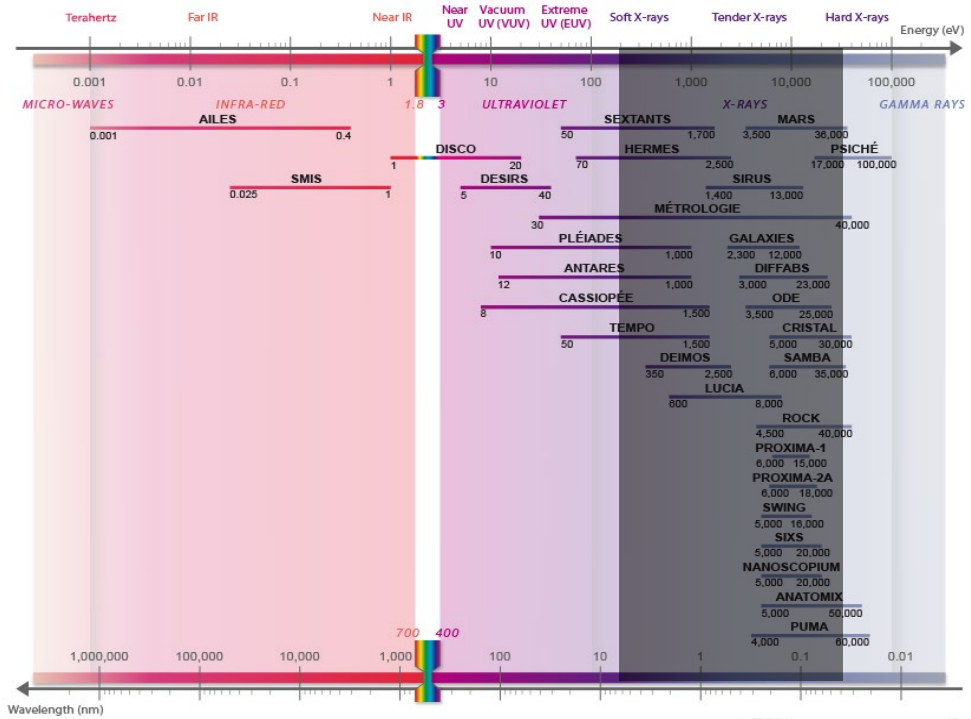
Facility Report : Synchrotron SOLEIL

Arkadiusz Dawiec, on behalf of the Detector Group

IFDEPS24, 18/03/2024

SOLEIL Synchrotron

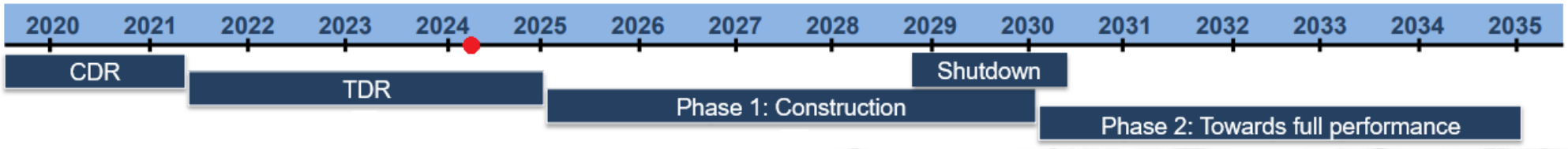
- 3rd generation synchrotron
- Ee = 2.75 GeV
- 354 m circumference
- 29 beamlines + support labs
- users since 2008
- energies : from IR to hard X-Rays



ongoing detectors

R&D programs

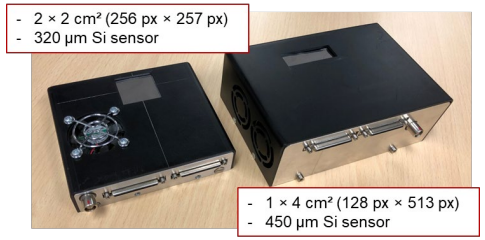
The upgrade project : SOLEIL II



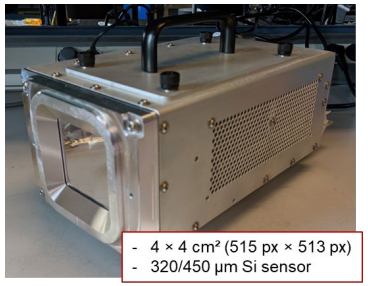
Detectors R&D @ SOLEIL : Tender/Hard X-rays

