SENSORTEHNOLOOGIAD MEDITSIINITEHNIKAS

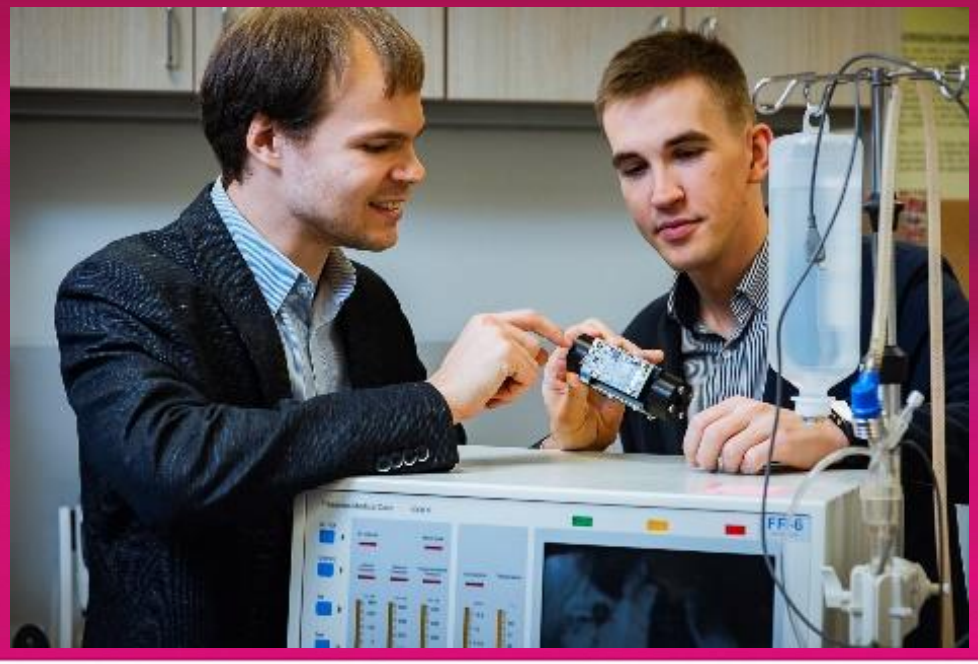
AKADEEMIKUKANDIDAATIDE KONVERENTS
24. OKTOOBRIL 2023, TALLINNAS

Ivo Fridolin, PhD
Tervisetehnoloogiate instituut
Infotehnoloogia teaduskond
Tallinna Tehnikaülikool
https://taltech.ee/tervisetehnoloogiate-instituut

TAL TECH

UURIMISGRUPP SENSORTEHNOLOOGIAD MEDITSIINITEHNIKAS

SENSOR TECHNOLOGIES RESEARCH GROUP AT BIOMEDICAL ENGINEERING (SENSORTECH@BME)



SENSORTEHNOLOOGIAD MEDITSIINITEHNIKAS

NUTIKAS NEERUASENDUSRAVI JÄLGIMISE SENSORTEHNOLOOGIA

Ivo Fridolin, PhD
Tervisetehnoloogiate instituut
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https://taltech.ee/tervisetehnoloogiate-instituut
CTO Optofluid Technologies OÜ

NEERUASENDUSRAVI FAKTIDES

Dialysis is associated with...

Low Quality of Life

Health-related Quality of Life for dialysis patients is

⬇ 27% – 49%

worse than for the general population

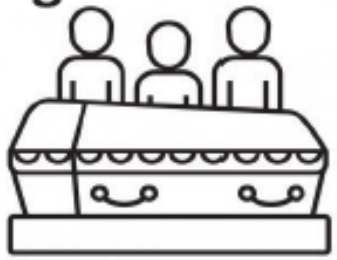
High Cost to Society

Dialysis is resource-heavy, costing up to

€80,000 or $89,000

per patient per year, depending on the country and dialysis method

High Mortality



Annual death risk of dialysis patients is

10 – 100x

higher than in general population

5-year survival on dialysis is

lower

than for most cancer treatments

2/3

of patients die without KRT access

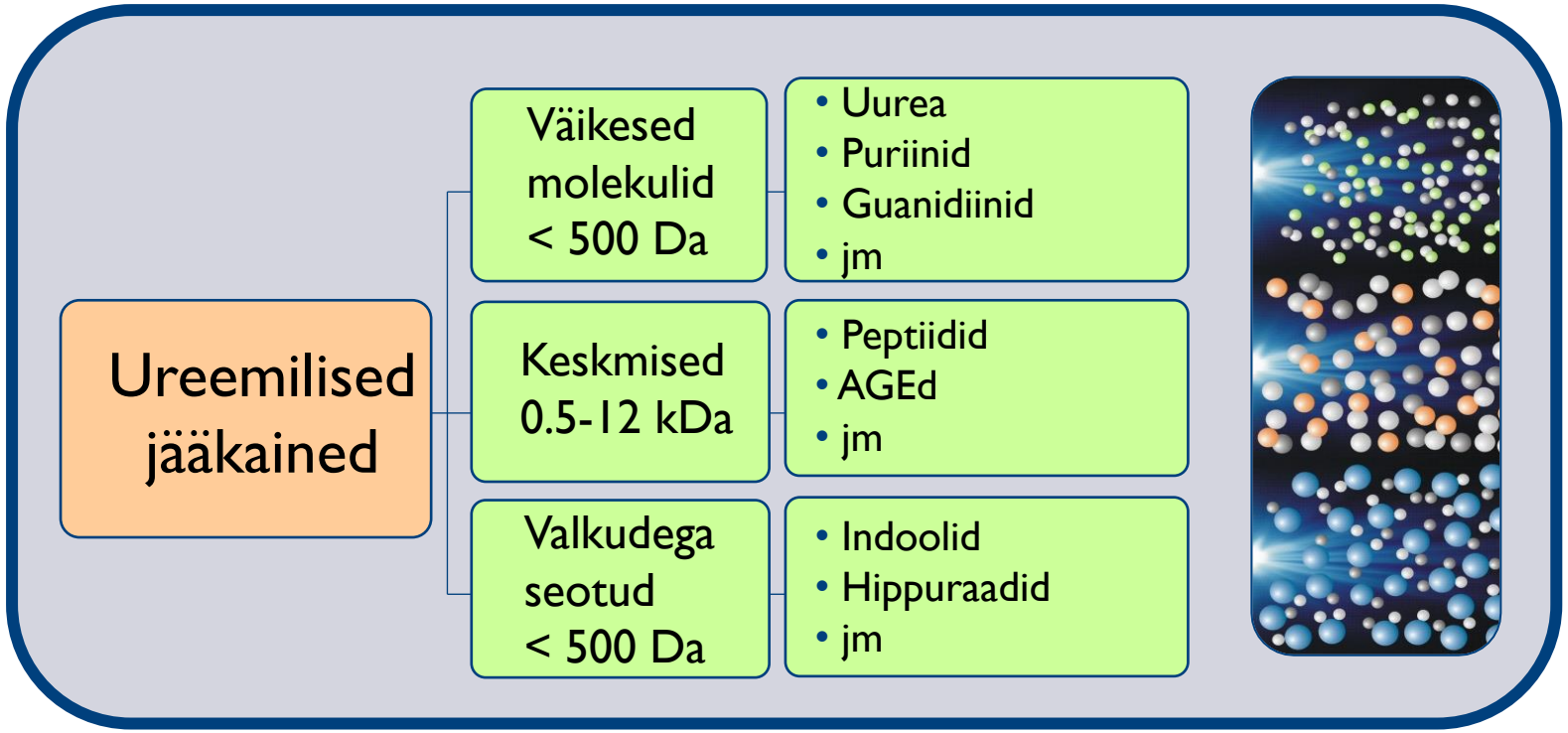
EKHA
EUROPEAN KIDNEY HEALTH ALLIANCE

TAL TECH

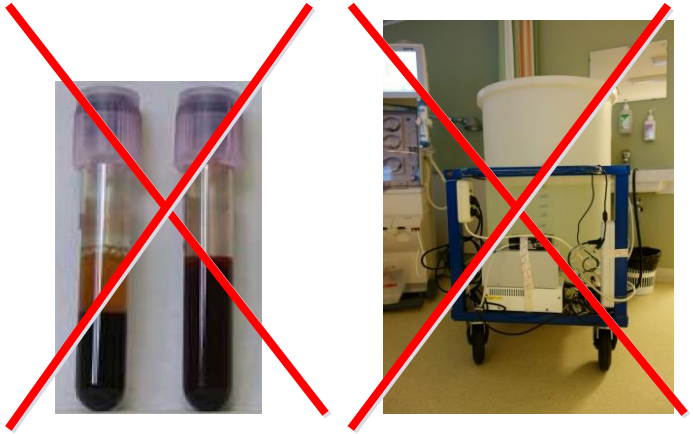
- Vajadus kvaliteetse ja kuluefektiivse neeruasendusravi järele

KAS OLEKS VÕIMALIK **NÄHA** AINEVAHETUSE JÄÄKAINETE EHK UREEMILISTE JÄÄKAINETE EEMALDAMIST?

?



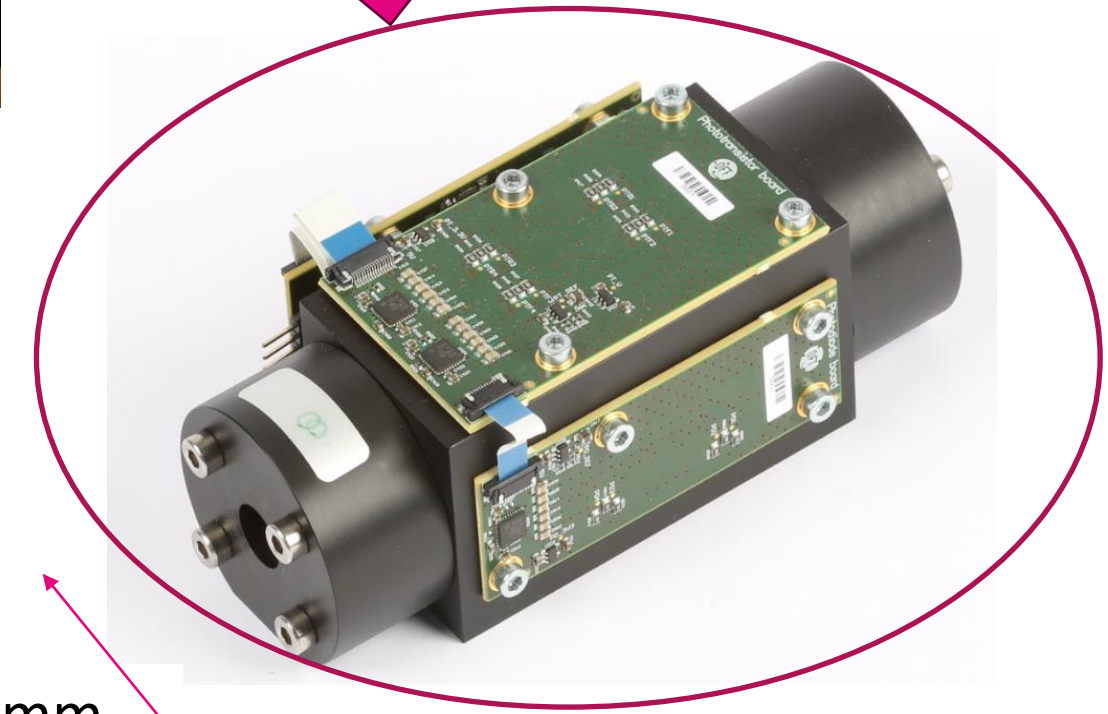
- Ilma vereproove võtmata
- Ilma keerukate mõõtemeetoditeta
- **Automaatselt, reaalajas**?



