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# MutaPLEX<sup>®</sup> CoV-2 MUT 3

## Real-Time-RT-PCR-Kit

*For the identification of the SARS-CoV-2 variants  
 Delta and Omicron.*

Valid from 2021-12-09



**KG193396**  
**KG1933-384**



96/384



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## 1 INTENDED USE

The MutaPLEX® CoV-2 MUT 3 Real-Time RT-PCR Kit is an assay for the detection of point mutations in the spike protein of SARS-CoV-2 from biological specimens. The test kit is used with samples that have been prequalified with screening PCRs like MutaPLEX® Coronavirus real time RT-PCR Kit (Immundiagnostik AG, Cat. No. KG192696/KG1926-384/KG1926-768).

## 2 PRINCIPLE OF THE TEST

The MutaPLEX® CoV-2 MUT 3 Real-Time RT-PCR Kit contains specific primer and probe systems for the detection of two SARS-CoV-2 spike protein mutations present in the **Delta Variant** of SARS-CoV-2 (B.1.617.2). The two detected mutations are L452R and P681R. Additionally, the combination of the mutations N440K, G446S, S477N, T478K, N679K and P681H, which are present in the **Omicron variant** of SARS-CoV-2 (B.1.1.529) can be detected. The test does not distinguish the lineages BA.1 from BA.2 (stealth version), both are detected as Omicron variant.

## 3 PACKAGE CONTENTS

The reagents supplied are sufficient for 96 or 384 reactions, respectively.

Table 1: Components of the MutaPLEX® CoV-2 MUT 3 Real-Time-RT-PCR Kit .

Label	Lid Colour	Content	
		96	384
Reaction Mix	yellow	1 x 1 325 µl	4 x 1 325 µl
Enzyme	blue	1 x 19.2 µl	1 x 76.8 µl
Positive Control WT	red	1 x 50 µl	1 x 100 µl
Positive Control Mut	violett	1 x 50 µl	1 x 100 µl
Positive Control Omicron	orange	1 x 50 µl	1 x 100 µl
Negative Control	green	1 x 150 µl	1 x 300 µl

## 4 EQUIPMENT AND REAGENTS TO BE SUPPLIED BY USER

- Sterile microtubes
- Calibrated precision pipets (adjustable volume) and sterile single-use tips with filter
- Disposable gloves
- Table centrifuge

- PCR grade water\*
- Vortexer
- Real-Time PCR instrument
- Optical PCR reaction tubes with lid or optical PCR reaction plate with optical foil
- Optional: Liquid handling system for automation

\* Immundiagnostik AG recommends the use of Ultra Pure Water (Water Type 1; ISO 3696), which is free of undissolved and colloidal ions and organic molecules (free of particles > 0.2 µm) with an electrical conductivity of 0.055 µS/cm at 25 °C (≥ 18.2 MΩ cm).

## 5 TRANSPORT, STORAGE AND STABILITY

The MutaPLEX® CoV-2 MUT 3 Real-Time RT-PCR Kit is shipped on dry ice or cool packs. All components must be stored at maximum -20°C in the dark immediately after receipt. Do not use reagents after the date of expiry printed on the package. Up to 20 freeze and thaw cycles are possible. For convenience, opened reagents can be stored at +2 to +8 °C for up to 6 months. Protect kit components from direct sunlight during the complete test run.

## 6 WARNINGS AND PRECAUTIONS

Read the Instruction for Use carefully before using the product.

Before first use check the product and its components for:

- Use of this product is limited to personnel specially instructed and trained in the techniques of Real-Time PCR procedures.
- Specimens should always be treated as infectious and/or biohazardous in accordance with safe laboratory procedures.
- Avoid microbial and nuclease (DNase/RNase) contamination of the eluates and the components of the kit.
- Always use DNase/RNase-free disposable pipette tips with aerosol barriers.
- Always wear protective disposable powder-free gloves when handling kit components.
- Use separated and segregated working areas for (1) sample preparation, (2) reaction setup and (3) amplification/detection activities. The workflow in the laboratory should proceed in unidirectional manner. Always wear disposable gloves in each area and change them before entering a different area.
- Dedicate supplies and equipment to the separate working areas and do not move them from one area to another.

