

# **Contribution of telemedicine to External Quality Assessment Scheme for blood smear and bone marrow interpretation: the Belgian experience**

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EQALM  
SZEGED  
HUNGARY  
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# Belgian EQAS for Blood smear interpretation

- **1991 : Operational (n = 616)**
- **Mandatory**
- **3 surveys/year**
- **2004 : MGG virtual microscopy (CD ROM)  
+ unstained blood smear (n = 232)**  
SZU-HEE LEE, Virtual Microscopy : Applications to Hematology,  
Laboratory Hematology. 2005;11:38-45
- **2006 : Didactic cases**
- **2008 : Bone marrow Pilot study #1 (n = 106)**
- **2009 : Bone marrow Pilot study #2 (n = 98)**

# Belgian EQAS virtual microscopy

2004 November	ALL
2005 March	Normal, B Prolymphocytic Leukaemia
2005 June	Normal, Hereditary Spherocytosis
2005 November	Normal, Secondary leukaemia
2006 March	Normal, B12 deficiency
2006 June	Normal, Drepanocytosis, <b>May Hegglin (didactic)</b>
2006 November	Myeloma, <b>Chediak-Higashi (didactic)</b>
2007 March	Normal, CML
2007 June	Normal, Reactive Lymphocytosis
2007 November	Normal, Hairy Cell Leukemia
2008 March	Normal, TTP
2008 May	<b>B12 deficiency, Secondary leukaemia (didactic) (bone marrow aspirate)</b>
2008 June	Secondary ALL, <b>BiN Polyclonal Hyperlymphocytosis (didactic)</b>
2008 November	T Prolymphocytic leukaemia, <b>MDS Ider20Q (didactic)</b>
2009 March	Hairy Cell Leukaemia, <b>t(8;21) AML (didactic)</b>
2009 June	Normal, T cell large Granular Lymphocytic leukaemia
2009 November	Normal, Leukemoid reaction
2009 November	<b>Myeloma (bone marrow aspirate)</b>
2010 March	CLL, <b>Mucopolysaccharidosis Maroteaux-Lamy syndrome (didactic)</b>

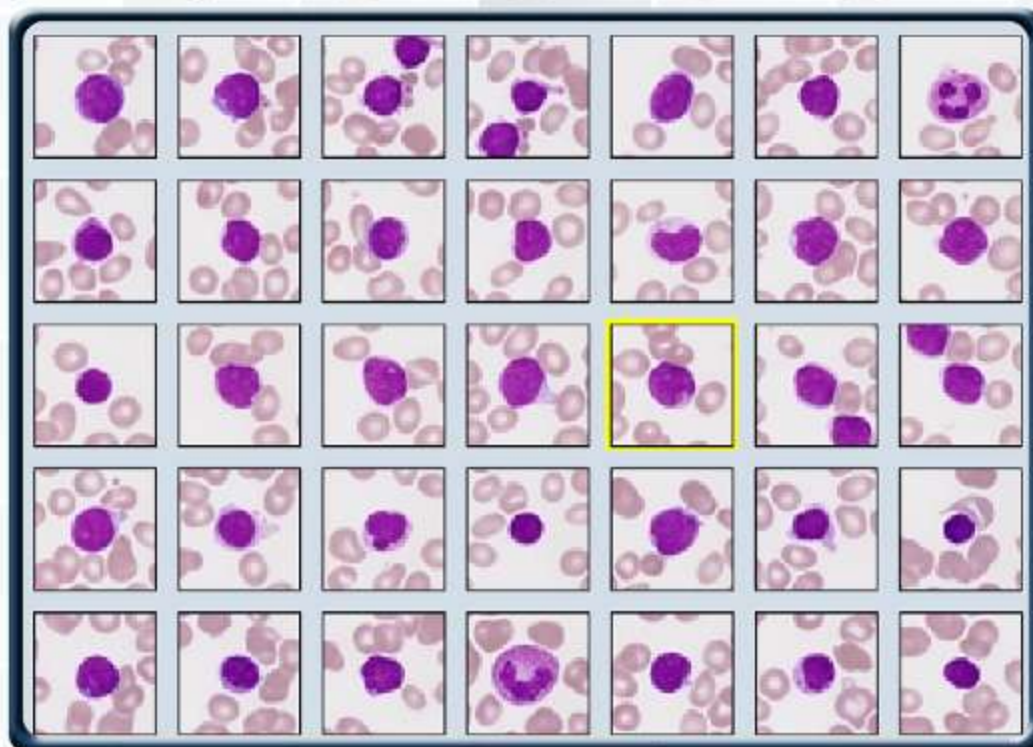
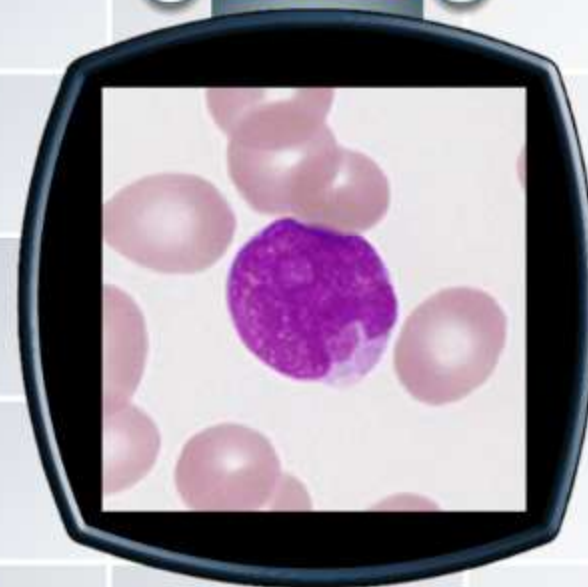
# Belgian EQAS virtual microscopy

