



UZ  
LEUVEN



# Moving to full lab automation; what to take into consideration

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UNIVERSITY HOSPITALS LEUVEN

# University Hospital Leuven

- Tertiary care teaching hospital
  - 2000 bed hospital
  - 100 intensive care beds
  - Covering all medical specialties
  - In 2013
    - 63.000 hospitalisations
    - 95.000 day hospitalns.
    - 461.000 consultations



# The bacteriology lab is part of an integrated lab

- Core data :
  - single platform of 4000 m<sup>2</sup>
  - 10.000 samples/day, 40.000 tests/day, 24/7 service
  - 130 FTE lab technicians, 20 non-medical staff, 18 medical staff
- Lab organised around common technical expertise, not around medical expertise
  - common lab software, common pre- and post-analytical procedures

# The Inpeco track in the integrated lab

- Experience with automated sample transport & handling
- Bacteriology:  
largest  
non-automated  
part of lab



# The bacteriology lab

- Bacteriology lab:
  - Culture based bacteriology
  - 800 samples/day, 23 lab technicians
  - Open 8am – 18pm 7/7, blood cultures processed 24/7
  - National ref lab for several micro-organisms including *S. pneumoniae*, mycoses
  - Medical steering Unit Microbiology: 5 microbiologists of which 3 daily involved in activities bacteriology lab
  - MALDI-TOF, VITEK2, all plates poured in bacterio kitchen

# Automation bacteriology lab

- First initiative in 2000:
  - Extensive contacts/negotiations with Kiestra :  
‘It’s the sample that moves’
  - Aim : manual work reduction
  - Finally decided not to implement
    - Opposition from microbiologists
    - Benefits (reduction manual work time) not clear

# Automation bacterio 2014

- Second try: 2013
  - Good results with Inpeco automation
    - reduction manual work, TAT similar but more standardised, importance IT & change management
  - Perception technology now mature, more competitors
  - Aim not clear: mixture reduction manual work, better service (faster turn-around time) improved quality of sample processing
    - not decided if partial or full automation best

# 1<sup>st</sup> phase: getting to know the field

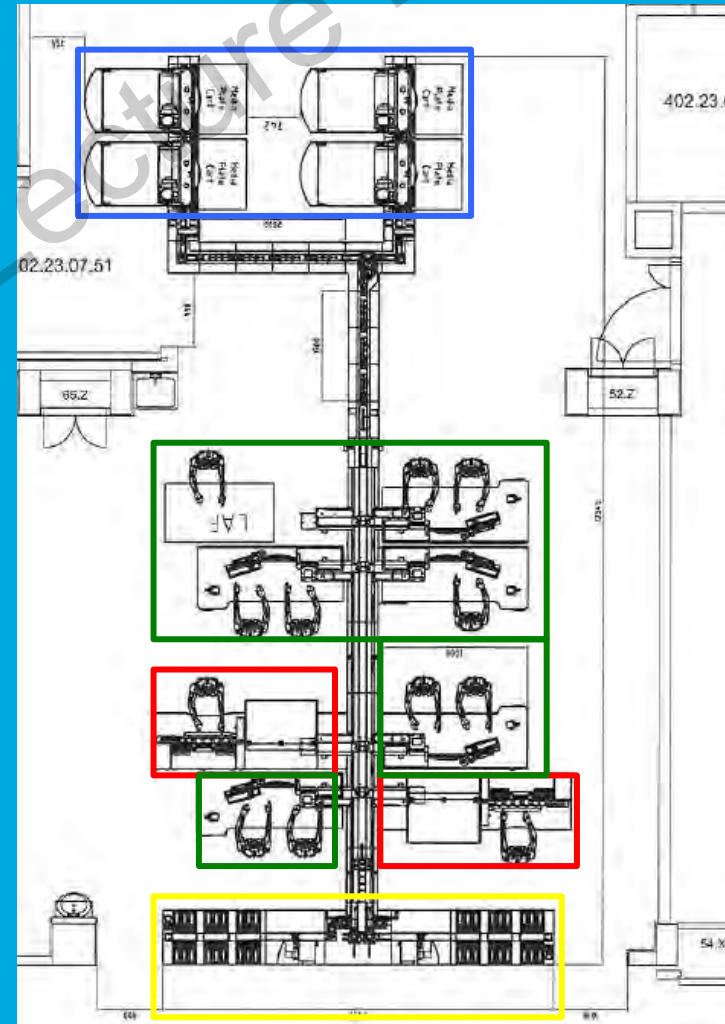
- Data on bacterio activities, growth scenario of 3% / year for 5 years
- Proposals solicited from Copan, BDKiestra & BioMérieux

