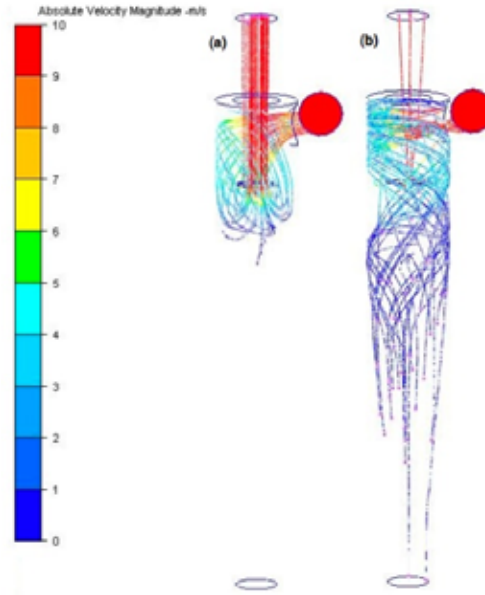




The Problem



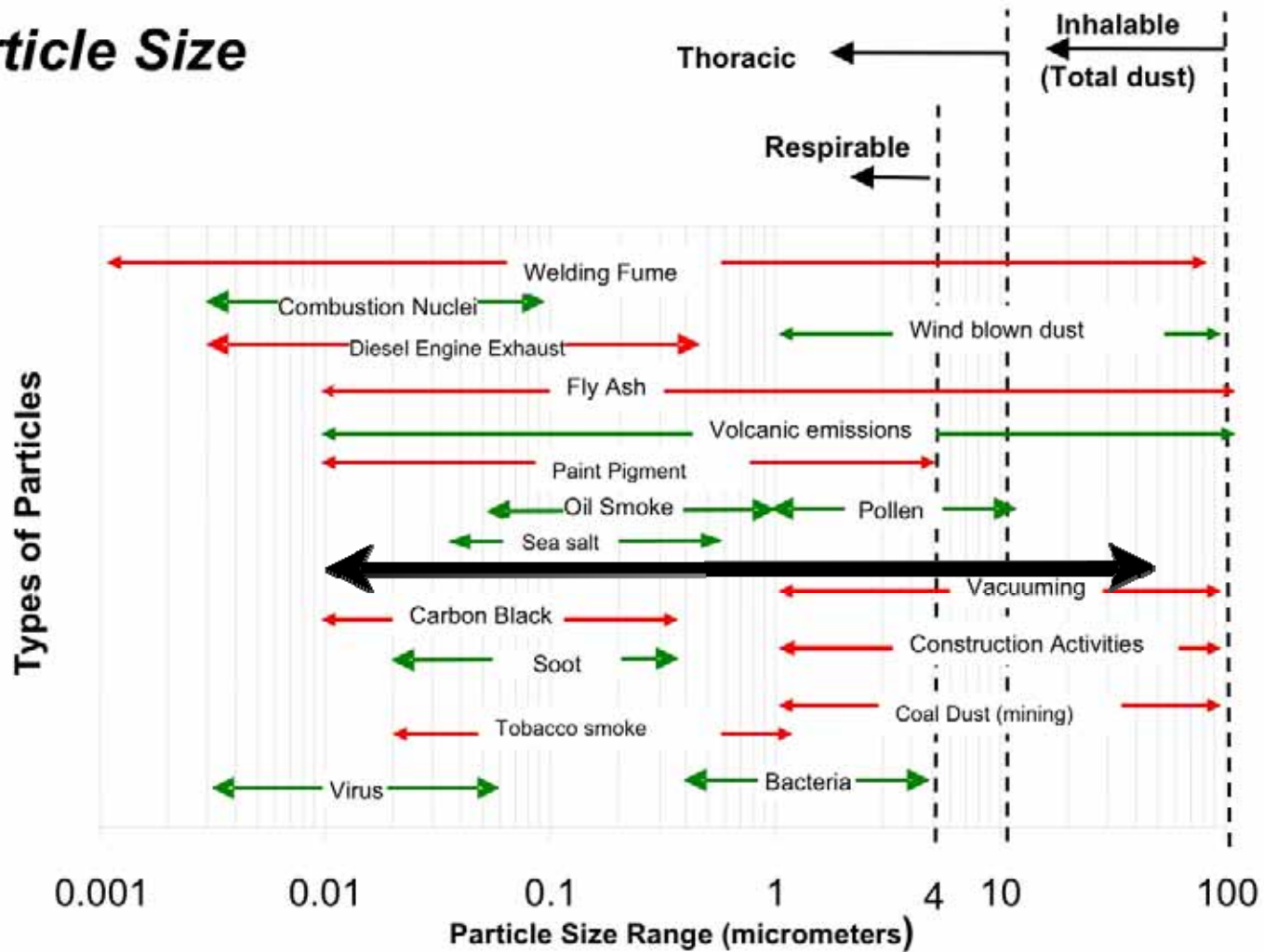
Reduced Gravity Student Flight Program

# Dust in the Wind

## Lunar Habitat Dust Mitigation via Inertial Filtration

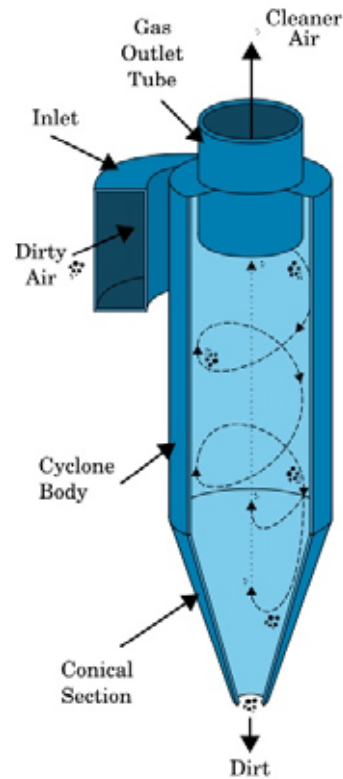
*Kevin Crosby  
Carthage College Department of Physics  
Kenosha, WI*

# Particle Size



← Environmental / Naturally Occurring Particles →

