Density Measurement & Pressure Broadening

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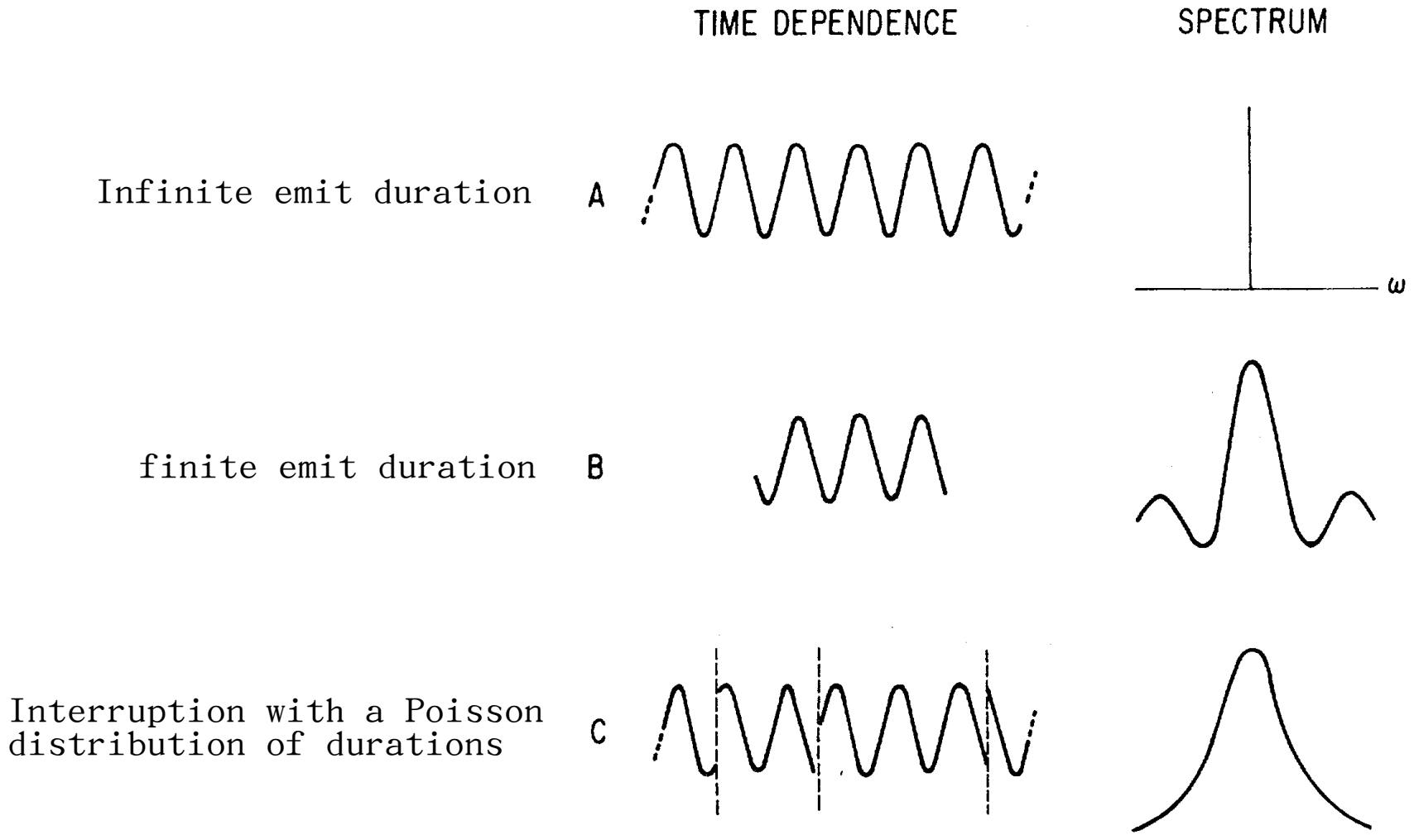
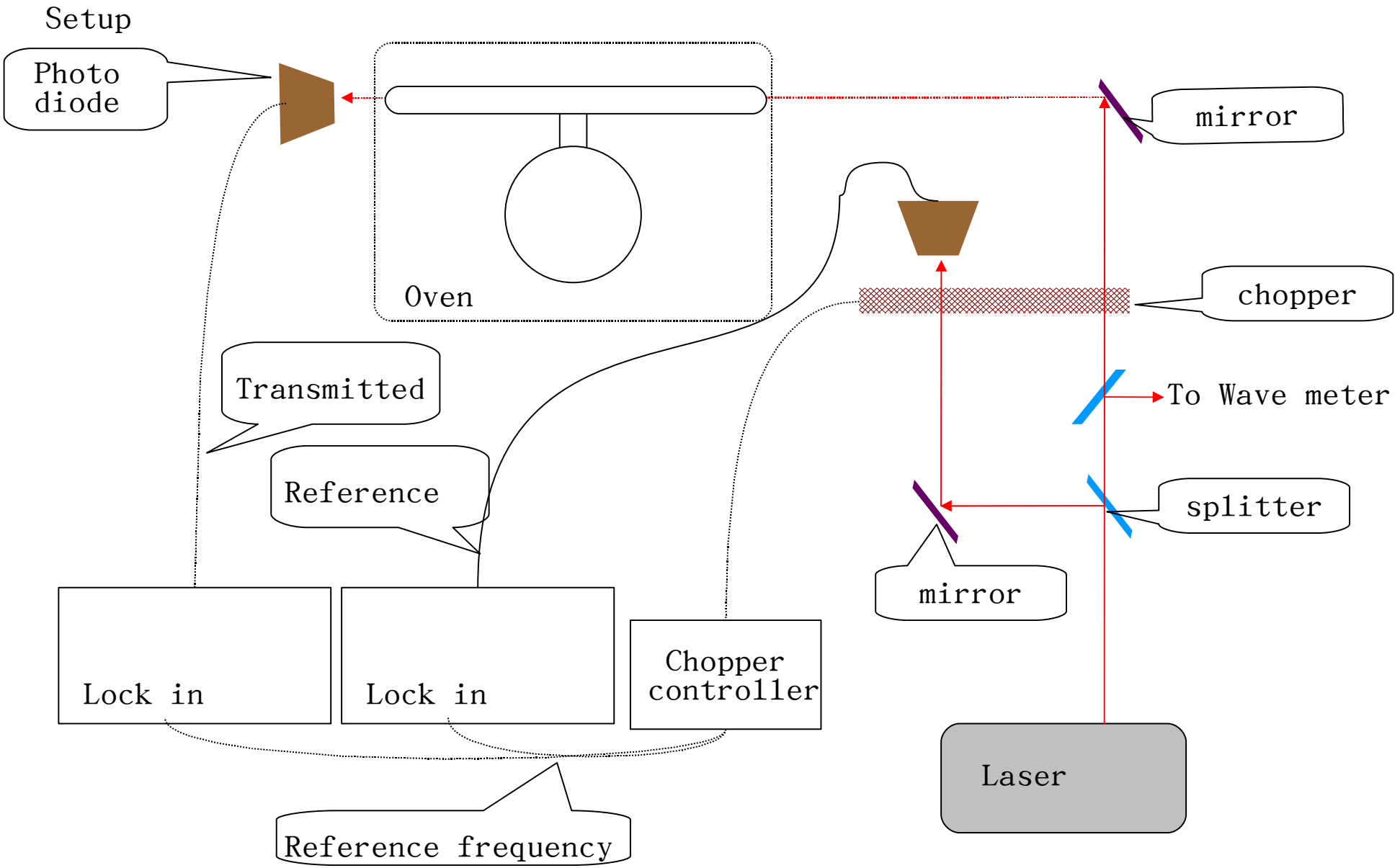
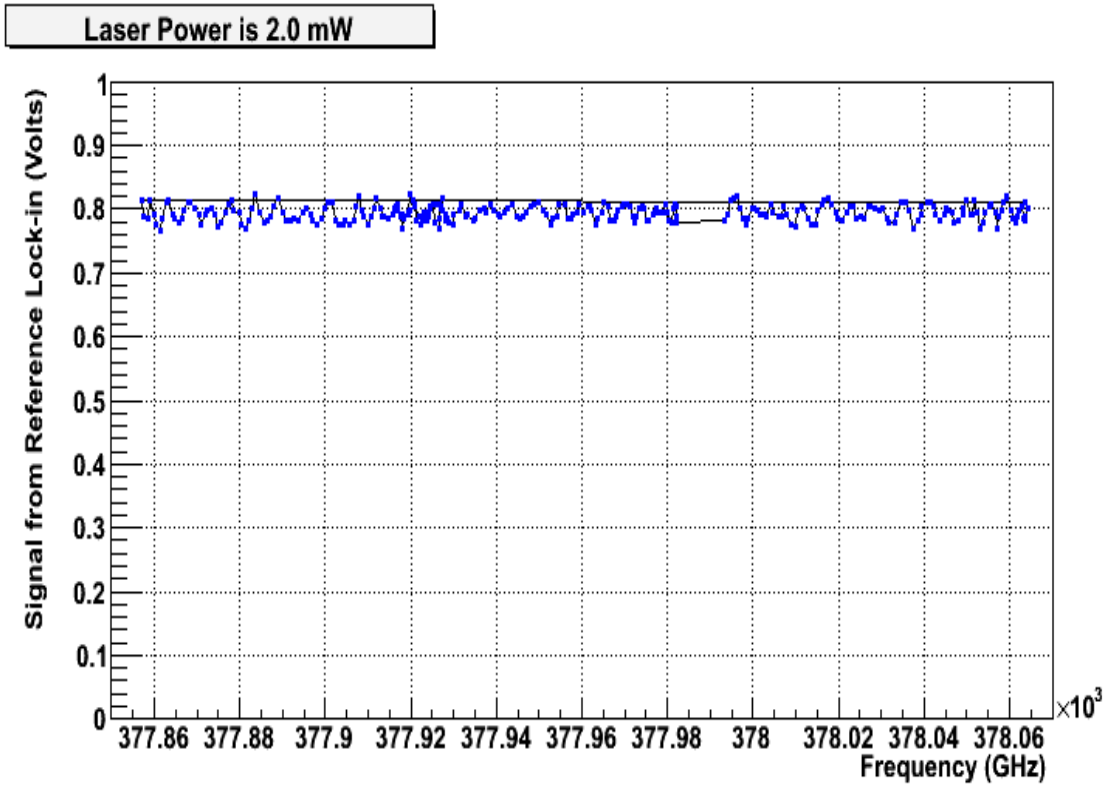
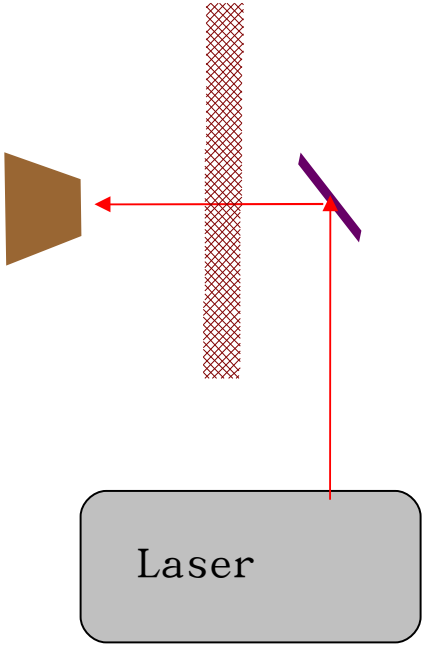
Principle


