Webinar on R&D at IIT Bombay for COVID-19 Mitigation

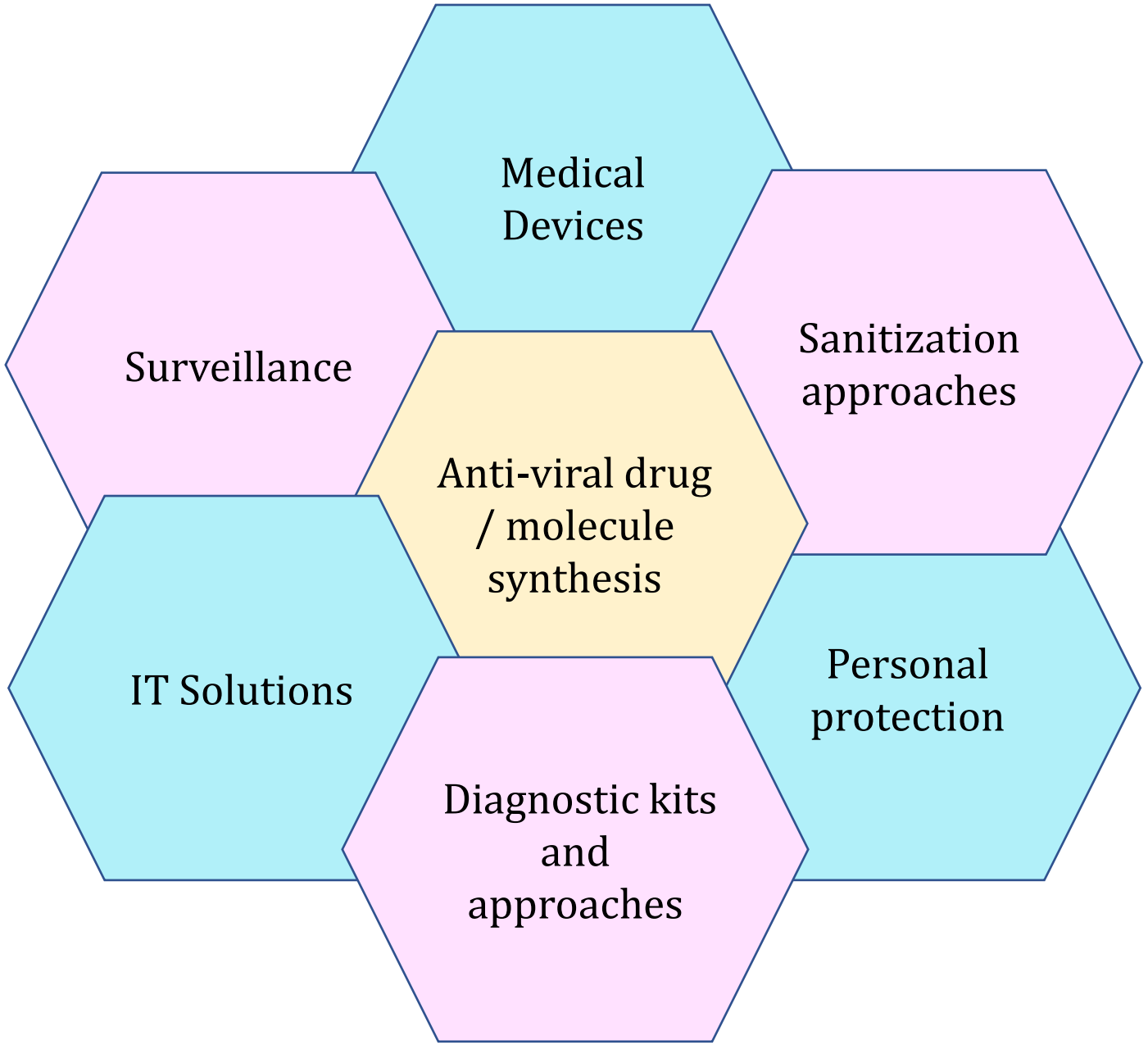
Saturday, 1st August 2020

Prof. Milind D. Atrey

Dean (Research & Development)

IIT Bombay

Technologies and expertise available at IIT Bombay for COVID-19



Technologies and expertise available at IIT Bombay for COVID-19

Medical Devices

- ICU ventilator for COVID patients
- CPAP helmet for mildly distressed patients
- Mechanized ambu-bag for COVID patients with moderate respiratory difficulties
- Advanced ventilator for severely critical COVID-19 patients

Sanitisation approaches

- UVC based sterilization units
- Phytoformulations for walk-through sanitizers, hand rub and surface sanitizers
- Incineration device for safe disposal of masks / gloves in hospitals and quarantine centres
- Surface spray for decontamination and antiviral action

Personal protection

- Wash resistant antibacterial & antiviral coatings for masks & textiles
- Biodegradable antiviral plastic like films for face shields
- PPE solutions: Face mask; face shield; washable ppe coverall suit; aerosol box for hospitals; urination attachment for coverall suit; low cost temperature controller for coverall suit

Technologies and expertise available at IIT Bombay for COVID-19

Anti-viral drug / molecule synthesis

- In-situ nasal gel formulations for pre-exposure prophylaxis of COVID-19
- Proteomics & metabolomics analysis of COVID-19 to identify biomarkers
- Anti-viral nutraceuticals and phytopharmaceuticals
- Aerosols for pneumonitis and ARDS complications of COVID-19

Diagnostic approaches

- Single-round smart pooling technique for COVID-19 testing

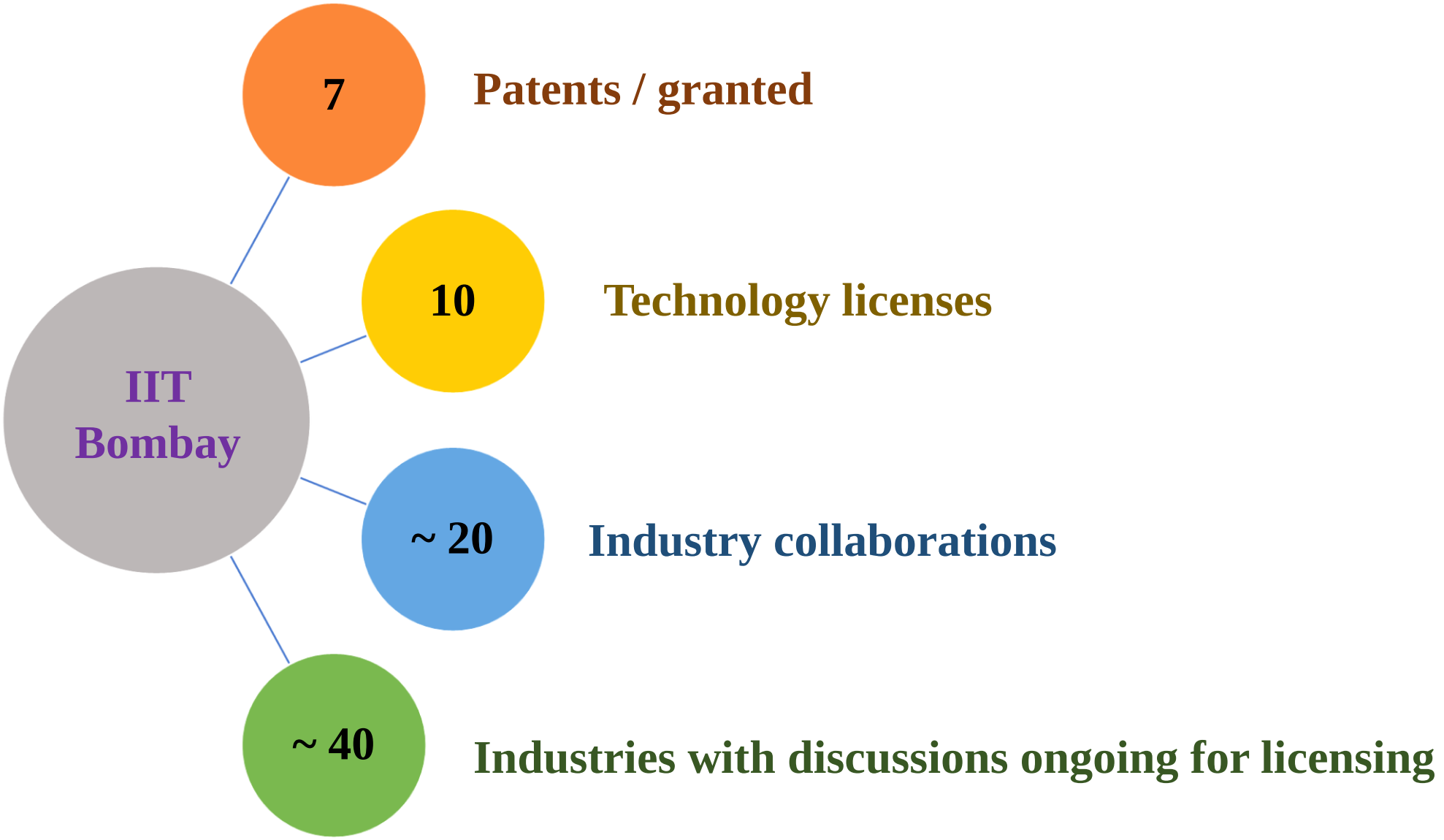
Surveillance

- Contact tracing app for asymptotic COVID carriers
- App for quarantine adherence privacy preserving contact tracing
- Contactless (video) surveillance at quarantine facilities

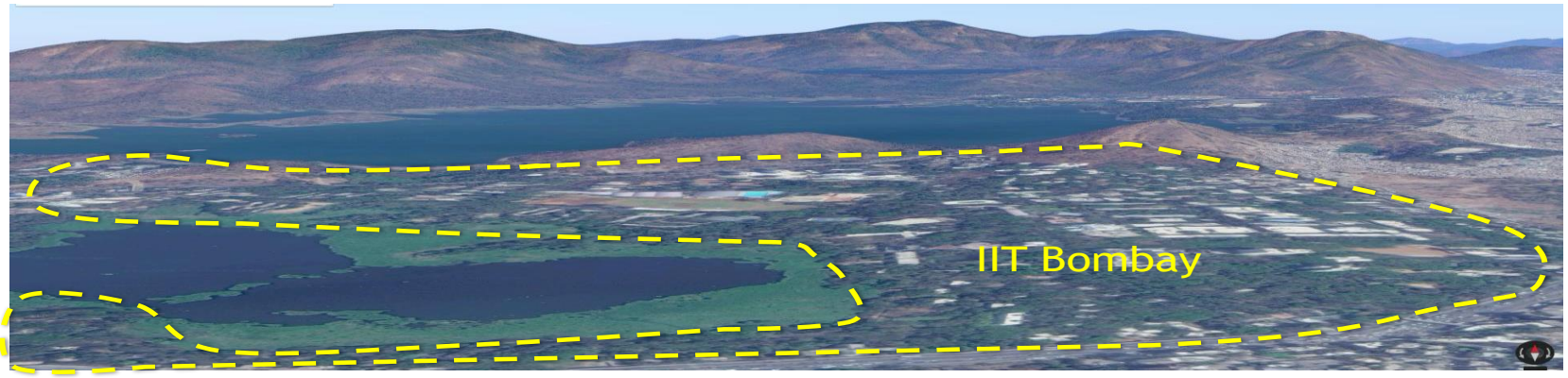
IT Solutions

- World Wide Help: Solution for user-friendly, cost effective and customized information access with humans-in-the-loop
- Platform for enabling MSMEs for e-commerce
- e-token and online ordering system
- Knowledge sharing platform for educational institutions

R&D at IIT Bombay for COVID-19 Mitigation



Development of Helmet-Patient Interface for Non-Invasive Ventilation



Prof. Ramesh Singh, IIT Bombay

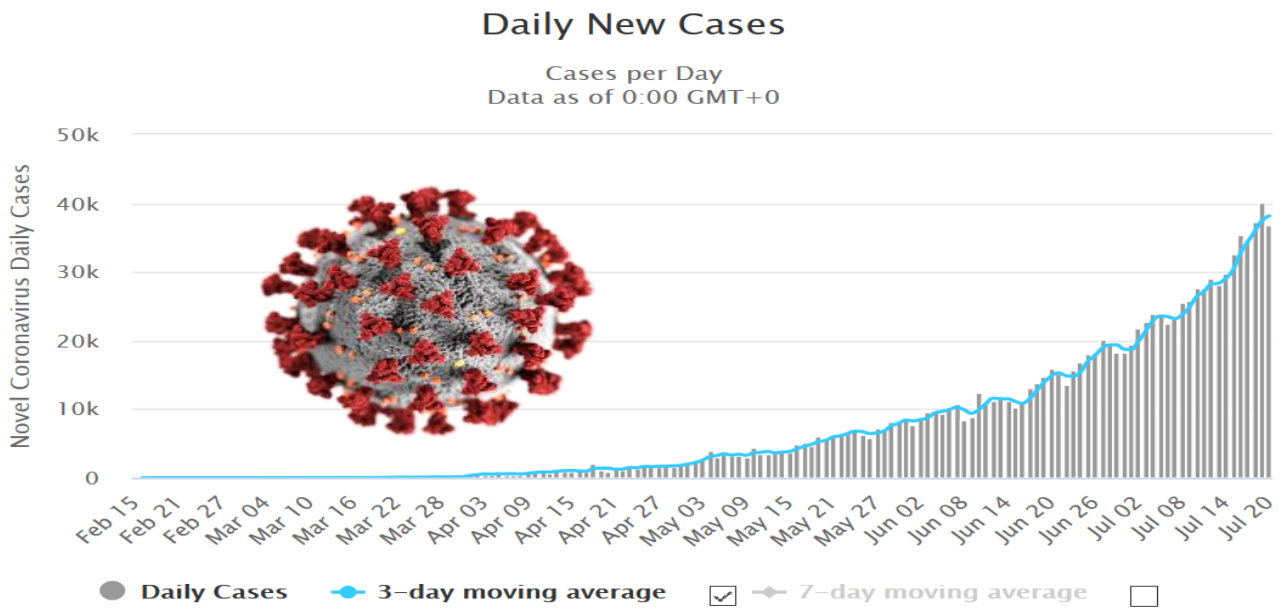
Prof. Soham Mujumdar, IIT Bombay

Dr. R. R. Sonde, Thermax Limited

Outline

- Need for non-Invasive ventilation (NIV) in COVID-19
- Product highlights and key features
- Engineering Innovations
- In-laboratory mechanical testing on mannequin
- Path to deployment with COVID-19 patients
- Summary

Need for Non-Invasive Ventilation in COVID-19 in India



- Unprecedented health crisis in India
- Graph still exponential with 12.4 lakhs cases and 29,861 deaths (8 am July 23)

- COVID-19 causes respiratory distress
- ~5% of the infected patients need oxygenation and ~2% need ventilator support
- High-flow Nasal Canula is conventionally used for oxygenation
- *A helmet patient interface (HPI) which delivers oxygen-rich air at a constant positive airway pressure (CPAP) is very effective way of oxygenation for COVID-19 Hypoxia patients*
- The effectiveness of this NIV helmet with COVID-19 patients has been reported from Europe

Strong Case for Helmet Patient Interface

Esquinas Rodriguez *et al. Critical Care* 2013, 17:223
http://ccforum.com/content/17/2/223

CRITICAL CARE

REVIEW

Clinical review: helmet and non-invasive mechanical ventilation in critically ill patients

Antonio M Esquinas Rodriguez[1*], Peter J Papadakos[2], Michele Carron[3], Roberto Cosentini[4] and Davide Chiumello[5]

- Clinical review of 152 studies establishes efficacy of helmet-based NIV
- NIV with helmet reduces CO_2 rebreathing and ventilator asynchrony
- Review concludes *"NIV delivered by helmet could be safe alternative to the face mask in*

Helmet used in Italy with CPAP

J Cardiothorac Vasc Anesth. 2020 May 8
doi: 10.1053/j.jvca.2020.04.060 [Epub ahead of print]
PMCID: PMC7205670
PMID: 32540245

Role of Helmet-Delivered Noninvasive Pressure Support Ventilation in COVID-19 Patients

Richard J. Ing, MBBCh, FCA (SA),*† Corey Bills, MD, MPH,†‡ Glenn Merritt, MD,§¶ Rosalia Ragusa, MD,‖ Ross M. Bremner, MD,# and Francesco Bellia, MD**

- Suggested key points
  - Long duration NIV
  - Skin lesions
  - Air leaks in masks/Mask intolerance
  - Avoid CPAP via Mechanical Ventilator
  - 50% higher PEEP with helmets as compared to masks

Helmet Patient Interface (HPI)
Non-invasive Ventilation (NIV) for Hypoxia

INDUSTRY-ACADEMIA COLLABORATION

IIT BOMBAY

THERMAX

InnAccel
innovation... accelerated

HPI SPECIFICATIONS

- Continuous Air/O_2 delivery
- Adjustable flowrate: 15 – 60 LPM
- FiO_2 between 21% (Air) to 100% (Pure O_2)
- Adjustable expiratory pressure : 5 – 20 cm H_2O
- *HPI works with CPAP device, wall oxygen-air supply, or any commercial ventilator*

Continuous Positive Air Pressure-Helmet Patient Interface (CPAP-HPI) is a *ready-to-use device*

Studies have found *non-invasive ventilation to be extremely effective* based on objective parameters of pulmonary mechanics, biochemistry and final treatment outcomes*

Key Features and Benefits

- **Benefits for the Patient**
  - Ventilation asynchrony is not present, minimizes claustrophobia, avoids pain and sense of suffocation
  - No nasal cannula or intubation, no headgear to tighten, no irritation → Comfort for a longer period
  - Spacious with a clear view all around
  - Patient can speak, listen, drink, wear glasses while being treated


Manometer

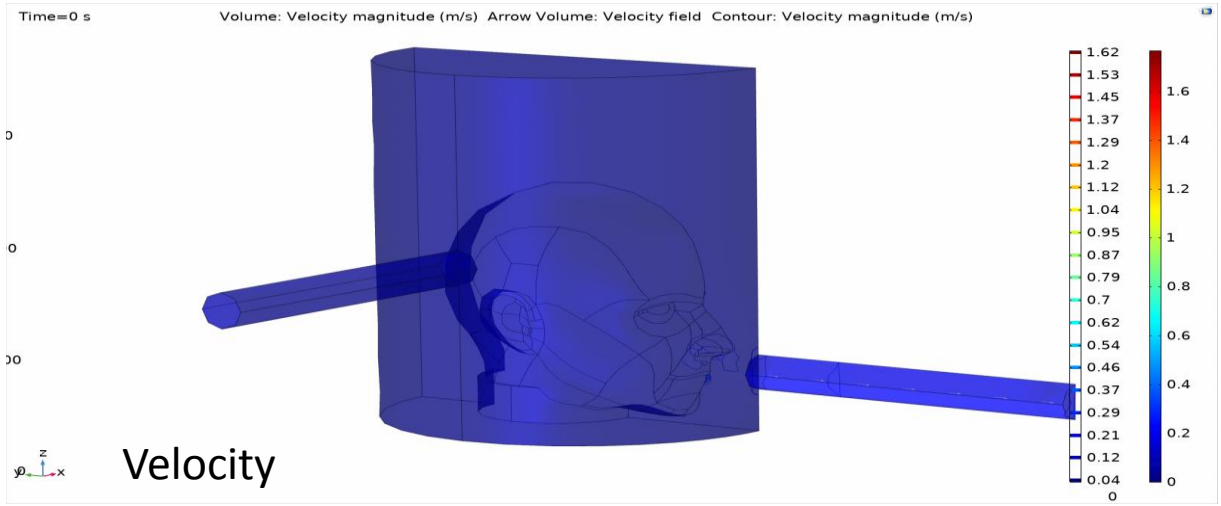

Catheter Port

- **Patient Management**
  - Due to completely sealed and "zero leakage", *protects associated health workers*
  - As patient is more comfortable, treatment is continued without breaks associated with intubati ures, nebulized drug therapy etc.
  - **LARGE ACCESS PORT:** For easy care - drink, facial cleaning, expectorate
  - **SEALED CATHETER PORT:** Provides access for drug delivery, sensors, liquid intakes
  - The upper portion is easily removable

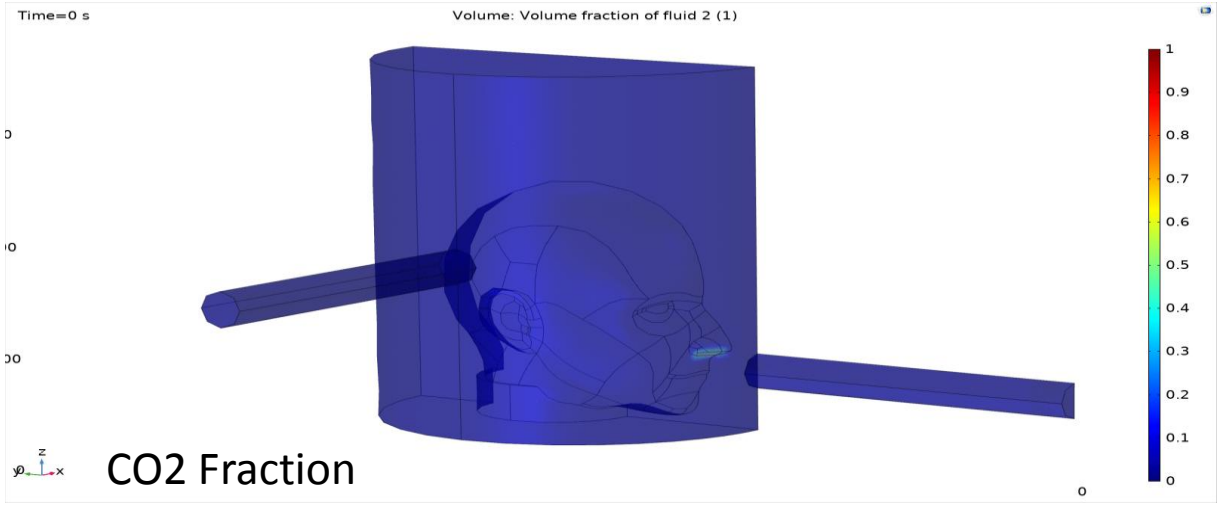

Anti Asphyxia Valve

- **Safety Features and Alarms**

Engineering Innovation



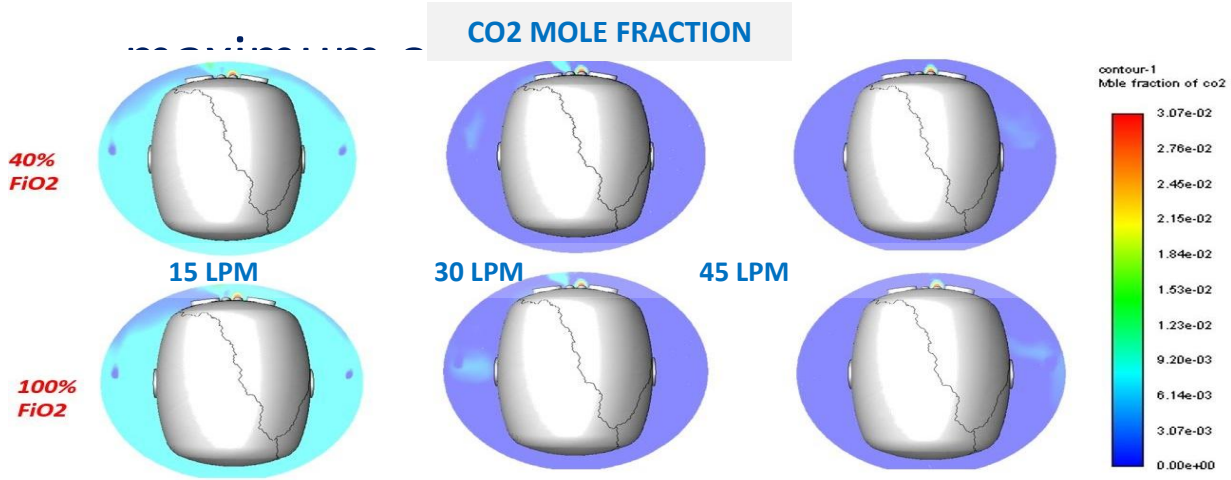
Velocity



CO2 Fraction

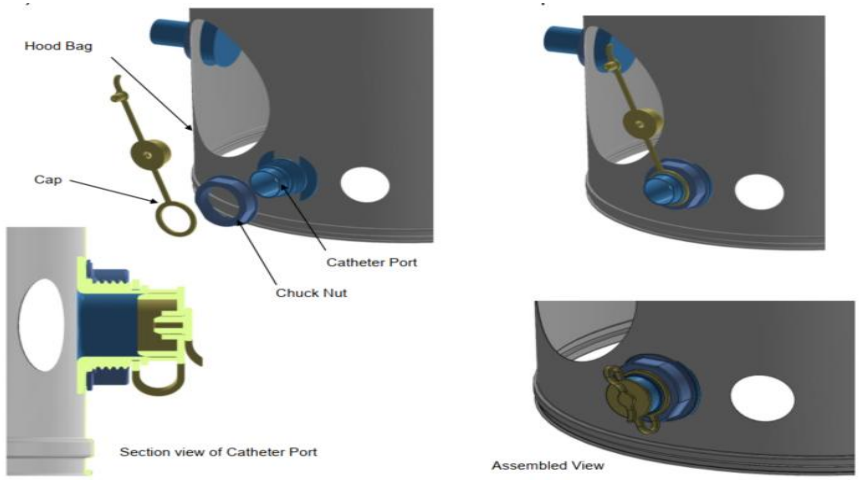
Computational Fluid Dynamics (CFD)

- CFD analysis provides a streamlined flow of air/oxygen under different flow rate conditions.
- Inlet/Outlet locations optimized for minimum CO2 rebreathing and

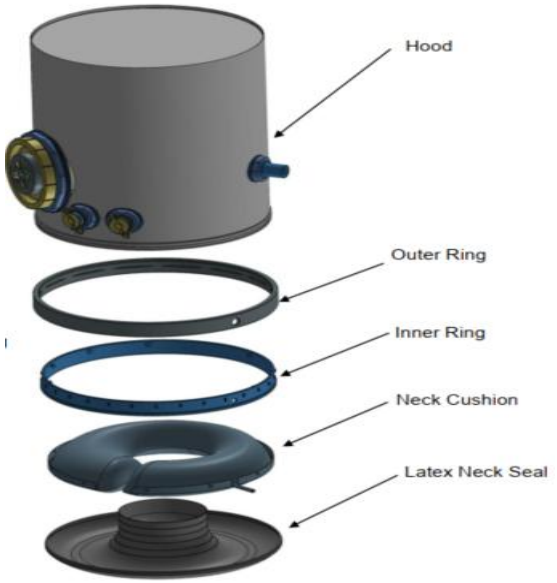


Engineering Innovation

Design Iterations for Improved Ergonomics and Patient Comfort

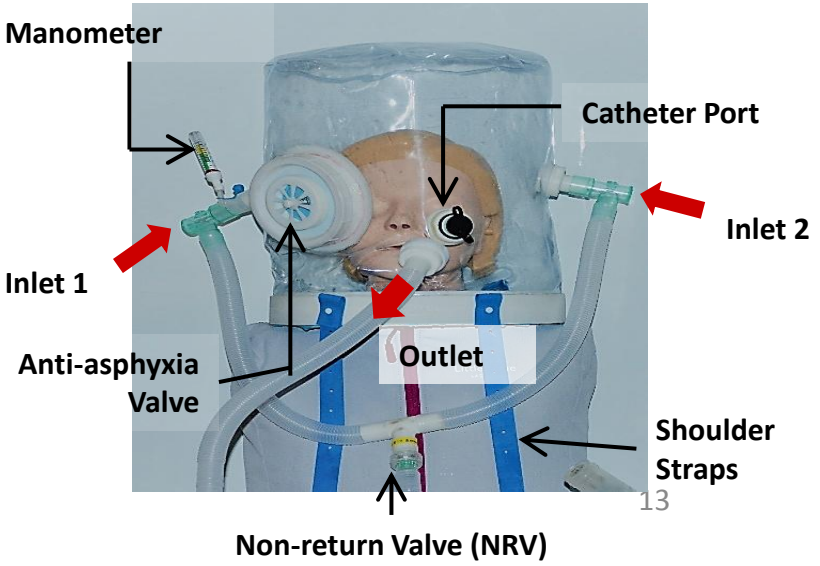


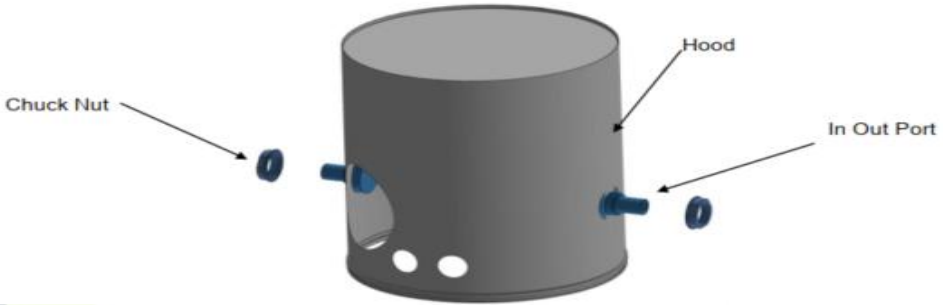
Large access ports and catheter ports for quick access



Neck ring with cushion and neck seal added to provide comfort and reduce leakage

Two inlets near ears and one outlet in front of the nose to improve flow



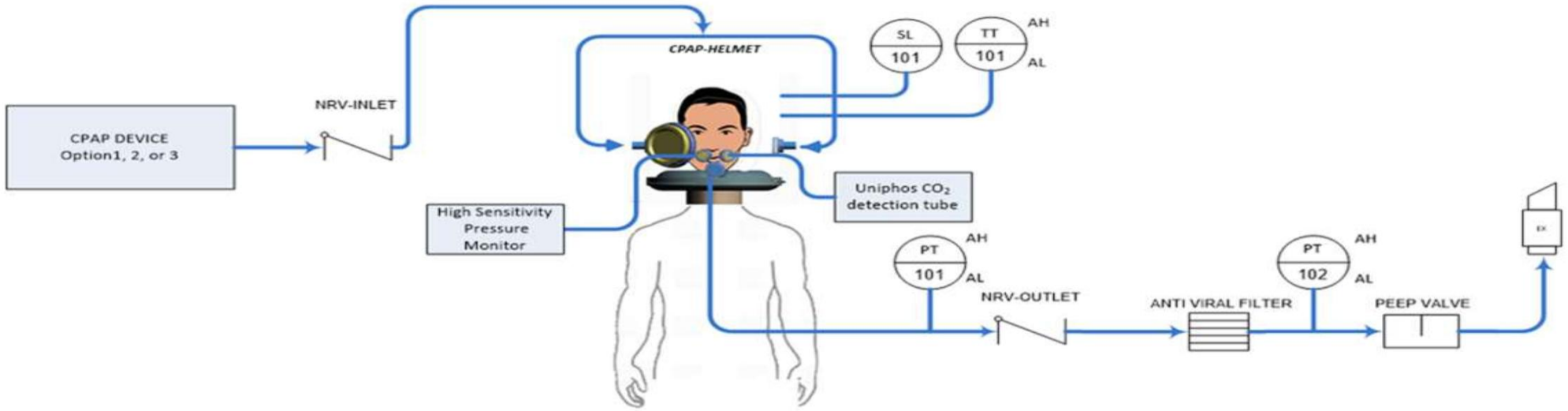


System Verification and Validation

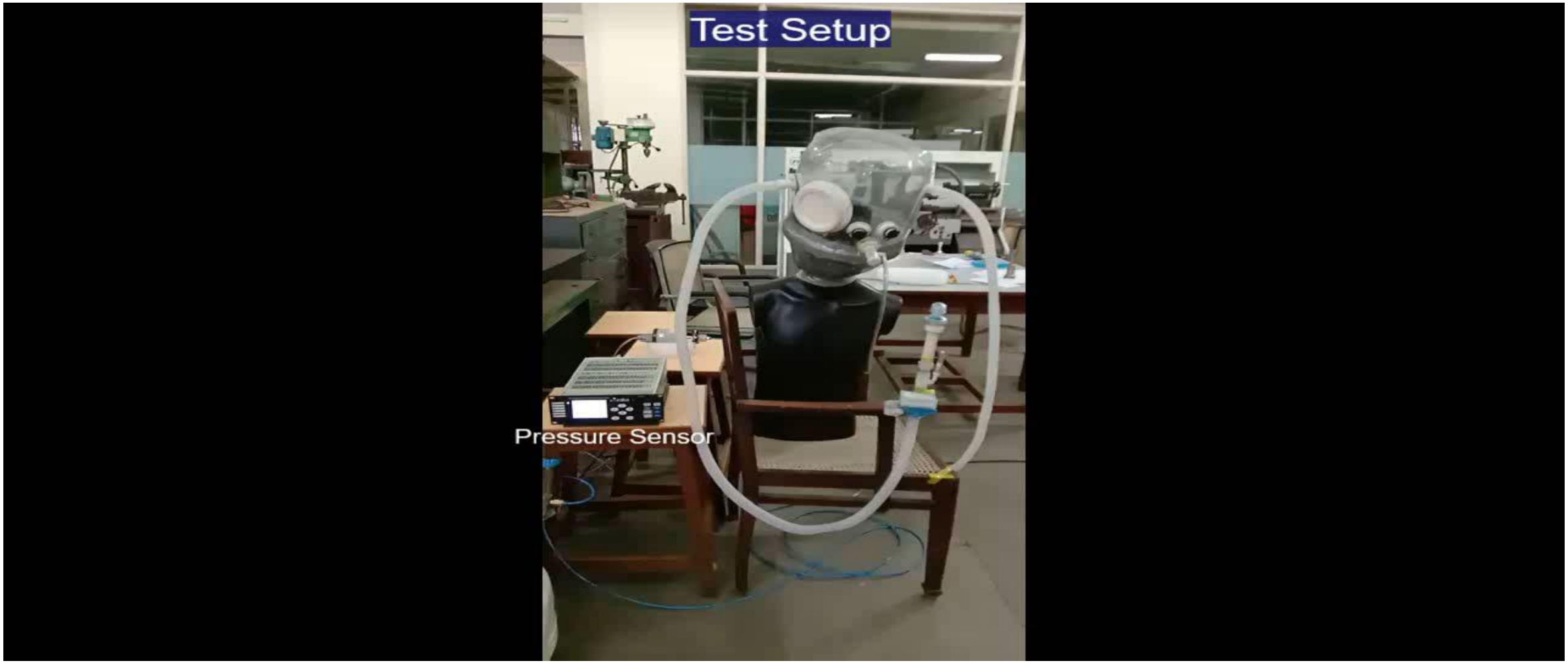
Test protocols designed to verify the functioning of the device

- Integrity, leakage and pressure hold test (up to 30 cm H2O pressure)
- Flow and pressure drop test (up to 40 LPM flow)
- PEEP pressure hold test (up to 40 LPM flow, 20 cm H2O pressure)
- High flow mode test (up to 60 LPM)
- Helmet fitment, fogging, and noise level test (on mannequin)
- Safe

Test Setup:



System Verification and Validation



Final Design

Path to Deployment: 2-Stage Clinical Studies

Stage I: Healthy Participants

- No history of respiratory disorder (preferred age < 35 years)
- In collaboration with IIT Bombay Hospital
- Following issues will studied
  - Noise harshness assessment
  - Discomfort due to retinal pressure
  - Assessment of helmet ergonomics
  - CO_2 concentration in the helmet

Stage II: COVID-19 Patients

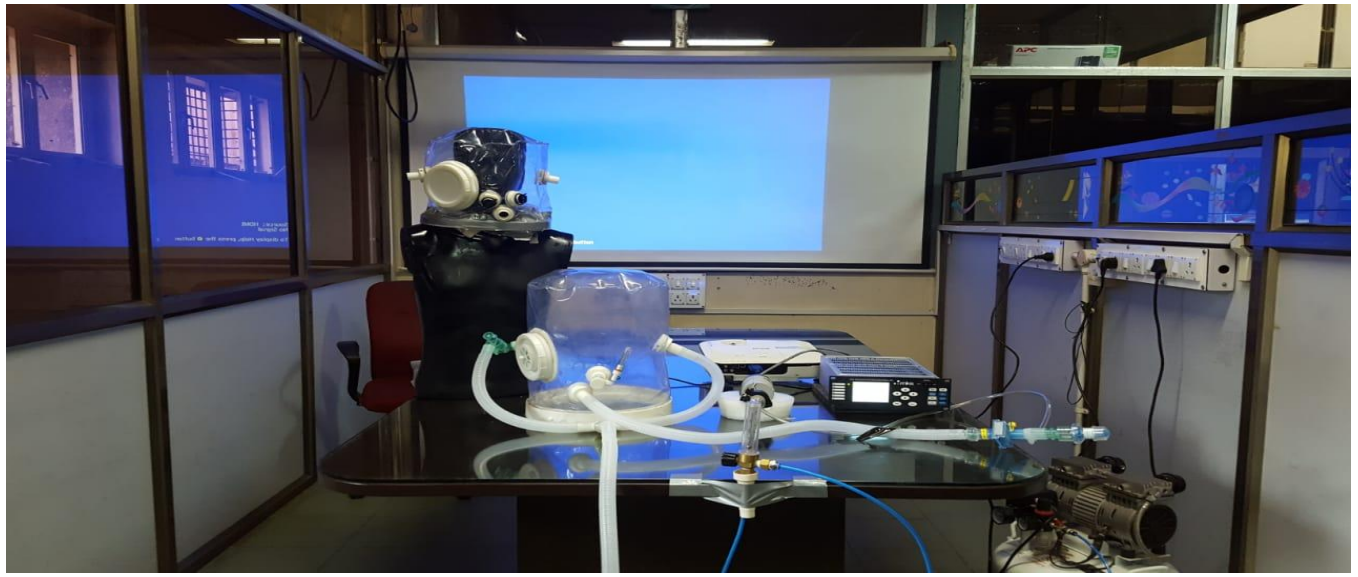
- COVID 19 induced Hypoxia (preferred age > 35 years)
- In collaboration with Tata Memorial Hospital
- Following issues will be studies
  - SpO_2 measurement
  - Arterial Blood Gas (ABG) /Blood chemistry
  - Noise harshness assessment
  - Discomfort due to retinal pressure
  - Assessment of helmet ergonomics

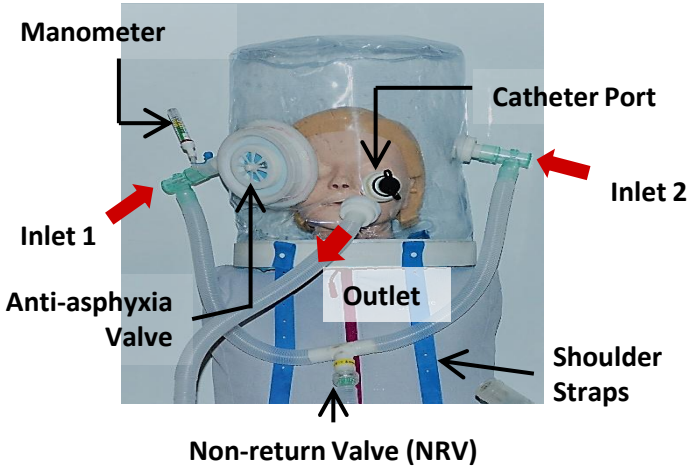
Path to Deployment: Status

- The Helmet Patient Interface has been engineered for optimal performance and has been manufactured to design specifications
- It has been tested comprehensively for mechanical integrity and flow performance in the lab
- IIT Ethics committee suggestions received for Stage I clinical studies at IIT Bombay Hospital
- Plan to conduct Stage I studies before August 15
- Stage II studies at Tata Memorial Hospital will be conducted after the data is analyzed from Stage I
- Partners on-board with capability to scale up. An excellent example of Industry-Academia Collaboration

Acknowledgements

- Machine Tools Lab Students & Staff
  - Chaitanya Vundru, Bhargavi Ankamreddy, Arun Nayar, Vasudevan Nayar and Vishwas Kevale
- Thermax (Funding and product development support)
  - Dr. R. R. Sonde, Mr. Ganpathy Iyer and Mr. Sameer Kulkrani
- IRCC & IIT colleagues (Funding and facilitation)
  - Prof. Milind Atrey, Prof. A. K. Suresh, Prof. Ankit Jain and IRCC staff
- IIT Hospital
  - Dr. Nisha Shah and hospital doctors
- InnAccel
  - Mr. Vijayarajan
- Dr. Satish Deopujari






Anti Asphyxia Valve

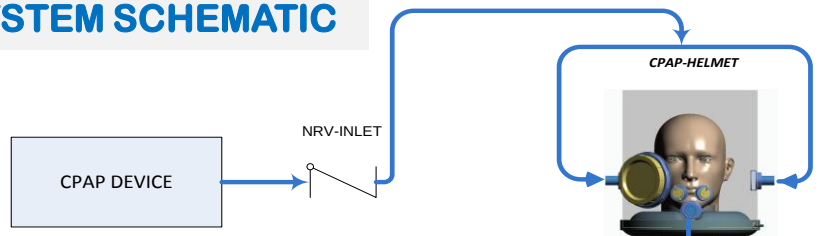

Manometer


Catheter Port

HPI SPECIFICATIONS

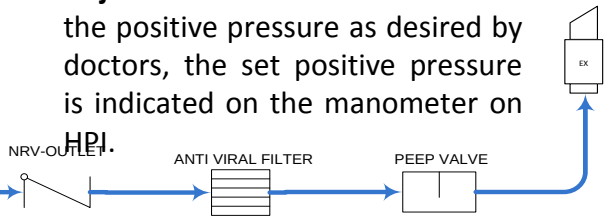
- Continuous Air/O_2 delivery
- Adjustable flow in range 15 – 60 LPM (meets patient's peak inspiratory requirements)
- FiO2 between 21% (Air) to 100% (Pure O_2)
- Expiratory pressure in range 5-20 cm H_2O

SYSTEM SCHEMATIC



CPAP device provides the continuous flow at positive pressure and is attached to the inlet NRV.

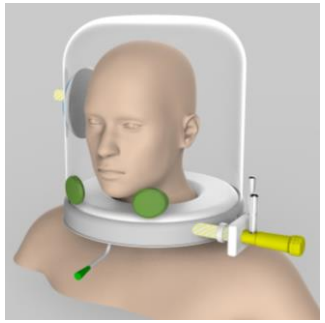
Adjustable PEEP valve maintains the positive pressure as desired by doctors, the set positive pressure is indicated on the manometer on HPI.



