Tampere University

Locating Radioactive Materials with Rapid Radioluminescence Imaging in Nitrogen-Flushed Gloveboxes

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EMPIR EURAMET

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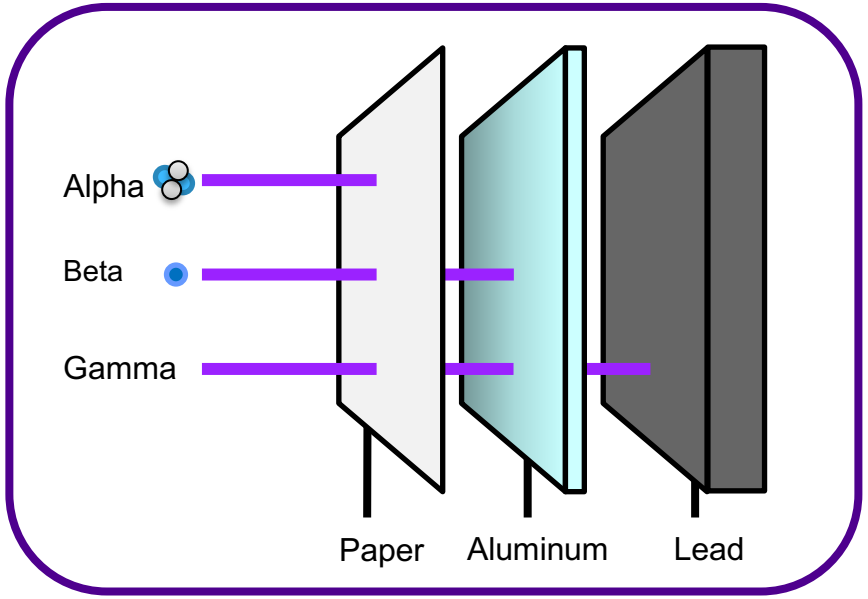
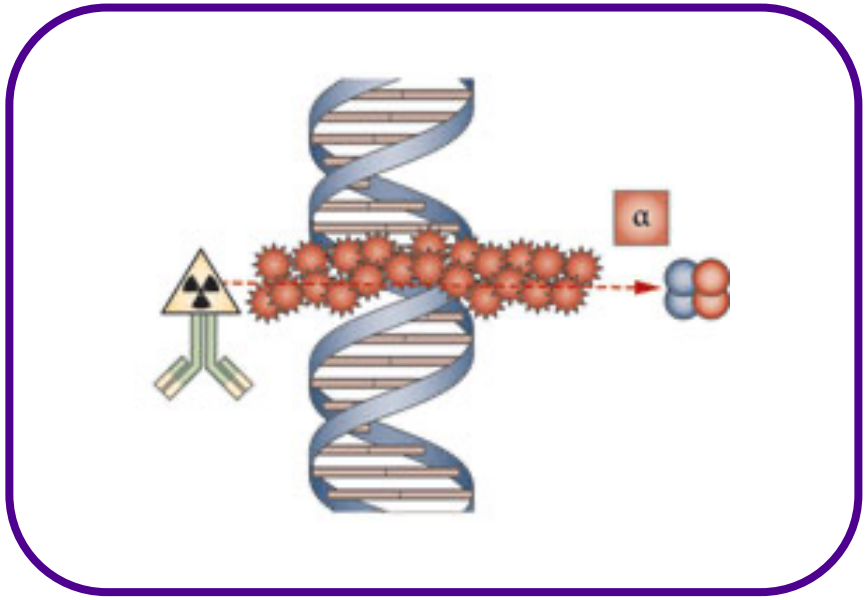
RemoteALPHA

Alpha Radiation

- Least penetrating
- Discharges kinetic energy in shortest distance
  - Internal exposure extremely dangerous
- Range in air ~ 4 cm
  - Inconvenient to detect directly





Alpha radiatio detection today

Swipe sampling

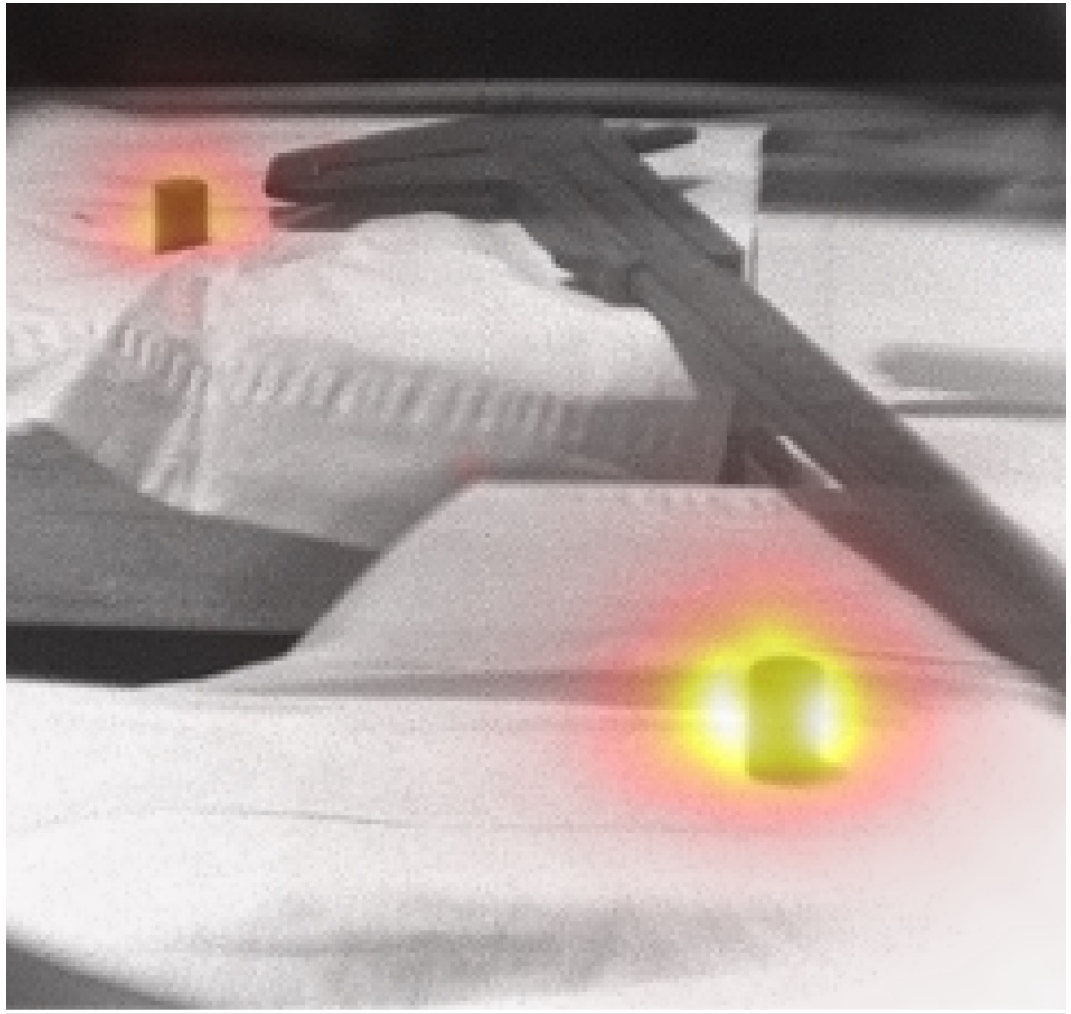
https://ehs.princeton.edu/book/export/html/244