UFXC project

- Originally developed for time resolved experiments
  - improved pump-probe method by introducing shot-to-shot normalization (second probe)
- pixels : 75 × 75 µm² with 2 counters/thresholds
- linear count rate up to 2×10^6 ph/pix/sec (max 10^7 ph/pix/sec)
- different readout modes : standard, continuous and pump-probe-probe
- fully (natively) integrated within Tango Control system

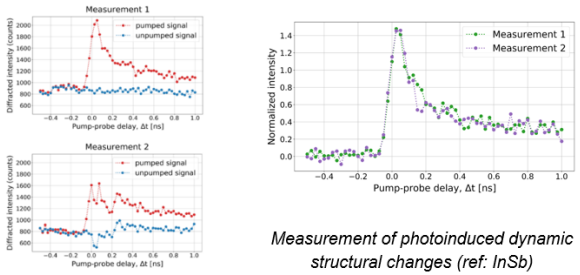


In regular use on beamlines



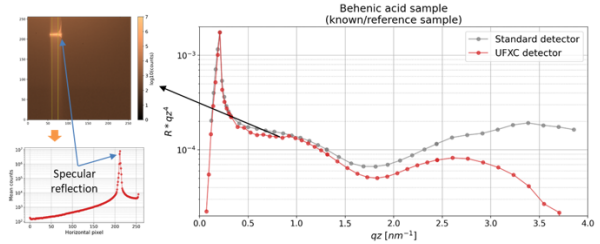
Software being finalized

Pump-probe-probe TR XRD



Measurement of photoinduced dynamic structural changes (ref: InSb)

Liquid XRR

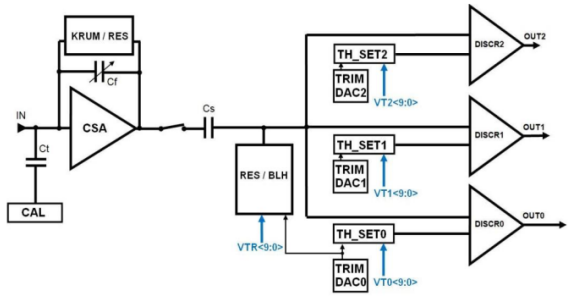


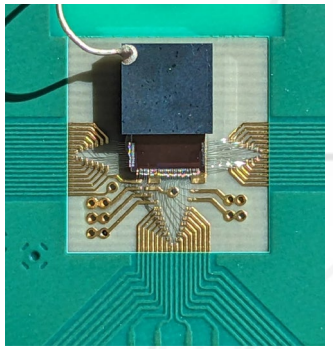
Measured normalized intensity of the specular reflection (ex: behenic acid layer on liquid)

[A. Dawiec et al., IEEE NSS Conf Proc (2021)]

UFERI project

- Ultra Fast Energy Resolved Imager
- Goal application: pseudo-Laue diffraction experiments with pink beam
- first prototype realized and characterized (design by AGH)
  - pixels : 75 × 75 µm² with 3 counters/thresholds
  - In-pixel offset and gain corections
  - linear count rate up to almost 10^7 ph/pix/sec





Complete characterization and performance measurements are ongoing => upcoming publication

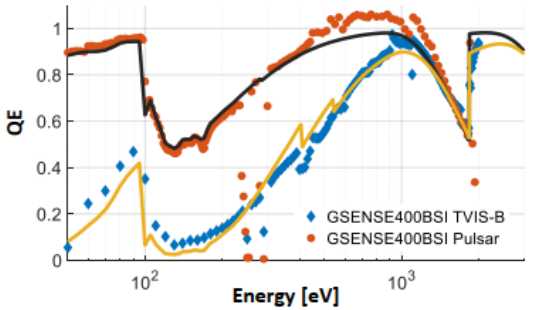
[F. Orsini et al., IWORID (2023)]

