Incoherent Diffraction Imaging with hard X-rays

Experimental Campaign Preparation

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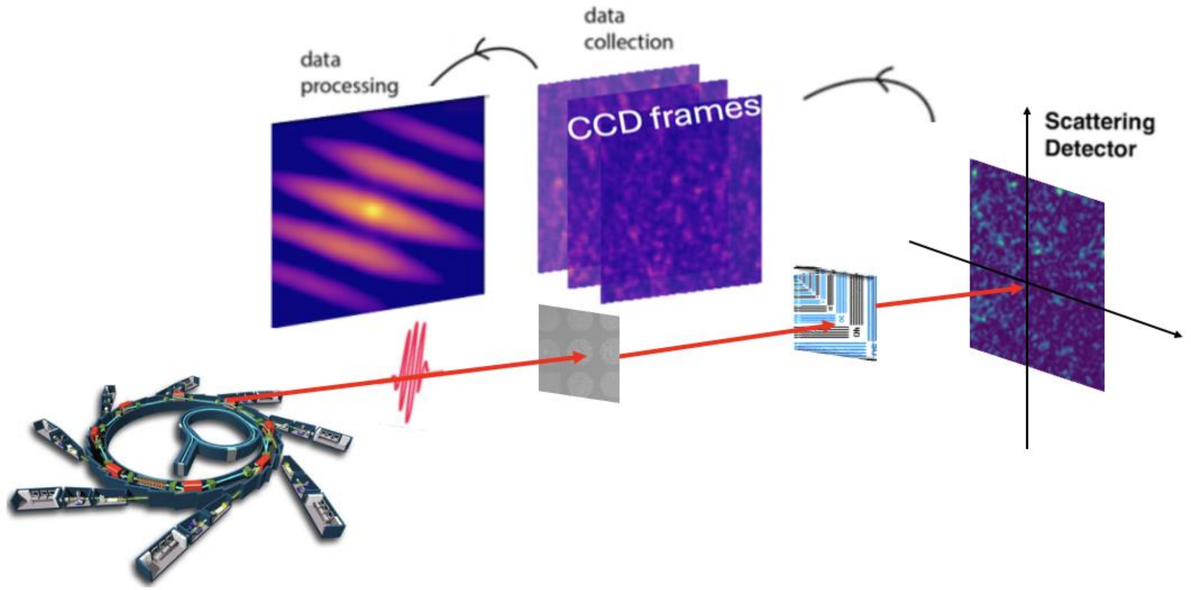

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Proposed goals

Main goal

Experimental work with IDI using hard X-rays at a synchrotron facility

PIC2 Project

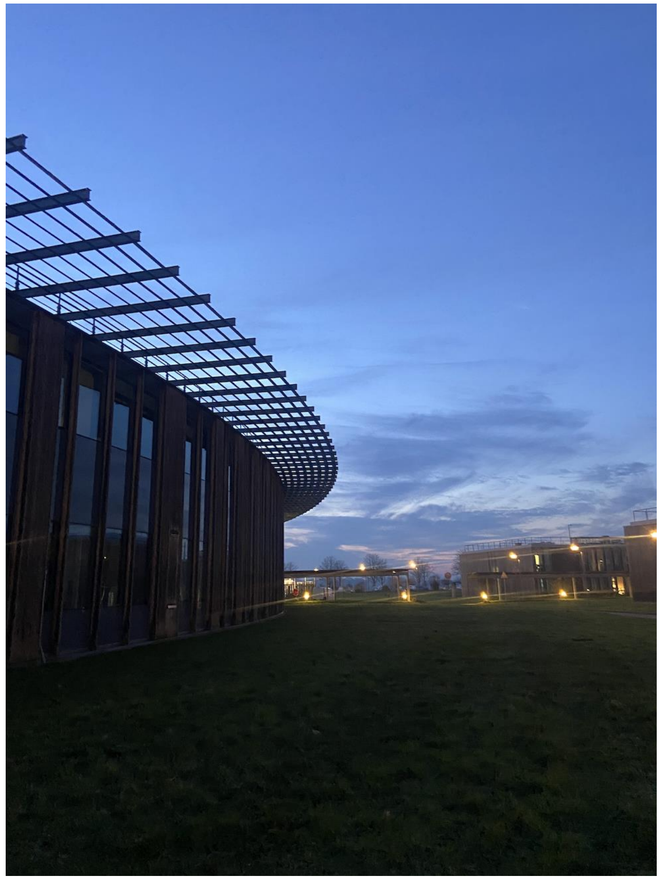
➡ Preparation of the experimental campaign