TIME DEPENDENCE
SPECTRUM
Infinite emit duration
A
ω
finite emit duration
B
Interruption with a Poisson distribution of durations
C

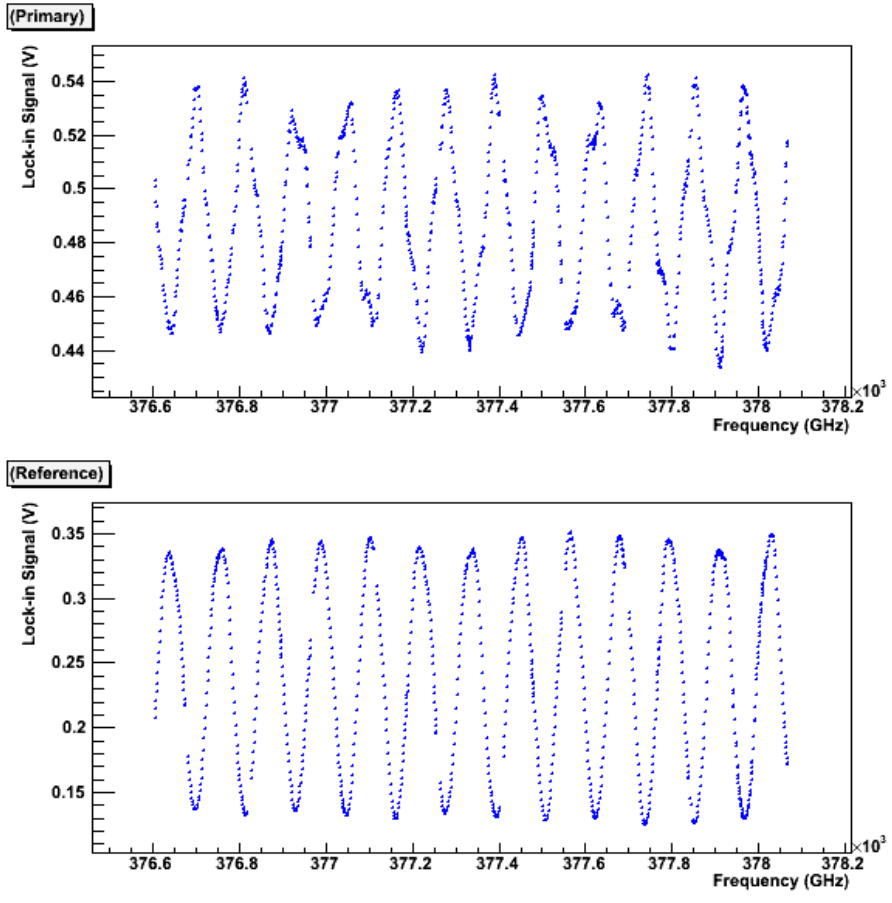

Setup
Photo diode
Oven
mirror
chopper
Transmitted
To Wave meter
Reference
splitter
mirror
Lock in
Lock in
Chopper controller
Laser
Reference frequency

