



# Standoff-detection of pollutants using tunable infrared lasers

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# Motivation

1. Military materials (TNT, DNT, MNT, RDX, TNB, trotil, pentril, bromanil)
2. Nitrocompounds, chinons
3. VOC's – organic compaunds
4. Transport, industry polutants (nitrogen, sulphur compounds, CO, CO<sub>2</sub>)

# Problems of stand-off measurements

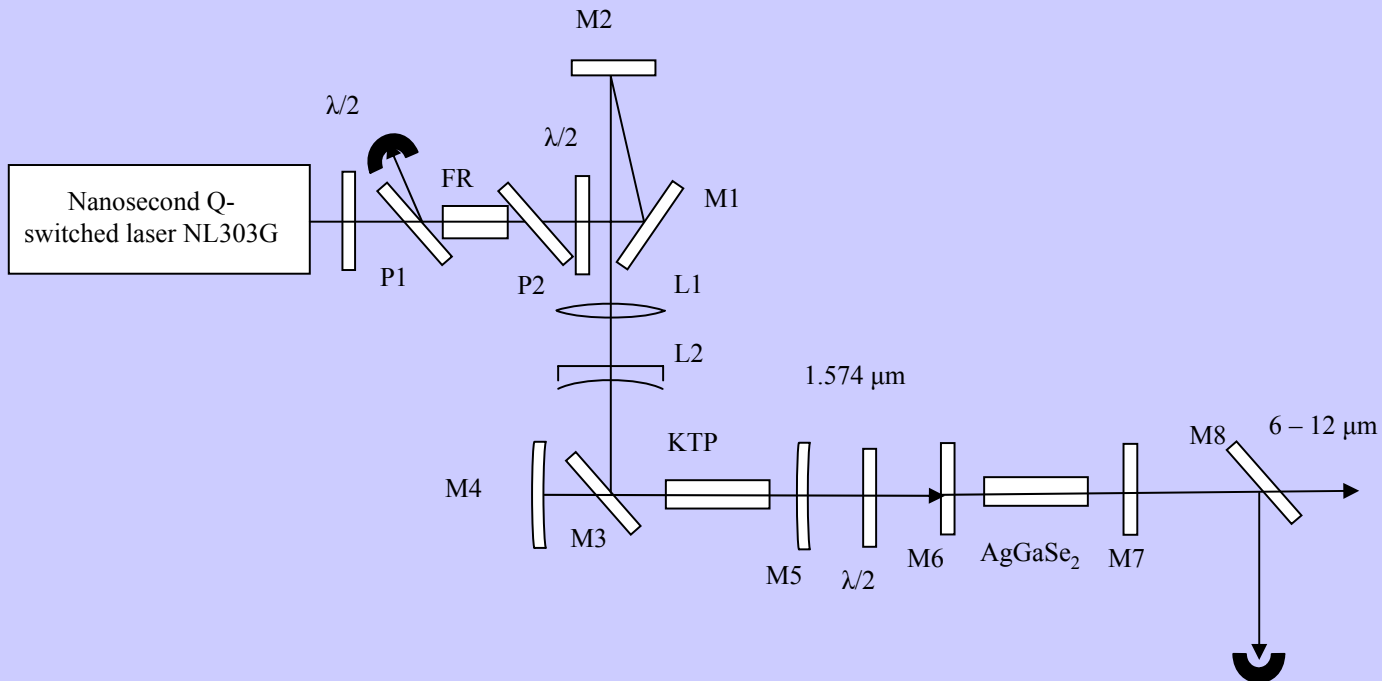
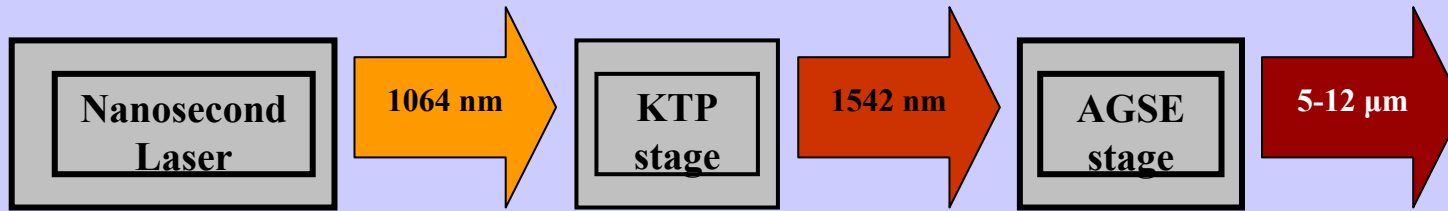
- Exclusion of interferences
- Turbulence of atmosphere
- Line position  $\nu$ , strength  $\sigma$ , linewidth  $\Delta\nu$ , spectral broadening,  $T^\circ$  dependence
- IR sources and detectors

