



Urban application of the AOTF-based NO₂ camera

Cedric Busschots, Pierre Gramme, Noel C. Baker, Emmanuel Dekemper, Stefano Casadio, Anna Maria Iannarelli, Nicola Ferrante, Gabriele Mevi, Giacomo Gostinicchi, Annalisa Di Bernardino, Jurgen Vanhamel, Paolo Pettinari, Elisa Castelli, Andre' Achilli, Giampietro Casasanta, Luca di Liberto, Francesco Cairo, Mauro Montagnoli, Giulio Esposito, Cristiana Bassani, Manuel Roca, Axel Kreuter

IDEAS-QA4EO



ROYAL BELGIAN INSTITUTE FOR
SPACE AERONOMY



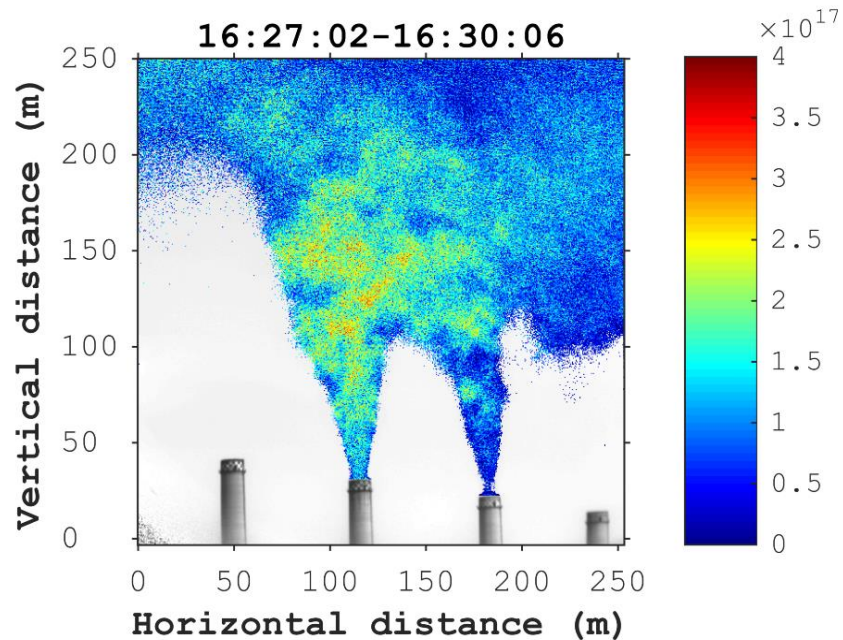
The NO₂ camera



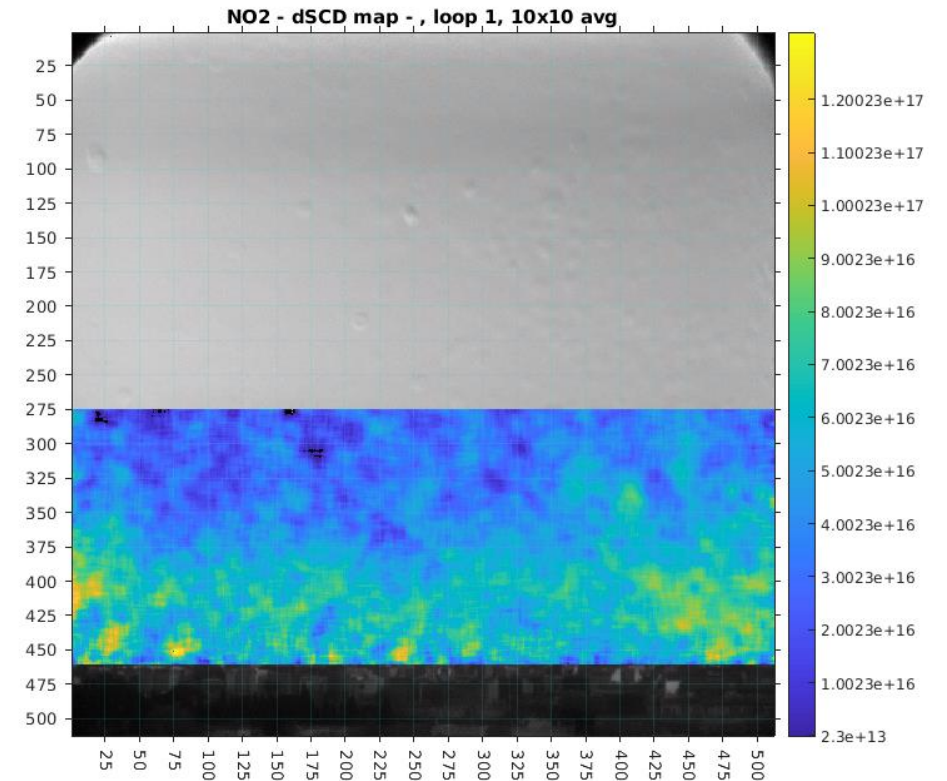
The NO₂ camera is an imager

Why?

Show dynamic effects



Dekemper, et al., AMT, 2016

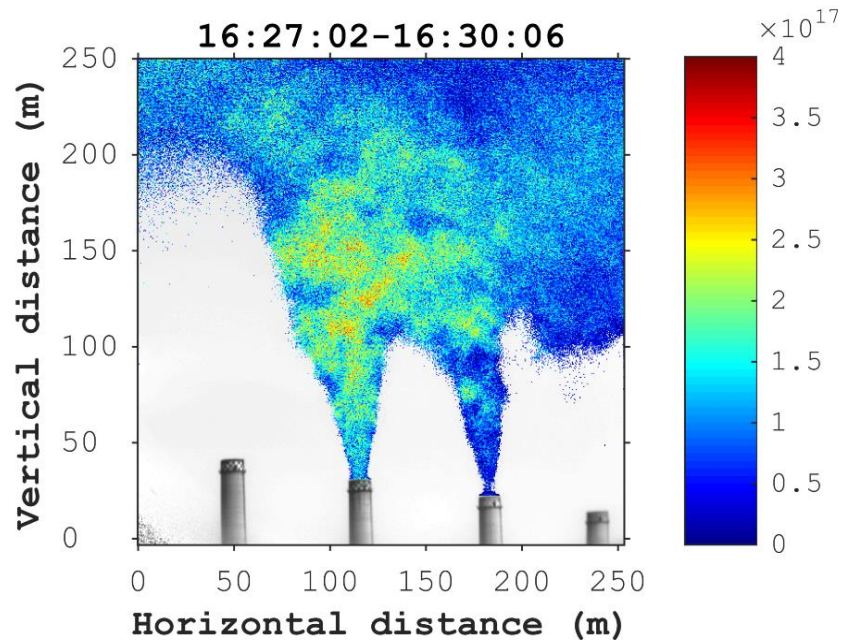


Show fine structures in NO₂ field

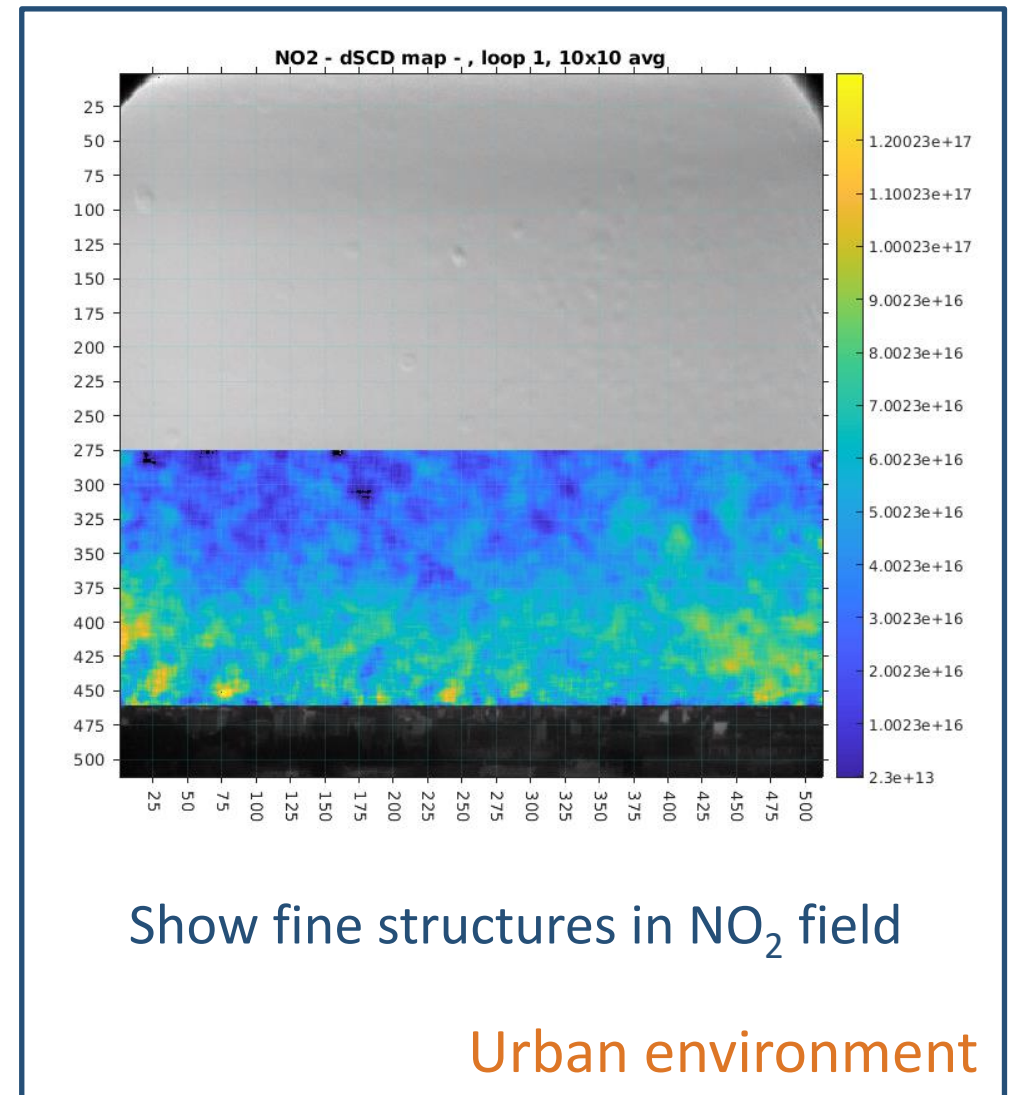
The NO₂ camera is an imager

Why?

