Probing Aerosols in Cloud Microstructures with Single Particle "Fast TRAC"

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*Patent Pending

Cloud Microstructures ≤ 1 m

Want to know the aerosols at this resolution

Aircraft flies at 150 m/s

Need time resolution 1 m/150 m/s

= 6 ms (!!!!!)

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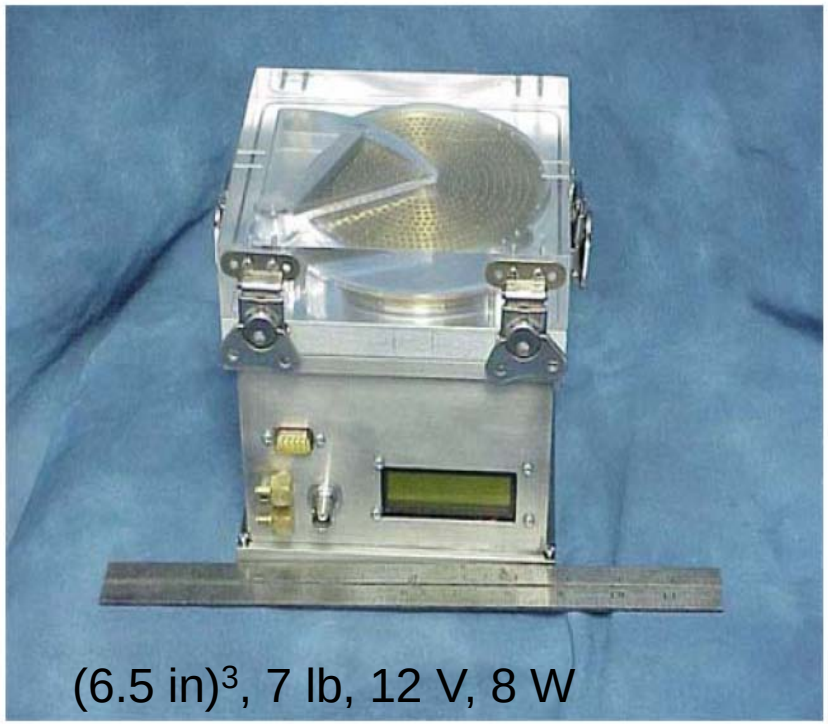
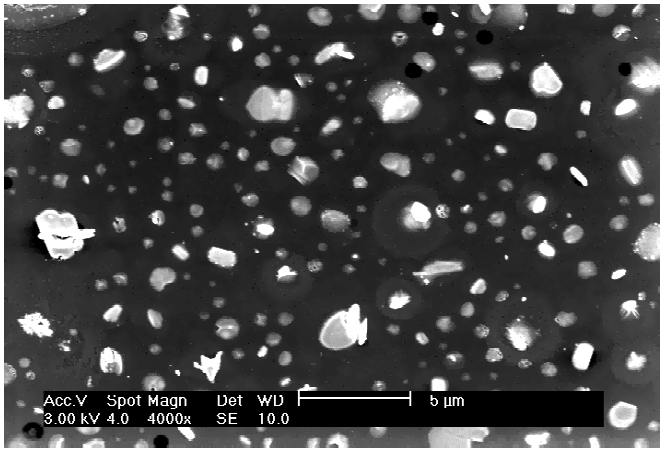
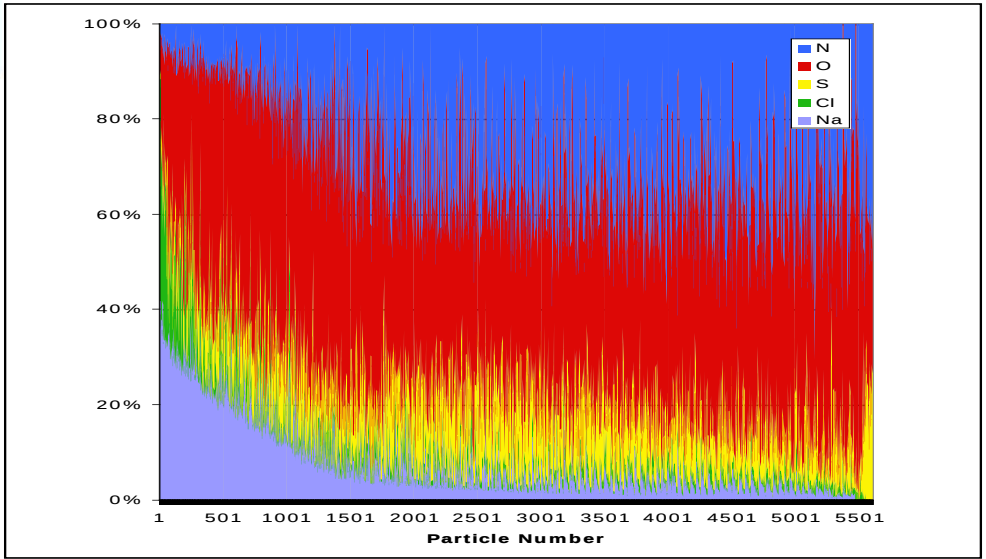
What is TRAC? - Time-Resolved Aerosol Collector