HEPA filter on the expiratory line to arrest pathogens from expiration

Fastest development from concept to testing Journey April-May

Partners: 2, Innaccel & Ceeo (C-CAMP)
Fabricators: 3, Caprihans, PPE, 3DPD
Design: 1, Elephant
Design & Testing : IIT B
Hospitals : 4



2 nd April

Signed MoU with InAccel for NIV Helmet Development & Deployment

Conceptual Design, Process Design, Medica Inputs, System Design, FMEA

7th April

10th April

Detailed Design, Intense Networking

- *With Doctors from NH (Bangalore), Jehangir (Pune), IITB*
- *Material Experts*
- *Prototype Manufacturers*

Component & System Developments and manufacturing

15th April

27th April

First Prototype demonstrated

Round Robin testing at IITB & Thermax 1st prototype

5th May

12th May

Testing Feedback for component refinement

Round Robin Testing at IITB & Thermax (with CPAP machine) on 2nd Prototype Tests 4.1 to 4.6

21st May

Experienced few failures and revising strategy in design almost on the fly

Antiviral coatings on textiles, prophylactic nutraceuticals and ARDS therapeutics for COVID 19

Prof. Rinti Banerjee FASc, FBAO
MaDHURI SINHA CHAIR PROFESSOR
IIT BOMBAY

PICOVRID_N: Immune booster, antiviral Prophylactics

- PICOVRID_N
  - Liquid formulation, 10ml once a day
  - Based on spices
  - FSSAI approved constituents according to Schedule VI
  - Within permitted food levels
  - Immune booster, Antiviral (antimicrobial), and anti-inflamm
  - High absorption, Stable formulations, taste masked
  - Single dose reduced IL6 levels in inflammatory respiratory c
  - Indian Patent filed
- Mechanism of action
  - Direct breakdown of viral envelope, inactivating virus in human cells in an hour
  - RNAse activity
  - Immune booster

PICOVRID

PICOVRID_P: Antiviral Ayurvedic Therapeutic

- PICOVRID_P
  - Liquid formulation, 10ml thrice a day
  - All constituents are Ayurvedic approved herbs, within approved limits
  - Two species oral toxicity shows safety even at 2000mg/kg body weight dose
  - Within safe GRAS approved levels
  - Antiviral and RNAse effects
  - Reduced bronchoalveolar IL6 levels in inflammatory respiratory conditions
  - High absorption, Stable formulations, taste masked
  - Indian Patent filed

- Mechanism of action
  - Direct breakdown of viral envelope, inactivating virus in human cells in an hour
  - RNAse activity
  - Immune booster, reduces pro-inflammatory cytokines IL6

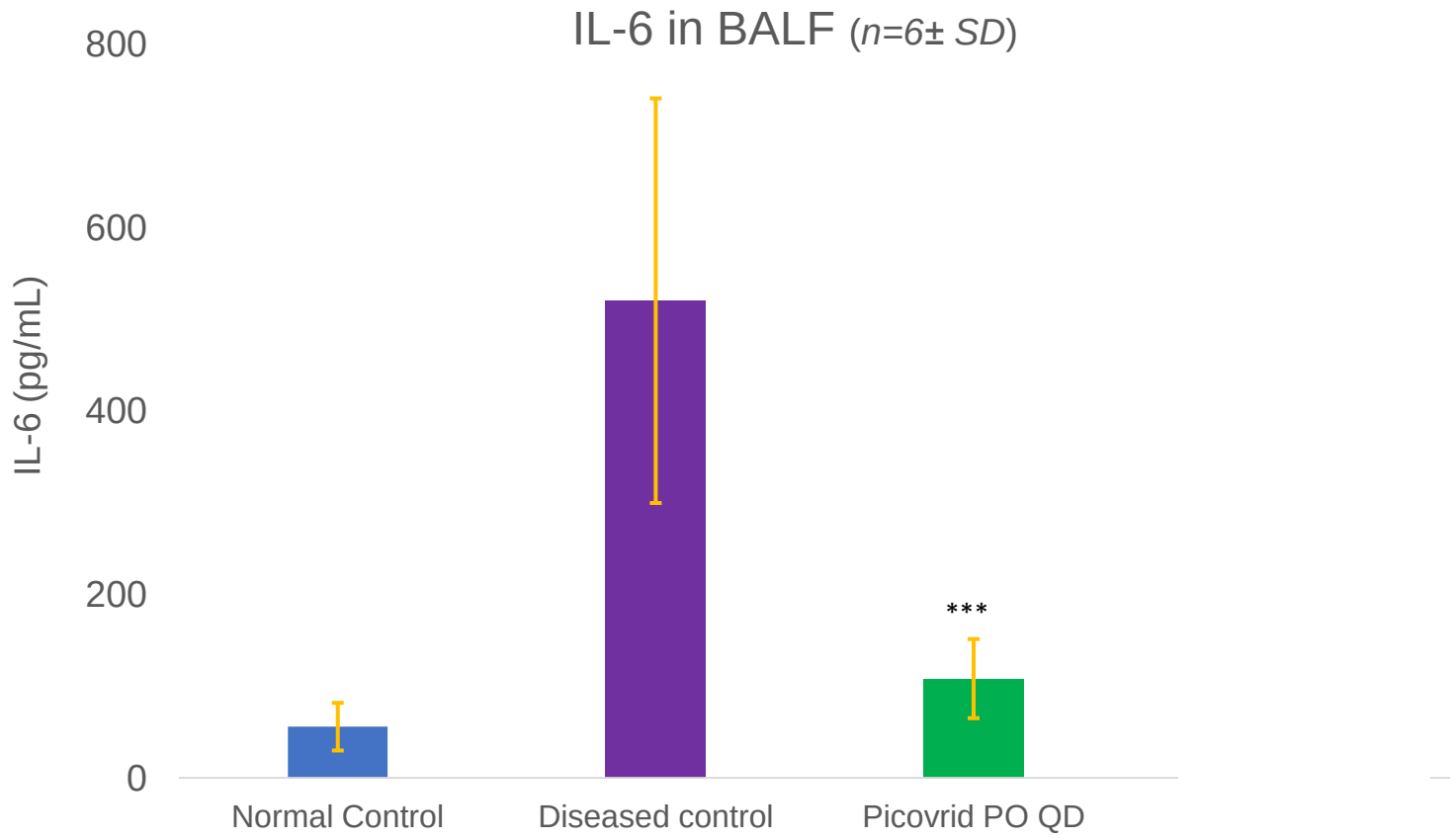
PICOVRID inactivates SARS-nCOV2 in vitro

- Validated against coronavirus samples in Kasturba Hospital
- Inactivates SARS-COV2 samples in vitro on incubation with PICOVRID for one hour
- No effects seen with dummy control

Swab Sample1 Cycle threshold on RT PCR	**Swab Sample 1 after incubation with formulation for 1 hour, RTPCR**
N Gene: 18 POSITIVE	N Gene: NEGATIVE
O Gene: 17 POSITIVE	O Gene: NEGATIVE
S Gene: 17POSITIVE	S Gene: NEGATIVE
Swab Sample 2 Cycle threshold on RT PCR	**Swab sample 2 after incubation with formulation for 1 hour, RT PCR**
N Gene: 22 POSITIVE	N Gene: NEGATIVE
O Gene: 22 POSITIVE	O Gene: NEGATIVE
S Gene: 22 POSITIVE	S Gene: NEGATIVE
Swab Sample 3 Cycle threshold on RT PCR	**Swab Sample 3 after incubation with formulation for 1 hour, RT PCR**
N Gene: 21 POSITIVE	N Gene: NEGATIVE
O Gene: 20 POSITIVE	O Gene: NEGATIVE
S Gene: 19 POSITIVE	S Gene: NEGATIVE
MS2 : PASS	MS2 : FAIL

PICOVRID reduces cytokine levels (Tested in acute lung injury models)

- Normal Control,
- Disease Control (Intratracheal Lipopolysaccharide 5 mg/kg),
- Picovrid (10ml human dose equivalent, Single dose)
- Bronchoalveolar lavage fluid IL6 levels evaluated



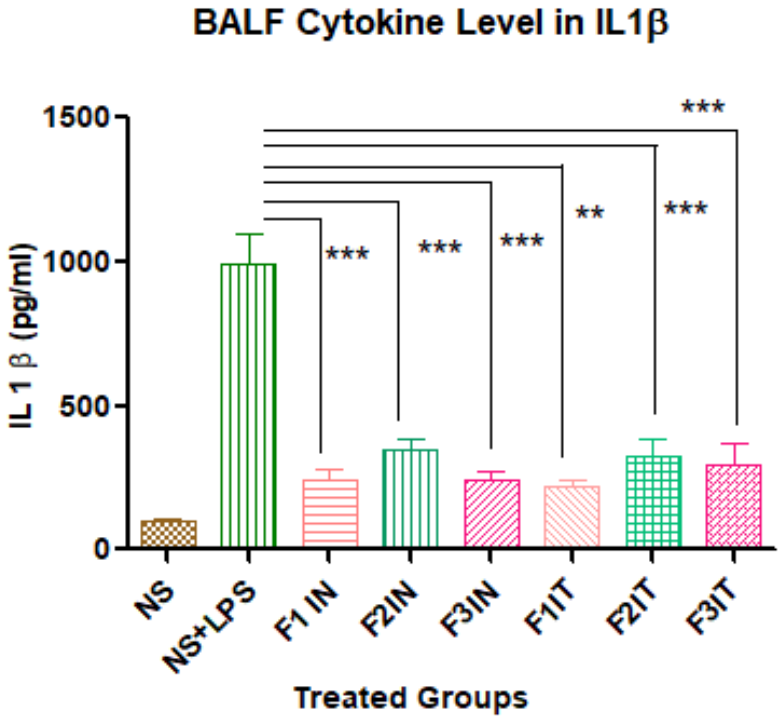
GMP Manufactured, Ready for Licensing

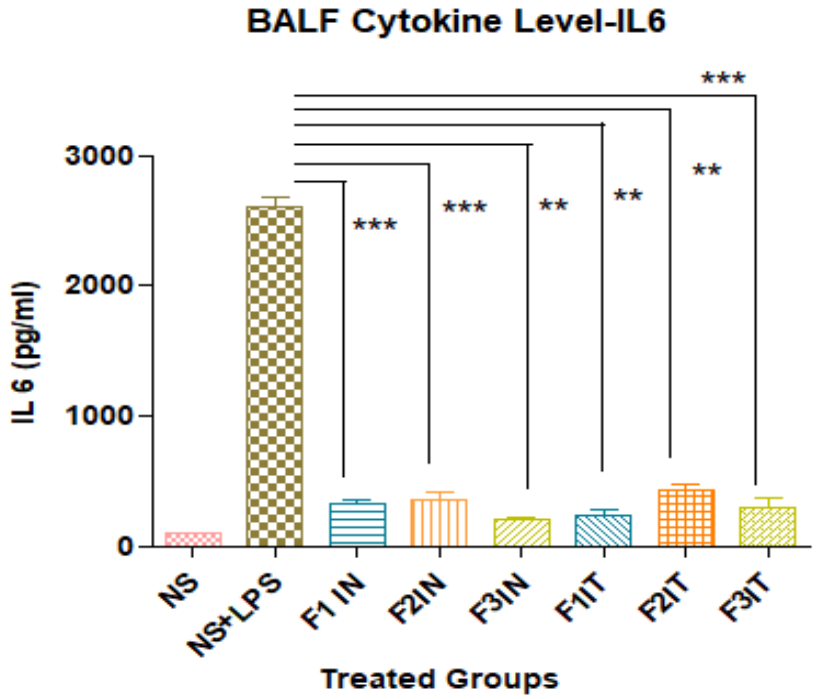
- GLP oral toxicity in rats and mice
  - No toxicity at 2000mg/kg
- Syrup, Liquid shot, Gel, Capsules, Herbal tea, herbal water, flavored beverage
- Batch to batch quality control established
- GMP scale up manufacturing done
- Accelerated stability established
- Clinical trials for nutraceutical planned in COVID 19 patients
  - EC approval from Government Medical College Nagpur, CTRI registration done
- Available for licensing as a nutraceutical and as an ayurvedic medicine

Nanosurf: Aerosols for Pneumonitis and ARDS Complications of COVID 19

- Address mortality associated with ARDS complications of COVID 19
- Unmet medical need, No known treatment
- Developed aerosol formulations that address the cytokine
- Mechanism of action
  - Acts on alveolo-capillary membrane, Reduces cytokine storm
  - Pulmonary surfactant mimetic
- US and Indian Patents Granted
  - Formulations optimized and extensively validated at laboratory
  - Validated against LPS induced ARDS models in rats
  - Significantly reduces cytokine storm, bronchoalveolar IL6 levels, protein levels, bronchoalveolar oxidant levels
  - All ingredients GRAS approved
  - GLP Acute inhalation toxicity done, Safe in accordance with OEC

Preclinical efficacy: Nanosurf reduces Bronchoalveolar lavage fluid cytokine levels





Reduction in inflammatory levels in lungs with aerosol formulation

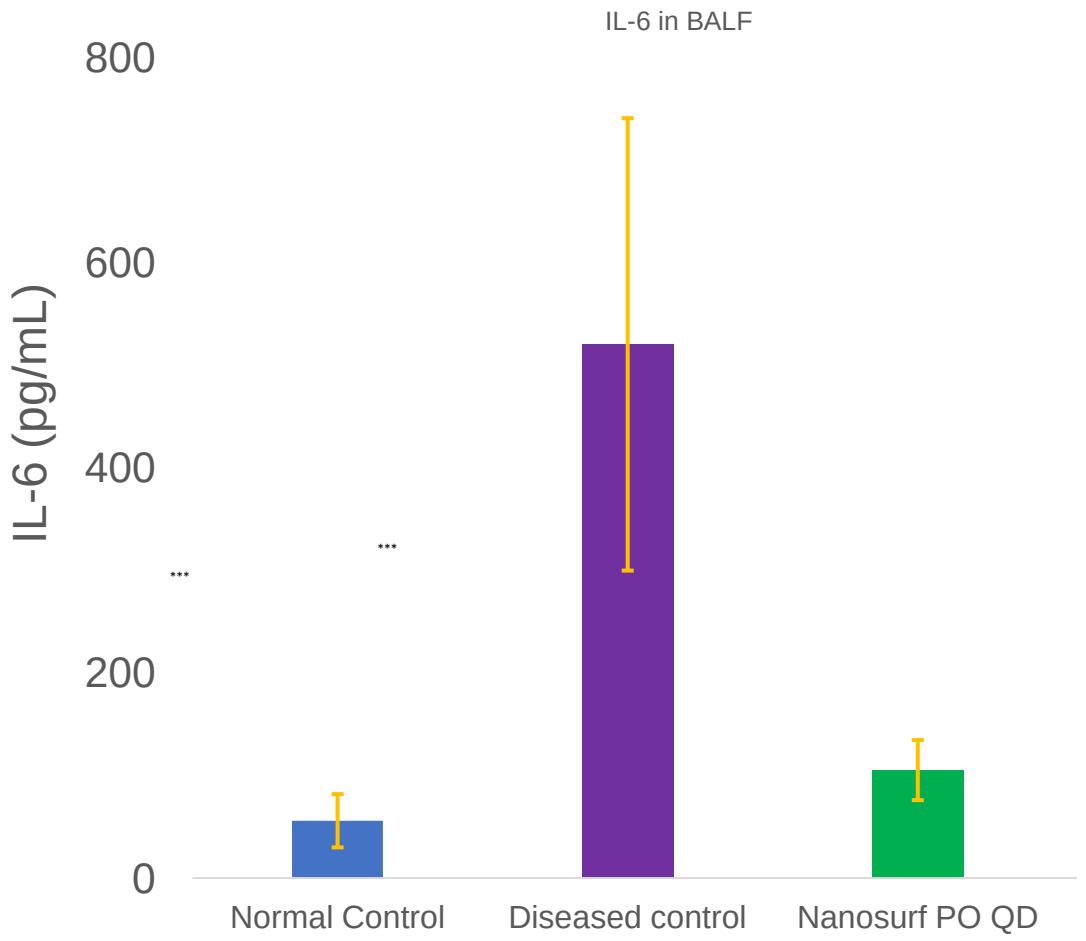
- ** , *** represent significant difference at $p < 0.01$ and $p < 0.001$ respectively by Newman–Keuls analysis following ANOVA at 95% confidence limit

GRAS Approved, Oral Anti-inflammatory

- Anti-inflammatory, antioxidant, pulmonary surfactant mimetic
- For emergency use in ARDS, severe COVID with pneumonitis
- Constituents are GRAS approved
- Liposomes formed by high speed homogenisation
- Liquid and lyophilised forms
- As aerosol, local effects on lungs
- As oral, all constituents GRAS approved

Reduces pulmonary cytokines

- Single dose oral
- Thrice a day oral
- Tested in LPS injured rats
- Significant reduction in bronchoalveolar IL6 levels seen



Nanosurf has high safety margins

- GLP Acute Inhalation toxicity Rats (safe for category 5 2000-5000mg/kg)
- GLP Acute Inhalation toxicity Mice (safe for category 5 2000-5000mg/kg)
- GLP Acute Oral Toxicity Rats (safe at 2000mg/kg)
- GLP Acute Oral Toxicity Mice (safe at 2000mg/kg)
- GLP I/V Toxicity Rabbits (safe at highest dose tested 300mg/kg, 20 times human equivalent dose)
- Available for licensing
  - Licensing and clinical trial as IND with DCGI approvals
  - Potential novel life saving formulation for ARDS complications of COVID
  - Potential to reduce mortality

ECORSANI: Alcohol free herbal sanitisers

- Develop safe alternatives for walk through sanitisers, handrub sanitisers, surface disinfectants
- ECORSANI completely inactivates coronavirus samples in an hour
- Alcohol free, Non-toxic
- ECORSANI_A
  - Indian Patent filed
  - All formulations food grade, GRAS approve
  - Environmentally friendly, safe, biodegradab
  - Aerosol sprays in tunnel
  - Residence time on clothing

ECORSANI-H

ECORSANI Kills Germs in 20 seconds

Method: ASTM E2315 - Assessment of Antimicrobial Activity Using a Time-Kill Procedure

Results: -

Time (Sec.) / Culture	Initial Count (CFU/mL)	20 Sec. (CFU/mL)	40 Sec. (CFU/mL)	60 Sec. (CFU/mL)	120 Sec. (CFU/mL)	10 min. (CFU/mL)
Escherichia coli **ATCC 8739**	1.3×10^5	<10	<10	<10	<10	<10
% Reduction	NA	>99.99	>99.99	>99.99	>99.99	>99.99
Staphylococcus aureus **ATCC 6538**	1.8×10^5	<10	<10	<10	<10	<10
% Reduction	NA	>99.99	>99.99	>99.99	>99.99	>99.99
Candida albicans **ATCC 10231**	2.0×10^5	<10	<10	<10	<10	<10
% Reduction	NA	>99.99	>99.99	>99.99	>99.99	>99.99
Aspergillus brasiliensis **ATCC 16404**	1.9×10^5	<10	<10	<10	<10	<10
% Reduction	NA	>99.99	>99.99	>99.99	>99.99	>99.99

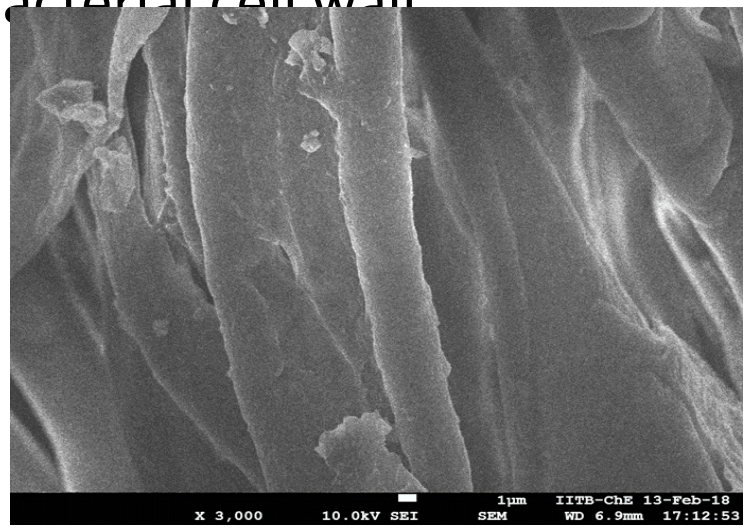
- **ASTM E2315 – Time kill**
- >99.99% bacterial and fungi reduced within 20 seconds
- Active against Gram Positive as well as Gram Negative bacteria
- Active against Yeast & Mold fungal strains

ECORSANI as hand rub, surface disinfectant, aerosol for tunnel

- ECORSANI_H
  - Effective as a sanitizer
  - Hand rub version, moisturising, safe to skin
- ECORSANI_S
  - As a surface disinfectant
  - Various surfaces
- ECORSANI_A
  - Aerosols
  - For tunnel
- Licensed
  - Life Essentials
  - Licensing ongoing with several interested industry partners
- Additional platforms ongoing
  - Mouthwash, mouthspray
  - Vegetable and fruit sanitiser

DURAPROT: Wash Resistant Antiviral & Antibacterial Coatings on Textiles

- Developed wash resistant antiviral & antibacterial coatings for textiles
- Mechanism of action
  - Easily Crosslinked to textile, Acts on viral envelope & bacterial cell wall
- DURAPROT Technology
  - Two Indian Patents filed
  - **Validated by AATC regulatory standards**
  - **Inactivates coronavirus samples in one hour**
  - Effective after 20 wash cycles
- DURAPROT Plus technology
  - Antiviral plus splash resistance and N95 functionality



Simple Process, Successfully Scaled Up

- Simple heating, stirring, drying process
- Successfully scaled up for industries

Duraprot Inactivates SARS-nCOV2 and other viruses

- Tested against SARS-nCOV2
- Duraprot directly causes complete inactivation of coronavirus samples in one hour at room temperature
- Tested against COVID positive swabs in Kasturba Hospital
- Viral load in RTPCR positive samples get completed degraded with no detectable viral RNA even after 40 cycles of amplification, converts to negative
- Dummy control remains positive with same period, volume and temperature of incubation
- Also tested against AATC-100 MS2 antiviral textile standard > 99.9% inactivation of viruses

Duraprot is Wash resistant

- Coating presence validated by FTIR and by bioassay
- Wash resistant to 20 wash cycles
- Crosslinked into fibre
- BITRA validation of coated textile
  - Effective after 20 wash cycles
  - Coating remains crosslinked without washing
- In accordance with AATC standard >99% killing of viruses seen with coated textile
- In accordance with AATC standard >99% killing of viruses seen with coated textile after 20 wash cycles
- In accordance with AATC standard >99% killing of bacteria seen with coated textile
- In accordance with AATC standard >99% killing of bacteria seen with coated textile after 20 wash cycles

Third Party Validation according to international standards

Duraprot coated masks meet standards of

- Antiviral effects
- Antibacterial effects
- Breathability

Advanced version Duraprot Plus developed

- Additional barrier as single or dual layer
- Meets Splash resistance
- Meets Particle filtration
- Meets Viral Penetration

	Test	WHO criteria	Mask coated with Duraprot	Mask coated with Duraprot Plus
1.	Breathability (EN 14683)	<40 pa/cm^2	**<17 pa/cm^2**	**<17 pa/cm^2**
2.	Flammability (16CFR part1610)	Class I	**Class I**	**Class I**
3.	Particulate filtration (ASTM F2299)	≥95%	**≥98%**	**≥98%**
4.	Bacterial Filtration efficiency (ASTM F2101)	≥95%	**≥99.99%**	**≥99.99%**
5.	Viral penetration (ASTM F1671)	<1 PFU/ml		**<1 PFU/ml**
6.	Fluid/splash resistance (ASTM F1862)	80 – 160 mmHg		**140 mmHg**
7.	Anti-bacterial textile (AATCC - 100)	-	**≥99.99%**	**≥99.99%**
8.	Viral Inactivation Anti-viral textile (AATCC – 100 MS2)	-	**≥99.99%**	**≥99.99%**
9.	Corona Virus Inactivation Anti – SARS-CoV-2 (RT-PCR)	-	**≥99.99%**	**≥99.99%**

Duraprot: Licensed and Commercialised

Commercialised by Meemansa, Ants Innovation
Also licensed to Ecostyle crafts

Additional licensing ongoing, Social Initiative: SHGs

- Licensing ongoing to several industries
  - Textile manufacturers
  - Textile chemicals and dyeing industries
  - Sports goods, Consumer goods
  - Reuseable PPEs

  - Social initiatives
  - Simplified process to train SHGs
  - State Rural Livelihood Mission
  - NGOs
  - Not for profit Foundations Khadi masks

Thank You
rinti@iitb.ac.in

Lokacart

Being Vocal About Local

https://lokacart.com/
http://www.cse.iitb.ac.in/~lokacart

Development Initiatives:
Prof. Ganesh Ramakrishnan: Dept of CSE, IIT Bombay
Ashvin Gami, IITB Alumnus, MD, ITAakash Strategic Software Pvt Ltd, (Technology License Transfer from IITB)

Acknowledgements:
Prof. Narendra Shah, Vikram Bansal, Pankaj Singh, Anamika Soni, Anand Rajguru, Nikesh Ingle, Anuja Dumada, Pranita Harpale

StrategicERP®
ITAakash Strategic Software (P) Ltd.

Assessment of small farming system towards sustenance

A thesis submitted in partial fulfillment of
the requirements for the degree of
Doctor of Philosophy
by

by Anand J Rajguru
Roll No. 09435002

Under the guidance of
Guide
Prof N. G. Shah
Co-Guide
Prof Ganesh Ramakrishnan

Centre for Technology Alternatives for Rural Areas (CTARA
INDIAN INSTITUTE OF TECHNOLOGY BOMB
2019

Understanding Supply Chain of Agricultural Produce of the Collectives of Marginal and Small Farmers and Exploring Possible Roles of ICT

Submitted in partial fulfilment of requirements of the degree of
Master of Technology in *Technology and Development*

By

Anamika Soni (Roll no. 153350023)

Under the guidance of

Prof. N. G. Shah
&
Prof. Ganesh Ramakrishnan

Study of Business Performance and Sustainability of Producer Companies

Submitted in partial fulfilment for the Degree
M. Tech in Technology & Development

by

Divyanshu Jaiswal
(Roll No. 163350025)

Under the guidance of

ABHINAV FARMER'S CLUB
ORGANIC FARM PRODUCE

Abhinav Farmer's Club- A success story using Lokacart

insightiitb.org/lokavidya-institutes-innovations/

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ight News All About Insti Life After Insti Print Edition II

MOTIVATION AND PROBLEM SOLVING

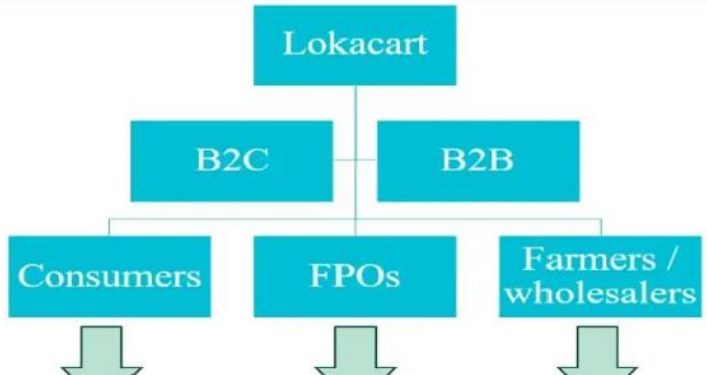
Lokavidya- the name says it all, 'Lok' means people and 'Vidya' is knowledge. The main vision is to use ICT to empower people in achieving value-based holistic development in a sustainable way, while also preserving traditional practices and knowledge.

THE INTERFACE

insightiitb.org/lokacart-app-institutes-innovations/

Extensions Yatra Online Passw... RA / MTP rive - Google Search https://www.cse.iitb... Inbox (5,16

News All About Insti Life After Insti Print Edition II

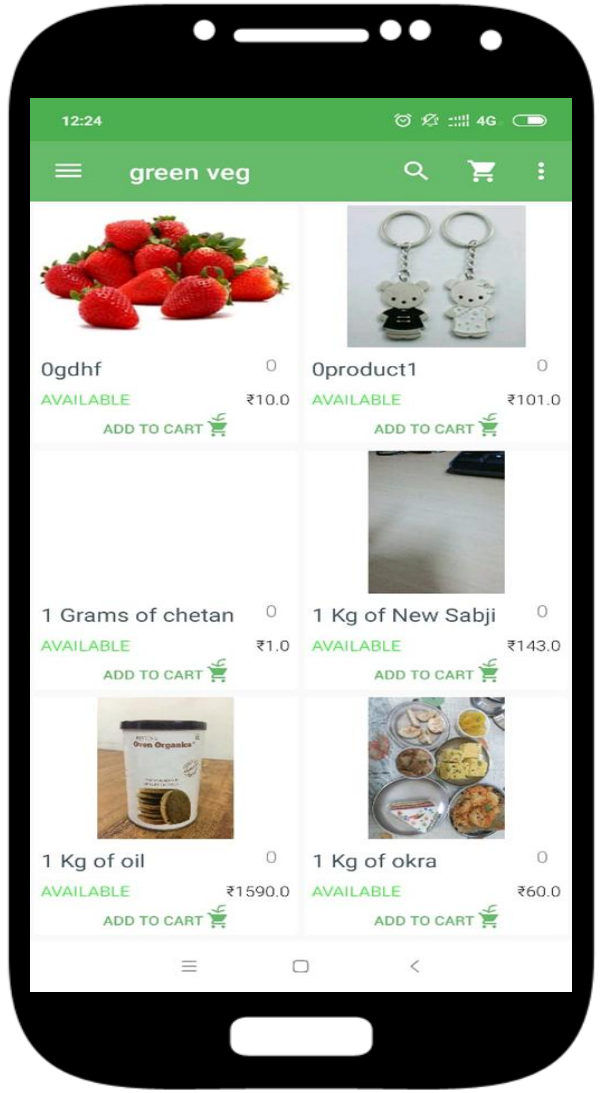


Lokacart

Being Vocal About Local

B2C Customer App

-Mobile App and Web App
-Connect with your sellers with Reference Code
-No Sign up / Login
-Enable to place new order in just 3 steps - Choose product, enter quantity and process History
-Delete/Cancel order
-Automated Bill Generation
-Multiple Organizations



GET IT ON Google Play

Lokacart

Being Vocal About Local

B2C Admin App

-Mobile App and Web App

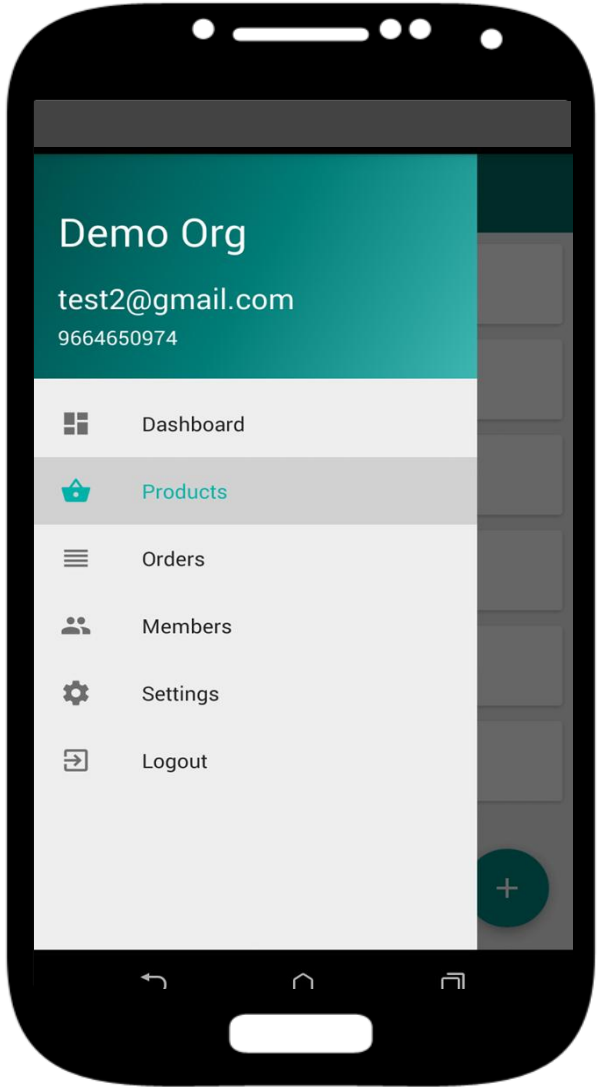
-Admin Manual (PDF): 04_LokaCart

-Manage Products and Stocks

-View placed, processed and cancelled orders

-Generate Bills for Orders

-Manage Members

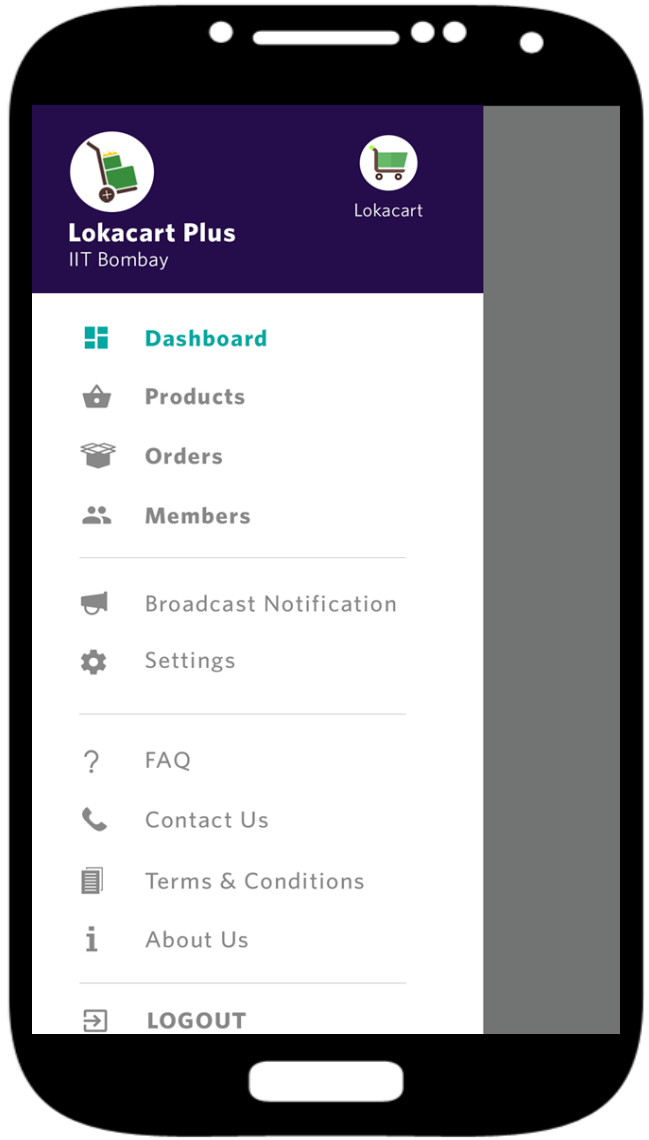


Lokacart

Being Vocal About Local

B2B App

-Upgraded version of lokacart
-Bulk orders can be placed
-No bound between customers and organization
- Open loop structure
-Downloadable from Playstore
-Available as Mobile App and Web App
-Can Order bulk items



LOKACART ADMIN APP

- SECURE LOGIN/DASHBOARD ✓
- VIEW SELLER OPTIONS
- CREATE PRODUCT TYPE & PRODUCTS
- ADD MEMBERS
- BROADCAST MESSAGE

Lokacart

Being Vocal About Local

So far: 194 sellers on Lokacart
Several Case Studies.
-Chhadva General Store

-Abhinav Farmers Club

ABHINAV FARMER'S CLUB
ORGANIC FARM PRODUCE

Lokacart

Being Vocal About Local

Few upcoming features in Lokacart Buyer and Admin Apps:

- Use of OCR technology to process the order and payment from the image
-Access and creation of Group / Society Details in Admin App
-Local language translation for all three applications
-Logistic support to the sellors by integration with courier apps.
-Option to add the Favourites products in cart in one click based on AI and history of user purchase.
-Predicting Future Orders inside Lokacart Admin app to show demand from various groups for tomorrow, or upto next 7 days using AI and history.
-Intimating sellers on dimisinging stocks for the product available in seller list items.

Lokacart

Being Vocal About Local

THANK YOU

StrategicERP®
ITAakash Strategic Software (P) Ltd.

Corontine: A Platform for Tracking, Alerting and Tracing of Contacts

Manjesh K. Hanawal, IEOR, IIT Bombay

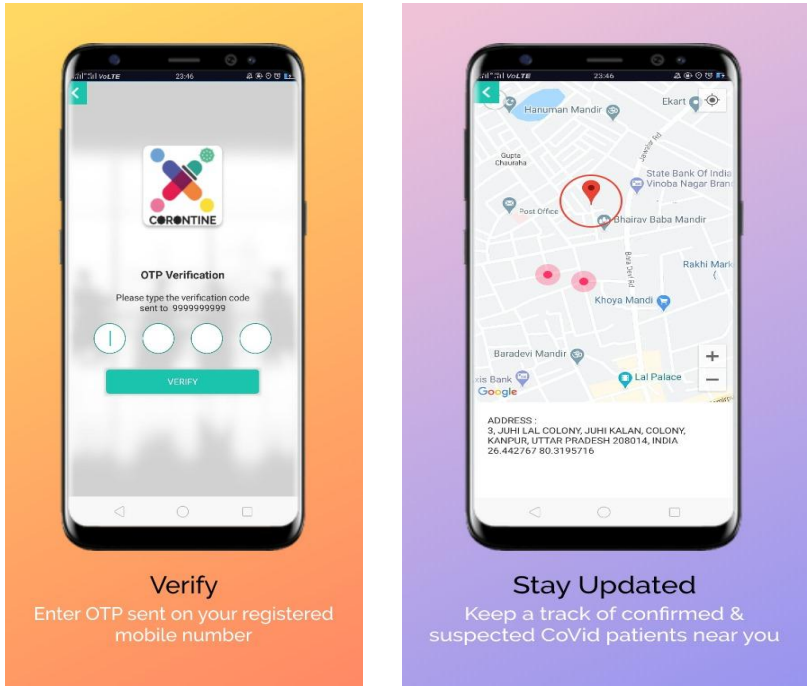
Ganesh Ramakrishnan, CSE, IIT Bombay

Industry partner: Ashvin Gami, MD, Managing Director, StrategicERP

25th July 2020

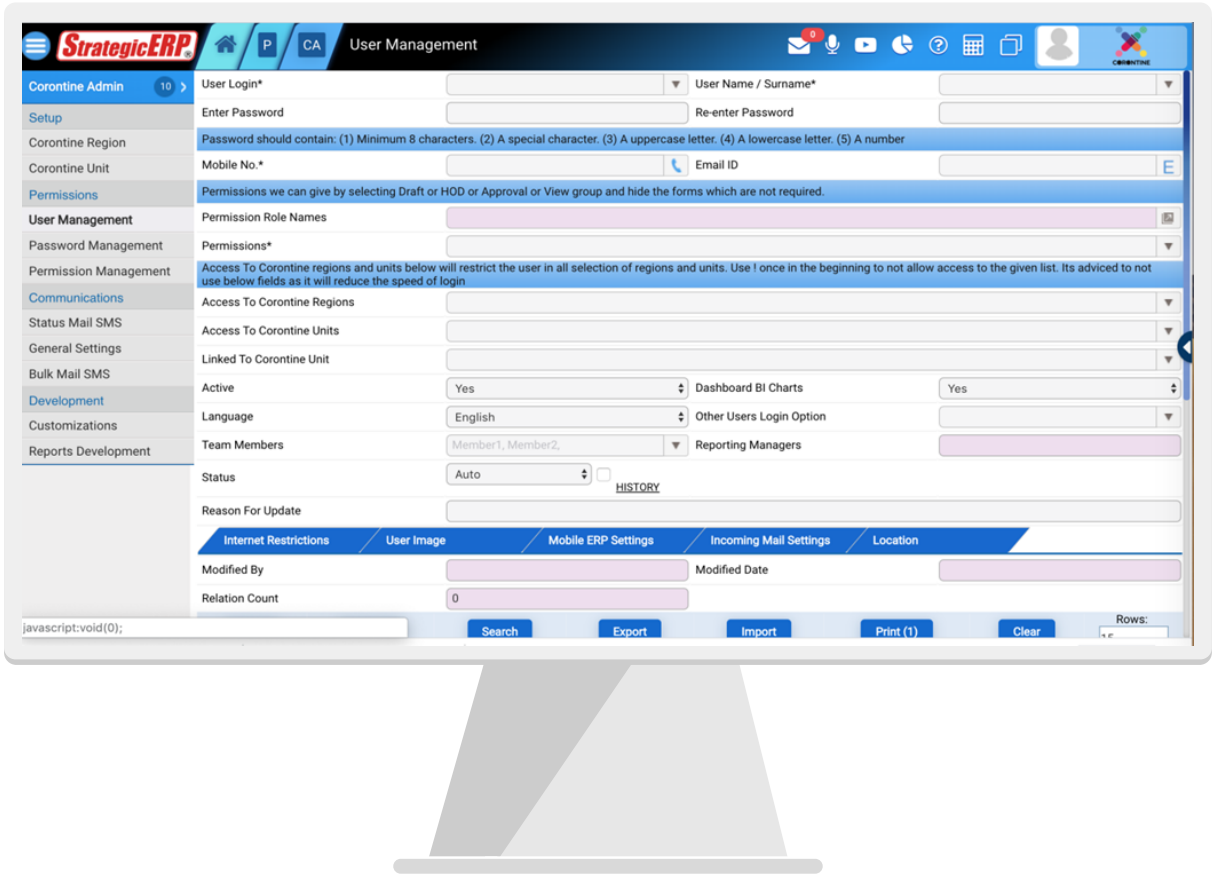
Architecture of Corontine:

Client App: Android/iOS app

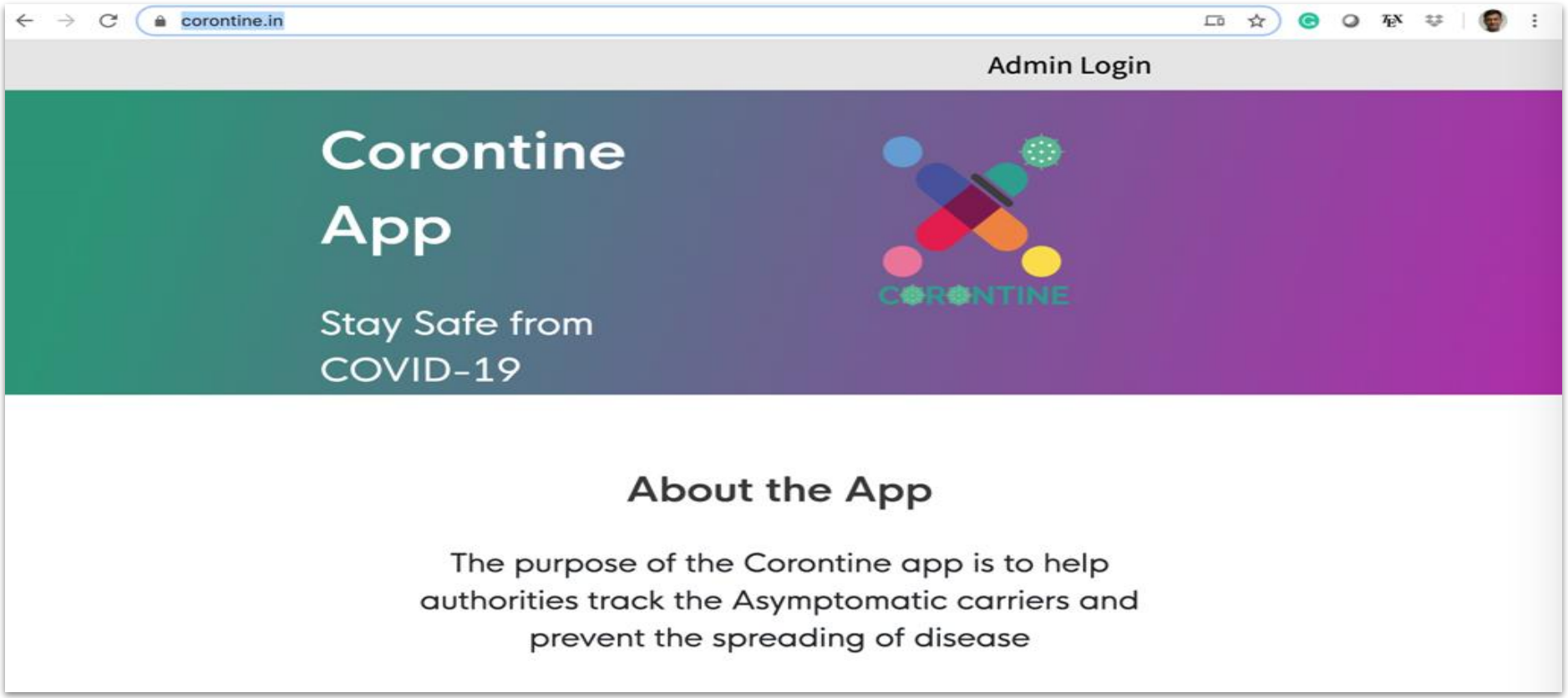


Available on Google Playstore

Back-end: Web based Java application on Linux platform

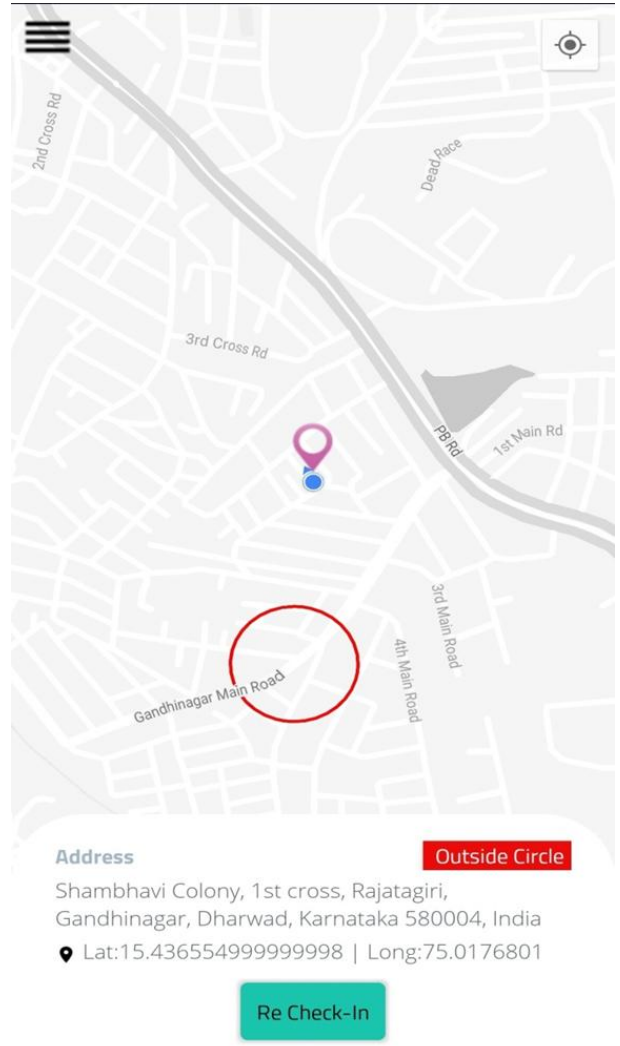


Corontine.in



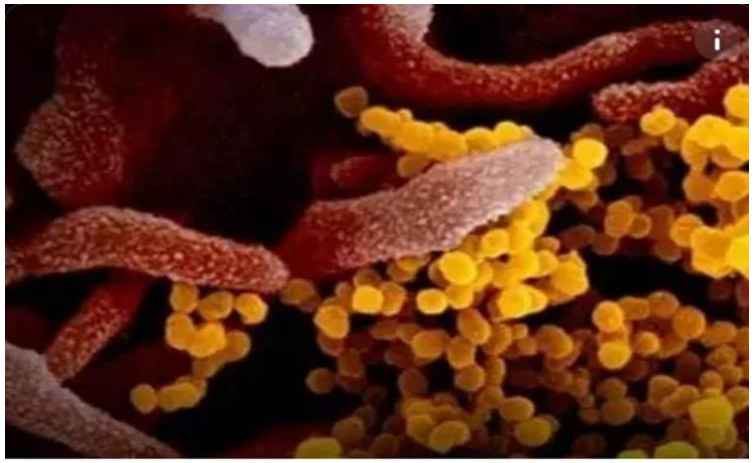
GPS based Tracking potentially infected people

- Asymptomatics (suspected carriers) are to be registered on the platform with name, email, and mobile number under the authority of a State Authorised body
- Asymptomatic users download the app and authenticate with an OTP
- Corontine App sends GPS coordinates to the server where user are *centrally* tracked
- Users can be geo-fenced - marked for confinement in a region
    - Automatic Alert generation on breaching movement restrictions



Usage of CORONTINE platform

- Used extensively in the state of Meghalaya
- Some aspects of Corontine used in Orissa Govt in collaboration with Deloitte



Govt changes its guidelines on when a coronavirus patient can end home isolation

Government's previous guidelines said COVID-19 patient can end home isolation if symptoms are clinically resolved and medical officer certifies him to be infection-free after testing. However, new guidelines say patients can end home isolation after 17 days of onset of symptoms and no fever for 10 days. "There's no need for testing after...home isolation period is over," revised guidelines said.

swipe left for more at Twitter / few hours ago

The app can be used to confirm home isolation!

