UNIVERSITY OF WARSAW

FACULTY OF BIOLOGY

„The Written Visegrad Heritage - protection for the future”

Magdalena Dyda

Visegrad Fund

Faculty of Biology
Analyses for the preservation of collections

analyses for the protection of national heritage
are carried out by scientists from the
Institute of Microbiology

and through RDLS – a spin-off company

established in 2014 at the University of Warsaw (UW)
as an initiative of scientists from the Faculty of Biology

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Microbiological analyses of surfaces

- microbiological surveys of collections, estimation of the scale of contamination of collections with moulds
- application of the Stanford method: 384 objects are chosen randomly out of the whole collection
- testing of objects before and after loans to external institutions
- Collection of samples for microbiological analyses from the area of 5x5cm using:

✓ dry sampling swabs,

✓ sterile filter papers,

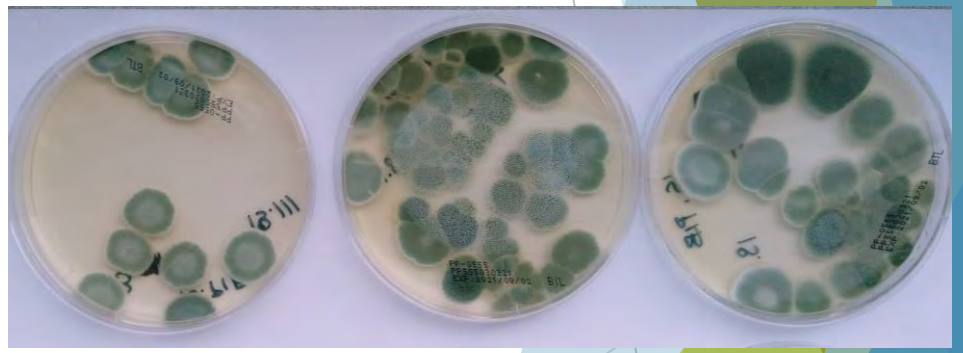
✓ commeracial ATP test

Microbiological analyses of surfaces

- analyses verifying the effectiveness of disinfection

- before disinfection

- 1st disinfection



- 2nd disinfection

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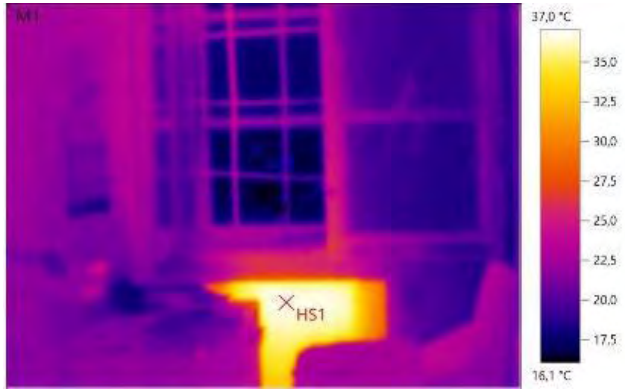
Integrated Pest management

- Entomological surveys of collections usying
- ✓ various entomological traps
- ✓ „active hunting”



Building condition surveys

- ✓ thermovision
- ✓ mycological analyses of buildings and ventilation systems
- ✓ removal of mycological contamination and disinfection of walls

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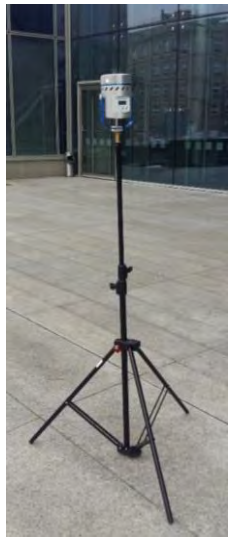
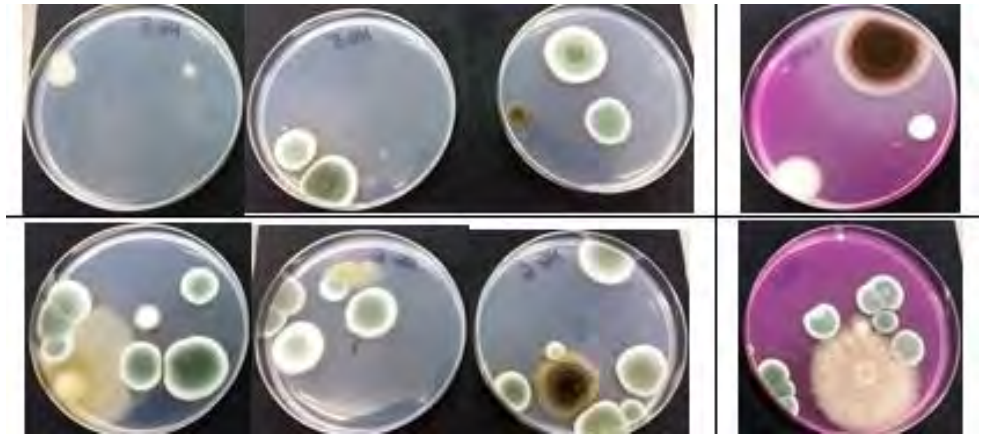
Air quality analyses and analyses of employee exposure to harmful factors

