

Versatile Mucosal Vaccines



Beyond Immunization

Rethinking vaccines for complete protection against infection and transmission

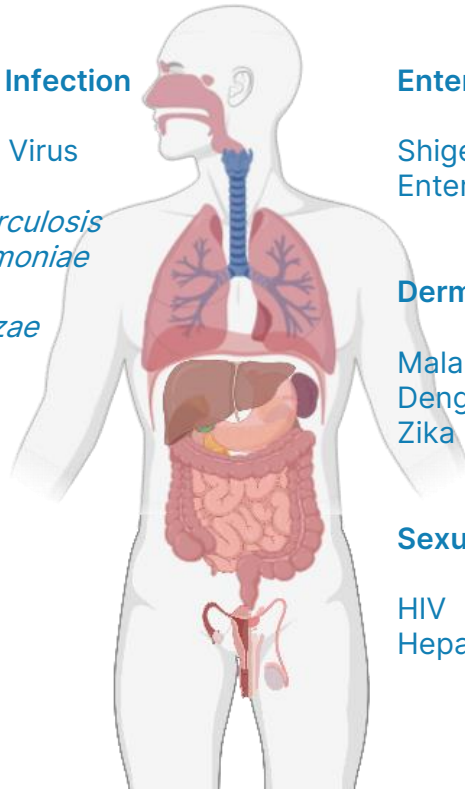


The Unmet Need

17M yearly deaths attributed to infectious diseases

Respiratory Route of Infection

Respiratory Syncytial Virus
SARS-CoV-1/2,
Mycobacterium tuberculosis
Streptococcus pneumoniae
Bordetella pertussis
Haemophilus influenzae



Enteric Route of Infection

Shigella, Helicobacter Pylori,
Enterotoxigenic *E coli*

Dermal Route of Infection

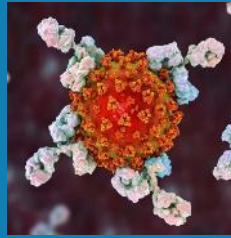
Malaria
Dengue
Zika

Sexual Route Of Infection

HIV
Hepatitis C Virus

Not or poorly addressed by current vaccines

Limitations of Current Vaccines



Lack of Immune Response

Current injectable vaccines induce systemic immune response but do not confer mucosal immunity, notably in the nasal compartment, the first barrier that respiratory pathogens breach before dissemination to the lungs.



Contagiousness

Current vaccines do not prevent contagiousness as vaccinated subjects can still become contagious.



Lack of broad proactive universal immune response

Current injectable vaccines are unable to provide broad-spectrum or universal protection against pan-genus and pan-family pathogens (emerging variants).

Opportunity with Nasal Vaccines

Nasal immunization is able to induce strong immune responses:

- Against nasal, pulmonary, oral, rectal and vaginal diseases
- Thanks to interconnection between mucosal tissues in the body

