



Michigan
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LIGHT ABSORBING AEROSOL CLOUD INTERACTIONS

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1. Michigan Technological University, Houghton, MI
2. Los Alamos National Laboratory (LANL)
3. Aerodyne Research, Inc.
4. Brookhaven National Laboratory
5. Pacific Northwest National Laboratory

BACKGROUND, AND MOTIVATION

- Black carbon containing particles (BC_{cp}) produced during incomplete combustion
 - Consists of
 - Aggregates of graphitic carbon
 - Organic Carbon
 - **primary light absorbing aerosols in the atmosphere**
 - **evolve** in the atmosphere due to aging and **cloud processes**
- **Studies of the interactions of black carbon containing particles with clouds are sparse**

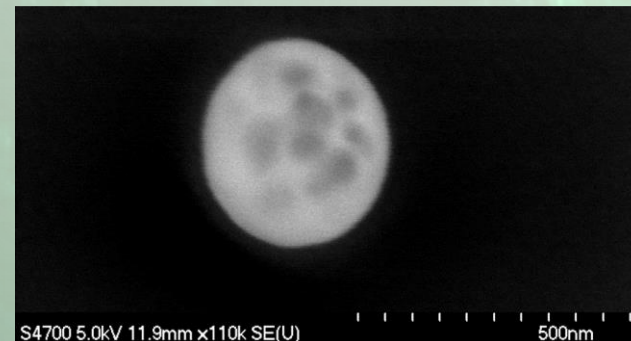
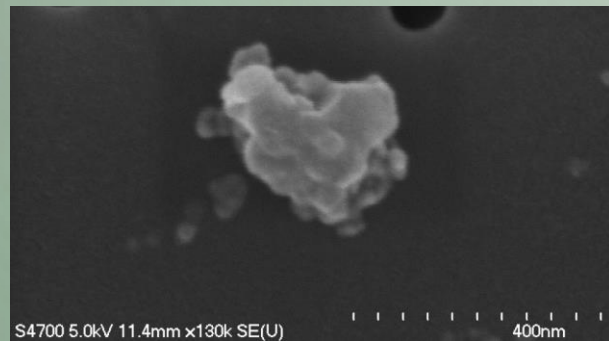


➤ **The objective of the LIGHT ABSORBING AEROSOL CLOUD INTERACTIONS (LAACI) project is to fill this gap by studying aerosol-cloud interactions in the MTU cloud chamber**

EVOLUTION OF LIGHT ABSORBING AEROSOLS

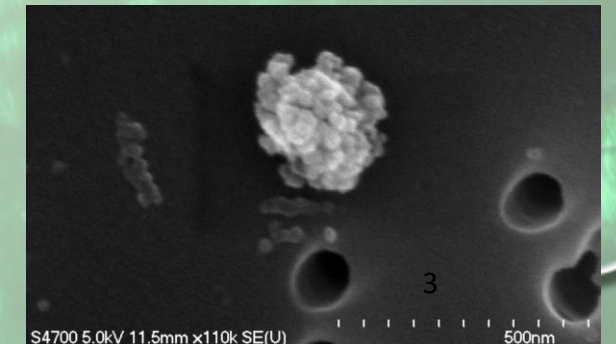
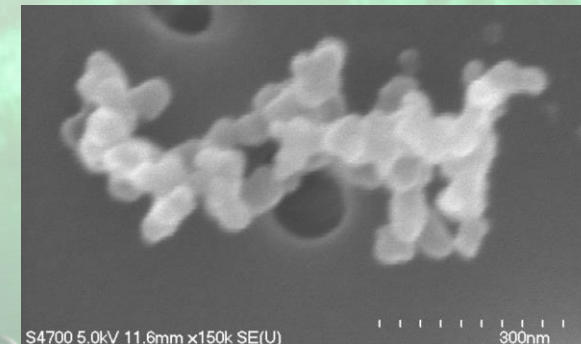
COMPLEX COATING

- Bcparticles can **develop complex coatings** when they interact with other materials in the atmosphere.
- **Cause enhancement of absorption**, by more than a factor of 2 in some cases
- COATING CAN VARY IN AMOUNT and changes with time

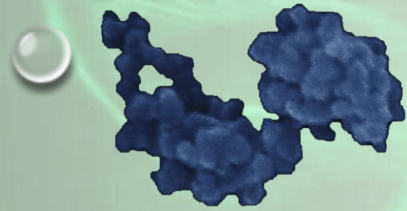


CHANGE OF MORPHOLOGY

- **Freshly Produced Black Carbon** Has A Fractal-like Lacy Structure
- **Aged Black Carbon Particles** That Go Through Cloud Interactions Or Develop Coatings Have A More Compacted Morphology



METHOD



Aerosol Generation



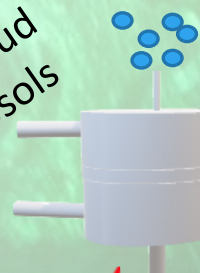
Size Selection



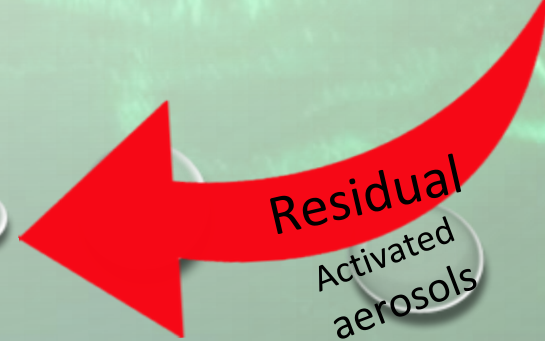
Michigan Tech Pi Chamber



Interstitials
Un-activated cloud chamber aerosols

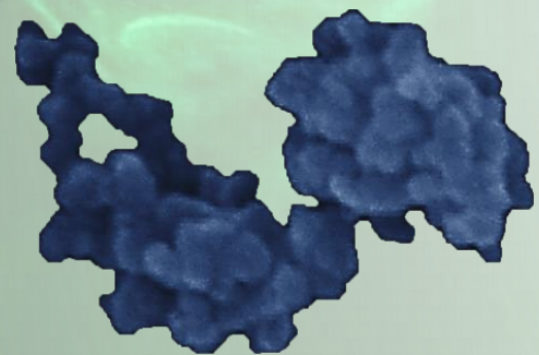


Pumped Counterflow Virtual Impactor (PCVI)



Physical properties like: mobility diameter, size, optical properties, mass, CCN activity and morphology

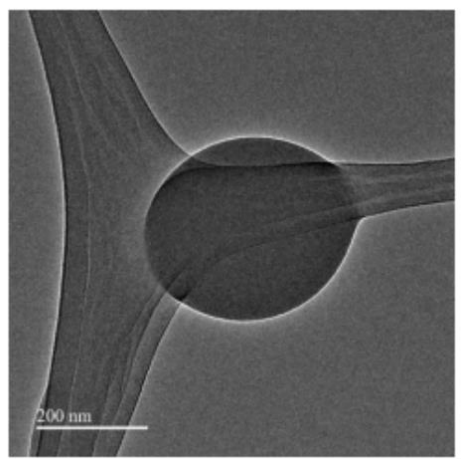
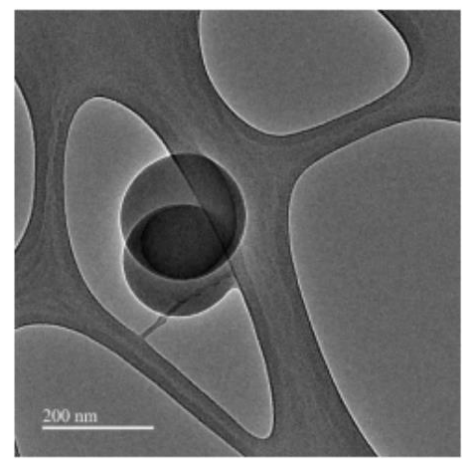
AEROSOL GENERATION: Where there is smoke there is fire



