10-year jubilee of the European Research Council's ERC Starting and Advanced Grant program

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Tamed Cancer

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Research and Innovation Center of Óbuda University
Physiological Controls Research Center

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- Healthcare 4.0 (Personalized healthcare)
- Tamed cancer problem statement
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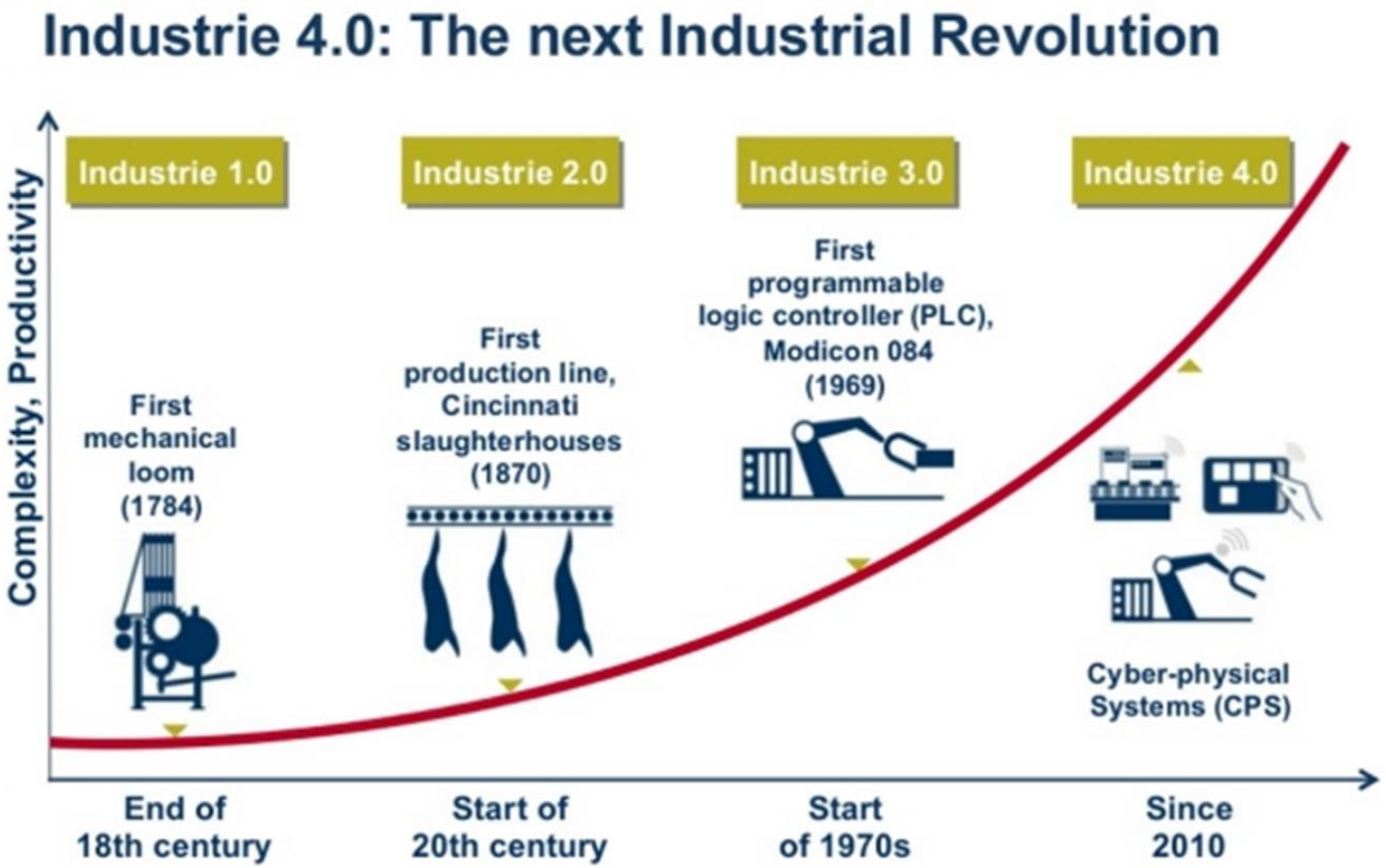
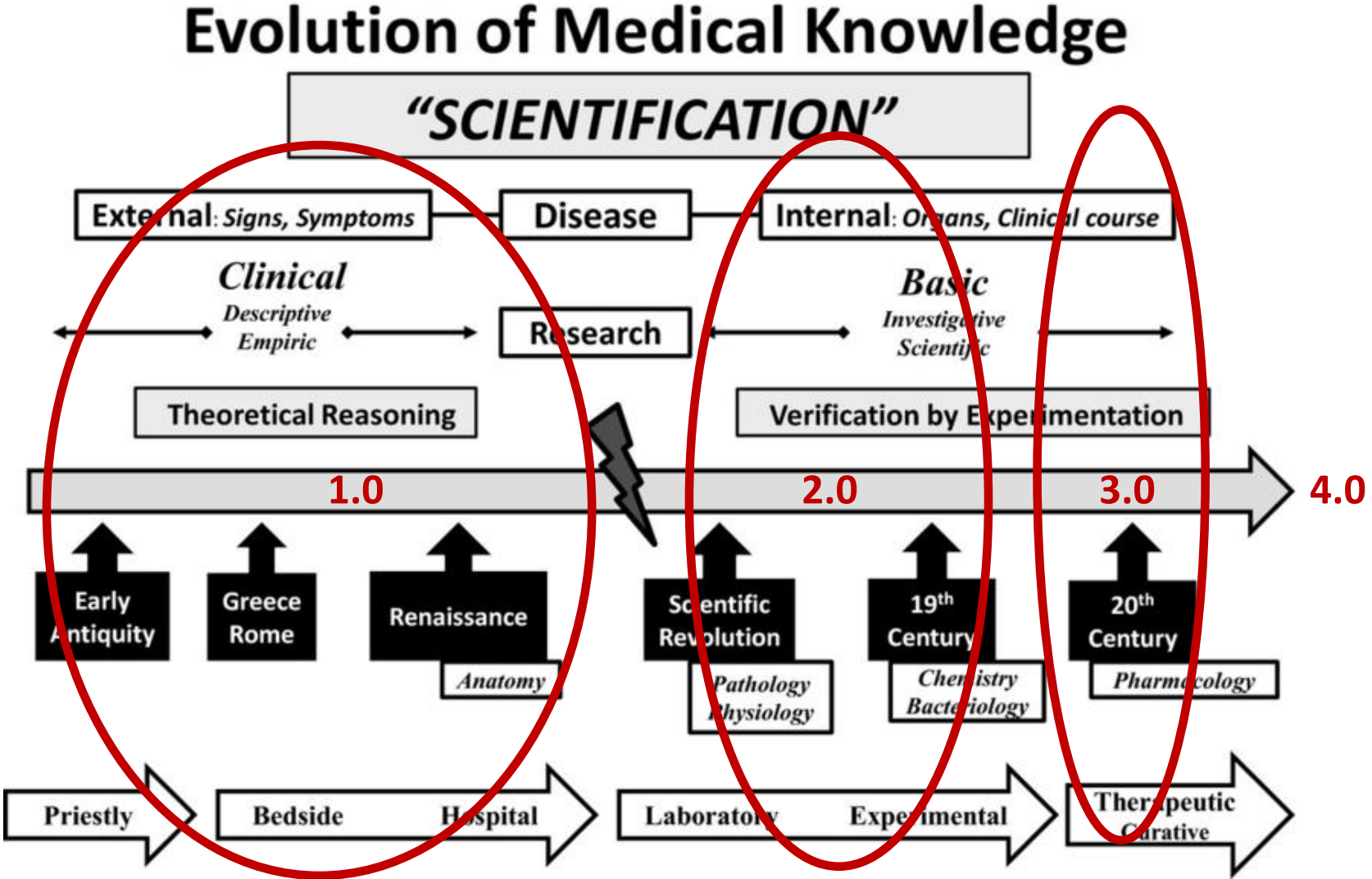
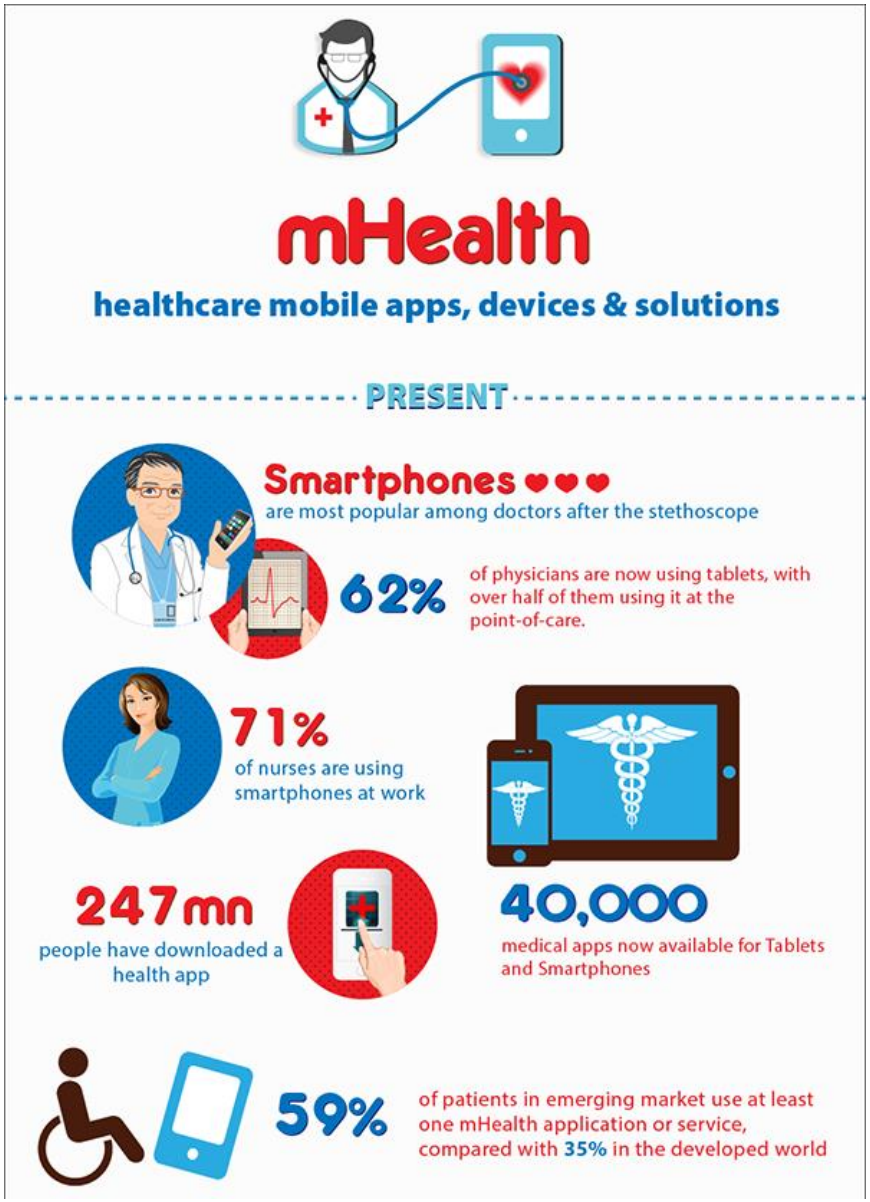
Industry 4.0