- Store positive and/or potentially positive material separated from all other components of the kit.
- Do not open the reaction tubes/plates post amplification, to avoid contamination with amplicons.
- Additional controls may be tested according to guidelines or requirements of local, state and/or federal regulations or accrediting organisations.
- Do not autoclave reaction tubes after the PCR, since this will not degrade the amplified nucleic acid and will bear the risk to contaminate the laboratory area.
- Discard sample and assay waste according to your local safety regulations.

## 7 SAMPLE MATERIAL

Starting material for MutaPLEX® CoV-2 MUT 3 Real-Time RT-PCR Kit is RNA qualified SARS-CoV-2 positive by Real-Time RT-PCR (e.g. MutaPLEX Coronavirus Real-Time RT-PCR Kit, Imundiagnostik, Cat. No. KG192696/KG1926-384/KG1926-768).

**Eluates with very low copy numbers resulting in  $C_t$  values > 32 are not suitable for testing with the MutaPLEX® CoV-2 MUT 3 Real-Time RT-PCR.**

## 8 REAL-TIME-RT-PCR

### 8.1 *Important points before starting*

- Please pay attention to chapter 6 “Warnings and Precautions”.
- Before setting up the Real-Time-RT-PCR familiarise yourself with the Real-Time PCR instrument and read the user manual supplied with the instrument.
- The programming of the thermal profile should take place before the RT-PCR set up.
- In every RT-PCR run one Positive Control WT, one Positive Control Mut, one Positive Control Omicron and one Negative Control should be included.
- Before each use, all reagents should be thawed completely at room temperature, thoroughly mixed (except the Enzyme) and centrifuged very briefly.
- Due to the high viscosity of the Enzyme (blue lid), prewarming at room temperature for 15 min is recommended.

## 8.2 Procedure

### Prepare the Master Mix according to Table 2.

Prepare a volume of Master Mix for at least one sample more than required, in order to compensate for pipetting inaccuracy.

Table 2: Preparation of the master mix

Volume per reaction	Volume master mix
13.8 µl Reaction Mix	13.8 µl x (N+1)
0.2 µl Enzyme	0.2 µl x (N+1)

## 8.3 Preparation of the Positive Controls

The Positive Control WT, Positive Control Mut and Positive Control Omicron are stored in an extra storage buffer which may alter the peak of the melting curves. For a better comparison with the samples, all Positive Controls need to be **freshly** diluted 1:10 in PCR grade water.

Table 3: Preparation of the Positive Control

Component	Volume
Positive Control WT / Mut / Omicron	2 µl
PCR grade water	18 µl

### Real-Time-RT-PCR set up

- Place the number of optical PCR reaction tubes needed into the respective tray of the Real-Time PCR instrument / take an optical PCR reaction plate.
- Pipet **14 µl** of the Master Mix into each optical PCR reaction tube / the optical PCR reaction plate.
- Add **6 µl** of the eluates, the three Positive Controls and the Negative Control to the corresponding optical PCR reaction tube / the optical PCR reaction plate (Table 4).
- Close the optical PCR reaction tubes / the optical PCR reaction plate immediately after filling in order to reduce the risk of contamination.

Table 4: Preparation of the Real-Time-RT-PCR

Component	Volume
Master mix	14.0 µl
Sample	6.0 µl
Total volume	20.0 µl

## 8.4 Instrument settings

For the Real-Time-RT-PCR use the thermal profile shown in table 5.

Table 5: Real-Time-RT-PCR thermal profile

Description	Time	Temperature	Number of Cycles	Aquisitions
Reverse Transcription	10 min	45 °C	1	no
Initial Denaturation	5 min	95 °C	1	no
Denaturation	10 sec	95 °C	45	no
Annealing and Extension	40 sec	60 °C		end of step
Melting Curve <sup>1</sup>	see the tables below for individual cycler settings			

<sup>1</sup> If the MutaPLEX® CoV-2 MUT 2 real time RT-PCR kit is performed in the same PCR run, use the melting curve protocol according to the MutaPLEX® CoV-2 MUT 3 manual.

