Microwave Remote Sensing at IRF Kiruna, Sweden

- KIMRA and MIRA-2 -

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Swedish Institute of Space Physics, Kiruna, Sweden

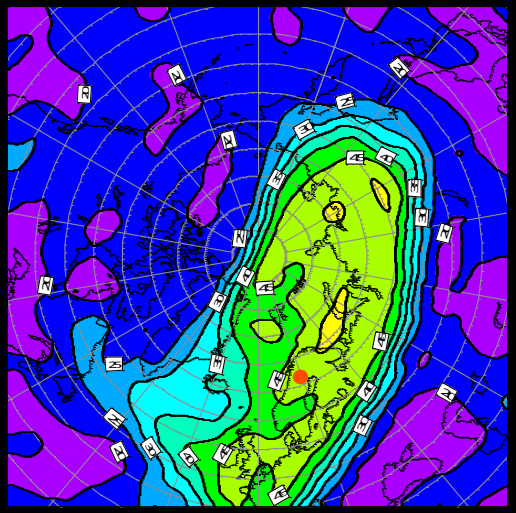
KIMRA

Location:

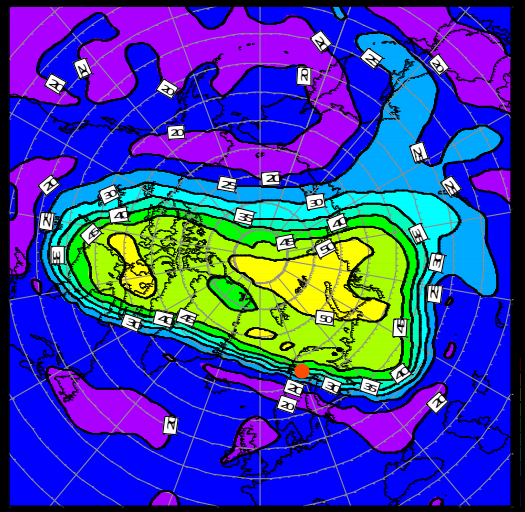
67 N / 21 E

400 m a.s.l.

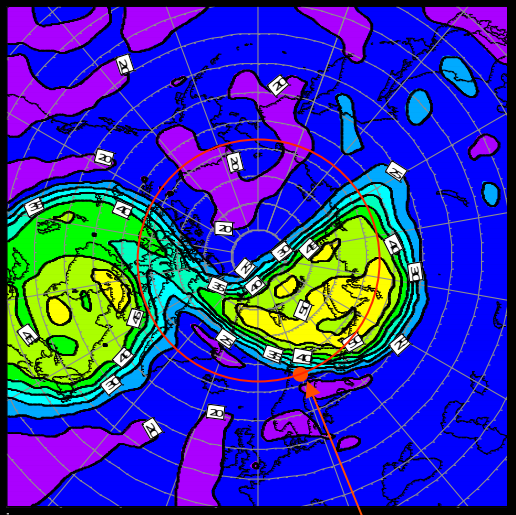
200 km North of the Polar Circle



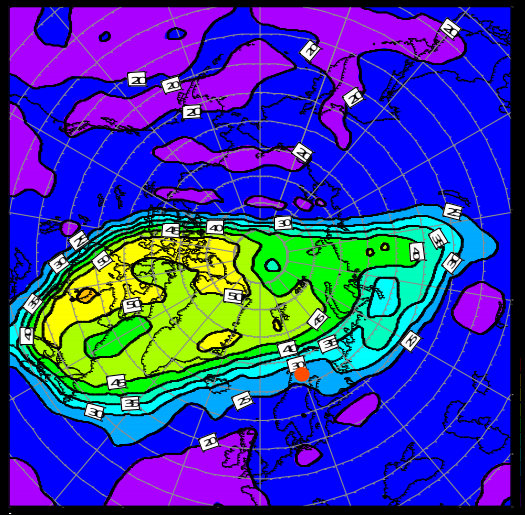
Jan 10



Jan 13



Jan 20



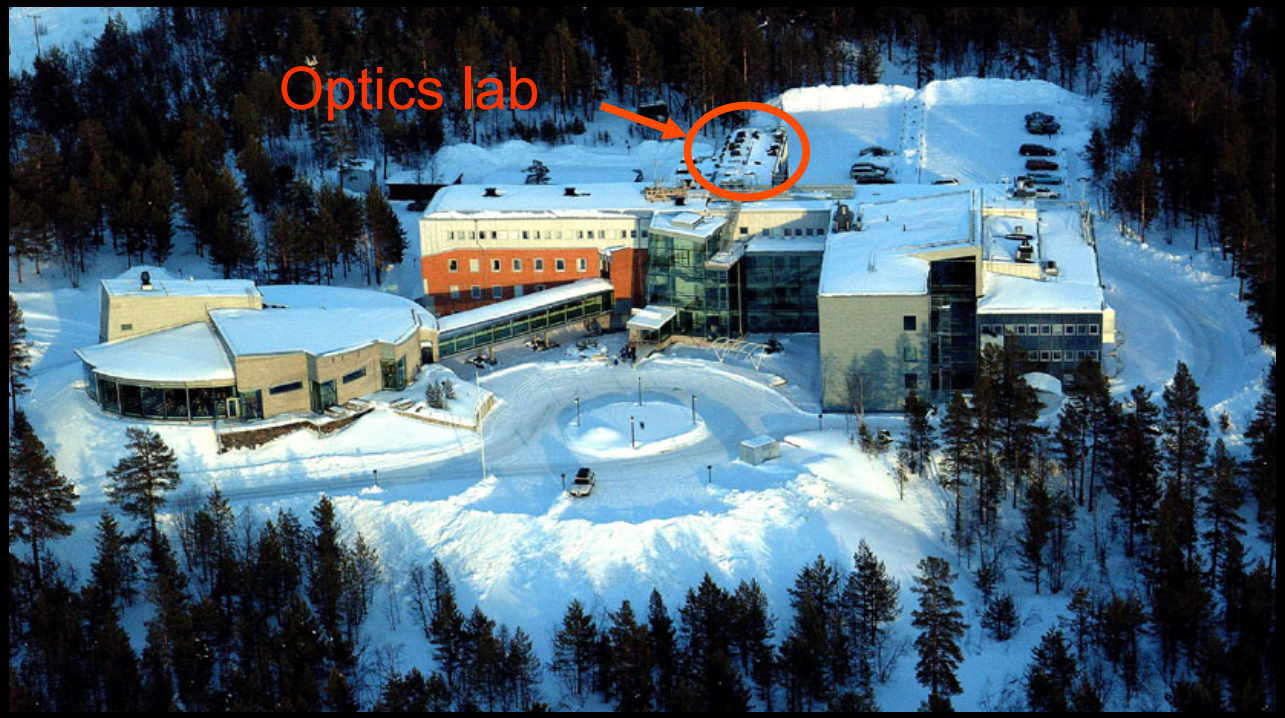
Jan 24

KIMRA and MIRA-2 at IRF Kiruna

KIMRA

2012-12-22 In the deepest polar night !!

