



Societatea Română
de Microbiologie



MOBILISE: A novel and green mobile One Health laboratory for (re-)emerging infectious disease outbreaks

**A XVI-a Conferință Națională de Microbiologie și Epidemiologie,
9th-11th NOVEMBER 2023**





HORIZON-CL3-2021-DRS-01: Disaster-Resilient Society 2021

→ HORIZON-CL3-2021-DRS-01-05: Fast deployed mobile laboratories to enhance situational awareness for pandemics and emerging infectious diseases

Special conditions:

- active involvement of at least **3 first responders' organisations or agencies** and representatives of local or regional authorities **in charge of managing sanitary crises** from at least **3 different EU Member States** or Associated countries.



Expected Outcomes

- **Inventory and comparison of existing mobile laboratories**, including heavy structures (both military and civilian) and light self-sustained systems, evaluation of quality management systems for maintenance, validation and testing
- **New (mobile laboratory) solutions for the fast, reliable and unambiguous detection and identification of infectious agents, diagnostic tests, monitoring and mapping of contamination and enhanced field data communication to decision-making authorities**
- Strategies to **orchestrate mobile laboratory capacities in the EU**, and improvements in the management of trained staff in Europe



Background

(Re)-emerging arboviruses - threat to Europe



Climate change in Europe



Changing weather patterns: Spread of arthropod vectors



Asian Tiger Mosquito is Vector of Dengue, Zika, Chikungunya viruses.

Photo: https://en.wikipedia.org/wiki/Aedes_albopictus



Ticks of the genus Hyalomma are the principal vector of Crimean-Congo haemorrhagic fever.

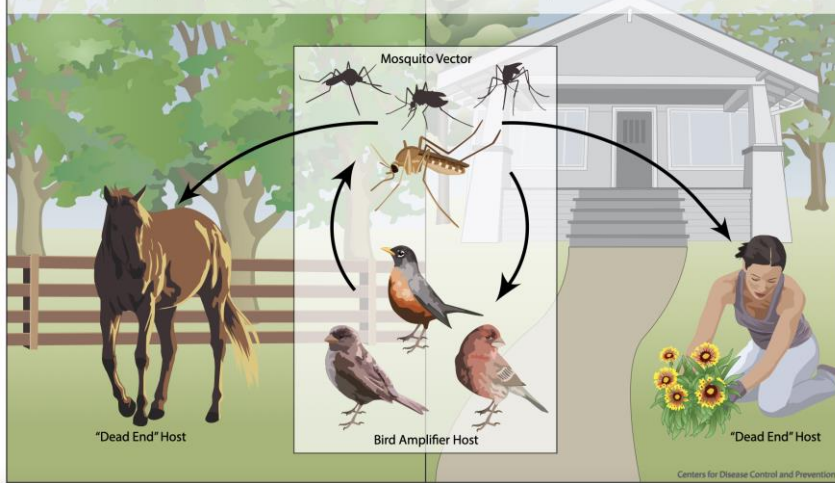
Photo: Robert Swanepoel/NICD South Africa (who.int)



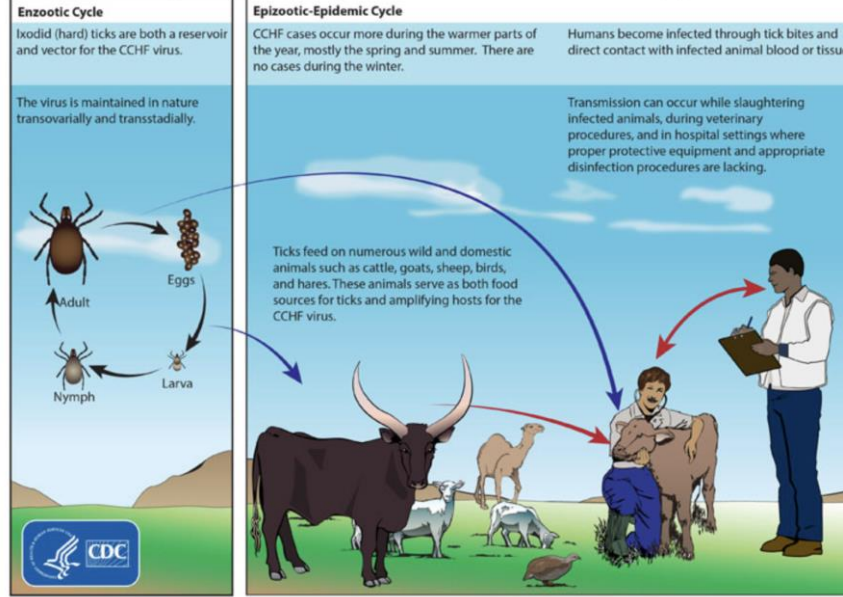
West Nile Virus Transmission Cycle

In nature, West Nile virus cycles between mosquitoes (especially *Culex* species) and birds. Some infected birds, can develop high levels of the virus in their bloodstream and mosquitoes can become infected by biting these infected birds. After about a week, infected mosquitoes can pass the virus to more birds when they bite.

