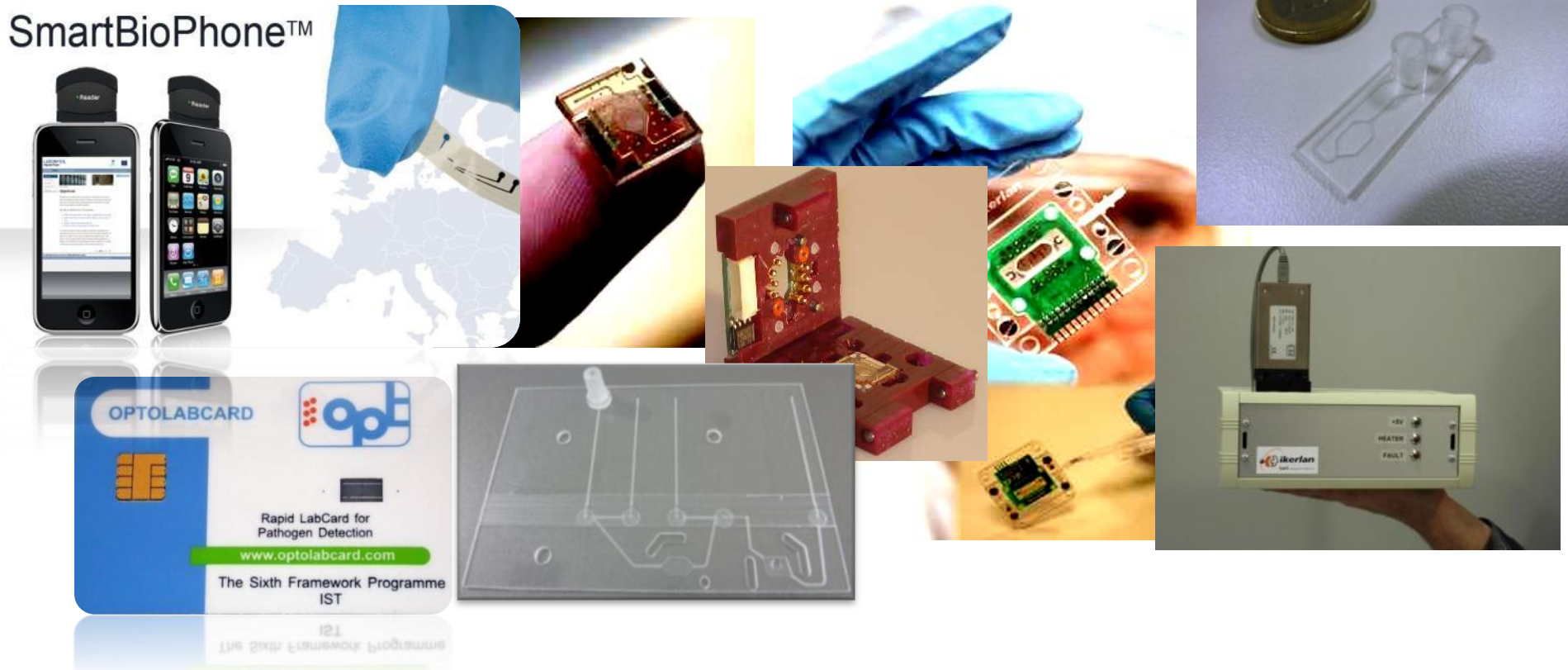


# “LabonFoil: Climbing the mountain through the south face using the MNBS convergence as a security rope”



*An already started trip from the LabonaChip to the market*

Jesús M. Ruano López

Ikerlan-IK4

# “Why Do We Keep Trying to Climb a Lab-on-a-Chip Mountain from the North Face?”



- ☐ We, humans, enjoy difficult things, challenges
- ☐ Scientist are some how like climbers
- ☐ It is in our nature to enjoy challenges by itself
- ☐ Those who did not like challenges were extinguished during a period with high uncertainty
- ☐ We must fight our ancestral instinct and **set realistic goals.**

# Content or climbing route

- ☐Climb Preparation

- ☐Mountain

- ☐Base camp

- ☐Climbing strategy

- ☐Height reached

- ☐Future

- ☐Conclusions

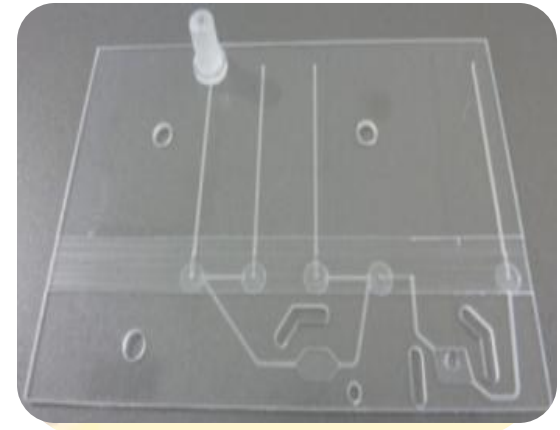
# Terminology or climbing tools



In-Vitro Diagnostic Platform (IVD)