Variants of Corontine Platforms

The corotine platform is very agile. Led to development of

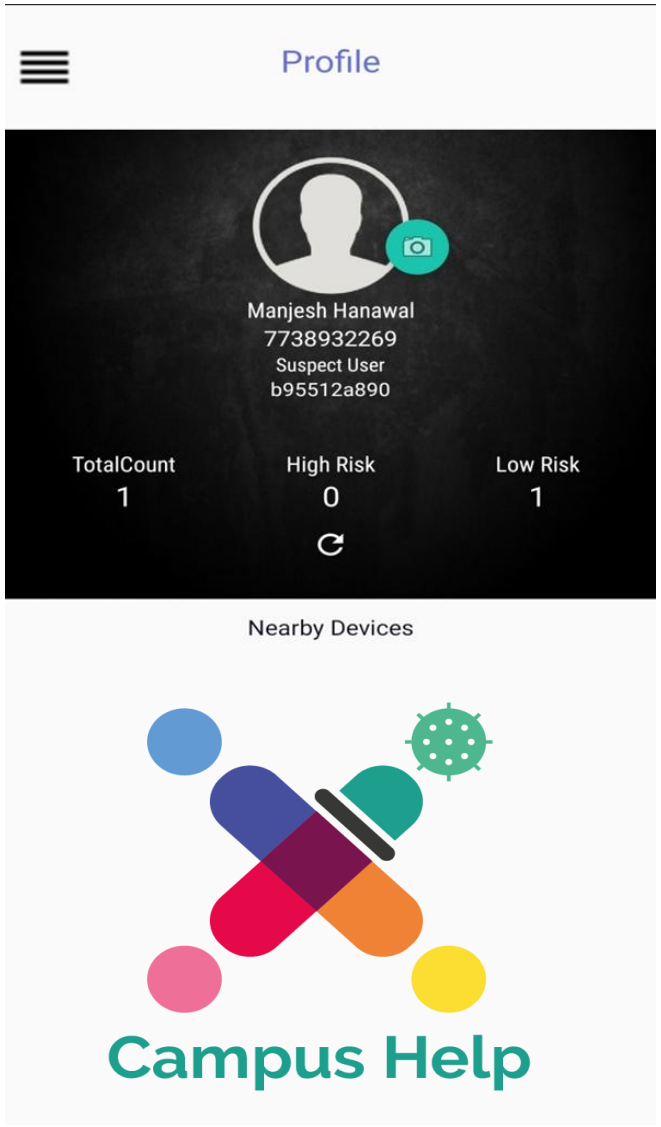
1. Happy to Help
2. CampusHelp for contact tracing
3. i_WRIST (Healthcare) app

Happy to Help

- A back-end call center platform
- Completely driven by volunteers
- Helping patients install Maharashtra government’s Maha Kavach app
- Used by Brihanmumbai Municipal Corporation (BMC)

CampusHelp: Contact Tracing for IITB

- The solution is based on Bluetooth Low Energy
- If a user comes in contact with a positive case, s/he will will be altered through vibration
- If users turns positive all the users who came in contact in the last 14 days will be alerted
- Only IIT Bombay will have access to user data
- Can be used in other campuses



i_WRIST
Traceable Intact Body Monitoring Wrist Band for Short-Term Large Population Observation

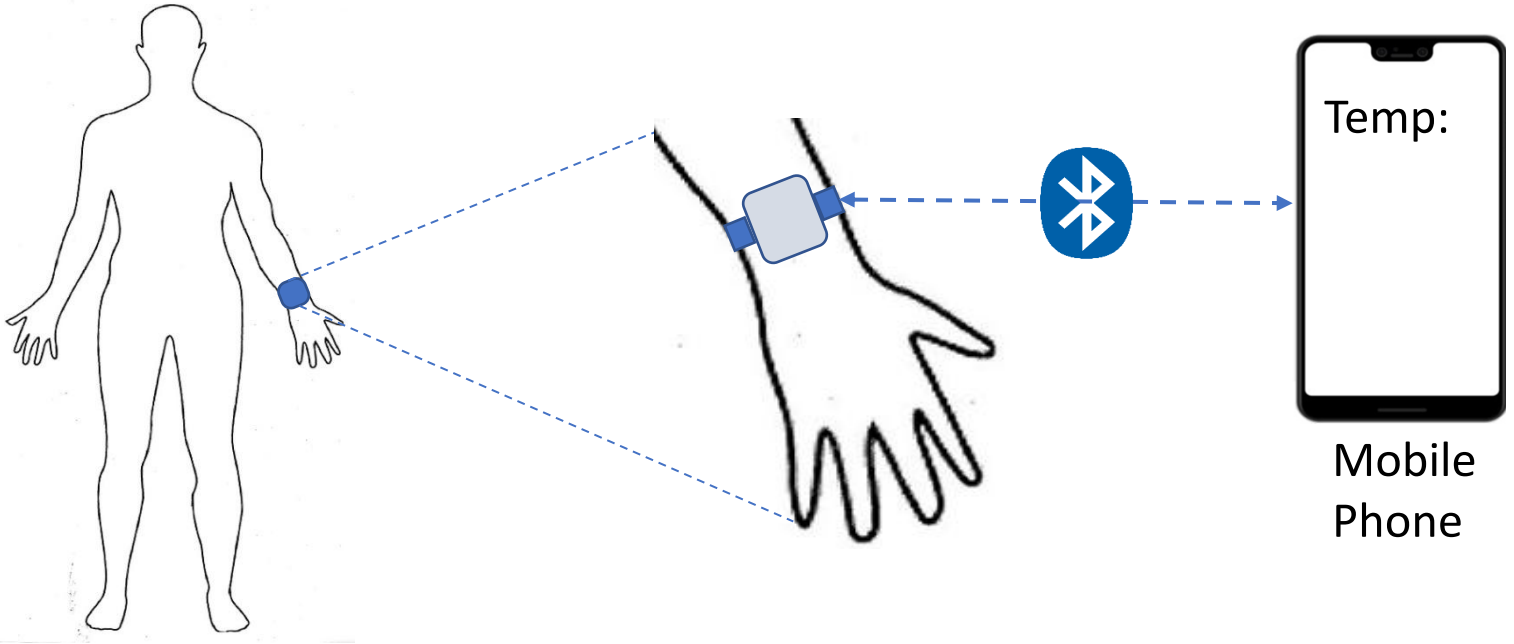
Maryam Shojaei (EE), Manjesh K. Hanawal (IEOR), G. Ramakrishnan (CSE)

Contact: mshojaei@ee.iitb.ac.in

Brief Information

Status

- The first prototype is completed and successfully tested both in the lab and at home.
- IDF is being prepared for filing the patent.
- Seeking first level funding for making more prototypes and running tests.



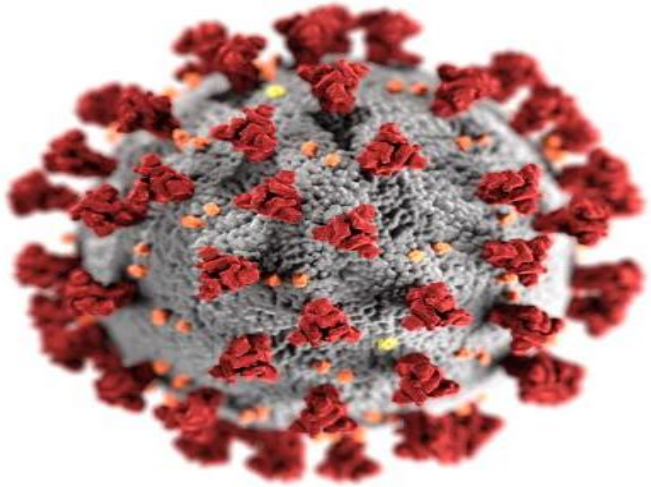
For detailed technical information please contact Maryam Shojaei: mshojaei@ee.iitb.ac.in

Thanks You

Development of in-situ nasal gel for pre-exposure prophylaxis of COVID-19

And

other Initiatives



https://phil.cdc.gov/details.aspx?pid=23312

Kiran Kondabagil
Department of Biosciences and Bioengineering
Contact: kirankondabagil@iitb.ac.in

Development of in-situ nasal gel for pre-exposure prophylaxis of COVID-19

Transmission electron microscope image of SARS-COV-2 the virus that causes coronavirus disease 2019

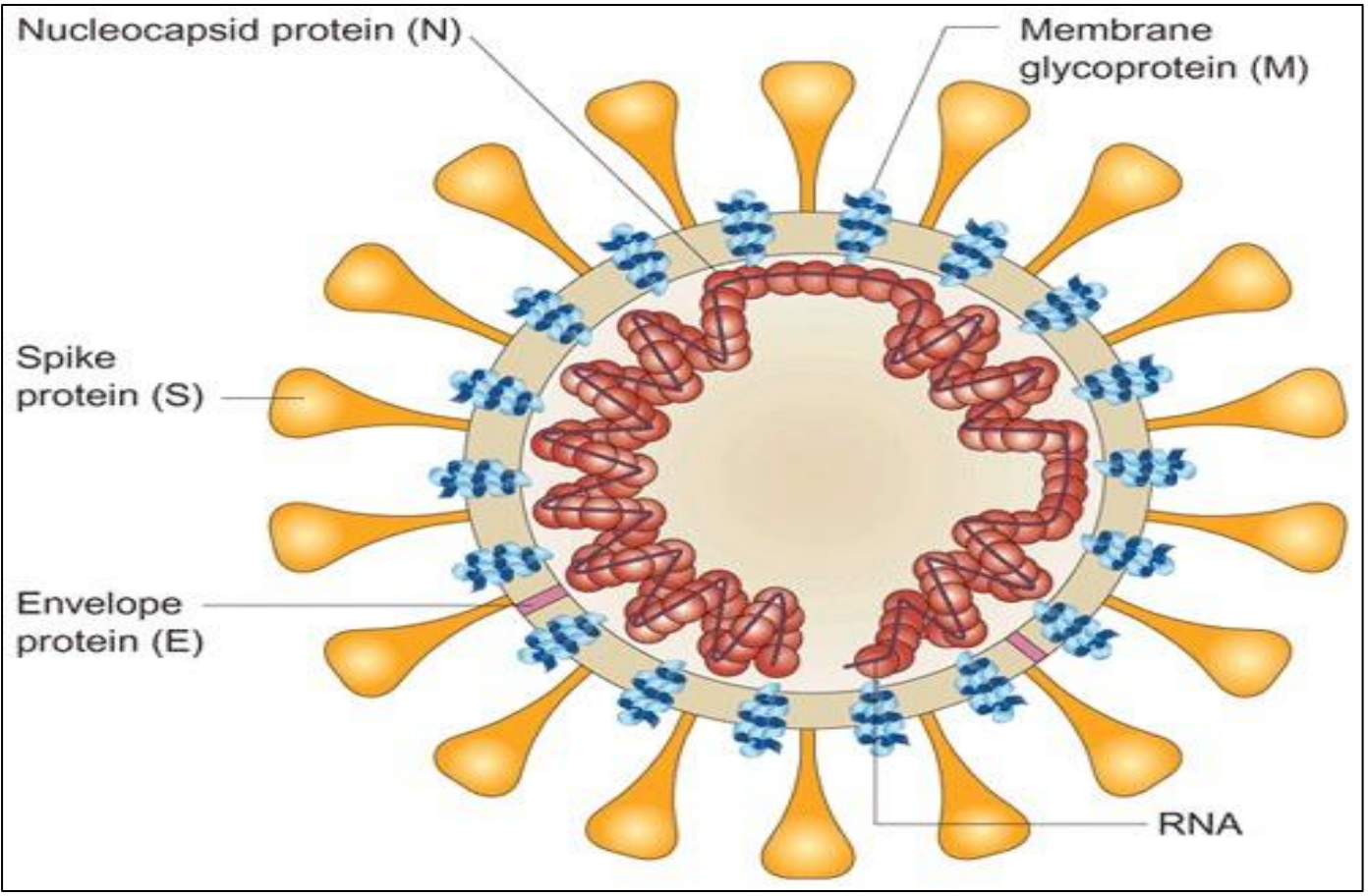
https://www.sciencemag.org/news/2020/03/

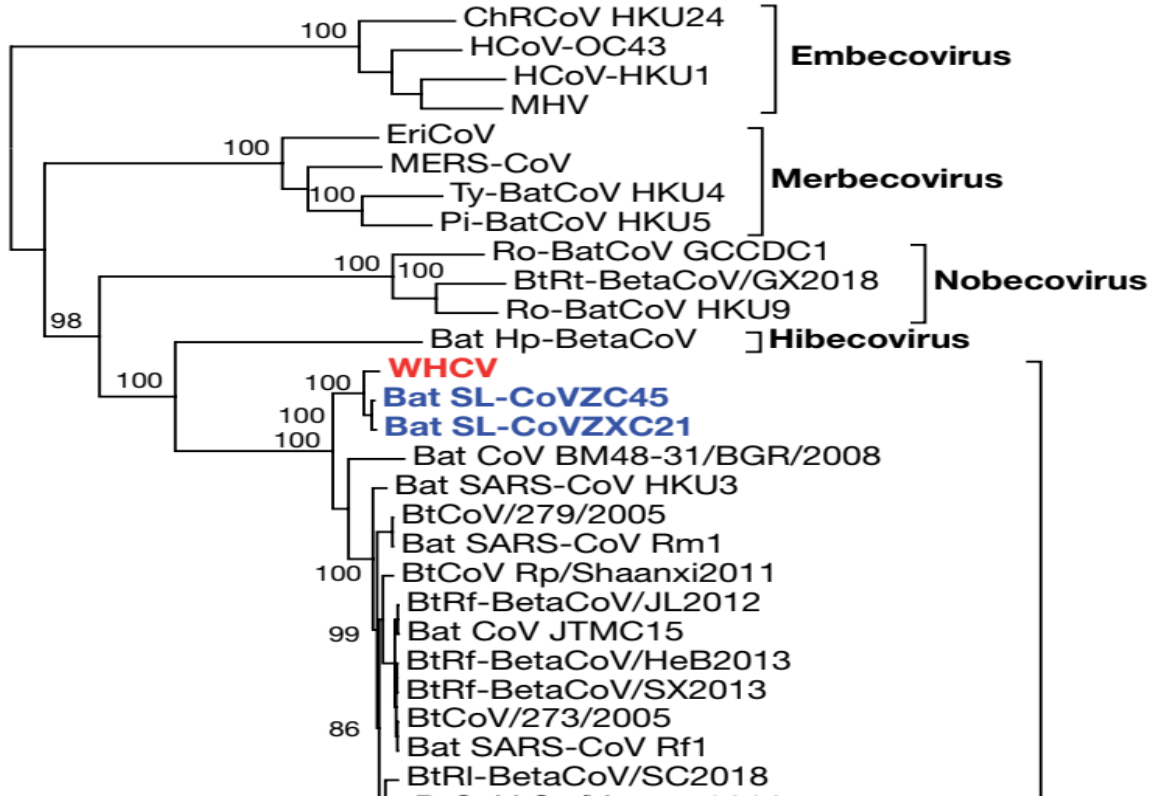
Team:
Shailesh Lad, Neha Saxena, Santosh Kumar, Shivangi Shukla, Roshan Keshari, Ashutosh Kumar, Shamik Sen, Rinti Banerjee, Kiran Kondabagil
Department of Biosciences and Bioengineering

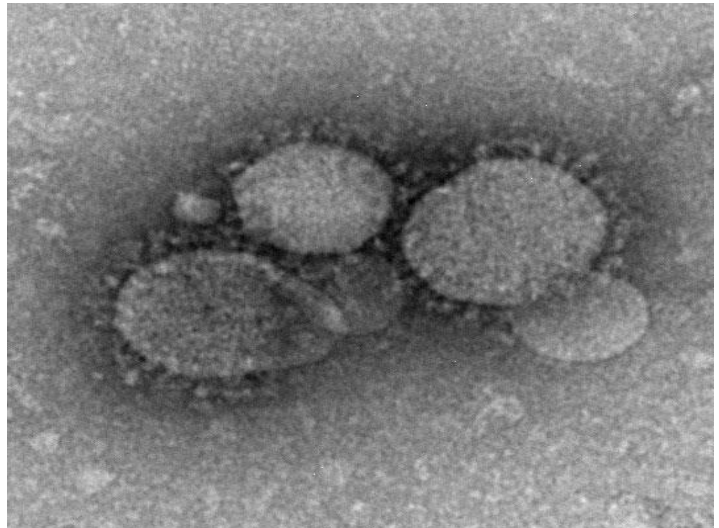
Funded by DST

iit bombay
हीरक जयंती २०१८
Diamond Jubilee 2018
एक साथ प्रगति की ओर
Achieving Excellence Together

Identification of the causative agent of the Wuhan outbreak

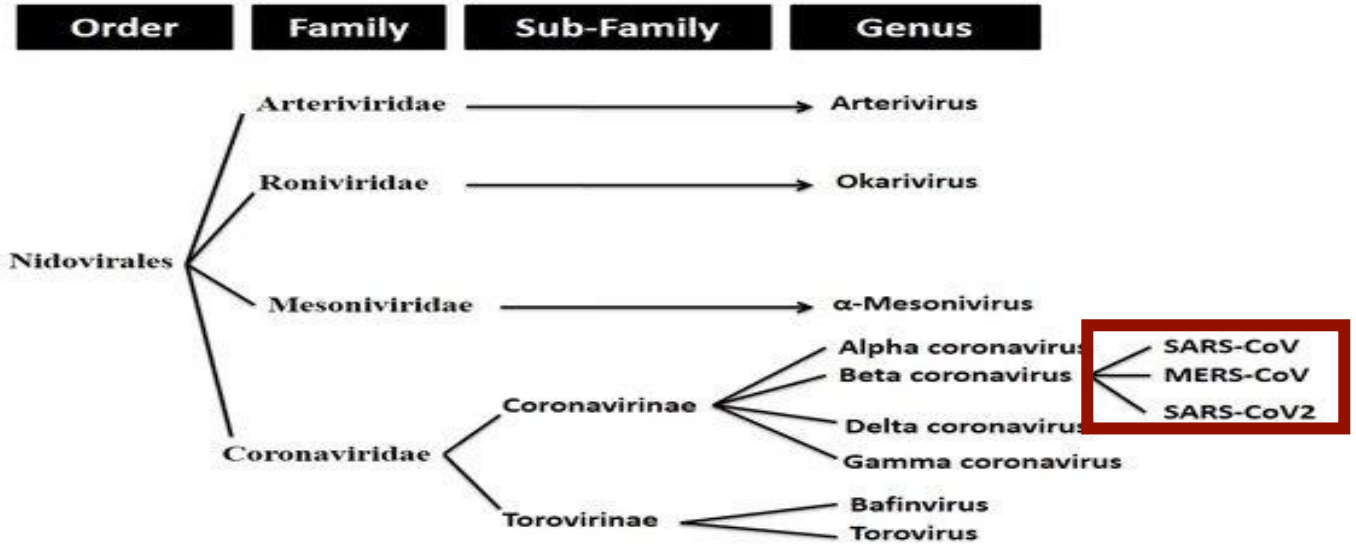




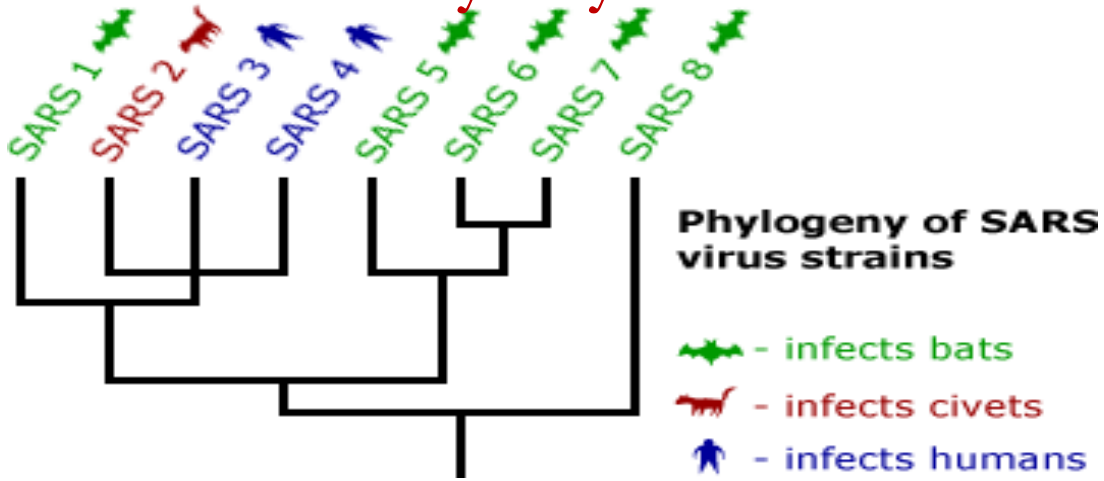


Published online on Feb 3, 2020; Nature | Vol 579 | 12 March 2020 | 265

- Coronaviruses are a group of related RNA viruses that cause disease in mammals and birds
- First human coronavirus was identified in 1965
- Named "corona" because of their crown-like appearance



Where did this mystery virus come from?



https://evolution.berkeley.edu/evolibrary/news/060101_batsars

How COVID-19 is different from earlier outbreaks?

Comparison	No. of cases	Deaths	Case fatality rate#	R_0#
SARS-COV-2*	15656884	636583	2.3	2-2.5
SARS	8437	813	9.5	1.7-1.9
MERS	2499	861	34.4	0.7

COVID-19 is much more contagious than influenza, due to asymptomatic/mildly symptomatic condition
SARS-COV-2 appears to be more stable outside the human body
SARS-COV-2 seems to have accumulated beneficial mutations that make them efficient in binding to host cells

*--from https://www.worldometers.info/coronavirus/

#-Petrosillo N, Viceconte G, Ergonul O, Ippolito G, Petersen E. COVID-19, SARS and MERS: are they closely related?. *Clin Microbiol Infect*. 2020;26(6):729-734. doi:10.1016/j.cmi.2020.03.026

Modes of transmission of SARS-COV-2

DIRECT

Direct transmission means that the disease is passed directly from one infected person or animal to another person or animal.

1. PERSON-TO-PERSON

Person-to-person transmission can occur anytime an infected person touches or exchanges body fluids with another person. For example, kissing can be one method of person-to-person transmission. A pregnant mother can also pass a disease on to her unborn child.

2. DROPLET

Some diseases are spread by coughing or sneezing, which can cause droplets containing the infectious agent to land on nearby people.

INDIRECT

Indirect transmission occurs when a disease is passed from an infected person to another person, even though the two people have not had direct contact.

3. FECAL-ORAL

Fecal-oral transmission occurs when feces—often microscopic amounts—are transmitted from an infected person or animal to another person by mouth. This can happen if food workers use the restroom but do not adequately wash their hands before preparing food for customers to eat.

4. AIRBORNE

Sometimes, an infectious agent enters the air when an infected person sneezes, coughs, laughs—or even just breathes—and it can remain in the air for an extended period of time. When another person comes into contact with the agent, this can lead to airborne transmission.

VECTOR

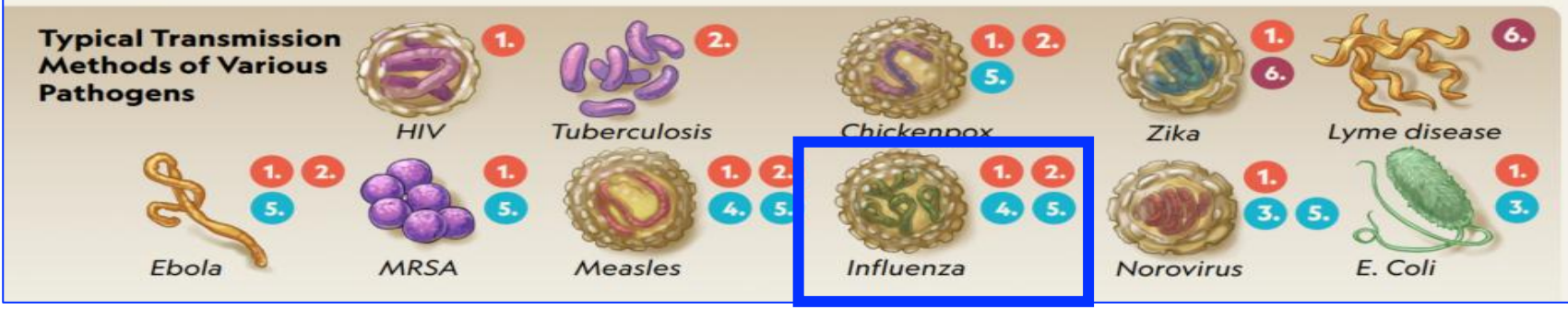
Vector transmission requires another organism to transmit a disease from person to person or from animal to person. This is a type of zoonotic (animal to person) transmission, but differs from direct zoonosis, in which a vertebrate animal contracts a disease and passes it directly to a person, as with rabies.

5. FOMITES

A fomite is an inanimate object that serves as a vehicle to pass an infectious disease from an infected person to a healthy person. For example, a water fountain might become contaminated by the saliva of an infected person and pass that disease on to another person who drinks from it. Other examples of potential fomites include doorknobs, handrails, and shared computer keyboards.

6. INSECT BITE

Vector-borne diseases are most commonly transmitted by insect bites. For example, mosquitoes acquire malaria parasites by feeding on infected humans and then transfer that infection to other people when they feed again. The plague, which killed tens of millions of Europeans in the fourteenth century, was transmitted from rats to humans through flea bites.



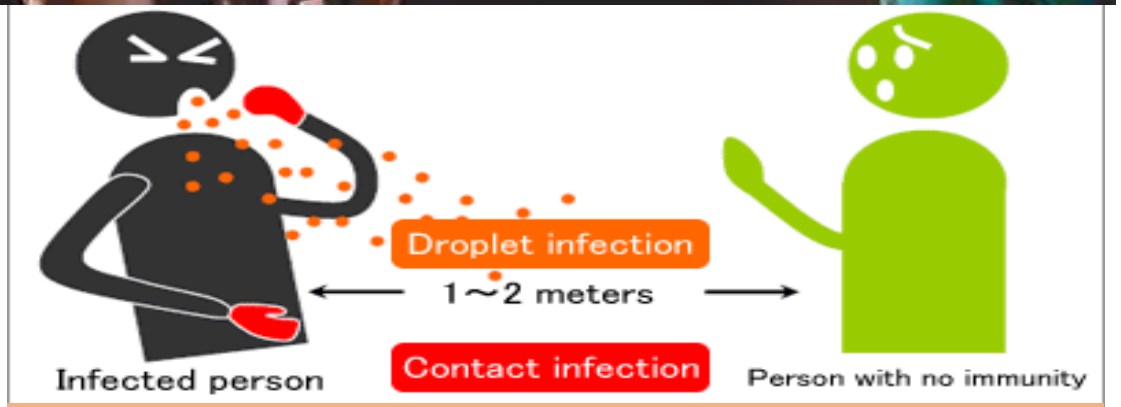
NATIONAL GEOGRAPHIC

https://www.nationalgeographic.org/media/methods-disease-transmission/

The Gross Science of a Cough and a Sneeze!

- Scientists who study the ways we cough and sneeze are shedding light on how viruses like influenza and coronaviruses spread

- A cough [~ 2 billion viruses]
  - 3000 droplets
  - 50 miles/hour
- A Sneeze [1-2 billion viruses]
  - 20000 droplets
  - 200 miles/hour
- A breath [20 virus particles/min]
  - 50-5000 droplets
  - Low velocity
- Speaking [200 virus particles/min]
  - 100-1000 droplets
  - Low velocity



Main root of influenza A virus (H1N1) and coronavirus infections

On an average one needs to ingest/inhale ~ 1000 virus particles to get infected

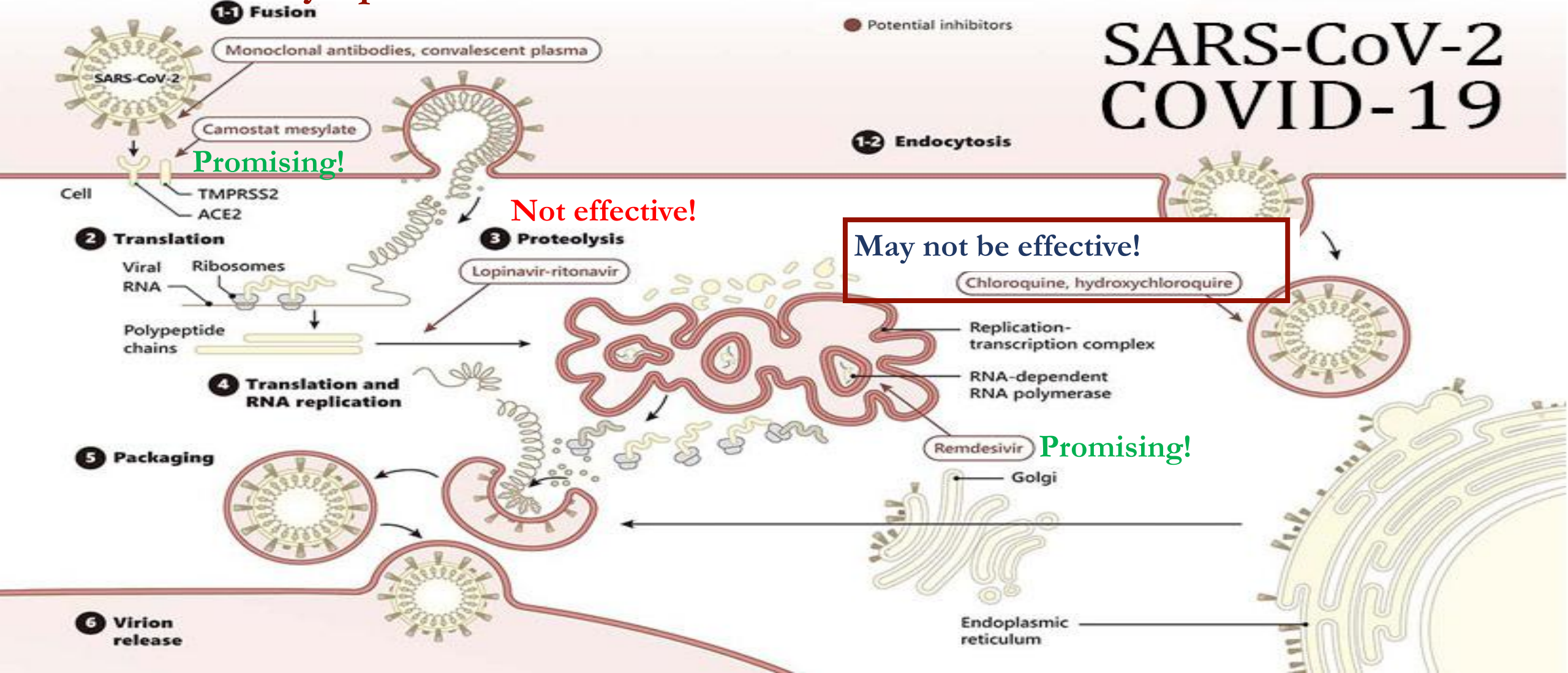
Routes of exposure to SARS-COV-2

What is known so far

• Ocular invasion	• Low-tear may contain virus
• Inhalation	• Very high
• Ingestion	• High
• Through skin	• Very low
• Bloodborne transmission	• ??
• Biological samples	• ??
• Intrauterine transmission	• ??

More than 15 drugs are being tested to treat COVID-19

- Most are post-exposure options
- Target viral replication cycle
- Control symptoms of the disease



Pre-exposure treatment currently involves drug regimen

	Title	Status	Study Results	Conditions	Interventions	Locations
1	Pre-Exposure Prophylaxis With Hydroxychloroquine for High-Risk Healthcare Workers During the COVID-19 Pandemic	Suspended	No Results Available	•COVID-19	•Drug: Hydroxychloroquine •Drug: Placebos	•ISGlobal, Barcelona, Spain
2	Efficacy of Various Doses of Hydroxychloroquine in Pre-Exposure Prophylaxis for COVID 19	Recruiting	No Results Available	•COVID 19	•Drug: Hydroxychloroquine Sulfate 200 MG •Other: Placebo	•Shaheed Zulfiaqar Ali Bhutto Medical University, Islamabad, Federal Capital, Pakistan
3	TAF/FTC for Pre-exposure Prophylaxis of COVID-19 in Healthcare Workers (CoviPrep Study)	Not yet recruiting	No Results Available	•Healthcare Workers •COVID-19 •SARS-CoV 2	•Drug: Emtricitabine/Tenofovir Alafenamide 200 MG-25 MG Oral Tablet •Drug: Placebo	•Sociedad Argentina de Infectología, A. J. Carranza 974, Ciudad Autonoma de Buenos Aires, Capital Federal, Argentina
4	HEalth Care Worker pROphylaxis Against COVID-19: The HERO Trial	Not yet recruiting	No Results Available	•Prophylaxis •COVID-19 •Health Care Worker •Hydroxychloroquine	•Drug: Hydroxychloroquine Pre-Exposure Prophylaxis •Drug: Placebo oral tablet	•The New York Center for Travel and Tropical Medicine, New York, New York, United States
5	COVID-19 PrEP HCW HCQ Study	Recruiting	No Results Available	•COVID-19	•Drug: Hydroxychloroquine (HCQ)	•NYU Langone Health, New York, New York, United States
6	COVID-19 Infection in Patients Infected With HIV and/or on PrEP	Completed	No Results Available	•HIV •Pre-exposure Prophylaxis	•Other: Data research, database analysis	•Croix-Rousse Hospital, Hospices Civils de Lyon, Lyon, France
7	Does Hydroxychloroquine Before & During Patient Exposure Protect Healthcare Workers From Coronavirus?	Enrolling by invitation	No Results Available	•Pre-Exposure Prophylaxis •Coronavirus •SARS-CoV 2	•Drug: Hydroxychloroquine •Drug: Placebo oral tablet	•University Health Network, Toronto, Ontario, Canada
8	Randomized Clinical Trial for the Prevention of SARS-CoV-2 Infection (COVID-19) in Healthcare Personnel	Recruiting	No Results Available	•Coronavirus Infection	•Drug: Emtricitabine/tenofovir disoproxil •Drug: Hydroxychloroquine •Drug: Placebo: Emtricitabine/tenofovir disoproxil Placebo •Drug: Placebo: Hydroxychloroquine	•Hospital Universitario de Ferrol, Ferrol, A Coruña, Spain •Hospital Clínico Universitario de Santiago, Santiago De Compostela, A Coruña, Spain •Hospital General de Elche, Elche, Alicante, Spain •Hospital Universitario Central de Asturias, Oviedo, Asturias, Spain •Hospital Sant Joan de Deu de Esplugues, Esplugues De Llobregat, Barcelona, Spain •Parc Sanitari Sant Joan de Déu de Sant Boi, Sant Boi De Llobregat, Barcelona, Spain •Hospital Infanta Margarita, Cabra, Córdoba, Spain •Hospital Insular de Las Palmas, Las Palmas De Gran Canaria, Gran Canaria, Spain •Hospital Universitario de Canarias, Las Palmas De Gran Canaria, Gran Canaria, Spain •Hospital de Donostia, San Sebastián, Guipuzcoa, Spain •and 52 more
9	Pre-exposure Prophylaxis for SARS-Coronavirus-2	Active, not recruiting	No Results Available	•COVID-19 •Corona Virus Infection •ARDS •Acute Respiratory Distress Syndrome	•Drug: Hydroxychloroquine •Other: Placebo	•Nationwide Enrollment via Internet, please email: covid19@umn.edu, Minneapolis, Minnesota, United States •University of Minnesota, Minneapolis, Minnesota, United States
10	Control of COVID-19 Outbreaks in Long Term Care	Not yet recruiting	No Results Available	•COVID-19 •SARS-CoV-2	•Drug: Favipiravir •Drug: Favipiravir Placebo	
11	Hydroxychloroquine for the Treatment of Mild COVID-19 Disease	Recruiting	No Results Available	•COVID-19	•Drug: Hydroxychloroquine •Drug: Placebo	•Institute for Tropical Medicine, Tübingen, Germany

https://clinicaltrials.gov/

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Diamond Jubilee 2018
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Our strategy

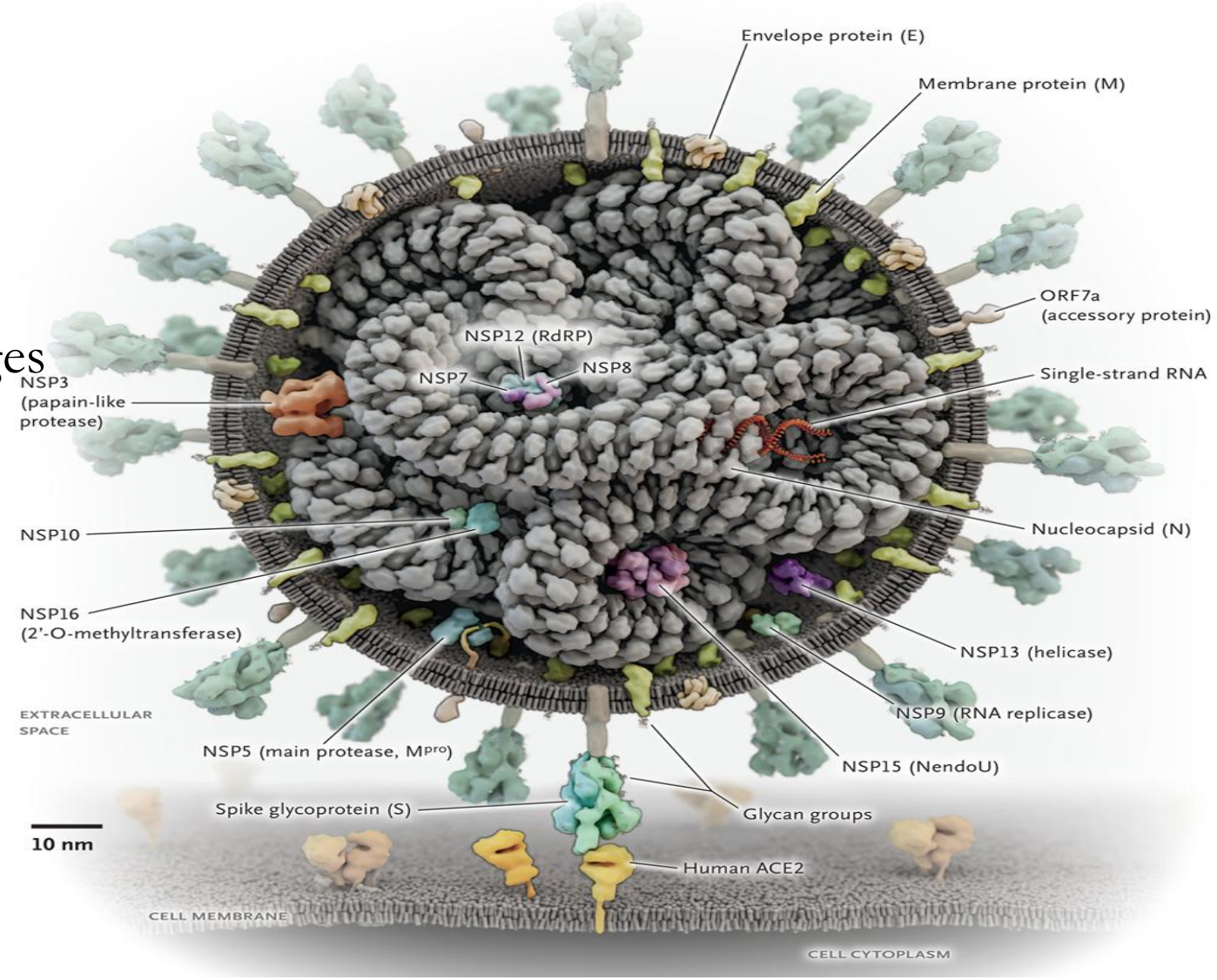
Irreversible capture of virus particles and their inactivation

Intended for application to the nasal passages either as gel or spray for local effects

For people who do not have infection but have a higher risk of exposure

- **Healthcare workers**
- **Public service personnel (Police, Transportation, etc.)**
- **People who work in a store**

The SARS-CoV-2 Virion and Its Proteins



https://www.nejm.org/doi/10.1056/NEJMcibr2007042

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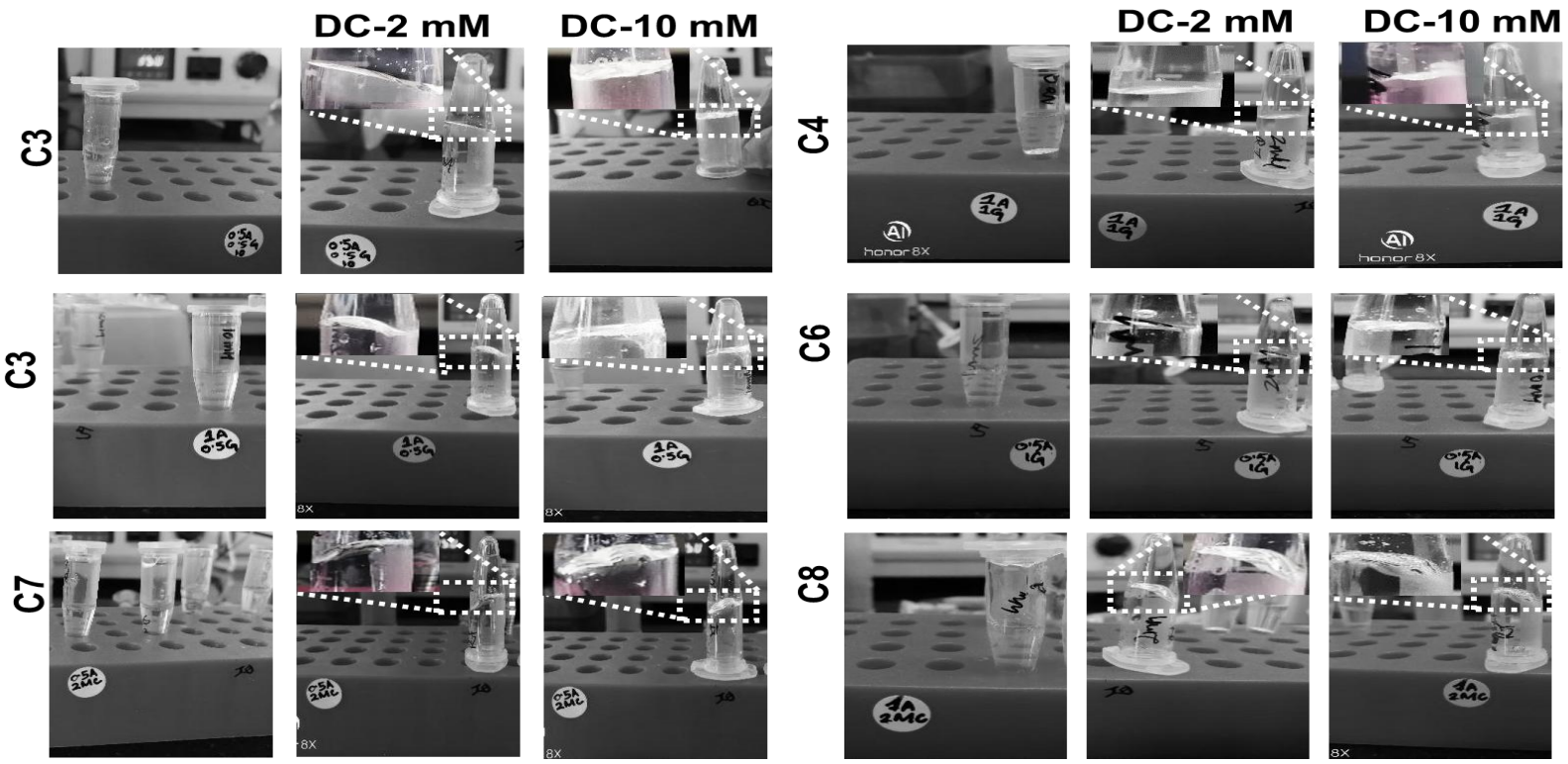
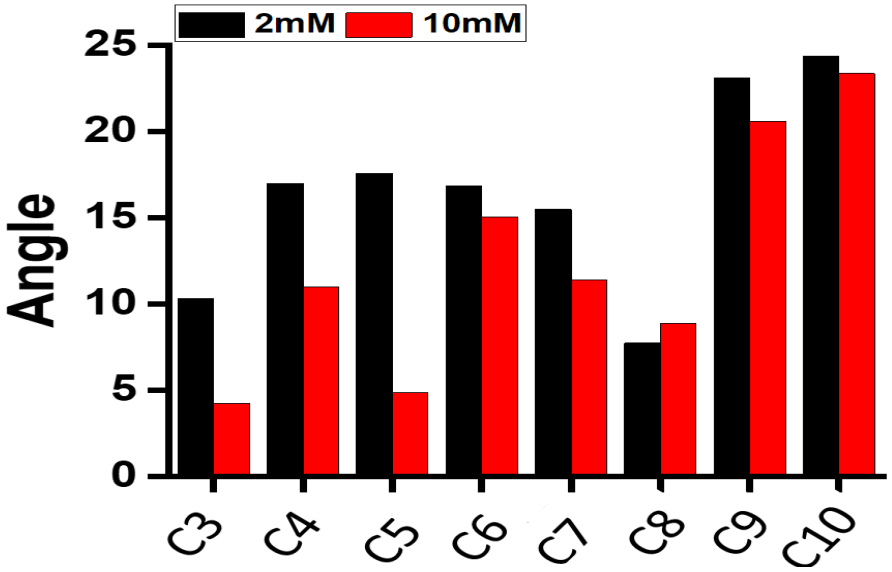
Visco-elasticity optimization of the Gel formulations





Liposome formulations with active anti-SARS-COV-2 ingredient have been optimized and characterized by DLS.

