

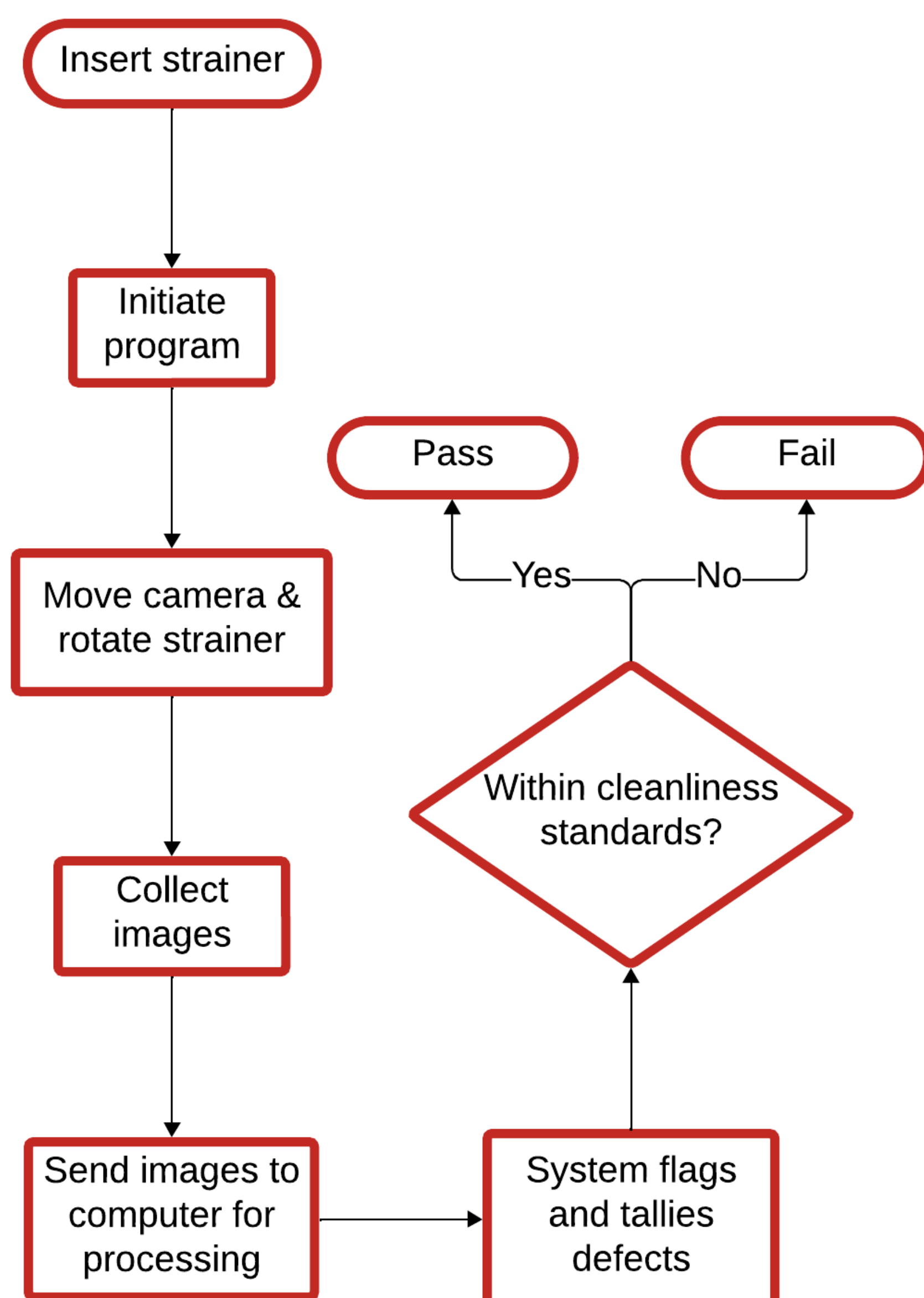
Background & Impact

- Wabtec's remanufacturing plant rebuilds engines with reused, repaired, and new parts
- Used parts must meet a proprietary cleanliness specification
- The oil strainer is the last line of defense in engine oil lubrication cleanliness
- Dislodged debris from the strainer can cause multimillion-dollar damages