https://seintl.com/articles/taking-a-radiation-swipe-survey-radiation-alert-ranger-wipe-test-plate-quick-start-guide

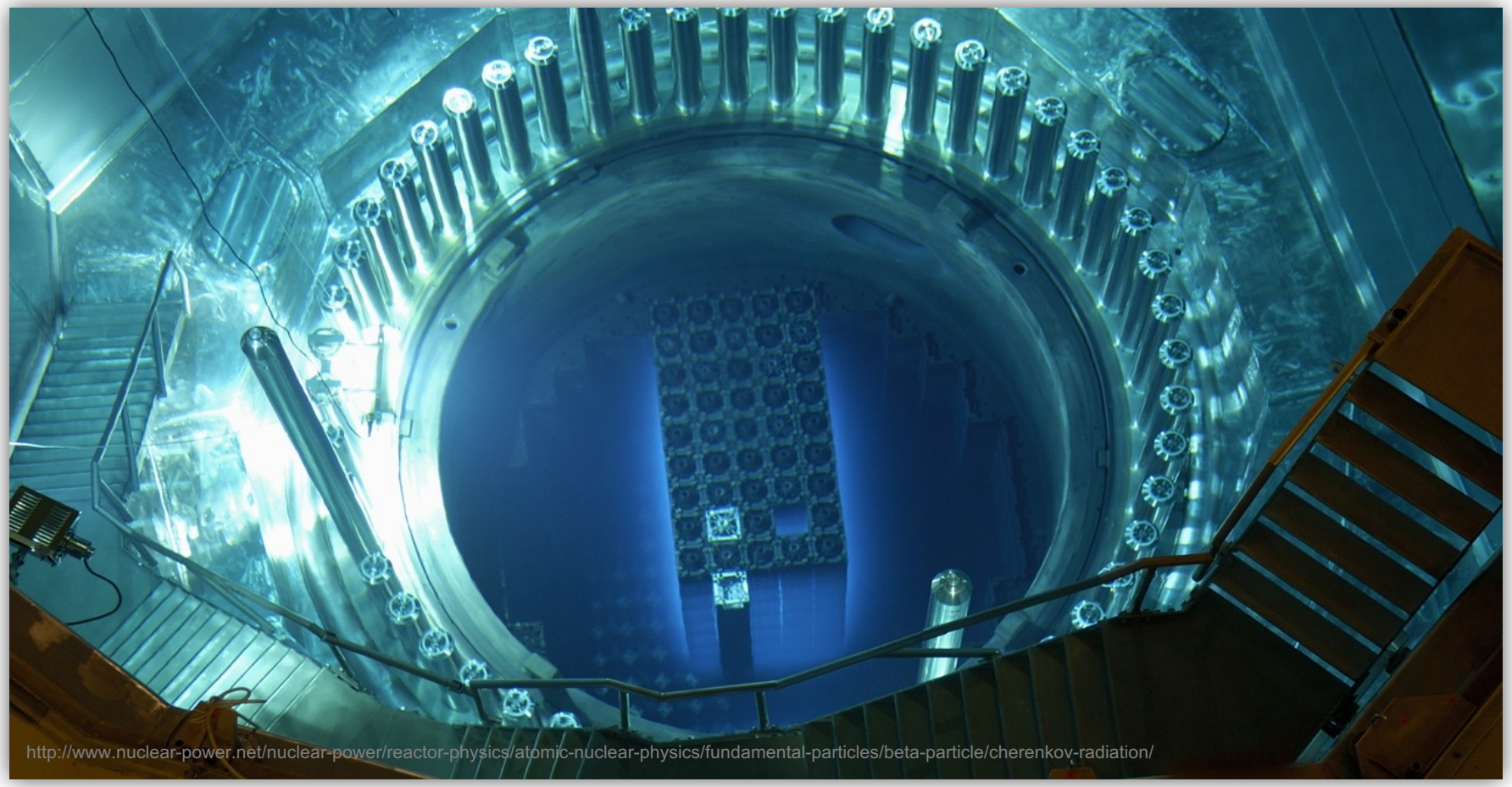
Direct detection

https://www.fluke.com/en-us/product/radiation-safety/fluke-481

Extending detection distance with radioluminescence



