Large scale genomic surveillance of SARS-CoV-2 in the UK: challenges and lessons learned

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Wellcome Sanger Institute

A world leader in genome research that delivers insights into human and pathogen biology that change science and medicine

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Our Covid operations so far...

+20 million

Samples handled

50,000

Weekly capacity

+400k

Variants of concern reported

COVID-19 surveillance (as of 20 September 2021)

690,348

coronavirus genomes sequenced by the Sanger Institute

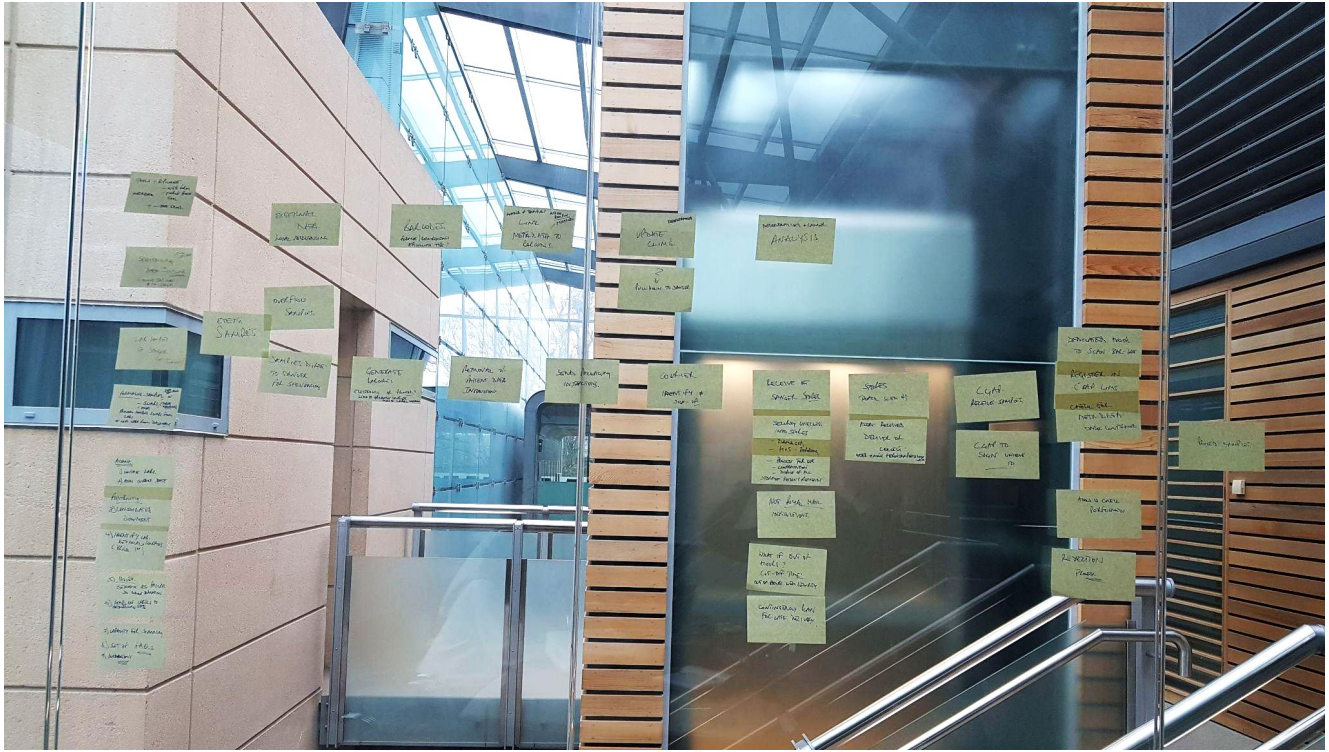
1,024,987

coronavirus genomes sequenced by the COVID-19 Genomics UK (COG-UK) consortium

300+

Sanger staff have contributed to the 7-days-per-week operation

Believe it or not, 18 months ago, this is how we started



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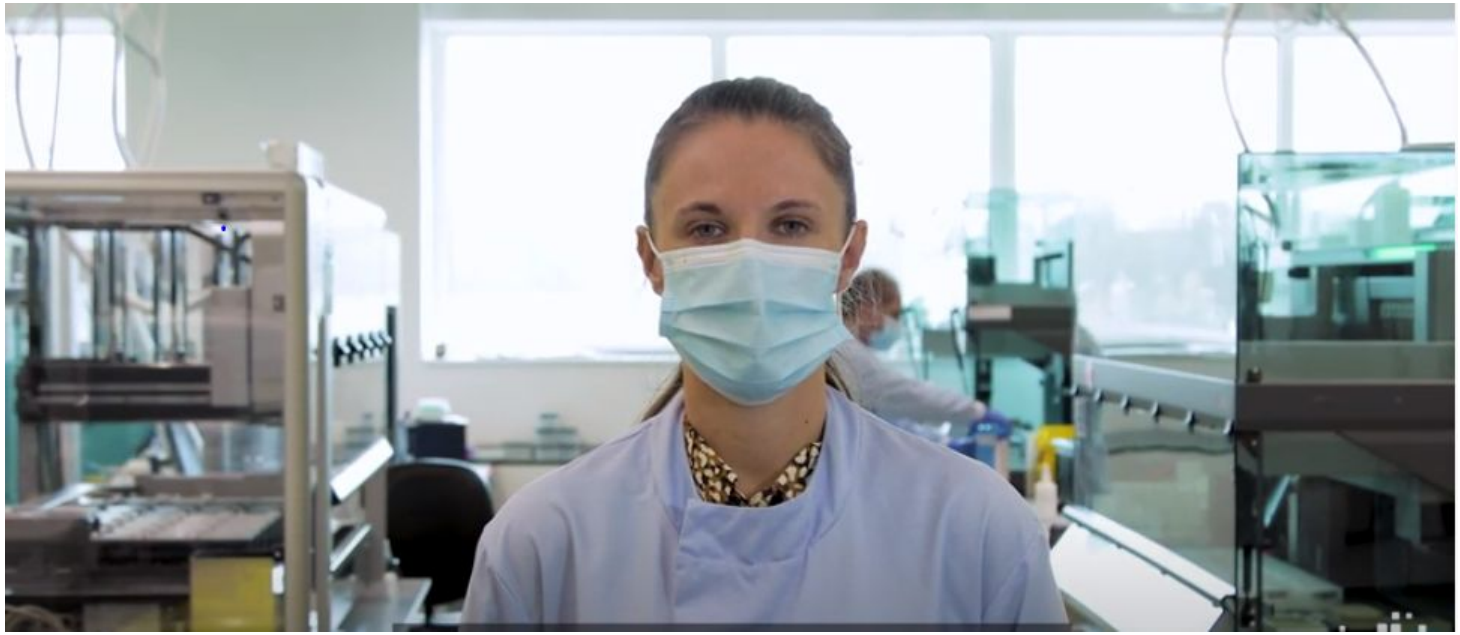
Completely new challenge!

We were figuring out how to work as a large team to best effect

First stand up meeting on the 17th of March 2020

Tanya Brooklyn chairing

Volunteers
Limited number of people on campus



“The teams, they didn’t have to come on site. You volunteered to come on site and everyone put their hands up. It was great!”

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Project Heron

High throughput genomic monitoring of the SARS-CoV-2 virus in the UK, aiding public health officials in their response to the coronavirus pandemic.

Monitor the virus for genetic mutations which could have public health implications

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Process Overview

Sample Flow

- Daily deliveries from all labs
- 7 day/week
- Boxes of 96 well plates of DNA/RNA extracts
- Barcoded boxes and plates

Operational Data Flows

- Box manifest (which plates in which boxes)
- Plate Maps (which sample in which well)

Sample Metadata Flows

Check Point

Sample prioritisation for sequencing
Samples filtered out
Samples with ct values >30
Plate maps, barcodes and box manifests
Samples of interest

Sample Receipt → Sample Picking → Library Prep → Sequencing and QC → Upload to CLIMB

Sequencing and QC → Reporting to UK government (including variants)

- If above capacity, sample storage and destruction (after 7 days)
- Selected samples are protected

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Department of Health & Social Care

Samples storage

Five temporary refrigerated containers at the car park
Each container holds 273 boxes
Each box holds 80 96-deep-well plates (~2 million samples in each container)