# Infrared sources

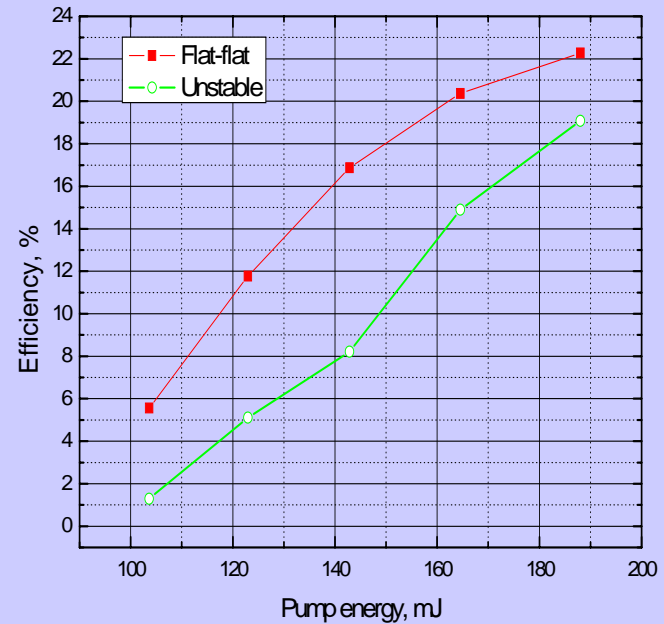
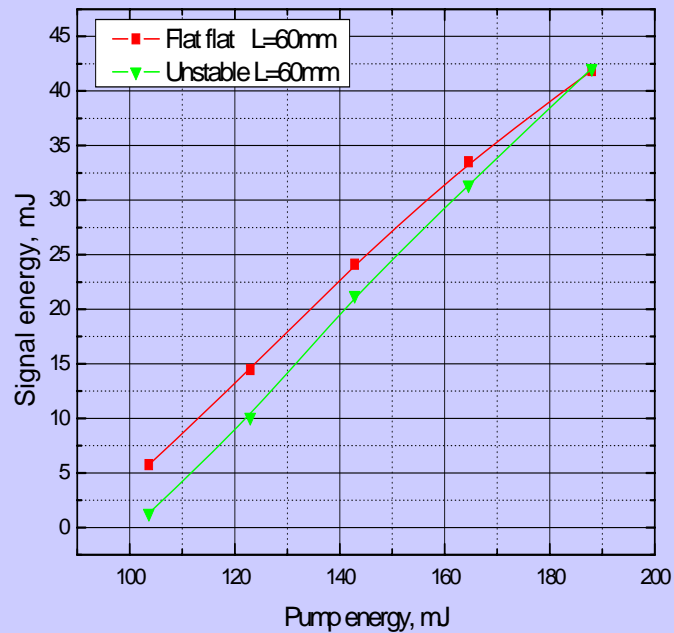
## Requirements:

- Wide spectral range
- Continuously tunable
- High power
- Narrow spectral linewidth
- Long time of operation
- Small, economical
- Low price