The mucosal route is also superior to the systemic route



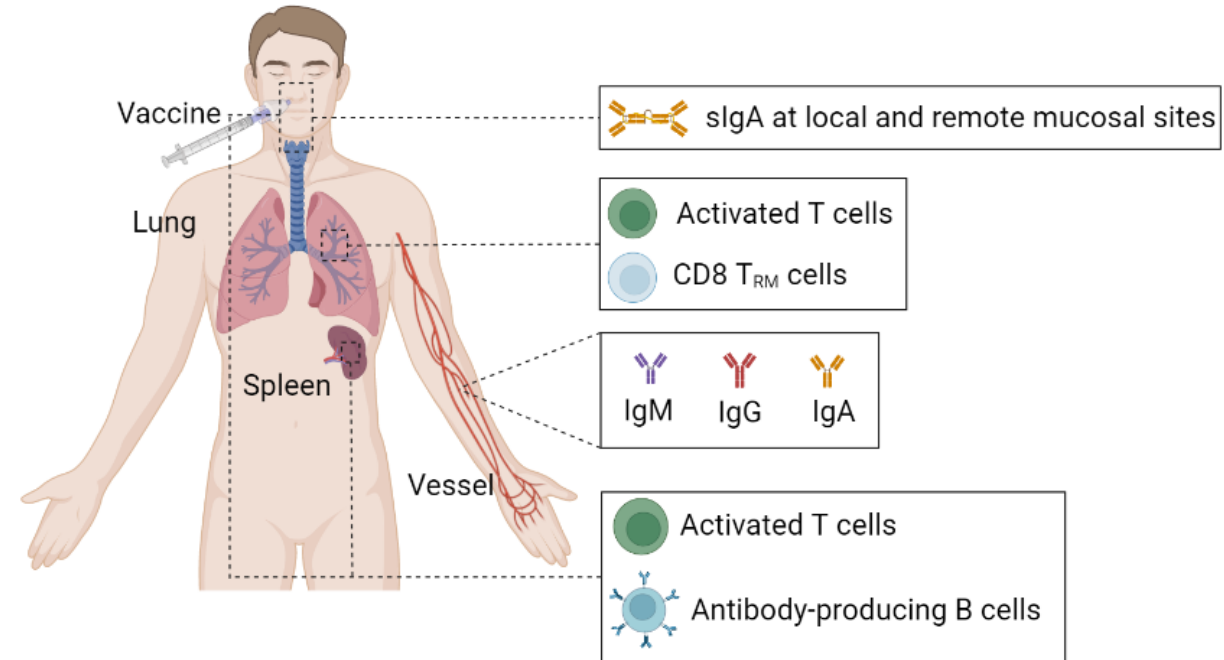
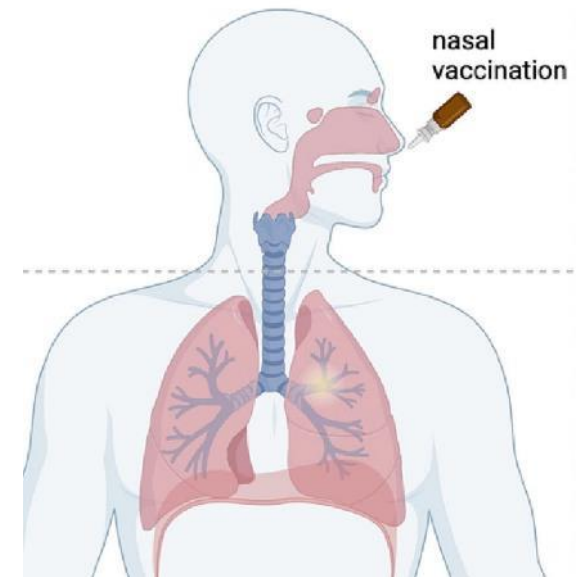
Today vaccination only triggers systemic immunity & ignores other mechanisms *i.e* mucosal immunity



Mucosal immunity: a clinically relevant key to prevent infectious diseases



Mucosal immunity activation: a game-changer to prevent the development and spreading of pathogens



Challenges with Nasal Vaccines

The mucosal route presents significant technical complexity compared to the systemic route:

- Rapid clearance by mucociliary barrier
- Limited inoculation volume
- Adjuvant and/or other delivery system required

25 Years of Research

Prof. Isabelle Dimier-Poisson
CSO of Lovaltech

Pioneering research on mucosal immunity at UMR ISP, a joint research lab between INRAE and University of Tours.

International recognized expert in anti-infectious immunology, vaccinology, and recombinant protein engineering.



INRAE

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de TOURS

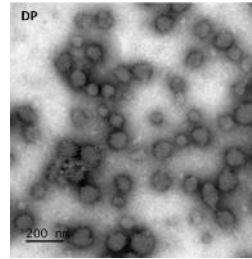
For any infectious disease, our team has the ability to develop:

- The right antigen to initiate a protective “universal” immune response while being manufacturable at scale
- The right vaccine formulation to deliver the antigen to antigen-presenting cells in the mucosa tract, avoiding mucociliary clearance, and ensuring sufficient immunogenic contact with the nasal mucous membrane
- The right medical delivery device to spread the vaccine in the lower airways, with a controlled and repeatable volume

Our Solution - Intranasal Vaccine Technology Platform

LVT001 Patented

MABimprove
LabEx Tours Montpellier



Vaccine Fusion Protein (VFP)

- LVT001: Fusion protein against COVID-19.
- LVT002, LVT003, LVT004: three more proteins in development against malaria, bronchiolitis and flu.
- Production in CHO cells, well suited to scale-up via stable transfection, from an established working cell bank.