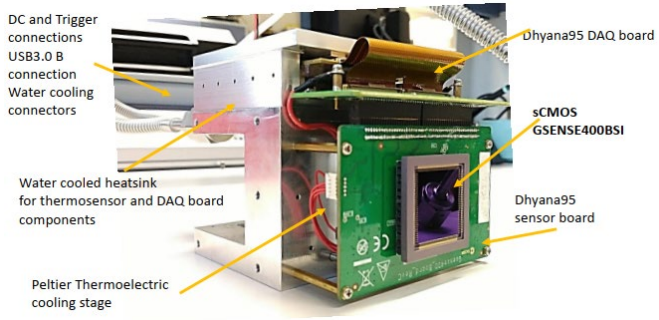
Detectors R&D @ SOLEIL : Soft X-Ray

In-house built soft X-ray CMOS-BSI camera

- First version based on TUCSEN Dhyana95 camera (4 Mpx GSENSE400BSI)
- Min. energy ~100 eV
- In-house built for vacuum and fully characterized
- Commercialazed by AXIS Photonique company
- Several versions in regular use at SOLEIL:
  - different geometries and sensors

Camera specification	
Resolution	2048 x 2048
Pixel size	11 µm x 11 µm
Sensitive area	22.5 mm x 22.5 mm
Shutter type	Rolling shutter
Dark noise	1.7 e- (HRD)
Full well charge	85 ke- (Low Gain mode) 30 ke- (HDR mode) 2 ke- (High Gain mode)
Frame rate	24 fps (Full frame)
Dark current	> 3 e-/s/pix @ -20°C

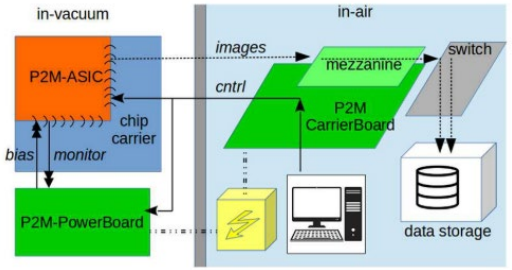


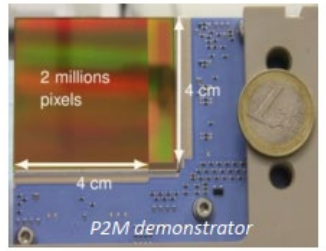


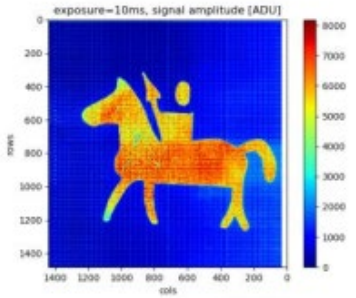
K. Desjardins et al, JSR 27 (2020)

Percival project

- 2 Mpx sensor with 27 µm² pixels (4 × 4 cm²), three gains, 82 Hz framerate
- Min. energy : ~100 eV
- SOLEIL joined collaboration in 2019
- New sensor version under fabrication
- Several user experiments at synchrotrons and FELs







DESY · Rutherford Appleton Lab / STFC · Elettra Sinchrotrone Trieste · Diamond Light Source · PAL Pohang Accelerator Laboratory · SOLEIL Synchrotron

A. Marras et al, JSR 28 (2021)

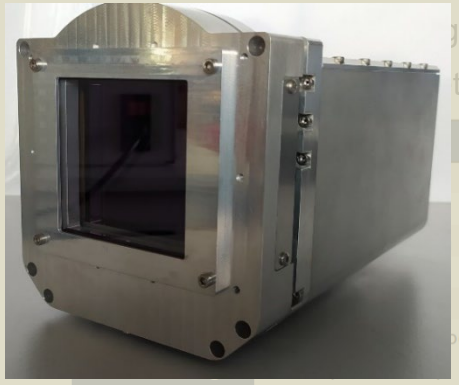
Detectors R&D @ SOLEIL : Soft X-Ray

In-house built soft X-ray CMOS-BSI camera

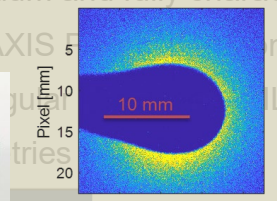
- First version based on TUCSEN Dhyana95 camera
- Min. energy ~100 eV
- In-house built for vacuum and fully characterized
- Distributed by AXIS Photonique

