Measurements of aerosol and cloud particles from in situ polarized nephelometers to remote sensing with the PACS/HARP system

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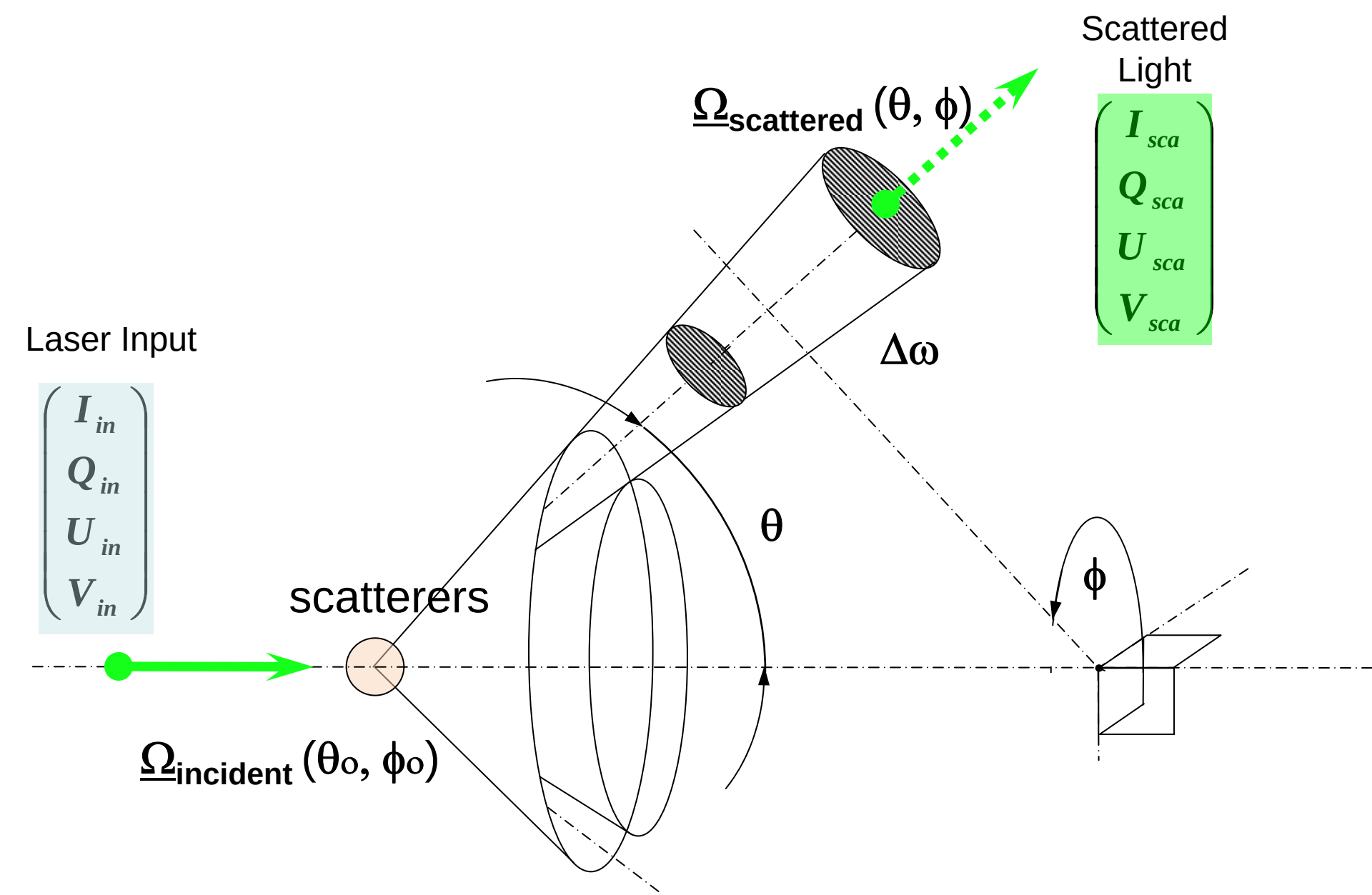
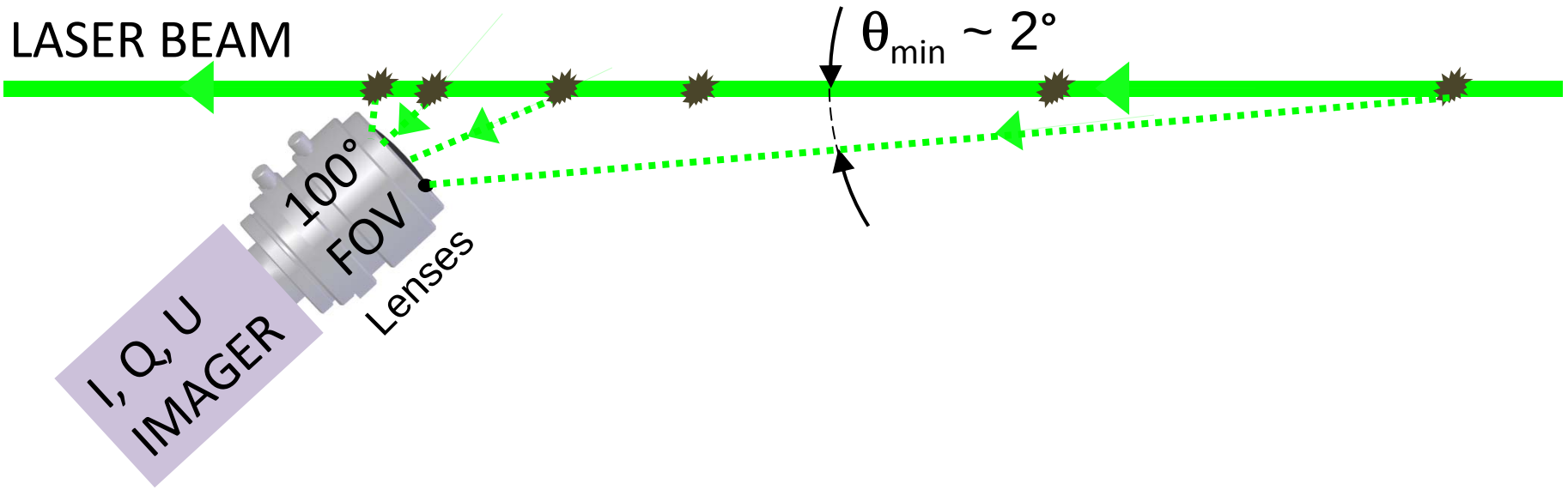
1- UMBC/LACO – JCET
2- NASA GSFC

Workshop on Observations and modeling of aerosol and cloud properties for Climate Studies – Paris 12-14 September 2011

