Real-time virus genome sequencing

A hands-on workshop on using nanopore sequencing and molecular epidemiology for virus outbreak response.

11th-15th December 2018, West Africa Centre for Cell Biology of Infectious Pathogens, University of Ghana, Accra, Ghana.

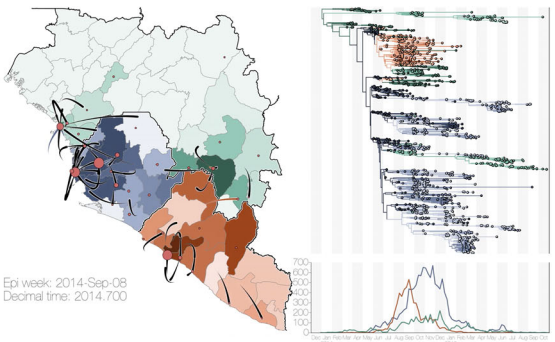
Overview

The NIHR Global Health Research Unit Tackling Infections to Benefit Africa at the University of Edinburgh (TIBA) partnered with the Wellcome Trust funded ARTIC Network to organise a 5-day training workshop in genomics. This workshop hosted by our partners, The West Africa Centre for Cell Biology of Infectious Pathogens, University of Ghana in Accra, Ghana.

The workshop provided hands-on, sample to interpretation, experience of sequencing virus genomes using Oxford Nanopore MinION sequencing. This technology is fast, portable and robust and enables the real-time surveillance and epidemiological tracking of virus outbreaks during epidemics. The MinION is a pocket-sized device which applies nanopore sequencing technology to nucleic acid analyses, with far reaching applications including real-time bacterial metagenomic community analysis, subtyping, and long read scaffolding for whole genome sequencing of organisms. The advantage of this device is that it is inexpensive, can be used in the field (outside the lab) and yields results in short turnaround times.

The training was attended by 21 participants from all nine TIBA partner countries and beyond (see next page for list of participants and affiliation). Participants included researchers and staff in public health laboratories who wish to introduce the capacity for real-time genome sequencing for real-time virus surveillance and outbreak epidemiology. Participants had experience or interest in the utilization of genomics approaches as part of outbreak response or for public health applications. Ten tutors from the ARTIC Network team facilitated the training. The course team are world-leaders in nanopore sequencing of pathogens, molecular epidemiology of infectious disease and the use of pathogen genomes for public health (see brief biographies of tutors below).






ARTICnetwork
Putting genomic surveillance at the heart of viral epidemic response
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WEST AFRICAN CENTRE FOR CELL BIOLOGY OF INFECTIOUS PATHOGENS
UNIVERSITY OF GHANA

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Course Structure

The course was a combination of lab based, hands-on, experimental approaches and interactive classroom-based sessions on data analysis and interpretation.

Day 1 focused on the principles of safe sample handling, extraction of viral nucleic acid and subsequent testing by real-time PCR. Participants were introduced to real-time sequencing in outbreaks situations and to the Lab-in-a-suitcase.

On Day 2 participants had some hands-on laboratory session and had a presentation on library preparation and native barcoding including loading of sequencing libraries onto the MinION sequencer.

Laboratory session including running the MinION sequencer, monitoring the output and diagnosing problems and assembling genome sequences were carried out on Day 3. There was also a presentation on MinION sequencing.

Participants were introduced to computer sessions and a presentation on the overview of the bioinformatics on Day 4.

On the final day there were presentations on Phylogenetics and molecular epidemiology and an overview of outbreak scenario interpretation alongside computer sessions. Participants were able to interpret the results of their data and made actionable epidemiological inferences, and broader phylogenetic and phylodynamic analysis.

