



## 3D Neutron Diffraction

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# 3D Neutron Diffraction

A Cereser<sup>1,2</sup>, M Strobl<sup>2</sup>, S Hall<sup>2,3</sup>, A Steuwer<sup>4</sup>, A Tremsin<sup>5</sup>, EB Knudsen<sup>1</sup>,  
P Willendrup<sup>1</sup>, S Kabra<sup>6</sup>, J Kelleher<sup>6</sup>, R Kiyanagi<sup>7</sup>, W Kockelmann<sup>6</sup>,  
S Peetermans<sup>8</sup>, T Shinohara<sup>7</sup> and S Schmidt<sup>1</sup>

<sup>1</sup>Technical University of Denmark - <sup>2</sup>ESS-AB - <sup>3</sup>Lund University - <sup>4</sup>Business Region Skåne -  
<sup>5</sup>University of California at Berkeley - <sup>6</sup>ISIS - <sup>7</sup>J-PARC - <sup>8</sup>PSI

3D Neutron Diffraction (3DND) is a new technique to study shape and orientation of the individual grains composing polycrystalline samples. 3DND enables non-destructive 3D grain mapping of mm- to cm-sized samples, covering larger sample volumes than existing X-ray methods like 3D X-Ray Diffraction (3DXRD) [1]. 3DND would complement 3DXRD, providing information on mechanical evolution, stress/strain states, recrystallization and allowing in-situ studies under extreme conditions.

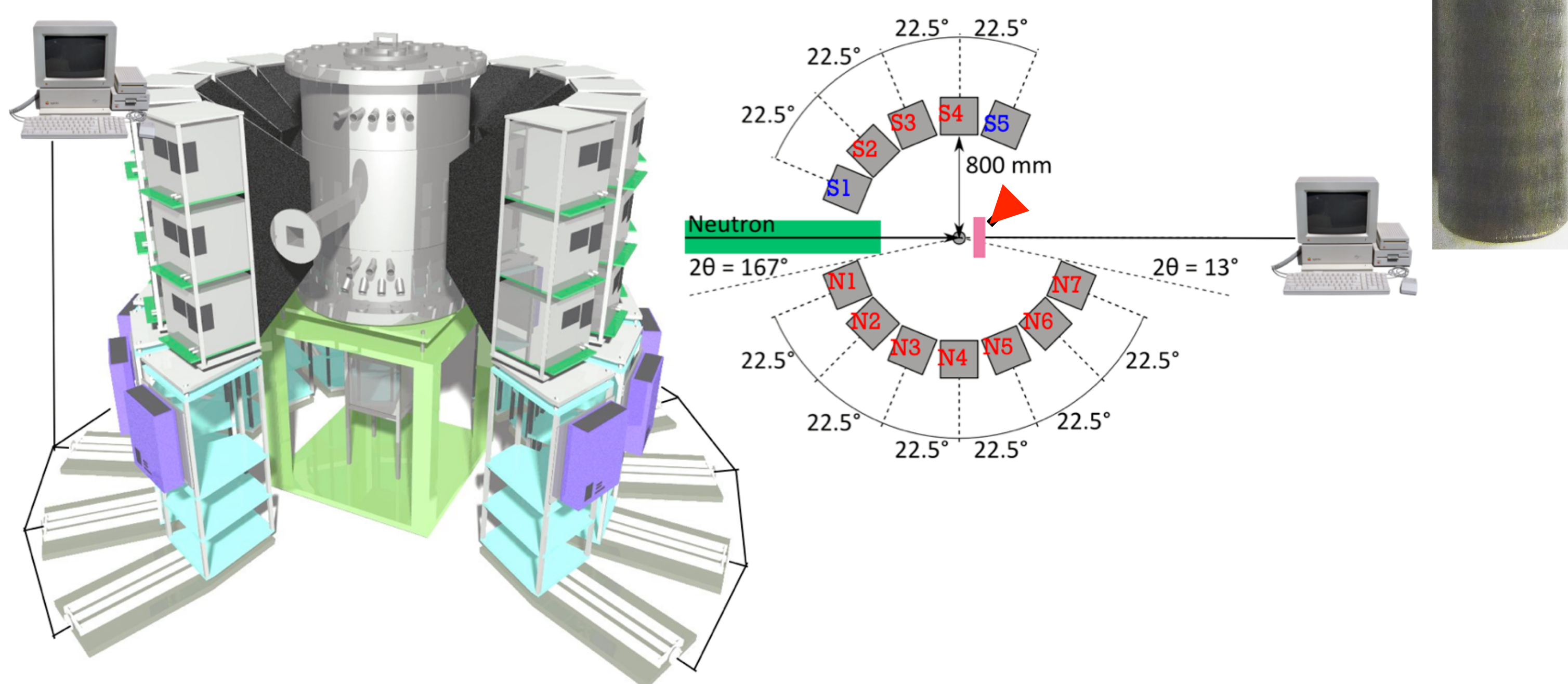
We are developing the algorithms for the 3D reconstruction based on datasets collected at BL18 (J-PARC), ENGIN-X (ISIS), ICON (PSI), and virtual experiments done using McStas [2].