Radioactive glow: Cherenkov light

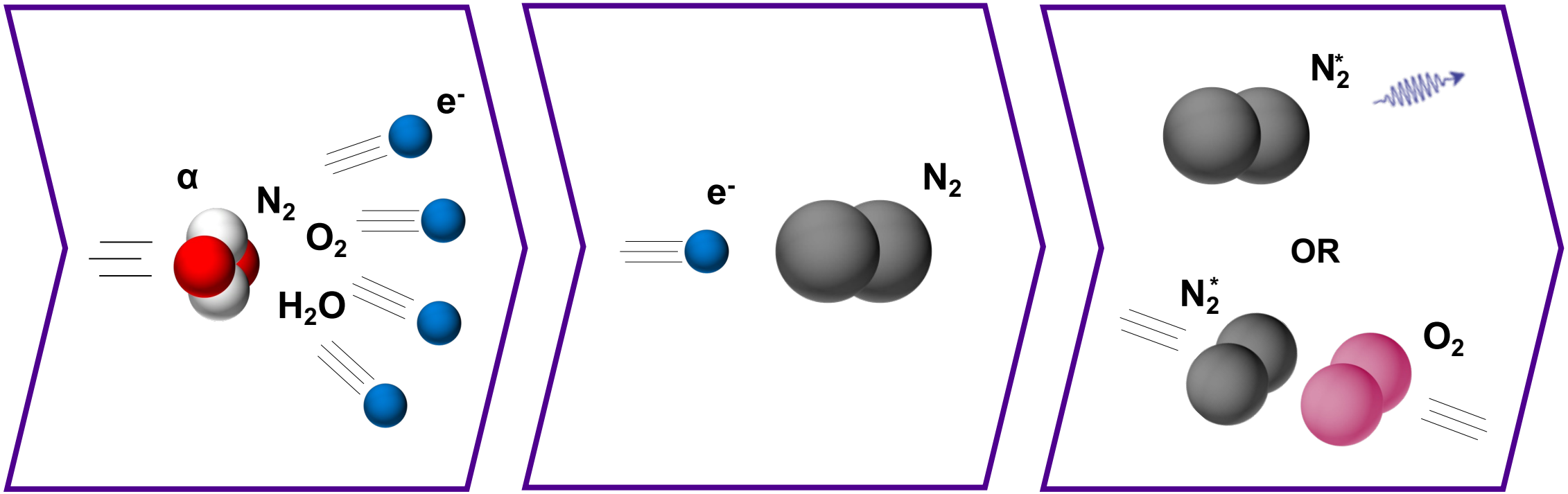


Radioactive glow: Radioluminescence

http://www.periodictable.com/Items/088.15/index.html

https://en.wikipedia.org/wiki/File:Gaseous_tritium_light_source.jpg

Radioluminescence in Air

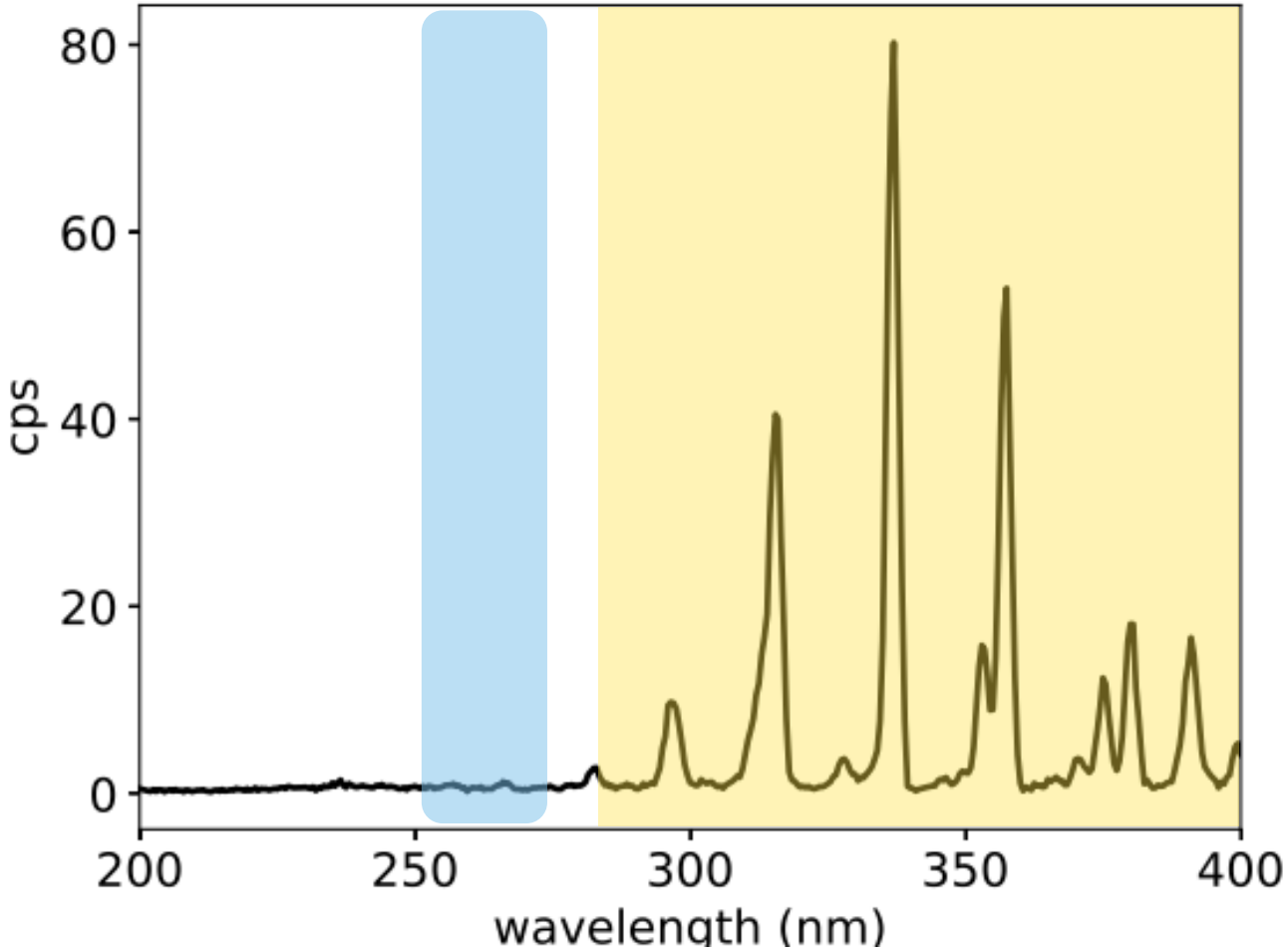


