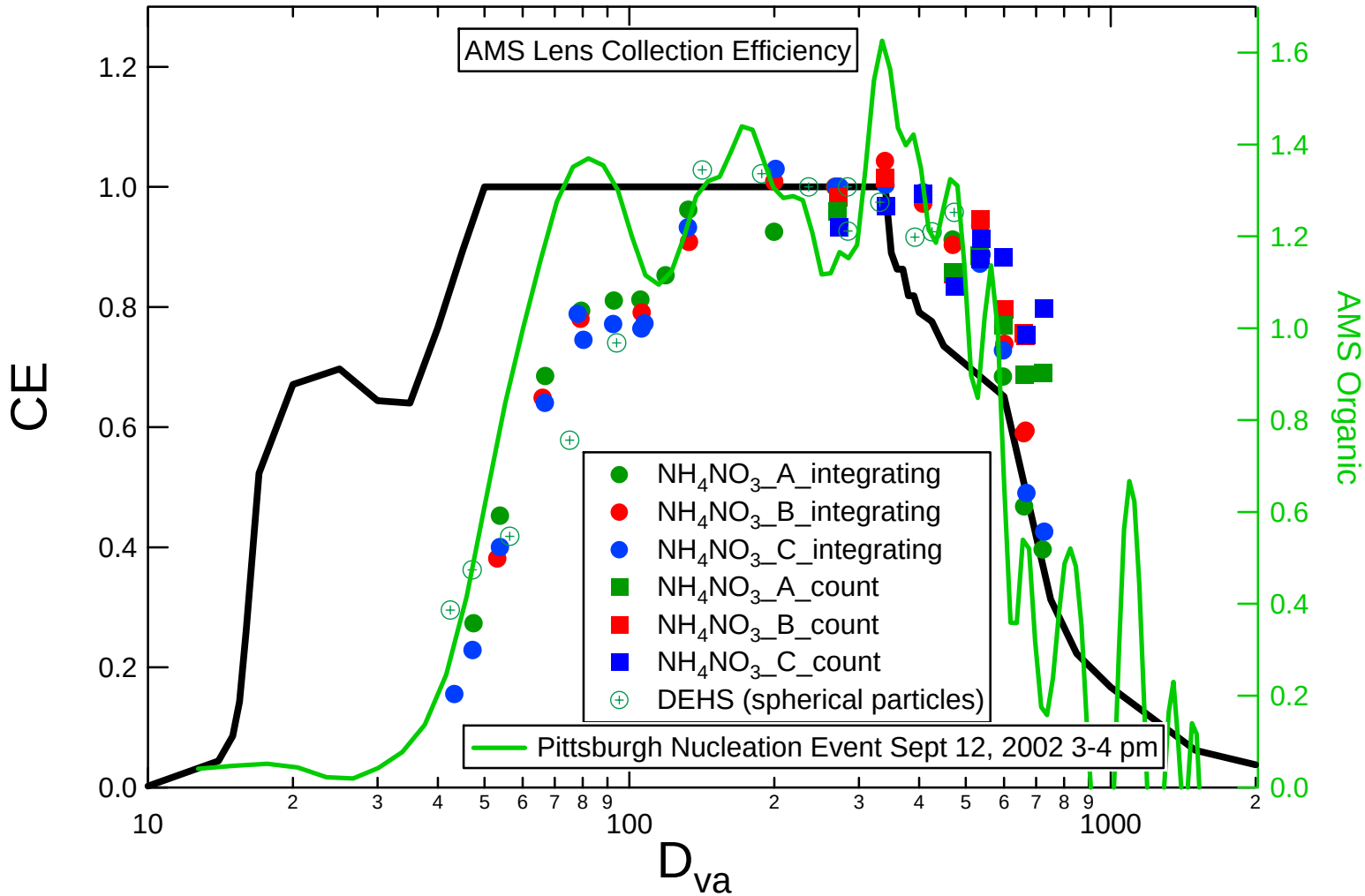
- Laboratory measurements by Peter Liu (UW) and ARI have been unsuccessful to match predicted transmission.