These are the approaches we used:

1. Laue diffraction, with wide bandwidth and a near-field diffraction detector in backscattering mode.
2. Time-of-flight diffraction, with transmission data collected by a near-field detector and diffraction data collected by far-field ones.

## Time-of-flight 3DND

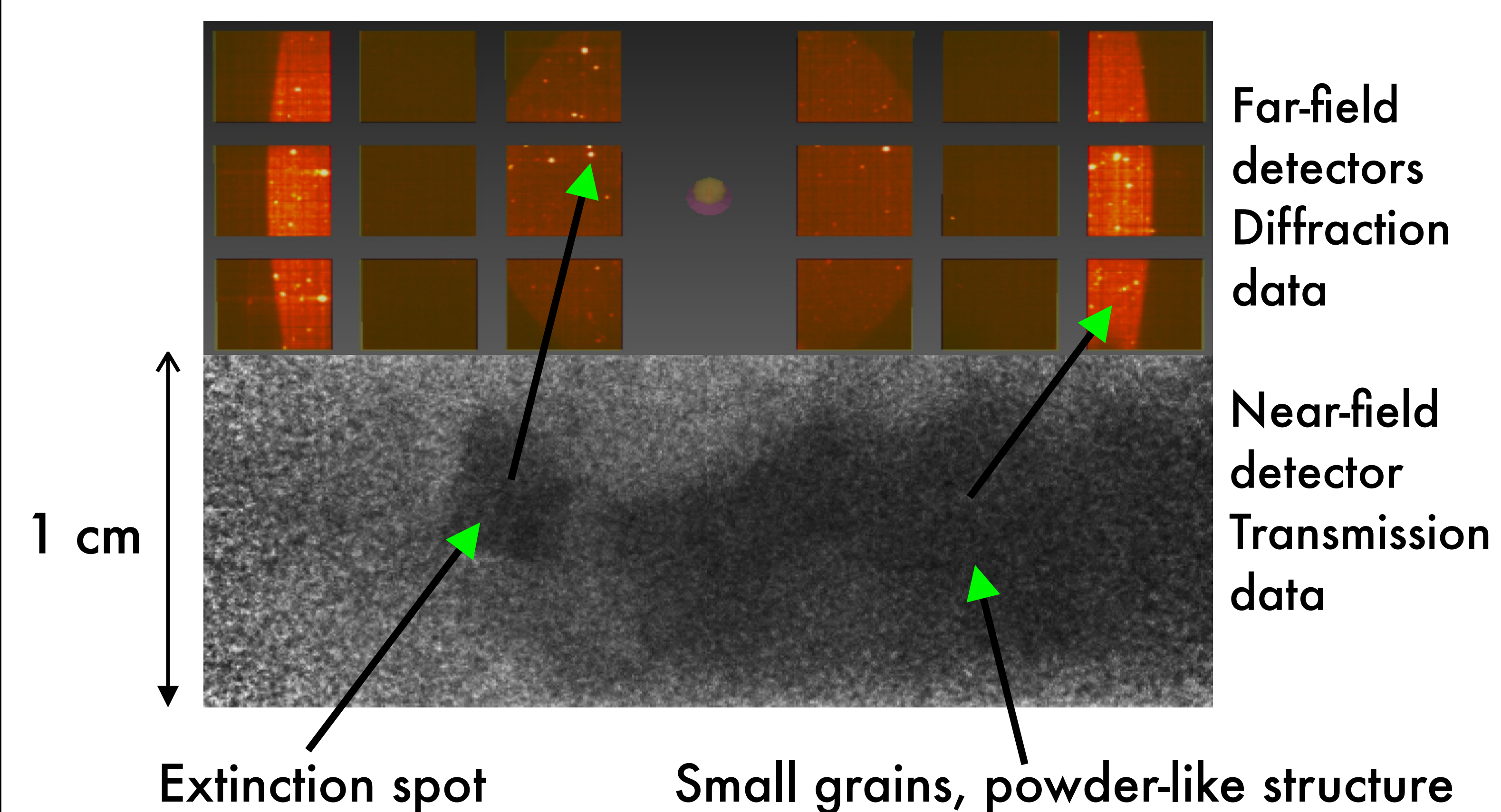
In June 2014 at BL18 we analysed an Armco Iron sample (length: 5 cm, diameter: 1 cm, 99.8% purity), prepared to contain mm-sized grains. The sample was scanned over 180deg in 3deg steps, acquisition time per projection  $\sim 1$ h.



Setup used at BL18. Data were acquired simultaneously by near- (indicated by red arrow) and far-field detectors.