Recent upgrade : a very large sCMOS Soft X-ray camera

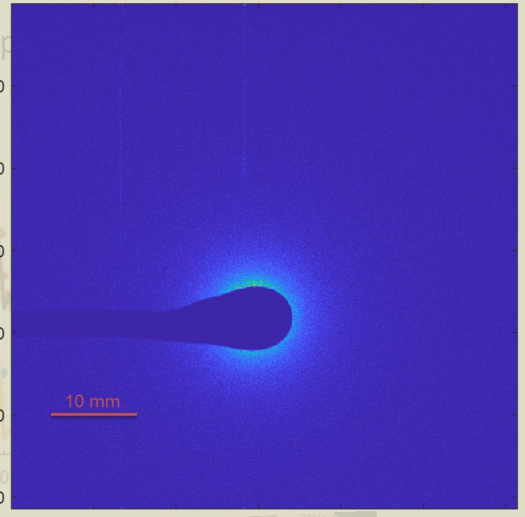
GSENSE 6060BSI



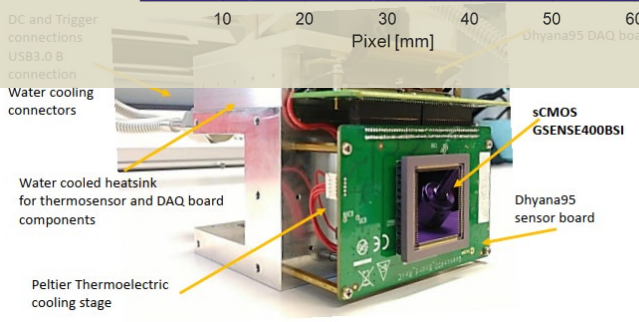
GSENSE 2020BSI



GSENSE 6060BSI



	2 ke- (High Gain mode)
Frame rate	24 fps (Full frame)
Dark current	> 3 e-/s/pix @ -20°C



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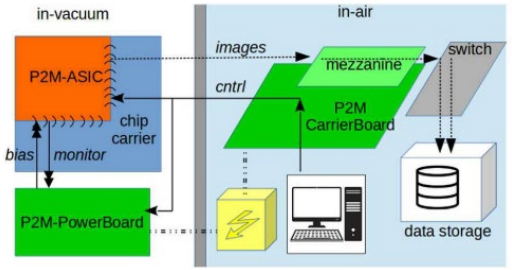
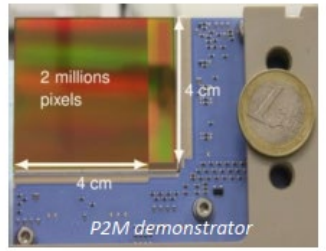
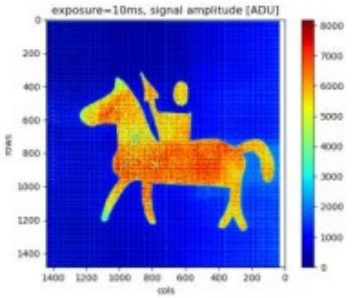






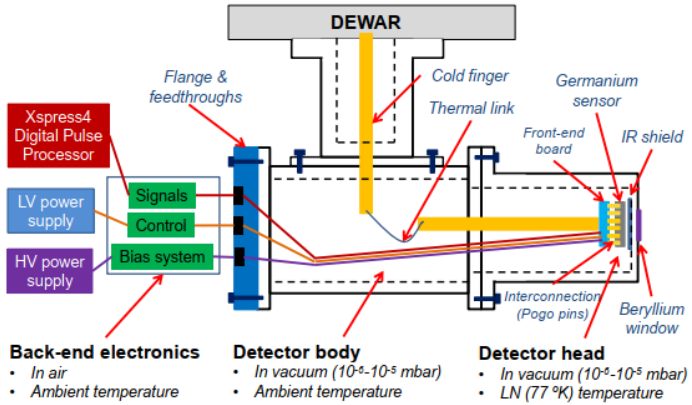
Rutherford Appleton Lab / STFC · Elettra Sinchrotrone Trieste · Diamond Light Source · Pohang Accelerator Laboratory · Soleil Synchrotron