| specimen           | h0  | h1  | h2  | h3 | h4  | h5  | h6  | h7 | h8  | h9  | h10 | h11 | h12 |
|--------------------|-----|-----|-----|----|-----|-----|-----|----|-----|-----|-----|-----|-----|
| <b>OCTOBER</b>     |     |     |     |    |     |     |     |    |     |     |     |     |     |
| MRSA               | 24  | 40  | 14  | 30 | 155 | 129 | 229 | 33 | 541 | 746 | 617 | 547 | 331 |
| urines             | 65  | 53  | 29  | 54 | 149 | 74  | 185 | 39 | 353 | 625 | 649 | 521 | 492 |
| aerobic            | 119 | 102 | 105 | 55 | 137 | 94  | 135 | 32 | 239 | 317 | 195 | 191 | 164 |
| anaerobic          | 120 | 95  | 110 | 55 | 134 | 89  | 136 | 31 | 235 | 316 | 196 | 183 | 153 |
| wound / pus        | 4   | 7   | 1   | 0  | 5   | 2   | 9   | 18 | 36  | 81  | 144 | 148 | 148 |
| faeces             | 6   | 6   | 7   | 2  | 8   | 10  | 10  | 3  | 17  | 50  | 55  | 50  | 47  |
| pediatrics         | 15  | 8   | 12  | 9  | 14  | 15  | 12  | 8  | 25  | 55  | 49  | 35  | 39  |
| rectal swab        | 2   | 7   | 2   | 3  | 8   | 3   | 9   | 5  | 96  | 52  | 64  | 50  | 33  |
| sputum             | 6   | 4   | 4   | 1  | 4   | 3   | 10  | 6  | 27  | 28  | 45  | 37  | 35  |
| vagina             | 5   | 8   | 2   | 1  | 1   | 2   | 1   | 1  | 5   | 10  | 26  | 43  | 37  |
| Bronchial aspirate | 14  | 5   | 2   | 17 | 73  | 32  | 45  | 4  | 17  | 13  | 16  | 20  | 24  |
| Tissue bank        | 0   | 0   | 0   | 0  | 0   | 0   | 0   | 0  | 0   | 2   | 8   | 5   | 6   |
| biopsy/ tissue     | 0   | 0   | 0   | 0  | 0   | 0   | 2   | 9  | 6   | 24  | 30  | 9   | 6   |



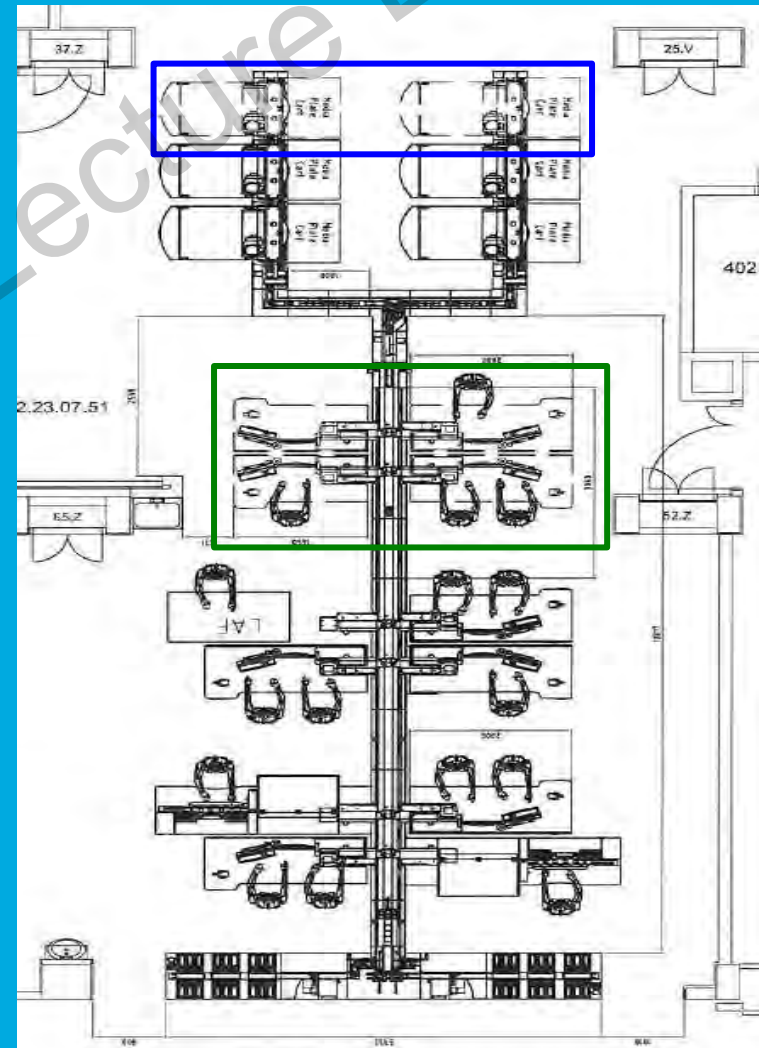
# Proposal BDKiestra – Total Lab Automation