Mosquitoes with West Nile virus also bite and infect people, horses and other mammals. However, humans, horses and other mammals are "dead end" hosts. This means that they do not develop high levels of virus in their bloodstream, and cannot pass the virus on to other biting mosquitoes.



Crimean-Congo Hemorrhagic Fever (CCHF) Virus Ecology



One Health!

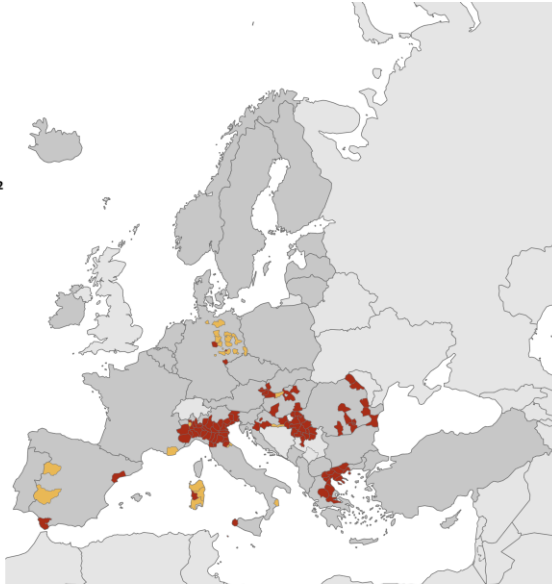


Distribution of human and animal West Nile virus infections in NUTS 3 or GAUL 1 regions of the EU/EEA and neighbouring countries during the 2022 season, as of 21 of September 2022

- Human infections, with or without outbreaks among equids and/or birds
- Outbreaks among equids and/or birds
- No infections reported
- Not included

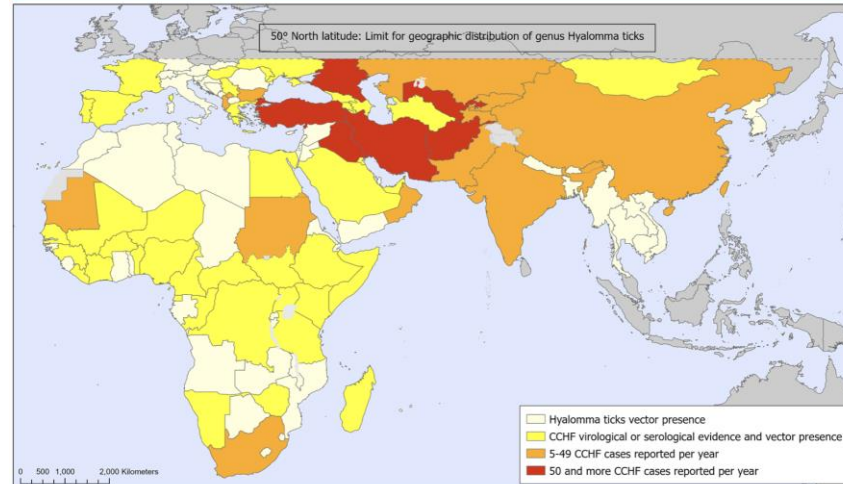
Countries not visible in the main map extent

- Malta
- Liechtenstein



Administrative boundaries: © EuroGeographics © The boundaries and names shown on this map do not imply official endorsement or acceptance by the European Union. Map produced by ECDC on 22 September 2022

Geographic distribution of Crimean-Congo Haemorrhagic Fever (2022)



The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of WHO concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: WHO - Viral Haemorrhagic Fevers (VHF)
Map Production: Jewgeni Bader, EYE Secretariat
Map Creation Date: 01 September 2022



Key Challenges for Outbreak Response in Europe



- Lack of “One Health” aspect – for zoonotic infections
- Lack of peripheral BSL 3/4 capacity – for risk group 3 and 4 pathogens
- Lack of interoperability of existing mobile laboratories to tackle cross-border pandemics
- Lack of green laboratory operations – for sustainability



MOBILISE Objectives



- (i) Develop a novel and green “One Health” mobile laboratory unit

- (ii) Develop a software solution for a “MOBILISE Emergency Operating Centre and Decision Support System (EOC/DSS)”

- (iii) Curation of established “European mobile laboratory inventory database”

