Calibration History of a Shadowband Instrument Measuring Aerosol Optical Depth

Presented at the

Aerosol Optical Depth Comparisons and Workshop
PMOD/WRC
Davos, Switzerland
25 September to 13 October 2000

K. Larman, F. Denn
Analytical Services & Materials, Inc.
Hampton, Virginia
USA
In support of NASA Langley Radiation & Aerosols Branch

Introduction

Instrument Description

Theory of Operation

Filter Spectral Response

Cosine correction

History filters & calibration

Summary

Instrument Description

Yankee Environmental Systems, Inc. MFRSR-7

Heated silicon sensors : SI, 416nm, 502nm, 616nm, 671nm, 870nm, 938nm

Diffuser alternately shaded and un-shaded, provide global and diffuse data.

Direct beam is calculated by global = diffuse + cos(Z) direc

Autonomous, field deployable.

Theory of Operation

Rearrange Bouguer Law : $\ln(V) - \ln(Vo) = - TAU$, $6 <= \text{Air Mass} <= 2$

Linear regress multiple measurements

Harrison's Objective Algorithm

1) find where dV/d(air mass) is positive- cloud activity ; remove data
2) check second derivative
3) two linear regressions, remove points >1.5 SD from first regression line
4) final linear regression yields coefficients Vo and TAU

Track Vo, incorporate into calibrations for Aerosol Optical Thickness.

Compared to a CIMEL at same site to .01 units

Summary

Operated the 379 MFRSR-7 at MLO (~3000m), at LaRC (SL), COVE (SL)

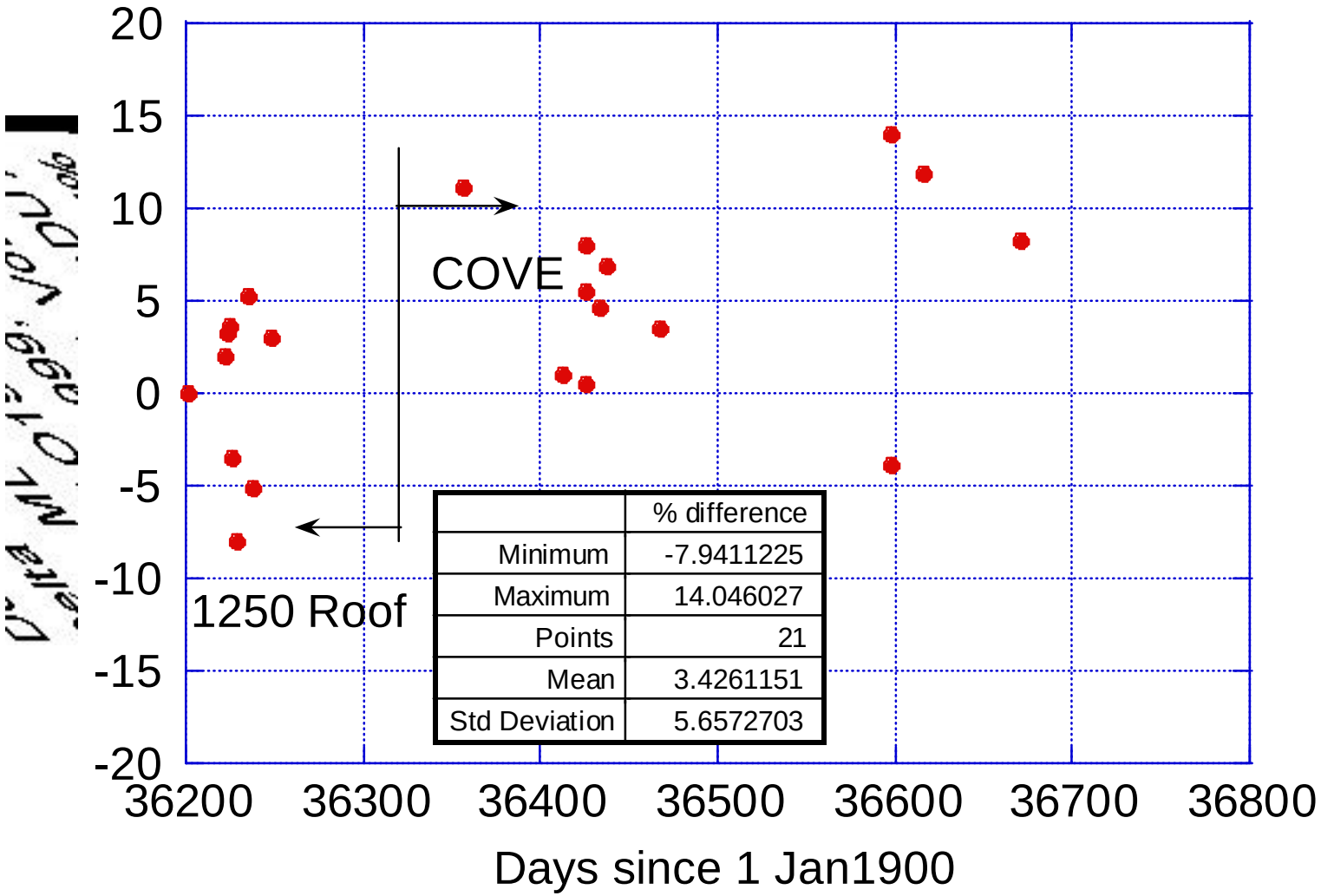
Found the least variability in data at MLO and most at COVE

