TCCON site Garmisch (47.5 °N, 11.1 °E, 745 m a.s.l.)
Steps towards operationality in 2007

Ralf Sussmann, Tobias Borsdorff, Markus Rettinger

Zugspitze, 47.4 °N, 11.0 °E, 2964 m:
NDACC
operational since 1995
138 meas. days during last 12 months

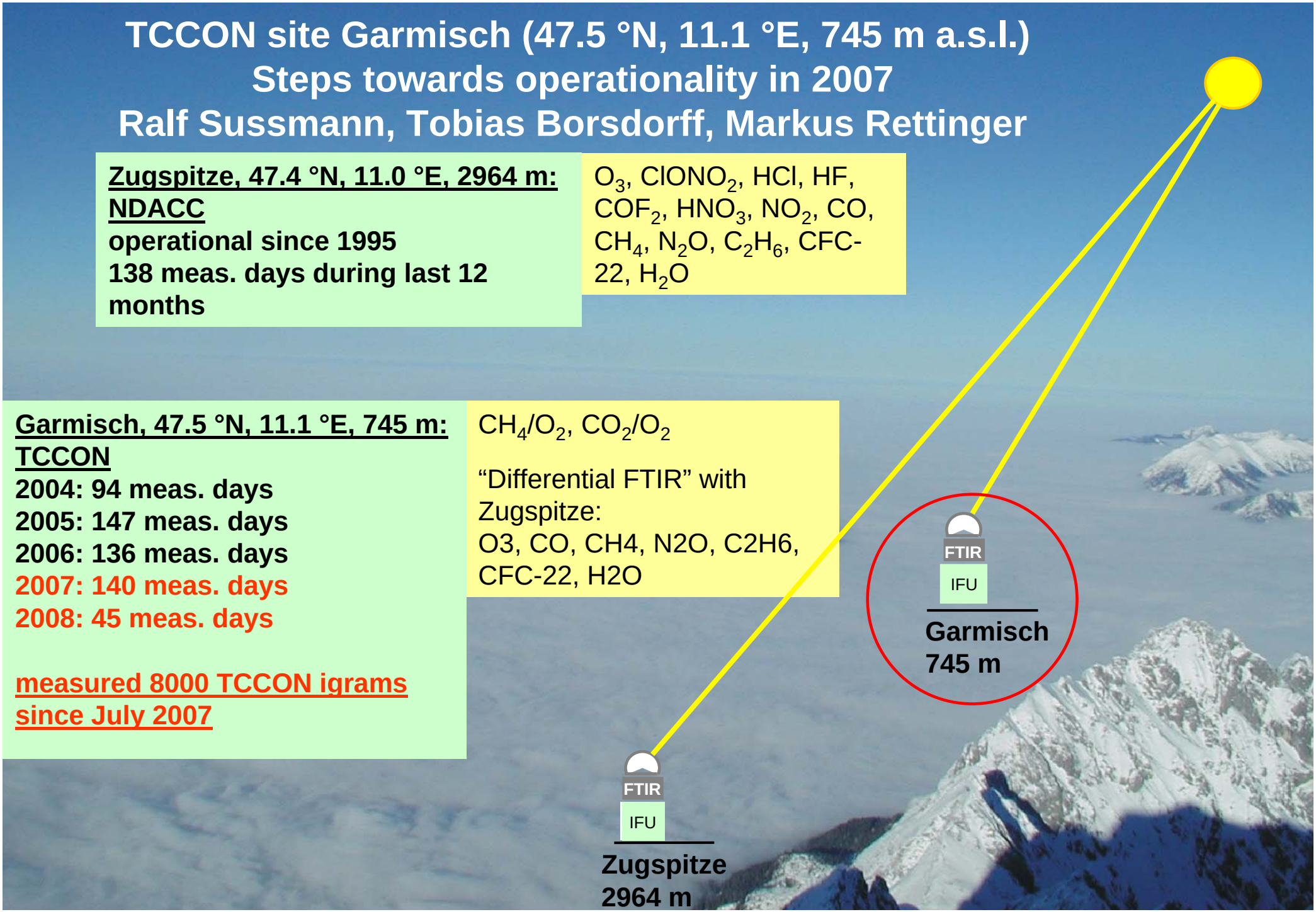
O_3, $ClONO_2$, HCl, HF, COF_2, HNO_3, NO_2, CO, CH_4, N_2O, C_2H_6, CFC-22, H_2O

Garmisch, 47.5 °N, 11.1 °E, 745 m:
TCCON
2004: 94 meas. days
2005: 147 meas. days
2006: 136 meas. days
2007: 140 meas. days
2008: 45 meas. days

measured 8000 TCCON igrams since July 2007

CH_4/O_2, CO_2/O_2

"Differential FTIR" with Zugspitze:
O3, CO, CH4, N2O, C2H6, CFC-22, H2O



Garmisch site: 47.5 °N, 11.1 °E, 745 m a.s.l.

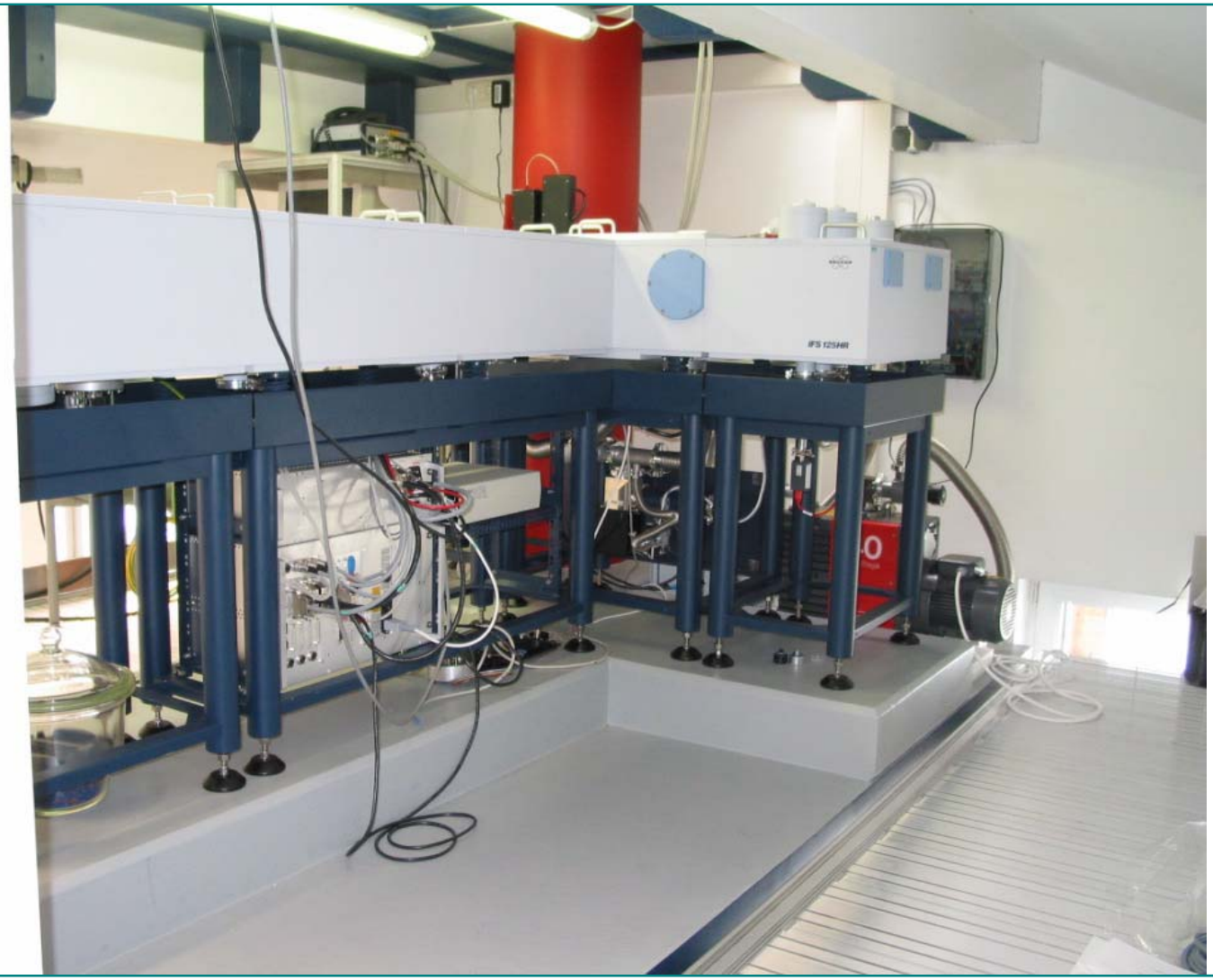
Research Center Karlsruhe **Ralf Sussmann**