Cab-o-jet

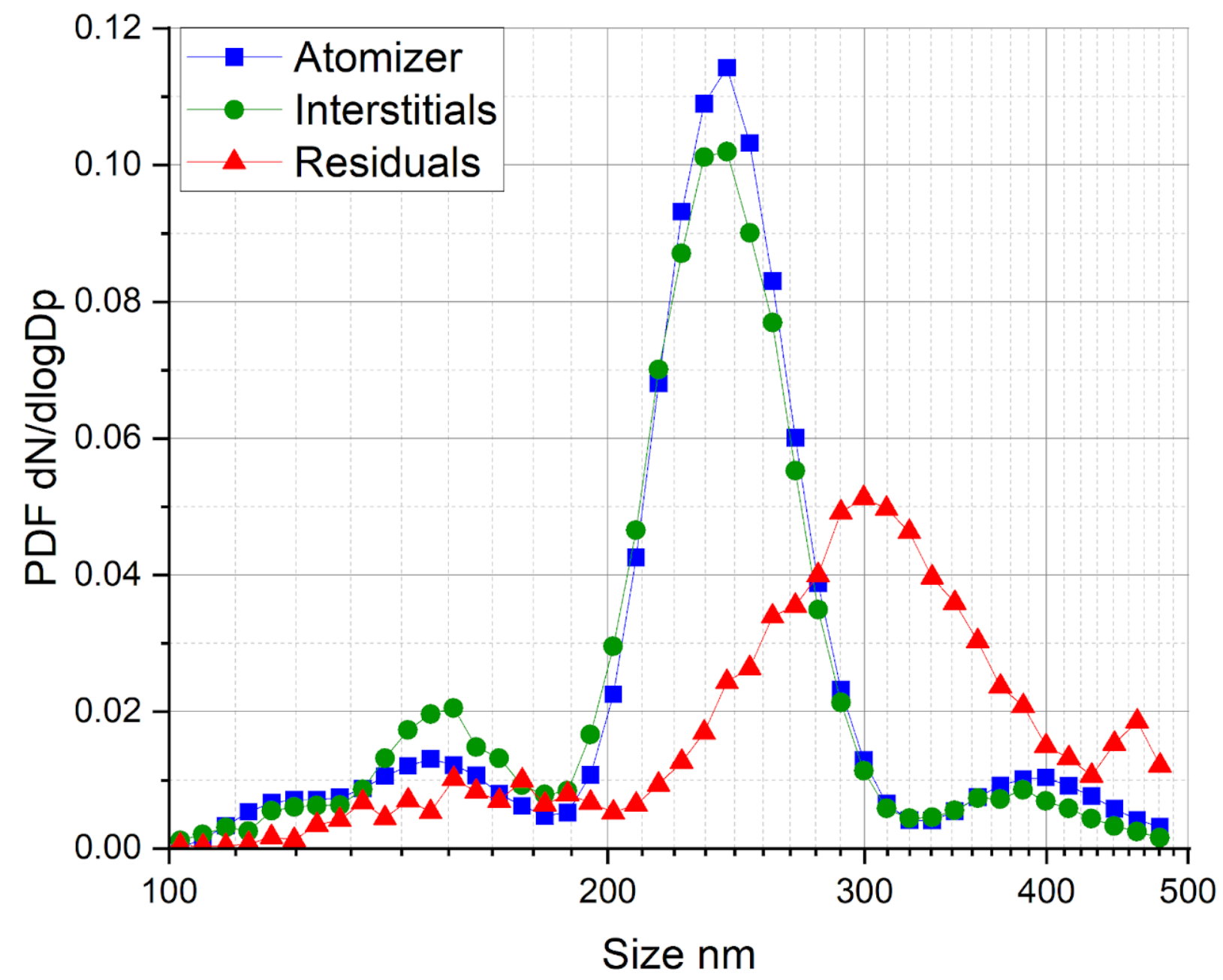


Liquid smoke(LS)



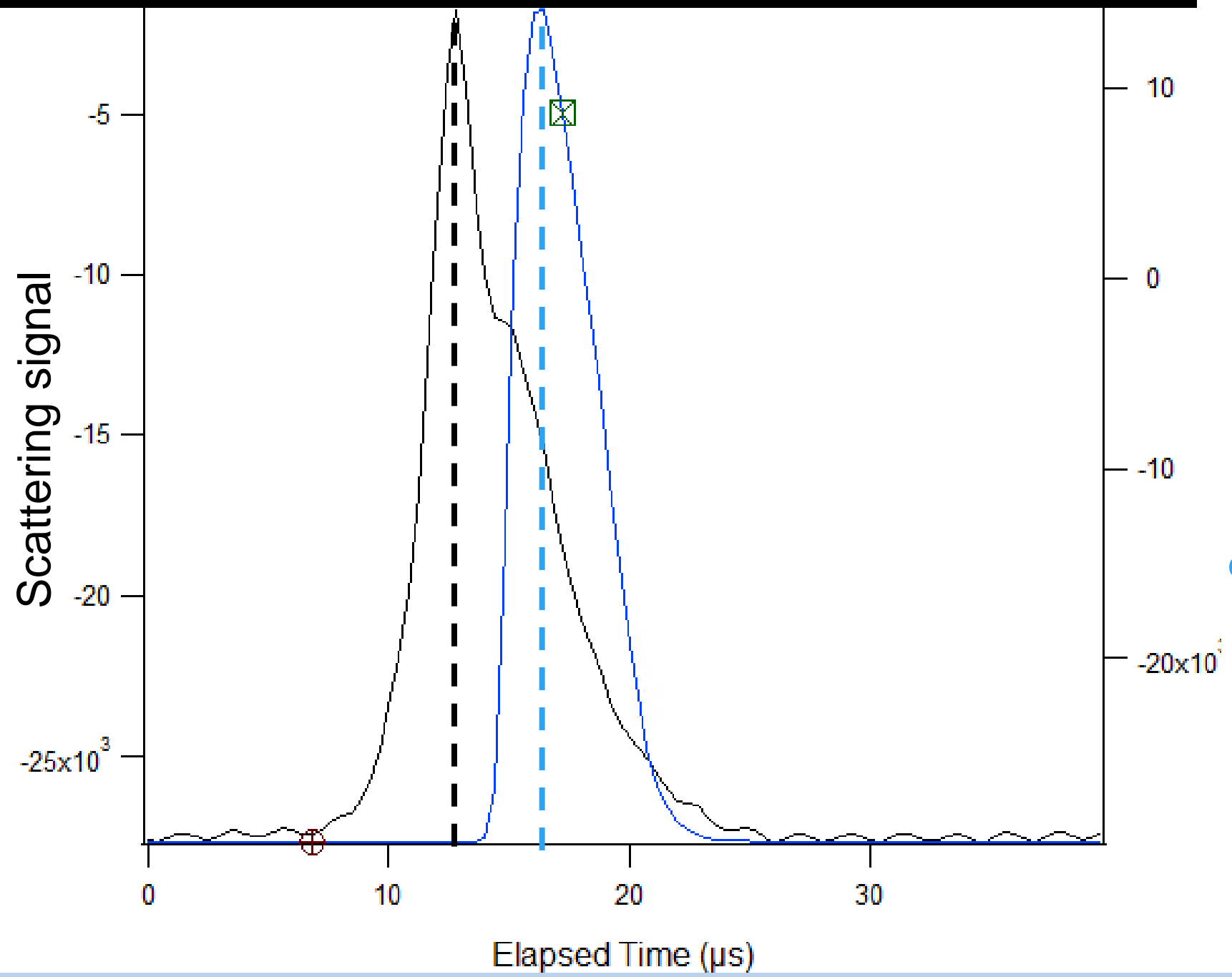
- **Cab-o-jet ink aerosols** were used as Black Carbon surrogate
- **Liquid smoke(LS)** used as a surrogate for Organic Carbon
 - Condensed smoke from wood
 - Commercially available

Results: Residuals are larger in size



Scattering signal

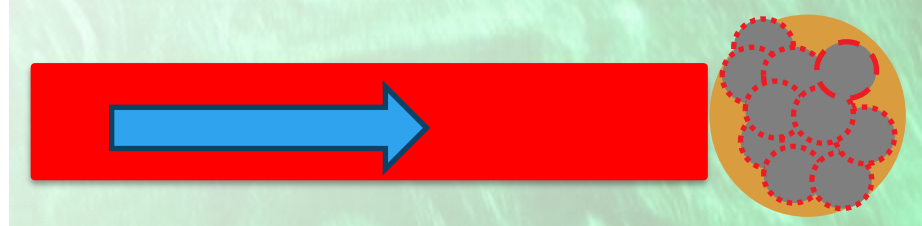
Method: Delay can be used to determine coating