Point of Care Platform (PoC)



Disposable component Labonachip (LOC)

|                   |          |                              |          |   |
|-------------------|----------|------------------------------|----------|---|
| <b>PoC or IVD</b> | <b>=</b> | <b>Control Unit</b>          | <b>+</b> | <b>Labonachip</b>                       |
| <b>LabonaChip</b> | <b>=</b> | <b>Sample Prep. Off chip</b> | <b>+</b> | <b>Sample Prep. On chip + Biosensor</b> |
| <b>Biosensor</b>  | <b>=</b> | <b>Channel</b>               | <b>+</b> | <b>Biological Layer + Sensor</b>        |
| <b>Sensor</b>     | <b>=</b> | <b>Material</b>              | <b>+</b> | <b>Microfabrication</b>                 |

**PoC or IVD=Control Unit +Sample preps.+Channel+ Biology + Material + Microfab.**

# Social need to progress

Demand of  
Diagnostic  
devices

Real food, human,  
environmental sample



IVD sector full of old  
“Gold Standards”

Current strategy

Available solutions

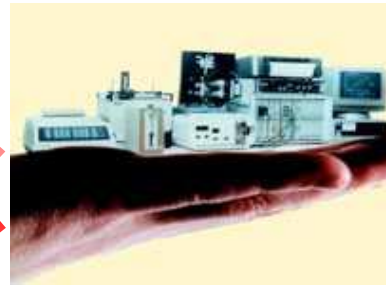


Lab on a Chip  
(LOC) strategy

Microtechnology

+  
ICT

+  
Biology



25 years keep trying  
Too focused on  
challenges  
Climbing mind?

Future solutions



Are we stuck?

The SmartBioPhone™, a Point of Care vision under development through two European projects: OPTOLABCARD and LABONFOIL Jesus M. Ruano-López *et al.*, *Perspective article*, **LabonaChip Journal**, DOI:10.1039/B902354M