JAH, SEE ON VÕIMALIK,
AGA
ME VAJAME "SPEKTROFOTOMEETRILIST NÄGEMIST"

La Forge VISOR-ga
(*Star Trek Voyager*)

Optiline sensor
ureemiliste jääkainete eemaldamise
jälgimiseks neeruasendusravil reaalajas



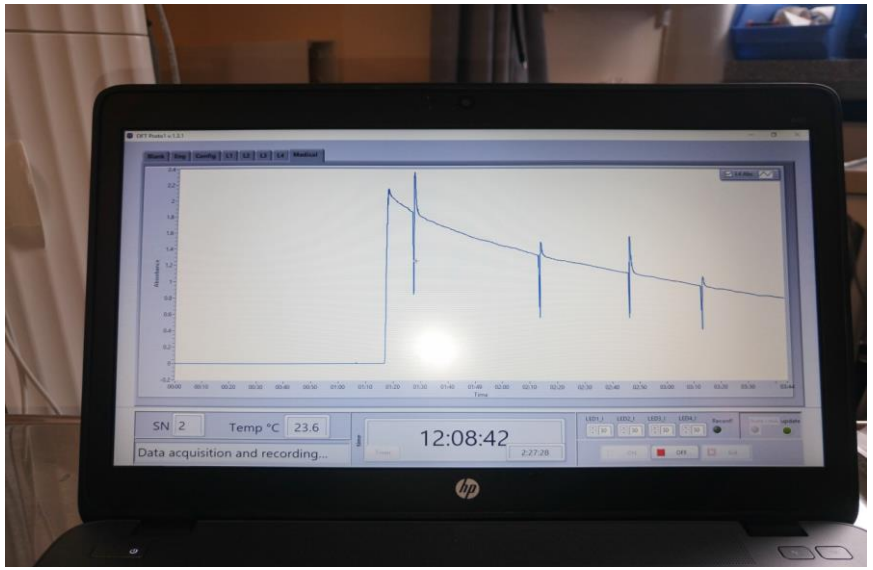
65 mm

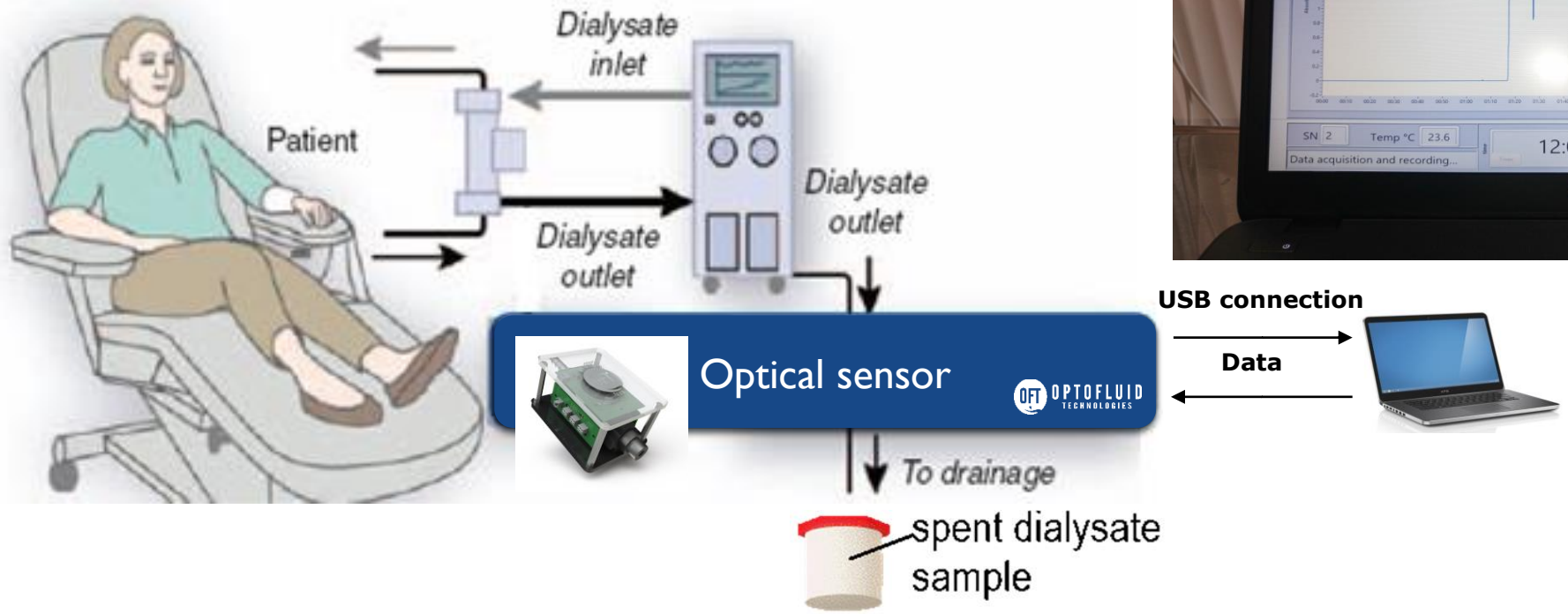
H2020 – SMEINST – 2 – 2017 OLDIAS2 - On-line Dialysis Sensor Phase2