IMK-IFU Garmisch-Partenkirchen

Garmisch TCCON Site Report

Garmisch FTS: Dome, “old“ Bruker solar tracker (mechanically strengthened)

Garmisch FTIR: Bruker 125 HR, 250 cm OPD_{max}, evacuated

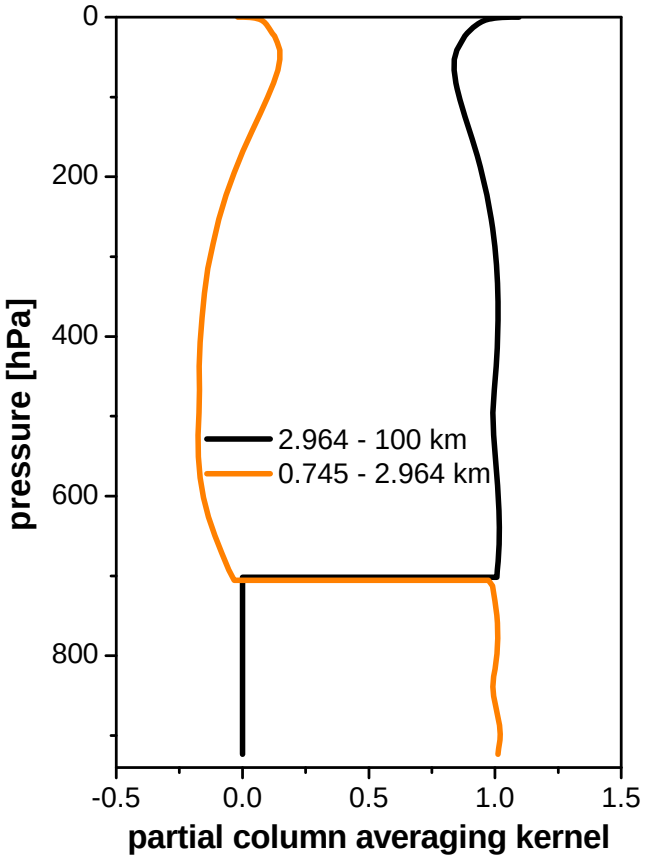


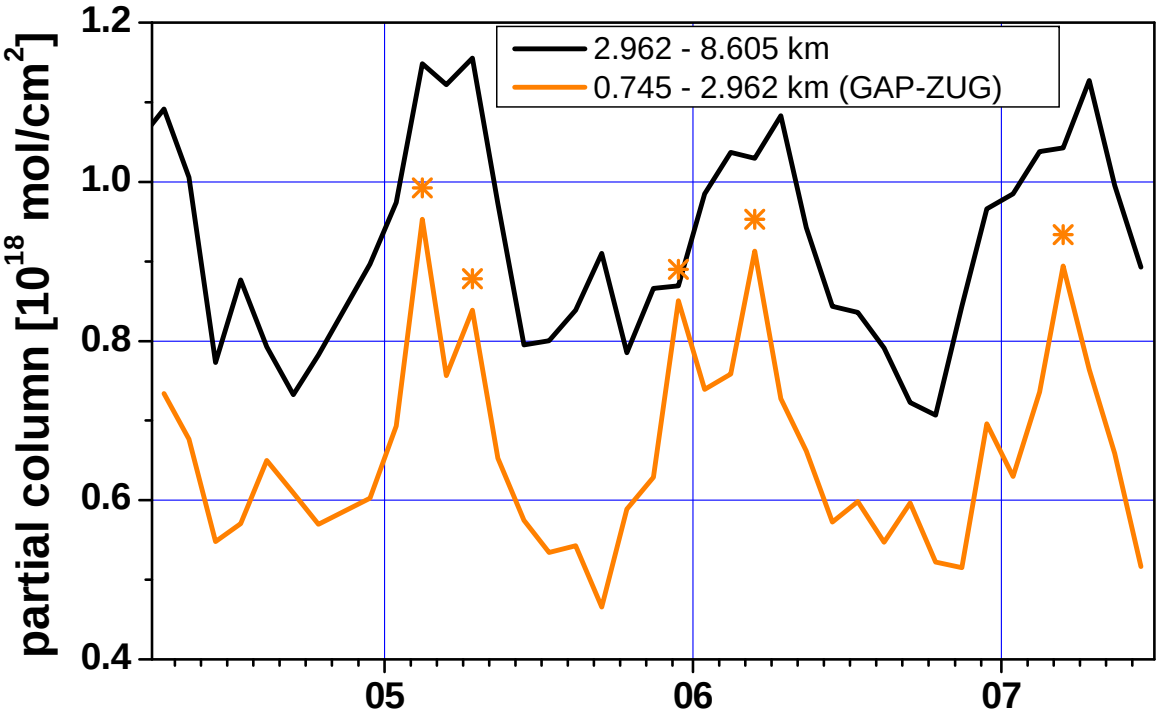
FTS measurements history at Garmisch

Spectral region (cm^{-1})	Years	Resolution (cm^{-1})	Beamsplitter	Detektor
4000 – 11500	Jul 2007 – ongoing	0.02	CaF2	InGaAs
11500 – 15800	Jul 2007 – ongoing	0.02	CaF2	Si-Diode
3750 – 8900	2006 – Jul 2007	0.02	CaF2	InSb
1850 – 2200	2004 – ongoing	0.0036	KBr⇒2007 CaF2	InSb
1900 – 2650	2004 – ongoing	0.0072	KBr ⇒2007 CaF2	InSb
2400 – 3100	2004 – ongoing	0.00513	KBr ⇒2007 CaF2	InSb
750 – 1250	2004 – Jul 2007	0.0036	KBr	MCT
3750 – 4370	2004 – Jul 2007	0.0079	KBr	InSb

Current Garmisch measurement strategy: alternating ≈5 min NIR and MIR measurements (50 % / 50 % time sharing) ⇒ **8000 TCCON igrams since July 2007**

“Differential“ Garmisch-Zugspitze FTIR: e.g., CO boundary layer column



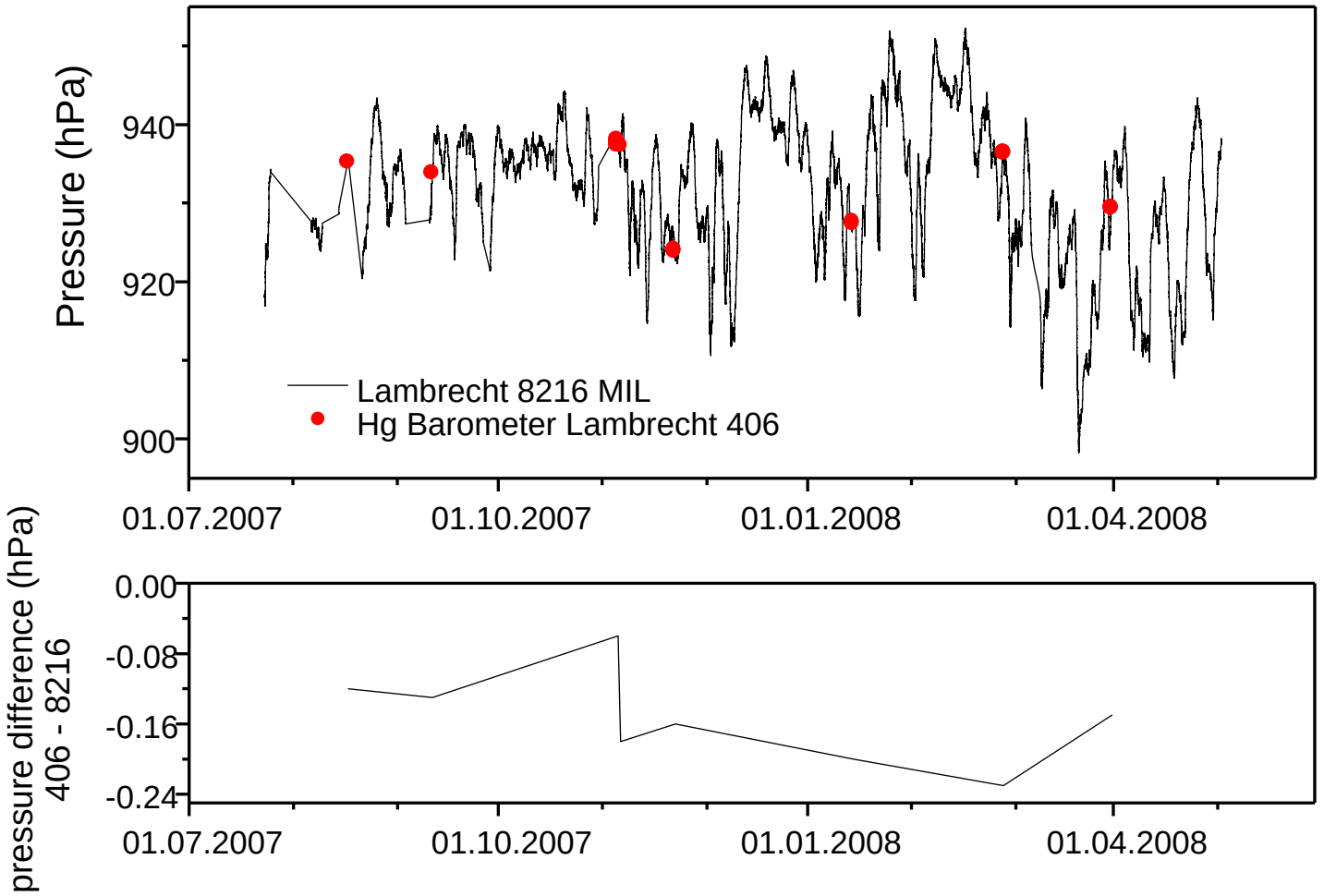


Borsdorf, Sussmann, to be published

TCCON adaptations - Pressure sensors: done July 2007

pressure sensor
Lambrecht 8126 MIL
accuracy: 0.15 hPa
long-term stability: < 0.1 hPa/year

