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# Improving solid-state NMR sensitivity using instrumentation, fast acquisition and post-processing



G. LAURENT, C. BONHOMME

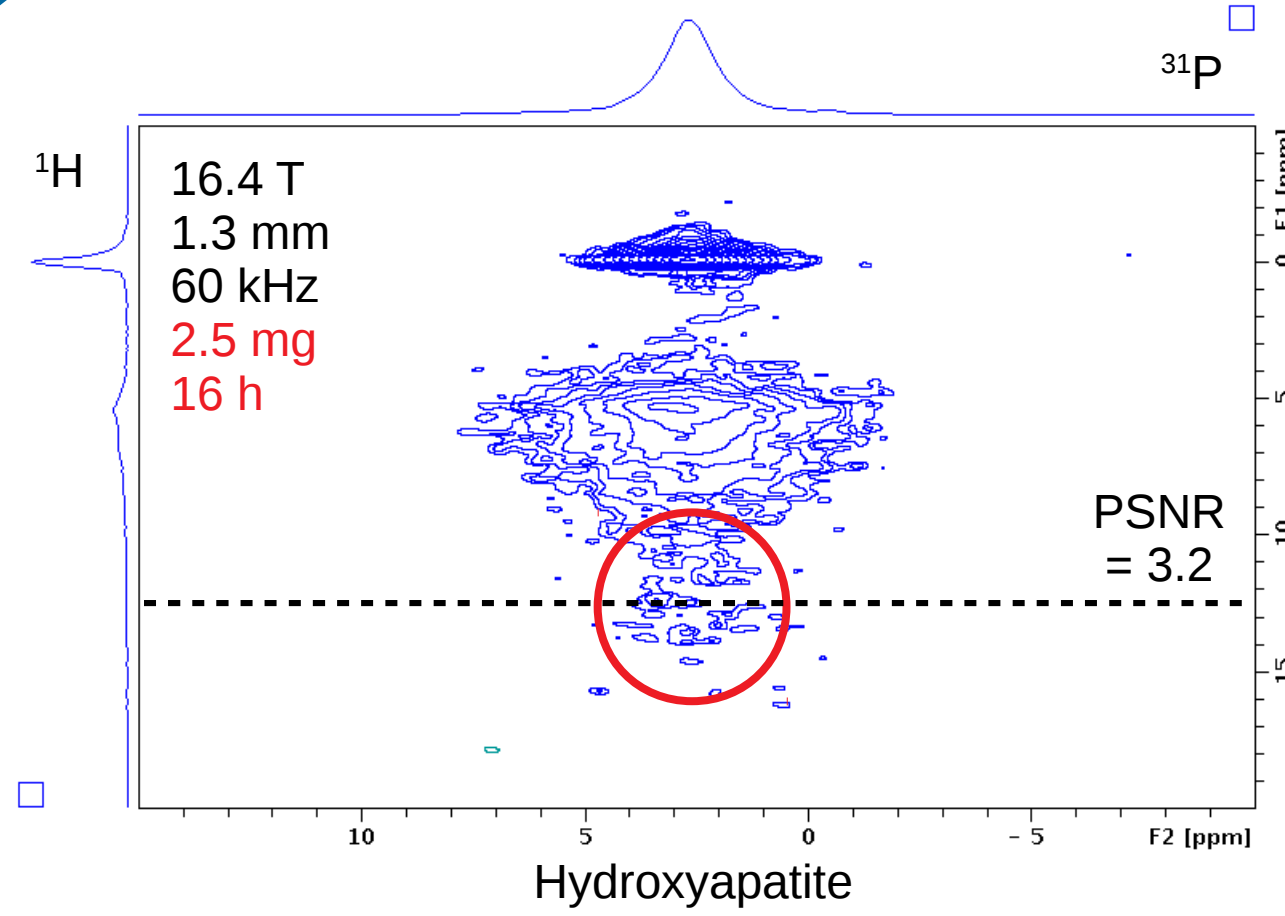


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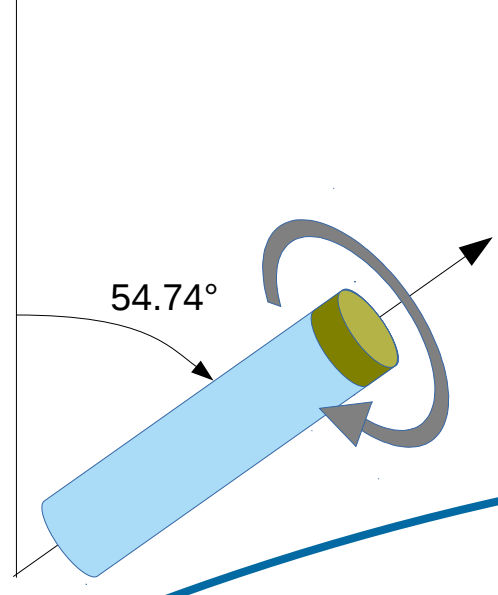


## 1 – Introduction

## 7 – References



Magic Angle Spinning (MAS)



