
# Brewer Calibration:Ozone Absorption issues

## Regional Brewer Calibration Center-Europe

## Izaña Atmospheric Research Center

## Spanish Meteorological Agency

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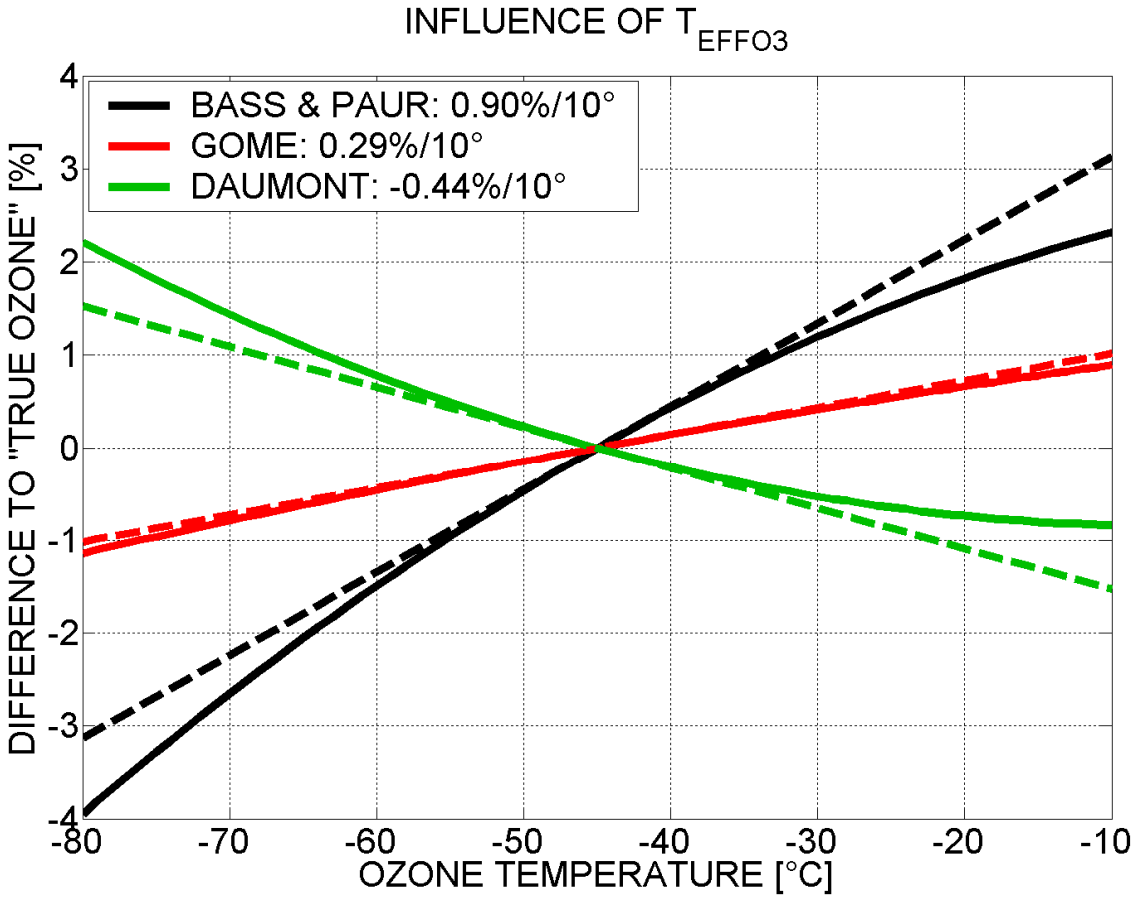
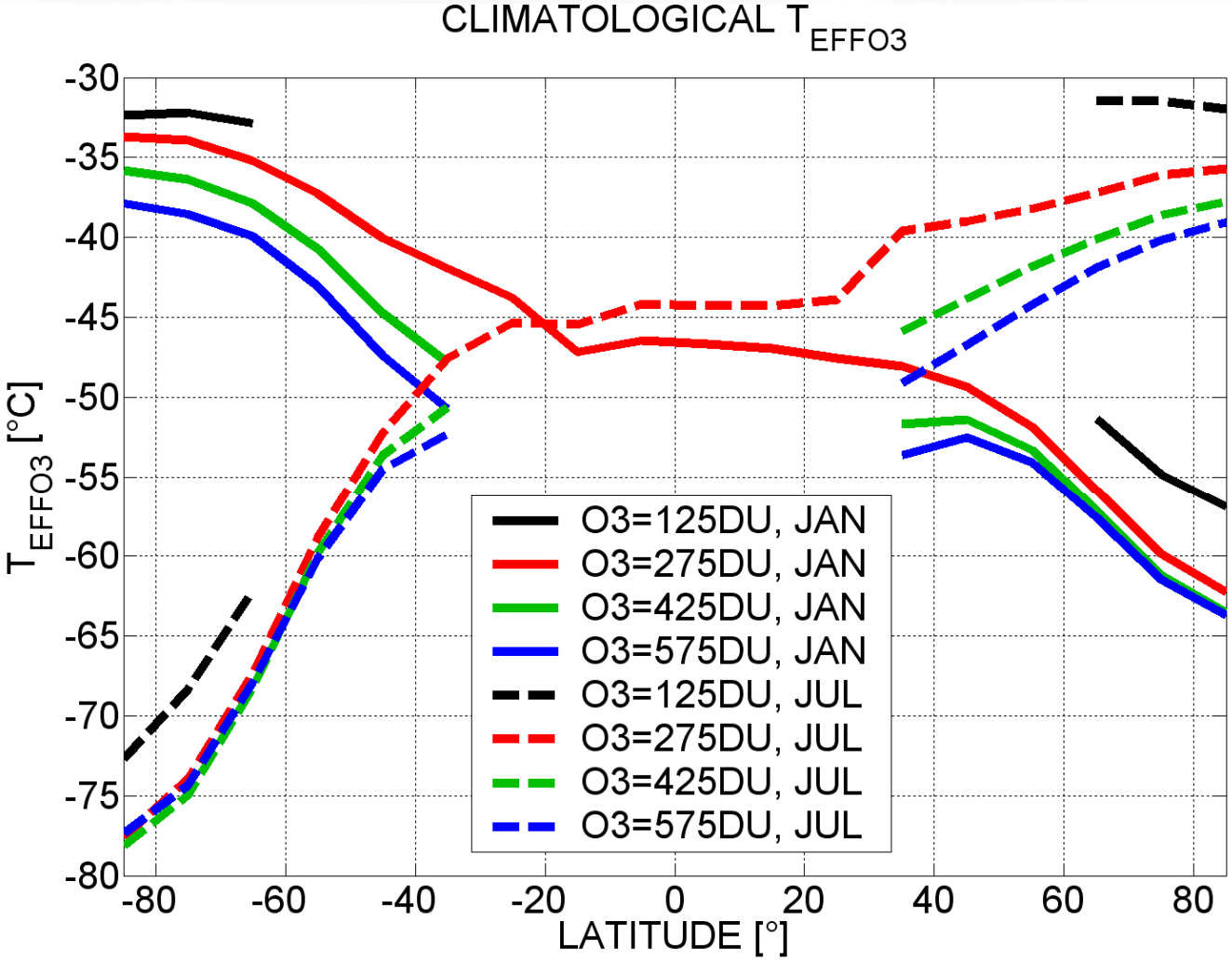
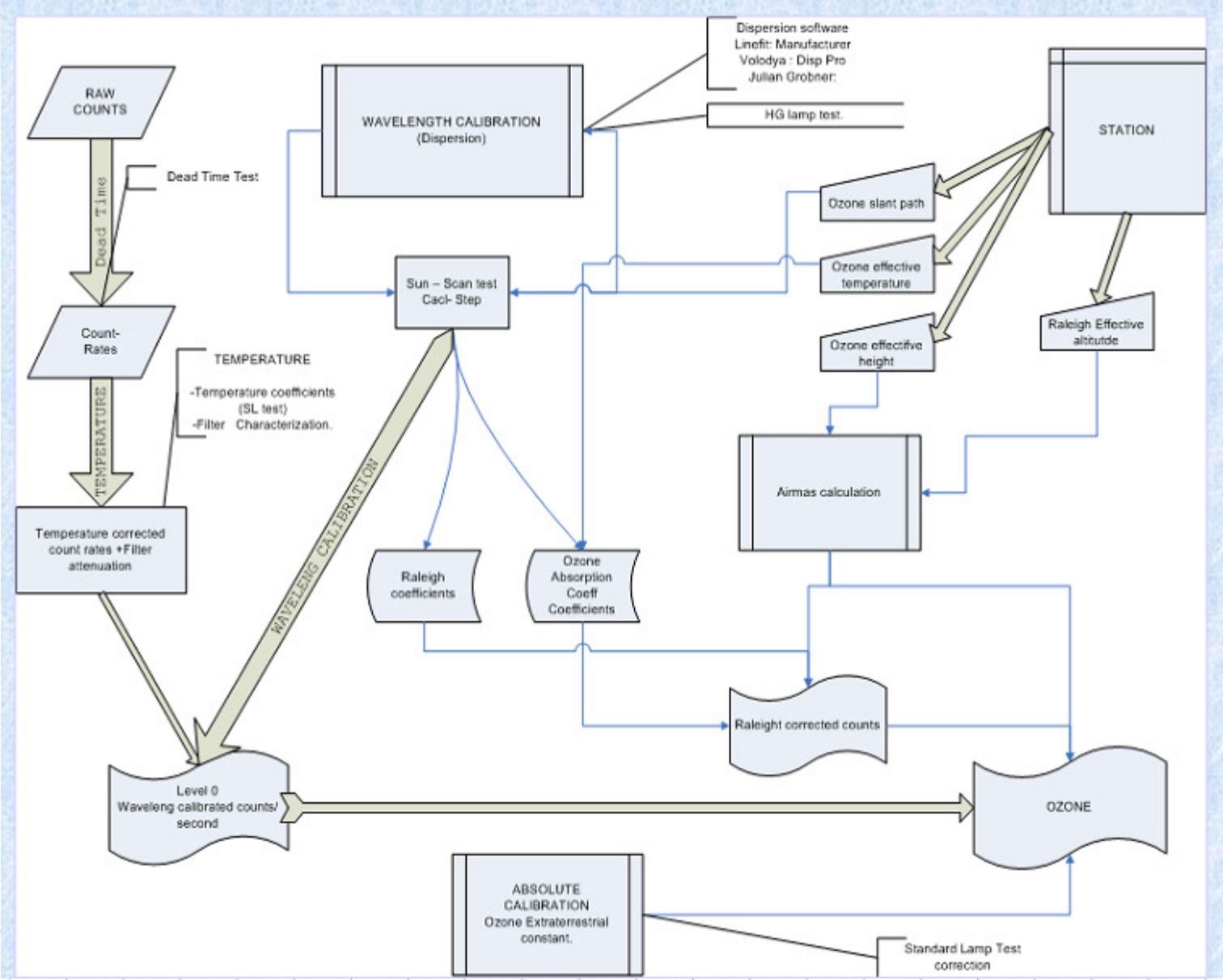
- Brewer Calibration:
  - Ozone Absorption issues
  - O3 absorption calculation.
  - Calibration  transfer.
  - FTIR-BREWER comparison

- Know issues on brewer algorithm
  - Rayleigh Scattering coefficients fixed
  - Effective ozone height fixed 22 Km (*)
  - Effective ozone temperature fixed (-45)

# Brewer Algorithm asumes the ozone effective temeperature is fixed to -45C.




CLIMATOLOGICAL $T_{EFFO3}$
$T_{EFFO3}$ [°C]
LATITUDE [°]
-30
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-80
-60
-40
-20
0
20
40
60
80
O3=125DU, JAN
O3=275DU, JAN
O3=425DU, JAN
O3=575DU, JAN
O3=125DU, JUL
O3=275DU, JUL
O3=425DU, JUL
O3=575DU, JUL