Collection Efficiency results for 1/2OD lens and 100 um pin hole
Peter Liu, U. Wyoming



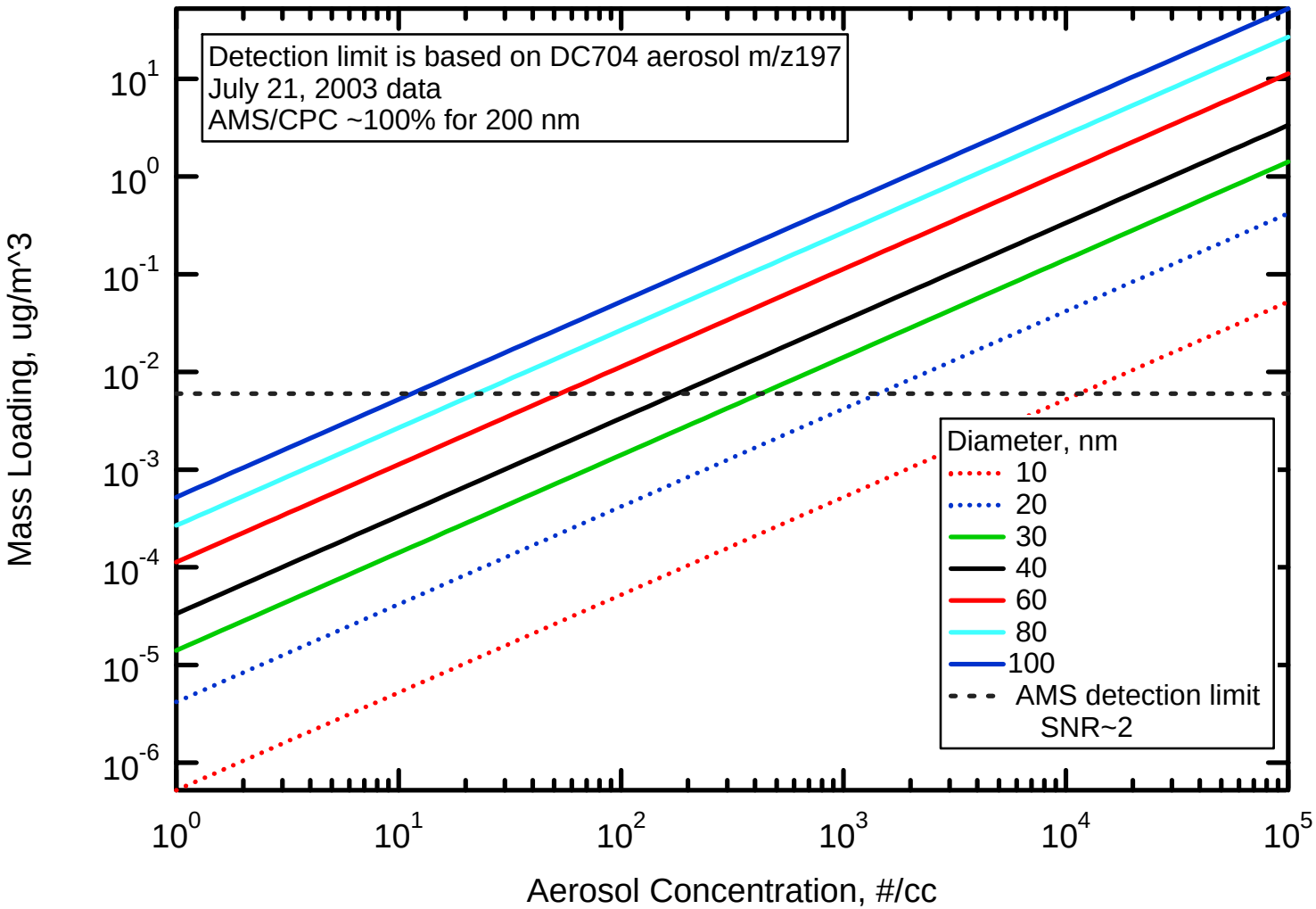

Lens press = 1.153 torr at Wyoming 780 mbars = 585. *Variation of flow changes velocity calibration and transmission*

Collection Efficiency results for 1/2OD lens and 100 um pin hole
Peter Liu, U. Wyoming




