Zugspitze Raman lidar

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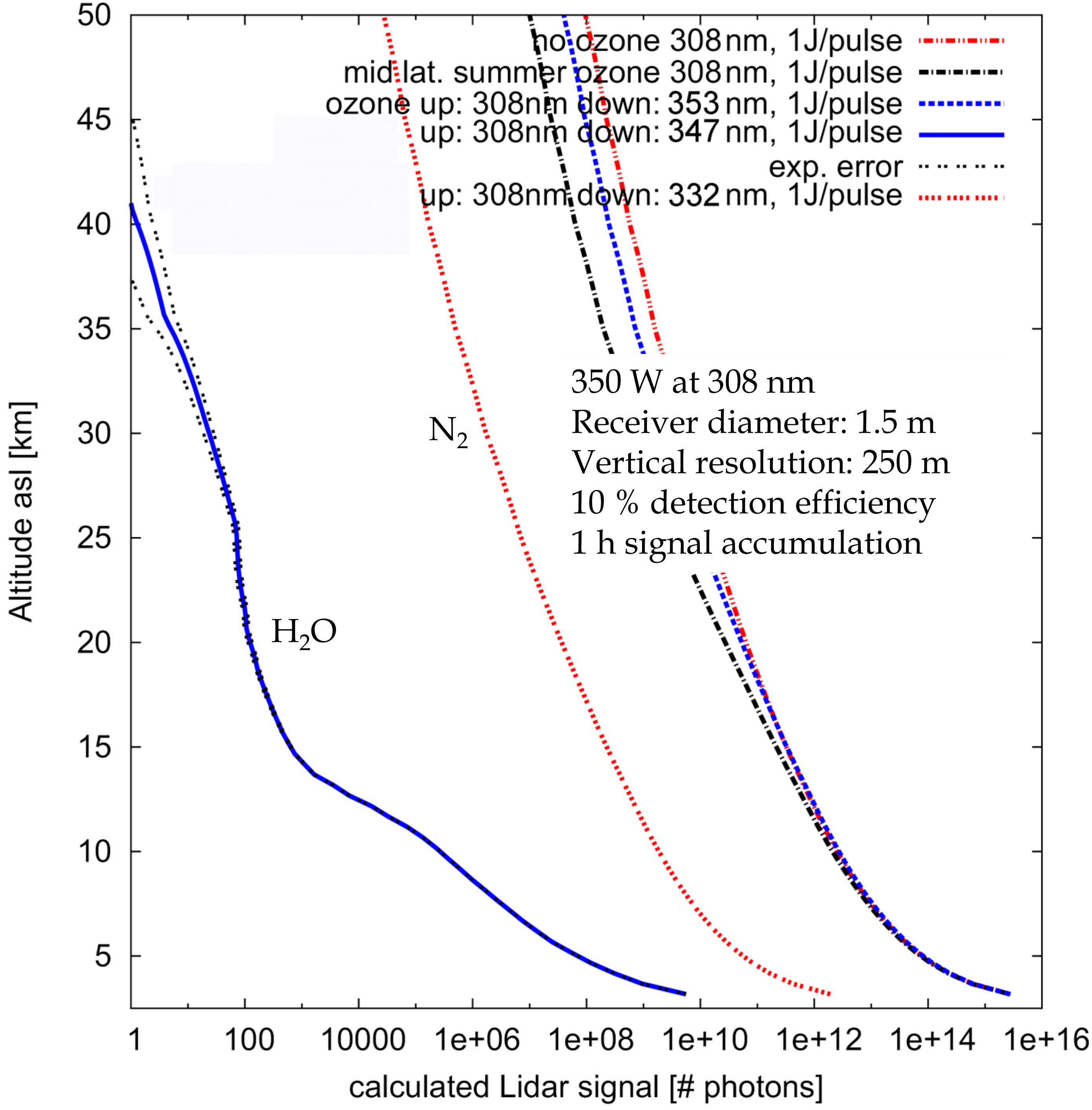