RAW COUNTS
Dead Time
Dead Time Test
Count-Rates
TEMPERATURE
TEMPERATURE
-Temperature coefficients (SL test)
-Filter Characterization.
Temperature corrected count rates +Filter attenuation
WAVELENG CALIBRATION
Level 0 Waveleng calibrated counts/ second
WAVELENGTH CALIBRATION (Dispersion)
Dispersion software
Linefit: Manufacturer
Volodya : Disp Pro
Julian Grobner:
HG lamp test.
Sun – Scan test Cacl- Step
STATION
Ozone slant path
Ozone effective temperature
Ozone effective height
Raleigh Effective altitude
Airmas calculation
Raleigh coefficients
Ozone Absorption Coeff Coefficients
Raleight corrected counts
OZONE
ABSOLUTE CALIBRATION
Ozone Extraterrestrial constant.
Standard Lamp Test correction

- Brewer calibration
  - Ozone Absorption Determination
    - Standard method (Kerr)
    - Improved method (Groebner & Kerr )
  - Single Reference vs Double Reference
  - Two point vs One point Calibration:
    - One point: O3 abs is determinate by Dispersion test.
    - Two point calibration: ETC and O3 abs are determinated by comparsion with a refeence

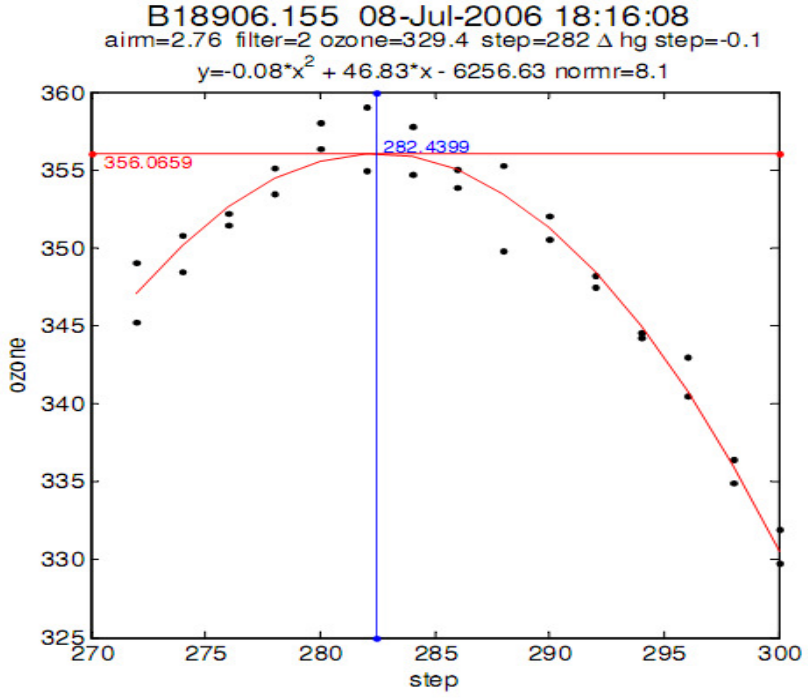
- Ozone Absortion
  - O3 abs coefficient is determinate by dispersion test : measure of spectral lines of discharge lamps (Hg,Cd,Zn).
    - Scan of the line, center determination, FHWM and get pairs of wavelength- micrometer step motor position.
  - This pairs are fitted for the six slits.
    - Standard method (Kerr). Fit to quadratic function
    - Improved method (Groebner)

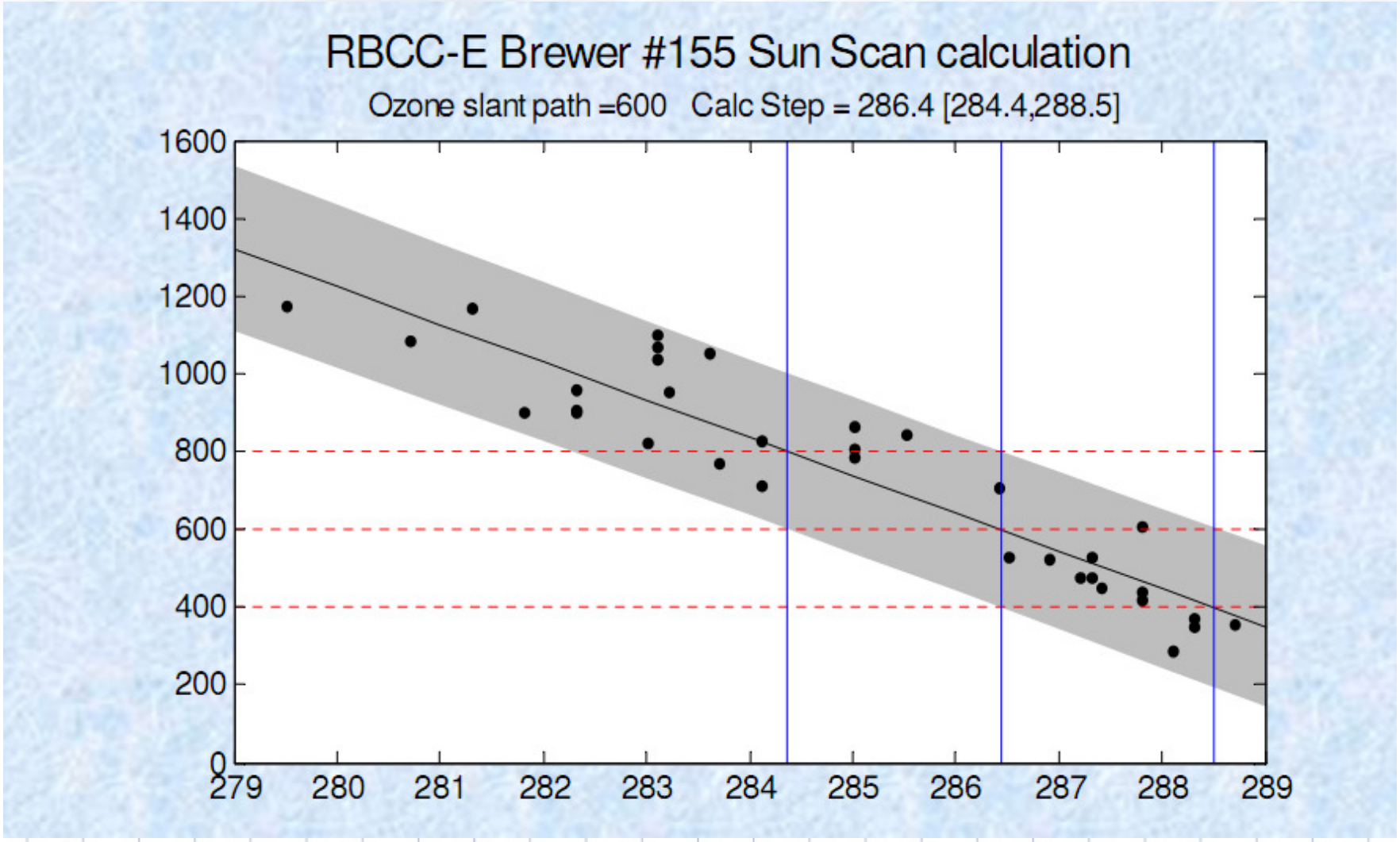
- Ozone wavelengths: Sun Scan empirical procedure ,

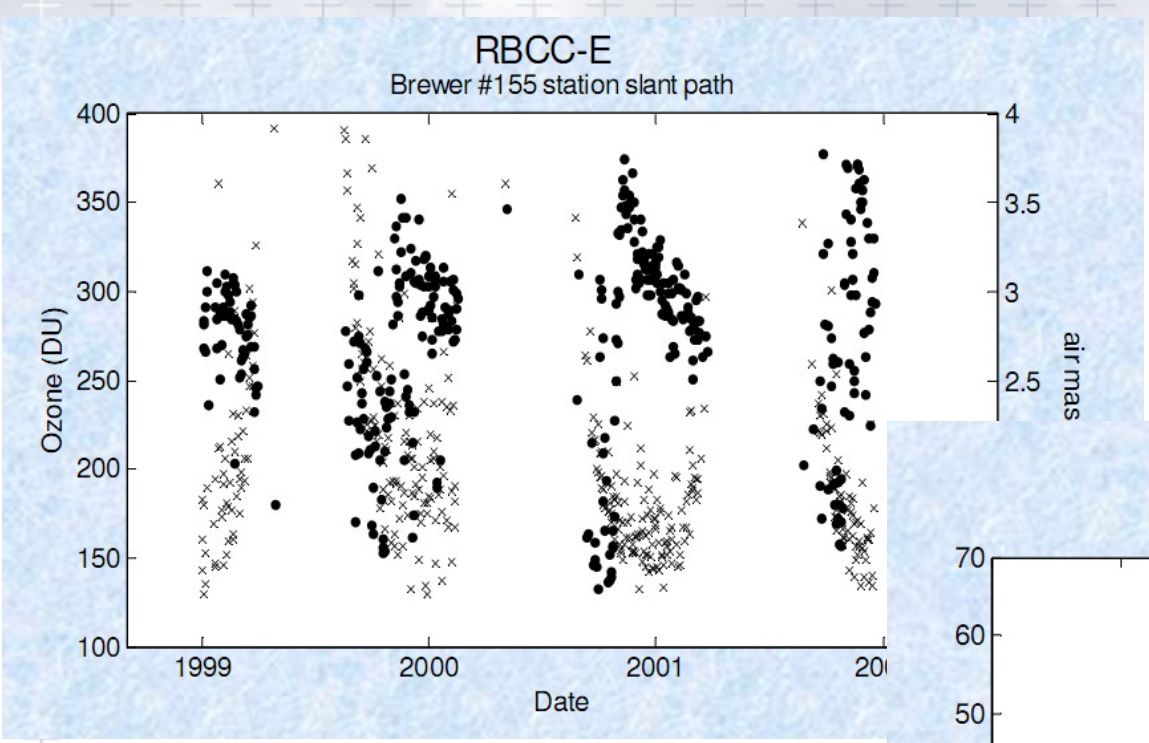
## Sun Scan test (SC)

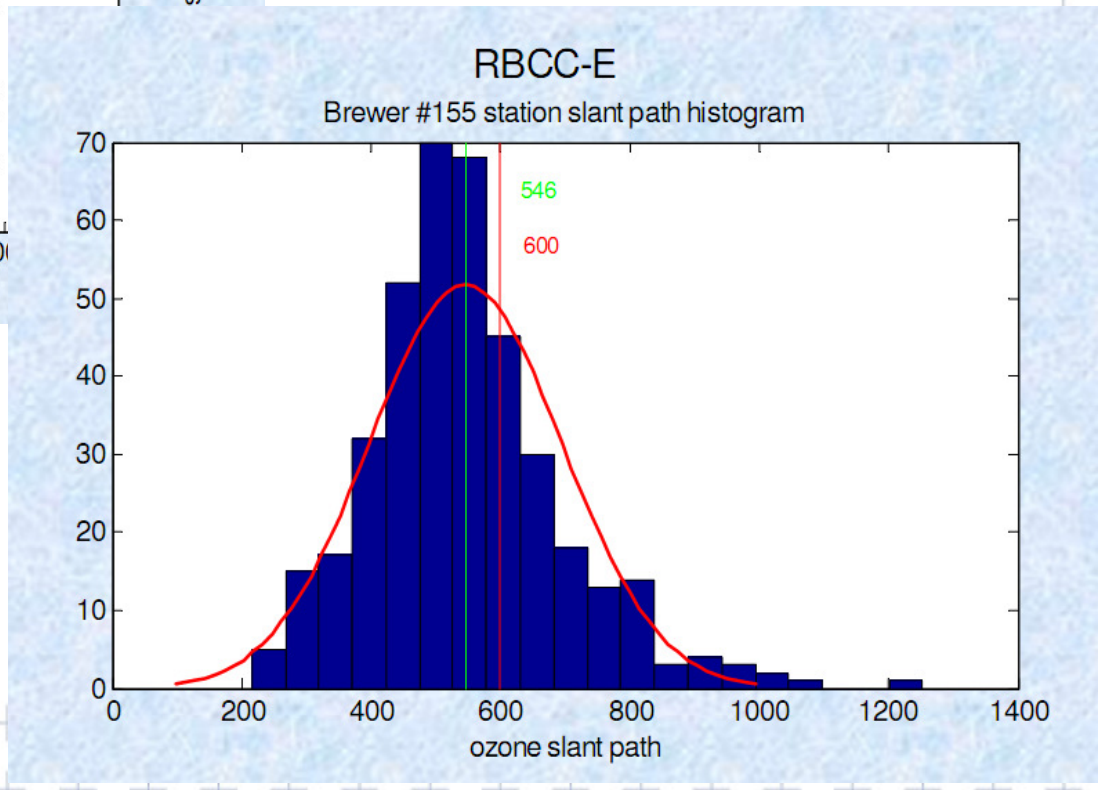
The design of the slit mask for the Brewer spectrophotometer provides the operating wavelengths near the minima and maxima in the solar spectrum features. The SC test fine-tunes the position of the micrometer that minimizes the sensitivity of the ozone and SO2 calculations to small changes in the angle of the grating.

