

Quantitative and Systematic Eco-Design of a Capsule Endoscopy System for Early Diagnosis of Gastrointestinal Diseases

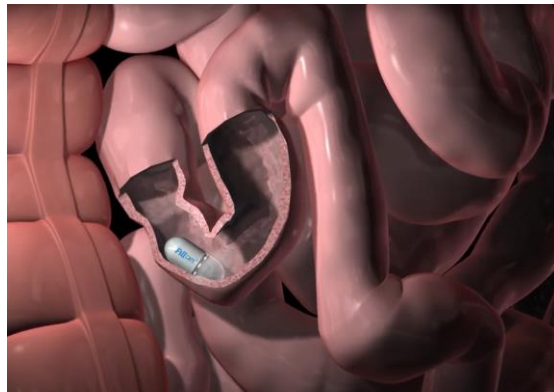
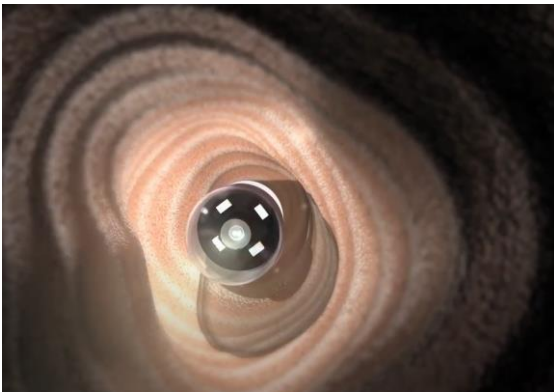
PhD thesis project

Augustin WATTIEZ

Supervisor: Prof. David BOL (ICTEAM, ECS Group)

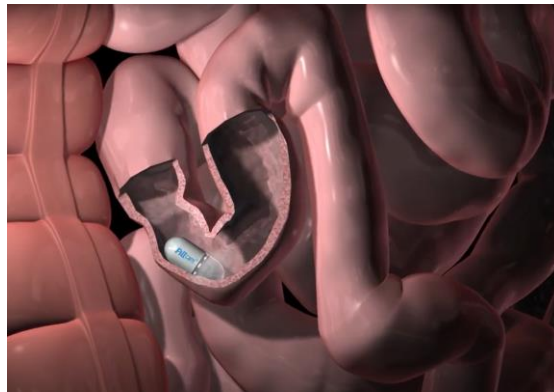
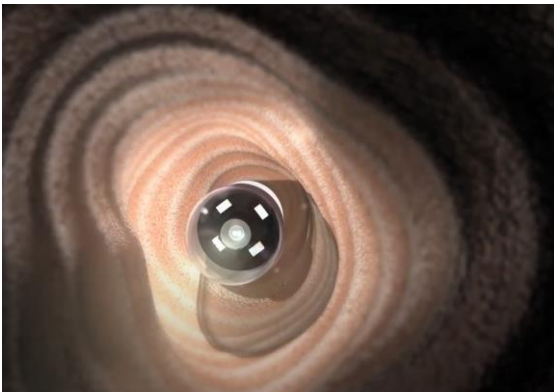
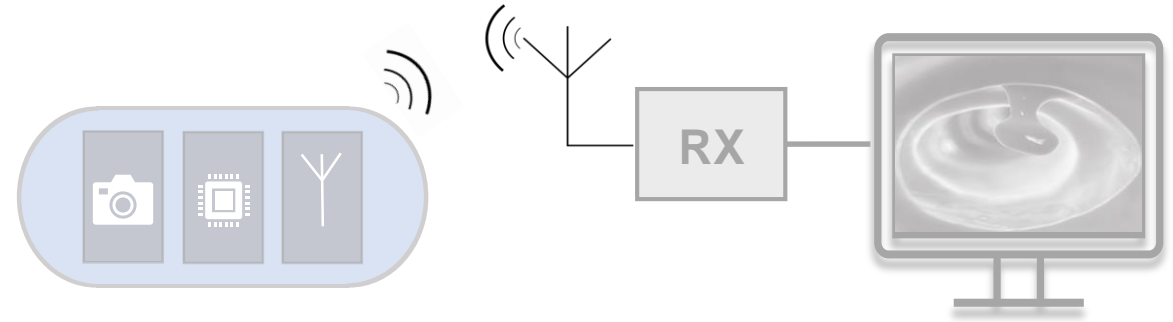
Supervisory Panel: Prof. Sandy TUBEUF, Prof. Jean-Pierre RASKIN

What is a pillcam ?



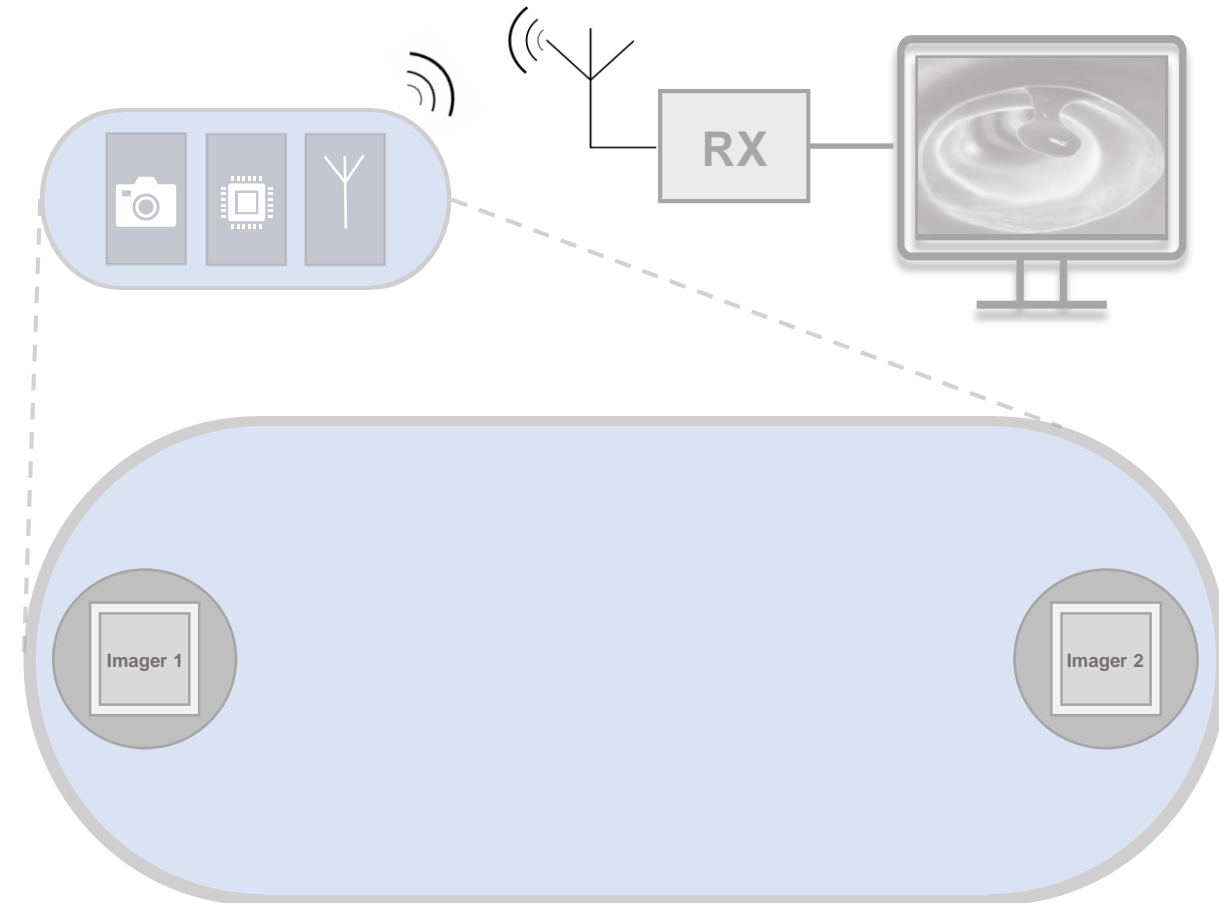
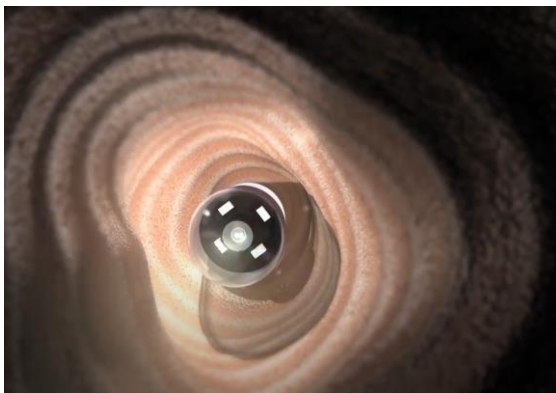
Source: Pillcam animation, Given Imaging

What is a pillcam ?