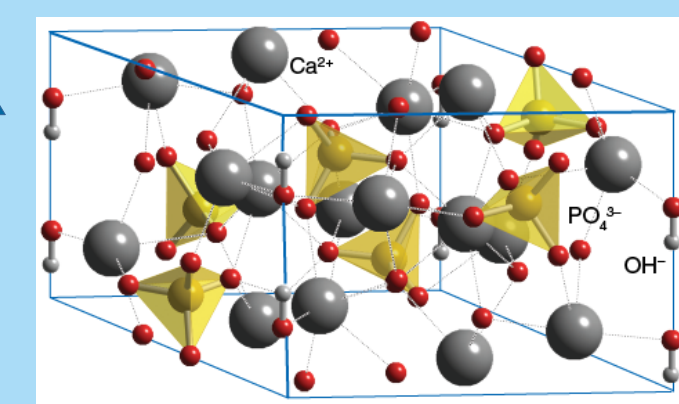
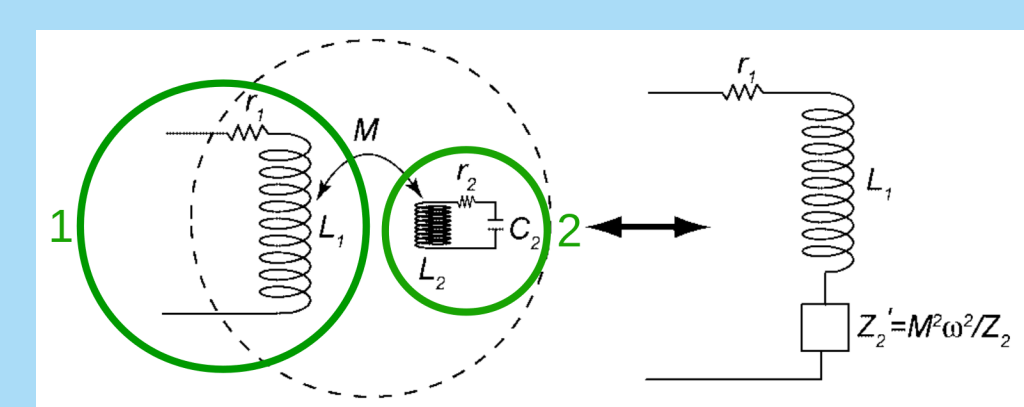
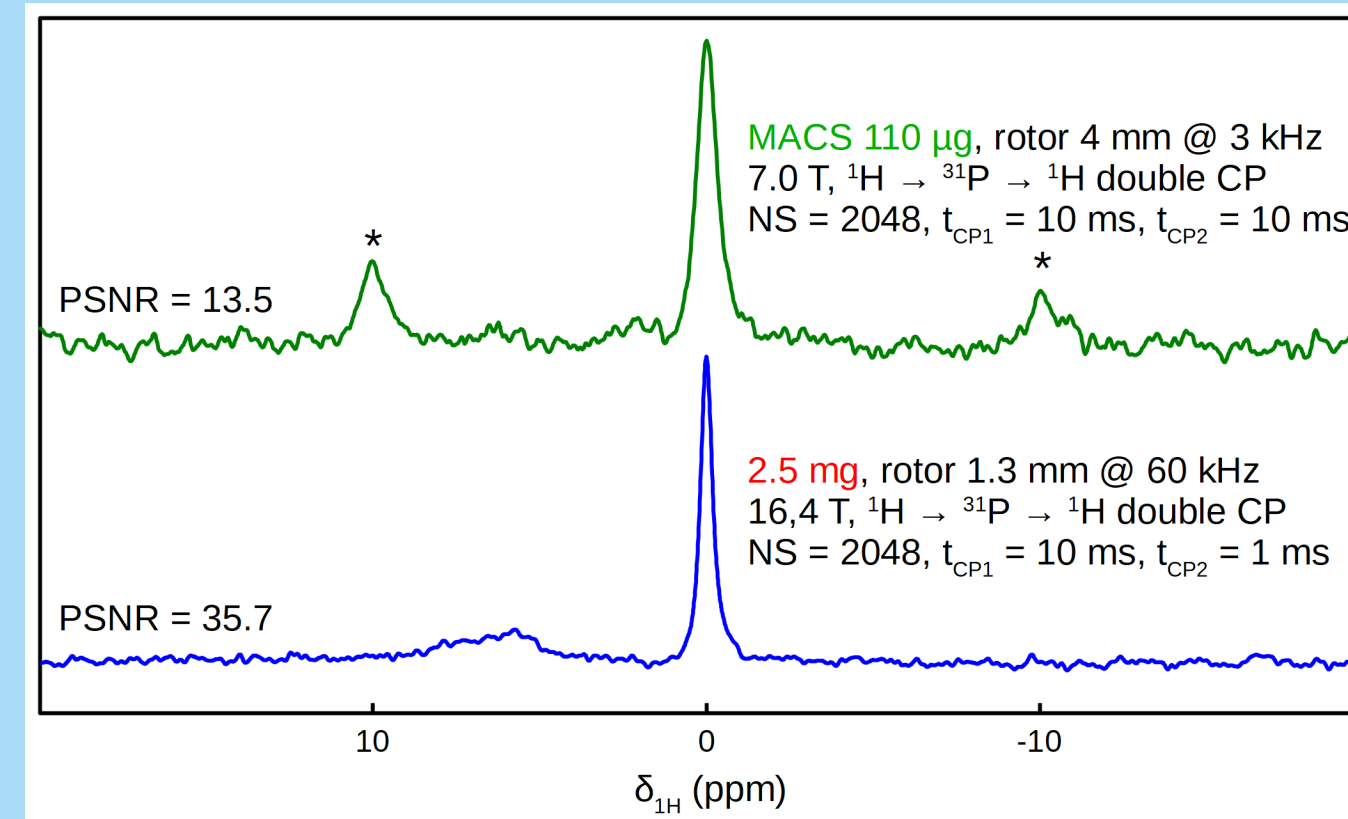