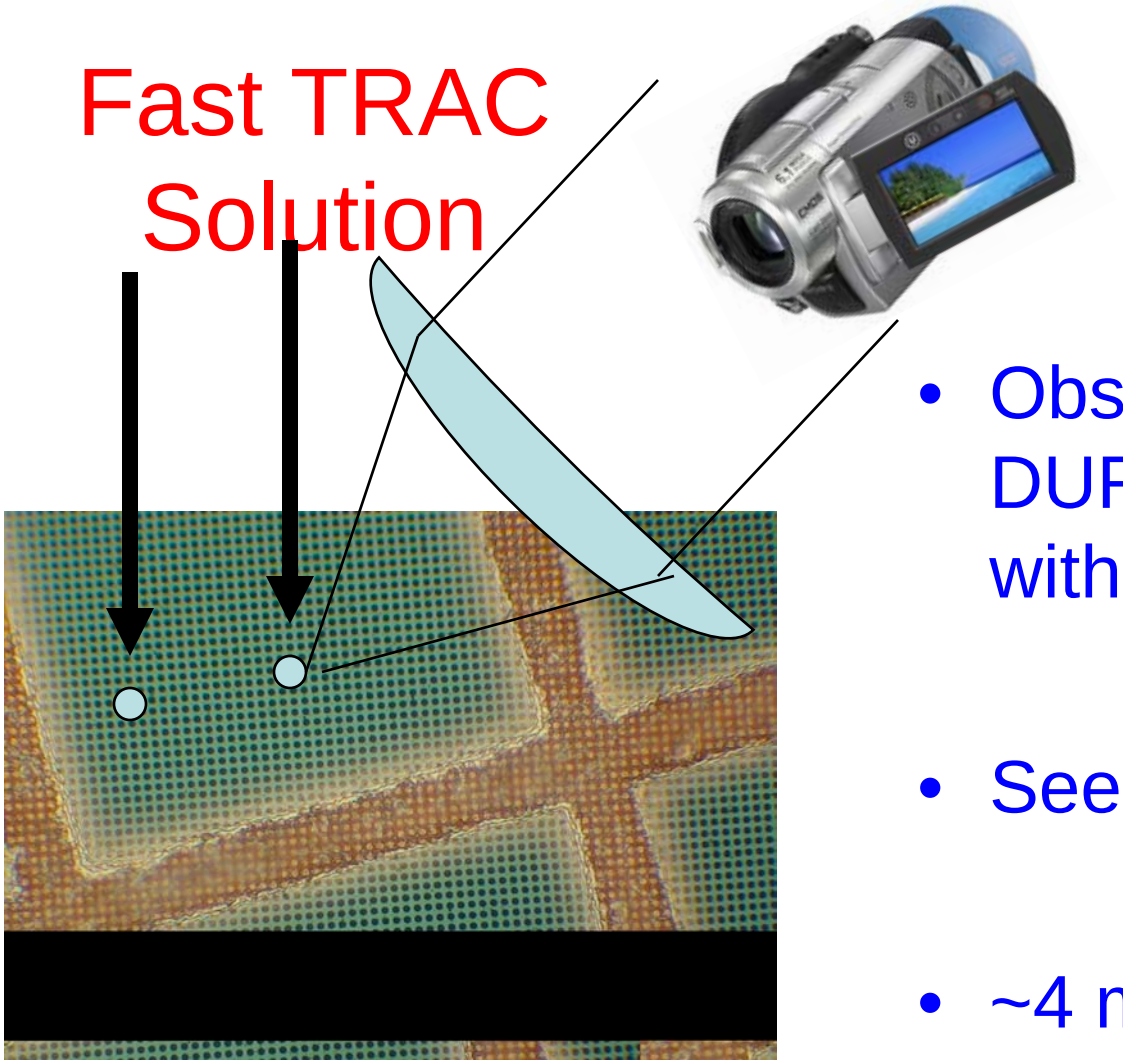


- Uses an impactor
- ~ 600 TEM samples
- Flow rate: 1 l/min
- Time resolution: ≥ 1 min*
- Applications: Off-line analysis:
  - particle hygroscopicity, morphology, composition..





Fast TRAC Solution



- Observe the particles DURING their collection with video microscope
- See ≥ 100 nm particles
- ~4 ms time resolution