KIMRA



At IRF there is a number of instruments for atmospheric remote sensing (some are operated in collaboration with other institutes): DOAS, FTIR, MW, Lidar, MST-radar, optical cameras, Solar irradiance, etc. …

Acknowledgments

KIMRA has been built in close collaboration with FzK (now KIT)

Gerd Hochschild
Gerhard Kopp
Jochen Gross
Rüdiger Lehm

MIRA 2 is entirely a development by FzK (now KIT)

Jochen Gross is left with this work

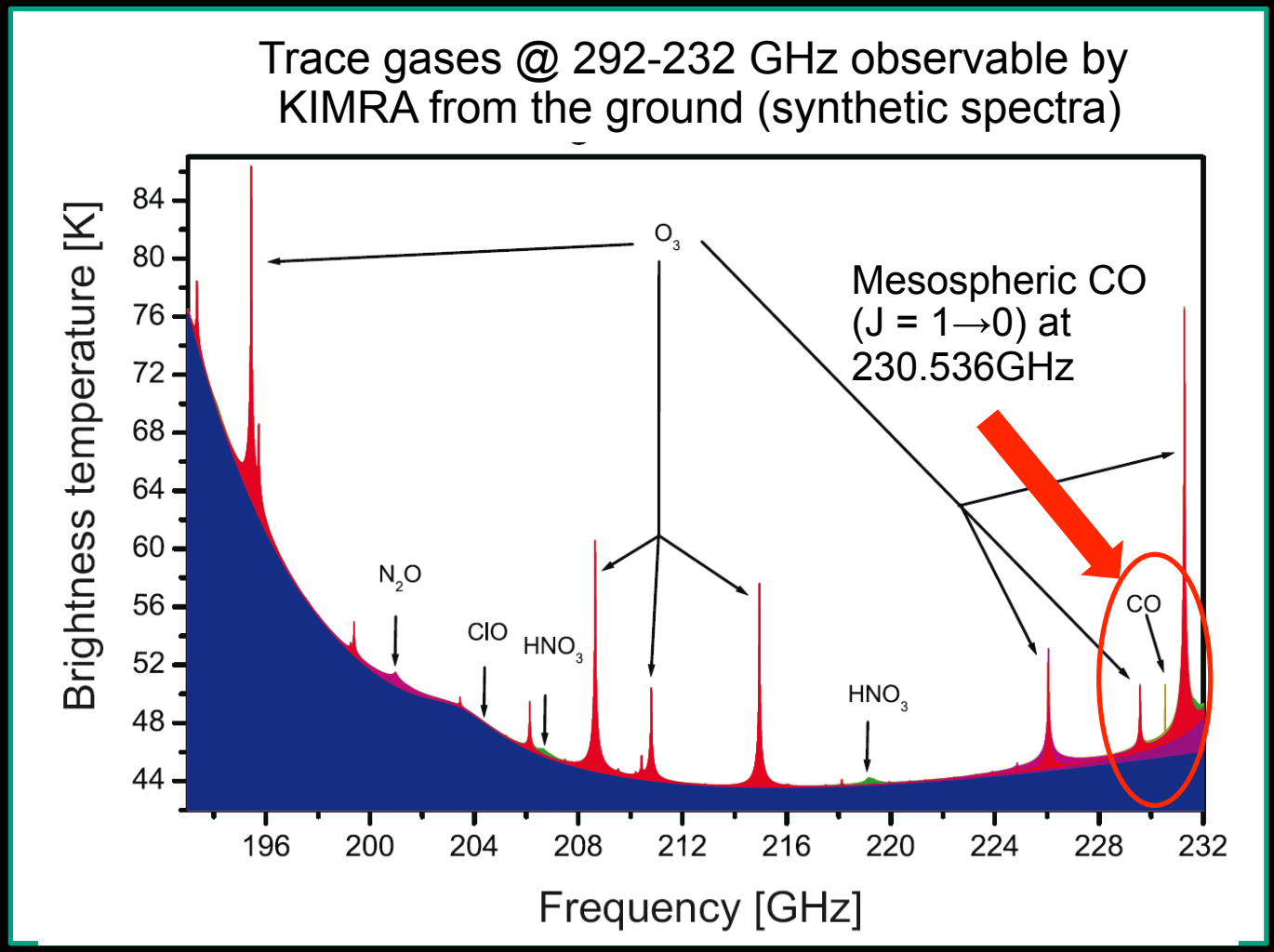
Data retrieval

has been done by Gerhard Kopp until 2010 (KOPRA and OEM).

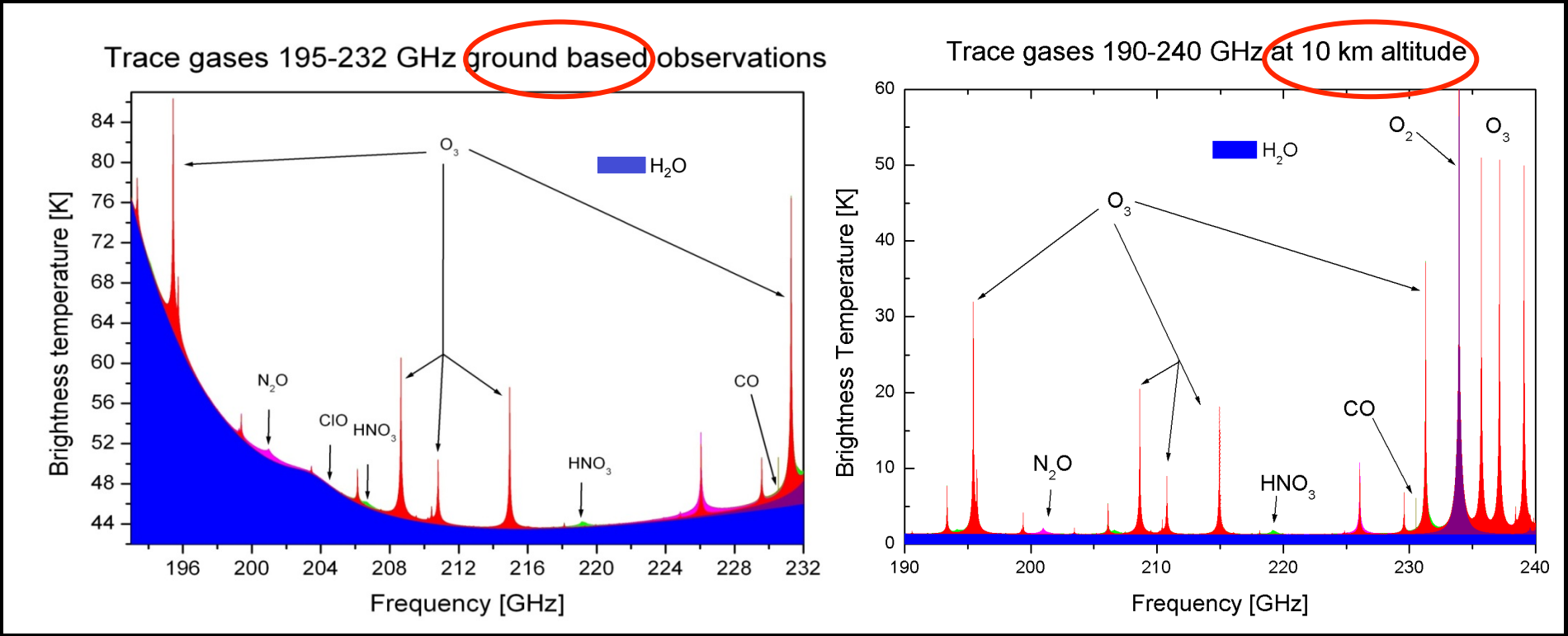
PhD thesis with KIMRA CO data by Christoph Hoffmann, University Bremen, 2012 (ARTS/qpack and OEM)

