UNODA
United Nations Office for Disarmament Affairs

ICGEB
International Centre for Genetic Engineering and Biotechnology

NORWEGIAN MINISTRY OF FOREIGN AFFAIRS

'Reducing Biological Risks by Promoting the Peaceful Use of Biology'
13:00 -14:45hrs
12 December 2023
Room XXV, Palais des Nations
Geneva, Switzerland

# ICGEB Capacity-Building Project in the Republic of Cameroon


## Dr FOKAM Joseph,

PhD-Infectious Dis, PGD-Epidemiology

**Virologist**

*Senior Scientist, Head of Virology Laboratory at CIRCB*

*Senior Lecturer, Faculty of Health Sciences, University of Buea*

*Lab Expert, National Public Health Emergencies Operations Coordination Centre*


***"To enhance detection capacity to respond to SARS-CoV-2 and other emerging infections in Sub-Saharan Africa by assessing and transferring cost-effective technology for rapid viral identification and surveillance"***

CIRCB

# OUTLINE

I. CAMEROON IN A NUTSHELL

II. INFECTIOUS DISEASE BURDEN

III. ICGEB CONTRIBUTION IN DIAGNOSTICS

IV. ICGEB CONTRIBUTION IN GENOMIC SURVEILLANCE

V. PANDEMIC PREPAREDNESS WITH ICGEB

VI. TAKE HOME MESSAGE

# I. CAMEROON IN A NUTSHELL

CIRCB

**Location**: A country at the Centre of Africa

**Capital cities** : Yaoundé (political) & Douala (economical)

**Overall surface** : 466 050 km²

**Population** : 28.6 million in 2023 (2.63% annual increase)

**Official languages** : French and English


*Yaounde (Capital)*

*Douala (Economic cap)*


**Fig. 1: Cameroon landscape**

*Kribi (Beach)*

*Limbe (Beach)*

*Wourri river (Douala sea port)*


*Mount Cameroon*

# II. INFECTIOUS DISEASE BURDEN (1/4)

| Disease surveillance week 48 | New Cases | New Deaths | Cumul Cases | Cumul Deaths |
|---|---|---|---|---|
| Anthrax ("*charbon*" in french) | 0 | 0 | 0 | 0 |
| Chikungunya | 0 | 0 | 0 | 0 |
| Cholera | 47 | 3 | 4238 | 153 |
| Dengue | 0 | 0 | 0 | 0 |
| Dracunculiasis | 0 | 0 | 0 | 0 |
| Viral haemorrhagic fever (last was Lyell syndrome) | 0 | 0 | 0 | 0 |
| Yellow fever | 35 | 00 | 1322 | 17 |
| Typhoid fever (all 10 regions) | 13376 | 20 | 609307 | 472 |
| Meningitis | 13 | 1 | 1057 | 46 |
| Malaria (all 10 regions) | 45 333 | 86 | 2099920 | 2673 |
| Poliomyelitis | 7 | 0 | 633 | 11 |

# II. INFECTIOUS DISEASE BURDEN (2/4)

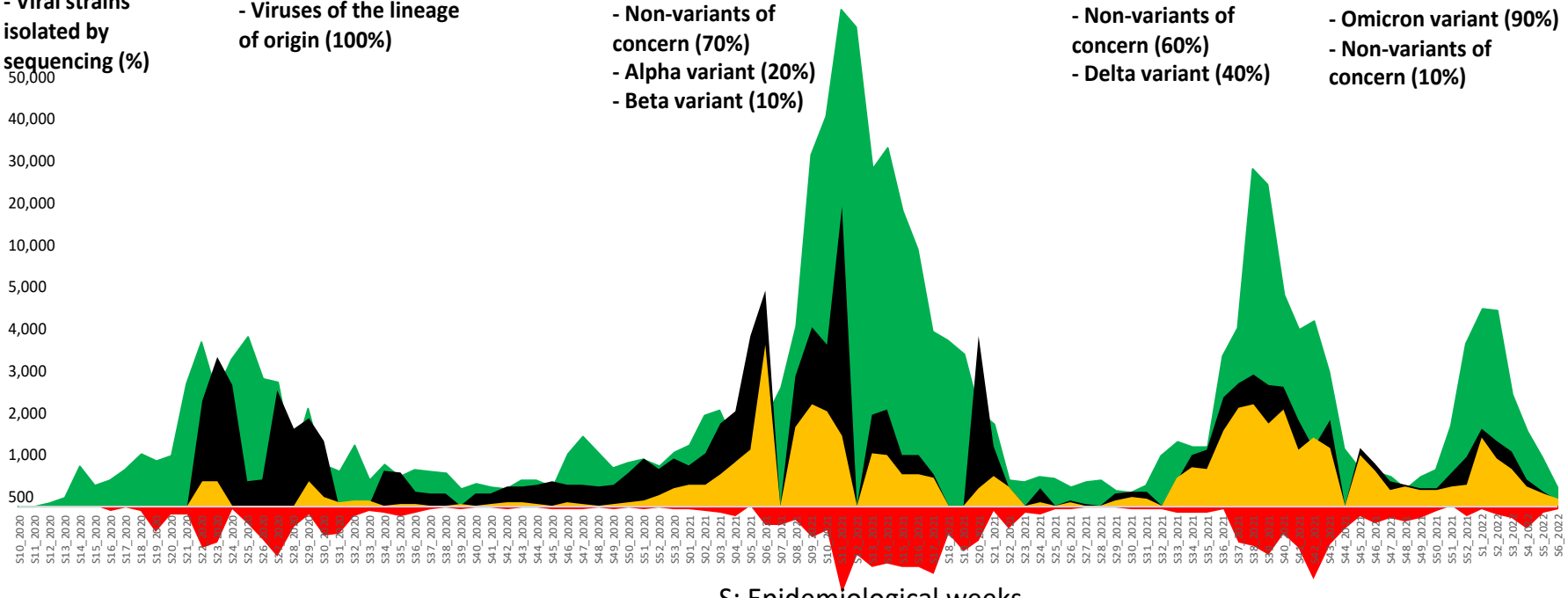
| Disease surveillance week 48 | New Cases | New Deaths | Cumul Cases | Cumul Deaths |
|---|---|---|---|---|
| Plague ("*Peste*" in french) | 0 | 0 | 0 | 0 |
| Dog bites | 150 | 0 | 5994 | 19 |
| Snake bites | 160 | 15 | 8873 | 103 |
| Rabies | 0 | 0 | 6 | 2 |
| Measles | 16 | 0 | 9135 | 57 |
| SRAS | 3 | 0 | 590 | 22 |
| Flu syndrome | 4934 | 7 | 215951 | 102 |
| Mpox | 0 | 0 | 89 | 0 |
| Smallpox | 0 | 0 | 0 | 0 |
| Diphtheria | 2 | 1 | 2 | 1 |
| COVID-19 | 1 | 0 | 808 | 11 |