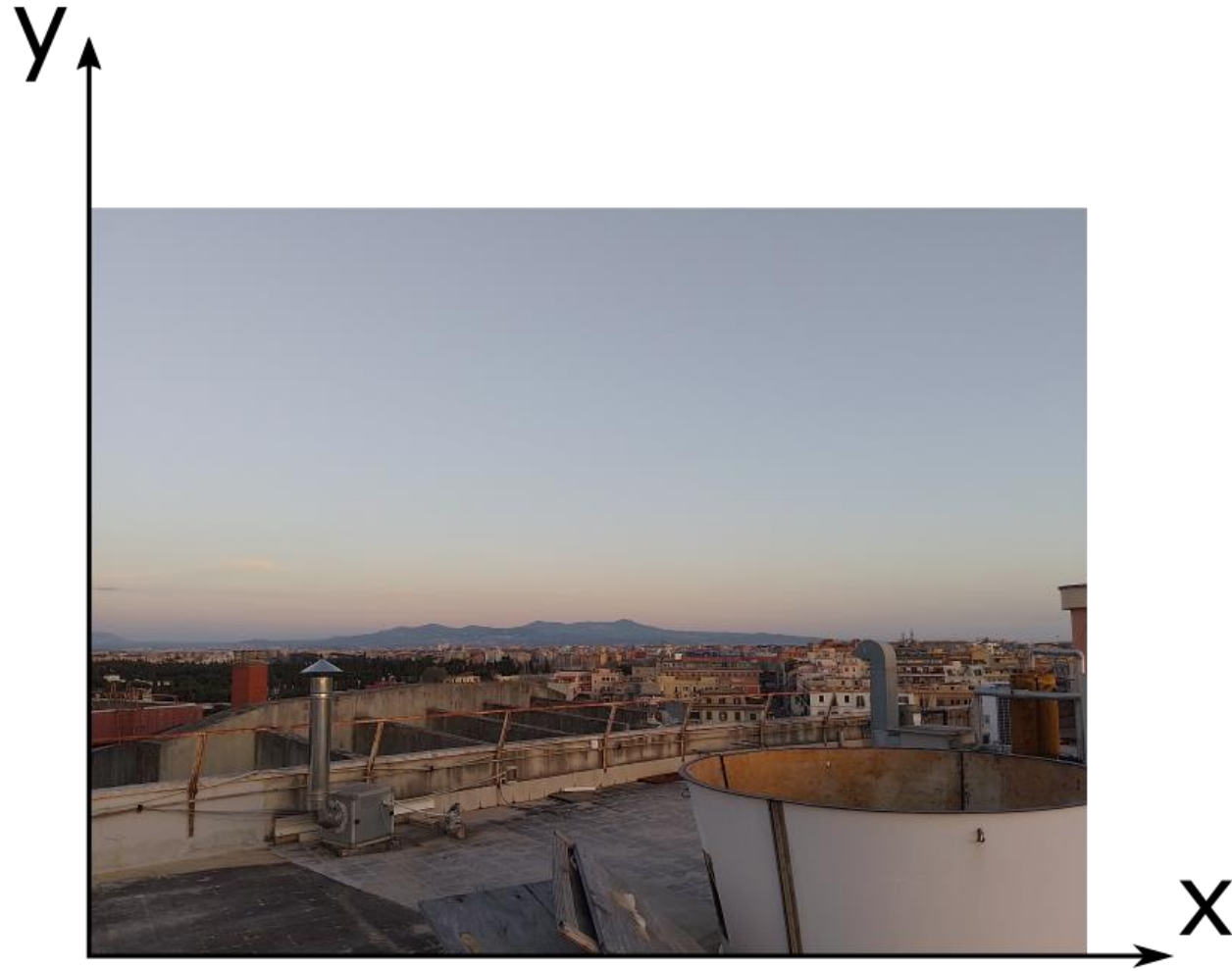
Show dynamic effects



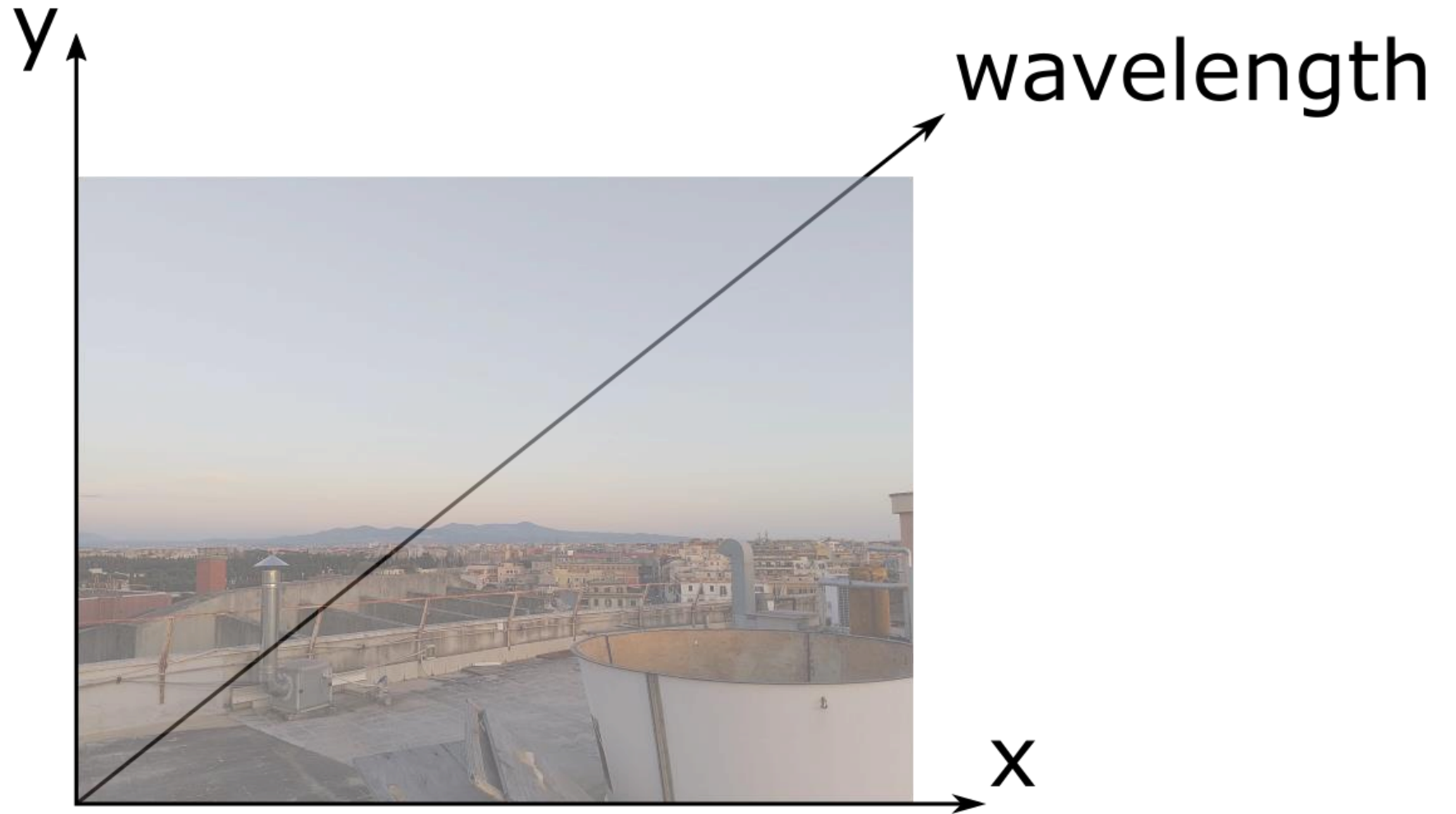
Dekemper, et al., AMT, 2016



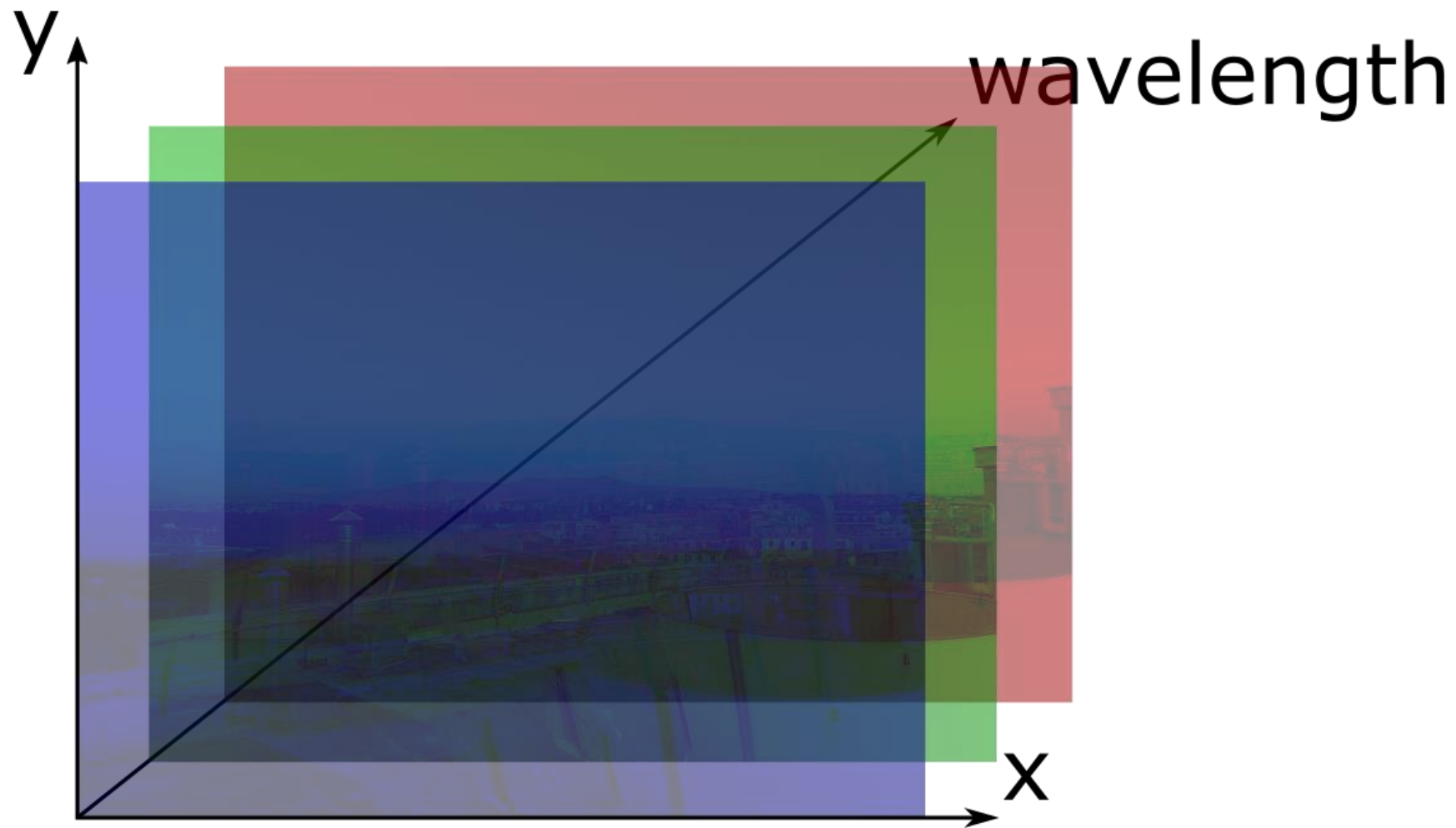
The NO₂ camera is an imager



The NO₂ camera is a **spectral** imager