# Optical layout of cascade mid-IR OPO

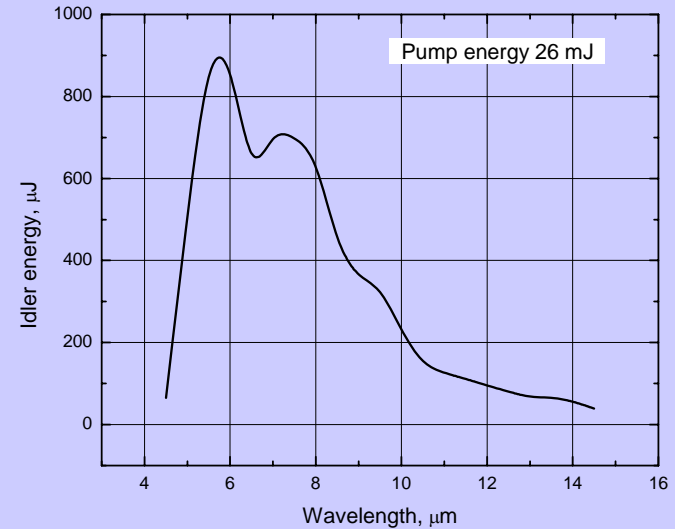
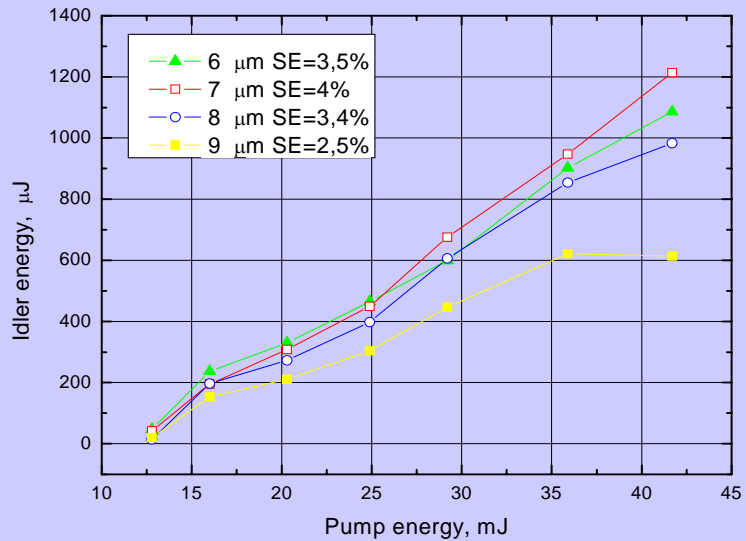


# KTP OPO parameters



- KTP (5x5x25 mm<sup>3</sup>) nonlinear crystal (EKSMA, Ltd)
- Pump up to 500mJ (3-6)ns @1064nm
- 45mJ after I KTP stage @1.57 $\mu$ m