# Social need to progress\*

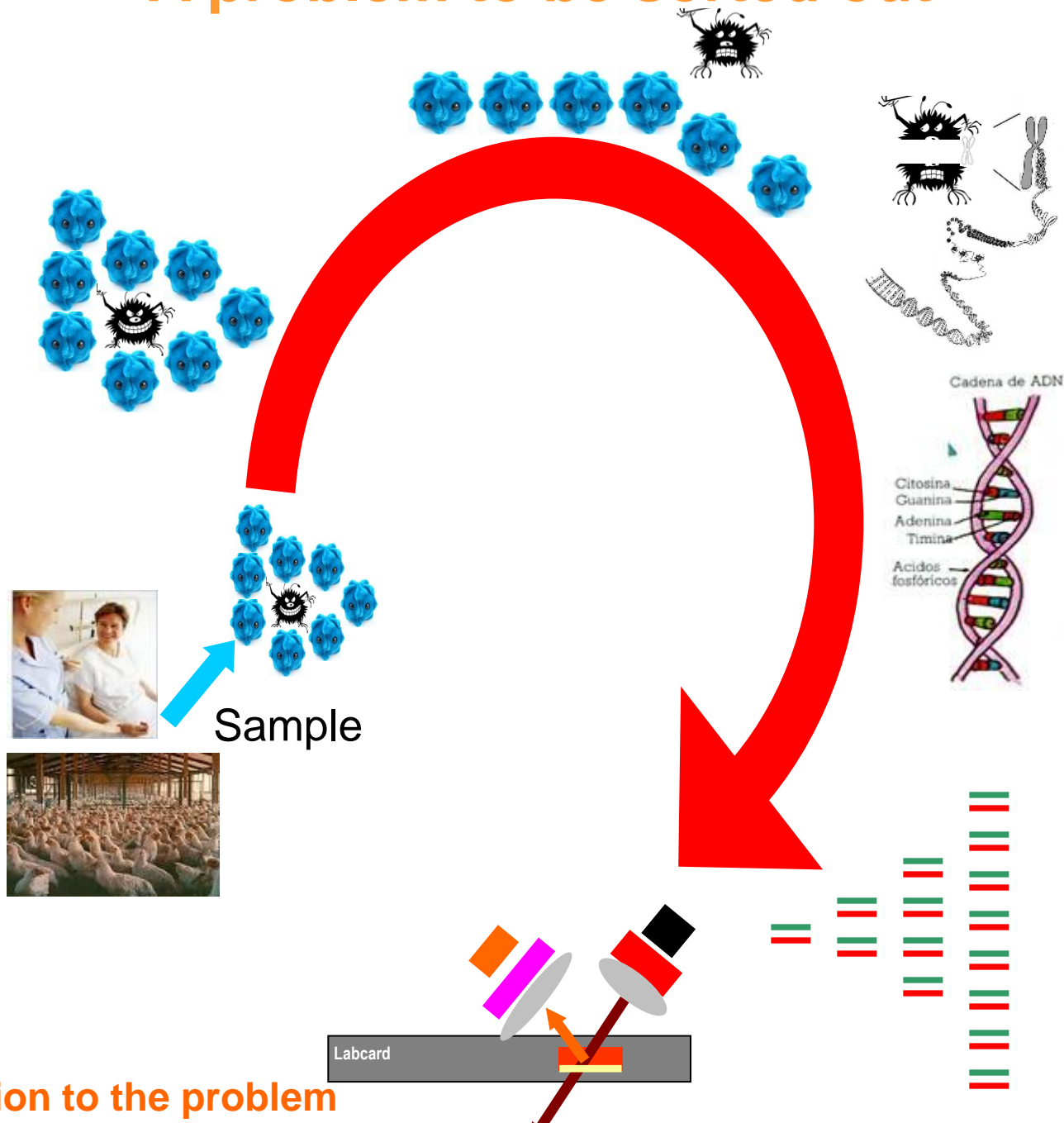


*\*“Progress is a gain of independence from a uncertain environment”, Jorge Wagensberg*

**Introduction to the problem**

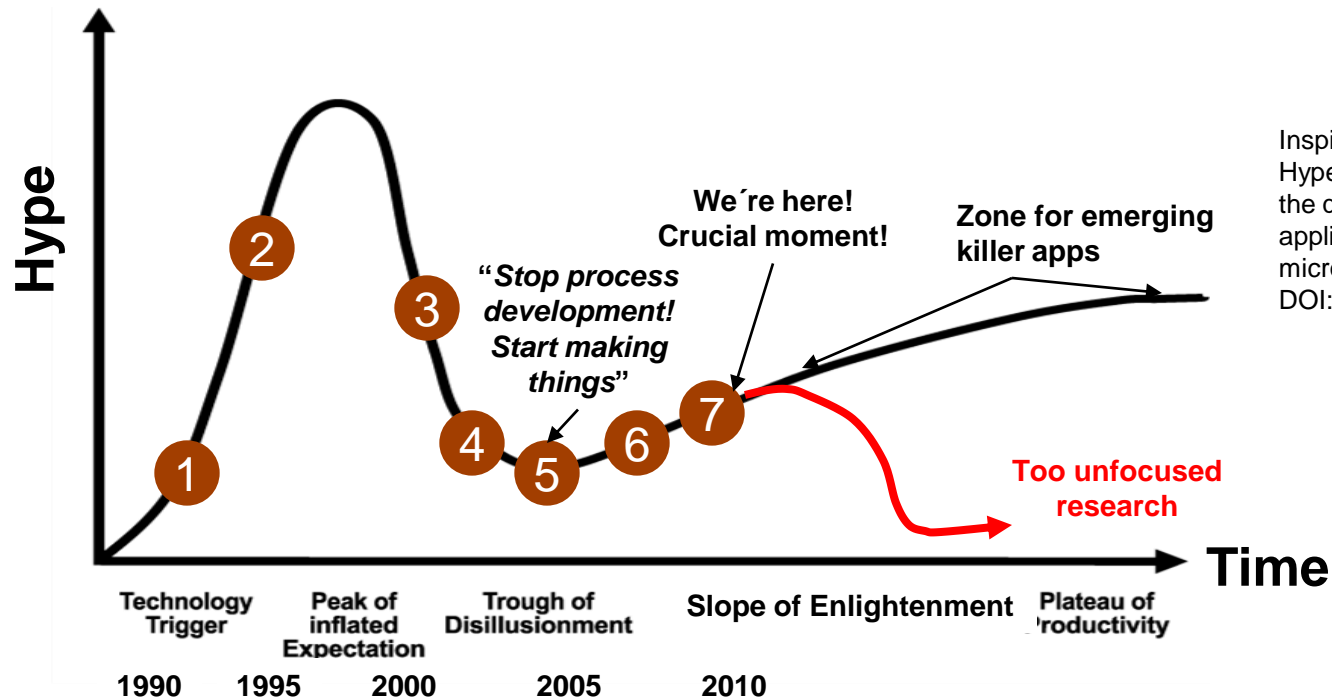
Barcelona, SSI 2011

# A problem to be sorted out

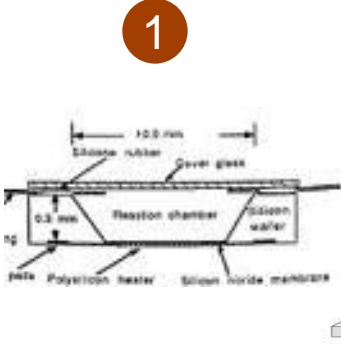


Introduction to the problem

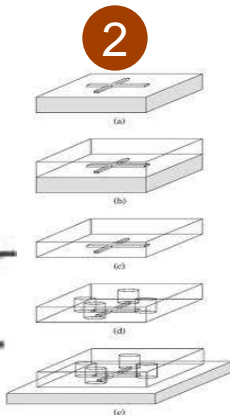
# State of the art of Molecular biology on chip