### LightCycler 480II

Programm Step	Melting Curve			Cooling
Parameter				
Analysis Mode	Melting Curves			None
Cycles	1			1
Target [°C]	95	40	76	40
Hold [hh:mm:ss]	00:00:30	00:02:00	-	00:00:30
Ramp Rate [°C/s]	4.4	1.5	0.29	1.5
Acquisition Mode	None	None	Continuous	None
Acquisitions [per °C]	-	-	1	-

**Bio-Rad CFX96**

Programm Step	Melt Curve
<b>Parameter</b>	
Melt from	52.0 °C to 76.0 °C
Increment	0.5 °C for 0:05 + Plate Read

**Mic qPCR Cycler**

Programm Step	Melt
<b>Parameter</b>	
Melt from	52.0 °C to 76.0 °C at 0.1 °C/s
Acquire on	Green

Programm Step	Melt
<b>Parameter</b>	
Melt from	52.0 °C to 76.0 °C at 0.1 °C/s
Acquire on	Red

**NEOS-96 qPCR**

Programm Step	Continuous Melt	
<b>Parameter</b>		
Cycle	1	
Step	1	2
Temperature	52.0 °C	76.0 °C
Time	00:01	-
Fluorescence	None	5 Readings/°C



## QuantStudio 5

Programm Step	Melt Curve Stage	
Parameter		
Step	1	2 (Dissociation)
Temperature	52.0°C	76.0°C
Time	00:01	00:01
Ramp Rate	1.6°C/s	0.1°C/s

Dependent on the Real-Time instrument used, further instrument settings have to be adjusted according to Table 6.

Table 6: Overview of the instrument settings required for the MutaPLEX® CoV-2 MUT 3 Real-Time-RT-PCR.

Real-Time-PCR-Instrument	Parameter Reaction Mix	Detection channel	Notes									
LightCycler 480II	P681R / N679K, P681H L452R	465 – 510 618 – 660	Color Compensation not required									
			<table border="1"> <thead> <tr> <th>Melt factor</th> <th>Quant factor</th> <th>Max integration time (s)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>10</td> <td>1</td> </tr> <tr> <td>1</td> <td>10</td> <td>3</td> </tr> </tbody> </table>	Melt factor	Quant factor	Max integration time (s)	1	10	1	1	10	3
			Melt factor	Quant factor	Max integration time (s)							
1	10	1										
1	10	3										
QuantStudio 5 Bio-Rad CFX96	P681R / N679K, P681H L452R	FAM Cy5	Reference Dye: None									
Mic qPCR Cycler	P681R / N679K, P681H L452R	Green Red	Gain 8 Gain 10									
NEOS-96 qPCR	P681R / N679K, P681H L452R	FAM Cy5	Reference Dye: None									

## 9 DATA ANALYSIS

### 9.1 Interpretation of the PCR Signals

SARS-CoV-2 positive samples should show curves in the FAM and Cy5 channel. If the amplification is only present in one channel, it must be considered for the interpretation of the results (Table 7). SARS-CoV-2 negative samples must show no amplification curve.

## 9.2 Interpretation of the melting curve and the amplification curve

**Figure 1 and Figure 2** show examples for real time RT-PCR melting curve results of the wildtype (Wuhan), the Delta Variant and the Omicron Variant of SARS-CoV-2 spike proteins.

**Figure 3 and Figure 4** show examples for real time RT-PCR amplification curve results of the wildtype (Wuhan), the Delta Variant and the Omicron Variant of SARS-CoV-2 spike proteins.

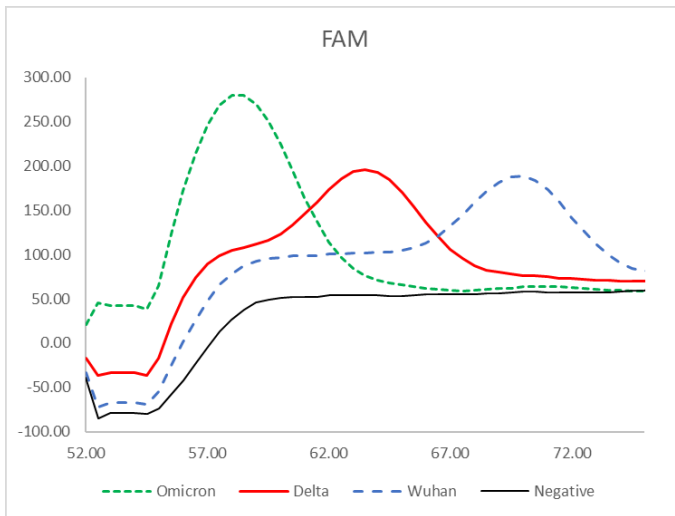


Fig 1: The melting curve of a sample positive for the P681R mutation (red line, Delta variant, peak at 63.5°C) in comparison to the melting curve of a wildtype sample (dashed blue line, Wuhan variant, peak at 70.0°C). The dashed green line indicates a sample positive for the mutations N679K and P681H (Omicron variant, peak at 58.0°C). The thin black line represents a negative sample.