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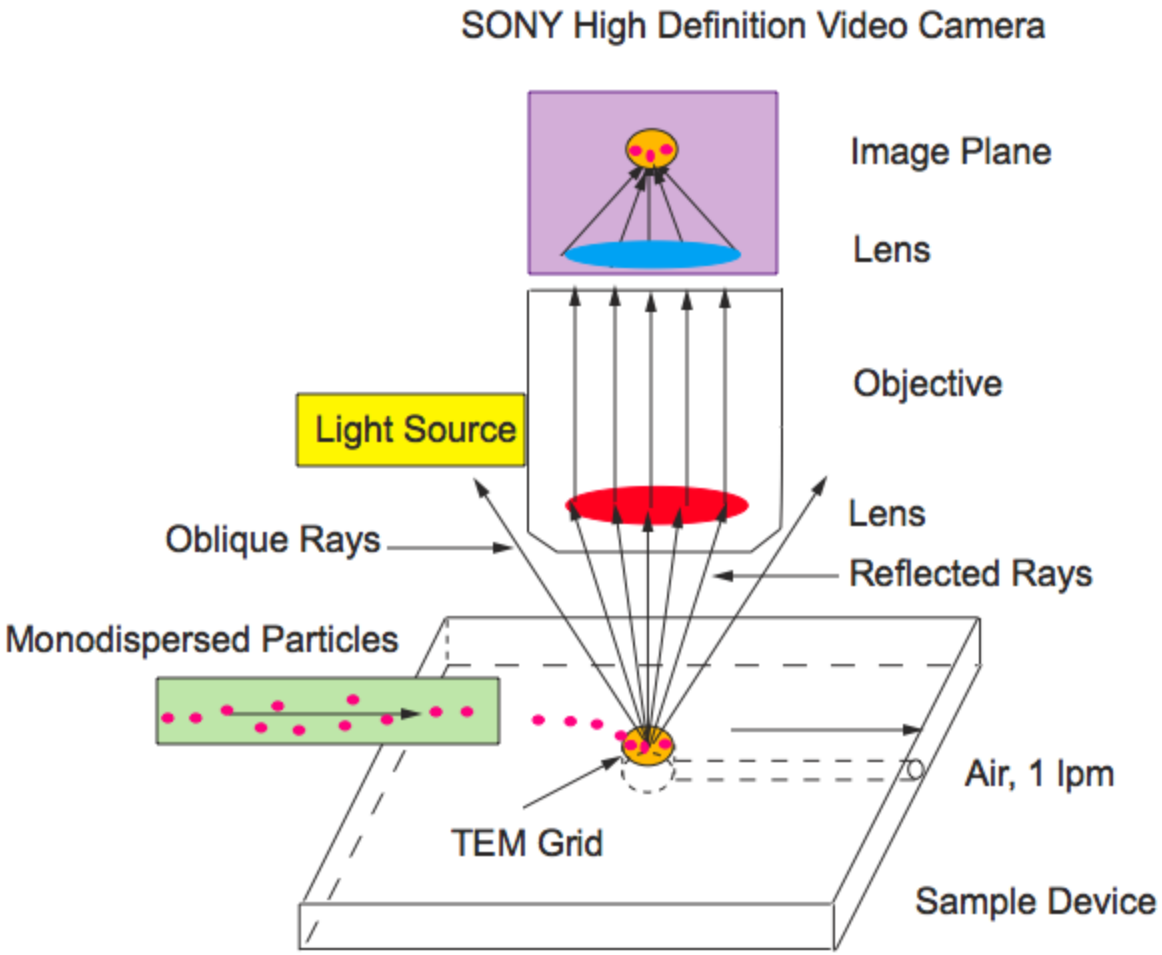
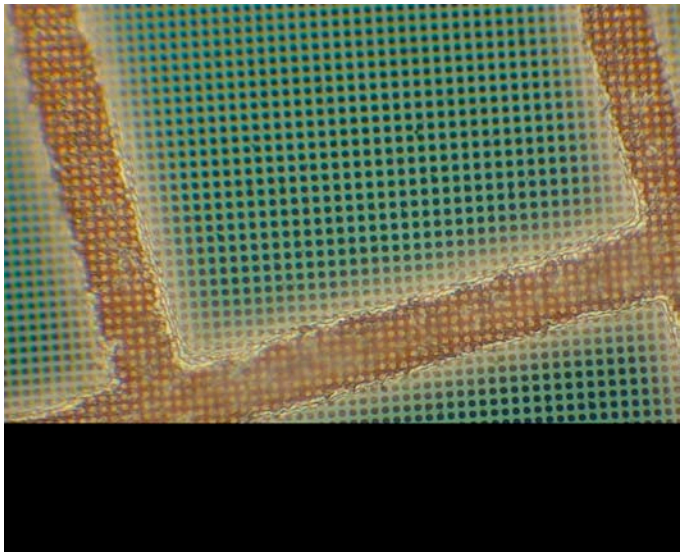
Proof of Concept