2010 June	Normal, Plasmodium Falciparum, <b>TTP</b>
2010 November	Normal, Sezary Lymphoma
2010 November	<b>Mantle Cell Lymphoma</b>
2011 March	Normal, Acute Lymphoblastic Leukemia
2011 June	Normal, Acute Myeloblastic Leukemia

# Galerie des globules blancs "Contrôle"



19 / 210



Ne	Ne non seg	Ly	Mo	Eo	Ba
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
0	0	0	0	0	0
0 %	0 %	0 %	0 %	0 %	0 %

MmN	MN	Promyé	Blastes	Cel. lymph.	Ly. réact.	Autres
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
0	0	0	0	0	0	0
0 %	0 %	0 %	0 %	0 %	0 %	0 %

Erythro
<input type="radio"/>
<input type="radio"/>
0
0 %

TOTAL : 0

Remise à 0

Aide



Accueil

Morphologie des globules  
rouges et des plaquettes

Galerie des globules blancs

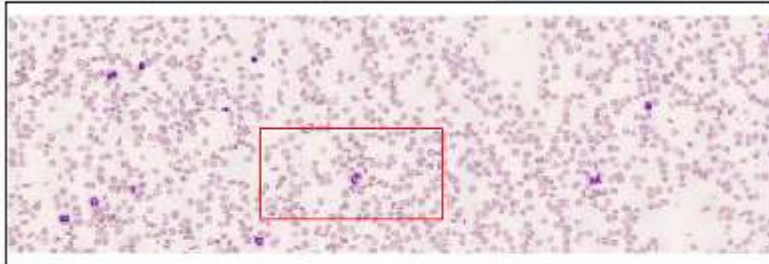
Renseignements patient

Résultats

Quitter le cd-rom

# Morphologie des globules rouges et des plaquettes

"Contrôle"