TAL TECH

OPTOFLUID TECHNOLOGIES

NEERUASENDUSRAVI OPTILINE REAALAJAS JÄLGIMINE

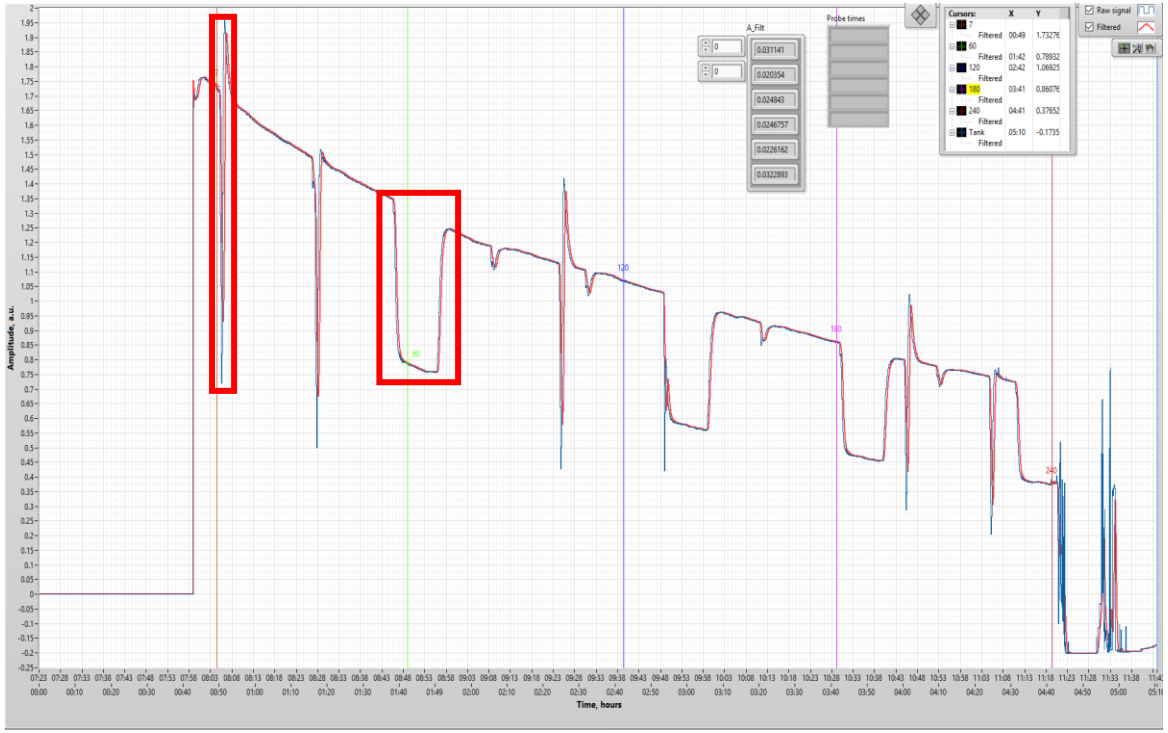




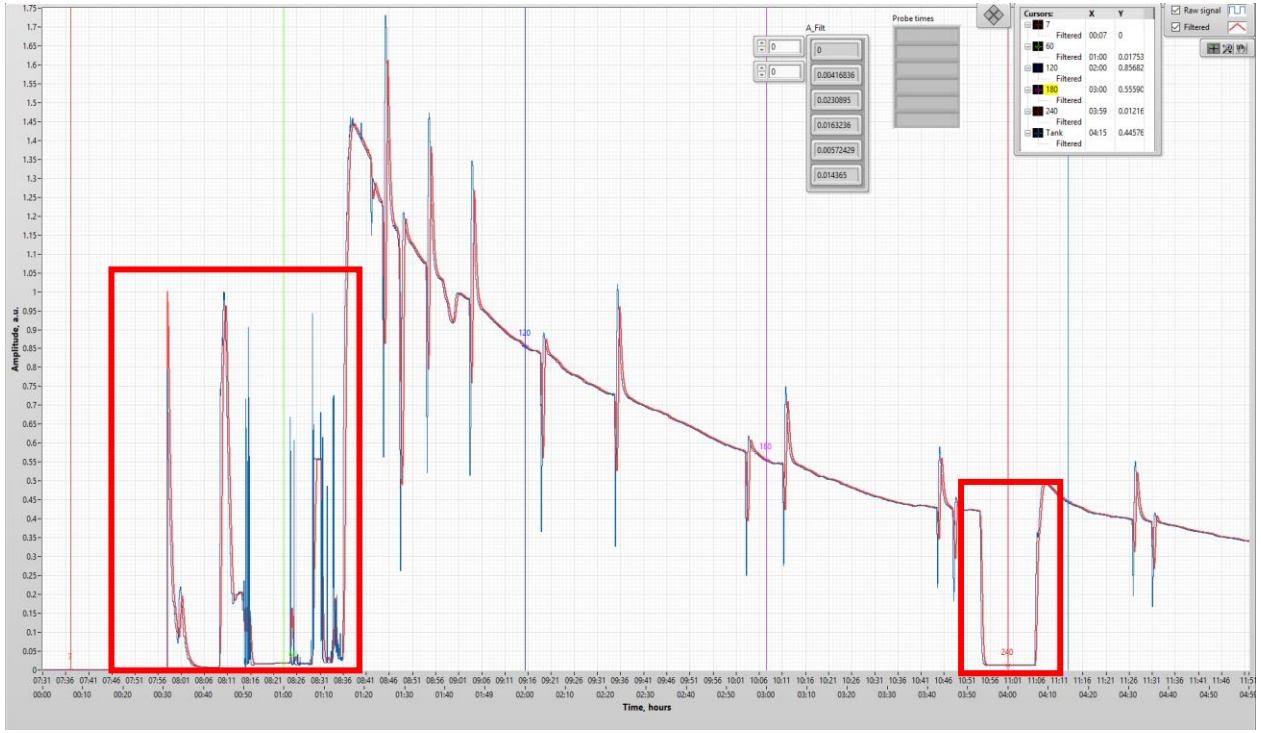
TAL TECH

OPTILINE DIALÜÜSRAVI REAALAJAS

Kunstneeruaparaadi enesetestid



Probleemne algus ja katkestus dialüüsravi ajal



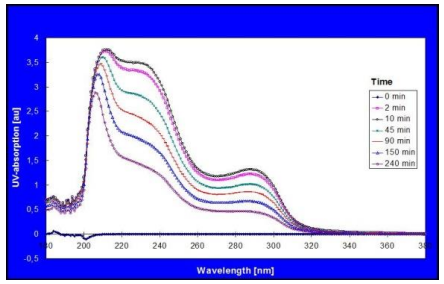
- Näide optilisest dialüüsravi jälgimisest erinevate HD-masina enesetestidega ning probleemse käivitamise ja katkestusega HD-seansi ajal

TAL TECH

OPTILINE SENSOR UREEMILISTE JÄÄKAINETE EEMALDAMISE REAALAJAS MONITOORINGUKS NEERUASENDUSRAVIL

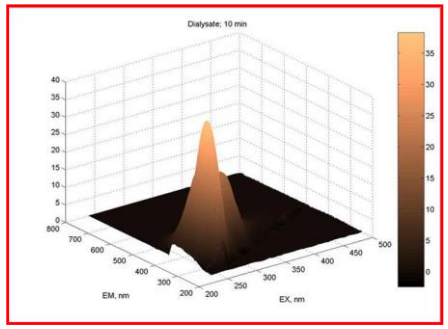
MULTICOMPONENT UREMIC TOXINS MONITOR MCM™

UV neelduvus



+

Fluorestsents



=

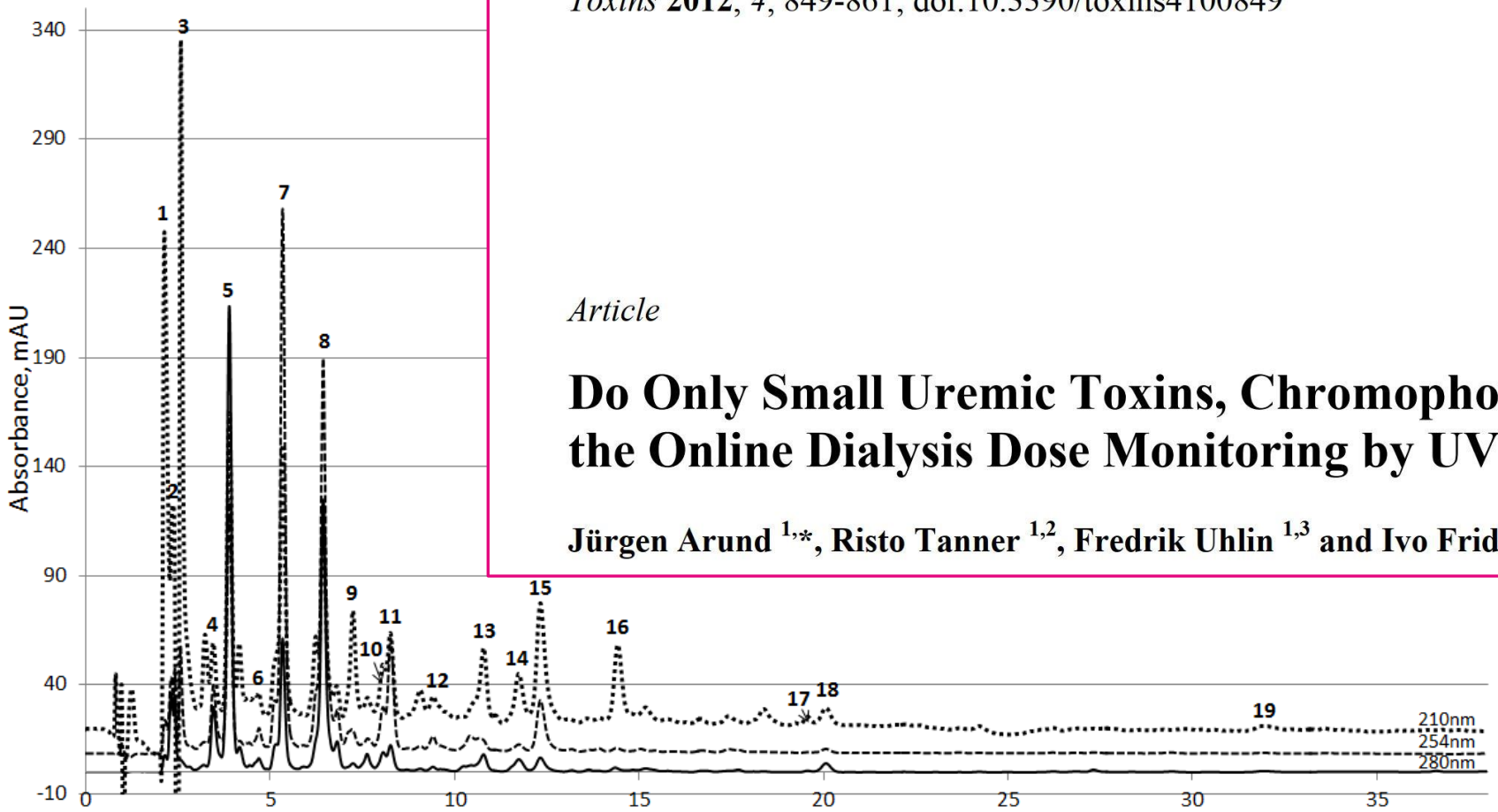
MCM™ sensor

OFT OPTOFLUID TECHNOLOGIES

MCM™ ühendab kaks optilist meetodit üheks uuenduslikuks mõõtmispõhimõtteks

TAL TECH

UREEMILISED JÄÄKAINED-KROMOFOORID HEITDIALÜSAADIS



Toxins **2012**, *4*, 849-861; doi:10.3390/toxins4100849

OPEN ACCESS

toxins

ISSN 2072-6651

www.mdpi.com/journal/toxins

Article

Do Only Small Uremic Toxins, Chromophores, Contribute to the Online Dialysis Dose Monitoring by UV Absorbance?

Jürgen Arund [1,*], Risto Tanner [1,2], Fredrik Uhlin [1,3] and Ivo Fridolin [1]

registered between 200 and 400 nm. Nearly 95% of UV absorbance originates from solutes with high removal ratio, such as uric acid. The contributions of different solute groups vary at different wavelengths and there are dynamical changes in contributions during the single

TAL TECH

› **UV-Absorbance (UVA) measures mainly small uremic toxins** *(Arund et al. 2012)*

UREEMILISED JÄÄKAINED-FLUOROFOORID HEITDIALÜSAADIS

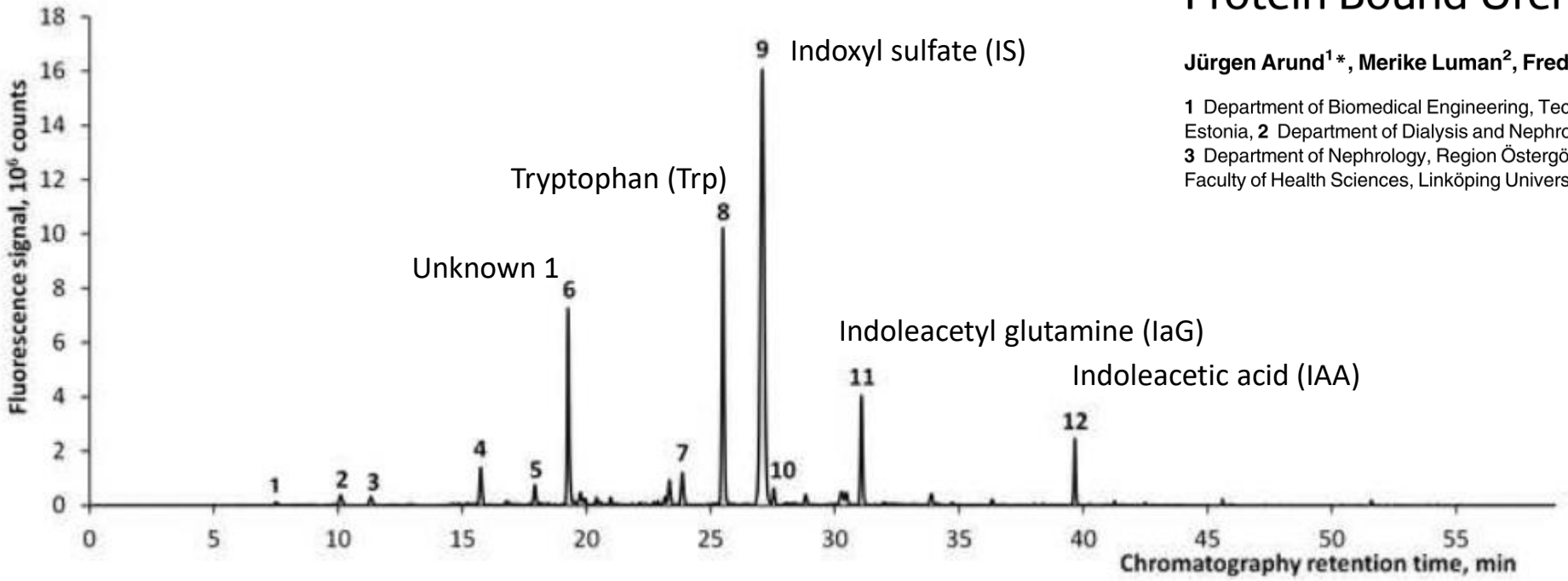
PLOS ONE

RESEARCH ARTICLE

Is Fluorescence Valid to Monitor Removal of Protein Bound Uremic Solutes in Dialysis?