TEM grid Quantifoil 1.2 micron holes on 2.5 micron centers



- Tested several sizes of monodispersed particles ≥ 100 nm

Results - movies of 200 nm lab particles

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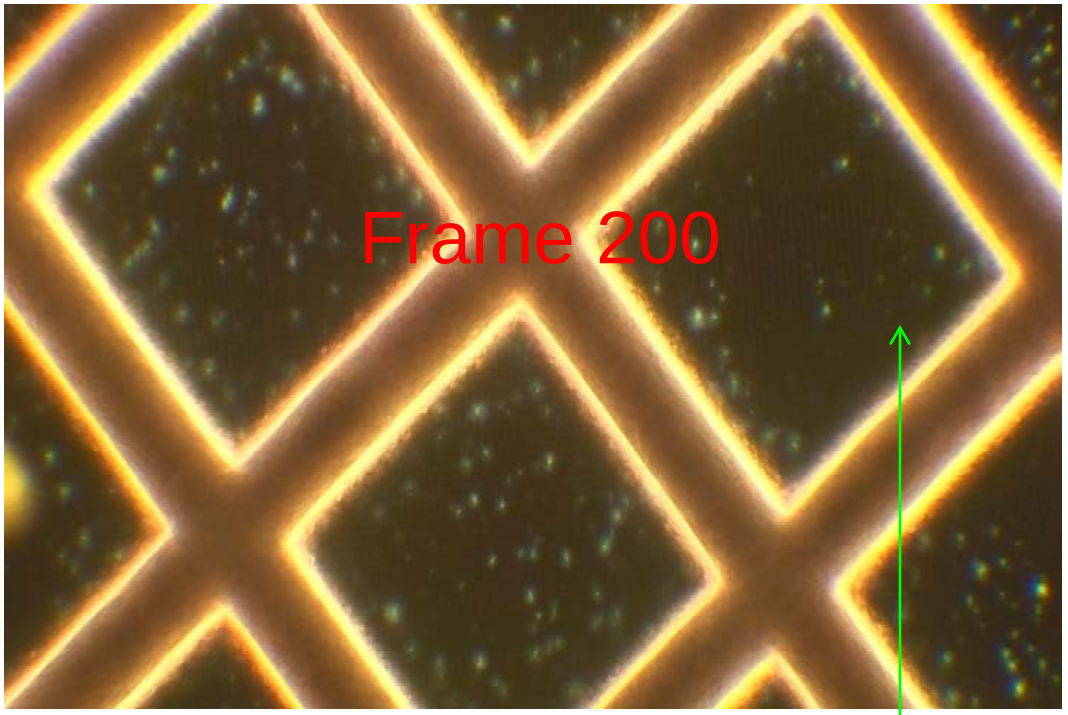
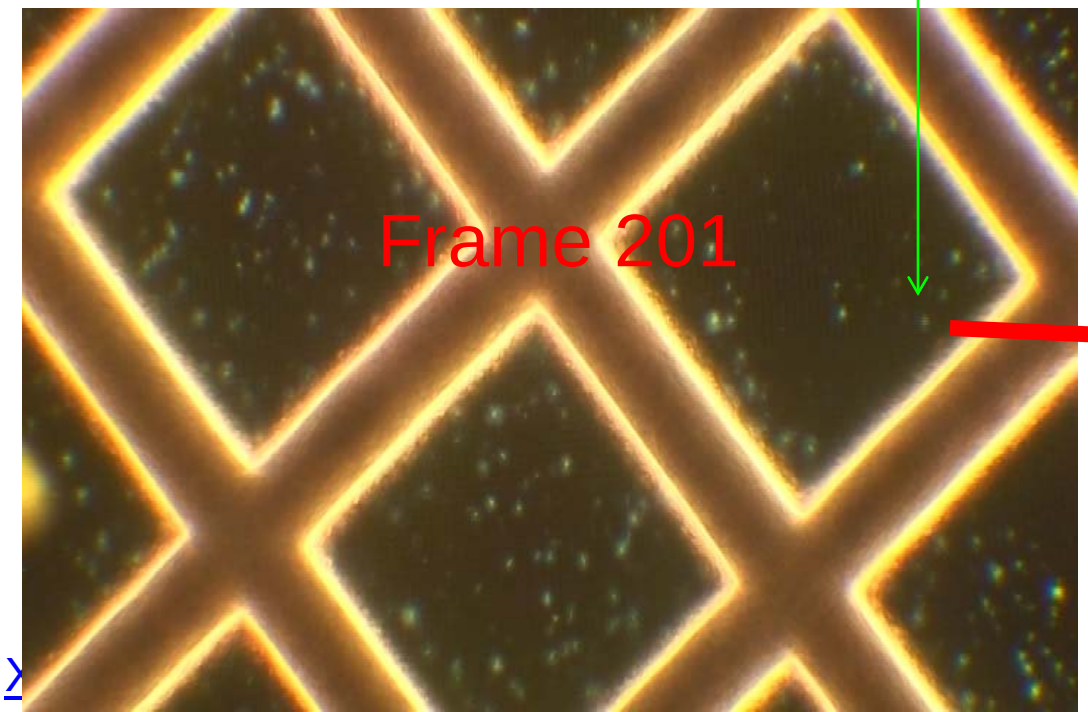
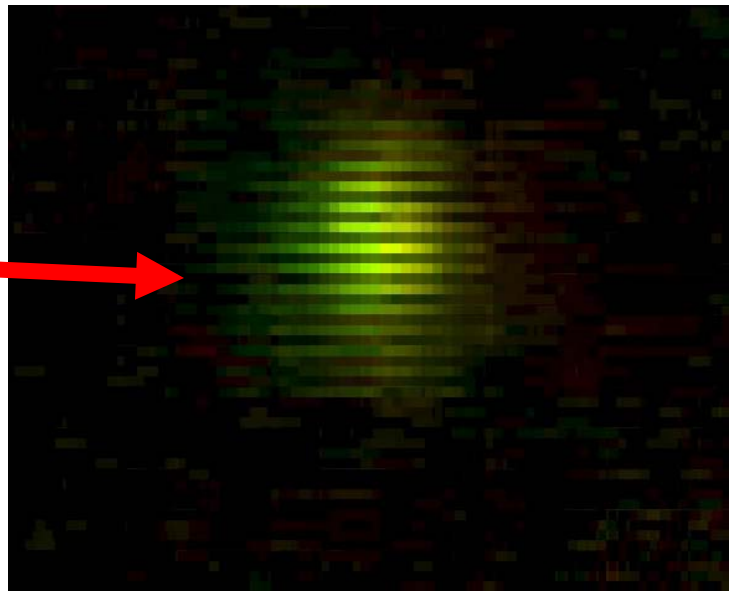
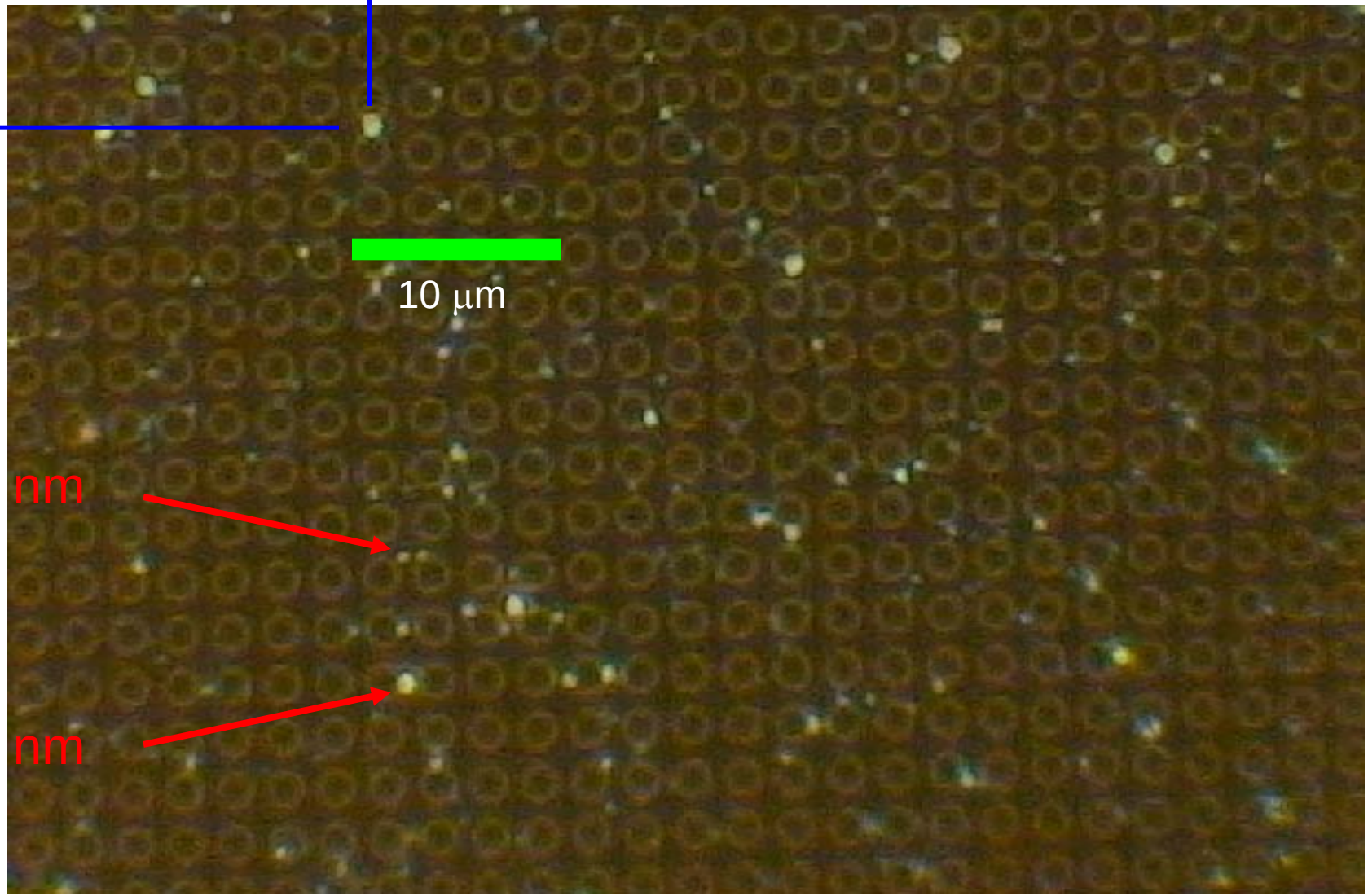