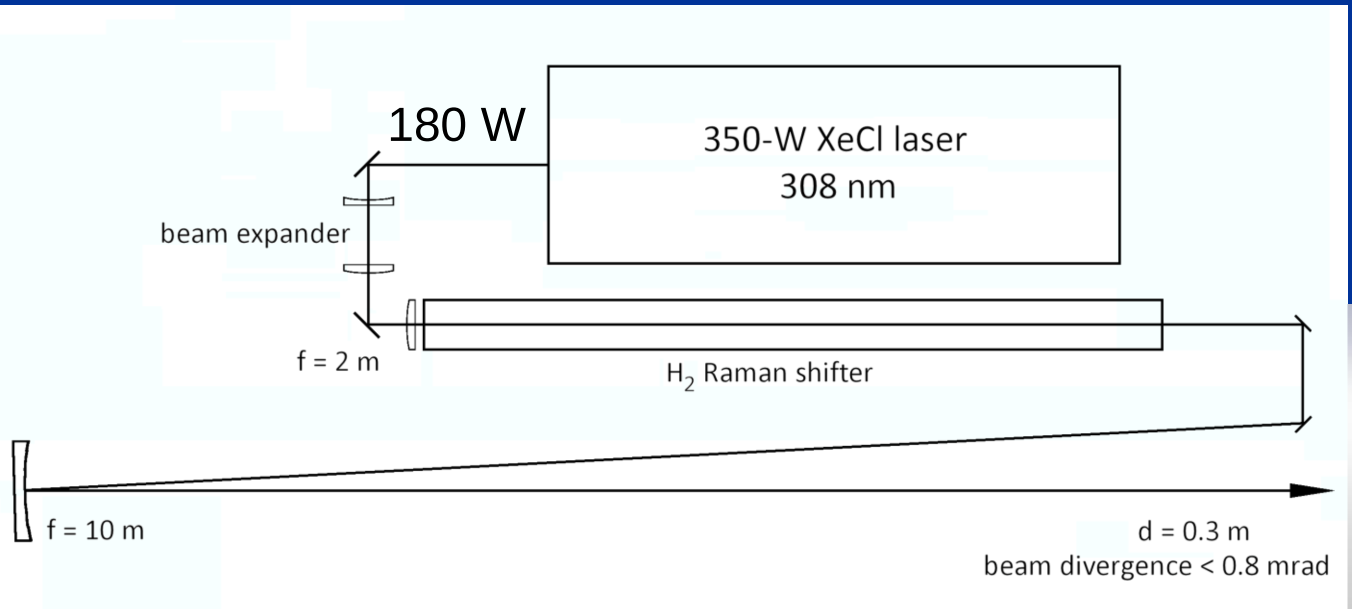
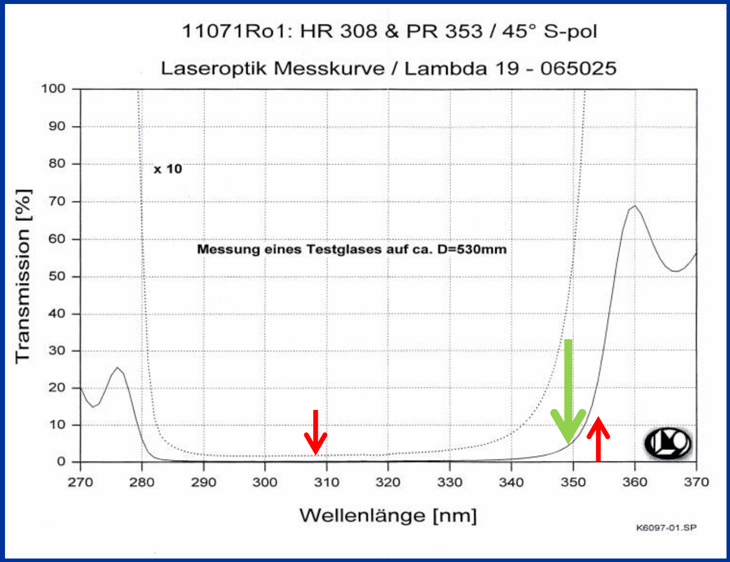
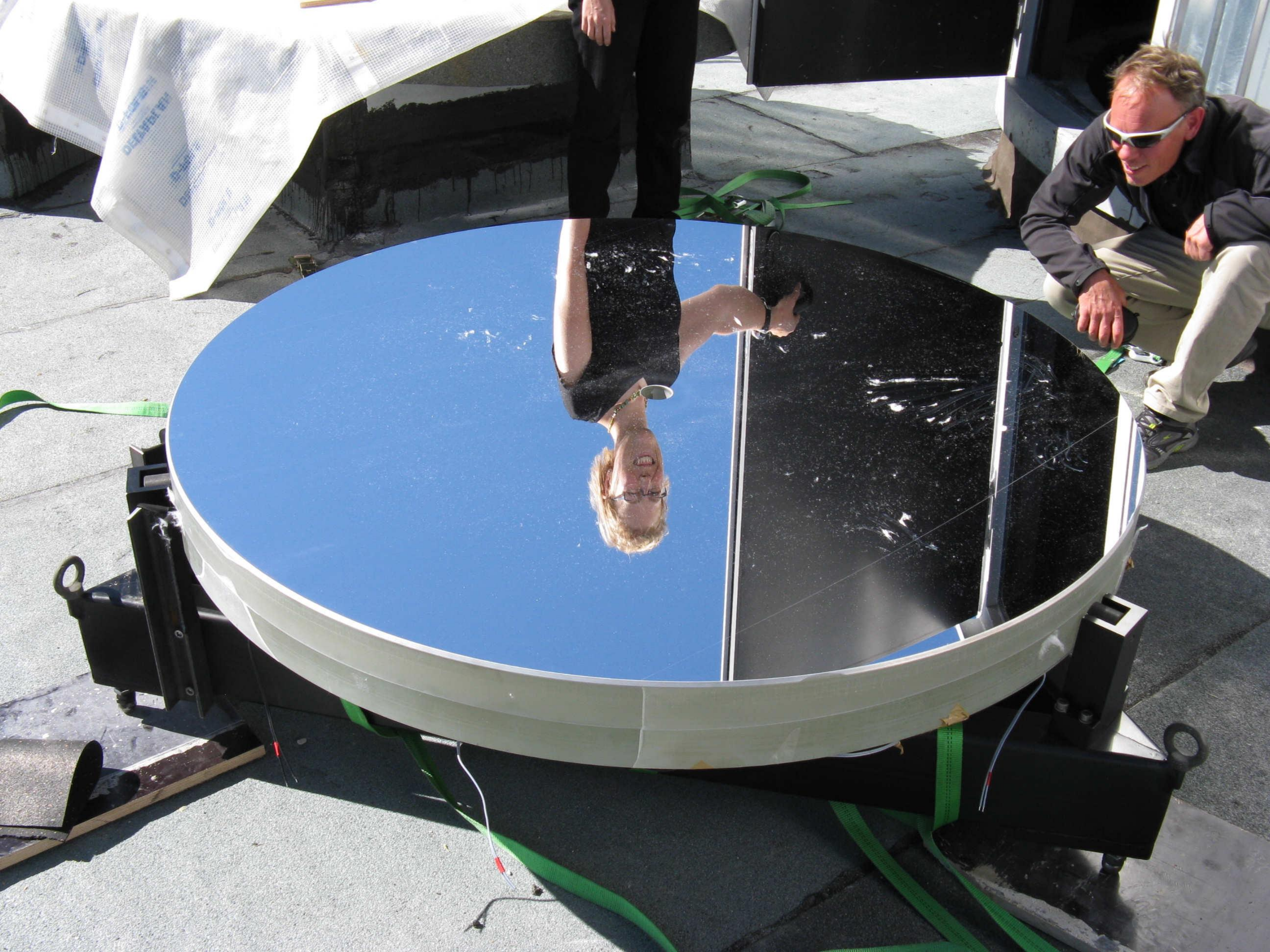