(Volodya Savastiouk Thesis)




RBCC-E Brewer #155 Sun Scan calculation
Ozone slant path =600 Calc Step = 286.4 [284.4,288.5]
1600
1400
1200
1000
800
600
400
200
0
279
280
281
282
283
284
285
286
287
288
289


RBCC-E
Brewer #155 station slant path
Ozone (DU)
air mas
Date
400
350
300
250
200
150
100
4
3.5
3
2.5
1999
2000
2001

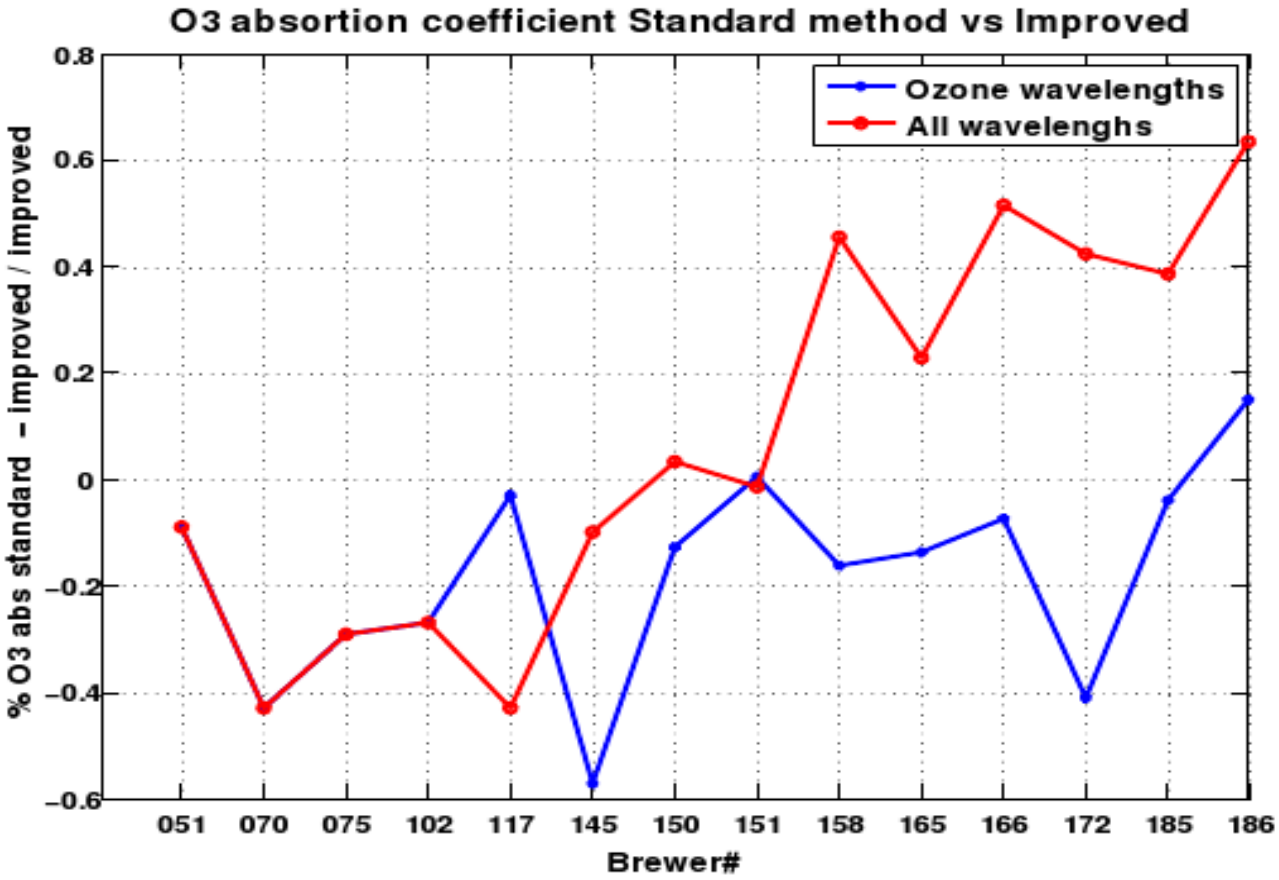

RBCC-E
Brewer #155 station slant path histogram
546
600
ozone slant path
70
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400

- # O3 Absorption calculation

$$\alpha(X,\mu) = \sum w_i \frac{\int \alpha(\lambda) * S(\lambda,\lambda') * F(\lambda,\lambda',X,\mu) d\lambda'}{\int S(\lambda,\lambda') * F(\lambda,\lambda',X,\mu) d\lambda'}$$

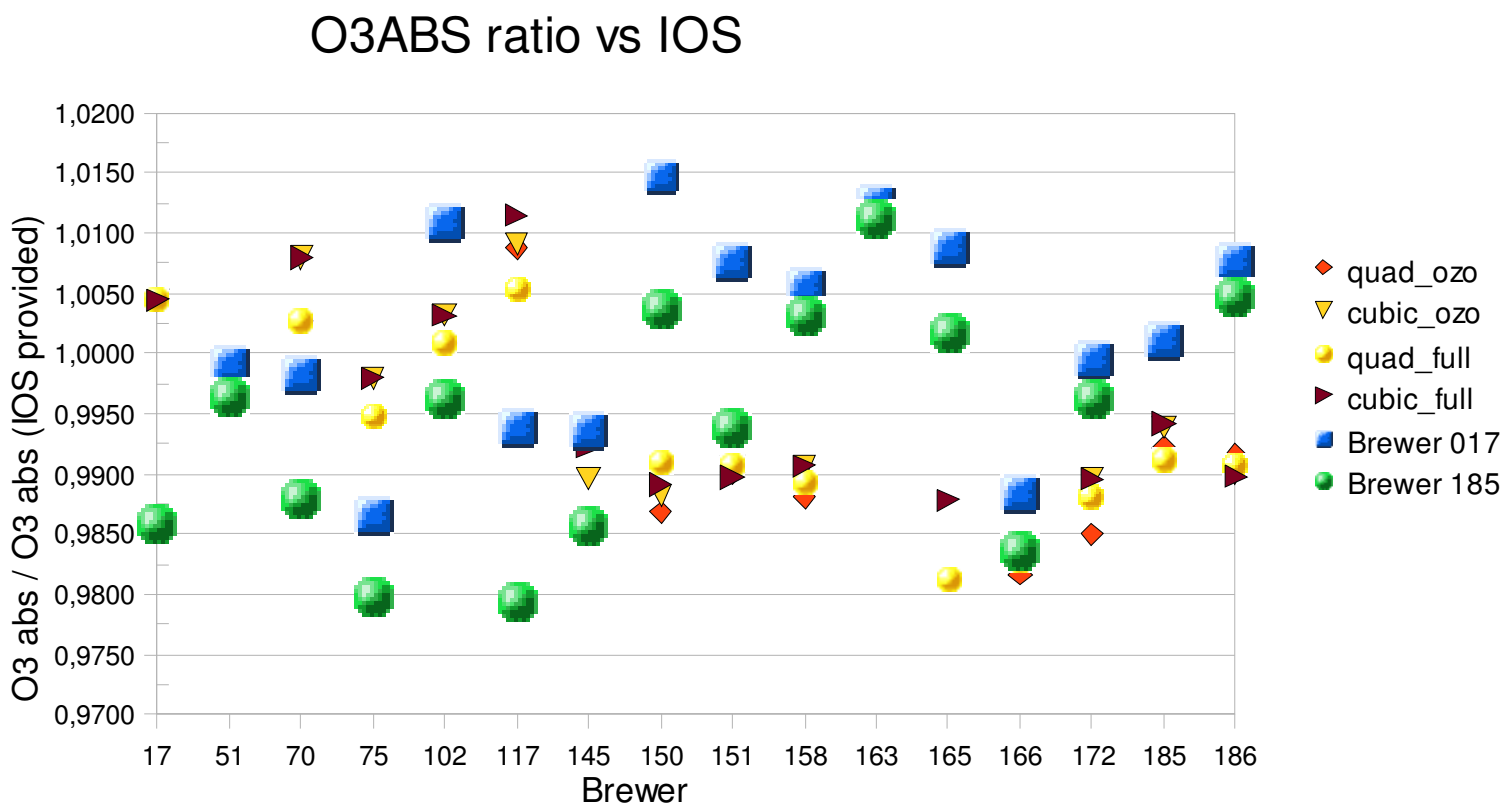
  - Use triangular slits, ' ideal' (no winds, '0' outside the triangle),
  - The FWHM of the triangle dependent of the slit.
  - This slit function is convolved with Bass & Paur absorption coefficient.
  - The 03abs (also SO2,rayleight,) are calculated for an interval of steps around the ozone position.
  - The ozone position can be also calculated from the dispersion equations.