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Detection of SARS-CoV-2 Nucleic Acid in wastewater

Team:
Shailesh Lad, Kirti Megha, Santosh Kumar, Kiran Kondabagil
Department of Biosciences and Bioengineering, IIT Bombay

Detection of SARS-CoV-2 Nucleic Acid in wastewater using low-cost sensing platform

Siddharth Tallur, Department of Electrical Engineering, IIT Bombay

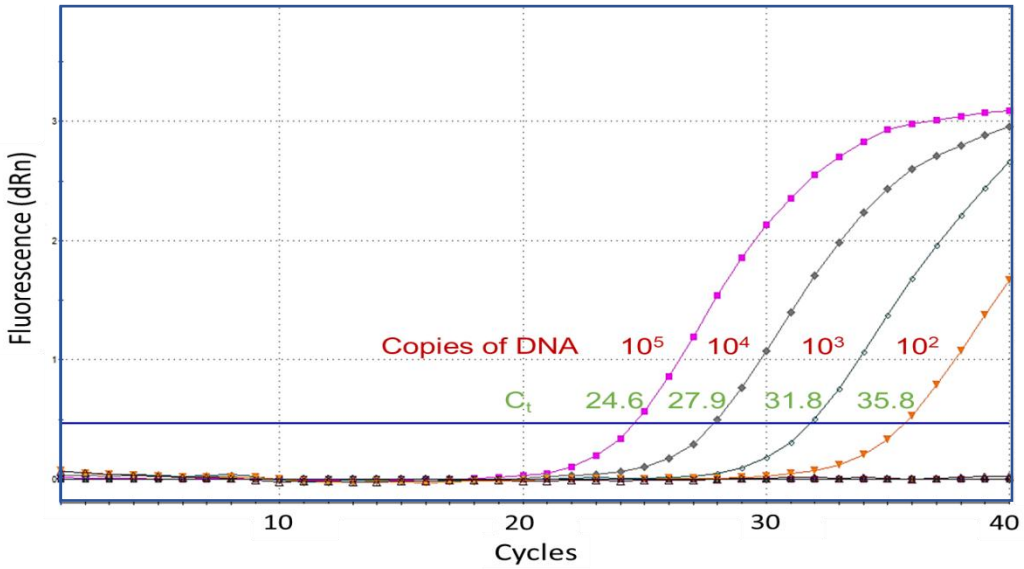
Andrew Ward, Charles Knapp, Adrian Butterworth, University of Strathclyde

Partly funded by
UK Research & Innovation Fund-Scottish Funding Council --Global Challenges Research (UKRI, SFC GCRF COVID19 Response Fund)

Detection of viral RNA from wastewater is a great tool for surveillance

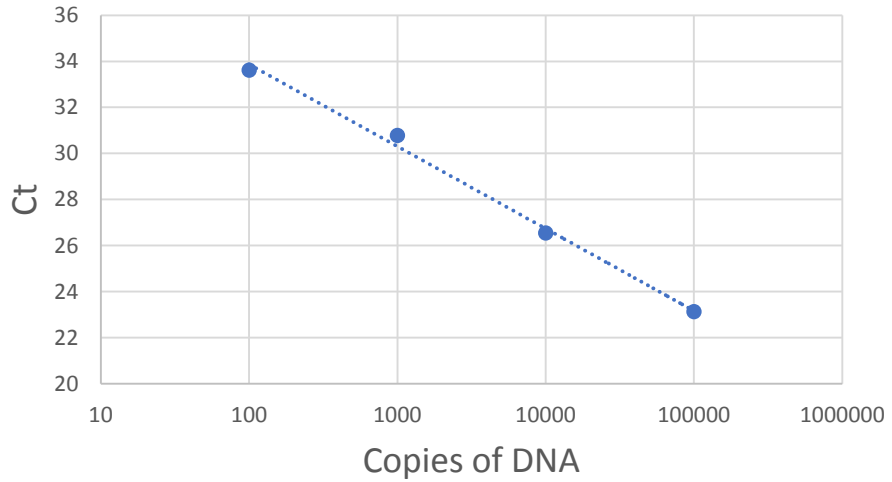
SARS-COV-2 RNA appears in wastewater well before the detection in the community

SARS-CoV-2 N1 Synthetic DNA

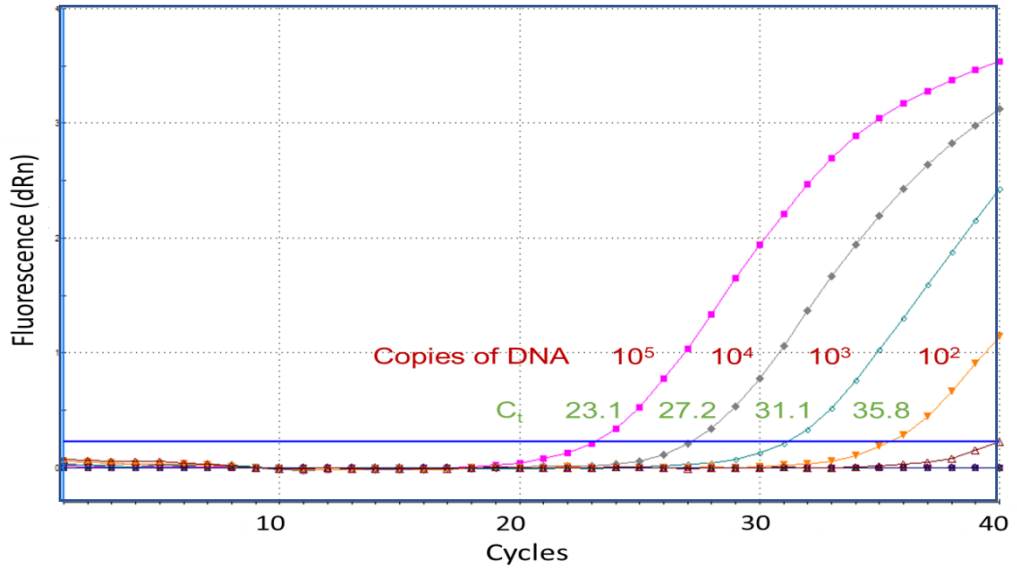


N1

y = -1.551ln(x) + 41.014
R² = 0.9948

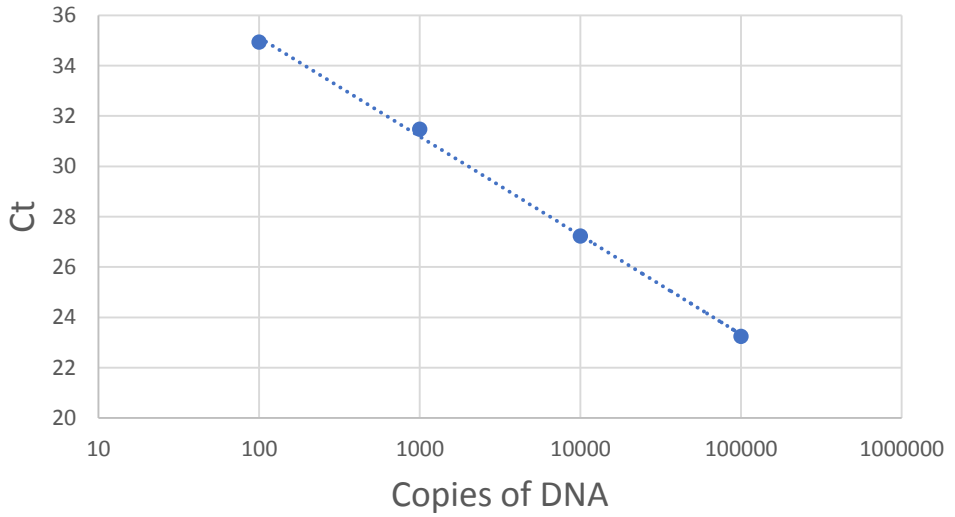


SARS-CoV-2 N2 Synthetic DNA

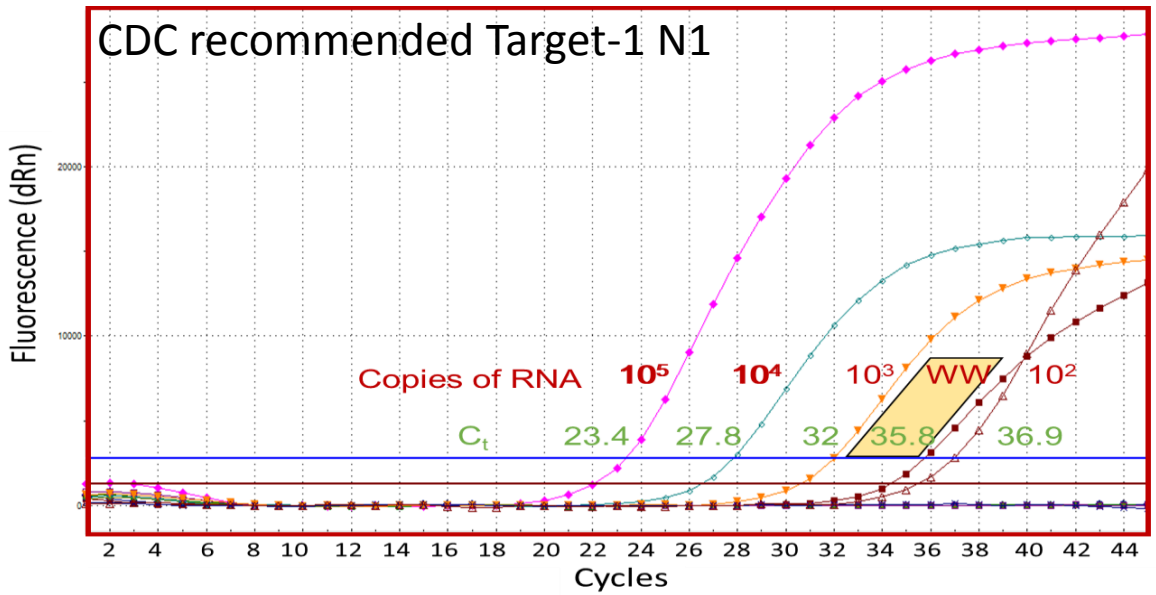


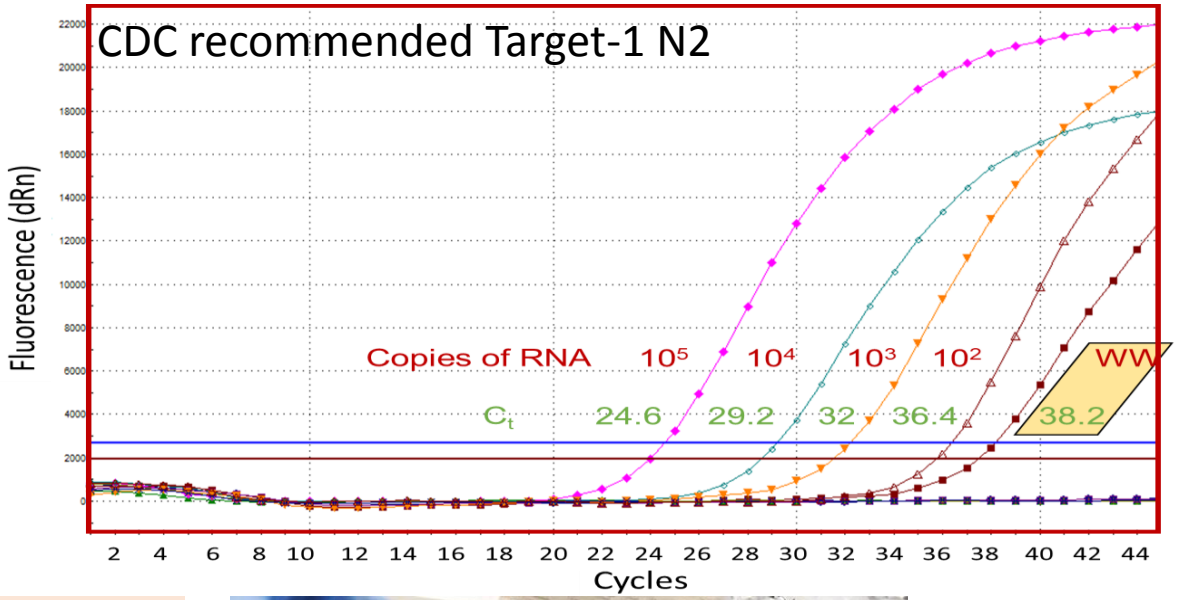
N2

y = -1.708ln(x) + 42.982
R² = 0.9984



Presence of SARS-CoV-2 RNA in wastewater

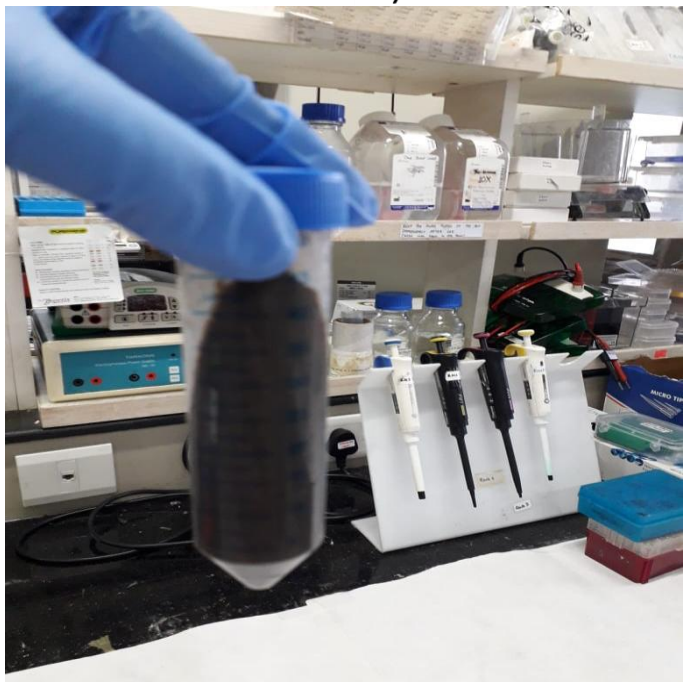




Tested untreated wastewater sample contains an estimated 3.5 ± 1.2 log 10 copies of SARS-COV-2 RNA/L

Results have been validated by independent methods

Complete workflow for detection and quantification of SARS-COV-2 nucleic acid from wastewater using RTPCR has been established



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Other COVID-19 projects and initiatives

Development of a two colour-based detection of SARS-COV-2 at point-of-care
Collaboration with Prof. Debjani Paul and Prof. Kantimay Dasgupta
Funding: Wadhwani Research Centre for Bioengineering, IIT Bombay

Development of UVC-based sterilization units and their validation
Collaboration with Prof. Ambarish Kunwar
Funding:
IIT Bombay
Wadhwani Research Centre for Bioengineering, IIT Bombay
BIRAC

Bio-safety training
With Prof. Ambarish Kunwar

Proteomics & Metabolomics analysis of COVID-19 patients to identify biomarkers

Dr. Sanjeeva Srivastava, *FRSB, FRSC*
Professor
Department of Biosciences & Bioengineering
IIT Bombay, India

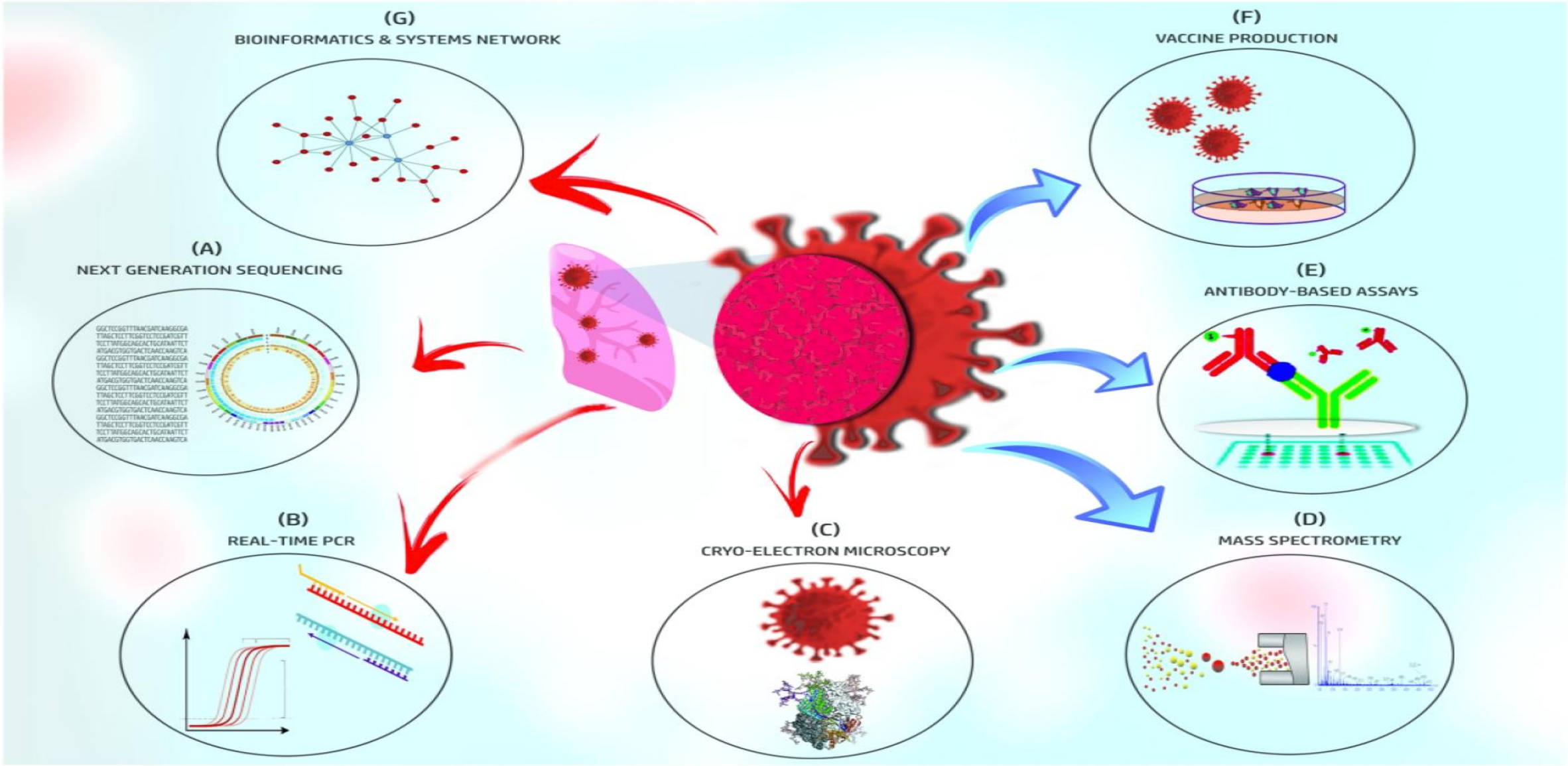
Visiting Professor: *Nottingham Trent University, UK*
Visiting Scientist:
ASU; UAEU

Guest Editor: *Proteomics, J of Proteomics, Nature India Editorial board, JPP*

Outline

- Introduction
- Peptide based detection
- Biomarkers for severity prognosis
- Other ongoing projects
- Summary

COVID-19: Proteomics and Multi-omics Research



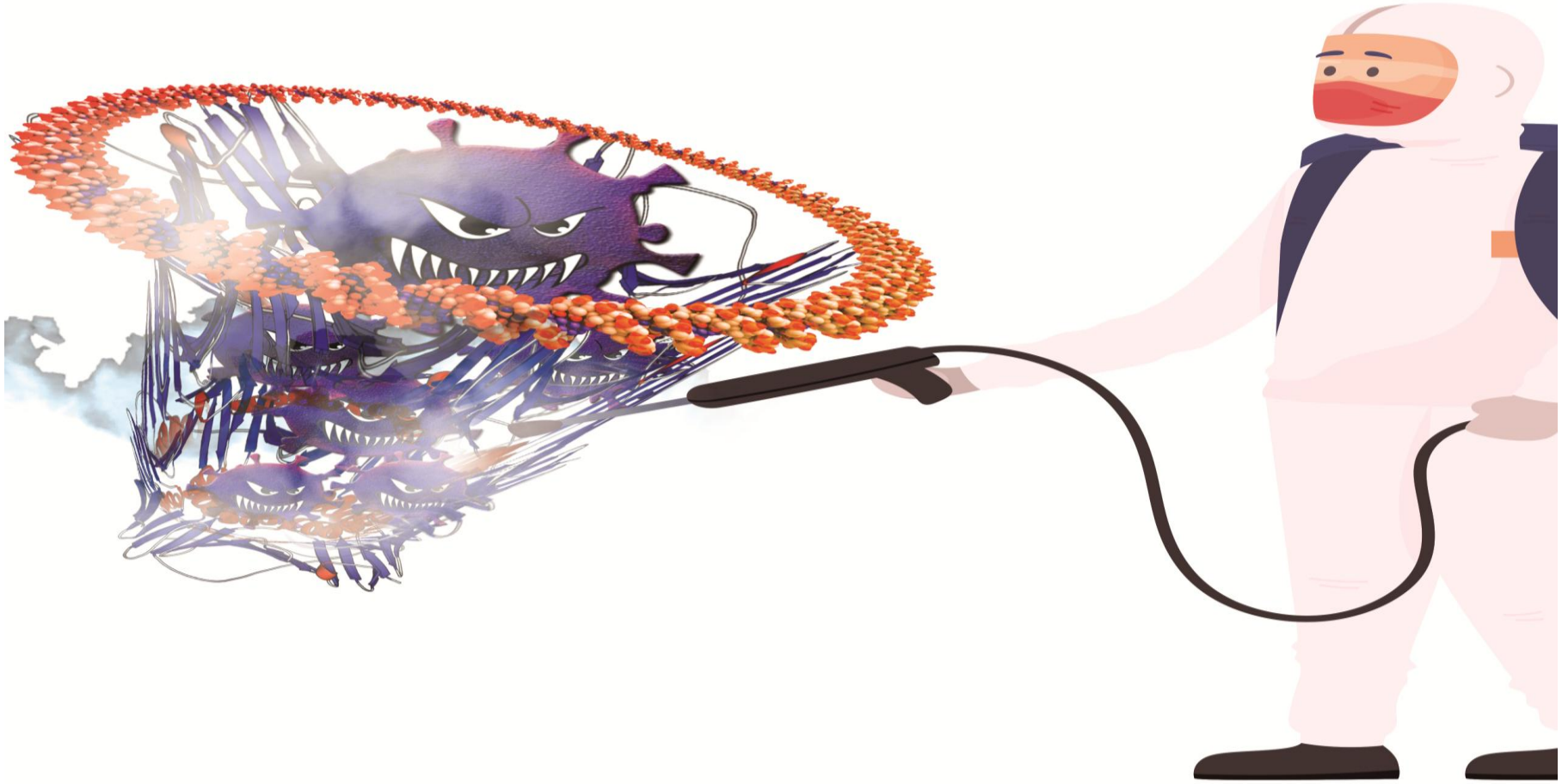
Ray S, Srivastava S. ***OMICS A Journal of Integrative Biology, 2020***

- **Peptide-based detection**
- **Biomarkers for severity**
- **Other ongoing projects**

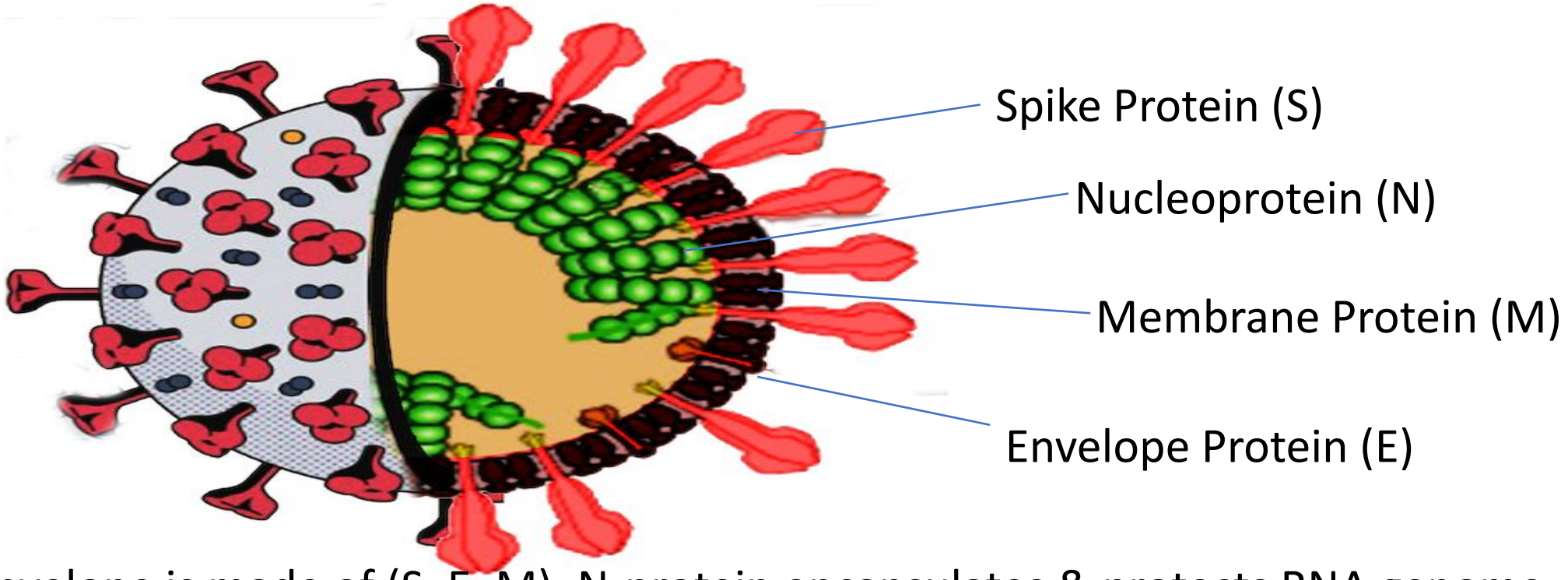
(I) A Simplified Mass Spectrometry-based Proteomics Approach to detect SARS-CoV-2 from Nasopharyngeal Swab of COVID-19 patients

Challenges of Virus detection using Antibody tests & Other Technologies!

How do we capture SARS-CoV-2 Peptides/ Proteins?



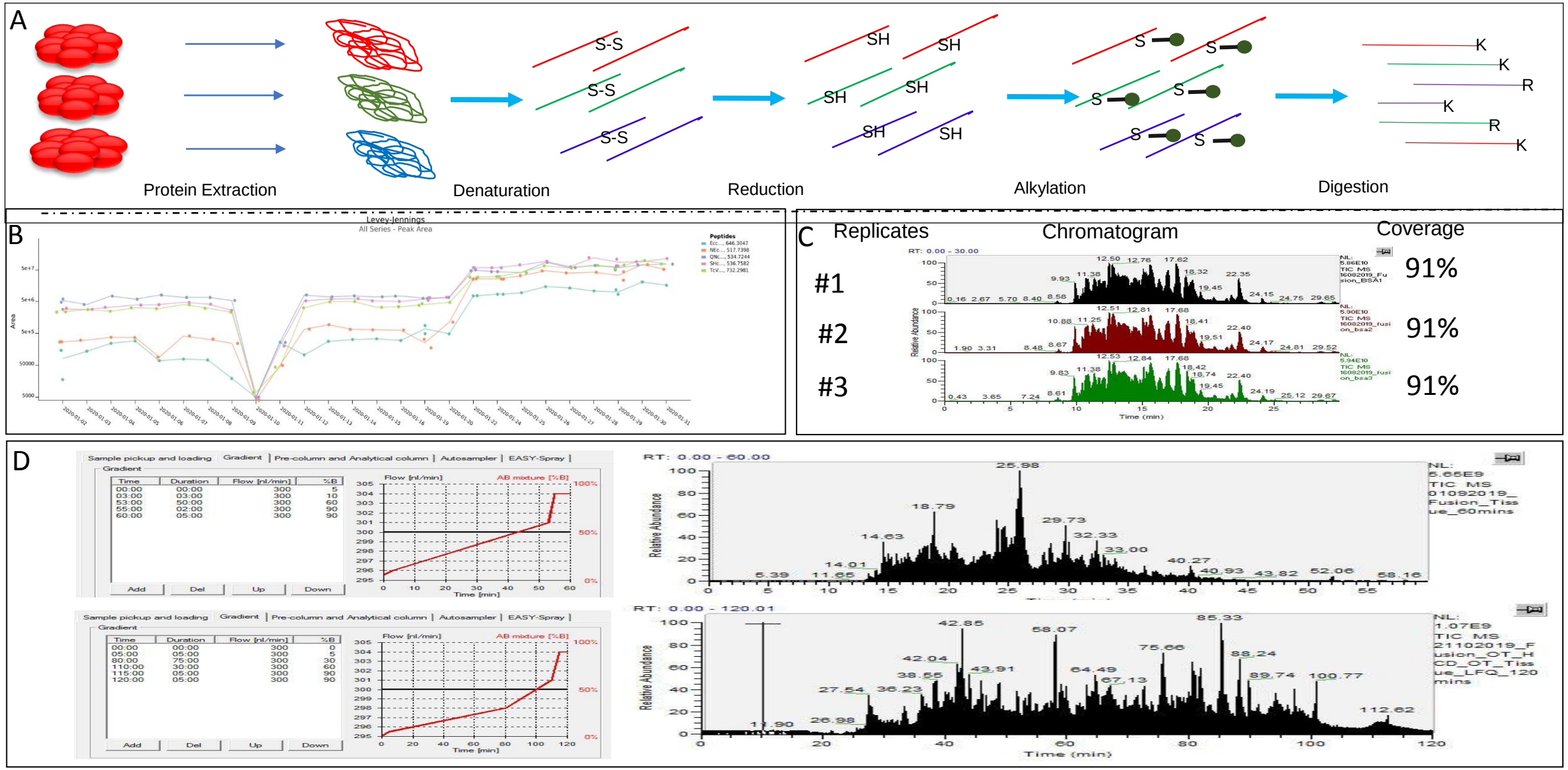
SARS-CoV-2 Proteins



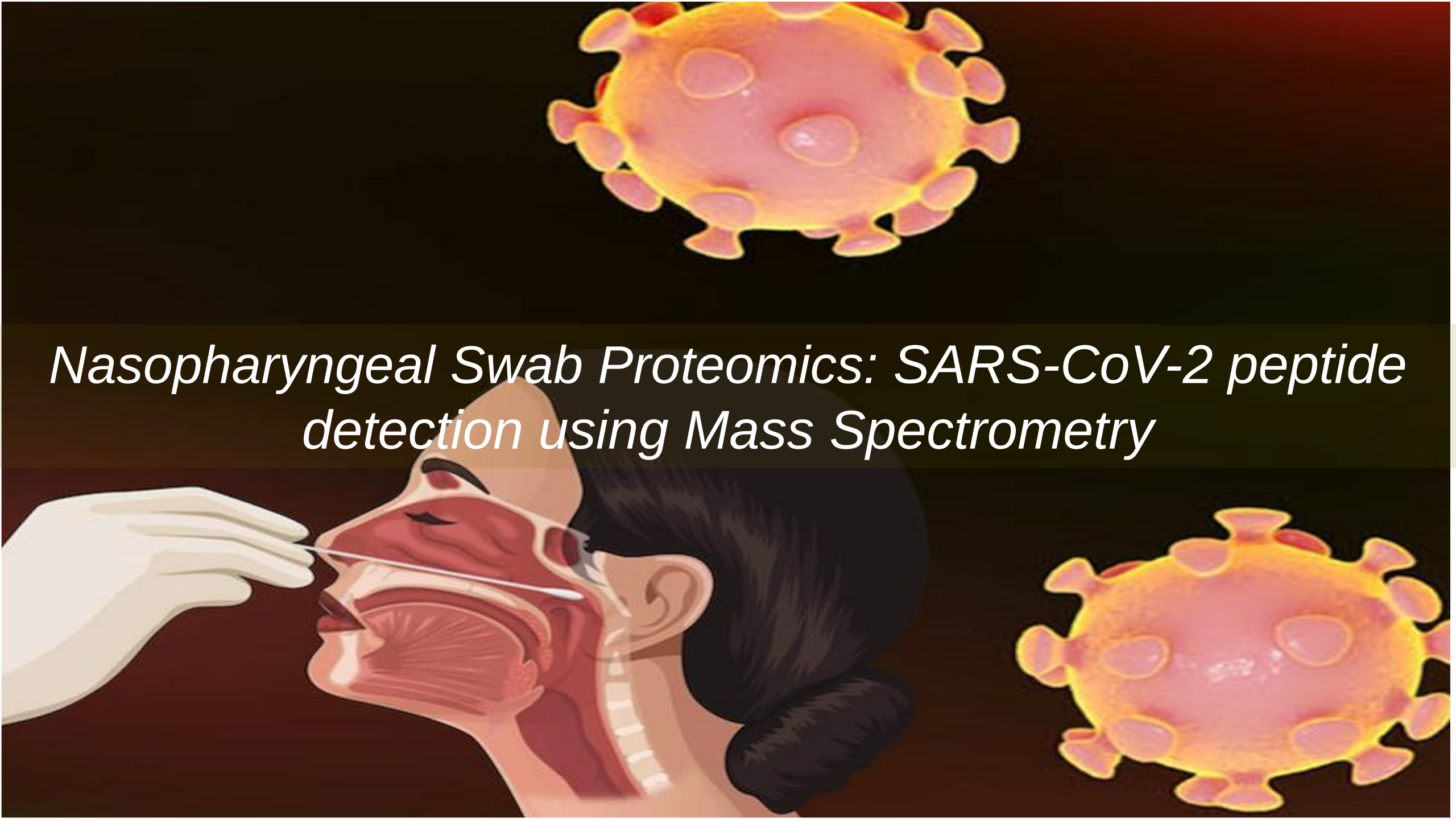
- Viral envelope is made of (S, E, M); N-protein encapsulates & protects RNA genome
- S (less copies); E, M (Short & tightly membrane bound) difficult to identify
- N-Protein is main target for detection


PROTEOMICS
MASSFIITB

MS-based Proteomics Workflow

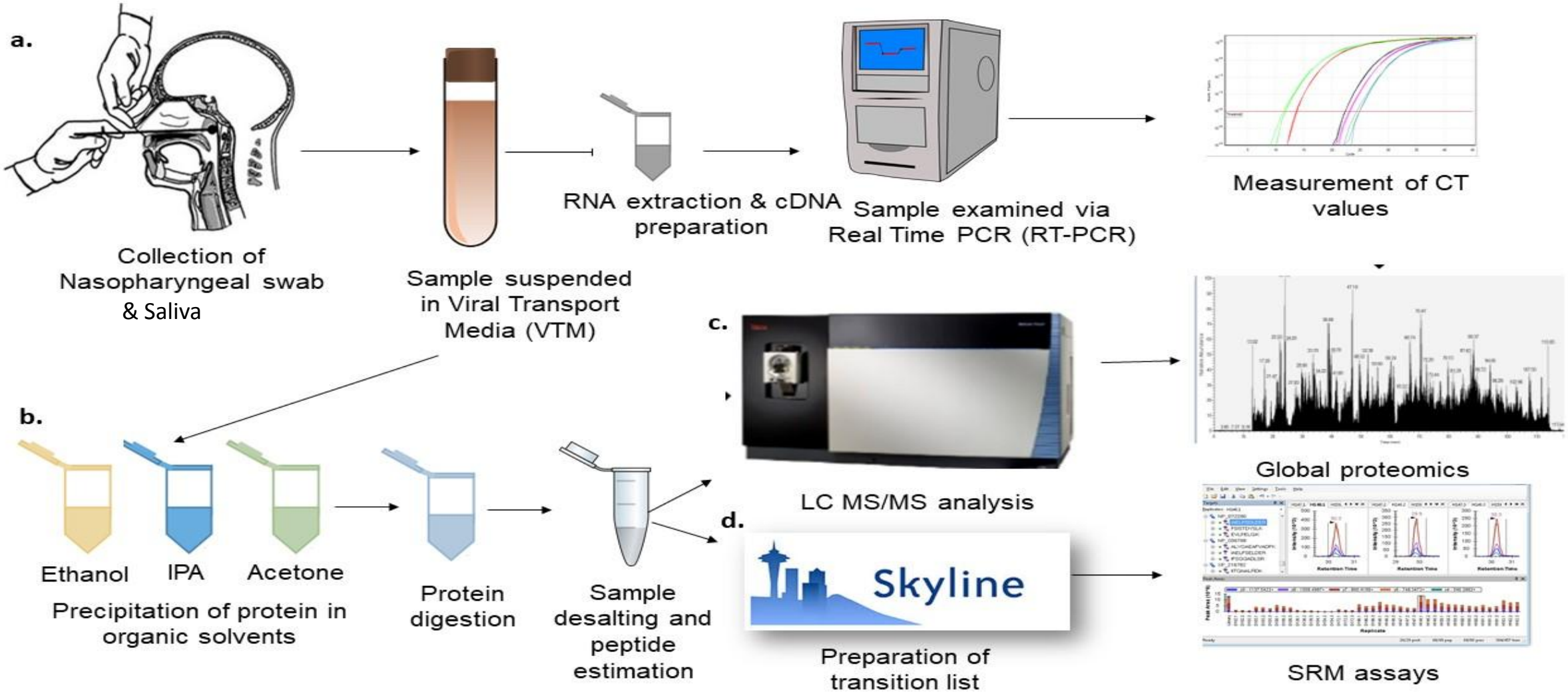


Kumar V. et al.. ***Frontiers Oncology (Rev), 2020***

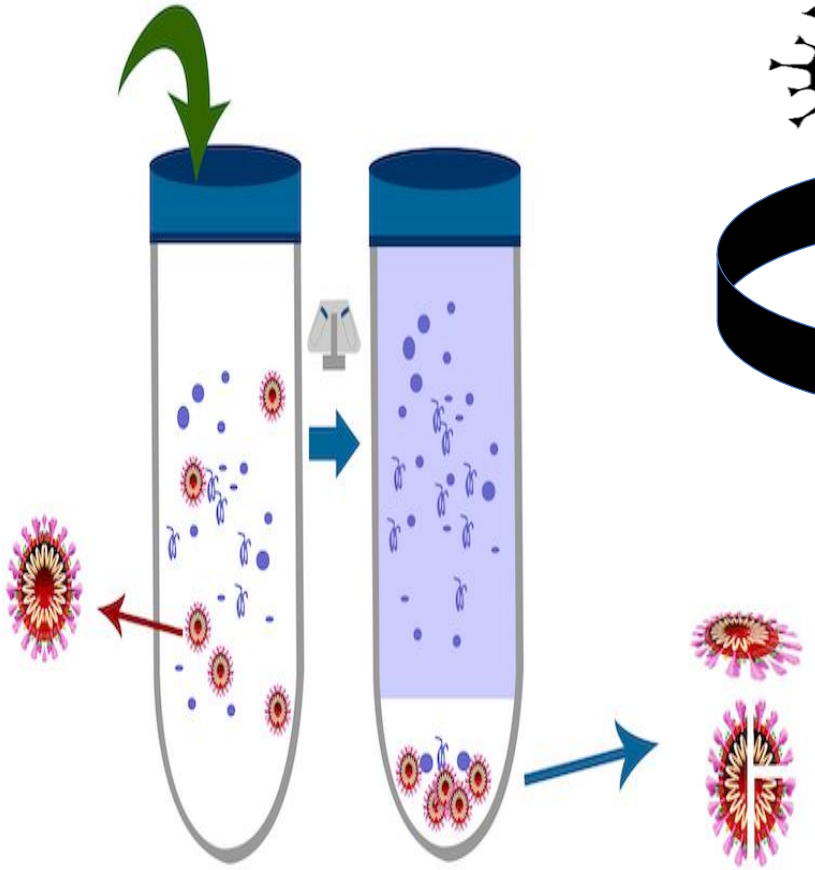

Nasopharyngeal Swab Proteomics: SARS-CoV-2 peptide detection using Mass Spectrometry

