GRATXRAY

Breast Cancer Imaging

Accurate and Painless

A one-stop solution for breast cancer diagnosis

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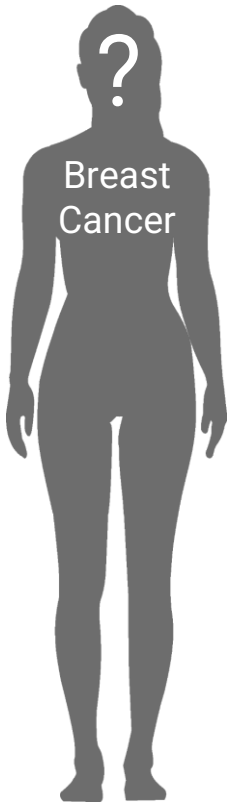
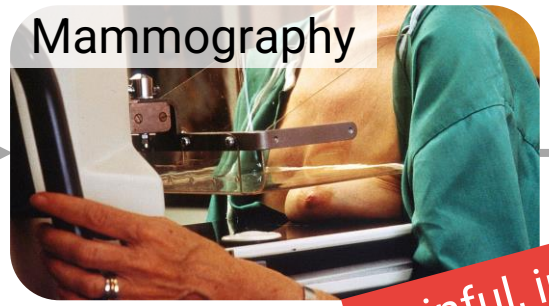
PAUL SCHERRER INSTITUT PSI spin-off

Spinoff ETH zürich

Problem: Breast Cancer Diagnosis Workflow





Painful, inconvenient

Operator dependent

Time-consuming, expensive

Positive?

Only 50% are confirmed to be positive!

- Inaccurate
- Inefficient
- Inconvenient

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Innovation: Major breakthrough in high-contrast X-ray imaging

2005
Invention

Paul Scherrer Institute (PSI) &
Swiss Federal Institute of Technology (ETH)

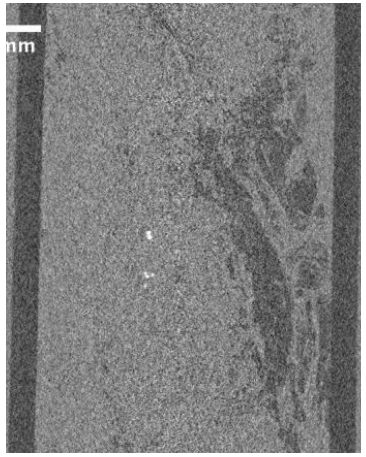
Grating Interferometry
X-ray imaging for soft tissue