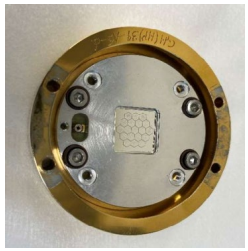
A. Marras et al, JSR 28 (2021)

Detectors R&D @ SOLEIL : Spectroscopy

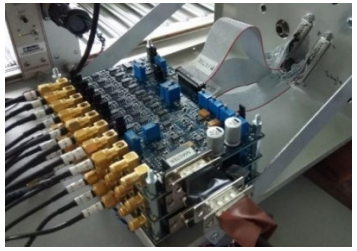
DLS-SOLEIL Germanium detector

- Germanium detector demonstrator within Diamond-SOLEIL collaboration
- Project started in 2018 (SOLEIL joined ongoing DLS R&D effort)
- Prototype with 19 elements and new FEC board
- First experimental tests made. New germanium crystal being processed.

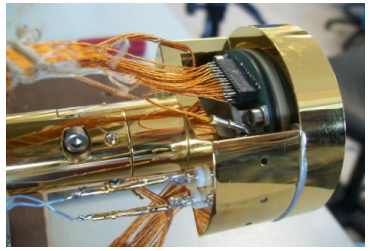


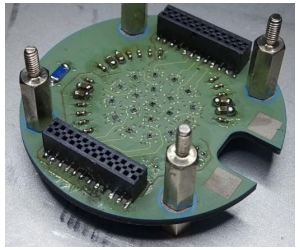


Detector head



Back-end electronics



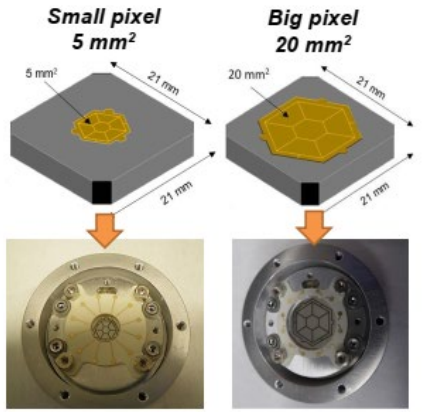


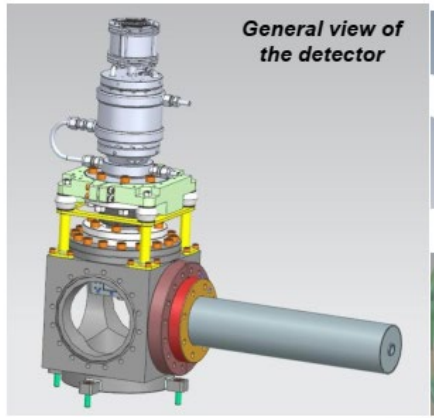
Front-end board with 19 CUBE preamplifiers

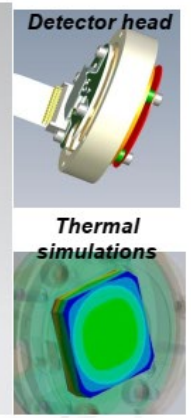
N. Tartoni al., IEEE-NSS 2022/MIC

LEAPS INNOV Germanium detector

- New generation of multi-element germanium detectors for spectroscopy applications within 5 – 100 keV energy range
- 11 partners : ALBA, DESY, DIAMOND, ELETTRA, ESRF, EuXFEL, INFN, MAXIV, PSI, SOLARIS, SOLEIL
- Project started in 2021, now in fabrication phase
- Main features:
  - two versions of germanium sensor: 5 mm² and 20 mm² pixel sizes,
  - a new full electronic chain has been designed and built,
  - the mechanical design has been optimized using thermal simulations.