Lens press = 1.153 torr at Wyoming 780 mbars = 585. *Variation of flow changes velocity calibration and transmission*

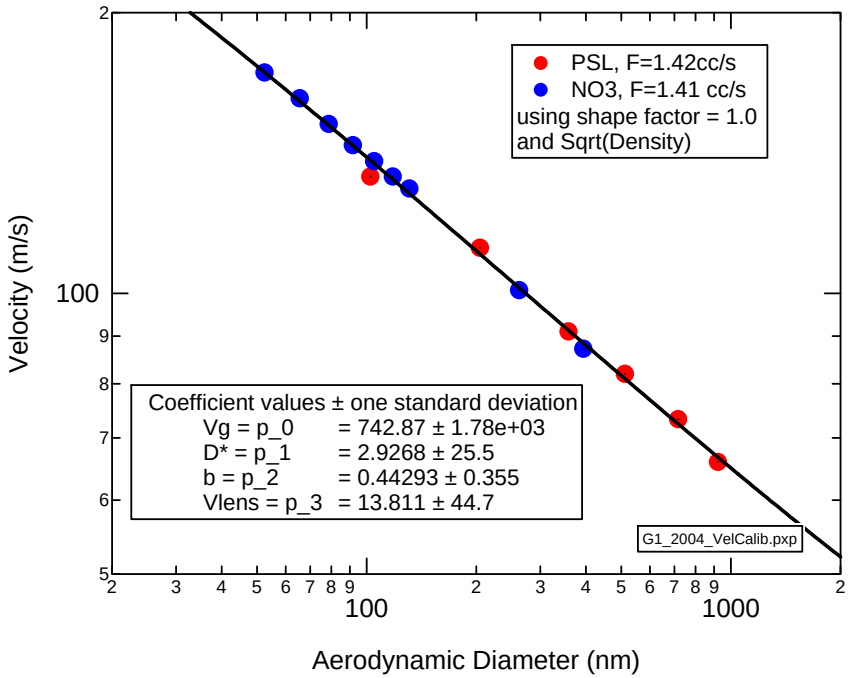
# Calculated mass as a function of aerosol concentration for several particle sizes



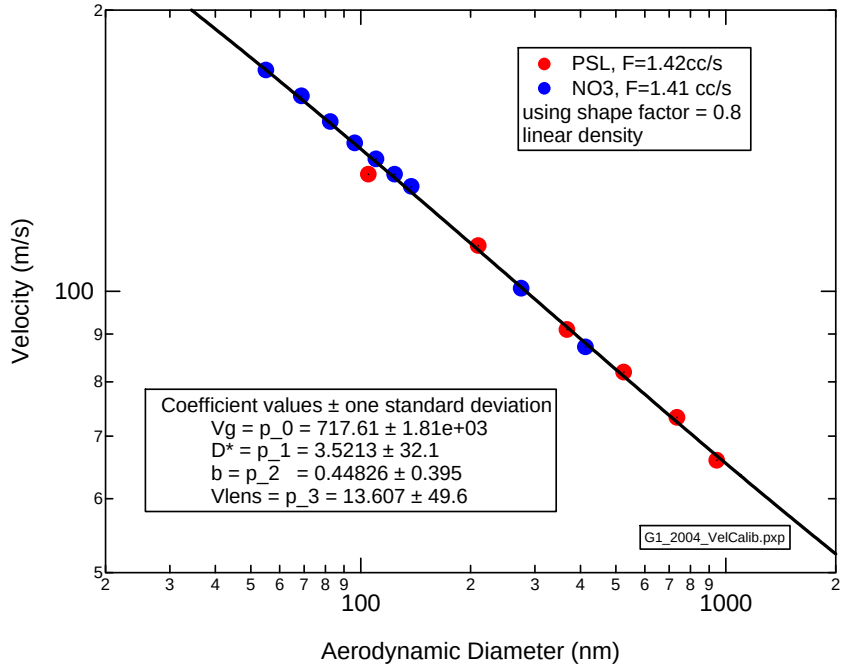

This figure suggests that if 30 nm particles at ~1000/cc were transmitted at ~60% as predicted by Fluent we should have no problem detecting them as far as sensitivity is concerned…