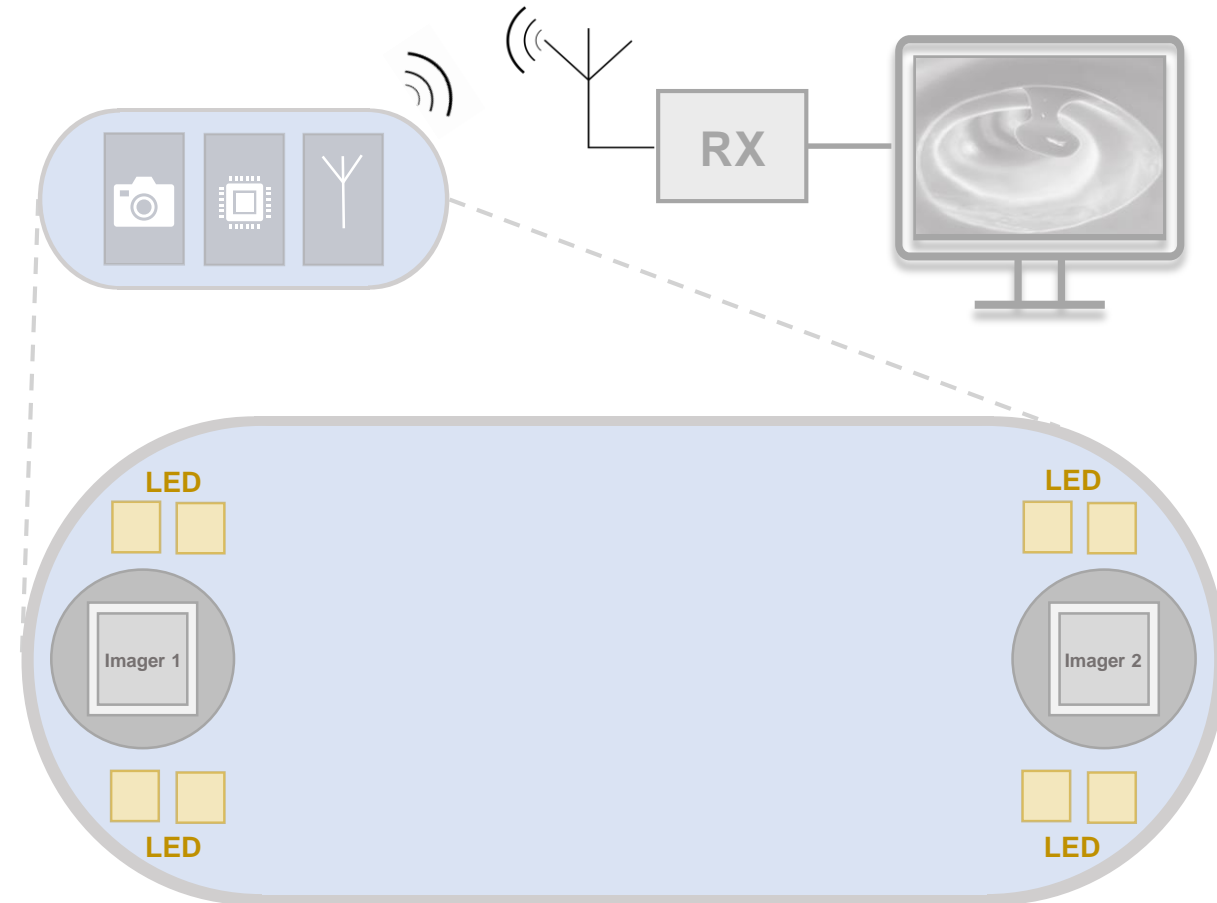
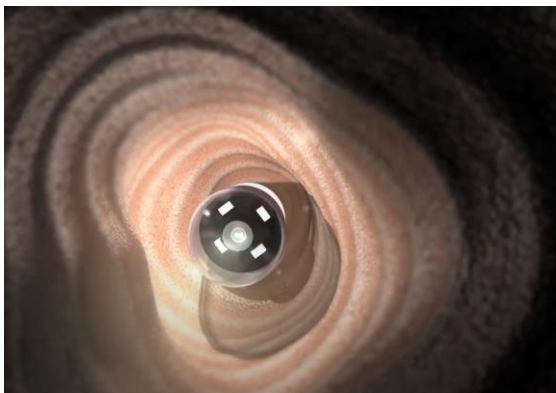
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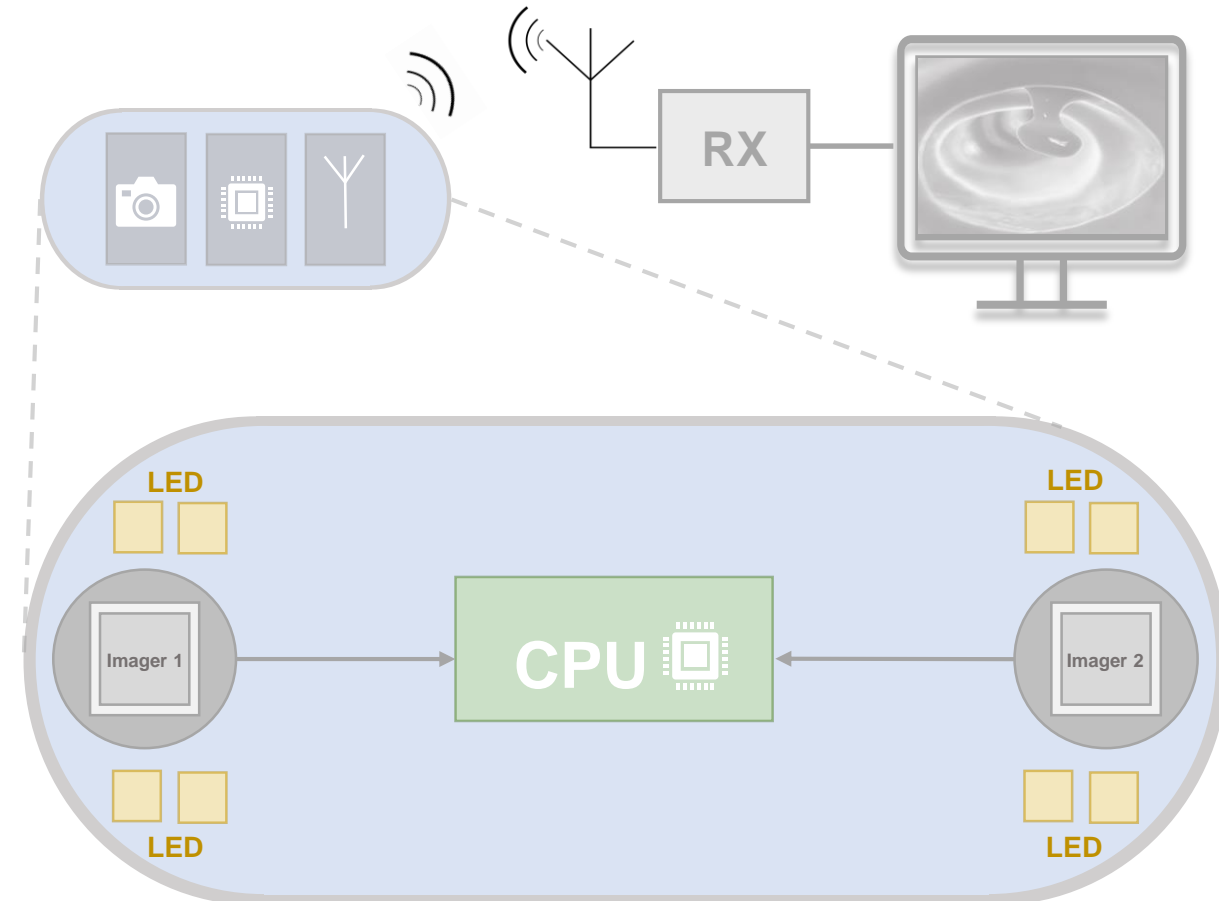
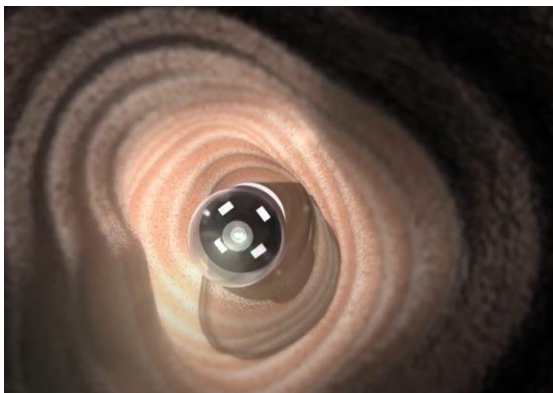
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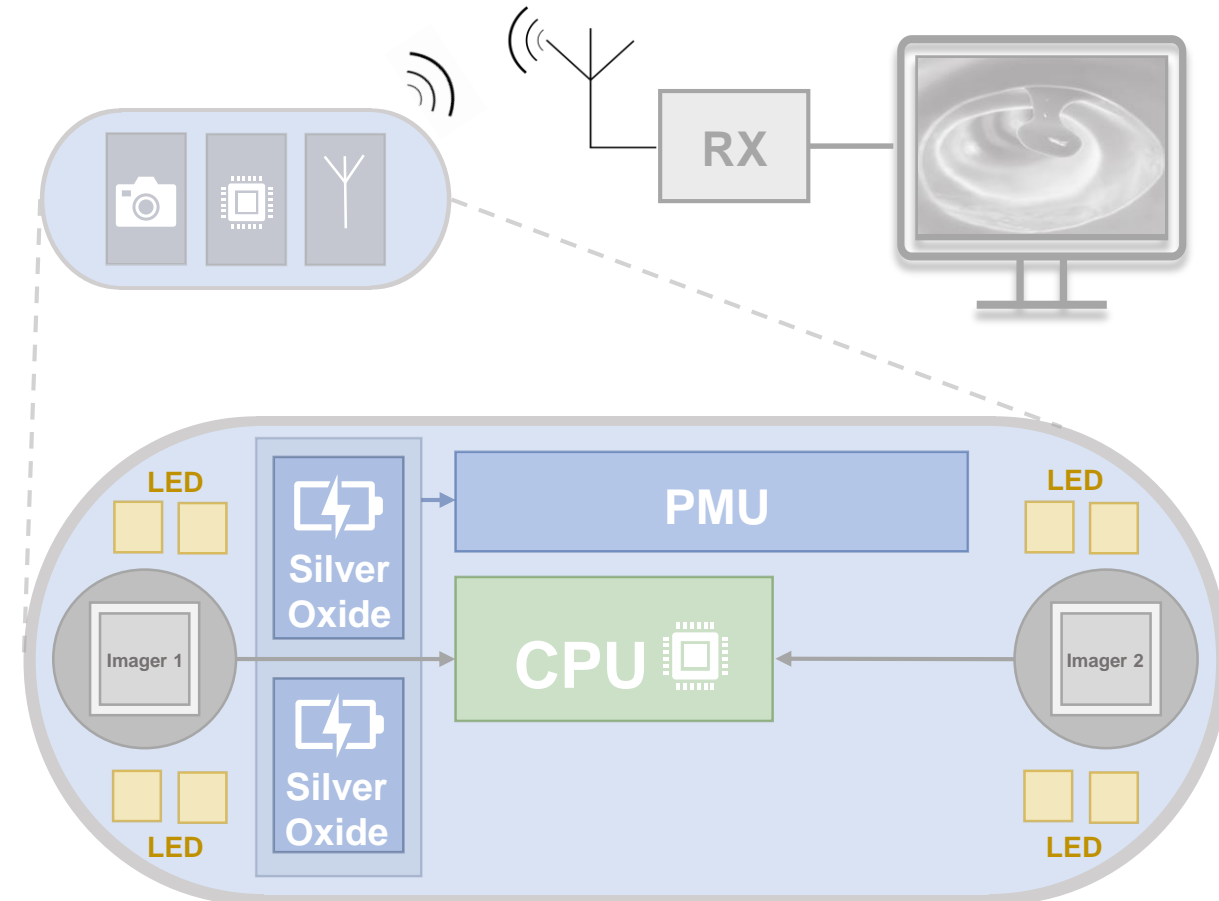
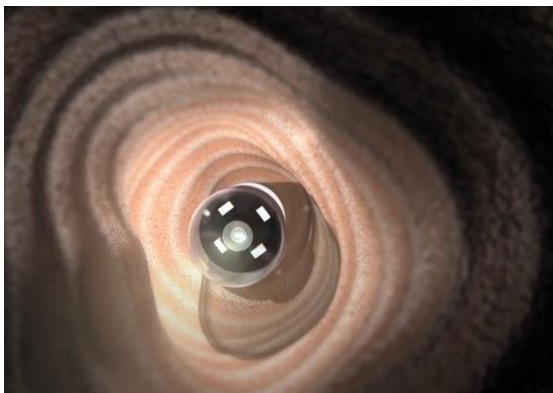
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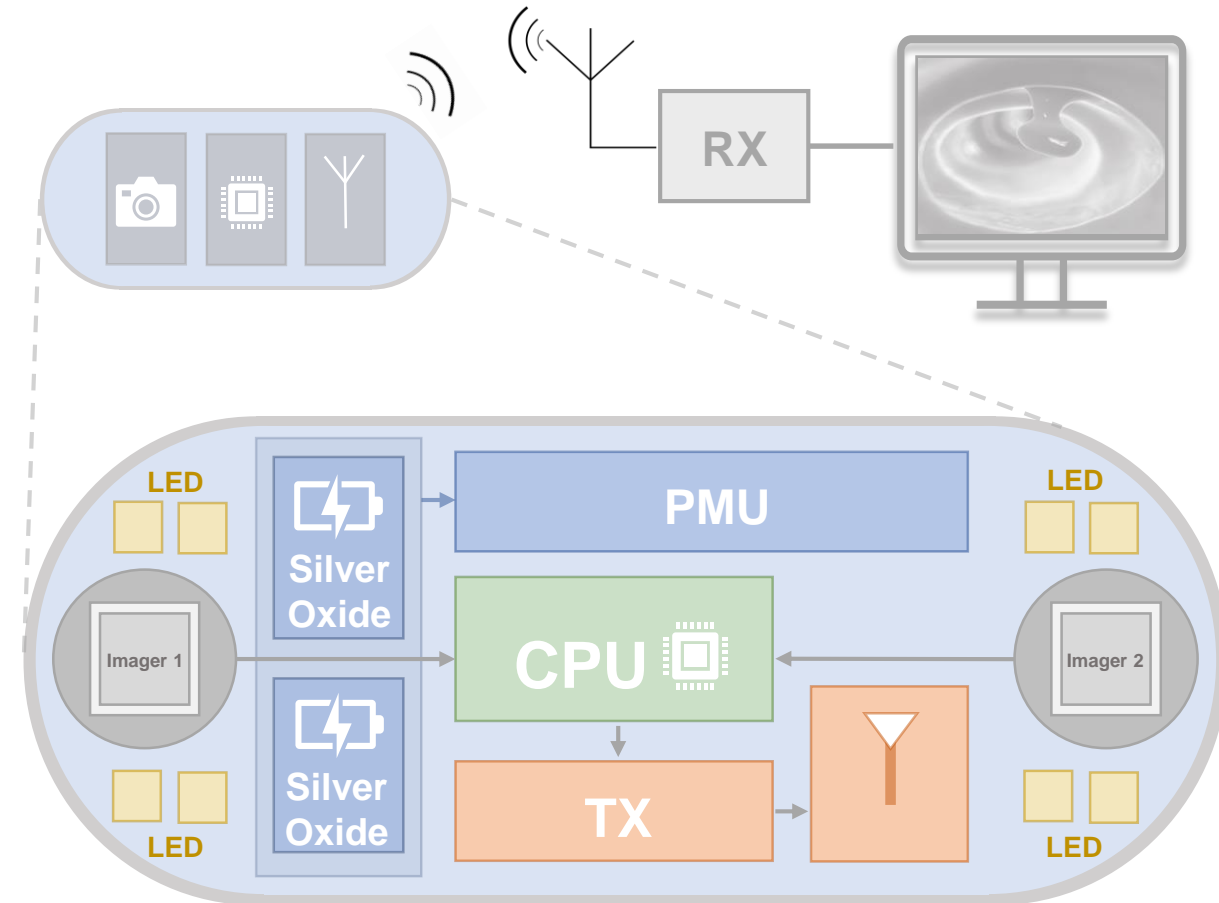
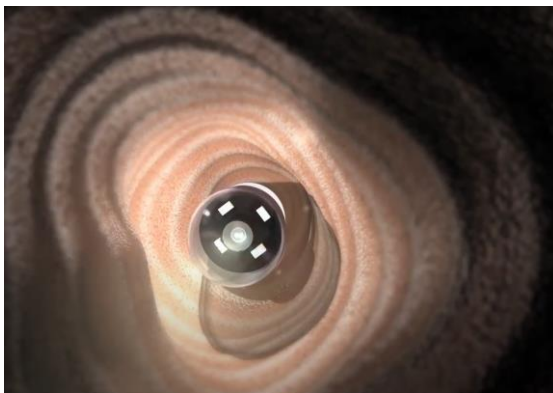
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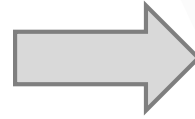


Source: Pillcam animation, Given Imaging

Pillcams for colorectal cancer screening



Slikeret al., Expert Review of Med. Devices (2014)



PillCam COLON 2
Medtronic

1. Higher patients **acceptance**

G. Ciuti, RBME, 2011

2. No risk of perforation

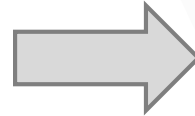
3. Move towards **medical target performance**

S. Monteiro, WJG, 2016

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Model	PillCam SB2 (FDA approval - 2003)	PillCam COLON 1 (Introduced in 2006)	PillCam COLON 2 (FDA approval - 2014)	Flexible endoscope
Frame rate (fps)	6	4	4 – 35 (adaptive)	30 (standard)
Resolution (pixels)	256 × 256	256 × 256	256 × 256	640×480 (up to HD)
Recording time (h)	8	10	10	infinite (NA)

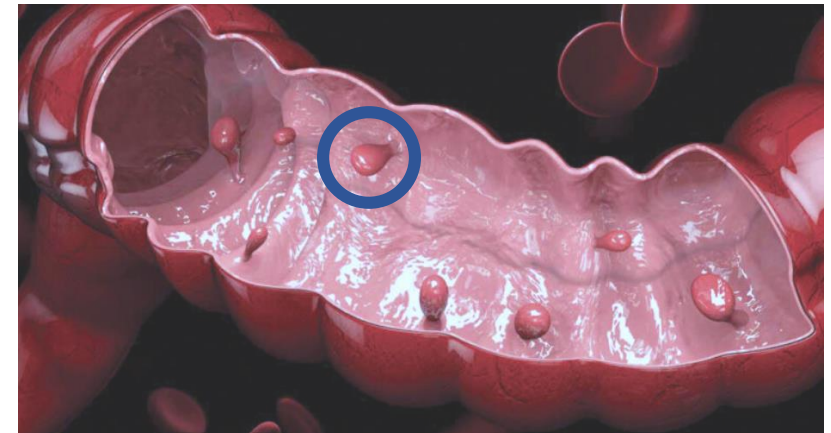
Fact sheet

Third most common cancer

- 1,930,000 new cases in 2020
- **916,000 deaths** in 2020



Fierce Biotech, 2018



Digestive Diseases Center

World Health Organization, 2022.
American Cancer Society fact sheet (2018).
Healthline, 2018.