Mucoadhesive Excipient

- Biocompatible and biodegradable.
- Ensure that vaccine fusion protein cross the epithelium barrier and is not cleared by mucociliary removal.
- Enhanced immunogenicity in the mucosa, increasing the magnitude and durability of antiviral immunity and exerting a dose-sparing effect.

Intranasal Delivery Device

- In conventional pipette-based delivery method: the vaccines are dropped into the nostrils, which is unprecise and unstandardized, drug volumes easily exceeding the nasal cavity volume.
- We use single-use prefilled delivery device to produce large particles, leading to decreased (and controlled) vaccine deposition into lower airways and reduced side effects.

The Right Time to Rethink COVID-19 Vaccine

Current vaccination against COVID-19 is not optimal

- ✗ No long-term immunity: multi booster needed
- ✗ Inability to stop contagion
- ✗ Low or no protection against variants
- ✗ Stability / storage at ultra low temperatures



7M Deaths Globally → 650M Infections

10 Variants → 10 Waves

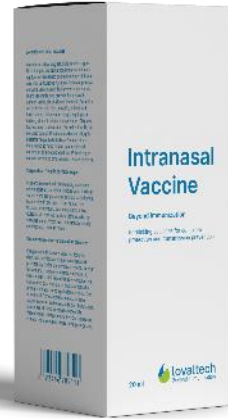
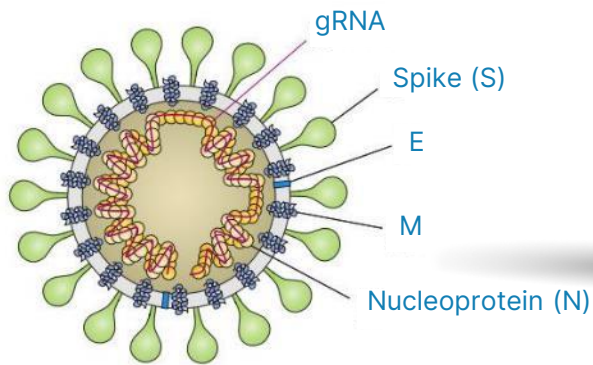
7 Approved Vaccines (EU) → Intramuscular only
Require adjustment to virus mutation

The Long COVID Burden

- Independent of strain or disease intensity
- 30-40% of the patients
- Unclear mechanisms
- Large varieties of debilitating symptoms
- No approved treatment
- Costs estimated to \$140-600bn / year in the US only

LVT001 Vaccine Development

SARS-CoV-2 Virus



Fusion Protein



INRAE

université de TOURS

MABimprove
LabEx Tours Montpellier

Homo-trimeric protein including SARS-CoV-2 S & N proteins and Fc domain (against COVID-19)



Identification of highly conserved and immunogenic antigens



Targeting the intracellular nucleoprotein which is not exposed to the immune system and thus not subject to mutation



Generation of a broad immune response against current and future SARS-CoV-2 variants



Stability at positive temperature for at least 6 months



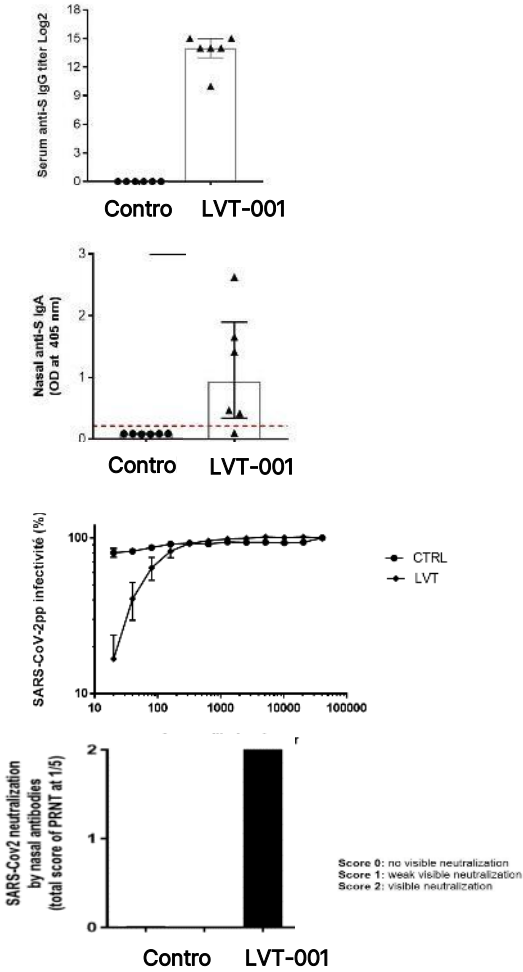
Worldwide & exclusive license agreement for all human and animal health applications of patent EP21306220

