Volumetric X-ray imaging at extremely low dose.

2016-2019, 4 M€

M. Fajardo & co
Instituto Superior Tecnico,Portugal

P. Zeitoun & co,
Laboratoire d'Optique Appliquée, CNRS, France

H. Merdji & co
CEA, France

O. de La Rochefoucauld
Imagine Optic, France

A. Cedola,
CNR- Roma, Italie

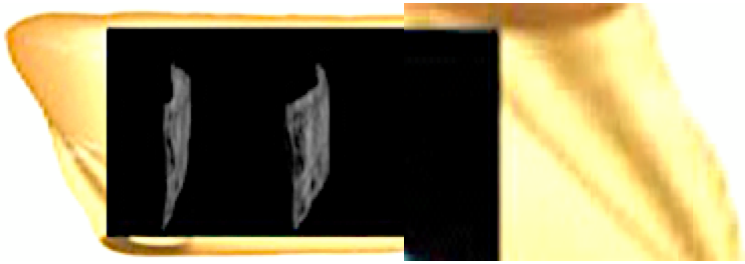
J. Batemburg & co
NWIO, Hollande

E. Oliva & co
Universidad Politecnica de Madrid, Espagne

UMR 7639

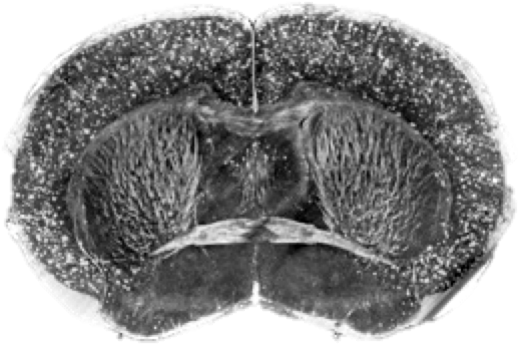
Quelques applications de l'imagerie X en 3 dimensions

- **Contrôle non destructif**
  Tests industriels, science des matériaux, mécanique, archéologie et patrimoine, agro-alimentaire…



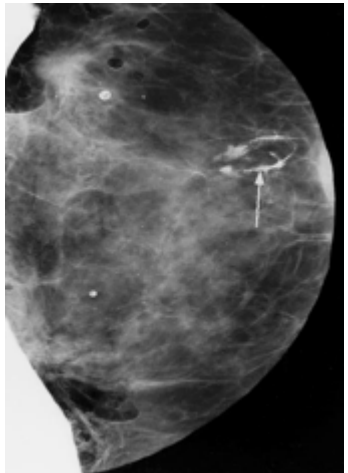
I. Bukreeva , Sci. Reports, 6, 2016

- **Recherche en biologie et médecine**
  Modèle animal d'étude de maladies ou étude de nouveau médicaments



E. Longo,
G. Bengali Provinciali

- **Imagerie médicale**:
  Recherche et clinique.



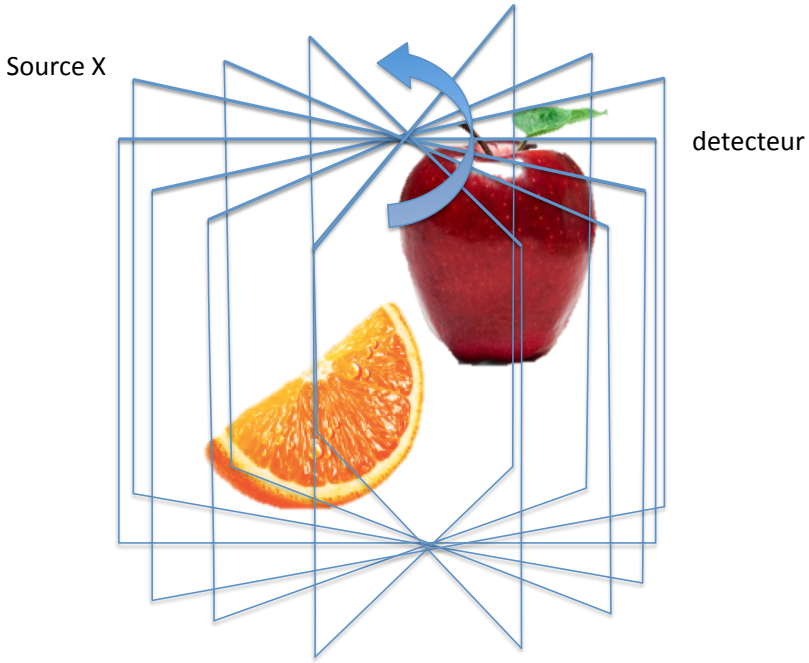
F. Arfelli, et al, Radiology 215, 2000

VOXEL

Notre projet « blue sky in a nutshell »