Fact sheet

Third most common cancer

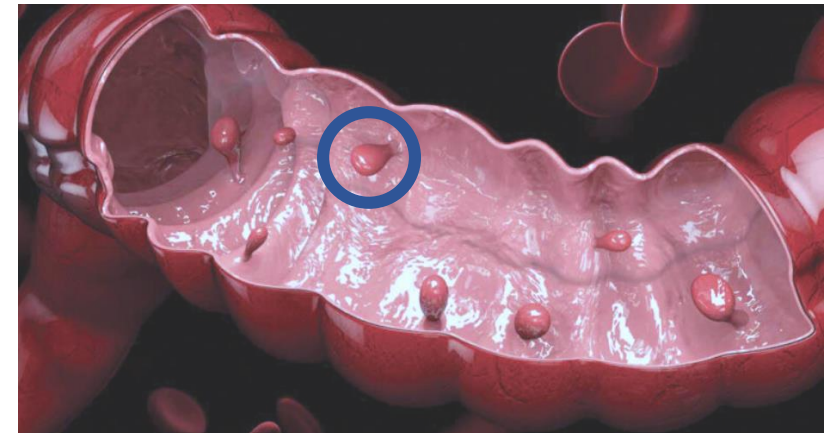
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Asymptomatic to late stages

- **Polyps** appear in the colon as the **only symptoms**



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Digestive Diseases Center

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Asymptomatic to late stages

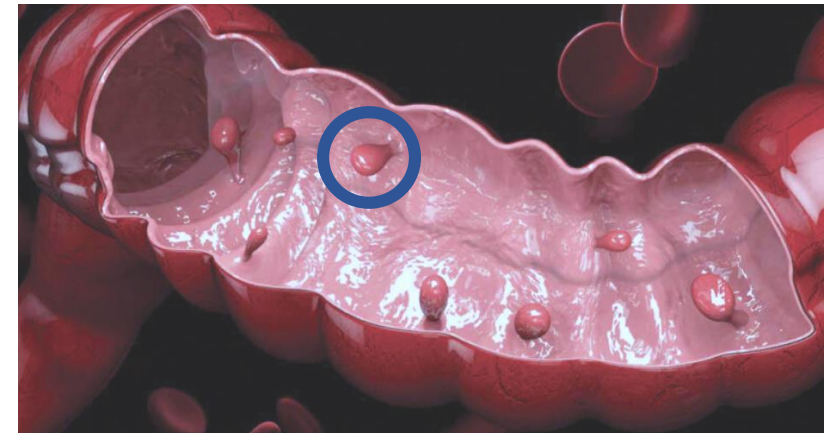
- **Polyps** appear in the colon as the **only symptoms**

5 years survival rate: 90% at first stage / 14% at fourth stage

Effective **early detection** procedure is of **major benefit**

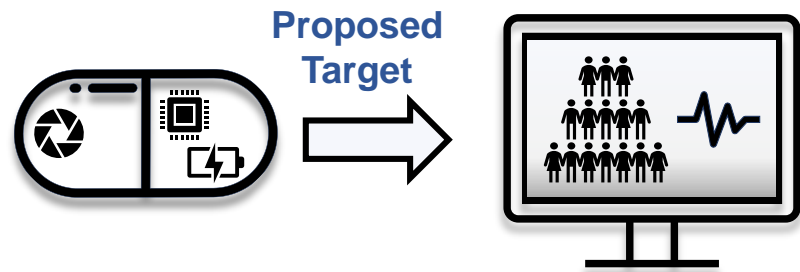


Fierce Biotech, 2018



Digestive Diseases Center

Current pillcams cannot enable a sustainable CRC mass screening

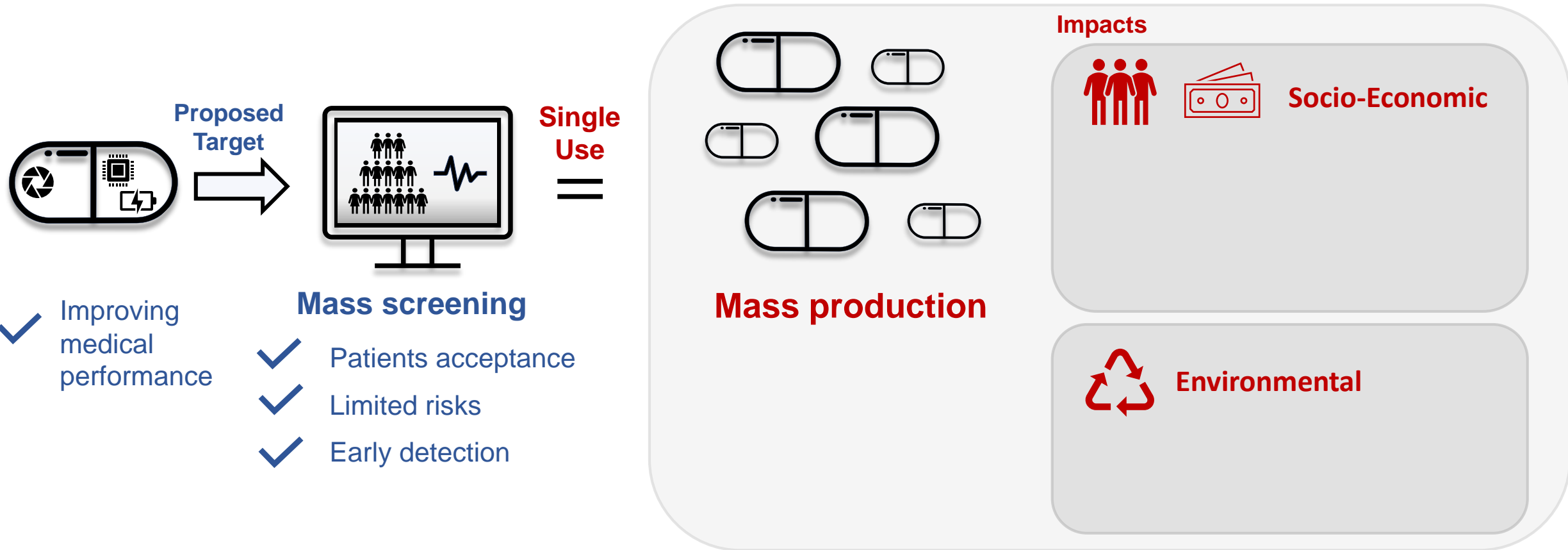


✓ Improving
medical
performance

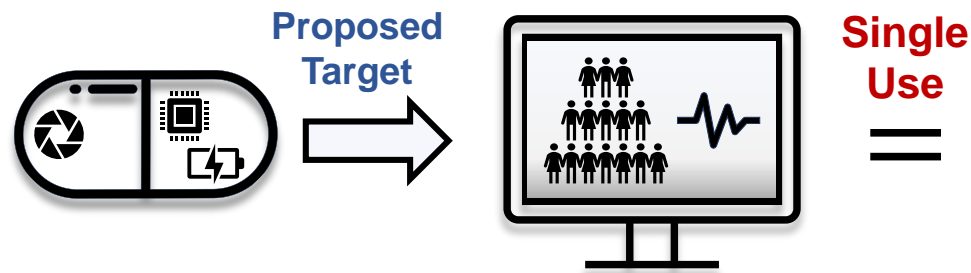
Mass screening

- ✓ Patients acceptance
- ✓ Limited risks
- ✓ Early detection

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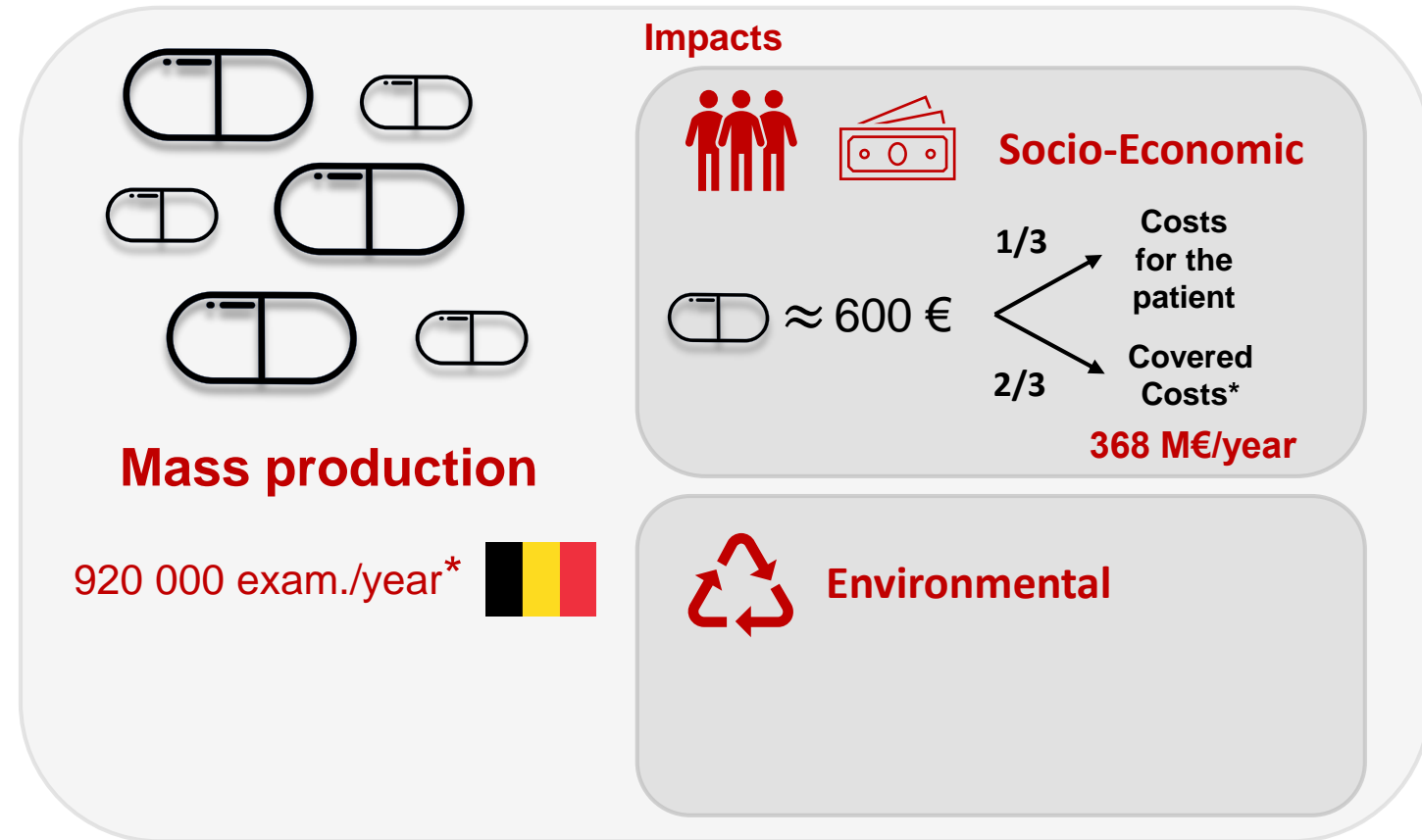
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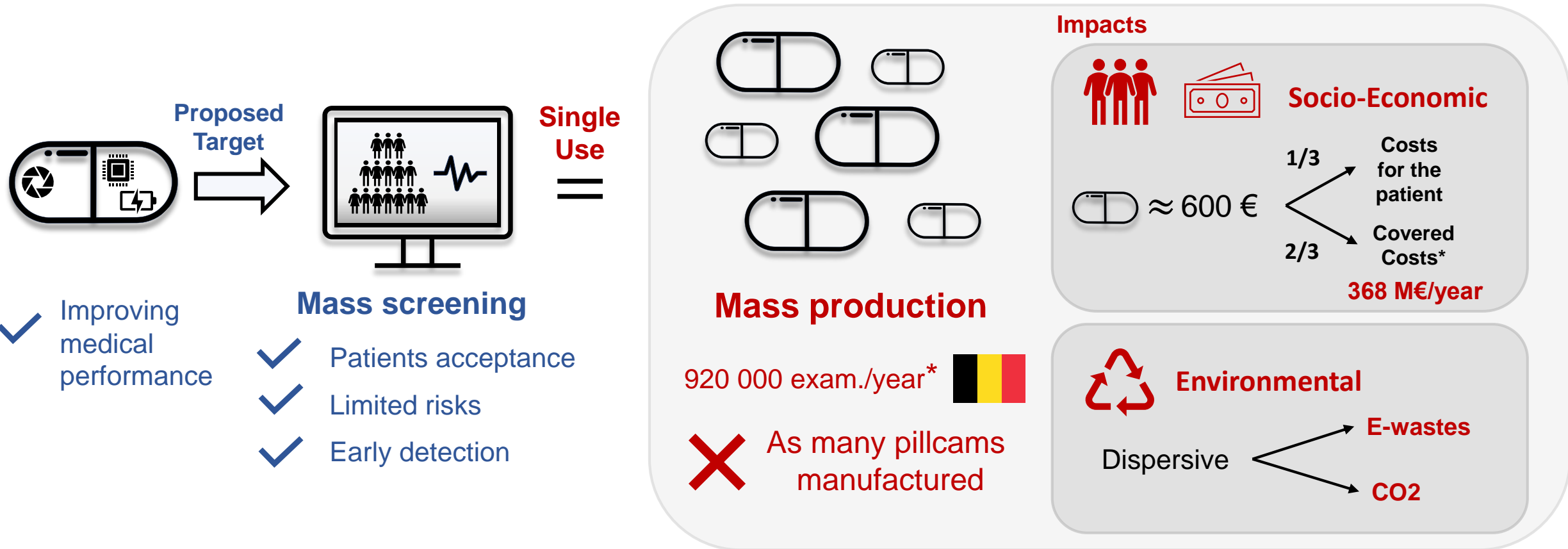
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Mass screening