LVT001 Pre-Clinical Results

Immunogenicity

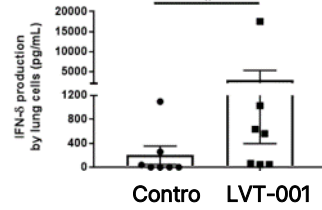


BALB/c JRj Murine Model

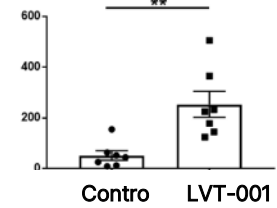


Strong humoral response at mucosal (IgA) & systemic (IgG) levels

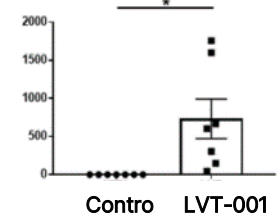
Wuhan Spike Stimulation



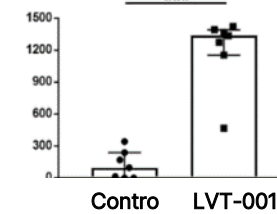
Nucleoprotein Stimulation



Delta Spike Stimulation



Omicron Spike Stimulation

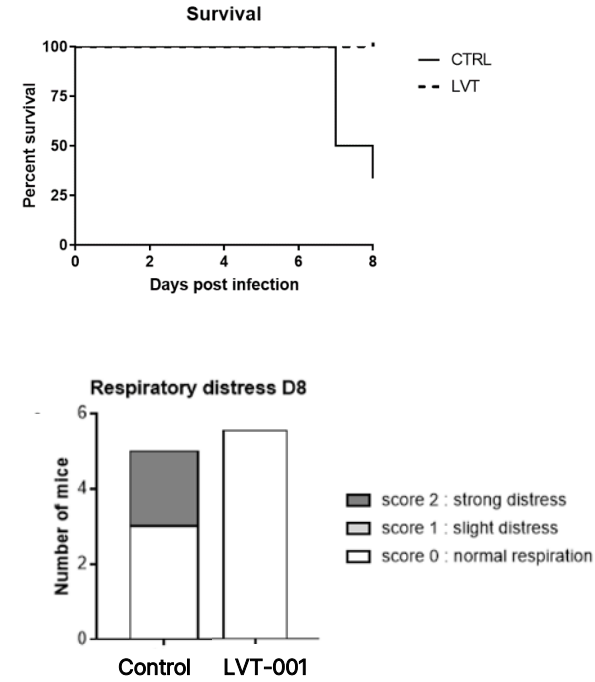


Robust cell-mediated response at mucosal & systemic levels (CD4+, CD8+, IFN-γ, IL-2)