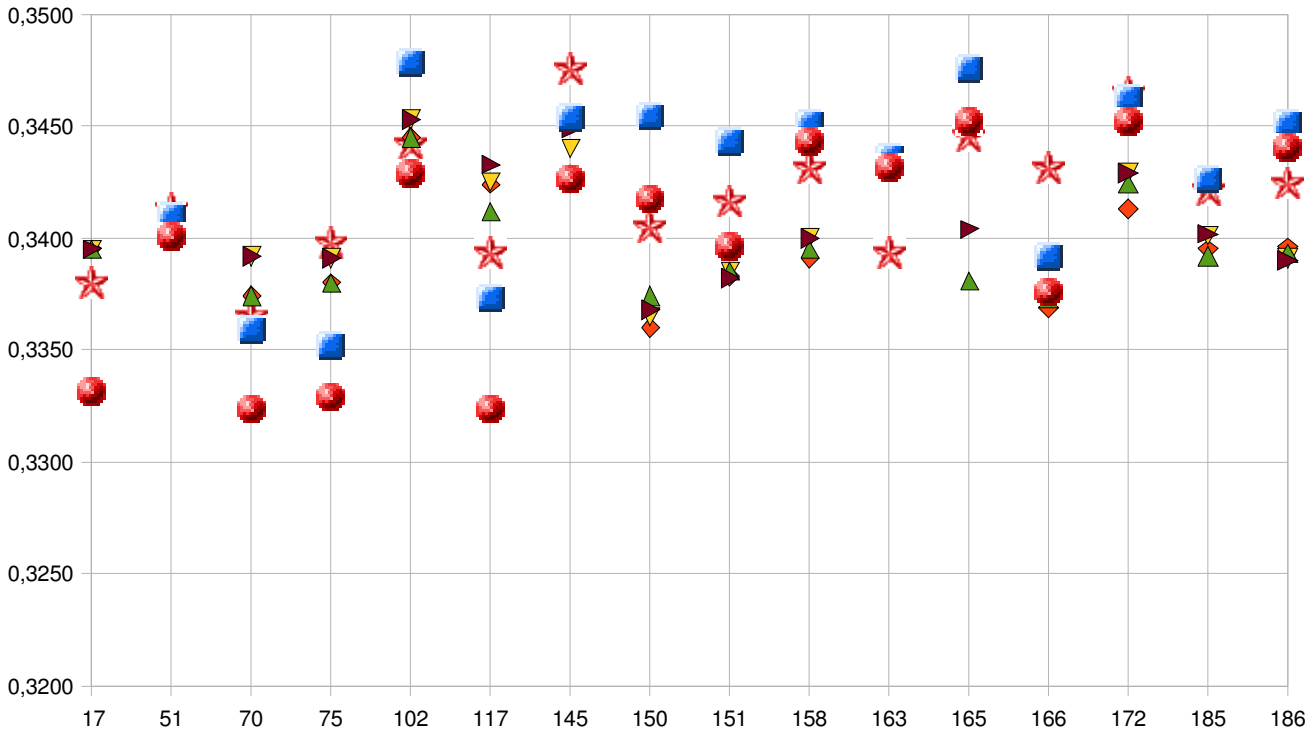
- Comparison standard vs improved



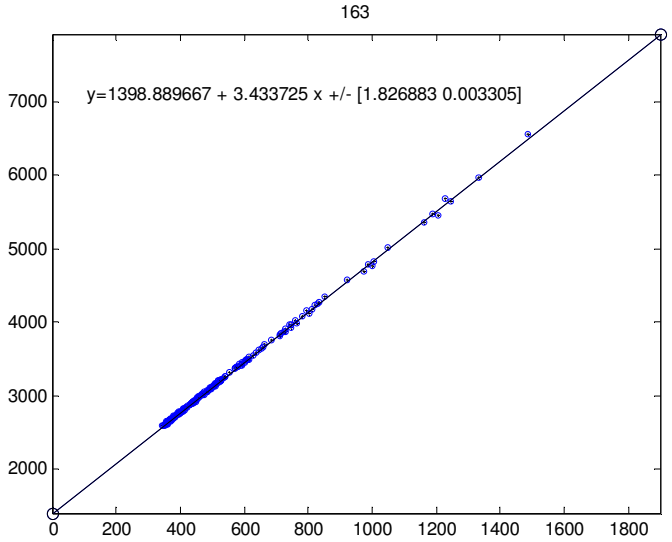

- The differences in O3 absorption coefficient calculation there aren't to big, it goes up to 0.4 % in double brewer 0% on MK-II

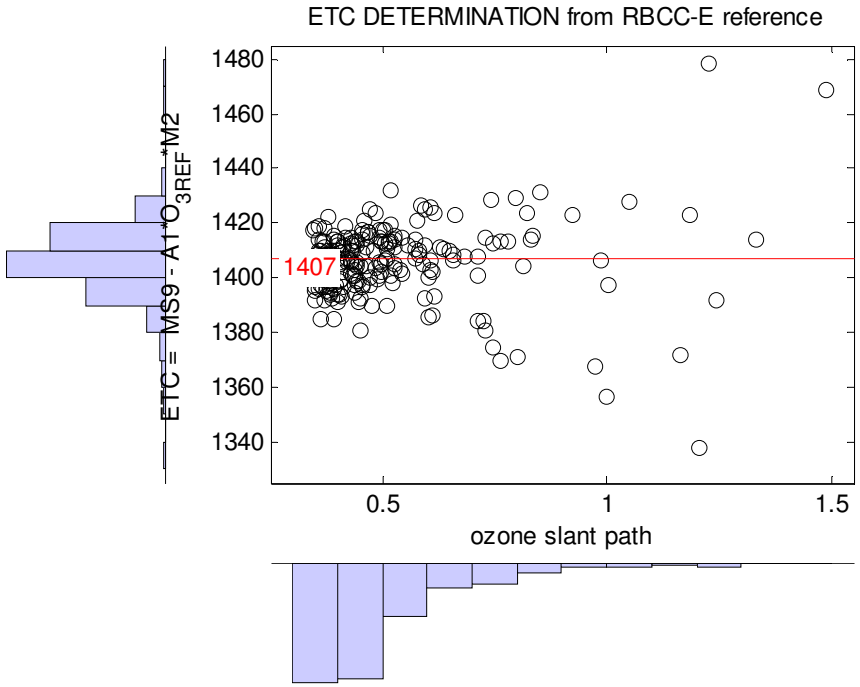
- Ozone Absortion determination.



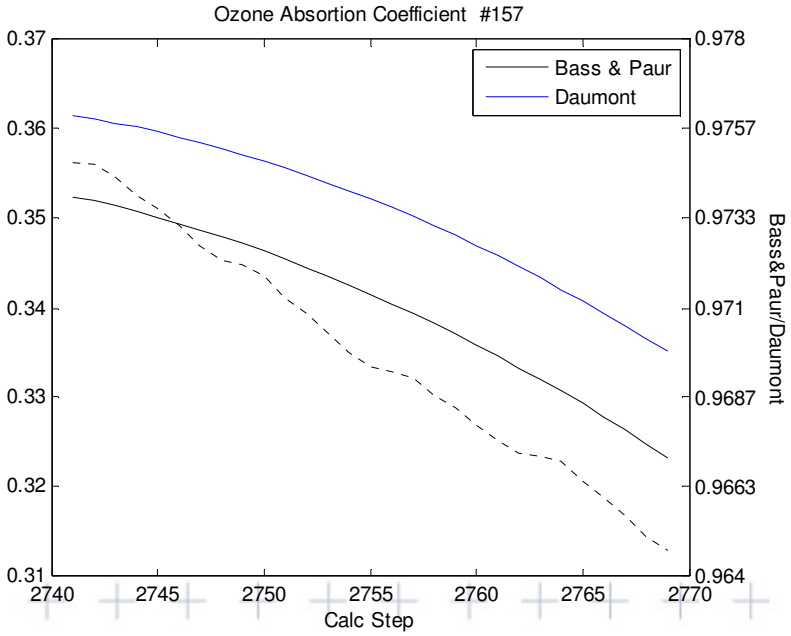

0,3500
0,3450
0,3400
0,3350
0,3300
0,3250
0,3200
17
51
70
75
102
117
145
150
151
158
163
165
166
172
185
186

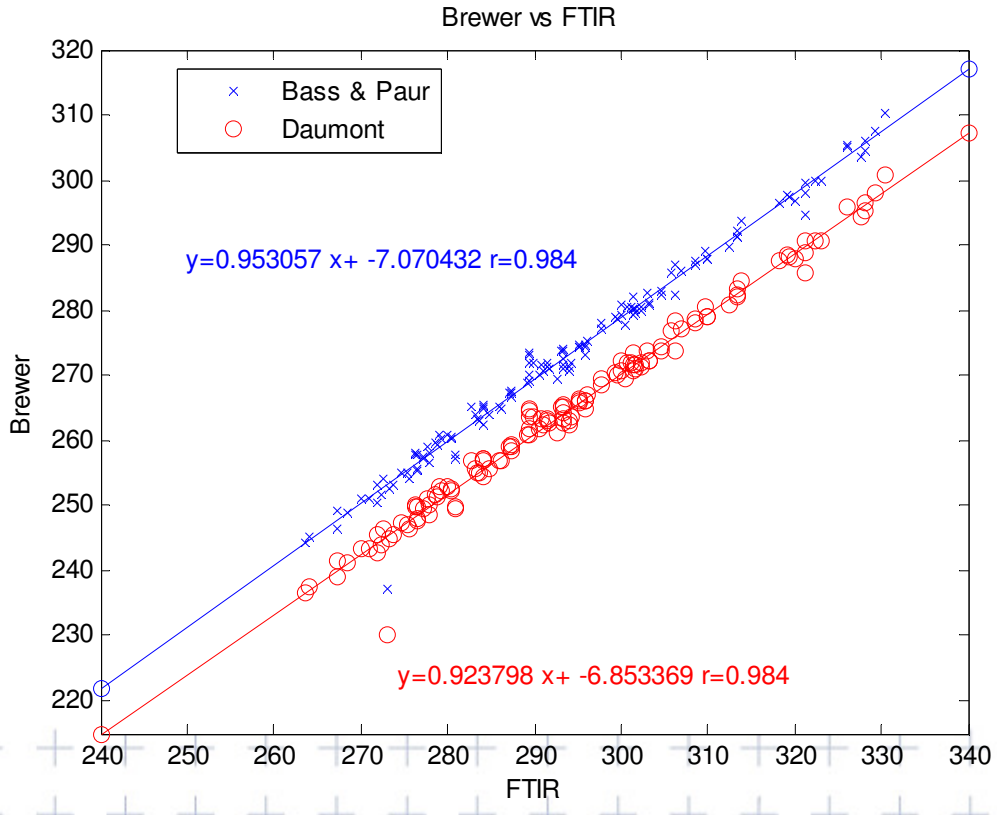
- ETC determination ;
- once determined the O3abs coefficient,ETC is calculated by comparison with the reference.
- $$O_3 = \left( F - ETC \right) / \alpha . \mu$$
- Also we can calculate ETC and O3ABS simultaneosly


163
y=1398.889667 + 3.433725 x +/- [1.826883 0.003305]
7000
6000
5000
4000
3000
2000
0
200
400
600
800
1000
1200
1400
1600
1800

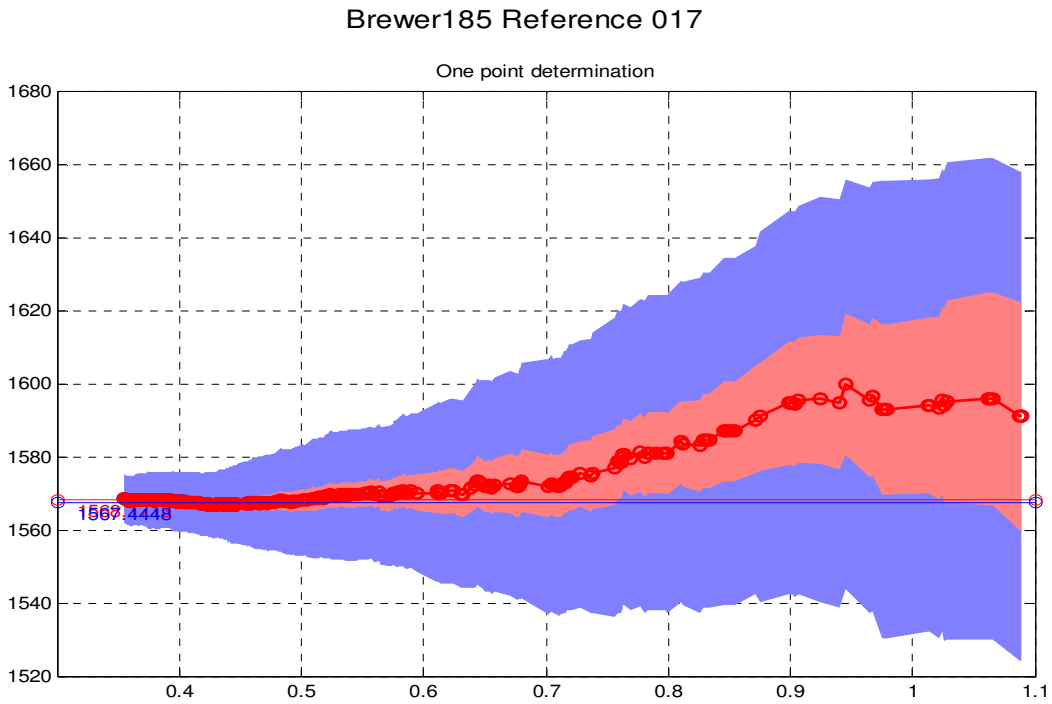

ETC DETERMINATION from RBCC-E reference
ETC = MS9 - A1*O3REF*M2
1480
1460
1440
1420
1400
1380
1360
1340
1407
0.5
1
1.5
ozone slant path

```
 2757 WL(A)          3031.84   3062.98   3100.49   3135.08   3168.05   3200.09
      Res(A)           11.37     11.22     11.03     11.22     11.19     10.95
      O3abs(1/cm)     2.6020    1.7804    1.0048    0.6757    0.3752    0.2927 O3:   0.3392
Daumt O3abs(1/cm)     2.6088    1.7753    0.9965    0.6702    0.3684    0.2936 O3:   0.3499
     So2abs(1/cm)     3.4606    5.6257    2.4097    1.8896    1.0554    0.6077
  1e4*Rayabs(1/cm)    5051.2    4832.4    4584.8    4370.7    4178.2    4001.6 R:   0.0010
Ozone offset due to Rayleigh: -2.9 DU
O3 factor from Bass & Paur to Daumont  =  0.9693
```