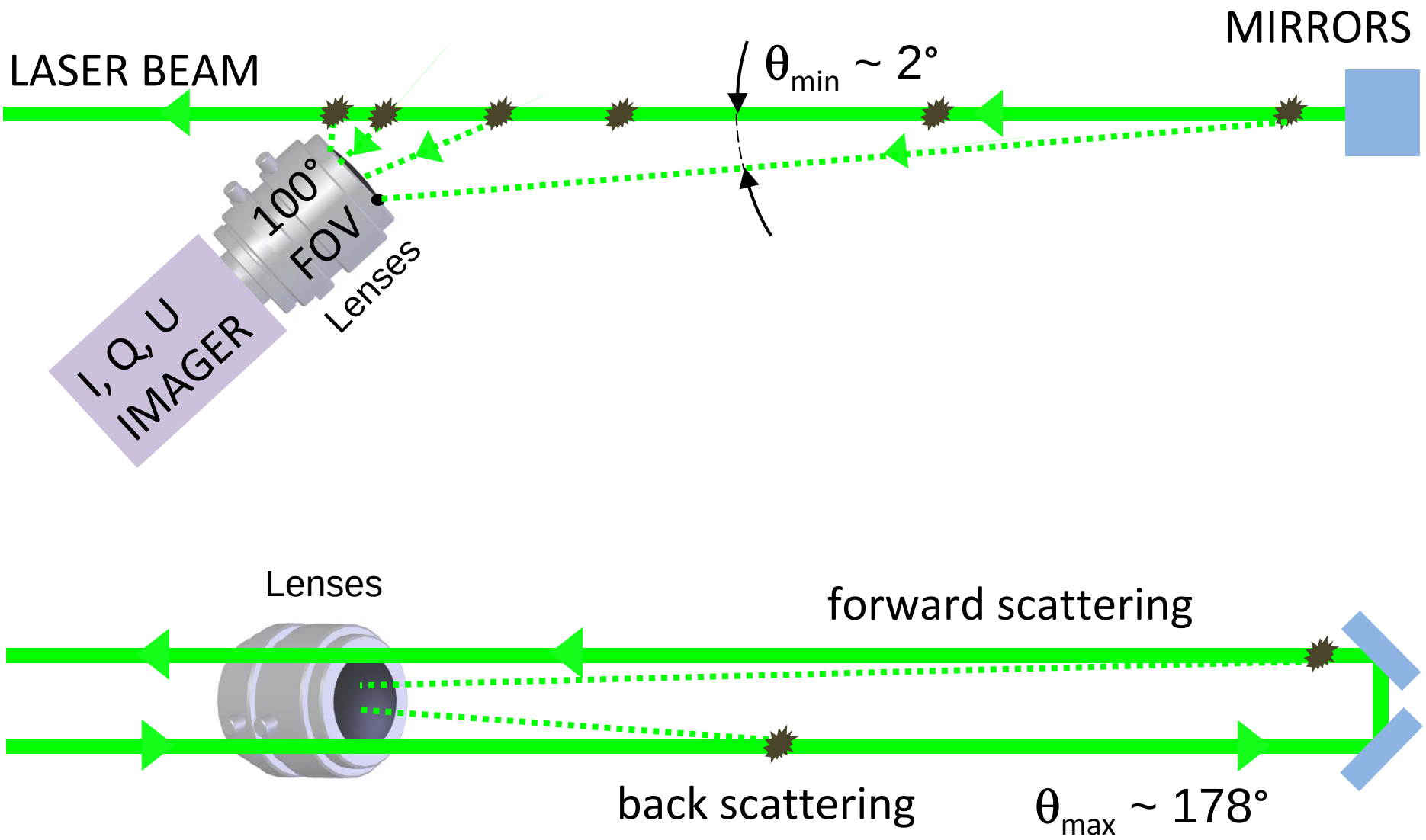

Scattered Light
$\underline{\Omega}_{scattered}\,(\theta, \phi)$
$\begin{pmatrix} I_{sca} \\ Q_{sca} \\ U_{sca} \\ V_{sca} \end{pmatrix}$
Laser Input
$\begin{pmatrix} I_{in} \\ Q_{in} \\ U_{in} \\ V_{in} \end{pmatrix}$
$\Delta\omega$
θ
ϕ
scatterers
$\underline{\Omega}_{incident}\,(\theta_o, \phi_o)$

Polarized Imaging Nephelometer

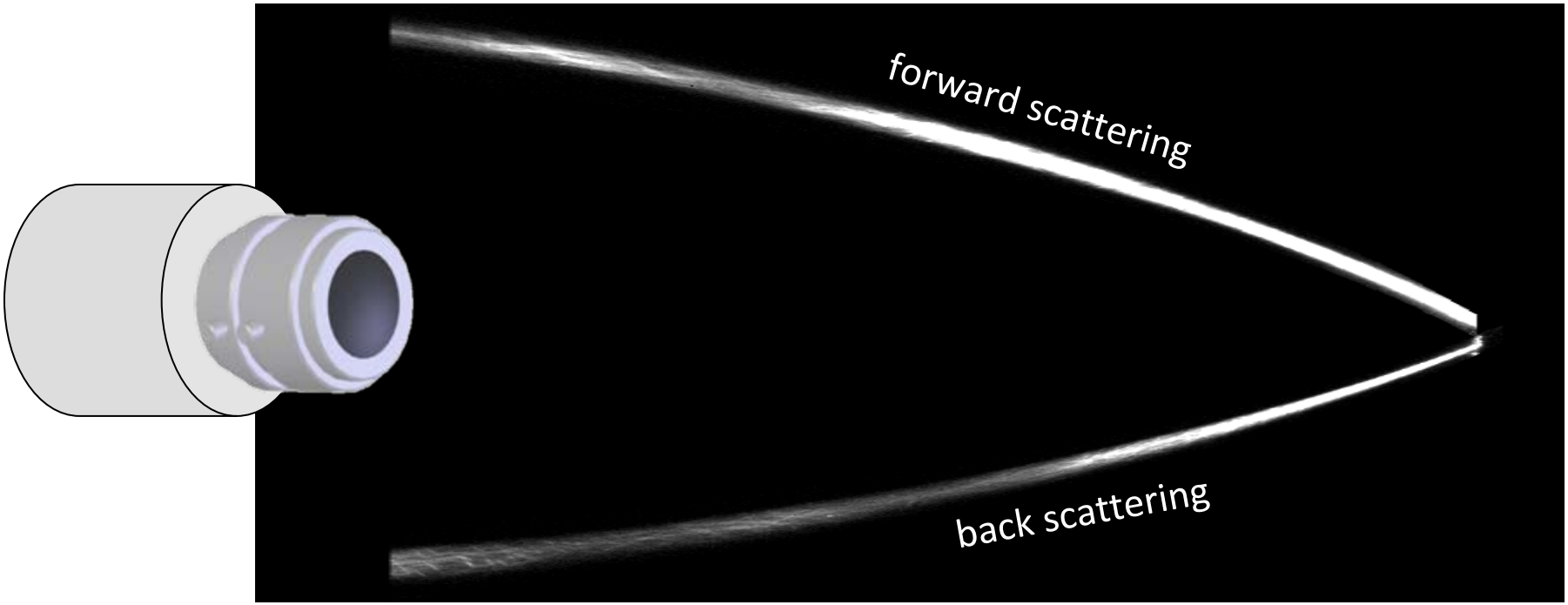


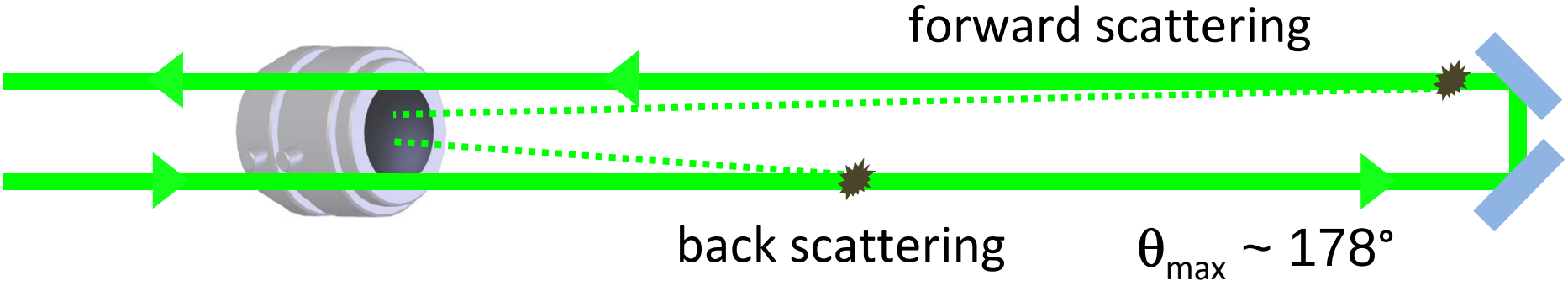
- Funded as part of the Langley DEVOTE project to be demostrated on the Langley B200 aircraft