- concentration of particulate matter in the air: PM1, PM2.5, PM4 and PM10 fractions
- microbiological air pollution: analyses of bacterial and fungal counts in the air
- concentration of chemical compounds influencing the rate of degradation of objects made on paper; in accordance with ISO:11799 standard (sulphur oxides, nitrogen oxides, formaldehyde, acetic acid, ozone) and others





FTIR analyser

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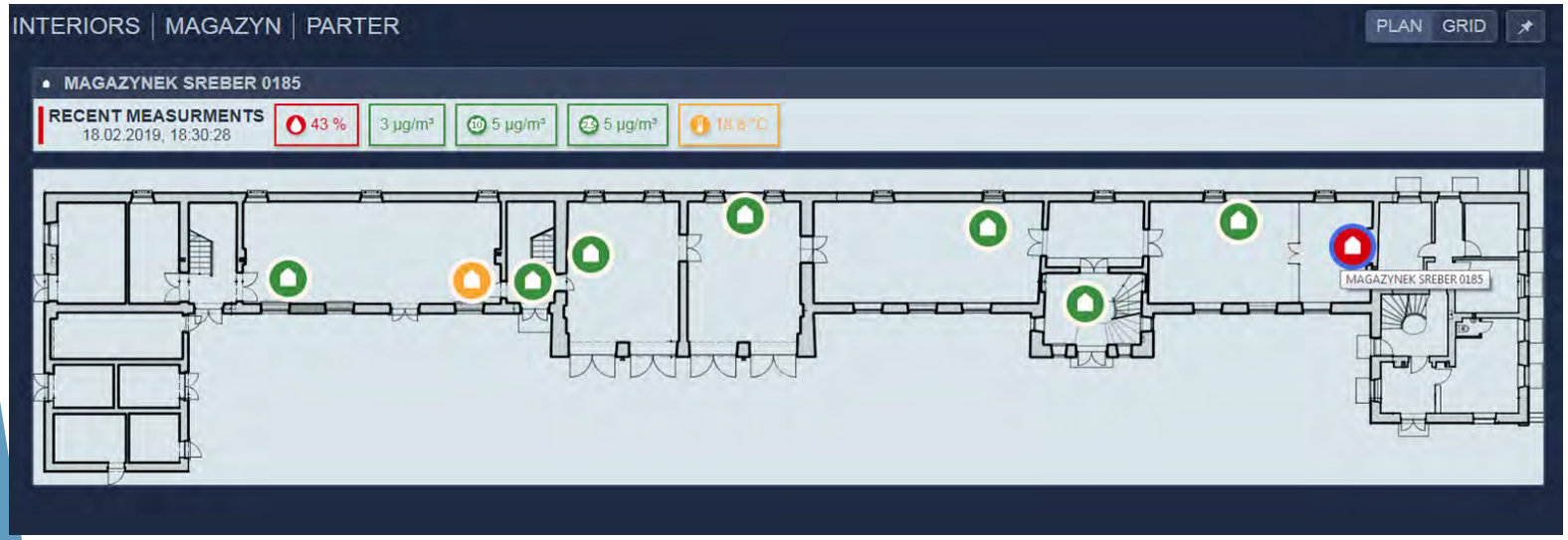
System for monitoring of climate parameters

- continous measurements of temperature, humidity, PM concentration in the indor and outdoor air



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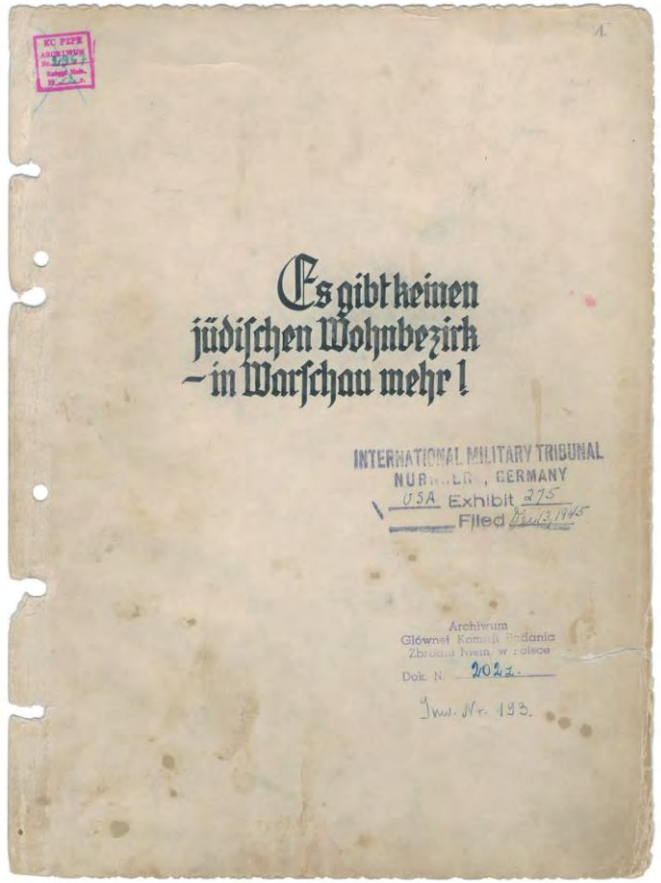
Analyses for the preservation of collections