Objective & Requirements

- ✓ Software flags debris on the sub-millimeter scale
- ✓ Completes a repeatable inspection process
- ✓ System weight < 50 lbs & physical footprint < 48" x 40"
- ✓ < 5 minutes of training for use
- ✓ Meets OSHA mechanical/electrical safety requirements
- ✓ Operates consistently over 8-hour industrial shifts
- ✓ Software detects more than 99.5% of particles
- ✗ < 10 minutes cycle time

Process Flow



Special Thanks: Behruz Rashidov | Mason Proud
Greg Rieker | Julie Steinbrenner | Daria Kotys-Schwartz
Victoria Lanaghan | Idea Forge & DCC Staff

Z-Axis Linear Actuator

- Adjusts camera vertically
- Holds camera mount assembly

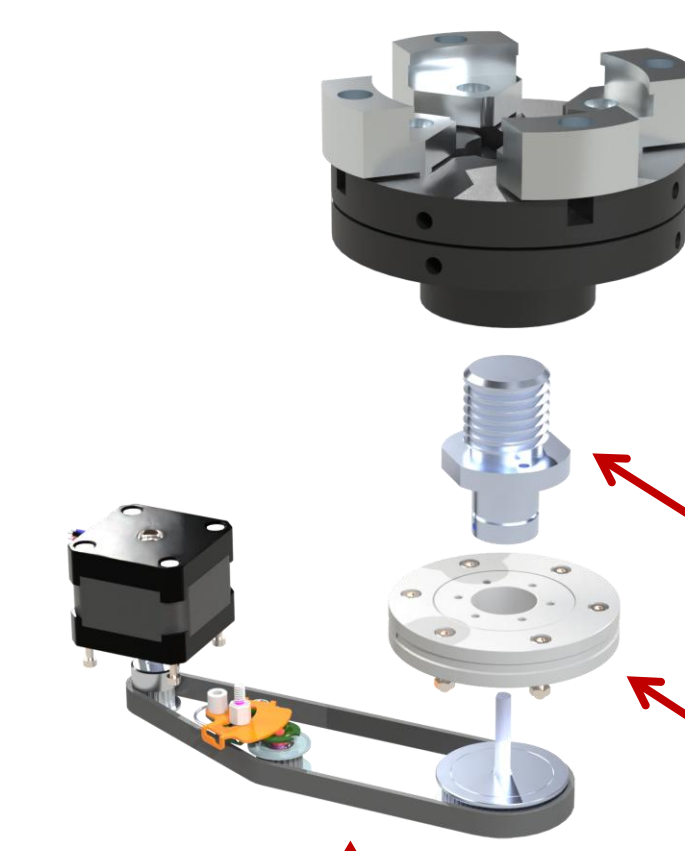
Y-Axis Linear Actuator

- Adjusts camera operating distance
- High precision: 2 mm lead

Rotary Assembly

- Secures strainer in place
- Spins strainer 360°

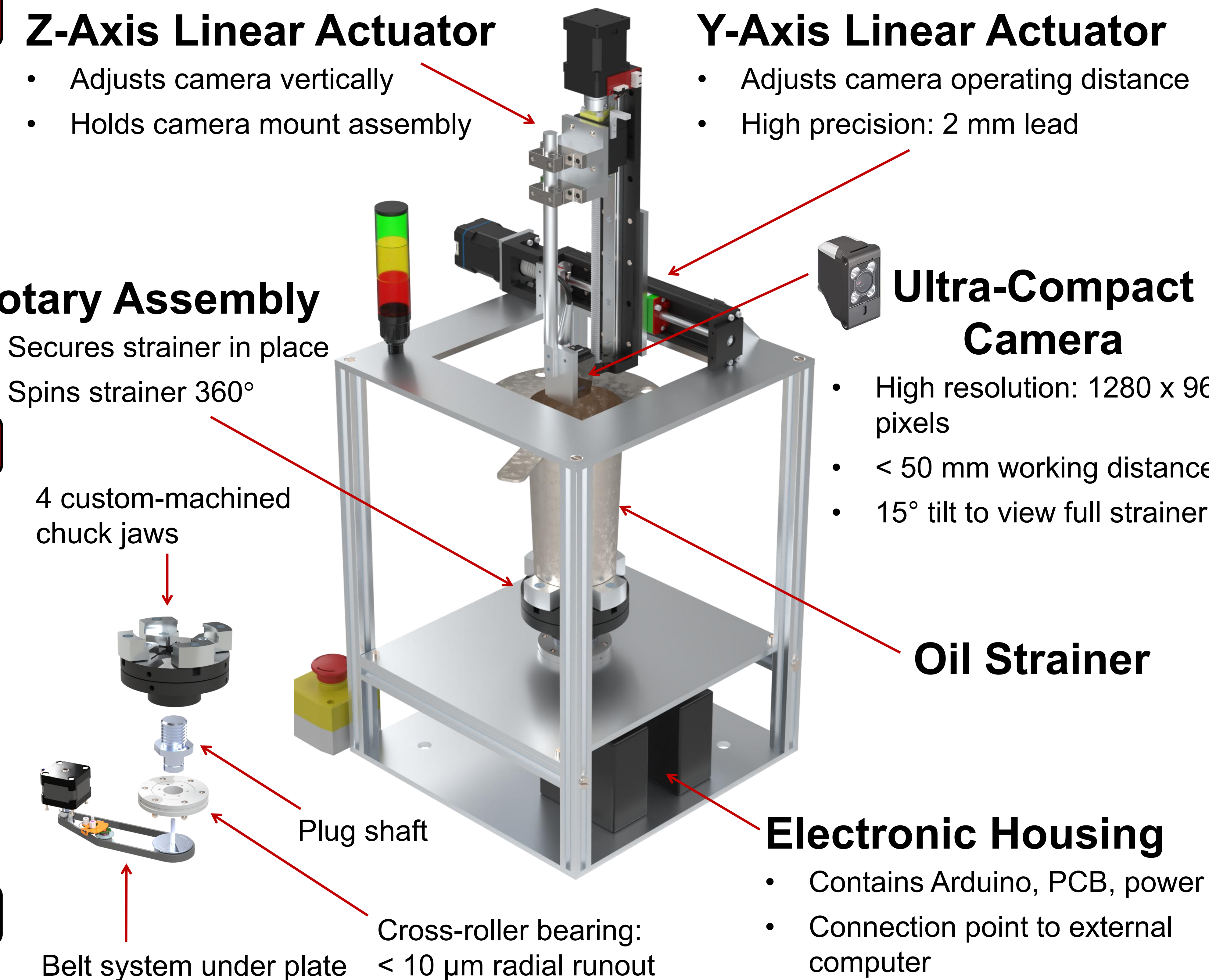
4 custom-machined chuck jaws



Plug shaft

Belt system under plate

Cross-roller bearing:
< 10 μm radial runout



Ultra-Compact Camera

- High resolution: 1280 x 960 pixels
- < 50 mm working distance
- 15° tilt to view full strainer

