Fundacja Rozwoju Kardiochirurgii im. prof. Zbigniewa Religi
Instytut Metalurgii i Inżynierii Materiałowej im.Aleksandra Krupkowskiego Polskiej Akademii Nauk
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Narodowe Centrum Badań i Rozwoju

Material Engineering in Regenerative Cardiac Surgery: "Yesterday and Today"

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The beginning

1882 Roland Ross- „The Vivisector Vivisected”

AN ARTIFICIAL HEART REVIVES A CORPSE:
SIR RONALD ROSS'S UNPUBLISHED STORY OF 1882,
"THE VIVISECTOR VIVISECTED"

Introduction

In 1882, exactly 100 years before the first artificial heart was implanted in a human chest [1], Ronald Ross—then an obscure young medical man serving in India—wrote "The Vivisector Vivisected," a hair-raising short story in which a man who bled to death is revived by an artificial heart.

When Ross (1857–1932) wrote "Vivisector" he was still some 15 years away from the famous researches in which he incriminated certain mosquitoes as the transmitters of malaria, a discovery that brought him the Nobel Prize. In 1882, however, he had only just qualified in medicine (studied at his father's behest but for which he felt "no predilection at all") [2, p. 29] and had left England to join the Indian Medical Service. Ross had for years been a serious writer and enjoyed many other intellectual interests, but now he found himself in South India among colleagues who "seemed to take interest in absolutely nothing. . . ." [2, p. 54]. Since his medical duties were negligible, the 25-year-old Ross devoted his considerable leisure to mathematics and the classics, and to writing poems, plays, and novels [2, pp 48–54].

During a brief assignment away from his base he wrote (in his words) "a weird short story called 'The Vivisector Vivisected' " [2, p. 49]. Ross's biographer, Mégroz, found the story "as gruesome as the title suggests.

The research was supported in part by a Research Career Award from the National Institutes of Health. The author thanks Alex M. Rodger, librarian, and the Royal College of Physicians and Surgeons of Glasgow, for permission to study and to publish Ronald Ross's "Vivisector." He also expresses individual thanks to Ronald colleagues Clifford Barger, Gustave J. Dammin, and Richard J. Wolfe for helpful comments.
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0018-5682/88/3103-0578$01.50

1928 Henry Hallet Dale & Edgar Schuster

restoring total circulation of the heartless animal

1935 Charles Lindbergh

perfusion pump („The Walking Dead”)

1937 Władimir Demichow

1982 Utah- implantation

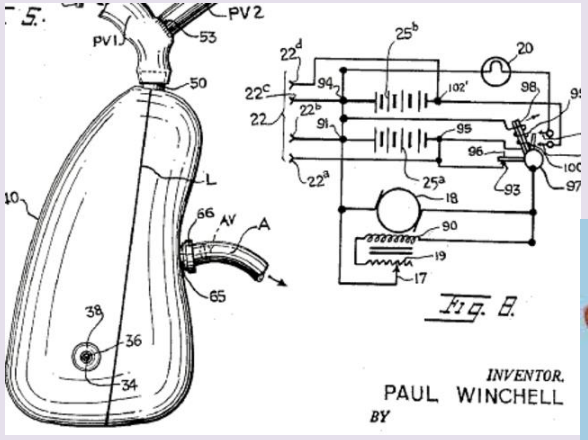
American Society for Artificial International Organs- ASAIO – Peter Salisbury

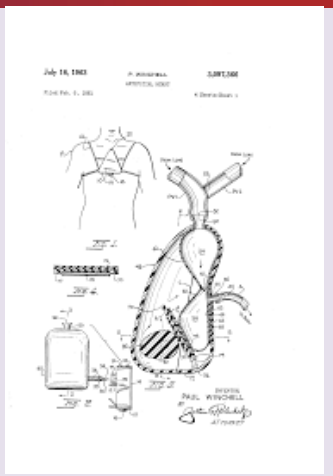
Adres: 41-800 Zabrze; Wolności 345a; tel: +48 32 3735660, fax: +48 32 3735665; romankustosz@frk.pl; www.frk.pl

The beginning

1957 Willem Kolff & Robert Jarvik

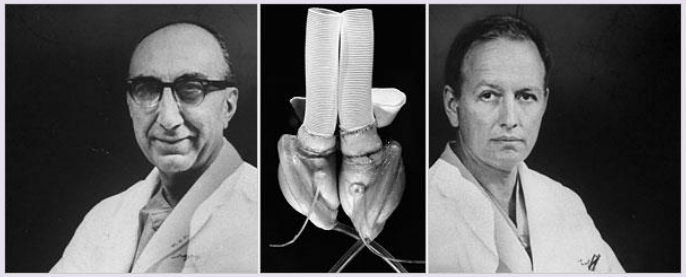
1963 Paul Winchell





Michael E. DeBakey & Liotta *left ventricular bypass pump*

Dr. Michael E. DeBakey, left, Dr. Denton A. Cooley and the early artificial heart device that led to their long-running split.



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The beginning

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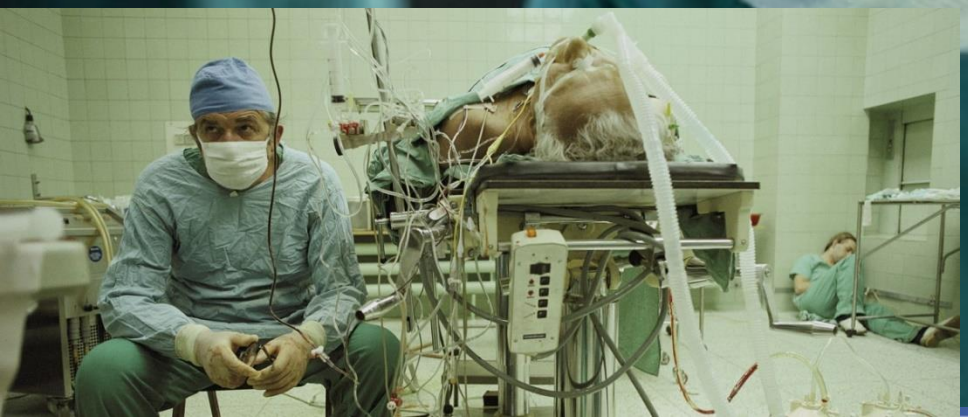
Narodowe Centrum Badań i Rozwoju

1991- Powstanie Fundacji Rozwoju Kardiochirurgii



The beginning

„Moje wielkie pragnienie stworzenia polskiego sztucznego serca nareszcie w pełni się urzeczywistnia. Usilne starania o otoczenie tego przedsięwzięcia opieką państwa, uwieńczone uchwaleniem Wieloletniego Programu "Polskie Sztuczne Serce", uważam za ogromny sukces. Bardzo się z tego cieszę i życzę powodzenia wszystkim, którzy zaangażowani są w realizację prac”.

https://www.youtube.com/watch?v=71_E3Hh2Jqg

prof. Zbigniew Religa

Heart support

„My great desire to create a Polish Artificial Heart finally fully fulfills...”

prof. Zbigniew Religa

„POLISH ARTIFICIAL HEART” Medicine

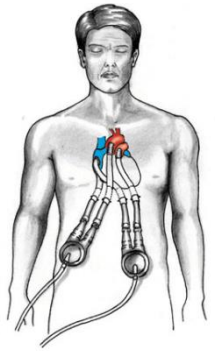
Modern technology

https://www.youtube.com/watch?v=7QFhxfVF7SA&list=PLMkpKh2ylbEa9OThOL0F6vQC_aKmHvgs8

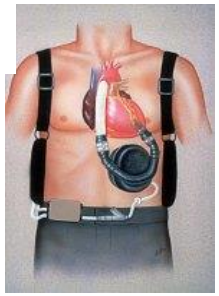
Heart support

DIVISION BY TYPE OF FAILURE

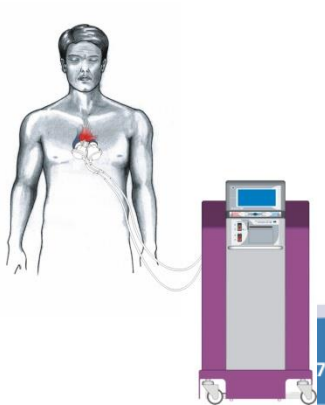
- **Acute failure**



- **Long-term failure**



- **Patients with cardiomyopathy**



Heart support

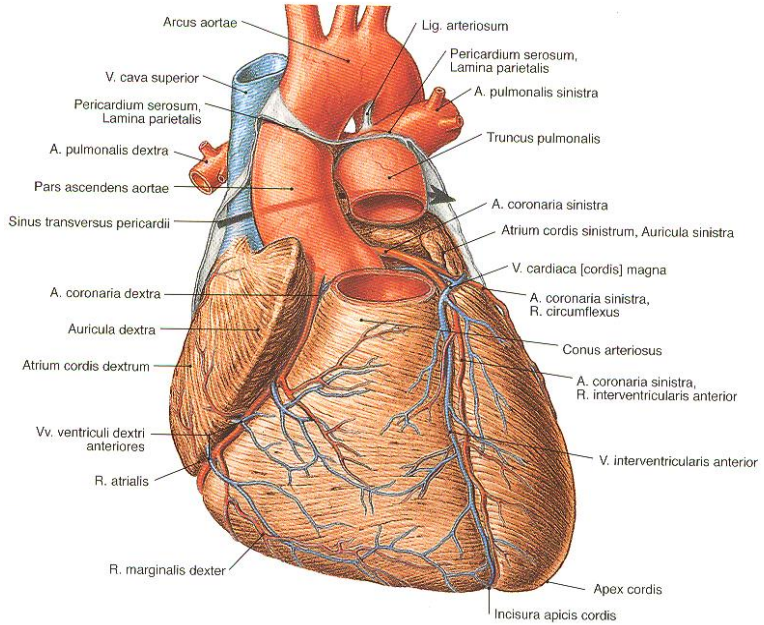
DIVISION BY SUPPORT TIME

Short-term

- An acute heart failure with a good prognosis of regeneration
- An infirmity with an uncertain prognosis for further treatment

Permanent support

- chronic heart failure disqualifying for transplantation
- cardiomyopathy



Heart support

More than 40 teams from 35 scientific and research institutions, clinical centers and professional entities producing elements of heart prostheses participated in the implementation of the Program.
As part of 5 projects, 17 research tasks and 12 implementation tasks, covering over 200 stages, were implemented.

I STRATEGIC GOAL

Developed families of Polish heart prostheses, with a completely implantable permanent heart prosthesis as a final element

II STRATEGIC GOAL

Clinical development of the use of Polish heart prostheses in the treatment of patients with critical heart failure

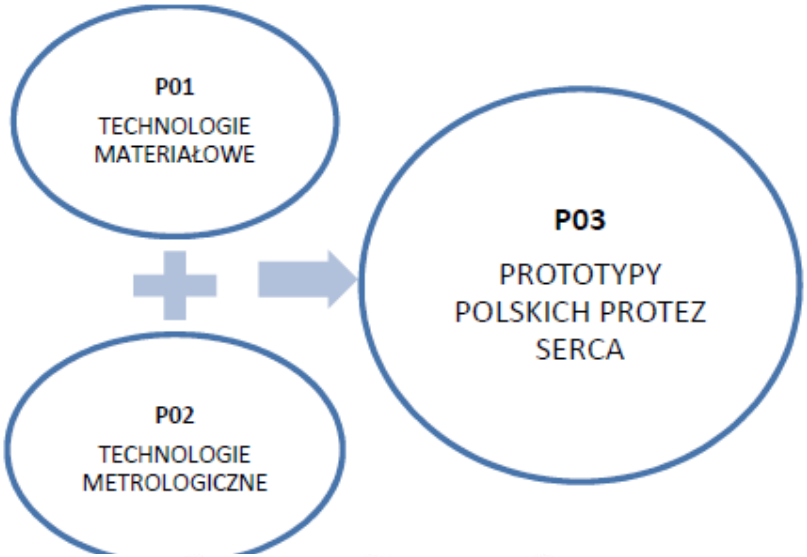
III STRATEGIC GOAL

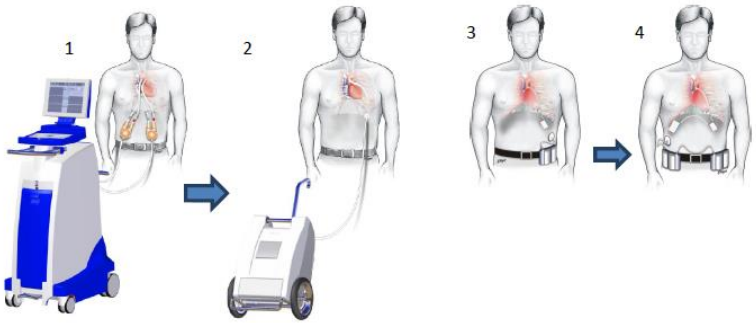
Creation of a highly specialized scientific and technological platform for the purpose of conducting comprehensive research and development in the field of heart prostheses

Heart support

Effects of the program

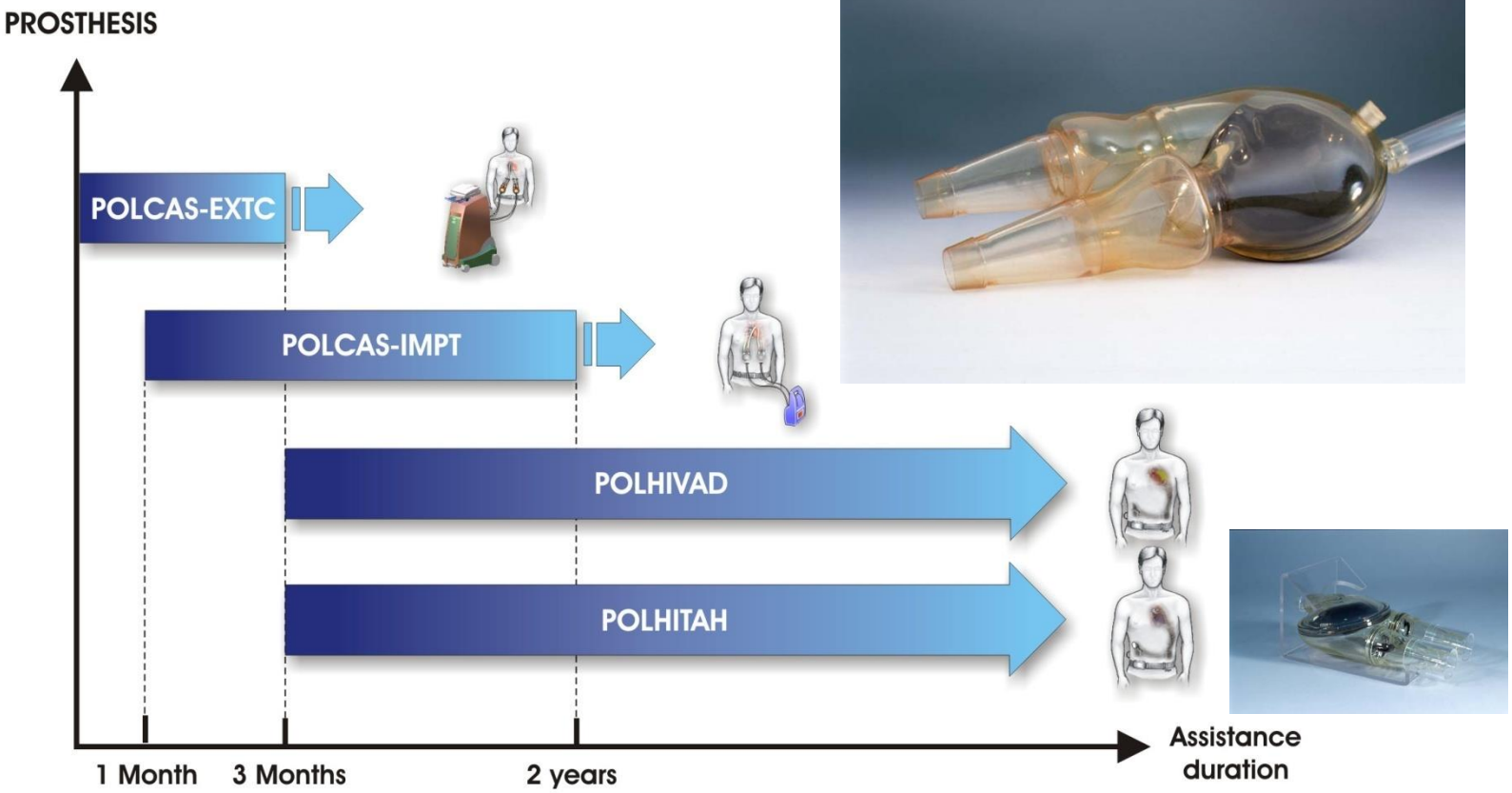
IMIM PAN- leader of the task
Prof. B. Major





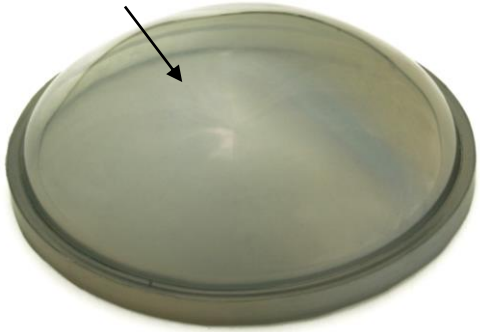
Heart support

System POLVAD

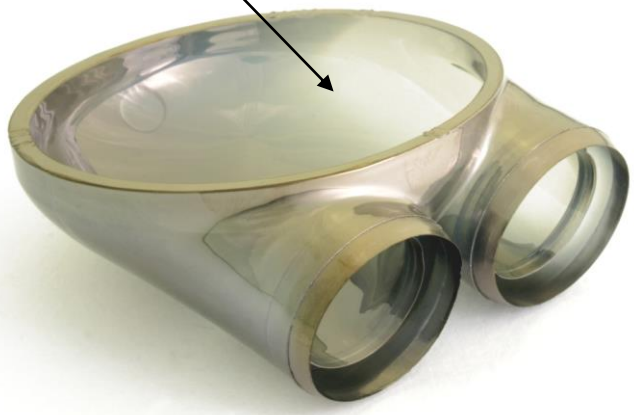


Heart support

Membrane

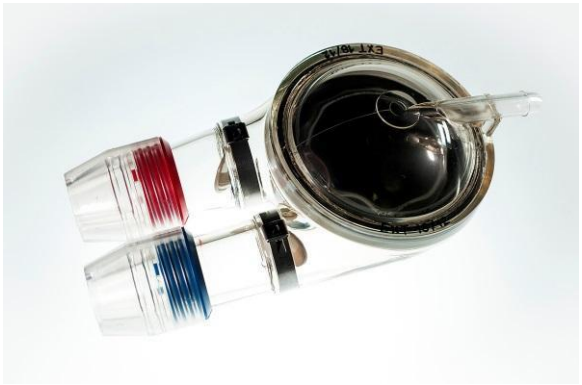


Chamber



Valve

The goal of the work is the reduction of life-threatening thrombo-emboli formation in heart assist systems by a new material design