← Workplace / man-made Particles →



## Air Cyclones:

- Low operating costs
- No consumables
- No moving parts
- Widely used in 1<sup>st</sup> stage filtration applications

*What role does gravity play in the operation of an air cyclone?*



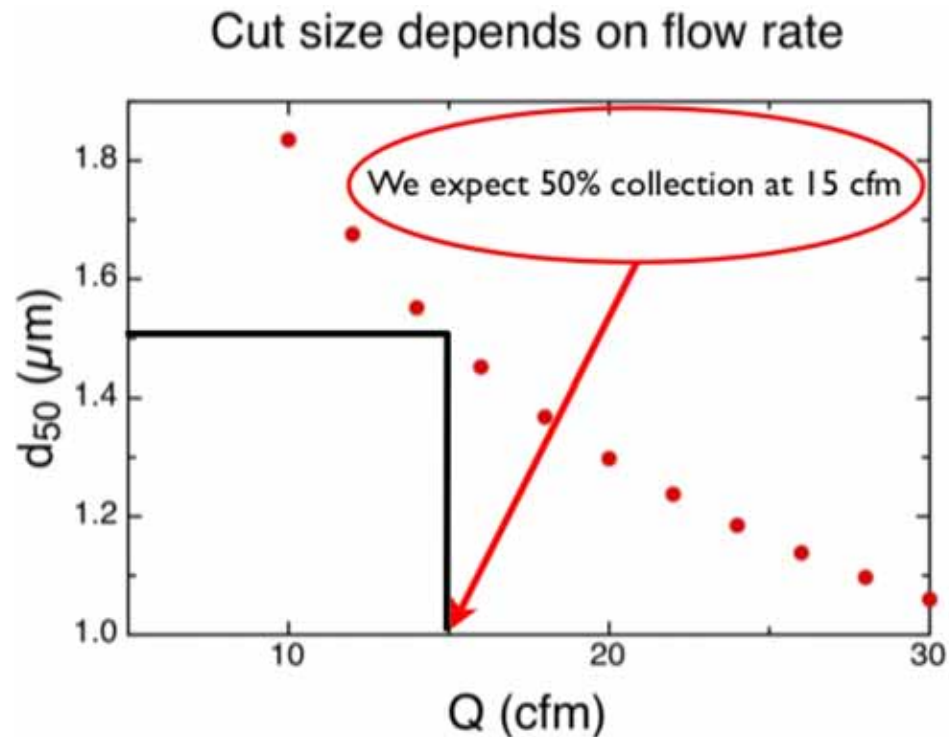
Dyson Vacuum Cleaner



Dyson Antigravity Vacuum Cleaner?

