

BUILDING LOGICAL GATES WITH SLIME MOLDS

A JOURNEY IN PROGRESS

Discovering Boolean Gates in Slime Mould

Simon Harding^{a,*}, Jan Koutník^b, Klaus Greff^b, Júrgen Schmidhuber^b, Andy Adamatzky^a,

^a*Unconventional Computation Centre, University of the West of England, Bristol UK*

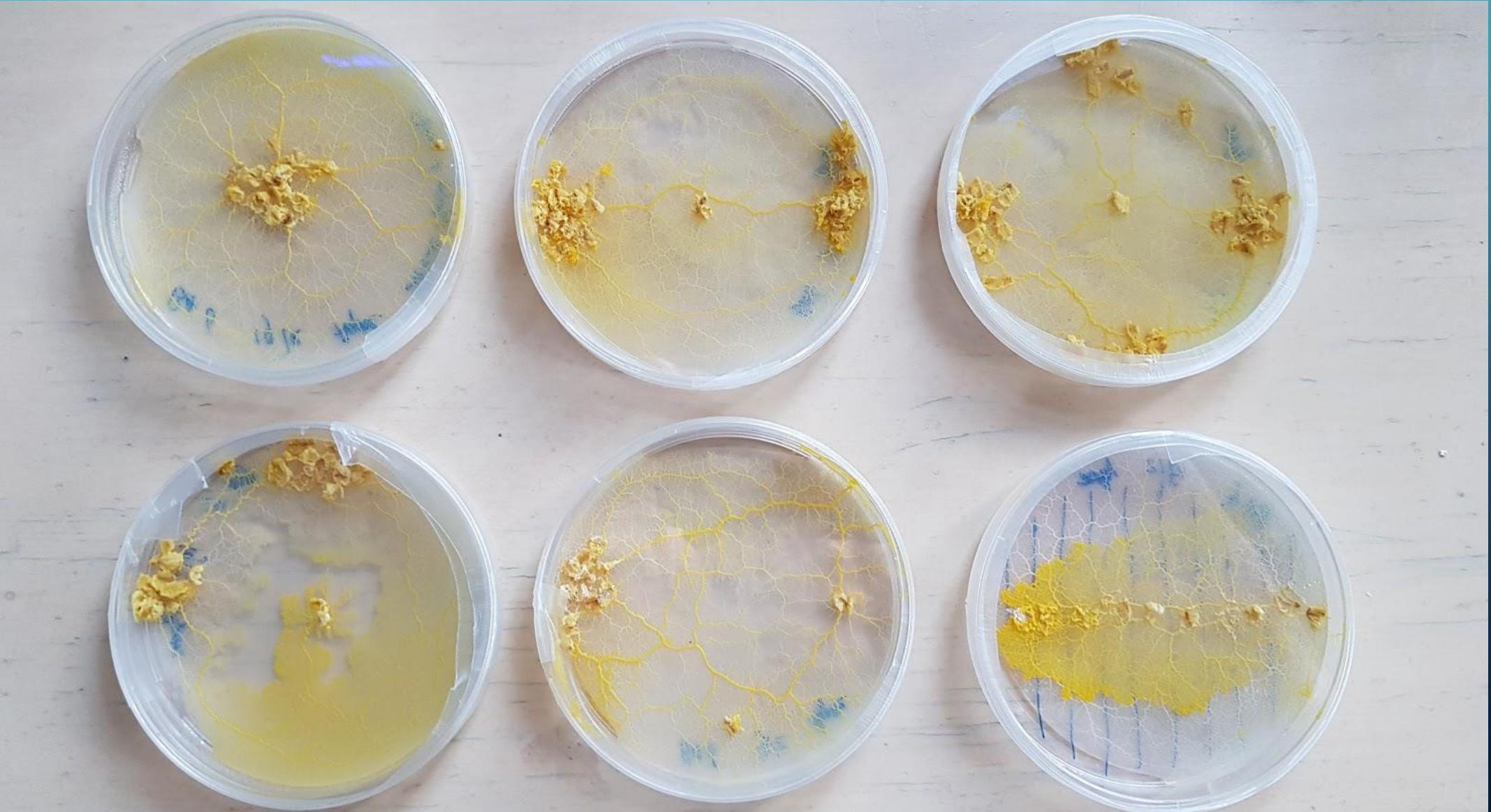
^b*IDSIA, USI&SUPSI, Manno-Lugano, CH*

Abstract

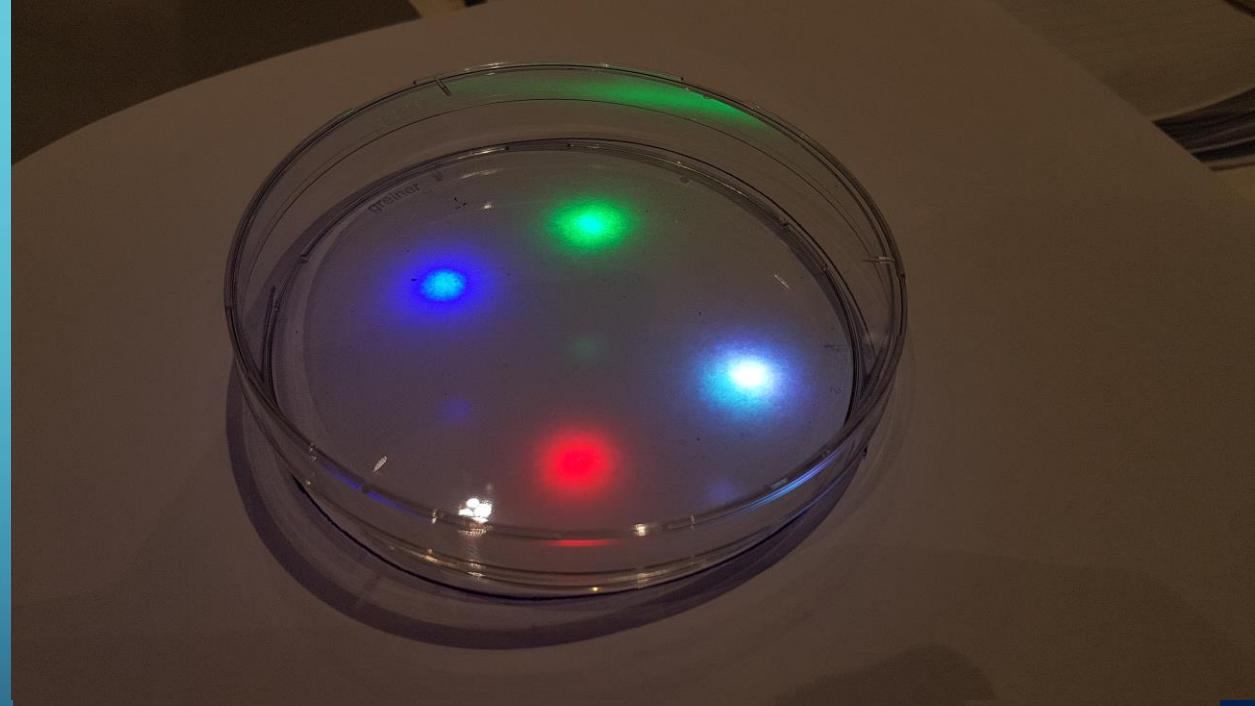
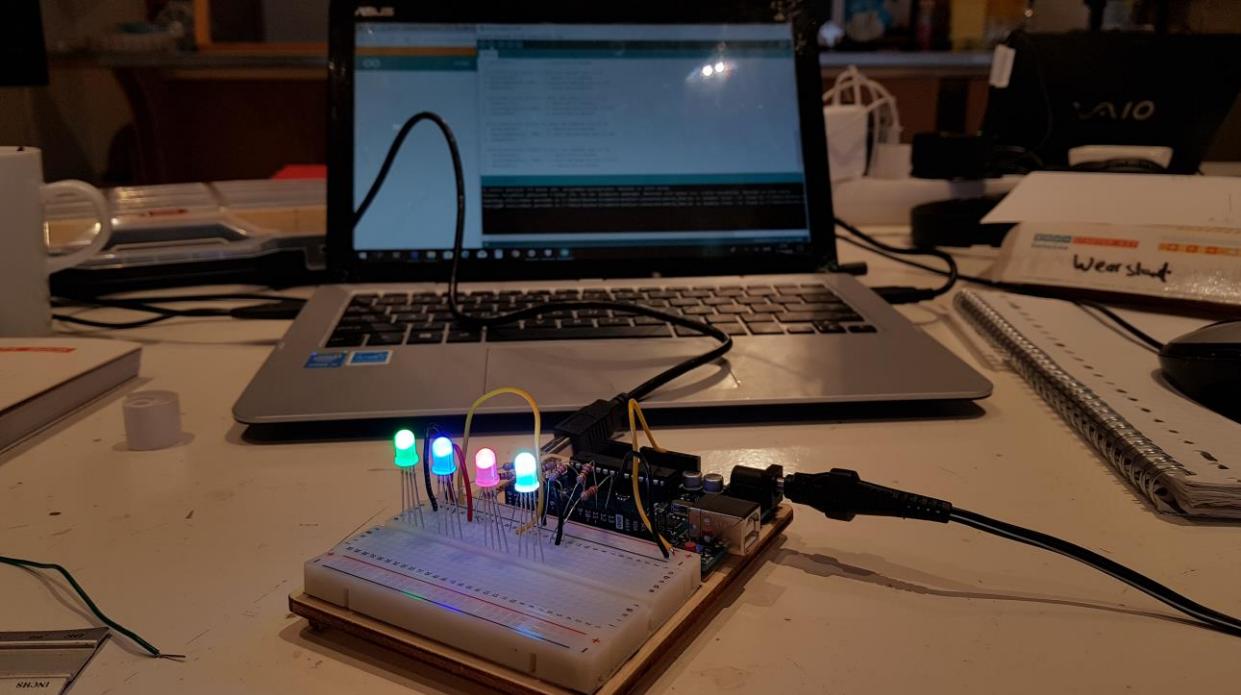
Slime mould of *Physarum polycephalum* is a large cell exhibiting rich spatial non-linear electrical characteristics. We exploit the electrical properties of the slime mould to implement logic gates using a flexible hardware platform designed for investigating the electrical properties of a substrate (*Mecobo*). We apply arbitrary electrical signals to ‘configure’ the slime mould, i.e. change shape of its body and, measure the slime mould’s electrical response. We show that it is possible to find configurations that allow the *Physarum* to act as any 2-input Boolean gate. The occurrence frequency of the gates discovered in the slime was analysed and compared to complexity hierarchies of logical gates obtained in other unconventional materials. The search for gates was performed by both sweeping across configurations in the real material as well as training a neural network-based model and searching the gates therein using gradient descent.

