Demonstration :

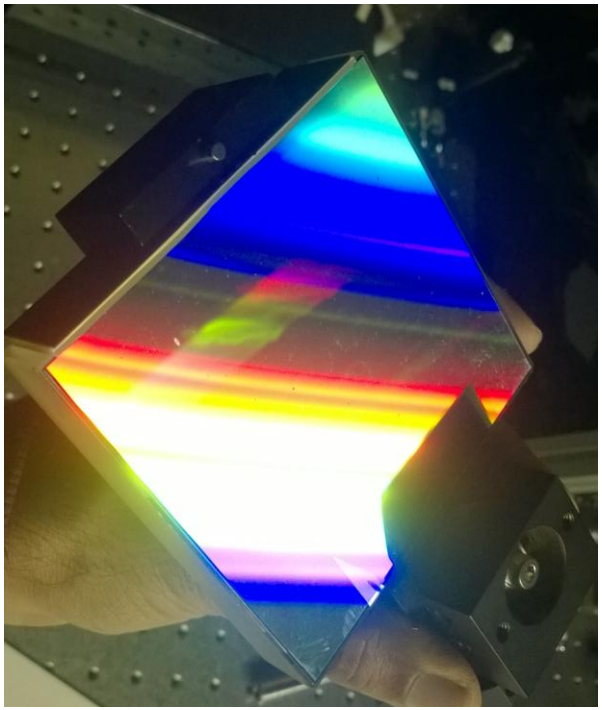
Dispersive optical element - Grating

Rotational Raman spectroscopy

Date: 03-24-2017

Grating used inside a polychromator to disperse light.

Reflective type grating



Transmission type grating

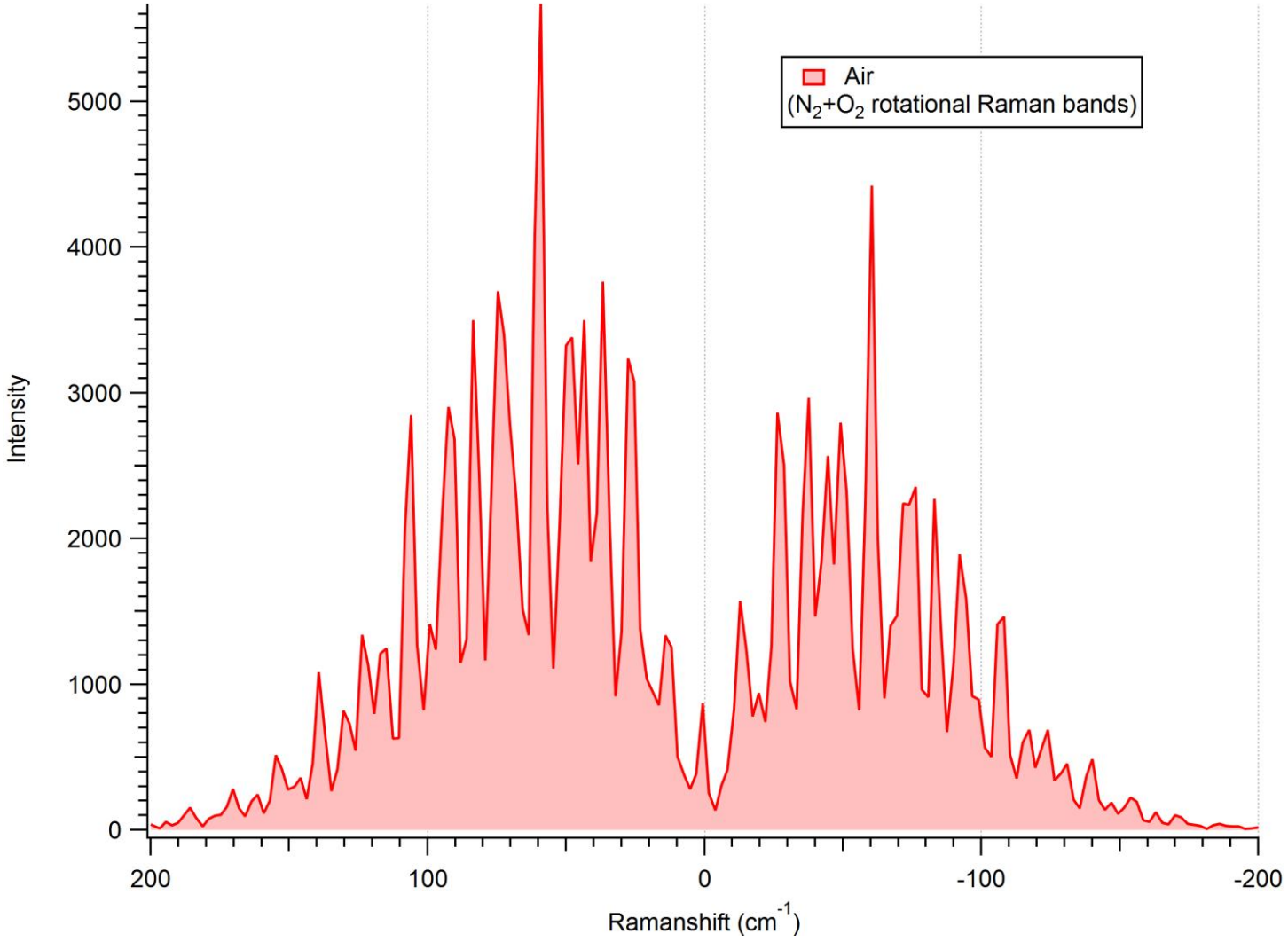
Measurement of air, breath, CO_2(5%), O_2 , neon lamp spectra