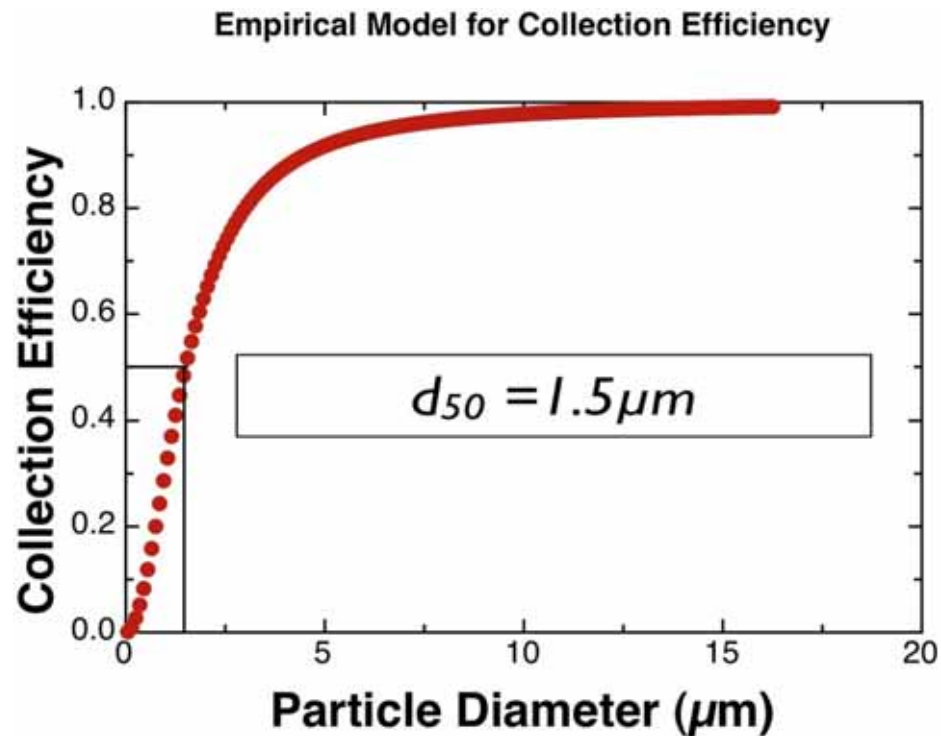
# Figures of Merit

- Residence Time  $\tau_{\text{residence}}$ : avg. time a particle spends in air stream before exiting at outlet
- Cut-size  $d_{50}$ : particle size at which cyclone capture efficiency is 50%

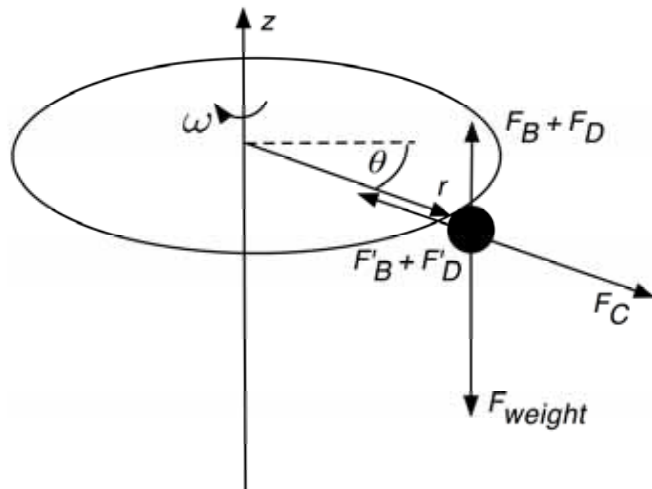


# Figures of Merit

- Residence Time  $\tau_{\text{residence}}$ : avg. time a particle spends in air stream before exiting at outlet
- Cut-size  $d_{50}$ : particle size at which cyclone capture efficiency is 50%



# Analytic Model of Particle Motion in Cyclone



Particle Frame

## Model Assumptions

- Stokes Regime
- Tangential motion: rigid body-like  $\omega \approx \text{const.}$
- Axial motion at terminal speed
- Radial motion: constant speed