 Position initiale





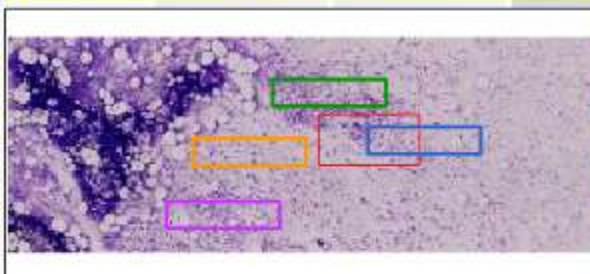
Accueil

Frottis sanguin

Médullogramme

Quitter le cd-rom

Zone A - 10 x



Zone A - 10 x

Zone A1 - 60 x

Zone A2 - 60 x

Zone A3 - 60 x

Zone A4 - 60 x

Zoom



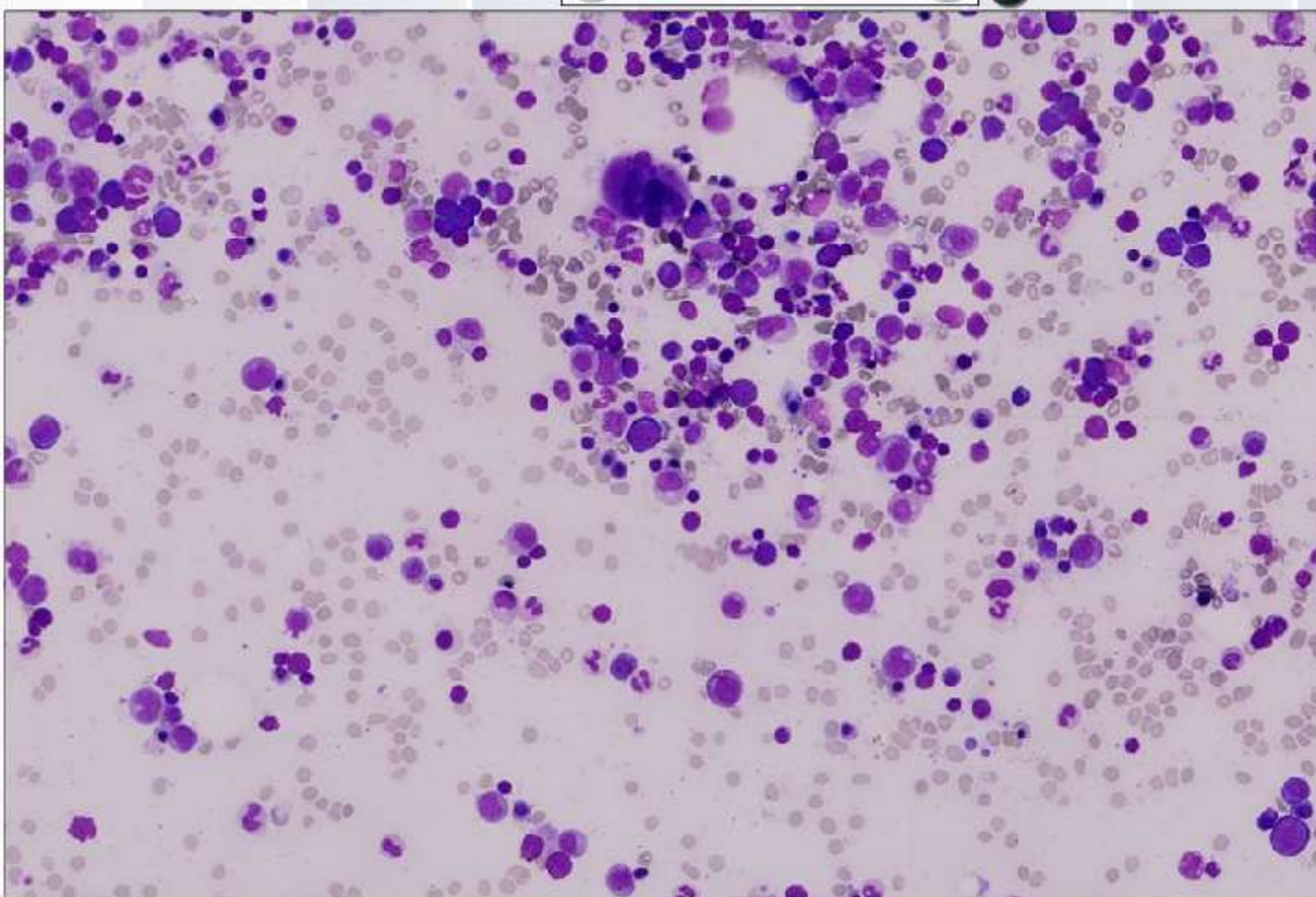
Mode plein écran



Position initiale

# Médullogramme

## "Contrôle"



Cacher le compteur

Remise du compteur à 0

TOTAL : 0

Myéloblaste

Lignée granulocytaire : Total : 0 0 %

Myobl	ProN	MN	MMN	Neutro
<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -
0	0	0	0	0
0 %	0 %	0 %	0 %	0 %

Mblg	ProII	ME	MME	Eo
<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -
0	0	0	0	0
0 %	0 %	0 %	0 %	0 %

Lignée érythroblastique : Total : 0 0 %

PEbl	EBaso	EPoly	EPyc
<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -
0	0	0	0
0 %	0 %	0 %	0 %

