Pitch script:

[cut from individual intro to group video]

"So, hi there! We are Team 31, and our project focuses on something truly fundamental - cell growth. Now, you might wonder, why is measuring cell growth so crucial?

"Cell growth is the heartbeat of biology. Understanding how cells proliferate is essential for appliances all over the scientific fields. From medical applications like drug discovery and development, all the way to environmental appliances, cell growth consistently plays a crucial role.

Our motivation is simple – we want to take a first step into the science of measuring cell growth. To achieve this, we're developing a cutting-edge device to accurately measure and analyze cell growth of yeast cells in real-time.

So, make yourself ready to join us on the exciting 3-week journey from building our own device to analyzing the data from the lab.

[cut to the design of the device]

Well, for a start, - Stefan – how did we go about designing our state-of-the-art cell growth measuring device?

[now continue to explain our design]

Good question – I’ll explain it to you:  
The concept is easy. We used a high-sensitivity low-noise light-to-voltage optical converter that combines a photodiode and a transimpedance amplifier on a single monolithic CMOS integrated circuit, to measure the light coming from a low-power general purpose orange LED passing through a plastic disposable UV-Cuvette containing yeast cells and food for the yeast.  
To hold all of this together, we built Steve. Steve is a Fusion 360 design, 3D printed with SLA technique.  
As the yeast feeds, it grows thicker and allows less light to pass through. The collected and plotted data allows real human scientists to analyze the trends and determine the hungriest yeast species!

Now Fedir could you explain how we connected our device to the Huzzah-board so we can actually record data.

Sure!

To illuminate our yeast sample, we wired the LED to the digital pin 12 through the 5kOhm sequence of resistors to lower the noise and get more precise measurements. The light sensor got connected to Pin 26 with a single 10kOhm resistor. The LED on the board is used to indicate the workflow of our code. Finally, we have a button to stop our measurements, connected to a pulldown resistor, so we don’t have an antenna instead of an input pin.

Let’s take a look at the whole device setup. By testing some very sophisticated light barriers like a jacket or a coffee cup, we came up with no less sophisticated solution of using a plastic lid from a Chinese food thermos and plasticine at the base that completely prevents any rays of light from entering. This in fact makes a big difference, as we discovered significant data deviations depending on what cover we used.

Enough of hardware, let’s now look at our software design:

We had to solve several problems with our software design in micro python. How bright should our LED in the 3D-Design be – determined by the duty cycle - and at what frequency should it shine? How do we make sure the data we get is correctly calibrated? Finally, how do we precisely record data and safely disconnect our device from the power source, so we don’t lose the data?

To solve these problems, we took a practical approach. For each problem we formulated some code and started testing. That’s how our final code looks like [show screen recordings of the code]. We settled on a duty cycle of 40% and a frequency of 100kHz for the LED. Regarding the calibration we took reference values and adjusted our measured values accordingly. The conversion function we acquired from that, we then applied on our measurements in the lab. To get accurate data we decided to save an average of 1000 values every 70 seconds. Finally, we implemented a safety button to stop the data recording so we can safely disconnect our device.

Well so much to the device, but what actually happened in the lab and with our data?

We had two main goals in the lab. Determining the growth curve of the yeast cells and making a CFU analysis. To determine the growth curve, we setup our device in the lab and started measuring over 70 hours. By using line fitting to our plotted data we could determine the growth rate of our yeast cells, which turned out to be 5.818\*10^-5. With this information we calculated the doubling time for the yeast cells and compared our result with the expected results. According to our data the doubling time is about 3.6 hours whereas the expected one would be 90 minutes. The deviation from the expected result could be explained by small leftovers of ethanol in our cuvette which might have slowed down the yeast growth. Another possibility could be slightly too low temperatures in the lab.

Finally, in the CFU analysis we determined the colony forming unit of three differently diluted versions of yeast samples. We used Agar-plates to spread the samples evenly and incubated them for 48 hours. Following that we counted the visual colonies on our plates and calculated the respective CFU value per ml and OD. We could observe that the CFU per ml and OD values increased for the samples with a higher dilution factor, even though they should roughly be the same. A possible explanation is that the higher dilutions give less accurate results. Another possibility is that there have been slight inaccuracies when the solutions were diluted.

Thanks for watching!