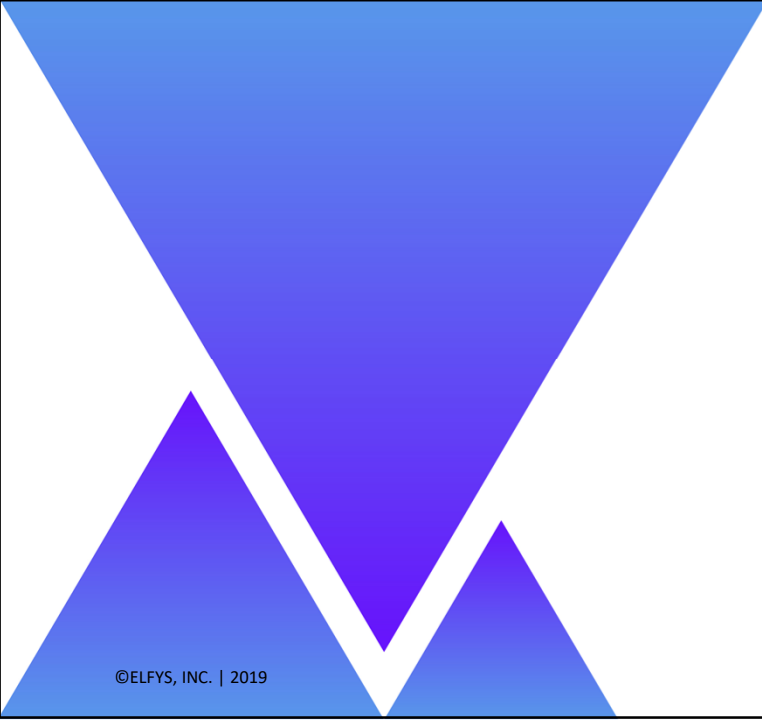


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Dr. Mikko A. Juntunen, CEO  
5.4.2019

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## BLACK SILICON INDUCED JUNCTION PHOTODIODE

**Excuse me?**

Nanotechnology and ALD based  
**Superior photodetector**

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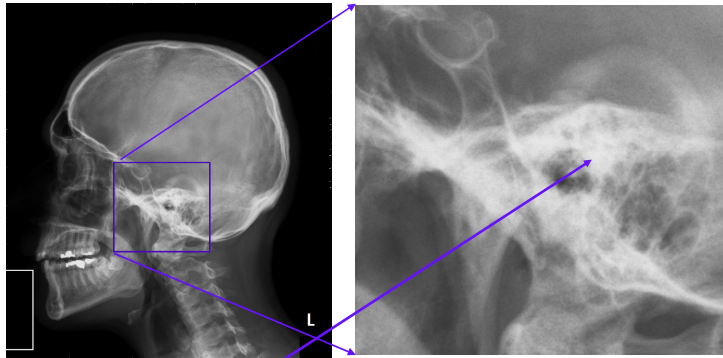
# WHERE DO WE NEED PHOTODETECTORS?

Mobile phones  
 Medical X-ray equipment  
 Spectrometers  
 Headlight and rearview mirror dimmers  
 Satellites and space probes  
 Luggage scanners (e.g. airports)  
 Smoke Detectors  
 Blood particle analyzers  
 Pulse oximeters  
 Flame monitors  
 Cameras  
 Twilight detectors  
 Fiber optic links  
 Bar code scanners  
 Photographic flash control  
 .....

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## BETTER DETECTOR – BETTER PERFORMANCE



- What's in there, can it be seen?
- How much radiation is needed? Could it be reduced?
- Solar cell efficiencies improve all the time. Something to learn?

