Annual Report

Funding Programme:	**Helmholtz Joint Research Groups**
Project ID No.:	HRSF 0004
Project Title:	Compton X-ray microscopy of biological specimens
Principal Investigator:	Heinz Graafsma
Report Period (=Calendar Year):	01/2019-12/2019

1) Group Structure

Please report briefly on the structure and personnel development of your group.

The group consists of 3 contributing subgroups, 2 on the German side, headed by Henry Chapman and Heinz Graafsma, respectively and one on the Russian side headed by Oleg Tolbanov.

The subgroups consist on many people involved in the project to a small degree (as outlined in the proposal). The proposal called for the addition of a PostDoc and a PhD student on the German side. Recruitment efforts were ultimately unsuccessful.

2) Network/ Meetings

Please describe how the group works together. Have there been any international meetings organized by or attended by the group? What is the contribution of the group to the networking of international partners and the Helmholtz Centre?

The partners have met regularly. The Russian partners joined by means of a video conference.

The meetings were focused on the preparation of a joined beamtime at PETRA III, a follow up beam time implementing lessons learned from the first experiments in 2018.

3) Scientific Progress / Milestones

How has your work plan progressed? What important milestones could be achieved during the report period? Is the progress of your work in accordance with original planning or has the work plan been changed?

Most of the second project year was spend in PHASE 2: Realization.

A prototype detector consisting out of 3 individual units with GaAs sensors was constructed. The detectors are based on a lightweight version of the established LAMBDA camera, reducing its weight from approximately 5.5 kg to less than 1 kg. The detectors were integrated into the beamline control system at PETRA and were used during an experimental beamtime (see below for details). Since that beamtime further improvements have been made on the control library increasing the data throughput significantly.

Efforts to develop tiles larger than 2x3 are still ongoing as larger sensor tiles are preferred, however progress has been slow. The anticipated pilot run for bonding with a room temperature process was initiated with an external partner but stalled by administrative delays and an equipment failure on the side of the partner. We remain hopeful to see results in 2020.

An experiment at PETRA P07 with a beam energy of approximately 65keV and two GaAs detectors consisting of one 2x3 sensor tile each was conducted.

The beamtime was a success in that the images could be successfully measured and showed

an improved contrast of the absorption measurement. A publication of the results is in preparation.

Unfortunately, and despite multiple calls and active search efforts, no suitable candidates for the open positions in the project on the German side have been found.

In year 1 and 2 these tasks could be compensated by the project team, but for year 3 this will probably not be possible anymore, as there have been personnel changes in the project team (Pablo Villanueva-Perez has left DESY, Julian Becker is only working 5 hours per week for DESY until March 2020).

In the upcoming phase 3 (implementation) of the project, the focus is on the production of a final prototype. The tasks of the planned staff position at this stage are mainly the preparation and coordination of the final specifications with manufacturers, this includes e.g. also definition of manufacturing masks. In addition, there is the coordination of the individual production steps. This particularly affects WP 3.1 and 3.4.

This will increase the costs of material and investments on the German side. For example, manufacturing masks can also be designed directly by the manufacturer, which significantly increases production costs. The same applies to the coordination of the individual production steps. Here, the manufacturers can be instructed to take over these coordination tasks within their area of responsibility, which however is reflected in increased material costs.

Therefore, we applied for a rededication of the German funding from personnel to material costs for the third project year with the Helmholtz association. This rededication was approved.

4) Financial Plan / Time Schedule

Can you comply with the financial plan and time schedule or do you see a need for adjustment?

Due to the failed recruitment of the two positions on this grant we were significantly underspending on personnel compared to the financial plan and have asked for the rededication of funds.

In addition, a large fraction on the anticipated material cost has been committed by ordering the requested materials and/or services, but not been spend, as two big contractors (IZM and RAL) have yet to invoice their work, this is especially true for work subcontracted to the Rutherford Appleton Labs in the UK, which are so far delayed by about 9 months in the hybridization of certain sensor parts intended for the final prototype in phase 3.

Furthermore, the ongoing Corona-Crisis caused the shutdown of virtually all major synchrotron facilities that could have supported this research. Those facilities that did not yet shutdown (namely Spring-8 in Japan) cannot be reached as international travel is suspended. Although once operations are resumed, researchers whose beam time was canceled will get priority access to the beamlines, instrumentation development is usually considered lower priority as it is rarely time critical.

Likewise, DESY is essentially shutdown and people are working from home. This delays the lab work necessary to assemble the final prototype.

Therefore, we see a very high risk that the project will not be completed on time. On the bright side, the budget will most likely support a cost neutral extension of the project, at least on the German side.

5) Publications of the Group

First results from Scanning Compton X-ray Microscopy at 60 keV, submitted to 15th

International Conference on X-ray Microscopy (XRM 2020), scheduled for July 19-24, 2020 in Taipei, Taiwan, but cancelled due to the Corona-Crisis.

6) External Funding

No additional external or third-party funding has been applied for.

7) Patent Applications
No. of pending/granted patents

No patents have been applied for.

8) Awards received by Group Members

None so far