(Plan: all data retrieval by Uwe Raffalski with ARTS and Qpack)

KIMRA

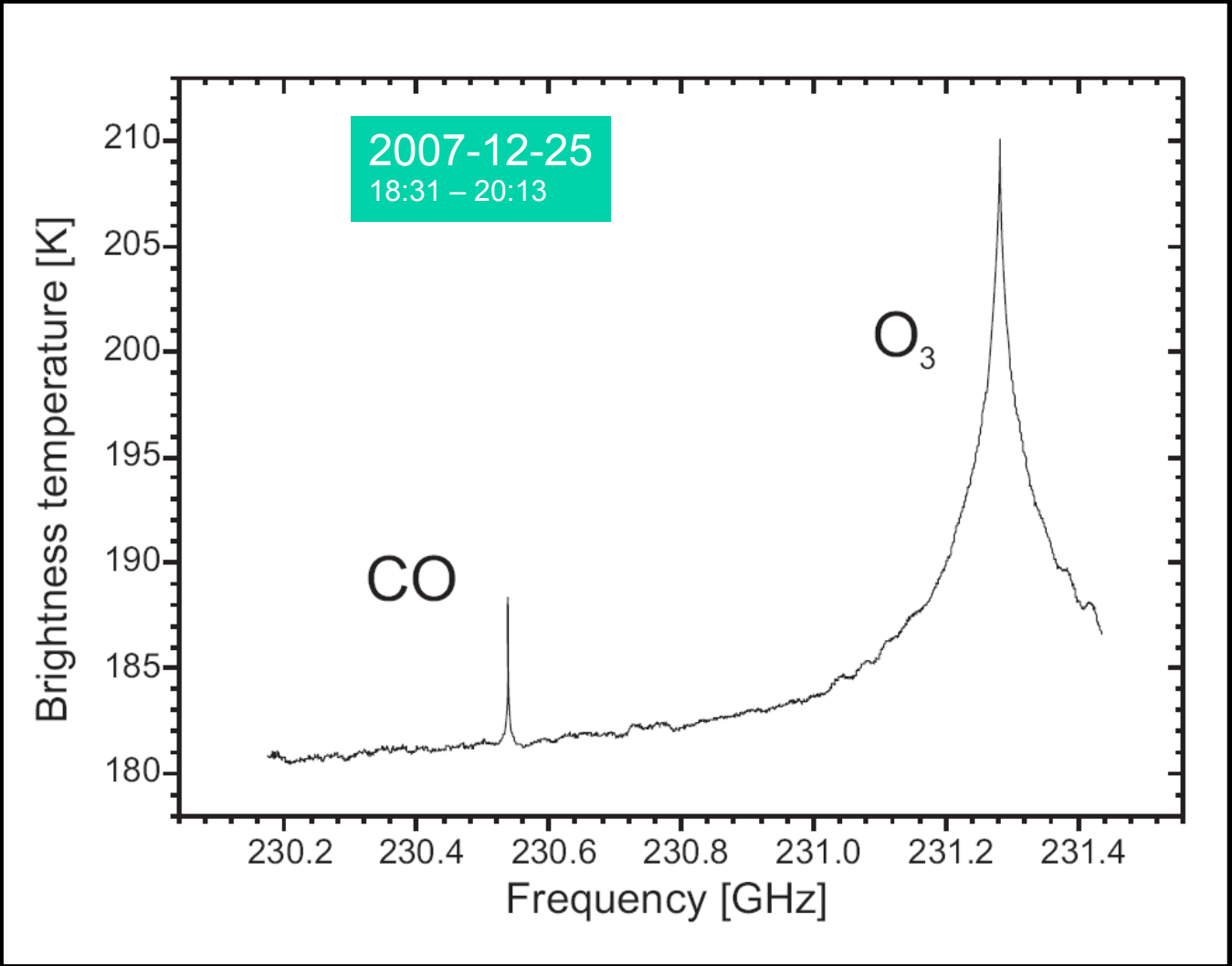

Trace gases @ 292-232 GHz observable by KIMRA from the ground (synthetic spectra)
Brightness temperature [K]
84
80
76
72
68
64
60
56
52
48
44
196
200
204
208
212
216
220
224
228
232
Frequency [GHz]
O3
Mesospheric CO (J = 1→0) at 230.536GHz
N2O
ClO
HNO3
HNO3
CO