Oil Strainer

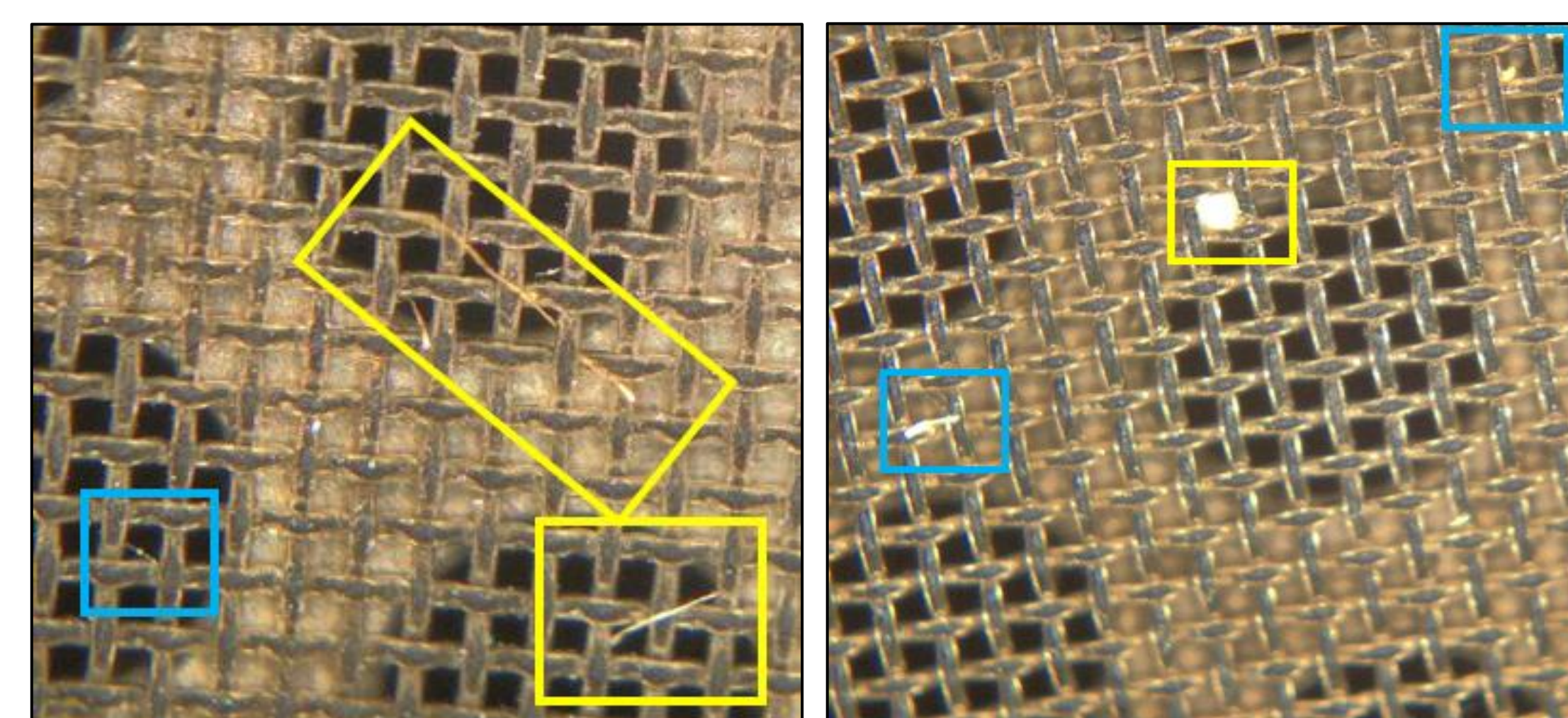
Electronic Housing

- Contains Arduino, PCB, power
- Connection point to external computer

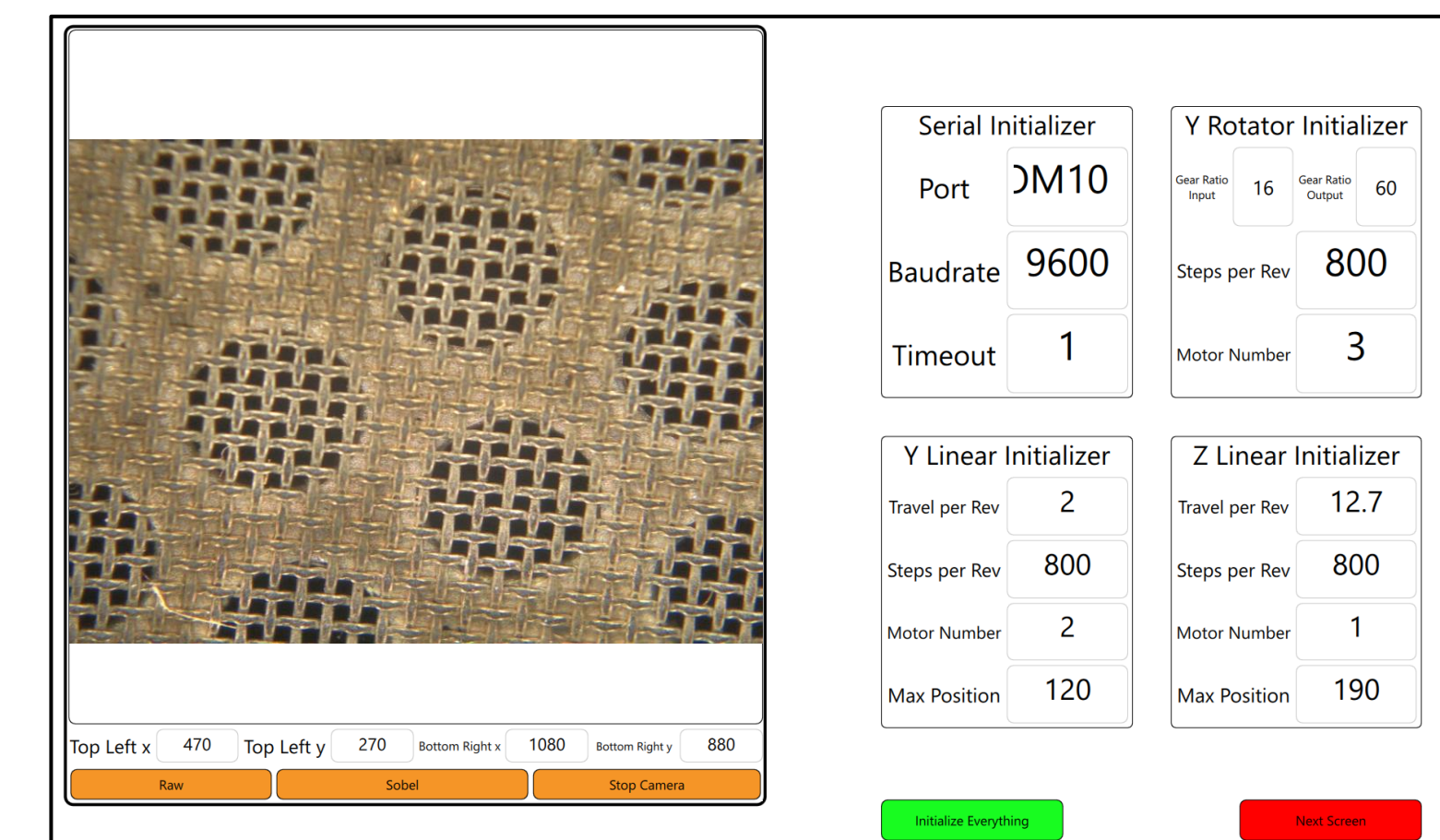