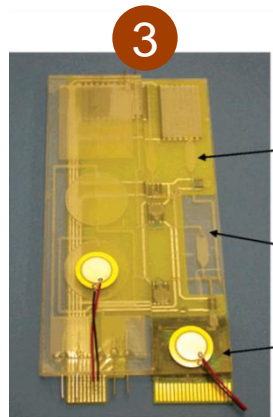
Inspired in H. Becker,  
 Hype, hope and hubris:  
 the quest for the killer  
 application in  
 microfluidics  
 DOI: 10.1039/b911553f



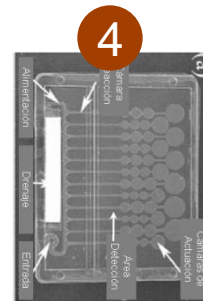
M.A.Northrup *et al.* 93



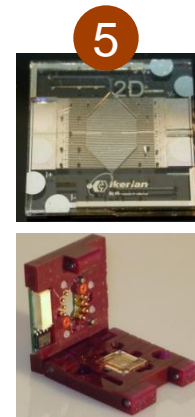
D.Duffy *et al.* 98



Y.Liu *et al.* 2002



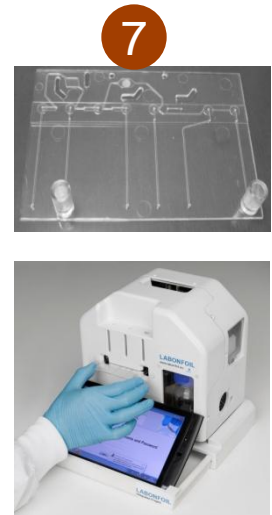
A.Gulliksen *et al.* 05



M.Aguirregabiria 07  
 L.Verdoj *et al.* 09  
 D. Bang *et al.* 09  
 Optolabcard EU