Keywords: Slime Mould, *Physarum*, Unconventional computing

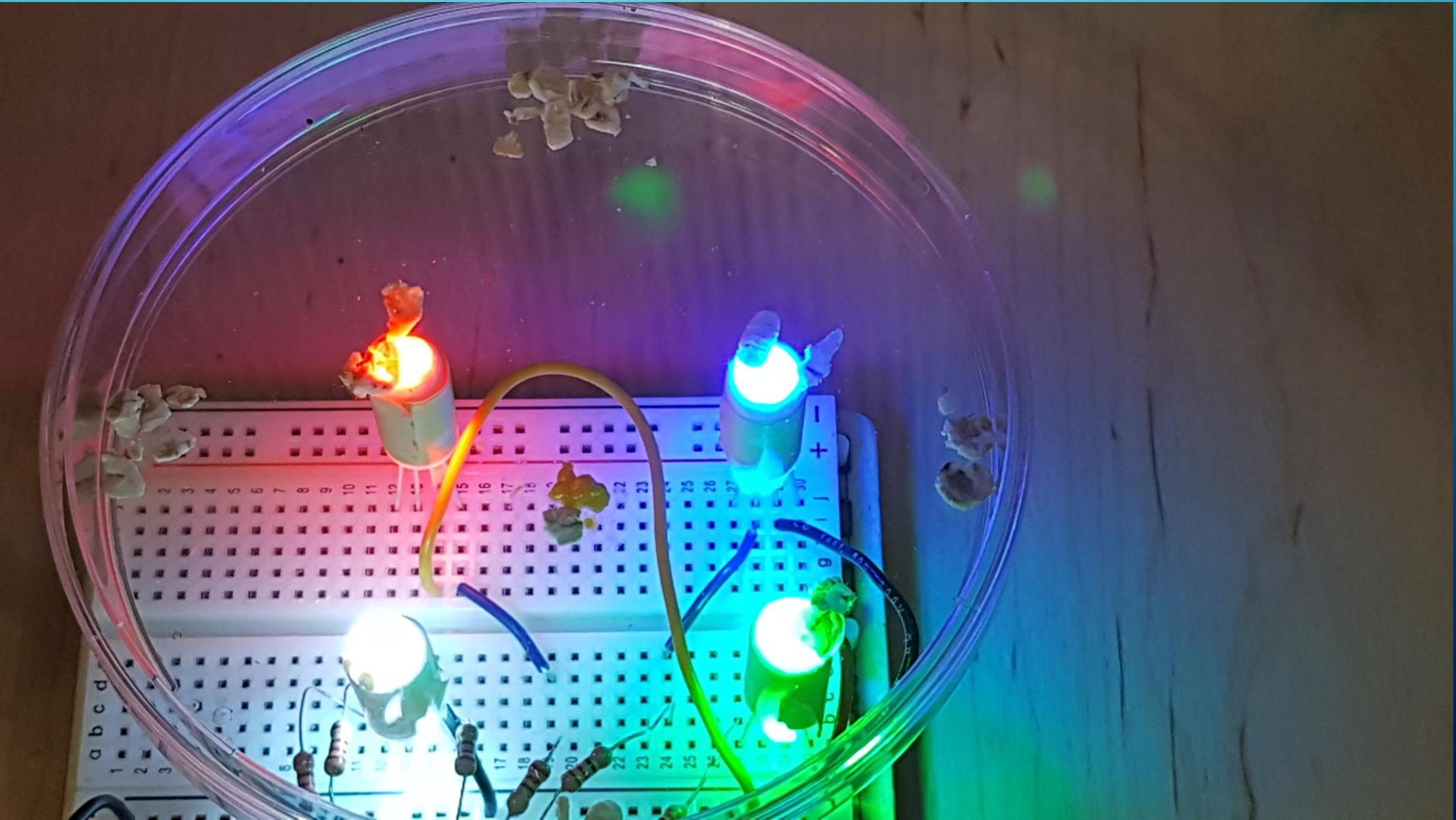
