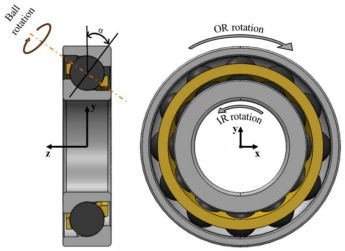
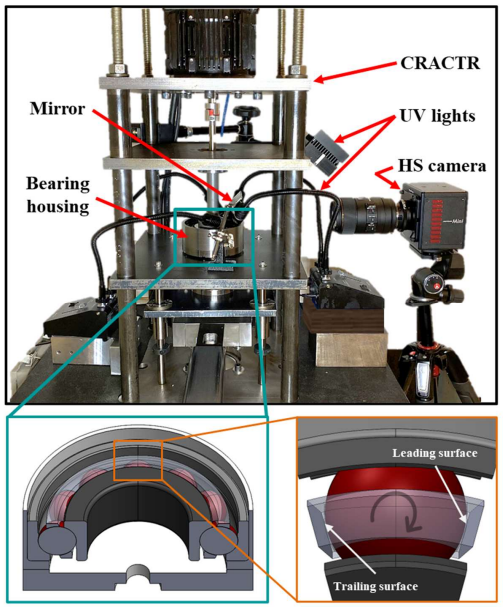
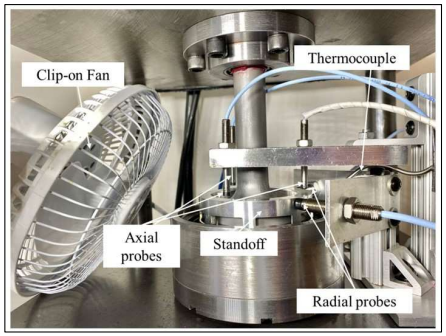
Counter Rotating Bearing Test Rig

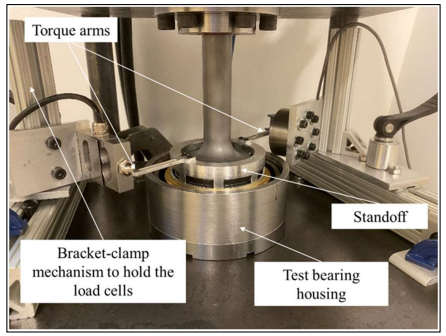
- Counter Rotating Bearing Test Rig allows for simultaneous rotation of inner and outer raceways such that the cage remains stationary
  - To visualize the oil flow in the **cage (stationary) reference frame**
- The test rig was instrumented with proximity probes and load cells to obtain the 3D cage whirl motion and the ball-cage contact forces during bearing operation
- The test rig was also equipped with the Photron high-speed camera to visualize the in-situ lubricant flow with clear cages





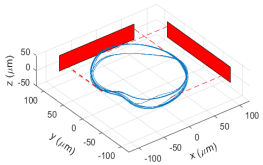
Dynamic motion of bearing cage & ball-cage contact forces





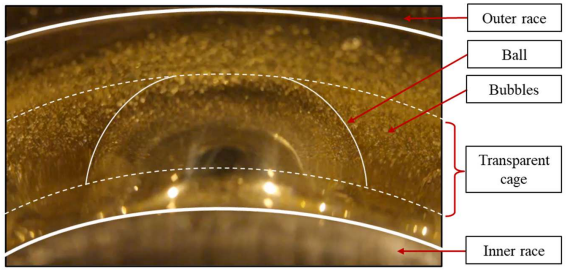
Objective: To experimentally examine the cage motion and ball-cage contact forces for an angular contact ball bearing (ACBB) operating under various load and speed combinations

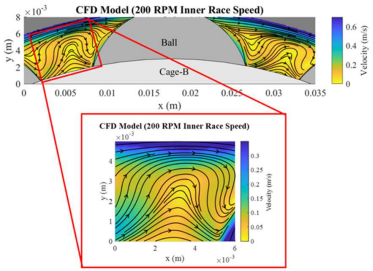
- Five proximity probes were used concurrently to measure the in-plane (radial) and out-of-plane (axial) motion for three commercially available cage designs
- Two load cells were used to measure the contact forces between the balls and cage pocket



Oil flow around bearing cages

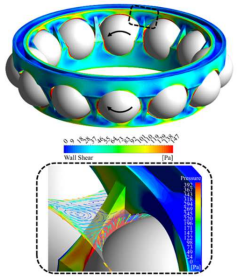
Bubble Image Velocimetry & CFD Modeling





Objective: To investigate the oil flow inside an angular contact ball bearing (ACBB) using an innovative visualization technique of Bubble Image Velocimetry (BIV)

- Used the technique of BIV to track the bubbles in the oil and evaluated the oil flow pattern inside the bearing for different conditions
- Experimental results were corroborated with a single-phase CFD model
- The BIV methodology presented a highly accurate and efficient fluid-flow analysis tool
  - Beneficial for design optimization in numerous tribological applications (for ex. bearing cage designs)



Oil Starvation inside bearing cages

UV fluorescence and Multiphase CFD modeling

Objective: To study the impact of various operating parameters on oil-air striation patterns and to analyze the lubricant distribution inside different ACBB cage shapes

- Visualized in-situ oil distribution inside different bearing cages using transparent cages and UV-dyed oils
- Corroborated experimental results for different cage types with multiphase Computational Fluid Dynamics (CFD) models
- Determined that the geometry and shape of the cage pocket are critical for oil starvation inside the cage pocket