Autres lignées : Total : 0 0 %

Lybl	Ly réact	Ly	Mono
<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -
0	0	0	0
0 %	0 %	0 %	0 %

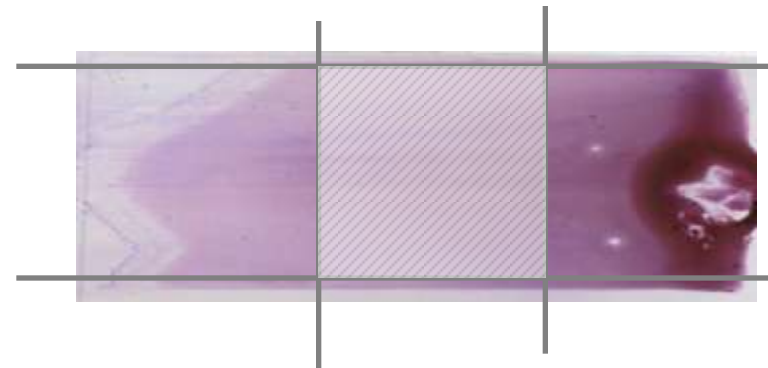
MastC	Macro	Plasmo	Baso
<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -
0	0	0	0
0 %	0 %	0 %	0 %

Cellules anormales : Total : 0 0 %

CelAn1	CelAn2	CelAn3	CelAn4
<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -	<input checked="" type="radio"/> + <input type="radio"/> -
0	0	0	0
0 %	0 %	0 %	0 %

# From wide fields to whole slide...

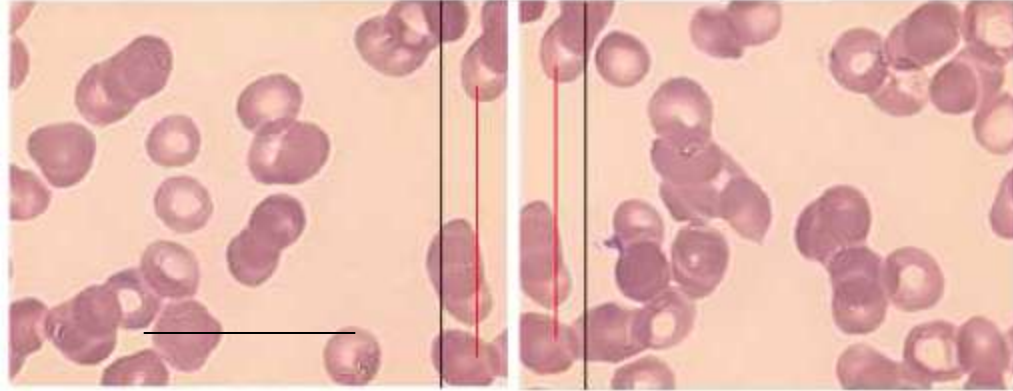
- Picture **resolution** (100x) :  $1360 \times 1024$  (24 bits images)  
→ ~4,177 MB per picture
- **QUANTITY (whole slide)**
  - 20x, 12% overlapping :  $40 \times 60 = 2400$  pictures
  - 40x, 12% overlapping :  $80 \times 120 = 9600$  pictures
  - 100x, 12% overlapping :  $300 \times 200 = 60.000$  pictures
  - (+ current research on multi level recombination)
- **SIZE**
  - WHOLE SLIDE
  - → 100x : 250GB
  - AREA OF INTEREST (1/5 of the Slide)
  - → 100x : 50GB (JPEG2000 : ~7GB)