Jürgen Arund[1]*, Merike Luman[2], Fredrik Uhlin[1,3], Risto Tanner[1], Ivo Fridolin[1]

1 Department of Biomedical Engineering, Technomedicum, Tallinn University of Technology, Tallinn, Estonia, **2** Department of Dialysis and Nephrology, North Estonia Medical Centre, Tallinn, Estonia, **3** Department of Nephrology, Region Östergötland, and Department of Medical and Health Sciences, Faculty of Health Sciences, Linköping University, Linköping, Sweden



TAL TECH

› **Fluorescence (Ex: 280 nm and Em: 360 nm) measures fluorophores which are mainly protein bound uremic toxins** *(Arund et al. 2016)*

VEREPROOVIDETA UREEMILISTE TOKSIINIDE SISALDUSE HINDAMINE NEERUASENDUSRAVI PATSIENTIDE VERES

Clinical Kidney Journal, 2023, vol. 0, no. 0, 1–10

https://doi.org/10.1093/ckj/sfac273
Advance Access Publication Date: 20 December 2022
Original Article

TAL TECH

ORIGINAL ARTICLE

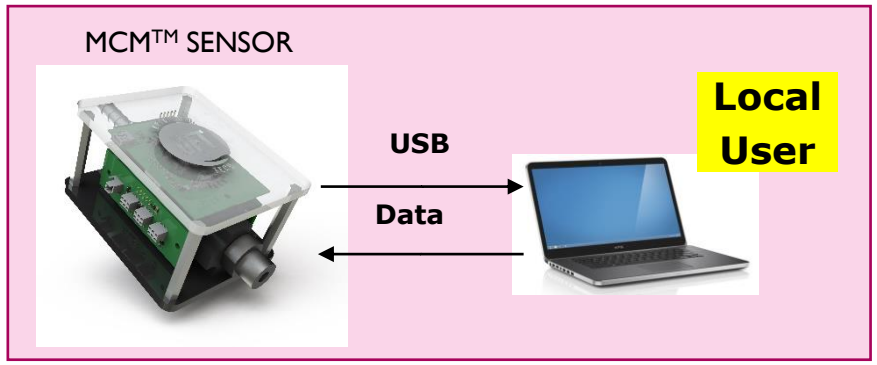
Time-averaged concentration estimation of uraemic toxins with different removal kinetics: a novel approach based on intradialytic spent dialysate measurements

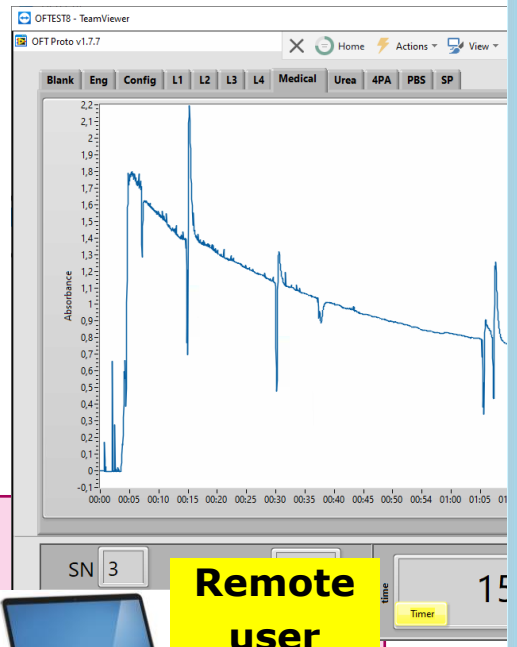
Joosep Paats [1], Annika Adoberg [2], Jürgen Arund [1], Annemieke Dhondt [3], Anders Fernström [4], Ivo Fridolin [1], Griet Glorieux [3], Emilio Gonzalez-Parra [5], Jana Holmar [1], Liisi Leis [2], Merike Luman [1,2], Vanessa Maria Perez-Gomez [5], Kristjan Pilt [1], Didier Sanchez-Ospina [5], Mårten Segelmark [4], Fredrik Uhlin [1,4] and Alberto Ortiz [5]

[1]Department of Health Technologies, Tallinn University of Technology, Tallinn, Estonia, [2]Centre of Nephrology, North Estonia Medical Centre, Tallinn, Estonia, [3]Nephrology Division, Ghent University Hospital, Ghent, Belgium, [4]Department of Nephrology and Department of Health, Medicine and Caring Sciences, Linköping University, Linköping, Sweden and [5]Fundación Jiménez Díaz University Hospital Health Research Institute, Madrid, Spain

Correspondence to: Joosep Paats; E-mail: joosep.paats@taltech.ee

NUTIKAS OPTILINE SENSOR: TELEMEETRIA NEERUASENDUSRAVIS

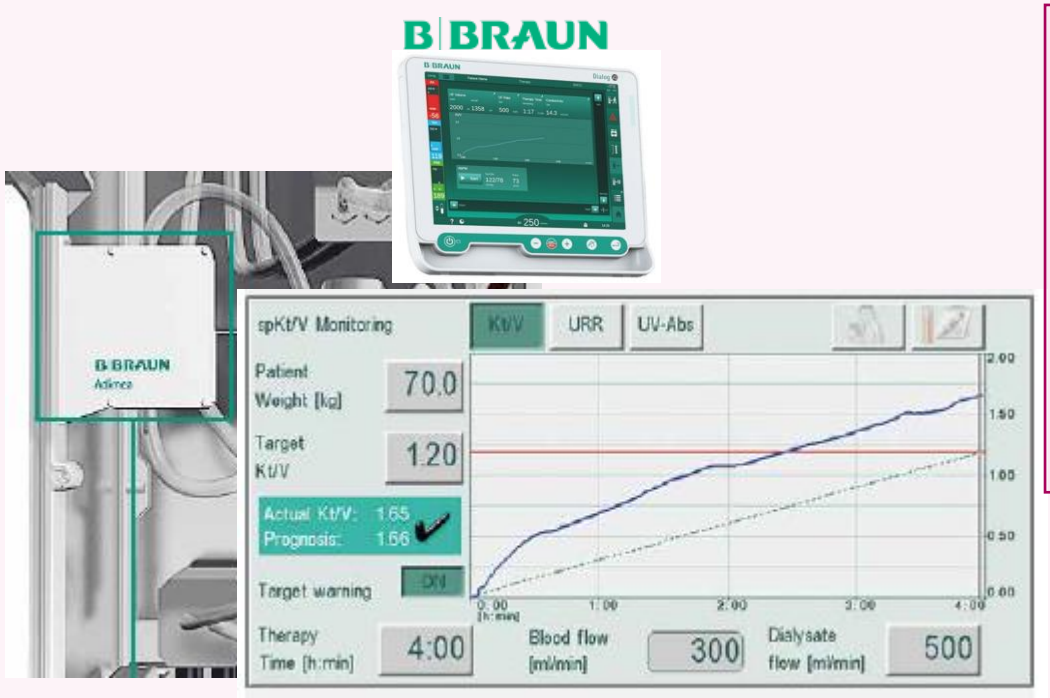




- Telemeetriarakendus võimaldab jälgida neeruasendusravi reaalajas distantsilt
- Regulaarselt koguda "suurandmeid (*big data*)" dialüüsravi kohta

TAL TECH

DIALÜÜSRAVI OPTILISE MONITOORINGU SENSORTEHNOLOOGIA TEHNOSIIRE



- Absorbance DIalysis MEAsurement (ADIMEA), BBraun Avitum

NIKKISO

Dialysis Dose Monitor

- Dialysis Dose Monitor (DDM), Nikkiso

AGA tegelikult …

TAL TECH

I põlvkonna sensorid (ADIMEA, DDM) väikeste ureemiliste toksiinide monitooringuks:

- Hindavad dialüüsi doosi parameetreid Kt/V ja URR (*Urea Reduction Ratio*)

II põlvkonna multikomponentsensor – *in progress …*

KIDNEW

Breakthrough technologies for an implantable artificial kidney

Consortium

- University Medical Centre Utrecht (NL)
- Utrecht University (NL)
- Imec Eindhoven (NL)
- Imec Leuven (BE)
- The Laboratory for Interdisciplinary Physics (LIPhy, CNRS)
- Optofluid Technologies OÜ (OFT)
- ME-SEP (PL)

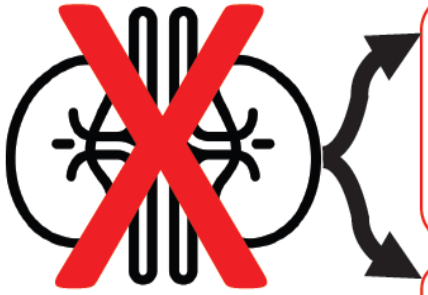
https://www.kidnew.eu/

Funded by the European Union

The project has received founding from the European Innovation Council and SMEs Executive Agency HORIZON-EIC-2022-PATHFINDEROPEN-01 Program under the Grant Agreement N°101099092

European Innovation Council

Kidney Failure: Present therapies are inadequate!



Kidney Failure
(**E**nd **S**tage **K**idney **D**isease) means:
Without **K**idney **R**eplacement **T**herapy
You Die!

Transplantation

Best & cheapest available KRT option, **but:**

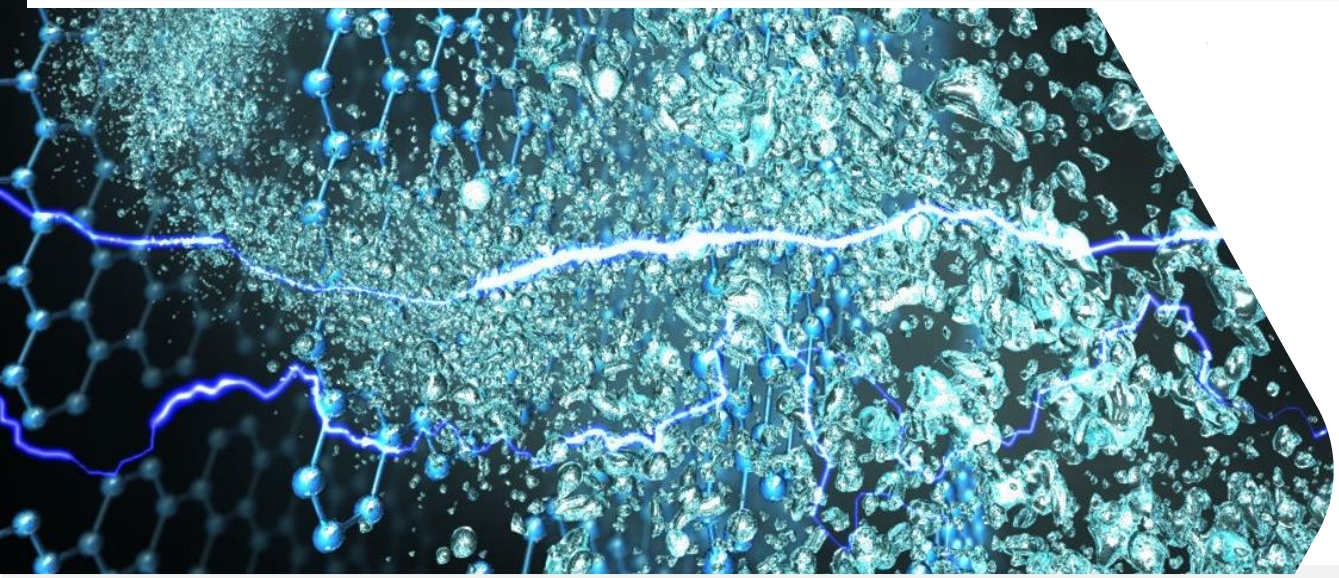
- Structural Shortage of Transplant Kidneys
  many Patients Die, while still on th
- Immune suppression drugs preven
  but also increase Risk of Cancer &
- Still up to 25% shorter remaining L