α-particles ionize molecules
-> Free electrons

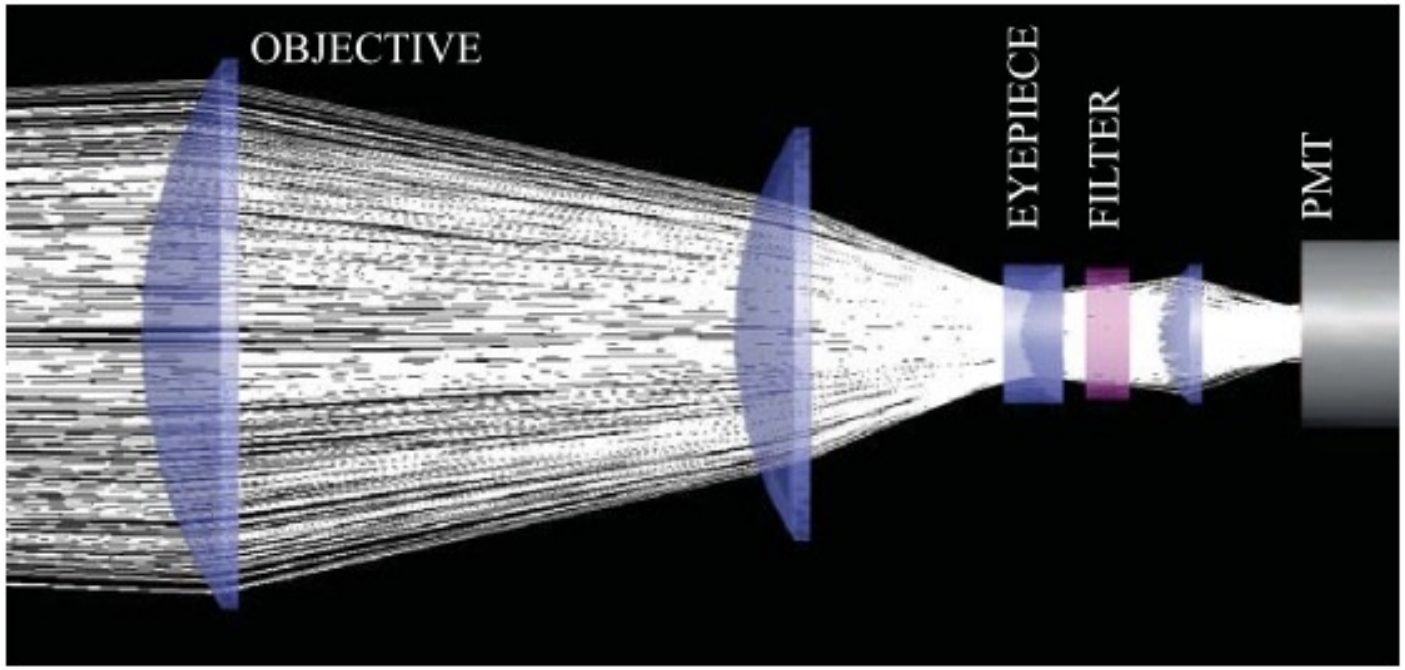
Free electrons excite N_2

N_2^* emit UV photons
OR
O_2 quench the N_2^*

Radioluminescence in Air

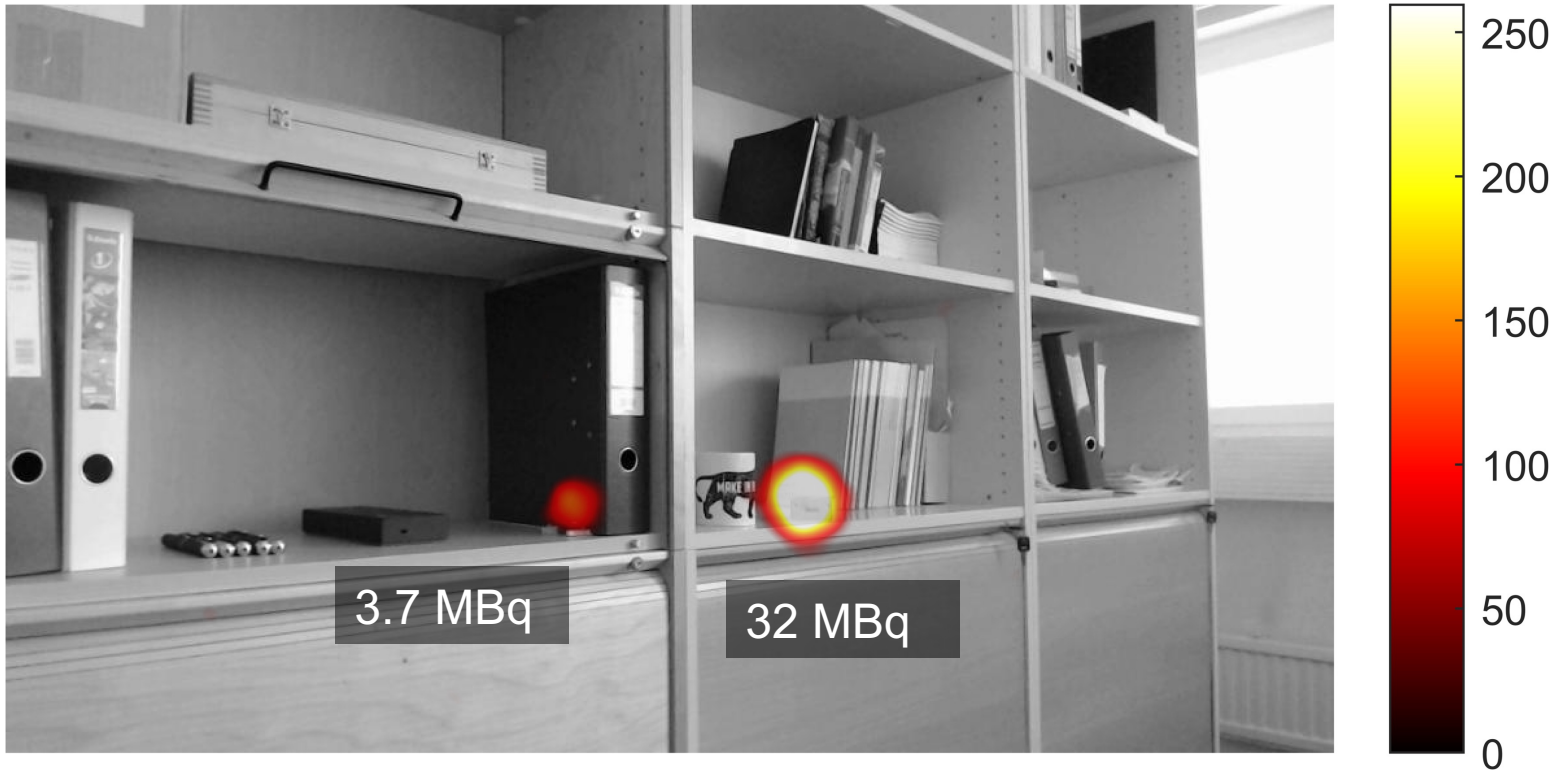


Scanning α Sources in Normal Air

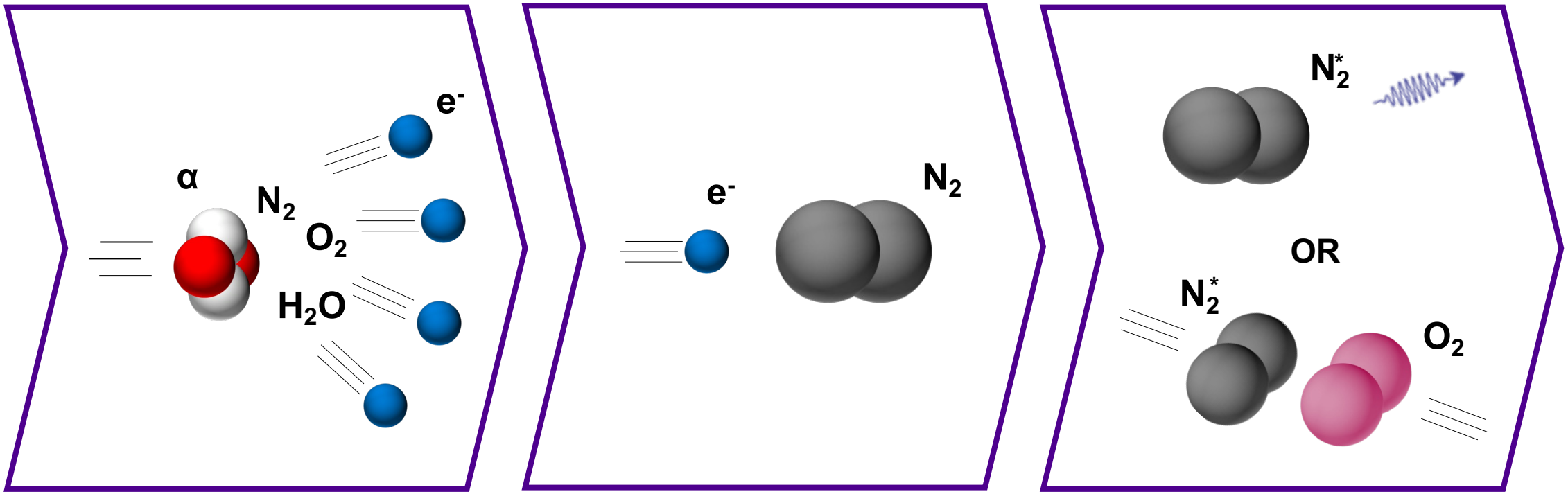