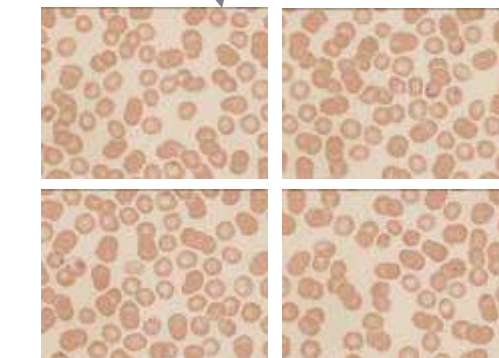


# Stitching

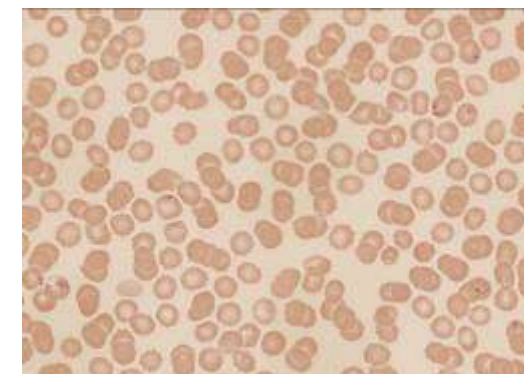
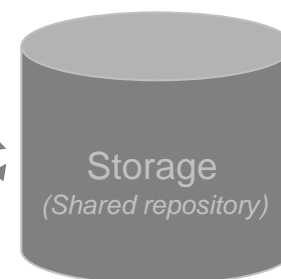
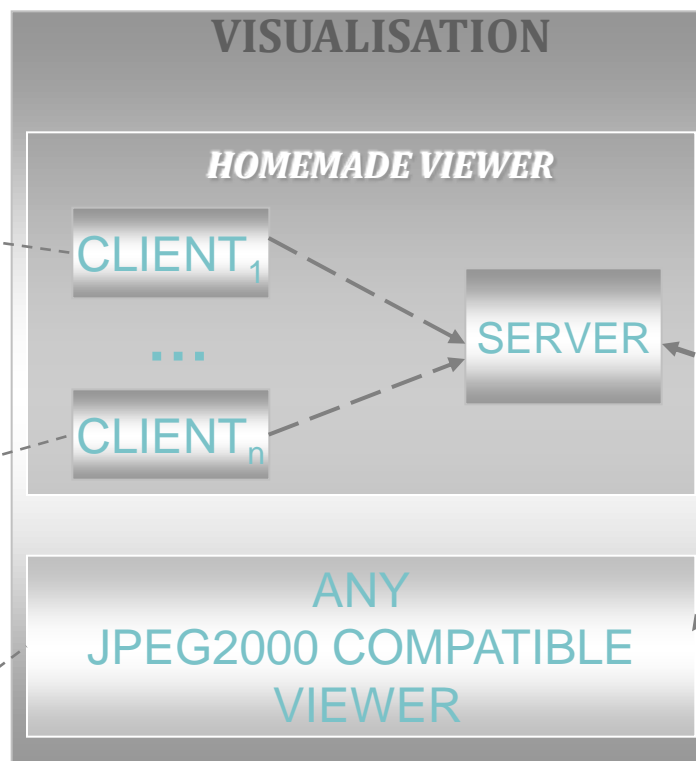
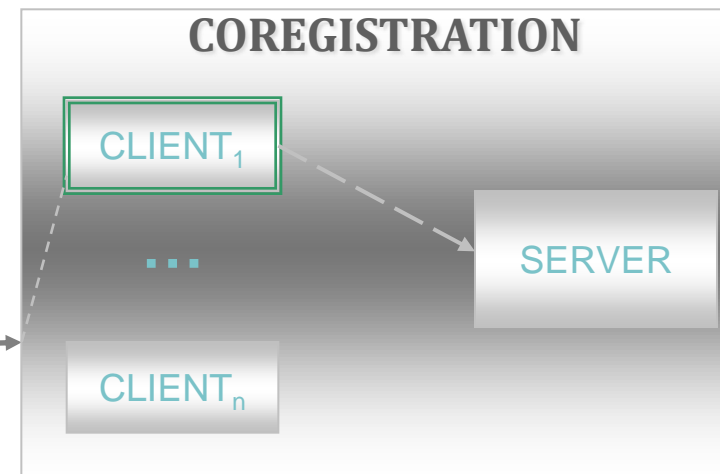
- 100x : 1pixel =  $\sim 0.2\mu$ 
  - highly **sensitive**
  - shifts



- **Rigid** registration (translation, rotation)
  - Capture path as input
  - Post optimisation
- **Algorithm**
  - Reference vector
    - Filtering : gray scale, normalisation
  - Best match vector
  - Computes the shift
  - Stitching