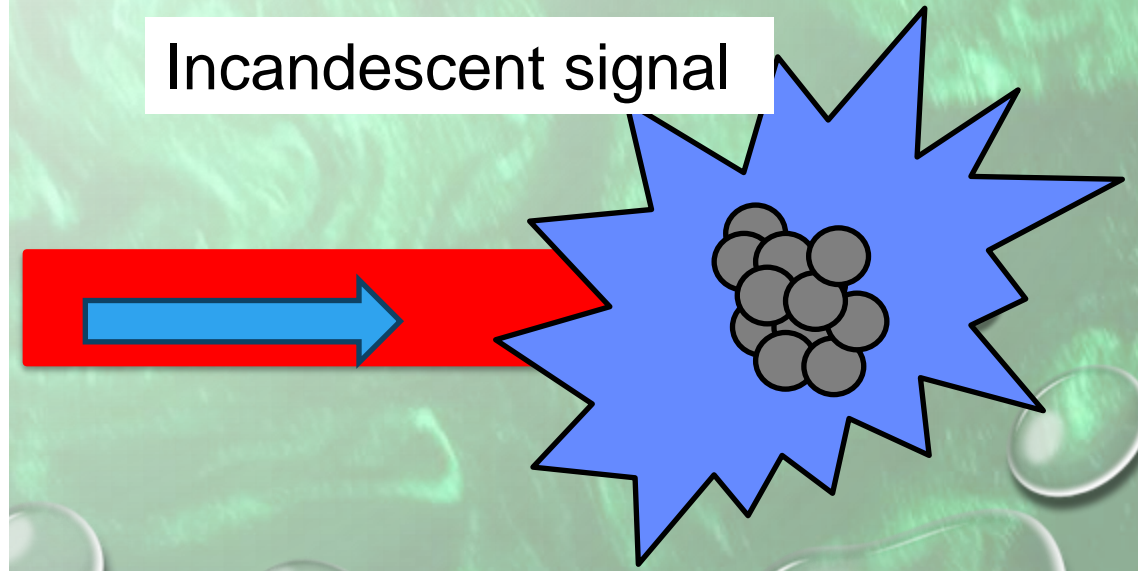
Incandescent signal



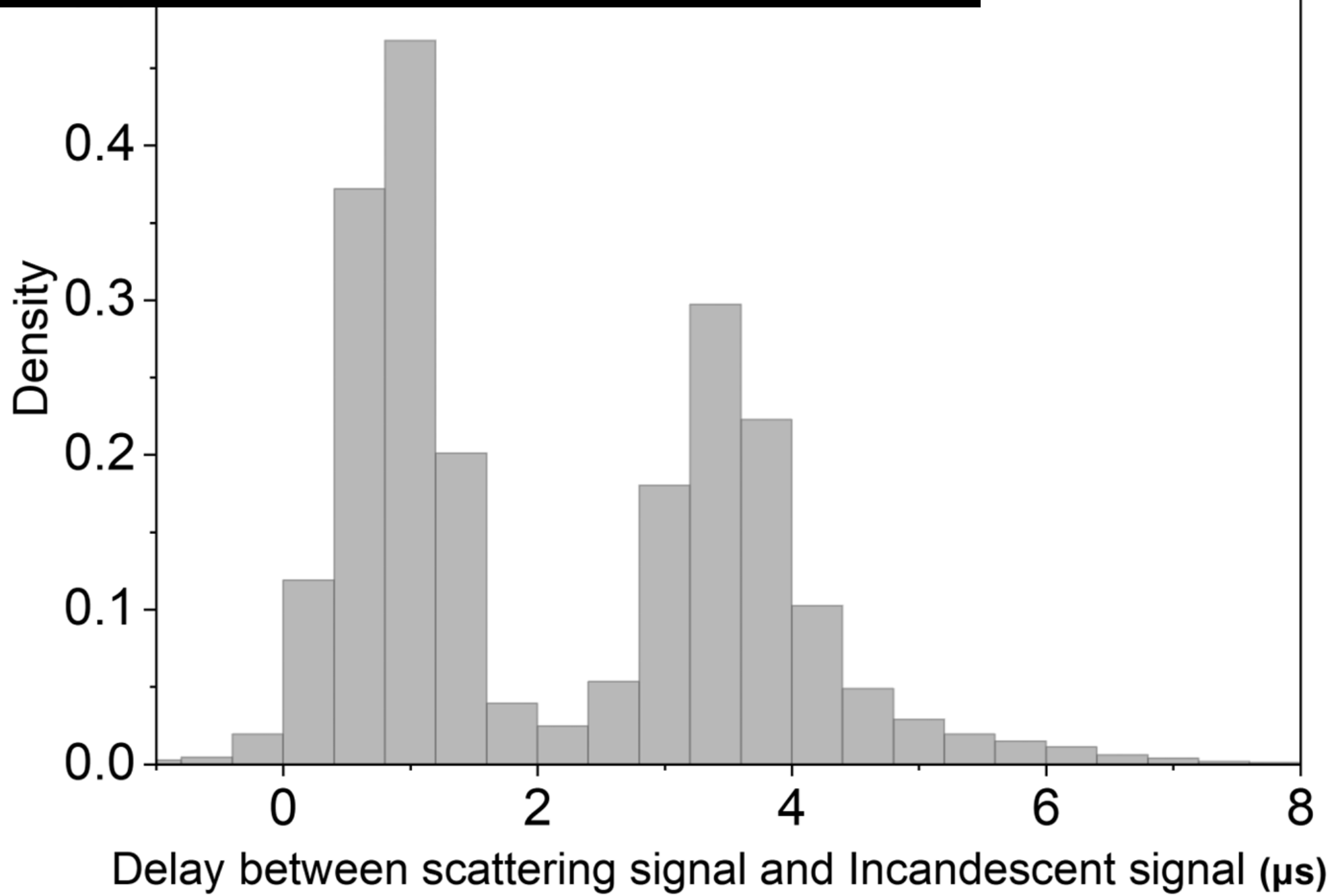
Heated core causes evaporation of coating