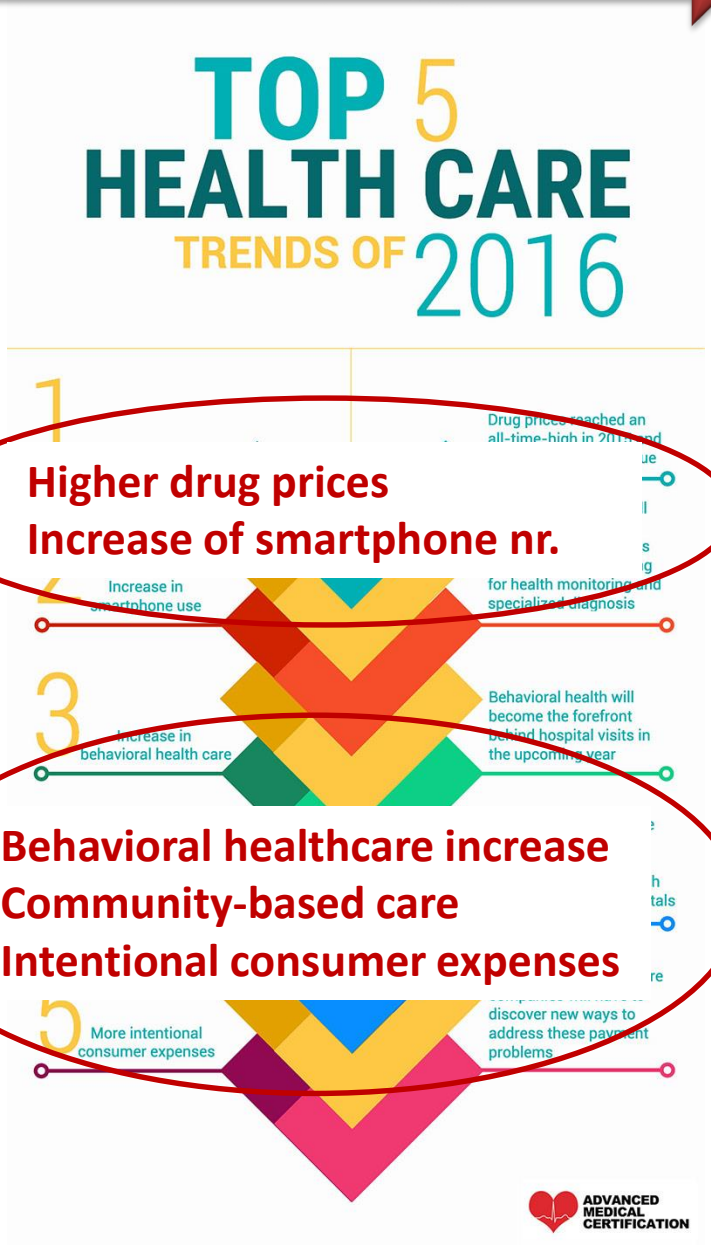

Industrie 4.0: The next Industrial Revolution
Complexity, Productivity
Industrie 1.0
Industrie 2.0
Industrie 3.0
Industrie 4.0
First mechanical loom (1784)
First production line, Cincinnati slaughterhouses (1870)
First programmable logic controller (PLC), Modicon 084 (1969)
Cyber-physical Systems (CPS)
End of 18th century
Start of 20th century
Start of 1970s
Since 2010