# AgGaSe<sub>2</sub> OPO parameters

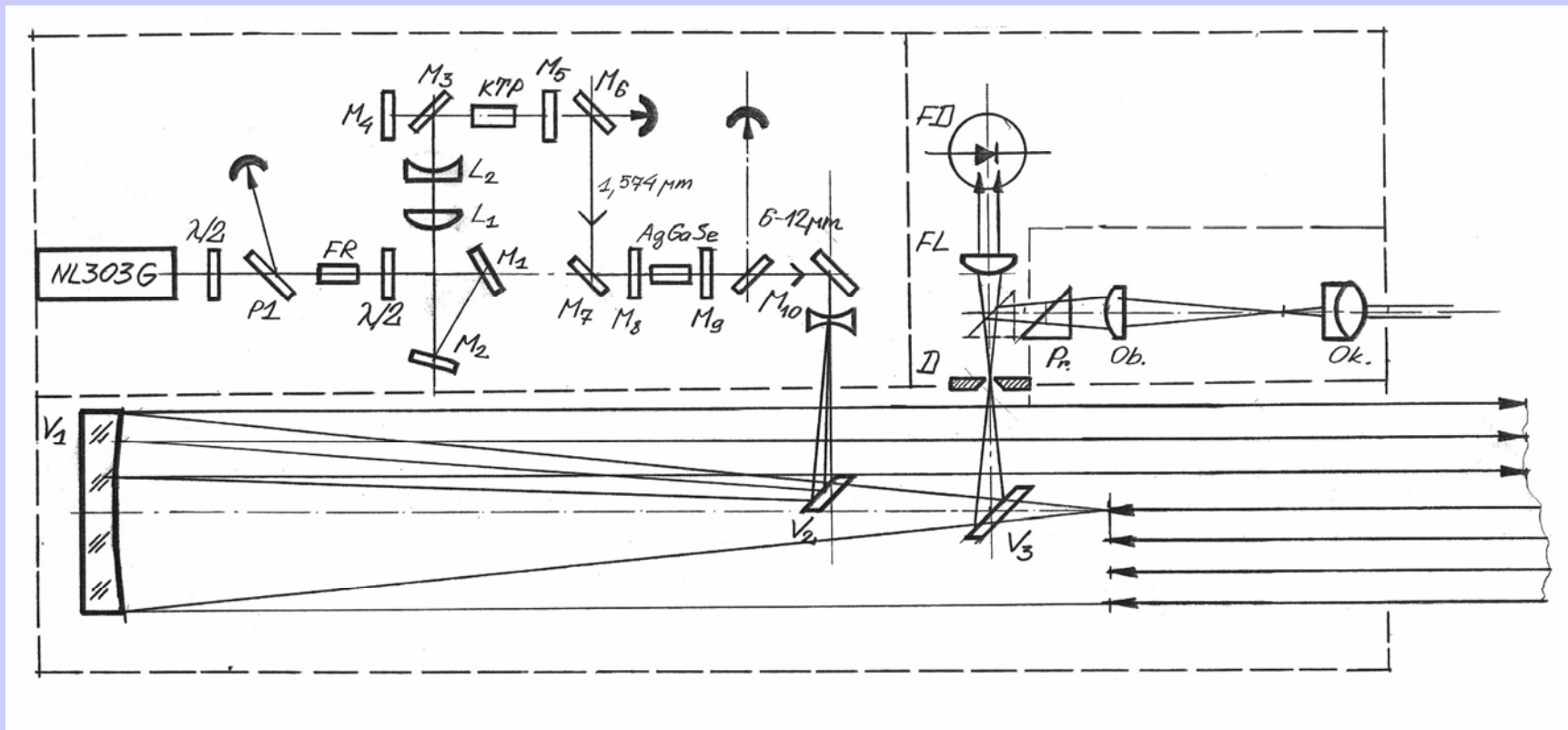


- No crystal damage during long term operation at  $>20$  MW/cm<sup>2</sup>.