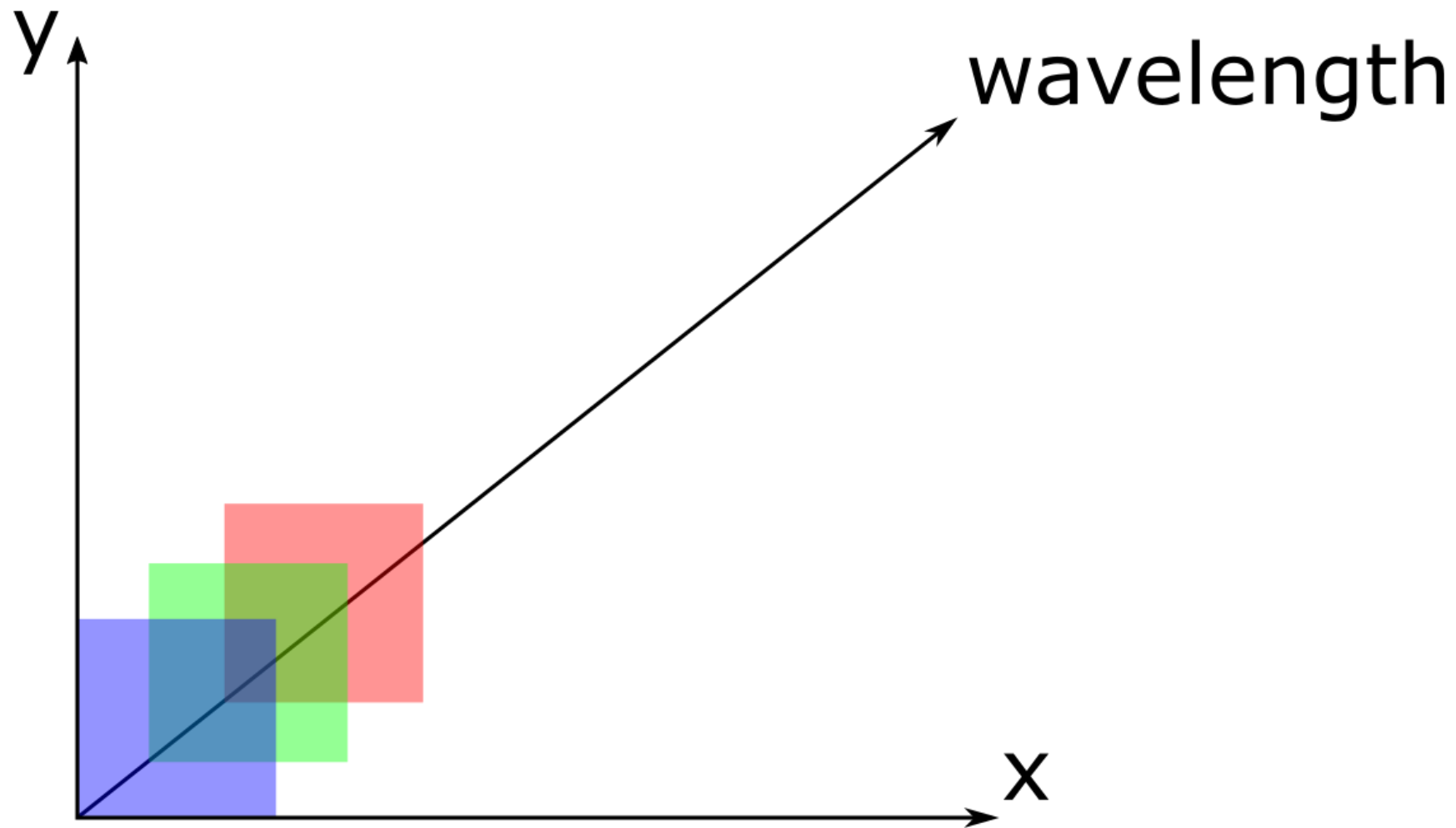
The NO₂ camera is a **spectral** imager



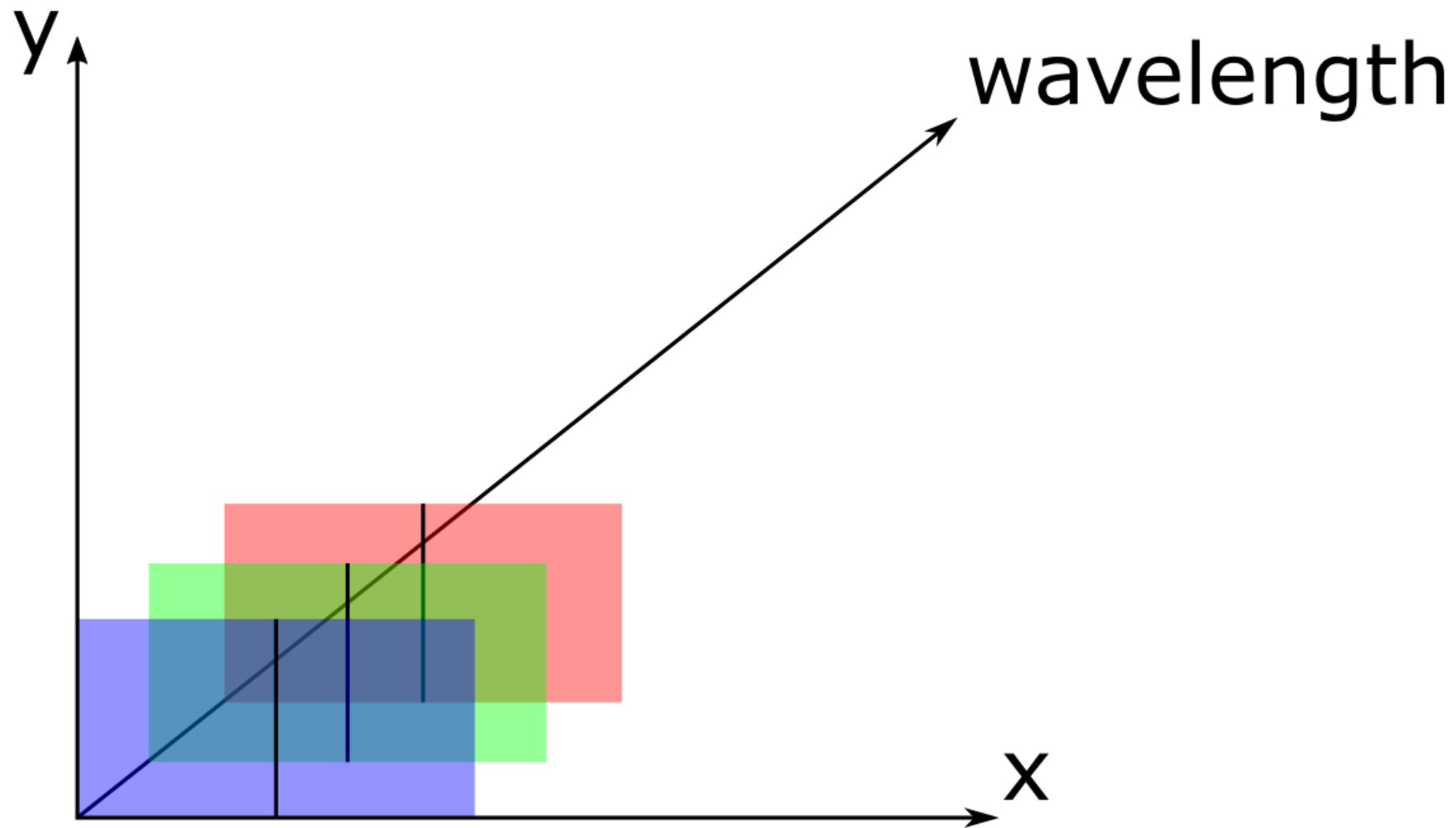
NO₂ camera among DOAS friends



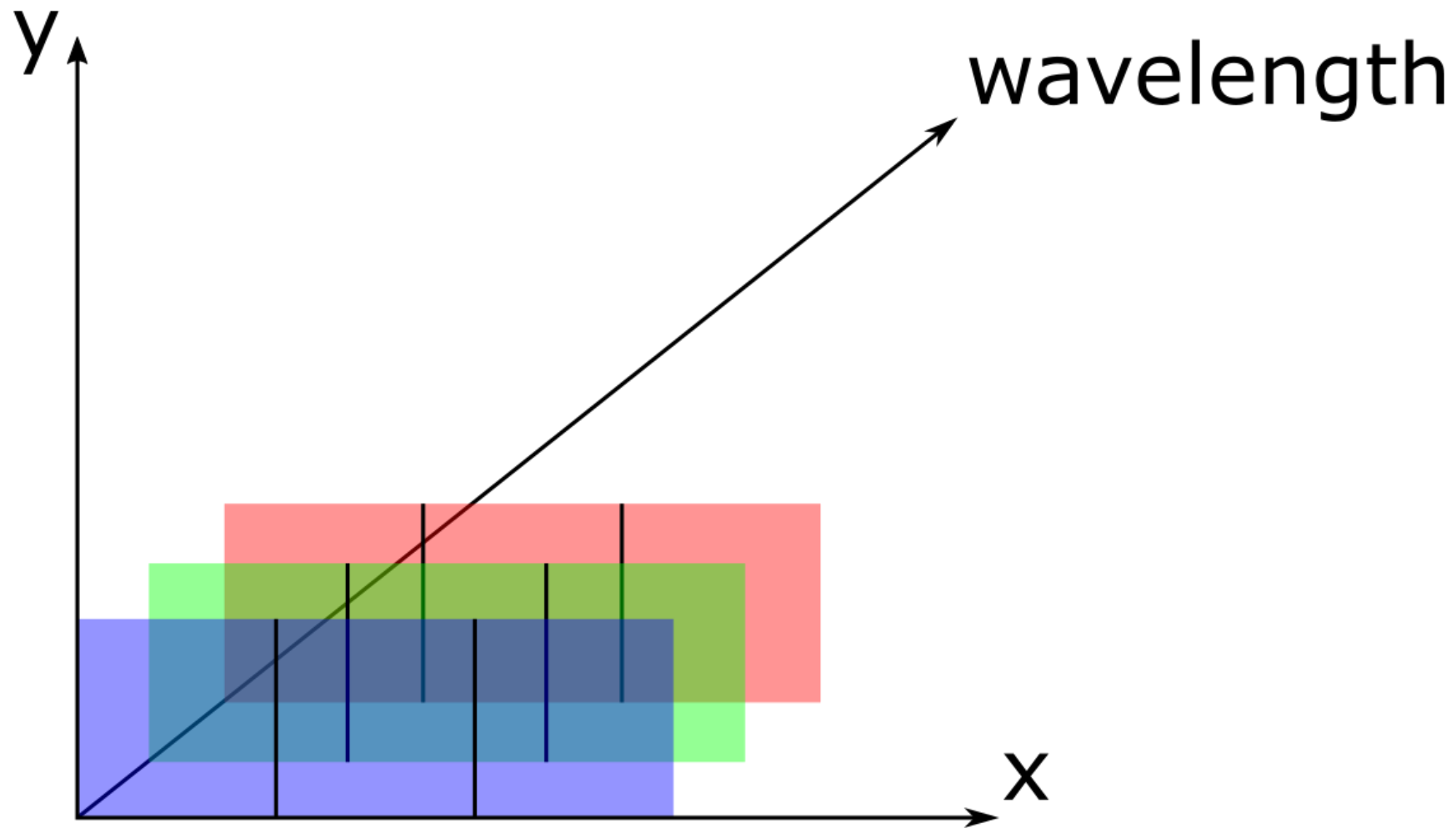
Imaging: the DOAS way



Imaging: the DOAS way