KIMRA



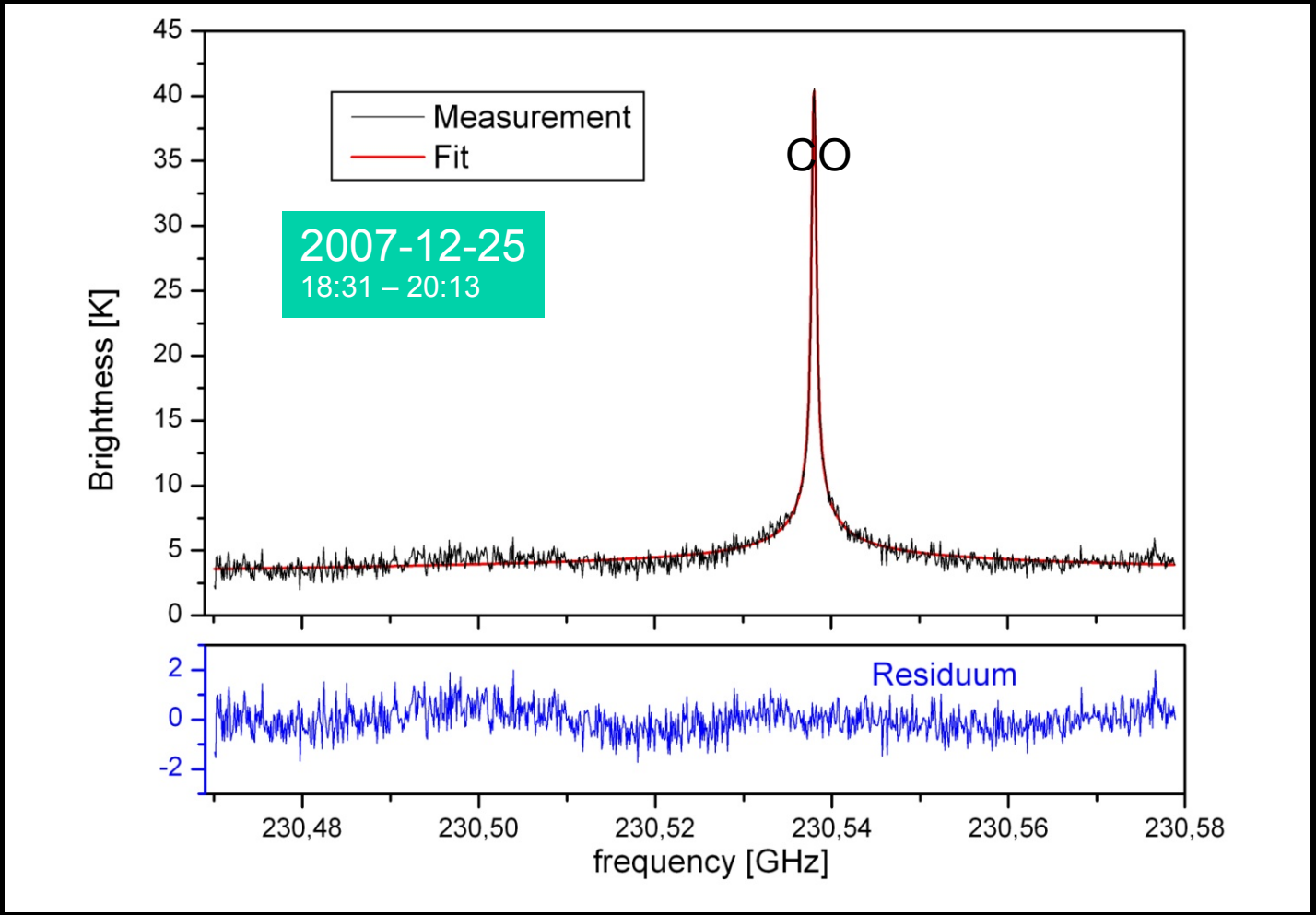
KIMRA and MIRA-2 at IRF Kiruna

KIMRA


2007-12-25
18:31 – 20:13
CO
O_3
Brightness temperature [K]
210
205
200
195
190
185
180
230.2
230.4
230.6
230.8
231.0
231.2
231.4
Frequency [GHz]

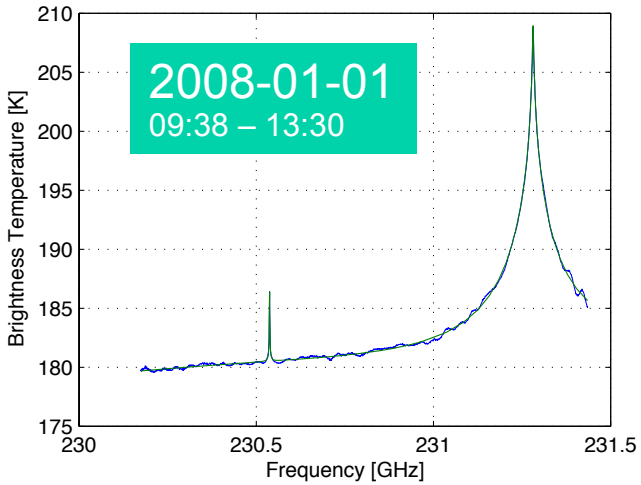
AOS

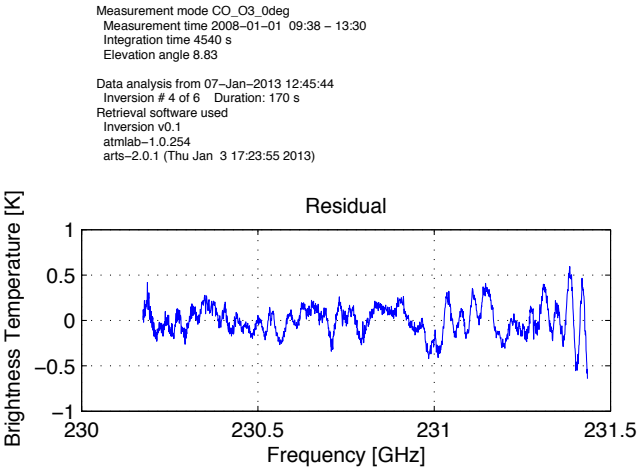
KIMRA

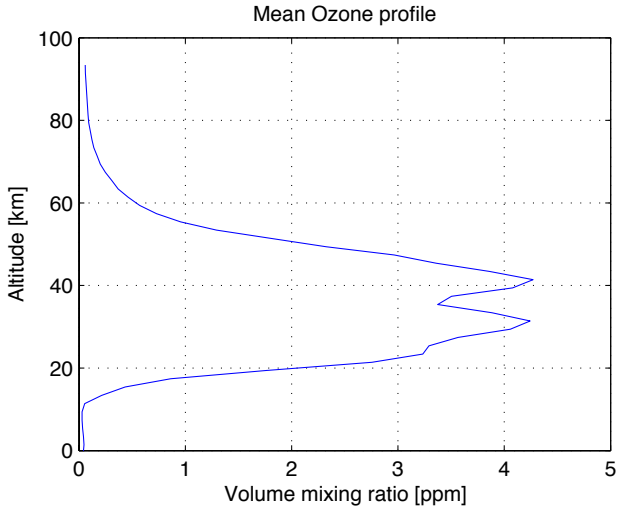

Measurement
Fit
CO
2007-12-25
18:31 – 20:13
Brightness [K]
Residuum
frequency [GHz]
230,48
230,50
230,52
230,54
230,56
230,58