Dialysis

Most widely used available KRT optior

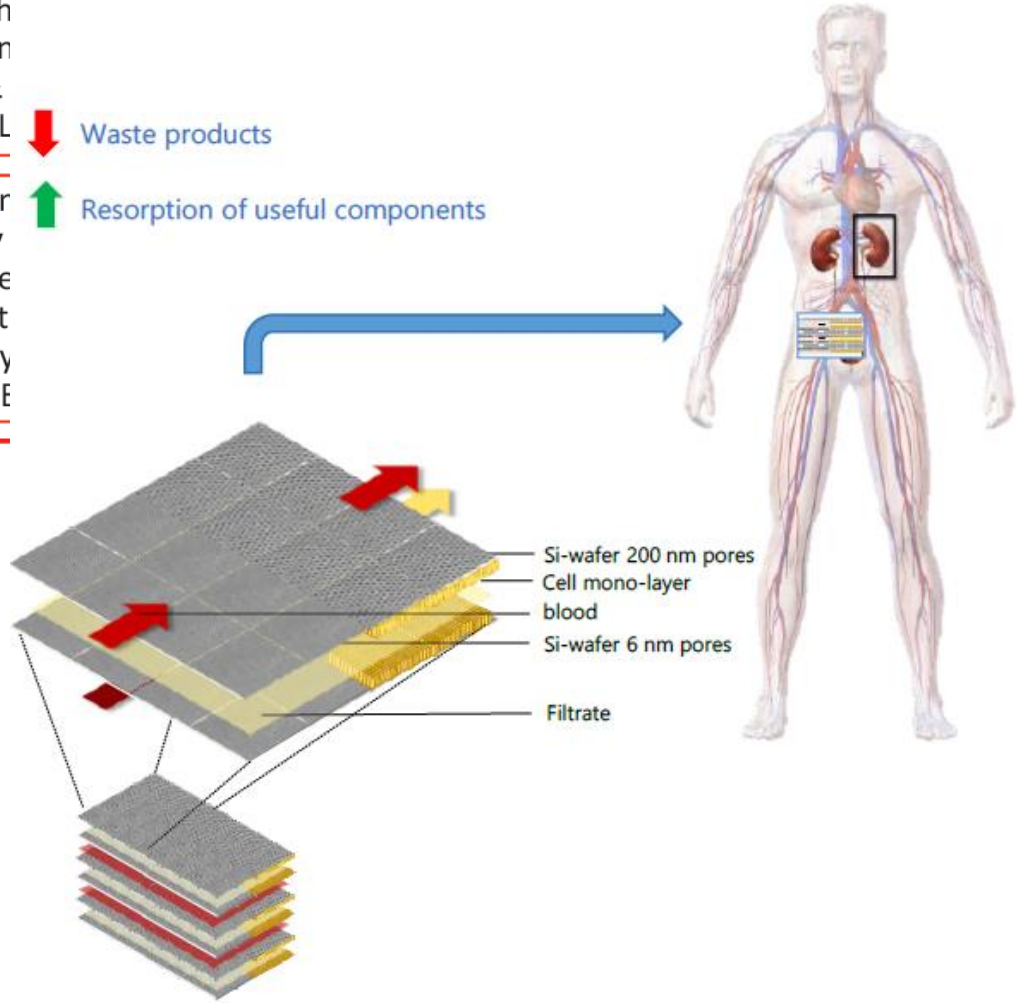
- Substitutes max 10-15% of kidney
- Does not substitute all other kidne
- Significantly lower Quality of Life t
- More Expensive & Resource-heavy
- Up to 70% shorter remaining Life E

KIDNEW



Waste products

Resorption of useful components



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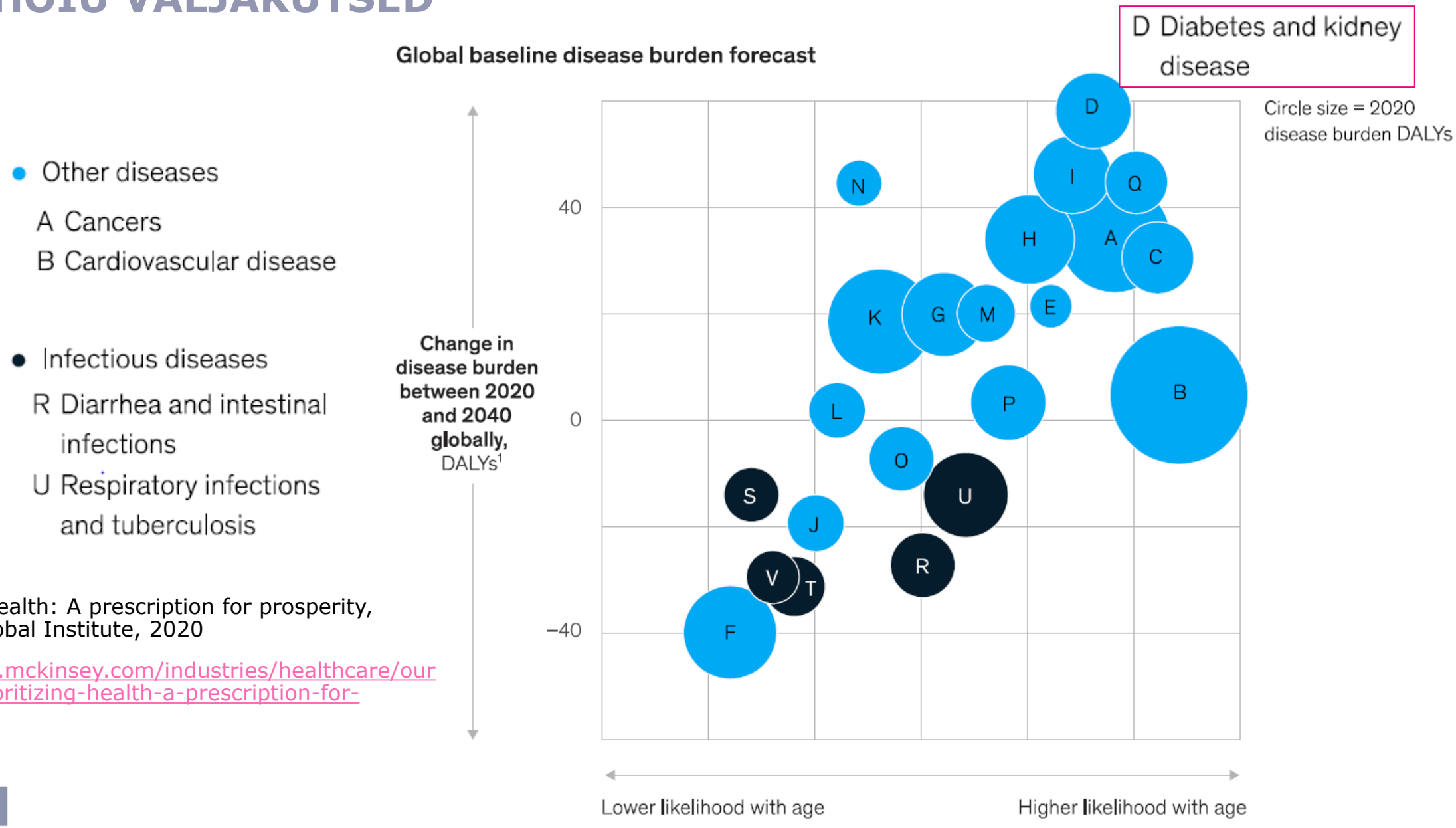
The project has received founding from the European Innovation Council and SMEs Executive Agency HORIZON-EIC-2022-PATHFINDEROPEN-01 Program under the Grant Agreement N°101099092

European Innovation Council

TERVISHOIU VÄLJAKUTSED

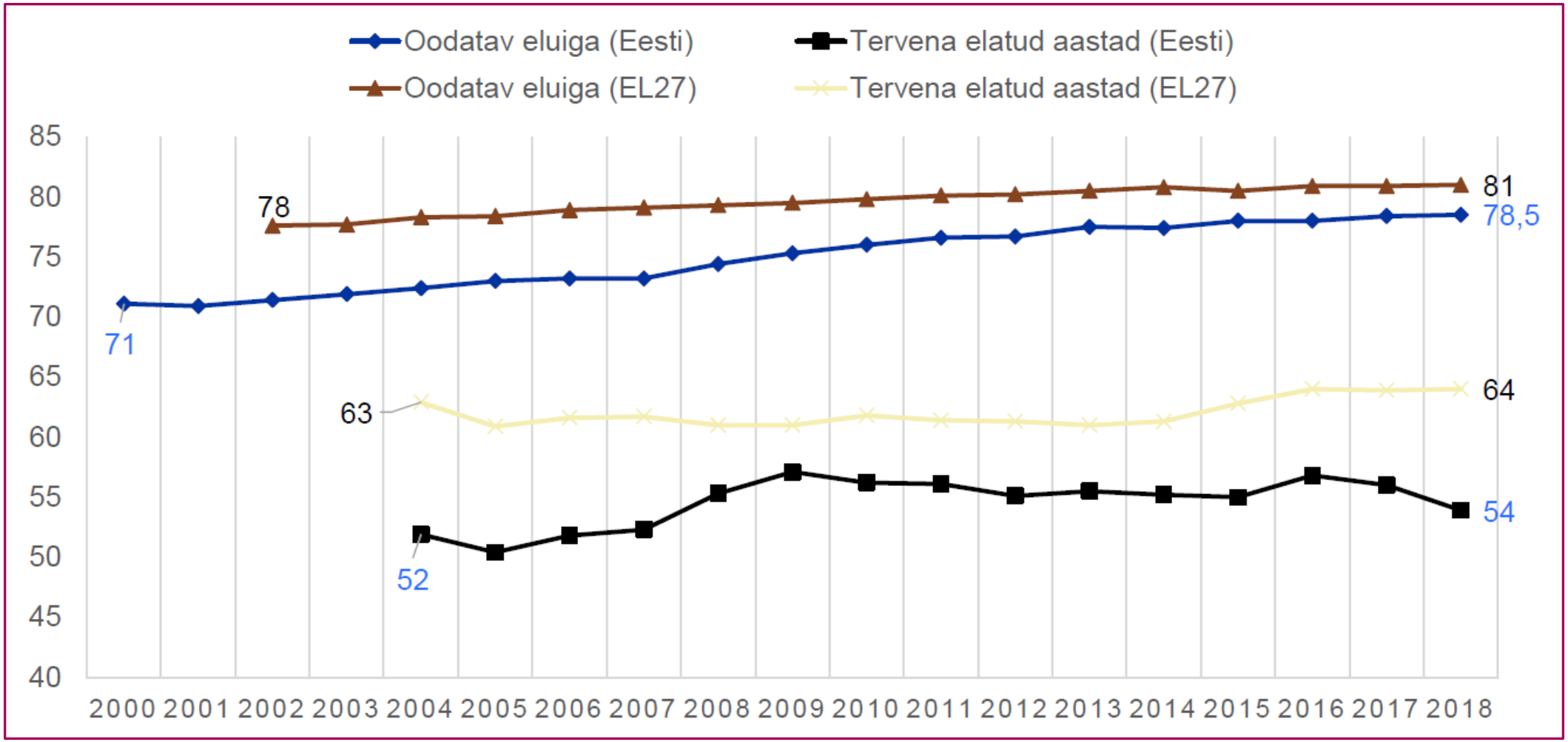


Prioritizing health: A prescription for prosperity, McKinsey Global Institute, 2020