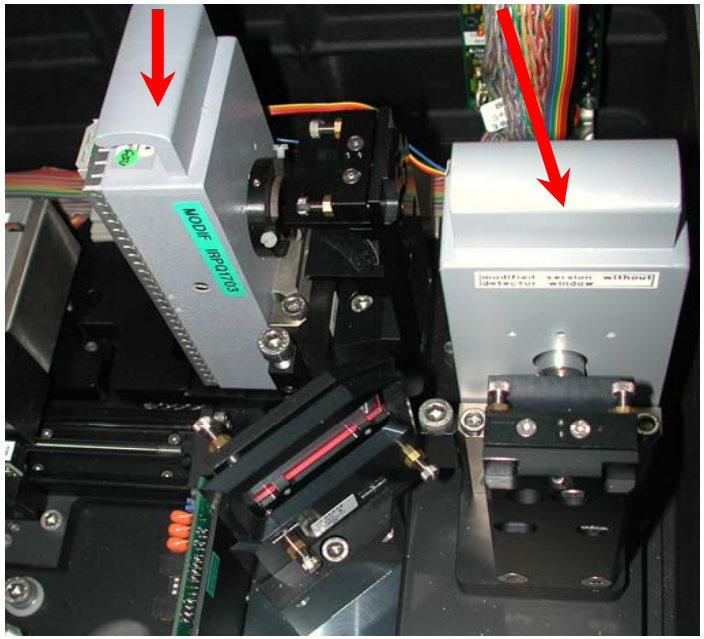
Hg barometer
Lambrecht 406
accuracy: 0.25 hPa



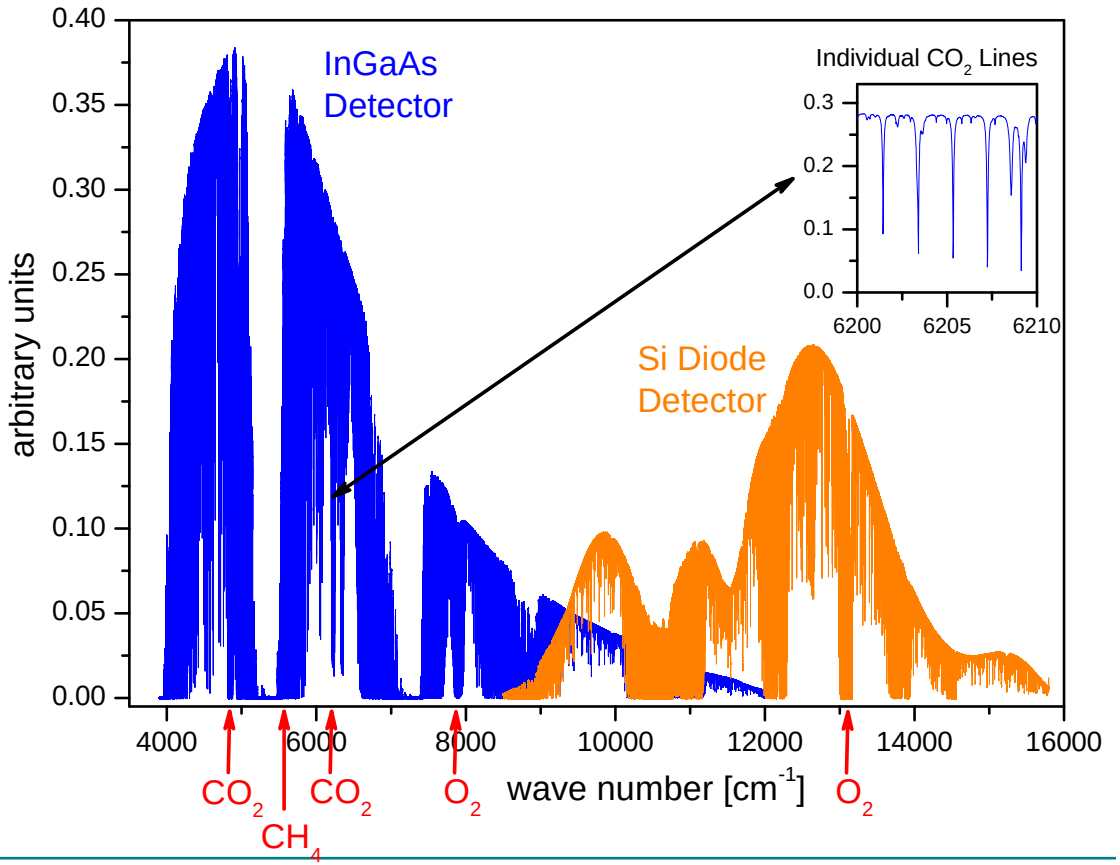
TCCON adaptations: Detectors (Bruker D429/B) & (Bruker D510/B)

adapted resistors (to digital signal range <32000 counts)
and capacitors (to modulation frequency ≈50 Hz)