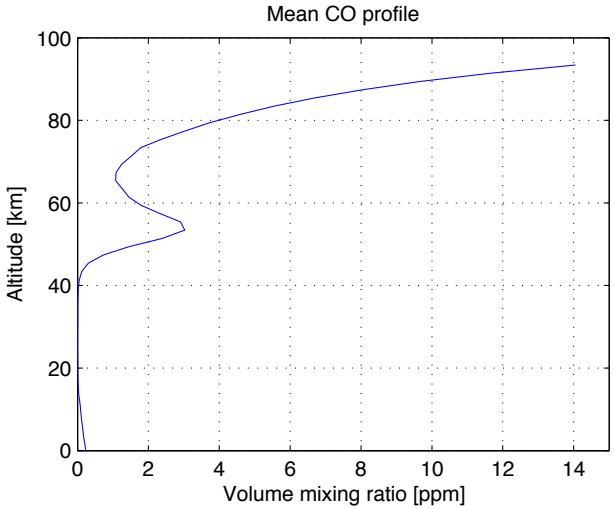
AOS

KIMRA





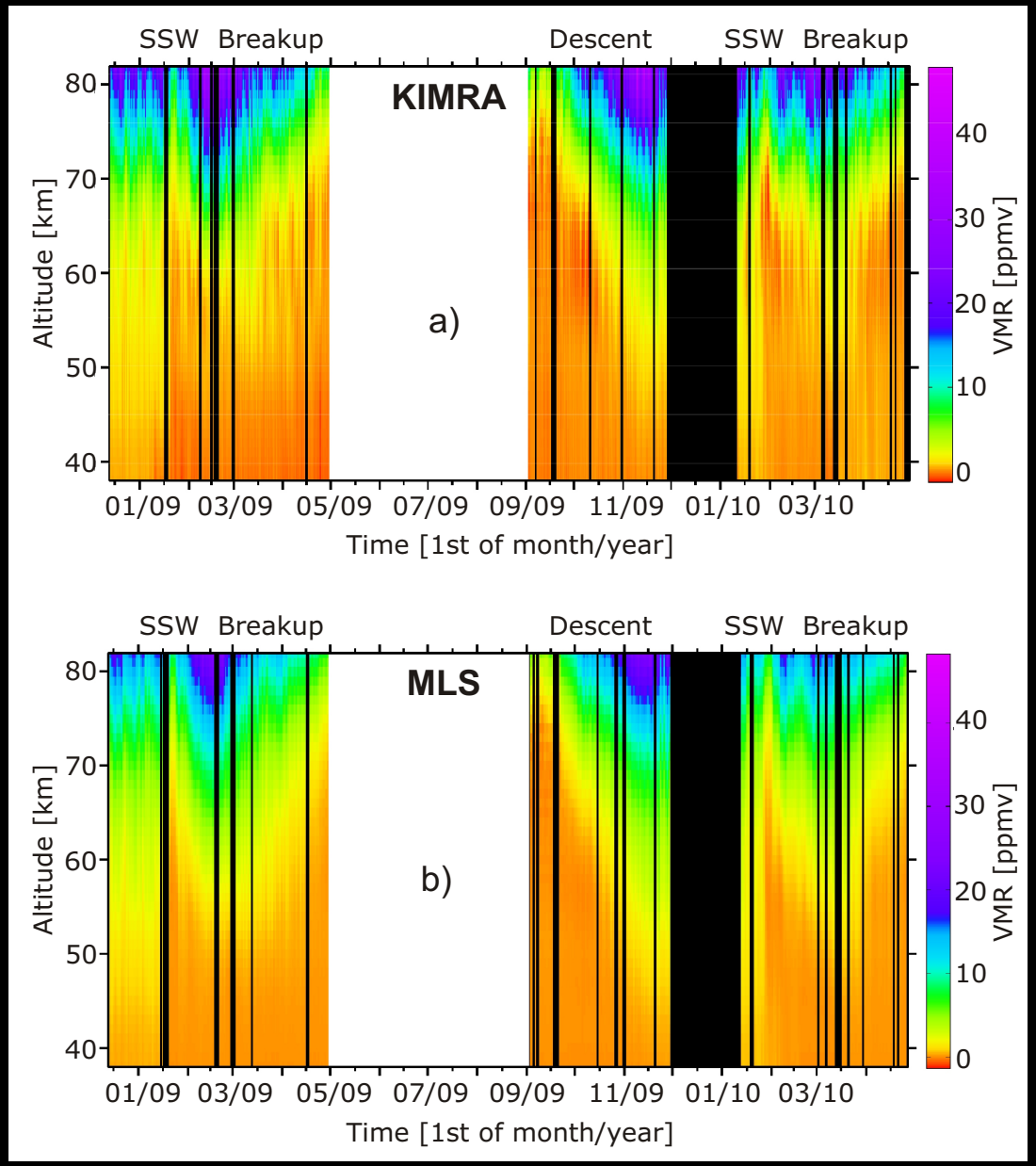




AOS

KIMRA and MIRA-2 at IRF Kiruna

KIMRA

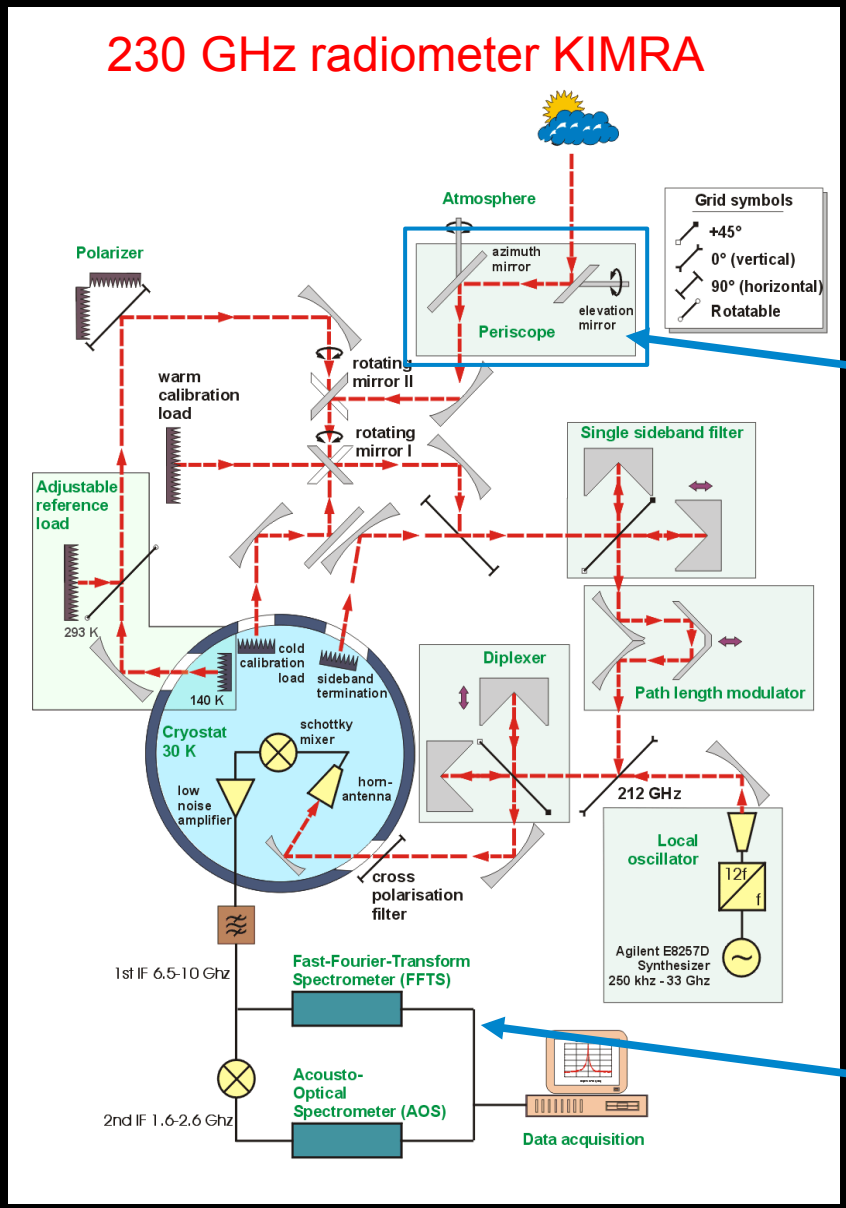


Ground-based

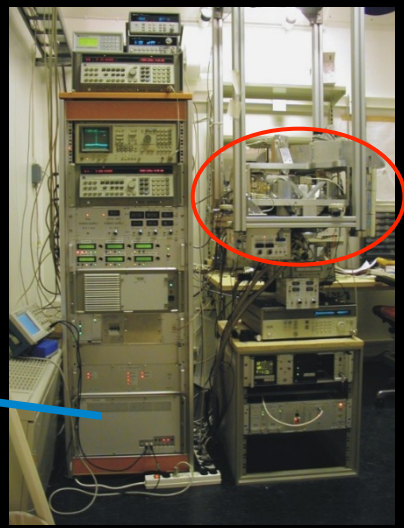
Satellite data

KIMRA and MIRA-2 at IRF Kiruna

KIMRA



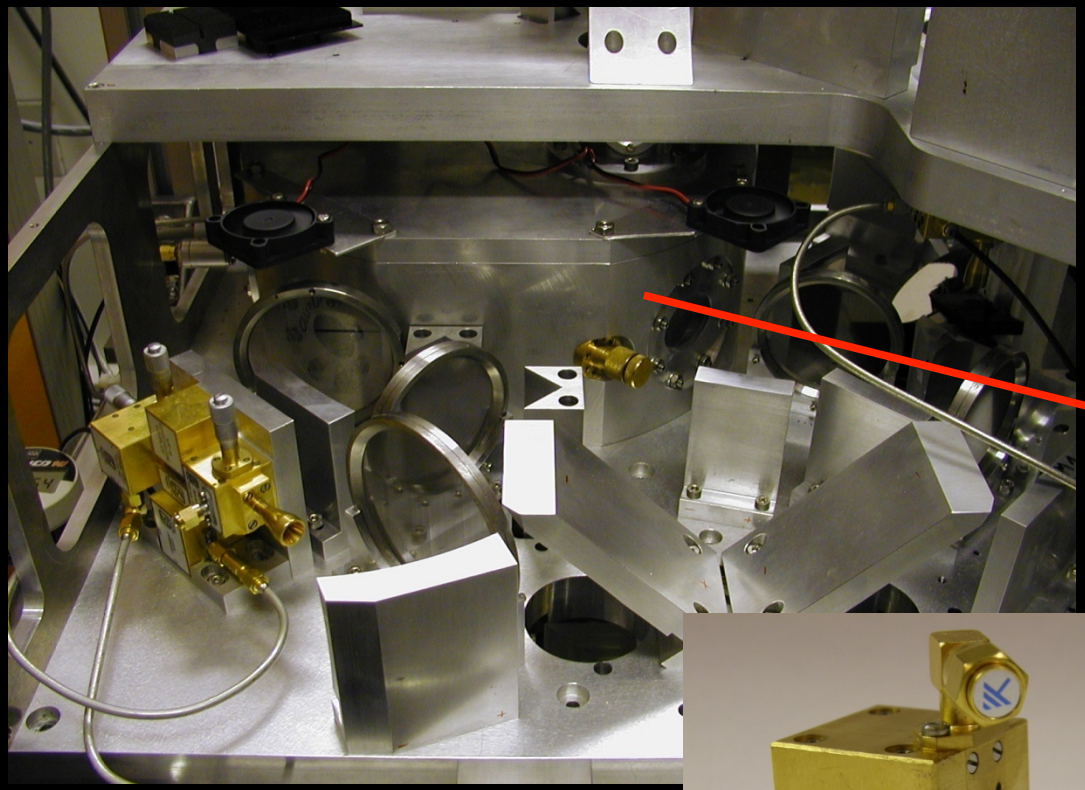
KIMRA Periscope



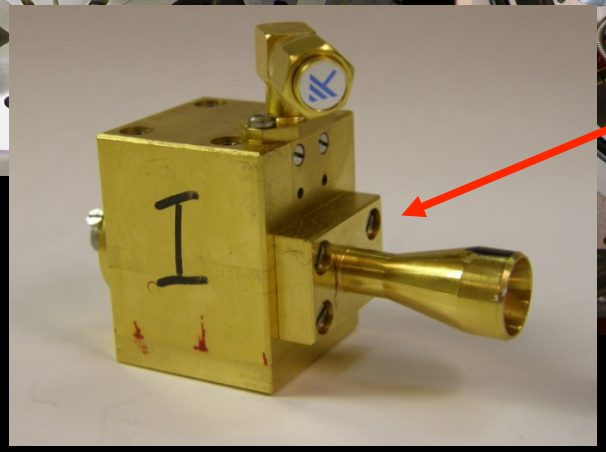
Quasioptics

KIMRA Elektronics

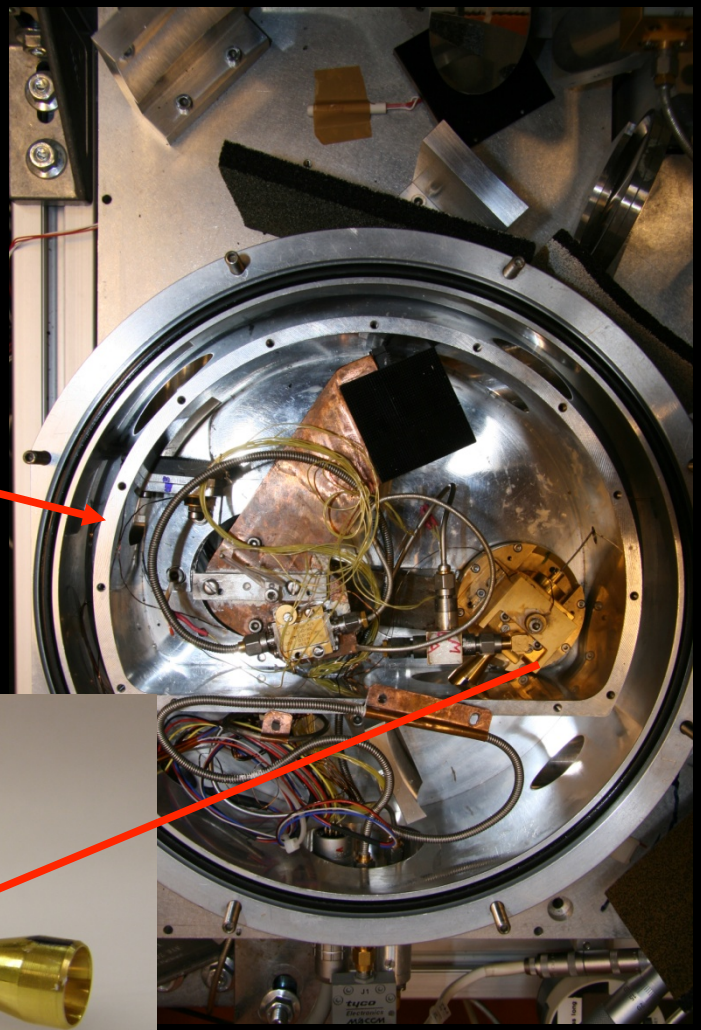
KIMRA



Quasioptics



230 GHz Mixer (RPG)



Vacuum dewar
with 25 K arm

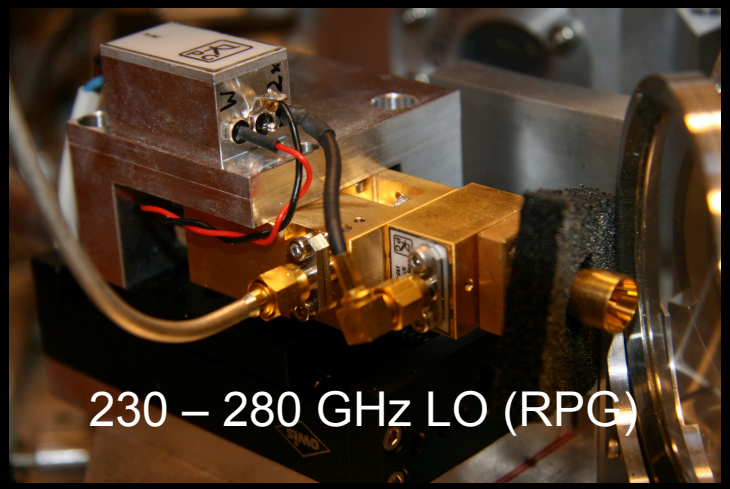
KIMRA

Technical Description of KIMRA				
Type of mixer	Schottky @ 25 K (RPG)			
Cooling	2-stage cryogenic			
Frequency	195 – 233 GHz			
System Noise	1800 K (SSB)			
Sideband sep.	Martin – Pupplett Interferometer			
Diplexer	Martin – Pupplett Interferometer			