8 Patents

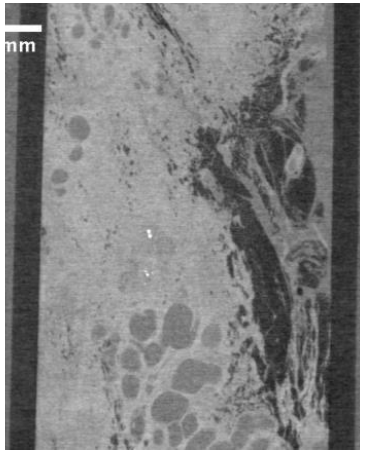
Technological
Development

2017 (founding year)
GratXray

Exclusive rights to use the knowledge and patents for medical applications



Standard X-ray



GratXray X-ray

New platform for
high-contrast X-ray imaging

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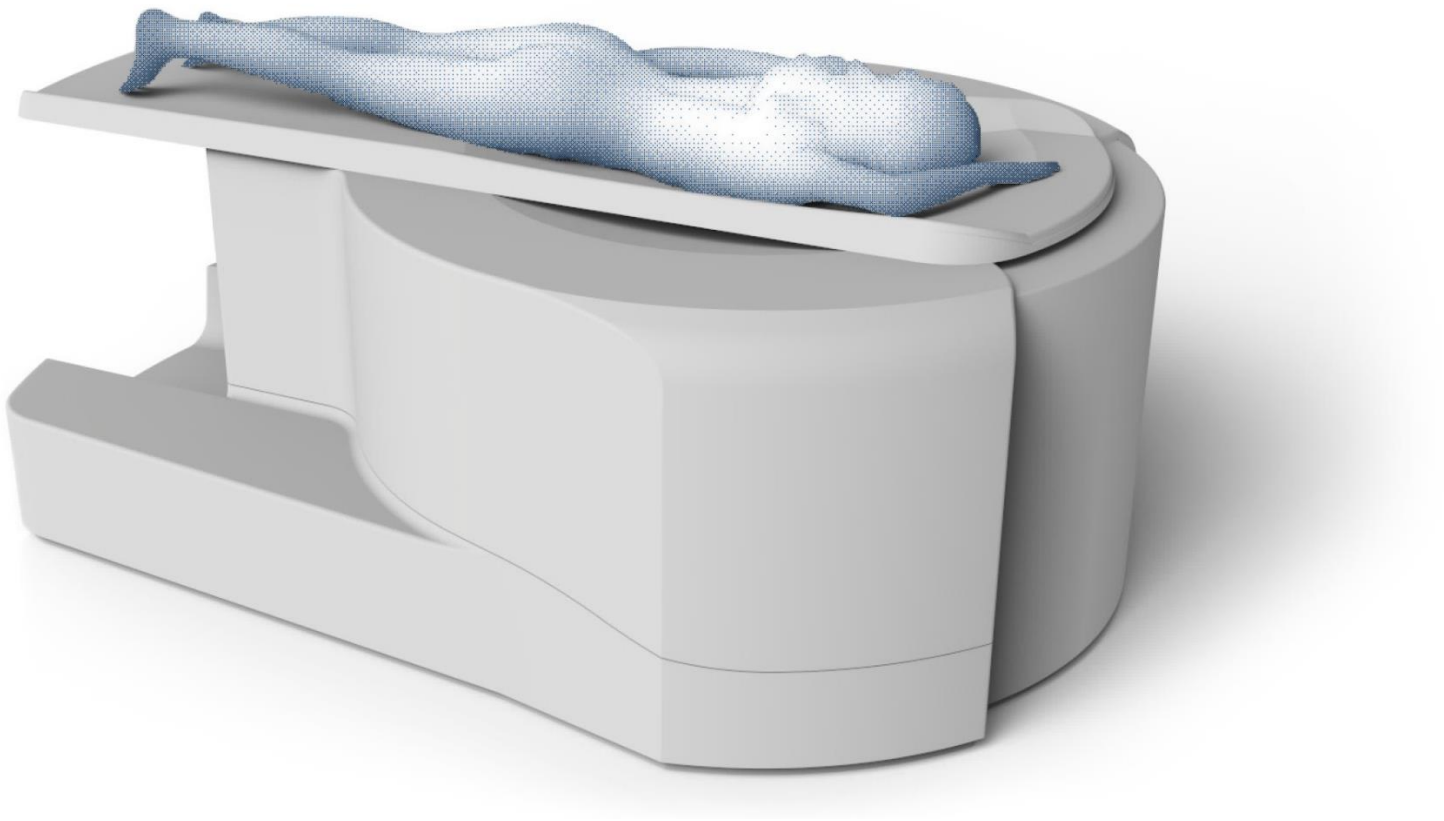