FUNDACJA ROZWOJU KARDIOCHIRURGII
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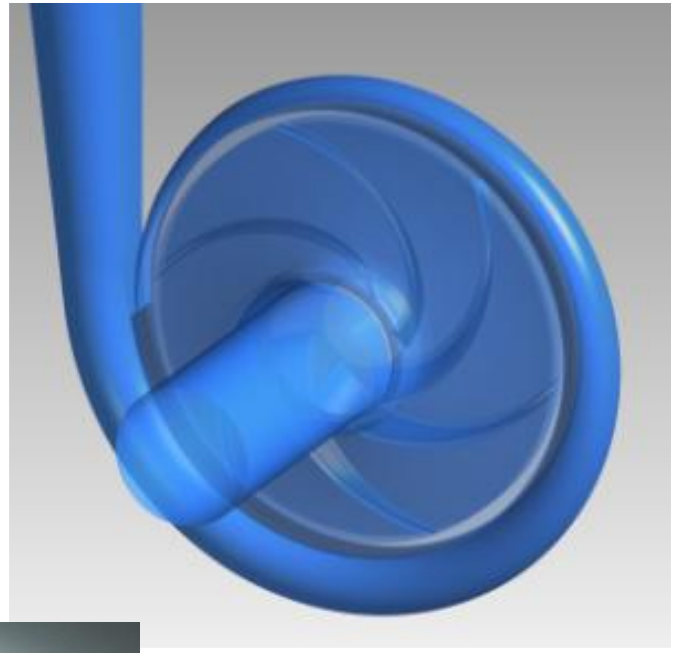
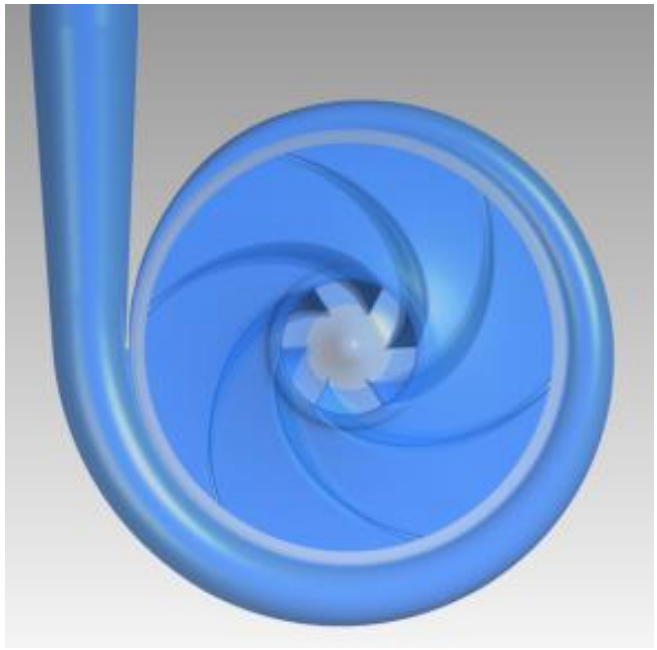




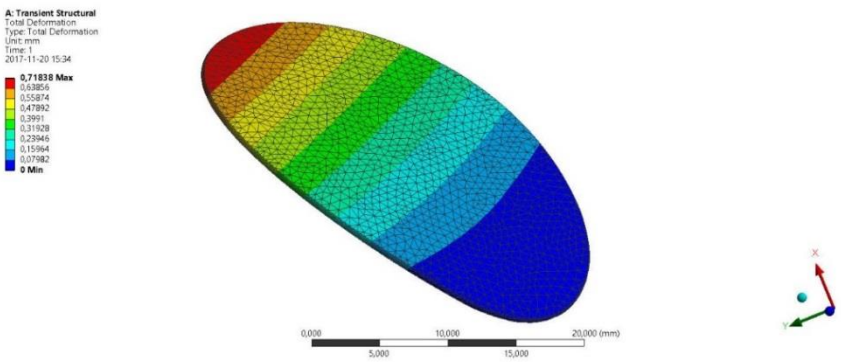
M-ERA.NET Transnational Call 2014
Project Acronym: bioVALVE

Partners:
JOANNEUM RESEARCH Forschungsges.m.b.H., Institute for Surface Technologies and Photonics, Austria;
Polish Academy of Sciences Institute of Metallurgy and Materials Science in Cracow, Poland;
Collegium Medicum of Jagiellonian University Cracow, Poland;
Foundation for Heart Surgery Development,Poland;
Chirmed Sp. z o.o. Poland

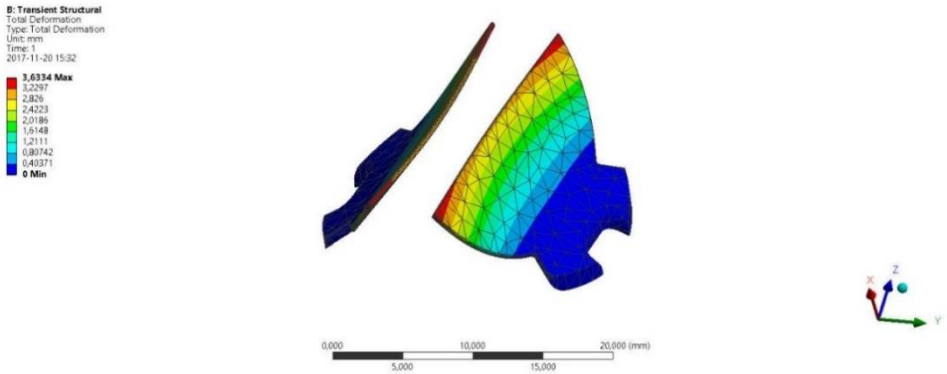
The aim of project bioVALVE was to life-treatening thrombo-embolii formation in pulsatile assist devices by ***a new biomimetic heart valve design***

Optimisation

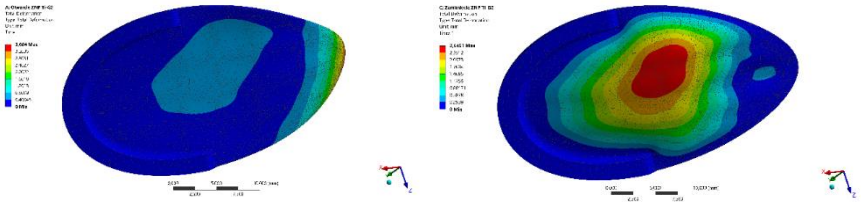
Optimization of mechanical properties and determination of fluid dynamics based on finite element methods for flexible heart valves



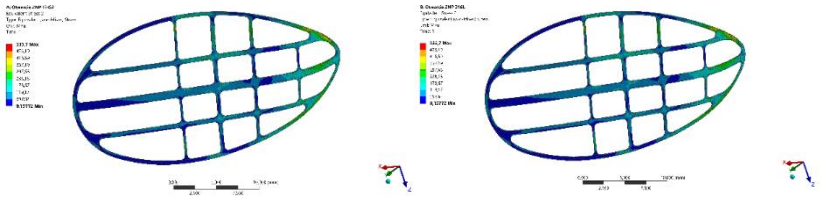
An example drawing of stress simulations in an inflow valve



An example drawing of stress simulations in an outflow valve



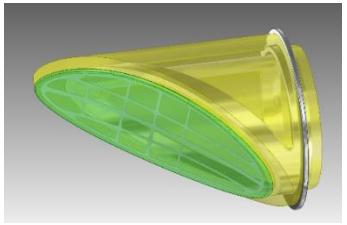
Strain of the inflow petal (Ti mesh) a- opened b- closed

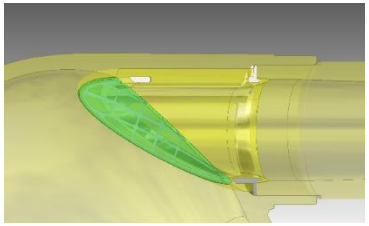


Stress in the inflow petal mesh a- Ti b- Steel

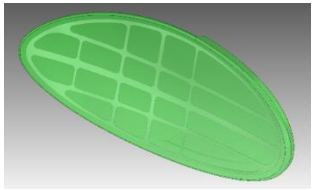
Optimisation

Optimization of mechanical properties and determination of fluid dynamics based on finite element methods for flexible heart valves

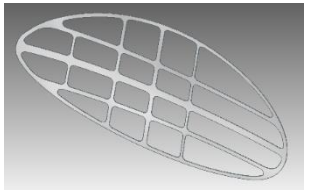




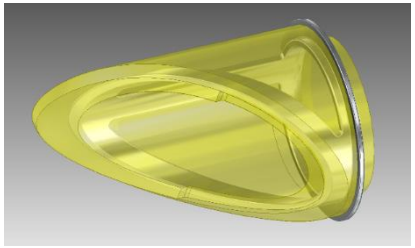
Inflow valve and cross-section through the area of the inflow channel.



a- Petal with embedded reinforcing mesh



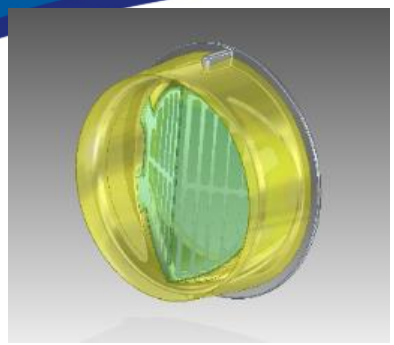
b – titanium reinforcing mesh

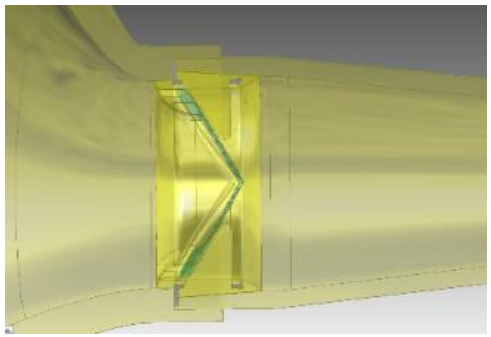


The carrier ring of the petal

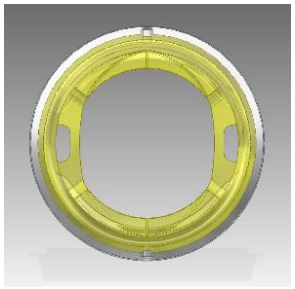
The frame of the ring

Optimisation

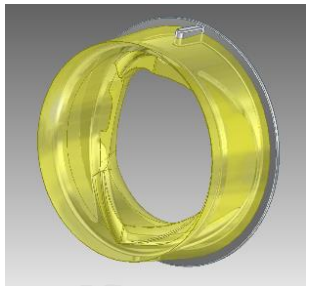




Polyurethane inflow valve and cross section through the outflow channel.



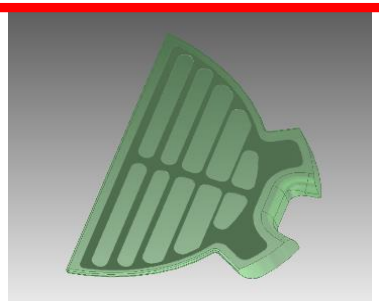
a - Valve ring: view from the outflow side



b - Valve ring: general view

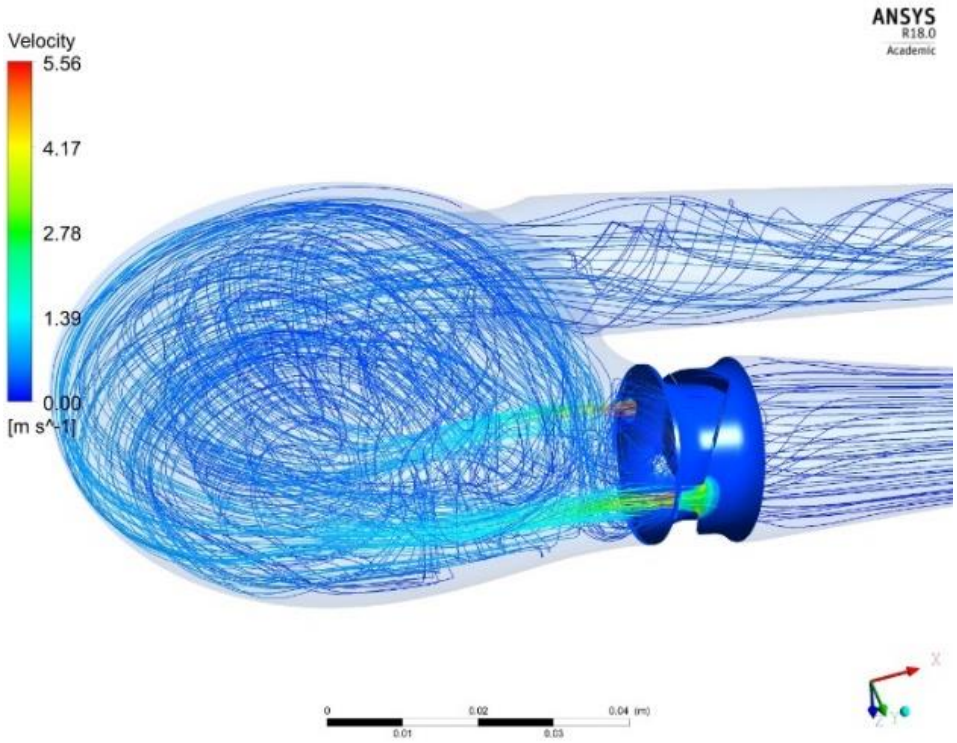
c - Valve ring; view from the inflow side

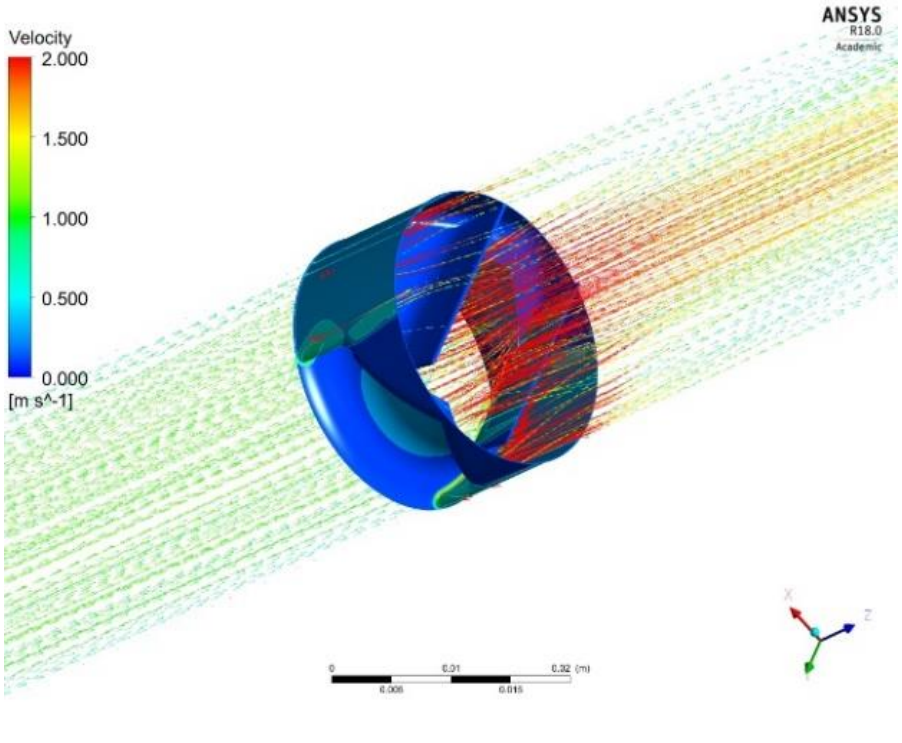
The frame of the ring



Polyurethane flake with covered frame

Optimisation





An example drawing of a flow velocity simulation (a) through a outflow valve in a ReligaHeart® heart assist pump equipped with new valve: (b) backflow flushing holes

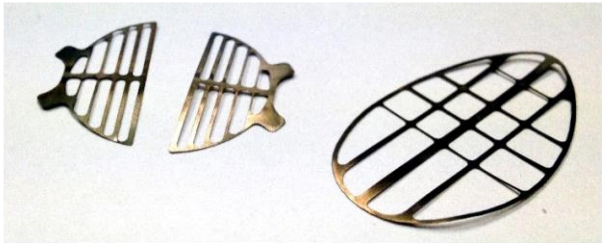
From the course of the hysteresis loop or individual load cycles it follows that as the stress on a particular step increases, the shape of the loop and their surface change significantly. **The larger area of the loop indicates high damping.**

The need for reinforcement of the valve through a metal scaffold

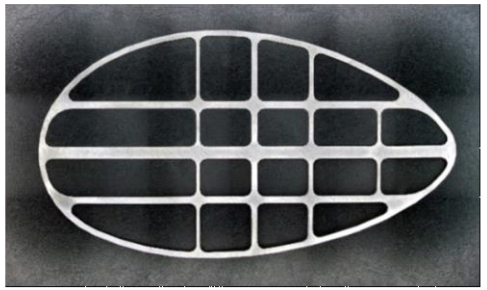
On the basis of the dynamic creep curve presented in it is stated that the total creep Δε, defined as the sum of delayed elastic strain εb and material flow εc, for the tested material was about 5.5 %. To the group of significant factors influencing the creep of the material should be not only the size of the load being applied and the duration of the test, but also the **temperature and the environment in which the sample is located.**