- Getting familiar with working principles
- Perform numerical simulations
- Design the experimental setup

X-ray source

SOLEIL SYNCHROTRON → Synchrotron Radiation from infrared to X-rays

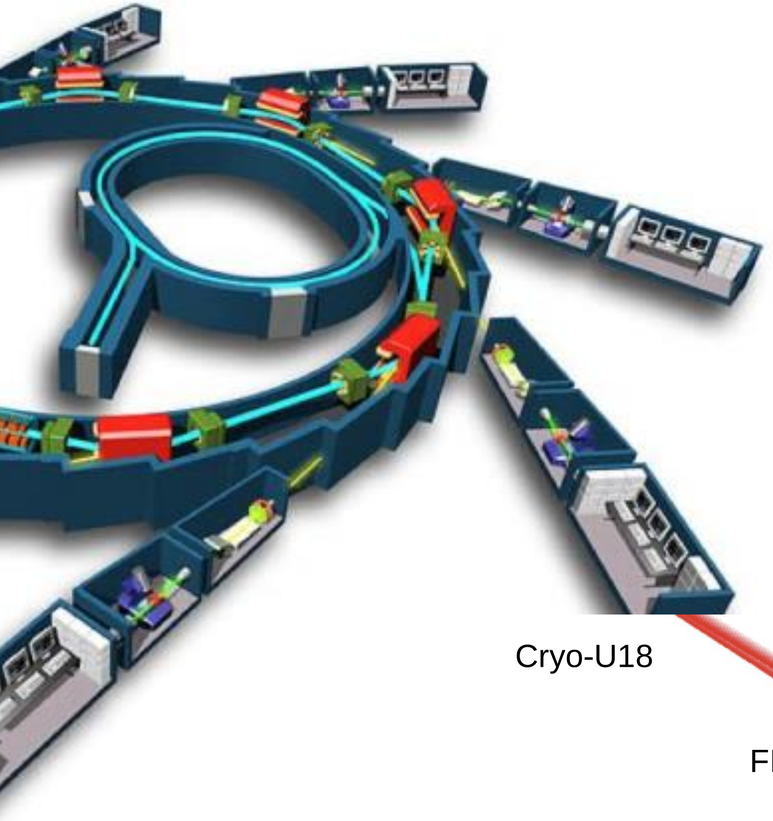
29 beamlines!

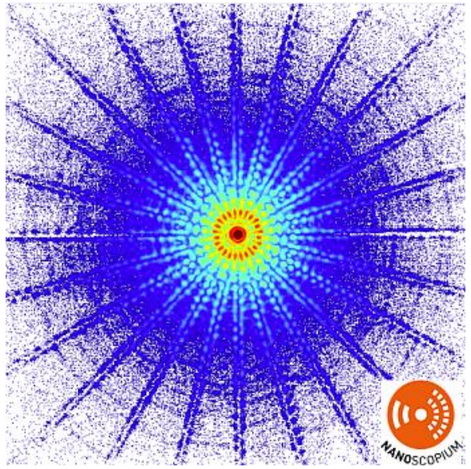


* A. Somogyi, et al.,“Optical design and multi-length-scale scanning spectro-microscopy possibilities at the nanoscopium beamline of synchrotron soleil,” Journal of synchrotron radiation, 2015