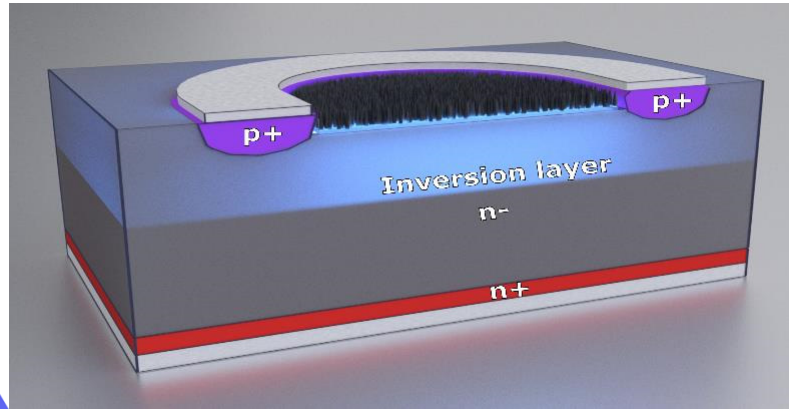
Sure! Savin, et.al. **Nature Nanotechnology** 10 (2015)  
gave a lesson that resulted in...

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Image: Wikimedia commons, Tomáš Vendiš

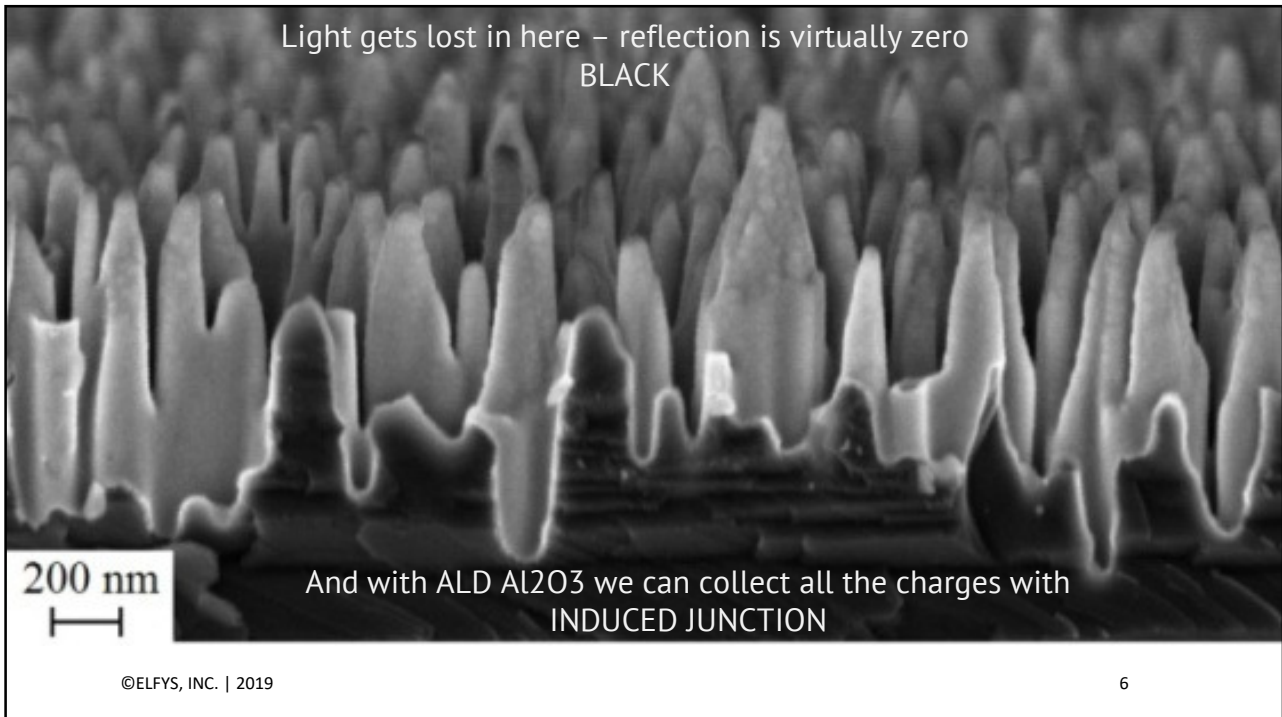
## INVENTION: BLACK SILICON INDUCED JUNCTION PHOTODIODE



Juntunen, et.al., *Nature Photonics* 10, 777-781 (2016)