Analysis of defects (adjucement- MESH WITHOUT DEFECTS)

(a)



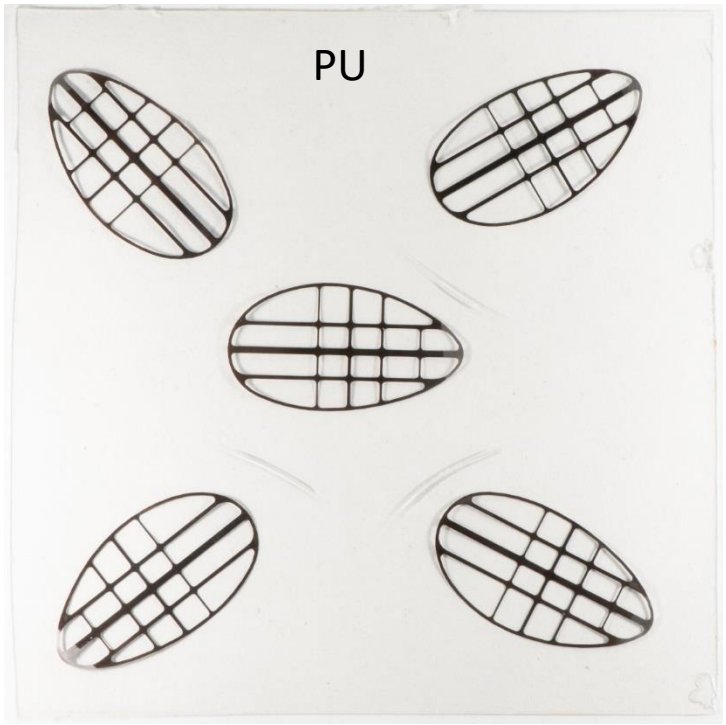
(b)



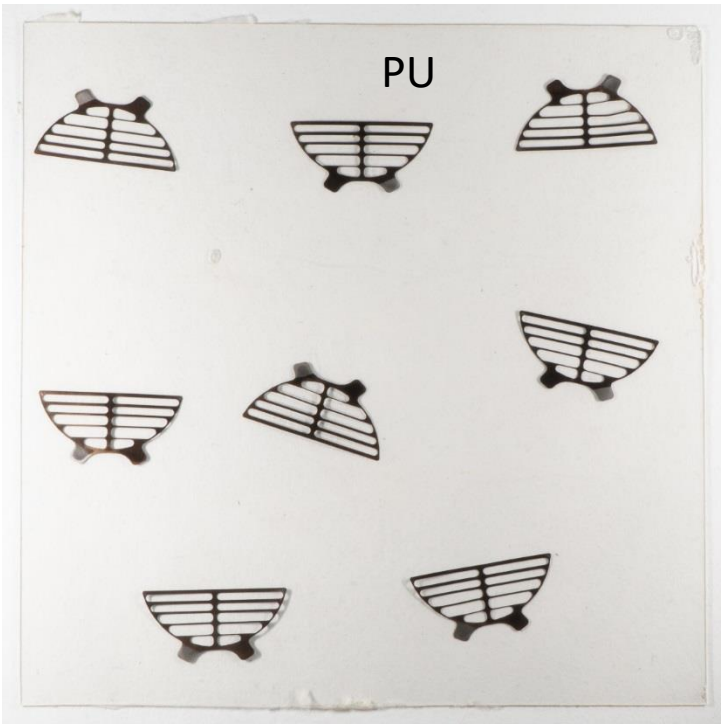
R&D of mesh-like metal scaffold with smooth sealing surfaces

Metallic meshes pressed in PU

inflow valve



outflow valve



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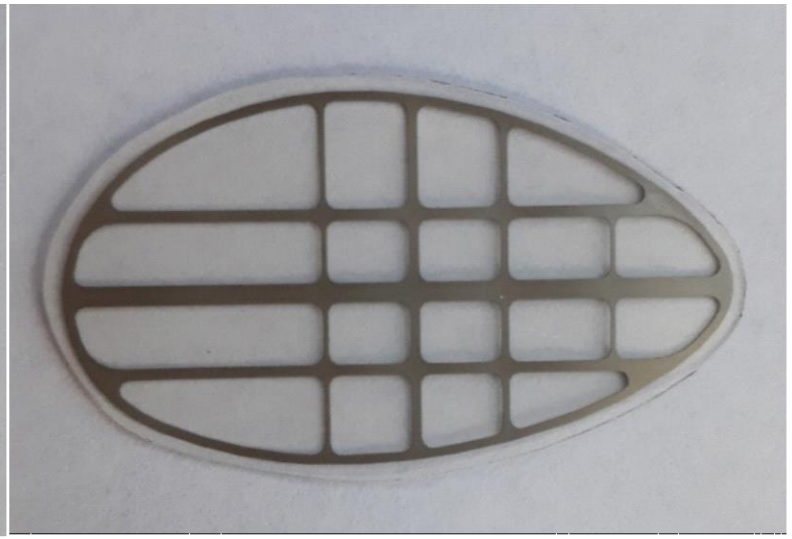
Valve flakes covered with polymer

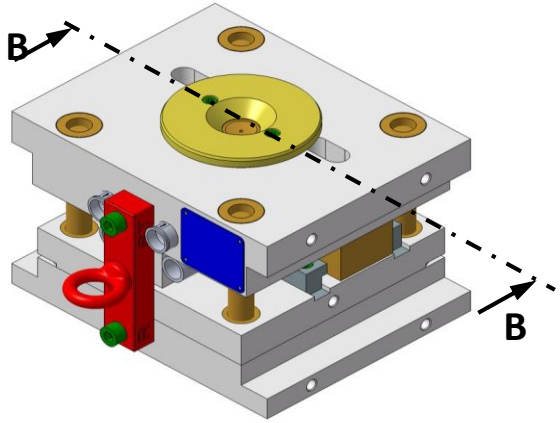


Rings dedicated for inflow and outflow valve- DRAWING

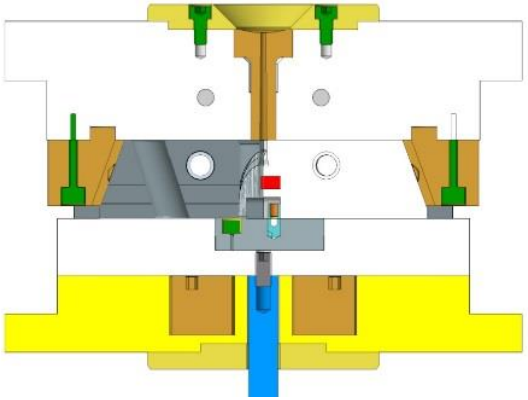
inflow valve

outflow valve

Rings dedicated for inflow and outflow valve- IM PROCESS



Research Form INFLOW VALVE

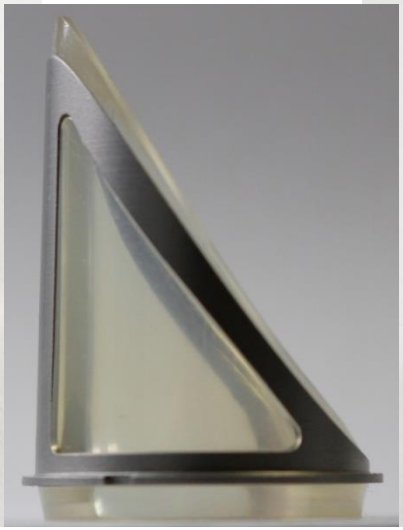


Shape concept of component INFLOW VALVE

Research form OUTFLOW VALVE

Inflow valve- PRODUCT






The need for improveent of the metall scaffold surface with hemocompatibile, coatings additionally improving METAL- PU adhesion!

R&D on surface coating deposition

Liferschein 2016096

Oznaczenie	Skład						Grubość	Przygotowanie	Atmosfera gazowa	Chropowatość	Kąt	Energia powierzchniowa		
	a-C:H	a-C:H:N	a-C:N	ta-C:H	ta-C:H:N	Si - a-C:H	[nm]		[sccm]	Ra [nm]	zwilżania	polar	dispers	Summe
B334_7				x			92,2	Ionenquelle	20,0 C_2H_2		79,9	3,5	40,0	43,4
B334_8				x			48,0	Ionenquelle	20,0 C_2H_2		78,3	3,5	42,4	45,9
B334_10				x			67,4	Ionenquelle	20,0 C_2H_2		79,7	3,3	41,4	44,6
B334_12				x			90,8	Ionenquelle	5,0 Ar + 15,0 C_2H_2		84,0	2,1	40,8	43,0
B372_6	x						94,7	sputtern	24,0 Ar + 6,0 C_2H_2	14,7	60,82	9,68	46,74	56,43
B372_7		x					103,8	sputtern	24,0 Ar + 4,5 C_2H_2 + 1,5 N_2	14,2	58,53	10,17	48,82	58,99
B372_8		x					103,1	sputtern	24,0 Ar + 3,0 C_2H_2 + 3,0 N_2	12,7	57,83	11,55	45,54	57,09
B372_9		x					95,2	sputtern	24,0 Ar + 1,5 C2H2 + 4,5 N2	24,0	53,03	13,70	46,55	60,25
B372_10			x				95,2	sputtern	24,0 Ar + 6,0 N_2	19,0	45,90	17,14	47,45	64,59
B372_15				x			94,7	Ionenquelle	20,0 C_2H_2	13,0	41,87	20,94	43,6	64,54
B372_16					x		110,2	Ionenquelle	17,5 C_2H_2 + 2,5 N_2	23,3	25,37	30,09	41,61	71,70
B372_17					x		100,3	Ionenquelle	15,0 C_2H_2 + 5,0 N_2	12,7	32,63	24,61	45,87	70,49
B372_18					x		82,7	Ionenquelle	12,5 C_2H_2 + 7,5 N_2	14,3	38,80	25,99	36,90	62,89
B372_23						x	124,3	sputtern	28,2 Ar + 1,8 C_2H_2	16,3	27,80	27,07	45,35	72,42
B372_24						x	15,0	sputtern	28,2 Ar + 1,8 C_2H_2	41,3	22,93	29,66	44,17	73,,83
B372_25						x	127,6	sputtern	27,0 Ar + 3,0 C_2H_2	19,2	19,37	29,47	46,89	76,36
B372_26						x	15,0	sputtern	27,0 Ar + 3,0 C_2H_2	38,3	25,97	29,98	41,36	71,33
B372_27						x	123,5	sputtern	24,0 Ar + 6,0 C_2H_2	26,2	24,35	27,62	47,07	74,69
B372_28						x	15,0	sputtern	24,0 Ar + 6,0 C_2H_2	27,7	23,33	30,11	43,05	73,16
B372_29						x	118,5	sputtern	18,0 Ar + 12,0 C_2H_2	14,0	54,33	11,98	49,66	61,64
B372_30						x	15,0	sputtern	18,0 Ar + 12,0 C_2H_2	52,7	51,17	14,28	47,68	61,96

Group	Symbol	Layer	Thickness [nm]
1	B372_6	a-C:H	94,7
	B372_7	a-C:H,N	103,8
	B372_8	a-C:H,N	103,1
	B372_9	a-C:H,N	95,2
	B372_10	a-C:N	95,1
2	B372_15	a-C:H	94,7
	B372_15+E059	a-C:H+SF6 (fluoridation)	94,7
	B372_16	a-C:H,N	110,3
	B372_17	a-C:H,N	100,3
	B372_17+E059	a-C:H,N+SF6 (fluoridation)	100,3
	B372_18	a-C:H,N	82,7
3a	B372_23	Si/a-C:H	124,3
	B372_25	Si/a-C:H	127,6
	B372_27	Si/a-C:H	123,5
	B372_29	Si/a-C:H	118,5
3b	B372_24	Si/a-C:H	15
	B372_26	Si/a-C:H	15
	B372_28	Si/a-C:H	15
	B372_30	Si/a-C:H	15

R&D on surface coating deposition

Blood-Material Interaction

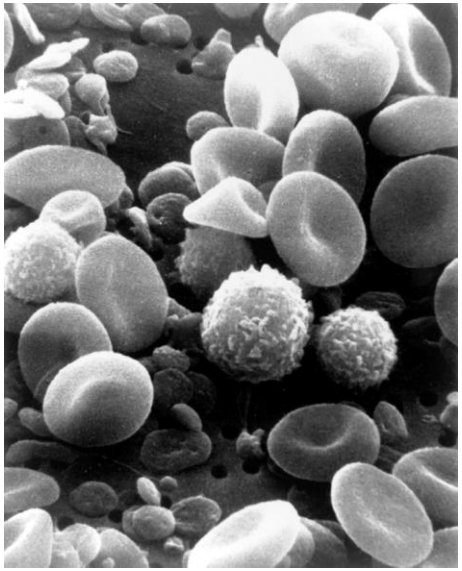
Whole human blood dynamic tests

ELSEVIER
Biomolecular Engineering 19 (2002) 91–96
Biomolecular Engineering
www.elsevier.com/locate/geneanbioeng

In vitro hemocompatibility testing of biomaterials according to the ISO 10993-4

Ulrich Theo Seyfert [a,*], Volker Biehl [b], Joachim Schenk [a]

[a] *Abteilung Klinische Hämostaseologie und Transfusionsmedizin, Haus 75, Universitätskliniken, D-66421 Homburg, Germany*
[b] *Universität des Saarlandes, Lehrstuhl für Metallische Werkstoffe, Im Stadtwald, D-66123 Saarbrucken, Germany*

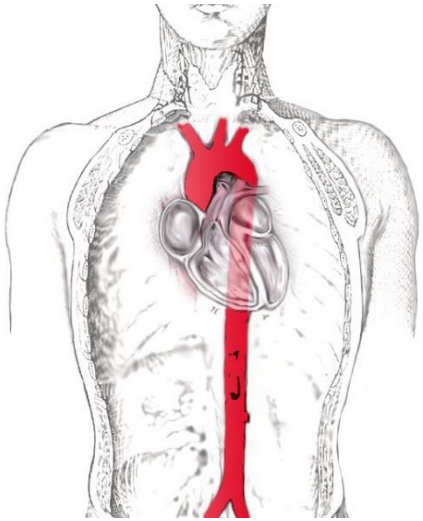


”A hemocompatibile material must not adversely interact with any blood component”

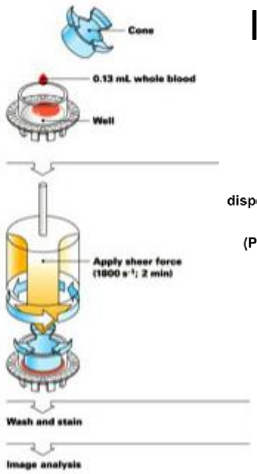
R&D on surface coating deposition

Blood-Material Interaction

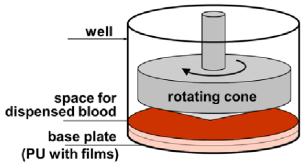
- Human blood (4 x 4.5 mL)
- ADP activation 5 min.
- Arterial flow condition simulation.
- 130 µL after the test.

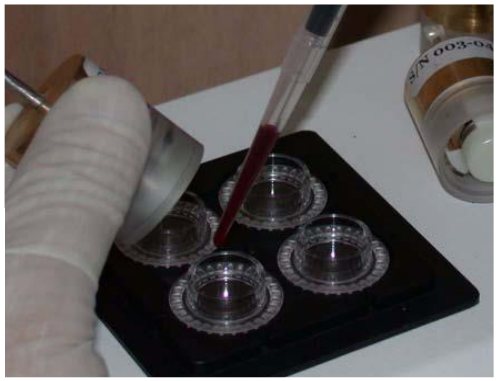


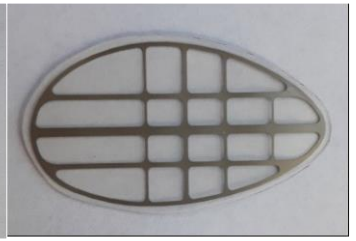
Arterial flow conditions on the flat surfaces