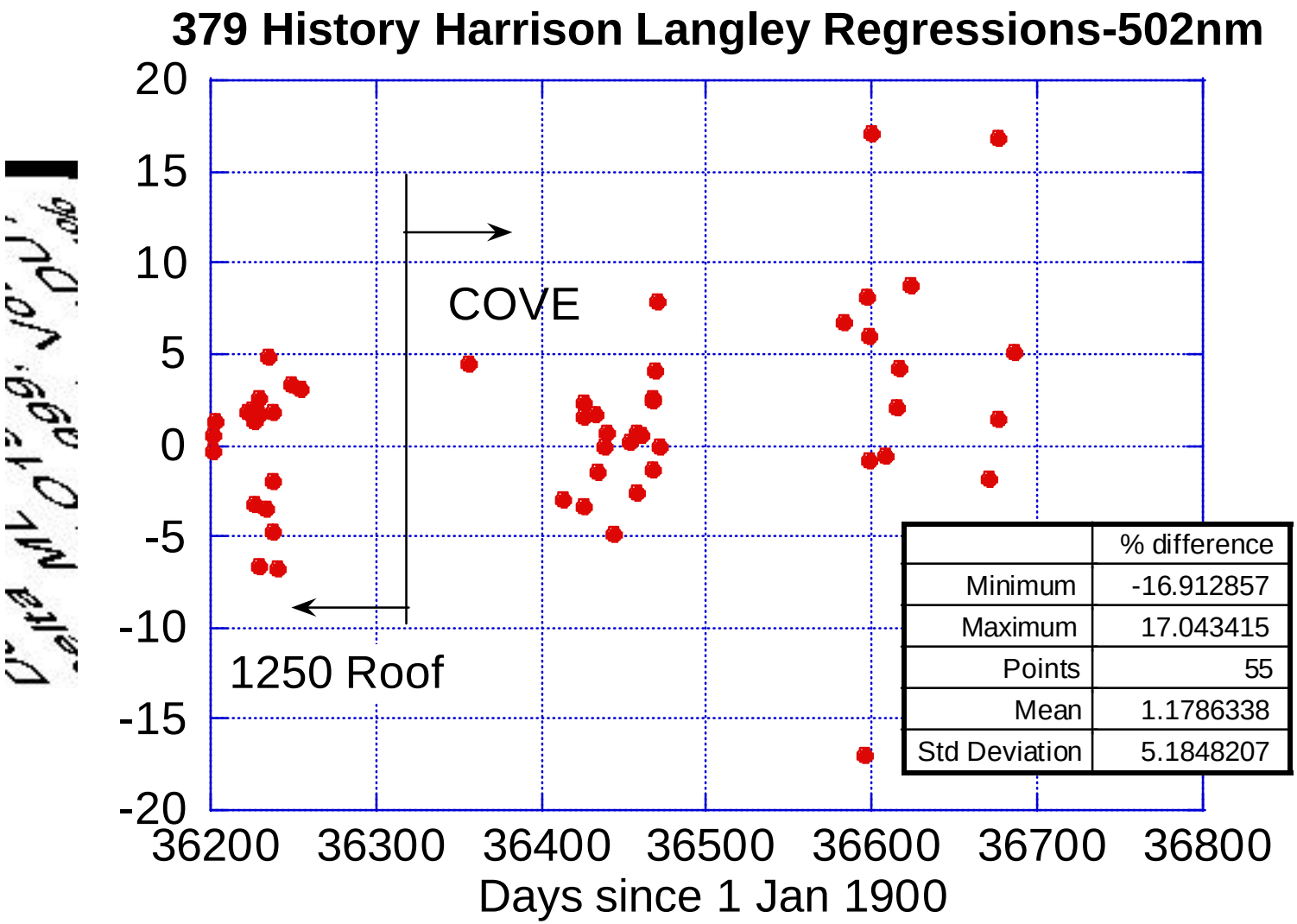
Compared well with a co-located CIMEL unit

