

Micro Project 1: Exterior Tomography

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1 The problem: reconstruction in exterior tomography

The exterior problem in tomography is in some sense complementary to the interior/region-of-interest (ROI) problem, where projections are truncated, i.e., only data corresponding to an ROI in the interior of the object is available. In the exterior problem, on the other hand, the interior data is unavailable while the outer data, typically corresponding to an annulus, is available. As will be described during the week exterior tomography occurs in some practical scenarios (such as non-destructive testing of rockets) where the central part of the object is too dense for X-rays to penetrate, while in the outer part satisfactory X-ray projection measurements can be obtained. This can be alone due to the longer path through the central part or due to features in the center blocking the X-rays completely.

2 The micro project

The micro project is quite open-ended with the overall goal to investigate the exterior problem, in particular to establish what can and cannot be reconstructed. In the lectures and exercises you are introduced to theory, techniques and tools for tomographic reconstruction. In the project it is up to you to choose from this material and apply to the exterior problem in order to understand the problem and the limitations of reconstruction from exterior data. A few ideas to get you started (feel free to pick from this list or pursue your own ideas within the course material and exterior tomography – please discuss ideas with us):

- Apply FBP including practical corrections such as padding as used for ROI data.
- Apply SVD analysis and compare singular values and vectors with full-data case.
- Apply ideas from micro-local analysis to assess which features can be reconstructed.
- Design phantoms with features to illustrate how reconstruction quality depends on size of features, closeness to boundary, radius of missing interior region, etc.
- Real-data: Investigate the effect of having exterior data on one or more of the real data sets provided by us or one that we acquired on Monday. Try to improve reconstruction e.g. using padding.

3 Practical information and assessment

You will be working together in groups of 3–4 students. There will be a few hours available to work on the micro project during Monday to Thursday, while all of Friday is dedicated to the micro project. At the end of Friday, from about 2pm, each group will present their work to the lecturers and other groups in 10–15 min oral presentations. Each group member is expected to contribute to the oral presentation. There is no written report – assessment is solely based on the oral presentation. In the presentation please explain what you have chosen to investigate, which theory/tools you have used, give your results (show plots, reconstructions, theoretical results, etc) and your conclusions.