Impact R test



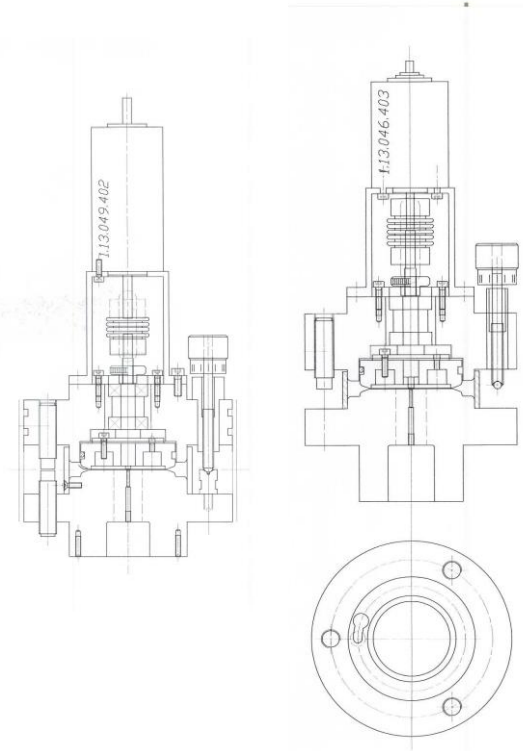


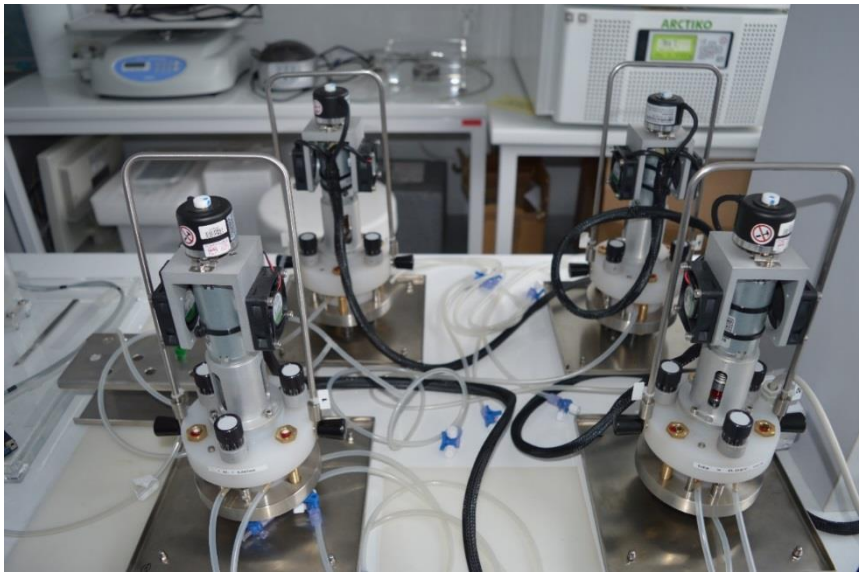


The blood-material interaction performed under the high shear stress conditions

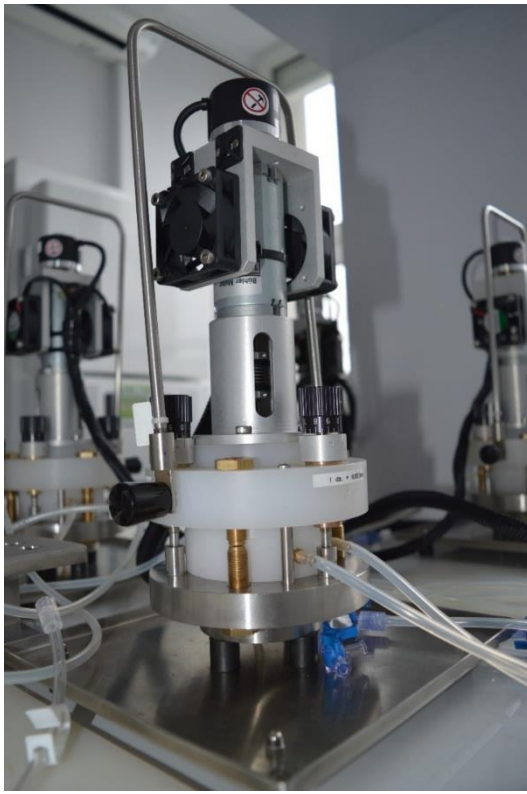
R&D on surface coating deposition

Haemocompatibility in dynamic conditions





High speed rotor 3000-5000 rpm



Material Engineering in Regenerative Cardiac Surgery: "Yesterday and Today"

Roman Major

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Marcin Surmiak, Marek Sanak, Maciej Gawlikowski, Roman Kustosz, Łukasz Major, Hanna Plutecka, Przemysław Kurtyka, Juergen M. Lackner, Boguslaw Major

deposition: P-selectin activation

negative	neutral
neutral	positive

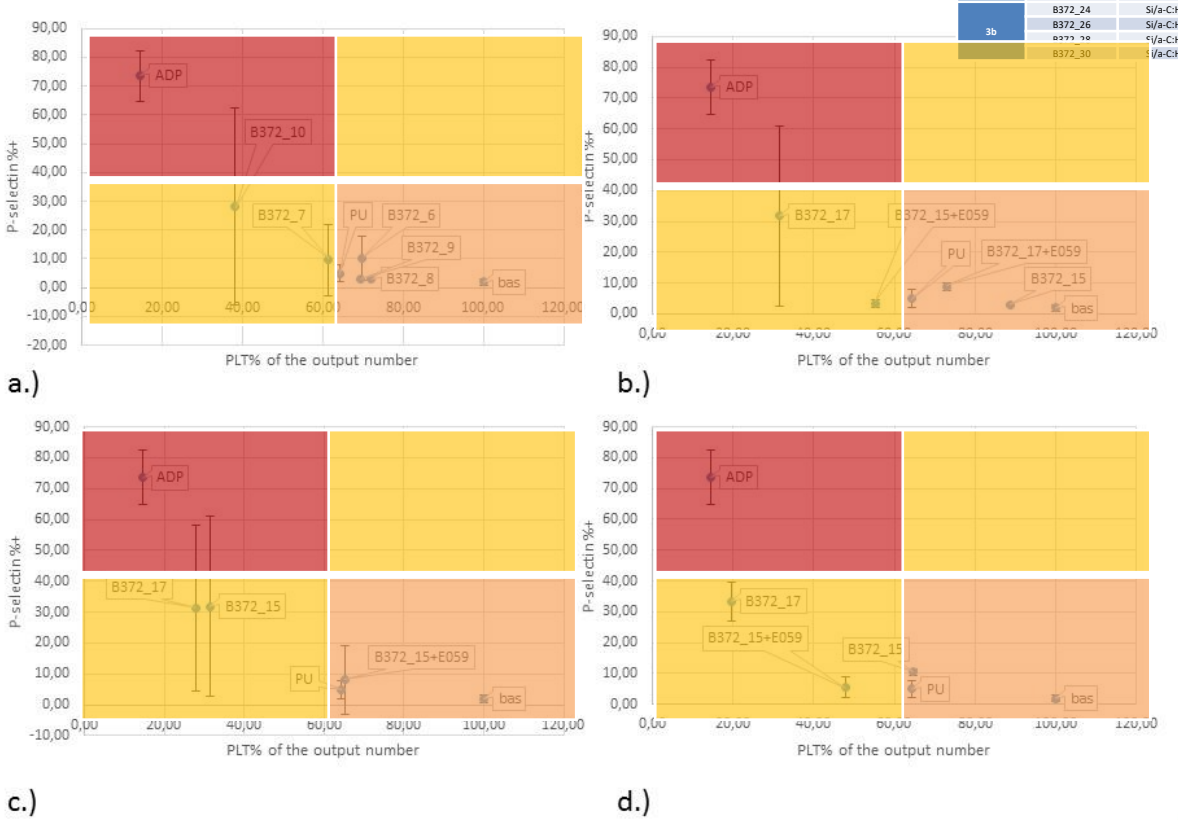
Group	Symbol	Layer	Thickness [nm]
1	B372_6	a-C:H	94,7
	B372_7	a-C:H,N	103,8
	B372_8	a-C:H,N	103,1
	B372_9	a-C:H,N	95,2
	B372_10	a-C:N	95,1
2	B372_15	a-C:H	94,7
	B372_15+E059	a-C:H+SF6 (fluoridation)	94,7
	B372_16	a-C:H,N	110,3
	B372_17	a-C:H,N	100,3
	B372_17+E059	a-C:H,N+SF6 (fluoridation)	100,3
3a	B372_18	a-C:H,N	82,7
	B372_23	Si/a-C:H	124,3
	B372_25	Si/a-C:H	127,6
	B372_27	Si/a-C:H	123,5
	B372_29	Si/a-C:H	118,5
3b	B372_24	Si/a-C:H	15
	B372_26	Si/a-C:H	15
	B372_28	Si/a-C:H	15
	B372_30	Si/a-C:H	15

Hemocompatibility in dynamic conditions

Blood-Material Interaction

P-selectin is protein that in humans is encoded by the SELP gene. P-selectin functions as a cel adhesive molecule
P-selectin- anti-selectin-P antibody

Integrin beta-3 (β3) encoded by the ITGB3 gene. CD61 is a cluster of differentiation found on thrombocytes.

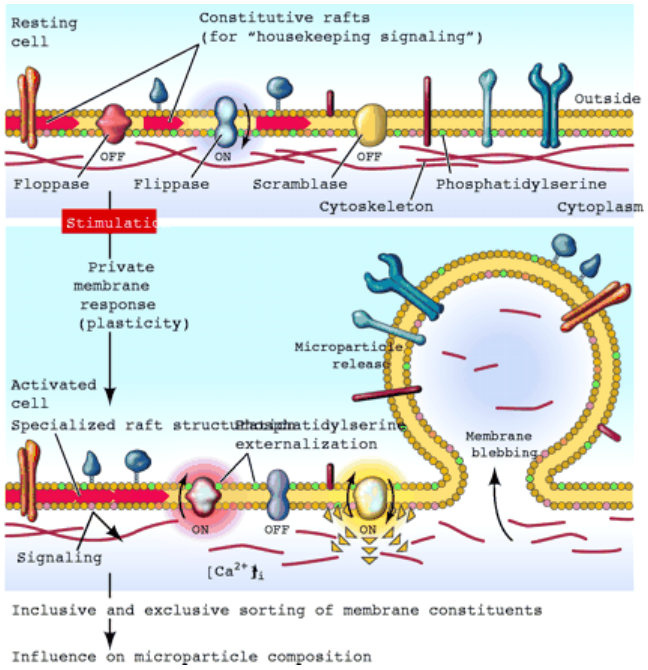


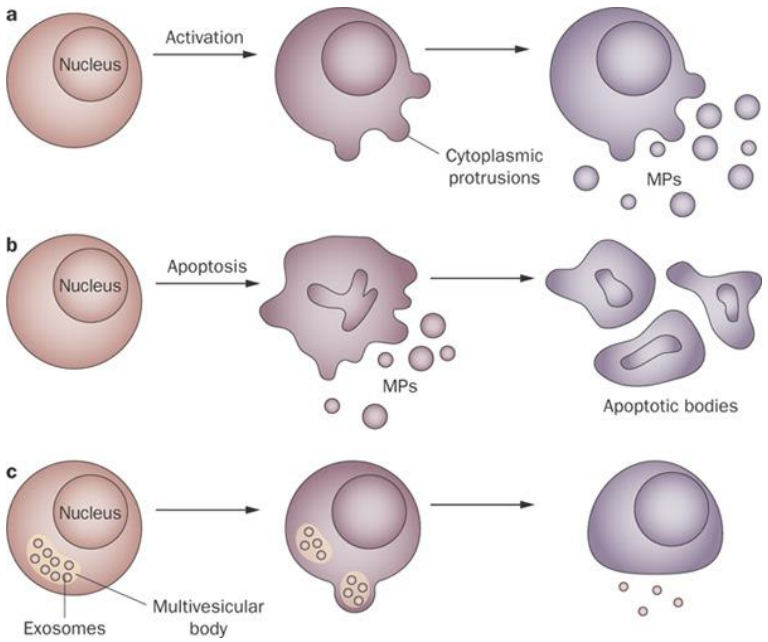
R&D on surface coating

R&D on surface coating deposition

Blood-Material Interaction

Microparticles (MPs) are small membrane vesicles that are released by activated or apoptotic cells.





R&D on surface coating

R&D on surface coating deposition

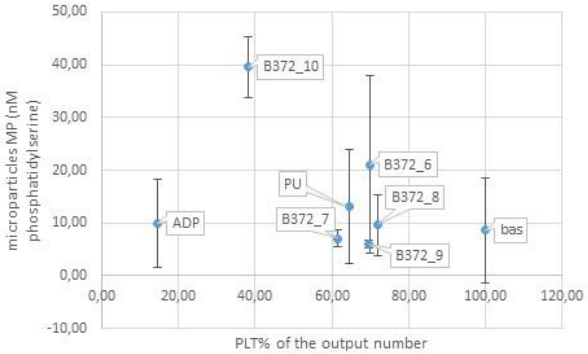
negative	neutral
neutral	positive

Group	Symbol	Layer	Thickness [nm]
1	B372_6	a-C:H	94,7
	B372_7	a-C:H,N	103,8
	B372_8	a-C:H,N	103,1
	B372_9	a-C:H,N	95,2
	B372_10	a-C:N	95,1
2	B372_15	a-C:H	94,7
	B372_15+E059	a-C:H+SF6 (fluoridation)	94,7
	B372_16	a-C:H,N	110,3
	B372_17	a-C:H,N	100,3
	B372_17+E059	a-C:H,N+SF6 (fluoridation)	100,3
	B372_18	a-C:H,N	82,7
3a	B372_23	Si/a-C:H	124,3
	B372_25	Si/a-C:H	127,6
	B372_27	Si/a-C:H	123,5
	B372_29	Si/a-C:H	118,5
3b	B372_24	Si/a-C:H	15
	B372_26	Si/a-C:H	15
	B372_28	Si/a-C:H	15
	B372_30	Si/a-C:H	15

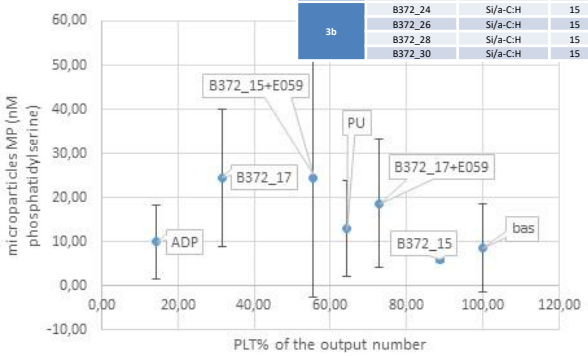
Haemocompatibility in dynamic conditions

Microparticles MP [nm fosfatydyloserin]

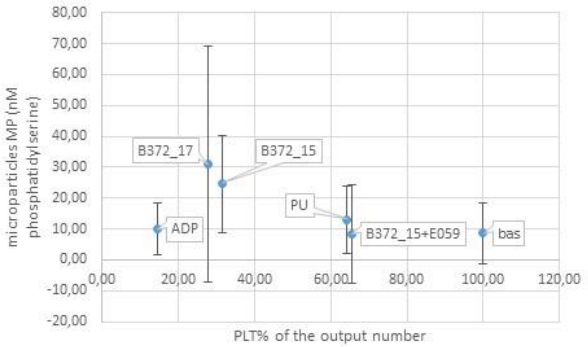
Blood-Material Interaction



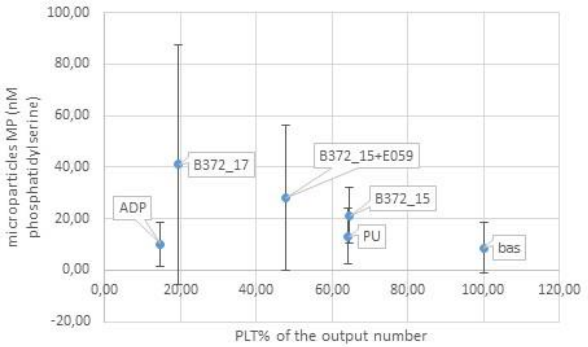
a.)



b.)



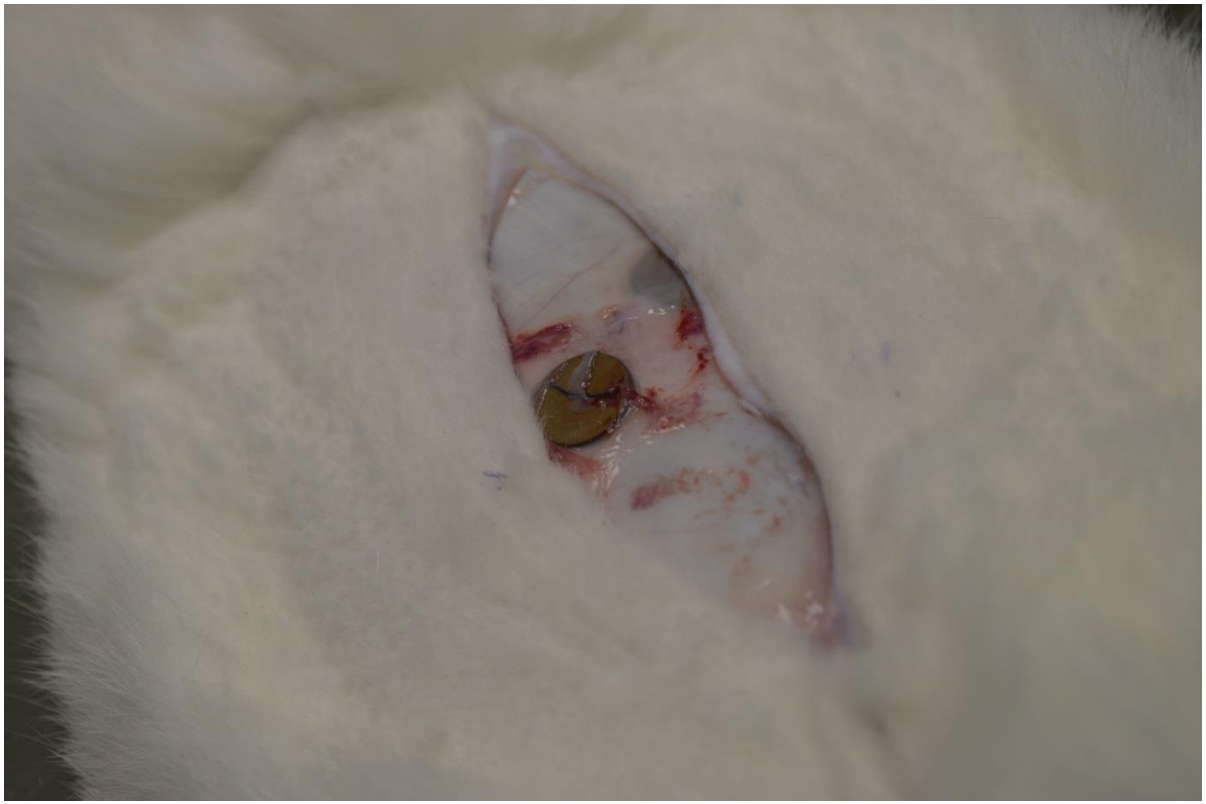
c.)



d.)