- **Aujourd'hui: La tomographie X**

Plusieurs centaines à milliers d'expositions



Plans réels (1 plan= 1 acquisition)

VOXEL

Notre projet « blue sky in a nutshell »

- **Aujourd'hui: La tomographie X**

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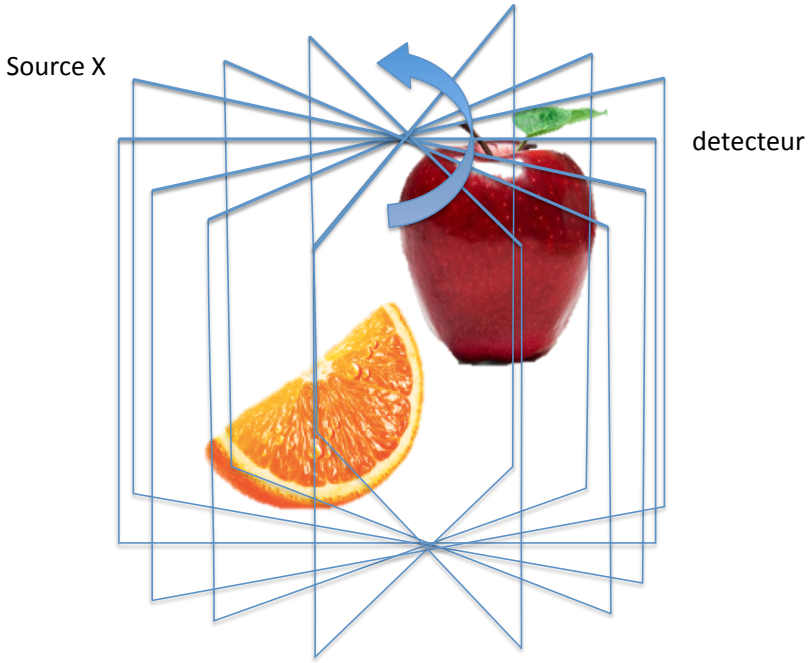
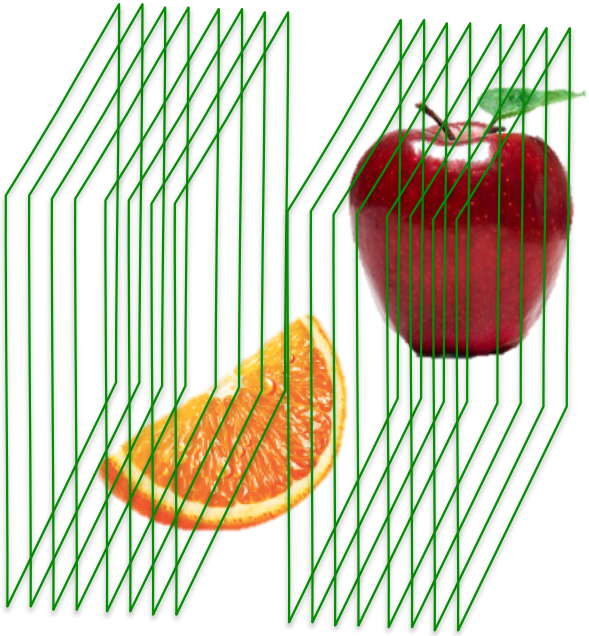


Plans réels (1 plan= 1 acquisition)

- **Demain: Le plénoptique X**

…Une exposition

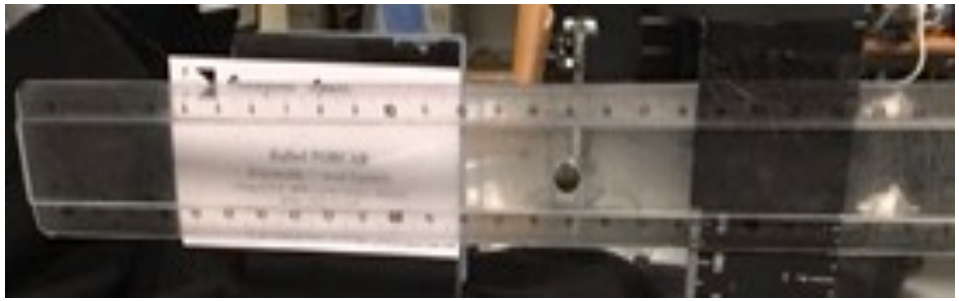


Plans virtuels (tous les plans = 1 acquisition)