GROW TEST



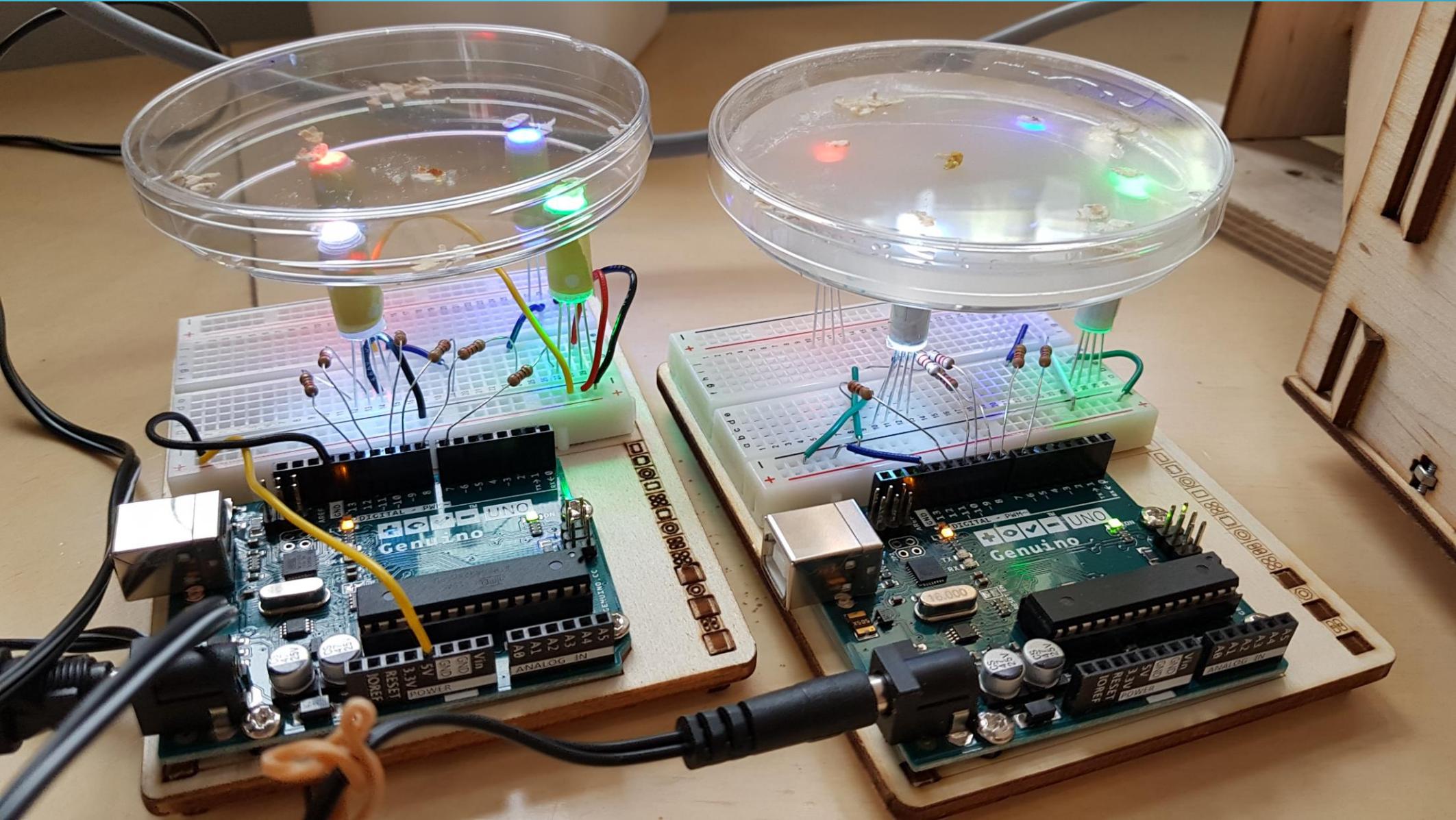
LIGHT INHIBITION GROW TEST SETUP