Solution

Unprecedented contrast
Excellent visibility of all tumor types

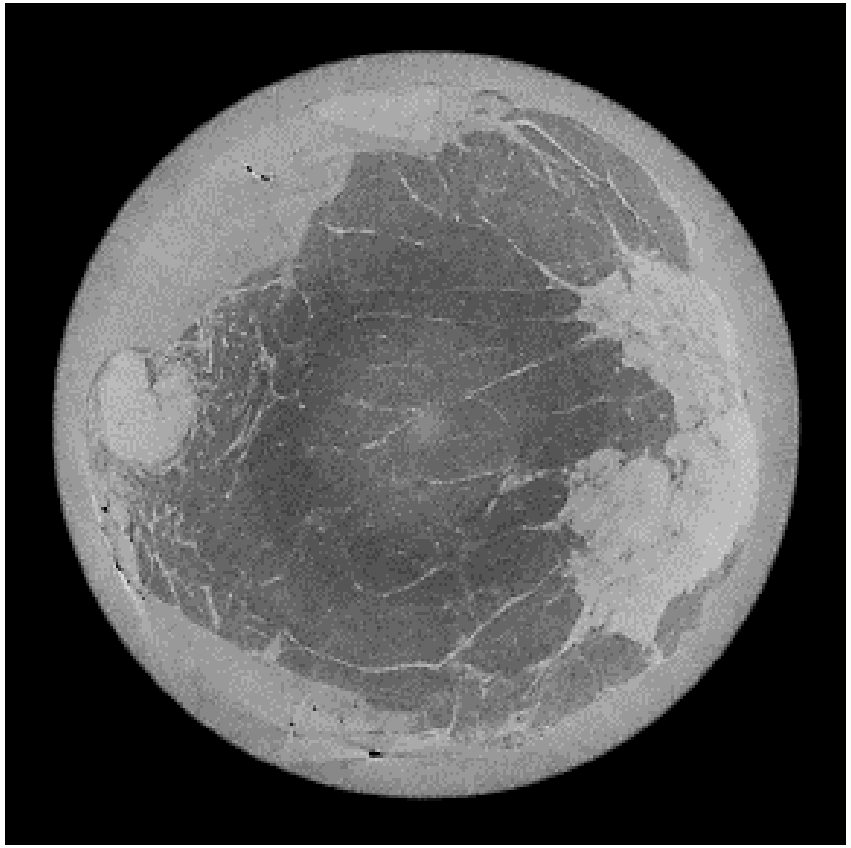
No tissue overlap (3D)
Accurate diagnosis also in dense breast tissue

No breast compression
Improved patient comfort

No contrast agent
Less side effects

One-stop Solution for Breast Cancer Imaging

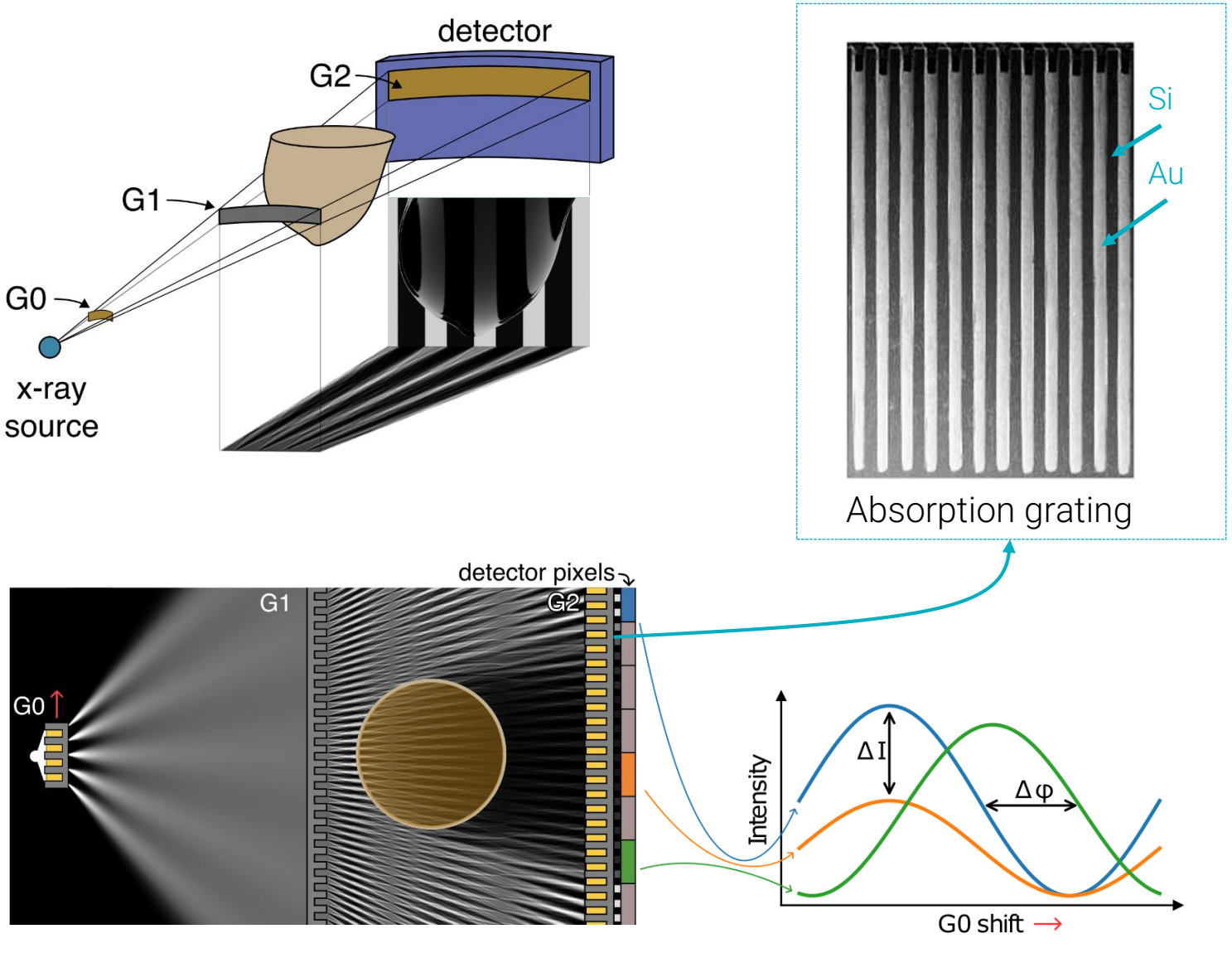
Prototype – Human Mastectomies/Tumorectomies