VOXEL

Un exemple de refocalisation numérique

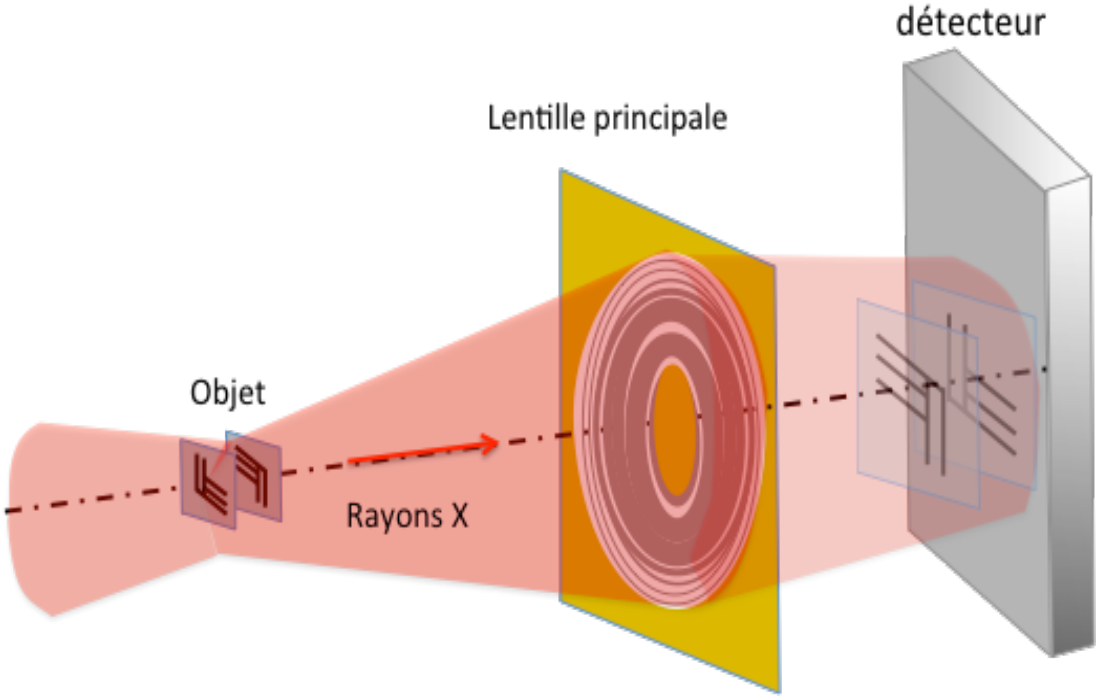
d=3,3 cm



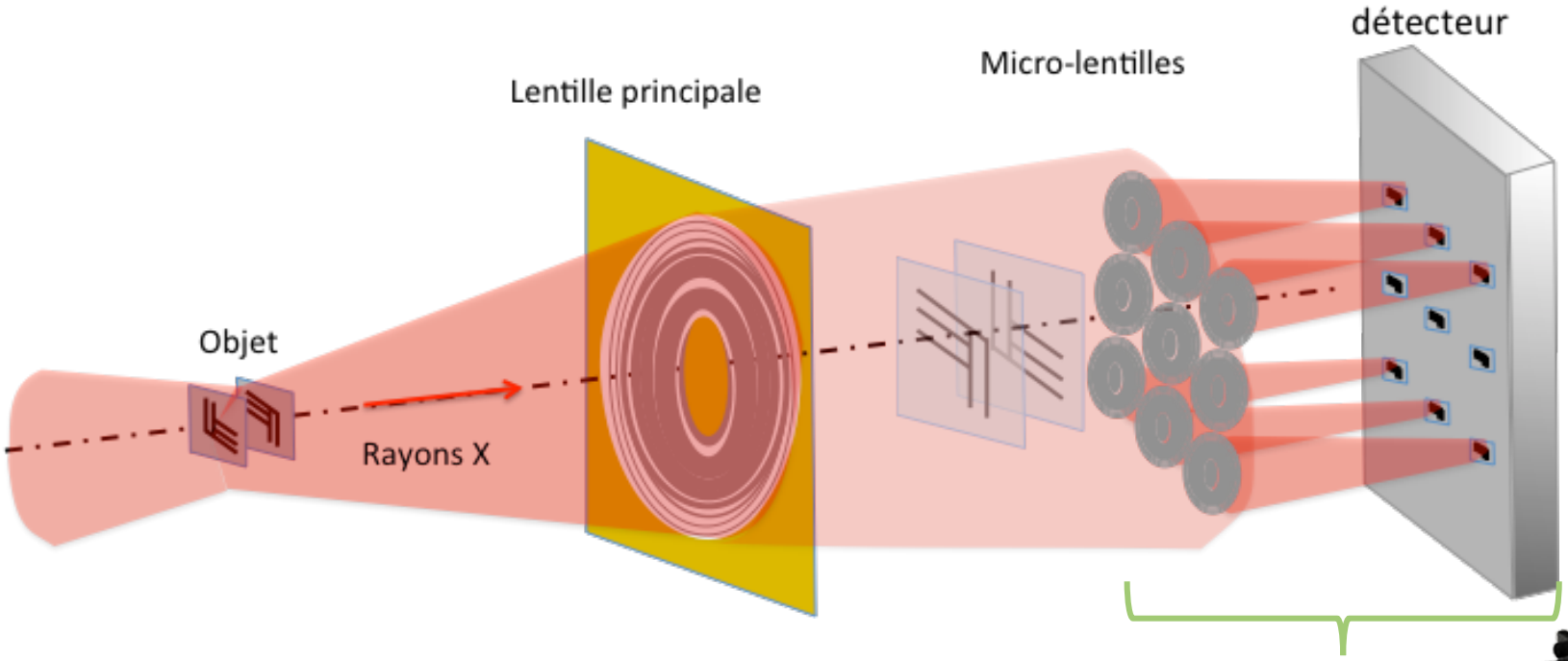
α=1,07

α=1

Plénoptique= objectif + senseur de front d'onde



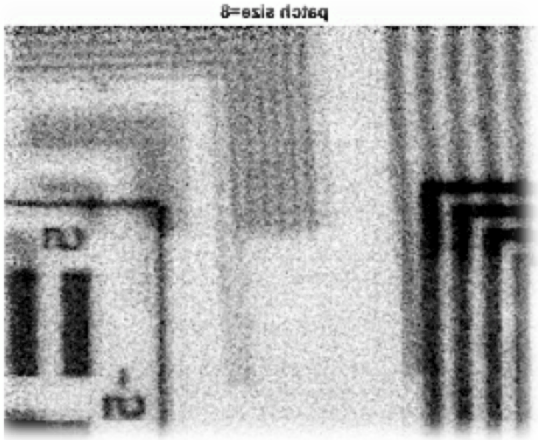
Plénoptique= objectif + senseur de front d'onde



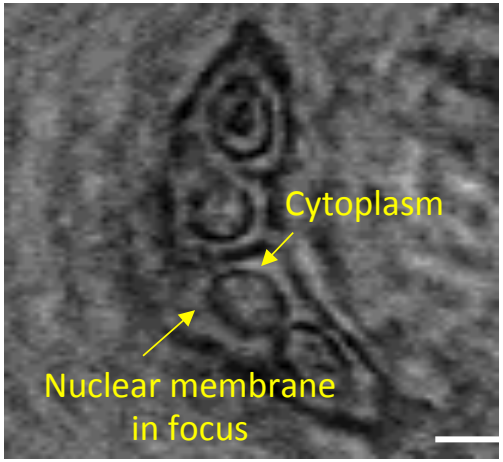
Senseur de front d'onde

- Senseurs de front d'onde: spécialité de la société Imagine Optic.
- Plénoptique= multi-vues stéréoscopique.