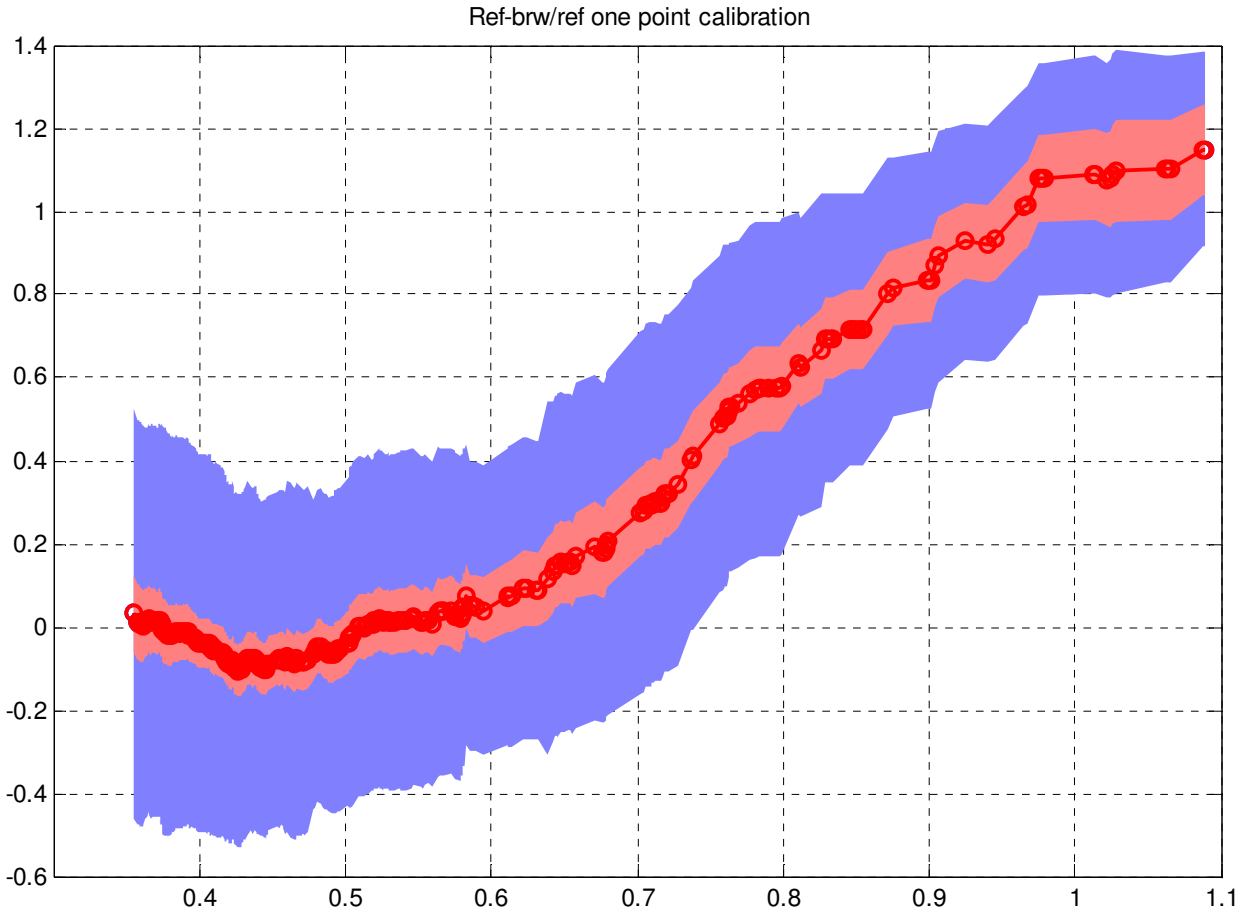
- With O3abs fixed, ETC is calculated by the median of (F - O3ref*O3abs*airm)



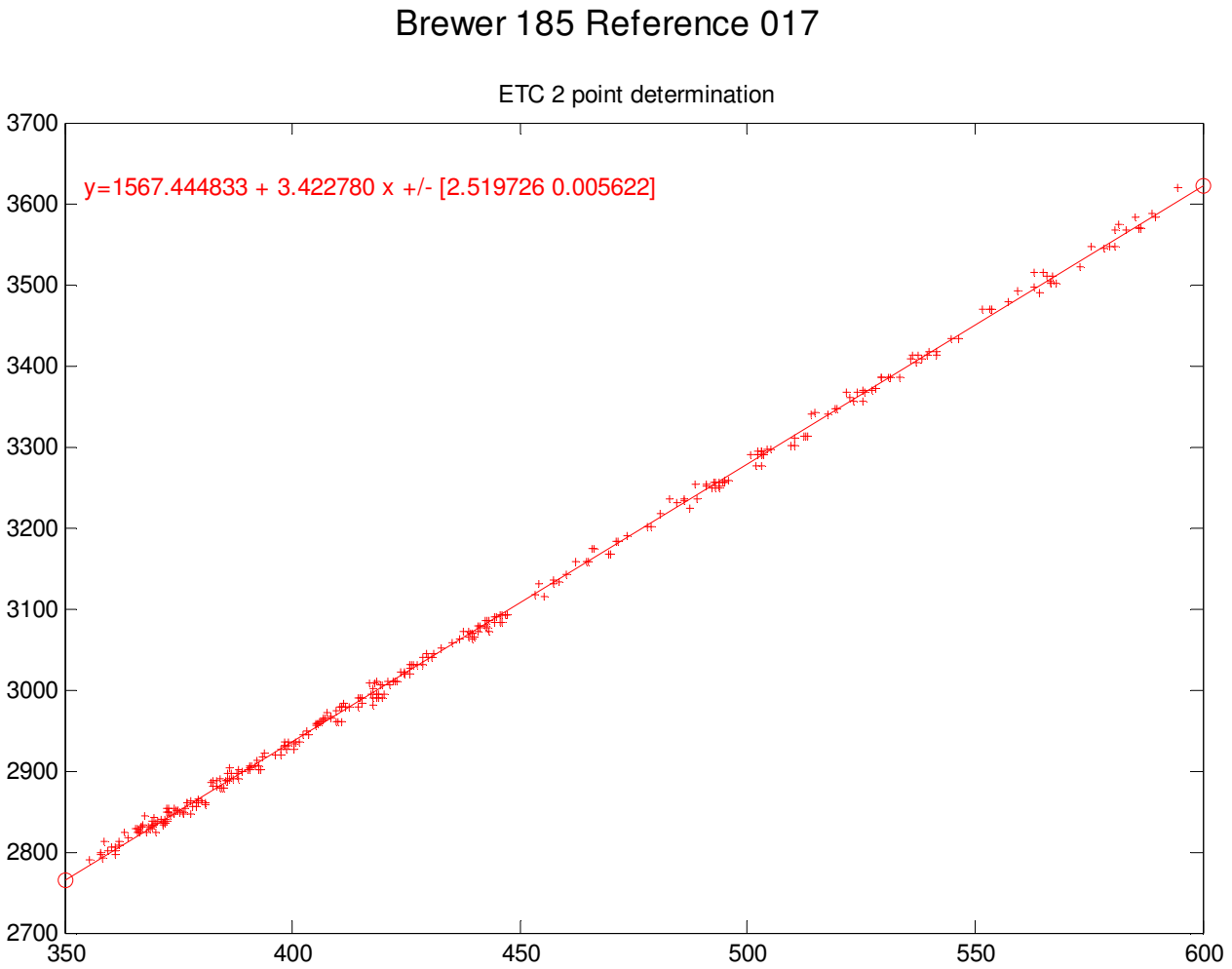
- Conclusions
  - With the **current algorithm** there isn't a big issue absorption change
  - Comparison with FTIR goes in wrong direction
  - Big effect on temperature effect but is not considered on the algorithm.

- Two parameters calibration vs one parameter calibration
- Single to Double calibration Transfer.