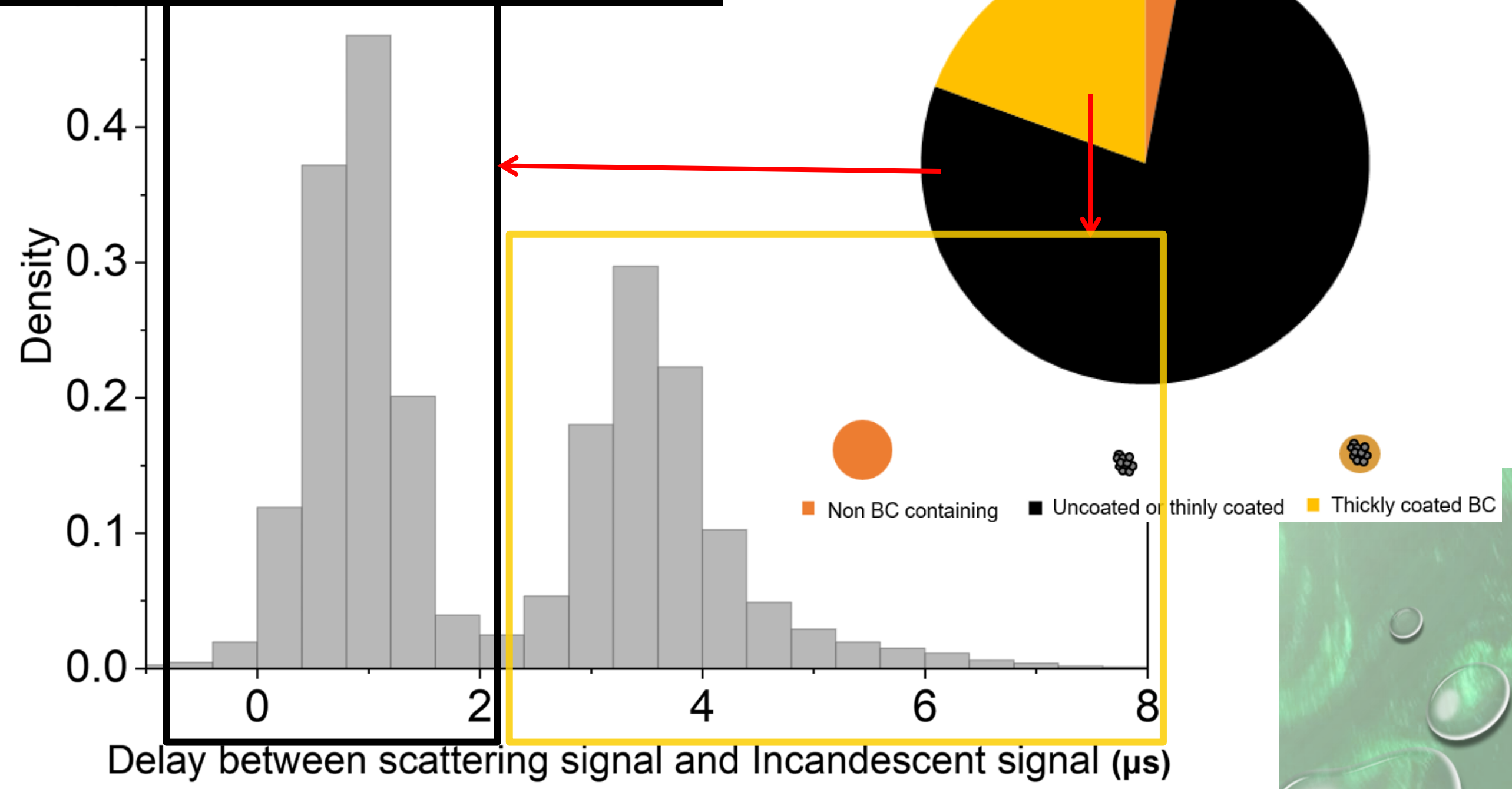
Incandescent signal



Results: Delay can be used as a coating thickness estimate



Results: Delay can be used to determine coating

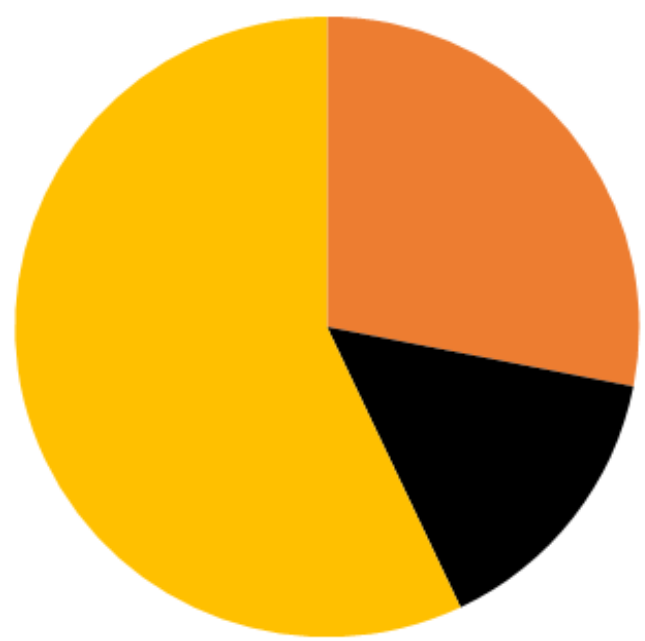


Results: External mixing can be determined

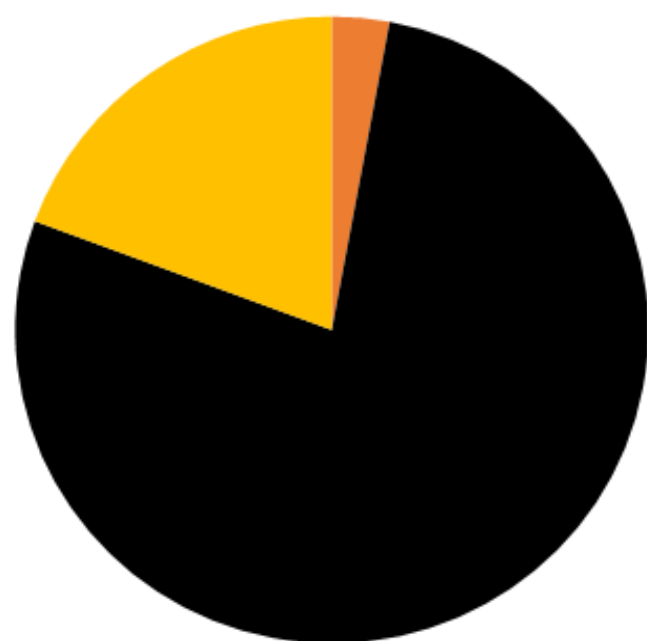
Exp C1



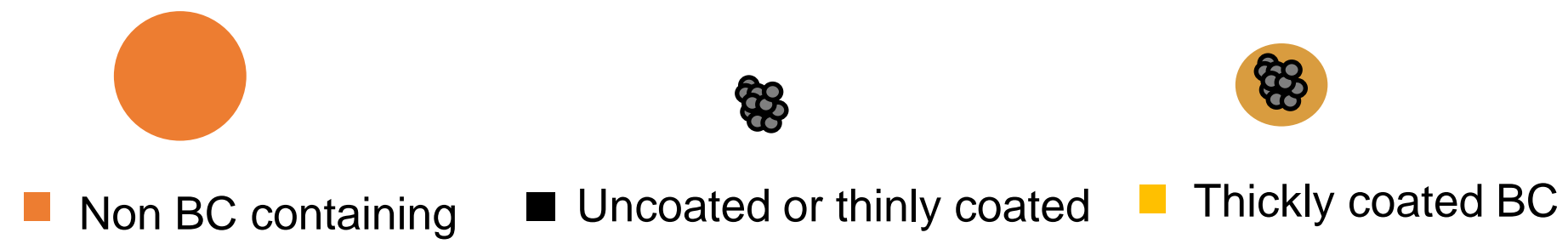
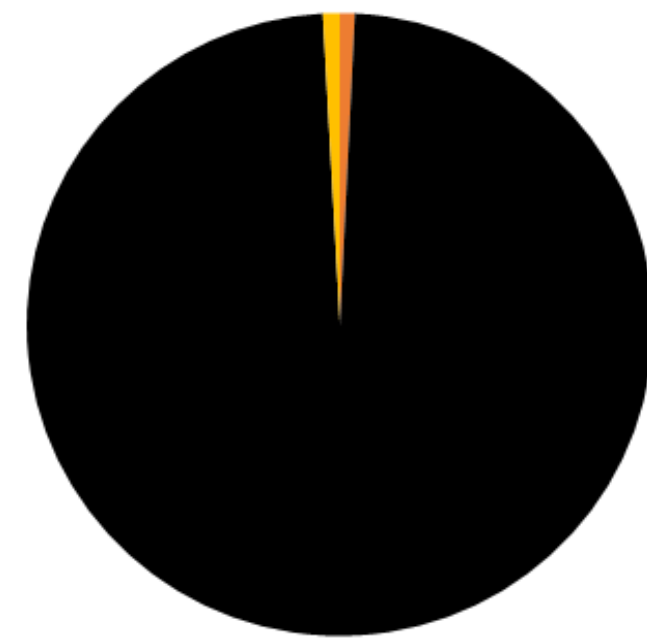
Exp C2