Polarized Imaging Nephelometer

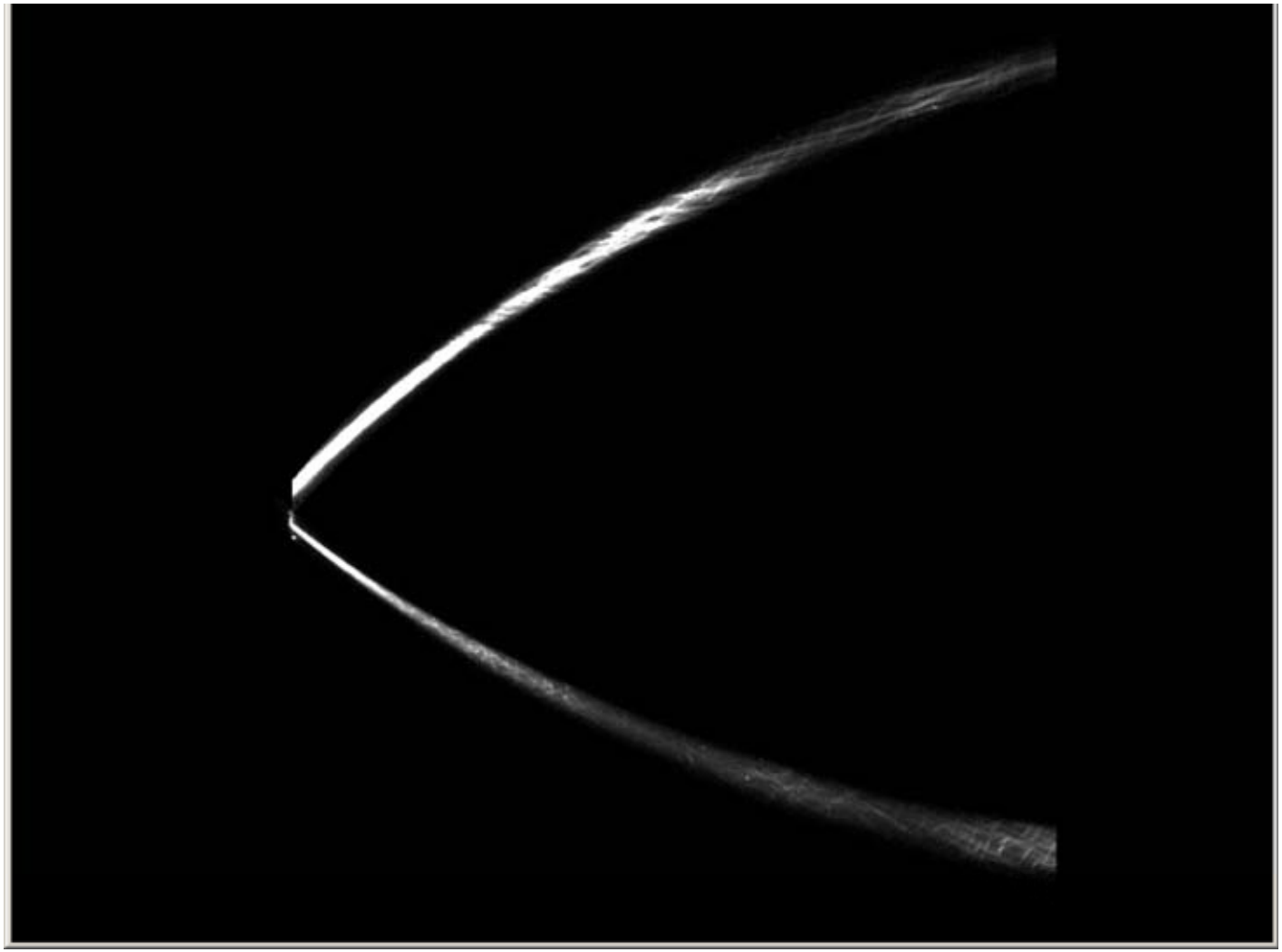


Real Picture of the scattered beam:

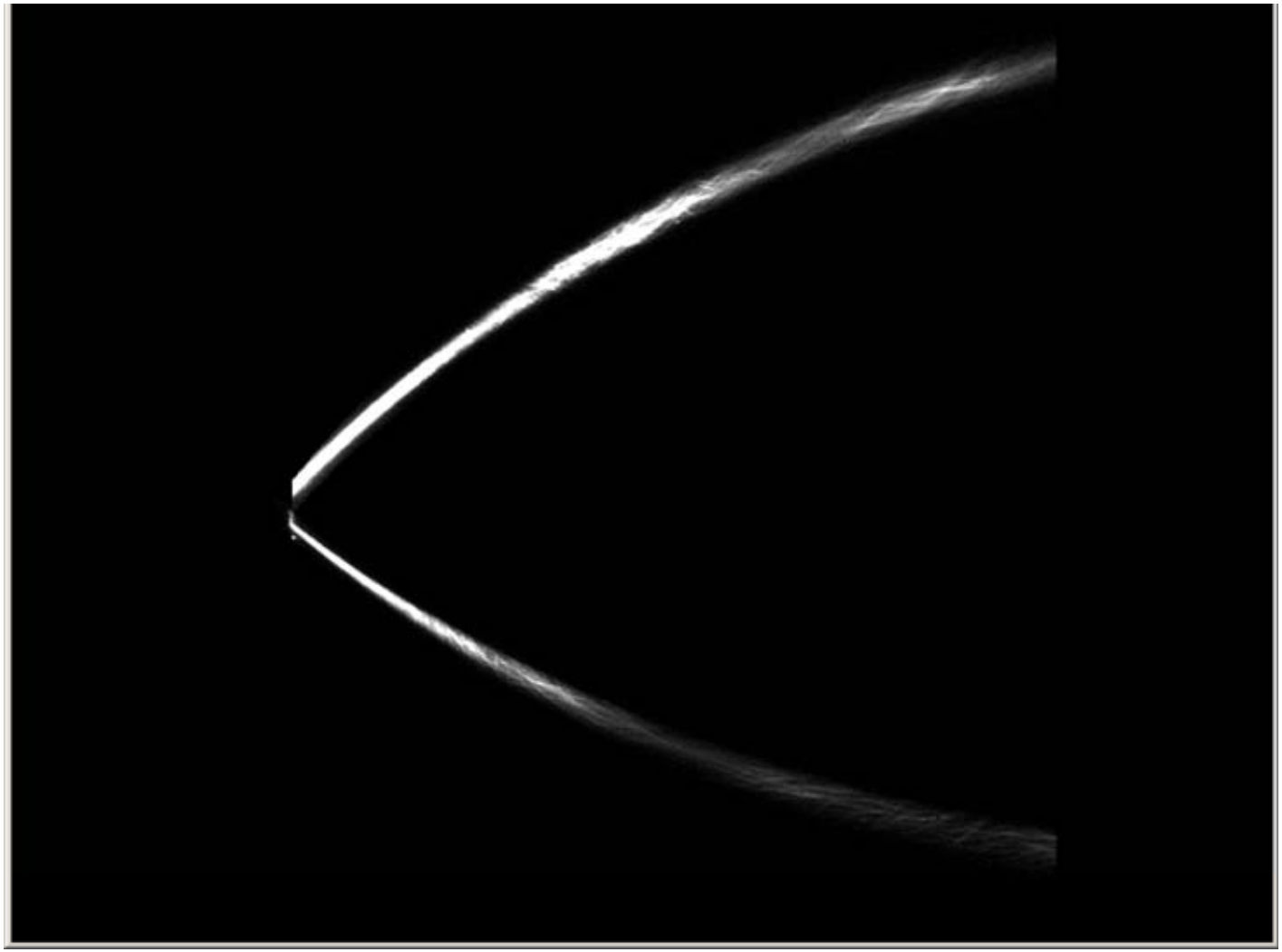


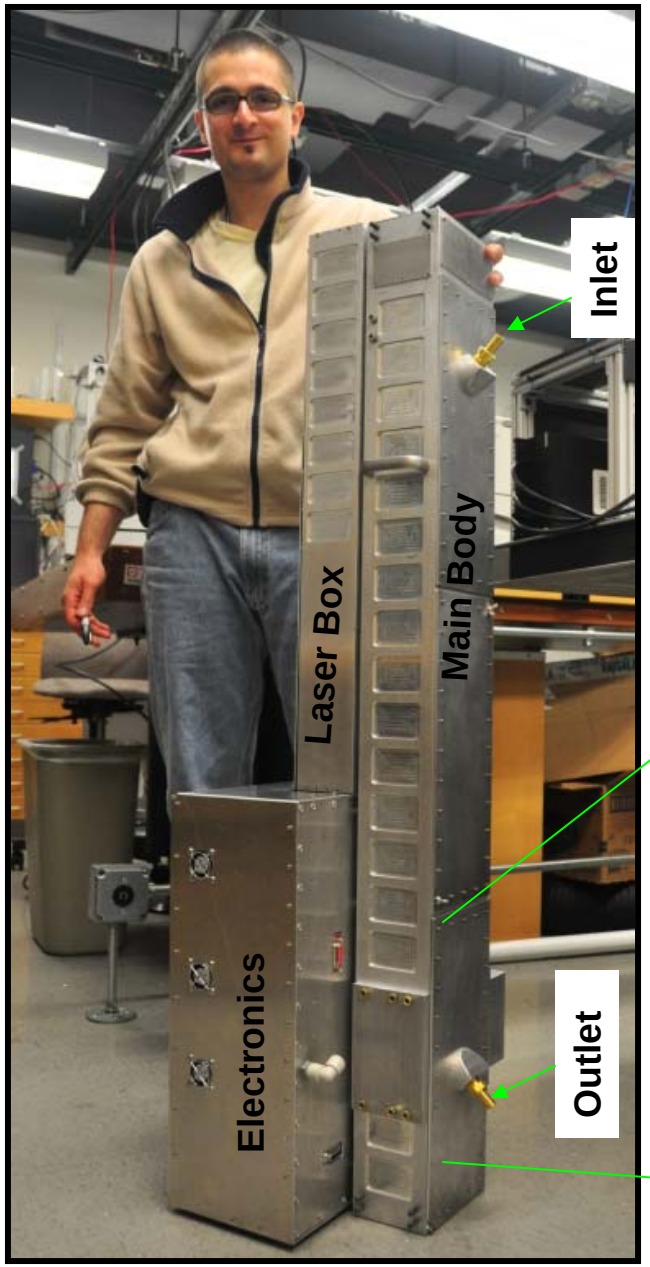


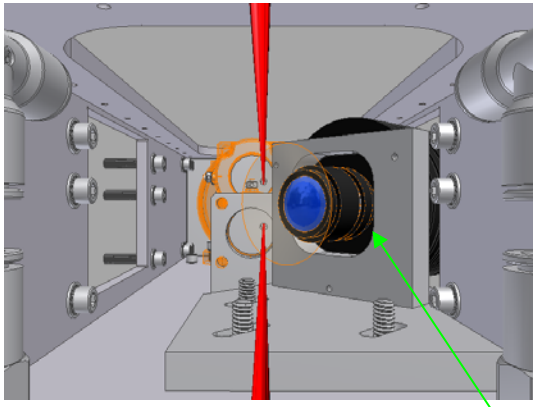
Laser Polarized at 0deg

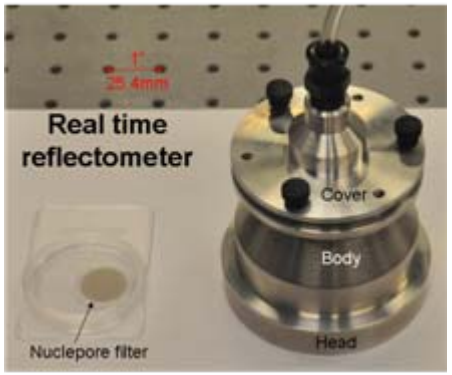


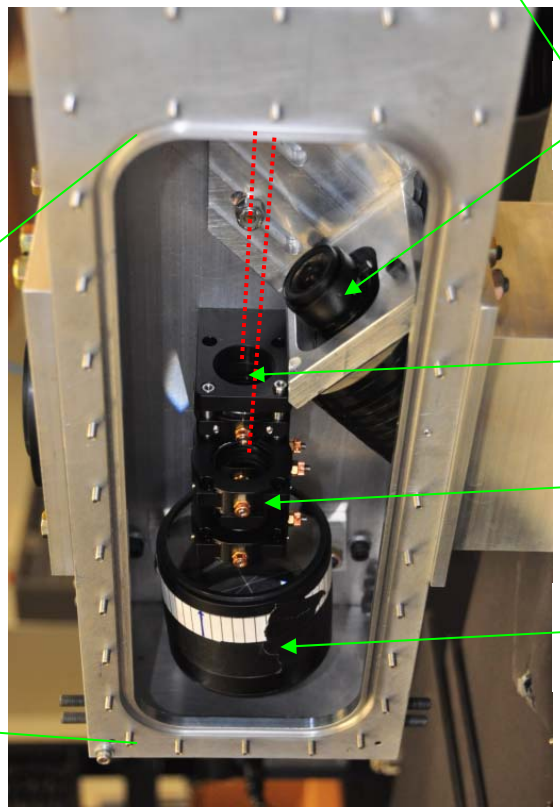
Laser Polarized at 90deg











Scattering Camera

Laser beams

colimators

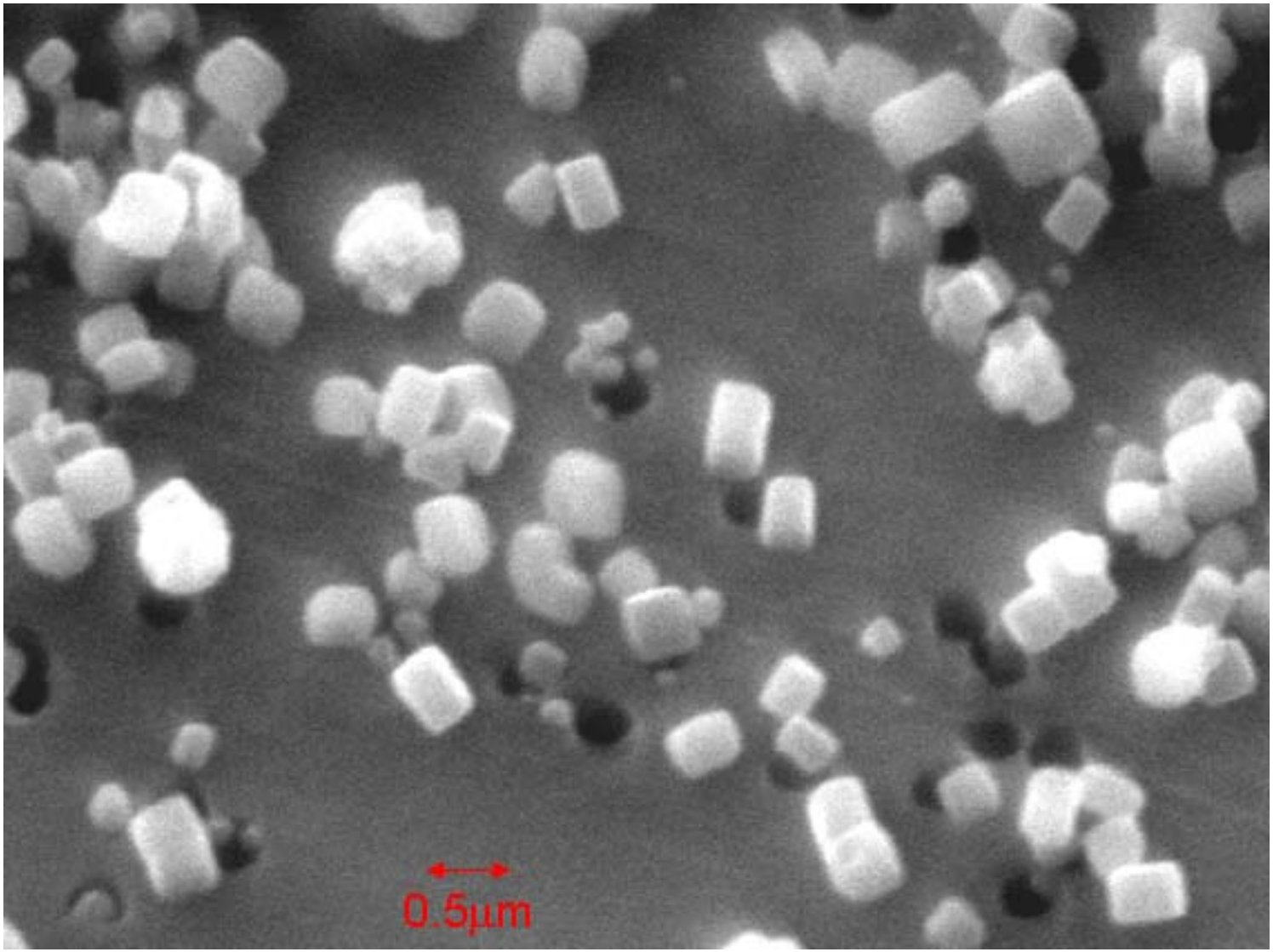