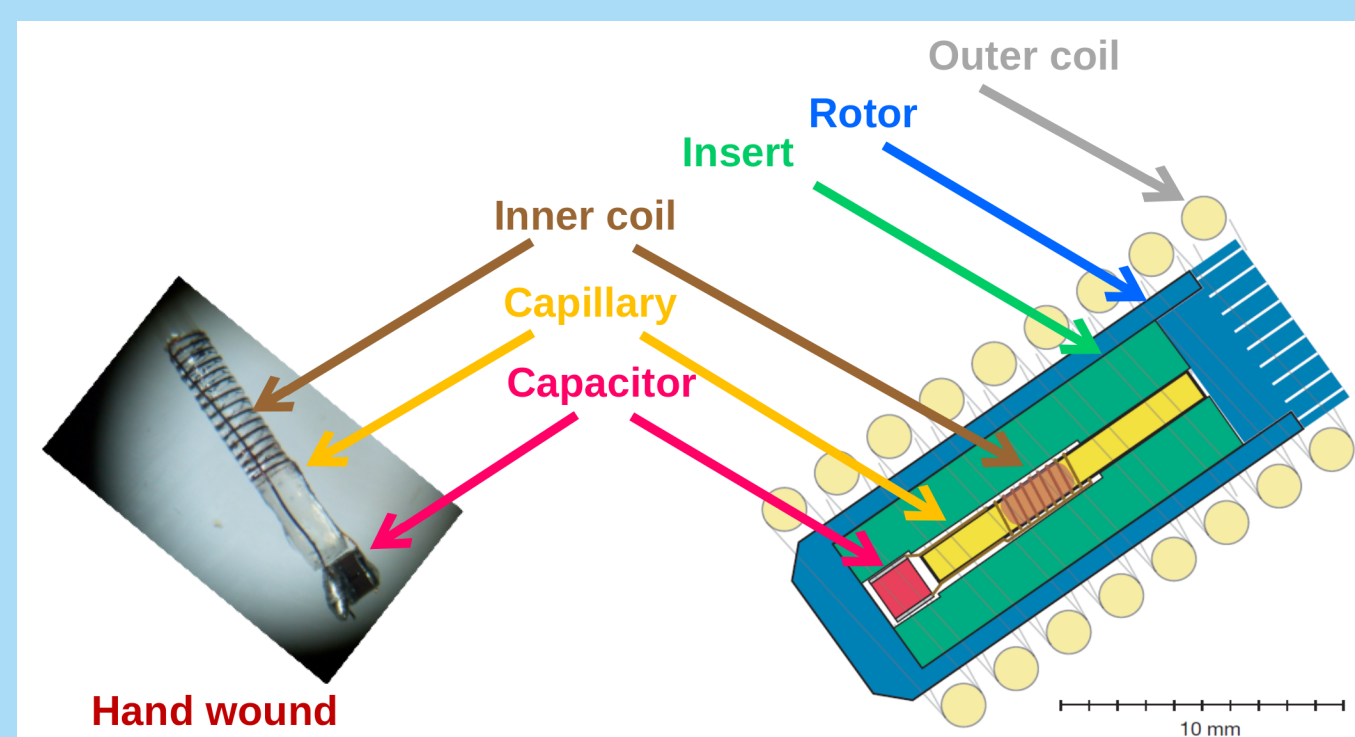
$$PSNR_{max} = \frac{H_{signal}}{h_{noise\_peak\_peak}} / 2$$