# II. INFECTIOUS DISEASE BURDEN (3/4)

## Dynamics of COVID-19 burden in Cameroon: 2020 – 2022

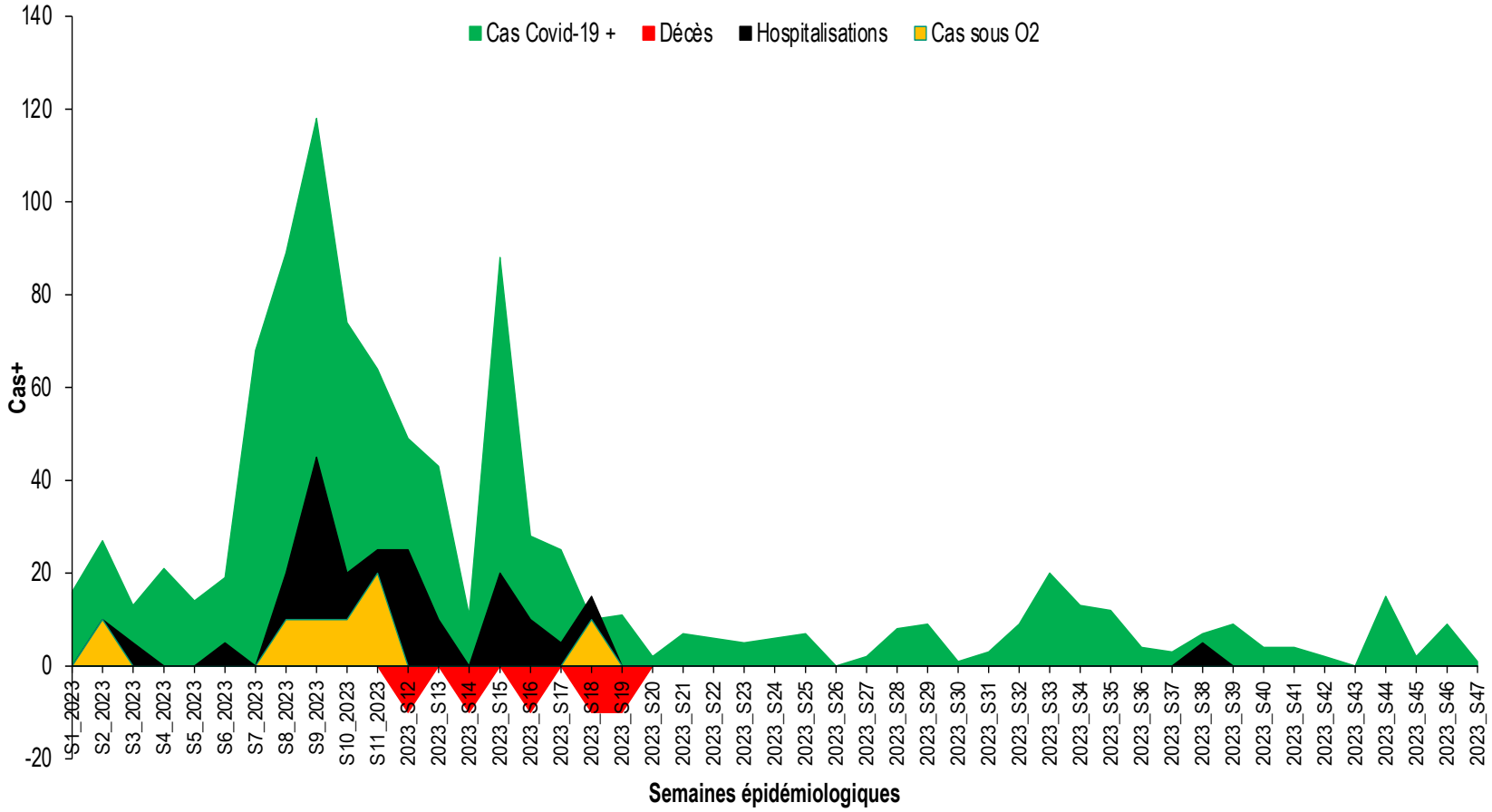
**Legend:**

| **Order of wave** | **First wave** | **Second wave** | **Third wave** | **Fourth wave** |
|---|---|---|---|---|
| Duration in weeks | 16 | 21 | 11 | 8 |
| Period (in weeks), Year | W18-33, 2020 | W2-22, 2021 | W36-W46, 2021 | W50, 2021 - W5, 2022 |
| Date start – Date end | 27/04/2020-16/08/2020 | 1/11/02-06/06/2021 | 15/06/09-21/11/2021 | 06/09/2022 to 06/02/2022 |
| Nber confirmed cases | 16,948 | 52,271 | 21,753 | 10,803 |
| Nber hospitalised | 1,847 | 4,675 | 2,230 | 809 |
| Nber deaths | 386 | 835 | 426 | 79 |
| Case Fatality rate | 2.3% | 1.6% | 2.0% | 0.73 |
| **- Viral strains isolated by sequencing (%)** | **- Viruses of the lineage of origin (100%)** | **- Non-variants of concern (70%)<br>- Alpha variant (20%)<br>- Beta variant (10%)** | **- Non-variants of concern (60%)<br>- Delta variant (40%)** | **- Omicron variant (90%)<br>- Non-variants of concern (10%)** |