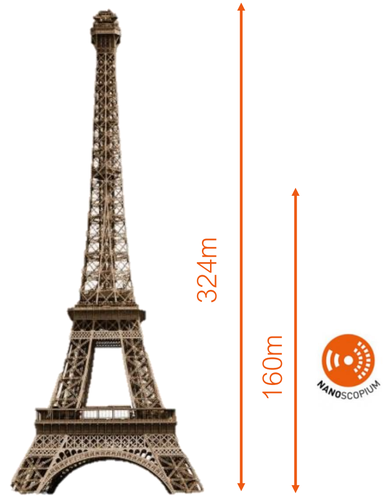
X-ray source

➢ Synchrotron Radiation from the Nanoscopium beamline





- ✓ 5–20 keV range --> 8keV
- ✓ <100 nm resolution!
- ✓ 160m long
- ✓ Beam size of 75–250 nm



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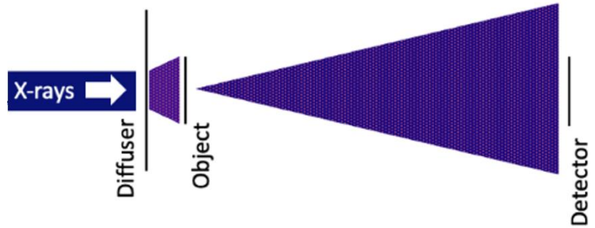
Diffuser

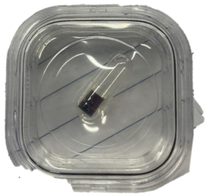
Creating a PTLS

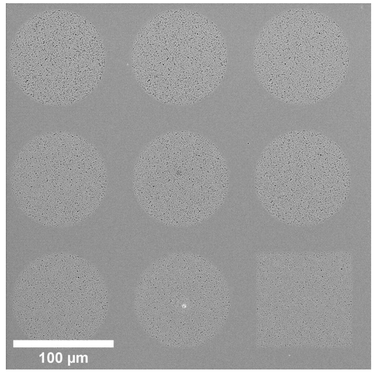
X-ray ⊕ Diffuser = Pseudo-Thermal Light Source

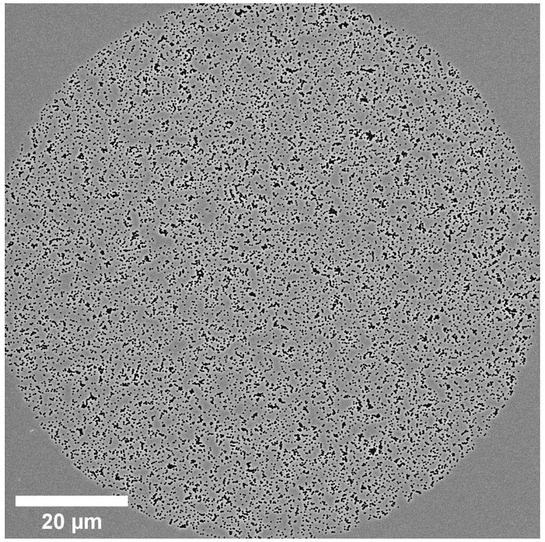


The diffuser

- 300 nm holes ⟶ independent emitters
- Unordered but known locations ⟶ spatial incoherence
- 1.6 μm thick tungsten layer ⟶ π phase-shift







* K. Lee et al.,“Direct high-resolution x-ray imaging exploiting pseudorandomness,”,2023.