Si-Diode InGaAs



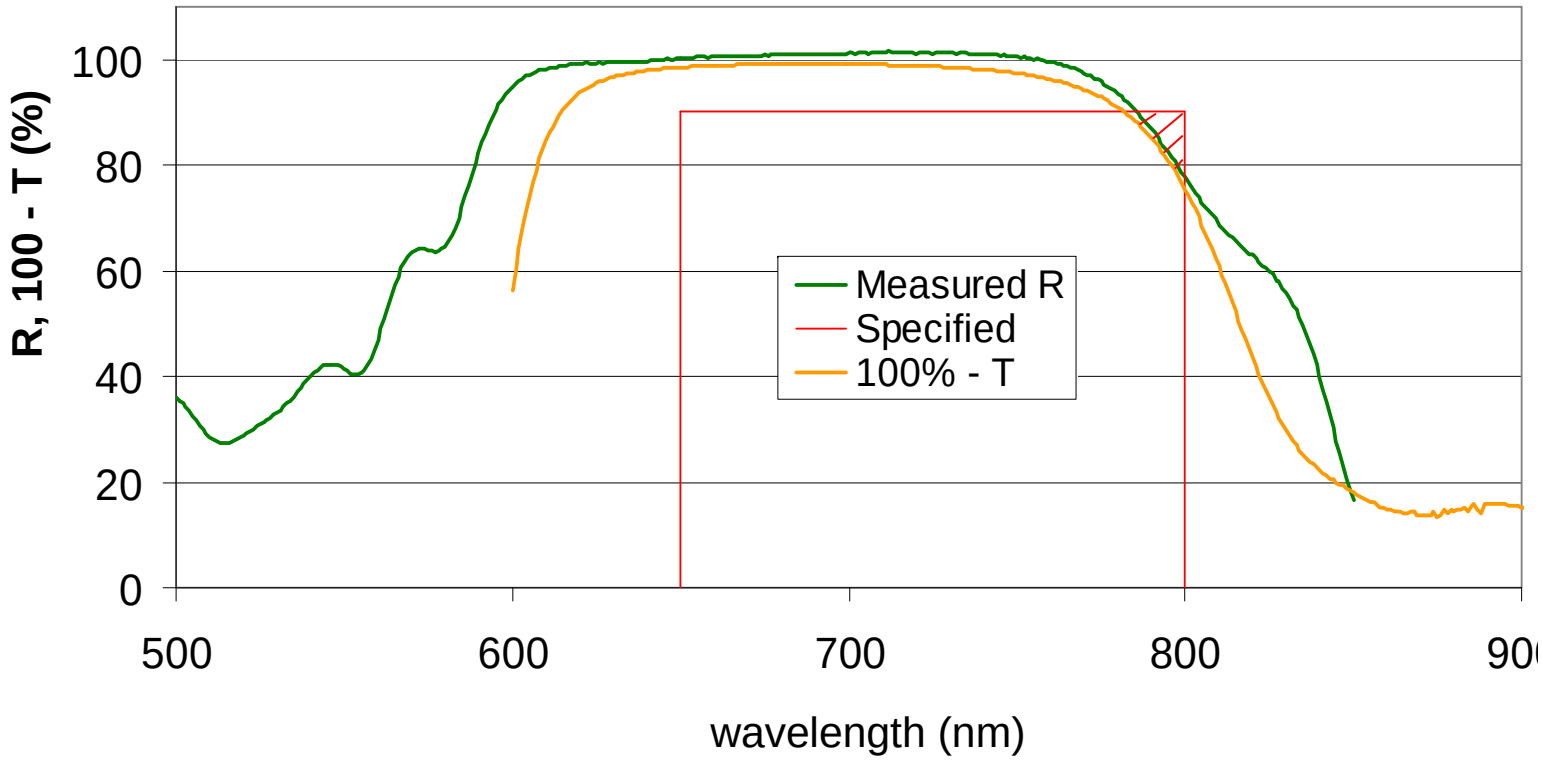
Garmisch July 2007 spectra



TCCON adaptations: Dichroic for InGas – Si dual acquisition

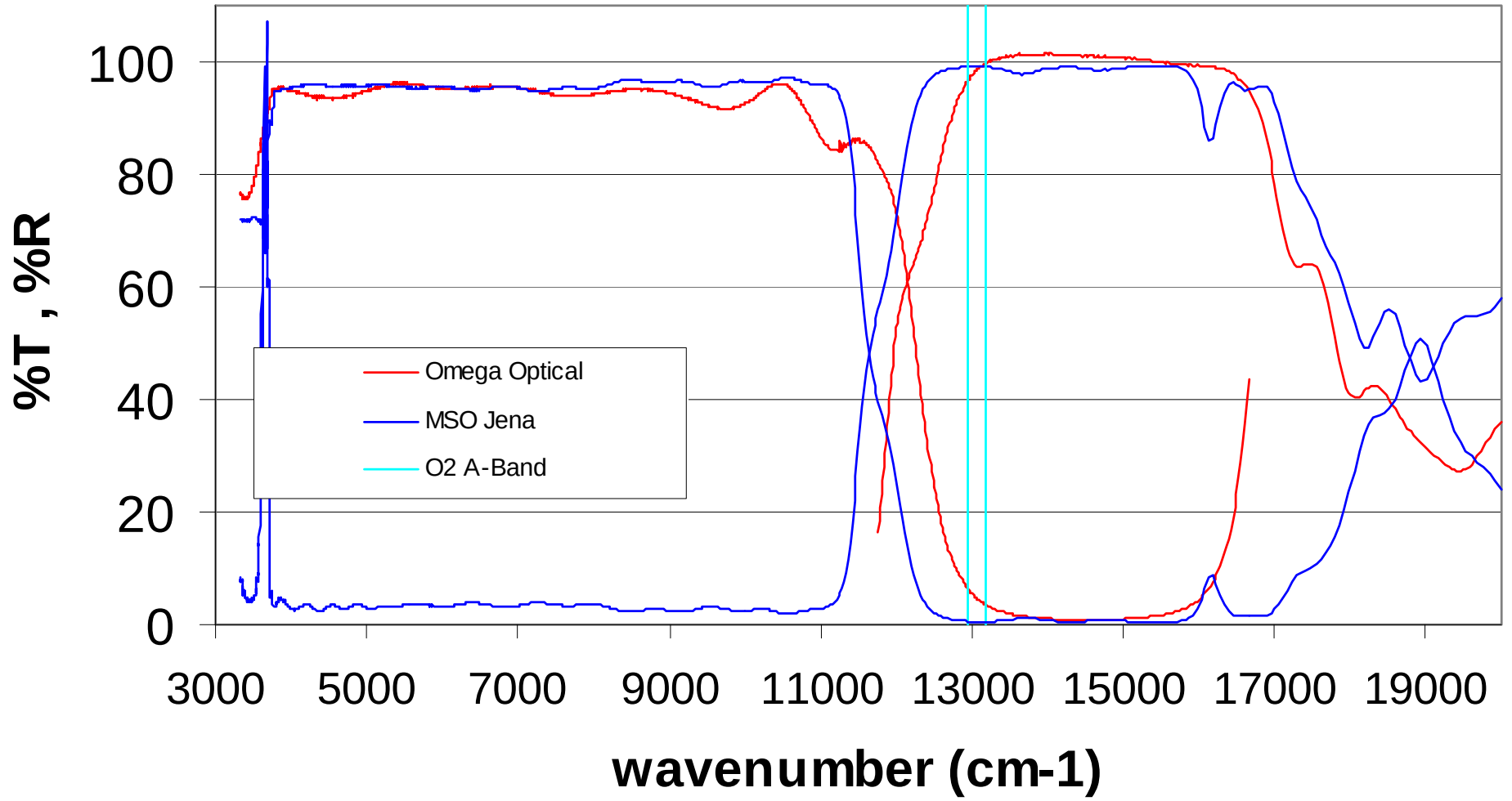
Omega Optical Part# 1000 DCLP manufactured in 2007 failed specs

- Transmission > 90% average, 85% min , 3300 – 7700 cm^{-1}
- Reflection > 95% average, 90% min , 12500 - 15500 cm^{-1}