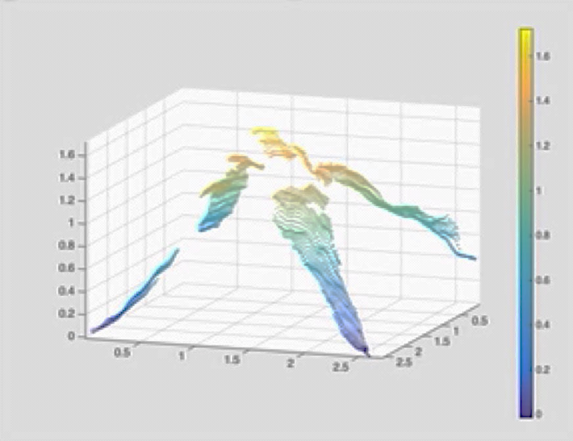
Plans B et études parallèles



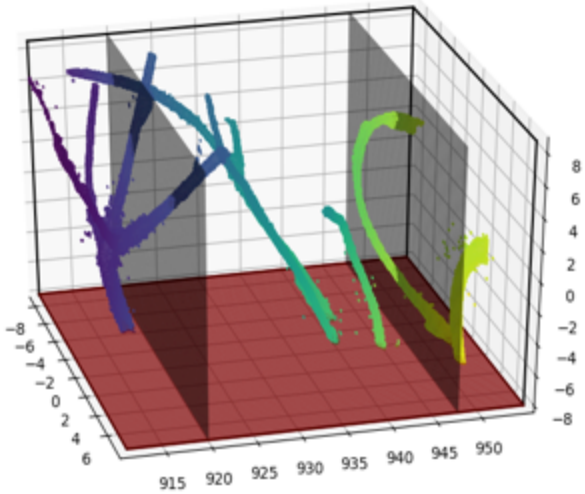
Plénoptique



Holographie



Stéréo-imagerie

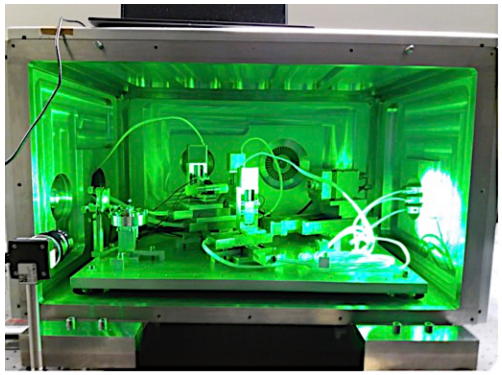


Tomographie normale
et en angles limités

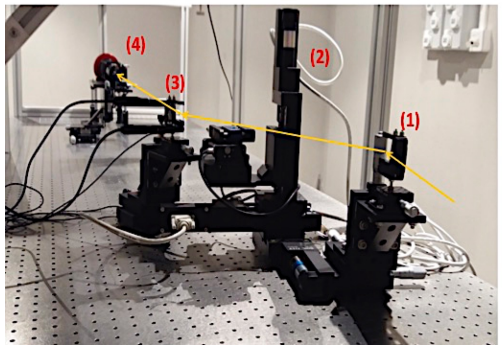
Les réalisations de VOXEL

Prototypes

"Water window" prototype (LOA)

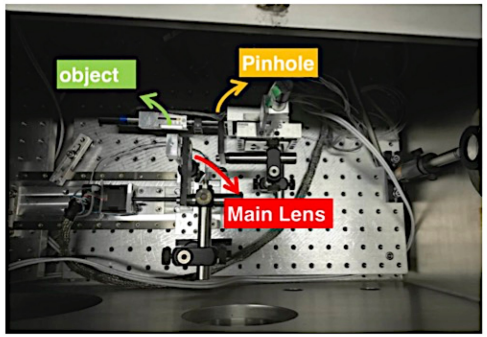


Hard X-ray prototype (IO +CNR)

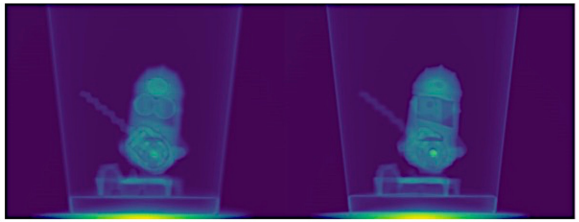


Demo stations

Soft X-ray Demo station (IST)



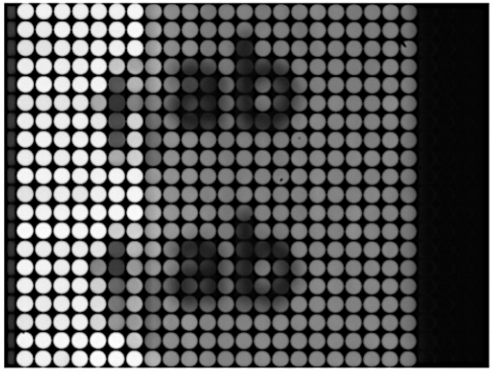
Hard X-ray Demo station (CWI, CNR)



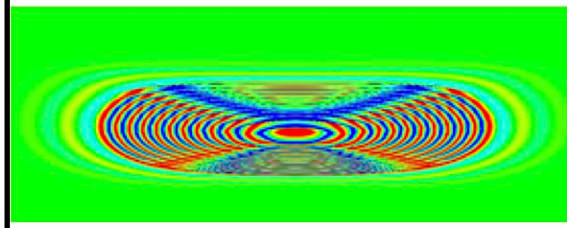
+ coherent optics demo (CEA)