Resolution Target

Material

- Gold features
  - Dense
  - High Z

→ Amplitude and Phase mask

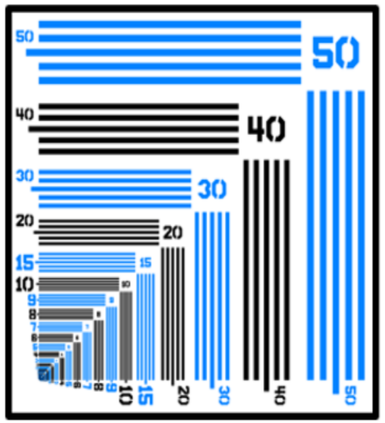
↓

Resolution Target

Chosen Target

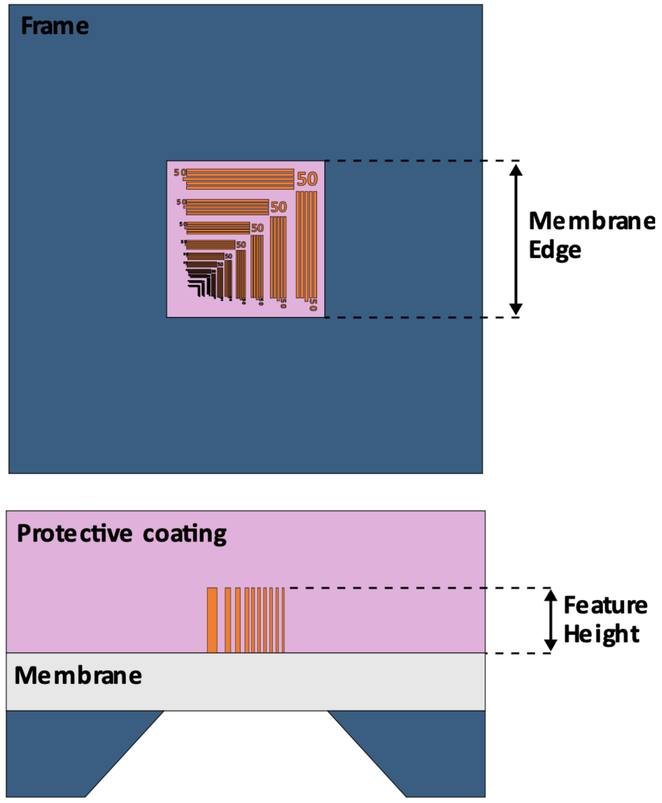
- Simple design layout

MicroCT Test Target Design Layout

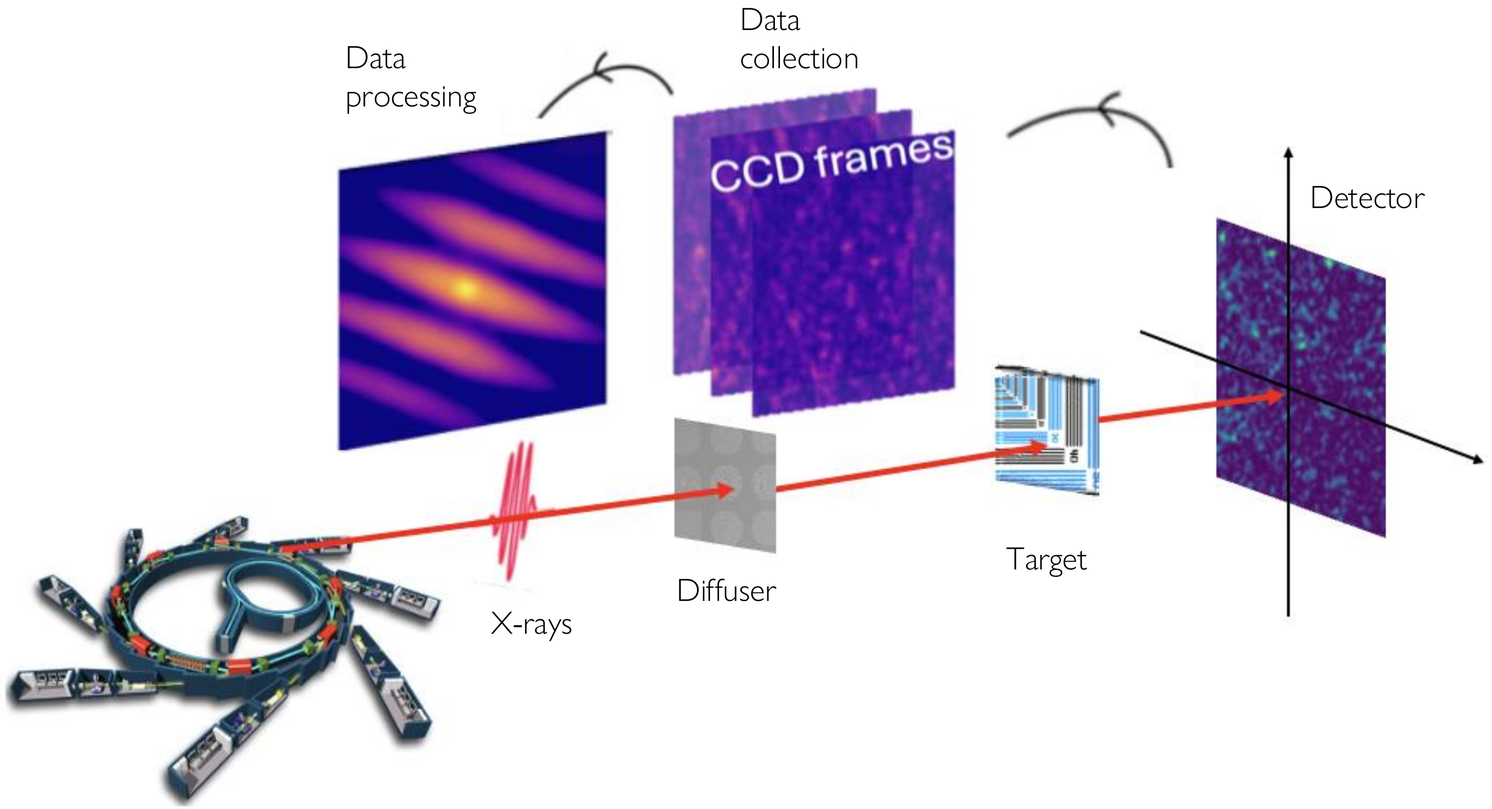