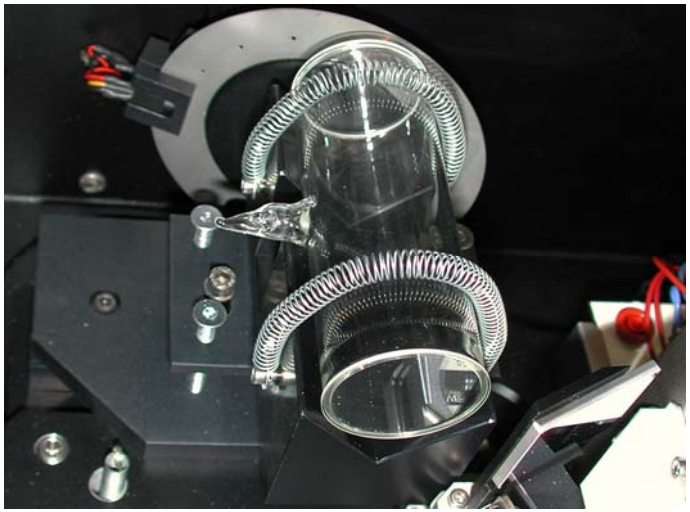


TCCON adaptations: Dichroic for InGas – Si dual acquisition

MSO Jena (W852/849) does better job



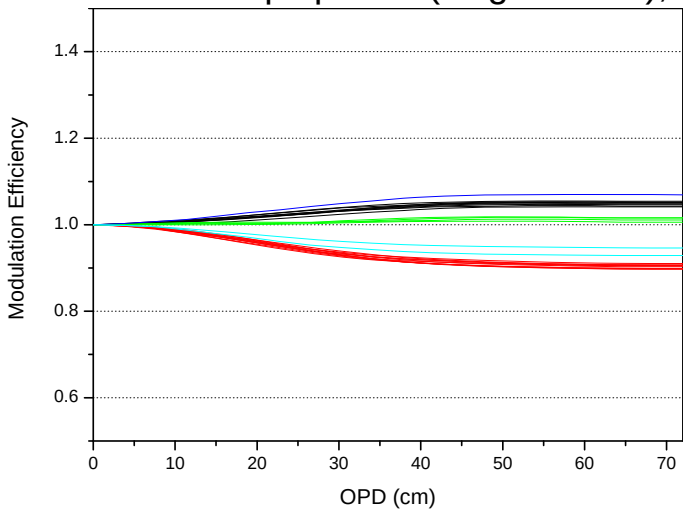
TCCON adaptations – HCl cell

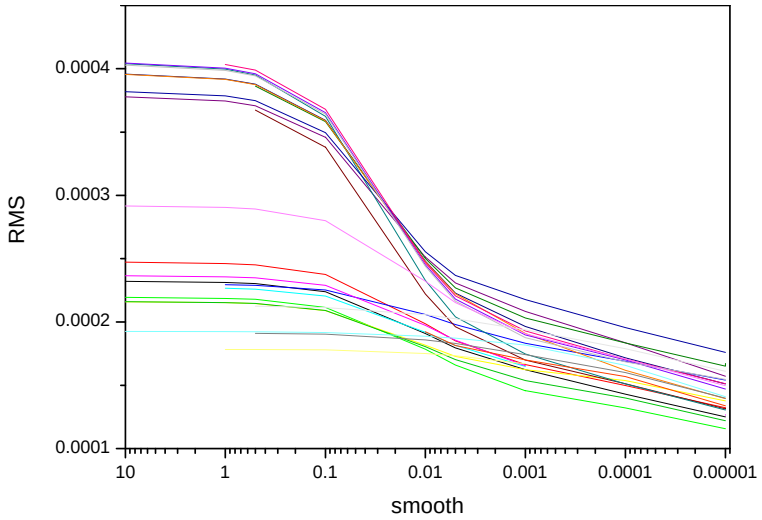


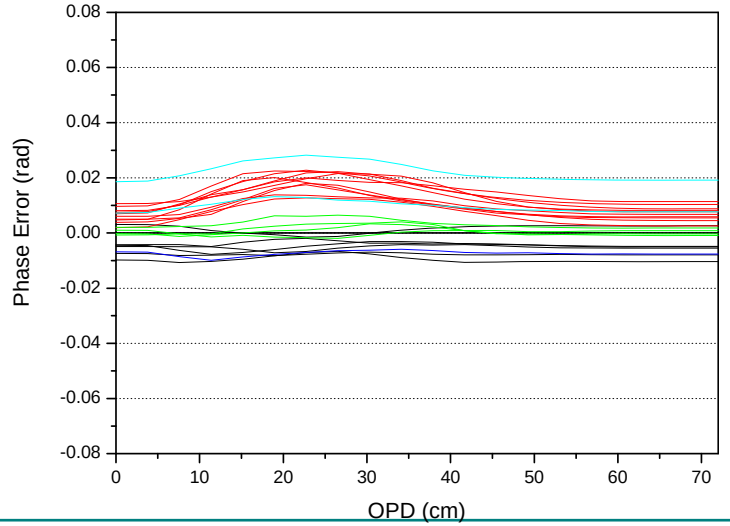
broken cell shipped by Paul,

filled and pinched off in Germany

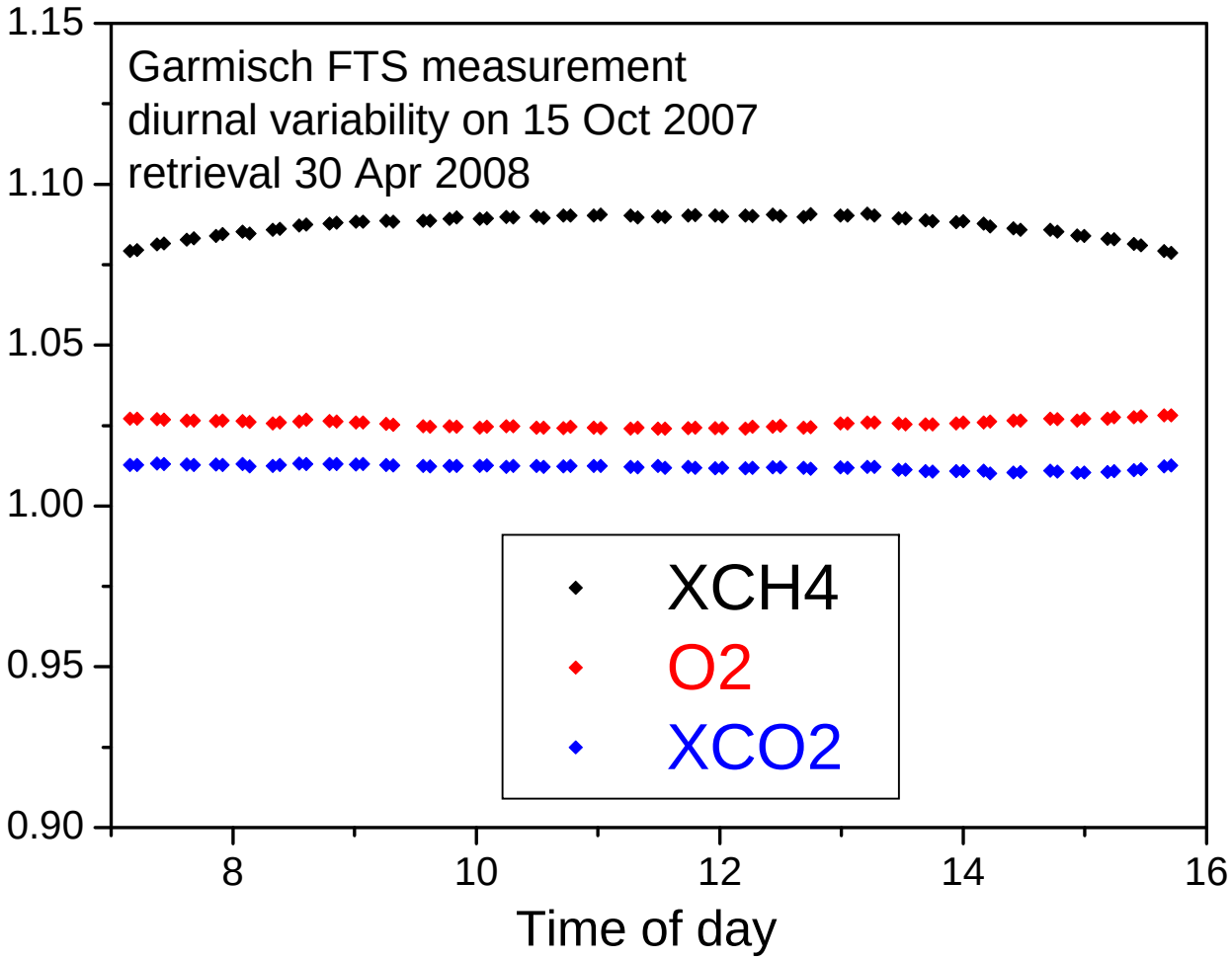
results from 25 lamp spectra (single scans), 3 lines



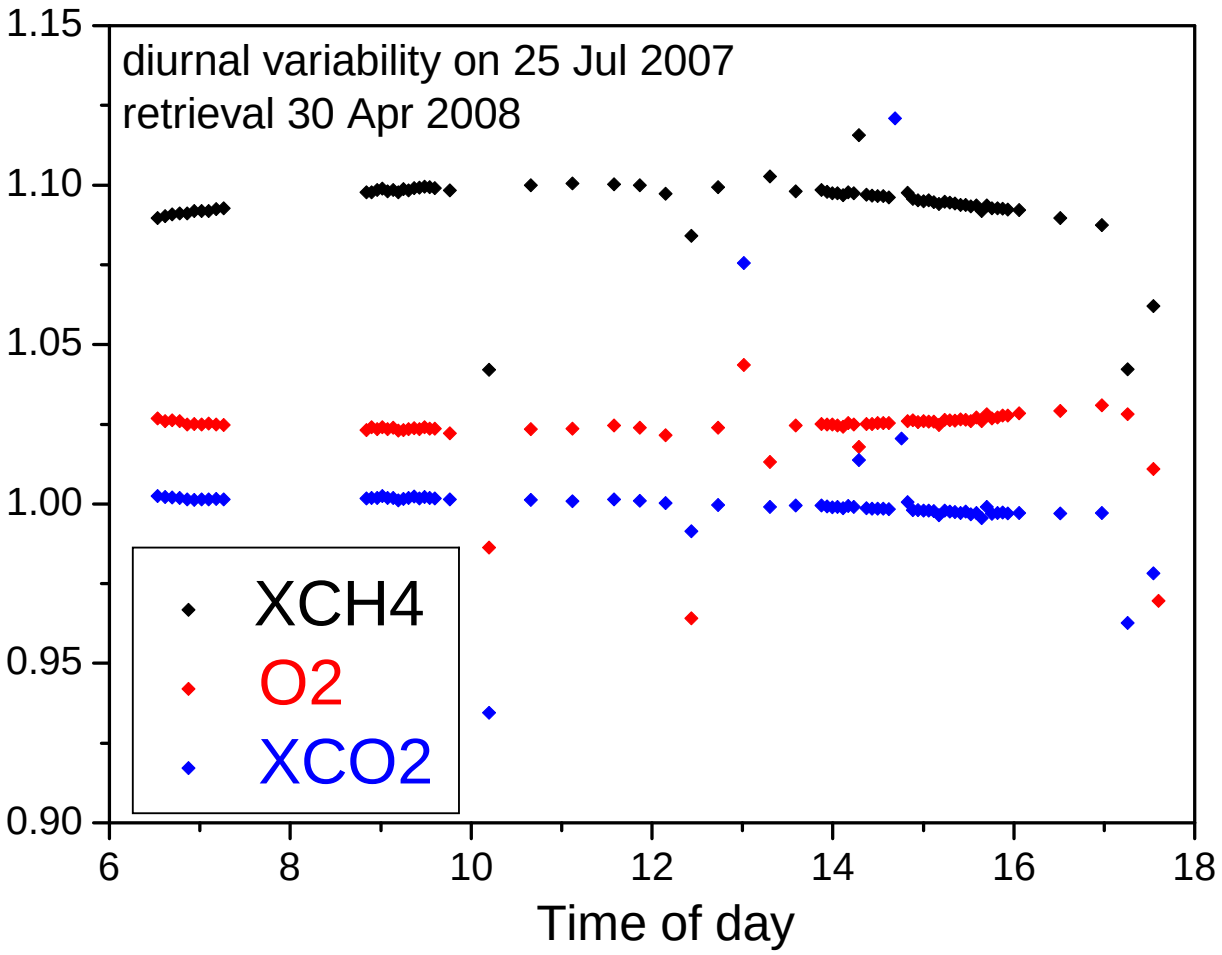




First GFIT retrievals: diurnal variation (clear sky day)