Retro-reflector

Polarized Imaging Nephelometer System

Wet and Dry Aerosol Generation

Chemical solutions » Water Droplets » dry/humidified aerosols

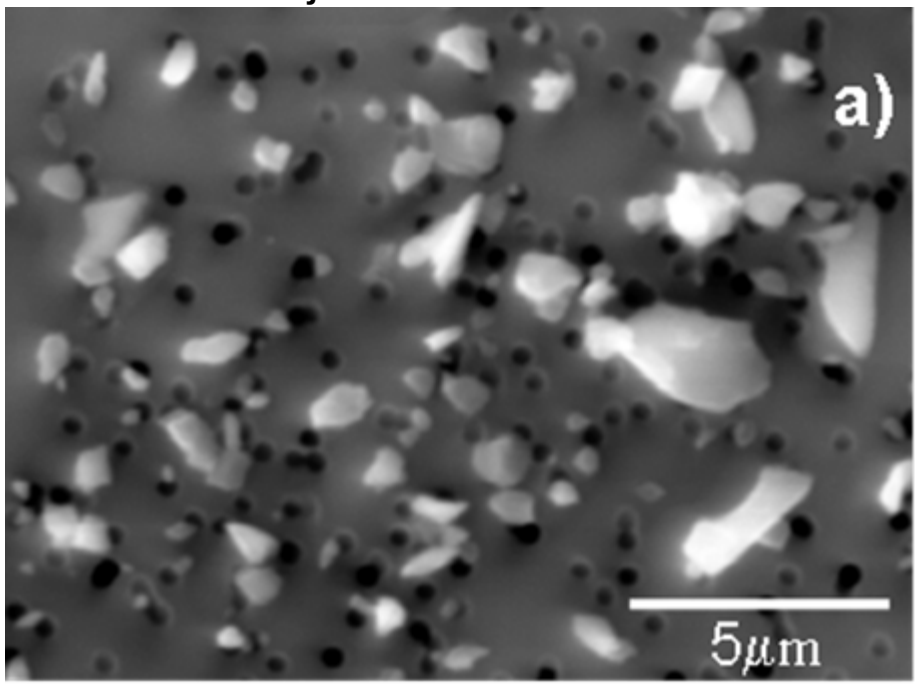
Cubic NaCl Particles



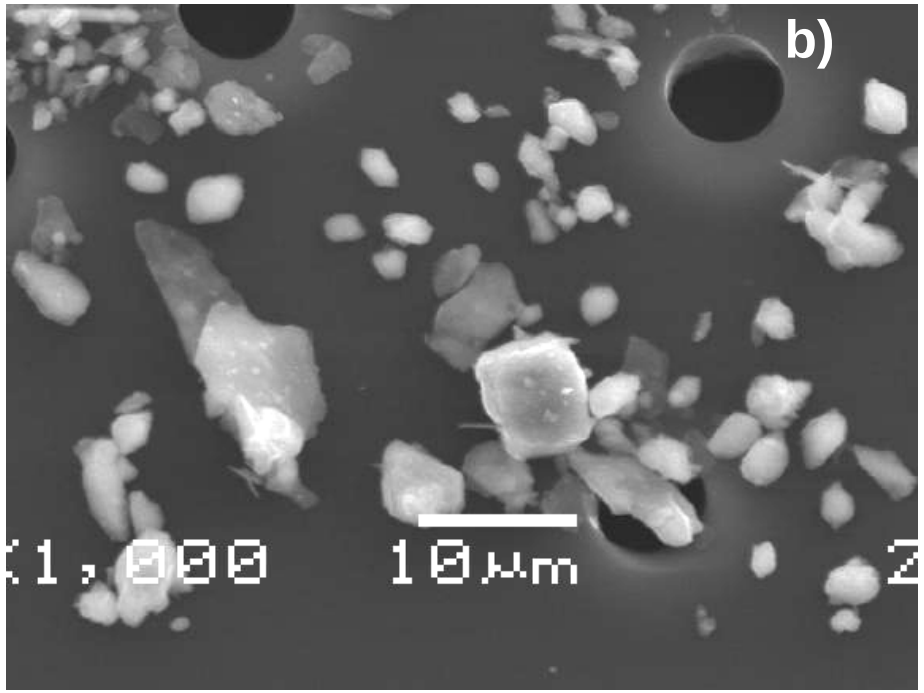
Dry Aerosol Generation

Solid Material » De-agglomeration/Re-suspension » Dry/Humidified aerosols:

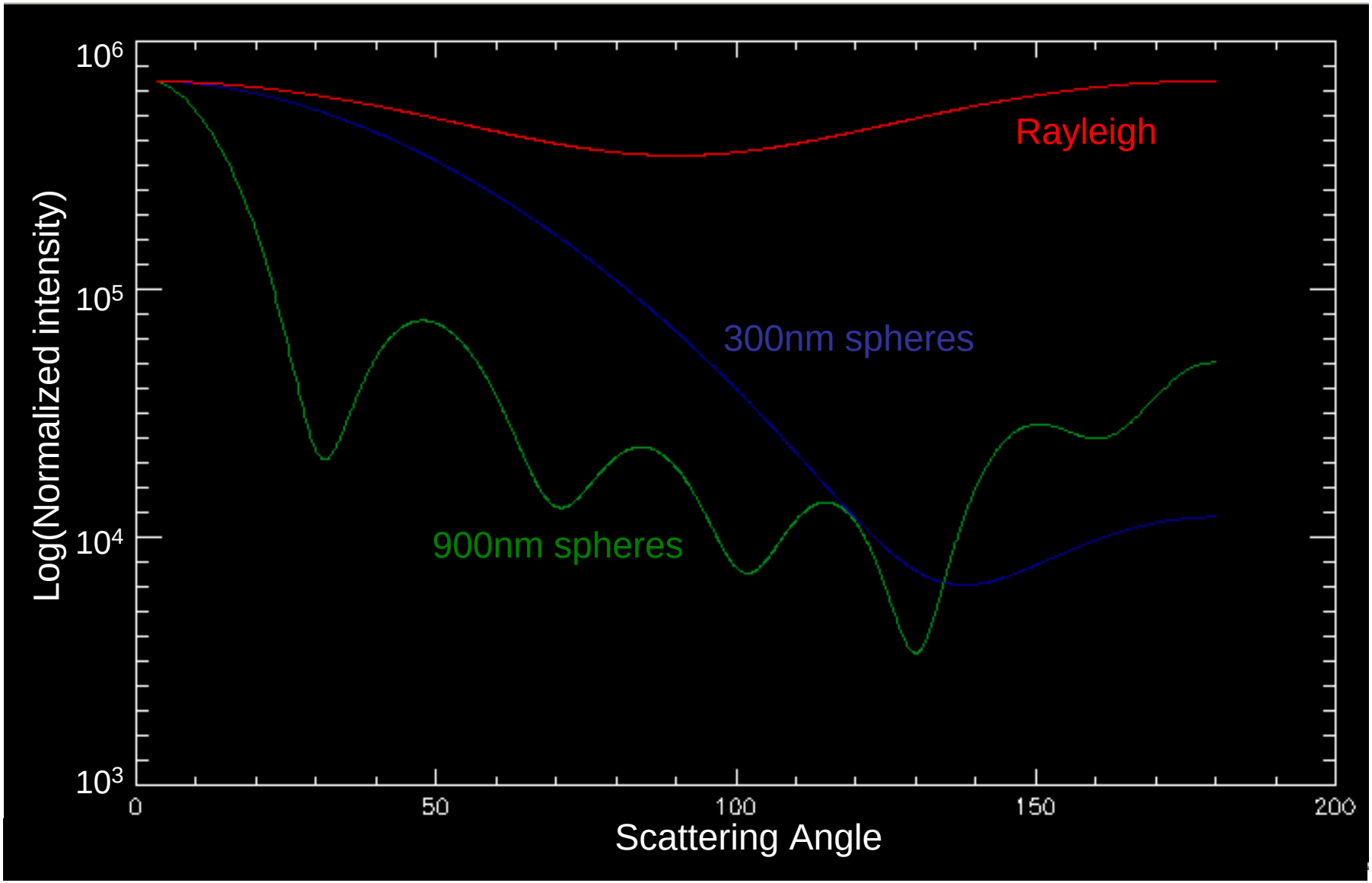
Volcano Eija 2010



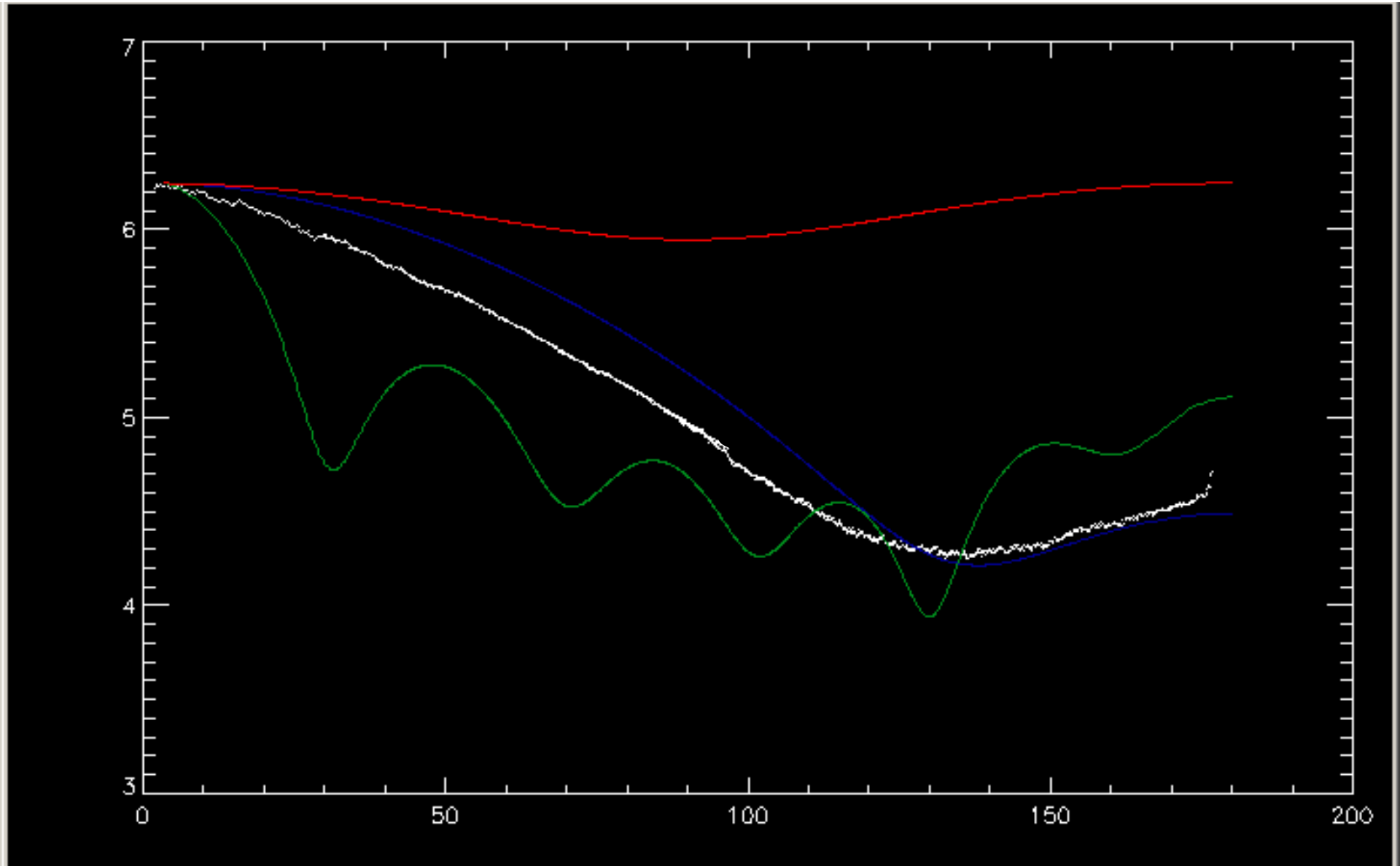
UMBC Dust



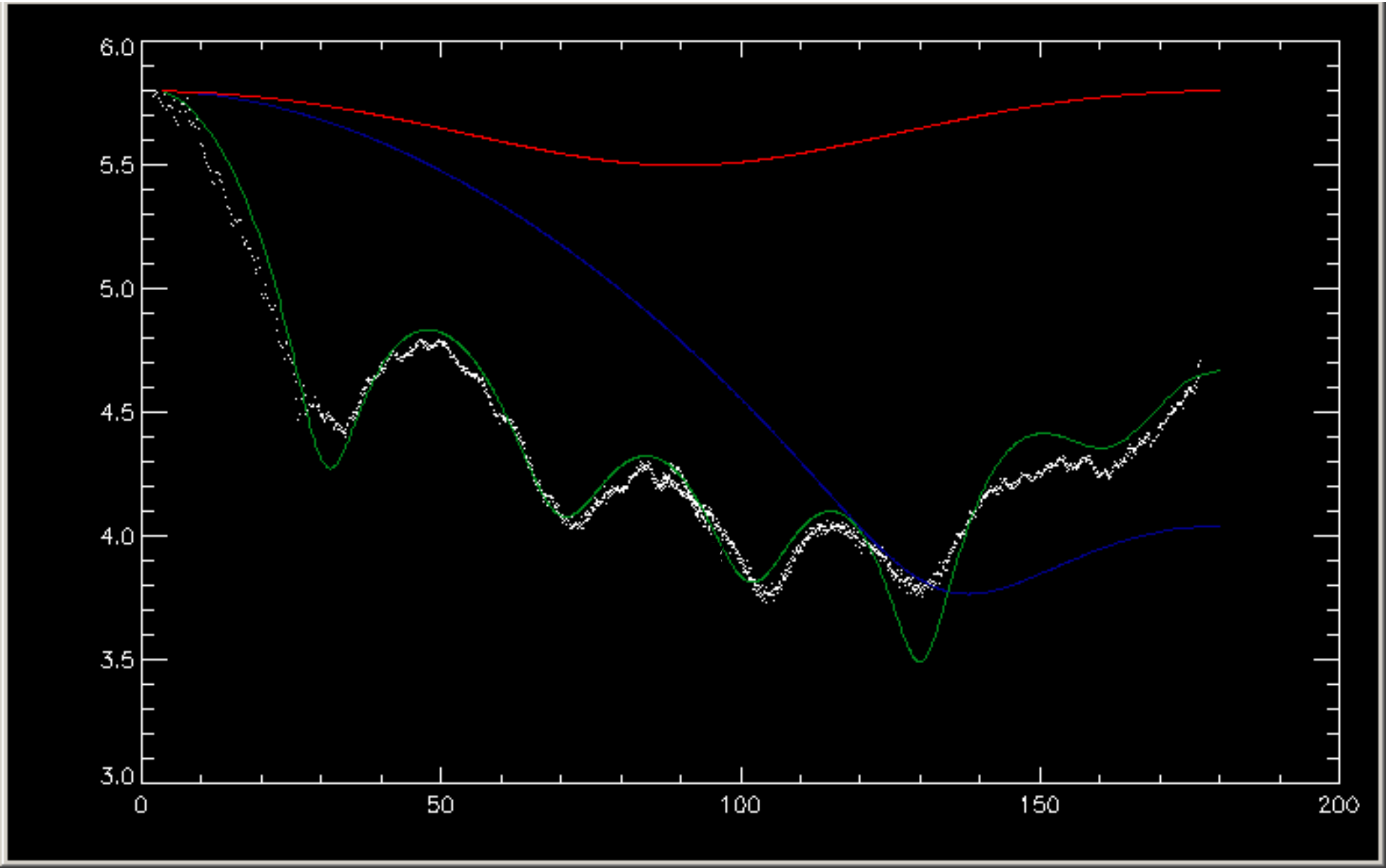
Phase Function (P11) for laboratory generated particles