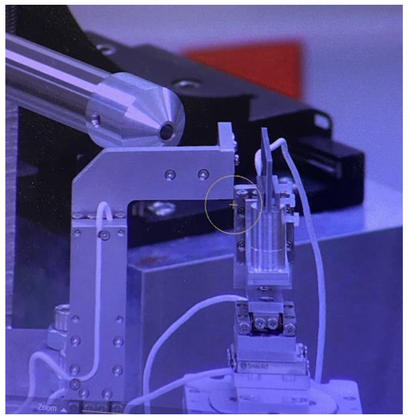
- Features with sizes from 50-0.2 µm

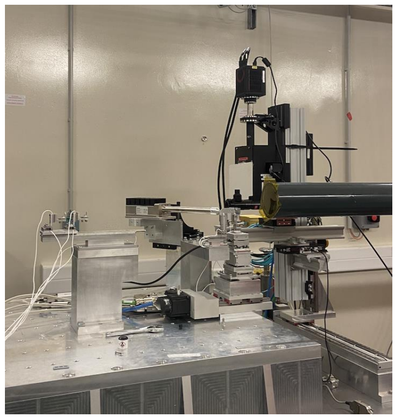
Chip design



Final Setup Design







Constrains and Conditions

CDI Simulations - Resolution

Double-slit experiment

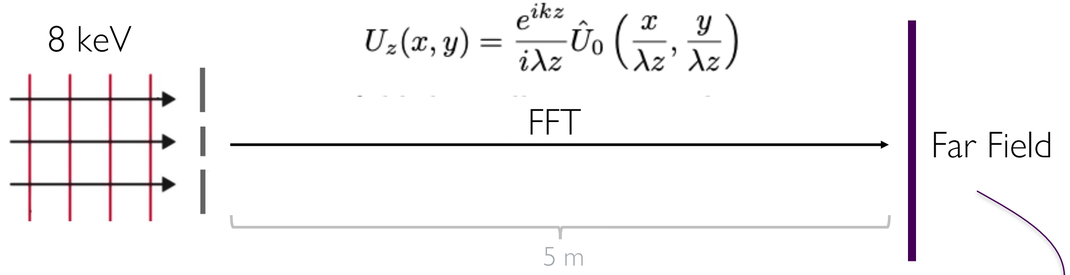
- Spacing of the fringes ⟶ $\omega = \frac{\lambda z}{d}$