Software

Plenotomos (CWI)

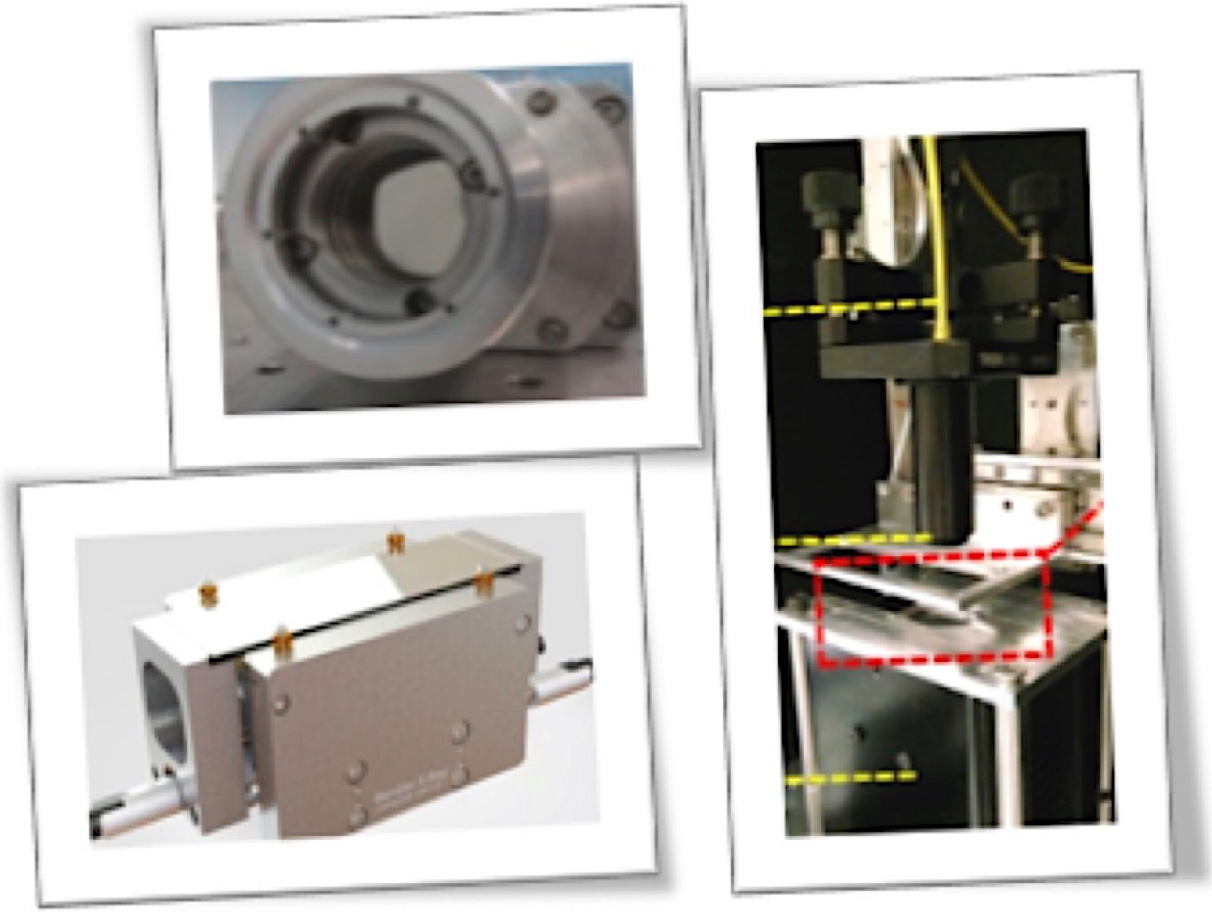


EMcLAW (UPM)



VOXEL

L'impact industriel de VOXEL



FET Innovation Launchpad (2019-2021): **3D X-LIGHT**

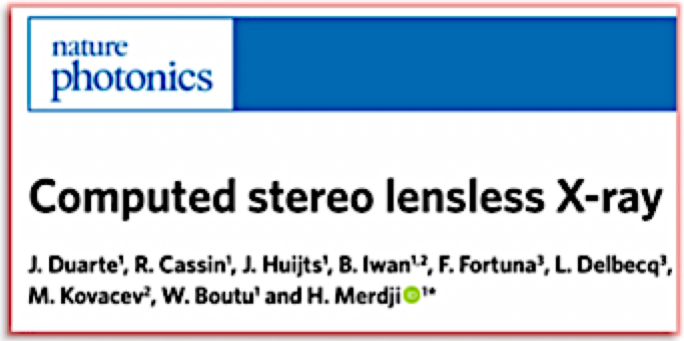
3D X-ray Light-Field: low-dose X-ray imaging with X-ray wavefront sensors

VOXEL

Publications et communications

- 40 Publications in refereed journals, including Nature Photonic, Scientific Reports, Physical Review Letters, of which 19 Gold Open Access

And more to follow.


nature photonics

Computed stereo lensless X-ray

J. Duarte[1], R. Cassin[1], J. Huijts[1], B. Iwan[1,2], F. Fortuna[3], L. Delbecq[3], M. Kovacev[2], W. Boutu[1] and H. Merdji[1*]

- Thesis 14

- Talks and posters

23 oral presentations including 7 Invited and 1 Plenary

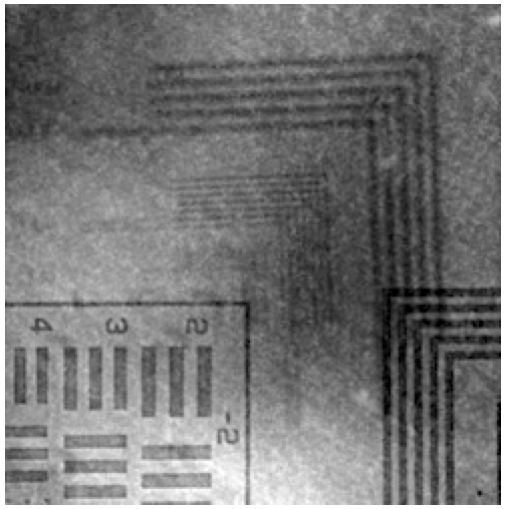
14 poster presentations

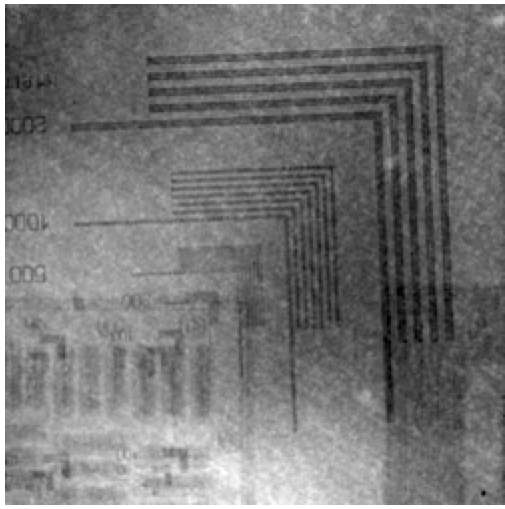
- Euronews movie
- DG Research Article
- IST: “Falar Global” **interview** CMjornal
- CNR: **youtube video, CNN interview**
- UPM: 2 Blog articles

IST: Several visits to IST VOXEL Metrology Station, from government to highschool students

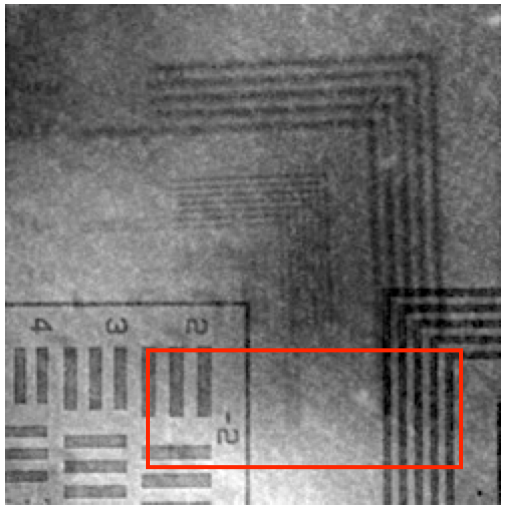
Et maintenant?

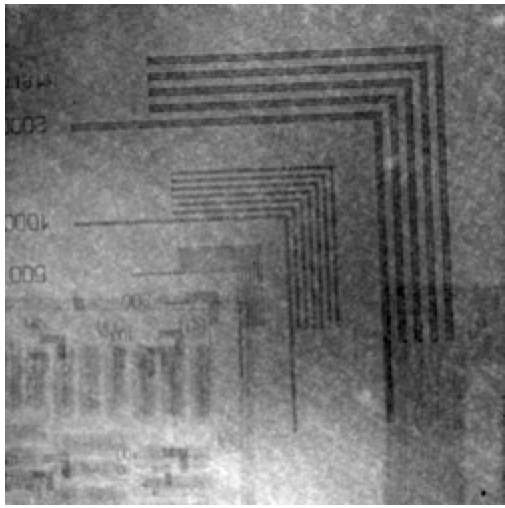
synchrotron
PETRAIII- P05





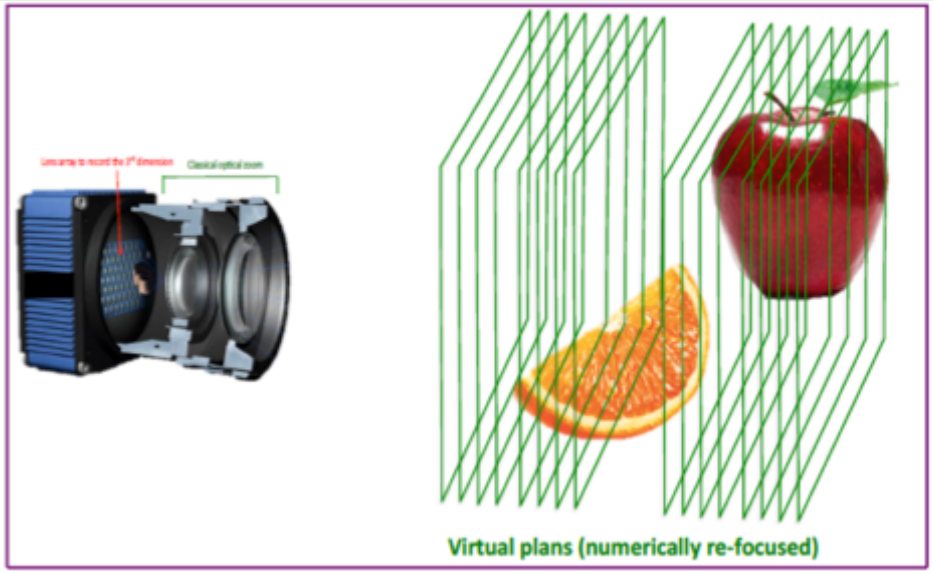
Et maintenant?



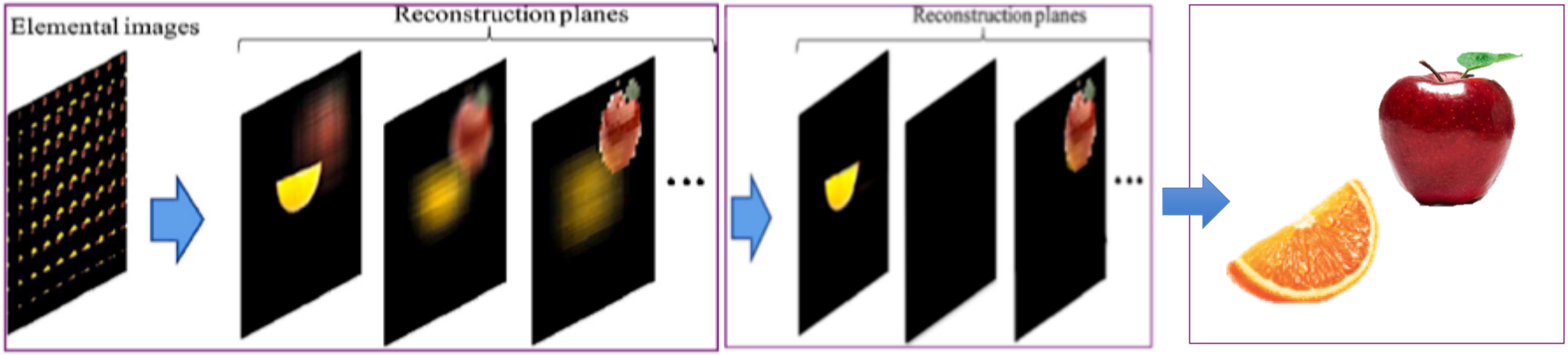


synchrotron
PETRAIII- P05

Et maintenant?



Adapté de
Park et al, 2009



Take-home message

- Chaque projet FET est différent.

- Un FET-Open doit être une aventure:

⇒ Le “proposal” doit le faire ressentir (rupture, risque et plans B … et C)
⇒ Il vaut mieux travailler avec une équipe soudée.
⇒ Il faut rester optimiste.
⇒ …4 ans passent très vite (trops vite pour VOXEL?)
⇒ Réflechissez bien avant d’impliquer un industriel.

- Le succès d’un “proposal”?…peut-être l’effet “waouw”.

VOXEL