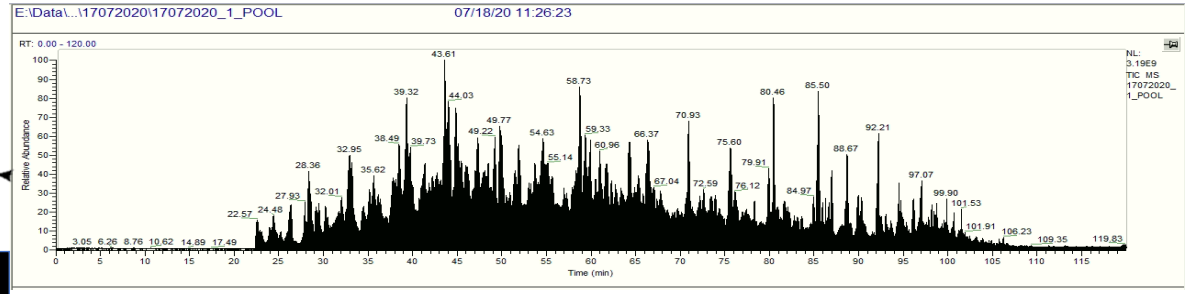
Proteomics Workflow for SARS-CoV-2 Detection

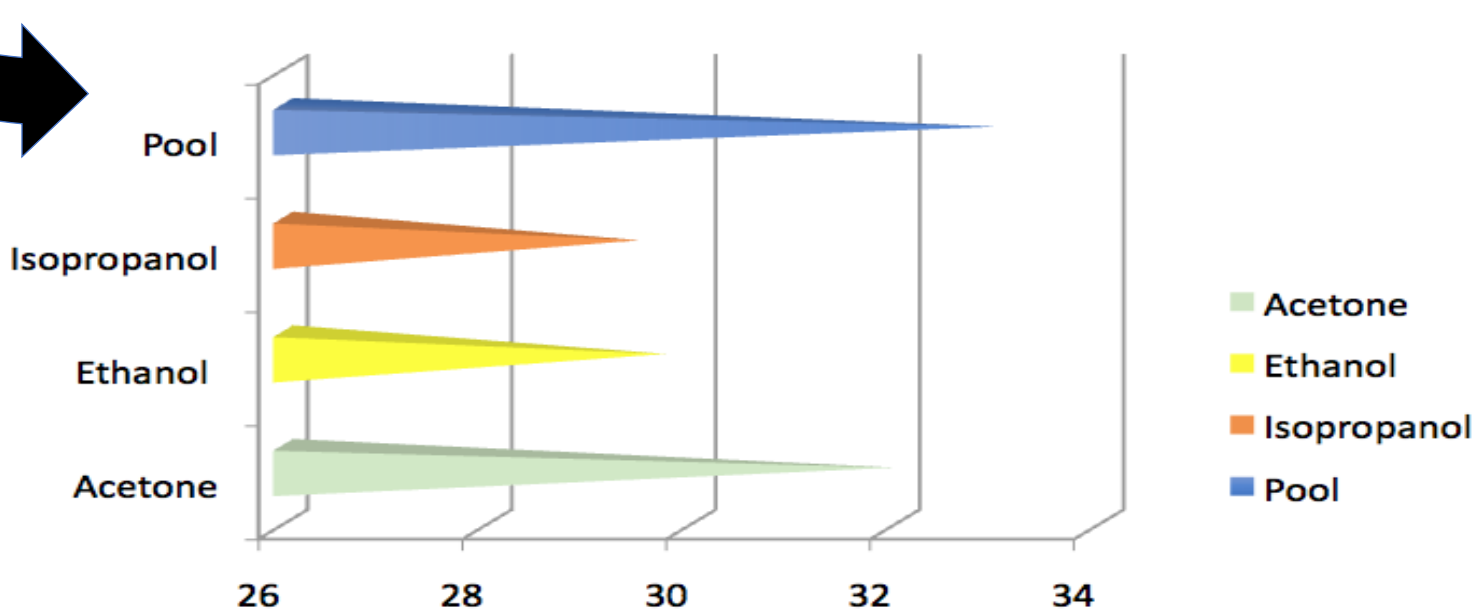
From NP Swab



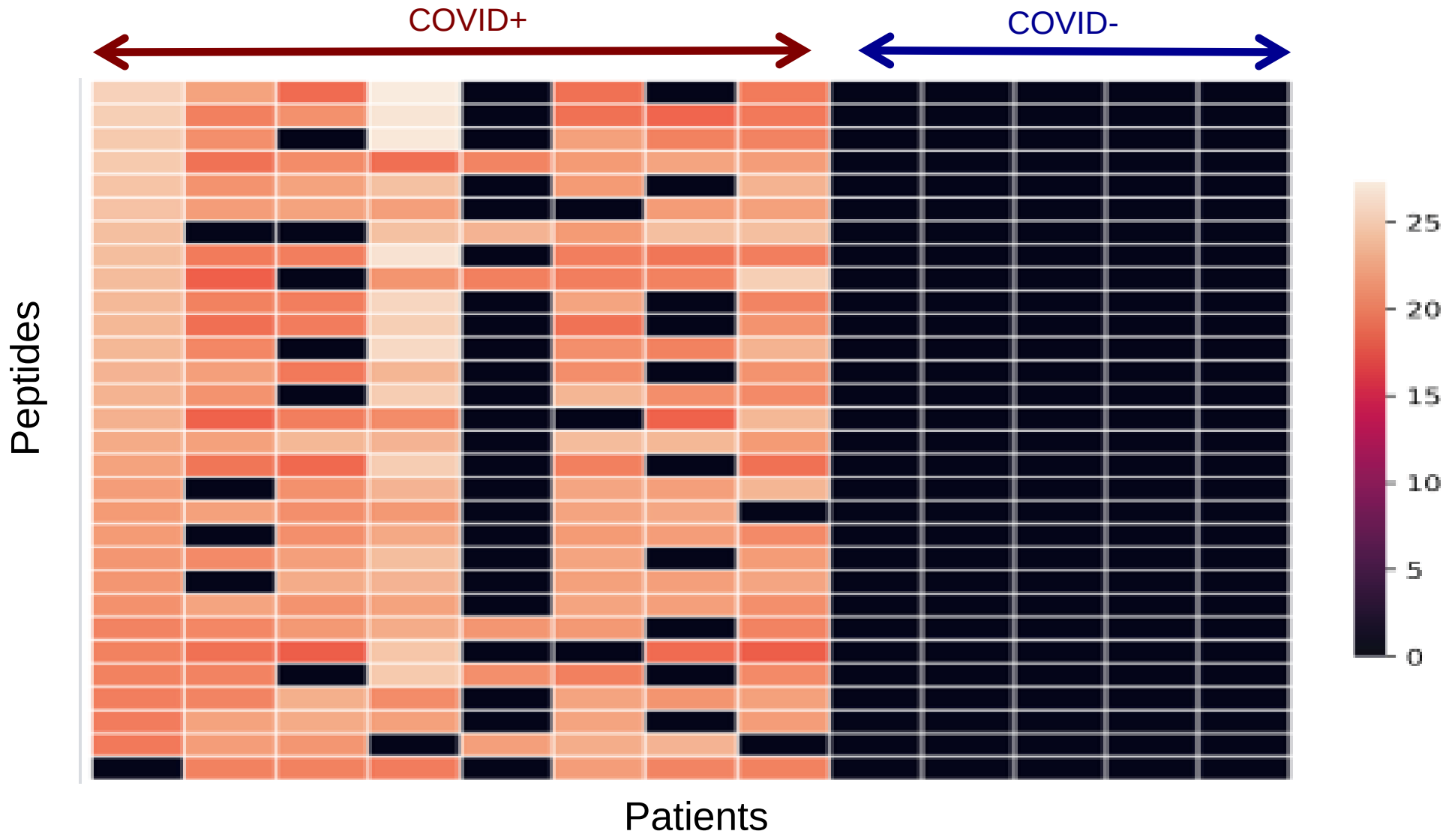
How to capture SARS-CoV-2 Peptides/ Proteins: Need to investigate various extraction methods!



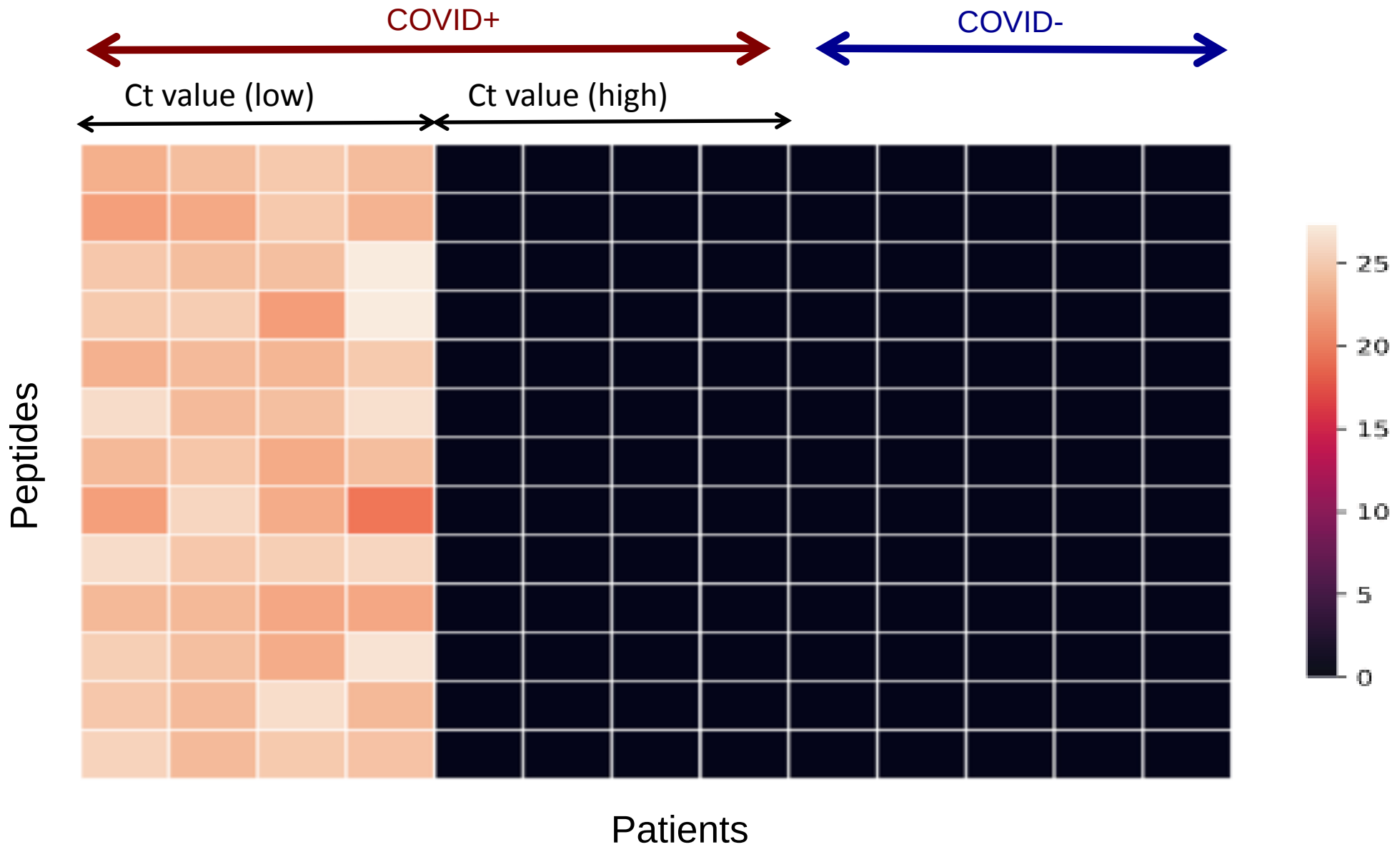


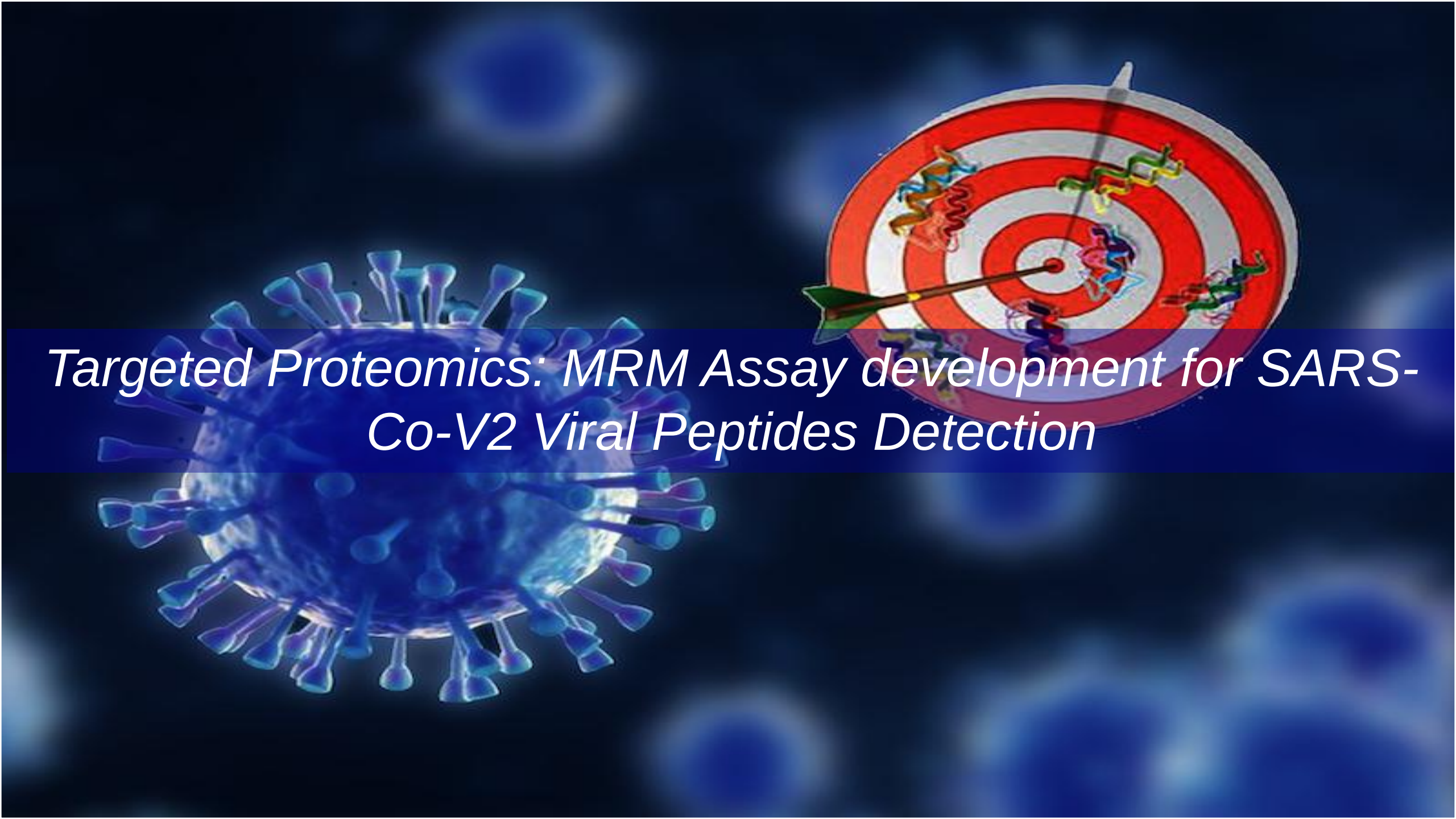


Viral peptides identified from respiratory specimen of COVID-19 patients

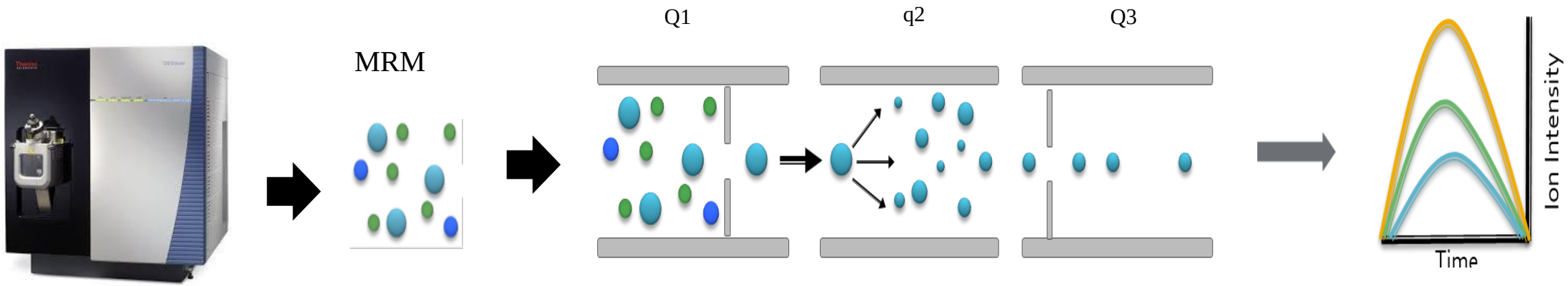


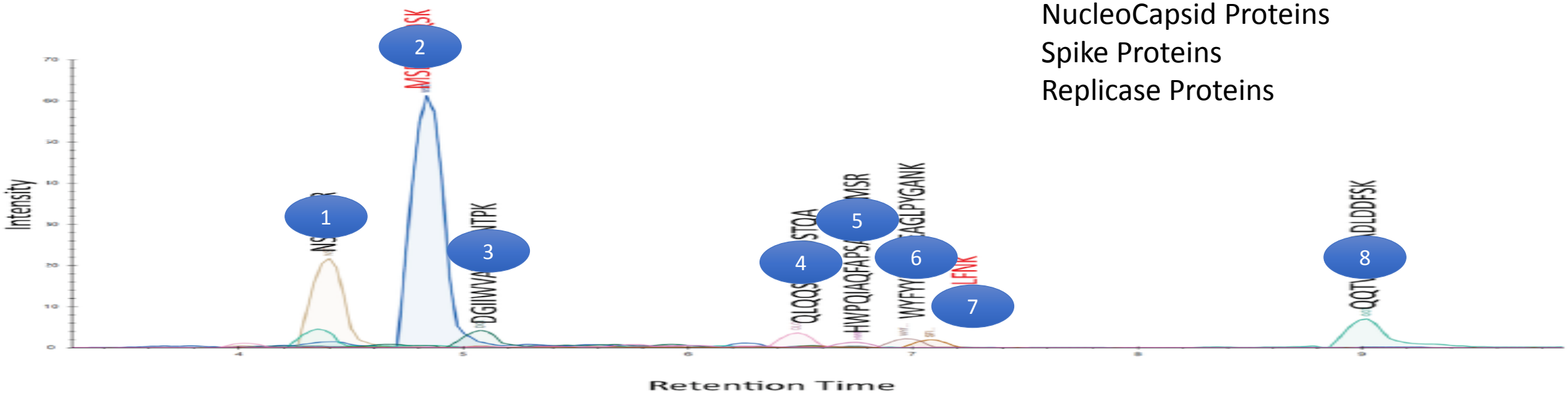
Viral associated peptides correlation with Ct values




Targeted Proteomics: MRM Assay development for SARS-Co-V2 Viral Peptides Detection

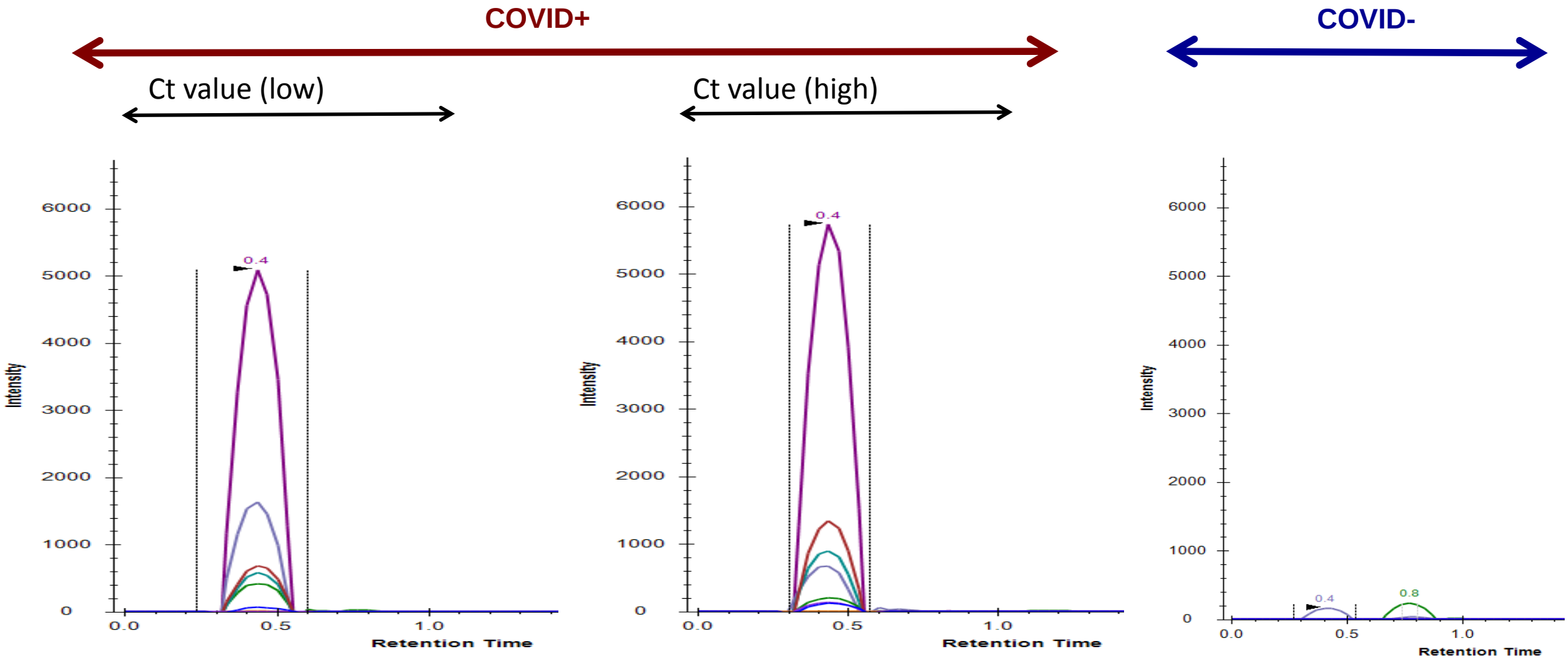
Detection of Viral Peptides Using MRM Assay





NucleoCapsid Proteins
Spike Proteins
Replicase Proteins

Development of MRM Assays from NP Swab Samples

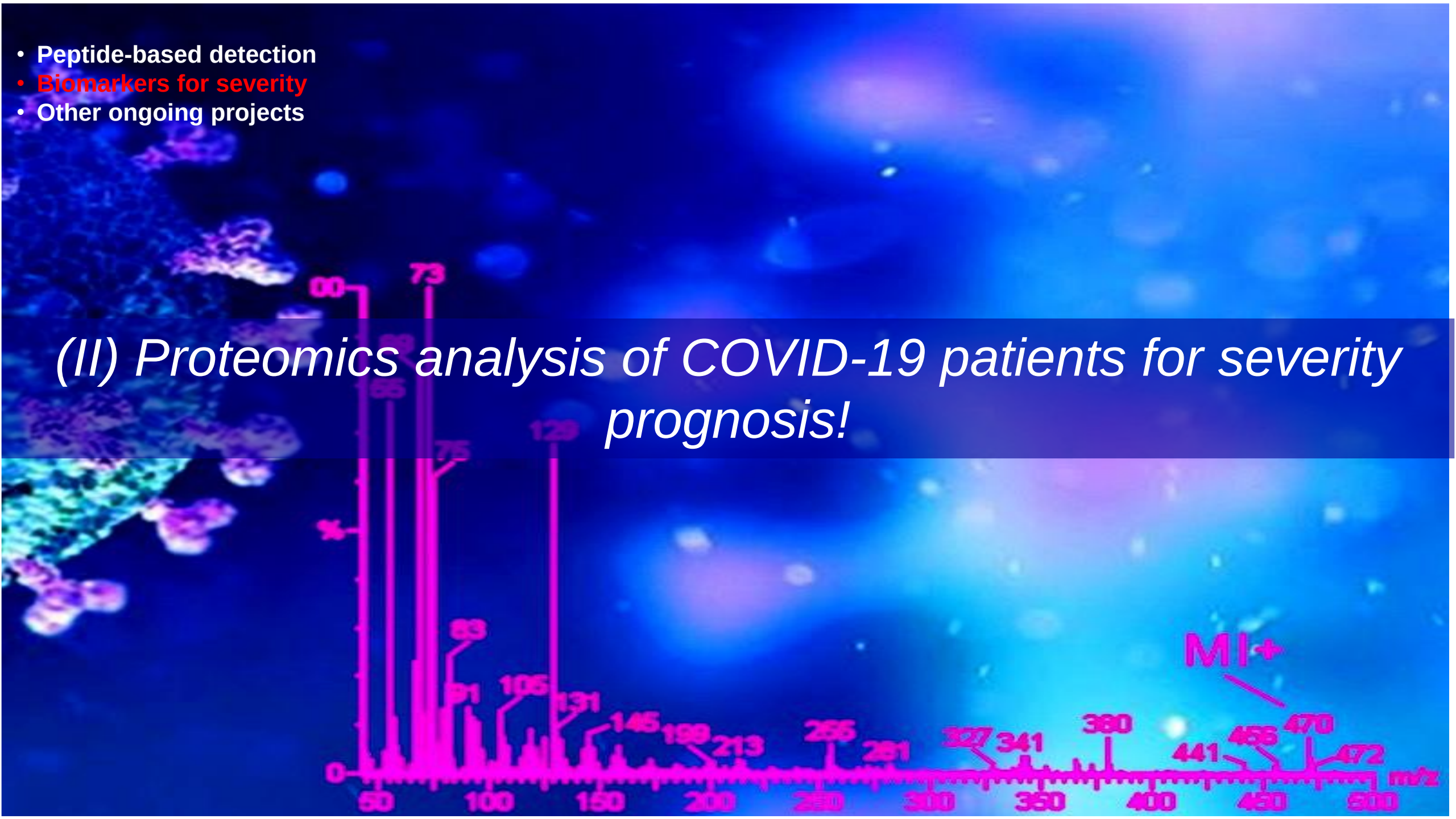


IDF: PAT/BS/SS-9/20-21

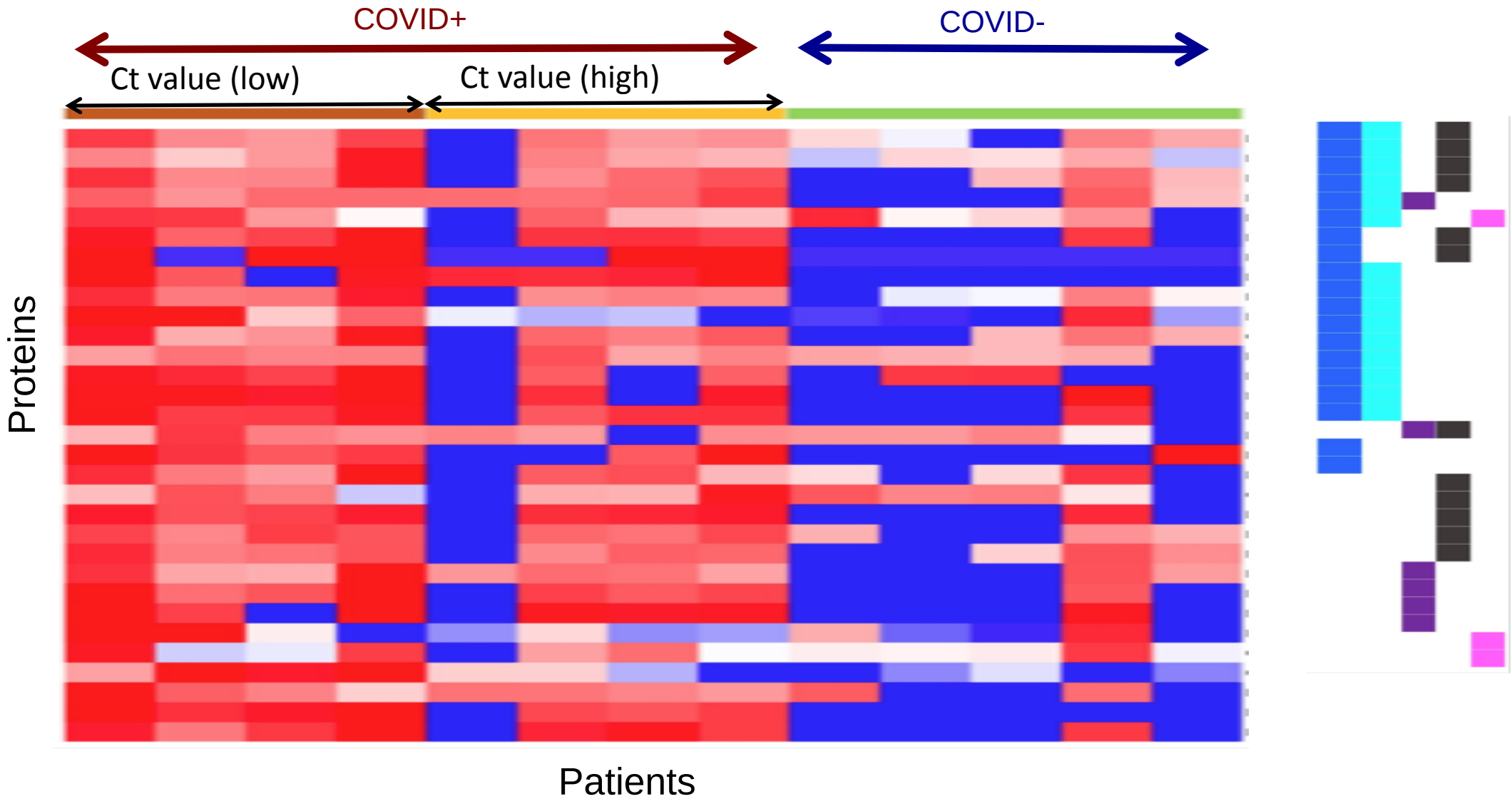
Next….Detection of SARS-Co-V2 Viral Peptides from Saliva?

- Peptide-based detection
- Biomarkers for severity
- Other ongoing projects

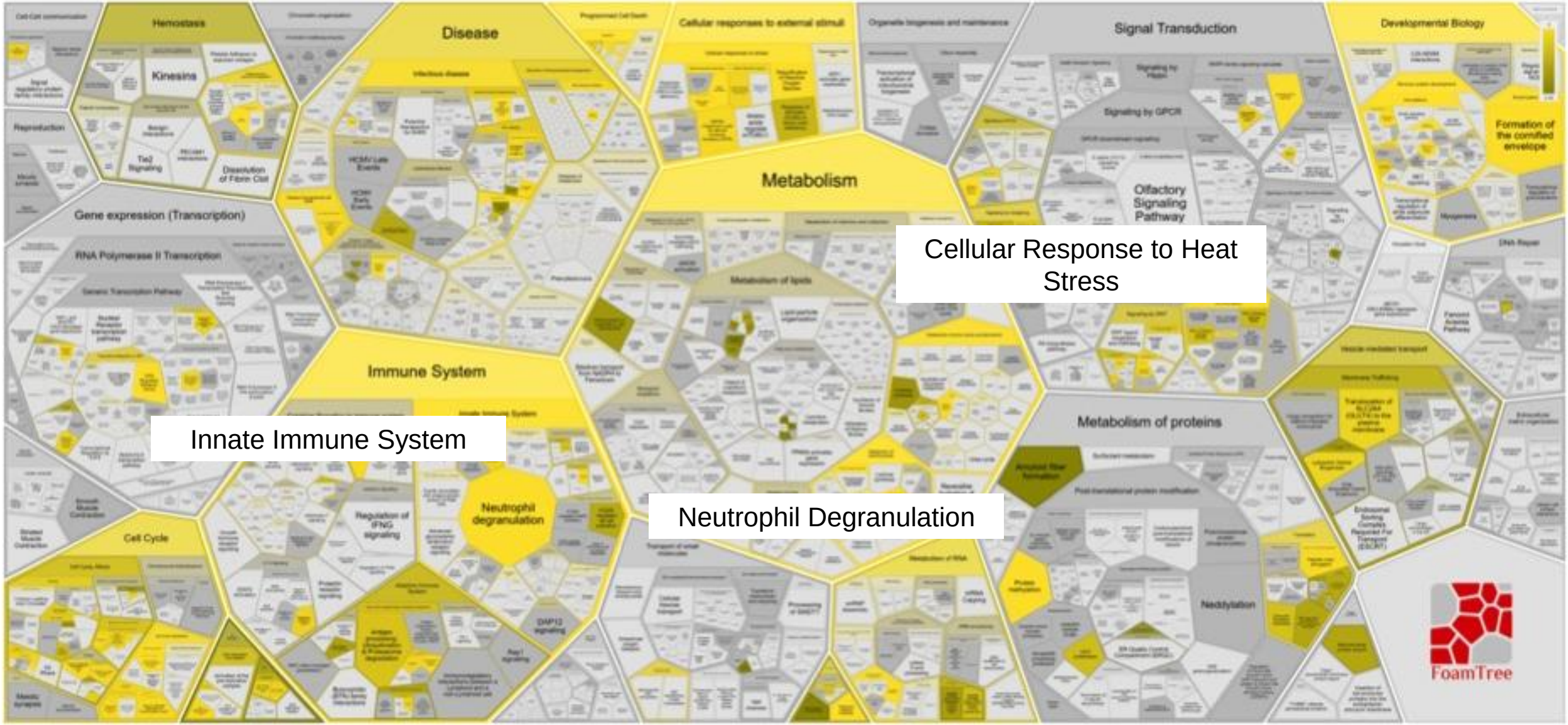
(II) Proteomics analysis of COVID-19 patients for severity prognosis!



Host proteins modulated in respiratory specimen of COVID-19 patients

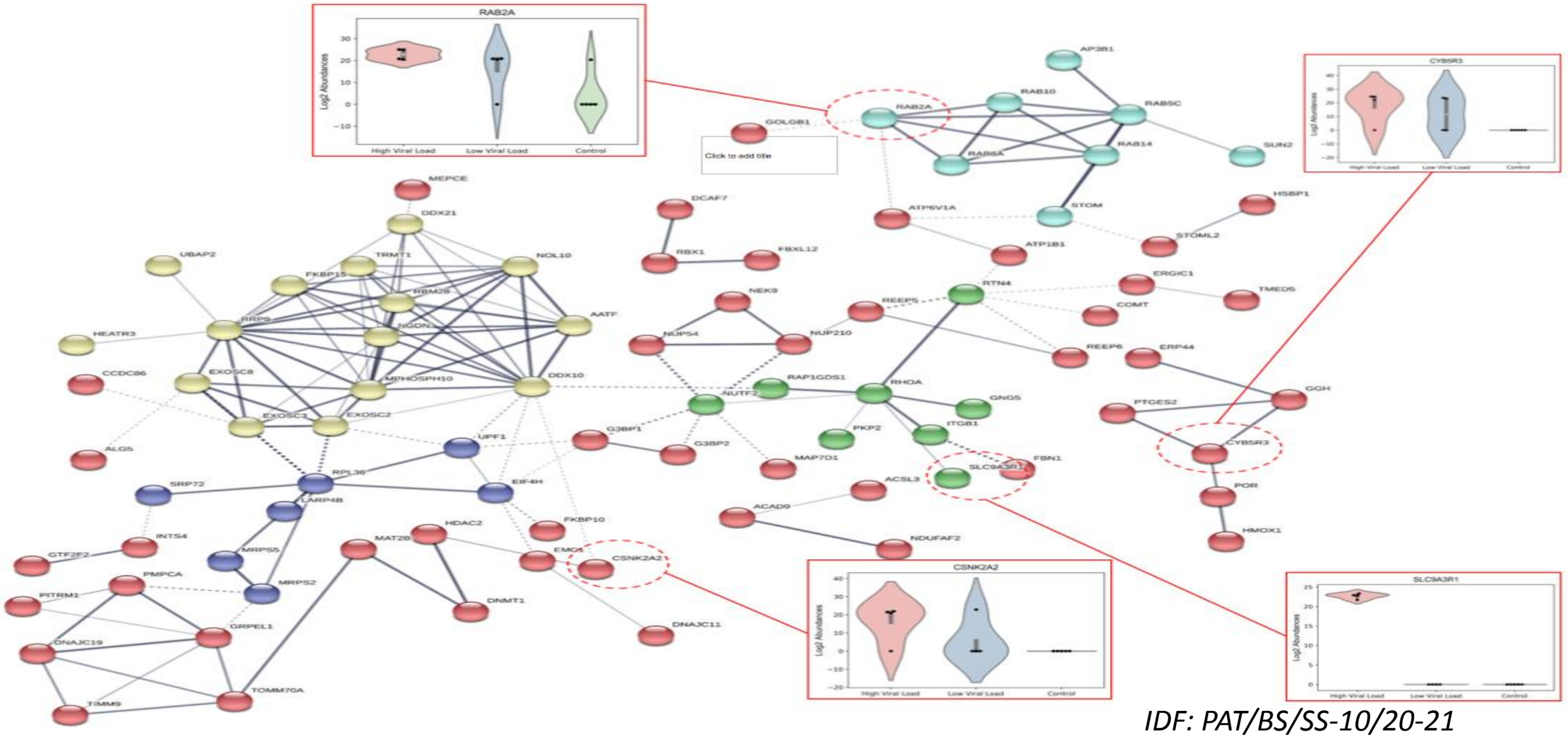


A landscape of Pathways modulated in COVID-19 patients



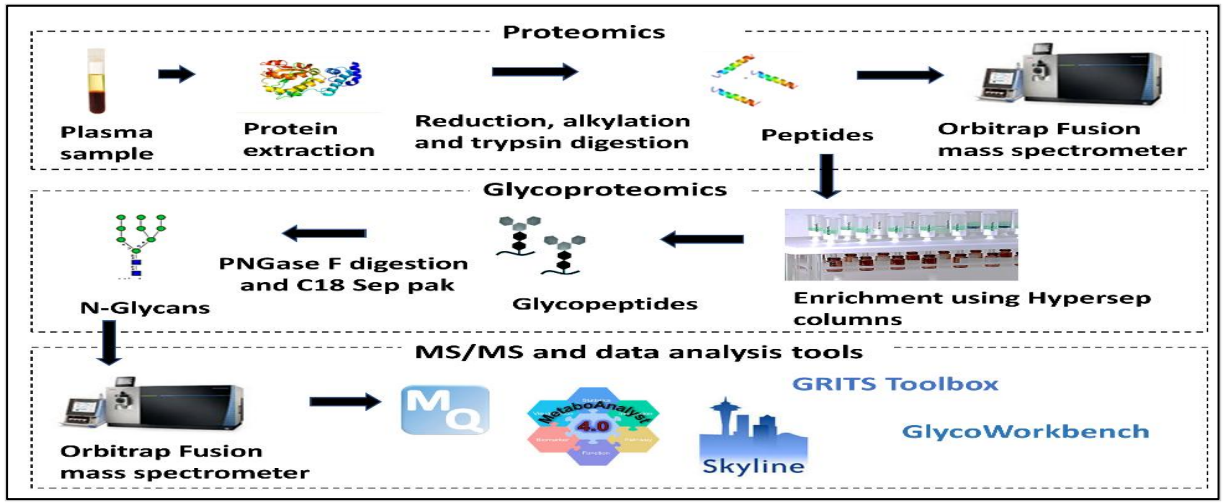

Identified host proteins compared with SARS-CoV-2 interacting proteins of Human Protein Atlas
Ref: https://doi.org/10.1038/s41586-020-2286-9

Host-COVID-19 Interaction Map & Biomarkers for Severity Prognosis

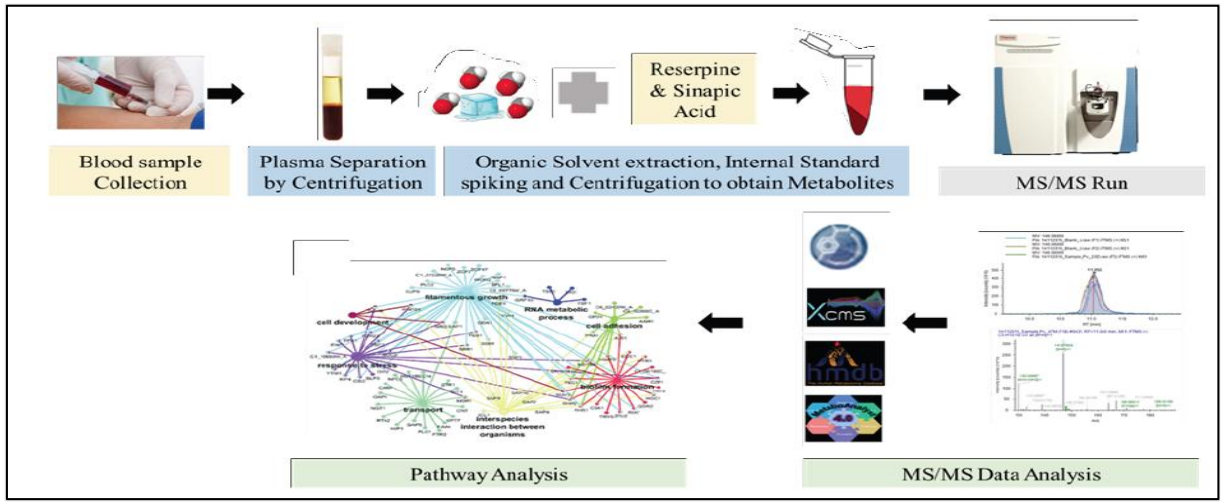


IDF: PAT/BS/SS-10/20-21

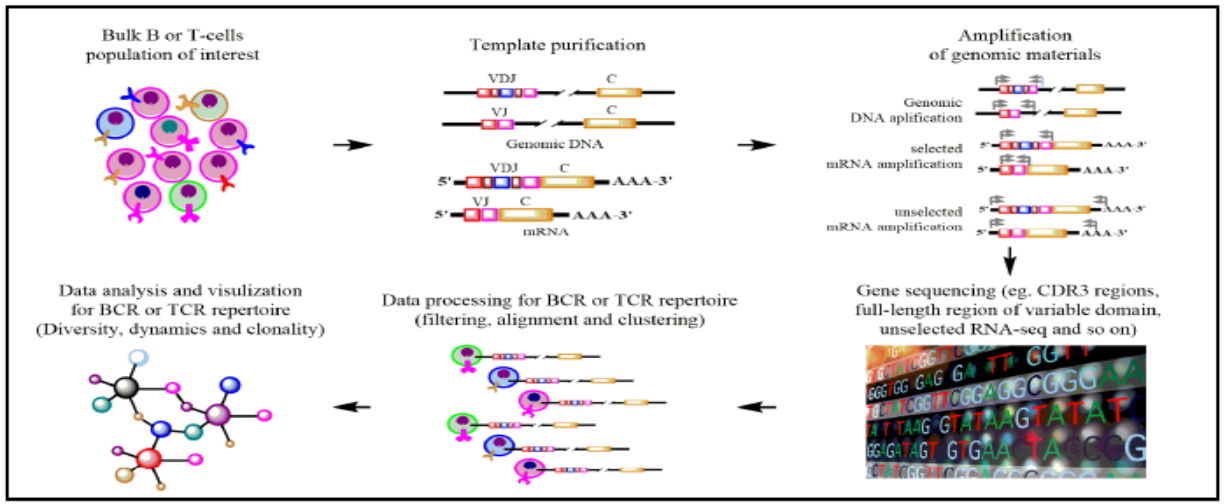
Other initiatives on COVID-19!