G.Cerovic 09  
 PortfastFlu EU



J.M. Ruano *et al.* 11  
 LabonFoil EU



# Content

☐Climb Preparation

☐Mountain

☐Base camp

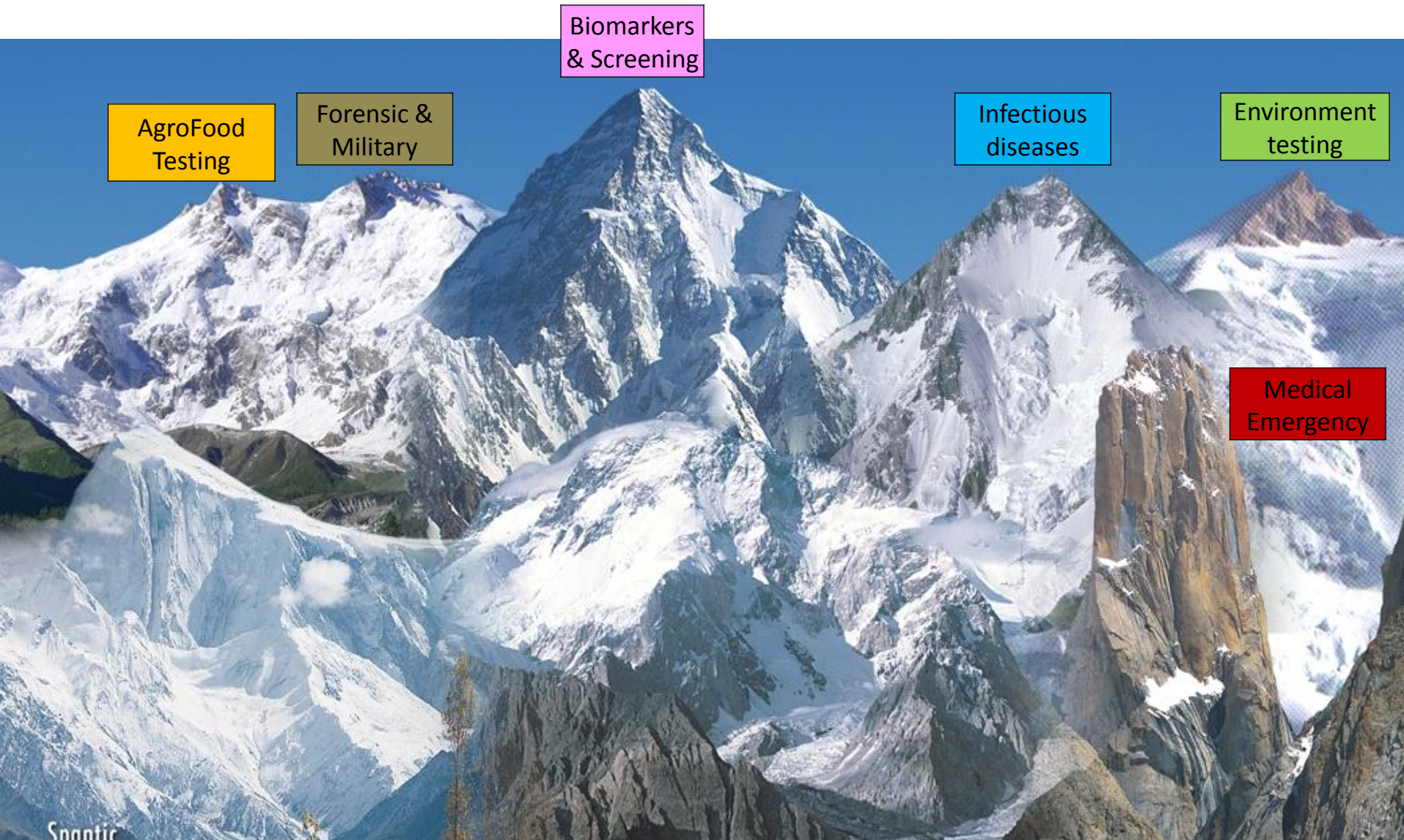
☐Climbing strategy

☐Height reached

☐Future

☐Conclusions

# Each peak is a Diagnostic market segment



Shutterstock

*“Classifying is to compress and compress is to comprehend”, Jorge Wagensberg*

# Let's describe the 6 peaks

| Technical Barriers                 | AgroFood<br>Testing | Forensic &<br>Military | Medical<br>Emergency | Infectious<br>diseases | Environment<br>testing | Biomarkers<br>Screening |
|------------------------------------|---------------------|------------------------|----------------------|------------------------|------------------------|-------------------------|
| Multiplex assays                   |                     |                        |                      |                        |                        |                         |
| 45' per analysis                   |                     |                        |                      |                        |                        |                         |
| 15' per analysis                   |                     |                        |                      |                        |                        |                         |
| Increase Resistance                |                     |                        |                      |                        |                        |                         |
| Simple sample extraction           |                     |                        |                      |                        |                        |                         |
| Complex sample extraction          |                     |                        |                      |                        |                        |                         |
| Positive control required          |                     |                        |                      |                        |                        |                         |
| Prevention of contamination system |                     |                        |                      |                        |                        |                         |
| Sensitivity                        |                     |                        |                      |                        |                        |                         |
| Certification ISO HA               |                     |                        |                      |                        |                        |                         |
| Acceptable price per assay         |                     |                        |                      |                        |                        |                         |

