ITT9: Challenges with Diamond

1. Dynamic Imaging
    a. Crack propagation
    b. Dynamical systems and physical models
    c. Probabilistic models
    d. 3D printing with metal (understand dynamics)
    e. Movie compression: can be done without inverse problems
2. Multi-modality and spectral imaging
    a. How to combine information?
    b. Maximize information gain of radiation, use / combine all available information: absorption, diffraction, fluorescence, ptychography
    c. How does the data relate to physical processes?
    d. What to do with the spectral information? (again here this can be done without inverse problems with 2D + spectral images)
3. Data sampling
    a. Optimal sampling
    b. Dimensionality reduction
    c. Probabilistic models
    d. Reduce time of acquisition => faster experiments
    e. Physical constraints?
4. Data processing
    a. Segmentation
    b. Image analysis, e.g. how to model shape of crystals in ice cream

Things that do not yet fit into these four challenges:

1. Missing angles
2. Reconstruction with a few phases (number of materials)
3. How similar is the data from experiment to the next?

Overall comments and questions:

1. What data will be provided?
    - Time Series (ice-cream temperature evolution [7](DK), dendrites evolution (DK), corrosion process (DK)). Both raw data and reconstructed data will be provided
    - Alignment, registration, tracking challenge (B24 (PQ), Ptychography (PQ), I23 (DK), i14(PQ)); Additive manufacturing video series [9] (DK)
    - Dimensionality reduction challenge and multi-modal reconstruction (i18 data (PQ,DK))
    - Optimal sampling, missing angles, artifacts reduction challenge (TomoPhantom to generate and reconstruct data)
2. What techniques are used at the moment?

References:

1. Multi-modality imaging at Diamond: https://www.ncbi.nlm.nih.gov/pubmed/28009564

2. Modern Inverse Problems: https://www.cambridge.org/core/journals/acta-numerica/article/modern-regularization-methods-for-inverse-problems/1C84F0E91BF20EC36D8E846EF8CCB830
3. Optimization methods for imaging: https://www.cambridge.org/core/journals/acta-numerica/article/an-introduction-to-continuous-optimization-for-imaging/1115AA7E36FC201E811040D11118F67F
4. Inverse problems and data assimilation techniques http://people.bath.ac.uk/mamamf/FrPo2013.pdf
5. A general Diamond page on Imaging (various modalities): https://www.diamond.ac.uk/Instruments/Techniques/Imaging.html
6. Ptychography related paper: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5247528/pdf/rspa20160640.pdf
7. Full field tomography data simulator: https://github.com/dkazanc/TomoPhantom. It can generate various phantoms, projection data and artifacts.
8. Ice-cream projects and links to the papers (some not open access, do we want to create a shared space for it?): https://www.diamond.ac.uk/Science/Research/Highlights/2018/3D-X-ray-tomography-scoops-up-information-about-ice-cream-microstructure.html
9. Additive manufacturing paper https://www.nature.com/articles/s41467-018-03734-7
10. Alignment of flat field to data, normalisation challenge. https://arxiv.org/pdf/1707.04531.pdf
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