Results with PMT Scanner

- 20 s exposure time per measurement point
- 11 h total measurement time



Radioluminescence in Air



α-particles ionize molecules
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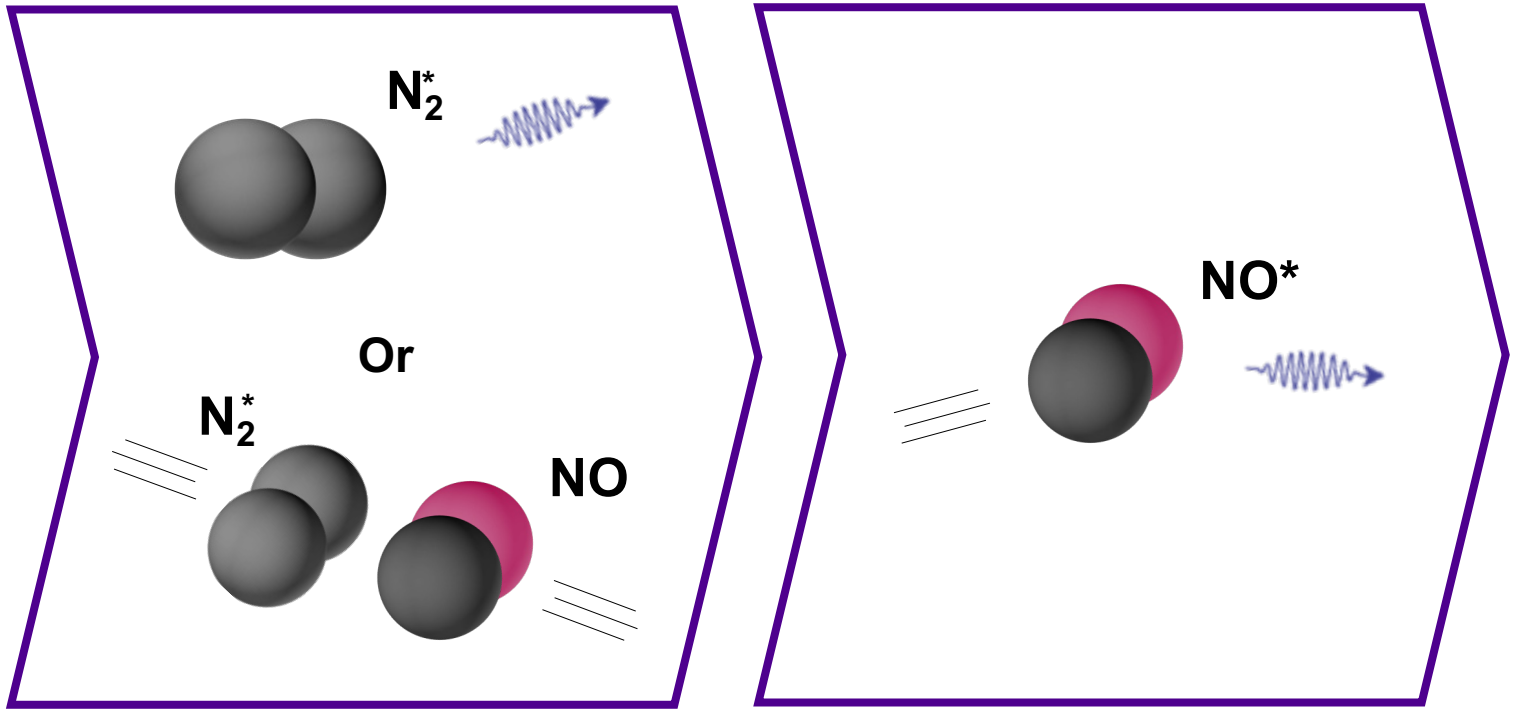
Radioluminescence in N_2 Doped With NO