- **2 SorterA 18-3**
  - 2 x 810 plates
- **2 BarcodA**
- **2 Inoqula**
- **2 Slide prep.**
  - 2x 40 slides
- **6 Digital reading stations**
  - 4 ReadA compact
  - 4 x 1150 plates

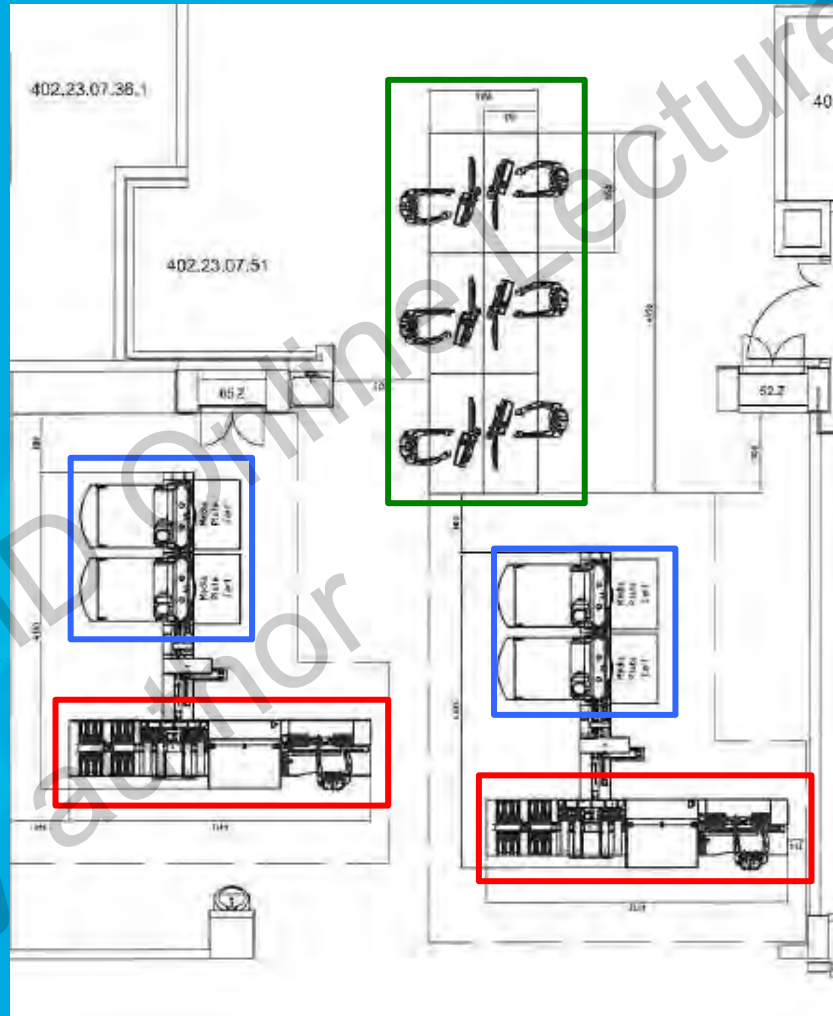


# Proposal BDKiestra – TLA: future extension

- **2 SorterA 18-3**
  - 2 x 810 plates
- **2 BarcodA**
- **2 Inoqula**
- **2 Slide prep.**
  - 2x 40 slides
- **6+4 Digital reading stations**
  - 4+2 ReadA compact
  - 6 x 1150 plates



# Proposal BDKiestra – Work Cell Automation



- Inoqua WCA  
+ slide prep.  
+ plate sorter  
(540 plates)