# II. INFECTIOUS DISEASE BURDEN (4/4)

## COVID-19 under control in Cameroon since mid-2023 (Jan-Dec)



# III. ICGEB CONTRIBIUTION IN DIAGNOSTICS (1/6)

## National Laboratory capacity in response to COVID-19

| N° | Key indicators | March 2020, (n) | March 2022 (n) | Specific comments |
|---|---|---|---|---|
| i. | Number of frameworks for the genomic surveillance platform | 0 | 1 | Strong governmental engagement (ministerial decision, April 12, 2021) |
| ii. | Number of national strategies for SARS-CoV-2 genomic surveillance | 0 | 2 | The first plan has been revised as per changes in the pandemic. |
| iii. | Number of laboratories with the capacity for COVID-19 molecular testing | 1 | 45 | 24 public laboratories and 21 private laboratories |
| iv. | Number of laboratories with the capacity for variant screening by PCR point mutation assay | 0 | 16 | These are laboratories with open real-time PCR systems for SARS-CoV-2 |
| v. | Number of laboratories with the capacity/network for SARS-CoV-2 sequencing | 0 | 6 | 5 public labs and 1 private lab (performing targeted and/or whole-genome sequencing) |
| vi. | PCR-positive samples successfully processed for SARS-CoV-2 genomic surveillance | 0 | 3,881 | 1,509 PCR-mutation assays, 1,612 targeted sequencing, 760 whole-genome sequencing |

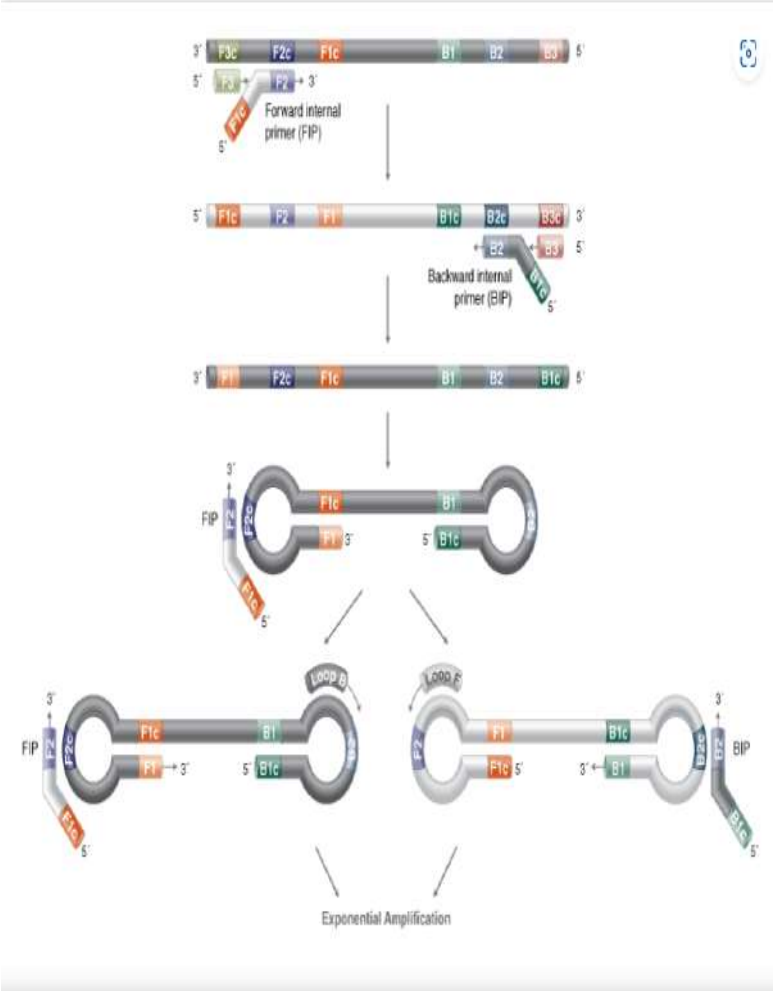
Cameroon report, CCOUSP 2022

# III. ICGEB CONTRIBIUTION IN DIAGNOSTICS (2/6)

## First experience with the RT-LAMP technology for COVID-19

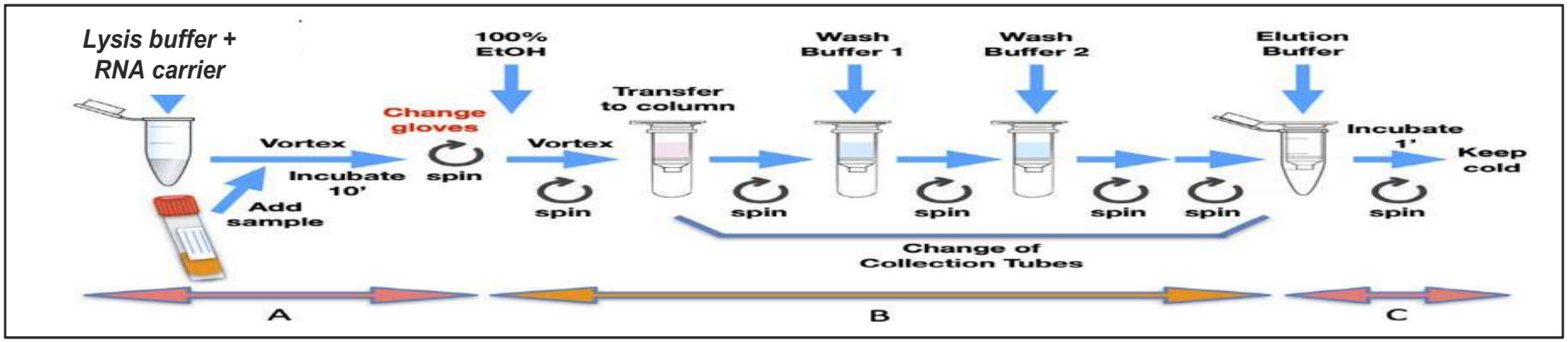
**Loop-Mediated Isothermal Amplification:**

- Loop-mediated isothermal amplification (LAMP) uses 4-6 primers recognizing 6-8 distinct regions of target DNA for a highly specific amplification reaction.
- A strand-displacing DNA polymerase initiates synthesis and 2 specially designed primers form “loop” structures to facilitate subsequent rounds of amplification through extension on the loops and additional annealing of primers.