This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 101004728.

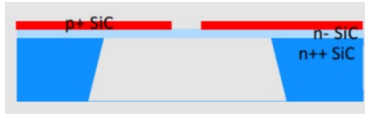
F. Orsini et al., NIM A 1045 (2023) 167600

Detectors R&D @ SOLEIL : Other activites

Beam diagnostic (examples)

SiC membranes

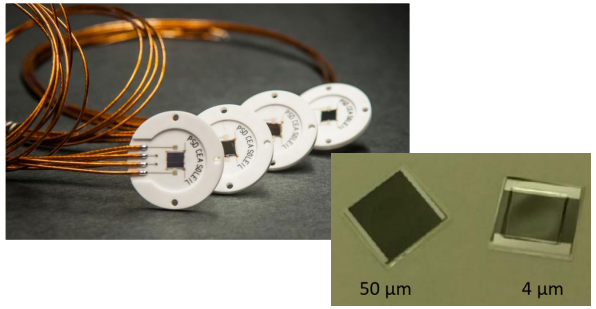
Tests and characterisation of the detectors from SenSiC



Possible thickness down to 200 nm

CVD Diamond XBPM

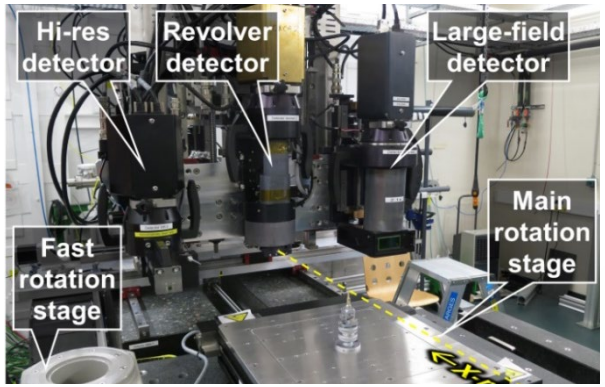
Collaboration with CEA-Saclay Diamond Lab



[K. Desjardins et al, JSR 25 (2018)]

Indirect X-ray cameras

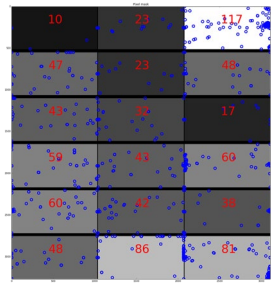
Example : tomography detectors on the ANATOMIX beamline

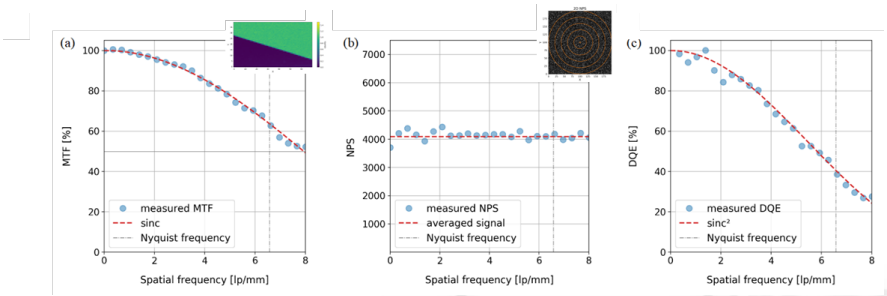


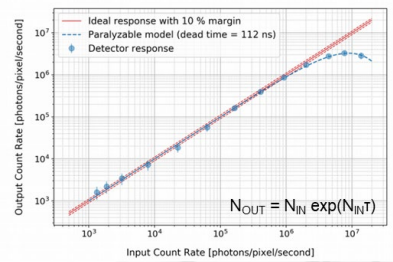
[K. Desjardins et al, MEDSI (2018)]

Beamlines support / detectors characterization :