- technological and materials sciences analyses: microscopic analyses, identification of substances of biological origin

INSTITUTE OF NATIONAL REMEMBRANCE

- The Stroop Report, originally entitled The Jewish Quarter of Warsaw is No More!, which was prepared for Heinrich Himmler after the destruction of the Warsaw ghetto in 1943, is a unique document in human history.
- The Report became a proof in lawsuits before the courts and tribunals in Nuremberg and Warsaw.
- The significance of Stroop Report was recently recognized by UNESCO, which included the document, kept in the IPN's Archive, into its "Memory of the World" program.



Technological and materials sciences analyses

- measuring the thickness of the writing media layer
- microscopic documentation of characteristic areas
- 3D modelling of microscopic images of surfaces
- leather binding: identification of animal species based on hair follicle mark pattern
- microscopic analyses of paintings, treads in tapestries
- Scanning Electron Microscopic visualisation
- analyses of dies, pigmens, proteins, lipids and others

Analyses for the preservation of collections

- expert consultations
- trainings, workshops for employees of cultural institutions, exchange of know-how
- scientific projects
- Publication with NIMOZ: Zagrożenia mikrobiologiczne kolekcji muzealnych; Seria: ABC Szkolenia Narodowego Instytutu Muzealnictwa i Ochrony Zbiorów 13/2020, Warszawa 2020, ISBN 978-83-64889-44-8

NATIONAL INSTITUTE FOR MUSEUMS AND PUBLIC COLLECTIONS

- https://nimoz.pl/files/publications/66/NIMOZ_Zagrozenia_mikrobiologiczne_zbiorow_muzealnych.pdf

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FACULTY OF BIOLOGY

Warsaw University of Technology

SOFTWARELY

Creation of intelligent system for environmental parameters monitoring along with built-in predictive models for protection of Cultural Heritage Objects

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European Union
European Regional Development Fund

Mazovia. heart of Poland

Fundusze Europejskie Program Regionalny

WOLF system

a system of sensors independent of electricity supply, in a MESH communication system, for measuring temperature, humidity and concentration of particulate matter in the air