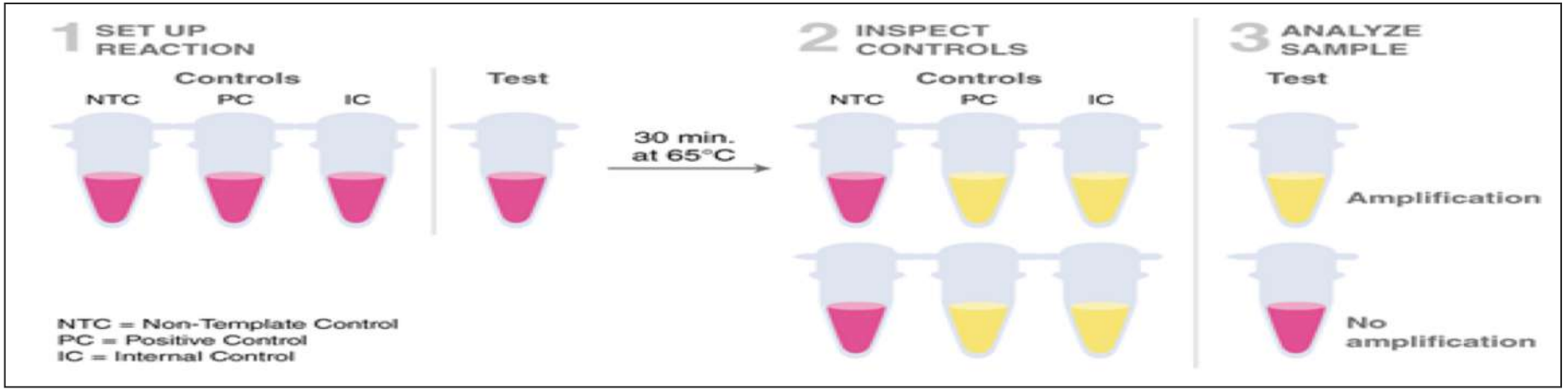


# III. ICGEB CONTRIBIUTION IN DIAGNOSTICS (3/6)

## First experience with the RT-LAMP technology for COVID-19




First step: Viral RNA isolation using a standard commercial kit (QIAamp® Viral RNA Mini Kit, Qiagen).




Second step: Amplification using a thermocycler at a single temperature of 65°

# III. ICGEB CONTRIBIUTION IN DIAGNOSTICS (4/6)

## Results of COVID-19 RT-LAMP on nasopharyngeal swabs

**Acceptable performance of RT-LAMP on nasopharyngeal specimens (excellent outcome with high viral loads)**

| Stratification | CAMEROON | |
|---|---|---|
| | N | Sensitivity % (CI 95%) |
| CT<25 | 129 | 98 (93-100) |
| CT≥25 | 93 | 63 (53-73) |

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Research Paper

Diagnostic performance of a colorimetric RT -LAMP for the identification of SARS-CoV-2: A multicenter prospective clinical evaluation in sub-Saharan Africa

Marycelin Mandu Baba[a,1], Molalegne Bitew[b,1], Joseph Fokam[c,d,1], Eric Agola Lelo[e,1], Ahmed Ahidjo[a], Kominist Asmamaw[b], Grace Angong Beloumou[c], Wallace Dimbuson Bulimo[e], Emanuele Buratti[f], Collins Chenwi[c], Hailu Dadi[b], Pierlanfranco D'Agaro[g,h], Laura De Conti[f], Nadine Fainguem[c], Galadima Gadzama[a], Paolo Maiuri[i], Janet Majanja[e], Wadegu Meshack[e], Alexis Ndjolo[c], Celine Nkenfou[c], Bamidele Soji Oderinde[a], Silvanos Mukunzi Opanda[e], Ludovica Segat[g], Cristiana Stuani[f], Samwel L. Symekher[e], Desire Takou[c], Kassahun Tesfaye[b], Gianluca Triolo[f], Keyru Tuki[b], Serena Zacchigna[f], Alessandro Marcello[f,*]

# III. ICGEB CONTRIBIUTION IN DIAGNOSTICS (5/6)

## Results of COVID-19 RT-LAMP on saliva without extraction

### Overall acceptable performance of RT-LAMP on saliva (n= 970)

**CT< 37 (National threshold)**

| | RT PCR (REFERENCE: Gold standard) | | | |
|---|---|---|---|---|
| RT-LAMP (Under evaluation) | | + | - | TOTAL |
| | + | 44 | 33 | 77 |
| | - | 11 | 798 | 809 |
| | TOTAL | 55 | 831 | 886 |

| Statistic | Value | 95% CI |
|---|---|---|
| Sensitivity | 80.0% | 68.4% to 88.6% |
| Specificity | 96.0% | 95.3% to 96.6% |
| Positive Predictive Value (*) | 57.1% | 48.8% to 63.3% |
| Negative Predictive Value (*) | 98.6% | 97.9% to 99.2% |

