HETERODYNE NEAR FIELD SPECKLES SIMULATIONS USING SRW AT THE ALBA FE21

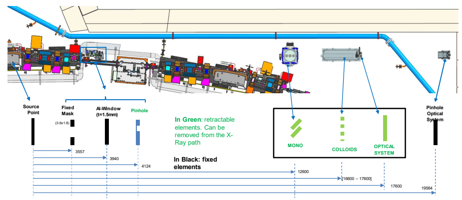
U. Iriso, J.M. Alvarez, A. Nosych, J. Nuñez, E. Solano and L. Torino
ALBA Synchrotron, CELLS, Barcelona (Spain)
B. Paroli, M. Potenza, M. Siano, Università di Milano, Milano (Italy)
D. Butti, S. Mazzoni, G. Tradt, CERN, Geneva (Switzerland)

ABSTRACT

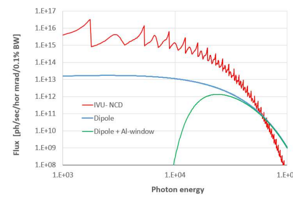
Several experiments were done to measure the transverse beam size at the NCD ALBA beamline using the Heterodyn Near Field Speckles (HNFS) technique. Inside the FCC collaboration, it was decided to move these experiments to the ALBA Front End 21, where currently an x-ray pinhole camera is working since 2021. The goal is that the two measurement techniques can work alternatively and measure the electron beamsize of the same source point, so that a direct comparison between both techniques can be done. This paper reports the SRW simulations performed in order to investigate the feasibility of the HNFS experiments at this new location. In particular, it focuses on the effect of the dipole radiation and the design of the high energy and high bandwidth monochromator requirements.

Introduction

In the past, XHNFS experiments were done at the ALBA beamline called NCD [1].
The design of teh XHNFS experiments at the location of the pinhole camera will allow a direct comparison between the two techniques.
However, the presence of an Al-window of 1.5mm thick in FE21 imposes several restrictions in terms of flux (too low compared with the NCD beamline) and x-ray energy (between 20-30 keV).



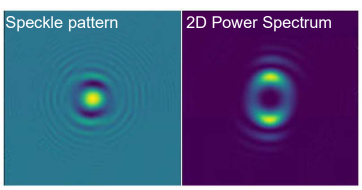
Sketch of FE21, with the elements of the x-ray pinhole and the components that need to be designed for the XHNFS (in green).

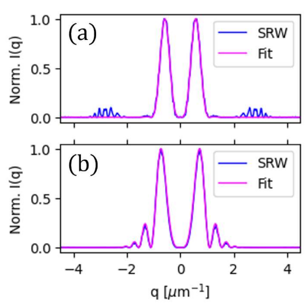


Flux for the In-Vacuum Undulator at the NCD beamline compared with the dipole flux at FE21, and the flux after the 1.5mm Al-window. The peak energy for the dipole + Al window is at 23.7keV.

SRW Simulations at FE21

SRW simulations using one single colloid, 500 e-
Wavefront size reduced to ~(0.4x0.2)mm.
➔ In monochromatic conditions, the vertical beamsize is reproduced within 1% of precision.



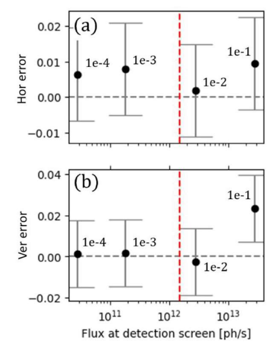


Energy Bandwidth Studies

Several monochromatic simulations are performed, and their speckle intensity pattern is summed considereint their probability distributions.

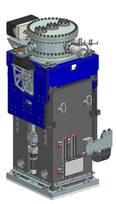
Distributions are considered to be Gaussian, with an bandwidth of: ΔE/E= 1e-4, … 1e-1

Results show that the error is within 1%, even for a ΔE/E=10%. However, in order to have a flux similar to the one at NCD (red dashed vertical line), we consider at least a bandwidth of 1%

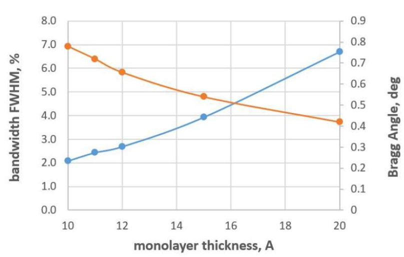


Monochromator Design

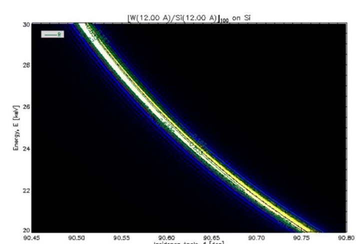
As seen in the previous section, the monochromator should be:
-monochromator peak energy: E_0=23.7 keV
-energy bandwidth of $\Delta E/E$>1%.
-energy range: [20 - 30]keV
High bandwidth monochromators are usually manufactured with a multilayer coatings on a Si substrate.



The energy bandwidth increases as the thickness of the layer increases, but at the same time the Bragg angle θ_B decreases
So a good compromise should be found between both bandwidht and Bragg angle.



Candidate: bilayers of W/Si over a Si substrate. The bilayer thickness ranging between 2.0 and 2.4nm/bilayer.
The layer of each component (W or Si) is half of the bilayer.
Finally, a multilayer of **W/Si with of 2.4nm** thickness is chosen.



Reflectivity curve relating the peak energy and the Bragg angle for a monochromator with a bilayer of W/Si in the range of (20 - 30)keV.

CONCLUSIONS

SRW simulations show that the most appropriate bandwidth for the monochromator in the proposed FE21 station is around 1%, which guarantees a good trade-off between the error produced by the XHNFS technique (less than 1%) and the photon flux arriving to the detection station. Using the XOP code, we have found that a single crystal monochromator of Si with a bi-layer 24 nm coating of W/Si fulfills the requirements set by the FE21 layout: energy peak of 23.7keV, with a Bragg angle of θ_B=0.64deg and a bandwidth of ~2%. The expected range for the XHNFS experiments will be between (20-30) keV. The monochromator is currently under fabrication and it is expected to be delivered at the beginning of 2025.

REFERENCES

1. M. Siano, B. Paroli, M. A. C. Potenza, L. Teruzzi,U. Iriso, A. A. Nosych, E. Solano, L. Torino, D. Butti,A. Goetz, T. Lefevre, S. Mazzoni, and G. Trad, «Two dimensional electron beam size measurements with x-rayheterodyne near field speckles," Phys. Rev. Accel. Beams,vol. 25, p. 052801, May 2022

www.albasynchrotron.es