List of Participants and Affiliations

First Name(s)	Surname	Institute	Country
Arnold	Tumedi	Botswana Institute for Technology Research and Innovation	Botswana
Lebotse	Molefi	University of Botswana	Botswana
Belinda	Herring	World Health Organization Regional Office for Africa	Congo
Kadjo	Herve	Institut Pasteur de Cote d'Ivoire	Cote d'Ivoire
George	Githinji	KEMRI-Wellcome Trust Research Programme	Kenya
Nicholas	Amoako	West Africa Centre for Cell Biology of Infectious Pathogens	Ghana
Osbourne	Quaye	West Africa Centre for Cell Biology of Infectious Pathogens	Ghana
Sylvester	Languon	West Africa Centre for Cell Biology of Infectious Pathogens	Ghana
Rahab	Amaza	National Reference Laboratory	Nigeria
Masroor	Alam	National Institute of Health, Pakistan	Pakistan
Enatha	Mukantwari	Rwanda Biomedical Center /National Reference Laboratory	Rwanda
Rashid	Ansumana	Njala University/Mercy Hospital Research Laboratory	
Ravesh	Singh	NHLS/UKZN, Inkosi Albert Luthuli Hospital	South Africa
Mohamed	Abdelrahim	Institute of Endemic Disease, University of Khartoum	Sudan
Gurdeep	Jaswant	Tanzania Industrial Research & Development Organisation	Tanzania
Marco	van Zwetselaar	Kilimanjaro Clinical Research Institute	Tanzania
Davis	Kuchaka	Kilimanjaro Clinical Research Institute	Tanzania
Eddie	Wampande	Makerere University	Uganda
Andrew	Tarupiwa	National Microbiology Reference Laboratory	Zimbabwe

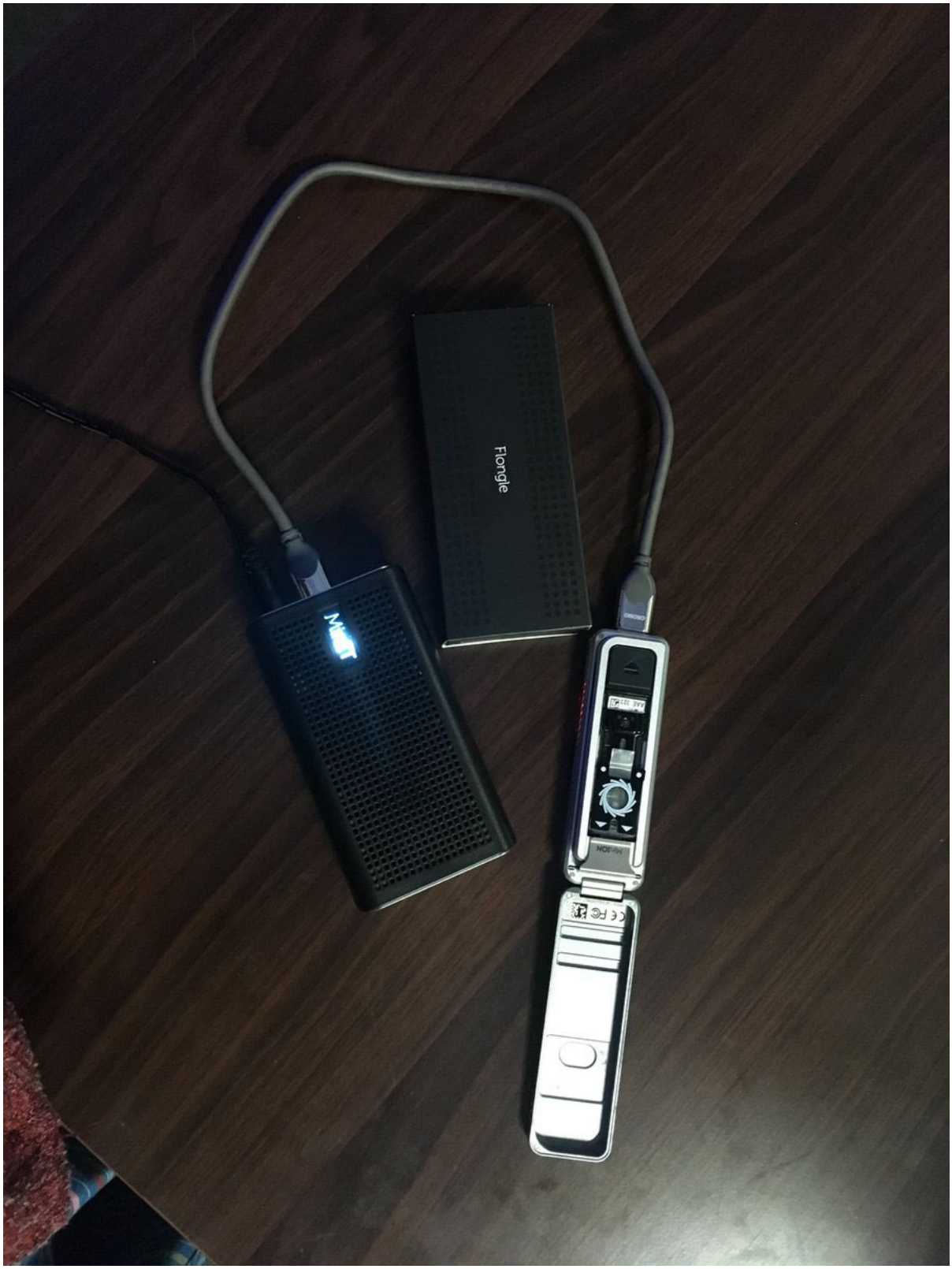
Takafira	Mduluza	University of Zimbabwe	Zimbabwe
Mark	Perkins	World Health Organization	