Kappa= 0.64 CI : 0.54 to 0.74

# III. ICGEB CONTRIBIUTION IN DIAGNOSTICS (6/6)

## Capacity-building on RT-LAMP for other laboratories





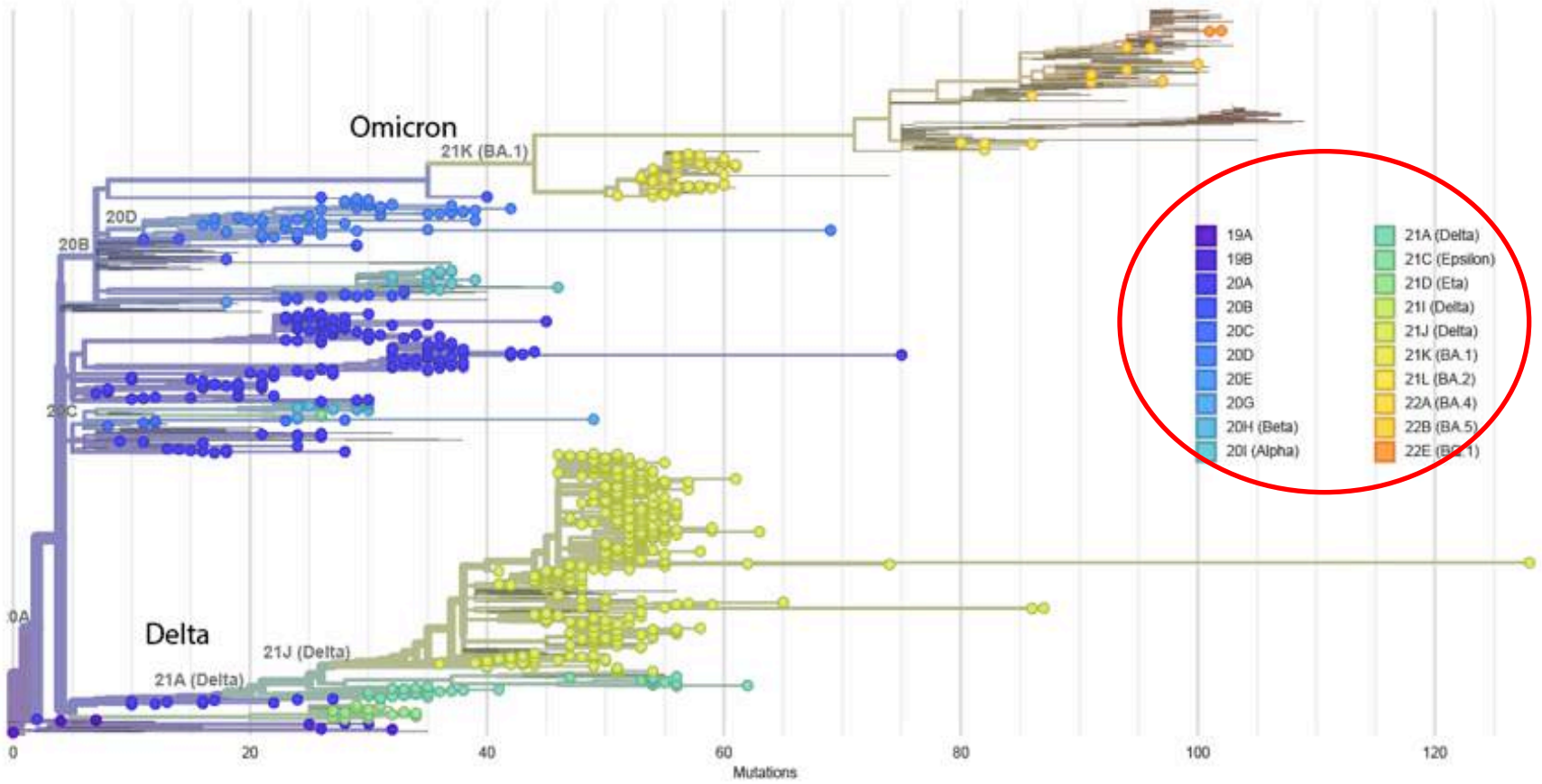




- **Successful implementation in all labs**: thermocycler, heating block, or water bath
- **Result perforrmance**: 100% concordance trained lab versus reference lab (CIRCB)

# IV. ICGEB CONTRIBIUTION IN GENOMIC SURVEILLANCE IN CAMEROON (1/5)

***Genomic surveillance of SARS-CoV-2 reveals highest severity and mortality of delta over other variants: evidence from Cameroon.*** Fokam *et al.*, Nat Sc. Reports 2023




**With contribution from ICGEB for whole genome sequencing (Bill & Melinda Gates sponsorship)**

# IV. ICGEB CONTRIBIUTION IN GENOMIC SURVEILLANCE IN CAMEROON (2/5)

## Targeted sequencing of SARS-CoV-2 of positive samples

**Sanger-sequencing and interpreted of variants using Stanford db.v9.5**

- **Site**: Virology Laboratory of the "Chantal BIYA" International Reference Centre (CIRCB), Yaoundé, Cameroon
- **Laboratory technique**: design of Sanger sequencing of the spike region of SARS-CoV-2 positive specimens.
- **Training**: Laboratory sequencing testing with reference to ICGEB whole genome sequences.