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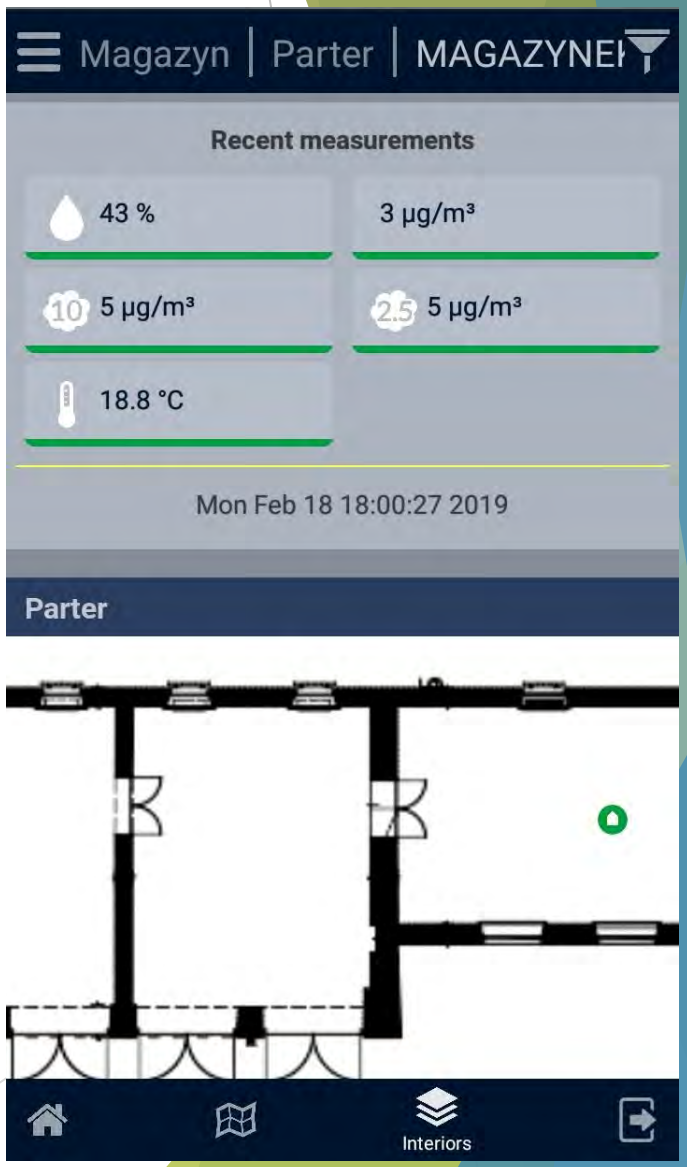
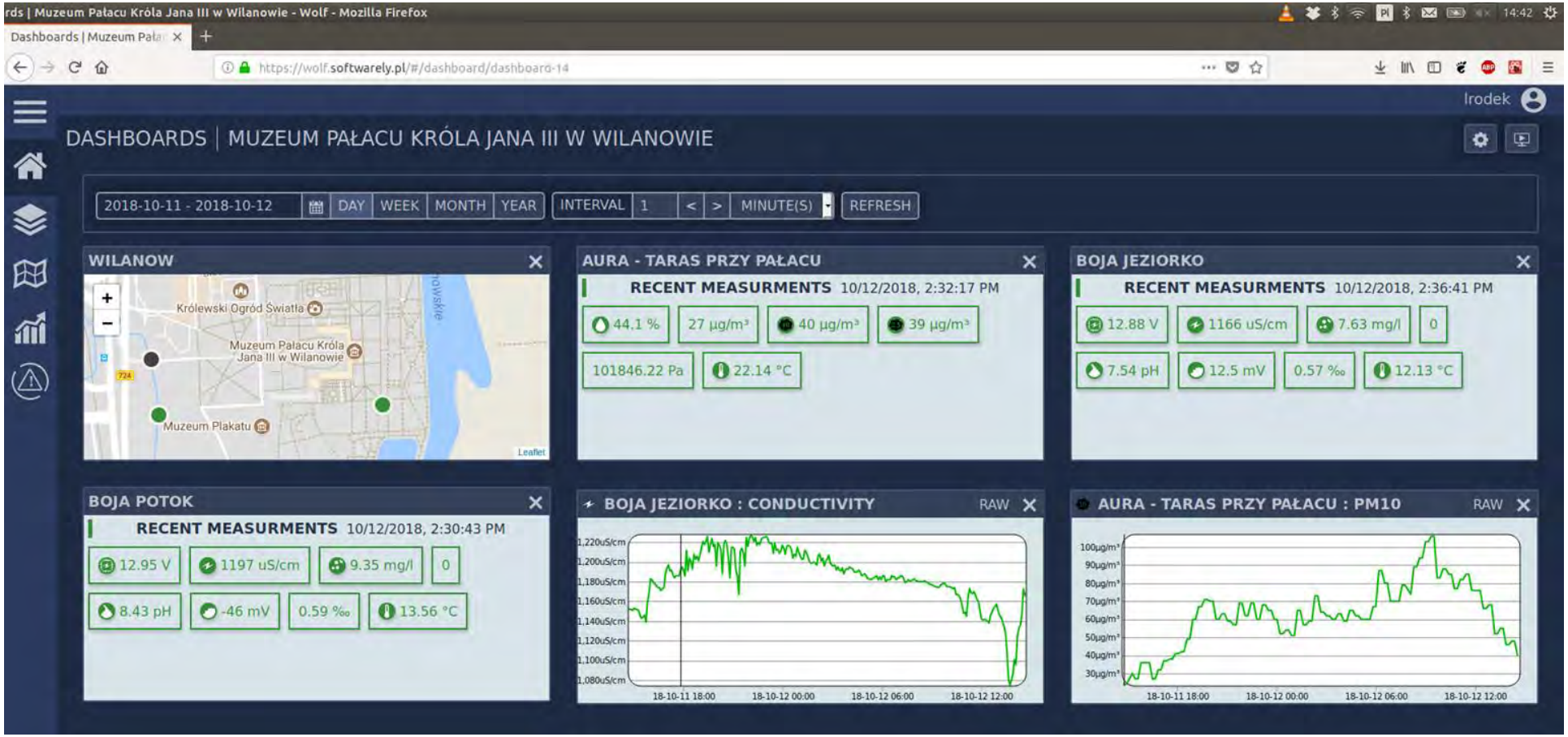
Online access to measurements





WOLF

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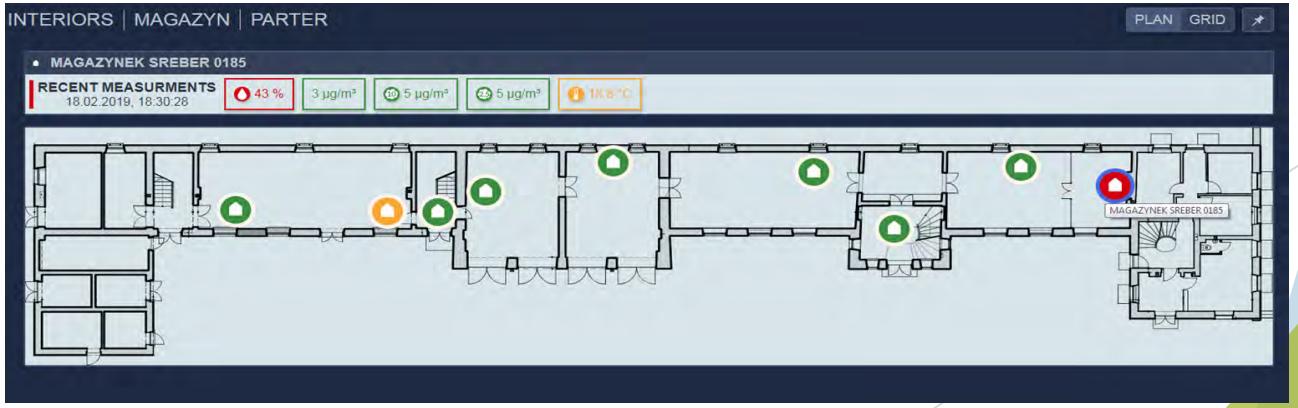