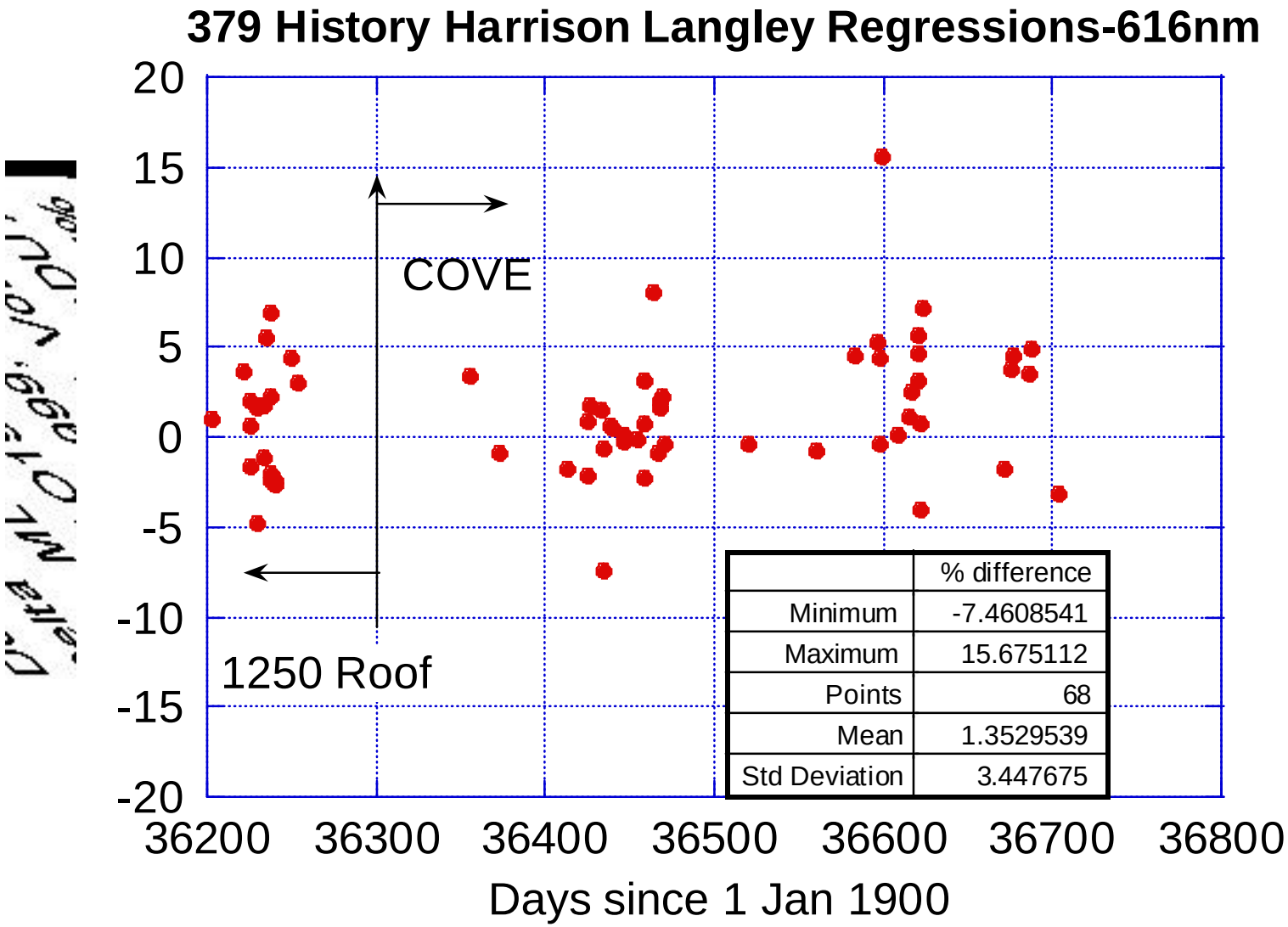
Changed to IAD filters

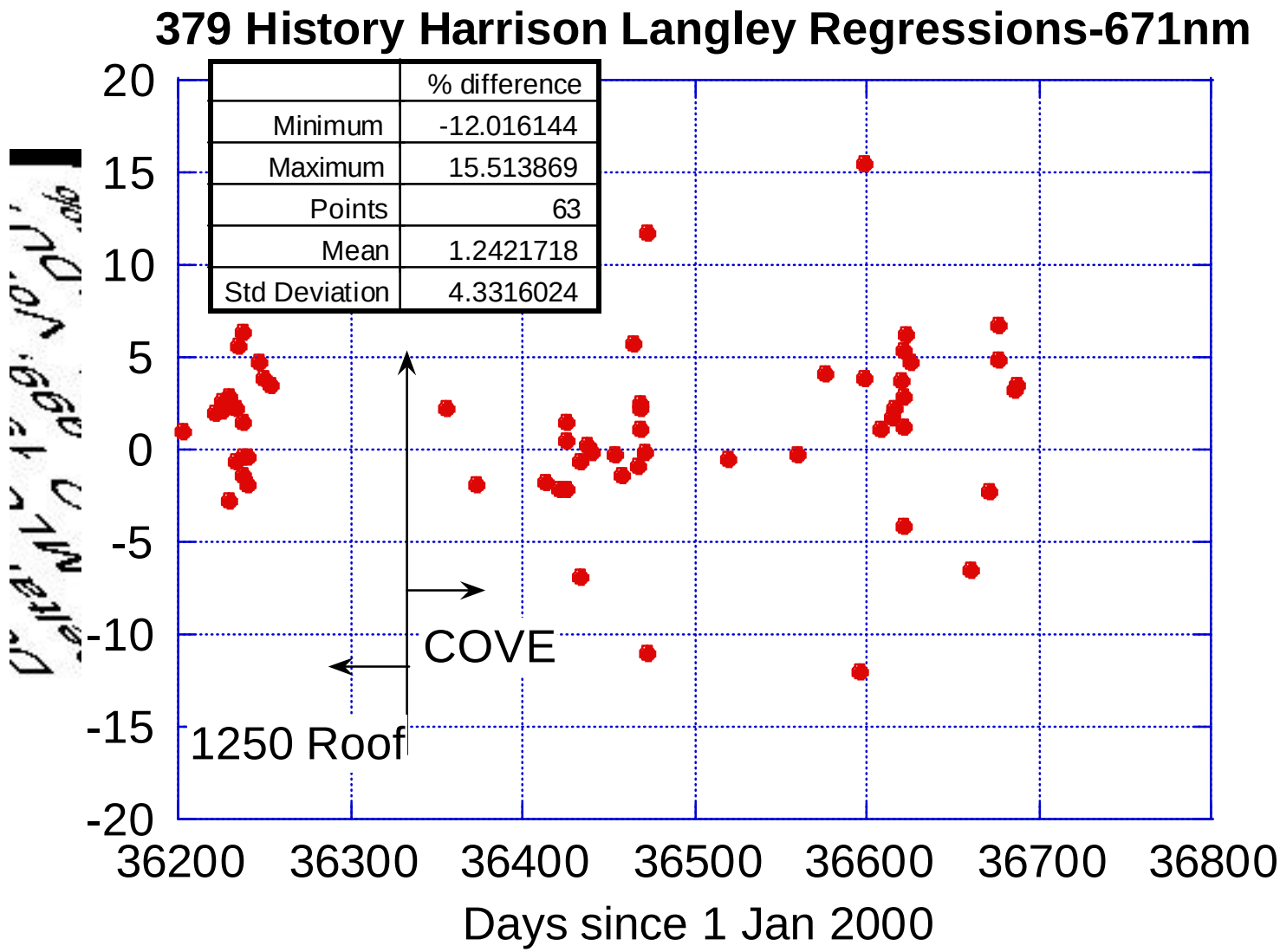
Plan to rotate sensor head between MLO, LaRC and COVE to track Vo.

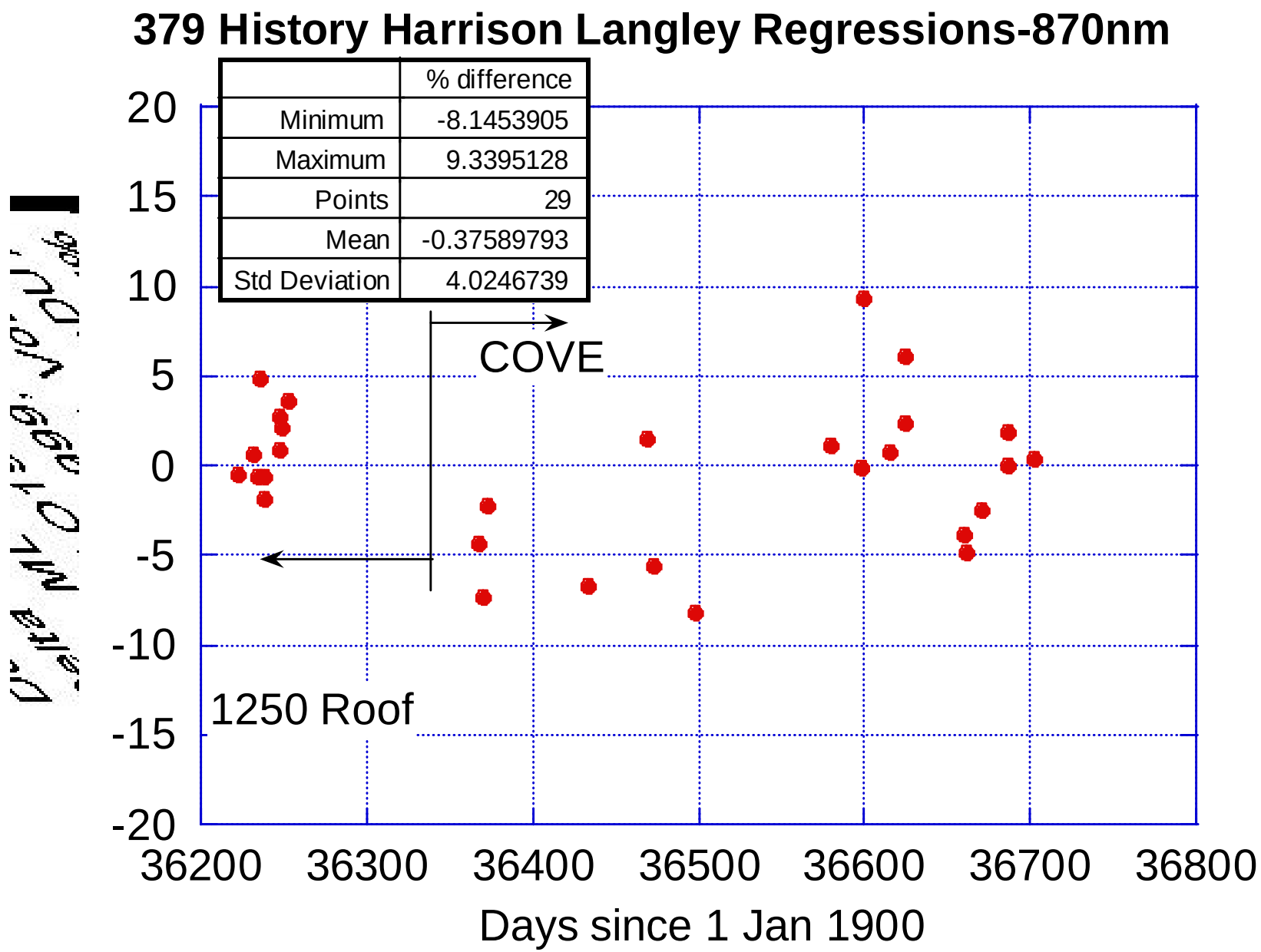
379 History Harrison Langley Regressions 416 nm