# Content

☐ Ascent Preparation

☐ Mountain

☐ Base camp

☐ Climbing strategy

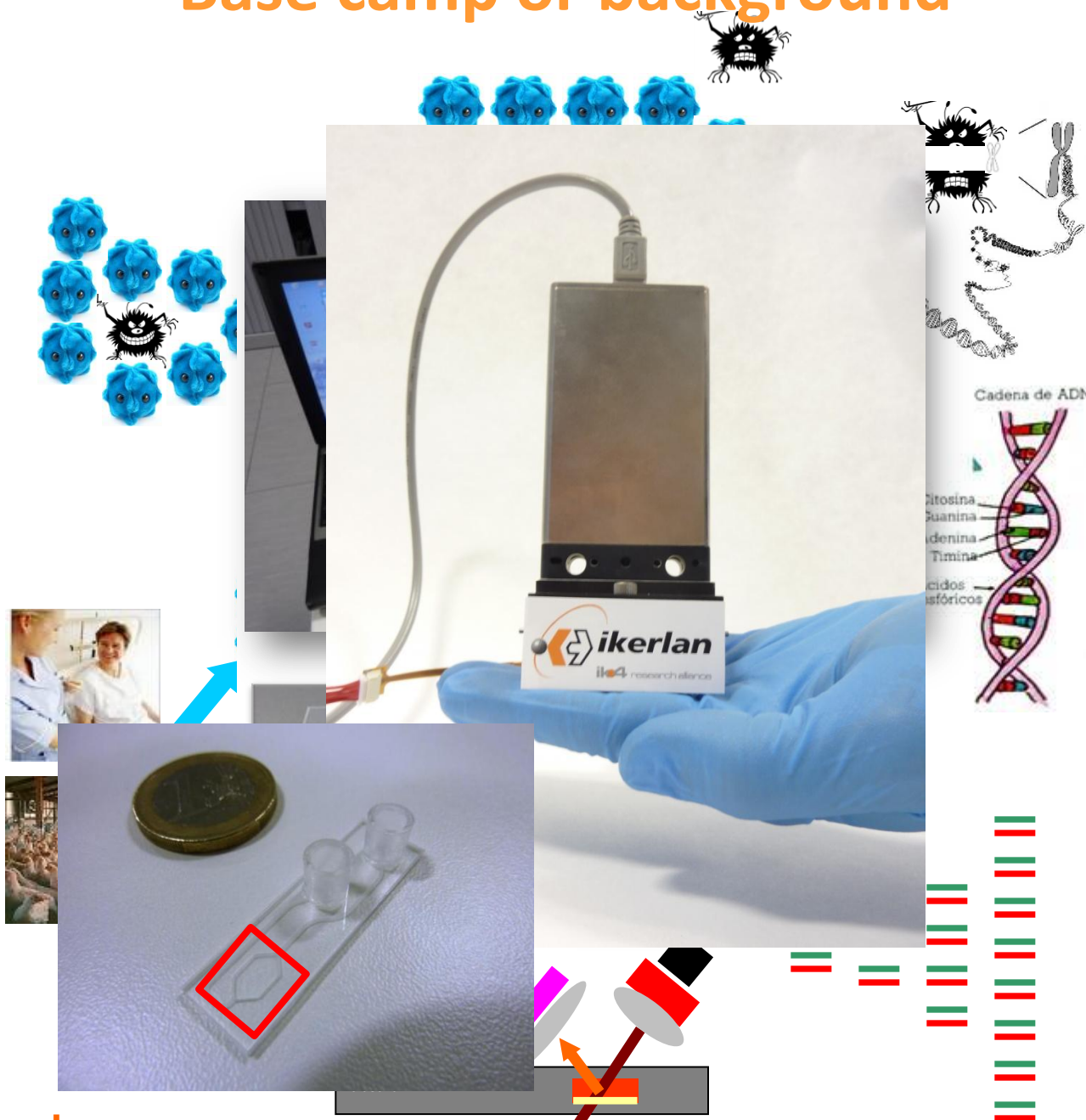
☐ Height reached

☐ Future Acent

☐ Conclusions



# Base camp or background



Background

Barcelona, SSI 2011

# Content

☐Climb Preparation

☐Mountain

☐Base camp

☐Climbing strategy

☐Height reached

☐Future

☐Conclusions

# Climbing route strategy



1. Don't go to applications where you can not offer a competitive **advantage** to the existing gold standard.
2. First demonstrate if we can make it by selecting the **easiest** route to do it. Then, take the following one and so on.
3. **Integrate** a Diagnostic **system** that involve sample preparation **reliably**.
4. Take advantage of all IVD **research tools** to get there and not focus on one (e.g. Biosensor).

**Team work in MNBS is as essential as it is in Mountaineering**

PoC or IVD= **Control Unit** + **Sample preps.** + **Channel** + **Biology** + **Material** + **Microfab.**  
Tools  
On chip  
Off chip

# Control Unit

PoC or IVD = **Control Unit** + **Sample preps.** + **Channel** + **Biology** + **Material** + **Microfab.**

## Tools

On chip  
Off chip

- Standard PC, iPad or Tablet PC

- Data base software
- Standard Operative System
- Hardware based on commercial components
- USB, SDIO connectors
- Bluetooth, WIFI, 3G, ZigBee
- Smartphone for remote control or portability

The requirements of each application defines how acceptable is the Off chip manipulation

- It is very convenient to use as much sample as possible to increase sensitivity.

Concentration steps

- If it is possible, we should use Molecular Biology Techniques

- Syringes, Filters, Swabs, eppendorfs tubes

- On chip sample preparation provides enough clean substance to be detected on the biosensor

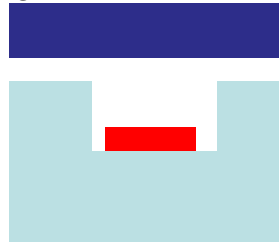
- A channel is a must to confined the liquid on top of the sensor

- A channel is formed by:

- A cavity

- A flat cover bond to the channel

- Low temperature for reagent storage or



- Biology to help simplify what it is difficult

- Molecular Biology on tube needs to be transferred to Chip

- Reactions such as Enzymatic amplification are helpful since amplify the target molecule

- Preferably non contact sensing mechanism labels

- Inert

- Low autofluorescence/transparent

- Low cost

- Same material in the prototypes than in the final product

- Low cost process

- Mass producible

- Simple fabrication to obtain high through put

- Polymer replication

- Good sealing



# Content

- ☐Climb Preparation
- ☐Mountain
- ☐Base camp
- ☐Climbing strategy
- ☐Height reached
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- ☐Conclusions

# Labonfoil EU project

## 3 Labcard applications targeted



### Agro-Food application

*Typing of pathogens*

**Gold standard ( DS/EN ISO 6579/10272-1)**

*Bacteria culture (EU)*

**Available solutions (non-standard)**

*Pall genesystems, Bio-rad, Applied Biosystems (Taqman),*

### Environmental application

*Algal detection*

**Gold standard**

*Fluorimetry, Microscopic solution to identify*

**Main technologies used today**

*AlgaeaTorch (Fluorimetry), (Satelite) imagery, cell counting*

### Medical application

*CEA detection in CRC*

**Gold standard:**

*Immunoassays*

**Main technologies used today**

*ELISA systems*

# General description: LoF product concept

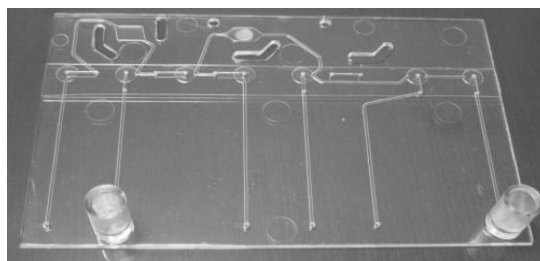
Customizable kit for each assay (high versatility)