- (iv) Field validation of the MOBILISE mobile laboratory prototype



Partners



No	Organisation name	Short name	Country
1 CO	Bernhard Nocht Institute for Tropical Medicine	BNITM	DE
2	AIT Austrian Institute of Technology	AIT	AT
3	EXUS AI Labs	EXUS	GR
4	Friedrich-Loeffler-Institute	FLI	DE
5	Austrian Agency for Health and Food Safety Ltd	AGES	AT
6	Red Cross district 5 Bucharest	SNCRR-S5	RO
7	BEIA Consult International	BEIA	RO
8	MDSC Systems OÜ	MDSC	EE
9	National Public Health Organization	NPHO	GR



Work Packages



	Work package title	Lead
WP1	Project management	BNITM
WP2	Mobile laboratory design	BNITM
WP3	Developing the MOBILISE Diagnostic portfolio: from conventional diagnostics to novel point of care devices and a One Health NGS platform	AIT
WP4	Emergency Operating Centre and Decision support System (EOC/DSS) and Curation of mobile laboratory inventory database	EXUS
WP5	System integration for a rapid outbreak response One Health MOBILISE laboratory demonstrator	BNITM
WP6	Dissemination and Exploitation	AGES



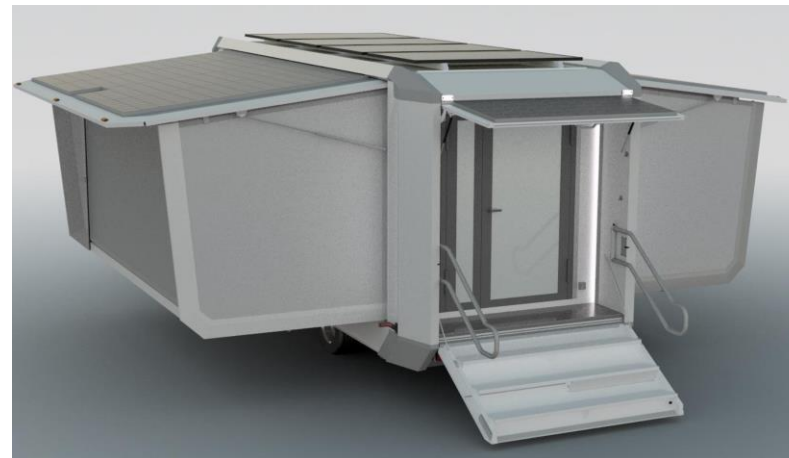
WP2: Mobile Laboratory Design

The green design



The MOBILISE laboratory has six power sources:

- Solar (4kW) → total: 3kW-3,5kW
- Wind (1,5kW)
- Battery system that will serve as UPS
- Stand-by generator (5-6kVa)
- Mains power connections
- (connection to alternator)



MOBILISE Diagnostics



- 🕒 **Arboviral and other viral (haemorrhagic) fevers (PCR):** Crimean-Congo Haemorrhagic Fever Virus, West Nile Virus, Rift Valley Fever Virus, Zika Virus, Dengue Virus, Chikungunya Virus, Usutu Virus, Yellow Fever Virus, Ebola/Marburg Virus, Lassa Fever Virus, Monkeypox Virus.
- 🕒 **Gastro-intestinal pathogens (PCR):** Norovirus, Rotavirus, Adenovirus, Astrovirus, Sapovirus, *Campylobacter spp.*, *Clostridium difficile*, *Salmonella spp.*, *Shigella spp.* / EIEC, *Vibrio spp.*, *Yersinia enterocolitica*, *Aeromonas spp.*, *E. coli* O157, STEC (stx1/2), EPEC (eaeA), ETEC (It/st), EAEC (aggR), *Giardia lamblia*, *Entamoeba histolytica*, *Cryptosporidium spp.*, *Blastocystis hominis*, *Dientamoeba fragilis*, *Cyclospora cayetanensis*.
- 🕒 **Respiratory pathogens (PCR):** SARS-CoV-2, MERS-CoV, Influenza virus, Respiratory syncytial virus A/B, Adenovirus, Enterovirus, Parainfluenza virus 1-4, Metapneumovirus, Bocavirus, Rhinovirus, Coronavirus NL63, Coronavirus 229E, Coronavirus OC43, *Mycoplasma pneumoniae*, *Chlamydia pneumoniae*, *Legionella pneumophila*, *Haemophilus influenzae*, *Streptococcus pneumoniae*, *Bordetella pertussis*, *Bordetella parapertussis*.
- 🕒 **GLASS pathogens (culture and AMR work):** *Escherichia coli*, *Streptococcus pneumoniae*, *Klebsiella pneumoniae*, *Salmonella spp.*, *Staphylococcus aureus*, *Shigella spp.*, *Acinetobacter baumannii*.
- 🕒 **Parasitic infections:** Malaria (as differential diagnosis for febrile illness)