Difference photo is black except for diffraction-limited image of 200 nm particle



Particle locations to +/- 0.1 micron



Real-time Optical Sizing !!!!

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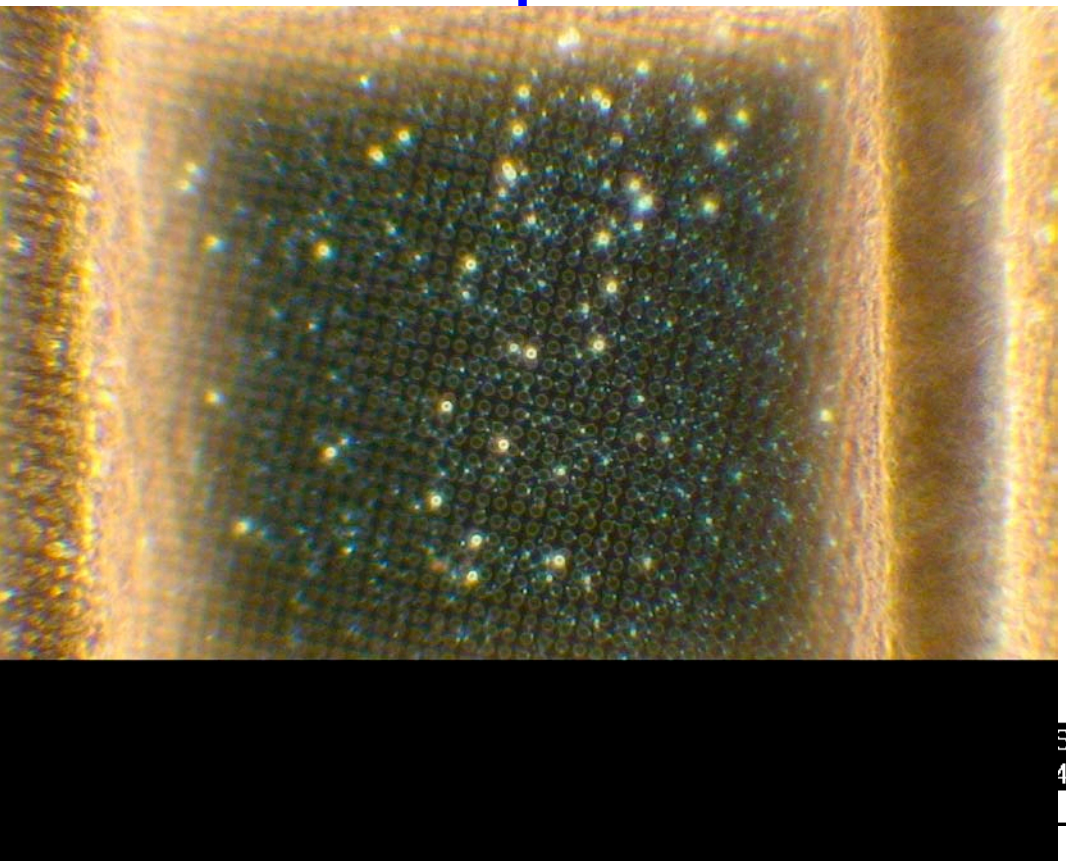
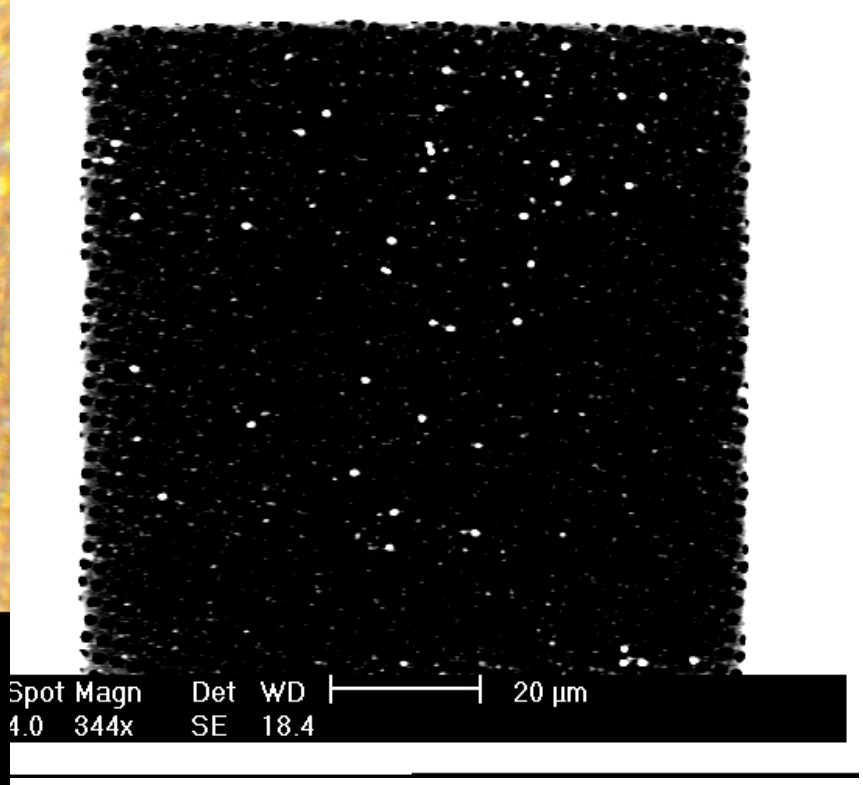
Optical and SEM Photos