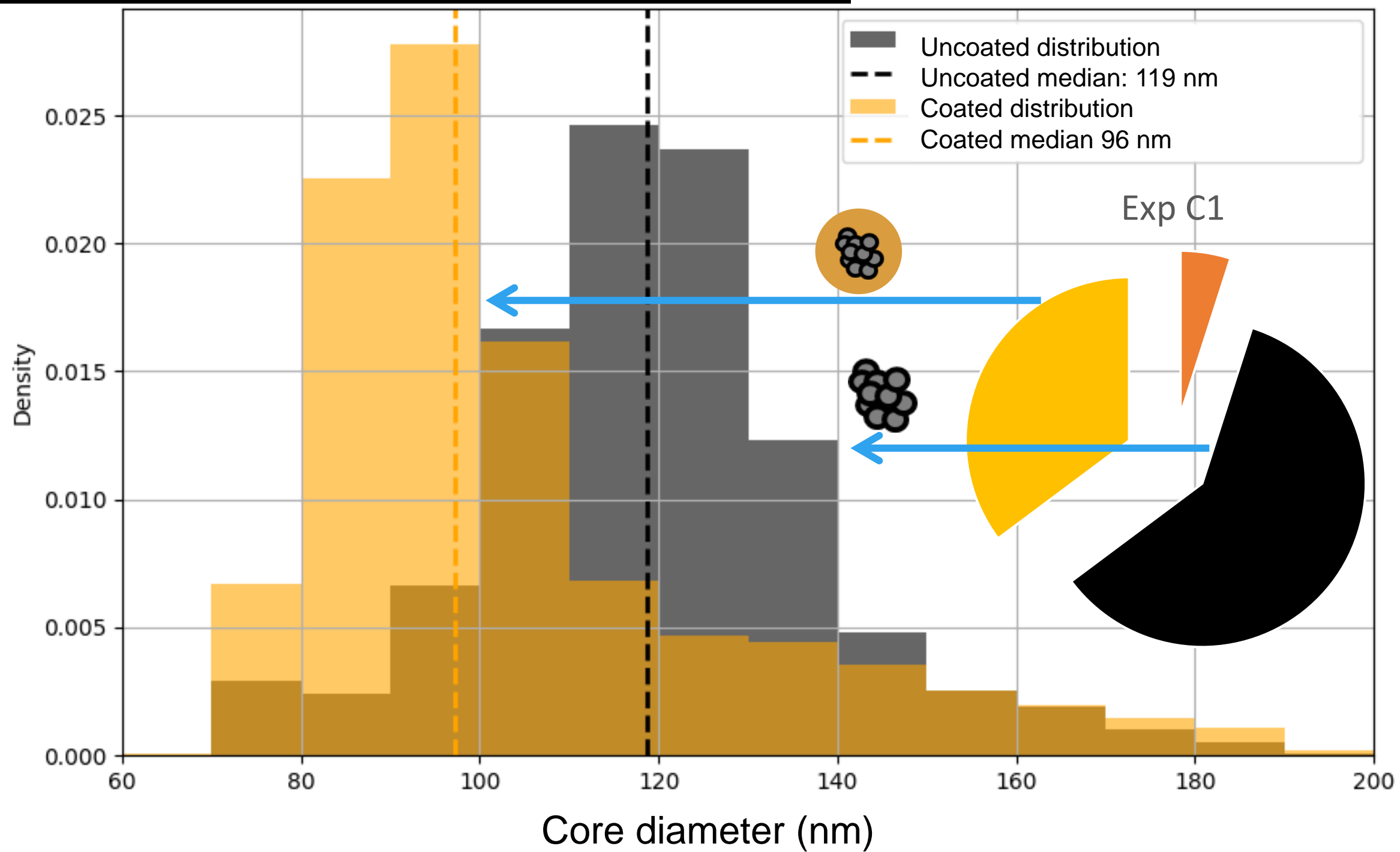
Exp C3



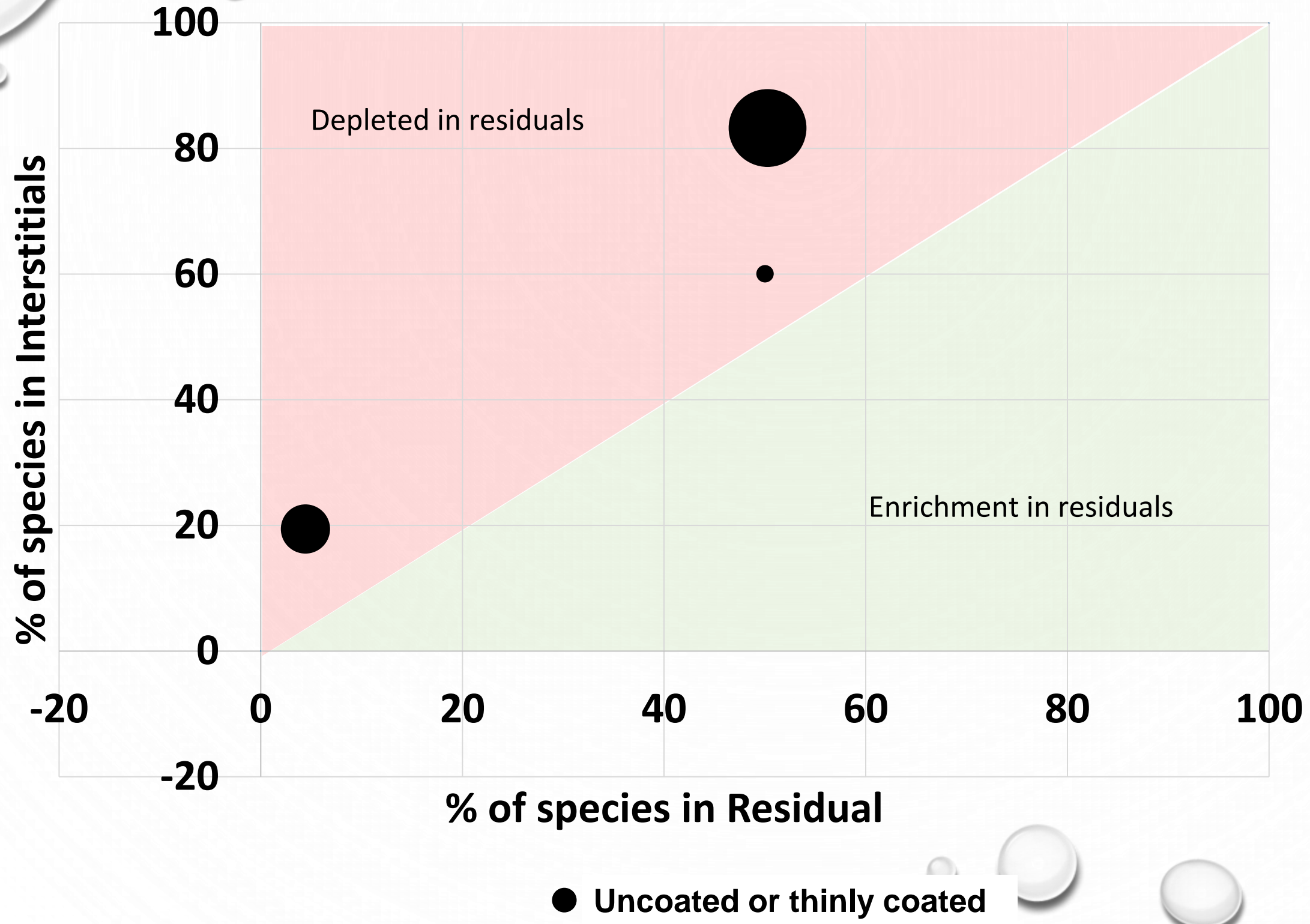
Exp U1



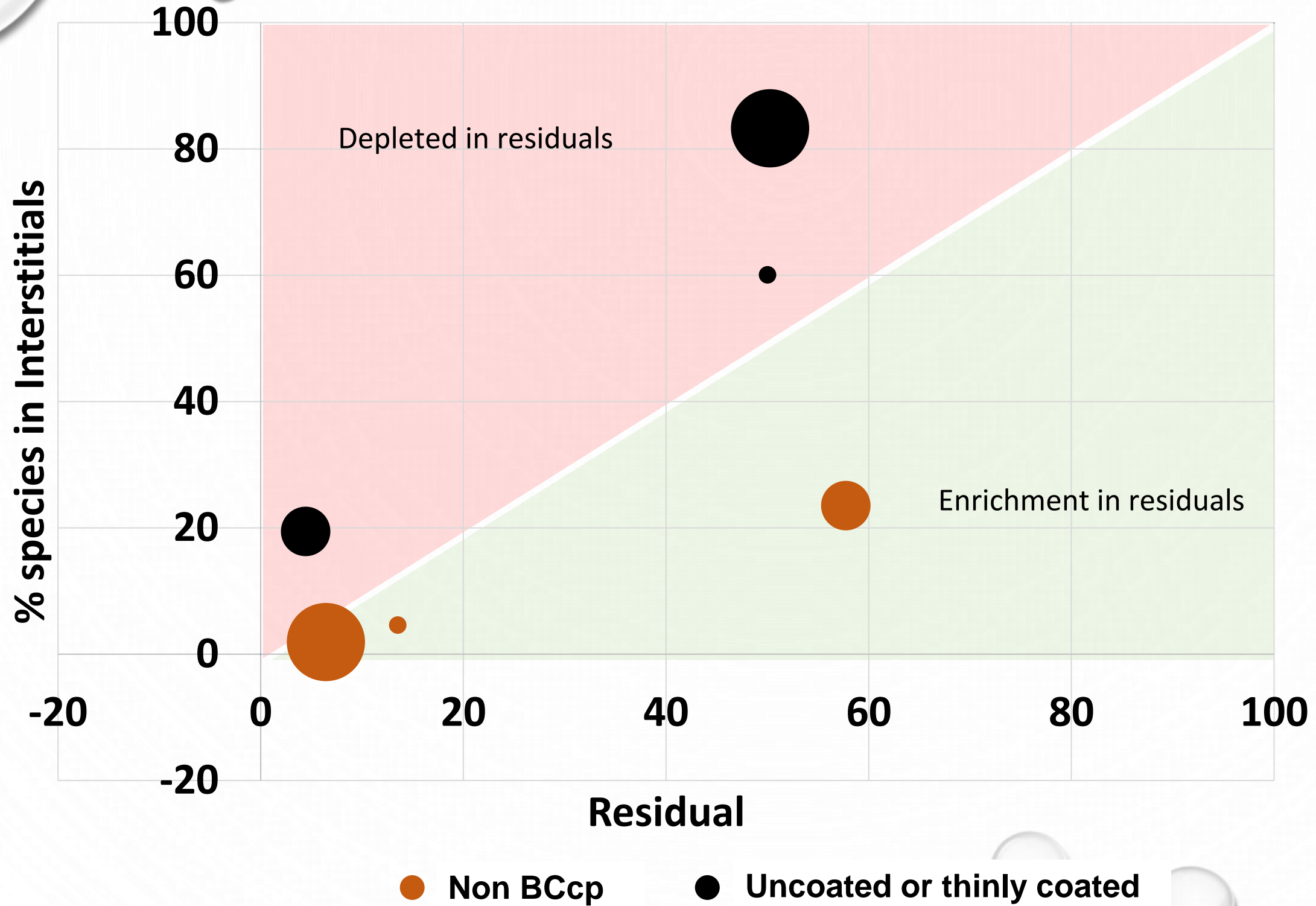
Results: Coated particles have smaller core