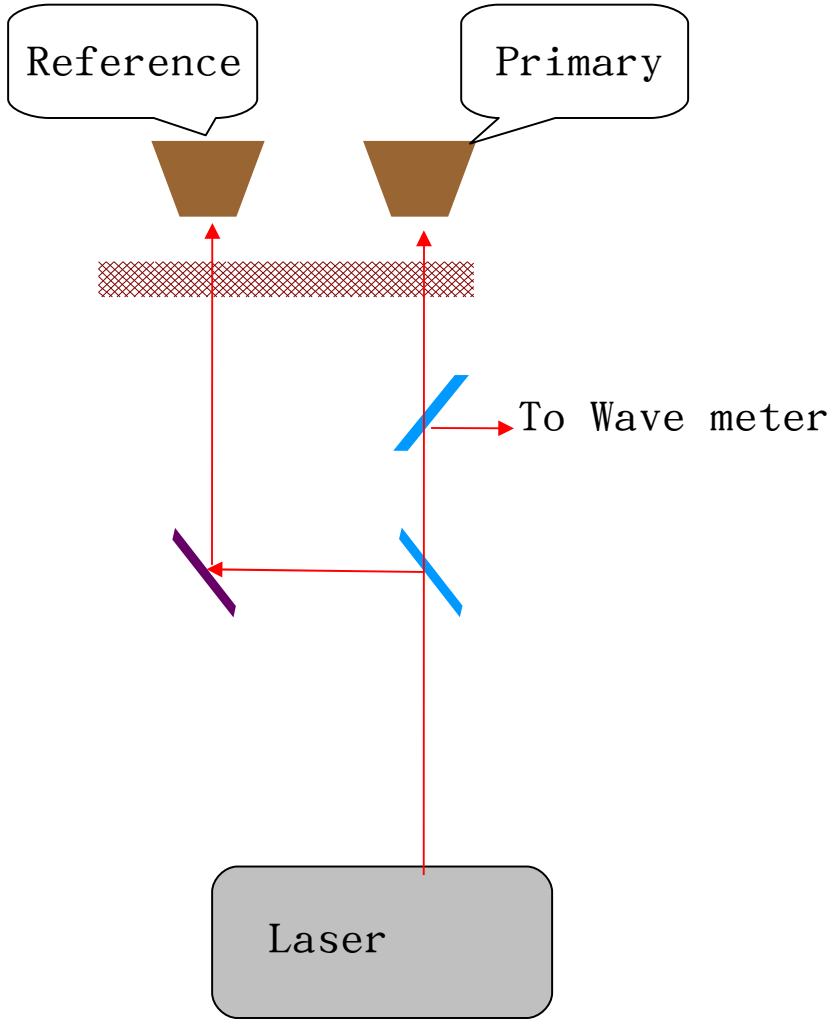
Oscillation



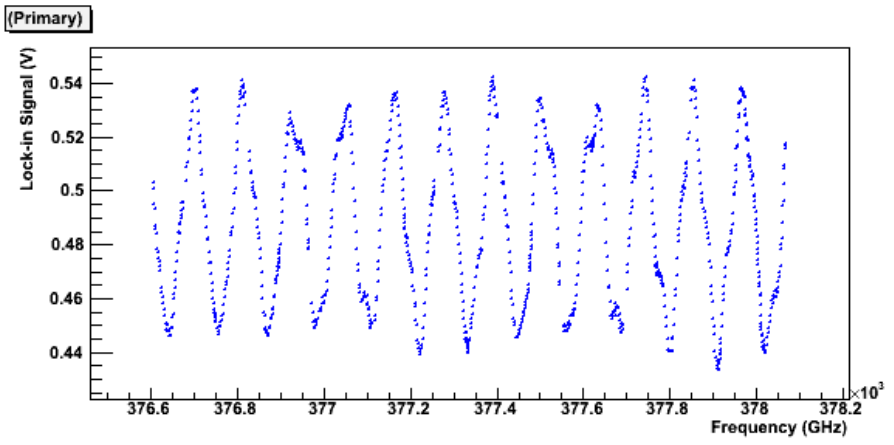


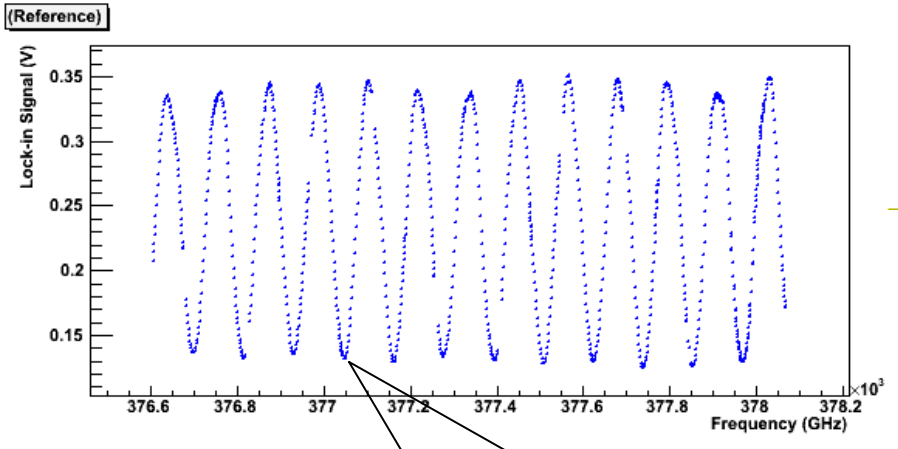
Oscillation



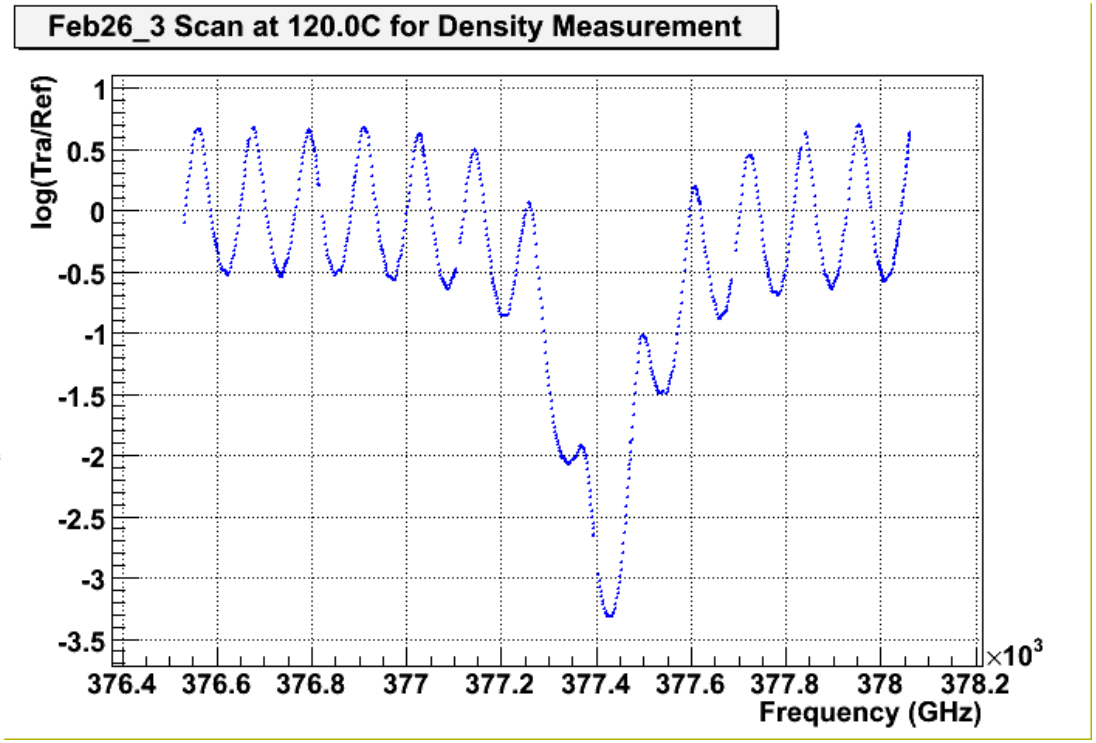


Oscillation

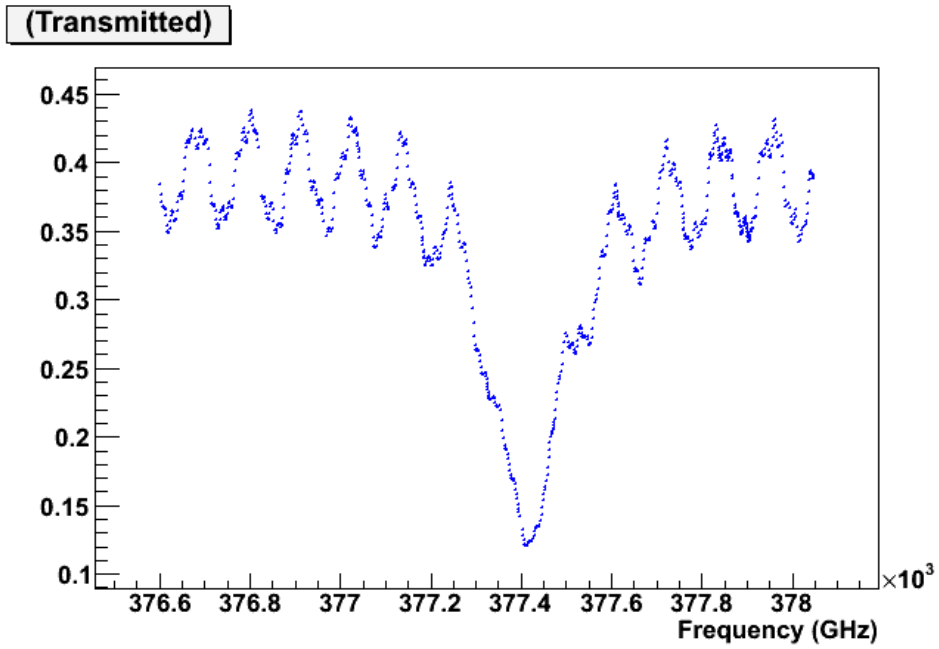


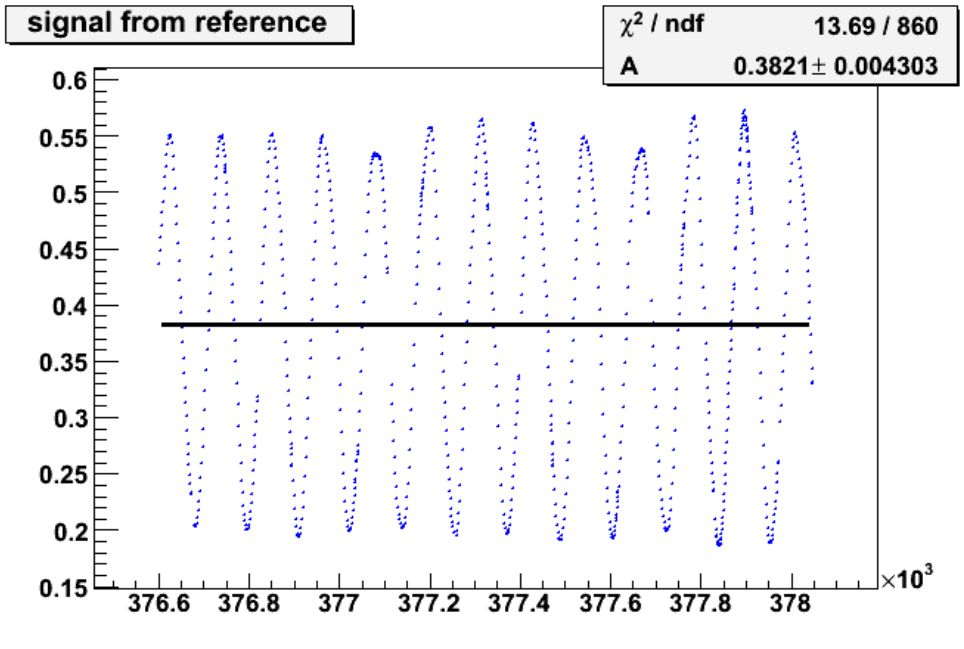


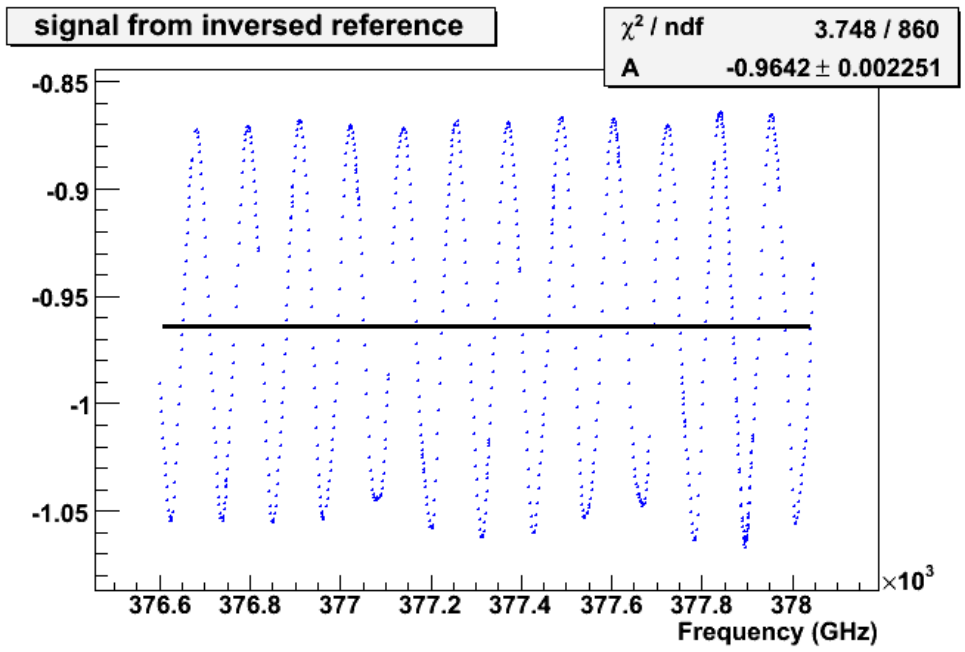
Inverse phase

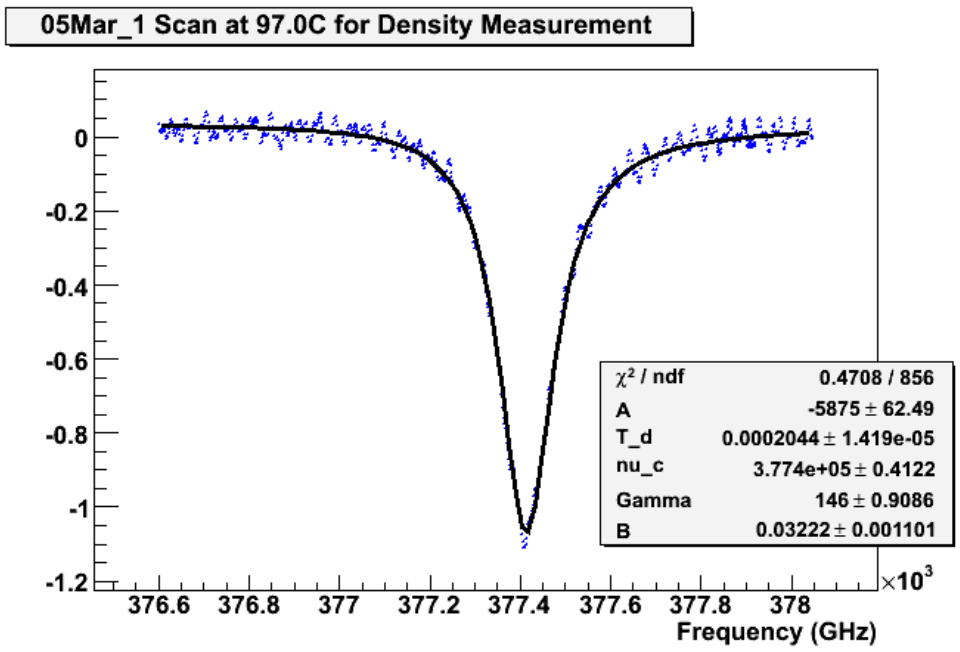


Oscillation will not be canceled but increased in final result.