Institutions: museums
archives

Museum of the History of Polish Jews
- from January 2018
- warehouses
- conservatory workshops
- library
- permanent exhibition

National Museum in Warsaw
- from December 2017
- warehouses
- conservation workshops
- Faras Gallery

Archive of the Institute of National Remembrance
- from January 2018
- warehouses
- conservatory workshops

Warsaw, Poland

Royal Castle Museum in Warsaw
- from February 2018
- warehouses
- conservatory workshops
- library
- permanent exhibition

Central Archives of Historical Records
- from February 2018
- warehouses
- conservatory workshops

Archive of New Records
- from December 2017
- conservatory workshops
- library
- 6 stores of warehouses
- bunker

Museum of King John's III Palace in Wilanów
- exposition – from November 2017
- warehouses – from March 2018

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Tasks for the Faculty of Biology

- tasks 3 and 6 (out of 10): Microbiological investigation, environmental parameters measurement and building of the expertise-based predictive models and their verification

- Environmental parameters measurements
  - more than 1 200 000 automatic measurements were conducted
  - temperature, humidity, PM, SO_x, NO_x, CO_x, wind, number of visitors, turbidity, pH etc.

- Microbiological investigation
  - collected more than 18 000 microbiological air samples

- Microbiological biodiversity analysis

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Tasks for the Faculty of Biology

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  - collected more than 18 000 microbiological air samples

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Materials and Methods

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Sample collection

- bacteria and fungi from air collected using impact method
- 12 microbial mediums
  - 6 for fungi
  - 6 for bacteria
- 3 repetitions
- more than 18 000 microbiological samples collected
- January - March 2018

MAS 100 Eco (MERCK)

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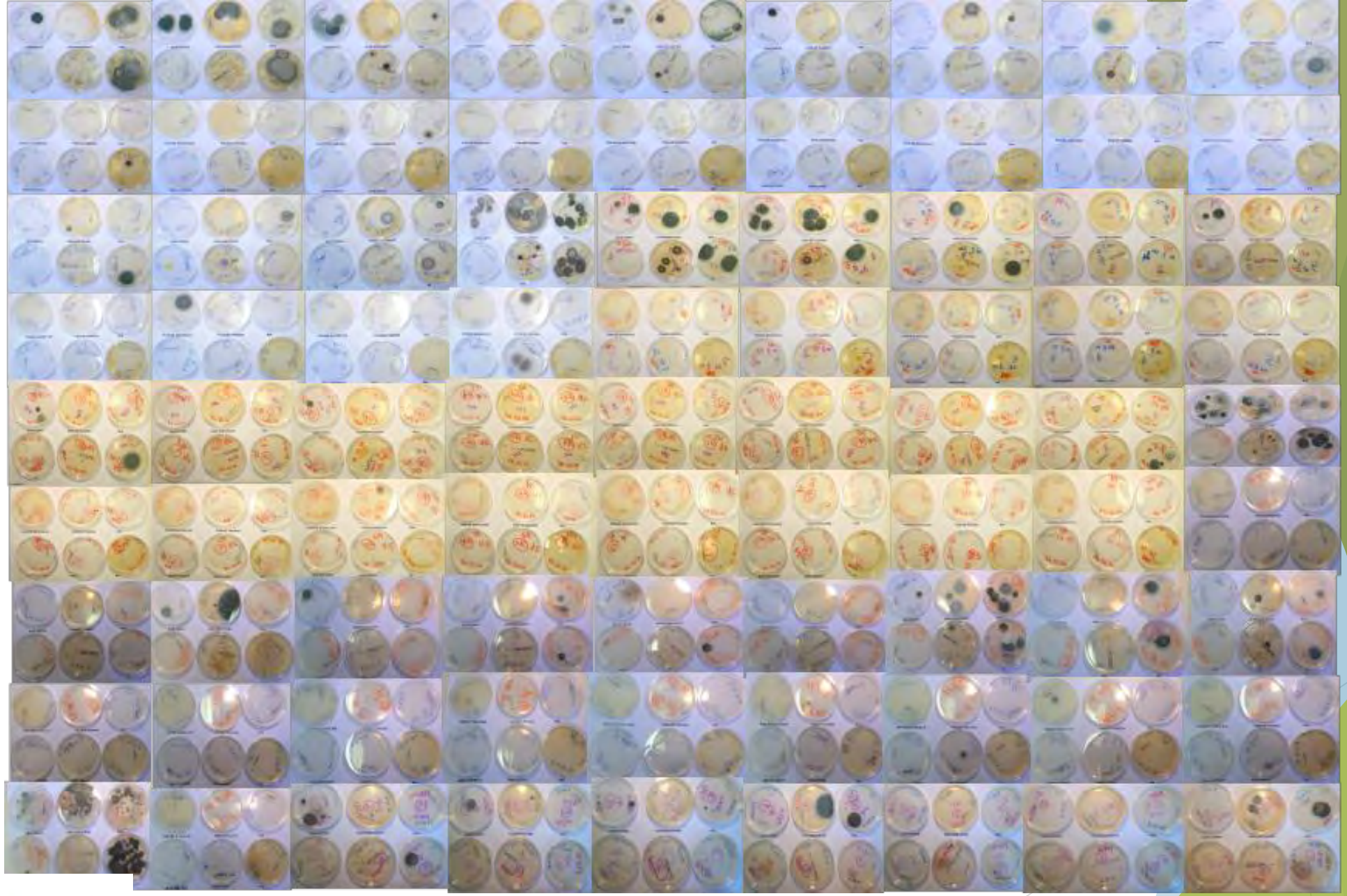