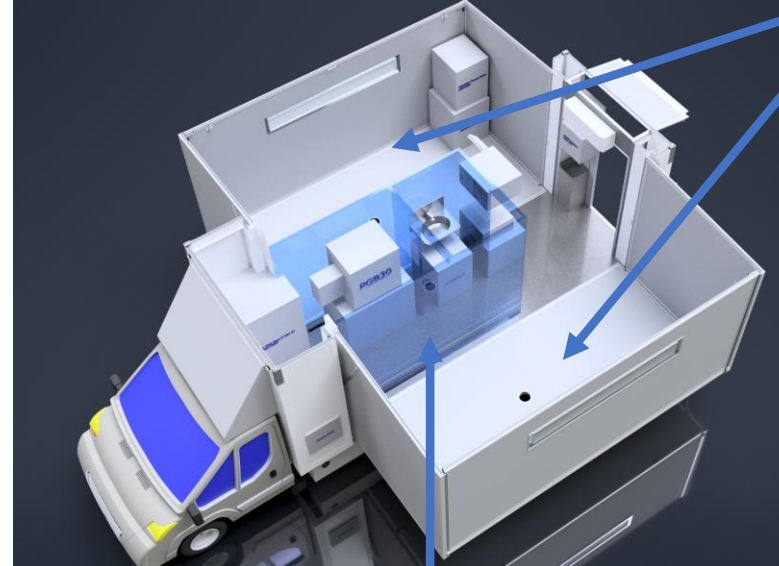
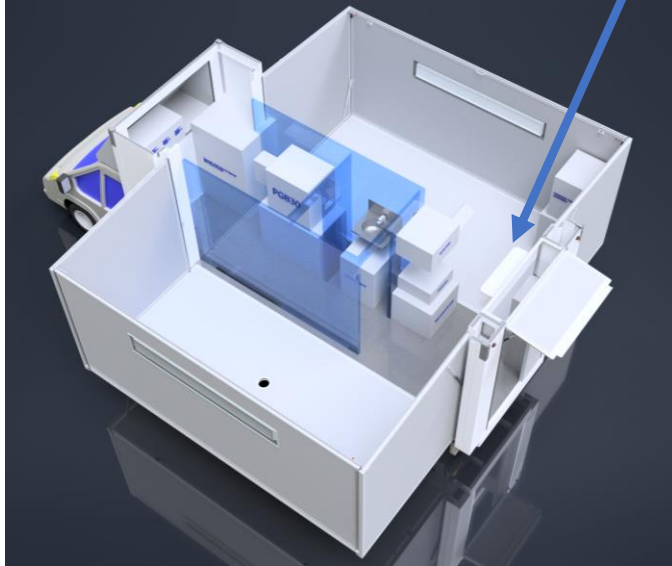
→ BSL-3 Level is needed



The BSL-3 design

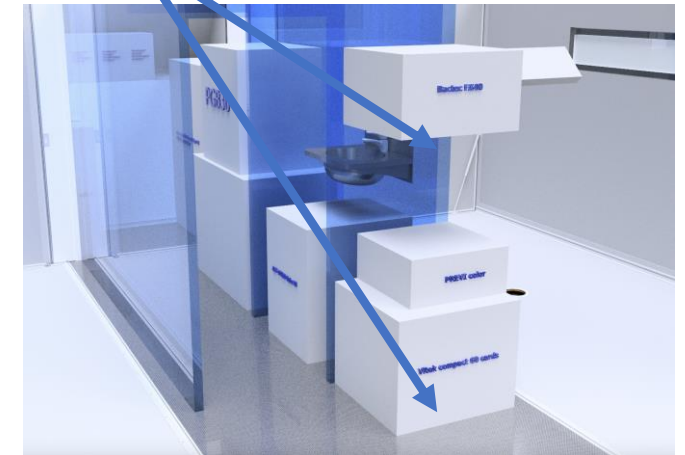


Climate control :Heatpump



„Molecular“ BSL-2 wings:
→ PCR
→ Sequencing

„Molecular“ BSL-2 wings:
→ Bactec FX40
→ Vitek 2 Compact



BSL-3 features:

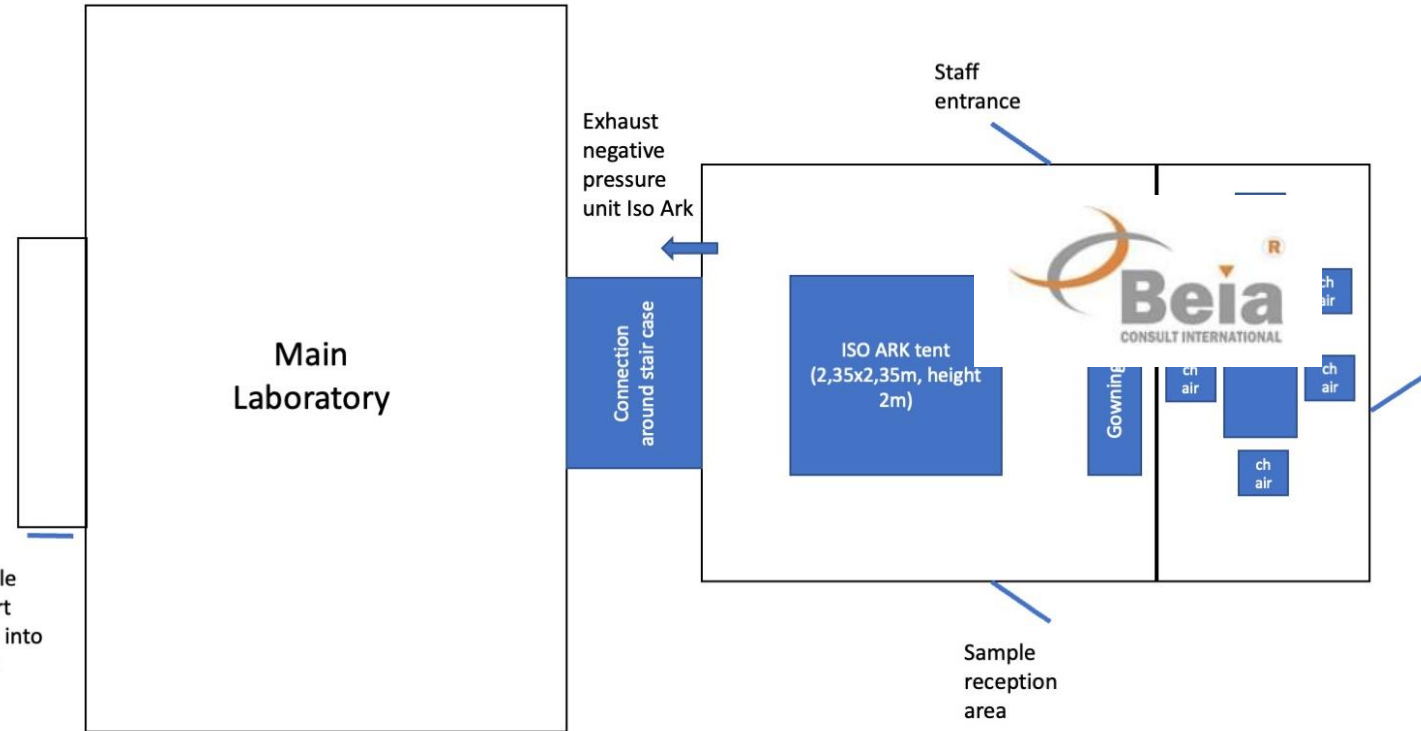
- Airlock with sink/shower
- Sealed BSL-room
- Negative pressure cascade
- Effluent decontamination system
- BSL-3 autoclave

BSL-3 room:

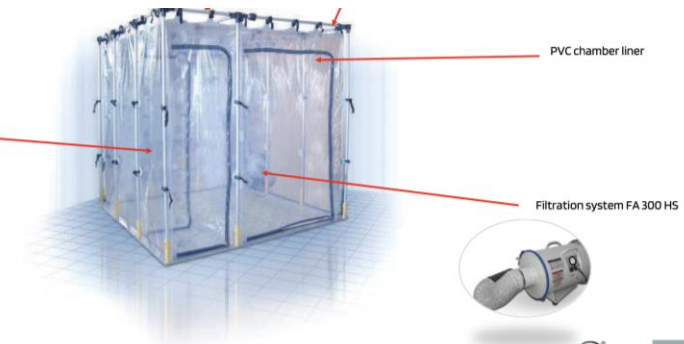
- Glovebox
- Class II cabinet
- Incubators



The One Health design



- One Health Mandate requires work with animal samples
- Laboratory contains separate animal sub-sampling workstation in IsoArk BSL-3 Isolation tent
- The IsoArk tent is housed within main tent (which is attached to Lab)
- A Portaclave is available for animal carcasses either in IsoArk tent or in main tent
- The main tent also houses a physically separated relaxation area for lab staff

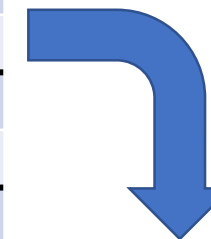
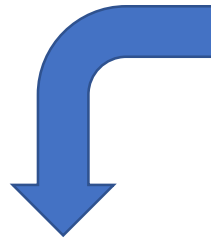


Energy-Efficient Design

Essential Infrastructure	wattage
RO Water system	60W
Undertable fridge	110W
Undertable freezer -40C	100W
2 x portable fridge/freezers	64W
Negative Pressure BSL-3 room	150W
BSL-3 tent	180W
Computer (4x75W)	Ca. 300W
Heatpump Climate Control	1500W
<hr/>	
Total	2464W
Effluent Decontamination system	1100W
Total Infrastructure	3564W



3kW!