Optical particle map and times

SEM/EDX map and elemental analysis

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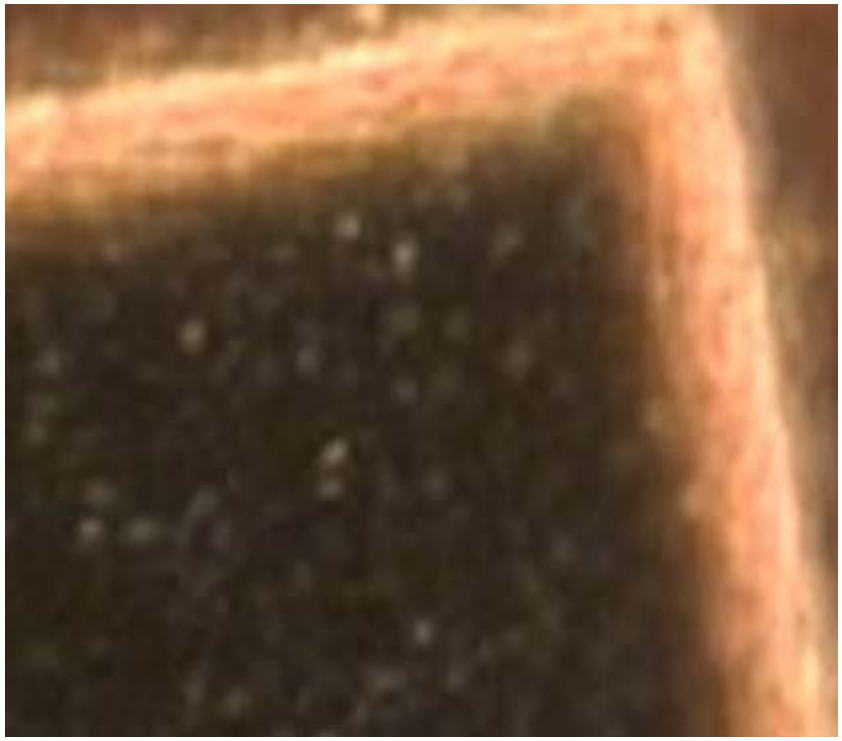
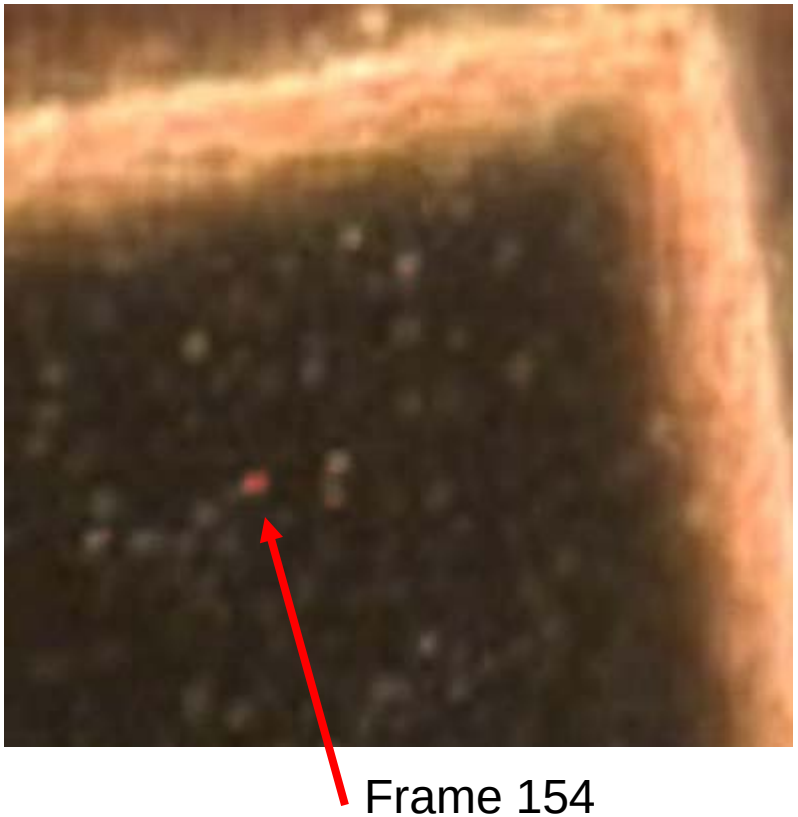
Fast Framing



Frame 153



Frame 154

New 100 nm
Particle Arrives

- 240 frames/sec
- 4 ms per frame
- See ≥ 100 nm particles arriving

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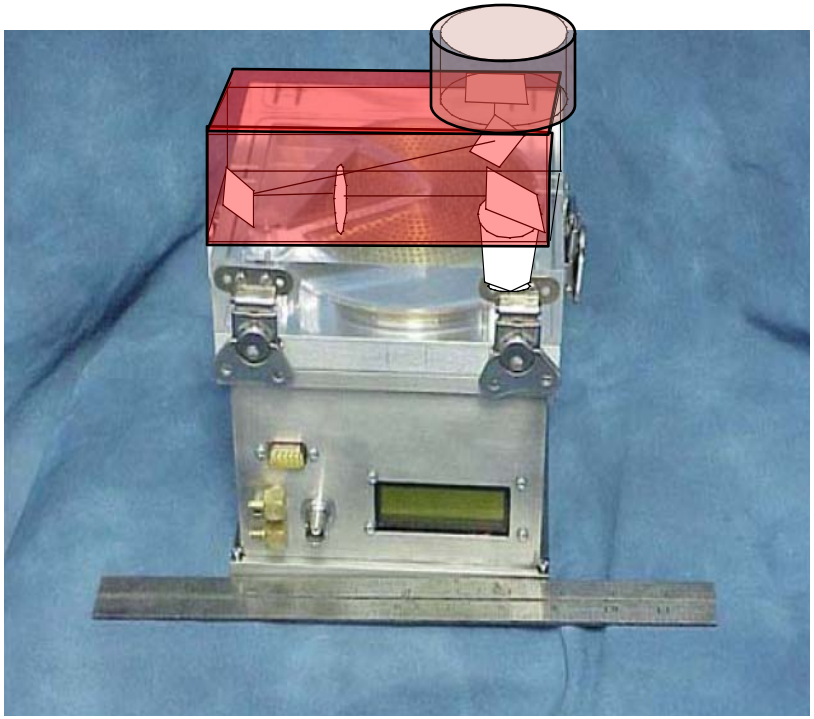
Fast TRAC Features