New labs dedicated to Covid

Robotics: 4 Beckmans and 2 Bioseros
Redundancy and resilience - global shortages

7 Illumina Novaseq - 10k samples per machine.
Average 2.5M reads per sample

The Journey

April 2020

Samples per week: 600
Turnaround (days): 26
Failure Rate: 30%

September 2020

Samples per week: 3,000
Turnaround (days): 19
Failure Rate: 25%

Jan 2021

Samples per week: 7,000
Turnaround (days): 19
Failure Rate: 20%

September 2021

Samples per week: 40,000
Turnaround (days): 5
Failure Rate: 15%

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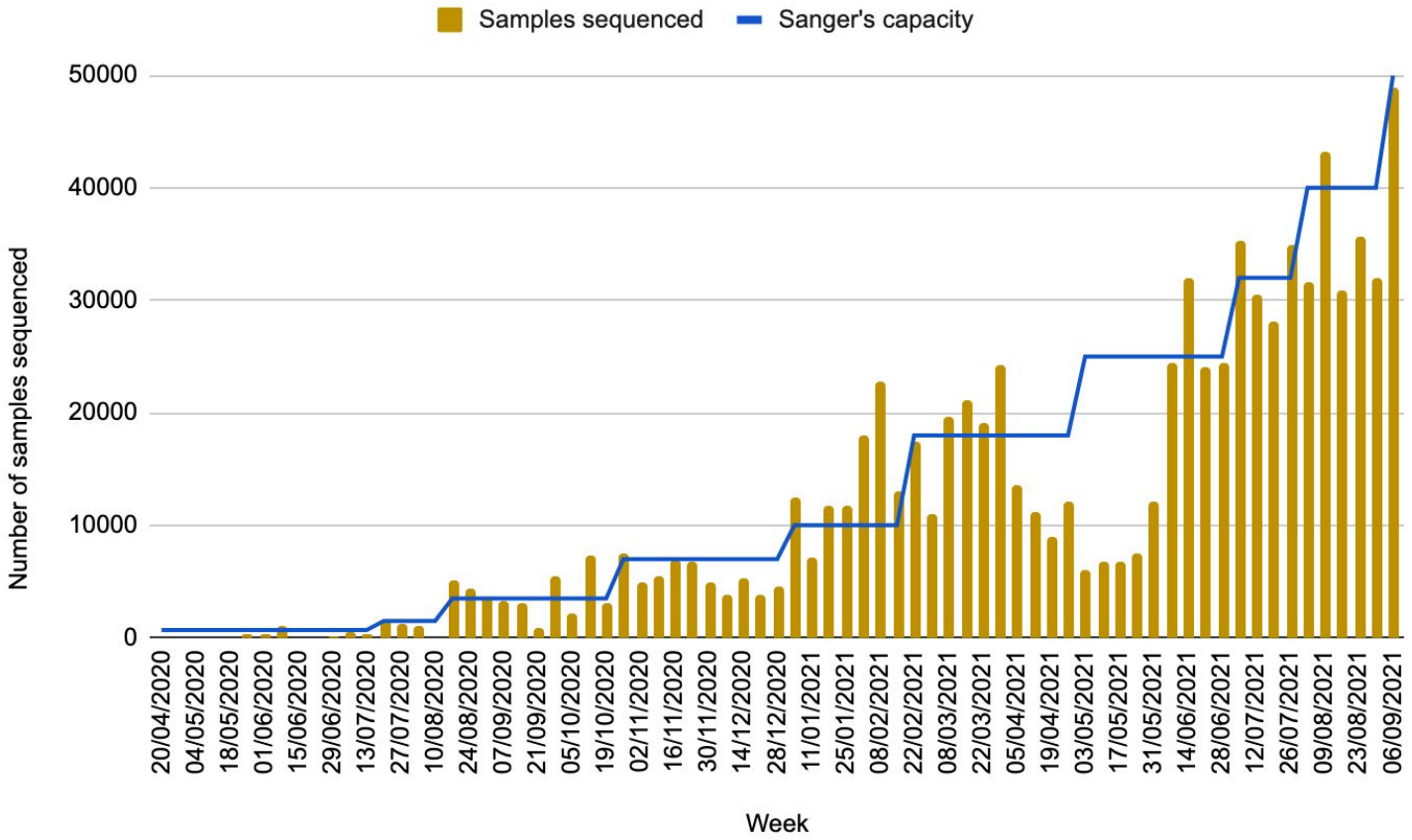
Samples sequenced per week