# Particle Velocity Scales Equally well in $D_{va}$ or $D_a$ Space

$D_{aero}=D_{mob}*1.0*sqrt(density)$

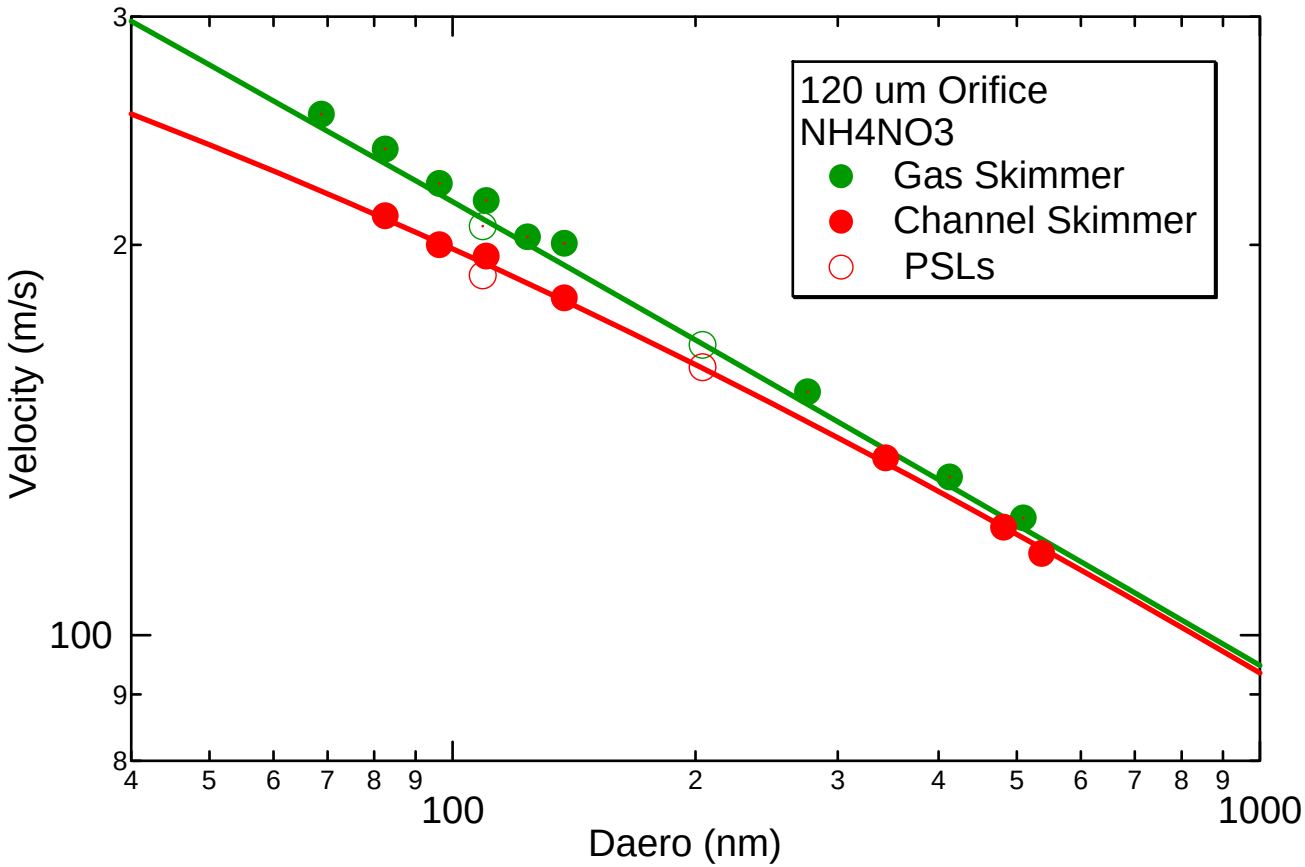


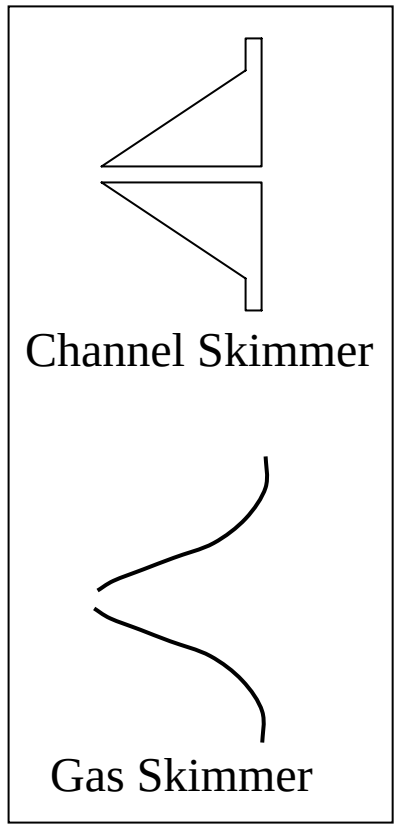

$D_{aero}=D_{mob}*0.8*density$




*What is the impact on $D_{mob}$ vs $D_{AMS}$ comparison…*