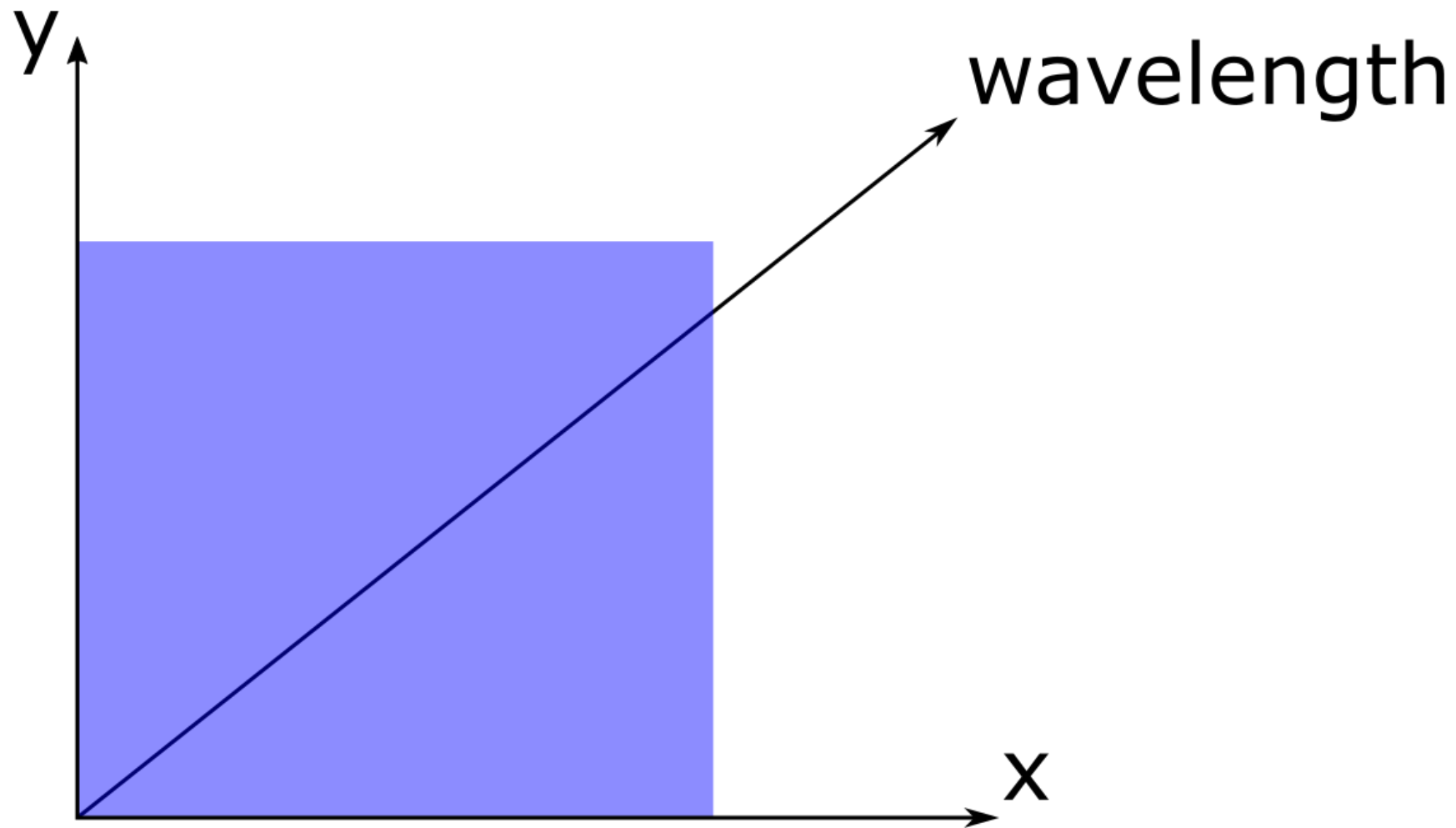
Imaging: the DOAS way



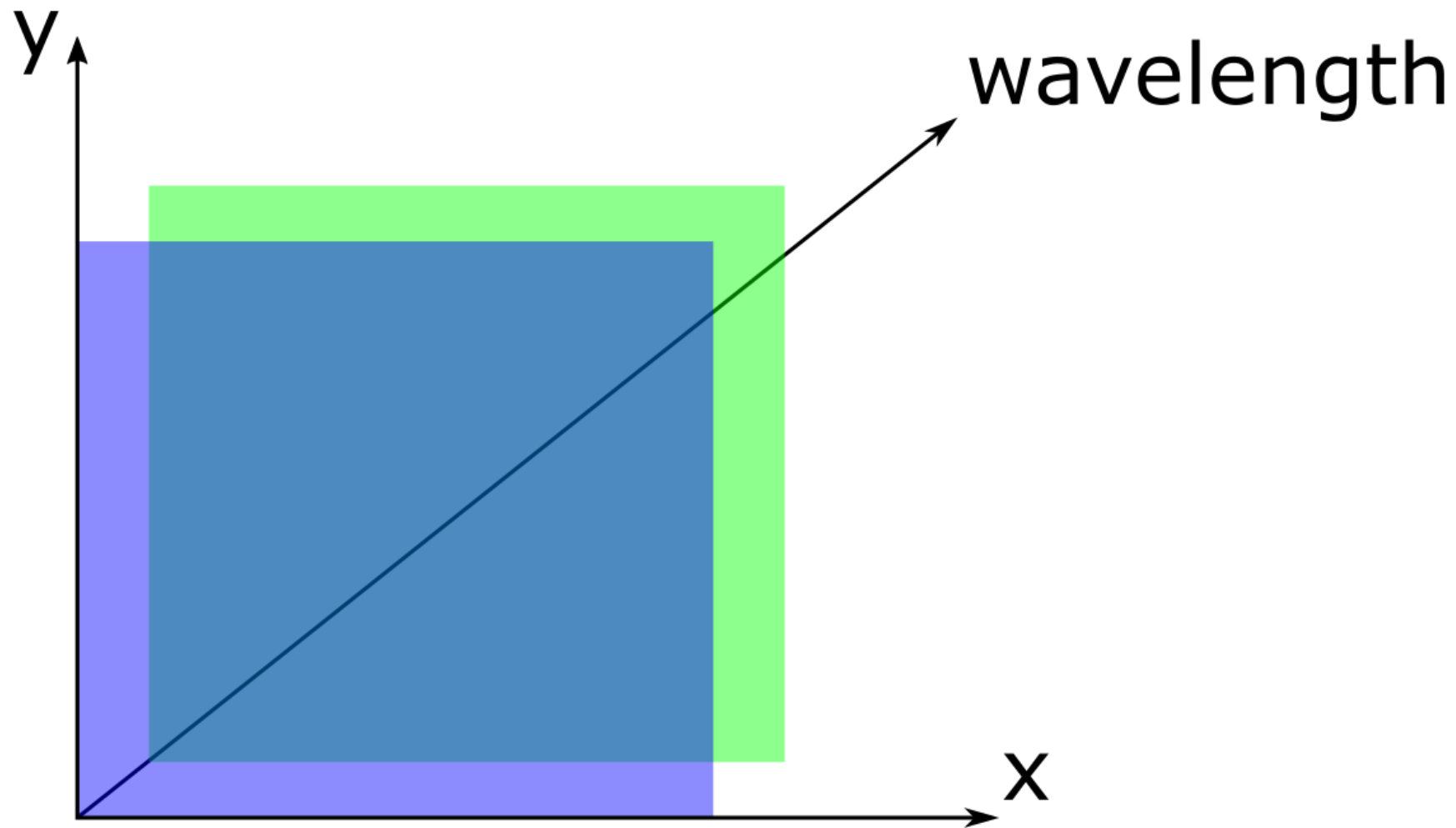
Imaging: the DOAS way

- + Well known method
- + Accurate retrievals
- Spatial scanning
- Imaging separated from measurement