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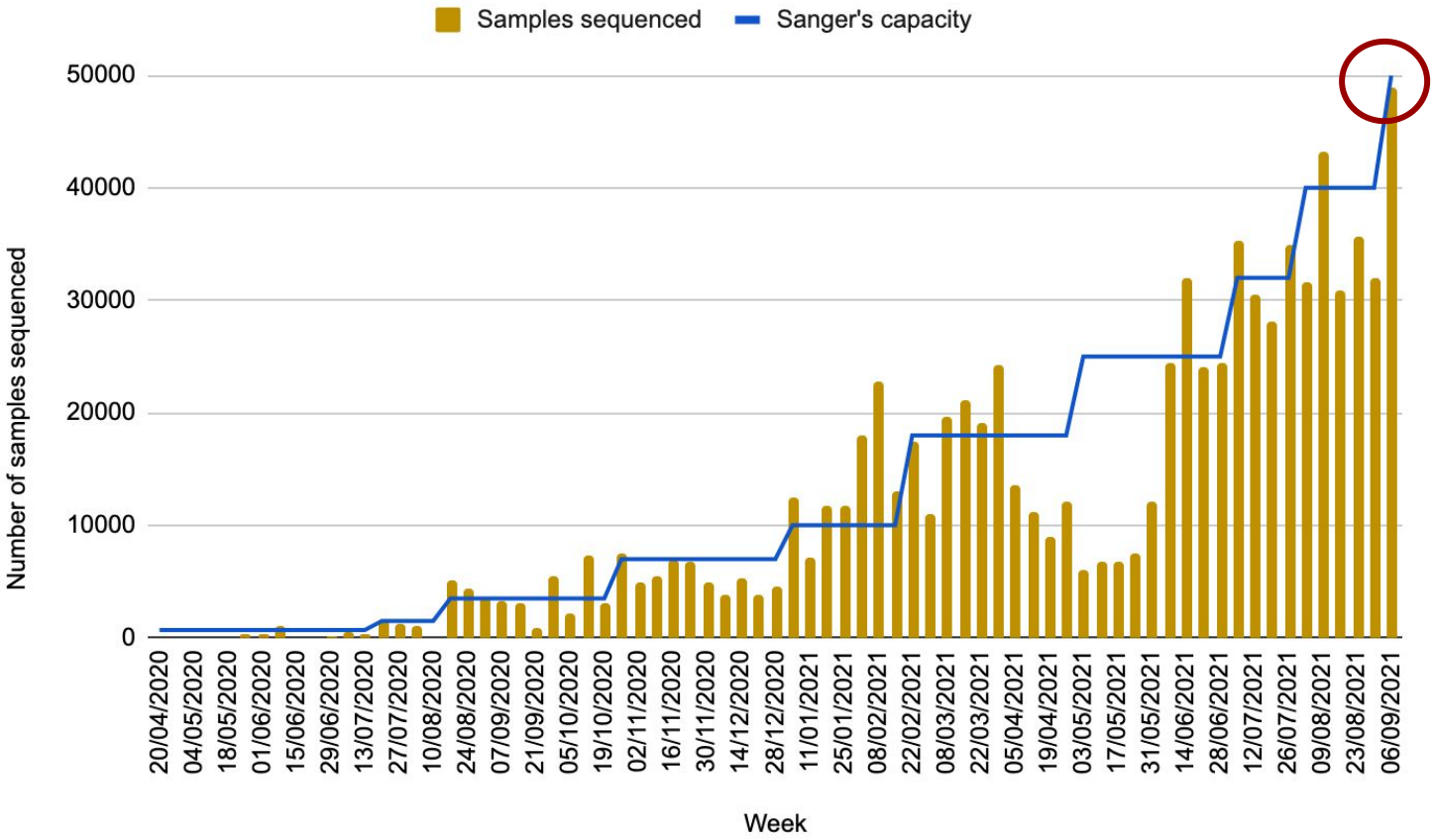

Close to 50,000