https://www.mckinsey.com/industries/healthcare/our-insights/prioritizing-health-a-prescription-for-prosperity

TAL TECH

TERVISHOIU VÄLJAKUTSED: TERVENA ELATUD AASTAD



Magnus Piirits, Arenguseire Keskus, 2020

TAL TECH

Kuidas mõõta objektiivselt linnaelanike heaolu?

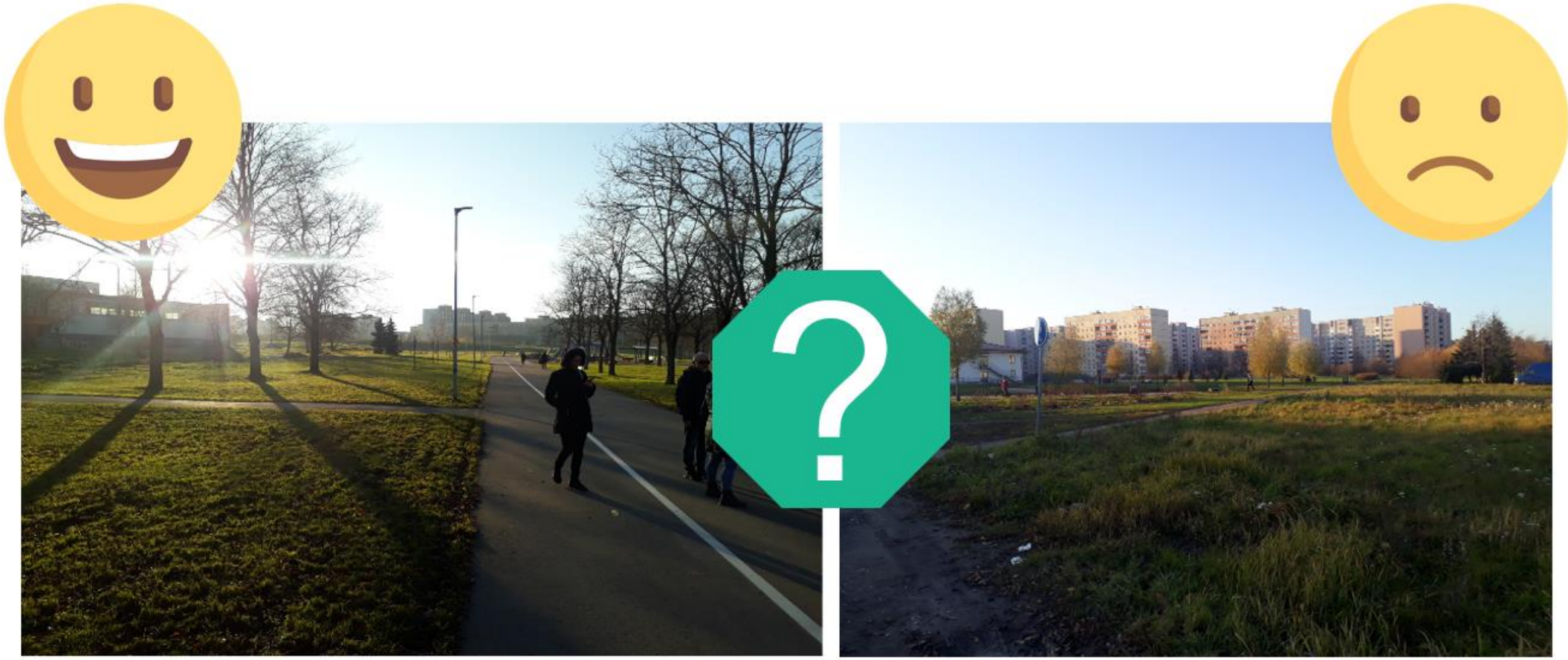
FinEst Centre
for Smart Cities

NARVA

Funded by
the European Union

FinEst Twins project is funded by two grants: the European Union´s Horizon 2020 Research and Innovation Programme, under the grant agreement No. 856602,
and the European Regional Development Fund, co-funded by the Estonian Ministry of Education and Research, under grant agreement No 2014-2020.4.01.20-0289.

Kuidas tajuvad linnaelanikud linnaruumi füsioloogiliselt?



Kas see võib olla seotud (linna)ruumi omadustega?

Funded by the European Union

Mõõtekohad-elamukvartalid Narvas

Kivilinna/Daumani

Kangelaste/Pähklimäe

Soldina/Tiimani

Kevade/Kalevi

Võidu/Gerassimovi

Uusküla

NARVA

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the European Union

Salvestatud signaalid

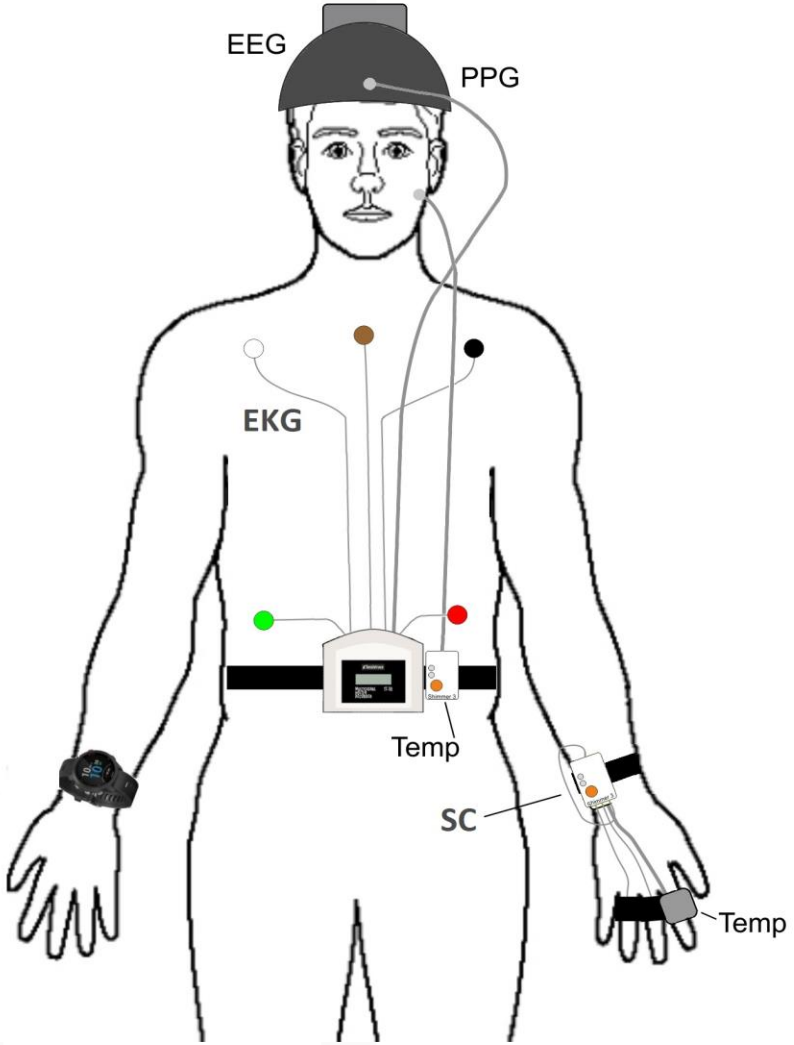
EEG – elektroentsefalogramm, peaaju elektriline aktiivsus

PPG – fotopletüsmogramm, veresoonte optilised omadused

EKG – elektrokardiogramm, südame elektriline aktiivsus

SC - naha juhtivus

Temp – naha temperatuur



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Füsioloogiline heaolu skoor

- WBS_{Brain} - **Ajusignaalide** põhjal hinnatud **füsioloogiline heaolu skoor**
- WBS_{Cardio} - **Südame-veresoonkonna** põhjal hinnatud **füsioloogiline heaolu skoor**
- WBS_{Ph} - **Integreeritud füsioloogiline heaolu skoor**