Survival & Clinical Symptoms



C57Bl/6 K18 Murine Model

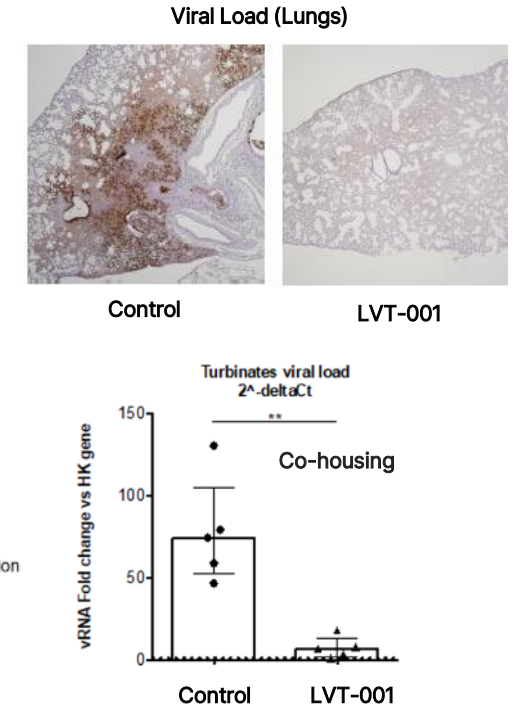


Full Protection
100% Survival Rate
0% Morbidity

Transmission & Contagiousness



Syrian Hamster Model



Early viral neutralization with no viral load = no contagiousness

Tested on Wuhan, Beta, Delta, Omicron strains

LVT001 Clinical Readiness

LVT001 – Pre-Clinical Completion

Completed regulatory studies.



Process scaled-up to 2000L in GMP conditions using standard equipment for easy transfer and optimized yield and COGS.



MUCOBOOST - First in Human Trials Safety and immunogenicity

Randomized, phase I/IIa multi-center trial (France)

360+ volunteers with full vaccine scheme
1 booster dose

Primary objective phase 1: LVT001 safety (3 dose levels)
Primary objective phase 2: LVT001 superiority vs mRNA vaccine in terms of mucosal immunity

Scientific Advice (ANSM) Q3 2023
Dossier Submission Q4 2023
Clinical investigation to qualify mucosal immunity Q4 2023
GMP batch manufacturing Q2 2024
First vaccine administration Q3 2024

LVT001 Competitive Landscape

About 200 Vaccines Candidates In Development

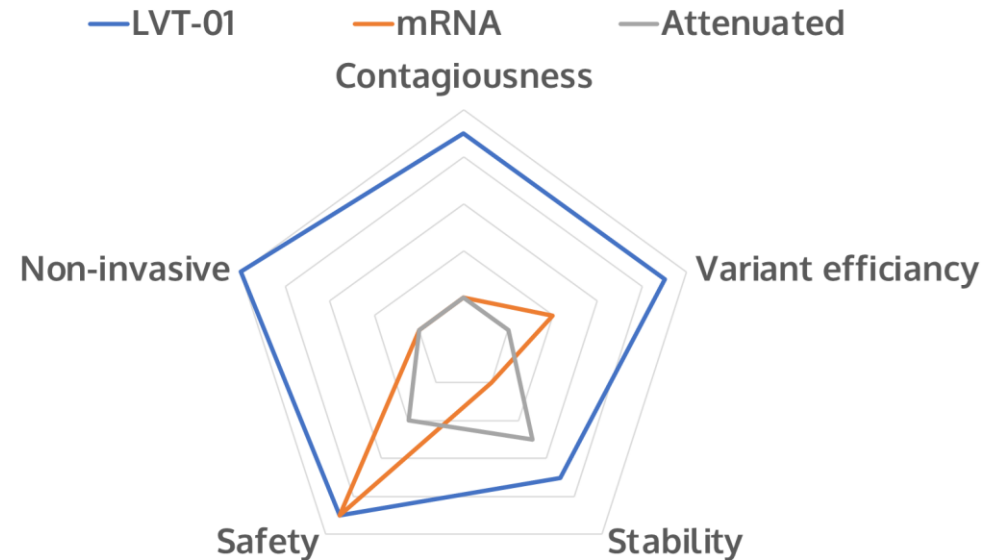
Only 15 nasal vaccine candidates

Only 2 nasal vaccine candidates based on protein sub-unit



Only 1 nasal vaccine candidate based on Spike and N protein sub-unit

- Protection against variants
- Prevention of contagiousness
- Safety



Target Markets

Endemic COVID-19 Vaccine Market

- During the peak of the pandemic phase, the COVID-19 vaccination market reached \$60B
- During the endemic phase, the COVID-19 vaccination market is forecasted to stabilize around \$20B, targeting primarily elderly adults and immunocompromised subjects

Nasal Vaccination Market

- Nasal Vaccination Market \$11B in by 2030 growing at 8.09% CAGR
- Growing market interest related to its non-invasive nature, ease of use and ability to stimulate mucosal immune response

Vaccine Development Platform

LVT001

- Our vaccine launch is planned for 2025 in collaboration with a pharmaceutical company, allowing us to capture part of the endemic market

LVT002, LVT003, ...