- 2 ReadA compact
  - 8 output stackers

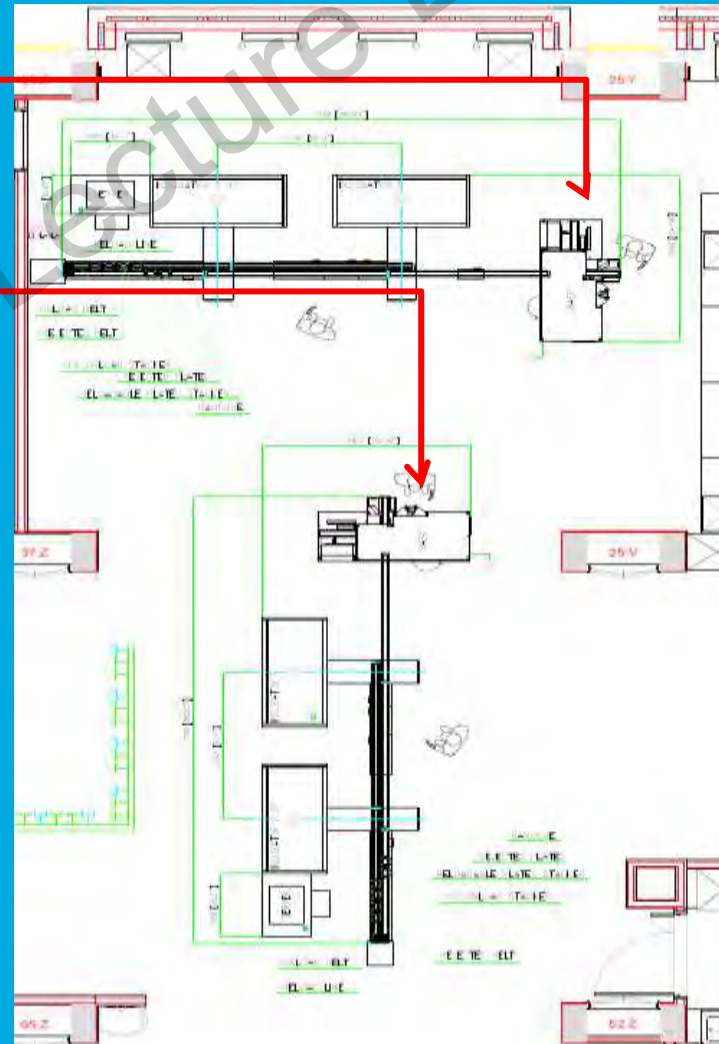
- 2 Inoqua WCA  
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(540 plates)

- 6 Digital reading stations

- 2 ReadA compact
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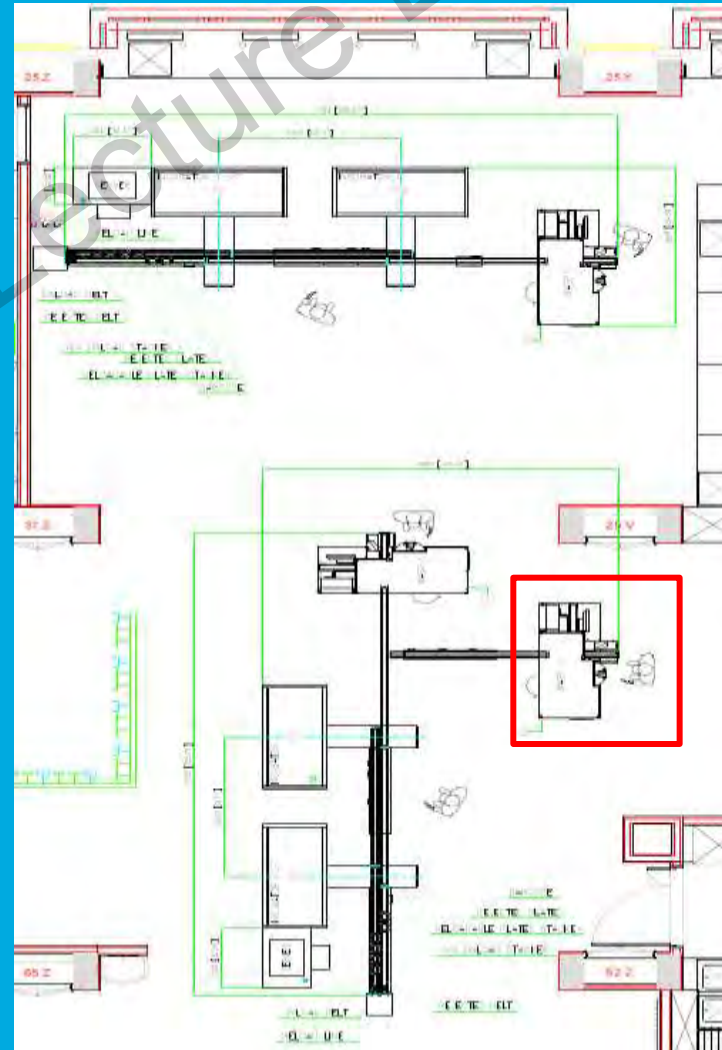
# Proposal Copan – 24/7 solution