Software

- Computer Vision (CV) uses unsupervised training with clean reference images
- Custom UI for easy training and operation
- Motor and camera control automatically collects ~ 500 images, accounting for strainer runout

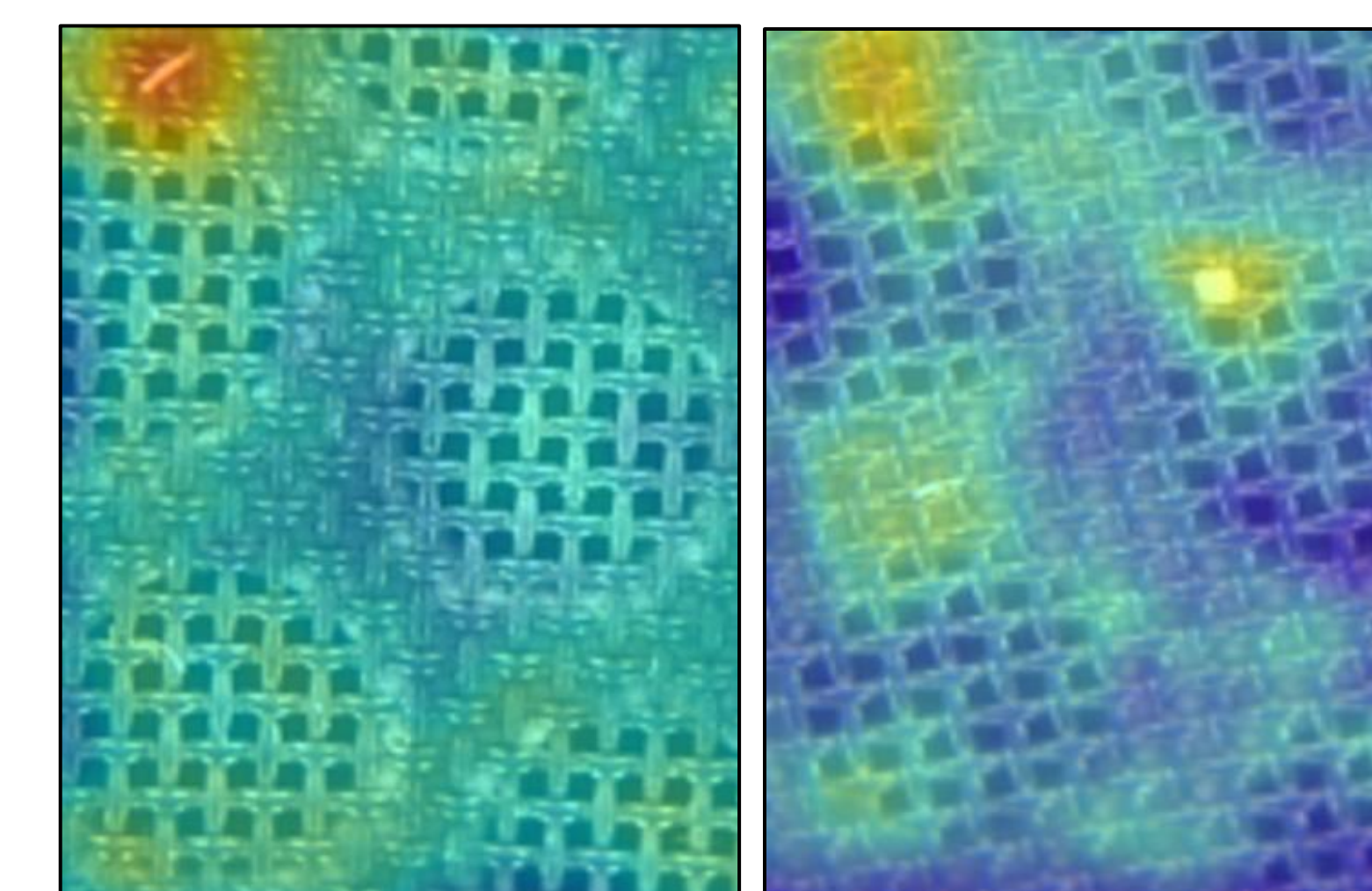
■ Particle does not pass standards ■ Particle is OK