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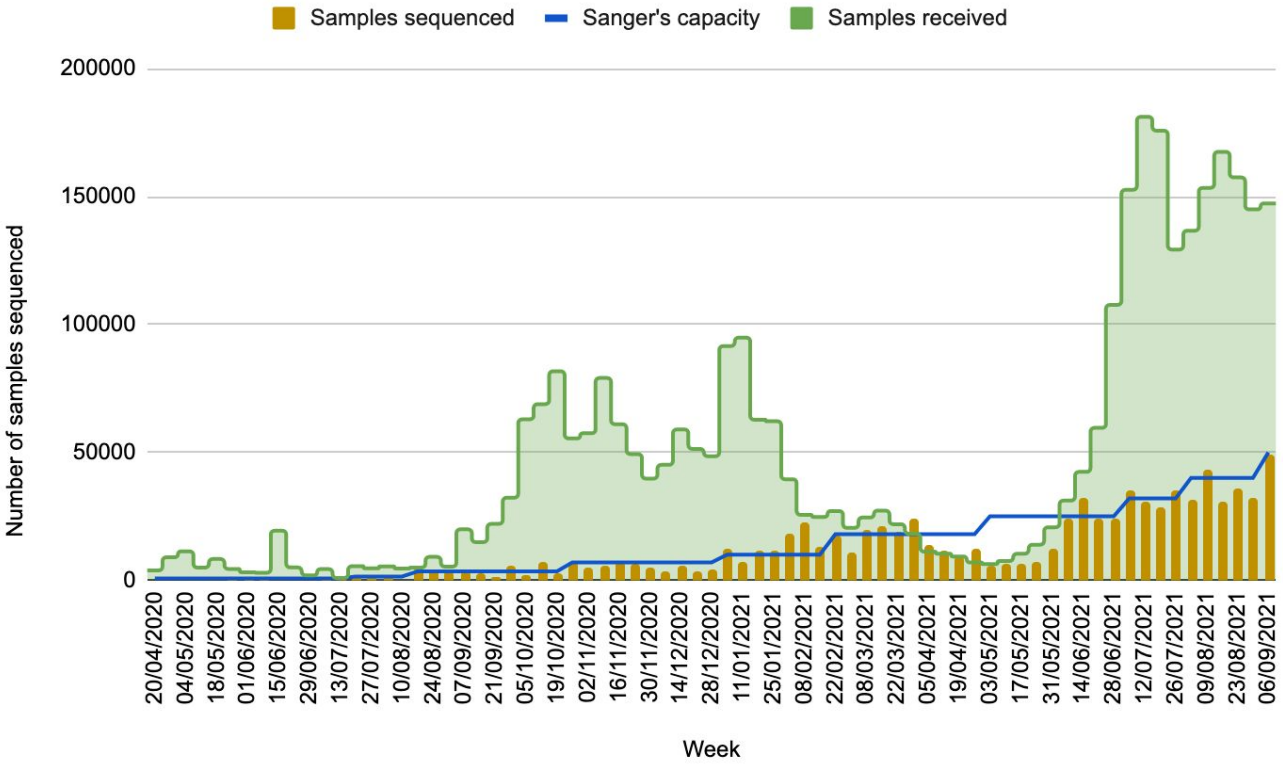
Samples received and sequenced per week