Experiment details.

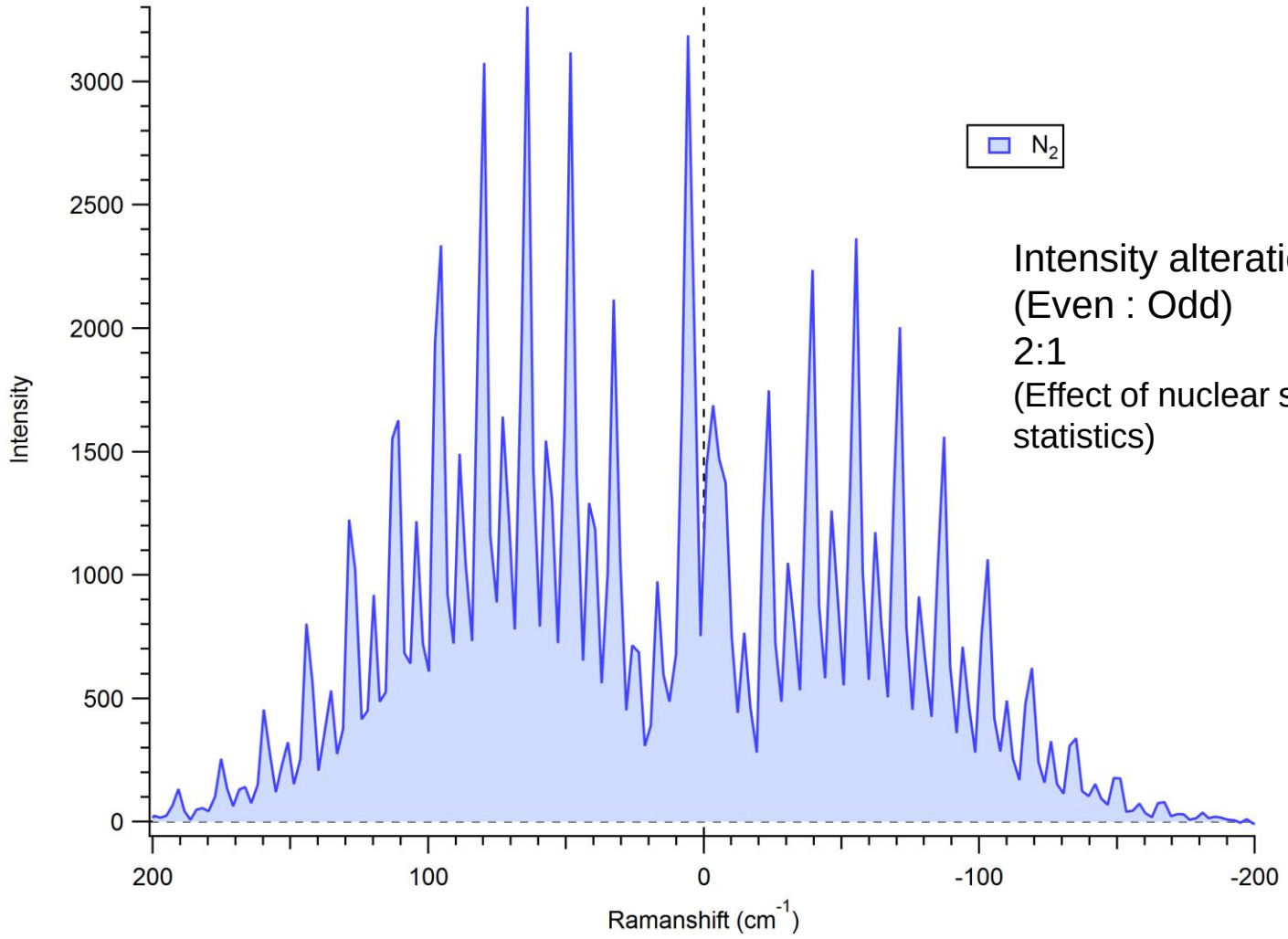
532 nm excitation.
~450 mW at sample with 50:50 beam splitter,
20x objective, NA=0.2;
polychromator entrance slit width =120 µm
Detected by liq.N_2 cooled CCD