Images with flagged defects

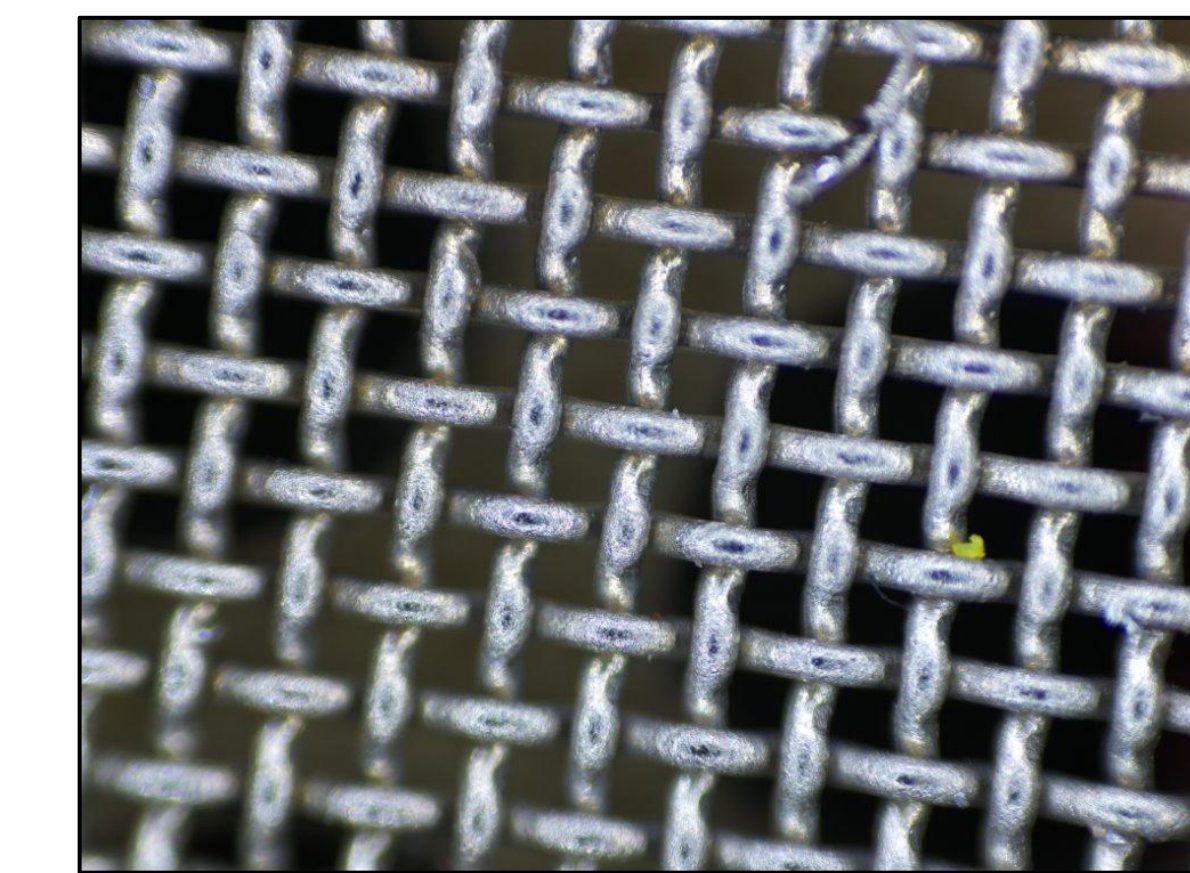


User interface (UI)