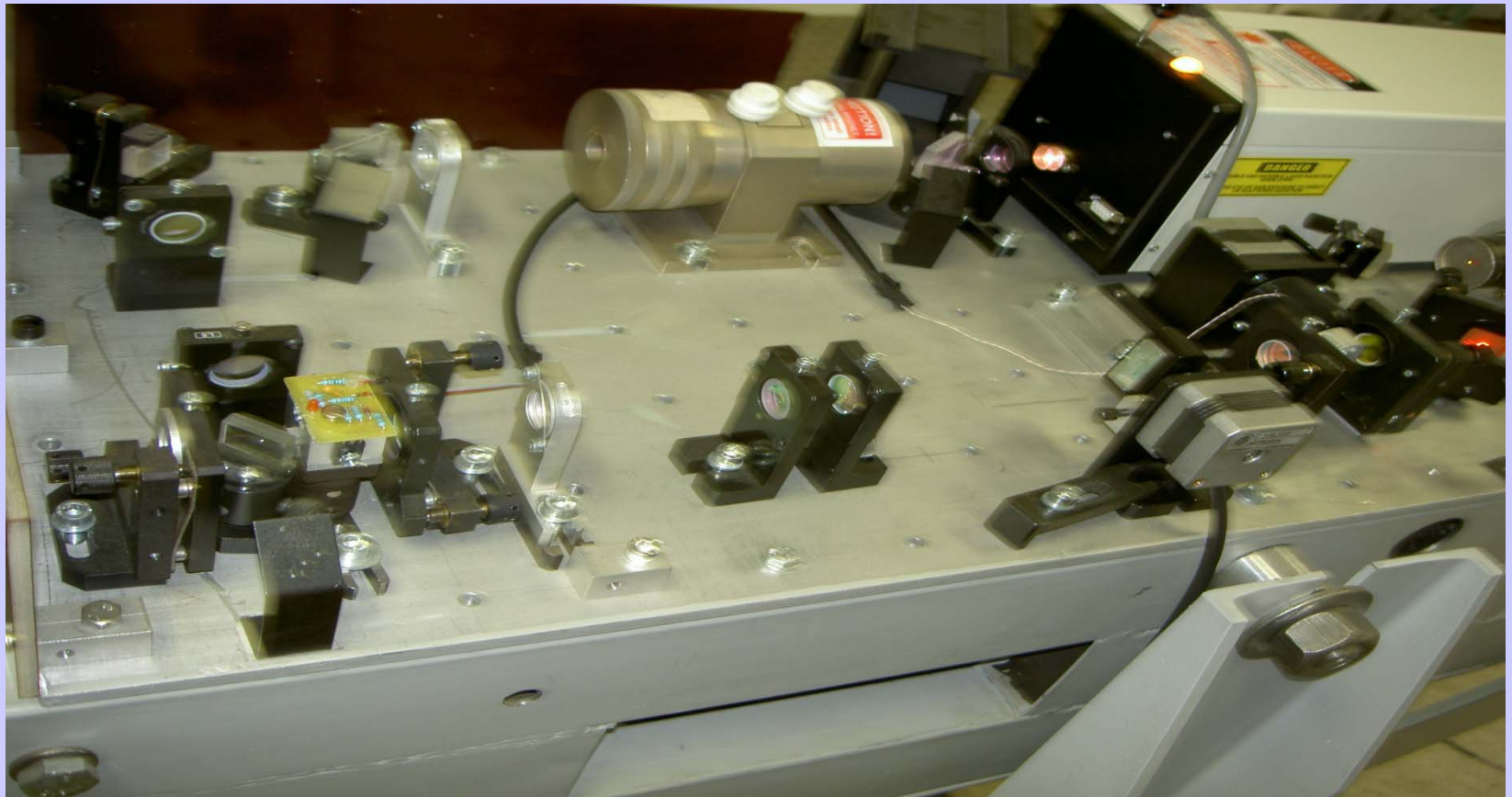
# MIR OPO technical parameters

- MIR spectral range 6 – 12  $\mu\text{m}$
- NIR spectral range (0.72-1.9  $\mu\text{m}$ )
- Pulse energy (0.2÷1.1) mJ, peak at 7.3 $\mu\text{m}$
- Spectral bandwidth 5  $\text{cm}^{-1}$  at 9  $\mu\text{m}$
- Pulse duration 5 ns
- Repetition rate 10 Hz