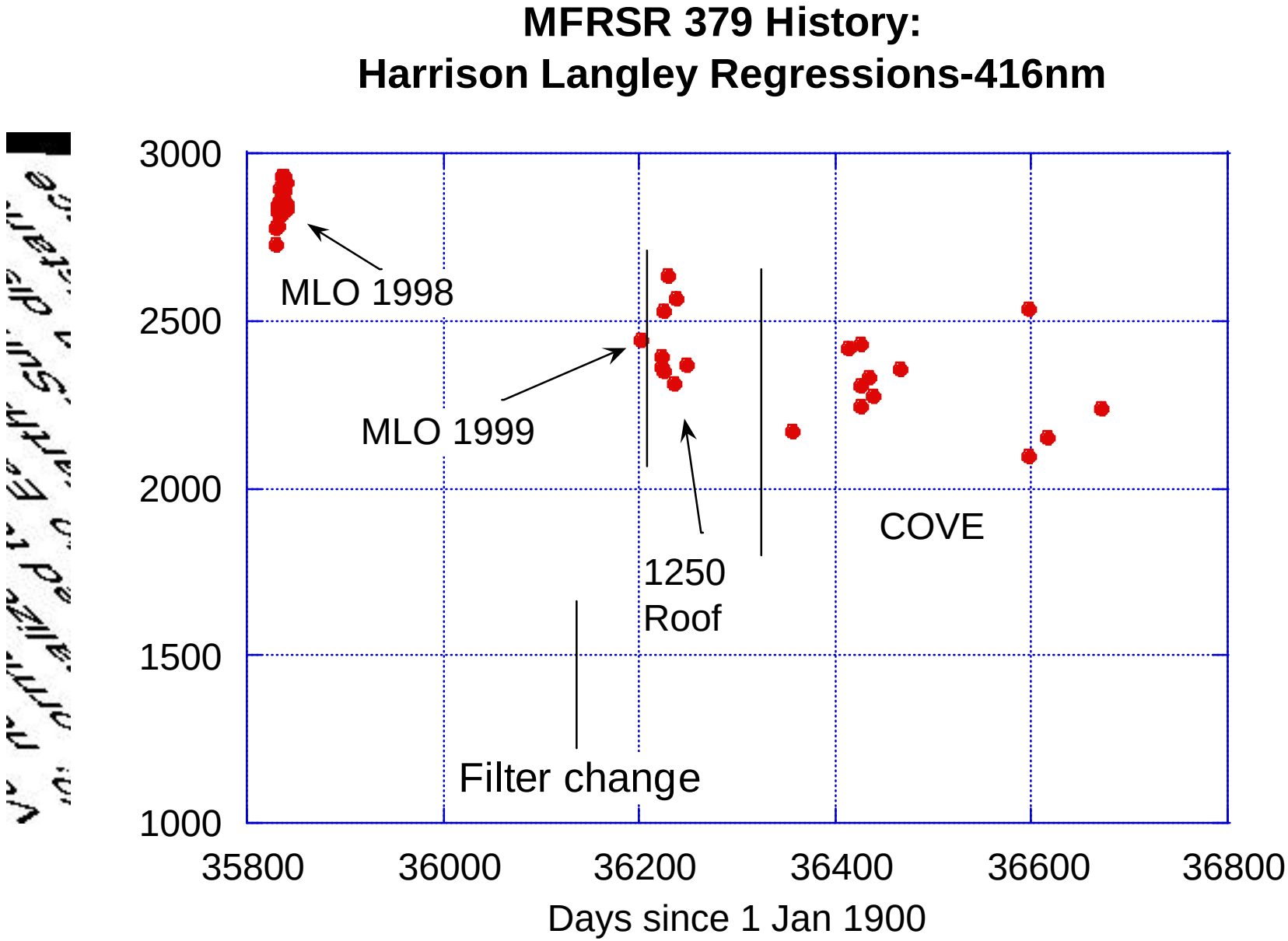



379 History Harrison Langley Regressions-502nm
20
15
10
5
0
-5
-10
-15
-20
36200
36300
36400
36500
36600
36700
36800
Days since 1 Jan 1900
COVE
1250 Roof
% difference
Minimum -16.912857
Maximum 17.043415
Points 55
Mean 1.1786338
Std Deviation 5.1848207