Microbiology workflow	wattage
4 x Mini-Incubators	4*45W=180W
Biomerieux Vitek Compact 2	600W
BD Bactec FX40	250W
Biosafety Cabinet class II	230W
<hr/>	
Total Microbiology	1260W
Total Infrastructure	2464W - 3564W
TOTAL	3724W - 4824W

Virology + PCR workflow	wattage
Glovebox	120 W
PCR clean bench	63W
PCR	360W
Centrifuge	240W
<hr/>	
Total Virology	783W
Total Infrastructure	2464W - 3564W
TOTAL	3247W - 4347W

Power generation solar/wind: 3kW-3,5kW

How to save more energy?



1.) Energy-efficient working procedures

- Smart home manager to measure actual consumption
- Develop smart workflows

2.) Explore lyophilised diagnostics kits

- No need for cold chain

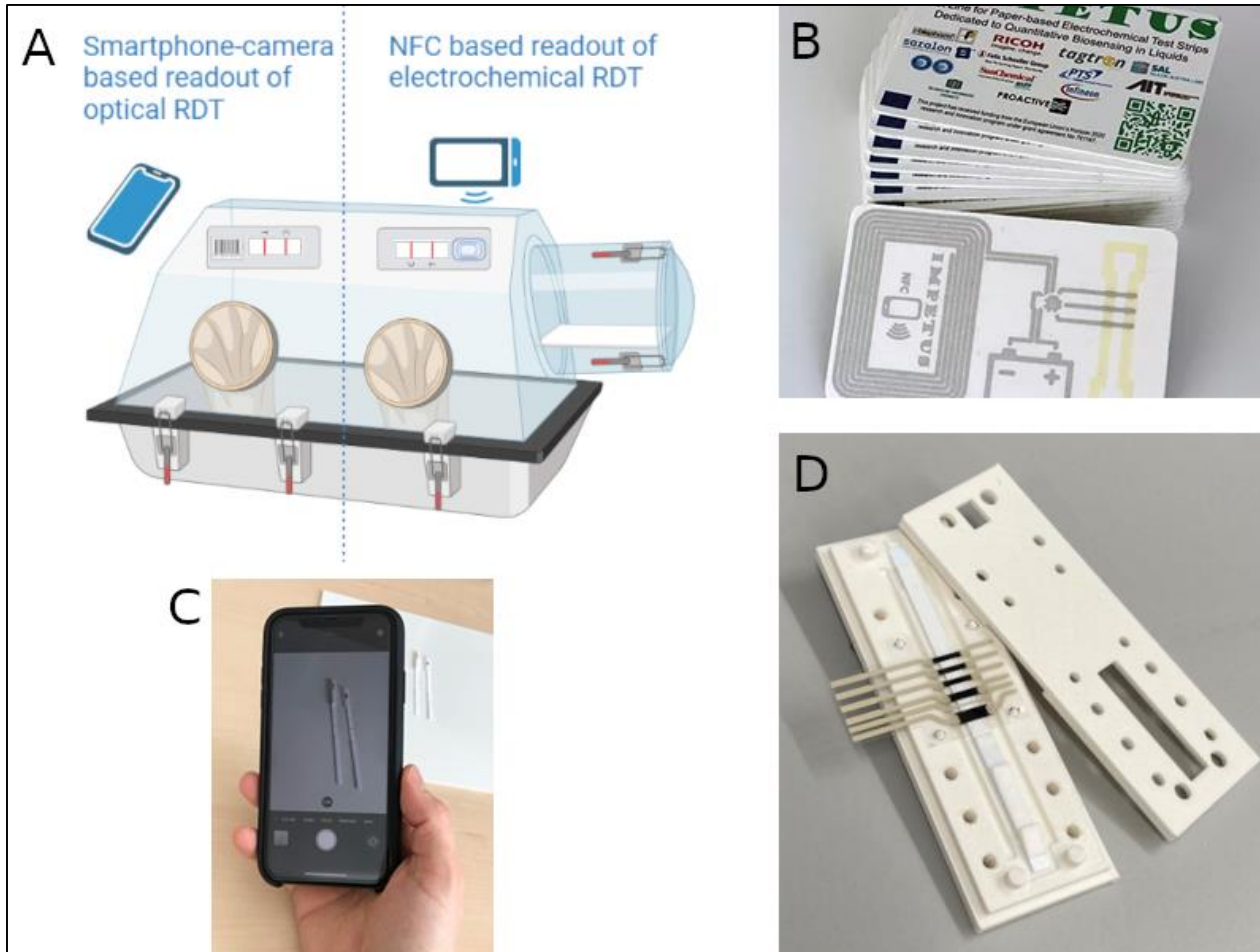




WP3: MOBILISE Diagnostic Portfolio



The next generation of rapid diagnostic tests (AIT)