no ozone 308 nm, 1J/pulse
mid lat. summer ozone 308 nm, 1J/pulse
ozone up: 308nm down: 353 nm, 1J/pulse
up: 308nm down: 347 nm, 1J/pulse
exp. error
up: 308nm down: 332 nm, 1J/pulse
350 W at 308 nm
Receiver diameter: 1.5 m
Vertical resolution: 250 m
10 % detection efficiency
1 h signal accumulation
N2
H2O
Altitude asl [km]
calculated Lidar signal [# photons]
50
45
40
35
30
25
20
15
10
5
1
100
10000
1e+06
1e+08
1e+10
1e+12
1e+14
1e+16

Sendeteil des Raman-Lidars



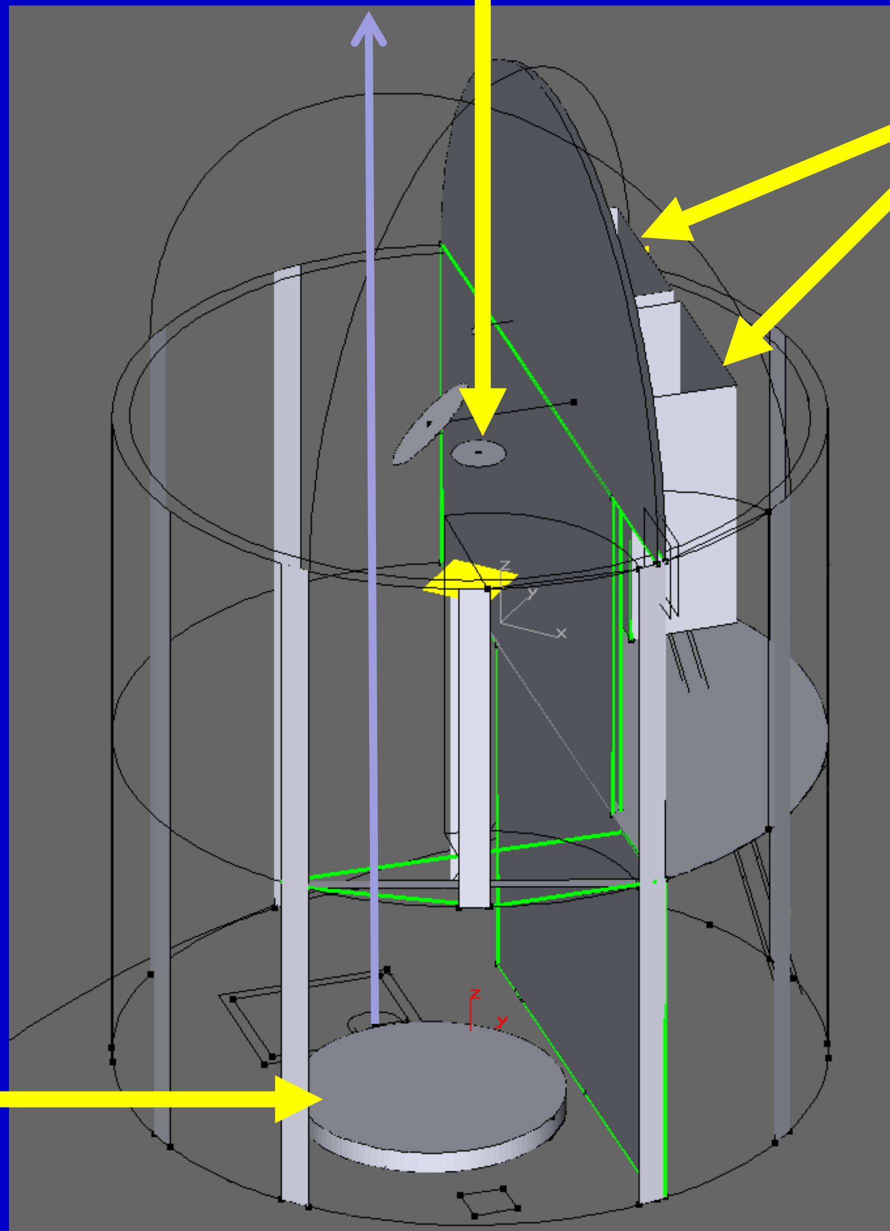




Near-field telescope: Mirror diameter 0.35 m

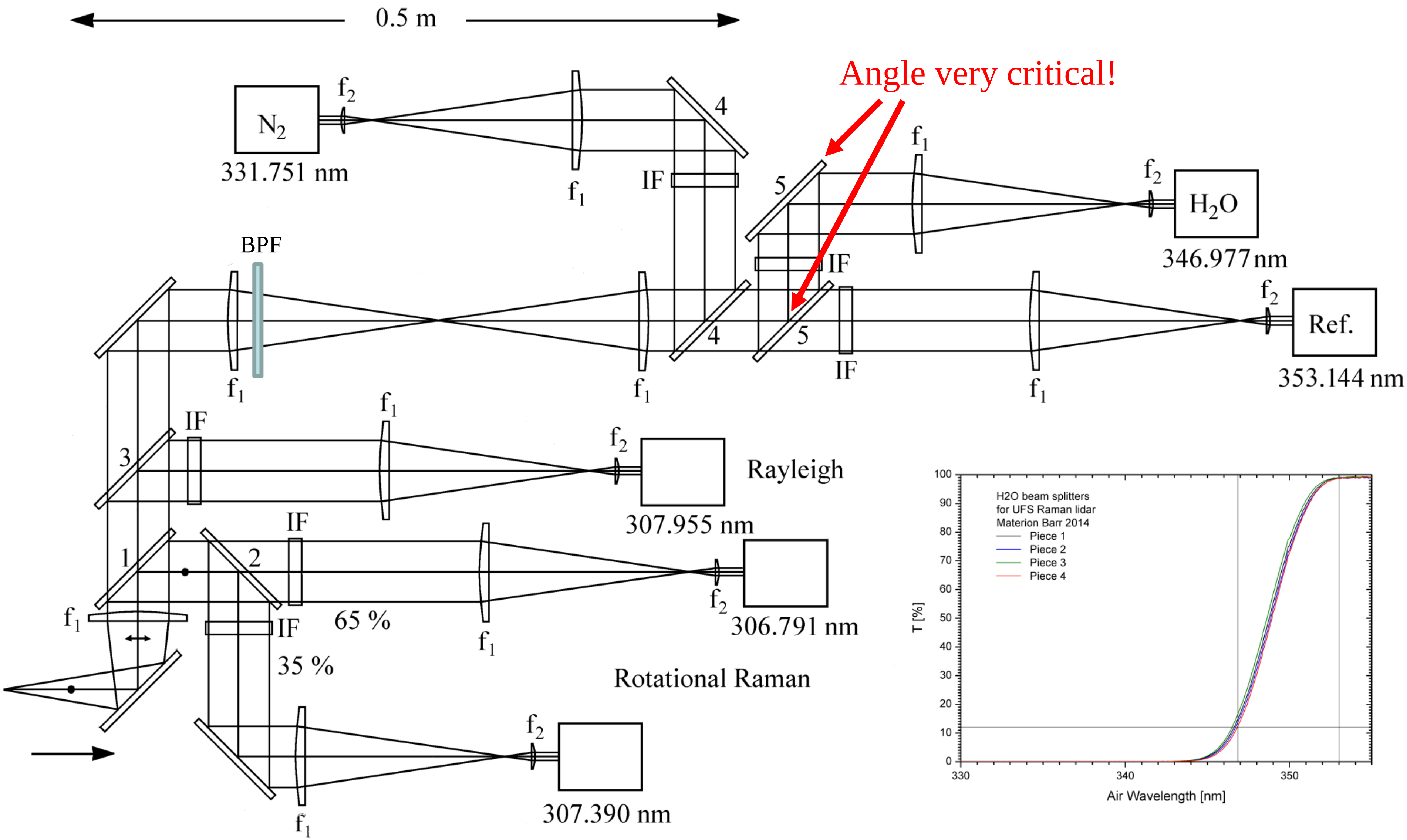
Laser beam

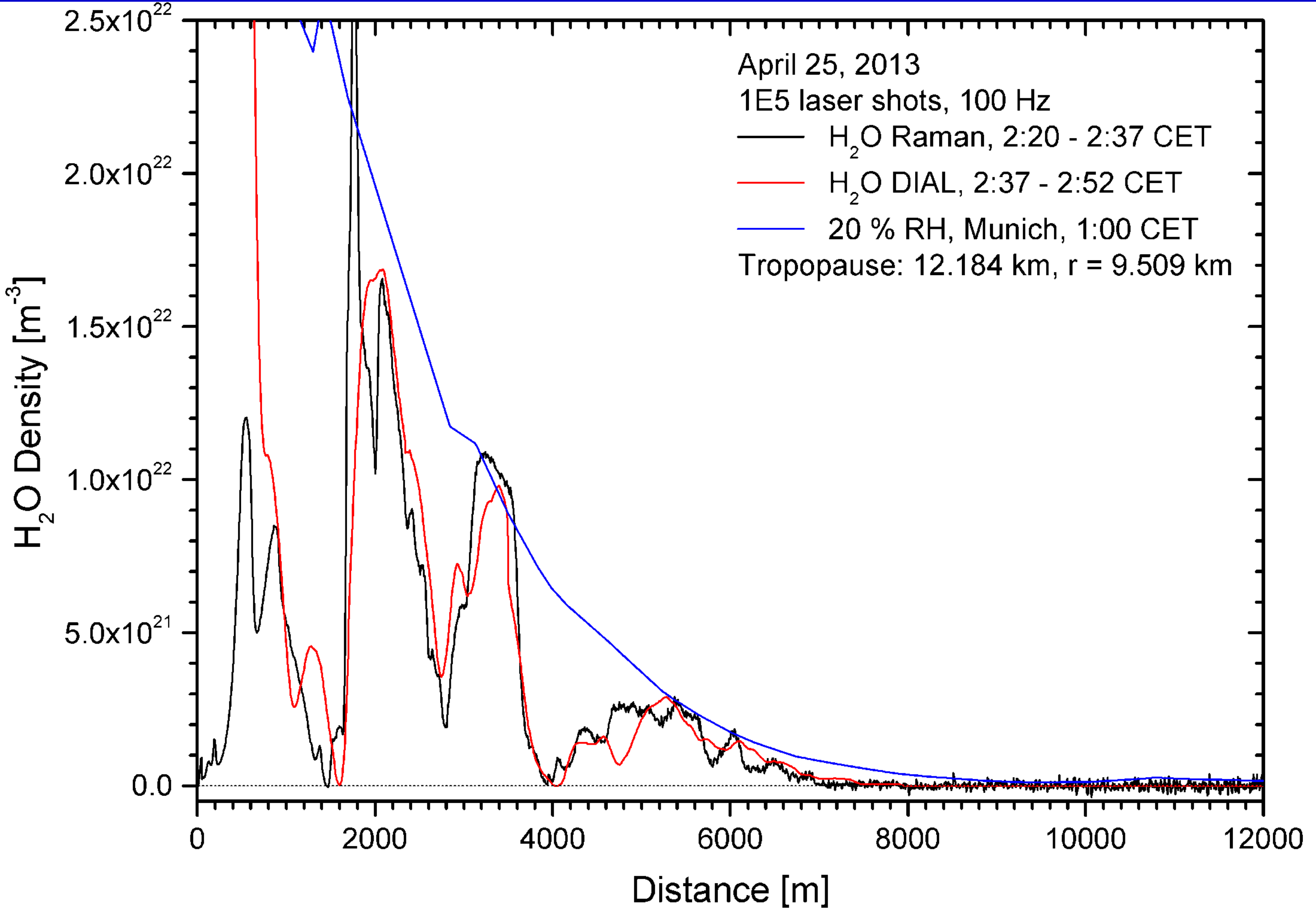
Polychromators

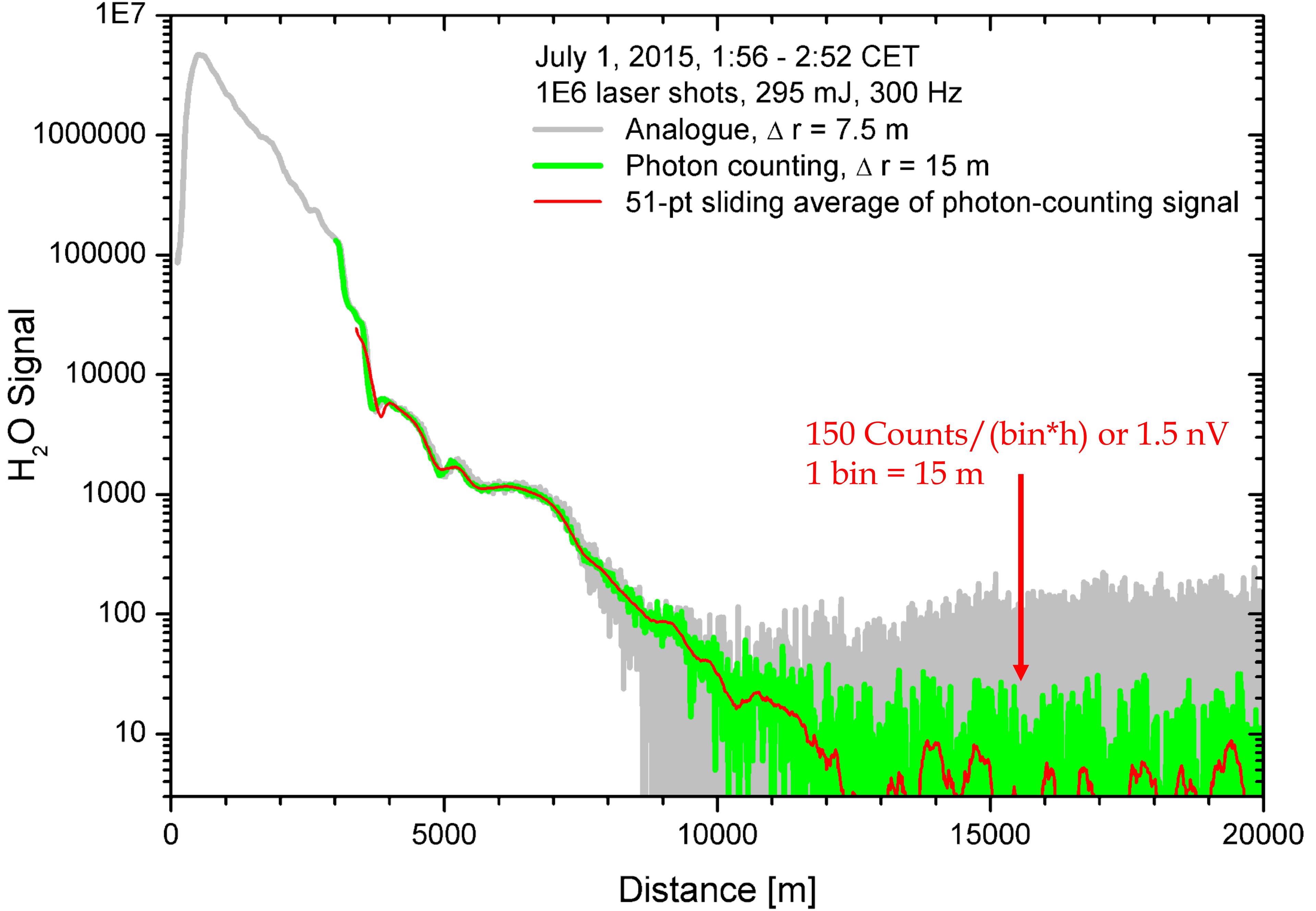


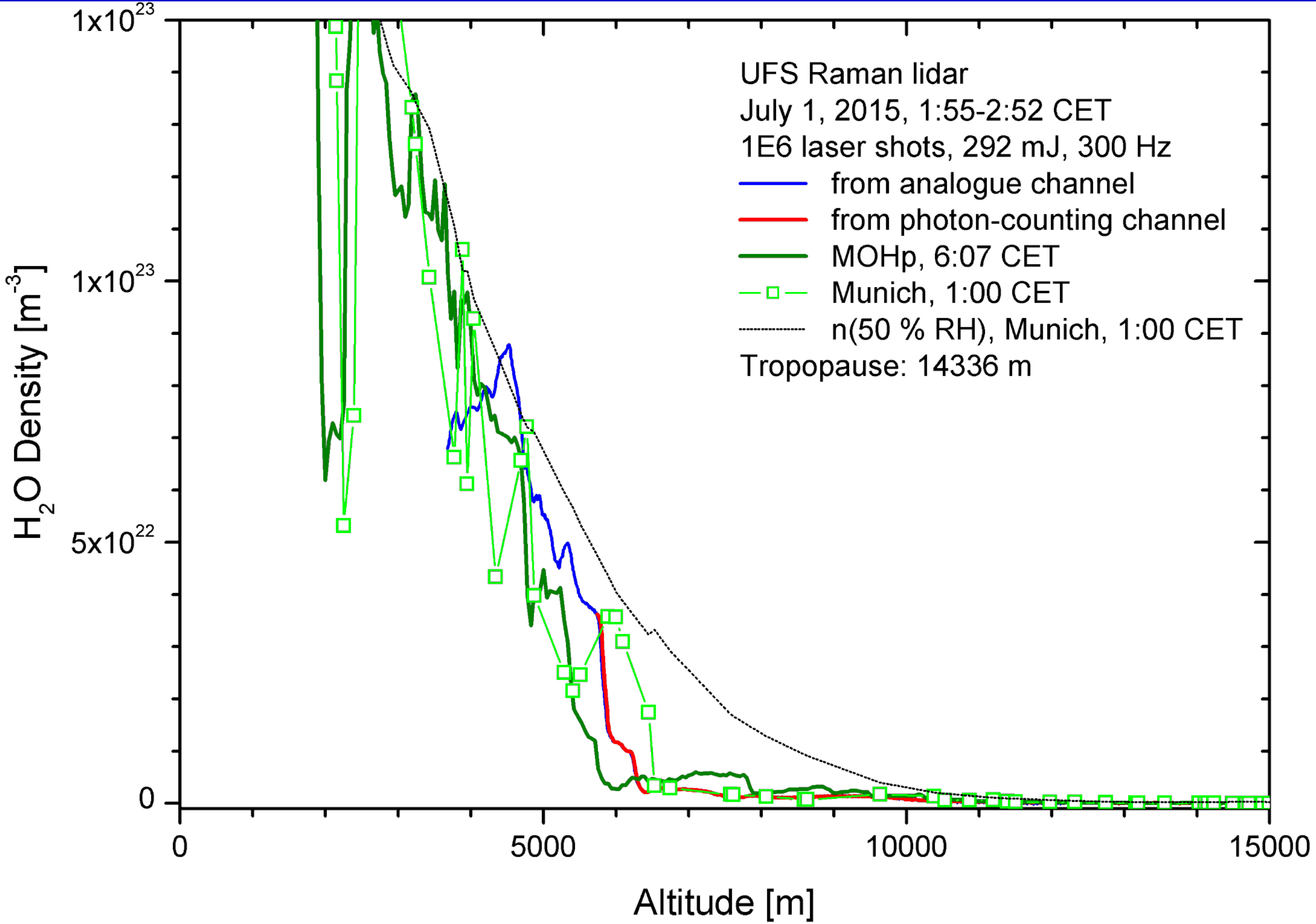