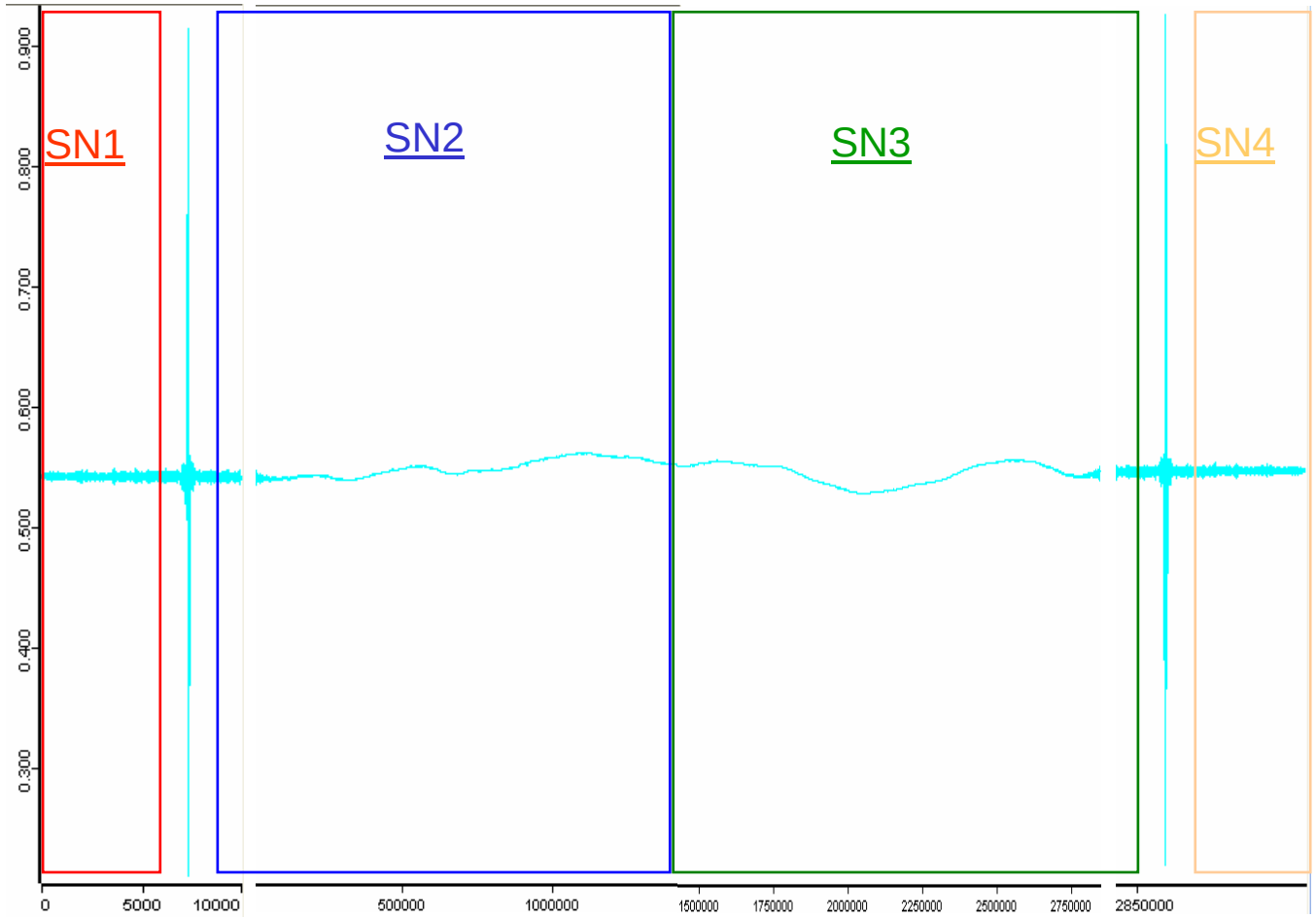


First GFIT retrievals: diurnal variation (cloudy day, without filtering/correction)

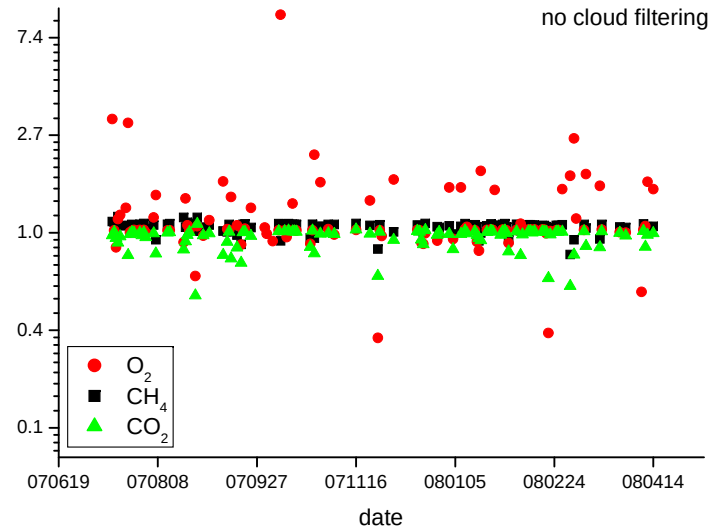


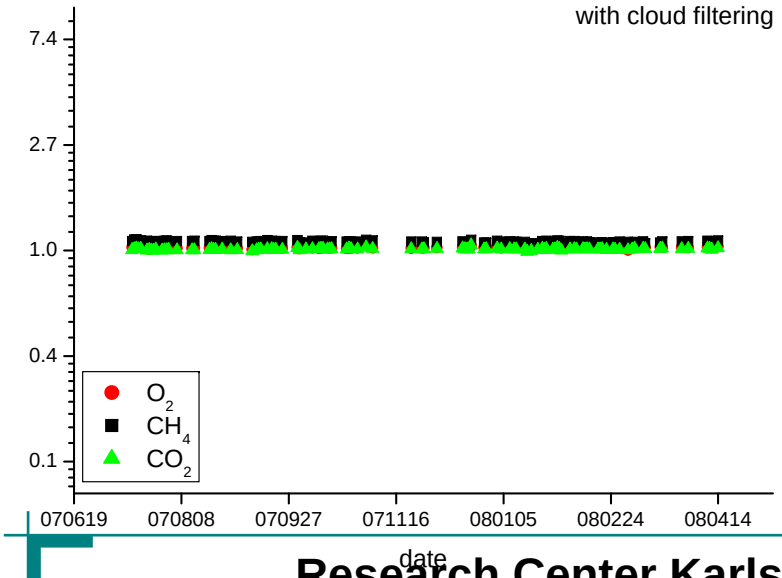
Cloud detection/filter: (done) we use InGaAs igram instead of quadrant diode