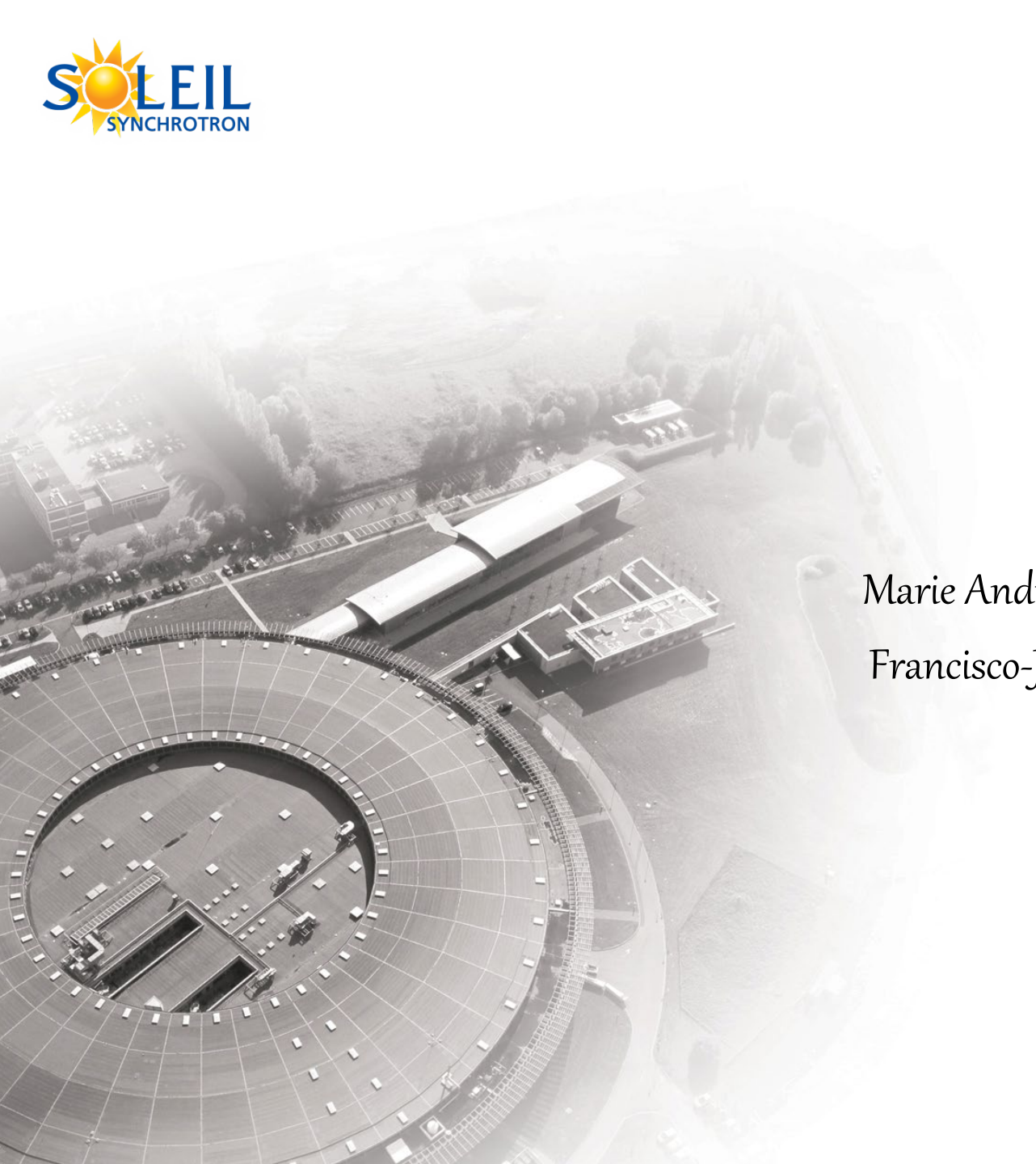
Technical specification → Call for Tenders → FAT → Reception → SAT → Beamline Integration → Maintenance & Troubleshooting







[Y. Nakaye et al, JSR 28 (2021)]



Thank you !

Marie Andrä, Arkadiusz (Arek) Dawiec, Kewin Desjardins, Nishu Goyal, Francisco-Jose (Paco) Iguaz-Gutierrezo, Claude Menneglier, Jean Roche