Far-field tele-
scope: Mirror
diameter 1.5 m

Polychromators

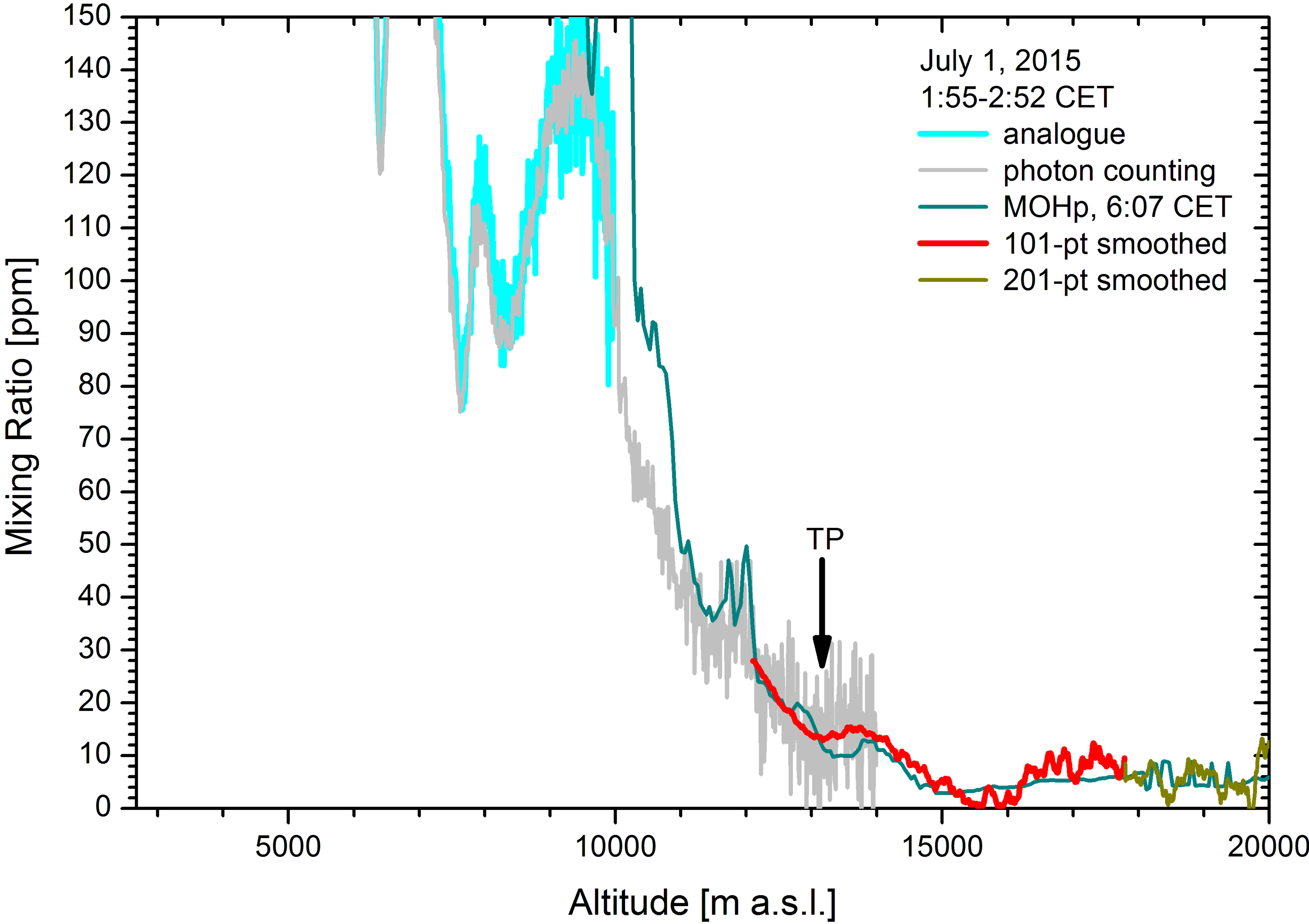



April 25, 2013
1E5 laser shots, 100 Hz
H2O Raman, 2:20 - 2:37 CET
H2O DIAL, 2:37 - 2:52 CET
20 % RH, Munich, 1:00 CET
Tropopause: 12.184 km, r = 9.509 km
H2O Density [m-3]
Distance [m]
2.5x10^22
2.0x10^22
1.5x10^22
1.0x10^22
5.0x10^21
0.0
0
2000
4000
6000
8000
10000
12000