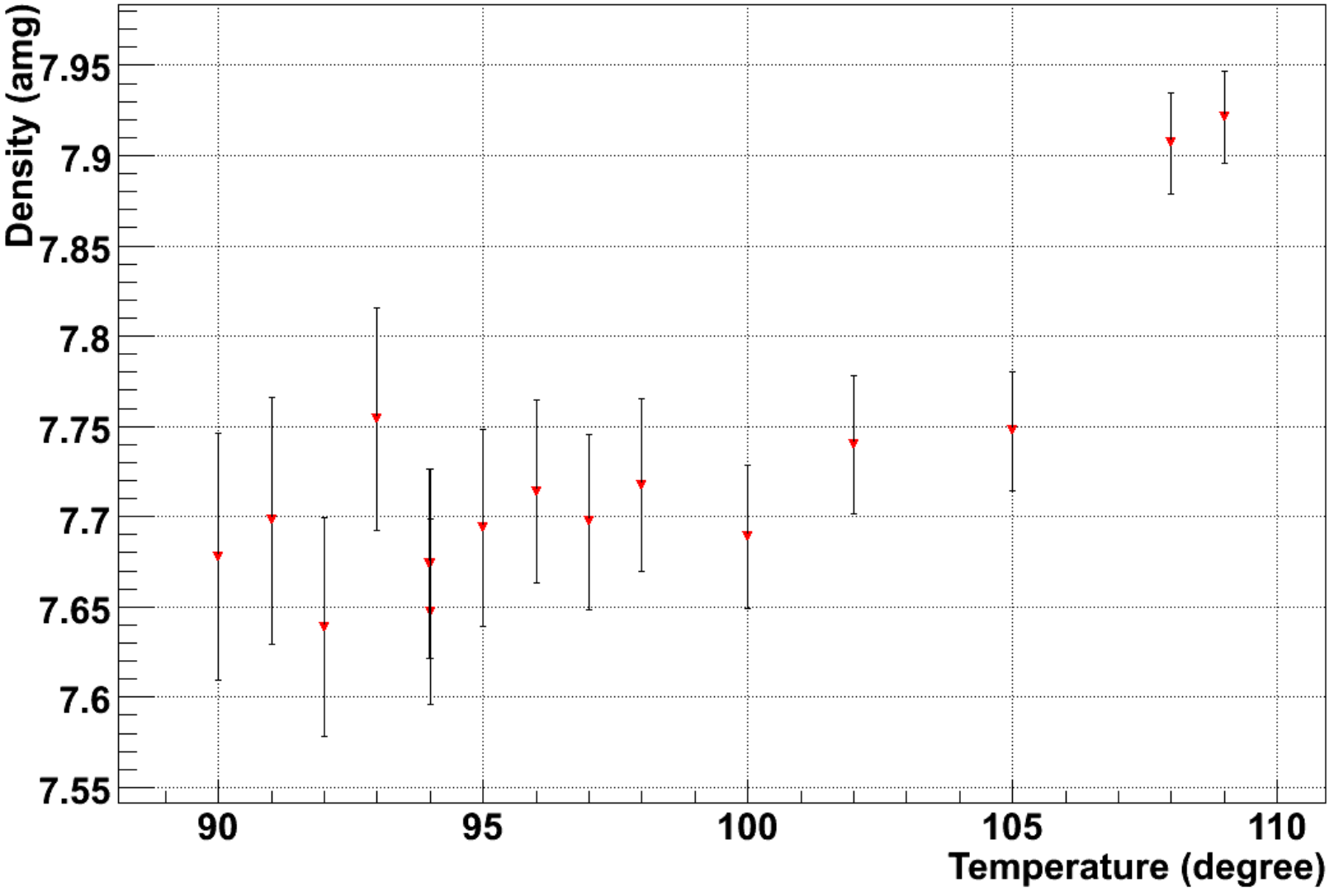

(Transmitted)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
376.6
376.8
377
377.2
377.4
377.6
377.8
378
×10^3
Frequency (GHz)

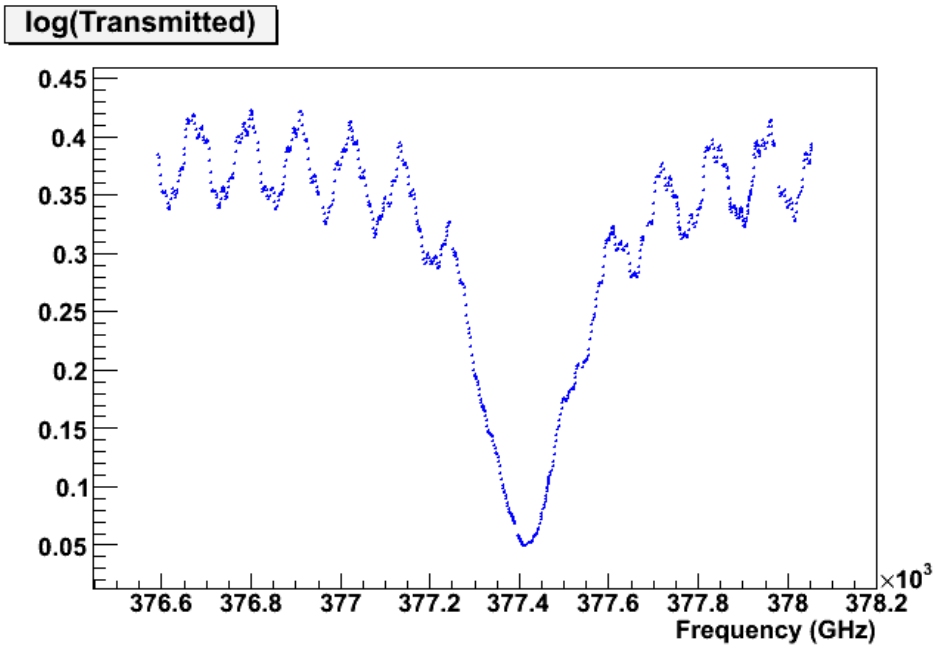

signal from reference
χ² / ndf 13.69 / 860
A 0.3821 ± 0.004303
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
376.6
376.8
377
377.2
377.4
377.6
377.8
378
×10^3

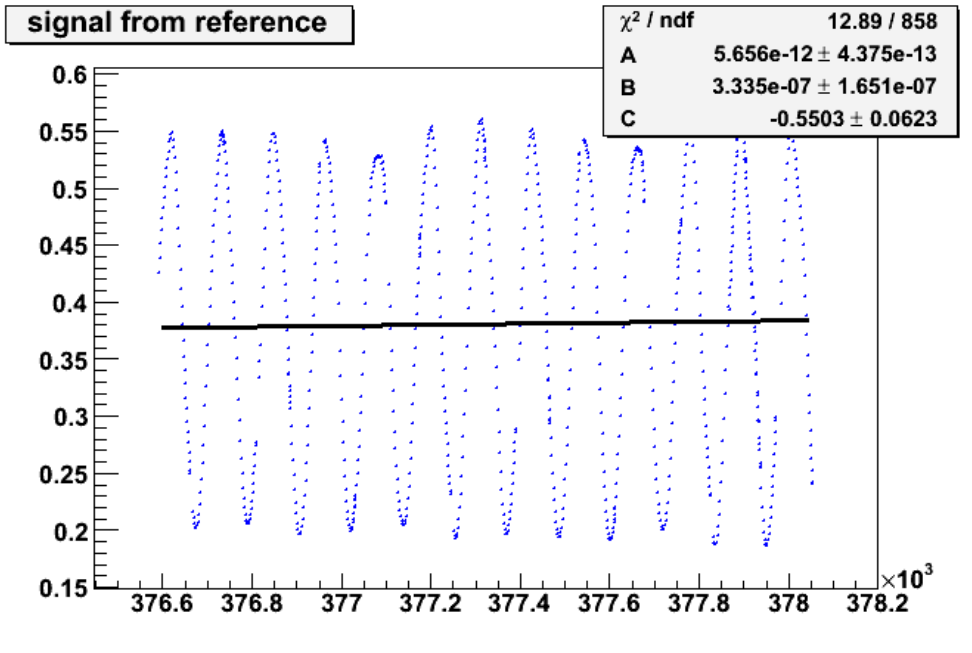

signal from inversed reference
χ² / ndf 3.748 / 860
A -0.9642 ± 0.002251
-0.85
-0.9
-0.95
-1
-1.05
376.6
376.8
377
377.2
377.4
377.6
377.8
378
×10^3
Frequency (GHz)