Breath sampled in a balloon.
Measured using Gas cell.
Gas cell was evacuated before every measurement.

Air
(N_2+O_2)

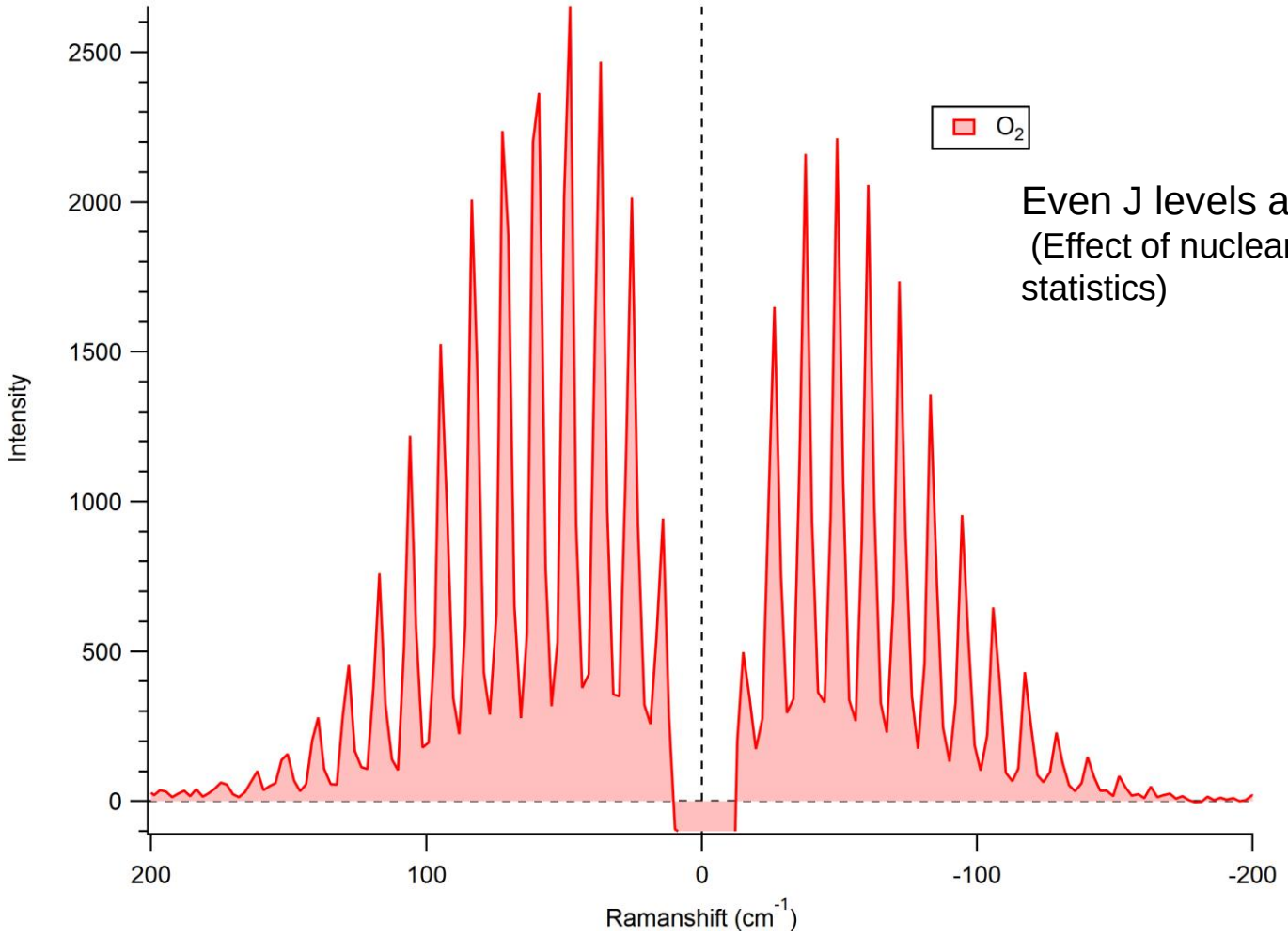

Air
(N_2+O_2 rotational Raman bands)