- Solid-state NMR:
- Broad peaks
  - Partial narrowing with MAS
  - Low sensitivity

- [1] D. Sakellariou *et al.*, *Nature*, vol. 447, no. 7145, pp. 694–697, Jul. 2007.
- [2] J.-F. Jacquinot and D. Sakellariou, *Concept. Magn. Reson. A*, vol. 38A, pp. 33–51, Mar. 2011.
- [3] G. Laurent, presented at the Instrumenter et innover en chimie physique pour préparer l'avenir, Paris, France, 22-Jan-2015.
- [4] K. Kazimierczuk and V. Y. Orekhov, *Angew. Chem. Int. Ed.*, vol. 50, no. 24, pp. 5556–5559, 2011.
- [5] G. Laurent, presented at the RMN structurale dans le Bassin Parisien, Orléans, France, 27-Mar-2018.
- [6] P. P. Man *et al.*, *Solid State Nucl. Mag.*, vol. 61–62, pp. 28–34, Jul. 2014.
- [7] G. Laurent, presented at the C2i-2016: 7ème colloque interdisciplinaire en instrumentation, Saint-Nazaire, France, 20-Jan-2016.
- [8] G. Laurent *et al.*, *Appl. Spectrosc. Rev.*, submitted.

## Magic Angle Coil Spinning (MACS) [1-3]

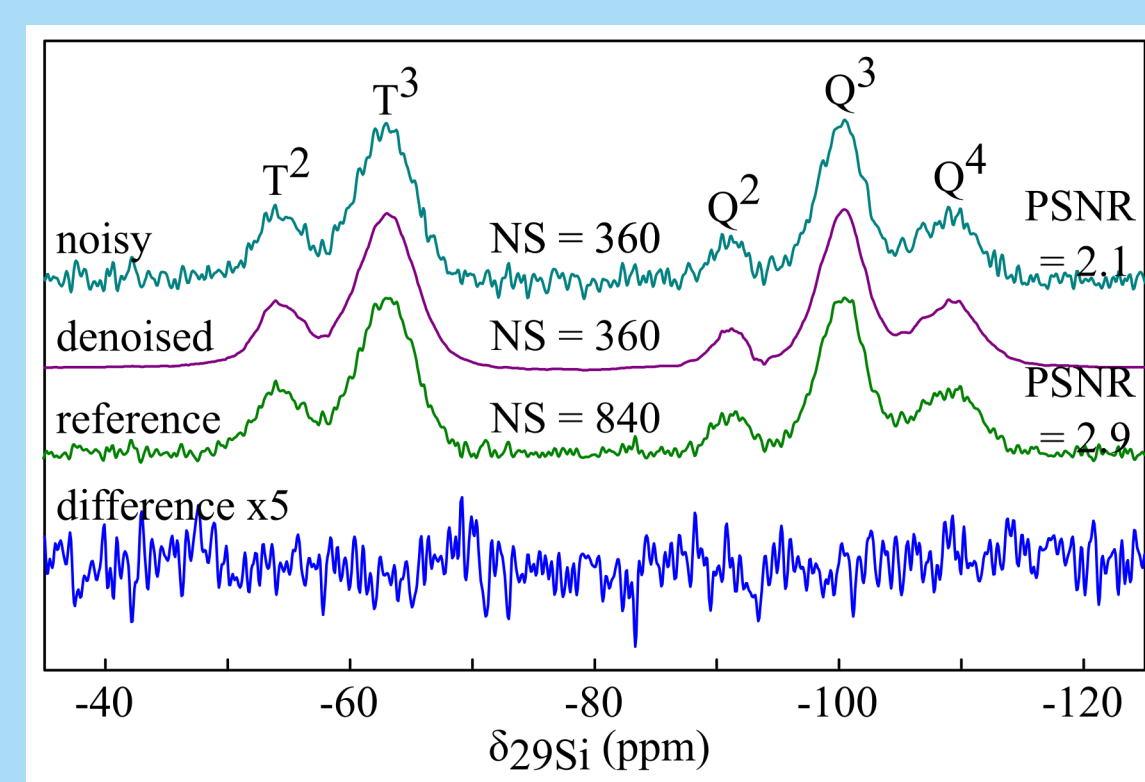
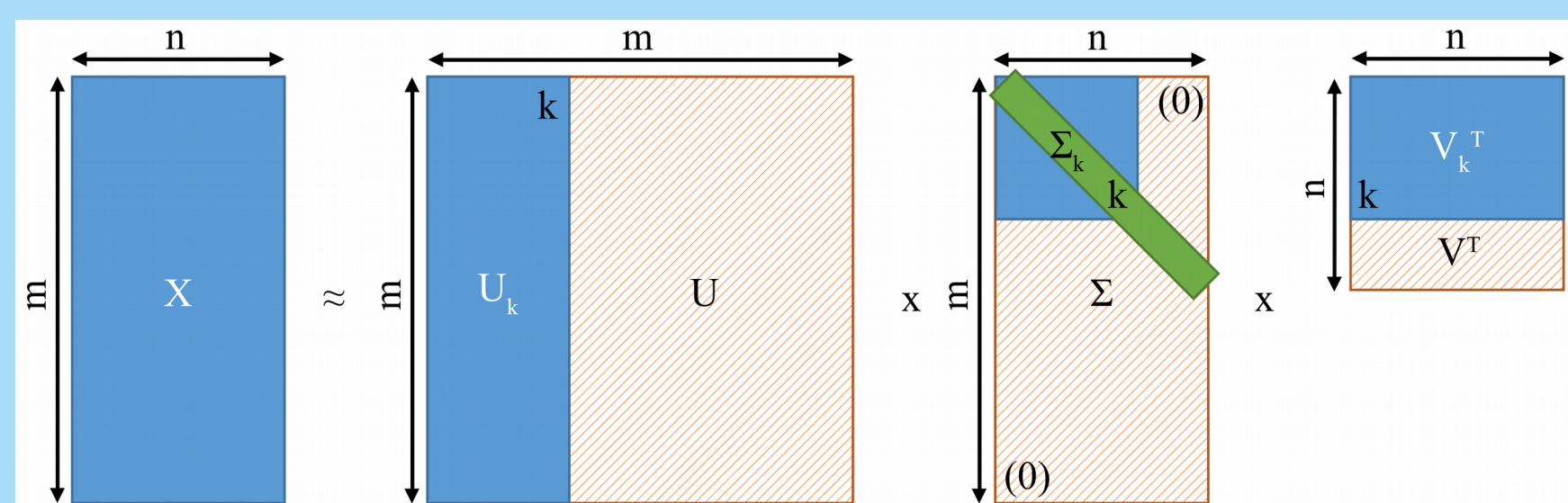
Micro-quantities (100 µg)  
PSNR / sqrt(t) / g → x 8



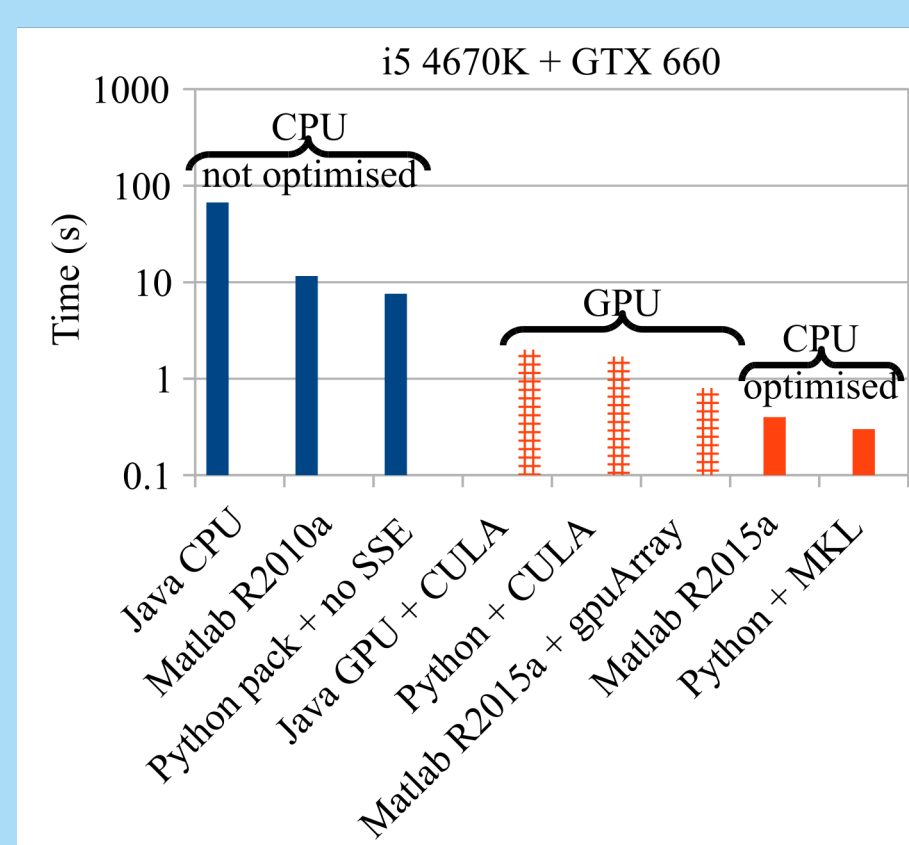
Hydroxyapatite  
 $Ca_{10}(PO_4)_6(OH)_2$   
Inorganic part of bone