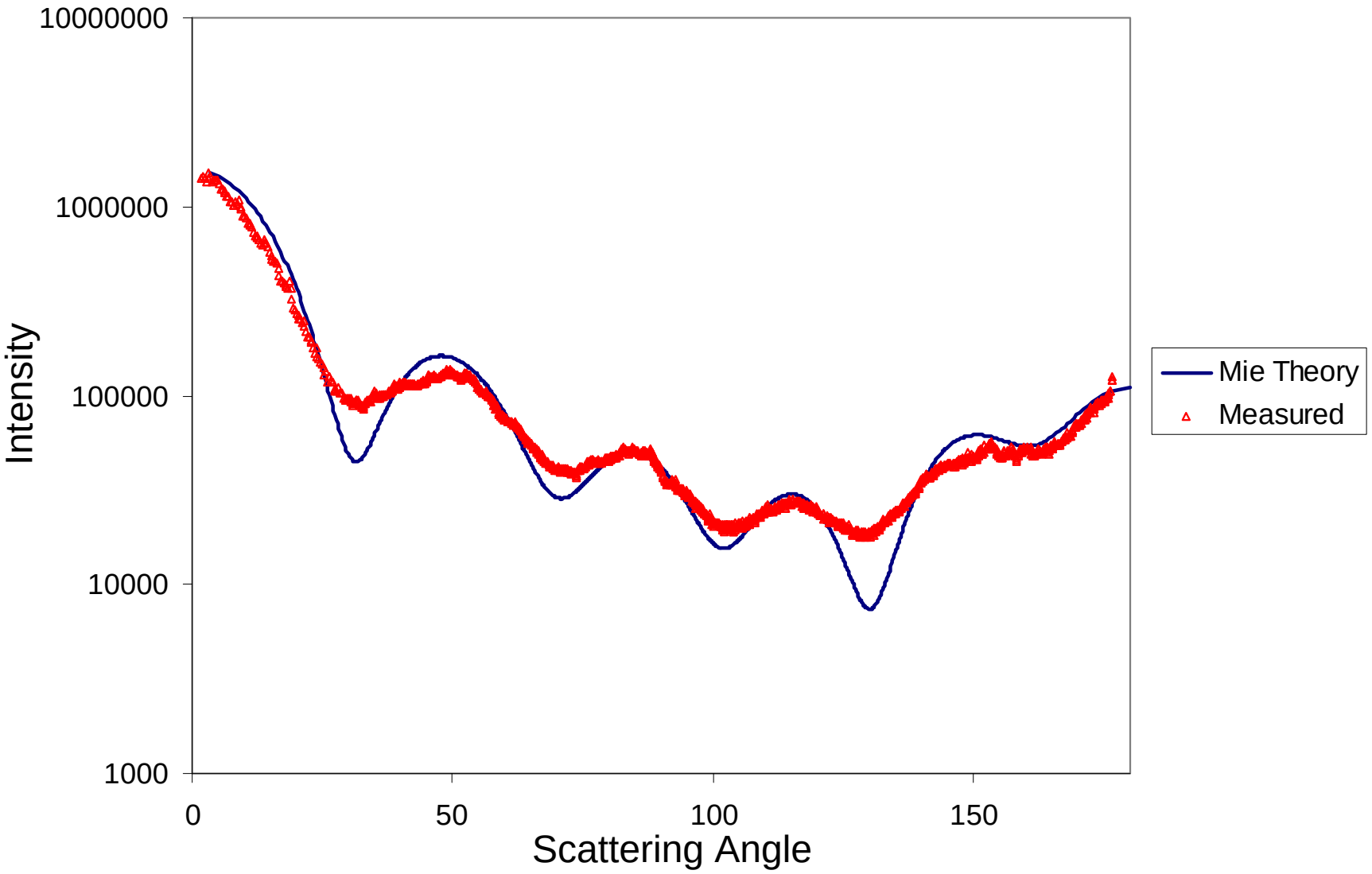
300nm Spheres after angular correction



900nm Spheres



900nm Spheres



Integration to Langley UC12 aircraft (last Friday)
1st Test Flight Tomorrow

Alternative for Polarized Remote Sensing Measurements

HARP (or PACS) – Hyper-angular Rainbow Polarimeter

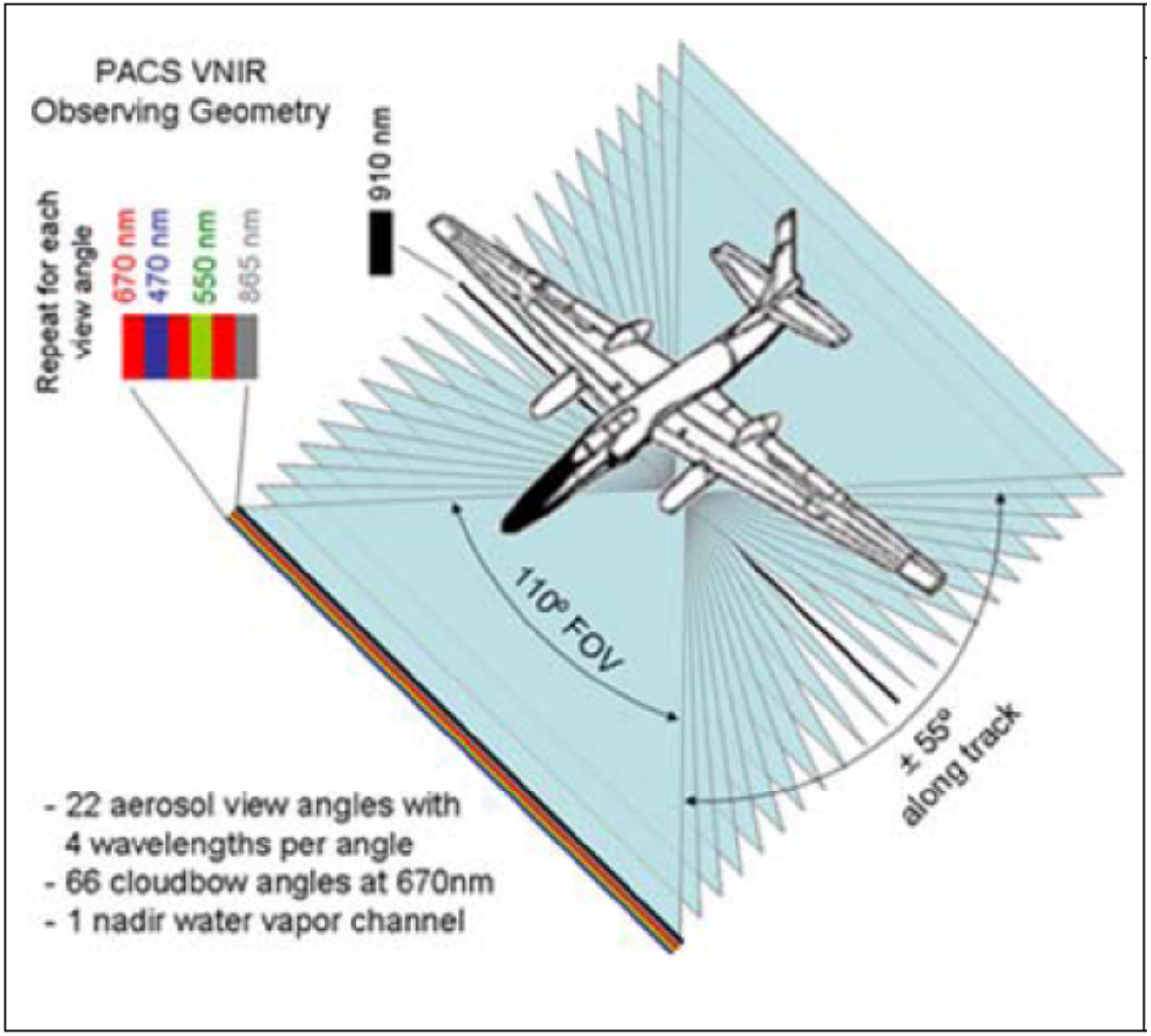
PACS/HARP Imaging Polarimeter

PACS ER-2 Facts:

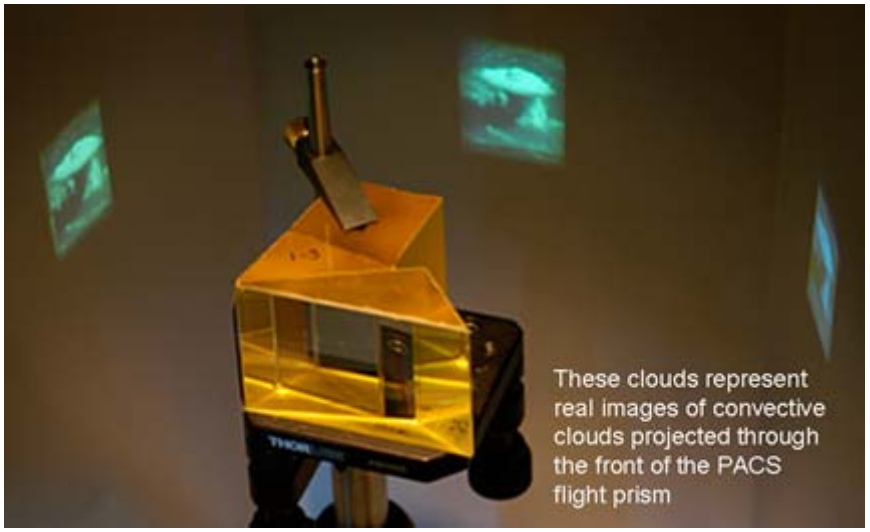
- Ground Resolution = 37m
- Swath = 37Km
- 470, 550, 670, 865, 910 nm
- 1K pixels x-track
- 22 aerosol angles
- 66 cloudbow angles at 670nm
- 110° FOV x-track
- +/-55° along-track