Intensity
5000
4000
3000
2000
1000
0
200
100
0
-100
-200
Ramanshift (cm^{-1})

N_2



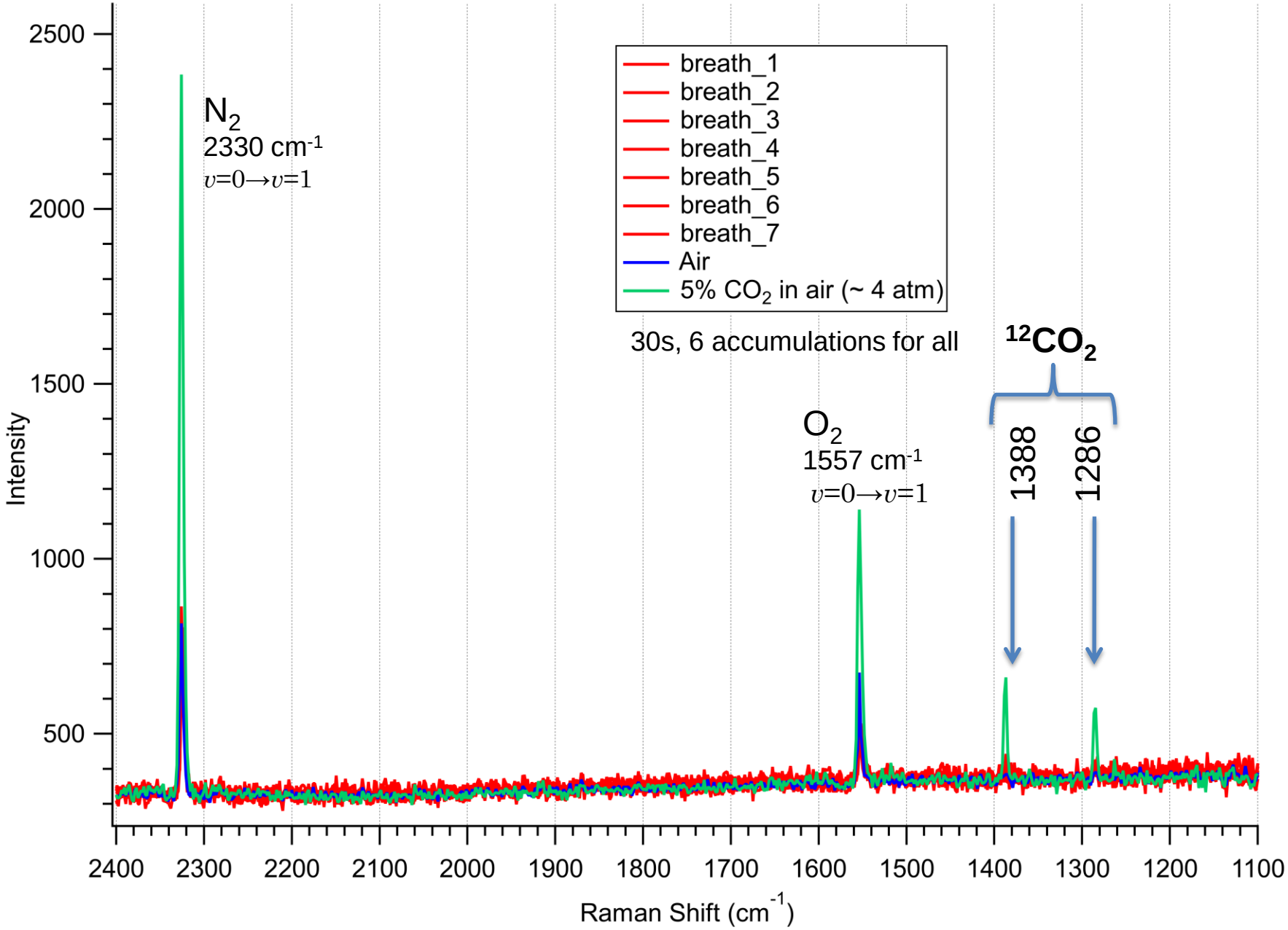
Intensity alteration
(Even : Odd)
2:1
(Effect of nuclear spin statistics)