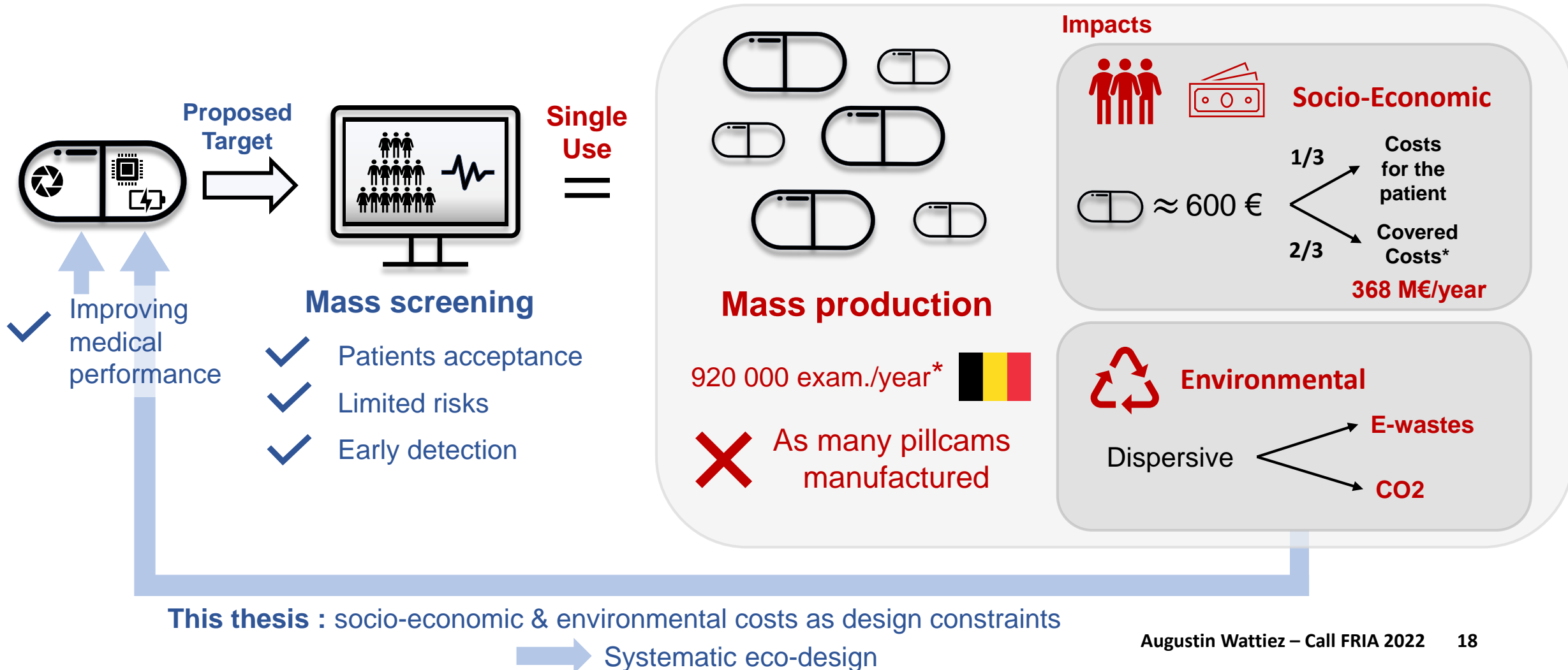
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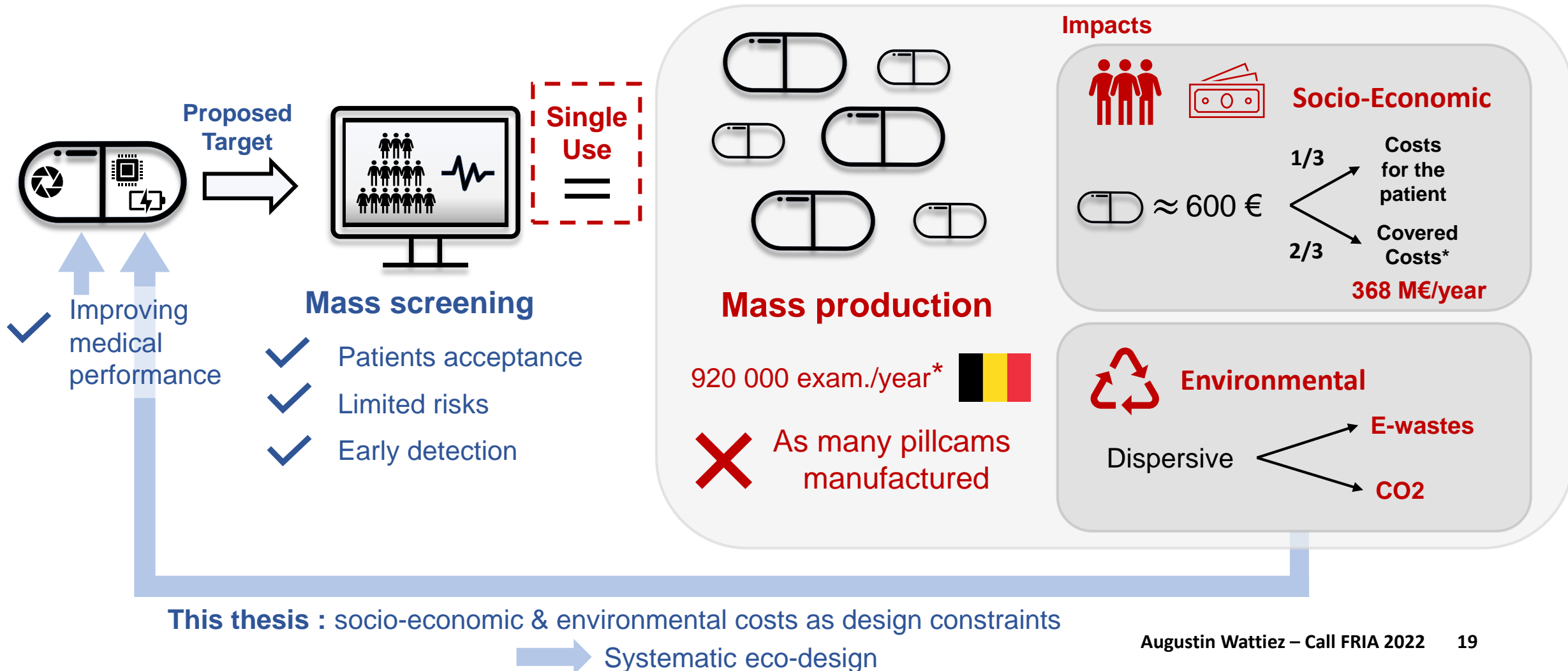
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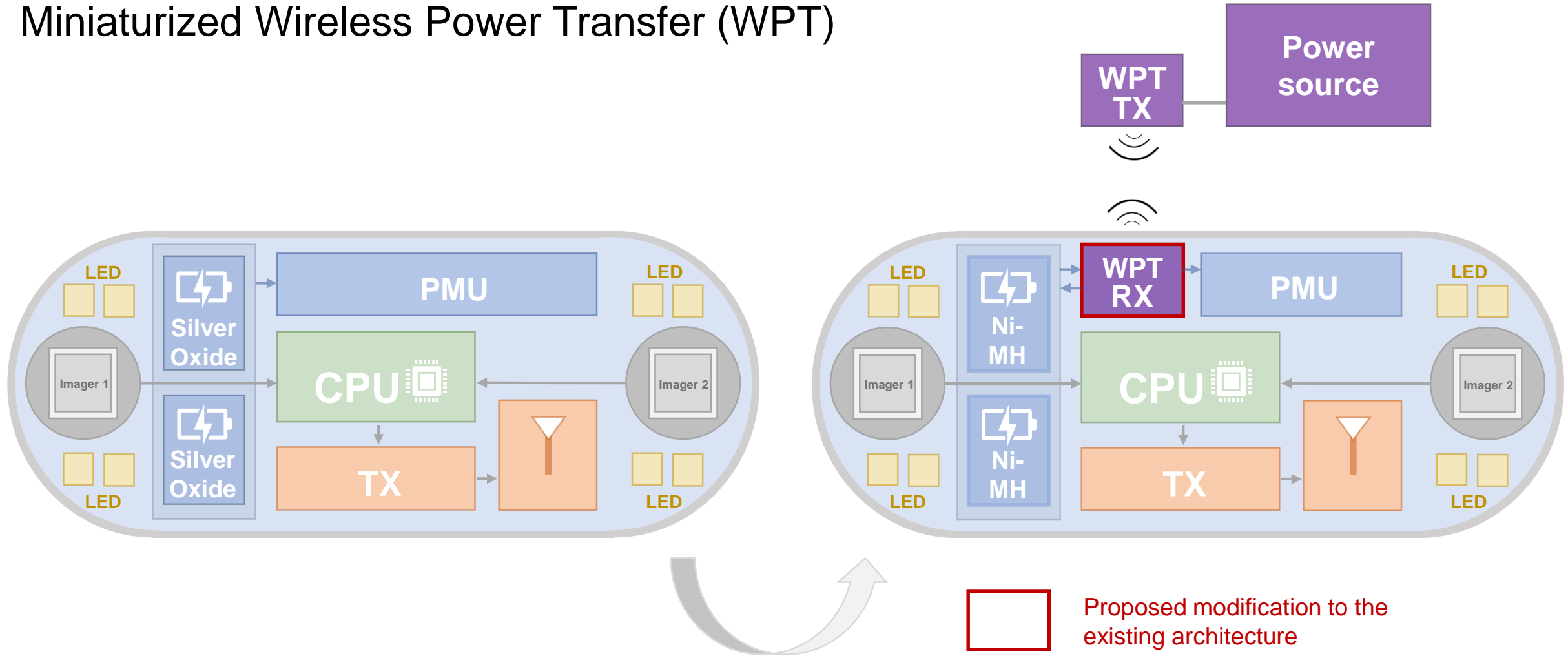


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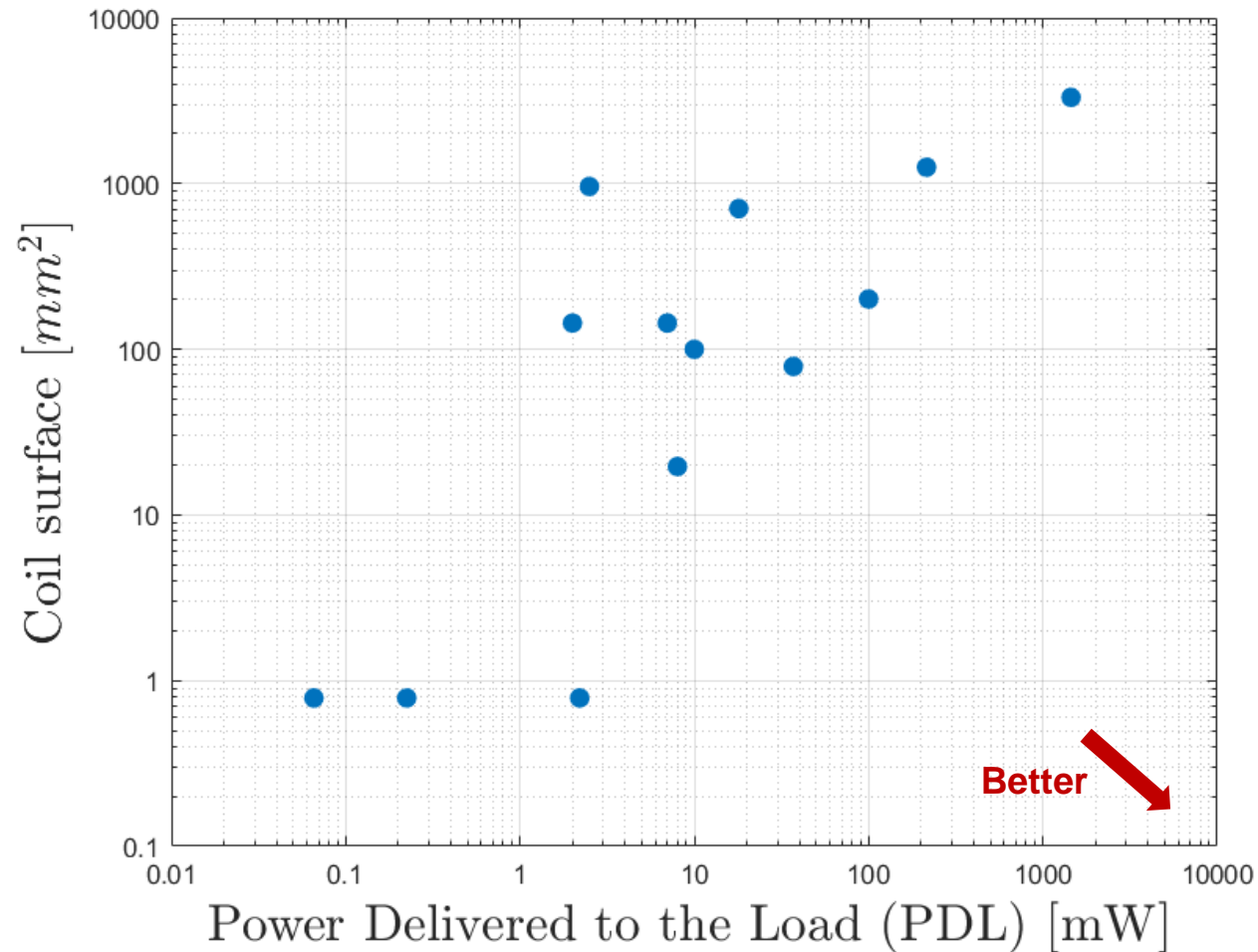