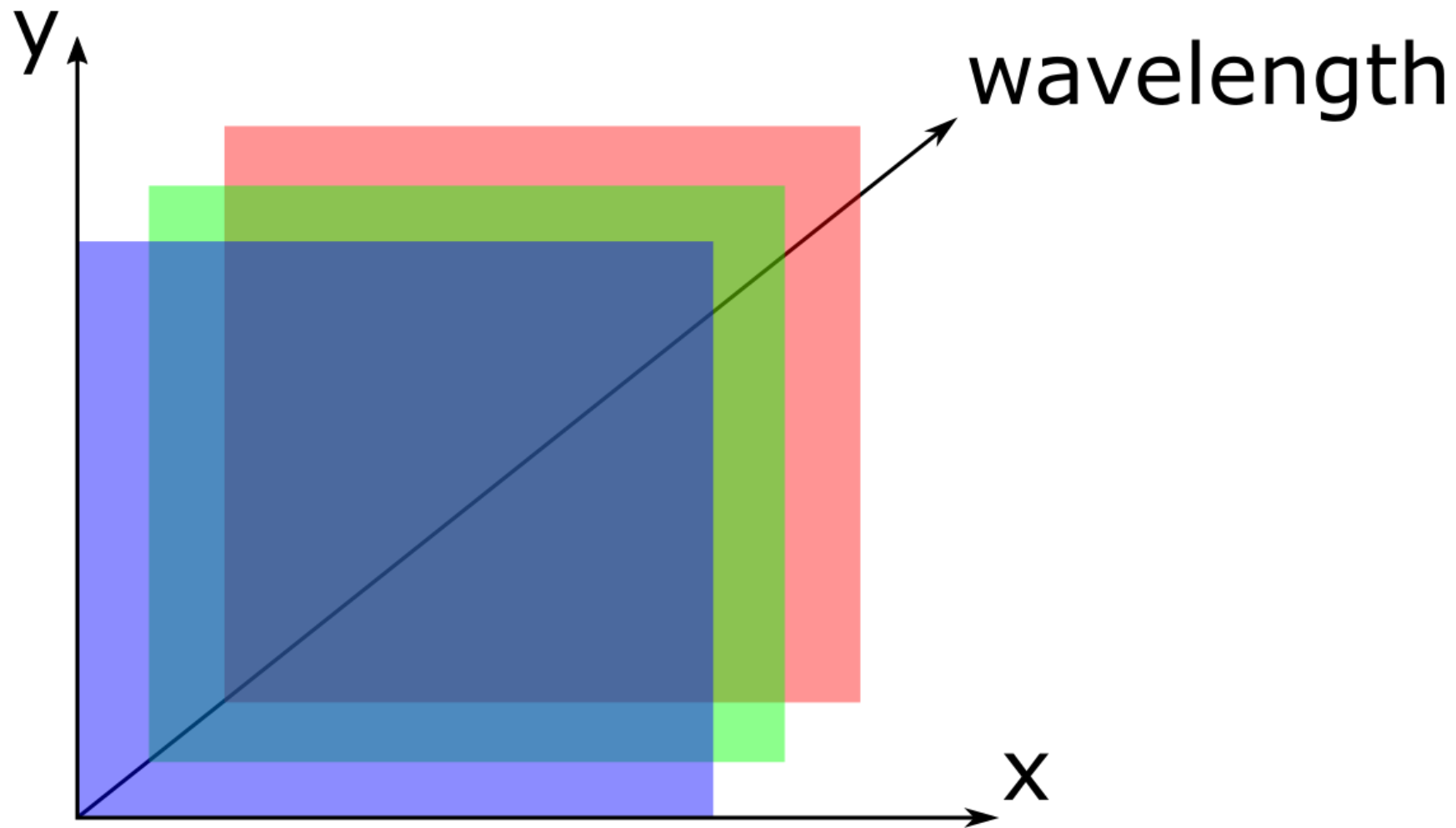
Imaging: the NO₂ camera way



Imaging: the NO₂ camera way



Imaging: the NO₂ camera way

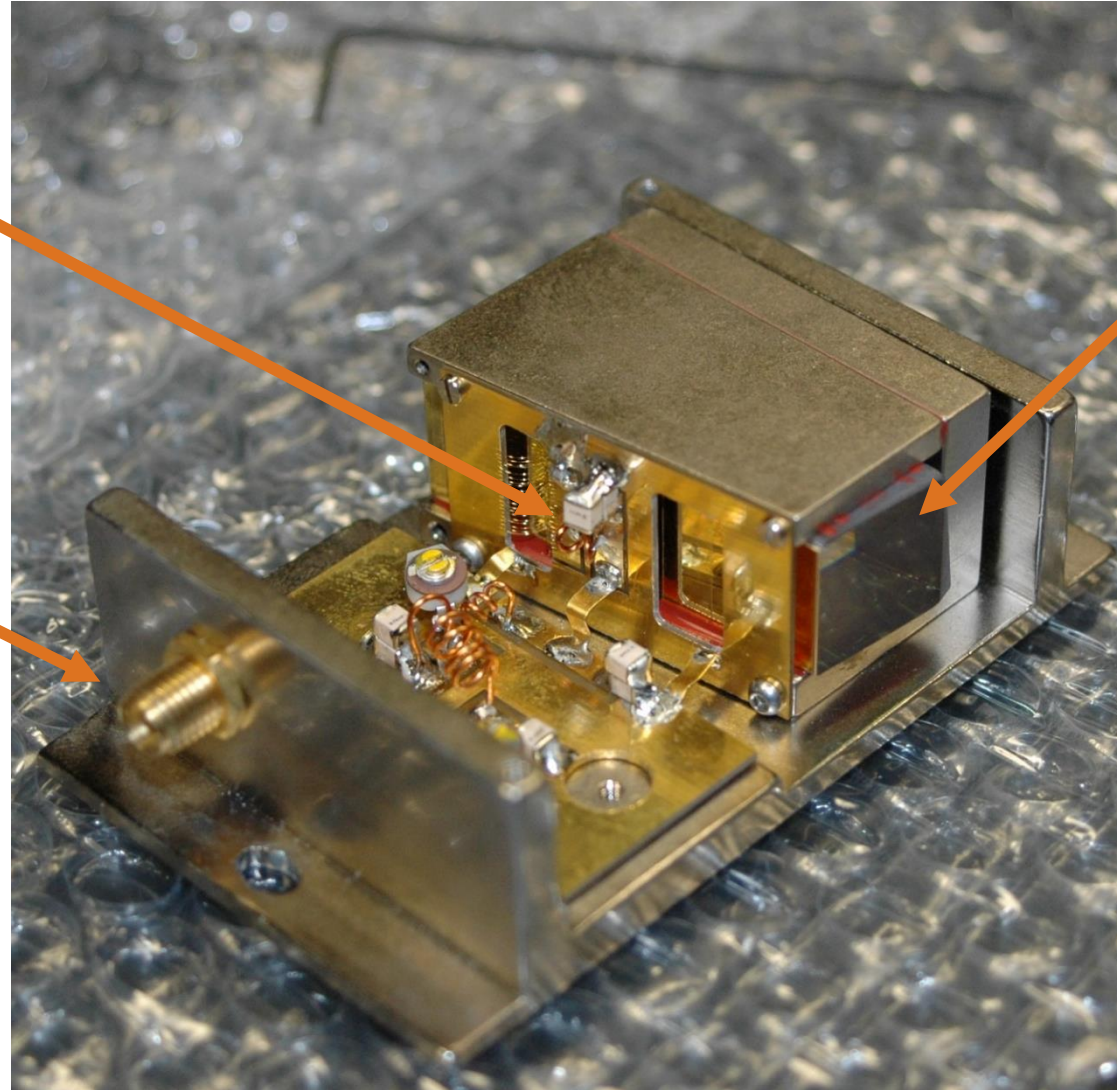


Acousto-Optical Tunable Filter (AOTF)