## Singular Value Decomposition (SVD) [6-8]

Denosing  
PSNR / sqrt(t) → x 2  
computation time / 100

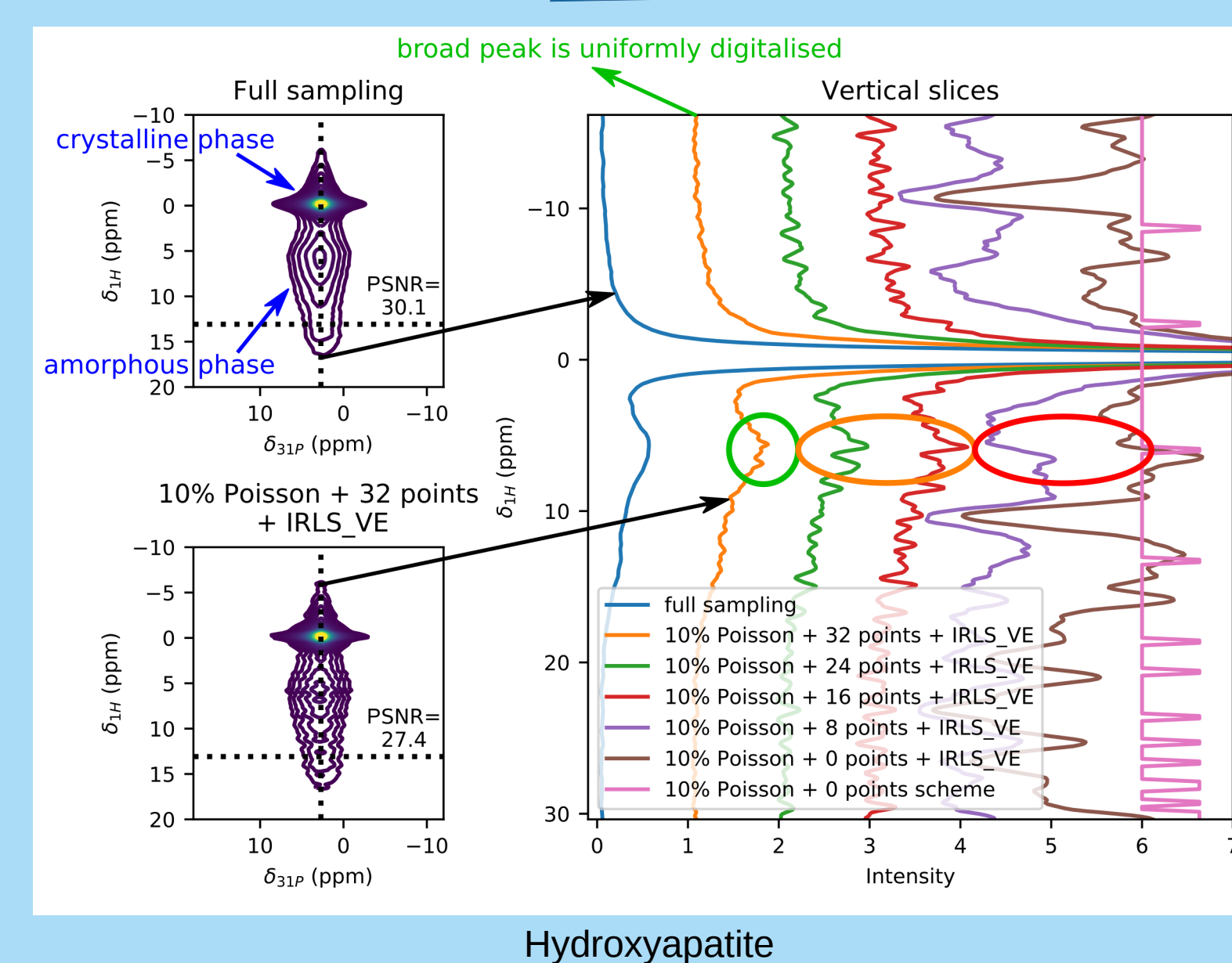
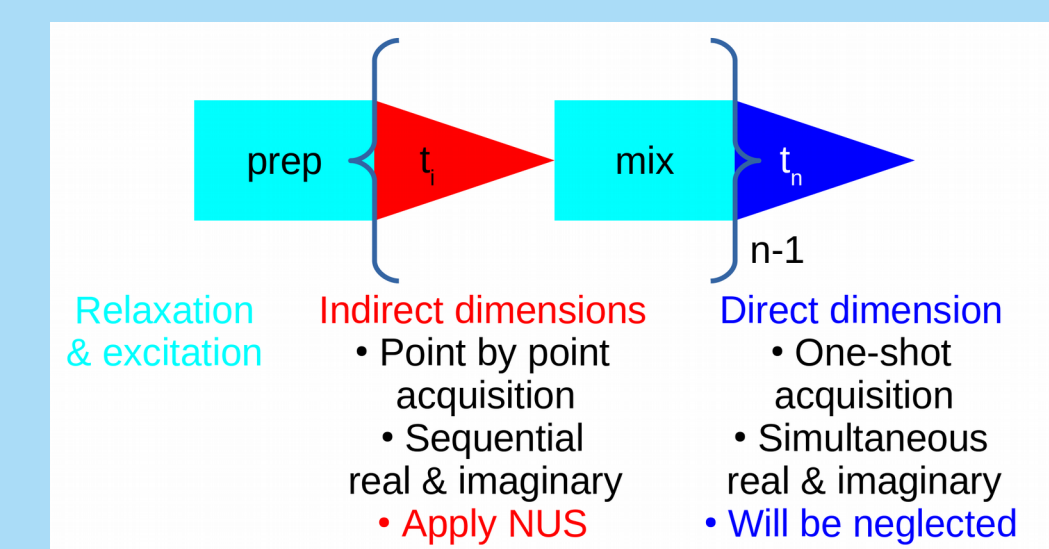