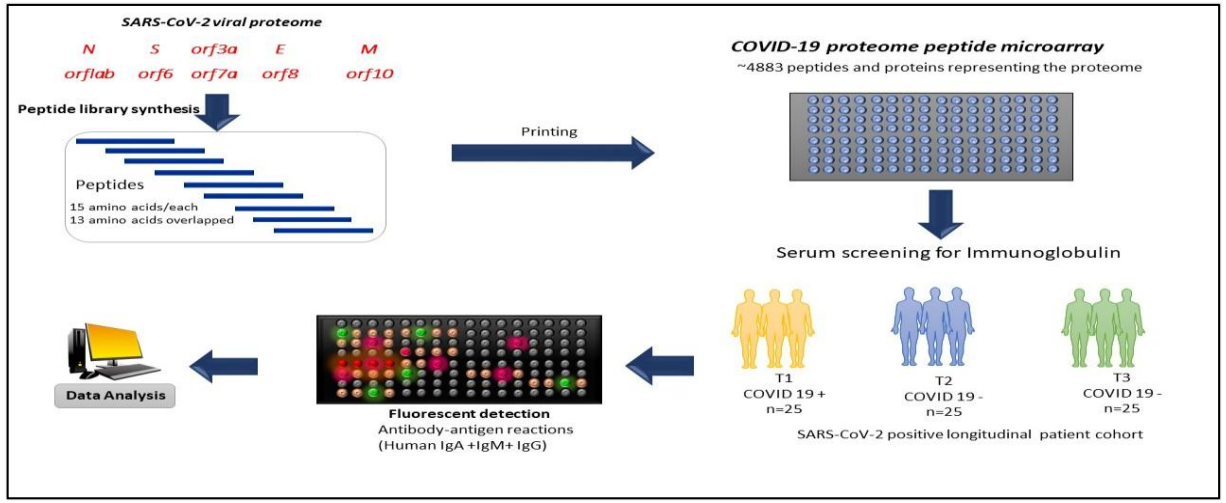
Proteomics investigation – targets for diagnosis



Metabolomics investigation – therapeutics



NGS - Immune system repertoire



Microarrays – epitope mapping & antibody response

Summary:

- Identification of peptides/ proteins that can aid diagnosis of SARS-CoV-2 from the nasal swab (& potentially Saliva) from COVID-19 patients using HT-MS platforms
- Implementation of global & targeted proteomics workflow to identify most significantly altered host proteins for severity prediction and prognostic value
- Other projects…epitope mapping, identification of targets for therapeutics

Thanks to Clinicians & Team of COVID-19 Project

Acknowledgement

Science and Engineering Research Board

IIT Bombay

Industrial Research and Consultancy Centre

sanjeeva@iitb.ac.in

Tapestry Pooling

IITB-InStem-NCBS-Wyss

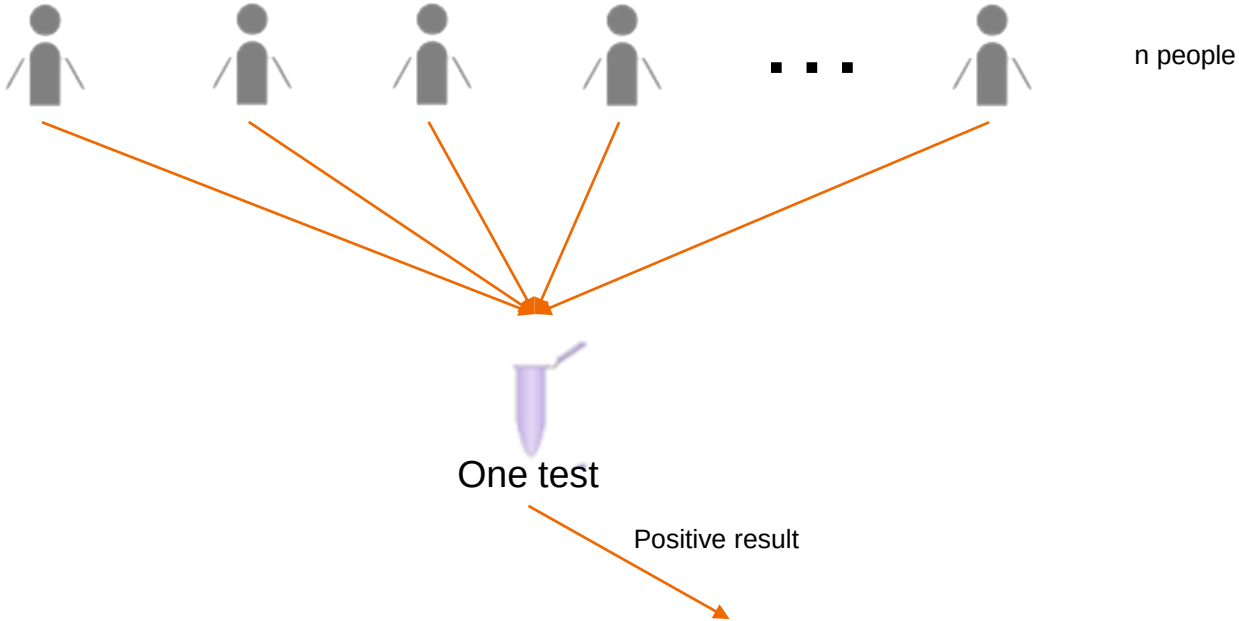
Asymptomatic super spreaders

Test ➔ Ease Lockdown ➔ Reboot Economy

<u>Enhance PCR testing</u>
More results per test
Faster
Conserve Effort
Conserve PPE, Kit, Reagents
High prevalence

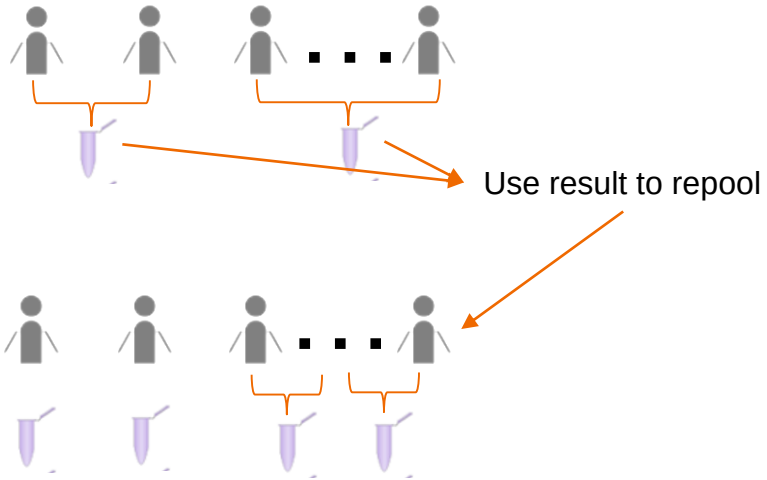
Tapestry Pooling

Pooling

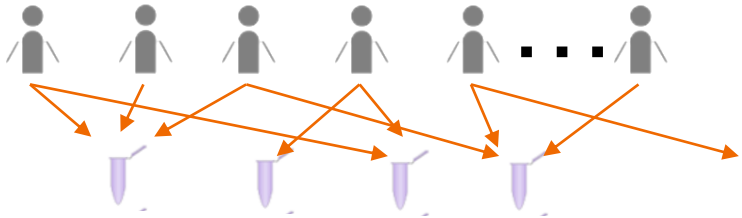


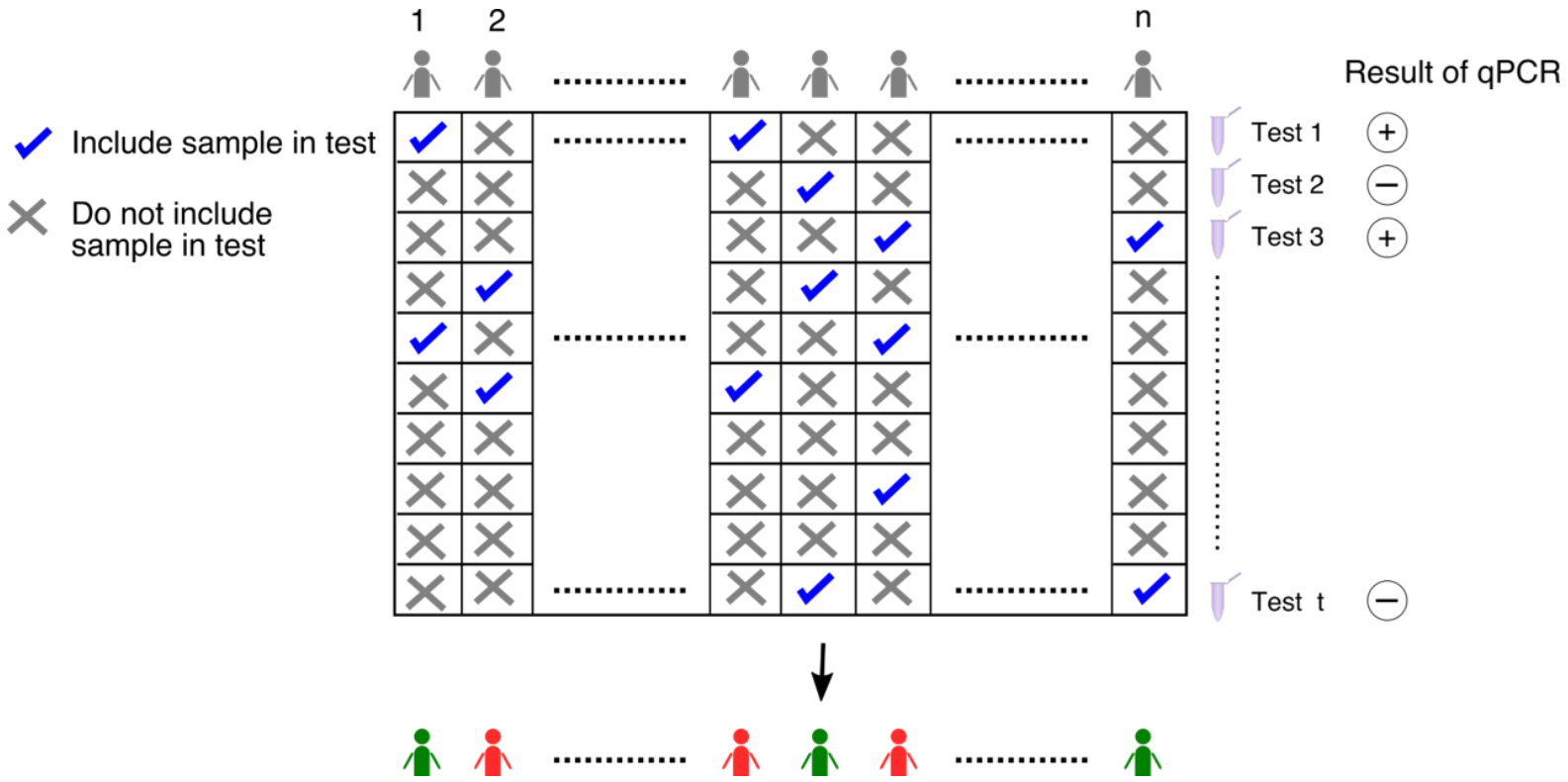
- Don’t know which individual(s) are positive
- Do more tests or quarantine all

Dorfman Pooling



Tapestry Pooling




1
2
n
Result of qPCR
Include sample in test
Do not include sample in test
Test 1
Test 2
Test 3
Test t

Patient Samples

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	Ct Values
T1		1											1	1				1																1	1				1			
T2		1			1						1						1							1			1								1							
T3						1		1	1			1											1							1		1										30.93
T4	1		1		1										1						1				1				1		1										
T5						1				1				1			1				1									1					1							
T6				1								1						1		1				1											1	1						
T7								1		1															1		1											1	1	1		
T8											1		1						1			1	1													1					31.04
T9	1															1						1						1			1	1					1			30.54
T10	1			1				1											1							1					1					1				
T11			1							1						1	1								1								1	1			1			1		
T12		1					1								1	1				1			1					1													
T13			1				1					1	1								1					1	1	1													
T14														1	1									1		1			1			1				1				
T15					1				1										1	1								1						1	1					1		30.67
T16				1		1	1		1													1						1				1						1		30.17

30.8

30.8

Each sample : 3 pools
Quantitative

Pool Ct values: $y = (y_1, y_2, \ldots, y_m)'$
Sample viral loads: $x=(x_1, x_2, \ldots, x_n)'$
A: Pooling Matrix

Solve $Ax = y$ for sparse x
Compressed Sensing (CS).

Viable upto 20% prevalence

Quantitative reconstruction

Conserves kits

Single round: Fast Results, Less work, Save PPE

Prior information

Tapestry Pooling by Numbers

Samples	Tests	Prevalence rate	Pool size
50	30	20%	5
72	36	12%	6
105	45	10%	7
70	21	5.71%	10
195	45	4.1%	13
399	63	2.5%	19
961	93	1%	31

Experimental Validation

Synthetic COVID-19 RNA genome spiked into mock samples.

120 samples in 40 tests with 3 positives

- Correctly identified all 3

1140 samples in 90 tests with 11 positives

- 18 minutes pipetting with a liquid handling robot!
- Correctly identified all 11 positives
- Three false positives

Clinical Trials with COVID19 samples (Ongoing)

105 samples in 45 tests with 7,8 positives

- Correctly identified all 210 samples

320 samples in 48 tests with 5 positives

- Correctly identified all 320 samples

500 samples in 60 tests with 10 positives

- No false negatives, 5 false positives

Use Cases

- Clinical Testing

- Campus Screening

Guarantees

Graceful failure: Batch to batch variation in prevalence

Sparse: Small Pool Sizes. Less Pipetting

Robust to errors in pipetting, contamination

Tested: 2000 clinical samples*

*Clinical trials projected to finish by July 27

Team

At IIT Bombay

Manoj Gopalkrishnan, Ajit Rajwade,Sabyasachi Ghosh, others

Phone App: Aditya Gupta, Vidhya Appu, Raunak Ramakrishnan, others

At NCBS-InStem

Dasaradhi P, Sandeep Krishna, Srikar Krishna, Anirudh, Sriram Varahan, Vinay Sagar, others

At Wyss Institute - Harvard Medical School

Peng Yin, Nikhil Gopalkrishnan, Thomas Schauss

MG and AR thank WRCB and DST for funding

UVC-BASED STERILIZATION UNITS AND OTHER INITIATIVES

Prof. Ambarish Kunwar
Department of Biosciences and Bioengineering
Indian Institute of Technology Bombay

akunwar@iitb.ac.in

http://www.bio.iitb.ac.in/~akunwar/

Routes of exposure to infectious agents

- Inhalation of infectious aerosols.
- Contact of the agent with the skin, eyes or mucous membrane.
- Inoculation by contaminated sharps.
- Bites from infected animals or contact with their body fluids.
- Ingestion of infectious agent through mouth pipetting or contaminated hands.

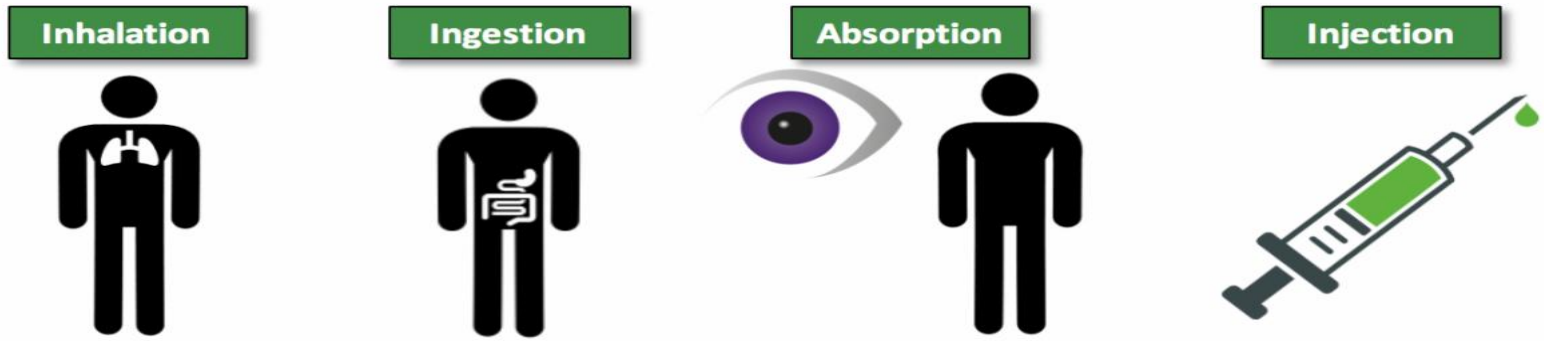


Figure Source: https://riskmanagement.unt.edu/hcs-ghs-module2

Routes of exposure to infectious agents: Aerosols and fomite

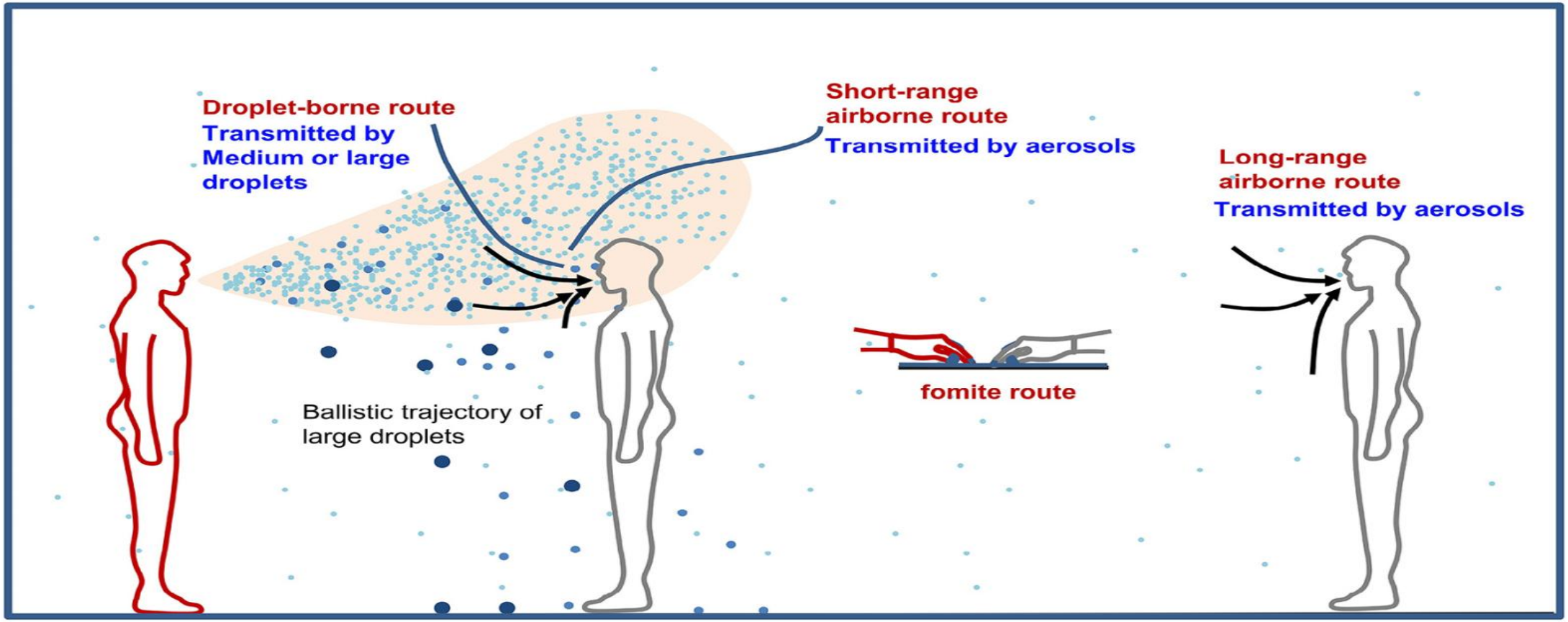
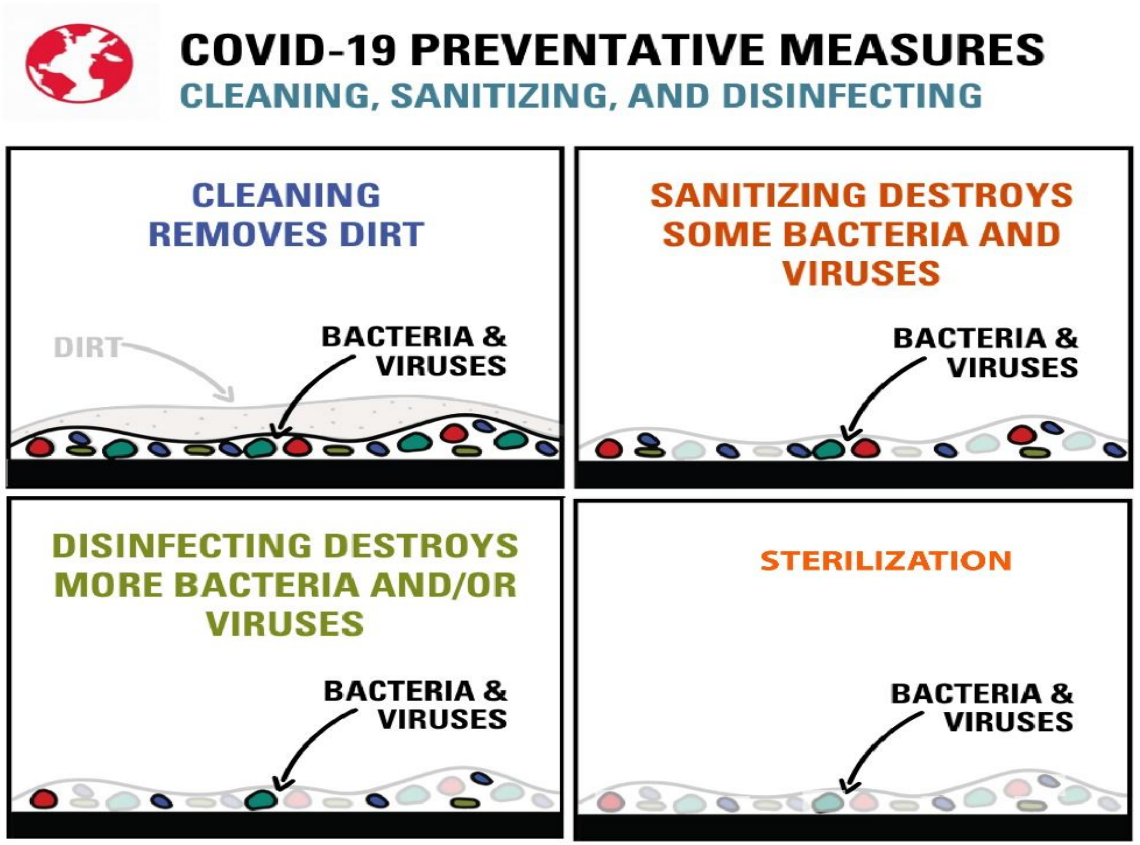
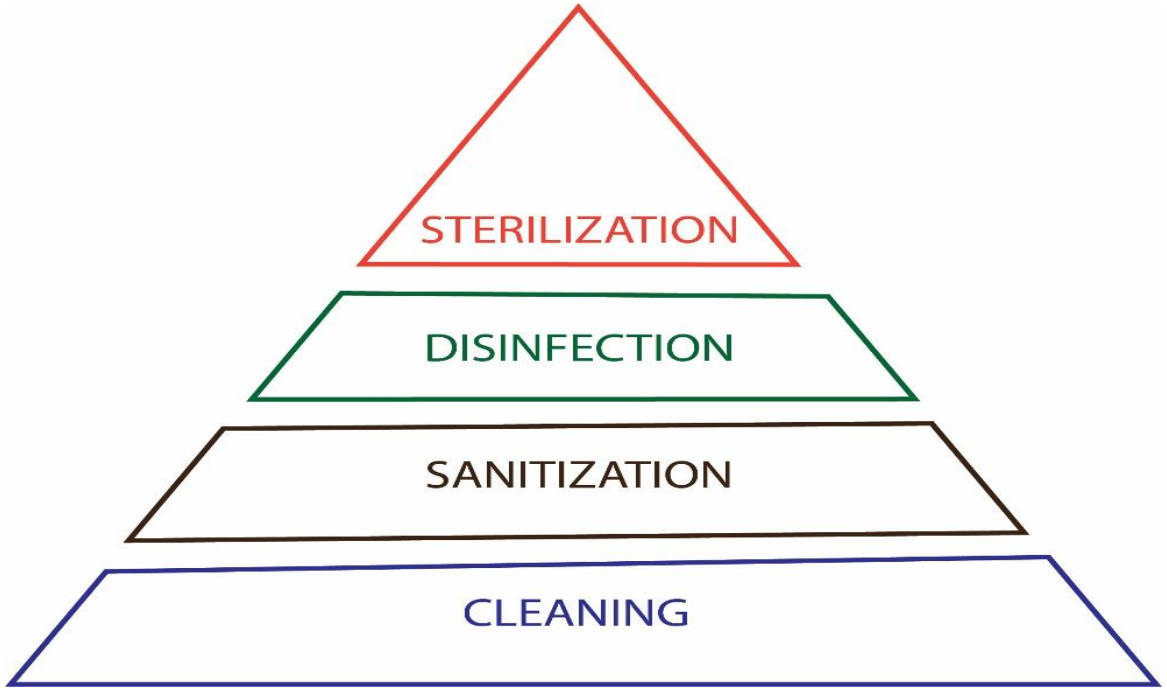


Figure Source: J. Wei, Y. Li / American Journal of Infection Control 44 (2016) S102-S108

Cleaning, Sanitization, Disinfection and Sterilization





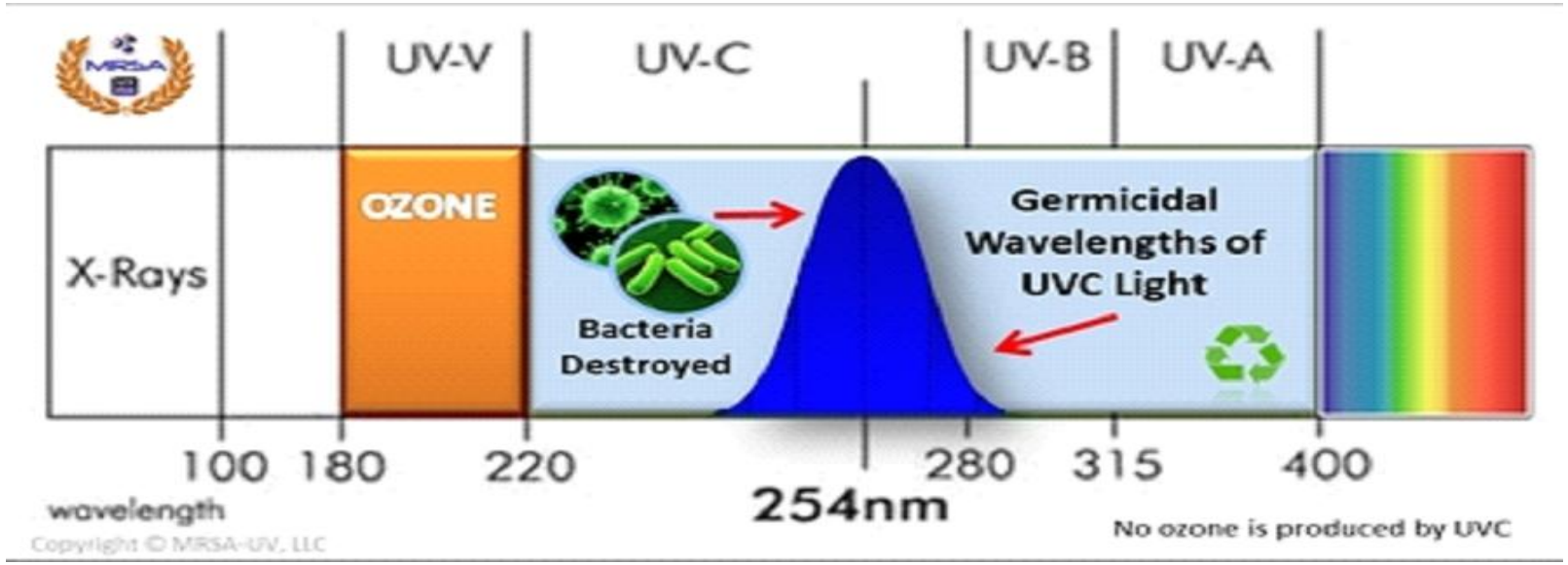
Adapted from: https://foodsafety.ces.ncsu.edu/2020/04/cleaning-and-disinfecting/

Methods of Sterilization

- Dry Heat Sterilization

- Steam Sterilization –autoclaves
- Chemical Sterilization-Alochol, Bleach, Sodium Hypochorite etc.
- Filtration
- Gas Sterilization-Ozone, Hydrogen Peroxide Vapour etc.
- Sterilization via ionizing radiation – Gamma radiation, X-ray
- Sterilization via non-ionizing radiation- UV radiation

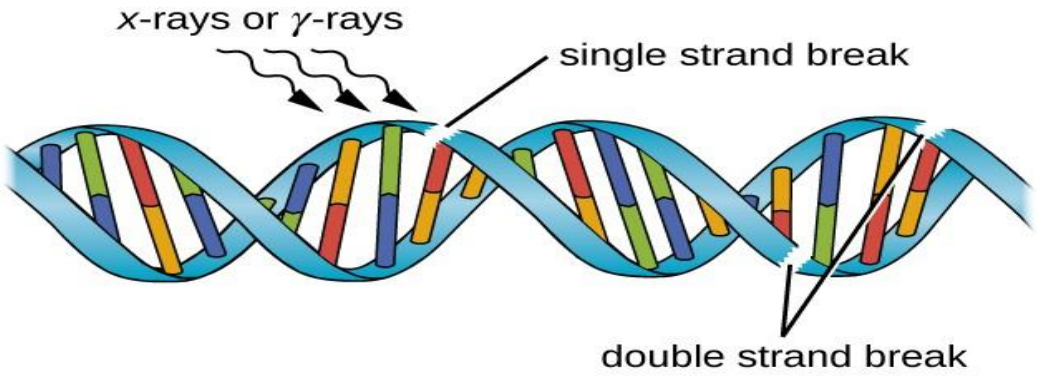
UV radiation



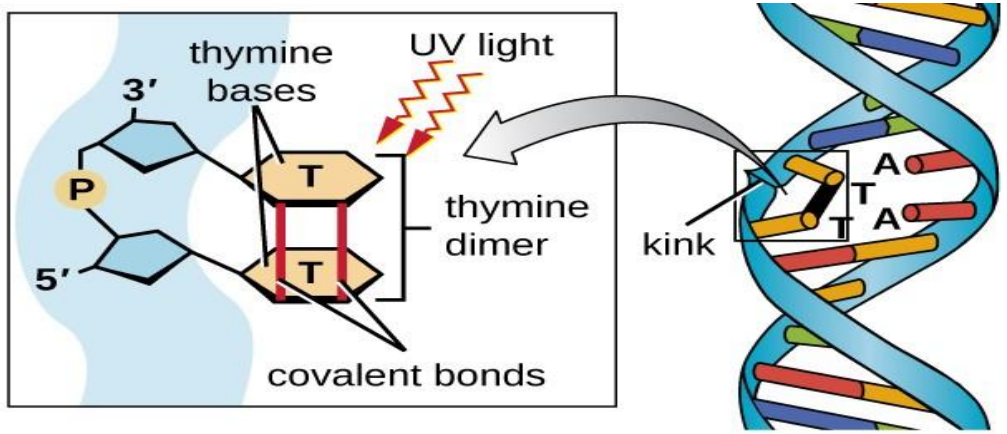
UV-A (long-wave)	from 315 to 400 nm
UV-B (medium-wave)	from 280 to 315 nm
UV-C (short-wave)	from 100 to 280 nm

Germicidal action of UV radiation

- The mechanism of UVC inactivation of microorganisms is to damage the genetic material in the nucleus of the cell or nucleic acids in the virus.
- The UV damage to the DNA and RNA of a microorganism often results from the dimerization of pyrimidine molecules. In particular, thymine (which is only found only in DNA) produces cyclobutane dimers.



(a) Ionizing radiation



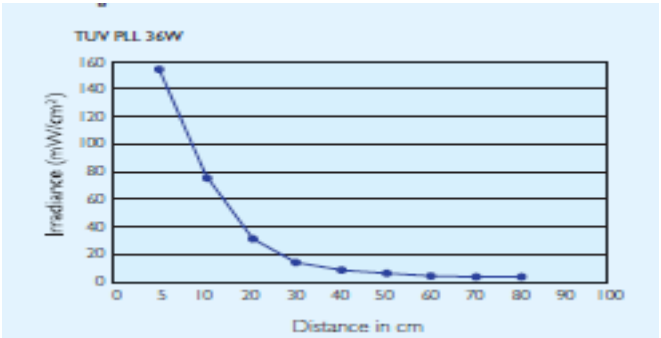
(b) Non-ionizing radiation

Figure Source: https://courses.lumenlearning.com/microbiology/chapter/mutations/

UV Dose and Log Inactivation

UV Dose = Irradiance x time

joule/ m^2 watt/m^2 sec



Log Inactivation = log N(0)/N(t)

1 log inactivation = 90% killing

2 log inactivation = 99% killing

3 log inactivation = 99.9% killing

4 log inactivation = 99.99% killing

5 log inactivation = 99.999% killing

Figure Source: https://www.assets.signify.com/is/content/PhilipsLighting/Assets/philips-lighting/global/20200504-philips-uv-purification-application-information.pdf

UV Dose (1 log inactivation)

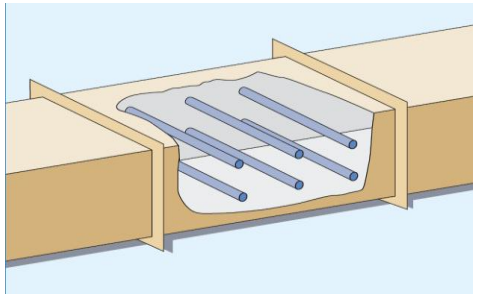
Bacteria	Dose	k
Bacillus anthracis	45.2	0.051
B. megatherium sp. (spores)	27.3	0.084
B. megatherium sp. (veg.)	13.0	0.178
B. parathyphosus	32.0	0.072
B. suptilis	71.0	0.032
B. suptilis spores	120.0	0.019
Campylobacter jejuni	11.0	0.209
Clostridium tetani	120.0	0.019
Corynebacterium diphteriae	33.7	0.069
Dysentery bacilli	22.0	0.105
Eberthella typhosa	21.4	0.108
Escherichia coli	30.0	0.077
Klebsiella ternifani	26.0	0.089
Legionella pneumophila	9.0	0.256
Micrococcus candidus	60.5	0.038
Micrococcus sphaeroides	100.0	0.023
Mycobacterium tuberculosis	60.0	0.038
Neisseria catarrhalis	44.0	0.053
Phytomonas tumefaciens	44.0	0.053
Pseudomonas aeruginosa	55.0	0.042
Pseudomonas fluorescens	35.0	0.065
Proteus vulgaris	26.4	0.086
Salmonella enteritidis	40.0	0.058
Salmonella paratyphi	32.0	0.072
Salmonella typhimurium	80.0	0.029
Sarcina lutea	197.0	0.012
Seratia marcescens	24.2	0.095
Shigella paradysenteriae	16.3	0.141
Shigella sonnei	30.0	0.077
Spirillum rubrum	44.0	0.053
Staphylococcus albus	18.4	0.126
Staphylococcus aureus	26.0	0.086
Streptococcus faecalis	44.0	0.052
Streptococcus hemoluticus	21.6	0.106
Streptococcus lactus	61.5	0.037
Streptococcus viridans	20.0	0.115
S.entertidis	40.0	0.057
Vibrio chlolerae (V.comma)	35.0	0.066
Yersinia enterocolitica	11.0	0.209

Yeasts	Dose	k
Bakers' yeast	39	0.060
Brewers' yeast	33	0.070
Common yeast cake	60	0.038
Saccharomyces cerevisiae	60	0.038
Saccharomyces ellipsoideus	60	0.038
Saccharomyces sp.	80	0.029
Mould spores		
Aspergillus flavus	600	0.003
Aspergillus glaucus	440	0.004
Aspergillus niger	1320	0.0014
Mucor racemosus A	170	0.013
Mucor racemosus B	170	0.013
Oospora lactis	50	0.046
Penicillium digitatum	440	0.004
Penicillium expansum	130	0.018
Penicillium roqueforti	130	0.018
Rhizopus nigricans	1110	0.002
Virus		
Hepatitis A	73	0.032
Influenza virus	36	0.064
MS-2 Coliphase	186	0.012
Polio virus	58	0.040
Rotavirus	81	0.028
Protozoa		
Cryptosporidium parvum	25	0.092
Giardia lamblia	11	0.209
Algae		
Blue Green	3000	0.0008
Chlorella vulgaris	120	0.019

Figure Source: https://www.assets.signify.com/is/content/PhilipsLighting/Assets/philips-lighting/global/20200504-philips-uv-purification-application-information.pdf

Applications of UV disinfection

Water
Domestic water
Ultra pure water
Waste water
Process water
Industrial drinking water
Fish ponds
Aquaria
Swimming pool
Agricultural recycling
Air
Space/upper air
Forced air/airco
Cooling coils
Dish dryer etc.
Surfaces
Food processing
Packaging



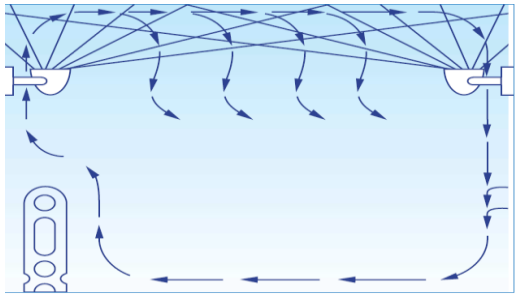


Figure Source: https://www.assets.signify.com/is/content/PhilipsLighting/Assets/philips-lighting/global/20200504-philips-uv-purification-application-information.pdf

UVC-based Sterilization Solutions developed at IIT Bombay

- Existing liquid based method: soap solutions, alcohol based sanitizer, beach solution, steam are not suitable due to presence of various delicate materials/electronics and time/error involved in manual disinfection

- The germicidal effect of UV-C light is well recognized and it kills various types of pathogenic bacteria and viruses including emerging viruses such (SARS-CoV), Crimean-Congo haemorrhagic fever virus (CCHFV) and Nipah virus (NiV).

Similar articles

Inactivation of Ebola virus and Middle East respiratory syndrome coronavirus in platelet concentrates and plasma by ultraviolet C light and methylene blue plus visible light, respectively.

Eickmann M, Gravemann U, Handke W, Tolksdorf F, Reichenberg S, Müller TH, Seltsam A.

Transfusion. 2018 Sep;58(9):2202-2207. doi: 10.1111/trf.14652. Epub 2018 May 6.

PMID: 29732571

Reduction of Zika virus infectivity in platelet concentrates after treatment with ultraviolet C light and in plasma after treatment with methylene blue and visible light.

Fryk JJ, Marks DC, Hobson-Peters J, Watterson D, Hall RA, Young PR, Reichenberg S, Tolksdorf F, Sumian C, Gravemann U, Seltsam A, Faddy HM.

Transfusion. 2017 Nov;57(11):2677-2682. doi: 10.1111/trf.14256. Epub 2017 Jul 17.

PMID: 28718518

Inactivation of yellow fever virus in plasma after treatment with methylene blue and visible light and in platelet concentrates following treatment with ultraviolet C light.

Faddy HM, Fryk JJ, Hall RA, Young PR, Reichenberg S, Tolksdorf F, Sumian C, Gravemann U, Seltsam A, Marks DC.

Transfusion. 2019 Jul;59(7):2223-2227. doi: 10.1111/trf.15332. Epub 2019 May 3.

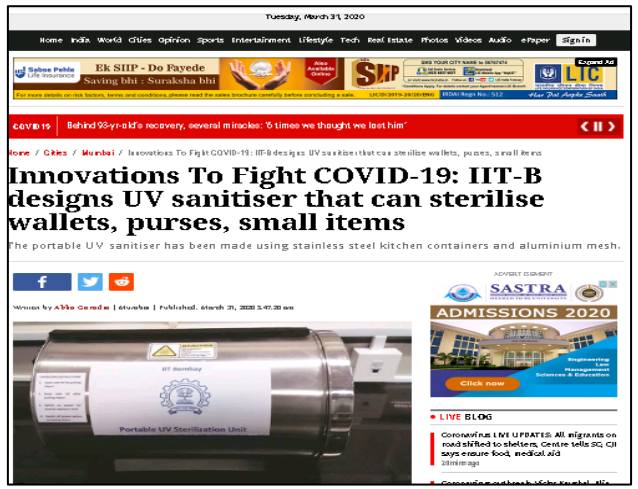
PMID: 31050821

Portable UV Sterilization Unit

- Portable UV sterilization unit is cylindrical unit with approximate diameter 25 cm and length 36 cm. It uses one single germicidal UV tube.
- Portable UV sterilization unit provides > 4 log inactivation of MS2 Phase for UV exposure of 90 seconds

Collaborators: Prof. Kiran Kondabagil and Prof. P. Kumaresan
Financial Support: IRCC, IIT Bombay

Portable UV Sterilization Unit

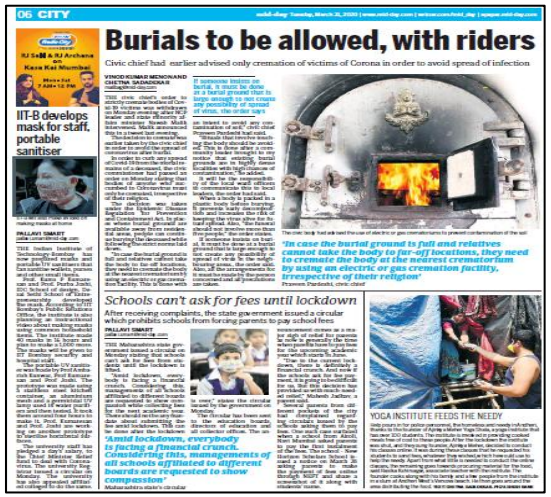

Tuesday, March 31, 2020

Innovations To Fight COVID-19: IIT-B designs UV sanitiser that can sterilise wallets, purses, small items

The portable UV sanitiser has been made using stainless steel kitchen containers and aluminium mesh.


hindustantimes

Covid-19: IIT-b makes prototype of uv sanitisers for phones, wallets

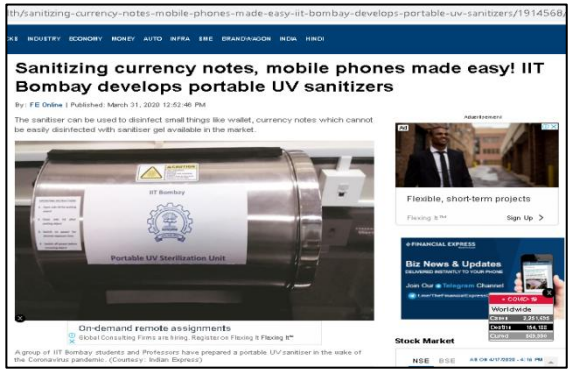

Burials to be allowed, with riders

Civic chief had earlier advised only cremation of victims of Corona in order to avoid spread of infection

IIT-B develops mask for staff, portable sanitiser

Schools can't ask for fees until lockdown

YOGA INSTITUTE FEEDS THE NEEDY


Sanitizing currency notes, mobile phones made easy! IIT Bombay develops portable UV sanitizers


कोरोना: आईआईटी बॉम्बे ने बनाया पोर्टेबल यूवी सैनिटाइजर, जानें- खासियत

- Product is available for non-exclusive licensing
- Non-exclusive license has been given to one company so far

Germicidal UV Cabinet

- This cabinet has approximate volume of 45cm X 45 cm X 35 cm.
- Experiment conducted in our lab using MS2 phage with this sterilization unit shows that 3 minutes second of exposure completely eliminates them (> log 7 inactivation)

Collaborators: Prof. Kiran Kondabagil
Financial Support: IRCC, IIT Bombay

Germicidal UV Cabinet

- Prototype is being used by IIT Hospital
- Product is available for non-exclusive licensing
- Non-exclusive license has been given to one company so far

Wheeled sterilization Unit for large areas

- This unit can be used in empty rooms/area by an outside operator using proper safety guidelines.
- Experiment conducted in our lab with this sterilization unit shows that 900 second of exposure completely eliminates using MS2 phage within 1 meter radius.