Composing Images



Mega-image

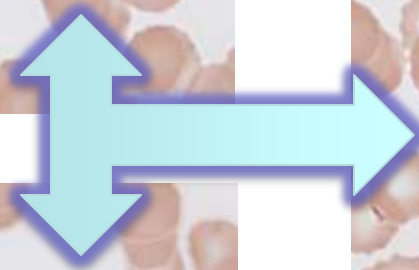
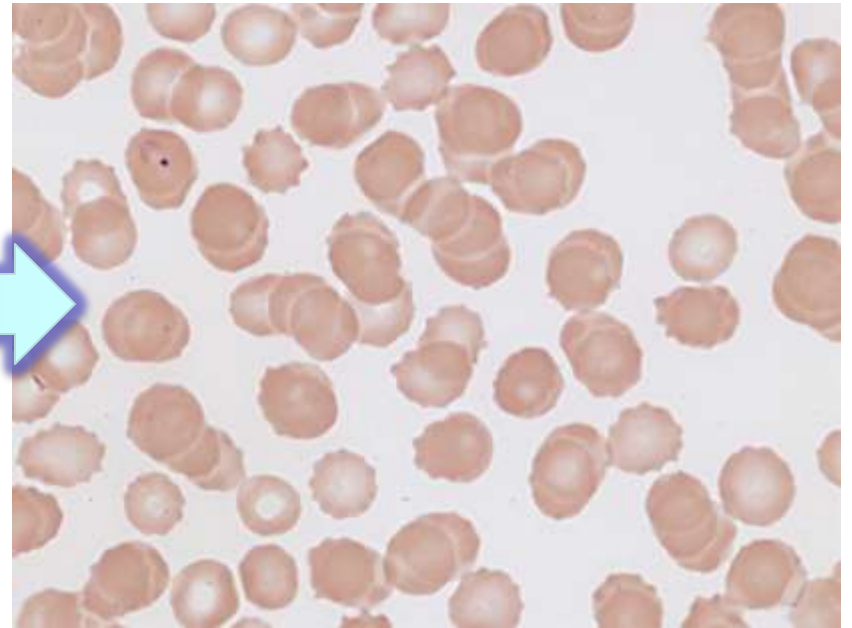
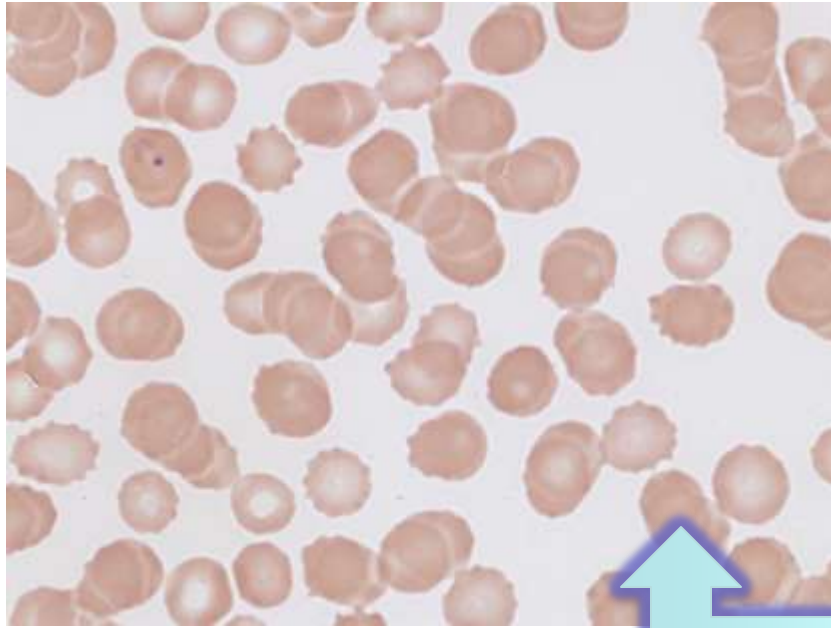
# Technical improvements: Size

The screenshot shows the DRISC - Ra232 Interfaced Stage Controller - untitled\* application. The main window displays a grid of 450 picture locations, arranged in 10 rows and 45 columns. The grid is numbered 1 to 450. A green box highlights the first 90 pictures (rows 1 to 9, columns 1 to 10). A green arrow points from this box to the rest of the grid. A green box on the right side of the grid contains the text "450 Pictures".