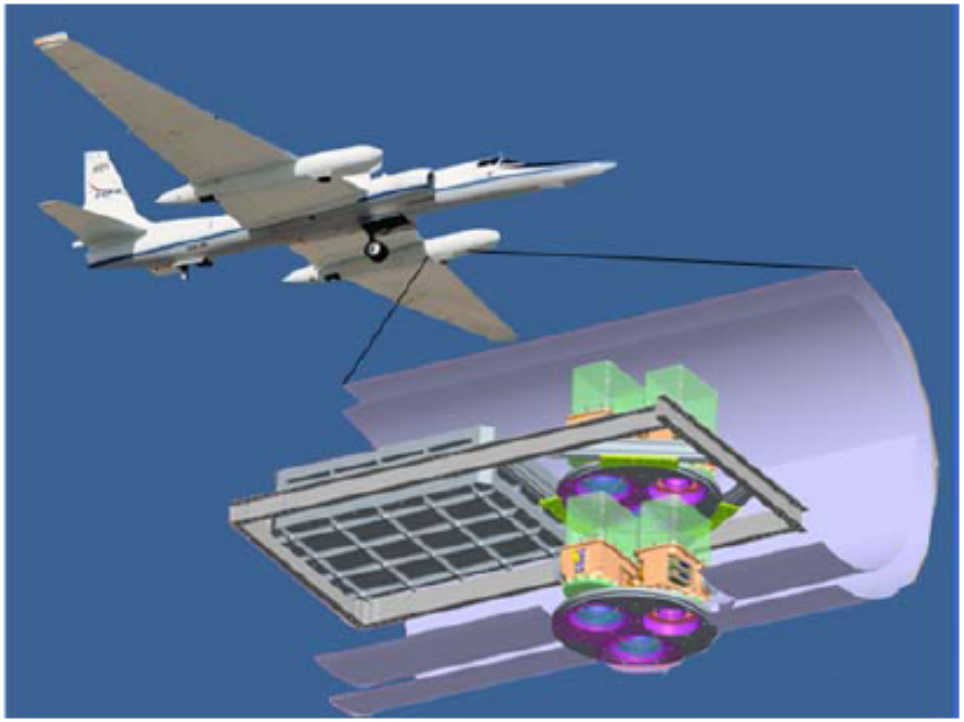
Next:

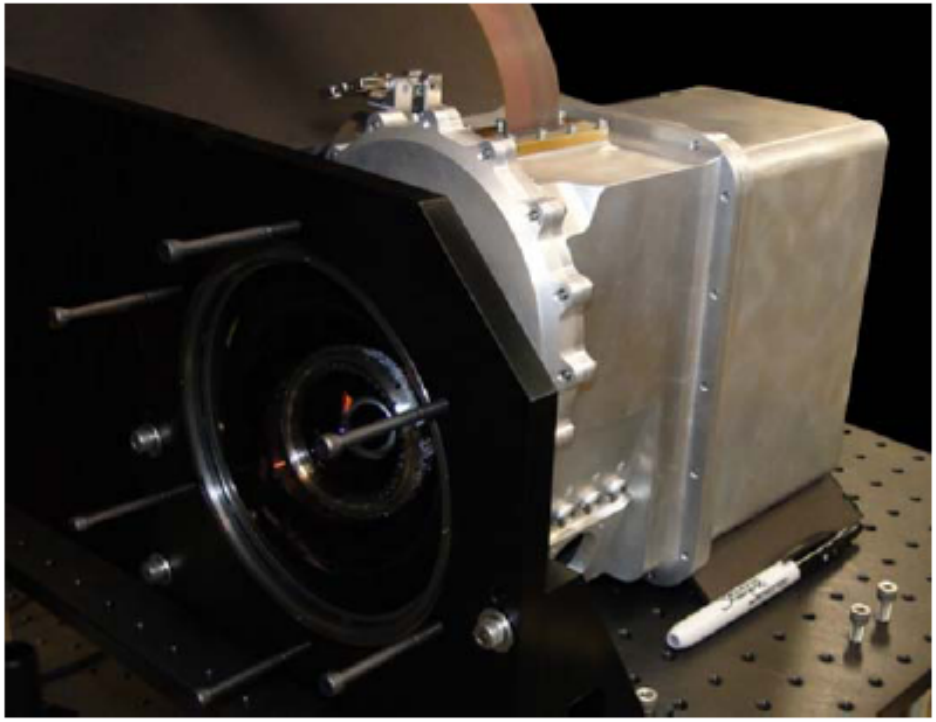
- SWIR Imager at 1650, 2130, 2250nm; 320x256 pixels, adjustable FOV
- System designed for the wing Super-Pod fore body. Other options are available requiring some modification



First Light from Aircraft







VNIR component to fly in 2011

Thank you.

LACO PI-Neph – Current Version 1

Intensity-only Measurement

Laser Inputs

$$\begin{pmatrix} P_{11}(\theta) \pm P_{12}(\theta) \\ P_{12}(\theta) \pm P_{22}(\theta) \\ 0 \\ 0 \end{pmatrix} \frac{1}{k^2 \cdot r^2} = \frac{1}{k^2 \cdot r^2} \begin{pmatrix} P_{11}(\theta) & P_{12}(\theta) & 0 & 0 \\ P_{12}(\theta) & P_{22}(\theta) & 0 & 0 \\ 0 & 0 & P_{33}(\theta) & P_{34}(\theta) \\ 0 & 0 & -P_{34}(\theta) & P_{44}(\theta) \end{pmatrix} \cdot \begin{pmatrix} 1 \\ \pm 1 \\ 0 \\ 0 \end{pmatrix}$$

LACO PI-Neph – Future Version 2

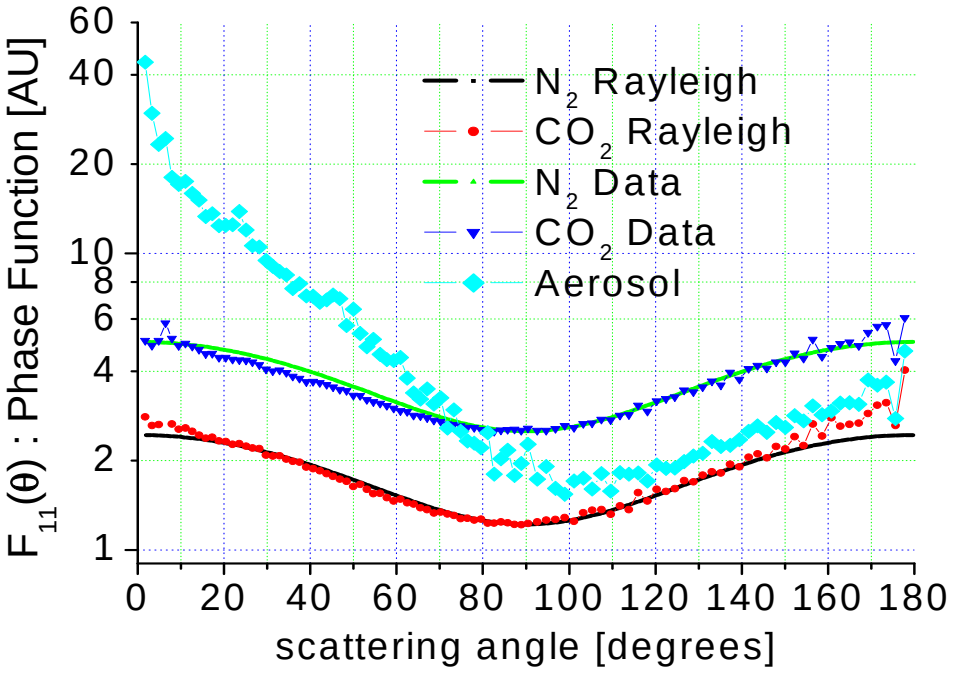
Measure 4 Stokes Parameters

Laser Inputs

$$\begin{pmatrix} P_{11}(\theta) \\ P_{12}(\theta) \\ \pm P_{33}(\theta) \\ \mp P_{34}(\theta) \end{pmatrix} \frac{1}{k^2 \cdot r^2} = \frac{1}{k^2 \cdot r^2} \begin{pmatrix} P_{11}(\theta) & P_{12}(\theta) & 0 & 0 \\ P_{12}(\theta) & P_{22}(\theta) & 0 & 0 \\ 0 & 0 & P_{33}(\theta) & P_{34}(\theta) \\ 0 & 0 & -P_{34}(\theta) & P_{44}(\theta) \end{pmatrix} \cdot \begin{pmatrix} 1 \\ 0 \\ \pm 1 \\ 0 \end{pmatrix}$$

LACO PI-Neph Prototype

F11 Raw Data:



Polarized Phase Function: