

Le ciel de Paris-Saclay
en juin 2015



OPTIQUES XUV

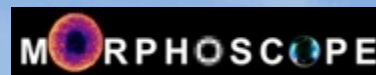
Franck Delmotte

Laboratoire Charles Fabry

Groupe Optique XUV



OPT2X
project



More than 35 years of research in XUV Optics @ LCF

Space science



SOHO (1995)... STEREO (2006)...
SOLAR ORBITER (2018) ...

LMJ - X-ray diagnostics



Broadband coatings for imagers & spectrometers

Synchrotron Radiation & FEL

Alternate ML Monochromators, ML optics

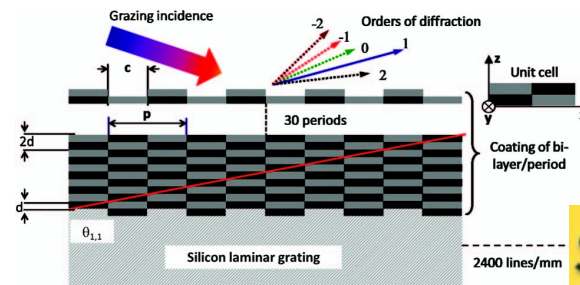
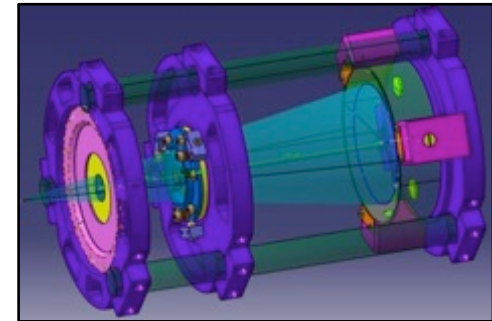
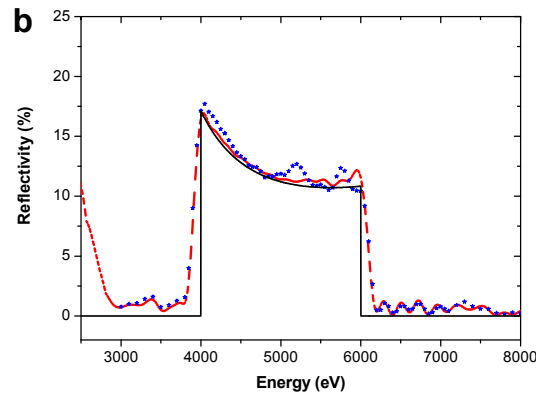
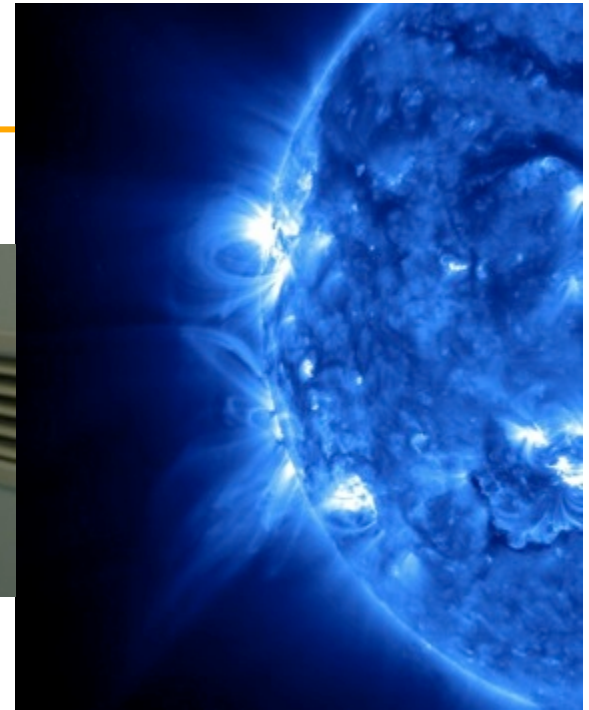
X-ray Microscopy

Equipex MORPHOSCOPE (LOB,...)

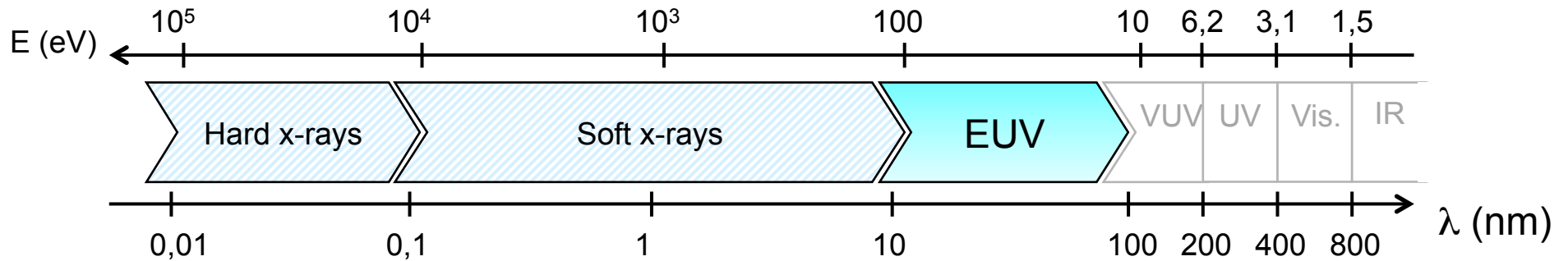
Ultrafast Science

Lidex OPT2X (ISMO, LPS, ...)

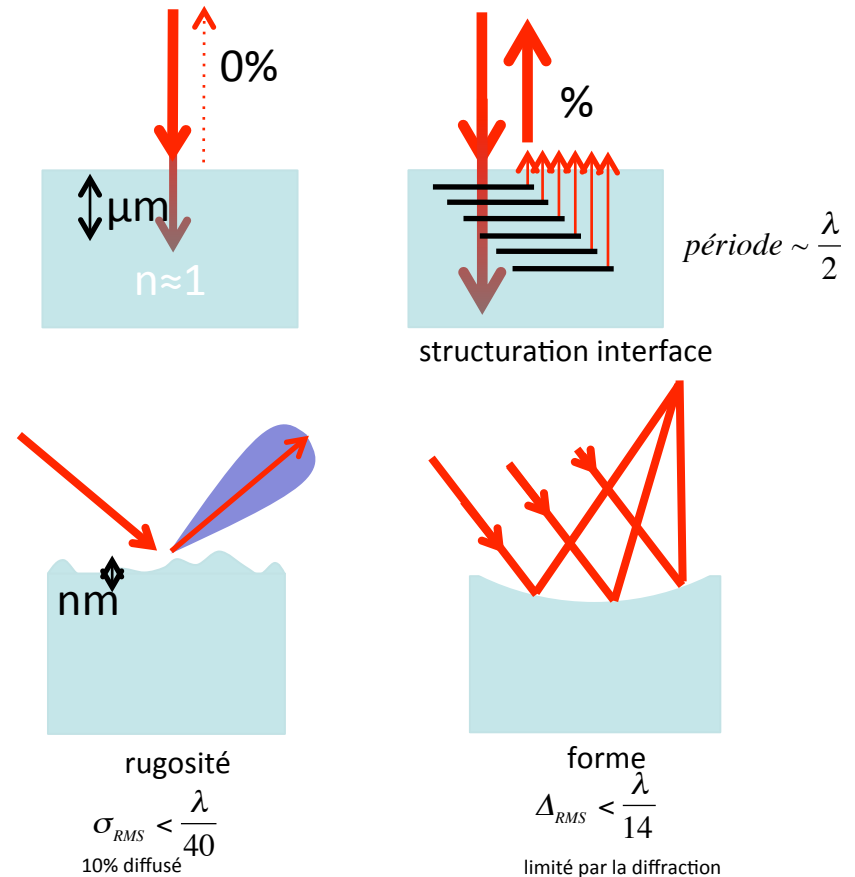
Equipex ATTOLAB (CEA Saclay, ...)



Challenges in the XUV spectral range



- Very low refraction effect ($r_{\text{Fresnel}} < 1\%$)
- Low absorption length ($\sim 10 \lambda$)
- High quality optical surfaces ($< 1 \text{ nm rms}$)
- Thickness control of thin films ($< 0.1 \text{ nm}$)
- Smooth interfaces ($< 0.3 \text{ nm rms}$)
- Metrology of surfaces and ultrathin films



multicouches
plateforme CEMOX

surfaces optiques
atelier d'optique de précision
surfaçage ionique



CeMOX : le chantier en images

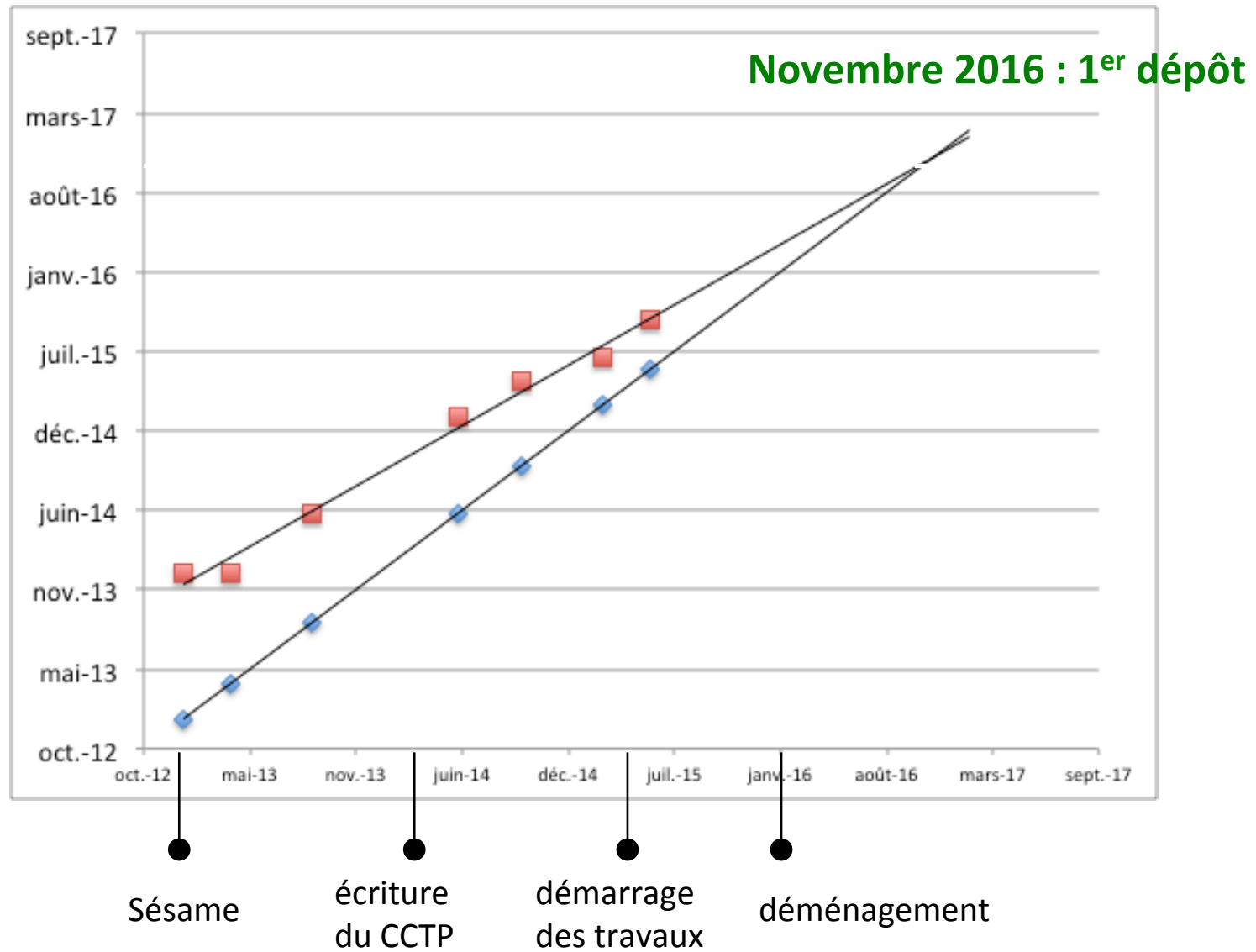




30 novembre 2016 : dépôt MP16001 !



Retour sur le planning



mission Solar Orbiter (oct. 2018+)

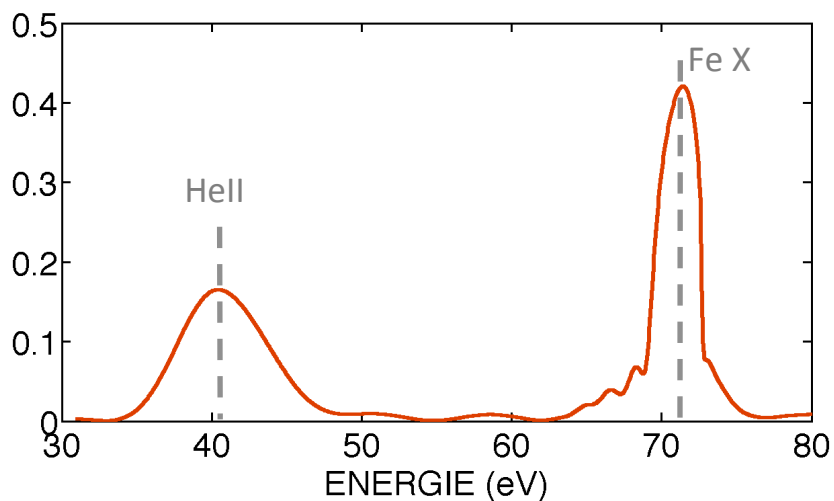
Extreme Ultraviolet Imager

PI: P. Rochus (CSL)



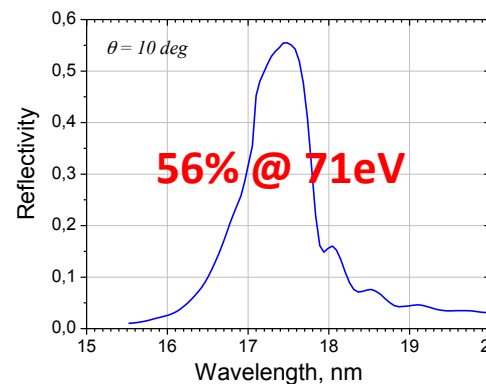
Full Sun Imager

1 surface asphérique hors axe
revêtement bi-bande Al-Mo-SiC



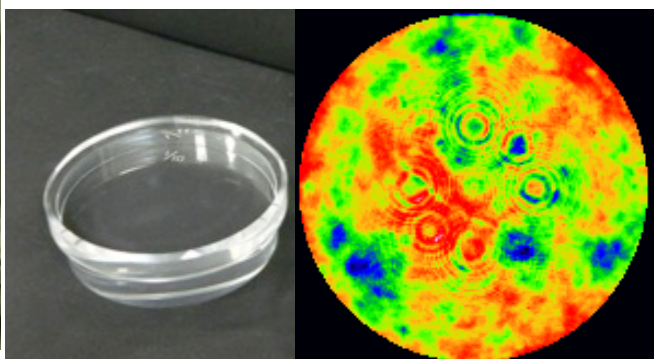
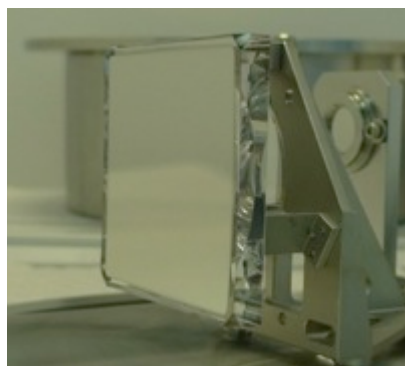
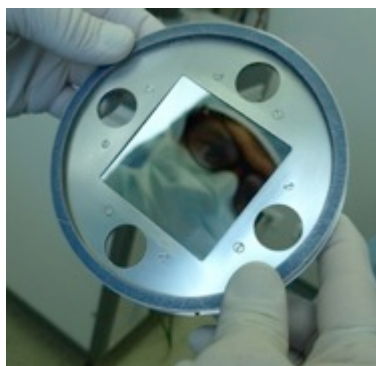
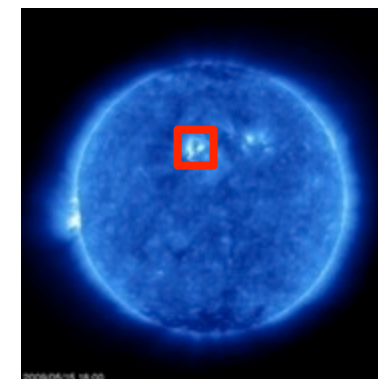
High Resolution Imager

2 surfaces asphériques (config. Cassegrain)
revêtement Al-Mo-SiC



E. Meltchakov et al., APA 2010

F. Delmotte, SPIE 2013



C. Hecquet et al., Appl. Phys. A 2009
E. Meltchakov et al., Proc. SPIE 2013

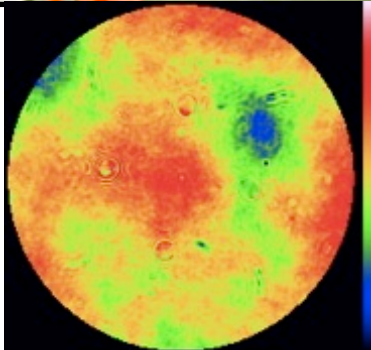
1 nm rms; 7.4 nm PV

Surfaces Optiques

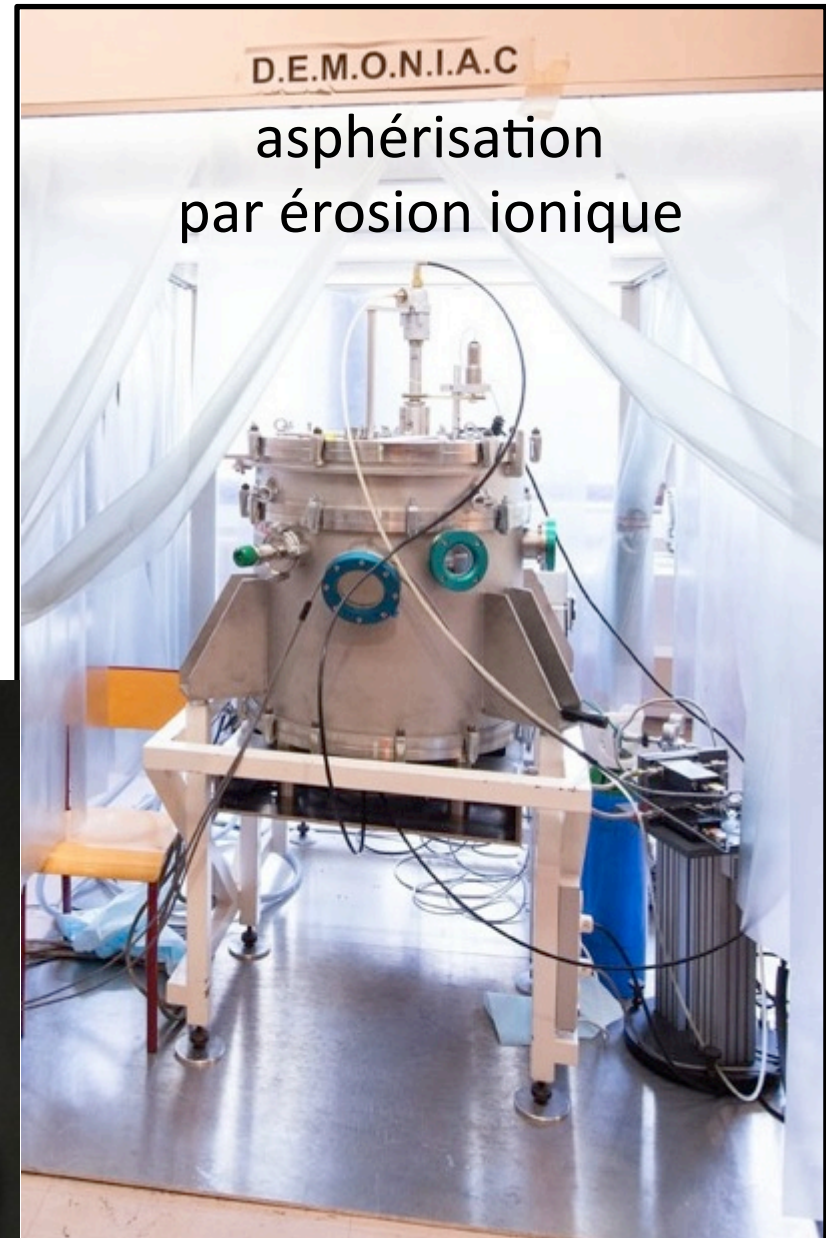


polissage manuel
plans et sphères

de forme à $\lambda/500^{\text{RMS}}$
de rugosité à 0,1 nm

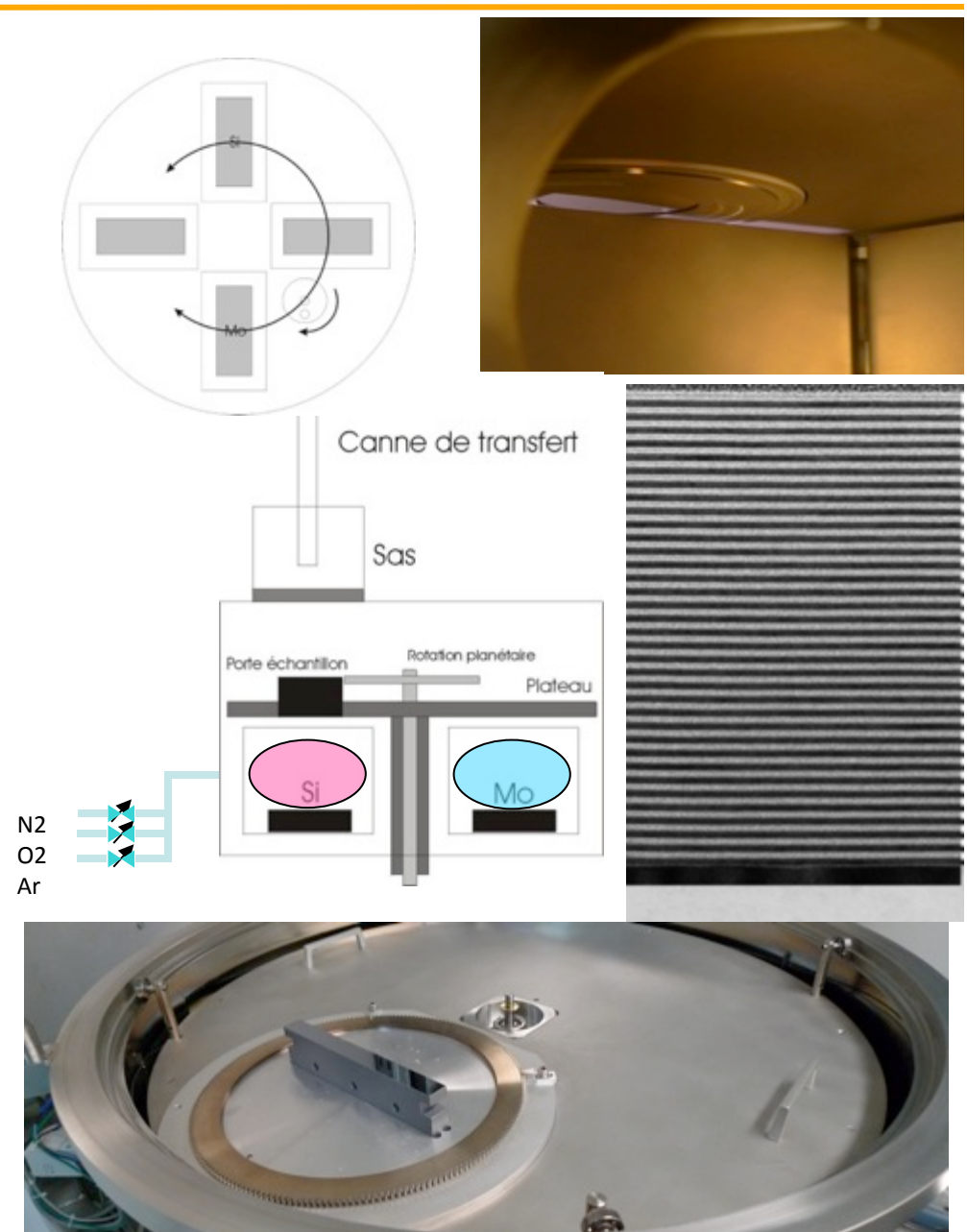


interférométrie au nm



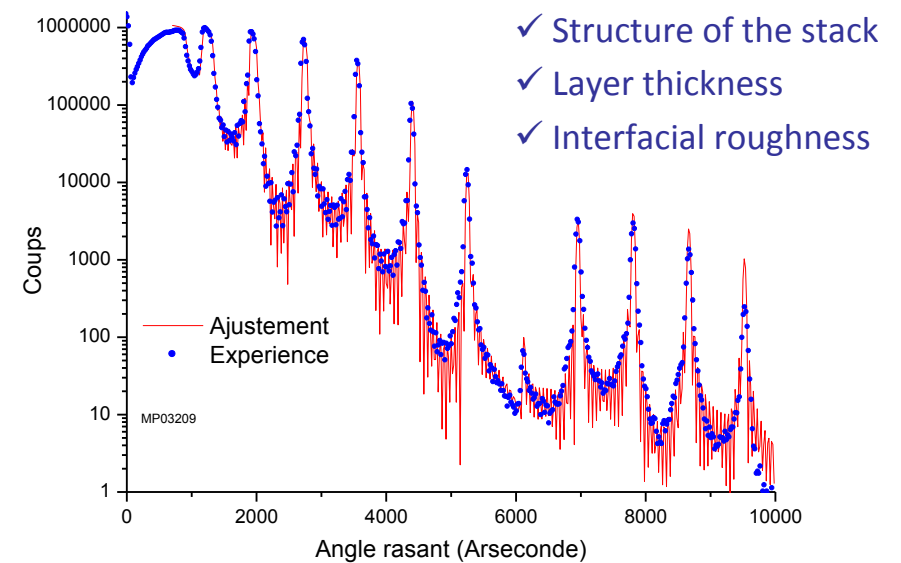
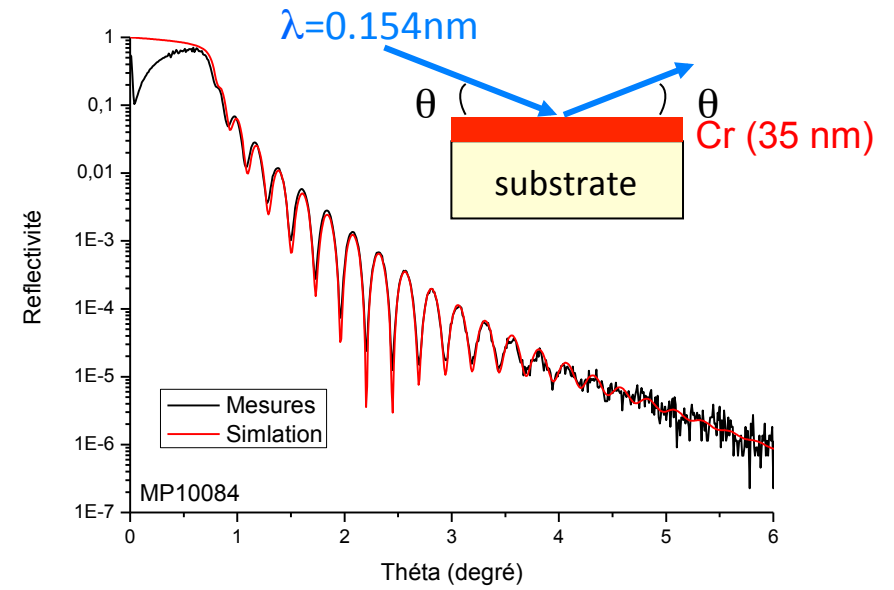
asphérisation
par érosion ionique

Magnetron Sputtering

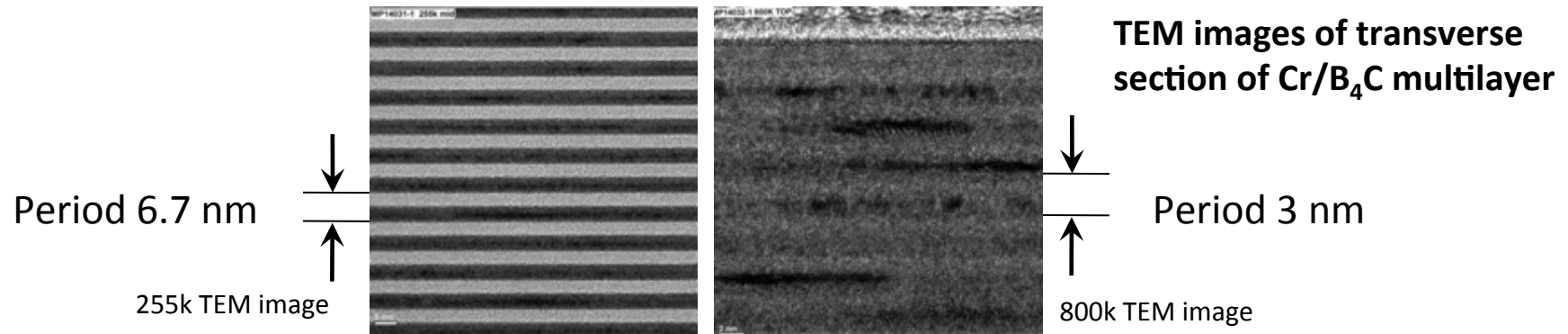


X-ray reflectometry at 0.154 nm

Bruker
Discover
D8

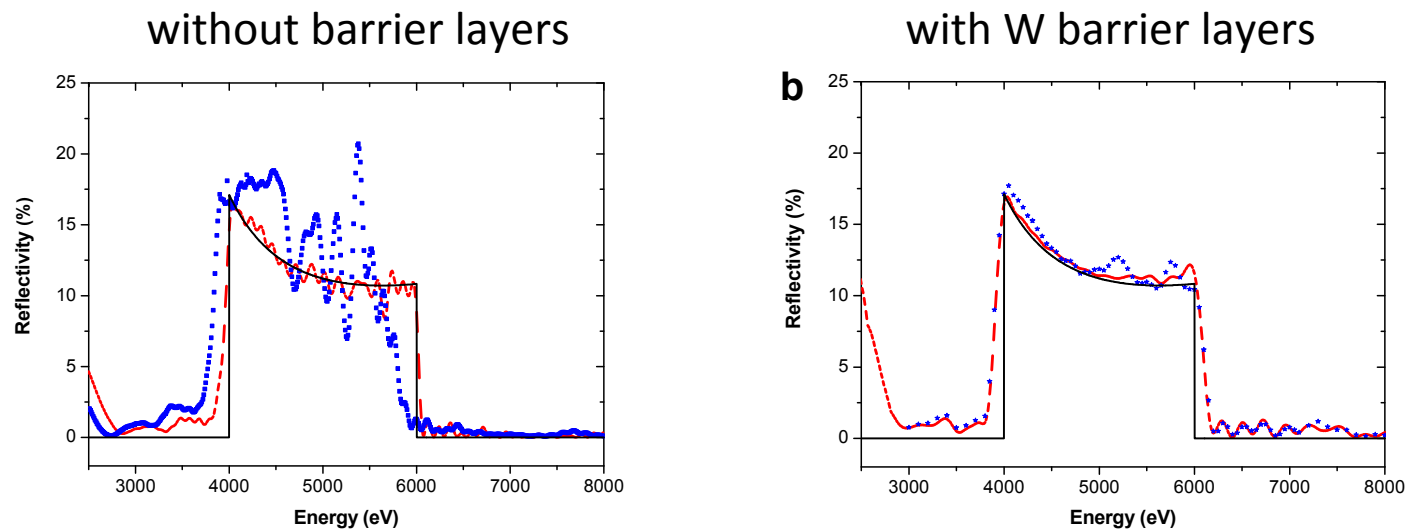


Periodic Cr/B₄C multilayer mirror



C. Burcklen et al., JAP 2016

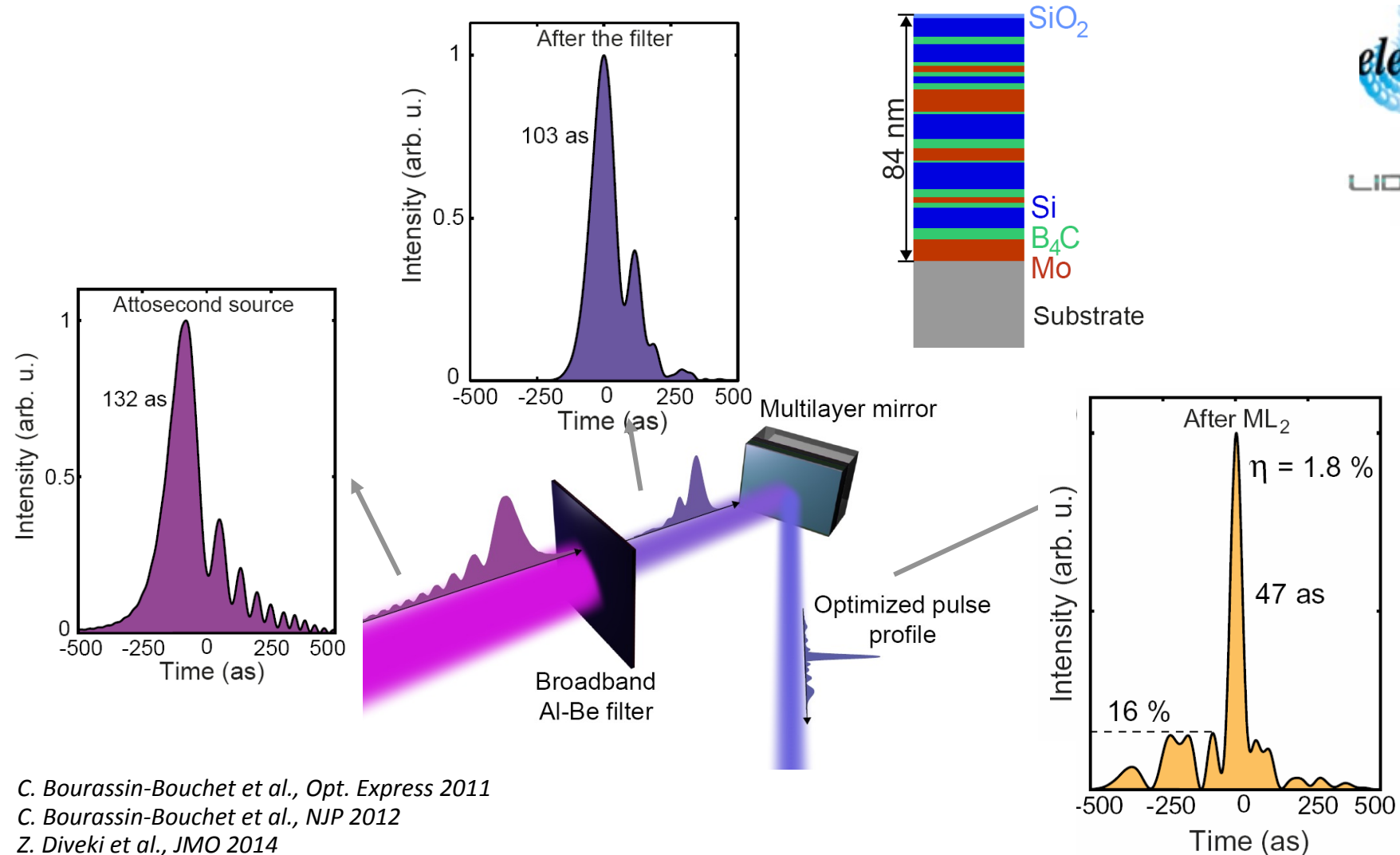
Aperiodic Ni/SiC multilayer mirror



B. Emprin et al., OE 2014

Modelage temporel

post compression attoseconde

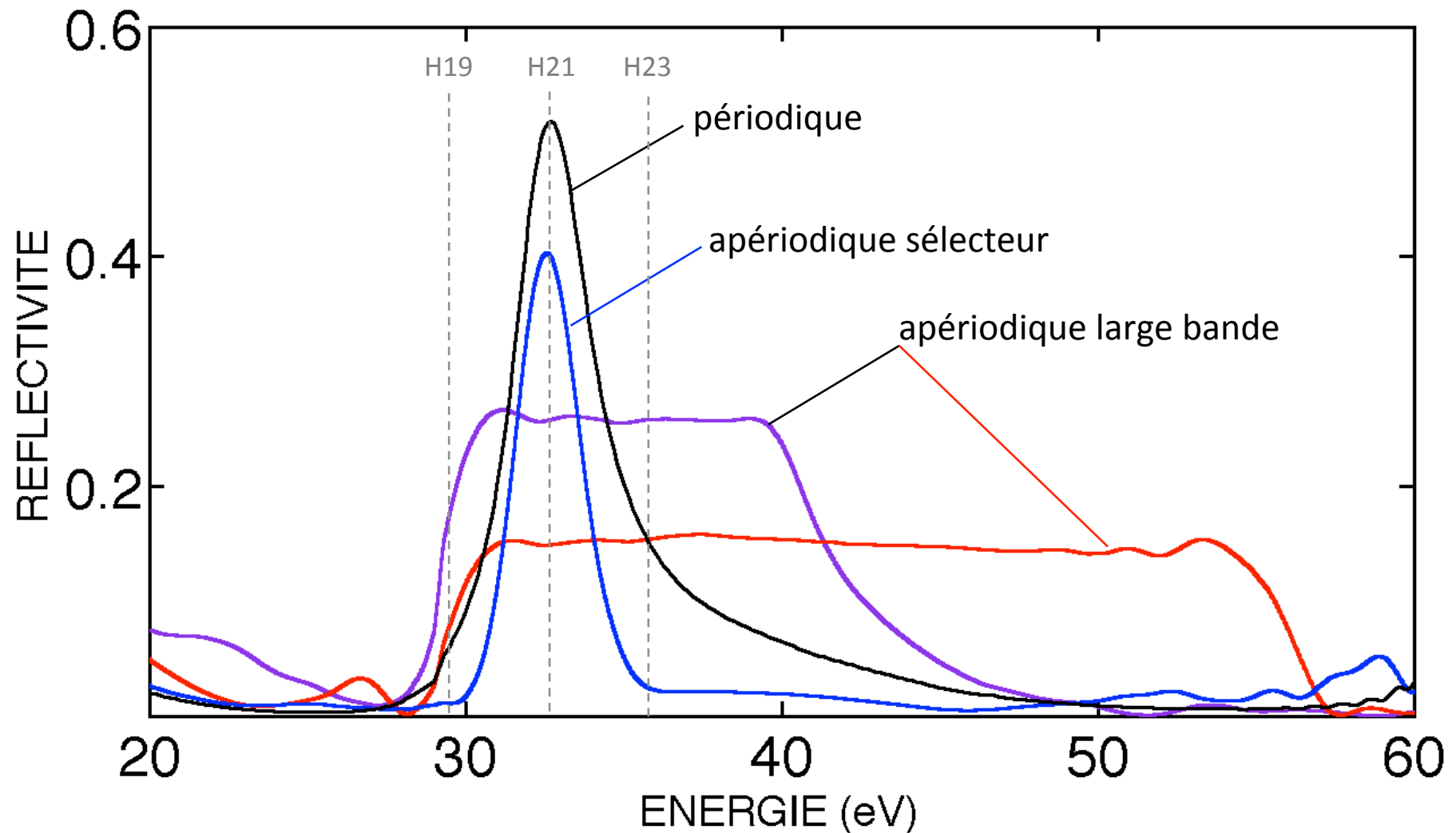


C. Bourassin-Bouchet et al., *Opt. Express* 2011
 C. Bourassin-Bouchet et al., *NJP* 2012
 Z. Diveki et al., *JMO* 2014

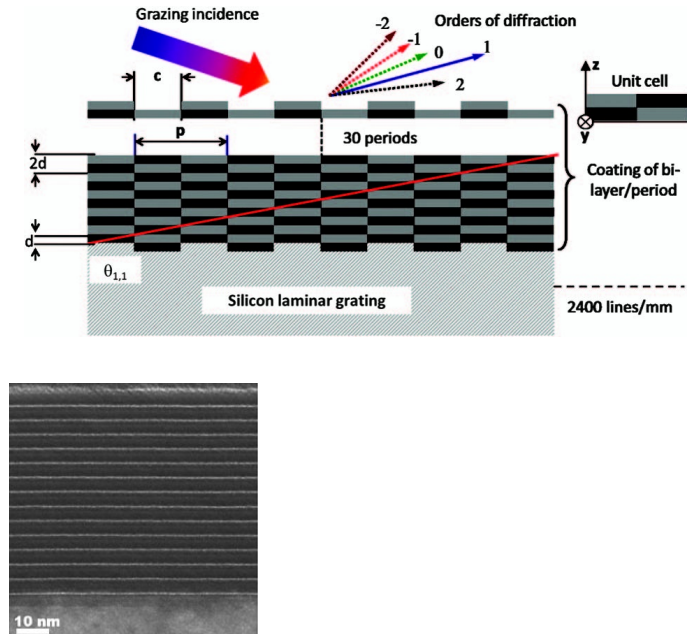
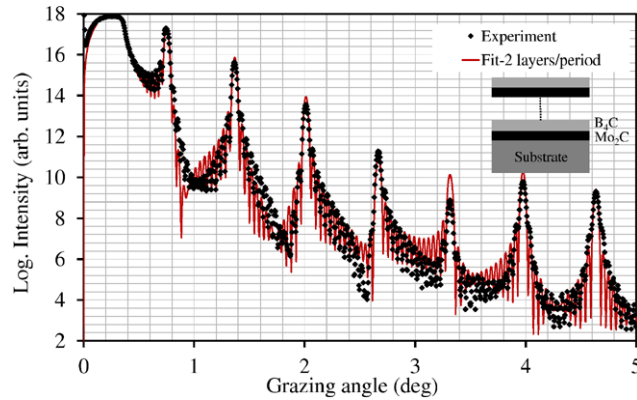
Modelage de la réflectivité

sélecteur d'harmonique-s

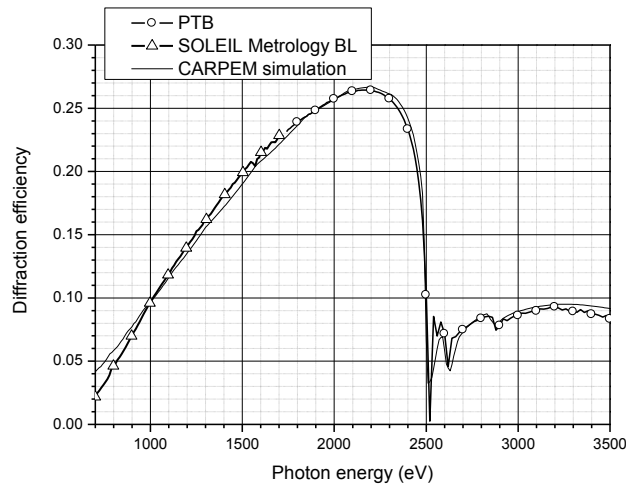
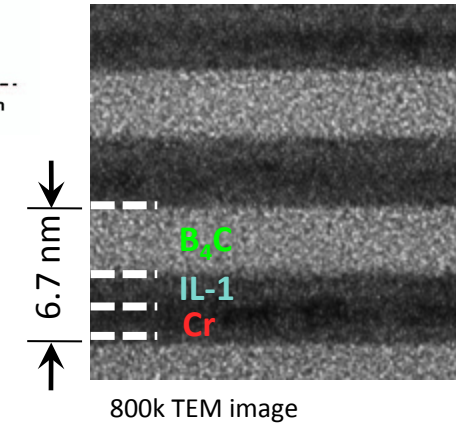
contrat postdoctoral OPTO2X : Maël Dehlinger



$\text{Mo}_2\text{C}/\text{B}_4\text{C}$

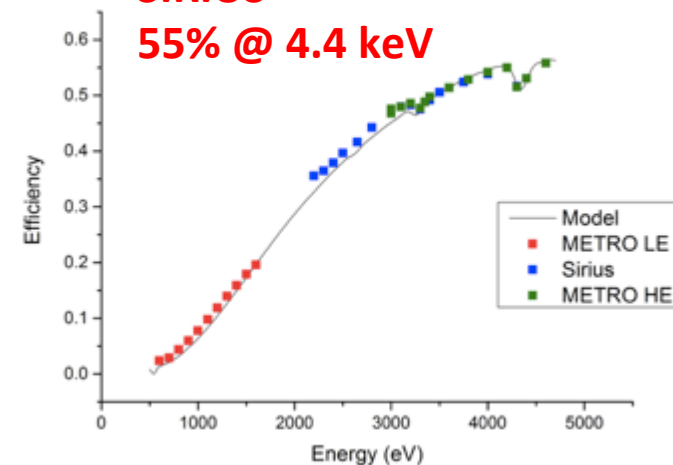


$\text{Cr}/\text{B}_4\text{C}$



DEIMOS
27% @ 2keV

SIRIUS
55% @ 4.4 keV



F. Polack et al., PXRNMS 2016

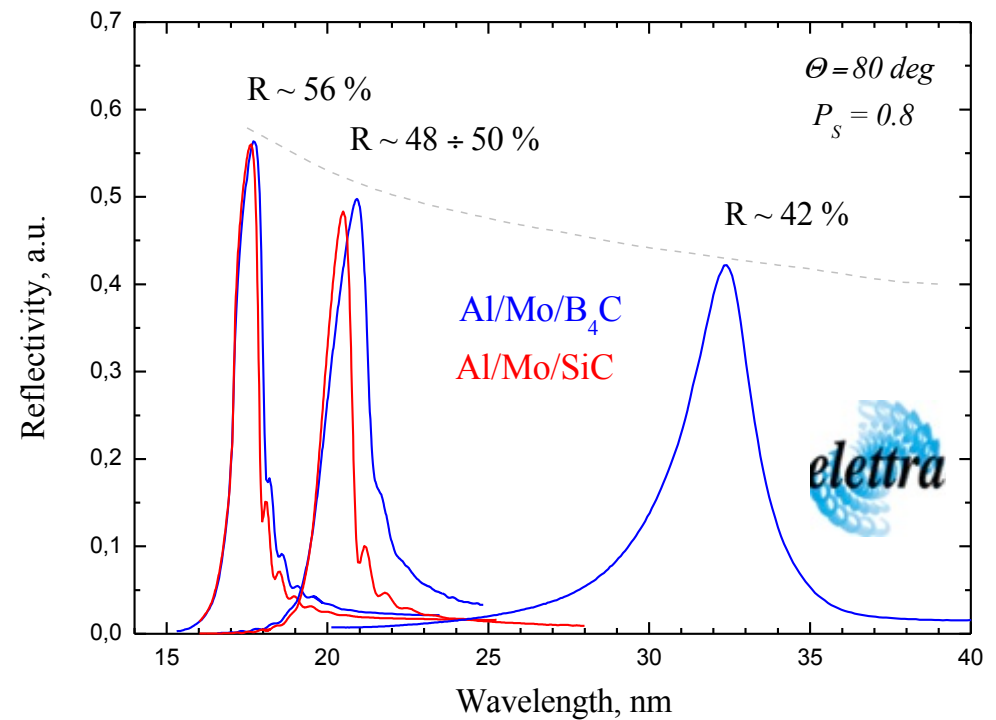
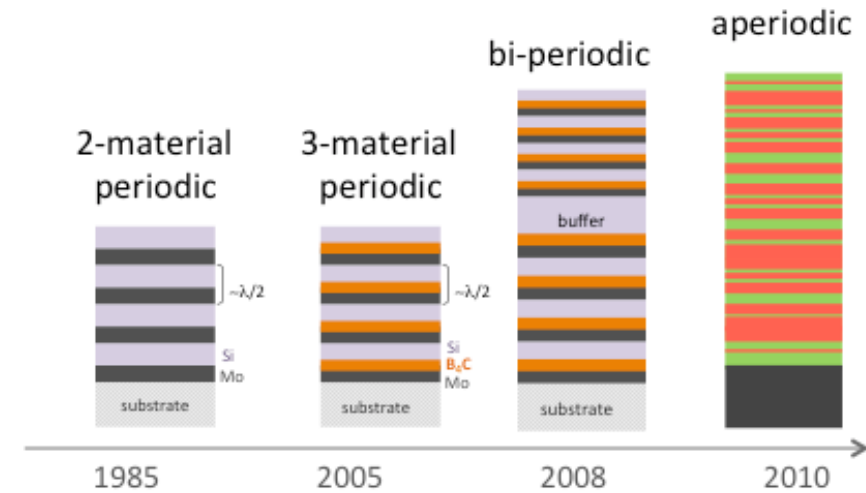
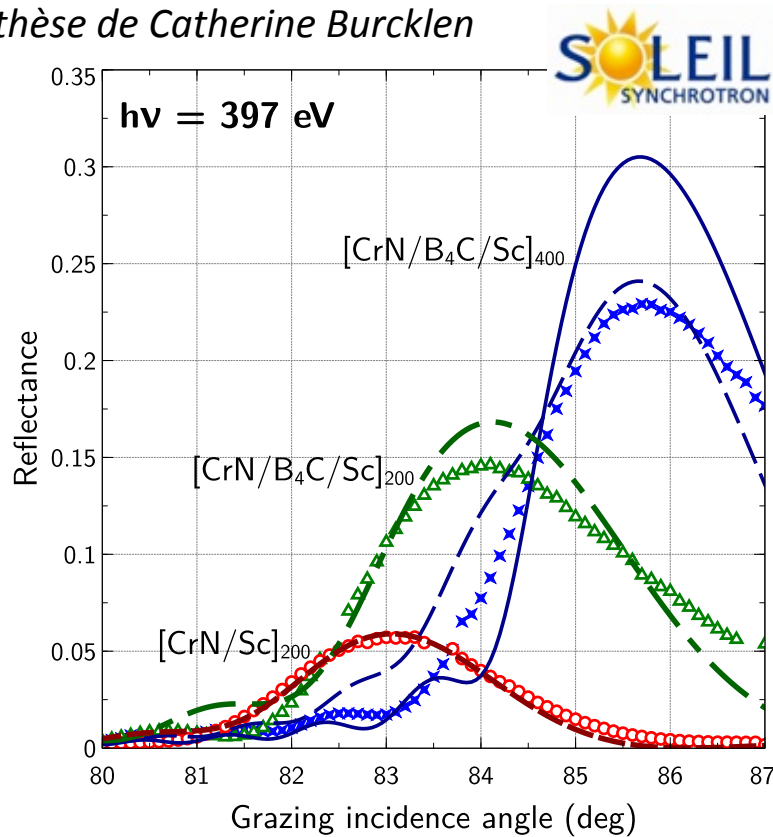
F. Chouekani et al., APA 2013

F. Chouekani et al. OL 2014

Plateforme CeMOX

Des solutions « efficaces »
de 60 nm à 0,1 nm
de 20 eV à 10 keV

Equipex Morphoscope
thèse de Catherine Burcklen



- **Laboratoire Charles Fabry – Optique XUV & ateliers**

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F. Bridou, M. Roulliay, R. Mercier, M. Dehlinger, C. Burcklen
C. Beurthe, S. Coumar, A. Guilbaud, P. Roth

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- F. Polack, D. Denetiere, M. Thomasset, B. Capitanio - SOLEIL (France)
- R. Soufli, Lawrence Livermore National Lab. (USA)
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- D. Dowek & OPT2X col. – ISMO / LUMAT
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