

Compensation of ringartifacts in tomographic images

Problem:

Concentric rings in tomographic images (figure 1) that occur because of incorrect measurements are represented as vertical, thin lines in the radon space, the sinogram. The presented method tries to compensate these ringartifacts with the help of the sinogram data.

Method:

It is the intention to raise the grey values of the vertical lines in that way, that they disappear in their environment. If this is reached the rings in the tomographic images will disappear equally. Therefore the sum for grey values of each column i of a sinogram is calculated by line.

$$y(i) = \sum_n proj_n(i)$$

The graph of these sums shows local minima (peaks) at the same positions where the thin lines are (see figure 2). With the so called “Moving Average Filtering” it is possible to delete these peaks suitable.

The applied filtering method replaces a value by averaging its neighbourhood with a span $2N+1$.

$$y_s(i) = \frac{1}{2N+1} (y(i+N) + y(i+N-1) + \dots + y(i-N))$$

With the help of this information it is possible to recalculate the grey values of each projection n in the sinogram as follows:

$$proj_{n_{new}}(i) = proj_n(i) \cdot \frac{y(i)}{y_s(i)}$$

The reconstruction of the modified sinogram data is nearly free from ringartifacts (see figure 3). The ring-shaped structures are disappeared.

Implementation (PyHST):

The presented solution is implemented in a sinogram filter for the reconstruction program PyHST. The parameter file that is needed for the reconstruction process has to be completed with the following lines:

```
DO_SINO_FILTER=YES
SINO_FILTER="SINO_Filter_Smooth"
span=51 ! should be odd
SINO_FILTER_PARA={"SmoothFilter":span}
```

The size of the averaging window can be modified with the *span* parameter.

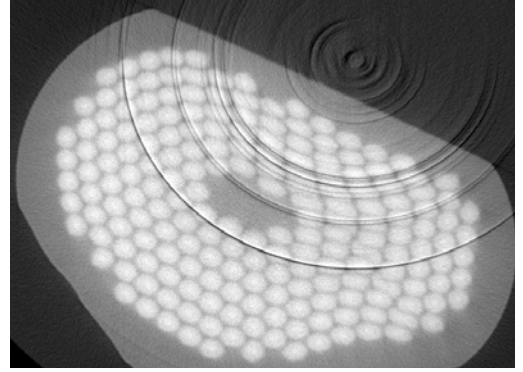


Fig. 1: Tomography of a superconductor with ringartifacts

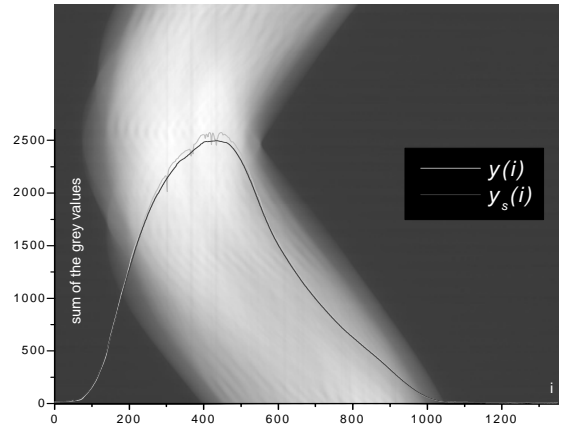


Fig. 2: Sinogram of a slice with vertical lines and a plotted diagram with the sum $y(i)$ of all projections and the calculated function $y_s(i)$.

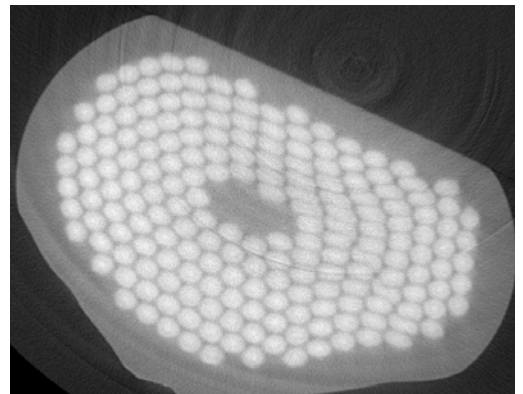


Fig. 3: Tomography after the correction of the sinogram with the „Moving Average Filtering“