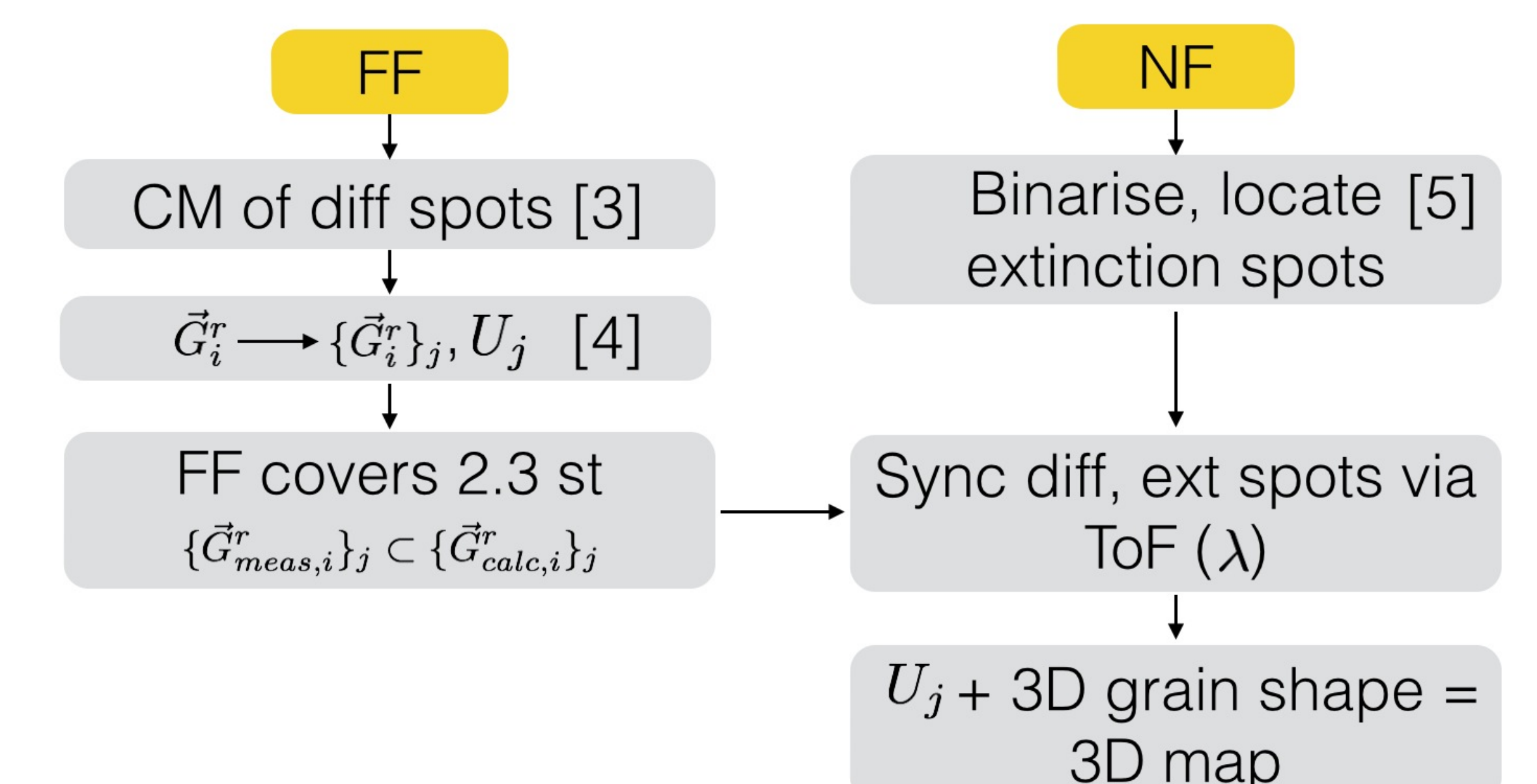
|                           |   |
|---------------------------|---|
| Near- field (NF) detector | MCP detector, $28 \times 28 \text{ mm}^2$<br>1200 fr/s, pixel size $55 \mu\text{m}$<br>Use: shape of the grains |
| Far-field (FF) detectors  | 36 det, each $256 \times 256 \text{ mm}^2$<br>Pixel size 4 mm, Q: 0.6-30.7<br>Use: orientation of the grains    |

Data collected by near- and far-field detectors at BL18, Fe sample



## Data analysis

Data acquired simultaneously by NF and FF detectors



3DND is a nondestructive technique to investigate, in a reasonable time frame, the 3D structure of mm- to cm-sized polycrystalline samples. It completes existing X-ray techniques, enabling to use complex sample environments. Combined with a time-of-flight beam, 3DND can be used to study samples composed by a large number of grains. Once the reconstruction algorithm is fully implemented, we will apply 3DND to study shape memory alloys.

[1] HF Poulsen et al. (2001). [2] K Lefmann and K Nielsen (1999). [3] T Ohhara et al (2009). [4] S Schmidt (2014). [5] W Ludwig et al (2008)



Alberto Cereser - PhD  
student at the Technical  
University of Denmark.  
[alcer@fysik.dtu.dk](mailto:alcer@fysik.dtu.dk)