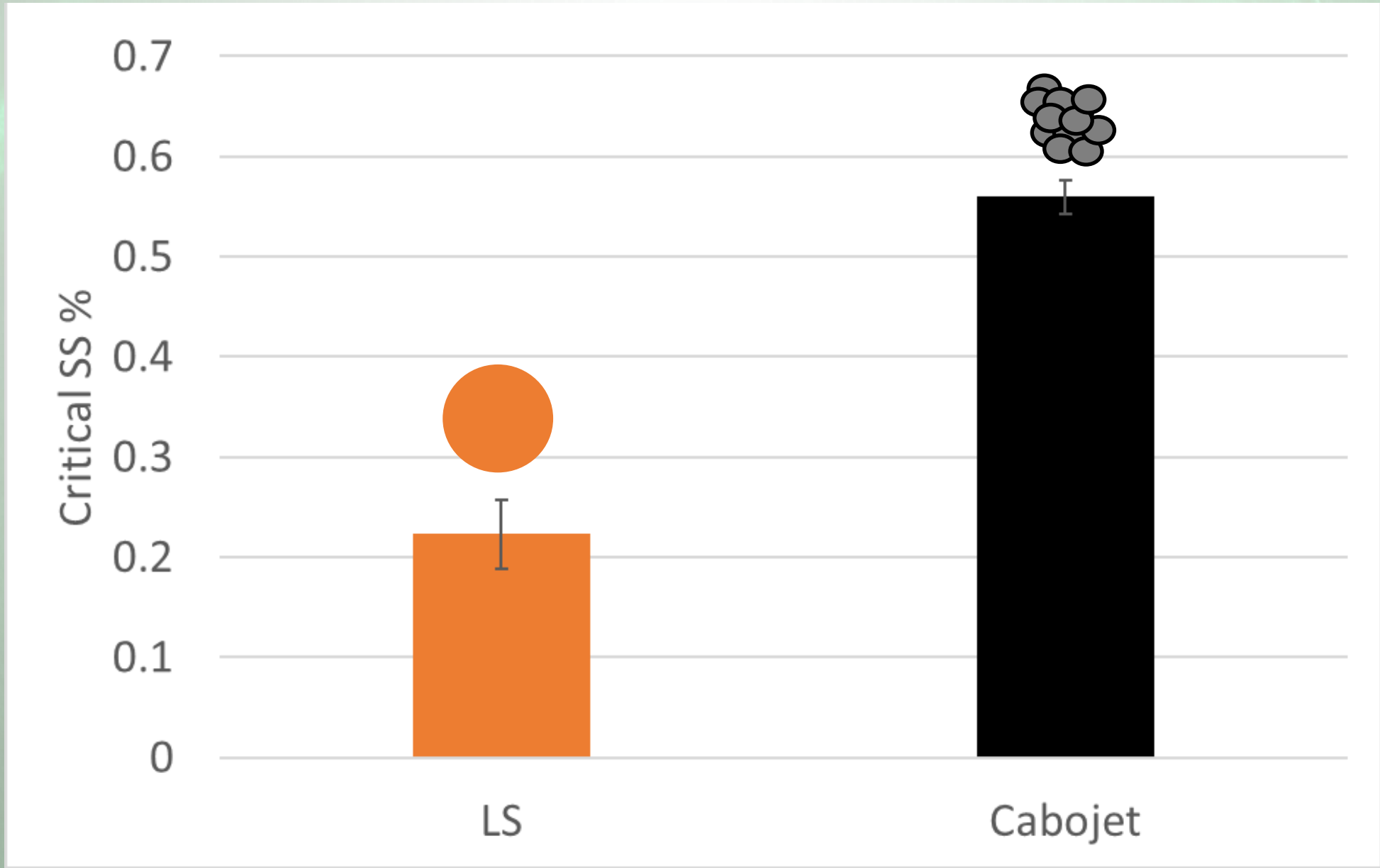
Results: Evolution of external mixing: Thinly coated BC is depleted in residuals