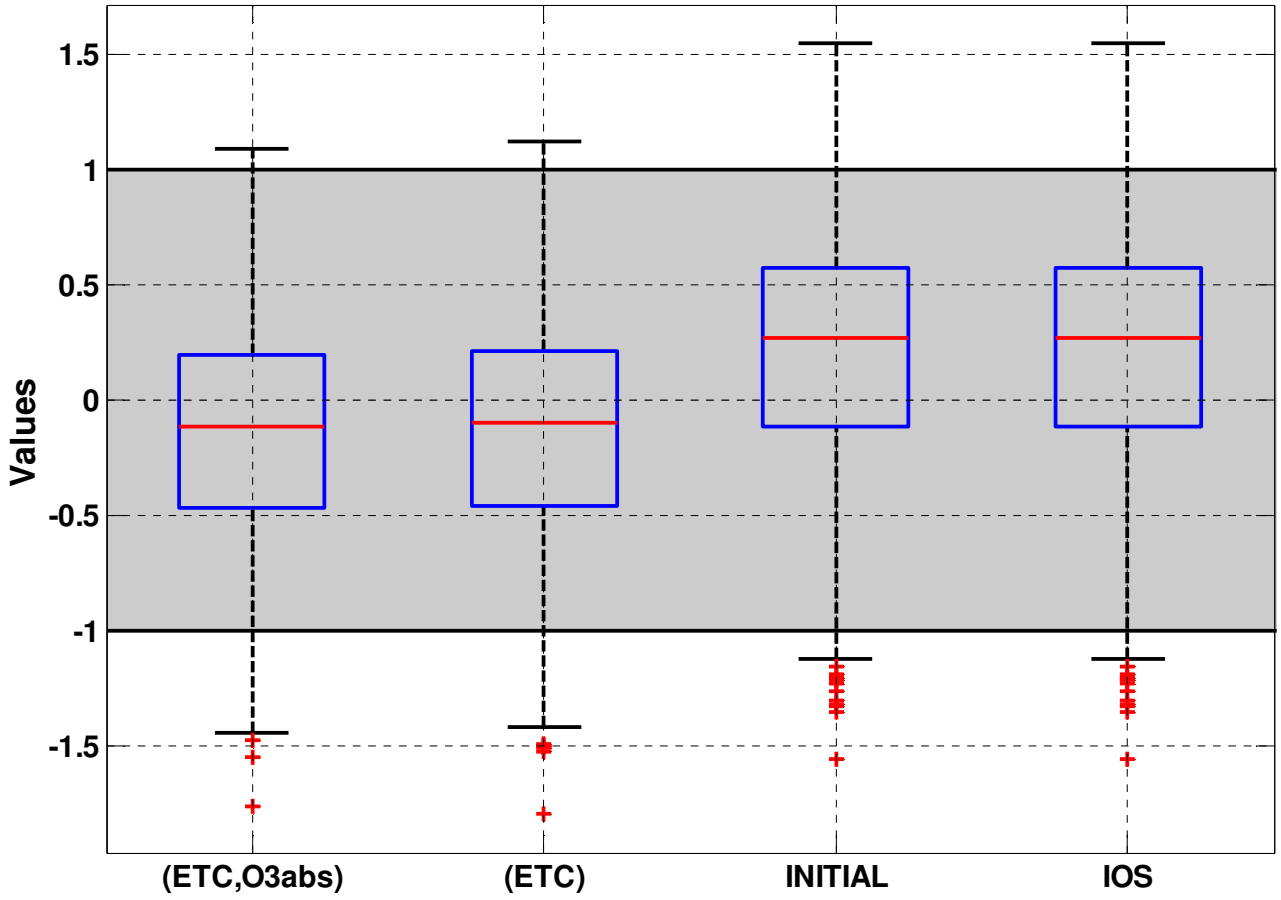
# Brewer 185 vs Reference 017



- Two point calibration

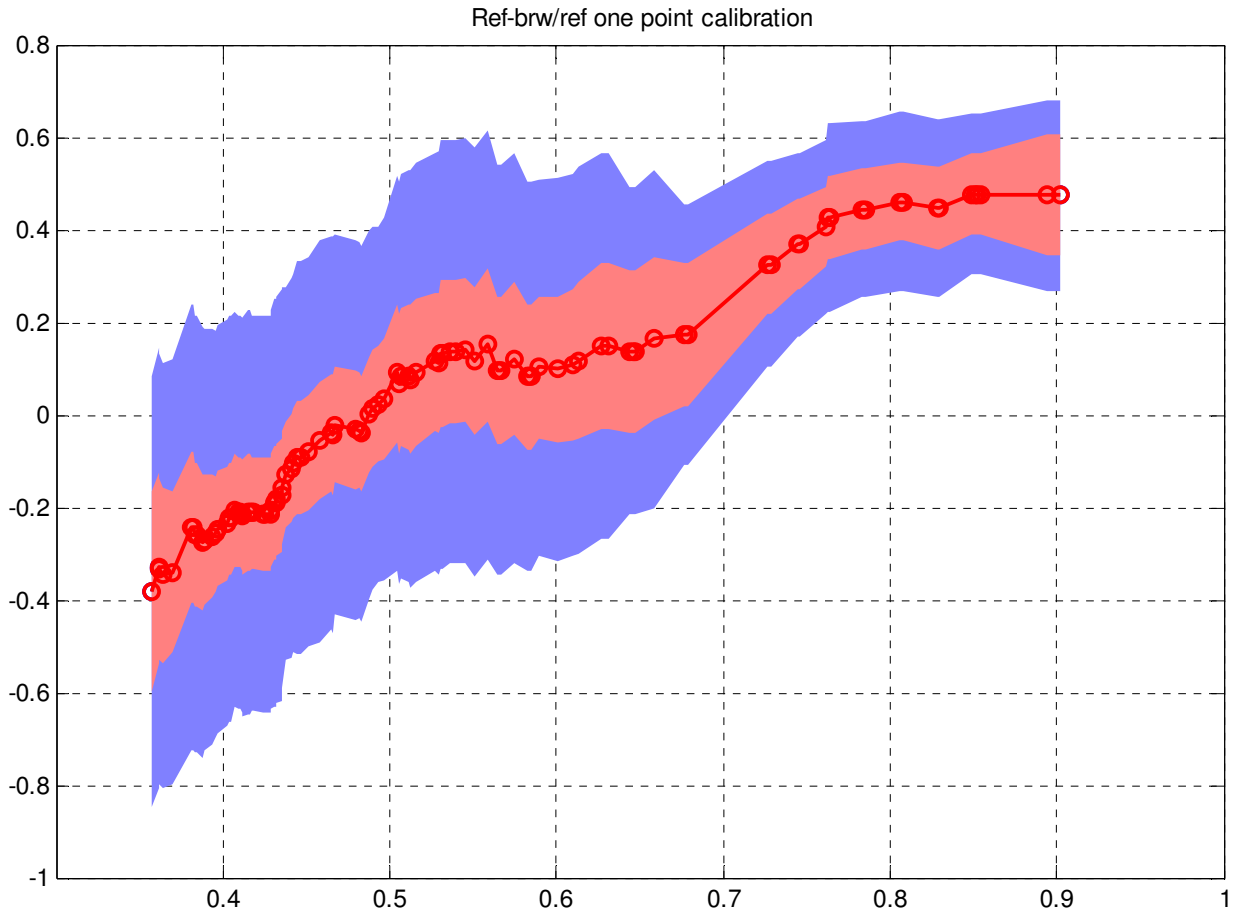


## Brewer 185 vs Reference 017

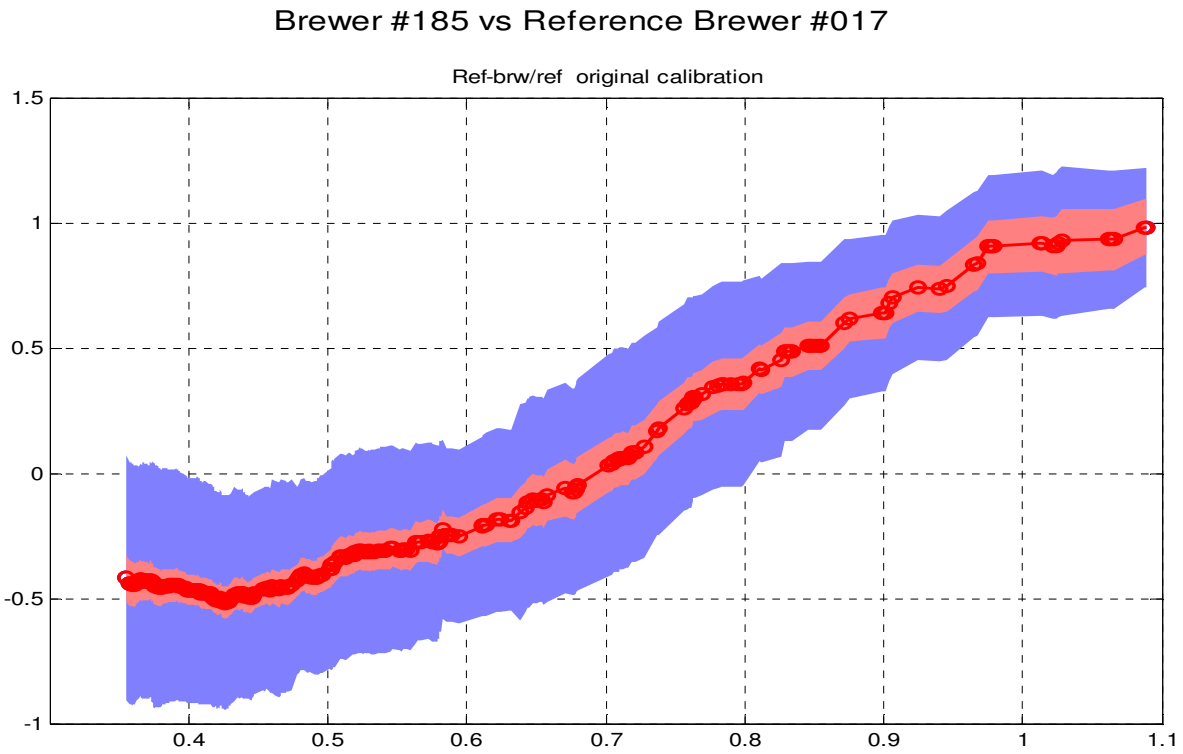


- If the … ne other, the ab…

Brewer 163 vs Reference 185



- To avoid the straylight problem on single brewer data below  700 UD slant path is used to the determination if the reference is a single brewer