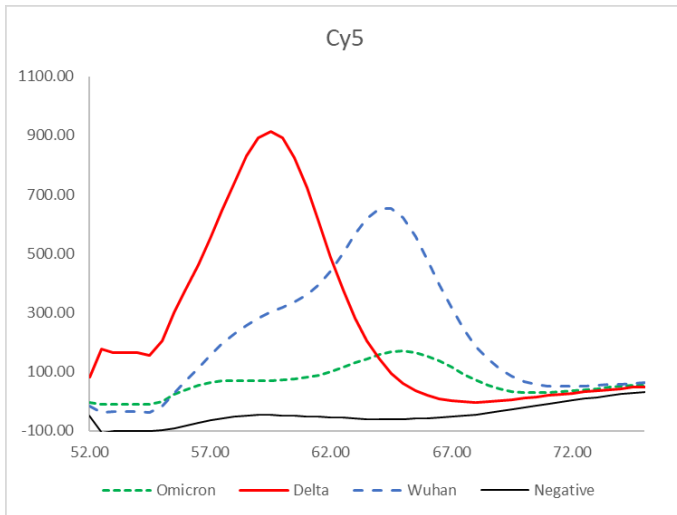


Fig 2: The melting curve of a sample positive for the L452R mutation (red line, Delta variant, peak at 58.5°C) in comparison to the melting curve of a wildtype sample (dashed blue line, Wuhan variant, peak at 64.5°C). The dashed green line indicates a sample positive for the mutations N679K and P681H (Omicron variant, peak at 64.5°C). The thin black line represents a negative sample.

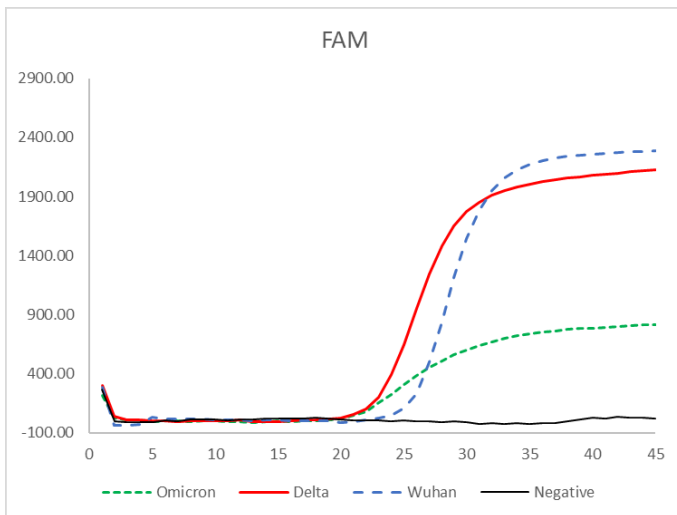


Fig 3: The amplification curves for the Omicron variant (dashed green line), the Delta variant (red line) and the Wuhan variant (dashed blue line) in the FAM channel. The thin black line represents a negative sample.