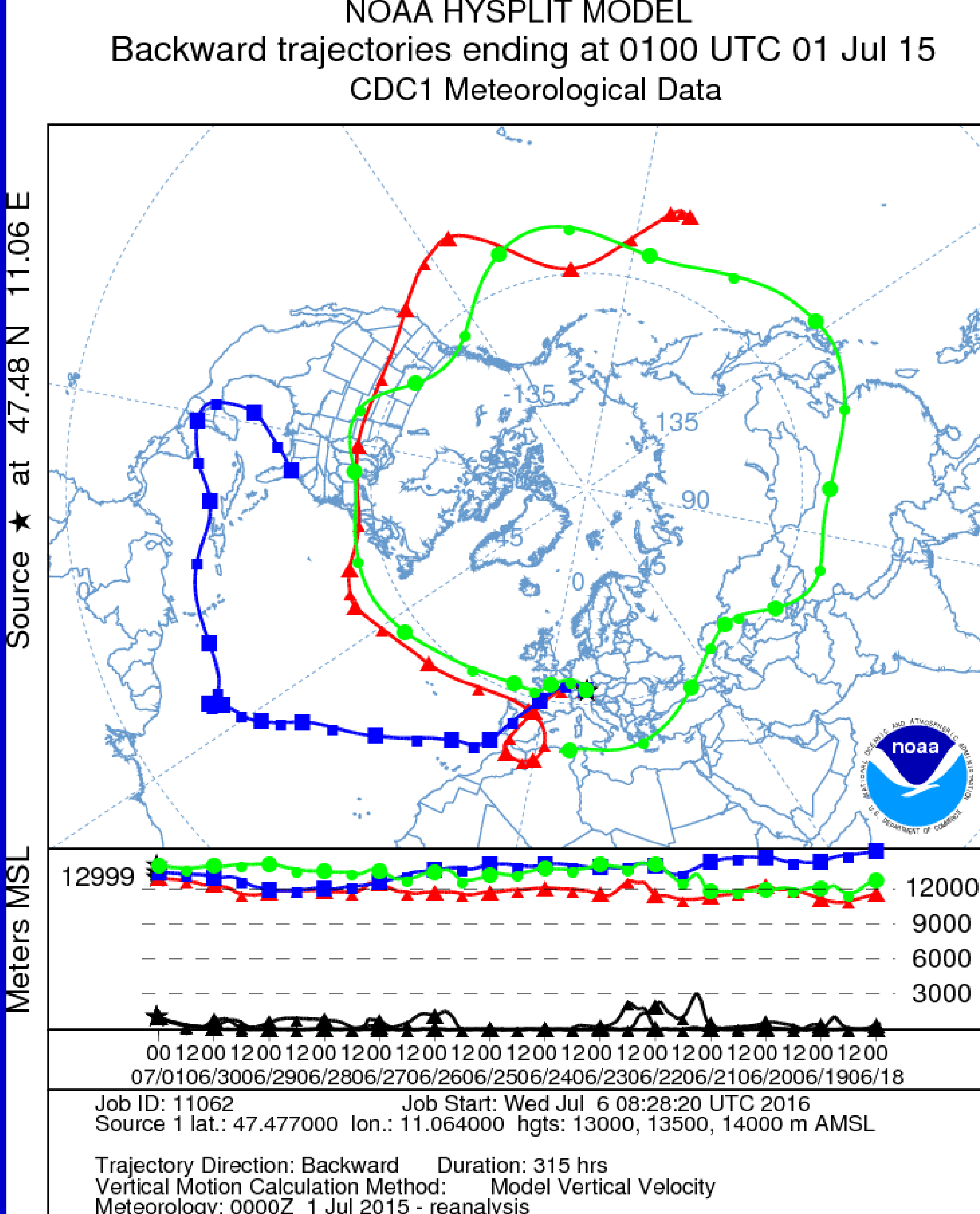

July 1, 2015, 1:56 - 2:52 CET
1E6 laser shots, 295 mJ, 300 Hz
Analogue, Δ r = 7.5 m
Photon counting, Δ r = 15 m
51-pt sliding average of photon-counting signal
150 Counts/(bin*h) or 1.5 nV
1 bin = 15 m
H_2O Signal
Distance [m]
1E7
1000000
100000
10000
1000
100
10
0
5000
10000
15000
20000

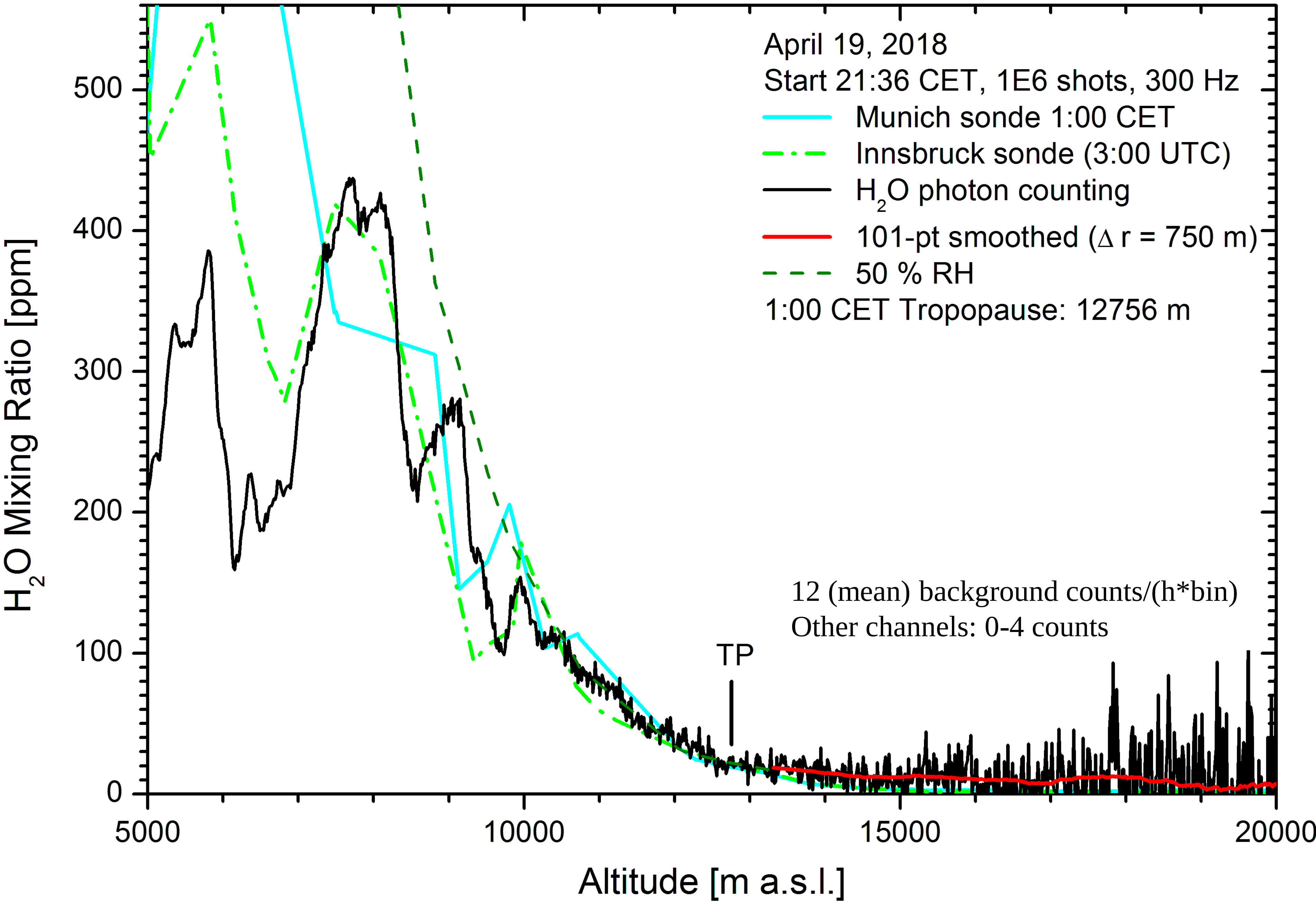


UFS Raman lidar
July 1, 2015, 1:55-2:52 CET
1E6 laser shots, 292 mJ, 300 Hz
from analogue channel
from photon-counting channel
MOHp, 6:07 CET
Munich, 1:00 CET
n(50 % RH), Munich, 1:00 CET
Tropopause: 14336 m
H_2O Density [m^{-3}]
Altitude [m]
1x10^23
1x10^23
5x10^22
0
0
5000
10000
15000