- An early and broadly immune response that prevent infection, reduces the risk of variants and stop contagiousness, and the only way to prevent future pandemics

Market Opportunity and Financial Forecast

A €20bn market for LVT001

- Booster jab for already vaccinated people (15-65 Y)
- Primo-vaccination: Multi-comorbidity patients, LMIC population

TAM €20bn (Endemic Phase)

SAM €5.5bn (US, JP, DE, ES, FR, IT, UK)

SOM €825M (15% Market Share)

A \$11bn market for other nasal vaccines by 2030

- Pandemic phase: Non-exclusive partnership with fast-developed vaccines (ex: mRNA) combined with LVT proprietary muco-excipients
- Endemic phase: LVT proprietary vaccines, efficient against all existing and future disease variants

**endemic phase also includes all existing pathogens causing public health concerns even if not leading to a pandemic phase*

License deal scheme with a big pharmaceutical company

€30-50M

Upfront:
Completion of phase
1/2a clinical trial

€50M

Milestone payment:
1st market authorization
granted

€80M

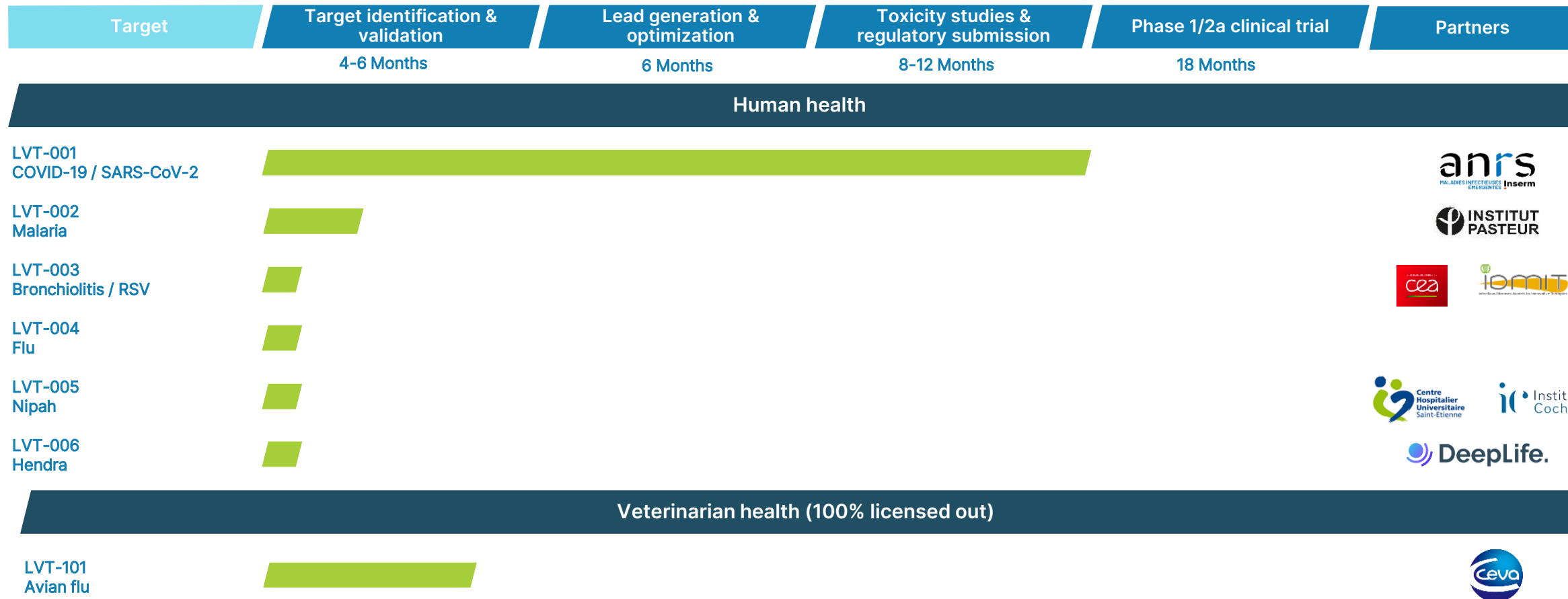
Yearly royalties:
15% market shares in main
territories (EU, US)