Results: Evolution of external mixing: Non BCcp enriched

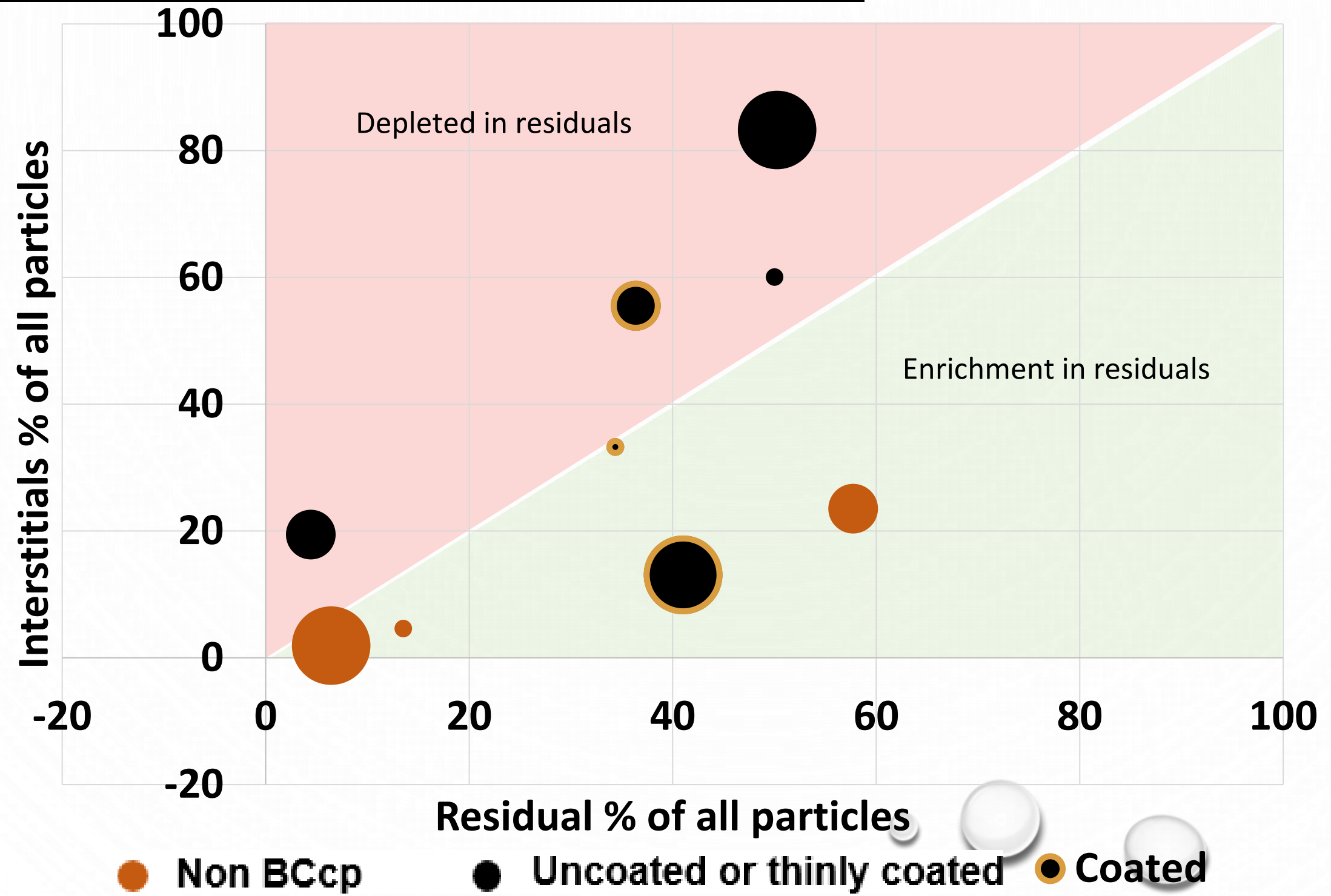


CCNC results: Liquid Smoke is more hygroscopic

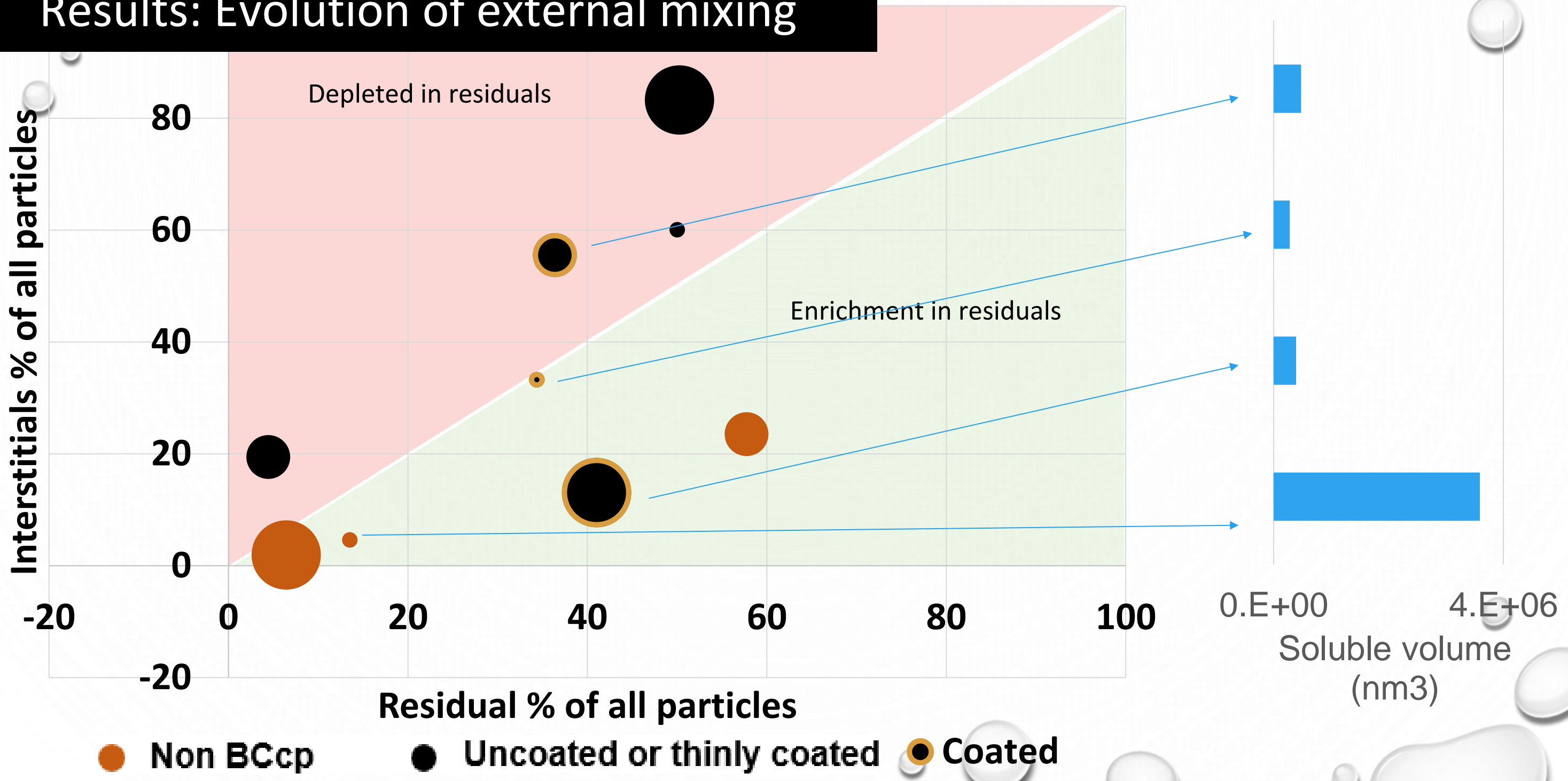


•LS has a lower critical SS % than Uncoated BC

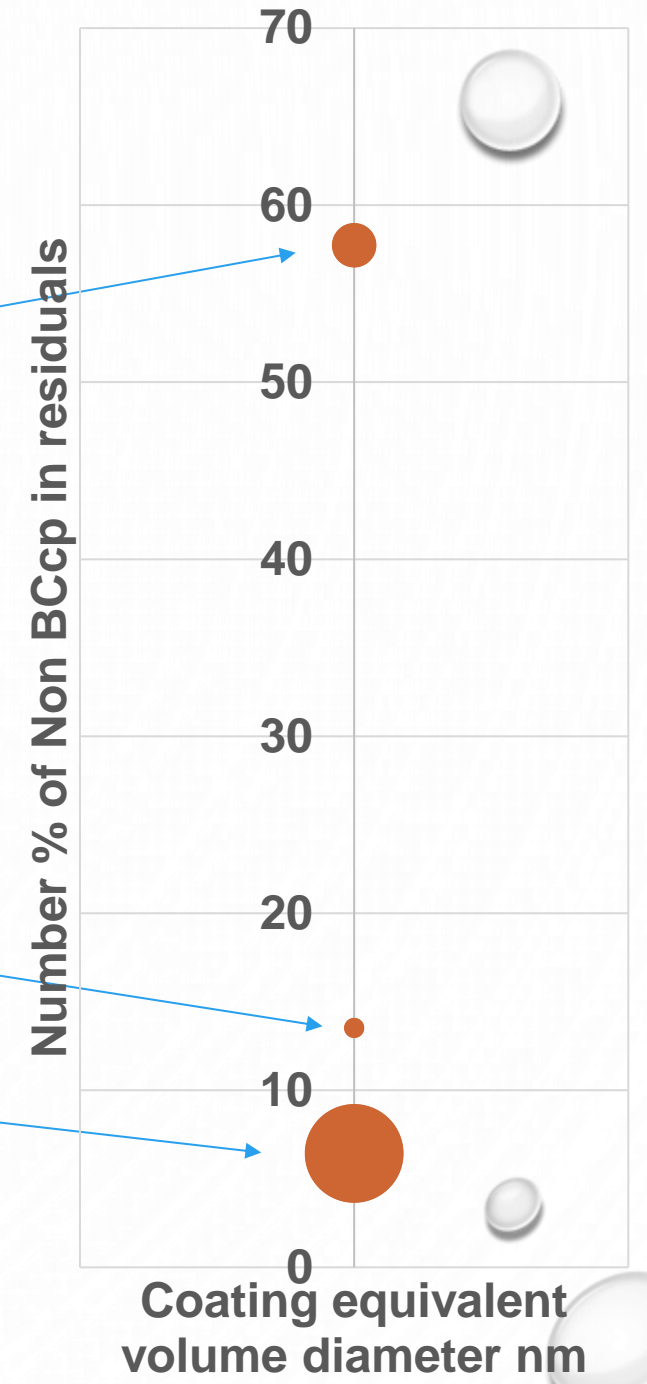
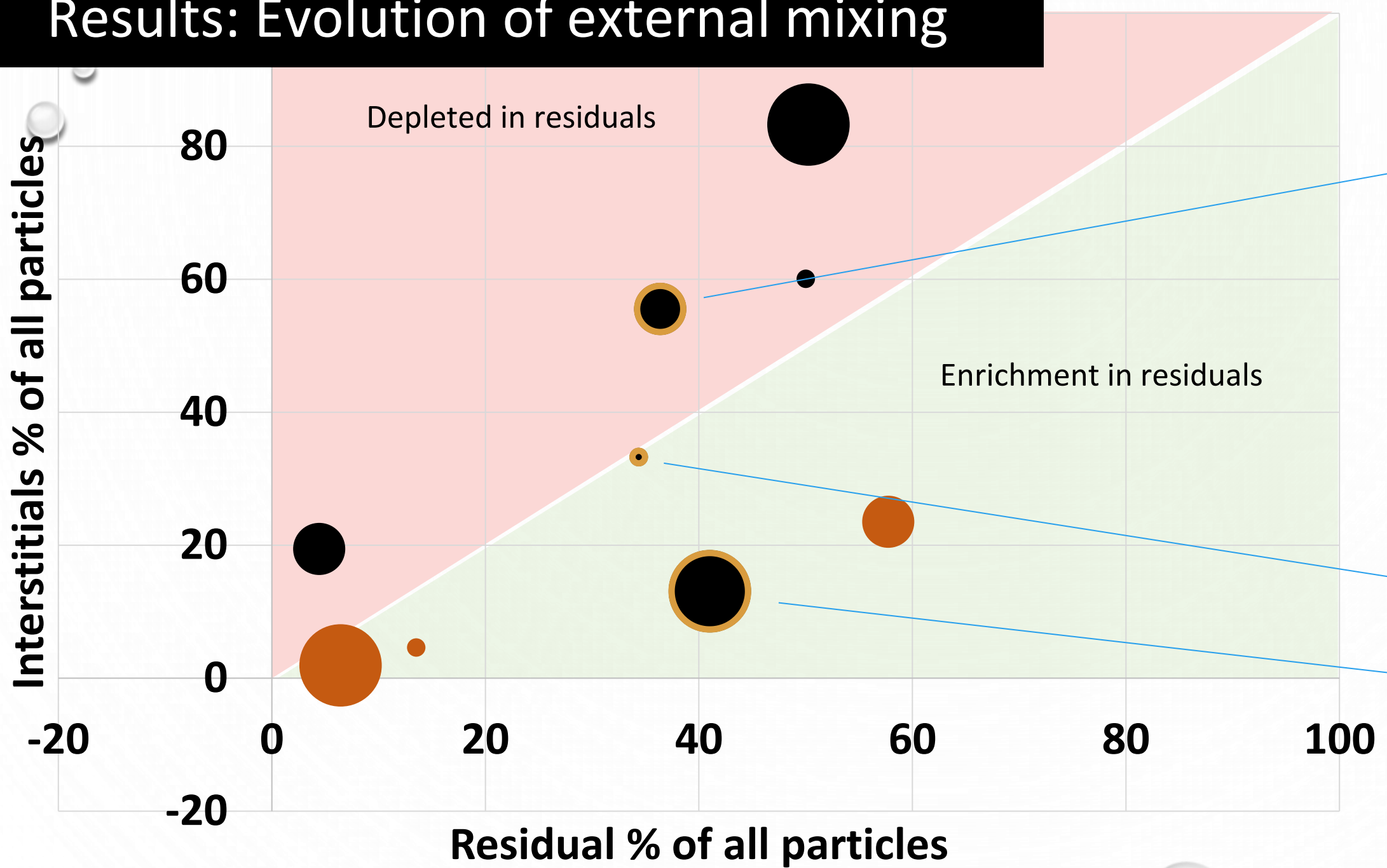
Results: Evolution of external mixing