- **Track A:**
  - 1 WASP + 2 double O<sub>2</sub> Incubators
- **Track B:**
  - 1 WASP + 1 double O<sub>2</sub> & 1 double CO<sub>2</sub> Incubator
- **WASP**
  - 9 stacks of 36-42 plates (324 – 378 plates)
  - 6 x 12 e-swabs
- **Double Incubator**
  - 1708 platen



# Proposal Copan – 14 hr/day solution

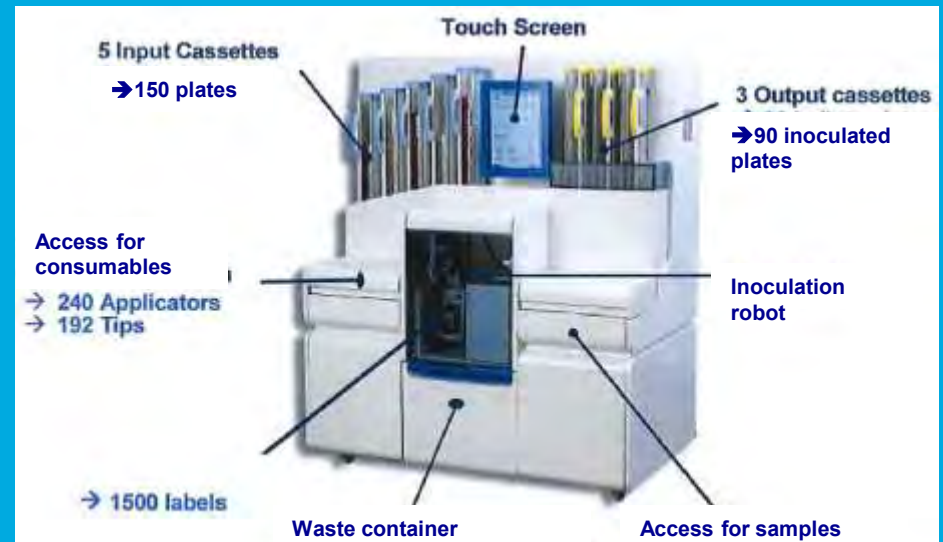
- **Track A:**
  - 1 WASP + 2 double O<sub>2</sub> Incubators
- **Track B:**
  - 2 WASP's + 1 double O<sub>2</sub> & 1 double CO<sub>2</sub> Incubator
- **WASP**
  - 9 stacks of 36-42 plates (324 – 378 plates)
  - 6 x 12 e-swabs
- **Double Incubator**
  - 1708 platen



# Proposal BioMérieux



- 4 Previ Isola
- 3 Incubators
- 2x (3x 1060 plates)
- 2 output/input stackers



## 2<sup>nd</sup> phase

- Intensive discussions internally and with IT dept, process managers
- Site visit Copan, BioMérieux
- Several Q&A sessions with people from companies to clarify points
  - define critical issues and relative importance
- Total time : 4 months

## Critical issues

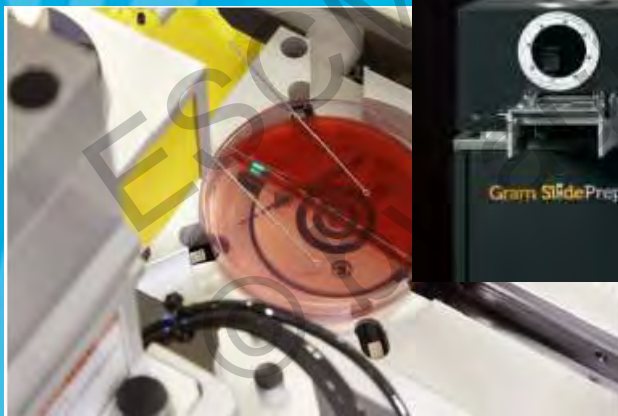
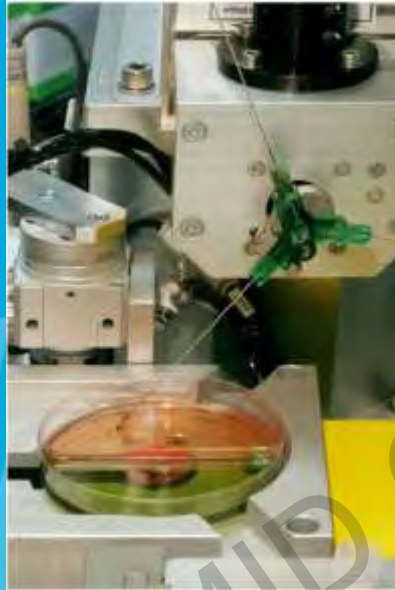
- Inoculation:
  - throughput, quality
- Incubation:
  - turn-around-time
  - camera and colony detection & identification software
- Possibilities for further automation:
  - colony picker