O_2

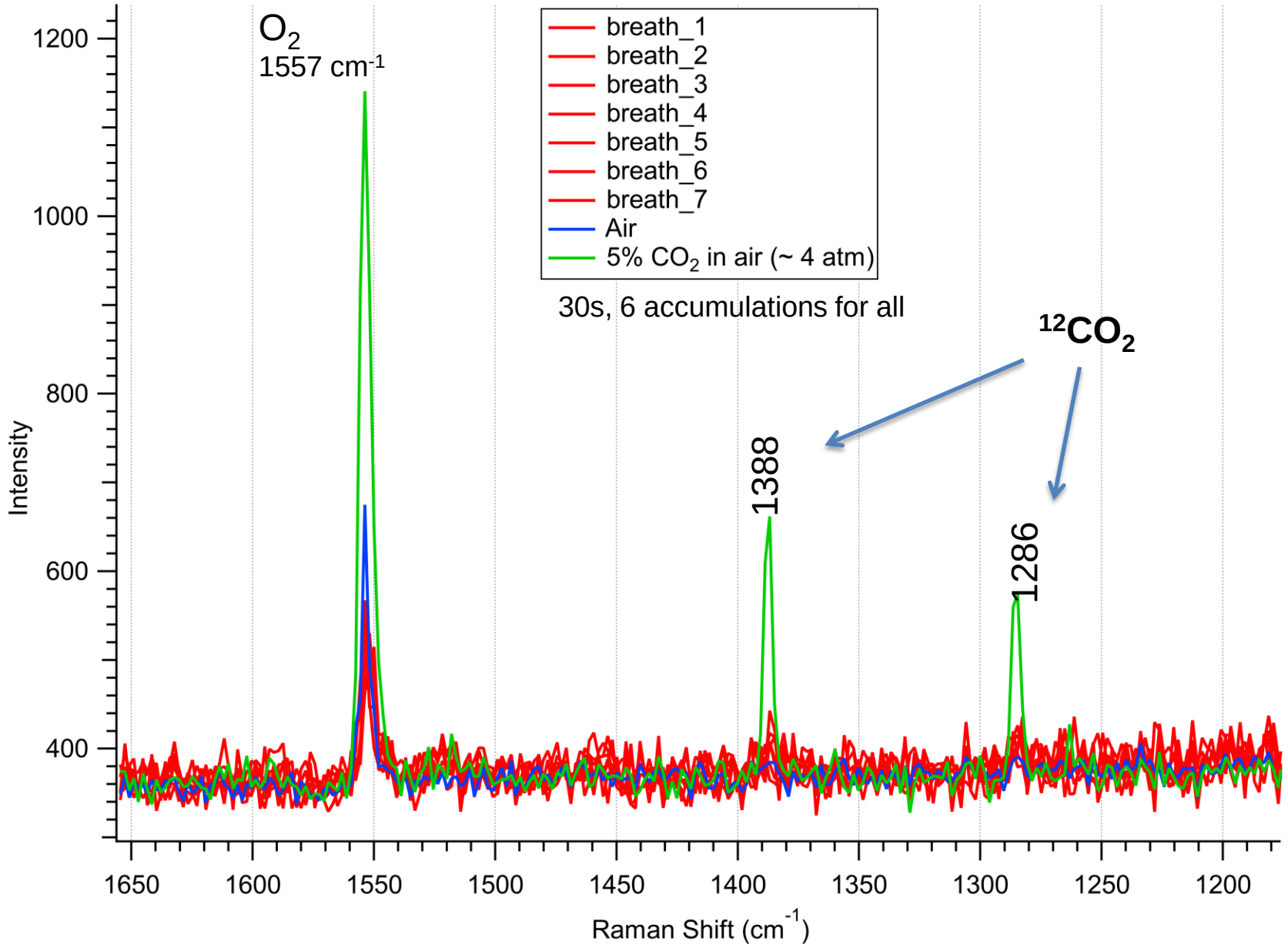


Even J levels are absent.
(Effect of nuclear spin statistics)

Measured spectra: Air, breath and CO_2



Measured spectra: Air, breath and CO_2 : Zoomed



Breath analysis

We can observe N_2 and O_2 bands.