Collaborator: Prof. Kiran Kondabagil

Wheeled sterilization Unit for large areas

IIT मुंबई ने विकसित किया यूवी सैनिटाइजर

बड़े क्षेत्रों को संक्रमण रहित करने में मिलेगी मदद

रोबोट संस्करण विकसित करने की योजना

लोकसत्ता

09 May 2020

निर्जंतुकीकरणासाठी आयआयटीचं नवं उपकरण!

रिमोटवर चालणारं

सॅनिटाइझेशन यंत्र

आयआयटीच्या विद्यार्थ्यांनी केलं संशोधन

- Prototype is being used by IIT Hospital
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आयआयटीच्या विद्यार्थ्यांनी केलं संशोधन

- Prototype is being used by IIT Hospital
- Product is available for non-exclusive licensing
- Non-exclusive license has been given to one company so far

Portable and Rechargeable Car Sanitizer

- This car sanitizer is currently powered via four 12V rechargeable batteries and total run-time depends on the battery's capacity.
- This prototype provides 9 log inactivation (99.9999999% inactivation) of MS2 Phage samples kept under directly illuminated zones inside the car in 35 minutes.

Collaborator: Prof. Kiran Kondabagil

Safe Biohazard Transporter

- This safe biohazard transporter is powered by single 12V rechargeable battery.
- The transporter can be used for inactivation, transport as well as safe disposal of solid and some liquid biohazards.
- This prototype is currently being used by proteomics lab to bring inactivated COVID samples from hospital.

Collaborator: Prof. Kiran Kondabagil

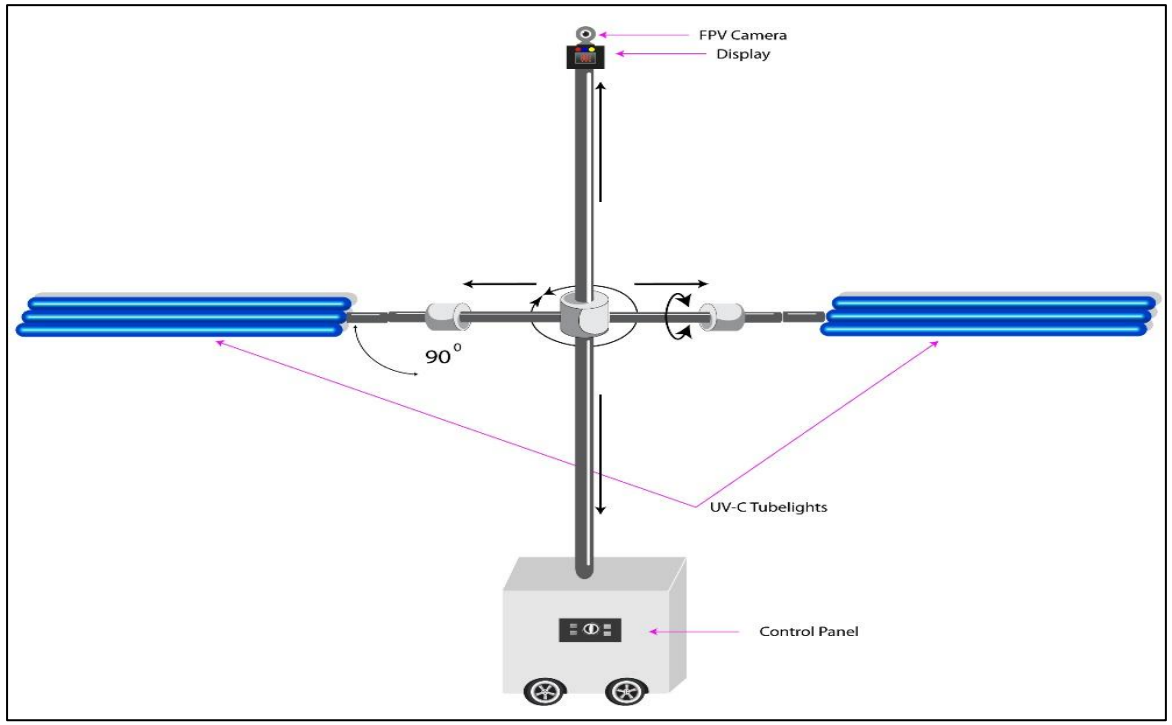
Expertise related to UVC Sterilization

- Consultancy project for UVC sterilization units
- Calculation of UVC dose via modeling
- Measurement of UVC dose
- Inactivation of pathogens (bacterial, virus and spores)

Collaborator: Prof. Kiran Kondabagil

Ongoing Project: Robotic UVC Sterilization Unit

Construction and Validation of Robotic UVC Sterilization Unit for Inactivating Coronavirus and Other Pathogens inside public transport system and hospital rooms



Collaborators: Prof. Leena Vachhani, Prof. Anirban Guha and Prof. Kiran Kondabagil

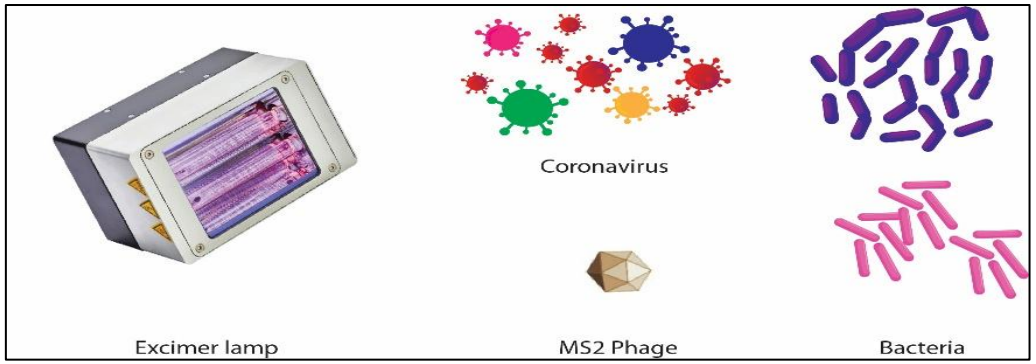
Funding: Wadhwani Research Centre for Bioengineering IIT Bombay

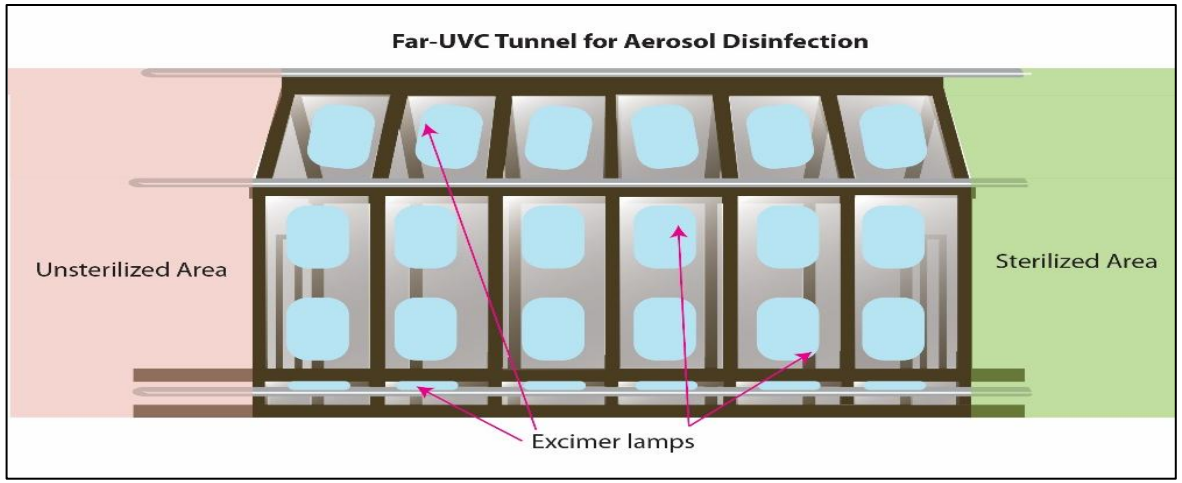
Other initiatives: Using Far-UVC radiation for sterilization

- Far-UVC radiation is emitted by excimer lamps
- It has been shown that far-UVC could kill pathogens without damaging mammalian skin. Far-UVC light is very unlikely to be a human health hazard as it penetrates through the outer dead-cell layer of human skin or the tear layer in the eye.
- It has been shown that far-UVC light 207-222 nm efficiently inactivates bacteria without harm to exposed mammalian skin.
- Besides, it has been also shown that far-UVC efficiently inactivates the aerosolized H1N1 influenza virus and human coronaviruses.
- Long-term effects of far-UVC lamps on mice suggest that far-UVC light produces DNA lesions only in the uppermost layer of the epidermis.

Future Directions: Using Far-UVC radiation for sterilization

LoI entitled "***Construction and Validation of Far-UVC Tunnels for Inactivating Coronavirus and Other Pathogens in Public Places***" submitted under COVID-19 Research Consortium call to BIRAC has successfully cleared the rigorous technical evaluation process and is **Recommended for support subject to financial, IP and legal clearances.**





Collaborator: Prof. Kiran Kondabagil and Prof. Shamik Sen
Industry Partners: Arklite and Litex

Other initiatives : Bio-safety Training

o TEQIP-II Course “Technical Skills for Non-teaching Staff Members“, March 20-23, 2017, IIT Bombay

o QIP Course “Laboratory and Ergonomics Safety For Engineers“, June 12-16, 2017, IIT Bombay

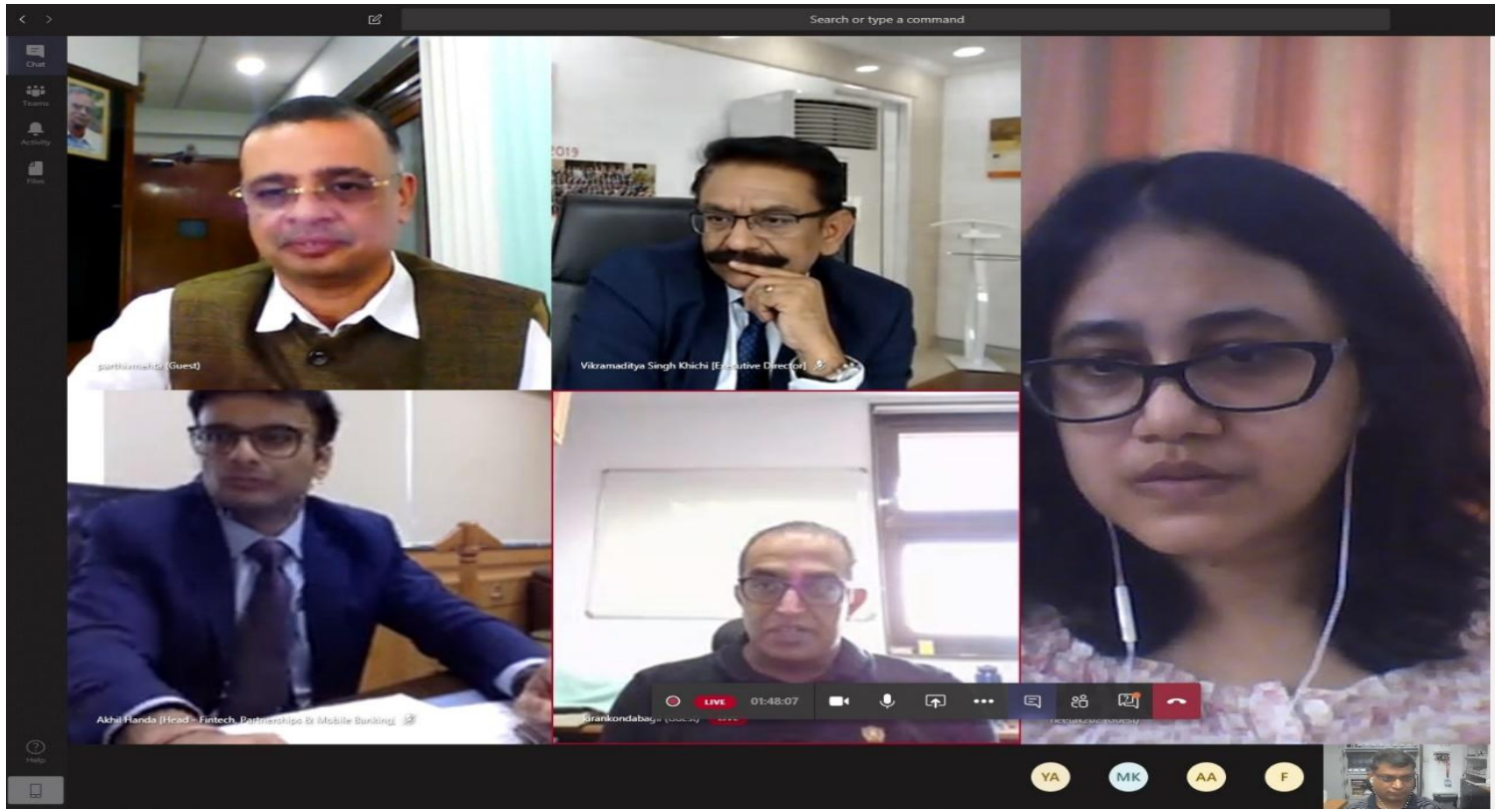
o QIP Course “Laboratory and Ergonomics Safety For Engineers“, June 11-15, 2018, IIT Bombay

o QIP/CEP Course “Laboratory and Ergonomics Safety For Engineers“, June 10-14, 2019, IIT Bombay

o CEP Course “Laboratory and Ergonomics Safety For Engineers“, August 05-09, 2019, IIT Bombay

Other initiatives : Bio-safety Training

Conducted webinar titled "**Achieving Bio-safety in COVID-19 times**" for employees of Bank of Baroda under "**Bank of Baroda-IIT Bombay innovation centre**"



https://www.youtube.com/watch?v=rpqg2GSUKGM

https://www.youtube.com/watch?v=LRy5PWvc_oE

Faculty: Prof. Neeta kanekar, Prof. Kiran Kondabagil and Prof. Ambarish Kunwar

THANK YOU

R&D for COVID-19 Mitigation, IIT-B, 1 Aug 2020

Biomedical Engineering & Technology Innovation Centre (BETIC)

Supported by RG S&T Commission, Mumbai & DST, Ministry of S&T, New Delhi

VISION: Idea → Invention → Innovation → Impact

Prof. B. Ravi

Mechanical Engineering Department, IIT Bombay

Medical Device Innovation – BETIC Facilities

Medical Device Innovation – Process

I. Define (Doctor)

- Team Building
- Clinical Immersion
- Problem Definition
- Concept & Feasibility

400 Problems

II. Develop (Researcher)

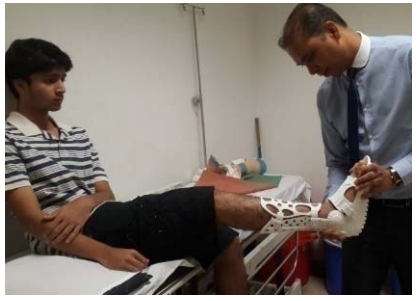
- Detailed Design
- Virtual Prototype
- Rapid Prototype
- Functional Prototype

200 Prototypes

III. Deliver (Entrepreneur)

- Pilot Manufacturing
- Pre-Clinical Testing
- Human Clinical Trials
- Device Certification

50 Patents



IV. Deploy (Investor)

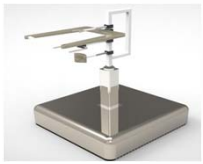
- IPR Management
- Business Model
- Production & Sales
- Scaling & Sustaining

20 Products

Medical Device Innovation – BETIC Products

Glaucoma screener*
(OKO Icare Solutions)

Centric jaw recorder*
(Prosthocentric)



Endotracheal block detector*
(Atmen Technovention)

Smart stethoscope*
(Ayu Devices)

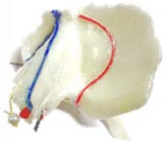
Surgery planner*
(Algosurg Products)

Biopsy gun
(Tenon Meditech)

Diabetic foot screener*
(Ayati Devices)

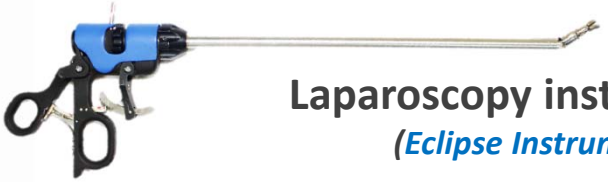
Clubfoot brace monitor
(Metwiz Materials)

Nasal surgery forceps
(Om Surgical)



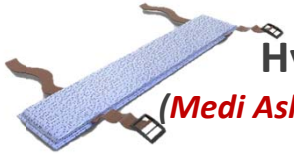
Artificial temporal bone*
(Nu Ossa Mediquip)

Mandible surgery guides*
(Precisurge)

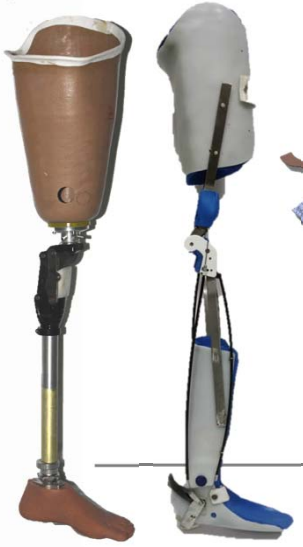


Laparoscopy instrument
(Eclipse Instrumentation)

Skin spray gun*
(Pacify Medical)



Hybrid splint*
(Medi Asha Technologies)

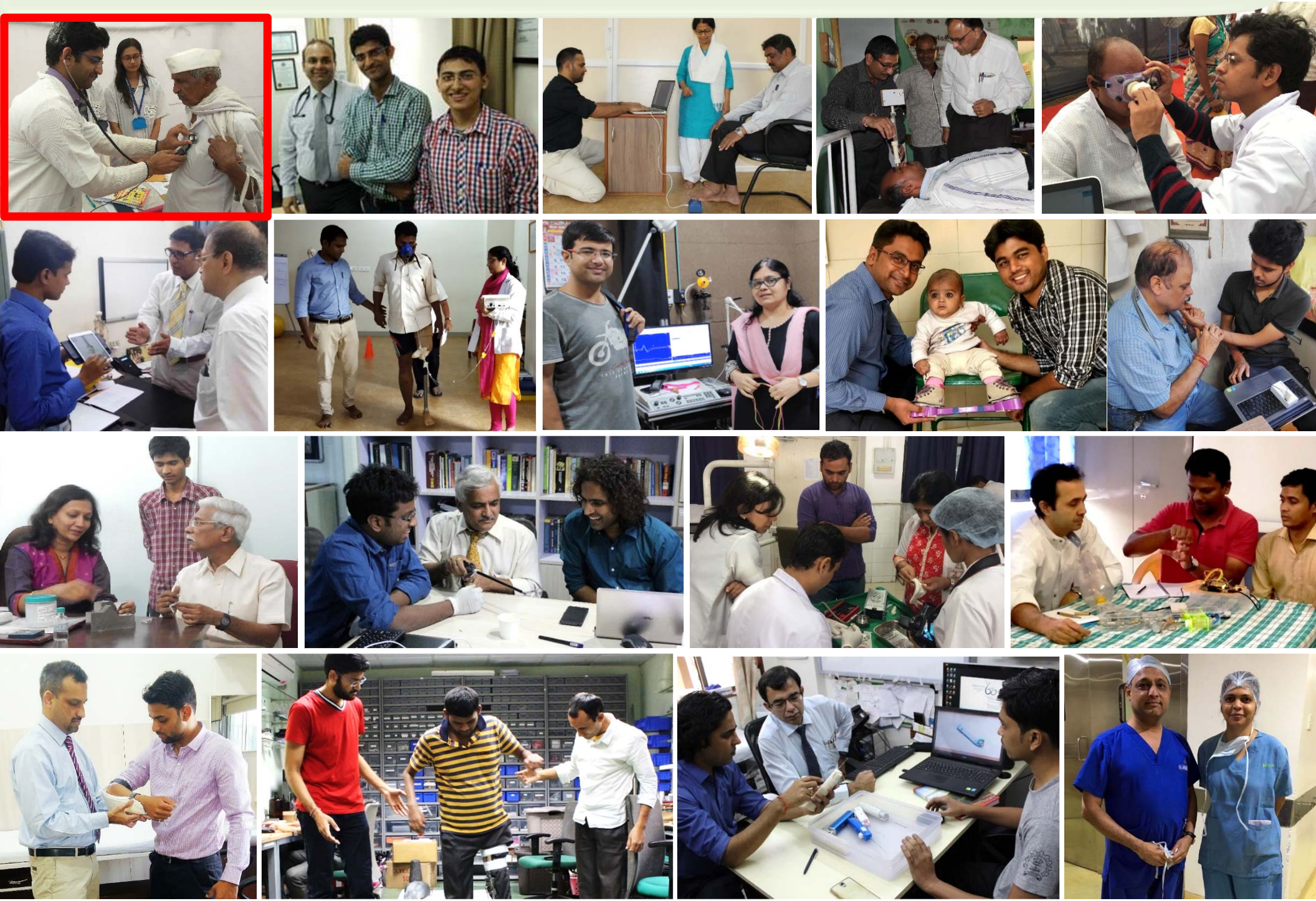


Knee ankle foot orthosis*
(Aumeesh Tech)

Prosthetic leg
(Ratna Nidhi Chritable Trust)

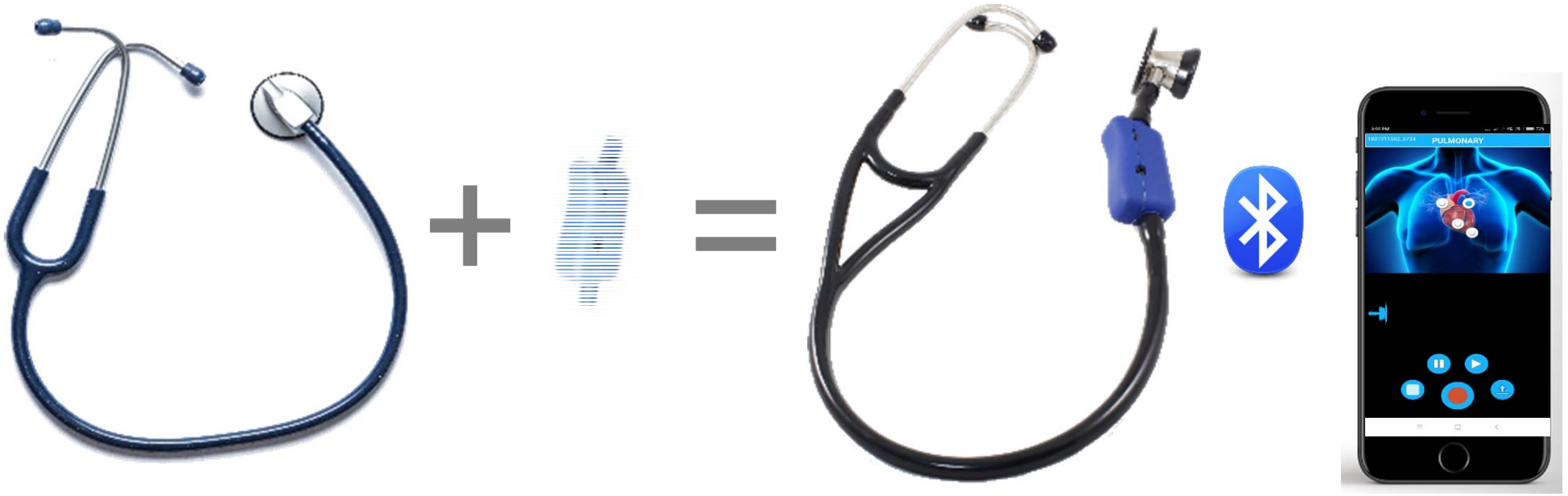
** BIRAC BIG Award* → ● *Startup company* | ● *Industry partner*

Medical Device Innovation – Clinical Validation



Smart Stethoscope – Digital Auscultation

Modular unit to convert standard stethoscope into digital



Bluetooth connectivity | Hi-fidelity amplification | Noise reduction

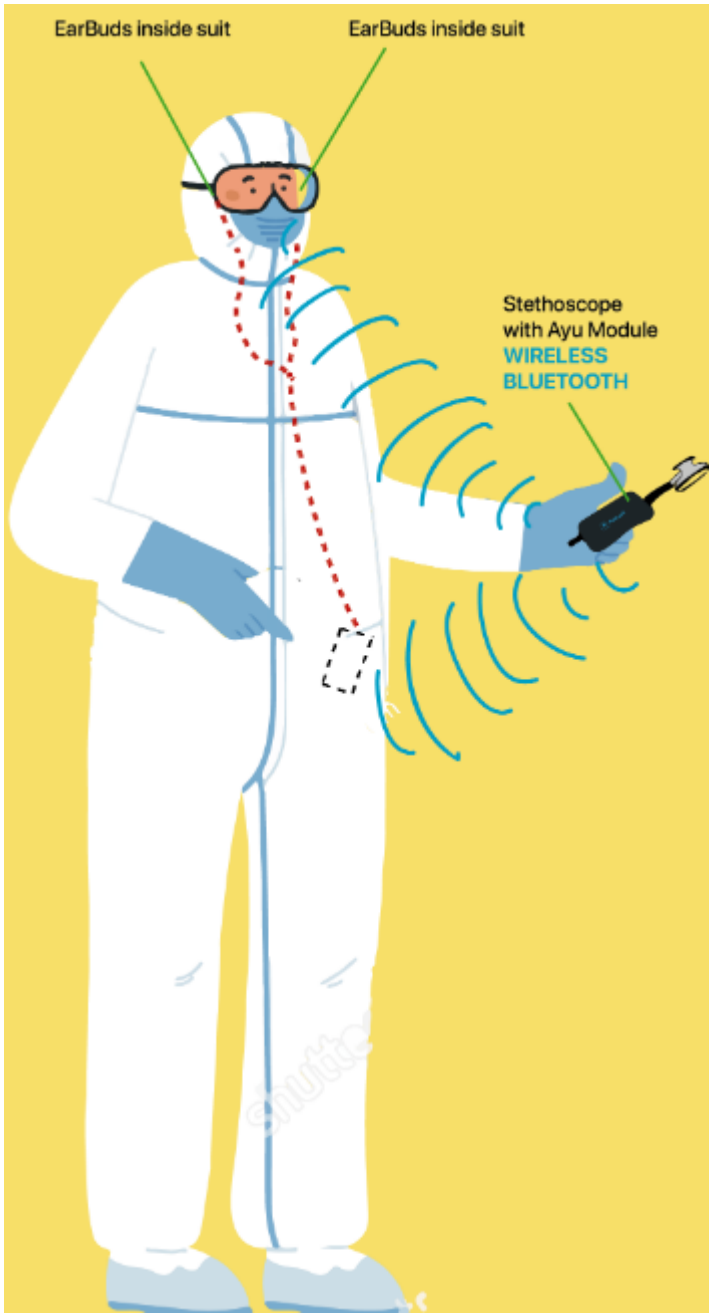
Recording | Playback | Visualization | Sharing through mobile app

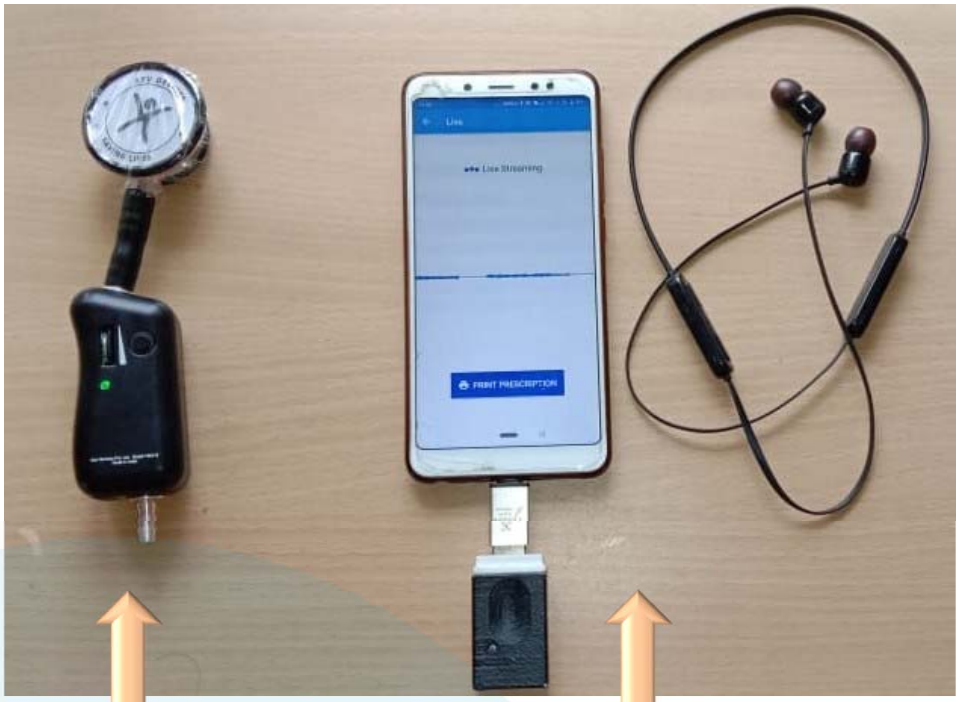
BETiC

Ayu Devices

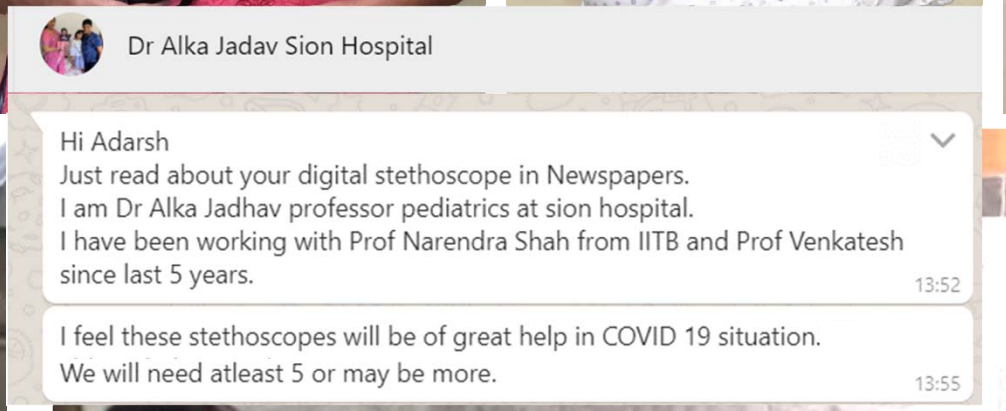
DEVICES FOR SAVING LIVES

Smart Stethoscope – Safe Auscultation



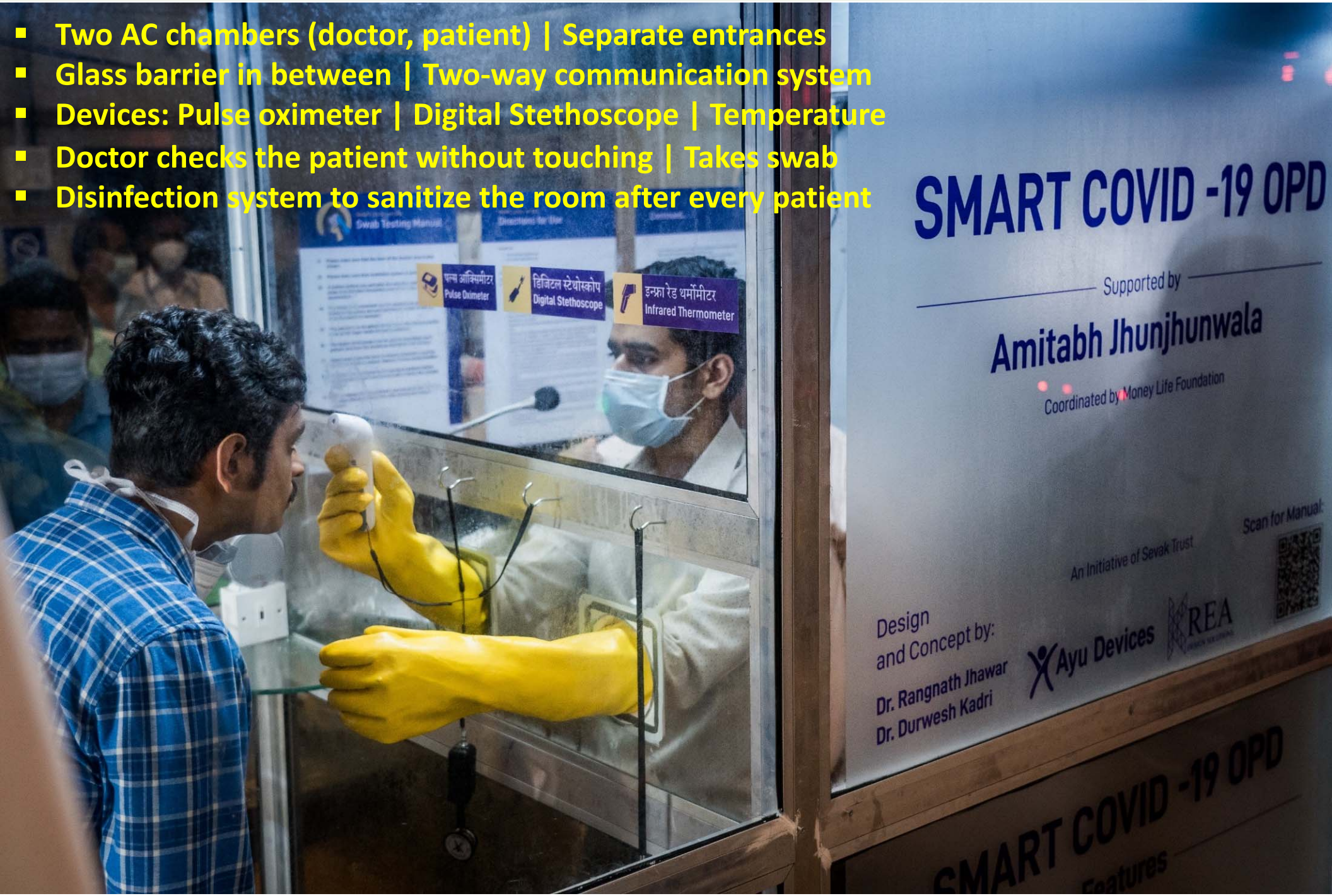


Smart Stethoscope – Safe Auscultation



Smart COVID Booth – Safe Screening

- Two AC chambers (doctor, patient) | Separate entrances
- Glass barrier in between | Two-way communication system
- Devices: Pulse oximeter | Digital Stethoscope | Temperature
- Doctor checks the patient without touching | Takes swab
- Disinfection system to sanitize the room after every patient



Smart COVID Booth – Safe Screening

15 SMART COVID OPDs
Sir J.J. Hospital
St. George's Hospital
Nair Hospital
Cama & Albless Hospital
HHSB Thackerey Hospital
Cooper Hospital
Sion Hospital
Rajawadi Hospital
Hospital in Lucknow
IIT Bombay Hospital

Smart Contactless Hand Sanitizer

Hospital

Office entrance gate

Shopping mall

Cinema entrance

Food court entrance

School/college entrance

GYM entrance

Home entrance

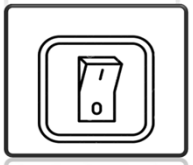
Construction

Shop entrance

Temple entrance

1 Mount on wall minimum 5 feet or as per requirement by drilling machine and fill sanitizer by opening cap

2 Plug in to power supply of 12 volt approx. 2 amp



3 Switch on the power supply to start

4 Maintain maximum distance of 10 cm

5 2 ml sanitizer drop is enough for killing virus or bacteria by adopting proper sanitizing procedure given in top

BETiC

OKO ICARE SOLUTIONS
innovations that care.....

VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY · NAGPUR ·

Smart Hand Sanitizer + Thermal Scanner

Hospital

Office entrance gate

Shopping mall

School/college entrance

Home entrance

Shop entrance

Cinema entrance

Food court entrance

GYM entrance

Construction

Temple entrance

1. Mount on wall minimum 5 feet or as per requirement by drilling machine and fill sanitizer by opening cap
2. Plug in to power supply of 12 volt approx. 2 amp
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BETiC

OKO ICARE SOLUTIONS
innovations that care.....

VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY · NAGPUR ·

Personal Protective Equipment

Disposable Hoods

Intubation Box

100,000 face shields
donated to frontline warriors

Face Mask, Shield

BETiC

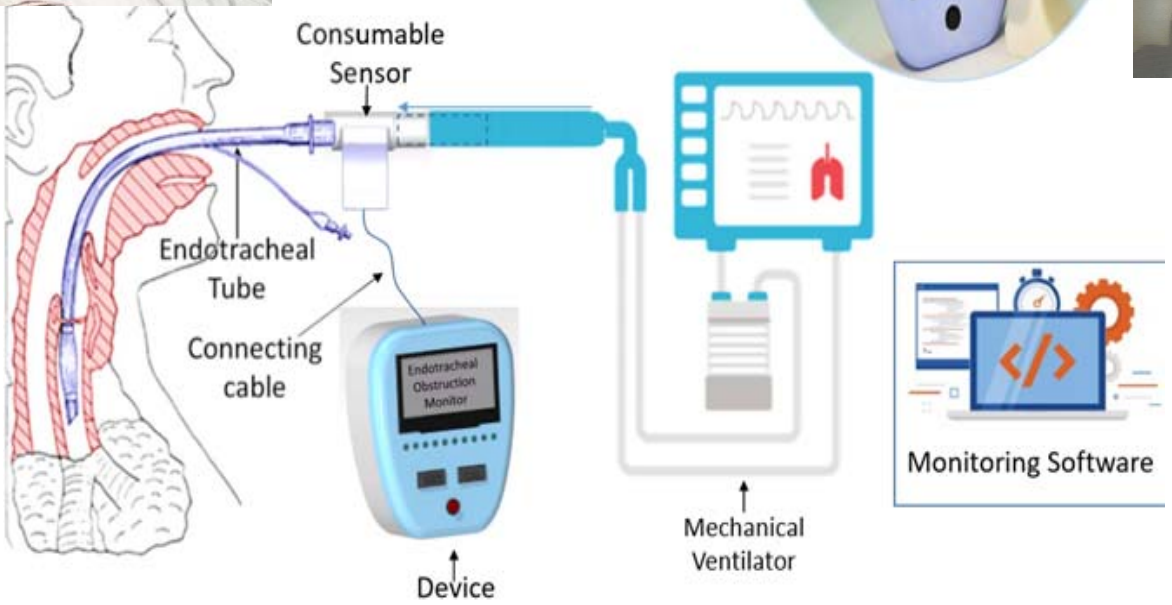
MediAsha
Hopes for a healthy life...

TRUTH
STRENGTH
ENDURANCE
COLLEGE OF ENGINEERING
PUNE

Endo-Tracheal Tube Blockage Detector

Developed Prototype, Tested on virtual environment →

Prototype



BETiC

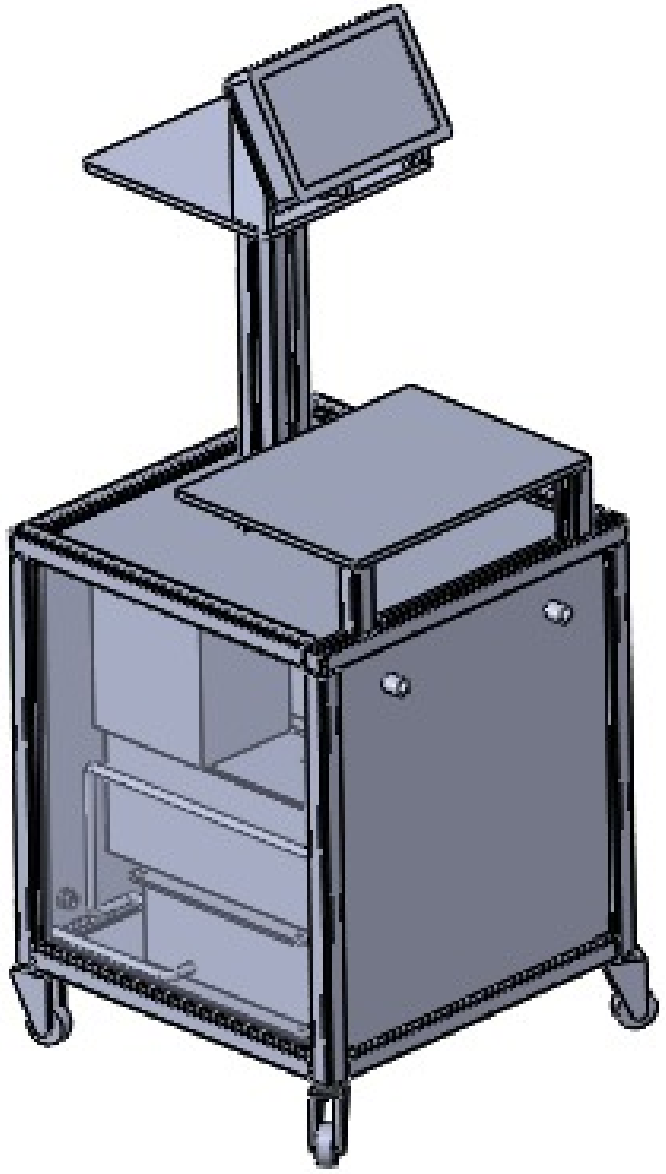
ATMEN TECHNOVENTION

TRUTH STRENGTH ENDURANCE COLLEGE OF ENGINEERING PUNE

ICU Ventilator (Specifications and Concept)

Key Features

- **Suitable** for both adults and pediatric patients
- **Parameters monitored:** Respiratory phase/type, Exhaled tidal & minute volume, Respiratory rate, Total leak percentage, Spontan. minute volume, I:E ratio, PIP & PEEP, Mean & Plateau pressure.
- **Multiple modes-** pressure/volume control
- **Touch display** to adjust/set the parameters
- **Graphic display-** Flow/Pressure/Volume vs. Time
- **Automatic-** Systems check | Alarms, history
- **Battery backup-** 4 hours minimum
- **IEC 60601-1-4** (Medical electrical equipment)



Key Specifications

- **Maximum peak pr- 60 cm water**
- **Peak respiratory rate- 60 BPM**
- **Inspiratory time- 0.3-5 seconds**
- **Tidal volume- 50 to 2000 ml**
- **Peak flow rate- 240 LPM**
- **PEEP- 0-30 cm of water**
- **Pressure support- 40 cm of water**
- **Insp. to exp. ratio- 1:4 to 4:1**
- **Flow sensitivity- 1 to 10 LPM**
- **Volume accuracy- 2-3% of FS**

Innvolution

ICU Ventilator (First Prototype)

BETIC Team and Network

BETIC Team: Biomedical | Design | Electronics | Manufacturing | Quality

IIT Bombay | COE Pune | VNIT Nagpur

KJSCE Mumbai | MIT-ADT Pune | Symbiosis Pune | GHRCE Nagpur

SINE, IIT Bombay | NCL-VC Pune

GMC & JJH Mumbai | HITRT Mumbai | MGMIHS Sanpada | BJMCH Pune | DMIMS Wardha | BKLWRH Dervan

Maharashtra (MSInS) | Gujarat (GTU) | Andhra (AMTZ)

More Information…

BETIC

About Partners Services Impact Events

Running Partner for Medical Device Innovation

Purpose Journey Team Resources

About BETIC

Medical devices are critical for healthcare. Indigenous development of novel, suitable, reliable and affordable devices leads to social impact as well as high-value jobs. Since its inception in 2014 at IIT Bombay, Biomedical Engineering and Technology Innovation Centre (BETIC) is building the necessary eco-system by connecting stakeholders – government, academia, medical community, industry, investors and facilitators. The team met several hundred doctors, identified 400 unmet needs, created 200 novel concepts, and filed 50 patents. Further, they developed 20 devices, incubated 15 startups, licensed 5 products to industry, and launched a few in the market.