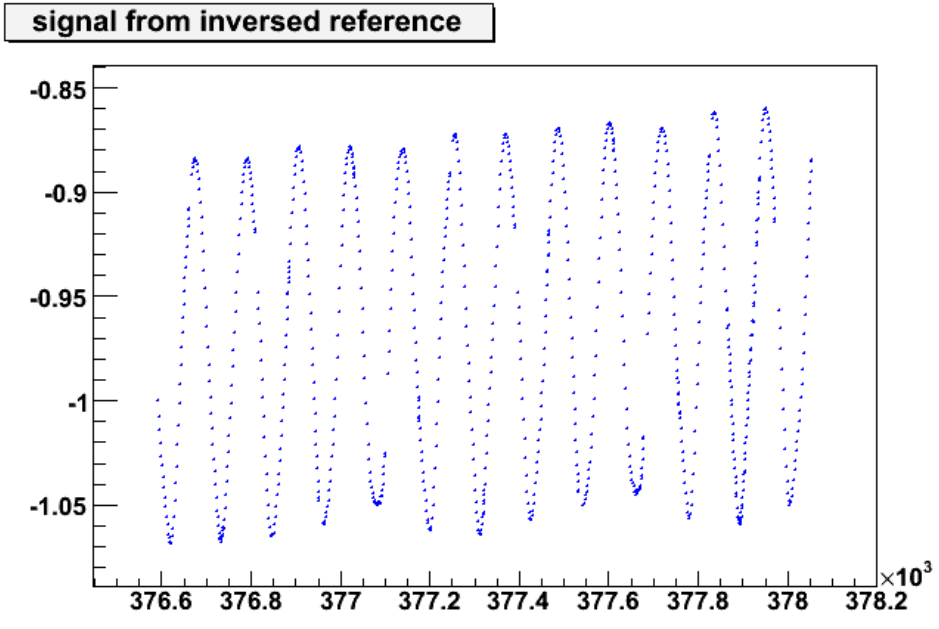

05Mar_1 Scan at 97.0C for Density Measurement
χ² / ndf 0.4708 / 856
A -5875 ± 62.49
T_d 0.0002044 ± 1.419e-05
nu_c 3.774e+05 ± 0.4122
Gamma 146 ± 0.9086
B 0.03222 ± 0.001101
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
376.6
376.8
377
377.2
377.4
377.6
377.8
378
×10^3
Frequency (GHz)

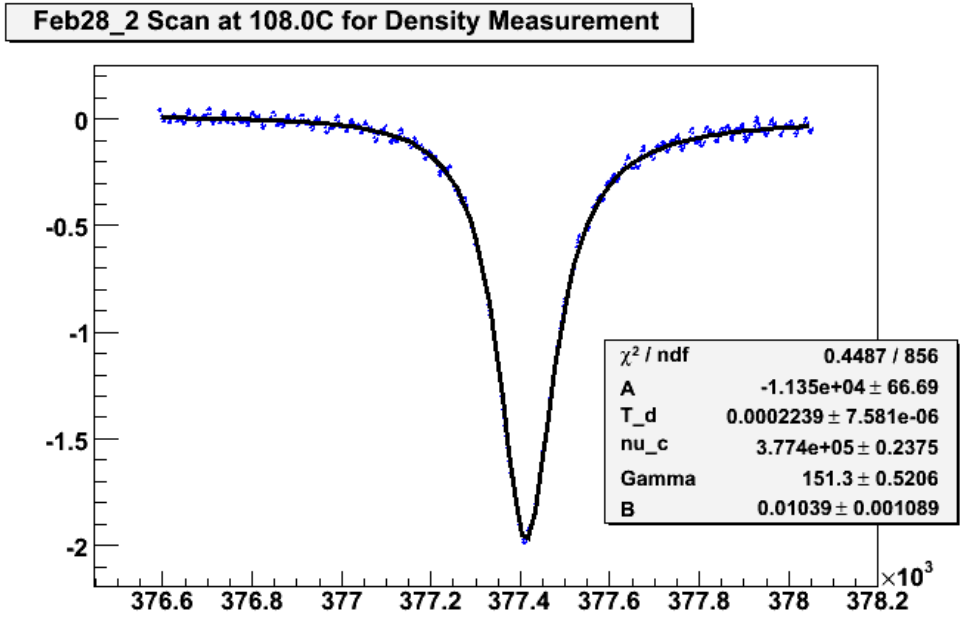
Current Result of density measurement



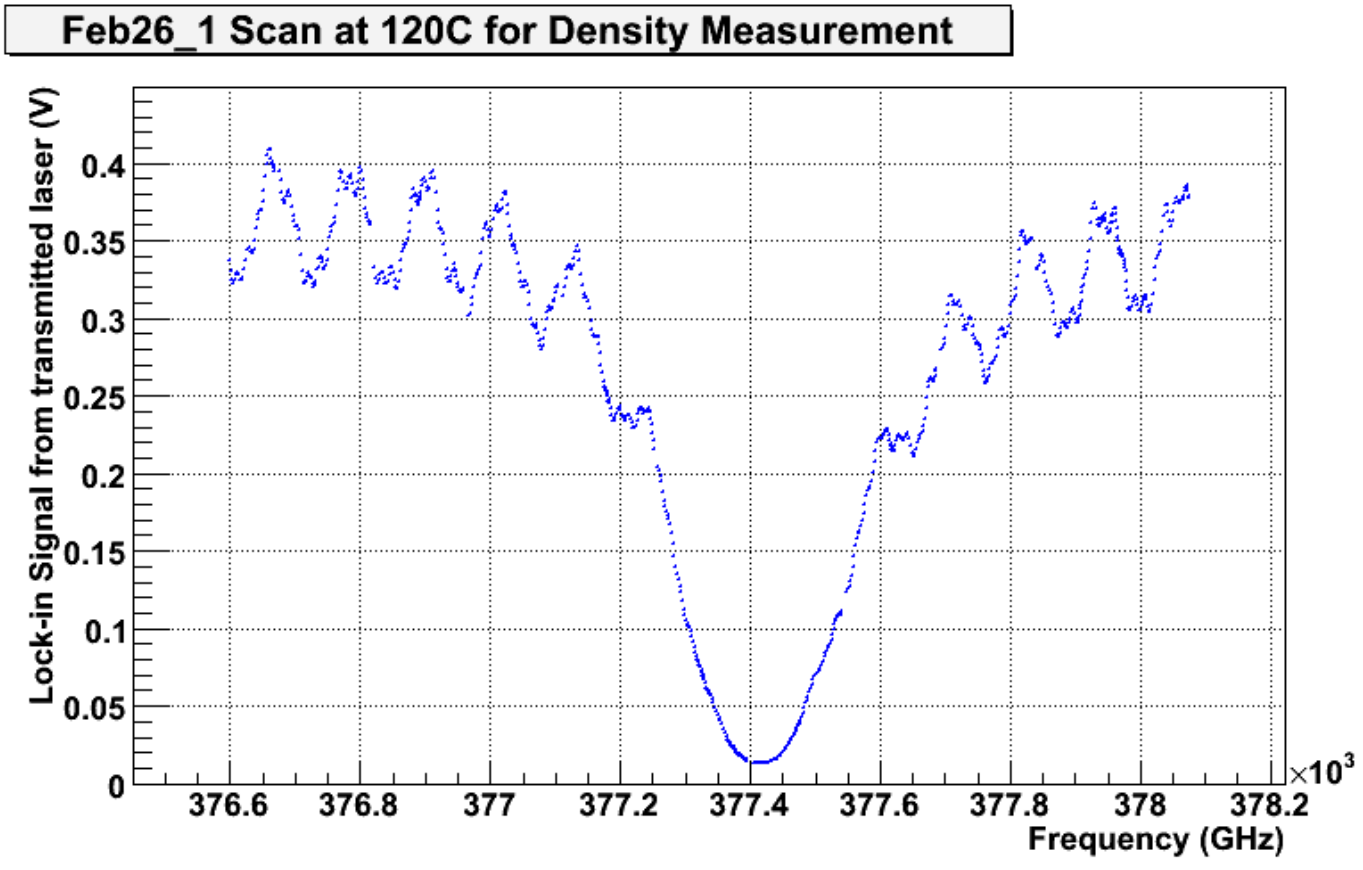

log(Transmitted)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
376.6
376.8
377
377.2
377.4
377.6
377.8
378
378.2
×10^3
Frequency (GHz)