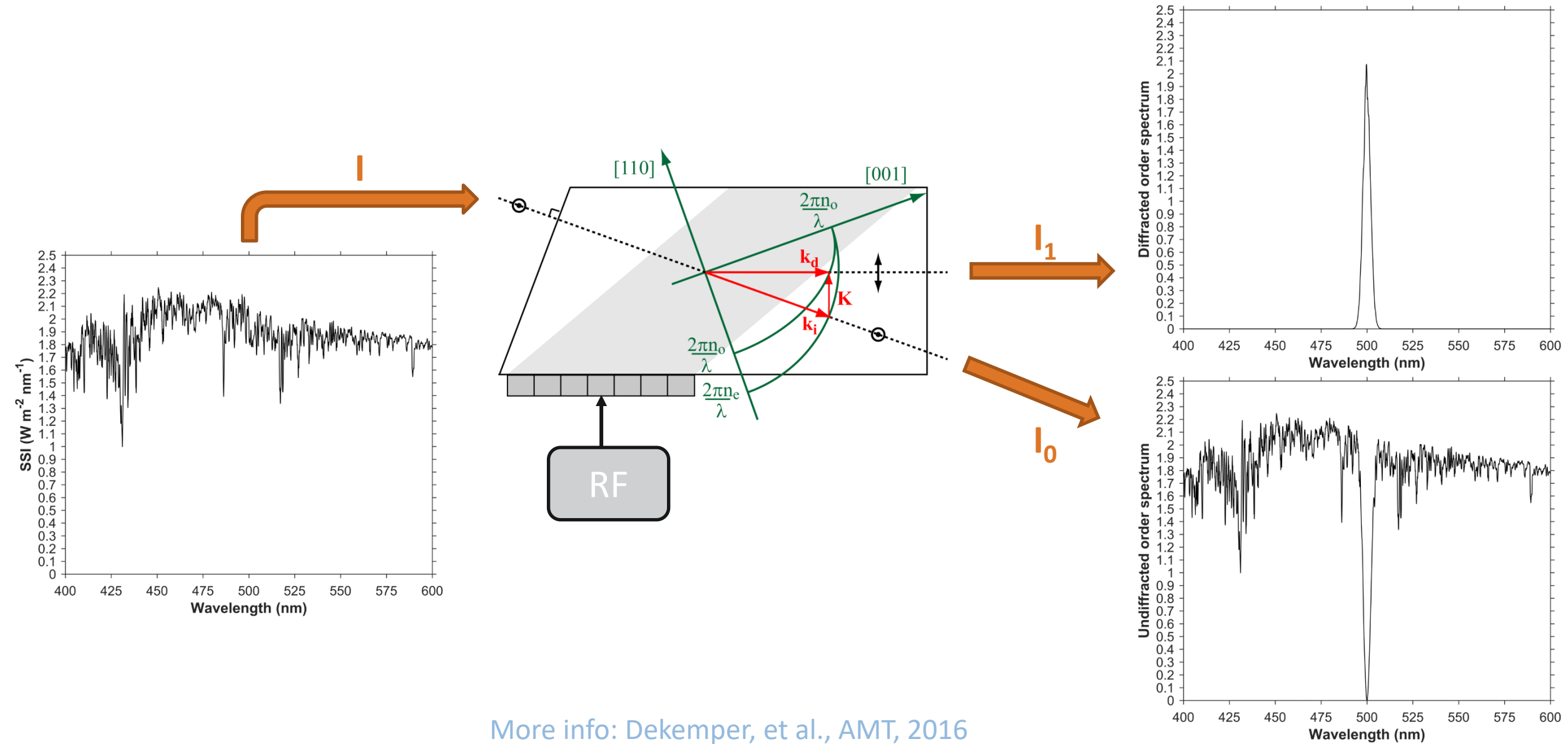
Transducer

TeO₂ crystal

RF input



Acousto-Optical Tunable Filter (AOTF)



More info: Dekemper, et al., AMT, 2016

Imaging: the NO₂ camera way

- + Imaging together with measurement
- + 1 picture @ 1 wavelength \approx 1 second
- Lower signal-to-noise ratio
- Little validation data

Imaging: the NO₂ camera way

+ Imaging together with measurement

+ 1 picture @ 1 wavelength \approx 1 second

– Lower signal-to-noise ratio

– Little validation data

Trade off speed, precision, resolution

A diagram consisting of two blue arrows pointing from the text 'Lower signal-to-noise ratio' and 'Little validation data' towards the text 'Trade off speed, precision, resolution'.

Imaging: the NO₂ camera way

+ Imaging together with measurement

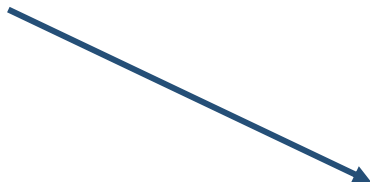
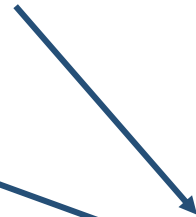
+ 1 picture @ 1 wavelength \approx 1 second

– Lower signal-to-noise ratio

– Little validation data

Trade off speed, precision, resolution

IDEAS-QA4EO project



IDEAS-QA4EO campaign in Rome

Goal

1. Test urban acquisition scenario NO₂ camera
2. Validate results NO₂ camera
3. Map spatio-temporal patterns in NO₂ field

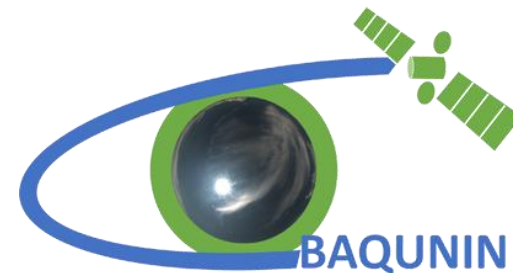
IDEAS-QA4EO campaign in Rome

Goal

1. Test urban acquisition scenario NO₂ camera
2. Validate results NO₂ camera
3. Map spatio-temporal patterns in NO₂ field

Why Rome?

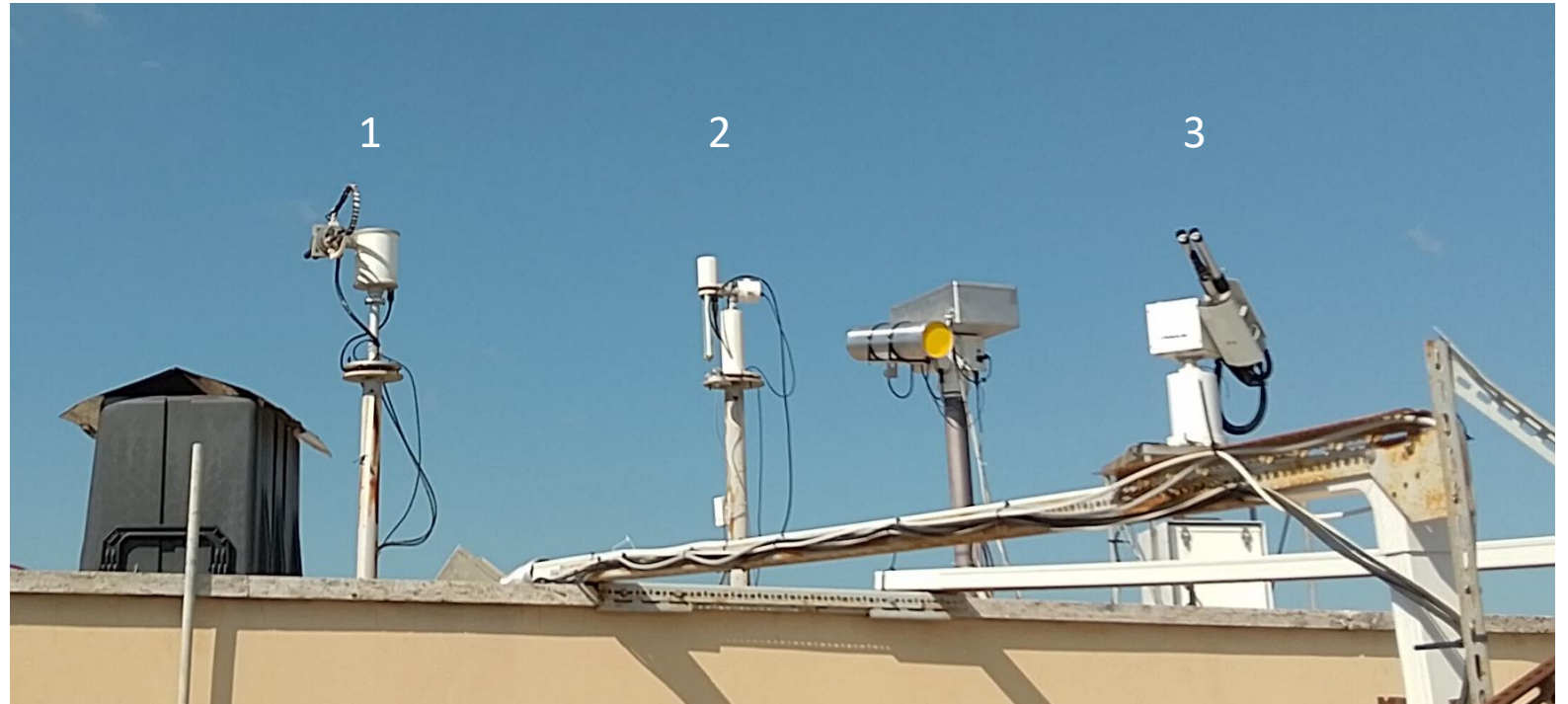
1. Urban environment
2. BAQUNIN supersite @ La Sapienza
3. Nice weather 🧐



Validation instruments available

BAQUNIN

1. Pandora (operating in DOAS mode)
2. Cimel
3. Sun/moon/sky radiometer
4. SkyCam
5. Ceilometer
6. ...



CNR

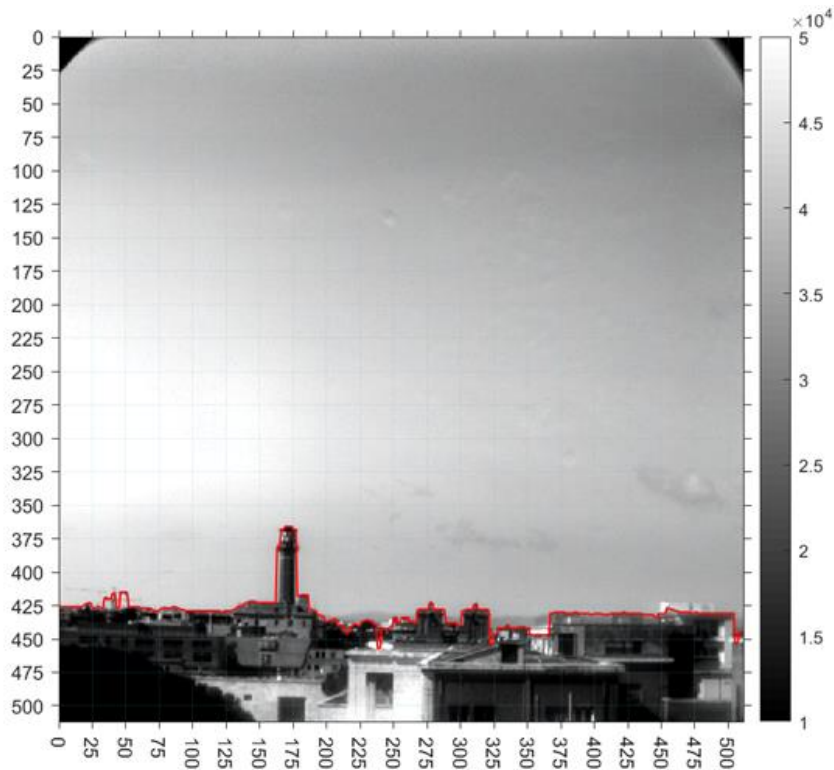
1. MAX-DOAS

Regular passes from Sentinel 5P (TROPOMI)