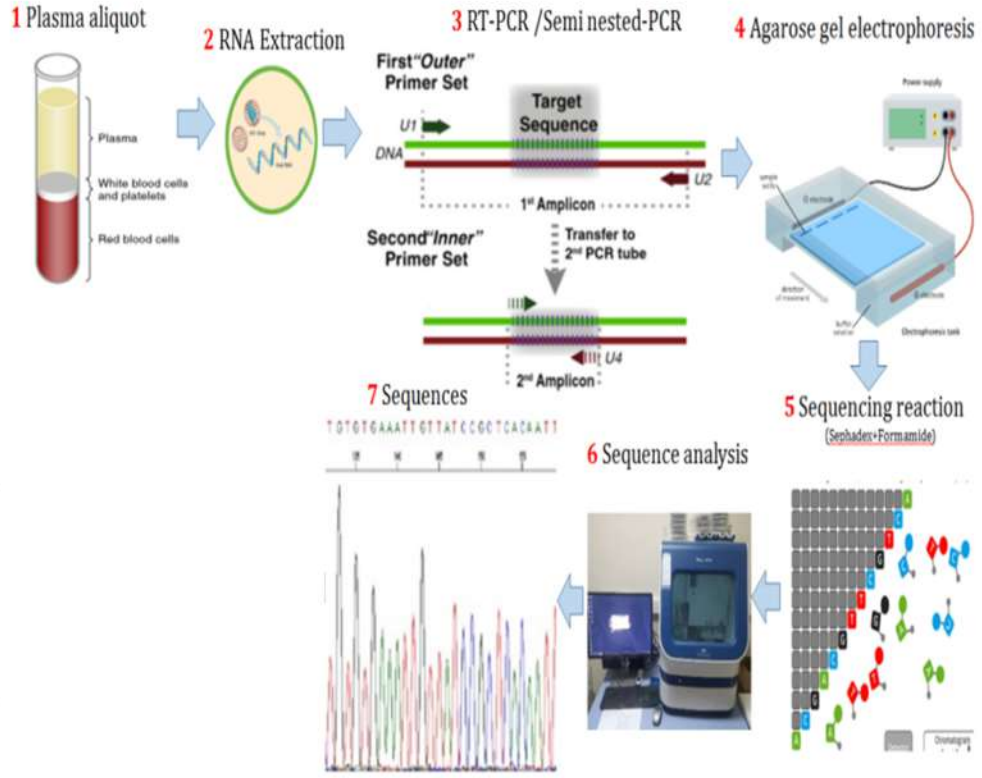



Figure : Sanger sequencing pipeline

# IV. ICGEB CONTRIBIUTION IN GENOMIC SURVEILLANCE IN CAMEROON (3/5)

## Real-time sequencing of sub-variants in 2023

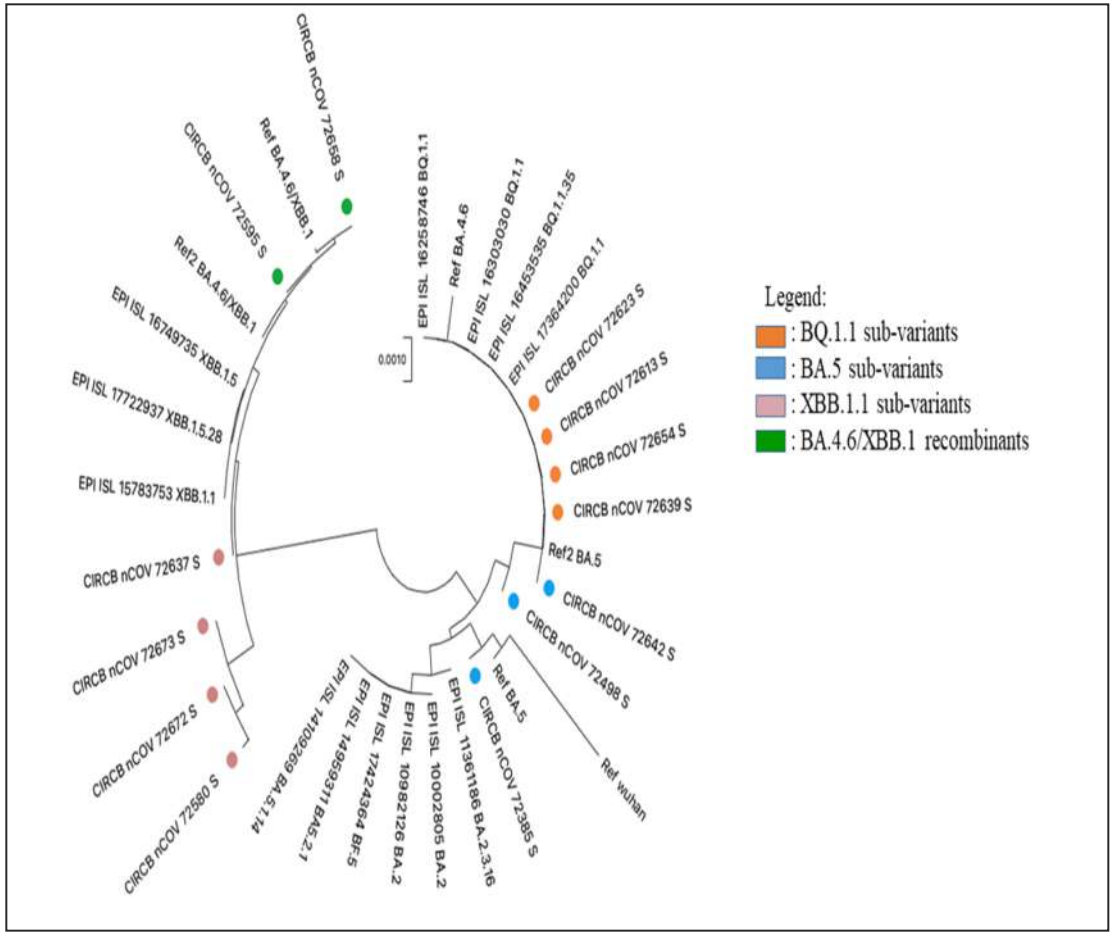



**Figure:** Phylogenetic tree of SARS-CoV-2 sequences obtained

- ***Current trend of COVID-19:*** *New Omicron sub-variants and recombinants with mild symptoms.*
- ***Genomic surveillance:*** *Atypical recombinants (BA.4.6/XBB.1), timely detect and track novel strains, related disease severity and risk of transmission for optimal pandemic control.*

# IV. ICGEB CONTRIBIUTION IN GENOMIC SURVEILLANCE IN CAMEROON (4/5)

## WORKSHOP ONT SEQUENCING FOR SARS-CoV-2 in ITALY & CAMEROON

ICGEB-Italy

CIRCB-Cameroon

**PORTABLE SEQUENCING DEVICE**
CE MARKED: YES
Dimensions Size: W 105 mm, H 23 mm, D 33 mm
Weight: 87 g

Fluorometer, benchtop

Qubit™ 4 Fluorometer, with WiFi

Incubators, laboratory, thermocycler

qTOWER³ G touch

qTOWER³ G touch (230 V), incl. color module 1

Primers: SARS-CoV-2 (ref. Diatheva)