Complete valve testing

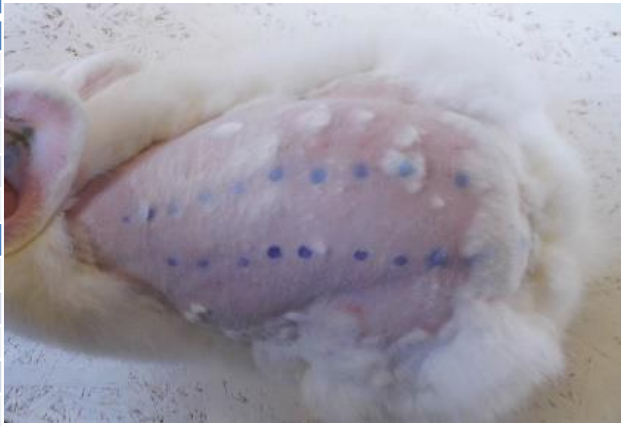
In vivo tests of „simple” samples



Complete valve testing

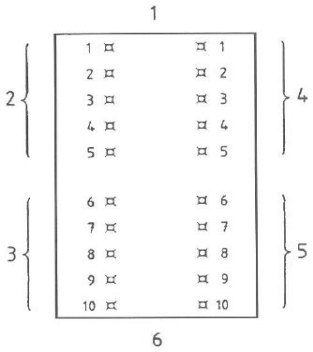
Reaction	Scoring irritation
Erythema formation	
No erythema	0
Very slight erythema	1
Well defined erythema	2
Moderate erythema	3
Severe erythema (dark red)	4
Edema formation	
Lack of edema	0
Very weak swelling (barely perceptible)	1
Well defined erythema (edges of the area well defined by elevation)	2
Moderate edema (elevation of about 1 mm)	3
Painful swelling (elevation above 1 mm goes beyond the area of exposure)	4
Maximum possible score	8

The scale of evaluation of responses in intradermal reactivity tests



An exemplary image of the animal's skin 72h after injection.

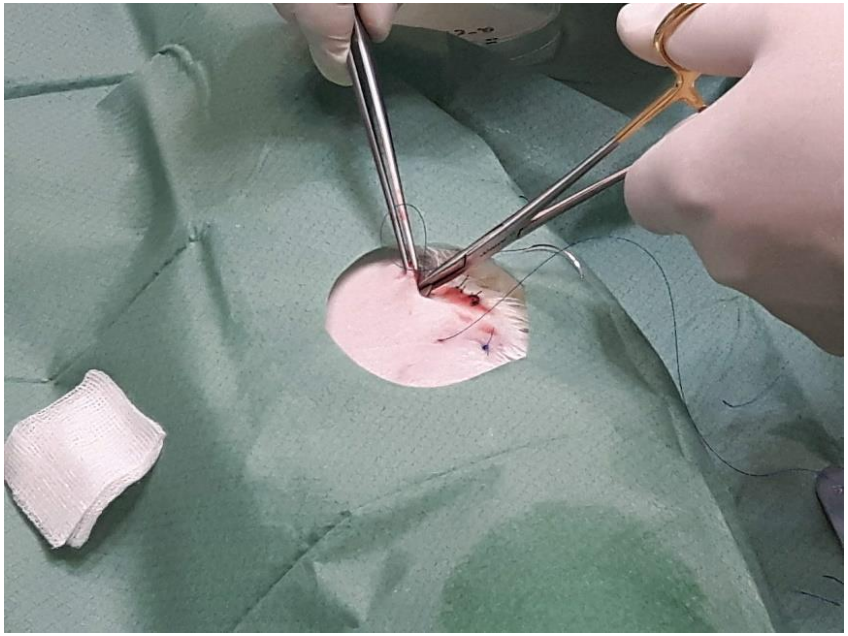
1- side of the animal's head, 2 injections of extract in polar solvent, 3 injections of pure polar solvent, 4 injections of the extract in a non-polar solvent, 5 injections of a pure non-polar solvent, 6 parts of the tail of the animal



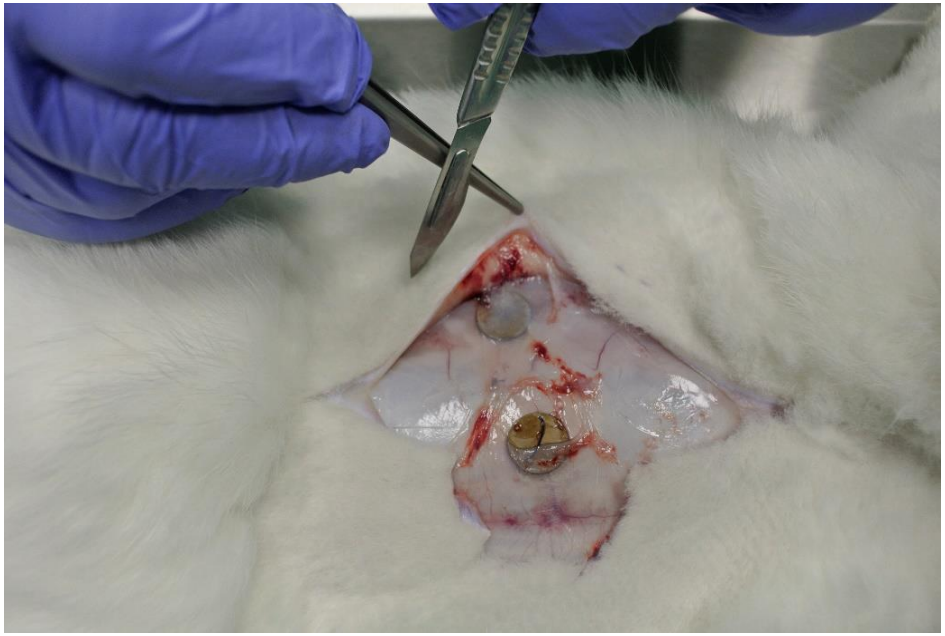
Intradermal reactivity - location of injection points (according to ISO 10993-10) Intradermal reactivity - location of injection points (according to ISO 10993-10)

The test results showed that the tested material extracted with apolar and polar extract did not irritate the skin of rabbits during the 72 h observation period. The tested material met the test requirements because the difference between the average test score and the average control score was less than 1.0 (= 0.13) and in accordance with the normative guidelines ISO 10993-10 was considered non-irritating. It can be concluded that the tested material does not induce intradermal reaction.

Studies of local reactions



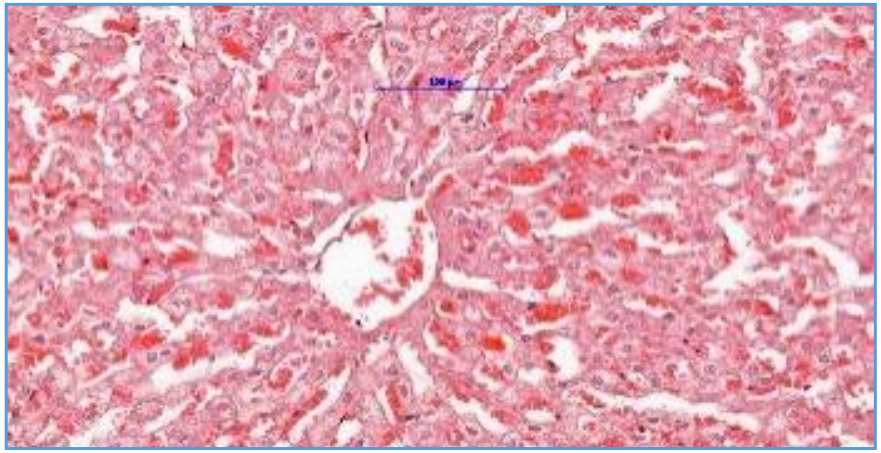
Placing the disc of the tested material under the skin on the back of the animal.



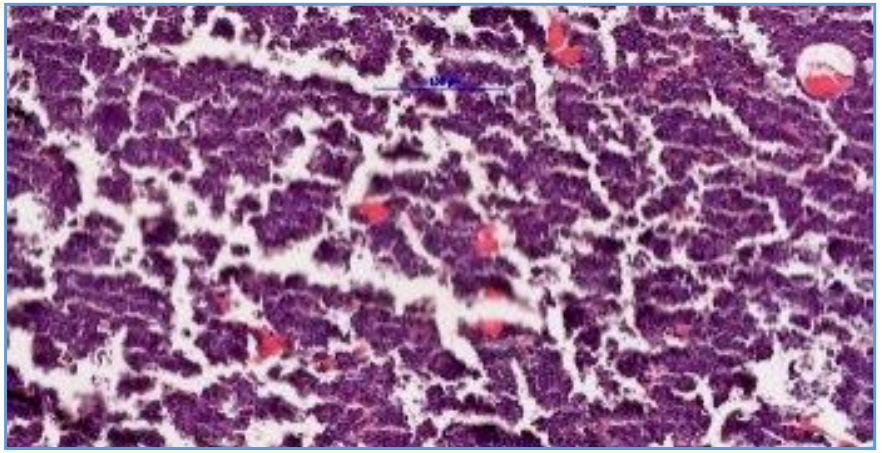
Study group, rabbit No. 2. Implanted site of implantation after 4 weeks, visible petechiae.

Studies of local reactions

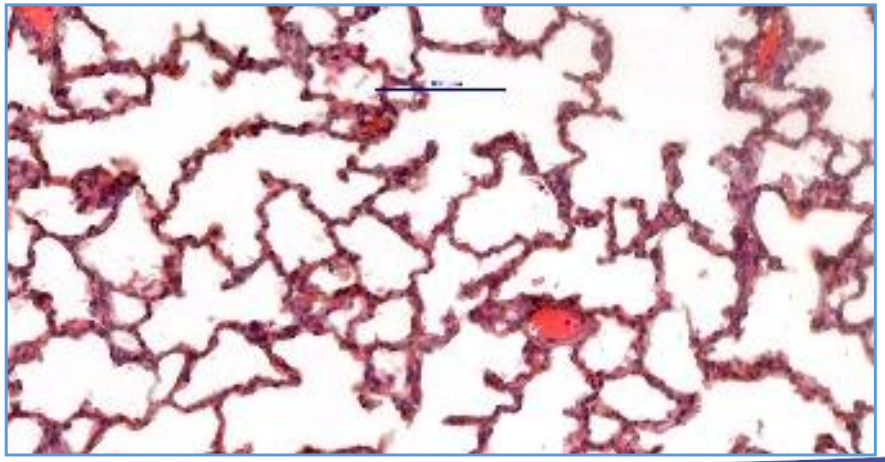
HISTOLOGY (liver, thymus, lung, myocardium)



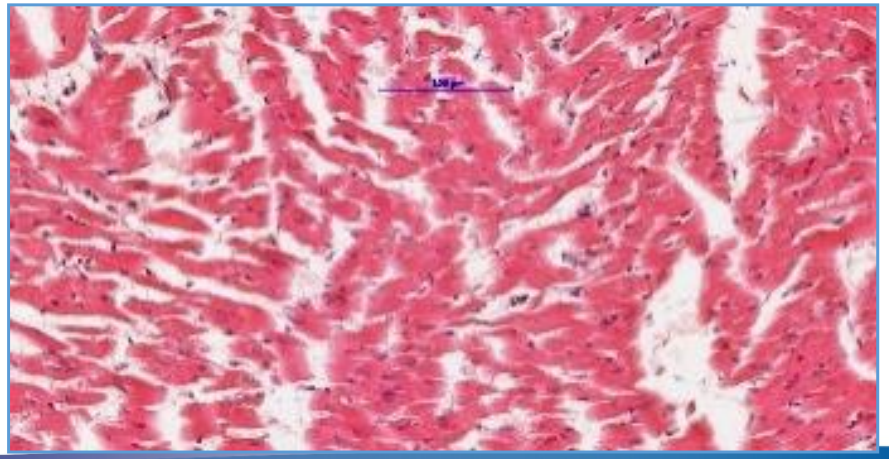
Correct liver lacunae. Mag. 200x



Proper thymic lacunae with Hassal's tiny pink bodies. Mag. 200x



Properly aerated lung parenchyma. Mag. 200x

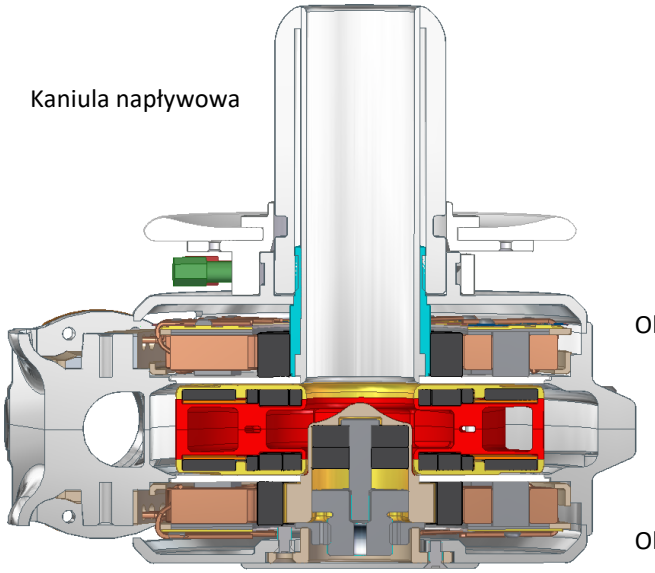


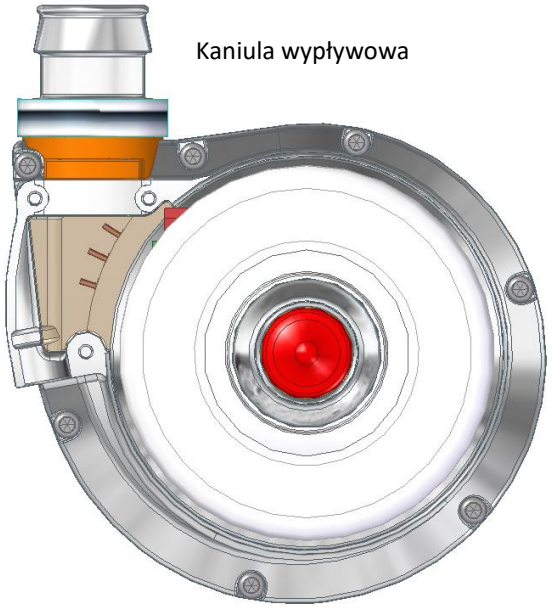
Correct binding of the myocardium. Mag. 200x

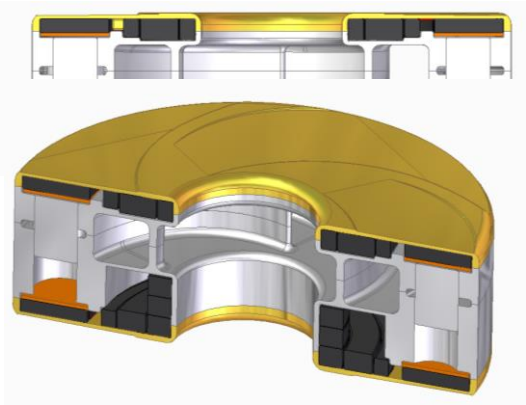
Technology readiness level

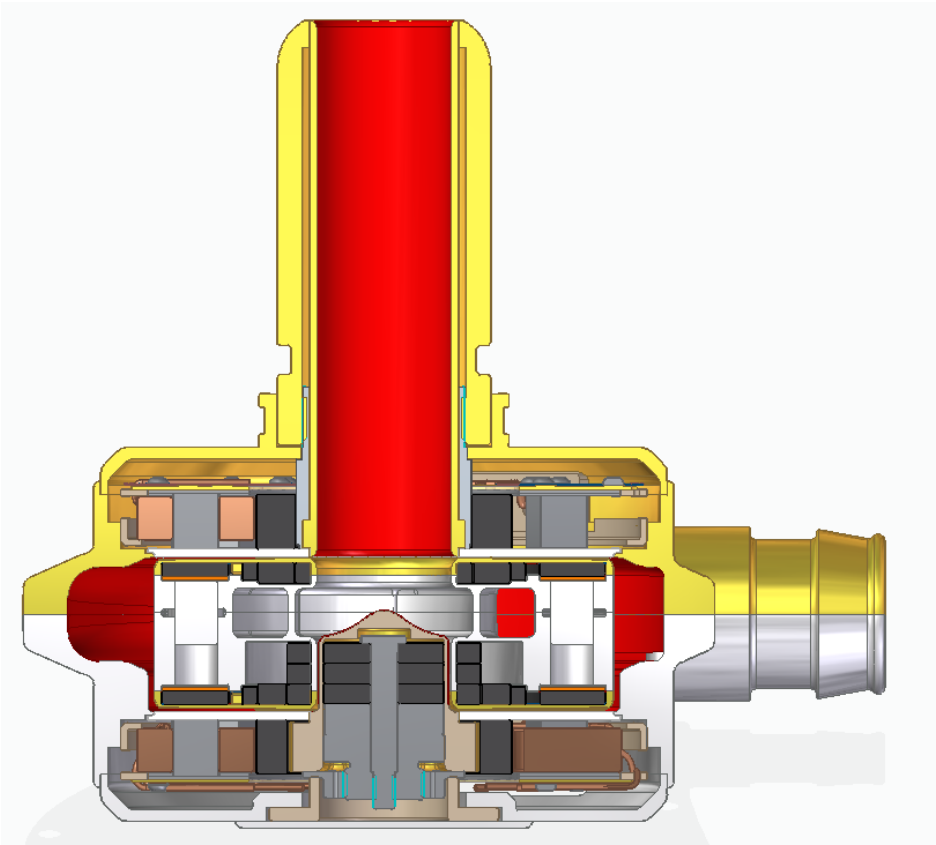
Technology readiness level

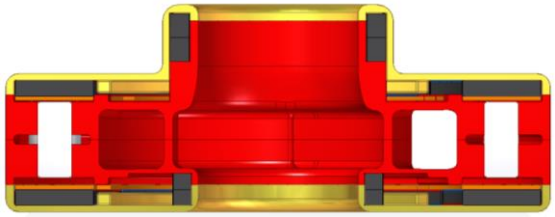
Presentation of the results of the project Single-piece miniature 4D rotor for blood pump M-ERA.NET2 2017/4/2019