LO	Frequency Multiplier 200 – 218 GHz (RPG)			
1st (and 2nd) IF	8 GHz (FFTS) and 2.1 GHz (AOS)			
Spatial Coverage	360° deg azimuth / 0° - 90° elevation			
Antenna opening angle	2.5° (FWHM)			
Measurement Modes	Reference Beam (w mixing load)/ Total Power (internal cold load or LN2)			
Spectrometer	AOS	FFT1	FFT2	
Manufacturer	Cologne University	Omnisys AB	RPG	
Bandwidth	1200 MHz	100 MHz	2500 MHz	300 MHz
Resolution	0.76 MHz	0.1 MHz	0.076 MHz	0.009 MHz

MIRA-2

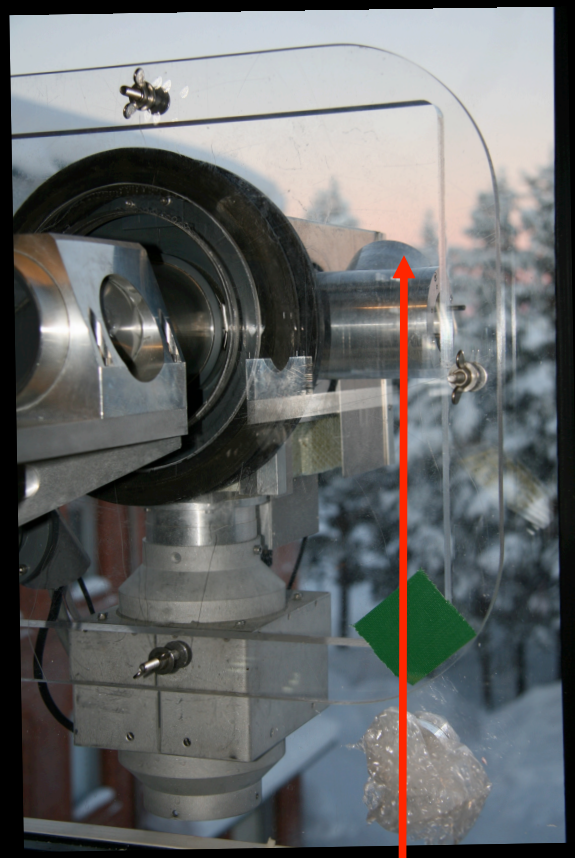
- Kiruna , Feb - Mar 1996
- Ny-Ålesund, Mar 1997
- Kiruna , Jan - Apr 1998
  Feb - Mar 1999
  Nov 1999 - Mar 2000
  Dec 2000 - Mar 2001
- Mount Zugspitze, Fermany, Feb – Jul 2003
- Pico Espejo, Venezuela, Mar 2004 – Jun 2010
- Kiruna , Nov 2012 -

MIRA-2

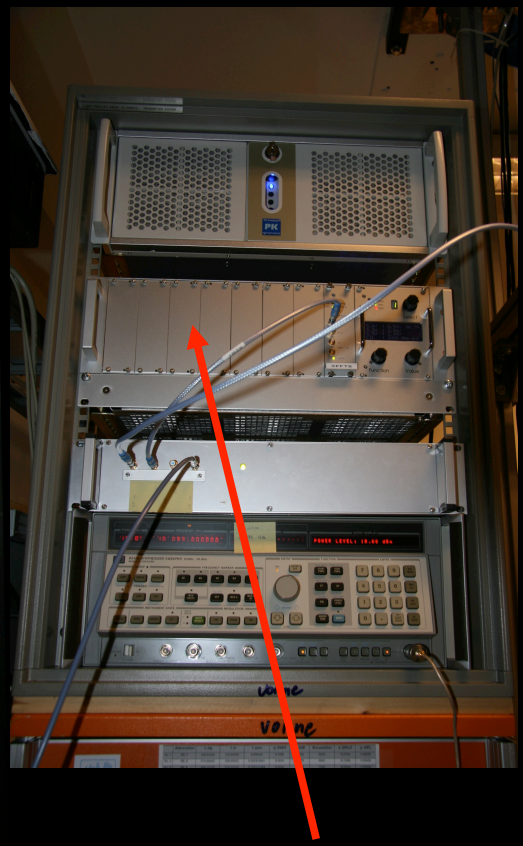


230 – 280 GHz LO (RPG)

Fabry-Perot Interferometer



Window view



RPGFFTS

MIRA-2

Technical Description of MIRA-2		
Type of mixer	Schottky @ 25 K	
Cooling	2-stage cryogenic	
Frequency	270 – 280 GHz	
System Noise	800 K (SSB)	
Sideband sep.	Martin – Pupplett Interferometer	
Diplexer	Fabry – Perot Interferometer	
LO	Frequency Multiplier 268 – 282 GHz (RPG)	
IF	2.1 GHz	
Spatial Coverage	North / 5° -90° elevation	
Antenna opening angle	2.5° (FWHM)	
Measurement Modes	Reference Beam (w mixing load)/ Total Power (internal cold load or LN2)	
Spectrometer	AOS	FFT
Manufacturer	Cologne University	RPG
Bandwidth	1200 MHz	1500 MHz
Resolution	0.76 MHz	0.076 MHz

Summary KIMRA and MIRA-2

- Automatic operation
- Integration Time
- Retrieval
  - KOPRA and OEM (Kopp until 2010)
  - ARTS and OEM (Raffalski)
- Data Storage
- Access to Data