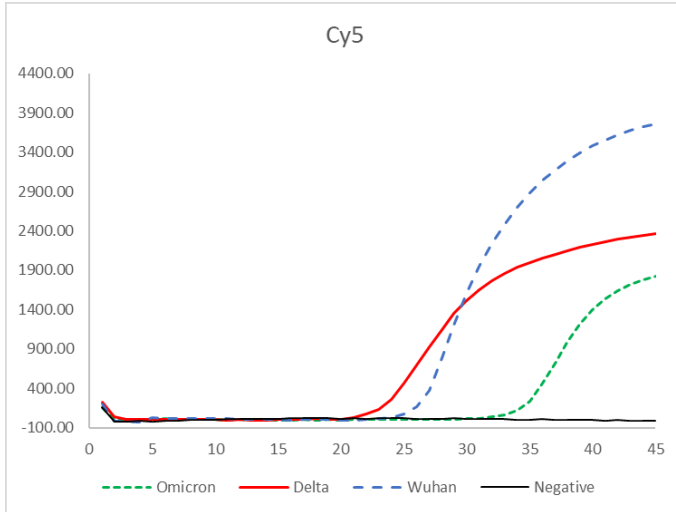


Fig 4: The amplification curves for the Omicron variant (dashed green line), the Delta variant (red line) and the Wuhan variant (dashed blue line) in the Cy5 channel. The thin black line represents a negative sample. The mutations N440K, G446S, S477N and T478K show a strong interference in the amplification curve for the Omicron variant, which results in a  $C_T$  shift of approximately more than 10, when compared to the FAM channel.

### 9.3 Interpretation of the results

It must be possible to clearly assign the peaks of the samples to one of the peaks of the Positive Controls. Their melting points may only deviate by  $\pm 1.0$  degrees from that of the corresponding Positive Control.

Furthermore, it is essential to look at the melting curves for the associated values given by the cycler. Melting peaks can occur which are not evaluated by the cycler but can be clearly evaluated optically.

Table 7: Interpretation of the results for MutaPLEX® CoV-2 MUT 3

Channel	Melting Peak	Interpretation
FAM	Melting peak of the sample aligned with melting peak of Positive Control Mut	<b>P681R mutation</b> is detected
	Melting peak of the sample aligned with melting peak of Positive Control WT	<b>Wildtype</b> is detected
	Melting peak of the sample aligned with melting peak of Positive Control Omicron	<b>N679K and P681H mutations</b> are detected

Channel	Melting Peak	Interpretation
Cy5	Melting peak of the sample aligned with melting peak of Positive Control Mut	<b>L452R mutation</b> is detected
	Melting peak of the sample aligned with melting peak of Positive Control WT	<b>Wildtype</b> is detected
	Melting peak of the sample aligned with melting peak of Positive Control WT / no melting peak <u>and</u> the $C_T$ value is shifted	<b>N440K, G446S, S477N and T478K mutations</b> are detected
FAM / Cy5	Melting peak of the sample not aligned with melting peak of one of the Positive Controls	another mutation is possible
	No melting peak	not enough sample material or SARS-CoV-2 negative
<p>Both channels need to be aligned with the Positive Control Mut to confirm the presence of the <b>Delta variant</b> (B.1.617.2).</p> <p>The FAM channel needs to be aligned with the Positive Control Omicron and the Cy5 channel must show a shift in the <math>C_T</math> values (compared to the FAM channel) to confirm the presence of the <b>Omicron variant</b> (B.1.1.529).</p> <p>Any other combination of results indicates the presence of another lineage.</p> <p>No mutations detected does not confirm the presence of the Wuhan variant.</p>		

## 10 ASSAY VALIDATION

### Negative Control

The Negative Control must show no peak in the melting curve in the FAM and the Cy5 channel.

### Positive control WT

The Positive Control WT must show a peak in the melting curve in the FAM and Cy5 channel.

### Positive control Mut

The Positive Control Mut must show a peak in the melting curve in the FAM and Cy5 channel. The peak in the FAM channel is approximately 6 degrees lower than the peak of the Positive Control WT. The peak in the Cy5 channel is approximately 5 degrees lower than the peak of the Positive Control WT.

## Positive control Omicron

The Positive Control Omicron must show a peak in the melting curve in the FAM channel. The peak is approximately 5.5 degrees lower than the peak of the Positive Control Mut. In the Cy5 channel may be a peak, which is aligned with the peak of the Positive Control WT. This peak is not obligate.

## 11 LIMITATIONS OF THE METHOD

- Strict compliance with the instructions for use is required for optimal results.
- Use of this product is limited to personnel specially instructed and trained in the techniques of Real-Time PCR and *in vitro* diagnostic procedures.
- Good laboratory practice is essential for proper performance of this assay.
- All reagents should be closely monitored for impurity and contamination. Any suspicious reagents should be discarded.
- This assay must not be used on a biological specimen directly. Appropriate nucleic acid extraction methods have to be conducted prior to using this assay.
- As with any diagnostic test, results of the MutaPLEX® CoV-2 MUT 3 Real-Time-RT-PCR Kit need to be interpreted in consideration of all clinical and laboratory findings.