Inhaled air
N_2 fraction = 78.08 %
O_2 fraction = 20.95 %
CO_2 fraction = 0.04%

Exhaled air
N_2 fraction = 78.08 % (stays constant)
O_2 fraction = decreases
CO_2 fraction = increases

<u>Band area is determined by following way:</u>

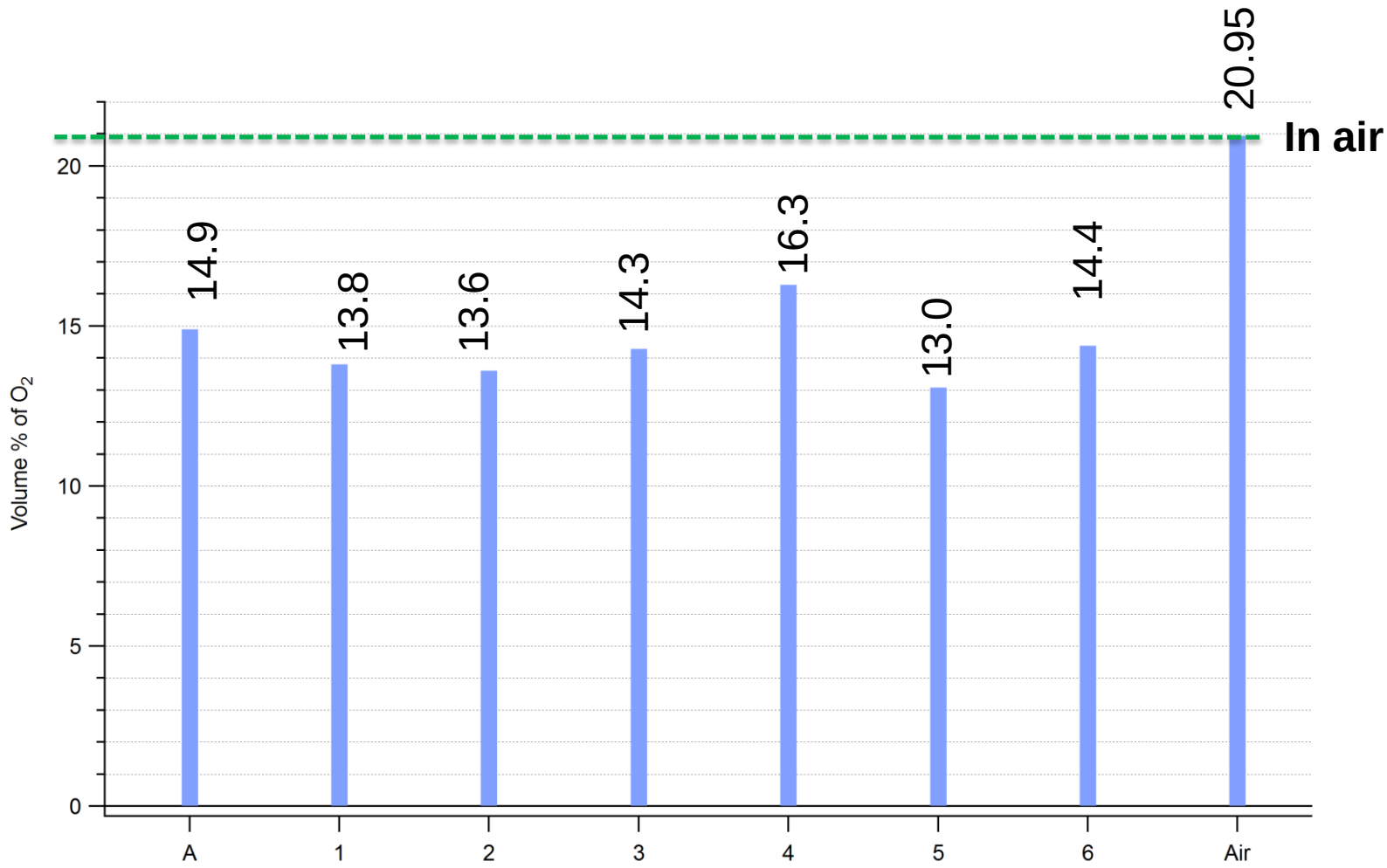
1. For each spectra the baseline is fit using cubic polynomial. Then the fit is subtracted to get a flat baseline.