Evolution of healthcare



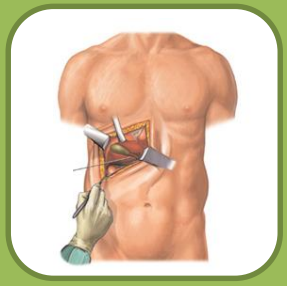
Intentional healthcare behavioral

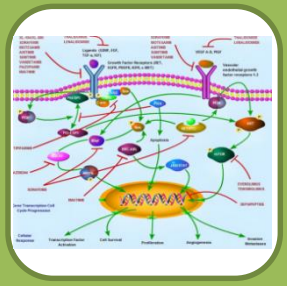




Personalized healthcare (model-based physiological control)

Medical knowledge



cancer treatments

general protocols

Healing of the patient

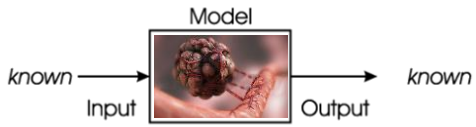
find more effective solutions in healing

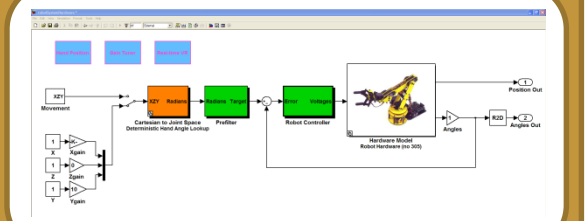
individual treatment for the patient

model identification

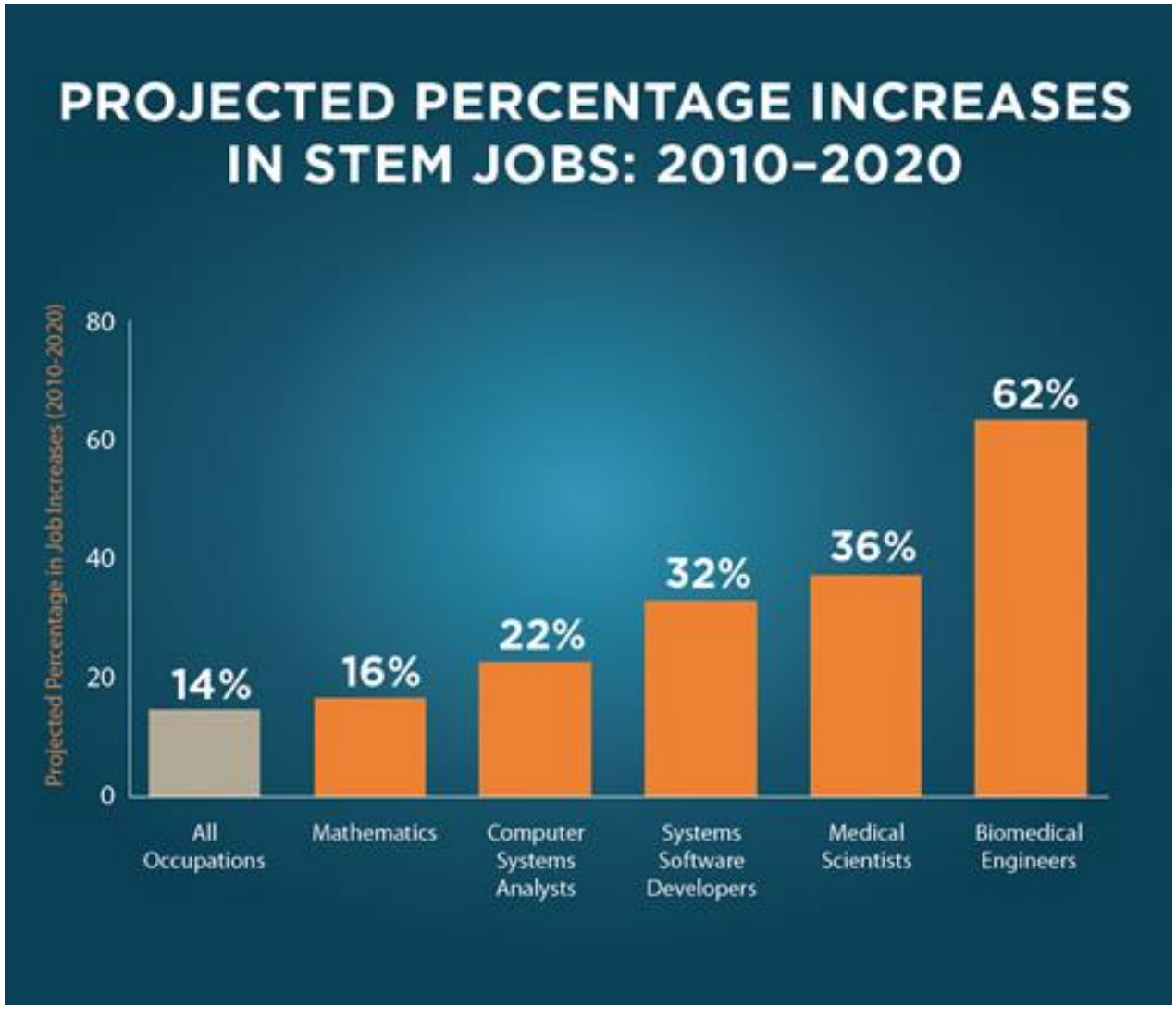
model-based protocols

Engineering knowledge





Biomedical Engineering



STEM = academic disciplines in
Science, **T**echnology, **E**ngineering, and **M**athematics

Research trends

Personalized Medicine
Smart Cyber-Medical Systems

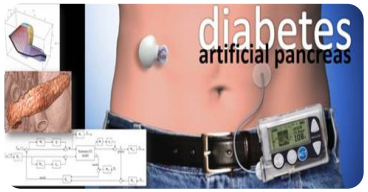
Personalized healthcare
Big-data
Cloud computations
m-Health
e-Health

Medical imaging
Safety critical systems

Evidence-based medicine
Physiological modeling and control
Automatic drug-delivery

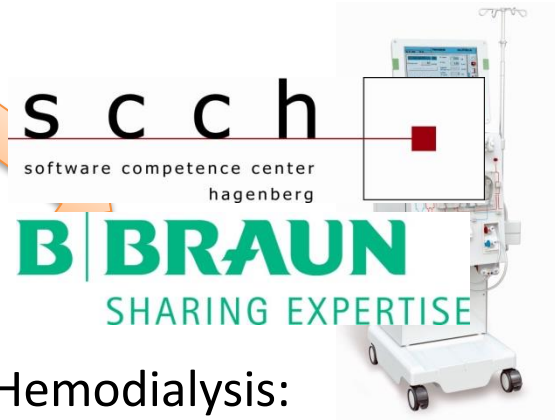
Physiological Controls Research Center

Diabetes:
Artificial pancreas



Cancer:
A TMT

Biostatistics:
Evidence based medicine



Hemodialysis:
Peristaltic pump control

Cancer statistics

- **EU 2016:** ≈ 1,3 million tumor-related deaths[1]
- **Hungary[2,3]:**
  - Leading in the EU!!
  - Listed 3rd in the World:
    - Listed 1st among men: 235.5/100000.