Expected Technical Challenges

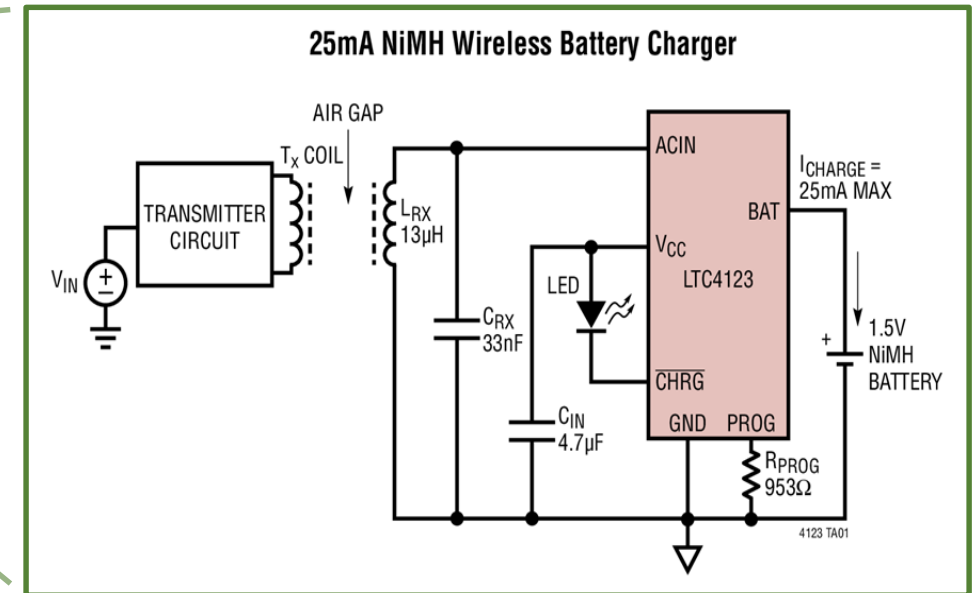
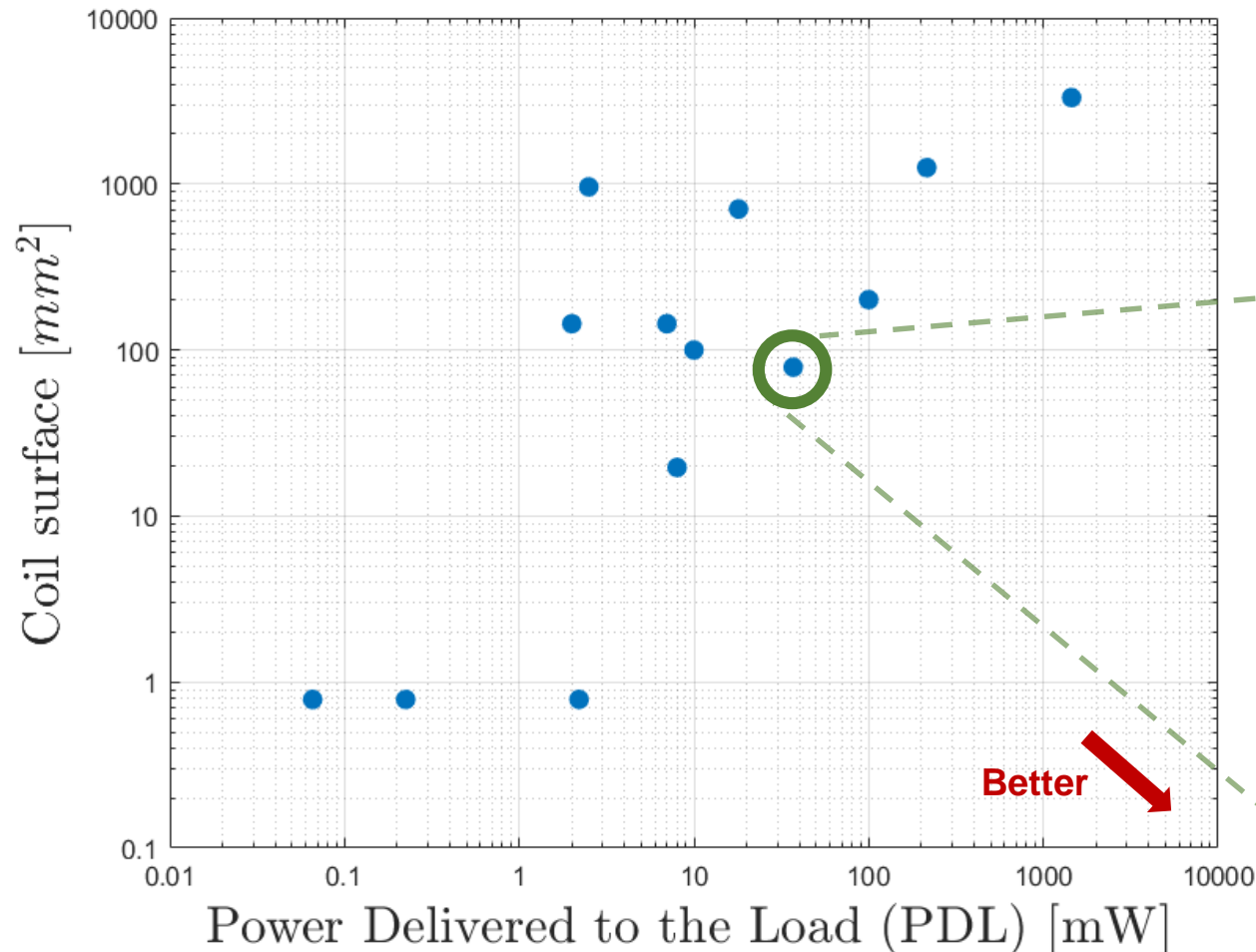
Miniaturized Wireless Power Transfer (WPT)



Inductive wireless power transfer

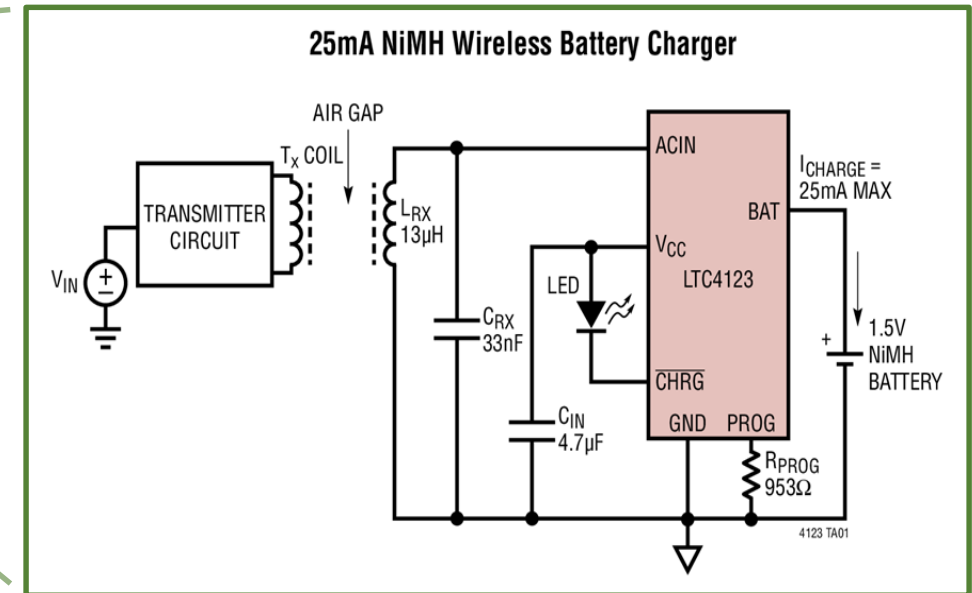
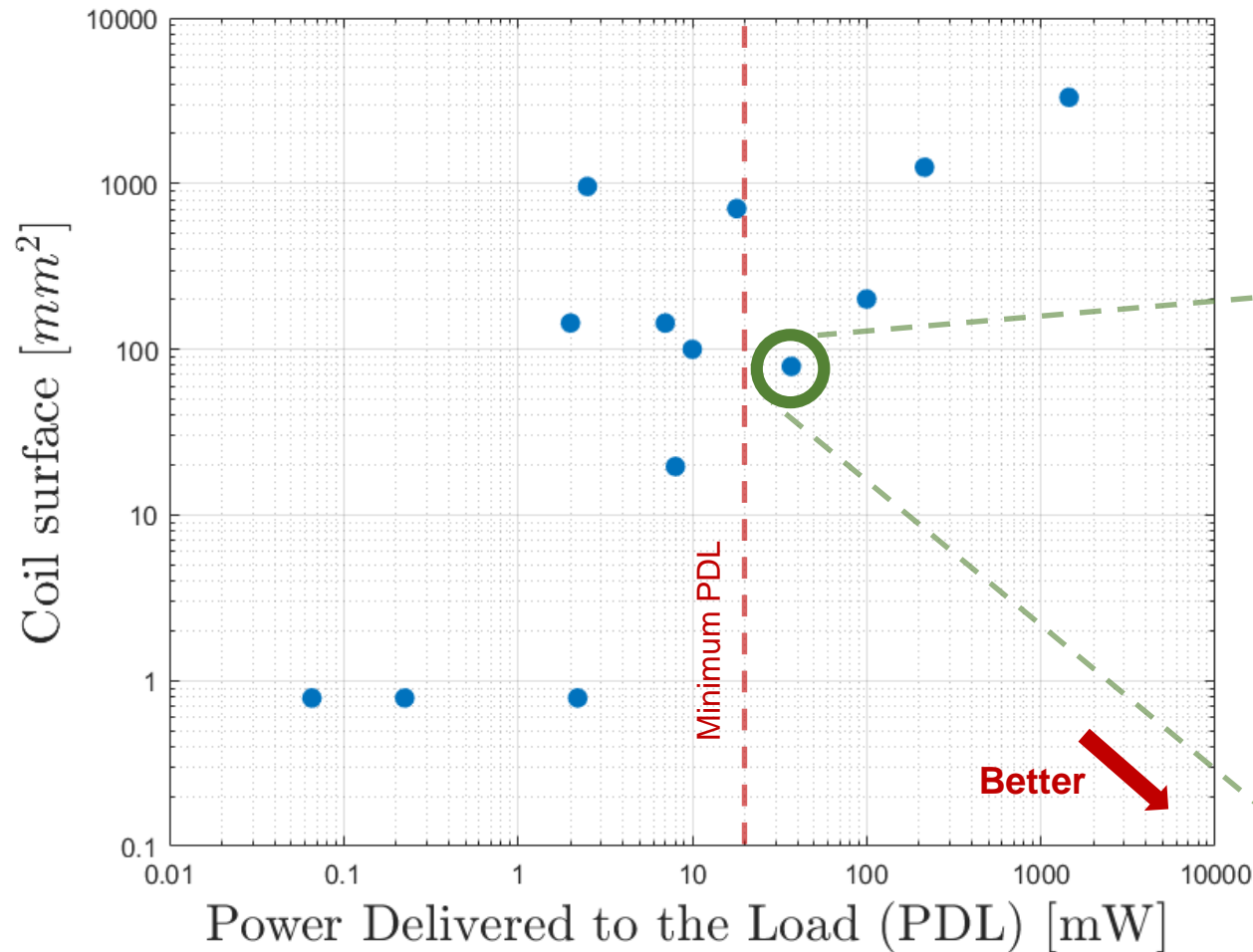