*Need to carefully consider comparison to SMPS.*

# Particle velocity influenced by collisions with gas molecules inside channel aperture

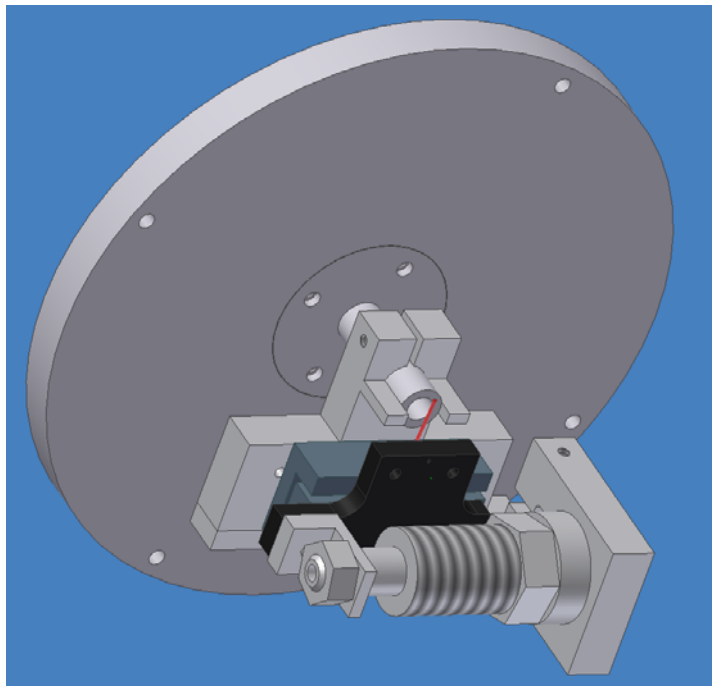



*How does this influence focusing of small particles?*
*Does this impact our thinking on $D_{va}$ vs $D_a$?*