Prof.b.ravi@betic.org

Thank You!

HaystackAnalytics

At-Scale Genomic Diagnostics

Real-Time Disease Mapping for **infectious diseases**

A data-driven approach to disrupt and revolutionize diagnostics.

Anirvan Chatterjee

महाराष्ट्र शासन
Maharashtra State Innovation Society

सत्यमेव जयते
Department of Industrial Policy and Promotion
Ministry of Commerce and Industry
Government of India

IIT Bombay
SINE
Business Incubator

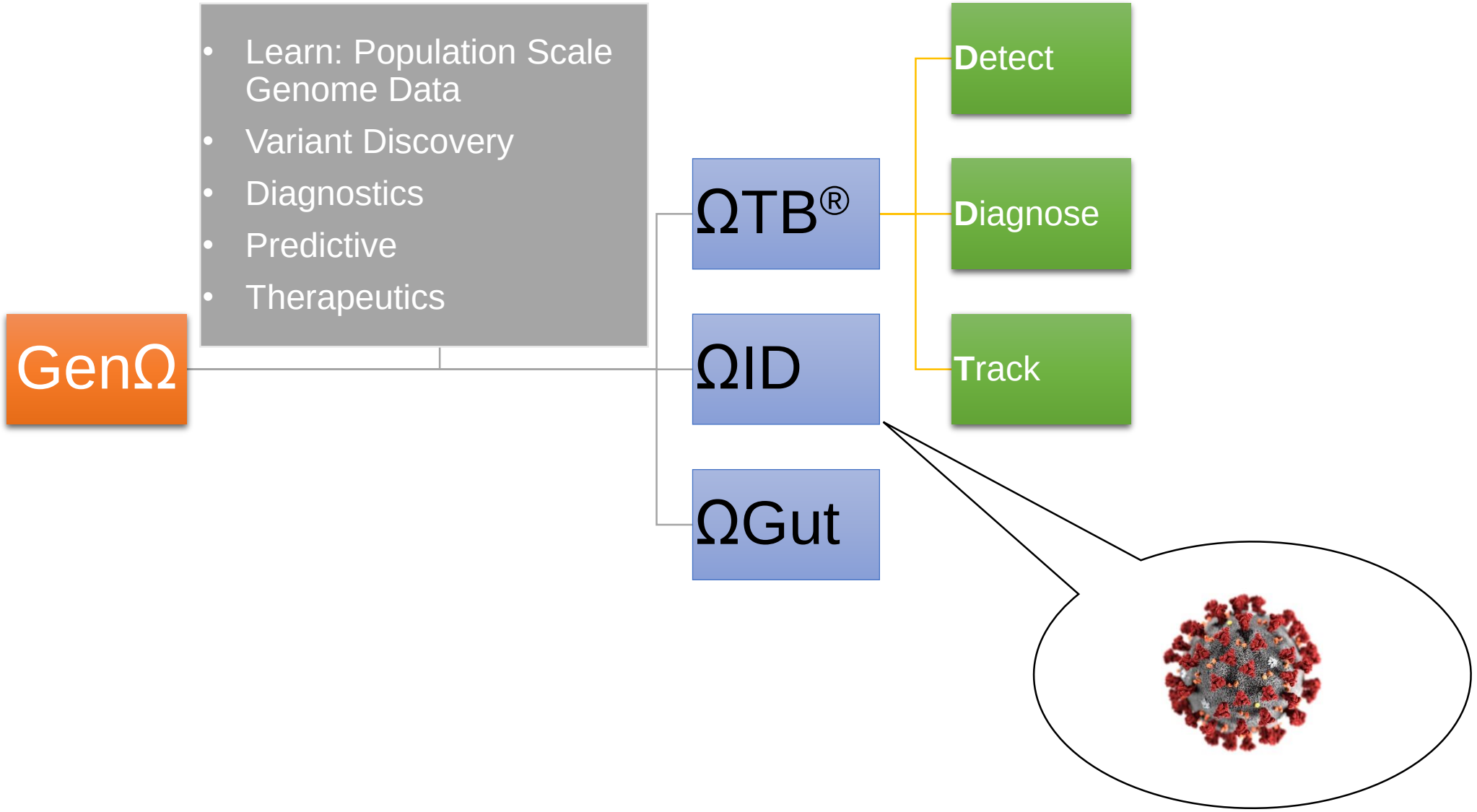
NIDHI PRAYAS

PLUGIN
Collaborative Incubation for Hardware & Systems Startups

DST
intel
SINE Business Incubator

#startupindia
Recognised under the Scheme

Haystack: Before **C**ovid



Covid19: Need for Integrated Solution

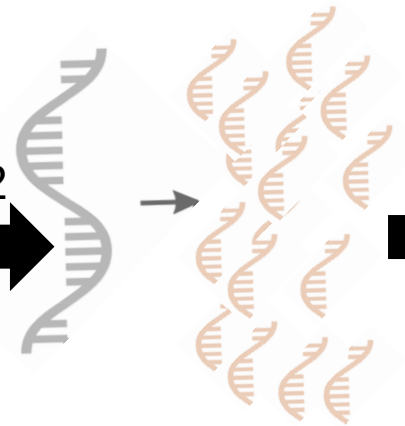
Detect	• qPCR • Ag Test • Radiology	**SARS-CoV-2 specific RNA sequence analysis**
Diagnose	• Comorbidities • Immune response Monitoring	**Association of genotypes with Outcome**
Track	• Trace: From Whom • Track: High Risks	**Relational database: Parsimonious reconstruction of transmission network**

ΩID

ΩID for Covid19

https://www.clinisciences.com/en/read/newsletter-26/covid-19-viral-transport-medium-2267.html

Enrich for SARS-CoV2

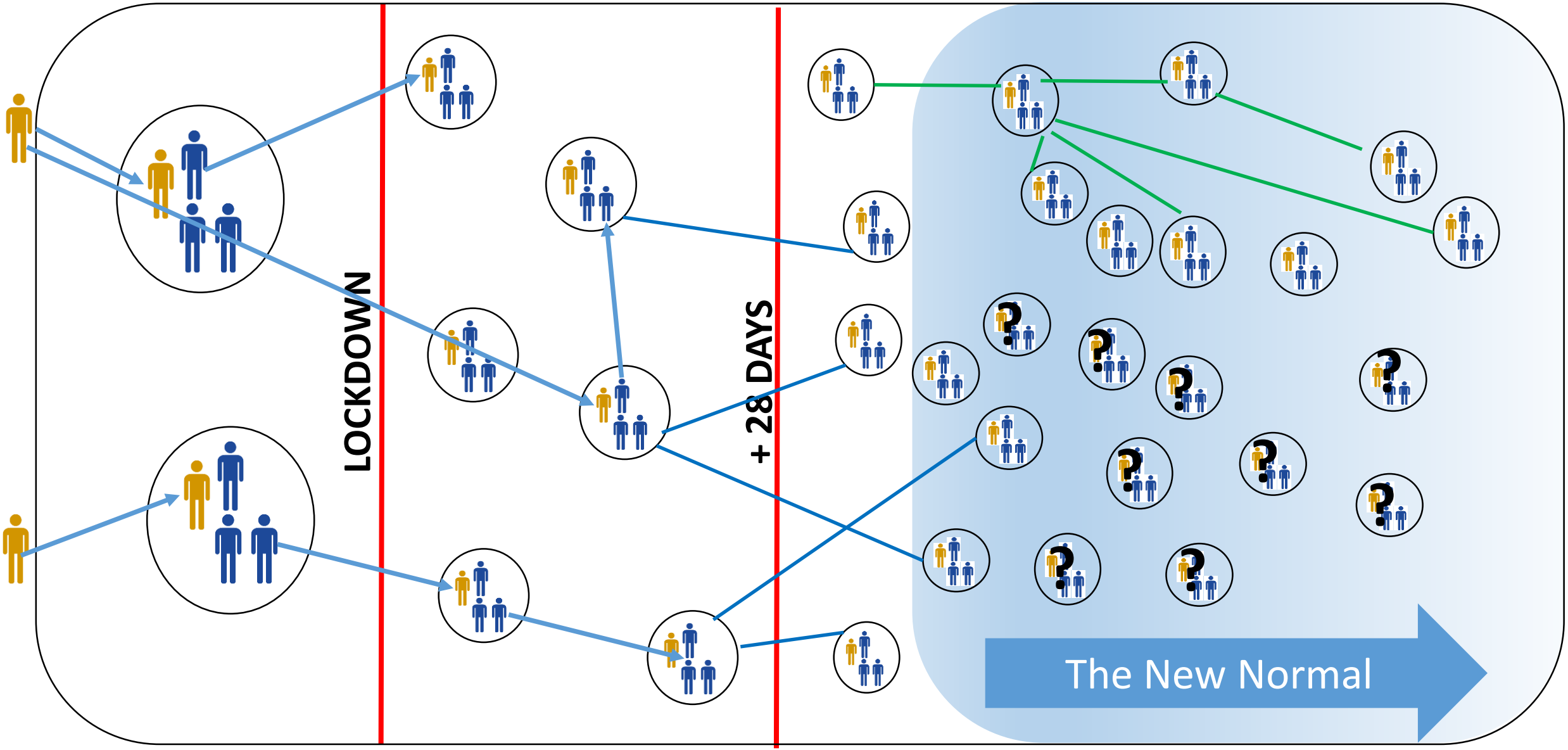


Sequence Assemble

Per Installation:

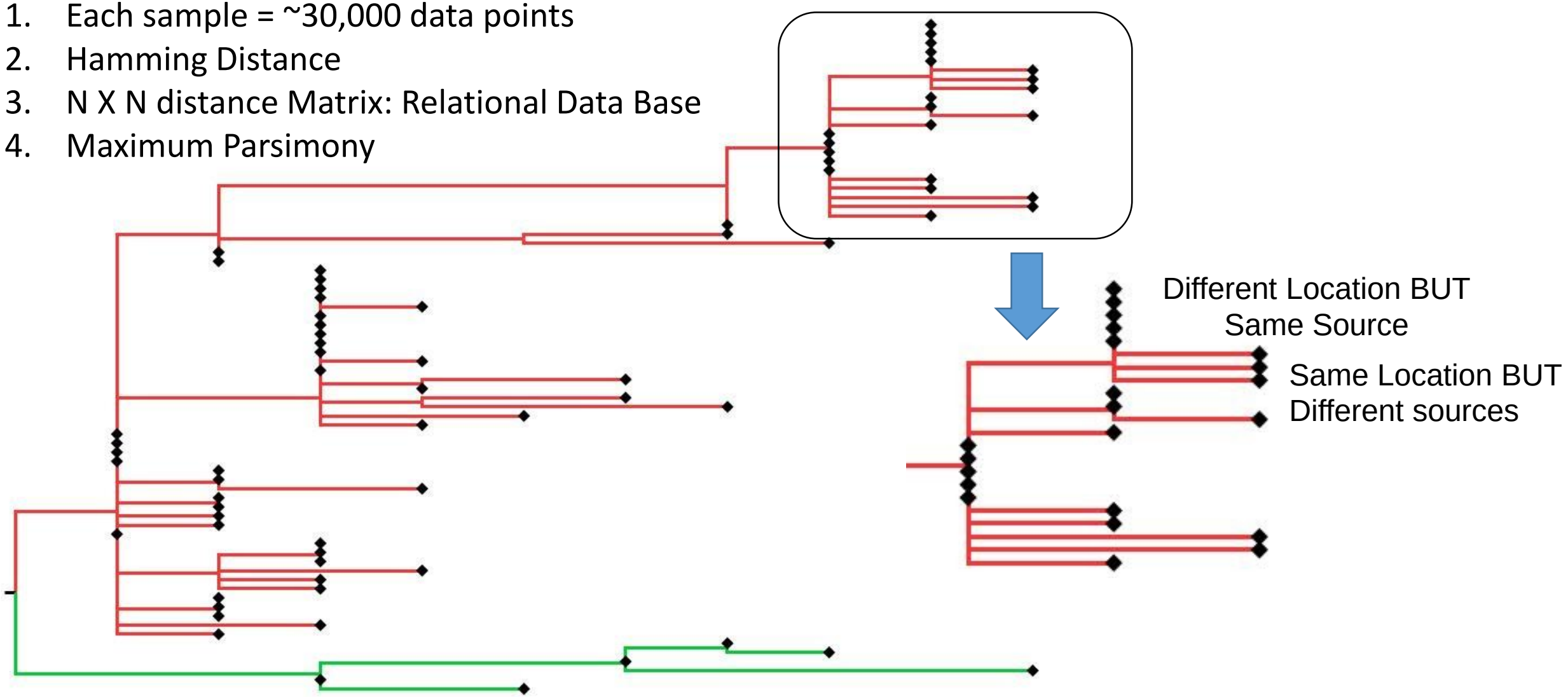
- 96 samples every 4 Hours
- INR 2500 / sample
- Automated analytics
- Real-time detection of transmission source
- **Conclusive evidence of no transmission in premises**

The Covid Network: Questionaire based tracking



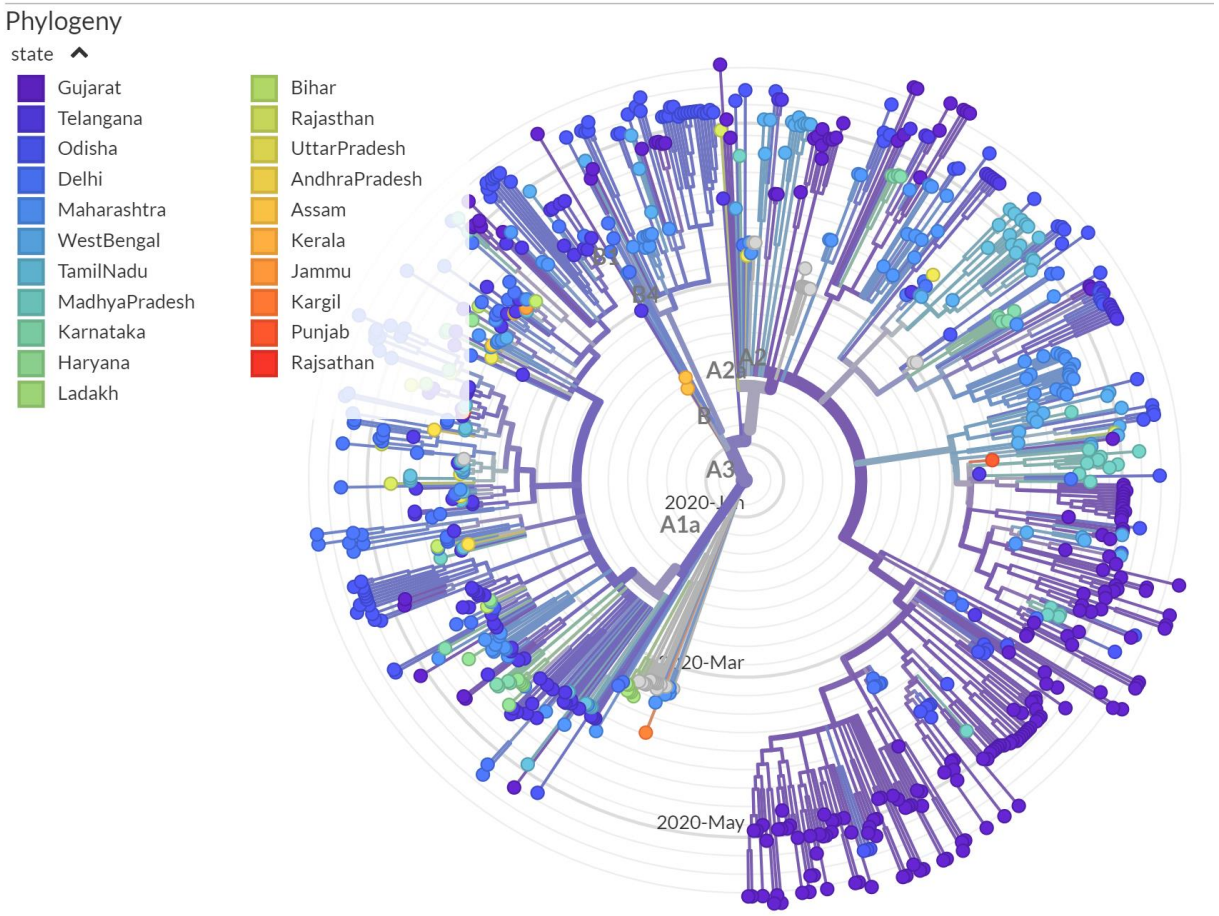
The Covid Network: Remote Tracking

1. Each sample = ~30,000 data points
2. Hamming Distance
3. N X N distance Matrix: Relational Data Base
4. Maximum Parsimony

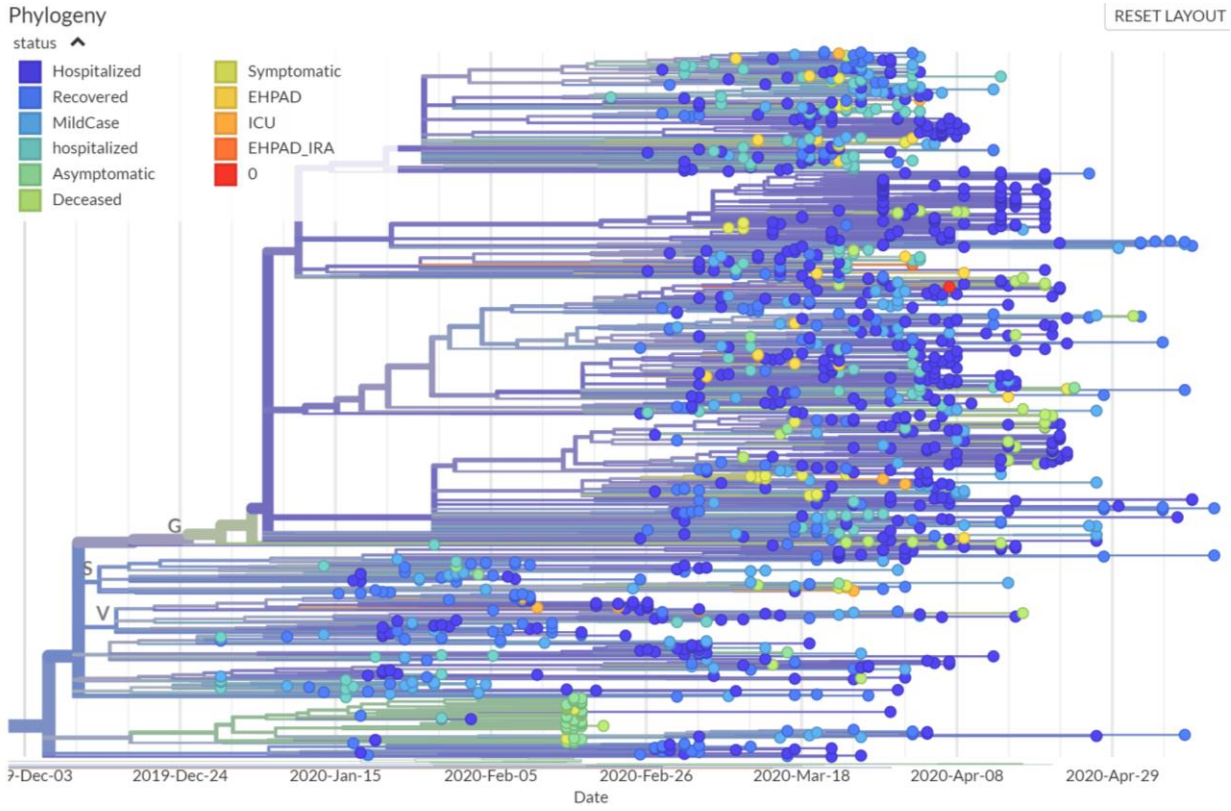


http://haystackanalytics.co.in/India/ncov

Phylogenetic Inference of Transmission Source

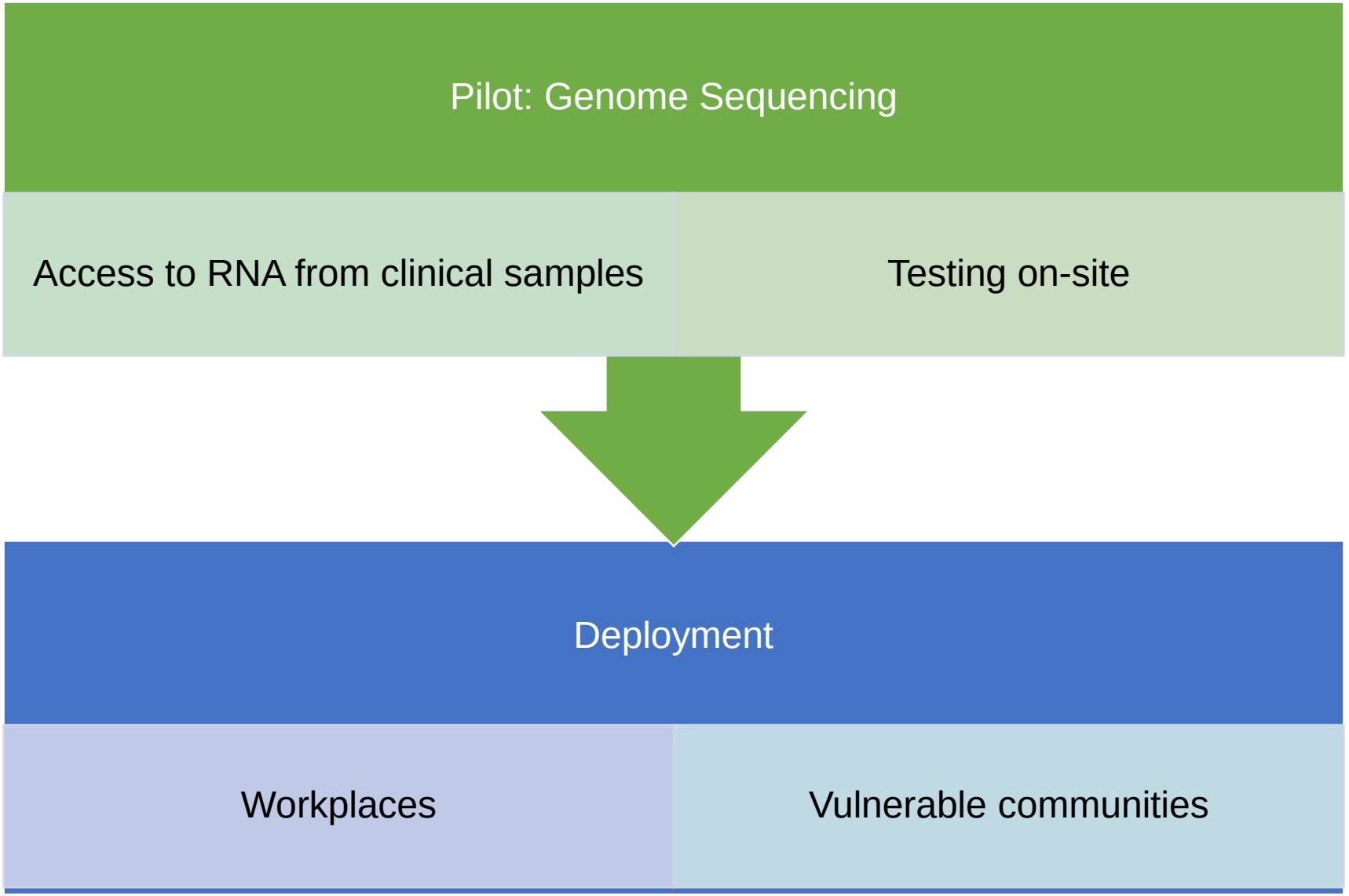


Genome Wide Association with Disease Outcome



Web deployment Built using the Nextstrain Web-Stack
https://github.com/nextstrain

DST CAWACH: Work in progress



The ability to trace the source of every infection is the key to unlocking the work place. We can enable screening, and tracking transmission on site. To unlock safely, contact us:

covid19@haystackanalytics.in

HaystackAnalytics

https://twitter.com/HaystackLab

https://www.linkedin.com/company/14718139/

https://haystackanalytics.in/

ENDIMENSION TECHNOLOGY

- AI Platform Technology for Medical Diagnosis

http://www.endimension.com/

Incubated at

IIT Bombay

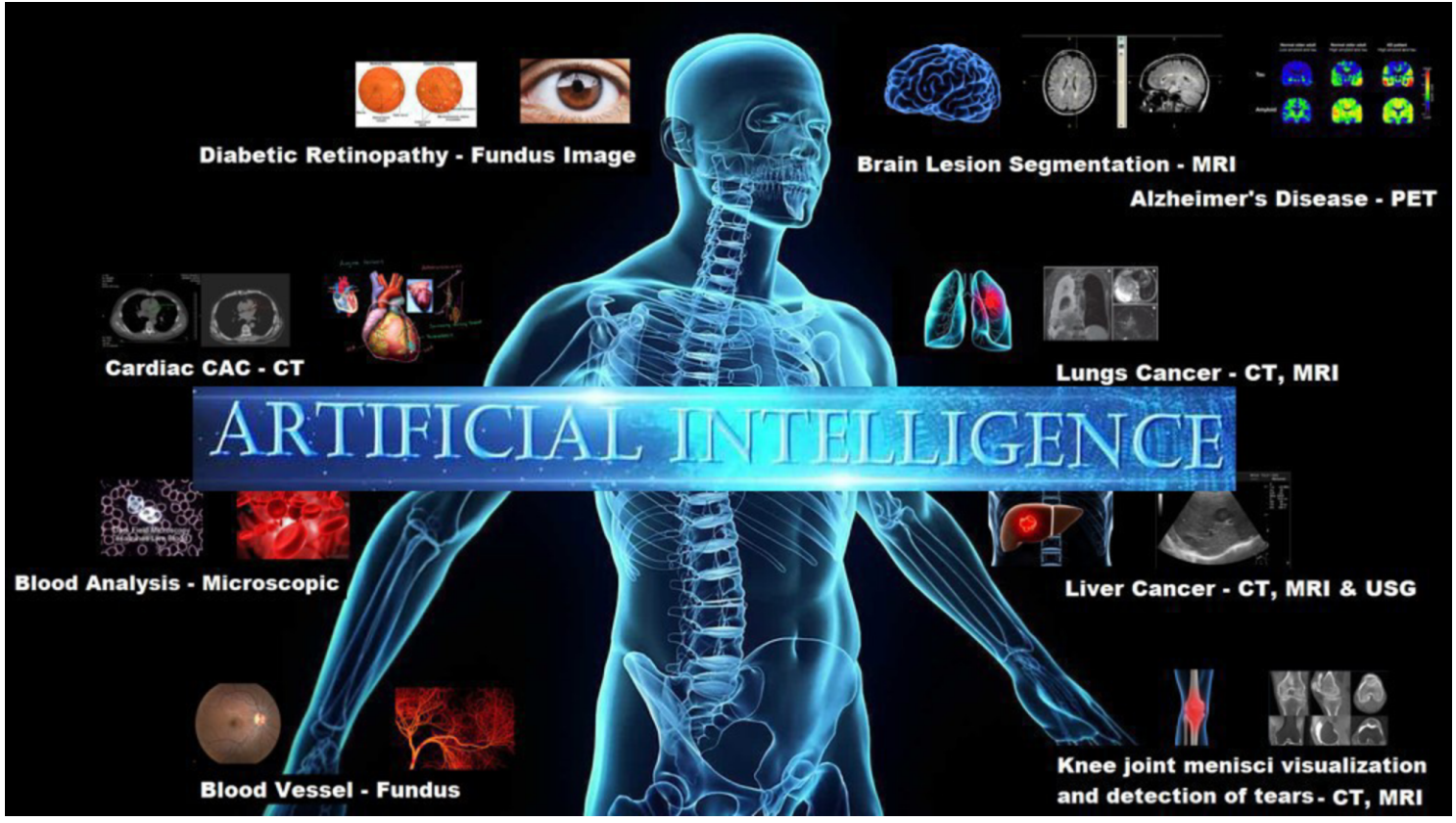
SINE

Business Incubator

EN DIMENSION

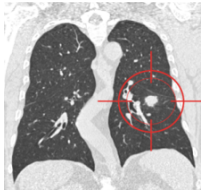
What are we about?

Using Artificial Intelligence to automatically detect diseases from Medical Scans



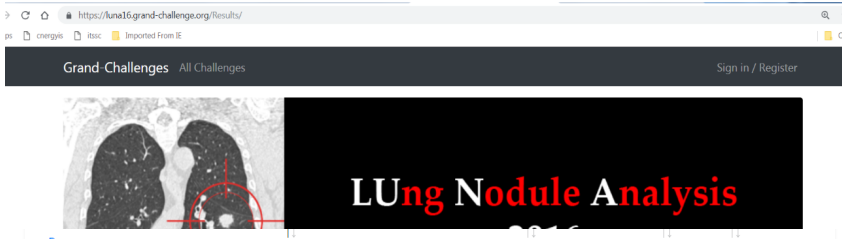
E DIMENSION

Earlier Work - AI for Lung Cancer Detection



LUNA16 (Lung Nodule Analysis)

Stood 1st among 360 Indian teams

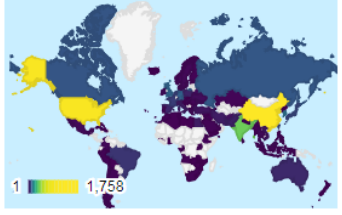


Data
Evaluation
Results
Download
Submit
Forum
Tutorial
Join

Rank	Team	Date	Score	Description
1	PAtech (PA_tech)	2 January 2018	0.951	description
2	JianPeiCAD (weiyixie)	22 December 2017	0.950	description
3	LUNA16FONOVACAD (zxp774747)	28 November 2017	0.947	description
4	iFLYTEK-MIG (yinbaocai)	17 August 2017	0.941	description
5	zhongliu_xie (zhongliu.xie)	29 September 2017	0.922	description
6	iDST-VC (chenjx1005)	13 July 2017	0.897	description
7	qfpxfd (qfpxfd)	27 May 2017	0.891	description
8	CASED (CASED)	15 June 2017	0.887	description
9	3DCNN_NDET (lishaxue3)	22 June 2017	0.882	description
10	Aidence (mjharte)	7 June 2017	0.871	description
11	junxuan20170516 (chenjx1005)	30 May 2017	0.865	description
12	MEDICAI (bharadwaj)	22 July 2017	0.862	description
13	Ethan20161221 (ethanhwang2012)	23 December 2016	0.856	description
14	resnet (QiDou)	21 February 2017	0.839	description
15	CCELargeCubeCnn (Intel_wuhui)	30 Sept 2017	0.833	description
16	ZNET (gzuidhof)	30 June 2016	0.811	description
17	MOT_M5Lv1 (elopez69)	18 October 2016	0.742	description
18	VisiaCTLung (jacobsc)	1 April 2016	0.715	description
19	etrocad (jefvdmb2)	7 April 2016	0.676	description
20	M5LCADThreshold0.3 (atraverso)	5 April 2016	0.608	description
21	lance (lancesy)	10 August 2017	0.543	description

Statistics

Number of users: 6957



Ref: luna16.grand-challenge/Results

OUR SOLUTION

INTEL RESEARCH

Canon
Visia™ CT Lung CAD
FDA Approved Product

AI for COVID-19 RadioDiagnosis

AI Software to automatically detect COVID-19 abnormalities from Chest Imaging

Advantages

1. Can be deployed at Healthcare Centres at all levels
    a. Primary
    b. Secondary
    c. Tertiary
    d. Radiology Diagnostic centres

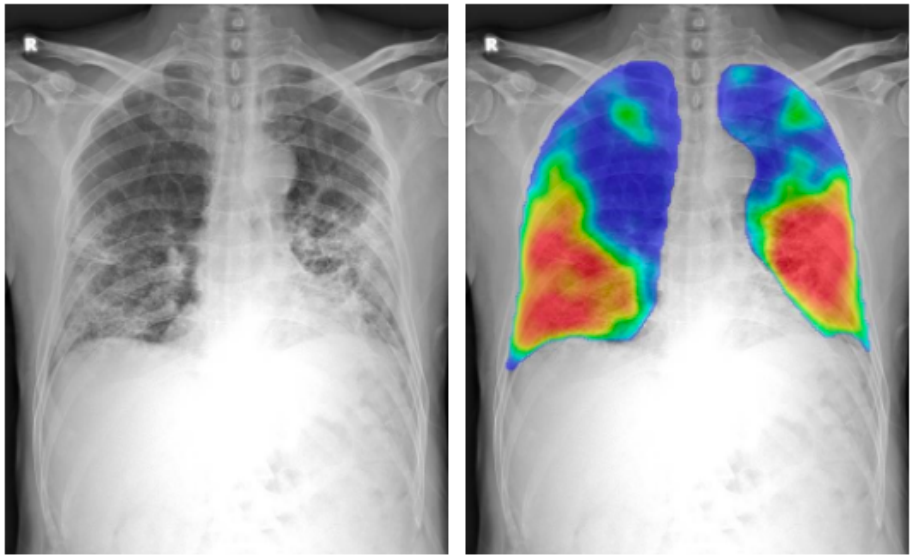
2. Low Cost Solution

3. Instant Diagnosis

4. Easily accessible for patients

5. Easy to deploy and scale

6. Reduced Community Transmission



AI Predicted COVID-19 Heat Map

AI for COVID-19 RadioDiagnosis

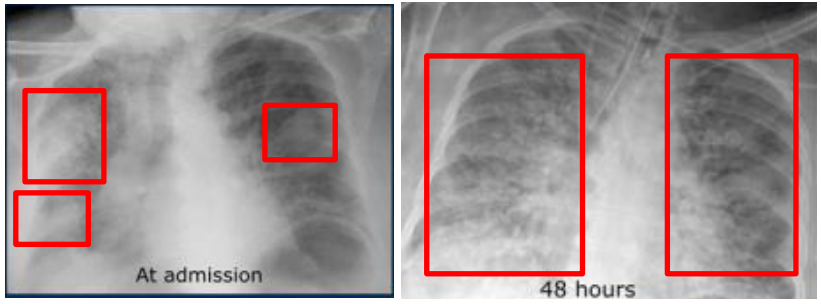
1. Triage Patients

Endimension Technology

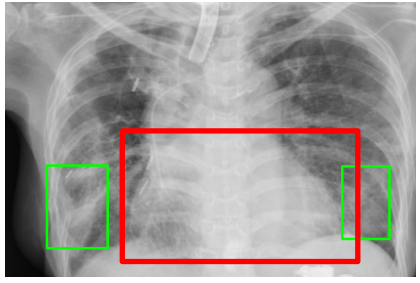
Search: Search all studies

	Patient Name	Study Description	# Images	COVID-19 Risk
1	501ANON	CT Thorax	412	High
2	540ANON	Unspecified CT Chest	990	High
3	342ANON	Chest Xray PA	1	High
4	752ANON	XRayChest PA View	2	Medium
5	525ANON	Chest AP	1	Low

2. Monitor Patient Condition



3. Incidental Findings



ENDIMENSION

Current Status – Ready to Deploy

1. AI validated on publicly available datasets

Dataset : 30727 X rays (covid, non-covid, normal)

Sensitivity	Specificity	Accuracy
0.909	0.939	0.936

2. Published Research with Tata Memorial Hospital

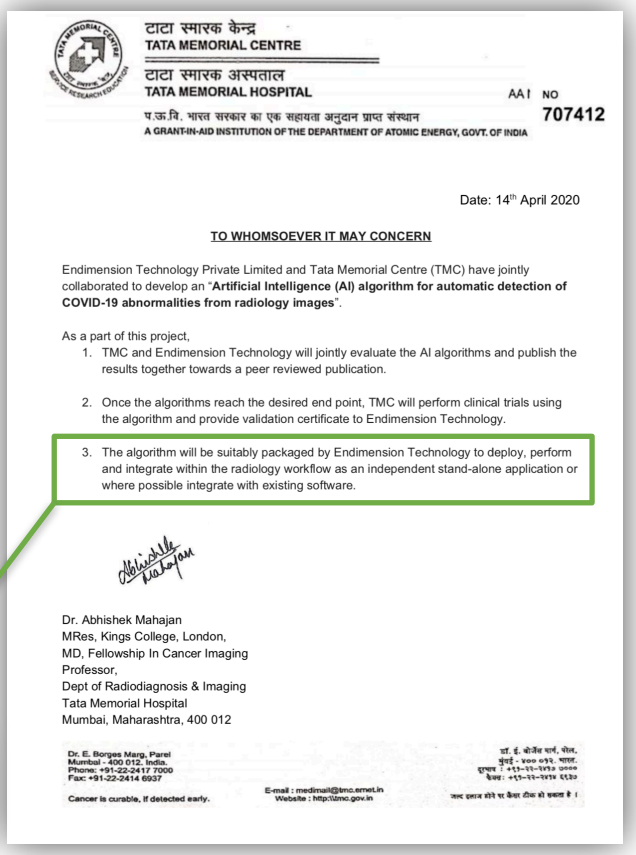
"Novel Artificial Intelligence Algorithm to Automate the Detection of COVID-19 Abnormalities from Chest CT Images"

Submitted to Indian Journal of Radiology and Imaging

Sensitivity	Specificity	Accuracy
0.92	0.995	0.972

3. LOI from Tata Memorial Hospital

3. The algorithm will be suitably packaged by Endimension Technology to deploy, perform and integrate within the radiology workflow as an independent stand-alone application or where possible integrate with existing software.



टाटा स्मारक केन्द्र
TATA MEMORIAL CENTRE
टाटा स्मारक अस्पताल
TATA MEMORIAL HOSPITAL
AA I NO 707412
प.क.वि. भारत सरकार का एक सहायता अनुदान प्राप्त संस्थान
A GRANT-IN-AID INSTITUTION OF THE DEPARTMENT OF ATOMIC ENERGY, GOVT. OF INDIA

Date: 14th April 2020

TO WHOMSOEVER IT MAY CONCERN

Endimension Technology Private Limited and Tata Memorial Centre (TMC) have jointly collaborated to develop an "**Artificial Intelligence (AI) algorithm for automatic detection of COVID-19 abnormalities from radiology images**".

As a part of this project,

1. TMC and Endimension Technology will jointly evaluate the AI algorithms and publish the results together towards a peer reviewed publication.
2. Once the algorithms reach the desired end point, TMC will perform clinical trials using the algorithm and provide validation certificate to Endimension Technology.
3. The algorithm will be suitably packaged by Endimension Technology to deploy, perform and integrate within the radiology workflow as an independent stand-alone application or where possible integrate with existing software.

Dr. Abhishek Mahajan
MRes, Kings College, London,
MD, Fellowship In Cancer Imaging
Professor,
Dept of Radiodiagnosis & Imaging
Tata Memorial Hospital
Mumbai, Maharashtra, 400 012

Dr. E. Borges Marg, Parel
Mumbai - 400 012. India.
Phone: +91-22-2417 7000
Fax: +91-22-2414 6937
Cancer is curable, if detected early.
E-mail : medimail@tmc.ernet.in
Website : http://tmc.gov.in

ENDIMENSION

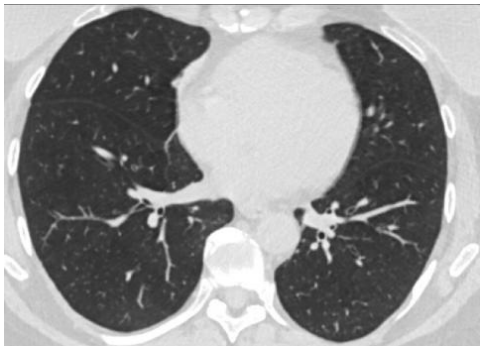
WHO Guide on ‘Use of Chest Imaging in COVID-19’

Patients likely to benefit :

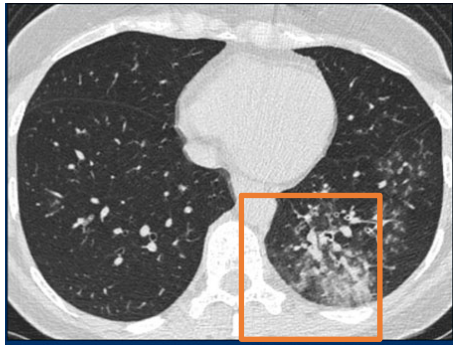
- Live in small homes
- Overcrowded households or densely-populated settings, where isolation is very difficult to implement
- Live in communities with people at high risk such as retirement homes or dormitories

Mild Symptoms	Moderate to Severe Symptoms	Hospitalized	Symptomatic & Suspected
Hospital Admission **vs** **Home Discharge**	**Regular Ward** **vs** **Intensive Care Unit (ICU)**	**Therapeutic Management**	**RT-PCR testing is not available** **RT-PCR testing is available, but results are delayed** **RT-PCR testing is negative, but with high clinical suspicion of COVID-19**

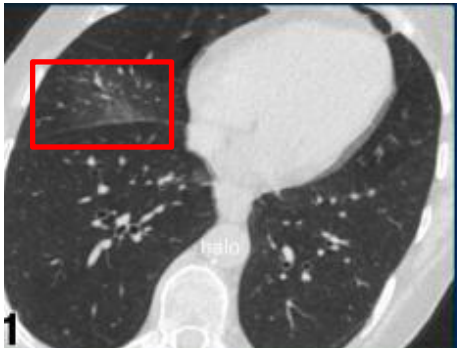
AI Risk Assessment for COVID-19



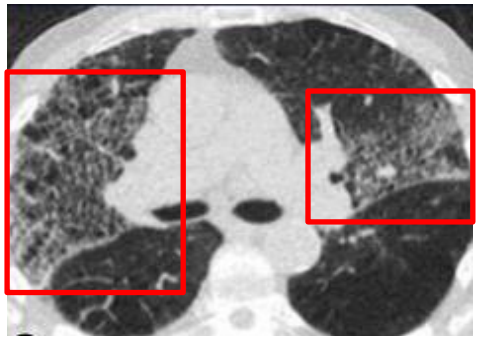
CO-RADS 1. Normal chest CT



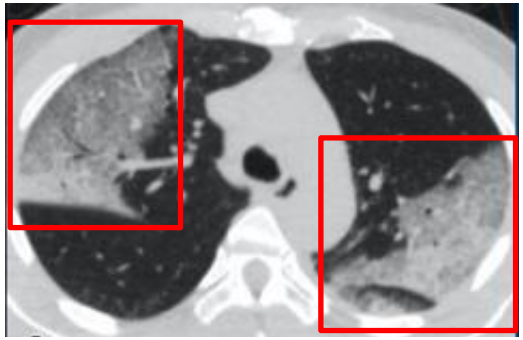
CO-RADS 2. Non COVID-19 infection



CO-RADS 3. Indeterminate



CO-RADS 4. High Suspicion



CO-RADS 5. Typical COVID-19

Our Supporters

DEPARTMENT OF BIOTECHNOLOGY
GOVERNMENT OF INDIA

सत्यमेव जयते
Department of Science and Technology (DST)

IIT Bombay
SINE
Business Incubator

Microsoft

NVIDIA

TATA MEMORIAL CENTRE
टाटा स्मारक केंद्र
SERVICE RESEARCH EDUCATION

sidbi

महाराष्ट्र शासन
Maharashtra State Innovation Society

विद्याविनियोगाद्विकास:
IIM AHMEDABAD

TiE MUMBAI
FOSTERING ENTREPRENEURSHIP

E DIMENSION

"Let us work together for

better diagnosis

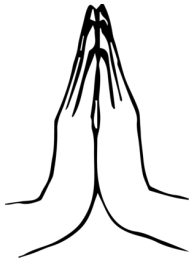
&

improved efficiency"

Website: www.endimension.com

Mail Id: bharadwaj_kss@endimension.com
apparao_mlv@endimension.com

Contact: +91 9967161926
+91 8898612916



THANK YOU

END DIMENSION