2025

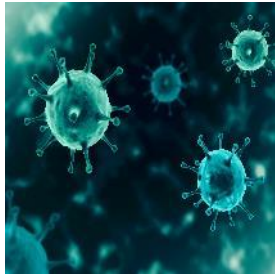
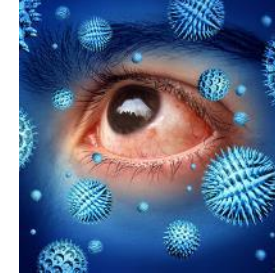
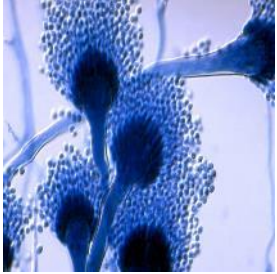
LVT-001 / COVID-19
Every 2-3 year a new
asset

Vaccine Pipeline

With LVT001, Lovaltech has demonstrated the superiority of the approach towards the other approved vaccines for COVID-19 and thus established the validity of its vaccine development platform.



Opportunities Beyond Infectious Diseases



Respiratory, Enteric and Sexually Transmitted Infections

Mucosal Tumors

Allergies

Our Key Value Proposition

Broad Spectrum



Fungi



Parasites



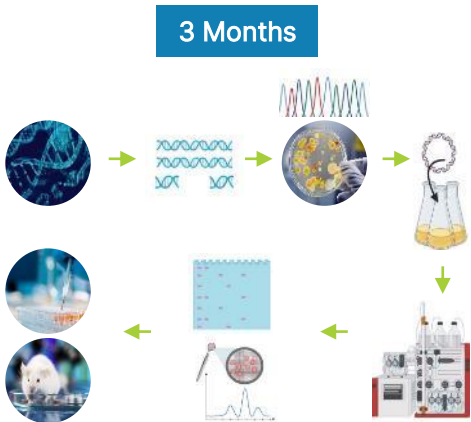
Bacteria



Virus

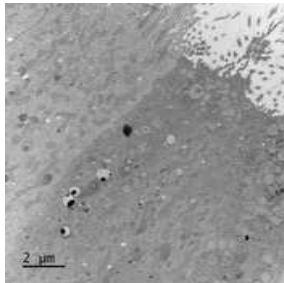
Applicable to Many Infectious Diseases and Pathogens

Rapid Proprietary Protein Engineering Process



1. Improved Vaccine Efficacy Against Variants
2. Can be Stored at Positive Temperature

Deep Understanding of the Mechanism of Action



Systemic + Mucosal Immunity = Protection against Infection and Transmission

Intranasal Delivery

Dedicated Medical Device



Established Collaboration with Aptar Pharma



Easy Delivery

Funding

Q1-Q2 2022

Q1 2023

Q3-Q4 2023

<p>Start-up Creation €465k</p> <p>bpifrance i-Lab</p> <p>CCI TOURAINE FMDR €160k <small>l'ACCÉLÉRATEUR DES ENTREPRISES</small></p>	<p>Pre-Seed €750k</p> <p>bpifrance BSA Air</p>
<p>€3.4M ANRS-MIE / MERS</p> <p>€400k University of Tours / INRAe</p> <p>   </p>	

<p>Grant €5.3M</p> <p> Lauréat <small>REPUBLIQUE FRANÇAISE</small></p>	<p>Current Round: Seed €1.5M</p> <p>Conduct Phase I/IIa Clinical Trial</p> <p>€500k Committed</p> <p> DA VINCI LABS</p>
<p>€3.1M Granted To Aptar Pharma</p> <p></p>	
<p>Series A €5M</p>	

Key Achievements



July 2023

- France 2030 i-Demo Programme
- €8.4M secured with partnership with Aptar Pharma, including €5.3M for Lovaltech.