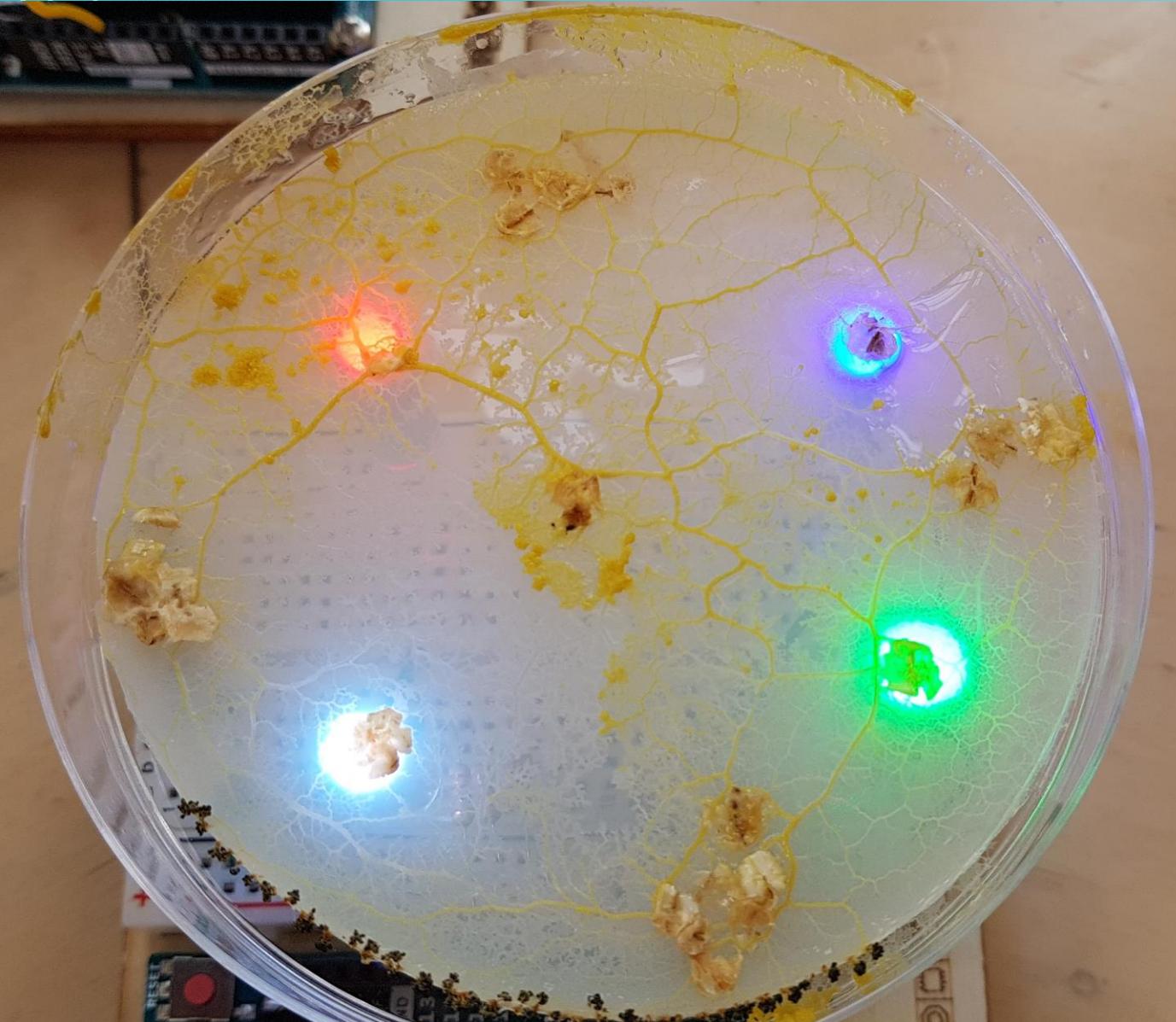
LIGHT INHIBITION GROW TEST RESULTS



LIGHT INHIBITION GROW TEST #2!



