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ScienceDirect

Physics Procedia 88 (2017) 196 – 199

Physics Procedia

8th International Topical Meeting on Neutron Radiography, Beijing, China, 4-8 September 2016

Quadruple axis neutron computed tomography

Burkhard Schillinger[a]*, Dominik Bausenwein[a]

[a]*Heinz Maier-Leibnitz Zentrum (FRM II) and Fakultät für Physik E21,Lichtenbergstr.1, 85748 Garching, Germany*

Abstract

Neutron computed tomography takes more time for a full tomography than X-rays or Synchrotron radiation, because the source intensity is limited. Most neutron imaging detectors have a square field of view, so if tomography of elongated, narrow samples, e.g. fuel rods, sword blades is recorded, much of the detector area is wasted. Using multiple rotation axes, several samples can be placed inside the field of view, and multiple tomographies can be recorded at the same time by later splitting the recorded images into separate tomography data sets. We describe a new multiple-axis setup using four independent miniaturized rotation tables.

Peer-review under responsibility of the organizing committee of ITMNR-8

Keywords: Neutron Radiography; Neutron Imaging; Neutron Computed Tomography; CCD Camera; Tomography

1. Previous work

Trtik et al. have presented a device called POLYTOM [1] where an add-on to a standard rotation table drives two more rotation axes with the aid of cogwheels (Fig.1). Considerable effort was made to install anti-backlash gears, so there would be no play in the driving mechanism.

Its big advantage is that it simply works as an add-on to an existing rotation table, disadvantages are the reversed sense of rotation for the outer tables, and the fixed distance between the axes.

Since precise clockwork gear seems to be a high art left best to expert clockmakers in Switzerland, other possibilities were examined to install independent rotation axes. Piezo rotation tables are the tiniest rotation tables available, but they have small load capacity, no prevision against slipping under load, and require expensive driving technology.

* Corresponding author. Tel.: +49-89-289-12185; fax: +49-89-289-14997.
E-mail address: Burkhard.Schillinger@frm2.tum.de

Peer-review under responsibility of the organizing committee of ITMNR-8
doi:10.1016/j.phpro.2017.06.027

Standard rotation tables seemed too big to place side by side, so a new approach was taken by placing the tables close to each other, but stacking them vertically to achieve smaller distances between the axes.

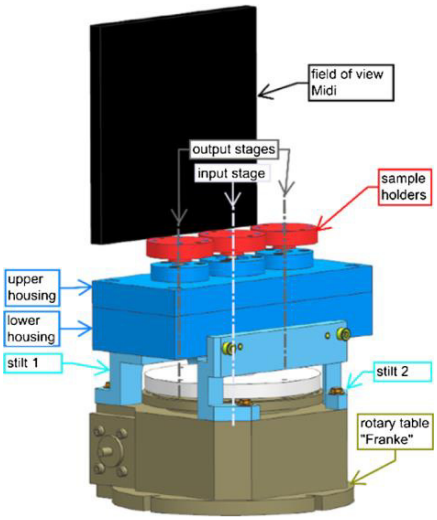

Fig.1: POLYTOM, the clockwork mechanism presented by Trtik et al. in [1].

2. The new approach: several miniaturized rotation tables on an optical rail

A new company named Standa [2] has recently emerged not only with competitive prices, but also miniaturized rotation tables with high load capacity. The model we selected has a load capacity of nominally 4 kg for a perfectly centered load, while its smallest diameter is only 45 mm. By installing neighboring tables on pedestals of different height and using rotation tables mounted on a narrow rod, we can achieve a distance of only 28 mm between rotation axes (Fig.2).

Four such pedestals with rotation stages are mounted on an optical rail, so the distance between the tables can be varied according to sample size (Fig.2).

The ensemble of four stages is shielded by an Aluminium frame that is coated with Borated rubber on the inside to protect the stages from neutron radiation and thus from activation (Fig.3). The whole setup is mounted on an extension of our cryostat manipulator, which can be moved in height and runs on rails in the floor to change the distance to the detector.

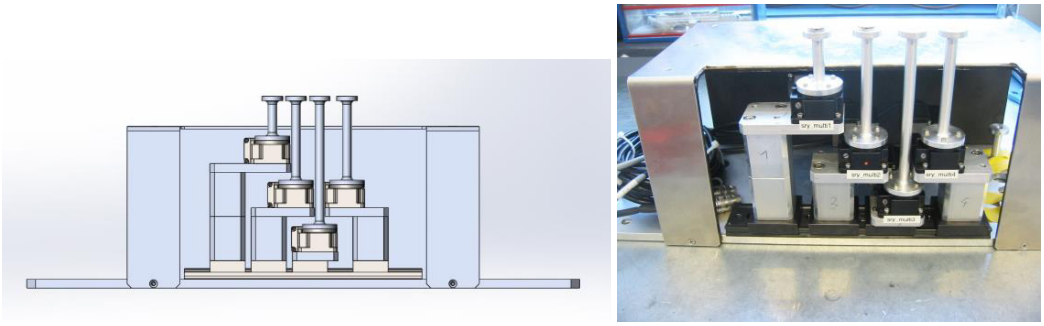

Fig.2: The four tables mounted overlapping at different heights