Machine readable RDTs:

-targets

→ WNV

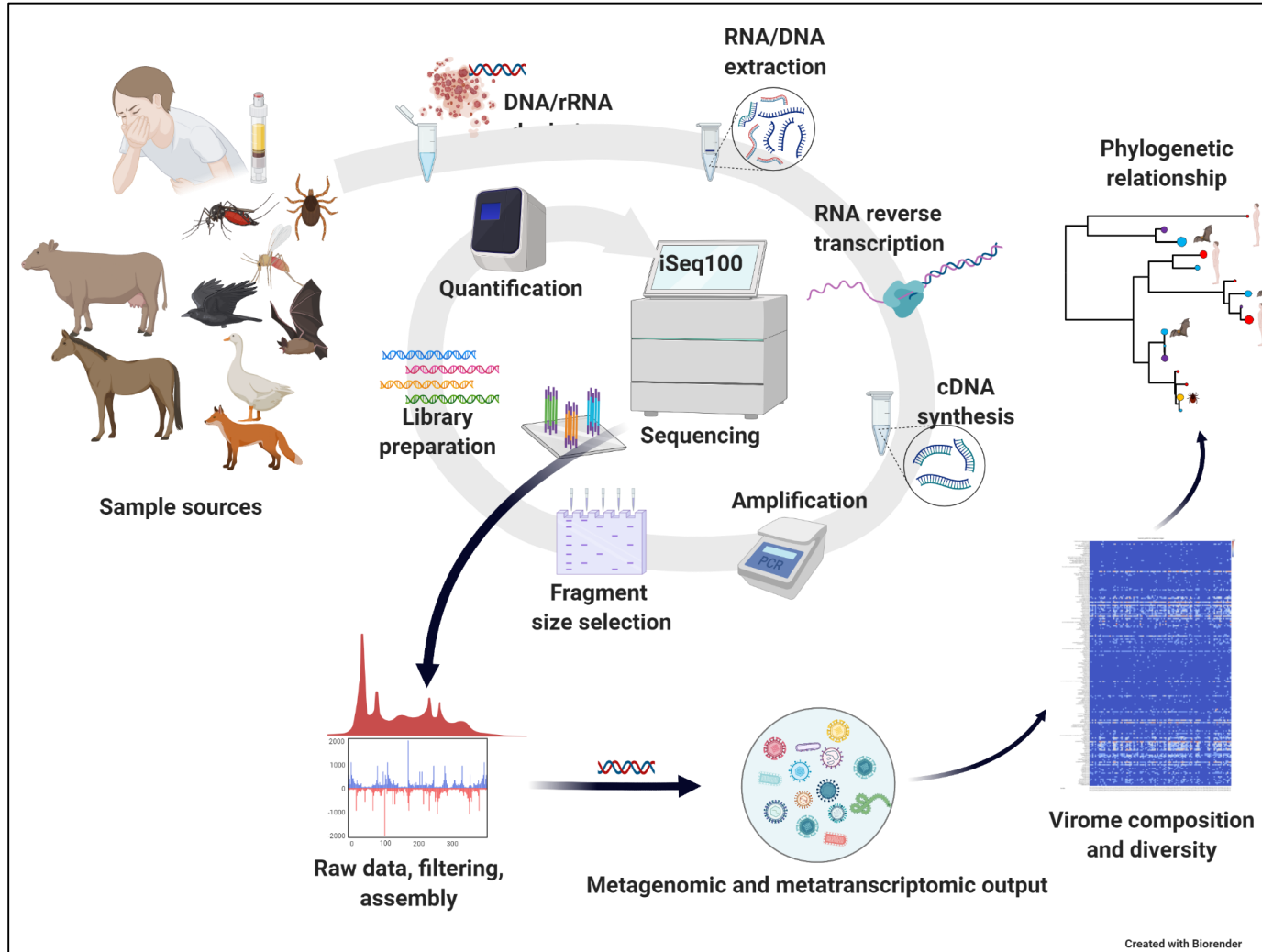
→ CCHFV (BSL-4 glovebox)

- conventional

- Explore quantitative

- into LIMS

A mobile One Health Sequencing Platform (Daniel Cadar)



- Identify viruses
- Characterize viruses (phylogeny)
- Detect Hosts/vectors
- Origin





WP4: EOC/DSS

Interoperability of Mobile Labs



EOC / DSS



Emergency Operating Centre (EOC):

- an epidemiological dashboard that visualizes the outbreak in real time
- AI-driven

Decision Support System (DSS):

- assist in the spatial allocation of mobile laboratory resources into an outbreak, to maximise the laboratories' impact
- In combination with European Mobile Laboratory Inventory