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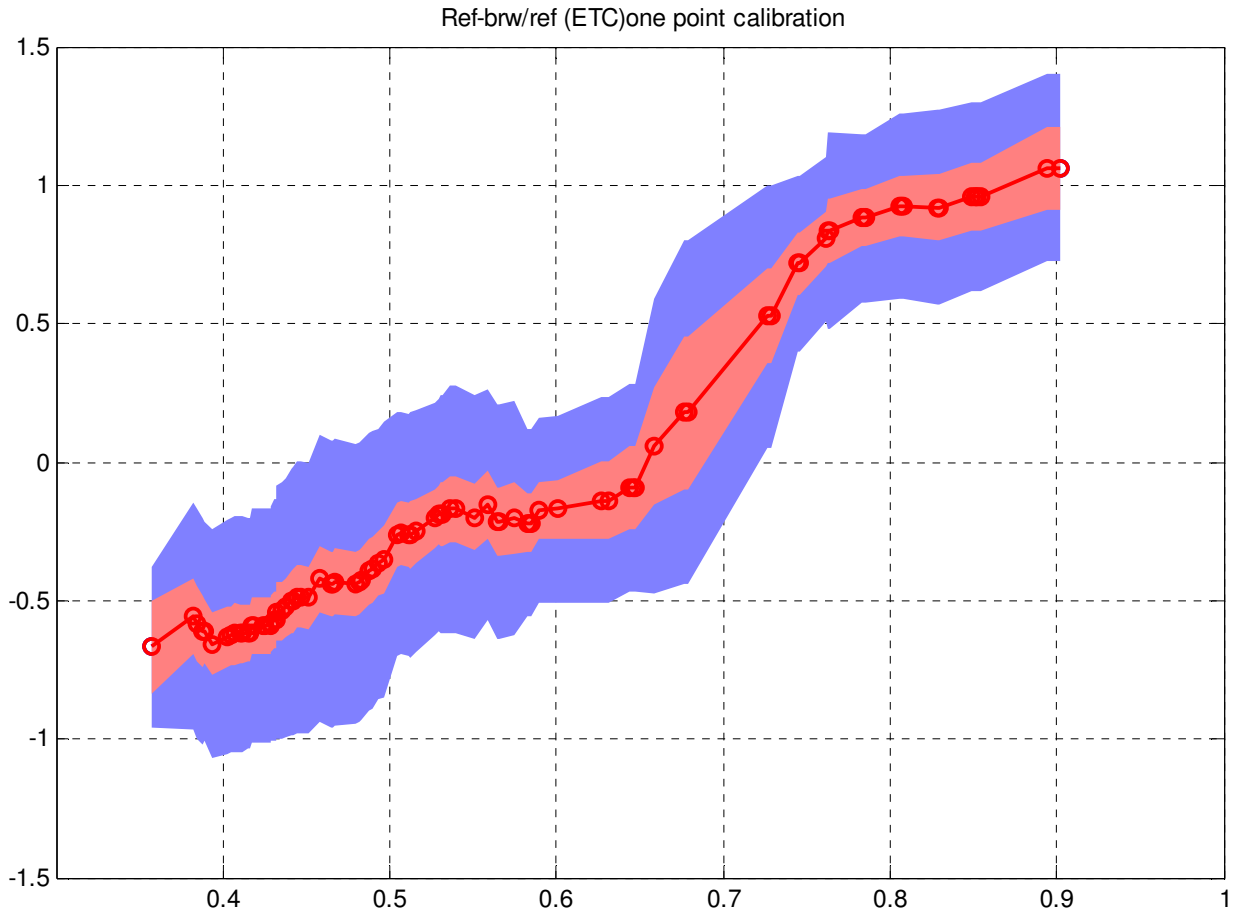
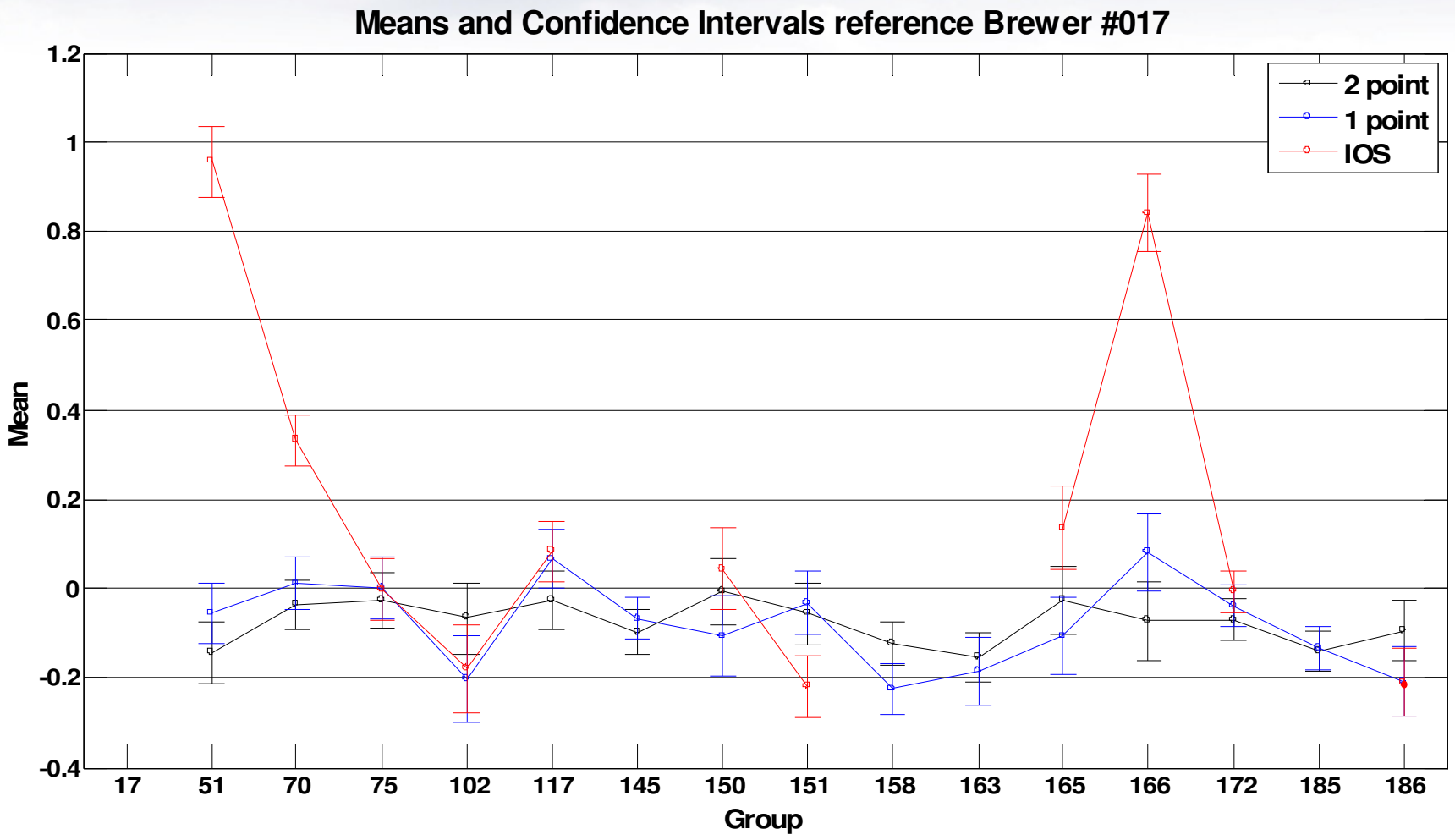
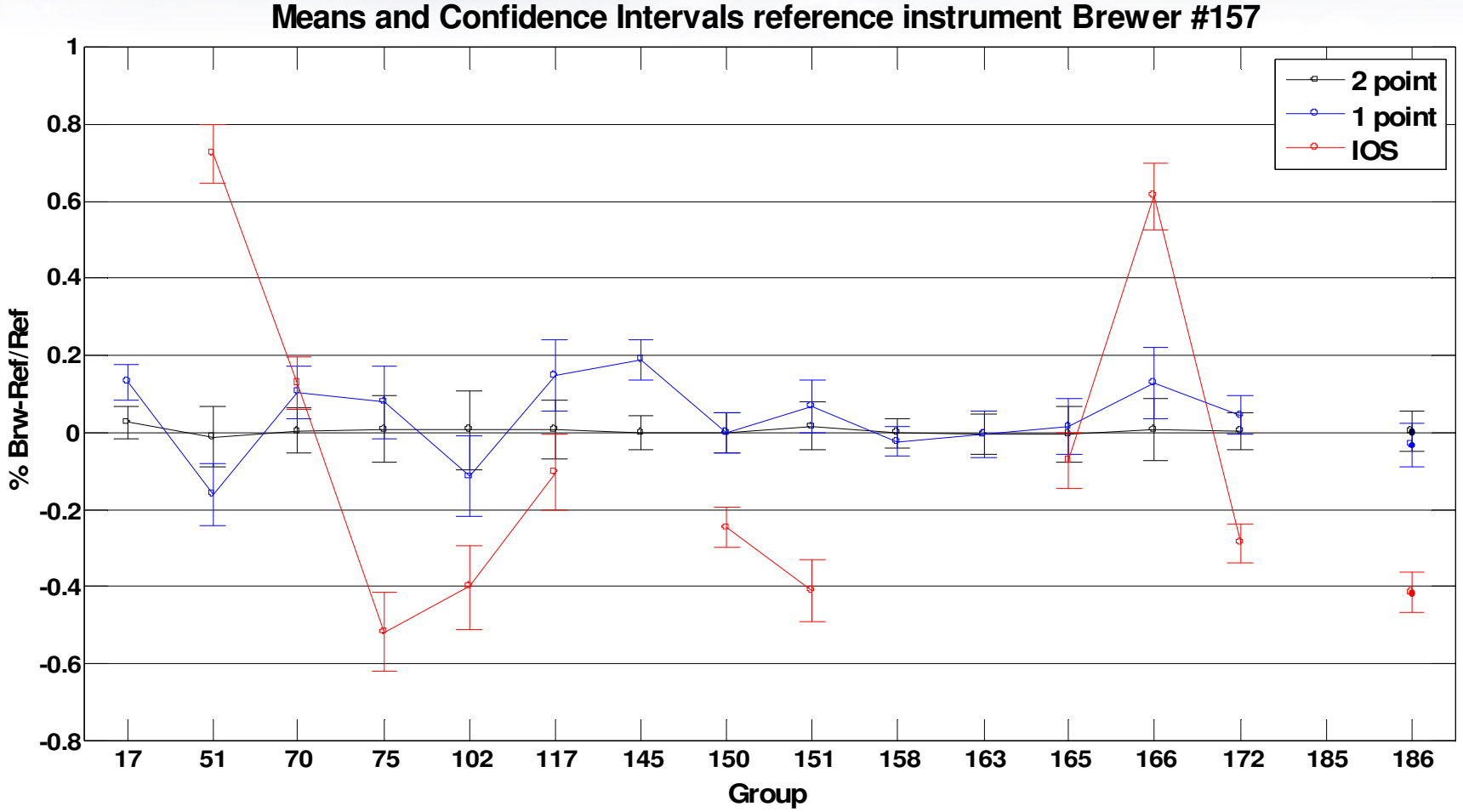
# Brewer 163 calibration185 vs 017




Means and Confidence Intervals reference Brewer #017
2 point
1 point
IOS
Mean
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
17
51
70
75
102
117
145
150
151
158
163
165
166
172
185
186
Group


Means and Confidence Intervals reference instrument Brewer #157
2 point
1 point
IOS
% Brw-Ref/Ref
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
17
51
70
75
102
117
145
150
151
158
163
165
166
172
185
186
Group

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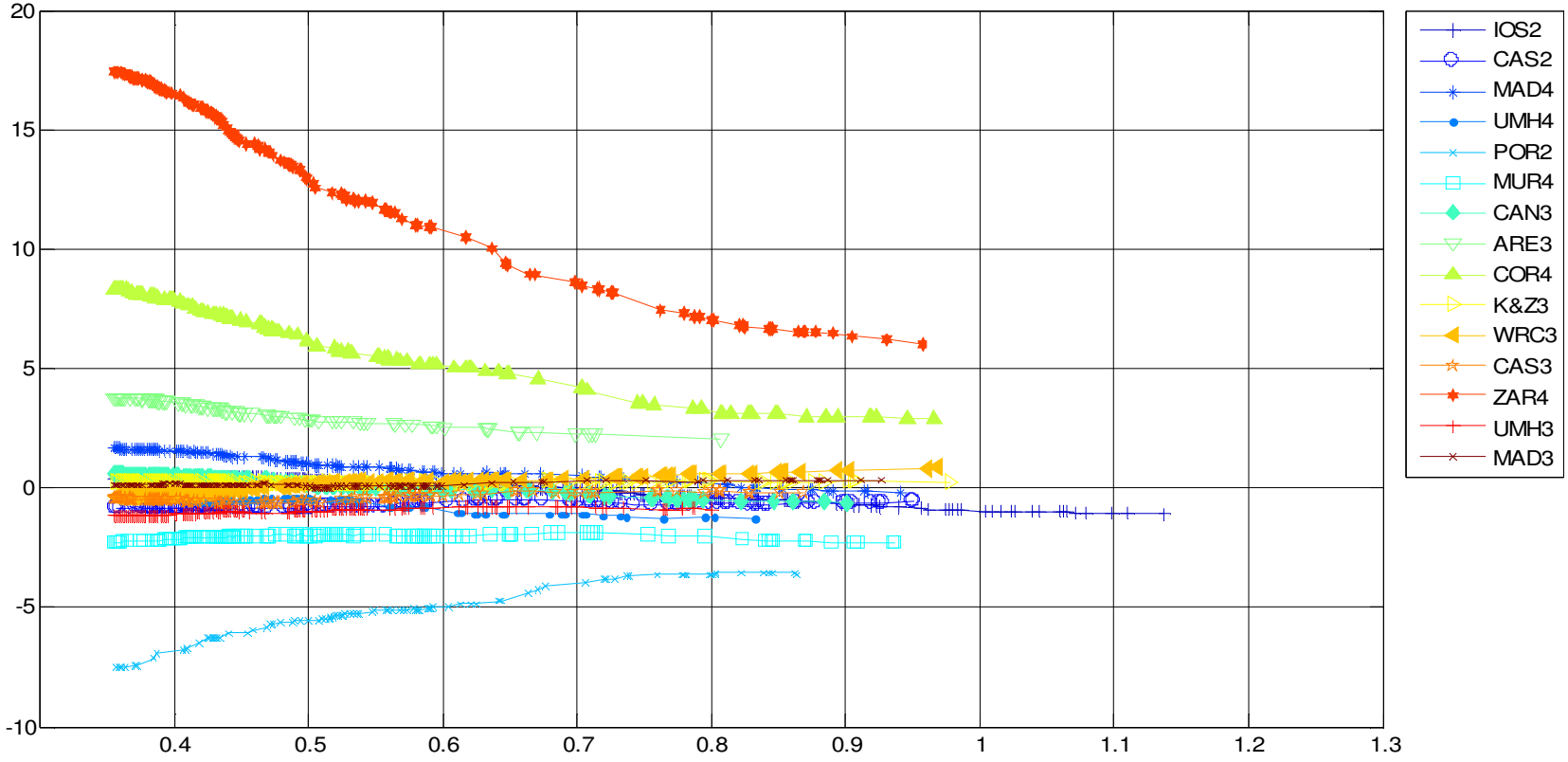
# II RBCC-E Campaing September 2007
# INITIAL CALIBRATION vs RBCC-E Brw#185