An unique diagnostic platform

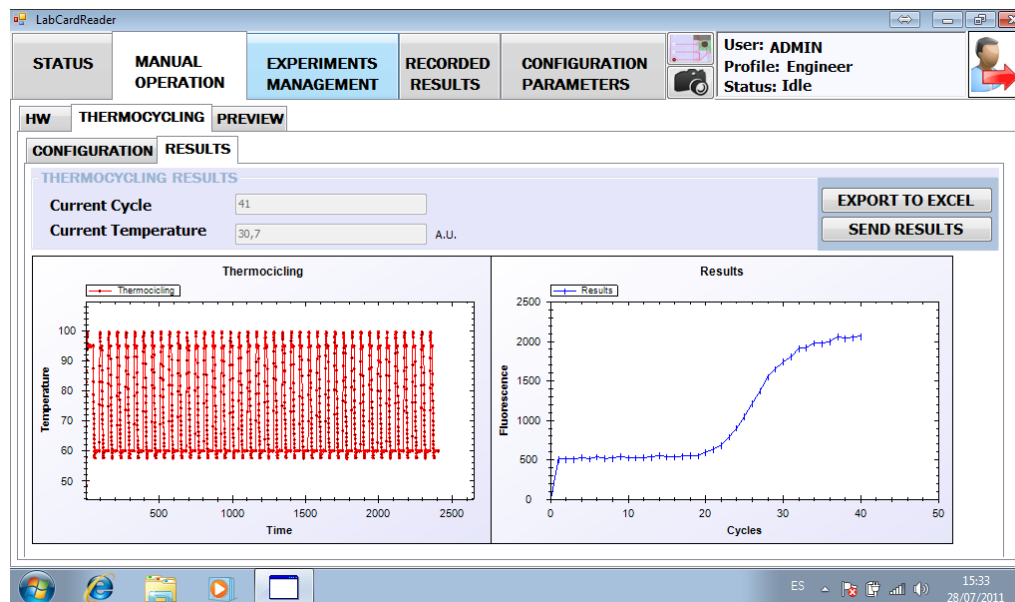


Pre-loaded syringe



Labcard with pre-stored reagents

- User friendly **software** controlling the platform.
- **Robust** LabCard **interface hardware** (heating system, valves, etc.)
- Selectable **dual optics**.
- **Remote** operation via a 3G **smartphone**
- **Automated experiments** (sample preparation and detection).

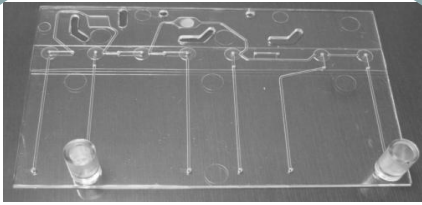


- ☐ Three LabCardReaders fabricated, calibrated and verified
- ☐ Successful **biological tests** were done with partners at Ikerlan.
- ☐ The readers were sent to bio partners and successfully biological tests are being carried out
- ☐ We have added 150 more tests to the 220 envisioned.
- ☐ Total verification tests: 380.



# Food typing of two pathogen -LOC

Sample preparation and multiplex PCR  
detection



Labonfoil labcard



Labcard reader unit

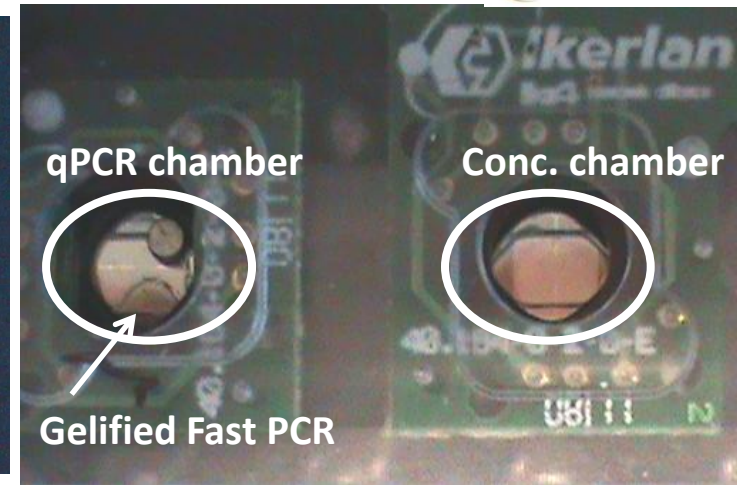
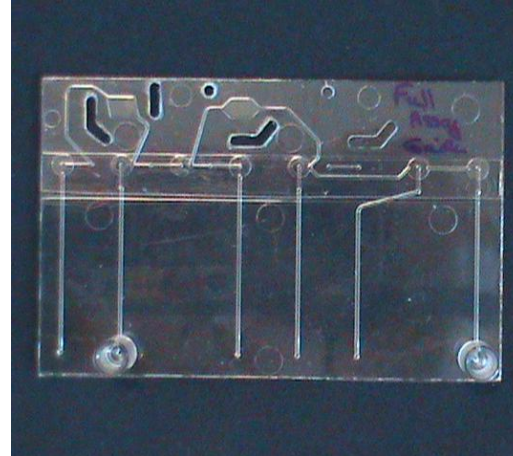
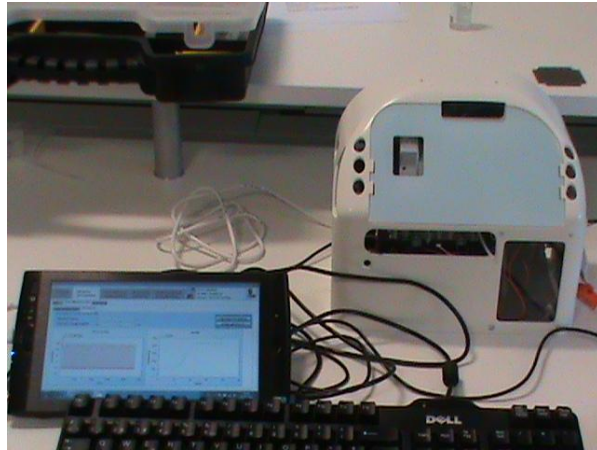
# Protein detection by Immuno qPCR on a LOC