1 – M. Malvezzi et al. *Ann Oncol*, **00**: 1-7

2 – http://rex.nci.nih.gov/NCI_Pub_Interface/raterisk/rates38.html

3 – http://chartsbin.com/view/lhq.4

Mission

Optimal { **drug-delivery** **efficiency** } control algorithm

Model-based personalized treatment

Less harmful cancer therapy

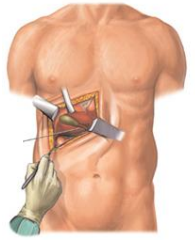
Increased life expectancy

Tamed cancer

Cancer treatments

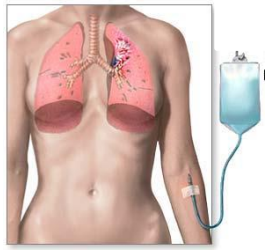
Surgical oncology

- the tumor cells can be totally removed (zero-order kinetics)
- tumor can be recurrent in many cases



Chemotherapy

- uses drugs to destroy cancer cells
- acts in general ways (by killing rapidly dividing cells)
- have many side effects
- tumor cells can become resistant to chemotherapy drugs

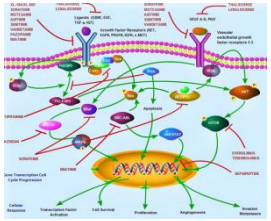


Radiotherapy

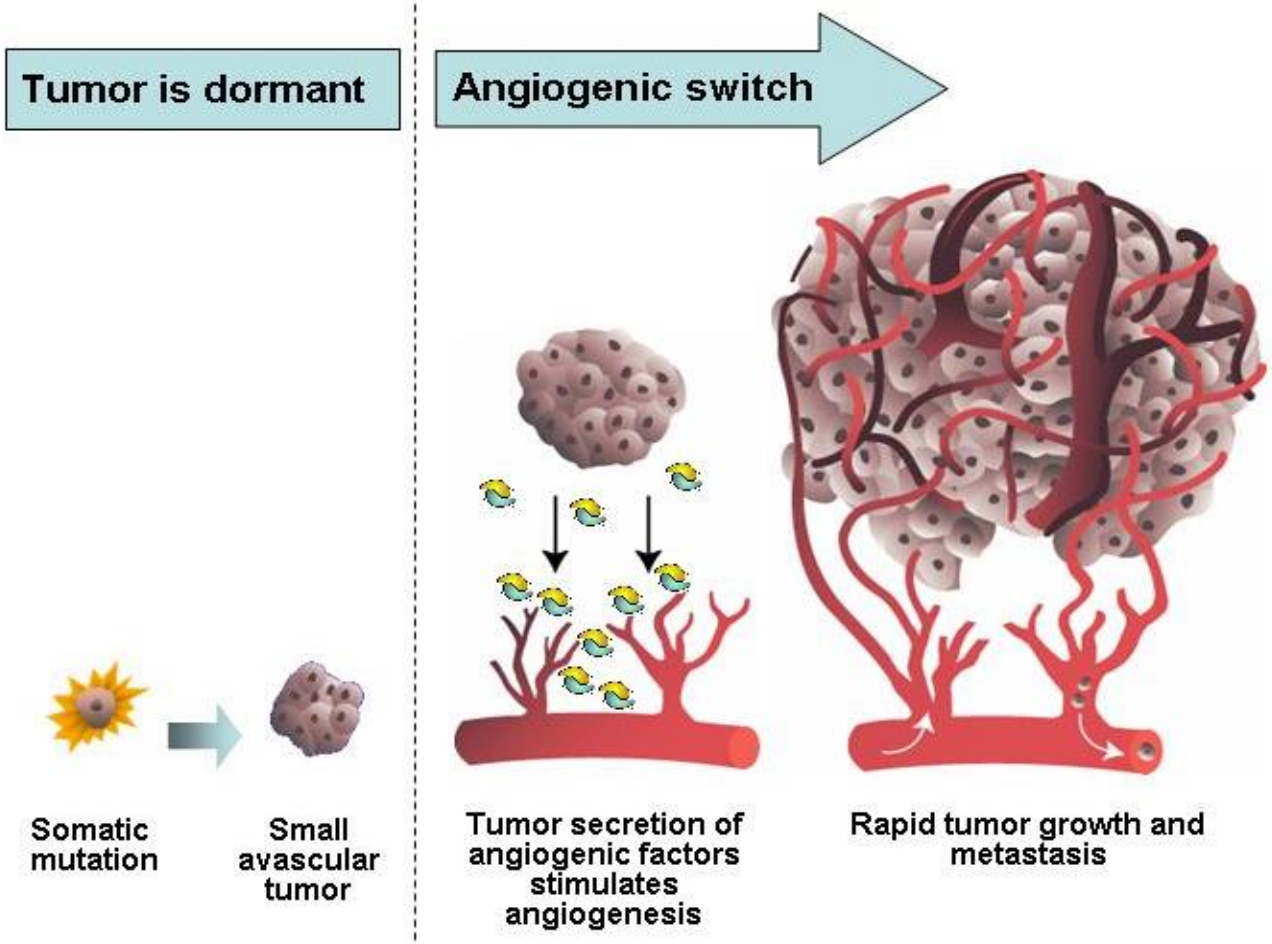
- destroy cancer cells with radiation
- acts in general ways (by killing rapidly dividing cells)
- have many side effects

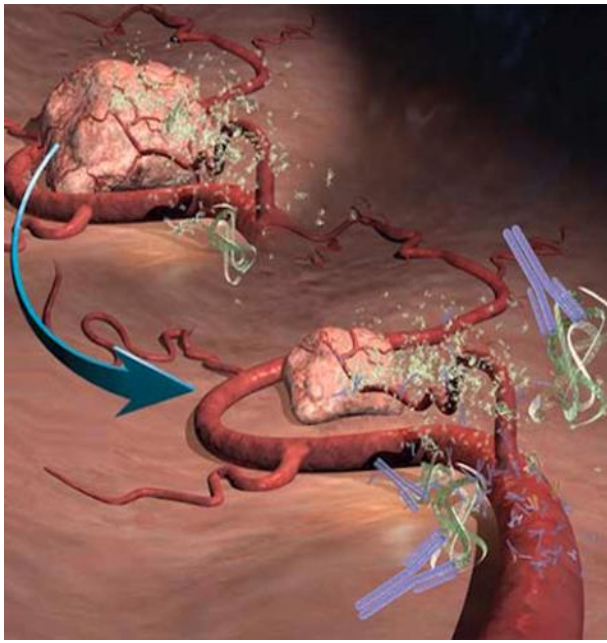
Targeted molecular therapies (TMTs)