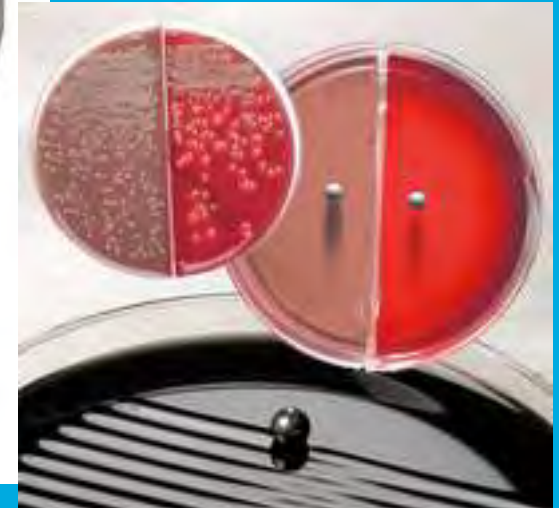
# Critical issues regarding Inoculation

- Speed of sample processing
- Sample tubes that can be used
- Quality of inoculation
  - carry-over
  - isolated colonies ; in view of automated colony picking
- Possibility Gram-staining

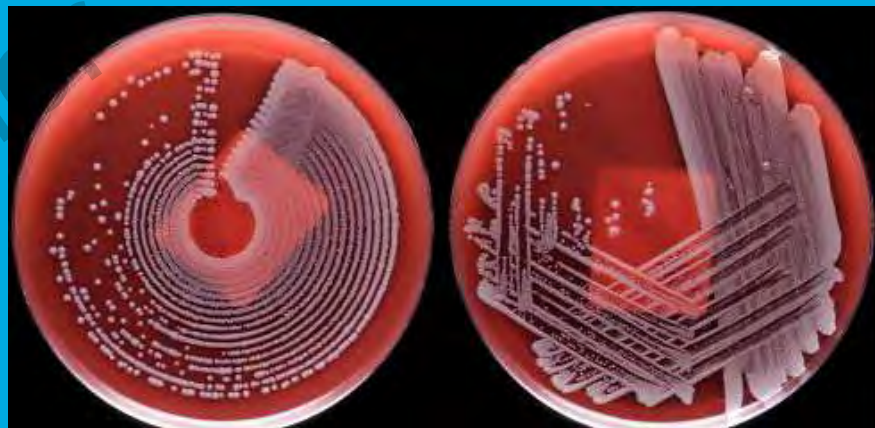
# Different inoculation technologies : Copan



# Different inoculation technologies : BDKiestra



# Different inoculation technologies: BioMérieux



# Sample processing speed (samples/hr)

|                       | BD InoquaA<br>(full -<br>automatic)            | BD InoquaA<br>(semi -<br>automatic) | Copan  | BioMérieux<br>(sample<br>opening/mixing not<br>automated) |
|-----------------------|--|-------------------------------------|--|---|
| 1 plate<br>/sample    | 95   | 245                                 | 144 (single streak pattern)<br>102 (multi quadrant)                                | 160 – 180   |
| 2 plates<br>/sample   | 95<br>(191 pl/u)                               | 151                                 | 76 (single streak pattern)<br>54 (multi quadrant)                                  | 180 - 200   |
| 1 sample<br>/biplate  | 95   | 245                                 | 92 (vertical biplate pattern)<br>163 (twin loop)                                   | 120   |
| Inoculation<br>volume | 10 µl  | All volumes                         | NiCr loops of 1, 10 & 30µl<br>(multiple inoculations -<br>pipettor in development) | 10, 18, 20 & 30 µl  |
| Gram-stain            | 40 slides + heating<br>- <u>manual</u> barcode |                                     | 100 slides + heating +<br>barcode  | Not possible  |

