A Computational Model to replicate WARER Experiments for Blade Erosion Studies

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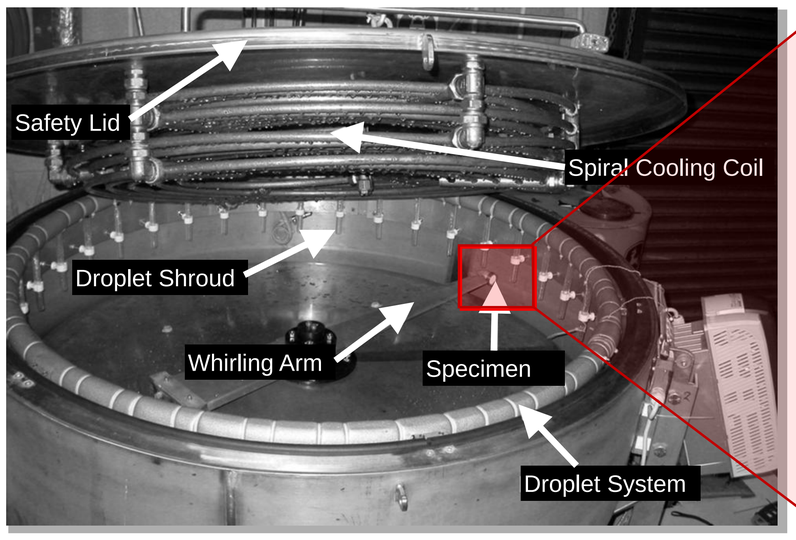
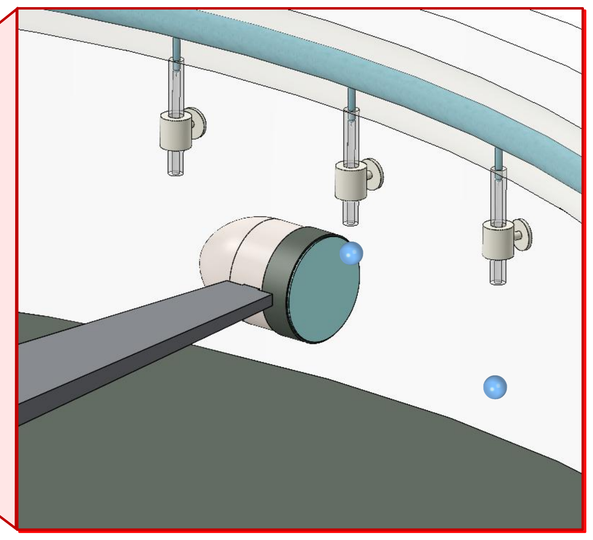
Whirling Arm Rain Erosion Rig (WARER)

An experimental setup designed to study the rain-induced erosion on blade coatings.





In WARER

an arm holding the coated specimen rotates under artificial rain, experiencing **droplet impacts**

Limitation

replicating realistic rainfall distributions (Droplet Size Distributions) compromise the **real site accuracy**

Approach

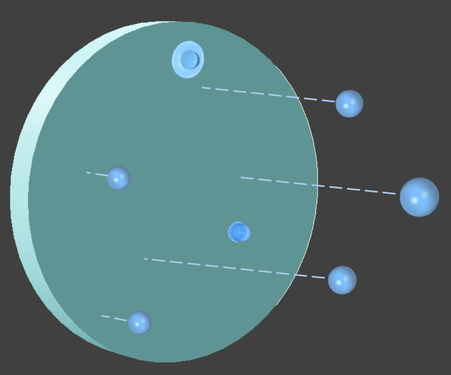
building a computational model to replicate WARER easily accommodate **regional rain distributions**

Computational WARER model

Developed erosion model has three steps

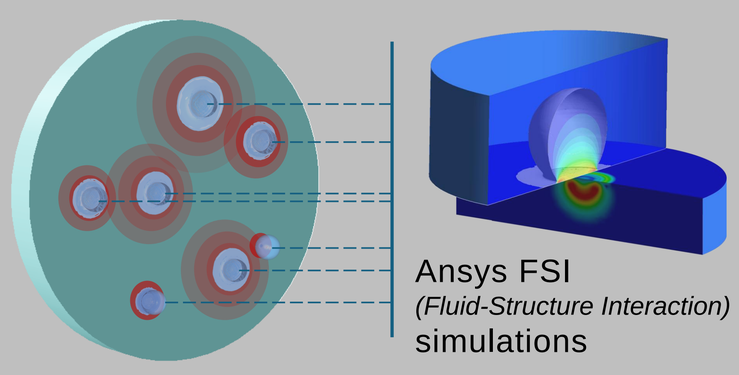
1 Number of impacts

Impact locations and timing



2 Applied the stress profile

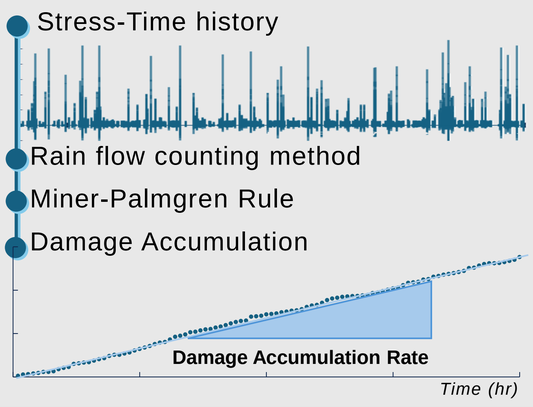
Based on single droplet impact simulation