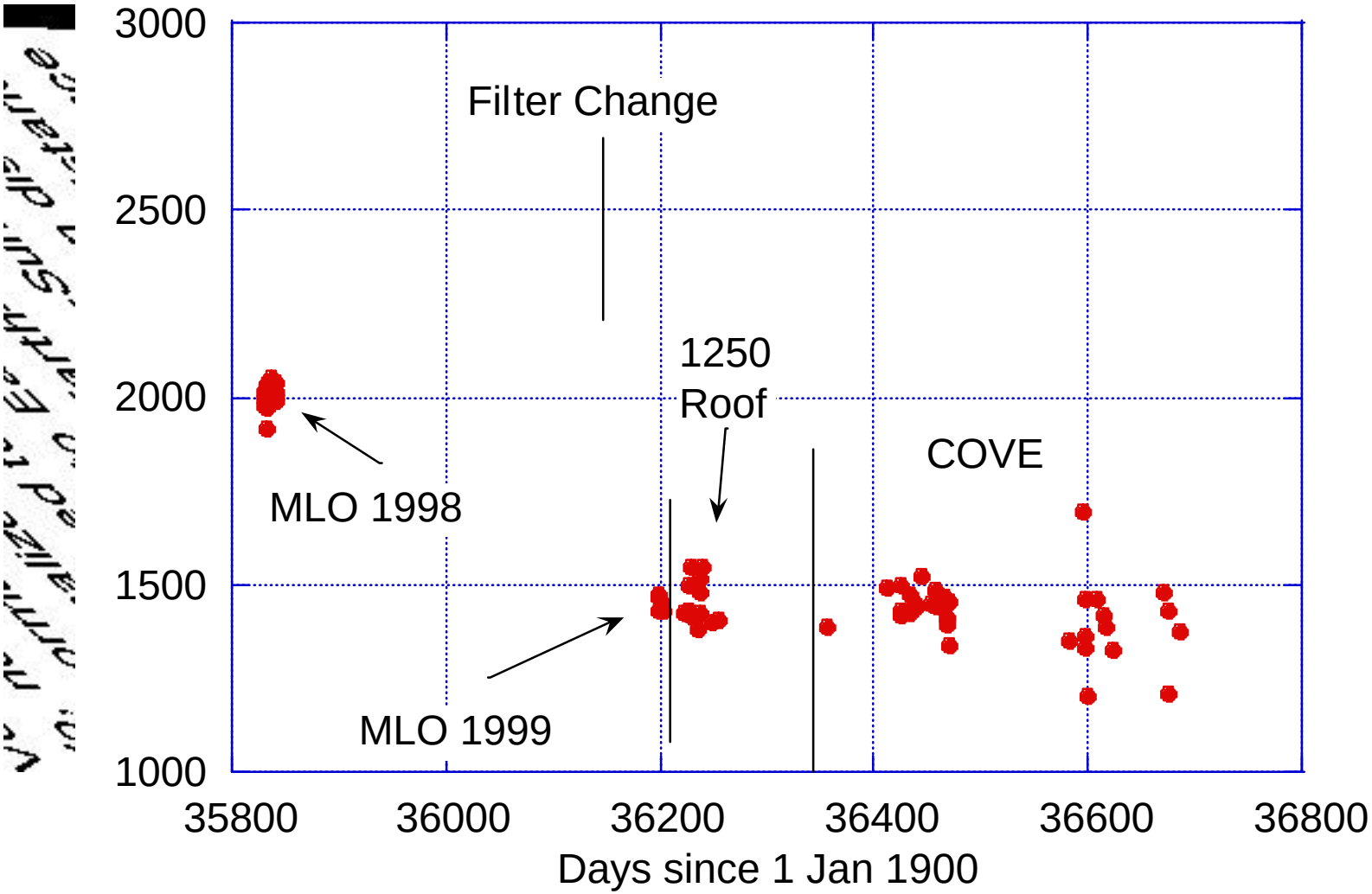

379 History Harrison Langley Regressions-616nm
20
15
10
5
0
-5
-10
-15
-20
36200
36300
36400
36500
36600
36700
36800
Days since 1 Jan 1900
COVE
1250 Roof
% difference
Minimum -7.4608541
Maximum 15.675112
Points 68
Mean 1.3529539
Std Deviation 3.447675


379 History Harrison Langley Regressions-671nm
% difference
Minimum -12.016144
Maximum 15.513869
Points 63
Mean 1.2421718
Std Deviation 4.3316024
20
15
10
5
0
-5
-10
-15
-20
COVE
1250 Roof
36200
36300
36400
36500
36600
36700
36800
Days since 1 Jan 2000

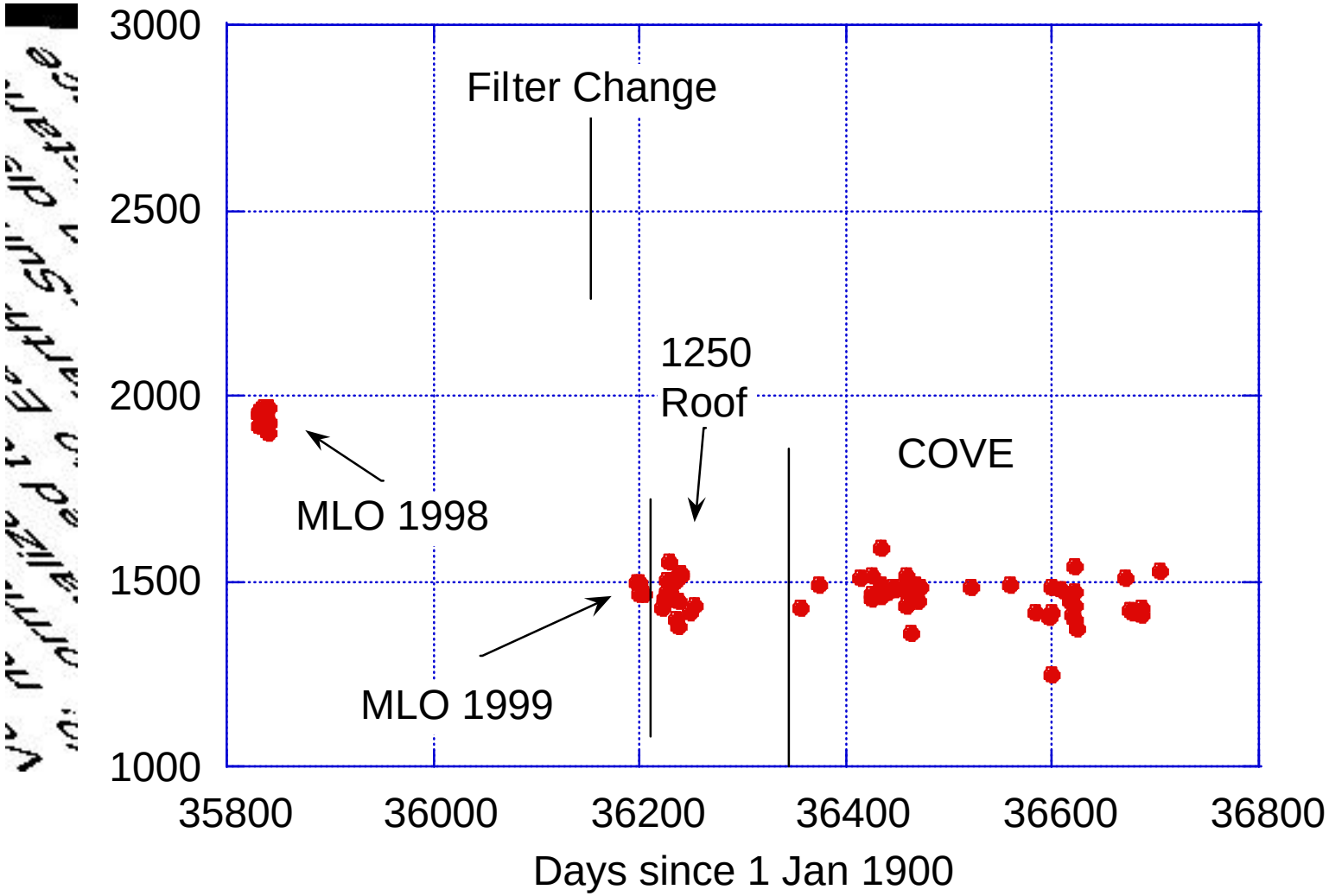

379 History Harrison Langley Regressions-870nm
% difference
Minimum -8.1453905
Maximum 9.3395128
Points 29
Mean -0.37589793
Std Deviation 4.0246739
COVE
1250 Roof
20
15
10
5
0
-5
-10
-15
-20
36200
36300
36400
36500
36600
36700
36800
Days since 1 Jan 1900