90 Pictures

450 Pictures

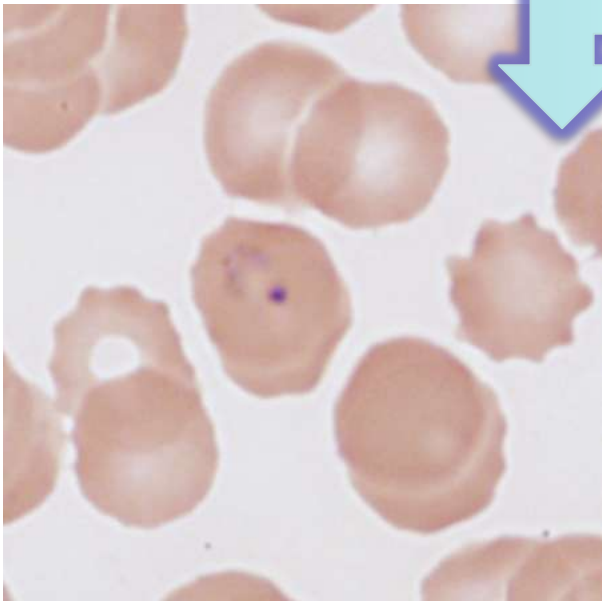
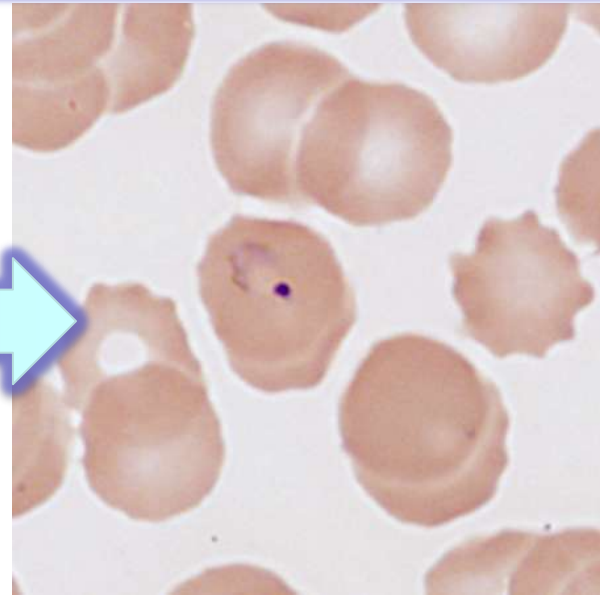
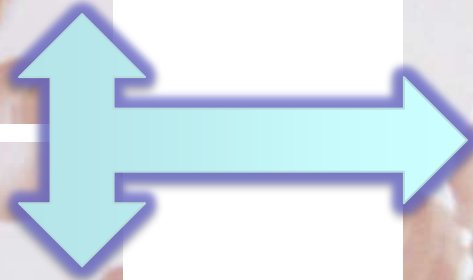
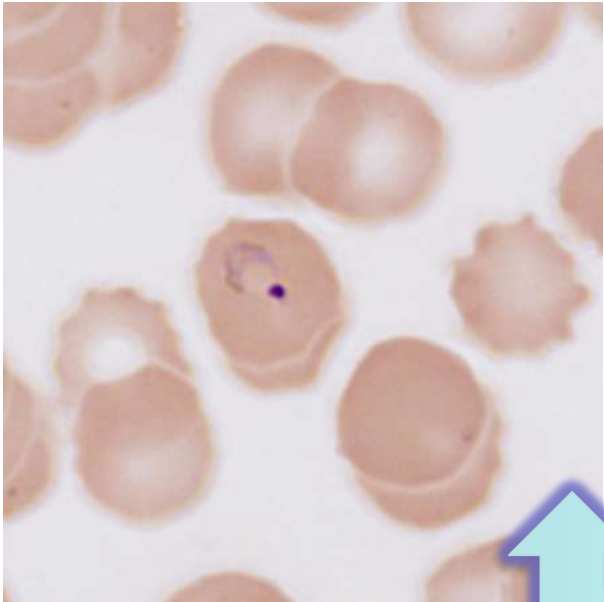
Technical  
improvements:  
Z axis combination