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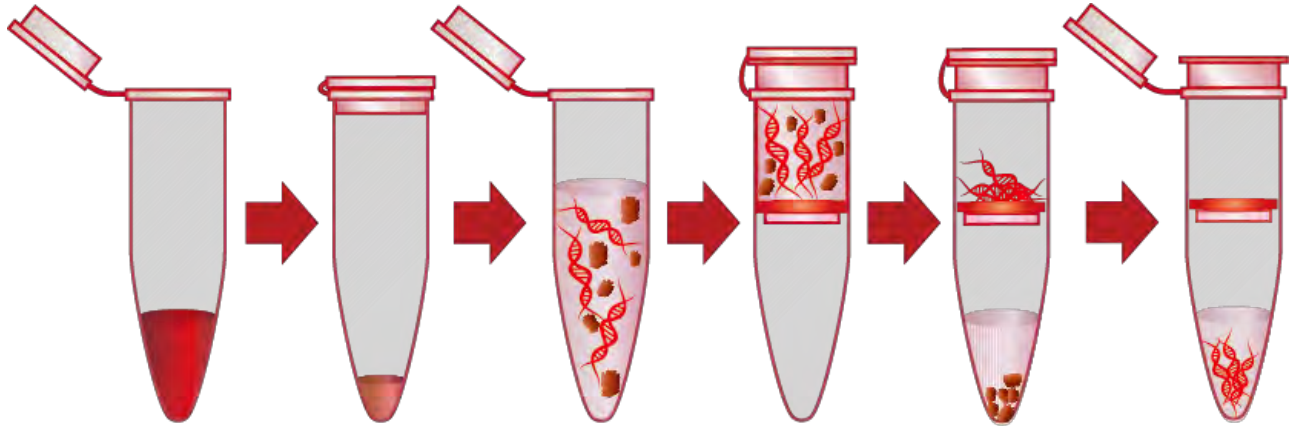
Microbial sample manipulation

1. fungi were counted and subjected to visual identification
2. bacterial colonies were counted and pooled for DNA analysis
3. bacterial DNA has been isolated and purified
4. V3-V4 region of the 16S rRNA marker gene has been amplified using PCR



DNA isolation and purification process

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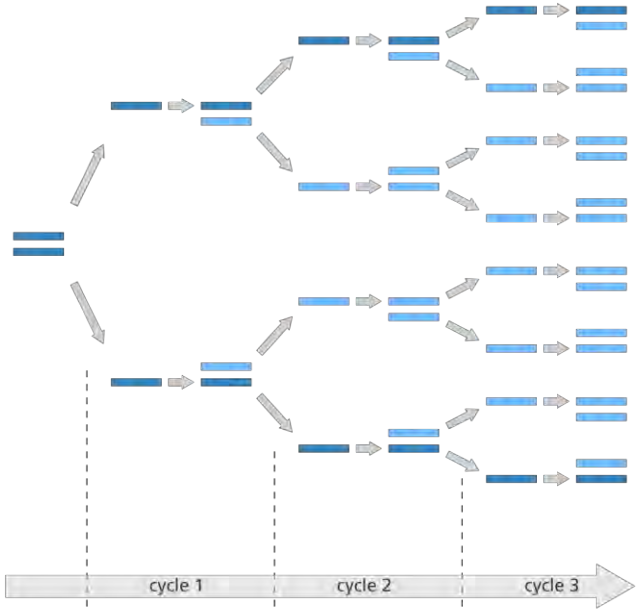
DNA and bacterial marker genes

- bacterial DNA size ~ 4 000 000 base pairs -> ~ 4 000 proteins
- 16S rRNA - part of ribosome (*cell's protein factory*)
- 16S rRNA - can be used as a bacterial "*fingerprint*"
- V3-V4 region of 16S rRNA constitutes only 0.012% of whole genome