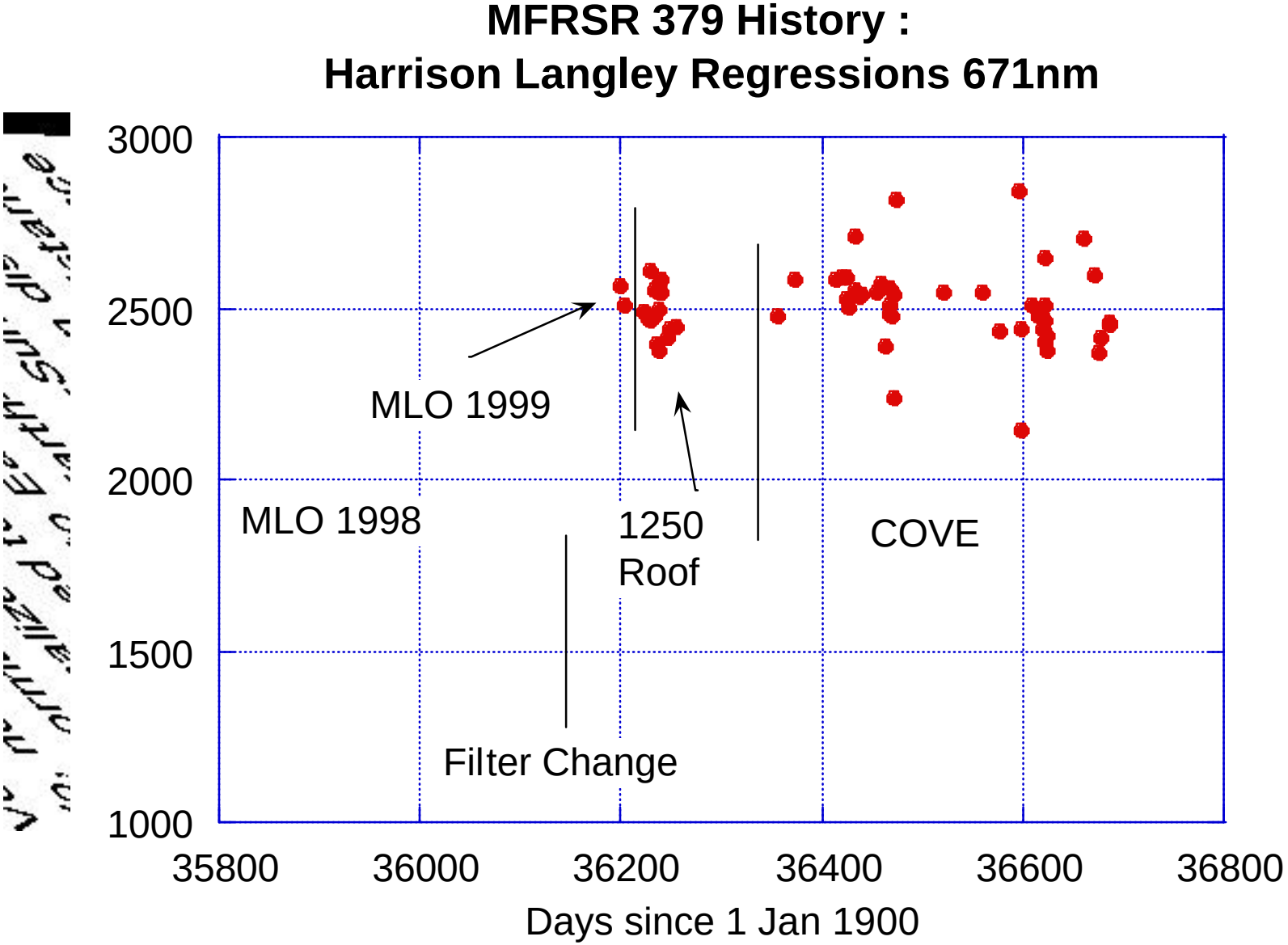

MFRSR 379 History:
Harrison Langley Regressions-416nm
3000
2500
2000
1500
1000
35800
36000
36200
36400
36600
36800
Days since 1 Jan 1900
MLO 1998
MLO 1999
1250
Roof
COVE
Filter change