50 / 50, MTEOS (T) / TEOS (Q)  
organic / inorganic hybrid material



## Non-Uniform Sampling (NUS) [4-5]

Increase resolution  
PSNR / sqrt(t) → x 2



Hydroxyapatite

Sensitivity

2 – Instrumentation

3 – Acquisition

4 – Processing

## 5 – Conclusion

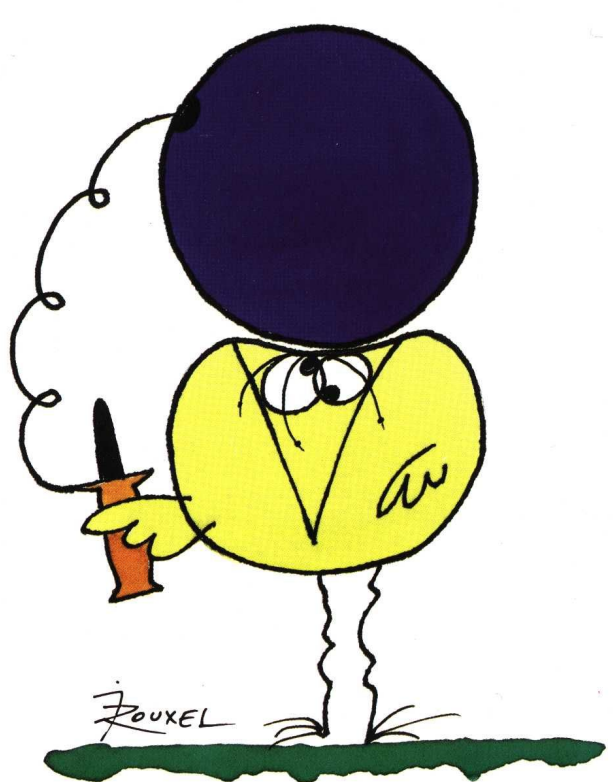
## 6 – Acknowledgements

- Complementary techniques:
- MACS: sensitivity increased by 8
  - NUS: sensitivity increased by 2
  - SVD: sensitivity increased by 2

- Next step:
- **Combining MACS + NUS + SVD: sensitivity increased by 32**

- Stanislas Von Euv and Virgile Barret-Vivin are thanked for providing the samples
- Laboratory head is acknowledged for its confidence
- Colleagues are recognized for their encouragements and fruitful discussions

Les devises Shadok



EN ESSAYANT CONTINUUELLEMENT ON FINIT PAR REUSSIR, DONC: PLUS ÇA RATE PLUS ON A DE CHANCES QUE ÇA MARCHE.