First results proved the performance of the device → Optimization process started!

M. Rawlik *et al.*, Optica 10(7):938-943, 2023

Grating Interferometry



Talbot-Lau Interferometer to retrieve three independent signals:

- Attenuation
- Differential phase shift
- Darkfield

G0	Line sources
G1	Phase shift (π)
G2	Analyzer grating

M. Rawlik *et al.,* **Optica** 10(7):938-943, 2023
D. Josell *et al.,* **J. Electrochem. Soc.** 167 132504, 2020

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Optimize Performance of the Interferometer

Challenges related to microfabrication

- Increase aspect ratio beyond 100

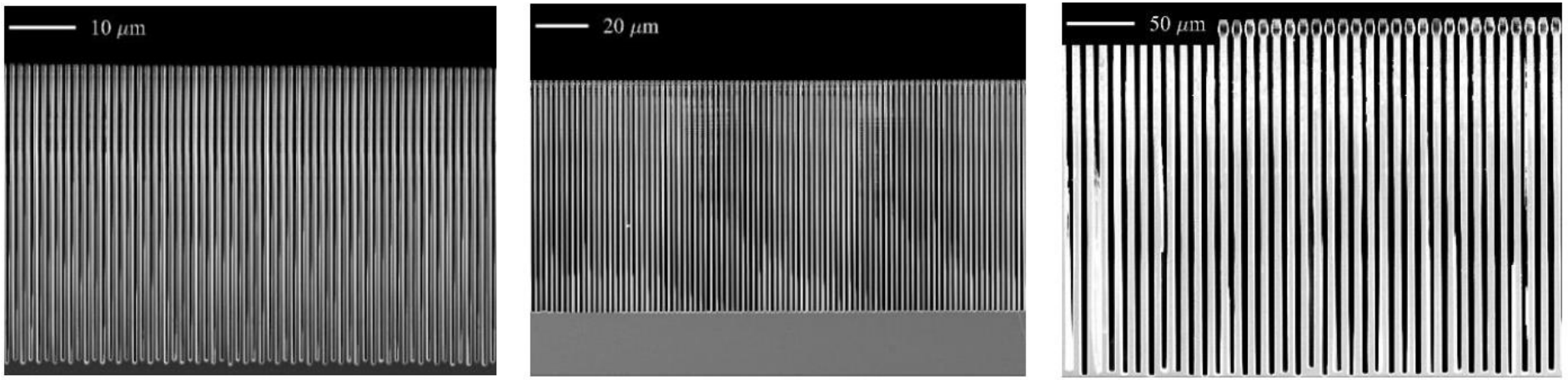

Figure 6. SEM images of cross-section of gratings. Grating period, height and aspect ratio: (**a**) $p = 1.2$ μm, $h = 40$ μm, $\alpha = 67$; (**b**) $p = 2$ μm, $h = 77$ μm, $\alpha = 77$; (**c**) $p = 9.92$ μm, $h = 231$ μm, $\alpha = 47$.