MFRSR 379 History :
Harrison Langley Regressions-502nm

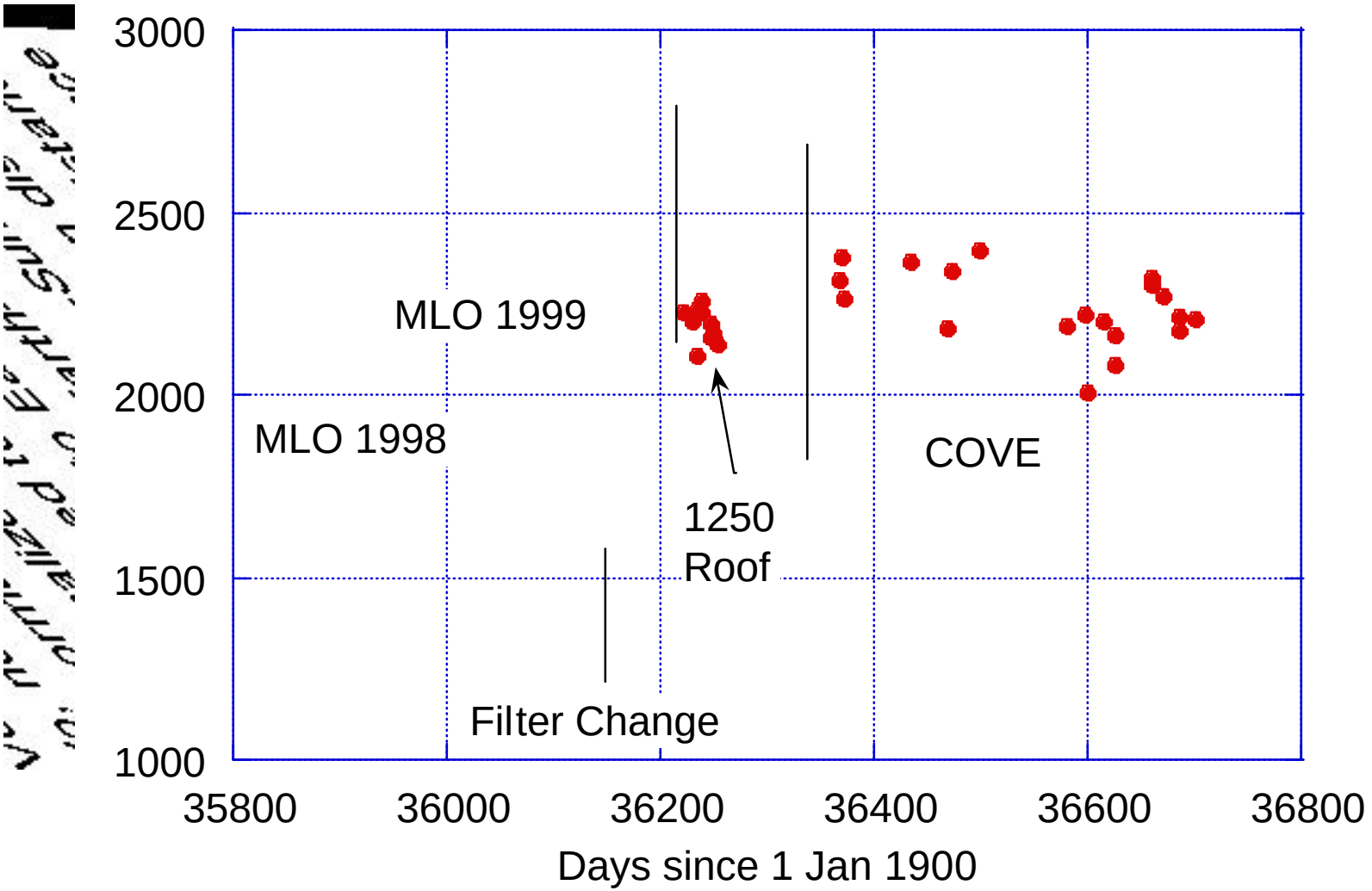


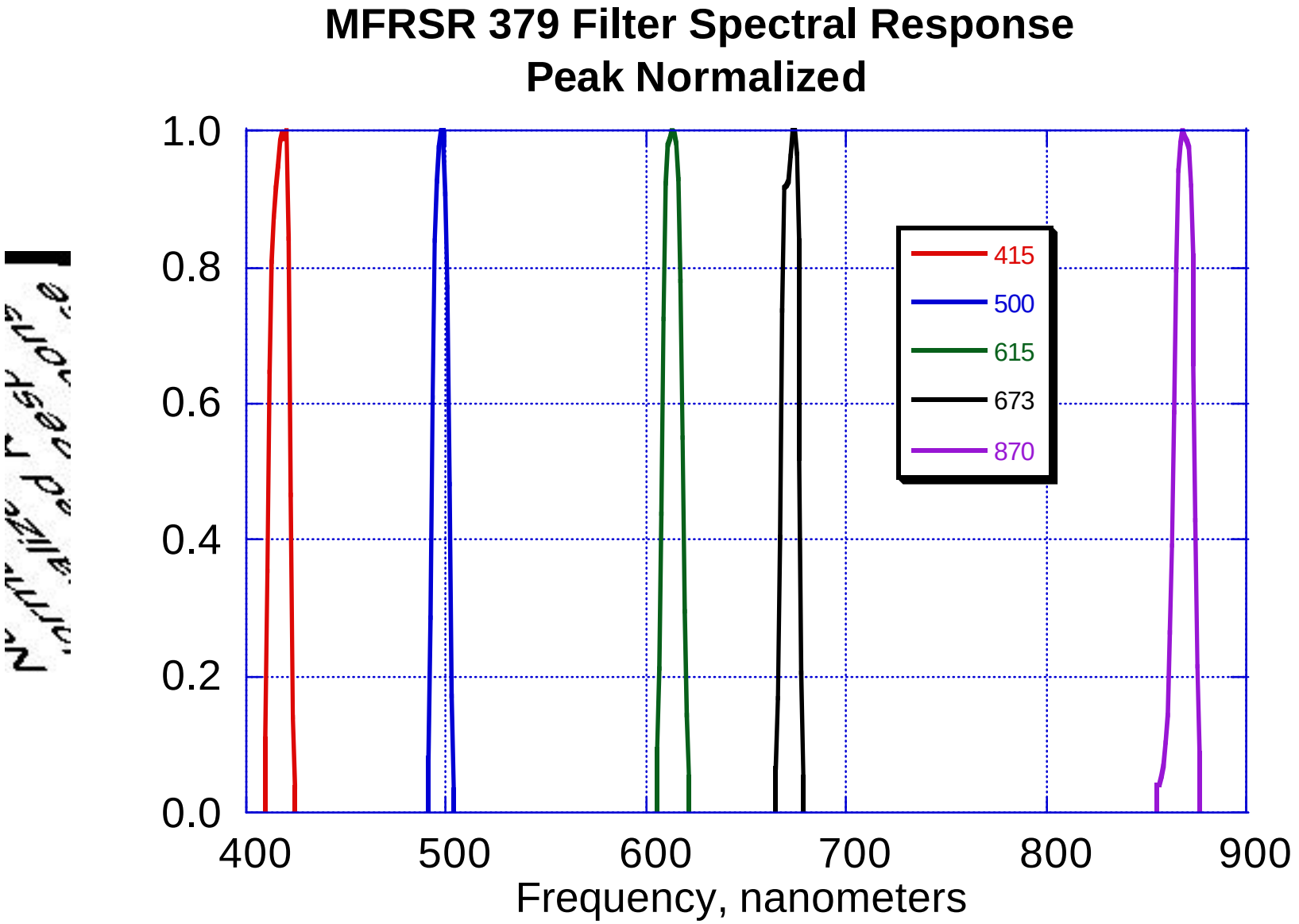
MFRSR379 History :
Harrison Langley Regressions-616 nm