# Related issues: sample uptake control

- BDKiestra:
  - foam/clot detection during pipetting
  - picture of sample deposit on plate by InoquaA
- Copan:
  - filling of loop checked by camera (3 tries – empty = error)
- BioMérieux:
  - imaging after liquid aspiration

# Sample tubes & Petri dishes

| Tubes             |  |
|-------------------|--|
| <b>BDKiestra</b>  | <p>Sample tube diameter: 12-50 mm / length: 60-125 mm</p> <p>Internal diameter: &gt; 9 mm / plastic and glass</p> <p>Cap diameter: 10-54 mm / height: 11-30 mm</p> |
| <b>Copan</b>      | <p>LBM tubes 12 x 80 mm (screw cap)</p> <p>(universal decapper and docking station)</p> <p>(only plastic tubes)</p>  |
| <b>BioMérieux</b> | -  |



| Dishes            |   | Biplates?                  |
|-------------------|---|----------------------------|
| <b>BDKiestra</b>  | <p>Diameter bottom: 87-91 mm / cover: 89-93 mm</p> <p>Total height (incl. cover): 14-16.2 mm</p>  | Yes, 1 sample/<br>biplate  |
| <b>Copan</b>      | <p>Diameter: 91-93 mm - Max. height: 16.5 mm</p> <p>Broth module: Copan 12 (12*80mm: max. 5 ml) or<br/>Copan 16 (16*100mm: max. 10ml)</p> | Yes, 2 samples/<br>biplate |
| <b>BioMérieux</b> | <p>Diameter cover: 89-93 mm / Total height: 13-15.7mm</p> <p>Agar thickness: min. 2.5mm</p>   | Yes                        |

# Theoretical considerations

- BDKiestra vs Copan
  - bead surface =  $78\text{mm}^2$  vs.  $4\text{mm}^2$  loop
    - more cells attached to bead ?
  - bead can move over agar much closer to side wall of dish
    - inoculation path length loop = 70 - 90 cm
    - Inoculation path length bead = 400 cm
    - 3-5 times more isolated colonies ?



- Automated inoculation compared to manual inoculation  
higher reproducibility, higher yield of isolated colonies
- Comparison between automated inoculation systems  
early days, more studies needed

# Critical issues regarding incubators

- Incubation conditions
- Capacity of the incubator
- Throughput
  - speed of input of plates
  - time needed to make pictures
  - retrieval time of plates
  - mixed actions

# Capacity & throughput of incubators (plates / hr)

|                                 | <b>BDKiestra<br/>ReadA compact</b>  | <b>Copan</b>   | <b>BioMérieux</b>   |
|---------------------------------|---|--|---|
| No positions                    | 1150  | 1708   | 1060  |
| Read only                       | <ul style="list-style-type: none"> <li>• 300-400 no. pictures/plate: to be determined by sample/type of plate</li> <li>• 9-12s/plate</li> </ul> | <ul style="list-style-type: none"> <li>• 100 (2 pictures/plate)</li> </ul> | <ul style="list-style-type: none"> <li>• 85-90</li> </ul> |
| Load only                       | <ul style="list-style-type: none"> <li>• <math>\pm 600</math> (400 pictures/hr)</li> </ul>  | <ul style="list-style-type: none"> <li>• 125 (2 pictures/plate)</li> </ul> | <ul style="list-style-type: none"> <li>• 90</li> </ul>    |
| Retrieve only and dispose       | <ul style="list-style-type: none"> <li>• 600</li> </ul>   | <ul style="list-style-type: none"> <li>• 180</li> </ul>                    | <ul style="list-style-type: none"> <li>• 90</li> </ul>    |
| Retrieve only and move to bench | <ul style="list-style-type: none"> <li>• 600</li> </ul>   | <ul style="list-style-type: none"> <li>• 180</li> </ul>                    | <ul style="list-style-type: none"> <li>• 60</li> </ul>    |