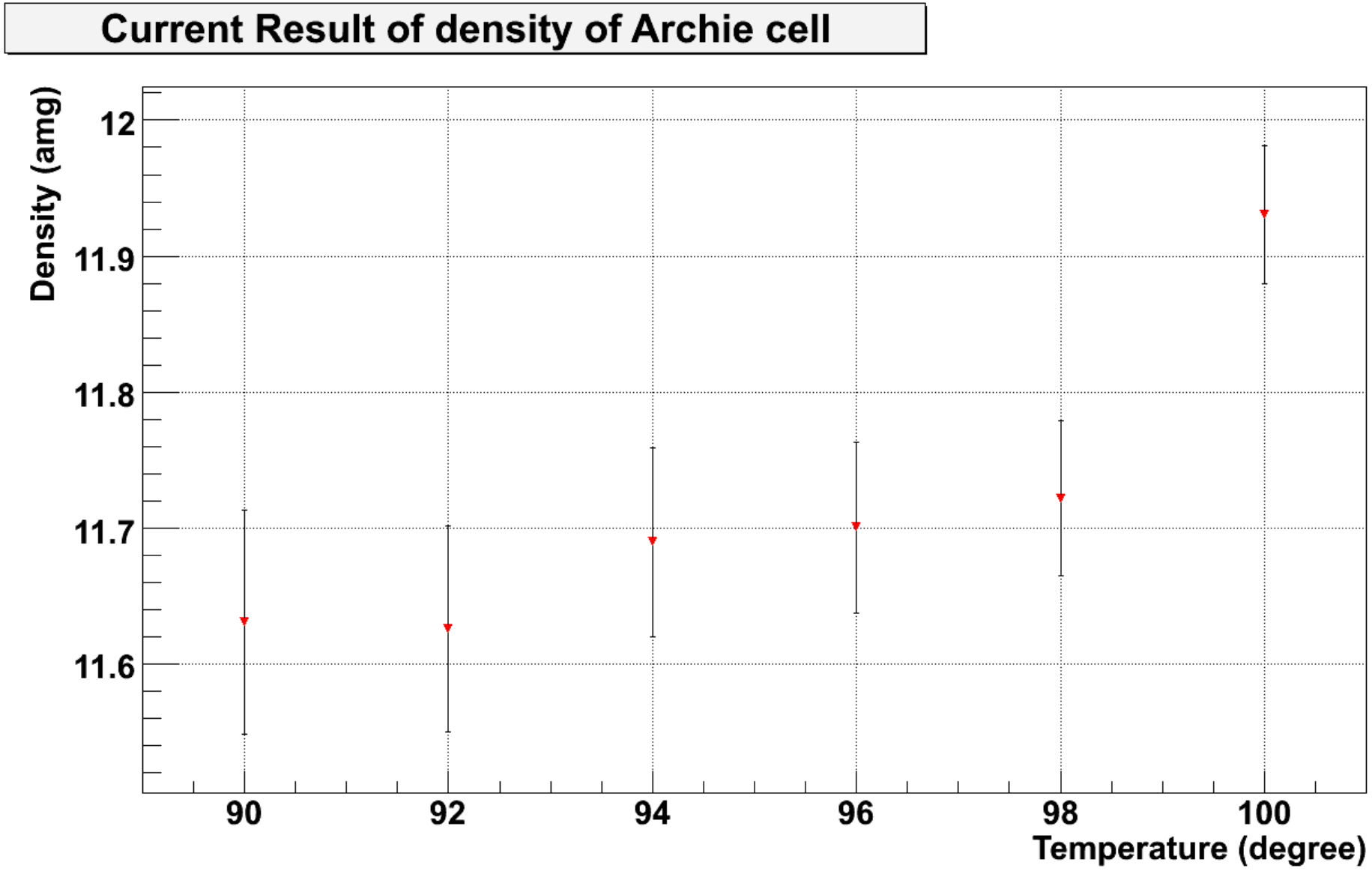

signal from reference
χ² / ndf 12.89 / 858
A 5.656e-12 ± 4.375e-13
B 3.335e-07 ± 1.651e-07
C -0.5503 ± 0.0623
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
376.6
376.8
377
377.2
377.4
377.6
377.8
378
378.2
×10^3

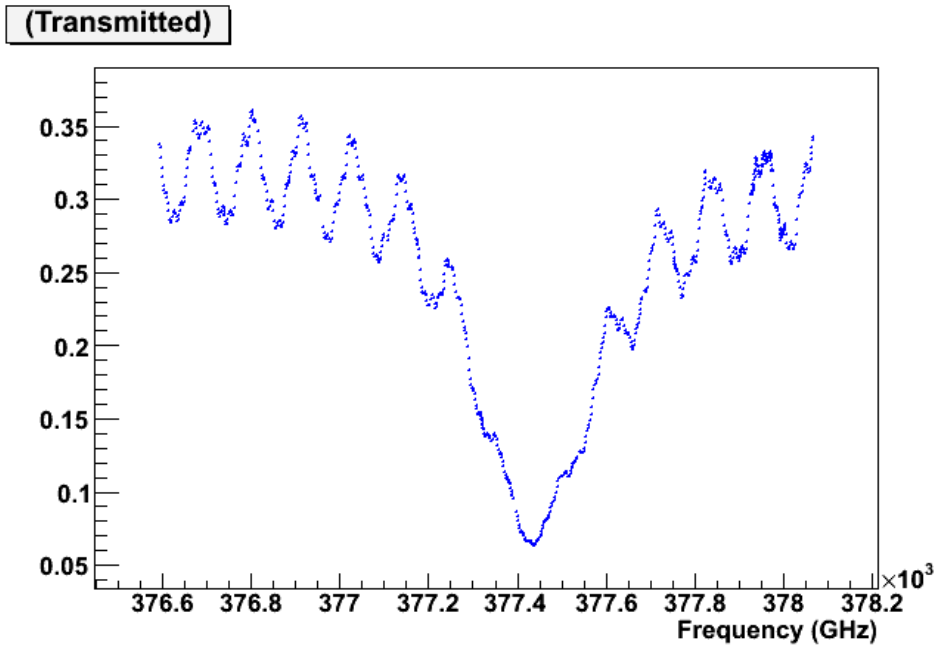

signal from inversed reference
-0.85
-0.9
-0.95
-1
-1.05
376.6
376.8
377
377.2
377.4
377.6
377.8
378
378.2
×10^3

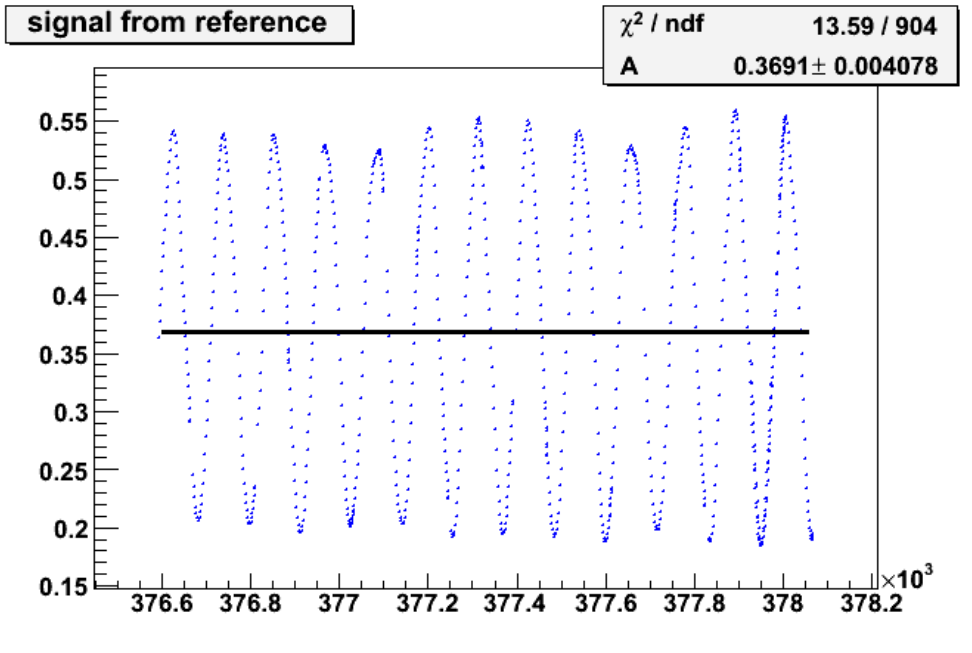

Feb28_2 Scan at 108.0C for Density Measurement
χ² / ndf 0.4487 / 856
A -1.135e+04 ± 66.69
T_d 0.0002239 ± 7.581e-06
nu_c 3.774e+05 ± 0.2375
Gamma 151.3 ± 0.5206
B 0.01039 ± 0.001089
0
-0.5
-1
-1.5
-2
376.6
376.8
377
377.2
377.4
377.6
377.8
378
378.2
×10^3

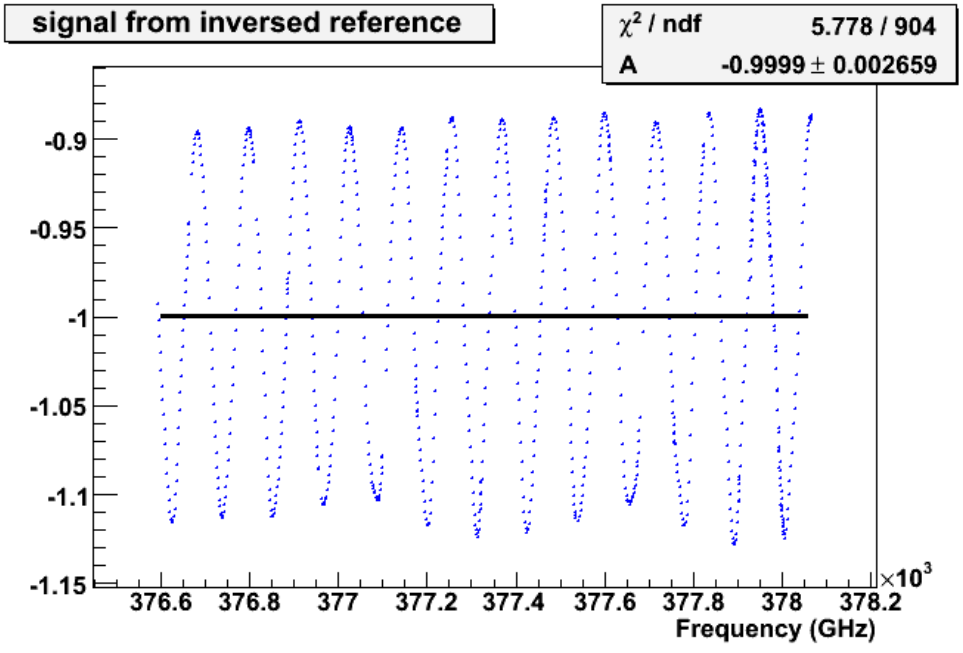
Saturation

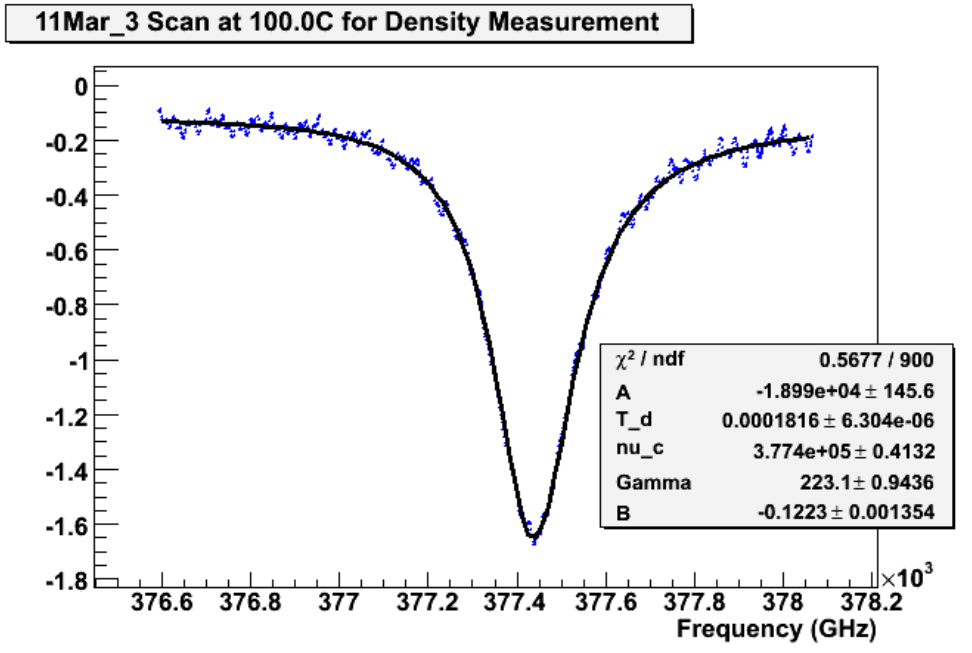

Feb26_1 Scan at 120C for Density Measurement
Lock-in Signal from transmitted laser (V)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
376.6
376.8
377
377.2
377.4
377.6
377.8
378
378.2
×10^3
Frequency (GHz)