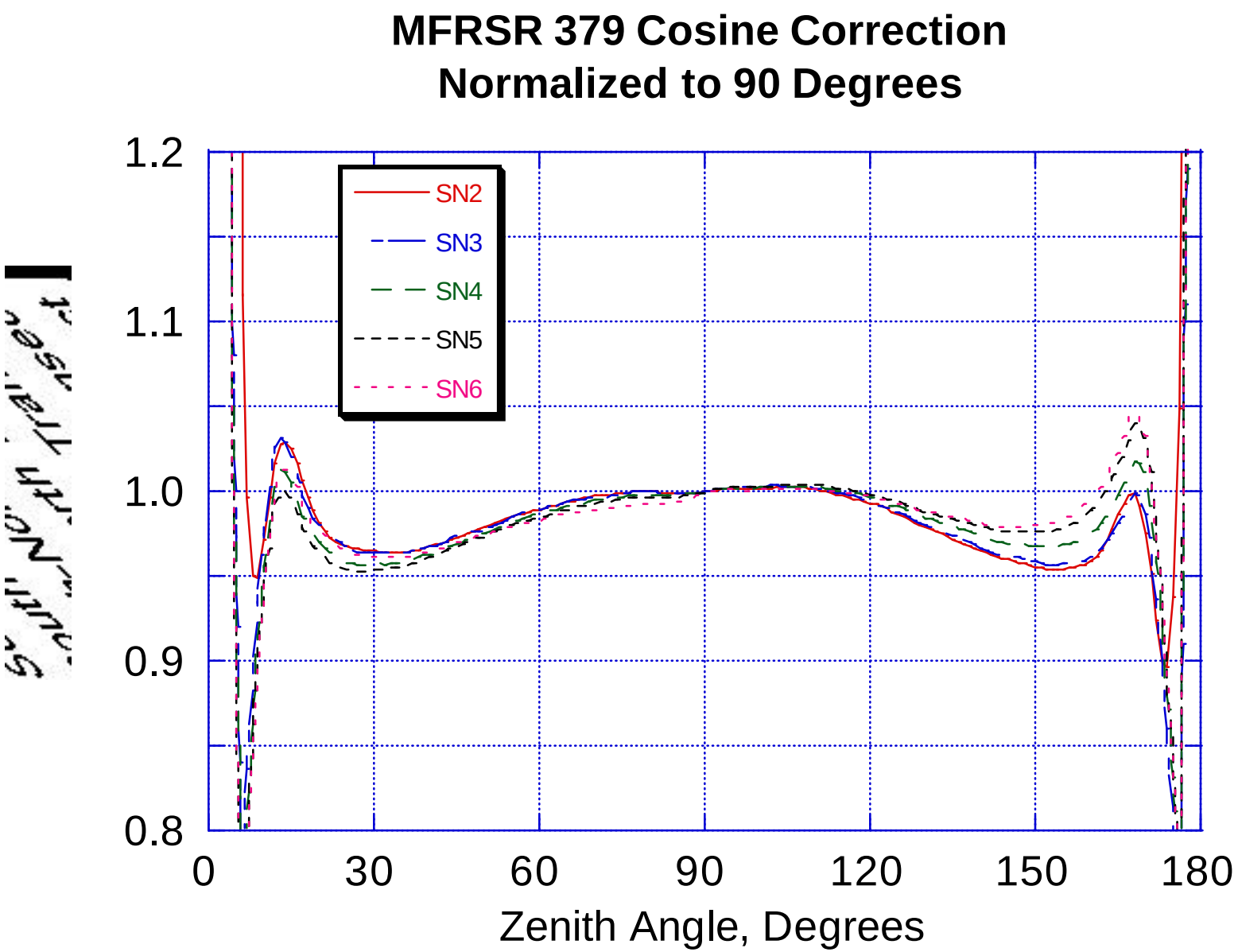


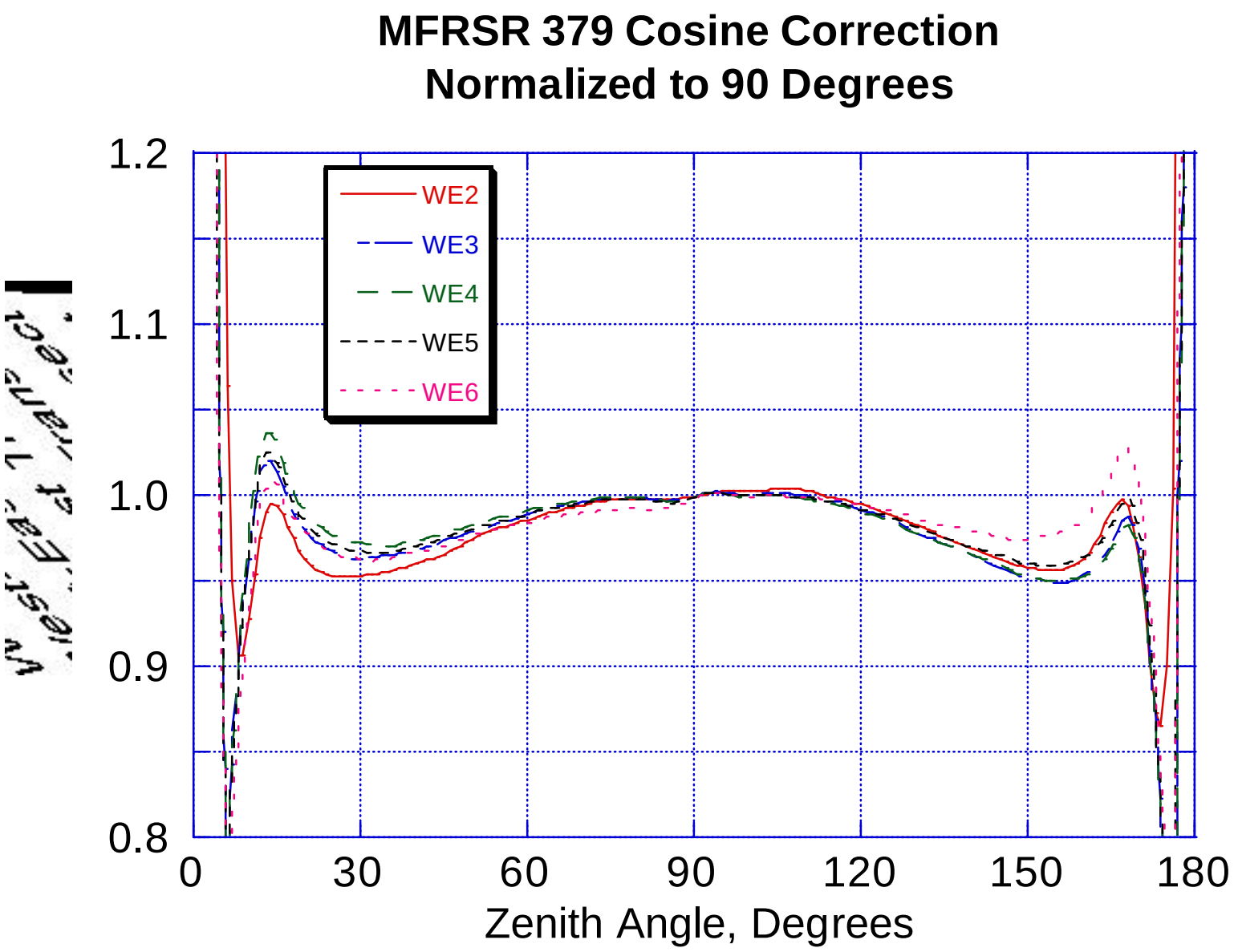

MFRSR 379 History :
Harrison Langley Regressions 671nm
3000
2500
2000
1500
1000
35800
36000
36200
36400
36600
36800
Days since 1 Jan 1900
MLO 1999
MLO 1998
1250
Roof
COVE
Filter Change

MFRSR 379 History :
Harrison Langley Regressions-870nm




MFRSR 379 Filter Spectral Response
Peak Normalized
1.0
0.8
0.6
0.4
0.2
0.0
400
500
600
700
800
900
Frequency, nanometers
415
500
615
673
870


MFRSR 379 Cosine Correction
Normalized to 90 Degrees
SN2
SN3
SN4
SN5
SN6
1.2
1.1
1.0
0.9
0.8
0
30
60
90
120
150
180
Zenith Angle, Degrees


MFRSR 379 Cosine Correction
Normalized to 90 Degrees
1.2
1.1
1.0
0.9
0.8
0
30
60
90
120
150
180
Zenith Angle, Degrees
WE2
WE3
WE4
WE5
WE6