Inductive wireless power transfer



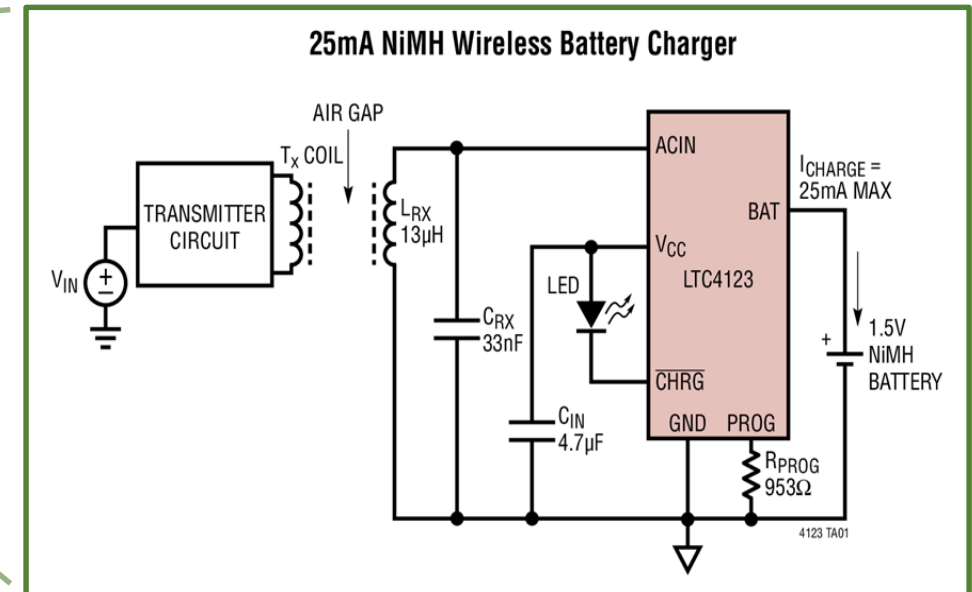
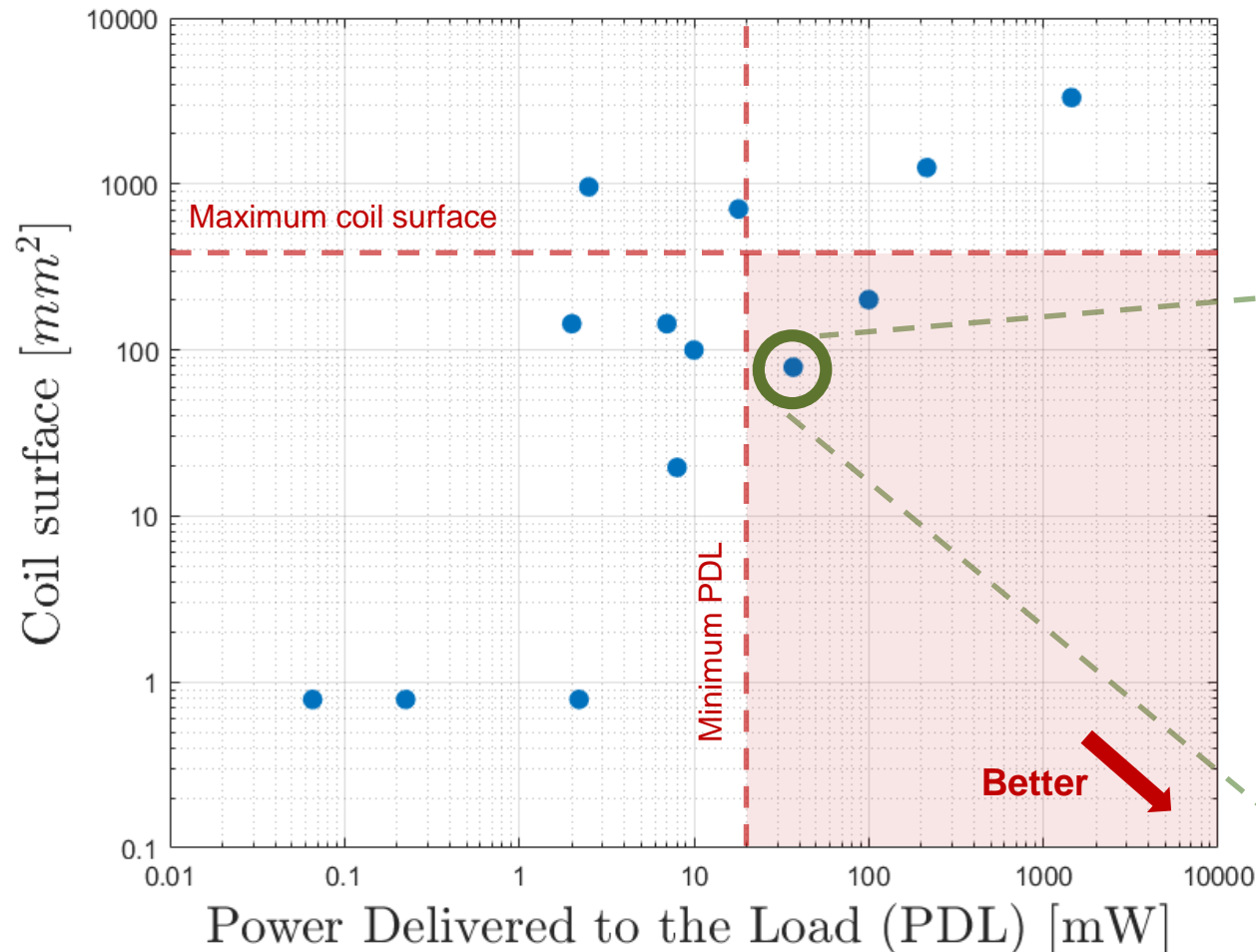
Low Power Wireless Charger for Hearing Aids LTC4123, Analog devices