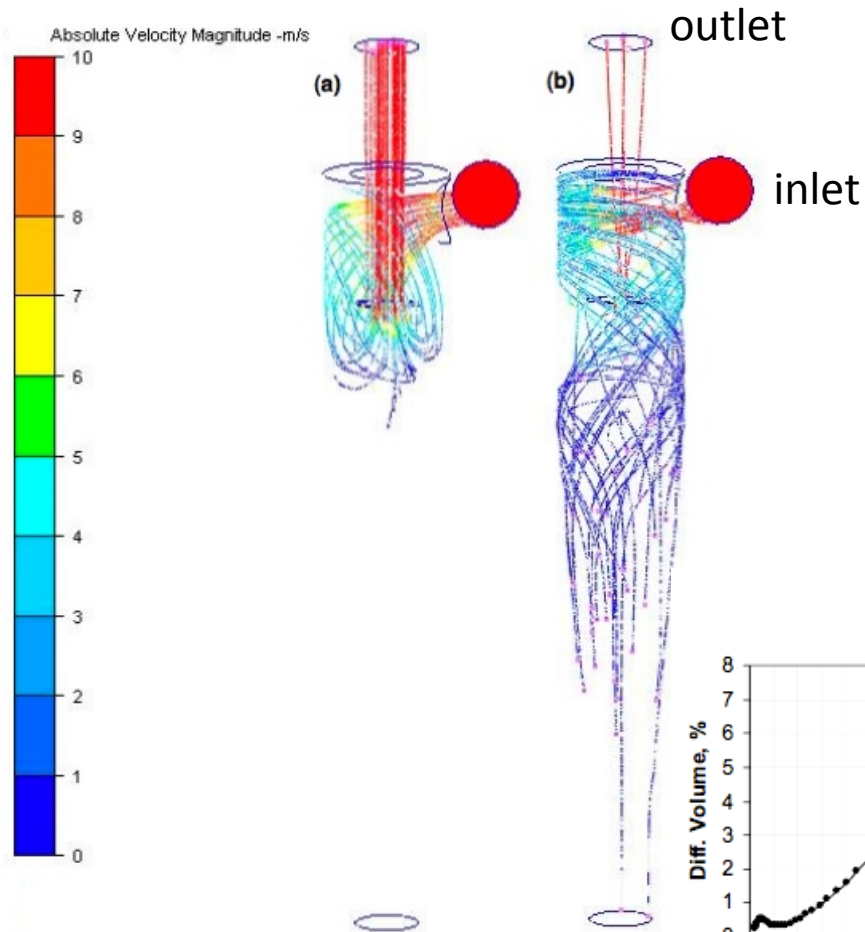
## Model Predicts Residence Time

$$T_{residence} = \frac{18\mu}{\omega^2 d_p^2 (\rho_p - \rho_g)} \log \left( \frac{R}{R_0} \right)$$

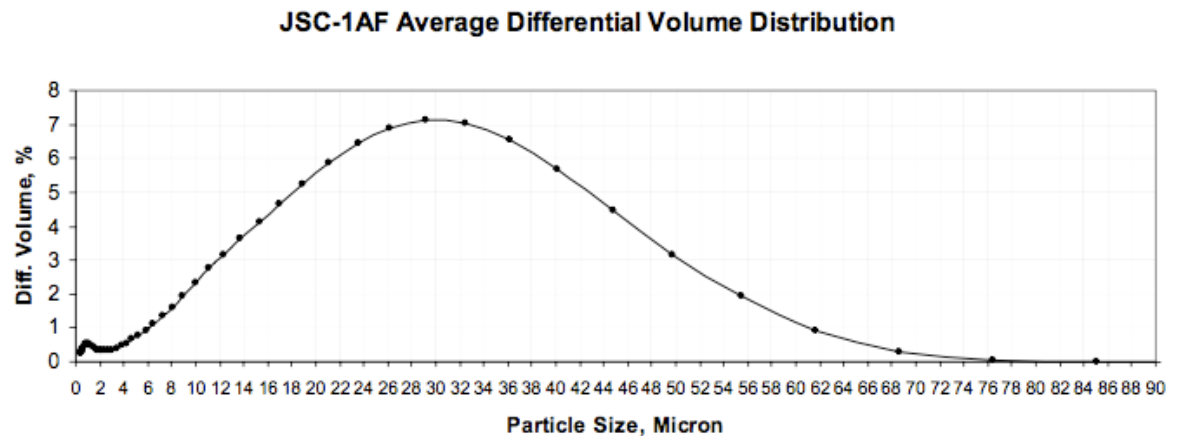
outer radius of cyclone (points to  $R$ )  
particle diameter (points to  $d_p$ )  
inner radius of cyclone (points to  $R_0$ )

