M2 Project, Scalable image reconstruction methods for large data : application to synchrotron CT of biological samples

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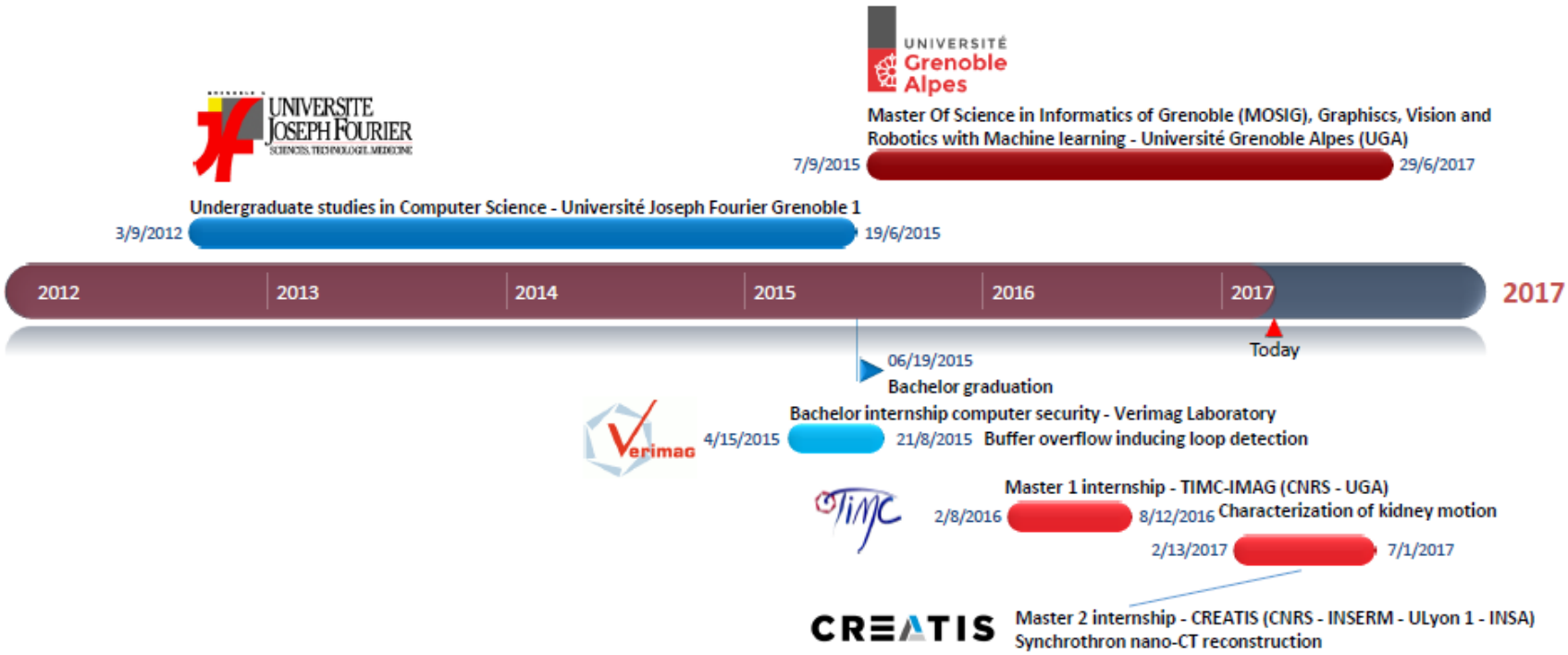
Overview

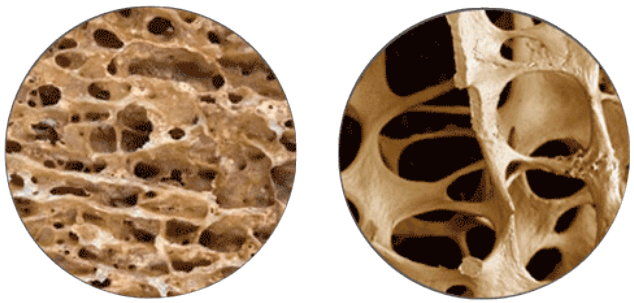
Personal studying background



Context of the M2 project

Osteoporosis study:

- Bone disease denoted by a loss of bone mass leading to bone deformation and increase of bone breaking risks.



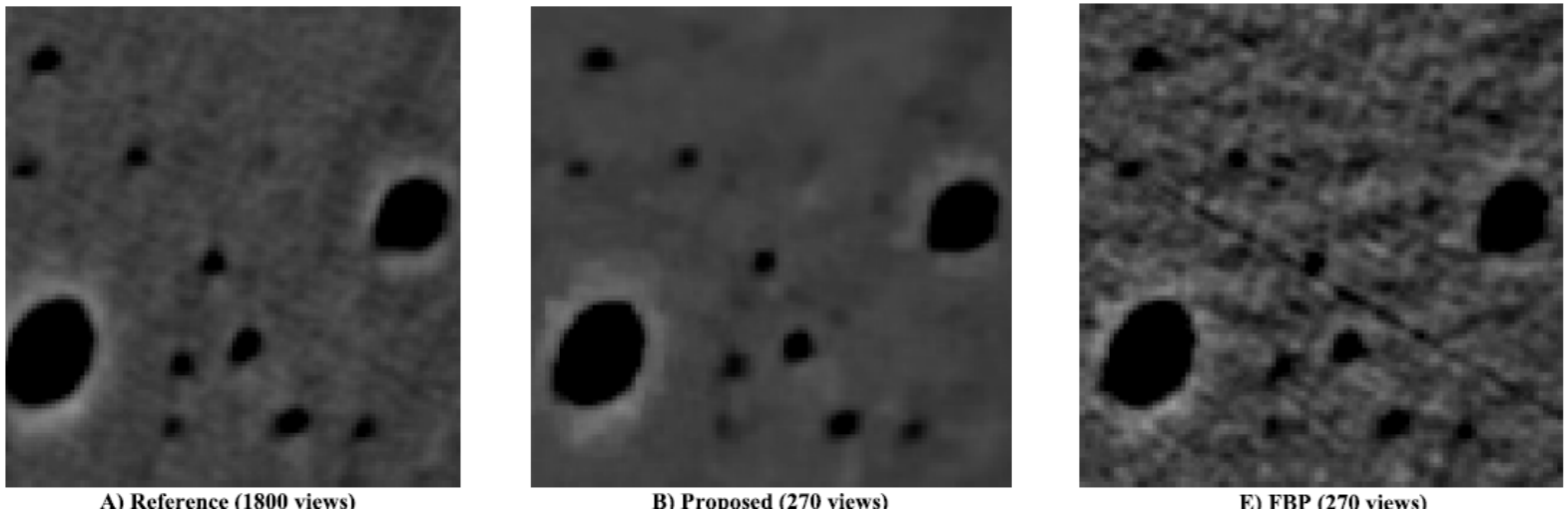
Normal bone density | Osteoporosis bone

- Interest in 3D nano-scale resolution imaging that is crucial to understand the disease.

- Synchrotron nano-CT could be used **but radiation dose at this resolution is too high (affects the sample)**
  $\rightarrow$ Need of low-dose methodology (acquisition protocols and algorithms)
- (-) No much work on low-dose synchrotron nano-CT
- **Objective:** Provide a scalable algorithm for low-dose Synchrothron Nano-CT and validate on bone data.

Objective and previous work (1)

Douglas splitting and wavelet shrinkage on Micro-SR-CT imaging[1]. Using 270 of 1800 projections to reconstruction with a resolution of $18\mu m$.

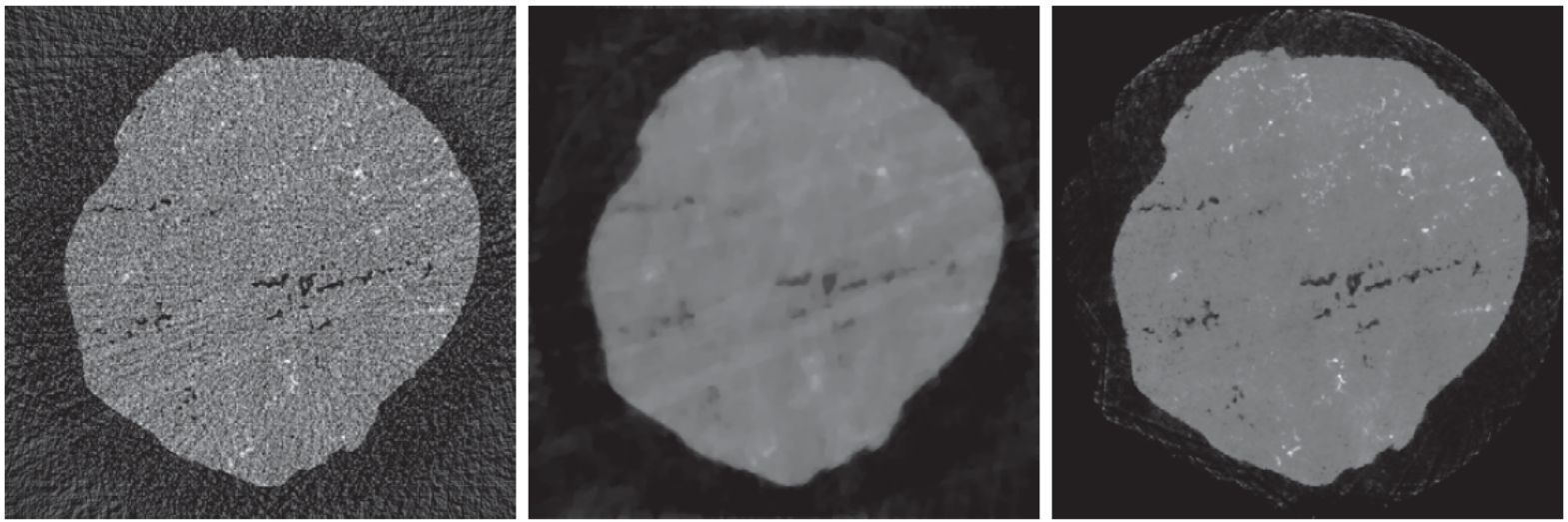


[1] S. A. Melli, K. A. Wahid, P. Babyn, D. M. Cooper, and V. P. Gopi. A sparsity-based iterative algorithm for reconstruction of micro-ct images from highly undersampled projection datasets obtained with a synchrotron x-ray source.
Review of Scientific Instruments, 87(12):123701

Objective and previous work (2)

Use of ordered subset intensity-based maximizing the a posteriori (OS-iMAP)[1]. From 1500 projections reconstruct using 100 of them with a resolution of $0.5\mu m$.

(a) FBP-50 (b) ART-TV-50 (c) OS-iMAP-50



[1] E. A. Rashed and H. Kudo. Statistical image reconstruction from limited projection data with intensity priors.
Physics in medicine and biology, 57(7):2039

M2 Project plan

Data set:

- Synchrotron nano-CT images of a bone sample of resolution $120nm$ with 2000 projections (2048×2000)
- Multiple reconstruction senarios with different number of projections and noise $\rightarrow$ low-dose simulation

Method:

- splitting methods (split Bregman, ART + denoising).
- investigate regularization functionals (bone detail preservation).
- Scalability and eficiency, exploiting ESRF facilities PyHST2[1].

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[1] A. Mirone, E. Brun, E. Gouillart, P. Tafforeau, and J. Kieffer. The pyhst2 hybrid distributed code for high speed tomographic reconstruction with iterative reconstruction and a priori knowledge capabilities. *Nuclear Instruments and Methods in Physics Research*, 324:41–48