LIGHT INHIBITION GROW TEST #2 RESULTS



LOGIC GATE TRUTH TABLE

INPUT 1	INPUT 2	OUTPUT OR	OUTPUT AND
0	0	0	0
1	0	1	0
0	1	1	0
1	1	1	1

PROTOTYPE LOGIC GATE

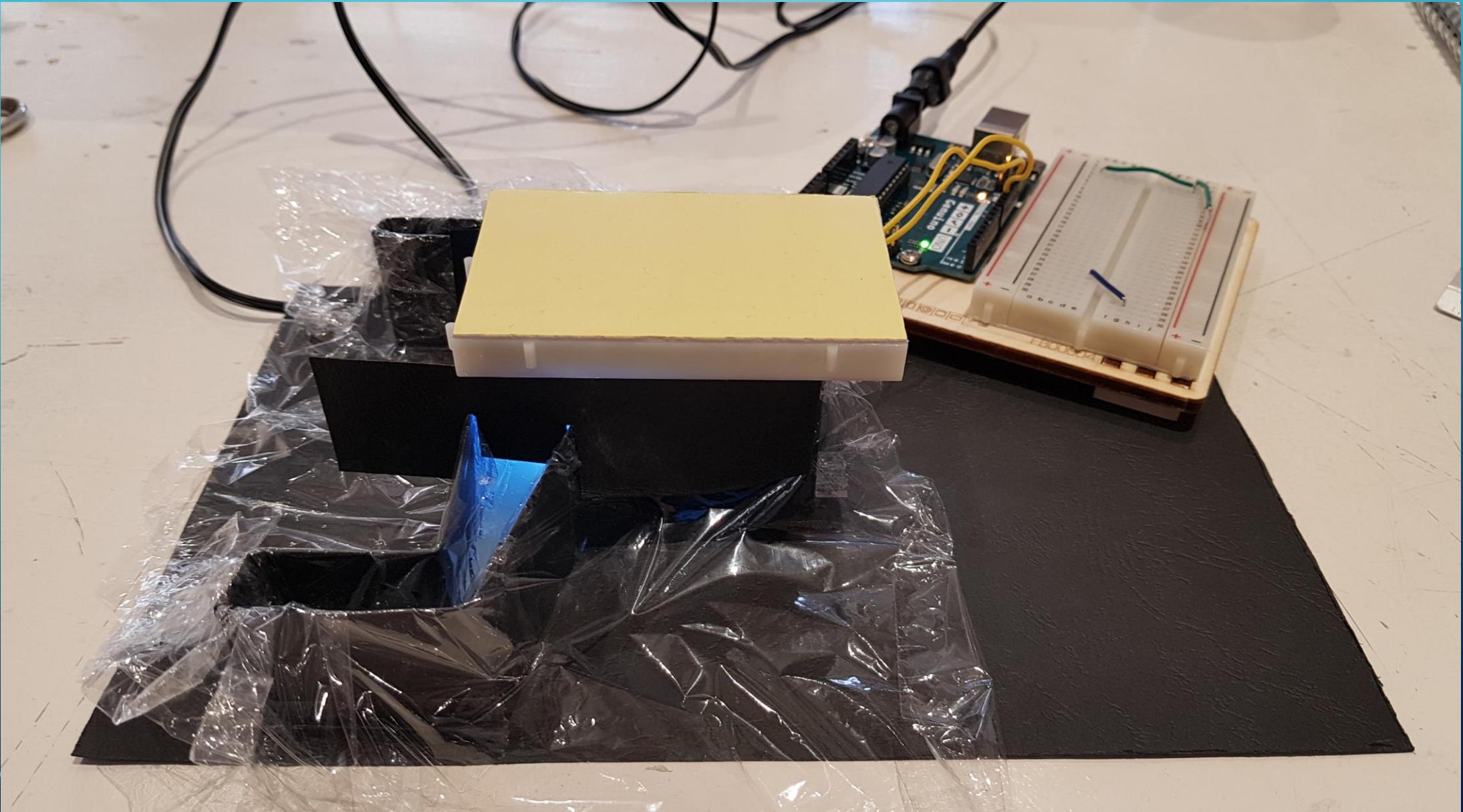
INPUT 1

OUTPUT



INPUT 2

PROTOTYPE LOGIC GATE SETUP



PROTOTYPE LOGIC GATE RESULT



PROTOTYPE LOGIC GATE RESULT +2 HOURS LIGHT SWITCHED OFF