Size of new Fast-TRAC



- Real-time particle optical sizing
- 4 ms time resolution
- Extensive off-line analyses
- **Good for cloud microstructures**
- **And plumes**

Future Work

- Make it field-portable
- Deploy Fast TRAC in field campaigns
- Collaborations

PNNL's Fast TRAC for cloud microstructures and plumes

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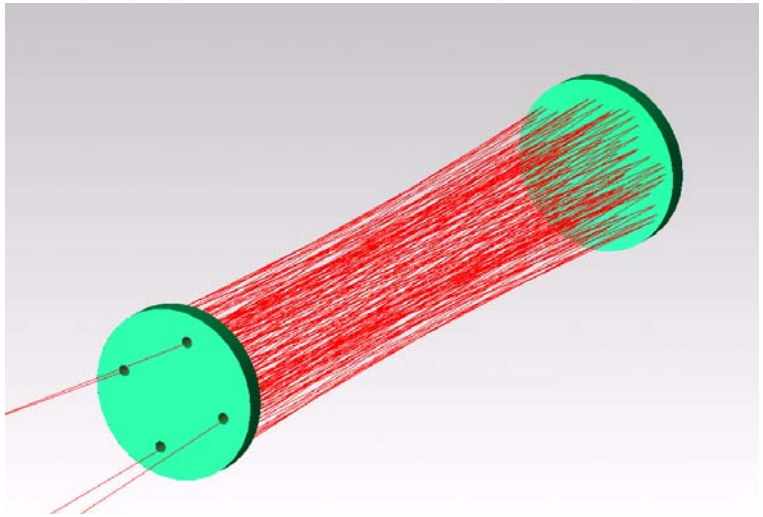
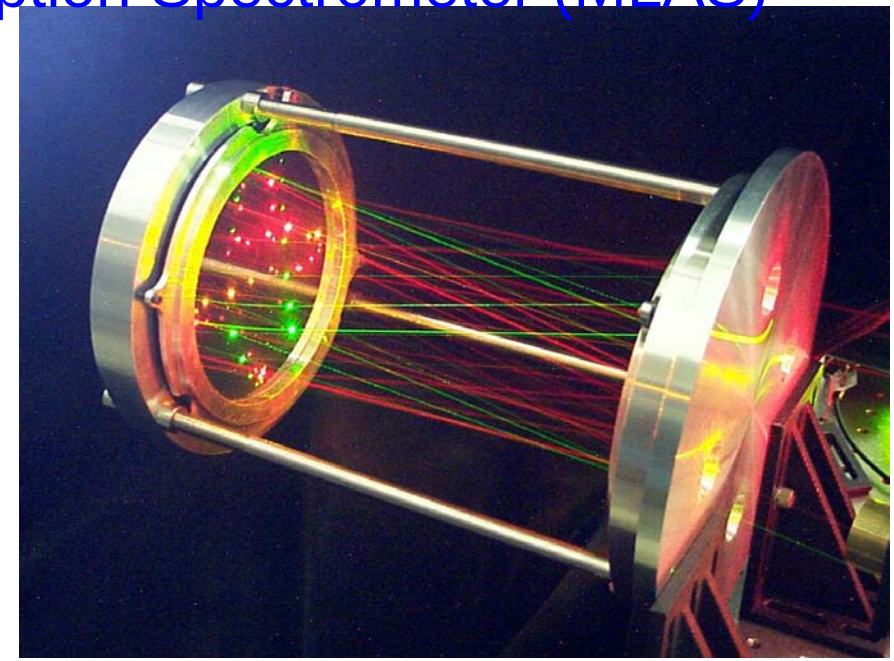
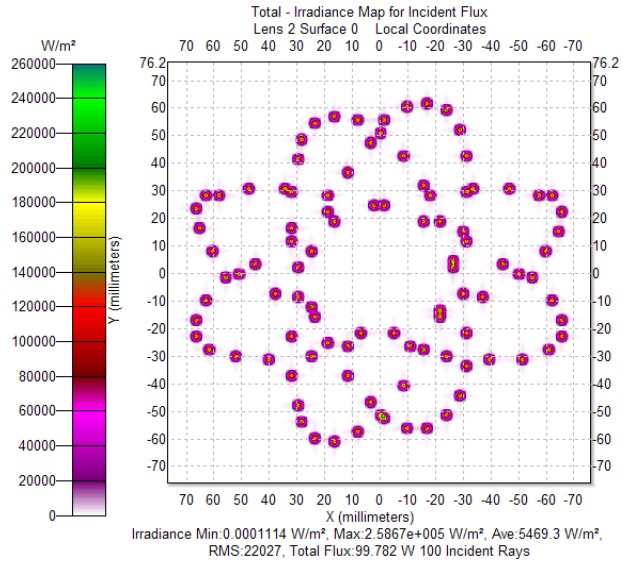
The Newest Achievement
Multichannel Laser Absorption Spectrometer (MLAS)



Theoretical design for 4 lasers





MLAS prototype uses 4 lasers

- Channel 1: 543.5 nm (green)
- Channel 2: 593.5 nm (yellow)
- Channel 3: 670 nm (red)
- Channel 4: 670 nm (red)

This technique offers the chassis of many applications, such as high sensitivity hygrometer or simultaneous detection of multiple compounds of interest by a compact sensor.

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