# IR DIAL system



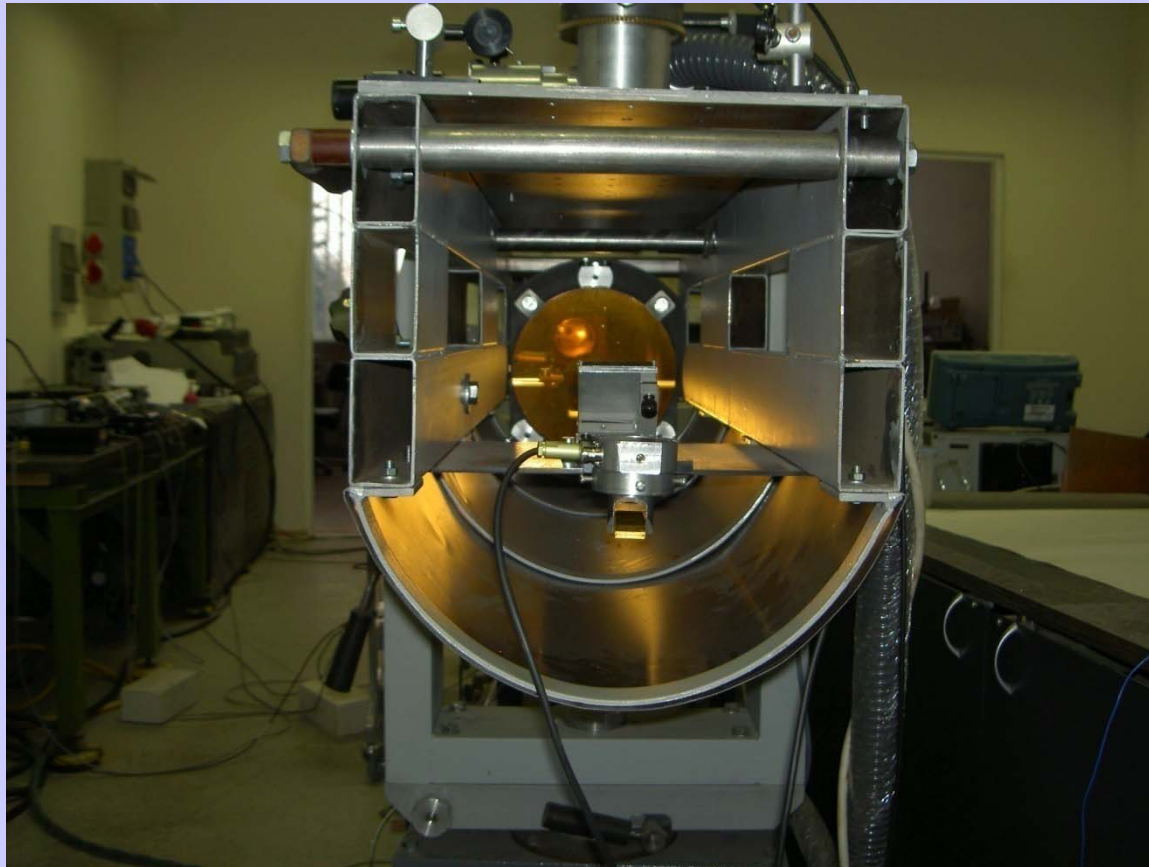
# Optomechanical configuration (continued)