Ansys FSI
(Fluid-Structure Interaction)
simulations

3 Fatigue analysis

Damage Accumulation Rate

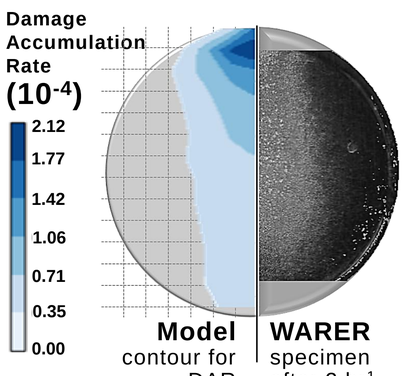


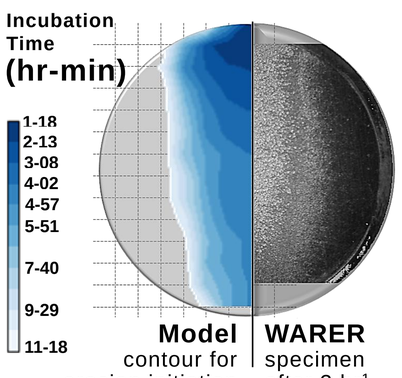
Validation

2 mm droplets with impact speed of 129 m/s on aluminum cladded (AA1100) specimen

Quantitative validation

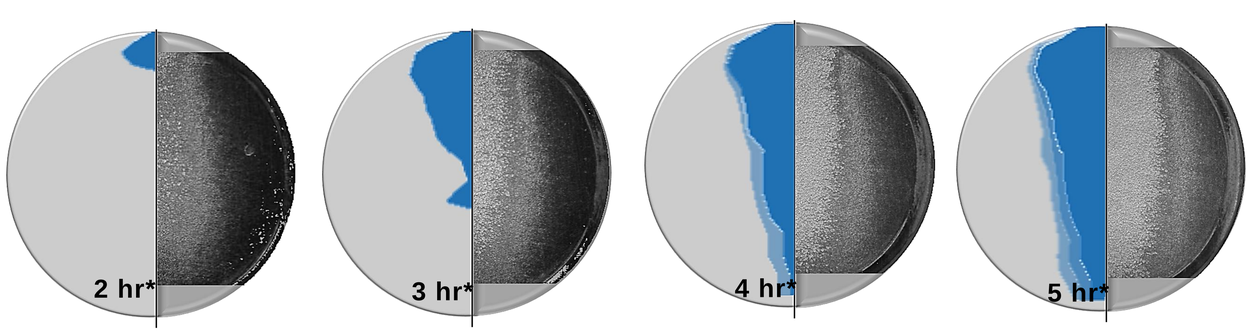
time taken for erosion initiation





Qualitative validation

progression of the erosion scar



Left side: Model scar contour | Right side: Experimented specimen

**testing time | darkest blue area of each figure refer the damage accumulation 1.0, 0.7, 0.8, 0.9 respectively*

Discrepancy

Experiment: Wide scar spreading at the center of the specimen *(after several hours of testing)*

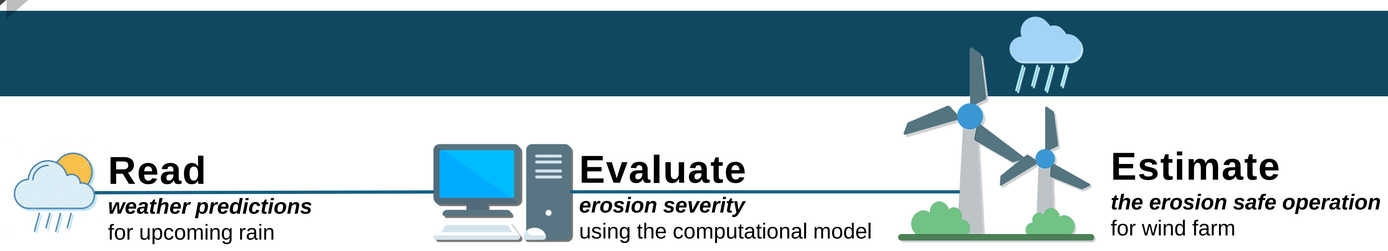
Model: triangular scar shape

Assumption

droplets may trap in the vortex region created by the high-speed specimen

Application

With Uncertainty Quantification framework,
the erosion model can be applied for regional rainfalls to identify erosion-safe modes



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References

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2. Tobin E.F., Young T.M., Raps D. and Rohr O. **(2011)** *Comparison of liquid impingement results from whirling arm and water-jet rain erosion test facilities*, **Wear** 271, 2625–2631, 2011

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