- fight specifically against different cancer mechanisms
- can be more effective and have limited side effects



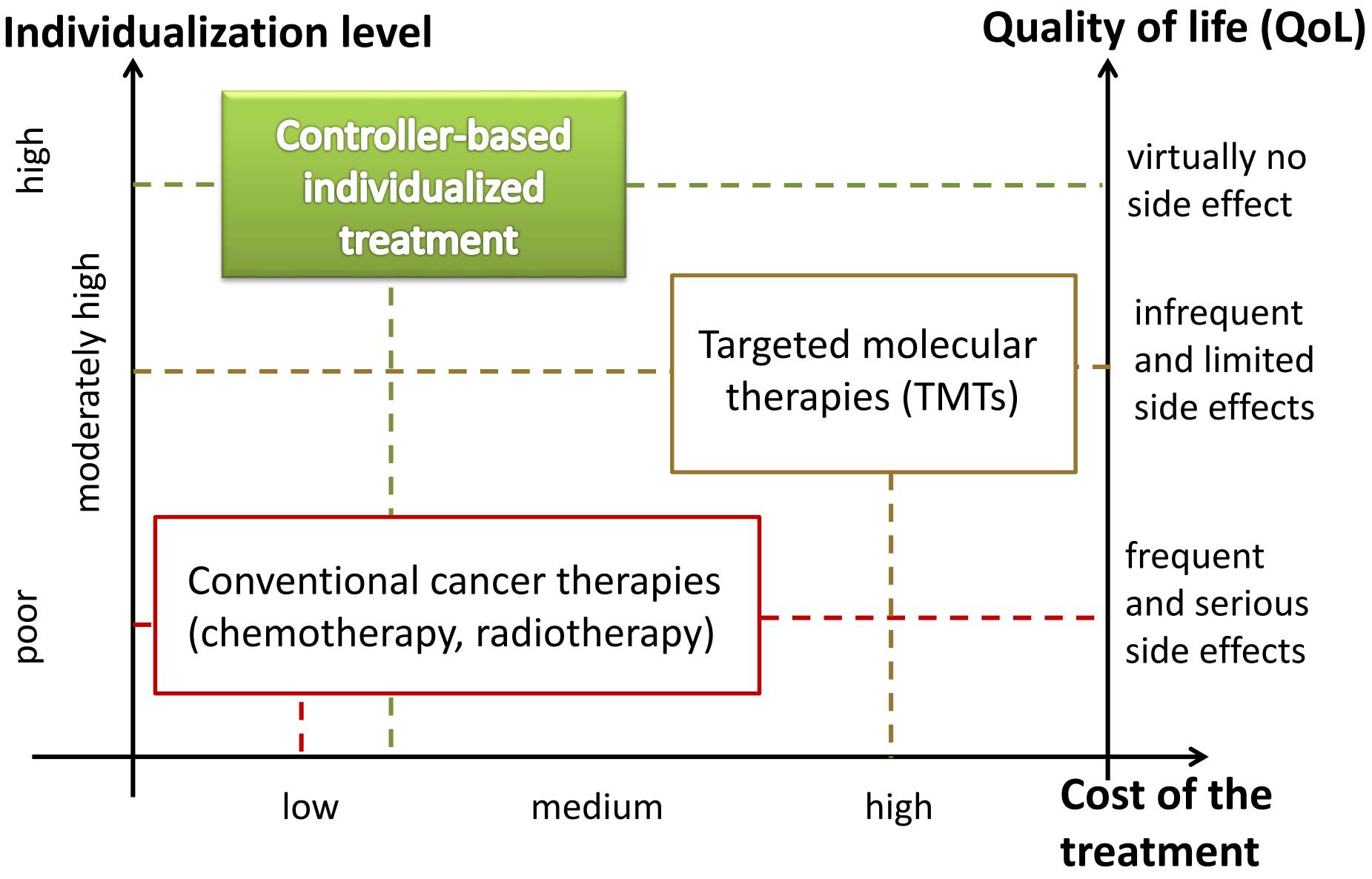
Antiangiogenic therapy



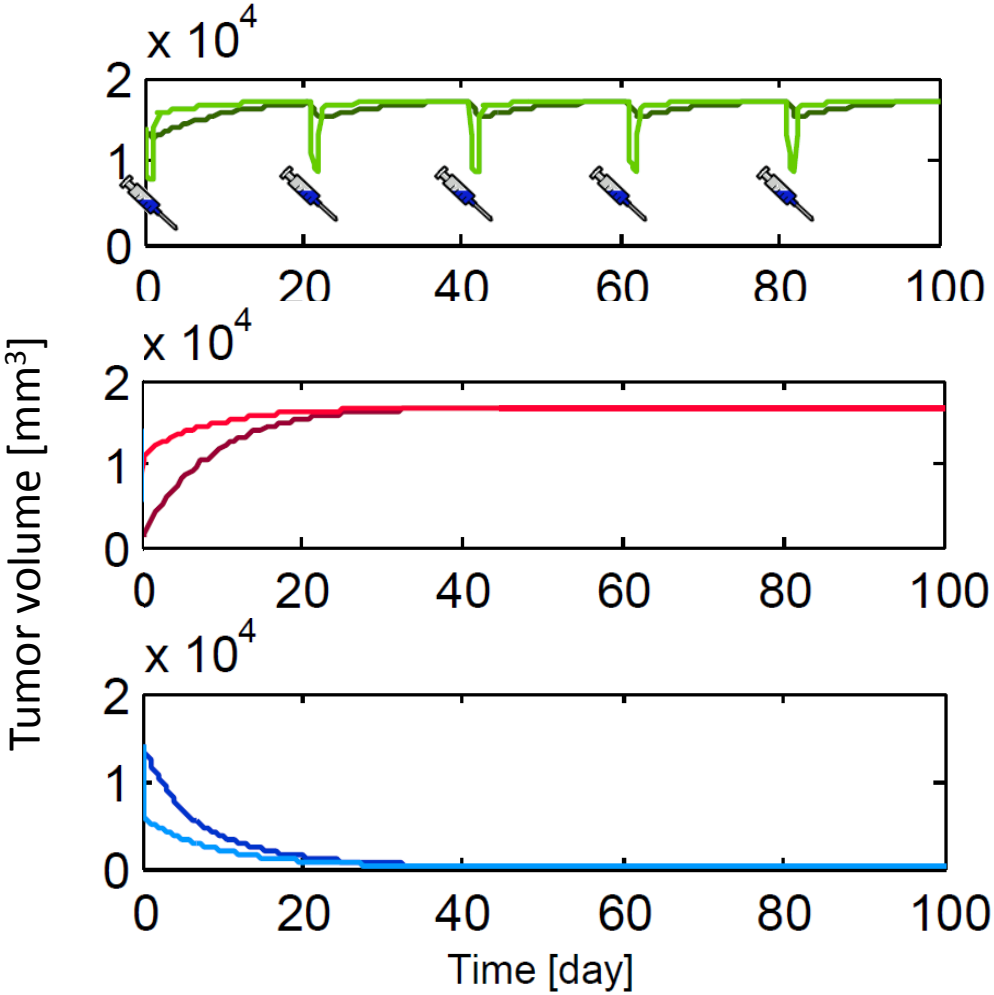


Gerber, D. E. (2008). *Am Fam Physician. 77(3):311–319.*

Concept of the research



Tumor volume control – output simulation results



Current (Hungarian) medical protocol

No treatment

Control approach

- Robust control
- Nonlinear control (LPV)