Primers: SARS-CoV-2 (ref. Diatheva) 5 kit for 100 reactions

SuperScript™ IV First-Strand Synthesis System
Catalog number: 18091050

R9 Flowcells (Oxford Nanopore)

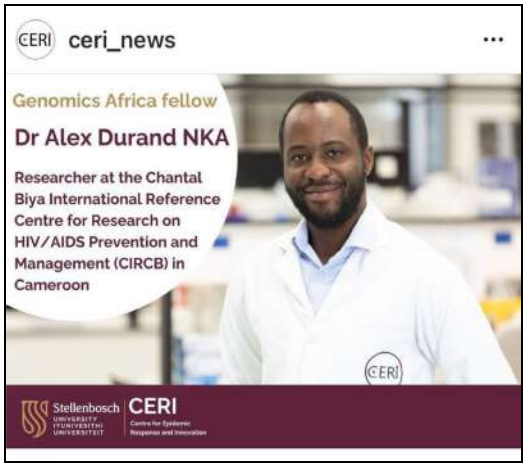
R9 Flowcells (Oxford Nanopore)
---
Flow Cells for MinION and MinION Mk1C
Supplier: Oxford Nanopore Technologies
Nanopore sequencing flow cells for use w

PC workstation
---
ESPRIMO P5011
Personal computer with licensed operating system a

# IV. ICGEB CONTRIBIUTION IN GENOMIC SURVEILLANCE IN CAMEROON (5/5)

## SETTING-UP OF A BIOINFORMATICS UNIT

Visit Minister of Health & Diplomates





Dr NKA, Head Unit trained on Bioinformatics at CERI – Prof Tulio

- ✓ **Bioinformatics unit**: Office workspace provided to the team;
- ✓ **Staff**: Head of unit & staff designated in the Virology Laboratory;
- ✓ **Basic equipment**: High throughput computers already in place;
- ✓ **Staff training**: further opportunities identified (ICGEB, CERI, Africa CDC);
- ✓ **pending needs**: a server/cluster for sequence data storage & sharing;
- ✓ **Vision**: become a bioinfo Ref. centre for surveillance in Central Africa.

# V. PANDEMIC PREPAREDNESS WITH ICGEB (1/3)

## National workshop to scale-up RT-LAMP in district laboratories of Cameroon for the surveillance of emerging pathogens

Phase 2+

Journal africain bilingue d'informations Sanitaires, Environnementales et de Développement durable

QUOTIDIEN ÉCHOS SANTÉ

L'information sanitaire à votre portée.

•N° 843 du vendredi 3 novembre 2023 •Tél. : (+237) 694 81 99 37 •Directeur de publication : Joseph MBENG BOUM

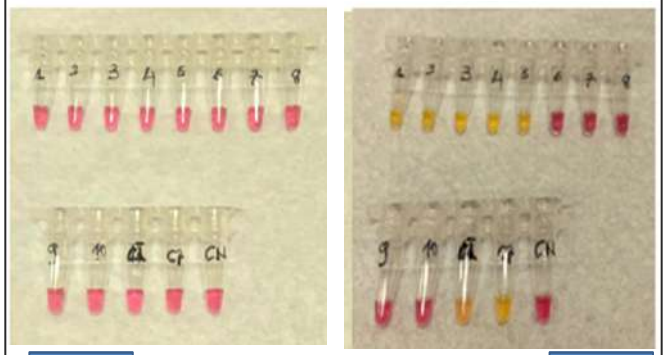
### Diagnostic moléculaire rapide et simplifié

# Les Laborantins s'abreuvent au Centre international de référence Chantal Biya

- C'est à la faveur d'un atelier qui a débuté hier, et s'achève ce jour, auquel prend part les responsables des laboratoires au niveau des districts en vue du renforcement de leurs capacités au diagnostic moléculaire rapide et simplifié de la Covid-19, pour l'appliquer à toute future pandémie.
- Ledit atelier est organisé par Le Centre international de référence Chantal Biya pour la recherche sur la prévention et la prise en charge du VIH/sida (CIRCB), dirigé par le Pr. Alexis Ndjolo, en partenariat avec le Centre de Coordination des Opérations d'urgence de la Santé publique (CCOUSP) et le Laboratoire National de Santé Publique (LNSP). Page 4

### RT-LAMP laboratory training

### RT-LAMP Result interpretation




Collaboration with the National Public Health Lab & the Public Health Emergencies Centre

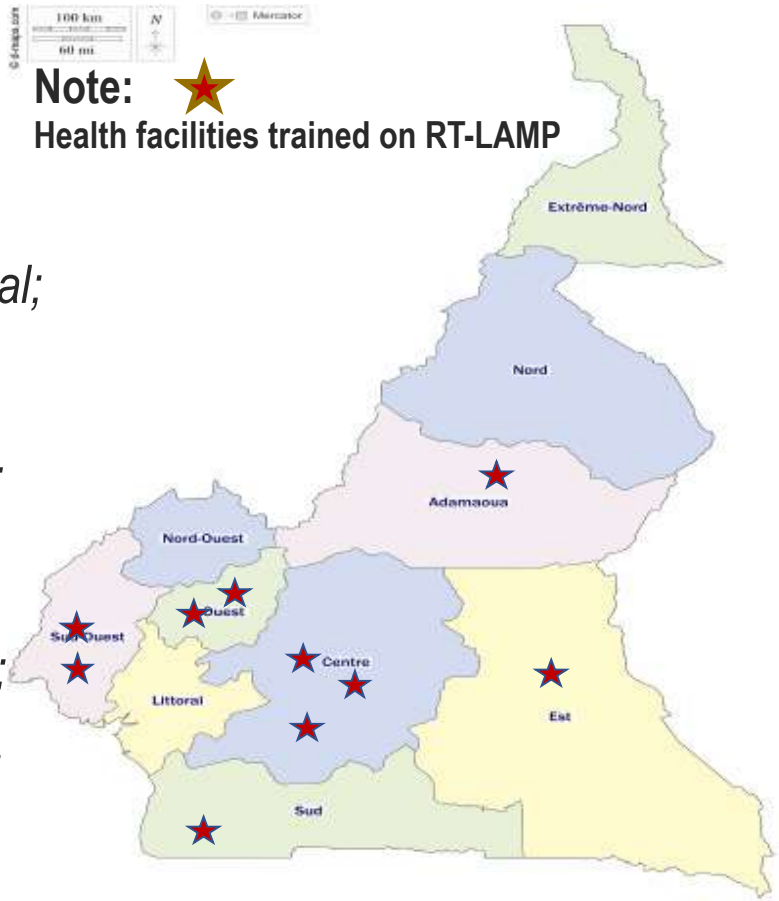
# V. PANDEMIC PREPAREDNESS WITH ICGEB (2/3)