2. Integration is performed (summing up the intensities).

Next, band area are normalized using N_2's (2330 cm^{-1}) band area.
Band area of O_2(1557 cm^{-1}) is now analyzed.

Using band area of O_2 from air and knowing it is 20.95% → **the % of O_2 in breath is estimated**

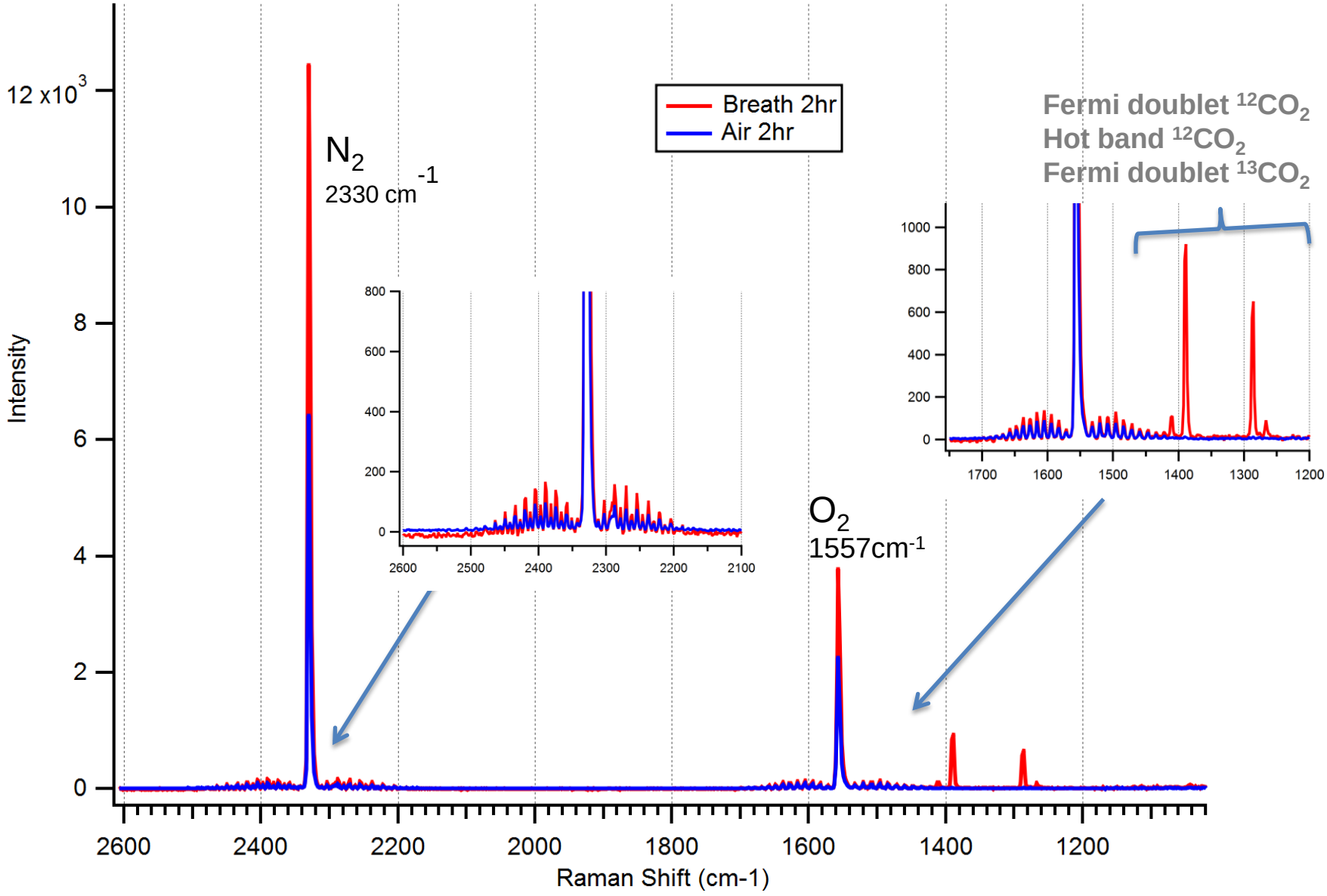
Volume % of O_2 in exhaled breath