- Empiricism & Rationalism

Kovács, L. et al (2013). *Comp Meth Prog Biomed. 114:98–110.*

Goal

Novel modern robust control algorithm

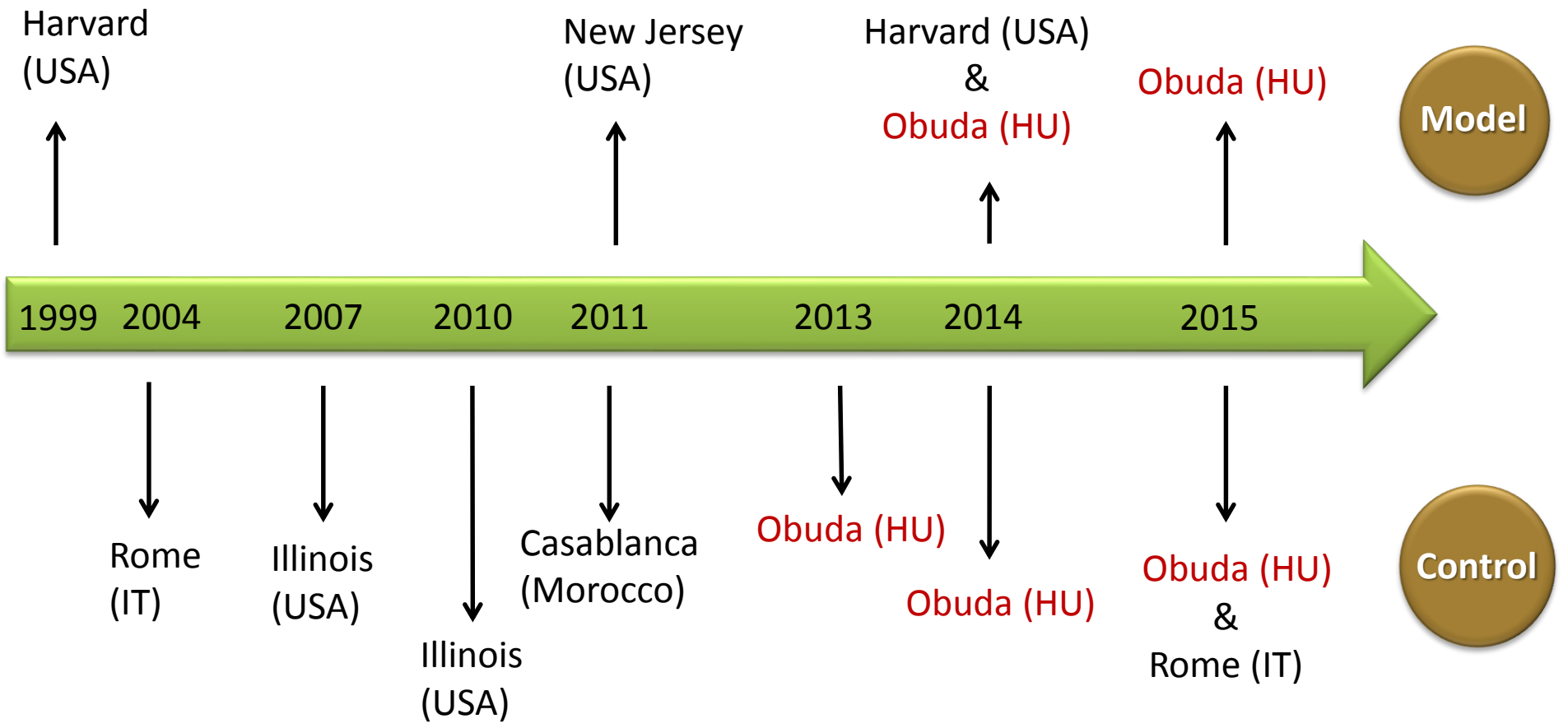
to stop angiogenesis process of the tumor

optimize drug intake (cost) & therapy efficiency (quality)

Objectives

- O1 Novel tumor growth model identification
- O2 Quasi-continuous low-dosage therapy protocol
- O3 Optimal robust control algorithms for continuous low-dosage therapy