## Rollout of RT-LAMP in 10 Laboratories of Cameroon for community-based surveillance of emerging pathogens

Phase 2+

**Established RT-LAMP Lab network**:

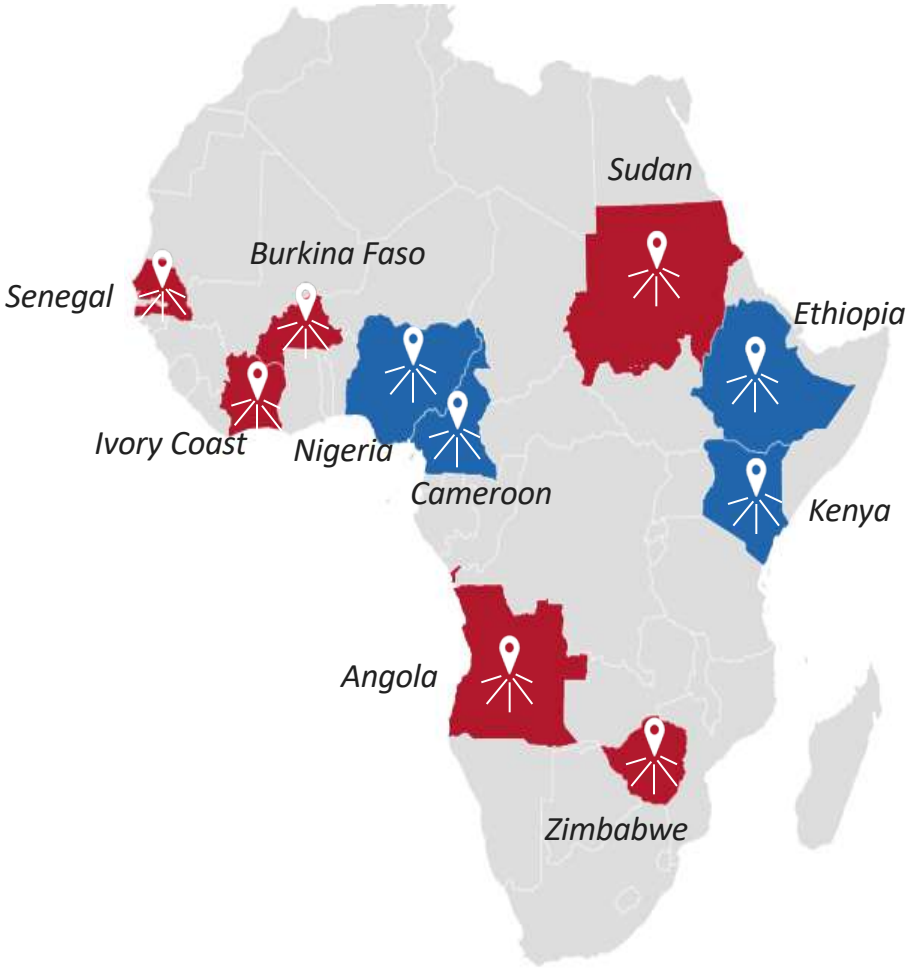
1. ***CIRCB****: Lead reference lab.*
2. ***NPHL****: Yaoundé urban;*
3. ***Ekoumdoum district hosp****: Yaoundé rural;*
4. ***Dang district hosp****: Northern region;*
5. ***Olamze district hosp****: Southern boarder;*
6. ***EUC laboratory****: urban western region;*
7. ***DREAM laboratory****: rural western region;*
8. ***FHS laboratory****: urban southwest region;*
9. ***Limbe Hosp****: southwest boarder region;*
10. ***Abong-Mbang district hosp****: East region.*



# V. PANDEMIC PREPAREDNESS WITH ICGEB (3/3)

## Rollout of RT-LAMP in 10 African countries and in community laboratories for front-line surveillance of emerging pathogens

Phase 2+




- The Project started officially on 20 August 2021 in five (05) African countries with nasopharyngeal swabs;
- Project expanded to 10 African countries with saliva testing and extraction-free;
- Project extended at the level of district laboratories for community-based surveillance of pathogens;
- Project network established for both epidemiological and genomic surveillance of other emerging pathogens (**arboviral diseases**) in sub-Saharan Africa.

# VI. TAKE HOME MESSAGE

## ICGEB Capacity-building in Cameroon:

- **RT-LAMP technology**: user-friendly across laboratories;
- **RT-LAMP implementation:** successful both with nasopharyngeal swabs and with saliva samples in across laboratories;
- **Genomic surveillance**: effective with sequencing of variants;
- **Extension of RT-LAMP technology to district laboratories**: an added-value for disease surveillance within the local communities;
- **Established network:** an effective system contributing for optimal pandemic preparedness and surveillance in sub-Saharan Africa.

# THANK YOU

CIRCB

COVID19 ICGEB RESOURCES NEW ENGLAND BioLabs

ICGEB

BILL & MELINDA GATES foundation

***COVID-19** team (at start)*

EDCTP

Ambasciata d'Italia Yaoundé

UNIVERSITA' degli STUDI di ROMA TOR VERGATA

***COVID-19 team** (with ICGEB)*

AGENZIA ITALIANA PER LA COOPERAZIONE ALLO SVILUPPO


UNESCO