**No "g" in residence time**

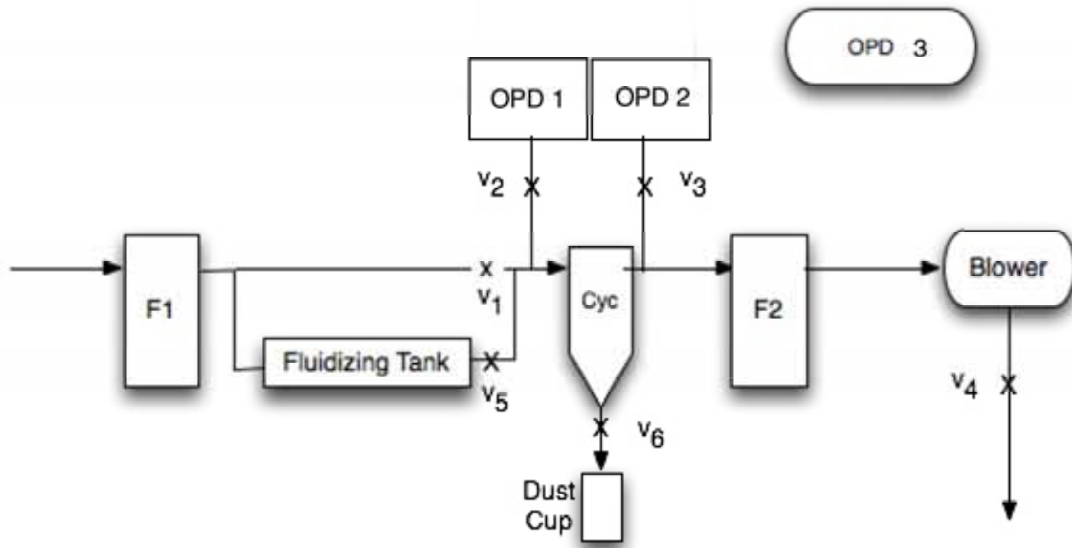
# Reduced Gravity CFD Analysis



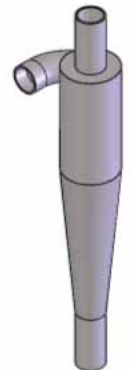
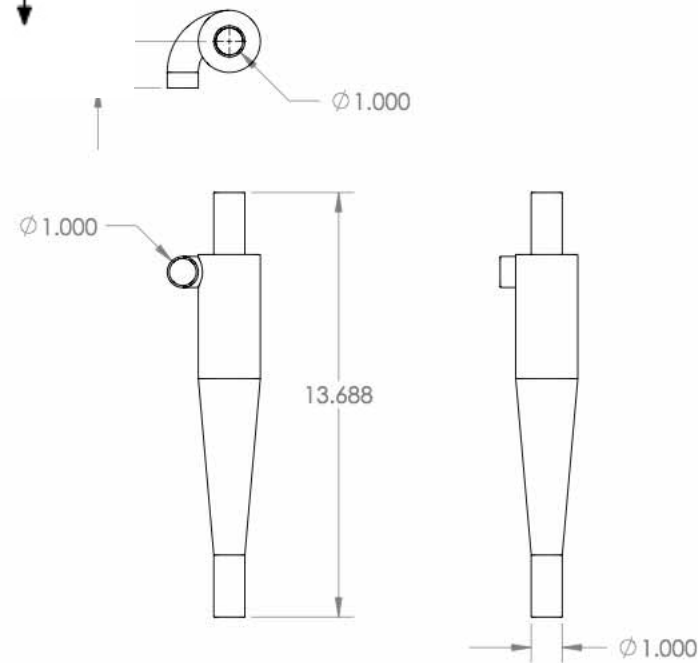
Representative particle traces for particles of diameter (a)  $0.1 \mu\text{m}$ , and (b)  $10.0 \mu\text{m}$ .