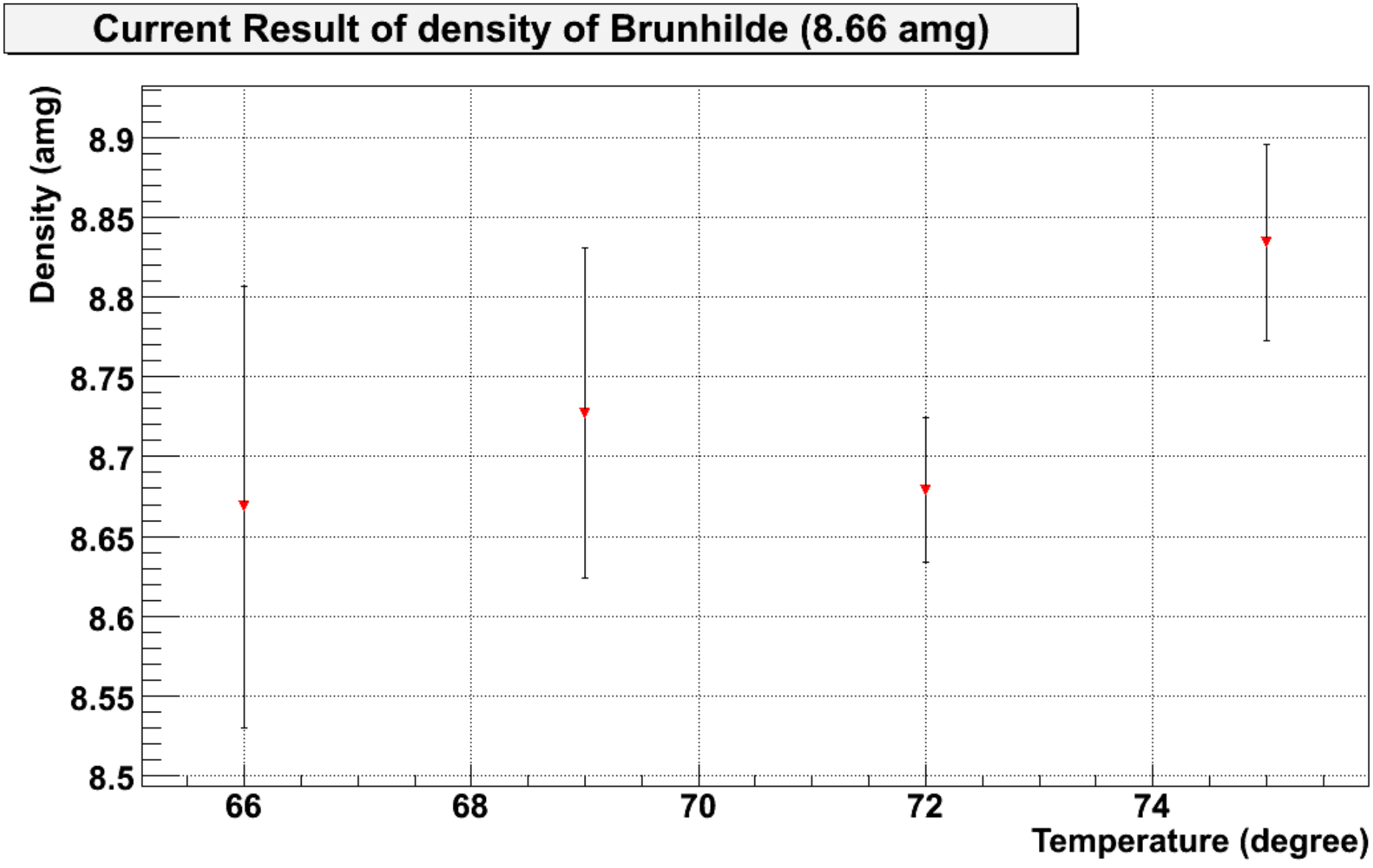

Current Result of density of Archie cell
Density (amg)
12
11.9
11.8
11.7
11.6
90
92
94
96
98
100
Temperature (degree)

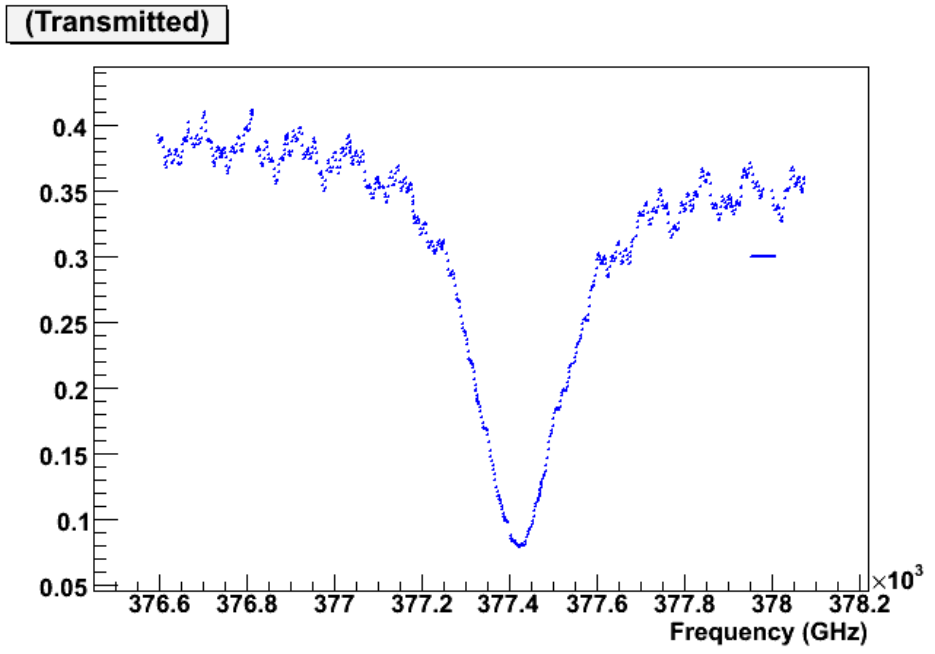

(Transmitted)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
376.6
376.8
377
377.2
377.4
377.6
377.8
378
378.2
×10^3
Frequency (GHz)

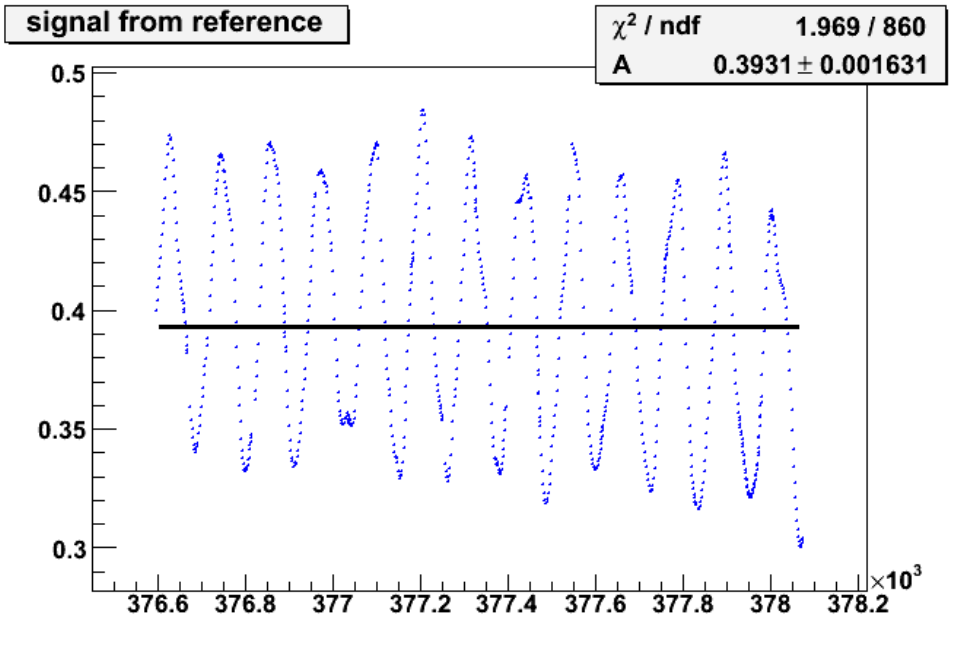

signal from reference
χ² / ndf 13.59 / 904
A 0.3691 ± 0.004078
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
376.6
376.8
377
377.2
377.4
377.6
377.8
378
378.2
×10^3