GAiKER  
ik4 research alliance

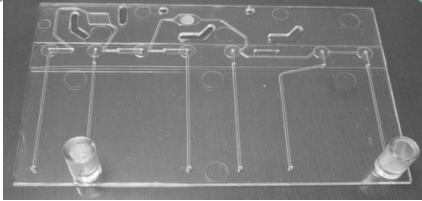
## IqPCR assay on LabCard

## ELISA and PCR on a Labcard



# Verification of Environmental app.

**primer annealing and  
real-time NASBA  
on-labcard**



**Labonfoil labcard**



**Labcard reader unit**

*Tsaloglou and IKERLAN (2011)*

# Content

- ☐Climb Preparation
- ☐Mountain
- ☐Base camp
- ☐Climbing strategy
- ☐Height reached
- ☐Future
- ☐Conclusions



# Next R&D: Address the unmet needs

| Technical Barriers                 | AgroFood Testing | Forensic & Military | Medical Emergen. | Infectious diseases | Environment testing | Biomark. Screening | Current situation    |
|------------------------------------|------------------|---------------------|------------------|---------------------|---------------------|--------------------|----------------------|
| Multiplex assays                   |                  |                     |                  |                     |                     |                    | ✓*                   |
| 45' per analysis                   |                  |                     |                  |                     |                     |                    | ✓                    |
| 15' per analysis                   |                  |                     |                  |                     |                     |                    | ✓                    |
| Increase Reliability               |                  |                     |                  |                     |                     |                    | ✓                    |
| Simple sample extraction           |                  |                     |                  |                     |                     |                    | ✓                    |
| Complex sample extraction          |                  |                     |                  |                     |                     |                    | ✓*                   |
| Positive control required          |                  |                     |                  |                     |                     |                    | ✓                    |
| Prevention of contamination system |                  |                     |                  |                     |                     |                    | ✓                    |
| Sensitivity                        |                  |                     |                  |                     |                     |                    | 10 c.f.u.<br>5 ng/ml |
| Certification CLIA                 |                  |                     |                  |                     |                     |                    | ✓                    |
| Acceptable price per assay         |                  |                     |                  |                     |                     |                    | <20€                 |

\* Ready for some segments

## *Who Are they?*

**POC MicroSolutions** is a Startup company promoted and owned by **IKERLAN-IK4** to commercialize the accumulated technological advancements and know-how in the field of POC diagnostics (Point Of Care)

**POC MicroSolutions** Mission is:

Design, Integration, Production, of Personalized In Vitro Diagnostic Platforms.

**Example: An 8 sample preparation+PCR multiplex system**



# Content

- ☐Climb Preparation
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# Market opportunity conclusions



- Although there is still room for research, it is now possible to move from research to exploitation
- Add an worthy advantage to the gold standard
- Research funding can start paying off
- The economic and behaviors risk are quite low. The reasons are twofold:
  - cost per analysis is very low
  - segments with strong unmet needs
- Application oriented research to beat gold standards
- It is time for bold companies and investors to take the lead
- We will succeed as long as we keep our mind in the goal and **we collaborate together**

**Do not forget the beauty of achieving a goal**

❑ Let's imagine what it will be like when YOUR Diagnostic system is in the market





# Acknowledgments and Questions

- ❑ As a coordinator I would like to publicly thank all Labonfoil researchers for their hard work, frustration resistance and positive spirit.
- ❑ It has been an intense year full of cooperation, trips, and assays
- ❑ Special thanks to my colleagues at Ikerlan.