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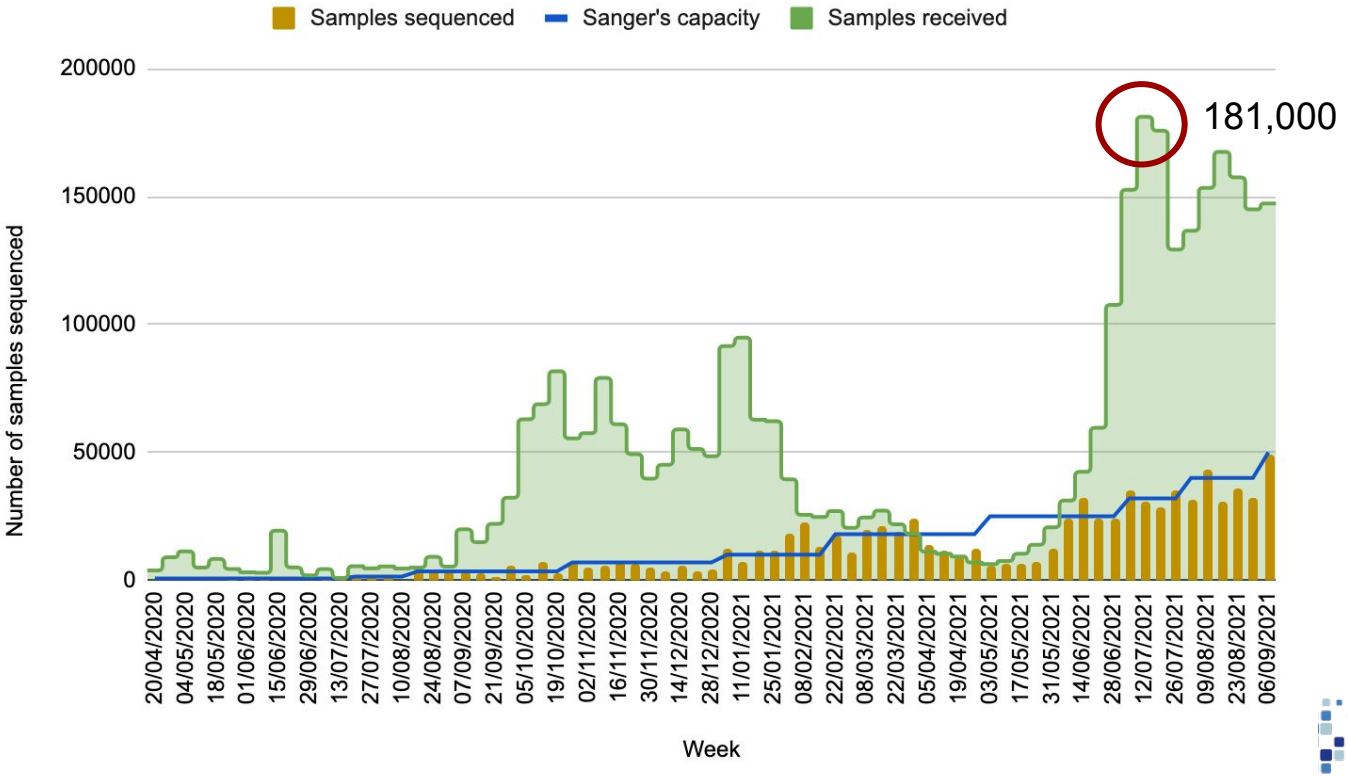
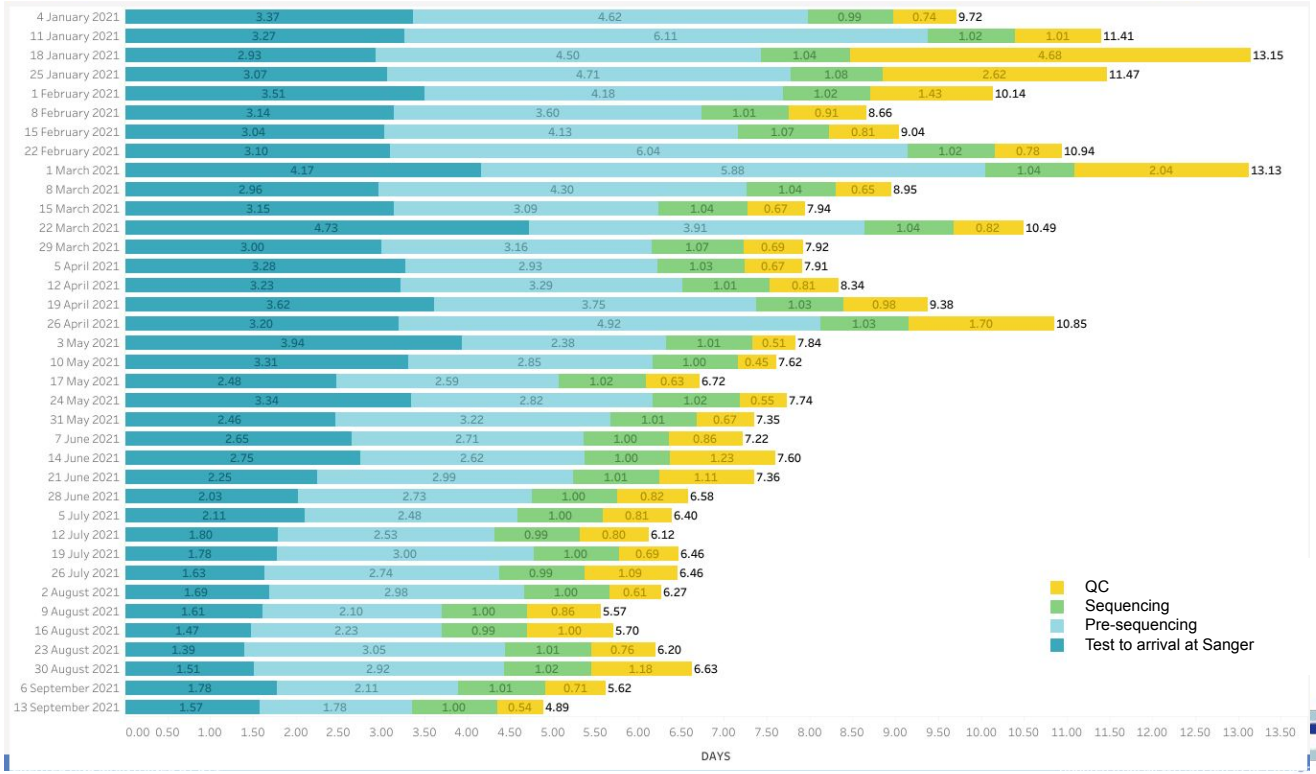