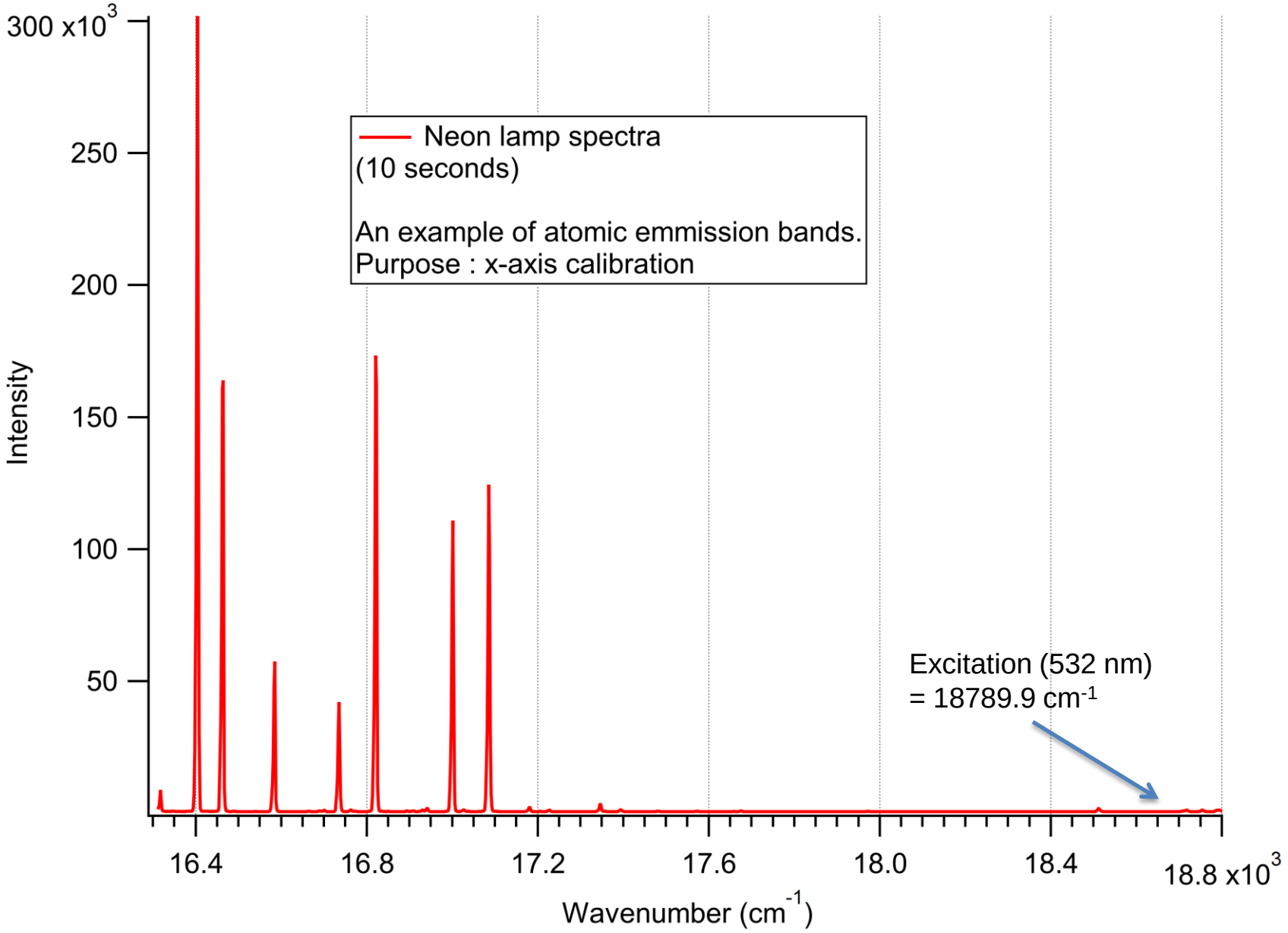
Net Error = ~5 %

Air and breath spectra : long exposure of 2 hr.

Measured in Dec 2016



Neon lamp


300 x10^3
250
200
150
100
50
Intensity
Neon lamp spectra
(10 seconds)
An example of atomic emmission bands.
Purpose : x-axis calibration
Excitation (532 nm)
= 18789.9 cm-1
16.4
16.8
17.2
17.6
18.0
18.4
18.8 x10^3
Wavenumber (cm-1)