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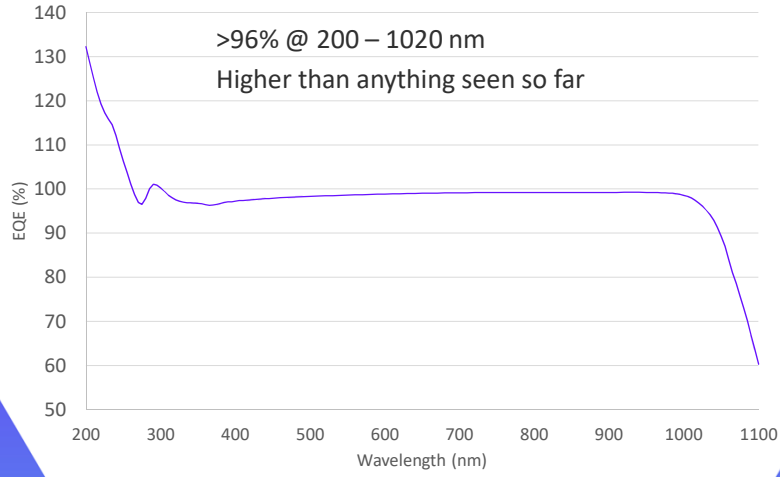
5



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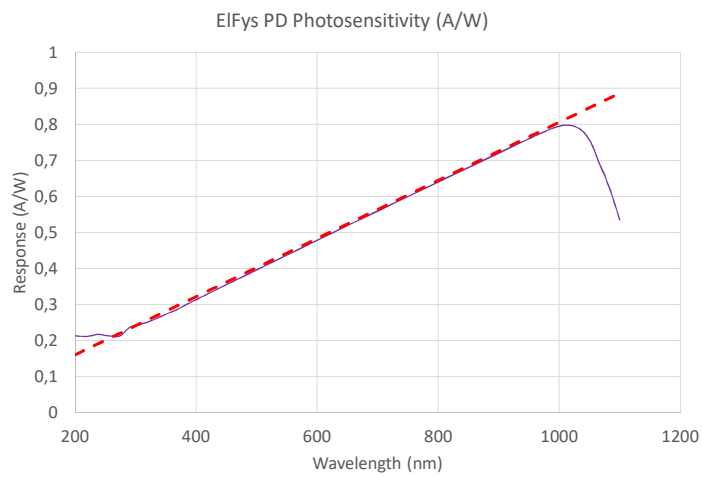
## EXTERNAL QUANTUM EFFICIENCY



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## PHOTOSENSITIVITY



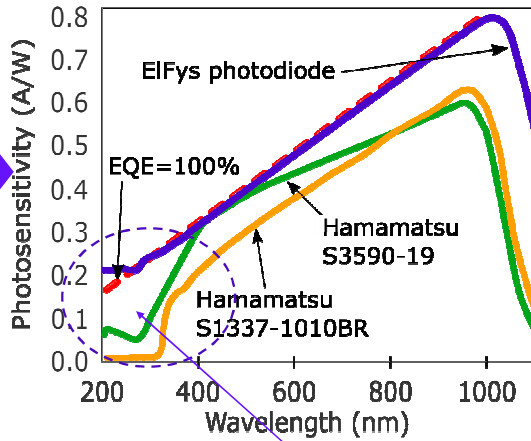
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## BEST PERFORMANCE