Journey of Improvement

Weekly average performance



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Health

Covid: New variant found 'due to hard work of UK scientists'

By Rachel Schraer
Health reporter

22 December 2020 | Comments

Coronavirus pandemic

The Economist

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Britain

Jan 16th 2021 edition ›

Genomics

How Britain has done so much sequencing of the coronavirus genome

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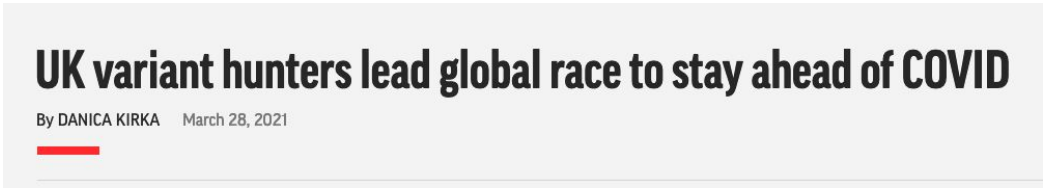
How the U.K. Became World Leader in Sequencing the Coronavirus Genome

U.S. is catching up but most countries are way behind; Britain alerted world to new variant

The Wall Street Journal


UK variant hunters lead global race to stay ahead of COVID

By DANICA KIRKA March 28, 2021

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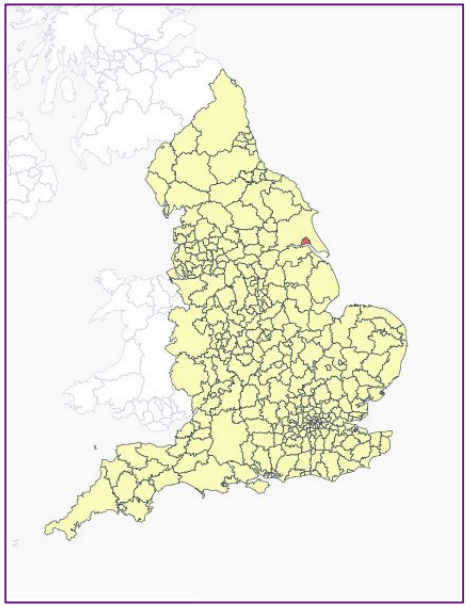
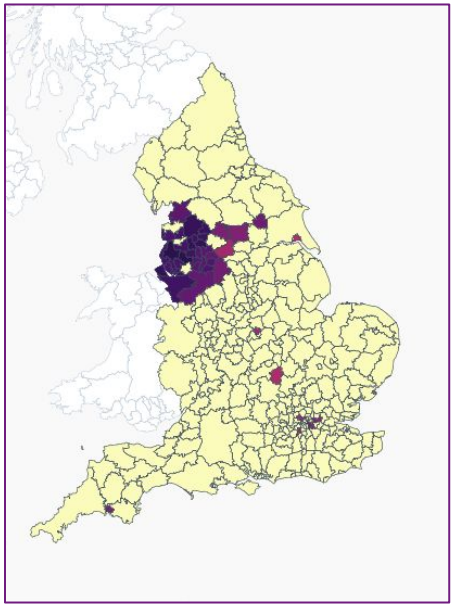
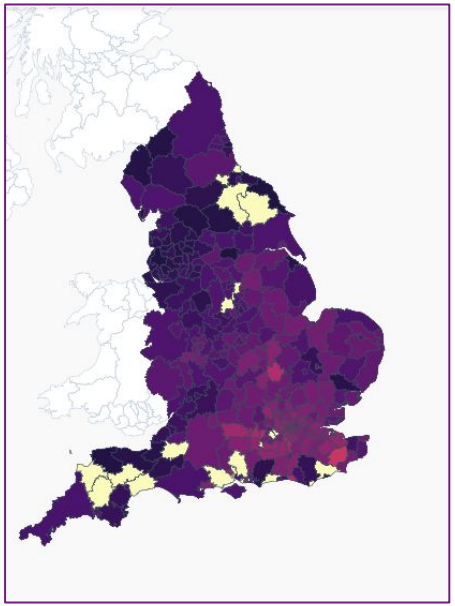
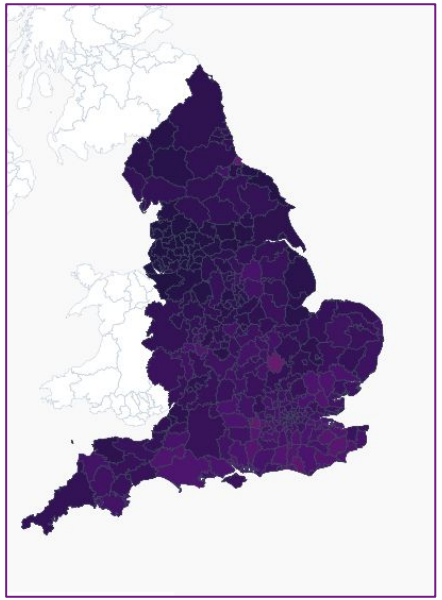
Delta variant