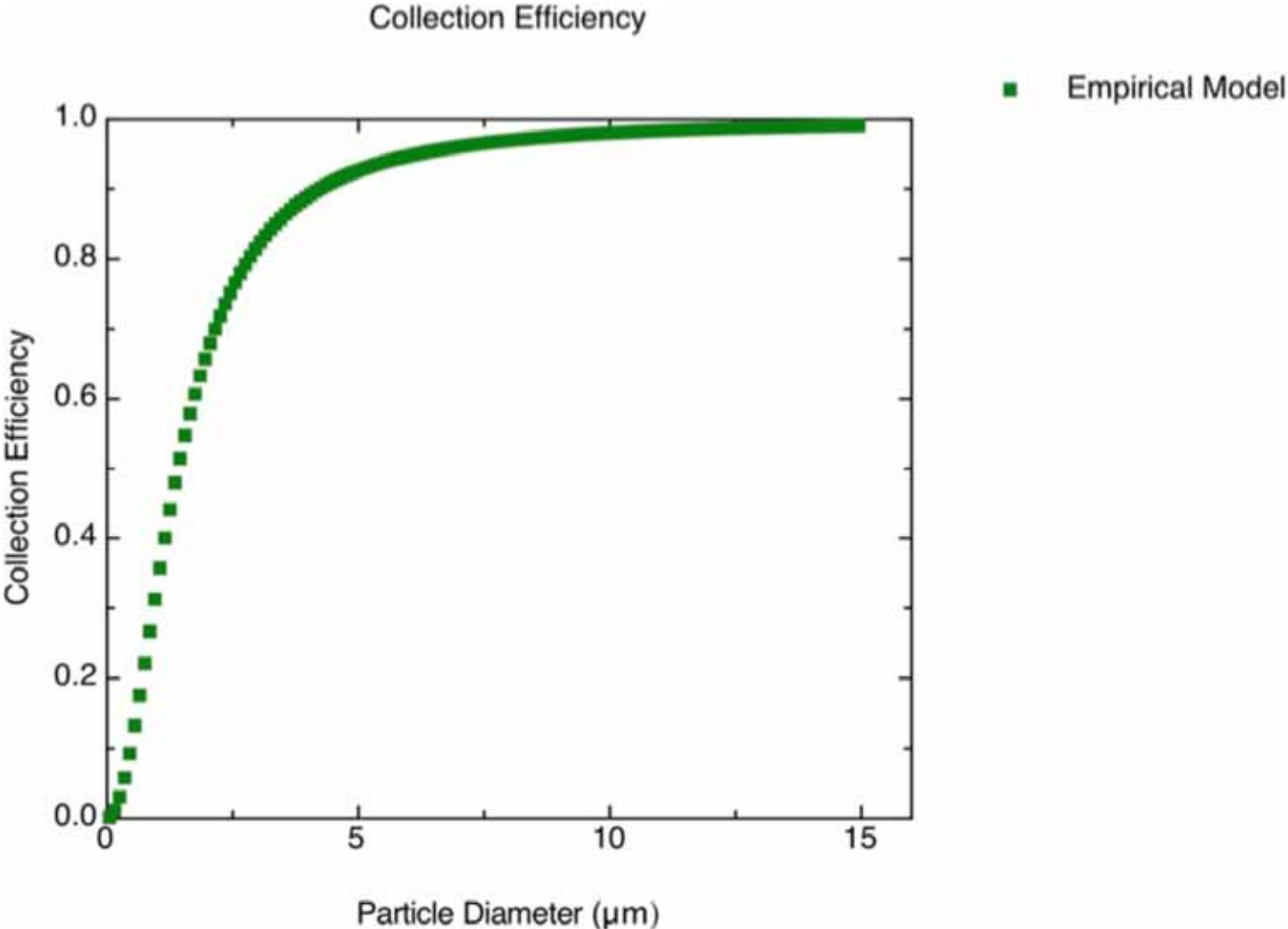
# Experimental Design



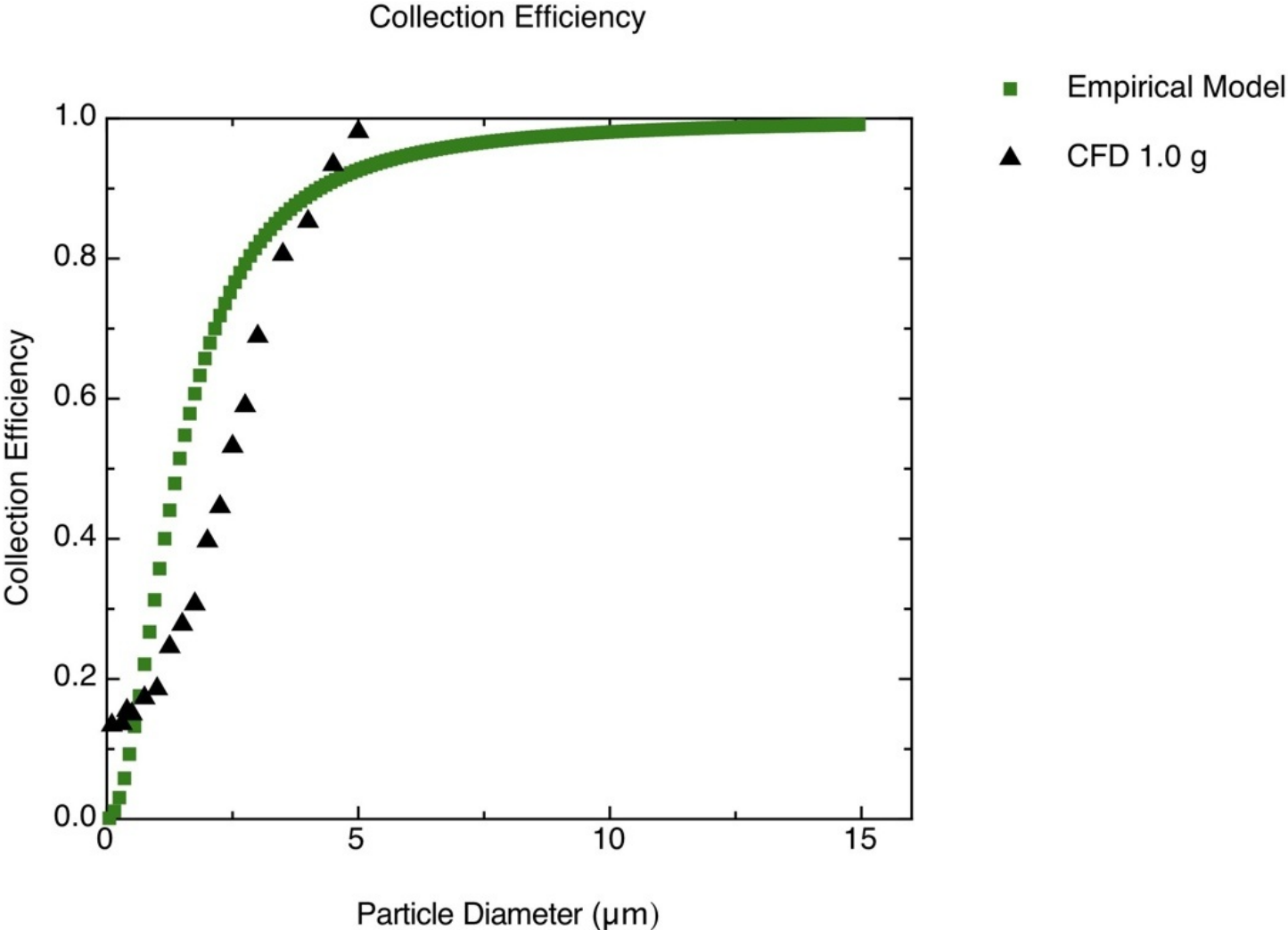
- F1 & F2: 0.01  $\mu\text{m}$  HEPA Filters
- OPD1-3: Optical Particle Detectors