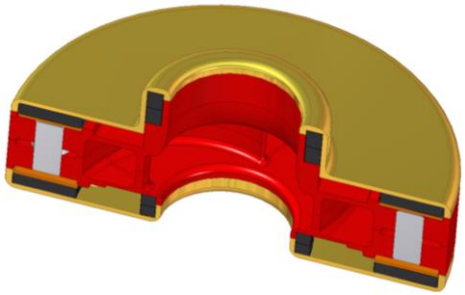

Kaniula napływowa
Obudowa górna pompy
Wirnik
Obudowa dolna pompy

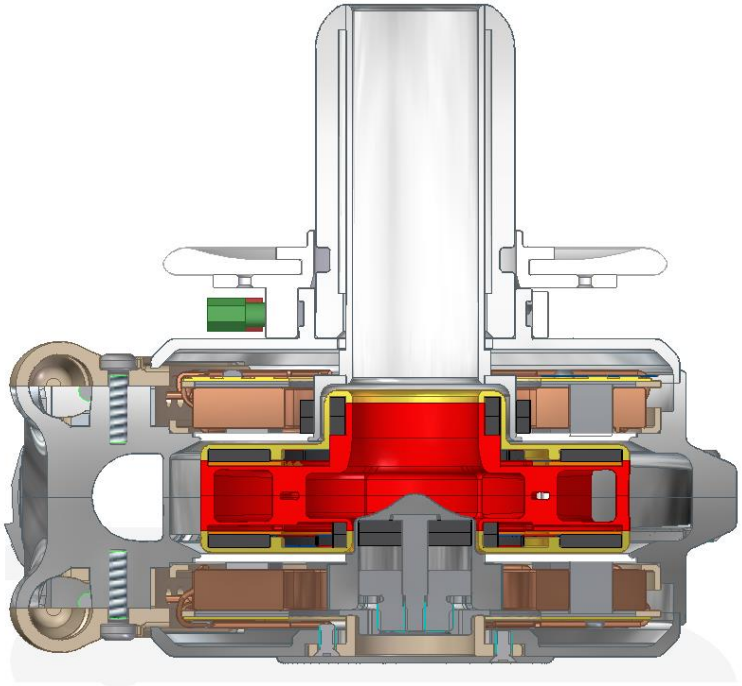

Kaniula wypływowa



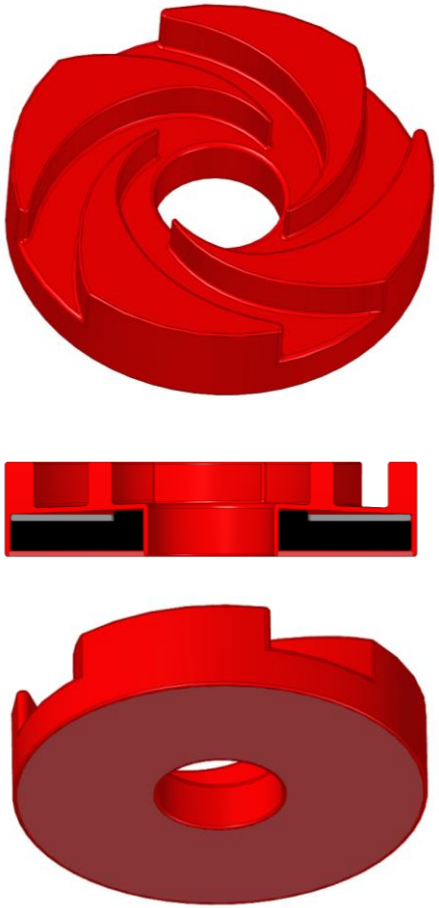




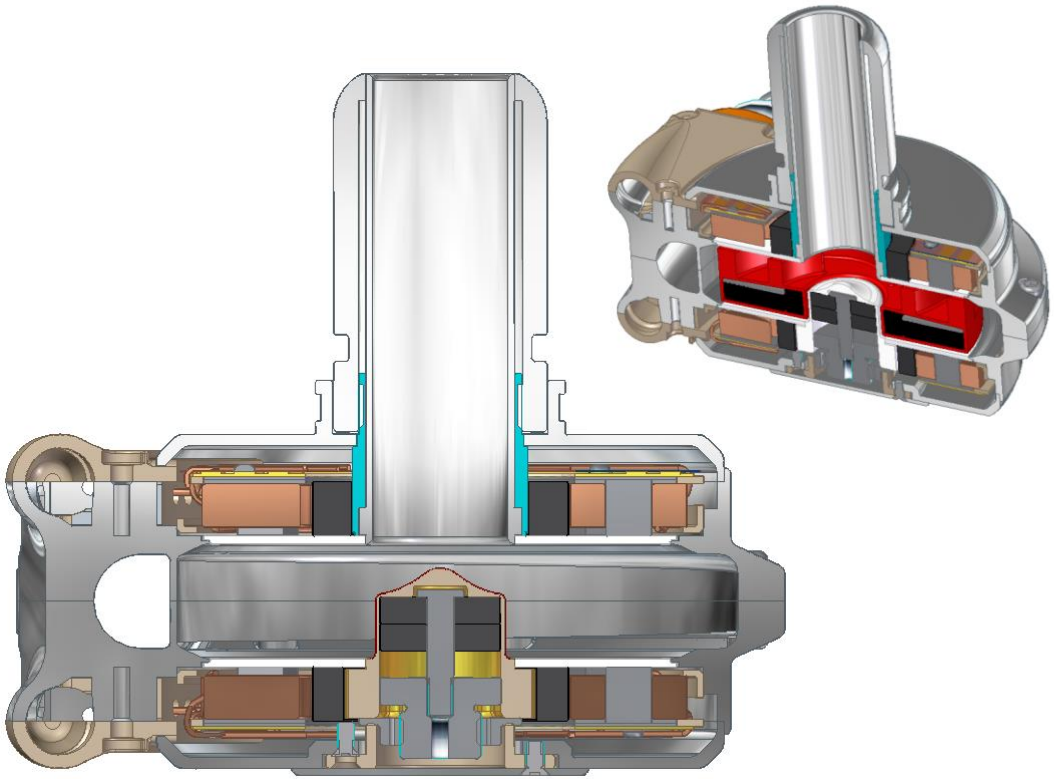




CAD – Dokumentacja konstrukcji wirnika pompy RH ROT MAGN z wirnikiem otwartym



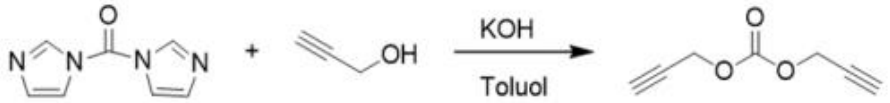
Nowa wersja wirnika otwartego



Obudowa pompy w wersji wejściowej konstrukcji nie wymaga istotnych modyfikacji w celu dostosowania do konstrukcji wirnika otwartego.

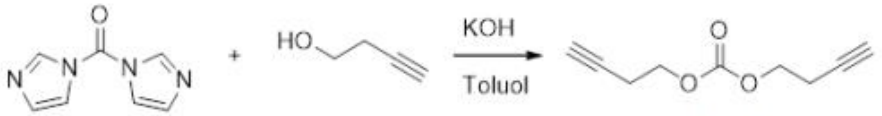
Monomer Synthesis

- **Di(prop-2-yn-1-yl) carbonate**
- MG = 138,12 g/mol
- 350 g (95% yield)



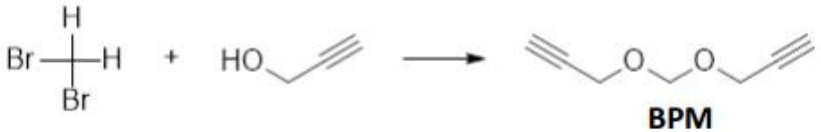
DPC

- **Di(but-3-yn-1-yl) carbonate**
- MG = 166,17 g/mol
- 350 g (98% yield)



DBC

- **Bis (prop-2yn-1-yloxy) methan**
- MG = 124,14 g/mol
- 250 g (85% yield)



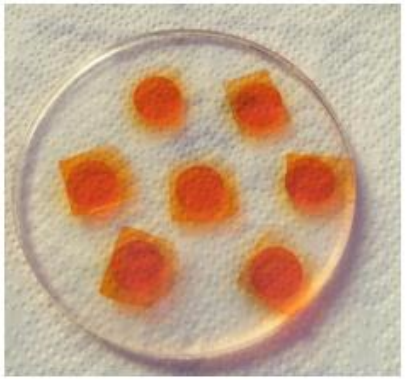
BPM

Adres: 41-800 Zabrze; Wolności 345a; tel: +48 32 3735660, fax: +48 32 3735665; romankustosz@frk.pl; www.frk.pl

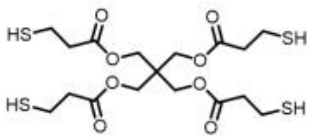
Evaluation of the Cytotoxicity in Dependence of Different Photoinitiators

Variation of photoinitiators:

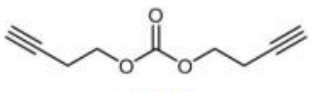
TPO-L:	0,25 wt%	0,5 wt%	1 wt%
Irg-819:	0,25 wt%	0,5 wt%	1 wt%
Ivocerin:	0,25 wt%	0,5 wt%	1 wt%



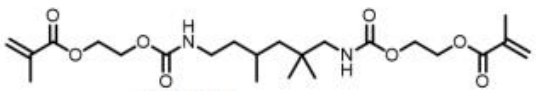
Monomer system:



PETMP

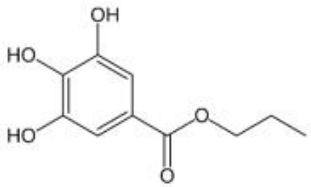


DBC

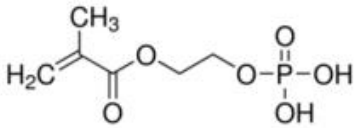


UDMA

Stabilizers:



Propyl gallate (0,5 wt%)



Miramer A99 (2 wt%)

Indication	Description
Batch : BE_190321_2	Propyl gallat DBC = Di(but-3-yn-1-yl) carbonate PETMP UDMA Acrylat Miramer A99 0.25 wt% TPO-L
Batch : BE_190321_3	Propyl gallat DBC = Di(but-3-yn-1-yl) carbonate PETMP UDMA Acrylat Miramer A99 0.5 wt% TPO-L
Batch : BE_190321_4	Propyl gallat DBC = Di(but-3-yn-1-yl) carbonate PETMP UDMA Acrylat Miramer A99 1.00 wt% TPO-L
Batch : BE_190322_5	Propyl gallat DBC = Di(but-3-yn-1-yl) carbonate PETMP UDMA Acrylat Miramer A99 0.25 wt% 819 BAPO
Batch : BE_190322_6	Propyl gallat DBC = Di(but-3-yn-1-yl) carbonate PETMP UDMA Acrylat Miramer A99 0.5 wt% 819 BAPO
Batch : BE_190322_7	Propyl gallat DBC = Di(but-3-yn-1-yl) carbonate PETMP UDMA Acrylat Miramer A99 1.00 wt% 819 BAPO
Batch : BE_190322_8	Propyl gallat DBC = Di(but-3-yn-1-yl) carbonate PETMP UDMA Acrylat Miramer A99 0.25 wt% Ivocerin
Batch : BE_190322_9	Propyl gallat DBC = Di(but-3-yn-1-yl) carbonate PETMP UDMA Acrylat Miramer A99 0.5 wt% Ivocerin
Batch : BE_190322_10	Propyl gallat DBC = Di(but-3-yn-1-yl) carbonate PETMP UDMA Acrylat Miramer A99 1.00 wt% Ivocerin

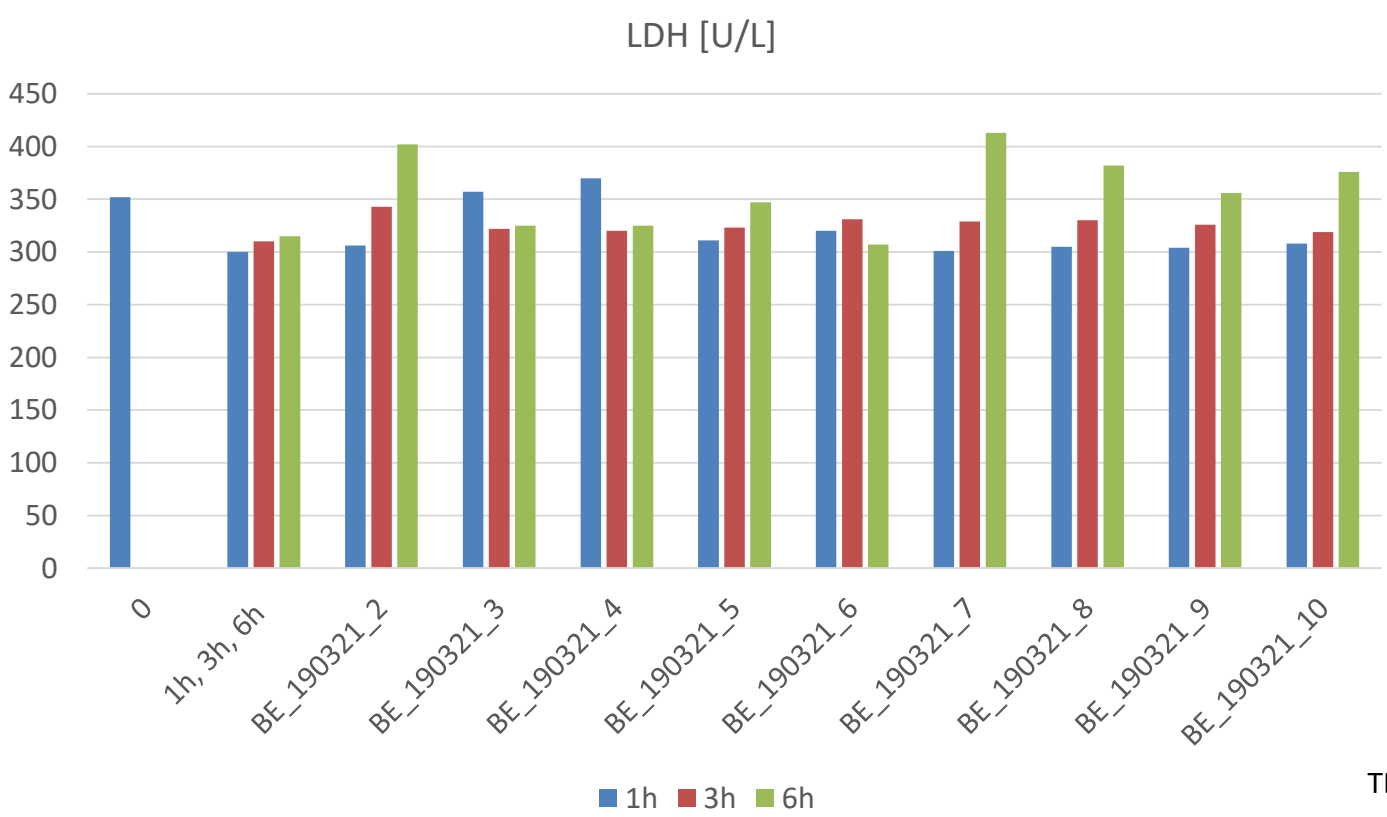
10000 cells/well in 24 well plate

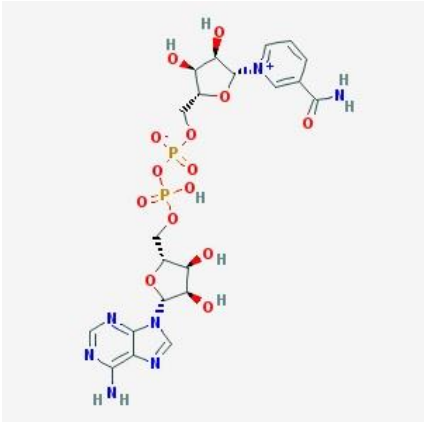
5 days culture to have ove division

Nuclei staining- CLSM

LDH- colorimetric

Luminex assay





Construction of NAD

The basis of LDH test

LACTATE → PYRUVATE

NAD+ → NAPDH+H+

TETRAZOLIN → FORMAZAN

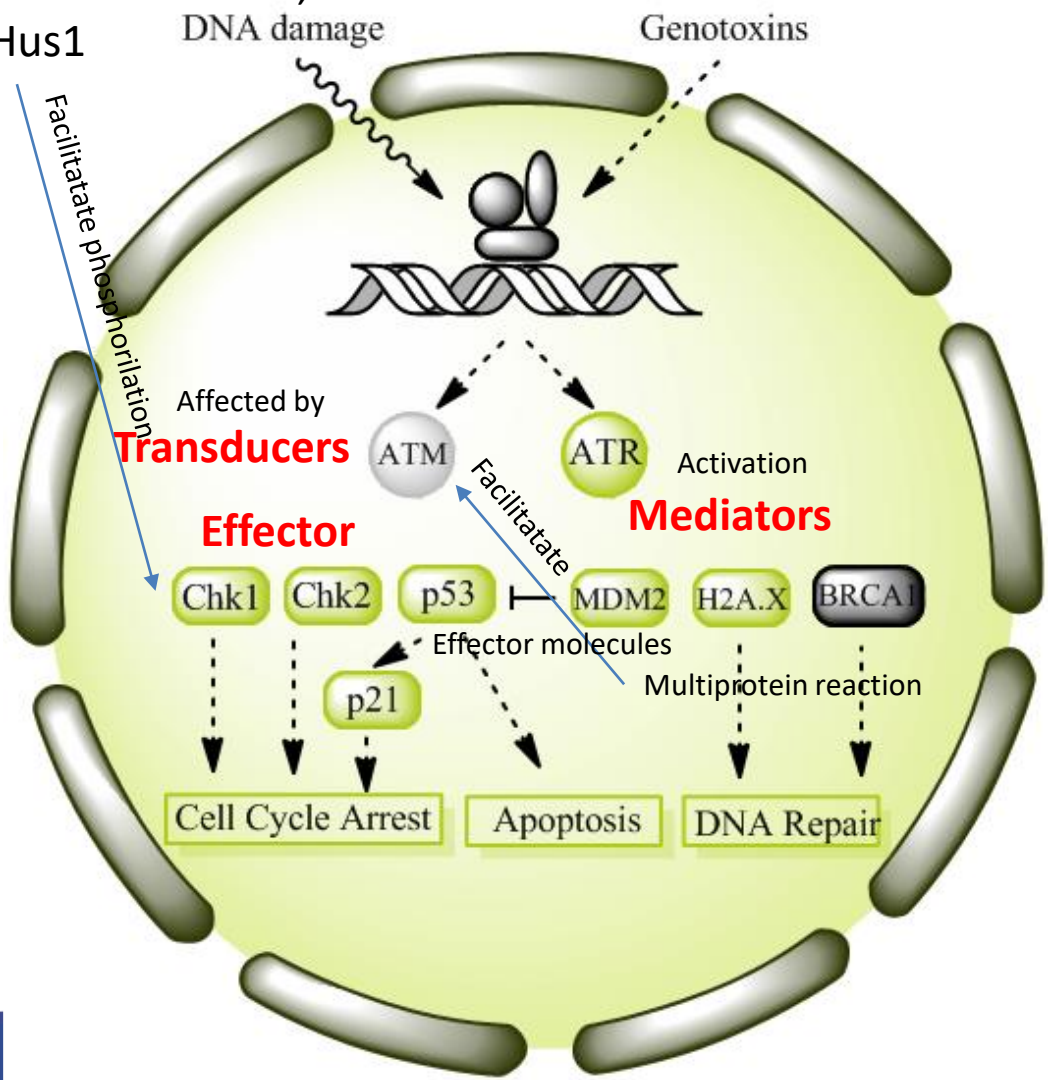
Diaphoresis

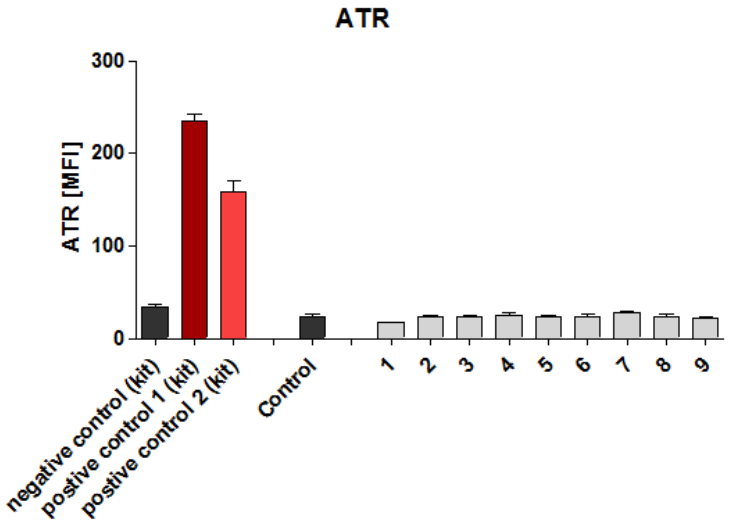
Adres: 41-800 Zabrze; Wolności 345a; tel: +48 32 3735660, fax: +48 32 3735665; romankustosz@frk.pl; www.frk.pl