## CERTIFIED



**PTB** Physikalisch-Technische Bundesanstalt  
Braunschweig und Berlin  
Nationales Metrologieinstitut



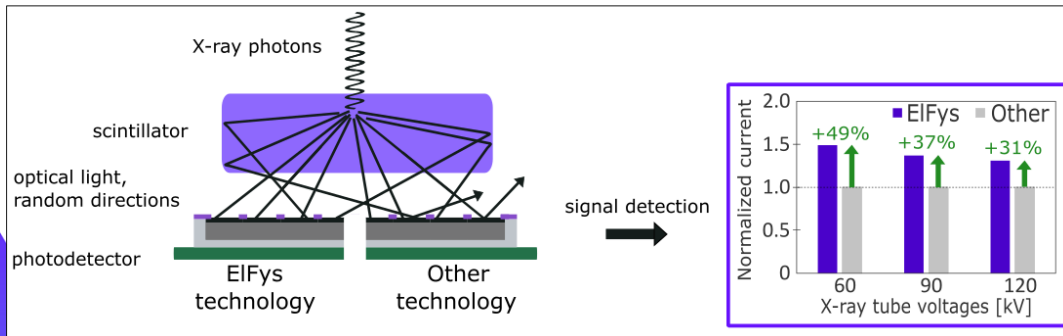
Bericht  
Report

Spectral radiant power responsivity  
of a black silicon photodiode

Ultraviolet sensitivity is several times higher

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## X-RAY APPLICATIONS

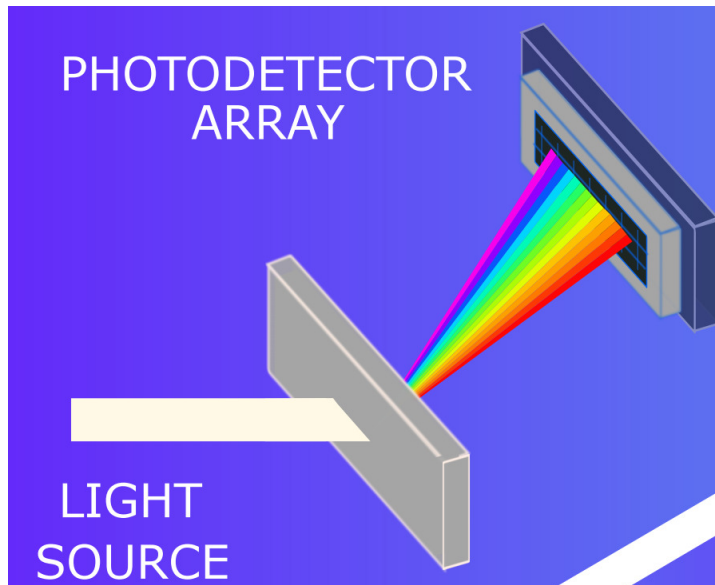


- Less radiation without compromising image quality
  - ~ 30 000 new cancers/year due to medical imaging in USA
  - ALARA (As Low as Reasonable Achievable) is regulatory
- Increased contrast and diagnostic value in medical imaging or accuracy in security screening

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## SPECTROSCOPY



Several times  
higher  
ultraviolet  
signal

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### (12) **United States Patent** **Juntunen et al.**

#### (54) **PHOTODETECTOR STRUCTURES AND MANUFACTURING THE SAME**

(71) Applicant: **Aalto University Foundation**  
(FI)

Inventors: **Mikko Juntunen**, Kirkko  
**Hele Savin**, Espoo (FI)  
Vantaa (FI); **Ville Väyrynen**  
(FI); **Antti Haarabö**

Address: **AALTO UNIVERSITY  
FOUNDATION**

Subject to a

ent is a

Copyright

### **AALTO UNIVERSITY SCIENCE BASED INVENTION AND STARTUP**

All IPR is assigned to Elfys

Thanks also to

- Euramet/EMRP (EU)
- University of Helsinki
- Tekes -> Business Finland
- Detection Technology Oyj
- Naps Solar Group
- Profium Oy
- Oxford Instruments Analytical Oy
- Mekitec Oy
- HS Foils -> Ametek Finland Oy
- ESA
- Ambassade de France à Helsinki
- And many others

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(19)



SUOMI - FINLAND  
(FI)

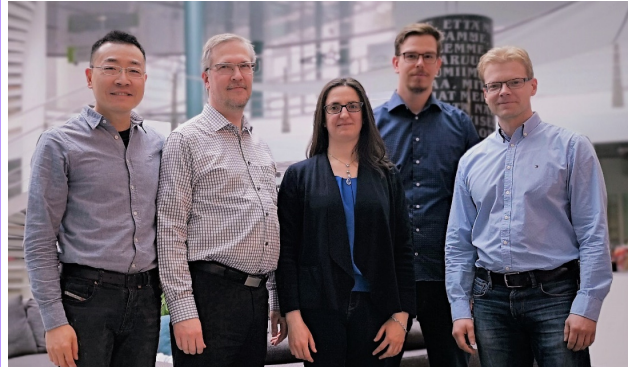
PATENTTI- JA REKISTERIHALLITUS  
PATENT- OCH REGISTERSTYRELSEN  
FINNISH PATENT AND REGISTRATION OFFICE

(73) Haltija - Innehavare - Proprietor  
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