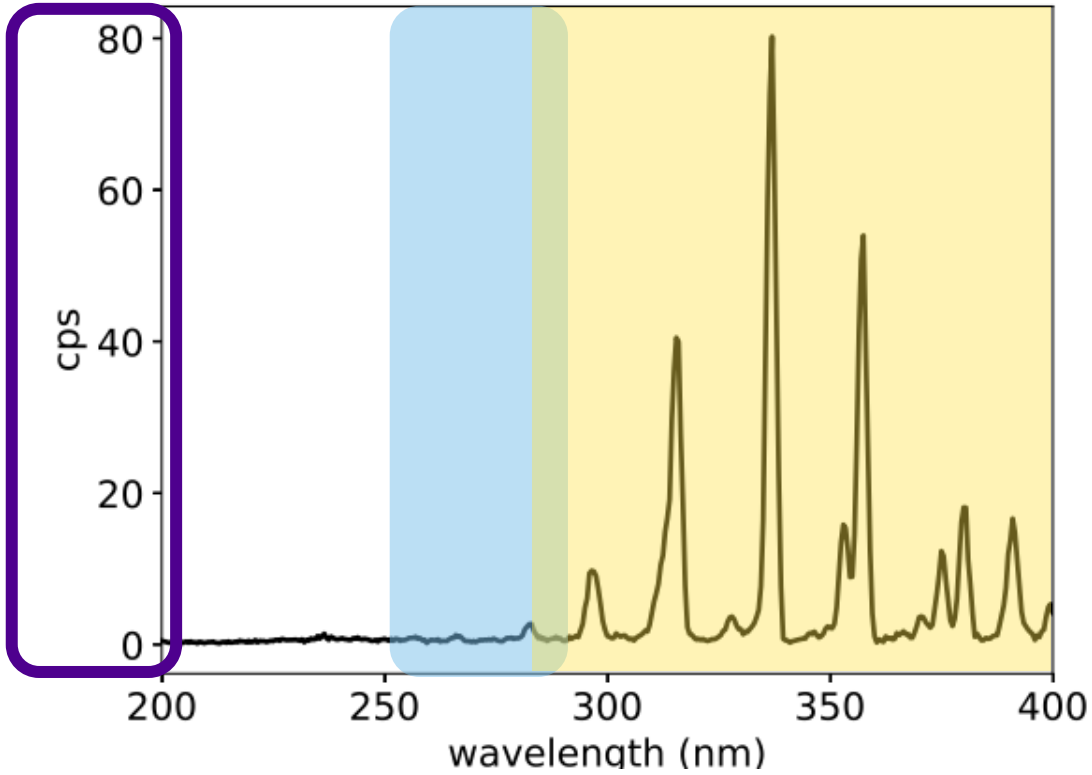


NO quenches the N_2^* and emits UV photos

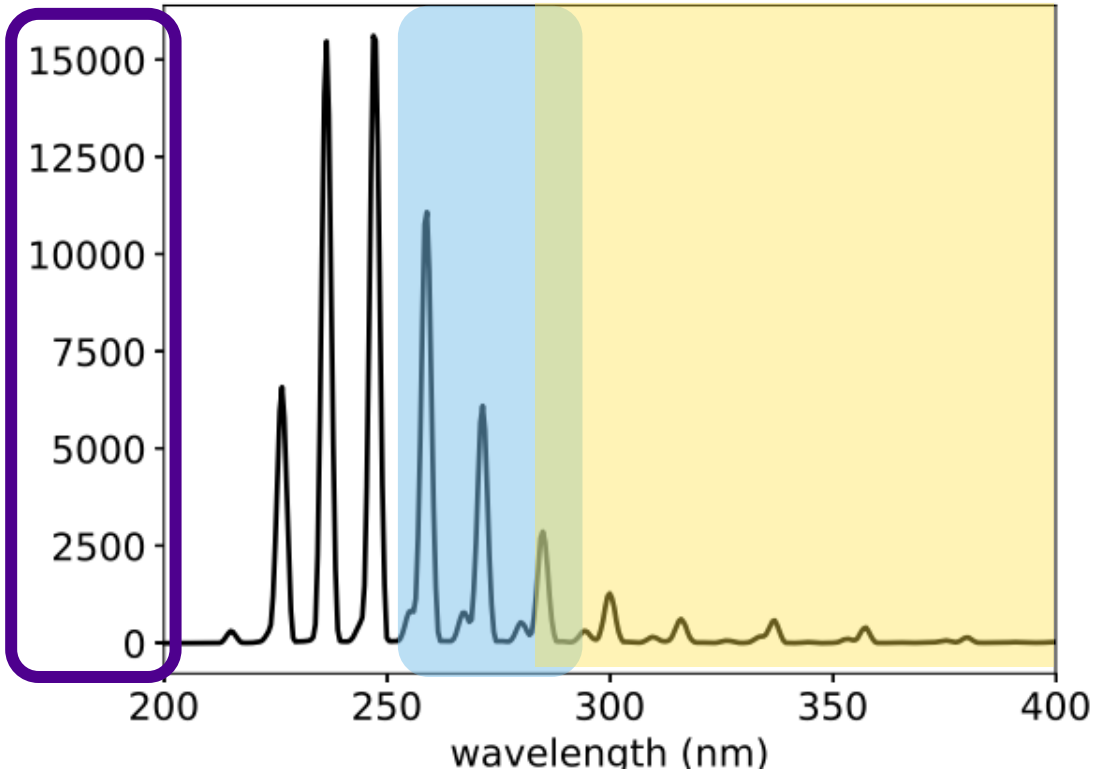