Shi *et al.* Towards the Fabrication of High-Aspect-Ratio Silicon Gratings by Deep Reactive Ion Etching, Micromachines, 2020
Shi *et al.* Optimization of displacement Talbot lithography for fabrication of uniform high aspect ratio gratings, Jpn. J. Appl. Phys., 2021

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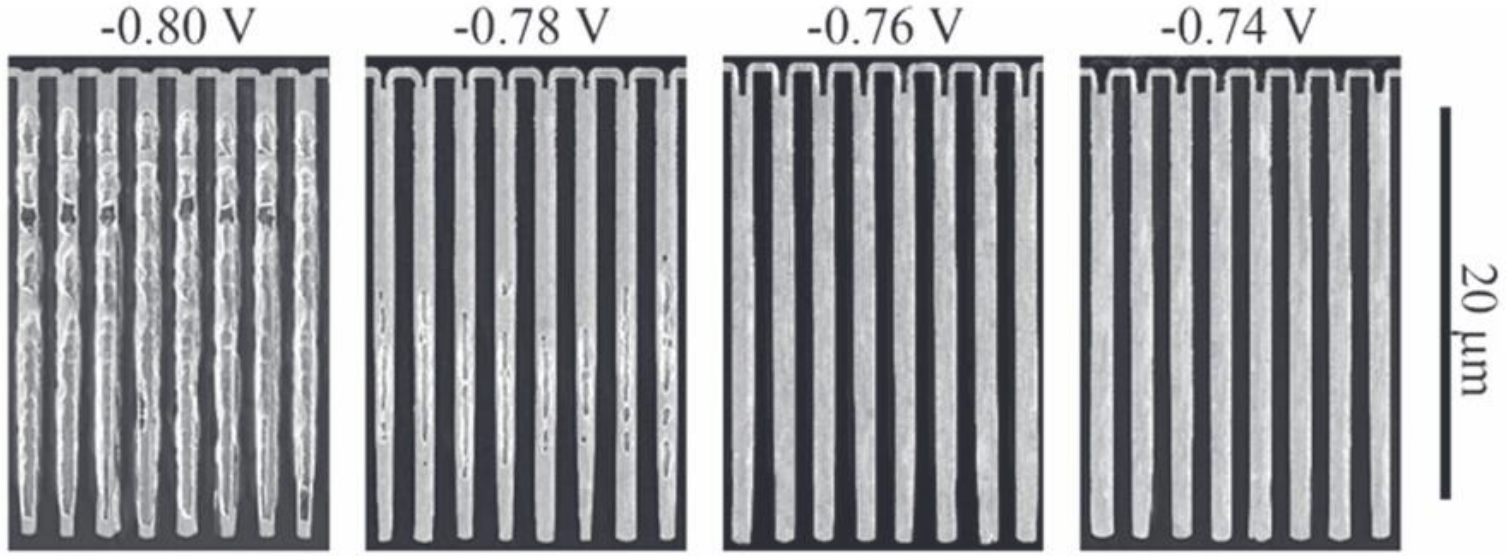
Optimize Performance of the Interferometer

Challenges related to microfabrication

- Improve quality (homogeneity, shape control, minimize defects)



Jefimovs *et al.* Fabrication of X-ray Gratings for Interferometric Imaging by Conformal Seedless Gold Electroplating, Micromachines, 2021
Josell *et al.* Bottom-Up Gold Filling in New Geometries and Yet Higher Aspect Ratio Gratings for Hard X-ray Interferometry, ECS, 2021