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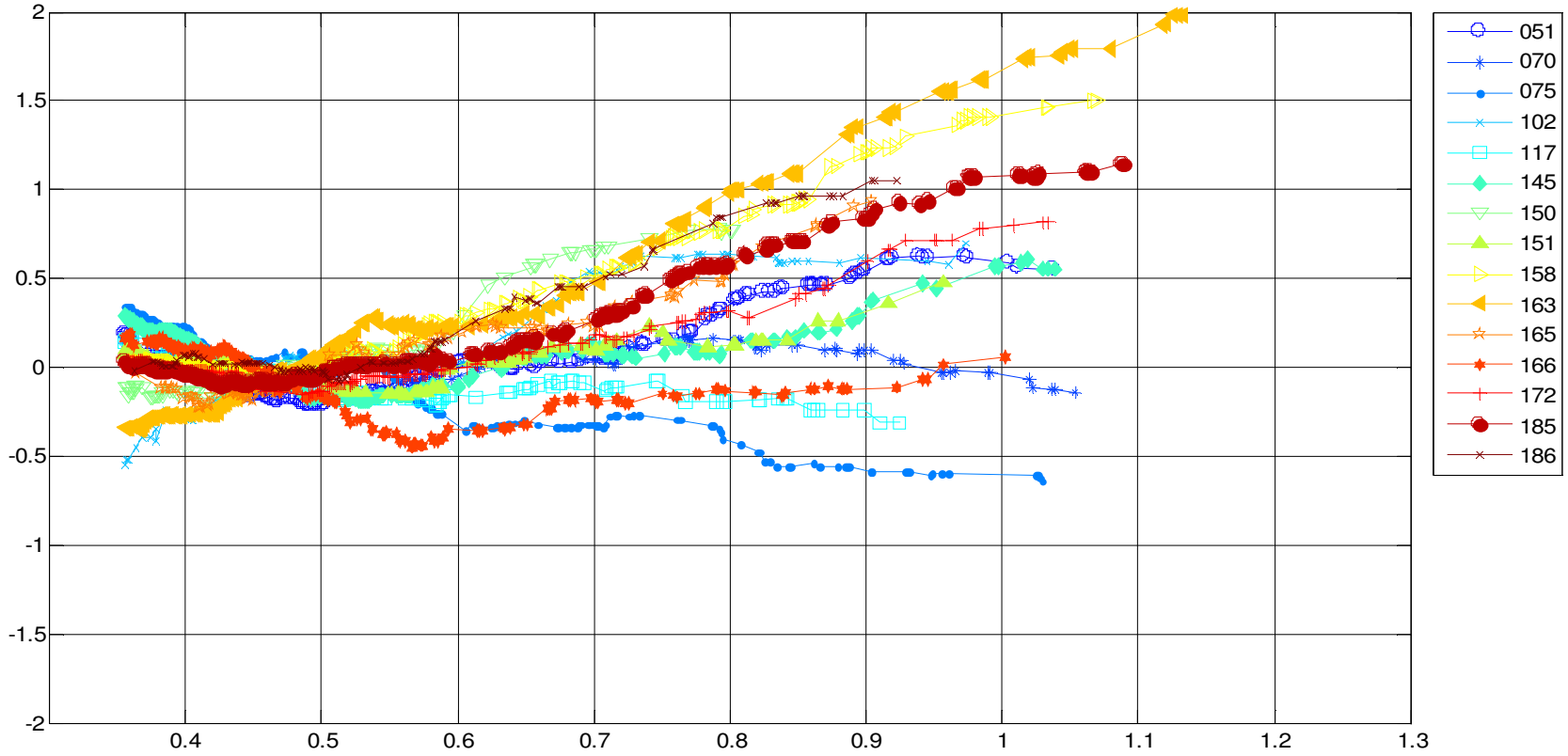
# II RBCC-E Campaing September 2007
## FINAL DAYS 1p reference Brw#017



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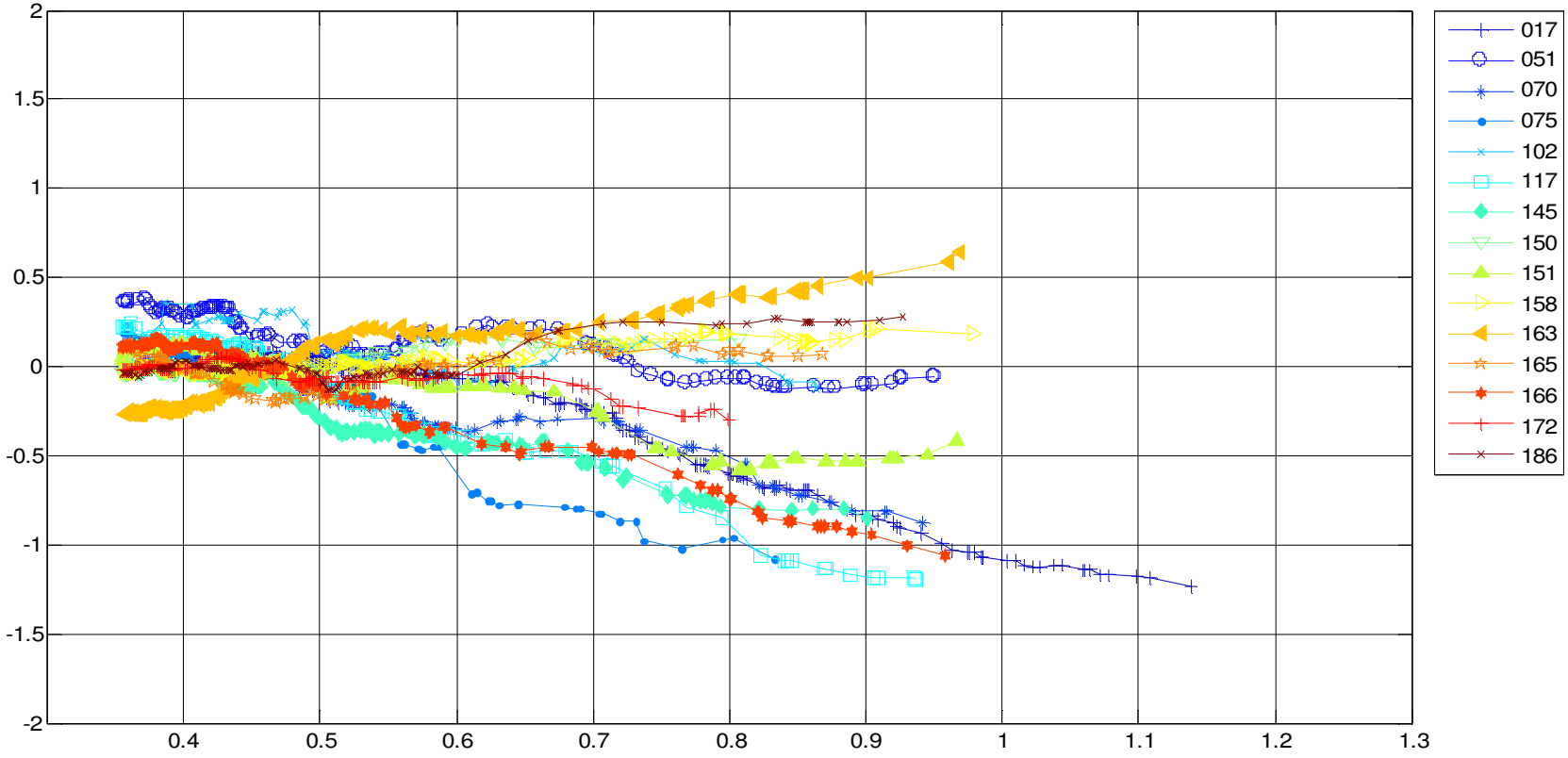
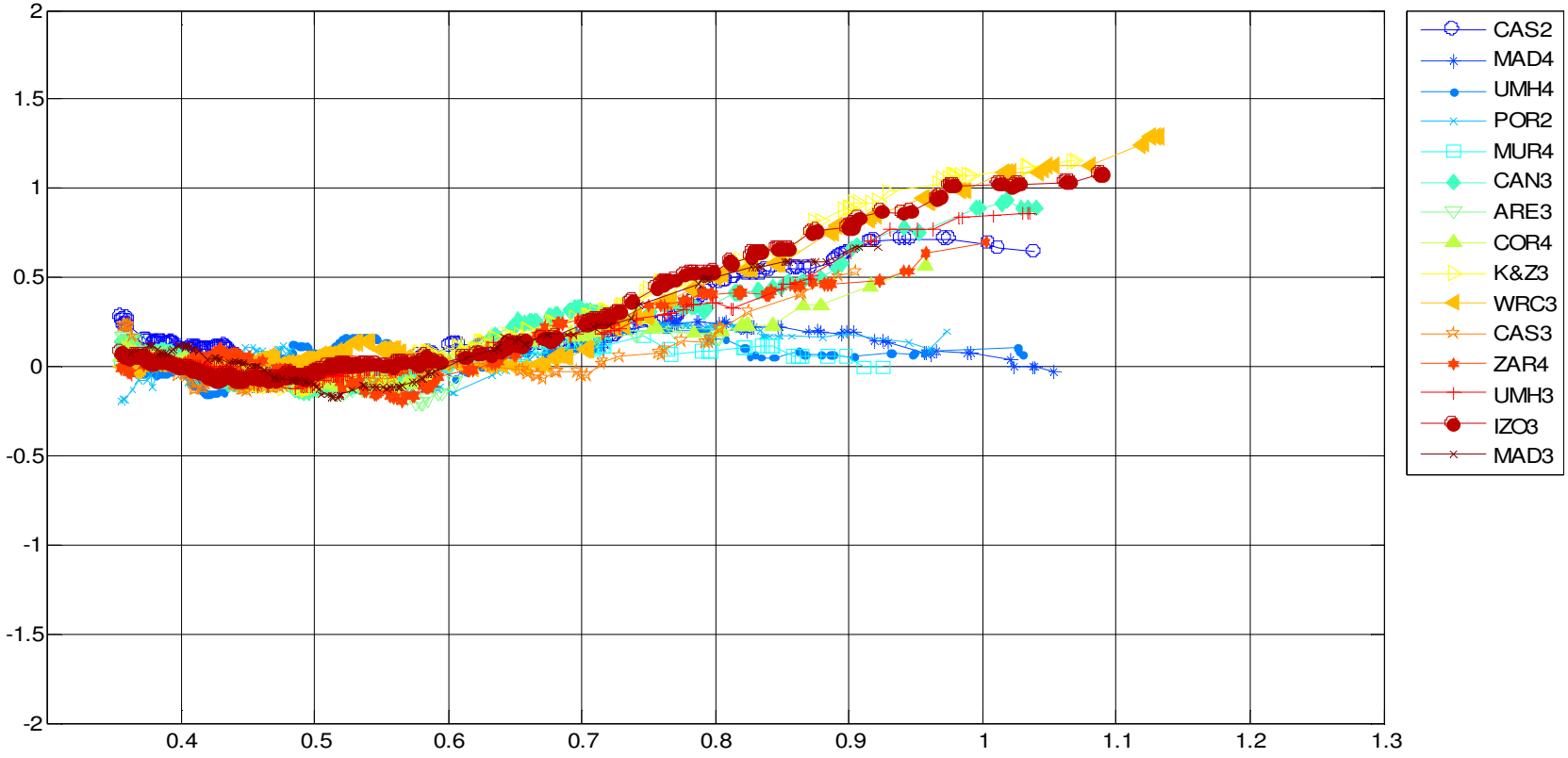
# II RBCC-E Campaing September 2007
## FINAL DAYS 1p reference RBCC-E Brw#185



II RBCC-E Campaing September 2007
FINAL DAYS 2p Reference Brw#070



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# II RBCC-E Campaing September 2007
# FINAL DAYS 2p Reference Brw#185