DNA region amplification - PCR reaction

- duplicating a region of interest multiple times
- quite similar to how its happening in our own cells
- PCR - Polymerase Chain Reaction
- 30 cycles -> 1 000 000 000 more copies



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Next Generation Sequencing

- "*DNA reading*" by sequencer
- can generate up to 6 terabytes of data
  - ~ 3 000 good quality movie files
- machine output - millions of very short sequences (up to 300 base pairs)

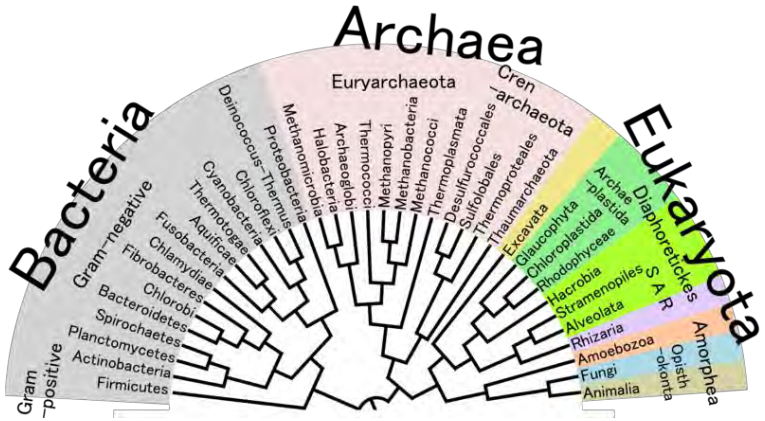
```
--->gzip -cd L2I_S1_L001_R1_001.fastq.gz | head
@M00805:5:000000000-A0VLL:1:1101:16473:1320 1:N:0:1
NTTGTCATCAGCTGAAGATGAAATAGGATGTAATCAGACGACACAGGAAGCAGATTTTGCTAAT
TTGGAACTAGGTCAGCTGAAGATCCTGTGAGCGAAGTTCCGGCAGTGTCACAGCAC
+
#55<<?BBDBDDDDDDFFFFFFHHHHHFHHAFHHHHHHHHHHBHHHHHFFFHHHHHHHHDGDGHC
AFHFHHHHHHFGHDDHFBFHDFFHFFFHHHFFA=@BEEEED)@<B?BE3==?EEEE
@M00805:5:000000000-A0VLL:1:1101:15023:1321 1:N:0:1
NAGAAATCACAGACATACAAAGCAGTCTGTGTCCTTAGGTCCTGAGCAGCCTCCAGCACATTCT
AGCATCTGCCGTCACATTGTTCTGCACACACCGTCCTTGTCACTGCAGAAGACAGA
+
#55???BBDDEDDDDDGGGGGGIIIIIIIIIIIIIIIIIHIHIIHFGHHHIIIIIIIIIHIIII
HHHHHHHHHHHHHHHHHHHHHHHHHHGGFGEGGGGGGGGGGGGGGGEGGGGCEGG>
@M00805:5:000000000-A0VLL:1:1101:14046:1321 1:N:0:1
NTTTCGTGGAAGTGGGTTACCTGACAGTGTGCACGCCCCCAGCAGGTTCACAATATTCTCGTGG
ACATGAGTGCCTCTCTTTCAGAGCTGTCTGCTTTTTCTGTCAAAGAAAGGAGCATT
```