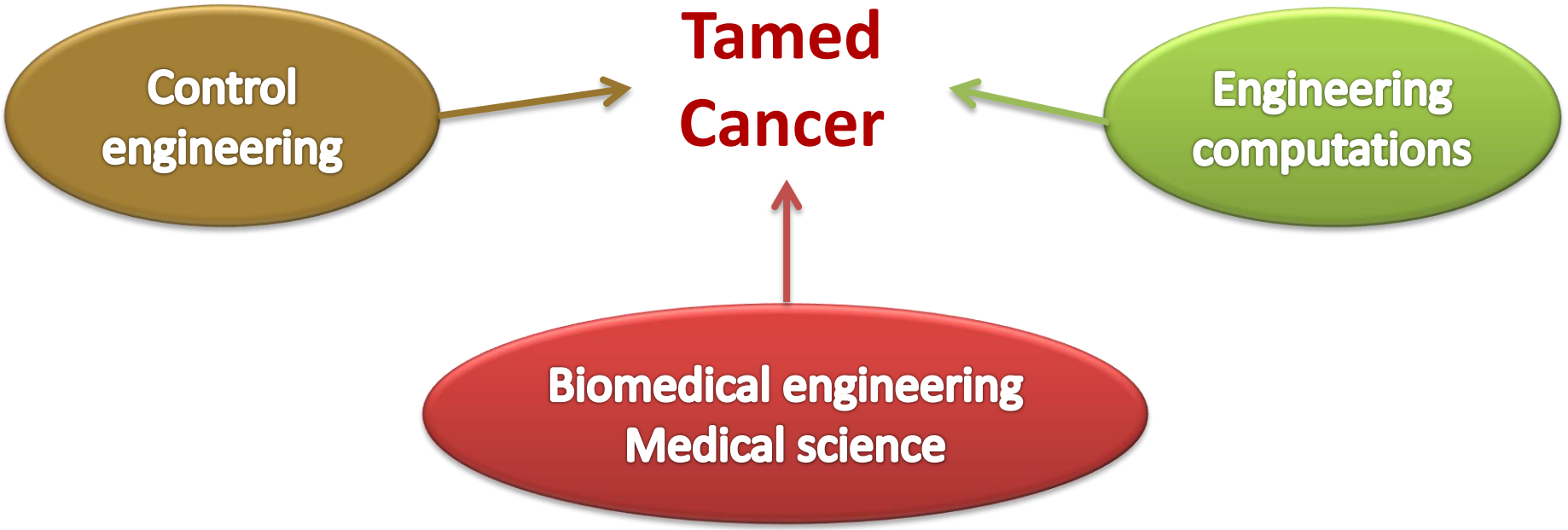
State of the art timeline



Sápi, J, Kovács, L et al. (2015). *Opt Contr Appl Meth. 37(5):848-866.*

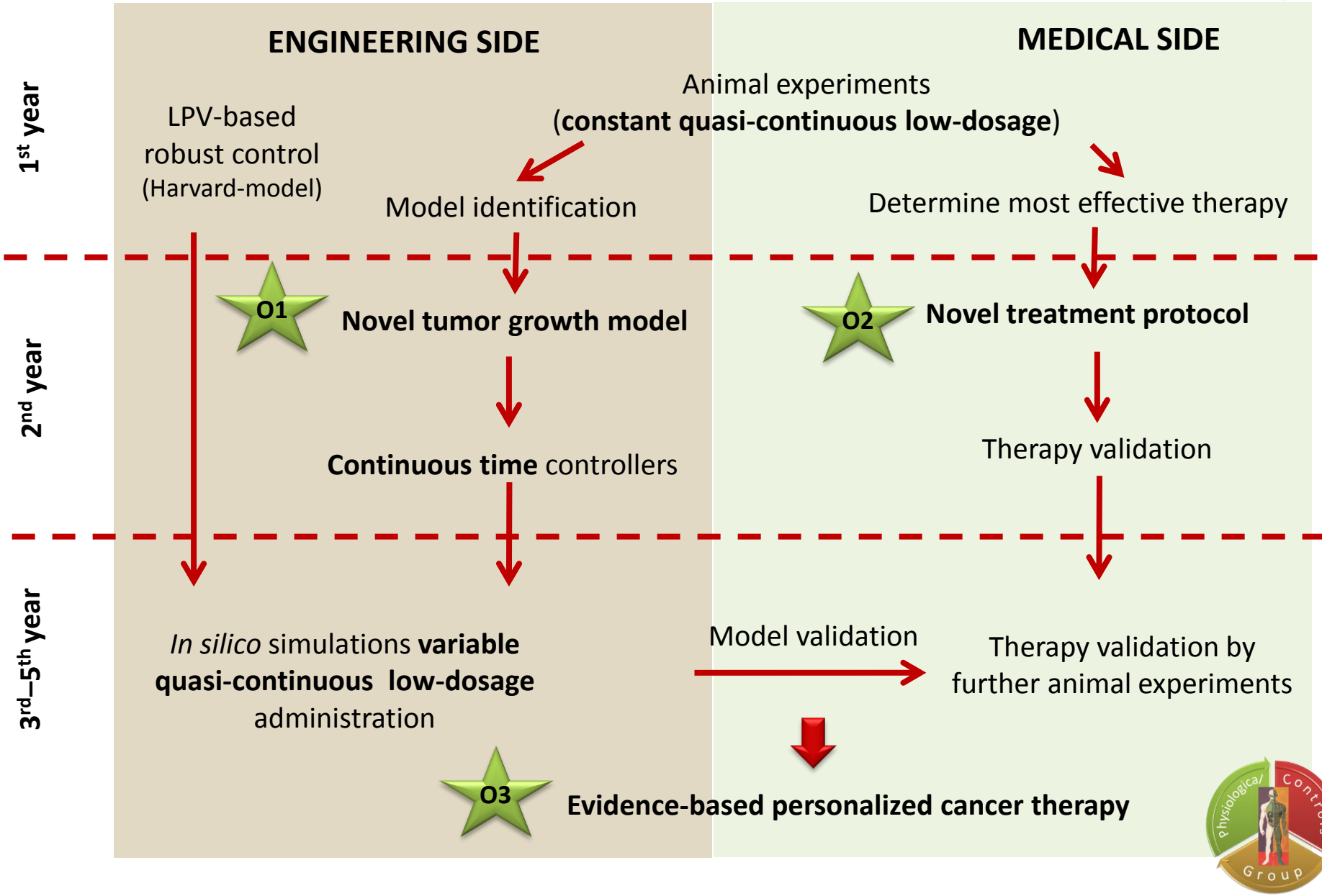
Sápi, J, Kovács, L et al. (2015). *PLoS ONE, 10(11):1-20..*

Expected results



- **Boosting** interdisciplinary cancer research competence
- **Personalized & optimal drug-delivery** approach

Methodology



Scientific impact

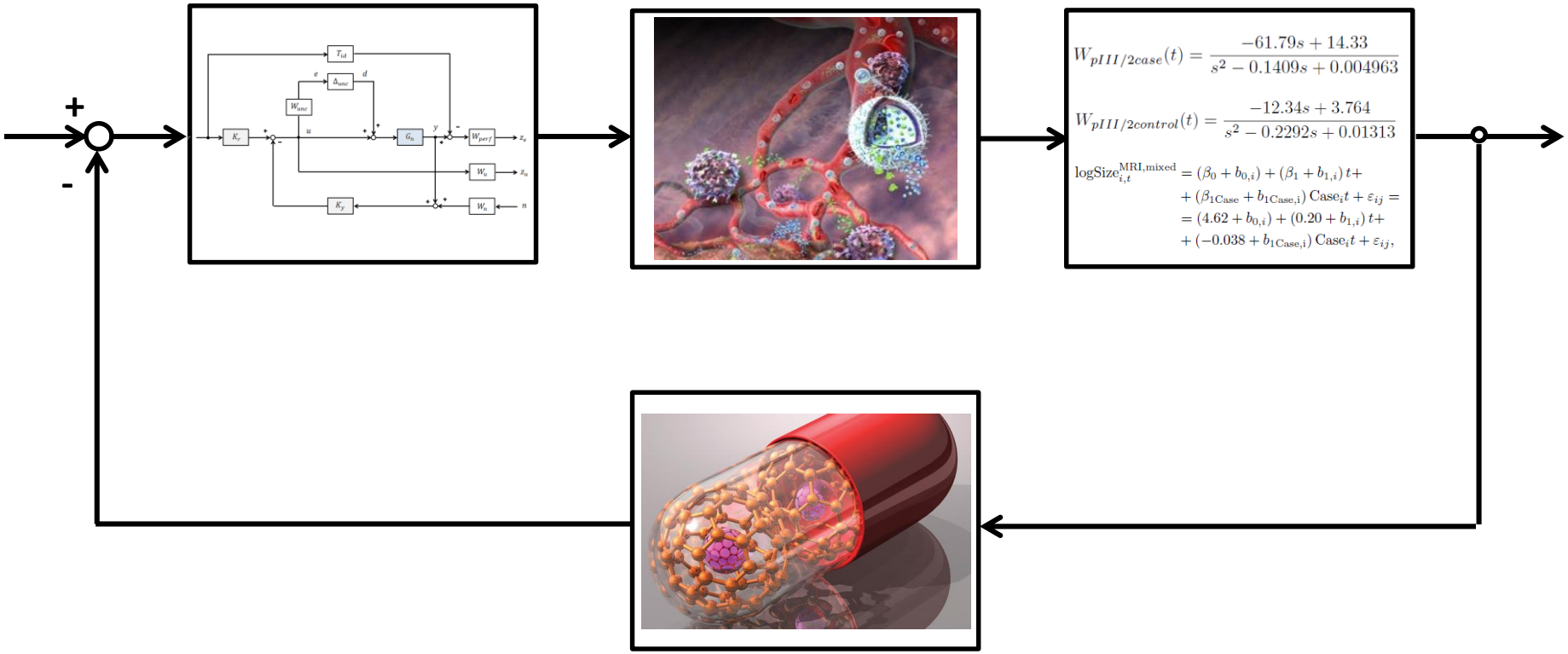
- Novel tumor growth model → novel in cancer science
- Quasi-continuous low dosage antiangiogenic protocol → novel in medical practice
- LPV-based nonlinear robust control algorithm → breakthrough in cancer therapy