Group photo of participants and tutor at the genome sequencing workshop in Ghana



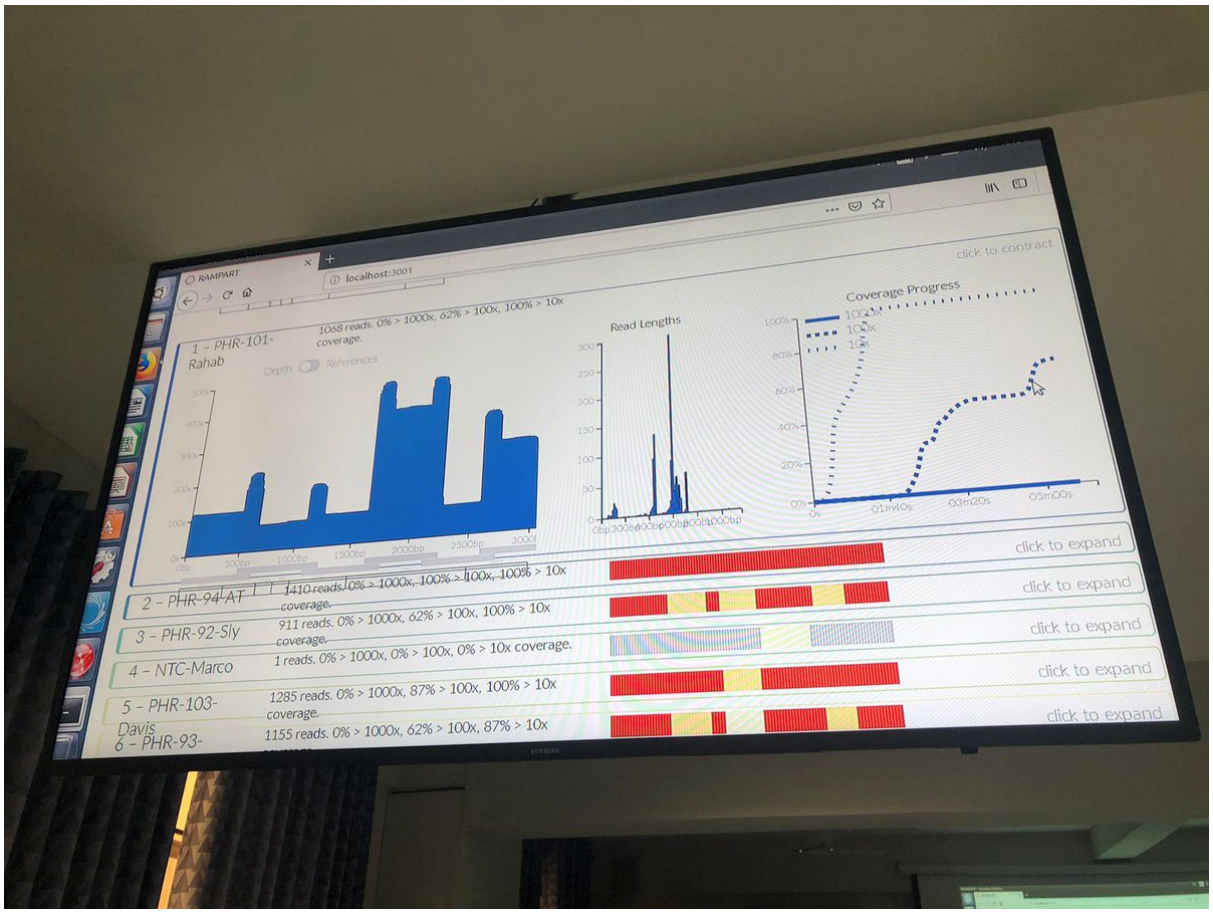
Professor Andrew Rambaut introducing participants to the objectives of the workshop.