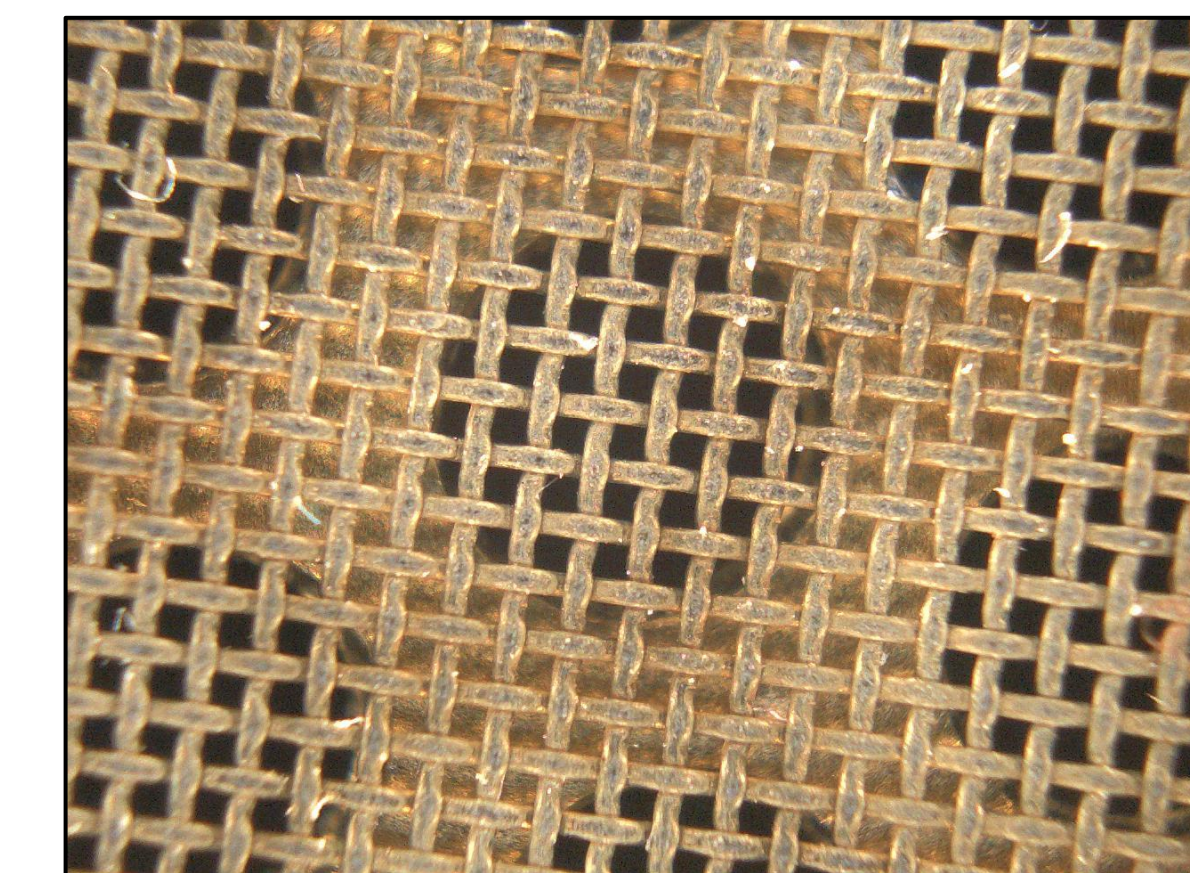


Debris heat maps

Image Progression

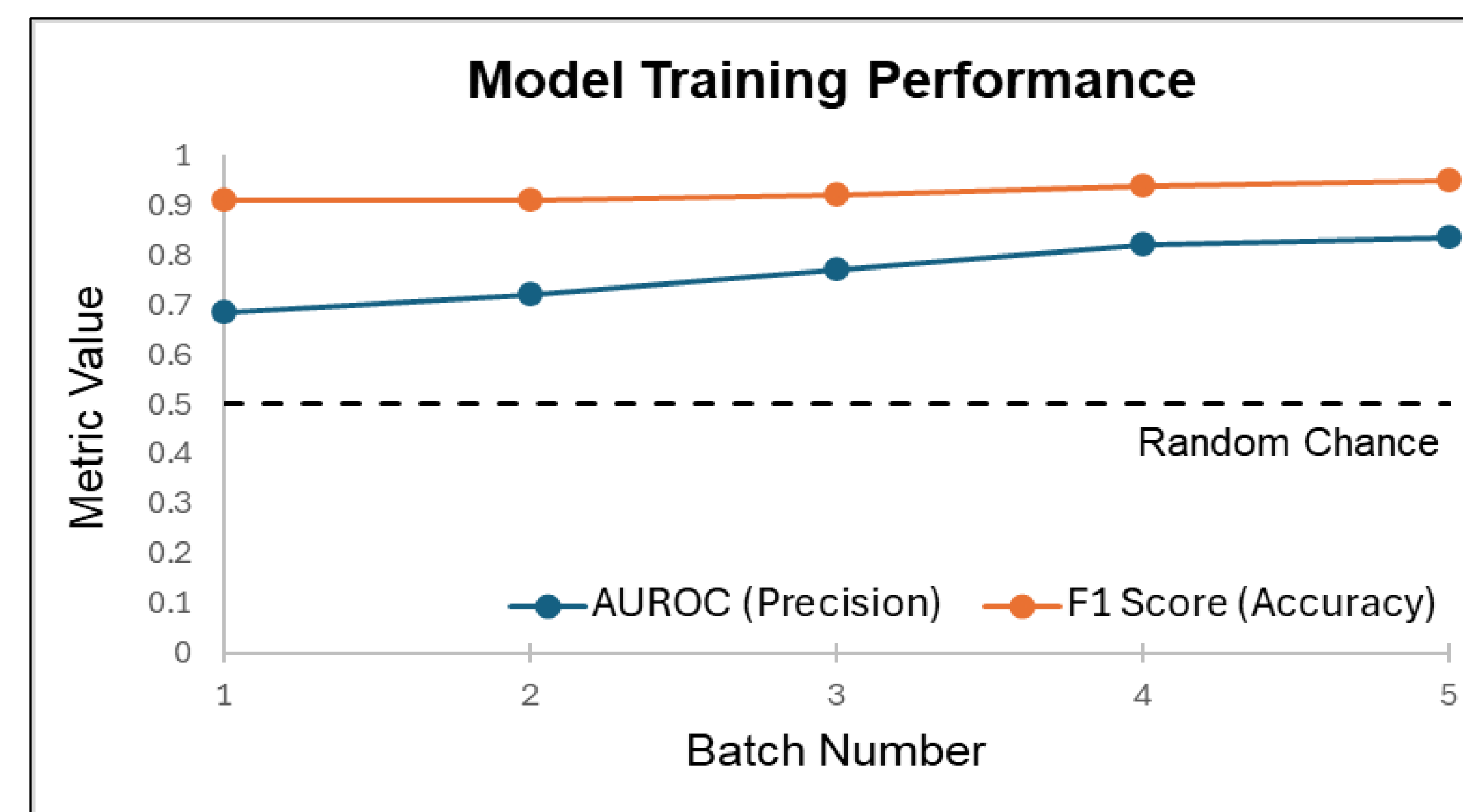


Prototype camera:
incorrect depth of field,
can only see interior mesh



Current camera:
can see both interior mesh
and exterior perforate sheet

Testing Outcomes



- Tested 5 batches containing varying image quantities and qualities
- Parameter optimization for consistent image results

In-Progress Testing

- Continuous training to close both metric gaps towards 1
- Limit false-negatives to ensure real defect detection
- Gage R&R study to ensure consistent results across operators using the same equipment
- Verify electrical component shielding and grounding

Future Work

- Replace motor controller with PLC
- Harden electrical connections
- Multilayered CV model with more data
- Add enclosure around system
- Reduce inspection time to < 10 minutes