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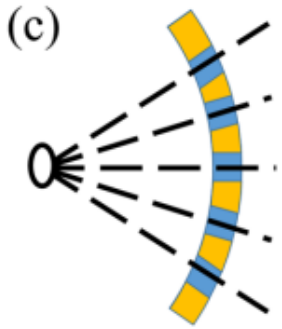
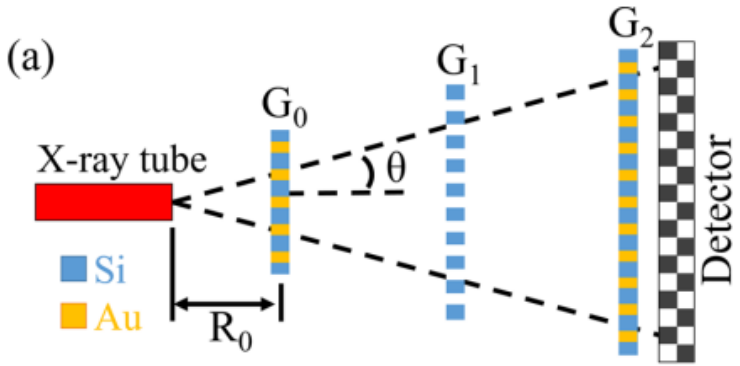
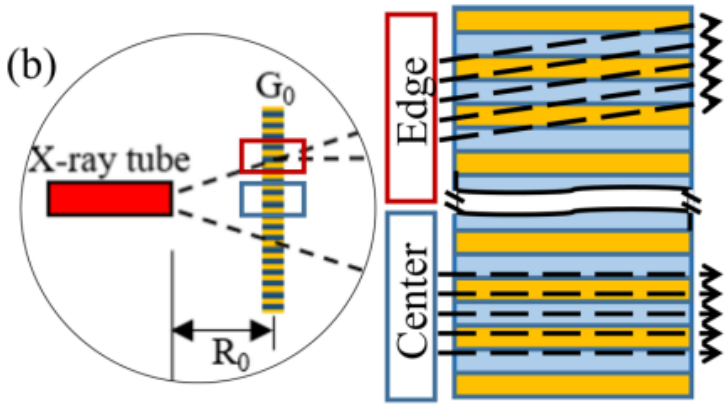
Optimize Performance of the Interferometer

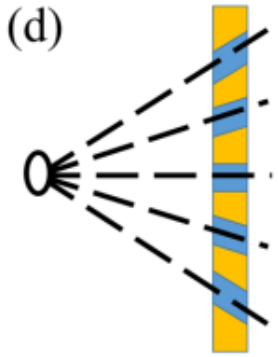
Challenges related to microfabrication

- Improved geometry of G0
  → bending vs. fan shape









Shi *et al.* Laboratory X-ray interferometry imaging with a fan-shaped source grating, Optics Letters, 2021
Shi *et al.* High aspect ratio tilted gratings through local electric field modulation in plasma etching, Applied Surface Science, 2022

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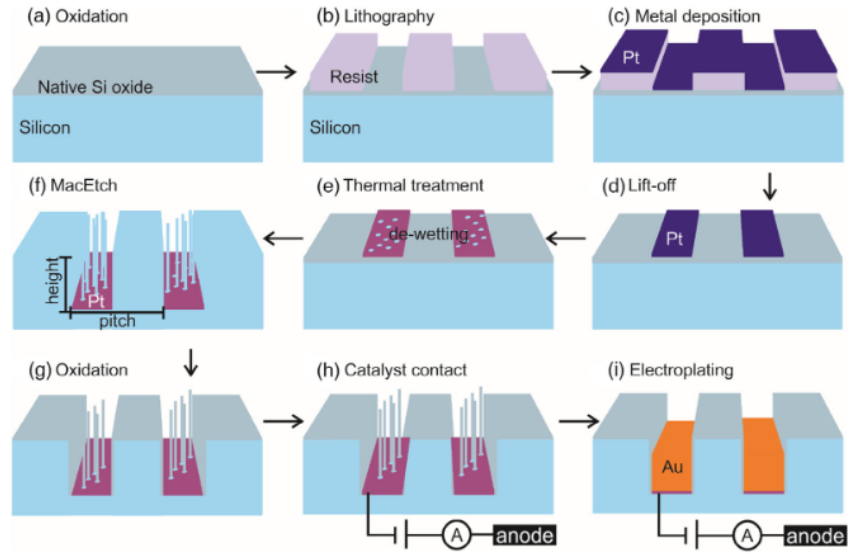
Optimize Performance of the Interferometer