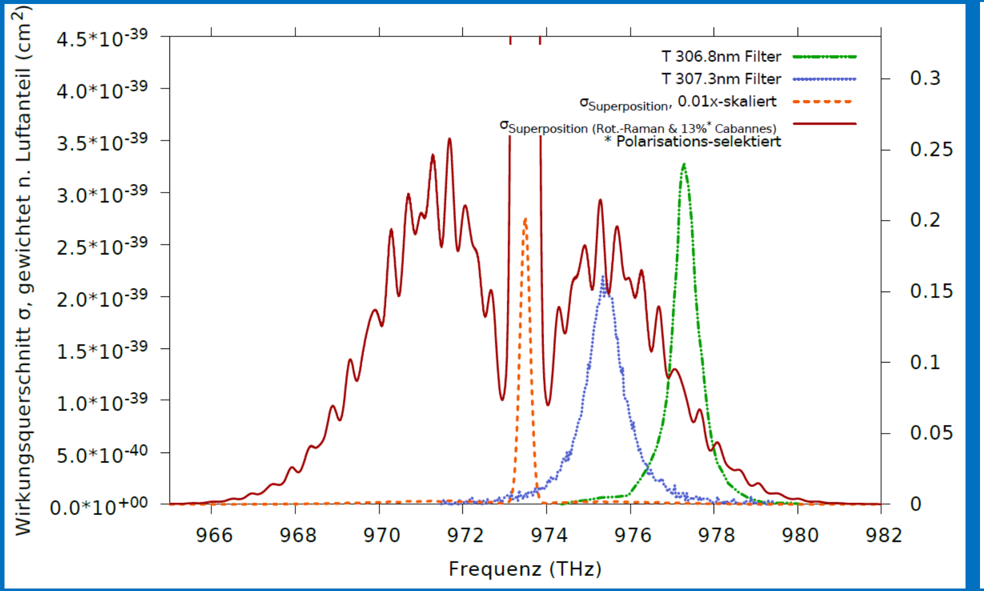


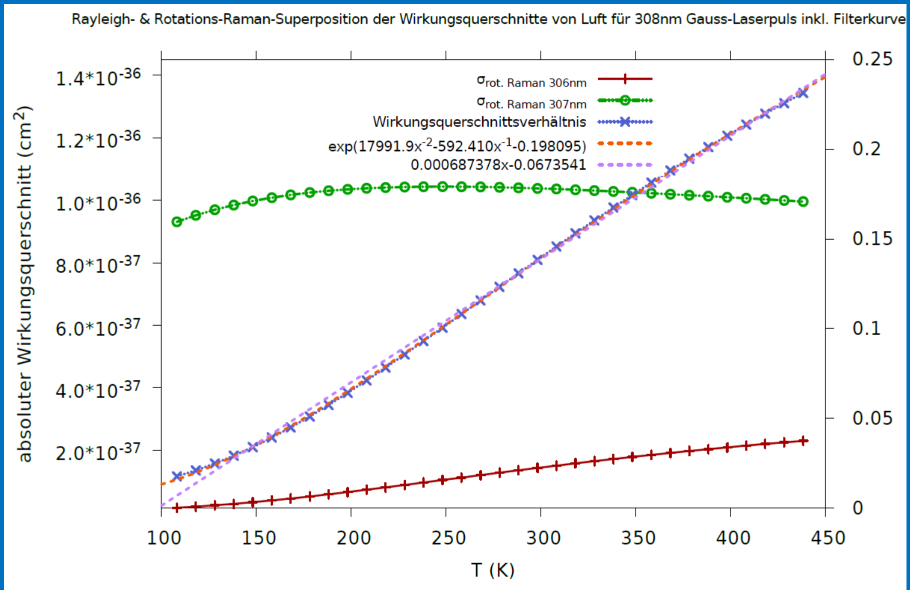
July 1, 2015
1:55-2:52 CET
analogue
photon counting
MOHp, 6:07 CET
101-pt smoothed
201-pt smoothed
TP
Mixing Ratio [ppm]
Altitude [m a.s.l.]
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
5000
10000
15000
20000


NOAA HYSPLIT MODEL
Backward trajectories ending at 0100 UTC 01 Jul 15
CDC1 Meteorological Data
Source ★ at 47.48 N 11.06 E
-135
135
90
45
0
noaa
Meters MSL
12999
12000
9000
6000
3000
00 12 00 12 00 12 00 12 00 12 00 12 00 12 00 12 00 12 00 12 00 12 00 12 00 12 00 12 00
07/01 06/30 06/29 06/28 06/27 06/26 06/25 06/24 06/23 06/22 06/21 06/20 06/19 06/18
Job ID: 11062
Job Start: Wed Jul 6 08:28:20 UTC 2016
Source 1 lat.: 47.477000 lon.: 11.064000 hgts: 13000, 13500, 14000 m AMSL
Trajectory Direction: Backward
Duration: 315 hrs
Vertical Motion Calculation Method: Model Vertical Velocity
Meteorology: 0000Z 1 Jul 2015 - reanalysis

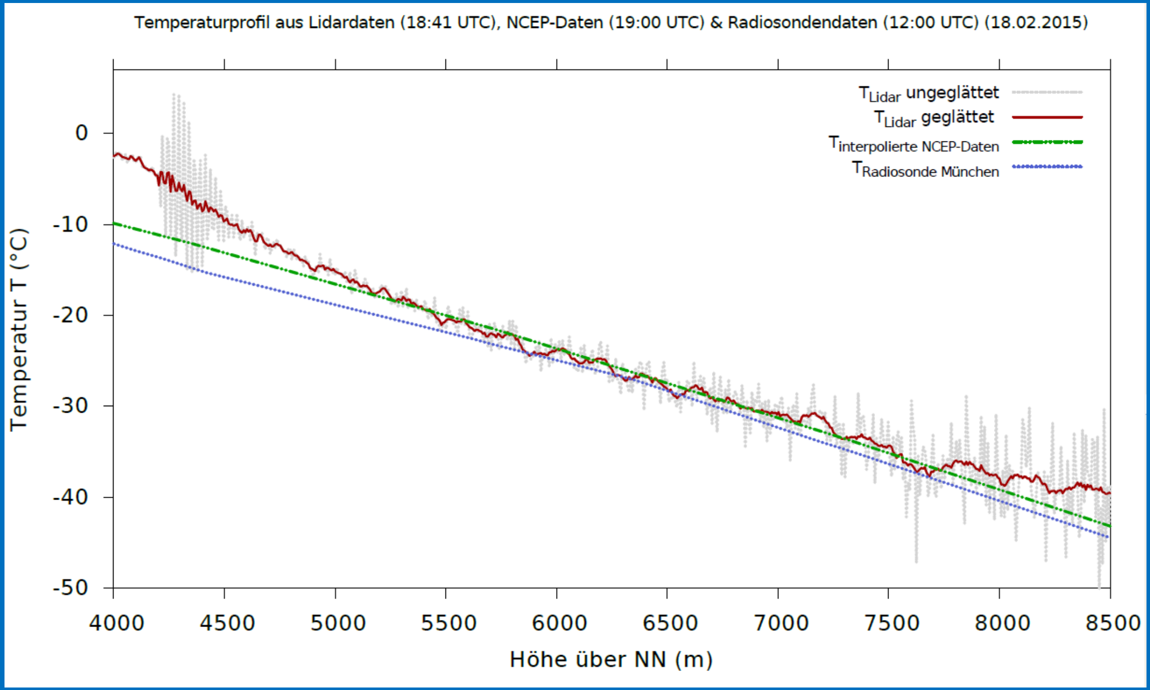

April 19, 2018
Start 21:36 CET, 1E6 shots, 300 Hz
Munich sonde 1:00 CET
Innsbruck sonde (3:00 UTC)
H2O photon counting
101-pt smoothed (Δ r = 750 m)
50 % RH
1:00 CET Tropopause: 12756 m
12 (mean) background counts/(h*bin)
Other channels: 0-4 counts
TP
H2O Mixing Ratio [ppm]
Altitude [m a.s.l.]
0
100
200
300
400
500
5000
10000
15000
20000