**Copan**  
**vs**  
**BDKiestra**



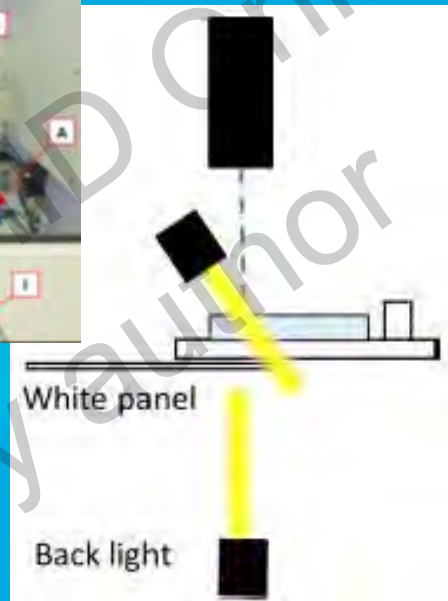
# Plate imaging

## Copan

- Linear with 48 MP
- 13 x zoom
- Telocentric optical lens

## BDKiestra

- High resolution industrial camera
- 3 LED light sources: top, bottom, side
- Different backgrounds, filters



## Workstations

- Independent of track (WCA)
- Linked to track (TLA)
- Quality of screens , recognition of colonies
- Software
  - BD – Vision toolbox software
  - Copan - WASPLab™ digital imaging



# Future extensions – colony picking

## **BDKiestra**

- Colony picking, single suspension for ID and AST & spot Bruker Maldi plate  
2015/2017
- Soft-integration with other BD instruments
- Automatic antibiotic disc placement

## **MLS - Copan**

- Colony picking in R&D (65000 €): mid-end 2015
- Same picker for AST? Sample suspension/colony?
- Colony tracer work bench available

## **BioMérieux**

- Ongoing work

# Maintenance contract

| contract                        |   |
|---------------------------------|---|
| <b>BD silver<br/>(10 years)</b> | <p>Tel. Mon–Fri. 8:00 – 22:00 (Drachten, Netherlands) within 60 min.<br/>           Prev Main: 2x/y Inoqua, 3x/j WCA, 4x/j TLA (1 week per maintenance)<br/>           Parts not included + Ensura (supply spare parts)<br/>           Corrective: next working day Mon–Fri 8:00 – 22:00</p>  |
| <b>BD Gold<br/>(10 years)</b>   | <p>Tel. Mon–Fri. 8:00 – 22:00 + Sat, Sun. and bank holidays: 8:00 – 14:00<br/>           (Drachten, Netherlands) within 30 min.<br/>           Prev Main: 2x/y Inoqua, 3x/j WCA, 4x/j TLA (1 week per maintenance)<br/>           Parts included + Ensura (supply spare parts)<br/>           Corrective: within 24hrs Mon–Fri. 24hrs/day</p> |
| <b>Copan</b>                    | <p>Gold Full omnium contract<br/>           PO: 2x/y<br/>           Corrective: by telephone within 8hr, intervention within 24hr</p>   |
| <b>BioMérieux</b>               | <p>Tel. within 2hr<br/>           Intervention within 8hr<br/>           Prev Main: 1x/j?</p>   |



# Related issues: maintenance-downtime

## **BDKiestra**

- Daily 5 min start-up
- Daily maintenance: ? min
- Weekly maintenance: ? min
- 4/year: preventive maintenance by BDKiestra:  
1 week

## **Copan**

- Weekly shutdown: 16 min
- Daily maintenance: 10 min
- Weekly maintenance: 15-20 min
- 2/year: preventive maintenance by Copan: ?

## **BioMérieux**

- Daily: 5 min (Previ Isola)
- Details preventive maintenance lacking

## Other issues to consider

- Software : servers, storage, coupling to LIS
- Footprint of systems
- Impact on lab routine (working hours, change management)
- On site technical support

## 3<sup>rd</sup> round - European tender

### 1. Price - 20 pnts

= total cost of ownership'

Provide price for future extensions (colony-picking)

### 2. Technical value - 50 pnts

High quality automated system with guaranty for continuous and long term use

### 3. Innovation - 20 pnts

Possibility to extend system (colony picker) and impact on general lab process

### 4. After sale services - 10 pnts

# BioMérieux vs BDKiestra vs Copan

- Only one TLA system : BDKiestra (if automated colony picking incorporated, ID & AST included)
- Automated inoculation systems superior to manual inoculation, comparison between automated systems ongoing
- Incubation: limited routine experience with incubators, speed of imaging may be discerning factor particularly with automated colony picking
- Digital colony identification software / colony picking / automated ID and AST in development

## WCA vs. TLA

- Partial vs total lab automation
  - Impact on work volume / FTE
  - Initial investment and total cost of ownership
  - Space, refurbishing of lab
- Future developments
  - Full automation through automated colony picking and fully automated ID and AST