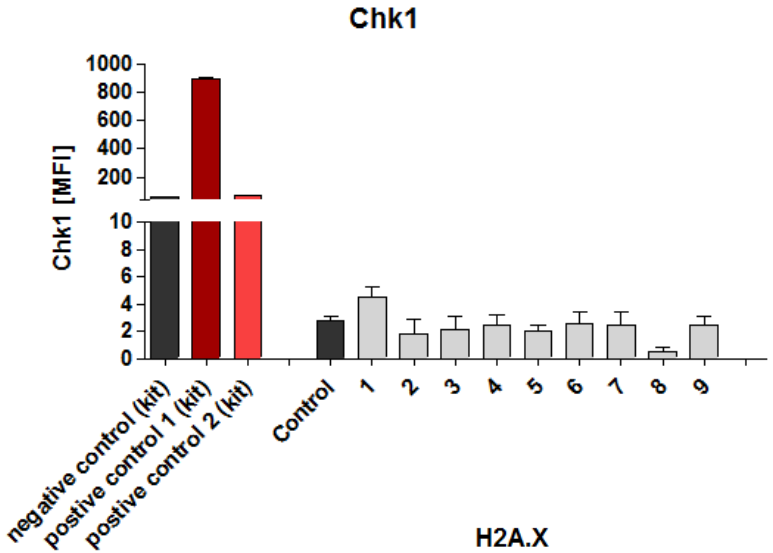
MILLIPLEX® MAP 7-plex DNA Damage/Genotoxicity Magnetic Bead Kit (nr kat. 48-621MAG) to zestaw do jednoczesnego oznaczenia ilościowego następujących 7 analitów w lizatach komórkowych:

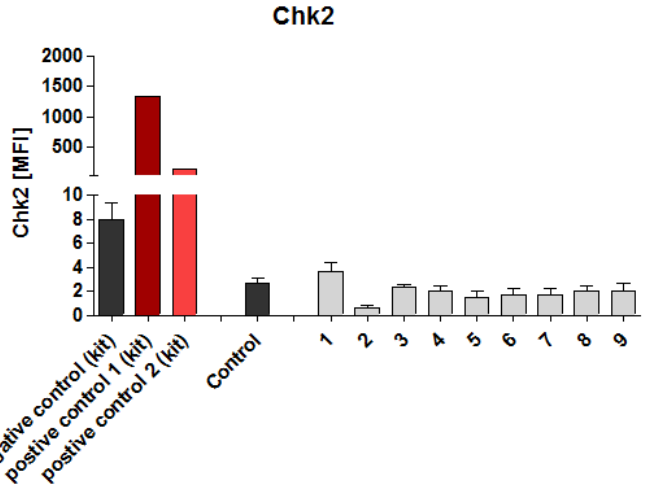
- ATR (total)
- Chk1 (Ser345)
- Chk2 (Thr68)
- H2A.X (Ser139)
- MDM2 (total)
- p21 (total)
- p53 (Ser15)

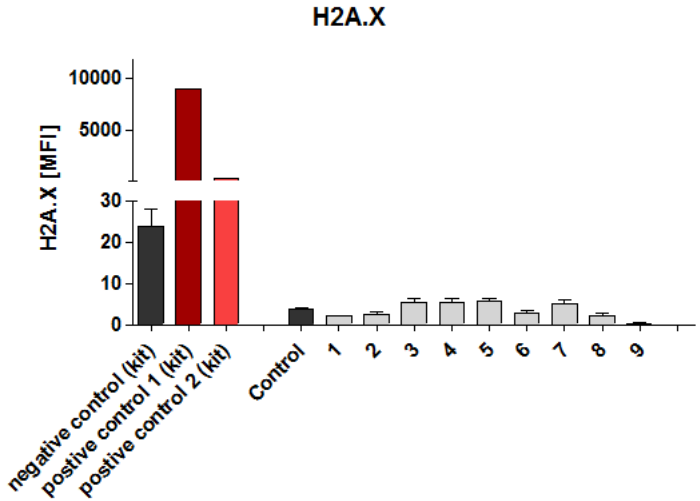
Sensor proteins like Rad9, Rad1and Hus1

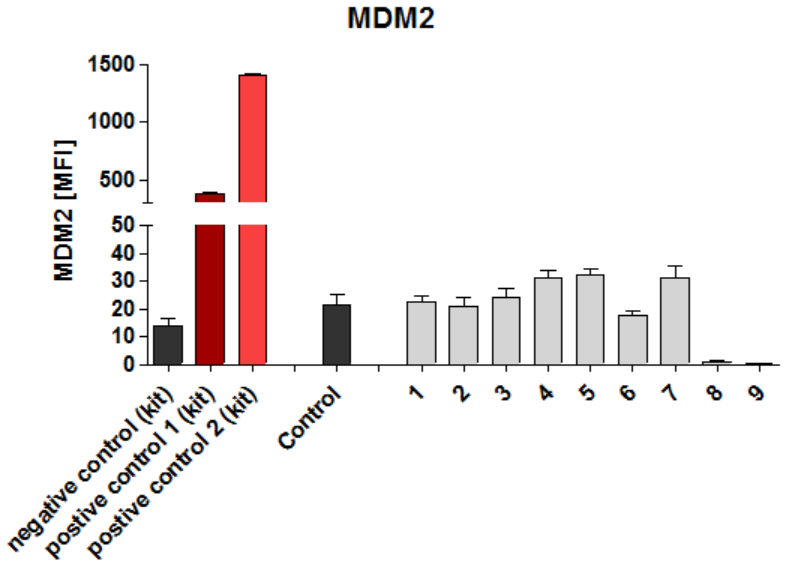


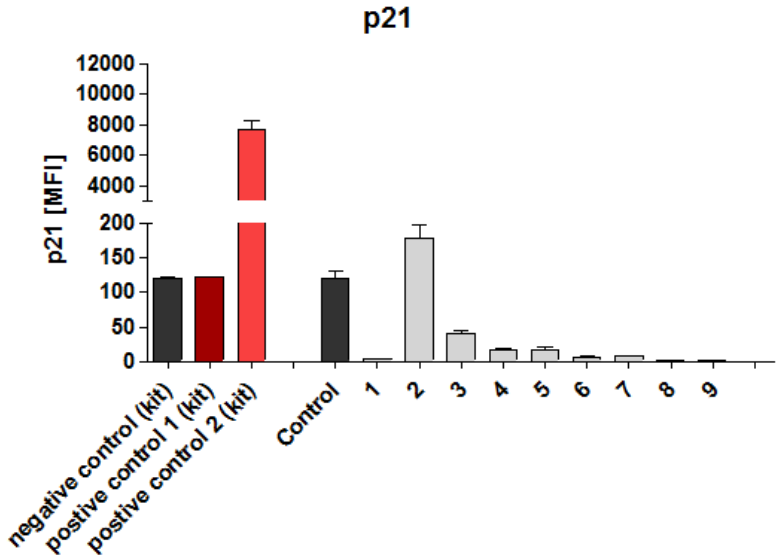

ATR
ATR [MFI]
300
200
100
0
negative control (kit)
postive control 1 (kit)
postive control 2 (kit)
Control
1
2
3
4
5
6
7
8
9


Chk1
Chk1 [MFI]
1000
800
600
400
200
10
8
6
4
2
0
negative control (kit)
postive control 1 (kit)
postive control 2 (kit)
Control
1
2
3
4
5
6
7
8
9


Chk2
Chk2 [MFI]
2000
1500
1000
500
10
8
6
4
2
0
negative control (kit)
postive control 1 (kit)
postive control 2 (kit)
Control
1
2
3
4
5
6
7
8
9

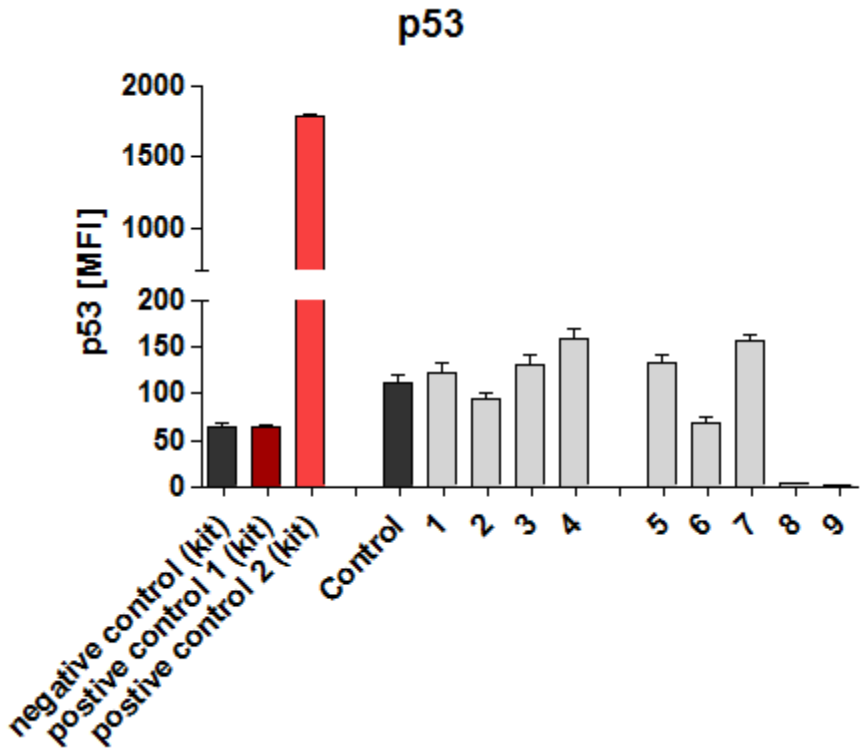

H2A.X
H2A.X [MFI]
10000
5000
30
20
10
0
negative control (kit)
postive control 1 (kit)
postive control 2 (kit)
Control
1
2
3
4
5
6
7
8
9





the main negative regulator of p53 in the cell - MDM2 protein

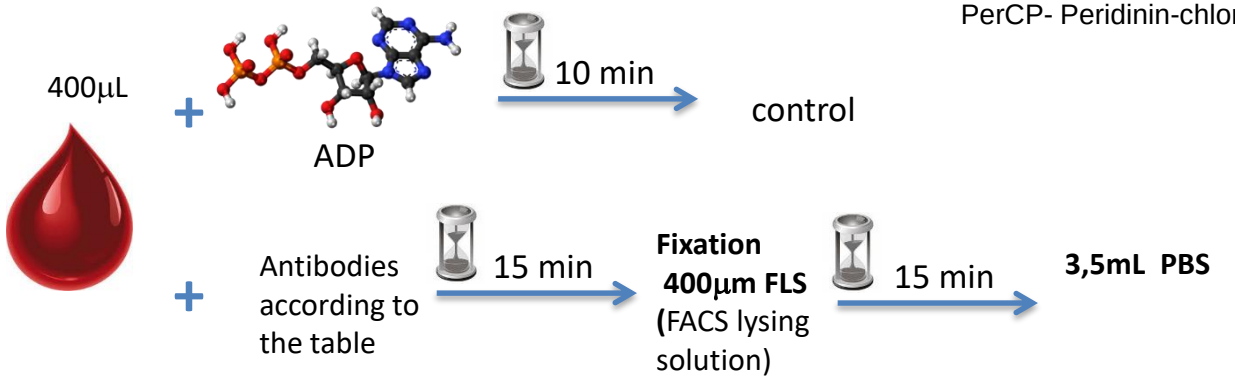
The p21 protein is a potent cyclin-dependent kinase inhibitor (CKI): it binds to the cyclin complexes CDK2 or CDK4, inhibiting their activity. It thus acts as a cell cycle regulator in the G1 phase.


p53
p53 [MFI]
2000
1500
1000
200
150
100
50
0
negative control (kit)
postive control 1 (kit)
postive control 2 (kit)
Control
1
2
3
4
5
6
7
8
9

Blood-Material Interaction

Name	Composition	Application
M	CD61-PerCP, CD62P, PAC-1	assessment of platelet activation under the influence of contact with the material (+ control)
A	CD61-PerCP, CD62P, PAC-1	assessment of platelet activation using ADP
ADP 1	ADP 0.4mM	Positive control
ADP	ADP 40mM	Kontrola pozytywna

PerCP- Peridinin-chlorophyll-protein

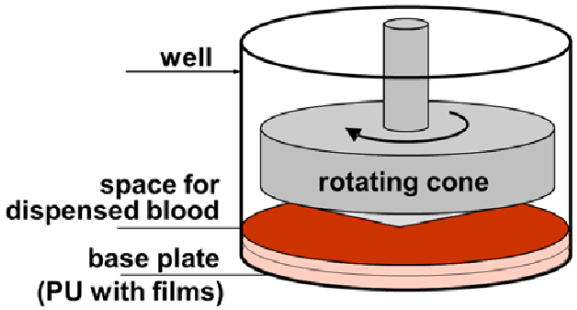


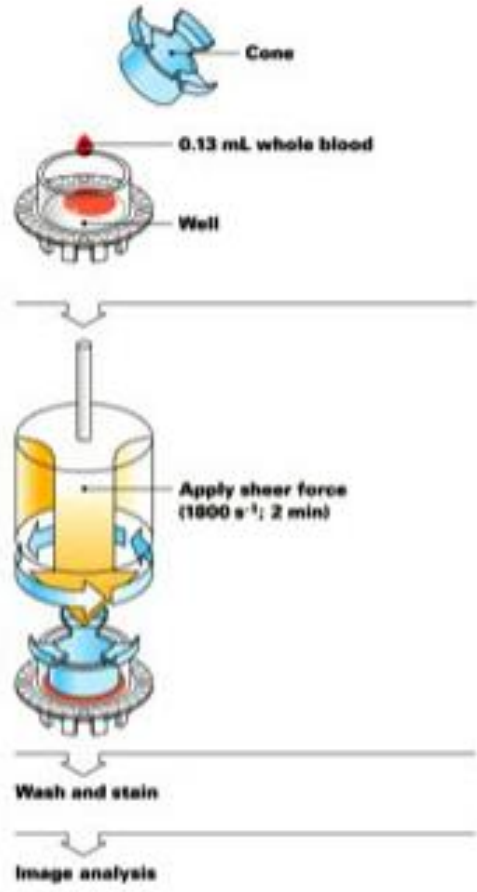
Arterial flow conditions

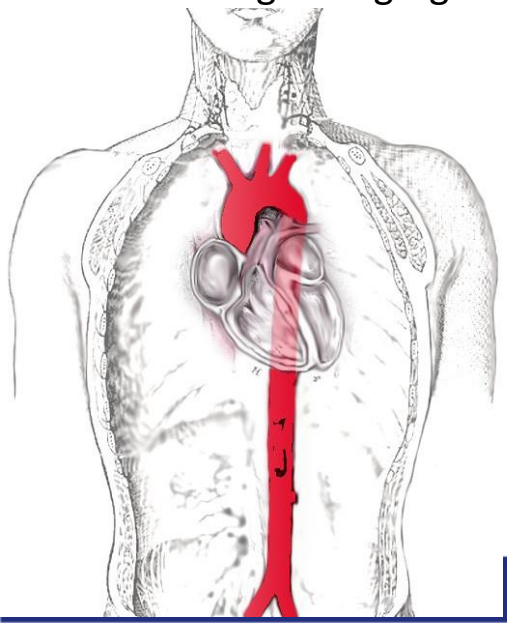
- Human blood (4 x 4.5 mL)
- ADP activation 5 min.
- Arterial flow conditio simulation.
- 130 μL after the test.