June 2023

- €750k seed round led by Da Vinci Labs
- Da Vinci Labs Acceleration Programme

H1 2023



LVT001 GLP regulatory toxicity study
LVT002 & LVT003 protein design



Medical device (Aptar Pharma) selected



Unprecedented understanding of mechanism
of action in nasal vaccination (article
submitted to peer-reviewed magazines)

Ongoing and Planned Research

Integrate explainable artificial intelligence (AI) to anticipate infectious threats and speed up vaccine development



Test on in vitro 3D human models to better understand human answers and decrease the use of animals in R&D studies



Use of next generation active ingredients to boost muco-adhesive properties and subsequent efficacy all decreasing the environmental impact of the process



Thorough understanding of nasal mucosa microenvironment to design optimal vaccine formulation for an enhanced efficacy



Executive Team



Serge Pampfer
CEO

Serge ventured into the startup world including CSA at Arevia GmbH, COO at Beta-Cell NV, CSO at VC EureKARE & CEO of incubator WBC with 2 IPOs & 5 acquisitions.



Mathieu Epardaud
Expert Senior Scientist & Co-Founder

INRAE Researcher.
20 years of experience in mucosal immunity.
Expertise in devices.



Patrick Barillot
President & Co-Founder

30 years of experience in pharma industry; International partnership marketing & business development, sales, production. Several missions to turn around structures and develop strategic plans.



Nicolas Aubrey
Expert Senior Scientist & Co-Founder

Assistant professor, 22 years of experience in the design and development of complex recombinant proteins (antigens, antibodies, fusion proteins, ...).



Isabelle Dimier-Poisson, Prof.
CSO & Co-Founder

25 years of experience in nasal vaccine development. Management of a team of 25 researchers at University of Tours. Member of the Vaccination Task Force European Federation of Immunological Societies.



Marianne Maquart
Project Manager - Virology

10 years of experience in virology as an assistant at the National Reference Center for Arboviruses in Marseille and then as a virology project manager in the INSERM U1259 MAVIVH unit.

Advisory Board & Scientific Committee

Advisory Board



Amine Tahiri
VP Clinical Development, Noema Pharma

Advisor on regulatory, manufacturing and business strategy. Healthcare executive with expertise in start-ups & large pharma companies.



Xavier Aubry
Founder, Zaz Ventures

Advisor on go to market, communication and fundraising. Deep tech entrepreneur with expertise in public/private fundraising.



Nadège Grabowski
Synthetic Biology Practice Leader, Da Vinci Labs

Advisor on regulatory, fundraising and business strategy. Healthcare research lead with expertise in start-ups.

Scientific Advisory Board



Stéphane Paul
Practitioner Immunology & Vaccinology (PU-PH),
INSERM CHU Saint Etienne

Member of the French COVID-19 vaccine scientific committee.



Morgane Bomsel
Senior researcher, CNRS - Institut Cochin

Virologist, Expert in mucosal immunity.



Cecil Czerkinsky
Research Director, INSERM

World expert in mucosal immunity.

Lovaltech in the Limelight

Congresses

- Sociétés françaises de parasitologie et de mycologie médicale, Marrakech - May 2023
- MotivHealth, Blois - Nov 2023
- GAT Aerosolstorming, Paris - June 2023
- CIVVet , Toulouse - May 2023
- Webinar SFI - May 2023
- Connect in pharma, Geneva - June 2023
- 2023 ISV Annual Congress, Lausanne – Oct 2023
- Simposio por el Dia Internacional de Immunologia, Quito - April 2023
- Immunotherapies & Innovations for Infectious Diseases, Lyon - Nov 2022
- Vivatech, Paris – June 2023

Media Coverage

- The Conversation, Sciences & vie, Maddynews, Pharmaceutiques...
- TV Tours, BFM Business

Awards

- French Tech Rise selection 2022
- Tours Métropole Val de Loire « Top des Entreprises 2022 »
- Finalist Hello Tomorrow 2022





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