Results: Evolution of external mixing

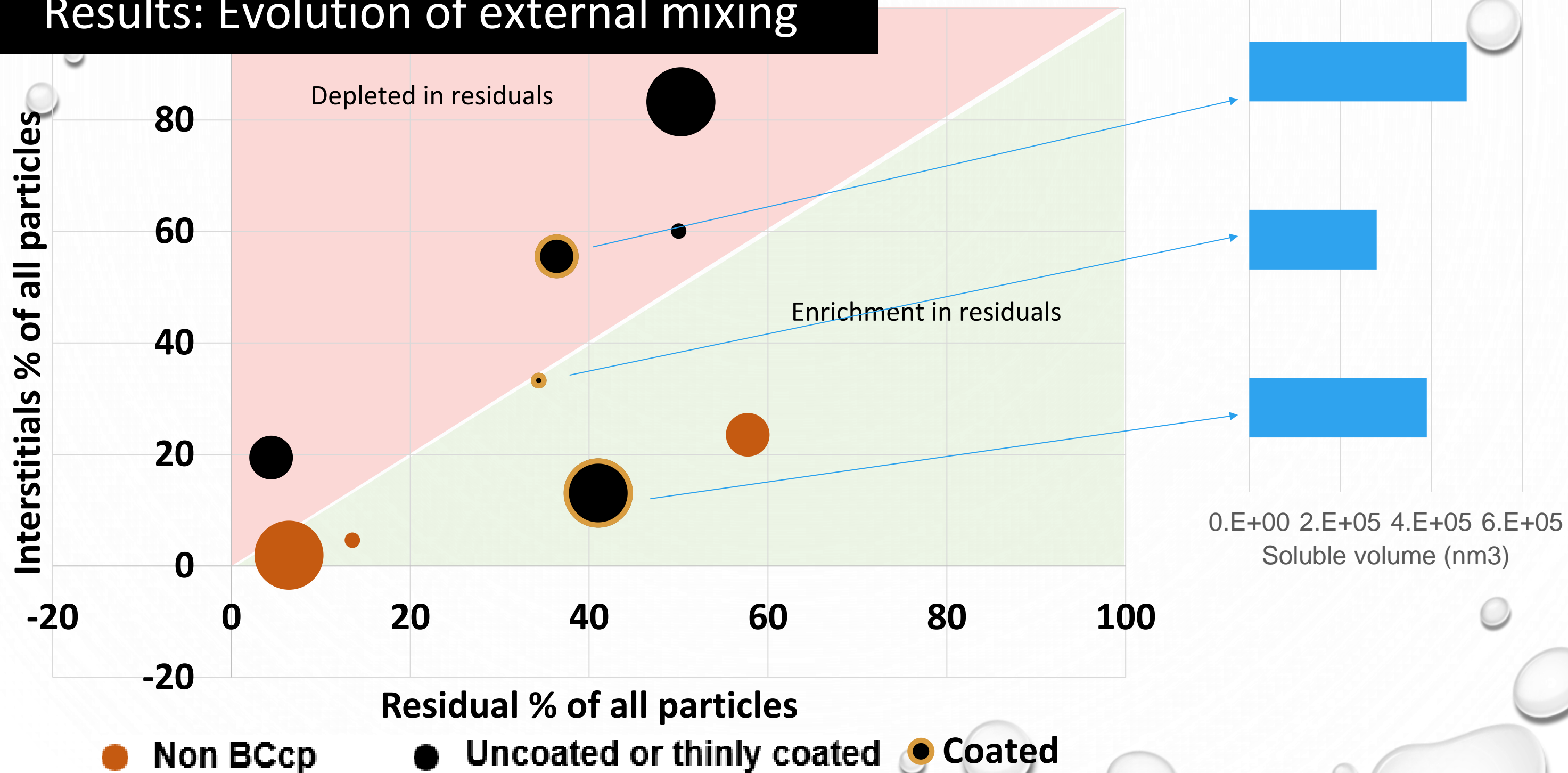


Results: Evolution of external mixing



- Non BCcp
- Uncoated or thinly coated
- Coated

Results: Evolution of external mixing

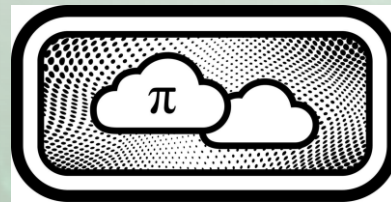


SUMMARY AND ACKNOWLEDGEMENTS

- Light absorbing aerosol surrogates were **injected into the cloud chamber**
- Change in external mixing
 - Non BC containing organic carbon are enriched in the residuals
 - Lightly coated BC or uncoated BC are depleted in residuals
 - Coated BC depends on the number of organic carbon and the amount of coating
- Aerosol **hygroscopicity increases** after interactions with clouds
 - Potentially driven by aqueous chemistry, surface coating or collision scavenging
- Residual Black Carbon was more scattering



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Elizabeth and Richard Henes Center for Quantum Phenomena
Thank You for coming to our presentation!

Feel free to contact Shreya at : shreyajo@mtu.edu or