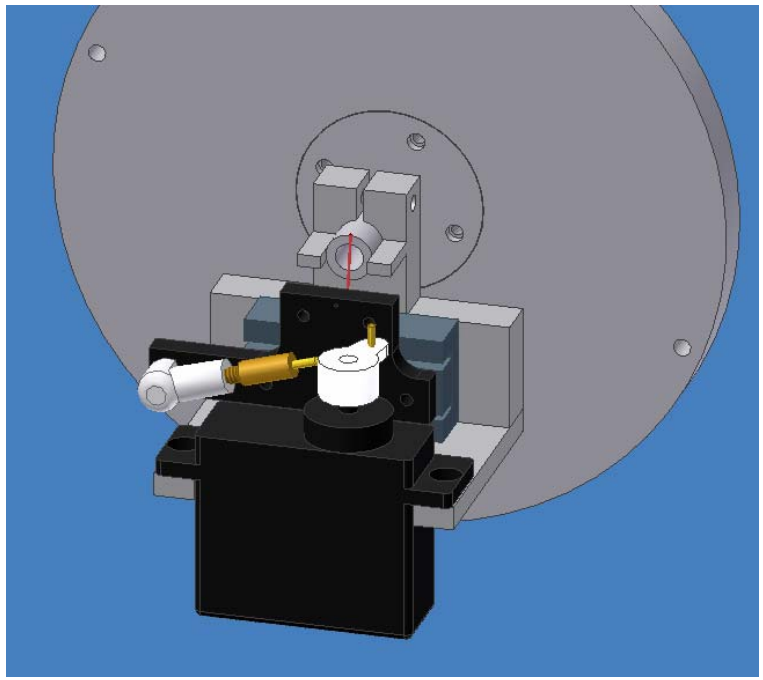
# Beam Width Probe

Stepper Motor Design



New unit

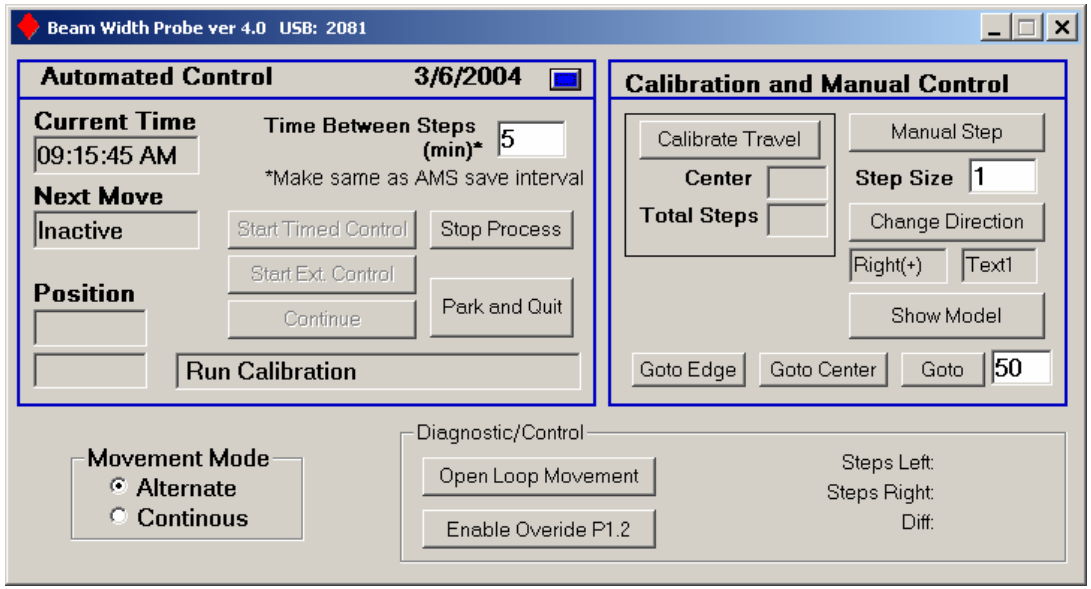
Servo Motor Design

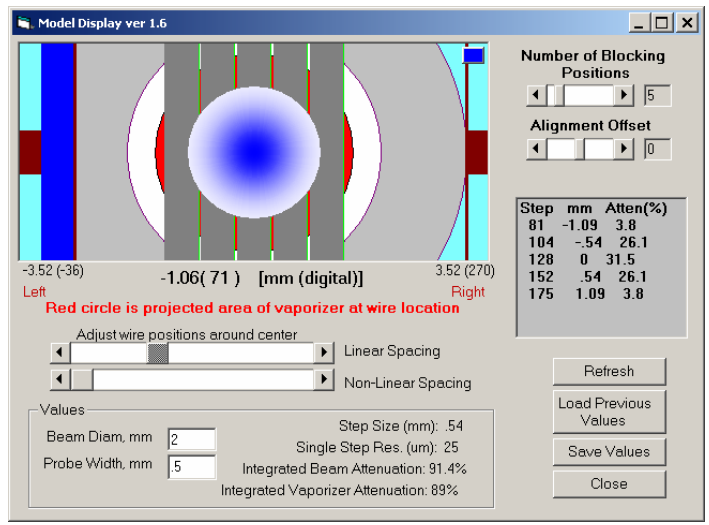


Old unit

# Position Resolution of BWP

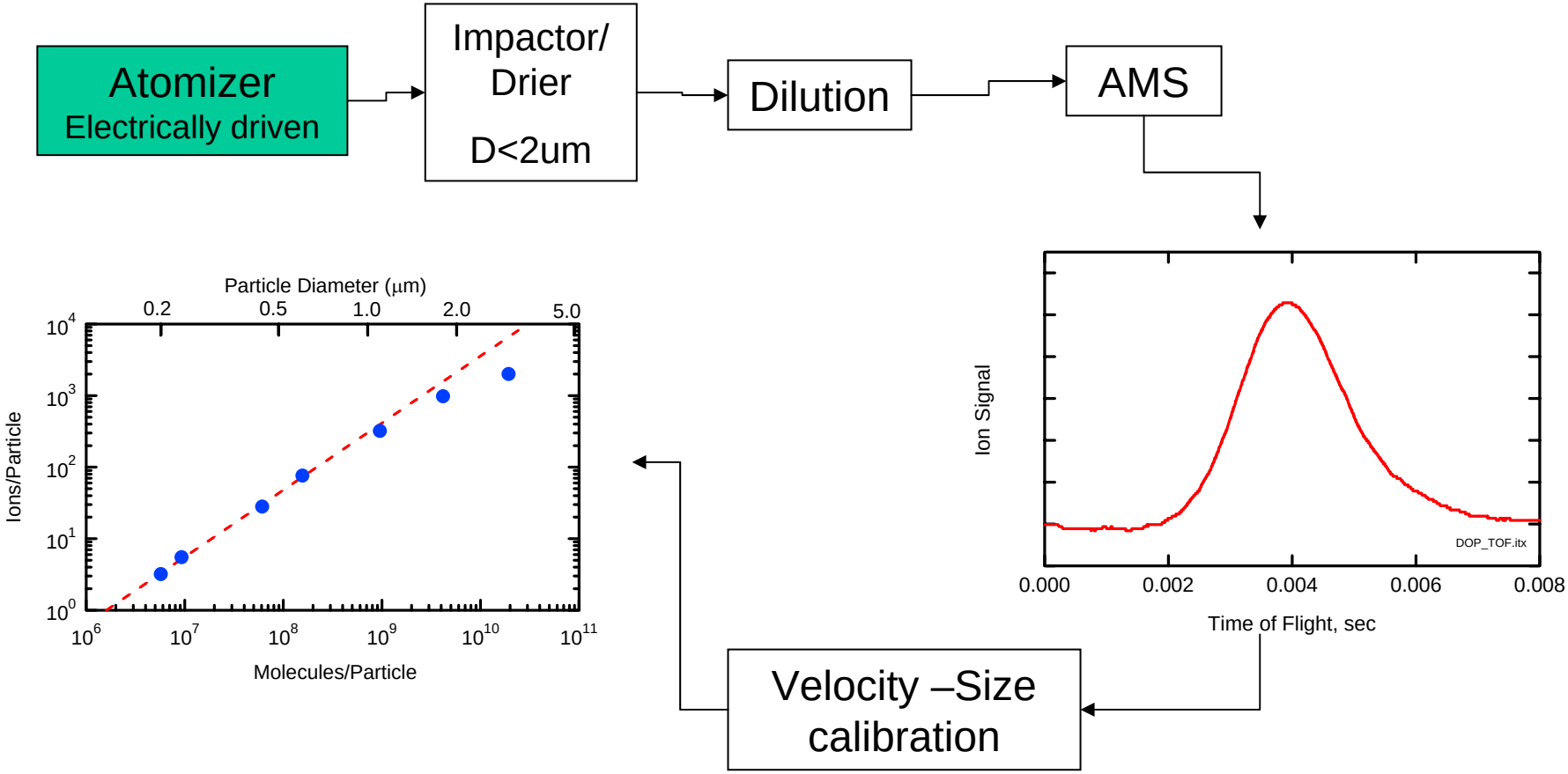
| | Servo | Stepper |
|---|---|---|
| Distance Between Stops, mm | 6.35 | 6.35 |
| Wire Diameter, mm | 1 | 1 |
| Number of steps | 85 | 260 |
| Dist/step, um | 63 | 21 |
| Hysterisis | 3 | 2 |
| Actual position resolution, um | 189 | 41 |




The BWP can be stepped by an externally supplied TTL pulse

# Schematic of DMA-less calibration setup




- Sample all single particles
- Determine IE and linearity in one measurement
- Check particle transmission