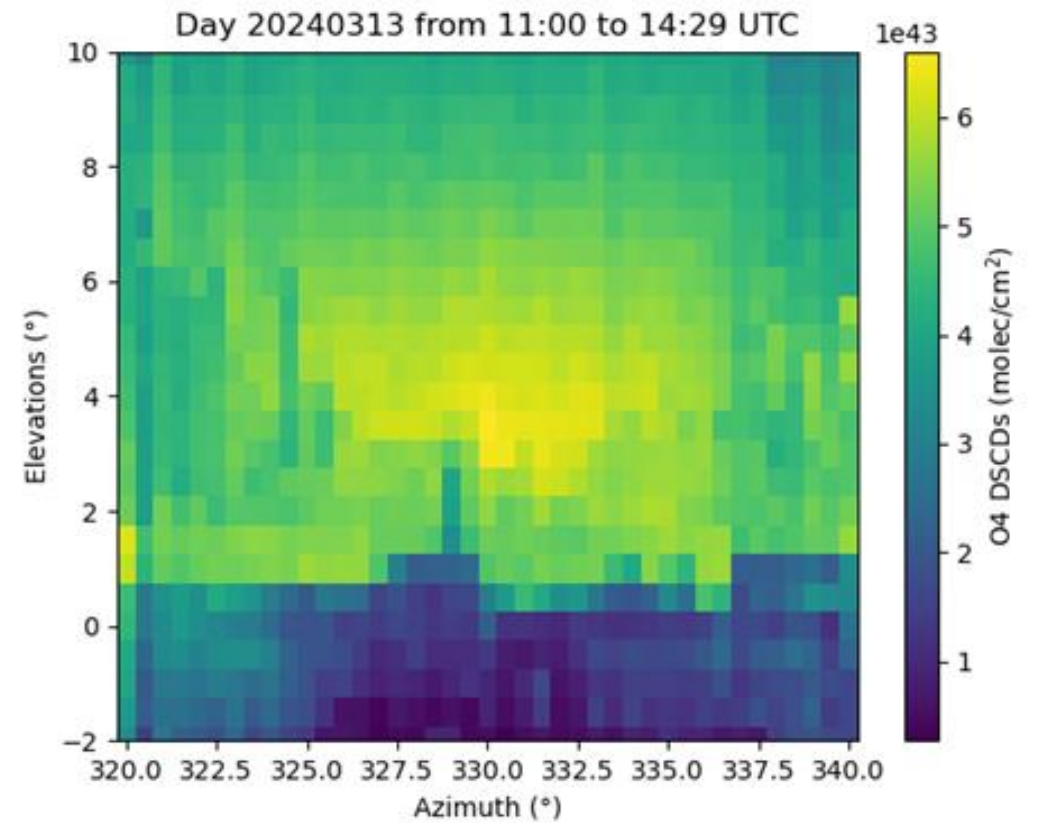
Campaign strategy

1. Determine pointing error

NO₂ camera

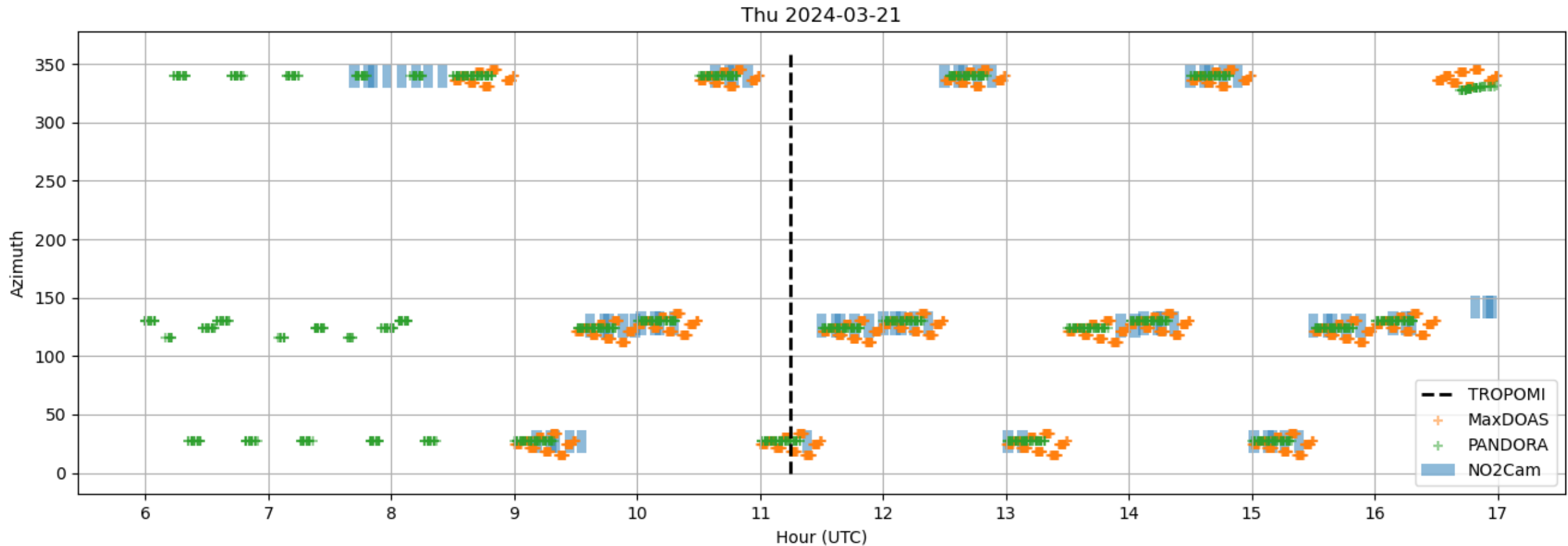


MAX-DOAS (O₄)

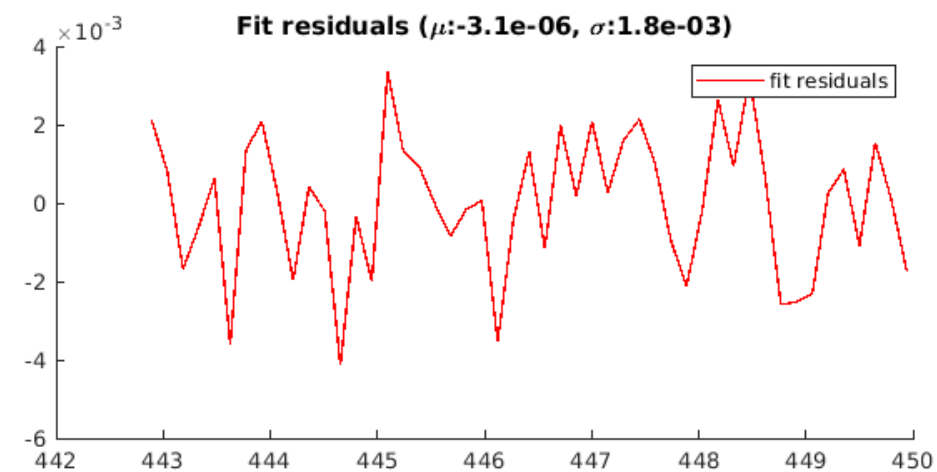
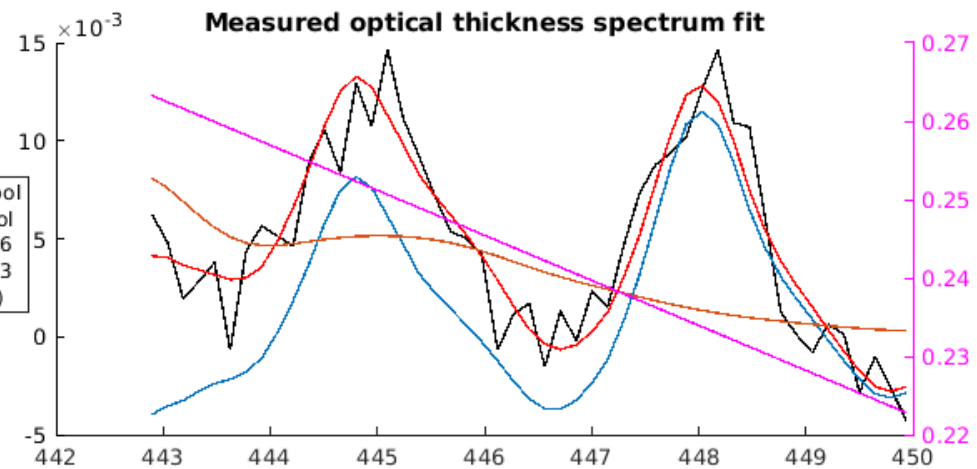
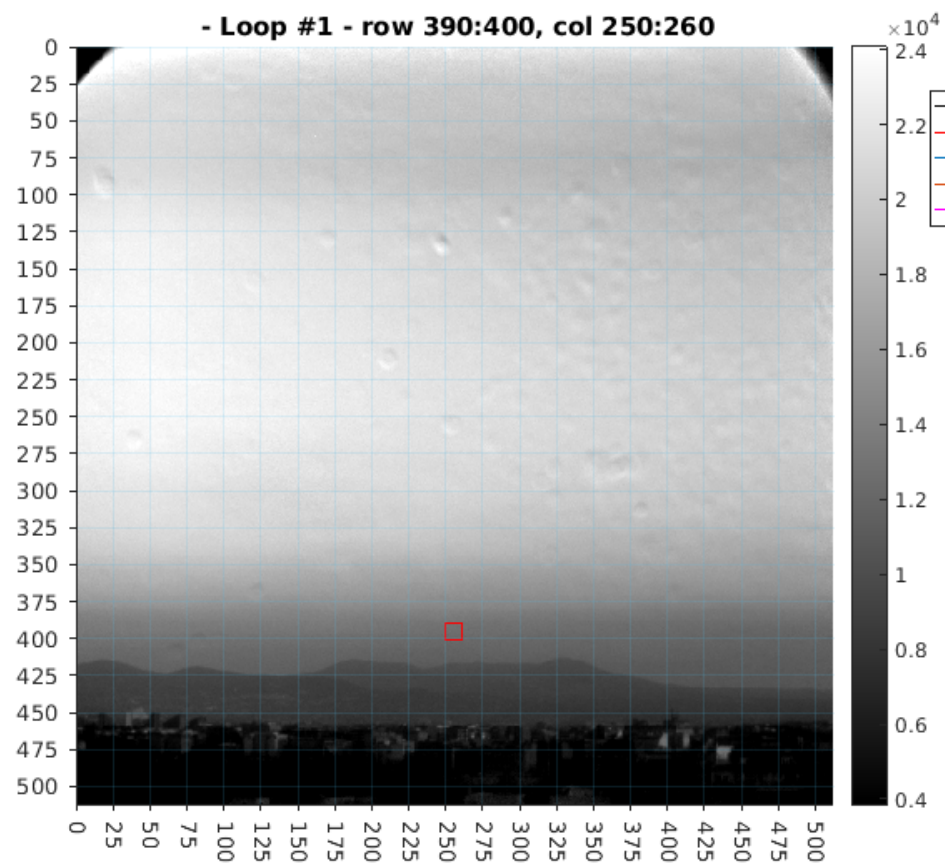