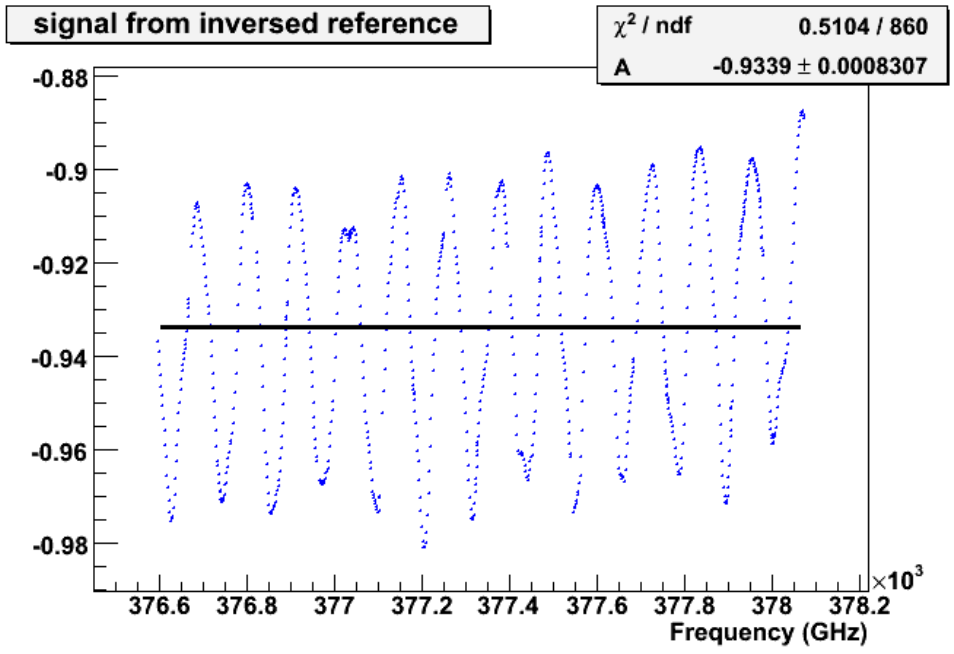

signal from inversed reference
χ² / ndf 5.778 / 904
A -0.9999 ± 0.002659
-0.9
-0.95
-1
-1.05
-1.1
-1.15
376.6
376.8
377
377.2
377.4
377.6
377.8
378
378.2
×10^3
Frequency (GHz)

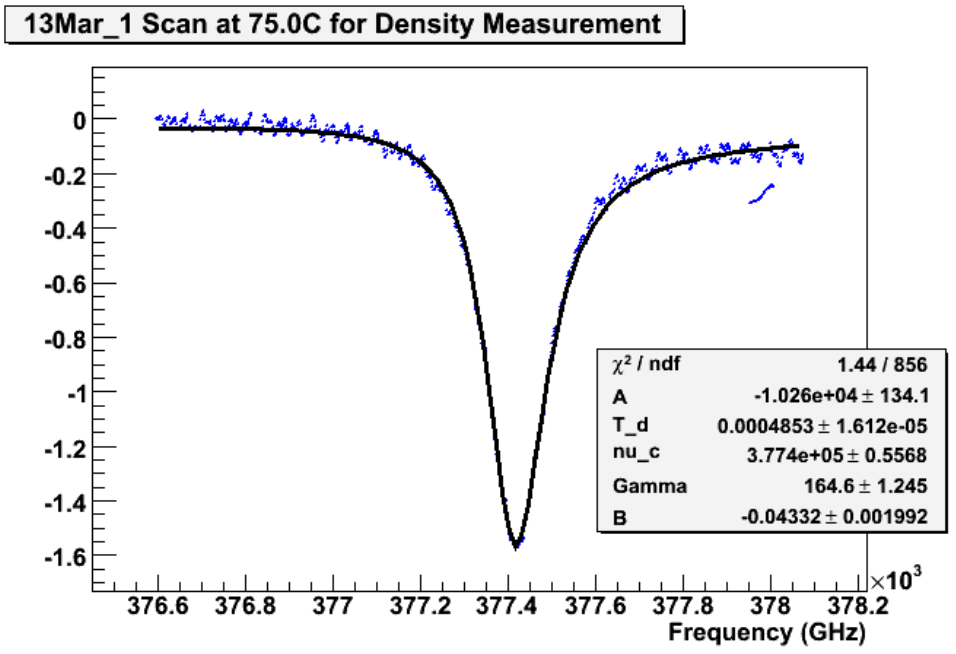

11Mar_3 Scan at 100.0C for Density Measurement
χ² / ndf 0.5677 / 900
A -1.899e+04 ± 145.6
T_d 0.0001816 ± 6.304e-06
nu_c 3.774e+05 ± 0.4132
Gamma 223.1 ± 0.9436
B -0.1223 ± 0.001354
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
376.6
376.8
377
377.2
377.4
377.6
377.8
378
378.2
×10^3
Frequency (GHz)


Current Result of density of Brunhilde (8.66 amg)
Density (amg)
8.9
8.85
8.8
8.75
8.7
8.65
8.6
8.55
8.5
66
68
70
72
74
Temperature (degree)


(Transmitted)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
376.6 376.8 377 377.2 377.4 377.6 377.8 378 378.2
×10^3
Frequency (GHz)


signal from reference
χ² / ndf 1.969 / 860
A 0.3931 ± 0.001631
0.5
0.45
0.4
0.35
0.3
376.6 376.8 377 377.2 377.4 377.6 377.8 378 378.2
×10^3


signal from inversed reference
χ² / ndf 0.5104 / 860
A -0.9339 ± 0.0008307
-0.88
-0.9
-0.92
-0.94
-0.96
-0.98
376.6 376.8 377 377.2 377.4 377.6 377.8 378 378.2
×10^3
Frequency (GHz)


13Mar_1 Scan at 75.0C for Density Measurement
χ² / ndf 1.44 / 856
A -1.026e+04 ± 134.1
T_d 0.0004853 ± 1.612e-05
nu_c 3.774e+05 ± 0.5568
Gamma 164.6 ± 1.245
B -0.04332 ± 0.001992
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
376.6 376.8 377 377.2 377.4 377.6 377.8 378 378.2
×10^3
Frequency (GHz)

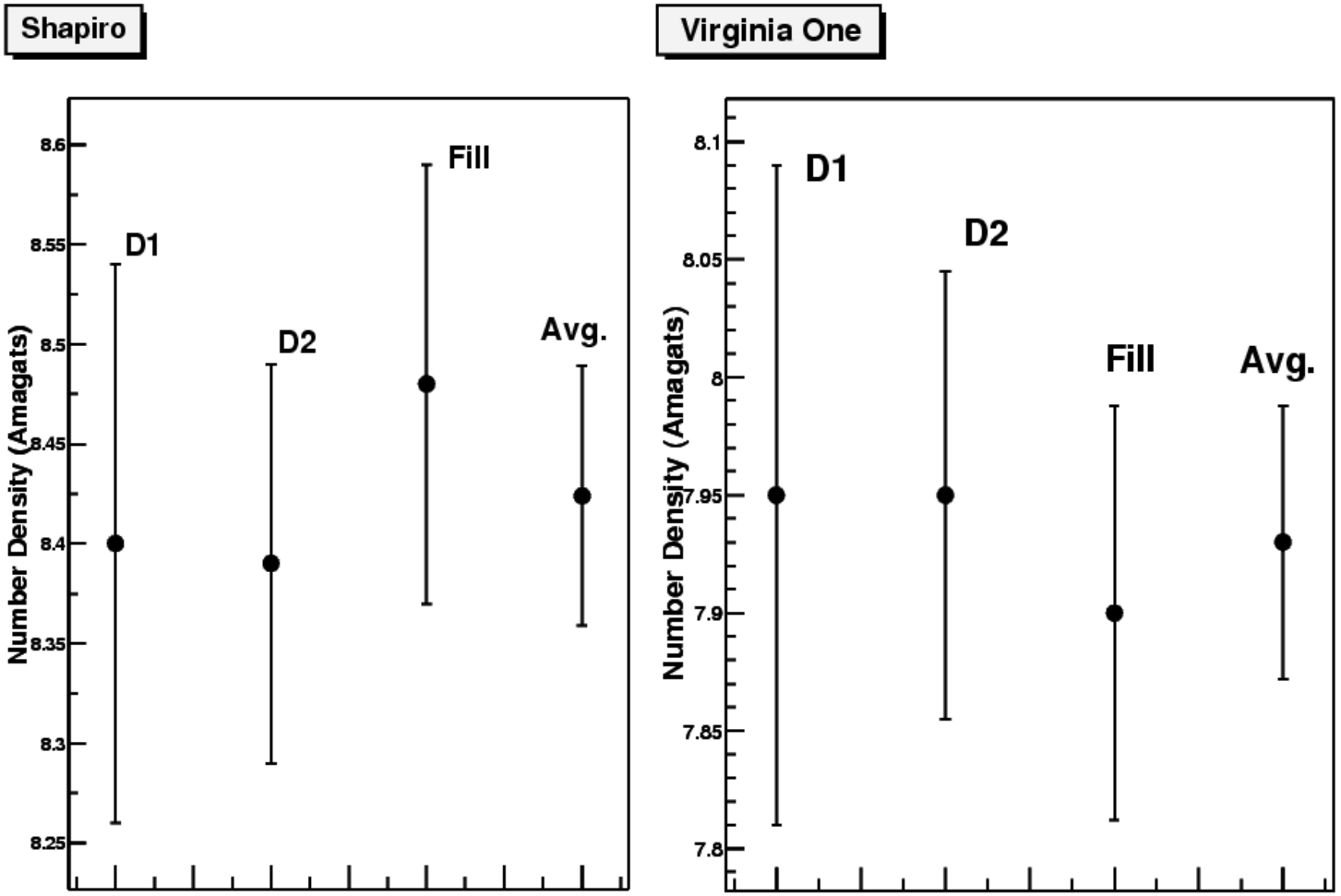


Figure 6.13: *The density of the two cells used in E97-103.*

From Kevin M.Kramer's thesis

Future plan

* Get a set of neutral filters to correct the response of photo-diode (it's important to get a precision ~1%)

* Try to get a better beam splitter to minimize the oscillation

* Measure other few cells and cross check with UVA result

* Other characterizing issue (wall thickness)...

Acknowledgment

Yi Qiang, Joe, Xiaohui, Chiranjib