Temperature (rotational Raman scattering)

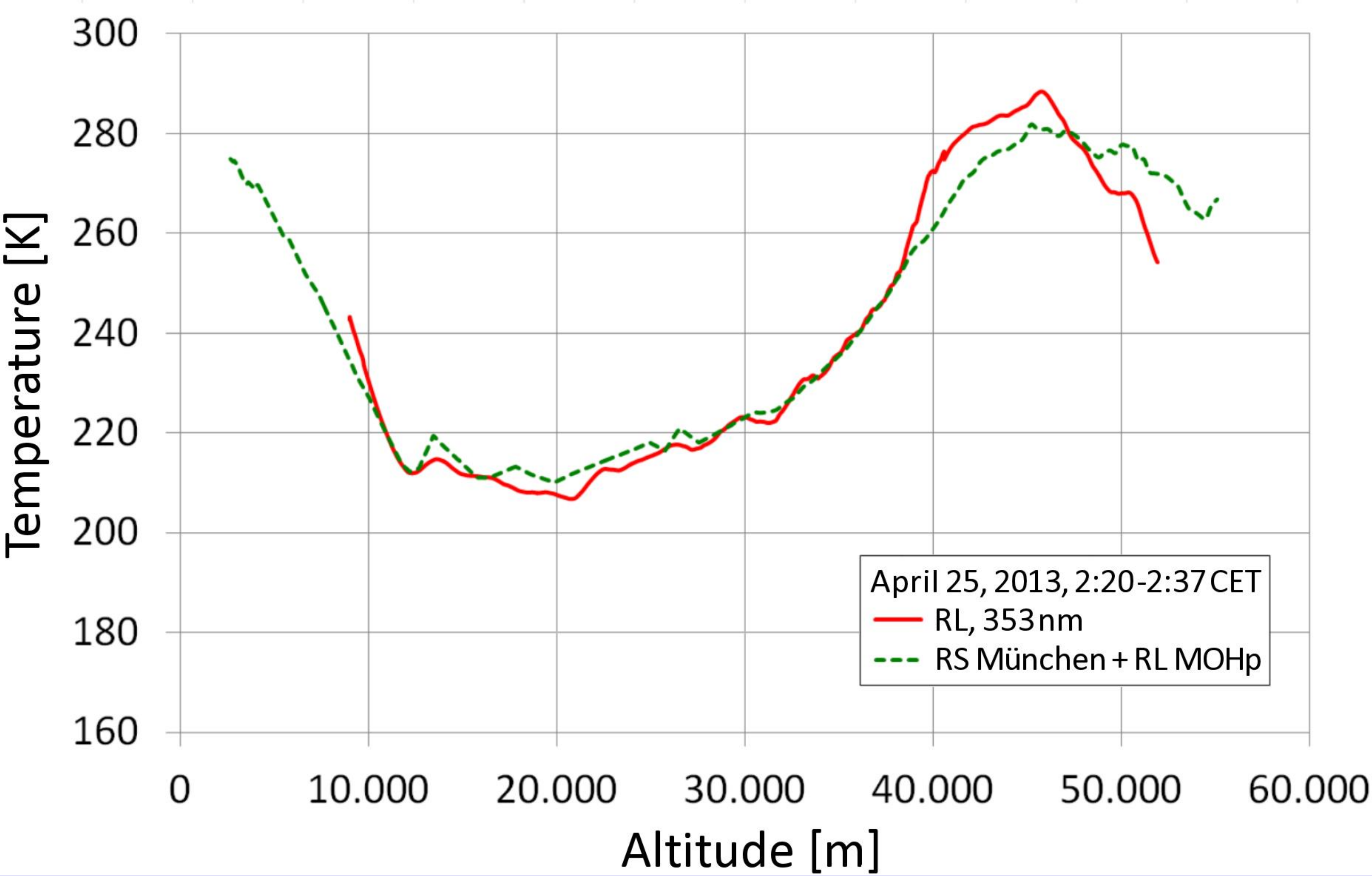




K. Höveler



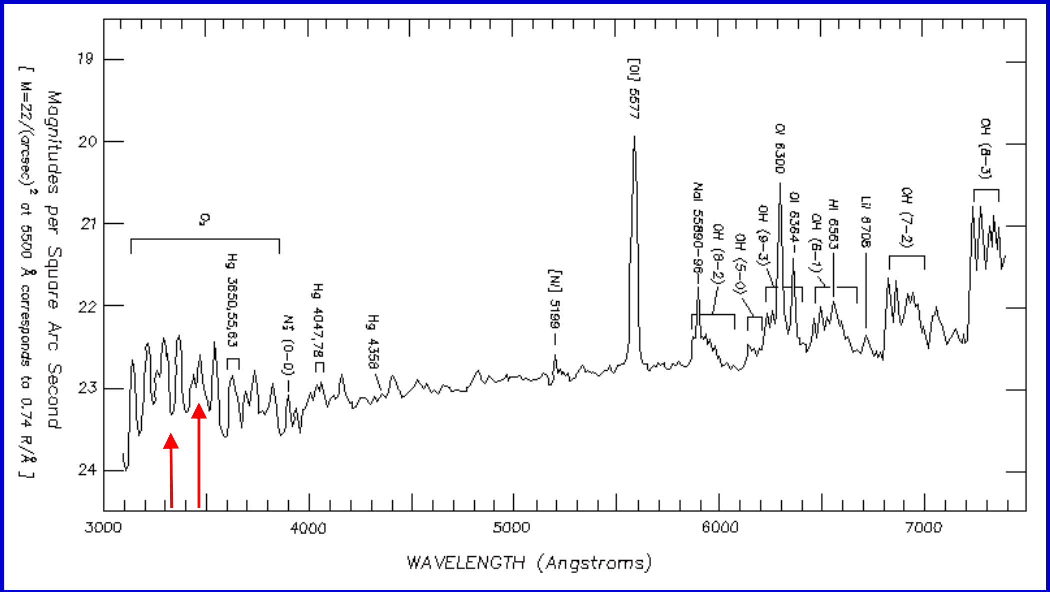
Cut off at 55 km, 1E5 shots only, low power at 353 nm



Better than 308 nm or 332 nm; for 308 nm chopper needed!

Next steps:

1. Reduce 347-nm background (see figure)
2. Solve thermal problems with laser (180 W): Active stabilization
3. Use 355 nm from PL8020 (former pump laser of DIAL): stable performance at 300 mJ (20 Hz), pulses delayed with respect to Lambda SX, more robust wavelength separation (347 nm → 355 nm instead of → 353 nm) and, thus, constant H_2O signal
4. New polychromator layout for this purpose



Sky light Mauna Kea