PROTOTYPE LOGIC GATE RESULT +4 HOURS LIGHT SWITCHED BACK ON



PROTOTYPE LOGIC CIRCUIT (2 GATES) TEST

INPUT A1

INPUT A2

OUTPUT A

=INPUT B1

INPUT B2

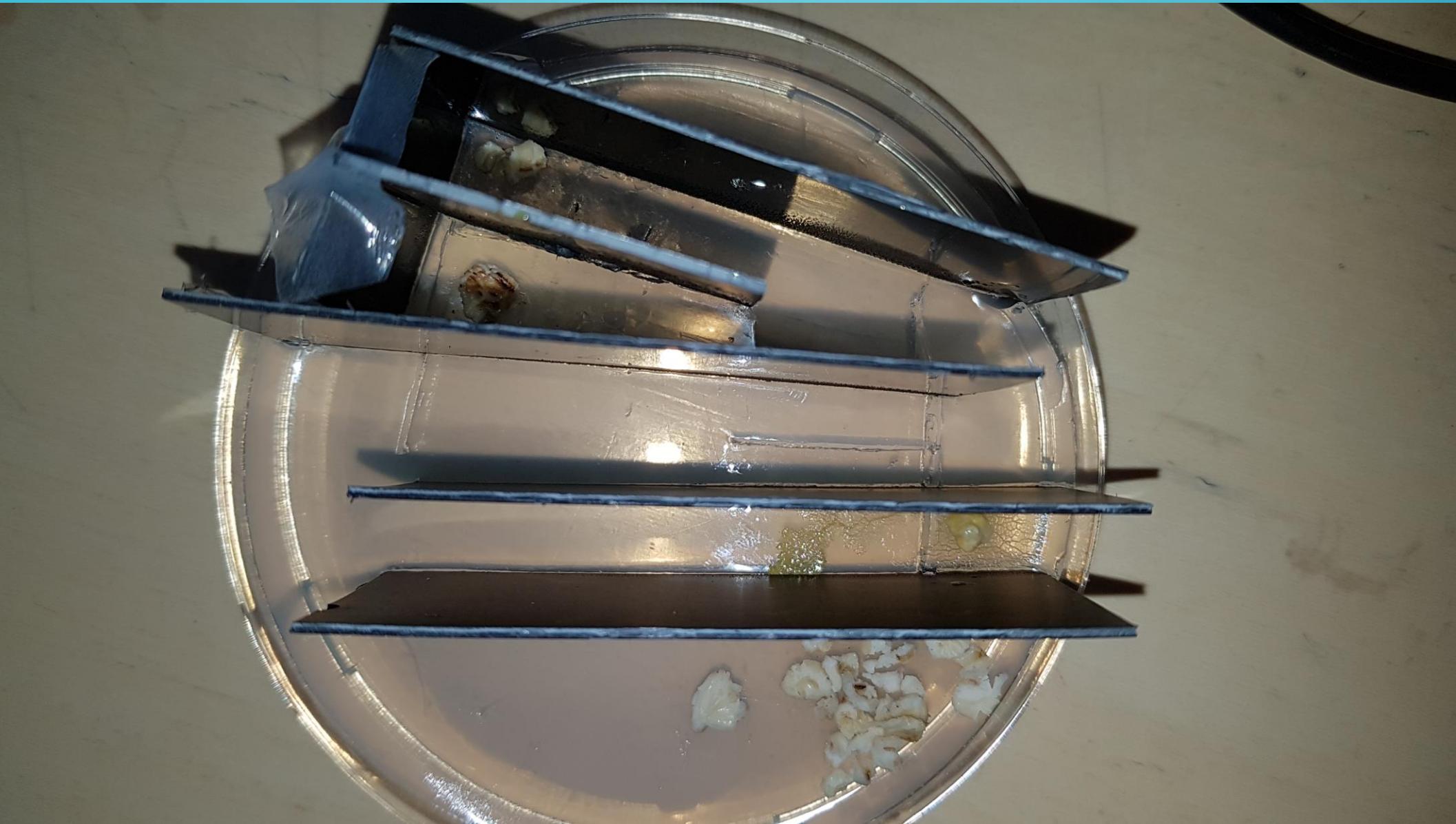
OUTPUT B



PROTOTYPE LOGIC CIRCUIT (2 GATES) SETUP



PROTOTYPE LOGIC CIRCUIT (2 GATES) RESULT



PROTOTYPE LOGIC CIRCUIT (2 GATES) TEST #2



PROTOTYPE LOGIC CIRCUIT (2 GATES) TEST #2

TODAY'S RESULTS