Campaign strategy

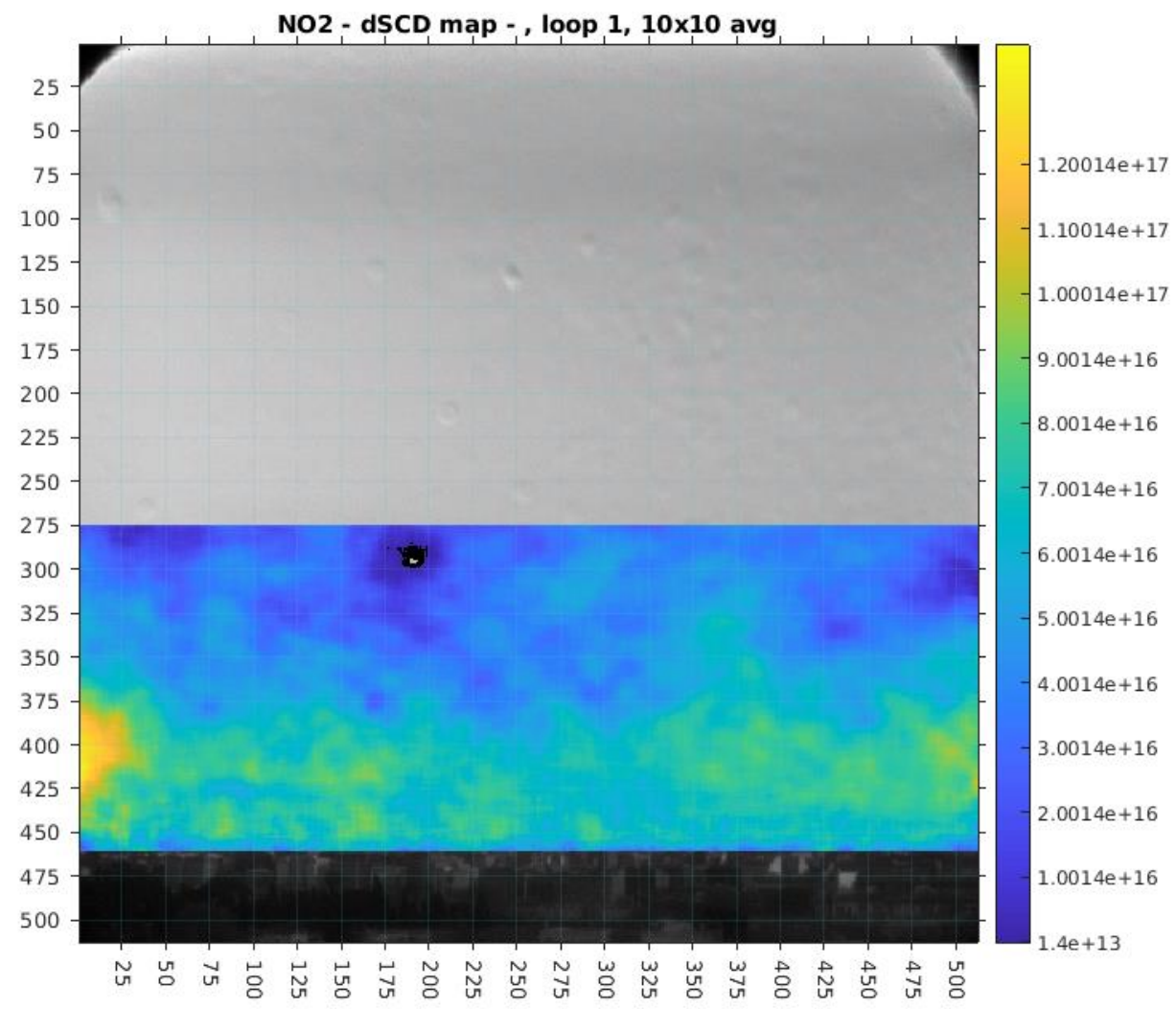
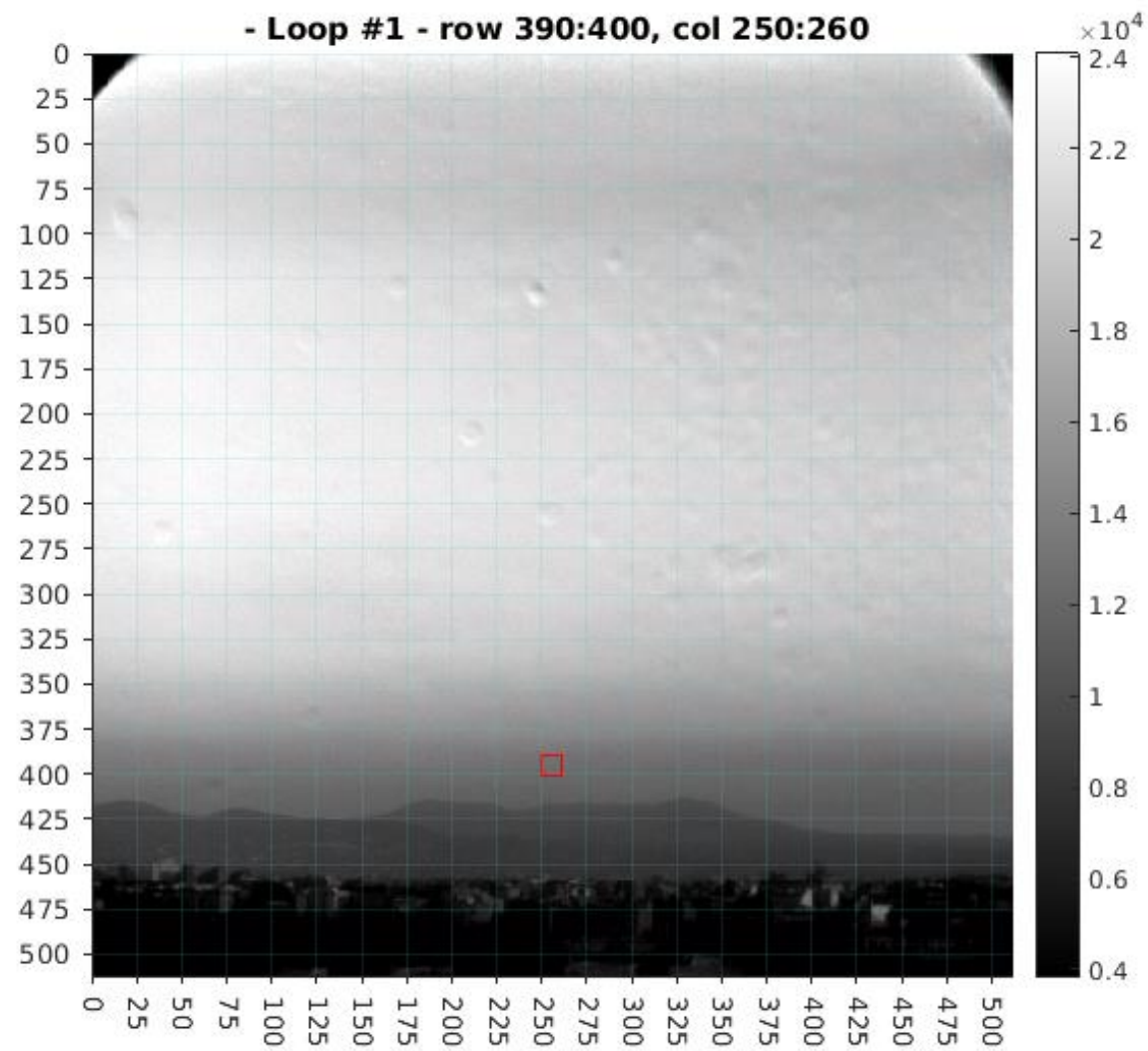
1. Determine pointing error
2. Synchronize measurements (subsample image of NO₂ camera)



First results



First results



What's next?

More data processing

→ paper in preparation

CINDI-3 campaign



Third Cabauw INtercomparison of DOAS-type Instruments



THANK YOU!
QUESTIONS?

www.aeronomie.be

Cedric.Busschots@aeronomie.be

This work is partially supported by the QA4EO contract QA4EO/SER/SUB/33

Bonus | Author affiliation

BIRA-IASB: Cedric Busschots, Pierre Gramme, Noel C. Baker, Emmanuel Dekemper

SERCO Italia: Anna Maria Iannarelli, Nicola Ferrante, Stefano Casadio, Gabriele Mevi, Giacomo Gostinicchi

Sapienza University: Annalisa Di Bernardino

TU Delft: Jurgen Vanhamel

CNR-ISAC Bologna: Paolo Pettinari, Elisa Castelli, Andre' Achilli

CNR-ISAC Tor Vergata: Giampietro Casasanta, Luca di Liberto, Francesco Cairo

CNR-IIA: Mauro Montagnoli, Giulio Esposito, Cristiana Bassani

LuftBlick (PGN): Manuel Roca, Axel Kreuter