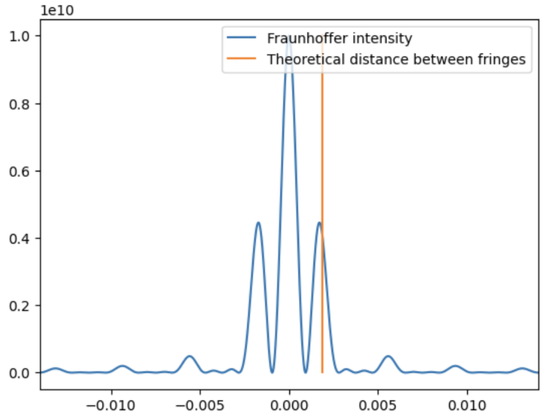
$$\omega > \textbf{pixel size}$$

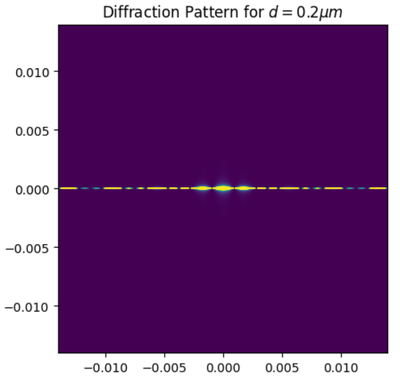
Resolvable feature size range: $10 - 0.2\ \mu m$

CDI Simulations - FOV

- Ideal FOV ⟶ Minimum 5 fringes visible







Conclusions & Future Work

➢ IDI represents a significant advancement over CDI

Avoid some of CDI's core restrictions: sample support and the need for highly coherence

➢ The experimental campaign was prepared sucessfully

Theoretical necessary concepts in place

Development of a diffuser, resolution target and setup design

❑ IDI Simulations

Perform detailed simulations that mimic the exact IDI setup to anticipate the experimental results at the lab during beamtime

❑ Beamtime at SOLEIL synchrotron

Data acquisition at experimental phase

Following data post-processing, reconstruction, and further analysis.

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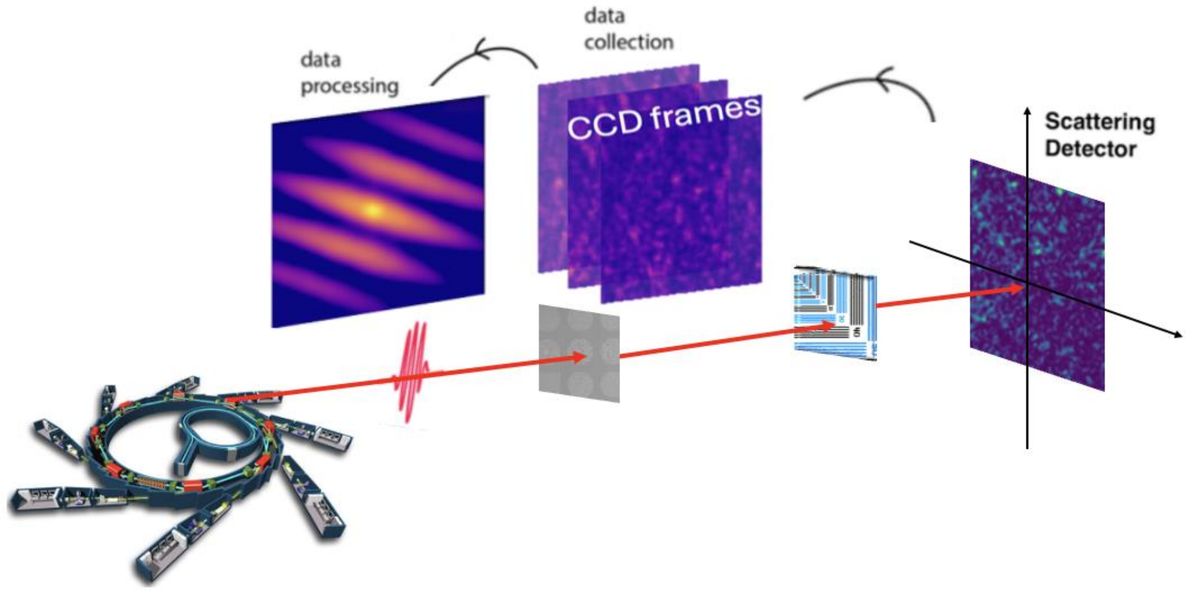
Experimental Campaign Preparation

Thank you for your attention!



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