fastq format - NGS machine output sample

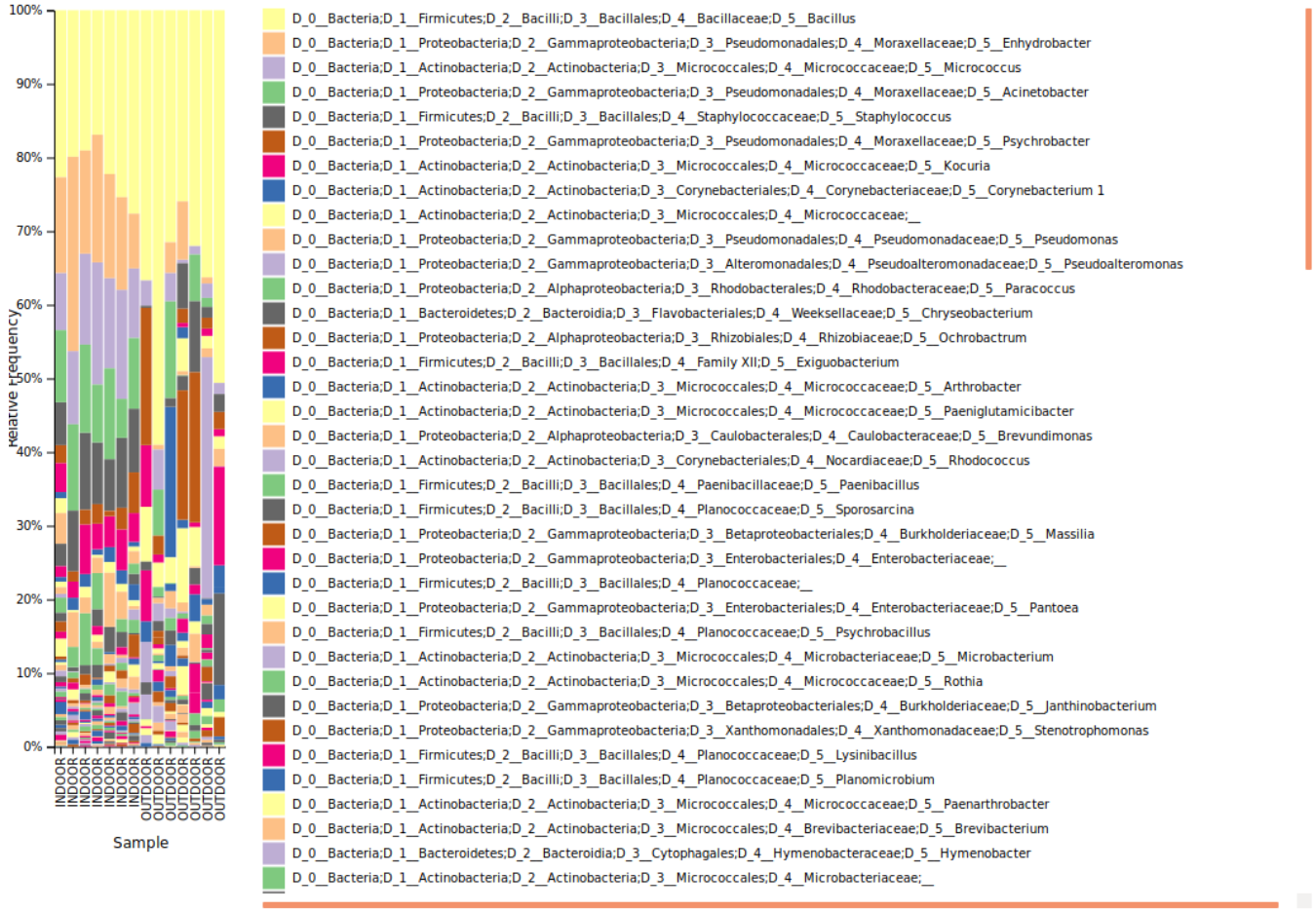
MiSeq Illumina - one of NGS sequencers

Meta-taxonomy

- taxonomy - "*the science of defining and naming groups of biological organisms*" (Wikipedia)
- *meta*- means that we are working with all the organisms in given sample
- taxonomy is assigned based on homology (<u>similarity</u>)
  - each read from the sequencer is <u>compared</u> to those already collected in various databases



Taxonomy analysis



Results

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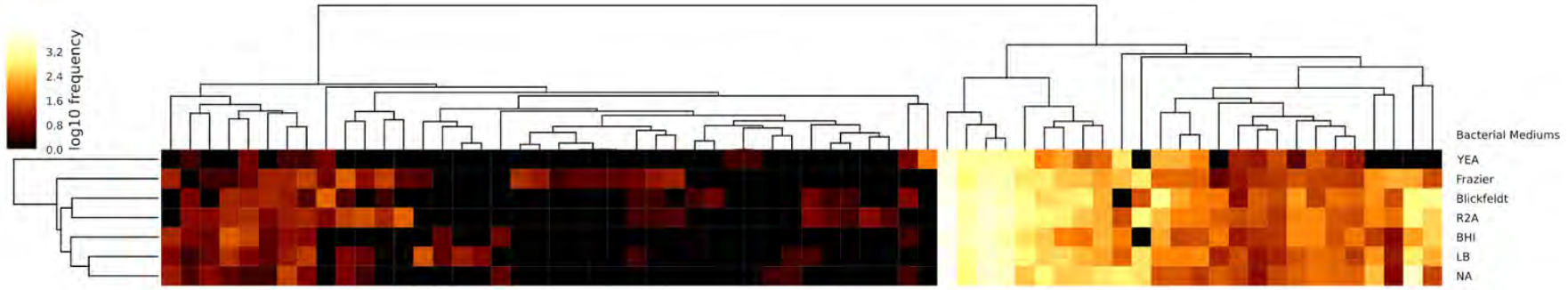
Best medium combination

- preliminary research conducted only in Museum of King John's III Palace in Wilanów



Heatmap of investigated bacterial media vs bacterial families they recoverd

Combination	Coverage	No. of mediums In combination
Frazier, LB, Blickfeldt, BHI, NA, R2A	99.21%	6
Frazier, LB, Blickfeldt, NA, R2A	96.83%	5
Frazier, LB, NA, R2A	92.86%	4
Frazier, LB, R2A	87.30%	3
Frazier, R2A	80.16%	2
Frazier	64.29%	1
NA	**45.24%**	**1**

Bacterial media combinations in regard to total genera coverage

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Thank You

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RDLS RESEARCH AND DEVELOPMENT FOR LIFE SCIENCES

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