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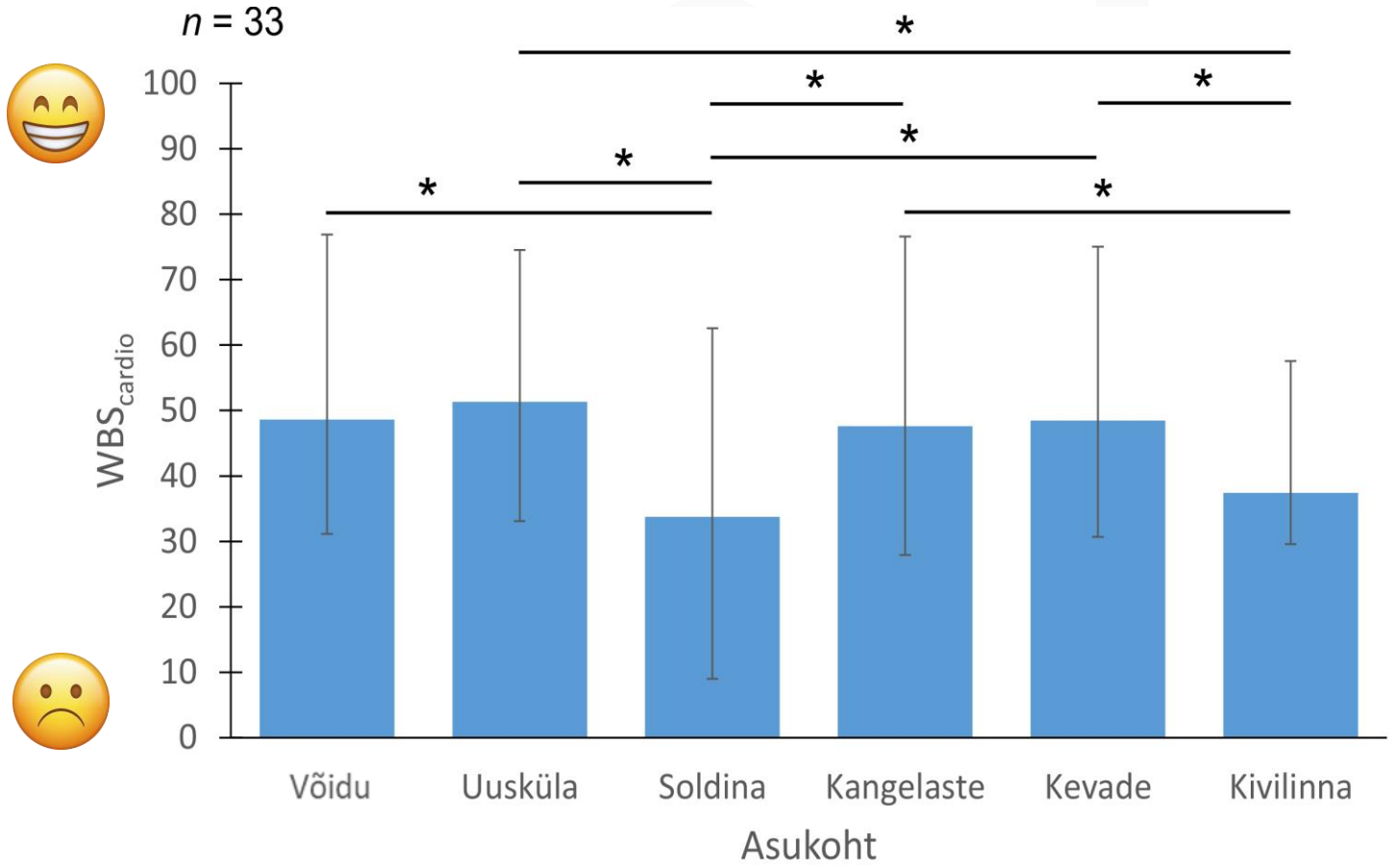
Füsioloogiliste mõõtmiste tulemused: südame-veresoonkonna signaalidega hinnatud heaolu



Mida kõrgem tulemus, seda madalam stressi tase.

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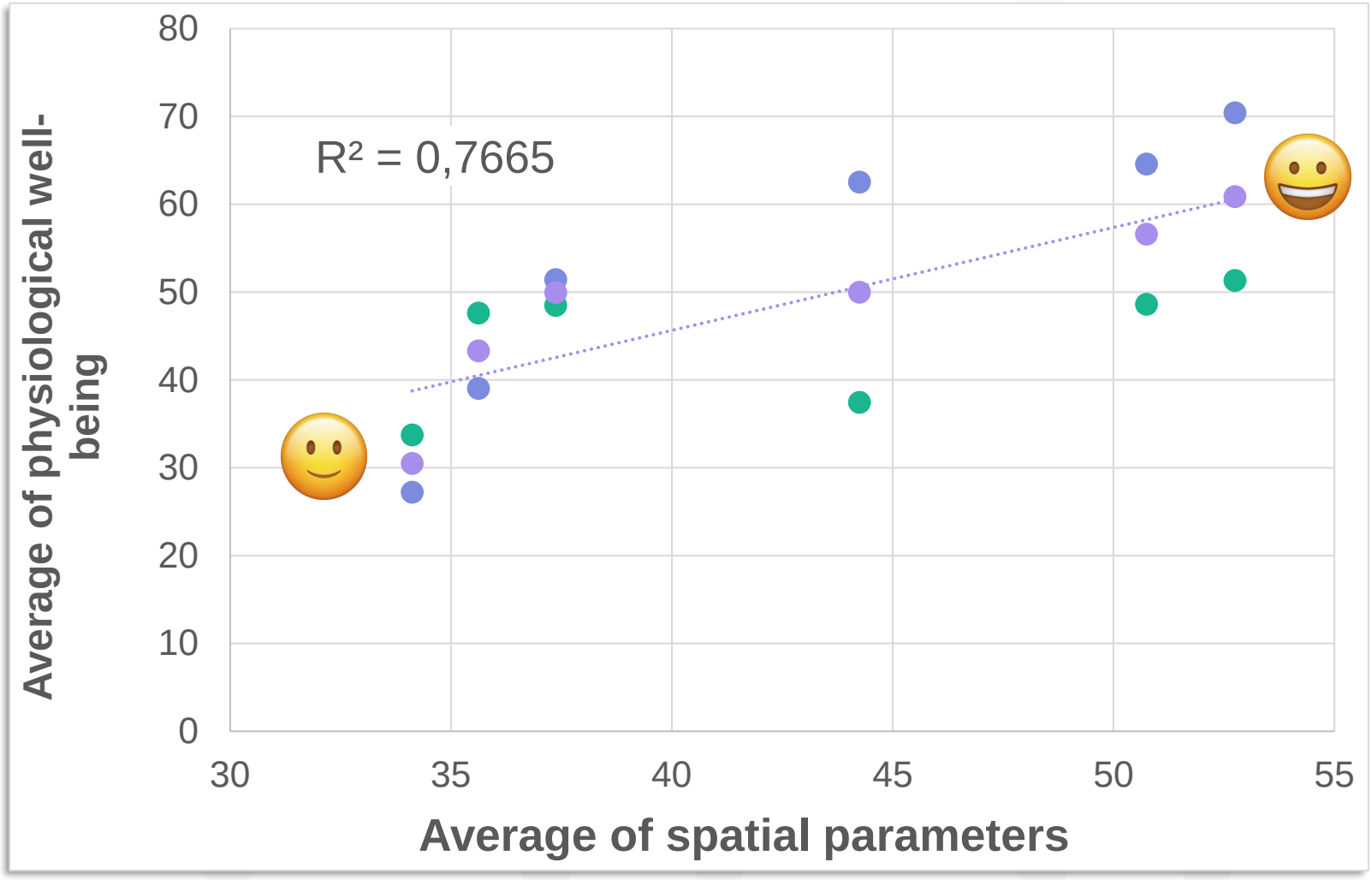
Tugevad seosed



Tugev korrelatsioon füsioloogiliste ja ruumiliste näitajate vahel

Funded by the European Union

Linnaplaneerimise heaolu skoor

- Esmakordne omataoline katse füsioloogilise heaolu skoori hindamiseks linnaruumis multiparameetriliste füsioloogiliste mõõtmiste põhjal linnaelanikel
- Pakub võimaluse integreerida heaoluskoori meetod 3D-tehnoloogia ja virtuaalreaalsusega
- **Meetod terviseteadlikkuse võimestamiseks?**

NARVA

Funded by the European Union

















FinEst Centre
for Smart Cities

NARVA

Ardo Allik, Maie Bachmann, Damiano Cerrone, Fabian Dembski, Kaie Enno, Ivo Fridolin, Marietta Gavriljuk, Kristi Grišakov, Jackline Holter, Priit Ingver, Deniss Karai, Kaja Mädamürk, Kristjan Pilt, Viktorija Prilenskaja, Silver Sternfeldt, Peeter Tambu, Külle Tärnov

Kontakt

Ivo Fridolin, ivo.fridolin@taltech.ee

Külle Tärnov, kulle.tarnov@taltech.ee

Funded by the European Union

MEDITSIINI(TEHNIKA) TULEVIK - TEHISINTELLEKT?

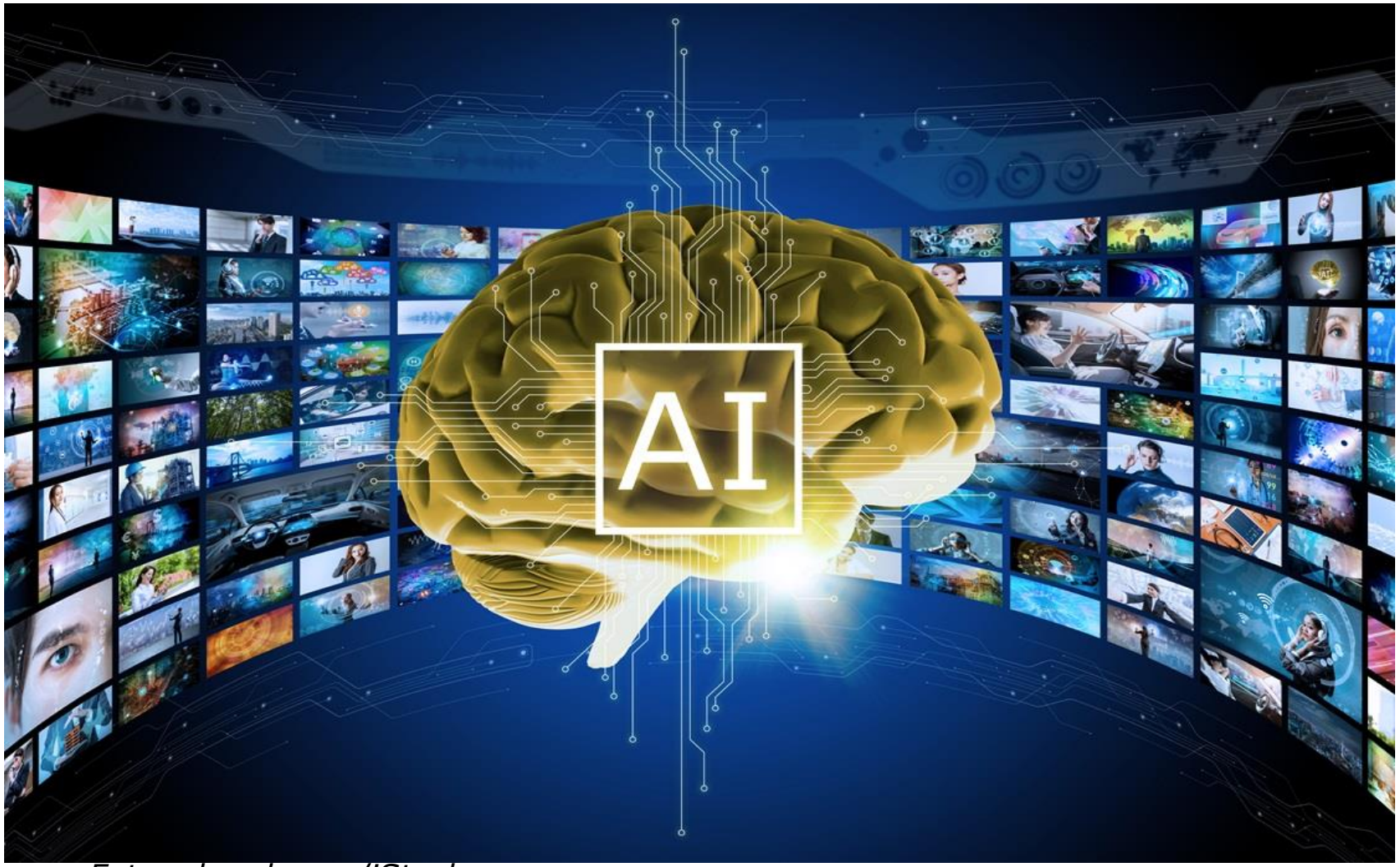
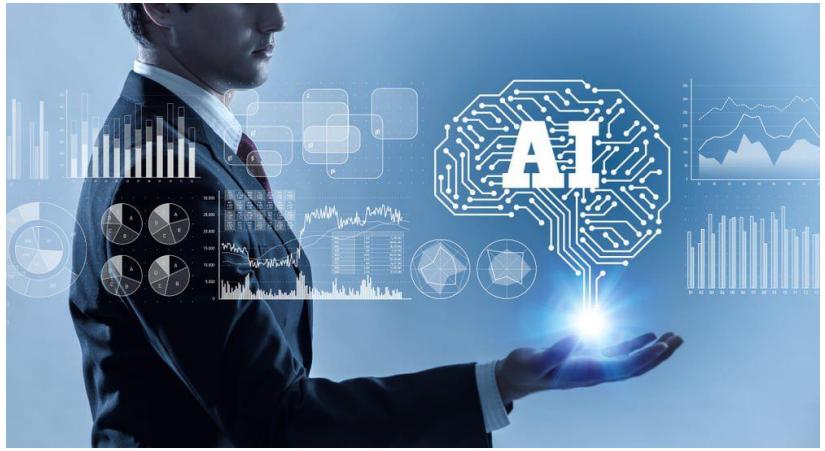