Excited NO emits an UV photon

Passband of EMCCD Setup

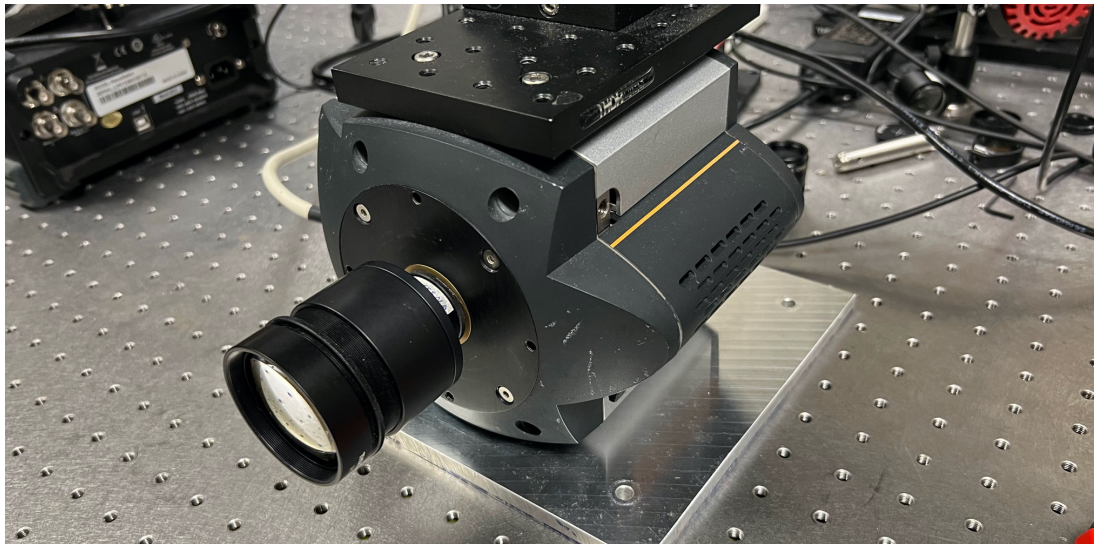
RL in air:



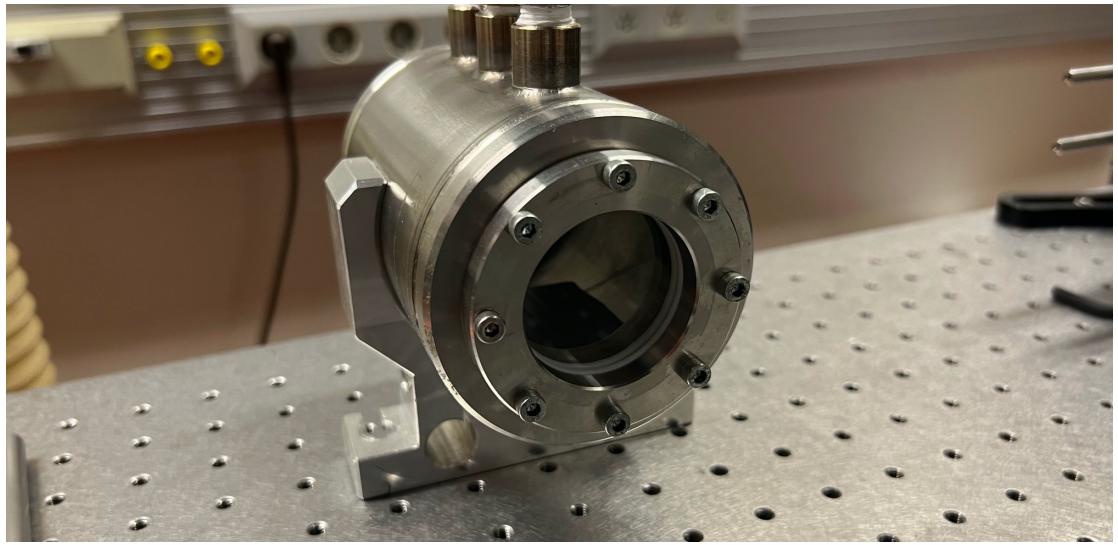
RL with 18 PPM of NO in N_2:



Rapid Imaging of α Sources in Modified Atmosphere



EMCCD camera with UV bandpass filter



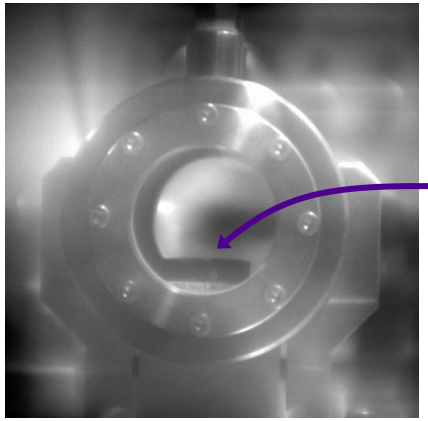
N_2 flushed chamber

- 3 PPM of NO

Results with EMCCD Camera

1. Visible light image without a filter

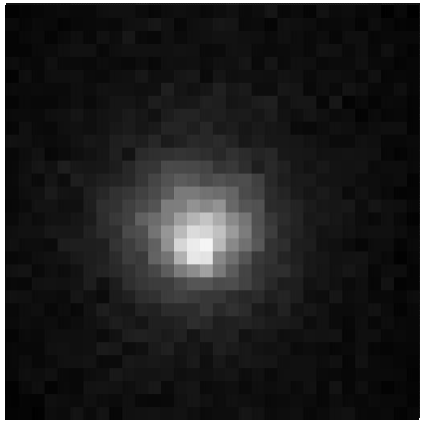
Exposure time: 5 ms



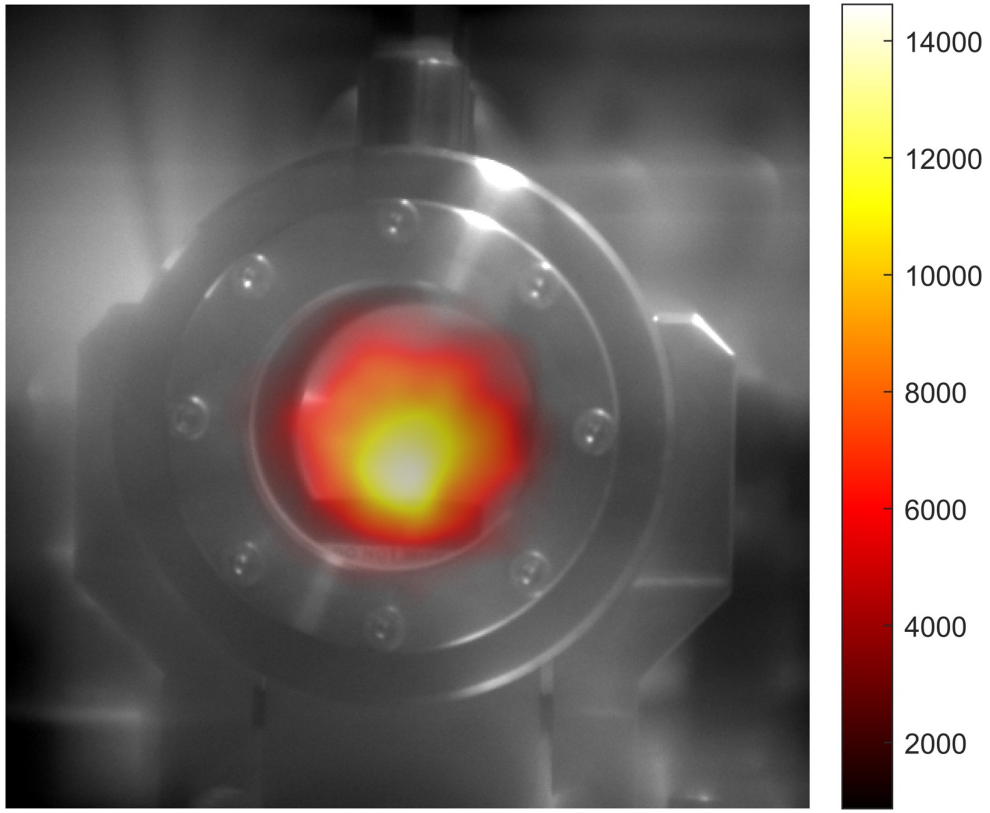
3.7 MBq

2. Second image with an UV-transmissive filter

Exposure time: 3 s



3. Images overlaid



Conclusions

- Rapid Imaging of α sources demonstrated in N_2/NO atmosphere
- In normal air, the same measurement requires hours of exposure
- Short exposure allows for real time surveillance camera type applications