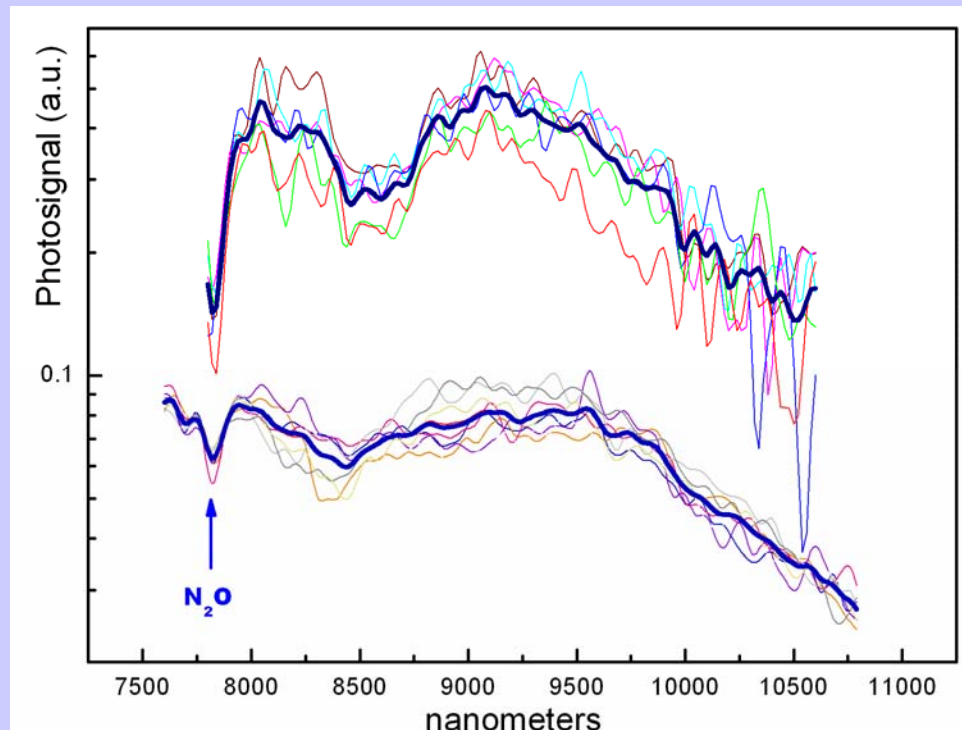
# Construction of lidar



# Construction of lidar (continued)

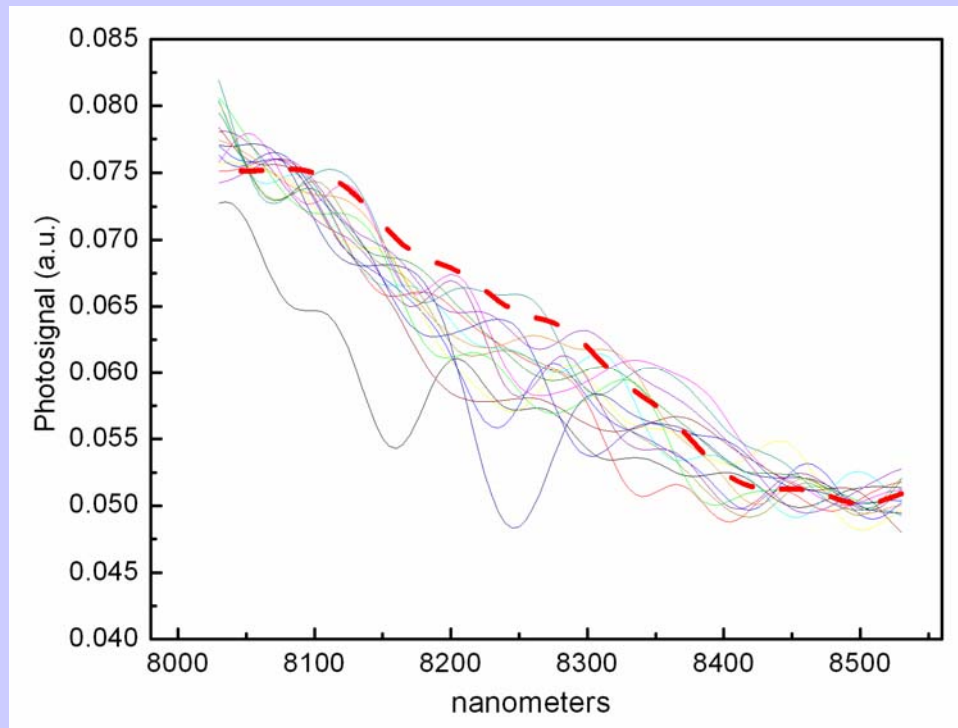


# 140m and 1km atmospheric spectra



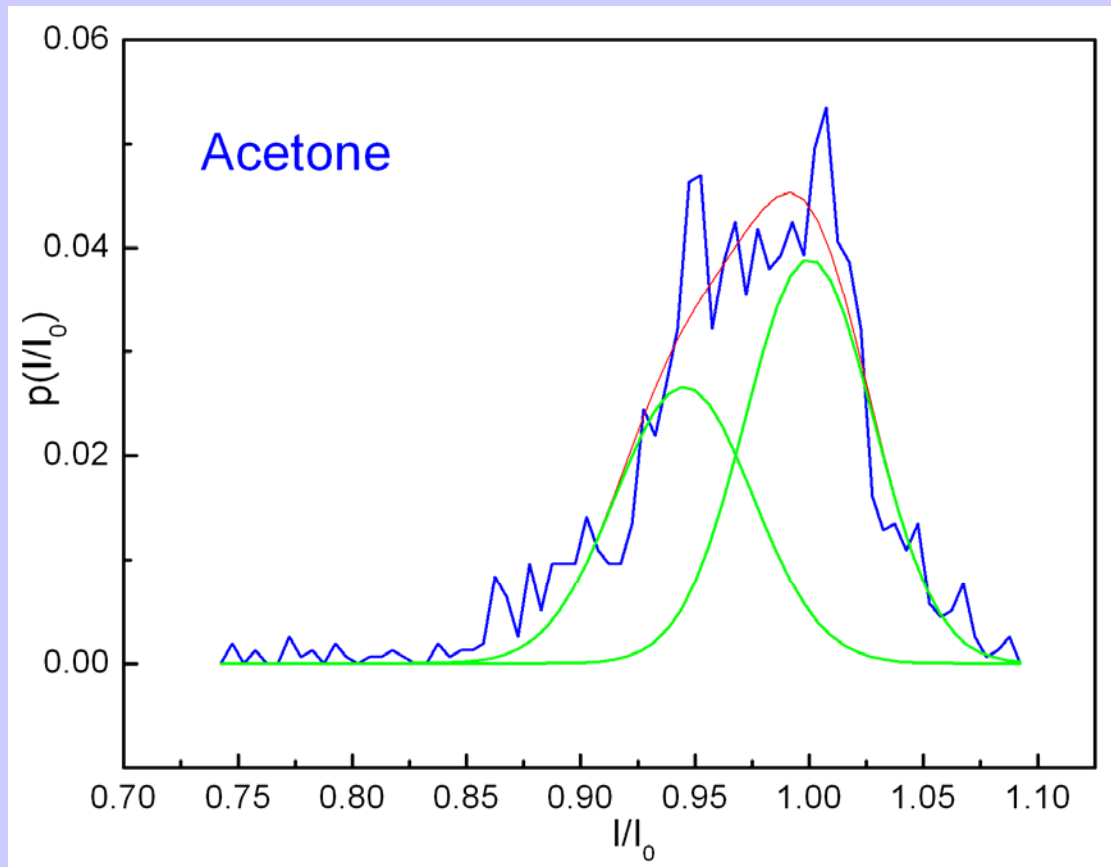
7840nm –  $N_2O$

# Acetone

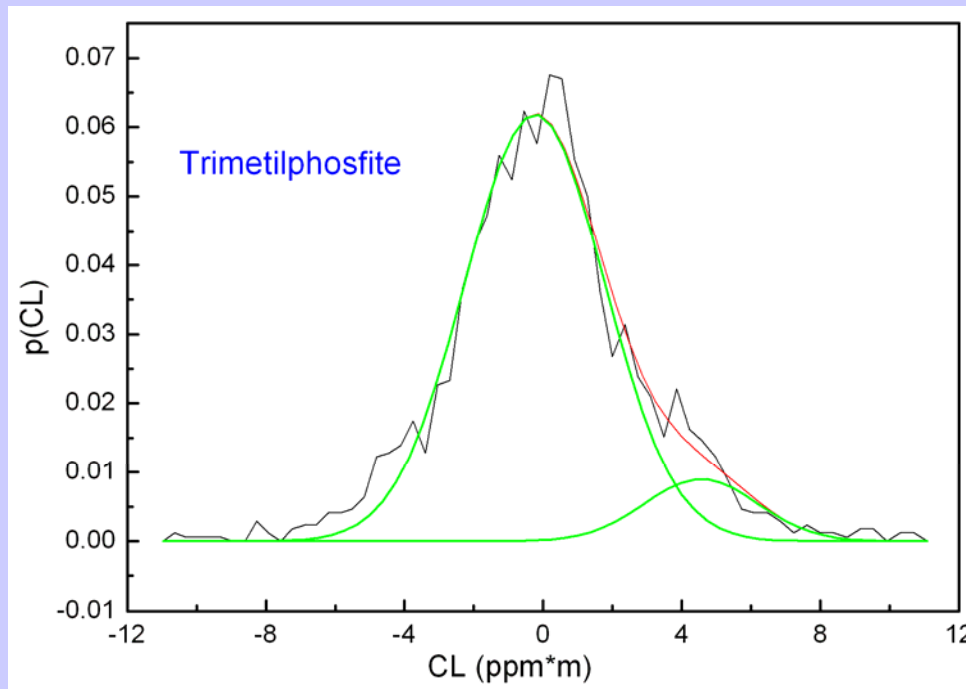


16 scans+ Fourier filtration  
Red-no gas (averaged spectrum)

# Acetone



# Trimetilphosphite



Trimetilphosphite-simulant of tactical gases

$CL=0$  – no gas,  $CL=4,6$  ppm\*m – gas

Noise dispersion halfwidth  $\pm 2,1$  ppm\*m

Detection treshold - 6,3 ppm\*m

# Future plans

- Diode pumped kHz frequency laser
- Flexible software and hardware for exclusion of gas interferences
- Expeditions in the “hot” regions