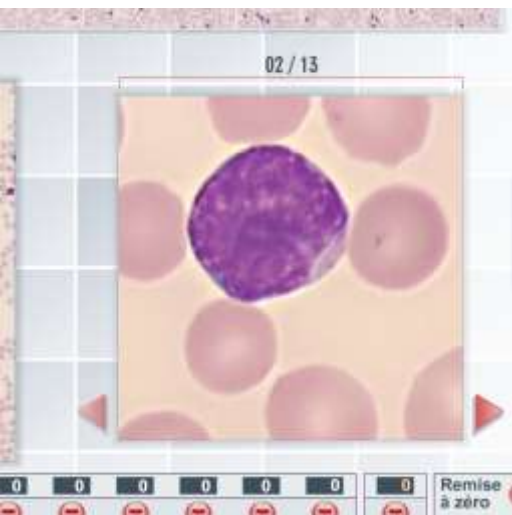
900 Pictures



Technical  
improvements:  
Z axis combination



900 Pictures

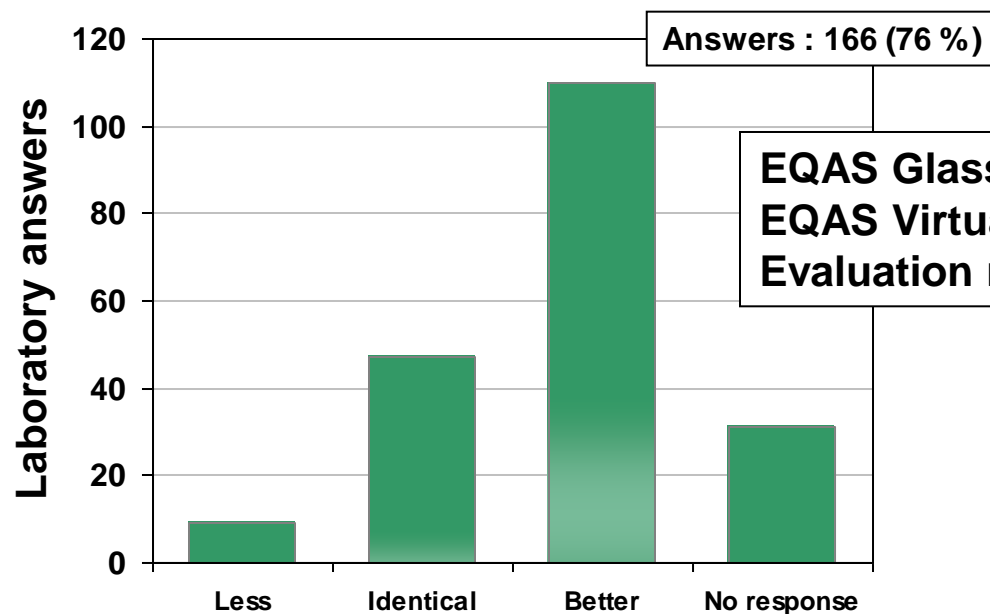


**2004**

**2005**



## Quality of Virtual Slide (2005 versus 2004)



EQAS Glass slide participants :	218
EQAS Virtual slide participants :	207 (95 %)
Evaluation reports :	197 (90 %)

**96 % of participants rated the software as good or excellent**

## **Didactic smears (virtual slide only) (2006 – 2010)**

	<b>Participation (%)</b>	<b>Diagnosis (%)</b>
<b>May-Hegglin anomaly</b>	<b>93</b>	<b>61</b>
<b>Chediak-Higashi syndrome</b>	<b>95</b>	<b>82</b>
<b>BiN Polyclonal Hyperlymphocytosis</b>	<b>97</b>	<b>67</b>
<b>MDS with isolated del(20q)</b>	<b>89</b>	<b>81</b>
<b>AML with t(8;21)(q22;q22)</b>	<b>92</b>	<b>86</b>
<b>Mucopolysaccharidosis</b>	<b>92</b>	<b>95</b>

# Belgian EQA Participant opinion

## Blood

- **Assessment : 88 % participants → Good/Very good**
- **Selected cells: relevant for diagnosis**
- **MGG virtual slide vs. Glass slide : no significant difference**

## Bone marrow

- **Easy to use : 61 % participants**
- **Picture quality : > 90 % satisfaction**
- **too small wide fields → number and quality of megakaryocytes difficult to evaluate.**



# Conclusions

**Implementation of Virtual Slides to EQAS in Belgium is well appreciated by the users by allowing control and improvement of the skills.**

**The quality was technically improved  
higher size of the wide-field  
automated capture  
thanks to the comments of the users.**

**Standardization of the observed cells by the experts allowed to improve the quality of the selected cases.**

**Virtual Microscopy allowed implementing a control on bone marrow smears which was impossible with manual smears for ethical and practical reasons.**

# Thanks to :



M. VAN BLERK



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C. LOOSEN  
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J. PRUVOT



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H. MEURISSE  
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C. PEETERS  
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