## 12 TROUBLESHOOTING

The following troubleshooting guide is included to help you with possible problems that may arise when performing a Real-Time RT-PCR. If you have further questions, please do not hesitate to contact our scientists on [info@immundiagnostik.com](mailto:info@immundiagnostik.com).

### No melting curve peaks in the FAM and/or Cy5 channel of the Positive Controls

#### ***The selected channel for analysis does not comply with the protocol***

Select the detection channels according to table 6.

#### ***Incorrect preparation of the Master Mix***

Make sure the enzyme is added to the master mix (chapter 8).

#### ***Incorrect configuration of the Real-Time-RT-PCR***

Check your work steps and compare with chapter 8.

#### ***The programming of the thermal profile is incorrect***

Compare the thermal profile with the protocol 'Instrument Settings' in Table 5 and Table 6.

***Incorrect storage conditions for one or more kit components or kit expired***

Check the storage conditions and the date of expiry printed on the kit label. If necessary, use a new kit and make sure kit components are stored as described in chapter Transport, storage and stability.

**No melting curve peaks in the FAM and/or Cy5 channel in a sample**

***The sample does not contain enough RNA to guarantee a proper result***

Review the prequalification of the screening PCR. If the  $C_T$  value for SARS-CoV-2 detection is  $> 32$ , the eluate is not suitable. If the  $C_T$  value is  $< 32$  repeat the PCR with this sample.

**Detection of a melting curve peak in the FAM and/or Cy5 channel of the Negative Control**

Contamination during preparation of the Real-Time RT-PCR

Repeat the real time RT-PCR in replicates. If the result is negative in the repetition, the contamination occurred when the samples were pipetted into the optical PCR reaction tubes. Make sure to pipet the Positive Controls last and close the optical PCR reaction tube immediately after adding the sample. If the same result occurs, one or more of the kit components might be contaminated. Make sure that workspace and instruments are decontaminated regularly. Use a new kit and repeat the real time RT-PCR.

**The peaks of the melting curve do not align with the 'Data Analysis'**

***Atypical peaks appear at the beginning or ending of the melting curve***

Peaks close to the beginning or the ending of the melting curves should not be considered in the data analysis.

***The Positive Controls were not diluted for the PCR reaction***

Peaks of the Positive Controls are lowered by 2 degrees.







***Sensitivity, fluorescence intensity and melt peak may differ on individual real time PCR Cyclers***

The samples should be aligned with the two provided Positive Controls.

### 13 KIT PERFORMANCE

Detailed information based on the latest state of knowledge is available at Immundiagnostik AG. Please address your inquiry to [info@immundiagnostik.com](mailto:info@immundiagnostik.com).

### 14 ABBREVIATIONS AND SYMBOLS

RNA	Ribonucleic Acid		Contains sufficient for <n> test
RT-PCR	Reverse transcription-PCR		Upper limit of temperature
<b>REACTION MIX</b>	Reaction mix		Manufacturer
<b>ENZYME</b>	Enzyme		Use by YYYY-MM-DD
<b>CONTROL WT +</b>	Positive control WT	<b>LOT</b>	Batch code
<b>CONTROL MUT +</b>	Positive control Mut	<b>CONTENT</b>	Content
<b>CONTROL Omicron +</b>	Positive control Omicron		Consult instructions for use
<b>CONTROL -</b>	Negative control	<b>IVD</b>	<i>In vitro</i> diagnostic medical device
<b>REF</b>	Catalog number		European Conformity

### 15 LITERATURE

1. [www.who.int/health-topics/coronavirus](http://www.who.int/health-topics/coronavirus)
2. Rambaut et al. Preliminary genomic characterisation of an emergent SARS-CoV-2 lineage in the UK defined by a novel set of spike mutations. nCoV-2019 Genomic Epidemiology
3. Garry. Mutations arising in SARS-CoV-2 spike on sustained human-to-human transmission and human-to-animal passage. nCoV-2019 Genomic
4. Faria et al. Genomic characterisation of an emergent SARS-CoV-2 lineage in Manaus: preliminary findings. nCoV-2019 Genomic Epidemiology