Inductive wireless power transfer



Low Power Wireless Charger for Hearing Aids LTC4123, Analog devices

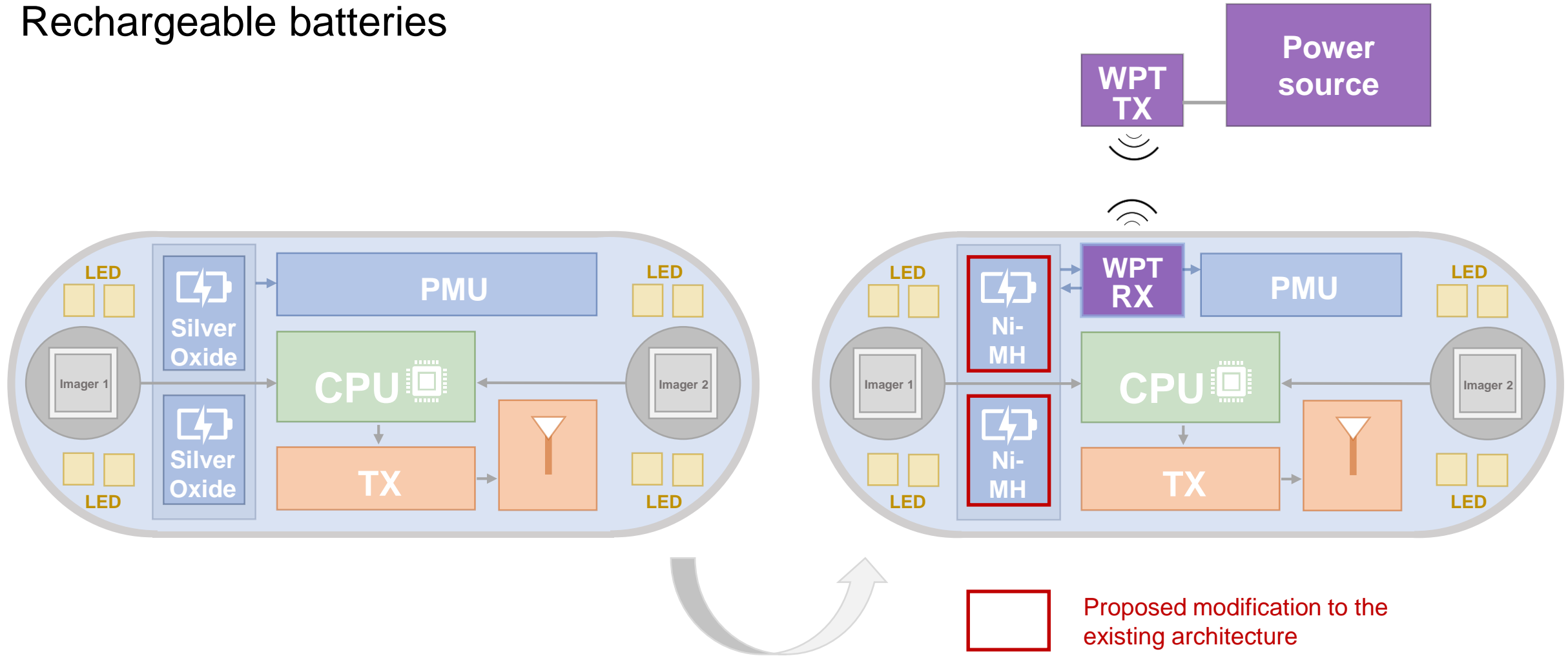
Inductive wireless power transfer



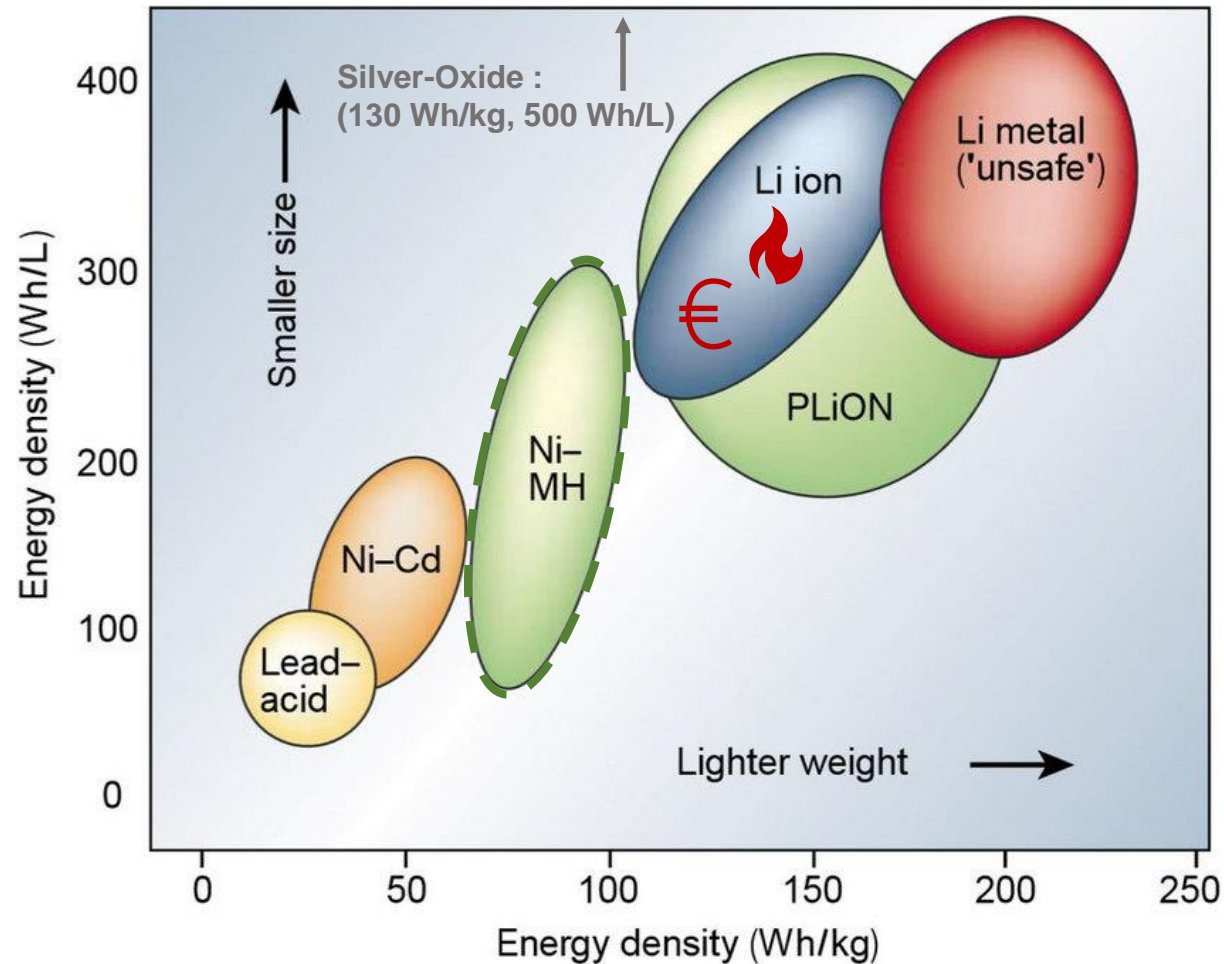
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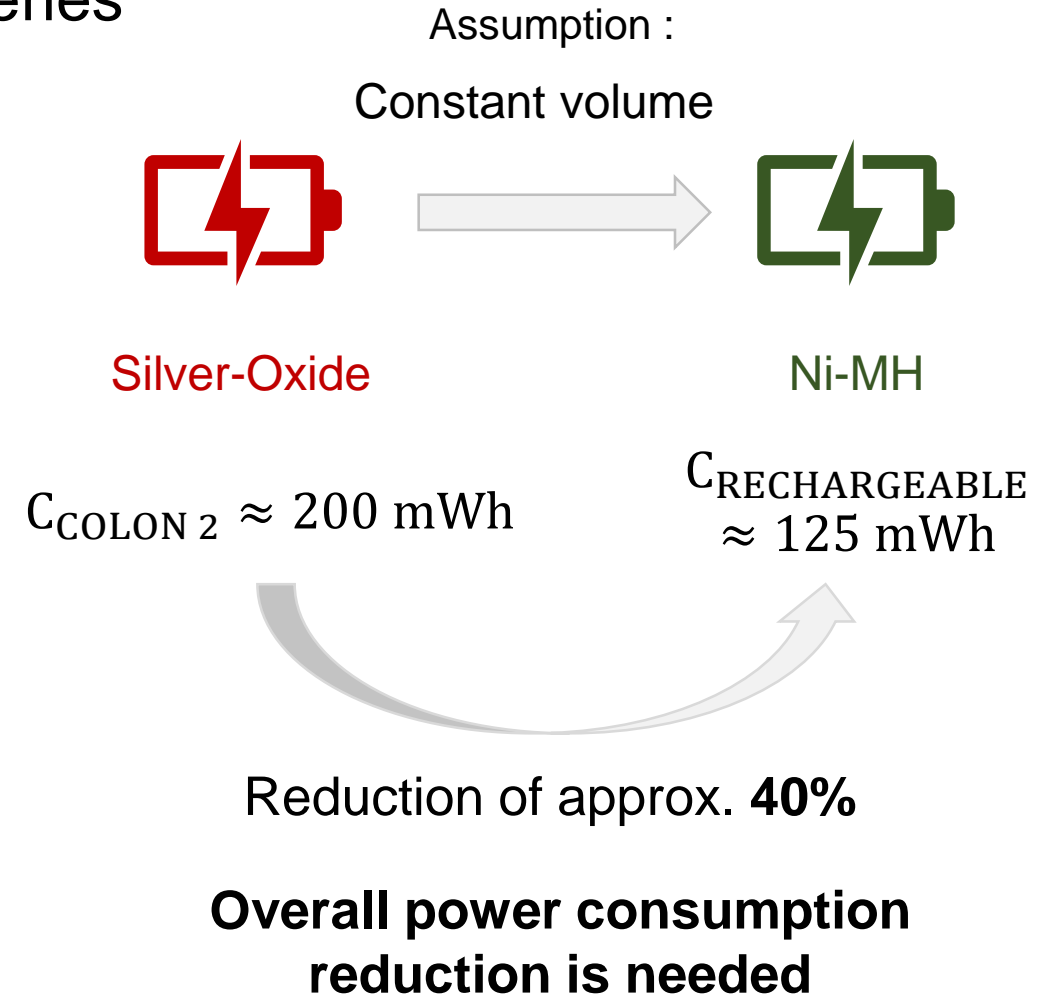
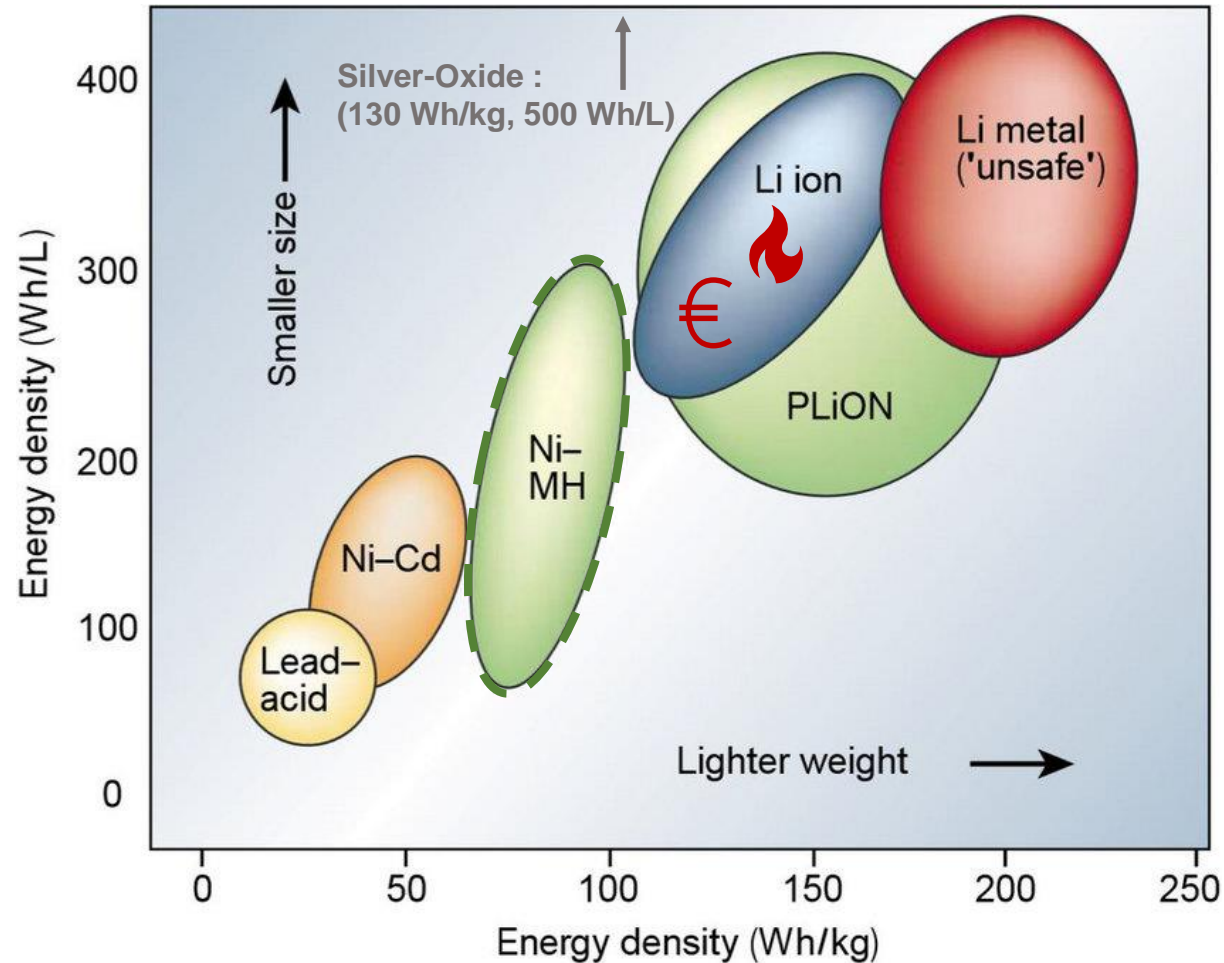
Rechargeable batteries



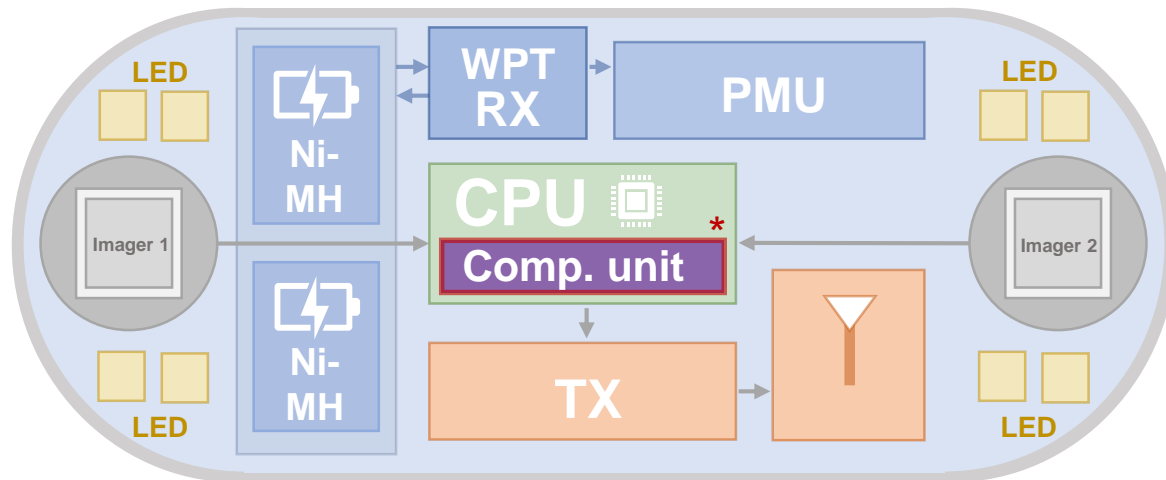
Stringent constraints of rechargeable batteries



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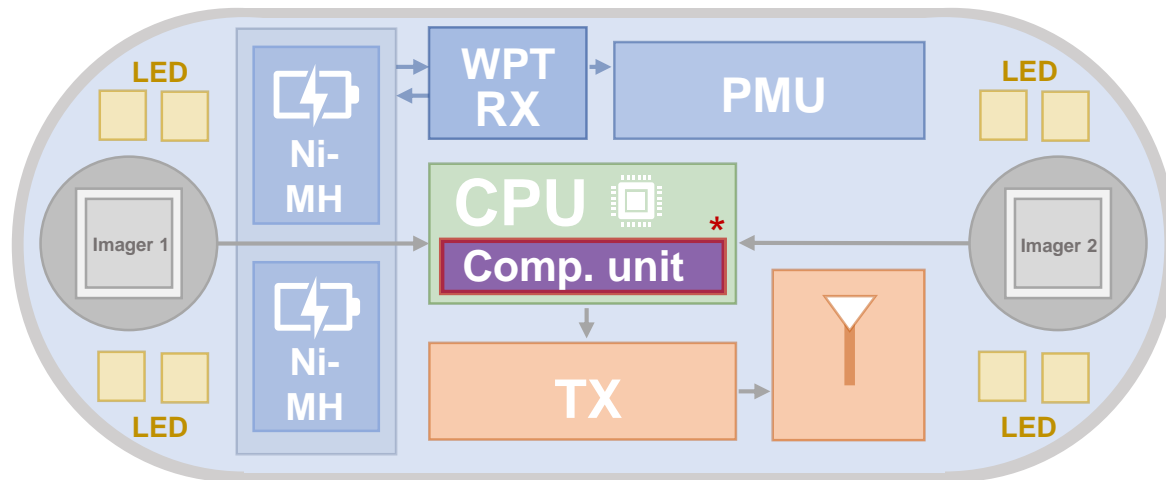