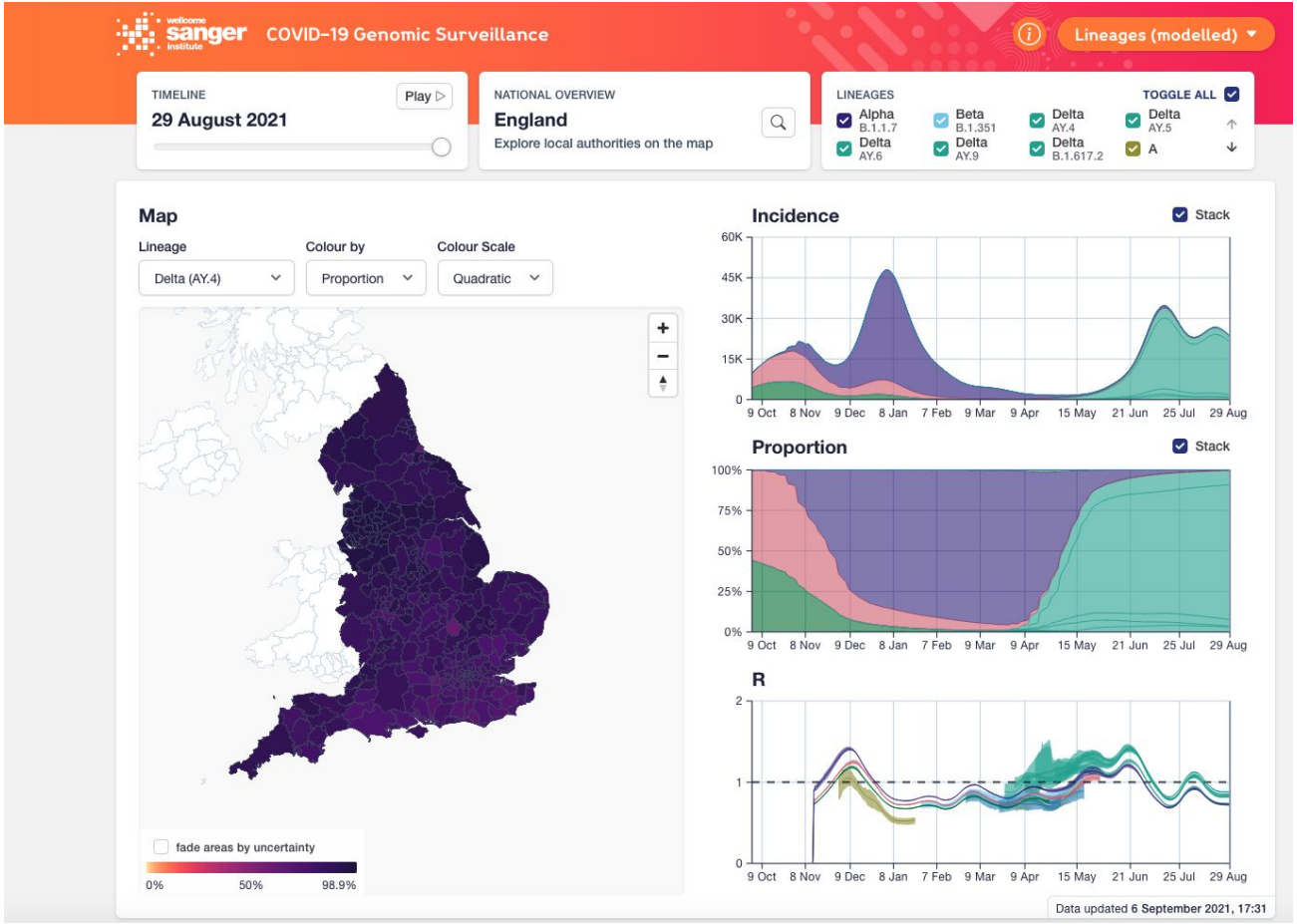
29/03/2021

29/04/2021

29/05/2021

29/06/2021

https://covid19.sanger.ac.uk



https://covid19.sanger.ac.uk

Challenges

- Global shortage of supplies
- Constantly changing landscape
- Logistics - getting samples and metadata to Sanger
- Sheer volume of samples handled
- Large team work
- External dependencies
- Timeliness of outcome
- Managing expectations - everyone wants their samples sequenced!
- Sample prioritisation - outbreaks, Eagle project and samples of interest
- Internal reporting - build a new system to track samples
- External reporting to Department of Health and Social Care - manual then fully automated
- Staff self-isolating, limited number of staff on site
- Floods, fires, sweat and tears, but also laughter

Lessons Learned

- Develop a really good relationship across all parts of the end-to-end process including external organisation
- Do not focus on targets but seek improvement and perfection
- Work really hard at creating a single view of the process through performance data
- Expect bumps in the road, bend and flow with them and seek improvement over a long period of time
- Continually invest in the science and robotics and support functions (IT, Facilities, HR)
- Recruit lab leaders that are used to high throughput labs
- Develop more capacity than you need, to cope with issues and problems
- The data QC part of the process to ensure high quality of data.
- Difficulties were with the constantly changing landscape and external dependencies as it was hard to pick apart what changes were having impact as often another part of the process would also be in flux.

More to do...

Improve, improve, improve

Increase capacity

And more!

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