Personalized model-based antiangiogenic therapy

↓

Social impact

Dream (within 15 years)



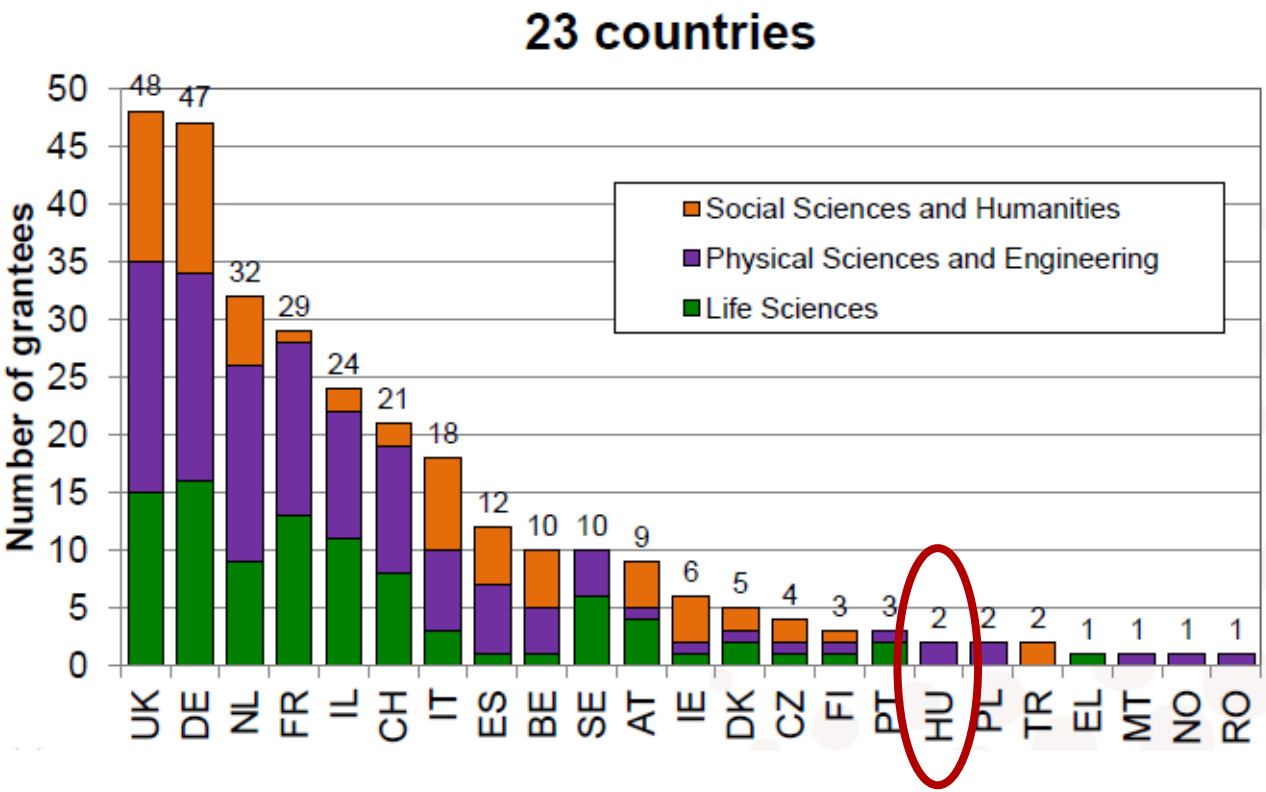
ERC StG results

ERC Starting Grant 2015 Call

Grantees by Country of Host Institution & domain

Total 291 grants

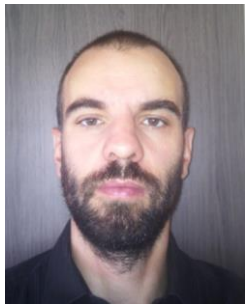
European Research Council
Established by the European Commission



ERC Tamed Cancer team members

Dr. Tamás Ferenci
- senior lecturer
- Σ publications = 140
- H-index = 5
- 2016 publications = 26

György Eigner
- PhD student
- Σ publications = 31
- H-index = 1
- 2016 publications = 10



Dr. Dávid Csercsik (PPKE)
- Post-Doc
- Σ publications = 44
- H-index = 4
- 2016 publications = 4

Dr. Johanna Sájevicsné Sápi
- senior lecturer
- Σ publications = 31
- H-index = 7
- 2016 publications = 3

Dr. Dániel András Drexler
- senior lecturer
- Σ publications = 47
- H-index = 6
- 2016 publications = 5

Krisztina Geresdi
- research assistant

PhysCon Research Center members

József Klespitz
- PhD student
- Σ publications = 13
- H-index = 2
- 2016 publications = 5

Róbert Pethes
- PhD hallgató
- Σ publications = 5
- H-index = 1
- 2016 publications = 4

Péter Szalay (Bosch)
- PhD student
- Σ publications = 26
- H-index = 4
- 2016 publications = 1

Obuda University
- 4 MSc students
- 2 BSc students

BME
- 5 MSc students

Péter Pázmány Chatolic University
- 2 MSc students

Ghent University
- 1 MSc student

National University of Singapore
- 2 MSc students

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2017.03.03.

Thank you for your attention!

Contact:

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Research and Innovation Center of Óbuda University,
Physiological Controls Research Center

Scientific ERC Tamed Cancer session

- 14:05 – Dr. Johanna Sápi → **Engineering methods for cancer treatment**
- 14:25 – Dr. Dávid Csercsik → **Control-oriented modelling of tumor and tumor vasculature growth**
- 14:45 – Dr. Dániel A. Drexler → **Control engineering challenges and results**