On-chip compression as a key lever to reduce power consumption

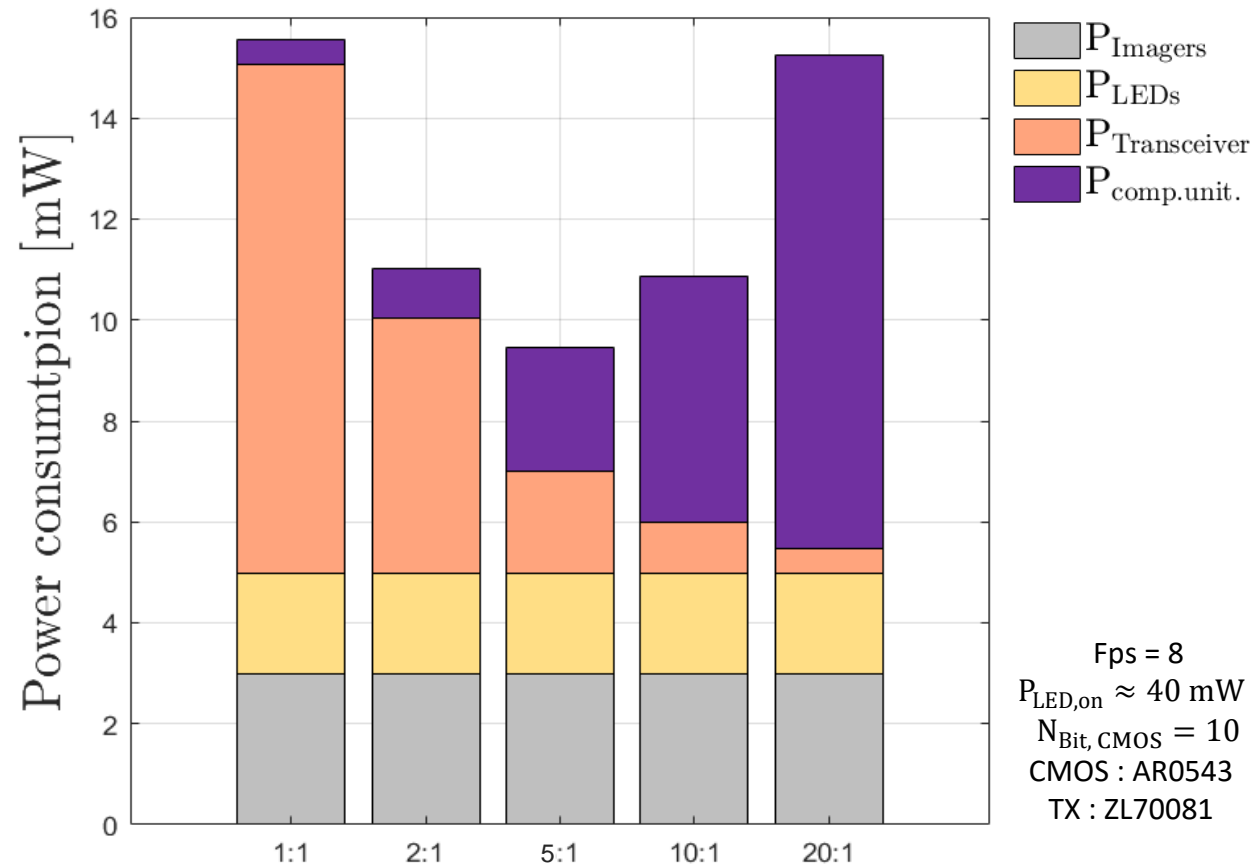


Added with respect to previous architecture
comp. = compression

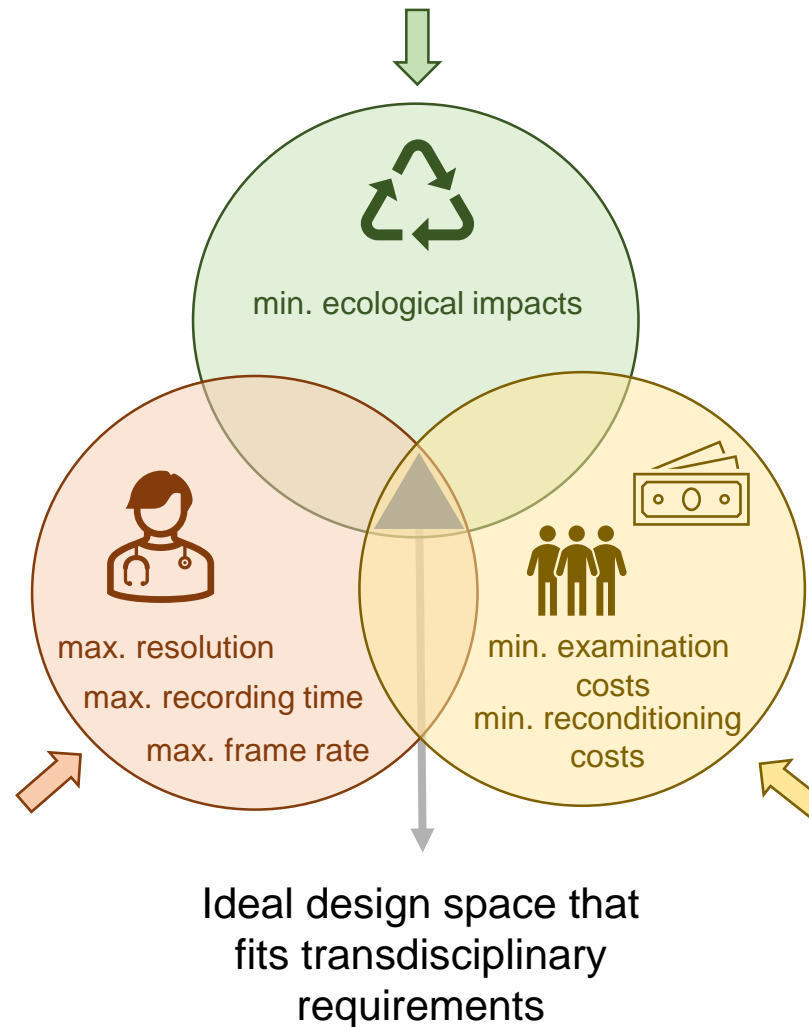
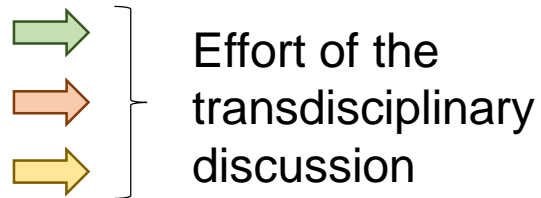
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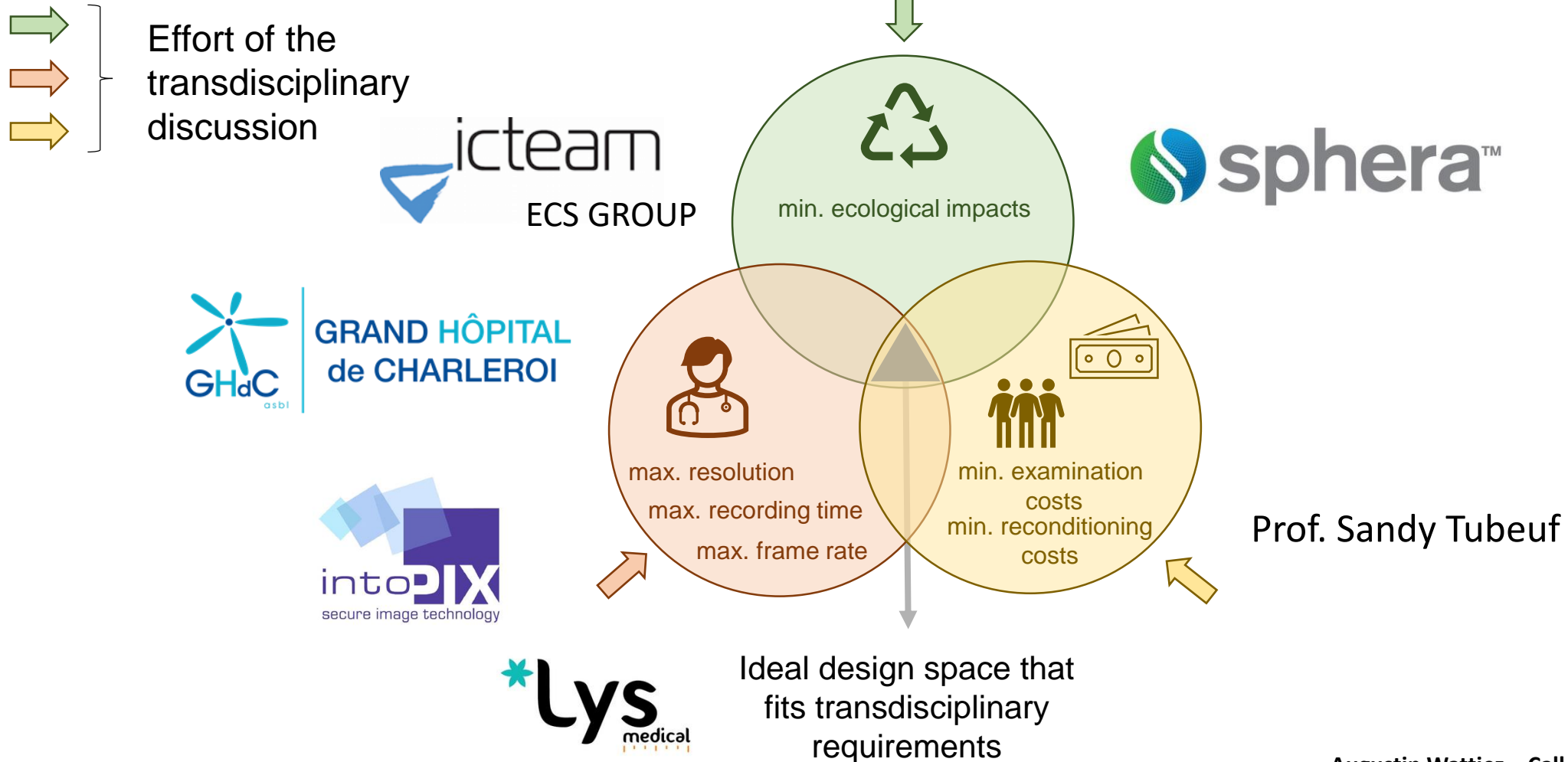
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Transdisciplinary approach

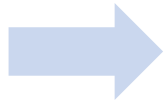
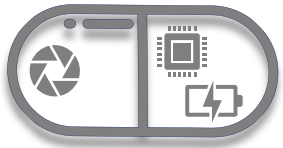


Transdisciplinary approach



Life Cycle Assessments (LCAs)

Architecture #1



**LCA for massive
diagnosis scenario**

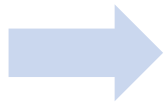
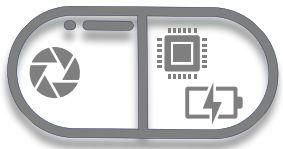


Environmental
impact #1

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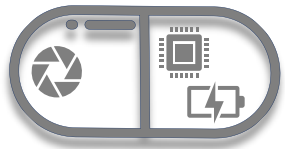
Architecture #N



Environmental
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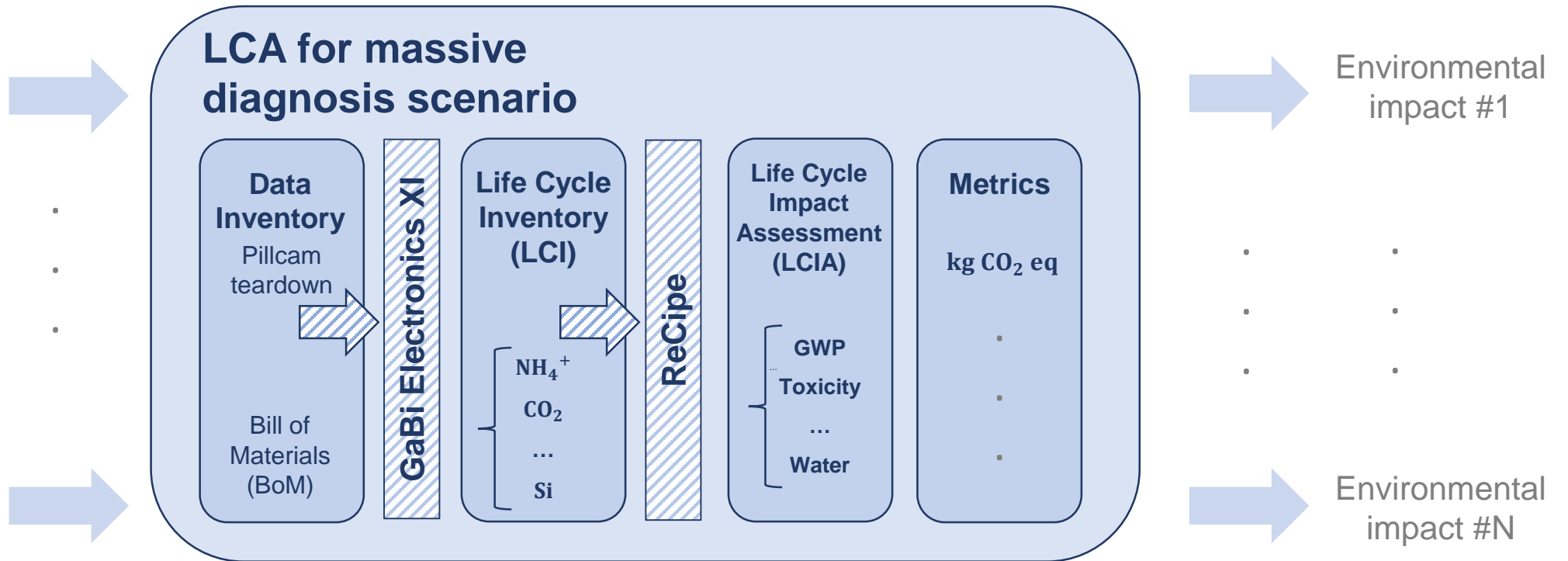
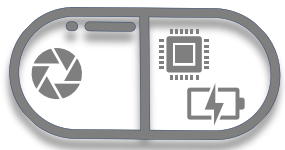
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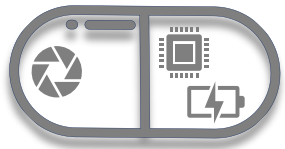
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Architecture #N



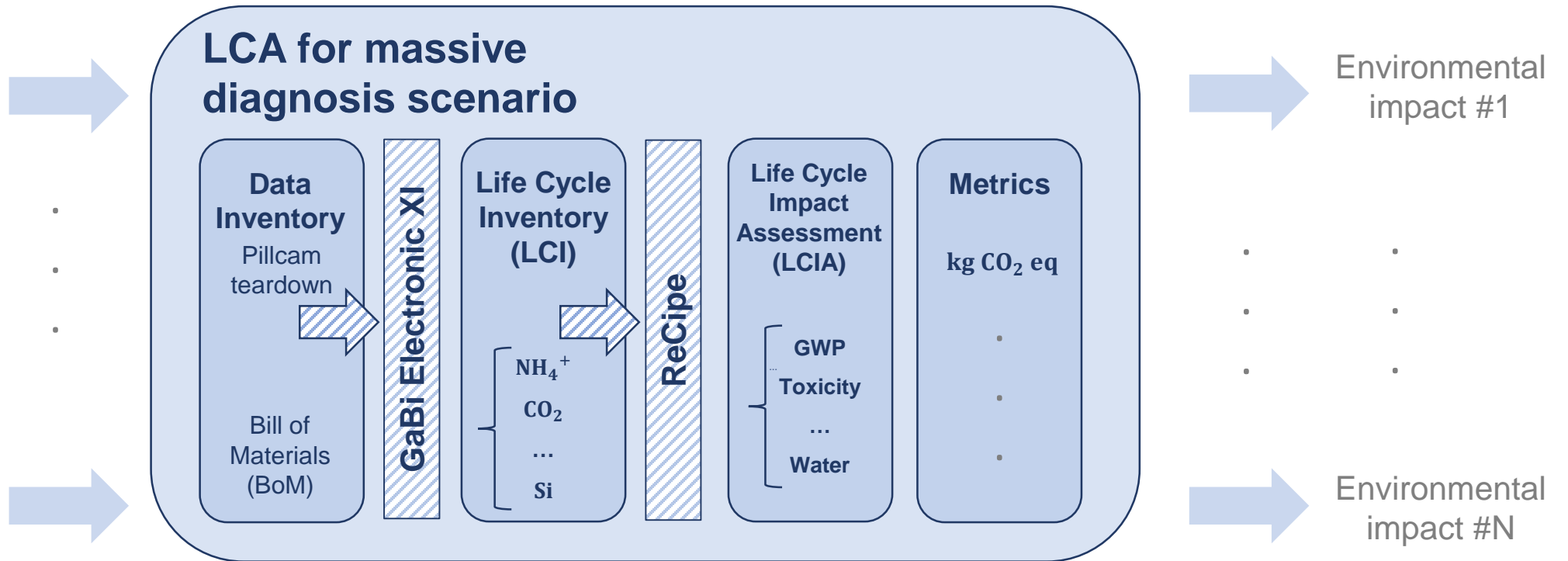
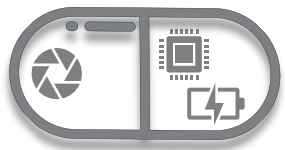
Life Cycle Assessments (LCAs)

Architecture #1



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Architecture #N



LCA Tools :



GaBi Software
PRODUCT SUSTAINABILITY

Thank you