The portable MinIon instumrnt



Hands on laboratory demonstration of the processes



Some data being generated as outputs of the sequencing.

Brief biographies of course tutors

Kirstyn Brunker is a postdoctoral research associate at the University of Glasgow, interested in how genetic data can be used for an enhanced understanding of rabies virus to guide rabies elimination programmes across Asia and Africa.

Jennifer Gardy holds the Canada Research Chair in Public Health Genomics at the University of British Columbia and is a Senior Scientist at the British Columbia Centre for Disease Control. She uses genome sequencing as a tool to understand tuberculosis transmission and develops methods to infer person-to-person transmission from genomic data.

Ian Goodfellow is a Professor of Virology from the University of Cambridge with an interest in the use of field deployable genomics as part of epidemic response. Through ongoing work in Sierra Leone, he has an interest in developing lab capacity in low- and middle-income countries.

James Hadfield

Verity Hill is a PhD student at the University of Edinburgh studying the use of genomic data to investigate the evolution and spread of Ebola virus.

Nicholas Loman is Professor of Microbial Genomics and Bioinformatics at the University of Birmingham. He works on novel approaches to pathogen genome sequencing to help understand and control the spread of infectious disease.

Luke Meredith is a postdoctoral research associate at the University of Cambridge, focused on field deployable laboratory diagnostics and sequencing, and how they can be used to prevent or monitor viral outbreaks in real-time.

Josh Quick

Andrew Rambaut is Professor of Molecular Evolution at the University of Edinburgh and Affiliate Scientist at Fogarty International Center. He works on the evolution and molecular epidemiology of RNA viruses and develops methods for analysing viral genome sequences.

Áine O'Toole is a PhD student at the University of Edinburgh studying the evolution of fast-evolving RNA viruses.

Funding

Funding was provided by the Wellcome Trust, the NHS National Institute for Health Research and the Division of International Epidemiology and Population Studies at the Fogarty International Center (FIC) of the U.S. National Institutes of Health. We also acknowledge the support of Oxford Nanopore Technologies.

Follow up

As part of our Work Package 2 and 6 on Making a Difference and Emergency Response respectively and following this successful partnership with the ARTIC Network, we have commissioned 2 projects in Botswana and Rwanda focussed on rotavirus and measles epidemics. Each project is funded for one year with £50,000.

Work Package 6 – Emergency Response

Botswana – The use of the MinIon real time genomics sequencer for the epidemiology and investigation of rotavirus outbreaks – post vaccine introduction: Botswana case study.

Dr M. Matsheka, Botswana Institute for Technology Research and Innovation

Rwanda – The epidemiology of measles virus genotypes associated outbreaks in Rwanda, 2019.

Ms M. Enatha, Rwanda Biomedical Centre, National Reference Laboratory Division