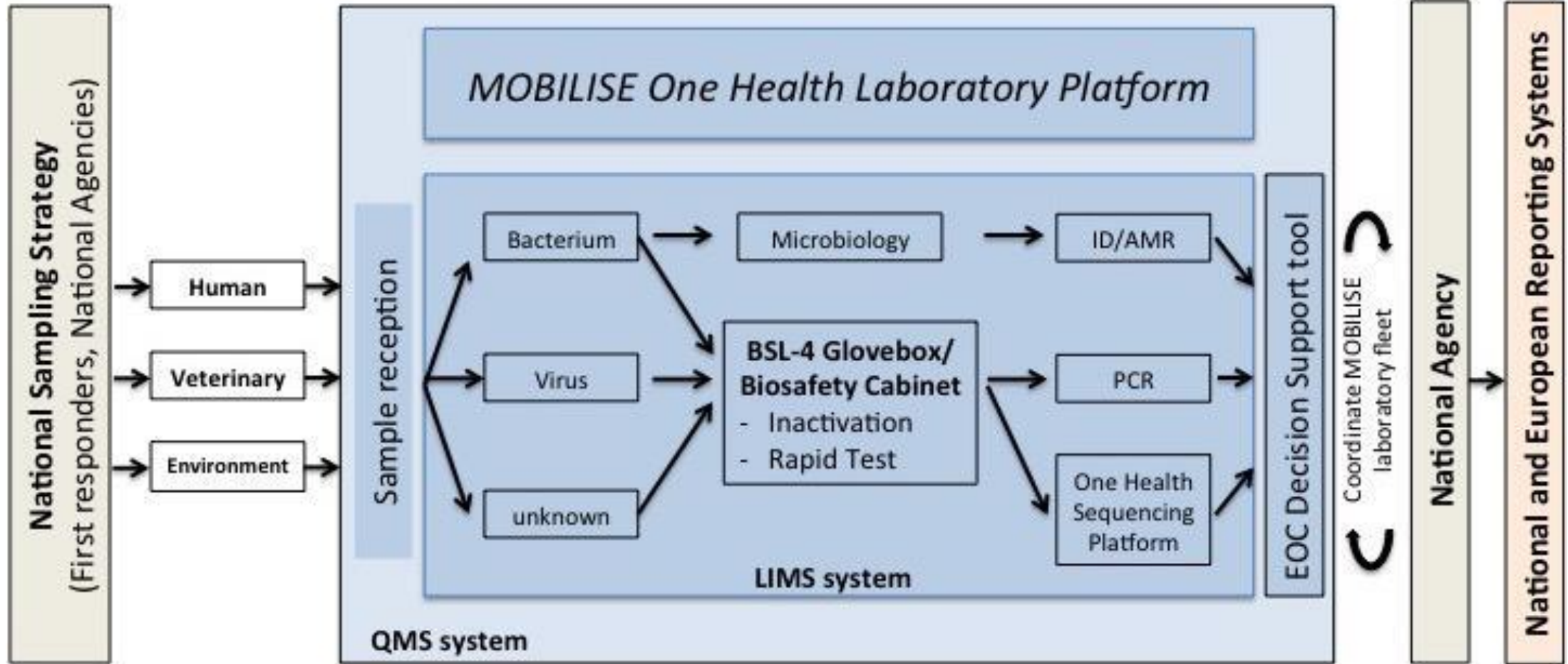




WP5: Systems Integration



Integration of all systems



Field missions to validate prototype



Austria (AGES)

→ Test laboratory workflows (CCHFV, African Swine Fever)

Greece (NPHO)

→ Test laboratory workflows (WNV)

Romania (Red Cross)

→ Test integration into national first responder's outbreak response

East Africa (EAC)

→ Usability of green platform in Africa, Rift Valley Fever outbreak?



MOBILISE protoype by October 2025



G. Technology readiness levels (TRL)

Where a topic description refers to a TRL, the following definitions apply, unless otherwise specified:

- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)



Challenges



- One Health workflows
- Mobile laboratory Commissioning in Germany? Europe?
- One Health Commissioning in Germany? Europe?



Acknowledgements



BNITM:

- Muna Affara
- Daniel Cadar
- Maria Kelly
- Kerstin Shand
- Jürgen May



AIT:

- Johannes Peham
- Georg Neubauer



AGES:

- Georg Duscher
- Lisa Winklmayer
- Karin Rainer
- Hermann Schildorfer



NPHO:

- Kassiani Mellou



Red Cross Romania:

- Ana Ungureanu



EXUS:

- Angelikki Vlachesterigou
- Eva Jaho



BEIA:

- George Suciu



MDSC:

- Holger Annus
- Kristjan Kamdron
- Andry Asamäe



FLI:

- Martin Groschup
- Markus Keller
- Sascha Knauf
- Klaas Dietze

THANK YOU SO MUCH!
Any questions? Contact us!

George Suciu

BEIA

george@beia.eu