Foto: chombosan/iStock

TEHISINTELLEKT: *UNBIGGEN AI*

Unbiggen AI on tehisintellektil põhinev tehnoloogia, mis on loodud selleks, et aidata organisatsioonidel hallata ja analüüsida suuri andmehulki tõhusalt ja kulutõhusalt. See saavutatakse andmete kompressioonialgoritmide ja masinõppetehnikate abil, et vähendada andmete hulka nende kvaliteeti ohverdamata.

Allikas (ENG): https://datasciencedojo.com/blog/unbiggen-ai-solutions/#

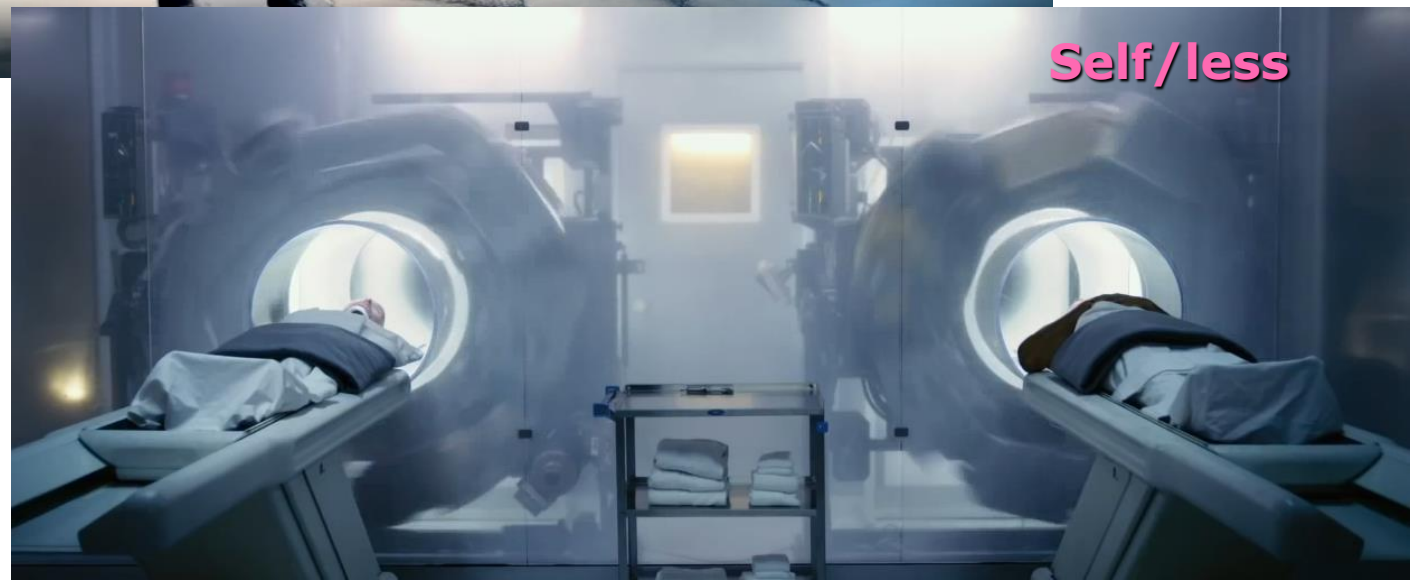


https://emeritus.org/in/learn/role-of-artificial-intelligence-in-the-industry/

"In many industries where giant data sets simply don't exist, I think the focus has to shift from big data to good data. Having 50 thoughtfully engineered examples can be sufficient to explain to the neural network what you want it to learn."
—Andrew Ng, CEO & Founder, Landing AI

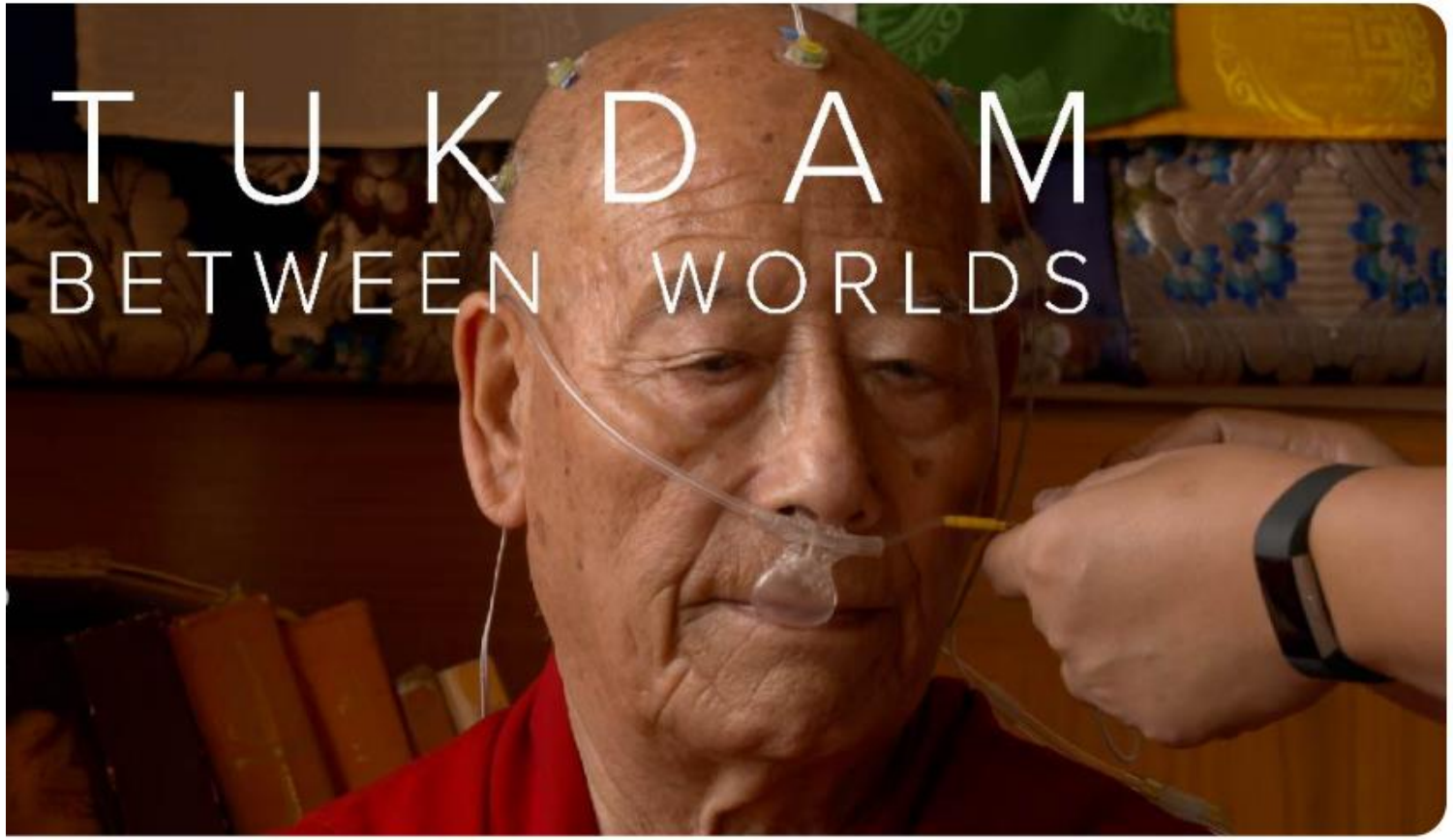
https://spectrum.ieee.org/andrew-ng-data-centric-ai

TERVISETEHNOLOOGIATE ÕPE JA NÄHTAVUSE SUURENDAMINE



https://www.youtube.com/watch?v=cyL9gKSc8G4, https://www.youtube.com/watch?v=3agaVwt0tb8

ELUST JA SURMAST – TEADUSPÕHISELT



Dokumentaalfilm“ Tukdam: Between Worlds“(„Tukdam: maailmade vahel“)
https://www.imdb.com/title/tt21945758/

- «Ma ei usu enam, et teadvus kaob kliinilise surmaga»

režissöör Donagh Coleman

https://www.waisman.wisc.edu/staff/davidson-richard/

TAL TECH

KOOSTÖÖ TEADUSTE AKADEEMIAGA

- Eesti riigi ja ettevõtete uute tervisetehnoloogiate ja -teenuste alane teadmine
- Meditsiini- ja tervisetehnoloogia valdkonna õpe noortele
- Meditsiini- ja tervisetehnoloogia valdkonna nähtavuse suurendamine
- Terviseteadlikkuse ja -oskuste parendamine ühiskonnas
- Valdkondadeüleste koostöövõimaluste loomine
- Akadeemia töös osalemine n ekspertkomisjonide kaudu
- Elu ja surma mõtestamine – teaduspõhiselt, inimlikult

Health is the greatest wealth!

Ülemaks kui hõbevara,
kallimaks kui kullakoorem
tuleb ~~tarkust~~ tervist
tunnistada!

I. Fridolin