Challenges related to microfabrication

- Testing alternative approaches to optimize the processes
- Moving towards 8-inch
- ...



e.g.: MacEtch

Romano *et al.* **High-Aspect-Ratio Grating Microfabrication by Platinum-Assisted Chemical Etching and Gold Electroplating**, Adv. Eng. Mater., 2020
Romano *et al.* **Metal assisted chemical etching of silicon in the gas phase: a nanofabrication platform for X-ray optics**, Nanoscale Horiz., 2020
Shi *et al.* **High aspect ratio arrays of Si nano-pillars using displacement Talbot lithography and gas-MacEtch**, Mater. Sci. Semicond, 2023

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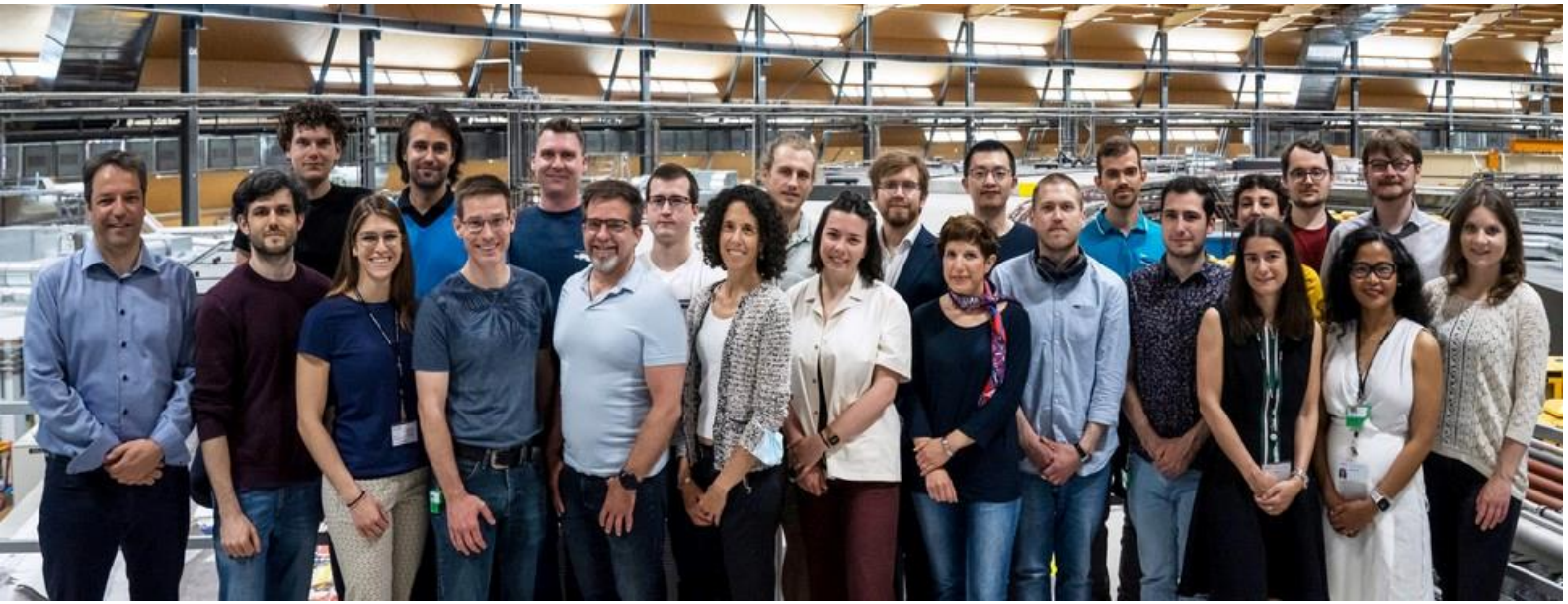
Acknowledgment



Close collaboration with PSI and ETH

- Research group of Prof. Dr. Marco Stampanoni
- Microfabrication team of Dr. Lucia Romano

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Thanks a lot!

Improved breast imaging to save women's lives!

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