Opening & Introduction
"Good afternoon everyone. We are Team Eureka 200, and for the Smart India Hackathon, we have chosen *Detection of Microplastics* as our problem statement."

Storytelling Hook – Why Microplastics Matter
"To truly understand the importance of this challenge, let's ask three simple questions: **WHY, WHAT, and HOW.**

Build-up
Picture this: You pick up a plastic water bottle. The water looks crystal clear — but hidden inside could be thousands of microscopic plastic fragments.
A study by Columbia University and Rutgers recently revealed that bottled water contains, on average, *2,400 plastic fragments per litre.* These particles, invisible to the naked eye and less than 5 millimetres in size, are called **microplastics**.

And it doesn't stop there. Our oceans and water bodies are heavily contaminated, turning into plastic-infested ecosystems, as you can see in this global estimation map."

Why – The Real Danger
"So why is this problem so urgent?

Let's follow the journey of these particles:

- When we drink or eat from plastics, microplastics silently enter our bodies, harming our health without us even realizing it.
- Once discarded, they flow into drainage systems, travel to rivers, and eventually end up in the ocean.
- Marine organisms consume them, ecosystems are destabilized, food chains begin to collapse — and in the end, the cycle comes back to us.
- On an industrial scale, the problem multiplies, turning into a massive environmental hazard.

This makes one thing very clear: **microplastics are not just an environmental concern — they are a threat to the entire ecosystem.** And if we don't act now, we risk sliding towards ecological collapse."

Transition – From Problem to Challenge
"Now that we understand the *why*, let's move on to the *what*.

Currently, there are detection methods like filtration, FTIR, Raman spectroscopy, and electron microscopy. While effective, these techniques have serious limitations:

- They are slow — taking 6 to 8 hours per sample.
- They are costly — with equipment ranging from $10,000 to $50,000.
- And they are restricted to labs — bulky and weighing several kilograms.

This means we are stuck at the very first step: **identification.** Without efficient detection, removal and further research become nearly impossible.

And this is exactly the gap we aim to bridge with our solution."

How are we solving this problem?

Our Solution – Portable Microplastic Detection System

"This gap inspired us to design a portable, low-cost microplastic detection system. A system that makes the invisible, visible — so researchers, policymakers, and industries can focus on solutions, not just the problem.

When we started designing this sensor, we asked ourselves: **how** do you reveal something invisible? The answer — is to look at light.

• Step 1: Lensless Holography. Imagine shining light through a glass of water. Instead of seeing the particles directly, we capture the interference patterns formed when light bends and scatters around them. These patterns contain hidden clues about each particle's size, shape, and position. Think of them as fingerprints waiting to be decoded — all without bulky microscopes.

• Step 2: Polarization-Sensitive Imaging. Every plastic polymer interacts with polarized light differently. Polyethylene barely changes it, while polystyrene twists it significantly. By capturing these subtle shifts, we can not only confirm if a particle is plastic but also identify what type of plastic it is.

Now let's go deeper into physics. Our system uses a 660 nm laser to generate an inline hologram. The laser light interacts with particles in the sample, producing a Fresnel diffraction pattern — concentric rings of dark and light. When multiple particles are present, this looks like static noise on a TV screen. But hidden in that "noise" is extremely rich information — both amplitude and phase.

This is where our approach shines. Using HoloPy, an advanced library for holographic analysis, we decode these complex interference patterns. What looks like random static is reconstructed into a 3D representation of particles suspended in water.

Next, using OpenCV and Support Vector Machine (SVM) algorithms, we analyze this 3D holographic data. The system identifies each particle, classifies it by type, measures its size, and even counts the number present.

And here's the most important part — all of this computation happens locally on a Raspberry Pi 3 using edge computing. This ensures real-time detection even in remote locations. Once the system is connected to a network, the data is seamlessly uploaded to the cloud. Over time, this creates a growing dataset that makes our models even more precise, fine-tuned, and research-ready."

Step-by-Step Workflow Recap:

1. Water sample prepared with filtration and vortex mixing.
2. Sample placed in a petri dish inside the device.
3. 650 nm laser generates holographic patterns.
4. Polarized lenses (0° and 90°) capture plastic-specific signatures.
5. Raspberry Pi HQ camera records the image.
6. Holography + OpenCV + SVM decode the image into particle type, count, and structure.
7. Results are computed locally, then synced to the cloud when connected.

Feasibility & Viability

"Our design is compact, affordable, and scalable. It uses simple yet powerful physics principles with widely available components like Raspberry Pi and a laser diode. Because it's lightweight and portable, it can be deployed anywhere — at a riverbank, a wastewater outlet, or even in classrooms for awareness.

Its integration of edge computing ensures offline functionality, while cloud connectivity builds collaborative datasets for global research. This combination of accessibility and scalability makes the solution both feasible today and future-ready."

Impact & Benefits

"This solution creates impact at multiple levels:

- Governments can monitor and regulate plastic pollution more effectively.
- Citizens gain awareness and transparency about water contamination.
- Scientists can conduct risk assessments and field research without heavy lab equipment.
- Industries can monitor their discharge points, enabling circular economy practices and accountability.

This is not just a prototype — it represents a new class of sensor: portable, real-time, and AI-powered. A device that can be used by researchers in labs, industries at discharge sites, or communities testing their local water sources.

It takes cutting-edge optics and transforms them into a tool that is both powerful and accessible."

Closing

"Our story started with an invisible problem — microplastics. It took us through the failures of conventional methods and brought us to a breakthrough that unites physics, optics, and advanced computing in a way never attempted before.

Today, we hold in our hands a device that truly makes the invisible visible. A technology designed not just to observe pollution, but to transform how the world detects and combats it.

We are Team Eureka 200, and this is our microplastic detection system — affordable, scalable, impactful, and urgently needed.

Because microplastics may be invisible, but their consequences are not. And it's time we take action."