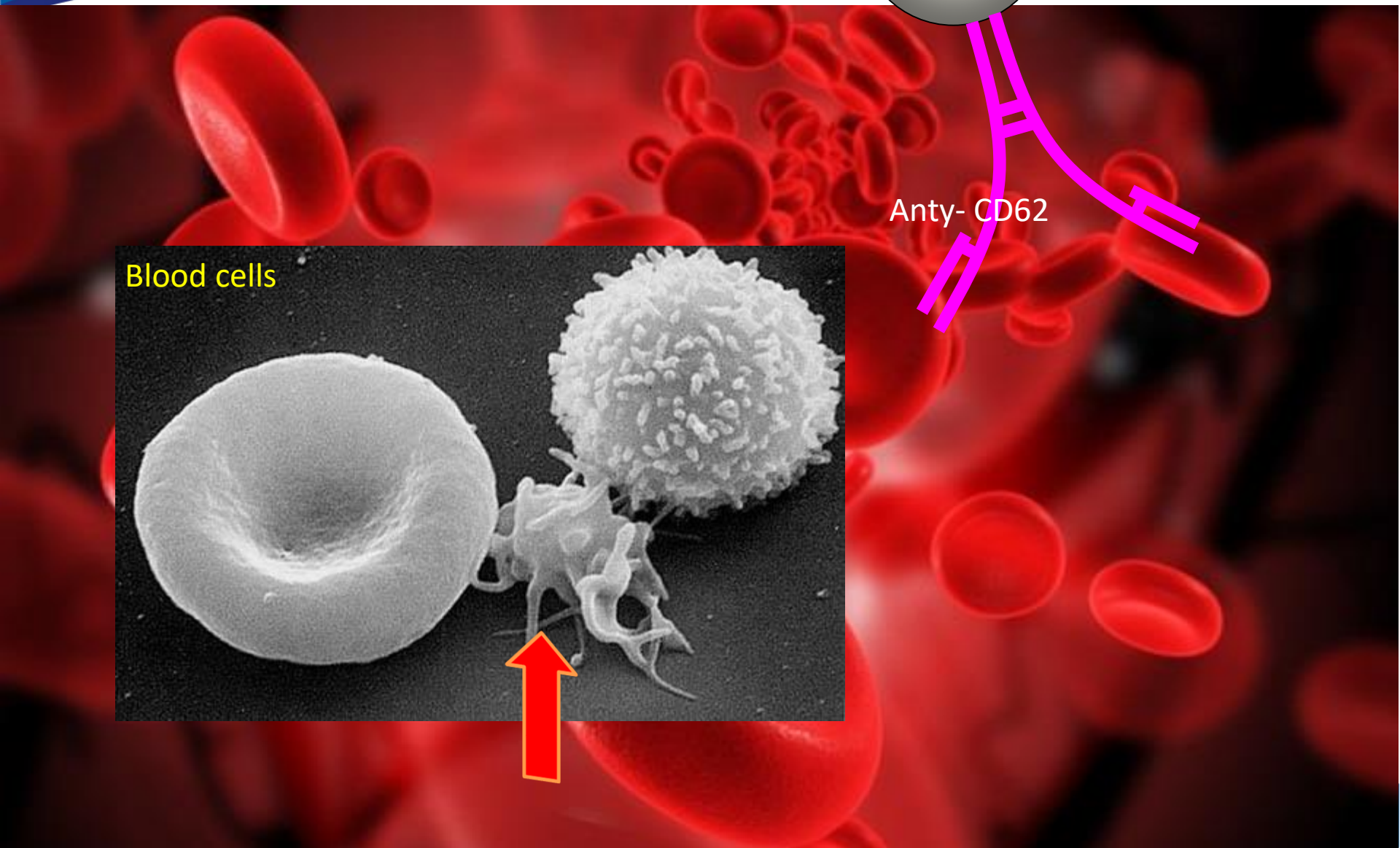
Analysis:

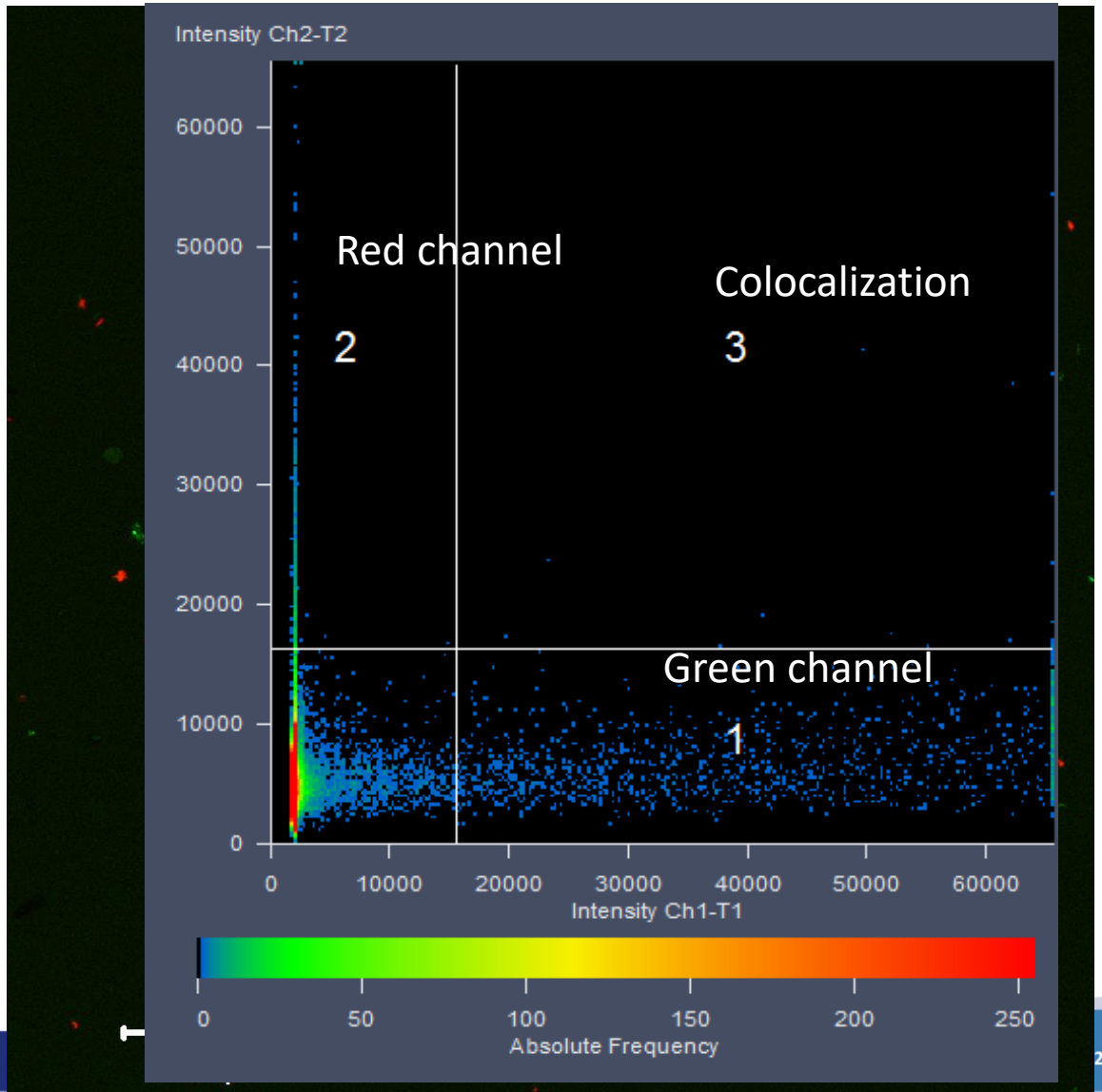
- Platelet marker expresion CD61
- PAC-1 glycoprotein IIb/IIIa
- CD62P for P-selectin
- Small and big PLT agregates



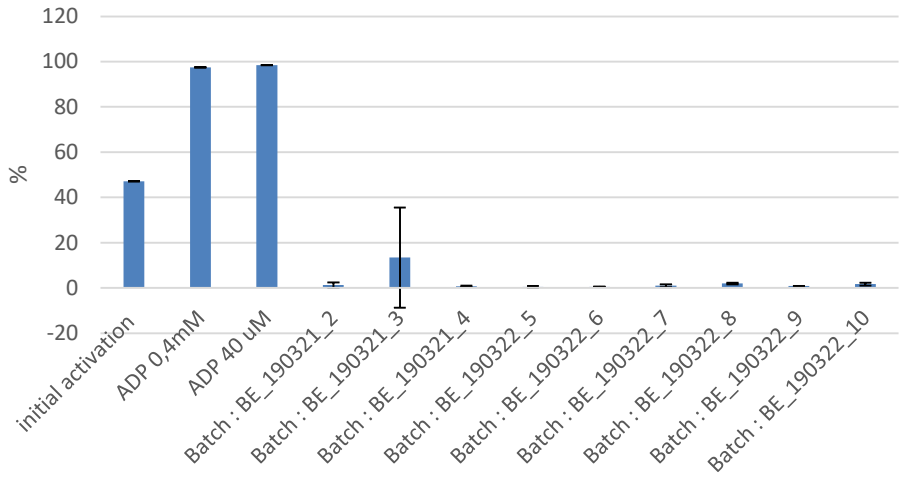




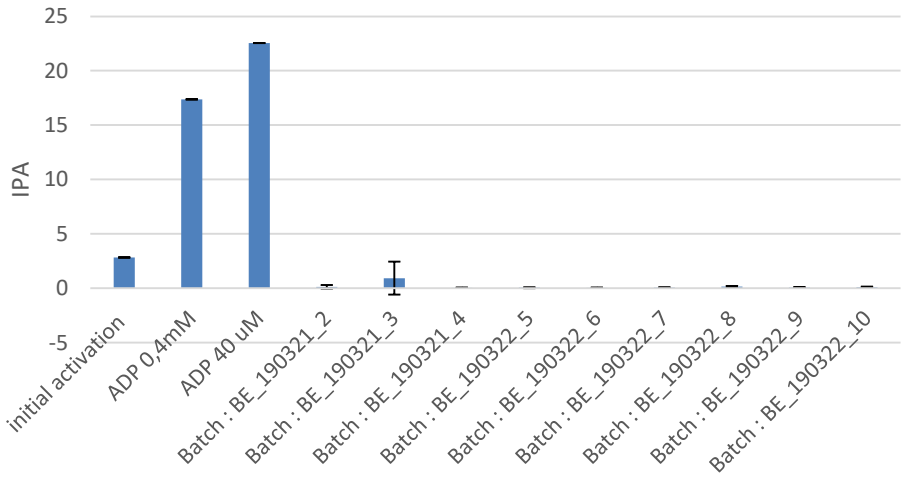

Anty- CD62
Blood cells


Intensity Ch2-T2
60000
50000
40000
30000
20000
10000
0
Red channel
2
Colocalization
3
Green channel
1
0
10000
20000
30000
40000
50000
60000
Intensity Ch1-T1
0
50
100
150
200
250
Absolute Frequency

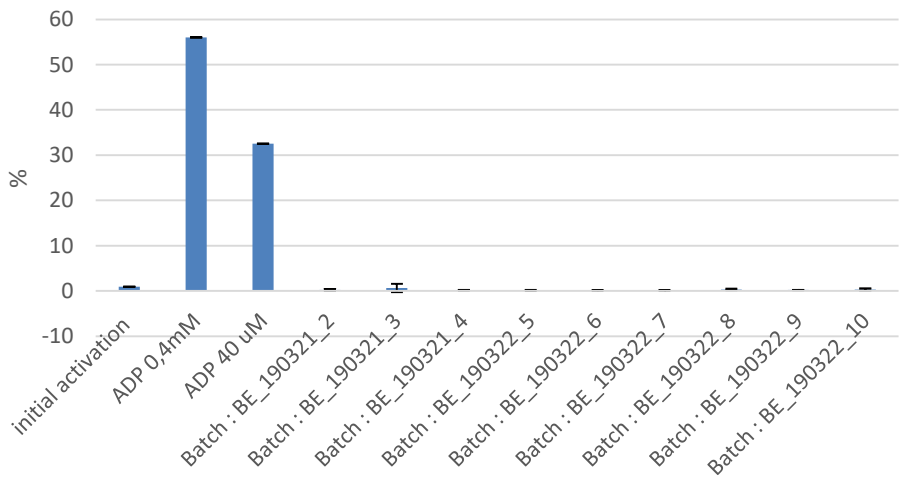
PAC-1



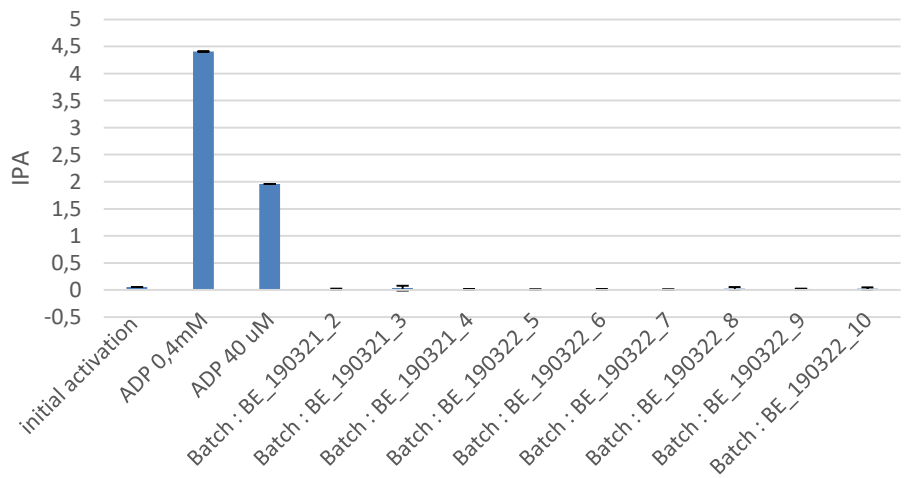
PAC-1

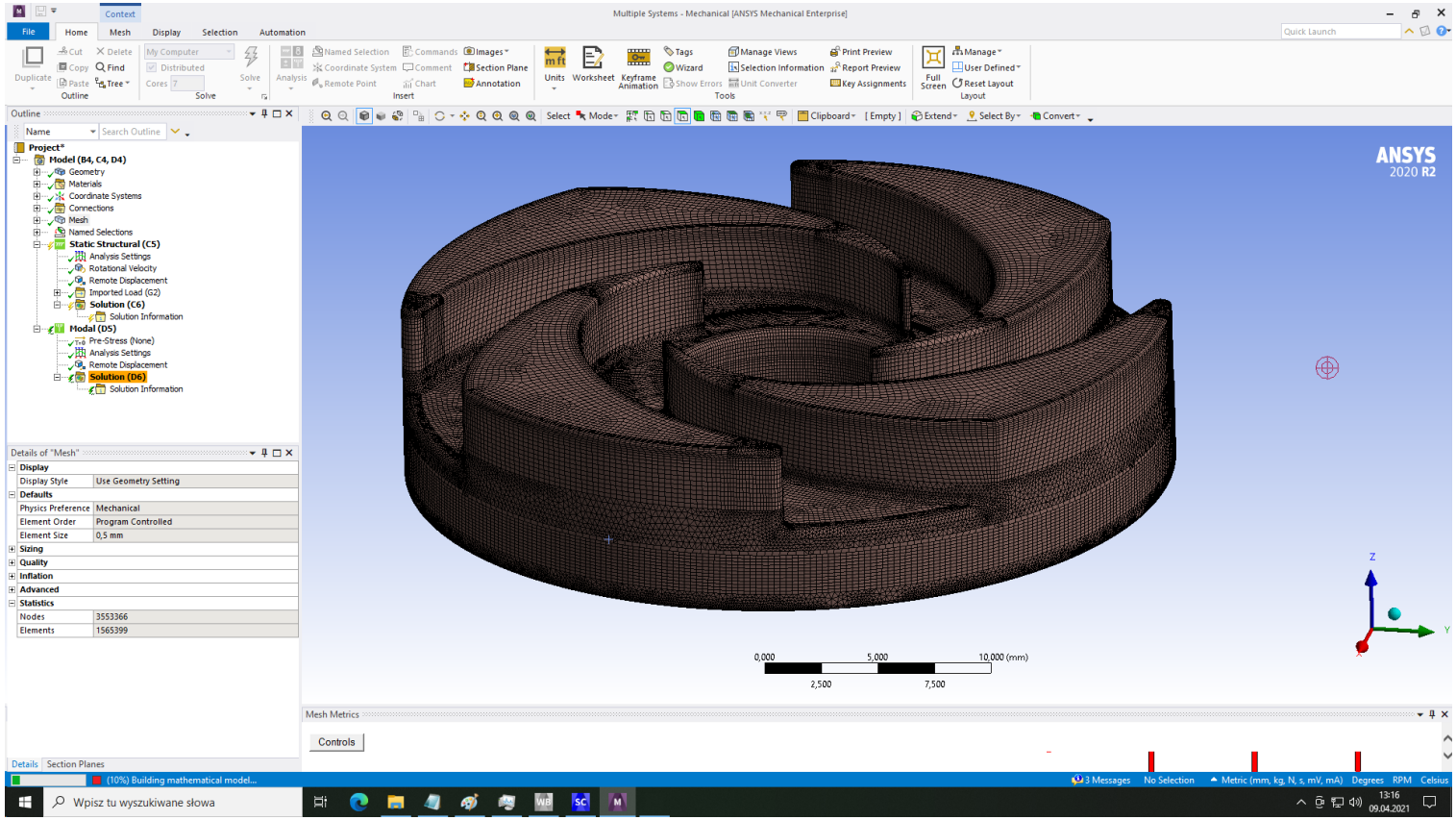


P-SEL



P-SEL




Multiple Systems - Mechanical [ANSYS Mechanical Enterprise]
ANSYS
2020 R2
Project*
Model (B4, C4, D4)
Static Structural (C5)
Modal (D5)
Solution (D6)
Details of "Mesh"
Mesh Metrics
Controls
0,000
5,000
10,000 (mm)
2,500
7,500