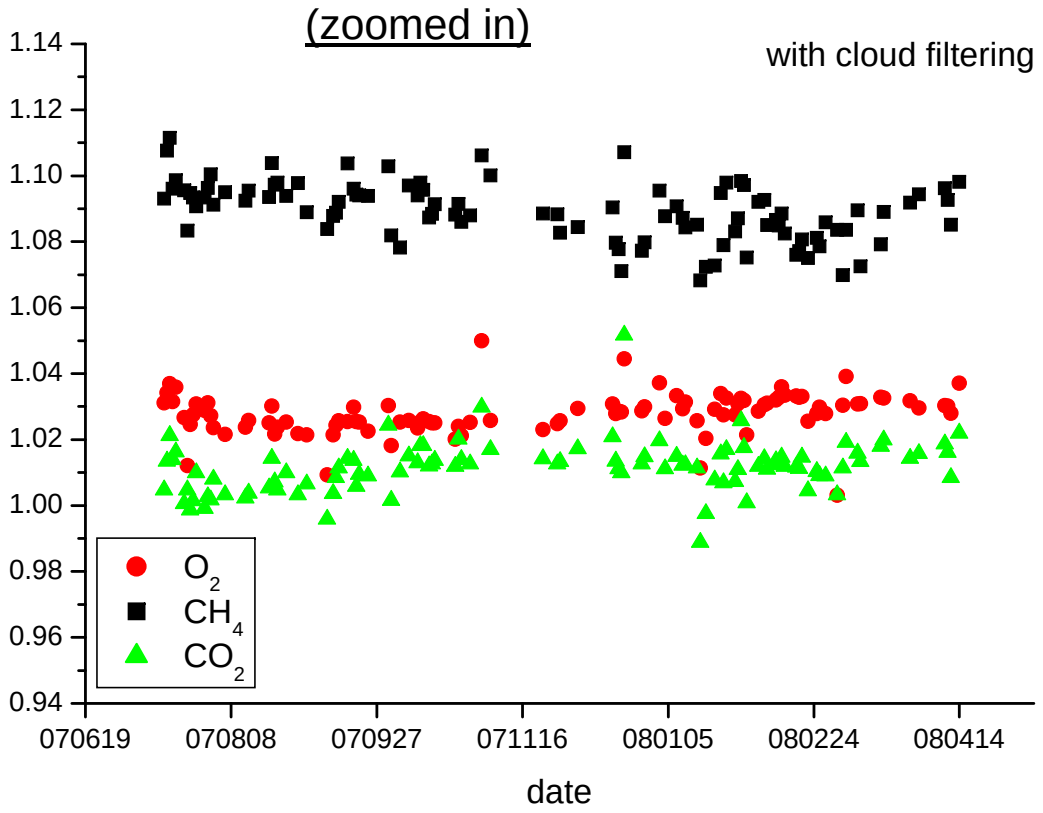
- cloud pass criterium: stdv of DC signal of InGaAs igram (center burst excluded) < 10 %



First GFIT retrievals: time series after cloud filtering (no DC correction yet)



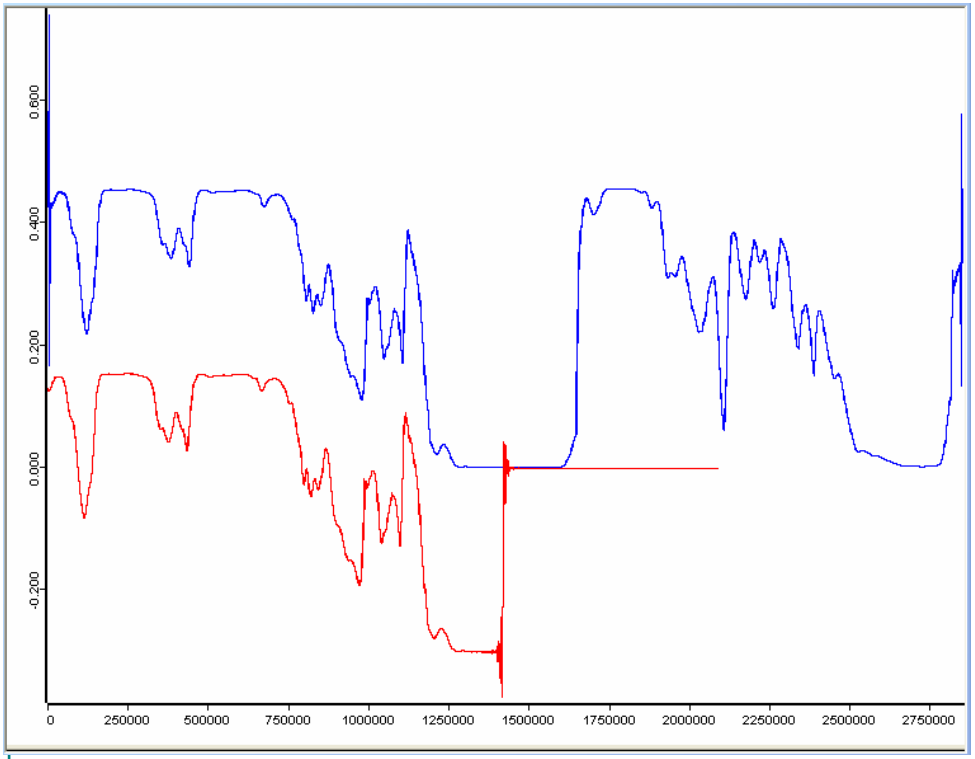


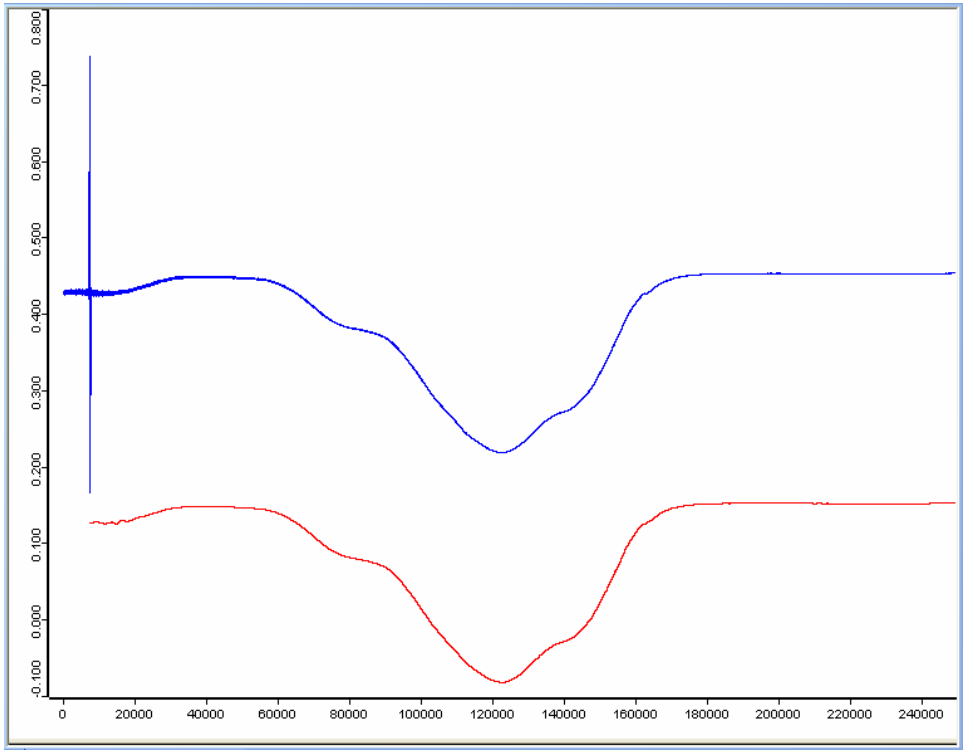


DC correction: problems with OPUS inverse fft

- started to implement Aleks et al. (Appl. Opt. 2007) DC correction with an OPUS Makro
- have to deal with forward-backward double igram
- encountered problems with inverse fft using OPUS fft tool

fft forward igram only, GKA filter applied upon spectrum, inverse fft:

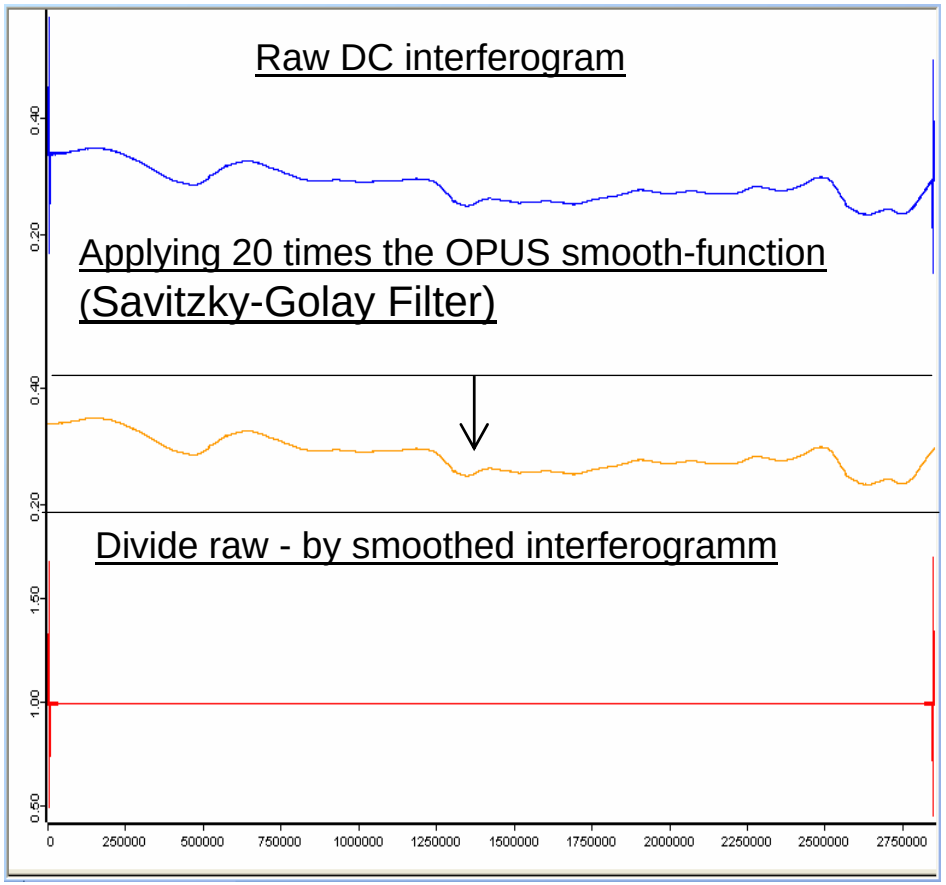


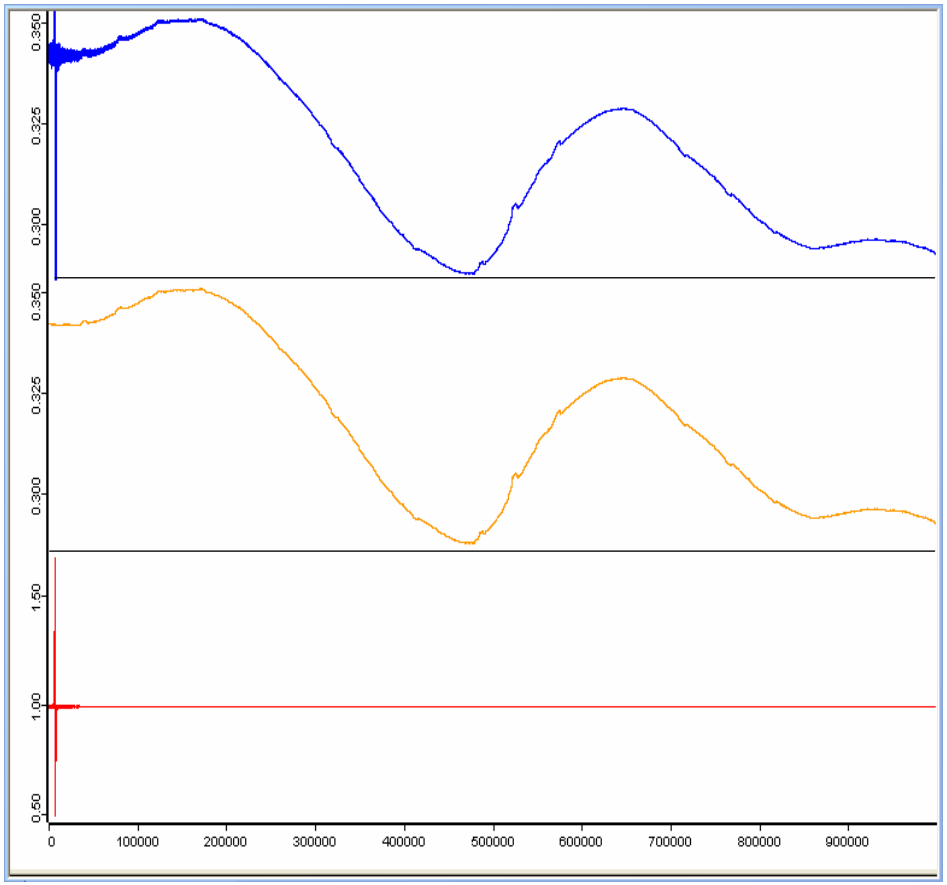


DC correction: alternative attempt – simple “smoothing“ DC correction

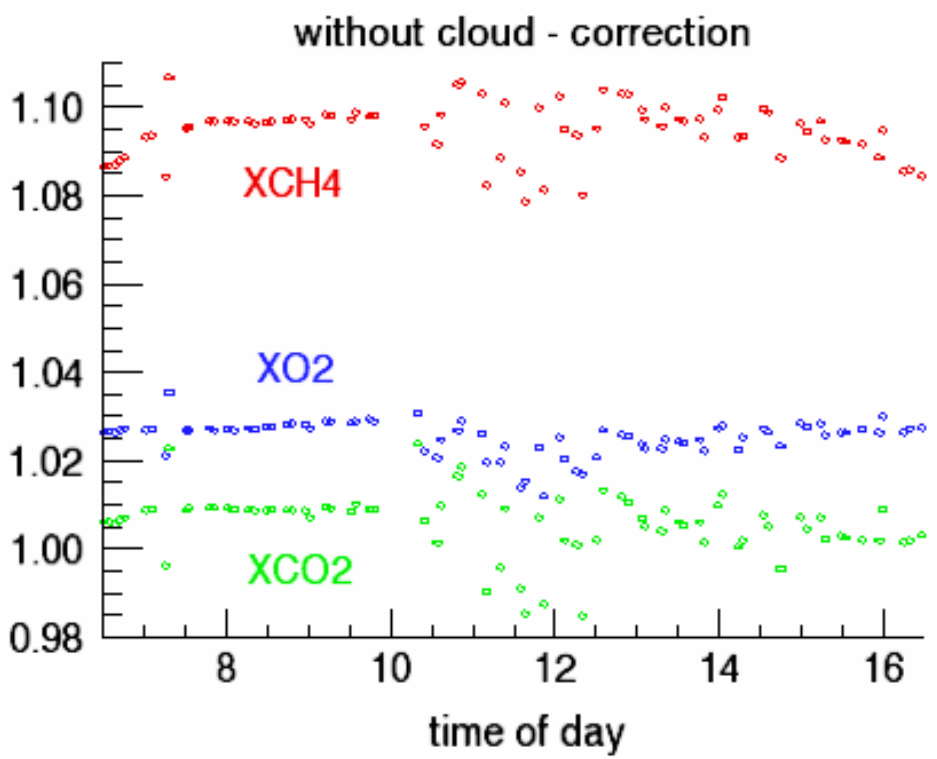
- implemented simple empirical igram-smoothing correction to avoid inverse fft

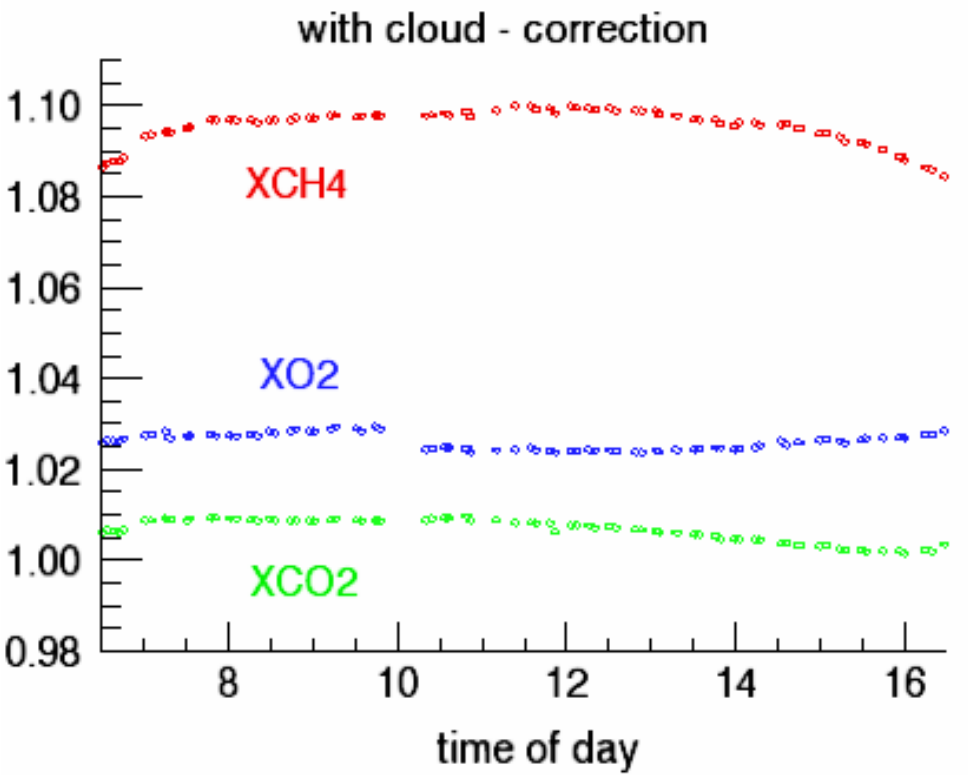
– seems to do a good job





DC correction: simple “smooting“ DC correction – seems to work?





DC correction: point of discussion

Would need at Garmisch DC correction tool that is able to handle

1. spectra acquired with OPUS software
2. double-ZPD (forward – backward) igrams

	handle spectra acquired with OPUS	perform DC correction	handle double (fwd-backwd) igrams
slice-ipp	no	yes	no
opus-ipp	yes	no	no

Acknowledgments

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Geoff Toon, Debra Wunch, Paul Wennberg, Brian Connor