KIMRA and MIRA-2

Plans for the Future

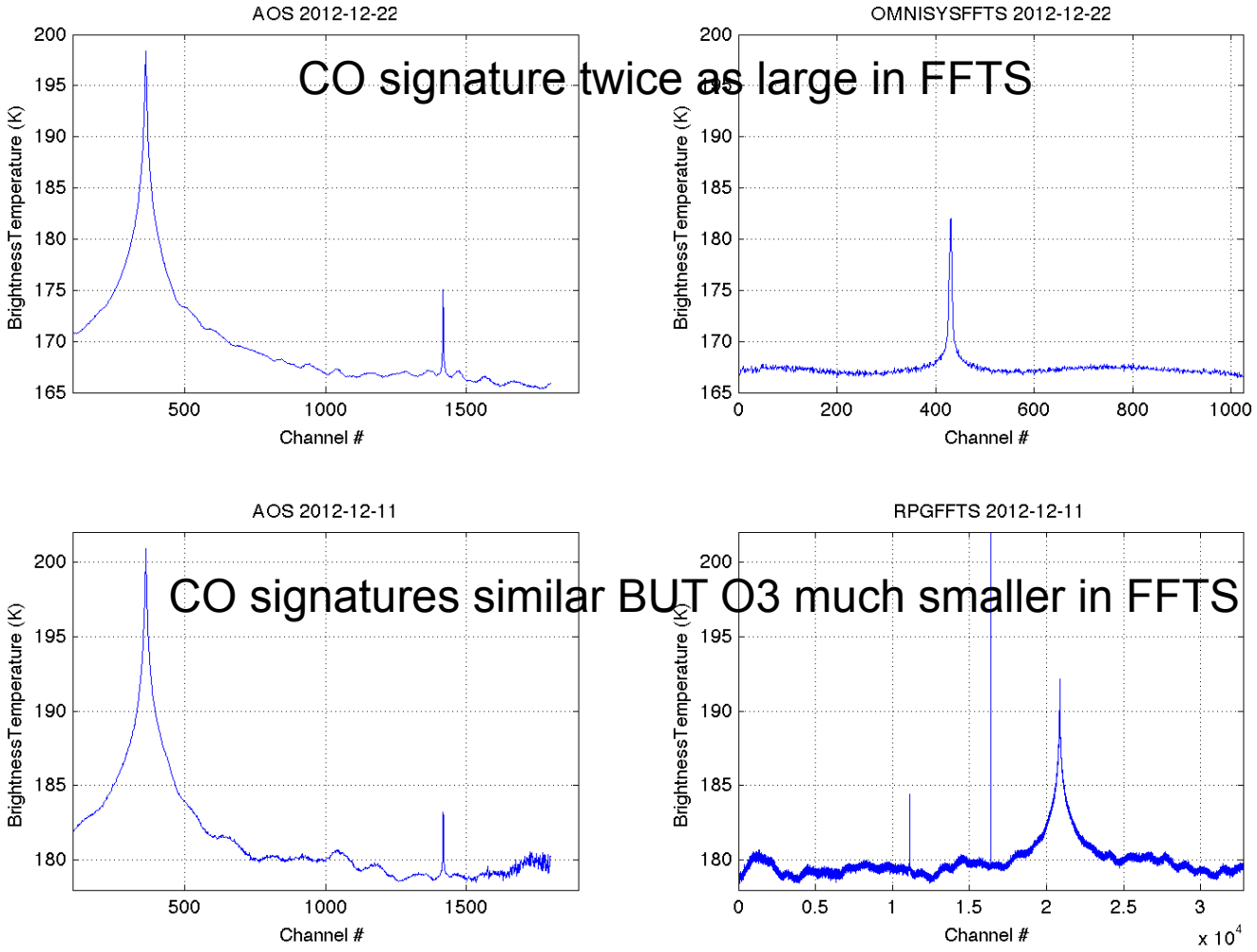
Technical Developments

- Fighting the standing waves
- Tuning the KIMRA Frequency Multiplier to access O2-line @ 235 GHz
- Decreasing the lowermost temperature of the Mixing load

Measurements and Retrieval

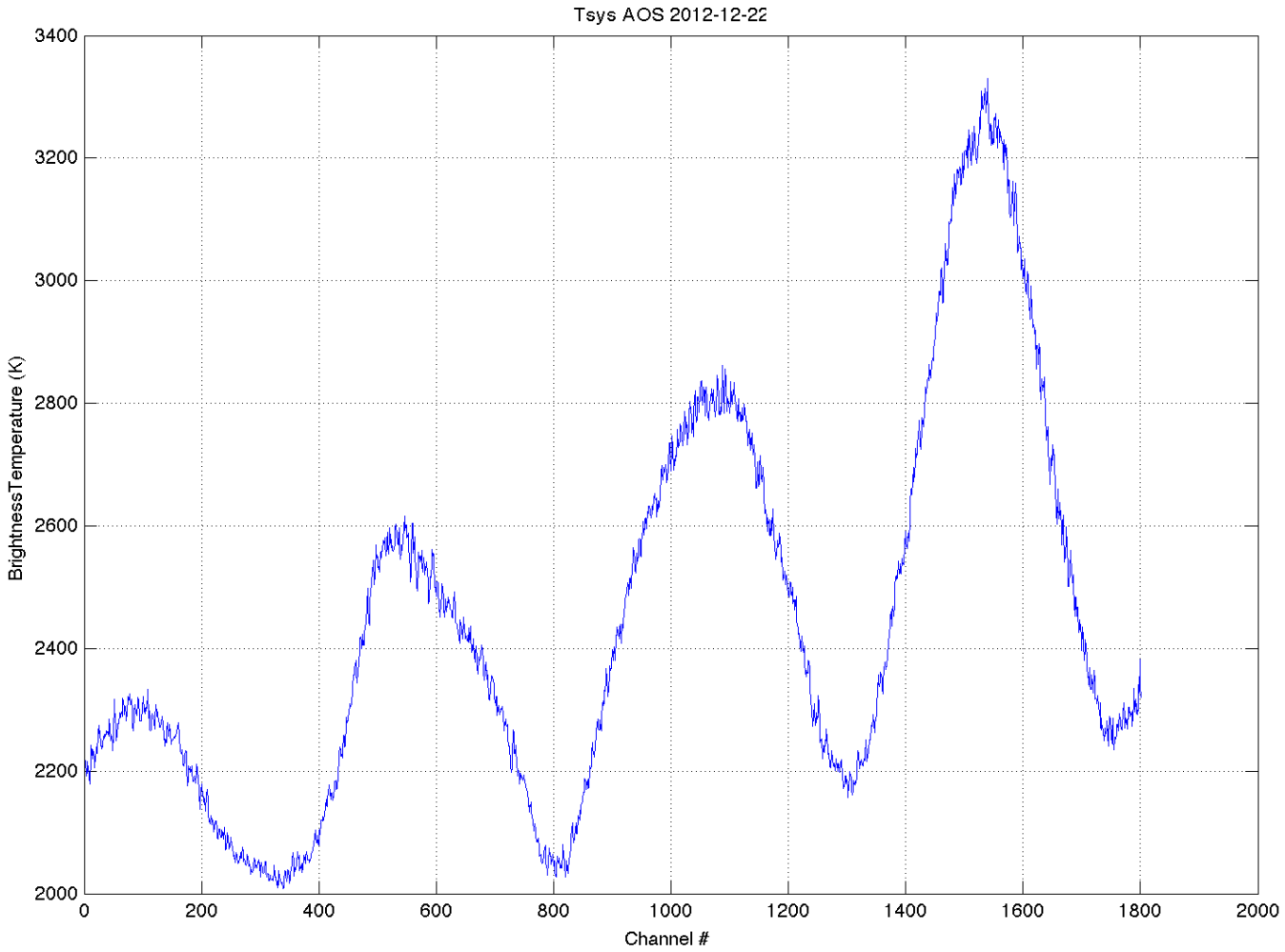
- Automatic operation (including switching between different trace gases)
- Operation of all three spectrometers simultaneously
- NDACC certification for both instruments
- Automatic retrieval (at least as quick-looks)
- Data Storage on NDACC database (Format?)
- Access to Data

Problem 1: Amplitude difference in FFTS/AOS



All measurements taken simultaneously for the respective date.

Problem 2: Tsys amplitude



KIMRA and MIRA-2 at IRF Kiruna