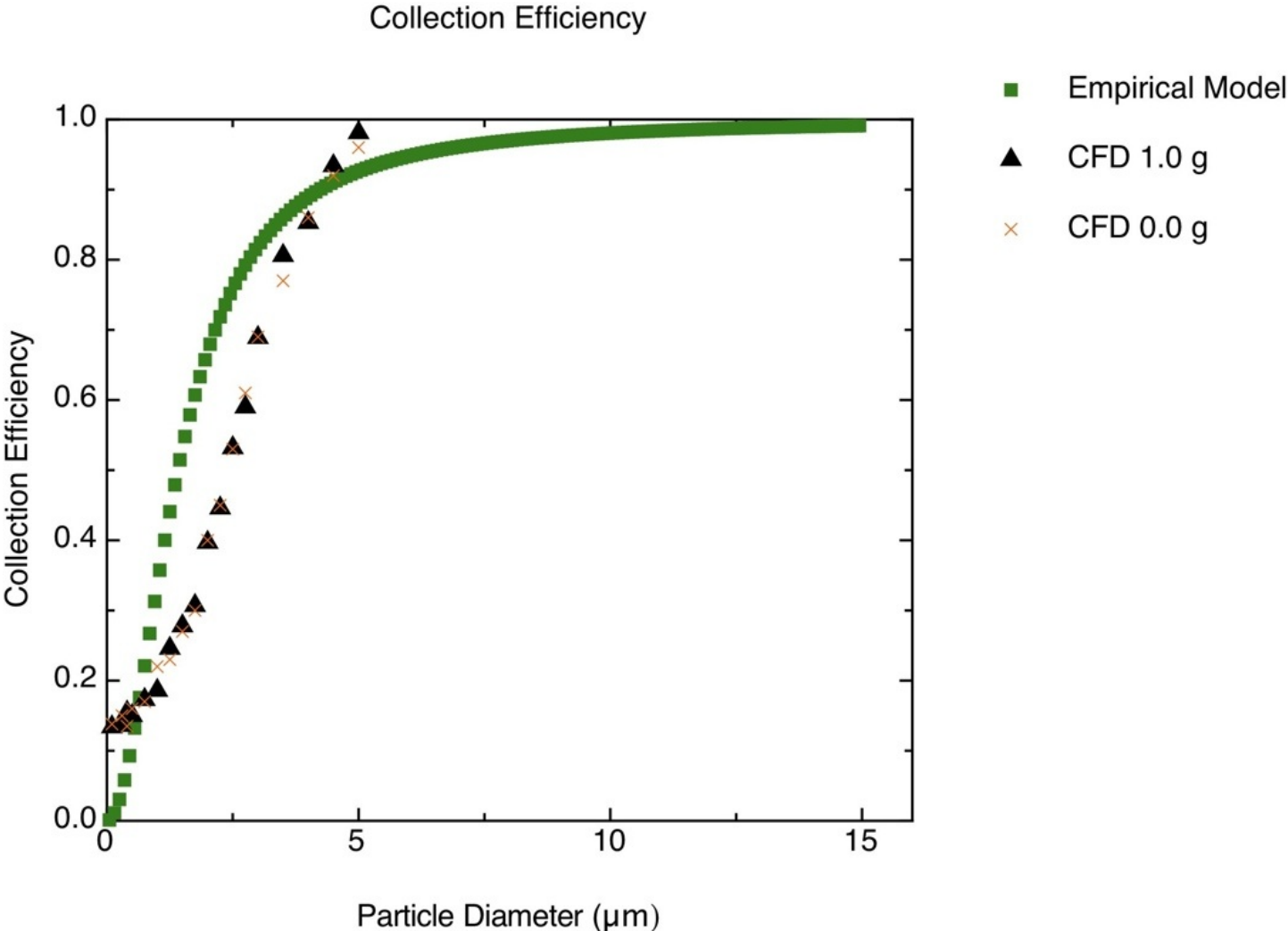
# Cyclone Collection Efficiency Data



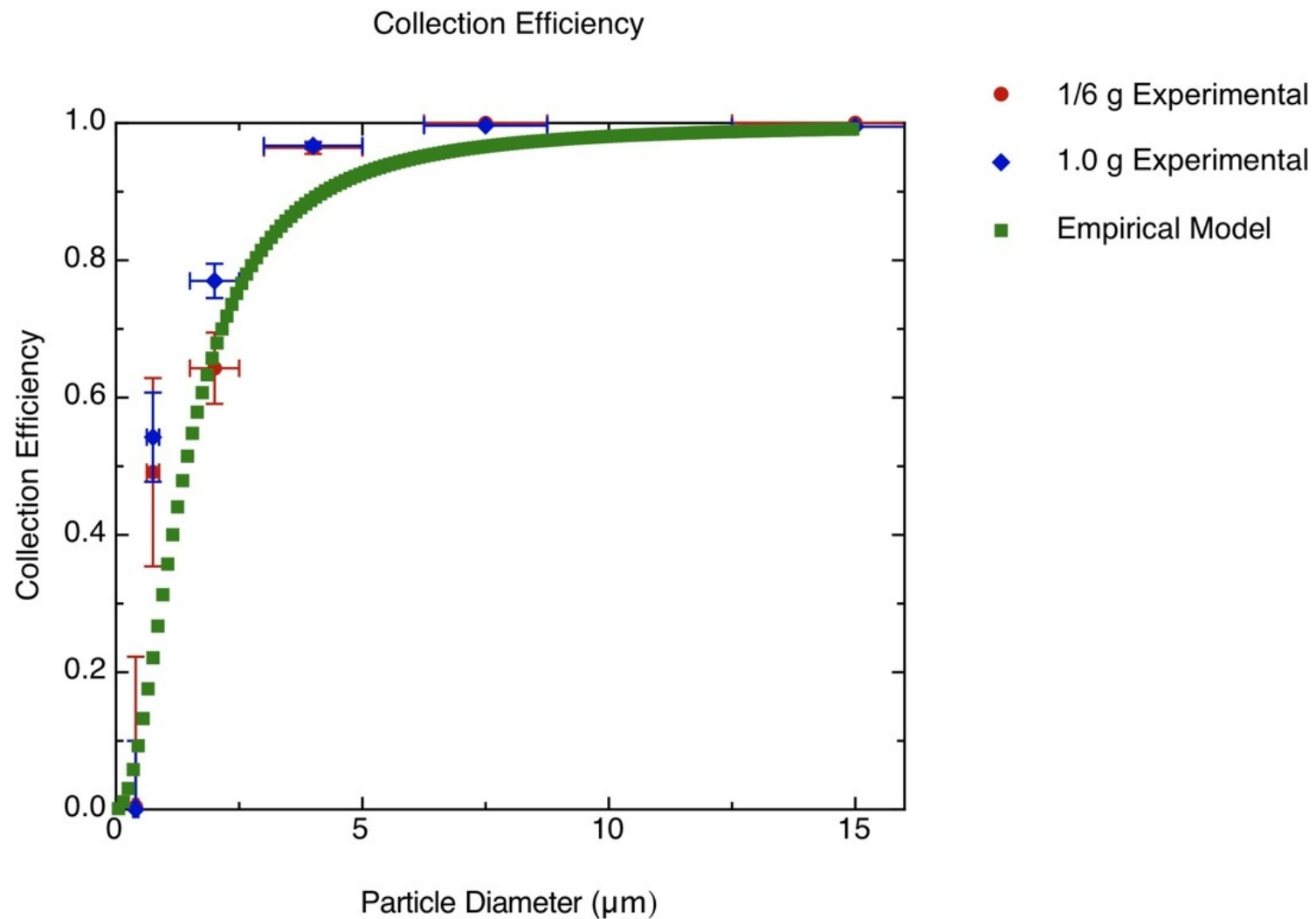
# Cyclone Collection Efficiency Data



# Cyclone Collection Efficiency Data

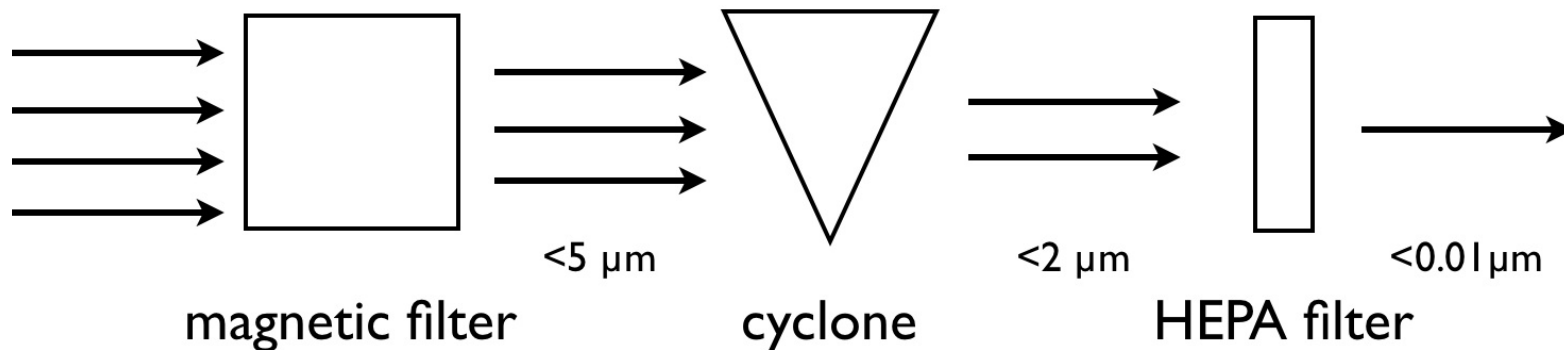


# Cyclone Collection Efficiency Data



# Summary

- Cyclone performance is unaffected in reduced gravity
- Cyclone can be tuned to desired  $d_{50}$  through geometry and flow rate.
- Operating costs scale with efficiency.
- Cyclones may be effectively used in conjunction with other mitigation strategies (magnetic collectors?)



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## Student Flight Team

- Erin Martin
- Caitlin Pennington
- Emily Sorensen
- Isa Fritz
- Brad Frye

## Collaborator

- Juan Agui (GRC)

